Laser Technology Laboratory Safety Rules

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These are the Safety Rules for the Laser Technology Laboratory located in Thorvaldson Building, room B9A. These rules are additional to those of the University of Saskatchewan 'LabSafety Rules' and the General and Laboratory Safety Rules at the SSSC.

Laser Safety is the responsibility of the laser system operator.

Laser Safety is more than simply wearing a pair of laser safety eyewear.

Users will follow all rules presented whether stated or implied.

Requirements for Access to the Laser Technology Laboratory

1- University of Saskatchewan, Department of Health, Safety & the Environment, Laboratory Safety Course (must be valid for position held).
2- University of Saskatchewan, WSEP/DHSE Laser Safety Course (must be valid for position held).
3- Must follow Standard Operating Procedures (SOP).
4- Must follow Laser Technology Laboratory Safety Rules in effect.
5- Must fill and sign the SSSC Laser Safety Access Form and give a copy directly to S. Brunet.

As such, this requirement applies to anyone wishing to be present while another individual is operating equipment (such as a supervisor present while a graduate student collects data) and for anyone receiving training in operating a Class 3/III or Class 4/IV laser system.

Those wishing to be present while SSSC staff operates a Class 3 laser for data acquisition for their sample can fulfill requirement #2 by viewing the laser safety video available via the Research Officer responsible for laser safety. This is intended to be a temporary measure until a laser safety course is available.

Requirements for Operating Lasers in Thorvaldson B9A

- Training by SSSC personnel on operating the laser system (to the level specified on the Training Form); this requirement is for each laser system.
- A copy of the Training Form must be given to S. Brunet.

- The lasers systems can be operated by NEW users ONLY during regular working hours. Permission to work after regular working hours can be requested after an individual has gained sufficient experience, typically 40 hours of unsupervised time over at least 5 different days for a Class 4 laser and typically 25 hours of unsupervised time over at least 3 different days for a Class 3 laser.
- Permission to work after regular working hours may require that the individual not be alone in the laboratory.

Current Legislation in the Province of Saskatchewan

The Radiation Health and Safety Act, 2005, Division 2: Laser Radiation (summary)

- Laser Classification: ANSI Z136.1-2000.
- Installation, operation, labelling and maintenance: ANSI Z136.1-2000
- Duty to Inform: Class 2, 3a, 3b or 4 as to the hazards of this radiation and draw attention to viewing restrictions.
- Exposure: no deliberate exposure of direct beam to any body part of any person.
- Operator: formally trained to carry out procedures for which that laser is to be used AND can demonstrate knowledge of equipment, biological effects, necessary safety procedures.

Laser Classification

- Class I levels of laser radiation are not considered to be hazardous.
- Class IIa levels of laser radiation are not considered to be hazardous if viewed for any period of time less than or equal to 1×10^{3} seconds but are considered to be a chronic viewing hazard for any period of time greater than 1×10^{3} seconds.
- Class II levels of laser radiation are considered to be a chronic viewing hazard.
- Class IIIa levels of laser radiation are considered to be, depending upon the irradiance, either an acute intrabeam viewing hazard or chronic viewing hazard, and an acute viewing hazard if viewed directly with optical instruments.
- Class IIIb levels of laser radiation are considered to be an acute hazard to the skin and eyes from direct radiation.
- Class IV levels of laser radiation are considered to be an acute hazard to the skin and eyes from direct and scattered radiation.

For more details on laser classification please refer to ANSI Z136.1 – 2000, Section 3.3 and ANSI Z136.5 – 2000 Section 3.2.

General Laser Safety Rules

- The installation, operation, labelling, and maintenance of laser or laser systems will be done in accordance with ANSI Z136.1-2000
- All individuals in the laboratory must obey the Safety Rules at all times.
- The operator of a laser system is responsible to ensure that all necessary safety precautions are followed at all times.

- The operator of a laser system is responsible for the safety of the individuals present in the work space.
- All users will follow the Laboratory Safety Rules set by the University of Saskatchewan and Workplace Safety and Environmental Protection (WSEP/DHSE).
- Class 3b and Class 4 Lasers will be operated "under the direct supervision of an individual knowledgeable in laser safety" ANSI Z136.1 – 2000.
- All Safety Rules of the SSSC, the Laser Technology Laboratory, and the equipment used must be followed at all times (this includes safety rules supplied by manufacturers for every piece of equipment present in the laboratory and updated SOP).
- Operators of laser systems must ensure that they follow all updated safety rules.
- Individuals installing equipment in the laboratory are responsible for informing others of the safety warnings included with the equipment being installed.
- The individual must inform the Research Officer responsible for the project of all safety warning or protocol supplied with the equipment they operate.
- No one is allowed to dispose or remove the safety warning accompanying equipment.
- DO NOT put items into laser cavities as this could result in chock hazard and stray beam hazard.
- Operators must read the SOP for the instrument which they are using as they may contain other safety warnings specific to the equipment used as well as updated warnings.
- The switch key must be removed from the controller unit once you are finished using the laser. "The master switch shall be disabled when the laser or laser system is not intended to be in use." ANSI Z136.5 – 2000 Section 4.6.4 page 12
- Operators of laser systems will not be allowed to remove laser beam covers (or laser beam housing). Only individuals trained in the alignment of some laser systems may gain this dispensation with written permission from Research Officer responsible for Class 4 lasers.
- Interlock(s) on the laser systems or outside the laser systems will not be defeated during operation of the laser systems. Only individuals trained in the maintenance of some laser systems may gain this dispensation with written permission from Research Officer responsible for Optical Spectroscopy.
- If a 'Panic Button' is present in the room, it will only be used for its intended purpose.
- Users of Class 4 laser systems will ensure that unprotected insulated wire (and any other rubberized items) will never be in the beam path.
- Only SSSC personnel will change the Nitrogen gas cylinders. Users will not change the pressure output of the regulators.

Unattended Lasers

- If a Class 3 laser system is to be left running while unattended, the shutter at the beam output will be closed if accessible. For lasers embedded in other instruments without direct access to the laser shutter, the instrument(s) will not be left running in a manner which gives direct access to an exposed beam.
- Class 4 laser will not be left running by the users while unattended. If it is necessary to leave the laser running, the output beam will be blocked using a laser beam blocker secured to the table and no laser beam will be left uncovered.

- During maintenance, it may be necessary that the laser be left unattended. The warning sign indicating "Laser maintenance in Progress – NO ENTRY" will be posted at the main doors of the laboratory.

Minimizing Risks

- Lowest laser energy will be used whenever possible.
- All risks and hazards will be minimized. No unnecessary hazards will be created.
- All unnecessary objects will be removed from proximity of the laser beam and optical table.

Eye Level

- The beam path will be kept away from eyelevel at all times. Proper precautions, such as turning laser off AND using beam dumps will be taken when picking items from the floor.
- Only chairs and stools with high seating will be used (such that the eye level MUST be above that of the laser beams). No extra chairs or stools will be brought into the laboratory.

Chemicals

- Because there is no fume hood in Thorvaldson B9A, sample preparation must be done elsewhere to respect the University of Saskatchewan Laboratory Safety rules.
- When working with Class 4 lasers, consideration for the flammability hazard will be given. Only the amount of flammable chemical necessary will be present. This is important when using methanol or acetone to clean optics.

Radioactive Substances and Biohazards

- The SSSC Laser Technology Laboratory is not rated to accept presence of radioactive substances. If you need to use the facility for studies involving such hazards, please contact Dr. Sammynaiken before reserving the instrument.
- If a user wishes to bring biohazardous material or notifiable biological substances to the laboratory, it must do so in accordance with the University of Sasktachewan safety rules. The WSEP/DHSE Biosafety Manager must approve the material or substance and the principal investigator's permit must include the SSSC room in which the item(s) will be brought. The user is responsible for leaving the facility and the instruments in manner which renders it safe for individuals without biosafety training.
- Please refer to the Biosafety Policy of the SSSC for more information.

Skin Protection

- Use screen on exposed skin when working around UV radiation.
- Use appropriate clothing to cover as much of the body as possible without creating a hazard from loose clothing and considering the flammability hazard present with Class 4 laser systems.
- Class 4 laser beams can damage hair. Users should tie their hair if it could fall into the laser beam.

Entering the Laboratory

- In order to inform other individuals with authorized access to the laboratory of the hazards present, operators of laser systems must update appropriately the 'Laser Warning Sign' located at the main entrance of the laboratory.
- Only use the main doors (this will give you the best information on hazards present). Do not use the emergency exit door (a sign "No Entry" is posted by this door).
- When accessing the laboratory or a curtained area, you must read all safety warning signs to ensure that you are aware of all hazards present while in the laboratory.
- Remove all jewellery before entering the Laser Laboratory.
- When a Class 3 or Class 4 laser is operational, open middle curtains one at a time in order to confine any possible stray beam to the lab. This will also protect others in the event of entry by individuals via the main doors (authorized or not).

Entering a Closed Curtained Area with Laser System in Operation, Procedure

- The operator of a laser system controls access to the area and as such you must wait until you get the operator's approval before entering the area. The operator has the right to refuse you entry.
- You may not enter without proper eye protection.
- Once you are in room B9A and are informed about the lasers in use, call up the operator of the laser system.
- Operators should inform the person that the request was heard.
- Wait for the operator to open the curtain and to allow you access to the area.
- SSSC-personnel will follow this protocol for entering areas except for emergency situations.
- Entry of SSSC-personnel in a timely manner will not be unjustifiably denied.

Laser Laboratory Access during Laser Servicing

Because of the nature of the curtains in the Laser Laboratory, users will not be allowed in the Laser Laboratory when lasers are being serviced or during significant laser alignment procedures, regardless of the area they wish to use. A notice to this effect will be posted outside the main door and instruments will not be available for reservation via the Faces Scheduling System (cancellation of reservations will occur if necessary).

Visitors

- No visitors are allowed in the Laser Technology Laboratory.
- Do not assume that individuals have received acceptable laser safety training. Ask SSSC-personnel.

Laser Safety Eyewear

DO NOT LOOK INTO THE LASER BEAM.
EVEN IF YOU ARE WEARING LASER SAFETY EYEWEAR, DO NOT LOOK INTO THE LASER BEAM.

"Laser protective eyewear shall be selected to withstand either direct or diffuse scattered beams. In this case, the protective filter shall exhibit a damage threshold for a specified exposure time, typically 10 seconds" (ANSI Z136.1 – 2000 Section 4.6.2.1 page 25).

Optical density (OD) values at specific wavelengths or wavelength range MUST be present on the eyewear. The manufacturer will guarantee the OD only at the wavelengths specified on the eyewear. OD values obtained from a spectral chart are not guaranteed.

Users must understand the limitation that "recent studies have indicated that existing laser eye protective filters (plastic, glass, interference, or hybrid filters) often exhibit non-linear effects such as saturable absorption when exposed to ultrashort (e.g., femtosecond) pulse durations" (ANSI Z136.1 – 2000 Section 4.6.2.1 page 25) and will take this under consideration when working in the laboratory.

Do not use Laser Safety Eyewear which could pose a hazard to yourself. If you think the SSSC eyewear is damaged, inform the Research Officer ASAP who will inspect the eyewear.

- Users of the laboratory will follow guidelines on the selection of proper Laser Safety Eyewear for best protection.
- Users are not allowed to use alignment eyewear. Only individuals trained in the alignment of some laser systems may gain this dispensation.
- All Laser Safety Eyewear (including alignment eyewear) will only be used for its prescribed use.
- All users of the laboratory will clean the Laser Safety Eyewear according to protocol. Only water and mild soap will be used unless specified otherwise on the eyewear. Users will store Laser Safety Eyewear in its designated case.
- All users of the laboratory will inform SSSC personnel if the find a problem or damage with the Laser Safety Eyewear.
- Users are expected to provide their own Laser Safety Eyewear to the laboratory, and they must follow the Laser Safety Eyewear selection guidelines. If you are working around lasers emitting ultrashort short pulses, ensure that the eyewear is rated for such conditions. The Research Officer will verify that the eyewear selected is appropriate.
- Use appropriate eye protection: this means that protection eyewear MUST be rated for Laser Safety; sunglasses are not (generally) rated to provide protection against laser

radiation and as such will not be acceptable in the laboratory (they also present a greater danger because of increased pupil dilation).
- The SSSCs Laser Safety Eyewear will not be removed from laboratory.

Selecting Laser Safety Eyewear

"Laser eye protection should be selected on the basis of affording the protection required to protect the eye against the maximum exposure anticipated while still permitting the greatest amount of light to enter the eye for the purpose of seeing"
http://www.laserinstitute.org/forum/read.php?5,61

- Factors listed in: ANSI Z136.1-2000, Section 4.6.2.4
- Select the highest OD for the wavelength(s) posing a hazard. Consider multiwavelength environments very carefully.
- Select the highest Visible Light Transmission (VLT) value.
- Select the goggle format over other types.
- Select absorptive glass filter over polycarbonate filter when working with ultrafast laser pulses or high power lasers.

Limitations

- The appropriate wavelength and the OD for that wavelength must be selected by the user. Consideration for the possibility of harmonics, pump laser, and broadband laser pulses must be made.
- The eyewear can have physical damages (polycarbonate, film, …).
- The low levels of visible light transmission can increase pupil dilation and pose a greater risk.
- Some eyewear is intended for protection during alignment procedures only.
- Some eyewear is intended for protection against diffuse viewing only.
- Femtosecond pulses: non-linear effects and possible damage to filter (polycarbonate: hole; glass: cracking).
- Time limit of protection (ANSI Z136.1 – 2000).
- Some laser safety eyewears have a reflective film from which stray beams could pose a hazard.
- Laser safety eyewear may not be rated for protection against physical impact and chemical splash.

Eye Protection Requirements

- Laser Safety Eyewear must be worn in order to meet the minimum requirements of ANSI Z136.1-2000, section 4.6.2.
- For Class 3 laser or laser system in operation: it is requested that laser safety eyewear be worn at all times
  - it is required that laser safety eyewear be worn when the laser beam housing and/or opaque protective barriers on the LSM410 stage are not in place;
  - laser safety eyewear should always be worn during alignment procedures.

- For Class 4 laser or laser system in operation: it is required that laser safety eyewear be worn at all times.
- For Class 4 laser or laser system in operation where the beam is covered and the scattering of light is covered with opaque covers, the lack of use of laser safety eyewear is at the user's own risks.

Beam Hazards and Laboratory Equipment

Some equipment used commonly in laser laboratories can reflect enough of the laser beam to cause hazard from stray beams (optics, opto-mechanical hardware, UV and IR viewing cards, power meters, ...).

For tracking or locating beam paths, use:
- Fluorescent card (if working with the UV)
- IR viewing card and / or IR viewer (if working with the IR).

When using an IR viewer, DO NOT LOOK INTO THE LASER BEAM. The IR viewer is NOT an instrument which can handle the power of a direct laser beam (Class 3 or 4) and it WILL NOT protect your eye against damage.

When using optical mounts such as New Focus 1" Flipper(TM) Mount (part number 9891) and New Focus Flip-Up(TM) Mount (part number 9897) for laser beam direction, operators must follow the safety protocols accompanying these products. As such, operators MUST ensure that the laser beam is blocked before reaching the mount when changing the orientation of the mount between the main positions.

LSM410 Confocal Microscope

- The laser beam will not be directed at objective when changing sample.
- The 'orange plastic shield' or the black anodized aluminium panels available in the laboratory will be put in place when illuminating the sample with the HBO lamp or any UV source, to prevent UV radiation from reaching individuals (eyes or skin).
- The black anodized aluminium panels available in the laboratory will be positioned around or above the sample when illuminating the sample with the Argon Ion Laser beam, the Mira Laser beam, the Harmonic Generator beam, or any visible HeNe Laser beam.

Emergency Procedures

- If possible, shut the laser off and remove the interlock key **(at a minimum, close the shutter or put a beam dump at the laser head output)**. If not possible, alert everyone to get out of the laboratory and leave the laboratory yourself.
- FIRE: get everyone out of the laboratory immediately. Shout "FIRE" loudly and frequently. Pull fire alarm.
- If necessary, call security (at extension 5555) or the fire department (at # 9911).
- Contact SSSC personnel immediately and describe the emergency.

Possible Bodily Injuries

- If you believe you have sustained bodily injury and wish to obtain medical attention, obtain proper transportation.
- If possible, inform SSSC staff before going to the hospital.
- Report the incident to Dr. Sammynaiken upon your return.

Appendix

Terminology

AEL: Accessible emission limit
LASER: Light Amplification by Stimulated Emission Radiation
LGAC: Laser Generated Air Contaminants
MPE: Maximum Permissible Exposure
OD: Optical Density
SOP: Standard Operating Procedure
VLT: Visible Light Transmission

Aversion Response: closure of eyelid or movement of head to avoid exposure to bright laser source (within 0.25 seconds)

References

Standard Operating Procedures (instruments and equipment, lasers, ...)
Manuals for individual pieces of equipment
OD Charts for Laser Safety Goggles
ANSI Z136.1 – 2000
ANSI Z136.5 – 2000
Laser Safety Workshop, University of Saskatchewan, May 2004
Laser Safety Training Handouts, University of Western Ontario
Hazards to the Eyes from Optical Radiation, BG Institute for Occupational Safety and Health, Germany, July 2002

Websites

University of Saskatchewan, Workplace Safety and Environmental Protection
Laser Institute of America
Occupational Safety and Health Administration
American National Standards Institute
US Food and Drug Administration, Center for Devices and Radiological Health
Laser Classification, EN 60825-1 and IEC 60825-1