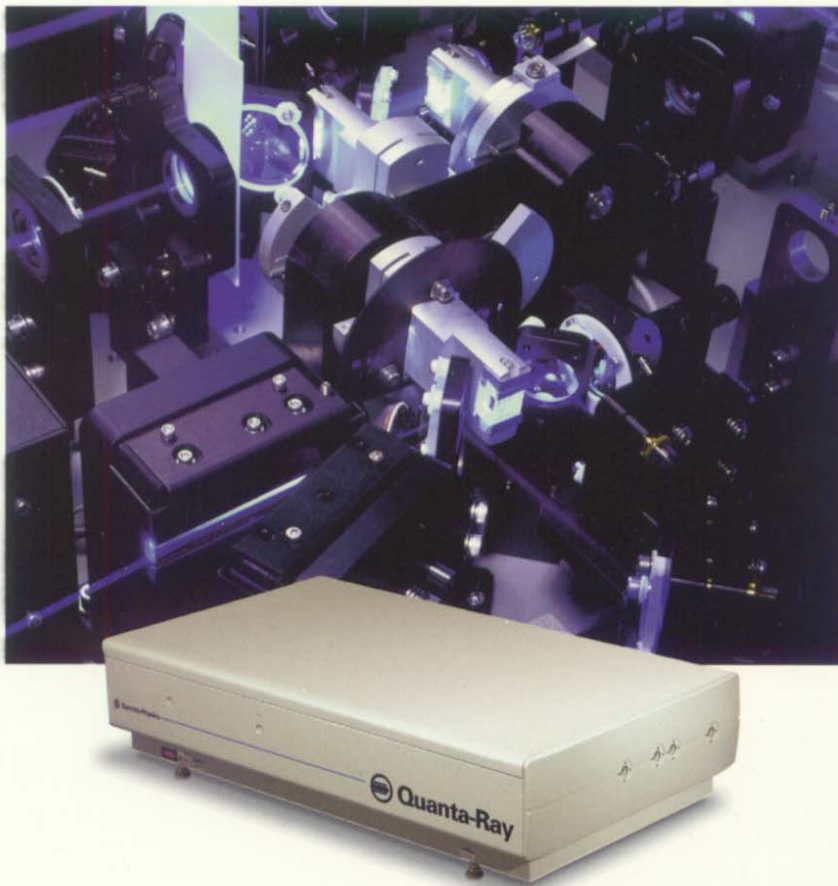


## MOPO SERIES

The Most Popular  
And Proven OPOs  
Worldwide.



 **Spectra-Physics**

The Solid State Laser Company™

# MOPO. The Number One Choice In OPO Technology.

In the arena of optical parametric oscillator (OPO) technology, Spectra-Physics enjoys a long history of firsts.

We were the first to seriously promote OPO technology. The first to deliver on a major scale with the groundbreaking master oscillator/power oscillator (MOPO) 700 Series. And the first to install this powerful medium in the

most respected scientific organizations in the world.

Today, Spectra-Physics is the number one supplier of OPO systems worldwide. Leading the industry with hundreds of installed systems, incorporated in a wide variety of applications, and operated within widely diverse laboratory environments.

Our unique advantage in having such a large installed base is our ability

to log thousands upon thousands of operating hours on working MOPO systems in real-life, working laboratories. Our top engineers have taken full advantage of this experience and have concurrently designed, refined, and tested our OPO technology to maximize performance and eliminate any hands-on adjustments made by the user.

The result is an OPO system whose rock solid performance is second to none. The fully automated MOPO provides hands-free operation and steadfast reliability, while delivering a



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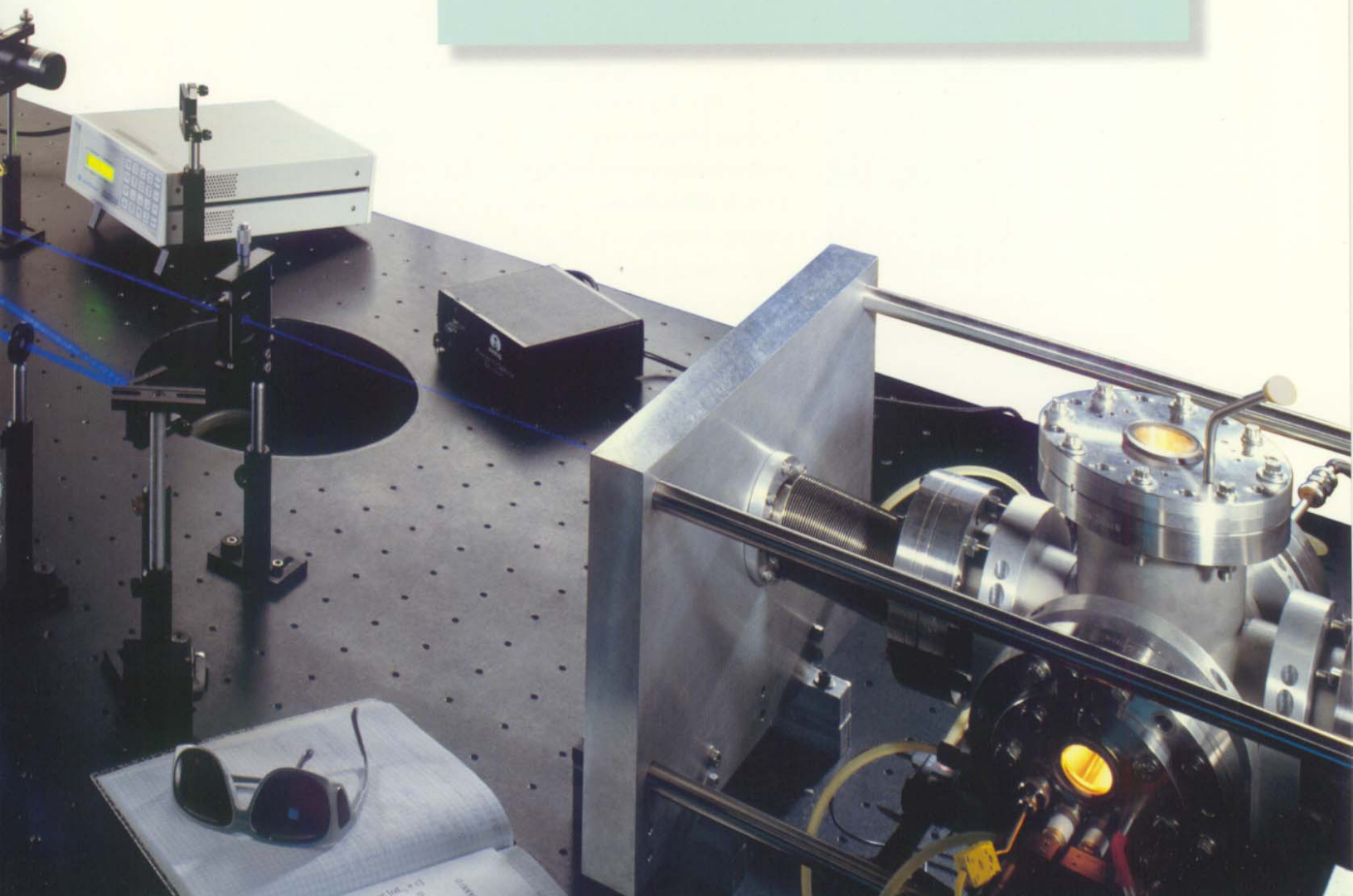
*"The SP MOPO-730 is one of the prized possessions in my laboratory. We have had it for more than two years, and it has performed in a reliable manner at the specs stated by the manufacturer. Any service that it has needed has been provided promptly, and in an expert manner."*

new level of tunable pulsed high-energy performance. The MOPO is pumped by the industry-renowned Quanta-Ray Nd:YAG laser. And backed with Spectra-Physics' unequalled service and support organization.

The range of experimental firsts enabled by the MOPO's unique performance characteristics is astounding. From studying high-harmonic generation in gases, which requires the MOPO's broad tunability into the UV, to performing Cavity Ring-Down experiments in the IR that demand low divergence, and narrow-linewidth operation, the day-to-day reliability and performance of the MOPO will take your experiments places they've never been before.

#### The MOPO OPO Advantage.

- *The largest installed base of BBO-based OPOs worldwide, plus the knowledge, experience, and support that has made this possible.*
- *Highest OPO performance on the market. Low fluence designs yield greater than 25% overall efficiency, resulting in typical energies in excess of 80 mJ in a choice of broadband or narrow linewidth outputs.*
- *Auto-tracking ensures peak performance day in and day out—eliminating the need to manually adjust crystals, measure output energies, or change the underlying look-up tables (enhancing performance on both the MOPO and FDO).*
- *Advanced coatings protect the BBO crystal and improve efficiency without introducing destabilizing heated housings onto the laser platform.*
- *Onboard performance monitoring provides real-time power levels and automatically optimizes performance at all times.*
- *Single mirror set design covers the entire tuning range—no need to change mirrors, realign experiments, or risk damage.*
- *Integrated frequency doubling option (FDO). All MOPO platforms are designed with the capacity to upgrade to an integrated frequency doubling package. Building the MOPO and FDO on a common baseplate assures superior stability and reliability.*
- *Larger beams and larger crystals allow for lower fluence levels that dramatically reduce long-term degradation in performance and running costs.*
- *Advanced options make it easy to tailor the system that's right for you. Choose from a full range of linewidth and energy characteristics, plus advanced Nd:YAG features such as BeamLok and D-Lok.*



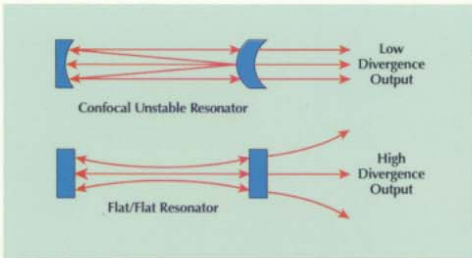
# The Benchmark In OPO Performance.

The OPO technology utilized in the Spectra-Physics MOPO is based on parametric gain in the non-linear crystal  $\beta$ -barium borate (BBO) pumped by the 355-nm third harmonic output of a Nd:YAG laser. The MOPO design incorporates two coupled OPOs, a master OPO, and a power OPO. This master oscillator/power oscillator (MOPO) design provides unprecedented linewidths and output energies with hands-off scanning throughout the visible and near infrared spectra.

Behind this superior performance are numerous solid design concepts.

## Unstable Resonator: Superior Efficiency, Beam Quality, Power.

Spectra-Physics' patented unstable resonator is an integral part of all



Quanta-Ray Nd:YAG lasers and as such is world-renowned for its performance enhancing power. Used as the MOPO's power oscillator, it has proven to be the most efficient way to extract parametric gain in a collimated beam with super-Gaussian beam profiles. In contrast, competing designs sacrifice conversion efficiency and divergence in an effort to simplify manufacturing and reduce material costs.

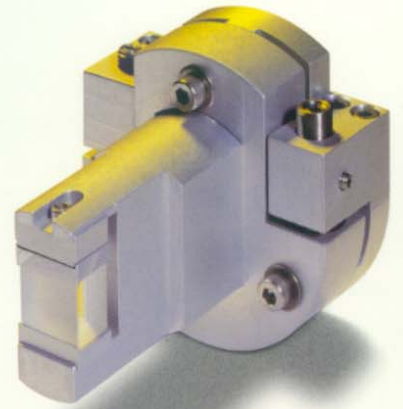
In fact, the MOPO consistently demonstrates 50% better overall efficiency compared to competing designs. This allows the system to be pumped by a much smaller pump laser, thereby reducing cost and lowering UV pump levels in the OPO.

So if you're thinking, "I need all the energy I can possibly get," consider this: 50% greater efficiency translates into 50% more energy. No other BBO-based OPO on the market comes close to the MOPO's output energy.

## Hard Coated BBO Crystal: Maximizes Stability And Improves Efficiency.

A hard, 355-nm anti-reflection coating preserves the heart of the MOPO — the BBO crystal. By encasing the BBO in a hard coating, two important operating criteria are accomplished:

Number one: The crystal is 100% protected from moisture and the environment, altogether eliminating the need to temperature stabilize the crystals in a sealed, heated housing. Properly coated crystals make obsolete the use of destabilizing heat sources in an otherwise unheated system. This approach ensures long crystal lifetime and stable output power and significantly reduces movement in components subject to heating.



Number two: Sealing the BBO in a protective anti-reflection coating increases efficiency. Dramatically. This way, fewer optical surfaces are exposed to high energy UV light, plus the coating itself reduces the rejection of 355-nm pump light. This results in an improvement in overall utilization of available pump light.

## Complete Tunability With A Single Mirror Set.

Building a rugged, durable coating that covers the wavelength range from 400 to 710 nm is no easy task. Spectra-



Physics, with its advanced optics manufacturing capability, remains the only company to have demonstrated long-lasting coatings with a wavelength coverage that spans the entire OPO tuning range. Other systems that still require mirror changes in the course of scanning not only necessitate the replacement and realignment of the mirrors themselves, but also often lead to the tedious realignment of all down-

stream optics. The MOPO's broadband dichroic mirrors separate the signal and idler across the entire tuning range.

Long range, uninterrupted scans, covering widely separated spectral regions, are easily achievable without mirror changes.

### **Injection Seeding Maximizes Stability And Reliability.**

The MOPO bypasses conventional single-pass amplification methods of achieving high energy, narrow line-width pulses with a more stable and robust approach: injection seeding.

Extensively proven in high energy YAG lasers, injection seeding in the MOPO comprises a master oscillator, which effectively seeds the power oscillator. There are two key benefits: (1) The power oscillator is far less sensitive to seed beam divergence and direction. Thus, environmental changes that may affect the quality of the master oscillator (seed) beam are not "amplified" in the power oscillator as they are in a conventional oscillator/single pass amplifier design. (2) The power oscillator approach requires one third the seed power of the amplifier technique, significantly reducing the risk of damage to optical components.

### **Larger Beam Diameters: Lower Fluence.**

Larger mirrors enable the MOPO to utilize larger UV beam diameters throughout the system. This reduces the peak fluence on optical surfaces, which in turn significantly reduces the

## **Quanta-Ray Nd:YAG Pumping**

*To ensure maximum OPO performance, all MOPO systems are pumped by Quanta-Ray Nd:YAG lasers, industry renowned for superior performance, quality, and reliability.*

*With such features as gold elliptical pump chambers, high-damage threshold optics, sealed beam paths, and unbeaten short- and long-term stability specifications, Quanta-Ray Nd:YAG lasers set the standard for efficiency, mode quality, and long-term performance.*

*Moreover, Quanta-Ray Nd:YAG lasers feature BeamLok and D-Lok active stabilization options—providing you with exceptional beam pointing and long-term stability, while also dramatically extending the life of the flashlamps. (You'll find more on BeamLok and D-Lok on the next page and in our special BeamLok brochure—be sure to ask for your copy.)*



long-term degradation of optical coatings. The overriding benefit? Better maintained performance and lower running costs.

Another key benefit to this approach is reduction of fluence on the BBO crystal surface. This further reduces long-term component stress and cuts running costs even more.

### **Active Feedback: Higher Performance, Dependability, And Operating Ease.**

Many scientists consider the MOPO's automated tracking and monitoring systems to be its most significant advantage.

These active feedback loops ensure peak, repeatable performance day in and day out in real-life laboratory envi-

ronments where ideal conditions such as constant temperature are not always maintained. Active control feedback loops also enable faster system warm-up times, superior beam pointing stability, and longer operational hours between adjustment. In addition, they allow the user to remotely monitor and adjust critical system parameters without removing covers or interrupting experiments.

Fully mature and extensively tested, these feedback loops have proven to play a critical role in the successful performance of hundreds of installed MOPOs. As such, they have run the gauntlet in thousands upon thousands of precision experiments.

# Exacting, Repeatable Performance.

One of the biggest challenges faced by all OPO manufacturers is the technology's inherent sensitivity to angular changes in the pump beam and to the stability of the mechanics.

Maintaining optimum OPO performance has been approached using passive and/or active stabilization techniques. The passive approach involves carefully engineering a high quality design that includes high precision mechanics and extremely stable

stabilization must constantly be re-optimized manually to compensate for any slight changes in the lab environment.

The fully automated MOPO Series is engineered for hands-off operation day in and day out, year after year. Its steadfast operation simply outperforms all other OPO designs.

## Auto Tracking Ensures Consistent Peak Performance.

The MOPO's unique auto tracking feature ensures constant, precise



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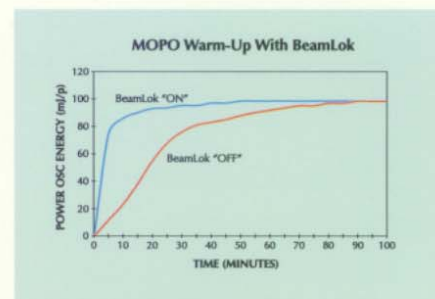
*"We greatly value the MOPO's ease of tunability. We can set the system scanning, and it will give us almost any wavelength we need. The stable IR generation capability is a delight compared to all the fiddling about traditionally associated with tunable IR production. We have arranged that the MOPO output can be directed into experiments in three different laboratories; it performs beautifully in each application."*

hardware. The active stabilization approach incorporates feedback loops that automatically monitor and optimize the OPO system performance without manual adjustments.

The MOPO Series and the FDO option employ *both*. Including passive and active performance optimization into the MOPO allows the system to operate under ideal and not so ideal laboratory conditions. Other OPO systems engineered solely with passive

performance of the MOPO and FDO at peak levels. Unlike other OPOs, which rely exclusively on the accuracy of look-up tables, the MOPO's auto tracking feature combines tables with active auto tracking — an approach proven to be superior to look-up tables alone in many non-linear mixing systems to date.

Because these control loops employ sophisticated time-averaging and feed-forward algorithms, they actually reduce average noise — not add to it.



They also counter long-term drift, the biggest source of experimental baseline problems. The inline monitoring devices provide a real-time measure of system performance and also give useful data for automated experimental systems.

## BeamLok: Superior Beam Pointing And Rapid Warm Up.

The MOPO's pump source, the Quanta-Ray Nd:YAG laser, includes a passive engineering design that sets the standard for pointing stability. Yet even greater control can be achieved with BeamLok, an optional, active beam stabilization system. With BeamLok, your OPO system will gain superior accuracy, ultra-long term stability over the day and over the months, and dramatically faster warm-up.

## D-Lok Provides Smoother, Longer-Term Performance.

As flash lamps age, the divergence in the UV pump beam increases, and the OPO's performance gradually degrades. But with Spectra-Physics' unique D-Lok feature, an integral part of the BeamLok system, the divergence with lamp life all but disappears. The result? Dramatically improved long-term OPO performance, and flashlamp lifetime increases of over 30%.

# OPO Operation Simplified.

Think operating an OPO is difficult? Think again. You'll enjoy smooth and intuitive operation with the MOPO's single mirror set, auto/manual control, onboard or remote computer interface, and real-time performance monitoring. Best yet, you can make most routine adjustments without ever having to remove the system's cover or interrupt work. The upshot? Experiments are easier, more effective, and downtime-free.

## Automatic Or Manual Control.

Control every aspect of the MOPO and FDO via the powerful onboard operating system. From the MOPO's low-profile, stand-alone controller, you can quickly step through a wealth of operating windows — each providing finer and finer control over the critical system mechanics. Set the system in automatic mode, and the MOPO self optimizes. Or, individually adjust each key

component in the system — without ever having to remove the lid.

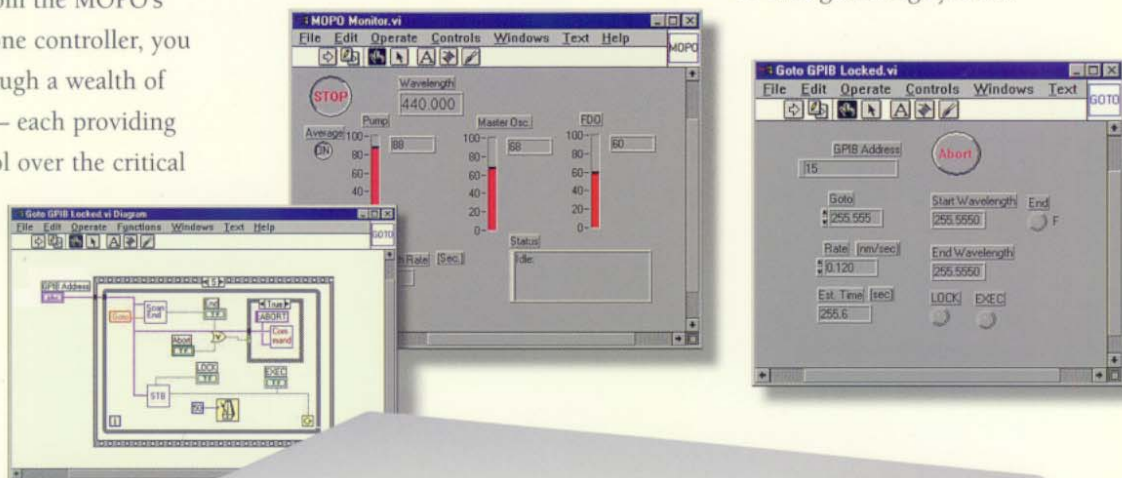
## LabVIEW™ Driver Available.

Prefer to integrate the MOPO into your existing computer controlled experiment? No problem. Simply incorporate the MOPO's dedicated LabVIEW<sup>1</sup> driver and you're ready to go — eliminating the hassle of complicated communications protocols needed to integrate OPOs that utilize a dedicated PC controller. If LabVIEW is not your preferred virtual instrument software, then the comprehensive MOPO manual contains a full guide to the

remote interface, detailing command structure, and interface protocols.

## Real-Time, Onboard Performance Monitoring.

Ensure your OPO is delivering peak performance at all times. Just check the controller screen where all critical performance parameters are constantly updated in real time. Moreover, you can optimize system performance manually without having to interrupt the laser beam or the experiment itself. Access to system performance parameters via the computer interface can be invaluable for integrated data gathering systems.



1. LabVIEW is a product of National Instrument.

# The FDO-900 Frequency Doubling Option.

Expand the MOPO's frequency coverage into the UV with the FDO-900 frequency doubling option. Featuring industry-leading tunability, repeatability, and beam pointing stability, the system is ideal for applications including absorption spectroscopy, photo desorption mass spectroscopy, combustion research, single and multiphoton absorption and ionization, and biological specimen analysis.

## Installs Directly Into The MOPO.

The FDO-900 fits neatly into the MOPO, bolting directly onto a common baseplate. Offering a fully integrated OPO and frequency doubler on a single, shared platform insures superior stability. Moreover, the MOPO's overall footprint doesn't increase, saving you valuable workspace.

## Dual Crystal Design.

The FDO uses two counter rotating BBO crystals to cover the entire UV range, avoiding the need for compensators. In this way, one crystal compensates while the other does the frequency

doubling. Once out of range the automated control electronics automatically change the crystal angles so that the second crystal compensates and the first doubles. A single Pelin Brocca prism separates the UV from the fundamental wavelength, allowing UV scanning without beam wander or beam displacement.

## Autotracking For Impeccable Repeatability.

The FDO-900 shares the proven passive/active tracking feature found in the MOPO. The FDO-900 combines passive look-up table tuning with active feedback "autotracking" to provide maximum UV output. Without autotracking, even the best mechanics cannot achieve reliable scanning, especially into the deep UV. However, with autotracking, reactive control loops detect changes in the FDO performance, then based on predictable response, the crystal angle is optimized to provide maximum performance. Combining look-up tables and autotracking allows long scans with fully optimized doubling performance without changing filters or other

optics and without manual adjustment. This fully automated feedback loop works non stop, ensuring optimal UV performance even on long wavelength scans.

## Fully Compatible With The MOPO's Controller.

Automate and control the FDO-900 from the MOPO's dedicated controller. A range of intuitive windows enables you to adjust all system mechanics without having to remove the MOPO's cover. Or, use the MOPO's LabVIEW drivers — including full FDO-900 functionality — to integrate the system into your computerized experiment.

## Performance Monitoring.

Like the MOPO, the FDO-900 features a series of sensors that monitors all performance parameters and displays them on the system controller in real time. This unique capability allows you to diagnose system performance without ever having to interrupt your experiment or measure the laser output. This feature also provides a useful data stream to automated experimental setups.



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