

User Guide

Tracer Series

Hand-held XRF Analyzers



Includes:

- Tracer III-V⁺
- Tracer III-SD
- Tracer IV-SD





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1 Overview

1.1 Introduction

The Tracer III-SD and Tracer IV-SD use Silicon Drift Detector (SDD) technology for dramatically improved speed and sensitivity. The technology is based on energy dispersive X-Ray fluorescence (EXRF) and uses an X-ray tube as its excitation source. Bruker's proprietary SDD, previously only available in large laboratory analyzers, offers unprecedented resolution and count rates.

The Tracer III- V⁺ may use a bulk Rhenium (Re), Rhodium (Rh) or Silver (Ag) target, depending on configuration required by the purchaser. This instrument contains a high-resolution, Peltier cooled, Silicon PIN (Si-PIN) diode detector.

The Tracer series are fully field portable analyzers with an integrated Personal Digital Assistant (PDA) computer. The removable PDA provides the user interface for operating the instrument and contains the BrukerS1 analytical program. This program enables the user to select analytical modes, view spectra, and save data. The display is a 320×240 pixel color touch screen (TFT) that can be operated with either a fingertip or the stylus provided.

The instrument is factory calibrated, based on a customer ordered configuration. Originally designed as a hand-held device, the Tracer series makes no compromises in the lab. When placed in the vertical stand, it becomes a powerful bench-top analysis tool. Couple this configuration with a PC or notebook computer and the Tracer series instrument becomes a truly versatile mobile laboratory.

The advent of SDD technology has reduced – and in most cases eliminated – the need for vacuum or helium flushing during light element analysis. With count-rates in excess of 100,000 cps, the Tracer SD can generate the statistics necessary for detecting trace concentrations of the lightest elements, including magnesium. The optional vacuum pump removes the air in the gap between the sample and the detector, further improving detection limits.

2 Radiation Safety Requirements

2.1 What is Radiation?

A basic understanding of radiation characteristics is necessary to prevent inadvertent and unnecessary radiation exposure to Tracer users and persons nearby. The concepts illustrated in this section of the manual have been simplified to give an essential picture of what radiation is and how it applies to operators of the Tracer XRF Analyzer.

The term *radiation* is used with all forms of energy (e.g., light, X-rays, radar, microwaves), which can be expressed as particles or waves. However, high levels of ionizing radiation, which has the potential to damage and/or alter the chemical structure of cells, may pose a danger to living tissue, resulting in various levels of illness, from mild to severe. This section identifies the exposure levels associated with this equipment.

2.2 Terminology

ALARA – “As low as reasonably achievable” refers to the practice of limiting the operator’s exposure to radiation using the factors of time, distance, and shielding.

Backscatter - The Tracer generates spectral data by analyzing the specific secondary X-ray energies that travel from the sample under test to the detector. This is referred to as backscatter. Although the Tracer is specifically designed to limit excess backscatter, there is always the possibility that a small amount of X-ray radiation may scatter beyond the detector in the direction of the operator. To ensure safe operation of the system, it is vital that the operator understands the radiation field. The radiation profiles provided in the next section illustrate the radiation field intensity for the Tracer series.



WARNING: Operators should carefully study radiation profiles prior to using the Tracer series.

Count-rate – When a material is analyzed, it is bombarded with X-ray radiation. As a result, characteristic X-rays are emitted from the material and counted by the detector. Count-rate is the rate at which these characteristic X-rays are detected, counted, and ultimately quantified.

Ionizing Radiation – Not all radiation is inherently dangerous (e.g., the heat and light from an incandescent bulb). However, the ionizing radiation emitted from “radioactive” materials or generated from X-ray tubes, which ionizes matter as it passes through it, may pose a danger to living tissue by altering the chemical structure of cells, causing damage that can result in various levels of illness, from mild to severe. For the purpose of this manual, radiation refers to invisible waves or particles of ionizing energy emitted from X-ray tubes.

Radiation Scatter - Radiation scatter is produced whenever an absorbing material is directly irradiated from a nearby source. The atoms within the material become temporarily excited, producing X-rays before becoming stable again. This process, called X-ray fluorescence (XRF), is the principle of operation of the Tracer.

X-Ray – X-rays are high-energy photons that can ionize matter by knocking electrons out of orbit around the nuclei of atoms. When this occurs, the matter through which the original X-rays passed produces additional X-rays.

These newly created X-rays are detected and quantified by the Tracer series instrument, forming the basis of X-ray Fluorescence.

2.3 Radiation from the Tracer Series Instrument

X-rays are emitted at a 53° incident angle from the examination window to the users' left (as viewed from the users' perspective), shown in Figure 1. From this position, the concentration of X-rays is at its highest level.

Although the X-ray beam exits the aperture at an angle, it is not a focused beam. Everything forward the nose will be radiated to some level. DO NOT point the analyzer at people during measurement when the red X-ray lamp is on. DO NOT expose any part of the body to the beam.



Figure 1 Emission of X-rays from the aperture



WARNING: High intensity X-rays! Do not expose any part of body to the beam!

2.4 Radiation Profile

The radiation profile of the Tracer SD shown in Figure 2 reflects the conditions during normal operation for instruments in the Tracer Series. These readings show the radiation background around the instrument in all directions. These values were obtained using a Bicorn® Low Energy Micro Rem ion chamber and indicate that the dose rate at 10 cm from any accessible surface was lower than 5.0 µSv/hr (less than 500 µrem/hr).

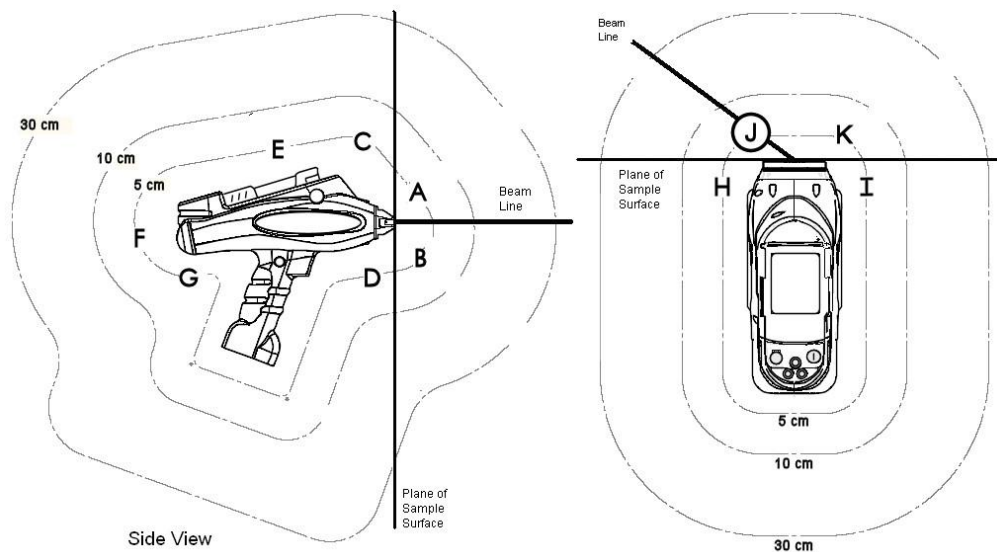


Figure 2 Radiation Profile of the Tracer SD

Table 1*

Reading		Reading	
A	bkgnd	G	bkgnd
B	bkgnd	H	bkgnd
C	bkgnd	I	bkgnd
D	bkgnd	J	bkgnd
E	bkgnd	K	bkgnd
F	bkgnd	L	bkgnd

40kV @ 20μA with Duplex 2205 Sample

Table 2*

Reading		Reading	
A	25 μrem/hr	G	bkgnd
B	bkgnd	H	bkgnd
C	bkgnd	I	bkgnd
D	bkgnd	J	bkgnd
E	bkgnd	K	10 μrem/hr
F	bkgnd	L	bkgnd

15kV @ 60μA with Al2024 Sample

**Dose rates for the Tracer SD normal operation configuration. All other locations on side, top, bottom and back of the analyzer are background (bkgnd). Readings taken with a Bicron Model RSO-50E low energy ion chamber survey instrument. Reference distances were measured from the effective center of the detector to the surface of the analyzer. The indicated readings were the maximum noted for the distances and locations. Each reading was taken over a one-minute period with the analyzer operating at its respective settings.*

Table 1 shows the results at 40 kV and 20 μA (the maximum voltage at the highest current available at that voltage) with the titanium/aluminum filter in place. Table 2 shows the results at 15 kV and 60 μA without a filter.



NOTE: The L-line of the silver target in the X-ray tube produces X-rays of ~3keV. This accounts for the higher emission in the open beam without the Ti/Al filter in place. Dose rates will vary based on current, energy, sample, target, collimator, and windows.

2.5 Safety Design

The Tracer series XRF analyzers employ a miniature X-ray tube, instead of radioactive material, to generate the X-rays. The general construction and the safety features described in this manual are the same for all models within the series.

2.5.1 Agency Approvals

The Tracer series instrument was designed to conform to ANSI N43.3 safety requirements for cabinet (i.e., closed beam) X-rays systems, with the exception of providing a totally enclosed beam. To prevent the operator from direct exposure to the open X-ray beam, extensive safety circuit requirements, including switches and fail-safe lamps, have been incorporated.

The Tracer series analyzers were tested by TÜV SÜD against safety requirements of IEC 61010-1, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory user, Part I General Requirements." The Tracer SD passed the ionizing radiation leakage requirements (IEC 61010-1, Section 12.2.1) of < 1 μSv/hr (< 0.1 mrem/hr) at 100 mm. Having passed all of the safety requirements, the device was awarded the cTUVus license, CB Global Scheme, and the general CE marks. The license requires periodic production audits by TÜV SÜD. See the Tracer series instrument Safety Features section (below) for

discussion of the high level of protection offered the operator by use of warning lamps, fail-safe features, and product labeling.

The Tracer series instrument employs a miniature X-ray tube operated with an acceleration voltage range of 10 to 40 kilovolts (kV) and an anode current range of 0.05 to 60 micro amps (μA), (the maximum high-voltage available at 60 μA is 15 kV). In some cases, allowable ranges for X-ray tube voltage and current may vary to comply with local regulations. The tube target is either rhodium (Rh) or silver (Ag), depending on instrument model.

The X-ray tube and high-voltage (HV) power supply are sealed in a fluid-filled assembly. The X-ray tube is shielded by a variety of materials in order to minimize any stray X-ray radiation. The assembly is mounted in the XRF housing. The XRF housing is closed using tamper-proof fasteners.

2.5.2 Safety Features

The Tracer series instrument is designed with an elaborate fail-safe safety system that prevents inadvertent operation of the analyzer. The primary safety system consists of a keyed or push-button switch, two operationally dependent LED indicator lamps, a manual push-button trigger, a minimum backscatter detection monitor, and an infrared proximity sensor to verify the presence of a test sample. The function of each of the Tracer series instrument safety features is described below:

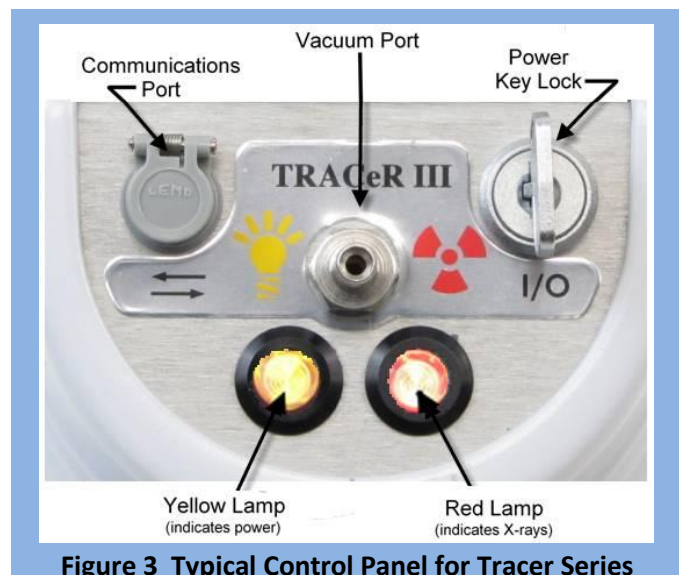


Figure 3 Typical Control Panel for Tracer Series

Primary Power Switch

A keyed main-power switch (Figure 3) controls power to all components. The key must be turned before any other actions can be initiated. For security, the key should be removed when the unit is not in use.


Yellow Power Indicator Lamp

When the switch is activated, the yellow lamp (Figure 3) illuminates, indicating that the instrument is powered. The lamp incorporates redundant LED elements for increased reliability. The redundant LED segments safeguard that if either of the LED elements fails, generation of X-rays is disabled. If the instrument microprocessors detect a malfunction in the instrument, the yellow lamp flashes to alert the user.

Password Protection

Once the BrukerS1 program is initialized, the user is prompted to enter a password. The analyzer will neither operate nor generate X-rays without the password being entered.

Software X-ray Radiation Warning

When starting the PDA software, a splash screen displaying a black and yellow X-ray radiation warning symbol () and a text warning are displayed. No user input is accepted during the 15 seconds that the warning is displayed.

Infrared (IR) Proximity Sensor

The IR proximity sensor is used to confirm that an object is within physical range of the examination window. The sensor is located in the instrument nosepiece near the examination window opening. If the nosepiece is separated from the sample by a distance greater than 38 mm (~1.5 inches), the IR proximity sensor will discontinue X-ray generation. Because reflectivity of sample surfaces vary, the exact distance is dependent on the sample material being tested and may vary dramatically.

Removable Filter Interlock (optional on Tracer III-SD and Tracer III-V+)

If the brass filter cap is removed or improperly installed, X-rays cannot be produced. Although optional, this may be required depending on local regulations

Operator Trigger Interlock

If the device's safety circuit has been satisfied, X-rays are generated when the trigger-style switch is pulled. The switch is spring-loaded and must be continuously squeezed during measurements. If the switch is inadvertently released, the spring mechanism will return the switch to its idle position and stop X-ray generation.

Minimum Backscatter Detection

The count-rate is continuously monitored during each measurement. If the count-rate drops below the allowable threshold (as it would be in the absence of a sample), the safety circuit will shut down the high-voltage supply and filament generator, further minimizing potential exposure.

Red X-ray Indicator Lamp

When the trigger is pulled and the infrared sensor is engaged, the red lamp (Figure 3) will illuminate, indicating the generation of X-rays. The lamp incorporates redundant LED elements for increased reliability. If either of the red LED elements fails, X-rays cannot be generated.

X-ray Enunciator (optional)

When the trigger is activated, an audible alarm will alert the operator and those nearby to the *potential* for exposure.

Operator Time-Out

If the analyzer remains idle for a period greater than 10 minutes, the program will require the operator to log back in. Upon login, the previous session will be restored.

2.5.3 Safety Warning Labels

The Tracer series instrument has safety-warning labels to alert the user and/or identify the functions of the controls. These labels are illustrated in Figure 4. Additionally, the radiation trefoil is located on the label

adjacent to the power switch. Both the vacuum window label and the clip-on window protector are embossed with warning signs.

A manufacturers' plate is mounted under the analyzer housing near the handle. The contents of this label may vary with local regulatory requirements.

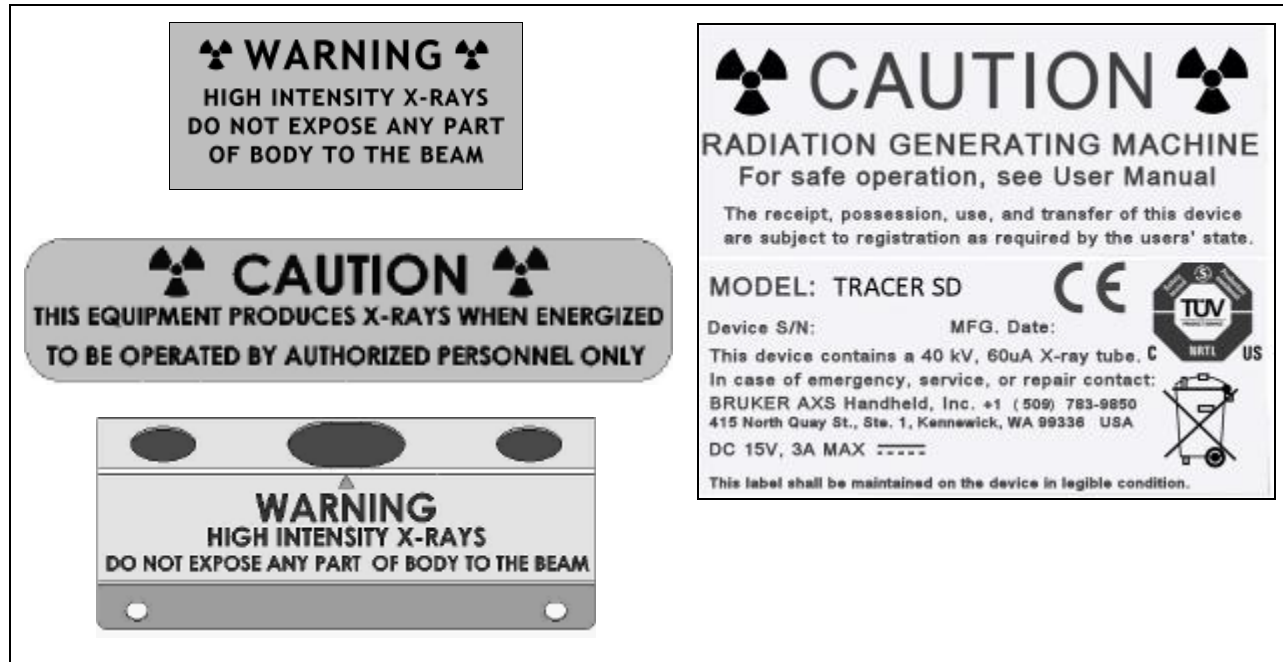


Figure 4 Assorted Warning Labels found on the Tracer series instrument

2.6 Using the Tracer Series Instrument Safely

When the Tracer series instrument is used properly, X-ray radiation from instrument poses no potential for harm to the user or others. A properly trained user will use the Tracer series instrument in a manner that eliminates or minimizes the risk of unnecessary exposure to X-ray radiation.

Safe use of any XRF device is based on the principles of:

Time – managing the amount of time during which X-rays are being produced by the instrument

Distance – keeping all parts of the user's body as far away from the X-ray producing nose as possible, pointing the analyzer away from others, and keeping others away from the instrument during use.

Shielding – ensuring that the Tracer series instrument is mechanically intact and sound, and using the shielded sample cup accessory when measuring physically small or unknown samples that might allow unnecessary X-ray radiation to escape.

Collectively, these practices are known by the phrase "As Low as Reasonably Achievable" (ALARA). Safe practice is further discussed during user training.

2.6.1 Radiation Safety Tips

Operators should follow minimum safety requirements discussed below. When handled properly, the amount of radiation exposure received from the analyzer will be negligible.

- Do not allow anyone other than trained and certified personnel to operate the analyzer.
- Be aware of the direction that the X-rays travel when the red lamp is on and avoid placing any part of your body (especially the eyes or hands) near the examination area during measurement (refer to Figure 6 and Figure 7).

When using the bench-top configuration, obtain a sample large enough to cover both the analyzer window and the IR sensor. The operator should never defeat the IR sensor in order to bypass this part of the safety circuit. Defeating this safety feature could result in unnecessary exposure of the operator. If a sample is not sufficient to cover both the examination window and the IR sensor, then the optional safety shield accessory should be used for testing that sample.



Figure 5 DO NOT use hands to hold sample!



WARNING: No one but the operator(s) should be allowed to be closer than 3 feet (1 meter) from the analyzer during measurement, particularly the beam port. Ignoring this warning could result in unnecessary exposure.



Figure 6 Safe use of the Tracer series instrument



Figure 7 Keep Clear of Examination Area

2.6.2 Low Density Samples

Low-density (LD) materials, such as plastic, wood, soil, paper, or ceramic, will not attenuate higher energy X-rays as efficiently as high-density materials, such as metal alloys. This creates a greater amount of scattered radiation, which can cause a higher dose rate if the operator continuously measures LD materials

for an extended period. If LD samples are measured frequently, the use of a bench-top stand is recommended to minimize scattered radiation. If the LD samples are small enough, the Small Sample Safety Shield is adequate.



WARNING: Never hold a sample to the window for analysis by hand, (Figure 5). Hold the window to the sample. The infrared (IR) sensor located on the nose is designed to prevent the emission of X-rays in the absence of an object.



WARNING: Pregnant women who use the Tracer series instrument should be aware that improper handling or improper use of the instrument could result in radiation exposure.



IMPORTANT: Wear an appropriate dosimeter if required by a regulatory agency when operating the analyzer.

IMPORTANT: The operator is responsible for the security of the analyzer. When in use, the device should be in the operator's possession at all times (i.e. either in direct sight or a secure area). The key (if equipped) should not be left in an unattended analyzer. Always store the instrument in a secure location when not in use; also store the key in a location separate from the analyzer to avoid unauthorized use.

IMPORTANT: During transport to and from the field, store the instrument in a cool, dry location (i.e. in the trunk of a car rather than in the back seat).

2.7 Positioning

Always place the analyzer on the sample, or when testing small parts, place the Tracer series instrument in the stand and place the sample onto the nose of the analyzer. When testing very small samples, use the Small Sample Safety Shield and keep a safe distance from the nosepiece of the analyzer while X-rays are being generated.

2.7.1 Thin or Light Element Samples

A less obvious risk of excess radiation exposure occurs when testing thin samples. Part of the radiation coming from the X-ray tube is sufficiently high in energy to penetrate thin samples, especially if the sample is composed of "lighter" (low atomic number) elements. Table 3 illustrates relative intensities after the radiation has passed through aluminum and iron sheets of various thicknesses (the tube is operated at 40 kV and is filtered by a 1.27 mm thick aluminum sheet inside the instrument). When testing thin samples, use of the radiation safety shield is recommended.

An aluminum sample must be quite thick

Table 3 Material thickness vs. Transmission of Energy

Aluminum Sheet		Iron Sheet	
Thickness (mm)	Intensity	Thickness (mm)	Intensity
0	100%	0.0	100%
1	46%	0.1	23%
2	26%	0.2	9%
3	16%	0.3	4%
4	11%	0.4	2.1%
5	7.5%	0.5	1.1%
10	1.5%	1.0	0.08%



before it absorbs a substantial amount of the radiation, while iron provides much better absorption. This difference in transmission demonstrates why measuring samples while holding them in your hand is an unsafe practice.

2.8 In Case of Emergency

If an analyzer is lost or stolen, notify the local law enforcement and regulatory authority as soon as possible. In the event of an accident with, or damage to the analyzer, immediately turn off the device and remove its battery pack.

2.8.1 Minor Damage

If any hardware item appears to be damaged, even if the analyzer remains operable, immediately contact Bruker Elemental at (800) 466-5323 or (509) 783-9850 for assistance. Use of a damaged analyzer may lead to unnecessary radiation exposure and/or inaccurate measurements.

2.8.2 Major Damage

If the analyzer is severely damaged, immediately stop using instrument, contact Bruker Elemental at (800) 466-5323 or (509) 783-9850, and notify the appropriate regulatory agency in your state or country. Ensure that personnel near the device are not exposed to unshielded X-rays that may be generated (i.e., if the safety logic circuit has been damaged and is not functional). Immediate removal of the battery pack will stop all X-ray production.

2.8.3 Loss or Theft

Should an analyzer be lost or stolen, immediately notify the appropriate regulatory agency in the state or country in which the device was located. Additionally, immediately notify local law enforcement authorities and Bruker Elemental at (800) 466-5323 or (509) 783-9850.

Take the following precautions to minimize the chance of loss or theft:

- Never leave the analyzer unattended when in use.
- When not in use, always keep the device in its shipping container and store it in a secure area, such as a locked vehicle or cabinet.
- When not in use, keep the key separate from the analyzer.
- Maintain records to keep track of all instruments owned, the operators assigned to use them, and the locations they were used.
- Never share the BrukerS1 program password with those not authorized to operate the analyzer.

2.9 License/Registration Requirements

The owner/operator of a Tracer series instrument may be subject to license and/or registration with the appropriate local agency. The owner/operator should:

- Contact the appropriate regulatory agency where the analyzer is to be used regarding specific requirements. In the U.S., this agency is generally the State Health Department.



- Never remove labels from the analyzer.
- Comply with all instructions and labels provided with the device.
- Store the analyzer in a safe place where it is unlikely to be stolen or removed accidentally.
- Maintain records of the storage, removal, and transport of the analyzer. Know its whereabouts at all times.
- Monitor operators' compliance with safe use practices. Use dosimetry where required.
- Report to the local regulatory agency any damage to the shielding and any loss or theft of the analyzer.
- Only sell or transfer the analyzer to persons registered to receive it.
- Notify your regulatory agency upon the transfer or disposal of the X-ray unit.

2.10 Transportation Requirements

An owner/operator of a Tracer series instrument may only transfer custody of the analyzer to authorized (licensed/registered) individuals. However, the user must notify the regulatory agency of the destination State or Province at least one week [typical] in advance of intent to transport and use the instrument in that locale. When transferring control or ownership of the analyzer, the owner must verify that the recipient is authorized to receive the analyzer. No verification is required when returning it to Bruker Elemental, the original manufacturer.

Check with your local regulatory agency prior to transporting or shipping an analyzer. For travel or shipment within the U.S., there are no special Department of Transportation (DOT) interstate travel and shipping regulations. All batteries meet the requirements of 49CFR § 173.185 for shipping as "normal cargo." The analyzer may be shipped using any available means. If the user is flying, it is recommended that the device be checked through due to possible concerns about the X-ray unit in the main cabin.

The owner is responsible for ensuring that all requirements of the local jurisdiction are followed. In the event that the analyzer is lost or stolen, and to prevent inadvertent exposure of a member of the public, the key (if equipped) should be maintained and shipped separately.

3 Principal Components

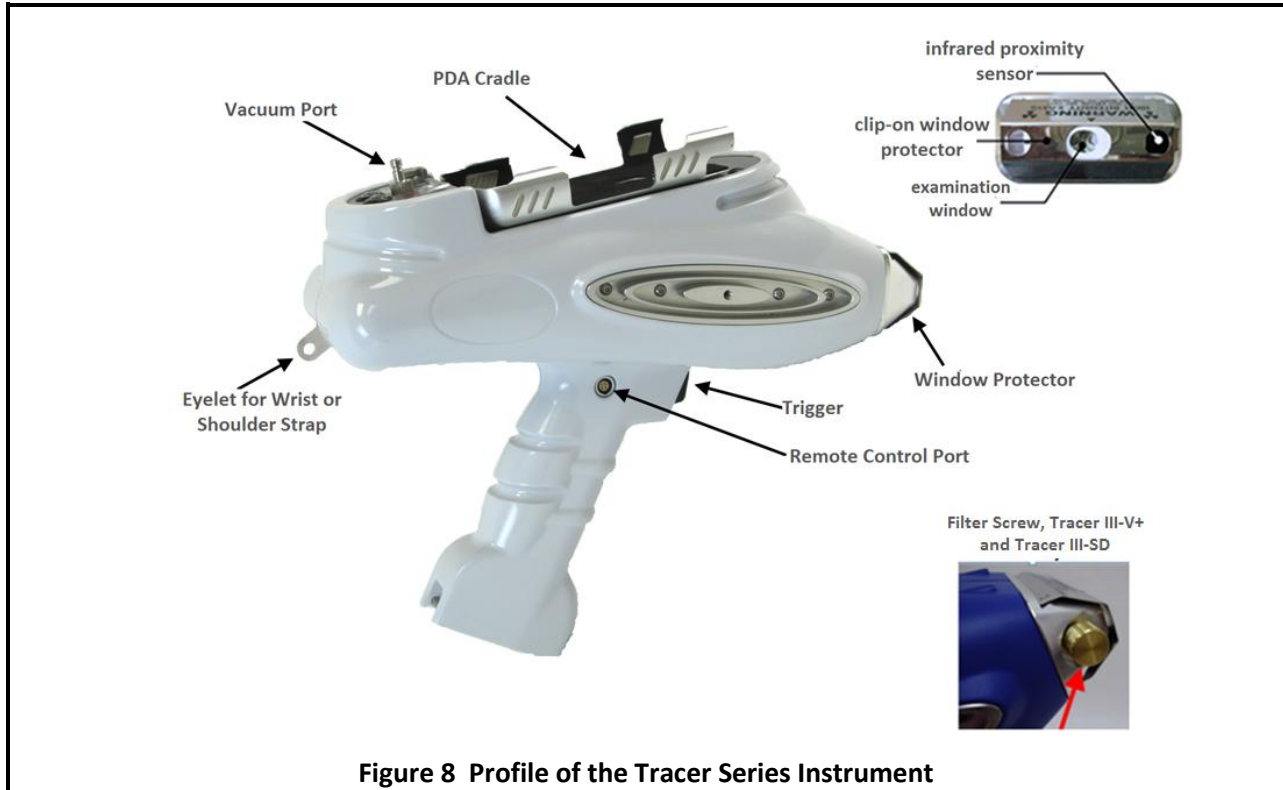


Figure 8 Profile of the Tracer Series Instrument

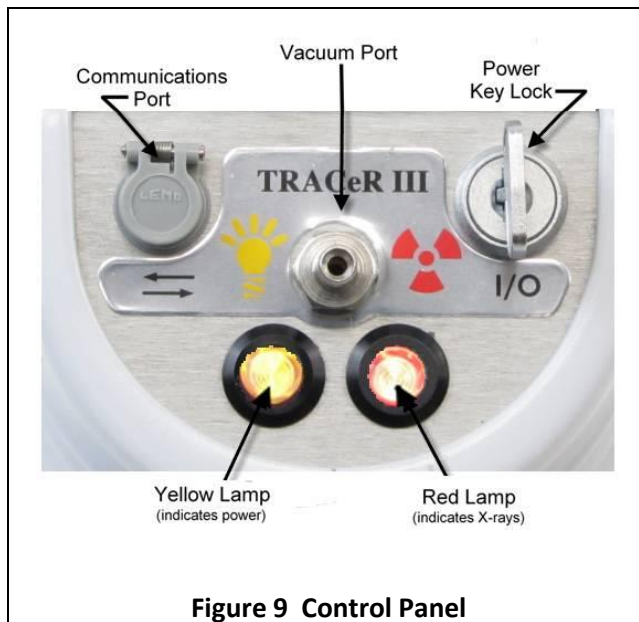


Figure 9 Control Panel

PDA



Figure 10 iPAQ PDA

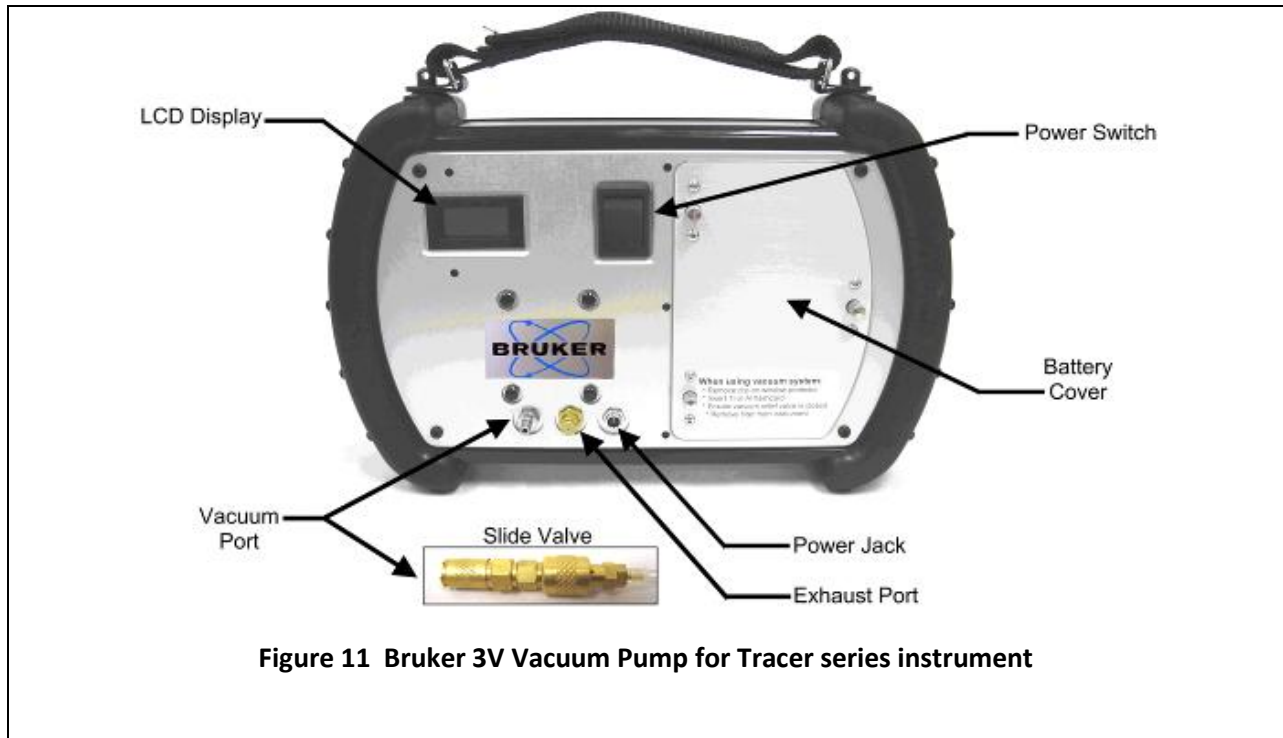


Figure 11 Bruker 3V Vacuum Pump for Tracer series instrument

4 Setup

4.1 Power Sources

Each analyzer may be operated using either battery or the optional AC adapter. The batteries for the Tracer series instrument should arrive fully charged. However, it will be necessary to fully charge the PDA battery prior to using the analyzer for the first time. In addition, Bruker recommends that the PDA be fully charged at the beginning of a workday to maximize battery duty cycle.

4.1.1 Analyzer

Analyzer Charging the Main Batteries

To charge the battery pack, connect the Li-ion battery charger to a 90-240V AC wall outlet with the supplied AC cord. Connect the battery to the battery charger. A fully depleted battery takes approximately 4 hours to charge. Refer to the instructional flyer included with the battery charger for complete directions.

A new, fully charged battery will power the analyzer for 4 to 8 hours, depending on usage.

Main Battery Removal/Installation

Each analyzer is supplied with two Li-ion battery packs. Turn the analyzer off prior to removing the battery pack.

To remove a battery pack, push the lever on the hilt of the handle and pull downward (Figure 12). Insert a charged battery into the handle until it snaps into place. Do not force the battery into the handle. Refer to the instructional flyer included in the charger packaging for detailed instructions.

External Power

To operate the analyzer using the optional AC adapter, ensure that the analyzer is off and the battery is removed. Connect the AC Adapter to a 90-240V AC wall outlet with the supplied cord. Connect the AC adapter to the analyzer as shown in Figure 12.

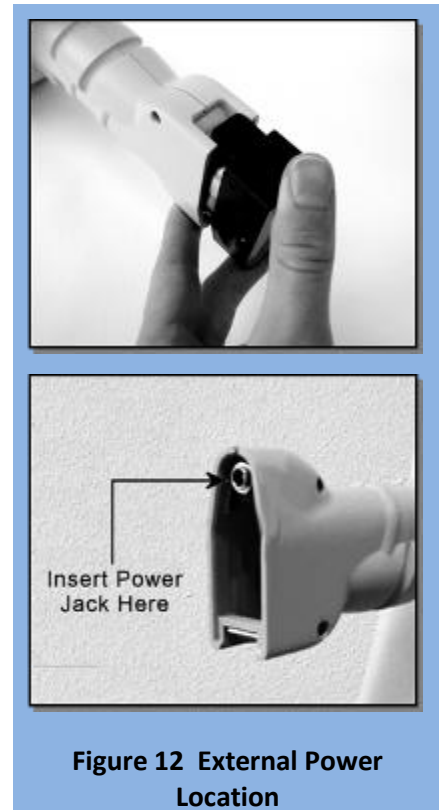


Figure 12 External Power Location

4.1.2 PDA

Battery Power

During normal operation, the PDA will continually draw power from the main battery. A fully charged PDA will only draw a small maintenance charge, while a depleted PDA will consume significantly more power due to inefficiencies in charging the device. Using a partially charged or depleted PDA will significantly reduce the runtime of the analyzer. Bruker recommends beginning each workday with a fully charged PDA.

Power Saving Features

The PDA is configured to shut itself off after 5 minutes of inactivity. This feature reduces the risk of unintentional depletion of the PDA battery. If the PDA is ever removed and used for purposes other than those recommended in this manual, it is possible that the PDA battery will need to be recharged externally to the analyzer.

In addition, if the PDA is ever hard reset, or the PDA battery completely depleted, this power saving feature will need to be re-established by the user. See Troubleshooting – My PDA Battery is Dead (page 51). See also PDA documentation regarding power management of the PDA.

Charging the Battery

To charge the PDA battery externally, ensure that the PDA and analyzer are powered off. Remove the PDA from the analyzer and connect it to the PDA AC adapter using the cords provided.

The orange LED on the PDA will blink to indicate that the battery is charging. The PDA may be externally charged by three different methods:

External Power - Connect the output of the wall-mounted iPAQ AC adapter to the connector adapter, and then to the bottom of the PDA (Figure 13).

Sync Cradle (optional) and External Power – Insert the PDA into the Sync Cradle. Connect the output of the iPAQ, wall-mount power supply to the back of the cradle (Figure 14).

USB Charging – Insert the PDA into the Sync Cradle. Refer to the iPAQ user manual for details. USB Charging is disabled by default and not recommended. When the battery is fully charged, the LED will remain on.



Figure 13 Charging with External Power Supply



Figure 14 Charging on the Cradle



NOTE: For more information on the PDA, please refer to the iPAQ user manual.

4.1.3 Vacuum Pump

The vacuum pump included with the Tracer series instrument is fully portable and may be operated from a battery or an AC adapter.

Battery Installation and Removal

The vacuum pump uses nickel metal hydride (NiMH) batteries. Ensure that the vacuum pump is off and the external power supply has been disconnected prior to removing the batteries. Rotate the three-battery compartment thumbscrews one-quarter turn counter-clockwise to remove the battery cover (Figure 15). Disconnect at the white plastic connector and remove the battery from the compartment.

To reinstall the battery, reattach the white connector labeled “output” to the vacuum pump and place the battery back into the compartment. Replace the battery cover and turn the three thumbscrews clockwise to lock it in place. A fully charged battery will operate the vacuum pump for 2 to 4 hours.



Figure 15 Battery Removal



Figure 16 Charging Pump Battery

Charging the Batteries

Disconnect and remove the battery from the vacuum pump. Move the charge rate switch on the charger to 1.8A. Connect the charger to a 90-240 AC outlet with the supplied power cord. Connect the charging leads on the battery pack to the charger (Figure 16). The orange LED on the charger indicates that the battery is charging, and the green LED indicates that the charge is complete. The vacuum pump batteries require 4 to 6 hours to recharge completely.

External Power

To operate the vacuum pump with the AC adapter, ensure that the analyzer is off and remove the batteries. Connect the power supply to a 90-240V AC wall outlet with the supplied cord. Plug the DC output of the supply into the power jack on the face of the vacuum pump. Although the battery may be connected while the pump is operating from the external power supply, the batteries will not charge under these conditions.

4.1.4 Notes on Batteries

The analyzer and its accessories use multiple types of batteries in varying sizes, shapes, and chemistries. Each battery type has been chosen for its functional characteristics.

Battery Chemistry

Both the analyzer and the PDA use Lithium Ion (Li-ion) batteries. This chemistry offers better performance, longer life, and lighter weight than traditional Nickel-Cadmium (NiCd) batteries

Proper Care

To prolong the life of the batteries:

- Ensure that the ambient temperature during charging is between 40 °F to 115 °F (+5 °C and +45 °C).
- If the battery packs are to be stored for a prolonged period, the batteries should NOT be fully charged before storage. Rather, keep the battery charged to about 30% to 50% and store at room temperature. If the battery is not used for extended periods, recharge about once per year to prevent over discharge. This applies to both Lithium and NiMH batteries.

General Battery Warnings

- Do not disassemble, crush, or puncture a battery.
- Do not place a battery in fire or water.
- Do not charge a battery except with the supplied charger.
- Do not short the battery terminals.
- Do not put batteries in the trash.



Disposal

Should any of the provided batteries reach their end-of-life, contact local waste management regarding disposal and recycling programs. Bruker Elemental will always accept used batteries from its products. A nominal shipping charge applies. If a battery fails to operate normally within the normal warranty period, return it to Bruker Elemental for evaluation and disposal.

4.2 Physical Configurations

The analyzer may be configured as a hand-held device or as a stationary, bench-top instrument, depending on the testing requirements. With analytical capabilities rivaling that of some laboratory instrumentation, the Tracer series instrument is an *all-in-one* tool, offering the performance of a bench-top XRF spectrometer along with the portability and versatility of a handheld

4.2.1 Hand-held

Hand-held operation is most suitable for field-testing, allowing the operator to remain mobile on the job-site for maximum efficiency. Having features common to many consumer portables – such as a pistol grip and trigger-style switch, full color display, and battery operation – the Tracer series instrument is a fully portable, hand-held XRF solution. Follow these guidelines for safe, effective hand-held operation:

Know your surroundings – Prior to taking a measurement, check the immediate work area for other persons. Do not begin a measurement with anyone in front of the analyzer or in the beam path. Keep all parts of the body away from the nose of the analyzer.

Use the wrist strap – Always wear the included wrist strap when using the analyzer as a hand-held device.

Avoid the Elements – Although *resistant* to moisture and dust, the device is not waterproof. Contact Bruker Elemental for specific weather requirements. The operating temperature ranges from 14 °F to 122 °F (-10 °C to +50 °C), and 25% to 95% humidity.

4.2.2 **Desktop Stand**

For applications requiring a more static workspace, the analyzer may be conveniently configured to operate as a desktop analyzer. This enables the operator to bring small and/or odd shaped samples to the instrument for analysis. In addition, the ability to operate from either battery power or an AC source allows the analyzer to remain portable while offering flexibility in the laboratory.

To set up the acrylic instrument stand, unfold it and tighten the nylon thumbscrew to hold it in place. Lift the shorter side until the legs swing down, and then fit them into the grooves in the base of the instrument stand. Attach the PDA cradle to the Velcro dots. For more convenient PDA viewing and input, the PDA can be removed from the instrument cradle and mounted on the front of the instrument stand. Remove the PDA from the analyzer PDA cradle and connect it to the analyzer with the null modem cable. Place the PDA in the cradle on the instrument stand. Place the analyzer into the stand by aligning the grooves in the body and handle and sliding it onto the stand so that the control panel of the analyzer is forward.

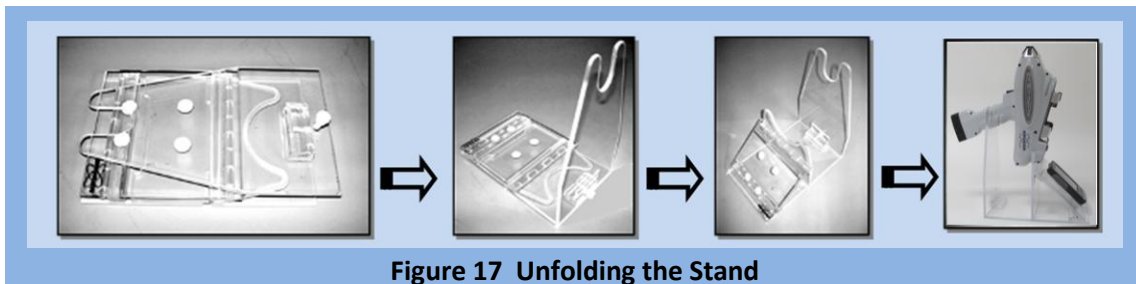


Figure 17 Unfolding the Stand

4.2.3 Small Sample Table

Whenever possible, analysis should be performed on samples large enough to completely cover both the examination window AND entirely fill the sample volume.

To analyze small samples or to have a flat surface on which to work, replace the clip-on window protector with the sample table (Figure 18).

Place the Safety Shield Accessory (Figure 19) over the sample volume when testing very small, thin, and/or light samples.

Placing samples directly onto the window film is not recommended. If possible, obtain a sample large enough to cover the entire examination window and rest upon the nose rather than the window film.

4.2.4 Remote Control (optional)

Certain operational circumstances may require the analyzer to be enabled remotely. This is typical in the desktop or bench-top configuration, where it is critical that the analyzer remain motionless. Depending upon the installed options, a 6-ft remote trigger cable may be included with the analyzer to accommodate such requirements. Operating the analyzer remotely is as simple as plugging the cable into the remote trigger port (Figure 8) and pushing the button.



CAUTION: The remote trigger cable contains a 4-pin circular connector and will only connect to the remote trigger port. Do not force this cable into the communications port on the control panel. Do not force the download cable into the remote trigger port. Turn off the analyzer before installing or removing the remote trigger cable.

4.2.5 Enclosed Bench-top Stand (optional)

When an application calls for radiation to be more closely monitored in a secure laboratory environment, a more stationary and semi-permanent configuration may be required.

The optional bench-top stand is made of solid steel construction and securely mounts both analyzer and PDA. The oversized sample table ensures that geometries are maintained for both large and small samples, and the pneumatic door and leaded window keep scatter tightly controlled.

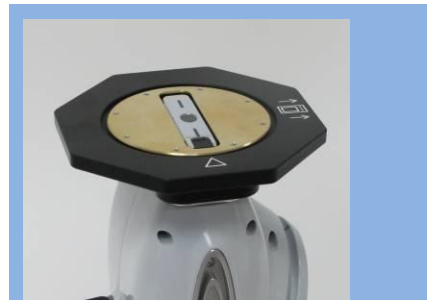


Figure 18 Sample Table



Figure 19 Sample Shield Accessory



Bench-top configuration

4.2.6 Tripod (optional)

Certain operational circumstances – such as when valuable artifacts are under test and may not be touched by the analyzer – may require the analyzer to remain motionless, at a precise distance, and enabled remotely.

This typical application of the Tracer series instrument series uses a tripod in tandem with a Laptop/Notebook PC running S1PXRF analytical software, which allows for a much more thorough investigation of sample composition. Such applications often require advanced knowledge of XRF and general spectroscopy.

4.2.7 Notebook/Laptop Accessory (optional)

Some tasks associated with laboratory analysis require additional processing power and extensive I/O and data entry. While the PDA is best suited for portable viewing and quick, in-field additions, it is not optimal for lab testing. For this reason, Bruker Handheld offers a Windows® compatible notebook PC containing their S1PXRF software as an optional accessory.



Tripod Configuration

4.3 Analysis Techniques

4.3.1 Non-Vacuum

For the majority of applications, including most light-element analysis, a vacuum is not required. Using this technique, the Tracer series instrument should be used with the clip-on window protector or clip-on sample holder installed to ensure that the critical geometry and distance from the detector to the sample is maintained.

4.3.2 Vacuum

Instances in which it is necessary to obtain highly accurate chemistry measurements of materials containing extremely low concentrations of critical light elements may require vacuum analysis. Because the surrounding air absorbs the lower energy X-rays generated by the excitation of light-elements, a vacuum is used to remove air from the majority of the volume between the sample and the detector, allowing the maximum number of X-rays to be detected, further reducing detection limits.

When operating in vacuum mode, remove the clip-on window protector, as illustrated in Figure 20. Grasp the window protector firmly on both sides and lift it off. To reinstall, gently press the window protector over the nose of the analyzer, lining up the four holes on the window protector with the alignment pins on the nose. Never use the analyzer without a window installed and intact.



Figure 20 Remove Clip-on Window Protector for Vacuum

Connecting the Vacuum Pump

Apply power to the vacuum pump by either connecting to the external AC adapter or installing a charged battery pack. Connect the valve-end of the vacuum hose to the pump and the other end to the port on the control panel of the analyzer (Figure 21). Ensure that the slide valve is open. Switch the pump power on using the large rocker switch on the front of the pump. After the pump is operating, slide the valve closed so that the detector chamber will evacuate and the LCD will display the pressure inside. Ensure that the valve is open before turning off the vacuum pump or removing the hose for either end. Failure to use the valve properly may cause damage to the window of the detector. This relative measurement will vary depending upon temperature, humidity, and relative barometric pressure. The system is ready for measurement when the display reads less than 10 Torr. A pressure of less than 5 Torr is preferable for accurate readings. It may take several minutes to reach this high vacuum level.



Figure 21 Connecting the Vacuum Pump

Monitoring Pressure

The vacuum level is measured in two locations: inside the instrument and at the pump itself. During an assay in vacuum mode, the BrukerS1 program will monitor the pressure level inside the instrument. If it

senses that the level is unacceptable, the PDA will display a message indicating unacceptable vacuum levels. Likewise, if the level is acceptable, it will indicate it is “good.” Due to the complexity of high-vacuum systems, the analyzer may signal a “bad” vacuum level when the pump indicates it is well within limits. For this reason, if the pump display indicates acceptable levels, it is safe to assume the vacuum is “good.” The pressure indication from the BrukerS1 software is to be used as a warning only, and to remind the operator to check the vacuum pump display regularly.

On instruments with vacuum capability, selecting a vacuum calibration initiates monitoring of the vacuum condition of the instrument. This will prevent acquisition of data using the wrong conditions

Select a vacuum method and tap **Continue**. The instrument will issue the warning (Figure 22). Activate the vacuum pump to evacuate the nose of the instrument. If done improperly, an error message (Figure 23) will appear when the Analysis begins.

If sufficient vacuum is achieved, tap **Analyze**. The Ready to Analyze screen (Figure 24) will appear. To acquire data, activate the trigger.

4.3.3 Hot Surface

The Tracer series instrument sacrifices high temperature analysis capability for the benefits of the vacuum and light-element analysis techniques. Under no circumstances should the nose of the Tracer series instrument be exposed to surfaces greater than 170°C.



CAUTION: *Measuring surfaces beyond this temperature without the hot surface option will destroy the thin-film examination window and increase the risk of damaging the detector.*

4.4 Setting up the Analyzer

If using the analyzer and accessories on battery power, begin with fully charged batteries in the analyzer and PDA. Otherwise, connect them to AC power. If small samples are to be analyzed in bench-top mode, install the sample table and Small Sample Safety Shield.

4.4.1 Hand-held Operation

- 1) Using the barrel key, unlock the PDA cradle by turning the key clockwise until the lock pin fully retracts
- 2) Carefully insert the PDA into the cradle.

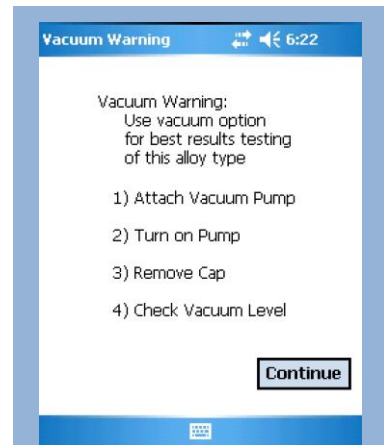


Figure 22 Vacuum Warning

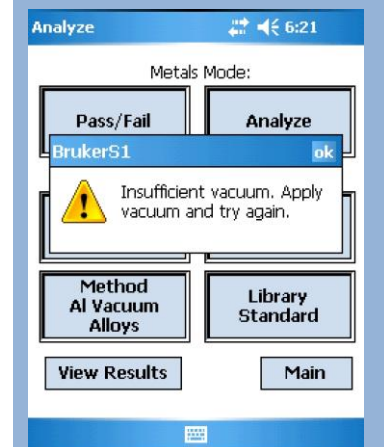


Figure 23 Error Message

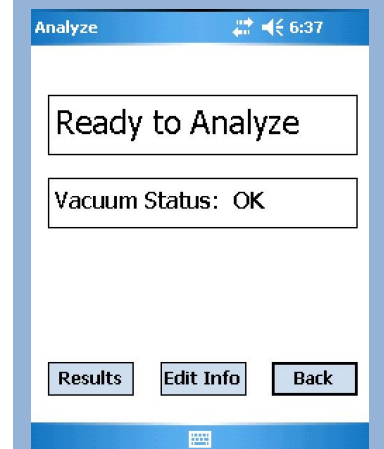


Figure 24 Vacuum Ready

- 3) Lock the PDA into place by returning the key to the previous position; the lock pin will extend, securing the PDA in the cradle.

4.4.2 Desktop/Bench-top Operation

- 1) Unfold the instrument stand and place on a flat surface near an electrical outlet.
- 2) Place the analyzer upright in the instrument stand.
- 3) Insert the null modem cable into the serial port on the control panel on the analyzer.
- 4) Insert the opposite end of the cable into the bottom of the PDA.
- 5) Place the PDA in the cradle on the instrument stand.



CAUTION: DO NOT force PDA into the analyzer as damage may occur to both connectors.

CAUTION: The circular connector on the null modem cable and the analyzer control panel are keyed and are designed to be inserted one way. Do not use excessive force as damage may occur to both connectors. The red dot on both mating ends indicates the proper orientation.

If the unit is to be used with a vacuum, connect the vacuum pump to the analyzer. Start the pump and wait for the LCD to display 10 Torr or less (an indication of 5 Torr or less is preferable). Make certain that the clip-on window protector has been removed. Install the wired remote into the remote trigger port on the handle of the analyzer, if desired.

Turn the instrument ON. The yellow lamp will activate, indicating the unit is on. Wait one minute for the detector and filament to reach their respective operating temperatures. During this time, on the Tracer-IV, the filter wheel will advance to the appropriate location, producing an audible sound.

Turn the PDA power on by pressing the button in the upper right corner of the PDA and start the BrukerS1 program by selecting it from the Start menu. Optionally, you may press the calendar button on the PDA.



IMPORTANT: After powering the analyzer, allow it to idle for 1 – 2 minutes before taking a measurement.

4.4.3 Window label

The window label protects the sensitive instrumentation from dust and debris in normal operation. The window must be replaced if it has been damaged, or if it has been contaminated. Five (5) replacement window labels are included with the Tracer series instrument.

4.4.4 Window Replacement

The following procedure details the proper application of a window label on Tracer series analyzers. Although your window may appear different, the procedure is the same for all window applications.



CAUTION: Removing the window label exposes the delicate beryllium window on the detector to dust and other contaminants. Replace the window quickly to limit exposure.

- 1) To replace a damaged window label, turn off the analyzer.
- 2) Remove the old window from the nose-piece of the instrument.



- 3) Carefully and thoroughly remove all remaining adhesive from the nosepiece with a soft, lint-free cloth dampened with alcohol. Oil, dirt, and old adhesive will prevent the new window from maintaining a quality seal.



- 4) With clean, dry hands, carefully remove the window label from the paper backing material.

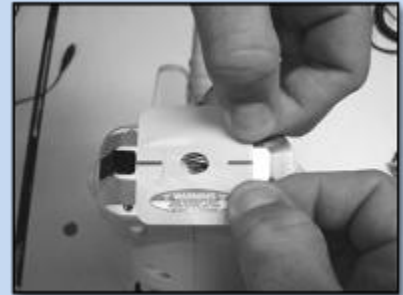
Please note that the thin window film is fragile and easily damaged; handle with care.



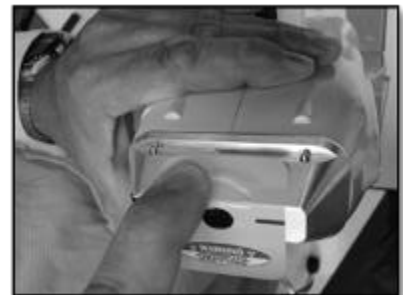
- 5) Position the window label and gently adhere only ONE edge near the IR sensor window on the face of the nose-piece, centering the window film over the aperture.



- 6) Carefully grasp the label edge opposite the IR sensor window and gently stretch the label just until taut, and adhere to the flat face of the nosepiece.



- 7) Rub along the bottom edge of the nosepiece face, gradually rolling the label down and smoothing from the flat face of the nosepiece to the edge of the label, taking care to remove all wrinkles as you go.



- 8) Repeat the process on the top edge of the nosepiece, smoothing from the flat facing edge of the nose-piece down toward the edge of the label, removing any wrinkles. Upon replacement, users may wish to check adhesion of the window by applying a vacuum.



4.5 Filter Configuration

In order to obtain optimal spectral information from an XRF spectrometer, it is important to control the excitation conditions. This includes control of the X-ray tube current and voltage, as well as the excitation filter used. This section provides instruction on how to manually replace and/or adjust the filter on the Tracer III-SD and Tracer III-V⁺.

The Tracer IV-SD will automatically switch to the correct filter when any of the pre-installed factory calibrations are used. Advanced users can also manually select the appropriate filter with the S1 PXRF PC software to optimize excitation conditions for their elements of interest.

4.5.1 Determining filter Configuration


Samples composed primarily of light elements, such as aluminum or titanium alloys, should be analyzed with the filter removed (and possibly with vacuum).

Other elements should be examined using the appropriate filter configuration. To optimize the excitation conditions for a particular element or group of elements in principle filters and tube voltage settings should be used that “position” the X-ray excitation energy impacting the sample just above the absorption edge(s) of the element(s) of interest.

4.5.2 Changing the Filter



*Caution: Ensure that the brass knurled screw has been replaced before using the instrument. **DO NOT OPERATE** the Tracer-III without the brass knurled screw in place.*



This side toward instrument **brass knurled screw** **filter insertion**

1. To insert or remove the filter, **UNSCREW** the brass knurled screw.
2. **INSERT** the filter (see figures above).
3. **USE** forceps to **INSERT** or **REMOVE** the filter.
4. **FINGER TIGHTEN** the brass knurled screw. **DO NOT OVERTIGHTEN.**

Filter Specifications Tracer III-SD and Tracer III-V⁺

Filter Number	Color	Layer 1	Layer 2	Layer 3
1	Red	12mil Al	1mil Ti	1mil Cu
2	Green	12mil Al	1mil Ti	6mil Cu
3	Yellow	12mil Al	1mil Ti	
4	Blue	1 mil Ti		

4.5.3 Filter Specifications, Tracer IV-SD, Automatic filter changer

Filter Number	Layer 1		Layer 2		Layer 3	
	Material	Thickness	Material	Thickness	Material	Thickness
1	Ti	25 μ	Al	300 μ		
2	Blank					
3	Ti	25 μ	Al	200 μ	Cu	75 μ
4	Ti	25 μ	Fe	50 μ	Mo	25 μ
5	Al	38 μ				

4.6 Sample Preparation

In a laboratory environment, samples are normally prepared as flat discs, 20-50 mm in diameter (typical). Samples are placed a small distance from the tube and detector window. Because the X-ray intensity follows an inverse-square law, in order to maintain a repeatable X-ray flux, the tolerances for this placement and for the flatness of the surface must be very tightly controlled. Methods of obtaining sample discs vary: metals may be machined to shape, minerals may be finely ground and pressed into a tablet, and glasses may be cast to the required shape. The matrix of the material often defines which method is used.

In the handheld world, manufacturing discs is not practical. Even so, it is imperative that the sample area – be it a pipe, ingot, or wire – be clean and relatively smooth. Irregular surfaces can produce poor results by reabsorbing lower energy X-rays, and contamination can lead to the identification of unwanted elements added to the spectra as well as attenuating desired X-rays.

Analysis of light elements, such as Mg, Al, and Si, are especially sensitive to surface condition. To ensure accurate light element analysis, sample surfaces must be clean and free of oxidation, oils, or other surface films. In addition, samples must be flat and cover the entire measurement window. In practice, this often means that sample surface needs to be mechanically prepared before analysis.

5 Operation

5.1 Starting the BrukerS1 Program

Each analyzer is delivered fully calibrated for the intended application. Therefore, it can be used for normal work without any preparation other than that described in earlier sections. The intuitive user interface makes it easy to begin using the Tracer series instrument right away. The analyzer is operated and maintained through the BrukerS1 analytical program, located in the **Start** menu on the PDA. Alternatively, the device can be activated by pressing the program Calendar button, located on the PDA directly above the communication port. To view the PDA desktop while running BrukerS1, press the **Show Desktop** button, located adjacent to the BrukerS1 **Start** button (Figure 25).



Figure 25 Start Button

5.1.1 Memory Card

The analyzer ships with a Compact Flash (CF) card of varying capacity. This card contains a backup of the BrukerS1 program and instrument calibration, and is specific to each analyzer. Store the flash card in a safe location; it is required to reinstall the BrukerS1 program. Refer to the Troubleshooting section (page 50) for instructions on how to reset and reinstall the software from CF card. DO NOT install a memory card from another analyzer in the PDA.



CAUTION: The memory card provided with the analyzer contains settings and calibrations specific to the instrument with which it ships. Using a memory card or PDA from another instrument may produce undesirable results.

The supplied flash memory card is not necessary to operate the analyzer; all components required to operate the analyzer are included on the PDA. Additionally, assays are saved to the internal memory of the PDA. If desired, the program can store these assay files to a memory card. Bruker recommends use of a separate memory card for file storage and supplies a Secure Digital (SD) card for this purpose.

After turning the power on to the instrument, select the “BrukerS1” icon from the **Start** menu. The icon is also located in the **Programs** group, (**Start Menu > Programs**). Upon starting the BrukerS1 program, the title screen will display, showing a progress bar. If the instrument connects successfully, the page will show the “Connected – Ready” status.



IMPORTANT: The analyzer arrives from the factory with the default password: 12345. It is highly recommended that the owner immediately change the password upon receipt. See “I forgot my password” in the Troubleshooting section.

Tap the **Exit** button to quit the BrukerS1 program, or the **Login** button to display the login screen, (Figure 26). Enter your personal password and tap **Continue**. When the software has verified the user password, a

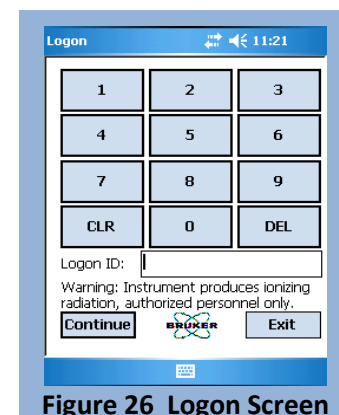


Figure 26 Logon Screen



Radiation Warning will display (Figure 27). No operator action is possible during this time. After 15 seconds, the **Main Menu** will appear (Figure 28). From the Main Menu, you can access either the **General Purpose Measure**, or **Utilities**.

5.2 General Purpose Measure

Selecting the General Purpose Measure button displays the **Mode Selection Menu** (Figure 29). The menu is organized into two groups of buttons: **Metals Mode** and **Configuration**.

5.2.1 Metals Mode

By default, the Tracer series instrument is set up to perform an unlimited measurement of materials in **Universal** mode. This feature will detect the type of alloy under test, and make automatic adjustments to the excitation parameters and filter settings during the first second of analysis. This default function is intended to remove the uncertainty in selecting method and analysis type, and make these decisions automatically—just point and shoot. Universal Mode is described in detail on page 37.

Pass/Fail

This useful option allows the user to determine if the material being analyzed matches a specific alloy from the library. Any number of materials can be added to the match list, including those from custom libraries; the program will compare the current analysis to the chemistries of the materials listed and issue a PASS/FAIL result. This is a fast and accurate way of quickly sorting materials based on Grade ID. FP and any

empirical method can be used in **Pass/Fail** Mode; however, the sample must be in the library to receive a PASS result.

Activate **Pass/Fail** analysis by tapping on the associated button, displaying the **Pass/Fail** screen (Figure 30). To test for a specific alloy, scroll down the “Fail” list and highlight the alloy of interest with the stylus. Tap the arrow button underneath to add the selected alloy to the “Pass” list. The Pass list indicates which alloys will be tested against the library. To remove an alloy from the Pass list, highlight the alloy on the Pass list and tap on the arrow button underneath to move the alloy into the Fail list.

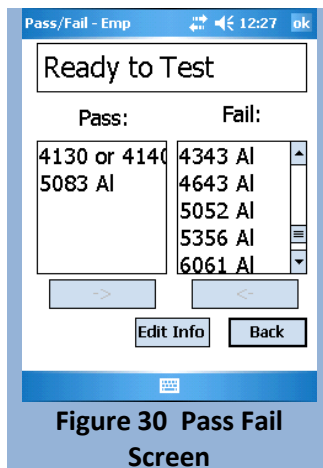


Figure 30 Pass Fail Screen



During analysis, An icon will appear showing that the instrument is calculating the results.

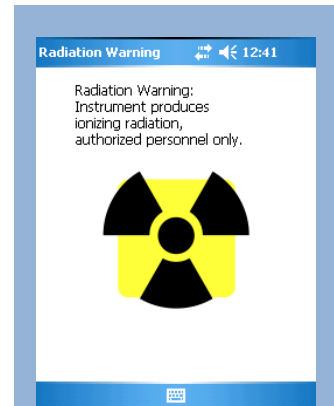


Figure 27 Radiation Warning

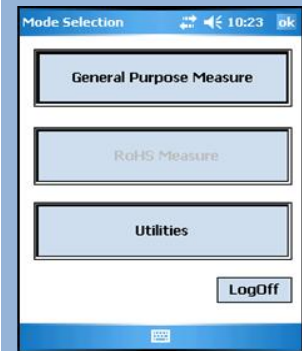


Figure 28 Main Menu

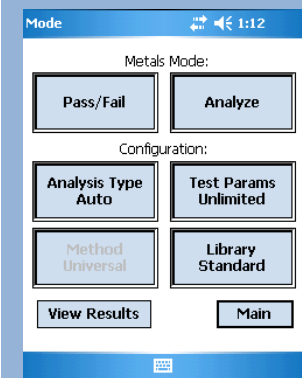


Figure 29 Mode Selection Menu

Once the alloys have been selected and testing is ready to begin, pull the trigger. The screen will display results similar to those shown in Figure 31. This screen displays the Grade ID name, the tested material's chemistry, and whether or not the material passes or fails the match test. As the test progresses, the color of the upper screen will indicate the test status: **green** indicates that the material matches one of the Grade IDs selected; **yellow** indicates a possible match; and **red** indicates that the material does not match any of the selected Grade IDs. The display also includes a **Match Quality** value (in parenthesis). This is a range 0.0 to 10, and indicates how closely the measured chemistry matches the chemistry for the Grade ID found in the library. Higher numbers indicate a closer match. For most standard alloy grades, a value of 8.0 or higher can be expected. If no match is found, the result will say No Match.

The **Results** screen presents additional information in column form: **El** (element), **Min** (the minimum percent value for passing), **Result** (the percent value recorded in the analysis), **Max** (the maximum percent value for passing), and **Err** (2 standard deviations). If the sample analyzed falls between the min and max values, it passes (green); if an element within the sample falls outside of the min and max values, but within the standard deviation, it is uncertain (yellow); if it falls outside the standard deviation, it fails (red). Tap on any column heading to sort that column.

Analyze



NOTE: If a material does not match one of the alloys in the PASS list, the Tracer series instrument will still attempt to determine a Grade ID.

NOTE: If the chemistry of the alloy does not closely match a chemistry in a library, "No Match" will display for Grade ID. The Match Quality threshold below which "No Match" is displayed is set to a default value of 5.0. The Match Quality threshold may be changed from the System Setup Menu (see page 43).

Analyze is the primary tool for obtaining the Grade ID (alloy name) and chemical composition of all materials—alloys, plastics, etc. Selecting Analyze from the menu prompts the **Analyze screen** (Figure 32), indicating that the instrument is ready to analyze. The screen also shows the status of the internal pressure (Vacuum Status). Depending on the selected method, a good, bad, or N/A status will be displayed. Near the bottom of the screen is the **Results button** which opens the **Results Viewer**. Next to the Results button is the **Edit Info button**, which allows the operator to change file names and add extra information. The **Back button** returns to the previous menu.

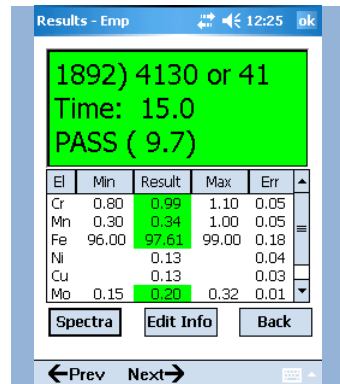


Figure 31 Pass Fail Results

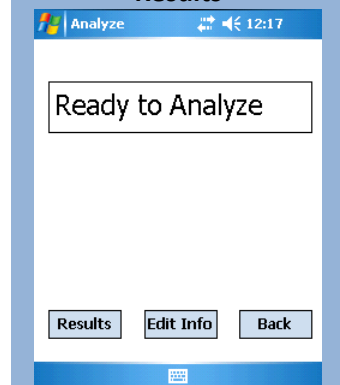


Figure 32 Ready to Analyze

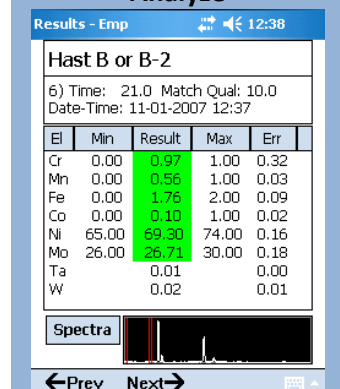


Figure 33 Live Results

5.2.2 Taking a Measurement

To begin a measurement, place a sample over the examination window and IR proximity sensor and pull the trigger. During a measurement, the **Live Results** screen (Figure 33) will display the assay number, Grade ID of the alloy, the match quality (confidence) number, and chemistry in weight-percent (wt%). As measurement time increases, the results will become more precise. At the bottom of the screen is a small spectral display that shows the energy lines in real time. It may be brought to the foreground by tapping on the **Spectra** button. Release the trigger at any time to halt the measurement and display the results (Figure 34).

Grade ID – If the material being measured is an alloy found in the sample library, the name will be displayed at the top of the screen. Materials not found in the library will be named “No Match.”

Match Quality – This is a range 0.0 to 10 and indicates how closely the measured chemistry matches the chemistry for the Grade ID found in the library. Higher numbers indicate a closer match. For most standard alloy grades, a value of 8.0 to 10 can be expected.

Chemistry List - The concentration of each element in the sample is compared to the allowable range of concentrations for that element in the reported Grade ID. Concentrations that fall within the allowable range are highlighted in green. Those elements outside of the range, but within the error limits of their respective ranges, are highlighted yellow. If an element falls outside the range beyond error, the concentration is highlighted red.

Edit Info - Information related to an assay may be added to the record by using this function. Tap on the **Edit Info** button on the **Results** screen to display the **Edit Info** dialog (Figure 35). From here, the user can enter the name of the test, the name (ID) of the material being tested, and other optional information in the two provided fields. To enter information in any field, tap on the field to display the cursor, activate the keyboard, and enter the desired information. When a particular field is complete, repeat the procedure for the other fields as needed. To save this information, tap **Continue** at the bottom of the screen. Tap the **Back** button to return to the Results. The data will be stored with each assay until they are changed again.



NOTE: The information will be saved with the next assay, not the current results.

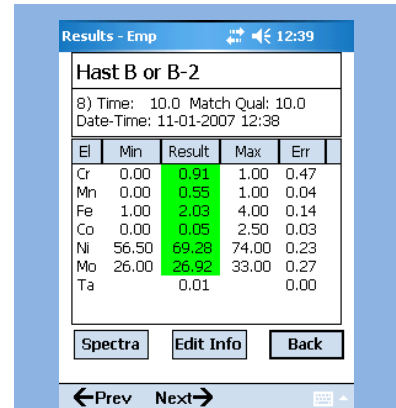


Figure 34 Final results of measurements

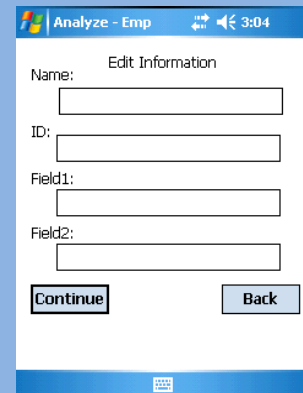


Figure 35 Edit info dialog

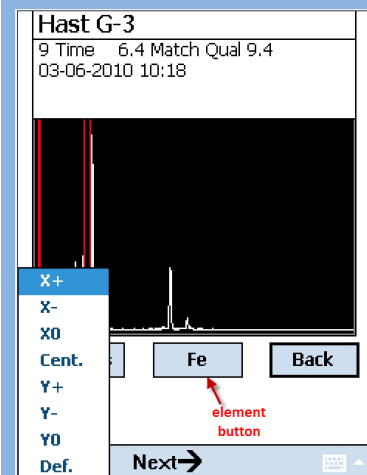


Figure 36 Spectrum Navigator

Spectra - This function allows the user to evaluate more closely the spectra stored on the PDA. Toggle back to the Results screen by tapping the **Results** button. The spectra (Figure 36) can be manipulated by dragging the stylus along the XY axis of the screen. Dragging the stylus up and down will stretch and compress the y-axis (count rate) scale. Dragging the stylus left and right will move the x-axis (keV) scale so that the entire spectrum can be viewed.

The spectrum can also be manipulated through the spectral menu. Press and hold the stylus anywhere on the spectrum to bring up the **Spectral Menu**.

The following options are available:

X+: Stretches the x-axis (keV) scale to zoom in on the spectrum.

X-: Compresses the x-axis (keV) scale to zoom out from the spectrum.

X0: Re-centers and returns the spectrum to the original x-axis scale.

Cent.: Re-centers the spectrum on both the x- and y-axes.

Y+: Stretches the y-axis (count rate) scale.

Y-: Compresses the y-axis (count rate) scale.

Y0: Returns the spectrum to the original scale along the y-axis.

Def.: Restores the spectrum to its default setting; the spectrum is re-centered and the original scale along both axes is restored.

To highlight specific peaks, tap anywhere on the screen to mark the region of interest with two red vertical lines (Figure 36). These lines correspond to the spectral energies of each element. Tap the **element button** and an element list appears (Figure 37). Select an element of interest and tap continue to see the spectral lines for that element.

To identify which spectral energy lines correspond to a particular element, tap on the **Results** button to return to the results page. Highlight the element of interest by tapping on the element name. Tap on the **Spectra** button to return to the spectrum. The spectral energy lines associated with the element of interest will be displayed by two red lines (the K and L energy lines).

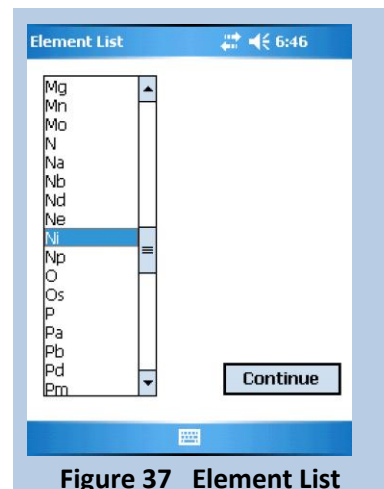


Figure 37 Element List

Back - Returns to the **Ready to Analyze** screen (Figure 32).

Previous and Next allow the user to scroll through the current list of recorded spectra.

To return to the **Ready to Analyze** screen from **Results**, tap the **Back** button. From the **Ready to Analyze** screen, you may begin another measurement; edit information for subsequent measurements; or view results. Once at the **Ready to Analyze** screen, tap the **Main** button to open the **Main Menu**, where

additional configuration options can be selected to further detail each subsequent measurement and alter the overall behavior of the analyzer.

5.2.3 Configuration

The **Configuration** group contains four buttons: **Analysis Type**, **Test Params**, **Method**, and **Library** (see Figure 29). The text displayed on each reflects the function of the button and the current selection.

Analysis Type

This button allows the operator to change the type of analysis for the selected **Method** (see page 38). The analysis types available are defined below. Changing the analysis type will affect general behavior of the analyzer and the accuracy of the results. Tapping this button will reveal the menu (Figure 38).

Universal

The **Universal** mode is the default analysis type (Figure 38), bringing together the benefits of Empirical and FP calibrations, automatic Method detection, and Dual Energy excitation. In the first second of a measurement, the analyzer determines the best excitation voltage, anode current, and beam filter based primarily on the matrix element, and automatically switch to it. In the next five seconds, the algorithm determines if the measurement would benefit from a second analysis at a lower energy (Dual Mode). Typically, at the end of a 10 – 15 second assay, the appropriate calibration will be chosen (Empirical or FP) and results will display. Analysis will halt at anytime by releasing the trigger.

Empirical (EMP)

The **Empirical** function (Figure 39) calculates elemental concentrations *empirically* based on valid count data. If the type of material is generally known (e.g., steel alloy, copper alloy), the Empirical analysis will identify the results more quickly than the FP type, and will often report more accurate analytical results.

Dual (Tracer IV-SD only)

The **Dual** function (Figure 40) is a subset of the Empirical and FP Analysis types that measure samples with two different excitation energies. It is available only on models containing light-element calibrations.

Some alloys contain critical light elements that define them, and are difficult to quantify with a 40kV source. With **Dual** enabled, the analyzer will drop to 15kV after five (5) seconds and continue analysis until the trigger is release or the measurement concludes. Dual Mode is a toggle function and can be selected when EMP or FP are

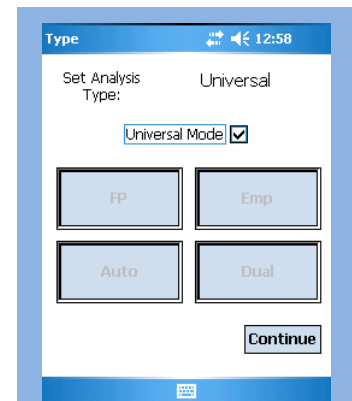


Figure 38 Analysis Type Menu

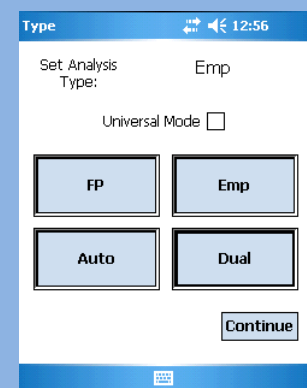


Figure 39 Empirical Analysis Type

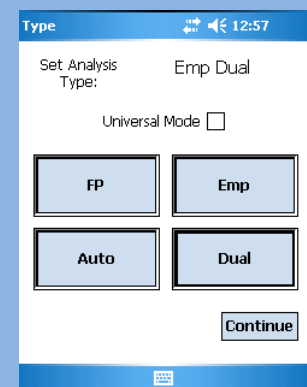


Figure 40 GradeID-EMP with Dual enabled

active. Figure 40 shows the EMP analysis type activated with Dual Mode enabled. Tapping the **Dual** button will turn off Dual and enable the original 40 kV Empirical analysis.

Fundamental Parameters (FP)

This function (Figure 41) analyzes valid counts for each element and computes concentrations. FP should be selected if the composition of the material is generally unknown. It can analyze the composition of a broader range of materials, but will typically take longer to display results, and the results may not be as accurate as those obtained using the Empirical analysis type.

Auto

Auto mode (Figure 42) automatically switches from Empirical analysis to Fundamental Parameters analysis if a grade ID cannot be determined within 10 seconds and/or the material under test is not defined in the empirical calibration.

Methods Menu

The **Methods menu** allows the user to choose instrument settings optimized for measurements of certain sample types to obtain more accurate results. These settings establish different voltage, current, and filter settings. The number of methods available will vary based on the purchased configuration. Simply select a one of the following methods and tap **Continue**:

Standard Alloys

This setting is the de facto standard method and is used for the general alloy analysis of steel, nickel, cobalt, and copper.

Aluminum FP Alloys

This setting is used for Grade ID and general chemistry of Aluminum alloys.

Additional methods for RoHS, Mining, Precious metals and other special calibrations are available; discuss these options with your sales representative.

Spectrum Acquisition

With Bruker S1 software version 1.0.2.9 or later, spectral data may be captured on the PDA. To use this feature, the instrument tube must first be set using X-Ray Ops (see the X-Ray Ops User Guide for details on tube pre-sets).

Tube settings are selected from the Methods window (Figure 43). These settings are created and saved using X-Ray Ops. See the X-Ray Ops User Guide for more detail on how to save tube settings.

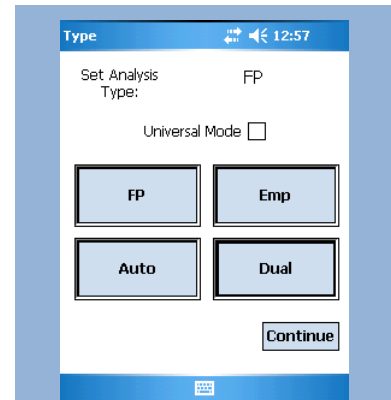


Figure 41 FP Analysis Type

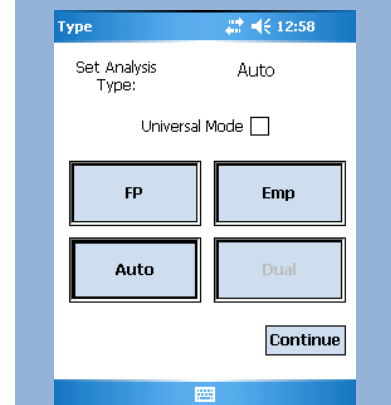


Figure 42 Auto Analysis Type

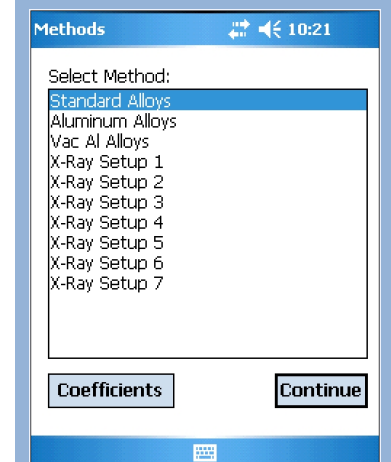


Figure 43 Example of Methods Menu

Using pre-set tube settings, spectra will be displayed as in Figure 44. Each acquisition is named SPECTRUM, auto-incremented, and stored as a PDZ file.

For operation of the **Results** window, see Spectra, page 36.

Test Parameters

This menu (Figure 45) allows the user to define minimum and maximum measurement time, trigger behavior, and Dual Mode reaction times. By default, the measurement time is Unlimited and Manual, which allows the analysis to continue as long as the trigger is pulled and safety criteria are satisfied.

Trigger Options

By default, the Tracer series instrument will run unlimited measurements (i.e., it will continue to collect data as long as the trigger is pulled and safety criteria are satisfied). Selecting the **Trigger Options** button will toggle this option to **Timed Measurement**. Once set, the operator will be able to change the Test Time and toggle the Manual/Auto trigger.

Manual Trigger – The analyzer requires physical contact with the trigger. It must be depressed completely to take a measurement. The measurement will continue for the set minimum time, up to the maximum time, or until the trigger is released or safety criteria are disturbed.

Auto Trigger – If the trigger is pulled for 2 seconds and released, the analysis will begin. Analysis time is controlled by the contents of the **Set Test Time** fields. Due to regulatory restrictions, this feature is not available in all locales.



IMPORTANT: Fields that appear grayed out are unavailable with the current configuration. Changing the Analysis Type or Trigger options will alter the availability of certain menu items.

Set Test Time

By entering minimum and maximum values, the measurement time is set. This feature is only available if **Timed Measurement** is active (see Trigger Options above and Figure 46). When set, the analysis will continue until the trigger is released or the maximum measurement time has been reached. If the trigger is released before the maximum time is reached, the measurement will stop. If the trigger is held beyond the maximum time, the measurement will stop at the set time. If an assay runs for less than the minimum time, no data will be stored and the file index will not be incremented. Note that if any of the safety criteria are disturbed, the measurement will stop.

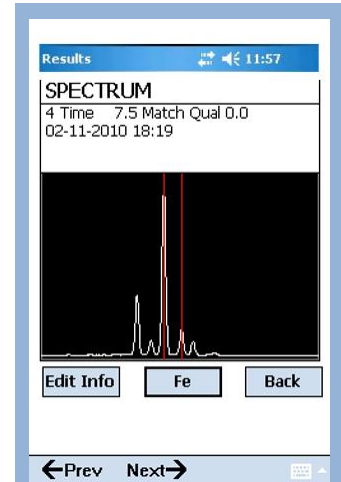


Figure 44 Spectrum

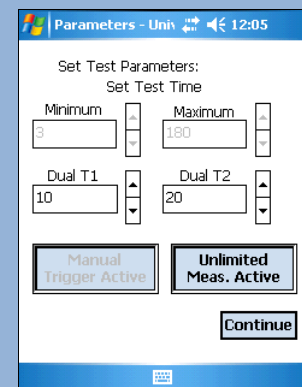


Figure 45 Test Parameters Menu

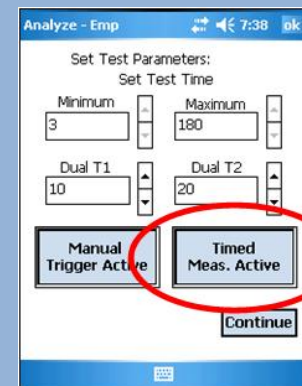


Figure 46 Timed Measurement Trigger Option

Dual Mode Reaction Time

Entering values into the **Dual T1** and **Dual T2** fields controls how Dual Mode operates. Used only when Dual analysis type is selected, Dual T1 sets the duration (in seconds) that a measurement will run at 40kV, and Dual T2 sets the duration for the 15kV measurement. It is unlikely these will ever need to be changed, but results may vary.

Library

The Library feature allows the operator to create custom libraries and add new samples unique to his/her application. In the context of the Tracer series instrument, a library is a file residing in memory on the PDA that defines the names (Grade ID) and allowable ranges of concentration for each element for a particular alloy. By default, the Standard factory library of alloys is used by the calibration for Grade ID. User Libraries are custom user-created libraries that contain definitions of alloys other than those contained in the Standard Library. From the Library menu, the operator may add/delete individualized libraries and/or samples, and even exclude the factory library entirely.



CAUTION: *Deleting a user library is PERMANENT; however, the standard factory library cannot be deleted.*

Adding a Library

Tap the Library button to open the Selection Screen (Figure 47). By default, only the Standard factory library is included.

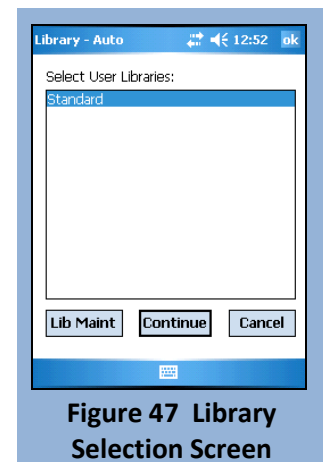


Figure 47 Library Selection Screen

To add a new library, tap the **Lib Maint** button to open the menu. Tap **Create Library** and the **New User Library** screen will display (Figure 48). Enter the name of your library and tap **OK**. The newly created library will open, showing an empty sample list (Figure 49).

Adding Samples to a Custom Library

From the sample list of the **User Library Maintenance** screen (Figure 50), tap the **Add New** button to display the **User Grade Entry** screen (Figure 50). Tap on the text field at the top and enter the name of the sample.

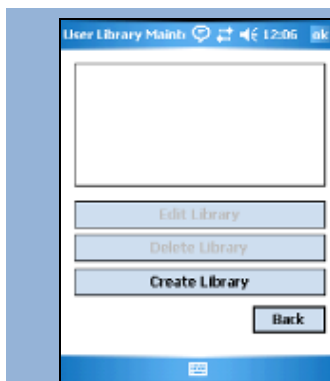


Figure 48 Library Maintenance Menu

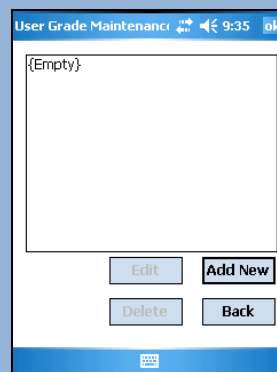


Figure 49 New library (empty)

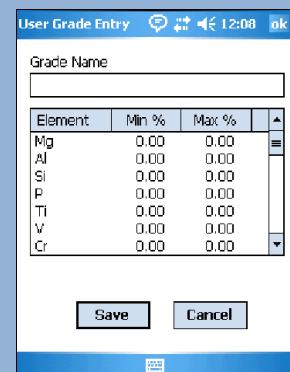


Figure 50 Grade entry screen



NOTE: To expose or hide the virtual keyboard, tap the keyboard icon at the bottom of the screen.

Using the stylus, scroll down to the defining elements and highlight them. Enter the ranges in wt% by tapping on the **Min** and **Max** value and entering proper percentage with the stylus and keyboard. Tap the **Save** button to commit the sample to the library and return to the **Library Sample** list. Enter additional samples (up to 100 entries per library) as required. Tap the **Back** button to return to the

Library Maintenance menu. Determining the minimum and maximum concentrations for each material is beyond the scope of this document. Use caution when selecting a range of values for a particular element that overlaps the ranges for that element in another material. Overlapping ranges may result in ambiguous Grade Identification.

The newly created library displays the list of available libraries (Figure 51). Additional libraries may be added at any time (the recommended limit is 100), and samples can be added to existing user-created libraries, but not the standard library. User libraries may also be deleted.

To return to the main **Library** menu, tap the **Back** button. Figure 51 shows the Standard factory library (highlighted) and the newly created library beneath it. To include the new library in future analysis, highlight it by tapping on the name and tap **Continue**. Notice the text on the **Library** button (Figure 52) changed from “Library Standard” to “Library Multiple,” as multiple libraries were selected. To exclude a library, tap the **Library** button then tap the undesired library to remove the highlight, and tap **Continue**.



IMPORTANT: Including multiple libraries, large ones in particular, will increase analysis time, as each library must be searched individually

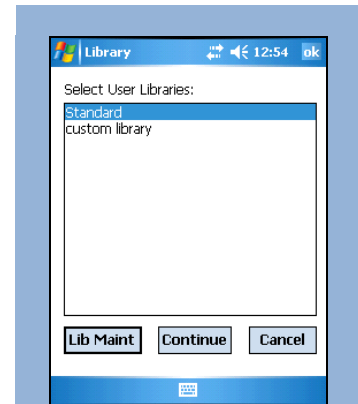


Figure 51 Available libraries

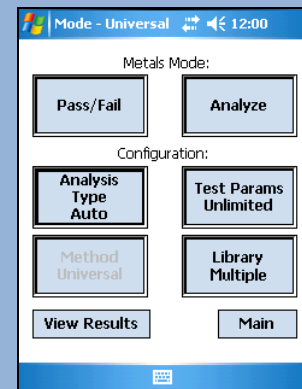


Figure 52 Multiple libraries listed

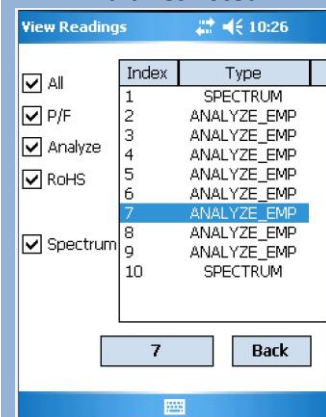


Figure 53 Results explorer

5.2.4 View Results



El	Min	%	Max	+/-
Fe	61.85	68.82	72.00	0.27
Cr	16.00	16.64	18.00	0.19
Ni	10.00	10.80	14.00	0.24
Mo	2.00	2.10	3.00	0.05
Mn	0.00	1.12	2.00	0.12
Cu		0.24		0.04
W		0.02		0.02
Nb		0.01		0.01

Figure 54 Results explorer

The final button in the **Configuration** group is **View Results**. This feature, which can be accessed from numerous locations throughout the program, allows the user to sort and review prior assays for a more detailed analysis.

Tap the **View Results** button to open the **View Readings** screen (Figure 53). This window displays every assay stored in memory, ordered by index. The five checkboxes to the left represent the modes used to collect the data stored on the PDA. Check the box corresponding to the assays to be viewed (e.g., to display assays collected in **Analyze Mode**,

check the box labeled **Analyze**). To view the results of a prior assay, highlight it with the stylus and tap the box at the bottom having that index number. The **Results** screen (Figure 54) appears and displays the results from that assay. Three buttons are available from this screen.

Spectra – See page 35 for description of this function.

Back – Returns to the **View Results** screen.

Edit Info – see page 35 for use of this feature.

5.3 Utilities

The **Utilities** menu contains a variety of tools for viewing and managing data, and manipulating system level functions. From the main **Mode Selection** menu, tap the **Utilities** button to display the screen (Figure 55).

5.3.1 View Readings

The View Readings tool performs identically to the View Results function previously detailed (see page 42).

5.3.2 View Energies

The View Energies tool (Figure 56) is a periodic table that contains pertinent information for each element. The table consists of:

- Atomic number
- Atomic Symbol
- Atomic Name
- Atomic Weight
- Spectral Line Energies
- Spectral line energies

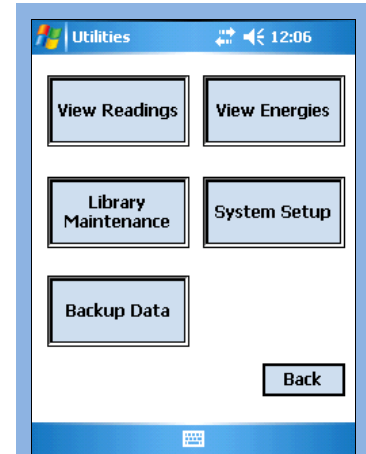
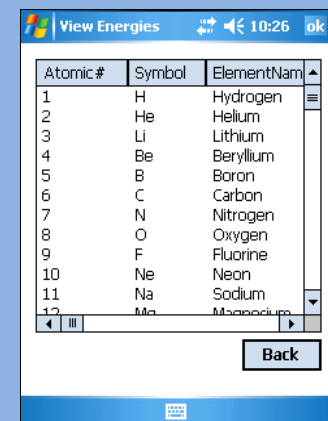
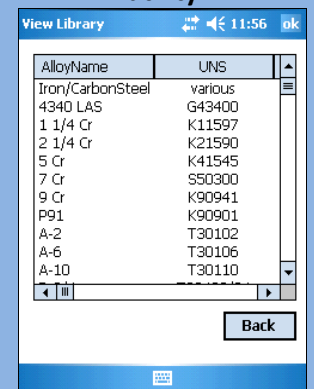


Figure 55 Utilities menu



Atomic.#	Symbol	ElementName
1	H	Hydrogen
2	He	Helium
3	Li	Lithium
4	Be	Beryllium
5	B	Boron
6	C	Carbon
7	N	Nitrogen
8	O	Oxygen
9	F	Fluorine
10	Ne	Neon
11	Na	Sodium
12	Mg	Magnesium

Figure 56 View energies utility



AlloyName	UNS
Iron/CarbonSteel	various
4340 LAS	G43400
1 1/4 Cr	K11597
2 1/4 Cr	K21590
5 Cr	K41545
7 Cr	S50300
9 Cr	K90941
P91	K90901
A-2	T30102
A-6	T30106
A-10	T30110

Figure 57 View Standard Library utility

5.3.3 Library Maintenance

Selecting the **Library Maintenance** button opens a menu that allows manipulation of certain aspects of the library system. Two options are available.

View Standard Library Utility

The **View Standard Library** utility allows the operator to view all alloys identified by the Tracer series instrument, as well as the allowable ranges by weight percent and the UNS designation (Unified Numbering System for Metals and Alloys). This library is installed at the factory and cannot be edited or deleted from within the BrukerS1 program (Figure 57). Advanced users may wish to import the library from the KTILIB.CSV in the System folder of the flash card.

Maintain User Libraries Utility

The **Maintain User Libraries** utility allows the user to create custom libraries and manage the contents by defining the chemistry of special materials. This Utility is identical to the **Library...** function within the **Mode Selection** menu. Refer to page 40 for details.

5.3.4 System Setup

The System Setup screen (Figure 58) enables the user to alter various settings for use during subsequent testing. In summary, the user may select which data files to record, where the data files will be written, which COM port to use for communication with the analyzer, and the threshold for Match Quality used in Pass/Fail testing. The user password may also be changed beginning from the **System Setup** screen. Whenever a system setting is changed, tap **Continue** and the system will prompt you to restart the program.

Saving Output Data

By default, all data is saved to the Data folder on the PDA in the root of My Device. When PDA memory has been completely filled with assay data, it will begin overwriting the files with the oldest time/date stamp. If a blank CF or SD card is inserted into the PDA, and the **Removable Media** box is checked, all assay data will be stored to the card, rather than PDA memory.

Results – Enabled by default. Uncheck this box to discard the results from all assays. The output options ‘Spectra’ and ‘Save CSV’ are ignored if this box is unchecked.

Spectra – Enabled by default. Spectra and results are stored in the .PDZ file format. They can be opened from within the **View Results** utility, or with a Windows Compatible PC running S1PXRF.

Save CSV – Enabled by default. The resulting Grade ID and chemistry of every alloy tested is appended to the RESULTS.CSV file in the Data folder. It can be imported into Microsoft Excel® for later evaluation.

Removable Media – Disabled by default. This option requires installation of a blank, formatted Compact Flash or SD Card into the PDA. Once enabled, all output files are stored in a Data folder residing

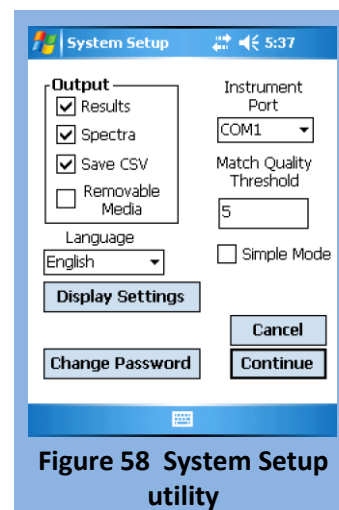


Figure 58 System Setup utility

on the card(s). When the card is removed, the default is reset. It is recommended to use a separate media card when using the *Removable Media* feature.



CAUTION: DO NOT use the compact flash card provided with the analyzer during normal operation. This card contains the files required for installation of the BrukerS1 program and will overwrite the contents of the PDA.

Language

Select available languages are from this drop-down menu. If a language is not available, contact a sales representative to discuss when it will become available. This option only changes the language of the BrukerS1 program. The language of the Windows environment is changed from within the PDA control panel under “regional settings.”

Instrument Port

By default, the PDA communicates to the Tracer series instrument on communications Port 1. Some special applications may require the use of another port. In most cases, the default value is applicable.

Match Quality Threshold

To change the threshold for Match Quality used in Pass/Fail calculations, enter the new value in the **Match Quality Threshold** box. For most Pass/Fail measurements, the default value is applicable. Changing this threshold is not recommended when using the Standard Library. Generally, the Match Quality Threshold should only be changed if a User Library is active (see *User Libraries*, page 40).

Simple Mode

Simple Mode allows the user to limit the functions available, simplifying the analysis process. When checked, Simple Mode will disable all functions except those in **Utilities**, **Edit Info**, and **Results**. Ensure that the method you want to use as default has been selected BEFORE selecting **Simple Mode** (see 0 for details on selecting methods). Once Simple Mode is selected, tap **Continue** and the program will reboot in the **General Measure** mode using settings active when **Simple Mode** was selected.

When **Simple Mode** is selected, the **Ready to Analyze** window will be reconfigured (Figure 61) to include the **Utilities** button. When you want to return to **Normal Mode**, use the **Utilities** button to return to Instrument Setup.

System Password

The Tracer series instrument arrives from the factory with the default password (12345). It is highly recommended that the owner immediately change the password upon receipt.

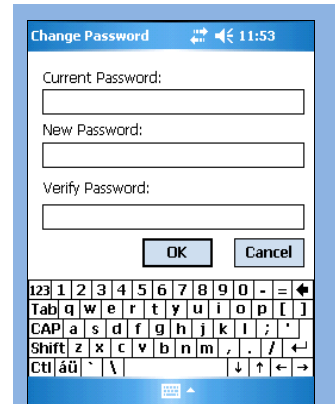


Figure 59 Change Password Utility

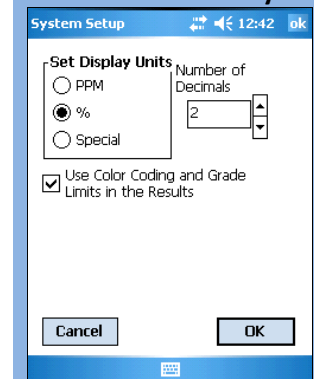


Figure 60 Display Settings

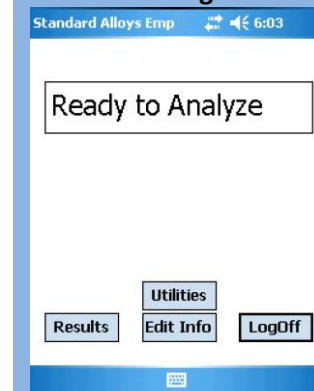


Figure 61 Simple Mode

Tap the **Change Password** button to display the **Password Management** dialog box (Figure 59). Enter the current password, then the new password, then re-enter the new password. Select **OK** to submit the new password. If successful, a dialog box will appear, indicating a successful change.

If the current password was entered incorrectly, a dialog box will appear stating that the New and Verify passwords do not match. In this case, carefully re-enter the new and verify passwords and try again.



IMPORTANT: The password scheme in the BrukerS1 software is case-sensitive. Be sure you record your selected password in a safe place away from the analyzer, as Bruker Elemental cannot recover a lost user password. See "I forgot my password" in the Troubleshooting section.

Display Settings

This function (Figure 60) allows the setting of display units, % or PPM (parts per million) and number of displayed decimals. Use Color coding and Grade Limits checkbox allows to choose whether grade color coding and grade limits are displayed in result screen or not. Color codes are enabled by default.

5.3.5 Backup Data

The Backup Data utility (Figure 62) will copy or move the results of every assay stored in local memory to another location, be it a Compact Flash, SD card, or another folder within PDA memory. If moving data, the operator is given the option to **Reset the Assay Filename Counter** (index). The next assay stored will begin with the index 1.

Select **Copy** to leave data on the PDA, or select **Move** to remove the data from the PDA. In either case, select the file destination and tap **Execute**.

5.4 Shutting Down

From any menu, continue tapping either the **Back** or **Main** buttons until the **Login** screen appears. Tap the **Exit** to return to the PDA desktop. Turn the PDA power off by depressing the power button in the upper right of the PDA. Depress the push-button switch to turn the instrument **OFF**.

5.5 Viewing and Exporting Stored Data

The Tracer series instrument saves and appends to the file RESULTS.CSV the chemistry of each material tested. Test results may be viewed outside the BrukerS1 program by exporting the stored results to a Windows Compatible PC running Excel 95 or later. Results can also be viewed individually on the PDA by accessing the **View Readings** screen in the Utilities menu (See page 42).

Windows™ PC

To view test data on a Windows Compatible PC running Excel 97 or later, you must first export the test data to the PC by one of two methods.

Media Card

If the BrukerS1 program was instructed to save files to Removable Media, simply remove the card from the PDA (Compact Flash or SD) and insert it into a media card reader attached to the Windows PC. Using File Explorer, browse to the Data Folder on the card. The folder contains two file types, PDZ and CSV.

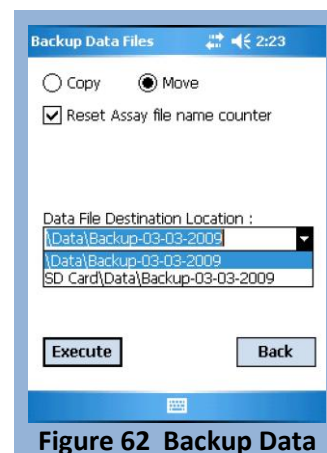


Figure 62 Backup Data

Double-click on the file RESULTS.CSV to open the file in Excel. Viewing PDZ files requires S1PXRF to be installed. Refer to the S1PXRF User Guide for details.

If the BrukerS1 Program was NOT instructed to save files to Removable Media, it is still possible to transfer them to a PC using this method. Insert a media card into the PDA and open File Explorer. Browse to the Data folder in the root of My Device. Scroll down and select the file RESULTS.CSV with the stylus. Tap Menu->Edit->Copy to copy the file to the clipboard. Next, browse to the media card. Tap Menu->Edit->Paste to paste the file from the clipboard to the media card. Remove the card from the PDA and insert it into a media card reader in the same manner.

Alternatively, data can be moved to a media card by using the Backup utility from within the BrukerS1 program (see page 45).

ActiveSync®

ActiveSync is a program that synchronizes files from frequently used applications to both PDA and PC. Every Pocket PC device is compatible with ActiveSync, but to use it, it must be installed on the PC.

Installing ActiveSync

1. Turn on the PC and log on to Windows.
2. A copy of ActiveSync has been provided for convenience. It is a software product distributed freely by Microsoft (following EULA) and updated frequently. There is no guarantee that the copy provided is the most current.
3. Insert the ActiveSync CD-ROM into the CD/DVD-ROM drive. Follow the instructions that appear on the screen.



NOTE: The most current version of ActiveSync may be downloaded from the Microsoft website:
<http://www.microsoft.com/windowsmobile/activesync/activesync45.msp>

Transferring Files

1. Connect the PDA cradle to the PC with the supplied USB cable.
2. Insert the PDA into the cradle. ActiveSync will start and ask if a Partnership should be established. This is not necessary and, in fact, not recommended. Click Cancel.
3. In the ActiveSync window, click on Explore from the toolbar. A File Explorer window will open to display the contents of the PDA memory.
4. Double-click the icon at the top labeled "My Windows Mobile-Based Device."
5. Select the Data folder, and then click Edit->Copy to copy the folder to the clipboard.
6. Browse to a location on the PC hard drive (such as My Documents) and click Edit->Paste. The entire Data folder will appear in the new location.
7. Open the new Data Folder to view the Spectra files (PDZ) and RESULTS.CSV.
8. Scroll down to the file RESULTS.CSV and double-click to open it in Excel.

5.6 Checking Calibrations

Each Tracer series instrument ships with two calibration check samples and documentation for each. Locate these in the shipping case:

- A stainless steel duplex 2205 check sample (used to verify general alloy calibration)
- An aluminum AA5083 or AA7075 check sample (used to verify the light-element and/or aluminum calibration)
- A calibration sheet for each
- A CD-ROM with a copy of the calibration files

All Tracer XRF analyzers are calibrated with NIST traceable alloy standards unless the client application is not intended for alloys or the library contains proprietary materials.

To verify the calibration of the analyzer, set the analyzer up to operate and run five 30-second assays. Calculate the average of the chemistry results (shown from within the RESULTS.CSV file). The results for each element should be within the tolerance range specified on the corresponding calibration sheet.

Contact Bruker Elemental if you suspect your calibration is invalid.

5.7 Coefficient Setup

5.7.1 Introduction to Coefficients

Coefficients enable the user to fine tune methods by setting up offset and slope corrections. This feature is intended for mining and specialty applications where site specific calibration optimization is required.

Coefficients are available in both General Measure and Pass-Fail Measure mode. Generally, coefficients should not be used for standard alloy application. Coefficients are specific to selected method and are applied only to selected method or method group.



Caution! Use of coefficients will change the results and if they are incorrectly used may lead to erroneous results. Use of coefficients is intended only for the advanced users. If in doubt how to correctly use this feature, don't use it!

Once a coefficient set has been defined for a specific method, it will be applied to that method in all instances when the method is used, including in Universal or Auto mode. An asterisk after the Method name indicates that a coefficient set has been applied to that method (Figure 63).

Coefficient sets are applied to the final measurement result of specific element and can contain slope and offset correction for multiple elements. It is possible to create and save multiple coefficient sets to one calibration method, but only one coefficient set can be active at a time.

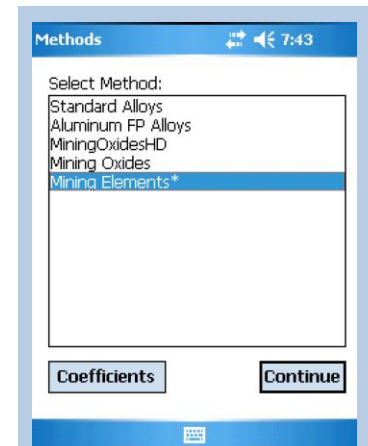


Figure 63 Method menu, with coefficient highlighted

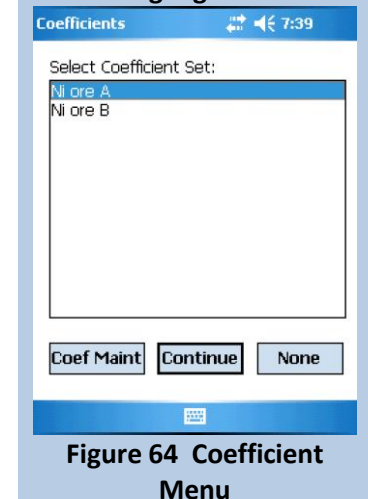


Figure 64 Coefficient Menu

Once a coefficient set has been activated, the adjusted results are reported on the PDA screen and in Results.CSV file. The original, uncorrected results are not saved.

5.7.2 Applying a Coefficient

From the **Main Menu**, select the Methods button to open the **Methods Menu** (Figure 63). Highlight the method for which you wish to apply a coefficient set, and then tap on the **Coefficients** button. The **Coefficient Menu** (Figure 64) will open. Highlight the coefficient set you wish to apply to the selected method, and then tap **Continue**. You will return to the **Methods Menu**. Ensure an asterisk now shows next to the selected method. Select the method and tap **Continue** to activate the adjusted method.

If a coefficient set needs to be adjusted, or a new coefficient added to the existing list, tap the **Coef Maint** button on the **Coefficients Menu** (see Section 5.7.3).

Tap **None** to return to the **Methods Menu** with no coefficient set selected.

5.7.3 Maintaining Coefficients

The **Coefficient Maintenance** window (Figure 65) allows the user to edit, delete, or add a new coefficient set for application to methods. See Section 5.7.4 for details on calculating slope and offset for coefficients.

To delete an existing coefficient set from the list, highlight the coefficient set and tap **Delete**.

To add a new coefficient set, tap **Add New** to open the **Coefficient Entry** window (Figure 66). Highlight the element of interest that you wish to adjust and the keyboard will open. Enter the **Coefficient Name** in the field provided, then change the offset and slope for each element you wish to adjust. Tap the **keyboard icon** at the bottom of the window to close the keyboard. Check the appropriate box for Empirical (**Emp**) and/or Fundamental Parameters (**FP**). Tap **Save** to set the new coefficient, or **Cancel** to discard the changes and return to the **Coefficient Maintenance** menu.

5.7.4 Slope and Offset Calculations

If a simple offset or slope correction is required (e.g., result are always relative 10% too low, slope coefficient is 1.1), the value can be determined without calculation. If, however, the relation between measured values and reference values (expected correct values) is more complex, multiple samples should be used to define the slope and/or offset correction. A sample Excel sheet (Figure 67) is included on the operator's disk provided by Bruker. This Excel sheet contains the required formulae for proper calibration.

To use this sheet to calculate coefficients, select a set of samples which are representative of the matrix of the unknowns and for which you have reliable analysis. These samples must cover the range of concentrations of interest. Measure each sample with sufficient measurement time (e.g., 60-300 sec) and

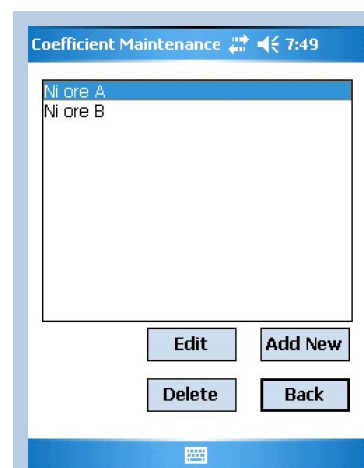


Figure 65 Coefficient Maintenance

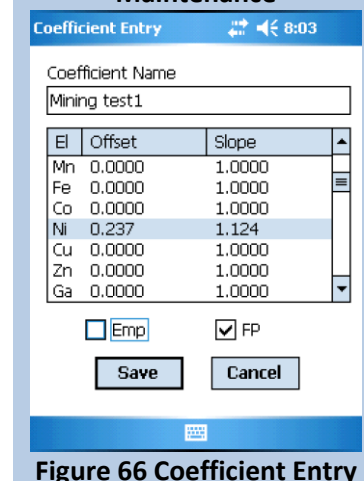


Figure 66 Coefficient Entry



record the values reported by the analyzer. Using the spreadsheet, enter the known values in the column marked "Reference Values" and the measured values in the column marked "S1 Meas. Results". When all samples have been entered, examine the correlation – the closer to 100% the better; if this value is greater than 80-85% , there is reasonable correlation between the measured value and the known value. Repeat this process for each element of interest. Once all the data has been input, create a coefficient set using the values in the Slope and Offset rows in the sheet.

Input Reference values and S1 Measurement results to BLUE cells.
 Estimated measurement result after Coefficients are applied is indicated in "Adjusted S1 Result" column.

Element 1		Ni	
SLOPE		1.0407	
OFFSET		0.4396	
CORRELATION		99.7%	
Reference values	S1 Meas. Results	Adjusted S1 Result	
2.3	1.8	2.31	
2.3	1.77	2.28	
4.5	3.92	4.52	
4.5	3.99	4.59	
6.4	5.75	6.42	
6.4	5.54	6.21	
7	6.12	6.81	

Element 2		Cu	
SLOPE		0.6214	
OFFSET		0.0752	
CORRELATION		99.1%	
Reference values	S1 Meas. Results	Adjusted S1 Result	
0.17	0.22	0.21	
0.17	0.22	0.21	
0.93	1.22	0.83	
0.93	1.34	0.91	
1.11	1.57	1.05	
1.11	1.66	1.11	
1.4	2.31	1.51	

Element 3		Co	
SLOPE		1.2355	
OFFSET		-0.4575	
CORRELATION		95.6%	
Reference values	S1 Meas. Results	Adjusted S1 Result	
2	1.9	1.89	
3.1	3.2	3.50	
4.4	3.7	4.11	
		-0.46	
		-0.46	
		-0.46	
		-0.46	

Figure 67 BrukerS1 Calibration Coefficient Calculation






6 Troubleshooting

Problem	Solution
<p>Error: measurement will not start</p>	<p>If the program is started before the instrument power key is turned on, the program will not respond to the spectral data. In this case—</p> <ul style="list-style-type: none"> • Exit the program and turn off PDA and instrument power • Ensure the instrument power is switched on before starting program. To prevent this error state, it is important to remember to exit the program before switching off the instrument power.
<p>The BrukerS1 program isn't on the "Start" menu.</p>	<p>Upon insertion, it can take up to 30 seconds for the PDA to read the compact flashcard and verify the installation. Tap somewhere else in the screen to get out of the "Start" menu and wait a few more seconds. Tap "Start" again and see if the program is visible on the menu. If the program still does not appear on the Start menu, turn off the PDA and ensure that the compact flashcard is inserted properly. Do not force the card into the PDA.</p>
<p>The program on the PDA "locked up."</p>	<p>If other programs are running, the program may "lock up" and fail to respond to commands. Closing other programs frees system memory for other tasks.</p> <ul style="list-style-type: none"> • If possible, exit out of the BrukerS1 program. • Tap the "Start" menu and select "Settings". • Choose the "System" tab. • Click on the "Memory" icon and select "Running Programs" tab. Tap the "Stop All" button to close all running programs. Attempt to restart the BrukerS1 program. • If the program has hard locked remove the PDA from the instrument cradle, remove any memory cards and press the reset button with the stylus. • Restart the BrukerS1 program.



Problem	Solution
<p>The program says a file is “corrupt” or the program is behaving erratically.</p>	<p>It is possible for the PDA to lock up while writing data to memory. If this occurs, it can lead to data corruption. Likewise, a system file can become corrupt. A “hard reset” is required to restore system files that may have become damaged.</p> <ol style="list-style-type: none"> 1) Disconnect the PDA from the analyzer and place on a table with the reset button near edge. 2) Remove any memory cards installed. 3) With one hand, press and hold the “calendar”, “mail”, and “power” buttons. The screen will turn on. 4) With the other hand, press and hold the reset button until a blue and white screen titled “HP iPAQ Pocket PC” is displayed with the text “Formatting PS” at the bottom. If this text is not shown, repeat the other two steps. 5) Follow the setup steps on screen. 6) Reinsert the memory card containing the BrukerS1 program and calibration files. The program will take up to 30 seconds to install and the BrukerS1 icon will appear in the Start Menu. 7) Promptly remove the card and return to a safe location. 8) Optionally adjust screen brightness and power management functions as described in the iPAQ user manual.
<p>PDA battery is dead.</p>	<p>Manually charge the PDA by connecting to the iPAQ AC adapter. This may take 30 to 60 minutes. The PDA may turn on automatically. If it does not, press the power button. Follow the steps displayed on the PDA screen. Once the setup process has completed, insert the flashcard containing the BrukerS1 setup program and calibration files. The program will take up to 30 seconds to install and the BrukerS1 icon will appear in the Start Menu. Promptly remove the card and return to a safe location. Optionally adjust screen brightness and power management functions as described in the iPAQ user manual.</p>

Problem	Solution
<p>The vacuum pump will not reach 5 Torr or less.</p>	<p>Ensure that the fittings on the tubing are fully inserted onto the vacuum pump and Tracer series instrument and that the vacuum release port is in the closed position.</p> <p>If there continue to be problems with the vacuum level, check the examination window for damage. Ensure that the window label and thin film is completely sealed and not punctured.</p> <p> CAUTION: Failure to open the vacuum release valve prior to removing the vacuum tubing from the pump or the instrument may damage the highly sensitive SDD detector.</p>
<p>The red lamp on the control panel does not turn on.</p>	<p>If the red lamp on the control panel does not turn on when taking a measurement, it is likely that the IR proximity sensor has not been covered completely or is focused on a darkened surface. X-rays will not be generated if the IR sensor is not covered by a sample.</p> <p> WARNING: DO NOT attempt to look into the nose of the instrument to see if X-rays are being generated. The IR sensor cannot detect black surfaces and therefore, the instrument will not generate X-rays. Be sure that the IR sensor is fully covered and that it is focused on a light-reflective surface.</p>
<p>The red lamp on the control panel looks uneven or dim.</p>	<p>Each lamp on the control panel contains two LEDs. If either appears dim or unevenly lit, one of the redundant LEDs is not functioning. If either or both of the red or yellow LEDs in either lamp malfunctions, X-rays will not be generated. Refer to the warranty information on how to return the instrument for evaluation.</p>

Problem	Solution
I forgot my password!	<p data-bbox="581 312 1414 380">Bruker cannot recover lost passwords. However, it is possible to reset it back to the factory password "12345":</p> <ol data-bbox="678 415 1403 848" style="list-style-type: none"><li data-bbox="678 415 1117 443">1. Remove all flashcards from the PDA.<li data-bbox="678 451 1403 699">2. Hard Reset the PDA:<ul data-bbox="737 489 1403 699" style="list-style-type: none"><li data-bbox="737 489 1403 556">• Simultaneously hold down the calendar, mail, and power buttons on the PDA.<li data-bbox="737 564 1403 632">• Using the Stylus, press and hold the reset button in until it reboots.<li data-bbox="737 640 1403 699">• If successful, the text "Formatting PS" will display at the bottom.<li data-bbox="678 707 1403 774">3. Upon reboot, reset the time/date, brightness, and power-off settings.<li data-bbox="678 783 1403 848">4. Reinsert the Original Flashcard containing the BrukerS1 program and calibration files. <p data-bbox="581 856 1403 932"> NOTE: Any data stored on the PDA will be lost after a hard reset. To prevent this, run the Backup Utility described in on page 45.</p>



Appendix A General Care

General Care

Do not store or leave the analyzer where the LCD display will be exposed to direct sunlight for long periods. Do not expose to sprays, liquids, or harsh solvents.

Cleaning

When replacing an examination window, do so in a clean, dust-free environment. Do not leave the open detector chamber uncovered; install a new window immediately.

If remaining adhesive needs to be removed, apply a small amount of isopropyl alcohol to a lint free cloth and gently clean around the aperture. Avoid inserting anything into the detector chamber.

If dust and dirt collects on the exterior of the analyzer, first use compressed air to remove the bulk, followed by a damp, lint-free cloth. Avoid using harsh solvents.

Maintenance

The Tracer series instrument, when used properly, should require very little maintenance beyond window replacement and battery recharging.



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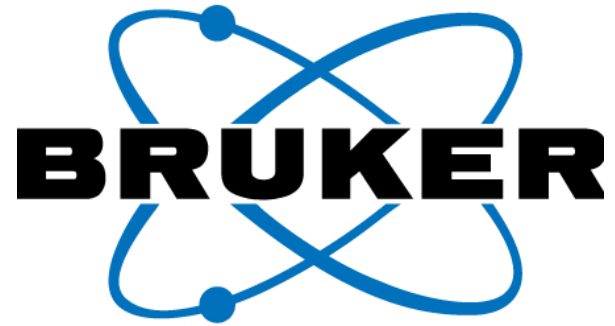
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