

Laser Devices, Laser Shows and Effect Vocabulary on Gameops.com

The first requirement of a laser show is, of course, a laser. The first section defines various types of lasers, as well as the optical devices used with them. Below is a list of **Laser and Optical Devices** along with some of their capabilities and limitations.

Display lasers have two main uses in sports and entertainment: laser shows and special effects. In a show, the laser is the primary attraction. As a special effect, the laser supports a primary attraction. Below are terms are widely used in **describing shows and effects**.

The primary hazard of light show lasers is eye damage. Higher power lasers also have some burn and fire hazards. However, no light show laser can do science-fiction type damage or disintegration.

Both equipment and show site must be made safe so beams cannot go into the audience. Usually, governmental regulatory agencies must be notified in writing before lasers can be used. Thus far, the regulations have worked well. There have been no reported injuries in the United States from light show lasers since U.S. federal regulations took effect in 1976.

Lasers and Optical Devices

Air-cooled laser

A laser using fans to force air over the laser tube and the power supply. Air-cooled lasers have the benefit of needing no water supply, although the fan noise can sometimes be a disadvantage. Usually only small and medium power lasers are air-cooled. Very small lasers, typically helium-neon, need no fans. Although technically they are "air cooled" via convection, the term is usually applied only to fan-forced cooling.

Argon laser

A laser filled with argon gas. It gives off green and blue light. The strongest lines are at 514 nm (green) and 488 nm (blue). Argons range from small 15 milliwatt 110 volt air-cooled models to large 50 watt 440 volt water-cooled systems. Argon lasers are the most common type of light show lasers since they provide usable brightness at a reasonable cost.

Chiller

A refrigeration unit sometimes used with water-cooled lasers. It includes a compressor and thus can perform more cooling than a heat exchanger.

Diode laser

A semiconductor similar to an LED (light-emitting diode) but which produces coherent light. Diode lasers are small and efficient, which has led to their use in compact disc players and pen-type laser pointers. Currently, diode lasers are too dim or expensive for most light show uses. This is likely to change over the next few years. See also: Solid-state laser.

Exciter

See Power supply.

Fiber optic cable

Flexible glass or plastic strands made into a cable, used to carry light from one place to another. There are two main types. Transmission fibers carry the beam with as little loss as possible. They are used to transmit the laser's light to remotely located projection devices. Display fibers have no cable jacket, so some light scatters out the side of the strands. The strands themselves become a special effect, such as a laser-lit "whip" or a glowing "rope" wrapped around objects.

Front-surface mirror

A piece of glass with an exposed broadband reflective optical coating. In a conventional back-surface mirror, the reflective coating is protected with a heavy paint-like substance; reflections are seen through the glass. In a front-surface mirror, light does not have to travel through the glass to reach the coating. Mirrors used in laser work are almost always front-surface, as they can reflect up to 99.8% of the incident light and they have no secondary reflections. Front-surface mirrors require greater care in handling to prevent damage to the coating. See also: Mirror.

Head

1) A laser tube enclosed in a case: the laser head (as opposed to the laser power supply). 2) A set of X-Y scanners which can produce laser graphics. A projector may have a number of heads. For example, a four-head projector can produce four different sets of graphics simultaneously.

Heat exchanger

A cooling unit sometimes used with water-cooled lasers. Hot water from the laser is cooled by water-to-water or water-to-air heat transfer. There is no active refrigeration, as in a chiller. See also: Recirculator.

Helium-neon laser

A laser filled with a helium/neon gas mixture. Most produce red-orange light having a wavelength of 633 nanometers. "HeNe"s are low powered, in the 0.5 to 50 milliwatt range. Most run on 110 volts, come with built-in power supplies, and need no special cooling. Some HeNes are made to produce orange (612 nm), yellow (594 nm) and green (543 nm) light. These have less power than a red HeNe of the same tube size and input power. Helium-neon lasers are the

most common type of gas laser. Because of their relatively low power, in laser display they are used only for small-scale light shows and studio monitors.

Krypton laser

A laser filled primarily with krypton gas. It produces red light, with yellow, green and blue also available with specially tailored optics. It has a very strong red line at 647 nm. Kryptons are similar to argons (the same tube design can be used for both). However, kryptons give off less light power than an equivalent argon. Krypton lasers are primarily used when a powerful red light is needed.

Laser

A device which produces a coherent beam of light. The beam remains parallel for long distances and contains one or more extremely pure colors. Light show lasers are usually gas-filled tubes using high voltage current to cause the gas to glow. Mirrors at each end of the tube help amplify a process called "stimulated emission". Most of the stimulated emission light travels between the two mirrors; about 1% comes out of one of the mirrors to create the beam we see. The gas used determines the color (or colors) of the beam. Gas lasers remain the overwhelming choice for display applications. The four main types used are a helium-neon mixture, argon, krypton, and an argon-krypton "mixed gas" mixture. "Laser" was derived from "Light Amplification by Stimulated Emission of Radiation".

Mask

A device used to obstruct the laser beam so it is blocked from undesired areas. The mask is usually placed at the final output aperture of the laser projector. Masks are used for aesthetic reasons, to keep light from going off a screen, and as a safety feature, to ensure lasers cannot reach the audience in case of equipment malfunction. This is also called a beam block.

Mirror

Large mirrors are used to reflect the beam coming from a projector, forming a beam sculpture or matrix in the air. Usually the mirrors are surrounded by black metal, so light which might miss the mirror is harmlessly dissipated.

Small mirrors mounted on actuators can be activated to reflect the beam out over the audience or onto large mirrors to form a beam sculpture or matrix.

Small mirrors on precision mounts are used within projectors as steering mirrors to reflect the beam from place to place inside a projector.

Tiny mirrors are used on the shafts of laser scanners, which move the beam at high speeds to form graphics. All of the mirrors above are usually front-surface mirrors.

Mixed gas laser

Many gas lasers contain mixtures of various gases, such as helium and neon. In the laser show industry, however, "mixed gas" usually refers to an argon-krypton mixture used to get a white-light beam containing red, green and blue lines. Yellow lines are additionally available for applications such as four-head projectors with one head each for red, yellow, green and blue. See also: White-light laser.

Power supply

A device converting readily available power, usually standard alternating current, into voltages necessary to energize laser tubes. It may also include other functions such as monitoring the laser's light output or current draw. A power supply is usually closely matched to a particular type of laser tube. Power supplies for high-power lasers (0.5 watt and above) often require 208 or 440 volts three-phase, and are cooled with flowing water. The supply is one of the two main parts of a laser; the other is the laser head. A power supply is also known as an exciter.

Recirculator

A pump used to recycle water, found in either a chiller or heat exchanger. The term "recirculator" is sometimes erroneously used to mean either of the more specific devices.

Solid-state laser

A laser where the lasing medium is a solid material such as a ruby rod. These can be optically pumped by a flashlamp or diodes. Currently, solid-state lasers are too expensive for most light show uses. This may change over the next few years. The most promising solid-state laser uses a material called Nd:YAG, producing up to 50 watts of green light at 532 nm.

Water-cooled laser

A laser using water to cool the laser tube. Often the laser power supply's electronics are also water-cooled. A gas laser (the type used in most laser display applications) is relatively inefficient. For example, an argon-filled laser producing 10 watts of light requires around 10,000 watts of electricity. In such a laser, water is used to carry off the 9,990 watts of excess energy as heat. Flow rates of two gallons (9 liters) per minute are typical. In many areas, the water can simply flow through the laser and down a drain. In water conservation areas, a chiller or heat exchanger is used to recycle the cooling water. Water supply considerations are always important to laser show producers. Even a brief interruption can cause problems. At best, flow sensors shut down the laser when the supply is inadequate. At worst, an expensive tube can overheat and be irreparably damaged.

White-light beam

Broadly, a laser beam which contains a number of different wavelengths (colors) so the beam appears white. If the beam is passed through a prism or diffraction grating, it is

separated into individual laser beams, each of a single specific wavelength. More specifically, a white-light beam ideally contains an equal mixture of red, green and blue light. It can be from a single white-light laser or from two or three lasers whose beams have been combined into a single beam. White-light beams are primarily used in RGB laser projectors. See the definition of white-light laser for more information on what constitutes an "equal mixture" of light.

White-light laser

Many lasers can produce a number of wavelengths (colors) simultaneously. A white-light laser is designed to give a good balance of red, green and blue wavelengths. Usually the laser is intended for an RGB laser projector. (Some models also deliberately add yellow light for specialized 4-color projectors.) Most white-light lasers use an argon/krypton gas mixture. It is somewhat difficult to produce an equal balance of desired colors, and to keep this balance consistent during the lifetime of the laser tube. At present, there are no standards defining the exact wavelengths and color proportions for a laser to be called "white-light". In addition, the sought-after color balance can be defined either as equal amounts on a photometer, or as visually equal amounts. Since the eye is much more sensitive to green, a visually equal or "photopically balanced" laser has roughly five times more power in red and blue than in green. Most white-light lasers today are not photopically balanced. See also: Mixed gas laser.

Terms widely used in describing shows and effects.

Animation

A sequence of frames where each frame is slightly different, giving the illusion of motion. "Animation" refers to the complete group including key frames and tweens. These can be precomputed, such as traditional hand-drawn animations. Or they can be computed in realtime; for example, the single frame of a logo may grow in size and rotate to produce the animation.

Abstract

Laser-projected images which are usually non-representational (as opposed to graphics). This implies using synthesizers or other techniques which do not afford point-by-point position control of the beam, and usually implies using scanners to create the abstract image. Usually excludes lumia, diffraction gratings, or similar non-scanner techniques.

Beam effects

Using the laser's beam as a sculptural element in space (as opposed to shining it on a screen to create graphics).

The beam can be static or kinetic. If static, it is usually reflected off a series of widely spaced mirrors to create a "beam sculpture" or "beam matrix". If kinetic, it can be shot directly into space (over an audience), or can be directed to different groups of mirrors to create moving beam sculptures. A common technique is to scan the beam through theatrical smoke; if a line is scanned you see a plane of laser light, if a circle is scanned you see a cone. These effects require high power lasers and often require smoke, dim lighting and other environmental controls. See also: Cone, Fan.

Beam sequence

A beam effect where beams are directed to different mirrors in quick sequence. This gives a Star Wars-type impression of shooting beams bouncing around the performance arena.

Chopping

The technique of turning the laser beam on and off at a regular rate (as opposed to blanking). High-speed chopping gives a "dotted line" effect. If used with densely scanned images, chopping creates areas of light and dark which shift as the chopping rate changes. See also: Color modulation.

Color modulation, color mod

Rapidly varying the color of the laser beam. In beam effects, color mod can be used on the entire beam matrix or can be sequenced in individual beams. In graphics effects, color appears to "chase" through an image. A classic light show effect is to project a dense spiral pattern, then use color mod to create shifting zones of colors pulsating through the image. See also: Chopping.

Cone

A beam effect where the beam is rapidly scanned to enclose space. For example, by scanning a circle, the effect looks like a cone of light emanating from the projector location. Other shapes can be scanned; for example, a square produces a pyramid "cone". Theatrical fog or smoke is often used to make the scanned light more visible. See also: Beam effects.

Fan

A beam effect where the beam is rapidly scanned from side-to-side, usually through theatrical smoke. If the scanning is smooth, the audience sees a plane of light. If the beam scans discrete positions, the audience sees a ribbed fan of light. The fan can be rotated and translated to produce a moving fan effect. Theatrical fog or smoke is often used to make the scanned light more visible. See also: Beam effects.

Flicker

A perceptual effect in laser-drawn graphics when the laser cannot complete its path before the eye's persistence of vision sees the image fade. The effect, usually undesired, is

that the image is flickering or pulsating. Solutions include fully darkening the environment, changing the laser's power, speeding up the scanning rate, or reducing the complexity of the graphic traced by the laser. A related effect occurs when viewing videotaped laser graphics. The laser's scan rate often does not match the TV camera's frame rate. The video image appears to flicker. Videotaped laser graphics generally exhibit much more apparent flicker than the original live laser graphics.

Graphic parts

There is a clear progression in laser computer graphics of the various parts which make up the final graphic. For example, a frame is made up of points; an animation is made up of frames. The following terms are recommended as the progression of computer graphics parts:

1. Point
2. Frame
3. Animation
4. Scene or module
5. Show

As explained in the definition of module, the terms "scene" and "module" express a similar idea: a group of related frames and animations. They differ in that a scene is more of an artistic concept, while a module is more of a technical concept.

Graphics

Laser-projected designs, usually representational (as opposed to abstract) such as logos or drawings. Graphics implies point-by-point control of the beam position, which in turn implies computer control of laser scanners. A computer can generate non-representational designs, but these are normally classed as graphics rather than abstracts.

Hologram

A light-sensitive film which captures and plays back light wave interference patterns. One of the most striking results is the true three-dimensional nature of the recreated holographic image. Image holograms are not usually used in laser display technology. They are mentioned here because of a frequent misconception that laser shows can present "floating" 3D holographic projections. Although a holographic image can appear to be floating in front of the film plate, the viewer must always be looking at or through the hologram. Viewing angles are usually limited to one or two people at a time, and image size is usually one cubic meter or less. At present, there are no free-floating "Princess Leia" Star Wars-type holograms. Note: The term is hologram ("a laser recording of interference patterns"), not holograph ("a document wholly handwritten by the person under whose name it appears").

Laserist

The person who performs a live laser show, especially in a planetarium environment. Can also be used for the person who designs and choreographs a pre-recorded show.

Laser light show

A presentation where laser light is the primary attraction (as opposed to laser special effects). The four main elements of a laser light show are: abstracts, graphics, lumia and beam effects. These may be present in various combinations. A laser show is usually set to music, often with other effects such as theatrical lighting and pyrotechnics. Musical shows are usually divided into a number of song-length modules.

Laser special effects

Any use of lasers where the laser is not the primary attraction (as opposed to laser light show). For example, a rock band may use complex laser lighting effects comparable to standalone laser light shows. However, because the band itself is the primary attraction, the lasers are considered supporting special effects.

Laserium®

A registered trademark of Laser Images Inc., referring to their laser light shows. Sometimes used incorrectly as a synonym for any planetarium-based laser light show.

Lumia

A gauze-like laser effect produced by shining a laser beam through distorting material such as rippled glass. Lumia are often composed of fine parallel lines of light and dark, and they show the characteristic speckle of coherent light. There are many different lumia effects, depending on the type of distorting material.

Module

A song-length segment of a laser light show. A module is the smallest unit of music-plus-lasers which can artistically stand on its own. A typical planetarium-type laser show is usually made up entirely of different modules.

Three-dimensional (3D) laser effects

In laser effects, can refer to beam effects or multiple scrim techniques. (In laser graphics, "3D" usually refers to either a 3D graphics database or to stereoscopic projection systems.) Laser beam effects are inherently 3D, filling space with static or kinetic beams. However, these cannot create space-filling objects. Science-fiction films have popularized the misconception that lasers can project large freestanding 3D images. At present, there is no technique which can do this without the image being enclosed in a small volume. One interesting simulation is to project laser graphics through partially translucent screens; a series of these screens can give a floating mid-air effect. This is not true 3D as all images are identical, and merely increase in size with

increased projection distance. See also: Three-dimensional laser graphics, Hologram.

Write-out

A special effect used in computer laser graphics. The laser appears to "write out" a design such as a signature. The opposite effect is called erase.

ILDA Laser Glossary

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