# GLOSSARY

# COMMON LASER TERMS AND EXPRESSIONS

*Here is a non-exhaustive list of terms related to Laser, with a short description for each of them. www.wikipedia.org is a good resource for laser terms not included in this document.*

| TERM | Description |
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| **ABLATION (OR MATERIAL REMOVAL)** | Removal of material with Laser beam action. Ablation can occur on “natural” material (engraving) or on a coated material (layer removal) on anodized aluminum for instance. |
| **ANNEALING** | Surface marking without removal of material (no ablation of engraving). On some materials, it produces high contrast which increases the aesthetic quality of the mark (ex : steel, titanium, etc.) |
| **AVERAGE POWER** | Power rating in continuous mode. This measure is often used to compare lasers, but can be misleading due to other factors that influence marking.<br><br>*See Peak Power, Pulse Duration, $M^2$* |
| **BEAM EXPANDER (TELESCOPE)** | Optical element located between the resonator and the scanning system. Its function is to expand the to improve scanning and focusing efficiency. |
| **CAVITY** | It is the module where the beam is generated. For Nd :YAG/Nd:$YVO_4$ Laser, it includes the Laser crystal. A fiber laser has no physical cavity. |
| **CAVITY MIRRORS** | Optical components of the resonator. Rear mirror reflects 100% of the Laser. Front mirror (or output coupler) reflects 80 to 90% (for amplification) and transmits 10 to 20% which are used for marking. |
| **CLASS 1 / CLASS 2M/ CLASS 4** | Security levels for the Laser machines :<br><br>Class 1 : No danger for operator. The machine is fully enclosed with no access to the marking chamber. The machine can be installed in any working environment.<br><br>Class 2M : Low power visible laser, for example preview diode. The beam is only dangerous is viewed through a magnifier.<br><br>Class 4 : Potential danger for operator. The machine has no casing (open marking area). Specific protection must be assured with restricted access area and use of laser goggles when operating the Laser. |

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| **CW CONTINUOUS WAVE MODE** | When the Laser does not operate in pulsed (Q-switched/amplified) mode, it produces a continuous wave beam (CW). This mode does not enable marking. It is used only for servicing and maintenance (beam quality and power control). |
| **DEFLECTION MIRRORS (OR SCANNER MIRRORS)** | 2 reflecting mirrors mounted on the galvanometers. They deflect the beam to produce marking on the part. |
| **DEPTH OF FIELD** | The distance +/- from the optimum Focal Distance in which the laser will still mark. A shorter Focal Lens will have a lower depth of field. |
| **DIODE PUMPING** | The energy to excite the crystal is created by a Laser Diode. The wavelength is 808nm. |
| **END-PUMPING** | Energy from Laser Diode is focused on the end of laser crystal. |
| **FIBER LASER** | Laser beam is created directly in fiber optic cable, rather than in a crystal. See Ytterbium. |
| **FIBER PUMPED** | Energy from Laser Diode is delivered to the Laser Crystal via a fiber optic cable. Not to be confused with a Fiber Laser. |
| **FLASH LAMP** | Special lamp used as energy source to excite laser crystal. Generates a lot of heat. Requires water cooling and very high voltage. |
| **FLAT FIELD LENS/FOCAL LENS** | Focusing lens that enables the focusing of the beam into a small laser spot (typically 30 to 100 µm). This focusing increases the density of energy/power and enables marking. The different types of lens produce different Spot Size, Focal Distance and Marking Area. Typical lens are F100, F160, F254 and F330. |
| **FOCAL DISTANCE** | Distance between part and Focal Lens for optimized marking performance. It varies according to the lens used.<br><br>*See Depth of Field* |
| **FREQUENCY** | *See Repetition Rate* |

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| **GALVANOMETER (OR SCANNER)** | Small motor with a mirror mounted on its shaft. This is the element that produces deflection of the beam. There are 2 galvos, 1 for X movement, 1 for Y movement.<br><br>↘ *See Deflection Mirror* |
| **GIANT FIRST PEAK** | It is the first pulse the Laser produces after a waiting period (Q-switch closing the beam). This pulse has more energy than the following ones as the crystal accumulated energy during the waiting period. This giant peak must be eliminated to avoid over-marking effects. |
| **LASER** | Light Amplification by Stimulated Emission of Radiation |
| **LASER CRYSTAL** | A special type of glass whose properties create a laser under specific conditions.<br><br>↘ *See Nd:YAG, Nd:$YVO_4$* |
| **LASER DIODE** | Type of laser used in Diode Pumping and for Positioning diodes. Not used directly for marking as beam quality and wavelength are not adapted. |
| **$M^2$ (M SQUARED)** | Measure of beam quality. The ideal value is 1. An $M^2$ closer to one has higher energy density. This value varies by type of laser. |
| **MARKING FIELD/**<br><br>**MARKING AREA** | Area in which the laser marks. Its varies depending on the Flat Field Lens used. |
| **MONOMODE (LM OR $TEM_{00}$)** | High Beam Quality : the beam has only one Optical Mode, and produces a small spot size on the part. It is achieved using an Iris in the Resonator in the case of a Lamp laser. Sometimes referred to as Low Mode. |
| **MULTIMODE (MM)** | The beam includes several modes, which produces higher power, but reduces the marking quality and increases the spot size. This mode only exists in Lamp pumping |
| **ND:YAG CRYSTAL (NEODYMIUM : YTTRIUM ALUMINIUM GARNET)** | It is the heart of the system, where the excited atoms (Neodymium) are. YAG is the nature of the crystal into which the Nd atoms are inserted. Produces 1064nm near-infrared laser. |

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| **ND:$YVO_4$ CRYSTAL (NEODYMIUM : YTTRIUM ORTHOVANADATE)** | Similar to Nd:YAG, same wavelength. Produces more stable power in end-pumped laser applications. |
| **OPTICAL MODE** | Defines the optical quality of the beam.<br>✍ *see Multimode / Monomode* |
| **PEAK POWER** | A key value which determines the effect of the laser on a material. It is calculated by dividing the Pulse Energy by the Pulse Duration. Typically measured in kilowatts. |
| **POSITIONING DIODE**<br>**(AIMING BEAM DIODE)** | Red Laser beam with low power. It is used to assist the operator to position the parts and the elements to mark. |
| **PULSE** | A pulse represents a single impact of the Laser on the part. It is characterized by an energy and a duration, which defines an instantaneous power (called peak power). These values depend on the Repetition Rate. |
| **PULSE DURATION** | Length of one laser pulse. Usually measured in nanoseconds ($10^{-9}$ seconds) |
| **PULSE ENERGY** | Higher energies permit material removal. It is estimated by dividing the Average Power by a Repetition Rate. Typically measures in millijoules. |
| **PUMPING**<br>**(LAMP OR DIODE)** | There are different technologies used to excite the crystal and accumulate the energy. It can be done using Flash Lamps or Laser Diodes.<br>✍ *Refer to Lamp vs. Diodes document* |
| **Q-SWITCH** | Acousto-Optic element used to produce the pulses of the beam. It is a crystal which, when excited by a RF signal, stops the beam in the resonator, creating an amplification effect. This energy is then released in a pulse. The Repetition Rate (Frequency) is generated by regular interruptions of the RF signal at the requested rate. |
| **REPETITION RATE** | Number of pulses per second. For marking, the beam is used in pulsed mode and the repetition rate is software adjustable. The range is typically 1 kilohertz to 100 kilohertz and depends on the type of laser<br>✍ *See Pulse and Q-switch* |

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| **RESONATOR**<br><br>**(LASER CAVITY)** | Group of elements which are used to produce the Laser (Laser source). The extremities are the cavity mirror (rear mirror and output coupler). All elements must be perfectly aligned to optimize operation of the Laser. |
| **SAFETY SHUTTER** | Mechanical safety component. When closed, it stops the beam, disabling any Laser emission for operator safety. It is linked to a security loop (interlock) to ensure safety on the workstation. |
| **SPATIAL FILTER (IRIS)** | Mechanical component inserted in the Laser cavity to reduce beam diameter. It is used to configure the beam either in Monomode (iris in, limited power) or Multimode (iris out, full power), depending on the application. |
| **SPOT SIZE** | The theoretical diameter of the laser beam when focused on the part. The actual size of the mark depends on value as well as the material and other properties of the laser. |
| **TELESCOPE** | See Beam Expander |
| **WAVELENGTH** | It defines the kind of beam and its color. Nd :YAG/Nd:$YVO_4$ are 1064 nm (invisible near infrared). Visible radiations are 350 to 700 nm, “Green lasers” and red postionning diodes . UV is below 350 and Infrared is beyond 700. CO2 is 10,640nm. |
| **YB (YTTERBIUM)** | Like Neodymium it is a rare earth element that when excited produces a laser beam. |