Spectra-Physics Model 165 Ion Laser

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FULL CONTROL OF THE OUTPUT— WAVELENGTH AND POWER.
True TEM_{00} output power at all argon and krypton wavelengths — deep red to UV • Snap-in mirror and prism mounts • Output power continuously adjustable down to a few milliwatts • Adjustable magnetic field for maximum power and optimum signal-to-noise ratio • Built-in power meter.

MAXIMUM STABILITY IN FREQUENCY AND POWER.
Beam power stabilized to ±0.5% long term • Etalon accessory for long coherence length applications.

ULTIMATE IN DESIGN, CONSTRUCTION, AND RELIABILITY.
Stabilite™ heat-shielded resonator structure • BeO plasma tube for high power, long life, and small size • Operator-controlled gas fill system with excellent pressure resolution • Fully regulated power supply — no transformer taps • Full one-year warranty.

The Spectra-Physics Model 165 Ion Laser is the most reliable and versatile source of laser light available in the ultraviolet to deep red range. It has been engineered to provide you with the optimum combination of size, stability, convenience, versatility, and reliability.

This laser will find use in a variety of applications including Raman spectroscopy, holography, Brillouin scattering, data storage and recording, eye surgery, biological experiments, and general laboratory experiments— wherever the intense power of the ion laser is required. Multi-wavelength power up to 4 watts is available from the 165. Convenient adjustments make it possible to obtain maximum, true single-line TEM_{00} output at all argon and krypton wavelengths.

Conservative design standards throughout make the 165 uniquely reliable. Long lifetime is insured by the fundamental design, the BeO plasma tube, and a number of self-protection features. Spectra-Physics' traditional attention to detail in engineering design and manufacturing makes the 165 truly the premium quality ion laser available today.

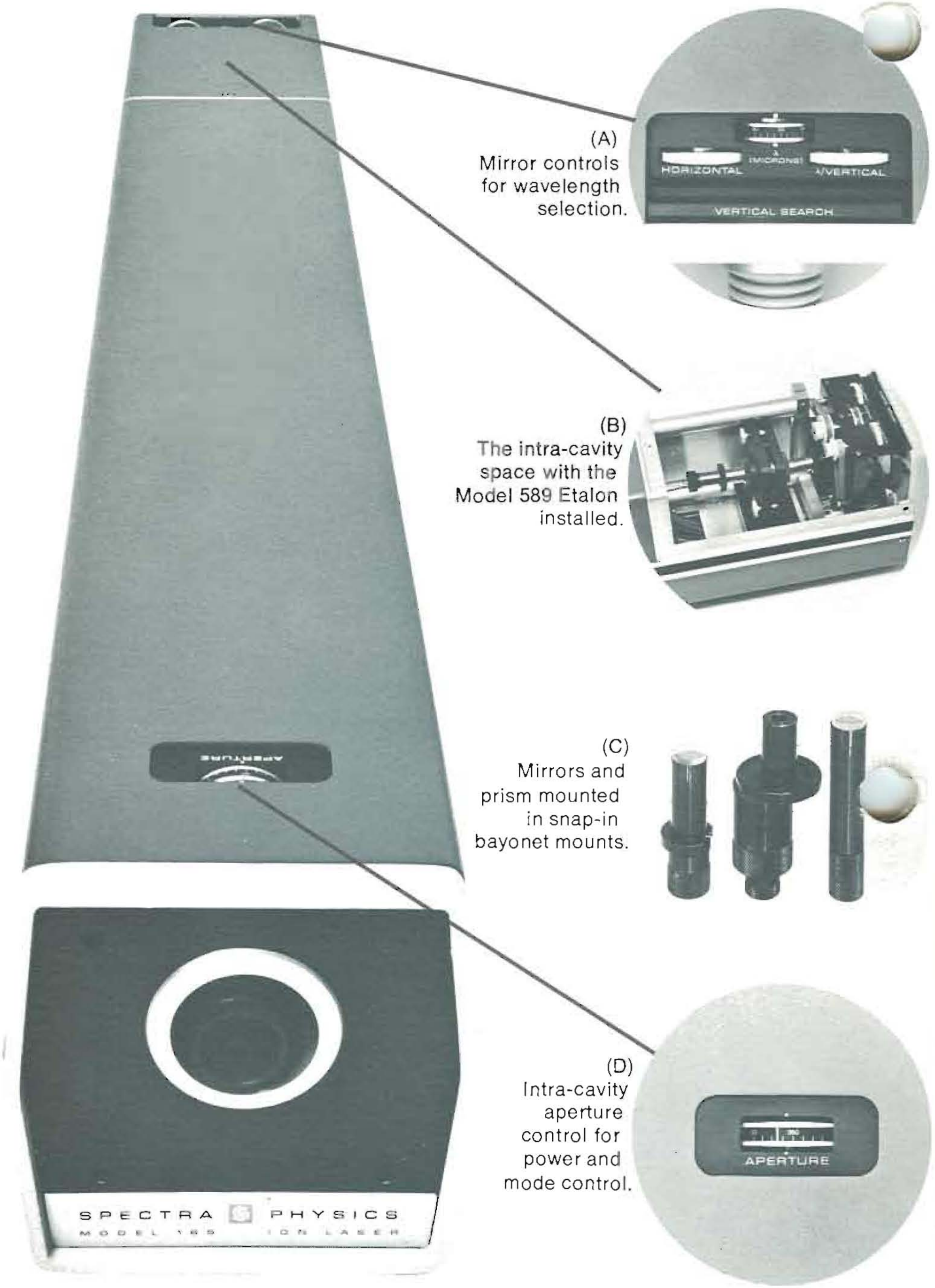

Figure 1 165 Laser Head
The Model 165 Laser Head was designed to a minimum size and weight to take full advantage of the superior operating characteristics of the BeO plasma tube.

Thumbwheel controls, flush with the top cover, provide fine tuning of the angular position of the rear mirror (wavelength selection) and control the diameter of the intra-cavity aperture near the output mirror (power and mode control). A threaded accessory mount, 1″-32 thread, on the output end of the laser will accept standard Spectra-Physics accessories such as a spatial filter, a beam expanding and collimating telescope, a broadband polarization rotator, a spectrum analyzer head, and a separate power meter head.

Four adjustable feet with locking thumb nuts will mate the 165 to almost any surface.

The 165 has a planned intra-cavity space between the rear prism (or flat mirror) and the Brewster window of the plasma tube for insertion of an etalon or for intra-cavity experiments, such as a gas cell for Raman spectroscopy. This space has its own cover which may be removed to expose it without removing the entire top cover of the laser head. The useful space between the plasma tube and rear reflector is approximately 3 inches. The standard Spectra-Physics mount Model 306-D attaches to the resonator cavity and can be utilized for holding apparatus for a number of experiments. The entire top cover may be easily removed for service or inspection of the head.

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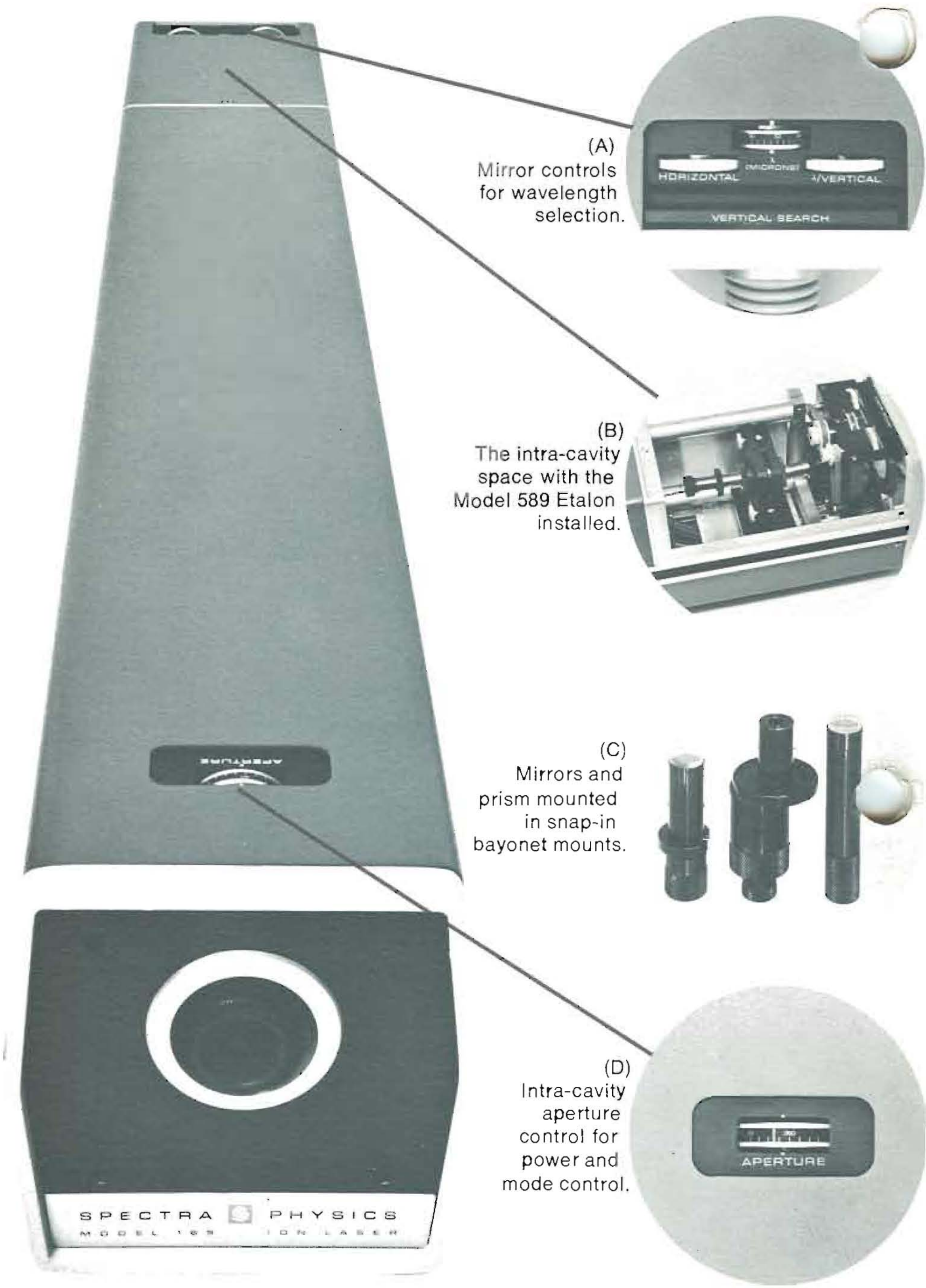

(A) Mirror controls for wavelength selection.

(B) The intra-cavity space with the Model 589 Etalon installed.

(C) Mirrors and prism mounted in snap-in bayonet mounts.

(D) Intra-cavity aperture control for power and mode control.

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Full control of the output; wavelength and power

e wavelengths available from an ion er vary from ultraviolet to deep red, depending on the gas in the plasma tube. The 165 is available with argon (blue and green), krypton (red and yellow), and a mixture of argon and krypton (blue, green, yellow, and red). Ultraviolet outputs are also available with optional reflectors. Power levels obtainable at the various wavelengths for standard tube configurations are listed in the specifications section.

Wavelength selection

The Model 165 has been designed to provide simple, quick mirror changes so that you can always use optimum reflective coatings from the UV to the far red. The mirrors and prisms are mounted in snap-in bayonet mounts (Figure 1C) which can be changed in a few seconds. The bayonet mirror and prism holders make an O-ring seal upon insertion to insure a hermetically tight dust-free space between the window and mirror. Every 165 is supplied with an output mirror in its bayonet holder (which includes the m splitter for the power meter and nt stabilizer); a rear mirror in its bayonet holder for operating at the highest all-line power; a prism in its bayonet holder which contains the full Brewster prism and rear reflector. A storage cap with O-ring hermetic seal is provided for the mirror holders not in use.

All optics used in the Model 165 are fabricated from highest grade fused silica or suprasil and all reflective surfaces are Spectra-Physics ultra-hard, low loss dielectric coatings. Wavelengths are selected by rotating the thumbwheel control on the top of the laser head; a calibrated wavelength dial assists in line identification. The Vertical and Horizonal controls at the rear of the laser head provide high resolution fine tuning of the laser mirrors through a gear reduction system to directly driven mirror mounts (Figure 1A). The fine tuning adjustments are provided only on the flat mirror end, to reduce the possibility that the untrained user will misalign the optics. For the experienced laser tuner, wdriver adjustments of angular ition of the mirrors are available on the output mirror end of the laser head.

If the laser becomes seriously misaligned, the 165 has a Vertical Search capability which will facilitate realigning the mirrors. The entire end plate holding the flat mirror (or prism) may be deflected approximately 5 degrees to scan the mirror on its vertical axis (Figure 1A). While scanning this axis, the horizontal axis is adjusted to bring the mode within the cavity. Release of pressure on the scan plate returns it to its previous position, and the vertical axis can be adjusted to complete the alignment.

Intra-cavity aperture

The wide range of available wavelengths from an ion laser, ultraviolet to far red, makes it impossible to design a plasma tube to obtain optimum TEM$_{00}$ power at all lines. Previously, ion lasers have been designed with a tube diameter to optimize the green wavelengths. This sacrifices power in the red where a larger tube diameter is called for; at short wavelengths this compromise has often resulted in a multimode beam because the tube diameter is too large. To solve this problem, the Model 165 tube is designed with an adjustable intracavity aperture so you can obtain true TEM$_{00}$ performance without sacrificing output power at any wavelength. In addition, if TEM$_{00}$ performance is not required, you may obtain an increase in power of 10% to 30% by fully opening the aperture. The largest multimode power increases are obtained at the shorter wavelengths.

The aperture is rigidly mounted to the output mirror mount and is positioned between the output mirror and the plasma tube. A convenient thumbwheel on the laser head smoothly adjusts the aperture diameter from 0.5 mm to less than 2.5 mm (Figure 1D).

Output power control

For applications which require less than maximum power or for making an initial visual alignment of an experiment, the tube current can be reduced to provide a power level as low as a few milliwatts. The adjustable aperture is also useful to reduce the power. Some users prefer this latter method because there is no change in the thermal characteristics of the laser as when the tube current is reduced. Neither beam position nor angle is changed when decreasing output power by the current control or intra-cavity aperture; this is important in experiments where alignment is critical.

The Model 165 is useful over the entire power range because of the stability of the resonator and because the power supply is fully regulated—even when operating the 165 at 10 mW, you will have a stable, useful output beam.

Adjustable magnetic field

To obtain the maximum power and minimum noise at some of the ion laser wavelengths, it is essential to vary the magnetic field in the tube bore. A front panel control on the 265 Power Supply adjusts the magnetic field from 500 to 1,000 gauss. The weaker argon lines, such as 472.7 nm and 465.8 nm, can be enhanced 40% to 60% by lowering the field value. The value of the adjustable magnetic field is even greater when using a krypton version of the 165 because some of the lines can be enhanced 30% to 80%. For example, the strong red line at 647.1 nm is enhanced about 30% by reducing the field; an 80% improvement can be realized in the line at 520.8 nm. Another benefit of the variable magnetic field is that you can change between argon and krypton tubes without having to change the magnet.

A separate, well-regulated power supply for the magnet insures a stable magnetic field without ripple so that there is no possibility of noise or ripple coupling to the output beam through the magnetic field.

Built-in power meter

Each 165 is provided with a built-in power meter which continuously monitors output power. The meter on the power supply panel has both 1 watt and 5 watt scales. A beam splitter and silicon detector (also used in the light stabilizer circuit) provide the continuous input to the power meter. The meter is calibrated for 514.5 nm, and a calibration chart for other wavelengths is provided with each instrument. Accuracy of the power readings is ±5%. An optional feature is available to provide direct meter readings to an accuracy of 5% on any wavelength.

Maximum stability in frequency and power

The 165 output beam has the ultimate in stability by all measures: temporal coherence, spatial coherence, amplitude drift, amplitude noise, FM noise, ripple, turn-on power, and warm-up time. This performance is a manifestation of the design and manufacturing experience of Spectra-Physics. The resonator is the most stable available in any ion laser.

Light stabilizer

Output power is held constant by an internal light stabilization circuit which may be selected with a front panel switch. With it you obtain output power constant to within ±0.5% after 30 minutes warm-up (Figure 2). Because constant output power is useful in almost all applications, the light stabilizer is a standard 165 feature.

The stabilization circuit consists of a beam splitter and silicon photodetector which samples the output beam. Through feedback-control electronics, the plasma tube current is automatically adjusted to maintain a constant output power. Because the 165 resonator structure is so stable and changes so little from "on" to "off," only a short warm-up is required before using the stabilizer. The bandwidth of the stabilizer is several kHz and therefore reduces ripple on the output beam by 50% to 75% and reduces low frequency beam noise by larger factors.

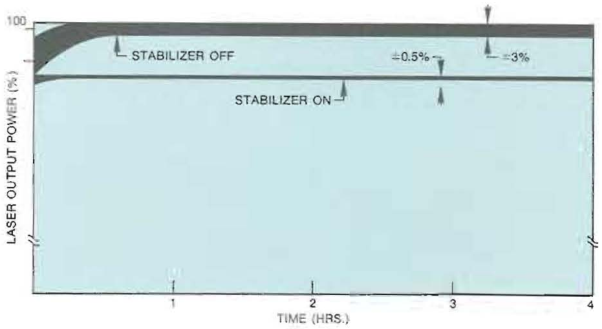
Etalon for stable, single-frequency operation

The Model 589 Air-Spaced Etalon accessory provides extremely stable single-frequency output power. For holography and interferometry, it provides extremely long coherence lengths—over several hundred meters. For Raman, Brillouin, and other scattering experiments, it provides a stable excitation line width of less than .001 cm^{-1}. Used in conjunction with an iodine vapor absorption cell for Raman spectroscopy, it provides the capability to resolve Raman scattering as close as 1 to 3 cm^{-1} from the Rayleigh line.

The Model 589 Etalon has stability specifications vastly superior to solid fused silica etalons because the reflective surfaces are air-spaced. Frequency drift in solid fused silica etalons is largely due to refractive index changes of the etalon which occur when the ambient temperature changes. By using a hollow cylindrical spacer with thin dielectric coated windows at each end, index changes are virtually eliminated, and the expansion coefficient of the spacer material becomes the primary source of instability. The 589 Etalon utilizes an ultra-low expansion titanium silicate spacer with a temperature coefficient of $\pm 0.03 \times 10^{-6}$ per °C, resulting in a frequency stability of ±18 MHz per °C change in the temperature of the etalon (Figure 3). Excellent resonator stability is imperative to fully utilize the frequency stabilizing capability of this etalon; the 165 resonator is so mechanically and thermally stable that is allows you to obtain full value from the etalon.

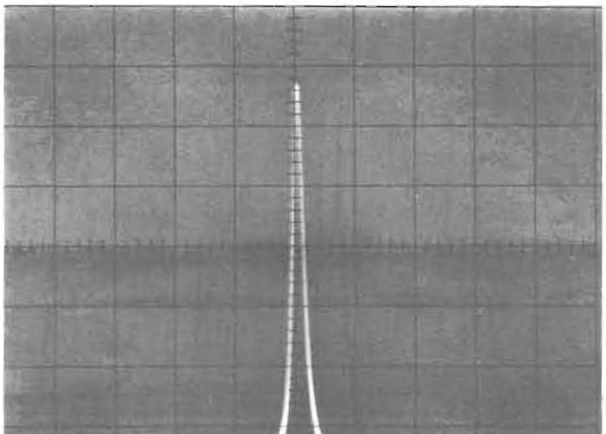
The Model 589 Etalon is simply and quickly installed in the intra-cavity space provided in the Model 165. Orthogonal, fine angular tuning of the etalon is provided by a highly stable, kinematic mount. Angular tuning of the etalon allows any single longitudinal resonant mode within the Doppler-broadened gain profile to be selected, such as those within the strong absorption line in iodine vapor.

Figure 2



Laser output power versus time — because of the inherent resonator stability, laser output power will reach 97% of its final value in about 15 minutes, long term stability is ±3%, and turn-on power is typically 90% of maximum with the stabilizer off. With the stabilizer on, output is held within ±0.5%.

Figure 3



Long term stability of the 165 and 589 Etalon. For this spectrum analyzer photograph the Etalon held the 165 output at a single frequency without mode hopping for over 8 hours.

Ultimate in design, construction, and reliability

Spectra-Physics lasers have earned a reputation for reliability and excellence in design and construction. The 165 Ion Laser incorporates concepts and techniques which are the basis of this reputation. You can be sure that this laser is the best available.

Resonator structure

Ultra-stable resonator design is characteristic of all Spectra-Physics lasers. The basic concepts initially developed at Spectra-Physics in the Stabilite™-type resonator are employed in the 165.

Three hollow quartz rods, ½-inch diameter and ⅛-inch wall thickness for optimum resonator stiffness, are surrounded by high thermal conductivity aluminum shields to maintain an even temperature across and along the rods. Heat flow plates are welded to the heat shields to insure that the three quartz rods do not differ in temperature. This basic resonator structure supports end plates which hold the mirrors and define the optical cavity. The end plates are held solidly against the quartz rods with stiff springs to minimize microphonic frequency shifts (FM noise) in the laser output. The tube is supported in a kinematically adjustable mount attached to the resonator structure so that the tube may be exactly positioned on the mirror centerline.

Three spherical bearings kinematically isolate the entire optical cavity from mechanical stress applied to the outer case, end bezels, or feet (Figure 4). The three spherical bearings also relieve any thermally generated mechanical stresses originating in the resonator structure. The stability of the three-bearing design has been proven in such ultra-stable lasers as the Spectra-Physics 125 He-Ne laser. Ask your Spectra-Physics sales engineer for a demonstration of the spherical-bearing concept.

The resonator structure incorporates the same thermally compensated prism mount that has been used in other Spectra-Physics lasers, e.g., the Model 125. As the prism temperature changes, its refractive index changes. To compensate for this, and to keep the power level constant, the mount changes the position of the mirror associated with the prism.

These design features provide the ultimate in resonator stability. You see evidence of this in the turn-on, warm-up, and stability specifications when operating without the stabilizer.

BeO plasma tube

Beryllium Oxide (BeO) is the optimum material for ion laser plasma tube capillaries. High thermal conductivity, resistance to the high ion laser bore temperatures, and low gas clean-up rates are the primary advantages of BeO. BeO also produces no particles to contaminate the output windows, an occasional problem with graphite bore tubes. The 165 head size is small and light because it was designed specifically to use a BeO tube.

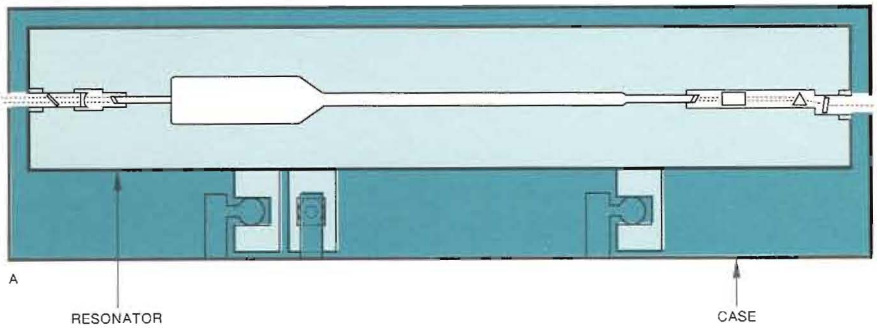
The 165 plasma tube is conservatively designed in all aspects to provide the user with a rugged and trouble-free ion laser. (Figure 5) The large diameter gas return path is external to the main bore, allowing more than adequate gas conductance of argon and even the larger krypton atom. Furthermore, the external gas return path eliminates the possibility of striking the discharge down the return path, making it impossible to start the tube. This may occur in tubes with internal return paths as they age.

The segmented pieces of the BeO bore are joined by a proprietary non-metallic bonding process. The Spectra-Physics non-metallic bond is superior to metallic bonds which encourage electrolysis and usually require closed-loop water-cooling systems with heat exchangers.

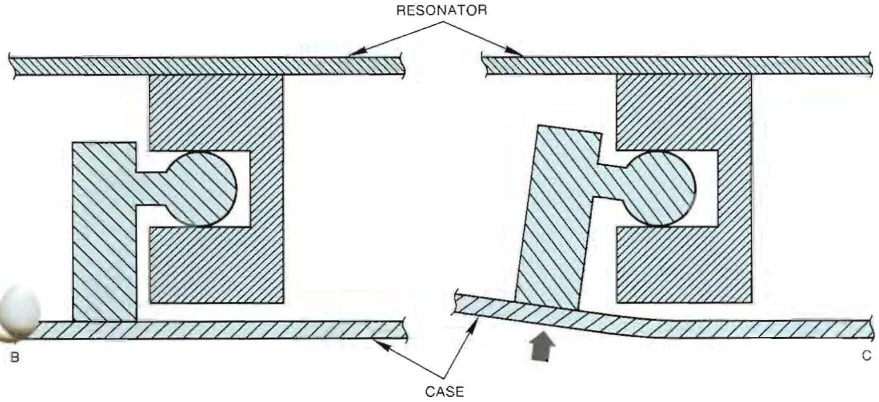
Changing tubes in the 165 is simple because the tube is a single, light-weight assembly, has an integral gas fill reservoir, and is completely separate from the magnet.

The windows of the 165 are fused onto the tube to allow high temperature vacuum bake-out of the entire tube during processing. This insures a clean, contamination-free tube with long operating life and long shelf life, and is an excellent example of Spectra-Physics' advanced technology in plasma tube fabrication and

Figure 4



The kinematic resonator mount.
(A) The resonator is supported by three spherical bearings which provide complete isolation from stresses applied to the outer case.



(B & C) Detail of the bearing shows how stress applied to the case is relieved and not transmitted to the resonator structure.

processing. A window protection electrode near each window is an additional safety feature to insure a long tube lifetime without a significant reduction in output power.

Gas refill system

The BeO plasma tube in the 165 is fully tested and stabilized with regard to its gas fill needs before it leaves the factory. Gas refills will be needed only after hundreds of operating hours. A small high pressure gas reservoir is separated from the plasma tube by a solenoid actuated fill valve. The reservoir contains gas for enough fills to allow well over 5,000 tube operating hours.

When the gas pressure drops below the desired operating pressure, an automatic audio alarm is activated in the 265 Power Supply. You can check the tube pressure at any time on the front panel meter. If the pressure is below the desired operating range, the solenoid valve is opened by a key-operated switch on the power supply front panel. The gas fill path to the tube is designed to have very low gas conductance, so that for a typical fill the valve should be open 10 to 20 seconds. This design gives you excellent control of the gas filling rate. An automatic tube pressure monitor prevents overfilling by an inexperienced operator. The front panel meter will tell you when you have the desired pressure. This high resolution fill system is especially important in krypton or mixed gas tubes where minor pressure changes substantially affect the power output.

Water cooling system

The Model 165 requires tap water for cooling of the transistor passbank in the power supply, the magnetic field solenoid, and the BeO tube. The cooling system has been conservatively designed to operate with water temperatures as high as 35°C, and requires a flow rate of 2.2 gpm at about 25 psi when operating the tube at a full 35 amperes of tube current.

Every 165 is provided with a tap water filter holder and two 25 micron filters. It is recommended that these be installed on the facility inlet hose bib. There is an additional filter screen in the 265 Power Supply directly in front of the safety flow switch to insure that small particles will not jam the switch.

265 Power Supply

The Model 265 Power Supply is conservatively designed for a long, trouble-free life. It is quite small and lightweight considering its power capability and functions.

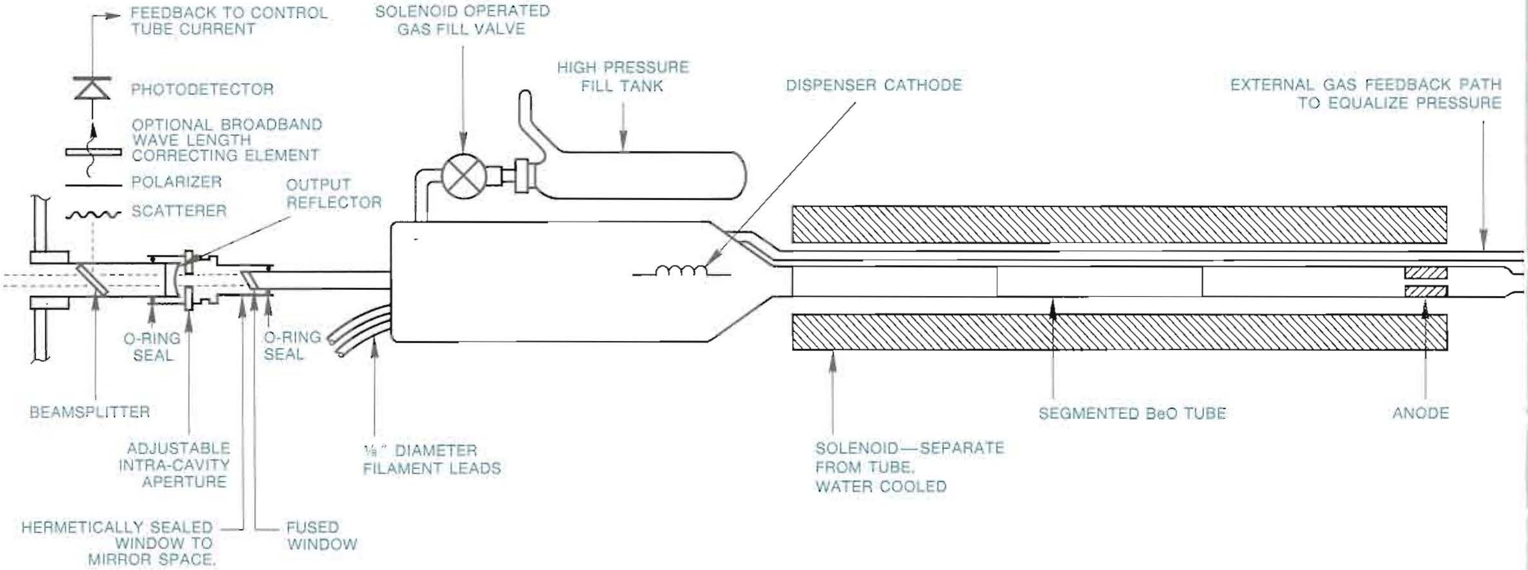
The Model 265 works directly from a three-phase 208V line and is fully regulated to provide constant laser performance and reliable power supply operation through line voltage changes from 190V to 225V.

The fully regulated power supply design is what you would expect from any well-designed instrument. It is definitely an advance over older ion laser power supply designs which use buck-boost transformers where you must change transformer taps as the line voltage changes, or suffer performance or reliability degradations. The fully regulated design is substantially more convenient and reliable.

Forty-four transistors are employed in the regulator passbank which uses a conservative series-parallel design so that each transistor carries less than 1.5 amps at 40V and operates well within its specified power rating. Every transistor is individually fused

Figure 5

The BeO plasma tube used in the 165 Ion Laser.



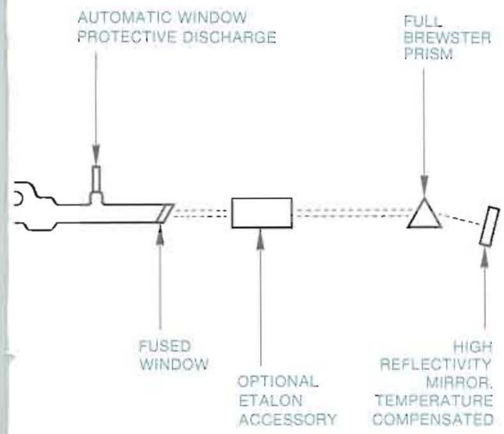
e that it will be automatically removed from the circuit if it should fail. Several transistor failures can occur before there is any change in laser performance. This self-correcting circuit design is typical of the careful engineering which will give you a highly reliable laser.

The 265 contains a separately regulated current supply for the plasma tube magnet which can be adjusted to the desired plasma tube field value. Ripple is held to a level well below that which could couple ripple into the output beam.

The 265 is designed for ease of maintenance. Both the top and bottom covers are easily removed by turning two twist screws and lifting off the cover. Transistors are socket mounted for ease of changing. The transistor passbank is hinged and swings up to allow free access to internal components. The 265 is supplied with a 15 foot power cable without a plug, since most installations will wire directly into a switch box.

Self-protect features

The 165 system may be operated unattended because of the many self-protection features in its design. Among these are: (a) a thermal cutout for protection if exhaust water temperature becomes too hot; (b) a flow rate cutout for protection if inlet water flow rate drops below a safe level; (c) individually fused power transistors which protect the power supply circuitry from catastrophic failure; and (d) a voltage cutout for protection if tube voltage becomes either too high or too low.

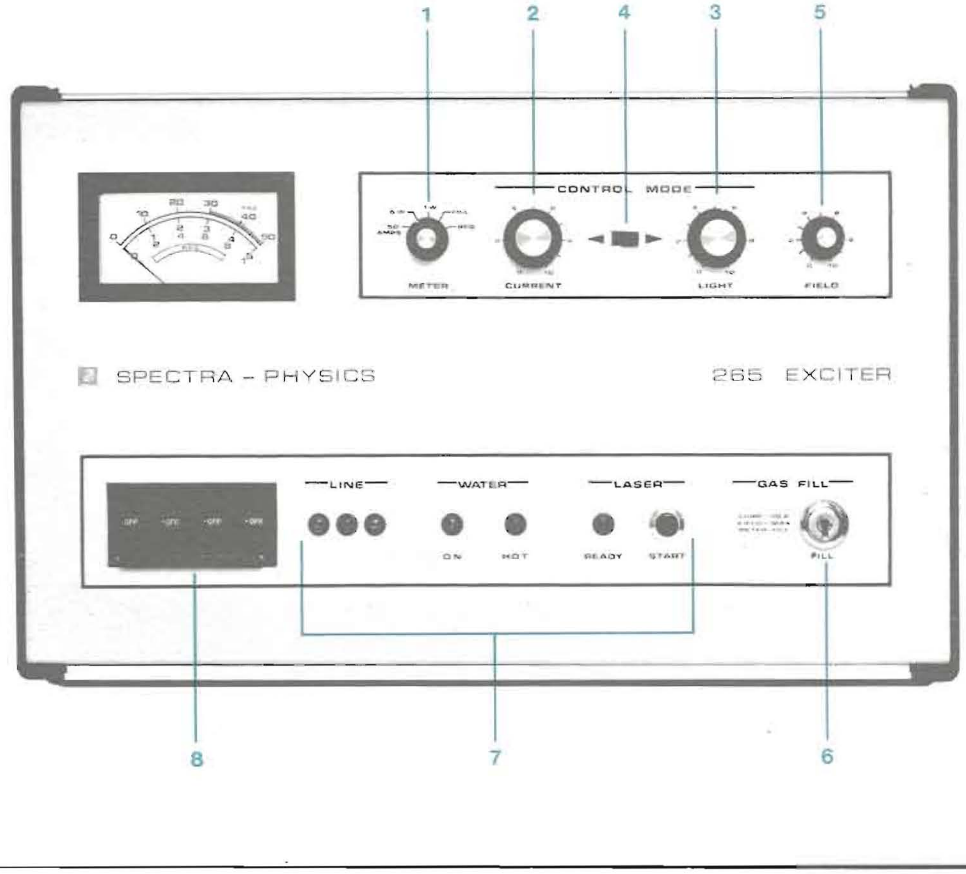


Warranty

The Spectra-Physics 165 Ion Laser is protected by a one-year warranty. All mechanical, electronic, and optical parts and assemblies, including the plasma tube, are unconditionally warranted to be free from defects in workmanship and material for the first year following delivery.

Figure 6
The 265 Power Supply: Front panel and controls meter and meter control knob

1. METER CONTROL KNOB The meter control knob has five positions to display:
   a) Tube Operating Current from 0–50 amperes
   b) Output Power, 5 watts full scale, 514.5 nm
   c) Output Power, 1 watt full scale, 514.5 nm
   d) Tube Pressure; meter face indicates normal operating range and when fill is needed.
   e) Regulation range of power supply; normal operating range is indicated on meter face.
2. CURRENT CONTROL KNOB Adjusts tube current over a sufficient range to allow operation as low as a few milliwatts for experiment alignment.
3. LIGHT CONTROL KNOB Adjusts the operating level of the automatic light stabilizer.
4. CONTROL MODE SWITCH Allows selection of the regulated current or regulated light mode of operation.
5. FIELD CONTROL KNOB Adjusts plasma tube magnetic field between 500 and 1000 gauss; used to optimize output power and decrease beam noise.
6. GAS FILL SWITCH The key-operated gas fill switch opens the solenoid valve between the tube and the gas reservoir and allows tube pressure to increase slowly.
7. INDICATORS The three LINE lights indicate that all three phases of the power line are properly connected and operating.
   The WATER ON light indicates a satisfactory water flow rate. The HOT light indicates a laser shut-off because of high temperature in the exhaust water.
   The READY lamp lights when the filament has reached the proper temperature and the tube can be started with the START button.
8. The three-phase circuit breaker is used for the ON-OFF switch and for overload protection.



Model 165 Ion Laser System Specifications

Output Power (All Output Power TEM_{00})

Wavelength	Gas Fill Options: Argon Model 165-00	Krypton Model 165-01	Argon/Krypton Model 165-02	Argon Model 165-03
799.3 nm		30 mW[1]		
793.1 nm		10 mW[1]		
752.5 nm		100 mW[1]		
676.4 nm		120 mW	20 mW	
647.1 nm		500 mW	200 mW[3]	
568.2 nm		150 mW	80 mW	
530.9 nm		200 mW	80 mW	
520.8 nm		70 mW	20 mW	
514.5 nm	800 mW		200 mW[3]	1400 mW
501.7 nm	140 mW		20 mW	250 mW
496.5 nm	300 mW		50 mW	400 mW
488.0 nm	700 mW		200 mW[3]	1300 mW
482.5 nm		30 mW	10 mW	
476.5 nm	300 mW		60 mW	500 mW
476.2 nm		50 mW		
472.7 nm	60 mW			150 mW
465.8 nm	50 mW			100 mW
457.9 nm	150 mW		20 mW	250 mW
454.5 nm				100 mW
351.1 nm + 363.8 nm				20 mW[2]
350.7 nm + 356.4 nm		40 mW[2]		

(1) Special optional optics are required to obtain output power on these wavelengths.
(2) Special optional optics are required to achieve these UV output powers. For information on higher power UV options, please contact your nearest Spectra-Physics representative.
(3) Multimode power approximately 25% greater.

Optics Supplied:
Model 165-00 and Model 165-03: Output reflector, all-wavelength rear reflector, single-wavelength rear reflector. All for blue/green wavelengths.

Model 165-01 and Model 165-02: Two sets of output reflectors and single-wavelength rear reflectors. One set for blue/yellow wavelengths and one set for red wavelengths. One all-wavelength rear reflector peaked in the red.

Beam diameter at $\frac{1}{e^2}$ points:
1.5 mm at 514.5 nm; 1.3 mm at 457.9 nm.

Beam divergence: 0.5 milliradians.

Cavity length: 1 meter with 2 mirrors; 1.05 meters with 1 mirror and 1 prism.

Cavity configuration: Long radius.

Bore material: BeO.

Resonator construction: Stabilite™ construction. Three longitudinal quartz rods heat shielded and thermally coupled.

Long term output power stability:
With Power Stabilizer ON:
±0.5% over 10 hours.
With Power Stabilizer OFF:
±3% after 30 minutes warmup.

Noise: ***(Argon Gas Fill)***
With Power Stabilizer ON:
10 Hz to 2 MHz—0.2% rms typical.
With Power Stabilizer OFF:
10 Hz to 2 MHz—0.5 to 1% rms typical.

Warmup:
With Power Stabilizer ON:
<1 second to within 95% of preset power level.
<±0.5% after 30 minutes.
With Power Stabilizer OFF:
>75% at turn-on.
>95% at 30 minutes.

Output polarization: Vertical.

Mirror and prism changes: By snap-in positive positioning mirror holders.

Tube excitation: Current regulated D-C. Regulated to better than ±0.5%.

Head mounting: Four adjustable feet. Range of adjustment 1 cm.

Head dimensions:
5¾"x 5¾"x 45" (14.6cm x14.6cm x 114.5cm). Umbilical turning radius requires an additional 4" of space.

Power supply dimensions: 16¾" x 10½" x 15⅞" (42.7 cm x 26.7 cm x 40.4 cm).

Weight: Head 40 lbs. (18.2 kg); Power Supply 70 lbs. (31.8 kg).

Input power requirements: 190 to 225 V, three phase, 35 amps per line.

Water flow required: 2.2 gallons per minute minimum at 25 psi. Water temperature 35°C maximum.

Model 589 Air Spaced Etalon Optional

Specifications

Etalon Dimensions . 15mm dia. x 19mm long
Spacer Material . . . ULE® Titanium Silicate
Temperature Coefficient of Spacer . . . . ±0.03% x 10^{-6} per °C
Frequency Stability . . . . 18 MHz/°C
Window Reflectivity . . . . 20 ± 2%
Transmission . . . . >99%
Free Spectral Range . . . . 10 GHz
% of Single Frequency Power to Multi-Frequency Power . . . . >50%
Spectral Range 450nm–520nm

Accessories for the 165 Ion Laser

Broadband polarization rotator
Model 310-21
Rotates the plane of polarization through an accurately calibrated angle, 0–720° in 2° ±0.2° increments. Extinction ratio 10^3; Transmission >98%; Clear aperture 8 mm; Wavelength range 400–700 nm.

Spectrum analyzer
Model 420/430 and 422 head
Gives frequency vs. power output display. Useful for monitoring mode structure especially in single mode operation. Choice of 2 GHz or 10 GHz free spectral range. The 420 is a plug-in module for a Tektronix 561A oscilloscope with calibrated controls. The 430 is a low-cost, uncalibrated sweep generator for use with most any oscilloscope. Both systems use the 422 analyzer head.

Beam expanding telescope
Models available with magnifications ranging from 1:1 to 1:50. Less than λ/8 wavefront distortion over wavelength range of 450 to 650 nm. Spatial filters also available.

Other optical accessories
Spectra-Physics produces a broad line of optical accessories such as polarization beamsplitters, intensity beamsplitters, linear polarizers, bandpass filters, front surface mirrors, etc., for use with the 165. Contact your field representative for details.

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