Lasers

MIT has over 600 registered class 3b or 4 lasers on the main campus and an additional 1,000+ lasers at Lincoln Laboratories. Needless to say, there is a wide range of laser types and energies and some brief laser terminology is given below to help sift through the differences.

Laser Basics

A LASER (Light Amplification by Stimulated Emission of Radiation) is usually described by 3 basic characteristics:

- Monochromatic: A single wavelength of light
- Directional: All photons are originating and ending at same location
- Coherent: All photon waves are synched together

Lasers can vary in their mode of operation. They can either have a continuous wave or be pulsed. Pulsed lasers will usually have a higher energy peak than a continuous laser.

Laser Terminology

- Maximum Permissible Exposure (MPE) is the level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes in the eye or skin.
- Nominal Hazard Zone (NHZ) The space within which the irradiance or radiant exposure exceeds the appropriate MPE.
- Optical Density (OD) is the approximate order of magnitude of transmittance (T) at a given wavelength. OD is determined by log10 (1/T). For example an OD of 1 reduces transmission by 10 and an OD of 3 reduces the transmission by 1000.
- Accessible Emission Limit (AEL) is the allowed emission within a certain laser hazard class. See Table 1 below.
- Laser Output is the maximum energy associated with the laser usually measured in Watts (W) or milliwatts (mW).
- Pulse energy is the amount of laser energy per pulse usually measured in Joule/pulse.
- Irradiance is the amount of continuous laser light energy per unit area usually measured in Watt/cm^2.
- Radiant exposure is the amount of laser light per pulse per unit area usually measured in Joule/cm^2.
- Aversion Response Time – 0.25 seconds

Laser Classification

Laser classification is the designation given to a laser to briefly describe what hazards it may have towards the eye and skin. Table 1 below is a brief description of laser classifications. It is not all encompassing since certain wavelengths will have different laser classes even if they have the same output. Table describes the classifications for most continuous wave visible lasers.

Class	Procedures	Training	Eye Exam	Energy	Hazards
1	Not Required	Not Required	Not Required		Non-hazardous to eye
1M	Not Required *	Not Required *	Not Required		Hazardous with collecting optics
2	Not Required	Not Required	Not Required	< 1 mW	Only hazardous if person overcomes Aversion Response
2M	Not Required *	Not Required *	Not Required		Hazardous with collecting optics and/or Class 2 hazards
3R	Not Required	Not Required	Not Required	1 - 5 mW	Hazardous when person overcomes Aversion Response or uses optics
3B	Required	Required	Suggested **	5 - 500 mW	Direct beam eye hazard. No serious injury from diffuse reflection or to skin.
4	Required	Required	Suggested **	> 500 mW	Hazard to eye & skin from direct, diffuse, or specular reflection; Fire hazard

* If collecting optics is used or the system is on and left unattended in a public space then these items are required.

** A baseline eye examination is suggested for anyone working with or around a Class 3B or 4 laser

M = Hazardous when viewed with an optical aid. Prescription glasses do not count.

R = Reduced requirements when compared to Class 3B lasers.

B = This symbol was used in previous standards when class 3 was divided into 3A and 3B. 3A was changed to 3R but 3B remained the same.

Laser Hazards

The most prevalent hazards from a laser system are from the laser itself; however, electrical, chemical, and mechanical hazards should also be kept in mind.

Beam hazards come in 3 ways:

Primary beam: Direct hit/exposure from primary beam. This is the most hazardous.
Specular reflection: Exposure from laser hitting a "shiny" object. This can be as hazardous as the primary beam.
Diffuse reflection: Exposure from a rough object. The "roughness" depends on the wavelength of the light.

Laser Eyewear

Eyewear is chosen with an OD that will reduce the eye exposure to the MPE or below. All eyewear must be labeled with the wavelength and corresponding OD values. It should also be free from any physical damage such as cracks, holes, or missing lens pieces. It should be noted that eyewear should be purchased for what it will be used for. Direct beam, diffuse beam, and alignment eyewear will all have different OD values. Mode of operation for the laser must be taken into account. Certain types of eyewear may provide protection for continuous wave lasers but not for femto-second pulsed lasers.

Choosing eyewear is a delicate process but RPP has the experience and tools necessary to aid in these decisions.