

The portability, resolving power, throughput (étendue), low stray light, and broad wavelength coverage of the EMU-120/65 makes the instrument ideal for LIBS (laser-induced breakdown spectroscopy), Raman, absorption, OES/AES, photoluminescence and other spectroscopy applications.

The EMU-120/65 is suitable for isotopic analysis and other applications requiring a high resolution spectrograph. The maximum resolving power (λ / FWHM) across the spectrum can exceed 60,000 with the IX grating cassettes.

The resolving power, wavelength coverage and throughput of the EMU instruments are critical for combined LIBS/Raman data acquisition. The F/4 120mm collimating mirror combined with the F/2.2 65mm camera focusing optics will reduce the slit image size by 0.54x. The slit demagnification allows the use of larger slits for improved throughput. The throughput of the EMU-120/65 can be 10x to 20x higher than other broadband echelle instruments, which are typically $\sim F/10$.

The EMU-120/65 is designed to take advantage of the characteristics of EMCCD cameras. These cameras have higher quantum efficiency, resolution, and frame rate than ICCD cameras. EMCCDs are more compact and less expensive than ICCDs. EMCCD cameras cannot be easily damaged by overexposure to light, unlike ICCDs.

The low stray light, along with software-controlled stray light removal algorithms, make this spectrograph a very powerful instrument for absorption spectroscopy.

The EMU-120/65 is designed, manufactured and marketed by Catalina Scientific Instruments, LLC, and it is protected under US Patents 7,936,454 and 7,936,455.

EMU-120/65 UV/VIS/NIR

High Resolution High Throughput Very Low Stray Light Echelle Spectrograph

- EMU is the **Echelle Multiplex Unit**
- High étendue (numerical aperture x slit area) allows for high throughput.
- Covers the entire wavelength range of the detector (190nm - 1100nm) and acquires completely linearized spectra in units of wavelength or Raman shift.
- Can be used with a variety of CCD, EMCCD, ICCD and CMOS cameras.
- A variety of user interchangeable grating cassettes, aperture stops, and entrance slits to optimize applications.
- Highest resolving power up to 60,000 with the IX series grating cassettes.
- Proprietary stray light and order cross-talk correction algorithms provide the highest quality spectra.

Interchangeable Grating Cassettes



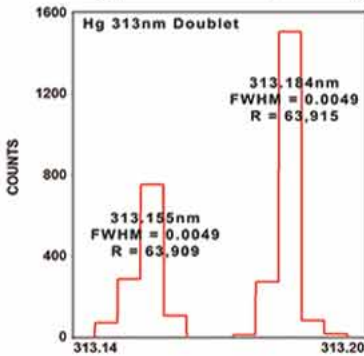
grating

HT Series:	up to R = 9,500
HR Series:	up to R = 12,000
UV Series:	up to R = 30,000
IS Series:	up to R = 40,000
IX Series:	up to R = 60,000

The grating cassettes for the EMU-120/65 are user interchangeable. The above values for R (λ / FWHM) are based upon $8 \times 8 \mu$ pixel size and $10\text{-}14 \mu$ wide entrance slit.

Resolving Power

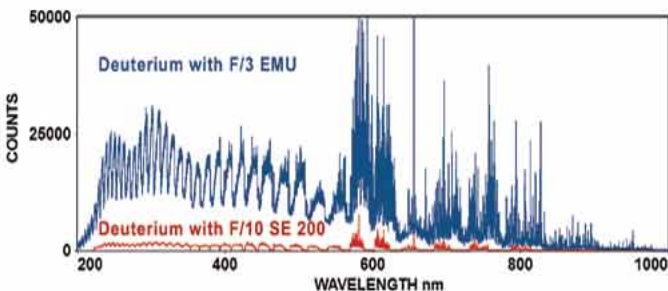
The EMU-120/65 optical design can yield **single pixel** resolving power with high throughput.



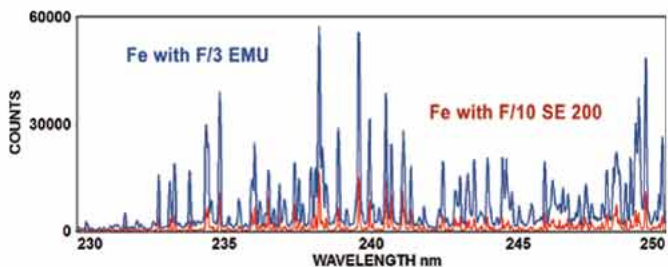
The Hg 313.155nm and 313.184nm doublet is clearly resolved using the IX series cassette. Each peak is one CCD pixel wide (8 microns) using an entrance slit 10 microns wide. Each peak has 0.0049nm FWHM resolution, for a resolving power of about 63,900. The IX cassettes have the highest resolving power.

Throughput/Etendue Comparisons

The deuterium/tungsten spectra below compare the throughput of an EMU (blue) with an SE 200 (red) echelle spectrograph. The EMU is configured with F/3 camera focusing optics and the SE 200 is F/10. Both systems had the same grating, same camera and same sized slit.

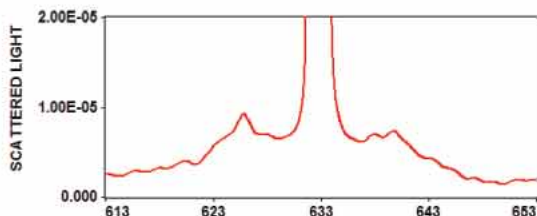


The iron LIBS spectra below compare the throughput of the EMU and EMCCD system (blue) with an SE 200 and ICCD system (red). Both echelle spectrographs used similar sized slits and exposures, and both used 10 laser shots.



Stray and Scattered Light

The overexposed HeNe laser line below shows the small angle scattering caused mostly by the grating. Scattered light is measured as a fraction of the HeNe peak intensity, and it drops below the CCD dynamic range limit at a fraction of a nm from the peak. The EMU-120/65 is designed to minimize stray light beyond the region affected by the scattering.



KestrelSpec™ Software

Industry-standard KestrelSpec™ software controls the EMU-120/65 system, with complete real-time camera control and spectra acquisition. Our unique "3-point calibration" to calibrate the EMU spectrograph is performed quickly and easily with high accuracy. Spectral diffraction orders are automatically linked, linearized and plotted as the data is acquired in either nm or cm^{-1} units. Image and spectral data can be easily exported in various formats. An Element Identification tool with a user-editable reference library can identify the elements in atomic emission spectra. A Windows DLL (dynamic link library) is available for control of the EMU spectrograph by third party developers' applications.

EMU-120/65 Specifications

- At the collimator: maximum F/4 input optics
- At the detector: max. F/2.2 camera focusing optics
- Focal Length (collimator): 120mm
- Focal Length (camera focusing optics): 65mm
- Magnification: $\sim 0.54x$
- Wavelength Coverage: 190nm - 1100nm
- Scattered Light: $2.0E-05$ at 1nm from the HeNe 633nm peak with an HR2 cassette
- Stray Light: $\sim 2.0E-06$
- Unit Volume: 7575 cm^3 (462 cubic inches)
Fits into a 390 x 255 x 170 mm box (15.5 x 10.0 x 6.5 inches) excluding camera, adapters and base
- Weight: 7 kg (15 lb) without camera, base, adapters
- Fiber Optic Input: SMA connector
- Entrance Slits: user interchangeable in varied sizes
8 to 128 μ wide, 12 to 128 μ tall
- Aperture Stops: user interchangeable in varied sizes
12 to 30mm in diameter
- Grating Cassettes: user-interchangeable gratings
with blaze angles from 32° to 76°

Computer System Requirements

- Windows™ XP/Vista/7/8/10 (32-bit or 64-bit)
- Appropriate driver to interface with the detector

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