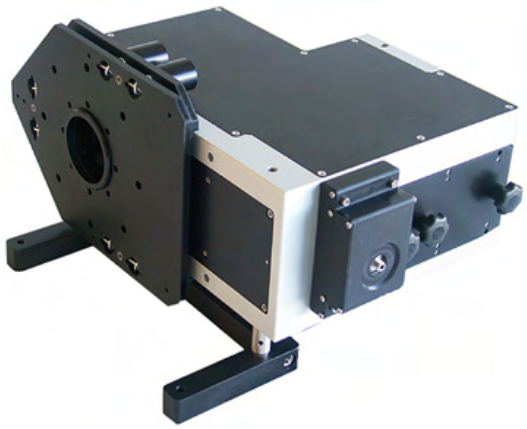
kestrel™ spectroscopy systems

Catalina Scientific



EMU-65

High Resolution
High Throughput
Ultra-Low Stray Light
Echelle Spectrograph

- Very high etendue (numerical aperture x slit area)
- Resolving power up to 31,000 λ/FWHM with UVU series of dispersion cassettes
- Can be used with a variety of CCD, EMCCD and ICCD cameras
- Covers the entire range of the CCD detector (UV-VIS-NIR) and acquires completely linearized spectra in units of wavelength or Raman cm^{-1} shift
- A variety of interchangeable dispersion cassettes, aperture stops, and entrance slits are adaptable to many user applications.
- Custom collimator optics within the spectrograph can be designed to match the input numerical aperture from the source collection optics.

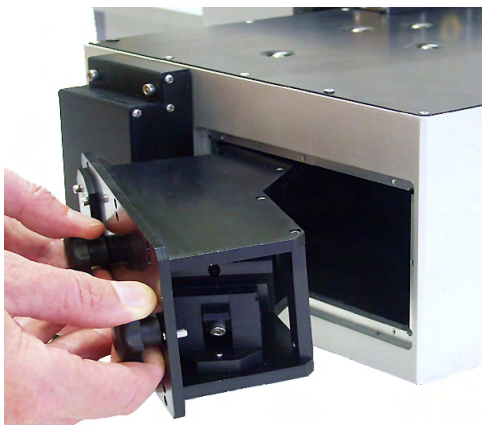
The EMU-65 has the highest etendue of any broadband echelle spectrograph, and it is designed to match N.A.= 0.22 (F/2.2) input fibers. The throughput can be 10x to 20x higher than other broadband echelle-type instruments, which are typically ~F/10.

The EMU-65 spectrograph is designed to take advantage of the characteristics of new EMCCD cameras. These cameras have higher quantum efficiency, resolution, and frame rate than ICCD cameras commonly used for LIBS (laser-induced breakdown spectroscopy). EMCCDs are smaller and more robust than ICCDs, they cannot be damaged by overexposure to light and they are less expensive than ICCDs. The noise level of an EMCCD is almost as low as an ICCD.

Because of its high etendue and resolving power, the EMU-65 is the first echelle spectrograph that is versatile enough for both LIBS and Raman applications. Its exceptionally low stray light offers performance more comparable to double monochromators than other echelle-type spectrographs.

KestrelSpec™ software is used to calibrate and create spectral data for the EMU-65. The software supports numerous CCD, EMCCD, and ICCD cameras. Wavelength calibration is fast and accurate using an Hg/Ar light source.

The EMU-65 is designed, manufactured and marketed by Catalina Scientific Instruments, LLC. CSI has a patent pending for the EMU-65 spectrograph.

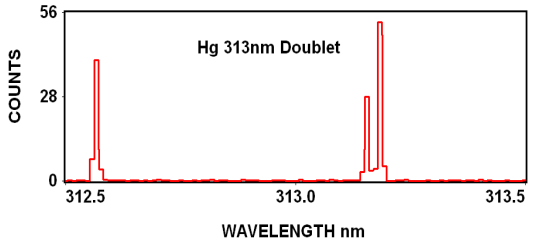


The custom dispersion cassettes on the EMU-65 are interchangeable

Resolving Power

The EMU-65 "cutting edge" optical design can yield ***single pixel*** resolving power with high throughput.

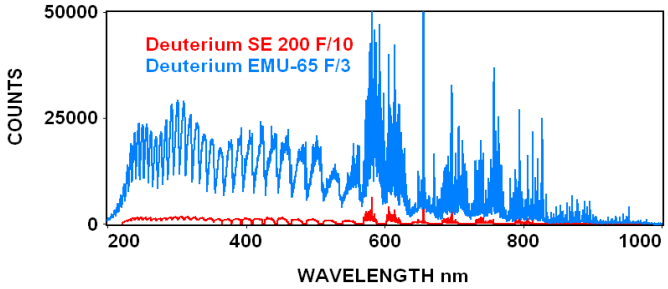
The Hg 313.155/313.184nm doublet is clearly resolved using the UVU2 cassette. Each peak is one 8μ CCD pixel wide using an 8μ width slit. Each peak shown has 0.010nm FWHM resolution.



Throughput/Etendue Comparisons

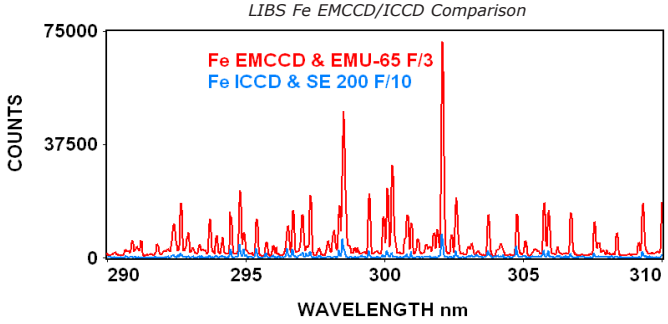
The deuterium/tungsten spectra below compare the throughput of an EMU-65 (blue) with an SE 200 (red) echelle spectrograph. Both systems used the same grating, camera and slit size.

Throughput/Etendue comparison between the EMU-65 and the SE 200 echelle spectrographs



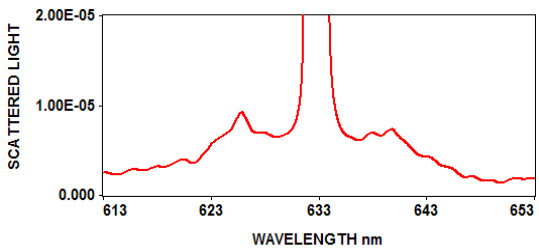
The iron spectra below compare the throughput of the EMU-65/EMCCD system (red) with an SE 200/ ICCD system (blue). Both echelle spectrographs used similar sized slits and exposures.

LIBS Fe EMCCD/ICCD Comparison



Stray and Scattered Light

The overexposed HeNe 633nm 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-65 is designed to minimize stray light beyond the region affected by the scattering.



KestrelSpec™ Software

The EMU-65 system is controlled by industry-standard KestrelSpec™ software, with complete real-time camera control and spectral acquisition. Our unique "3-point calibration" is performed quickly and easily with high accuracy. Spectral diffraction orders are automatically linked, linearized and plotted as data is acquired. Image and spectral data can be easily exported as ASCII files. An Element Identification tool with a user-editable reference library can identify the elements in atomic emission spectra for applications such as LIBS.

EMU-65 Specifications

- Input: F/2 to F/3.3 aperture stops
- Focal Length (collimator): 65mm
- Magnification: ~ 1:1
- Wavelength Coverage: 190-1100nm
- Resolving Power* (λ/FWHM)
  - HTU Series Cassettes (at F/3.3)
    - 4700 with 16μ slit
    - 9500 with 8μ slit
  - HRU Series Cassettes (at F/3.3)
    - 6000 with 16μ slit
    - 12,000 with 8μ slit
  - UVU Series Cassettes (at F/3.3) with data gaps above ~500nm
    - 14,000 with 16μ slit
    - 27,000 with 8μ slit
- Scattered Light: 2.E-05 at 1nm from HeNe 633nm peak using the HRU2 cassette
- Stray Light: ~2.E-6
- Unit Volume: 6120 cm^3 (360 cubic inch)
  Fits into a 265 (10.5) x 210 (8.5) x 110 (4.5) mm (inch) box excluding camera, adapters and base
- Weight: 5 kg (11 lb) w/o camera, base, adapters
- Fiber Optic Input: SMA connector
- Slits: User interchangeable
- Dispersion Cassettes: User interchangeable

* Resolving power is listed as the average λ/FWHM from 200-1100nm using an 8x8μ pixel detector.

Computer System Requirements

- Windows™ 2000/XP/Vista
- Appropriate driver to interface with the CCD

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