

SCHOOL OF MATH AND SCIENCE STANDARD OPERATING PROCEDURE 5104.5A

From: Dean, School of Mathematics and Science

Subj: SAFETY OPERATION AND PROCEDURES FOR THE BRUKER M4 TORNADO
SCANNING XRF SPECTROMETER

Ref: (a) Bruker-AXS "M4 TORNADO User Manual, Bruker, 2011"
(b) NAVMED P-5055 "Radiation Health Protection Manual"
(c) NAVSEA S0420-AA-RAD-010 (RAD-010) "Radiological Affairs Support Program Manual"
(d) USNAINST51042.A "USNA Radiological Safety Program"
(e) Bruker-AXS M4 Tornado User Manual, Bruker 2011

Encl: (1) Facility Description
(2) Facility Radiation Safety Evaluation
(3) General Controls and Practices
(4) General Operating Instructions
(5) Emergency Procedures
(6) Radiation Monitoring
(7) Authorized User Qualification Requirements
(8) Training Requirements
(9) Records

1. Purpose. This instruction outlines the procedures for safe operation of the Bruker M4 TORNADO XRF spectrometer.

2. Cancellation. The instrument updates the former instruction MATHSCIDIVINST 5104.5A to MATHSCIDIVSOP 5104.5A as part of the 5-year review and re-authorization performed by the USNA Radiation Safety Committee (RSC).

3. Applicability. This instruction shall be used to govern operation of the XRF spectrometer located in Michelson 036.

4. Discussion. The Bruker M4 TORNADO is a scanning benchtop XRF spectrometer. The instrument uses X-ray radiation to determine the chemical composition of solids and liquids. The primary purpose of the X-ray spectrometer is to give midshipmen practical experience in using XRF techniques in analytical chemistry. The instrument is also used to support midshipman and faculty research.

5. Responsibilities

a. Laboratory Manager

The Laboratory Manager shall:

- (1) ensure that the Bruker M4 TORNADO is operated only in accordance with this instruction.
- (2) ensure and certify that Authorized Users are familiar with this instruction and with references (a) through (c) and are able to operate the spectrometer safely.

(3) conduct initial radiation safety training of authorized users as required by reference (c), provide appropriate annual refresher training.

(4) conduct periodic surveillance checks to ensure that hazard areas are posted.

(5) maintain the facility records in the facility binder and postings on the facility walls and door.

(6) ensure that required Usage Log and Radiation Survey Logs are properly maintained.

(7) investigate and report alleged or suspected incidents of overexposure to the Radiation Health Officer via the Radiation Safety Committee.

(8) keep RSO informed of any issues related to management of the Bruker XRD laboratory, to include recommending (to the RSO) the removal of Authorized User qualification as needed.

(9) endorse qualified users to the RSC for authorization.

b. Authorized Users

(1) Machine sources at USNA are only to be operated by Authorized Users. In order to qualify as an Authorized User, the individual must meet the following conditions:

i. The individual shall be a DoD employee or student or shall have an official appointment to the USNA faculty/staff.

ii. The individual shall meet with the RSO to discuss radiation safety. The individual shall have been designated as a qualified operator by the Laboratory Manager and authorized by the Radiation Safety Committee, Chemistry Department Chair, and Dean of Math & Science.

iii. The individual shall have attended the training program outlined by the Laboratory Manager. The training will be commensurate with the type of risk they are exposed in the workplace.

iv. The individual shall have received on job training (OJT) from the Laboratory Manager covering the specific procedures and attendant hazards associated with the work to be performed in accordance with this instruction.

(2) Authorized Users are not required to be classified as Radiation Workers. All personnel shall strive to control their radiation exposure in accordance with the "ALARA principle - As Low As Reasonably Achievable".

(3) The Authorized User shall:

i. be responsible for all aspects of spectrometer operation, including the radiation safety of everyone in and around the spectrometer.

ii. ensure that he/she is a Qualified Authorized User, as defined in Enclosure (7) of this instruction, before attempting to operate the spectrometer.

iii. ensure that he/she is familiar with the contents of this SOP, its enclosures and the relevant parts of the references.

iv. Review SOP yearly.

v. Undergo non- radiation worker training initially and each following year.

vi. operate the spectrometer only in strict accordance with this instruction.

vii. complete and record all checks required on the Usage Log sheet before starting the spectrometer.

viii. ensure that radiation surveys are current prior to commencing routine operations.

ix. lock the workstation if the machine is scanning but not attended.

x. in the event of an abnormal shutdown or equipment malfunction, stop all operations, make a note on the Usage Log and contact the Lab Manager.

xi. ensure that the spectrometer lab facility is securely locked when no other personnel are in the lab.

xii. log off the controlling computer when spectrometer operations are completed.

xiii. power down the instrument when operations are completed.

c. Other Personnel

Other personnel, like midshipmen and guests, are allowed access to the Instrument Suite laboratory while the equipment is in operation. If those individuals are using the spectrometer they shall:

(1) be accompanied by an Authorized User while equipment is in operation and/or whenever equipment is energized.

(2) only operate the instrument under the guidance of an Authorized User.

(3) control their radiation exposure in accordance with the "ALARA principle – As Low As Reasonably Achievable".

(4) follow all directions of the Authorized User.

(5) follow all provisions of this SOP.

d. Radiation Health Officer

(1) The Radiation Health Officer shall:

(2) establish standards of radiological health requirements.

(3) specify and provide personnel monitoring or dosimetry devices.

(4) maintain records of personnel exposure.

(5) certify that all users who require thermoluminescent dosimeters (TLDs) have satisfactorily completed the required Radiation Physical examination before issuing TLDs.

(6) investigate alleged or suspected incidents of overexposure and prepare the necessary reports required by the Bureau of Medicine and Surgery and the Navy Radiological Affairs Support Office, Yorktown, Virginia.

e. Radiation Safety Officer (RSO)

(1) The Radiation Safety Officer shall:

(2) have authority to terminate immediately any operation that he/she finds to be unsafe or not in accordance with this or other applicable instructions.

(3) ensure that area monitoring surveys are conducted and recorded every 6 months and prior to commencing routine operations after equipment maintenance or modification.

(4) certify the satisfactory completion of non-radiation worker annual training.

(5) provide support as necessary to ensure compliance with higher authorities.

(6) provide immediate assistance should any radiological safety incident occur.

f. Radiation Safety Committee (RSC)

(1) The RSC shall qualify users submitted by the lab manager as Authorized Users. This may be performed during quarterly meetings or on an ad hoc basis.

6. Review. This instruction will be in effect for the entire time that the Bruker M4 TORNADO spectrometer is installed at the U.S. Naval Academy. The instruction will be reviewed on an annual basis by the Lab Manager and the RSO to ensure that the procedures are current and in full compliance with reference (c). Authorized users must also review this instruction on an annual basis. This instruction must undergo complete review every five years by the Naval Academy Radiation Safety Committee.

7. Approvals. This instruction and all references contained therein have been reviewed and approved by the US Naval Academy Radiation Safety Committee. Operation or maintenance of the spectrometer in any manner or in reference to any procedure not described herein must first be approved by the RSO. Approval of such requested operation, procedure, or both will be temporary and will not constitute general approval by the RSO of the requested operation or procedure.

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MATHSCI
Chemistry Department
Radiation Safety Officer

FACILITY DESCRIPTION

The Bruker M4 TORNADO is a scanning benchtop XRF spectrometer. The instrument uses X-ray radiation to determine the chemical composition of solids and liquids. The primary purpose of the X-ray spectrometer is to give midshipmen practical experience in using XRF techniques in analytical chemistry. The instrument is also used to support midshipman and faculty research.

The spectrometer and the data acquisition/analysis computer are all located in Michelson Hall, Mi-036, as illustrated in Figure 1 and 2. This room is surrounded by two hallways on the northeast and northwest sides and two teaching labs on the southwest and southeast sides. The interior walls are made of standard “2x4” gypsum construction.

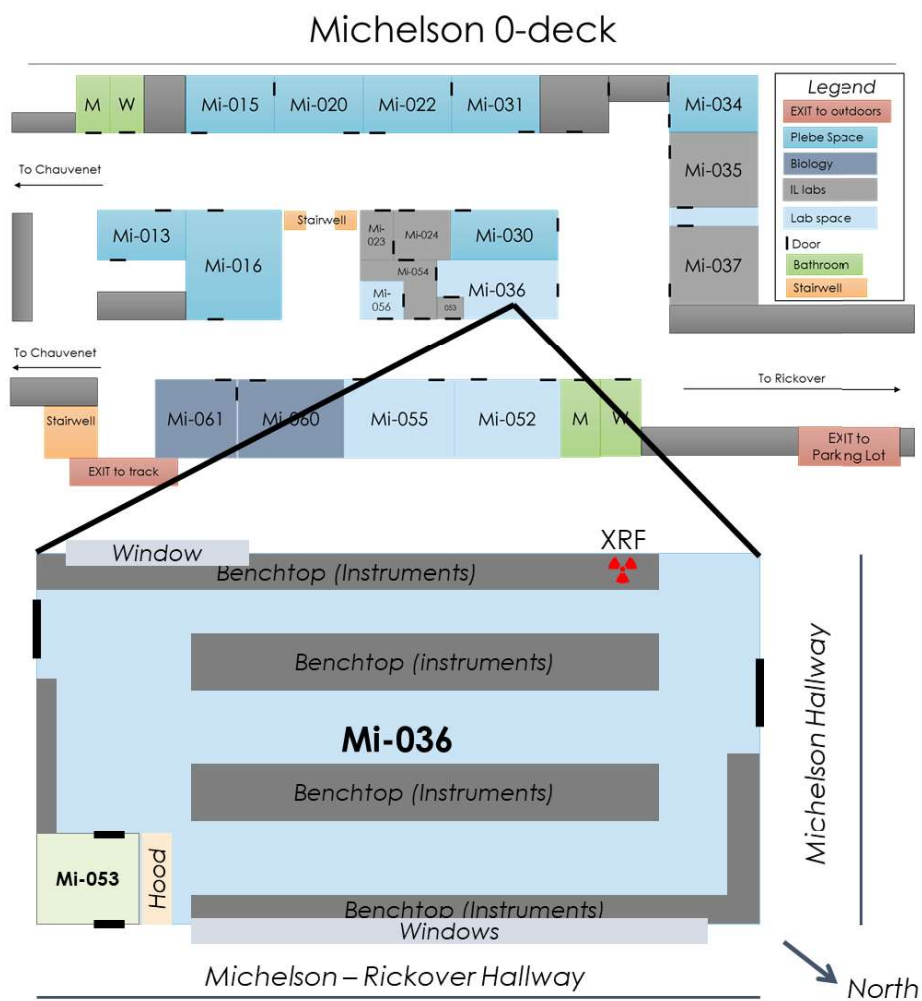


Fig. 1. The Bruker M4 TORNADO is located in Mi-036 within the Instruments Lab, a 38 ft x 46 ft. room on the Michelson Hall lab deck. The orientation of the room is specified in the diagram. The spectrometer is located on the westernmost bench as noted.



Fig. 2. Location of spectrometer (XRF) equipment in Mi-036 as seen from the doorway opening on the northwest side of the room.

Entrance to the lab room Mi-036 is available through the hallway doors on the northwest side, the door in Mi-054 and the shared door with room Mi-053. There are 5 large windows on the north side that occupy most of the northeastern wall. Windows are also located in the doors on the northwest side. The room has 7 standard building HVAC vents overhead, rated at 425 cfm per vent. Volatile radioactive materials are not used in Mi-036. The spectrometer does not generate any radioactive material. As a result, there is no requirement for radiological controls when the spectrometer is off. Doors are posted with emergency contact information. Status lights on the spectrometer, showing operational status, can be seen from the windows on the northeast wall and the window in the northwest side, hallway door.

Bruker M4 TORNADO

The Bruker M4 TORNADO Spectrometer, serial #411001561015, is a benchtop XRF spectrometer designed for the determination of the chemical compositions of solid and liquid samples.



Fig. 3. View of the spectrometer, computer monitor and keyboard. X-ray sources and detectors are located at the top of the instrument.

Experimental Area

The M4 TORNADO is an energy dispersive X-ray spectrometer that can be used for elemental analysis of bulk materials but also for coating analysis (determination of thickness and composition). The special analytical task for the M4 TORNADO is the analysis of small sample areas which can be used for the examination of small particles and inclusions and also for elemental distributions along a line (Line scan) and on areas (Mapping). The unit is equipped with two X-ray sources, Rh and Ag X-ray tubes. The operating parameters may be varied but cannot exceed 50kV at a power of 40 W. The Rh beam uses poly-capillary optics to produce a tightly collimated beam with a focus of 25 microns. The Ag beam is conditioned with a 1 mm collimator. The two beamlines, Rh and Ag, are both contained within the instrument enclosure. Although both sources may be energized simultaneously, only one source can be used at a given time. To prevent exposure of personnel to the X-ray beam, interlocks keep the beam from entering the scattering chamber unless the enclosure is secure. The spectrometer is controlled using a dedicated computer and monitor. The only user controls located on the chamber are the key, power on and off, and the emergency shutoff button.



Fig. 4. Inside the spectrometer chamber showing the computer controlled, sample stage.

FACILITY RADIATION SAFETY EVALUATION

Hazard Discussion

The Bruker M4 TORNADO is classified as an enclosed beam X-ray spectrometer. Safety requirements for closed-beam, stationary X-ray equipment are listed in Section 13.1 of Reference (c). Issues concerning radiation safety that pertain to the spectrometer are:

1. Radiation levels outside of the hutch – Initial surveys of the M4 TORNADO show that rates are less than 0.10 mrem/hr as measured with a Navy RADIAC. As a result, the following requirements have been met.
 - a. The dose rate from high voltage rectifiers shall not exceed 2 mrem/hr.
 - b. Under normal operation, an authorized user would not be able to experience a dose of 0.25 mrem/hr.
 - c. The enclosure is lined with 3mm brass and 3mm Cu that prevents readings greater than 0.25 mrem/hr outside of the instrument.
2. The spectrometer complies with all of the requirements of a closed beam system.
 - a. The radiation source, sample and detector are completely enclosed in a chamber.
 - b. The chamber is protected by a fail-safe interlock system.
 - c. Authorized users are prohibited by the fail-safe interlock system from entering the hutch while the system is producing X-rays. The chamber is locked during operation and can only be opened by using the computer software at which time the X-ray shutter closes.
 - d. The beam cannot operate when the chamber is open while the interlock system is in place.
 - e. Authorized users are considered to be non-radiation workers and are not required to wear dosimetry.
3. The spectrometer is only to be serviced by personnel who have been trained by Bruker-AXS. A Radiation Survey must be performed after any alignment procedure has been performed.
4. The spectrometer does not activate material and, as a result, does not produce any airborne radioactivity.

GENERAL CONTROLS AND PRACTICES

Physical Controls for Michelson 036 (Mi-036)

Security

1. The spectrometer is located in a working chemistry laboratory. Although other individuals may be present in the area, the spectrometer may only be controlled through the password protected software. There is no detectable radiation risk to anyone standing outside of the instrument while the spectrometer is operating.
2. The spectrometer is powered on by a keyed switch and a power on button.
3. The key shall be removed from the switch and secured when the spectrometer has been powered down. The key will then be returned to the lock box in Mi-036. A backup key will remain in the lock box in the Chemistry Prep Room (Mi-016) at all times.
4. The computer that controls the spectrometer is password protected to prevent use by unauthorized users.
5. At all times, one of the following three conditions must be met:
 - (1) Mi036 is occupied by an Authorized User of the XRF.
 - (2) The XRF software is not running (no user logged in).
 - (3) The XRF software is running, but the computer screen is locked to prevent any modification to current XRF conditions.

Warning Devices:

1. Lighted warning signs.
 - a. The spectrometer hutch is equipped with lighted warning signs that operate automatically when the spectrometer controls are set to produce radiation.
 - b. A yellow warning light on top of the hutch will illuminate when the system is powered on. See Figure 5.



Fig. 5. Yellow Warning light.

c. Other controls and lights on the front panel indicate the status of the instrument. See numbered references in Figures 6, 7, 8 and 9.

1. Power key
2. Green Power ON Button
3. Red Power OFF Button
4. Green Power light indicating that instrument is energized.
5. Blue Vacuum light indicating that the chamber has been evacuated. Door cannot be opened in this condition.
6. Close light indicating that the chamber door has been fully closed.
7. XRAY1 button that indicates the Rh tube is energized. Failure of this light is part of the interlock system and will prevent high voltage from being turned on.
8. BEAM1 is the shutter indicator for the Rh beam. If lighted, in conjunction with the XRAY1 light being on, this will indicate that X-rays are present in the housing.
9. XRAY2 button that indicates the Ag tube is energized. Failure of this light is part of the interlock system and will prevent high voltage from being turned on.
10. BEAM2 is the shutter indicator for the Ag beam. If lighted, in conjunction with the XRAY2 light being on, this will indicate that X-rays are present in the housing.
11. Door button allows for opening and closing of the door. In the open position, the shutters cannot be opened.
12. Emergency Stop Button.

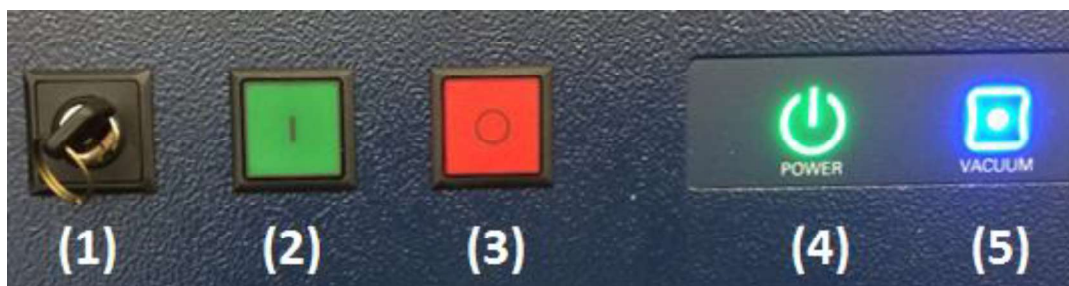


Fig. 6. Left side of the front panel showing the (1) Power Key, (2) Green ON Button, (3) Red OFF Button, (4) Power Indicator Light and (5) Blue Vacuum Light.



Fig. 7. Front panel showing the (6) Close light, (7) X-RAY 1 Power Indicator Light, (8) Red BEAM 1 Shutter On Light, (9) and (10) BEAM 2 X-RAY Power Indicator and Shutter Lights.



Fig. 8. Open/Close Button on the Front Panel.



Fig. 9. Emergency Stop on right side of Front Panel

2. Other signs and barriers.

a. A sign is posted on the spectrometer hutch bearing the conventional yellow and magenta radiation symbol and the words: "CAUTION: RADIATION. THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED. TO BE OPERATED ONLY BY QUALIFIED PERSONNEL".

b. Entrances to Mi-036 are posted with yellow and magenta signs bearing the words: "CAUTION: RADIATION. THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED".

GENERAL OPERATING INSTRUCTIONS

These procedure(s) represent a basic outline for safely operating the spectrometer. More detailed data collection procedures can be found in Reference (a). Only qualified authorized users are allowed to operate the spectrometer unassisted.

1. Obtain the key from the lock box in the Mi-036.
2. Record the starting time and date on the sheet in the Usage Log. Enclosure (8) contains a copy of the Usage Log sheet.
3. Check that the “Emergency Stop” button on the control panel is not pushed in. See Figure 9.
4. On the front panel, power on the spectrometer by inserting and turning the key clockwise. Then press the green Power ON Button. See Figure 6.
5. Log onto the control computer and initialize the M4 software. Allow the computer to fully connect with the TORNADO.
6. Use the computer software or the Open/Close button (Figure 8) to open the chamber. Place the sample or samples onto the scanning stage and close the chamber.
7. Initiate the experimental run through the computer software interface. There are various types of scans and parameter settings that are too numerous to mention in this instruction. Reference (a) contains procedures for programming the instrument for these various procedures. If the XRF software is running, but the authorized user is not present in Mi-036 for the entire scan, the computer screen must be locked to prevent any modifications to current XRF conditions.
8. When the experiment is complete, use the software interface to power down the X-ray tubes.
9. Remove all samples from the instrument and record the ending time and date of the experiment in the Usage Log.
10. Exit the software interface.
11. Log out of the control computer.
12. Power down the instrument by pressing the red Power OFF button on the front panel.
13. Turn the key, counterclockwise, to the ‘Off’ position.
14. Return the key to the lock box in Chemistry Mi-036.
15. Record the ending time in the log book.

Additional standard operating procedure (SOP)

1. Sign into the green log book. Check to see when the survey needs to be reauthorized.
2. Obtain the key found in the XRF lockbox in MI-036.

3. Insert key, turn, then press the green button.
4. Log into the computer using USNA credentials.
5. Click on M4 Tornado icon.
6. Login to the software.
7. Initialize stage.
8. Click on “point” tab.
9. Click “eject” to eject the stage.
10. Place samples within the target area.
11. Close the door (big gray button on the front of the M4).
12. Click “load”.
13. Click “vacuum” ~ 25mbar.
14. CTRL click on 2nd spectrometer, both should say “input”.
15. Depending on which X-ray source you intend to use, click either the “x-ray 1” button (Rh tube), or the “x-ray 2” button (Ag tube) to turn on the X-ray source then click “yes”. Both tubes can be energized at the same time if needed. Click and highlight which source you elect to use.
16. Click on the equilibrium arrow button by the “project” location to load/save a project.
17. Name project: Click “new”, click “save as”.
18. Click 10X.
19. Click up/down arrow to move stage up and down.
20. Click and hold red [+], hold and drag to move stage up or down (in the panel below you can see stage moving up - stop before you get stage to camera).
21. Click side/side arrow to move stage side to side.
22. Click and hold red [+], hold and drag to move stage left or right.
23. Click on multipoint.
24. Change “image name” to short identifier.
25. Click on + point.
26. Set “image #” to 1.

27. Left-click on several points around the sample. Choosing a total of 5-20 points is typical, from which you can obtain the average and standard deviation of the sample's composition.
28. Click on "select all" (all crosshairs on spots should turn YELLOW).
29. Set "image #" to "1".
30. X-ray tube 1 should be highlighted yellow.
31. Click on the arrow down next to "acquire". The most commonly used option for scan duration is selected by clicking on "automatic" and "precise" from the drop-down window. Then click "okay". Scan durations other than "precise" are available. If a less precise but more rapid acquisition of composition is desired, select "fast", and for a more precise, but longer, measurement choose "exhaustive" from the drop-down window.
32. Click on "acquire". An XRF spectrum is acquired for each point you chose (in step 27). Each spectrum will require 30 to 120 seconds to collect, depending on your choice of X-ray source (Rh takes less time than Ag) and scan duration.
33. Click on the arrow down next to "quantify".
34. Click either "spectrum elements Rh method", or "spectrum elements Ag method", depending on which source you used.
35. Shift click lines 5 thru 1 to index the set you want to quantify.
36. Click periodic table icon – click elements you want to quantify – click Rh or Ag "off".
37. Click "quantify".
38. Window to the right of spectrum has a "table" tab. Click on that to see values and averages.
39. Click on calculator image to change the display to "atomic percent".
40. Whichever screens you want to save, go to the equilibrium arrow button next to each and "add to project".
41. Go back and save the project using the equilibrium arrow button.
42. Print the atomic percent table, by clicking on the equilibrium arrow button and "add to report".
43. Click "report".
44. Double click on the box, then highlight and change font size to 16.
45. Click "print".
46. Then delete the data from the box.
47. To run a new sample, delete all points; "select all" on the points, then hit delete.

48. Under the spectrum, click the “trashcan” to delete the previous scan data.
49. Create a “new project”, “save as” for the next pellet.
50. Go back to step 18.

Shutdown

1. Click vacuum to release.
2. Click X-ray 1 and/or X-Ray 2 to turn off.
3. Click on “point”.
4. Click “eject”.
5. Retrieve sample.
6. Click garage door button.
7. Push red power button.
8. Put key away.
9. Log off and sign out.

MAINTENANCE PROCEDURES

All hardware maintenance and alignment procedures will be performed by authorized Bruker personnel. Surveys must be performed after all maintenance.

EMERGENCY PROCEDURES

In the event of an emergency requiring a quick shutdown to minimize risk of human injury, the following procedures shall be followed.

1. Shut down the instrument by turning off the power by pressing the Red OFF button or the Emergency Stop button. See Figures 4 and 9.
2. Lockdown the facility by closing and locking all means of access. For Mi-036, this requires evacuating rooms Mi-023, Mi-024, Mi-053, Mi-054, and Mi-056 and locking all doors.
3. Notify the XRF lab manager (Matt Buck, 3-5217), the radiation safety officer (Daniel Marron, 3-5137), and the 0-deck laboratory supervisor (John Houman, 3-5222) to ensure the space remains secured.

Notify other emergency contacts, such as fire, or police departments, if appropriate (ext. 3-3333).

Michelson 0-deck

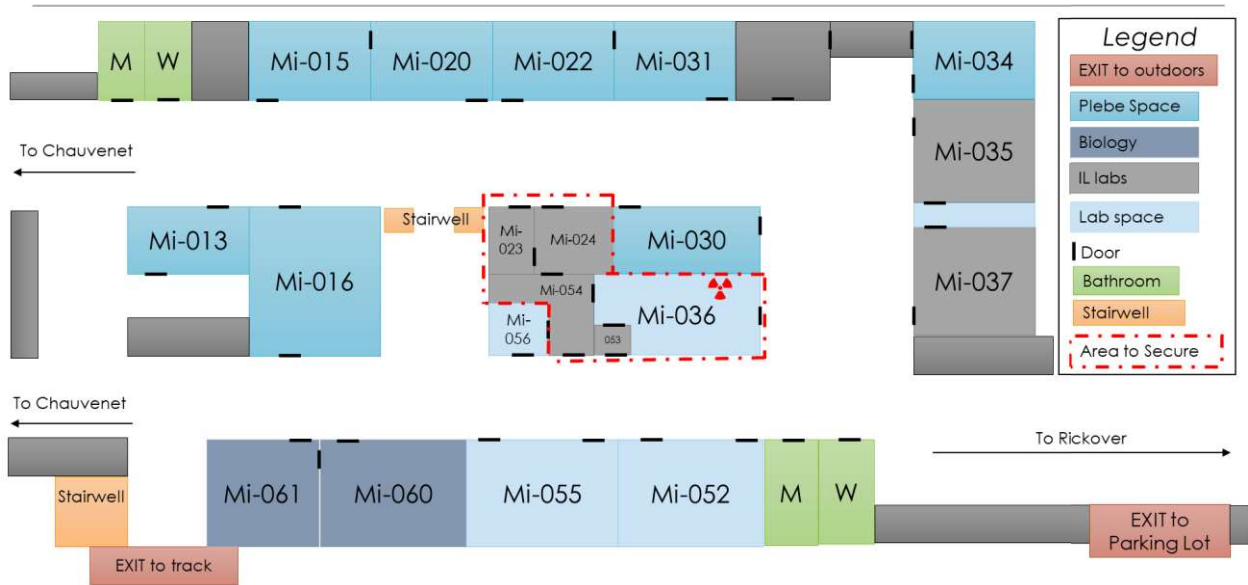


Fig. 10. The above graphic shows how all the laboratory rooms are connected to Mi-036. In the event of an emergency, Mi-023, Mi-024, Mi-054, and Mi-056 should be secured.

RADIATION MONITORING

Personnel Radiation Monitoring Equipment:

All authorized users of the Bruker M4 TORNADO are non-radiation workers and do not require personnel dosimetry.

Equipment Radiation Monitoring Equipment:

1. According to Section 13 of RAD-010 and the USNA Broadscope license, a radiation survey of the spectrometer, is required to be performed at least semi-annually, after service, and whenever an issue with the beam alignment is suspected. (Semi-annual means to perform once in the first 6 months of the calendar year and once in the second 6 months of the calendar year.)
2. Surveys will be performed with an Ion Chamber Survey Meter (RADIAC), suitable for X-ray radiation. Only RASO approved meters shall be used to measure radiation levels needed to satisfy legal and health related documentation requirements.
3. Each location must be surveyed for at least 30 seconds before moving the next location.
4. RADIACS must be in calibration and source-checked prior to use.
5. The survey will be performed by the laboratory manager and documented by the RSO.
6. Full requirements and the sheet used for surveys is found in Enclosure (9).

Permanent Area Radiation Monitors:

A TLD will be placed close to the radiation hutch to serve as an area monitor.

Interlock Testing:

To prevent exposure of personnel to the X-ray beam, interlocks keep the beam from entering the scattering chamber unless the door is secure as described in Enclosure (1). The following steps are for verifying that the interlock system is operating properly, and shall be performed at least semi-annually alongside the radiation survey described above. Two independent tests can be performed to verify that the interlock system is operational:

Test 1:

Attempt to energize the x-ray sources when the Emergency Stop button is engaged.

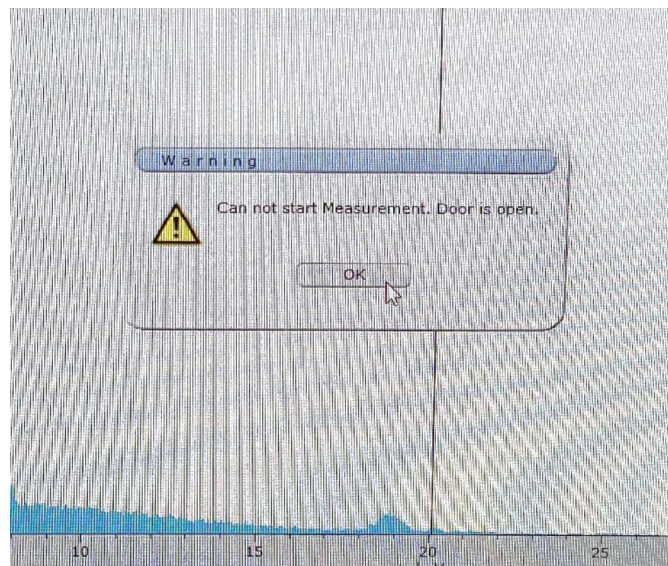
1. When in the depressed OFF position, the red Emergency Stop button on right side of Front Panel, shown in Figure 9, Enclosure (3), prevents the instrument from producing X-rays.
2. With the Emergency Stop button in the OFF position, the tester shall attempt to turn on the X-ray sources by turning Power Key and pressing the Green ON Button, both shown on the instrument front panel in Figure 6, Enclosure (3).

3. The interlock system is working if the instrument is unable to produce X-rays, as would be evidenced if the green ON button and the yellow warning light on top of the instrument would fail to illuminate.

Test 2:

Attempt to initiate an XRF measurement with the chamber of the instrument open. The spectrometer is controlled using software on a dedicated computer and monitor. When an XRF measurement is initiated using the program, either the BEAM 1 (Rh source) or BEAM 2 (Ag source) icons on the front panel become illuminated, indicating that the X-ray shutter has been opened and the measurement is in progress.

1. Follow Steps #1-31 of the “Additional Standard Operating Procedure” for performing an XRF measurement, found in Enclosure (4), but skip Step #13. The interlock test requires that the front door be opened which cannot be done while the chamber is under vacuum.
2. After performing Step #31, open the chamber door using the big gray button on the front panel.
3. Attempt to initiate the XRF measurement by clicking on “acquire” in the program.
4. The interlock system will prevent start of the measurement, and the following error message will appear in the software.



5. The BEAM 1 icon will also fail to illuminate, indicating that the interlock system has successfully prevented the shutter from opening while the chamber door is open.

AUTHORIZED USER QUALIFICATION REQUIREMENTS

A qualification program shall include, as a minimum:

1. Radiation health requirements in accordance with the reference b.
2. Radiation safety requirements in accordance with reference b and reference c.
3. Knowledge of operating procedures in accordance with reference e.
4. Have a full understanding of this SOP.

Users shall be qualified by XRF laboratory manager and a list of the qualified users shall be maintained using enclosure in the instruction. All authorized users shall be qualified by the RSC and signed off by the Dean M&S and Chem Department chair and this list shall be maintained in the local authorization. Only under the circumstance in which a midshipman requires use of the instrument on a continuous and recurring basis shall he or she be certified as a qualified authorized user. Qualification sheets are maintained and documented by the Laboratory Manager. Examples can be found in Enclosure (9).

TRAINING REQUIREMENTS

Initial Training Req.	Laboratory Manager	Authorized User	Other Personnel
Non-Radiation Worker Training	X	X	X
Emergency Procedures	X	X	X
Read SOPs	X	X	X
Read MATHSCIDIVSOP 5104.5A	X	X	
On the Job Training as defined by Laboratory Manager (OJT)*		X	

Annual Training Req.	Laboratory Manager	Authorized User	Other Personnel
Non-Radiation Worker Training	X	X	X
Emergency Procedures	X	X	X
Review SOPs	X	X	X
Participate in Quarterly surveillance as overseen by Laboratory Manager		X	

**Typical Information Reviewed during OJT with Laboratory Manager*

1. Overview of Non-radiation worker training requirements.
2. Review how to properly use the instrumentation.
3. Understand where documentation is located and maintained.
4. Review emergency procedures.
5. Laboratory manager will observe any authorized user using the instrument to ensure it is done so properly.

RECORDS

Usage Log:

1. Each use of the spectrometer shall be documented by the authorized user in the Usage Log maintained for that purpose at the spectrometer control console. Information recorded shall include the following items.

- a. Machine manufacturer, make, model serial number and location of the lab.
- b. Laboratory Manager's name and office phone.
- c. User name and signature.
- d. Date and Start/Stop time.
- e. Radiation exposure time length.
- f. Machine settings (Anode material and maximum operating parameters (kV and mA)).
- g. Target Material.
- h. Verification that radiation surveys are current.
- i. Date RSO reviewed log

The Usage Log sheet is shown in Enclosure (9).

Radiation Survey Log:

1. A complete radiation survey for each source, with the spectrometer running under typical conditions, shall be conducted every six months or whenever maintenance has been performed which might result in an increase in radiation levels. Data recorded shall include the following.

- a. The date and time of the survey.
- b. The name of the surveyor.
- c. Date of last survey and interlock check.
- d. Verification of the interlock check.
- e. Survey meter used to include: Model #, Serial #, Calibration and Due date.
- f. System parameters including: Anode, kVp and mA.
- g. Diagram showing survey points.
- h. Readings (mR/hr) at the survey points.

- i. RSO signature.
2. This radiation survey satisfies the requirement for 6-month radiation surveys and 6-month interlock checks.
3. The sheet for the radiation survey is shown in Enclosure (9).

Authorized User Authorization Sheet:

This sheet is found in Enclosure (9).

Lists of Qualified Authorized Users:

This sheet is found in Enclosure (9).

Machine Usage Log – Bruker M4 Tornado (Mi-036)
Serial #: 411001561015

User Name (Print)	Signature	Date	Time *	Radiation exposure time length	Max operating voltage (kV) and current (μA)	Anode (Circle) **	Target Material	Date of Last Survey
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		
			Start: _____ Stop: _____			Rh / Ag		

* exposure time can be calculated as “Stop” minus “Start”
** Rh and Ag parameters – 50 kV and 30W (maximum)

Laboratory Manager: Matt Buck (mbuck@usna.edu) Phone: 3-5217

RSO Review: _____

Enclosure (9)

RADIATION SURVEY
BRUKER M4 TORNADO (Serial #: 411001561015) MI-036

(Semi-annual means to perform once in the first 6 months of the calendar year and once in the second 6 months of the calendar year.)

Date _____ Time _____ Performed by _____

Date of last: Facility Review and Re-Authorization & SOP Update (5 yrs) _____

General Radiation Survey (semi-annual) _____

Interlock check (semi-annual) _____

Interlock verified (initials) _____

Survey Meter

Model # _____

Serial # _____

Calibration Date _____

Due Date _____

System Parameters

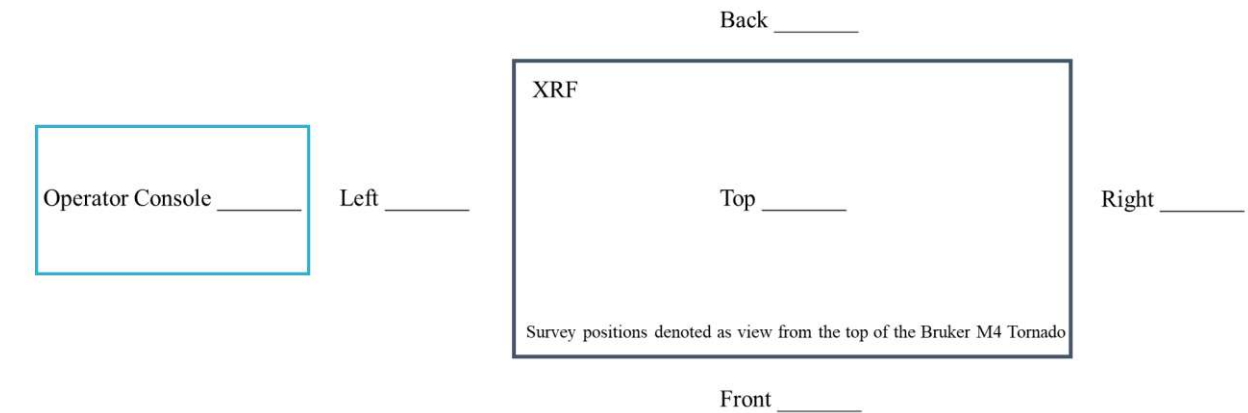
Anode: Circle Below

Rh (50 kV, 800 μ A)

Ag (50 kV, 800 μ A)

Survey points are 5 cm from the enclosure. Readings (mrem/hr). Results must be less than 0.25 mR/hr.

Back Wall in Mi-036



RSO review: _____

AUTHORIZED USER QUALIFICATION REQUIREMENTS
BRUKER M4 TORNADO (Serial #: 411001561015)

Name: _____

1. Familiar with radiation health requirements of NAVMED P-5055 and RAD-010.

Laboratory Manager/Date

2. Trained by the laboratory manager on the identification of radiation safety hazards, warning systems and safety precautions associated with the instrument.

Laboratory Manager/Date

3. Properly trained on performing radiation surveys.

Laboratory Manager/Date

4. Familiar with operating procedures and MATHSCIDIVSOP 5104.5A and able to safely operate the Bruker M4 TORNADO spectrometer.

Laboratory Manager/Date

5. Qualified.

Laboratory Manager/Date

6. RSO Review

RSO/Date

7. RSC Vote on Authorization

RSC chair or delegate/Date

8. Department Chair Authorization

Department Chair, Chemistry/Date

9. School Dean Authorization

Dean M&S/Date

QUALIFIED OPERATORS BRUKER M4 TORNADO
(Serial #: 411001561015)

Name	Date Qualified	Laboratory Manager Signature