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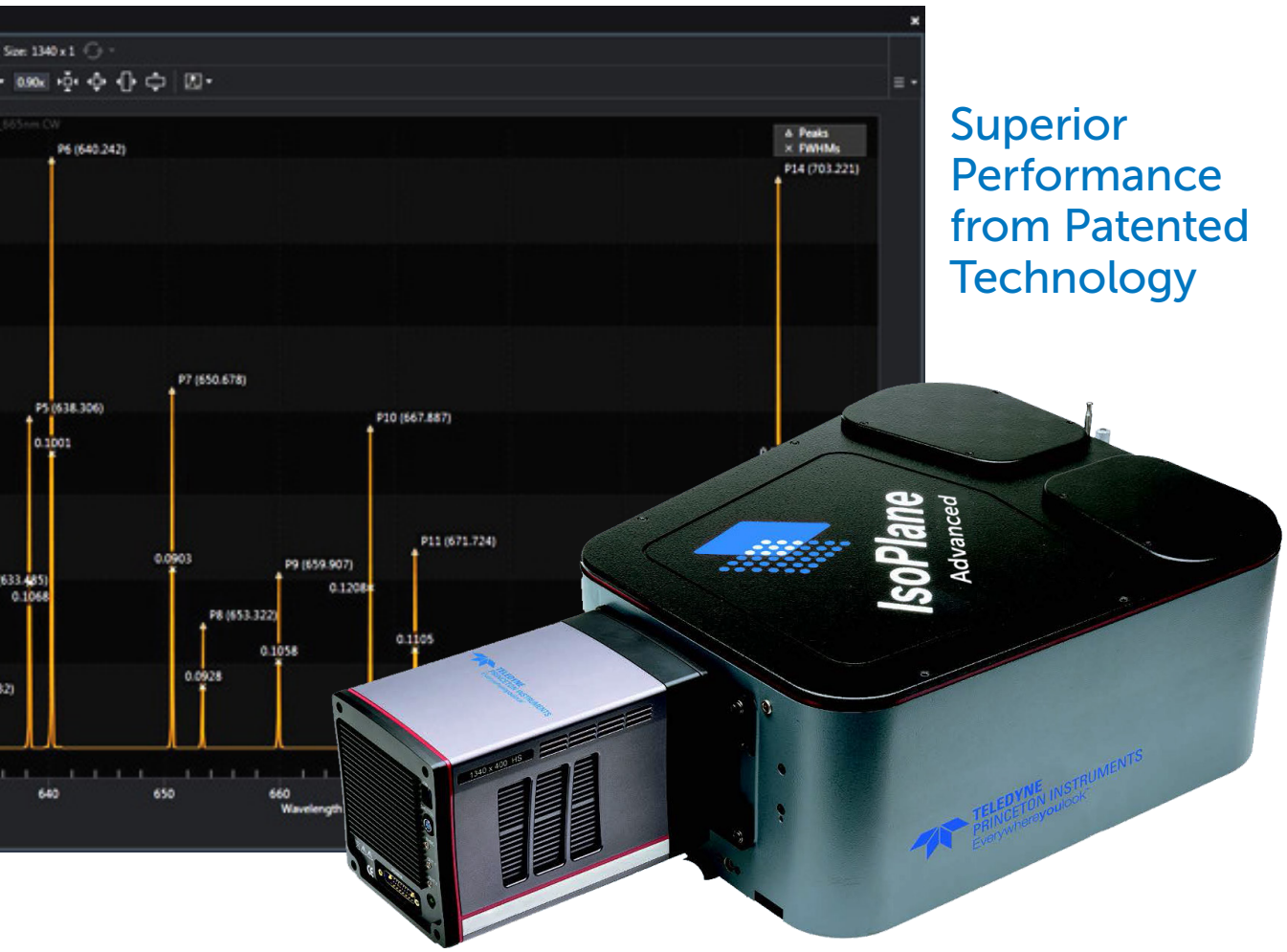
IsoPlane® Datasheet



Superior Performance from Patented Technology

IsoPlane 160
IsoPlane 320
IsoPlane 320A Advanced

THE BEST SPECTROSCOPY SOLUTIONS BY ANY MEASURE

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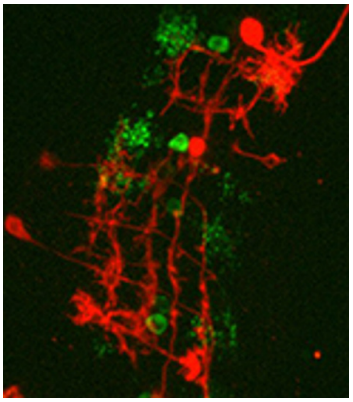
Teledyne

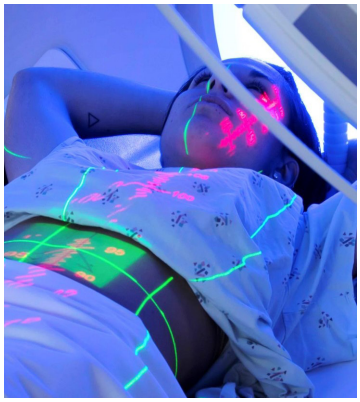
Focused on the success of our customers.

Leveraging a remarkable portfolio of technology in sensing, signal generation and processing.

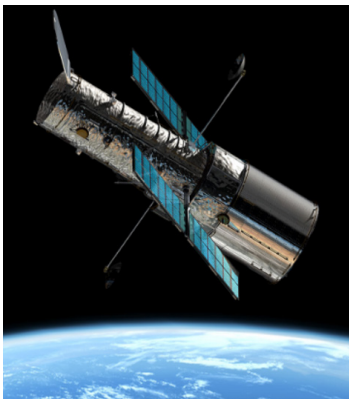


Scientific
TS&I | Photometrics | IDI |Princeton Instruments
Lumenera | Acton Optics
Cameras and software for scientific research, including spectroscopy and microscopy

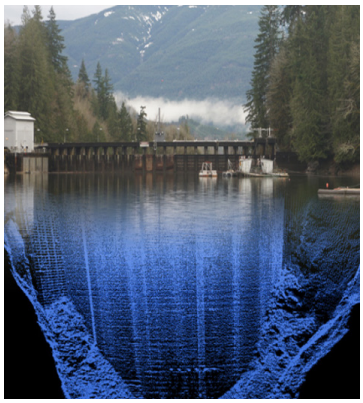
Medical and Life Sciences
DALSA | e2v
Radiography detectors, Radiotherapy generators



Machine Vision
DALSA | e2v | TS&I | ICM
Image sensors, cameras, processing hardware and software, Infrared, Visible, UV, X-Ray



Aerospace & Defense
e2v | TS&I | DALSA
Sensors and systems for astronomy, earth science, and defense, High reliability chipsets & subsystems



Geospatial
Optech | CARIS
Lidar & Sonar 3D Surveying, Geographic Information Systems Software

Semiconductors
DALSA | e2v
MEMS foundry
CCD foundries
Packaging services

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Contents

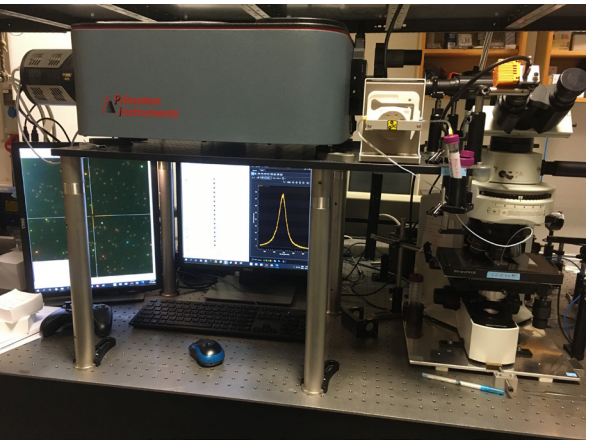
IsoPlane Features & Benefits

In a class of its own with higher sensitivity and resolution than comparable focal-length spectrographs, without astigmatism!

	Feature	Benefit(s)
EXCLUSIVE	Patented, astigmatism-free design	Spectra are free of astigmatism at all wavelengths across the entire focal plane. Can resolve >100 optical fiber channels with minimal crosstalk. Excellent spatial and spectral resolution over the entire area of a 1" square sensor. No other mirror-based scanning spectrograph offers comparable performance.
	Outstanding imaging performance	Yields much higher spatial and spectral resolution.
	High fluence	IsoPlane provides higher signal-to-noise compared to comparable focal length instruments.
	Fixed-position camera mount with micrometer focus adjustment	Easy and fine adjustment for razor-sharp camera focus.
	Kinematic, torque-limiting turret mount	Improves reproducibility when changing grating turrets. Up to three triple-grating turrets supported.
	High-efficiency optical coatings	Acton #1900 enhanced aluminum mirror coating offers the highest reflectivity from UV to NIR. Optional silver, gold, or custom coatings are available with reflectivity of 98% or better. See page 20 for details.
	Compatible with a wide range of cameras	Supports Teledyne Princeton Instruments BLAZE®, PIXIS, PyLoN®, PyLoN-IR, ProEM®, PI-MAX®, and NIRvana® cameras with spectroscopy or C-mount.
	Wide range of accessories	Including application CUBES, fiber bundles, adapters, shutters, filter wheels, purge ports, light sources, and the IntelliCal wavelength and intensity calibration system. Accessories sold separately.
	Optional: LightField (for Microsoft® Windows® 8/10, 64 bit) or WinSpec (for Windows XP/7/8, 32 bit)	Flexible software packages for data acquisition, display, and analysis. LightField offers intuitive cutting-edge user interface, IntelliCal, hardware time stamping, and more. Software sold separately. It supports Python® (PSF), MATLAB® (MathWorks), and LabVIEW® (National Instruments).
	Operating conditions	0°C to 30°C; 70% RH non-condensing

IsoPlane spectrometers are the best spectroscopy solutions by any measure

Trusted by researchers worldwide for highest sensitivity, unmatched aberration-correction, and superior signal-to-noise performance for demanding light research applications.

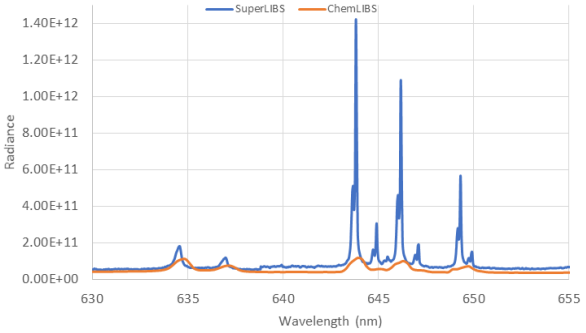


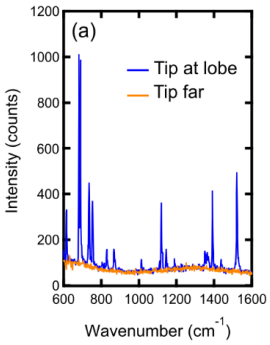
> As the IsoPlane is aberration corrected, we can have highly reliable intensity values over the whole range of the CCD.

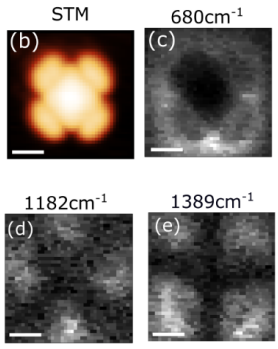
D. András Deák,
Centre for Energy Research, Hungarian Academy of Sciences

> Teledyne Princeton Instruments has the most sensitive and flexible spectrometers available.

Prof. Darby Dyar,
Department of Astronomy, Mount Holyoke College, Massachusetts, United States







> We like the high throughput and the good background reduction of the IsoPlane. We can highly recommend such a system to those working in in all kinds of Raman spectroscopy such as TERS, resonance Raman, low frequency Raman, etc.

Prof. Yousoo Kim, Dr. Rafael Jaculbia
Surface and Interface Science Laboratory, RIKEN, Japan

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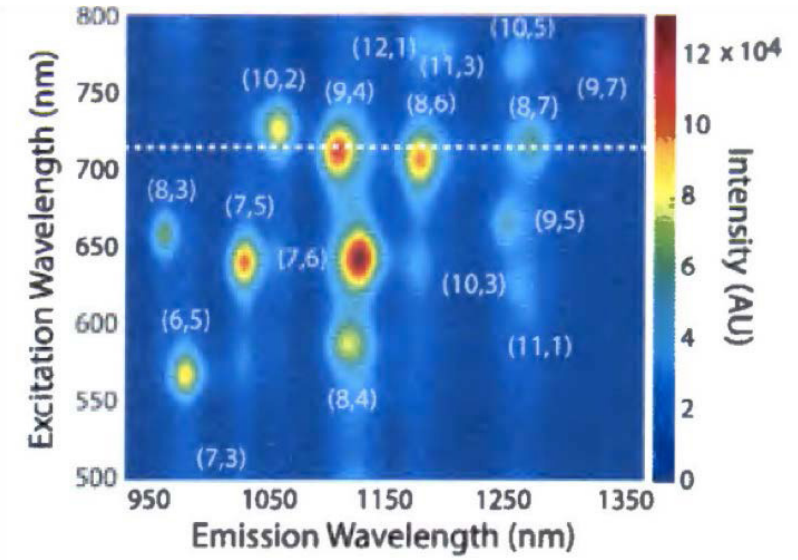
Applications

IsoPlane – Uncompromising Performance for Demanding Spectroscopy Applications

Carbon Nanotubes / Optical Nanosensors for Biosciences and Cancer Detection

Researcher: Dr. Daniel Heller (Memorial Sloan Kettering Cancer Center, USA)



Photoluminescence excitation map of carbon nanotubes of different chirality acquired with an IsoPlane 320 spectrometer and a Teledyne Princeton Instruments NIRvana InGaAs camera. Data courtesy of Daniel Heller (Memorial Sloan Kettering Cancer Center, USA). First published in P.V. Jena, Y. Shamay, J. Shah, D. Roxbury, N. Paknejad, and D.A. Heller, "Photoluminescent carbon nanotubes interrogate the permeability of multicellular tumor spheroids," Carbon 97, 99–109 (2016).

Summary:

Nanomaterials are widely studied for applications in biosciences, biosensing, and cancer detection and therapy. These sensors can be designed to target specific tissue and emit in the SWIR wavelength range (where scattering and absorption in tissue is low). Optical spectroscopy is an important tool for the design/characterization of nanomaterials as well as for signal detection in specific applications.

Why IsoPlane Matters:

Superior data quality and better signal-to-noise measurements, as well as compatibility with state-of-the-art InGaAs detector technology.

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Tip-Enhanced Raman Spectroscopy

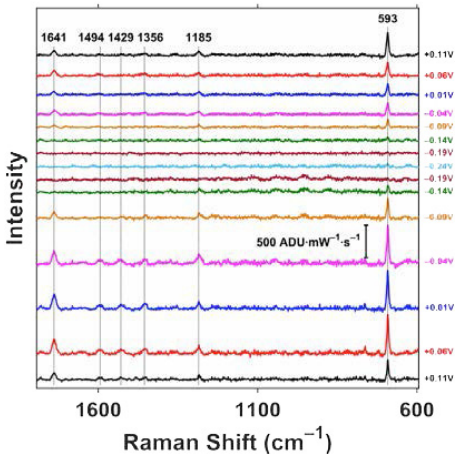
Researcher: Prof. Richard Van Duyne (Northwestern University, USA)

Summary:

Tip-enhanced Raman spectroscopy, or TERS, is utilized to measure material surfaces with atomic resolution. TERS reveals imaging data as well as chemical and structural specificity. The method provides unique insights in biomedical and material sciences. For more information about this type of work, refer to "Electrochemical STM Tip Enhanced Raman Spectroscopy Study of Electron Transfer Reactions for Covalently Tethered Chromophores on Au(111)," X. Chen, G. Goubert, S. Jiang and R. P. Van Duyne, J. Phys. Chem. C, 122, 11586–11590 (2018); DOI: 10.1021/acs.jpcc.8b03163.

Why IsoPlane Matters:

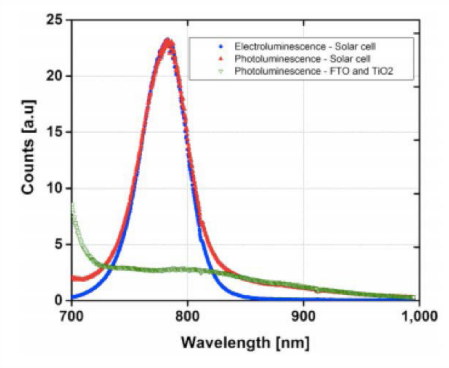
Superior data quality and better signal-to-noise measurements, as well as compatibility with state-of-the-art InGaAs detector technology.



TERS spectra acquired with an IsoPlane 320 spectrometer. Data courtesy of Richard Van Duyne (Northwestern University, USA).

Perovskites

Researcher: Prof. Ziv Hameiri (The University of New South Wales, Australia)



Luminescence spectra of a completed perovskite solar cell and of the FTO-TiO2 test structure acquired using an IsoPlane 120 spectrometer. Data courtesy of Ziv Hameiri (The University of New South Wales, Australia). First published in Z. Hameiri et al. Photoluminescence and electroluminescence imaging of perovskite solar cells. Progress in Photovoltaics: Research and Applications, 2015; 23: 1697.

Summary:

Perovskite-based solar cells are heavily researched for future applications in photovoltaics. Sensitive photo- and electroluminescence spectroscopy techniques are critical to investigations of these highly promising materials.

Why IsoPlane Matters:

Spectral quality and low aberration.

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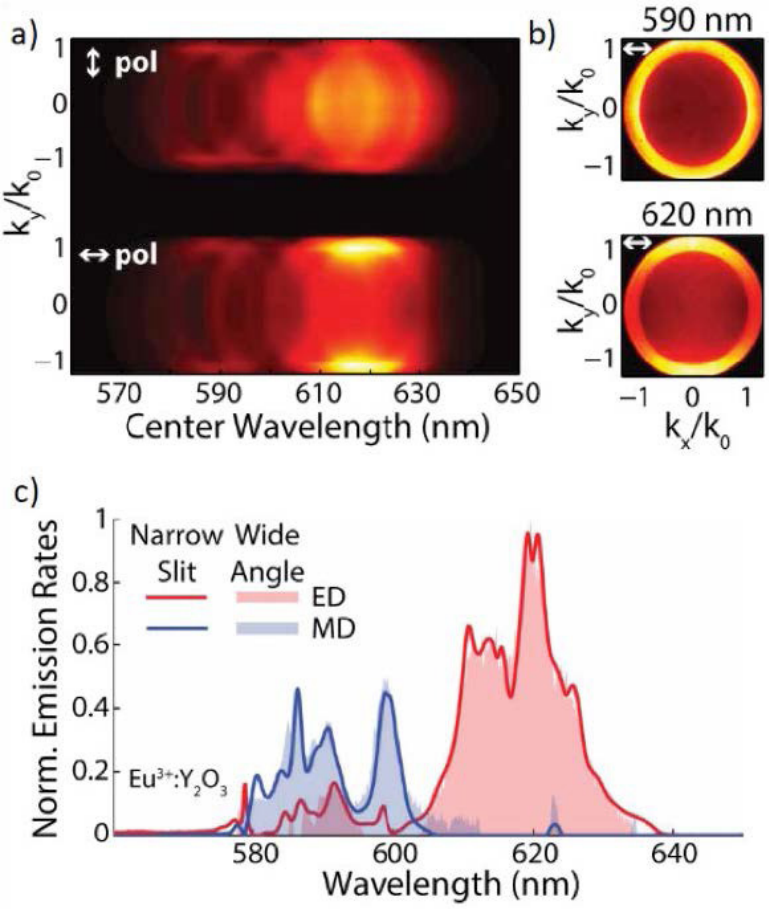
Wide-Angle Energy-Momentum Spectroscopy

Researcher: Prof. Rashid Zia (Brown University, USA)

Research using IsoPlane 320A Advanced



Wide-angle energy-momentum spectrum and emission rates of an $Eu^{3+}:Y_2O_3$ thin film collected using a Teledyne Princeton Instruments IsoPlane 320 and PIXIS:1024B. Data courtesy of Rashid Zia (Brown University, USA). First published in Opt. Lett., vol. 39, pp. 3927-3930, 2014.

Summary:

Nanomaterials are widely studied for applications in biosciences, biosensing, and cancer detection and therapy. These sensors can be designed to target specific tissue and emit in the SWIR wavelength range (where scattering and absorption in tissue is low). Optical spectroscopy is an important tool for the design/characterization of nanomaterials as well as for signal detection in specific applications.

Why IsoPlane Matters:

Superior data quality and better signal-to-noise measurements, as well as compatibility with state-of-the-art InGaAs detector technology.

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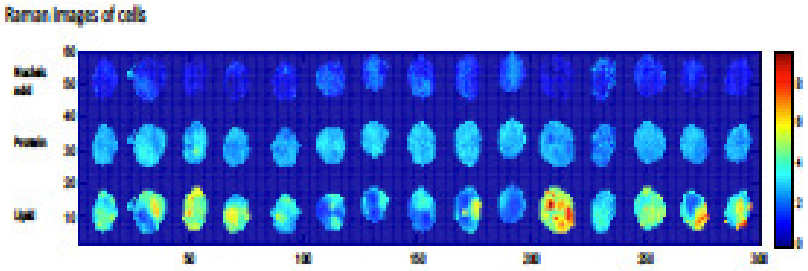
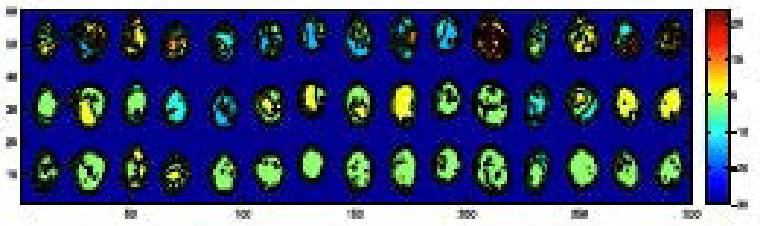
Raman Micro-Spectroscopy Mapping of Cells

Researcher: Prof. Jürgen Popp (Friedrich Schiller University Jena, Germany)



Raman images of pancreatic cancer cells visualize the macromolecular distribution of nucleic acids, proteins, and lipids within the cells.



Same cells as above, but the visualization is based on the score values after a principal component analysis on the dataset. This captures the spectral variance and shows the components that vary at the same time.

Data collected with an IsoPlane 160 spectrometer and a Teledyne Princeton Instruments PIXIS:400BRX CCD camera. Courtesy of Jürgen Popp (Friedrich Schiller University Jena, Germany). First published in Schie IW, Kiselev R, Krafft C, Popp J. Rapid acquisition of mean Raman spectra of eukaryotic cells for a robust single cell classification. Analyst. 2016; 141: 6387–95; DOI: 10.1039/c6an01018k.

Summary:

Micro-spectroscopy reveals the distribution of nucleic acids, proteins, and lipids within a cell and can be used to classify different cell types based on their Raman spectrum. The use of an aberration-corrected spectrometer is helpful due to its increased signal-to-noise ratio and the need to avoid crosstalk in hyperspectral measurements. For information about the design and first applications of a flexible Raman micro-spectroscopic system for biological imaging, refer to Biomedical Spectroscopy and Imaging, vol. 5, no. 2, pp. 115–127, 2016; DOI: 10.3233/BSI-160141.

Why IsoPlane Matters:

Aberration-corrected design with high resolution provides strong and uniform outer bands without any fall off in SNR.

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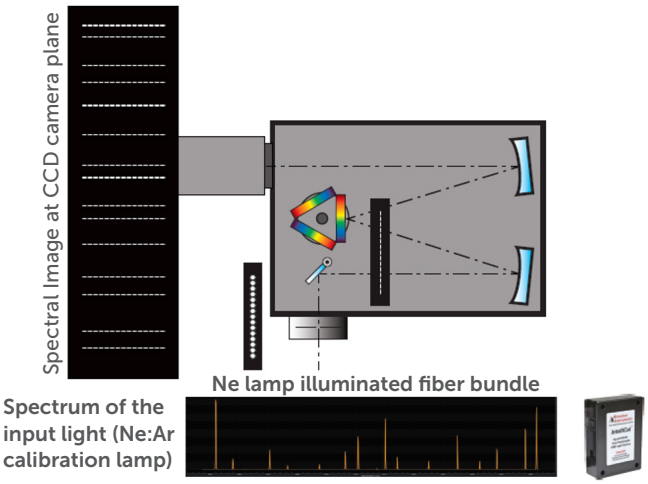
Role of Imaging Aberrations in Spectroscopy



Imaging power of a spectrograph

IsoPlane spectrographs achieve their remarkable performance by improving optical imaging power. But what does imaging have to do with spectroscopy?

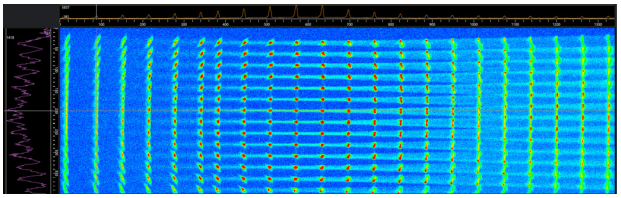
Virtually every optical system can be viewed as an imaging system. Spectrographs, for example, create an image of the entrance slit plane at the focal plane of the spectrograph where an array detector is typically positioned. The figure on the left shows a spectrograph illuminated by a fiber bundle emitting light from an atomic emission lamp with discrete emission lines. An image of the fiber after the slit is created on the detector for any discrete wavelength that exists in the source. This allows the user to determine the spectral characteristics of the source or sample.

Optical aberrations

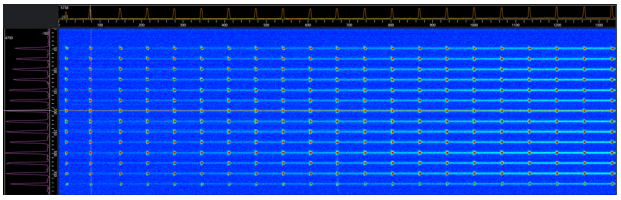
Even an ideal imaging system does not have infinitely small resolution. It obeys the diffraction limit that is determined by the illumination wavelength and the diameter of the system aperture. However, no optical system is perfect. The performance is further limited by optical aberrations, the most prominent being spherical aberrations, coma, astigmatism and chromatic aberrations (chromatic aberrations don't exist in lab spectrographs due to the use of reflective optics only).

Aberrations negatively impact spectral resolution and can lead to distorted, asymmetric shapes of spectral lines. To illustrate their impact, consider the images on the right. They show images of a fiber optic source at different positions on the focal plane taken with a traditional spectrograph (Czerny-Turner design, top) and an IsoPlane spectrograph (bottom). In this instance astigmatism, present in the Czerny-Turner image, limits spectrograph imaging performance. In contrast, IsoPlanes are free from astigmatism, therefore provide a clean, sharp images

Traditional C-T spectrograph will offer good astigmatism correction in the middle of focal plane only:

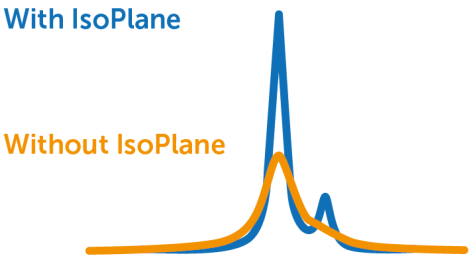


IsoPlane 320 provides excellent spectral and spatial resolution across the entire focal plane:



Benefits of Reduced Optical Aberrations

Spherical astigmatism and coma are optical aberrations that distort images, causing light to spread over an area rather than producing a sharp focus. Simply speaking, if these aberrations can be reduced, it will result in improved image quality. Better imaging allows a spectrograph to sharply focus light, i.e. on fewer sensor pixels for improved spatial and spectral resolution capabilities. This has multiple advantages for spectroscopy

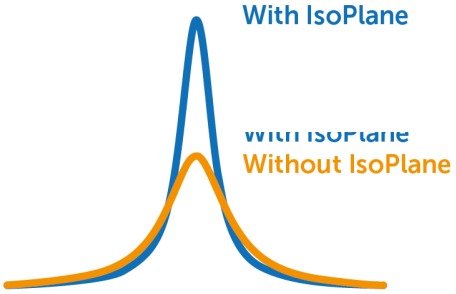


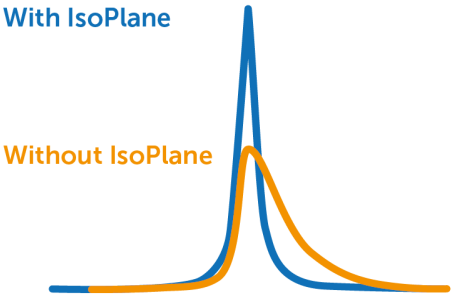
Higher spectral resolution

- Sharper focus with lower aberrations means higher spectral resolution
- IsoPlane 160 spectral resolution is similar to 300mm C-T spectrographs
- IsoPlane 320 spectral resolution is similar to 500mm C-T spectrographs
- IsoPlane 320A can exceed the spectral resolution of 500 mm C-T spectrographs
- Larger aperture (compared to 500mm CT) means twice the light collection power

Higher sensitivity

- Better focusing of photons to fewer camera pixels
- Signal focused on fewer camera rows means less detector dark noise in the signal
- Up to 3x (300%) higher S/N compared to traditional spectrographs





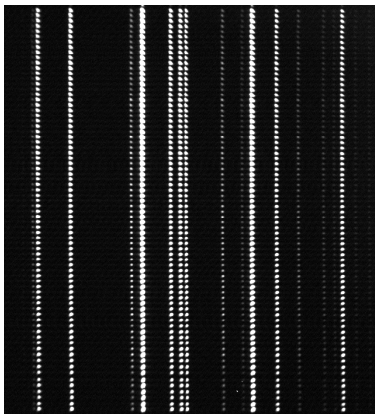
Increase quality of spectral lines

- Same spectral line looks the same no matter where on the sensor it is measured (unlike CT systems)
- Bin signals from extended source spread across whole height of the sensor without line shape distortions

Unmatched multi-track capability

- Zero astigmatism means no overlap of adjacent spectral channels
- Ideal for multiple fiber optic inputs
- Measure tens to hundreds of optical channels simultaneously

This figure shows greater than sixty 50 µm diameter optical fibers imaged with the IsoPlane. There is excellent spatial resolution and minimal crosstalk. This high spatial resolution is attainable over sensor sizes as large as 22 mm tall by 27mm wide. The IsoPlane is excellent for hyperspectral imaging and multi-channel spectroscopy



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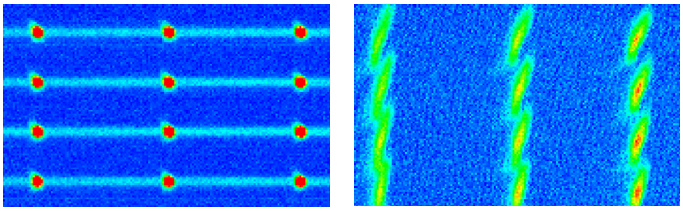
Characterization of Aberrations

Proper evaluation and comparison of different spectrographs requires that their imaging power is quantified in addition to their spectral resolution. Here are the parameters we use to describe the imaging performance across the focal plane.

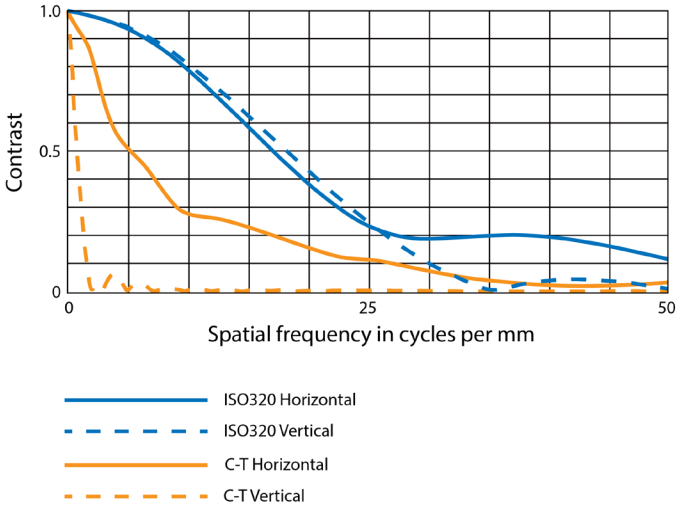
Astigmatism

- Astigmatism appears as elongated images, especially at the edges of the Czerny-Turner focal plane away from the center
- Unique optical designs of IsoPlane 320 and 320A spectrographs completely eliminate astigmatism across the entire focal plane



Images of point light sources at the focal plane edge of IsoPlane (left) and Czerny Turner (right) spectrograph.

Zero astigmatism means no overlap of adjacent spectral channels.



MTF of the IsoPlane-320 vs. 300mm Czerny-Turner design at the focal plane edge.

Spatial resolution

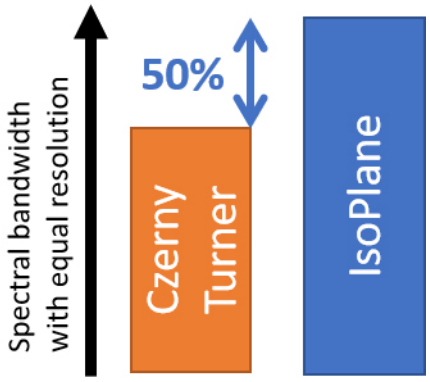
- All optical systems are characterized by their modulation transfer function (MTF)
- Includes effects of all optical aberrations and is measured in line pairs/mm (lp/mm) specifying the contrast between closely spaced line pairs
- IsoPlane minimizes aberrations and improves the MTF across the whole focal plane

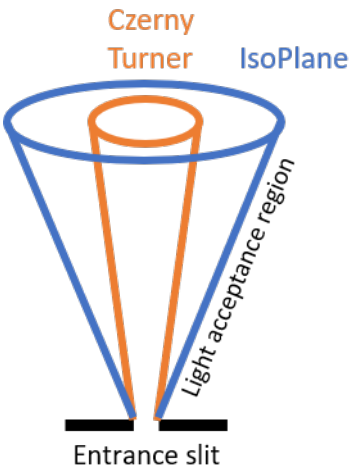
IsoPlane spectrographs achieve high spatial resolution at all points of the focal plane.

IsoPlane enhances the performance of spectrographs beyond previous limits and trade-offs.

IsoPlane spectrographs have more bandwidth while keeping the same resolution

The limited imaging power of traditional spectrographs designs trades off spectral bandwidth for to gain spectral resolution. Isoplane spectrographs Increase spectral bandwidth at same spectral resolution.





IsoPlane spectrographs achieve high resolution at full aperture

The spectral and spatial resolution of spectrographs can be improved by reducing the input aperture of the instrument (similar to squinting with your eyes). This common trick, however, reduces the light collection ability of the spectrograph so signal will be lost. IsoPlane spectrographs achieve high spectral and spatial resolution at full aperture. Additionally, they also provide near diffraction-limited optical imaging performance when used in low aperture applications such as microspectroscopy.

IsoPlane spectrographs simultaneously optimize spectral and spatial resolution

When measurements require high spatial resolution, some manufacturers of Czerny-Turner systems rotate the detectors into the sagittal focal plane where light is focused well in the vertical direction (good for multitrack spectroscopy). However, the spectral resolution will be severely limited as astigmatism is not corrected in the horizontal direction for this mode of operation. The unique optical designs of IsoPlane 320/320A spectrographs optimize spectral and spatial resolution across the entire 2D focal plane area. The result is high spectral resolution, zero-astigmatism and reduced aberrations for dramatically improved image quality and signal to noise.

The IsoPlane family – High performance

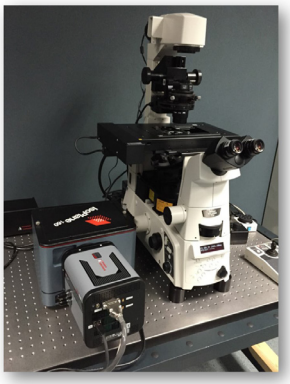
High spectral resolution, superior signal-to-noise performance, and unmatched aberration-correction for demanding spectral/imaging applications

The IsoPlane are Teledyne Princeton Instrument's, award-winning line of high performance imaging spectrographs and scanning monochromators offering the highest spectral resolution at fast input apertures. At the core of IsoPlane is an advanced optical design that reduces optical imaging aberrations and as a result consequentially increases resolution, light throughput and sensitivity. IsoPlane also enables entirely new measurement techniques that make use of the entire two-dimensional detection plane previously restricted due to optical distortions such as astigmatism. All IsoPlane models support the full range of Teledyne Princeton Instruments CCD, CMOS and InGaAs cameras as well as helpful tools like IntelliCal calibration, making them the ultimate spectroscopic measurement tool anywhere from deep UV to the infrared wavelength range.

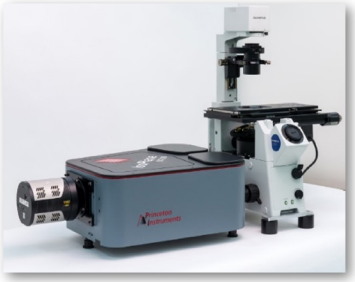
Available IsoPlane Models

(see page 16 for detailed specifications):

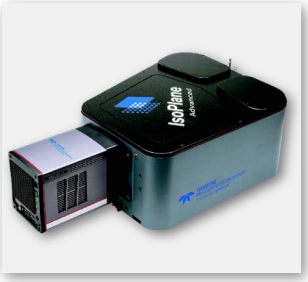
IsoPlane 160 **The most compact version of IsoPlane**	**IsoPlane 320** **The original, award-winning design**	**IsoPlane 320A Advanced** **Highest performance version**
Compact footprint	High resolution	Best resolution
Large f/3.9 input aperture	High input aperture	High input aperture
Widest spectral bandwidth	Wide spectral bandwidth	Wide spectra bandwidth
Minimizes optical aberrations and astigmatism	Minimizes optical aberrations	Lowest optical aberrations
Good multichannel performance	Eliminates astigmatism	Zero astigmatism
	Great multitrack performance	Best multitrack performance



Ideal for Micro-Spectroscopy
The compact size of the IsoPlane 160 makes it an ideal add-on for new and existing microscope systems.



High performance
IsoPlane 320 astigmatism-free design offers the best performance for most spectroscopy applications.

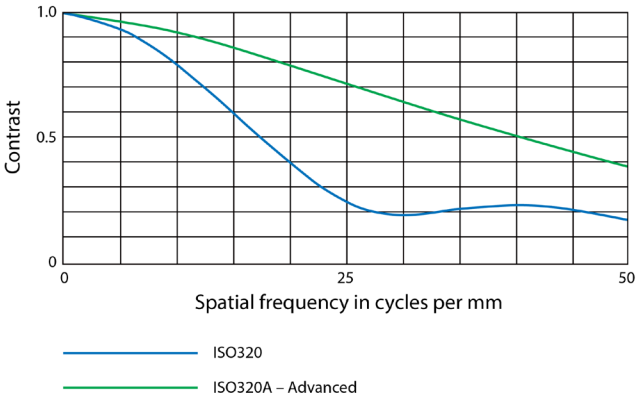


Best for extreme spectral imaging
More than 200 distinct fiber channels can be measured on the focal plane area of the IsoPlane 320A Advanced.

Introducing the IsoPlane 320A Advanced

The best just got better! Building on the unmatched performance of the industry standard IsoPlane 320, we added proprietary high performance imaging optics for dramatically improved optical performance. Benefits include improved spectral resolution, superior image quality and enhanced signal to noise performance. The IsoPlane 320A Advanced may be the ideal spectrometer for your demanding optical research.

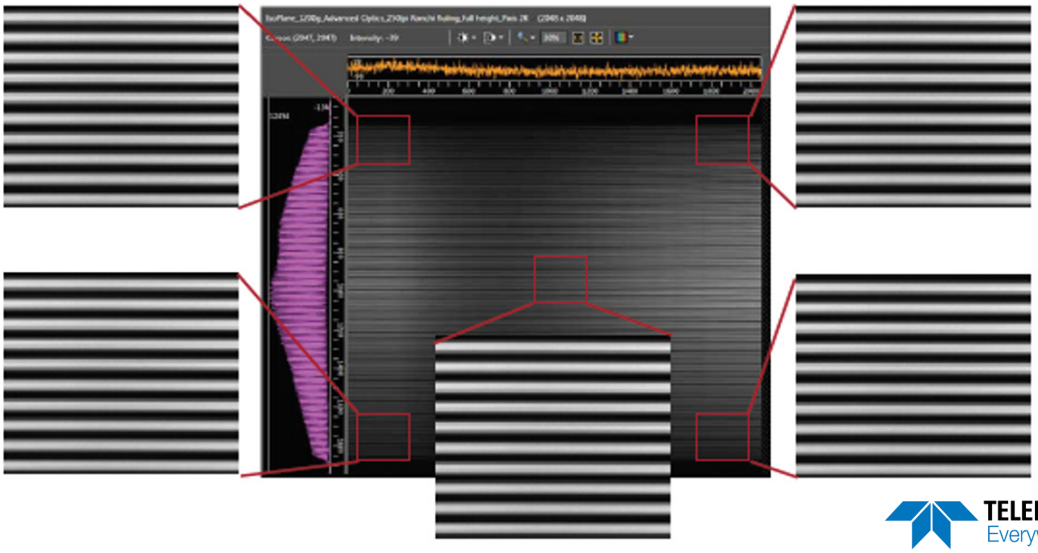
IsoPlane-320A Advanced provides unmatched performance for spectroscopic applications. Shown with state of the art Blaze CCD.



MTF of the IsoPlane-320 and IsoPlane-320A Advanced at the focal plane center.

Application: High Density Multitrack Spectroscopy

The image below shows a spectral image of a Rhonchi ruling taken with a SOPHIA-2048 camera (22mm x 27.6mm imaging area) and IsoPlane Advanced. All tracks are well resolved at all points in the focal plane.



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IsoPlane Specifications

Specifications	IsoPlane 160	IsoPlane 320	IsoPlane 320A
Focal length	203 mm	320 mm	320 mm
Aperture ratio	f/3.88	f/4.6	f/4.6
Spectral resolution with PMT*	0.13 nm	0.05 nm	0.04 nm
CCD spectral resolution**	0.16 nm or better across a 27 mm wide focal plane	0.08 nm at all points on the focal plane	0.065 nm
CCD spectral resolution with ResXtreme	0.07 nm or better (typ.)	0.05 nm or better (typ.)	0.04 nm or better (typ.)
Reciprocal linear dispersion	3.61 nm/mm	2.30 nm/mm	2.30 nm/mm
Wavelength coverage across 26.8 mm wide CCD	97 nm (nominal)	63 nm (nominal)	63 nm (nominal)
Focal plane size (width x height)	27 mm x 14 mm	27 mm x 22 mm	27 mm x 22 mm
Scan range	0 to 1400 nm		
Drive step size	0.005 nm/step	0.002 nm/step	0.002 nm/step
Wavelength accuracy	+/-0.2 nm (up to 0.02 nm with IntelliCal wavelength calibration)		
Wavelength reproducibility	+/-0.025 nm	+/- 0.015 nm	+/- 0.015 nm
Turret	Interchangeable triple-grating CTS-Turrets self-align to system when installed		
Grating change repeatability	0.02 nm (typ.)		
Grating size	40 mm x 40 mm gratings	68 mm x 68 mm gratings	68 mm x 68 mm gratings
Number of turrets allowed	Accepts as many as 3 turrets, each with 3 gratings		
Astigmatism	<100 µm at all wavelengths across the entire focal plane	Zero at all wavelengths	Zero at all wavelengths
Spatial resolution (MTF)	≥12 line pairs/mm @ 50% modulation, measured at focal plane center ≥6 line pairs/mm @ 50% modulation, measured over 27 x 8 mm focal plane	≥15 line pairs/mm @ 50% modulation, measured at focal plane center ≥8 line pairs/mm @ 50% modulation, measured over 27 x 8 mm focal plane	≥25 line pairs/mm @ 50% modulation, measured at focal plane center ≥10 line pairs/mm @ 50% modulation, measured over 27 x 8 mm focal plane
Computer interface	USB and RS-232		
Certification	CE tested to the following standards: EN 55022:2010/AC:2011, EN 61000-3-2:2014, EN 61000-3-3:2013, EN 61000-6-3:2007/A1:2011, EN 61326-1:2013		

Dimensions		
Length	11.8" (299.7 mm)	20.4" (518 mm)
Width	9.8" (248.9 mm)	17.7" (450 mm)
Height	8.6" (218.4 mm)	8.5" (216 mm)
Weight	15 lbs (6.8 kg)	55 lbs (25 kg)
Optical axis height	5.0" to 5.875" (127 mm to 149.225 mm), adjustable	

Note: Unless otherwise stated, specifications are with a 1200 g/mm grating @ 435.8 nm.

** PMT resolution measured with a 1200 g/mm grating @ 435.8 nm, 10 µm slit width, and 4 mm slit height.*
*** CCD resolution measured at the focal plane center with 10 µm slit and a Teledyne Princeton Instruments PIXIS:400F with 20 µm pixels @ 546 nm.*

Specifications are subject to change

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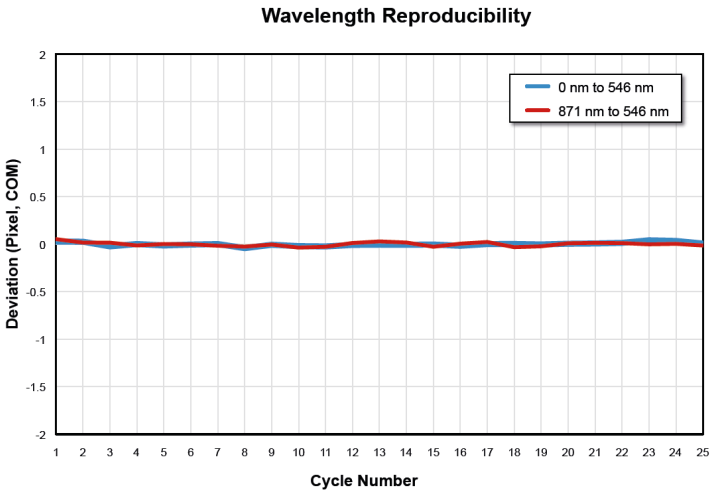
AccuDrive System Delivers Unmatched Accuracy and Repeatability

IsoPlane imaging spectrographs feature Teledyne Princeton Instruments' AccuDrive grating scan system for dramatically improved wavelength accuracy and repeatability. This drive system outperforms previous scan systems, yielding significant improvements in accuracy and reproducibility.

On start-up, AccuDrive automatically identifies the turret and gratings installed. The system then performs several optical alignment routines to ensure accurate initialization of the spectrometer. The exceptional wavelength reproducibility of the IsoPlane results from using only the highest quality optomechanical components available.



Scan system repeatability test

To show the exceptional accuracy and repeatability of the IsoPlane AccuDrive grating drive system, Teledyne Princeton Instruments conducted the following 25-cycle scanning test. Each cycle consisted of a scan from zero to 546 nm, then to 871 nm, and then back to 546 nm. Every time 546 nm was reached, the exact center of mass (COM) was recorded, allowing scan repeatability to be measured in both scanning directions. In this test, the AccuDrive system provided better than 0.015 nm for the IsoPlane 320 and 0.025 nm for the IsoPlane 160 repeatability in both scanning directions.

Grating change reproducibility

The purpose of a triple-grating turret feature in any spectrograph is to allow as many as three gratings to be mounted on a turret and selected when required for an application. The grating drive system is only useful if it maintains spectral and spatial precision for all gratings installed in the spectrograph. AccuDrive increases the grating-to-grating wavelength precision to sub-pixel repeatability, typically 0.02 nm (1200 g/mm grating).

Robust design

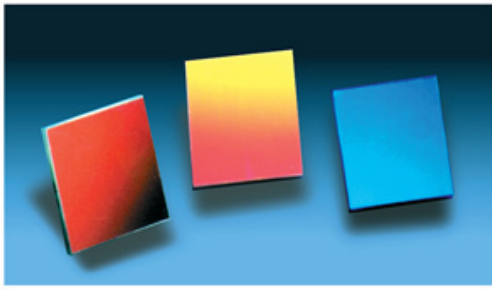
IsoPlane spectrographs are so robust that they can operate in any attitude. We now offer configuration options that make it possible to run this instrument on its side, on its end, or in virtually any orientation. Contact Teledyne Princeton Instruments for more information.

Wide Variety of Gratings Optimized To Enhance Your Specific Application

Choosing the right diffraction gratings is one of the most important steps to ensure the best optical performance in your application.

Diffraction gratings

IsoPlane spectrographs and monochromators use diffraction gratings as the optical element that separates (disperses) polychromatic "white" light into individual wavelengths (colors). When polychromatic light encounters the grating, it is dispersed so that each wavelength reflects from the grating at a slightly different angle. The dispersed light is then re-imaged by the monochromator or spectrograph so that individual wavelengths (or a desired band of wavelengths) can be directed to a detection system (CCD, sCMOS, or single-channel detector) or a sample.



Selecting the Proper Grating

Groove Density (Groove Frequency)

The number of grooves contained on a grating surface is expressed in grooves per mm (g/mm) or lines per mm (l/mm). Groove density affects both the wavelength region in which an instrument can operate (mechanical scanning range) and the dispersion properties of a system. It is also a factor in determining the resolution capabilities of a monochromator. Higher groove densities result in greater dispersion as well as higher resolution capabilities. Teledyne Princeton Instruments recommends selecting a grating that delivers the required dispersion when using a CCD or array detector, or the required resolution (with an appropriate slit width) when using a monochromator.

Mechanical scanning range

The mechanical scanning range refers to the mechanical rotation capability (not the "operating" or "optimum range") of a grating drive system with a specific grating installed. Teledyne Princeton Instruments recommends selecting a grating groove density that allows operation over a specified application's required wavelength region. This mechanical limit to grating rotation relates directly to grating groove density, and ultimately the longest wavelength allowed for a specific grating.

Blaze wavelength

Diffraction grating efficiency plays an important role in monochromator or spectrograph throughput. Efficiency at a particular wavelength is largely a function of the blaze wavelength if the grating is ruled, or modulation if the grating is holographic. Blaze wavelength relates to the angle in which the grooves are formed with respect to the grating normal, often termed blaze angle. Modulation is the depth of the grooves formed by holographic methods, assuming the grooves are sinusoidal. The collection of efficiency curves for typical IsoPlane gratings shows the effect that blaze wavelength has on the efficiency of a grating, and ultimately on the throughput of the monochromator or spectrograph.

Optimum wavelength range

The optimum wavelength range is the wavelength region of highest efficiency for a particular grating, normally determined by the blaze wavelength. Teledyne Princeton Instruments recommends selecting a grating with maximum efficiency over the specified application's required wavelength region.

Selecting the correct Blaze wavelength

To determine the correct blaze wavelength for an application, consider the total wavelength region required for current and future applications. From a practical standpoint, Teledyne Princeton Instruments recommends selecting a blaze wavelength that favors the short wavelength side of the spectral region to be covered.

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Advantages of multiple-grating turrets

Quite often it becomes necessary to select two or three gratings to achieve efficient light throughput over a broad spectral region. That's why IsoPlane monochromators and spectrographs are equipped with multiple-grating turrets as a standard feature. Turrets make grating changes an easy push-button or computer-controlled operation, and also reduce the risk inherent in handling the delicate gratings.

Multi-grating versatility

IsoPlane spectrographs with interchangeable CTS-Turrets allow a single instrument to perform a variety of experiments. For example, one turret optimized for UV-VIS-NIR emission spectroscopy and a second optimized for Raman spectroscopy could be selected. A third turret might contain gratings for NIR experiments, micro-spectroscopy, fluorescence, or photoluminescence. IsoPlane spectrographs accept up to three CTS-Turrets, each capable of holding up to three gratings.

In addition to the versatility of multiple grating sets, CTS-Turrets provide superior installation accuracy and reproducibility. CTS-Turrets feature a stress-free mount, eliminating the risk of over-tightening the screws securing a turret in place and any resultant misalignment of the gratings during installation. Simply insert a turret into the kinematic mount and tighten the center torque screw. These IsoPlane grating turrets self-align to the optical system. An optical turret ID sensor identifies the turret and gratings installed, making it very easy to change from one set of gratings to another without having to re-program the spectrograph. Teledyne Princeton Instruments LightField software detects and identifies the turret and gratings when installed and automatically sets up controls for operation and calibration.

Need help?

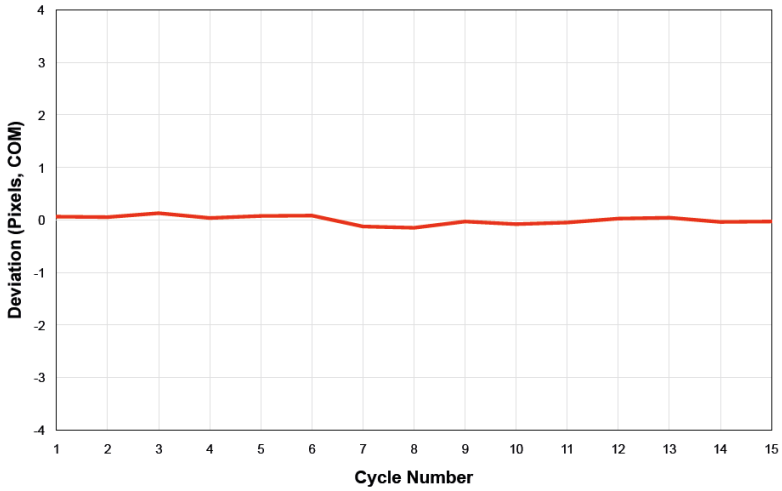
Teledyne Princeton Instruments' experienced technical staff is ready to assist you in selecting the best gratings for your application.

Turret Interchange Repeatability

IsoPlane spectrometers include TPI's exclusive self-aligning CTS-turrets, for fast and easy interchange of turrets with exceptional accuracy and repeatability. Once installed, LightField software automatically identifies the turret installed and sets up the correct operating parameters.

Test: CTS-Turret installed 15 times, with the center of mass (COM) of an atomic emission line measured after each installation.

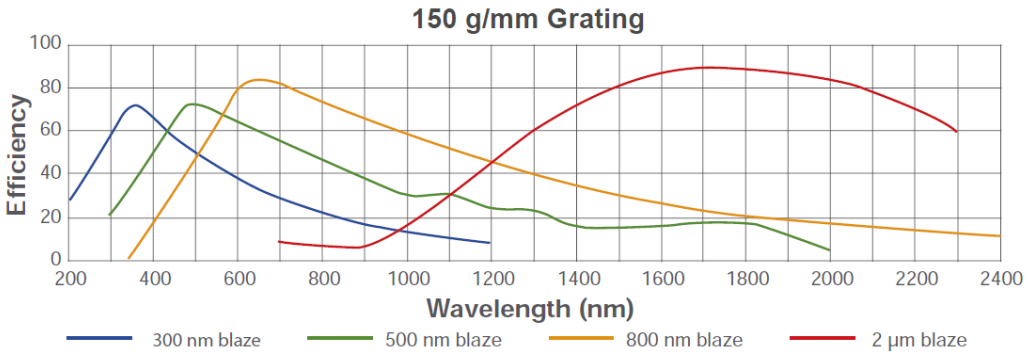
Turret interchange reproducibility is typically 0.02 nm (sub-pixel). (IsoPlane 320 with 1200 g/mm grating and PIXIS 1340 x 400 CCD camera with 20 µm pixels).

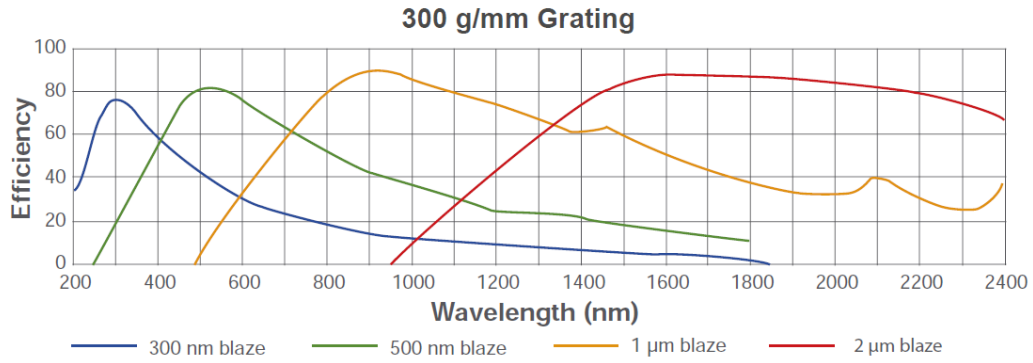


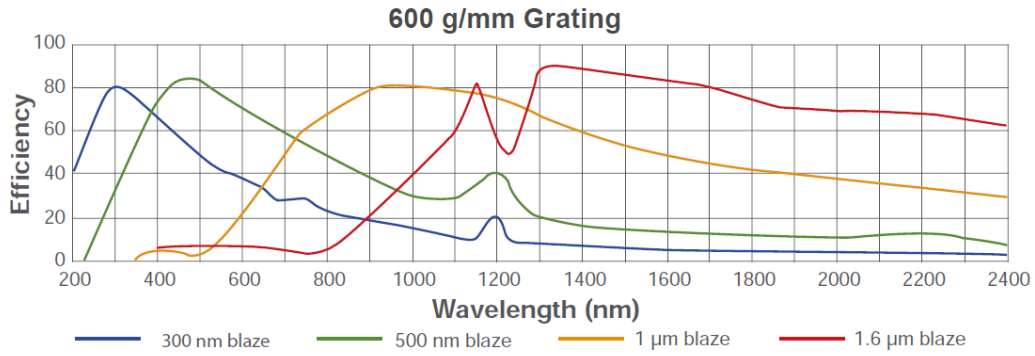
Standard IsoPlane Gratings

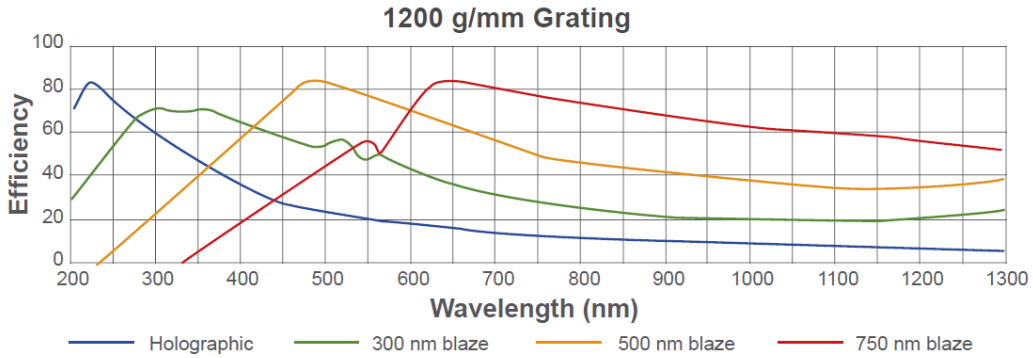
Groove density (g/mm)	Blaze wavelength (nm)	Mechanical scanning range	Optimum wavelength range (nm)		Grating part number (40 mm x 40 mm)	Grating Part Number IsoPlane-160	Grating Part Number IsoPlane-320/320A
50	600	0 – 36 µm	402	950	i160-005-600-P	i160-005-600-P	i3-005-600-P
150	300	0 – 12 µm	200	500	i160-015-300-P	i160-015-300-P	i3-015-300-P
150	500	0 – 12 µm	330	800	i160-015-500-P	i160-015-500-P	i3-015-500-P
150	800	0 – 12 µm	425	1400	i160-015-800-P	i160-015-800-P	i3-015-800-P
150	1250	0 – 12 µm	850	2100	i160-015-1250-P	i160-015-1250-P	i3-015-1250-P
150	4000	0 – 12 µm	2600	6000	i160-015-4000-P	i160-015-4000-P	i3-015-4000-P
300	300	0 – 6 µm	200	500	i160-030-300-P	i160-030-300-P	i3-030-300-P
300	500	0 – 6 µm	330	800	i160-030-500-P	i160-030-500-P	i3-030-500-P
300	750	0 – 6 µm	500	1200	i160-030-750-P	i160-030-750-P	i3-030-750-P
300	1000	0 – 6 µm	650	1600	i160-030-1000-P	i160-030-1000-P	i3-030-1000-P
300	1200	0 – 6 µm	700	2100	i160-030-1200-P	i160-030-1200-P	i3-030-1200-P
300	2000	0 – 6 µm	1300	4000	i160-030-2000-P	i160-030-2000-P	i3-030-2000-P
600	150	0 – 3 µm	105	250	i160-060-150-P	i160-060-150-P	i3-060-150-P
600	300	0 – 3 µm	200	500	i160-060-300-P	i160-060-300-P	i3-060-300-P
600	500	0 – 3 µm	330	800	i160-060-500-P	i160-060-500-P	i3-060-500-P
600	1000	0 – 3 µm	670	1600	i160-060-1000-P	i160-060-1000-P	i3-060-1000-P
600	1250	0 – 3 µm	850	2100	i160-060-1250-P	i160-060-1250-P	i3-060-1250-P
600	1600	0 – 3 µm	1050	2500	i160-060-1600-P	i160-060-1600-P	i3-060-1600-P
900	550	0 – 2 µm	335	800	i160-090-550-P	i160-090-550-P	i3-090-550-P
900	NIR	0 – 2 µm	700	1100	i160-090-HNIR-P	i160-090-HNIR-P	i3-090-HNIR-P
1200	150	0 – 1500 nm	105	250	i160-120-150-P	i160-120-150-P	i3-120-150-P
1200	300	0 – 1500 nm	200	700	i160-120-300-P	i160-120-300-P	i3-120-300-P
1200	500	0 – 1500 nm	325	1000	i160-120-500-P	i160-120-500-P	i3-120-500-P
1200	750	0 – 1500 nm	475	1500	i160-120-750-P	i160-120-750-P	i3-120-750-P
1200	850	0 – 1500 nm	525	1500	i160-120-850-P	i160-120-850-P	i3-120-850-P
1200	UV holographic	0 – 1500 nm	200	450	i160-120-HUV-P	i160-120-HUV-P	i3-120-HUV-P
1200	VIS holographic	0 – 1500 nm	400	1100	i160-120-HVIS-P	i160-120-HVIS-P	i3-120-HVIS-P
1800	500	0 – 1000 nm	330	800	i160-180-500-P	i160-180-500-P	i3-180-500-P
1800	UV holographic	0 – 1000 nm	200	500	i160-180-HUV-P	i160-180-HUV-P	i3-180-HUV-P
1800	VIS holographic	0 – 1000 nm	350	1000	i160-180-HVIS-P	i160-180-HVIS-P	i3-180-HVIS-P
2400	150	0 – 750 nm	105	250	i160-240-150-P	i160-240-150-P	i3-240-150-P
2400	240	0 – 750 nm	160	400	i160-240-240-P	i160-240-240-P	i3-240-240-P
2400	UV holographic	0 – 750 nm	200	500	i160-240-HUV-P	i160-240-HUV-P	i3-240-HUV-P
2400	VIS holographic	0 – 750 nm	250	750	i160-240-HVIS-P	i160-240-HVIS-P	i3-240-HVIS-P
3600	240	0 – 500 nm	160	400	i160-360-240-P	i160-360-240-P	i3-360-240-P
3600	UV holographic	0 – 500 nm	200	500	i160-360-HUV-P	i160-360-HUV-P	i3-360-HUV-P
MIRROR	-	0 nm	-	-	i160-MIRROR-P	i160-MIRROR-P	i3-MIRROR-P

Grating Efficiency Curves









High-Efficiency Optical Coatings

Teledyne Princeton Instruments operates its own state-of-the-art coating laboratory, Teledyne Acton Optics, which provides high-efficiency mirrors and coatings for use in the UV, VIS, and NIR. The coating facility is renowned for producing some of the highest-efficiency UV mirrors and coatings commercially available. Acton coatings are utilized by industrial customers, universities, space agencies, and government research facilities worldwide.

This exclusive coating capability enhances the performance of Teledyne Princeton Instruments spectrographs and monochromators. Whether the broadband performance of the Acton #1900 enhanced aluminum or the superior VIS-NIR reflectance of the Acton protected silver is selected, maximum throughput is ensured!

A Coating options for Teledyne Princeton Instruments spectrographs and monochromators

The standard coating provided with IsoPlane spectrographs and monochromators is the #1900 enhanced aluminum. Silver and gold coatings are available as an option.

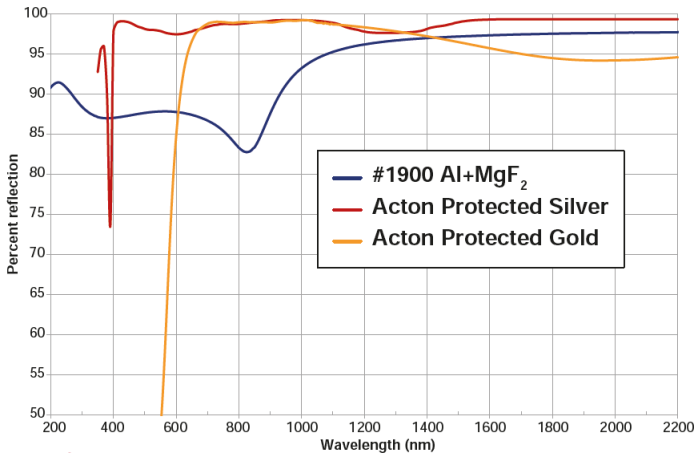
B Acton #1900 UV-enhanced Al+MgF2 vs. bare aluminum

The Acton #1900 coating provides superior reflection in the UV compared to conventional aluminum coatings. At 200 nm, reflection throughput can be up to 1.65x greater with exclusive Teledyne Princeton Instruments coatings. Calculated reflection at 200 nm shows that the #1900 coating will have 1.65x greater light throughput than aluminum after only three reflections!

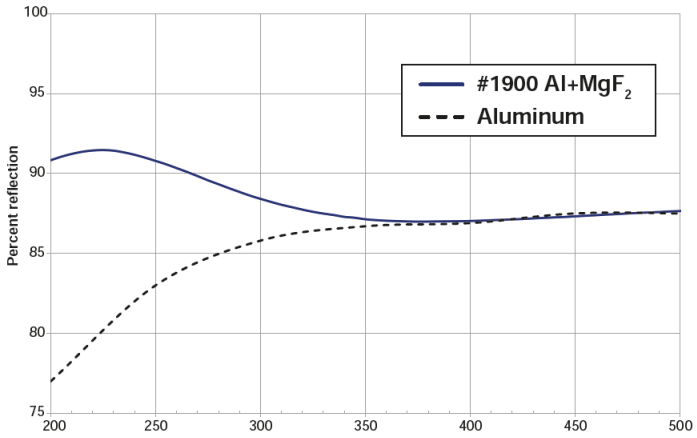
C Acton protected silver vs. conventional protected silver

Acton protected silver actually enhances reflectance (and light throughput) down to 400 nm whereas conventional silver absorbs significantly. After only three reflections, calculated throughput at 400 nm using Acton protected silver can be ~1.48x greater than conventional protected silver coatings.

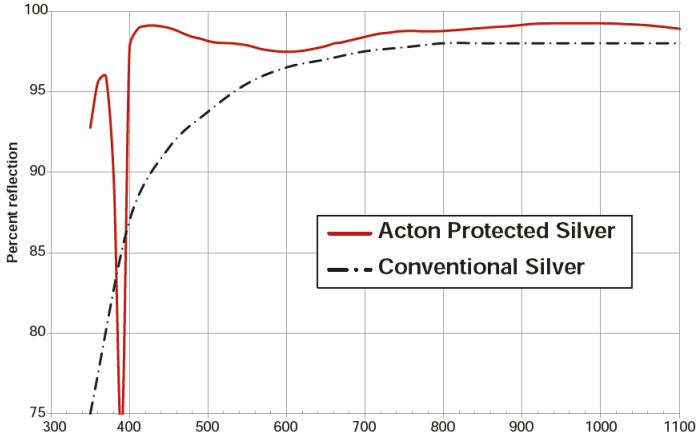
A Coating Options for Teledyne Princeton Instruments Spectrographs and Monochromators



B Acton #1900 UV-Enhanced Al+MgF² vs. Bare Aluminium



C Acton Protected Silver vs. Conventional Protected Silver



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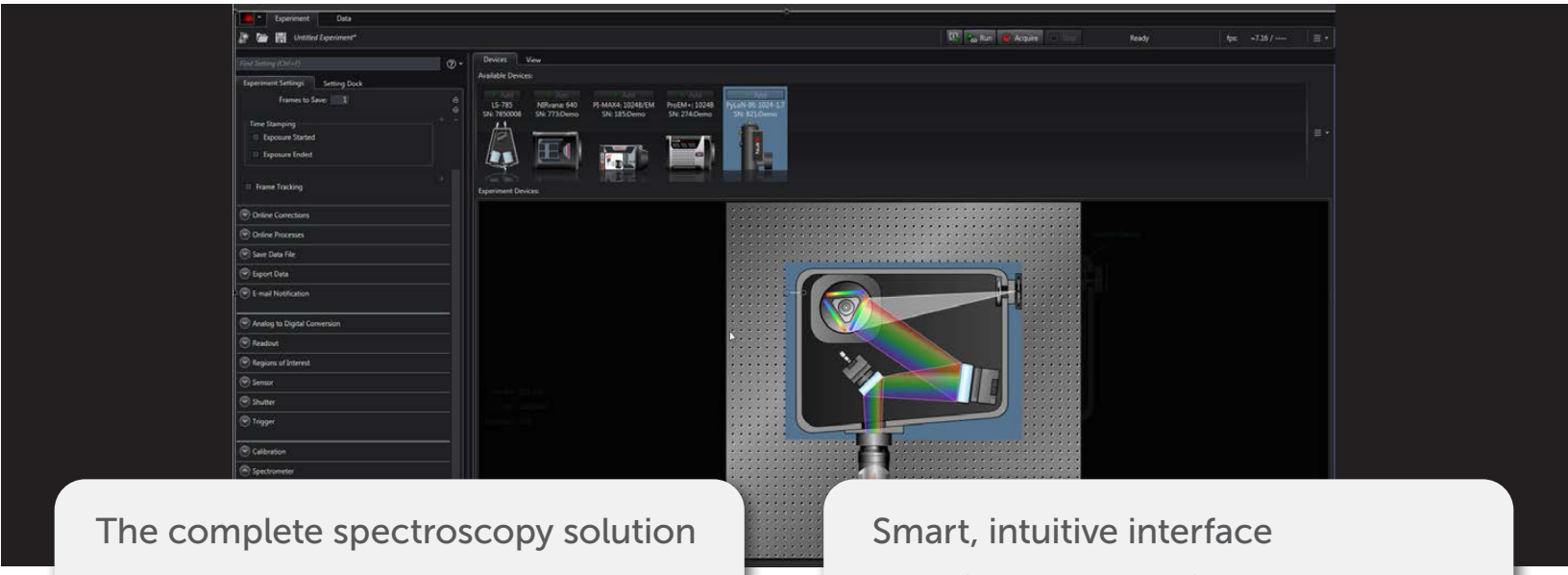
LightField®

Powerful functionality combined with easy-to-use interface and support for third-party software integration



The complete spectroscopy solution

Teledyne Princeton Instruments LightField is an intelligent and easy-to- use software package loaded with powerful features. This "command center" provides complete control of the entire spectroscopy system and experiment: the IsoPlane, Teledyne Princeton Instruments array detector, spectral acquisition, data processing, and more.

Smart, intuitive interface

LightField's plug-and-play interface makes it easy to add hardware. Simply plug in the USB or GigE cable and LightField automatically adds the device. Unplug the cable and LightField removes the device. When a camera or spectrometer is connected, LightField automatically recognizes Teledyne Princeton Instruments hardware and sets up all the controls required.

The 64-bit software's intuitive user interface puts everything right at the researcher's fingertips. Either select experimental controls from the convenient pull-down menus or use "smart search" to find whatever's needed.

Features for spectroscopy

- Shutter control
- Sensor temperature
- Spectrometer center wavelength
- Step-and-glue
- Grating selection
- Background correction
- Multiple regions of interest (ROI)
- Find center wavelength
- Time stamping
- SuperSynchro timing for PI-MAX4 ICCDs and time-resolved measurements
- Powerful data acquisition and processing features
- Data display (spectra, images, spectra plus images, spectral overlays, zoom)
- Formulas (select from pre-defined formulas or customize)
- Synchronize spectra with images for dynamic evaluation of data
- Works seamlessly with IntelliCal to enable accurate
- wavelength and intensity calibration

Software Flexibility

Many spectroscopy experiments need flexibility - and the IsoPlane is a perfect fit:

- Microsoft® Windows® 10 or Linux® 64-bit operating system support
- Seamless integration of controls and data acquisition into MATLAB®
- (MathWorks), LabVIEW® (National Instruments), ASCOM, Maxim
- DL™ (Cyanogen Imaging), and Python®
- SDK / API compatible with Microsoft Windows and Linux

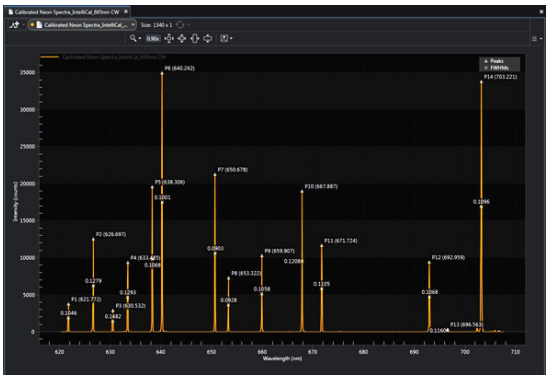
IntelliCal®

Automated wavelength and intensity calibration boosts data confidence with the push of a button

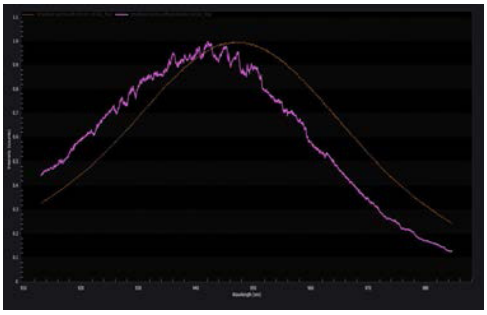
Teledyne Princeton Instruments IntelliCal is one of the most important tools for IsoPlane spectrographs, enabling wavelength and intensity calibration that are essential to the success of spectroscopic applications. With IntelliCal, calibration is fast and easy.

IntelliCal wavelength calibration achieves up to 10x greater wavelength calibration accuracy than conventional calibration methods, while IntelliCal intensity calibration removes unwanted instrument responses from spectral data. IsoPlane spectrographs with IntelliCal ensure authentic spectroscopic data that can be published or shared across multiple user facilities.

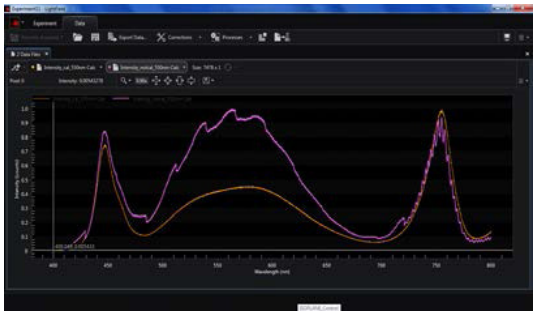
IntelliCal calibration light sources can be mounted directly to the IsoPlane entrance slit, or can be used at the sample/source location.



IntelliCal calibrates wavelength for every pixel across the CCD. The result is greater accuracy across the entire wavelength region of interest.



Intensity calibration eliminates system artifacts to show the correct spectral response of the light source or sample.



Intensity calibration can eliminate fringe patterns (etaloning), fixed pattern detector noise, and other instrument artifacts that can degrade spectral data.

ResXtreme Spectral Deconvolution Improves Spectral and Spatial Resolution and Peak Intensity

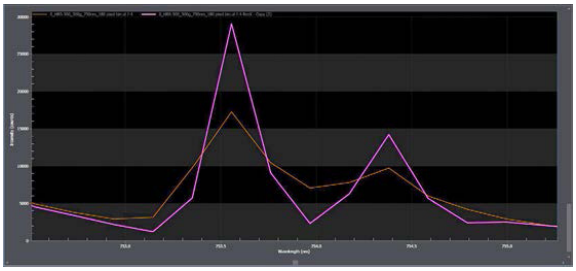
Introducing ResXtreme, Teledyne Princeton Instruments' exclusive 2D spectral deconvolution technology developed specifically to optimize the performance of IsoPlane spectrographs.

ResXtreme is based on the proven and widely accepted Richardson-Lucy deconvolution algorithm. It knows the point spread function (PSF) of IsoPlane spectrographs at all focal plane positions, all wavelengths, available gratings, and a variety of aperture ratios. It intelligently utilizes this information to dramatically improve spectral and imaging resolution. With the push of a button, ResXtreme enables up to a 60% improvement in spectral resolution as well as increased peak intensities across the 2D focal plane. Because ResXtreme works across the entire CCD, signal-to-noise performance is improved no matter where the source is positioned on the detector. Exclusive ResXtreme is included with all IsoPlane spectrographs that are purchased with Teledyne Princeton Instruments LightField software!*

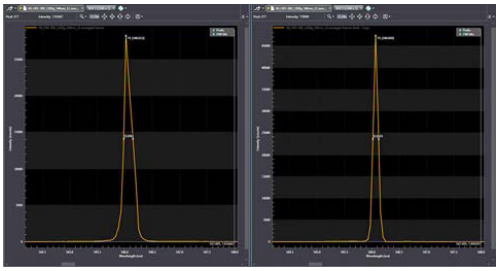
ResXtreme features

New ResXtreme technology offers the following advantages:

- Improves spectral resolution by up to 60%
- Improves peak intensity of spectral lines by up to 60%
- Provides up to a 60% improvement in spectral uniformity at all CCD positions
- Conservation of energy... maintains total signal under the peak
- Improves signal-to-noise performance
- Saves original spectral information, allowing data to be recalled without ResXtreme
- Based on proven, widely accepted Richardson-Lucy deconvolution algorithm

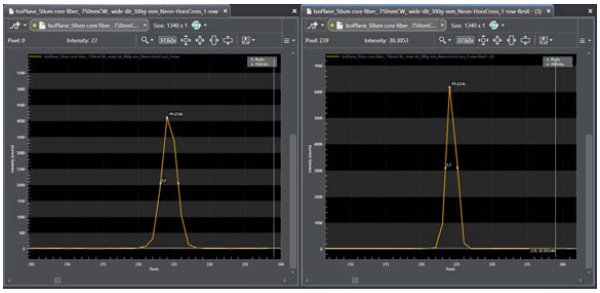


ResXtreme uses powerful spectral 2D deconvolution to improve spectral resolution and signal-to-noise capabilities.

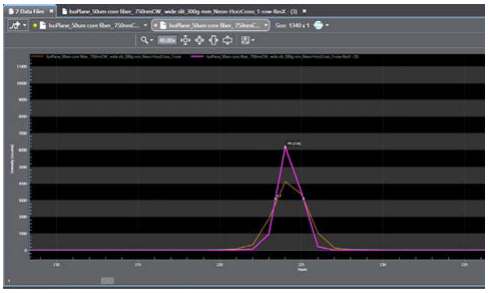


Resolution before ResXtreme: 0.1663 nm

After ResXtreme: 0.1024 nm



ResXtreme Control Panel: The convenient ResXtreme Preview function displays how much improvement is possible based on a number of variables, including aperture ratio, signal-to-noise ratio, and sharpness.



In this example, spectral resolution improves from 0.0934 nm to 0.0615 nm after ResXtreme. (IsoPlane 320, 1200 g/mm grating, ProEM-HS:1K EMCCD with 10 µm pixels.)

Scientific-Grade Cameras Provide Unmatched Performance

PIXIS

Low-Noise CCD and X-Ray Cameras

High Performance Imaging

PIXIS

HIGH-PERFORMANCE CCD CAMERAS

MULTICHANNEL ARRAY

High-QE, low-noise PIXIS cameras are ideal for spectroscopy applications from the deep UV to NIR spectral regions. Utilizing Teledyne Princeton Instruments' XP cooling technology, PIXIS cameras provide deep cooling for low noise plus an all-metal vacuum seal with a lifetime vacuum guarantee for peace of mind. These proven cameras are available with proprietary eXcelon technology for a dramatic increase in sensitivity with excellent suppression of etalon interference fringes common to back-illuminated sensors in the NIR.

- Highest sensitivity from 120 nm to 1100 nm
- Wide variety of CCD array sizes
- All-metal seals with permanent vacuum guarantee
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

BLAZE

ArcTec™ Cooled CCD Spectroscopy Camera

High NIR Sensitivity

BLAZE®

NEXT-GENERATION CCD CAMERAS

MULTICHANNEL ARRAY

Highly advanced BLAZE CCD cameras for spectroscopy integrate low-noise electronics and proprietary ArcTec thermoelectric cooling technology to allow air-cooled operation down to -95ºC (-100ºC with 20ºC water). Proprietary sensors with multiport readout allow these cameras to operate at spectral rates greater than 16 MHz. The speed and sensitivity of BLAZE cameras make them ideal for a wide range of demanding spectroscopic applications.

- Dual 16 MHz readout ports for highest spectral rates
- Exclusive ArcTec technology for deep cooling and low dark current
  - » Cools to -95ºC with air, without chillers or cryo-coolers
- Exclusive new sensor technology
  - » **LD-Sensors:** IMO deep-depletion devices for low dark current and excellent broadband performance
  - » **HR-Sensors:** Unmatched quantum efficiency in the near infrared! Up to 75% QE @ 1000 nm!

PyLoN

Cryogenically Cooled CCD Cameras

Wide Spectral Coverage

PyLoN®

ULTRA-LOW-NOISE CCD CAMERAS

MULTICHANNEL ARRAY

Cryogenically cooled, ultra-low-noise PyLoN cameras include all the essentials for low-light spectroscopy applications. With dark current levels at 0.3 e-/pixel/hour, these cameras are ideal for photon-starved applications that require long exposure times (i.e., minutes to hours). PyLoN cameras are available with eXcelon sensor technology to boost sensitivity and reduce etalon interference fringes.

- Sensitivity from 120 nm to 1100 nm
- CCD cooled with LN2 down to -120ºC
- Flexible readout speeds from 50 kHz to 4 MHz
- Digital correlated double sampling and bias stabilization
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

PyLoN-IR

Cryogenically Cooled InGaAs Cameras

Wide NIR Spectral Coverage

PyLoN-IR

InGaAs CAMERAS

LINEAR ARRAY

Cryogenically cooled PyLoN-IR linear InGaAs cameras are a superb choice for NIR and SWIR spectroscopy. The photodiode array (PDA) detectors supported by this platform provide exceptional sensitivity from 0.8 µm to 1.7 µm or from 1.0 µm to 2.2 µm, respectively. Benefits include the fastest spectral rate and lowest system read noise of any deep-cooled InGaAs camera, 16-bit digitization, and the use of indium metal seals to extend vacuum longevity. An integrated cryogenic cold shield reduces ambient thermal noise by increasing background rejection.

- Highest NIR and SWIR sensitivity
- Greatly reduced dark current
- Up to 6600 spectra/sec
- 16-bit digitization
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

TELEDYNE IMAGING
Everywhereyoulook™

Scientific-Grade Cameras Provide Unmatched Performance

NIRvana Family

Cooled InGaAs Cameras

High Speed NIR/SWIR Imaging

NIRvana®

2D InGaAs CAMERAS

MULTICHANNEL ARRAY

NIRvana cameras utilize a two-dimensional InGaAs focal plane array (FPA) detector optimized for NIR and SWIR spectroscopy. Thermoelectrically cooled NIRvana models provide high sensitivity from 0.9 µm to 1.7 µm; LN2 cooling reduces dark current even further while providing sensitivity from 0.9 µm to 1.55 µm. Camera benefits include flexible scan rates as well as low system read noise and 16-bit digitization for wide dynamic range.

- High sensitivity from 0.9 µm to 1.55 µm or 1.7 µm
- 640 x 512 InGaAs FPA with 20 µm2 pixel pitch
- Thermoelectrically cooled version achieves -85ºC
- Cryogenically cooled version achieves -190ºC
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

ProEM-HS

High Resolution EMCCD Cameras

eXcelon3 Technology

ProEM®-HS

HIGH-SENSITIVITY EMCCD CAMERAS

MULTICHANNEL ARRAY

Thermoelectrically cooled ProEM-HS cameras incorporate electron-multiplying CCDs (EMCCDs) with eXcelon3, a proprietary sensor technology that reduces etaloning while increasing sensitivity in the UV and NIR. EM gain enables these high-resolution, back-illuminated EMCCD cameras to deliver single-photon sensitivity. Sustained spectral rates of up to 20 kHz are achievable.

- Patented eXcelon3 technology for highest UV-to-NIR sensitivity
- Unique vacuum technology backed by a lifetime guarantee
- Spectra-kinetics mode and ultra-high-speed readout mode
- EM gain calibration via OptiCAL with built-in light source
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

PI-MAX4

ICCD and emICCD Cameras

<500 Picosecond Gating

PI-MAX®4

GATED ICCD & emICCD CAMERAS

MULTICHANNEL ARRAY

PI-MAX4 intensified CCD (ICCD) and intensified EMCCD (emICCD) cameras challenge the status quo in time-resolved spectroscopy applications. The PI-MAX4 camera platform offers high-precision gating capabilities to <500 psec, a sustained intensifier gating repetition rate of 1 MHz, the ability to perform frequency-domain measurements using RF modulation, and unsurpassed experimental control via LightField's unique, oscilloscope-like timing interface.

- Wide choice of front- and back-illuminated CCDs and EMCCDs
- World's first emICCD cameras offer single-photon sensitivity
- Broad selection of Gen II and filmless Gen III intensifiers
- Achieves sustained spectral rates of >10,000 spectra/sec
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

Kuro

Back-Illumnated sCMOS Cameras

High Speed, Low Noise

KURO®

BACK-ILLUMINATED sCMOS CAMERAS

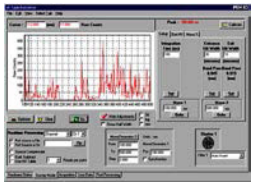
MULTICHANNEL ARRAY

KURO is the world's first scientific CMOS camera platform to implement back-illuminated sensor technology. Optimized for spectroscopy, KURO cameras deliver both the high frame rates of front-illuminated CMOS cameras and the exceptional sensitivity of back-illuminated CCD cameras. Unlike front-illuminated CMOS cameras, no microlenses are needed to redirect light into the sensor's pixels. The fixed pattern noise is also greatly reduced.

- Back-illuminated sCMOS detector (>95% peak QE)
- Large pixels and wide dynamic range
- Very high speed and very low read noise
- TTL output signals and flexible trigger modes
- Fully compatible with all IsoPlane spectrographs
- Seamlessly integrated into LightField data acquisition and control software

TELEDYNE IMAGING
Everywhereyoulook™

Single-Channel Light Detection Accessories



SpectraSense data acquisition software

SpectraSense is a spectral acquisition software package designed to work exclusively with Teledyne Princeton Instruments scanning monochromators, single-channel detectors, and related accessories. SpectraSense software controls and synchronizes monochromator scanning with data acquisition. It also allows control of important scan parameters such as integration time, wavelength scan range, scan step size, and more. Typical spectral scans include intensity vs. wavelength, intensity vs. time, reflection, transmission, and absorption. Data can be saved, printed, or recalled for post-processing.

Detector Interface/Readout System

SpectraHub

This detector interface/readout system is designed for single-channel detector applications and includes RS-232 and USB interfaces, and 12 VDC power. SpectraHub requires SpectraSense software, a scanning monochromator, and a single-channel detector for operation. SpectraHub is required for operation of all single-point detectors except those that require lock-in amplifiers.

PMT power supply
PHV-400

This high-voltage power supply, 0 to 1500 V, is designed for use with Teledyne Princeton Instruments PMTs (P1, P2, P3) and PMT housings (PD-438, PD-439).

NOTE: *All single-channel detectors require SpectraHub readout system and SpectraSense software for operation.*

Silicon detector
SI-440

This silicon detector has a 10 mm diameter active area and is provided with a housing that includes BNC signal connector and mounting flange. It offers IsoPlane users' sensitivity from 400 to 1100 nm.

UV-enhanced silicon detector
SI-440-UV

This UV-enhanced silicon detector has a 10 mm diameter active area and is provided with a housing that includes BNC signal connector and mounting flange. It offers IsoPlane users sensitivity from 200 to 1110 nm.

PMT detector housing
PD-438

This universal PMT detector housing mounts to the IsoPlane slit assembly. It requires a 1 1/8 side-window PMT and a high-voltage power supply for operation.

Integrated PMT detector housing
PD-471

This integrated PMT detector housing has a built-in high-voltage power supply (0 to 1000 V) and mounts to the IsoPlane slit assembly. It requires a 1 1/8 side-window PMT (P1, P2, P3), SpectraHub, and SpectraSense for operation.

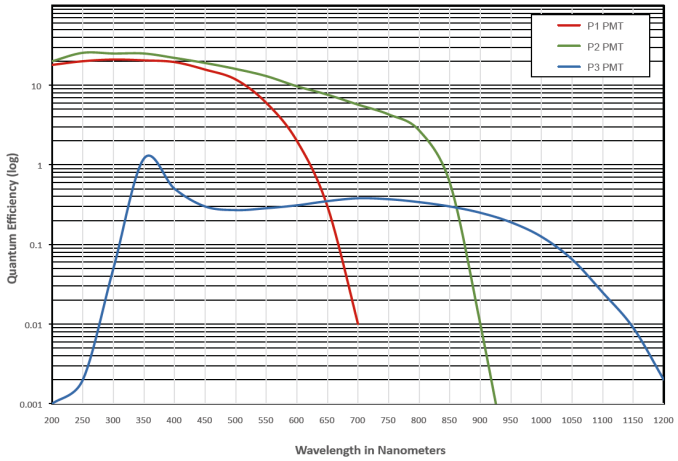
PMT detector housing with shutter
PD-439

This universal PMT detector housing mounts to the IsoPlane slit assembly. It requires a 1 1/8 side-window PMT and a high-voltage power supply for operation.

Single-Channel Light Detection Accessories

Photomultiplier tube (PMT)
P1 / P2 / P3

Three 1 1/8 side-window photomultiplier tubes are available for the IsoPlane. Each requires a housing and a power supply for operation.
P1: sensitivity from 190 to 650 nm
P2: sensitivity from 190 to 900 nm
P3: sensitivity from 300 to 1100 nm

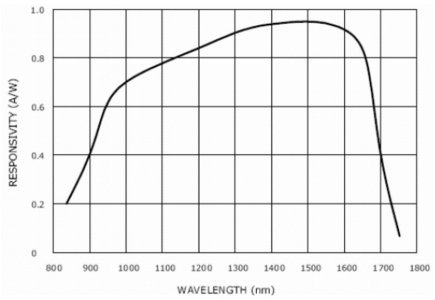


Integrated photon-counting detector system
PD-473-1

This integrated photon-counting detector system is designed for use in the range from 185 to 850 nm and includes a PMT, amplifier/discriminator, and built-in high-voltage power supply. It mounts on the IsoPlane slit assembly. SpectraHub and SpectraSense are required for operation.

Solid-state infrared detectors: InGaAs

Teledyne Princeton Instruments offers two InGaAs detectors covering the wavelength region extending from 800 nm to 1700 nm, in cooled and uncooled versions. Both require SpectraHub readout system and SpectraSense software for operation.



Solid-state InGaAs detector
ID-441

This is an uncooled single-channel InGaAs detector with pre-amplifier for 800 to 1700 nm.

Solid-state, cooled InGaAs detector
ID-441-C

This cooled InGaAs detector with pre-amplifier for 800 to 1700 nm requires a 442-1A TE-cooler controller for cooled operation.

Light Input

Fixed-position fiber adapter
FC-446-010

This fixed-position fiber adapter is designed for general light input to a spectrograph and is not intended for imaging applications. It mounts directly to IsoPlane spectrograph slit assemblies. Optional FC-446-010-FC for fibers with FC-connectors, FC-446-010-SMA for fibers with SMA-905 connectors.

Note: This adapter cannot be used with motorized slit assemblies.

Adjustable fiber adapter
FC-446-020

This adjustable fiber adapter is designed to hold 10 mm diameter fiber bundles directly at the entrance slit of the IsoPlane. It includes a spring-loaded slide mechanism that facilitates precise horizontal alignment of the fibers to the slit opening. Thumb screws on each side control horizontal adjustment. Optional FC-446-020-FC for fibers with FC-connectors, FC-446-020-SMA for fibers with SMA-905 connectors.

Universal fiber coupler
FC-446-021-U

This versatile universal fiber coupler features X-Y micrometer control, 0.12 inches (3 mm) of travel, an interchangeable 10 mm diameter ferrule, an SMA 905 connector, and FC inserts. A slit baffle is included for use with the IsoPlane. Highly recommended for coupling fibers to IsoPlane spectrographs.

Imaging fiber adapter
FC-446-030-U

The imaging fiber adapter refocuses fiberoptic input and is designed for use with filter wheels or other devices placed between the fiber end and the IsoPlane entrance slit. The adapter accepts fiber bundles with FC/PC, SMA-905 or 10mm diameter ferrules and provides horizontal and vertical alignment capabilities. The all-reflective design eliminates chromatic aberrations and the aspheric mirror cancels astigmatism, allowing precise imaging of fibers to the spectrograph entrance slit. There is also a 0.75" (19 mm) thick removable spacer to allow use with filter wheels or other accessories.

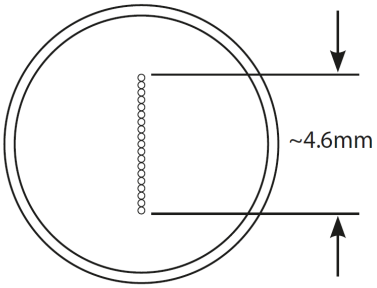
Raman filter chamber
ARC-446-070

The Raman filter chamber offers an efficient and easy method for using Raman or edge filters with the IsoPlane spectrograph. The chamber collects the output of fibers and collimates the beam, which passes through the filter. A second lens focuses the beam on the entrance slit of the IsoPlane. The chamber includes an adapter for 1.0" (25.4 mm) filters. A micrometer controls the filter angle from 0 to 10° for precise rejection of unwanted Raleigh scatter. The chamber can also accept non-fiber sources or focused sample images.

Sample chamber
SC-447

The sample chamber features ports with light-tight covers and two quartz lenses. It includes one mounting port for the IsoPlane entrance/exit slit, and two mounting ports for light sources or detection. Requires sample holder.

Fiberoptic Bundles



Single-leg fiber bundles (190–1100 nm)

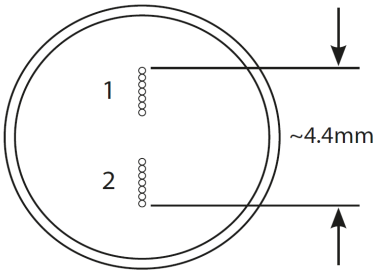
LG-455-020-1 / LG-455-020-3

This single-leg fiberoptic bundle is designed for use with the IsoPlane when working in the wavelength range from 190 to 1100 nm. It comprises nineteen 200 µm fibers and has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the light source input end to a line (column) at the output (slit) end. The bundle is available with a length of either 1 meter (LG-455-020-1) or 3 meters (LG-455-020-3).

Single-leg fiber bundles (400–2200 nm)

LG-456-020-1 / LG-456-020-3

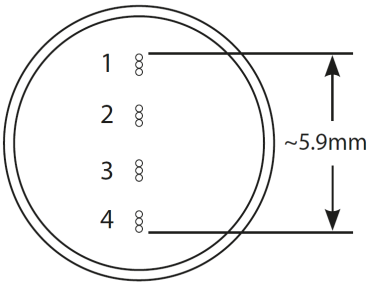
This single-leg fiberoptic bundle is designed for use with the IsoPlane when working in the wavelength range from 400 to 2200 nm. It comprises nineteen 200 µm fibers and has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the light source input end to a line (column) at the output (slit) end. The bundle is available with a length of either 1 meter (LG-456-020-1) or 3 meters (LG-456-020-3).



Two-leg fiber bundle

BFB-455-7

The two-leg fiberoptic bundle is 1 meter long with seven 200 µm fibers per leg. Designed for use with the IsoPlane when working in the wavelength range from 190 to 1100 nm, it has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the two light source input ends to a line (column) at the common output end, with ~1 mm spacing between fiber groups. See illustration.



Four-leg fiber bundle

QFB-455-3

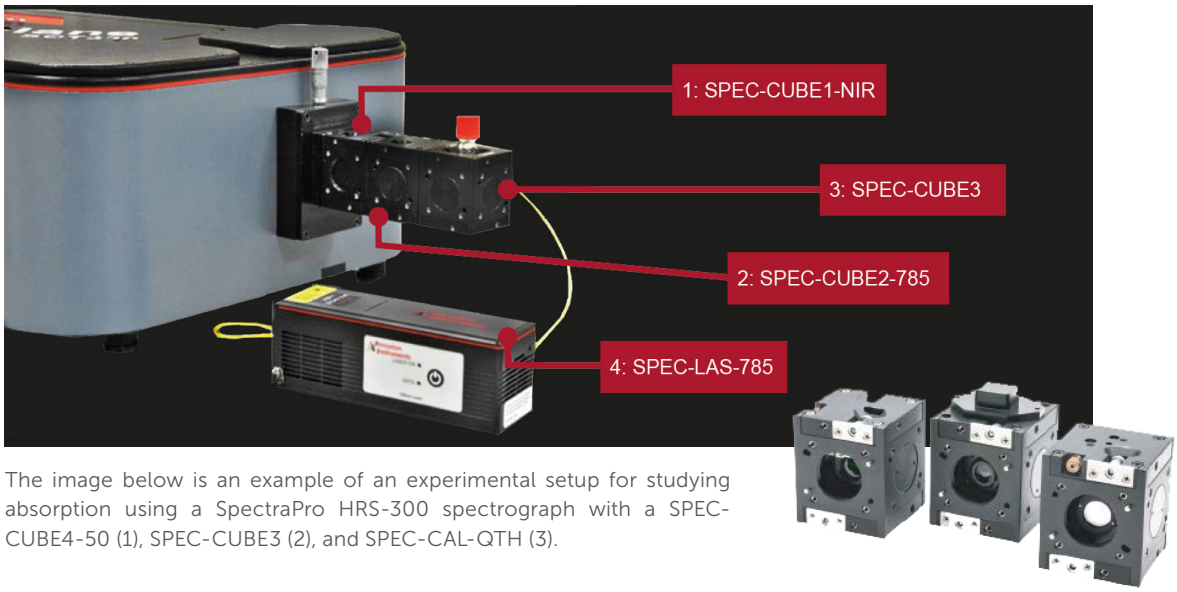
The four-leg fiberoptic bundle is 1 meter long with three 200 µm fibers per leg. Designed for use with the IsoPlane when working in the wavelength range from 190 to 1100 nm, it has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at each of the four light source input ends to a line (column) at the common output end, with ~1 mm spacing between each fiber group.

Custom fibers available on request

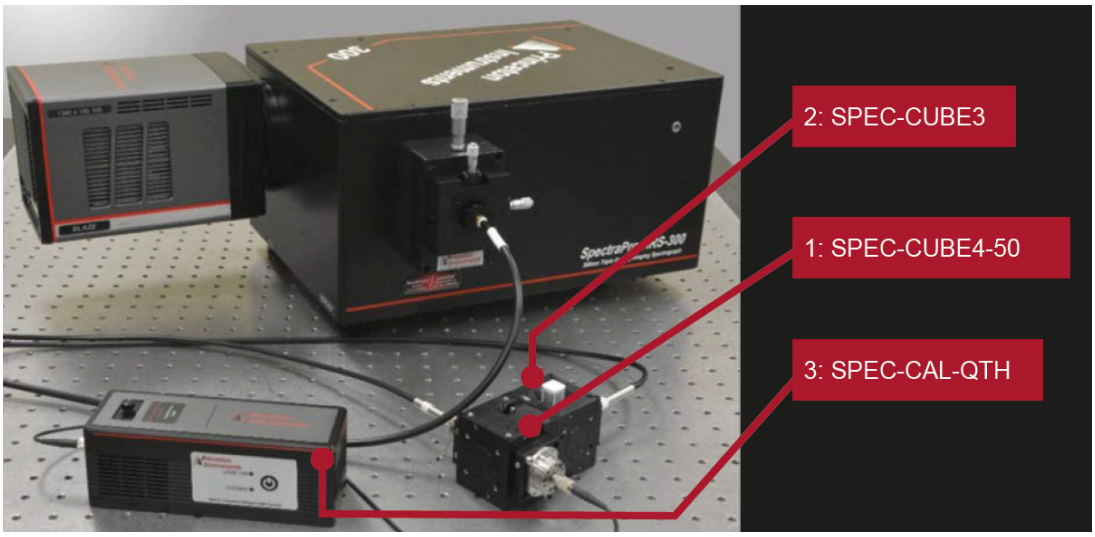
Application CUBES and Accessories

Teledyne Princeton Instruments offers a comprehensive series of spectroscopy accessories that provide integrated solutions compatible with our wide selection of spectrographs, including SpectraPro®, SpectraPro HRS, and all IsoPlane spectrographs. These accessories afford users flexibility to conduct a variety of applications, such as Raman, absorption, transmission, photoluminescence, and fluorescence, among others.

The image below shows an experimental setup using an IsoPlane 320 spectrograph with a SPEC-CUBE1-NIR (1). SPEC-CUBE2-785 (2), SPEC-CUBE3 (3), and SPEC-LAS-785 (4). This setup provides an integrated solution to study Raman spectra of samples in a cuvette.

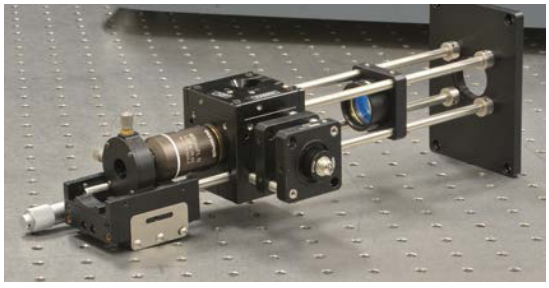


The image below is an example of an experimental setup for studying absorption using a SpectraPro HRS-300 spectrograph with a SPEC-CUBE4-50 (1), SPEC-CUBE3 (2), and SPEC-CAL-QTH (3).



Application CUBES and Accessories

Part Number	Description
CAGE-SPEC	Adapter plate and 30 mm cage mount to entrance slit. Compatible with IsoPlane, SpectraPro, SpectraPro HRS, and LS-785 spectrometers.
SPEC-CUBE1-UV	Focusing CUBE for PI spectroscopy products, including SpectraPro HRS, SpectraPro, and IsoPlane. Contains achromatic doublet for focusing incoming light onto the slit. Precision X-Z stage for fine focus and slit alignment. Optimized for UV (250 to 425 nm). Includes adapter for mounting cube assembly to HRS/SP-Series and IsoPlane-Series entrance slit
SPEC-CUBE1-VIS	Focusing CUBE for PI spectroscopy products, including SpectraPro HRS, SpectraPro, and IsoPlane. Contains achromatic doublet for focusing incoming light onto the slit. Precision X-Z stage for fine focus and slit alignment. Optimized for VIS (400 to 700 nm).
SPEC-CUBE1-NIR	Focusing CUBE for PI spectroscopy products, including SpectraPro HRS, SpectraPro, and IsoPlane. Contains achromatic doublet for focusing incoming light onto the slit. Precision X-Z stage for fine focus and slit alignment. Optimized for NIR (650 to 1050 nm).
SPEC-CAL-QTH	QTH calibration lamp • Allows automated relative intensity calibration • Stabilized optical output • NIST traceable • USB interface
SPEC-CUBE2-785	Raman filter CUBE (785 nm) • Contains mounted 785 nm narrowband laser line filter, PI long-pass dichroic filter (127 cm-1 edge), and matching edge filter (OD 6) with precision built-in angle tuning adjustment • Optimized for 785 nm Raman spectroscopy
SPEC-CUBE3	Sample chamber CUBE • Contains two lenses and four optical ports • Contains sample chamber for 12.5 mm cuvette (not included) and light cover
SPEC-CUBE4-50	Beam splitter CUBE • Allows splitting of beam paths in 50:50 optical ratios without beam walk off • Contains precisely aligned and mounted non-polarizing cubic beam splitter
SPEC-CUBE4-70	Beam splitter CUBE • Allows splitting of beam paths in 70:30 optical ratios without beam walk off • Contains precisely aligned and mounted non-polarizing cubic beam splitter
SPEC-CUBE4-90	Beam splitter CUBE • Allows splitting of beam paths in 90:10 optical ratios without beam walk off • Contains precisely aligned and mounted non-polarizing cubic beam splitter
SPEC-CUBE5	Filter CUBE • Three-position CUBE for 1/2-inch-diameter filters • Filters not included
SPEC-FIBER-LAS	Laser excitation fiber • 105 µm multimode fiber for coupling excitation light from laser
SPEC-FIBER-PTH	Fiber patch cable 400 µm multimode fiber for coupling light from QTH lamp for absorption/ transmission spectroscopy
SPEC-LAS-785	Wavelength-stabilized multimode 785 nm laser • Fiber coupled • 475 mW power, narrow laser line, ideal for Raman spectroscopy



Light Sources

IntelliCal Atomic Emission (AE) light source

This compact USB-powered AE light source features high stability and spectral line output useful for wavelength calibration. The IntelliCal AE light source includes both Hg and Ne-Ar lamps in a housing designed for mounting to the entrance slit of IsoPlane spectrographs. It includes a toggle switch for lamp selection and a handy reference chart with available emission lines. When used with a Teledyne Princeton Instruments spectrograph, CCD, and LightField software, this versatile light source enables precise, automated wavelength calibration.

Deuterium light sources

DS-421 / DS-421-220

The 30 watt deuterium light source provides a useful UV continuum from ~190 nm to ~350 nm for the IsoPlane. Negligible visible light output helps minimize stray light. A 110 V or 220 V light source is available.

Quartz Tungsten-Halogen (QTH) light sources

TS-425

The 30 watt QTH light source with DC power supply provides output from ~350 nm to more than 2.5 µm.

TS-428

This 250 watt QTH light source includes variable brightness control, forced-air cooling, and AC power supply.

TS-428-DC

This 250 watt QTH light source features a regulated DC power supply plus variable brightness control and forced-air cooling.

Deuterium & Tungsten-Halogen light sources

TDS-429 / TDS-429-220

The dual light source combines 30 watt deuterium and tungsten-halogen lamps in the same housing for output useful from 190 nm to 2.5 µm. It includes a manually controlled source-selection mirror, power supplies (either 110 V or 220 V), and a forced-air cooling fan.

Xenon light source

XS-432

The 75 watt xenon light source features broad wavelength output from the UV to IR. The advantage of a xenon light source is the small light emission area, which permits efficient light delivery to a monochromator or spectrograph. The XS-432 light source provides a bright continuum from 190 to 750 nm with declining output out to 2.7 µm.

Filter Wheel Assemblies

Motorized filter wheels

FA-2448

Motorized six-position filter wheel for 1.0" (25.4 mm) diameter samples with stepping motor and controller, plus RS-232 interface for computer-controlled filter indexing. Filters not included.

FA-2448-1

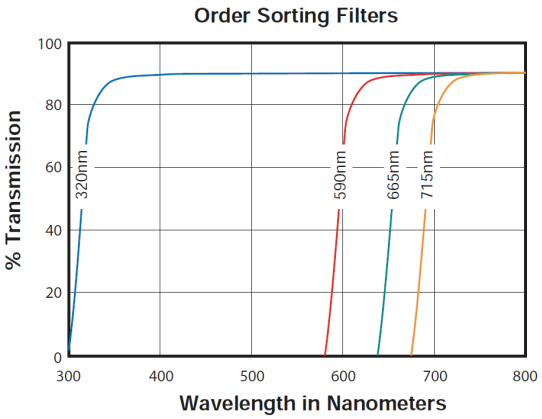
Motorized six-position order sorting filter wheel. Includes 320 nm, 590 nm, 665 nm, and 715 nm order sorting filter set in motorized filter wheel assembly

Motorized filter wheels are controlled by computer through the IsoPlane interface panel.

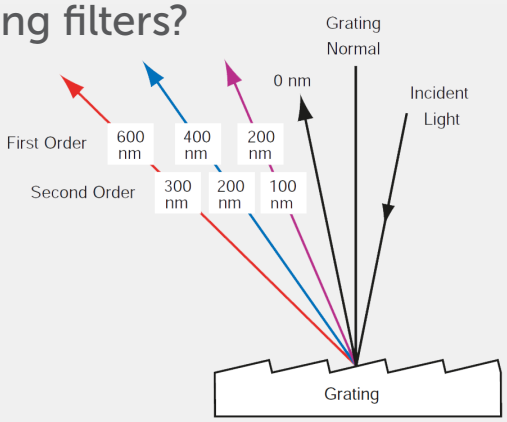
Filter set

FA-2448-F

This standalone filter set is compatible with the FA series of filter wheels available for the IsoPlane (described above). The set consists of 1.0" (25.4 mm) diameter cut-off filters at 320 nm, 590 nm, 665 nm, and 715 nm.

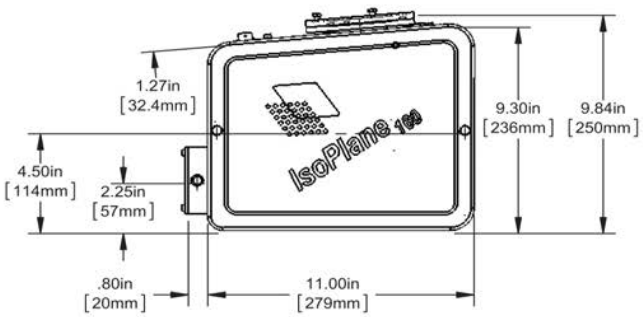


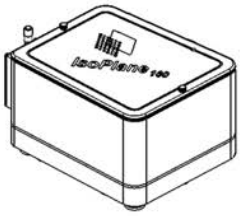
Why do I need order sorting filters?

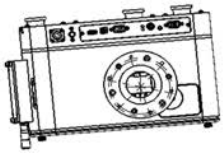


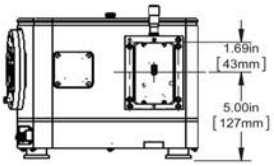
Diffraction gratings produce multiple orders of diffracted light where constructive interference permits light of one wavelength to appear at more than one angle of diffraction. This superposition of wavelengths can lead to ambiguous spectral data because the detector cannot normally distinguish between light of either wavelength. Order sorting filter sets are designed to eliminate unwanted second order radiation.

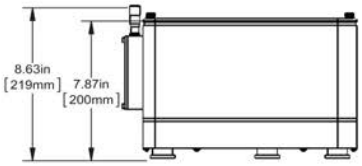
IsoPlane 160 Outline Drawings

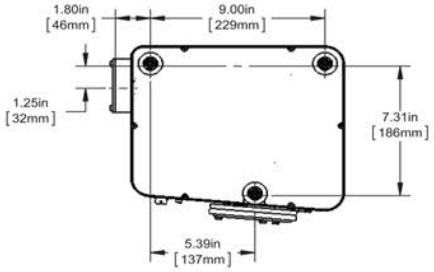




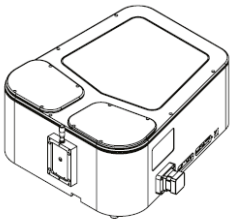


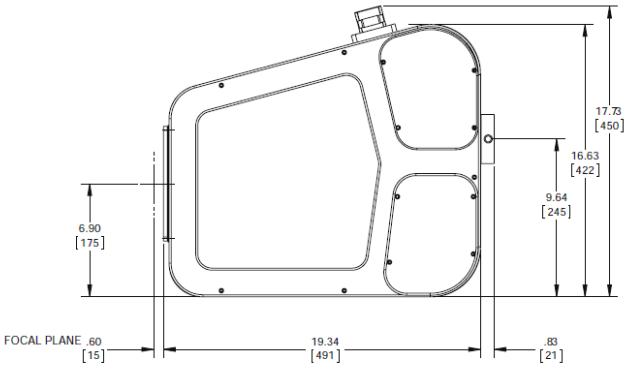


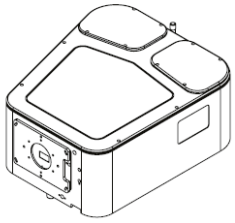


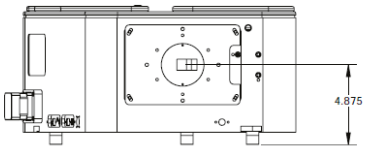


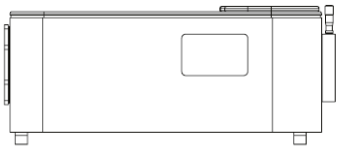
IsoPlane 320 and 320A Outline Drawings

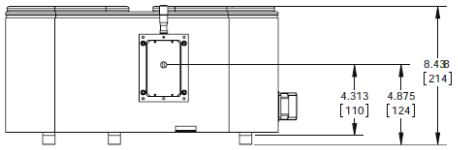












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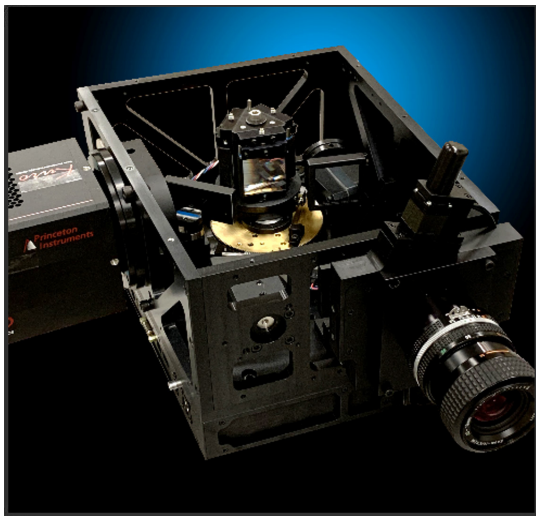

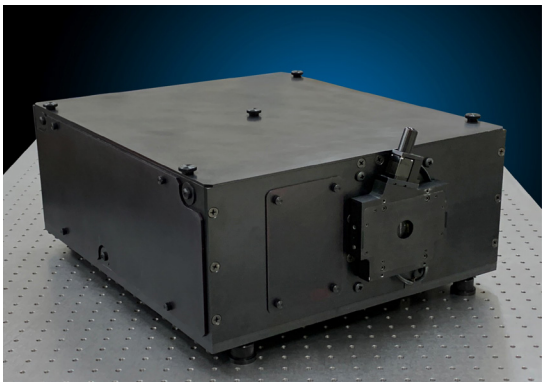

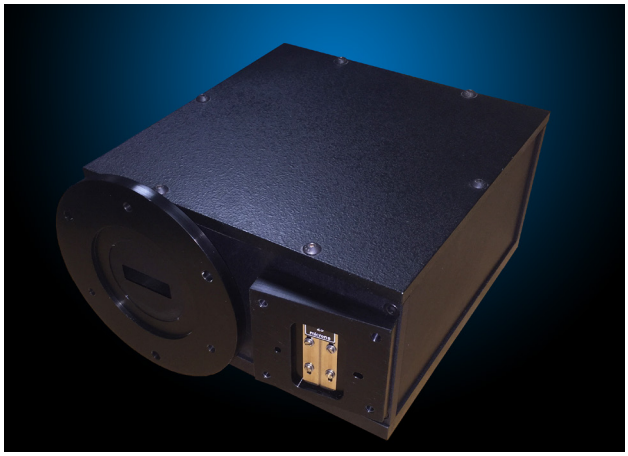

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