

X-Ray Safety Training for Students of Laboratory Courses

I. General Laboratory Safety

- C We have a safety program in place
- C Students and instructors alike play active roles in the safety program
- C Students can expect us to set up and run safe experiments
- C Students are expected to work safely
- C Laboratory safety literature is included in the laboratory manual
- C Students are expected to read the laboratory safety section of their laboratory manual

II. General X-Ray Safety

A. Brief Description of the Regulatory Chain

All radiation-producing equipment on this campus must have a license to operate and every operator of this equipment must have proper training and must be added to the license. The Office of Environmental Health and Safety manages this license. It also conducts regular inspections of the equipment and it provides radiation safety training for all operators and principal investigators. Their authority to issue this license comes from the State of California which in turn comes from the Federal government.

B. The Nature of Radiation

1. Radiation units

- rad radiation adsorbed dose – a unit describing the amount of radiation that is absorbed by an object
- rem radiation equivalent in man – a measure of the amount of damage that a rad of radiation does to the human body. One rad of x-ray is equal to one rem.

2. Typical exposures

- | | |
|-------------------------------------|---------------------|
| Cross country flight | 300 mrem |
| Background | 150 - 300 mrem/year |
| Cat Scan (20 slices) | 3000 - 6000 mrem. |
| Chest x-ray | 15-65 mrem/view |
| Exposure to x-ray users at UC Davis | 10 mrem/month |

3. Federal and local exposure limits

- | | |
|----------|--------------------------------------|
| Federal | 5000 mrem/year full body dose, adult |
| UC Davis | 2500 mrem/year full body dose, adult |

C. Summary of the Accident in Chemistry

Students were repairing the shutter to the x-ray tube. The instrument was on, the warning lights had been disabled and the cabinet's interlocks had been overridden. The shutter is located very close to the source of the x-rays so the intensity of the beam was as high as possible in this system. The students received severe burns to the fingers and eventually had to have skin grafts. Campus reviewed the laboratory's operating procedures and training procedures. It also reinspected every instrument on campus and at UCDCM and it called every operator in for renewed training.

D. Strict Policy on Safety in the X-ray Diffraction Laboratory

We appreciate EH&S's efforts and we follow all of the rules regarding x-ray safety. Anyone who doesn't follow these rules will not be allowed to operate the equipment. No exceptions.

III. X-Ray Safety Specific to the Scintag Diffractometer

A. Description of the Safety Section in the Scintag Operator's Manual

Section 2 of the operator's manual covers all safety issues regarding this instrument and the laboratory that it is in. This includes proper operating procedures, training procedures, inspection and emergency procedures.

B. Students are expected to read the whole safety section of this manual

Please read it carefully.

C. A Brief Description of the X-ray Diffractometer

1. Nature and Power of the X-ray Source

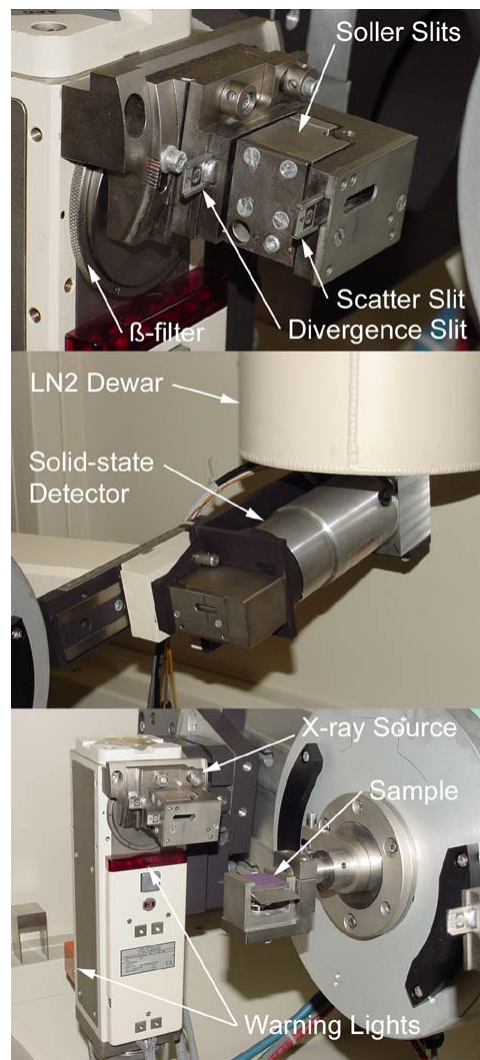
The source is in the tube tower which is the component on the left arm to the left of the center of the instrument. The tube tower shields the room from all radiation except in the direction on the specimen and even that is shielded when the shutter is closed. The maximum power for this source is 2.2 kW and the operating power level is 1.8 kW. The maximum accelerating voltage during normal operation is 45 kV while the highest intensity is at about 8 kV. The normal operating current is 40 mA.

2. System Interlocks

Cabinet The cabinet provides shielding from x-rays. When the cabinet is opened the system will activate its interlock circuits which will cause the shutter to close.

Interlock Reset If the interlock for the x-ray source is activated the shutter cannot be reopened until it has been manually reset.

Power Supply The power supply for the x-ray source will shutdown whenever any of the operating parameters are out of bounds and it will not energize the tube unless cooling water is running. It won't energize the tube if any of the lights on the control panel have burned out.



Tube Tower	The tube is energized at all times. Large red lights are lit whenever the shutter is open.
Cooling Water	The chiller keeps the tube from overheating. If it is turned off for any reason the tube will be de-energized. The chiller may shut down if the water reservoir is too low, if the water temperature is too high or if the water pressure exceeds preset limits.
Goniometer	Clutches in the goniometer help prevent damage in the event of a collision. Limit switches and the microcontroller detect when the goniometer moves one of the arms past preset limits.
Detector	The detector requires cooling by liquid nitrogen. If all of the nitrogen boils off and the detector begins to warm up the detector's power supply will shut down to prevent damaging the detector.

3. Additional Safety Issues

- C The tube is energized at all times. The shutter is open when the red lights are on.
- C The students must be accompanied by their instructor.
- C The instructor will wear full body and hand dosimetry. Dosimetry will indicate that the operator has been exposed to x-rays. It is not a protective device.
- C Our powder specimens may present a minor hazard, not because of toxicity of the chemicals but due to the very fine particle size. Handle them properly.