

From: [Botts, Rene'](#)
To: ["Hess, Andrew"](#)
Subject: RE: 5987 OF, Spectrometer, Breach language clarification
Date: Tuesday, February 5, 2019 10:48:00 AM
Attachments: [image001.png](#)

Andrew,

The State of Nebraska is clarify that Bruker Nano Inc. is accepting the original terms of the Invitation to Bid 5987 OF, Section G. Breach.

I will include this email chain as a clarification to the original bid.

Thank you,

René A. Botts, C.L.S.Y.B.

Buyer III | Materiel Division, State Purchasing Bureau
1526 K Street, Suite 130 | Lincoln, NE 68508

Nebraska Department of Administrative Services

OFFICE 402-471-0971

FAX 402-471-2089

rene.botts@nebraska.gov

das.nebraska.gov | [Facebook](#) | [Twitter](#)

From: Hess, Andrew <Andrew.Hess@bruker.com>
Sent: Tuesday, February 5, 2019 10:22 AM
To: Botts, Rene' <rene.botts@nebraska.gov>
Subject: RE: 5987 OF, Spectrometer, Breach language

Hi Rene,

Thank you for running this by your Legal Counsel. We accept your rejection and withdraw our request to amend the terms stated in Section G; Paragraph #2.

We will accept the original terms of the contract in 5987 OF ITB Section G in its entirety and as original drafted. Please let me know if I need to update/amend the ITB document accordingly with my initials. Please note, this emails also serves as acceptance to Section G: Breach.

Regards,
Andrew

Andrew Hess
Sr. Sales Engineer- XRD/XRF

Bruker Nano Inc. Phone: +1 608-616-2842 Andrew.Hess@bruker.com
5465 E. Cheryl Parkway Phone: +1 800-234- www.Bruker.com
Madison, WI 53711 XRAY(9729)
United States

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From: Botts, Rene' <rene.botts@nebraska.gov>
Sent: Tuesday, February 5, 2019 8:43 AM
To: Hess, Andrew <Andrew.Hess@bruker.com>
Subject: FW: 5987 OF, Spectrometer, Breach language

Andrew,

Please see my Legal Counsel's response below.

Thank you,

René A. Botts, C.L.S.Y.B.

Buyer III | Materiel Division, State Purchasing Bureau
1526 K Street, Suite 130 | Lincoln, NE 68508

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From: Shotkoski, Dale <dale.shotkoski@nebraska.gov>

Sent: Tuesday, February 5, 2019 9:40 AM

To: Botts, Rene' <rene.botts@nebraska.gov>

Subject: RE: 5987 OF, Spectrometer, Breach language

Rene'

I am rejecting their language except possibly the last sentence if they wish to add that to the second paragraph that they took exception to. The standard language in the first paragraph already requires a written notice of default and a thirty calendar days or longer period to cure. The language they are requesting instead calls for "a reasonable period to be agreed between the Parties" which is not a defined period and could potentially create additional delays in getting the product needed. Once there is a breach situation it is often difficult to get an agreement on such time periods so this language is not acceptable.

The language they are proposing also puts a cap on the damages if the substitute product costs more than 25% and this is basically a limitation on liability that is not acceptable.

Again if they want to add their last proposed sentence that would be fine.

Dale M. Shotkoski

Assistant General Counsel | Legal & Compliance

Nebraska Department of Administrative Services

1526 K Street, Suite 140

Lincoln, NE 68508

Office 402-471-1638

dale.shotkoski@nebraska.gov

das.nebraska.gov | [Facebook](#) | [Twitter](#)

From: Botts, Rene' <rene.botts@nebraska.gov>

Sent: Tuesday, February 5, 2019 9:27 AM

To: Shotkoski, Dale <dale.shotkoski@nebraska.gov>

Subject: FW: 5987 OF, Spectrometer, Breach language

Dale,

Please see two attached documents. The first is the second paragraph of the Section G. Breach language the vendor would like us to consider. The second attachment is the entire bid the vendor submitted in response to our ITB 5987 OF.

Please let me know if you want me to make an appointment to meet with you.

Thank you,

René A. Botts, C.L.S.S.Y.B.

Buyer III | Materiel Division, State Purchasing Bureau

1526 K Street, Suite 130 | Lincoln, NE 68508

Nebraska Department of Administrative Services

OFFICE 402-471-0971

FAX 402-471-2089

rene.botts@nebraska.gov

das.nebraska.gov | [Facebook](#) | [Twitter](#)

From: Hess, Andrew <Andrew.Hess@bruker.com>
Sent: Tuesday, February 5, 2019 9:19 AM
To: Botts, Rene' <rene.botts@nebraska.gov>
Subject: RE: 5987 OF, Spectrometer, Breach language

Hi Rene,

Please review the attached proposed language from Bruker Nano for Section G in word doc format.

I would be happy to further discuss at your earliest convenience.

Regards,
Andrew

Andrew Hess
Sr. Sales Engineer- XRD/XRF

Bruker Nano Inc. Phone: +1 608-616-2842 Andrew.Hess@bruker.com
5465 E. Cheryl Parkway Phone: +1 800-234- www.Bruker.com
Madison, WI 53711 XRAY(9729)
United States

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From: Botts, Rene' <rene.botts@nebraska.gov>
Sent: Monday, February 4, 2019 11:17 AM
To: Hess, Andrew <Andrew.Hess@bruker.com>
Subject: 5987 OF, Spectrometer, Breach language

Andrew,

Can you send me the Paragraph Two language you would like the State of Nebraska to negotiate? Please do send it as a word document so we can use Track Changes on any language changes.

G. BREACH

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
		AH	Paragraph One and Three are accepted with no issue; Paragraph Two can not be accepted in its current iteration as it violates Bruker internal policy. We would request the option to craft mutually agreed upon alternative language.

Either Party may terminate the contract, in whole or in part, if the other Party breaches its duty to perform its obligations under the contract in a timely and proper manner. Termination requires written notice of default and a thirty (30) calendar day (or longer at the non-breaching Party's discretion considering the gravity and nature of the default) cure period. Said notice shall be delivered by Certified Mail, Return Receipt Requested, or in person with proof of delivery. Allowing time to cure a failure or breach of contract does not waive the right to immediately terminate the contract for the same or different contract breach which may occur at a different time.

In case of breach by the Contractor, the State may, without unreasonable delay, make a good faith effort to make a reasonable purchase or contract to purchased goods in substitution of those due from the contractor. The State may recover from the Contractor as damages the difference between the costs of covering the breach. Notwithstanding any clause to the contrary, the State may also recover the contract price together with any incidental or consequential damages defined in UCC Section 2-715, but less expenses saved in consequence of Contractor's breach.

The State's failure to make payment shall not be a breach, and the Contractor shall retain all available statutory remedies. (See Indemnity - Self-Insurance and Payment)

Thank you,

René A. Botts, C.L.S.S.Y.B.
Buyer III | Materiel Division, State Purchasing Bureau
1526 K Street, Suite 130 | Lincoln, NE 68508

Nebraska Department of Administrative Services

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State of Nebraska - INVITATION TO BID CONTRACT

Return to:
State Purchasing Bureau
1526 K Street, Suite 130
Lincoln, Nebraska 68508

Telephone: 402-471-6500
Fax: 402-471-2089

Date	12/11/18	Page	1 of 2
Solicitation Number	5987 OF		
Opening Date and Time	01/10/19	2:00 pm	
Buyer	RENE BOTTS (AS)		

DESTINATION OF GOODS

NDOT M&R
1400 NE HWY 2-TEST
PO BOX 94759
LINCOLN NE 68509-4759

Per Nebraska's Transparency in Government Procurement Act, DAS is required to collect statistical information regarding the number of contracts awarded to Nebraska contractors. This information is for statistical purposes only and will not be considered for contract award purposes.

NEBRASKA CONTRACTOR AFFIDAVIT: Bidder hereby attests that bidder is a Nebraska Contractor. "Nebraska Contractor" shall mean any bidder who has maintained a bona fide place of business and at least one employee within this state for at least the six (6) months immediately preceding the posting date of this ITB.

I hereby certify that I am a Resident disabled veteran or business located in a designated enterprise zone in accordance with Neb. Rev. Stat. §73-107 and wish to have preference, if applicable, considered in the award of this contract.

Contract to supply and deliver SEQUENTIAL XRF SPECTROMETER EQUIPMENT WITH EXTERNAL WATER RECIRCULATING SYSTEM to the State of Nebraska as per the attached specifications for a five (5) year period from date of award. The contract may be renewed for five (5) additional one (1) year periods when mutually agreeable to the vendor and the State of Nebraska.

(vc 12/10/18)

INVITATION

Line	Description	Quantity	Unit of Measure	Unit Price	Extended Price
1	SEQUENTIAL XRF SPECTROMETER EQUIPMENT WITH EXTERNAL WATER RECIRCULATING SYSTEM	1.0000	EA	<u>237,500.00</u>	<u>237,500.00</u>
2	TRADE IN VALUE FOR BRUKER S4 PIONEER AND EXTERNAL WATER CIRCULATING SYSTEM. DEDUCTION AMOUNT	1.0000	EA	<u>(50,000.00)</u>	<u>187,500.00</u>
3	ANNUAL FLAT RATE PREVENTATIVE MAINTENANCE PLAN	1.0000	EA	<u>22,600.00</u>	<u>210,100.00</u>

BIDDER MUST COMPLETE THE FOLLOWING

DISCOUNT PAYMENT TERMS: 0 % 0 DAYS

By signing this Invitation to Bid form, the bidder guarantees compliance with the provisions stated in this Invitation to Bid, agrees to the terms and conditions unless otherwise agreed to (see Section III) and certifies that bidder maintains a drug free work place environment. Vendor will furnish the items requested within 120 days after receipt of order. Failure to enter Delivery Date may cause quotation to be REJECTED.

Sign Here  (Authorized Signature MANDATORY - MUST BE SIGNED IN INK)

Enter Contact Information Below

VENDOR#

VENDOR:

Address:

Bruker Nano Inc.
5465 E CHERYL PARKWAY
MADISON, WI 53711
UNITED STATES

Contact

Telephone

Facsimile

Email

Andrew Hess

(608) 616-2842

(608) 276-3006

andrew.hess@bruker.com

State of Nebraska - INVITATION TO BID CONTRACT

Return to:
State Purchasing Bureau
1526 K Street, Suite 130
Lincoln, Nebraska 68508

Telephone: 402-471-6500
Fax: 402-471-2089

Date	12/11/18	Page	2 of 2
Solicitation Number	5987 OF		
Opening Date and Time	01/10/19	2:00 pm	
Buyer	RENE BOTTS (AS)		

DESTINATION OF GOODS

NDOT M&R
1400 NE HWY 2-TEST
PO BOX 94759
LINCOLN NE 68509-4759

INVITATION

Line	Description	Quantity	Unit of Measure	Unit Price	Extended Price
4	HOURLY RATE FOR SERVICE CALL REGULAR BUSINESS HOURS INCLUDE ALL EXPENSES (TRAVEL, MILEAGE, FOOD LODGING, PARKING, FUEL, LABOR, NEXT DAY SERVICE PARTS SHIPPING COSTS/DELIVERY FEES.)	50.0000	HR	<u>375.00</u>	<u>18,750.00</u>
5	HOURLY RATE FOR SERVICE CALL WEEKEND AND HOLIDAY HOURS INCLUDE ALL EXPENSES (TRAVEL, MILEAGE, FOOD LODGING, PARKING, FUEL, LABOR, NEXT DAY SERVICE PARTS SHIPPING COSTS/DELIVERY FEES.)	20.0000	HR	<u>750.00</u>	<u>15,000.00</u>
6	MISC NON CORE XRF EQUIPMENT PERCENT OF DISCOUNT OFF RETAIL PRICE LIST FOR PARTS, ACCESSORIES, WARRANTIES, SERVICE MAINTENANCE PLANS, SOFTWARE, HARDWARE, AND FIRMWARE (EXCLUDING CORE ITEMS)				<u>10</u> %
OPTIONAL ITEMS					
7	HOURLY RATE FOR REMOTE METHOD DEVELOPMENT THAT EXCEEDS THE NO CHARGE 40 HOURS ASSISTANCE	20.0000	HR	<u>0.00</u>	<u>0.00</u>
8	HOURLY RATE FOR ON-SITE METHOD DEVELOPMENT THAT EXCEEDS THE NO CHARGE 40 HOURS ASSISTANCE SHALL INCLUDE ALL EXPENSES (TRAVE, MILEAGE, FOOD, LODGING, PARKING, FUEL, LABOR) ASSOCIATED WITH THE METHOD DEVDPLOPMENT RATE.	20.0000	HR	<u>400.00</u>	<u>8,000.00</u>

INVITATION TO BID

Number 5987-OF

The State of Nebraska (State), Department of Administrative Services (DAS), Materiel Division, State Purchasing Bureau (SPB), is issuing this Invitation to Bid (ITB) for a commodity contract, ITB Number 5987 OF for the purpose of selecting a qualified Bidder to provide **Sequential XRF Spectrometer Equipment with External Water Recirculating System for Nebraska Department of Transportation (NDOT) Materials and Research Division**. Specifications can be found in **Section VI. Invitation to Bid Technical Specifications**. The resulting contract may not be an exclusive contract as the State reserves the right to contract for the same or similar goods from other sources now or in the future.

The term of the contract will be five (5) years commencing upon execution of the contracts by the State and the Bidder. The Contract includes the option to renew for five (5) additional one (1) year periods upon mutual agreement of the Parties. The State reserves the right to extend the period of this contract beyond the termination date when mutually agreeable to the Parties.

INFORMATION PERTINENT TO THIS INVITATION TO BID CAN BE FOUND ON THE INTERNET AT:

<http://das.nebraska.gov/materiel/purchasing.html>

IMPORTANT NOTICE: Pursuant to Neb. Rev. Stat. § 84-602.04, State contracts in effect as of January 1, 2014, and contracts entered into thereafter, must be posted to a public website. The resulting contract, the ITB, and the successful Bidder's bid or response will be posted to a public website managed by DAS, which can be found at:

<https://statecontracts.nebraska.gov/>

In addition and in furtherance of the State's public records statute (Neb. Rev. Stat. § 84-712 et seq.) all bids or responses received regarding this ITB will be posted to the SPB website.

These postings will include the entire bid or response. Bidders must request that proprietary information be excluded from the posting. The Bidder must identify the proprietary information, mark the proprietary information according to state law, and submit the proprietary information in a separate container or envelope marked conspicuously using an indelible method with the words "PROPRIETARY INFORMATION". The Bidder must submit a **detailed written document showing** that the release of the proprietary information would give a business advantage to named business competitor(s) and explain how the named business competitor(s) will gain an actual business advantage by disclosure of information. The mere assertion that information is proprietary or that a speculative business advantage might be gained is not sufficient. (See Attorney General Opinion No. 92068, April 27, 1992) **THE BIDDER MAY NOT ASSERT THAT THE ENTIRE BID OR RESPONSE IS PROPRIETARY. COST WILL NOT BE CONSIDERED PROPRIETARY AND IS A PUBLIC RECORD IN THE STATE OF NEBRASKA.** The State will then determine, in its discretion, if the interests served by nondisclosure outweighs any public purpose served by disclosure. (See Neb. Rev. Stat. § 84-712.05(3)) The Bidder will be notified of the agency's decision. Absent a State determination that information is proprietary, the State will consider all information a public record subject to release regardless of any assertion that the information is proprietary.

If the agency determines it is required to release proprietary information, the Bidder will be informed. It will be the Bidder's responsibility to defend the Bidder's asserted interest in non-disclosure.

To facilitate such public postings, with the exception of proprietary information, the State of Nebraska reserves a royalty-free, nonexclusive, and irrevocable right to copy, reproduce, publish, post to a website, or otherwise use any contract, bid, or response to this ITB for any purpose, and to authorize others to use the documents. Any individual or entity awarded a contract, or who submits a bid or response to this ITB, specifically waives any copyright or other protection the contract, bid, or response to the ITB may have; and, acknowledges that they have the ability and authority to enter into such waiver. This reservation and waiver is a prerequisite for submitting a bid or response to this ITB, and award of a contract. Failure to agree to the reservation and waiver will result in the bid or response to the ITB being found non-responsive and rejected.

Any entity awarded a contract or submitting a bid or response to the ITB agrees not to sue, file a claim, or make a demand of any kind, and will indemnify and hold harmless the State and its employees, volunteers, agents, and its elected and appointed officials from and against any and all claims, liens, demands, damages, liability, actions, causes of action, losses, judgments, costs, and expenses of every nature, including investigation costs and expenses, settlement costs, and attorney fees and expenses, sustained or asserted against the State, arising out of, resulting from, or attributable to the posting of the contract or the bids and responses to the ITB, awards, and other documents.

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GLOSSARY OF TERMS

AASHTO: American Association of State Highway and Transportation Officials.

Acceptance Test Procedure: Benchmarks and other performance criteria, developed by the State or other sources of testing standards, for measuring the effectiveness of products or goods and the means used for testing such performance.

Addendum: Something to be added or deleted to an existing document; a supplement.

After Receipt of Order (ARO): After Receipt of Order

Agency: Any state agency, board, or commission other than the University of Nebraska, the Nebraska State colleges, the courts, the Legislature, or any other office or agency established by the Constitution of Nebraska.

Agent/Representative: A person authorized to act on behalf of another.

Amend: To alter or change by adding, subtracting, or substituting.

Amendment: A written correction or alteration to a document.

Appropriation: Legislative authorization to expend public funds for a specific purpose. Money set apart for a specific use.

ASTM: American Society for Testing and Materials

Award: All purchases, leases, or contracts which are based on competitive bids will be awarded according to the provisions in the ITB. The State reserves the right to reject any or all bids, wholly or in part, or to award to multiple Bidders in whole or in part. The State reserves the right to waive any deviations or errors that are not material, do not invalidate the legitimacy of the bid, and do not improve the Bidder's competitive position. All awards will be made in a manner deemed in the best interest of the State.

Best and Final Offer (BAFO): In a competitive bid, the final offer submitted which contains the bidder's (vendor's) most favorable terms for price.

Bid/Proposal: The offer submitted by a vendor in a response to written solicitation.

Bid Bond: An insurance agreement, accompanied by a monetary commitment, by which a third party (the surety) accepts liability and guarantees that the vendor will not withdraw the bid.

Bidder: A vendor who submits an offer bid in response to a written solicitation.

Business: Any corporation, partnership, individual, sole proprietorship, joint-stock company, joint venture, or any other private legal entity.

Business Day: Any weekday, except State-recognized holidays.

Calendar Day: Every day shown on the calendar including Saturdays, Sundays, and State/Federal holidays.

Cancellation: To call off or revoke a purchase order without expectation of conducting or performing it at a later time.

Central Processing Unit (CPU): Any computer or computer system that is used by the State to store, process, or retrieve data or perform other functions using Operating Systems and applications software.

Change Order: Document that provides amendments to an executed purchase order.

Collusion: An agreement or cooperation between two or more persons or entities to accomplish a fraudulent, deceitful, or unlawful purpose.

Commodities: Any equipment, material, supply or goods; anything movable or tangible that is provided or sold.

Commodities Description: Detailed descriptions of the items to be purchased; may include information necessary to obtain the desired quality, type, color, size, shape, or special characteristics necessary to perform the work intended to produce the desired results.

Competition: The effort or action of two or more commercial interests to obtain the same business from third parties.

Confidential Information: Unless otherwise defined below, "Confidential Information" shall also mean proprietary trade secrets, academic and scientific research work which is in progress and unpublished, and other information which if released would give advantage to business competitors and serve no public purpose (see Neb. Rev. Stat. §84-712.05(3)). In accordance with Nebraska

Attorney General Opinions 92068 and 97033, proof that information is proprietary requires identification of specific, named competitor(s) who would be advantaged by release of the information and the specific advantage the competitor(s) would receive.

Contract: An agreement between two or more parties creating obligations that are enforceable or otherwise recognizable at law; the writing that sets forth such an agreement.

Contract Administration: The management of the contract which includes and is not limited to contract signing, contract amendments and any necessary legal actions.

Contract Management: The management of day to day activities at the agency which includes and is not limited to ensuring deliverables are received, specifications are met, handling meetings and making payments to the Contractor.

Contract Period: The duration of the contract.

Contractor: Any individual or entity having a contract or awarded purchase order to furnish commodities or goods.

Cooperative Purchasing: The combining of requirements of two or more political entities to obtain advantages of volume purchases, reduction in administrative expenses or other public benefits.

Copyright: A property right in an original work of authorship fixed in any tangible medium of expression, giving the holder the exclusive right to reproduce, adapt and distribute the work.

Core List: Identifies the most commonly purchased items from contractor.

Critical Program Error: Any Program Error, whether or not known to the State, which prohibits or significantly impairs use of the Licensed Software as set forth in the documentation and intended in the contract.

Customer Service: The process of ensuring customer satisfaction by providing assistance and advice on those products or goods provided by a Contractor.

Default: The omission or failure to perform a contractual duty.

Deviation: Any proposed change(s) or alteration(s) to either the terms and conditions or deliverables within the scope of the written solicitation or contract.

Evaluation: The process of examining an offer after opening to determine the vendor's responsibility, responsiveness to requirements, and to ascertain other characteristics of the offer that relate to determination of the successful award.

Evaluation Committee: Committee(s) appointed by the requesting agency that advises and assists the procuring office in the evaluation of bids/s (offers made in response to written solicitations).

Extension: Continuance of a contract for a specified duration upon the agreement of the parties beyond the original Contract Period. Not to be confused with "Renewal Period".

Free on Board (F.O.B.) Destination: The delivery charges are included in the quoted price and prepaid by the vendor. Vendor is responsible for all claims associated with damages during delivery of product.

Free on Board (F.O.B.) Point of Origin: The delivery charges are not included in the quoted price and are the responsibility of the agency. Agency is responsible for all claims associated with damages during delivery of product.

Foreign Corporation: A foreign corporation that was organized and chartered under the laws of another state, government, or country.

Installation Date: The date when the procedures described in "Installation by Contractor", and "Installation by State", as found in the ITB, ITB (written solicitation) or contract are completed.

Invalid Bid: i.e., a fax or email response for a term contract.

Invitation to Bid (ITB): A written solicitation utilized for obtaining competitive offers.

Late Bid: An offer received after the Opening Date and Time.

Licensed Software Documentation: The user manuals and any other materials in any form or medium customarily provided by the Contractor to the users of the Licensed Software which will provide the State with sufficient information to operate, diagnose, and maintain the Licensed Software properly, safely, and efficiently.

Mandatory/Must: Required, compulsory, or obligatory.

May: Discretionary, permitted; used to express possibility.

Module (see System): A collection of routines and data structures that perform a specific function of software.

Must: See Shall/Will/Must.

NA: Not Applicable.

National Institute for Governmental Purchasing (NIGP): National Institute of Governmental Purchasing – Source used for assignment of universal commodity codes to goods and goods.

NDOT: Nebraska Department of Transportation.

Non-Core List: Identifies additional items available from contractor not listed as part of the Core-List.

Open Market Purchase: Authorization may be given to an agency to purchase items above direct purchase authority due to the unique nature, price, quantity, location of the using agency, or time limitations by the AS Materiel Division, State Purchasing Bureau.

Opening Date and Time: Specified date and time for the public opening of received, labeled, and sealed formal bids.

Operating System: The control program in a computer that provides the interface to the computer hardware and peripheral devices, and the usage and allocation of memory resources, processor resources, input/output resources, and security resources.

Outsourcing: The contracting out of a business process which an organization may have previously performed internally or has a new need for, to an independent organization from which the process is purchased back.

Payroll & Financial Center (PFC): Electronic procurement system of record.

Performance Bond: An insurance agreement, accompanied by a monetary commitment, by which a third party (the surety) accepts liability and guarantees that the Contractor fulfills any and all obligations under the contract.

Platform: A specific hardware and Operating System combination that is different from other hardware and Operating System combinations to the extent that a different version of the Licensed Software product is required to execute properly in the environment established by such hardware and Operating System combination.

Point of Contact (POC): The person designated to receive communications and to communicate

Pre-Bid/Pre-Proposal Conference: A meeting scheduled for the purpose of clarifying a written solicitation and related expectations.

Product: Something that is distributed commercially for use or consumption and that is usually (1) tangible personal property, (2) the result of fabrication or processing, and (3) an item that has passed through a chain of commercial distribution before ultimate use or consumption.

Program Error: Code in Licensed Software which produces unintended results or actions, or which produces results or actions other than those described in the specifications. A program error includes, without limitation, any Critical Program Error.

Program Set: The group of programs and products, including the Licensed Software specified in the ITB, plus any additional programs and products licensed by the State under the contract for use by the State.

Project: The total scheme, program, or method worked out for the accomplishment of an objective, including all documentation, commodities, and goods to be provided under the contract.

Proposal: See Bid.

Proprietary Information: Proprietary information is defined as trade secrets, academic and scientific research work which is in progress and unpublished, and other information which if released would give advantage to business competitors and service no public purpose (see Neb. Rev. Stat. § 84-712.05(3)). In accordance with Attorney General Opinions 92068 and 97033, proof that information is proprietary requires identification of specific named competitor(s) advantaged by release of the information and the demonstrated advantage the named competitor(s) would gain by the release of information.

Protest/Grievance: A complaint about a governmental action or decision related to an ITB or resultant contract, brought by a vendor who has timely submitted a bid response in connection with the award in question, to AS Materiel Division or another designated agency with the intention of achieving a remedial result.

Public Bid Opening: The process of opening correctly submitted offers at the time and place specified in the written solicitation and in the presence of anyone who wished to attend.

Recommended Hardware Configuration: The data processing hardware (including all terminals, auxiliary storage, communication, and other peripheral devices) to the extent utilized by the State as recommended by the Contractor.

Release Date: The date of public release of the written solicitation to seek offers

Renewal Period: Optional contract periods subsequent to the original Contract Period for a specified duration with previously agreed to terms and conditions. Not to be confused with Extension.

Request for Information (RFI): A general invitation to vendors requesting information for a potential future solicitation. The RFI is typically used as a research and information gathering tool for preparation of a solicitation.

Responsible Bidder: A Bidder who has the capability in all respects to perform fully and lawfully all requirements with integrity and reliability to assure good faith performance.

Responsive Bidder: A Bidder who has submitted a bid which conforms to all requirements of the solicitation document.

Shall/Will/Must: An order/command; mandatory.

Should: Expected; suggested, but not necessarily mandatory.

Software License: Legal instrument with or without printed material that governs the use or redistribution of licensed software.

Sole Source – Commodity: When an item is available from only one source due to the unique nature of the requirement, its supplier, or market conditions.

Sole Source – Service: A service of such a unique nature that the vendor selected is clearly and justifiably the only practical source to provide the service. Determination that the vendor selected is justifiably the sole source is based on either the uniqueness of the service or sole availability at the location required.

Specifications: The detailed statement, especially of the measurements, quality, materials, and functional characteristics, or other items to be provided under a contract.

Statutory: These clauses are controlled by state law and are not subject to negotiation.

Subcontractor: Individual or entity with whom the contractor enters a contract to perform a portion of the work awarded to the contractor.

System (see Module): Any collection or aggregation of two (2) or more Modules that is designed to function, or is represented by the Contractor as functioning or being capable of functioning, as an entity.

TBA: To Be Announced

Termination: Occurs when the contract expires or either party, pursuant to a power created by agreement or law puts an end to the contract prior to the stated expiration date. All obligations which are still executory on both sides are discharged but any right based on prior breach or performance survives.

Third-Party: Any person or entity, including but not limited to fiduciaries, shareholders, owners, officers, managers, employees, legally disinterested persons, and sub-contractors or agents, and their employees. It shall not include any entity or person who is an interested Party to the contract or agreement.

Trade Secret: Information, including, but not limited to, a drawing, formula, pattern, compilation, program, device, method, technique, code, or process that (a) derives independent economic value, actual or potential, from not being known to, and not being ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use; and (b) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy (see Neb. Rev. Stat. §87-502(4)).

Trademark: A word, phrase, logo, or other graphic symbol used by a manufacturer or vendor to distinguish its product from those of others, registered with the U.S. Patent and Trademark Office.

Upgrade: Any change that improves or alters the basic function of a product of service.

Vendor: An individual or entity lawfully conducting business in the State, or licensed to do so, who seeks to provide goods or goods under the terms of a written solicitation.

Vendor Performance Report: A report issued to the Contractor by SPB when products or goods delivered or performed fail to meet the terms of the purchase order, contract, and/or specifications, as reported to SPB by the agency. The SPB shall contact the Contractor regarding any such report. The vendor performance report will become a part of the permanent record for the Contractor. The State may require vendor to cure. Two such reports may be cause for immediate termination.

Will: See Shall/Will/Must.

Work Day: See Business Day.

I. PROCUREMENT PROCEDURE

A. GENERAL INFORMATION

The ITB is designed to solicit bids from qualified Bidders who will be responsible for providing **Sequential XRF Spectrometer Equipment with External Water Recirculating System for Nebraska Department of Transportation (NDOT) Materials and Research Division** at a competitive and reasonable cost. A detailed description can be found in Section VI. – Invitation to Bid Technical Specifications.

Bids shall conform to all instructions, conditions, and requirements included in the ITB. Prospective Bidders are expected to carefully examine all documents, schedules, and requirements in this ITB, and respond to each requirement in the format prescribed. Bids may be found non-responsive if they do not conform to the ITB.

B. PROCURING OFFICE AND COMMUNICATION WITH STATE STAFF AND EVALUATORS

Procurement responsibilities related to this ITB reside with the SPB. The point of contact (POC) for the procurement is as follows:

Name: René A. Botts
 Agency: State Purchasing Bureau
 Address: 1526 K Street, Suite 130
 Lincoln, NE 68508
 Telephone: 402-471-6500
 E-Mail: as.materielpurchasing@nebraska.gov

C. COMMUNICATION WITH STATE STAFF

From the date the ITB is issued until the Intent to Award is issued communication from the Bidder is limited to communication with the State Purchasing Bureau (SPB). Only SPB is empowered to make binding statements regarding this ITB. SPB will issue any clarifications or opinions regarding this ITB in writing. Only SPB can modify the ITB, answer questions, render opinions, and only the SPB can award a contract. Bidders shall not have any communication with, or attempt to communicate or influence any evaluator involved in this ITB. After the intent to award is issued the Bidder may communicate with individuals the State has designated as responsible for negotiating the contract on behalf of the State.

The following exceptions to these restrictions are permitted:

1. Contact made pursuant to pre-existing contracts or obligations;
2. Contact required by the schedule of events or an event scheduled later by the SPB; and
3. Contact required for negotiation and execution of the final contract.

Violation of these conditions may be cause to reject a Bidder's bid and/or withdraw an Intent to Award, or terminate a contract if the State determines there has been a violation of these procurement procedures.

D. SCHEDULE OF EVENTS

The State expects to adhere to the procurement schedule shown below, but all dates are approximate and subject to change.

ACTIVITY		DATE/TIME
1.	Release ITB	December 11, 2018
2.	Last day to submit written questions	December 19, 2018
3.	State responds to written questions through ITB "Addendum" and/or "Amendment" to be posted to the Internet at: http://das.nebraska.gov/materiel/purchasing.html	December 21, 2018
4.	Bid opening Location: State Purchasing Bureau 1526 K Street, Suite 130 Lincoln, NE 68508	January 10, 2019 2:00 PM Central Time
5.	Review for conformance of mandatory requirements	TBA
6.	Evaluation period	TBA
7.	Post "Letter of Intent to Award" to Internet at: http://das.nebraska.gov/materiel/purchasing.html	TBA

ACTIVITY		DATE/TIME
8.	Contract finalization period	TBA
9.	Contract award	TBA
10.	Contractor start date	TBA

E. WRITTEN QUESTIONS AND ANSWERS

Questions regarding the meaning or interpretation of any ITB provision must be submitted in writing to the SPB and clearly marked "ITB Number 5987 OF; **XRF Spectrometer Equipment with External Water Recirculating System for Nebraska Department of Transportation (NDOT) Materials and Research Division** Questions". SPB is not obligated to respond to questions that are received late per the Schedule of Events.

Bidders should present, as questions, any assumptions upon which the Bidder's bid is or might be developed. Bids will be evaluated without consideration of any known or unknown assumptions of a Bidder. The contract will not incorporate any known or unknown assumptions of a Bidder.

It is preferred that questions be sent via e-mail to as.materielpurchasing@nebraska.gov, but may be delivered by hand or by U.S. Mail. It is recommended that Bidders submit questions using the following format.

ITB Section Reference	ITB Page Number	Question

Written answers will be posted at <http://das.nebraska.gov/materiel/purchasing.html> per the Schedule of Events.

F. RECYCLING (§ 81-15,159(d)(2))

Preference will be given to items which are manufactured or produced from recycled material or which can be readily reused or recycled after their normal use. Preference will also be given to purchases of corn-based biodegradable plastics and road deicers if available and suitable. No preference shall be given if such preference would result in the purchase of products, materials, or supplies that are of inadequate quality or of substantially higher cost.

G. SECRETARY OF STATE/TAX COMMISSIONER REGISTRATION REQUIREMENTS (Statutory)

All Bidders must be authorized to transact business in the State and comply with all Nebraska Secretary of State Registration requirements. The Bidder who is the recipient of an Intent to Award will be required to certify that it has complied and produce a true and correct copy of its current (within ninety (90) calendar days of the intent to award) Certificate or Letter of Good Standing, or in the case of a sole proprietorship, provide written documentation of sole proprietorship and the United States Citizenship Attestation Form, available on the DAS website at <http://das.nebraska.gov/materiel/purchasing.html>. This must be accomplished prior to execution of the contract.

H. ETHICS IN PUBLIC CONTRACTING

The State reserves the right to reject bids, withdraw an intent to award or award, or terminate a contract if a Bidder commits or has committed ethical violations, which include, but are not limited to:

1. Offering or giving, directly or indirectly, a bribe, fee, commission, compensation, gift, gratuity, or anything of value to any person or entity in an attempt to influence the bidding process;
2. Utilize the services of lobbyists, attorneys, political activists, or consultants to influence or subvert the bidding process;
3. Being considered for, presently being, or becoming debarred, suspended, ineligible, or excluded from contracting with any state or federal entity;
4. Submitting a bid on behalf of another party or entity;
5. Collude with any person or entity to influence the bidding process, submit sham bids, preclude bidding, fix pricing or costs, create an unfair advantage, subvert the bid, or prejudice the State,

The Bidder shall include this clause in any subcontract entered into for the exclusive purpose of performing this contract.

Bidder shall have an affirmative duty to report any violations of this clause by the Bidder throughout the bidding process, and throughout the term of this contract for the successful Bidder and their subcontractors.

I. SPECIFICATIONS

Any manufacturer's names, trade names, brand names, information and/or catalog numbers listed in a specification are for reference and not intended to limit competition, but will be used as the standard by which equivalent material offered will be judged. The Materiel Administrator will be the sole judge of equivalency. The Bidder may offer any brands which meets or exceeds the specification. When a specific product is required, the ITB will so state. Any item bid is to be the latest current model under standard production at the time of order. No used or refurbished equipment will be accepted, unless otherwise stated.

J. SAMPLES

When requested, samples shall be furnished at the Bidder's expense prior to the opening of the bid, unless otherwise specified. Each sample must be labeled clearly and identify the Bidder's name, the ITB number and the item number. Samples submitted must be representative of the commodities or equipment which would be delivered if awarded the bid. The State reserves the right to request samples even though this may not have been set forth in the ITB. Samples not destroyed in testing will be returned at Bidder's expense, if requested, or will be donated to a public institution.

K. BID PREPARATION COSTS

The State shall not incur any liability for any costs incurred by Bidders in replying to this ITB, including any activity related to bidding on this ITB.

L. DISCOUNTS

Prices quoted shall be inclusive of ALL trade discounts. Cash discount terms of less than thirty (30) days will not be considered as part of the bid. Cash discount periods will be computed from the date of receipt of a properly executed claim voucher or the date of completion of delivery of all items in a satisfactory condition, whichever is later.

M. PRICES

All prices, costs, and terms and conditions outlined in the bid shall remain fixed and valid commencing on the opening date of the bid until award of the contract or the ITB is cancelled. Prices quoted on the ITB form or Cost Sheet shall remain fixed for one (1) year of the contract period. Any request for a price increase subsequent to the one (1) year must be submitted in writing to the SPB for approval, and be accompanied by documentation justifying the price increase. These documents include, but are not limited to: 1) invoices for physical components of contracted item(s) Further documentation may be required by the State to justify the increase. The State reserves the right to deny any requested price increase. No price increases are to be billed to any State Agencies prior to written amendment of the contract by the parties.

The State reserves the right to deny any requested price increase. No price increases are to be billed to any State Agencies prior to written amendment of the contract by the parties.

N. DEVIATIONS FROM THE INVITATION TO BID

The requirements contained in the ITB (Sections II. through VI.) become a part of the terms and conditions of the contract resulting from this ITB. Any deviations from the ITB in Section II. through VI. must be clearly defined by the Bidder in its bid and, if accepted by the State, will become part of the contract. Any specifically defined deviations must not be in conflict with the basic nature of the ITB, mandatory requirements, or applicable state or federal laws or statutes. "Deviation", for the purposes of this ITB, means any proposed changes or alterations to either the contractual language or deliverables within the scope of this ITB. The State discourages deviations and reserves the right to reject proposed deviations.

O. ALTERNATE/EQUIVALENT BIDS

Bidder may offer bids which are at variance from the express specifications of the ITB. The State reserves the right to consider and accept such bids if, in the judgment of the Materiel Administrator, the bid will result in goods and/or services equivalent to or better than those which would be supplied in the original bid specifications. Bidders must indicate on the ITB the manufacturer's name, number and shall submit with their bid, sketches, descriptive literature and/or complete specifications. Reference to literature submitted with a previous bid will not satisfy this provision. Bids which do not comply with these requirements are subject to rejection. In the absence of any stated deviation or exception, the bid will be accepted as in strict compliance with all terms, conditions and specification, and the Bidder shall be held liable therefore.

P. LUMP SUM OR 'ALL OR NONE' BIDS

The State reserves the right to purchase item-by-item, by groups or as a total when the State may benefit by so doing. Bidders may submit a bid on an "all or none" or "lump sum" basis, but should also submit a bid on an item-by-item basis. The term "all or none" means a conditional bid which requires the purchase of all items on which bids are offered and Bidder declines to accept award on individual items; a "lump sum" bid is one in which the Bidder offers a lower price than the sum of the individual bids if all items are purchased, but agrees to deliver individual items at the prices quoted.

Q. BID REQUIREMENTS

The bids will first be examined to determine if all requirements listed below have been addressed and whether further evaluation is warranted. Bids not meeting the requirements may be rejected as non-responsive. The requirements are:

1. Original Commodity ITB form signed using an indelible method (electronic signatures are not acceptable);
2. Clarity and responsiveness of the bid;
3. Completed Sections II. through VI. ;
4. Completed ITB Form or State's Bid Sheet.

R. FAILURE TO COMPLY WITH INVITATION TO BID

Violation of the terms and conditions contained in this ITB or any resultant contract, at any time before or after the award, shall be grounds for action by the State which may include, but is not limited to, the following:

1. Rejection of a Bidder's bid;
2. Withdrawal of the Intent to Award;
3. Withdrawal of the Award;
4. Termination of the resulting contract;
5. Legal action; or,
6. Suspension of the Bidder from further bidding with the State for the period of time relative to the seriousness of the violation, such period to be within the sole discretion of the State.

S. SUBMISSION OF BIDS

*******ALL BIDS MUST BE SUBMITTED IN A SEALED ENVELOPE OR CONTAINER!*******

Only one (1) original bid shall be submitted. Each bid should be in a separate envelope or container. Bid responses should include the completed Form A, "Bidder Contact Sheet". Bids must reference the ITB number and be sent to the specified address. Please note that the address label should appear as specified below, on the face of each container or Bidder's bid response packet. The ITB number must be included in all correspondence.

Name: René A. Botts
Agency: State Purchasing Bureau
Address: 1526 K Street, Suite 130
Lincoln, NE 68508
Telephone: 402-471-6500

E-Mail: as.materielpurchasing@nebraska.gov

If a recipient phone number is required for delivery purposes, 402-471-6500 should be used.

Emphasis should be concentrated on conformance to the ITB instructions, responsiveness to requirements, completeness, and clarity of content. If the Bidder's bid is presented in such a fashion that makes evaluation difficult or overly time consuming the State reserves the right to reject the bid as non-conforming.

Sealed bids must be received in the State Purchasing Bureau by the date and time of the bid opening per the Schedule of Events. No late bids will be accepted.

It is the responsibility of the bidder to check the website for all information relevant to this solicitation to include addenda and/or amendments issued prior to the opening date. Website address is as follows:
<http://das.nebraska.gov/materiel/purchasing.html>

By signing the "ITB" form, the Bidder guarantees compliance with the provisions stated in this ITB.

T. EMAIL SUBMISSIONS

The SPB will not accept bids by email except for one-time purchases under \$50,000.00. .

U. BID CORRECTIONS

A bidder may correct a mistake in a bid prior to the time of opening by giving written notice to the State of intent to withdraw the bid for modification or to withdraw the bid completely. Changes in a bid after opening are acceptable only if the change is made to correct a minor error that does not affect price, quantity, quality, delivery, or contractual conditions. In case of a mathematical error in extension of price, unit price shall govern.

V. LATE BIDS

Bids received after the time and date of the bid opening will be considered late bids. Late bids will be returned unopened, if requested by the Bidder and at Bidder's expense. The State is not responsible for bids that are late or lost regardless of cause or fault.

W. BID OPENING

Anyone may attend the opening. It is considered a public opening. The Buyer will read the names of the respondents. Depending upon the complexity of the bid, the buyer may read the bids aloud or allow bids be available for viewing by the public during the bid opening. Once the bid opening has concluded, the bids will not be available for viewing until the Intent to Award has been posted. An initial bid tabulation will be posted to the website as soon as feasible. Information identified as proprietary by the submitting vendor, in accordance with the RFP/ITB and state statute, will not be posted. If the state determines submitted information should not be withheld, in accordance with the [Public Records Act](#), or if ordered to release any withheld information, said information may then be released. The submitting bidder will be notified of the release and it shall be the obligation of the submitting bidder to take further action, if it believes the information should not be released.

X. BID TABULATIONS

Bid tabulations are available on the website at: <http://www.das.state.ne.us/materiel/purchasing/bidtabs.htm>.

Y. BEST AND FINAL OFFER

The State reserves the right to request Best and Final Offers. However, a Bidder should provide its best offer in its original bid. Bidders should not expect that the State will request a best and final offer.

Z. REFERENCE AND CREDIT CHECKS

The State reserves the right to conduct and consider reference and credit checks. Reference or credit checks may be grounds to reject a bid, or withdraw an intent to award or award of a contract. The State reserves the right to use third parties to conduct reference and credit checks.

AA. REJECTION OF BIDS

The State reserves the right to reject any or all bids, wholly or in part, in the best interest of the State.

BB. RESIDENT BIDDER

Pursuant to Neb. Rev. Stat. §§ 73-101.01 through 73-101.02, a Resident Bidder shall be allowed a preference against a Non-resident Bidder from a state which gives or requires a preference to Bidders from that state. The preference shall be equal to the preference given or required by the state of the Nonresident Bidders. Where the lowest responsible bid from a resident Bidder is equal in all respects to one from a nonresident Bidder from a state which has no preference law, the resident Bidder shall be awarded the contract. The provision of this preference shall not apply to any contract for any project upon which federal funds would be withheld because of the provisions of this preference.

CC. AWARD

All purchases, leases, or contracts which are based on competitive bids will be awarded according to the provisions in the ITB. The State reserves the right to reject any or all bids, in whole or in part, or to award to multiple Bidders in whole or in part, and at its discretion, may withdraw or amend the ITB at any time. The State reserves the right to waive any deviations or errors that are not material, do not invalidate the legitimacy of the bid, and do not improve the Bidder's competitive position. All awards will be made in a manner deemed in the best interest of the State. The ITB does not commit the State to award a contract. If, in the opinion of the State, revisions or amendments will require substantive changes in bids, the bid opening date may be extended.

By submitting a bid in response to this ITB, the Bidder grants to the State the right to contact or arrange a visit in person with any or all of the Bidder's clients.

Once the Intent to Award decision has been made, an Intent to Award will be posted to the Internet at:

<http://das.nebraska.gov/materiel/purchasing.html>

The protest procedure is available on the Internet at:

[http://das.nebraska.gov/materiel/purchase_bureau/docs/vendors/protest/ProtestGrievanceProcedureForVendors%20\(2\).pdf](http://das.nebraska.gov/materiel/purchase_bureau/docs/vendors/protest/ProtestGrievanceProcedureForVendors%20(2).pdf)

Any protests must be filed by a vendor within ten (10) business days after the Intent to Award is posted to the Internet.

The State reserves the right to award contracts in a manner, and utilizing methods, selected in the State's best interest and discretion. The State may waive informalities or irregularities in bids if the waiver is in the best interest of the

State and such waiver does not prejudice other Bidders in the State's discretion. After evaluation of the bids, the State may take, in the State's discretion, one or more of the following actions:

- Accept or reject a portion of or all of a bid;
- Accept or reject all bids;
- Withdraw the ITB;
- Elect to rebid the ITB;
- Award single lines or multiple lines to one or more Bidders; or,
- Award one or more complete contracts.

The State reserves the right to make awards that are in the best interest of the State. The State may consider, but is not limited to, one (1) or more of the following award criteria:

- Price;
- Location;
- Quality;
- Delivery time; and,
- State contract management requirements and/or costs.

II. TERMS AND CONDITIONS

Bidders should complete Section II. through VI. as part of their bid. Bidder is expected to read the Terms and Conditions and must initial either accept, reject, or reject and provide alternative language for each clause. The Bidder should also provide an explanation of why the Bidder rejected the clause or rejected the clause and provided alternate language using 'Track Changes'. Upon request an electronic copy of the bid with 'Track Changes' must be submitted in an editable Word format. By signing the ITB Bidder is agreeing to be legally bound by all the accepted terms and conditions, and any proposed alternative terms and conditions submitted with the bid. The State reserves the right to negotiate rejected or proposed alternative language. If the State and Bidder fail to agree on the final Terms and Conditions, the State reserves the right to reject the bid. The State is soliciting bids in response to the ITB. The State reserves the right to reject bids that attempt to substitute the Bidder's commercial contracts and/or documents for this ITB.

The Bidder should submit with their bid any license, user agreement, service level agreement, or similar documents that the Bidder wants incorporated in the Contract. Upon notice of Intent to Award, the Bidder must submit a copy of these documents in an editable Word format. The State will not consider incorporation of any document not submitted with the Bidder's bid. These documents shall be subject to negotiation and will be incorporated as addendums if agreed to by the Parties.

If a conflict or ambiguity arises after the addendums have been negotiated and agreed to, the addendums shall be interpreted as follows:

1. If only one (1) Party's document has a particular clause then that clause shall control;
2. If both Party's documents have a similar clause, but the clauses do not conflict, the clauses shall be read together;
3. If both Party's documents have a similar clause, but the clauses conflict, the State's clause shall control.

A. GENERAL

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The contract resulting from this ITB shall incorporate the following documents:

1. Invitation to Bid and Addenda;
2. Amendments to the ITB;
3. Questions and Answers;
4. Contractor's bid (ITB);
5. Award;
6. The executed Contract and any Addenda; and,
7. Amendments to the Contract

These documents constitute the entirety of the contract.

Unless otherwise specifically stated in a future contract amendment, in case of any conflict between the incorporated documents, the documents shall govern in the following order of preference with number one (1) receiving preference over all other documents and with each lower numbered document having preference over any higher numbered document: 1) Amendment to the executed Contract with the most recent dated amendment having the highest priority, 2) executed Contract and any attached Addenda, 3) Amendments to ITB and any Questions and Answers, 4) the original ITB document and any Addenda, and 5) the Contractor's submitted Bid.

Any ambiguity or conflict in the contract discovered after its execution, not otherwise addressed herein, shall be resolved in accordance with the rules of contract interpretation as established in the State.

B. NOTIFICATION

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

C. NOTICE (POC)

The State reserves the right to appoint a Buyer's Representative to manage [or assist the Buyer in managing] the contract on behalf of the State. The Buyer's Representative will be appointed in writing, and the appointment document will specify the extent of the Buyer's Representative authority and responsibilities. If a Buyer's Representative is appointed, the Contractor will be provided a copy of the appointment document, and is expected to cooperate accordingly with the Buyer's Representative. The Buyer's Representative has no authority to bind the State to a contract, amendment, addendum, or other change or addition to the contract.

D. GOVERNING LAW

Notwithstanding any other provision of this contract, or any amendment or addendum(s) entered into contemporaneously or at a later time, the parties understand and agree that, (1) the State of Nebraska is a sovereign state and its authority to contract is therefore subject to limitation by the State's Constitution, statutes, common law, and regulation; (2) this contract will be interpreted and enforced under the laws of the State of Nebraska; (3) any action to enforce the provisions of this agreement must be brought in the State of Nebraska per state law; (4) the person signing this contract on behalf of the State of Nebraska does not have the authority to waive the State's sovereign immunity, statutes, common law, or regulations; (5) the indemnity, limitation of liability, remedy, and other similar provisions of the final contract, if any, are entered into subject to the State's Constitution, statutes, common law, regulations, and sovereign immunity; and, (6) all terms and conditions of the final contract, including but not limited to the clauses concerning third-party use, licenses, warranties, limitations of liability, governing law and venue, usage verification, indemnity, liability, remedy or other similar provisions of the final contract are entered into specifically subject to the State's Constitution, statutes, common law, regulations, and sovereign immunity.

The Parties must comply with all applicable local, state and federal laws, ordinances, rules, orders, and regulations.

E. BEGINNING OF WORK

The Contractor shall not commence any billable work until a valid contract has been fully executed by the State and the successful Contractor. The Contractor will be notified in writing when work may begin.

F. CHANGE ORDERS OR SUBSTITUTIONS

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

The State and the Contractor, upon the written agreement, may make changes to the contract within the general scope of the ITB. Changes may involve specifications, the quantity of work, or such other items as the State may find necessary or desirable. Corrections of any deliverable, service, or work required pursuant to the contract shall not be deemed a change. The Contractor may not claim forfeiture of the contract by reasons of such changes.

The State or Contractor may prepare a written description of the work required due to the change and the Contractor shall prepare an itemized cost sheet for the change. Changes in work and the amount of compensation to be paid to the Contractor shall be determined in accordance with applicable unit prices if any, a pro-rated value, or through negotiations. The State shall not incur a price increase for changes that should have been included in the Contractor's bid, were foreseeable, or result from difficulties with or failure of the Contractor's bid or performance.

No change shall be implemented by the Contractor until approved by the State, and the Contract is amended to reflect the change and associated costs, if any. If there is a dispute regarding the cost, but both parties agree that immediate implementation is necessary, the change may be implemented, and cost negotiations may continue with both Parties retaining all remedies under the contract and law.

Vendor will not substitute any item that has been awarded without prior written approval of SPB.

G. BREACH

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
		AH	Paragraph One and Three are accepted with no issue; Paragraph Two can not be accepted in its current iteration as it violates Bruker internal policy. We would request the option to craft mutually agreed upon alternative language.

Either Party may terminate the contract, in whole or in part, if the other Party breaches its duty to perform its obligations under the contract in a timely and proper manner. Termination requires written notice of default and a thirty (30) calendar day (or longer at the non-breaching Party's discretion considering the gravity and nature of the default) cure period. Said notice shall be delivered by Certified Mail, Return Receipt Requested, or in person with proof of delivery. Allowing time to cure a failure or breach of contract does not waive the right to immediately terminate the contract for the same or different contract breach which may occur at a different time.

In case of breach by the Contractor, the State may, without unreasonable delay, make a good faith effort to make a reasonable purchase or contract to purchased goods in substitution of those due from the contractor. The State may recover from the Contractor as damages the difference between the costs of covering the breach. Notwithstanding any clause to the contrary, the State may also recover the contract price together with any incidental or consequential damages defined in UCC Section 2-715, but less expenses saved in consequence of Contractor's breach.

The State's failure to make payment shall not be a breach, and the Contractor shall retain all available statutory remedies. (See Indemnity - Self-Insurance and Payment)

H. NON-WAIVER OF BREACH

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The acceptance of late performance with or without objection or reservation by a Party shall not waive any rights of the Party nor constitute a waiver of the requirement of timely performance of any obligations remaining to be performed.

I. SEVERABILITY

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

If any term or condition of the contract is declared by a court of competent jurisdiction to be illegal or in conflict with any law, the validity of the remaining terms and conditions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the contract did not contain the provision held to be invalid or illegal.

J. INDEMNIFICATION

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

1. GENERAL

The Contractor agrees to defend, indemnify, and hold harmless the State and its employees, volunteers, agents, and its elected and appointed officials (“the indemnified parties”) from and against any and all claims, liens, demands, damages, liability, actions, causes of action, losses, judgments, costs, and expenses of every nature, including investigation costs and expenses, settlement costs, and attorney fees and expenses (“the claims”), sustained or asserted against the State for personal injury, death, or property loss or damage, arising out of, resulting from, or attributable to the willful misconduct, negligence, error, or omission of the Contractor, its employees, Subcontractors, consultants, representatives, and agents, resulting from this contract, except to the extent such Contractor liability is attenuated by any action of the State which directly and proximately contributed to the claims.

2. INTELLECTUAL PROPERTY

The Contractor agrees it will, at its sole cost and expense, defend, indemnify, and hold harmless the indemnified parties from and against any and all claims, to the extent such claims arise out of, result from, or are attributable to, the actual or alleged infringement or misappropriation of any patent, copyright, trade secret, trademark, or confidential information of any third party by the Contractor or its employees, Subcontractors, consultants, representatives, and agents; provided, however, the State gives the Contractor prompt notice in writing of the claim. The Contractor may not settle any infringement claim that will affect the State’s use of the Licensed Software without the State’s prior written consent, which consent may be withheld for any reason.

If a judgment or settlement is obtained or reasonably anticipated against the State’s use of any intellectual property for which the Contractor has indemnified the State, the Contractor shall, at the Contractor’s sole cost and expense, promptly modify the item or items which were determined to be infringing, acquire a license or licenses on the State’s behalf to provide the necessary rights to the State to eliminate the infringement, or provide the State with a non-infringing substitute that provides the State the same functionality. At the State’s election, the actual or anticipated judgment may be treated as a breach of warranty by the Contractor, and the State may receive the remedies provided under this ITB.

3. PERSONNEL

The Contractor shall, at its expense, indemnify and hold harmless the indemnified parties from and against any claim with respect to withholding taxes, worker’s compensation, employee benefits, or any other claim, demand, liability, damage, or loss of any nature relating to any of the personnel, including subcontractor’s and their employees, provided by the Contractor.

4. SELF-INSURANCE (Statutory)

The State is self-insured for any loss and purchases excess insurance coverage pursuant to Neb. Rev. Stat. § 81-8,239.01 (Reissue 2008). If there is a presumed loss under the provisions of this agreement, Contractor may file a claim with the Office of Risk Management pursuant to Neb. Rev. Stat. §81-8,829 through 81-8,306 for review by the State Claims Board. The State retains all rights and immunities under the State Miscellaneous (Section 81-8,294), Tort (Section 81-8,209), and Contract Claim Acts (Section 81-8,302), as outlined in Neb. Rev. Stat. § 81-8,209 et seq. and under any other provisions of law and accepts liability under this agreement to the extent provided by law.

K. ATTORNEY’S FEES

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

In the event of any litigation, appeal, or other legal action to enforce any provision of the contract, the Parties agree to pay all expenses of such action, as permitted by law and if order by the court, including attorney's fees and costs, if the other party prevails.

L. ASSIGNMENT, SALE, OR MERGER

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

Either party may assign the contract upon mutual written agreement of the other party. Such agreement shall not be unreasonably withheld.

The Contractor retains the right to enter into a sale, merger, acquisition, internal reorganization, or similar transaction involving Contractor's business. Contractor agrees to cooperate with the State in executing amendments to the contract to allow for the transaction. If a third party or entity is involved in the transaction, the Contractor will remain responsible for performance of the contract until such time as the person or entity involved in the transaction agrees in writing to be contractually bound by this contract and perform all obligations of the contract.

M. CONTRACTING WITH OTHER POLITICAL SUB-DIVISIONS OF THE STATE OR ANOTHER STATE

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

The Contractor may, but shall not be required to, allow agencies, as defined in Neb. Rev. Stat. §81-145, to use this contract. The terms and conditions, including price, of the contract may not be amended. The State shall not be contractually obligated or liable for any contract entered into pursuant to this clause.

The Contractor may, but shall not be required to, allow other states, agencies or divisions of other states, or political subdivisions of other states to use this contract. The terms and conditions, including price, of this contract shall apply to any such contract, but may be amended upon mutual consent of the Parties. The State of Nebraska shall not be contractually or otherwise obligated or liable under any contract entered into pursuant to this clause. The State shall be notified if a contract is executed based upon this contract.

N. FORCE MAJEURE

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

Neither party shall be liable for any costs or damages, or for default resulting from its inability to perform any of its obligations under the contract due to a natural or manmade event outside the control and not the fault of the affected party ("Force Majeure Event"). The Party so affected shall immediately make a written request for relief to the other party, and shall have the burden of proof to justify the request. The other Party may granted the relief requested; relief may not be unreasonably withheld. Labor disputes with the impacted party's own employees will not be considered a Force Majeure Event.

O. CONFIDENTIALITY

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

All materials and information provided by the Parties or acquired by a Party on behalf of the other Party shall be regarded as confidential information. All materials and information provided or acquired shall be handled in accordance with federal and state law, and ethical standards. Should said confidentiality be breached by a Party, the Party shall notify the other Party immediately of said breach and take immediate corrective action.

It is incumbent upon the Parties to inform their officers and employees of the penalties for improper disclosure imposed by the Privacy Act of 1974, 5 U.S.C. 552a. Specifically, 5 U.S.C. 552a (i)(1), which is made applicable by 5 U.S.C. 552a (m)(1), provides that any officer or employee, who by virtue of his/her employment or official position has possession of or access to agency records which contain individually identifiable information, the disclosure of which is prohibited by the Privacy Act or regulations established thereunder, and who knowing that disclosure of the specific material is prohibited, willfully discloses the material in any manner to any person or agency not entitled to receive it, shall be guilty of a misdemeanor and fined not more than \$5,000.

P. EARLY TERMINATION

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

The contract may be terminated as follows:

1. The State and the Contractor, by mutual written agreement, may terminate the contract at any time.
2. The State, at its sole discretion, may terminate the contract for any reason upon thirty (30) calendar day's written notice to the Contractor. Such termination shall not relieve the Contractor of warranty or other service obligations incurred under the terms of the contract. In the event of termination the Contractor shall be entitled to payment, determined on a pro rata basis, for products or services satisfactorily performed or provided.
3. The State may terminate the contract immediately for the following reasons:
 - a. if directed to do so by statute;
 - b. Contractor has made an assignment for the benefit of creditors, has admitted in writing its inability to pay debts as they mature, or has ceased operating in the normal course of business;
 - c. a trustee or receiver of the Contractor or of any substantial part of the Contractor's assets has been appointed by a court;
 - d. fraud, misappropriation, embezzlement, malfeasance, misfeasance, or illegal conduct pertaining to performance under the contract by its Contractor, its employees, officers, directors, or shareholders;
 - e. an involuntary proceeding has been commenced by any party against the Contractor under any one of the chapters of Title 11 of the United States Code and (i) the proceeding has been pending for at least sixty (60) calendar days; or (ii) the Contractor has consented, either expressly or by operation of law, to the entry of an order for relief; or (iii) the Contractor has been decreed or adjudged a debtor;
 - f. a voluntary petition has been filed by the Contractor under any of the chapters of Title 11 of the United States Code;
 - g. Contractor intentionally discloses confidential information;
 - h. Contractor has or announces it will discontinue support of the deliverable; and,
 - i. In the event funding is no longer available.

Q. CONTRACT CLOSEOUT

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

Upon termination of the contract for any reason the Contractor shall within thirty (30) days, unless stated otherwise herein:

1. Transfer all completed or partially completed deliverables to the State;
2. Transfer ownership and title to all completed or partially completed deliverables to the State;
3. Return to the State all information and data, unless the Contractor is permitted to keep the information or data by contract or rule of law. Contractor may retain one copy of any information or data as required to comply with applicable work product documentation standards or as are automatically retained in the course of Contractor's routine back up procedures;
4. Cooperate with any successor contractor, person or entity in the assumption of any or all of the obligations of this contract;
5. Cooperate with any successor contractor, person or entity with the transfer of information or data related to this contract;
6. Return or vacate any state owned real or personal property;

Nothing in this Section should be construed to require the Contractor to surrender intellectual property, real or person property, or information or data owned by the Contractor for which the State has no legal claim.

III. CONTRACTOR DUTIES

A. INDEPENDENT CONTRACTOR / OBLIGATIONS

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

It is agreed that the Contractor is an independent contractor and that nothing contained herein is intended or should be construed as creating or establishing a relationship of employment, agency, or a partnership.

The Contractor is solely responsible for fulfilling the contract. The Contractor or the Contractor’s representative shall be the sole point of contact regarding all contractual matters.

The Contractor shall secure, at its own expense, all personnel required to perform the services under the contract. The personnel the Contractor uses to fulfill the contract shall have no contractual or other legal relationship with the State; they shall not be considered employees of the State and shall not be entitled to any compensation, rights or benefits from the State, including but not limited to, tenure rights, medical and hospital care, sick and vacation leave, severance pay, or retirement benefits.

By-name personnel commitments made in the Contractor's bid shall not be changed without the prior written approval of the State. Replacement of these personnel, if approved by the State, shall be with personnel of equal or greater ability and qualifications.

The Contractor warrants that all persons assigned to the project shall be employees of the Contractor or a Subcontractor, and shall be fully qualified to perform the work required herein. Personnel employed by the Contractor or a subcontractor to fulfill the terms of the contract shall remain under the sole direction and control of the Contractor or the subcontractor respectively.

With respect to its employees, the Contractor agrees to be solely responsible for the following:

1. Any and all pay, benefits, and employment taxes and/or other payroll withholding;
2. Any and all vehicles used by the Contractor’s employees, including all insurance required by state law;
3. Damages incurred by Contractor’s employees within the scope of their duties under the contract;
4. Maintaining Workers’ Compensation and health insurance that complies with state and federal law and submitting any reports on such insurance to the extent required by governing law;
5. Determining the hours to be worked and the duties to be performed by the Contractor’s employees; and,
6. All claims on behalf of any person arising out of employment or alleged employment (including without limit claims of discrimination alleged against the Contractor, its officers, agents, or subcontractors or subcontractor’s employees).

If the Contractor intends to utilize any subcontractor, the Subcontractor's level of effort, tasks, and time allocation must be clearly defined in the Contractor's bid. The Contractor shall agree that it will not utilize any Subcontractors not specifically included in its bid in the performance of the contract without the prior written authorization of the State.

The State reserves the right to require the Contractor to reassign or remove from the project any Contractor or Subcontractor employee.

Contractor shall insure that the terms and conditions contained in any contract with a sub-contractor does not conflict with the terms and conditions of this contract.

The Contractor shall include a similar provision, for the protection of the State, in the contract with any Subcontractor engaged to perform work on this contract.

B. EMPLOYEE WORK ELIGIBILITY STATUS

The Contractor is required and hereby agrees to use a federal immigration verification system to determine the work eligibility status of employees physically performing work within the State. A federal immigration verification system means the electronic verification of the work authorization program authorized by the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, 8 U.S.C. 1324a, known as the E-Verify Program, or an equivalent federal

program designated by the United States Department of Homeland Security or other federal agency authorized to verify the work eligibility status of an employee.

If the Contractor is an individual or sole proprietorship, the following applies:

1. The Contractor must complete the United States Citizenship Attestation Form, available on the DAS website at <http://das.nebraska.gov/materiel/purchasing.html>

The completed United States Attestation Form should be submitted with the ITB response.

2. If the Contractor indicates on such attestation form that he or she is a qualified alien, the Contractor agrees to provide the U.S. Citizenship and Immigration Services documentation required to verify the Contractor's lawful presence in the United States using the Systematic Alien Verification for Entitlements (SAVE) Program.
3. The Contractor understands and agrees that lawful presence in the United States is required and the Contractor may be disqualified or the contract terminated if such lawful presence cannot be verified as required by Neb. Rev. Stat. § 4-108.

C. COMPLIANCE WITH CIVIL RIGHTS LAWS AND EQUAL OPPORTUNITY EMPLOYMENT / NONDISCRIMINATION (Statutory)

The Contractor shall comply with all applicable local, state, and federal statutes and regulations regarding civil rights laws and equal opportunity employment. The Nebraska Fair Employment Practice Act prohibits Contractors of the State, and their Subcontractors, from discriminating against any employee or applicant for employment, with respect to hire, tenure, terms, conditions, compensation, or privileges of employment because of race, color, religion, sex, disability, marital status, or national origin (Neb. Rev. Stat. §48-1101 through 48-1125). The Contractor guarantees compliance with the Nebraska Fair Employment Practice Act, and breach of this provision shall be regarded as a material breach of contract. The Contractor shall insert a similar provision in all Subcontracts for goods or services to be covered by any contract resulting from this ITB.

D. COOPERATION WITH OTHER CONTRACTORS

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

Contractor may be required to work with or in close proximity to other contractors or individuals that may be working on the same or different projects. The Contractor shall agree to cooperate with such other contractors or individuals, and shall not commit or permit any act which may interfere with the performance of work by any other contractor or individual. Contractor is not required to compromise Contractor's intellectual property or proprietary information unless expressly required to do so by this contract.

E. PERMITS, REGULATIONS, LAWS

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The contract price shall include the cost of all royalties, licenses, permits, and approvals, whether arising from patents, trademarks, copyrights or otherwise, that are in any way involved in the contract. The Contractor shall obtain and pay for all royalties, licenses, and permits, and approvals necessary for the performance of the contract. The Contractor must guarantee that it has the full legal right to the materials, supplies, equipment, software, and other items used to execute this contract.

F. OWNERSHIP OF INFORMATION AND DATA / DELIVERABLES

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The State shall have the unlimited right to publish, duplicate, use, and disclose all information and data developed or obtained by the Contractor on behalf of the State pursuant to this contract.

G. NOTICE OF POTENTIAL CONTRACTOR BREACH

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

If Contractor breaches the contract or anticipates breaching the contract the Contractor shall immediately give written notice to the State. The notice shall explain the breach or potential breach, and may include a request for a waiver of the breach if so desired. The State may, at its discretion, temporarily or permanently waive the breach. By granting a temporary waiver, the State does not forfeit any rights or remedies to which the State is entitled by law or equity, or pursuant to the provisions of the contract. Failure to give immediate notice, however, may be grounds for denial of any request for a waiver of a breach.

H. ANTITRUST

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The Contractor hereby assigns to the State any and all claims for overcharges as to goods and/or services provided in connection with this contract resulting from antitrust violations which arise under antitrust laws of the United States and the antitrust laws of the State.

I. CONFLICT OF INTEREST

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

By submitting a bid, Contractor certifies that there does not now exist a relationship between the Contractor and any person or entity which is or gives the appearance of a conflict of interest related to this ITB or project.

The Contractor certifies that it shall not take any action or acquire any interest, either directly or indirectly, which will conflict in any manner or degree with the delivery of its goods hereunder or which creates an actual or an appearance of conflict of interest.

The Contractor certifies that it will not employ any individual known by Contractor to have a conflict of interest.

The Parties shall not knowingly, for a period of two years after execution of the contract, recruit or employ any employee or agent of the other Party who has worked on the ITB or project, or who had any influence on decisions affecting the ITB or project.

J. STATE PROPERTY

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The Contractor shall be responsible for the proper care and custody of any State-owned property which is furnished for the Contractor's use during the performance of the contract. The Contractor shall reimburse the State for any loss or damage of such property; normal wear and tear is expected.

K. SITE RULES AND REGULATIONS

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The Contractor shall use its best efforts to ensure that its employees, agents, and Subcontractors comply with site rules and regulations while on State premises. If the Contractor must perform on-site work outside of the daily operational hours set forth by the State, it must make arrangements with the State to ensure access to the facility and the equipment has been arranged. No additional payment will be made by the State on the basis of lack of access, unless the State fails to provide access as agreed to in writing between the State and the Contractor.

L. ADVERTISING

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The Contractor agrees not to refer to the contract award in advertising in such a manner as to state or imply that the company or its goods are endorsed or preferred by the State. Any publicity releases pertaining to the project shall not be issued without prior written approval from the State.

M. NEBRASKA TECHNOLOGY ACCESS STANDARDS (Statutory)

Contractor shall review the Nebraska Technology Access Standards, found at <http://nitc.nebraska.gov/standards/2-201.htm> and ensure that products and/or goods provided under the contract are in compliance or will comply with the applicable standards to the greatest degree possible. In the event such standards change during the Contractor's performance, the State may create an amendment to the contract to request the contract comply with the changed standard at a cost mutually acceptable to the parties.

N. DISASTER RECOVERY/BACK UP PLAN

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

The Contractor shall have a disaster recovery and back-up plan, of which a copy should be provided upon request to the State, which includes, but is not limited to equipment, personnel, facilities, and transportation, in order to continue delivery of goods as specified under the specifications in the contract in the event of a disaster.

O. DRUG POLICY

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AT			

Contractor certifies it maintains a drug free work place environment to ensure worker safety and workplace integrity. Contractor agrees to provide a copy of its drug free workplace policy at any time upon request by the State.

IV. PAYMENT

A. PROHIBITION AGAINST ADVANCE PAYMENT

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

Payments shall not be made until contractual deliverable(s) are received and accepted by the State.

B. TAXES

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

The State is not required to pay taxes and assumes no such liability as a result of this solicitation. The Contractor may request a copy of the Nebraska Department of Revenue, Nebraska Resale or Exempt Sale Certificate for Sales Tax Exemption, Form 13 for their records. Any property tax payable on the Contractor's equipment which may be installed in a state-owned facility is the responsibility of the Contractor.

C. INVOICES

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

Invoices for payments must be submitted by the Contractor to the NDOT Materials and Research Division requesting the services with sufficient detail to support payment. Invoices must reference the purchase order number. The terms and conditions included in the Contractor's invoice shall be deemed to be solely for the convenience of the parties. No terms or conditions of any such invoice shall be binding upon the State, and no action by the State, including without limitation the payment of any such invoice in whole or in part, shall be construed as binding or estopping the State with respect to any such term or condition, unless the invoice term or condition has been previously agreed to by the State as an amendment to the contract.

D. INSPECTION AND APPROVAL

Accept (Initial)	Reject (Initial)	Reject & Provide Alternative within ITB Response (Initial)	NOTES/COMMENTS:
AH			

Final inspection and approval of all work required under the contract shall be performed by the designated State officials.

The State and/or its authorized representatives shall have the right to enter any premises where the Contractor or Subcontractor duties under the contract are being performed, and to inspect, monitor or otherwise evaluate the work

being performed. All inspections and evaluations shall be at reasonable times and in a manner that will not unreasonably delay work.

If a simple inspection of the goods would reveal nonconformity, notice of nonconformity should be provided to the vendor as soon as reasonably practical, but not to exceed thirty (30) days from receipt of goods. This includes visual inspection of product to ensure packaging is not damaged, dented or compromised.

E. PAYMENT (Statutory)

State will render payment to Contractor when the terms and conditions of the contract and specifications have been satisfactorily completed on the part of the Contractor as solely determined by the State. (Neb. Rev. Stat. Section 73-506(1)). The State may require the Contractor to accept payment by electronic means such as ACH deposit. In no event shall the State be responsible or liable to pay for any services provided by the Contractor prior to the Effective Date of the contract, and the Contractor hereby waives any claim or cause of action for any such services.

F. LATE PAYMENT (Statutory)

The Contractor may charge the responsible agency interest for late payment in compliance with the State of Nebraska Prompt Payment Act (See Neb. Rev. Stat. §§ 81-2401 through 81-2408).

G. SUBJECT TO FUNDING / FUNDING OUT CLAUSE FOR LOSS OF APPROPRIATIONS (Statutory)

The State's obligation to pay amounts due on the Contract for a fiscal years following the current fiscal year is contingent upon legislative appropriation of funds. Should said funds not be appropriated, the State may terminate the contract with respect to those payments for the fiscal year(s) for which such funds are not appropriated. The State will give the Contractor written notice thirty (30) calendar days prior to the effective date of termination. All obligations of the State to make payments after the termination date will cease. The Contractor shall be entitled to receive just and equitable compensation for any authorized work which has been satisfactorily completed as of the termination date. In no event shall the Contractor be paid for a loss of anticipated profit.

H. RIGHT TO AUDIT (Statutory)

The State shall have the right to audit the Contractor's performance of this contract upon a thirty (30) day written notice. Contractor shall utilize generally accepted accounting principles, and shall maintain the accounting records, and other records and information relevant to the contract (Information) to enable the State to audit the contract. (Neb. Rev. Stat. §84-304 et seq.) The State may audit and the Contractor shall maintain the information during the term of the contract and for a period of five (5) years after the completion of this contract or until all issues or litigation are resolved, whichever is later. The Contractor shall make the Information available to the State at Contractor's place of business or a location acceptable to both Parties during normal business hours. If this is not practical or the Contractor so elects, the Contractor may provide electronic or paper copies of the Information. The State reserves the right to examine, make copies of, and take notes on any Information relevant to this contract, regardless of the form or the Information, how it is stored, or who possesses the Information. In no circumstances will contractor be required to create or maintain documents not kept in the ordinary course of contractor's business operations, nor will contractor be required to disclose any information, including but not limited to product cost data, which is confidential or proprietary to contractor.

The Parties shall pay their own costs of the audit unless the audit finds a previously undisclosed overpayment by the State. If a previously undisclosed overpayment exceeds three percent (3%) of the total contract billings, or if fraud, material misrepresentations, or non-performance is discovered on the part of the Contractor, the Contractor shall reimburse the State for the total costs of the audit. Overpayments and audit costs owed to the State shall be paid within ninety (90) days of written notice of the claim. The Contractor agrees to correct any material weaknesses or condition found as a result of the audit.

V. SCOPE OF WORK

The Bidder must provide the following information in response to this ITB.

A. SCOPE

It is the intent of this bid invitation to establish a contract to supply **Sequential XRF Spectrometer Equipment with External Water Recirculating System** per the attached specifications from date of award for a period of five (5) years with the option to renew for an additional five (5) one (1) year periods when mutually agreeable to the vendor and the State. The State reserves the right to extend the period of this contract beyond the end date when mutually agreeable to the vendor and the State.

Complete specifications, manufacturer's current descriptive literature and/or advertising data sheets with cuts or photographs must be included with the bid for the IDENTICAL items proposed. Any information necessary to show compliance with these specifications not given on the manufacturer's descriptive literature and/or advertising data sheets must be supplied in writing on or attached to the bid document. If manufacturer's information necessary to show compliance with these specifications is not attached to the bid document, the Bidder may be required to submit requested information within three (3) business days of a written request. Failure to submit requested descriptive literature or advertising data sheets may be grounds to reject the bid.

B. AMENDMENT

This Contract may be amended in writing, within scope, upon the agreement of both parties.

C. REVISIONS

In the event any product is discontinued or replaced upon mutual consent during the contract period, the State reserves the right to amend this contract to include the alternate product at the same price.

VI. INVITATION TO BID - TECHNICAL SPECIFICATIONS

A. BIDDER INSTRUCTIONS

Bidder must respond to each of the following statements. Specifications listed are minimum conditions that must be met in order for a Bidder to qualify for the award.

“YES” response means the Bidder guarantees they can meet this condition.

“NO” response means the Bidder cannot meet this condition and will not be considered.

“NO & PROVIDE ALTERNATIVE” responses should be used only with a narrative response in the NOTES/COMMENTS section explaining in detail any deviation from the Bidder’s ability to meet the condition, and an explanation of how this would be determined to be an acceptable alternative to meeting the condition. Alternatives must be detailed in such a way that allows such deviations to be fully evaluated. The State shall determine at its sole discretion whether or not the Bidder’s alternative is an acceptable alternative.

B. NON-COMPLIANCE STATEMENT

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Read these specifications carefully. Any and all exceptions to these specifications must be written on or attached to quotation request. Any noncompliance may void your quotation. Non-compliance to any single specification can void your quotation.
AH			2. It is the responsibility of Bidders to obtain information and clarifications as provided below. The State is not responsible for any erroneous or incomplete understandings or wrongful interpretations of this ITB by any Bidder.
AH			3. No interpretation related to the meaning of bid specifications or other pre-bid documents will be made orally to any Bidder by the State. Any ITB interpretation must be put in writing and faxed by the Bidder to: the State Purchasing Bureau, Fax (402) 471-2089 or e-mailed to AS Materiel Purchasing as.materielpurchasing@nebraska.gov by the last day to submit written questions that is specified in the Schedule of Events. (Inquiries received after the last day to submit written questions may not be addressed).
NOTES/COMMENTS: Bruker guarantees that it will meet all conditions of Section B.			

C. SEQUENTIAL XRF SPECTROMETER EQUIPMENT

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Equipment bid shall be new and the latest current models in production as of the date of the ITB and be of proven performance.
AH			2. Equipment shall be under standard design, complete as regularly advertised and marketed.
AH			3. Equipment shall be delivered fully operational, complete with all necessary parts, specified accessories, tools, and special features, whether or not they may be specifically mentioned below.
AH			4. Used, demonstrator, prototype, or discontinued equipment is not acceptable.

NOTES/COMMENTS: Bruker guarantees that it will meet all conditions for Section C.

D. RADIATION SAFETY

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The Spectrometer must conform to all applicable state and federal radiation regulations. Current regulations may be obtained from the links: <ul style="list-style-type: none"> http://dhhs.ne.gov/Pages/reg_t180.aspx https://www.nrc.gov/about-nrc/radiation.html
AH			2. The manufacturer must provide a lamp that will indicate when the x-ray tube is energized. It shall be of a "fail-safe" design in which the power to the x-ray tube will be shut down if the lamp fails to operate.
AH			3. The manufacturer must provide an emergency shut down system to protect the operator and the spectrometer in the event of a power failure or any unsafe condition.
NOTES/COMMENTS: Bruker guarantees that it will meet or exceed all radiation safety requirements in Section D.			

E. X-RAY SYSTEM:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The bidder shall provide full and detailed specification(s), literature, and brochures describing the X-Ray Fluorescence Spectrometer as bid with the Invitation to Bid.
AH			2. The spectrometer shall be in a temperature controlled sealed cabinet.
AH			3. The spectrometer shall be equipped with castors to allow movement and access.
AH			4. The x-ray tube shall be an end-window design with a rhodium anode.
AH			5. The x-ray tube shall be positioned below the sample.
AH			6. The beryllium window thickness of the x-ray tube shall be 50 microns or less.
AH			7. The x-ray generator shall be of solid state high frequency design.
AH			8. The x-ray system power shall be at least 2 kW.
AH			9. The x-ray system shall require an external water cooling system.
AH			10. The output voltage shall be at least 60 kV and output current shall be at least 120 mA.
AH			11. The goniometer shall provide angular accuracy (θ and 2θ) of at least $\pm 0.01^\circ$ on LiF crystals and angular reproducibility (θ and 2θ) of at least $\pm 0.0002^\circ$.

AH			12.	The goniometer θ and 2θ axes shall have independent control.
AH			13.	The goniometer components shall be fully enclosed in a temperature controlled vacuum environment.
AH			14.	The spectrometer shall be equipped with at least two collimators: one for high resolution and one for high sensitivity.
AH			15.	The instrument shall be equipped with collimator masks with the ability to automatically switch to at least three different aperture openings appropriately selected to correspond with the applications stated in F.9.
AH			16.	The spectrometer shall be equipped with at least four primary beam filters selected to optimize analyses as stated in F.9. One shall be a beryllium filter to protect the tube during analysis.
AH			17.	An automatic crystal changer, with a minimum of 8 crystal positions, shall be included with the system.
AH			18.	A pre-mounted LiF 200 crystal, optimized for analyzing elements from potassium to uranium, shall be provided.
AH			19.	A pre-mounted PET crystal, optimized for analyzing elements from aluminum to chlorine, shall be provided.
AH			20.	A pre-mounted synthetic multilayer crystal, optimized for analyzing elements from oxygen to magnesium, shall be provided.
AH			21.	A pre-mounted, curved Ge crystal, optimized for analyzing elements phosphorous, sulfur, and chlorine, shall be provided.
AH			22.	A pre-mounted LiF 220 crystal, optimized for analyzing elements for vanadium to uranium, shall be provided.
AH			23.	A pre-mounted crystal, optimized for analyzing high concentrations of aluminum and silicon, shall be provided.
AH			24.	A pre-mounted synthetic multilayer crystal or detector with greater sensitivity for analyzing potassium to uranium, shall be provided.
AH			25.	The x-ray spectrometer shall be equipped with a flow proportional detector with linearity of at least 2000 kcps and a scintillation detector with linearity of at least 1500 kcps.
AH			26.	The detectors shall have a combined angular range of at least 8 to 148 degrees.
AH			27.	All detectors shall be in vacuum.
AH			28.	The temperature of the spectrometer environment shall be controlled to at least $\pm 0.5^{\circ}\text{C}$ within the temperature setting.
AH			29.	The instrument shall be able to operate under vacuum or helium. A helium flushing system for the analysis of liquids and loose powders shall be included.
AH			30.	A vacuum pump compatible with the system shall be included.
AH			31.	Accessories for connecting P-10 gas and helium gas to the spectrometer shall be provided.
AH			32.	The spectrometer shall be equipped with a sample changer capable of holding at least 48 samples for automatic remote loading.
AH			33.	A minimum of 30 sample holders shall be provided that are capable of holding 40 mm pressed pellets, 40 mm fused beads, and film cups for liquid and powder samples. Guides and spring loaded holders shall also be provided for each sample holder for stabilizing odd-shaped samples.
AH			34.	Drift monitors and QC standards for ASTM C114 cement analysis shall be included.

NOTES/COMMENTS: Bruker guarantees that it will meet or exceed all X-Ray System requirements in Section E.

F. COMPUTER SYSTEM AND SOFTWARE

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The contractor shall provide within seven (7) business days of contract award the type of minimum computer requirements needed to successfully operate the Sequential XRF Spectrometer Equipment.
AH			2. The contractor shall provide within seven (7) business days of contract award the type of minimum computer requirements needed to access the State of Nebraska's network.
AH			3. The software shall have functionality to export data for replication purposes. It shall ideally connect to a standard or enterprise edition SQL server 2016 or above database.
AH			4. The software shall support spectrometer operation and data handling under Windows 10 x64.
AH			5. The contractor shall guarantee software updates throughout the functional life of the product in order to interface with Windows OS and/or Microsoft package upgrades.
AH			6. After equipment and computer installation, any software licensing, upgrades and update costs shall be included, at no additional cost to NDOT during the initial warranty period as defined in Section Z.3.
AH			7. The Contractor shall ensure any licenses, upgrades and updates of the Spectrometer Software will be made available as a Catalog/Non-Core item (see Section U.5) by the manufacturer throughout the functional life of the product. This includes new versions released that would correct any functionality problems and/or that would add or upgrade operational features.
AH			8. The software shall be able to manage analysis setup selection, parameter selection, simple routine measurement and procedures for reporting and printing results.
AH			9. The software shall have the capabilities for qualitative and quantitative analysis. It shall allow calibration, drift correction, and re-calibration. The calibration of the spectrometer must meet the ASTM C114 requirements for cement testing. It shall have the capability to accurately and precisely measure TiO2 in traffic paint according to ASTM D4764, phosphorus in binders according to ASTM D6443, heavy metals in glass beads according to AASHTO TP106, calcium carbonate according to ASTM C25, and distinguish SO3 from S2- in cement according to ASTM C114.
AH			10. The software shall have the capability to add Agency-defined fields to assist in interfacing with other Agency systems.
AH			11. The software shall allow for editing of sample identification information after analysis.
AH			12. The software shall have password protection so that unauthorized personnel will not have access to instrument operation.
AH			13. The spectrometer shall be calibrated for standard-less analysis by drift monitors included as part of the package software.
AH			14. The software shall provide automatic standard-less analysis for a wide variety of sample materials, including solids, liquids, loose powders, and thin films/foils. All samples shall be analyzed by a single calibrated measuring program.
AH			15. The equipment shall be capable of printing from a network printer or a direct-attached printer.

NOTES/COMMENTS: Bruker guarantees that it will meet or exceed all computer system and software requirements detailed in Section F.

G. INSTALLATION AND TRAINING

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Complete on-site installation and instrumentation start-up of the spectrometer by a contractor certified service engineer will be included in the bid.
AH			2. The contractor shall provide at no additional cost to NDOT, three (3) days of on-site training by a certified service engineer and an applications specialist at the time of installation to give a basic orientation of the instrument.
AH			3. During the training, the service engineer and/or the application specialist shall provide on-site calibration of the spectrometer to meet ASTM C114 certification requirements with fused bead and pressed pellet preparations as well as accuracy and precision verification of the standard-less analysis by drift monitors included in the standard-less XRF software package.
AH			4. Upon completion of installation, and at no additional cost to NDOT, the service engineer and/or the application specialist shall, within 30 days, also provide on-site or remote assistance for the calibration of the following: Limestone (CaCO ₃) and Hydrated Lime (ASTM C25), TiO ₂ in Traffic Paint (ASTM D4764), SO ₃ and S ₂ - (ASTM C114), Phosphorus in Bituminous Binders (ASTM D6443), and aggregates high in Aluminum and Silicon.
AH			5. During the training, and at no additional cost to NDOT, the service engineer and/or application specialist shall set up the instrument for the primary application, including method set-up and validation, and demonstrate various features directly related to the primary applications.
<p>NOTES/COMMENTS: Bruker guarantees that it will meet or exceed all installation and training requirements specified in Section G.</p>			

H. SYSTEM WARRANTY:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. A minimum of one (1) year warranty after the date of installation is required. This shall cover all parts, labor, travel, and living expenses.
AH			2. The x-ray tube shall come with a minimum warranty of two (2) years without hours or proration limitations. This warranty must also apply to all purchased replacement tubes during the contract term.
<p>NOTES/COMMENTS: Bruker guarantees that it will meet the system warranty requirements detailed in Section H.</p>			

I. TECHNICAL SUPPORT:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Hardware and software for remote diagnostics shall be provided for service and support throughout the life of the contract.
AH			2. Operation and safety manuals for the spectrometer and software shall be included.
AH			3. Troubleshooting, diagnostics, performance checks, and application technical support by telephone or through remote access shall be provided during regular working hours at no additional charge to NDOT.
AH			4. Requests for technical support shall be answered within at least a twenty-four hour (24) period from placement of request.
<p>NOTES/COMMENTS: Bruker guarantees that it will meet or exceed the technical support requirements described in Section I.</p>			

J. PREVENTATIVE MAINTENANCE SERVICE PLAN:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The contractor shall provide as a Core item (see Section U.5.) an annual flat-rate preventative maintenance plan. This must include all expenses of travel, mileage, food, lodging, parking, fuel, labor, and next day preventative maintenance parts kit shipping costs/delivery fees.
AH			2. The preventative maintenance shall include cleaning, all work performed with a preventative maintenance parts kit, verification the equipment is in safe working order, minor repairs, if needed, and performing testing for the presence of radiation outside the spectrometer.
AH			3. Upon completion of a preventative maintenance service, the contractor shall provide, at no additional cost to NDOT, an inclusive service report and certification detailing all work/repairs conducted to document the equipment is in safe working order.
<p>NOTES/COMMENTS: Bruker guarantees that it will meet all of the preventative maintenance service plan requirements detailed in Section J.</p>			

K. SERVICE CALLS:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The contractor shall provide as a Core Item (see Section U.5.) an hourly rate for service calls during normal working hours (Monday through Friday, 8:00 AM to 5:00 pm) not covered by any purchased service plans. This rate shall include all expenses (travel, mileage, food, lodging, parking, fuel, labor, next day service parts shipping costs/delivery fees) associated with the service call.
AH			2. The contractor shall provide as a Core Item (see Section U.5.) an hourly rate for service calls during weekend and holiday hours not covered by any purchased service plans. This rate shall include all expenses (travel, mileage, food, lodging, parking, fuel, labor, next

			day service parts shipping costs/delivery fees) associated with the service call.
AH			3. For service calls worked greater than eight (8) hours in a work day, not covered by a purchased service plan, the awarded bid hourly rate for service calls will be applied. No overtime rates will be applied. See Section K.1. and K.2.
AH			4. Any contractor service calls completed in under four (4) hours, NDOT will apply the service call hourly rate of only four (4) hours.
AH			5. Upon completion of a service call, the contractor shall provide, at no additional cost to NDOT, an inclusive service report and certification detailing all work/repairs conducted to document the equipment is in safe working order.
AH			6. If it is determined a service call is required, the response time shall be three (3) business days or less.
<p>NOTES/COMMENTS: Bruker guarantees that it will meet the service calls specifications described in Section K.</p>			

L. METHOD DEVELOPMENT:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The contractor shall provide at least up to forty (40) hours of remote and/or on-site method development assistance at no additional cost to NDOT for each new analysis NDOT requires. Method development would include assistance in selecting standards, sample preparation recommendations, software parameters set-up, calibration, and/or any other services the contractor chooses to provide.
AH			2. The contractor may provide an hourly rate for remote method development assistance that exceeds forty (40) hours and is not covered by any purchased service plans.
AH			3. The contractor may provide an hourly rate for on-site method development assistance that exceeds forty (40) hours and is not covered by any purchased service plans. This rate shall include all expenses (travel, mileage, food, lodging, parking, fuel, labor) associated with the method development rate.
<p>NOTES/COMMENTS: Bruker will meet or exceed the method development criteria detailed in Section L.</p>			

M. TRADE-IN:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Is there a trade-in option available for Sequential XRF Spectrometer and External Water Recirculating System?
<p>NOTES/COMMENTS:</p>			

N. REMOVAL OF EXISTING XRF SPECTROMETER EQUIPMENT:

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. The contractor shall de-commission and take possession of the existing spectrometer (Bruker S4 Pioneer) and the External Water Recirculating System within ten (10) business days.
AH			2. If trade-in option is not available, Section N.1. will not apply to this Invitation to Bid.
NOTES/COMMENTS:			

O. ANNUAL USAGE, ESTIMATED

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Annual usage figures provided are estimates and are not to be construed as either a minimum or maximum purchase quantity. The orders shall be for the actual quantities of each item ordered by or for any agency during the life of the contract. Vendor shall not impose minimum order requirements.
NOTES/COMMENTS:			

P. DELIVERY ARO

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Delivery shall be within 120 days after receipt of order. A successful Bidder will maintain sufficient inventory to process and deliver within twenty (20) calendar days ARO for Non-Core catalog items. There will be no minimum order requirements for all Core/ Non-Core items.
AH			2. At the time of delivery, a designated State employee will sign the "invoice/packing slip." This signature will only indicate that the order has been received and that the items actually delivered agree with the delivery invoice. This signature does not indicate all items were received in good condition and/or that there is not possible hidden damage.
AH			3. The bid price shall include the delivery/shipping charges FOB destination of the X-Ray Fluorescence Spectrometer System.
AH			4. All Deliveries are to be FOB destination to NDOT location specified on the purchase order or as directed by NDOT at the time of purchase in accordance with this Invitation to Bid.
AH			5. Contractor shall be responsible for the shipping cost of returning and replacing defective and/or damaged products received.
AH			6. Deliveries must be clearly marked with the purchase order number.
AH			7. Deliveries shall be made during normal working hours between the hours of 8:00 A.M. and 5:00 P.M., Monday through Friday (excluding State holidays and / or as otherwise directed).

AH			8. If an emergency exists, delivery may be made through prior arrangements with receiving personnel.
AH			9. If delays in delivery are anticipated, the Contractor will immediately notify the NDOT Materials and Research Division of the expected delivery date. Nebraska Department of Roads Materials and Research Division Chemistry Laboratory 1400 Hwy. 2 Lincoln, NE 68502 Phone – 402-479-4874
AH			10. The order may be canceled if the delivery time is unsatisfactory, and the State may procure item(s) from other sources and the Contractor will be held responsible for any/all excess cost.
NOTES/COMMENTS: Bruker will meet the delivery ARO requirements detailed in Section P.			

Q. PACKAGING

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Cartons are to be clearly marked with size, weight, color, quantity, and the purchase order number. Cartons must be of suitable size and of sufficient strength to protect the contents during shipping, handling and storage.
NOTES/COMMENTS: Bruker will meet the packaging requirements described in Section Q.			

R. ORDERS

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Orders will be placed either by, phone, fax, e-mail or Internet (if available and not to the exclusion of the other methods).
AH			2. All orders must reference a purchase order number and the purchase order number must be referenced on the packing slip, and invoice.
AH			3. Invoices are to be sent to the "Invoice to" address on the purchase order.
NOTES/COMMENTS:			

S. QUALITY

YES	NO	NO & PROVIDE ALTERNATIVE	

AH			1. Product quality must meet specifications and be consistent for the term of the contract.
AH			2. A guarantee of satisfactory performance by the supplier and meeting delivery dates are considered to be an integral part of the purchase contract resulting from this bid invitation.
AH			3. All materials must be of first quality, under standard production by the manufacturer and be of standard design, complete as regularly advertised and marketed and be of proven performance.
AH			4. Products are to be fully guaranteed and may be returned for full credit or replacement (at the State's option) for any reason during the initial warranty period with no additional charges for shipping or restocking.
NOTES/COMMENTS: Bruker will meet the quality requirements described in Section S.			

T. CORE LIST AND CATALOG/NON-CORE: PRICES

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Core List prices quoted shall be net, including transportation and delivery charges fully prepaid by the vendor, FOB Destination to the ordering state facility/agency. Core List pricing is to remain firm for the initial one (1) year of the contract.
AH			2. Any request for increased pricing must be submitted in writing to the SPB a minimum of thirty (30) days prior to proposed effective date of increase and be accompanied by any/all supporting documentation such as a notification letter from the manufacturer indicating the percentage of increase. The supporting information must clearly establish the increase is for all customers, not to the State alone. Further documentation may be required by the State, to authenticate the increase (such as manufacturer invoices). Failure to supply any requested supporting documentation may be grounds to cancel the contract.
AH			3. Catalog/Non-Core item purchases shall be net, including transportation and delivery charges fully prepaid by the vendor, FOB Destination to the ordering state facility/agency.
AH			4. Discount bid off of manufacturer's suggested list price shall remain fixed for the duration of the contract.
AH			5. During the life of the contract, there may be new manufacturer's list price schedules published. In the event this occurs, it will be necessary for the Contractor to supply the SPB and any requesting agencies with one (1) copy of each as applicable.
AH			6. New catalog and/or price list(s) will be incorporated into the contract thirty (30) days after receipt by the SPB.
AH			7. Discounts for Catalog/Non-Core items shall be applied to products as presented as Catalog/Non-Core items in the ITB.
AH			8. Bidder shall include each manufacturer's list price schedule to coincide with manufacturers presented as Catalog/Non-Core items in the ITB.
AH			9. Prices quoted for products on the Core List and Catalog/Non-Core items shall be inclusive of all costs, to include but not limited to storage, processing and/or delivery throughout the State. Vendor cannot impose any additional service fees. Vendor shall inform the

			SPB in the event of any unanticipated or overlooked contingency affecting pricing or contract performance.
AH			<p>10. NO price increases are to be billed to the State facilities without prior written approval by the SPB.</p> <p>The State further reserves the right to reject any proposed price increase(s), cancel the contract and re-bid if determined in the best interest of the State.</p>
AH			<p>11. It is understood and agreed that in the event of a reduction in the manufacturer's published standard price list for all or any portion of the proposed items, the State will be given full benefit of such decline in price immediately, including any promotional allowances offered to the balance of the trade during the contract period.</p>
NOTES/COMMENTS:			

U. CORE LIST and CATALOG/NON-CORE: CORE LIST PRICING

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Any quantities stated are estimated annual quantities and shall not be construed to be either a minimum or a maximum. The State will not accept substitutions.
AH			2. A manufacturer's model/number has been provided for each item.
AH			3. All bid units should match exactly. NOTE: If contractor fails to provide a price on any items, those items for that contractor will be adjusted to the highest quoted price for those items.
AH			4. In those cases where items may have more than one brand name, the contractor may bid on either brand. Please indicate which brand was bid. Bidder must complete Core and Non-Core List. Please pay special attention to the unit of measure.
AH			<p>5. Core Items have been identified as follows:</p> <ul style="list-style-type: none"> a. Sequential XRF Spectrometer Equipment with External Water Recirculating System. b. Annual Flat Rate Preventative Maintenance Plan. c. Hourly Rate for Service Calls (Regular Working Hours). d. Hourly Rate for Service Calls (Weekend/Holiday Hours).
NOTES/COMMENTS:			

V. CORE LIST AND CATALOG/NON-CORE: CATALOG/NON-CORE PRICING/PERCENTAGES

YES	NO	NO & PROVIDE ALTERNATIVE	

AH			1. Prices for Catalog/Non-Core items shall be determined by applying the quoted discount for the item to the manufacturer's current catalog or price list. The percentage discount for the items shall remain firm for the duration of the contract period. Bidder must clearly state the date of the catalog or price list used and provide a copy of the catalog to the SPB upon request.
AH			2. The pricing structure, consisting of all pricing formulas and pertinent information, for all non-core items must be clearly defined and documented for future auditing purposes.
AH			3. The percentage discount rate for Catalog/Non-Core items or categories will not decrease during the life of the contract.
AH			4. A firm percentage rate must be quoted--a range of percentages will not be considered.
AH			5. Catalog/ Non-Core Categories have been identified as follows (excluding core items): a) XRF Spectrometer Equipment parts & accessories. b) Service plans. c) Software, Hardware, and Firmware updates/upgrades. d) Method Development. e) Diagnostic, Repair, and Maintenance Training at Contractor Facility.
NOTES/COMMENTS:			

W. CORE LIST and CATALOG/NON-CORE: ADDITIONAL PRICE LISTS AND CATALOGS

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. After award of the contract(s), the contractor(s) shall supply additional copies of the current catalog or price list used for this ITB for distribution to any requesting state agency at no charge, within ten (10) business days of request.
AH			2. Additional catalogs and/or price lists may be required and shall be provided without charge.
AH			3. Any catalog or price list revisions which occur during the duration of the contract shall be provided upon request without charge.
NOTES/COMMENTS:			

X. CORE LIST and CATALOG/NON-CORE: USAGE REPORTS

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			1. Usage reports may be requested by the SPB. The reporting period may be determined based on need and may include the following: a. Fill rate information for core and non-core items, statewide and by agency to include the number of orders received, orders processed, back orders, and partially filled orders.

			<p>b. Usage reports by agency and statewide indicating the numbers of each core item and non-core item sold.</p> <p>c. Any additional report the SPB may deem necessary.</p>
<p>NOTES/COMMENTS:</p>			

Y. GRAY MARKET PRODUCTS PROHIBITION

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			<p>1. The State will not accept Gray Market Products for this solicitation. Gray Market is defined as the trade of a commodity through distribution channels which, while legal, are unofficial, unauthorized, or unintended by the original manufacturer. Gray Market items are not designed to be sold in a particular market and cannot be supported by the authorized importer because of various reasons.</p>
<p>NOTES/COMMENTS:</p>			

Z. AUTHORIZED DEALER & WARRANTY

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			<p>1. To the extent required by the manufacturer, the Bidder shall be an authorized dealer.</p>
AH			<p>2. Bidder may be required to substantiate that he/she is an authorized dealer. Proof, if required, must be submitted to the SPB within three (3) days of the request and prior to the award of any contract.</p>
AH			<p>3. The terms of the original manufacturer's standard warranty shall apply to all equipment acquired from this solicitation for the entire warranty period.</p>
<p>NOTES/COMMENTS:</p>			

AA. WARRANTY

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			<p>1. Contractor must warrant the average life expectancy supplies hereunder to be not less than that stated in the manufacturer's price list and agree to replace, without cost, all supplies failing to meet this requirement, except where the reduced life is due to conditions beyond the control of the Contractor.</p>
AH			<p>2. Defective parts or those damaged in shipment must be replaced by the Contractor at no charge to the State.</p>

AH			<p>3. The manufacturer's standard warranty shall apply and be in effect for at least one (1) year from the date the equipment was placed in service.</p>
<p>NOTES/COMMENTS:</p>			

BB. SUBSTITUTIONS

YES	NO	NO & PROVIDE ALTERNATIVE	
AH			<p>1. Vendor will not substitute any item that has been awarded without prior written approval of SPB.</p>
<p>NOTES/COMMENTS:</p>			

CC. SECRETARY OF STATE REGISTRATION REQUIREMENTS

CHOOSE "YES" TO BEST ANSWER ONLY, CHOOSE "NO" FOR REMAINING LINES

YES	NO	*Prior to contract award and/or upon request of SPB, potential award recipient(s) will be asked to certify compliance with Nebraska Secretary of State Registration by providing a true and exact copy of current (dated within 90 days) valid Certificate of Good Standing or Letter of Good Standing.
	AH	<p>1. Bidder is a SOLE PROPRIETORSHIP (in which case, no Letter of Good Standing/Certificate of Good Standing is required)</p> <p>If the Bidder is an Individual or Sole Proprietorship, the following applies:</p> <p>a. The Bidder must complete the United States Citizenship Attestation Form, available on the Department of Administrative Services website at http://das.nebraska.gov/materiel/purchasing.html</p> <p>The completed United States Attestation Form should be submitted with the Invitation to Bid response.</p> <p>b. If the Bidder indicates on such attestation form that he or she is a qualified alien, the Contractor agrees to provide the U.S. Citizenship and Immigration Services documentation required to verify the Contractor's lawful presence in the United States using the Systematic Alien Verification for Entitlements (SAVE) Program.</p> <p>c. The Bidder understands and agrees that lawful presence in the United States is required and the Contractor may be disqualified or the contract terminated if such lawful presence cannot be verified as required by Neb. Rev. Stat. § 4-108.</p>
	AH	<p>2. Bidder is a GENERAL PARTNERSHIP (in which case, no Letter of Good Standing/Certificate of Good Standing is required).</p>
	AH	<p>3. Bidder is a FOREIGN or DOMESTIC CORPORATION or BUSINESS and a copy of current Letter of Good Standing/Certificate of Good Standing from the Nebraska Secretary of State is provided within bid submission documents.</p>
AH		<p>4. Bidder is a FOREIGN or DOMESTIC CORPORATION or BUSINESS and a copy of current Letter of Good Standing/Certificate of Good Standing from the Nebraska Secretary of State will be provided in a timely manner upon request prior to award.</p>

Form A
Bidder Contact Sheet
Invitation To Bid Number 5987 OF

Form A should be completed and submitted with each response to this ITB. This is intended to provide the State with information on the Bidder's name and address, and the specific person(s) who are responsible for preparation of the Bidder's response.

Preparation of ITB Contact Information	
Bidder Name:	Bruker Nano Inc.
Bidder Address:	5465 E. Cheryl Parkway Madison, WI 53711 USA
Contact Person & Title:	Andrew Hess- Sr. Sales Engineer
E-mail Address:	andrew.hess@bruker.com
Telephone Number (Office):	(608) 616-2842
Telephone Number (Cellular):	(608) 616-2842
Fax Number:	(608) 276-3006

Each Bidder shall also designate a specific contact person who will be responsible for responding to the State if any clarifications of the Bidder's response should become necessary.

Communication with the State Contact Information	
Bidder Name:	Bruker Nano Inc.
Bidder Address:	5465 E. Cheryl Parkway Madison, WI 53711 USA
Contact Person & Title:	Andrew Hess- Sr. Sales Engineer
E-mail Address:	andrew.hess@bruker.com
Telephone Number (Office):	(608) 616-2842
Telephone Number (Cellular):	(608) 616-2842
Fax Number:	(608) 276-3006



**S8 TIGER Series 2
SEQUENTIAL WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE
SPECTROMETER
HIGH PERFORMANCE with EASE-OF-USE**

The S8 TIGER Series 2 is the new high performance sequential wavelength-dispersive X-ray fluorescence spectrometer for universal qualitative, quantitative and "standardless" multi element analysis from Beryllium to Americium in solids and liquids (depending on optional spectrometer configuration) ensuring precise and accurate results. It is the perfect solution for all applications in Process Control, Quality Control, Research and Development or in in Monitoring. The robust, reliable technology "Made In Germany" dedicates the S8 TIGER even to rough environments and optimal instrument uptime.

The S8 TIGER Series 2 offers a superior analytical performance in wavelength dispersive X-ray fluorescence spectrometry with cutting-edge technology. The HighSense beam comprising with the new HighSense counting electronics for ultimate detector linearity and the HighSense X-ray tubes are delivering best element sensitivities and therefore lowest detection limits. The S8 TIGER has a high analytical flexibility with up to 9 primary beam filters, up to 4 collimators and up to 8 analyzer crystals and two dedicated detectors ensuring the optimum resolution and intensity even for demanding applications. With the brand new analyzer crystals of the XS-Series, the S8 TIGER, can be configured for specific purposes. The direct loading into the reference position and remaining the goniometer always under vacuum ensures best analytical stability.

Short Description

Item	Qty.	Catalogue-ID	
1			Core Items: Sequential XRF Spectrometer Equipment with External Water Recirculating System
1.1	1	S8_A01_A	S8 Tiger
1.2	1	S8_A02_6	S8 TIGER 2nd GENERATION (3kW)
1.3	1	S8_A03_G	HI, Rh, 50µm, 3 kW / 4 kW
1.4	1	S8_A04_1	Gas flushing system
1.5	1	S8_A05_D	autom.mask changer w/o mapping S8 Tiger 2nd GEN.
1.6	1	S8_A06_4	without Touch Control S8 TIGER 2nd GENERATION
1.7	1	S8_A07_C	208V (±10%) - 1 p 50/60Hz (3 kW/4kW)
1.8	1	S8_A08_5	Detectors (FC / SC) S8 Tiger 2nd GENERATION
1.9	1	S8_A09_A	Sample magazine for 60 sample holders
1.10	1	S8_A10_1	Vacuum pump with oil mist filter
1.11	1	S8_A01	Crystal LiF (200)
1.12	1	S8_A02	Crystal LiF (220)
1.13	1	S8_A06	Crystal PET
1.14	1	S8_A09	Crystal XS-55
1.15	1	S8_A13	Crystal XS-CEM
1.16	1	S8_A14	Crystal XS-Ge-C (curved)
1.17	1	S8_A15	Crystal XS-400
1.18	2	S8_B01	Blank collimator (DUMMY)
1.19	1	S8_B02	Collimator 0.23°
1.20	1	S8_B03	Collimator 0.46°
1.21	1	S8_D09	closed (cover) S8 TIGER 2nd GENERATION
1.22	1	S8_D10	Collimator mask Ø18mm S8 TIGER 2nd GENERATION
1.23	1	S8_D13	Collimator mask Ø34mm S8 TIGER 2nd GENERATION
1.24	1	S8_D15	Collimator mask Ø8mm (snorkel) S8 TIGER 2nd GEN.
1.25	1	S8_E04	Sample holder (two-parts)/ 8 mm Steel exch.
1.26	1	S8_E05	Sample holder (two-parts)/ 18 mm Steel exch.
1.27	30	S8_E08	Sample holder (two-parts)/ 34 mm Steel exch.
1.28	30	S8_E12	Distance ring
1.29	1	S8_E17	SampleCare™ Be-Filter (Protection for X-Ray-Tube)
1.30	1	S8_F37	Spectra+ V4 for S8 TIGER 2nd GENERATION and XRF Square Software
1.31	1	S8_F02	5 Reference samples for SPECTRAplus
1.32	1	S8_F03	QUANT-EXPRESS Standardless Calibration
1.33	1	S8_F04	S8 Tiger Instrument CD
1.34	1	S8_G02	PC with monitor, International
1.35	1	S8_H02	Introduction to XRF English
1.36	1	S8_H08	Supplement Folder S8 TIGER
1.37	1	S8_H12	S8 TIGER 2nd GENERATION preinst/safety multi
1.38	1	S8_H14	S8 TIGER 2nd GENERATION user manual English
1.39	1	862-112800	Refrigerated Water Recirculating System (Water To Water), 60 Hz, 6.9kW
1.40	1	862-300600	CEMENT XRF RECAL SAMPLE ACEM & BCEM
1.41	1	862-089700	P10 Regulator for Flow Counter



1.42	1	862-089800	Helium Regulator
1.43	1	862-307500	XRF 3 days service/application training
1.44	1	PM1000	Preventative Maintenance (standard instruments)

2 Additional Core Items

2.1	1	862-871400	Annual Flat Rate Preventative Maintenance Plan (S8 TIGER SERIES II, Parts Plus Service Contract, 1 year)
2.2	1	H1000	Hourly Rate for Service Calls (Regular Working Hours).
2.3	1	H1001	Hourly Rate for Service Calls (Weekend/Holiday Hours).

3 Non-Core Items

3.1	1	C79298A3246B59	Sample holder (two-parts)/ 8 mm Steel exch.	450.00	USD
3.2	1	C79298A3246B58	Sample holder (two-parts)/ 18 mm Steel exch.	450.00	USD
3.3	1	C79298A3246B56	Sample holder (two-parts)/ 34 mm Steel exch.	450.00	USD
3.4	1	K230C101-S	HI, Rh, 50µm, 3 kW / 4 kW	47,500.00	USD
3.5	1	A15D149	Maintenance kit S8Tiger	357.00	USD
3.6	1	A15D109	S8 TIGER 2nd Generation spare part kit	7,732.00	USD
3.7	1	862-089700	P10 Regulator for Flow Counter	1,036.00	USD
3.8	1	862-089800	Helium Regulator	1,036.00	USD
3.9	1	862-863000	XRF 2 days On-Site Application training	6,100.00	USD
3.10	1	862-300100	XRF 3 days On-Site Application training	8,100.00	USD
3.11	1	862-862600	S8 TIGER V3 application class at Bruker facility	3,500.00	USD
3.12	1	862-838100	S8 TIGER maintenance class at Bruker facility	5,500.00	USD
3.13	1	862-871200	S8 TIGER SERIES II, Premium Service Contract (1 year)	37,080.00	USD
3.14	1	862-871300	S8 TIGER SERIES II, Full Service Contract (1 year)	27,810.00	USD
3.15	1	869-999900	Method Development (per hour on-site)	400.00	USD

Please note: There are currently no existing software, hardware and/or Firmware updates/upgrades that Bruker can list under the Non-Core Items. If/when these become available, Bruker will update the Non-Core Items List for the NDOT.

As part of our ISO procedure each system undergoes a comprehensive test procedure to check the functionality and performance of the system.

After the instrument has passed the internal system test, the same parameters will be confirmed onsite for final acceptance. Acceptance parameters can be downloaded from www.brukersupport.com/BrukerDownloads/1.

Detailed Description

Item	Qty.	Catalogue-ID
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1		Core Items: Sequential XRF Spectrometer Equipment with External Water Recirculating System.
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1.2	1	S8_A02_6
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S8 TIGER Series 2

3 kW HIGH PERFORMANCE SEQUENTIAL WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE SPECTROMETER

High performance sequential wavelength-dispersive X-ray fluorescence spectrometer for universal qualitative, quantitative and "standardless" multi element analysis of the elements from Beryllium to Uranium in solids and liquids (depending on optional spectrometer configuration) ensuring a non-destructive and environmentally safe analytical method. The S8 TIGER Series 2 is the perfect solution for all applications in Process Control, Quality Control, Research and Development or in Monitoring. The robust, dirt resistant design dedicates the S8 TIGER even to rough environments.

HighSense technology (optional) makes the S8 TIGER Series 2 to one of the most powerful and most sensitive spectrometers on the market. A combination of uniquely to Bruker available components as the HighSense X-ray tube with 50 μm or 28 μm window thickness and the combination of unique XS-series analyzer crystals plus the HighSense detectors leads to unsurpassed analytical precision and detection power.

XRF2 mapping (optional) enables the S8 TIGER to map an active area of 34mm diameter of a sample with either 0.3 mm or 1,25 mm spot size. Based on the dedicated proportional counter for light elements and the fast scintillation counter for heavy elements plus the unique beamguide technology for small beam diameter.

TouchControl (optional) is the unique way for the easiest operation of an analytical instrument. Routine and fail-safe operation becomes an easy job with the integrated robust touch screen and the intuitive software. After a minimum of training any user can define and run measurements obtaining accurate results. Samples are ergonomically loaded to the magazine and the measurements are started quickly with a touch of a finger.

User access levels, separation of routine operation and advanced tasks and clear user guidance ensures fail-safe and reliable operation. TouchControl with the integrated computer makes the S8 TIGER an independent unit. TouchControl works seamlessly with any SPECTRAplus - PC via network connection.

SampleCare (optional) provides unique optimal 5x protection of all measurement components against contamination by dust particles and sample droplets for maximum up-time and minimum of maintenance costs. During loading, unloading and evacuation the X-ray tube and the goniometer with all components are protected by contamination shields (optional). During the measurement the tube window is protected with the optional Be-Filter. Dust and droplets are collected in an easy accessible dust reservoir. Even during measurements the unique vacuum seal (optional) with high transmission window can protect the goniometer against contamination maintaining the analytical performance. The optional automatic sample recognition automatically switches to the best mode to run samples, e.g. it only enable measurements of liquid samples under Helium atmosphere to prevent from spillage.

The S8 TIGER offers a superior analytical performance in wavelength dispersive X-ray

fluorescence spectrometry with cutting-edge technology. A closed coupled beam path from the tube anode to the detector guarantees best element sensitivities and therefore lowest detection limits. The S8 TIGER has a high analytical flexibility with up to 9 primary beam filters, up to 4 collimators and up to 8 analyzer crystals and two dedicated detectors ensuring the optimum resolution and intensity even for demanding applications. New developed analyzer crystals, dedicated for the S8 TIGER, fulfils even specific requirements. The direct loading into the reference position and remaining the goniometer always under vacuum ensures best analytical stability.

Electronic gearing in combination with the high precision mechanical goniometer ensures highest analyzing speed, analytical accuracy and sample throughput.

3 kW X-RAY FLUORESCENCE SPECTROMETER

Smallest and most compact single-cabinet spectrometer system with minimal installation requirements. Due to the space saving less than 0.9 square meter of floor space is occupied. The spectrometer is mounted on castors.

The high frequency design of the high voltage X-ray generator with optimal stability for the end window X-ray tube provides:

- high voltage (20 - 60kV) and tube current (5 - 150mA) programmable in intervals of 1kV or 1mA
- maximum power output 3 kW
- stability of high voltage and tube current: +/- 0.00005% per % of main power supply variation
- compensation of mains voltage variation up to +/- 10%

The S8 TIGER applies as a complete X-ray radiation protection unit according to German federal regulations ("Röntgenverordnung").

The closed internal cooling water system runs with deionized water for the end-window X-ray tube with internal heat exchanger. Automatic temperature controlled minimization of water consumption (max. 3l/min, less than 2l/min average) at constant cooling temperature, and compensation of short term water flow interruptions. External cooling water system (tap water or water chiller) is required.

Optical encoder controlled goniometer based on high precision gear with separate theta and 2-theta stepper motors for automatic instrument adjustment. Digital control, electronic gearing and temperature stabilizer of spectrometer cabinet (internal air conditioning, +/- 0.05°C) makes the spectrometer insensitive to temperature changes.

The spectrometers sample handling is based on a modular concept with the most flexible capability to adapt the spectrometer to automation processes according to the customer's needs. The characteristics of the sample magazine with rapid change-over from one sample to the other are described below.

The reproducibility of the spectrometer is optimal by positioning of sample holders to reference surface within the spectrometer. The Sample rotation at 30rpm compensates for inhomogeneity effects.

The spectrometer is equipped with two separate high-voltage supply, amplifier and pulse counting electronics for each detector. Modern high stability solid state boards with individual peak shift compensation at very high count rates for optimum linear dynamic range.

Programmable primary beam filter changer with 10 positions and optimized filter configuration (Cu: 0.3, 0.2mm; Al: 0.8, 0.5, 0.2, 0.1, 0.0125 mm) for flexible optimization of peak/background ratio and one contamination shield. The offered copper filters improve measurement conditions for elements such as Rhodium and Cadmium. The given selection of Aluminum filters improve peak signal to background ratio increasing sensitivity for all light matrix materials. The contamination shield protects the X-ray tube against contamination and damage from dust particles and sample droplets and is part of SampleCare of the S8 TIGER.

The bidirectional collimator changer can be equipped with up to four programmable collimators providing the most optimized resolution over the whole spectral range. For a detailed configuration, see collimators listed below.

The bidirectional crystal changer with magnetic coupling unit can be equipped with up to eight preadjusted analyzer crystals. For configuration, see analyzer crystals listed below.

Core System Warranty:

Complete and installed including one (1) year labor and parts warranty, with the exception of the goniometer (gears and worms) which carries a five (5) year warranty and the x-ray tube which carries a two (2) year full warranty.

1.3 1 S8_A03_G

50 μm THIN WINDOW X-RAY TUBE WITH HIGHEST INTENSITY OPTIMIZED FOR THE ANALYSIS OF LIGHT ELEMENTS, EQUIPPED WITH SampleCare COATING FOR ENHANCED PROTECTION

High-performance end-window X-ray tube with Rhodium anode for long operating lifetime and optimal excitation over the full element range from Beryllium (Be) to Uranium (U).

- Optimized beam path for highest intensity with max. 4 kW excitation power
- Close optical coupling between tube target
- Ultra-thin Beryllium window (50 μm) for superior light element analysis
- SampleCare Coating for enhanced protection of the X-ray tube against dust and liquids

1.4 1 S8_A04_1

VACUUM AND GAS FLUSHING SYSTEM FOR THE ANALYSIS OF SOLID AND LIQUID SAMPLES

Vacuum system for the measurement of solid samples. The automatic vacuum control guarantees the best analytical reproducibility and maximum analytical sensitivity to ultra-light elements.

Gas (Helium or Nitrogen) flushing system for safe analysis of liquid samples.

Using a spectrometer of the S8 family, two Helium modes are available in SPECTRAplus:

- Helium with reduced pressure of about 150-250 mbar ("He")
- Helium with atmospheric pressure ("HeAtm")

The vapor pressure of the sample is checked and the appropriate mode is defined via the measurement method. The HeAtm mode allows the analysis of highly volatile samples like gasoline. In contrast the reduced He mode consumes less Helium and allows the analysis of low volatile samples like oils.

During the analysis of liquid samples, the sample and spectrometer chamber are separated by a programmable Vacuum Seal, allowing very fast switching between solid and liquid samples. As only the small sample chamber is flushed with He (or N), the Vacuum Seal reduces the gas consumption significantly while assuring higher detector stability combined with better reproducibility. The unique Vacuum Seal also protects the spectrometer chamber in the event of sample breakage or leakage.

The Vacuum Seal is part of the S8 TIGER's SampleCare package.

1.5 1 S8_A05_D

AUTOMATIC MASK CHANGER

Automatic mask changer for complete, automated analysis of different sample sizes. The changer can be equipped with masks from 5 to 34 mm in diameter.

One mask changer position can be used alternatively for the solid contamination shield to protect the goniometer from contamination by sample dust or droplets during sample loading and chamber evacuation. The contamination shield is part of the SampleCare package of the S8 TIGER.

1.7 1 S8_A07_C

ELECTRICAL POWER SUPPLY, 208 V, 1 PHASE

The spectrometer is prepared for fast connection to the mains voltage 208 V ($\pm 10\%$) with 50/60 HZ (3 or 4 kW Version of the S8 TIGER).

1.8 1 S8_A08_5

HighSense PROPORTIONAL FLOW COUNTER AND SCINTILLATION COUNTER

Proportional flow counter and scintillation counter with independent settings of discriminator levels for each detector, programmable selection of flow counter (light elements) or scintillation counter (heavy elements) with high speed data processing for wide linear detector range of more than 2 Mio cps, capacity of more than 3 Mio cps.

The digital flow counter gas stabilization assures best precision.

1.9 1 S8_A09_A**60-POSITION SAMPLE MAGAZINE**

Totally integrated 60-position sample magazine for sample holders providing:

- large sample magazine for fast, comfortable changing and storing of standard samples, reference samples and series of unknown routine samples with a maximum diameter of 52 mm and a maximum thickness of 47 mm
- fixed sample positions for quick and efficient loading and unloading of samples
- safe sample holder grabber system with fast diagonal sample transport for user-selectable order of analysis and automatic repetitions of, for example, recalibration standards
- individual analytical tasks for each of the 60 positions and loading of additional (e.g. priority) samples during measurement
- four levels of priority are available for every sample

1.10 1 S8_A10_1**LOW NOISE VACUUM PUMP**

The spectrometer system is equipped with one low noise vacuum pump with oil mist filter which is integrated in the spectrometer housing.

1.11 1 S8_A01**PRE-MOUNTED ANALYZER CRYSTAL LiF(200), 2d = 0.403 nm**

General purpose crystal for analyzing elements from Potassium to Uranium.

1.12 1 S8_A02**PRE-MOUNTED ANALYZER CRYSTALS LiF(220), 2d = 0.284nm**

Crystal with higher resolution, but lower reflectivity than LiF(200) for analyzing elements from Vanadium to Uranium.

1.13 1 S8_A06**PRE-MOUNTED ANALYZER CRYSTAL PET, 2d = 0.875 nm**

Pentaerythrite crystal for analyzing elements from Aluminum to Chlorine.

1.14 1 S8_A09**PRE-MOUNTED ANALYZER CRYSTAL XS-55, 2d = 5.5 nm**

Analyzer crystal with synthetic multilayer structure, intensity optimized for the analysis of Oxygen to Magnesium.

1.15 1 S8_A13**PRE-MOUNTED ANALYZER CRYSTAL XS-CEM, 2d = 2.75 nm**

Analyzer crystal with synthetic multilayer structure, optimized for the analysis of Aluminum to Sulphur for best reproducibility and long-term-stability. Recommended for all demanding applications, like cement, minerals, glass, if the PET crystal is not sufficient.

1.16 1 S8_A14**PRE-MOUNTED ANALYZER CRYSTAL CURVED XS-GE-C, 2d = 0.6502 nm**

Curved Germanium crystal for analyzing Phosphorous, Sulphur and Chlorine. Due to the specific curvature of this Ge-analyzer crystal, the X-ray fluorescence radiation from the sample is focused to the detector. Highest intensities and best detection limits are achieved. 2nd and 4th order lines are eliminated.

1.17 1 S8_A15**PRE-MOUNTED ANALYZER CRYSTAL XS-100**

This uniquely from Bruker available brand new analyzer crystals reduces significantly the analytical measurement time from sodium to chlorine due the unique structure. Based on a specific multilayer structure the entire element range is covered with just one crystals, saving two crystal changes and reduces the number of background positions.

1.19 1 S8_B02**FINE COLLIMATOR 0.23°**

Fine collimator with 0.23° divergence for high resolution and high intensity.

1.20 1 S8_B03**UNIVERSAL COLLIMATOR 0.46°**

Universal collimator with 0.46° divergence, ideal for high intensity, typically used with the analyzer crystals XS-55, LiF(200) and LiF(220).

1.21 1 S8_D09**SAMPLE CARE - AUTOMATED CONTAMINATION SHIELD**

The instrument is equipped with an automated contamination shield to protect the goniometer and the components (collimators, crystals and detectors) during sample loading and the evacuation of the sample chamber. This contamination shield is part of the SampleCare™ package of the S8 TIGER.

1.22 1 S8_D10**AUTOMATED COLLIMATOR MASK, 18 MM DIAMETER**

The instrument is equipped with an automated collimator mask between sample and collimator to remove the influence of sample holder masks with a 18 mm diameter.

1.23 1 S8_D13**AUTOMATED COLLIMATOR MASK, 34 MM DIAMETER**

The instrument is equipped with an automated collimator mask between sample and collimator to remove the influence of sample holder masks with a 34 mm diameter.

1.24 1 S8_D15**AUTOMATED SNORKEL COLLIMATOR MASK, 8 MM DIAMETER**

The instrument is equipped with an automated collimator mask between sample and collimator to remove the influence of sample holder masks with a 8 mm diameter.

1.25 1 S8_E04**SAMPLE HOLDERS (TWOPART) WITH STEEL MASK, 8 MM**

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 8 mm.

1.26 1 S8_E05**SAMPLE HOLDERS (TWO-PART) WITH STEEL MASK, 18 MM**

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 18 mm.

1.27 30 S8_E08**SAMPLE HOLDERS (TWO-PART) WITH STEEL MASK, 34 MM**

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 34 mm.

1.28 30 S8_E12**DISTANCE RINGS**

Distance plastic ring (1 pcs.) for sample centering.

1.29 1 S8_E17**PROTECTION FILTER, MADE OUT OF BERYLLIUM**

Beryllium-Filter as protection for the X-Ray tube during measurements. Recommended for the analysis of liquid and dusty samples to avoid damages or contamination of the tube window.

1.30 1 S8_F37**ANALYTICAL SYSTEM SOFTWARE SPECTRAplus V4 FOR THE S8 TIGER**

SPECTRAplus V4 is the powerful modern analytical software suite for calibration, evaluation and reporting with the S8 TIGER X-ray spectrometer S8 TIGER. SPECTRAplus includes all program functions for qualitative, quantitative and standardless multi-element analysis. SPECTRAplus operates with Windows 10 and provides full functionality. SPECTRAplus V4 is specially developed for easy and fast operation and completely supports the unique TouchControl™ of the S8 TIGER.

SPECTRAplus V4 supports networking and provides full analytical functionality with any personal computer over the network (TCP/IP), such as application development, evaluation and reporting. The number of installations is not limited.

SPECTRAplus is characterized by its:

- superior analytical performance with the complete integration of the standardless quantitative analysis package QUANT EXPRESS and effective matrix correction with the automatic calculation of individual correction coefficients as well as theoretical and variable alphas.
- fast and comfortable operation with the navigation toolbar SPECTRAplus Launcher, eliminating the large number of desktop icons of conventional software and supporting the network functionality of SPECTRAplus V4.
- Integrated Analytical Intelligence is the XRF-expert system in SPECTRAplus, automatically providing the user with important settings during the development of specific applications and actively guiding through the process
- Easy and simple software operation with clear software structure. Ample use of

- fast, interactive graphics under mouse control with integrated menus
- Simple and clear data structure with integrated application and results database for fast access

In combination with TouchControl™ of the S8 TIGER, SPECTRAplus V4 offers a unique simple and fail-safe operation of the X-ray spectrometer:

Routine operation with SPECTRAplus:

- complete control of the X-ray spectrometer S8 TIGER
- simple and fast start of measurement with full support of TouchControl™
- Easy mode to define and start measurement jobs on remote PC's with smart dialogues functionality of the LOADER software
- online display of results
- direct graphical on-line display of the actual spectrometer status for easy editing of sample sets and control of loaded samples
- reliable and fail-safe automatic spectrometer operation
- measurement of high priority samples at any time without data loss

Qualitative Analysis with SPECTRAplus:

- simple, high-resolution display of acquired spectra
- automatic background subtraction and smoothing
- interactive or automatic peak search with peak and element identification

Quantitative Analysis with SPECTRAplus:

- complete integration of the standardless calibration package QUANT EXPRESS for the fast analysis of totally unknown samples
- integrated Analytical Intelligence, the XRF- expert system for the simple creation of user specific applications to make use of the full analytical performance of the S8 TIGER
- software wizards for user guidance during the development of specific applications, display and control of the application status
- flexible input of preparation data and any available chemical information
- integrated database for comprehensive handling of sample-specific data
- fully integrated matrix correction with fundamental parameter methods individually calculated for each sample, theoretical and variable alphas
- fixed alphas for combination of theoretical and empirical coefficients as well as intensity and mixed intensity/concentration models
- calculation of calibration coefficients minimizing absolute or relative deviations or using the counting statistical error as a weight factor
- graphical display of measured and corrected intensities or background intensities as well as confidence intervals for standard data

- flexible definition and calculation of user-defined modules for interactive evaluation of concentrations via integrated peak/background or scan presentation and interactive optimization on the screen
- user-tailored printouts for documentation of concentrations (e.g. different concentration units, elements/compounds, printing order, statistical error and limits of detection) and easy integration into reports
- automatic control of application-specific limit values and display of warnings exceeding these limits
- integrated global or specific drift correction procedures

Reporting with the RESULTS MANAGER

- Definition of own reporting formats, including measurement parameters, sample properties and the specimen spectra
- Definition of printout formats and display of results on screen for the reporting of results on paper, in LIMS, files or for the transfer with XML or Windows to external software

Mapping Client

- Simple-to-use software for defining, measuring and evaluating small-spot and mapping analysis with graphical interface
- Quick definition of small spot and mapping measurements by drag-and-drop, mouse click selection of elements and easy definition of measurement parameters

The integrated "Daily-Check-Routine" of SPECTRAplus is the basis for simple periodical instrument checks according to Good Laboratory Practice (GLP).

1.31 1 S8_F02

SET OF REFERENCE SAMPLES FOR SPECTRAplus

Set of five reference samples (SQ-1, SQ-2, SQ-3, STG-5 and GRAPHITE) for installation and recalibration of precalibrated measurement methods in SPECTRAplus for the S8 TIGER.

1.32 1 S8_F03

QUANT-EXPRESS - STANDARDLESS ANALYSIS PACKAGE

QUANT-EXPRESS allows the automatic analysis of totally unknown samples without performing a calibration. QUANT-EXPRESS provides unrivalled analytical flexibility. It can either perform a complete standardless analysis as fast scan in less than 2 minutes or an accurate analysis of samples to measure even trace levels. According to users' requirements, QUANT-EXPRESS performs scan measurements to provide full performance for interactive evaluation or can be set to peak and background mode for a faster time-to-result.

QUANT-EXPRESS is part of the S8 TIGER's integrated Analytical Intelligence. It automatically performs peak fitting, element and peak identification and accurate determination of net intensities with background and line overlay corrections. The powerful variable alpha matrix correction, unique to SPECTRAplus, automatically corrects for matrix effects as well as for all different kind of samples (thin films, infinitely or non-infinitely thick samples). User input of sample properties, known concentrations of elements and matrix components can be integrated to further improve the analytical results.

QUANT-EXPRESS can be fully utilized for user-specific calibrations, based on the variable alpha model, to allow the determination of elements where no standards are available. It is therefore an integrated part of SPECTRAplus to provide an XRF- expert system with the best line settings for any application.

1.33 1 S8_F04

S8 TIGER TOOLS FOR DIAGNOSIS, MAINTENANCE AND SERVICE

Unique software package for diagnosis, maintenance and service, allowing direct control and inspection of all system components of the S8 TIGER. Easy control and analysis of the system is ensured. Failures during operation are easily recognized and repaired. Easy operation and maintenance as well as high system uptime are guaranteed. Users get direct online help. Unauthorized access is not possible due to login procedures.

1.34 1 S8_G02

PREMIUM-SYSTEM-PC DELL

CPU Intel Core i5-6500. (Quad Core, 3.2 GHz turbo 6 MB) 8 GB RAM 1600 MHz, 1 TB SATA-HD, mouse, keyboard, AMD Radeon HD Graphics Adapter, 16x DVD+/- RW, 24" LED-monitor, 2 network adapters, international US/Europe model

Operating system MS Windows 10 Professional 64-bit

Technical changes are possible, features may be upgraded at time of delivery.

1.35 1 S8_H02

INTRODUCTION TO XRF, ENGLISH

Handbook for XRF basics, English edition

1.36 1 S8_H08

S8 TIGER SUPPLEMENT FOLDER

Folder with test protocols, X-ray radiation certificates and related instrument documentation

1.37 1 S8_H12

S8 TIGER Series 2 INTRODUCTORY USER MANUAL AND PREINSTALLATION

Preinstallation guide with detailed information about the installation requirements

1.38 1 S8_H14

OPERATORS MANUAL S8 TIGER Series 2, ENGLISH

Operator's manual with detailed instructions for the correct and safe operation and maintenance of the S8 TIGER Series 2

1.39 1 862-112800

REFRIGERATED WATER RECIRCULATING SYSTEM (WATER TO WATER), 60HZ

Small footprint, external closed cooling-water circuit for cooling of X-ray generator and X-ray tube. The unit is water cooled and possess a supply water saving active condenser.

Cooling capacity 6,900 Watts (23,500 BTU/HR) with 23.8°C (75° F) condenser water temperature and 20°C (68°F) supply water temperature.

- Refrigerant: R407C
- Water Pump Capacity: 15.1 l/min (4.0 G/min)
- Water Temp Stability +/- 0.05 °C
- Single pump system
- Reservoir Volume: 9.1 Liters (2.4 Gallons)
- Water Connections: ½" FNPT brass
- Power Requirements:
 - > Voltage: 208/230V, 60Hz, 1-phase
 - > Electrical Ratings: MCA: 18.3 A, MOCP: 25 A
- Dimensions:
 - > Width: 48 cm (19")
 - > Depth: 85 cm (33.5")
 - > Height: 86 cm (34")
- Shipping Weight 116 kg (254 lbs)

1.40 1 862-300600**TWO STABLE RECALIBRATION GLASS SAMPLES FOR THE CEMENT INDUSTRY****1.41 1 862-089700****REGULATOR/P10 GAS CYLINDER****1.42 1 862-089800****REGULATOR/HELIUM GAS CYLINDER****1.43 1 862-307500****SERVICE/APPLICATION TRAINING, 3 DAYS**

Three days onsite training by service/application engineer in conjunction with instrument installation.

1.44 1 PM1000**PREVENTATIVE MAINTENANCE**

A trained Bruker AXS Inc. specialist will take those actions necessary to ensure that the equipment is functioning properly. The specialist will inspect, clean, make minor adjustments, verify the operation, and perform general system tests. It is understood that ordinary cleaning, maintenance and care will be performed by the customer. One preventative maintenance visit will be scheduled based on the needs of the equipment during the warranty period. OQ Validation is not included.

2 Additional Core Items**2.1 1 862-871400****Annual Flat Rate Preventative Maintenance Plan (S8 TIGER SERIES II, Parts Plus Service Contract, 1 year)**

Includes:

- One emergency visit and one preventative maintenance visit scheduled within contract period are included. If additional visits necessary, labor, travel, living expenses will be charged at billable rates.
- Unlimited parts, shipping, telephone support and Bruker software updates (as required).
- Haskris Chiller covered if purchased from Bruker.
- 10% discount on software upgrades and/or hardware installation costs.
- 10% discount on service training classes.
- 10% discount on X-ray tube.



Plan excludes computers, peripherals, X-ray tubes, consumables and loaner equipment.

2.2 1 **H1000**

HOURLY RATE FOR SERVICE CALLS (REGULAR WORKING HOURS).

Per Item 4 of the State of Nebraska - Invitation to Bid Contract

2.3 1 **H1001**

HOURLY RATE FOR SERVICE CALLS (WEEKEND/HOLIDAY HOURS).

Per Item 5 of the State of Nebraska - Invitation to Bid Contract

3 **Non-Core Items**

3.1 1 **C79298A3246B59**

SAMPLE HOLDERS (TWO-PART) WITH STEEL MASK, 8 MM

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 8 mm.

3.2 1 **C79298A3246B58**

SAMPLE HOLDERS (TWO-PART) WITH STEEL MASK, 18 MM

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 18 mm.

3.3 1 **C79298A3246B56**

SAMPLE HOLDERS (TWO-PART) WITH STEEL MASK, 34 MM

Two-part sample holder with steel mask, analyzed sample surface with a diameter of 34 mm.

3.4 1 **K230C101-S**

50 μm THIN WINDOW X-RAY TUBE WITH HIGHEST INTENSITY OPTIMIZED FOR THE ANALYSIS OF LIGHT ELEMENTS, EQUIPPED WITH SampleCare COATING FOR ENHANCED PROTECTION

High-performance end-window X-ray tube with Rhodium anode for long operating lifetime and optimal excitation over the full element range from Beryllium (Be) to Uranium (U).

- Optimized beam path for highest intensity with max. 4 kW excitation power
- Close optical coupling between tube target

- Ultra-thin Beryllium window (50 µm) for superior light element analysis
- SampleCare Coating for enhanced protection of the X-ray tube against dust and liquids

3.5 1 **A15D149**

BASIC-MAINTENANCE KIT kit S4/S8 TIGER

3.6 1 **A15D109**

S8 TIGER 2nd Generation spare part kit

3.7 1 **862-089700**

REGULATOR/P10 GAS CYLINDER

3.8 1 **862-089800**

REGULATOR/HELIUM GAS CYLINDER

3.9 1 **862-863000**

XRF - 2 Days of Onsite Applications Training

Two (2) full days of dedicated support by an experienced XRF Applications Specialist at designated customer site including travel and lodging expenses within the continental US.

This support is customized to fulfill the documented requirements for calibration, assistance and/or training by customer.

An Application Requirement statement needs to be part of this quote and detail the requested services.

Prerequisite is the completed installation of the instrument prior to scheduling. Needed safety training, screenings are part of the support session and cannot be split.

3.10 1 **862-300100**

XRF – 3 Days of Onsite Application Training

Three (3) full days of dedicated support by an experienced XRF application specialist at designated customer site including travel and lodging expenses within the continental US.

This support is customized to fulfill the documented requirements for calibration, assistance and/or training of the customer.

An Application Requirement statement needs to be part of this quote and detail the requested services.

Prerequisite is the completed installation of the instrument prior to scheduling. Needed safety training, screenings are part of the support session and cannot be split.

3.11 1 **862-862600**

SPECTRAPLUS V3 for WDXRF SYSTEMS Training Course (4.5 days)

This course applies to users of the S8 TIGER series instruments. Participants will receive 4.5



days of intensive training on the fundamentals of X ray spectrometry, sample preparation techniques, and the SPECTRAplus software for Wavelength Dispersive X-ray systems. This course applies to users of the Bruker AXS SPECTRAplus V3 software with a S8 TIGER Wavelength Dispersive X-ray Spectrometer. Users can receive an update to the latest version of SPECTRAplus at the end of the course. Because each course will be tailored to the individual registrants' applications, participants are encouraged to contact the course instructor in advance for more information or to convey specific requests. No other materials are required.

Note: Unused training expires one year from installation date if purchased with the instrument, or one year from date of the received Purchase Ordered

3.12 1 **862-838100**

Service Training Class, S8 TIGER (4.5 days)

Bruker's customer training classes provide an introduction to the maintenance and repair of Bruker X-ray instruments. Courses cover basic maintenance principles, user-serviceable components, routine maintenance and alignment procedures. Detailed information is provided for the electrical, mechanical, cooling water and pneumatic circuits used in the instrument, and the theoretical discussions are accompanied by sessions where the customer receives "hands-on" experience in maintaining the instrument.

Class sizes are limited so that each participant can receive individualized attention and participate in every activity. Service manuals and other documentation are included as required for each course.

NOTE: Unused training expires 1 year from installation date if sold with a system or 1 year from PO date if sold as a stand alone training.

3.13 1 **862-871200**

S8 TIGER SERIES II, Premium Service Contract (1 year)

Includes:

- Unlimited labor (emergency visits), parts, x-ray tubes, consumables, shipping, telephone support and Bruker software updates (as required).
- One preventative maintenance visit scheduled within contract period.
- Priority access to loaner equipment when available.
- Haskris Chiller covered if purchased from Bruker.
- 10% discount on software upgrades and/or hardware installation costs.
- 10% discount on service training classes.

Plan excludes computers and peripherals.



3.14 1 862-871300

S8 TIGER SERIES II, Full Service Contract (1 year)

Includes:

- Unlimited labor (emergency visits), parts, shipping, telephone support and Bruker software updates (as required).
- One preventative maintenance visit scheduled within the contract period.
- Priority access to loaner equipment when available.
- Haskris Chiller covered if purchased from Bruker.
- 10% discount on software upgrades and/or hardware installation costs.
- 10% discount on service training classes.
- 10% discount on X-ray tube.

Plan excludes computers, peripherals, X-ray tubes, and consumables.

3.15 1 869-999900

METHOD DEVELOPMENT (On-Site)

Per Optional Item 8 of the State of Nebraska - Invitation to Bid Contract



SPECIAL TERMS AND CONDITIONS: (US STANDARD SYSTEM)

Freight Terms:

F.O.B. Destination, Prepaid and Included

Payment Terms:

100 % upon acceptance, Net 30

Delivery: 120 Days ARO

Any extraordinary requirements that are required to deliver the system to the final lab space from the delivery truck are the responsibility of the customer (riggers, special moving equipment, etc.) unless otherwise agreed to by Bruker in advance of delivery.

Validity:

This quotation is valid for one (1) year after issuance.

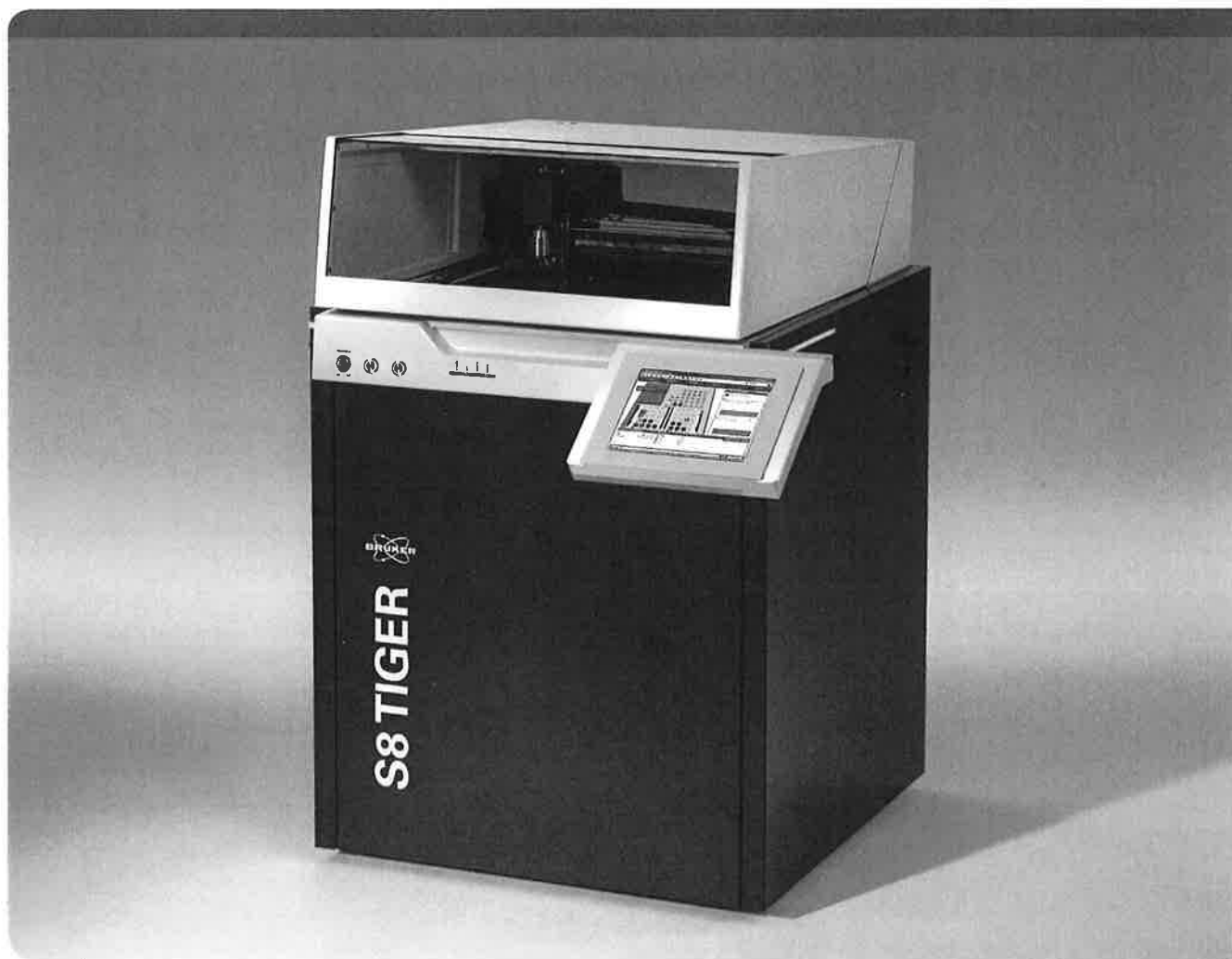
Acceptance:

The acceptance test is considered successful if the system confirms the acceptance parameters in accordance with the comprehensive test procedure within the framework of our ISO procedure for testing the functionality and performance of the system. (The acceptance parameters can be downloaded from <http://www.brukersupport.com/BrukerDownloads/1>)

Purchase order may be faxed to [608-276-3006](tel:608-276-3006) or emailed to SOP.Team.AXS.US@bruker.com.

Bruker Nano, Inc.

5465 E. Cheryl Parkway
Madison, WI 53711
United States



S8 TIGER Series 2

- Spectrometry Solutions

Innovation with Integrity

XRF



HighSense



XRF²



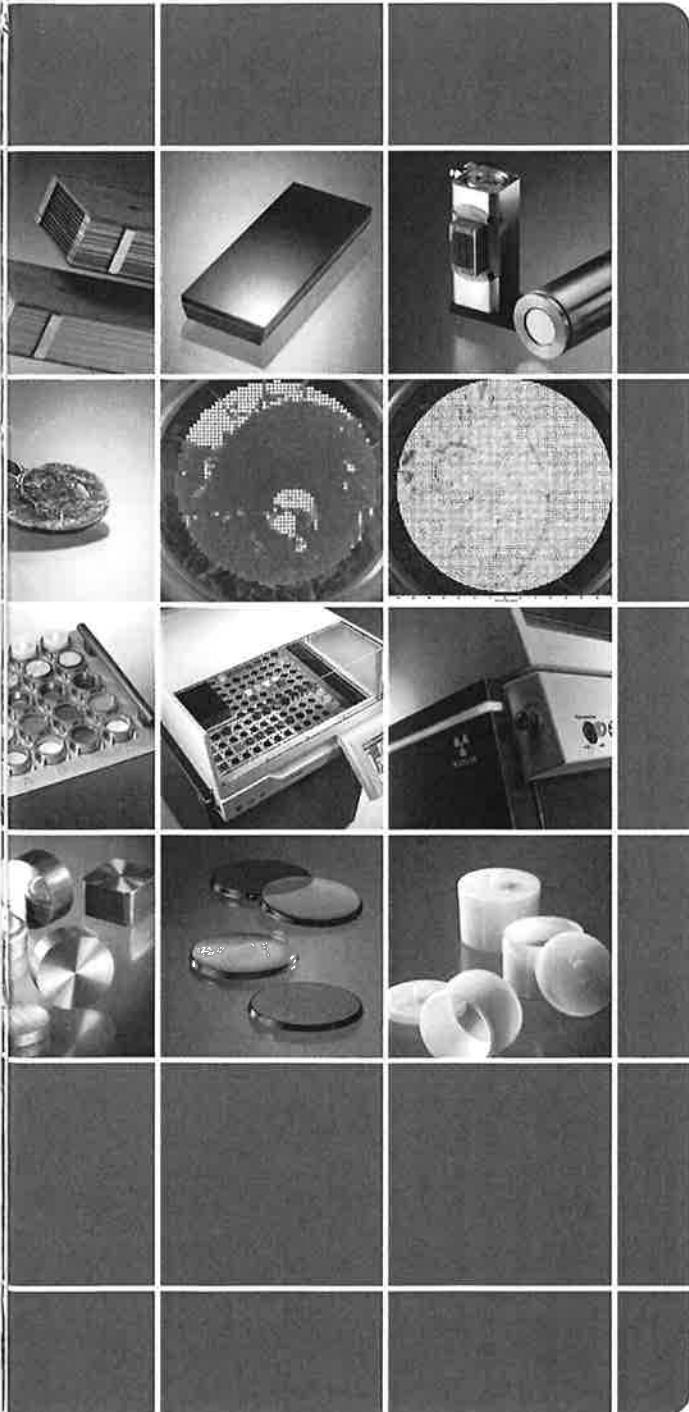
EZ Ergo



Samples



S8 TIGER Series 2 – Take the Next Step in Analytical Performance and Flexibility !



HighSense™: Accuracy and precision are vital for industrial quality and process control analytics. Close control levels and tight sample grids in elemental analysis are the success factors for better quality and cost efficiency. The S8 TIGER WDXRF spectrometer is the ideal analytical tool for these tasks: Thanks to HighSense technology it delivers the optimal sensitivity for all elements from Beryllium (Be) to Americium (Am). HighSense technology includes new XS-Series analyzer crystals, the HighSense counting electronics, and the HighSense X-ray tubes. This enables the S8 TIGER Series 2 to deliver the maximum performance for fastest time-to-result, lowest detection limits, and best analytical precision.

XRF²: Analytical flexibility is of foremost importance in research and academia. The analysis of all materials, including bulk samples, small particles or elemental distributions, are perfectly mastered with the all-new S8 TIGER Series 2. With the HighSense beam path, high-resolution WDXRF technology, and optimal detection of light, medium, and heavy elements, the XRF² mapping tool of the S8 TIGER Series 2 delivers best sensitivity, smallest spot size down to 300 µm, and highest resolution for small-spot applications.

EZ Ergo: Ergonomic and failsafe operation is vital for efficiency and best analytical data. Ease-of-use operation is guaranteed with the multilingual TouchControl interface on the S8 TIGER Series 2. The EasyLoad magazines allow easy handling of all sample types. Optimal instrument uptime and low running cost are guaranteed by the SampleCare technology which protects S8 TIGER Series 2 components.

Simply get the best with the S8 TIGER Series 2:

- Best accuracy and precision for quality and process control: HighSense technology for ultimate sensitivity and detection limits
- Ultimate analytical flexibility for research and academia: XRF² mapping with smallest spot size (300 µm FWHM) and 100 µm step size
- EZ Ergo for ergonomic, fail-safe operation with TouchControl for unique ease-of-use
- Optimal system uptime and lowest cost of operation with SampleCare technology

S8 TIGER Series 2 with HighSense Technology: Impressive Performance

The goal of any analysis is to obtain the most accurate results with the highest precision in the shortest possible time. In elemental analysis, speed leads to the shortest time-to-result and the highest sample throughput. Speed, accuracy and reliability demand outstanding technology.

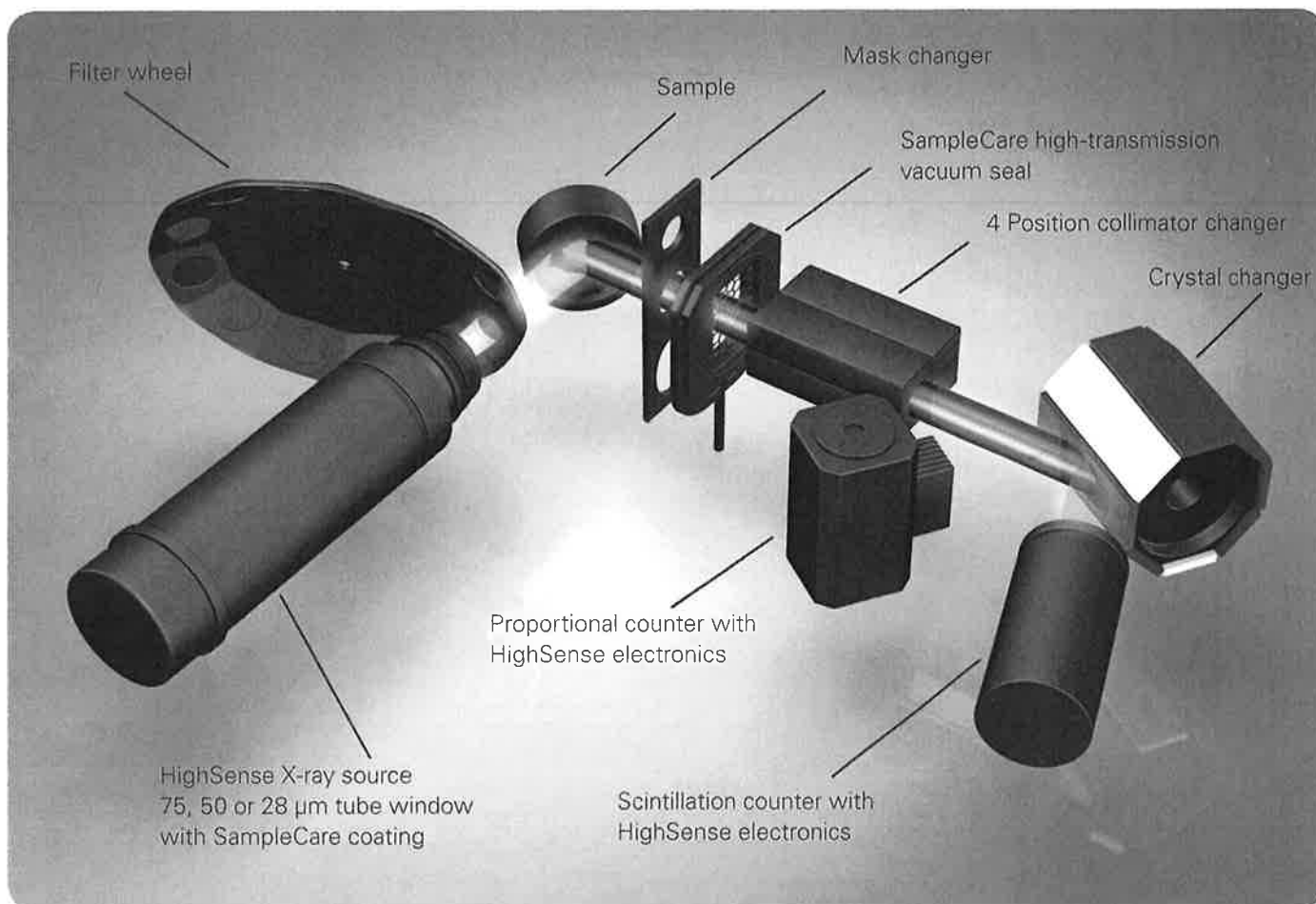
This is where the S8 TIGER Series 2 shines: Every single component in the beam path was designed for performance and robustness. It starts with the unrivalled flexible Bruker HV generator and HighSense X-ray tubes with up to 170 mA current for optimal excitation. A series of our XS analyzer crystals from the XS-Series enable the S8 TIGER Series 2 to achieve the highest intensity, best

precision and optimal resolution in various applications: The XS-400 crystal delivers 35% higher intensity over the entire element range from K – Am. The XS-CEM brings ultimate precision for Al and Si in cement and mineral applications.

As a highlight the new HighSense counting electronics delivers ultimate high linear countrates for both, the scintillation and proportional counter. With the DynaMatch technology this range even goes up to 13 Mcps making the S8 TIGER Series 2 the perfect choice for process control applications achieving, highest precision and maximum sample throughput.



S8 TIGER Series 2 for industrial quality and process control – Higher accuracy and precision with HighSense technology



HighSense X-ray beam path of the S8 TIGER Series 2

S8 TIGER Series 2 HighSense Technology

- The **HighSense X-ray tube** and primary radiation filter guarantee that each element in the sample is optimally excited. Gain more than 35% more intensity for light elements with the 28 μm window.
- The **automatic mask changer** adjust to the sample size and carries the **HighSense XRF²** beam guide snorkel mask. The intensity in mapping is up to 10 times higher than with conventional WDXRF systems.
- The **high-transmission vacuum seal** as part of SampleCare separates the sample and goniometer chamber – it dramatically reduces cost of operation and enhances system uptime.
- **Four position collimator changer** enables users to make the optimal choice between intensity and resolution. This makes the S8 TIGER Series 2 the most flexible WDXRF system.
- **The analyzer crystals** play a crucial role: They break down the fluorescence spectrum into the specific wavelengths for the elements: The advanced Bruker XS crystals are enhancing the S8 TIGER Series 2 in sensitivity, detection limits, resolution, analysis speed and precision.
- For the detection of light elements a **proportional counter** and for the heavier elements a **scintillation counter** is used. Both detectors are perfectly suited for WDXRF applications with ultimate linear range applying DynaMatch with up to 13 Mcps counts.

Excitation



High Voltage Generator

- 1 kW up to 50 mA
- 3 kW up to 150 mA
- 4 kW up to 170 mA

Current 170 mA

Precision and flexibility

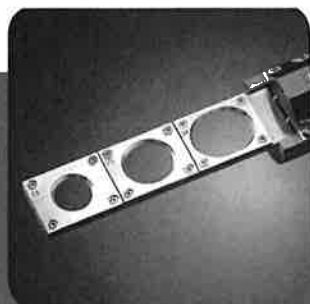
- DynaMatch: Unrivalled flexibility, instant switch from 20 to 60 kV and 5 to 170 mA
- Best HV precision: $< \pm 0.00005$
- 170 mA for best light element excitation



HighSense X-ray tube

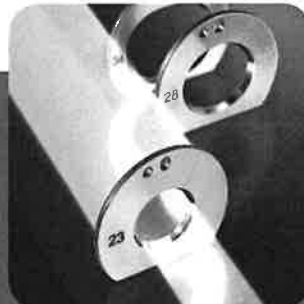
- 75 μ m Be Window
- Closest coupling anode to sample
- Long life: 2 year warranty

Sample



Automatic mask changer

- Options for 34, 28, 23, 18, 8, 5, 1.2 and 0.3 mm masks
- SampleCare shield to protect the goniometer



Small spot analysis

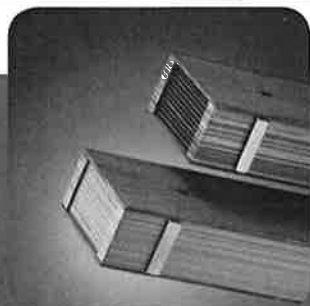
- Snorkel masks: 8, 5, 1.2 and 0.3 mm
- Beamguide technology for lowest background and higher intensity



High-transmission vacuum seal

- Separates sample and goniometer chamber
- No loss on intensity
- Instant switch solid – liquid sample

Intensity/ Resolution



Automatic 4 position collimator

- Best analytical flexibility
- Optimized sensitivity and resolution
- Different openings from 0.12 – 2°

XS-GE-C

XS-Series Crystals

- Selection of more than 18 crystals available
- Application optimized analyzer crystals

S + 20%

XS-GE-C analyzer Crystal

- 40% more intensity for P
- 20% higher count rates for S
- 0.2 ppm detection limit for 4 kW

Detection



Detectors

- High efficiency flowcounter for light element detection
- High sensitivity scintillation counter for optimal heavy element detection

Ultimate Linear Range

HighSense MCA

- Count rates up to 4 Mcps
- Wide calibration ranges
- On the fly dead time correction

DynaMatch 13 Mcps

DynaMatch

- 13 Mcps max count rate
- Enhanced standardless analysis
- No method setup for majors in unknown samples

HighSense 50 μm

HighSense X-ray tube 50 μm

- 15% higher intensity (light elements)
- 50 μm Be Window
- SampleCare coating

HighSense 28 μm

HighSense X-ray tube 28 μm

- 35% higher intensity (light elements)
- 28 μm Be Window
- SampleCare coating

Primary Beam Filters

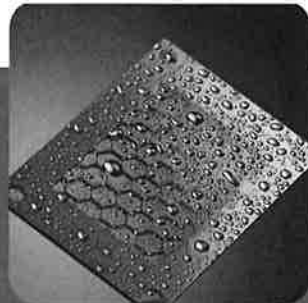
- 10 positions beam filter
- Optimal peak to background ratios
- SampleCare tube shield



Sample Care

SampleCare

- Shields goniometer
- Best instrument uptime
- SampleCare coating



SampleCare

- Locks out drops and particles
- Protects components
- Enhances instrument uptime

He purge – 60%

Economic Helium mode

- Reduced Helium mode for oils
- Saves 60% of He
- Atmospheric He mode for volatile samples



High intensity crystal XS-400

- Covers K – Am
- Proprietary crystal structure
- For precision in mining and metals

XS-400 + 35%

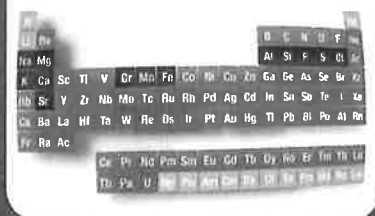
High intensity crystal XS-400

- Saves > 35% counting time per element
- Replaces expensive 3rd detectors
- More efficient than sealed gas counters

N + 100%

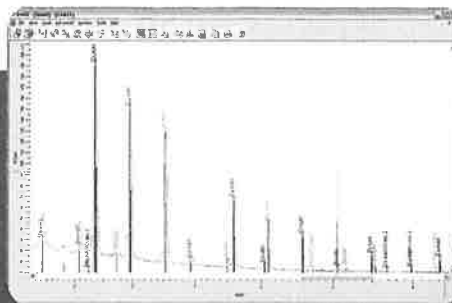
Nitrogen with XS-N HighSense

- 2 times higher intensity for N
- Time saving
- 30 % better detection limits for N



ElectronicGearing

- Less than 2 minutes scan
- Simultaneous alignment of all drives
- Up to 1200° scan speed



Fast monitoring

- High precision goniometer
- Reproducibility better than $\pm 0.0001^\circ$
- Digital optical encoders

XRF² in the S8 TIGER Series 2 – Explore the Microcosmos !


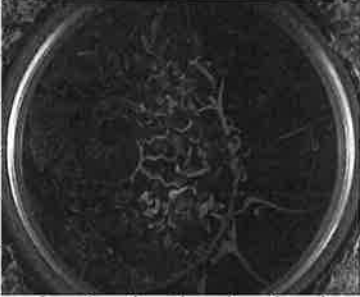
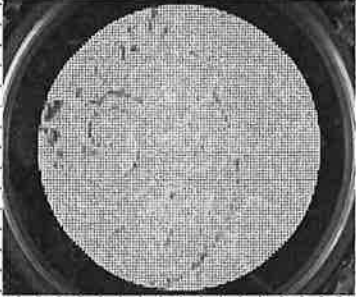
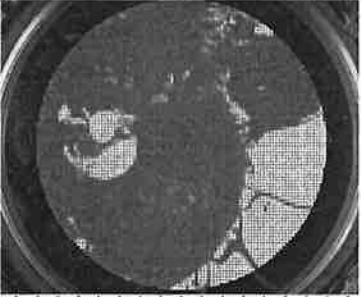
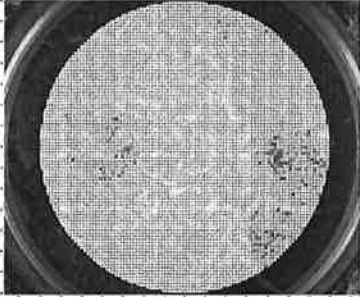
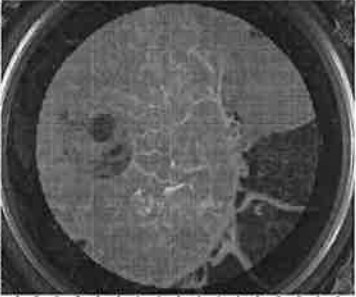
Element mapping and particle analysis are important for troubleshooting in production and material research. In contrast to electron microscopes mapping is a straightforward task with XRF due to the simple sample preparation and it is even easier with the S8 TIGER Series 2: Intuitive quick setup of measurements and powerful graphical reporting are easily achieved with the Mapping Client of SPECTRA^{plus}.

The XRF² mapping tool of the S8 TIGER Series 2 offers unrivalled analytical performance: With a spot size as low as 300 µm (FWHM) and 100 µm step size, the S8 TIGER sets the benchmark in its class! With up to 10 times higher sensitivity due to HighSense mapping optics, the S8 TIGER Series 2 is ideal for elemental mapping of major, minor, and trace elements. Using its WDXRF goniometer, the S8 TIGER delivers better resolution and more efficient light and heavy element detection than EDXRF based mapping systems.



S8 TIGER Series 2 with XRF² mapping: An indispensable analytical tool for trouble shooting in production and laboratories for material research and academia

XRF² Mapping

				
	<p>Geochemical mapping in Palaeontology: Fossilized ammonite shell with different chamber fillings</p>	<p>Sample view with HD camera of the Mapping Client in the S8 TIGER Series 2: High-resolution image for definition of freely selectable scan area</p>	<p>Strontium concentration traces white shell remnants and is highest in outer shell and lowest in crosspieces of compartments</p>	
				
	<p>Chamber filling (I): Ca concentration correlating with beige brown filling</p>	<p>Chamber filling (II): Si concentration correlates well with dark grey filling at center and entrance of ammonite shell</p>	<p>Chamber filling (III): Fe concentration shows positive correlation with Si concentration and is highest at shell entrance</p>	

Highlights of XRF² Mapping

<p>Smallest Spot Size !</p> <ul style="list-style-type: none"> ▪ 300 µm ▪ 1.2 mm alternatively <p>100 µm step size</p> <ul style="list-style-type: none"> ▪ High resolution spatial mapping 	<p>WDXRF performance</p> <ul style="list-style-type: none"> ▪ Best light element analysis with dedicated proportional counter ▪ Optimal heavy element detection with scintillation counter ▪ High WDXRF resolution 	<p>Best intensity</p> <ul style="list-style-type: none"> ▪ More than ten times higher sensitivity ▪ HighSense beam path ▪ Trace element detection in mapping 	
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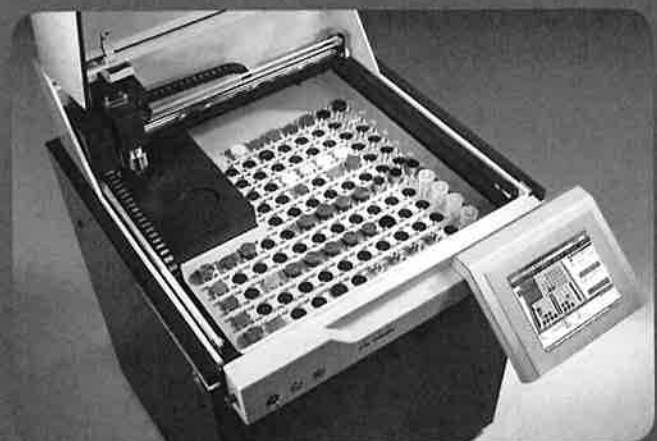
Load any kind of sample – be productive with EZ Ergo !



75 Pos EasyLoad Magazine (71 Pos, when automated with liquid sample detection)



60 Pos Sample Cup Loader for heavy samples and XRF² mapping with HD camera



108 Pos bare samples with vacuum grabber for flat samples (pressed pellets and fused beads)

EasyLoad makes work incredibly simple and gives you a sure hand: Either insert samples into one of the fixed positions or fill a prepared sample tray as required, start the measurement or a whole mixed series of measurements and ... that's it!

Thanks to EasyLoad that is all you have to do and you need not worry that anything will go wrong. Owing to the automatic identification of the sample type – solid or liquid – EasyLoad reliably prevents incorrect operation, such as measurement of liquids or loose powders under vacuum.

In combination with the intuitive interface TouchControl the S8 TIGER Series 2 becomes an incredible ergonomic lab instrument – we call this EZ Ergo!

Sample magazine for every need:

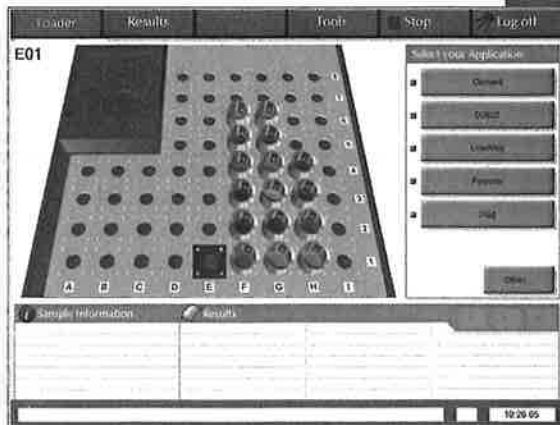
- 75 Pos EasyLoad with two sample trays for convenient loading
- Automatic liquid sample detection
- 60 Pos sample cup magazine for flexibility in sample handling, from light to heavy, from large to small
- 108 Pos bare flat samples for maximum productivity with vacuum grabber
- Combination of magazines for cups and bare samples

Automation:

- Automation interface to belt and conveyors
- AXSCOM SW interface to automation

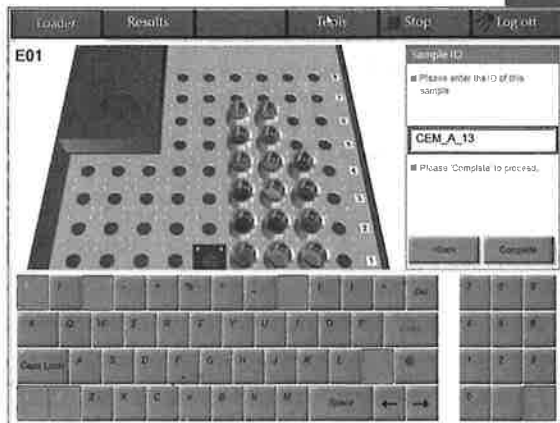
1

The measurement of any sample is as simple as it can be: Just place the sample in the magazine and select the application! Perfect for industrial use: All routine applications are quick start buttons!



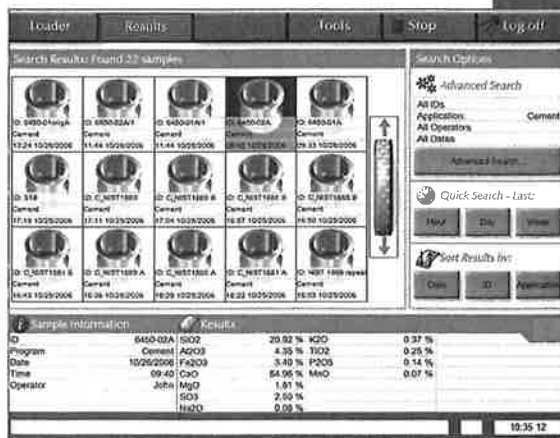
2

Quick: Now you type in the sample ID. Direct on the touchscreen, no hassle with a PC, mouse or keyboard: Simply press "MEASURE" to analyze! There is nothing to remember, it's simply step-by-step.



3

Instant results: Each result is displayed on the touchscreen, sent to the printer and stored in the results database. Limit values are checked automatically and reported color coded. Different user access levels protect relevant data!



TouchControl. Analyze'n Go – intuitive quick sample start, adjustable

SPECTRA^{plus} and QUANT-EXPRESS – That is so easy !

- User-specific calibration (e.g.)
- Added elements with QUANT-EXPRESS calibration
- Elements with QUANT-EXPRESS calibration
- Not available

Unlimited flexibility with QUANT-EXPRESS: full standardless analysis or any combination with standard-based calibrations and QUANT-EXPRESS calibrated lines

Line Name	Line kV	Tube kV	Filter	Collimator	Crystal	Detector	21h Peak
Mn KAl-Maj	17.49	50	None	0.23	LF200	Sci	20.293
Mn LA1-HR	0.6371	30	None	0.23	MS-55	Gas	40.515
Mn LA1-HS	0.6371	30	None	0.46	MS-55	Gas	40.515
Mn KB1-ALT-Min	6.495	60	None	0.23	LF200	Sci	94.282
Mn KB1-ALT-Tr	6.495	60	None	0.23	LF200	Sci	94.282
Mn KB1-HR-Min	6.495	60	None	0.23	LF200	Sci	56.676
Mn KB1-HR-Tr	6.495	60	None	0.23	LF200	Sci	56.676
Mn KB1-HS-Tr	6.495	60	None	0.46	MS-55	Gas	40.515
Mn KA1-ALT-Min	6.495	60	None	0.23	LF200	Sci	94.282
Mn KA1-ALT-Tr	6.495	60	None	0.23	LF200	Sci	94.282
Mn KA1-HR-Min	6.495	60	None	0.23	LF200	Sci	56.676
Mn KA1-HR-Tr	6.495	60	None	0.23	LF200	Sci	56.676
Mn KA1-HS-Min	6.495	60	None	0.46	MS-55	Gas	40.515
Mn KA1-HS-Tr	6.495	60	None	0.46	MS-55	Gas	40.515
Mn KA1-Maj	17.49	50	None	0.23	LF200	Sci	20.293
Mg KA1-HR-Min	12	30	None	0.23	LF200	Sci	56.676
Mg KA1-HR-Tr	12	30	None	0.23	LF200	Sci	56.676
Mg KA1-HS-Min	12	30	None	0.46	MS-55	Gas	40.515
Mg KA1-HS-Tr	12	30	None	0.46	MS-55	Gas	40.515

QUANT-EXPRESS™: Unique Line Library with Integrated Analytical Intelligence

- 1 Element line for a specific concentration range
- 2 Measurement conditions (peak position, excitation parameters, crystal, collimator, detector)
- 3 Calibration coefficients
- 4 Overlapping lines with correction factors

QUANT-EXPRESS is the unique standardless software: You benefit both from the advantages of customized calibrations with your own standards (maximum accuracy and maximum precision), as well as from the flexibility and versatility of QUANT-EXPRESS.

QUANT-EXPRESS comprises a unique multi-purpose calibration prepared by Bruker using innumerable certified standards. All our decades of experience in XRF are made available with these calibrations and measurement methods. We call it: integrated Analytical Intelligence.

QUANT-EXPRESS not only enhances the potential of your routine system, it also assists you with other tasks. When setting up your own calibrations, QUANT-EXPRESS automatically creates the optimal measurement method to match each element and every concentration range – quickly simply, and reliably.

The real class of QUANT-EXPRESS comes fully into account, when performing the fast, reliable, and complete analysis of unknown solid and liquid samples. Less than two minutes for a qualitative and quantitative screening of unknown samples – only QUANT-EXPRESS™ can do that for you.

The S8 TIGER Series 2 comes with SPECTRA^{plus} – the comprehensive analytical XRF software package making setup, operation and data maintenance easy, yet powerful.

Application

It is quite simple to create applications: SPECTRA^{plus} directly follows your workflow – from the definition of standard samples, through sample preparation, the calculation of the calibration and on to the final release of the application. SPECTRA^{plus} supports you in all these steps. When creating your own measurement method, the integrated Analytical Intelligence assists you utilizing the full performance of the S8 TIGER.

Measurement

To start your measurements, you only enter the preparation parameters and assign the measurement method. That's all! With a simple click you can even launch a whole series of samples.

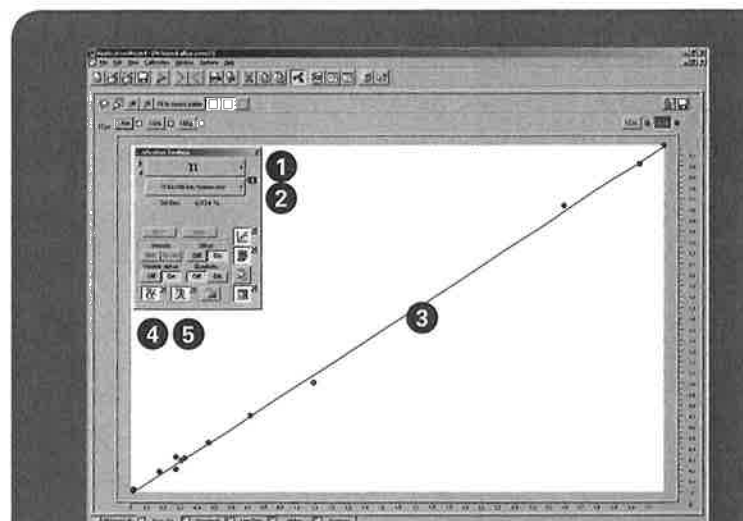
Evaluation

Whether it is qualitative or quantitative evaluation – SPECTRA^{plus} leaves all options open: Scan measurements are always evaluated fully automatically, the elements are identified and the concentrations are calculated. If you like, you can check and refine the results interactively.

Reporting

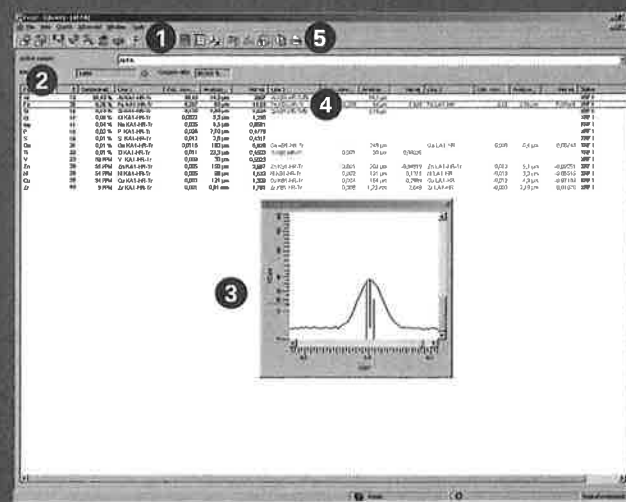
You define your own printout format, summarize the results in tables, and export the data to other programs just as you wish and need. For GLP compliant documentation the results are also archived in SPECTRA^{plus}.

- Seamless integrated standardless evaluation for all kind of samples
- Complete easy-to-use analytical software package for calibration, evaluation and reporting
- Integrated Analytical Intelligence to achieve maximum analytical performance
- Powerful state-of-the art fundamental parameter matrix correction with unique variable alphas



CALIBRATION

- 1 Element with selected analytical line
- 2 Calculated deviation of the calibration
- 3 Calibration curve
- 4 Matrix correction model: FP, variable alpha model, empirical, theoretical,...
- 5 Overlay correction



INTERACTIVE QUANTITATIVE EVALUATION

- 1 Sample ID, database search
- 2 Element with calculated result, analytical line
- 3 Display of selected element peak
- 4 Alternative analytical line
- 5 Data export to results database, export and print

S8 TIGER Series 2 – The perfect fit for every need. Customize for your application

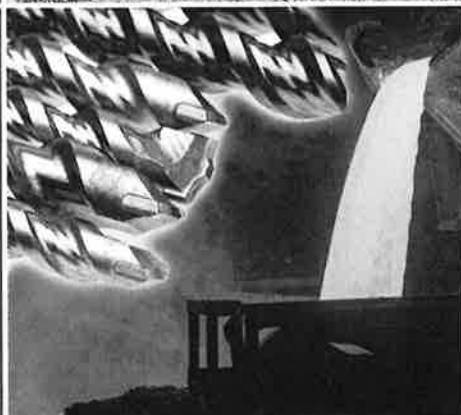
**Minerals,
Mining,
Geology**



HighSense technology

- Ultimate linear detector ranges
- Enhanced element sensitivities
- XS-100 analyzer crystal for short measurement times
- XS-400 analyzer crystal for 35% higher intensity

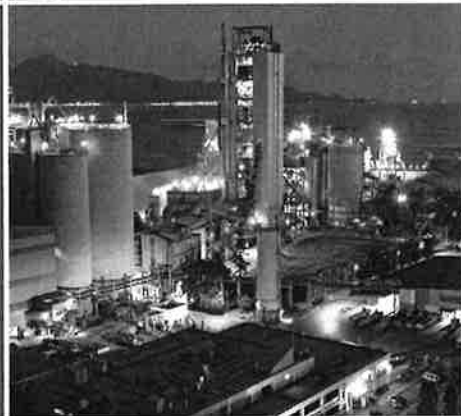
Metals



HighSense technology

- Ultimate linear detector ranges
- Enhanced element sensitivities
- XS-400 analyzer crystal for 35% higher intensity
- 30% less background for carbon with XS-C

Cement



HighSense technology

- Ultimate linear detector ranges
- Enhanced analytical precision and longterm stability with XS-CEM analyzer crystal
- High sulfur precision and speciation with XS-Ge-C
- AXSCOM interface for straightforward integration to automations

	<ol style="list-style-type: none"> 1) GEO-QUANT Basic for majors and minors in geological materials 2) GEO-QUANT Advanced for majors and minors in oxides for minerals, ores, ceramics, glass, raw materials 3) GEO-QUANT T for trace element determination in all geological samples 4) GEO-QUANT Iron Ore for grade control acc. to ISO 9516 	<ul style="list-style-type: none"> ▪ Optimal precision and detection limits ▪ High sample throughput ▪ High productivity with EasyLoad ▪ Failsafe operation with TouchControl ▪ Best results and data quality based on Bruker solutions ▪ High instrument uptime with DirectLoading and S8 Tools 	
	<ol style="list-style-type: none"> 1) METAL-QUANT for iron and copper based alloys 2) SLAG-QUANT for accurate analysis of slag composition from blast furnace and EAF operations, as well as in DRI and for ladle slags 3) ML plus for coating thickness analysis (single and multiple layers) 	<ul style="list-style-type: none"> ▪ Cost savings with fastest time to result ▪ High sample throughput ▪ Optimal precision and detection limits ▪ Failsafe operation with TouchControl ▪ Best results and data quality based on Bruker solutions ▪ Analytical flexibility for metals, raw materials and final products in one instrument ▪ High instrument uptime with DirectLoading and S8 Tools 	
	<ol style="list-style-type: none"> 1) CEMENT-QUANT for norm compliant analysis of cements according to ASTM C 114, ISO 29581, EN 196-1 2) GEO-QUANT Basic for majors and minors in raw materials 3) GEO-QUANT T for trace element determination for green eco cements 	<ul style="list-style-type: none"> ▪ Optimal precision and detection limits ▪ High sample throughput ▪ High productivity with EasyLoad ▪ Failsafe operation with TouchControl ▪ Best results and data quality based on Bruker solutions ▪ Flawless integration to automation and data transfer ▪ High instrument uptime with DirectLoading and S8 Tools 	

Petro



- Ultra-low detection limit for S down to 0.2 ppm due to XS-Ge-C
- Safe analysis of volatile samples with atmospheric helium mode
- Reduced helium consumption due to vacuum seal
- Safe sample handling with EasyLoad sample detection and SampleCare
- Long measurement times possible with low temperature tube head
- Aut – O – matic: Oxygen analysis with SPECTRA^{plus} feature

Polymers



- Ultra-low detection limit for S down to 0.2 ppm due to XS-Ge-C
- Optimal analysis of Mg in polymers with XS analyzer crystal
- Best detection limits for traces in virgin polymers due to XS-400 analyzer crystal

Quality and Process Control



- HighSense detector technology with MCA for ultimate wide linear ranges
- 10 primary beam filters
- 4 collimators
- 8 analyzer crystal
- High precision DynaMatch HV generator
- High precision analyzer crystals XS-100, XS-CEM, XS-Ge-C, XS-400
- Smallest particles analysis with 0.3 mm mask

R&D, Academia



- HighSense technology for enhanced analytical precision
- HighSense X-ray tube with 28 μm tube window for best light element excitation
- DynaMatch HV generator up to 170 mA for ultimate light element excitation
- Enhanced light element analysis with dedicated Analyzer crystals: XS-B, XS-C, XS-N-HighSense, XS-55
- Unrivalled analytical flexibility with
 - 10 primary beam filters
 - 4 collimators
 - 8 analyzer crystal
 - 8 sample sizes
- XRF² small spot mapping with best sensitivity due to HighSense optics
- Smallest spot size down to 0.3 mm

- 1) **PETRO-QUANT** ready to analyze solution for 30 trace elements and wear metals in oil, wax, lubricants, water, polymers, slurries
- 2) **Norm compliant factory calibrations** for
 - a. ASTM: D 2622, D 6443, D 5059
 - b. EN ISO: 14596, 14597, 15597, 20884
 - c. DIN: 13723, 51363, 51391, 51399, 51431, 51790

- Lowest cost of operation with reduced helium consumption
- Lowest maintenance costs due to SampleCare
- Best analytical precision due to longer measurement times possible with low temperature tube head
- Long X-ray tube life due to SampleCare

- 1) **POLYMER-QUANT A** for the quick analysis of additives in polymers
- 2) **RoHS-QUANT ABS** for the safe determination of toxic heavy elements in consumer goods

- Best analytical precision due to longer measurement times possible with low temperature tube head
- High analytical precision with DirectLoading

- 1) **QUANT-EXPRESS** for the quick, fast and accurate determination of all product related materials
- 2) **ML plus** for coating thickness analysis (single and multiple layers)

- Cost savings in production due to tighter process and quality control
- Lowest cost of operation with SampleCare
- High productivity with EZ Ergo technology: TouchControl and EasyLoad
- Optimal analytical flexibility for today and future control requirements

- 1) **QUANT-EXPRESS** for the quick, fast and accurate determination of all product related materials
- 2) **ML plus** for coating thickness analysis (single and multiple layers)

- Best possible data for light elements
- Accurate and precise analysis of bulk and small samples
- Unrivalled analytical flexibility
- Fast screening of large sample batches
- Best spatial resolution for mapping applications
- Mapping of traces and light elements

S8 TIGER Series 2 – Evolution of Reliability

- 1 Grabber with automatic sample detection
- 2 DuraBeryllium tube shield
- 3 Contamination shields
- 4 Mask changer
- 5 Vacuum seal
- 6 Dust reservoir



SampleCare™

Low maintenance and high instrument uptime due to unique protection during loading and unloading:

- Two integrated contamination shields for tube and goniometer protection
- Dust reservoir: Dust and liquid collection at safe place and simple cleaning w/o service
- DuraBeryllium™ shield for tube window protection
- Sample Care coating for 50 and 28 μm X-ray tube
- Unique vacuum seal with high transmission window for goniometer protection

A simple recipe leads to success: Continuous analysis, steady improvement, learning, and striving for the best. The S8 TIGER Series 2 has evolved from every past WDXRF generation improving on instrument uptime and robustness.

Thanks to SampleCare you can rely on the S8 TIGER to 100%. SampleCare constantly protects all important system components from contamination, which might lead to incorrect results or in the worst case to system shutdown. Our S8 TIGER with SampleCare prevents this safely in 4 ways: The DuraBeryllium tube shield protects the head of the X-ray tube; the mask changer and the vacuum seal protect the goniometer chamber. If, by chance anything should have gone wrong during preparation and the sample breaks or leaks, this is not a problem. System components are well protected, easy to access, and can be cleaned with little effort.

The S8 Tool software continuously monitors all system parameters and offers a clear view to users what is happening. In case of trouble, a simple click on the FIRST AID button brings the instrument back to normal conditions. Visual warnings indicate preventative maintenance tasks to be scheduled.

When it comes to instrument uptime, low running cost, and easy maintenance, there is no better deal than the S8 TIGER.

- Safe analysis of delicate samples with automatic sample recognition
- Unique instrument protection due to contamination shields
- Lowest maintenance and best system uptime
- Most flexible sample handling – convenient sample loading with trays

Latest WDXRF Technology made in Germany

Bruker develops, designs, and manufactures the S8 TIGER Series 2 in Karlsruhe, Germany. To deliver best quality and optimum performance, latest XRF technology and core components of the S8 TIGER Series 2 are specifically developed and made for this instrument at Bruker's plant in Karlsruhe.

It starts with vital components, such as the goniometer in our machine shop, the HighSense HV generator or the XS Series analyzer crystals. Based on the specifically for the S8 TIGER developed X-ray tubes and the HighSense detectors, the spectrometer are fine-tuned for optimum analytical performance in the Karlsruhe test center prior to shipment.

With our worldwide presence, our local service hubs, with our trained service teams, Bruker supports its customers worldwide. We offer different levels of service and maintenance contracts and our hotline centers support our customers with modern WebEx service tools. The Bruker application team provides excellent factory training and onsite support globally to offer best customer service from A to Z.

Any question left – simply call!



Bruker facility in Karlsruhe



XRF production in Karlsruhe, Germany



Bruker's worldwide service organization for total customer satisfaction

Technical Data

Systems	S8 TIGER 1K	S8 TIGER 3 kW	S8 TIGER 4 kW
	1 kW 50 kV max. 50 mA max.	3 kW 60 kV max. 150 mA max.	4 kW 60 kV max. 170 mA max.
X-ray tubes	Rh, 75 µm Be Window	Rh, 75 µm Be Window Rh, 50 µm Be Window, SampleCare protective coating Rh, 28 µm Be Window, SampleCare protective coating Cr, max.3.3 kW	Rh, 75 µm Be Window
Collimator	Automatic collimator changer (up to 4)		
Analyzer crystals	Automatic crystal changer (up to 8) Included: XS-55, PET, LiF (200) Optional: XS-B, XS-C, XS-N, XS-PET-C, XS-CEM, XS-Ge-C, LiF (220), LiF (420), ADP, Ge, TIAP, InSb, XS-400, XS-100		
HighSense Detectors	Proportional flow counter and scintillation counter with MCA technology		
DynaMatch™	Linear intensity range more than 13 million cps		
XRF^{2 1)}	High resolution and high intensity element mapping with 300 µm and 1.2 mm spot (FWHM)		
Automated Mask Changer	Automatic masks (up to 3): closed (SampleCare;) 34 mm, 28 mm, 23 mm, 18 mm, 8 mm (BeamGuide), 5 mm (BeamGuide)		
TouchControl™ 1)	Integrated touchscreen for easy and intuitive operation		
SampleCare™ 1)	X-ray tube and goniometer protected by contamination shields Sample and spectrometer chamber separated by programmable vacuum seal		
EasyLoad™ 1)	Automatic sample recognition Portable sample trays		
Power requirements	208 – 240 V (1P/3P) 50/60 Hz	208 V, 60 Hz (1P/3P) 230 V, 50/60 Hz (3P)	
Compressed air	Not required		
Detector gas	P5 gas (5% methane, 95% argon) for flow counter P10 gas (10% methane, 90% argon) for flow counter		
External cooling water	No cooling water	Cooling water Water consumption automatically regulated and minimized, short term interruptions are compensated	
Dimensions (height x width x depth)	135 cm x 89 cm x 90 cm; 53.1" x 35" x 35.4"	135 cm x 89 cm x 104 cm; 53.1" x 35" x 41"	
	Touchscreen: Allows additional width of 12 cm (4.7")		
	446 kg	476 kg	
Quality & safety	DIN EN ISO 9001:2008 CE certified Fully radiation protected system; radiation < 1 µSv/h		

1) optional packages

Bruker AXS GmbH

info.baxs@bruker.com

Worldwide offices

bruker.com/baxs-offices

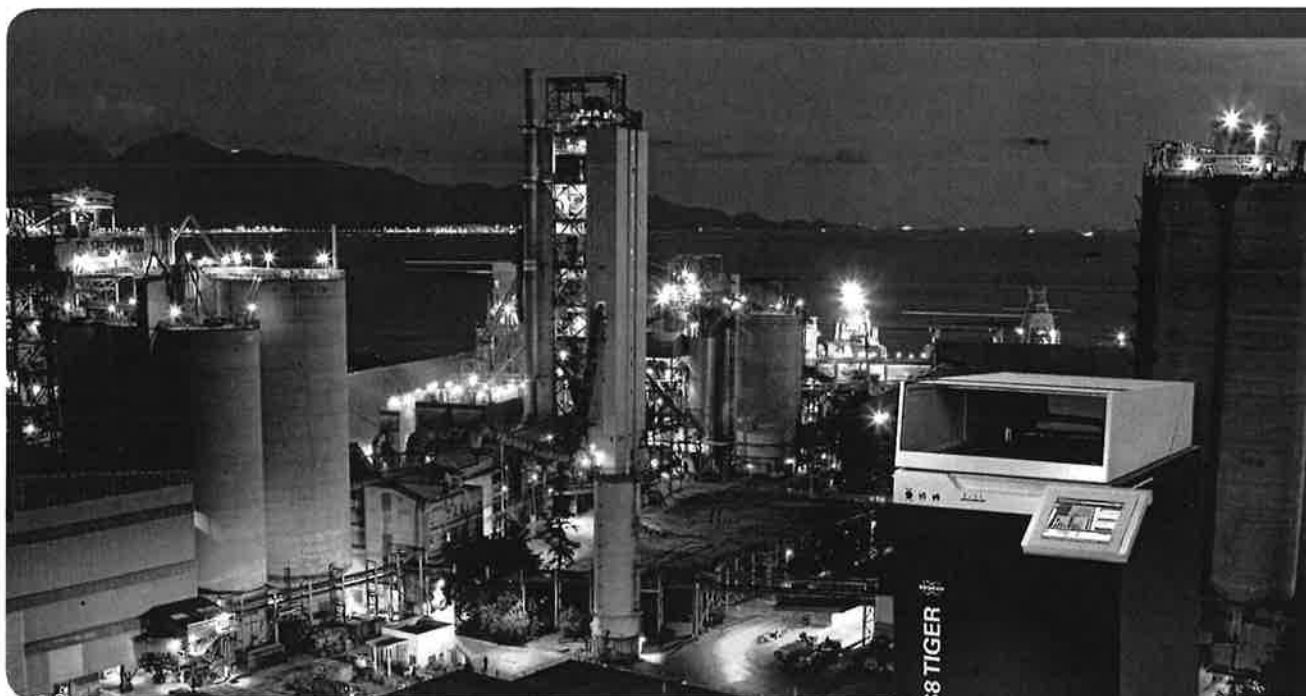
Online information

bruker.com/s8tiger

www.bruker.com



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Lab Report XRF 145

S8 TIGER Series 2

- The Determination of Sulfur Species (Sulfide – Sulfate) in Cement by WDXRF

Introduction

The examination of the sulfate concentration in cement is vital, because the presence of high amounts of sulfate delays the hydration of the aluminate phase. Especially for blast furnace slag cement the total concentration of sulfur and the

ratio of the two sulfur species finally determines the cement quality. Traditionally the sulfate concentration is analyzed with wet chemical methods requiring long analysis time combined with high costs.

In general, X-ray fluorescence (XRF) is used to determine the total concentration of the elements. However, today the analysis of the different chemical compounds of lighter elements such as sulfur is possible by using wavelength dispersive XRF (WDXRF) with modern high resolution analyzer crystals. The different chemical compositions of the sulfur species will cause a peak shift, which can be used to separate both sulfur compounds, sulfate (SO_4^{2-}) and sulfide (S^{2-}) and determine the concentrations. The results can be used to calculate the slag concentration by subtracting the part derived from cement from the total sulfur concentration. This report explains how the modern sequential WDXRF spectrometer S8 TIGER Series 2 performs speciation of sulfur in cement samples.



S8 TIGER Series 2 WDXRF spectrometer

Chemical speciation with XRF

The outer electrons of lighter elements up to the atomic number 18 are present in the atomic shells which are important for the emission of X-ray fluorescence lines. Sulfur has 6 valence electrons in the M-Shell. Any change in the oxidation state and therefore in the number of electrons in this shell will affect the K_{β} line of sulfur.

In cement there are two sulfur species present: Sulfide (S^{2-}) and sulfate (SO_4^{2-} , calculated as SO_3 in cement). Sulfide has 8 electrons in total, in the M-shell, while sulfate has no electron left in the important outer shell. This difference leads to changes in the spectrum, which can be used for the specification of the sulfur compounds:

- The X-ray line shifts (chemical shift)
Both the K_{α} and K_{β} lines show a shift of the line position. The physical reason is a shift of the energy levels caused by the chemical bonding influence.
- Additional X-ray lines appear (Satellite lines)
There is a significant difference concerning the presence of an additional line on the low energy side of the K_{β} line of sulfate, but not for sulfide.
- Changes in the ratio between K_{α} and K_{β}
The sulfide/sulfate ratio can be calculated based in the K_{α}/K_{β} ratio with respect to the total sulfur concentration.

Quantitative Determination

For the quantification of sulfide and sulfate the samples are analyzed with the sequential WDXRF spectrometer S8 TIGER Series 2. The S K_{β} line is measured by using the fine collimator with an opening of 0.23° and the high resolution crystal XS-Ge-C. This curved crystal provides a higher resolution and increased sensitivity for sulfur in comparison to traditional crystals, leading to a better analytical performance. The absolute precision of the goniometer positioning is vital for the accurate determination of the sulfur species. The S8 TIGER owns a high precision mechanical goniometer with ElectronicGearing for the optimized simultaneous rapid and reproducible positioning of all system components. This ensures the optimum resolution of neighboring peaks. The spectra of two samples with pure sulfide (red) and sulfate (grey) are shown in figure 1. In figure 2 spectra of real blast furbase slag cements are shown.

In both spectra the effects of the chemical bonding on the spectrum can be seen. The S K_{β} line shows a clear peak shift of about 0.2° (2θ). This difference is typically too small for a routine determination of the two compounds. The intensity of the S K_{β} line is composed by the emission of sulfide and sulfate. But sulfate in addition has a satellite line on the low energy side, the so called S K_{β} SX line. The difference of the peak positions is about 0.68° (2θ), which can be clearly resolved. The total sulfide concentration can now be analyzed using the K_{β} line. The part from sulfate is subtracted by defining a line overlay correction based on the satellite line S K_{β} SX.

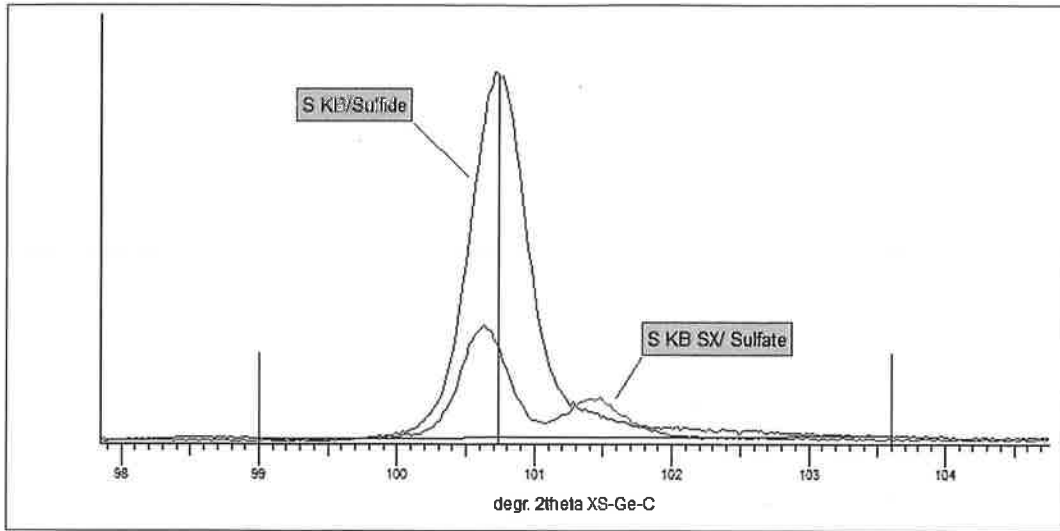


Figure 1: Set of sample spectra - pure sulfide sample is highlighted in red, the spectral background is colored blue, and sulfate is shown in grey

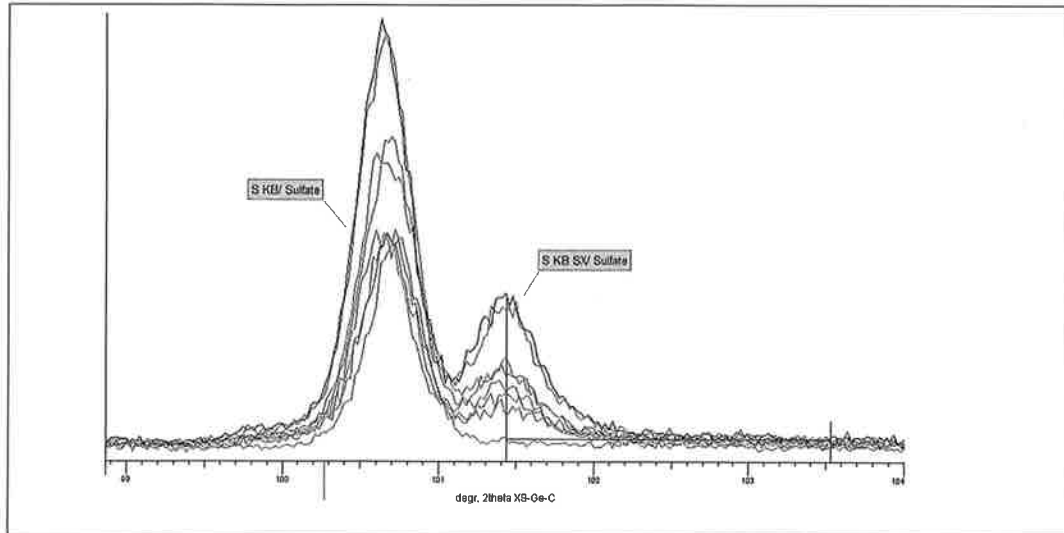


Figure 2: Set of blast furnace slag cements with varying concentrations of sulfide and sulfate.

Calibration

The S8 TIGER was calibrated using a set of 8 cement samples with varying concentrations of sulfide and sulfate. In addition also the ratio between both compounds was not constant. The samples were freshly prepared as pressed powder. For this 10 g sample was milled with 3 tabs of cellulose grinding aid and then

pressed with 20 tons for 20 seconds in aluminum cups. Measurement time was 60 seconds for each line and 30 seconds for two common backgrounds. The calibration curves for both sulfur species are shown in figure 3 and figure 4. Results of calibration standards are shown in table 1.

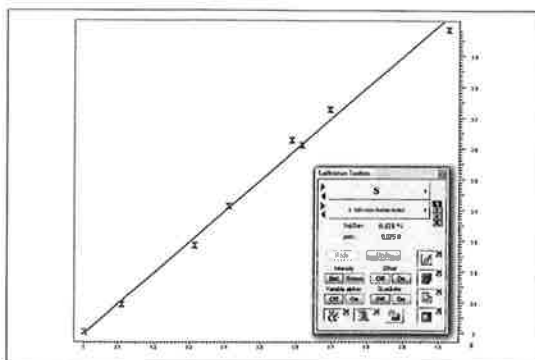


Figure 3: Calibration Curve for sulfide by applying line overlap correction

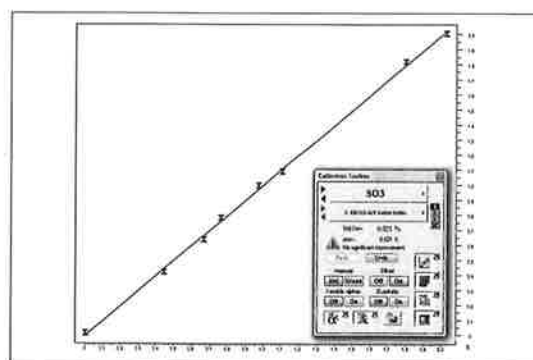


Figure 4: Calibration Curve for sulfate

Table 1: The results for some calibration standards

Sample name	Reference S ²⁻ [%]	Measured S ²⁻ [%]	Abs. Diff. [%]	Reference SO ₃ [%]	Measured SO ₃ [%]	Abs. Diff. [%]
S1	0	0.0059	0.0059	1.1068	1.0909	0.0159
S2	1.0254	0.9838	0.0416	0	0.0155	0.0155
S3	0.1074	0.0945	0.0129	2.022	2.0061	0.0159
S4	0.6934	0.7258	0.0324	0.7587	0.7808	0.0221
S5	0.4102	0.4135	0.0033	0.6649	0.6394	0.0255
S6	0.5859	0.6283	0.0424	0.9739	0.9955	0.0216
S7	0.3125	0.286	0.0265	1.7991	1.8187	0.0196
S8	0.6152	0.6122	0.003	0.442	0.4206	0.0214

Stability and repeatability

One additional cement sample was measured 10 times to check the stability and repeatability of the method. Table 2 shows the results of stability measurement.

Table 2: Results of the stability test

	S ² [%]	SO ₃ [%]
reference	0.758	2.093
1	0.759	1.995
2	0.762	1.998
3	0.760	1.991
4	0.766	2.062
5	0.754	2.029
6	0.759	2.015
7	0.740	2.021
8	0.768	1.995
9	0.767	2.034
10	0.762	2.039
average	0.756	2.018
std. dev.	0.008	0.023

Results and Conclusions

The analysis of sulfide and sulfate in cement samples for quality control can be realized on a daily routine based on WDXRF. The S8 TIGER Series 2 with the high resolution setup, applying the fine collimator and the curved crystal XS-Ge-C allows the accurate and reproducible analysis of neighboring peaks. The differences between the reference values and the measured concentrations are in the very low ppm range while the total concentrations of sulfur in the cement are in the range of 3 to 5 %. This report demonstrates that WDXRF can completely replace time consuming wet chemical procedures in the cement laboratory.

Link

QUANT-EXPRESS

<https://www.bruker.com/quant-express>



Bruker AXS GmbH

info.baxs@bruker.com

www.bruker.com

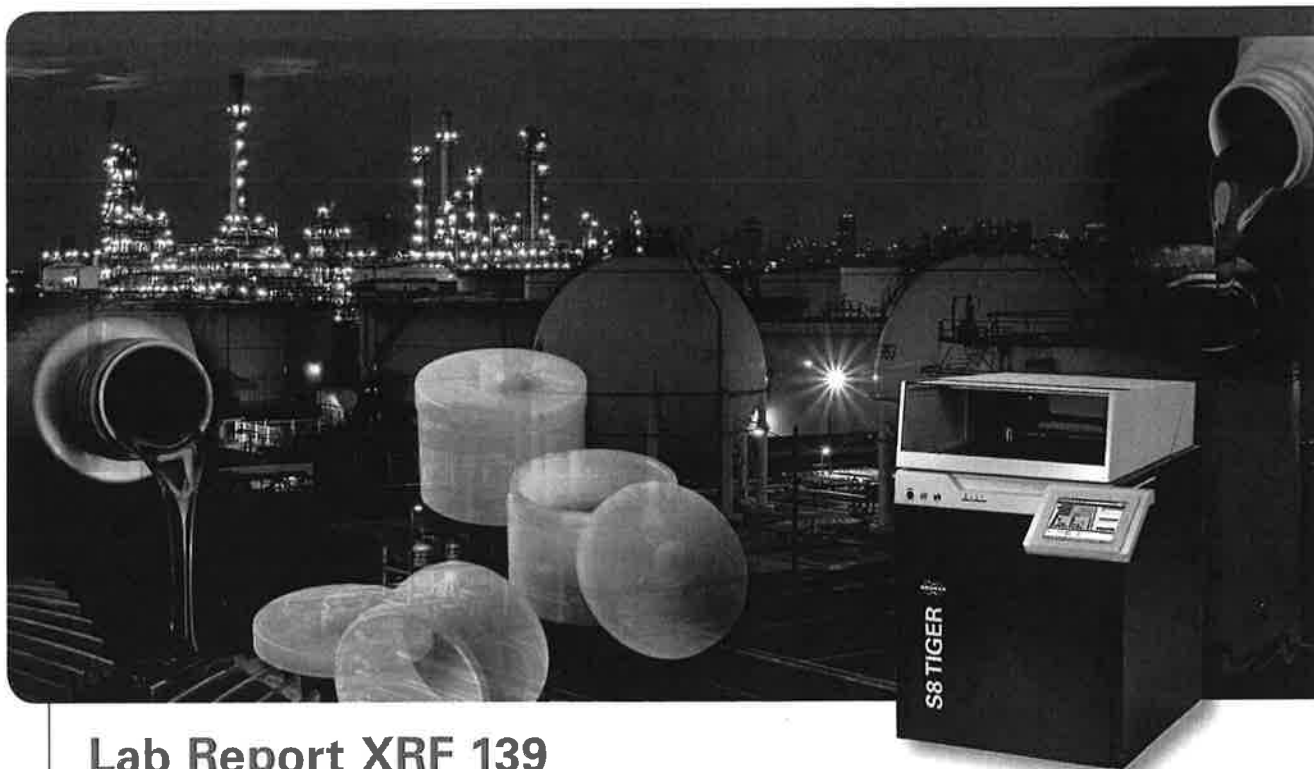
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Lab Report XRF 139

S8 TIGER Series 2 for ASTM D 6443

- Standard Test Method for Determination of Ca, Cl, Cu, Mg, P, S and Zn in Unused Lubricating Oils and Additives

Introduction

Lubricating oils are generally formulated with additives which act as detergents, anti-oxidants, anti-wear agents, etc. These additives can contain calcium, copper, magnesium, phosphorus, sulfur and zinc. Chlorine can also be present in these oils as a contaminant. The ASTM Standard Test Method D 6443 can be used to determine if the oils, additives and additive packages meet speci-

fications with respect to the added elements and with respect to chlorine contamination.

The analysis of lubricating oils by WDXRF provides a non-destructive method that is easily incorporated into a production environment. This lab report covers the performance of the S8 TIGER Series 2 for ASTM D 6443 including precision and Lower Limits of Detection (LLD).

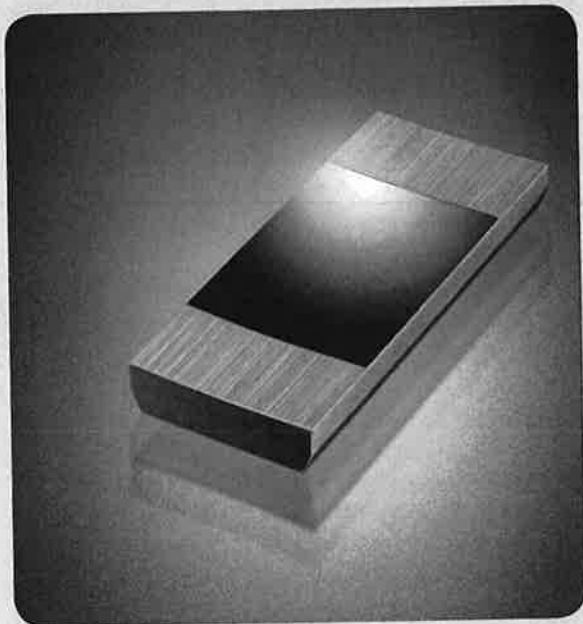


Figure 1: Curved germanium crystal XS-GE-C

The reliable and precise analysis of trace elements requires the highest sensitivity and best possible resolution. Laterally curved crystals are focussing the emitted fluorescence radiation towards the center of the detector. This arrangement achieves for elements with high reflection angles more intensities and an increased resolution in comparison to the flat crystal geometry. The analyzer crystal XS-GE-C is based on a curved Ge(111) crystal and offers the enhanced analytical performance for the elements P, S, Cl.

Instrument Configuration

The S8 TIGER Series 2 is an ideal solution for analyzing petroleum products. It uses a 4kW end-window X-ray tube with an ultra-thin 75µm beryllium window. A closely coupled optical path helps provide high intensities and low detection limits for all elements. Automatic computer control of the X-ray generator allows the kV and mA settings to be adjusted automatically for each element. This optimization of the voltage and current settings provides maximum sensitivity for all elements. The lower atomic number elements are typically analyzed using low kV and high mA settings, while the higher atomic number elements are analyzed with high kV and lower mA settings.

The S8 TIGER Series 2 has all of the features one expects for a complete Bruker AXS instrument in this class: a 10-position primary beam filter changer up to 4 primary collimators and up to 8 analyzer crystals. It

uses two detectors mounted side-by-side in the vacuum chamber. One is a scintillation detector, which is used to measure the higher energy lines and the other is a gas flow proportional detector for measuring the lower energy lines.

Traditional liquid sample analysis requires the entire optical path in the X-ray spectrometer to be flushed with helium. Bruker AXS has developed a unique vacuum seal that utilizes a thin window between the spectrometer chamber and the sample chamber. This allows the spectrometer chamber to remain under vacuum at all times, and only the sample chamber needs to be flushed with helium when measuring liquids. This arrangement minimizes the time required to switch between vacuum and helium mode of operation. The vacuum seal also provides a safety interlock between the sample and spectrometer chambers preventing liquids from contaminating the optical path in the event of sample cup leakage. This arrangement always keeps the flow detector in a vacuum atmosphere allowing ultra thin entrance windows to be used without the risk of them breaking. The automatic sample recognition of the EasyLoad magazine prevents that a liquid sample is analyzed while the spectrometer is in a vacuum mode. The software will not allow the introduction of a sample identified as a liquid into the vacuum path.

The automatic sample loader is designed to handle both liquid and solid samples at the same time with random access capabilities. Priority levels can be set for individual samples, which control the measurement sequence of these samples. This allows samples, which have just been loaded to become the very next samples to be measured without interruption of the current running sample. An immediate mode is also available, which allows rush samples to be analyzed immediately by interrupting the current measurement without loss of data collected up to the point of interruption. These features allow a wide variety of samples to be handled routinely without any modifications to the system.

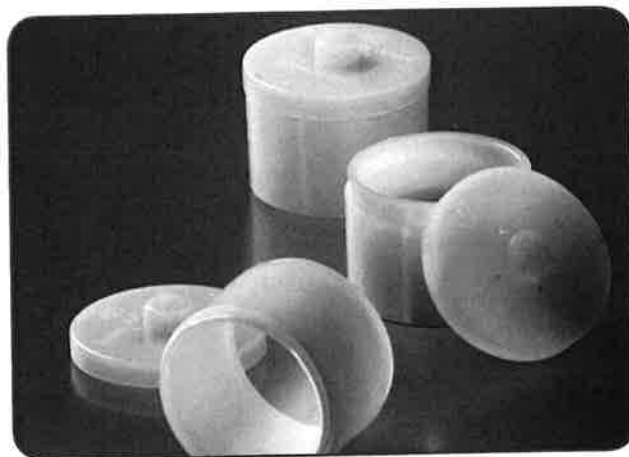


Figure 2: Prepared lubricating oil sample

Experimental

22 lubricating oil standards of the PETRO-QUANT ASTM D6433 solution, which included a blank, were used. These standards had been prepared gravimetrically using reagents traceable to NIST standard reference materials. Compositions for the calibration standards used are listed in Table 3.

Individual specimens were prepared by dripping about 7ml of each sample into a Bruker AXS 40µm diameter liquid sample cell that was fitted with a 4µm Prolene® window. The sample cells used have vented caps to prevent the window from bulging during sample analysis. These liquid cells were then placed into sample cups fitted with stainless steel masks having openings of 34mm in diameter.



Figure 3: S8 TIGER Series 2 WDXRF spectrometer with safe sample handling for unrivalled instrument uptime and lowest running costs

The intensities at the peak and off-peak background angles were measured from the liquid samples using the operating parameters of PETRO-QUANT.

The counting time listed in table 1 was a maximum time to count each peak and off-peak background position. The SPECTRA^{plus} software has provisions for doing an optimized counting time. In this mode the user enters a target statistical error and a maximum counting time. Each intensity is then measured to the desired statistical error or the maximum counting time, whichever is shorter.

Calibration coefficients were calculated using the 22 calibration standards by regressing the concentration data with the measured intensity data for each analyte. Matrix corrections (influence coefficients) were applied using a concentration based calibration model. Theoretical influence coefficients (alphas) were calculated using a "Fundamental Parameters" program and the Variable Alphas model that is a standard part of the SPECTRA^{plus} software. The Variable Alphas model calculates the alpha coefficients individually from each standard composition instead of using an average composition. This gives more appropriate alpha factors and allows accurate calibrations over wide concentration ranges. The calibration curve for Mg with excellent linear regression function and standard deviation covering a broad concentration range is shown in figure 4, for Cu in figure 5.

Table 1 lists the estimated Lower-Limit-of-Detection (LLD) for each of the analyte elements. These LLD's were calculated based on the actual counting times used. The SPECTRA^{plus} software estimates the LLD for each of the calibration standards by calculating 3 times standard deviations of the background intensity and converting this to a concentration. This is consistent with the generally accepted formula given below, except instead of using "m" to convert the intensity to a concentration the calibration coefficients are used.

The detection limit is calculated according to

$$LLD = \frac{3}{m} \sqrt{\frac{I_b}{T_b}}$$

m = sensitivity of analyte in kcps/mass%

I_b = background intensity for analyte in kcps

T_b = counting time in seconds at the background angle

Element	LOD@time	Peak time	Bkg time
Mg	1.7 ppm	32 s	32 s
P	0.7 ppm	12 s	12 s
S	6.6 ppm	20 s	20 s
Cl	1.9 ppm	16 s	16 s
Ca	1.0 ppm	12 s	12 s
Cu	0.4 ppm	20 s	20 s
Zn	0.3 ppm	12 s	20 s

Table 1: Detection limits at given measurement time

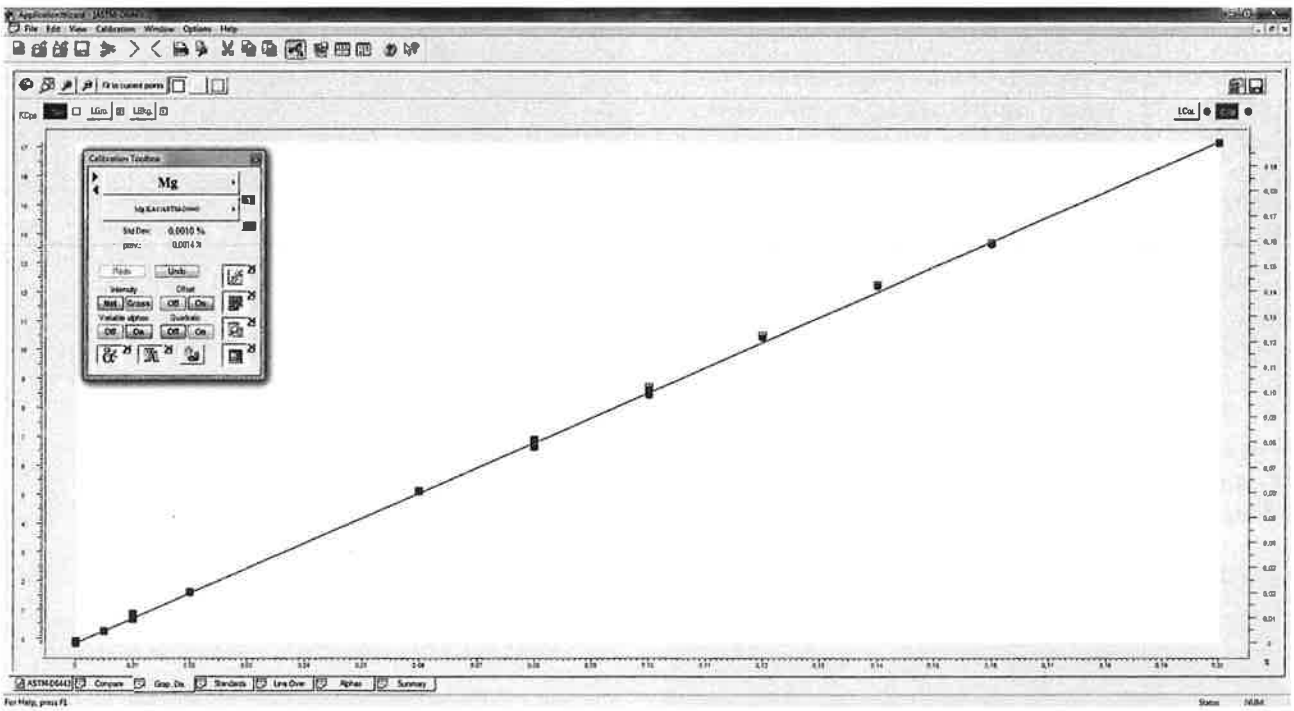


Figure 4: Calibration curve for Mg in lubricating oil

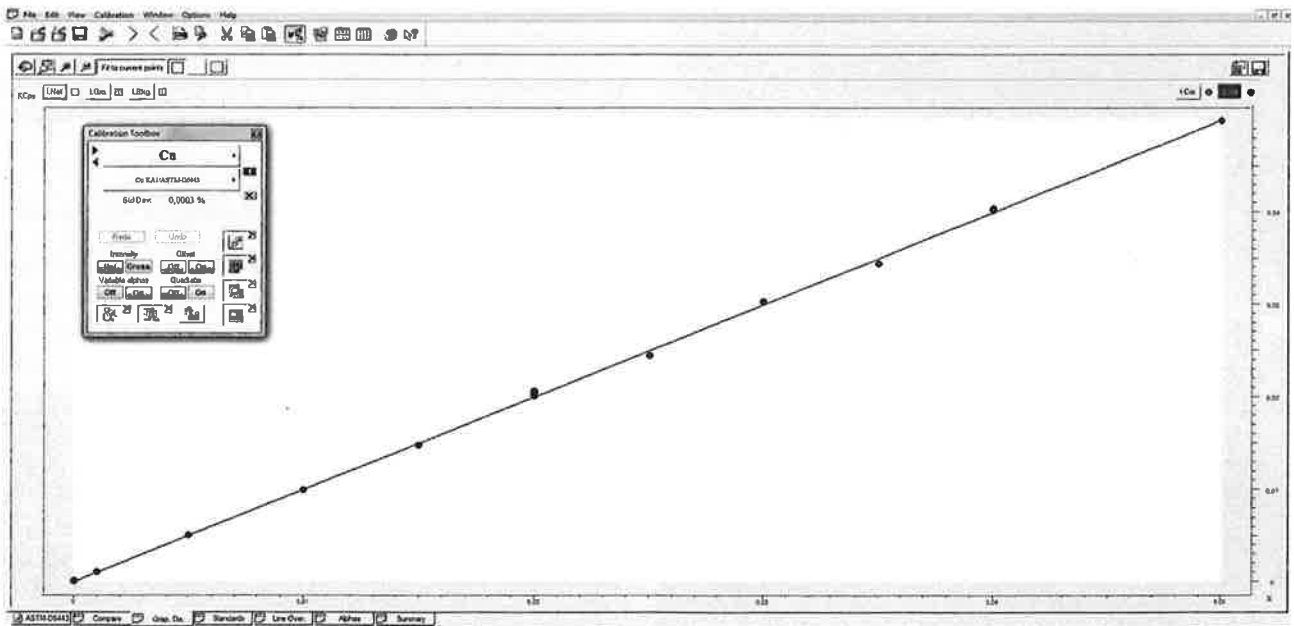


Figure 5: Calibration curve for Cu in lubricating oil

A precision test was performed on twenty individual sample preparations for one check sample with known concentrations. The results of this precision test and statistical evaluation of the data is summarized in Table 2. This table includes a comparison to the known chemical concentrations for each analyte in the sample. It also includes the ASTM expected repeatability limits

along with those determined from the measured data. This repeatability is the difference between successive test results for the same sample obtained from a single operator using the same instrument. Over the long run 19 out of 20 values are expected to be within the prescribed limits. The results produced by the S8 TIGER Series 2 were all within the prescribed limits.

Sample	Mg (%)	P (%)	S (%)	Cl (%)	Ca (%)	Cu (%)	Zn (%)
1	0.0740	0.0490	0.2780	0.0510	0.1960	0.0199	0.0500
2	0.0740	0.0500	0.2800	0.0510	0.1960	0.0199	0.0490
3	0.0750	0.0500	0.2770	0.0510	0.1960	0.0200	0.0500
4	0.0730	0.0500	0.2780	0.0510	0.1960	0.0199	0.0500
5	0.0720	0.0490	0.2760	0.0500	0.1960	0.0199	0.0500
6	0.0740	0.0500	0.2760	0.0510	0.1960	0.0199	0.0490
7	0.0760	0.0500	0.2790	0.0510	0.1960	0.0200	0.0500
8	0.0760	0.0500	0.2790	0.0510	0.1960	0.0199	0.0500
9	0.0740	0.0500	0.2760	0.0510	0.1960	0.0199	0.0500
10	0.0730	0.0500	0.2790	0.0510	0.1960	0.0200	0.0500
11	0.0740	0.0500	0.2790	0.0510	0.1960	0.0199	0.0490
12	0.0750	0.0500	0.2790	0.0510	0.1960	0.0199	0.0500
13	0.0730	0.0500	0.2790	0.0510	0.1970	0.0201	0.0500
14	0.0740	0.0490	0.2780	0.0510	0.1960	0.0200	0.0500
15	0.0730	0.0500	0.2790	0.0510	0.1970	0.0200	0.0500
16	0.0730	0.0490	0.2760	0.0510	0.1960	0.0198	0.0490
17	0.0730	0.0500	0.2770	0.0510	0.1960	0.0199	0.0490
18	0.0730	0.0490	0.2750	0.0510	0.1960	0.0199	0.0490
19	0.0730	0.0500	0.2780	0.0510	0.1960	0.0199	0.0490
20	0.0750	0.0500	0.2810	0.0510	0.1970	0.0200	0.0500
21	0.0730	0.0500	0.2770	0.0500	0.1960	0.0198	0.0500
Average	0.0738	0.0498	0.2779	0.0510	0.1961	0.0199	0.0497
abs. SD	0.0011	0.0004	0.0015	0.0002	0.0004	0.0001	0.0005
rel. SD	1.46	0.88	0.56	0.43	0.18	0.36	0.97

Table 2: Precision test from twenty one measurements of Lubricating Oil Check Sample 1 with the S8 TIGER Series 2 and the curved Ge analyzer crystal XS-GE-C.



Figure 5: Easy and quick analysis of oil samples with PETRO-QUANT and the S8 TIGER

The PETRO-QUANT basic universal calibration for petrochemicals is prepared using the powerful SPECTRA^{plus} analytical software suite. Since matrix effects caused by the sample composition and the changing sample geometry influences the quality of the results the analytical software must cope with these effects. The unique variable alpha model for matrix correction is enabling wide concentration ranges and huge variations in sample composition, geometry and sample weight. No other fundamental parameter model can achieve a similar analytical flexibility. Typically each matrix type such as lube oils or fuels requires a different calibration. However, Bruker AXS PETRO-QUANT solutions don't: It enables a universal calibration for all kinds of hydrocarbons. PETRO-QUANT lets you analyze up to 30 elements with just one calibration. It covers all relevant trace elements, additives, and major elements saving you weeks of calibration work. All you need to do is: One click of a button and you can see the results of your analysis.

Bruker AXS also provides the fully calibrated S8 TIGER Series 2 spectrometers to match the needs of your laboratory. You select the norms and Bruker AXS sets up the analyzer in the factory, saving you a great deal of time and effort. After the on-site installation, the spectrometer can perform routine analysis on the spot with no need for highly trained personal, saving lots of time and money. Additionally to PETRO-QUANT you can order the ASTM D 6443 ready to analyze calibration based on the set of standards listed in table 3.

Summary

The optimum WDXRF system features used to efficiently measure unused lubricating oil and additive products are listed below. The precision, Lower Limit of Detection and regression analysis are also summarized below:

- 1) The close coupled ultra-thin (75 μ) end window X-ray tube operating at 4000 watts with up to 170mA provides maximum intensity for the harder to analyze lighter elements found in these samples (Mg, P, S).
- 2) The sample handling capabilities of the S8 TIGER Series 2 allows both liquid and solid samples to be analyzed simultaneously decreasing the overall analyzing time. Random access of any position in the sample changer allows "rush" samples to be processed in a priority data collection mode.
- 3) A fail-safe vacuum interlock between the sample and the spectrometer chamber eliminates the risk of contaminating the optical path from accidental spills.
- 4) A repeatability test performed on two known samples showed the repeatability of the S8 TIGER Series 2 to be within the guide lines outlined in the ASTM Test Method D6443.
- 5) The Lower Limits of Detection (LLD) are excellent for the short given measurement time. High sample throughput, safe sample handling with high instrument uptime and excellent results with high precision are a given with the S8 TIGER.

The S8 TIGER Series 2 fully meets the requirements for the determination of calcium, chlorine, copper, magnesium, phosphorus, sulfur and zinc in unused lubricating oils and additives as outlined in ASTM D 6443. The S8 TIGER Series 2 is ideally suited for the wide range of process control applications found in the petroleum industry.

	Mg (%)	P (%)	S (%)	Cl (%)	Ca (%)	Cu (%)	Zn (%)
ASTM-D6443_01	0.06	0.06	0.275	0.08	0.3	0.03	0.06
ASTM-D6443_02	0.01	0.15	0	0.1	0.25	0	0.15
ASTM-D6443_03	0.16	0.15	0	0	0.5	0.035	0.02
ASTM-D6443_04	0.12	0.08	0.2	0.01	0.35	0	0
ASTM-D6443_05	0.1	0.1	0.3	0	0.11	0.015	0.05
ASTM-D6443_06	0.2	0.05	0.25	0.1	0.2	0	0.15
ASTM-D6443_07	0	0	0.45	0.05	0	0.025	0.02
ASTM-D6443_08	0.1	0.03	0.4	0.03	0.15	0	0.04
ASTM-D6443_09	0.16	0	0.35	0.15	0.25	0.01	0.08
ASTM-D6443_10	0.005	0.03	0.75	0.15	0.11	0.04	0.15
ASTM-D6443_11	0	0	0.75	0.05	0.26	0	0
ASTM-D6443_12	0.14	0.08	0.5	0	0.2	0.005	0.08
ASTM-D6443_13	0.02	0.02	0.2	0	0	0.005	0.02
ASTM-D6443_14	0.08	0.14	0.65	0.15	0.07	0.02	0.15
ASTM-D6443_15	0	0.15	0	0	0.05	0	0
ASTM-D6443_16	0.08	0	0.5	0	0.4	0.001	0.02
ASTM-D6443_17	0	0.02	0.6	0.02	0.18	0.02	0.06
ASTM-D6443_18	0.01	0.02	0	0.01	0.4	0.001	0
ASTM-D6443_19	0.01	0.02	0.2	0.02	0.01	0.04	0.1
ASTM-D6443_20	0	0.008	0	0.005	0.05	0.05	0.12
ASTM-D6443_21	0.08	0.05	0.275	0.05	0.2	0.02	0.05
ASTM-D6443_22	0	0	0	0	0	0	0

Table 3: Concentration list of the standards of PETRO QUANT ASTM D 6443 solution (Order No: PQ2-ASTMD6443-INST)

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Links

S8 TIGER

<https://www.bruker.com/s8tiger>



QUANT-EXPRESS

<https://www.bruker.com/quant-express>



PETRO-QUANT

<https://www.bruker.com/petro-quant>



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Lab Report XRF 140

S8 TIGER Series 2 for ASTM C 114

- Process and Quality Control in Cement Production

Introduction

The fast and accurate determination of the elemental composition of all materials involved in cement production is vital for successful process control and product quality. Immediate feedback allows the close control of all process parameters. Routine analysis demands very short measurement times and this, in turn, frees the same instruments for additional tasks, such as the analysis of alternative fuels or non-routine samples like hot meal and filter dust.

For all these tasks sequential wavelength-dispersive X-ray fluorescence (WDXRF) spectrometry is today well established.

This report demonstrates the outstanding analytical performance of the S8 TIGER Series 2 regarding precision, analytical speed, sample throughput and time-to-result, offering also analytical flexibility for today's and future tasks.

Instrument

The S8 TIGER Series 2 spectrometer combines ease-of-use through its unique TouchControl™ and SampleCare™ with superior analytical performance. SampleCare™ ensures reliable operation and high instrument uptime of the S8 TIGER Series 2 through innovative 4x protection of all spectrometer components against contamination and damage by dust and liquids.

S8 TIGER Series 2 comes with HighSense technology and is equipped with the high intensity 4 kW Rhodium X-ray tube, two collimators (0.23° and 0.46°) and five analyzer crystals. The system offers the most flexible and compact beampath. In combination with the high performance X-ray tube and advanced analyzer crystals, this compact beampath gives highest intensity and analytical speed.

The analysis of sodium and magnesium benefits from the use of the intensity-optimized XS-55 crystal. The curved germanium crystal XS-GE-C provides 20-40% more intensity for the elements P, S and Cl. Unrivalled long term stability for the elements Al and Si are guaranteed by the multilayer XS-CEM crystal. Sample Preparation

10 g of raw meal were finely ground with three grinding aid tablets and pressed with a pressure of 20 tons. This procedure reproducibly formed very stable samples and could be used either for manual or automated sample preparation.

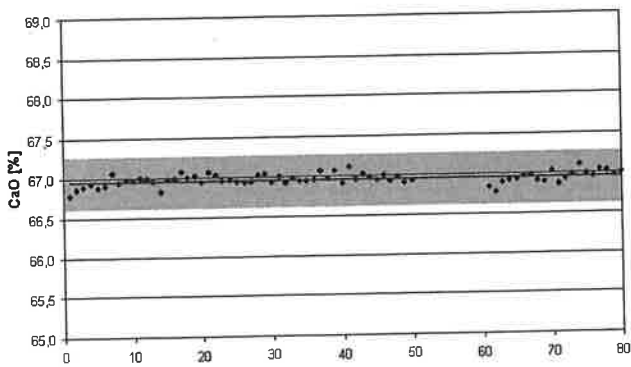


Figure 1: Process control chart from two non-consecutive days for CaO

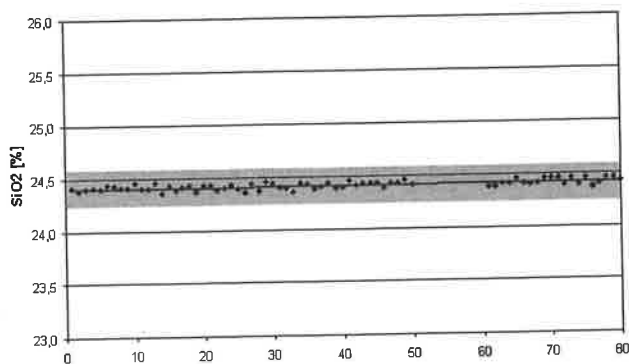


Figure 2: Process control chart from two non-consecutive days for SiO₂

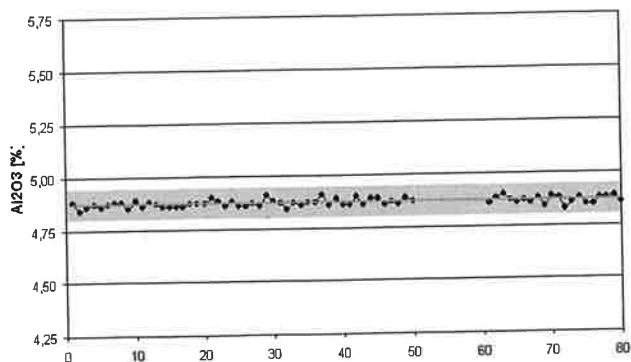


Figure 3: Process control chart from two non-consecutive days for Al₂O₃

Measurement

Measurements were performed on the S8 TIGER Series 2 with 4 kW Rh excitation. The total time-to result was 113 s, including loading, evacuation, analysis and reporting of the results. Two samples were measured alternatively, each sample 50 times to demonstrate the analytical performance under real conditions.

The elements Na, Mg, Al, Si, P, S, K, Ca, Mn and Fe were measured and the concentrations were calculated as oxides. This test was set up to demonstrate that there is no compromise regarding quality of analytical data or reproducibility under real conditions. The precision test was repeated 20 times a second day to show the analytical stability.

Results

The summary of the calibration data and the maximum difference between certified and measured data are shown in Table 1.

Precision data for CaO, Al₂O₃ and SiO₂ are shown as an example in the process control chart (Figures 1-3) and summarized for all elements in Tables 2 and 3. Both precision and accuracy of the S8 TIGER Series 2 clearly exceed the requirements of ASTM C114, even with short measurement times since the instrument provides enough countrate. The counting statistical error is reduced to a minimum, making sample preparation the critical factor for succesful process control.

Element	Concentration Range [%]	ASTM Max. Diff	Max. Diff
Na ₂ O	0.08 - 0.45	0.05	0.02
MgO	1.2 - 4.2	0.2	0.1
Al ₂ O ₃	3.1 - 5.8	0.2	0.1
SiO ₂	17.6 - 25.2	0.2	0.1
P ₂ O ₅	0.02 - 0.2	0.03	0.03
SO ₃	1.9 - 3.2	0.1	0.1
K ₂ O	0.1 - 1.5	0.05	0.04
CaO	61.5 - 68.2	0.3	0.15
Mn ₃ O ₄	0.08 - 0.6	0.03	0.01
Fe ₂ O ₃	0.3 - 4.4	0.10	0.03

Table 1: Summary of calibration details for ASTM C114

Time	Na ₂ O [%]	MgO [%]	Al ₂ O ₃ [%]	SiO ₂ [%]	P ₂ O ₅ [%]	SO ₃ [%]	K ₂ O [%]	CaO [%]	Mn ₃ O ₄ [%]	Fe ₂ O ₃ [%]
18:35:36	0.141	2.188	6.300	22.72	0.121	4.075	1.021	60.80	0.130	2.248
18:40:41	0.144	2.189	6.320	22.73	0.120	4.082	1.020	60.77	0.128	2.246
...
20:37:23	0.143	2.192	6.300	22.77	0.119	4.094	1.015	60.87	0.128	2.248
20:42:28	0.144	2.191	6.290	22.79	0.120	4.087	1.018	60.76	0.129	2.245
...
22:39:09	0.144	2.191	6.280	22.77	0.120	4.088	1.024	60.87	0.129	2.249
22:44:13	0.144	2.186	6.300	22.79	0.121	4.092	1.019	60.80	0.129	2.254
Mean Value	0.143	2.189	6.300	22.77	0.120	4.084	1.021	60.78	0.128	2.248
Std.Dev.	0.001	0.006	0.016	0.02	0.001	0.006	0.002	0.05	0.001	0.004
RSD.	1.03	0.27	0.25	0.10	0.62	0.14	0.22	0.08	0.74	0.19

Table 2: Summary of 50 measurements of one cement sample (Day one)

Time	Na ₂ O [%]	MgO [%]	Al ₂ O ₃ [%]	SiO ₂ [%]	P ₂ O ₅ [%]	SO ₃ [%]	K ₂ O [%]	CaO [%]	Mn ₃ O ₄ [%]	Fe ₂ O ₃ [%]
08:42:25	0.140	2.164	6.310	22.77	0.120	4.076	1.014	60.78	0.123	2.228
08:47:29	0.143	2.179	6.330	22.83	0.120	4.078	1.014	60.73	0.129	2.224
10:13:45	0.142	2.199	6.310	22.79	0.121	4.095	1.018	60.76	0.129	2.243
10:18:49	0.141	2.181	6.310	22.81	0.121	4.089	1.017	60.76	0.126	2.239
Mean Value	0.141	2.187	6.303	22.78	0.121	4.085	1.017	60.79	0.128	2.240
Std.Dev.	0.001	0.009	0.018	0.02	0.001	0.007	0.002	0.04	0.001	0.007
RSD	0.94	0.39	0.28	0.10	0.67	0.17	0.23	0.07	1.15	0.33

Table 3: Summary of 20 measurements of the same cement sample (Day three)

Conclusions

The excellent precision achieved within the test period demonstrates the S8 TIGER Series 2's superior analytical performance. The design of the S8 TIGER Series 2 beampath provides the best intensity for each element. Specific analyzer crystals e.g. the XS-CEM are optimized for a maximum of intensity and stability guarantee long-term precision. Immediate feedback on the process ensures best product quality. The high analytical speed and shortest time-to-result frees the S8 TIGER Series 2 also for additional tasks.

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Links

S8 TIGER

<https://www.bruker.com/s8tiger>

QUANT-EXPRESS

<https://www.bruker.com/quant-express>

CEMENT-QUANT

<https://www.bruker.com/cement-quant>



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S8 TIGER 2nd Generation

- Introductory User Manual

Original Instructions (English)

Translation of the Original Instructions (German, French, Spanish)

Innovation with Integrity

XRF

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We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections are included in subsequent editions. Suggestions for improvement are welcome.

All configurations and specifications are subject to change without notice.

Order no. DOC-M80-ZXX201 V1. August 1, 2017.

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Contents

1 About

1.1 About This Manual

This manual contains general information and guidelines about the Bruker AXS instruments, which have to be observed to ensure personal safety, as well as to protect the product. These notices are highlighted in this manual by the warning symbols and are marked as follows according to the level of danger.

This manual is an integral part of the device, and must be kept in close proximity to the device where it is permanently accessible to personnel. In addition, instructions concerning labor protection laws, operator regulations tools and supplies must be available and adhered to.

CAUTION

Risk of injury due to improper use of the system

Ignoring the required safety precautions can lead to serious injuries for the user and other persons, or strong damages of the instrument.

- ▶ Read all manuals thoroughly and understand its contents before switching on the instrument
- ▶ Only operate the instrument after you have understood the described safety warnings and make sure to meet all recommended safety instructions!
- ▶ Compliance with all specified safety and operating instructions, as well as local accident prevention regulations must be ensured.

The figures shown in this manual are designed to be general and informative and may not represent the specific Bruker model, component or software/firmware version you are working with. Options and accessories may or may not be illustrated in each figure.

1.2 Target Audience

This document is meant for trained and skilled personnel working with the instrument described. It conveys information on how to understand and fulfill the respective work and duties. This document is a reference book. It does require particular knowledge and expertise specific to the instrument described.

1.3 Symbols and Conventions

Safety instructions in this manual are marked with symbols. The safety instructions are introduced using indicative words which express the extent of the hazard. In order to avoid accidents, personal injury or damage to property, always observe safety instructions and proceed with care.



DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.



WARNING

WARNING indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.



CAUTION

CAUTION indicates a hazardous situation, which, if not avoided, may result in minor or moderate injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.

NOTICE

NOTICE indicates a property damage message.

This is the consequence of not following the notice.

1. This is a safety condition.
 - ▶ This is a safety instruction.

SAFETY INSTRUCTIONS

SAFETY INSTRUCTIONS are used for control flow and shutdowns in the event of an error or emergency.

This is the consequence of not following the safety instructions.

1. This is a safety condition.
 - ▶ This is a safety instruction.



This symbol highlights useful tips and recommendations as well as information designed to ensure efficient and smooth operation.

1.4 Disclaimer and Liability

Bruker AXS has checked the contents of this manual for agreement with the hardware, firmware, and software described. Since deviations cannot be excluded entirely, Bruker AXS cannot guarantee full agreement. However, the information in this manual is reviewed regularly and any necessary corrections will be included in subsequent editions. Suggestions for improvements are welcome.

If at any time there is a conflict between the safety information contained in this manual and any relevant national, state or local regulations, the local rules always take precedence.

2 Pre-Installation Guide

2.1 Laboratory Requirements

Careful room planning and completed pre-installation requirements are prerequisites for successful installation and operation of the S8 TIGER. Bruker AXS recommends performing your room planning and pre-installation with the assistance of a Bruker AXS Service Representative.

2.1.1 Area of Installation

The installation of the S8 TIGER spectrometer must be planned so that the following criteria are fulfilled:

- Accessibility to the spectrometer from the front.
- Floor and platform should be level and should have a suitable load capacity (see *Technical Specifications [73]*)
- Unrestricted flow of the cooling air entering and exiting the rear panel: ~ 40 cm (~ 15 inches) distance from the wall is recommended.
- Access to mains supply and computer network for advanced service support (i. e. remote diagnostics).
- Space for an external water chiller (for S8 TIGER 3 kW / 4 kW versions only) or an uninterruptible power supply (UPS) close to the instrument must be planned, if you have chosen this option.
- If planning an automation with conveyor belt, the spectrometer must be positioned so that the sample magazine is accessible from the rear side.
- For analyzing liquids or loose powders, space for secured gas bottles (nitrogen or helium) must be planned. Gas bottles must be positioned according to local, state, and national regulations and must be secured against falling over.

- If you have ordered a gas flow counter, you will need to provide space for at least one more gas bottle. Flow counters are typically operated with an argon-methane gas mixture which is flammable. Therefore, you will need positions for two (or, even better, for three) secured gas bottles. The gas bottles must be accessible for future exchange of consumed gas cylinders.
- Exposure to direct sunlight should be avoided

2.1.2 Required Laboratory Infrastructure

The following table contains an overview of the infrastructure and connections required for your instrument. In-depth description of the connection details are given later in this manual.

Table 2.1: Laboratory infrastructure and connections

Configuration	S8 TIGER 1 kW	S8 TIGER 3 kW / 4 kW
Utilities:		
Electricity	required	required
Water	not required	required or chiller
Compressed air	not required	not required
Gas connections:		
He or N ₂	for liquid or loose powder samples	
P-10 or P-5 (Ar:CH ₄)	if flow counter is installed	
Data lines:		
Ethernet jack	network configuration 3 or 4	
Telephone jack	for enhanced Bruker AXS support	

2.1.3 Dimensions and Weight

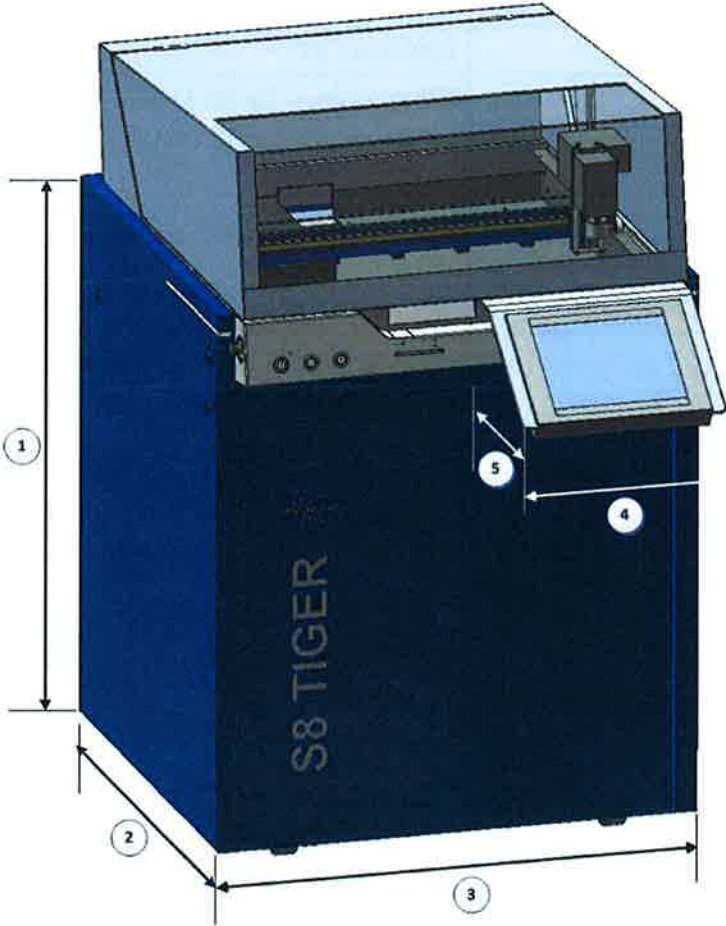


Figure 2.1: System dimensions (dimensions in mm and inches)

Table 2.2: Dimensions

Entry	Type	Dimension
①	Height	1040 mm / 41"
②	Depth	865 mm / 34.1" for S8 TIGER 1 kW 1220 mm / 48" for S8 TIGER 3 kW and S8 TIGER 4 kW
③	Width	890 mm / 35"
④	Width of the touchscreen	380 mm / 15"
⑤	Depth of touchscreen	290 mm / 11.4" (measured from front panel)
	Weight	~ 446 kg / 981 lb for S8 TIGER 1 kW ~ 476 kg / 1047 lb for S8 TIGER 3 kW / 4 kW

2.1.4 Environmental Specifications

Table 2.3: Environmental Specifications

Specifications	Data
Optimal room temperature	24 °C / 75 °F
Temperature operation range	17 – 29 °C (63 – 84 °F), $\Delta T \leq \pm 2$ °C (3.6 °F) for very high stability of the measuring values
Maximum temperature gradient	2 °C (3.6 °F) per hour
Relative humidity	20 % - 80 %, condensation not allowed
Atmospheric pressure	Spectrometry system operational at all terrestrial locations under atmospheric air pressure conditions up to an altitude of 3000 meters (9800 feet).

2.1.5 Heat Dissipation to Air

The heat dissipated must be removed by a ventilation or air conditioning system.

Table 2.4: Heat Dissipation to Air

Configuration	S8 TIGER 1 kW	S8 TIGER 3 kW / 4 kW
Heat load (with control electronics, X-ray generator and vacuum pump)	≤ 2.0 kW	≤ 0.5 kW
Minimum clearance behind instrument	50 cm / 20"	20 cm / 8"

2.2 Pre-Installation

2.2.1 Mains Connection and Grounding

Table 2.5: Electrical requirements (including X-ray generator and control electronics, not including accessories)

Device	S8 TIGER 1 kW	S8 TIGER 3 kW / 4 kW
Power consumption	2.9 kVA	5.2 kVA / 7 kVA
Mains voltage and frequency (standard configuration)	208 – 230 V, 50 / 60 Hz, 16 A, 1-phase	208 – 230 V (50 / 60 Hz) 40 A, 1-phase 208 – 230 V (50 / 60 Hz) 32 A, 3-phase



Power consumption of the optional external devices (water chiller, host PC, etc.) is not included in table above. (Refer to the technical specifications for the specific device(s) being installed at your site.)

The S8 TIGER is shipped with a 7 m (23') long power cable (5 x 6 mm) with an approved CEE form plug connector ready to be connected to a three-phase AC network. Alternatively, the cable may be connected directly to the switchboard of the in-house mains system.

The instrument's connection to the in-house network must be protected with fuses or automatic circuit breakers for all phases. It must be possible to disconnect the system completely from the power supply using either:

- a labeled switch; or
- a labeled automatic circuit-breaker located near the spectrometer.

The fuses or circuit breakers should be easily accessible.

 **WARNING**

Risk of Electric Shock

Life-threatening electric shock due to high voltages.

In certain local mains networks, the neutral wire (marked with "N") is **not** connected to ground potential.

- ▶ In this case, the neutral (N) and all three phases (L1 to L3) must be controlled by a four-phase automatic circuit breaker.
- ▶ In case of an error, the circuit breaker must disconnect all power lines (N, L1, L2 and L3) from the mains network. (Please refer to your local regulations.)



 **WARNING****Risk of Electric Shock**

Life-threatening electric shock due to high voltages.



1. If the potential of your neutral wire (N) is floating compared to ground (PE) in such a way that the voltage between ground (PE) and any of the remaining power lines (L1, L2, L3) may exceed 254 V,
 - ▶ you need an isolating transformer connected upstream of the system.
 - ▶ In order to maintain tolerable voltage levels tie the secondary winding (N') to ground (PE).

Additional prerequisites

- If a residual current circuit breaker is used, it must be designed for a triggering current of at least 30 mA.
- For the installation, a wall outlet or terminal box should be located no further than 5 m (16') from the S8 TIGER.
- Moreover, additional protective grounding (grounding resistance $\leq 0.5 \Omega$) in accordance with the local regulations may be provided.

The four first figures below show various mains connection options of the S8 TIGER 3 kW / 4 kW system. The two last figures show the mains connection options of the S8 TIGER 1 kW system.

Mains connection options of the S8 TIGER 3 kW / 4 kW system

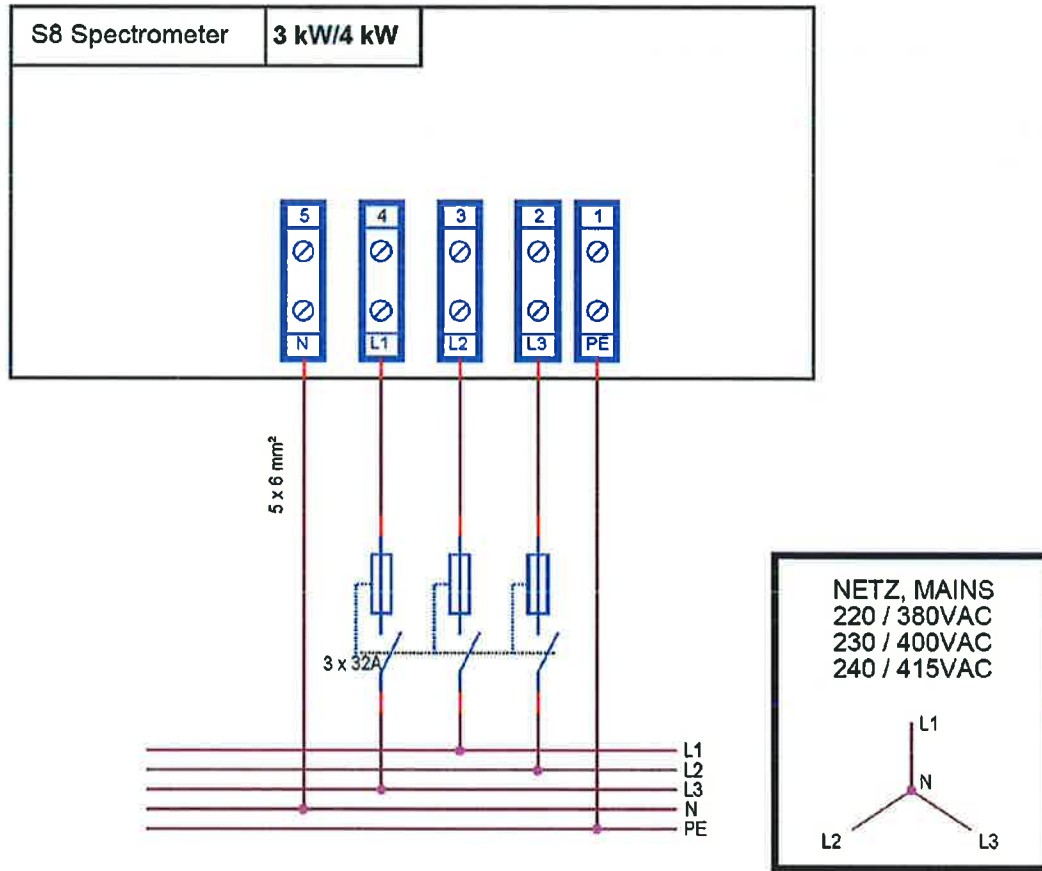


Figure 2.2: Option 1: Mains connection (three-phase supply); Y-connection (S8 TIGER 3 kW / 4 kW only!)

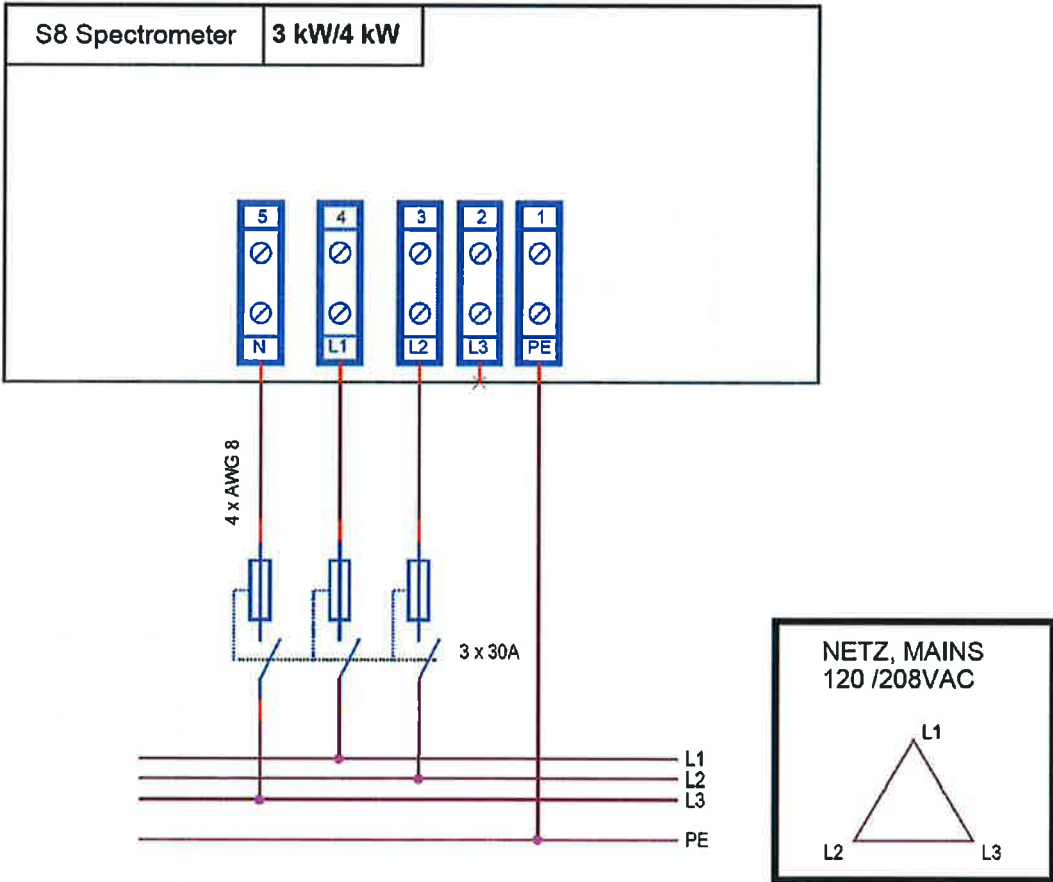


Figure 2.3: Option 2: Mains connection (three-phase supply); delta connection (S8 TIGER 3 kW / 4 kW only!)

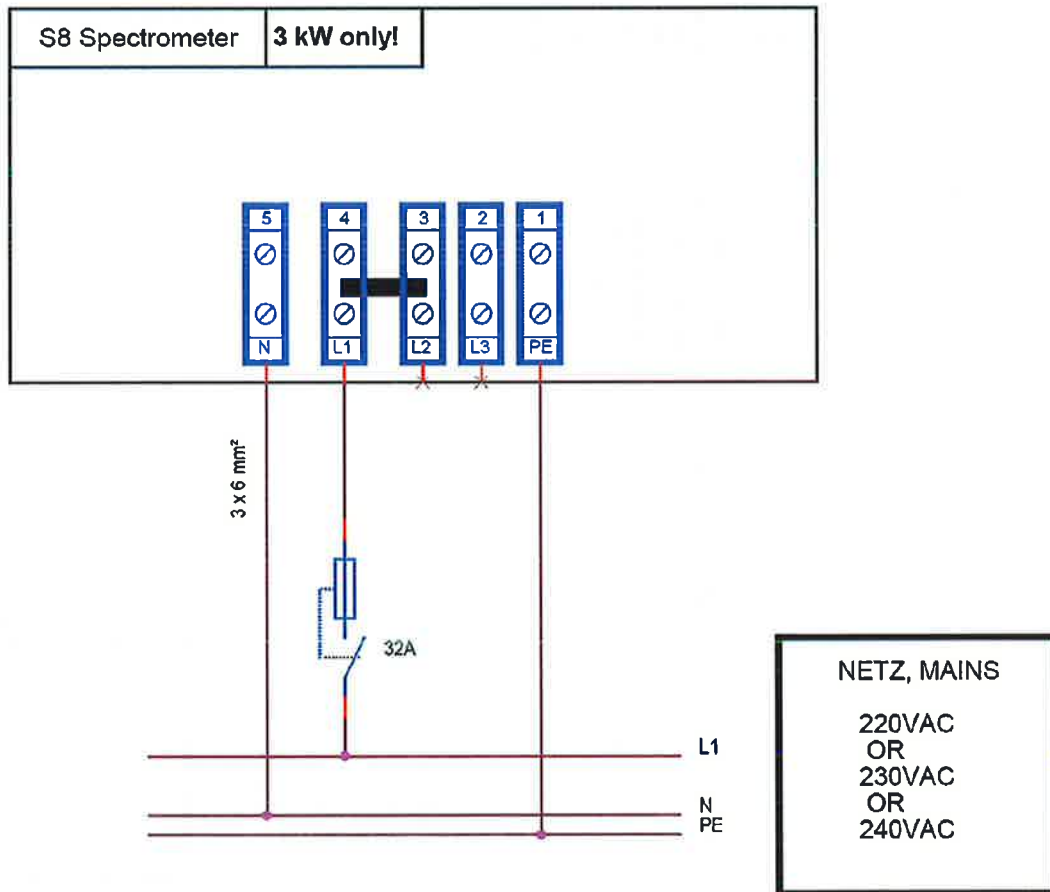


Figure 2.4: Option 3: Mains connection (one phase supply); 220 - 240 VAC (50/60 Hz) (S8 TIGER 3 kW only!)

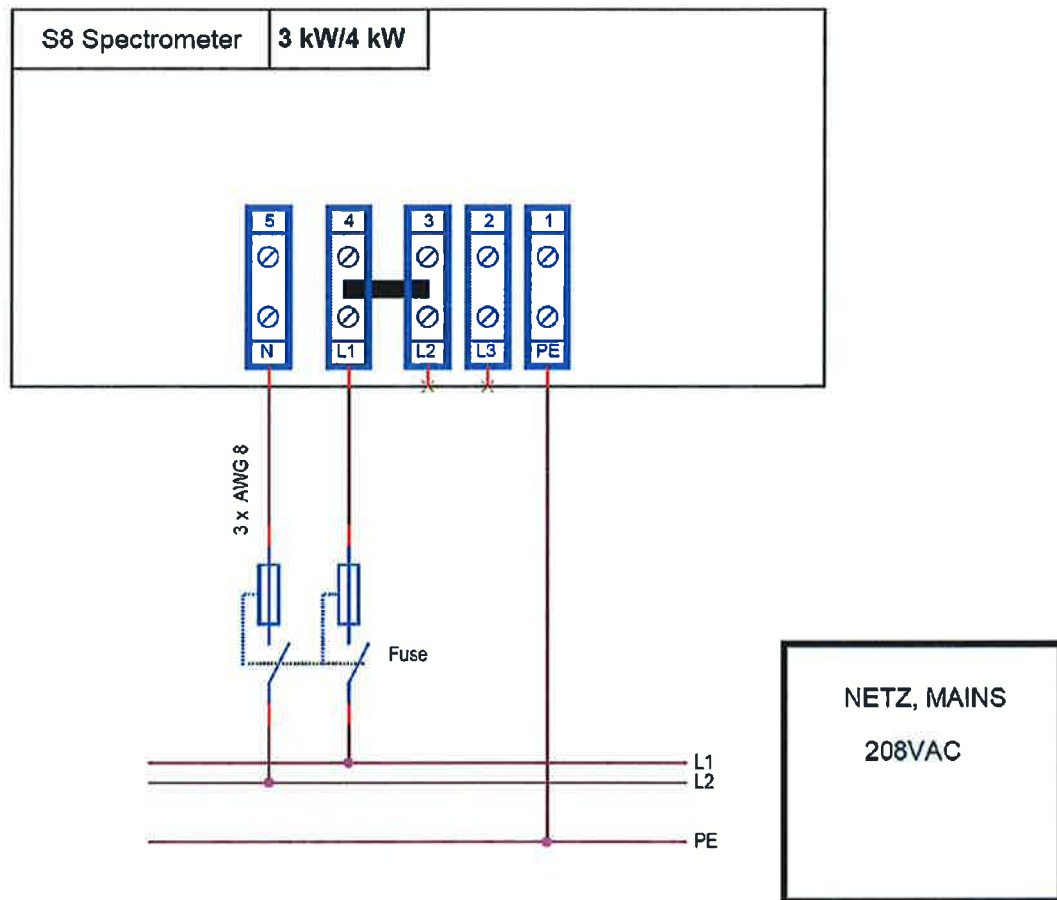


Figure 2.5: Option 4: Mains connection (one-phase supply); 208 VAC (50/60 Hz)

Fuse ratings for option 4



The rating of the fuses or the automatic circuit breaker may be reduced for S8 TIGER 3 kW systems if requested. The fuse ratings are:

- S8 TIGER 4 kW 2 x 40 A
 - S8 TIGER 3 kW 2 x 30 A
-

Mains connection options of the S8 TIGER 1 kW system

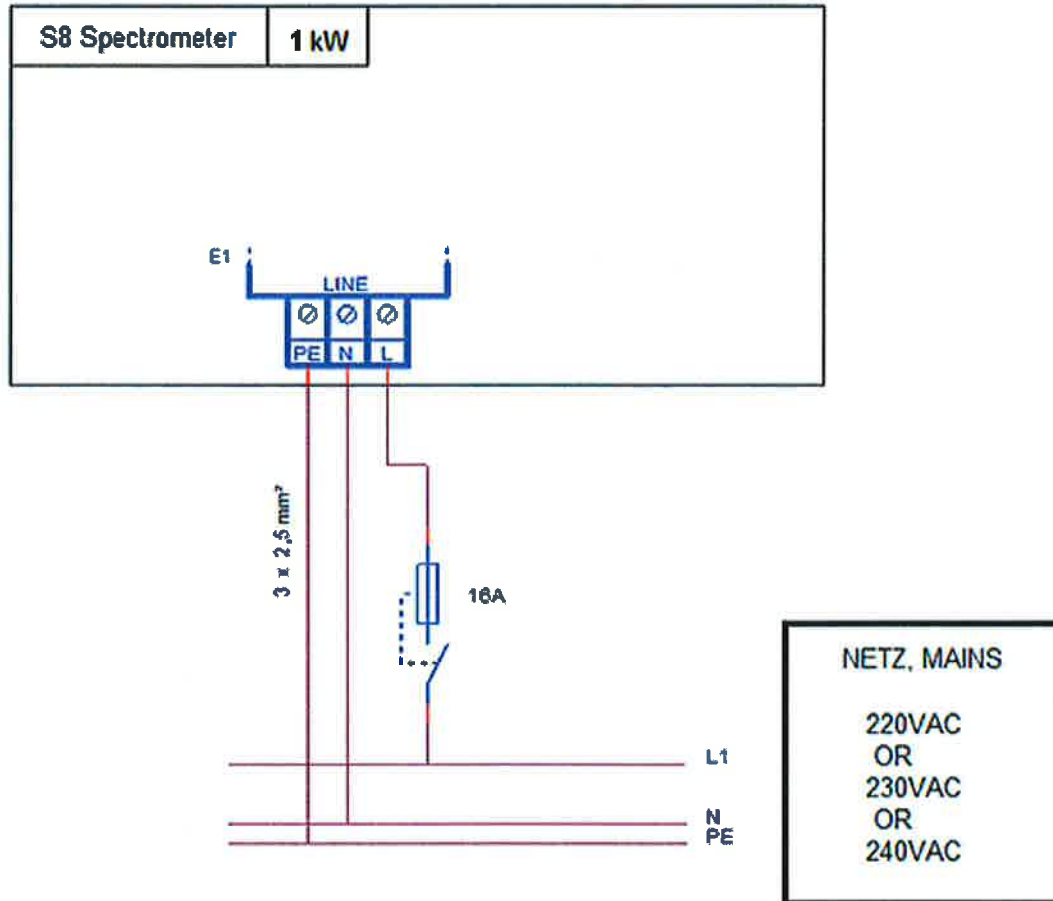


Figure 2.6: Option 5: Mains connection (one phase supply); 220 – 240 VAC (50/60 Hz)
(S8 TIGER 1 kW only!)

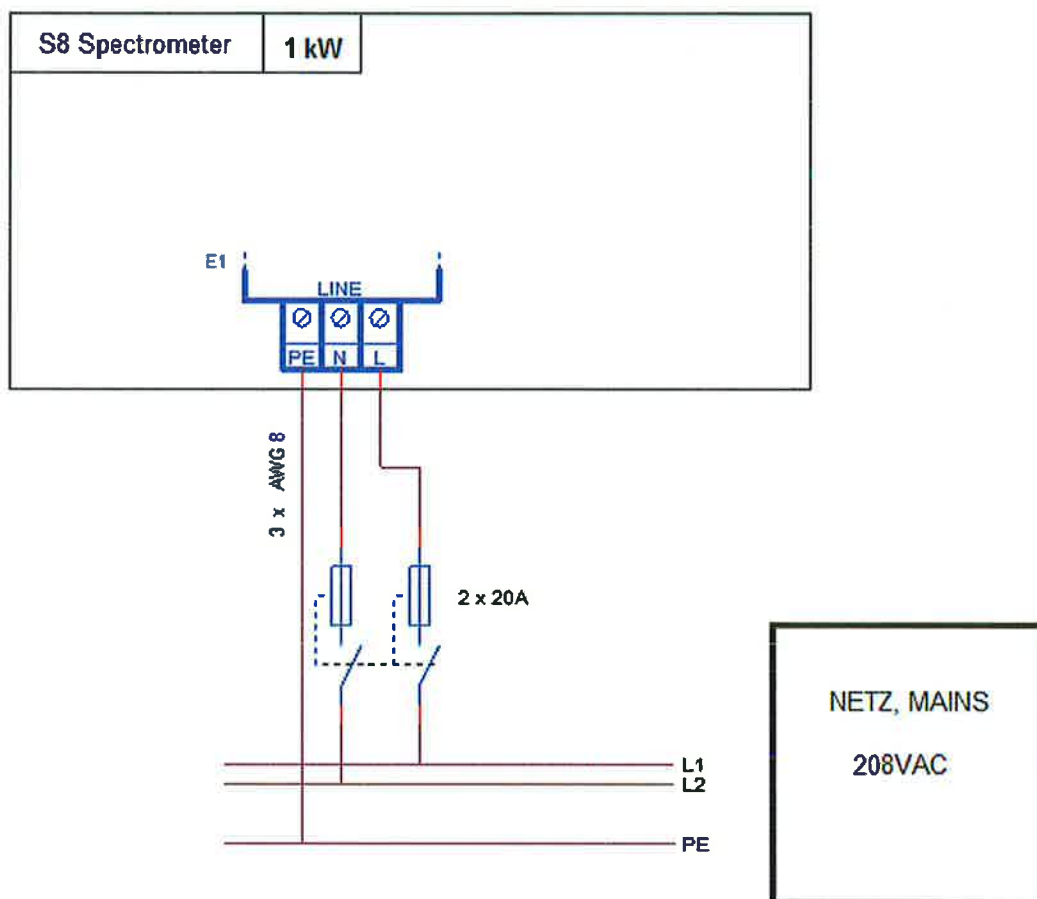


Figure 2.7: Option 6: Mains connection (one-phase supply); 208 VAC (50/60 Hz) (S8 TIGER 1 kW only!)



In case of unstable or unreliable mains power, an uninterruptible power supply (UPS) may be switched between the mains network and the system.

Depending on your system model, we recommend using an Effekta, Toshiba or Powervar UPS, as listed in *UPS for the S8 TIGER* [79]. For installation consult the technical documentation of your UPS.

2.2.2 Vacuum Equipment

If the supplied air filter for the vacuum pump is not used, an outdoor vent opening should be provided for the pump's exhaust gases.

2.2.3 Helium or Nitrogen Supply

A helium or nitrogen cylinder with a dual pressure regulator (e.g. 200 bar / 5 bar or 3000 PSI / 75 PSI) must be provided for the S8 TIGER with gas flushing system (this is the case if liquid or loose powder samples are used). We recommend a dual pressure regulator with a two-stage reduction valve, for example part no. C79298-A3228-C11. We recommend using a compressed-gas cylinder with 50 l (13 gallons) contents and 200 bar (3000 PSI) filling pressure. The cylinder must be supported to prevent it from falling over. Observe your local safety regulations and work codes. Set the secondary regulator pressure (outlet pressure) to 2 bar (30 PSI). This is now the inlet pressure for your S8 TIGER. We also recommend using helium grade 4.6 (He purity of 99.996 %).

Medium	Hose
Helium or nitrogen	SL 4x1, PU

2.2.4 Gas Supply for X-ray Flow Counter

A gas cylinder with pressure regulator must be provided for the flow counter detector's gas supply. If possible, you should also plan a location for a spare cylinder.

The tubing from the gas cylinder to the spectrometer should be made as short as possible. For short distances, Viton hoses should be used. However, if the gas supply must be placed far from the S8 TIGER, copper or stainless steel tubing should be used up to the vicinity of the spectrometer. The tubing must be clean and free of oil, water, and solvents,

and must not contain any solids such as scale or sand. The gas lines must not be placed near heat sources such as radiators. Measurements with gaseous detectors are degraded by variations in gas temperature.

In order to stabilize gas flow, a fine regulator for test gases should be provided downstream from the main pressure regulator (200 bar / 600 mbar or 3000 PSI / 9 PSI). Bruker AXS offers a suitable dual pressure regulator for this purpose (order number C79298-A3228-B1). The regulator outlet pressure, shown at the secondary dial, should be set to 500 mbar (7.4 PSI). This is the inlet pressure for the S8 TIGER.

The flow counter tube is usually operated with the commercially widely available P-10 gas mixture. It consists of 90 % argon and 10 % methane. The gas must be technically clean. At maximum, the impurity can be 0.5 % v/v (e.g. P-10 gas - Ar 4.6 and CH₄ 2.5 or P-10 gas for spectrometry - Ar 5.0 and CH₄ 3.5).

You should use compressed-gas cylinders with a volume of 50 l (13 gallons) and filling pressure of about 200 bar (3000 PSI). Cylinders must be installed such that it is impossible for them to fall over. The safety regulations for flammable gases must be observed at all times. The flow counter is used in an open loop configuration. Therefore, a separate vent to open air must be provided for the consumed counter gas.

2.2.5 Cooling Water Supply (S8 TIGER 3 kW / 4 kW only)

The high power S8 TIGER 3 kW / 4 kW, require heat dissipation by water. The cooling water system may be fed with either city/well water (tap water) or a closed-circuit cooling system. To minimize difficulties with cooling water, for example suspended solids, low pressure, or extreme water temperature variations, an external cooling water unit with closed-circuit water re-circulation can be of advantage.

2.2.5.1 Open Cooling System (city/well water)

In order to supply the cooling water, a connection must be made to the main water supply. The discharge should occur without pressure. The layout and the recommended tubing are shown in the figure below. You need to connect piping between the supply water inlet and the instrument. Connect a discharge pipe between the instrument and a drain.

Please check that the cooling water is poor in suspended matter. You are strongly advised to install a suitable filter in the inlet line. It is recommended to connect two water filters in parallel if the water is contaminated. Having two filters bears the advantage that the device does not need to be switched off when one of the filters is being cleaned. Alternatively the S8 TIGER can be ordered with pre-installed filter system and pressure reducer.

NOTICE

Applies to both cooling systems - Damage to property

The pressure of the main water supply must not exceed 6.0 bar (87 PSI).

- ▶ If the local water pressure is larger, a pressure reducer must be used!

Applies to both cooling systems

The water inlet valves are only opened to the degree necessary. At times they might be entirely closed. As a result, water consumption is reduced to a minimum.

- ▶ Assure that all tubing and all fittings outside the instrument are properly dimensioned and withstand the water pressure.
- ▶ Check the rating of the components before turning on the instrument.

Reliability and safety of the external plumbing must be assured by the customer.

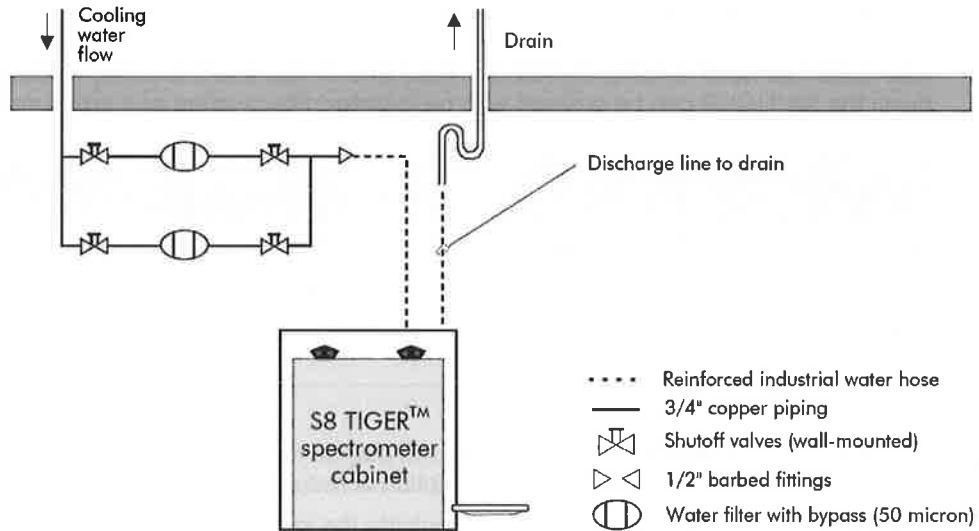


Figure 2.8: Open loop cooling system

Table 2.6: Cooling water supply requirements

Cooling water supply (applies to both cooling systems)	Technical Data
Flow rate	0 to 15 l/min (0 to 4 gallons/min) (always adjusted to minimum)
Difference pressure (= difference between input and pressure-free output pressure)	4 to 6 bar (58 to 87 PSI)
Water temperature	10 to 20°C (50 to 68°F) at 6 bar 10 to 16°C (50 to 61°F) at 4 bar
Maximum particle size (suspended solids)	< 90 µm

2.2.5.2 Closed-circuit Cooling System (optional external chiller)

If a sufficient city/well water ("tap water") supply is not available, an external cooling water unit with a closed water circulation loop may be used. In this case, it must be considered that the water flow is not continuous (see note). The discharge should occur without pressure. Therefore, it may be necessary to install a bypass.

There are two types of chillers: one dissipates the heat to a secondary water loop, the other to laboratory air. Especially if you decide to use the latter version, e.g. the model listed in the table below, we strongly recommend installing the unit in a room separate from the instrument. This helps to reduce the overall noise level at the S8 TIGER. The figure below shows the version using a secondary water loop.

Ideally the unit is located on the same floor as your spectrometer. Otherwise you need to take into account the required additional pump pressure. It might be required for the water to overcome the resulting pressure difference due to the height difference. Also observe the maximum allowed tubing length of the chiller chosen (consult the chiller's manual).

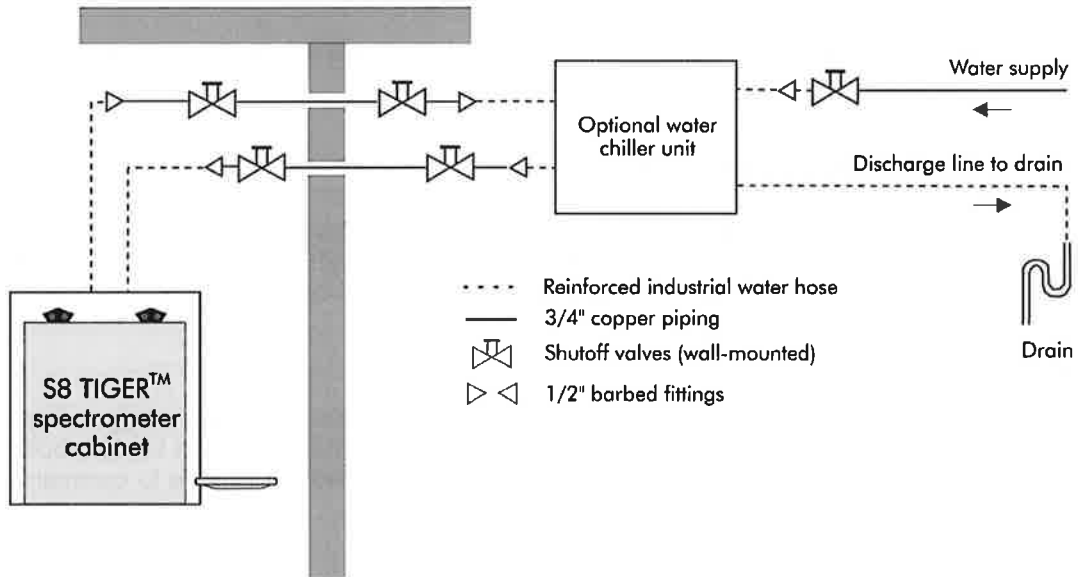


Figure 2.9: Closed loop cooling system

As an external cooling unit with a self-contained cooling water circulation we recommend the ERL 3000 water air heat exchanger. The technical specifications of ERL 3000 are listed in *Water Chiller (for S8 TIGER 3 kW / 4 kW only)* [82].

The ERL 3000 unit is delivered with a 10 m power cable, a 10 m controller cable, and two 10 m water hoses. For internal pressure compensation, it is equipped with a bypass to improve operation reliability. Technical specifications can be changed with additional parts.

2.2.6 Ergonomic Design of Workrooms

For detailed recommendations for ergonomic design of computer and video workstations, please refer to the EU directive 90/270/EWG on safety and health protection when working with visual display units.

2.2.7 PC and Peripheral Devices

Four spike-proof AC outlets/sockets or one quadruple connector strip are necessary for peripheral devices (PC, printer, etc.).

2.2.8 Network Configurations

The S8 TIGER and the PC must be networked to enable the calibration software suite to communicate with the device, both are equipped with standard 10/100 Mbit Ethernet. There are 4 networking options available, summarized below:

Direct connection

In this configuration, the Ethernet cable from the system is simply plugged into the Network Interface Card (NIC) of the PC. After the systems have been started, both devices will obtain an automatic private IP address (APIPA) and will be able to communicate with each other.

Advantages	Disadvantages
Zero configuration.	Unable to use network printers, storage, LIM systems and external backup solutions.
Secure (no link to outside world).	

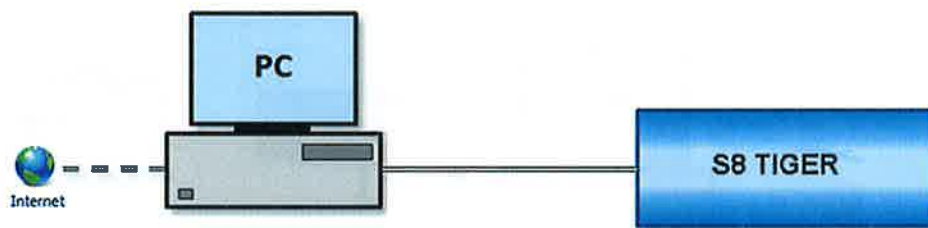


Figure 2.10: Direct connection network configuration

Private LAN

This configuration is very similar to Configuration 1, but both devices are plugged into a network hub or switch. This setup allows other network devices to be used; however, they must also support Automatic Private IP addressing (APIPA).

Advantages	Disadvantages
Zero configuration.	Unable to use network devices that reside on your company network. They may include network printers, storage, LIM systems and external backup solutions.

Advantages	Disadvantages
Use of other network devices. However, only the PC will be able to use these devices. Additionally, the devices must support APIPA.	
Secure (no link to outside world).	

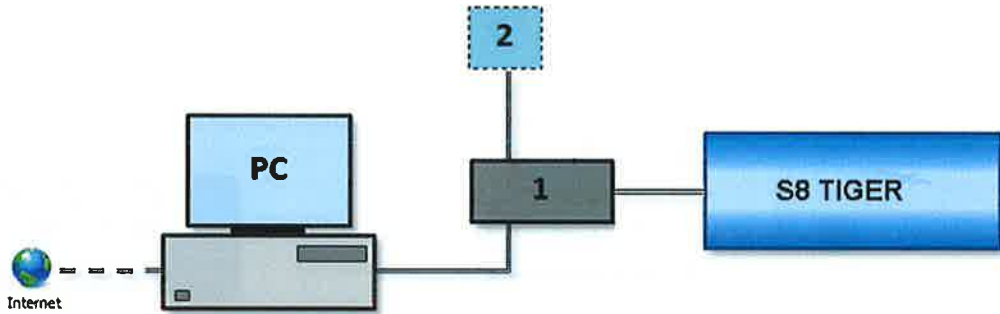


Figure 2.11: Private LAN network configuration

Company LAN

In this configuration, both devices are simply plugged into your LAN. This configuration requires there to be a Dynamic Host/Client Protocol (DHCP) server on your network. After the systems have been started, both devices will obtain an IP address from the DHCP server and will be able to communicate with each other. This configuration allows the PC to communicate with other devices (such as shared storage and printers) on your network. This also enables other devices to access the S8 TIGER which allows integration with LIM systems and remote backup solutions.

Advantages	Disadvantages
Zero configuration.	Remote diagnosis may impact your IT policy because of the modem link.

Advantages	Disadvantages
Use of other network devices.	
No distance limit between PC and S8 TIGER.	

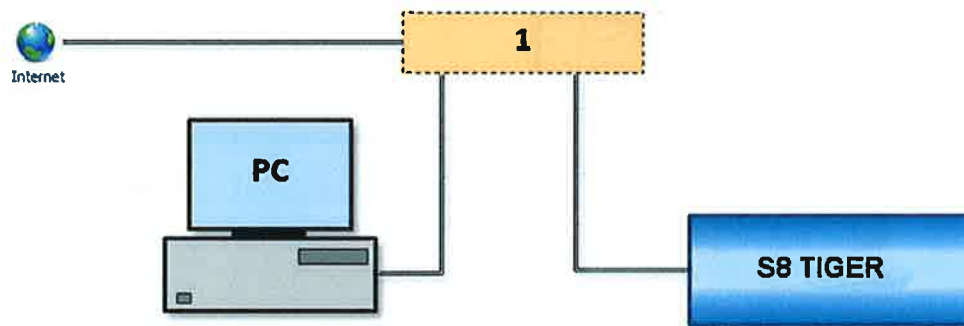


Figure 2.12: Company LAN network configuration

Twin NIC (network interface card)

This configuration is a combination of configurations 1 and 3. The S8 TIGER and PC are connected directly and are allocated IP addresses via APIPA. An additional network card (described as NIC2 in the figure) is installed inside the PC and connected to your company network. The PC will now be able to communicate with your company network and also with the system. However, with this configuration, the system is isolated from your LAN.

Unlike configuration 3, this configuration should not impact on your IT policy when remote diagnosis is required. If remote diagnosis is required, you will be advised to unplug your PC from your LAN (the cable plugged into NIC2). This means that remote diagnosis can assist you with any problem you may have without requiring access to your network.

Advantages	Disadvantages
Use of other network devices.	May require some initial configuration.

Advantages	Disadvantages
Remote diagnosis should not have an impact on your IT policy.	Requires additional network card (NIC)

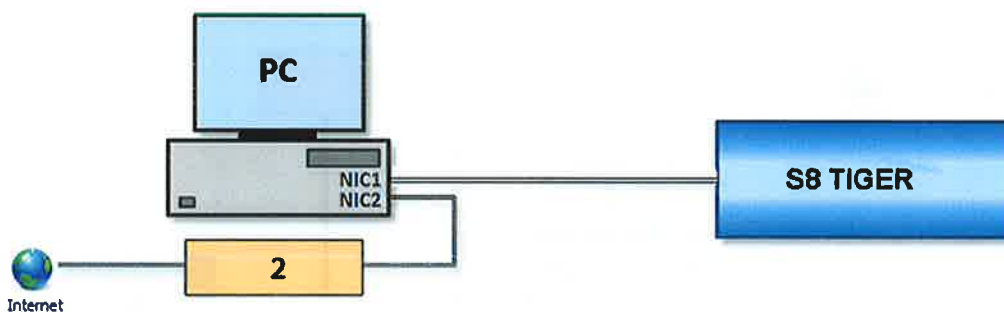


Figure 2.13: Twin NIC network configuration

2.3 Before the Final Instrument Installation

The completion of the described installation preparation must be executed by the customer. After this is done, an installation date will be arranged. Bruker AXS Service will finish the installation of the S8 TIGER only after the customer has confirmed that the preparation is finished.



Please check that the instrument can be transported from the loading dock to the laboratory. The larger package for the S8 TIGER 3 kW / 4 kW measures 120 cm x 132 cm x 160 cm (D x W x H) and has a mass of about 510 kg (S8 TIGER 1 kW: 120 cm x 110 cm x 160 cm; 490 kg).

2.3.1 Installation Checklist

Table 2.7: Installation Checklist

Component	YES/NO	Value/remark
Room Location and Environment		
Floor can support the instrument		
Floor space free of equipment and clean		
Have minimum clearance behind unit		
Doors and hallways from loading dock to location have adequate clearance for moving the instrument in its shipping crate; freight elevator available		
Environmental considerations met		
Internal Cooling Water		
Distilled water is available		
Communications		
Internet access for remote diagnostics via WebEx.		
Second voice line (near computer)		
Ethernet network connection from S8 TIGER to computer		
Electrical Power available		
For S8 TIGER		
For computer and/or peripherals		
For the water chiller (if installed)		

Component	YES/NO	Value/remark
Check that electrical power is reliable and within tolerances (see Reference), if not get USP		
Supply Gases (Note: A flow counter and/or the optional helium mode require gas cylinders, P-10 or P-5 and/or He, and appropriate regulators. Neither gas cylinders or regulators are factory-supplied)		
P-10 or P-5		
Cylinder/regulator securely mounted to wall (near the instrument)		
If mounted farther away than the supplied hose length, correct tubing/piping line installed		
Gas quality is sufficient		
Helium		
Cylinder/regulator mounted securely to wall		
If mounted farther away than the supplied hose length, correct tubing/piping line installed		
Gas quality is sufficient		
External Instrument Cooling (S8 TIGER 3 kW / 4 kW only)		
Open cooling system Plumbing/piping complete		
or: Closed cooling system Plumbing/piping complete		
Vacuum		
Exhaust to outside (optional)		

Component	YES/NO	Value/remark
Final Check		
All local safety codes are met		
In case of questions or if assistance is needed, call your local Service Representative http://brukersupport.com/		

2.3.2 When System arrives

1. Upon arrival, check goods immediately for any visible damages. Even if there is only suspicion of damage, don't issue an entire receipt for the carrier. Carrier or other third parties (e.g. shipping company, railway authority, port authority) must be held liable in writing (letter or reserve) for any damages or loss.
2. Contact a claim surveyor if the claim amount seems higher than EUR 22.500,00. The needed address is shown in the certificate of shipment or can be found under *VHT* (<http://www.vht-online.de>)

2.3.2.1 In Case of Damage

In case of loss or damage please send following information **immediately**, but no later than 5 days after receipt, to:

Table 2.8: Contact information in case of transport damage

Bruker AXS GmbH	
Address:	Oestliche Rheinbrueckenstr. 49 76187 Karlsruhe Germany
Phone:	+49 721 50997-0
Fax:	+49 721 50997- 5654
Email:	info.baxs@bruker.com

Bruker AXS GmbH	
subject:	"transport damage"

Necessary documents

- Supplier's reference no.
- Short description of the incident
- Estimated amount of the claim
- Photos
- Report of claim surveyor, if applicable



Do not wait longer than 5 days with the announcement of damages even if you do not have all information mentioned above!

Do not scrap, return or repair any damaged goods and/or packaging until further advice!

In case of non-observance insurance coverage may expire.

2.4 Changing the Location of the System

The S8 TIGER is designed to be a mobile analytical device. The spectrometer can be moved on its mounted wheels.

With each permanent location change, the following points must be considered:

- Before permanently changing the location of the system, please consult your local Bruker AXS Service Representative.
- During transport, **all** mechanical vibrations are to be avoided. Otherwise, sensitive physical components may be damaged.
- Please make sure that the S8 TIGER is securely positioned to avoid unintentional movement at its new location (please use the provided blocking wedges).

- The mains connection at the new location must meet the requirements given in the section *Mains Connection and Grounding* [15].
- At the new location, make sure that all local radiation protection regulations and operation permits are strictly observed.

 **CAUTION****Injury during moving the instrument**

You may be injured by the casters or when the instrument tilts.

1. Move the instrument with caution, use a ramp.
 - ▶ Be aware of the casters, watch your feet.
 - ▶ Avoid tilting of the instrument.
 - ▶ Fix all four casters of the instrument to avoid damage due to a rolling device.
 - ▶ Avoid mechanical shocks to avoid damaging the sensitive components.

NOTICE**System damage during transportation**

Mechanical shocks can damage the system

1. Avoid mechanical shocks to avoid damaging the sensitive components
 - ▶ After each change of location, the instrument must be checked by staff authorized and trained by Bruker AXS
 - ▶ Please contact your Bruker AXS service representative.

**Important**

Please ensure that the entire documentation of the system has been moved to the new location.

3 Safety Guidelines

3.1 Correct and Intended Usage

The instrument was designed to perform element analysis by means of X-ray fluorescence. This device and its components may only be used for the applications described in the technical description or in the Bruker AXS literature (e.g. XRD/XRF LabReports or XRD/XRF Application Reports). You can request those reports from your local Bruker AXS Service or Sales Representative. It may only be used in conjunction with devices or components from other manufacturers which have been approved or recommended by Bruker AXS, for example for automation solutions.

NOTICE

Correct functioning of the instrument

The instrument can only function correctly and safely if it is transported, stored, set up, and installed correctly, and if it is operated and maintained as recommended by Bruker AXS.

3.2 Qualified Personnel

All Bruker AXS X-ray systems or parts of them must only be set up and operated in accordance with this manual and the specific manuals belonging to the instrument (e.g. General Safety Instructions, Introductory User Manual and User Manual). Only suitable trained and qualified personnel shall be allowed to work with this equipment.

Qualified personnel are able to carry out assigned work and to recognize and prevent possible dangers self-reliant due to their professional training, knowledge and experience, as well as profound knowledge of applicable regulations.

The installation, maintenance and repair of the system may be carried out only by personnel who are authorized and trained by Bruker AXS. All repairs, adjustments and alignments performed on any components of the system (including the host computer) must be carried out in strict accordance with the established safety practices and standards of the country in which the equipment is installed.

To prevent any risk for health and safety the analysis of samples with the instrument, including handling and/or preparation steps, must be entrusted only to persons who have qualifications in accordance with their activities and functions, and who, based on their technical training, their experience and their knowledge of the applicable standards, are able to evaluate the work assigned to them and recognize possible hazards. This also includes the knowledge of applicable accident prevention regulations, generally recognized safety regulations, EC guidelines and country-specific standards and regulations. Carefully read and follow all safety and handling advice in the appropriate Safety Data Sheets (SDS).

3.3 Limitation of Liability

All specifications and instructions in this manual have been compiled taking account of applicable standards and regulations, the current state of technology and the experience and insights we have gained over the years.

The manufacturer accepts no liability for damage due to:

- Failure to observe this manual
- Improper use
- Deployment of untrained personnel
- Unauthorized modifications
- Technical modifications
- Use of unauthorized spare parts

The actual scope of supply may differ from the explanations and depictions in this manual in the case of special designs, take-up of additional ordering options, or as a result of the latest technical modifications.

The undertakings agreed in the supply contract, as well as the manufacturer's Terms and Conditions and Terms of Delivery, and the legal regulations applicable at the time of the conclusion of the contract shall apply.

3.4 Warnings and Signage

3.4.1 Illuminated X-ray Warning Displays



Figure 3.1: Warning displays on the front of the instrument



X-RAYS ON

There are two illuminated orange warning displays indicating that radiation is generated in the interior of the system. The displays are visible from the front and either side of the instrument.


For detailed information, refer to the [Radiation Protection and the X-ray Safety System \[61\]](#) section in this manual.

3.4.2 Signage

The following symbols and information signs may be displayed on the instrument. Strictly obey all instructions and warning text printed on the labels which are attached to the various parts of the equipment.

Table 3.1: Meaning of the warning symbols

Symbol	Meaning of the Symbol
	Radiation Danger!
	Live Part! Risk of Electric Shock!
	General warning
	Toxic Substances
	Hot Surface
	Danger of Injury! Danger of Crushing!
	Protective Ground/Earth Terminal

Symbol	Meaning of the Symbol
	Follow all valid national, state, and local regulations for disposal.

3.5 General Safety Precautions

3.5.1 Precautions Concerning X-ray Radiation

The S8 TIGER spectrometer system is an analytical instrument with a strong X ray source. Shielding and safety equipment guarantee that the emitted radiation does not exceed 1.0 $\mu\text{Sv/h}$ during operation.

Shielding and safety features designed into the equipment guarantee that the emitted radiation does not exceed 1.0 $\mu\text{Sv/h}$ (at 5 cm from any external surface of the device) during operation. This level is below the regulatory limit in all jurisdictions. The ICRP dose limits in Publication 60 and 103 to the whole body for a radiation worker averaged over a 5-yr period is 20 mSv in a year, and for a member of the public it is 1 mSv in a year. It is highly unlikely that the radiation worker dose limits will be exceeded when trained and qualified personnel use such devices.

Read the section **Protection Against Radiation** of the *Introductory User Manual* before turning on the system. Please observe local regulations for the operation of X-ray systems.

If you suspect that the safety system does not work correctly or that radiation protection is impaired for any reason, immediately switch off the system and contact your local Bruker AXS Service Representative.

 **WARNING**

X-ray radiation hazard

Exposures to radiation, even for a fraction of a second, cause severe burns and / or fatal injuries or lethal diseases (cancer). Even without visible injuries or sensible pain, lethal diseases might evolve many years later.



- ▶ Switch off the system immediately when any part of the enclosure gets damaged!
- ▶ Switch off the system immediately when the safety system does not or seems not to work correctly!
- ▶ Switch off the system immediately when the radiation protection is impaired!
- ▶ Never manipulate or modify the safety system or parts of it – this is strictly forbidden!
- ▶ Never remove sealed screws or parts which are protected by sealed screws – this is strictly forbidden!
- ▶ Never manipulate any interlocks or other safety-relevant devices!
- ▶ Contact your local Bruker AXS service representative in case of doubt.


The X-ray generator is controlled by a three position Keyed switch (**OFF / NEUTRAL / ON**) similar to the ignition switch of a car. The key can only be removed when the switch is in the **OFF** position. The switch will remain in the **OFF** position until the key is inserted and turned. Therefore the removal of the key will terminate production of X-ray.

3.5.2 Precautions Concerning Electricity

 **WARNING**

**High voltages, up to several tens of thousands Volts DC in:
high-voltage generator | X-ray tube | radiation detectors | high-voltage
cables**

High risk of lethal electrical shock when components are damaged!

- 
- ▶ Disconnect the system **completely** from the mains supply following this instruction step-by-step when any component carrying high voltage has been damaged:
 - ▶ Step 1: Immediately switch off the system! Use the **Emergency Switch OFF!**
 - ▶ Step 2: Switch off the **Mains Disconnect** switch!
 - ▶ Step 3: Disconnect all **Power Supply Lines** from the mains supply!
 - ▶ Step 4: Switch off the **Automatic Circuit Breaker** or the **External Power Disconnect** switch, located in the vicinity of the instrument!
 - ▶ Step 5: Contact your local Bruker AXS service representative.

The system must be operated **ONLY** with such mains supply voltages as are listed on the spectrometer's rear plate. As long as the system is connected to the external mains supply, some terminals of the internal components may present a danger of high-voltage shock.

 **WARNING**

Terminals of internal components stay alive, when the system is switched off.

High risk of lethal electric shock.

- 
- ▶ Disconnect the system **completely** from the mains supply.
 - ▶ Wait at least 1 minute before removing any panel.

NOTICE

Wrong mains supply voltages

Substantial damage may result when wrong mains supply voltages are connected to the system.

- ▶ Only connect the mains supply voltages listed on the instruments type plate.

Inside the S8 TIGER spectrometer there are closed loop water circuitries for cooling the X-ray tube, the X-ray generator and also for the internal air-conditioning. In addition to that, S8 TIGER 3 kW and S8 TIGER 4 kW instruments are provided with water hoses which are connected to the building's water supply system.

If there are any water leakages (caused by faulty components or by accident during the refilling of the internal water reservoir) the spectrometer must remain switched off or be turned off instantly! This must be done by switching off the automatic circuit breaker or power disconnecter which is located in the vicinity of the instrument. It is not sufficient to just turn off the spectrometer using the **Power Off** button as some terminals inside the instrument will stay connected to mains supply voltage.

The S8 TIGER must stay powered-off until the leakage source has been repaired and all wet regions have been dried thoroughly. Be aware, there is a high danger of electrical shocks whenever there is leakage of water!

WARNING

Leakage or splashing of cooling fluids

High risk of lethal electric shock as long as water or other cooling liquids are present in or near the system.

- ▶ Disconnect the system **completely** from the mains supply.
- ▶ Be cautious when refilling the fluid tank.
- ▶ Repair the leakage source.
- ▶ Dry all wet regions thoroughly before connecting the system to the mains supply again.



3.5.3 Precautions Concerning Health Risk of Components and Disposal

The X-ray tube and the scintillation detector contain Beryllium.

 **WARNING****Beryllium**

Beryllium is carcinogenic and causes diseases of the skin, splenic, liver and lungs.

- ▶ Never touch, inhale or incorporate fumes, dust or pieces of beryllium.
- ▶ Wear personal protective equipment (PPE).
- ▶ Do not touch any part of the instrument which contains beryllium, e.g. X-ray tube radiation outlet window, the detector front window or the heating chamber windows of some systems.
- ▶ Do not cut, machine, or handle beryllium in any way.
- ▶ It must not escape into the environment.
- ▶ Disposal of beryllium must comply with all applicable national, state, and local regulations.
- ▶ Strictly obey the applicable national, state, and local safety regulations.

For special customer applications, the S8 TIGER may be equipped with a TLAP analyzer crystal. This crystal (if installed) contains Thallium, an extremely toxic heavy metal. This crystal is water-soluble and can cause poisoning by skin contact.

Please handle this crystal with maximum care and avoid any skin contact! Strictly obey the applicable national, state, and local safety regulations.

Disposal of Thallium-containing parts must comply with all applicable national, state, and local regulations.

 **WARNING**



Thallium

Thallium is an extremely toxic heavy metal (lethal dose 800 mg) which causes death or acute and chronic diseases.

1. Thoroughly avoid any skin contact and incorporation of Thallium
 - ▶ Don't touch the analyzer crystal TLAP
 - ▶ Wear personnel protective equipment.
 - ▶ Strictly obey the applicable national, state, and local safety regulations.

 **CAUTION**



Analyzing Harmful Volatile Substances

Harmful volatile substances pose different kinds of health threats.

1. Special laboratory equipment is required.
 - ▶ Avoid inhalation!
 - ▶ Provide a vent to open air for the exhaust gases of the vacuum pump!
 - ▶ Only use the sample holders recommended by Bruker AXS for the respective measurements.
 - ▶ Strictly follow national, state and local safety regulations!

 **WARNING**



Analyzing toxic substances

Incorporated toxic substances may cause intoxications or even death.

1. Never touch, inhale or incorporate toxic substances.
 - ▶ Wear personal protective equipment (PPE).
 - ▶ Strictly follow all national, state, and local safety regulations!

 **CAUTION** **Analyzing Biological Active Substances**

Biological active samples contain microorganisms, viruses or toxins and can be infectious or pathogenic.

1. Special laboratory equipment is required.
 - ▶ Wear personal protective equipment.
 - ▶ Follow applicable national, state, and local safety regulations.

 **CAUTION** **Disposal of instrument**

Health-threatening substances are set free when the instrument is disposed of illegally.

Also environmental pollutants can be set free, e. g. beryllium (X-ray tube and detector), thallium (for instruments with TLAP analyzer crystal), batteries (some electronic boards) and oil. The instrument contains heavy and toxic metals like Pb, Cr, Mo, W, Ta, Bi and others.

1. Instrument must only be disposed of professionally.
 - ▶ Follow all valid national, state, and local regulations for disposal.
 - ▶ Contact Bruker AXS service for additional assistance.

 **CAUTION** **Disposal of Beryllium or Thallium**

Beryllium and Thallium are highly toxic substances posing a high risk for human health when disposed illegally in the environment.

1. Disposal of Beryllium and Thallium, or parts containing Beryllium or Thallium must comply with all applicable national, state, and local regulations.
 - ▶ Strictly avoid contact with these substances.

 **CAUTION**



Batteries contain acids and (heavy) metal ions

Leaking Batteries cause chemical burns on the skin. Batteries contain environmental pollutants.

1. Avoid any skin contact with damaged batteries.
 - ▶ Wear gloves, when touching damaged batteries.
 - ▶ Collect the batteries in an acid resistant box until they are disposed of correctly.
 - ▶ Disposal of batteries must comply with all applicable national, state, and local regulations.

NOTICE

Disposal of Oil

Oil is an environmental pollutant. Disposal of oil must comply with all applicable national, state, and local regulations.

3.5.4 Precautions Concerning Other Sources of Personal Damage

Several components (mainly all stepper motors, the air heating element, the water pump and the vacuum pump) of the spectrometer get very hot during standard operation due to power dissipation and could cause severe burns when being touched. Normally, these components cannot be accessed as the side panels are installed and, the motors inside the sample loader are covered by metal pieces. But, during maintenance and repair the hot surfaces could be touched by accident.

Be aware that the surface temperature of internal S8 TIGER components might exceed 100 °C (212 °F) whenever the instrument is switched on. Before touching any of these components turn off the instrument and wait until the components have cooled down sufficiently.

**⚠ CAUTION****Hot Surfaces between 70 and 100 °C (156 and 212 °F) on internal components**

Risk of severe burns when touching the surfaces.

- ▶ Turn off the instrument and wait until all components have cooled down!

While the instrument is running there is an enhanced risk of injuries due to moving parts and components.

It is the responsibility of the operator to assure that no person can touch or get close to the following components or units while the instrument is running:

- Sample turn unit (e.g., for automation systems)

If in doubt, if the instrument is already running, stay away from its components! Do not check motion by using your hand!

The samples to be measured are positioned by means of a fast XYZ sample changer system. To prevent personal injury, all motions are immediately stopped if the sample magazine cover is opened.

If you suspect that the safety system does not work correctly, immediately switch off the system and contact your local Bruker AXS Service Representative.

 **WARNING**

Moving parts

Injuries, e.g. by entanglement (fingers, hair, clothing), abrasion, cutting, or crushing are possible.



- ▶ Keep your hands off!
- ▶ Do not check parts in motion by using your hand!
- ▶ Stay away from moving components!
- ▶ Immediately switch off the system, when you suspect a present failure of the safety system for motorized drives.
- ▶ Contact your local Bruker AXS service representative

 **CAUTION**

Cover

Crushing hazard in case of failing struts.



- ▶ Take care not to have your hands where the lid is closing.



Figure 3.2: Gas strut (1)

The S8 TIGER spectrometer is designed to be a mobile analytical instrument. During transportation, please avoid mechanical shocks to avoid damaging the sensitive physical components.

NOTICE

System damage during transportation

Mechanical shocks can damage the system

1. Avoid mechanical shocks to avoid damaging the sensitive components
 - ▶ After each change of location, the instrument must be checked by staff authorized and trained by Bruker AXS
 - ▶ Please contact your Bruker AXS service representative.

NOTICE

Substantial damage

The instrument may be damaged when it's pulled on the top cover handle.

- ▶ Do not use the handle of the top cover to pull the instrument!

3.5.5 Hazards Caused by Gases

Systems with gas flow devices require external gas cylinders, if no in-house gas supply system is available. The cylinders must be secured so that the cylinders are prevented from falling over. Correct and secure installation of gas cylinders must be provided at all times!

Follow applicable national, state, and local regulations for installation and operation of P-10 (argon-methane gas mixture), helium, and nitrogen gas operation and gas cylinders.

Be aware, that this gas is also released to the environment during measurement. A separate vent to open air should be provided to let off the gas.

It is the responsibility of the user to assure that the correct gas type is connected to the instrument. Before opening the gas valves leading to the instrument, double check that the specified gas is used. In particular exclude the inadvertent use of any explosive or corrosive gas.

SAFETY INSTRUCTIONS

Proper change of gas cylinders

1. Follow the instruction thoroughly.
 - ▶ Close the main valve of the empty tank/gas bottle.
 - ▶ Disconnect the regulator.
 - ▶ Screw on the valve protection cap.
 - ▶ Never leave a tank without the protection cap and attachments to prevent the tank from falling over.
 - ▶ Remove the used tank.
 - ▶ Secure the new tank.
 - ▶ Double check you have chosen the right gas!
 - ▶ Remove the protection cap.
 - ▶ Attach the regulator and tighten it.
 - ▶ Do not change the secondary pressure setting.
 - ▶ The regulator should be set to 0.5 bars/7 psi. You can adjust the secondary side only if gas is flowing.
 - ▶ Open the main valve.
 - ▶ Use soap water to check the connection to the regulator.

3.5.6 Cleaning the Spectrometer System



WARNING

Risk of injury from electrical shock!

A life threatening shock may result when cleaning, maintenance or replacement operations are performed before disconnecting the system from the power supply.

- ▶ Shut down the system.
- ▶ Turn off the power of the system.
- ▶ Disconnect the power supply cable from the mains net.

Exterior Panels

For cleaning the side panels and also the interior of the sample magazine use a damp cloth. Do not use soap or aggressive cleansing agents. The transparent sample magazine cover can be cleaned with any standard household-type window detergent.

Sample Magazine / Loader

The sample magazine and the sample cups should be kept clean and dry. The sample cups can be washed with hot soapy water or an organic solvent and dried prior to use.

NOTICE

Disposal of solvents

Solvents are environmental pollutants. Disposal of solvents must comply with all applicable national, state, and local regulations.

Larger particles of dirt on the sample magazine or inside the loader can be removed with a vacuum cleaner.

Touchscreen

To clean the touchscreen, avoid the use of abrasives or aggressive solvents. Only use a soft damp cloth with a mild detergent if necessary.

3.5.7 Servicing Precautions

To ensure that the S8 TIGER system operates in a reliable and precise way, preventive maintenance must be performed at regular intervals as recommended by Bruker AXS.



All repairs, adjustments and alignments performed at any component of the system (including host computer) need to be carried out by authorized and trained personnel in strict accordance with the approved work practices of the country where the equipment is installed only.

The S8 TIGER system is equipped with an Ethernet network interface. Therefore, they can be controlled remotely by computers. These can be part of the local company network or even a wide area network. The implemented safety features of S8 TIGER systems make sure that the instrument is – at all times – in a safe state during standard operation (with respect to X-rays, electrical voltages, and mechanical movements). In case of failure, generation of X-rays and movement of mechanical drives will be stopped immediately.

 **WARNING****Risk of X-ray radiation, high voltage and moving of mechanical drives due to remote control via network!**

Severe injuries may result when the instrument is operated in servicing mode and at the same time controlled via remote control.

1. Only authorized and trained people are allowed to perform repair work on an instrument with opened enclosure.
 2. Disconnect the instrument physically from the network.
 3. Connect the instruments network interface directly to a computer located nearby.
 4. Disconnect this computer from any LAN networks during entire duration of the work.
- ▶ Do not leave the instrument unattended during this time.

 **DANGER****Live parts! Risk of electric shock!**

Life-threatening electric shock due to accessible high voltages.

1. Only trained specialized personnel, authorised by the plant operator may carry out the following operations
2. Before carrying out any operations, disconnect the instrument completely from the mains supply.
 - ▶ Shut down the high voltage generator,
 - ▶ Switch off the instrument and disconnect the main power cord.
 - ▶ Disable high voltage operation by switching S650 keyswitch in position 0 „X-RAYS DISABLED“.
 - ▶ Remove the key from the switch.
 - ▶ Lock out and tag out the instrument.
 - ▶ **Allow five minutes for discharge of internal capacitance of the high voltage generator.**

4 X-ray Safety System

4.1 Radiation Protection and the X-ray Safety System

The S8 TIGER spectrometer system is an analytical instrument with a strong X-ray source. Shielding and safety equipment guarantee that the emitted radiation does not exceed $1.0 \mu\text{Sv/h } H^*(10)$ during operation. Bruker AXS screens each single instrument for X-ray radiation leakage prior to delivery. This is done under worst case conditions as maximum high voltage and use of a scattering sample.

Shielding is the most effective method of reducing exposures to X-rays in a X-ray spectrometer system. X-ray radiation is diminished in intensity by any given absorber but not completely stopped. Materials having a high atomic number can absorb more X-rays than lighter elements. A frequently used shielding material is lead. It is important to remember that X-rays can be scattered in the shielding material and emerge at odd angles.

 **WARNING**

X-ray radiation hazard

Exposures to radiation, even for a fraction of a second, cause severe burns and / or fatal injuries or lethal diseases (cancer). Even without visible injuries or sensible pain, lethal diseases might evolve many years later.



- ▶ Switch off the system immediately when any part of the enclosure gets damaged!
- ▶ Switch off the system immediately when the safety system does not or seems not to work correctly!
- ▶ Switch off the system immediately when the radiation protection is impaired!
- ▶ Never manipulate or modify the safety system or parts of it – this is strictly forbidden!
- ▶ Never remove sealed screws or parts which are protected by sealed screws – this is strictly forbidden!
- ▶ Never manipulate any interlocks or other safety-relevant devices!
- ▶ Contact your local Bruker AXS service representative in case of doubt.

 **WARNING**

X-ray radiation hazard due to removal of parts mounted by sealed screws

Exposures to radiation, even for a fraction of a second, cause severe burns and / or fatal injuries or lethal diseases (cancer). Even without visible injuries or sensible pain, lethal diseases might evolve years later.



1. Screws with sealed heads serve as protection against unauthorized removal of safety related components. They are part of the safety system.
 - ▶ Never remove parts which are protected by sealed screws during normal operation. This is strictly forbidden for any person!
 - ▶ Never manipulate or modify parts of the safety system - it is strictly forbidden!

 **WARNING****X-ray radiation**

Exposure to X-ray radiation with severe consequences to your health is possible.

- ▶ The fault which caused the shut-down has to be repaired before the X-ray safety system may be resetted
- ▶ Never reset the system while the fault is present!
- ▶ Contact your Bruker AXS service for help!

4.2 Prerequisites for X-ray Generation

X-rays will be generated only if each of the following conditions is met:

- Both safety circuits have been enabled by the S8 TIGER's safety system. (The micro-processor will enable the safety circuits only if all self-tests and plausibility checks of safety-relevant components have been completed successfully.)
- The sample seal is closed and all switches monitoring its position indicate the status "Seal closed".
- All side panels have been mounted correctly.
- The tripline switches, which monitor the X-ray source and the sample seal cover, are closed.
- The cathode heater voltage has been switched on by turning the key switch.
- All four X-ray warning displays are illuminated. (Each X-RAYS ON warning display, as shown in *Illuminated X-ray Warning Displays* [p. 43], consists of two illuminated panels: one on the front of the instrument and one on the side.)
- The optional external warning display is turned on (if installed).

A fail-safe time delay unit prevents the sample seal from opening before X-ray high voltage has been turned off completely.

4.3 Description of the X-ray Safety System

The S8 TIGER has two electromechanical safety circuits. The detailed wiring schematics and block diagrams are available inside the *S8 TIGER Supplement Folder* which is shipped with the instrument. Both circuits are totally independent. A microcontroller monitors all components of the safety circuits and continuously performs plausibility and functionality checks.

In the event of any error that affects the X-ray radiation safety, the two safety circuits will be interrupted and the X-ray radiation will be switched off. The two safety circuits control the two contactors (K52 and K53, located inside the X-ray generator) that enable the generation of high voltage. The error condition will be saved in the microcontroller's non-volatile flash memory. Consequently, the safety controller will block the X-ray generator by disabling relays K1 and K2. Even after powering off and powering back on, it is not possible to turn on X-rays. In order to enable X-rays again, the error condition must be fixed and the safety system must be reset by a special password-protected command.

X-ray safety circuit #1

Safety Circuit #1 consists of:

- contactor K52 (activation of high voltage generation);
- relay K6 (auxiliary function);
- relays K8 through K11 (monitoring the sample seal position switches S659 through S662);
- safety switches S651, S653, S655, S657 (monitoring the side panels);
- tripline (monitoring the X-ray source, the high-voltage cable, and the cover of the sample entry position); and
- safety relays K1 and K2 (controlled by the safety microcontroller).

If all of these switching contacts are closed, the "heating voltage" (see signal "Heating Voltage + 24 VDC") will be transferred via a fuse to the X-ray generator. This voltage will activate contactor K52 inside the X-ray generator and enable the generation of high voltage.

X-ray safety circuit #2

Safety Circuit #2 consists of:

- contactor K53 (activation of high voltage generation);
- relay K7 (auxiliary function);
- relays K8 through K11 (monitoring the sample seal position switches S659 through S662);
- safety switches S652, S654, S656, S658 (monitoring the side panels);
- tripline (monitoring the X-ray source, the high voltage cable, and the cover of the sample entry position); and
- safety relays K1 and K2 (controlled by the safety microcontroller).

If all of these switching contacts are closed, the “heating voltage” (see signal “Heating Voltage + 24 VDC”) will be transferred via a fuse to the X-ray generator. This voltage will activate contactor K53 inside the X-ray generator and enable the generation of high voltage.

Delayed control of the sample seal drive

When turning on the X-ray generator high voltage, the sample seal motor will be disconnected from its electrical control circuits by the safety relays K3 and K4. The sample seal drive remains disconnected as long as the two contactors K52 and K53 are turned on.

After switching off the high voltage generator, the two relays K3 and K4 remain turned off and will not be activated before a defined delay time has completely elapsed. Therefore, the delay circuit ensures that the sample chamber cannot be opened before the high voltage has been turned off completely.

4.3.1 X-ray Warning Displays

Two directly connected X-ray warning displays indicate the status “X-RAY ON”. Each display consists of two LED illumination panels. The warning displays are controlled by the contactors K52 and K53 and are illuminated when the high voltage is switched on. The current through the displays is continuously checked by the microcontroller. In case of any error, the safety relays K1 and K2 interrupt both safety circuits and instantly switch off the X-rays.

4.3.2 Optional External X-ray Warning Display

A fail-safe external X-ray warning display can be connected to the instrument if requested. It will be controlled by safety relay K5 and is monitored by the micro controller. In case of any error, the safety relays K1 and K2 will interrupt both safety circuits and switch off the X-ray generation immediately.

4.3.3 Monitoring of the Individual Components of the Safety Circuits

All components of the S8 TIGER's X-ray safety system are monitored by a microcontroller. This section describes the checks performed by the microcontroller.

Monitoring of the relays

All relays used in the S8 TIGER's safety system are special safety relays with a feature called "forcibly guided contacts". The microcontroller monitors and verifies the status of these relays by reading back the switching state of their contacts.

Start-up checks

After turning on the instrument, several checks verify that the microcontroller is operating correctly. Also, the status of the safety system's components is read back and verified.

The functionality of the sample seal position switches is checked by opening and then closing the sample seal after powering up the instrument.

If none of the startup tests detects an error, the microcontroller will enter normal operation mode (see the section *Monitoring of the Individual Components of the Safety Circuits [67]*). If there are any errors, the microcontroller will block the X-ray generator and enter error operation mode (see the section *Monitoring of the Individual Components of the Safety Circuits [67]*).

If the error memory indicates any safety errors that have not yet been confirmed and reset, the microcontroller will block the X-ray generation and enter error operation mode (see the section *Monitoring of the Individual Components of the Safety Circuits [67]*).

Checks during normal operation mode

The status of every safety system component is monitored continuously. As long as all components pass their plausibility checks, the microcontroller will activate the two safety relays K1 and K2, enabling the generation of high voltage.

Error operation mode

If the microcontroller detects any error within the X-ray safety system, both relays K1 and K2 will be disabled immediately. Consequently, the two contactors K52 and K53 will be turned off and the high-voltage generator will be shut down instantly.

The error condition is saved in non-volatile memory to make sure that the system stays blocked even after powering the instrument off and then on again.

4.3.4 Components of the Safety Lines

The various components of the safety lines work as follows:

K6/K7:

When turning on key switch S600 (i.e. the clockwise end position), the two relays K6 and K7 will close and stay activated (enabling the two safety lines). If either of the safety lines is interrupted, both relays will be switched off immediately.

K52/K53:

The switching contacts of the two contactors K52 and K53 turn on the high-voltage generation unit inside the X-ray generator. As soon as this unit is activated, the connected X-ray tube will be supplied with the specified electrical power. The values for high voltage and tube current will be set individually by firmware.

If the two safety lines are closed, the contactors K52 and K53 can be turned on and off by firmware control. If either of the two safety lines is interrupted, both contactors will be switched off immediately and stop the generation of X-rays.

S651-S658:

Switches S651 through S658 check that the four side panels of the S8 TIGER are mounted correctly. If any of these switches are interrupted (e.g. because panels are loose or not attached), high voltage generation will be stopped immediately.

S659/S660:

Switches S659 and S660 monitor the position of the sample seal. They are located at the front edge of the sample seal. They guarantee that the generation of high voltage can only be enabled if the sample seal has been closed properly.

S661/S662:

Switches S661 and S662 are located at the rear side of the sample seal and check the position of the sample seal. They make sure that the generation of high voltage can only be enabled if the sample seal has been closed properly.

Tripline Switch:

The tripline switch makes sure that:

- the cover of the sample entry position is mounted correctly
- the high voltage cable is properly attached to the X-ray tube and
- the X-ray tube is inserted into the tube mount.

K1/K2:

The relays K1 and K2 are activated by the microcontroller located on the "safety board" inside the system.

The switching contacts of relays K1 and K2 are inserted in both safety line 1 and safety line 2. If all safety conditions are met, K1 and K2 will be activated and their switching contacts will close (i.e. enable) both safety lines.

In case of an error, K1 and K2 will be turned off and their contacts will interrupt both safety lines. The X-ray generator will stop generating high voltage.

4.4 System Control



Figure 4.1: Control panel (including all switches)

Button	Description
1: EMO button (Emergency Machine Off)	The EMO button switches off the control electronics, high voltage generator and all components of the system. Therefore, the X-ray source will be turned off instantly and all drives will stop their movements. The EMO button should only be pressed in case of an emergency. Do not use it for normal shutdown.
2: Power Off Button (red)	The red Power Off button switches off all components of the S8 TIGER, including the high-voltage generator.
3: Power On Button (green)	The green Power On button switches on all components of the S8 TIGER, including the high-voltage generator. After switching on the system, all four illuminated status LEDs will flash until the system is fully initialized. The green LED will remain lit, indicating that the system is ready. After the startup procedure, the system can be fully activated with the key switch (see below). Subsequently, the instrument enters Measurement Standby mode.

NOTICE

Shortened life time of X-ray tube and high voltage generator

Do not force shut down the instrument while X-rays are being generated by the high-voltage generator, as indicated by the X-ray symbol on the generator screen key. This can shorten the service lives of the X-ray tube and the high voltage generator.

Each time a sample is removed, the high voltage is switched off automatically. The high voltage may also be switched off using the control software.

Turning the key switch clockwise: Measurement Standby Mode ON

Continue turning the key clockwise until it reaches the **READY** position. The orange status LED begins to flash. The system is now in **Measurement Standby** mode (i.e., it is ready to measure samples).

If a system alarm is present, **Measurement Standby** mode cannot be started (see *Illuminated Status Displays* [71]).



Samples may only be transferred into the sample measurement chamber or removed when the system is in **Measurement Standby** mode.

Turning the key switch counterclockwise: Measurement Standby mode OFF

Before switching off the system (or during long periods between measurements), exit **Measurement Standby** mode. To exit **Measurement Standby** mode, turn the key as far counterclockwise as possible and hold it until the orange status LED extinguishes.

Protection against unauthorized operation

To prevent unauthorized persons from using the system, remove the key from the key switch. This also prevents the X-rays from being accidentally turned on.



The X-ray generator is controlled by a three position keyed switch (**OFF / NEUTRAL / ON**) similar to the ignition switch of a car. The key can only be removed when the switch is in the **OFF** position. The switch will remain in the **OFF** position until the key is inserted and turned. **Therefore the removal of the key will terminate production of X-ray.**

4.4.1 Illuminated Status Displays



Figure 4.2: Status display

Ready	Measurement Standby mode: A flashing orange LED indicates that the system is in Measurement Standby mode. The system is ready and measurements of samples can start immediately.
On	System ON: The green LED indicates that the control electronics and the high-voltage generator are turned on.
Alarm	Alarm and Warning Display: The red LED indicates that a system alarm (steady red light) or a system warning (flashing red light) is pending (see section 'Alarms and Warnings' in section 'System Control software').
Busy	Measurement is running/Measurement is paused: The yellow LED indicates that a measurement is being executed (steady yellow light) or that the current measurement has been cancelled because a physical system component is not ready (flashing yellow light).

X-ray tube ON

After a sample has been moved into measurement position, the high-voltage generator is activated. While the X-ray tube is generating the specified X-ray power, the orange Status LED lights steadily.



After turning on the system, all four illuminated status LEDs will light until the system control has finished its initialization. After initialization, the green System ON LED lights steadily.

5 Technical Specifications

5.1 Certified Compliance and Safety Standards

Table 5.1: Certified Compliance and Safety Standards

Certified Compliance and Safety Standards	
Electrical Safety	DIN EN 61010-1 and DIN EN 61010-2-081 IEC 61010-1 and IEC 61010-2-081
Electromagnetic Compatibility	EN 61000-6-1 and EN 61000-6-2 EN 61000-6-3 and EN 61000-6-4
Safety of Machinery	EN ISO 14121-1, Machinery Directive 2006/42/EC European Union
Radiation Safety	<ul style="list-style-type: none"> • Fully radiation protected system: BfS 09/07 V RöV approval, PTB test certificate 6.32-V246. Radiation dose < 1 µSv/h H*(10) (NB: This is the lowest certifiable level.) [Approval (“Bauartzulassung”) by the German agencies BfS (Bundesamt für Strahlenschutz) and PTB (Physikalisch Technische Bundesanstalt). S8 TIGER spectrometers are certified as devices called “Vollschutzgeraete” according to “Annex 2 No.3” of the German regulation called “Roentgenverordnung”.] • S8 TIGER’s meet “Safety Category No. 3” as defined by the standard EN954-1, and also the requirements defined by the standard DIN 54113. • Each instrument passes an individual X-ray leakage and safety test at Bruker AXS prior to shipment. • S8 TIGER’s further conforms to the following recommendations, instructions, and laws:

Certified Compliance and Safety Standards	
	<ul style="list-style-type: none"> • Recommendations of ICRP (International Commission on Radiological Protection) • Recommendations of IAEA (International Atomic Energy Association) • Instructions of EURATOM (Europäische Atomgemeinschaft) • German Law „Atomgesetz“ • French radiation safety standard: AFNOR NFC 74-100
Protection Classification according to IEC 536	Class I
Protection Degree according to IEC 529	IP 2 0

5.2 Electrical Specifications

Table 5.2: Electrical Specifications

X ray Generator and Control Electronics	
<p>Mains Supply Voltage</p> <p>(Actual nominal voltage is factory-preset and printed on the system label located on the system's rear panel.)</p> <p>(For more details see section <i>Mains Connection and Grounding</i> [15])</p>	<p>Three-phase supply:</p> <p>3 x 120 VAC (± 10 %)</p> <p>3 x 230 VAC (± 10 %)</p> <p>3 x 240 VAC (+6 % / -10 %)</p> <p>(For details see schematics 'S8-Mains Distribution')</p> <p>One-phase supply (on request only):</p> <p>208 VAC (-10 % / +10 %)</p> <p>230 VAC (±10 %)</p> <p>240 VAC (+6 % / -10 %)</p>
Frequency Range	47 Hz – 63 Hz
Overvoltage Category according to IEC 664	II

Table 5.3: Electrical requirements (including X-ray generator and control electronics, not including accessories)

Device	S8 TIGER 1 kW	S8 TIGER 3 kW / 4 kW
Power consumption	2.9 kVA	5.2 kVA / 7 kVA
Mains voltage and frequency (standard configuration)	208 – 230 V, 50 / 60 Hz, 16 A, 1-phase	208 – 230 V (50 / 60 Hz) 40 A, 1-phase 208 – 230 V (50 / 60 Hz) 32 A, 3-phase

5.2.1 High-voltage Generator

Table 5.4: Electrical Specifications continued

High-voltage generator K410	
Output power limit	1 kW
Output voltage	20-50 kVDC (in steps of 1 kV)
Output current	5 mA - 50 mA (in steps of 1 mA)
High-voltage generator K431	
Output power limit	3 kW
Output voltage	20 - 60 kVDC (in steps of 1 kV)
Output current	5 mA - 150 mA (in steps of 1 mA)
High-voltage generator K440	
Output power limit	4 kW
Output voltage	20 - 60 kVDC (in steps of 1 kV)
Output current	5 mA - 170 mA (in steps of 1 mA)

5.3 Recommended X-ray Tubes

Below is a list of X-ray tubes recommended for use with your S8 TIGER. There are more options available (e.g. target materials). For availability of a specific tube type's target materials, please contact your Bruker AXS Service or Sales Representative. In most countries and states, you will need an individual on-site X-ray test if you choose to use a target material heavier than rhodium. The table lists the recommended operation parameters.

Table 5.5: Recommended X-ray Tubes

1 kW operation	
Type	AG22
Maximum high voltage	50 kVDC
Maximum current	50 mADC
Maximum power	1 kW
Anode material	Rhodium
3 and 4 kW operation	
Type	OEG95LT
Maximum high voltage	60 kVDC
Maximum current	170 mADC
Maximum power	4 kW
Anode material	Rhodium

5.4 Laboratory Requirements

5.4.1 S8 TIGER Mechanical Specifications

Table 5.6: S8 TIGER system dimensions (dimensions in mm and inches)

Dimensions	S8 TIGER 1 kW	S8 TIGER 3 kW / 4kW
Height	1040 mm / 41"	
Depth	865 mm / 34.1 "	1220 mm / 48 "
Width	890 mm / 35 "	
Width of the Touchscreen	380 mm / 15 "	
Depth of Touchscreen	290 mm / 11.4 " (measured from front panel)	

Table 5.7: S8 TIGER system weight

Weight	S8 TIGER 1 kW	S8 TIGER 3 kW / 4kW
Weigth	~ 446 kg / 981 lb	~ 476 kg / 1047 lb

5.4.2 Environmental Specifications

Table 5.8: Environmental Specifications

Specifications	Data
Optimal room temperature	24 °C / 75 °F
Temperature operation range	17 °C – 29 °C (63 °C – 84 °F), $\Delta T \pm 2$ °C (3.6 °F) for very high stability of the measuring values
Maximum temperature gradient	2 °C (3.6 °F) per hour
Relative humidity	20 % - 80 %, condensation not allowed

Specifications	Data
Atmospheric pressure	Spectrometry system applicable at all terrestrial locations under atmospheric air pressure conditions up to an altitude of 3000 meters (9800 feet).

5.4.3 Gas Consumption

5.4.3.1 Helium/Nitrogen Operation

Table 5.9: Gas Specifications

Helium/Nitrogen operation at reduced pressure	
Medium	Helium or Nitrogen
Consumption during measurement	~ 0.5 l/min
Consumption during sample change	~ 5 - 10 l
Pressure inside sample chamber	250 mbar (3.63 PSI) by default

Helium/Nitrogen operation at atmospheric pressure	
Medium	Helium or Nitrogen
Consumption during measurement	~ 1 - 4 l/min
Consumption during sample change	~ 10 - 30 l
Pressure inside sample chamber	atmospheric

Counter gas consumption	
Media	P-10 (Argon:Methane 9:1) or P-5 (Argon:Methane 95:5)
Consumption during measurement	~ 2 l/hr

Counter gas consumption	
Pressure inside flow counter	~ 80 mbar above atmospheric at day of installation (1.16 PSIG)

5.5 Accessories

Below is a list of additional equipment that may enhance the system's reliability or increase its uptime if the laboratory infrastructure is not reliable enough.

5.5.1 UPS for the S8 TIGER

If the power supply is unstable, an uninterruptible power supply (UPS) may be switched between the mains network and the S8 TIGER. Depending on your system model, we recommend using an Effekta, Toshiba or Powervar UPS, as listed below.

Suitable for the S8 TIGER 1 kW:

Table 5.10: UPS type Effekta Pegasus 31 (3 ph. / 1ph.)

UPS type Effekta (order no. Pegasus33 -10kVA)	
Nominal output power	10 kVA / 8 kW
Backup time	20 min at rated power
Dimensions (H x W x D)	1200 mm x 450 mm x 650 mm
Weight	250 kg
Input	3 x 32 A, 380-415 V ($\pm 15\%$), 50/60 Hz
Output	3 x 32 A, 50/60 Hz

Table 5.11: UPS type Toshiba 1600EP (1 ph. / 1 ph.)

UPS type Toshiba (order no. UE3G2L080C61T)	
Nominal output power	8 kVA / 6.8 kW

UPS type Toshiba (order no. UE3G2L080C61T)	
Backup time	15 min at rated power
Dimensions (H x W x D)	1200 mm x 450 mm x 650 mm
Weight	260 kg
Input	3 x 32 A, 380-415 V ($\pm 15\%$), 50/60 Hz
Output	3 x 32 A, 50/60 Hz



Configure the output voltage of the Toshiba UPS to 240 V! 208 V are preset by the manufacturer.

Table 5.12: UPS type Powervar (1 ph. / 1 ph.)

UPS type Powervar (order no. ABCDEF 8000-22)	
Nominal output power	8 kVA / 7.2 kW
Backup time	> 5 min
Dimensions (H x W x D)	850 mm x 350 mm x 980 mm
Weight	203 kg
Input	2 x 40 A, 200 – 240 V ($\pm 10\%$), 50/60 Hz
Output	230 V, 50/60 Hz



Configure the output voltage of the Powervar UPS to 230 V!

Suitable for the S8 TIGER 3 kW / 4 kW:

Table 5.13: UPS type Effekta Pegasus 31 (3 ph. / 1ph.)

UPS type Effekta (order no. Pegasus31 -15kVA)	
Nominal output power	15 kVA / 12 kW
Backup time	15 min at rated power
Dimensions (H x W x D)	1200 mm x 450 mm x 650 mm
Weight	260 kg
Input	3 x 32 A, 380-415 V ($\pm 15\%$), 50/60 Hz
Output	2 x 40 A, 50/60 Hz

Table 5.14: UPS type Toshiba (1 ph. / 1 ph.)

UPS type Toshiba (order no. UE3G2L140C61T)	
Nominal output power	14 kVA / 11.9 kW
Backup time	15 min at rated power
Dimensions (H x W x D)	992 mm x 445 mm x 885 mm
Weight	281 kg
Input	2 x 40 A, 208-240 V ($\pm 10\%$), 50/60 Hz
Output	2 x 40 A, 240 V, 50/60 Hz



Configure the output voltage of the Toshiba UPS to 240 V!
208 V are preset by the manufacturer.

Table 5.15: UPS type Powervar (1 ph. / 1 ph.)

UPS TYPE Powervar (order no. ABCDEF 10.0-22)	
Nominal output power	10 kVA / 9 kW
Backup time	> 5 min
Dimensions (H x W x D)	850 mm x 350 mm x 980 mm
Weight	203 kg
Input	2 x 40 A, 200 – 240 V ($\pm 10\%$), 50/60 Hz
Output	230 V, 50/60 Hz



Configure the output voltage of the Powervar UPS to 230 V!

Available Toshiba accessories: sub-switch board in-/ output 1-ph, fuses 2 x 16 A for 5 safety plugs, splitter type A02, including cables net-UPS 10 m and UPS-sub-switch board 4 m.

Available Effekta accessories: sub-switch board output Cekon plug socket 3-ph, fuse 1 x 40 A, 3 safety plug power sockets 1-ph, fuse 1 x 16 A, splitter type A03, including cables net-UPS 10 m and UPS-sub-switch board 4 m.

5.5.2 Water Chiller (for S8 TIGER 3 kW / 4 kW only)

As an option, an external cooling unit with self-contained cooling water circulation loop can be used for cooling the X-ray generator and X-ray tube. We recommend the following water/air heat exchanger:

Table 5.16: Water Chiller

Water Chiller ERL 3000 (order no. ERL 3000)	
Cooling capacity	6.6 kW at $T_{\text{ambient}} = 32\text{ }^{\circ}\text{C}$, $T_{\text{cooled water}} = 18\text{ }^{\circ}\text{C}$
Cooling water outlet	15 $^{\circ}\text{C}$ to 25 $^{\circ}\text{C}$ (adjustable)

Water Chiller ERL 3000 (order no. ERL 3000)	
Temperature stability	±1 °C
Tank capacity	40 l
Water flow	300 l/h
Required electricity	400 V, 3-phase, 50 Hz
Power consumption	3.52 kW
Dimensions (H x W x D)	1212 mm x 600 mm x 741 mm
Weight (empty)	220 kg
Compliance	CE
Degree of protection	IP44

The ERL 3000 unit is delivered with a 10 m power cable, a 10 m controller cable, and two 10 m water hoses. For internal pressure compensation, it is equipped with a bypass to improve operation reliability. Technical specifications can be changed with additional parts.

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S8 TIGER 2nd Generation

- Operator's Manual
Original Instructions (English)

Innovation with Integrity

XRF

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We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections are included in subsequent editions. Suggestions for improvement are welcome.

All configurations and specifications are subject to change without notice.

Order no. DOC-M80-EXX202 V1. August 15, 2017.

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S8 TIGER

- Operator's Manual
Original Instructions
Version 08.2017

Innovation with Integrity



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This manual was written by

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For further technical assistance for this product, please do not hesitate to contact your nearest BRUKER dealer or contact us directly at:

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Oestlich Rheinbrueckenstrasse 49
76187 Karlsruhe

Phone:
E-mail: info.baxs@bruker.com
Internet:

For your Safety

WARNING

X-ray radiation, electrical and mechanical hazards due to incorrect handling

Hazards may cause severe and life-threatening injuries.

- ▶ To prevent accidents and system damage consider all safety warnings and instructions within the provided manuals.
- ▶ Read and understand **all** manuals provided with the instrument thoroughly!
- ▶ Follow the instructions given in the manuals!
- ▶ Never manipulate or modificate the safety systems of the instrument!
- ▶ Strictly observe all national, state, and local regulations for the operation of X-ray systems!

WARNING

Moving parts

Injuries, e.g. by entanglement (fingers, hair, clothing), abrasion, cutting, or crushing are possible.

- ▶ Keep your hands off!
- ▶ Do not check parts in motion by using your hand!
- ▶ Stay away from moving components!
- ▶ Immediately switch off the system, when you suspect a present failure of the safety system for motorized drives.
- ▶ Contact your local Bruker AXS service representative



 **WARNING**

X-ray radiation hazard

Exposures to radiation, even for a fraction of a second, cause severe burns and / or fatal injuries or lethal diseases (cancer). Even without visible injuries or sensible pain, lethal diseases might evolve many years later.



- ▶ Switch off the system immediately when any part of the enclosure gets damaged!
- ▶ Switch off the system immediately when the safety system does not or seems not to work correctly!
- ▶ Switch off the system immediately when the radiation protection is impaired!
- ▶ Never manipulate or modify the safety system or parts of it – this is strictly forbidden!
- ▶ Never remove sealed screws or parts which are protected by sealed screws – this is strictly forbidden!
- ▶ Never manipulate any interlocks or other safety-relevant devices!
- ▶ Contact your local Bruker AXS service representative in case of doubt.

 **WARNING**

**High voltages, up to several tens of thousands Volts DC in:
high-voltage generator | X-ray tube | radiation detectors | high-voltage
cables**



High risk of lethal electrical shock when components are damaged!

- ▶ Disconnect the system **completely** from the mains supply following this instruction step-by-step when any component carrying high voltage has been damaged:
- ▶ Step 1: Immediately switch off the system! Use the **Emergency Switch OFF!**
- ▶ Step 2: Switch off the **Mains Disconnect** switch!
- ▶ Step 3: Disconnect all **Power Supply Lines** from the mains supply!
- ▶ Step 4: Switch off the **Automatic Circuit Breaker** or the **External Power Disconnect** switch, located in the vicinity of the instrument!
- ▶ Step 5: Contact your local Bruker AXS service representative.

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S8 TIGER X-ray Spectrometer



1 About This Manual

This manual contains general information and guidelines about the Bruker AXS instruments, which have to be observed to ensure personal safety, as well as to protect the product. These notices are highlighted in this manual by the warning symbols and are marked as follows according to the level of danger.

This manual is an integral part of the device, and must be kept in close proximity to the device where it is permanently accessible to personnel. In addition, instructions concerning labor protection laws, operator regulations tools and supplies must be available and adhered to.

CAUTION

Risk of injury due to improper use of the system

Ignoring the required safety precautions can lead to serious injuries for the user and other persons, or strong damages of the instrument.

- ▶ Read all manuals thoroughly and understand its contents before switching on the instrument
- ▶ Only operate the instrument after you have understood the described safety warnings and make sure to meet all recommended safety instructions!
- ▶ Compliance with all specified safety and operating instructions, as well as local accident prevention regulations must be ensured.

The figures shown in this manual are designed to be general and informative and may not represent the specific Bruker model, component or software/firmware version you are working with. Options and accessories may or may not be illustrated in each figure.

1.1 Symbols and Conventions

Safety instructions in this manual are marked with symbols. The safety instructions are introduced using indicative words which express the extent of the hazard. In order to avoid accidents, personal injury or damage to property, always observe safety instructions and proceed with care.



DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.



WARNING

WARNING indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.



CAUTION

CAUTION indicates a hazardous situation, which, if not avoided, may result in minor or moderate injury.

This is the consequence of not following the warning.

1. This is the safety condition.
 - ▶ This is the safety instruction.

NOTICE

NOTICE indicates a property damage message.

This is the consequence of not following the notice.

1. This is a safety condition.
 - ▶ This is a safety instruction.

SAFETY INSTRUCTIONS

SAFETY INSTRUCTIONS are used for control flow and shutdowns in the event of an error or emergency.

This is the consequence of not following the safety instructions.

1. This is a safety condition.
 - ▶ This is a safety instruction.



This symbol highlights useful tips and recommendations as well as information designed to ensure efficient and smooth operation.

1.2 Overview of this Manual

This manual consists of several chapters. First the safety warnings are given, which are also listed in the *Introductory User Manual* (order number DOC-M80-ZXX201) and the *General Safety Instructions* (order number DOC-M90-ZXX006). The *Introductory User Manual*, including the safety warnings, and the *General Safety Instructions* are available in several languages. Please consult your local Bruker AXS service organization for availability in your language.

This chapter describes the instrument, its components and basic operation modes. The following chapter describes how to switch the spectrometer on and off. Further, there is an overview of the basic operation of the touchscreen. Next a QUANT-EXPRESS measurement is described. The servicing, maintaining and troubleshooting of the system is described in the subsequent chapters.

About This Manual

SPECTRA^{plus} is the analytical software package that is delivered with the instrument. The S8 TIGER runs SPECTRA^{plus} Version 3.0. The software is described in a separate manual (order number DOC M80 EXX109). For unknown samples it is recommended to use QUANT-EXPRESS. QUANT-EXPRESS is the standardless method applying a fundamental parameter approach for the analytics. Basic QUANT-EXPRESS operation is described in a separate chapter.

2 Safety Guidelines

2.1 Correct and Intended Usage

The instrument was designed to perform element analysis by means of X-ray fluorescence. This device and its components may only be used for the applications described in the technical description or in the Bruker AXS literature (e.g. XRD/XRF LabReports or XRD/XRF Application Reports). You can request those reports from your local Bruker AXS Service or Sales Representative. It may only be used in conjunction with devices or components from other manufacturers which have been approved or recommended by Bruker AXS, for example for automation solutions.

NOTICE

Correct functioning of the instrument

The instrument can only function correctly and safely if it is transported, stored, set up, and installed correctly, and if it is operated and maintained as recommended by Bruker AXS.

2.2 Qualified Personnel

All Bruker AXS X-ray systems or parts of them must only be set up and operated in accordance with this manual and the specific manuals belonging to the instrument (e.g. General Safety Instructions, Introductory User Manual and User Manual). Only suitable trained and qualified personnel shall be allowed to work with this equipment.

Qualified personnel are able to carry out assigned work and to recognize and prevent possible dangers self-reliant due to their professional training, knowledge and experience, as well as profound knowledge of applicable regulations.

The installation, maintenance and repair of the system may be carried out only by personnel who are authorized and trained by Bruker AXS. All repairs, adjustments and alignments performed on any components of the system (including the host computer) must be carried out in strict accordance with the established safety practices and standards of the country in which the equipment is installed.

To prevent any risk for health and safety the analysis of samples with the instrument, including handling and/or preparation steps, must be entrusted only to persons who have qualifications in accordance with their activities and functions, and who, based on their technical training, their experience and their knowledge of the applicable standards, are able to evaluate the work assigned to them and recognize possible hazards. This also includes the knowledge of applicable accident prevention regulations, generally recognized safety regulations, EC guidelines and country-specific standards and regulations. Carefully read and follow all safety and handling advice in the appropriate Safety Data Sheets (SDS).

2.3 Disclaimer and Liability

Bruker AXS has checked the contents of this manual for agreement with the hardware, firmware, and software described. Since deviations cannot be excluded entirely, Bruker AXS cannot guarantee full agreement. However, the information in this manual is reviewed regularly and any necessary corrections will be included in subsequent editions. Suggestions for improvements are welcome.

If at any time there is a conflict between the safety information contained in this manual and any relevant national, state or local regulations, the local rules always take precedence.

2.4 Limitation of Liability

All specifications and instructions in this manual have been compiled taking account of applicable standards and regulations, the current state of technology and the experience and insights we have gained over the years.

The manufacturer accepts no liability for damage due to:

- Failure to observe this manual
- Improper use

- Deployment of untrained personnel
- Unauthorized modifications
- Technical modifications
- Use of unauthorized spare parts

The actual scope of supply may differ from the explanations and depictions in this manual in the case of special designs, take-up of additional ordering options, or as a result of the latest technical modifications.

The undertakings agreed in the supply contract, as well as the manufacturer's Terms and Conditions and Terms of Delivery, and the legal regulations applicable at the time of the conclusion of the contract shall apply.

2.5 General Safety Precautions

2.5.1 Precautions Concerning X-ray Radiation

The S8 TIGER spectrometer system is an analytical instrument with a strong X ray source. Shielding and safety equipment guarantee that the emitted radiation does not exceed 1.0 $\mu\text{Sv/h}$ during operation.

Shielding and safety features designed into the equipment guarantee that the emitted radiation does not exceed 1.0 $\mu\text{Sv/h}$ (at 5 cm from any external surface of the device) during operation. This level is below the regulatory limit in all jurisdictions. The ICRP dose limits in Publication 60 and 103 to the whole body for a radiation worker averaged over a 5-yr period is 20 mSv in a year, and for a member of the public it is 1 mSv in a year. It is highly unlikely that the radiation worker dose limits will be exceeded when trained and qualified personnel use such devices.

Read the section **Protection Against Radiation** of the *Introductory User Manual* before turning on the system. Please observe local regulations for the operation of X-ray systems.

If you suspect that the safety system does not work correctly or that radiation protection is impaired for any reason, immediately switch off the system and contact your local Bruker AXS Service Representative.

 **WARNING**

X-ray radiation hazard

Exposures to radiation, even for a fraction of a second, cause severe burns and / or fatal injuries or lethal diseases (cancer). Even without visible injuries or sensible pain, lethal diseases might evolve many years later.



- ▶ Switch off the system immediately when any part of the enclosure gets damaged!
- ▶ Switch off the system immediately when the safety system does not or seems not to work correctly!
- ▶ Switch off the system immediately when the radiation protection is impaired!
- ▶ Never manipulate or modify the safety system or parts of it – this is strictly forbidden!
- ▶ Never remove sealed screws or parts which are protected by sealed screws – this is strictly forbidden!
- ▶ Never manipulate any interlocks or other safety-relevant devices!
- ▶ Contact your local Bruker AXS service representative in case of doubt.

The X-ray generator is controlled by a three position Keyed switch (**OFF / NEUTRAL / ON**) similar to the ignition switch of a car. The key can only be removed when the switch is in the **OFF** position. The switch will remain in the **OFF** position until the key is inserted and turned. Therefore the removal of the key will terminate production of X-ray.

2.5.2 Precautions Concerning Electricity

WARNING

**High voltages, up to several tens of thousands Volts DC in:
high-voltage generator | X-ray tube | radiation detectors | high-voltage
cables**

High risk of lethal electrical shock when components are damaged!

- ▶ Disconnect the system **completely** from the mains supply following this instruction step-by-step when any component carrying high voltage has been damaged:
- ▶ Step 1: Immediately switch off the system! Use the **Emergency Switch OFF!**
- ▶ Step 2: Switch off the **Mains Disconnecter** switch!
- ▶ Step 3: Disconnect all **Power Supply Lines** from the mains supply!
- ▶ Step 4: Switch off the **Automatic Circuit Breaker** or the **External Power Disconnecter** switch, located in the vicinity of the instrument!
- ▶ Step 5: Contact your local Bruker AXS service representative.

The system must be operated **ONLY** with such mains supply voltages as are listed on the spectrometer's rear plate. As long as the system is connected to the external mains supply, some terminals of the internal components may present a danger of high-voltage shock.

WARNING

Terminals of internal components stay alive, when the system is switched off.

High risk of lethal electric shock.

- ▶ Disconnect the system **completely** from the mains supply.
- ▶ Wait at least 1 minute before removing any panel.

NOTICE

Wrong mains supply voltages

Substantial damage may result when wrong mains supply voltages are connected to the system.

- ▶ Only connect the mains supply voltages listed on the instruments type plate.

Inside the S8 TIGER spectrometer there are closed loop water circuitries for cooling the X-ray tube, the X-ray generator and also for the internal air-conditioning. In addition to that, S8 TIGER 3 kW and S8 TIGER 4 kW instruments are provided with water hoses which are connected to the building's water supply system.

If there are any water leakages (caused by faulty components or by accident during the refilling of the internal water reservoir) the spectrometer must remain switched off or be turned off instantly! This must be done by switching off the automatic circuit breaker or power disconnecter which is located in the vicinity of the instrument. It is not sufficient to just turn off the spectrometer using the **Power Off** button as some terminals inside the instrument will stay connected to mains supply voltage.

The S8 TIGER must stay powered-off until the leakage source has been repaired and all wet regions have been dried thoroughly. Be aware, there is a high danger of electrical shocks whenever there is leakage of water!

WARNING

Leakage or splashing of cooling fluids

High risk of lethal electric shock as long as water or other cooling liquids are present in or near the system.

- ▶ Disconnect the system **completely** from the mains supply.
- ▶ Be cautious when refilling the fluid tank.
- ▶ Repair the leakage source.
- ▶ Dry all wet regions thoroughly before connecting the system to the mains supply again.



2.5.3 Precautions Concerning Health Risk of Components and Disposal

The X-ray tube and the scintillation detector contain Beryllium.

 **WARNING** **Beryllium**

Beryllium is carcinogenic and causes diseases of the skin, splenic, liver and lungs.

- ▶ Never touch, inhale or incorporate fumes, dust or pieces of beryllium.
- ▶ Wear personal protective equipment (PPE).
- ▶ Do not touch any part of the instrument which contains beryllium, e.g. X-ray tube radiation outlet window, the detector front window or the heating chamber windows of some systems.
- ▶ Do not cut, machine, or handle beryllium in any way.
- ▶ It must not escape into the environment.
- ▶ Disposal of beryllium must comply with all applicable national, state, and local regulations.
- ▶ Strictly obey the applicable national, state, and local safety regulations.

For special customer applications, the S8 TIGER may be equipped with a TLAP analyzer crystal. This crystal (if installed) contains Thallium, an extremely toxic heavy metal. This crystal is water-soluble and can cause poisoning by skin contact.

Please handle this crystal with maximum care and avoid any skin contact! Strictly obey the applicable national, state, and local safety regulations.

Disposal of Thallium-containing parts must comply with all applicable national, state, and local regulations.

 **WARNING**

Thallium

Thallium is an extremely toxic heavy metal (lethal dose 800 mg) which causes death or acute and chronic diseases.

1. Thoroughly avoid any skin contact and incorporation of Thallium
 - ▶ Don't touch the analyzer crystal TLAP
 - ▶ Wear personnel protective equipment.
 - ▶ Strictly obey the applicable national, state, and local safety regulations.

 **CAUTION**

Analyzing Harmful Volatile Substances

Harmful volatile substances pose different kinds of health threats.

1. Special laboratory equipment is required.
 - ▶ Avoid inhalation!
 - ▶ Provide a vent to open air for the exhaust gases of the vacuum pump!
 - ▶ Only use the sample holders recommended by Bruker AXS for the respective measurements.
 - ▶ Strictly follow national, state and local safety regulations!

 **WARNING**

Analyzing toxic substances

Incorporated toxic substances may cause intoxications or even death.

1. Never touch, inhale or incorporate toxic substances.
 - ▶ Wear personal protective equipment (PPE).
 - ▶ Strictly follow all national, state, and local safety regulations!

 **CAUTION****Analyzing Biological Active Substances**

Biological active samples contain microorganisms, viruses or toxins and can be infectious or pathogenic.

1. Special laboratory equipment is required.
 - ▶ Wear personal protective equipment.
 - ▶ Follow applicable national, state, and local safety regulations.

 **CAUTION****Disposal of instrument**

Health-threatening substances are set free when the instrument is disposed of illegally.

Also environmental pollutants can be set free, e. g. beryllium (X-ray tube and detector), thallium (for instruments with TLAP analyzer crystal), batteries (some electronic boards) and oil. The instrument contains heavy and toxic metals like Pb, Cr, Mo, W, Ta, Bi and others.

1. Instrument must only be disposed of professionally.
 - ▶ Follow all valid national, state, and local regulations for disposal.
 - ▶ Contact Bruker AXS service for additional assistance.

 **CAUTION****Disposal of Beryllium or Thallium**

Beryllium and Thallium are highly toxic substances posing a high risk for human health when disposed illegally in the environment.

1. Disposal of Beryllium and Thallium, or parts containing Beryllium or Thallium must comply with all applicable national, state, and local regulations.
 - ▶ Strictly avoid contact with these substances.

 **CAUTION**

Batteries contain acids and (heavy) metal ions

Leaking Batteries cause chemical burns on the skin. Batteries contain environmental pollutants.



1. Avoid any skin contact with damaged batteries.
 - ▶ Wear gloves, when touching damaged batteries.
 - ▶ Collect the batteries in an acid resistant box until they are disposed of correctly.
 - ▶ Disposal of batteries must comply with all applicable national, state, and local regulations.

NOTICE

Disposal of Oil

Oil is an environmental pollutant. Disposal of oil must comply with all applicable national, state, and local regulations.

2.5.4 Precautions Concerning Other Sources of Personal Damage

Several components (mainly all stepper motors, the air heating element, the water pump and the vacuum pump) of the spectrometer get very hot during standard operation due to power dissipation and could cause severe burns when being touched. Normally, these components cannot be accessed as the side panels are installed and, the motors inside the sample loader are covered by metal pieces. But, during maintenance and repair the hot surfaces could be touched by accident.

Be aware that the surface temperature of internal S8 TIGER components might exceed 100 °C (212 °F) whenever the instrument is switched on. Before touching any of these components turn off the instrument and wait until the components have cooled down sufficiently.

**⚠ CAUTION****Hot Surfaces between 70 and 100 °C (156 and 212 °F) on internal components**

Risk of severe burns when touching the surfaces.

- ▶ Turn off the instrument and wait until all components have cooled down!

While the instrument is running there is an enhanced risk of injuries due to moving parts and components.

It is the responsibility of the operator to assure that no person can touch or get close to the following components or units while the instrument is running:

- Sample turn unit (e.g., for automation systems)

If in doubt, if the instrument is already running, stay away from its components! Do not check motion by using your hand!

The samples to be measured are positioned by means of a fast XYZ sample changer system. To prevent personal injury, all motions are immediately stopped if the sample magazine cover is opened.

If you suspect that the safety system does not work correctly, immediately switch off the system and contact your local Bruker AXS Service Representative.

 **WARNING**

Moving parts

Injuries, e.g. by entanglement (fingers, hair, clothing), abrasion, cutting, or crushing are possible.



- ▶ Keep your hands off!
- ▶ Do not check parts in motion by using your hand!
- ▶ Stay away from moving components!
- ▶ Immediately switch off the system, when you suspect a present failure of the safety system for motorized drives.
- ▶ Contact your local Bruker AXS service representative

 **CAUTION**

Cover

Crushing hazard in case of failing struts.



- ▶ Take care not to have your hands where the lid is closing.



Figure 2.1: Gas strut (1)

The S8 TIGER spectrometer is designed to be a mobile analytical instrument. During transportation, please avoid mechanical shocks to avoid damaging the sensitive physical components.

NOTICE

System damage during transportation

Mechanical shocks can damage the system

1. Avoid mechanical shocks to avoid damaging the sensitive components
 - ▶ After each change of location, the instrument must be checked by staff authorized and trained by Bruker AXS
 - ▶ Please contact your Bruker AXS service representative.

NOTICE

Substantial damage

The instrument may be damaged when it's pulled on the top cover handle.

- ▶ Do not use the handle of the top cover to pull the instrument!

2.5.5 Hazards Caused by Gases

Systems with gas flow devices require external gas cylinders, if no in-house gas supply system is available. The cylinders must be secured so that the cylinders are prevented from falling over. Correct and secure installation of gas cylinders must be provided at all times!

Follow applicable national, state, and local regulations for installation and operation of P-10 (argon-methane gas mixture), helium, and nitrogen gas operation and gas cylinders.

Be aware, that this gas is also released to the environment during measurement. A separate vent to open air should be provided to let off the gas.

It is the responsibility of the user to assure that the correct gas type is connected to the instrument. Before opening the gas valves leading to the instrument, double check that the specified gas is used. In particular exclude the inadvertent use of any explosive or corrosive gas.

SAFETY INSTRUCTIONS

Proper change of gas cylinders

1. Follow the instruction thoroughly.
 - ▶ Close the main valve of the empty tank/gas bottle.
 - ▶ Disconnect the regulator.
 - ▶ Screw on the valve protection cap.
 - ▶ Never leave a tank without the protection cap and attachments to prevent the tank from falling over.
 - ▶ Remove the used tank.
 - ▶ Secure the new tank.
 - ▶ Double check you have chosen the right gas!
 - ▶ Remove the protection cap.
 - ▶ Attach the regulator and tighten it.
 - ▶ Do not change the secondary pressure setting.
 - ▶ The regulator should be set to 0.5 bars/7 psi. You can adjust the secondary side only if gas is flowing.
 - ▶ Open the main valve.
 - ▶ Use soap water to check the connection to the regulator.

2.6 Biological Effects

(from Princeton University web page)

Mechanisms of damage

Injury to living tissue results from the transfer of energy to atoms and molecules in the cellular structure. Ionizing radiation causes atoms and molecules to become ionized or excited. These excitations and ionizations can:

- Produce free radicals.
- Break chemical bonds.
- Produce new chemical bonds and cross-linkage between macromolecules.
- Damage molecules that regulate vital cell processes (e.g. DNA, RNA, proteins).

The cell can repair certain levels of cell damage. At low doses, such as that received every day from background radiation, cellular damage is rapidly repaired.

At higher levels, cell death results. At extremely high doses, cells cannot be replaced quickly enough, and tissues fail to function.

Tissue sensitivity

In general, the radiation sensitivity of a tissue is:

- proportional to the rate of proliferation of its cells
- inversely proportional to the degree of cell differentiation

For example, the following tissues and organs are listed from most radiosensitive to least radiosensitive

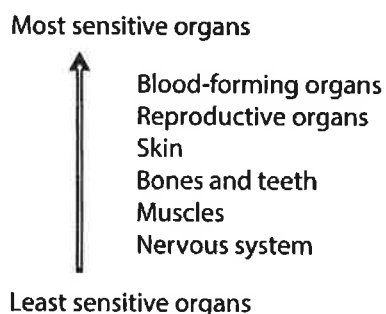


Figure 2.2: Increasing sensitivity from nervous system to blood-forming organs

This also means that a developing embryo is most sensitive to radiation during the early stages of differentiation, and an embryo/fetus is more sensitive to radiation exposure in the first trimester than in later trimesters.

Prompt and delayed effects

Radiation effects can be categorized by when they appear.

- Prompt effects: effects, including radiation sickness and radiation burns, seen immediately after large doses of radiation delivered over short periods of time.
- Delayed effects: effects such as cancer induction that may appear months or years after a radiation exposure

Delayed effect of radiation exposure - cancer

Studies of people exposed to high doses of radiation have shown that there is a risk of cancer induction associated with high doses.

- The specific types of cancers associated with radiation exposure include leukemia, multiple myeloma, breast cancer, lung cancer, and skin cancer.
- Radiation-induced cancers may take 10 - 15 years or more to appear.
- There may be a risk of cancer at low doses as well.

3 Introduction to the Instrument

3.1 Overview of the Product

The S8 TIGER is a wavelength dispersive spectrometer available in three power ratings:

- The base instrument allows maximum settings of 50 kV and 50 mA, while the power is limited to 1 kW. The 1 kW version can be operated without external water cooling. The intermediate system runs at 3 kW with 60 kV and 150 mA as voltage and current limits. The increase of the voltage to 60 kV allows a better detection of heavier elements.
- The high power system allows operation at up to 4 kW. The maximum high voltage remains at 60 kV, but the current can be increased up to 170 mA, which is unique in the market. For light element detection this allows shorter measurement times.

The default configuration for all three power settings is identical:

The spectrometer is equipped with a helium system for liquid samples, a 34 mm manual mask, a flow counter, a scintillation counter, and a 60 position cup loader with 10 cups mounted with 34 mm masks. In addition it is equipped with the following analyzer crystals: XS-55, PET, and LiF200. The 0.23° and 0.46° collimators are also pre-installed. The purpose of the optical components is explained later in this chapter.

You will also find 5 reference samples delivered with the instrument. The application and usage are, for example, trained during on-site and factory site training courses. For routine operation the SPECTRA^{plus} software suite, S8 TOOLS, and remote access software is installed on the computer. QUANT-EXPRESS, a standardless evaluation module, is installed as trial version, which expires after 90 days. It is a powerful analysis package of unknown samples. If the QUANT-EXPRESS package was purchased, a permanent licence is installed.

Please note that your instrument may be ordered in a different configuration adapted to your particular analytical needs. It can be beneficial to install additional monochromators to boost system performance. For example for petro-chemical applications we recommend the use of the XS-Ge-C; for geological application the LiF220, and for cement application the use of both XS-CEM and XS-Ge-C. For the detection of boron, carbon, and nitrogen, XS-B, XS-C, and XS-N should be used, respectively.

Commercially, the following packages are available as factory installed options:

- EasyLoad™: An 75 position loader with two trays for 51 mm rings, automatic liquid sample detection, and 20 sample rings .
- SampleCare™: An automatic mask changer with one closed position for goniometer protection during pump-down, a 28 mm and a 34 mm mask installed, and a Be foil tube window protection.
- TouchControl™: This is a hardware component, a touchscreen with a dedicated single board computer and a user interface for intuitive operation. It can be ordered with a great number of languages that can be switched on-the-fly. The touchscreen software, S8 TOUCH, was specifically written with routine operation in mind. It is seamlessly integrated into to the SPECTRA^{plus} software suite.

Please check your shipping and order information if which options were included in your instrument.

3.2 Overview of the Operation Principle



Note:

The document *Introduction to X-ray Fluorescence Analysis DOC-M84-EXX001* provides you a detailed description of the XRF technique.

Inside the spectrometer samples are irradiated by X-rays. The X-ray beam originates from the X-ray tube and impinges on the sample which then sends out X-ray fluorescence. The X-ray fluorescence radiation is characteristic for each element of the periodic table. For its creation the energy of the primary beam needs to be larger than the characteristic excitation radiation. The S8 TIGER can probe to energies up to 60 keV, the S8 TIGER 1 kW version up 50 keV. Typically, the samples are measured in vacuum for best detection limits, especially for light elements. In case of liquid samples, or in case of loose powder samples, it is also possible to measure while applying a nitrogen or helium atmosphere.



Figure 3.1: S8 TIGER with EasyLoad™ and TouchControl™

The X-ray “fingerprints” of the elements are detected by the S8 TIGER detectors. The measured intensities are used to determine the elemental concentrations.

The standard beam path for a fully equipped S8 TIGER is shown in the figure below. The spectrum of the primary beam can be changed by inserting a primary beam filter. This can be useful if the excitation spectrum should be biased, for example to excited heavier elements more easily. To reduce the erroneous signals and background, the sample beam is collimated and made parallel by a collimator mask and a collimator. The collimator mask can be changed automatically like all other components in the beam path. The collimator is labelled by its opening angle. This limits the beam divergence of the excited beam. Smaller values lead to a better energy resolution albeit a smaller intensity. There are up to four collimators available.

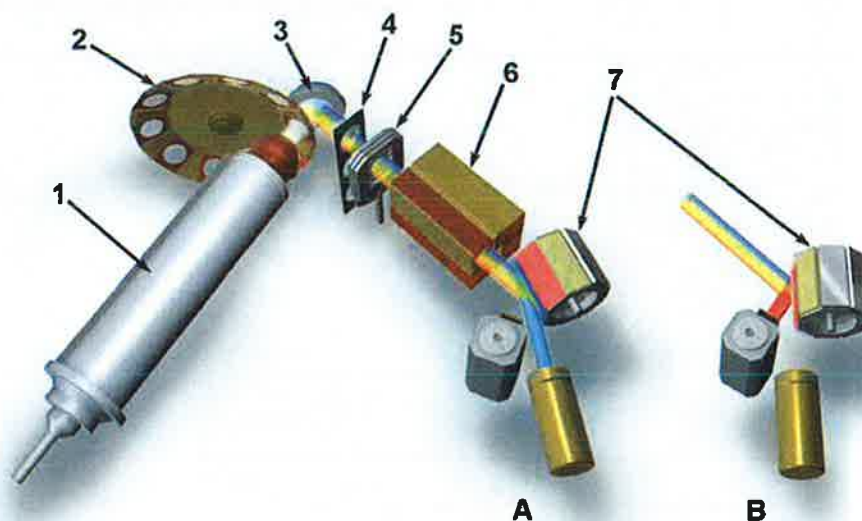


Figure 3.2: X-ray beam path of the S8 TIGER

1	X-ray source	2	Filter wheel (primary beam filter)
3	Sample	4	Mask changer
5	Vacuum seal	6	Collimator changer
7	Crystal changer		
A	Scintillation counter (heavy elements)	B	Proportional counter (light elements)

After leaving the collimator the beam impinges on an analyzer crystal. Those crystals are organic or artificially produced multi-layers. Depending on the lattice spacing and obeying Bragg's Law the X-ray beam is diffracted at certain angles. A total of eight crystal positions can be used. As a default, three positions are used for PET, XS-55, and LiF 200 analyzer crystals. A quick overview of the typical elemental range of those standard crystals for fully equipped S8 TIGER (3 analyzer crystals and 2 detectors) is shown in the next figure. In

addition, Bruker AXS offers a large variety of optional crystals optimized for specific applications. The number of options is continuously growing. Please contact your local application or sales representative for detailed and up-to-date information.

H	XS-55																PET					LIF 200					He							
Li	Be																	B	C	N	O	F	Ne											
Na	Mg																	Al	Si	P	S	Cl	Ar											
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																	
Fr	Ra	Ac																																
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																		
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No																			

Figure 3.3: Typical elemental range for fully equipped S8 TIGER

The radiation from the analyzer crystal is detected by one of the two detectors. One detector is optimized for soft, one for hard radiation (Light elements emit soft (= low energy) radiation). To reduce the background even further, both detectors are equipped with soller slits (not shown in figure 5.2).

The detectors are mounted onto the 2-theta goniometer, the crystals on the theta goniometer. For the measurement the respective detector and crystal are either positioned at a given angular position (peak measurement) or moving during the measurement (scan measurement). The angular position of constructive interference is determined by Bragg's Law. This means the 2-theta position of a peak depends both on the d-spacing of the analyzer crystal and the characteristic wavelength of the element probed. Since all elements are measured subsequently, the instrument is referred to as sequential X-ray spectrometer.

The beam path is inside a housing to shield the user from X-ray radiation. A safety circuitry assures that the radiation can only be produced if both the spectrometer chamber is closed and the protective covers are installed. The S8 TIGER can be operated with a variety to sample magazines.



 **WARNING**

Exposure to X-ray radiation due to manipulation on safety circuits

Risk of severe injury and even lethal diseases due to the X-rays!

1. Manipulations and modifications of the safety systems are strictly forbidden!
 - ▶ Never manipulate or modify the safety system

3.3 Instrument Components

The S8 TIGER is a fully automated X-ray spectrometer, both operation and analysis can run with very little user interaction. In this manual we will focus on the general instrument operation.

All the connection lines and cables can be found at the back of the instrument. Through those lines you supply electricity and water. You can also connect to a local area network via an Ethernet connection. Depending on your configuration and application, there might be two gas hoses, one for supplying P10 to the flow counter and one for supplying helium or nitrogen to the sample chamber.

From the front and either side of the instrument, you can see a field of LEDs that are illuminated when X-rays are produced. These are the X-ray warning lights. When standing in front of the spectrometer you see the on and the off button, an emergency off switch and the generator turn-on key switch on the left side. On the right side are the touchscreen and the panel with four LEDs that display an abbreviated instrument status.

When you open the instrument's top you can have a close look at the sample magazine and the sample robot.

Towards the back left the sample chamber can be found. There are many magazine types available. The whole magazine and robotics is often referred to as the loader. Prior to the measurement the test specimen is placed into a sample container, like a ring or a cup, and subsequently this ring or cup is placed into the loader.

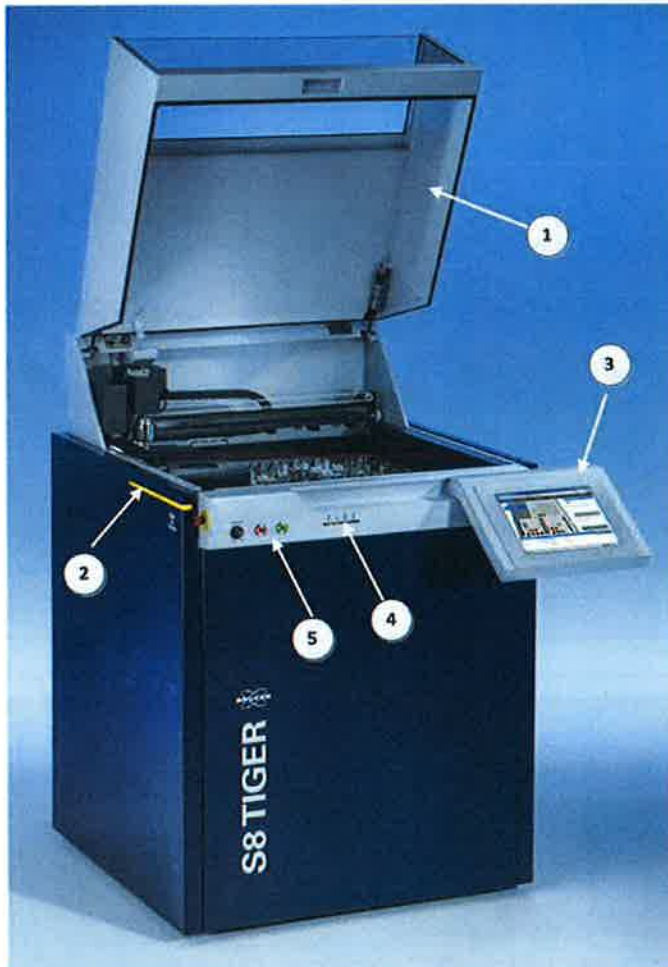


Figure 3.4: Front view with TouchControl™

1	Top cover	2	X-ray warning light
3	TouchControl™	4	Status LEDs
5	On and Off switches		

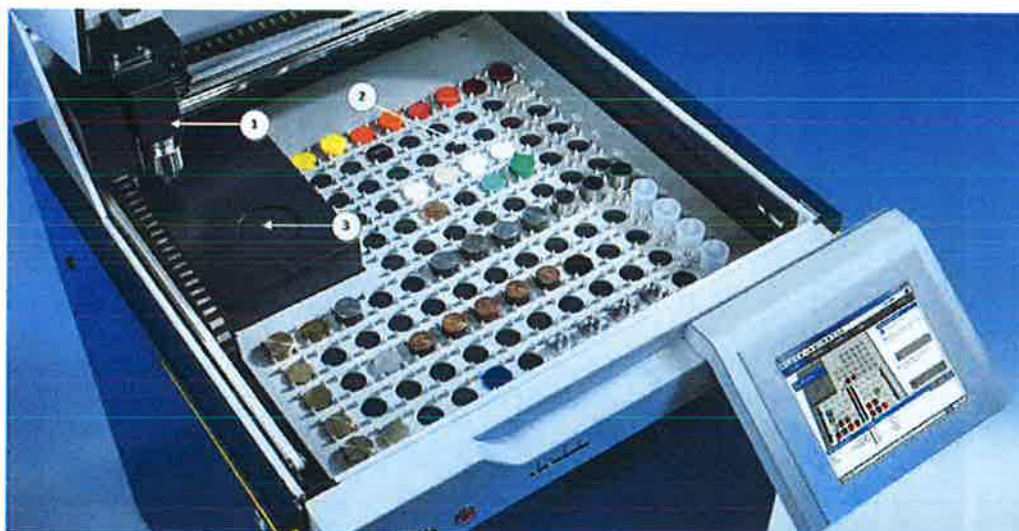


Figure 3.5: Inside the loader (sample magazine)

1	Sample grabber	2	Sample position
3	Sample chamber		

During operation, all side panels must be mounted, since they are part of the X-ray safety system.

During installation and system commissioning and in case of a service visit, panels will be removed. The internal arrangement of the instrument will be revealed.



Figure 3.6: View on the instrument after removing the front and the right side panel

1	Electronic control rack	2	Generator
3	Heat exchanger		

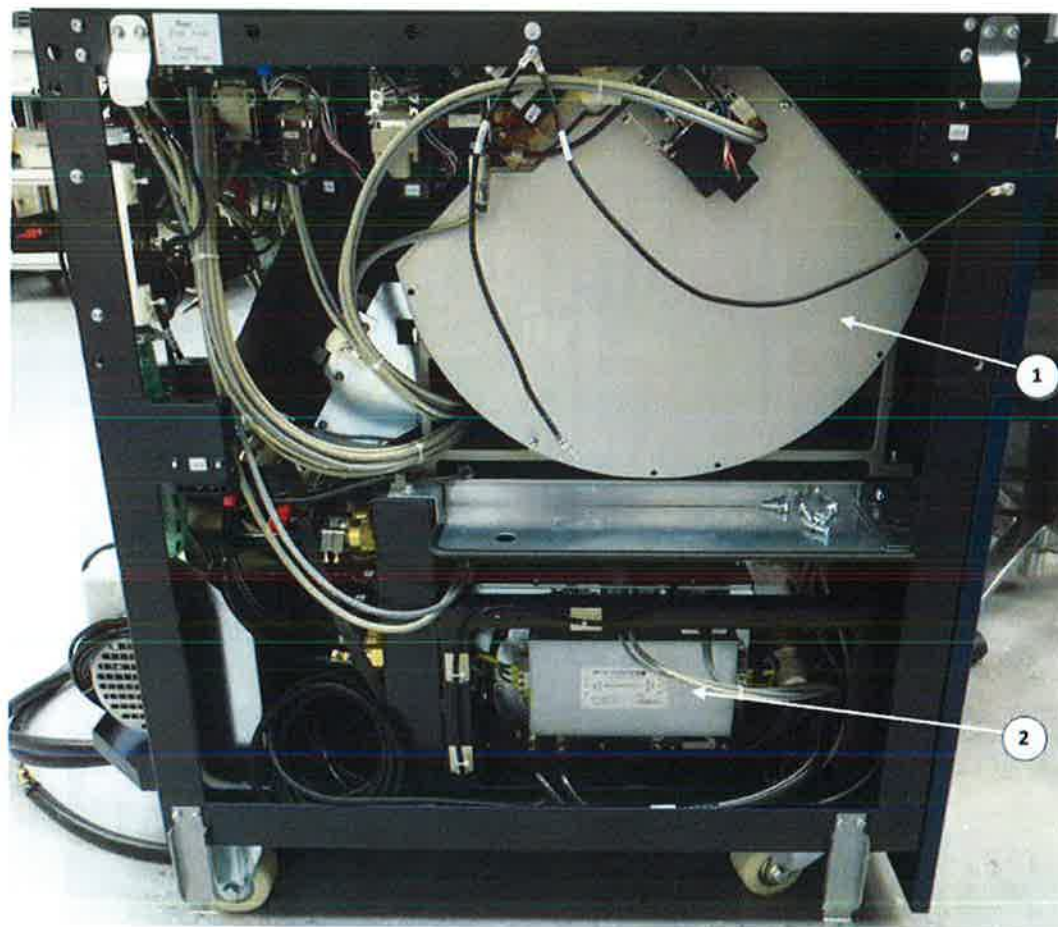


Figure 3.7: View on the instrument after removing the front and the left side panel

1	Spectrometer chamber	2	Backside of the generator
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Figure 3.8: View on rear and left side of the 3 or 4 kW version after removing the back and the left side panel

1	Spectrometer chamber	2	Vacuum pump
3	X-ray tube	4	Port to the conveyor belt (open for the ONLINE option)

3.3.1 Illuminated Status Display

Table 3.1: Status Display and LED Guide

	Ready (orange)	permanently on blinking	generator heating current on, High voltage off, system is in measurement standby mode
	On (green)	permanently on blinking	High voltage generator and control electronics turned on (see "all LEDs")
	Alarm (red)	permanently on blinking	system alarm system warning is pending
	Busy (yellow)	permanently on blinking	measurement is running a ready flag is missing, data taking is interrupted
	All LEDs	blinking at a frequency of about 2 Hz	thermal shut down active

3.4 Measurement Execution Basics of the S8 TIGER

This chapter describes how the instrument executes a measurement. Also, the motivation for some of the implementations is given.

The S8 TIGER is designed to detect a wide range of elements. The elements in a sample are excited by X-ray radiation. Depending on the atomic structure, photons of different energies are emitted. The lighter the element, the smaller the energy of the most energetic photon emitted. Since the (soft) X-ray radiation of light elements is readily absorbed in air, samples are usually measured in vacuum.

To speed up measurement time, the beam path is separated into two chambers: the sample chamber and the spectrometer chamber, which houses most of the optical components and the detectors. During loading and unloading of a sample, the two chambers are separated, so that only the relatively small sample chamber needs to be evacuated or flooded with air. However, after the initial turn-on also the spectrometer chamber needs to be evacuated.

In order to avoid the liquid cup to crack under vacuum for the measurement of fluid samples, the sample chamber needs to be flooded with helium or nitrogen. There are two **Helium** modes: measurement at atmospheric pressure for highly volatile liquids, and measurement at reduced pressure for less volatile liquids. Both modes are optional. If you need to measure loose powders, it is strongly recommended to use **Helium** mode, too.

Table 3.2: Overview of the atmospheric measurement modes

Mode	Samples	Remarks
Vacuum	Metals, Fused beads, Pressed pellets Glass	Compact solid samples to achieve best sensitivity for light elements
Separated vacuum	Pressed powders (dusty samples)	The vacuum seal protects the goniometer and compartments against dust particles released from the sample. IMPORTANT: It is strongly recommended to prepare pressed pellets as stable as possible by using the appropriate binder and applying best pressure
Helium (reduced pressure)	Liquid samples oils, water Loose powders in a cup with polymer film	To avoid sample evaporation and the resulting contamination and/or damages, liquid samples must not be measured under vacuum. The helium mode with reduced pressure is recommended for liquids with a high boiling point. The helium pressure is reduced to gain better intensity for light elements and to keep helium consumption low.
Atmospheric Helium	Liquid samples automotive fuels or solvents	All liquid samples with a low boiling point, like fuels, must be run under atmospheric helium to avoid boiling and evaporation of the sample.

Several pressure sensors monitor the vacuum continuously. Only after the pressure is sufficiently low, it is possible to start a measurement.

The S8 TIGER is a wavelength-dispersive spectrometer. Intensities for individual wavelengths are determined in what is also known as Bragg-Brentano geometry with, in our case, the sample acting as radiation source. The analyzer crystal and detector are moved in a fixed angular relationship of 1:2. This gives great flexibility to the instrument. It can be adjusted to almost any new analytical task. On the other hand, this also means that measurements of different samples are executed in sequence. So, before the sample is in measurement position, the instrument has to know for which elements to probe. Based on this input, the optical components (beam filter, mask, collimator, analyzer crystal, and detector) are moved into position while the chamber is being evacuated. Most motions can be executed in parallel.

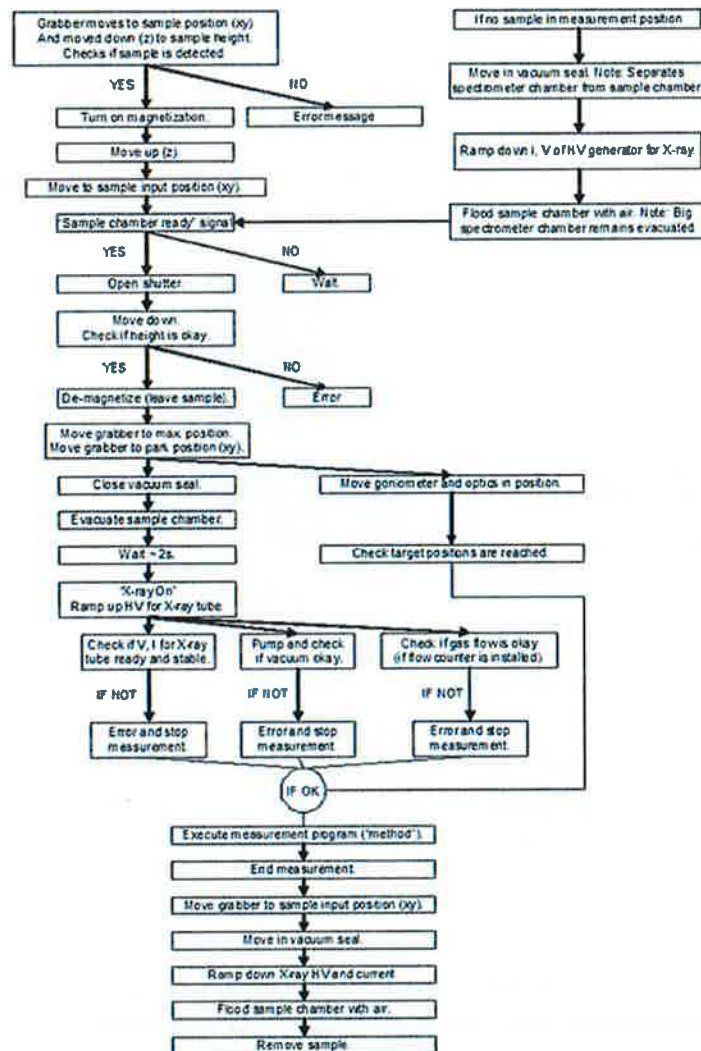
Once in position, the measurement starts immediately. All components move in parallel to get ready for the measurement. After all measurement tasks are finished, the sample is removed from the sample chamber. During sample transfer, no X-rays are produced for your safety. There are two types of measurements: Peak Measurement (faster, only the intensity at one position is measured) and Scan Measurement (the goniometer performs a coupled scan, the peak shape and intensity over an angular range is determined).

More background on XRF analysis and some instrumentation background can be found in the Bruker AXS publication *Introduction to X-ray Fluorescence Analysis DOC-M84-EXX001*. Additional references are given therein.



Please consult the *Introductory User Manual DOC-M80-ZXX201* for an in-depth description of the safety system.

3.4.1 Flow Chart Showing Standard Operation



3.5 Network Configuration

The SPECTRA^{plus} PC and the S8 TIGER are connected together via a network. Depending on your network configuration this may be a simple cable from the PC to the S8 TIGER, or the devices may be connected via a hub or switch. Alternatively both devices may be connected to your local-area-network (LAN). The S8 TIGER will request an IP address via DHCP, and if a DHCP server is not available, it will assign itself an automatic private IP. It is recommended that the SPECTRA^{plus} PC is configured for DHCP to ease any network configuration problem. The network settings of the devices leaving the factory are guaranteed to work. If you need to reconfigure the devices for your network please contact your Bruker representative for advice and instructions.

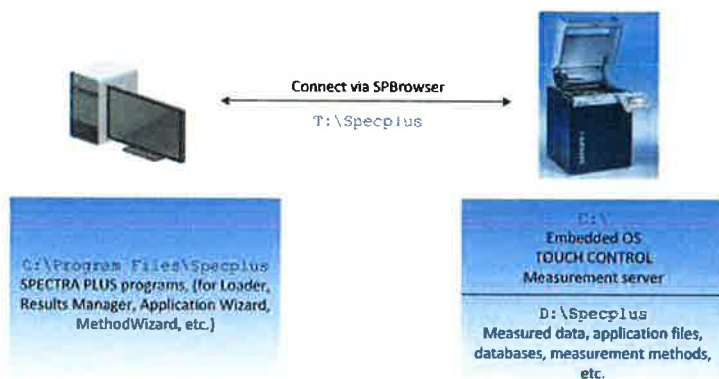


Figure 3.9: S8 TIGER – SPECTRA^{plus} PC network connection

The SPECTRA^{plus} PC accesses data on the S8 TIGER via a Windows mapped drive. It is recommended to use the SPBrowser program map the S8 TIGER drive automatically.

The figure above shows an overview of the software and data files for the PC-S8 TIGER system. It is important to note that there is a separation between data files and programs. This is to allow the S8 TIGER to work as a stand alone instrument, allowing routine measurements even when the PC is switched off.

Use of an External PC

You can operate the S8 TIGER with TouchControl on the touchscreen or with the measurement software SPECTRA^{plus} on an external PC via network.

4 Switching the Instrument On and Off

4.1 Switching On – Auto Start Up of the S8 TIGER

- ▶ Verify the instrument is connected to a 40 A 208 - 240 V AC supply.
 1. Check that the external cooling water system is operating correctly.
 - ▶ All valves connecting to the instrument are open and hoses correctly connected to the S8 TIGER.
 2. Check if the P10 counter gas and helium supply (optional) is turned on and set correctly.
 - ▶ The P10 should be set to 0.5 bar (~7 PSI). Helium should be set to 2 bar (~29 PSI).
- ▶ The system configuration should be set in the **Default parameters** pane to **Airlock mode = Spectrometer mode** (Standby parameters) and **Vacuum with seal** (Mode). The default settings are shown following figure.

Switching the Instrument On and Off

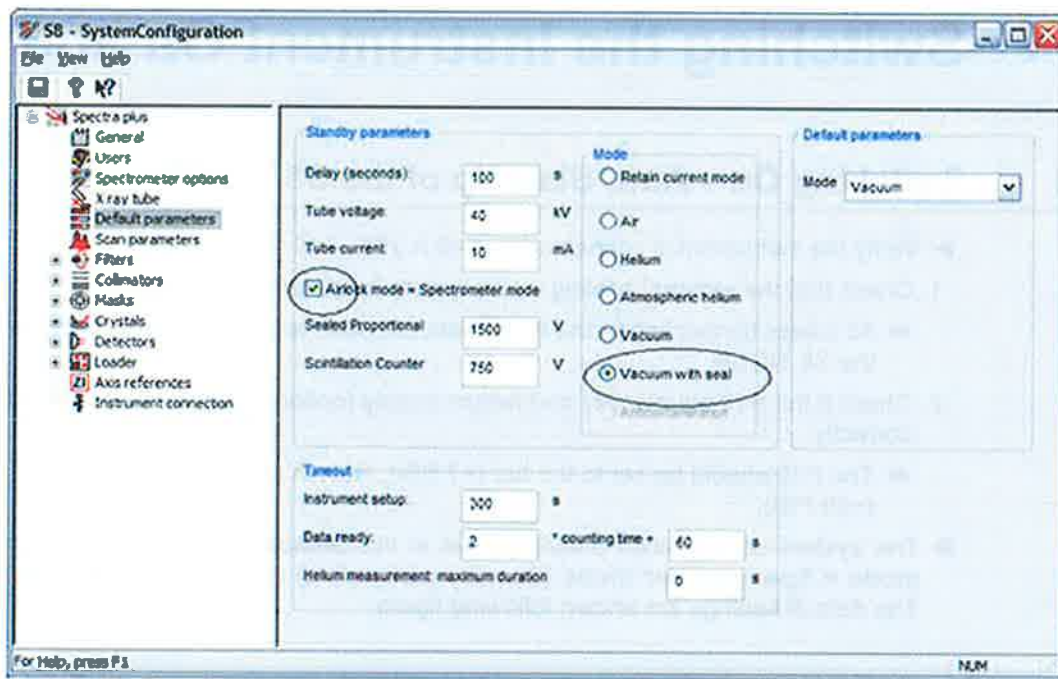


Figure 4.1: Settings in **System Configuration** for the auto start up procedure

1. Press the green **Power On** button on the front of the spectrometer (next figure, on the left side).
 - All four lights will come on for about 30 sec.

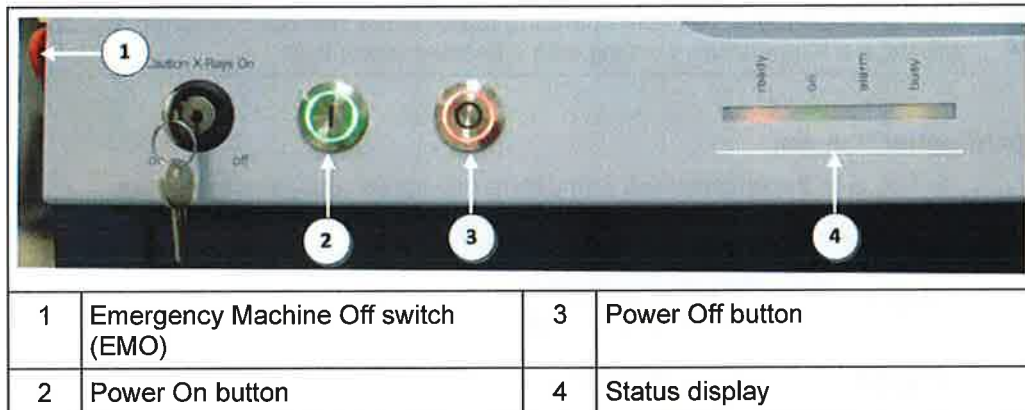
If the lights do not come on

1. verify the **EMO** button is out by turning it clockwise, then
2. press the green **Power On** button again.



For this procedure to work, **Auto setup** (auto setup = 1 in setup.ini) must be enabled. This is the default setting.

Table 4.1: Control panel and Status display of S8 TIGER



When the S8 TIGER has finished initialization, the green **On** and the red **Alarm** lights should be on (figure above, right side).

Immediately afterwards, the z drive moves up and the sample seal (shutter) opens and closes for an automated safety circuit check. This takes up to 30 seconds because the sample chamber might need to be flooded with air.



You must leave the cover closed; otherwise the start-up routine is interrupted.

1. The X-ray generator can now be turned on by inserting the key and turning the key clockwise.
 - The instrument **ready** light blinks.
 - High voltage is turned on, the X-ray warning lamps turn on and the ready LED is permanently illuminated.
2. Release the key.
 - It is spring-loaded and should return to the middle position.



If the S8 TIGER has been turned off for a while, it will take a few hours to return to its operating temperature. Until the operating temperature has been reached, the spectrometer will show a temperature warning with a flashing alarm light.

For TouchControl™ users:

1. Log in to the touchscreen with username: admin and password: pass.



Figure 4.2: Login screen of TouchControl

4.2 Switching Off – Power-off Procedure



The large red button is the **EMO** button (Emergency Machine Off button). The **EMO** button can be reset by turning the knob to the right until it pops back out.

The EMO button must only be used in an emergency.

The S8 TIGER is designed for constant operation. It is recommended to keep the system running at all times, even when routine measurements are not carried out e.g. evenings and weekends. However there may be occasions when it is required to switch the ma-

chine off e.g. prolonged inactivity, expected power outage or relocation of the machine. In such a situation it is recommended to follow the procedure below. This will ensure the system is shutdown gracefully into a safe state, and will avoid any loss of data.

4.2.1 Switching Off Using TouchControl™

1. Log off TouchControl™.
2. Press the **Shutdown** button as shown in the figure below



Figure 4.3: Shutdown

3. Then confirm you want to shutdown by pressing **Yes**.



Figure 4.4: Confirm the shutdown

- ▶ Wait until the message **It is now safe to switch off your machine** appears on the screen.
- 4. Press the **Power Off** button on the front of the machine (see chapter [Switching On – Auto Start Up of the S8 TIGER \[47\]](#)).
- 5. Isolate the power from the wall supply.

4.2.2 Switching Off Without Using TouchControl™

Follow these steps if your S8 TIGER does not have a touchscreen:

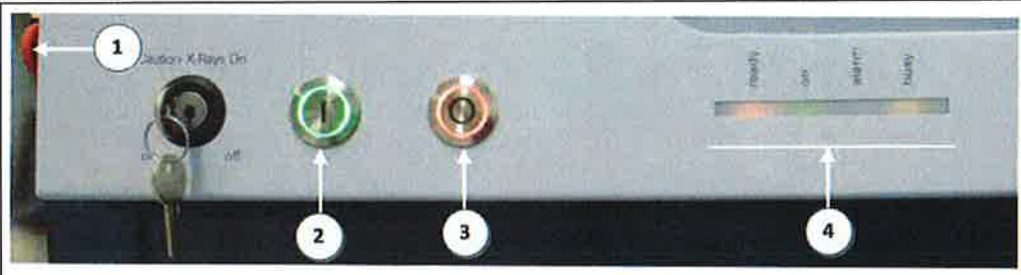
1. Start S8 TOOLS.
2. Connect to the S8 TIGER using the **Connect** button.



Figure 4.5: S8 Tools Connect button

- ▶ Make sure that there is no sample in the sample chamber:
 1. Click on **Functional Unit | Sample Handler**.
- ▶ If a sample is in the sample chamber,
 1. click on the **Unload Sample** command of the **Functions** menu.
 2. Change the spectrometer mode to **Air**.
 3. Click on **Functional Unit | Spectrometer Mode**.
 4. Click on the **Operating Mode** command of the **Functions** menu.
 5. Select **Air** from the list.
 6. Wait until the **Air** mode has been achieved.
- ▶ Only when the **Air** mode has been achieved,
 1. turn the **X-ray key** to the left.
 2. Press the **Power Off** button to turn off the S8 TIGER.

Table 4.2: Control panel and Status display of S8 TIGER



1	Emergency Machine Off switch (EMO)	3	Power Off button
2	Power On button	4	Status display

4.2.3 Switching Off using the Power Off button (Soft-Shutdown)



Figure 4.6: Power-off button in red on the right

1. Press on the **Power Off** button (red button) for at least 5 seconds.
2. The S8 TIGER automatically shuts down by stopping all the related hardware components in a nicely way:
 - Generator
 - X-ray tube
 - Internal CPU

5 TouchControl Operation

5.1 Introduction

This chapter describes how to use the TouchControl™ interface. The interface is designed to be easy to use and intuitive to allow operation with minimal training, yet powerful enough for all routine operations. TouchControl is not used for creating or editing calibrations which requires the SPECTRA^{plus} software package to be installed on a standard PC.

NOTICE

In order to avoid damage to the TouchControl, the use of sharp objects should be avoided. The interface has been designed to be used with your fingers only. Gloves may be used to avoid contamination. To clean the touchscreen, avoid the use of abrasives or aggressive solvents. Only use a soft damp cloth with a mild detergent if necessary.

5.2 TouchControl™ User Interface




The TouchControl interface has been designed for easy and intuitive operation. All operations are carried out using **controls**. The following tables describe the different types of **controls** used.




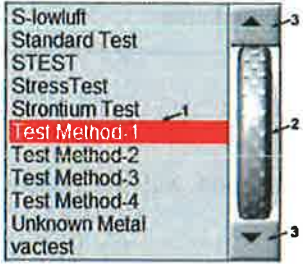
The TouchControl interface is available in different languages. Please contact your Bruker AXS sales representative to check if your choice is available.

5.2.1 TouchControl™ Controls


This chapter may give you an overview of the possibilities to work with the TouchControl.

Buttons		
Active Button		This button is active and can be pressed. The button's action is described on the button and is sometimes accompanied by an icon
Disabled Button		This button is disabled cannot be pressed.
Selection Buttons		The selection is marked clearly with a tick mark.

Thumbwheel	
	<p>The Thumbwheel allows you to scroll items in a vertical direction. Press and hold while sliding your finger up or down to rotate the wheel.</p> <p>The Thumbwheel is also used in the Selection List control (see below).</p>

Selection List	
	<p>This control is used to select an item from a list. The highlighted text is the selected item. To select another item, the following methods can be used:</p> <ol style="list-style-type: none"> 1. Touch the item text. 2. Use the Thumbwheel. 3. Use the Up or Down buttons.


Screen Selector



Once you have logged into the S8 TIGER, this control is always located at the top of the screen. This is used to navigate through the various screens in the software. Since only one screen can be displayed at any time, only one button is highlighted. Simply press the button to display that screen.


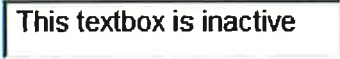
The **Stop** button becomes active during measurements and can be used to interrupt the current measurement and to pause the measurement queue. When this button is pressed the text will change to **Restart** which will restart the measurement queue.

Screen-Keyboard



The **Screen-Keyboard** is used to enter text and operates in the same way as a normal keyboard. The text is inserted into a Textbox (see below). The Caps Lock key is used to toggle between lower and upper case characters.

Textbox

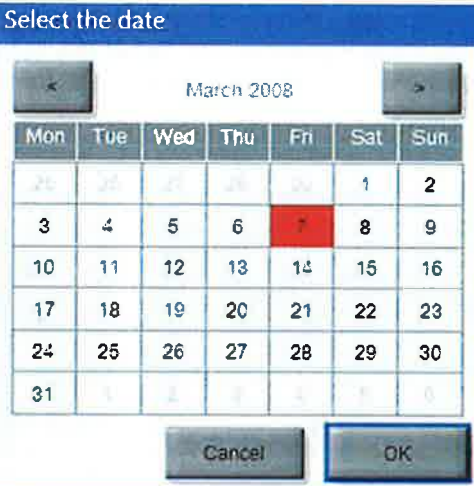
	<p>This is the active Textbox. Text entered with the Screen-Keyboard will be inserted here.</p>
	<p>This is an inactive Textbox. Touch this to make it active.</p>

Textbox

The **Textbox** is used to enter details such as sample ID's, usernames, passwords etc. An active Textbox has a thick border and receives text entered from the **Screen-Key-board**. An inactive Textbox has no border and will not receive text from the keyboard. Touching an inactive Textbox will make it active.

Date Selector

Select the date



The **Date Selector** is used to select a date and is used when performing a data-base search. Simply touch the required date. The selected date is highlighted with a red square.

The < and > buttons will choose the previous and next months.



Press the **OK** button when you have selected your date.

Status Bar

On line - idle 16:36 56

The Status Bar is always located at the bottom of the screen and provides the following machine information:

<div style="border: 1px solid black; padding: 2px; margin-bottom: 2px;"> <p>On line - idle</p> </div>	<p>Current machine action and any warning message</p>
---	---

Status Bar	
	Status light. Green = On line – normal operation. Red = Alarm active or communication problem with measurement server.
	Current time.

5.2.2 Logging into TouchControl™

The **Login** screen is shown in the following figure and is the first screen you will see. To control the instrument you must first supply a username and password. The S8 TIGER leaves the factory with the user **admin** installed with the password set to **pass**. This user has access to all functions within the software in-cluding the ability to add or remove users. It is recommended to add a user for every operator that will use the instrument (see section [User Editor \[75\]](#)). It is also recommended to change this password and to store this information in a safe place .



Figure 5.1: Login screen

To login to the S8 TIGER you will need to enter your username and password.

1. Touch the **textboxes** and
2. use the **Screen-Keyboard** to enter your details.

⇒ After logging into TouchControl the **Loader** screen will be displayed.

Login information			
User Name	admin	Password	pass

5.2.3 TouchControl™ Main Screens

There are four main screens in the **TouchControl** interface that are used to for measurement control, resulting reporting and status:

Main screens	
Loader	This screen is used to define and start your measurements. It displays all samples defined on the magazine including analytical results. All users have access to this screen (see section <i>Loader Screen [61]</i>).
Results	This screen allows access to the measurement database to recall all previous measurements performed on the S8 TIGER. You may restrict access to this screen for certain users (see section <i>Results Screen [62]</i>).
Status	This screen displays the current status of the machine, spectrometer values and a schedule of queued measurements. You may restrict access to this screen for certain users (see section <i>Status Screen [67]</i>).
Tools	This screen includes various pages which allow the users to change options, edit user details, perform diagnostics and view the on-line help. You may restrict access to this screen for certain users (see section <i>Tools Screen [70]</i>).

5.3 Loader Screen

The **Loader** screen is where samples are defined for measurement. All measurements on the S8 TIGER are performed by running an application. An application contains all the information needed to measure, analyze and display the results. Applications are created and edited with the SPECTRA^{plus} software package which is described separately.

1. Select an empty position on the virtual sample magazine.
2. Select an application from the **Application Chooser**.
3. Enter the sample specific parameters of the application (see section [Performing a Measurement with QUANT-EXPRESS \[90\]](#) as an example for a standardless measurement)
4. Enter the **Sample Information** (= Sample ID)
5. Press the **Measurement** button to start the measurement.



Figure 5.2: **Loader** screen

1	Sample Magazine	2	Application Chooser
---	-----------------	---	---------------------

5.4 Results Screen

Every measurement performed on the S8 TIGER is archived into a database. The **Results** screen allows the operator to search and access any result stored on the S8 TIGER. It is divided in three parts as shown in the figure below.

- **Search Results:** The results of the search are displayed on the left side.
- **Search Options:** The operator defines and chooses the criteria for a search in the database.
- **Sample Information and Results:** The sample information and results are displayed on the bottom of the screen

Loader Results Status Tools Stop Log off

Quick search (last week): Found 7 samples

Steel_05032008	pe-check1	s8-check0	s8-check2
QuantExpress/Elements	QE/Check/Vac34	S8-Check/Vac34	S8-Check/Vac34
09:54 06/03/2008	09:20 06/03/2008	09:06 06/03/2008	14:43 06/03/2008

Search Options

Quick Search - Last

Hour Day Week

Advanced Search

Advanced Search

Sort by

Date ID Application

Invalidate Print

Sample Information Results

ID	Steel_05032008	Si	0.1186 %	Co	0.2429 %
App	QuantExpress/Elements	P	0.01517 %	Ni	0.1546 %
Date	06/03/2008	S	0.03122 %	Cu	0.08003 %
Time	09:54	V	1.105 %	Ga	0.008842 %
Operator	admin	Cr	3.969 %	As	0.02031 %
		Mn	0.2673 %	Mo	0.4148 %
		Fe	75.51 %	Rh	0.0 %
				Tb	0.0009708 %
				W	18.48 %
				Sum	100.4 %
				Compton	99.45 %

On line - idle 10.03.24

Figure 5.3: Results screen

To access the results a search is required. There are two types of search available:

Quick Search

1. Press the **Hour**, **Day** or **Week** buttons to perform a **Quick search**
 - ▶ All measurements that have been measured during the **last** hour, day or week will be displayed in the **Search Results** area.
2. Select a sample to see the results.
 - ▶ The results of completed samples can be printed.
3. Press the **Print** button.

Advanced Search

1. Click on the **Advanced Search** button to start an advanced search.
 - ▶ The **Advanced Search** page is displayed.
2. Limit the search by using the appropriate parameters: **Measurement date**, **Sample ID**, **Application is**, **Measured by**.
 - ▶ The red tick marks indicate what options have been set.
3. Click **OK**.
 - ▶ All measurements that fit the **Advanced Search** criteria will be displayed.
4. Select a sample to see the results.
 - ▶ The results of completed samples can be printed.
5. Press the **Print** button.

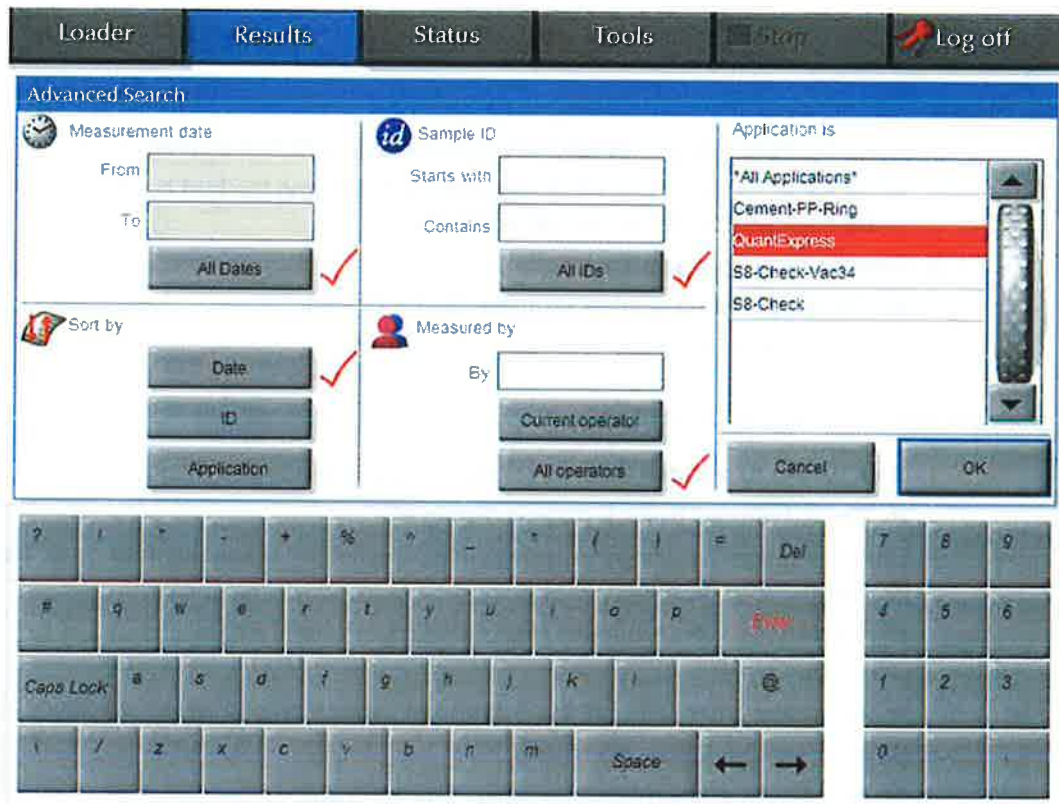


Figure 5.4: *Advanced Search* screen

5.4.1 Sorting and Printing Results

The following figure shows the **Search Options** which contain buttons to sort the search results according to **Date**, sample **ID** and **Application** name.

1. Press the appropriate button to sort the results.
2. Select a sample and press **Print** to print the results.

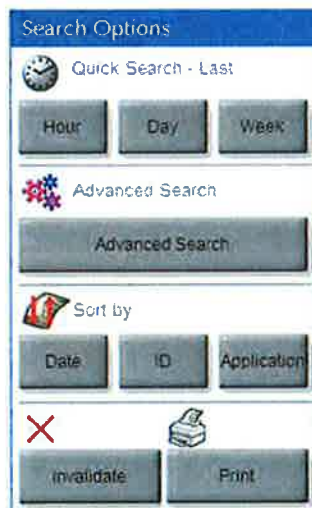


Figure 5.5: Details of Search Options

5.4.2 Invalidating Results

The **Search Options**, as shown in [Results Screen \[62\]](#) contain a button to invalidate a result. This **Invalidate** button allows an operator to mark a result in the database as invalid in case it turns out that there is something wrong with the sample, or the wrong sample has been measured. The sample will remain in the database, however, and is still visible within the SPECTRA^{plus} software package. If for some reason the sample needs to be remarked as valid again, this can also be performed using the SPECTRA^{plus} software.

To mark a sample as invalid simply

1. select the sample and
2. press **Invalidate**.
 - A dialog as shown in the next figure will ask for confirmation.
3. Confirm the invalidation by pressing **Yes**.

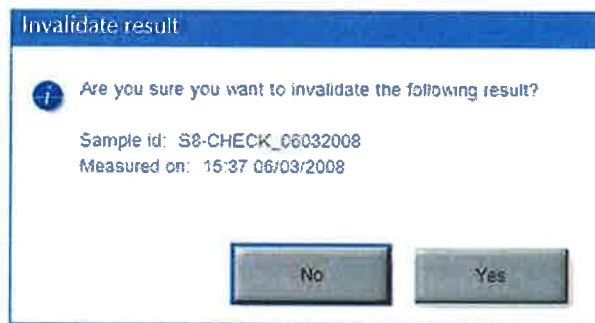


Figure 5.6: Confirm Invalidation

5.5 Status Screen

The **Status** screen displays the current status of the machine and is shown in the figure below. The information is grouped into five sections:



Figure 5.7: Status screen

Machine status flags

They show whether the device is ready for measurement (**ready**), measuring (**busy**) or if any **warnings** or **alarms** are present. If a warning is present, details will be displayed in the **Status** bar at the bottom of the screen. For alarms, see section [Alarms \[82\]](#) for details.

Loader

The loader shows the **x, y and z coordinates** of the sample grabber. It also shows whether the loader **cover** is open or closed and shows the magazine position of the **active** sample.

Drive 1: theta and Drive 2: 2theta

The lights show if the drives are ready and running and will also show any errors present.

Spectrometer

The section shows details of the spectrometer such as the theta, 2theta, tube conditions, and count rates. It also shows the selected primary filter, crystal and mask.


Ready flags

Before a measurement can be performed all ready flags have to be set. This section shows which parts of the machine are ready for measurement and can be useful for diagnostics.

5.5.1 Schedule


The **Status** screen also contains a **Schedule** button which shows all samples waiting to be measured. The **Loader schedule** page shows the sample's position in the queue (**#**), the magazine position (**Pos**), the **Sample ID**, the expected start time (**Start**), the expected end time (**End**), and for active samples, a progress bar (**Progress**). To close the page, simply press the **OK** button.

Loader schedule

 Samples waiting in the measurement queue are listed below:

#	Pos	Sample ID	Start	End	Progress
1	1B1	S8-Check	15:19 07/03/2008	15:25 07/03/2008	
2	1C1	QE-Check	15:25 07/03/2008	15:32 07/03/2008	

There are currently 2 measurements in the queue






Figure 5.8: **Schedule** page

5.6 Tools Screen

The **Tools** screen which is shown in the figure below contains seven pages of options and information. The functionality of these pages is described in the following sections.

5.6.1 Appearance

The **Appearance** page contains options that affect the appearance of the **Loader** screen. Here you can select a **3D** or **2D** graphical **Loader**, the movement direction of the cursor and whether the magazine (tray) position is displayed. These options do not affect the measurement process in any way.

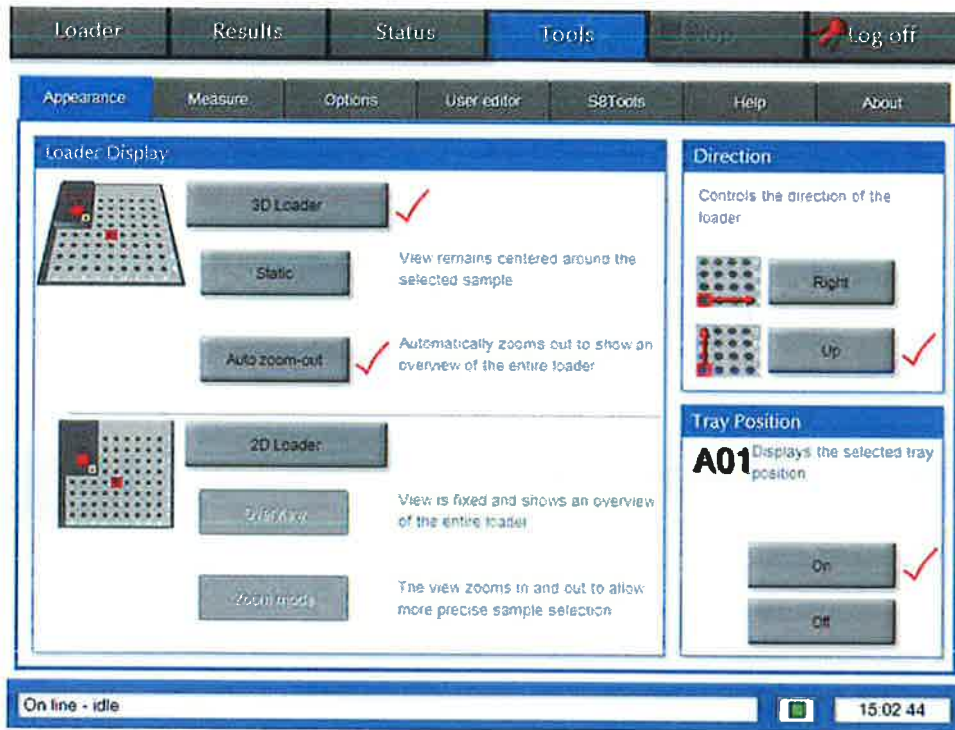


Figure 5.9: Appearance page

5.6.2 Measure

Changing the options in the 3 areas on the **Measure** page affect how measurements are started and with which priority samples are measured.

Auto-move

By default, after defining a sample (see section *Loader Screen [61]*) the sample will not be added to the measurement queue and the cursor will move onto the next empty magazine position (**Auto-move**). This is suitable when a large number of samples need to be defined but you do not want to measure the samples immediately. The **Auto-move** option can be switched off by simply pressing the **Off** button.

Auto-measure

If you wish to send the sample to the measurement queue immediately after it has been defined, switch the **Auto-measure** option **On**.

Priority

Samples can also be defined and measured using the SPECTRA^{plus} software. The **Priority** options set the priority level of the TouchControl samples.

- **High** priority will interrupt SPECTRA^{plus} samples,
- **Normal** priority will measure TouchControl samples first but will not interrupt SPECTRA^{plus} and
- **Low** priority will measure TouchControl last.

Normal priority is recommended.

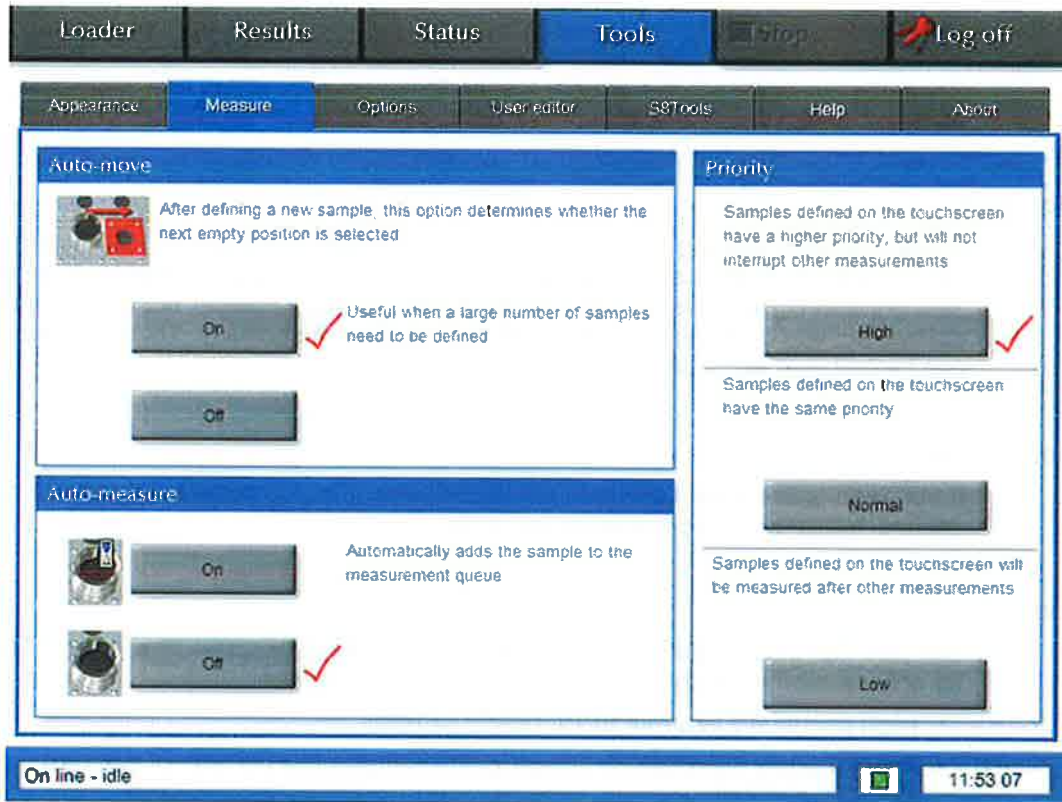


Figure 5.10: Measure page

5.6.3 Options

The **Option** page allows you to choose your **Application Shortcuts** (see section [Loader Screen \[61\]](#)), choose your **Language**, set your preferred **Date format** and **Temperature scale**, and enable the **Auto log-off** option.

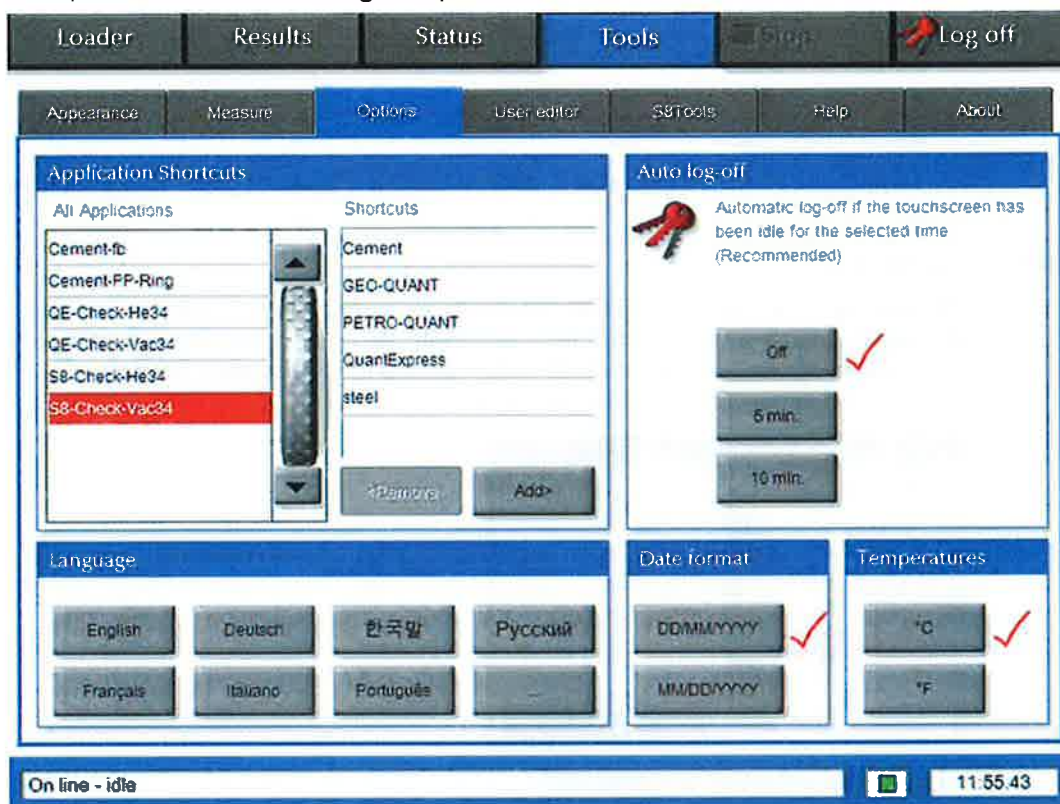


Figure 5.11: Options page

Auto log-off - Language – Date format – Temperatures

- The **Auto log-off** option will automatically log the current user off if there has been a period of inactivity. The period of inactivity can be set as either 5 or 10 minutes. This option is recommended to prevent unauthorized operators using the machine if the current operator forgets to log off.
- TouchControl is available in various languages; select your language by pressing the appropriate button.
- The date format used in TouchControl can be switched between **month/day/year** and **day/month/year**.
- Temperature may be displayed in degree Celsius (°C) or degrees Fahrenheit (°F)

Application Shortcuts

The next figure shows how to add or remove an **Application Shortcut**. Shortcuts are applications which are represented as a button in the **Loader** screen. This allows a user to choose their application with a single button press. It is recommended that you include frequently used applications in your shortcuts.



Figure 5.12: **Application Shortcuts** field

1. Select the application from the **All Applications** list on the **left** using the thumbwheel and
2. press **Add>** to add an application to the shortcuts.
3. Select the application from the **Shortcuts** list on the **right** and
4. press **<Remove** to remove a shortcut.

5.6.4 User Editor

The **User editor** page which is shown in the next figure is used to add or change the privileges of an existing user. It is only available from the admin account. It is recommended to add a user for every operator that uses the S8 TIGER II. It is also recommended that you change the default password for the user admin.

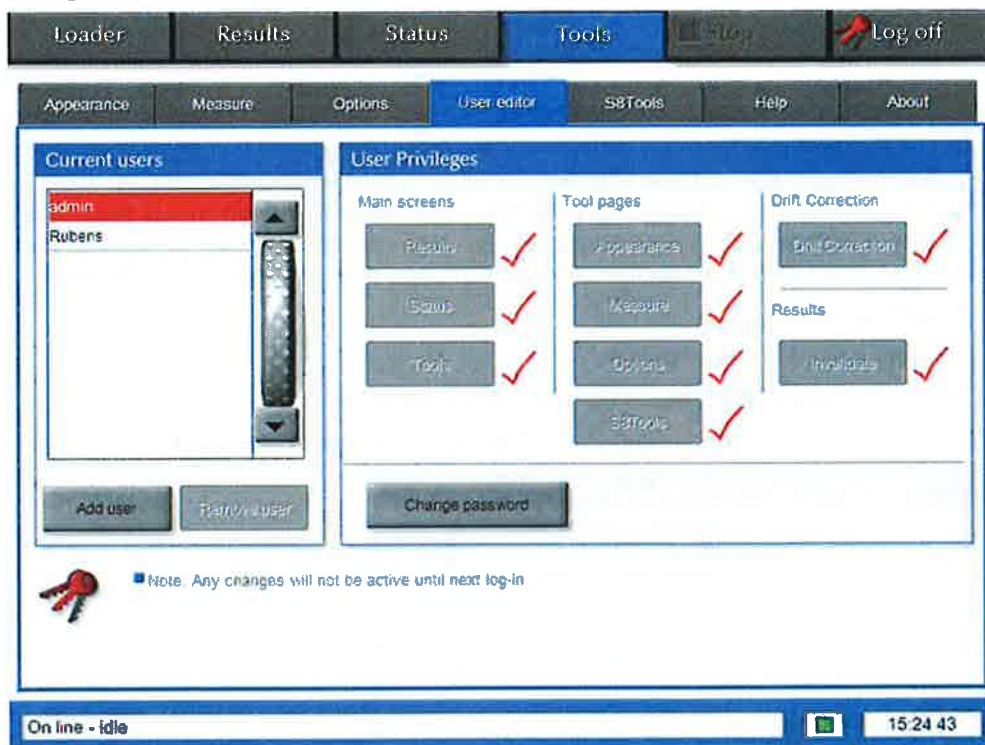


Figure 5.13: **User editor** page

Changing a password

To change a password,

1. select the user from the Selection List on the left-hand side and

2. press the **Change Password** button.
 - You will now be asked to enter the new password.
3. Enter the password using the **Screen-Keyboard**.
4. Press the **OK** button when you have finished.

Remember to make a note of your new password and store it in a safe place. If you forget your password you will need to contact your Bruker AXS representative.

Adding new users

It is recommended that you add a user for every operator that will use the S8 TIGER II. This will enable you to track who measured a particular sample and if you wish, grant limited access to the software options. You may want to spend some time using the S8 TIGER II before adding new users, so that you can decide what options to set. Alternatively you can add users straightaway and change their privileges at a later date.

To add a new user,

1. press the **Add User** button.
 - A dialog will be displayed which is shown in the following figure.
2. Enter the username and password using the **Screen-Keyboard**.



Figure 5.14: Add new user

Changing a user's privileges (access rights)

After you have added a new user you will need to select their privileges. By default all users have access to the **Loader** screen, where samples are defined and measured. Restricting access to other parts of the software can simplify the operation for new users, but also limits the functionality. Remember that a user's privileges can be changed at any time using this procedure. The figure below shows the user privilege options.

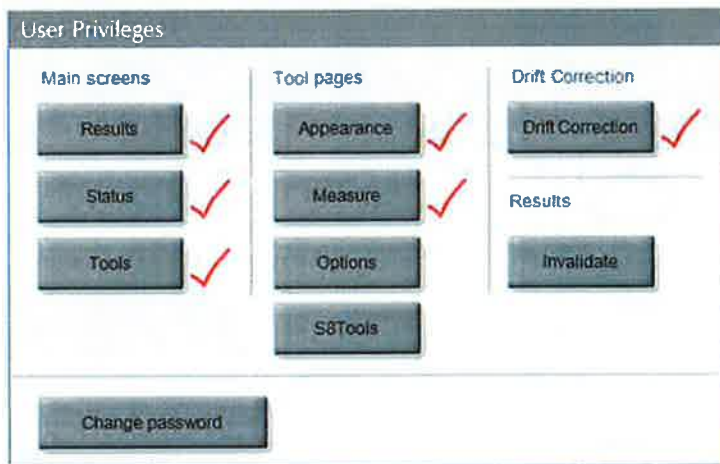


Figure 5.15: *User Privileges* page

5.6.5 S8 Tools

The **Tools** page allows a manual mask to be inserted into the machine, initialize the device and start the advanced S8 Tools which can help diagnose any problem with the device.

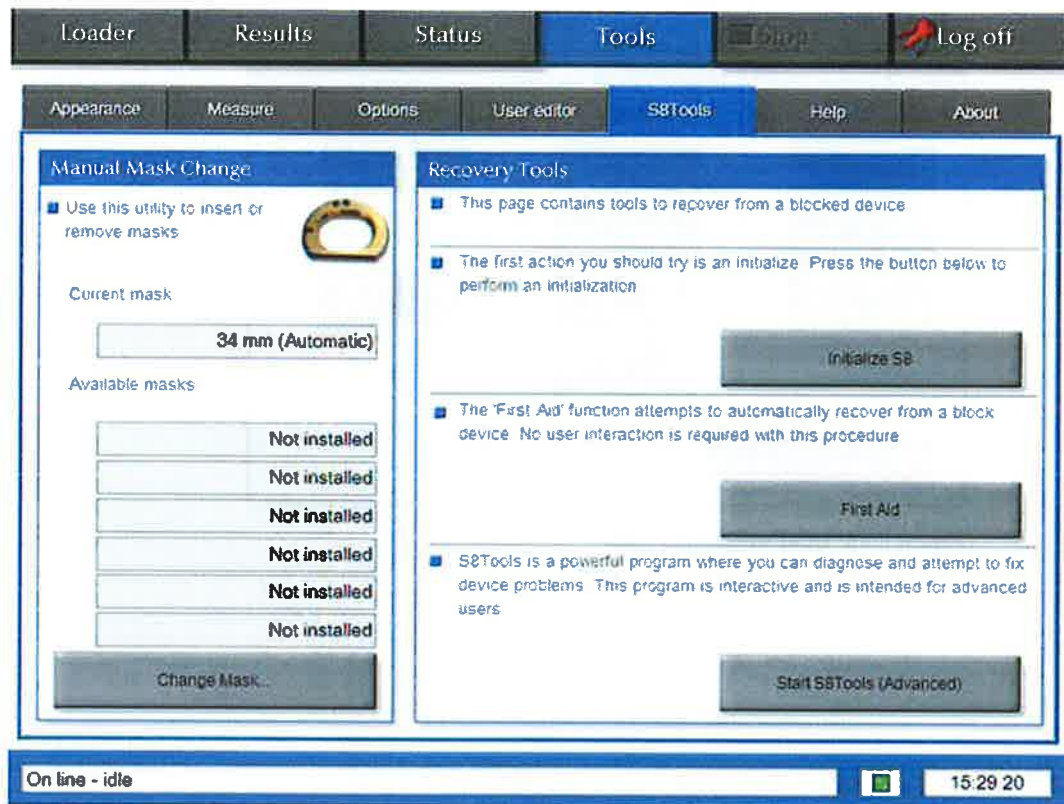


Figure 5.16: S8Tools page

Manual mask

Some applications require a specific mask size for measurement. The S8 TIGER II can be equipped with an optional automatic mask changer for up to 3 masks (automatic masks). If an additional mask size is required for measurement, it can be inserted manually using the **S8Tools** page (manual mask). The **S8Tools** pages show the current installed mask and a list of available manual masks. Mask changes can only be performed when the machine is idle and not measuring a sample.

To insert a mask

1. press the **Change Mask** button.
 - The dialog shown in the figure below will be displayed. The mask changer will automatically select the correct position for the manual mask.
2. Wait for the chamber shutter to open before opening the magazine cover, then
3. insert the mask into the mask changer.

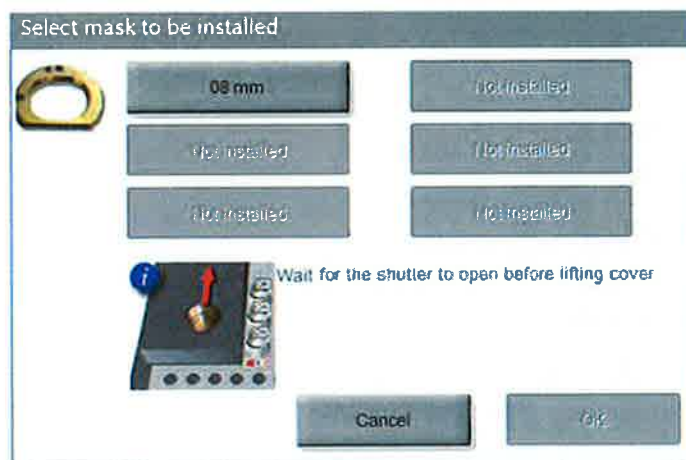


Figure 5.17: Mask change page

Initialize S8

If there is a problem with the device you may try to re-initialize it by pressing this button.

S8 Tools (advanced)

If a problem persists you can start S8Tools (advanced) by pressing the **Start S8 Tools (Advanced)** button. Using the separate S8Tools program requires specific training.

The S8 Tools program can also be started from the external PC.

5.6.6 Help & About

The **Help** page contains an on-line version of this manual. The **About** page, which is shown in the following figure, contains version information and can be useful if you report a problem to Bruker AXS.

Table 5.1: Contact information

Bruker AXS GmbH	
Address:	Oestliche Rheinbrueckenstr. 49 76187 Karlsruhe Germany
Phone:	+49 721 50997-0
Fax:	+49 721 50997- 5222
Email:	info.baxs@bruker.com
Customer Service	
Phone:	+49 721 50997-5200
Fax:	+49 721 50997- 5222
Email:	service.axs@bruker.com

Loader Results Status **Tools** Stop Log off

Measure Options User editor S8Tools **About**

Brüker Advanced X-ray Solutions

BRÜKER S8TIGER

SpectraPlus V4.0g
SS-209951



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Information

Touchscreen IP	172.17.49.142
Firmware IP	172.17.49.148
Firmware MAC	00:03:2D:2B:F3:76
Touchscreen version	4.0.0.5
MeasSp version	3.1.732
Eval2	2.5.555
QueryRes version	2.2.189
Firmware version	6.22/13-Dec-2016
Safety version	1.00
Generator version	K440 V3.03
PIOB1 version	4.1,3.2.0
AIB1 version	3.2.0,2.3.0,4.2.1
AIB2 version	3.2.0,2.3.0,4.2.1
AIB3 version	3.2.0,2.3.0,4.2.1
UMCB1 version	3.0,3.3.0

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Tel. +49 (721) 595-2011
Tel. (USA) +1 (800) 234-XRAY

Figure 5.18: About page

5.7 Alarms

If the machine detects a problem, an alarm will be displayed. All alarms are displayed in the **Loader** screen. While an alarm is active no measurement can be run. An example of an active alarm is shown in the next figure. In this example a generator error is reported. Follow the instructions on the Alarm message to clear the alarm. You may be advised to use **S8Tools (advanced)** to diagnose and clear the alarm. If you have difficulty clearing an alarm or you feel you are experiencing problems you should contact your Bruker AXS representative.



Figure 5.19: **Alarm** page

6 Operating the S8 TIGER

6.1 Measuring Samples with QUANT-EXPRESS

QUANT-EXPRESS offers users of the S8 TIGER II the fast and complete quantitative analysis of unknown samples without performing a calibration. Therefore, it is standard-less for the user. QUANT-EXPRESS is set up to analyze liquid, solid or powdered samples as prepared for the most common XRF specimens.



All systems are equipped with a temporary installation of QUANT-EXPRESS.

The example in the following sections shows how to measure an unknown sample with the QUANT-EXPRESS application.

Start material specific and other applications in the same way. Some sample information might not be required and can be skipped.

You can measure samples with either vacuum or helium modes. The following table offers guidance on which mode to choose.

Table 6.1: Overview: Methods

Method	Shortcut	Sample
Atmospheric Helium	AtmHe	Volatile liquids
Helium	He	Liquids, powders and granulates
Separated vacuum	Svac	Pressed samples
Vacuum	Vac	Compact solids

6.1.1 Sample Preparation

The sample is prepared according to best practice experience and using the respective preparation equipment in the laboratory. The table below gives an overview of the most common materials and the recommended sample preparation method:

Table 6.2: Sample preparation techniques for typical samples

Shape	Typically Material		Important
Compact solids	Metals Polymers	Polishing Milling Hot melting	Flat surface
Powders	Chemicals Geological samples	Pressed pellet (Milling and Pressing) Fused bead	Homogenous sample (Using wax as a binder to form a stable specimen) Homogenous sample Reduction of matrix effects and grain size effects
Granulates	Chemicals Polymers	Cup with polymer film	Quick preparation method (less accurate)
Liquids	Fuels Solvents Water Oils, Grease	Cup with polymer film	Film must be chemically resistant against the sample (Mylar for fuels, Prolene for oils) Reduction of intensities for light elements due to absorption in the film

6.2 Basic Operation without Touchscreen

The S8 TIGER and a PC with the software SPECTRA^{plus} are connected together via a network. To define and start measurements, start SPECTRA^{plus} on your PC. Basic operation with SPECTRA^{plus} and how to measure a sample is described in the *SPECTRA^{plus} V3 User Manual*.

6.3 Basic Operation with TouchControl™

Defining and starting measurements is easy with TouchControl. TouchControl is one of the new developments for the S8 TIGER which provides a simple and failsafe operation of the S8 TIGER. The intuitive design makes it easy to perform measurements. This applies to both unknown samples analyzed using QUANT-EXPRESS and to routine measurements applying specific calibrations. This chapter will explain how samples are defined and measurements are made with TouchControl.

6.3.1 Routine Check

To verify the correct functionality of the S8 TIGER II and to recognize the need of maintenance for the system we recommend that you run a system check regularly. Bruker AXS has already installed two methods on the S8 TIGER II, the S8 CHECK and the QE CHECK.

For material specific applications we recommend that you apply the same quality procedure based on a stable sample (please refer to the *SPECTRA^{plus} V3 User Manual*).



We recommend that you perform the routine check once a week. To comply with even stricter quality rules we recommend that you run it on a daily basis.

6.3.1.1 Instrument Performance Verification – S8 CHECK

During the measurement of typical samples with the S8 TIGER II, a lot of different parameters must be properly adjusted in a short time. These are, for example, the atmospheric mode of the sample chamber, sample rotation, tube current and voltage, detector high voltage, detector type, filter wheel, mask, collimator, crystal type, theta and 2 theta drive.

To verify the instrument quality and to enable a fast diagnosis of the instrument performance a specific method is installed, called **S8 CHECK**:

1. Load the sample **STG 2** in a sample cup with 34 mm mask size and place it on the loader.

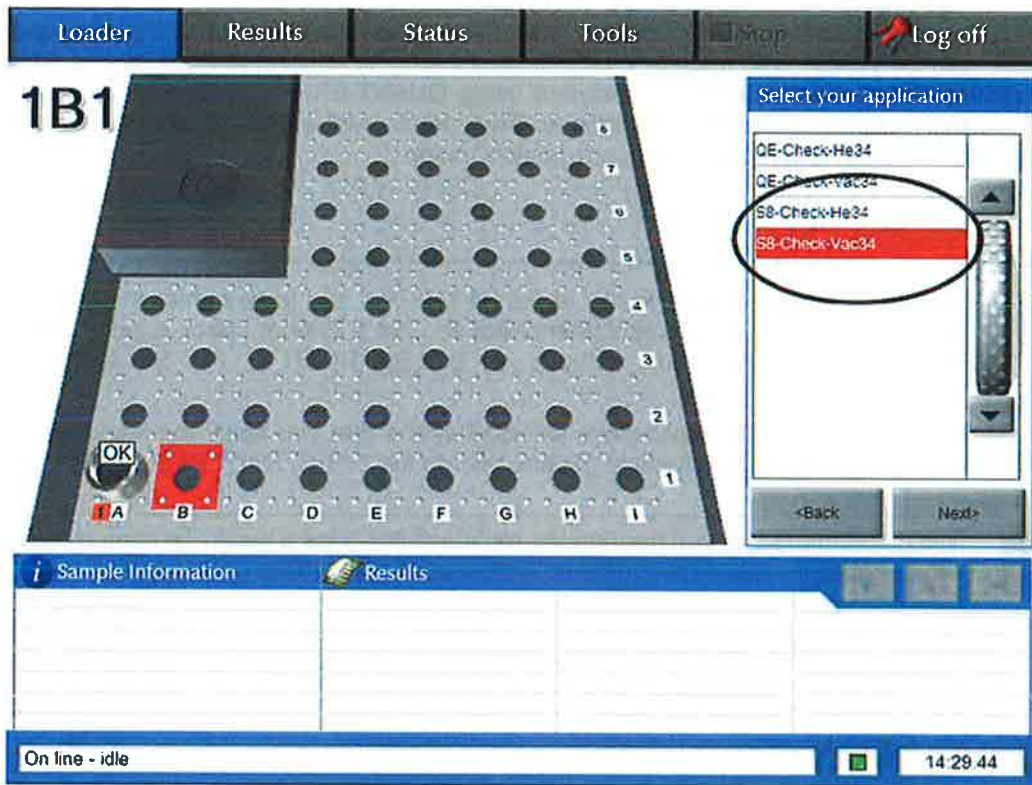


Figure 6.1: Loader screen S8 CHECK

2. Now select the appropriate position on the screen by touching it with the finger.
 3. Press the button **S8 CHECK**. If the button **S8 CHECK** is not displayed, first select and press **others**. Now select **S8 CHECK**.
 4. Start the measurement by pressing **START** on the touchscreen.
- ⇒ The loader of the S8 TIGER II now picks up the sample and loads it automatically. The sample is analyzed in vacuum. After the measurement the result is displayed at the bottom of the page.

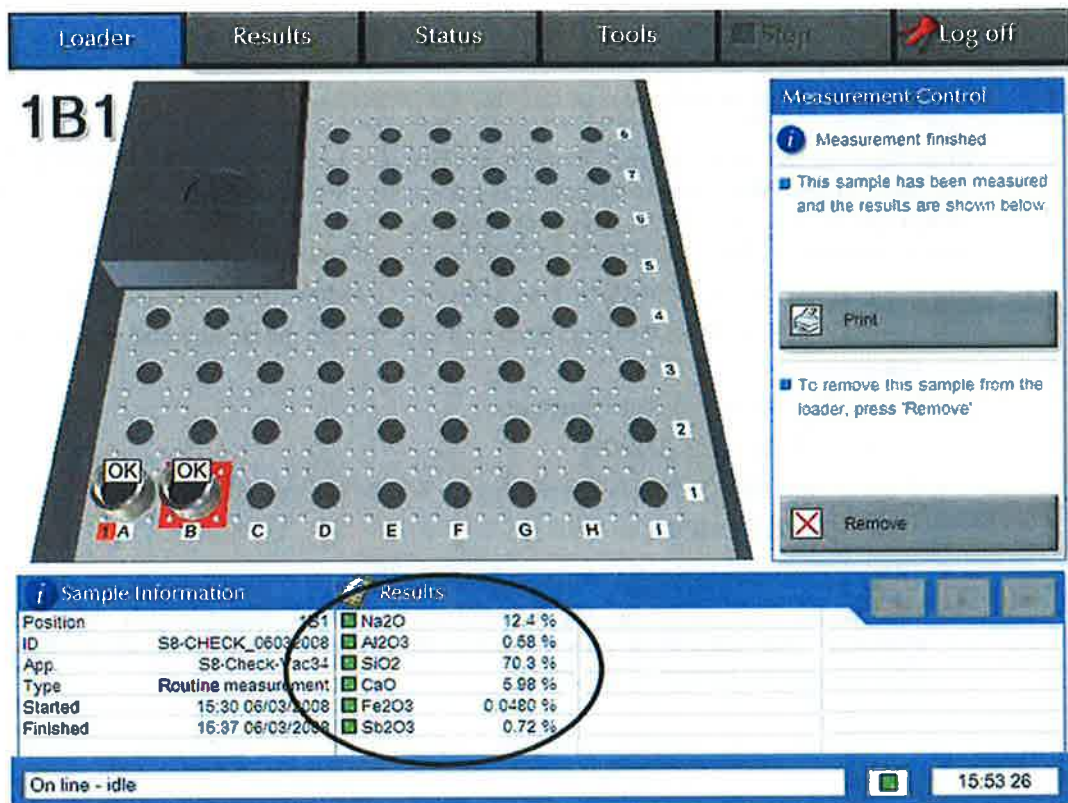


Figure 6.2: Results check for the instrument performance verification S8 CHECK



Please note that your measurement results might differ from the results of the example shown in the figure above. This is due to changes between the reference sample lots.

Compare your results and tolerances with the results of the acceptance protocol in your *Supplement Folder, chapter 3*. These results apply particularly to your S8 TIGER II system.

If the results are outside the limits please refer to the chapter *Troubleshooting the System [p. 133]* in this manual.

6.3.1.2 Verification of the Installation of QUANT-EXPRESS – QE CHECK

In addition to the standardless analysis of unknown samples, QUANT-EXPRESS is also the basis of the integrated analytical intelligence and the initial setup of the global drift correction for the S8 TIGER II. It assists during the setup of individual methods. It is therefore recommended to check the QUANT-EXPRESS installation on your S8 TIGER II.

For this purpose a specific method was setup in the factory called **QE CHECK**:

1. Load the sample **STG 2** in a sample cup with 34 mm mask size and place it on the loader.
 2. Now select the appropriate position.
 3. Press the button **QE CHECK**.
 4. If the button **QE CHECK** is not displayed, first select and press **others**.
 5. Now select **QE CHECK**
 6. Start the measurement by pressing **MEASURE**.
- ⇒ The loader now picks up the sample and loads it automatically into the sample chamber. The sample is now analyzed in vacuum. Upon completion, the result is displayed at the bottom of the page.



Figure 6.3: Results check for the QE CHECK measurement



Please note that your measurement results might differ from the results of the example shown in the figure above. This is due to changes between the reference sample lots.

Compare your results and tolerances with the results of the acceptance protocol in your *Supplement Folder, chapter 3*. These results apply particularly to your S8 TIGER II system.

If the results are outside the limits please refer to the chapter *Troubleshooting the System [133]* in this manual.

6.3.2 Performing a Measurement with QUANT-EXPRESS

According to the analytical target, the samples are measured with predefined measurement methods and evaluated using the master calibration. Due to the powerful fundamental parameter method, based on the variable alpha model and predefined line overlay corrections, all different kind of samples can be fully analyzed with QUANT-EXPRESS.

Sample specific information must be entered before starting the sample to achieve the best possible results with QUANT-EXPRESS. All necessary information is entered following the dialog of TouchControl to completely define the samples.

The specimen is placed on the loader tray using the appropriate sample cup. According to the sample size, the respective mask in the sample cup has to be used. This mask and the collimator mask must fit together. Depending on the configuration of the S8 TIGER you may be asked to place the appropriate collimator mask in the instrument before you can analyze smaller samples.

Define the measurement on the basis of the following six steps:

6.3.2.1 Step 1: Sample ID

Now you can start the measurement of the sample.

1. Touch the correct sample position in the **Loader** screen and the button **QUANT-EXPRESS**.



If the button **QUANT-EXPRESS** is not shown on your screen, press **OTHER** to achieve a listing of all installed applications where you will find also QUANT-EXPRESS. The button can be created on the tool page.

2. Now you are asked to enter the **sample ID** using the keyboard on the touchscreen.

This is important for the correct identification of the sample. All related information is stored using this **sample ID** in the measurement database.

1. Confirm the sample ID by pressing the button **NEXT>**.



Figure 6.4: Enter sample ID

6.3.2.2 Step 2: Material

For sample evaluation, QUANT-EXPRESS can integrate additional sample information about the matrix composition and light elements. Even if those elements cannot be measured directly by XRF. This is needed to achieve a good quantitative result. By default, QUANT-EXPRESS comes with three evaluation models.

Table 6.3: Evaluation models of QUANT-EXPRESS

Method	Matrix	Material
Elements	none	Metals, chemicals, ores
Oxides	none	Glass, geological samples, oxidized chemicals, ceramics
Organics	CH ₂	Oils, fuels, solvents, polymers, grease

1. Choose the right evaluation model for your sample, here **Elements** for a metal sample and
2. press **NEXT>**.



Additional matrix information about your sample or concentrations for light elements which has been determined by another method can be included during the interactive evaluation using the program EVAL2 and will further improve the results.



Figure 6.5: Sample materials

The program **Application Setup** is used to create customized evaluation models (.evm file). The evaluation models are based on user input like sample type and competition. The .evm files must be stored in the directory **SPECplus/Libraries/Calibrations** on the hard drive on the S8 TIGER. At the next start-up of QUANT-EXPRESS these models will be shown automatically on the screen.

6.3.2.3 Step 3: Preparation

QUANT-EXPRESS automatically calculates and displays the concentration values of the original sample prior to preparation. Effective sample dilution and chemicals used during the preparation of the specimen, e.g. wax or flux, are taken into account during the evaluation. Also the information about the sample shape (diameter, thickness, weight) will help QUANT-EXPRESS to properly correct for sample effects.

All preparation methods stored in the central database fluo.mdb are displayed.

1. Press the **Preparation** button according to the sample and
2. press **NEXT>**.

In our case the metal sample is defined as **SOLID**, the diameter of the metal disk is 40 mm and infinitely thick for XRF.



Figure 6.6: Selection of the sample preparation

6.3.2.4 Step 4: Mode

All atmospheric modes can be used to perform measurements with QUANT-EXPRESS. Compact solid samples are typically measured in vacuum (**Vac**). The highest sensitivity for light elements is achieved in vacuum. If your S8 TIGER is equipped with the vacuum seal of SampleCare™ and helium flushing unit, three additional modes are available: separate vacuum (**Svac**), helium (**He**) and atmospheric helium (**AtmHe**).

1. The metal disk is run under vacuum by pressing **Vac** and **Next>**.



QUANT-EXPRESS automatically recognizes sample preparation methods which cannot be run under vacuum. If the sample is filled into a liquid cup (with a polymer film as bottom) the vacuum modes are automatically disabled. This is true only if the preparation method is properly defined.



Figure 6.7: Selection of the measurement mode

Also if the instrument is not equipped with helium flushing unit and a vacuum seal only the vacuum mode is displayed. In this case the instrument is configured to analyze only compact solid samples.

6.3.2.5 Step 5: Diameter

Within this step the sample diameter is defined. According to the instrument configuration all available masks are displayed in the combo box. The S8 TIGER allows the use of two mask types: Automatic masks in the mask changer, this is recommended. If you own manual masks from other Bruker instruments, you can also use most of them. Also, some of the low background small area masks are only available as manual mask.

If an automatic mask is selected, the S8 TIGER automatically installs the corresponding mask before the measurement. If a manual mask is chosen, you will be asked before the measurement to place the corresponding mask in the sample chamber.

Note that after this measurement you may need to change back to another mask to run new samples.

1. Select the appropriate mask, in our example **34 mm** is selected.



Figure 6.8: Selection of the sample mask diameter

6.3.2.6 Step 6: Measurement Method

In the next combo box you select the **Measurement** method according to the analytical target. By default there are three different methods installed:

Table 6.4: QUANT-EXPRESS measurement methods

Method	Typical duration	Target
Fast Screening	~ 3 minutes	Fast characterization of totally unknown samples with determination of major elements
Full Analysis	~ 8 minutes*	Full quantitative analysis of major and minor elements in the sample
Best Detection	~ 15 minutes*	Analysis of all elements down to the trace concentration level

*The total measurement time for each sample may change according to the sample composition. The measurement methods of QUANT-EXPRESS run the samples using the automatic count rate reduction to avoid detector saturation. The current of the X-ray tube is automatically reduced so that the intensity of each major element is measured in the linear range of the detector



Prolonging the measurement time especially for trace elements will improve data quality and result in lower detection limits for these elements.



When setting measurement times for measurement methods, take into account to which degree your sample and the element distribution remains stable during the measurement. In liquids one often observes element separation, e.g. heavier elements collect at the bottom close to the foil.

Measurement methods with customized settings can be stored in the folder: **Measurement methods\QuantExpress**.

The file name must include settings for the mode and mask size, the name of the file must end with the corresponding naming, e.g. ***-Vac34mm.mm** for the vacuum mode and the 34 mm mask.



Figure 6.9: Selection of the measurement method

1. Select now **Full Analysis** to finish the sample definition.
⇒ The sample is now ready to be measured.

6.3.2.7 Starting the Measurement



Figure 6.10: Start the measurement

1. You may now start the sample by pressing the button **Measure**.
 - ⇒ The sample grabber picks up the cup and places the sample in the chamber. The S8 TIGER automatically adjusts mode and sample mask and performs the measurement. When the measurement is finished, the sample is automatically placed to its original position. The next sample will be loaded.



Figure 6.11: Status during the measurement

6.3.2.8 Viewing and Printing the Results

The result is displayed at the bottom of the **Loader** page of TouchControl or can be retrieved from the database of the **Results** page.

1. Print the results by pressing the **Print** button.



Figure 6.12: Results after the measurement

The results could also be retrieved performing a database search on the **Results** screen (see section [Results Screen \[62\]](#)).

You may now check the results. It is recommended to check the quality of the result in EVAL2 interactively. By default QUANT-EXPRESS performs the measurement in scan mode. The major benefit is that the user can change interactively later analytical settings (analytical lines), check for line overlays, provide more detailed sample information (matrix compounds) or correct sample preparation parameters. The quality of the analytical result may improve and the new evaluation can be stored in the database as a new record.

6.4 User Calibrations with SPECTRAplus

The typical use of modern WDXRF instrumentation is accurate and precise quality and process control. Therefore in most cases calibrations specific to material groups are created. To run a sample on the S8 TIGER and get concentration values for this sample, the following files are needed. These files are automatically created and saved during the calibration process with SPECTRA^{plus}. (Please refer to the software manual.) The **Evaluation** method is the file which finally creates the button in TouchControl.

Table 6.5: Files needed for SPECTRA^{plus} custom calibrations.

Method	File name	Description
Evaluation Method	<My application.evm>	links all files and information for the measurement and the evaluation of the sample
Measurement Method	<My application.mm>	contains all information about measurement parameters e.g. mode, mask size, time, element specific lines (name),...
Calibration file	<My calibration.fcl>	contains all calibration parameters e.g. sensitivities, offsets, line overlay factors, matrix correction type and factors,...
Line Library	S8-LineLibrary.fll	contains all element lines with their measurement parameters (collimator, crystal, detector type and discrimina-

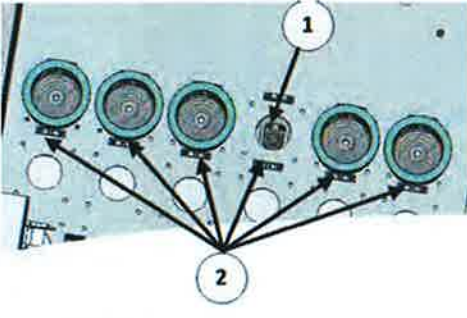

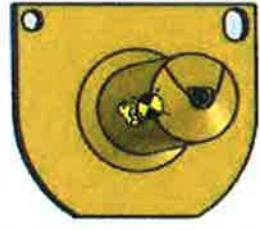
Method	File name	Description
		tors, dead time, peak and background positions, drift correction settings and information,...)
Preparation database	Fluo.mdb	contains all information about standards and their preparation, also about preparation types
Results database	Measure.mdb	all sample information is stored in this database e.g. sample I.D., time, date and duration, concentration values, operator,...
Specification database	Specification.mdb	contains all information about specifications e.g. warning and alarm limits
Instrument configuration	S8-configuration.cnf	contains the installed instrument configuration e.g. crystals, collimators, detectors...

7 Mapping Option

The S8 TIGER now offers an option to perform micro-spot analysis and mapping.

7.1 Changes in the Hardware

S8 TIGER's with the Mapping option differentiate from other S8 TIGERs by:

On the Loader		<p>1: Position with camera</p> <p>2: Special positions with orientation pins</p>
Sample Holders		Special sample with pins
Collimator Mask		Collimator mask Ø 0,3 mm or Ø 1,25 mm

7.2 Additional Software

The Mapping analysis is performed using the **Mapping Tool** program. The document DOC-M80-EXX200 describes this option in a comprehensive way.

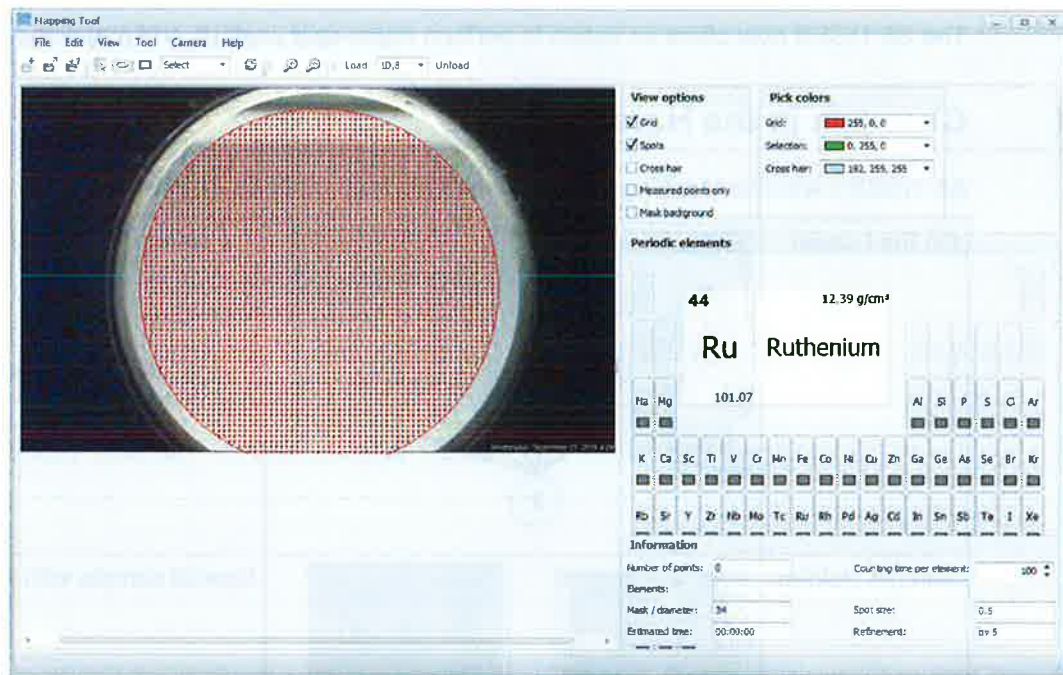


Figure 7.1: Mapping Tool

7.3 Workflow

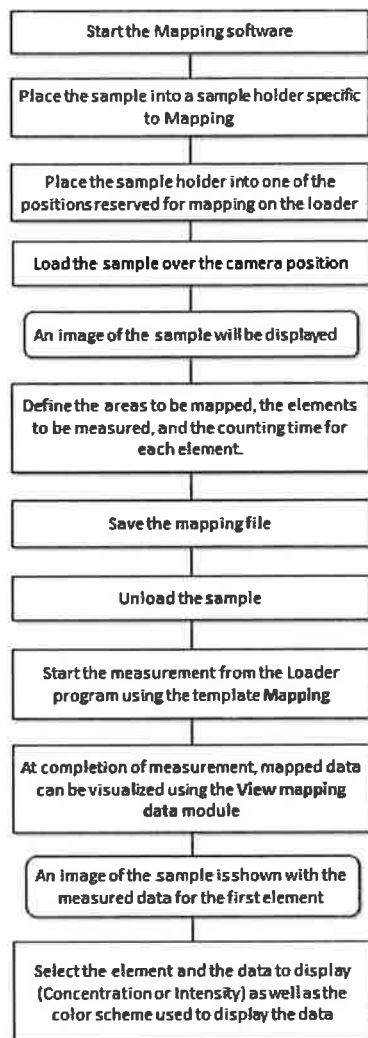


Figure 7.2: Workflow for mapping analysis

Mapping Option

8 Servicing and Maintaining the Spectrometer System

8.1 Cleaning the Spectrometer System

WARNING



Risk of injury from electrical shock!

A life threatening shock may result when cleaning, maintenance or replacement operations are performed before disconnecting the system from the power supply.

- ▶ Shut down the system.
- ▶ Turn off the power of the system.
- ▶ Disconnect the power supply cable from the mains net.

Exterior Panels

For cleaning the side panels and also the interior of the sample magazine use a damp cloth. Do not use soap or aggressive cleansing agents. The transparent sample magazine cover can be cleaned with any standard household-type window detergent.

Sample Magazine / Loader

The sample magazine and the sample cups should be kept clean and dry. The sample cups can be washed with hot soapy water or an organic solvent and dried prior to use.

NOTICE

Disposal of solvents

Solvents are environmental pollutants. Disposal of solvents must comply with all applicable national, state, and local regulations.

Larger particles of dirt on the sample magazine or inside the loader can be removed with a vacuum cleaner.

Touchscreen

To clean the touchscreen, avoid the use of abrasives or aggressive solvents. Only use a soft damp cloth with a mild detergent if necessary.

8.2 Handling the STG Samples

Bruker AXS provides with each S8 TIGER II a set of stable samples (graphite, metals and glass samples) used for the alignment of the instrument and drift correction/recalibration of quantitative methods.

It is very important to handle these samples very carefully, since the analytical performance and quality of the results depends on the correct measurement of these samples.

- Keep the samples in a safe, clean and dry place (e.g. desiccator).
- Always keep the surface free of dust and fingerprints!
- The surface of the regular base must be cleaned with pure alcohol and a lintfree tissue.

This procedure allows retaining the same high quality on results over time. In case of sample damage or high deviation of the results contact the Bruker AXS representative for a replacement of the sample.

8.3 Refilling the Deionized Water of the Internal Cooling Unit

8.3.1 Important Safety Instructions

When the equipment is connected to the mains supply, high voltage (i.e. voltage ranging from 110 V up to 60 kV) will be present at the terminals of the mains distribution unit and within the various internal components of the spectrometer system.

Therefore, it is absolutely necessary to switch off the external mains supply before opening the side panels of the S8 TIGER II. It is not sufficient to press the **Power Off** button on the front of the spectrometer.

The mains supply must be switched off at a wall socket by removing the mains supply plug or a switch external to the S8 TIGER II as shown in [Refilling the Deionized Water of the Internal Cooling Unit \[109\]](#).

WARNING

Danger of injury from electrical shock!

A life threatening shock may result when the housing is open during operation.

- ▶ Only qualified personnel should open the housing.
- ▶ Disconnect the device from the electrical power supply before opening the device. Use a voltmeter to verify that the device is not under power!
- ▶ Be sure that the power supply cannot be reconnected without notice.

SAFETY INSTRUCTIONS

Complete and secure disconnection of the system

Internal parts of the instrument stay live, when the system is only switched off. Risk of electrical shock!

1. Follow the instructions step-by-step to disconnect the system **completely** from the external mains supply.
 - ▶ Switch off the system using the **Stand by** button.
 - ▶ Switch off the **Mains Disconnect** switch.
 - ▶ Disconnect all **Power Supply Lines** from the mains supply!
 - ▶ Switch off the **Automatic Circuit Breaker** or the **External Power Disconnect** switch located in the vicinity of the instrument!

WARNING

Leakage or splashing of cooling fluids

High risk of lethal electric shock as long as water or other cooling liquids are present in or near the system.



- ▶ Disconnect the system **completely** from the mains supply.
- ▶ Be cautious when refilling the fluid tank.
- ▶ Repair the leakage source.
- ▶ Dry all wet regions thoroughly before connecting the system to the mains supply again.

CAUTION

Hot Surfaces between 70 and 100 °C (156 and 212 °F) on internal components

Risk of severe burns when touching the surfaces.



- ▶ Turn off the instrument and wait until all components have cooled down!

8.3.2 How to Check the Water Level

Due to evaporation or very small leaks in the water circuit, the water needs to be refilled occasionally. The water level is controlled by the instrument control software.

- It shows **WARNING** if the water level in the reservoir is low.
- It shows **ALARM** if the water level in the reservoir is below a critical limit.



If the system shows **ALARM**, the HV is switched off immediately, and can not be switched on again as long as the **ALARM** is present.

Display on the S8 TIGER II LED's:

- In case of a Warning, the **Alarm** LED is blinking.
- In case of an Alarm, the **Alarm** LED is flashing permanently, the HV can not be switched on.

Display in the S8 Tools:

- **Instrument | Warnings**
- **Instrument | Alarms**

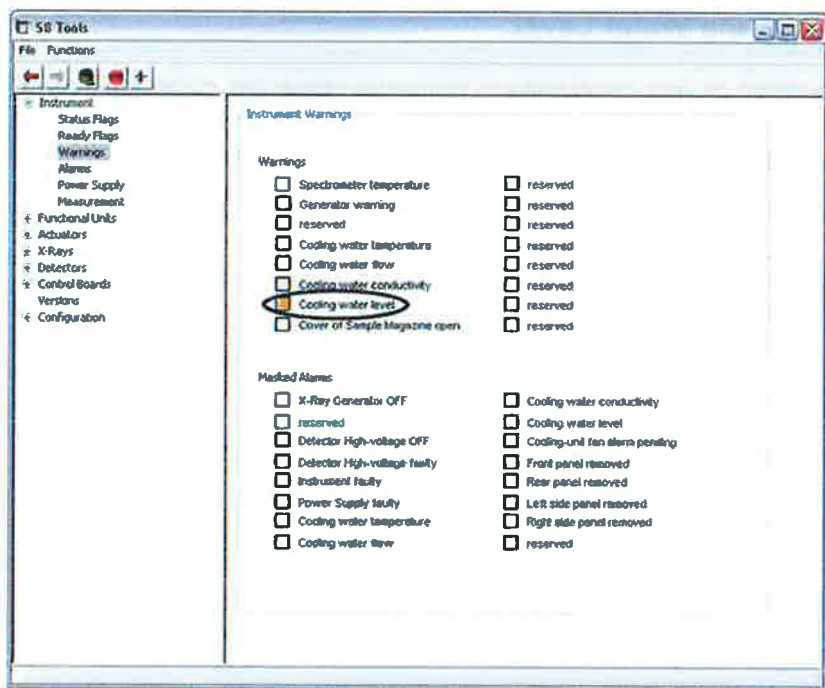


Figure 8.1: S8 Tools instrument warning **Cooling water level**

8.3.3 Refilling the Cooling Water

1. Refill the water for the external cooling unit.
2. Switch the S8 TIGER II off like described in chapter [Switching the Instrument On and Off \[47\]](#).
3. Disconnect the instrument from the mains power (pull the mains plug).



Figure 8.2: Disconnect the mains power

4. Remove the rear panel. Use a slit screwdriver and open the 2 lock screws (1) and (2), turn clockwise:



Figure 8.3: Backside view

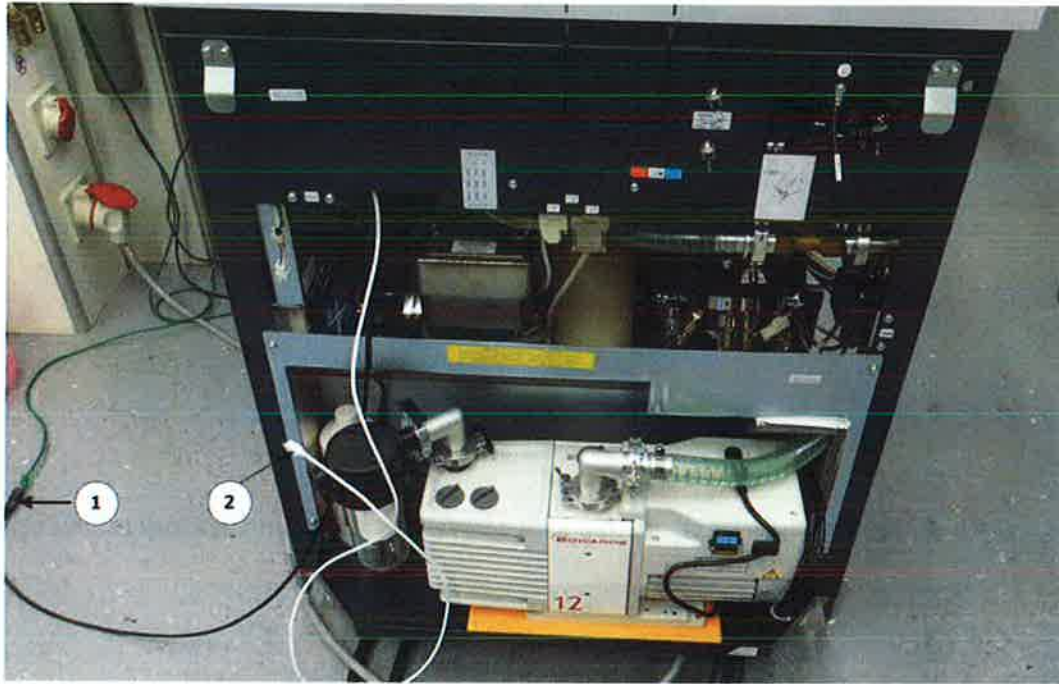


Figure 8.4: Backside view with removed back panel

1	USB cable	2	Network cable
---	-----------	---	---------------

It is not necessary to remove the gas pipes; these are connected directly on the frame, not on the rear panel. If you pull back the rear panel carefully the ground plugs will be stripped off automatically.



The USB- and LAN-plugs and the power for the fans on the rear panel do not need to get disconnected. If you prefer to do so for better access, take care to attach them again after refilling the water.

The water tank is placed on the left side, above the vacuum pump (see figure below).



Figure 8.5: Refill of the deionized water reservoir

1. Open both of the thumb screws and remove the cover of the cooling water reservoir.

NOTICE

Damage to the instrument

Only use deionized water!

1. Use a watering can or the funnel and hose delivered with the system to refill the reservoir. (Do not use this watering can for normal tap water.)
2. Fill up the water reservoir to 5 mm below its top edge.
3. Put the cover to the tank and fix it with the thumb screws.
4. Put the rear panel back, be careful with the gas hoses and don't forget to plug the ground cable, USB and LAN if they were disconnected.

5. Use a screwdriver to fix the rear panel.
6. Reconnect the system to the mains power. Plug in the mains connector.



Figure 8.6: Reconnect to the mains power

7. Switch on the S8 TIGER II as described in chapter [Switching the Instrument On and Off \[47\]](#).

8.4 Changing the P10 Detector Gas

8.4.1 Reason

Due to slightly different mixtures and tanks it is necessary to readjust the high voltage settings for the system after a tank change. The realignment can be done with the SPEC-TRA^{plus} program **SpectrometerAlignment.exe**.

8.4.2 Changing the Tank



Make sure that no measurements are running at that time.

If you do not have control on the S8 TIGER:

1. open the program **MeasControl** located in the folder: **Programs/Spectra Plus**
2. connect to the instrument
3. type **RC0** and press **Enter**
4. open the programm **S8Tools**
5. connect to the instrument and
6. switch to the section **Functional Units | Counter Gas** (figure below):

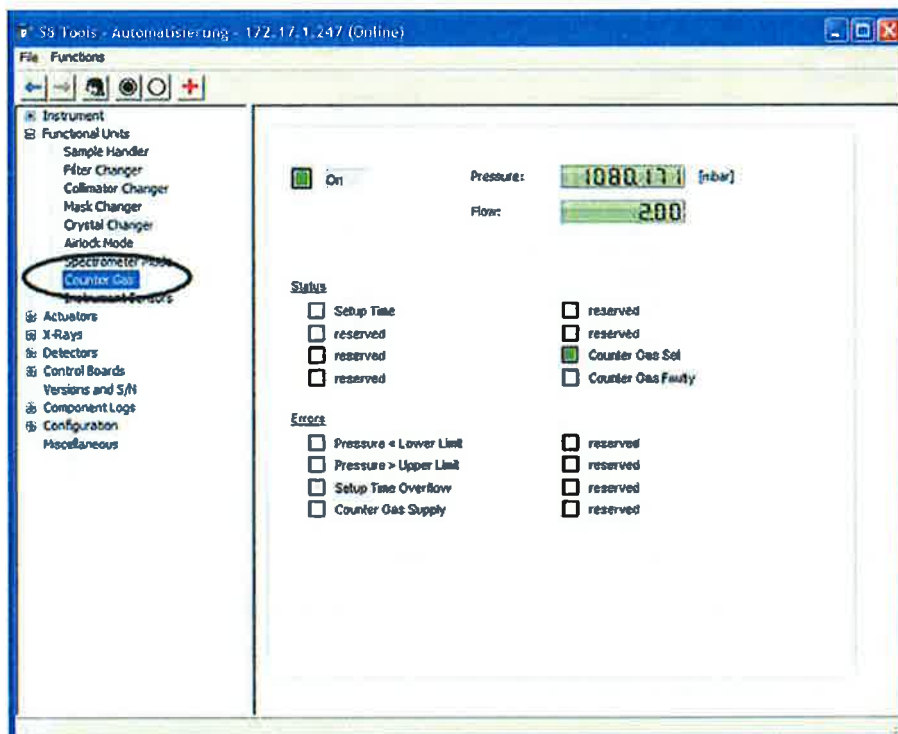


Figure 8.7: S8 TOOLS – ONLINE – Counter Gas

7. Select **Utilities | Counter Gas Utilities | Counter Gas Off** or click on the fifth button from the left

- The right side will display **Off** and a flow of 0.00 l/h (see figure *S8 TOOLS – ONLINE – Counter Gas On* [p. 120])

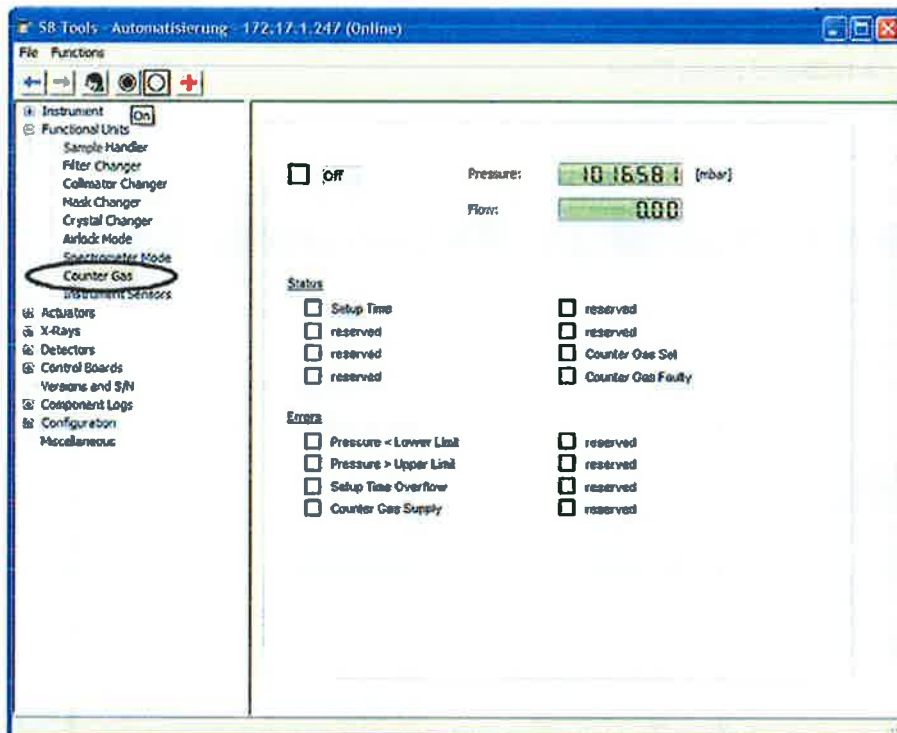


Figure 8.8: S8 TOOLS – ONLINE – Counter Gas Status

8. Switch to the section **Functional Units | Spectrometer Mode**
 9. Select **Utilities | Operating Mode Utilities** and change mode to **AIR**.
- ⇒ Now the P10 tank can be changed!

SAFETY INSTRUCTIONS

Proper change of gas cylinders

1. Follow the instruction thoroughly.
 - ▶ Close the main valve of the empty tank/gas bottle.
 - ▶ Disconnect the regulator.
 - ▶ Screw on the valve protection cap.
 - ▶ Never leave a tank without the protection cap and attachments to prevent the tank from falling over.
 - ▶ Remove the used tank.
 - ▶ Secure the new tank.
 - ▶ Double check you have chosen the right gas!
 - ▶ Remove the protection cap.
 - ▶ Attach the regulator and tighten it.
 - ▶ Do not change the secondary pressure setting.
 - ▶ The regulator should be set to 0.5 bars/7 psi. You can adjust the secondary side only if gas is flowing.
 - ▶ Open the main valve.
 - ▶ Use soap water to check the connection to the regulator.

1. Select **Utilities | Counter Gas utilities | Counter Gas On**
or click on the fourth button from the left

► The right side will display a light green button (figure below) during the setup time (~ 2 min).

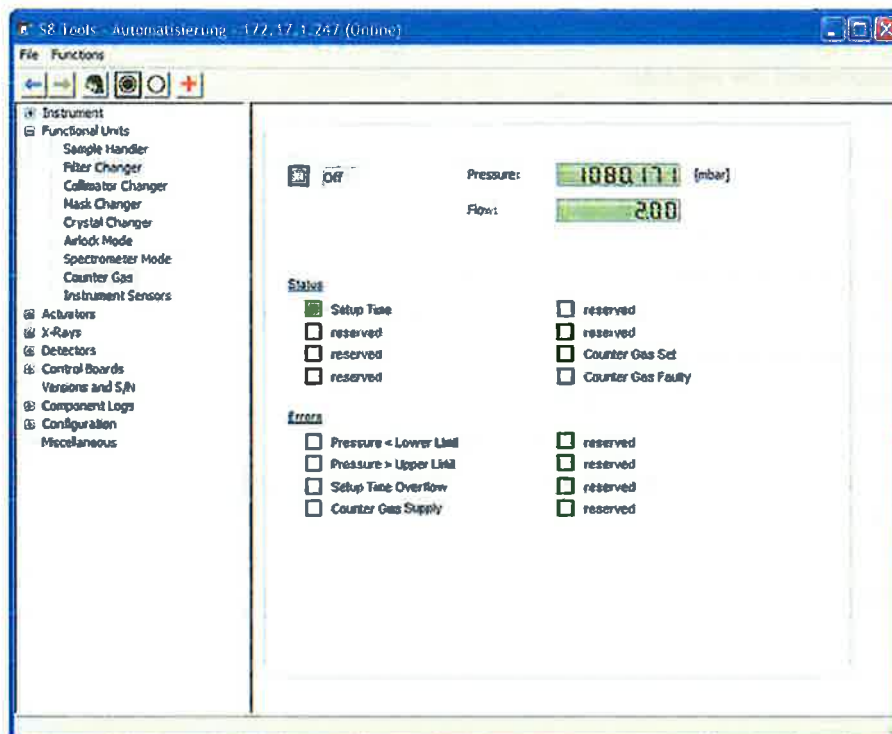


Figure 8.9: S8 TOOLS – ONLINE – Counter Gas On

1. Wait until the **Counter Gas Set flag** is set (figure below).

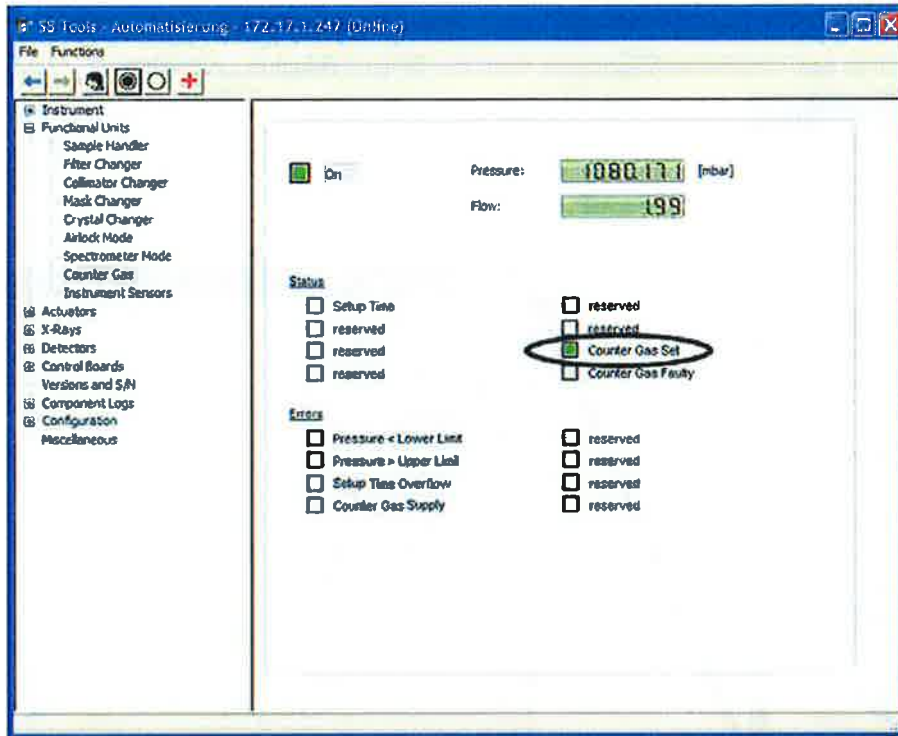


Figure 8.10: S8 TOOLS – ONLINE – Counter Gas Set flag

If you encounter any errors,

1. adjust the pressure accordingly and/or check the supply.
2. Select **SpectrometerAlignment** from the **SPECTRAplus Launcher**.

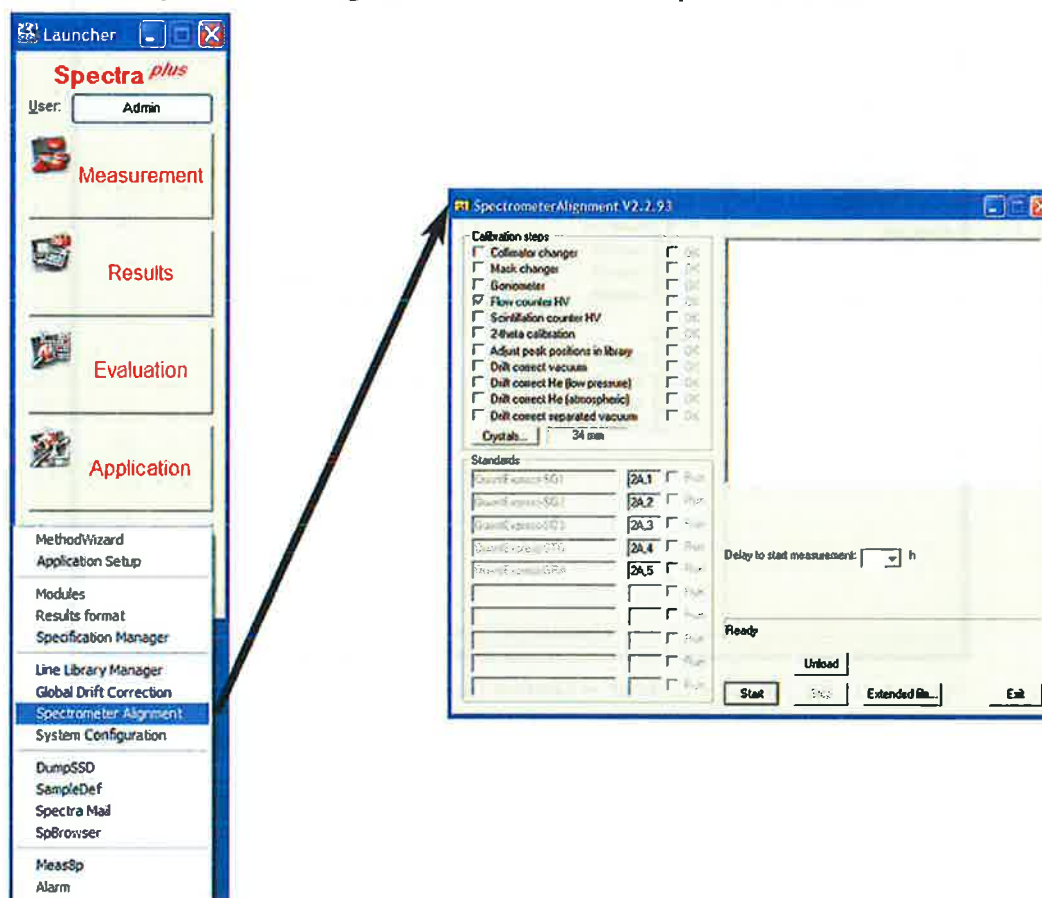


Figure 8.11: SpectrometerAlignment

3. Tick the **Flow counter HV** box.
4. Check if the sample position for the STG sample is correct and change the positions if necessary.
5. Press **Start**.
6. After the alignment is finished, check the status (see next section) and terminate the program by clicking on **Exit**

8.4.3 Checking the HV-Alignment

The result of the alignment is shown on the right side of the program window by ample lights:

- a green light indicates that the alignment has run successfully
- a yellow light indicates a warning and
- a red light indicates a problem

If the message relates to warnings or errors, check the **SUMMARY1.tsv** file and the **Spectrometer-Alignment.log** file, which are located in the **SPECPLUS\datafiles\info** directory. If the summary files are not created, please refer to the appendix on how to have them created.

In any case it is advisable to have a look at the **SUMMARY1** file. Locate the summary section for your current alignment (end of file) and compare the settings for HV and resolution with the previous settings obtained.

The differences are typically in the range of only a few volts. If the differences are much higher, the composition of the gas changed significantly or there might be a problem.

If the resolution increased by more than 50 % from the first resolution, the wire inside the flow counter needs to be changed (as well as the FC window).

S8 TIGER II

Table 8.1: Summary of Peak alignment function on 16-Sep-2008 23:07:05

Sample	Line	Initial	Measured	KCps	Status
QuantExpress-STG	Al KA1/S8-Check	144.661	144.687	18.203	Adjusted
QuantExpress-STG	Ca KA1/S8-Check	113.037	113.127	157.61	Adjusted
QuantExpress-STG	Fe KA1/S8-Check	57.489	57.570	7.2848	Adjusted
QuantExpress-STG	Na KA1/S8-Check	25.007	25.008	249.56	Adjusted
QuantExpress-STG	Si KA1/S8-Check	109.026	109.009	244.73	Adjusted
QuantExpress-STG	Sb KA1/S8-Check	13.415	13.457	40.92	Adjusted

Instrument S/N 4157 - Calibration report created on 16-Sep-2008 23:07:06

Operator	Admin
----------	-------

Table 8.2: Calibration report created on 16-Sep-2008 23:07:06

Line	Sample_ID	Xtal	Sol-ler	Det.	ZI1	ZI2	Int	FWHM	HV	Res	ZI7	ZIMask
Fe KA1	QuantExpress-GRA	LiF200	0.23	Gas	---	---	---	---	---	---	---	30.70
Zn KB1	QuantExpress-SQ1	LiF200	0.23	Scint	---	---	90.376	---	---	---	79.750	
Zn KB1	QuantExpress-SQ1	LiF200	0.23	Gas	-0.961	10.194	77.645	0.346	---	---		
Zn KB1	QuantExpress-SQ1	LiF200	0.23	Gas	---	---	---	---	1493	14		

Line	Sample_ID	Xtal	Soller	Det.	ZI1	ZI2	Int	FWHM	HV	Res	ZI7	ZIMask
Zn KB1	QuantExpress-SQ1	LiF200	0.23	Scint	-0.958	-24.807	104.138	0.331	---	---		
Zn KB1	QuantExpress-SQ1	LiF200	0.23	Scint	---	---	---	---	677	35		
Zn KB1	QuantExpress-SQ1	LiF200	0.46	Gas	-0.938	10.216	122.697	0.589	---	---		
Zn KB1	QuantExpress-SQ1	LiF200	0.46	Scint	-0.929	-24.787	93.377	0.563	---	---		
Zn KB1	QuantExpress-SQ1	LiF220	0.23	Gas	-0.915	10.166	35.355	0.355	---	---		
Zn KB1	QuantExpress-SQ1	LiF220	0.23	Gas	---	---	---	---	1454	15		
Zn KB1	QuantExpress-SQ1	LiF220	0.23	Scint	-0.909	-24.824	114.593	0.339	---	---		
Zn KB1	QuantExpress-SQ1	LiF220	0.23	Scint	---	---	---	---	650	36		
Zn KB1	QuantExpress-SQ1	LiF220	0.46	Gas	-0.891	10.188	56.232	0.599	---	---		
Zn KB1	QuantExpress-SQ1	LiF220	0.46	Scint	-0.886	-24.802	118.784	0.574	---	---		

Servicing and Maintaining the Spectrometer System

Line	Sample_ID	Xtal	Sol-ler	Det.	ZI1	ZI2	Int	FWHM	HV	Res	ZI7	ZIMask
Na KA1	QuantEx press- STG	XS-55	0.23	Gas	-0.810	10.585	128.086	0.557	---	---		
Na KA1	QuantEx press- STG	XS-55	0.23	Gas	---	---	---	---	1750	39		
Na KA1	QuantEx press- STG	XS-55	0.46	Gas	-0.793	10.596	245.616	0.736	---	---		
Na KA1	QuantEx press- STG	XS-55	1.00	Gas	-0.799	10.596	172.858	1.135	---	---		
N KA1	QuantEx press-BN	XS-N	1.00	Gas	-0.848	10.538	8.503	2.196	---	---		
N KA1	QuantEx press-BN	XS-N	1.00	Gas	---	---	---	---	1737	80		
N KA1	QuantEx press-BN	XS-N	0.46	Gas	-0.848	10.538	4.534	2.013	---	---		
C KA1	QuantEx press- GRA	XS_C	1.00	Gas	-0.903	10.393	30.081	2.428	---	---		

- Please note down the the HV's and Resolutions (Res.) in the LOG spreadsheet.
- The changes in the example are small and show that all is ok. Drift correction is not necessary.
- If the resolution increases significantly, there could be a problem with a contaminated FC wire and the foil.
- If the HV decreases, the detector is leaking and the foil needs to be replaced.

- In order to replace a contaminated wire, please contact the Bruker AXS service organization or representative or refer to the FC Detector Service Procedure.

8.4.4 Checking User Specific Calibrations

1. Run the check samples, which are defined for your methods and verify that the concentration values stay within their limits. If they are out of limits, perform the drift correction and rerun the respective check sample(s).
2. Run the **S8 Check** in order to check the performance of the S8 TIGER II compared with the date of installation (see next section).

8.4.5 Checking the S8 TIGER and QUANT-EXPRESS with S8 CHECK and QE CHECK

For QUANT-EXPRESS the check sample is the glass sample STG2.

The obtained values are compared to the Installation Acceptance Test data sheet (values obtained at customer site). They have to be within the prescribed limits as outlined in the test.

- ▶ Use the 34 mm Mask and corresponding sample cup, and load the **clean** sample to start the S8 CHECK and QE CHECK from the external Loader program:
 1. Start the **Loader**.
 2. Load the definition file **drift correction.def** if it is not already loaded.
 3. Select the position on the displayed loader tray.
 4. Select from the menu **Standards** the tab **Drift Correction**.
 5. Select the Application **QE-Check-Vac34** and **S8-Check-Vac34**.
 6. Now select the **control standards** from the menu.
 7. Click on **Import** to load the samples.
 8. Start the samples by clicking the **Send Current Sample** or **Send Selected Samples** or **Send all Samples**.
 9. Check results and limits in **QUERY RES**.
- ▶ Alternatively you can use TouchControl to start the sample from the window **Loader**:

1. Click in the window **Select Your Application** on the **Drift** button.
2. Select the method **QE CHECK** or **S8 CHECK**.
3. Press on **Control Standards**.
4. Load the **STG sample** on the tray.
5. Start the sample by clicking on **Measure**.

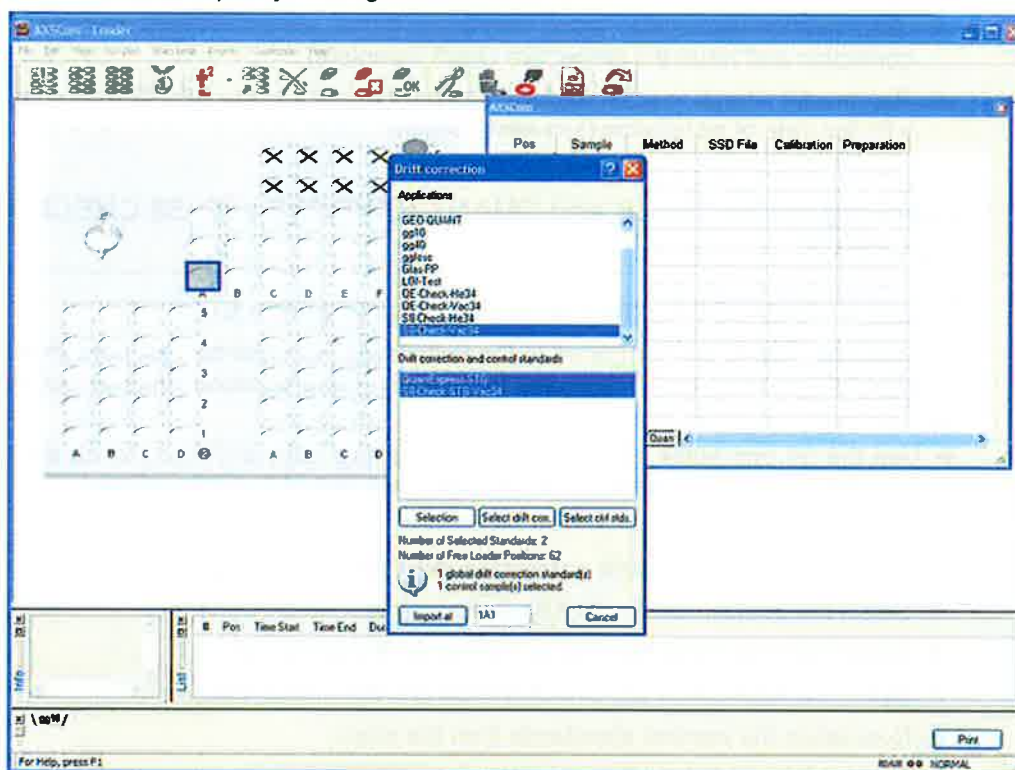


Figure 8.12: Loader | Drift correction | S8 CHECK and QE CHECK

6. Print the results and compare with the values from the acceptance test, or in lieu of this with results obtained at a day close to the installation of the software. If the values are within the prescribed limits no further actions are necessary, otherwise it is necessary to run the drift correction/recalibration.

8.4.6 Recalibration - Drift Correction

The intensity drift that occurs in the lifetime of any spectrometer is compensated by so-called recalibration measurements. These measurements compensate the drift by calculating a time depending loss coefficient by the help of intensity measurements. The recalibration samples (=reference samples) do not have to be standards of the respective calibration! A typical recalibration sample is long term stable (i.e. no polymers or pressed pellets) and the intensities are roughly in the same magnitude than the intensities of the calibration standards.

In general there are two kinds of recalibration measurements. On one hand there is the system of the „global“ recalibration prepared by Bruker AXS for the standardless program delivered with the system. On the other hand there is the recalibration, drift correction of the specific user methods.

8.5 Consumables

Table 8.3: List of consumables

Order number	Name of the item
C79298A3228C10	Helium gas grade 4.6 (50 l, 200 bar)
M34055A1851	Flow counter gas P10
K280C6	Disposable Resin for ion exchanger, 2.7 litre bag to refill K280C5
C71428A4D14	Detector foils, 0.6 µm, with support frame
C70144A952B40	Flow counter tube wires
7KP19018CF	Ultragrade19 vacuum pump oil, 4 litre can
K120C1	Waste air filter inserts for Edwards vacuum pump
	Deionized water

8.6 Maintenance Parts Package S8 TIGER

Table 8.4: Package A15D103/A15D113 content

Order number	Name of the item	A15D103	A15D113	
		S8 1KW	S8 3KW	S8 4KW
C79298-A3246-B99	Grid with foil	x	x	x
C79298-A3204-C10	Vacuum Seal-O-ring	x	x	x
C71121-Z100-A8	Vacuum Seal-O-ring	x	x	x
C79298-A3204-C17	Sealing-Sample Input	x	x	x
C79298-A3204-C16	Sealing-Sample Chamber	x	x	x
C71121-Z100-A307	O-Ring Tube input	x	x	x
C79121-Z101-A23	Lip Seal (S3K)		x	x
C79121-Z101-A21	Slot Ring	x	x	x
K280C6	Resin/Ion Exchanger	x	x	x
K140-C19	Turbine flow meter	x	x	x
A12D2	Pump for internal cooling unit	x	x	x
C79298-A3202-C18	Water Hose		x	x
C79298-A3202-C24	Hose NW 1/2IN	x	x	x
K290C32	oil for vacuum pump (1 liter)	x	x	x
K110C174	Antikink Flute	x	x	x
C171428A4D14	2 pieces Foils for FC 0,6 Micron	x	x	x
A15D250	Grease worm gear	x	x	x
C79298-A3204-C41	O-Ring for 1kW S8	x		
C79298-A3248-C45	Filter X-Ray Generator	x		

8.6.1 Time Intervals for Preventive Maintenance

The time intervals for the checks and maintenance depend on the instrument use; they must be adapted to the external conditions (e.g. type of samples, environmental influences) and the operating mode of the instrument.

Bruker AXS recommends an interval of 12 month for normal use and an interval of 6 month for use in dusty environment or in case of an operation of 24 h per day per 7 days a week.

8.7 Service Contracts

There are several service contract levels available to meet your specific needs, covering basic maintenance up to full service support with immediate response.

Please contact your local Bruker AXS representative for the options included in those packages and prices. Availability may be subject to instrument location.

Servicing and Maintaining the Spectrometer System

9 Troubleshooting the System

If you encounter a problem with your spectrometer system there are several ways to deal with it.

- Use the first aid button (on the touchscreen or in S8Tools if using an external PC).
- Call the Bruker AXS Hotline.
- Run a system check and comply with the trouble shooting flowchart at the end of this section.

9.1 Using the First Aid Button on the Touchscreen

The first aid button is used to conveniently recover from common error situations like sample handler errors and counter gas errors.

The first aid procedure can recover from many situations full-automatically, whereas other situations may require little user interaction.

If user interaction is required, the first aid procedure explicitly states what the user is expected to do.

The procedure includes the recovery from detector failures, operating mode (air/helium/vacuum) errors, counter gas failures, X-ray safety system errors, sample handler errors, goniometer errors and other miscellaneous component errors.

While the first aid procedure is active, a window displays the current status of the procedure. A timeout counter in the lower left corner indicates the maximum time the procedure is expected to take.

The first aid function is a component of the **S8Tools**. You can find the first aid button on the **S8Tools** screen of the touchscreen.

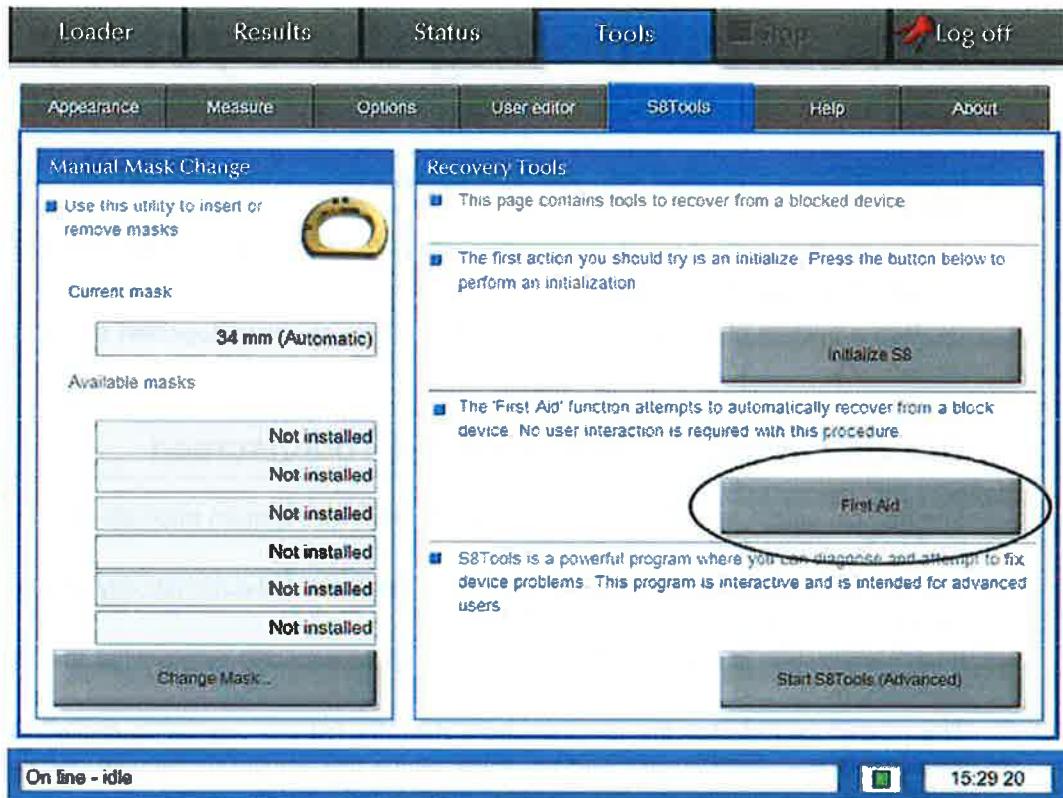


Figure 9.1: S8Tools screen with the first aid button

9.2 Calling the Bruker AXS Hotline

Call the international Bruker AXS Hotline for X-ray Fluorescence:

Table 9.1: XRF Service Hotline

Bruker AXS Hotline for XRF	
Phone	+49 721 50997 5200
Email	service.axs@bruker.com

Share your system information with the connected Bruker AXS personnel in one of the following ways:

- Participating in a WebEx session or
- Using Spectra Mail.



You will find a detailed description of **Remote Support via WebEx** and **Spectra Mail** in the *Supplement Folder DOC-M80-ZXX203* of the instrument.

9.3 Trouble Shooting Flowchart

If the results of the S8 CHECK and the QE CHECK are off the defined limits or specification, please check the following list of possible causes:

- Check the scans using the graphical display in EVAL2 and re-evaluate the sample. (see *SPECTRA^{plus} V3 User Manual*)
- Check the samples, possible causes are:
 - use of wrong sample
 - contaminated sample surface
 - overfilled liquid or powder sample cups
 - wrong sample cup mask.
- Check all necessary supplies, such as counter gas for flow counters, helium gas and cooling water (see chapter *Servicing and Maintaining the Spectrometer System* [p. 107]).

- Run S8 CHECK / QE CHECK and comply with the following troubleshooting flowchart.

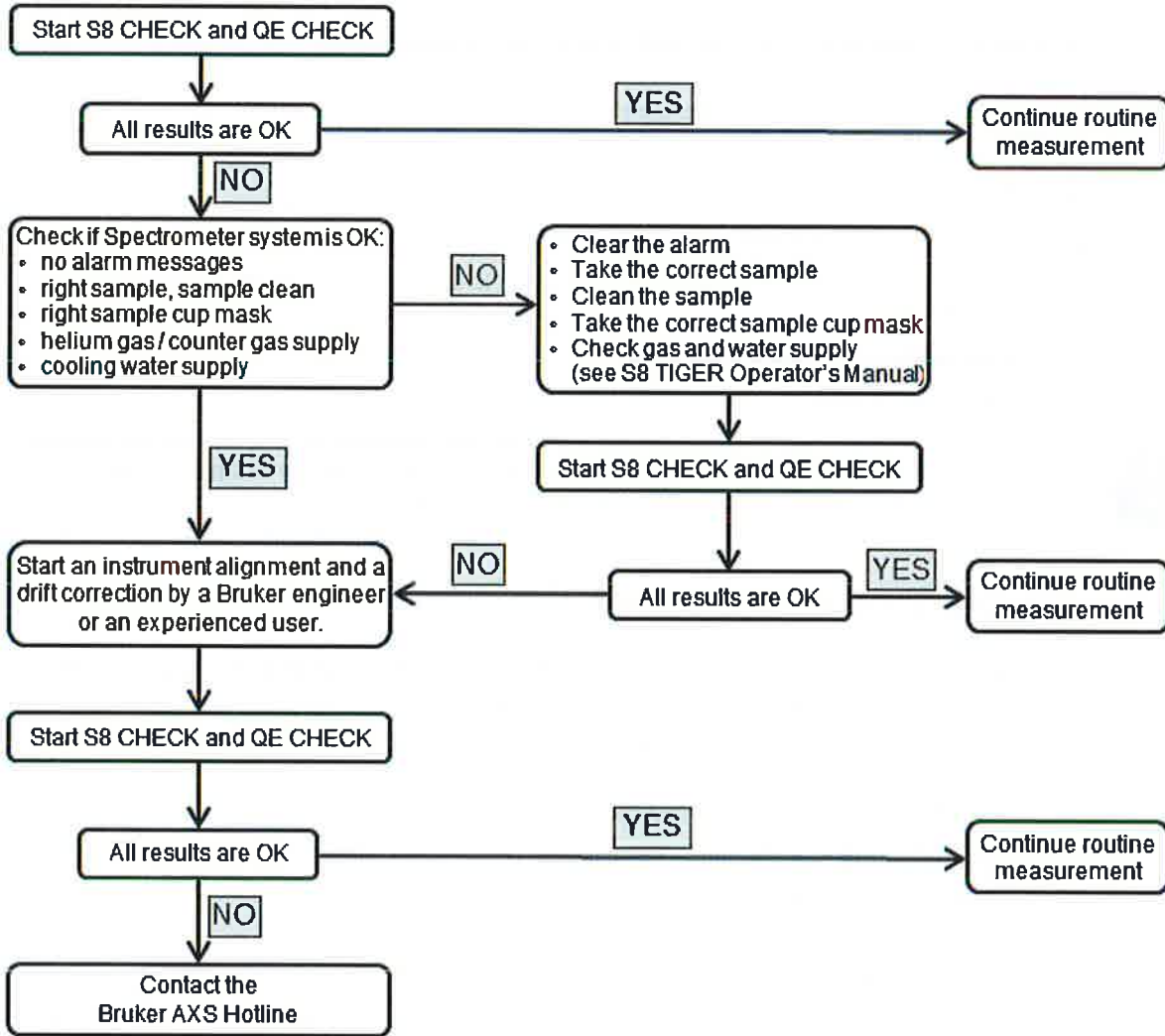


Figure 9.2: Troubleshooting flowchart

10 Overview S8 TIGER Solutions

Table 10.1: S8 TIGER Solutions

Solution	Description	1 kW	3 kW	4kW
CEMENT-QUANT (A1001A19)	Pre-Calibrated solution for the analysis of cement, clinker, raw meal and other related material, prepared as fusion beads. Elements: Na ₂ O, MgO, Al ₂ O ₃ , SiO ₂ , P ₂ O ₅ , SO ₃ , K ₂ O, CaO, TiO ₂ , Cr ₂ O ₃ , Mn ₂ O ₃ , Fe ₂ O ₃ , ZnO, SrO Requirements: XS-Ge-C, XS-CEM	✓	✓	✓
GEO-QUANT Advanced (A1001A16)	Pre-Calibrated solution for the analysis of 22 major and minor elements in geological materials, prepared as fusion beads. Elements: Na ₂ O, MgO, Al ₂ O ₃ , SiO ₂ , P ₂ O ₅ , SO ₃ , K ₂ O, CaO, TiO ₂ , V ₂ O ₅ , Cr ₂ O ₃ , Mn ₂ O ₃ , Fe ₂ O ₃ , NiO, CuO, ZnO, SrO, ZrO ₂ , BaO, HfO ₂ , PbO Requires: XS-Ge-C, LiF220	✓	✓	✓
GEO-QUANT Basic (A1001A15)	Pre-Calibrated solution for the analysis of 14 major and minor elements in geological and raw materials, prepared as fusion beads. Elements: Na ₂ O, MgO, Al ₂ O ₃ , SiO ₂ , P ₂ O ₅ , SO ₃ , K ₂ O, CaO, TiO ₂ , Cr ₂ O ₃ , Mn ₂ O ₃ , Fe ₂ O ₃ , ZnO, SrO	✓	✓	✓
GEO-QUANT Iron Ore (A1001A21)	Pre-Calibrated solution for the analysis of iron ores, according to ISO9516. Elements: MgO, Al ₂ O ₃ , SiO ₂ , P ₂ O ₅ , SO ₃ , K ₂ O, CaO, TiO ₂ , V ₂ O ₅ , Cr ₂ O ₃ , Mn ₃ O ₄ , Fe ₂ O ₃ , Co ₃ O ₄ , NiO, CuO, ZnO, As ₂ O ₃ , SnO ₂ , BaO, PbO Requirements: XS-100, XS-Ge-C, LiF220	✓	✓	✓

Overview S8 TIGER Solutions

Solution	Description	1 kW	3 kW	4kW
GEO-QUANT Traces (A1001A2)	Pre-Calibrated solution for the analysis of trace components in geological materials, prepared as fusion beads. Elements: CaO, TiO ₂ , MnO, Fe ₂ O ₃ , Sc, V, Cr, Co, Ni, Cu, Zn, Ga, As, Rb, Sr, Y, Zr, Nb, Mo, Sn, Sb, Cs, Ba, La, Pb, Ce, Th, U Requirements: LiF220	✓	✓	✓
METAL-QUANT (A1001A10)	Pre-Calibrated solution for the analysis of various metal alloys. Elements: Al, Si, P, S, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Sn, Sb, Ta, W, Pb, Bi Requirements: 100 µm Cu Filter, LiF220, XS-Ge-C	✓	✓	✓
PETRO-QUANT (A1001A1)	Pre-Calibrated solution for the analysis of 30 elements in a range of petrochemical matrices. Elements: Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Br, Zr, Mo, Ag, Cd, Sn, Sb, Ba, Tl, Pb, Bi Requires: XS-Ge-C, Helium Flushing Mode.	✓	✓	✓
POLYMER-QUANT (A1001A5)	Pre-Calibrated solution for the analysis of trace metals found in the base additives of a range of polymeric matrices. Elements: Mg, Al, Si, P, Cl, Ca, Ti, Zr, (S, Zn) Requirements: XS-Ge-C.	✓	✓	✓
QUANT-EXPRESS (A1001A3)	Standardless analysis package for the quantitative analysis of materials, without a dedicated calibration.	✓	✓	✓
RoHS-QUANT-ABS (A1001A4)	Pre-Calibrated solution for the analysis of 5 elements in a range of polymeric matrices. Elements: Cr, Br, Cd, Hg, Pb	✓	✓	✓

Solution	Description	1 kW	3 kW	4kW
	Requirements: 100 µm Cu Filter, LiF220, Helium Flushing Mode.			
SLAG-QUANT (A1001A18)	Pre-Calibrated solution for the analysis of iron and steel making slags, prepared as fusion beads. Elements: Na ₂ O, MgO, Al ₂ O ₃ , SiO ₂ , P ₂ O ₅ , SO ₃ , K ₂ O, CaO, TiO ₂ , V ₂ O ₅ , Cr ₂ O ₃ , Mn ₂ O ₃ , Fe ₂ O ₃ , NiO, CuO, ZnO, PbO Requirements: LiF220, XS-Ge-C	✓	✓	✓

Overview S8 TIGER Solutions

11 Specifications

11.1 Analytical Performance

The S8 TIGER II combines high analytical performance, space saving and cost efficiency. Its outstanding light element analysis capacity is based on innovative multilayer analyzer crystals, appropriate collimators and the optimized close sample/X-ray tube coupling. Besides, the S8 TIGER II is optimized by the thin 75 μm or ultra thin 50 μm X-ray tube window, up to 170 mA excitation and the high transmission thin detector window technology.

Features:

- Analysis range Beryllium to Uranium.
- Concentration range concentrations from sub ppm to 100 %.
- Precision 0.05 % (relative).
- Sample form: powder, solid, liquid, paste, coating, slurry, film, filter deposit, etc.
- Sample size loose powder and liquids: up to 50 ml.

11.2 Instrument Specification

Table 11.1: Instrument specification

Technical Data	
X-ray tube	<p>3 and 4 kW: High performance X-ray tube with low temperature tube head, Rh target up to 4 kW, 20 -60 kV, 5-170 mA, 75 μm Beryllium window or 50 μm Beryllium window with SampleCare protectice coating (optional)</p> <p>3.3 kW: High performance X-ray tube with low temperature tube head, Cr target; up to 3.3 kW, 20-60 kV, 5-150 mA, 75 μm Beryllium window or 50 μm Beryllium window with SampleCare protectice coating (optional)</p> <p>1 kW: Long lifetime tube; 1 kW, 20-50 kV, 5-50 mA</p>

Specifications

Technical Data	
Sample size	Liquids, loose powders: up to 50 ml, solids: up to 51 mm (2") Ø, 4 mm (1.8") height
Samples	Powder, solid, liquid, paste, coating, slurry, film, filter, ...
Analysis range	Beryllium to Uran
Concentration range	Concentration from sub-ppm to 100 %
Precision	Precision up to 0.05 % rel.
TouchControl™	Integrated touchscreen for easy and intuitive operation
SampleCare™	X-ray tube and goniometer protected by contamination shields Automatic sample recognition (optional), Sample and spectrometer chamber separated by programmable vacuum seal (optional), X-ray shield made of Beryllium (optional)
Filter	Pb 1 mm, Cu 300 µm, Cu 200 µm, Al 800 µm, Al 500 µm, Al 200 µm, Al 100 µm, Al 12.5 µm, open
Collimator	Automatic collimator changer (4 positions available) 0.12°, 0.17°, 0.23°, 0.46°, 1°, 2° (optional)
Mapping	Spot size: 300 µm and 1.2 mm (FWHM) Step size: 100 µm Intensity: more than 4.5 kcps for Cu Ka1 at 300 µm spot size (pure copper, peak maximum to background), more than 1.2 kcps for Al Ka1 at 300 µm spot size (pure aluminum, peak maximum to background) Maximum mapped area: 32 mm diameter for 300 µm spot size 34 mm diameter for 1.2 mm spot size Full HD camera with LED light
Masks	Automatic mask changer (3 positions available) Additional low background masks available 34 mm, 28 mm, 23 mm, 18 mm, 8 mm, 5 mm (optional) XRF ² Mapping masks Ø 300 µm and 1.2 mm

Technical Data	
Analyzer crystals	Automatic crystal changer (8 positions available) Included: XS-55, PET, LiF (200) Optional: XS-B, XS-C, XS-N, XS-CEM, XS-GE-C, XS-PET-C, XS-400, LiF (220), LiF (420), ADP, Ge, TIAP, InSb, XS-100
Flow proportional counter	Counter gas supply: 0.5 - 2 l/h Energy range: 0.1 keV – 8 keV (Be - Cu) Multi Channel Analyzer with simultaneous on-the-fly dead time correction Count rate: more than 4 Mcps Linear range: better than 2 Mcps DynaMatch: more than 13 Mcps
Scintillation counter	Nal (Ti) Energy range: > 4 keV (Sc - U) Multi Channel Analyzer with simultaneous on-the-fly dead time correction Count rate: more than 4 Mcps Linear range: better than 2 Mcps DynaMatch: more than 13 Mcps
Detector gas	P10 gas (10 % Methane, 90 % Argon) for flow counter P5 gas optional (5 % Methane, 95 % Argon)
Goniometer	2 theta: 0 -115° FC, 17 – 152° SC Steps: 0.0005° Angular: < ± 0.001° Reproducibility: < ± 0.0001° Theta and 2 theta drives: two independent stepper motors with encapsulated optical encoders and ElectronicGearing Velocity: max. 2400°/ min Scanning: max. 1200°/ min
Vacuum pump	Integrated
Gas for analysis of liquids and loose powders	Helium or Nitrogen, at reduced or normal atmospheric pressure
Compressed air	Not required

Specifications

Technical Data	
Quality & safety	DIN EN ISO 9001:2000 CE certified Fully radiation protected system BfS 09/07 V R6V Radiation < 1 $\mu\text{Sv/h}$ H*(10) Compliant with EU Machinery Directive

Table 11.2: Instrument specification

Technical Data	S8 TIGER 1 kW	S8 TIGER 3 kW	S8 TIGER 4 kW
Dimensions (height x width x depth)	1040 mm x 890 mm x 865 mm; 41" x 35" x 34.1"	1040 mm x 890 mm x 1220 mm; 41" x 35" x 48"	
	Touchscreen: Allow additional depth of 290 mm (11.4") when standing out (alternatively aligned with right side panel)		
Weight	446 kg / 981 lb	476 kg / 1047 lb	
External cooling water	No cooling water	Cooling water Water consumption automatically regulated and minimized, short term interruptions are compensated	
Excitation source (max. values)	50 kV 50 mA	60 kV 150 mA	60 kV 170 mA
Power requirements	208 - 240 V (1P/3P) 50/60 Hz	208 V, 60 Hz (1P/3P) 230 V, 50/60 Hz (3P)	
Generator output stability	< ± 0.000005 at 1% variation		

12 References

Table 12.1: List of Available XRF and S8 TIGER Manuals

Manuals	Order number
Introduction to X-ray Fluorescence Analysis, English (also available in German)	DOC-M84-EXX001
General Safety Instructions, multilingual (English, German, French, Spanish)	DOC-M90-ZXX006
General Safety Instructions CD ROM, multilingual (additional European languages)	DOC-M90-ZXX007
S8 TIGER II Introductory User Manual, multilingual (English, German, French, Spanish)	DOC-M80-ZXX201
S8 TIGER II Operator's Manual, English	DOC-M80-EXX202
S8 TIGER II Supplement Folder	DOC-M80-ZXX033
S8 TIGER II Getting Started - Working with TouchControl, English (also available in German and French)	DOC-M80-EXX205
S8 TIGER Mapping Tool	DOC-M80-EXX200
SPECTRA ^{plus} V3 for S8 TIGER User Manual	DOC-M80-EXX109

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Order No: DOC-M80-EXX202