(Show) Laser

What is a laser?

> Laser stands for ***L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.*
> A laser is a device that projects a highly concentrated narrow beam of light which is amplified to great brightness using stimulated radiation.

A show laser is a device that projects changing laser beams on a screen to create a moving image. A laser projector may contain one laser light source for single-color projection or three sources for RGB (red, green, and blue) full color projection.

To compare:
Projection video from a regular (laser)projector is sent in a fixed resolution, with al those pixels simultaneously (beam). Projection from a showlaser is 1 pixel at a time, but so fast that our eyes perceive a picture (for the HKU laser this is up to 65000rps).

Both show lasers and projector beams are used for visual displays, but they operate on different principles and have distinct characteristics:

1. **Show Laser**:
   - **Principle**: Show lasers use the process of stimulated emission of radiation to produce coherent light. They typically use a medium such as a gas, liquid, or semiconductor to generate laser light.
   - **Light Source**: Show lasers use lasers as their light source. These lasers emit highly concentrated light beams with a narrow wavelength range.
   - **Beam Quality**: Show lasers produce coherent beams of light with high brightness and sharpness. They are capable of creating intricate patterns and shapes with precision.
   - **Color Options**: Show lasers can produce a wide range of colors by using different types of lasers and by modulating the intensity of the laser beams. They are commonly used in laser light shows, concerts, and entertainment events.
   - **Safety Considerations**: Show lasers require careful handling due to the potential hazards associated with high-intensity laser beams. Safety precautions, such as beam attenuation and audience scanning limitations, are essential to prevent eye injuries.
2. **Projector Beam**:
   - **Principle**: Projector beams use conventional light sources, such as incandescent lamps, light-emitting diodes (LEDs), or laser diodes, to generate non-coherent light. The light is then focused and directed onto a surface using lenses and mirrors.

- **Light Source**: Projector beams use non-coherent light sources, which emit broad-spectrum light with various wavelengths.
- **Beam Quality**: Projector beams produce diffused light with less coherence compared to lasers. While they can still create detailed images and videos, the quality may not be as sharp or precise as that of show lasers.
- **Color Options**: Projector beams can also produce a range of colors by using color filters or by mixing different color light sources. However, achieving certain colors or color transitions may be more challenging compared to show lasers.
- **Applications**: Projector beams are commonly used in multimedia presentations, movie theaters, and home entertainment systems. They are versatile and can project a wide variety of content onto screens or surfaces.
- **Safety Considerations**: While projector beams do not pose the same laser safety hazards as show lasers, precautions should still be taken to ensure safe operation, such as proper ventilation for heat dissipation and avoiding direct exposure to the eyes.

In summary, show lasers and projector beams differ in their underlying technology, light sources, beam characteristics, color options, applications, and safety considerations. Show lasers excel in producing coherent, high-quality light beams for artistic and entertainment purposes, while projector beams offer versatility and are more commonly used for general projection tasks.

LASERS ARE DANGEROUS - DAMAGE TO YOUR OR THE AUDIENCE'S EYE SIGHT IS A VERY REAL RISK

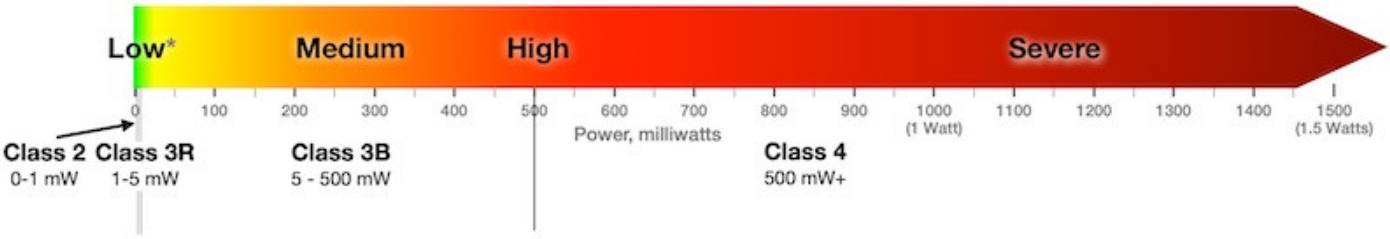
If you plan to use lasers

1. Understand all the laws and regulations for laser operation in your area.
2. Become a certified Laser Safety Officer (this is required by law in some areas). Courses are available from ILDA directly: ILDA Laser Safety Courses 10
3. Make sure an emergency stop button is close to you at all times.
4. Do not let anyone enter the laser projection area unless all precautions have been taken to limit the output.
5. Make sure there are no reflective surfaces in the projection area that might cause the beam to reflect unintendedly.

Laser classes

Below is a a figure and sheet with risks and precautions for different laser classes:

Eye injury hazard



*Eye injury hazard descriptions above are valid for for exposures relatively close to the laser. Because the beam spreads, less light will enter the pupil at greater distances. The hazard decreases the farther a person is from the laser, and the shorter the exposure time (e.g., do not deliberately look or stare into the beam). For example, a 1mW Class 2 laser beam is eye safe for unintentional exposures after about 23 ft (7 m), a 5mW Class 3R beam is eye safe after about 52 ft (16 m), a 500 mW Class 3B beam is eye safe after about 520 ft (160 m), and a 1500 mW Class 4 beam is eye safe after about 900 ft (275 m).
(Calculations are for visible light, a 1 milliradian beam, and a 1/4 second Maximum Permissible Exposure limit.)

ANSI and IEC laser classification	Class 1		Class 2		Class 3		Class 4	Notes
Sub-class	**Class 1**	**Class 1M**	**Class 2**	**Class 2M**	**Class 3R**	**Class 3B**	**Class 4**	
U.S. FDA laser classification	Class I	No special FDA class	Class II	No special FDA class	Class IIIa (definition is different but results are similar)	Class IIIb	Class IV	Newer ANSI/IEC number classes are now preferred over older FDA Roman numeral classes
Human-accessible laser power (for visible light)	For visible light, emits beam less than 0.39 milliwatts, or beam of any power is inside device and is not accessible during operation.		Emits visible beam of less than 1 milliwatt.		For visible light, emits beam between 1 and 4.99 milliwatts.	For visible light, emits beam between Class 3R limit (e.g. 5 milliwatts) and 499.9 milliwatts	For visible light, emits beam of 500 milliwatts (1/2 Watt) or more	Non-visible lasers emitting infrared or ultraviolet laser are not included in this chart. Only visible lasers are discussed.
Label descriptive text		DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS	DO NOT STARE INTO BEAM	DO NOT STARE INTO BEAM OR EXPOSE USERS OF TELESCOPIC OPTICS	AVOID DIRECT EYE EXPOSURE	AVOID EXPOSURE TO BEAM	AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION	For visible-light lasers, the word "light" can be used instead of "radiation". The latter is more accurate for lasers emitting infrared and ultraviolet radiation.
EYE AND SKIN HAZARDS								
Eye hazard for intraocular exposure (having a direct or reflected beam enter the eye)	Safe, even for long-term intentional viewing. For visible light, usually applies when the laser is enclosed inside a device (ex: CD or DVD player) with no human access to laser light.	Safe for unaided eye exposure. May be hazardous if viewed with optical instruments such as binoculars or eye loupe.	Safe for unintentional exposure less than 1/4 second. Do not stare into beam.	Safe for unintentional (< 1/4 sec) unaided eye exposure. May be hazardous if viewed with optical instruments such as binoculars or eye loupe.	Unintentional or accidental exposure to direct or reflected beam has a low risk. Avoid intentional exposure to direct or reflected beam.	Eye hazard; avoid exposure to direct or reflected beam.	Severe eye hazard; avoid exposure to direct or reflected beam.	
Maximum or typical Nominal Ocular Hazard Distance (for 1 milliradian beam, exposure time less than 1/4 second)	Not an eye hazard -- does not apply	Consult an LSO as described in the Technical Note below	**NOHD of 0.99 mW beam:** 23 ft (7 m)	Consult an LSO as described in the Technical Note below	**NOHD of 4.99 mW beam:** 52 ft (16 m)	**NOHD of 499.9 mW beam:** 520 ft (160 m)	**NOHD of 1000 mW (1 Watt) beam:** 733 ft (224 m). **NOHD of 10 W beam:** 2320 ft (710 m)	Avoid eye exposure to a direct or reflected laser beam, within the NOHD. The closer you are to the laser, the greater the chance of hazard and the more serious the injury potential.
Eye hazard for diffuse reflection exposure (looking at the laser "dot" scattered off a surface)	None	Consult an LSO	None	Consult an LSO	None	Generally safe. Avoid staring at the laser "dot" on a surface for many seconds at close range.	To avoid injury, do not stare at laser "dot" on a surface. The light is too bright if you see a sustained afterimage, lasting more than about 10 seconds.	
Skin burn hazard	None	Consult an LSO	None	Consult an LSO	None	Can heat skin if beam is held long enough on skin at close range	Can instantly burn skin. Avoid direct exposure to the beam.	
Materials burn hazard	None	Consult an LSO	None	Consult an LSO	None	Can burn materials if beam is held long enough on substance at close range	Can instantly burn materials. Avoid direct exposure to the beam, for materials susceptible to burning.	Dark materials which absorb heat, and lightweight materials such as paper and fabric, are most easily burned by visible laser light.
VISUAL INTERFERENCE DISTANCES								
Maximum or typical flashblindness distance (FAA 100 μW/cm², for 1 milliradian beam, 555 nm green light)	Not applicable; beam is usually contained inside a device such as a CD or DVD player	Consult an LSO	**For a 0.99 mW beam:** 117 ft 36 m	Consult an LSO	**For a 4.99 mW beam:** 261 ft 80 m	**For a 499 mW beam:** 2,614 ft (1/2 mile) 797 m (0.8 km)	**For a 1 Watt beam:** 3,696 ft (0.7 mile) 1,127 m (1.1 km) **For a 10 W beam:** 11,689 ft (2.2 miles) 3,563 m (3.5 km)	Value given is for 555 nm, the green wavelength that appears brightest to the light-adapted human eye. This gives the longest hazard distance. To approximate for red laser light, divide the distance by about 5; for blue, divide by 20.
Maximum or typical glare distance (FAA 5 μW/cm², for 1 milliradian beam, 555 nm green light)	See above	Consult an LSO	523 ft 159 m	Consult an LSO	1,169 ft 356 m	11,689 ft (2.2 miles) 3,563 m (3.5 km)	**For a 1 Watt beam:** 16,531 ft (3.1 miles) 5,039 m (5 km) **For a 10 W beam:** 52,275 ft (9.9 miles) 15,933 m (16 km)	See above
Maximum or typical distraction distance (FAA 0.05 μW/cm² or 50 nanowatts/cm², for 1 milliradian beam, 555 nm green light)	See above	Consult an LSO	5,227 ft (1 mile) 1,593 m (1.6 km)	Consult an LSO	11,689 ft (2.2 miles) 3,563 m (3.5 km)	116,890 ft (22 miles) 35,628 m (35.6 km)	**For a 1 Watt beam:** 165,307 ft (31 miles) 50,386 m (50 km) **For a 10 W beam:** 522,746 ft (99 miles) 159,333 m (160 km)	See above
Technical Notes	For a 1/4 second exposure to accessible visible-light beams, Class 1 limits are the same as Class 2, and such lasers are usually labeled as Class 2.	We are unaware of any Class 1M laser devices intended for consumer use. If you do have such a laser, consult a qualified Laser Safety Officer for more detailed analysis.	Class 2 (and 2M) only applies to visible lasers. Infrared and ultraviolet lasers cannot be Class 2 (or 2M).	We are unaware of any Class 2M laser devices intended for consumer use. If you do have such a laser, consult a qualified Laser Safety Officer for more detailed analysis.	Class 3R is either: (1) From 1 to 4.99 mW into a 7mm aperture (e.g., pupil of the eye) or (2) five times the Class 2 limit of 2.5 mW/cm², which works out to be 12.5 mW/cm². The second method is used by LaserSafetyFacts to determine NOHD.			
	Class 1	**Class 1M**	**Class 2**	**Class 2M**	**Class 3R**	**Class 3B**	**Class 4**	
	Class 1		**Class 2**		**Class 3**		**Class 4**	

source: https://www.lasersafetyfacts.com/laserclasses.html

Available to borrow at Blackbox JK after a safety instruction:

Laserworld CS-1000RGB (manual)

A powerful semi-professional analog modulated pure diode laser, capable of intense standard laser effects like beams, waves and tunnels but also basic graphics. This laser has easy plug and play, sound-to-light and stand-alone modes, DMX control, so it can be controlled with the rest of your lighting, but also has an ILDA port for professional computer control.

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