1. Introduction

Room 210 of the Free-Electron Laser (FEL) Facility at Jefferson Lab (hereafter referred to as User Lab 3) has a transport system carrying THz radiation from the accelerator downstairs into the lab. Normally the hazard is dealt with using a laser personnel safety system (LPSS) with two shutters between the beamline and the lab. Occasionally the LPSS is not available but the THz is required for diagnostic purposes. This LSOP describes operation in this non-standard mode, in which the THz light is completely contained within a class I laser enclosure.

2. Personnel

Since the THz light is enclosed in a class I laser enclosure, no restrictions are in place for personnel except that personnel must be escorted if they are not GERT and EH&S orientation trained.

3. The IR Upgrade THz light source

The IR Upgrade Free-electron laser produces THz light via multiparticle enhanced synchrotron radiation as the electron beam traverses the magnetic chicane around the upstream mirror of the FEL cavity. The light is broadband, from DC to a frequency governed by the bunch length, but which is typically 1 THz, or 33 cm^{-1}. The spectral power density is up to 10 Watts per cm^{-1} (1 cm1 is a unit equivalent to 30 GHz in frequency space). The maximum total power is thus 10 Watts/cm—1 multiplied by the spectral bandwidth. The THz beam is transported in a vacuum of 100 millitorr from a diamond window in the vault to lab 3 where it is delivered through a 1 degree wedged diamond window. The beam at the window is diverging with an angle of about 125 mrad and the source is 2mm high by 3mm wide. The light is pulsed, being “on” for the duration of the pulse length, and “off” in between. Since lasing is not required for the generation of THz light, the pulse repetition frequency can take any value from 585 kHz to 74.85 MHz in multiples of two. The maximum power per pulse is ~10 microJoules.

For purposes of safety we classify this THz beam as a Class IV laser.

4. Hazards

The transport system will completely enclose the THz radiation when operated in class I mode. As long as the shield is intact there is no hazard. The power will be absorbed in a water-cooled dump inside the enclosure.

Non-beam hazards

The non-beam hazards present in User Lab 3 are, in order of their likelihood, electrocution, oxygen deficiency, and fire.

Some of the experimental equipment has electronic controls. Only qualified personnel shall do work on electronics. Proper lock, tag, and try procedures must be followed. Users working on electrical equipment must have completed SAF104, Lock, Tag, and Try.

There is a nitrogen line used to let up the vacuum system. An orifice restricts the flow rate to prevent rapid inerting of the lab. In addition, there are oxygen sensors in the room that activate an alarm if the percentage of O_2 falls below 19.5%. The oxygen sensors are monitored in the MCC. The lab is considered an ODH 0 area. Users may bring in a small dewar of liquid nitrogen to fill detectors if necessary. Quantities up to 2 liters are not a problem. An ODH assessment will be required for any larger quantity. The penetration for the THz beam is sealed with expandable foam to a depth of 12 inches or more to keep helium from entering the room from the vault. This foam must not be removed without permission from the safety warden for the lab.

The user must keep cables and cords routed out of access routes in order to reduce trip hazards. Reroute cables or wires if necessary to reduce these hazards.

5. The laser environment in the user lab

The THz source is located in the accelerator vault. The THz light is transported from the FEL to User Lab 3 through an evacuated metal transport line. Two safety shutters are interlocked to the vacuum for this transport line so light cannot exit the enclosure in lab 3 with the beamline in an incomplete (esp. open) state. All vacuum pipes are labeled as such, and are not to be opened without permission from the optical transport system owner (now M. Shinn). In class I operation these shutters are buggered. This status must be entered into the bugger list in Devlore and must be removed before normal operation can resume. The enclosure is also labeled as a class I enclosure. Tools are required to open the enclosure. The enclosure may not be opened without the permission of the LSS for the FEL (not Stephen Benson).

Fire Protection System

The fire protection system is a layered system that includes:

1. **Detection systems** such as local smoke detectors in the laser personnel safety system (LPSS), building smoke alarms connected to the building fire alarm panel, and manual pull boxes and,

2. **Suppression systems** consisting of wet pipe sprinklers throughout the upper level of the FEL and portable fire extinguishers.

The LPSS smoke detectors not only provide a machine protection function (personnel are unlikely to be present when they detect smoke) they also reduce the likelihood of fire spreading due to the FEL and are thus a good idea from a fire safety standpoint as well. The LPSS smoke detectors are connected to the building Fire Alarm Control Panel (FACP) and are programmed to activate a trouble signal if they detect smoke. The smoke detector that has been activated by smoke will display a slow flashing red LED on the plastic cover of the detector. The FEL operator must find the cause of the smoke production and eliminate it before resuming laser beam delivery.

The building smoke detectors activate an alarm signal in the FACP that will sound the building audible alarms. If an LPSS smoke detector is activated, the building audible alarm will not sound. The building audible and visual alarms sound when smoke in the area exceeds the trip level of the building smoke detectors. These are connected to the FACP in the FEL lobby and are monitored by the MCC and Security Guard Post 2 at the main gate. They do not affect the state of the FEL or accelerator.

Manual Pull boxes are present near the building exits and should be used when smoke or a fire is observed but the alarm has not yet activated. Operating a manual pull box is the fastest and best way to evacuate the building and notify emergency responders.

Portable fire extinguishers are present in all laser labs, usually next to the door. They are class C and can be used to extinguish small fires.

Fire suppression sprinklers are present in all labs and will activate (spray water) if the heat from a fire reaches 165°F for a period of 5 minutes. Each sprinkler head activates individually as the heat from a fire spreads.

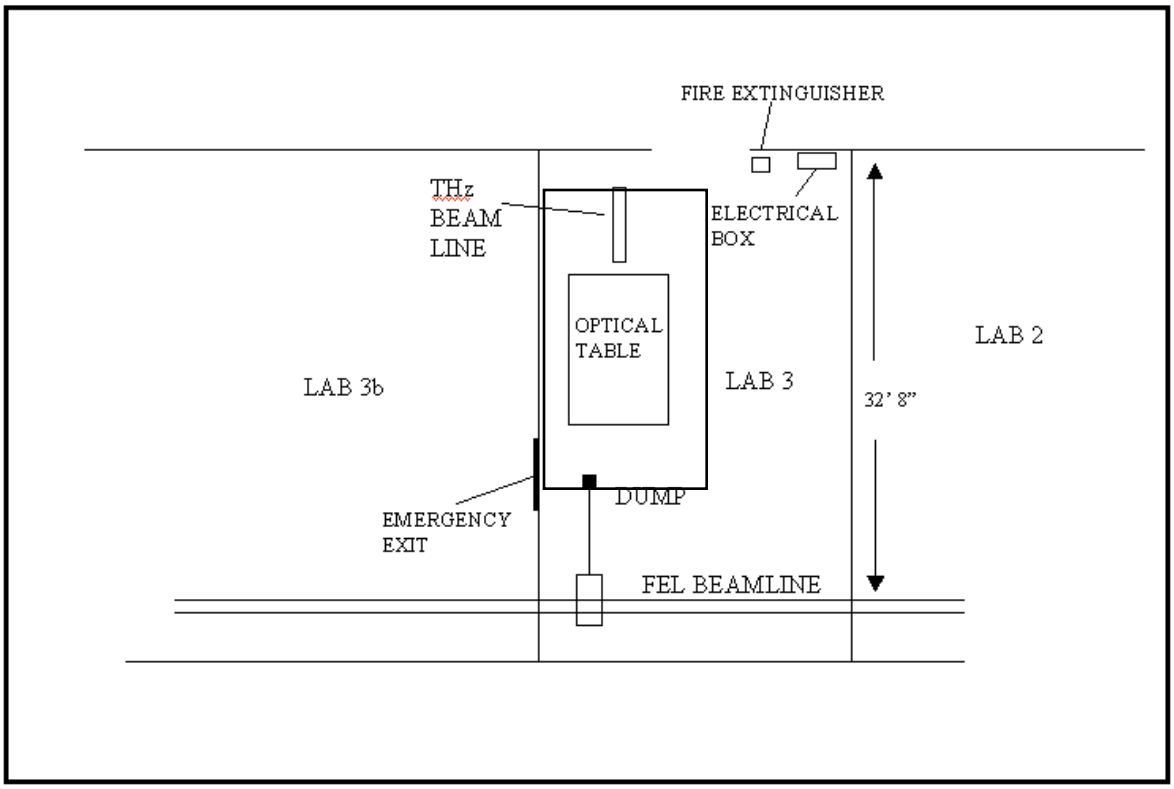

Figure 1. Plan view of User Lab 3. Location of the fire extinguisher, and the LPSS panel are shown. Both the FEL and the THz beamlines are indicated.

6. Procedures

When operation in class I mode is required the transport between the beamline coming up from downstairs and any diagnostic equipment must be covered. The enclosed path must also have provision for dumping the beam into a water cooled beam dump. The enclosures must be labelled with labels indicating that the enclosure is a class I enclosure and the removal will expose a class IV laser source. The enclosure must be inspected by the LSS for the FEL facility (now Stephen Benson) before electron beam operations commence. At that point the two shutters in the beamline may be buggered open. The bugger must be recorded in the Devlore bugger log.

When operation in class I mode is finished, the buggers must be removed and the operation of the shutters checked. At this point the covers may be removed from the transport between the transport from downstairs and the diagnostics.

Off-Normal Procedures

In the event of fire in the user lab, a fire extinguisher in the room may be used. If the fire cannot be extinguished in this manner, the user should leave the room, pull the nearest fire alarm box and exit the building. If the fire alarm sounds due to a fire outside of the lab, all personnel must immediately evacuate the building. In the event of a building fire alarm, the FEL Operator must terminate lasing by crashing the optical control room LPSS (push the red crash button next to the OCR door). The FEL Operator must also close the drive laser shutter in order to shut off the electron beam. The operator should then verify that personnel have evacuated the user labs and then exit the building and gather at the muster point (just outside the main door). The operator should then dial 4444 and report the fire. Every month the fire extinguisher must be checked and documented.

In the event of a building ODH alarm the users must crash the LPSS and exit the lab. The crew chief in the MCC must be contacted at x7045 or 9-630-7050 once the building is evacuated. Finally the ODH sensor in the experimental enclosure must be re-calibrated if necessary.

Alignment

All alignment must be done before the final transport is closed up. It must be done using a class II or class IIIa laser while the accelerator is not in BEAM PERMIT. If the alignment must be checked, the accelerator must be brought out of BEAM PERMIT, the enclosure must be opened under LSS supervision, the alignment done, and the covers must be reinstalled and inspected by the LSS.

7. Laser controls:

The hazard in this system is handled passively so there are no active laser safety controls.

Oxygen deficiency sensors are located in the user labs. The PSS Group must check them every 6 months.