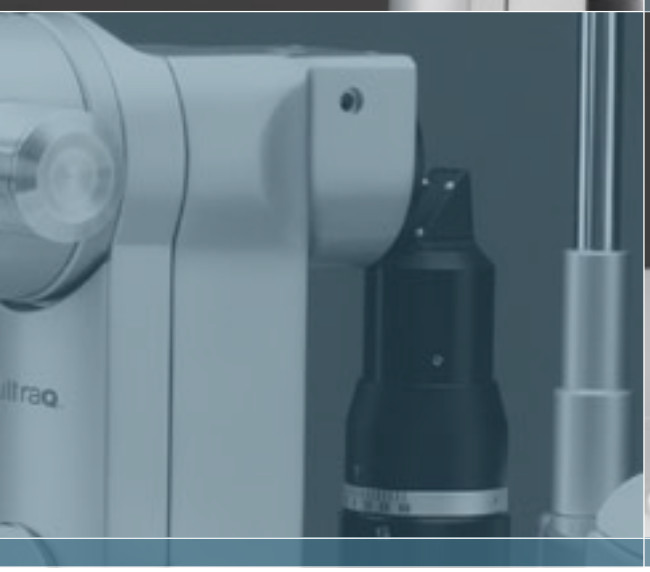
Precision Photodisruption

A guide to choosing the right Nd:YAG laser



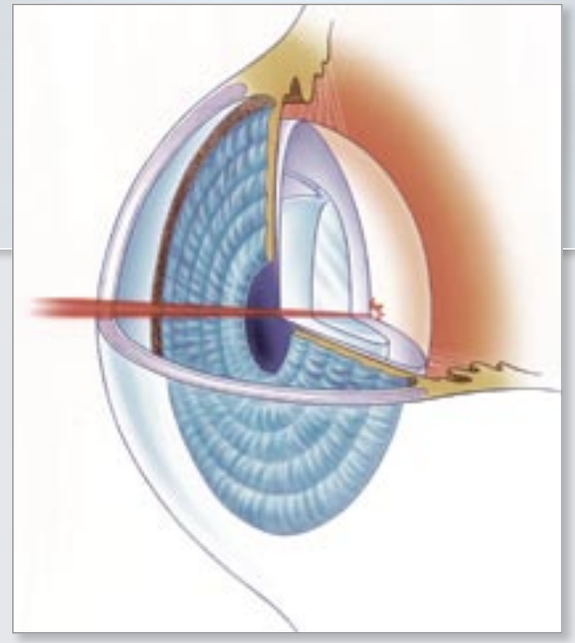
ellex

Introduction to Precision Photodisruption

The Nd:YAG photodisruptor laser is an essential part of modern ophthalmology. Primarily used for posterior capsulotomies, photodisruptors are laser “scalpels”, capable of providing consistently accurate, precise surgery on delicate ocular tissue.

At some point in their career, most ophthalmologists will purchase a photodisruptor, and will want to know the difference between models and manufacturers. Features such as system design, usability, laser performance and quality vary widely, and should be carefully evaluated before making any investment in YAG technology. This booklet is intended to explain – minus the technical jargon – the five key aspects that should be addressed during the selection process. They include:

- Laser Performance
- Slit Lamp Performance
- System Design
- Warranty & Service
- Manufacturer



Laser Performance

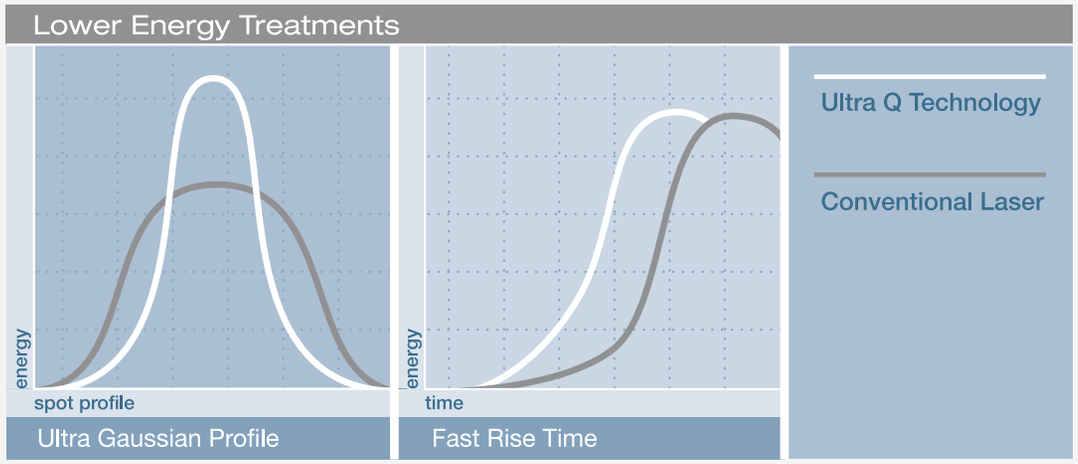
To ensure high performance and minimize the risk of side effects, photodisruptors must perform to specification. The most critical aspects of laser performance include optical breakdown, reliability and durability.

Low Energy Optical Breakdown

Optical breakdown results in the plasma spark and subsequent shockwave, which incises the capsule or iris. Photodisruptors should achieve optical breakdown at low energy.

Low energy breakdown can only be achieved by a custom-designed laser cavity optimized to produce an Ultra Gaussian pulse. The laser cavity should produce a short pulse of no more than four nanoseconds with high peak energy. Fast pulse rise time is another critical component of laser performance. It allows the energy delivered to reach the optical breakdown threshold and form a tight plasma ball with less energy conduction and loss in surrounding tissue.

Together, a high energy Ultra Gaussian pulse and fast pulse rise time contribute to plasma formation and tissue incision at lower energy which is safer and enables more precise treatment.



IOL-friendly photodisruption

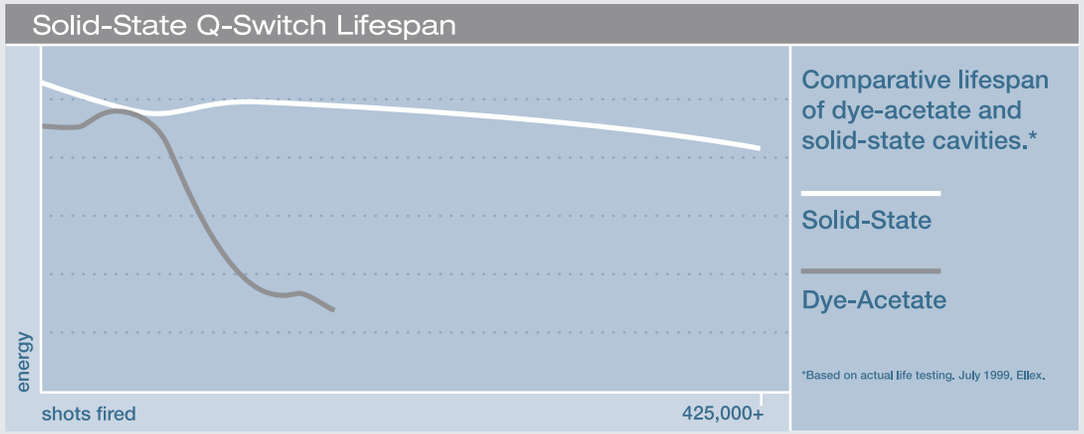
The importance of optical breakdown at very low energies cannot be overemphasized, for several reasons:

- Silicone and acrylic IOLs are extremely susceptible to pitting and require lower energy settings.
- Implantable contact lenses (ICL) and phakic AC IOLs require accurately sized peripheral iridotomies to avoid monocular diplopia.
- Refractive lenses, which include accommodating and multi-focal lenses, require a very accurate capsulotomy procedure to maintain perfect centration and positioning.

Reliability and Durability

Another important factor to consider is downtime over the life of the laser. The type of Q-switch material used in a YAG laser cavity has a significant impact on system reliability and durability.

A Q-switch is an optical component used to "gate" energy in order to generate a short, high peak-energy pulse. High quality and durable YAG lasers employ solid-state Q-switches which utilize a crystal to gate the energy delivered. There are other Q-switch materials that are less expensive, such as dye-acetate, which is a liquid dye suspended in a plastic matrix. However, these non solid-state Q-switches can degrade quickly in less than ideal environmental conditions, such as high temperature or humidity. As a non solid-state Q-switch degrades, the laser system will likely be plagued by missed and inconsistent shots, require relatively high energy to achieve optical breakdown, and result in less efficient tissue cutting and make it slow and difficult to perform precise treatment. In contrast, a solid-state Q-switch provides a longer and more stable laser cavity lifespan, offering hundreds of thousands of shots over a wide range of operating conditions with negligible downtime.



The above graph shows the significantly shorter lifespan of the dye-acetate-type Q-switch, as opposed to the solid-state Q-switch.

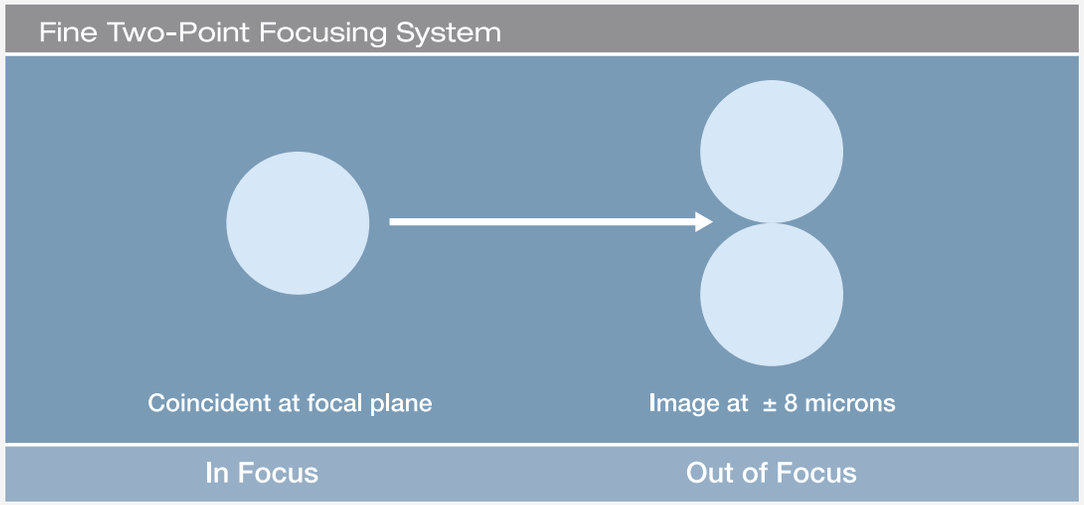
Slit Lamp Performance

The quality of a photodisruptor's slit lamp microscope, focusing mechanism and posterior offset control are all crucial to performing efficient and precise treatment.

Precise Focusing System

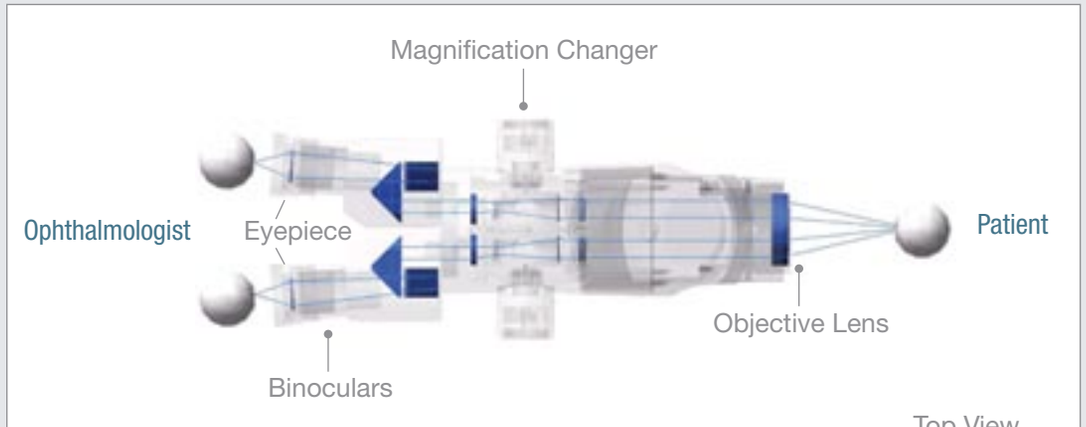
Focusing on the posterior capsule is critical to preventing IOL pitting. Two-point focusing systems, where two aiming beams converge in the focal plane, are the most accurate at indicating when the laser and slit lamp view are in proper focus. This is because a simple two-point focusing system allows the operator to see a separation of the two aiming beams, which indicates out-of-focus, with even the smallest of slit lamp movements.

In comparison, four-point and many other focusing systems require a significant shift in the slit lamp's position before the operator can distinguish any separation of the aiming beams. Less precise aiming can be compensated for by using higher power and creating a larger plasma in the patient's eye, but this also increases the risk of lens pitting and other undesirable effects.



Slit Lamp Optical System

The quality and design of the slit lamp optics are important to consider when choosing a YAG laser. Slit lamps with Galilean converging optics provide a more natural stereoscopic view, which means fatigue-free operation for the physician's eyes. Eyepieces also play an important role in the viewing function of the slit lamp, with larger diameter oculars providing a wider field of view of the target area.



Posterior Offset Adjustment

The posterior offset is used to set the distance between the focal plane and the position of the plasma ball. Since the plasma ball creates shock waves that move back in the direction of the laser source, the ideal placement of the plasma ball is slightly "posterior offset" from the target tissue to be incised. In order to deliver precise treatment and avoid the risks of side effects like IOL pitting, the laser system should provide a selection of offset settings. The best design is a continuously variable posterior offset adjustment that allows the most precise adjustment of the plasma ball's position and gives the physician the most control.

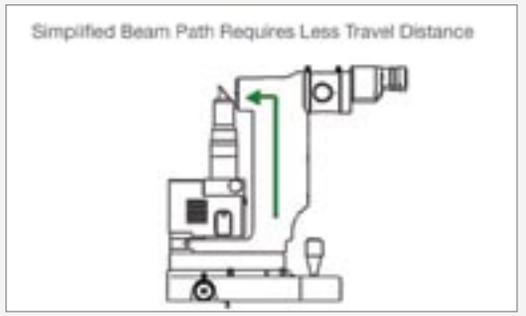
Some laser manufacturers offer an anterior offset option that positions the plasma anterior to the focal plane, which they claim is useful for dusting off precipitates of the anterior lens surface or cutting anterior membranes. In truth, any automatic positioning of the plasma further forward than the focal plane introduces unnecessary risks. The preferred approach is to use a more precise laser that can produce low energy plasma, and set the anterior offset to zero so that the operator sees the exact position in focus where the plasma ball will be created.

System Design

When evaluating system design and manufacturing quality, it is useful to examine the functionality of each of the controls and adjustments, as well as to explore whether the system offers flexibility in terms of portability and the ability for future upgrades.

Simplified Beam Path

A simplified beam path reduces risk of optical misalignment. Integrated YAG laser systems that incorporate only one reflecting mirror, and require the beam to travel less distance, result in more stable, reliable and consistent energy delivery.



A large working distance provides accessibility and comfort for both doctor and patient.

Appearance and Aesthetics

With today's patients expecting to be treated with sophisticated, modern technology, appearance and overall aesthetics play an important role.

Superior Ergonomics

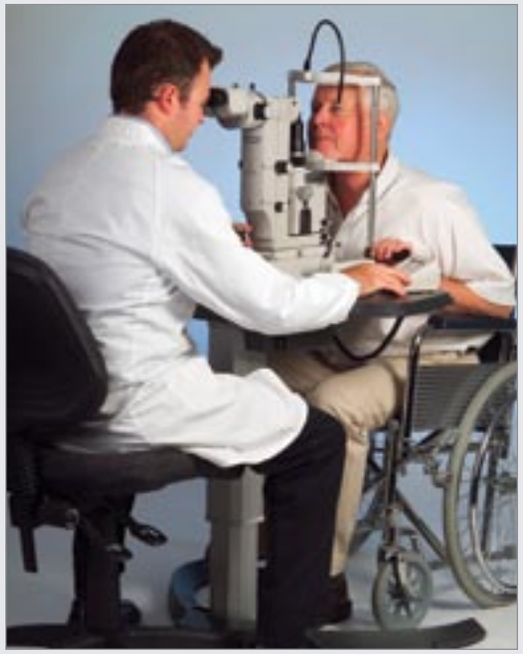
System ergonomics – including system size, table space, control reach, power cord location, leg room and working distance – dictate both user and patient comfort. Many photodisruptors claim to have ergonomic design; however, it is important to evaluate these design features in terms of user-friendliness and user and patient comfort, as well as accessibility in terms of the controls, display and working distance.

Ambidexterous controls ensure ease of operation.

Laser controls like energy and posterior offset should be easily accessible, and are ideally positioned directly in front of the user. They should be located within comfortable reach, whether the user is right or left-handed. The

display panel must also be conveniently located so that it can be positioned centrally, or in the case of a remote control, moved to either the right or left side of the system. A less desirable design approach is to have push buttons located on the slit lamp itself, which can cause the entire slit lamp to move out of focus when the user presses a button.

The system's ability to fit the user, and particularly the patient, can often be an issue. Because patients differ so widely in size, a YAG laser that has both ample leg room and an easily and widely adjustable chin rest is important. In almost all cases, a motorized table is necessary. A wheelchair accessible table further enhances overall system ergonomics, as well as allowing for greater height adjustment. Finally, cables and connectors should not be exposed, ensuring that anxious patients are unable to grab and accidentally disconnect them during the procedure.



Choice of motorized table stands – wheelchair accessible and mobile configurations available.

Adjustments that are continuously variable allow for precise settings.

Continuously Variable Parameter Adjustments

In some YAG systems, only a step-control adjustment with fixed, pre-determined position settings is provided for the energy and posterior offset controls. This prevents the user from precisely adjusting parameter settings as required, and could potentially result in too much or too little energy on the target. The solution is continuously variable energy and posterior offset control adjustments that provide optimum flexibility. The user sets the parameters as required, delivering the precise level and position of the plasma for more effective and safer photodisruption.

Portability

Many ophthalmologists need one laser system that can travel with them to multiple locations. Robust design and components are necessary to ensure that the laser can be safely and easily packed, unpacked and assembled without the assistance of a service technician.

Sturdy carrying cases with roll-away wheels provide ease of transport.

Firing Rate

A good photodisruptor should be fast firing, as measured in Hertz (Hz), the number of shots that can be fired per second. In order to complete treatment reasonably fast and work at a pace that is comfortable for the patient, a fast firing (at least 2 Hz) YAG laser is recommended.

Combination YAG and Green Laser Designs

Several manufacturers offer combination YAG photodisruptor and green photocoagulator laser systems. These systems allow the use of one slit lamp for both photodisruption and photocoagulation procedures. The major design challenge for combination systems is that the most common YAG procedures are in the anterior part of the eye, while a greater number of green laser procedures involve the retina in the back of the eye. It is a unique challenge to design a slit lamp laser delivery device that is optimized for both the front and back of the eye at the same time. More commonly, the result is a set of compromises that offer "less" rather than "more."

When considering combination systems, important questions to ask include:

- Is it a "toaster oven" that does several things, but none very well?
- Does it offer the best possible anterior view and focusing?
- Does it offer the best possible posterior and peripheral view?
- Are the working distance and ergonomics as good as separate systems?

Accessories

Accessories are important for fulfilling both present and future needs, and can greatly enhance the flexibility of a YAG laser photodisruptor. The minimum range of accessories should include, but not be limited to:

- Laser lenses
- Video camera adaptor
- 35mm camera adaptor
- Co-observation tube
- Carrying cases
- Laser safety glasses

When considering slit lamp accessories, an appropriate tonometer post for the YAG slit lamp allows the system to function as both a diagnostic and treatment workstation.

A range of accessories can enhance the flexibility of a YAG system.

Warranty and After-Sales Support

Warranty and after-sales support should be factored into any laser purchase decision.

A one-year parts and labor warranty is standard for medical capital equipment, including lasers. And, while better manufacturers will offer longer warranty periods, the best companies will separate out the most expensive and technology-rich component – the laser cavity – for special extended warranty protection. It is also important to consider the value of the warranty that is bundled into the laser purchase price. One manufacturer may offer a better price, but reading the fine print will disclose that it is not a better value, because the warranty terms are not equal to the higher-priced laser.

It is also important to remember that the warranty is only as good as its implementation. Prompt, high quality, after-sales service and support will maintain optimal operational ability and limit system downtime. Important considerations include:

- Customer service reputation of the manufacturer
- Proximity of the field service engineer that will service the laser
- Promised response time
- Availability of spare parts
- Service department and technical support organization behind the local engineer

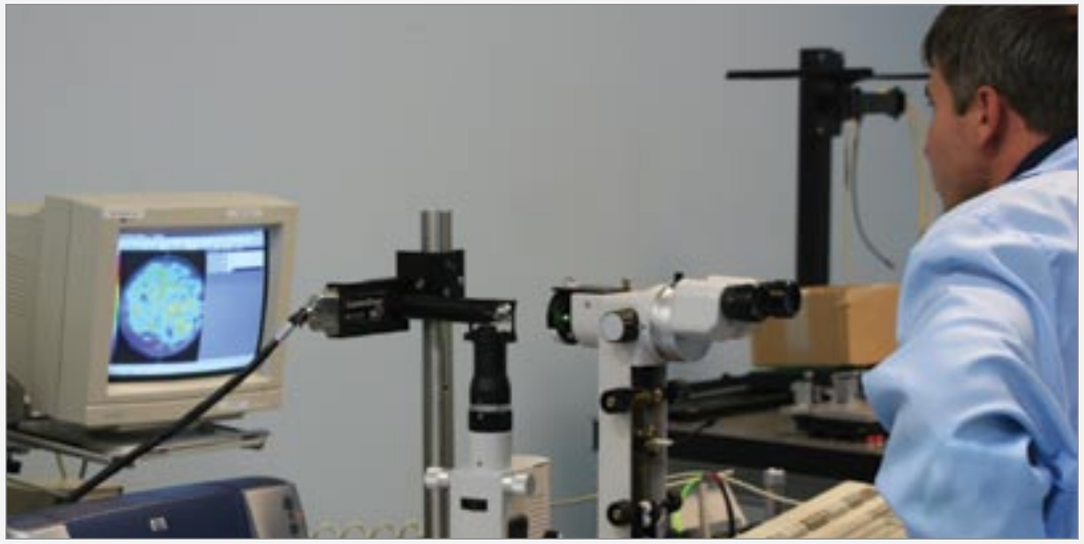
Manufacturer

A laser purchase is a decision to work with a company for the useful life of the system, usually 7 – 10 years. For that reason, it is important to choose this new partner carefully.

As lasers are highly specialized devices, most ophthalmologists and hospital administrators choose to purchase from a specialized laser company. Manufacturers vary widely, but the best equipment comes from companies that are focused on ophthalmology, and that have a commitment to develop lasers and other devices to incorporate changes in the field. These manufacturers update their designs regularly, based on physician input.

Referrals are often the best way to learn about a manufacturer's track record. A prospective buyer should always ask the sales person for a list of other owners who can be contacted to discuss their experience with the laser system.

The manufacturer's financial stability is also an important consideration when making a laser purchase decision. With a useful life that requires maintenance service for 7 – 10 years, it is important to be sure that the laser company will be around as long as the laser.



About Ellex

Ellex engineered its first high-performance ophthalmic laser in 1985, and today is the only laser manufacturer focused solely on the ophthalmic market. Ellex manufactures and sells a complete line of solid-state laser systems for treating cataract, retina and glaucoma patients. In all, more than 10,000 Ellex manufactured lasers are in use worldwide.

Ellex's vision is to be the leading brand of lasers used by ophthalmologists to fight blindness. This vision is underscored by a strong global presence, a growing number of regional customer service and sales support centers and a single brand name representing the company and its products.

ellex.com

Worldwide
82 Gilbert Street
Adelaide, SA
5000 AUSTRALIA
+61 8 8104 5200

USA
7138 Shady Oak Road
Minneapolis, MN
55344 USA
1 800 824 7444

Japan
4-3-7 Miyahara 4F
Yodogawa-ku Osaka
532-0003 JAPAN
+81 6 6396 2250