Since 1953

Master Catalog

Spectrometers, Monochromators & Spectrographs
Soft X-ray
Extreme Ultraviolet
Vacuum Ultraviolet
Deep UV
Ultraviolet
Visible
Near Infrared
Mid-wave Infrared
Long-wave Infrared

Spectral analysis systems
Astrophysics Calibration
Atomic Emission in Vacuum UV
Cathodoluminescence Microscopy
Chemiluminescence
Double Spectrometers for Radiometry
Fluorescence, Steady State and Dynamic Flow
High Throughput Spectrometers
Imaging Spectrometers
Photoluminescence
Phosphorescence
Raman, Triple Stage Research Tools
Raman, Single Stage Analytical Tools
Reflectometry
Remote Spectral Sensing
Spectral Test Stations
Spectrophotometry UV-Visible and Infrared
Spectrophotometry Vacuum Ultraviolet
Micro Spectroscopy Cathodoluminescence
Ultrafast Compensated Path Spectrometers

Instruments Made to Measure Light, for a

You have choices when it comes to selecting tools to measure light. Our mission is to make your choice simple, to provide solutions for challenging spectroscopy applications, to deliver quality equipment you can rely on, and information to help make your buying decisions simple.

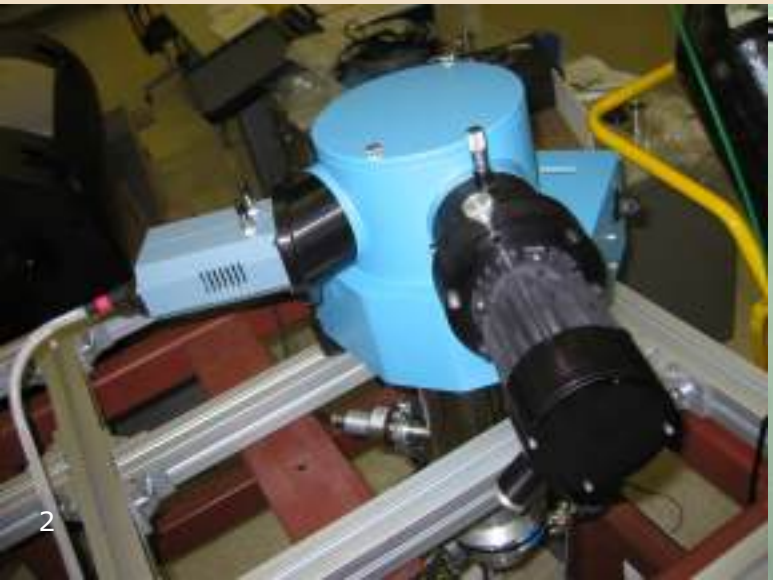
Solution oriented systems provide for fluorescence, Raman, luminescence, microscopy, thermonuclear fusion diagnostics, astrophysics calibration and more. You are the scientific experts. We hope to influence your work by delivering high quality, unique and effective instrumentation that improves every result.

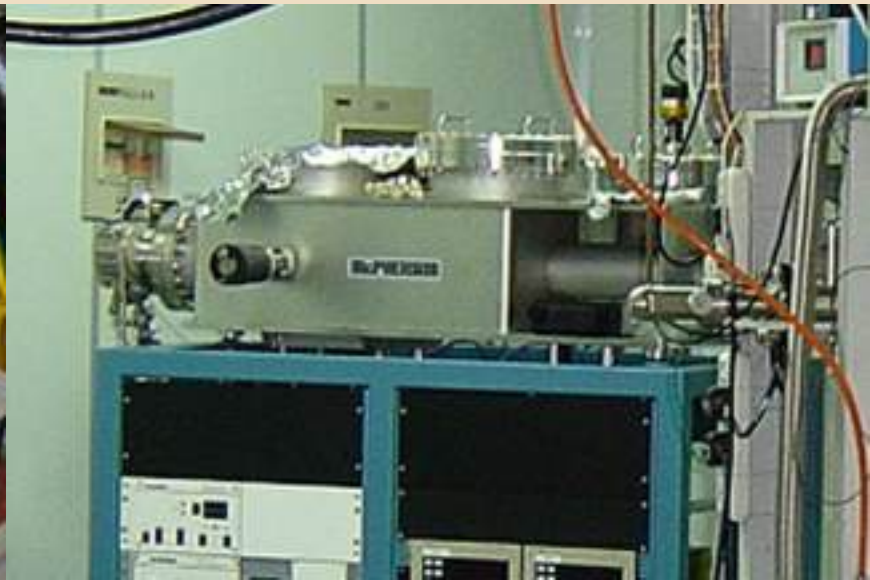
Application: **Raman Spectroscopy**
What to use: **Triple Spectrometer**

2035 Subtractive + Model 207 = UV capable, tunable, awesome rejection of scatter and phenomenal f/4.8 aperture. The best light gathering power.
(more about our Triple Monochromators on page 11)

Application: **Vacuum Ultraviolet Spectroscopy**
What to use: **234/302**

Model 234/302 simplifies work from 30-nm to the Visible. It is good all around. It's affordable and works with CCD & scanning detectors.
(more about our vacuum spectrometers on page 21)





World of Applications.

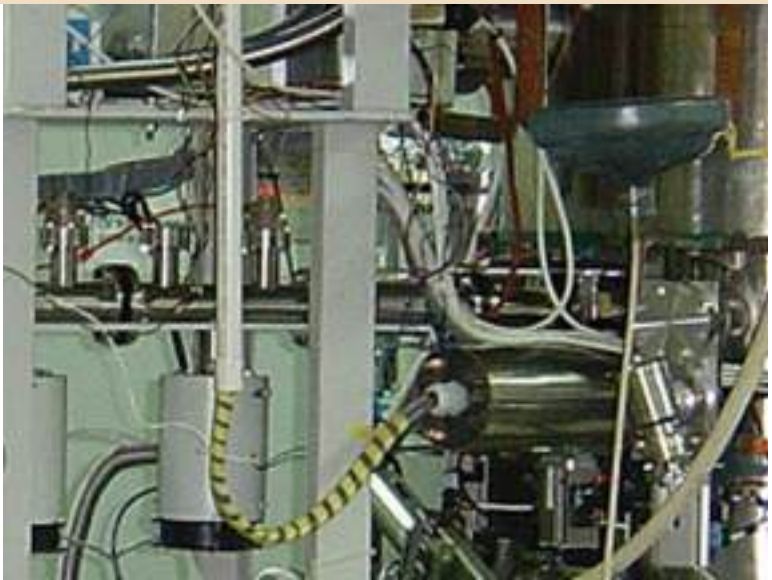
If you are a funded scientist who needs spectra, you've come to a good place. We hope to be working together soon.

Where to go: **www.McPhersonInc.com**

What you need: **www.McPhersonInc.com/allproducts**

Raman process, analytical and teaching applications benefit from simple, single stage spectrometers like our 2035. It delivers improved light throughput and lower cost. Coupled with broadly available CCD detectors and specialty filters, the 2035 simplifies Raman experiments.

Use the 1m 225 for high-resolution vacuum UV spectroscopy at experimental fusion reactors, synchrotron storage rings, with pulsed laser, EBIT, pinch and other energetic light sources. Plasma - the fourth state of matter - the 225 can help you learn more.



The 1.33meter focal length f/9 system brings better resolution and more dispersion. Excellent spectral resolution, very symmetrical line shape, and low scatter are features of the 209.

Our Best-Selling Monochromators.

Choose 350mm focal length f/4.8 for great spectral resolution (0.05-nm) and good throughput (f/4.8.) The compact housing is compatible with all accessories.

Vacuum compatible 200mm monochromator works from 30nm to the Visble. With up to three ports, available CCD mounts and clean construction it is the ideal instrument for the vacuum UV.

The go-to 1m instrument for high resolution plasma physics and material studies in the vacuum UV. Patented auto-focus, triple-grating turret, CCD mounts, multiple ports and clean, stainless steel construction are all found in the 225.

Table of Contents

McPherson, Inc.
7A Stuart Road, Chelmsford, MA 01824

1-978-256-4512 **www.McPhersonInc.com**

www.McPhersonInc.com/ Solutions

Systems for Spectroscopy

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/Double Monochromators
/Double Pass & Dispersion
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Monochromators, at a glance.

Ultraviolet, Visible & Infrared pp. 8 - 26

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Spectral Ranges

Electromagnetic radiation at wavelengths between the region of transistion to x-rays (about 1nm) and the region of transition to microwaves (about 1mm) is called optical radiation. Electromagnetic radiation in this range can be treated by optical methods (for example, imaged by mirrors, diffracted by gratings.) Radiation shorter than 200nm is strongly absorbed by the Oxygen and other atmospheric constituents. These wavelengths must be studied under vacuum or in very good purge environments. In the infrared, a measureable absorption occurs in the bands of water vapor, carbon dioxide and methane, among others. Vacuum or purge may be required depending on the exact region of interest.

Extreme Ultraviolet	XUV	1 to 100nm	124 to 12.4eV	$1*10^{8}$ to $1*10^{5}$ cm^{-1}
Vacuum Ultraviolet (UV-C)	VUV	100 to 200nm	12.4 to 6.2eV	$1*10^{5}$ to $5*10^{4}$ cm^{-1}
Far Ultraviolet (UV-C)	FUV	200 to 280nm	6.2 to 4.4eV	50,000 to 36,000 cm^{-1}
Middle Ultraviolet	UV-B	280 to 315nm	4.4 to 3.9eV	36,000 to 32,000 cm^{-1}
Near Ultraviolet	UV-A	315 to 380nm	3.9 to 3.3eV	32,000 to 26,000 cm^{-1}
Visible	VIS	380 to 780nm	3.3 to 1.6eV	26,000 to 13,000 cm^{-1}
Near Infrared (IR-A)	NIR	780 to 1400nm	1.6 to 0.9eV	13,000 to 7,000 cm^{-1}
Near Infrared (IR-B)	NIR	1400 to 3000nm	0.9 to 0.4eV	7,000 to 3,300 cm^{-1}
Middle Infrared (IR-C)	MIR	3000 to 50,000nm	0.4 to 0.025eV	3,300 to 200 cm^{-1}

The names for various sub-regions of optical electromagnetic radiation are from the International Electrotechnical Commission (IEC) Publication 50, International Electrotechnical Vocabulary, Lighting 1987

Relationships

Diffraction Angle = $d \sin\theta = m\lambda$

Diffraction Limit = (f/no. * λ) for incoherent sources. For coherent sources the diffraction limit = (f/no. * λ) * 2

eV = 1239.842 / nm

F/no. = (1 / NA) / 2

F/No. = Focal Length / (sqrt(ruled area/π)*2)

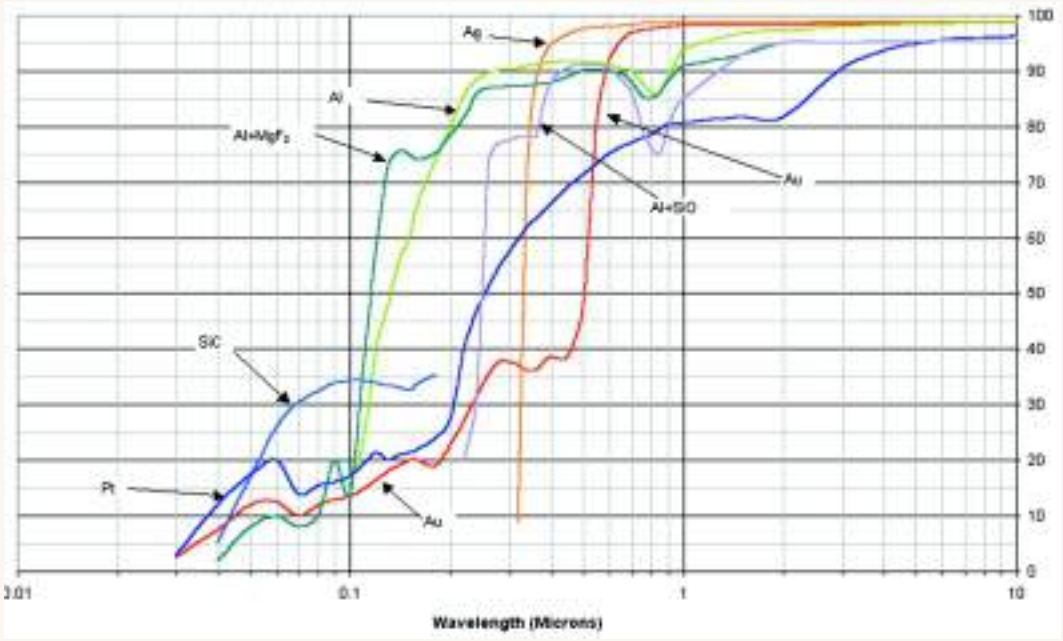
Grating Equation = $m\lambda = d (\sin\alpha \pm \cos\beta)$

Resolving Power = $\lambda / \Delta\lambda$

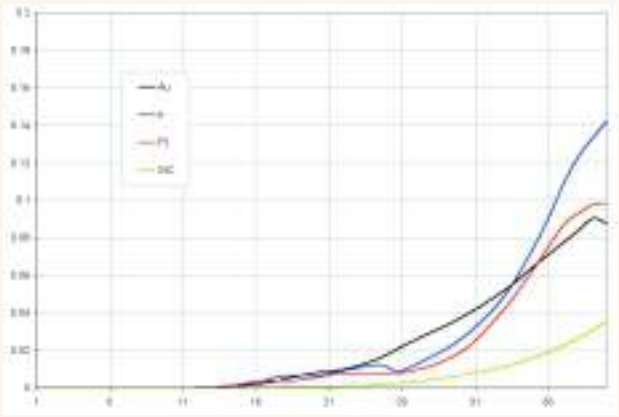
Transmission = $10^{(2\text{-ABS})}$

Reflectivity

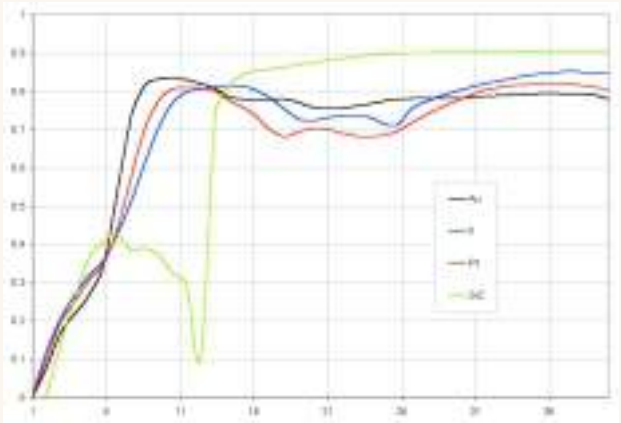
Reflectivity curves of various common reflectors. Measured at, or near, normal incidence angles.

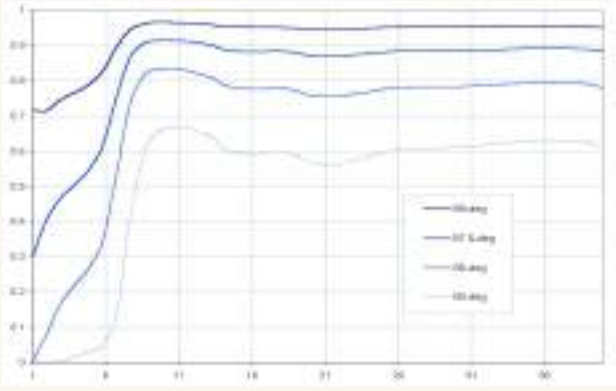


Theoretical EUV reflectivity of various reflectors measured 35° off normal incidence.



Theoretical EUV reflectivity of various reflectors at 85° off normal and Gold at grazing angles from 1 to 10°.





Theoretical data courtesy of the Center for X-ray Optics web site calculator = http://www-cxro.lbl.gov/multilayer/

272

Optical Design ..... Corrected Grating
Wavelength Range ..... <185 to 1250nm*
Focal Length 200mm
Resolution, FWHM 1.6nm*
Dispersion ..... 4nm per mm*
Calibration Accuracy 2nm
Reproducibility 0.1nm
Focal Plane 25mm
Aperture f/2
Gratings ..... 104mm diameter
Stray Light Rejection ..... 10^{-3}
Port Possibilities 2
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

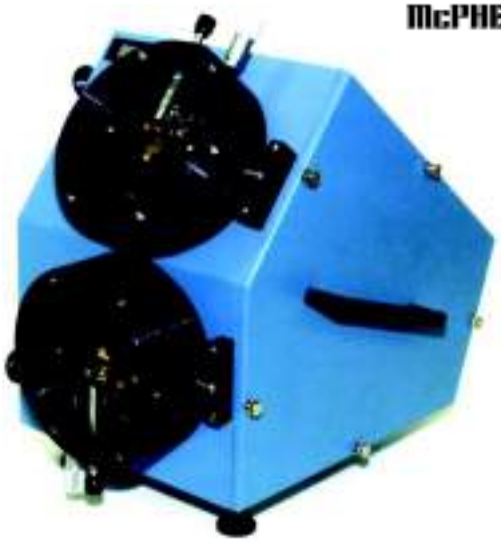
Single grating with kinematic mount standard. Easy exchange of gratings in the field.

Slits: Continuously variable micrometer actuated width from 25um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1140g/mm grating. Other holographic gratings available.



f/2 - throughput

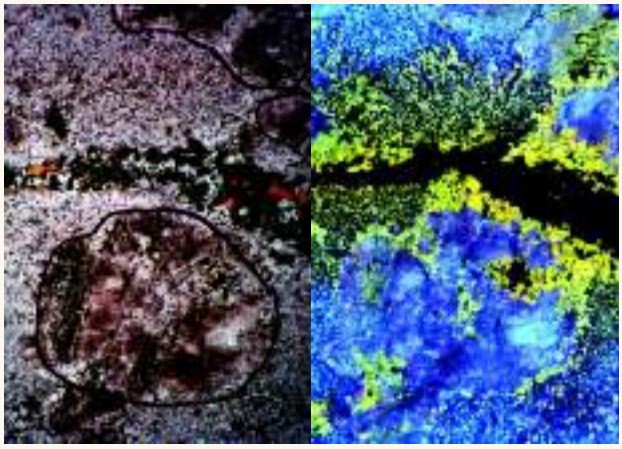
The 272 monochromator contains a **large diffraction grating.** This guarantees a large solid angle of light collection. The gratings corrected design reduces optical aberrations. This improves the spectral resolution of this high throughput optical system. The 272 is a versatile research grade monochromator. The 272 opto- mechanical system is ruggedly constructed for use in any environment. The precision wavelength drive will provide years of accurate use. The grating scans are controlled by the optional Model 789A-3 digital scan drive system. Use McPherson signal recovery and control software too.

McPherson accessories work with this instrument. It is best to inquire to make sure the f/2 beams work at full capacity. Use the 272 monochromator for Raman, Photoluminescence, Fluorescence, Emission, Reflection and Transmission.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	2280	1710	1140	570
Resolution** (nm)	0.7	0.9	1.6	3.2
Dispersion (nm/mm)	2	3	4	8
Wavelength Range	185 - 650 nm	185 - 950 nm	185 - 1250 nm	185 - 2500 nm

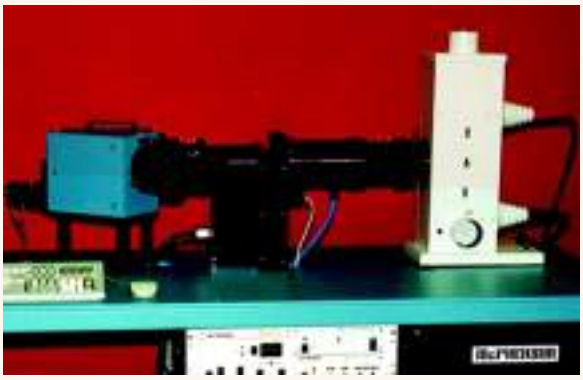
** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.



Cathode luminescence (CL) - The photos show a thin slice of biotite-hornblende. The photo (left) was taken in transmission mode (conventional microscopy.) The photo (right) was excited by cathode luminescence. The same sample is shown in both photos.

Solution:
Spectral Microscopy

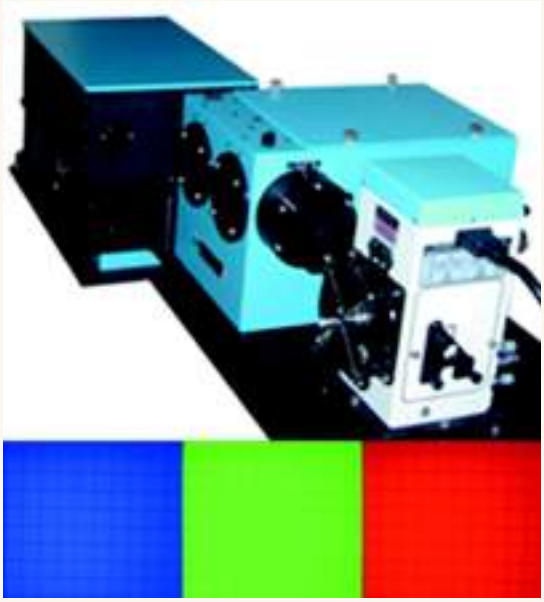
The quick f/2 aperture makes the 272 the first choice for any low light experiment. An accessory package comprised of the 272, relay lens, fiber optic and CCD was integrated for Smithsonian researchers in Washington DC. This system helps the Smithsonian researchers to learn more about the composition and age of the minerals they're studying. Samples on the microscope stage are excited by cathode luminescence (a 20 keV electron beam) until they emit, which is subsequently analyzed. The CL excitation and subsequent spectral analysis reveals detail. In this 170 million year old sample of volcanic tuff "the yellow luminescence has begun to replace the blue luminescent k-feldspar the yellow (plagioclase)" telling researchers that "components were transported into the vein about 100 million years ago." The 272 helps with spectral identification of the elements involved.



The 272 above is built into a light train with a 1kW Xenon arc lamp, condensing and focusing lenses, a filter wheel and a high speed optical chopper. The light is delivered to the 272 entrance slit for selection of wavelength and bandpass. The 272 output slit is equipped with a focusing lens and a turning mirror to deliver the high intensity monochromatic light to a sample on the table.

272 App Note: **High Intensity Monochromatic Illuminator**

The f/2 272 is capable of collecting a large solid angle of light. Used with intrinsically small and high power sources like the 450W or 1kW Xenon arc lamps it gathers a tremendous amount of light. The large diameter grating has a large area over which to distribute the energy. This reduces the chance of damage to the optical surface. The high intensity monochromatic illumuminator can simply be the light source efficiently coupled to the monochromator . It can also include filters for order sorting or ND types for intensity variation. Choppers for modulation can be built in as can reference or feedback sensors for stability control or reference measurements.



The 2035 is used here to deliver with wide open slits and a 300W Xenon source for ~10nm bandpass through the Visible region. This monochromatic source system can be tuned to deliver any 'color' to the sample under test. The picured system delivers ~50mW per cm^2 over a 100mm diameter beam with good unifromity. The system was configured for throughput and light intensity. Other system, with less throuput power can be confugured with high grade telescopes with great collimation should your application require.

Solution:
Spectral Test Station

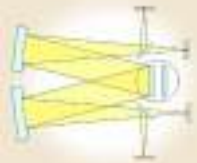
Spectral test stations are available for custom or standard applications. They provide unobstructed apertures from 1 to 12 inches with a wide variety of f/ numbers. Telescopes with high precision optics off axis parabolic optics with Zerodur™ substrates are interferometrically aligned. System wave front accuracies up to lambda/10 (at 632.8nm) can be provided. Utilizing all reflective optics allows these systems to work through very wide spectral regions. Monochromatic light from the vacuum ultraviolet to the LWIR can be delivered. Bandpass can be set by the monochromator. Sub nanometer to very broad band pass systems are available. Uniformity is assured by spatial filtering or use of integrating spheres for light delivery to the telescope. If you need exceptional spectral purity we can configure these light delivery systems with double monochromators. We take care to assemble and test systems prior to shipment.

The 2035 spectrometer is equipped with a CCD for quick emission wavelength (color) measurements. Phosphor samples are analyzed in more detail too, especially lifetimes (nanosecond time scales.) McPherson systems may be equipped with tunable monochromatic light sources for excitation from 115nm to the Visible. Complete, ready to use systems are available.

2035 & 234/302 App Note:
PDP Phosphor Analysis

Plasma Display Panels consist of thousands of cells. The cells contain an inert gas, a phosphor, and electrodes. Passing current through the cell causes the gas to heat up and change to plasma. The plasma emits UV that excites the phosphor, causing it to glow. Phosphors used in Plasma Display Panel (PDP) technology require accurate characterization of emission wavelength and lifetime. The 2035 is an ideal monochromator for this. The McPherson PDP Analyzer delivers Vacuum UV excitation wavelengths at 146 nm, 173 nm and more. The excitation wavelengths are focused to sample phosphors. The phosphor samples may be exchanged while maintaining the vacuum required for high-energy excitation. Phosphor emission is collected and delivered to a 2035 for analysis.

2035



Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 350mm
Resolution, FWHM 0.05nm*
Dispersion ..... 2nm per mm*
Calibration Accuracy 0.2nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 30mm
Aperture f/4.8
Gratings 68*68mm
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret and single grating with kinematic mount available. Both permit easy exchange of gratings.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

big performance, nice package

The 2035 is a 350mm focal length symmetrical Czerny-Turner monochromator. It has **high resolution**, 0.05nm with a 1200g/mm grating, and **quick aperture** f/4.8. High quality **master optics** provide excellent performance from the Deep UV to the Infrared. For users working below 185-nm or in the far Infrared the 2035 is available with purge gas fittings. Spectrally agile, 2035 optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings.

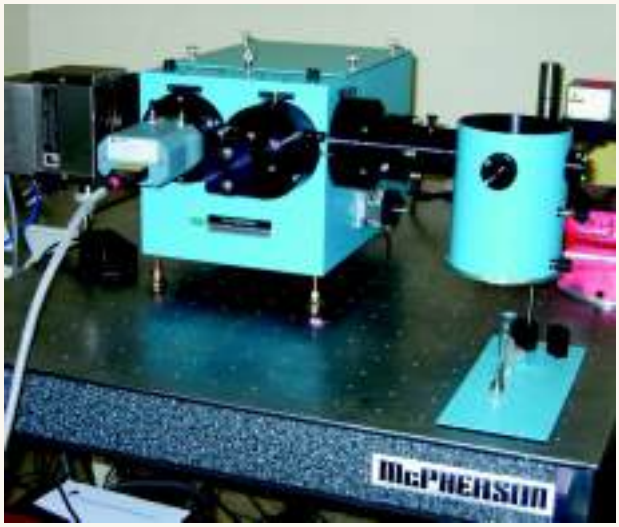
The 2035 optics provide **best spectral resolution**. Aspheric optics are used for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large focal plane.**

Use the 2035 monochromator for research or teaching. Use it for Raman, Photoluminescence, Fluorescence, Emission, Reflection and Transmission.

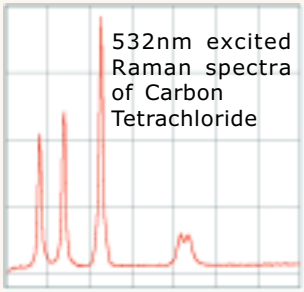
Performance with Alternate Gratings

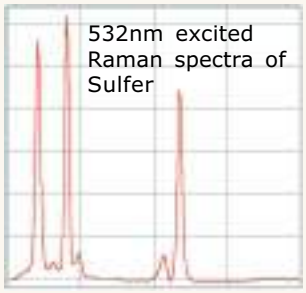
Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.016	0.02	0.03	0.04	0.08	0.16	0.32	0.64
Dispersion (nm/mm)	0.5	0.83	1.10	1.66	3.33	6.66	13.3	26.6
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.



Ready to work? **2035 Raman System** with 50mW DPSS laser, 125 sample chamber, notch filter, 2035, cooled PMT, photon counter and cold, high QE CCD.

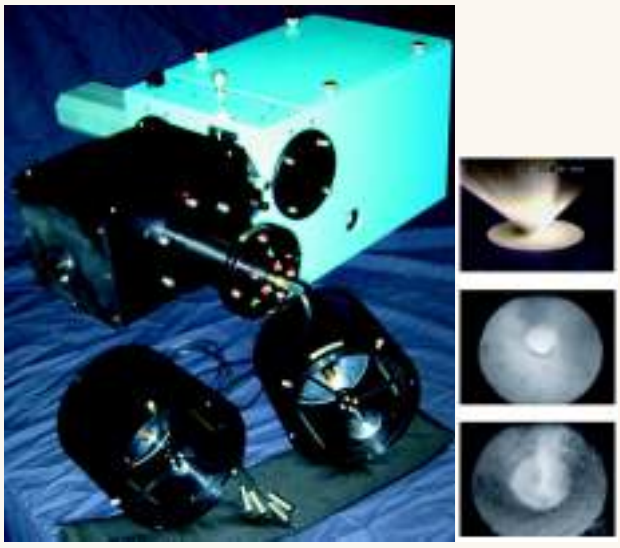




Solution: **Raman**

The quick aperture, good imaging and extensive grating selection make the 2035 first choice for many experiments. High-quality low-scatter optics and an efficient optical design provide an excellent platform for signal limited experiments. Raman, fluorescence & photoluminescence are all well served. The 2035 based Raman System shown here is provided complete by McPherson and includes a DPSS laser, 125 sample chamber, sharp-cut notch filter, 2035 spectrometer, cooled PMT with photon counting signal recovery and a ultra-cold thermoelectrically cooled back-thinned CCD with high quantum efficiency. The system is software controlled. It provides control of signal recovery in CCD and scanning modes.

Raman applications in research, process control, analytical laboratories and teaching can all benefit from the 2035 Raman system. It delivers improved light throughput at lower cost. Notch and shrp edge rejection filters and lasers are readily available for wavelengths from 325 to 1064nm and the 2035 grating and detectors are tuned for optimum results.

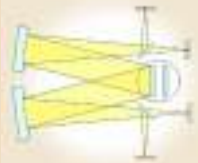


The 2035 imaging and wide range remote sensing system. Above right, a high-speed sequence of images (1msec between frames) of a copper sphere traveling at 4.5 km/sec impacting porous pumice. The bright "flash" is a high temperature plume that shoots out of the hole created as the projectile penetrates the target. The ejecta curtain resembles a funnel. These images courtesy of NASA Deep Impact and the Department of Geophysics, Brown University.

2035 App Note:
Remote Spectral Sensing

Use the 2035 for multi fiber spectroscopy and imaging . Use our reflective telescopes to illuminate fibers for great spectral range capability and fewer losses from chromatic aberrationa. Build your system this way to view dangerous or difficult to reach targets or experiments. View, collect and store spectral data on a nanosecond time scale by using intensifed CCD detectors or fast PMTs. The 2035 spectrometer delivers 0.1mm images and < 0.1-nm spectral resolution. Our telescopes are equipped with high quality parabolic optics for optimal light gathering and signal delivery to fibers. UV capable fibers are available. The spectrometer includes a reflective fiber-coupling accessory to aperture match fast fibers to the 2035. Wide range spectra (several hundred nanometers) can be collected from multiple targets simultaneously. Measure, monitor and plot characteristics of fast and optically interesting phenomena in no time at all.

205



Available versions:
205 ..... all-purpose research f/6.9
205wr ..... wide-range quad turret f/4.4
205f ..... fast, high-throughput f/3.6

Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 500mm
Resolution, FWHM 0.04nm*
Dispersion ..... 1.67nm per mm*
Calibration Accuracy 0.1nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 30mm
Aperture f/6.9
Gratings 68*68mm
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret and single grating with kinematic mount available. Both methods permit easy exchange of gratings.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

* Specification set with 1200g/mm grating in 205. Performance may vary with other aperture ratios.

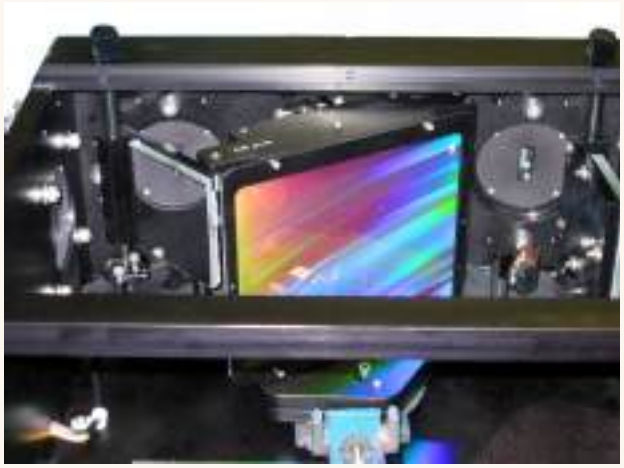
great flexibility, fits everyplace

Three versions of the 205 were instigated by researchers and built by McPherson. They match diverse spectral analysis requirements. The 500mm focal length provides good spectral resolution in **your choice of aperture** . Every lab has room for a half meter monochromator! Since every experiment is unique, the versions of the 205 allow you to specify the instrument to produce the best data. The 205 optics are Aluminum and Magnesium Fluoride coated for broadband performance. Coatings like Gold or Silver can also be provided to favor the Infrared. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. The 205 optics provide best spectral resolution. Aspheric optics are used for imaging. The output focusing mirror reduces losses of intensity and delivers the spectrum across a large focal plane.
Use the 205 for Raman, Photoluminescence, Fluorescence, Emission, Reflection and Transmission.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.016	0.02	0.03	0.04	0.08	0.16	0.32	0.64
Dispersion (nm/mm)	0.5	0.83	1.11	1.67	3.34	6.68	13.4	26.7
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.



Diffraction gratings with large substrates measuring up to 128*154mm fit the 205f (see photo.) In these large sizes groove density and blaze selection is limited. f/3.6 120*140mm and still more f/4.4 110*110mm gratings are available for work anywhere in the 205 range.

205f variant:

Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 500mm
Aperture Ratio f/3.6
Resolution, FWHM 0.1nm*

* Specification set with 1200g/mm grating.

Faster = 205f

Gather more light with the 205! The instrument optics **work as fast as f/3.2** and actual aperture is limited only by the gratings ruled area. Any time photons are at a premium, the Model 205f can help! Designed for large 120*150-mm gratings this McPherson instrument delivers **phenomenal light gathering power**, light throughput and respectable FWHM resolution. Optical coatings may be specified to further optimize for reflectivity or spectral agility. The Model 205 is provided with two exit ports. **Best imaging** is delivered to the lateral exit port while the axial port provides best resolution. Two entrance ports are also available. These are ready to adapt to your experiment and calibration sources. Many additional gratings are available for operation at f/4.4 or even f/6.9. **Gratings may be easily exchanged**.
The efficient design and fast aperture ratio of the 205 make it the best choice for light starved experiments like Raman, fluorescence, and photoluminescence.

Four 110*110mm diffraction gratings fit the 205wr at one time. The instrument works at f/4.4. This combination of aperture ratio and its ability to access a wide range make the 205wr the ideal instrument for spectral test stations. An example is pictured below.

205wr variant:

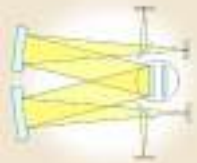
Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 500mm
Aperture Ratio f/4.4
Resolution, FWHM 0.05nm

* Specification set with 1200g/mm grating.

More Range = 205wr

A spectral test system was required to test the sensitivity of airborne sensors. Our customers needed to confirm performance in the ultraviolet, visible, midwave infrared (MWIR) and long wave infrared (LWIR.) By using the 205wr with four gratings, the user optimized test conditions for all required spectral regions with one instrument. Like all our spectral test systems, the 205wr output illuminates a reflective collimator providing a uniform test beam for a variety of sensor and sample packages.

207



Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 667mm
Resolution, FWHM 0.03nm*
Dispersion ..... 1.24nm per mm*
Calibration Accuracy 0.05nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 50mm
Aperture ..... f/4.7 (or f/5.8)
Gratings ..... 120*140 (or 110*110mm)
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret available for f/5.8 operation only. Single grating mounts work at f/4.7 or f5.8 with kinematic (patented SNAP IN) mounting. Exchange of gratings is easy, regardless of the method.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

a little more

Stand out from the crowd! The 207 provides a unique, 667mm focal length. Constructed of **heavy duty** cast Aluminum this is a **stable instrument** suitable for any demanding spectroscopy technique. Use the large 120*140mm f/4.7 gratings to optimize for throughput. Opt for f/5.8 110*110mm gratings for the option to use a **dual grating turret.** High quality **master optics** provide excellent performance from the Deep UV to the Infrared. For work below 185-nm or in the far Infrared the 207 is available with purge gas fittings. The optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. The 207 optics provide **best FWHM spectral resolution**. Aspheres are installed for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large focal plane.** Use it for Raman, Photoluminescence, Fluorescence, Emission, Reflection and Transmission.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.013	0.016	0.02	0.03	0.06	0.12	0.24	0.48
Dispersion (nm/mm)	0.41	0.62	0.83	1.24	2.48	4.96	9.9	19.8
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

f/4.8 triple monochromator consisting of 207 with 2035DS monochromator as preliminary filter stage, introducing the...

Raman Commander

Focal Length ..... 350 / 350 / 667 mm
Aperture Ratio: f/4.8
Dispersion 0.83nm/mm (1800g/mm)
Resolution ..... 1 cm^-1 at 500nm
..... 4 cm^-1 at 244nm
Focal Plane 50-mm

Drive Mechanism ..... Sine bar
Step Size ..... 0.0002 nm
Calibration Accuracy ... 0.05nm
Reproducibility 0.005nm

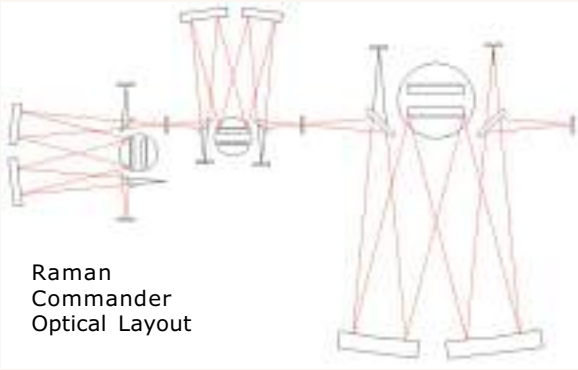
Slit Locations ..... Axial or Lateral.
Second entrance slit direct to Spectrograph stage. Double pre monochromator can also be used as stand alone double or single monochromator.

Slits ..... 0.01 to 4 mm wide
..... 2 to 20 mm high
Slit (intermediate) ..... 0.025 to 10 mm wide
..... 0.025 to 10 mm high

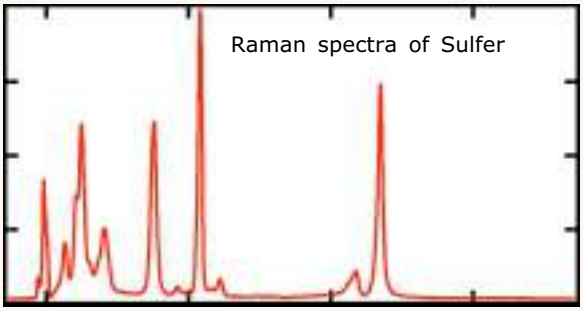
Grating Size (2X) 68*68mm and (1X) 120*140mm; select from many gratings incl. original (master) high fidelity holographic gratings

Solution: **Raman Triple**

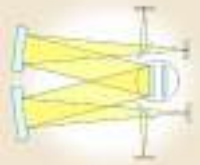
The quick f/4.7 aperture of the 207 is a big plus when working with light starved experiments requiring good resolution or dispersion. For applications like **UV Raman** or, any Raman **work closer to Raleigh scatter**, we can provide a **triple monochromator that works at f/4.8**. The good solid angle of light collection is a plus. The requirement to magnify the precious sample image at the entrance slit just to match a sluggish f/number is gone. The combination of the 207 with 2035DS results in a triple monochromator we call the Commander. Check out our specs, you will understand why.



Raman
Commander
Optical Layout



2061



Optical Design ..... Symmetrical Czerny-Turner

Optional master, hand figured off-axis aspheres for rigerous applications with limited field of view.

Wavelength Range ..... <185 to 1300nm*
Focal Length 1000mm
Resolution, FWHM 0.02nm*
Dispersion ..... 0.83nm per mm*
Calibration Accuracy 0.05nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 50mm
Aperture ..... f/7 (or f/8.6)
Gratings ..... 120*140 (or 110*110mm)
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

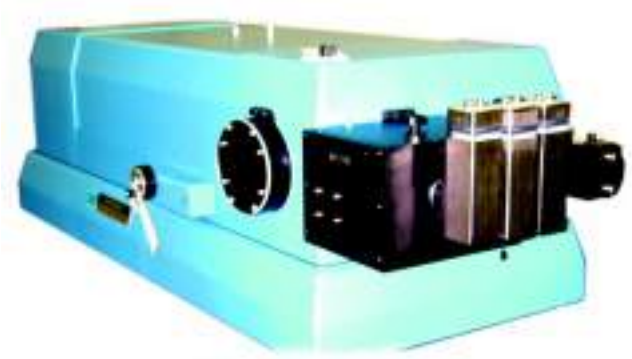
Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret available for f/5.8 operation only. Single grating mounts work at f/4.7 or f5.8 with kinematic (patented SNAP IN) mounting. Exchange of gratings is easy, regardless of the method.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.



right. anywhere, anytime

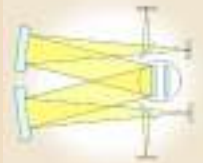
The 2061 is a decidedly classic, all pupose instrument for spectroscopy. It is the original. It led to the 207 (for more throughput) and the 209 (for more resolution.) The 2061 provides a balance of all the great features. The **heavy duty** cast Aluminum housing is **stable.** Use the large 120*140mm f/7 gratings to optimize for throughput. Opt for f/8.6 110*110mm gratings to use a **dual grating turret.** High quality **master optics** provide excellent performance from the Deep UV to the Infrared. For work below 185-nm or in the far Infrared the 2061 is available with purge gas fittings. The optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. The 2061 optics provide **best FWHM spectral resolution**. Aspheres are installed for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large focal plane.** Use it for Raman, Emission, Radiometry, and Material Science.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.007	0.012	0.015	0.02	0.04	0.08	0.16	0.32
Dispersion (nm/mm)	0.28	0.42	0.55	0.83	1.6	3.2	6.4	12.8
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

209



Optical Design ..... Symmetrical Czerny-Turner

Optional master, hand figured off-axis aspheres for rigerous applications with limited field of view.

Wavelength Range ..... <185 to 1300nm*
Focal Length 1334mm
Resolution, FWHM 0.01nm*
Dispersion ..... 0.62nm per mm*
Calibration Accuracy 0.05nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 50mm
Aperture ..... f/9.4 (or f/11.6)
Gratings ..... 120*140 (or 110*110mm)
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret available for f/5.8 operation only. Single grating mounts work at f/4.7 or f5.8 with kinematic (patented SNAP IN) mounting. Exchange of gratings is easy, regardless of the method.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

exceptional price/perfornace

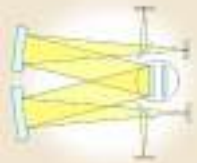
The 209 reduces the angle of incidence on the diffraction grating to improve line symmetry. Long 1.33meter focal length, built for high resolution spectroscopy. Get a lot more instrument for just a few more dollars. The **heavy duty** cast Aluminum housing is **stable.** Use the large 120*140mm f/9.4 gratings to optimize for **resolution AND throughput**. Opt for f/11.6 110*110mm gratings to use a **dual grating turret.** High quality **master optics** provide excellent performance from the Deep UV to the Infrared. For work below 185-nm or in the far Infrared the 209 is available with purge gas fittings. The optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. The 209 optics provide **best FWHM spectral resolution**. Aspheres are installed for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large focal plane.** Use it for Emission, Radiometry, hyperfine structure, Stokes shifts and Zeeman splitting.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.005	0.006	0.007	0.01	0.02	0.04	0.08	0.16
Dispersion (nm/mm)	0.21	0.31	0.41	0.62	1.24	2.48	4.96	9.9
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

2062



Optical Design ..... Symmetrical Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length 2000mm
Resolution, FWHM 0.005nm*
Dispersion ..... 0.42nm per mm*
Calibration Accuracy 0.05nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 50mm
Aperture ..... f/14.1 (or f/17.4)
Gratings ..... 120*140 (or 110*110mm)
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret available for f/17 operation only. Single grating mounts work at f/14.1 or f/17.4 with kinematic (SNAP IN) mounting.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

McPHERSON

hyperfine resolution

Possibly the **highest resolution** diffraction spectrometer commercially available. The McPherson 2062 2m focal length Czerny Turner can be equipped with large gratings (up to 220mm wide). Double pass optics can be installed for 4m focal length operation. Our regular **heavy duty** housing has in addition a temperature control option. It is a **stable instrument.** High quality **master optics** provide excellent performance from the Deep UV to the Infrared. For work below 185-nm or in the far Infrared the 2062 is available with purge gas fittings. The optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. The 2062 optics provide **best FWHM spectral resolution**. Aspheres are installed for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large focal plane.** Use it for Emission, hyperfine structure, Stokes shifts and Zeeman splitting.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.003	0.0035	0.004	0.005	0.01	0.02	0.04	0.08
Dispersion (nm/mm)	0.14	0.21	0.28	0.42	0.84	1.68	3.4	6.7
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

Imaging

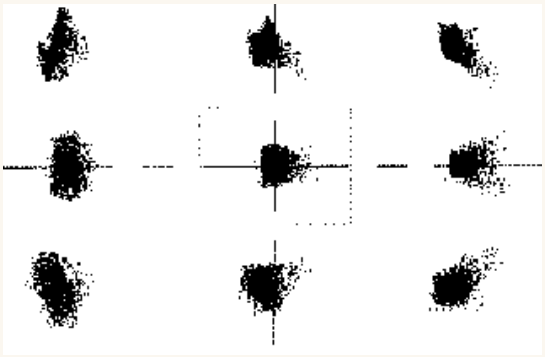
CCD detectors quickly and easily brought the ability to measure spatial as well as spectral features to spectroscopy. Imaging spectrometers for this purpose are frequently requested. Typical spectrometers employ spherical mirrors for collimation and focusing. In scanning systems astigmatism from spherical mirrors does not effect resolution. The dispersion plane is in excellent focus and resolution acheived.

Spherical mirrors are ideal in commercial scanning instrumentation because their shape permits the use of master polished optics. At McPherson these usually feature lambda/8 wave front (at 632.8), 60/40 scratch dig and 0.5nm RMS microroughness. These mirrors provide high throughput, low scatter and excellent resolution and image formation in the dispersion plane.

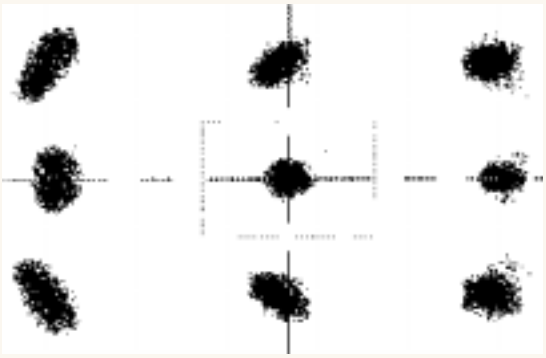
First surface optical systems contain four major aberrations: spherical aberration, astigmatism, coma, and line curvature. The first two are the most significant in spectrometers. Balancing aberrations to improve astigmatism generally incurs a deterioration of resolution.

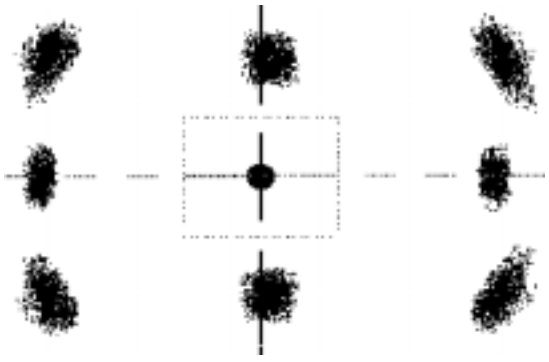
Parabolic mirrors are ideal for imaging when used on axis. Off axis (dispersion or spatial plane) there can be a 10X reduction in performance. Toroidal mirrors will typically provide the least astigmatism across the exit plane but will not provide optimum resolution or spatial information - spherical aberration and coma remain unchanged. Parabolic and toroidal mirrors are commercially available. CCD detectors are capable of measuring both the dispersion plane and the spatial plane, or slit height. Development and use of novel optics in McPherson instrumentation reduces the astigmatism in spectrometers to better suit these applications and detectors.

Spherical mirrors with corrective cylinder - The images are somewhat irregular because the optics are designed to balance best resolution with minimum astigmatism. This method keeps the instrument flexible and useful for imaging or scanning applications and provides best optical performance for cost. Average image size 130 x 130 um (FWHM), based on an input image of 100 x 100 um (Model 2061).



Toroidal mirrors - Fair image formation, excellent correction for astigmatism and equivalent reduction in resolution. Expensive to obtain with high qualities equivalent to spheres. Lower cost mirrors, e.g. diamond turned or replicated may not be available in qualities suitable for UV-VIS spectroscopy. Average image size 139 x 139 um (FWHM)), based on an input image of 100 x 100 um (Model 2061).





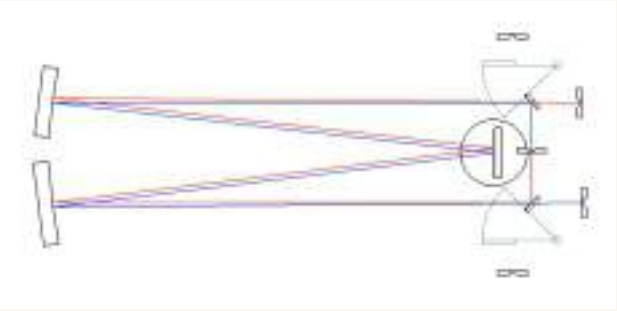
Parabolic mirrors - Superior on-axis images over a limited field of view. Even these 1 meter focal length parabolas degrade significantly when moving off axis in dispersion of spatial direction. Possibly the ideal monochromator mirrors for small slit height not a good choice for imaging. Average image size 153 x 153 um (FWHM)), based on an input image of 100 x 100 um (Model 2061).

Double Pass, Double Dispersion

Double pass, double dispersion accessory optics are available for 0.67 to 2m focal length monochromators. Double pass monochromators allow you to work with low f/number, great throughput and double resolution. Unique 'doubling' of resolution and dispersion is achieved by plane folding mirrors that multiply the monochromator focal length. Inside the instrument, the fold mirrors repeat the light path. Monochromator aperture ratio (f/number) is unchanged. Light passes over the diffraction grating two times. The multiple pass monochromator is useful for reaching twice the resolution or dispersion with very aggressive f/number and excellent light throughput. Scanning monochromator applications as well as imaging and other CCD based detection approaches benefit.

Double pass monochromators are ideal for experiments where more spectral resolution is required and lab space or budget cannot accommodate a large instrument. The multiple pass approach is not to be confused with double monochromators where light passes through separate instruments to achieve low scatter light levels.

A 207 double pass - it doubles the 0.67-m focal length for dispersion and resolution equivalent to a 1.33m unit while maintaining f/4.7 aperture.



Double pass monochromators use a pair of plane fold mirrors in the monchromator light path. These mirrors send the light around the instrument two times. The diagram shows the first pass in red and the second in blue traces. The offset between beams in this plan view is for purpose of illustration only. The beams are offset vertically to clear the fold mirrors. The top 10mm of the entrance and exit slits are used.

275D

compact double

The 275D is a dedicated 200mm focal length double grating monochromator providing additive or subtractive dispersion. The optics are aberration corrected concave holographic gratings. Spectrally agile, the 275D features all first surface optics and Aluminum with Magnesium Fluoride coatings for broadband response. Several gratings are available in order to optimize for ultraviolet, visible or near infrared operation. The 275D's compact housing contains the scanning mechanism and mechanical linkage of one sine drive for two gratings. Wavelength control is via a single stepper motor and scan drive. The stepper drive is interfaced for operation via PC. Double monochromators are used for a variety of applications that require extremely low levels of scattered or stray light. Applications include: source and detector standardization, radiometry, Raman and photoluminescence.

Optical Design ..... modifed Seya Namioka
Wavelength Range ..... <185 to 1000nm*
Focal Length 200mm
Resolution, FWHM 0.15nm*
Dispersion ..... 4nm per mm*
Calibration Accuracy ..... 0.1 (Visible)*
..... 0.5 (entire range)*
Reproducibility 0.05nm*
Drive Step 0.0002nm*
Aperture f/4.2
Gratings 45*40mm
Stray Light (measured)
$< 6.4 \times 10^{-4}$ (UV NPL procedure, broadband)
$< 5.0 \times 10^{-4}$ (UV-Vis NPL procedure, broadband)
$< 1.3 \times 10^{-6}$, 10 nm from 632.8 nm (100 µm slits)

Port Possibilities 2
Nitrogen Purge ..... Optional

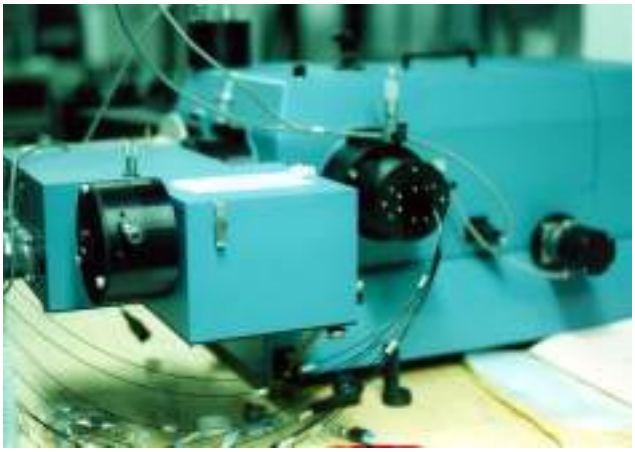
Gratings are aberration corrected concave holographic. They are available in 300, 600, 1200 and 2400g/mm densities. Master gratings can be provided with unusual groove densities or optimization.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

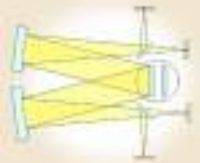
Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

Specifications are for subtractive mode, divide by 2 for additive mode specification.



2035D



Optical Design ..... Double Czerny-Turner
Wavelength Range ..... <185 to 1300nm*
Focal Length ..... 350±350mm
Resolution, FWHM 0.05nm*
Dispersion ..... 2nm per mm*
Calibration Accuracy ... 0.07nm (Visible)*
..... 0.25nm (entire range)*
Reproducibility ..... 0.005nm (Visible)*
..... 0.02nm (entire range)*
Drive Step 0.0002nm*
Aperture f/4.8
Gratings 68*68mm
Grating Exchange 0.02nm
Tracking ..... Linear with slits >75um
Stray Light (measured)
< 8 x 10^{-6} (NPL procedure, broadband)
< 1.2 x 10^{-8}, 10 nm from 632.8 nm (100 µm slits)

Port Possibilities ..... 6, Axial and Lateral
Nitrogen Purge ..... Optional

Double grating turret available. Single grating mounts recommended for radiometry work. Exchange of gratings is easy, regardless of the method.

Slits: Continuously variable micrometer actuated width from 10um to 4mm. Specify 792 for remote and stepper driven width. Manually selectable height variable in 8 steps, from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

Specifications are for subtractive mode, divide by 2 for additive mode specification.

radiometric calibration

The 2035 double monochromator is configured with two individual 350mm focal length instruments. It can be built for either additive or subtractive dispersion. Optically coupled these Czerny-Turner spectrometers are equipped with choice of ruled or holographic gratings to suit the application. The wavelength drives can be driven simultaneously and with mechnical coupling in some cases. Perferably two unique motor drives are used to allow best tracking between the instruments. There are hundreds of gratings to fit this instrument. Spectrally agile, the 2035D features all first surface optics and Aluminum with Magnesium Fluoride coatings for best broadband response.

We characterize stray light with lasers and broadband and/or continuum sources. Double spectrometers are used for a variety of applications which require extremely low levels of scatter or stray light. Applications include: source and detector standardization, radiometry, Raman, and photoluminescence.

Performance with Alternate Gratings

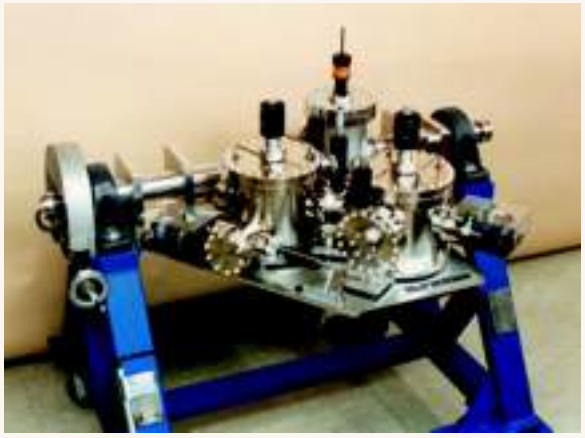
Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.016	0.02	0.03	0.04	0.08	0.16	0.32	0.64
Dispersion (nm/mm)	0.5	0.83	1.10	1.66	3.33	6.66	13.3	26.6
Wavelength Range	185 - 430 nm	185 - 650 nm	185 - 860 nm	185 - 1300 nm	185 - 2600 nm	185 nm 5.2 um	185 nm 10.4 um	185 nm 20.8 um

** Subtractive mode resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

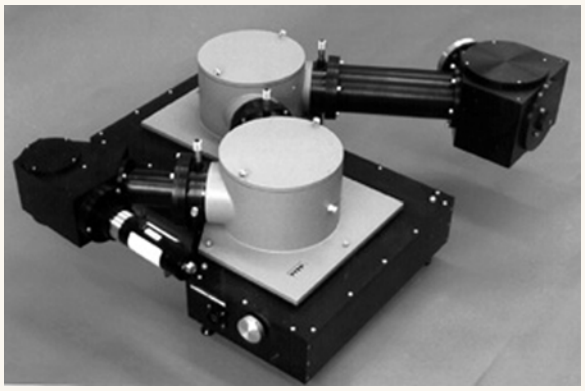
Unique Double Monochromators

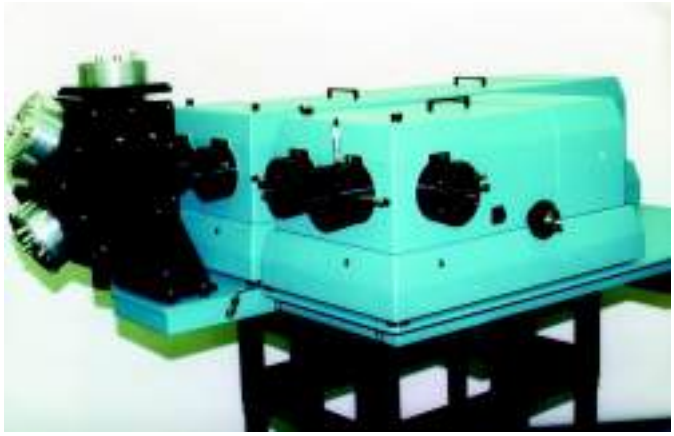
Double monochromators are used to double dispersion, improve spectral resolution and/or reduce stray light. Stray light is unwanted scatter or out of band wavelengths. Double monochromators are constructed in additive and subtractive configurations. A double monochromator performs with stray light content of 10^{-8} or 10^{-9} or less in the selected pass band of energy. 10^{-9} is our specification for the f/8.6 1m 2061 with prism, laser, and holographic grating.

Additive dispersion allows two monochromators to be coupled so that dispersion and spectral resolution are increased while scatter is reduced. Subtractive dispersion instruments are zero dispersers. For zero dispersion, the double is used to select a very specific and adjustable band pass (at the middle or intermediate slit) and then recombine the selected wavelengths into a small, slit size image. These instruments are most popular in Raman and photoluminescence applications.



Double monochromators are built in many focal lengths and optical designs. Some are vacuum compatible. The double Seya-Namioka (above) is ultra high vacuum comptabile (10^{-10} torr) and can be rotated through 90° allowing it to be used to examine polarization in synchrotron beamlines.

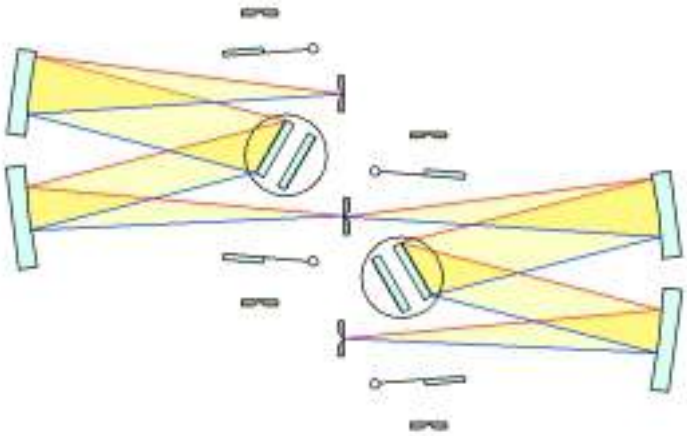




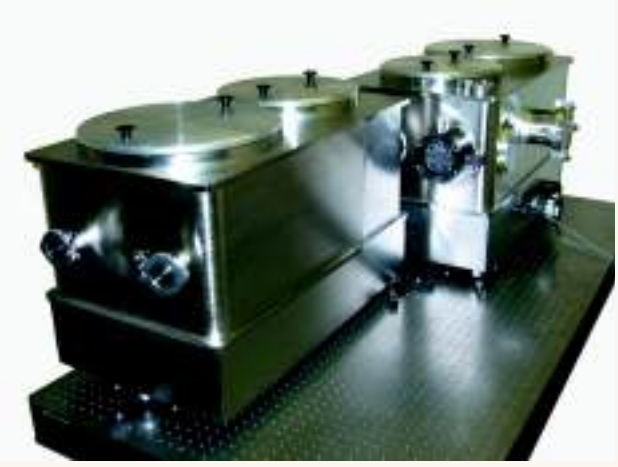
This unique double monochromator is used at the Joint European Torus fusion research facility. It facilitates measurement of light from 20 chordal views of the plasma. The first monochromator in the double (207) functions as a low dispersion, tunable bandpass filter. The intermediate aperture is an array of 20 pinhole slits. These form the entrance image of the high resolution (209) spectrometer. According to N. Hawkes and N. Peacock of JET, the main advantage of this design is the ability to f/no. match the fiber optic array. It allows 4X magnification without requiring a 70mm high slit. Conservation of light is vital to improve the time resolution of measurements at JET and other fusion research facilities. Researchers at JET reached readout time of about 0.5msec for spectra from these 20 channels.

Double Monochromators for Ultrafast Pulses

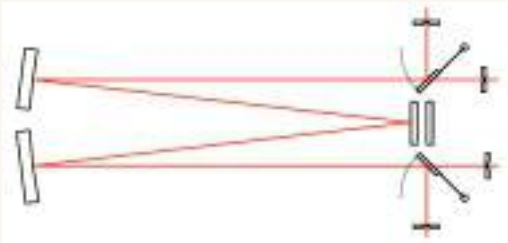
Here is the optical path of a unique, balanced double monochromator. It is designed not to stretch light pulses. It offsets the "time of flight" for a photons on a particular path through the system. Trace along one of the edge of the light beam and you will see that in one monochromator the light beam reflects from the near corner of the diffraction grating. It reflects from the furthest corner in the second monochromator. If the light strikes the far corner in both instruments, for example, the light pulses entering the instrument would be stretched. This McPherson design avoids stretching completely. Care is taken to maintain the desired mode of operation while considering the direction of grating rotation. The optical path demonstrates equal arrival times (negligble pulse broadening.) Scientists at the Technical University of Berlin qualified this system and it demonstrated negligible broadening to the femtosecond time scale.



The 207 built as a double for vacuum and as a double for atmospheric applications is shown below. We can build double monochromators from any of our monochromators. We welcome your innovative suggestions. If you have a unique idea please let us know. It is our pleasure to work with you, and help bring ideas to light.

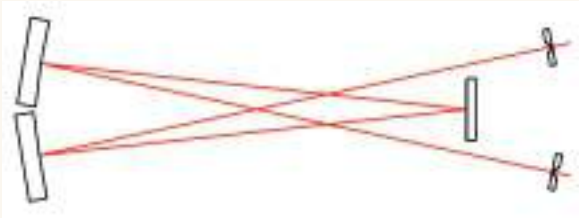


Optical Designs for Popular Monochromators



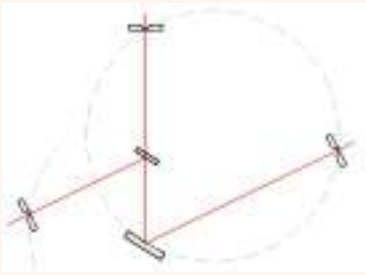
Using plentiful plane gratings with seperate focusing and collimating mirrors the Czerny-Turner design is one of the most popular. Linear wavelength positioning is acheived by grating rotation. The rotation point is coincident with the grating surface. The focus and collimating optics can be spherical, elliptical, toroidal or parabolic depending on instrument requirements. This design delivers a flat focal plane perfect for CCD detectors.

The criss cross Czerny-Turner optical path minimizes the angle of incidence. This improves optical performance by reducing aberrations. The criss-cross variant of the Czerny-Turner is a McPherson patent. It is used exclusively in the 218 which is vacuum or purge compatible and works from 105nm to the LWIR.



Normal Incidence monochromators use concave gratings to disperse and focus light. They work as short as 30nm by virtue of reduced optical surfaces. The 'McPherson 15°' is a patented instrument with this design. The wavelength drive rotates and focuses the grating for best spectral resolution. These instrument are suitable for use with CCD and microchannel plate (MCP) intensified detectors.

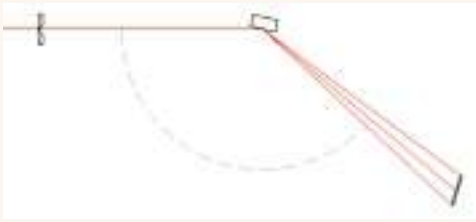
The Seya-Namioka design uses 70°15' angle between entrance and exit slits. Concave, spherical, Rowland circle gratings are used. Some aberation corrected gratings are available that improve resolution. These designs are used mainly when experiments require work at less than 105nm and need a lot of space between slits to accomodate experiment chambers, light sources or detectors.



The modified Seya-Namioka or corrected holographic design uses corrected concave holographic gratings. The grating designs reduce astigmatism and improves spectral resolution. The result is our 234/302. A compact, fast optical system with good resolution and throughput. This is a popular instrument used from 30nm to the Visible region.

Grazing Incidence instruments work from ~1 to >100nm. One slit travels the Rowland circle. CCD detectors mount normal to the exit ray, microchannel plate intensifiers tangent to the circle. Arrays can be scanned along the circle to intercept region of interest. A source can be mounted at the scanning slit for a calibration systems.

Flat field instruments rely on uniquely shaped grating substrates or aberration corrected groove design and spacing. These are useful instruments when the region of interest in known and fixed. They are somewhat limited in range of collection and provide a very simple instrument construction. Due to the demands on the grating few designs exist and these are costly. They also are the most elegant means to collect a low resolution extreme UV spectrum.



234/302

Optical Design	Modified Seya-Namioka
Angle between slits	64° or 180°
Vacuum Compatible	10^{-6} torr (or 10^{-10})
Wavelength Range	<30 to 550nm*
Focal Length	200mm
Resolution, FWHM	0.1nm*
Dispersion	4nm per mm*
Calibration Accuracy	0.1nm
Reproducibility	0.05nm
Drive Step	0.00005nm
Focal Plane	25mm
Aperture	f/4.5
Gratings	40*45mm
Stray Light Rejection	10^{-5}
Port Possibilities	3
Nitrogen Purge	Optional

Gratings are concave holographic with sinusoidal groove profile. Single grating with kinematic mount standard, double grating turret available.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine approximate range collected per acquision.

Slits: Continuously variable micrometer actuated width from 10um to 3mm. Specify 792 for remote and stepper driven width. Manually adjust height rom 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

enter the vacuum ultraviolet

The 234/302 is a 200mm focal length modified Seya Namioka monochromator. It is constructed and cleaned and suitable for all manner fo vacuum spectroscopy. It uses concave master holographic gratings to focus and disperse. It provides **good f/4.5 throughput** and **0.1nm spectral resoltuion** with 1200g/mm grating. The high quality **master gratings** provide excellent performance. This instrument uses only one optical surface. The range deep in the vacuum ultraviolet is limited by the efficiency of the coating. He II at **30.4nm can easily be seen**. Then efficiency becomes the limiting facter. Coatings like Gold or Platinum can be provided. Overall, wavelengths from <30nm to 2.2-um can be covered within the scanning range and with appropriate gratings.

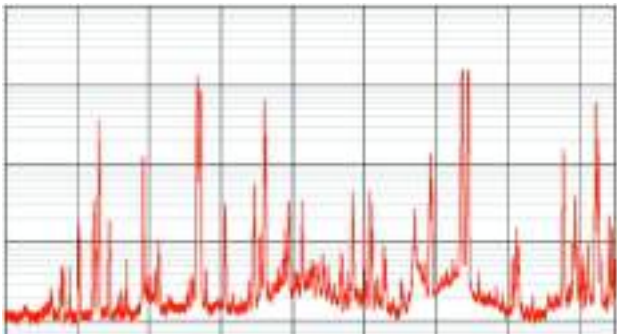
The 234/302 is equipped with a single entrance and exit port. Optionally, a second entrance or exit can be provided. A port selection mirror is then also included. The compact construction of the 234/302 makes it the ideal first instrument for work in the VUV. It fits directly to most experiments.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	2400	1200	600	300
Resolution** (nm)	0.05	0.1	0.2	0.4
Dispersion (nm/mm)	2	4	8	16
Wavelength Range	30 - 225 nm	30 - 550 nm	30 - 1100 nm	30 nm 2.2 um

** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.

Enter the VUV! 234/302 monochromator for UV atomic emission measurements. Shown with windowless glow discharge light source, differential pumping, speciality absorbance cells and a scintillated photomultiplier tube detector assembly good for 30 to 300nm.

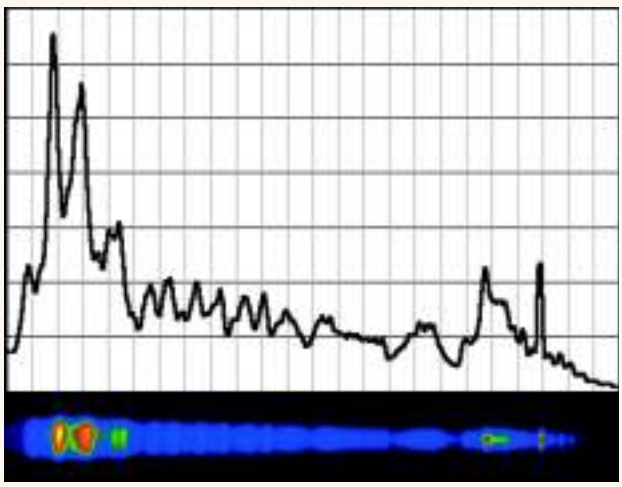


HeNe gas emission (20 to 190nm) from 629 hollow cathode source scanned with f/4.5 200mm 234/302.

Solution: **Emission Analysis**

Use the 234/302 vacuum monochromator to produce and detect emission spectra from 30nm to the Visible. Scanning monochromators allow monitoring of discrete emissions and CCD based systems are useful for broad range detection. Detect and measure atomic emission in the vacuum ultraviolet. The 629 windowless discharge lamp can provide emission spectra from inert gases for photoionization experiments or for calibration work. Run Helium gas as a low background carrier gas and introduce sample gases from process chambers or other sources. Analyze or monitor gaseous nonmetals (atomic fluorine and chlorine, for example.) Applications include calibraiton, VUV materials tranmission and reflection, and end point detection of process gases, etc.

We can integrate turnkey systems to best to suit your applications or provide stand-alone components. Call with your application today!



234/302 App Note: **CCDs**

McPherson provides normal incidence, Seya-Namioka and corrected grating instrumentation. Instruments like the 234/302 are small, cost effective and an ideal way to venture into the Deep and Vacuum Ultraviolet. Equipped with a 25-mm wide CCD this instrument can display about 100-nm in a single acquisition. Gratings are tunable so the ceter wavelength can be anyware from 30 to 550-nm. Long 1-meter focal length versions are readily available for users who need better imaging or spectral resolution.

Windowless, uncoated and back illuminated CCD detectors are available for direct detection of vacuum UV and higher energy photons. These devices deliver excellent quantum qfficiency, better signal-to-noise ratio, and spatial resolution. CCD devices can simplify, speed up and improve your results!

At left, the 234/302 with CCD detector. Spectra shows the Deuterium spectrum from about 105 to 170nm. Image shows the 2D image for same spectrum (image about 3mm tall.)

VUVaS

Vacuum UV measurements

Vacuum Ultraviolet Spectrophotometer
Tranmission, Reflection, Scatter, Emission

Corrected (two detector) system for measurement of solids, liquids and/or gases.

Wavelength Range ..... 120 to 380nm
Vacuum Compatible ..... 10^{-6} torr
Automatic Purge System ..... Optional
Precision (at 157nm) 0.05%
Precision (overall) ..... <0.3%
Bandpass ..... 1 to 10nm
Calibration Accuracy 0.1nm
Reproducibility 0.05nm
Drive Step 0.00005nm
Aperture f/4.5
Gratings 40*45mm

Detector position variable from <10 to 180°
Sample position variable from 0 to 60°

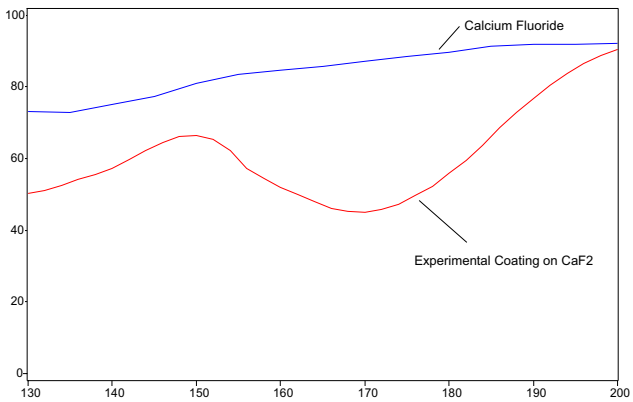
Standard sample holder accomodates 3 samples with 25mm diameter x 6mm thickness. Speciality sample holders are available accomodating greater numbers or larger samples, up to 350mm diameter x 100mm thick.

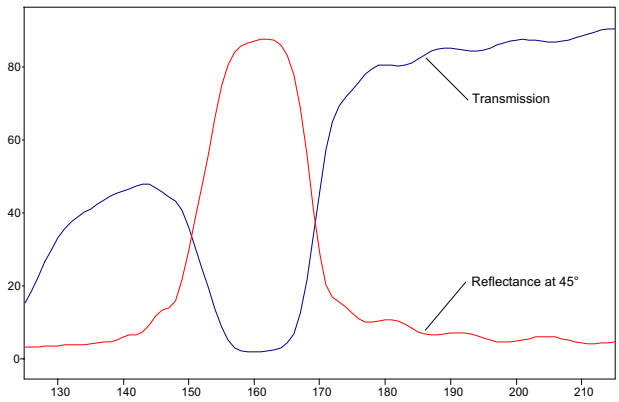
Sample holders that measure tranmsisison and spatially map 6025 style semiconductor samples for homogenity are also available.

Contact us about your vacuum ultraviolet measurement requirements.

Size .....
Weight .....

The VUVaS Series of corrected spectrophotometers **work through the 115 to 380nm region**. These units operate under vacuum or purge. The MgF_2 Deuterium lamp with **optimization** accessory and 234/302 deliver **best throughput and spectral performance.** Collimated light maintains high signal levels at the detector(s). An optional mount is available for Magnesium Fluoride Rochon type polarizers. Chopped signals (sample and reference) are delivered alternately to sample and reference positions. AC signal recovery allows rejection of noise. Improved data with signals free from noise.
Sample and detector angle is set manually. Settings can be made while under vacuum or purge. The sample and detector may be positioned independently.
The VUVaS is **provided complete** with vacuum pumping or automatic purge gas delivery and gauge systems. Our **easy to use** LabView based software allows control of all automated parameters and complete control of signal recovery.





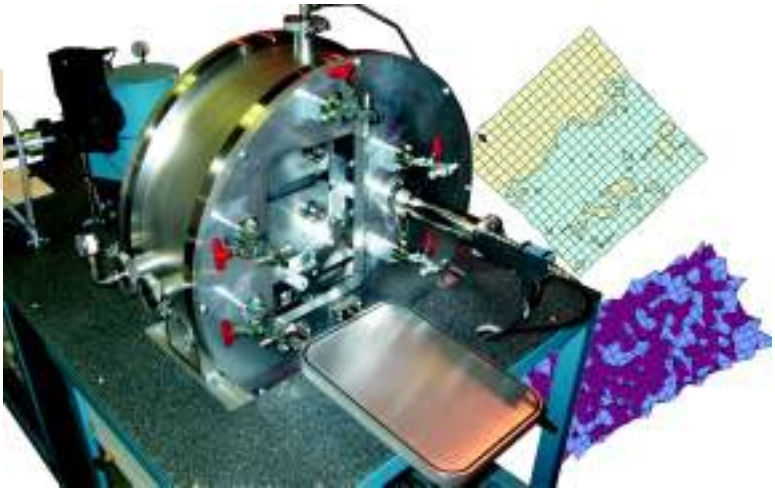
VUVaS Reflectometery

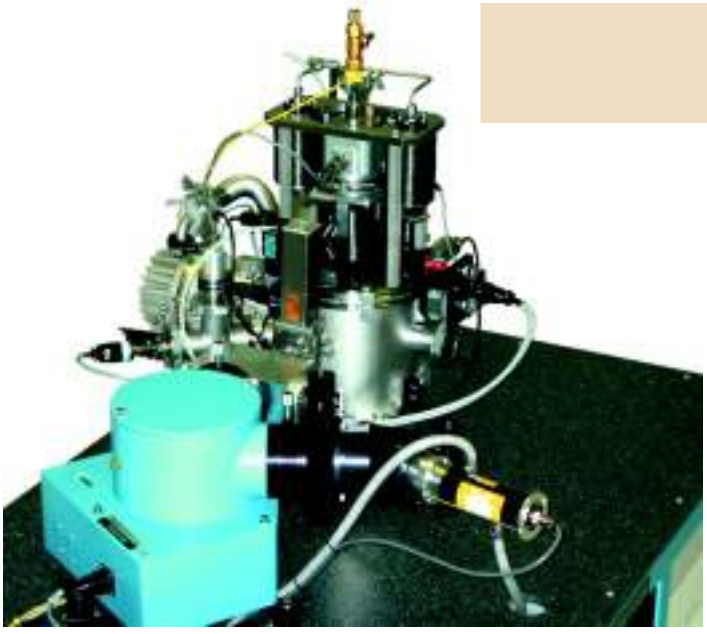
The VUVaS Spectrophotometer system is **a powerful tool** for a wide variety of experimental situations. The VUVaS comes in **single beam or dual beam versions**. The work station is complete with operating software and vacuum pumps or purge system. The design of the VUVaS system is **extremely flexible.** If we do not already have a sample chember that fits your requirement there isi a great chance we can adapt our system to your requirement.

At left a tranmission and variable angle reflection sample mount for eight 50mm diameter samples up to 10mm thick.

VUVaS Homogeneity

At right, VUVaS with vertical sample mount accepting 6025-style semiconductor industry samples. These and other larger samples may be s**patially mapped to test material homogeneity or coating uniformity** from 120 to 380nm.





VUVaS Cryo Cool Samples

At left, a speciality sample chamber. **Cryogenically cooled and heated sample** chambers and mounts are available. We can also provide special (ambient temperature) cells for measuring LIQUIDS and GASES in the vacuum UV region.

We can integrate turnkey systems to best to suit your applications or provide stand-alone components. Call with your application today!

218

Optical Design ..... Criss-cross Czerny-Turner
Angle between slits ..... 44°
Vacuum Compatible ..... 10^{-6} torr
Wavelength Range ..... <105 to 1000nm*
Focal Length 300mm
Resolution, FWHM 0.06nm*
Dispersion ..... 2.6nm per mm*
Calibration Accuracy 0.1nm
Reproducibility 0.005nm
Drive Step 0.0002nm
Focal Plane 17mm
Aperture f/5.3
Gratings ..... 50*50mm Snap In
Stray Light Rejection ..... 10^{-5}
Port Possibilities 2
Nitrogen Purge ..... Optional

Gratings are plane Snap In types. Single grating with kinematic mount only.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine approximate range collected per acquision.

Slits: Continuously variable micrometer actuated width from 10um to 2mm. Specify 792 for remote and stepper driven width. Manually adjust height from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

have you seen me

The unique criss-cross optical design of the 218 is a McPherson patent. The Snap In gratings that fit into this unit are too. Over many years this has been one of the most popular monochromators in the world. The vacuum compatible housing allows use in the vacuum ultraviolet. It often also finds use in the Infrared, the tight housing purged or under vacuum, to avoid atmospheric absorption.

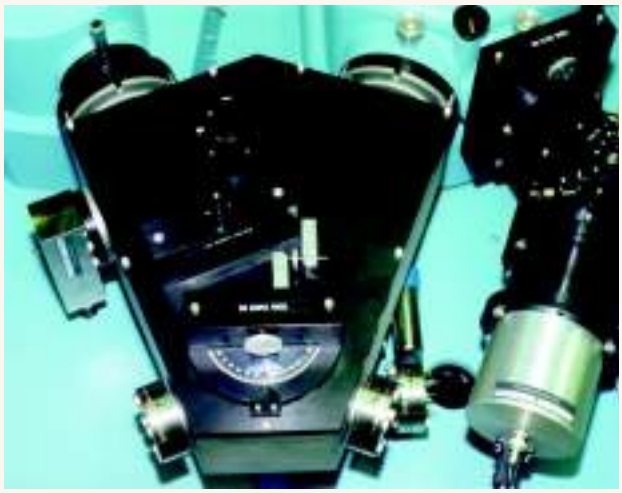
The reasonable f/5.3 aperture and tight angles on the grating facilitated by the criss-cross design provide nice symetrical line profiles and sharp spectral resolution. High quality **master optics** provide excellent performance from the Deep UV to the Infrared. Specialized Aluminum and Magnesium Fluoride coated optics reach 105nm with reasonable efficiency. They also offer **broadband performance** far into the red. Wavelengths from <185nm to 78-um can be covered within the scanning range and with appropriate gratings. Use the 218 monochromator for research or teaching from the vacuum UV to far IR.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.02	0.03	0.04	0.06	0.12	0.24	0.48	0.96
Dispersion (nm/mm)	0.9	1.3	1.7	2.6	5.2	10.4	20.8	41.6
Wavelength Range	105 - 335 nm	105 - 500 nm	105 - 670 nm	105 - 1000 nm	105 - 2000 nm	105 nm 4 um	105 nm 8 um	105 nm 16 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

The 218 emission monochromator and the 234/302 excition instrument are combined with dual source and detector accessories and the 123 sample chamber. The 123 (pictured below) focuses the energy from the excitation monochromator. The focused energy is transmitted through or reflected off the samples and refocused to the emission monochromator. The sample holders allow sample rotation with respect to the beam.



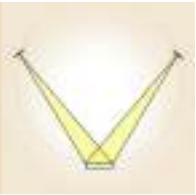
Solution: **Far UV Analysis**

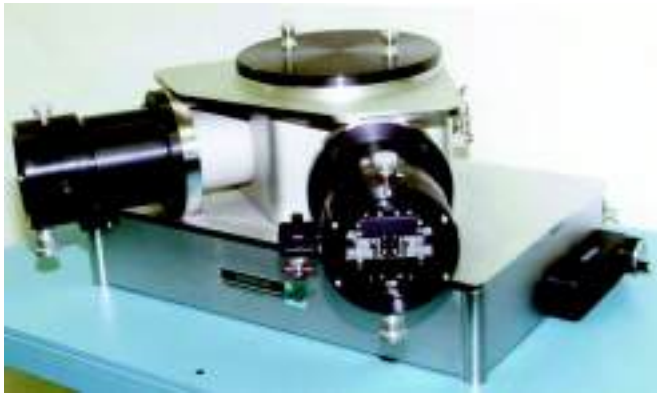
The 218 plays a unique role in systems for vacuum ultraviolet measurements. In these spectrophotometers, it serves as an instrument for emission analysis. In one case, we excite with the 234/302 in the 120 to 380nm wavelength region. In the other, the 235 uses a windowless hollow cathode lamp to measure and excite at less than 100nm. In both cases the 218 is used to measure **vacuum ultraviolet, visible and near infrared emissions.** The systems we build for transmission, reflection and emission measurements work across a broad wavelength range. The 218 used as an emission detection system works from 115 to 1000nm, and beyond. The all these systems the sample holders are interchangeable and routine versions hold five 1" diameter samples in the emission, transmission and reflectance measurement positions. The sample holders allow sample rotation with respect to the beam. The angle adjustment can be used to exclude the specular component when measuring fluorescent or diffuse samples. The angle adjustment can also be used to optimize the signal when measuring glossy samples such as mirrors or wafers. Sample mounts which can be heated to 500° C or cooled to LN2 temperatures are available. This chamber is also equipped with a intensity monitor. Stability information is fed back to the software to eliminate source fluctuation from the data. Optical and pumping systems are built into a support table equipped with castors and leveling legs for easy transport and set up. The electrical components are built into a portable rack, and the computer sits on a separate table.

Solution: **VUV Excitation**

The spectrophotometer at right is built to help scientists analyze cosmic dust. The excitation monochromator, our 235, is equipped with the MgF2 window Deuterium lamp for far ultraviolet excitation. It also has a hollow cathode lamp and differntial pumping for windowless operation. The hollow cathode lamp is for excitation at intense gas emission lines at wavelengths less than 120nm. The wide range 218 is used as emission monochromator with appropriate gratings and detectors and works from ~115 to 2500nm.

235





Optical Design ..... Seya-Namioka
Angle between slits ..... 70°15'
Vacuum Compatible ..... 10^{-6} torr (or 10^{-10})
Wavelength Range ..... <30 to 300nm*
Focal Length 500mm
Resolution, FWHM 0.05nm*
Dispersion ..... 1.66nm per mm*
Calibration Accuracy 0.1nm
Reproducibility 0.005nm
Drive Step 0.0002nm
Focal Plane 25mm
Aperture f/11.4
Gratings 30*50mm
Port Possibilities 3
Nitrogen Purge ..... Optional

Gratings are concave ruled replica or holographic. Single grating with kinematic mount standard.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine approximate range collected per acquision.

Slits: Continuously variable micrometer actuated width from 10um to 2mm. Specify 792 for remote and stepper driven width. Manually adjust height rom 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

more reach, better resolution

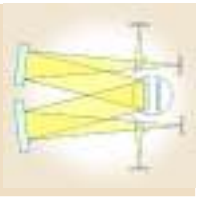
The 235 is the McPherson 500-mm focal length Seya-Namioka monochromator. This f/11.4 optical system is housed in a clean stainless steel housing capable of achieving 10-6 torr vacuum. It delivers typical resolution of 0.05-nm with a 1200-g/mm grating and operates by simple rotation of the grating about its apex. An angle of 70° 15' subtends the entrance and exit slit arms. The focal length provides increased resolution and work space. Stainless steel construction makes this proven design suitable for use with high vacuum, contaminant free experiments or microchannel plate intensifiiers.
Seya-Namioka mounting maintains all components (slits and gratings) on the Rowland circle. Resolution is maintained over a broad spectral region, astigmatism should be considered depending on the application. The image height at the exit of this instrument is theoretically equal to the height of the entrance image plus 2/3 grating ruled height. Wavelengths from 30-nm to 1.2-um can be covered within the scanning range and with appropriate gratings. The 235 is for scanning and microchannel plate intensifier or CCD spectroscopy.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300
Resolution** (nm)	0.02	0.03	0.035	0.05	0.1	0.2
Dispersion (nm/mm)	0.55	0.8	1.1	1.6	3.2	6.4
Wavelength Range	30 - 100 nm	30 - 150 nm	30 - 200 nm	30 - 300 nm	30 - 600 nm	30 nm 1.2 um

** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.

207V



Optical Design ..... Symmetrical Czerny-Turner
Vacuum Compatible ..... 10^{-6} torr (or 10^{-10})
Wavelength Range ..... 105 to 1300nm*
Focal Length 667mm
Resolution, FWHM 0.03nm*
Dispersion ..... 1.24nm per mm*
Calibration Accuracy 0.05nm*
Reproducibility 0.005nm*
Drive Step 0.0002nm*
Focal Plane 50mm
Aperture ..... f/4.7 (or f/5.8)
Gratings ..... 120*140 (or 110*110mm)
Stray Light Rejection ..... 10^{-5}
Port Possibilities ..... 4, Axial and Lateral
Nitrogen Purge ..... Optional

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision.

Double grating turret available for f/5.8 operation only. Single grating mounts work at f/4.7 or f5.8 with kinematic (patented SNAP IN) mounting. Exchange of gratings is easy, regardless of the method.

Slits: Continuously variable micrometer actuated width from 10um to 2mm. Specify 792 for remote and stepper driven width. Manually adjust height rom 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating. Many other holographic and ruled gratings available.

best aperture for focal length

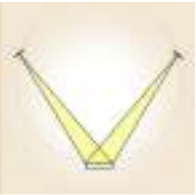
The unique 207 667mm focal length built clean and vacuum tight. Constructed of **stainless steel** this is a **stable instrument** suitable for any spectroscopy technique requiring vacuum or purge conditions. Use the large 120*140mm f/4.7 gratings to optimize for throughput. Opt for f/5.8 110*110mm gratings for the option to use a **dual grating turret.** High quality **master optics** provide excellent performance from about 105nm vacuum ultraviolet all the way to the Infrared. The optics are Aluminum and Magnesium Fluoride coated for best **broadband performance**. Coatings like Gold or Silver can also be provided.
Wavelengths from 105nm to 78-um can be covered within the scanning range and with appropriate gratings. The 207 optics provide **best FWHM spectral resolution**. Aspheres are installed for imaging. The output focusing mirror reduces losses of intensity and delivers spectra across a **large, 50mm focal plane.** Use it for Raman, Photoluminescence, Fluorescence, Emission, Reflection and Transmission.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.013	0.016	0.02	0.03	0.06	0.12	0.24	0.48
Dispersion (nm/mm)	0.41	0.62	0.83	1.24	2.48	4.96	9.9	19.8
Wavelength Range	105 - 430 nm	105 - 650 nm	105 - 860 nm	105 - 1300 nm	105 - 2600 nm	105 nm 5.2 um	105 nm 10.4 um	105 nm 20.8 um

** Resolution measured at 313.1nm with scanning system using 10um wide slits 2mm high.

231



Optical Design	Seya-Namioka
Angle between slits	70°15′
Vacuum Compatible	10^{-6} torr (or 10^{-10})
Wavelength Range	<30 to 300nm*
Focal Length	1m
Resolution, FWHM	0.025nm*
Dispersion	0.83nm per mm*
Calibration Accuracy	0.1nm
Reproducibility	0.005nm
Drive Step	0.0002nm
Focal Plane	25mm
Aperture	f/23
Gratings	30*50mm
Port Possibilities	3
Nitrogen Purge	Optional

Gratings are concave ruled replica or holographic. Single grating with kinematic mount standard.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine approximate range collected per acquision.

Slits: Continuously variable micrometer actuated width from 10um to 2mm. Specify 792 for remote and stepper driven width. Manually adjust height rom 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

spacious at 0.025nm FWHM

The 231 1m Seya-Namioka monochromator is a f/23 optical system in a clean stainless steel housing capable of achieving 10^{-6} torr vacuum. It delivers **resolution of 0.025-nm** with a 1200-g/mm grating and operates by simple rotation of the grating about its apex. An angle of 70° 15' subtends the entrance and exit slit arms. The focal length provides **increased resolution and work space.** Stainless steel construction makes this proven design suitable for use with high vacuum, contaminant free experiments or microchannel plate intensifiiers.
Seya-Namioka mounting maintains all components (slits and gratings) on the Rowland circle. Resolution is maintained over a broad spectral region, astigmatism should be considered depending on the application. The image height at the exit of this instrument is theoretically equal to the height of the entrance image plus 2/3 grating ruled height. Wavelengths from 30-nm to 1.2-um can be covered within the scanning range and with appropriate gratings. The 231 is for scanning and microchannel plate intensifier or CCD spectroscopy.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300
Resolution** (nm)	0.01	0.13	0.017	0.025	0.05	0.1
Dispersion (nm/mm)	0.28	0.42	0.55	0.83	1.6	3.2
Wavelength Range	30 - 100 nm	30 - 150 nm	30 - 200 nm	30 - 300 nm	30 - 600 nm	30 nm 1.2 um

** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.

231 vacuum ultraviolet monochromator with the 629 hollow cathode source, source optimization optic and exit focus optic that concentrates energy at the sample.

Solution: **Hi-Res Excitation**

The 231 delivers 0.025nm full-width half-max spectral resolution and dispersion of 0.83nm/mm when used with a 1200g/mm grating. With this dispersion the 231 is a good choice for seperating narrow and closely spaced emission lines in the vacuum ultraviolet. In the photo at left the 231 is used with a windowless hollow cathode source and optimization optics that increase system throughput and focus vacuum ltraviolet light where needed - at the experiment.

231 App Note: **Synchrotron**

The 231 Seya-Namioka features fixed entrance and exit slit positions as well as fixed beam direction from the exit slit. When used as a scanning spectrometer these valuable characteristics make the Model 231 suitable for use in applications at synchrotron storage rings. The 231M4 is designed specifically synchrotron applications. It offers white light bypass optics as well as diverting optics for the monochromator. Its triple grating turret simplifies instrument demands during experiments.

225

Optical Design	Normal Incidence
Angle between slits	15°
Vacuum Compatible	10^{-6} torr (or 10^{-10})
Wavelength Range	30 to 300nm*
Focal Length	1m
Resolution, FWHM	0.01nm*
Dispersion	0.83nm per mm*
Calibration Accuracy	0.1nm
Reproducibility	0.005nm
Drive Step	0.0002nm
Focal Plane	25mm
Aperture	f/10.4
Gratings	56*96mm
Port Possibilities	3
Nitrogen Purge	Optional

Gratings are concave ruled replica or holographic. Single grating with kinematic mount standard and double or triple grating turrets are available options.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine approximate range collected per acquision.

Slits: Continuously variable micrometer actuated width from 10um to 2mm. Specify 792 for remote and stepper driven width. Manually adjust height rom 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

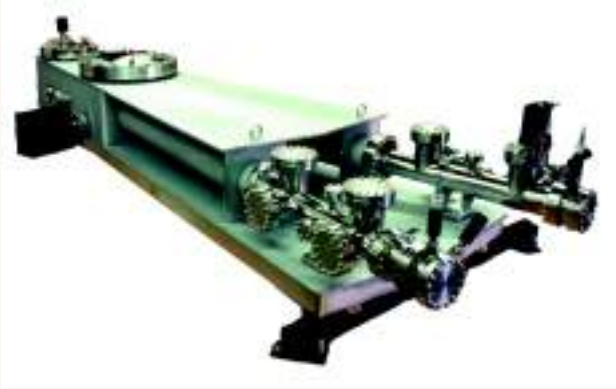
the McPherson 15°

The 225 1m normal incidence monochromator (NIM) has 15° between entrance and exit slits. This design, also known as the McPherson 15°, uses a spherical grating to collect and focus energy. It provides maximum flux density with minimal astigmatism and polarization. This is an ideal imaging instrument for use with microchannel plate intensified or CCD type array detectors. The 225 featrues a stainless steel vacuum chamber. This is an very clean design - the wavelength drive is outside the vacuum vessel. It works with single gratings as well as double and triple grating turrets. It can be used to vertically or horizontally disperse. The grating drive automatically focuses to maintain highest performance throughout the range of interest. The popular normal incidence design is built in focal lengths of 1m and longer. Resolving powers of 78,000 have been obtained at 46.4nm with the a 6.65m version.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300	150	75
Resolution** (nm)	0.005	0.008	0.01	0.015	0.03	0.06	0.12	0.24
Dispersion (nm/mm)	0.28	0.42	0.56	0.83	1.66	3.32	6.6	13.3
Wavelength Range	30 - 100 nm	30 - 150 nm	30 - 200 nm	30 - 300 nm	30 - 600 nm	30 nm 1.2 um	30 nm 2.4 um	30 nm 4.8 um

** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.



2253 3m NIM pictured above. It provides 0.005nm FWHM resolution when used with a 1200g/mm grating.

Solution: **VUV Resolving Power**

The McPherson Normal Incidence Monochromators have been built in focal lengths from 1 to 6.65m. Here is the nominal performance for some popular models.

Focal Length	**2m**	**3m**	**5m**
Resolution (nm)	0.007	0.005	0.003
Dispersion (nm/mm)	0.42	0.28	0.17
Wavelength Range	30 - 300 nm	30 - 300 nm	30 - 300 nm

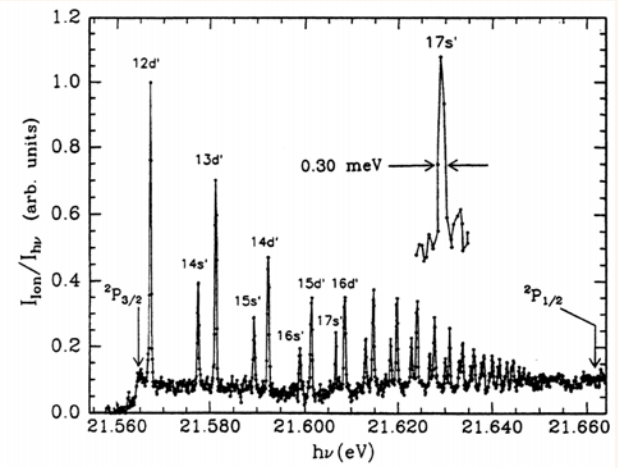
At left, 225 UHV built for 10^{-10} torr

225 App Note: **Calibration**

McPherson normal incidence monochromators set and transfer standards for national metrology labs around the world.
NIST (USA) uses a 2 meter version and the Physikalische Technische Bundesanstalt (PTB, Germany) uses a 1 meter. The 1m is most popular and is also in use at NASA, JPL, LLNL, Sandia and many prestigous laboratories.

Highest Resolution NIM

The McPherson Eagle, 6.65m focal length normal incidence monochromator, shown below, achieves **record resolving power > 72,000 at 21.6 eV, and > 100,000 at 12.13 eV.** This instrument is an *Eagle* design. It is like our 225 but with a twist. The plane of dispersion remains on axis. It is used at the Advanced Light Source, Lawrence Berkeley National Laboratory. The ground breaking research facilitated by this instrument has been widely published.



Typical applications for this instrument include photoionization studies, photochemistry, and crossed beam reactive scattering.

248/310

McPHERSON

Optical Design ..... Grazing Incidence
Angle between slits ..... 88 to 84°
Vacuum Compatible ..... 10^{-6} torr (or 10^{-10})
Wavelength Range ..... <1 to 310nm
Focal Length 1m
Resolution, FWHM 0.018nm*
Dispersion ..... 0.05 - 0.27nm/mm*
Focal Plane 40mm
Aperture f/44
Gratings 25*20mm
Port Possibilities 2

Gratings are concave ruled replica or holographic. Single grating with kinematic mount standard.

The 248/310 may be used with a scanning exit slit, CCD detector mounted normal to exit ray, or a microchannel plate intensifier mounted tangent to the Rowland circle.

Entrance and exit slit position interchangable.

Scanning System: 789A-3 digital stepper drive 18,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

extreme UV for your lab

For 1 to 100-nm region choose the 1m focal length grazing incidence spectrometer 248/310. This instrument is packed with features **simplifying measurement in the extreme UV.** The monochromator scans wavelengths by moving the exit slit along the Rowland circle. Alternately, a **microchannel plate intensifier or CCD can be scanned.** A wide variety of available gratings allow wavelength coverage from **< 1 to 310nm**. Kinematically mounted gratings insure that gratings repeat position when interchanged.

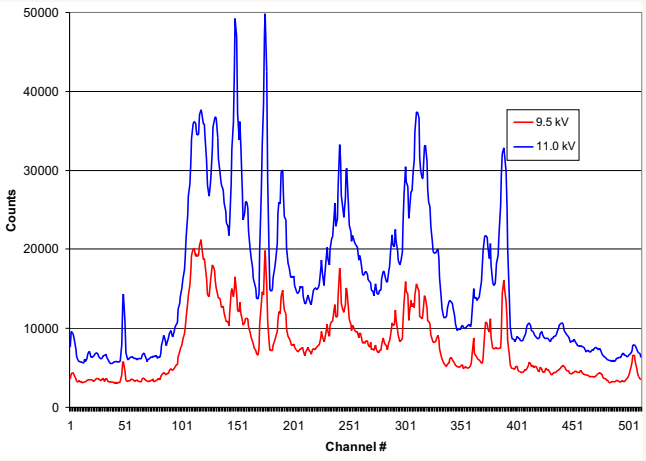
The 248/310G is available as a single channel scanning instrument, a multi channel spectrometer (using microchannel plate intensifier or CCD) and, when configured to operate in reverse, **a variable source of extreme ultraviolet and soft x-ray emissions.**

All versions can be supplied with o-ring sealed vacuum or UHV all metal sealed compatibility. The variable angle of incidence helps optimize for the wavelength region of interest. The precision machined Rowland circle is accurate to ± 4 microns. There is an optional integral filter mount useful when working at the highest energies.

Performance with Alternate Gratings

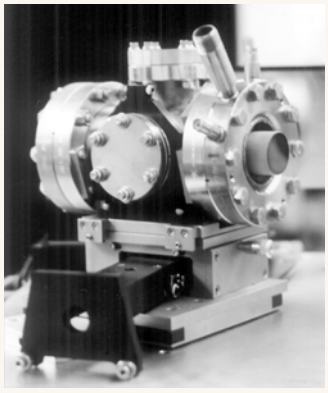
Grating Groove Density (g/mm)	2400	2160	1800	1200	600	576	300	133.6
Resolution** (nm)	0.009	0.01	0.012	0.018	0.036	0.038	0.072	0.16
Dispersion (nm/mm)	.03 - .15	.03 - .16	0.4 - .18	.05 - .27	.08 - .34	.08 - .34	.16 - .70	.40 - 1.6
Wavelength Range	1 - 17 nm	1 - 19 nm	1 - 23 nm	1 - 35 nm	1 - 70 nm	1 - 73 nm	1 - 140 nm	1 - 310 nm

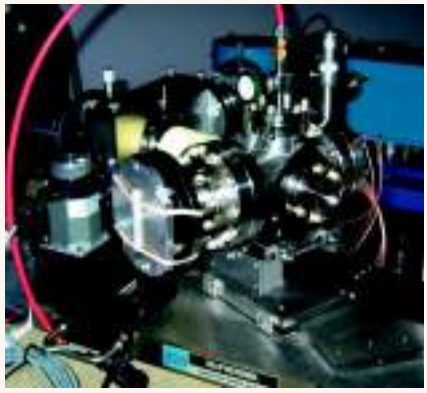
** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.

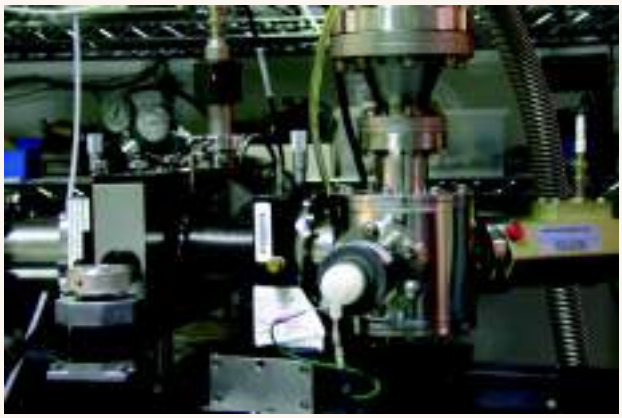


Solution: **Array Detectors**

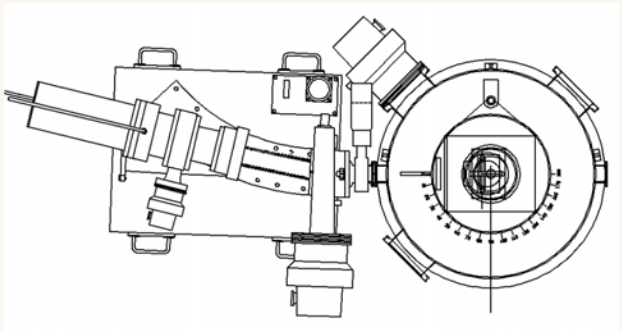
The 248/310 delivers! This instrument function as a high resolution scanning monochromator or a spectrograph for the extreme ultraviolet. At left, ionized Xenon spectra collected by CCD from a Z-pinch. Data centered at about 11nm. Photos below, left to right, showing the 248/310 with CCD, the microchannel plate mounting and adjustment chamber and the complete 248/310 with mounted 6-strip microchannel plate. It is being scrubbed by UV light from a low pressure Mercury pen lamp.







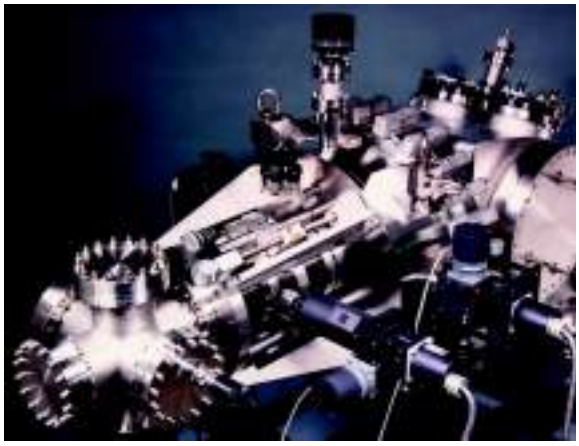
Above, the 642 filament x-ray source with exchangeable anodes on the 248/310 scanning slit. This is from the Chandra satellite calibration set up. Below the 248/310 is mounted on a reflectometry test chamber.



248/310 App Note: **Astrophysics Calibration**

Calibration and reflectance work can be performed with the 248/310. Built in reverse, the light source is mounted on the scanning carriage. Tune the monochromator to a specific wavelength and have a good, fixed focus point and trajectory exit beam for calibration and reflectometry. The light sources used with the monochromator set up this way should be compact. Choices include hollow cathode 629 and the filament x-ray source 642. The latter is shown in the photo. It has two equivalent output beams that help facilitate absolute measurements. The 642 anodes may be readily interchanged. There are many different anodes and combinations available. This combination of source and monochromator are for laboratory work in the highest energy range attainable with diffraction grating instruments. The 248/310 is a relatively small instrument that can be mounted horizontally or vertically. It is easy to integrate with your test chambers.

247



extreme spectroscopy

Optical Design ..... Grazing Incidence
Angle of Incidence ..... 88 to 82° variable
..... in vacuum
Vacuum Compatible ..... 10^{-6} torr (or 10^{-10})
Wavelength Range ..... <1 to 250nm
Focal Length 2.2m
Resolution, FWHM 0.008nm*
Dispersion 0.023-0.15nm/mm*
Focal Plane 40mm
Aperture f/43
Gratings 30*50mm

Gratings are concave ruled replica or holographic. Single grating with kinematic mount standard. The 247M22 version (pictured) features a triple turret.

The 247 may be used with a scanning exit slit, CCD detector mounted normal to exit ray, or a microchannel plate intensifier mounted tangent to the Rowland circle.

Entrance and exit slit position interchangable.

Slits: Continuously variable micrometer actuated width from 10um to 1mm. Specify 792 for remote and stepper driven width. Manually adjust height from 2 to 20mm.

Scanning System: 789A-3 digital stepper drive 36,000 steps per revolution, RS232 interface

Size .....
Weight .....

* Specification set with 1200g/mm grating.

The 2.2m focal length grazing incidence spectrometer 247 resolves better than 0.01nm FWHM in the extreme UV. This instrument allows you to vary the angle of incidence while under vacuum**.** The 247 may be used with a scanning exit slit, CCD detector mounted normal to exit ray, or a microchannel plate intensifier mounted tangent to the Rowland circle. The entrance and exit slit positions are interchangeable. Configured to operate in reverse, **a variable source of extreme ultraviolet and soft x-ray emissions.**

A wide variety of available gratings allow wavelength coverage from **< 1 to 250nm**. Kinematically mounted gratings insure that gratings repeat position when interchanged. The247M22 is available with a three grating turret and two detectors that may be moved along the Rowland circle while under vacuum.

All versions can be supplied with o-ring sealed vacuum or UHV all metal sealed compatibility. The precision machined Rowland circle is accurate to ± 4 microns.

Performance with Alternate Gratings

Grating Groove Density (g/mm)	3600	2400	1800	1200	600	300
Resolution** (nm)	0.003	0.004	0.006	0.008	0.015	0.030
Dispersion (nm/mm)	.011-.05	.012-.075	.015-.10	.023-.15	.037-.30	.064-.60
Wavelength Range	1 - 21 nm	1 - 32 nm	1 - 23 nm	1 - 63 nm	1 - 125 nm	1 - 250 nm

** Resolution measured at 184.9nm with scanning system using 10um wide slits 2mm high.

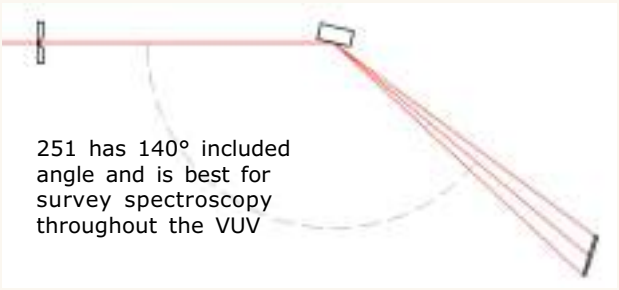
251

Optical Design ..... Flat-field Corrected Grating
Vacuum Compatible .... 10^{-6} torr (or 10^{-10})

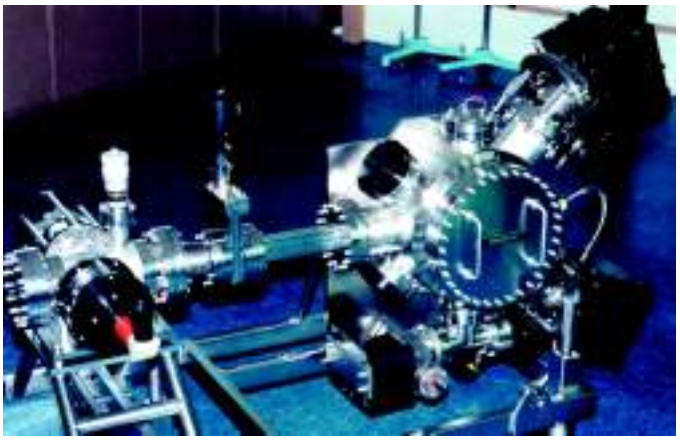
Gratings for the 251 are toroidal substrate ion milled aberration corrected master gratings. The 251MX uses ion milled aberration corrected replicas on a spherical substrate.

Multiply *dispersion* of the selected grating with the *width* of your CCD (*mm)* to determine range collected per acquision. Grating designs furnish either 40 or 25mm wide flat, in focus spectra. Refer to gratings.

Slits: 251 entrance slit is dove tail guided fixed width slit. It may be exchanged at atmsophere. The 251MX entrance slit is variable. It has micrometer actuated width from 5um to 1mm.



251 has 140° included angle and is best for survey spectroscopy throughout the VUV

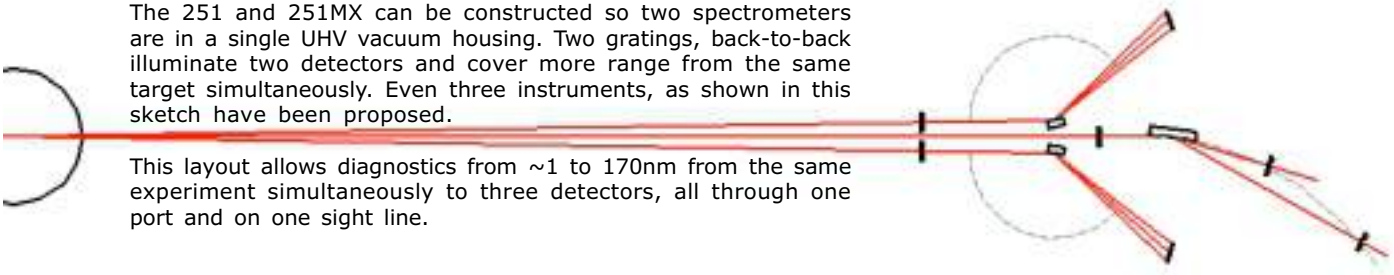


VUV flat field & imaging

251 and 251MX are toroidal and aberration corrected grating **flat field** instruments. These **simplify work in the soft x-ray and extreme ultraviolet**. The flat field instruments works over a fixed wavelength range. The design of the toroid and aberration corrections restricts the range of use. In comparison to other designs, this severely limits the selection of gratings. This geometry allow you to **use a CCD for direct detection** of the high-energy spectra. Microchannel plate (MCP) intensifiers can be reserved for those systems requiring gating. The flat field 251 and 251MX lend themselves well to **fast acquisition** of predetermined and fixed spectral regions. Instrument construction lends itself to operation in any attitude and ultra high vacuum (UHV, 10^{-10} torr) compatibility. We test and ship the 251 and 251MX as instruments or complete systems, with detectors.

The 251 and 251MX can be constructed so two spectrometers are in a single UHV vacuum housing. Two gratings, back-to-back illuminate two detectors and cover more range from the same target simultaneously. Even three instruments, as shown in this sketch have been proposed.

This layout allows diagnostics from ~1 to 170nm from the same experiment simultaneously to three detectors, all through one port and on one sight line.



VUV Flat Field Instrument Performance

Model	Deviation Angle	Resolution (nm)	G/mm	Focal Plane Width (mm)	Spectral Range (nm)	Spectral Range (eV)
251MX	172°	0.01	2400	25	1 to 5	248 to 1240
251MX	167°	0.028	1200	25	5 to 20	62 to 248
251	140°	0.05	2105	40	9.5 to 32	39 to 130
251	140°	0.10	450	40	10 to 110	11 to 124

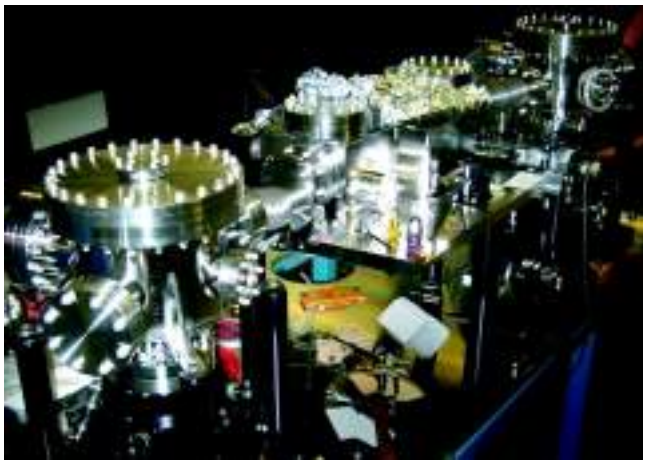
XCT

Optical Design ..... Grazing Incidence
Angle of Incidence ..... 82°
Vacuum Compatible ..... 10^{-6} torr (or 10^{-10})
Wavelength Range ..... <5 to 60nm
Focal Length 2m
Resolution, FWHM 0.1nm*
Aperture f/50
Gratings 50*50mm

Gratings are plane, ruled replica or holographic. The triple grating mount is standard.

The XCT may be used for scanning applications with an exit slit or array detectors (eg. CCD or microchannel plate intensifiers.)

Slits: Continuously variable micrometer actuated width from 10um to 1mm. Specify 792 for remote and stepper driven width. Manually adjust height from 2 to 20mm.



extreme UV with fixed focus

The 2m grazing incidence Czerny-Turner,XCT, uses plane gratings and provides fixed focus and fixed slit position. This is sdifferent from Rowland circle systems. Use the XCT with experimental sources that can not be scanned and large experimental chambers, like reflectometers. The XCT triple grating rack is standard equipment. The XCT can be supplied with o-ring sealed vacuum or UHV all metal sealed compatibility.

SGM

Optical Design ..... Grazing Incidence
Angle of Incidence ..... 87.5°
Vacuum Compatible ..... 10^{-10}
Wavelength Range ..... 1 to 15nm, 1000 to 80eV
..... 5° with 0.02arcsec accy
Focal Length 35m
Resolving Power ..... ~6000
Gratings 82*140mm

Gratings are concave, spherical ion etch holographic masters. The triple grating mount is standard and available with facilities for water cooling.

Entrance and exit slits can be scanned 300 and 75mm respectively, for optimum focus positioning.

Slits: Continuously variable micrometer actuated width from 5um to 1mm. Entrance is water cooled.

extreme UV workhorse

SGM beamline monochromator - a high performance monochromator complete with an water cooled entrance slit, cooled zero order baffle, internally cooled gratings (3.) Index gratings under vacuum, manually or by motor control. Entrance and exit slits may be scanned to obtain best focus. Ultra high vacuum (UHV) instruments are baked and RGA tested prior to shipment.

PGM

plane grating monochromator

Optical Design ..... Grazing Incidence
Angle of Incidence ..... 77 to 88.5°
Vacuum Compatible ..... 10^{-10}
Wavelength Range ..... 0.5 to 240nm, 2300 to 5eV
..... 23° with 10arcsec accy
Focal Length 6m
Resolving Power ..... ~10,000
Gratings 30*100mm

Gratings are plane, ion etch (laminar and blazed) masters. The double grating mount is standard and available with facilities for cooling.

Slits: Continuously variable micrometer actuated width from 5um to 1mm. Entrance is water cooled.

Modes of Operation

high throughput - synchronously scans pre-mirror and grating angles to stay on blaze

fixed focus - selects and drives pre- mirror and grating angle for desired wavelength

high order rejection - selects and drives pre- mirror and grating angle for desired wavelength, and alters the same to avoid multiple order effects

constant wavelength - selects wavelength and drives pre-mirror and grating to maintain wavelength and find peak intensity or throughput

independent - allows user to set desired grating and pre-mirror angle and pre-mirror position

McPherson PGM beamline monochromator and complete beamlines. The dual or triple grating PGM provides soft x-rays with high resolution and intensity from 0.5 to 240nm (2300 - 5eV). Theoretical resolution with a 360g/mm grating is less than 0.01eV at 10eV and less than 0.1eV at 443eV.

Our synchrotron beam line products include high precision bilaterally adjustable slits, apertures, mirror manipulators, mounts and chamber systems. Many of these also available with efficient wter cooling. Unique proven McPherson designs separate support members for chambers and precision grating mechanism. This for reduced sensitivity to vibration and thermal environmental factors. Scan grating angle by computer control and use rotary or laser tilt encoders for absolute feedback. Index gratings under vacuum, manually or by motor control. Ultra high vacuum (UHV) instruments are baked and RGA tested prior to shipment. We have a variety of beam line instruments and accessories available.

At left a 4m focal length normal incidence monochromator (like the 225) intended for the CAMD synchrotron at Louisiana State University.
At right a strut style mirror mount and maniulator and accessory flanges for UHV installations.