

**Principal Investigator:**

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**Secondary Contact:**

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**Emergency Information:**

Strobel (cell): 720-261-2748

BBR (Gary Bors): 202-510-8577

All other emergencies: 911

**Purpose:**

This laboratory is used for X-ray crystallography and general sample preparation. Chemical substances are characterized and loaded within diamond cells in sub-mg quantity. This lab contains common solvents. Compressed gases are used intermittently. A 473 nm laser pointer (~1 mW) is used for the gasket indentation spectrometer. Several hand tools are kept in this lab.

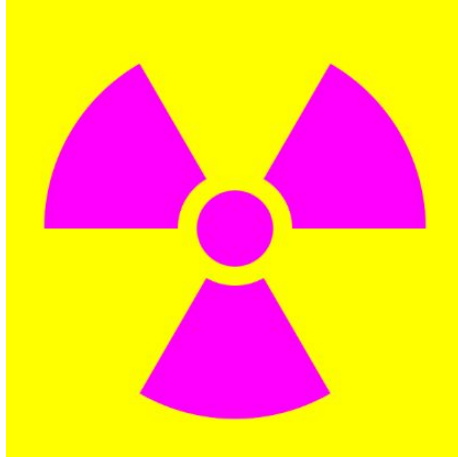
*All laboratories and facilities on the Broad Branch Rd. campus are controlled areas. Specific training must be completed and documented before working in this laboratory / facility. All General Laboratory Safety Rules apply in this space.*

***Radiation Safety***

Users of the X-ray Diffraction Laboratory must complete the general X-ray radiation safety training outlined in this form, as well as instrument-specific training, in order to use these facilities.

X-Ray radiation is a form of ionization radiation that is potentially very hazardous. X-ray radiation poses the risk of extremely dangerous direct bodily harm, and potential future health risks associated with radiation exposure. The most intense—and therefore most dangerous—part of the instrument is the path of the incident X-ray beam. Thus, care should always be exercised to know the expected path of the incident beam. Scattered radiation is typically of reduced intensity and poses a smaller health risk to the researcher.

The radiation safety policy requires us to put the following sign on the door, which indicates the presence of ionizing radiation. Users must obtain permission to enter XCL (Room 108a) from the responsible staff member listed above. A sign above the laboratory door is illuminated with X-ray generators are energized. This sign is an indication that X-rays are actively being produced within the lab.



*International Radiation Symbol – Be aware! This symbol indicates the presence of radiation.*

It is important to remember the ***Inverse Square Law***: radiation intensity is inversely proportional to the square of the distance from a point source. Always stay as far away from the actual point source as possible.

There are several properties of X-rays that make this type of radiation particularly dangerous to use in the laboratory. X-Ray radiation cannot be sensed by humans! Some people feel a tingling sensation on their skin when exposed to X-rays from an analytical instrument. They are not feeling the X-ray beam, but rather they are feeling charged air particles produced by the interaction of the ionizing X-rays with air. If you ever feel a tingling sensation when working around any X-ray instrument, immediately turn off the instrument and contact the responsible staff member. Only some people feel this tingling sensation; do not assume that the instrument cannot harm you if you do not feel a tingling sensation.

We are committed to the goal of keeping occupational doses and public doses **As Low As Reasonably Achievable, **ALARA**. This goal serves as the overall controlling aim of radiation safety, and commits all users of radiation sources to the principle that all unnecessary exposure is to be avoided. There are three general rules to reduce a person's exposure to any type of ionizing radiation. These rules provide the framework for achieving an **ALARA** program as required by the federal Nuclear Regulatory Commission (NRC).**

1. Reduce the time you are exposed to the radiation source.
2. Increase the distance between yourself and the radiation source.
3. Increase the shielding between yourself and the radiation source.

The X-ray diffraction laboratory has three diffractometers that generate X-ray radiation for the purpose of crystallography experiments: Bruker D8 Discover with copper radiation, Bruker D2 phaser with copper radiation and a custom Rigaku/Huber/Incoatec “Ingaku” system with silver radiation. All instrument have X-ray shielding and advanced safety systems so radiation levels outside of these instruments are effectively zero.



X-ray Diffractometers at GL. Left – Bruker D8; center – Bruker D2 phaser (powder), right – “Ingaku” (single crystal)

### ***Dosimeter badges***

Dosimetry film badges are positioned in the laboratory to monitor radiation levels. The dosimetry film badge contains a piece of radiation sensitive film. The film is packaged in a light proof, vapor proof envelope preventing light, moisture or chemical vapors from affecting the film (see image below). The film badge is a monitoring device and provides a permanent record. It is able to distinguish between different energies of photons, and it can measure doses due to different types of radiation.

GL provides optional personal dosimeter badges for regular users. Badges need to be worn correctly so that the dose they receive is accurately recorded. The badges should be worn on the body between the neck and the waist for man and near waist for woman. When not in use, film badges may be stowed in the storage case located outside the XCL. Inquire with the PI to obtain a personal badge.



*Personal dosimetry badge – Area monitors are used in the lab. Personal badges are optional.*

Occupational radiation standards for the District of Columbia are posted outside the door of this lab and can be obtained online at <https://dchealth.dc.gov/node/173882>.

### ***Instrument safety instructions***

**All users must obtain instrument-specific training in order to operate equipment lab.** There are tutorials and manuals for each X-ray diffraction instrument. Before you start your experiment, you must spend time to read them for your safety. **All users must first become "authorized**

**users" to be able to operate the instrument independently.**

For all instruments:

1. Know the expected path of the incident X-ray beam. Always keep all body parts outside of this path.
2. Understand all warning symbols and instrument lights.
3. Whenever possible, keep safety doors to the instrument closed and latched.
4. Understand all safety interlock systems and emergency shutdown procedures. You may not, under any circumstance, override any of the safety interlock features on the X-ray generators, safety enclosures, goniometers, collimators, tube shields and shutters.
5. Always use the instrument log book and keep detailed notes.
6. Inform the PI immediately of any problems or safety incidents.
7. Periodically test for X-ray radiation around the electro-magnetic shutter and make sure the X-ray shielding works properly by using a Geiger counter.
8. All users must consult with PI prior to working alone / after hours in the laboratory.

### **X-ray diffraction equipment authorization**

#### Instrument Authorization

**1. Bruker D2 Phaser (Bruker)**

X-ray source:	Cu K <sub>α</sub> 300W tube	_____	
Detector:	Silicon strip	Staff Signature	Training Date

**2. Bruker D8 (Bruker)**

X-ray source:	Cu K <sub>α</sub> Microfocus	_____	
Detector:	Area detector	Staff Signature	Training Date

**3. "Ingaku" (Rigaku/Incoatec/Huber)**

X-ray source:	Ag K <sub>α</sub> Microfocus	_____	
Detector:	Scintillation counter	Staff Signature	Training Date

***Additional safety information***

- Properly label, store and dispose of all chemicals and waste.

- Chemical safety datasheets are available in R109 and at <https://www.msdsonline.com/>. Chemicals, aside from common solvents are not to be stored in R108a.
- Specific training is required for the gasket indentation spectrometer which includes a 473 nm laser pointer (~1mW). Users must follow all laser safety procedures and never remove the laser enclosures.
- Specific training is required for all benchtop electric tools including the hobby drill press.
- Personal protection equipment including gloves, goggles and lab coats should be used when necessary. All of these items are available in the lab.
- Users must follow all appropriate safety protocols when working with and transporting compressed gasses.
- Fire extinguishers are located near the laboratory door and in the hallway.
- The emergency eyewash is located at the sink. The emergency chemical shower is located in R109.

#### Laboratory User

*I agree that I have thoroughly read and understood this laboratory safety document. I have access to this safety information at all times when I am working. I have been trained to be able to identify the hazards to which I may be exposed and to follow the work practices and procedures discussed in this document. I certify that I will conduct my research work safely and that I will be responsible for following stated safety policies.*

\_\_\_\_\_  
User Name (Print)

\_\_\_\_\_  
User Signature

\_\_\_\_\_  
Date

#### Principal Investigator

*I certify that the information presented in this safety document is accurate and complete. I agree to comply with all safety procedures and to fully train and supervise all researchers under my direction.*

\_\_\_\_\_  
PI Signature

\_\_\_\_\_  
Date