



Laser Measurement in Medical Laser Service

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The global medical industry incorporates thousands of lasers into its arsenal of treatment tools. Wavelengths from UV to Far-Infrared are used for everything from Lasik eye surgery to cosmetic skin resurfacing. Visible wavelengths are used in dermatology and ophthalmology to target selective complementary color chromophores. Laser powers and energies are delivered through a wide range of fiber diameters, articulated arms, focusing handpieces, scanners, micromanipulators, and more. With all these variables, medical laser service personnel are faced with multiple measurement obstacles.

At the Laser Training Institute (<http://www.lasertraining.org>), with headquarters in Columbus Ohio, we offer a week-long laser service school to medical service personnel. Four times a year, a new class learns the fundamental concepts of power and energy densities, absorption, optics, and, most of all, how lasers work. With a nice sampling of all the major types of medical lasers, the students learn hands-on calibration, alignment, and multiple service skills.

Lasers used in the medical field fall under stricter safety regulations than other laser usages. Meeting ANSI compliances are critical to the continued legal operation of all medical and aesthetic facilities. Laser output powers and energies are to be checked on a semi-annual basis according to FDA Regulations and are supported by ANSI recommendations which state regular scheduled intervals. In our service school we exclusively use Ophir-Spiricon laser measurement Instrumentation. We present a graphically enhanced presentation on measurement technologies and the many, varying, critical parameters that are faced with not only each different type of laser but design differences between manufacturers.

Ophir offers a plethora of measurement heads that can satisfy any need. Needs, such as, beam diameters, multiple wavelengths, nanosecond pulse widths, and very low or high power and energy levels. As if these aren't enough variables to deal with, space confinement can be a problem. Ophir also manufactures small heads to get into the tiny places. For example, I have a 20C-SH head that fits nicely between optical components inside our KTP lasers. The same head sits securely by itself on top of the fiber launch

output on our argon laser. This physical compatibility works great when we are peaking output power with the OC mirror adjustments.

Capturing nanosecond, mJ pulses from an Ophthalmic Q-Switched, Nd:YAG laser is always a good time. As a side note, always collect the reading on the prefocus side the impact. The defocus side will have a diminished reading because of losses in the photoacoustic shockwave at the focal point.

IPLs (Intense Pulsed Light) though not laser, are used in the aesthetic market because of their large spot sizes. Lasers, known for their ability to be focused into very tiny spot sizes, become less desirable when performing light-based hair removal on legs and backs. Large spot sizes can treat the areas in a fraction of the time. However, when checking output energies, trying to jam that large spot into a traditional laser head aperture is messy. Ophir recently introduced a head for IPLs with a large 65mm aperture.

Whether the laser operates in continuous wave mode (CW), pulsed, or Q-switched, Ophir-Spiricon is our first choice for testing and/or calibration measurement.

Most Common Medical and Aesthetic Lasers

CO₂ (10,600nm) - Because of its very long and Far-IR wavelength, the CO₂ beam has a very shallow absorption depth and a great affinity for water and almost everything including glass and fiber optics. Though the beam must be delivered via mirrors mounted in an articulated arm, the CO₂ makes a great surgical “light” scalpel and ablator. When used with a scanner or pattern generator, cosmetic skin resurfacing is easily achieved. The treatment can be fractional or totally ablative.

Er:YAG (2,940nm) – Similar to the CO₂ but having a greater affinity for water, it creates a shallower surface ablation in skin resurfacing. This makes the treatment less traumatic but also less effective.

Ho:YAG (2,100nm) – Also an affinity for water but able to transmit through fiber optics making it a unique surgical tool for Urology and Orthopedic surgery.

Nd:YAG (1064nm) – This wavelength, just outside the visible spectrum, has the longest absorption depth. Because of this attribute, it is used in surgery (via fiber optics) as a deep tissue coagulator. With special, light absorbing fiber tips, it is used for cutting. This laser is also very popular in the aesthetic field for a multiple of treatments. Depending upon specific balances of pulse width, spot size, and power levels, it is used for hair removal, small leg vein ablation, skin rejuvenation, tattoo removal, and more.

Diode Lasers (950/810/etc) – Critically depending upon their varying wavelengths and delivery settings, diode lasers are used in dentistry, dermatology, ophthalmology, aesthetics, and surgery.

Alexandrite (755nm) – A popular laser for hair removal on lighter skin types only (the shorter wavelength than the Nd:YAG is absorbed more by melanin and can cause hyper/hypo pigmentation problems in darker skin types).

Ruby (694nm) – The first laser invented is used for tattoo removal (Q-switched only) and hair removal on very light skin (skin type I).

KTP (532nm) – The KTP laser, also called a “Frequency-Doubled YAG,” is actually an Nd:YAG laser (or diode) with an add-on KTP crystal. The 1064nm wavelength is transmitted through the KTP crystal which then, by resonance, induces a frequency an “octave” above the excitation frequency. In other words, 1064nm (when doubled in frequency) becomes 532nm. This is a green wavelength, half the wavelength of the 1064nm. Green wavelengths are absorbed by their complementary color pigment (see your color wheel chart). This makes them very useful for ablating reds and browns as in vascular and pigmented lesions.

Argon (515/488nm) – The green 515nm wavelength of the argon is generally used more than the blue 488nm in medicine. Like the 532nm green of the KTP, it is used for the same treatments. However, the argon 515nm wavelength is preferred in Ophthalmology for retinal photocoagulation than the 532nm because of its greater affinity for hemoglobin. This translates into less discomfort for the patient.

Dye (577nm) = This laser, capable of operating in a continuous wave modality, is generally used as an optical pumping source to excite the dye used to create a red 632nm beam. This dye laser is mainly used in Photodynamic Therapy (PDT) to destroy cancerous tumors.

Pulsed Dye (585/595nm/etc) – The yellow and orange wavelengths of the pulsed dye are used in dermatology and ophthalmology to target their complementary color pigments, which are mainly reds (vascular). The difference between using the yellow versus the green wavelengths for vascular, is that the yellow has no affinity for melanin.

Xenon Chloride (308nm) – Delivered via fiber optics, the XeCl laser is used primarily for Angioplasty and general vessel clearing, but is also used in Dermatology to treat conditions such as psoriasis.

Argon Fluoride (193nm) – This is only laser that performs “Lasik” eye surgery. Contrary to popular belief, the mechanism used here to re-shape the cornea, is NOT heat or ablation. This unique and very short wavelength borders on tissue damaging UV. The 193nm wavelength itself does the work. With not much power, the 193nm light collapses the 3D carbon molecules into a 2D configuration wherever the light irradiates the tissue. This mechanism of laser treatment is called Photo-disassociation. With computer control of this “soft” ablation of tissue, a cornea can be reshaped to a less positive, convex lens, thus changing the diopter of the eye optics. This corrects the focal length of the eye optics to meet the retina as eyeglasses would.