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FIXED IMAGING COMPACT SPECTROGRAPHS
FICS™
MODELS 77440, 77441, 77442 & 77443

Please read these instructions completely before operating this equipment. If there are any questions or problems regarding the use of this equipment, please contact: ORIEL INSTRUMENTS - or - the representative from whom this equipment was purchased.

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I. INTRODUCTION

The name FICS™ stands for **F**ixed **I**maging **C**ompact **S**pectrograph. We offer four models all with unique aberration corrected ion etched holographic concave gratings. Each model covers a different spectral range.

The spectrographs were designed specifically for multichannel detector arrays with precise imaging of the input in the flat optical output field. The corrected output focal planes are between 23.3 and 25.6 mm long in the spectral direction, depending on the model. The focal planes are well matched to our popular InstaSpec ICCD, CCD and PDA multichannel detector systems. An internal TTL activated shutter in each FICS™ allows zero referencing and is adequate for imaging applications with the CCD or ICCD.

The grating in any of the FICS™ family is fixed; you cannot change the spectral range by rotating the grating nor can you change resolution by changing gratings. Each FICS™ has dimensioning optimized for the particular grating. Fixing the grating is useful when you need to retain wavelength or instrument spectral transmittance calibration.

FICS™ has high throughput due to F/number as low as F/2.1. This low F/number was chosen as a close match to the F/2.2 emergent cone from fused silica fibers (where the launch or fiber length and lay result in a filled fiber core). No F/number matching is required to prevent over filling, and the fiber core can act as the input slit.

Numerous optical elements in spectral instruments usually give rise to stray light. Poor quality of gratings and reentrant spectra (radiation reflected from the detector and coming back after re-diffraction)are another source of stray light in spectral instruments. FICS™ has a high quality concave grating as, practically, the only optical element inside the unit. Image plane is tilted in a way to avoid reentrant spectra. All this measures reduced significantly the stray light in FICS™ in comparison with conventional spectrometers having similar F/number.

Imaging is one of the most important features of FICS™ spectrographs. High quality of the image in spatial direction allows you to obtain 3 independent spectral tracks simultaneously along our 25 x 6.9 mm CCD detectors.

II. SPECIFICATIONS

Purpose	Multi-channel Imaging Spectrograph
F/number	2.1
Focal length	129.4 - 132.0 mm*
Grating type	Concave ion etched holographic
Grating mount	Fixed
Dispersion Axis Length	23.3 - 25.6mm**
Optical axis height relative to bottom of housing	2.25 inch , 57.0 mm
Dimensions	4x6x7 inch , 102x150x178 mm***
Shutter	Normally closed , TTL activated minimum opening time is 0.2s , operating rate is 0.5Hz maximum.
Shutter power supply	5 volts dc

* Depending on model.

**See table below

***See Fig. 1

DIFFERENT MODELS COVER DIFFERENT SPECTRAL RANGES

We offer four models of FICS™, each optimized for a particular spectral range as shown in the Table 1:

Table 1

Nominal Spectral Range*	Grating Density (l/mm)	Average Reciprocal Dispersion (nm/mm)	Design Length of Dispersion Axis (mm)	Resolution Limit (nm)**	Model
190nm - 625nm	405	17	25.6	2	77440
190nm - 800nm	285	24.4	25.2	3	77441
285nm - 715nm	405	16.8	25.6	2	77442
400nm - 1100nm	230	30	23.3	3.5	77443

* The spectral range you will record depends on the exact placement of the detector element. Typical tolerances result in about ±12nm uncertainly for 77440 and 77442; and ±20nm uncertainty for 77441 and 77443.

** Recorded halfwidth of a very narrow spectral line using an array detector with 25 - 27 um wide (in the spectral direction) pixels, 25um by 3mm input slit. Resolution degrades somewhat towards the wavelength extremes particularly near the shorter wavelength limit.

III. MOUNTING

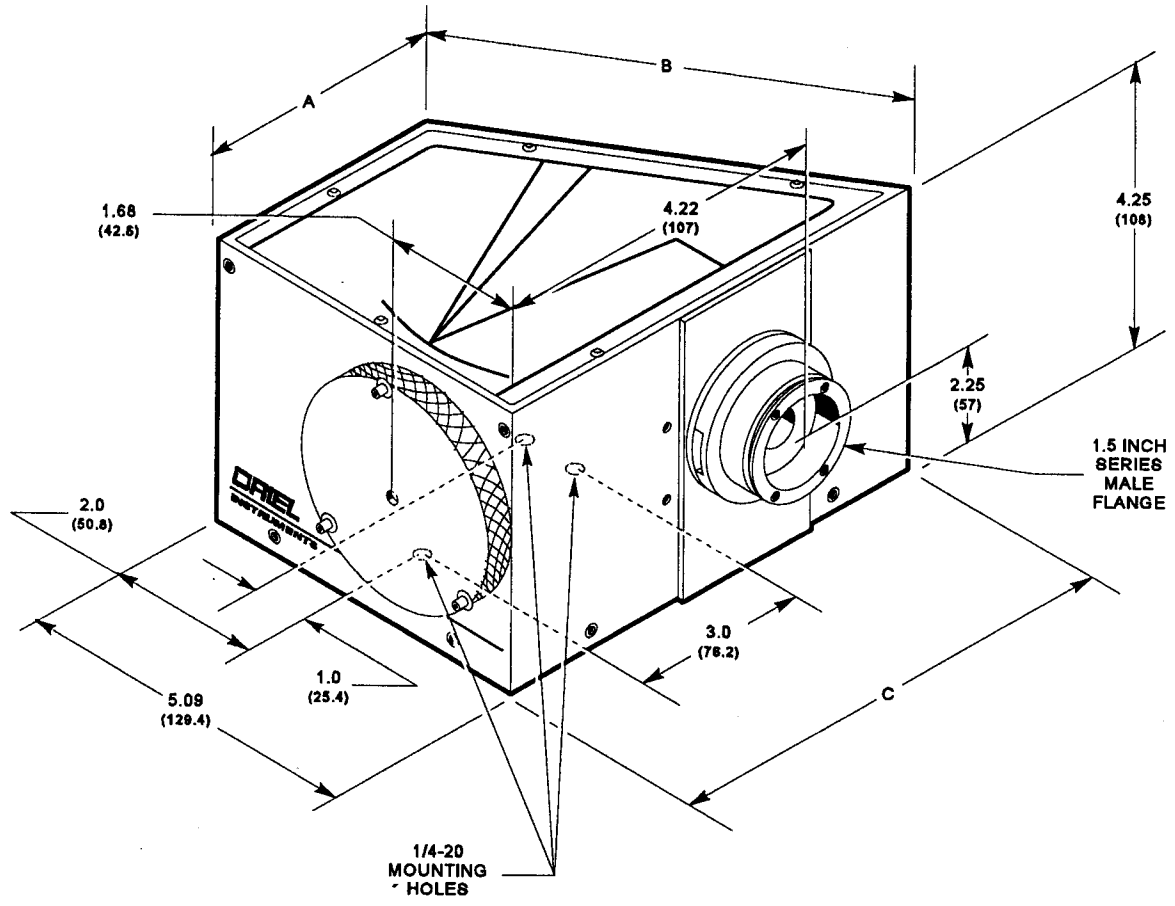
FICS™ IS EASILY MOUNTED TO A VARIETY OF SURFACES

- Two 1/4-20 tapped holes spaced 1 inch apart are located under the housing. These holes are inline with the input optical axis. A third hole is displaced perpendicular to the optical axis , see Fig. 1 on page 4.

- The 1/4-20 tapped holes are inline with the input optical axis are suited for rod mounting.

- Mounting plate model number 77450 will allow easy access to the top of an optical table. The mounting plate should first be mounted with the (3) 1/4-20 socket head cap screws supplied with the kit to the bottom of the FICS™ housing. See the accessories section for more information.

- Fig. 2 on page 5 indicates the proper method to install a fixed slit into a fixed slit housing.



MODEL	A	B	C
77440	4.01 (101.9)	5.85 (148.6)	6.82 (173.2)
77441	3.86 (98)	5.93 (150.6)	6.83 (173.5)
77442	3.80 (96.5)	6.07 (154.2)	7.07 (179.6)
77443	4.0 (101.6)	5.81 (147.6)	6.76 (171.7)

Figure 1 Dimensional Diagram of FICS™

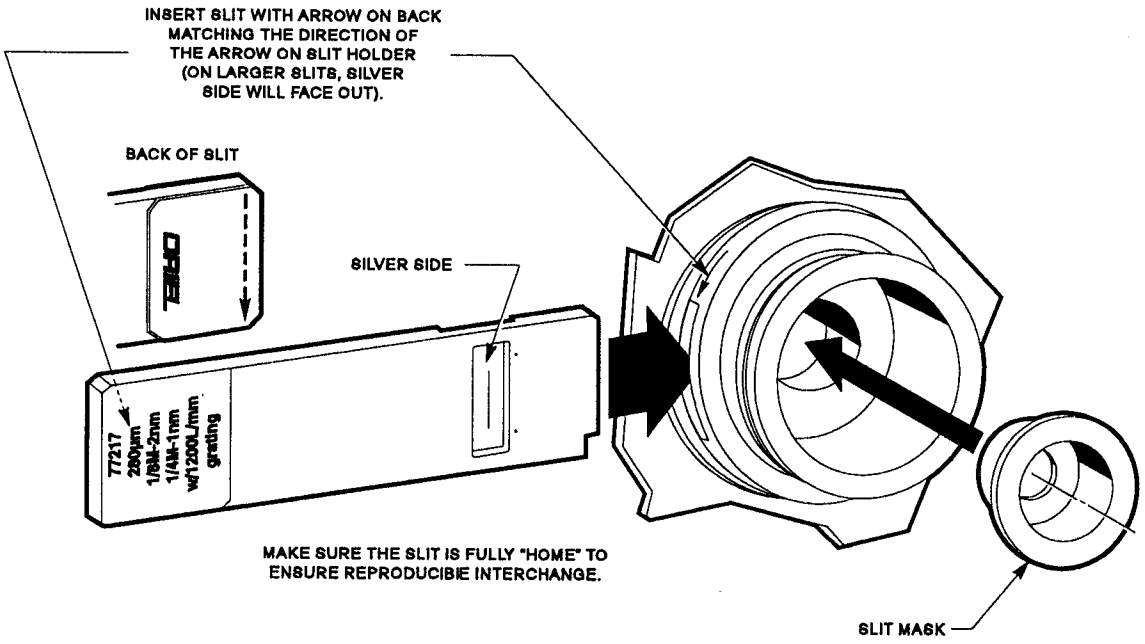


Figure 2 Fixed Slit Holder

IV. PERFORMANCE OF SPECTROGRAPHS

EFFICIENCY OF GRATINGS

The ion etched holographic gratings are corrected to produce the superb imaging and spectral performance. The grating efficiency curves are similar to those shown in Fig. 3, and are remarkable for lack of anomalous features and good efficiency over the design range.

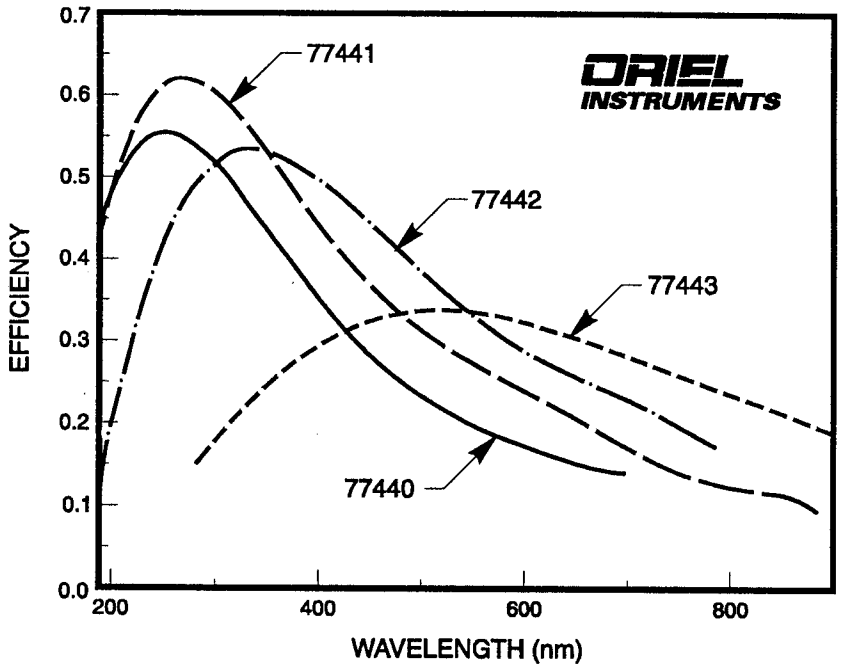


Figure 3 Grating Efficiencies for the Various FICS™ Instruments.

SPECTRAL RESOLUTION

The resolution of any multichannel spectrograph depends on the input slit, optical magnification and reciprocal dispersion. For wide slits (>100 μm), the FWHM of any spectral line is slightly greater than the product of slit width and the reciprocal dispersion, since the magnification is 1.

The resolution limit, the limit as the slit width is reduced, is additionally determined by optical aberrations and the pixel width of the recording array. Fig. 4 shows the 435.8 nm line from a 6034 Calibration Lamp recorded with an InstaSpec™ IV 1024 x 256 pixel CCD, and a 77441 FICS™ with a 25 μm x 3 mm input slit. The CCD pixels normal to the dispersion axis direction were fully binned so any slit curvature effects are included. The half width with the linear interpolation shown in Fig. 4a, is 1.7 nm. Fig. 4b shows the actual recorded data for this line for individual pixels. The full wavelength range recorded by the 1024 pixel array was 277.6-745.8 nm. The average waveband over each pixel is then 0.46 nm, so the theoretical resolution limit for a perfect optical system, based on the simple "two pixel" definition, is ≈1 nm. For FICS™, as for most spectrographs, the resolution degrades at the short wavelength edge of the field, and with increasing recorded slit height due to slit curvature and aberrations that increase away from the optical axis. With a fully illuminated 25 μm x 6 mm slit and fully binned pixels over this 6.9 mm high array, the line halfwidth degrades from 1.7 to 2.2 nm . Note, the recorded slit height can be set by the detector. With the 6 mm high slit and the 1.54 mm high CCD of the 77118 InstaSpec™ detector, the recorded slit height is only 1.54 mm. The measured resolution is 1.6 nm.

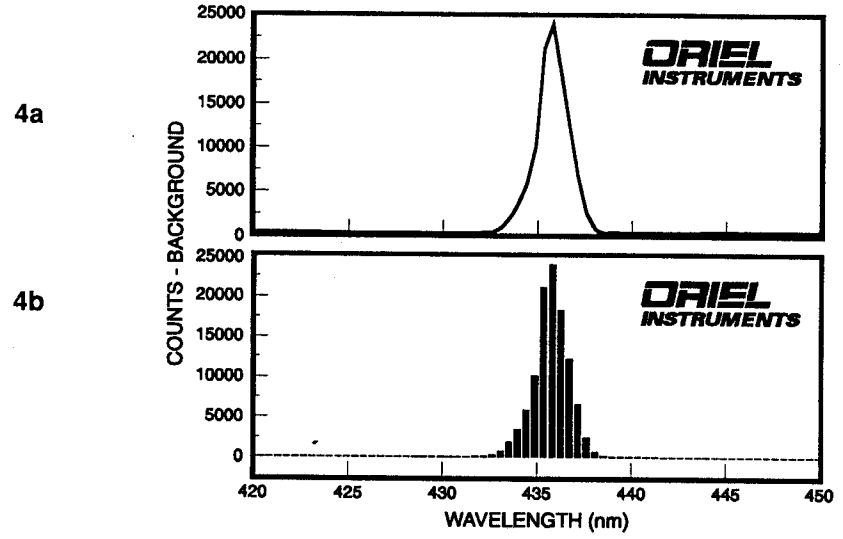


Figure 4 **435.8 nm line recorded using 77442 FICS™ and the InstaSpec™ IV CCD. Top drawing shows the FWHM with linear interpolation. Bottom drawing shows actual recorded data.**

SPATIAL RESOLUTION

Though FICS™ is using a special aberration corrected grating, it is impossible to get an absolutely sharp image and some residual aberrations always exist. The useful way to characterize these aberrations is to show the size of a blur at the image plane produced by spot source.

For FICS™ the vertical size of this blur varies between 50 and 150 microns depending on the position of the image in the field of view. This blur will be added to the sharp image of the source. For example, 200 microns fiber at the input will have in the worst case image height about 200 + 150 = 350 microns. This relatively small blur will allow you to resolve 3 spectral tracks simultaneously

V. OPTICAL ALIGNMENT

For optimum results FICS™ should be optically coupled with the illuminating source (or an illuminated sample) in such a way that the maximum radiant power is transmitted through the slit. This condition can usually be optimized by the appropriate choice of source size and coupling optics. Pages 2-4 to 2-13 of Oriel Volume II catalog show how the optical throughput of a spectrograph or monochromator can be calculated and give suggestions for its optimization.

A large number of optical accessories are available for configuring your optical system, ranging from sample compartments to fiber optics, and integrating spheres to ellipsoidal and parabolic reflectors. Oriel Volume II catalog for full information.

Note: Regardless of the detector system used care must be taken to eliminate light leakage between the spectrograph and the detector, since small leakages of ambient light can often be greater than the desired signal. A wide selection of flange mounted accessories are available which will provide almost light tight coupling of the spectrograph and detectors provided they are correctly installed.

Optical layouts of all four models of FICS™ family of spectrographs are shown in Fig. 5 a, b, c, d page 10. The optical axis of any input optics you design should be aligned with, and parallel to, the optical axis of the FICS™ itself.

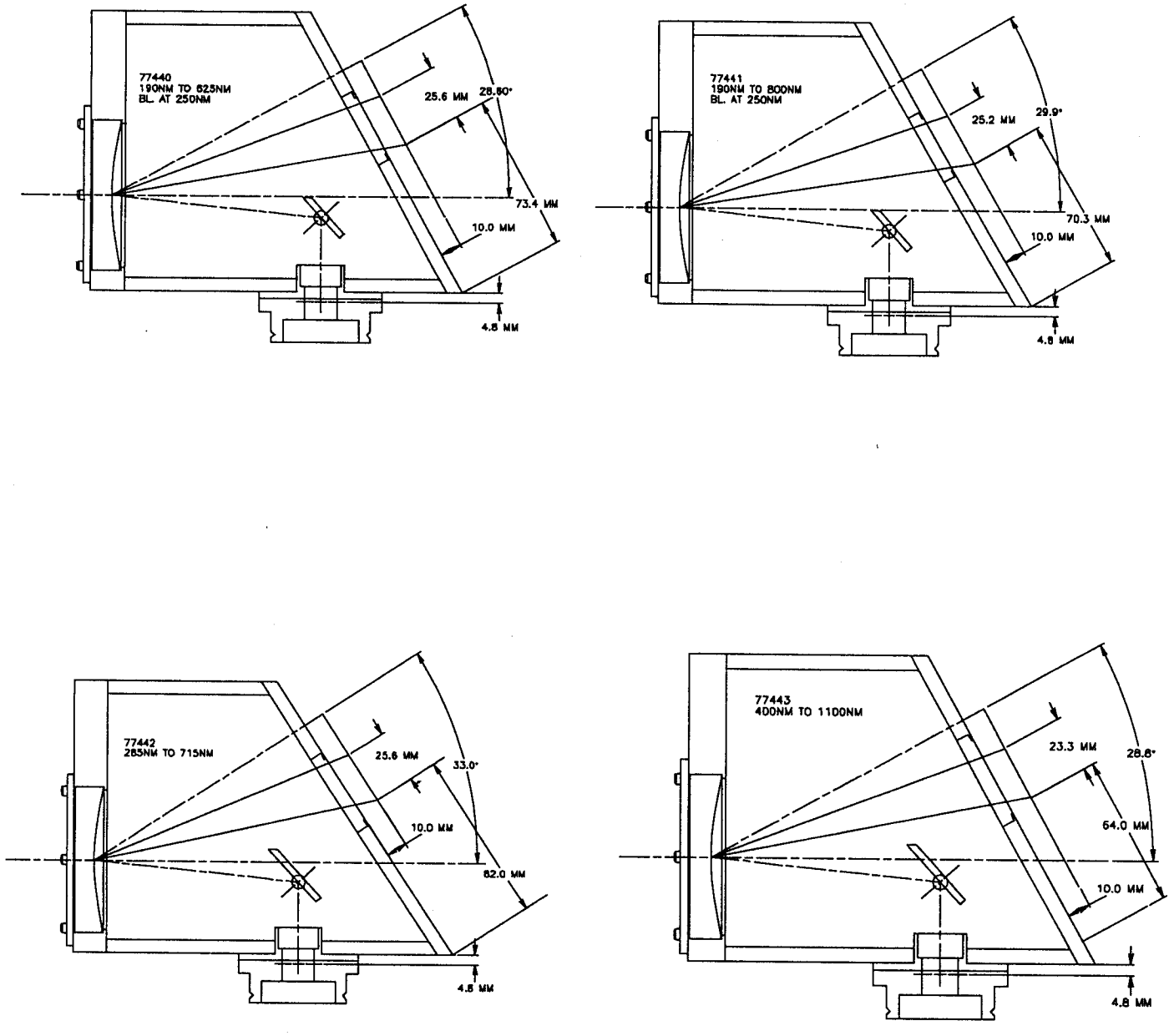


Figure 5 Optical Layout of FICS™

VI. SPECTRAL CALIBRATION

The spectral scale is fixed relative to the field of view, however, because of some tolerances in the detector mount, it can shift as much as ±20nm (depending on the model you are using) relative to the detector chip. This means that the combination of FICS and detector will require spectral calibration. Since the grating is locked in place, you will not need to recalibrate the spectral axis unless your detector is removed from the spectrograph.

For precise calibration, attach the multichannel detector and lock it in place, then calibrate the wavelength scale with our pencil-type calibration lamp (see page 1 - 25 of Oriel catalogue *New Products for Light Research*). Detailed instructions on performing wavelength calibrations are included in the InstaSpec™ manuals. The most suitable calibration lamp for the spectral range in question is mercury lamp #6034 or 6035. The mercury line spectra that you are supposed to observe on your computer screen when you attach your multichannel detector to one of the FICS™ instruments are shown on Fig. 6 a, b, c, d. Use spectral identification of the lines shown in these pictures to calibrate your instrument.

You can also calibrate the system spectral responsivity of FICS™ with attached multichannel detector using our irradiance standards, but you must first select appropriate fore optics. These can include fiber probes, integrating spheres or diffusers as described in the Volume II catalog.

Note: Longer wavelengths are positioned at the left hand side of the screen because of the particular diffraction order that is used by the FICS™ grating.

<<<<< CAUTION >>>>>

DO NOT EXPOSE THE EYES TO DIRECT RADIATION FROM THIS LAMP WITHOUT GLASS SHIELDING. THE SHORT WAVE U.V. WILL CAUSE PAINFUL BURNS TO THE OUTER LAYER OF THE EYE.

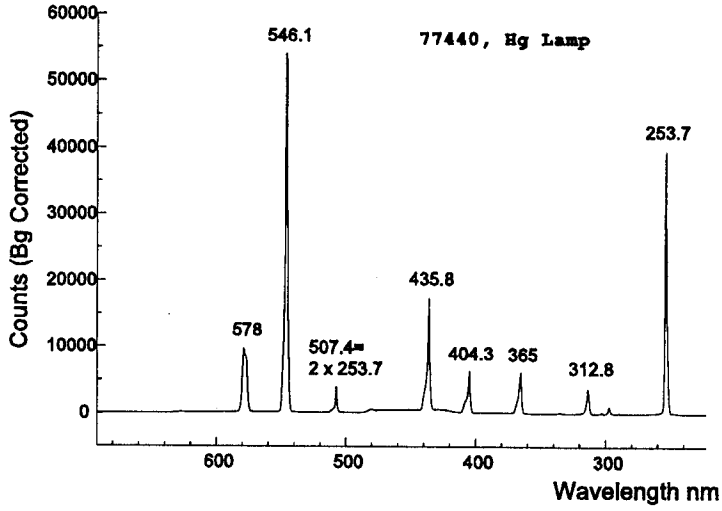


Figure 6a Typical Spectra of 6034 Lamp with 77440 FICS™

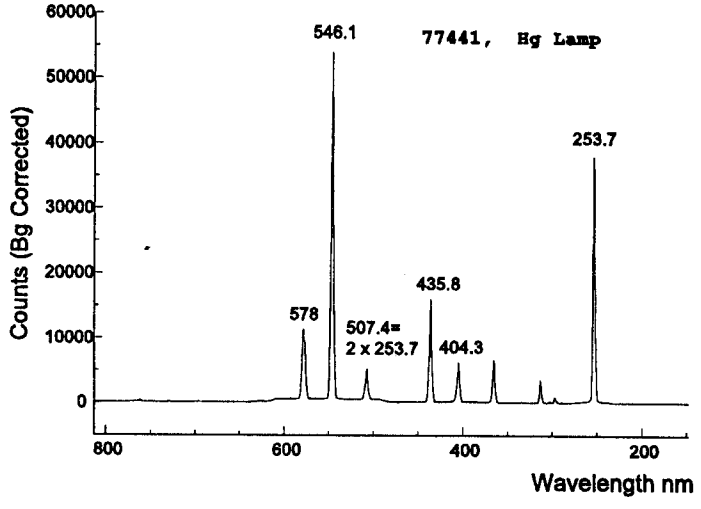


Figure 6b Typical Spectra of 6034 Lamp with 77441 FICS™

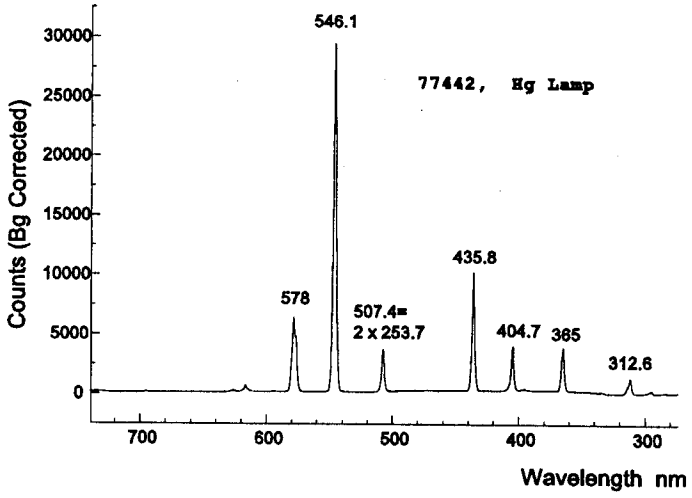


Figure 6c Typical Spectra of 6034 Lamp with 77442 FICS™

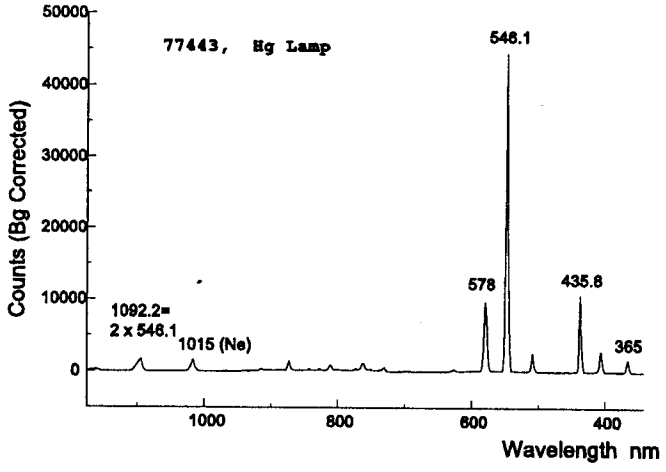


Figure 6d Typical Spectra of 6034 Lamp with 77443 FICS™

VII. FICS™ ACCESSORIES

WIDEST RANGE OF INPUT ACCESSORIES

Each FICS™ uses Oriel slit assemblies and so has a standard 1.5" male Oriel flange at the input. This facilitates connection of the entire range of Oriel products including input optics, sample chambers, integrating spheres, etc.

MOUNTING PLATE FOR THE FICS™

Mounting plate model number 77450 will allow easy access to the top of an optical table. The mounting plate should first be mounted with the (3) 1/4-20 socket head cap screws supplied with the kit to the bottom of the FICS™ housing, see Fig. 1 on page 4 for the location of the 1/4-20 tapped holes.

FIBER OPTICS FOR THE FICS™

The Oriel Volume II catalogue has a large section on fiber optics and light guides. It includes suggestions for using optical fiber bundles or flexible liquid light guides to measure light from a remote or inaccessible location, utilizing the depolarizing properties of optical fibers.

Fiber optics accessories increase the effectiveness of the spectrograph in that they enable the user to measure a small source at a relatively long distance; to measure an extended source; and to measure an arrow beam.

Experiments can be set up more quickly and easily with fiber optics. Light can be brought to your sample, rather than your sample to the light. Particular fiber optics accessories which may be useful are bifurcated and trifurcated fiber optics cables, which enable light to be conducted down one arm to a common area and then the absorbed, reflected or fluorescent light can be sent back up the other arm to the spectrograph input.

Table 2 shows some Oriel fibers that are well matched to FICS™

Table 2

Number of Tracks	Fiber(s) Core Diameter	For These Detectors	Fiber Model#	
			SMA	ST
Single	100μm	1.5mm high CCDs	77403	77427
Single	200μm	6.9 mm high CCDs	77532	77534
2	200μm	6.9 mm high CCDs	77676	77677
3	200μm	6.9 mm	77678	77679

Use the 77863 fiber adapter to couple a fiber to the input of FICS™.

SLITS

Each FICS™ has a standard Oriel fixed slit holder that accepts any of the fixed slits listed in Table 3.

Table 3 Fixed Slits for FICS™

Slit Width (μm)	Slit Height (without mask) (nm)	Approx. Bandpass* with 77440 FICS™(nm)	Approx. Bandpass with 77441 FICS™(nm)	Approx. Bandpass with 77442 FICS™(nm)	Approx. Bandpass with 77443 FICS™(nm)	Model No.
25	3	2	2.7	2	3.5	77220
50	3	2	2.7	2	3.5	77221
50	6	2.1	3	2.1	3.7	77219
100	3	2.6	3.7	2.6	4.6	77223
120	12	3.4	4.9	3.4	6	77218
200	3	3.7	5.3	3.7	6.5	77224
280	12	5	7	5	8.8	77217
600	12	11	16	11	19	77216
760	12	14	20	14	25	77215
1240	12	22	31	22	39	77214
1560	12	28	40	28	50	77213

* The halfwidth in nm recorded on an array detector when the slit is fully illuminated with monochromatic radiation. The array detector is 6.9 mm high and the pixels parallel to the slit fully binned.

SLIT MASKS

Do not use an illuminated slit height significantly greater than the height of the detector array with FICS™. Simply select the proper mask to match the slit and detector height. Magnification of the FICS™ is 1:1.

1.5MM	SLIT MASK	#77451
2.5MM	SLIT MASK	#77452
6.5MM	SLIT MASK	#77453

To install the mask, first insert the slit into the fixed slit housing (see Fig. 2 on page 5). Next, insert the mask as shown till it stops on the slit.

VIII. BUILT-IN SHUTTER AND PANEL CONTROLS

The built-in shutter serves the purpose of zero referencing and imaging applications with CCD or ICCD. The normally closed shutter location behind the input slit effectively blocks light from entering FICS™. The shutter circuitry is housed inside FICS™; shutter power is from a 5 V supply (provided). The TTL activated shutter accepts pulses from InstaSpec™. Minimum opening time is 0.2 s. This shutter operates at rates to 0.5 Hz. Controls of the shutter are shown in Figure 7.

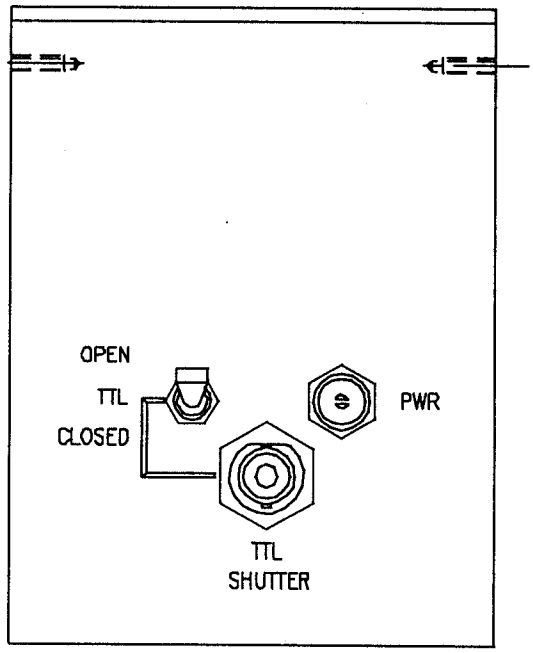


Figure 7

SHUTTER SWITCH: The toggle switch on the FICS™ spectrograph is a 3 position switch.

Open: This position opens the shutter, used for optical setup and alignment.

TTL: This position controls the shutter by a TTL signal. Shutter is closed until a TTL pulse is applied.

Closed: The shutter is closed as in the power off condition.

POWER: 5V power in from the power supply.

TTL SHUTTER: TTL signal in, BNC connector.

WARRANTY AND RETURNS

WARRANTY

Oriel Instruments warrants that all goods described in this manual (except consumables such as lamps, bulbs, filters, ellipses, etc.) shall be free from defects in material and workmanship. Such defects must become apparent within the following period:

1. All products described here, except spare and repaired parts: one (1) year or 3000 hours of operation, whichever comes first, after delivery of the goods to buyer.

2. Spare parts: ninety (90) days after delivery of goods to buyer.

3. Repaired items: ninety (90) days after delivery of goods to buyer.

Oriel Instruments' liability under this warranty is limited to the adjustment, repair and/or replacement of the defective part(s). During the above listed warranty period, Oriel Instruments shall provide all materials to accomplish the repaired adjustment, repair or replacement. Oriel Instruments shall provide the labor required during the above listed warranty period to adjust, repair and/or replace the defective goods at no cost to the buyer ONLY IF the defective goods are returned, freight prepaid, to an Oriel Instruments designated facility.

Oriel Instruments shall be relieved of all obligations and liability under this warranty if:

1. The user operates the device with any accessory, equipment or part not specifically approved or manufactured or specified by Oriel Instruments unless buyer furnishes reasonable evidence that such installations were not a cause of the defect.

2. The goods are not operated or maintained in accordance with Oriel's instructions and specifications.

3. The goods have been repaired, altered or modified by other than Oriel authorized personnel.

4. Buyer does not return the defective goods, freight prepaid, to an Oriel repair facility within the applicable warranty period.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY SHALL REPLACE ALL WARRANTIES OF FITNESS AND MERCHANTABILITY. BUYER HEREBY WAIVES ALL OTHER WARRANTIES, GUARANTIES, CONDITIONS OR LIABILITIES, EXPRESSED OR IMPLIED, ARISING BY LAW OR OTHERWISE, WHETHER OR NOT OCCASIONED BY ORIEL'S NEGLIGENCE.

This warranty shall not be extended, altered or varied except by a written document signed by both parties. If any portion of this agreement is invalidated, the remainder of the agreement shall remain in full force and effect.

CONSEQUENTIAL DAMAGES -

Oriel Instruments shall not be responsible for consequential damages resulting from misfunctions or malfunctions of the goods described in this manual. Oriel's total responsibility is limited to repairing or replacing the misfunctioning or malfunctioning goods under the terms and conditions of the above described warranty.

INSURANCE -

Persons receiving goods for demonstrations, demo loan, temporary use or in any manner in which title is not transferred from Oriel, shall assume full responsibility for any and all damage to the goods while they are in their care, custody and control. If damage occurs which is unrelated to the proper and warranted use and performance of the goods, then the recipient of the goods accepts full responsibility for restoring the goods to their condition upon original delivery, and for assuming all costs and charges.

RETURNS

Before returning equipment to Oriel for repair, please call the Customer Service Department at (203) 377-8282. Have your purchase order number available before calling Oriel. The Customer Service Representative will give you a Return Material Authorization number (RMA). Having an RMA will shorten the time required for the repair, because it ensures that your equipment will be properly processed. Write the RMA on the returned equipment's box. Equipment returned without a RMA may be rejected by the Oriel Receiving Department. Equipment returned under warranty will be returned with no charge for the repair or shipping. Oriel will notify you of the cost of repairs not covered by warranty before starting out of warranty repairs.

Please return equipment in the original (or equivalent) packaging. You will be responsible for damage incurred from inadequate packaging, if the original packaging is not used.

Include the cables, connector caps and antistatic materials sent and/or used with the equipment, so that Oriel can verify correct operation of these accessories.