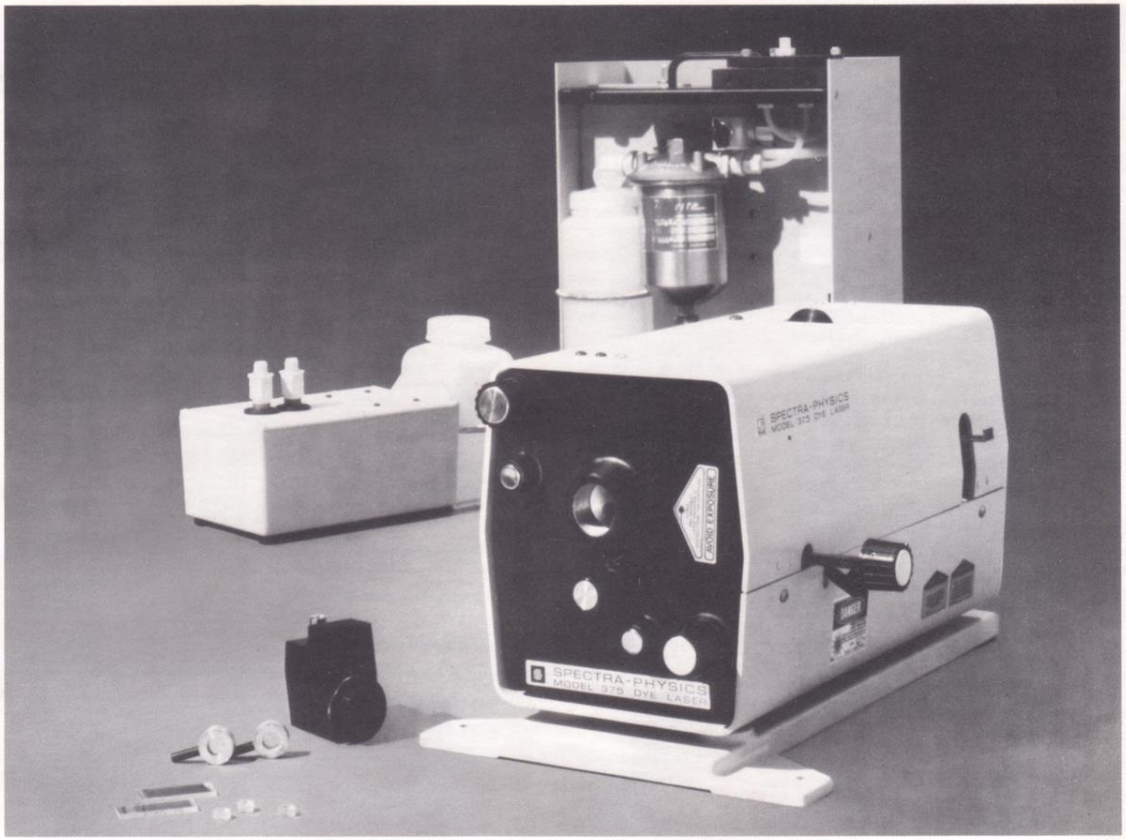
CW Dye laser Spectra Physics

par ARNOLD

Spectra-Physics
CW Dye Lasers



The Spectra-Physics Model 375 Dye Lasers are sources of intense tunable coherent light, ideally suited for use as a tool for spectroscopy in atomic and molecular physics, chemistry, and materials research. These lasers provide maximum user flexibility, producing CW or pulsed output across the visible spectrum and into the infrared. Spectra-Physics dye lasers are designed to provide superb performance and years of reliable operation. Continuing technical support for these products is provided by Spectra-Physics' worldwide sales and service organization.

Model 375 General Purpose Dye Laser

Option	-01	-02	-03	-04	-05	-06
Dye Type[1]	R6G	R110	RB	C1	R101	Oxazine 1
Wavelength[2]	600 nm	570 nm	630 nm	460 nm	640 nm	745 nm
Wavelength Range[2] **(20% points)**	572 nm to 640 nm	545 nm to 600 nm	603 nm to 670 nm	450 nm to 490 nm	625 nm to 690 nm	700 nm to 790 nm
Power for Specified Pump[2]	0.6 W	0.3 W	0.3 W	0.05 W	0.3 W	0.7 W
Specified Pump Source	4 W TEM_{00} 458 - 514 nm	4 W TEM_{00} 458 - 514 nm	4 W TEM_{00} 458 - 514 nm	1.5 W TEM_{00} 351 - 364 nm	4 W TEM_{00} 458 - 514 nm	4 W TEM_{00} 647 - 676 nm
Linewidth [2,3,4]	40 GHz 1.33 cm^{-1}	40 GHz 1.33 cm^{-1}	40 GHz 1.33 cm^{-1}	20 GHz 0.66 cm^{-1}	40 GHz 1.33 cm^{-1}	60 GHz 2 cm^{-1}
Tuning Resolution	8 GHz	8 GHz	8 GHz	4 GHz	8 GHz	12 GHz
Output Beam Diameter	0.54 mm @ 600 nm	0.53 mm @ 570 nm	0.55 mm @ 630 nm	0.47 mm @ 460 nm	0.56 mm @ 640 nm	0.60 mm @ 745 nm
Output Beam Divergence	1.41 mrad @ 600 nm	1.38 mrad @ 570 nm	1.45 mrad @ 630 nm	1.24 mrad @ 460 nm	1.46 mrad @ 640 nm	1.58 mrad @ 745 nm
Noise, 10 Hz to 100 kHz	1.0% rms without Stabilizer[2], 0.5% rms with Stabilizer[5]					
Amplitude Stability, 0.1 sec to 10 Hrs at dye peak	$<$3% Peak to Peak without Stabilizer[2], $<$0.5% Peak to Peak with Stabilizer[5]					
Output Beam Mode	TEM_{00} Vertically Polarized					
Cavity Mode Spacing	420 MHz ($L = 35.5 \pm 0.4$ cm)					
Model 376 Input Power	115/230 Volts, $\pm$ 10% Single Phase, 50-60 Hz, 200 VA					

1 Laser is tested with dye stated. The optics and tuning elements may work with other dyes as well. See page 15 for a list of dyes and optics.

2 Specification is at the peak of the dye with standard Model 375 tuning elements, and assumes that no dye degradation has occurred.

3 Line width may be significantly reduced in some dye ranges with optional tuning elements. See page 7 for details.

4 To convert from frequency units to wavelength units use the following relationship: $\Delta\lambda = \frac{\lambda^2}{C}\Delta v$

5 Optional Model 373 Amplitude Stabilizer. Ion pump power $>$ 50% of full power.

Laser Safety

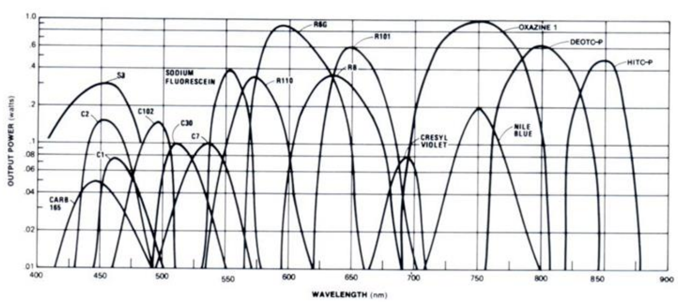
Spectra-Physics has worked closely with federal agencies to promote the safe use of lasers and has designed these products to comply with the Bureau of Radiological Health (BRH) standards now in effect in the United States.

To assure compliance of this dye laser with 21CFR1040, use only with a certified pump laser.

BRH warning logotypes, similar to that shown below, appear on each laser to indicate the BRH classification and to certify that the output power of the laser will not exceed the power level printed on the logotype.

Health Warning

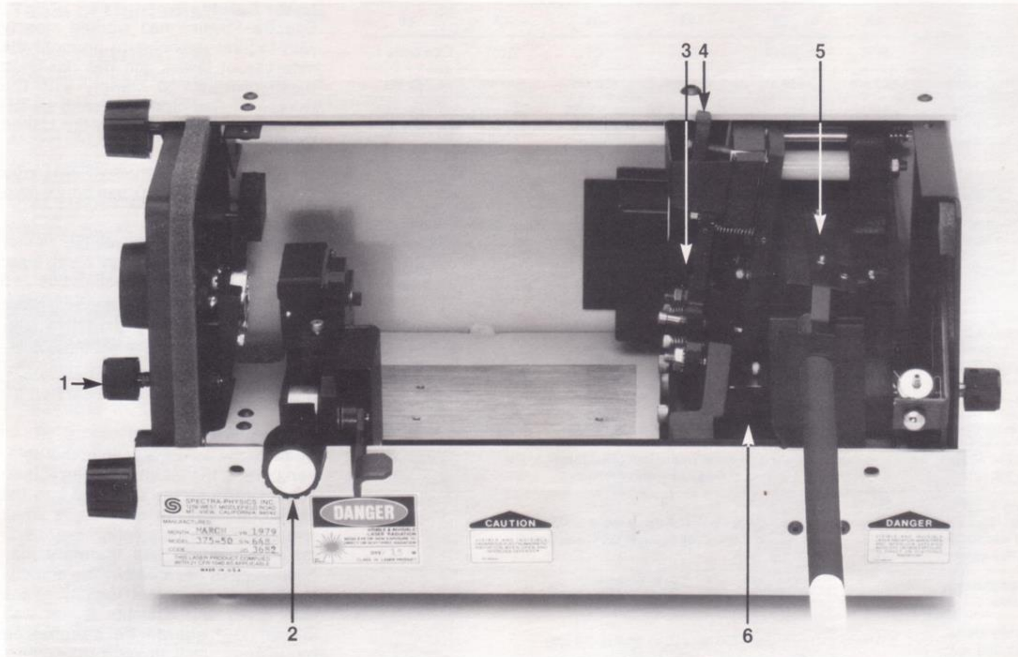
Some of the solvents used in dye solutions have the ability to carry their solutes through the skin and into the body chemistry. In addition, a small amount of the dye solution may be in the vapor phase and therefore may be inhaled or absorbed by the mucous membrane. The exact toxicity of the laser dyes and solvents is not well known and should be considered hazardous until proven otherwise. Precautions such as wearing butyl rubber gloves while handling the dye solution and adequate ventilation are recommended. (Ref.: Dyes Can Be Deadly; *Laser Focus,* May 1975.)



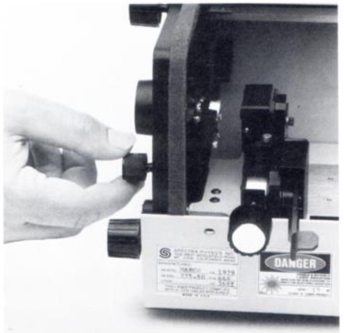
The curves to the left represent typical output powers of the Model 375 with various dyes. The dyes, the pump laser power, and wavelength used to obtain the performance curves of those dyes are listed below.

Dye	Pump Power	Pump Wavelength
CARB 165, C2, C1, C102	1.5 W	351 - 364 nm
C30	1.3 W	457.9 nm
C7	1.2 W	476.5 nm
Sodium Fluorescein, R110, R6G, RB, R101, Cresyl Violet	4 W	458 - 514 nm
Nile Blue	2 W	590 nm
Oxazine 1, DEOTC-P, HITC-P	4 W	647 - 676 nm

Model 375 General Purpose Dye Laser



The Spectra-Physics Model 375 Dye Laser, a source of intense tunable coherent light, is designed for convenient, versatile use in the research laboratory. Using commercially available dyes, the laser can be tuned from 420 to 950 nm. Optimized optics and tuning elements provide the user with a choice of tuning range and linewidth.

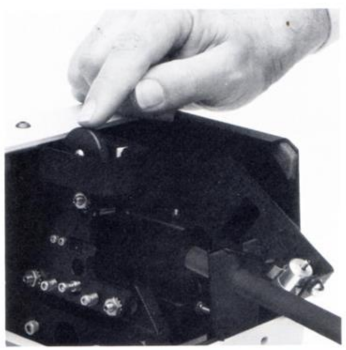


1. Fine Tuning Adjustment
A very thin uncoated etalon plate allows positioning the dye laser frequency to better than one fifth of its line width, or 0.15 cm^{-1}. Optimum frequency centering of the dye laser with respect to an absorption line is quick and easy.

2. Tunable Filter
A thin-film interference wedge with very sharp dispersion characteristics is used to tune the wavelength from 460 to 950 nm with the various dyes. Tuning is accomplished by translating the wedge across the intra-cavity beam. No realignment is required to operate over the 460 to 950 nm range.

An optional tuning filter is available for operation in the 420 to 500 nm range.

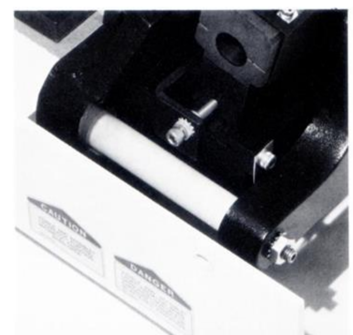
3. Snap-In Reflectors
The cavity mirrors are easily removable and may be replaced in seconds to accommodate different wavelength ranges and to optimize power at a particular frequency. Exchanging reflectors requires minimal or no adjustment for output power optimization.



4. Adjustable Pump Focus Reflector
Angular alignment between the dye laser and argon laser is accomplished by simply adjusting the pump focusing mirror.

5. High-Quality Nozzle
The jet nozzle is designed to project a thin optical quality laminar foil of any dye with viscosity from 5 to 25 centipoise. This permits use of a wide range of solvents to provide maximum fluorescence efficiency in a desired wavelength range.

Careful nozzle design reduces noise to $<0.5\%$ rms typical. The nozzle slides in a dovetail for convenient mounting during dye change or cleaning, without need for realignment.



6. Quartz Rod Cavity
The folded cavity is mounted on thermally-compensated quartz rods which limit frequency drifts to less than 3 x 10^{-3} cm^{-1} per °C. The optical configuration of the three-rod cavity ensures high angular stability of the dye laser mode, reducing the requirement for angular adjustments. Laser alignment is simple and can be performed in minutes by super-positioning two fluorescent spots.

Versatility

Designed for Versatility
The Model 375 Dye Laser can be optically pumped with a CW source to produce tunable CW output, or a pulsed or mode-locked source to produce tunable high-peak-power pulses. The dyes are easily changed for operation in different regions of the spectrum, and combinations of tuning elements can be selected to provide various linewidths and tuning ranges.

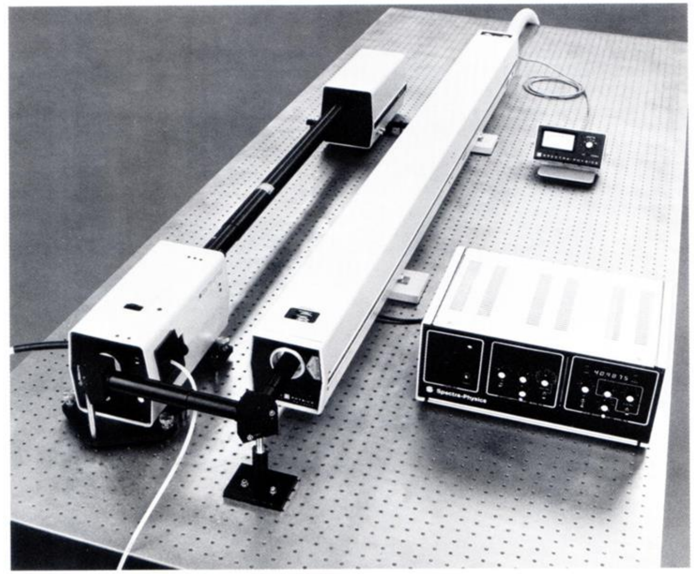
The dye laser and pump laser can be conveniently mounted to either an optical bench using a mounting plate, or can be mounted on a separate platform which maintains pump laser-dye laser alignment.

Easy Dye Change
Several dyes are required to provide tunable laser output over the visible and infrared spectrum. The performance of the Model 375 with readily available commercial dyes is shown graphically on page 3. The dye is chosen for high fluorescence efficiency in the spectral range of interest. Optical excitation of the dye is accomplished using an argon or krypton ion laser. It is also possible to excite a dye with the output of a second dye laser. Selection of the appropriate pump laser is determined by the spectral absorption properties of the dye of interest. Spectral absorption curves for most commercial dyes are shown on page 14.

If dye changes are infrequent, a single circulator is usually sufficient. The nozzle assembly may be removed for flushing without disturbing optical alignment. Both the dye reservoir and filter housing are conveniently located on the exterior of the circulator housing to permit easy change of dye. The entire dye change process may be accomplished with the dye circulator upright and without removing its cover.

If dye changes are frequent, use of multiple circulators is recommended. Detachable hoses allow the new dye to be quickly introduced.

Convenient Optics Change
Optics changes are simple. A spring tab holds the mirror in a precision mirror seat to maintain alignment. Mirrors can be removed to be changed or cleaned by simply lifting the spring tab. When the optics are reinstalled, the laser immediately lases and maximum output power is restored with a minimum of readjustment.



Choice of Time Domain
The Model 375 may be operated in either the CW or pulsed mode, as required by the time domain requirements of the dye laser application.

When the Model 375 is pumped with a CW source, the output is continuous. Output pulses ranging down to 0.6 picoseconds in duration have been obtained when the dye laser is synchronously pumped with a mode-locked ion laser as discussed below.

Synchronous Pumping—Picosecond Pulses
For time domain experiments such as fluorimetry, Raman spectroscopy with fluorescence suppression, gain profiling, or excited state lifetime studies, the Model 375 Dye Laser can be operated in the mode-locked configuration.

When the dye laser is pumped with a mode-locked argon or krypton ion laser and the cavity length of the dye laser is matched to that of the ion laser, the dye laser can produce pulses as short as 0.6 picoseconds at the c/2L repetition frequency of the pump laser. User modification of the Model 375 for this mode of operation is straightforward. An application note on construction of a synchronously mode-locked dye laser is available from Spectra-Physics. This technique has been extended by several researchers to the selection of mode-locked pulses at lower repetition rates by utilizing an acousto-optic cavity dumper. Pulses with peak powers on the order of kilowatts have been obtained using a synchronously mode-locked, cavity-dumped dye laser.

Raman Spectroscopy—No Artifacts
The output of a dye laser has side bands when the dye fluorescence covers a spectral range broader than the free spectral range of the tuning elements. These side bands, or artifacts, are produced when the dye fluorescence radiation passes through adjacent transmission peaks of the tuning element.

In Raman experiments, the anomalous scattered light signals associated with these artifacts make interpretation of the Raman spectra difficult. Dye lasers using etalons or birefringent filters with small free spectral ranges as tuning elements always exhibit these side bands. The Model 375, when operated using only the wedge interference filter to tune the laser, does not exhibit these side bands since the next bandpass of the tuning filter is beyond the fluorescence band of the dye.

Tunability

Model 570 Tuning Wedge

The Model 375 Dye Laser is designed for convenient and reliable operation over a broad range of applications. Wavelength tuning is accomplished with the unique Spectra-Physics "wedge," a highly selective Fabry-Perot tuning element. The design of the optical cavity simplifies the alignment of the pump laser to the dye laser and provides the user with easy access to all dye laser optics and wavelength tuning elements.

A Simple Wavelength Tuning Mechanism

The unique "wedge" tuning element in the Model 375 provides broadband, narrow-line operation from 460 to 950 nm with the standard wedge, and from 420 to 500 nm with the "blue" wedge. Simple translation of the tuning element across the laser beam will tune the wavelength across the dye emission curve. Adjustable stops are provided on the sliding mount of the wedge to establish the "start" and "stop" wavelengths of the tuning element and to protect the experiment from accidental exposure to radiation of an incorrect wavelength.

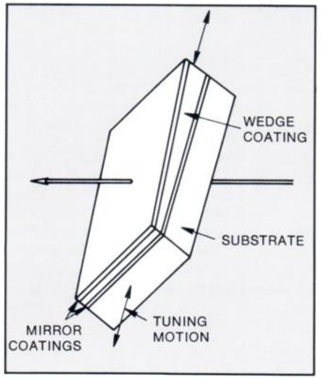


Figure 1. Tuning wedge.

The fine-tuning etalon can be inserted into the dye laser to further narrow the linewidth and to increase the tuning resolution of the laser. Tuning of the dye laser through the absorption spectrum of a molecule thus is easily and routinely accomplished.

Choice of Linewidth

Combinations of etalon and wedge tuning elements can be selected to provide laser output with a variety of linewidths and tuning ranges. Typical linewidth performance of the Model 375 is indicated in the oscilloscope trace below.

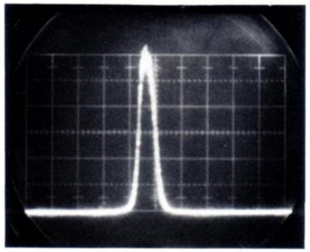


Figure 2. Typical linewidth of Model 375 laser. Spectrum at 5900A was recorded with Spectra-Physics Model 410 interferometer. Horizontal scale is 50 GHz/cm. Linewidth is shown to be 30 GHz or 1 cm^{-1} with dye laser output power of 800 mW. An optional fine-tuning etalon will reduce this linewidth to less than 10 GHz with only 30% loss in power at 5900A.

Tuning Resolution

Tuning resolution is defined as the smallest change in the laser center frequency that can be made repeatedly using tuning adjustments. The tuning elements in the Model 375 can easily adjust the wavelength of the dye laser to a resolution of 20% of the linewidth, regardless of which tuning configuration is chosen.

When the ultrafine etalon is used with the wedged interference filter, the linewidth of the laser output is 0.01 nm. With this etalon, the dye laser may be adjusted to within 0.002 nm of the desired wavelength and the dye laser can be tuned over 1 nm without mode hops.

When only the wedged interference tuning element is used in the Model 375, the tuning resolution is 0.03 nanometers and the dye laser may be tuned across the entire dye range without etalon mode hops.

Typical linewidth performance of the Model 375 using various combinations of tuning elements

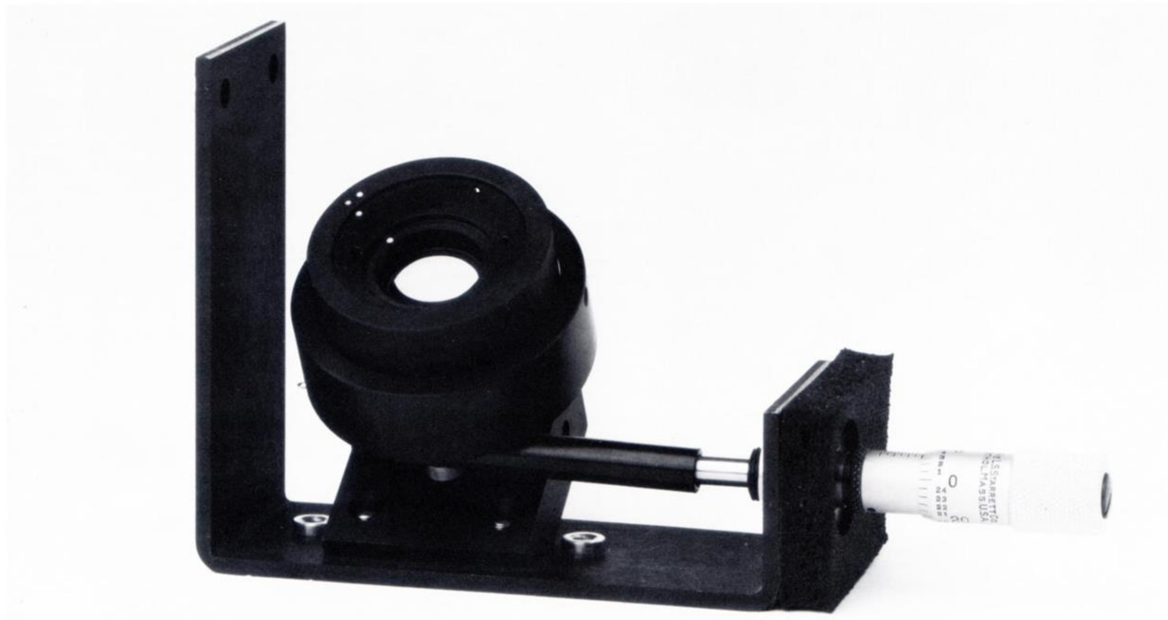
	No Fine Etalon	Standard Fine Etalon P/N 411-650-1 420-950 nm	Ultra-Fine Etalon P/N 411-650-2 500-700 nm	Ultra-Fine Etalon P/N 411-650-3 420-500 nm
No Wedge	1000 GHz			
Standard Wedge				
460-900 nm P/N G0059-002	240 GHz	35 GHz	7 GHz	8 GHz
420-500 nm P/N G0059-005	200 GHz	20 GHz	—	4 GHz
High Resolution Wedge				
540-640 nm P/N G0059-004	110 GHz	35 GHz	7 GHz	—
590-710 nm P/N G0059-006	110 GHz	35 GHz	7 GHz	—

Standard tuning elements supplied with laser

Model 375

Dye Option	-01 R6G	-02 R110	-03 RB	-04 C1	-05 R101	-06 Oxazine
Main Tuning Wedge	G0059-002	G0059-002	G0059-002	G0059-005	G0059-002	G0059-002
Fine Etalon	411-650-1	411-650-1	411-650-1	411-650-1	411-650-1	411-650-1

Model 573 Birefringent Filter



The Spectra-Physics Model 573 Birefringent Filter is a wavelength-selection device for the Spectra-Physics Model 375 Dye Laser. It can be mounted directly inside the laser and used interchangeably with the tunable wedge etalon.

The heart of the birefringent filter consists of crystalline quartz plates cut parallel to their optical axes. These plates are positioned at Brewster's Angle inside the dye laser. Wavelength tuning is achieved by rotating the plates around an axis normal to the plates.

Because the performance of the birefringent filter is a sensitive function of the parallelism between the optical axes and the surfaces of the plates, all of the Spectra-Physics crystalline quartz boules are aligned by X-ray diffraction before slicing.

Narrow Linewidth

The Model 573 Birefringent Filter, is capable of producing narrow linewidths without an additional etalon. Two-element and three-element versions are available. The linewidth of a Spectra-Physics Model 375 Dye Laser with a three-element birefringent filter is typically less than 40 GHz. This output is useful for general spectroscopic applications. The linewidth with a two-element birefringent filter is 200 GHz. This version is used primarily in mode locked dye lasers.

Resettability

The wavelength tuning rotation of the birefringent filter is precisely controlled with a calibrated micrometer drive. By observing the micrometer markings, it is possible to reset the filter to within 1.5Å of a particular wavelength.

Low-Loss, Wide-Wavelength Coverage

The Spectra-Physics Model 573 Birefringent Filter is a Brewster Angle device which uses no coatings. As a result, it has very low loss and can be used for all lasing dyes from 400 to 1000 nm.

Modular Design

Easy installation into the Model 375 Dye Laser is provided by the modular design of the Model 573 Birefringent Filter, which may be factory-installed or purchased as a separate module.

Stability

Short-Term Amplitude Stability
The typical low amplitude noise of 0.75% rms in the Model 375 is achieved by careful design to optimize the optical quality of the dye stream. Since trapped air bubbles, impurities, velocity variations, and short-term temperature fluctuations in the dye can cause orders of magnitude increases in the noise, however, the design of the entire dye circulating system, pump, dual filter assembly, heat exchanger, nozzle, dye stream collector assembly, and the dye reservoir, determines the ultimate amplitude stability of the dye laser.

In the dye circulator, a dual filter assembly traps and removes air bubbles, contaminants, and photo degradation products from the dye. A massive dye-to-water heat exchanger regulates the dye temperature and thus the viscosity. The nozzle and collector assembly are designed to smoothly collect the dye in the reservoir without entrapping air bubbles.

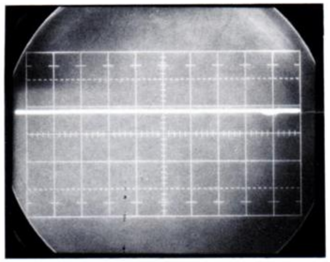


Figure 3. Typical noise performance of Model 375 laser with R6G, with ethylene glycol as high-viscosity solvent. Exposure time is 1 second. Vertical scale is 10 mV/cm. Measured rms fluctuation is 0.3 mV.

Long-Term Amplitude Stability
The typical long-term stability of 2.5% is achieved by paying strict attention to design criteria affecting resonator alignment stability, variations in dye flow rates, and the degree of contamination of dye laser optics with dye vapor.

The Model 375 utilizes an ultra-stable temperature-compensated three-quartz-rod resonator structure of the same design used on our highest quality ion lasers.

A sliding sputter shield protects the optics from dye splatter on start-up and shut-down of dye flow. The radius of curvature of the optics near the jet stream allows sufficient separation of the mirror from the dye jet to minimize condensation of dye on the mirrors.

The flow rate of the dye stream is determined by the dye viscosity, which changes with temperature. Since variations in the dye flow rate cause variations in output power, the dye temperature is stabilized by a dye-to-water heat exchanger which is integrated with the filter assembly and located in the dye circulator.

Model 373 Dye Laser Light Stabilizer
Long- and short-term stability of the Model 375 may be further improved with the use of the optional Model 373 Dye Laser Stabilizer in conjunction with a Spectra-Physics ion laser. Stability at fixed dye wavelengths is $\pm 0.5\%$ for a period of up to one hour. In the wavelength scanning mode, stability is $\pm 2.5\%$ over any nm scan. The full capabilities of the Model 373 are discussed on page 12.

Beam-Pointing Stability
The beam-pointing characteristics of a laser are determined by the angular stability of the resonator optics. The same design parameters which provide superb amplitude and frequency stability make the Model 375 excel in terms of beam-pointing stability. The rigid three-rod cavity, with the mirror mounted within the cross-section, maintains the output beam within 0.1 mrad.

Frequency Stability
The basic resonator structure of the Model 375 has been designed to accommodate the frequency stability requirements of single frequency operation. The long-term frequency stability is achieved by designing temperature compensation into the quartz rod resonator structure. (See Figure 4 below.) The resulting temperature sensitivity of the system is 90 MHz/°C or 3 x 10^{-3} cm^{-1}/°C.

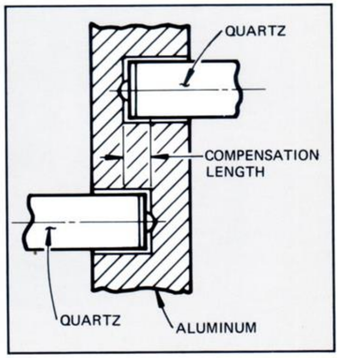
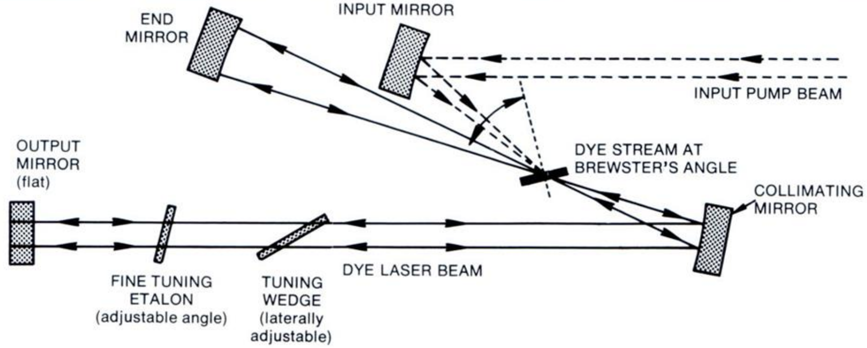


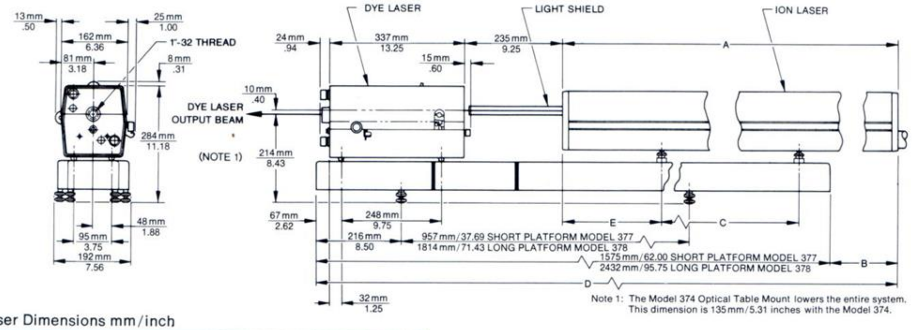
Figure 4. Resonator cavity.

Dye Laser Outline Drawings

Dye Laser Optical Schematic



Dye Laser Systems Outline Drawing

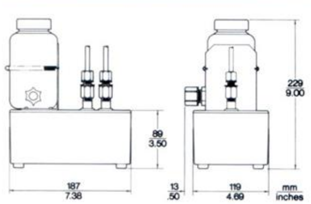


Ion Laser Dimensions mm/inch

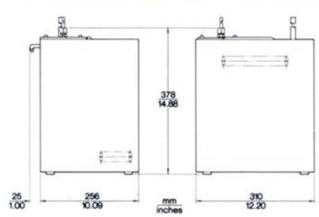
Model	A	B	C	D	E
164/165	1143/45.0	175/6.9	648/25.5	1750/68.9	248/9.8
171	1880/74.0	142/5.6	841/33.1	2574/101.3	543/21.4

Models 164 and 165 use Model 377 or 374-01 Mounting.
Model 171 uses Model 378 or 374-02 Mounting.
See page 13 for details.

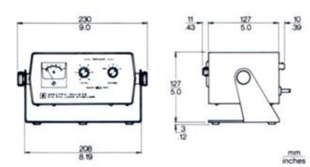
Model 372A



Model 376

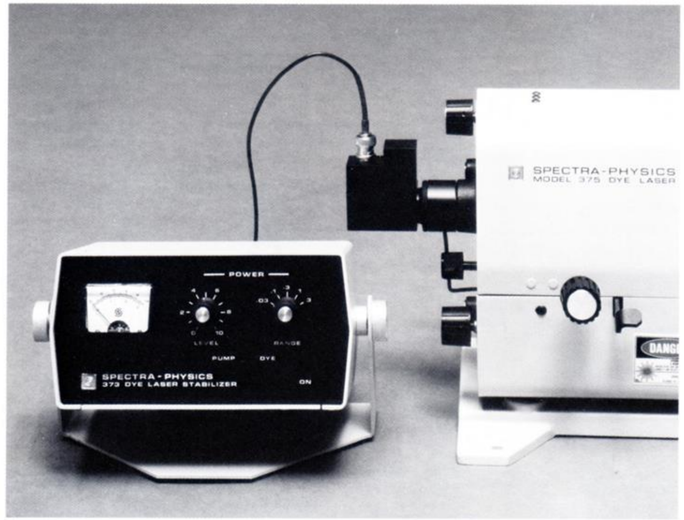


Model 373



Accessories

Model 373
Dye Laser Amplitude Stabilizer



- **Stability to 0.5%**
- **Spectral Range 400-1000 nm**
- **Built-in Power Meter**

The output power of all dye lasers will vary as a function of time or during wavelength scanning, making some applications difficult or impossible. The Model 373 Dye Laser Amplitude Stabilizer, when used with a Model 375, will improve the long-term stability as well as low-frequency amplitude noise over the spectral range from 400 to 1000 nm. The total response time of the Model 373-ion laser system is 10 ms.

The built-in power meter has five ranges (30 mW to 3 Watts full scale) and may be calibrated to ±10% accuracy at any point over the spectral range from 400 to 1000 nm. The user can preset the power level at which the dye laser is to operate. A switch on the panel allows selection of a fixed pump power which can be used for alignment and setup.

The Model 373 may be used with any dye laser pumped by a Model 171 with the wide range regulator, or by any Model 164 or 165 ion laser.

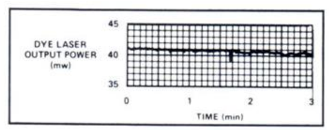


Figure 5. Dye laser operating at fixed wavelength as a function of time

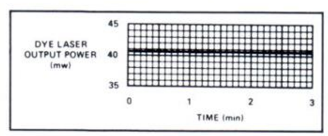
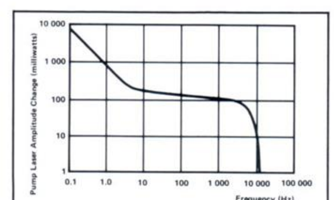


Figure 6. Same dye laser output with dye laser stabilizer.

Specifications

Spectral Range	400 to 1000 nm.
Stabilized Power Level	10 mW to 3 watts, in five ranges.
Meter Calibration Accuracy	±10% possible, ±25% as supplied.
Level Resettability	±1%, front panel control.
Stability	±0.5% for any one hour period, fixed wavelength. ±2.5% within any 20 nm scan length.
Controller Current Gain	100 dB (30 mW range) to 60 dB (3 W range), nominal.
Frequency Response	See graph below.
Monitor Output	Bandwidth: DC to 5 kHz min. Impedance: 4.7 kΩ nominal. Level: ±4 V DC for full scale, typical.
Interface	Supplied with 3 meter (10 ft.) cable and mating connectors to interface with Spectra-Physics 164/165 and 171 series ion lasers with wide range regulator.
Selector Switch	Pump/dye selector stabilizes ion laser or dye laser output.
Power Required	115/230 V AC, 50/60 Hz.



Approximate Frequency Response of Model 373

Interferometers and Spectrum Analyzers

The Spectra-Physics line of interferometers is capable of a wide range of measurements throughout the visible spectrum, and is recommended for use with ion and dye lasers.

The Model 410, a medium-finesse, plane-parallel Fabry-Perot interferometer, is well suited for line width measurements in dye lasers or monitoring of single frequency operation. The Model 410 is available in 30, 300, and 1200 GHz free spectral ranges with bandpasses of 0.6, 6, and 24 GHz, respectively. Two wavelength ranges are available, 450-550 nm and 550-650 nm.

The Model 450, a high finesse, temperature-compensated confocal spectrum analyzer, is used in laser mode structure analysis and in applications requiring the detection of mode-locking effects in ion lasers. The Model 450 is available in 2 or 10 GHz free spectral range and a choice of 450-550 nm or 550-650 nm wavelength range.

The Model 470, an all-purpose confocal interferometer, is designed for use as a spectrum analyzer for laser mode structure analysis, a bandpass filter, a Fabry-Perot ring interferometer, or a frequency monitor. The Model 470 is available in 2 or 8 GHz free spectral range and a choice of 450-550 nm or 550-650 nm wavelength range. Optional mirror sets permit both the free spectral range and the spectral range to be changed by the user.

The Model 476 scan generator will operate any of the interferometers, and provides complete control of the oscilloscope display.

A separate data sheet is available on these products.

Model 342S Mode-Locker

The Spectra-Physics Model 342S Mode-Locker has been successfully used to mode-lock the major argon and krypton lines in the 164, 165, and 171 Ion Lasers.

Mode-locking is a technique which produces a train of high-peak-power pulses at a rate which is determined by the cavity length of the ion laser. Pulsewidths of 200 ps and less have been obtained.

Mode-locked ion lasers are now being used to synchronously pump dye lasers to obtain tunable high-peak-power pulses. Mode-locking is also used in experiments requiring a low-noise light source, since mode-locking virtually eliminates cavity mode intermodulation noise.

A separate data sheet is available on this product.

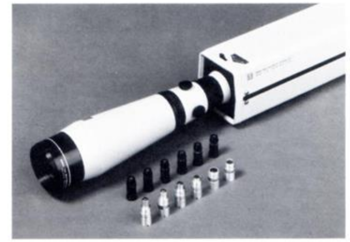
Mounting Platforms

The Model 377 and 378 Mounting Platforms allow the aligned dye and pump lasers to be moved about as a unit without misalignment. They are shown on pages 6 and 15.

The Model 374 Optical Table Mount may be attached directly to a honeycomb or granite optical table to take advantage of their superior vibration damping ability. The ion laser however is mounted separately, and the ion/dye laser combination cannot be moved without misalignment.

Both types of mounting systems utilize the three-ball reference mounting system, which allows the dye laser to be removed and replaced without realignment with respect to the pump laser. Both types of mounting systems also isolate the ion laser vibrations from the dye laser with a specially designed foam isolation pad to provide the lowest passive frequency jitter in the industry.

Telescopes and Spatial Filters



Spectra-Physics high quality beam expanding and collimating telescopes offer versatility for a wide variety of laser applications where large-diameter collimated or diverging beams are required, with or without spatial filtering.

The Model 332 produces filtered spherical wavefronts between f/50 and f/3.5, depending upon which expanding lens is chosen.

The Model 336 collimating lens converts the spherical wavefront of the Model 332 to a collimated plane wavefront with less than $\lambda/8$ distortion over the 450-650 nm range. A smooth Gaussian intensity profile across the beam is obtained with a spatial filter. Interchangeable optics provide collimated output beam diameters from 5 mm to 50 mm.

A separate data sheet is available on these products.

Selection of Dyes and Dye Laser Pump Sources

The purpose of these dye absorption curves is to assist the user in selecting the laser pump source which will most effectively pump the dye laser.

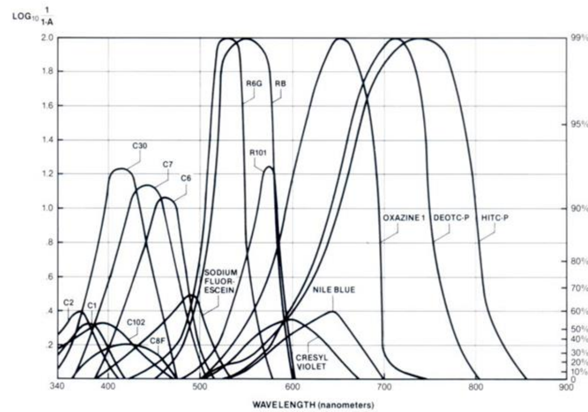
Optimized dye laser performance is achieved by spectrally matching the dye laser pump source to the absorption band of the dye, and adjusting the concentration of the dye for maximum absorption. In general, it is desirable to keep dye concentrations low to limit self-absorption and absorption above 80-90% to best utilize the available pump power.

To calculate the correct concentration, use the $\log_{10} \frac{1}{1\text{-A}}$ scale and the following relationship:

Desired Concentration (millimolar) =

$$\frac{1}{\left(\mathrm{Log}_{10} \frac{1}{1\text{-A}}\right) @\text{Pump } \lambda}$$

The resulting concentration will result in an absorption of approximately 90%.



Dyes, Pumplines, and Optics

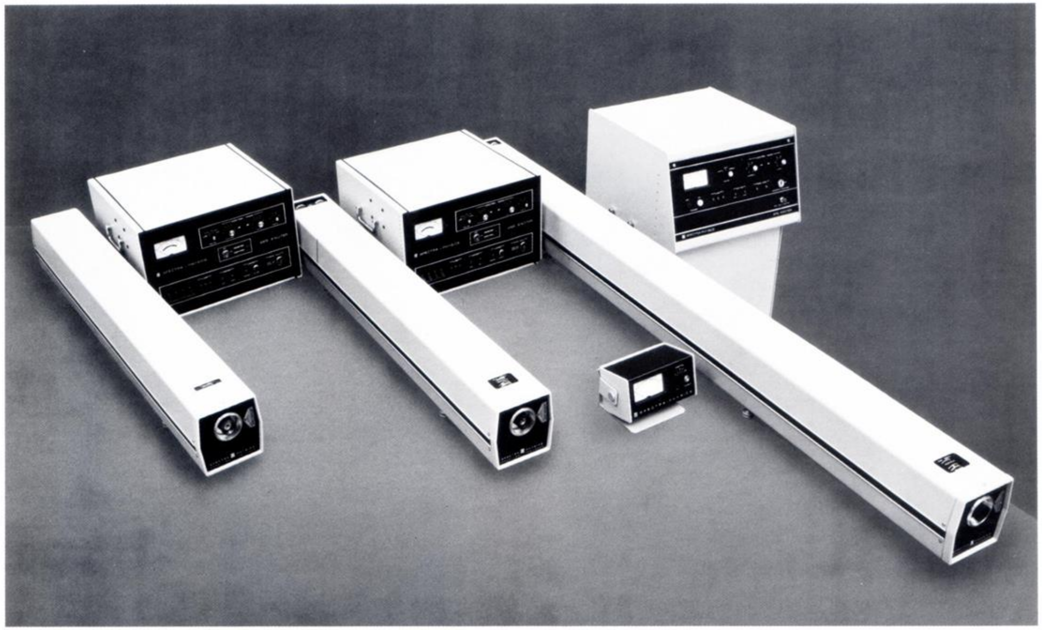
Literature or Common Name	Dye Center Frequency (nm)	Lasing Range (1) (nm)	Pump Line (2) (nm)	Input Mirror	Folding Mirror	Output Mirror	Eastman Kodak®	Exciton®	Recommended Concentration Moles/liter
Carbostyril 165	445	419 - 485	350 - 365	G3845-001	G3845-002	G3862-002 G3862-003 (3)	11987	—	2.5 x 10^{-3}
Coumarin 2	450	435 - 485	350 - 365	G3845-001	G3845-002	G3862-002 G3862-003 (3)	11988	Coumarin 450	3 x 10^{-3}
Coumarin 1	470	450 - 495	350 - 365	G3845-001	G3845-003	G3862-003	P5419	Coumarin 460	3 x 10^{-3}
Coumarin 102	495	470 - 515	400 - 420	G3845-002	G3845-003	G3862-003 G3862-008 (3)	11928	Coumarin 480	3 x 10^{-3}
Coumarin 30	515	495 - 545	400 - 420	G3845-002	G3845-003	G3862-003 G3862-008 (3)	11986	—	1 x 10^{-3}
Coumarin 7	535	505 - 565	400 - 420 nm	G3845-002	G3845-012	G3862-003 G3862-008 (3)	14083	—	5 x 10^{-3}
Coumarin 6	538	521 - 551	458 - 514	G3845-003	G3845-012	G3862-008	11929	Coumarin 540	1.25 x 10^{-3}
Sodium Fluorescein	552	538 - 573	458 - 514	G3845-003	G3845-012	G3862-004	735	Disodium Fluorescein	2.7 x 10^{-3}
R110	570	540 - 600	458 - 514	G3845-003	G3845-004	G3862-004	11927	Rhodamine 560	1.25 x 10^{-3}
R6G	590	570 - 650	458 - 514	G3845-003	G3845-004	G3862-001	10724	Rhodamine 590	2 x 10^{-3}
RB	630	601 - 675	458 - 514	G3845-003	G3845-009	G3862-009	4453	Rhodamine 610	2 x 10^{-3}
R101/R6G	645	620 - 690	458 - 514	G3845-003	G3845-006	G3862-009	14318	Rhodamine 640	1.5 x 10^{-3} R101 1.5 x 10^{-3} R6G
Cresyl Violet/R6G	695	675 - 708	458 - 514	G3845-003	G3845-006 G3845-008 (3)	G3862-005	11884	Cresyl Violet 670	2.4 x 10^{-3}
Nile Blue	750	710 - 790	647 nm	G3845-006	G3845-008	G3862-006	11953	Nile Blue 690	1 x 10^{-3}
Oxazine 1 (4)	750	695 - 801	647 - 672	G3845-006	G3845-008	G3862-010	11885	Oxazine 725	0.6 x 10^{-3}
DEOTC-P (4)	795	765 - 875	647 - 672	G3845-006	G3845-011	G3862-013	N/A	N/A	0.6 x 10^{-3}
HITC-P (4)	875	840 - 940	647 - 672	G3845-006	G3845-010	G3862-012	N/A	N/A	0.74 x 10^{-3}

(1) To 20% points.
(2) First choice. Consult absorption curves for alternate pump lines.
(3) The upper part number covers the short wavelength portion of the dye emission range, and the lower part number covers the long wavelength portion of the range.
(4) These dyes are available from Spectra-Physics on special order.

Standard Optics and Tuning Elements

	Model 375					
Dye Option	-01	-02	-03	-04	-05	-06
Main Tuning Wedge	G0059-002	G0059-002	G0059-002	G0059-005	G0059-002	G0059-002
Fine Etalon	411-650-1	411-650-1	411-650-1	411-650-1	411-650-1	411-650-1
Input Mirror	G3845-003	G3845-003	G3845-003	G3845-001	G3845-003	G3845-006
HR Folding Mirrors (2 ea) (2 ea) (2 ea)	G3845-0040	G3845-0040	G3845-0090	G3845-0020 G3845-0030	G3845-0060	G3845-008 G3845-011 G3845-010
Output Coupler (1 ea) (1 ea) (1 ea)	G3862-0010	G3862-0040	G3862-0090	G3862-0020 G3862-0030	G3862-0090	G3862-010 G3862-013 G3862-012

Dye Laser Excitation Sources



Spectra-Physics manufactures the most complete line of CW and pulsed ion lasers designed to optically pump the various dye laser products described. All Spectra-Physics ion lasers provide the user with the ultimate in low noise, reliability, and stability. The power supplies feature flexible control of laser operation and regulation over ±8% input line voltage changes. All of these features are critical when pumping dye lasers, and make the choice of the pump laser as important as the choice of the dye laser itself. Detailed information on Spectra-Physics ion lasers is available in a separate brochure.

Model 164 and 165 Argon Lasers

These lasers provide 2–5 Watts of all-lines CW output power (450–520 nm). The Model 164 with its cost-effective extruded aluminum resonator structure is ideally suited to pump the Model 375. The Model 165 should be selected if the ion laser is to be used in other applications where long-term frequency stability is required.

Model 171 Krypton Laser

The Model 171-01 Krypton Ion Laser offers the largest selection of emission lines across the spectrum from the ultraviolet to the far red. These lines have been grouped together with special optics sets to optimize their use as a dye laser pump source. The red krypton lines are essential for CW operation of the new infrared dyes which operate to 950 nm. The Model 171 Krypton Ion Laser features a unique pressure control system which automatically maintains the gas pressure at a preset level to ensure stable long-term operation of the pressure-sensitive krypton laser.

Model 171 Argon Laser

This laser provides 9–18 watts of all-lines CW power and provides sufficient single line power in several lines in the 450–490 nm range to pump dyes which emit in the green/yellow portion of the spectrum. In addition, the UV Model 171-17, -18 or -19 provides sufficient power to pump dyes which emit in the blue portion of the spectrum. When longer pumping wavelengths are required, the Model 171 can be used to pump a Model 375 operating untuned with R6G, RB, or R101 to provide 2–3 Watts of power in the yellow and red to pump dyes which emit in the deep red or infrared portion of the spectrum.

Synchronously Mode-Locked Operation

The Model 375, when synchronously mode-locked, can produce pulses of less than 10 picoseconds in duration at the c/2L frequency of the mode-locked ion laser pump. The required components and an application note describing the technique can be obtained from Spectra-Physics. The Model 342S Mode Locker is available for all Spectra-Physics ion laser models, and is described in more detail on page 13 of this brochure.