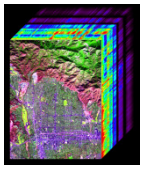

A High Uniformity and High SNR Imaging Spectrometer for Science Measurements of the National Ecosystem Observatory Network (NEON)

Robert O. Green, Michael Eastwood, and Carl Bruce

Jet Propulsion Laboratory, California Institute of Technology

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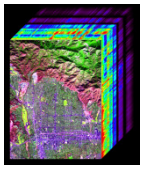
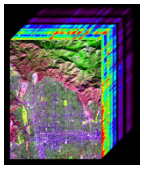
Overview



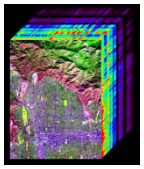
- Enabling elements of a high uniformity and high SNR imaging spectrometer
- Uniformity required for imaging spectroscopy
- Signal to Noise Ratio
- Critical elements of NEON imaging spectrometer
- Overall Configuration
- Summary

Five Unique Enabling Capabilities Held at JPL



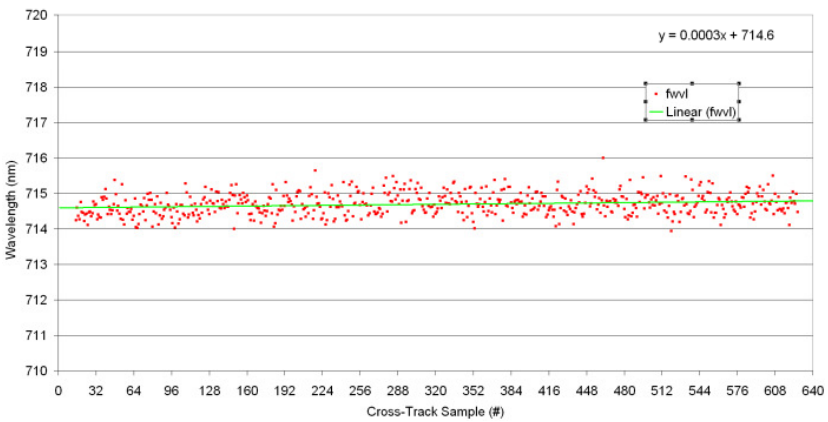
- Mouroulis Design
- Electon beam lithography gratings
- Electron beam lithography air slits
- Finely adjustable mounts that can be locked with fraction of a micron precision and accuracy
- Alignment and calibration sources and methodologies to achieve requirements.

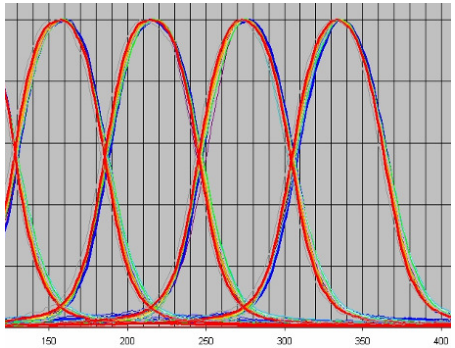
Design Performance :Uniformity



Uniformity is enables straightforward spectroscopy in the image domain

Five enabling elements
- Spectrometer design (Mouroulis)
- Uniform air-slit (e-beam)
- Curved multi-blaze grating (e-beam)
- 0.2 um adjustable mounts for flight
- Alignment technique for 0.2 um adjustments

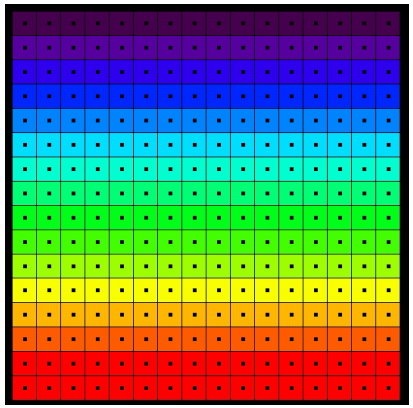




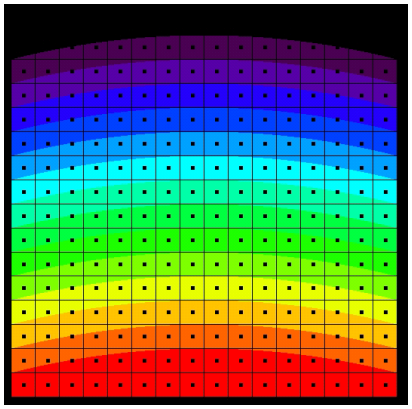
Pushbroom Uniformity Depiction
- Grids are the detectors
- Spots are the IFOV centers
- Colors are the wavelengths

Cross-Track

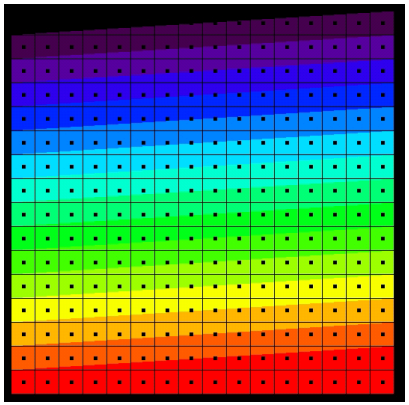
Wavelength



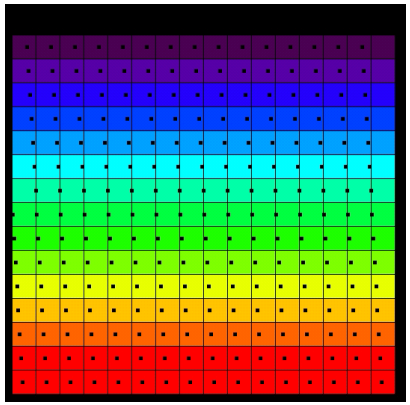
√ **Uniformity Goal**



X Cross-Track "frown"

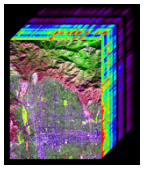


X Cross-Track Twist

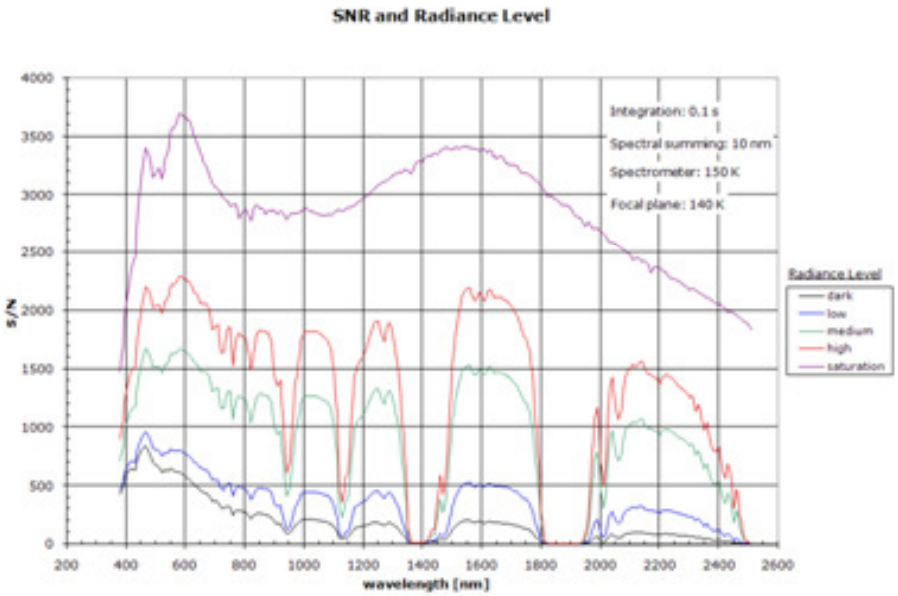


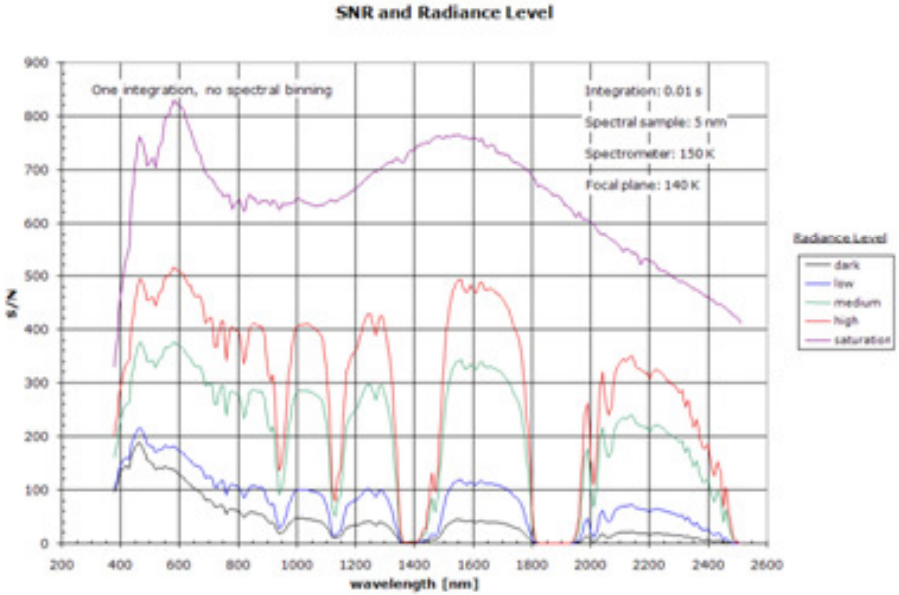
X Spectral-IFOV-shift

NEON Imaging Spectrometer Predicted SNR



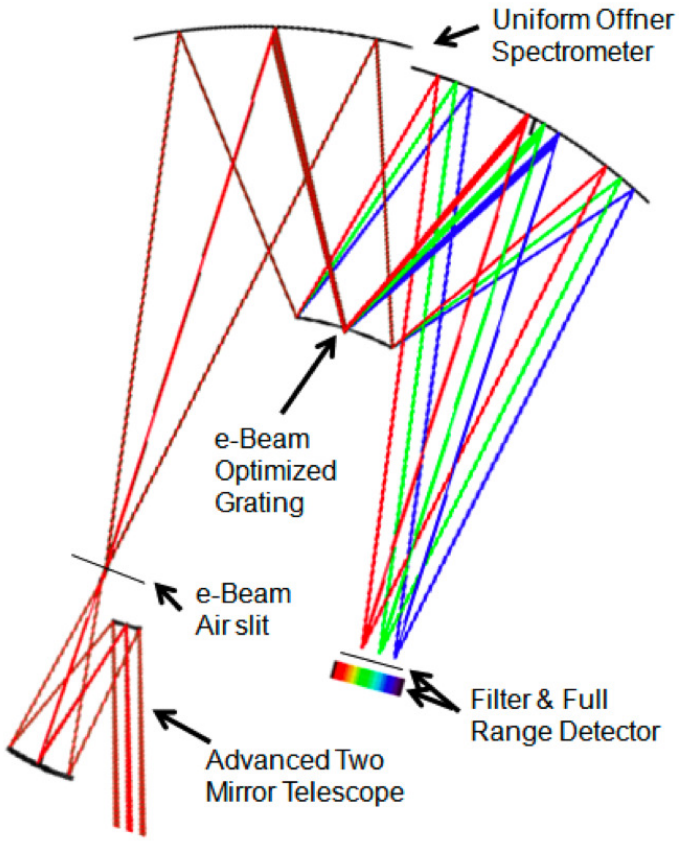
High SNR along with uniformity has been shown to be the most critical requirement for ecological science pursued with imaging spectroscopy measurements

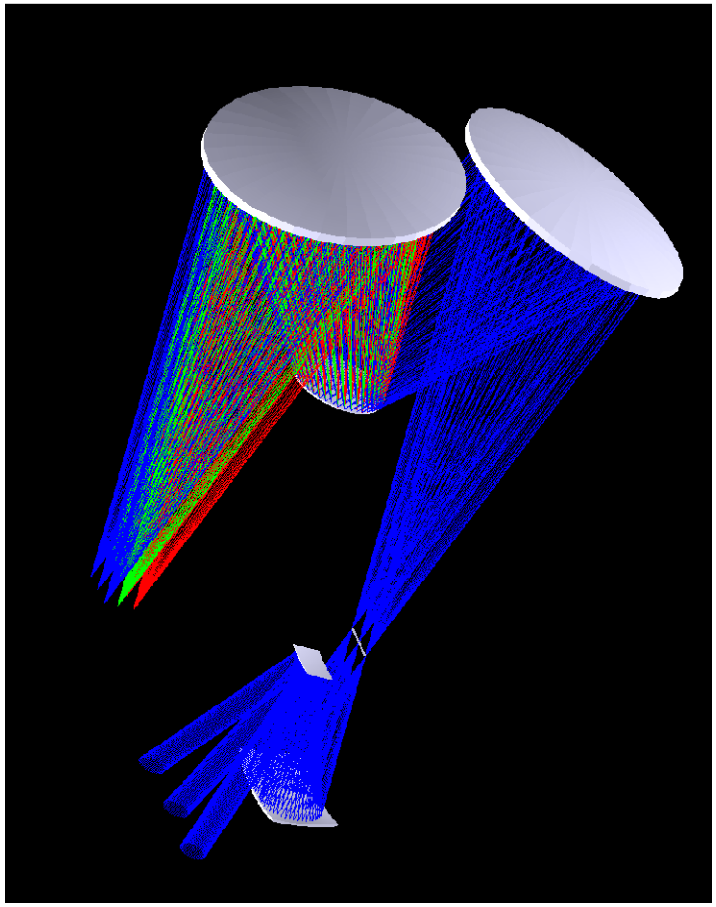




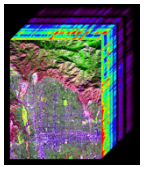
Third Gen Mouroulis Optical Design

Mouroulis Journal Article establishing this design form: Mouroulis P., Green R. O., Chrien T. G., “Design of pushbroom imaging spectrometers for optimum recovery of spectroscopic and spatial information,” APPL OPTICS 39: (13) 2210-2220 MAY 1 2000

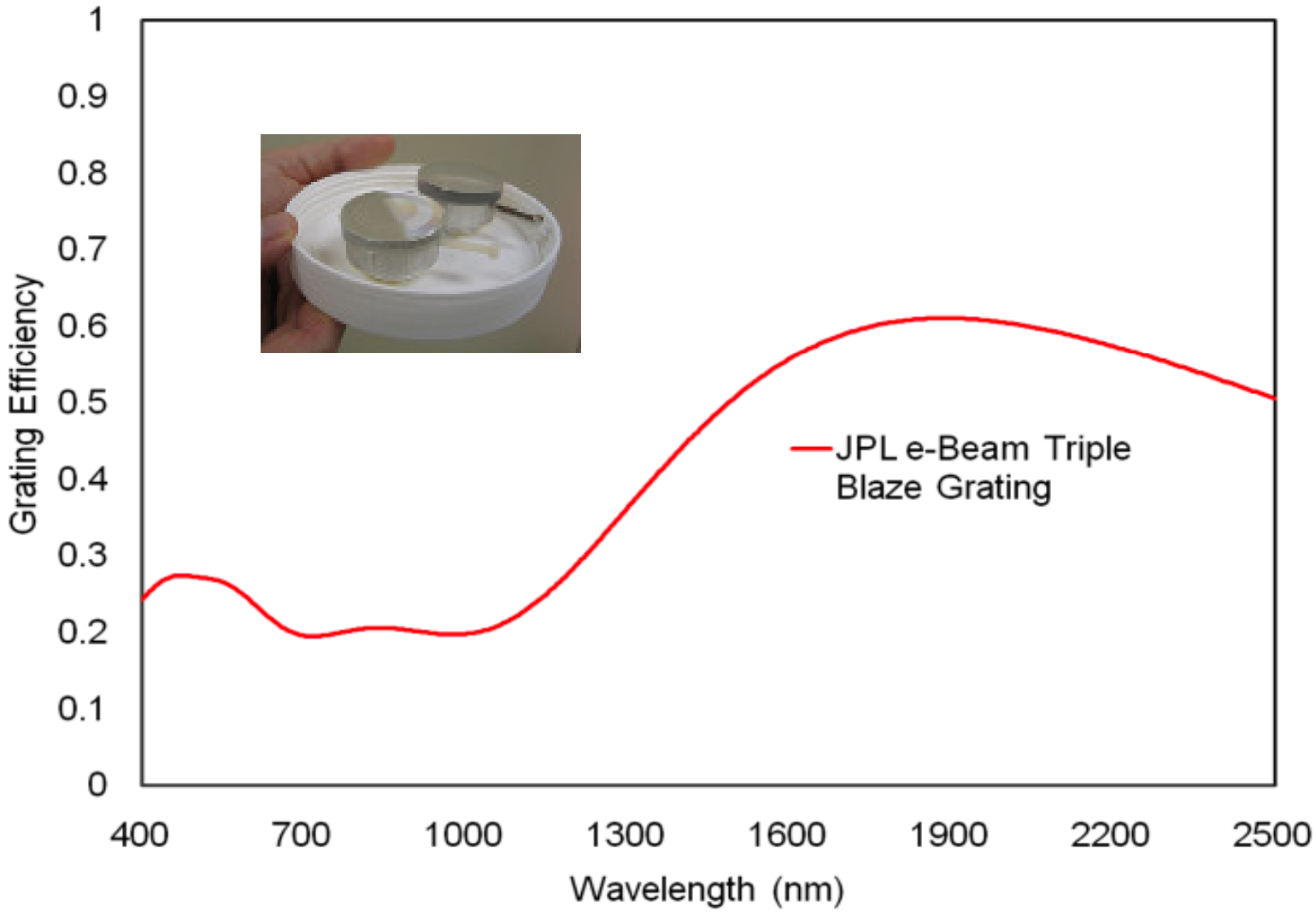




Unique Custom Triple Blaze Grating:



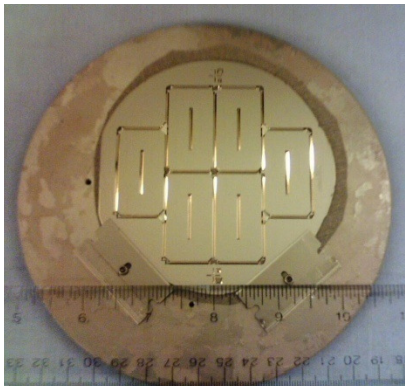
Allows full coverage from 400 to 2500 nm with one detector
Required for science measurement uniformity and robust design



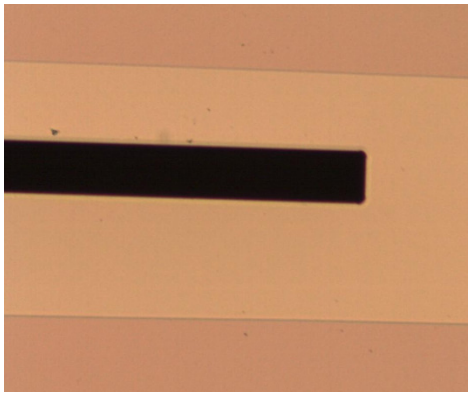
Unique SiN e-Beam Lithography based Air Slit:

Required to achieve science measurement uniformity requirement

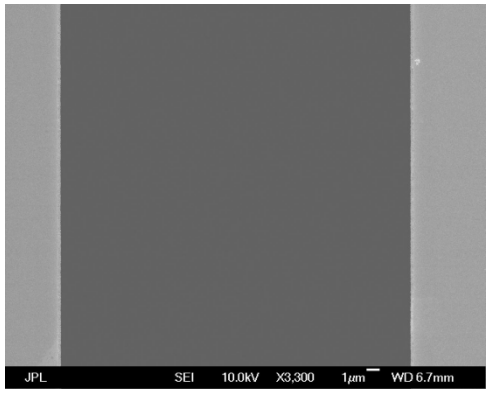
Wafer

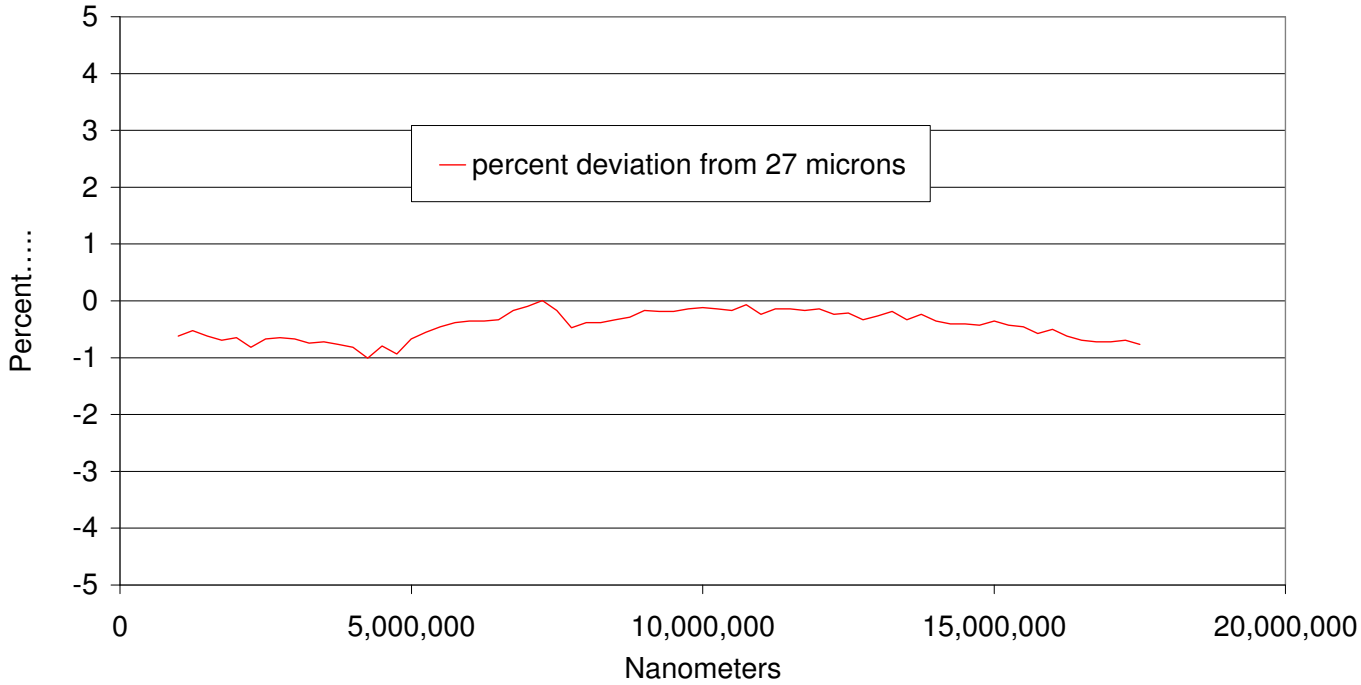


Photograph

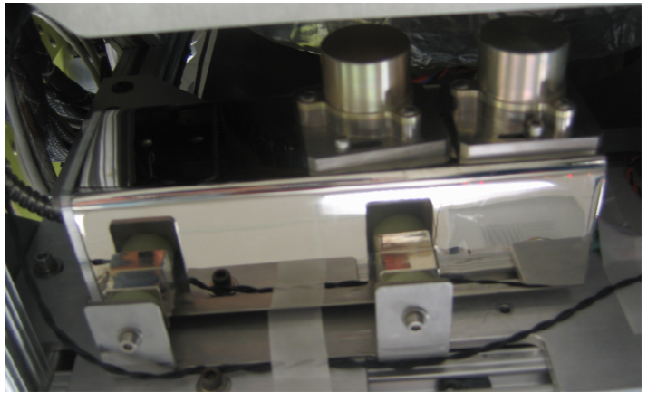


SEM Edges of Slit



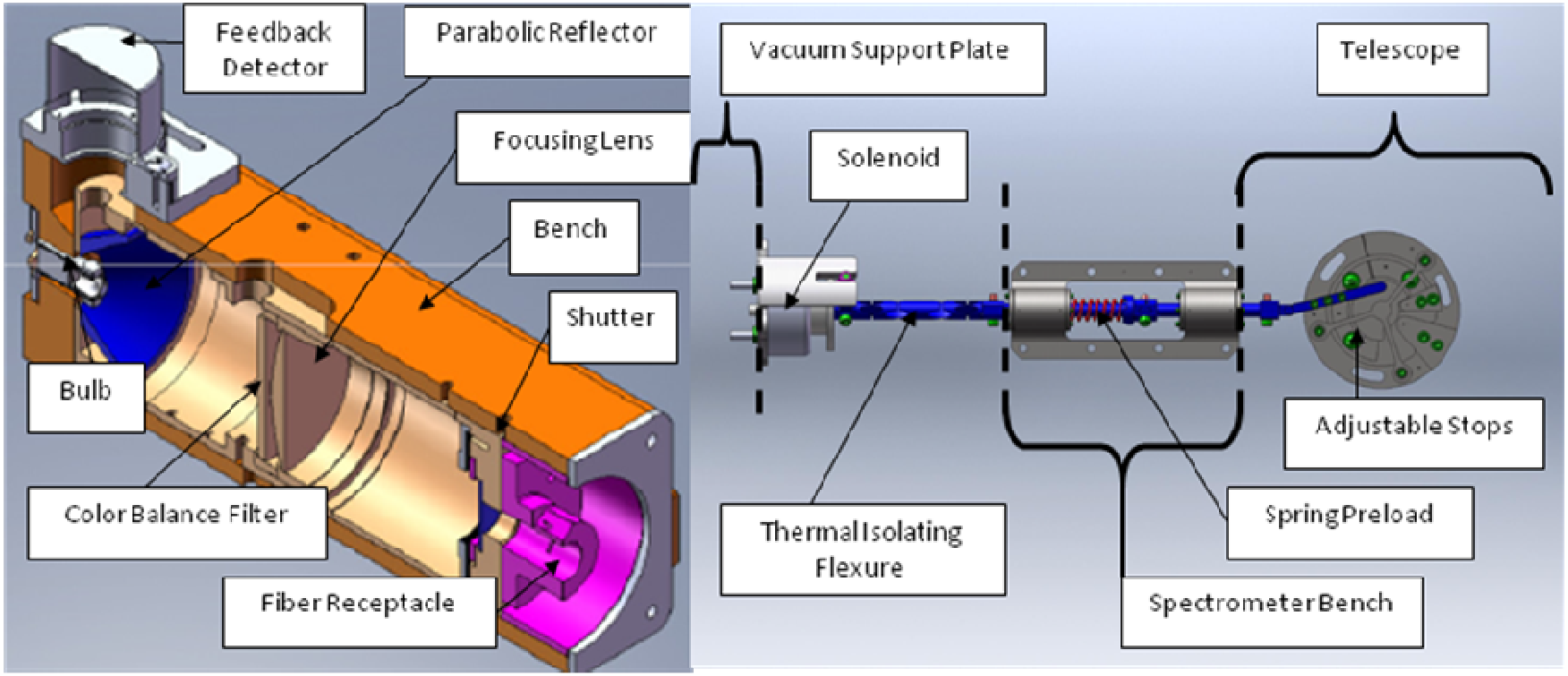


Third Generation Ultra-stable on-board Calibrator

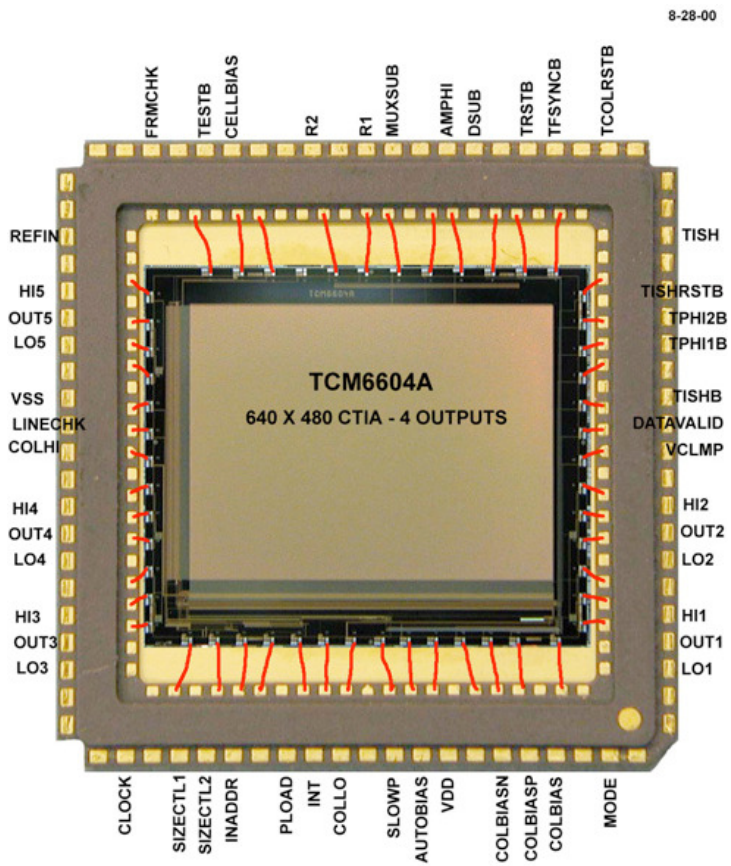


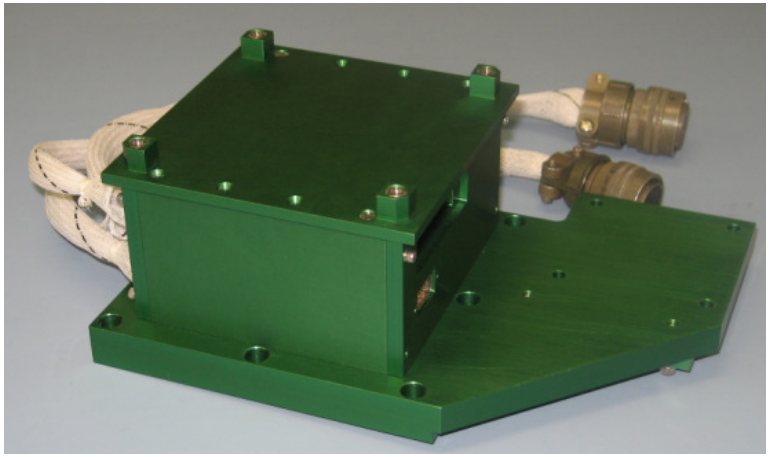
-This OBC illumination source has 10 years total use in two existing imaging spectrometers

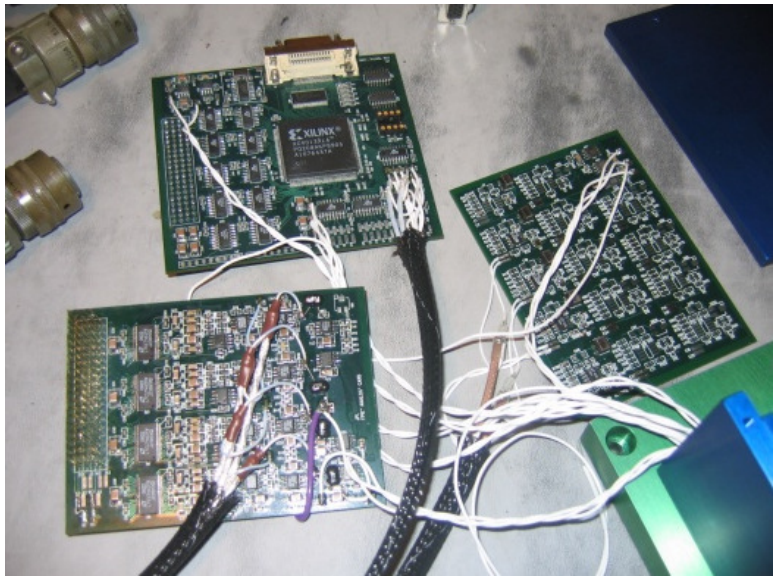
- This OBC is required for science measurement radiometric calibration and flat fielding.



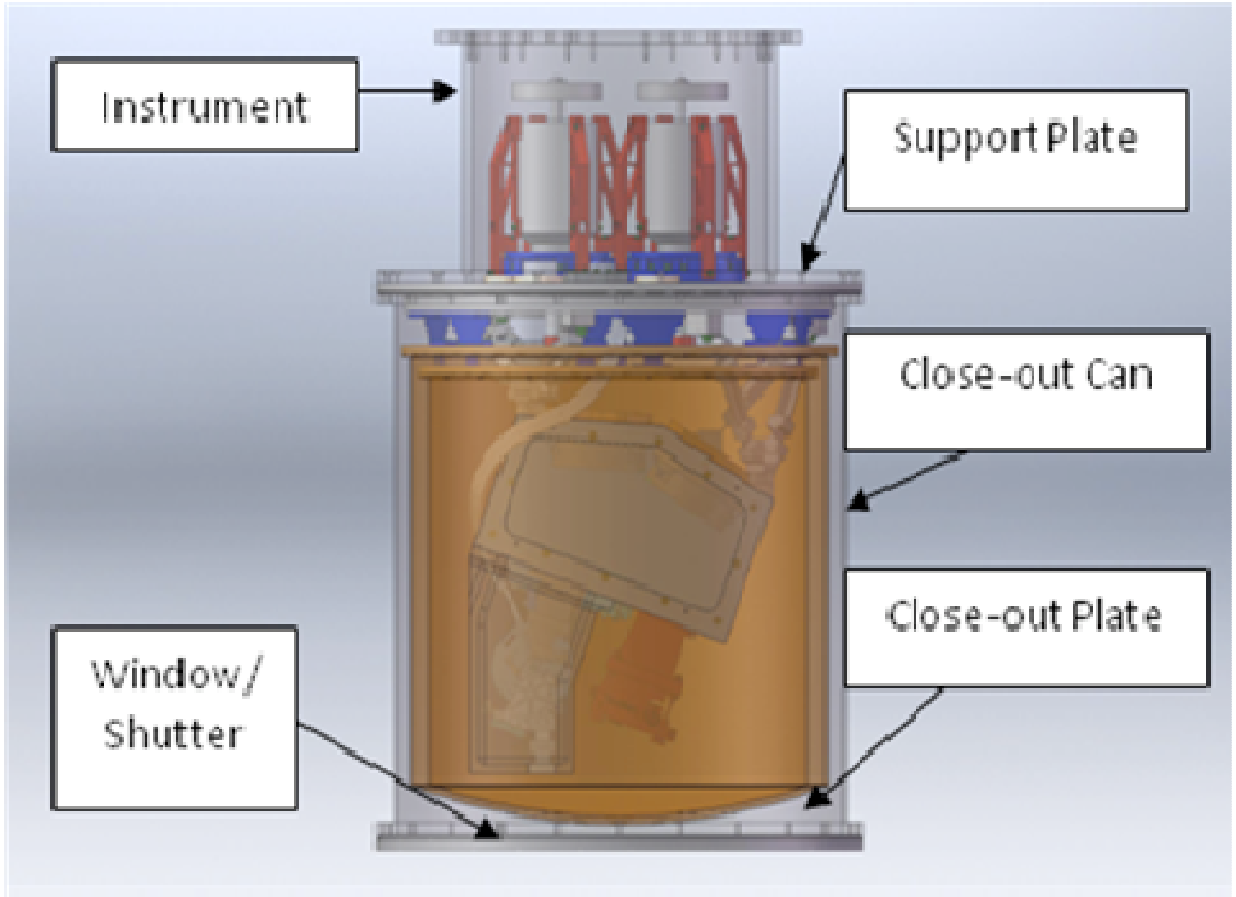
Imaging Spectrometer Optimized Detector Array and Low Noise Drive Electronics



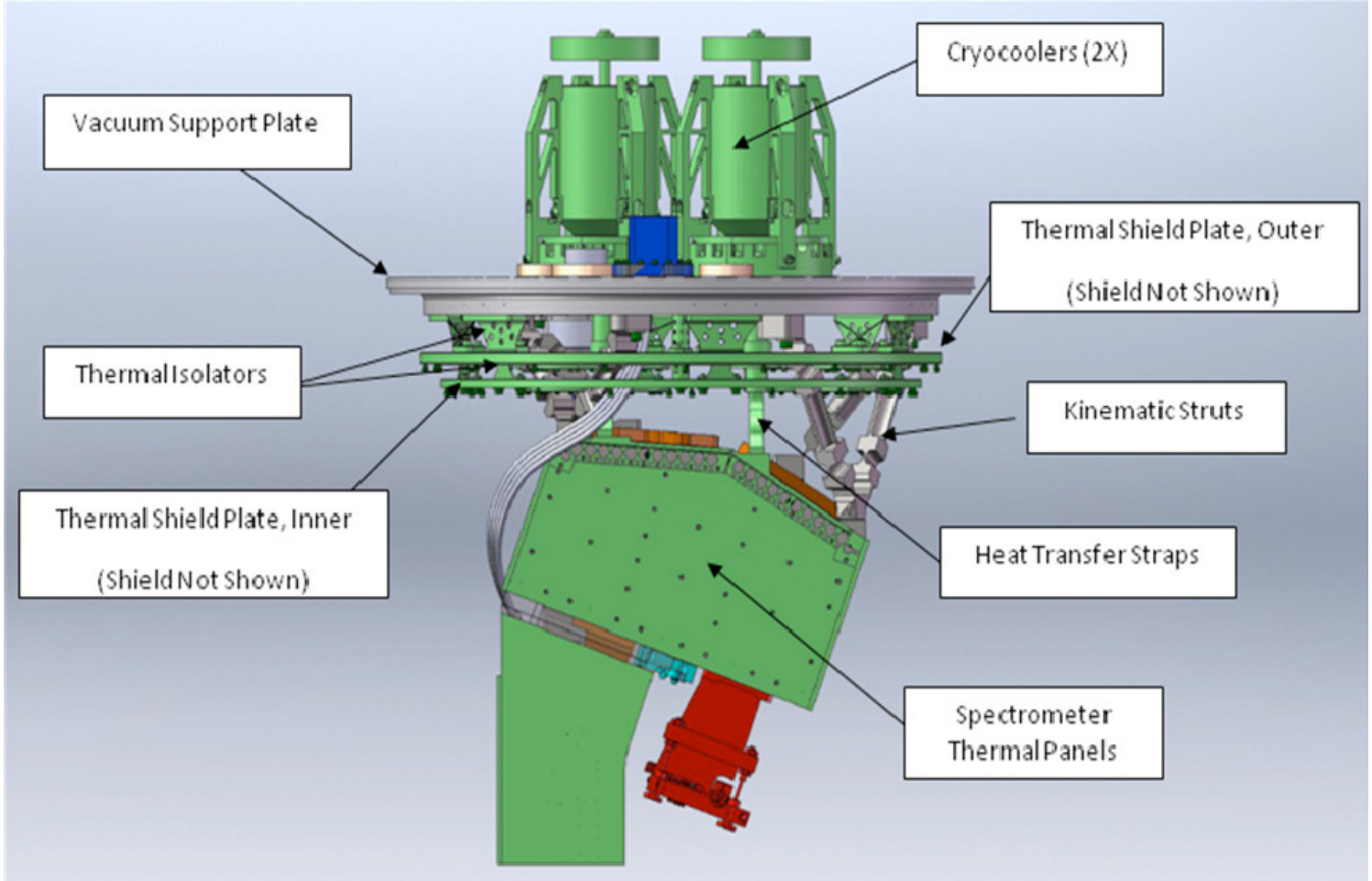




Configuration with Shutter and Window Location

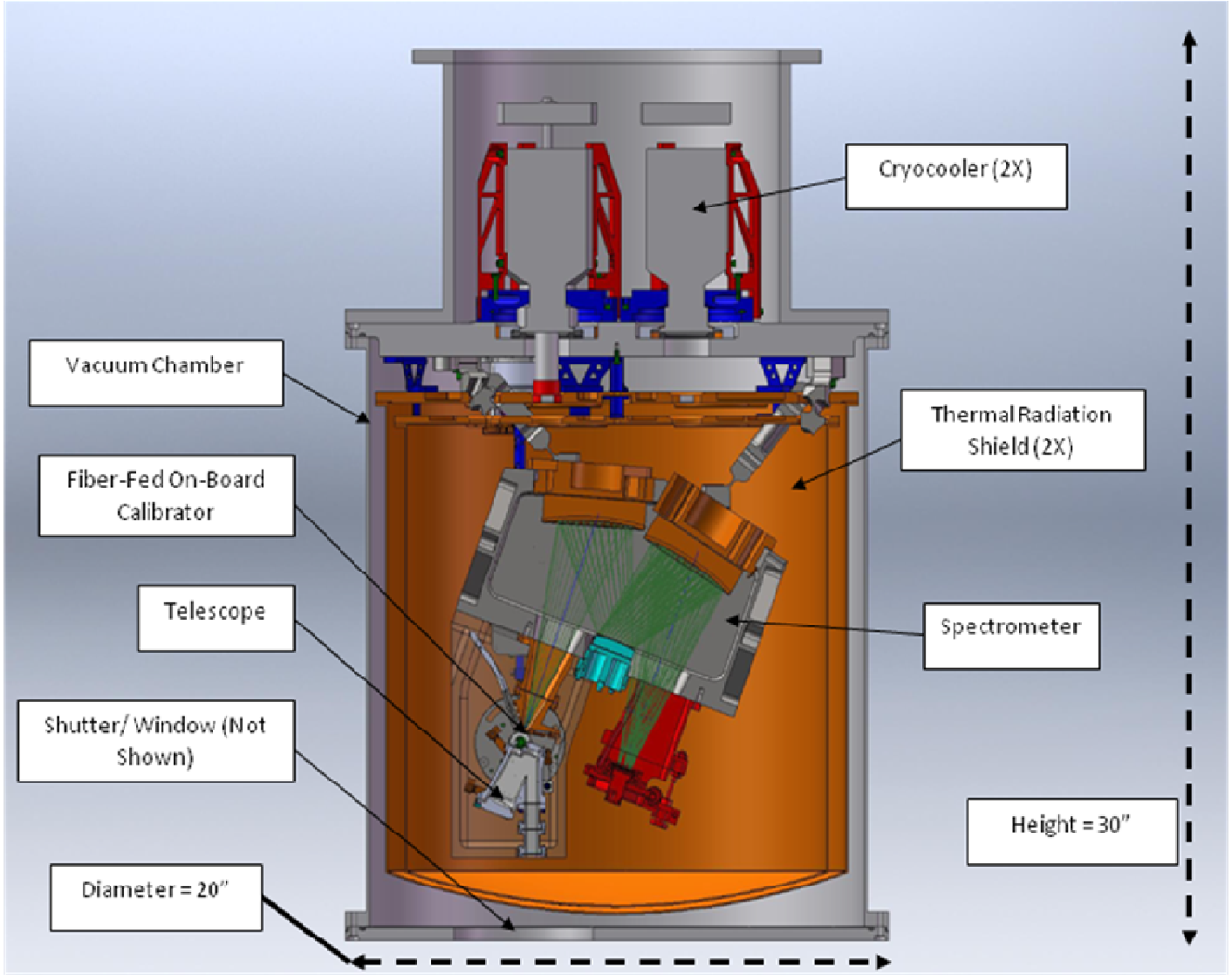


Cryocoolers and Spectrometer

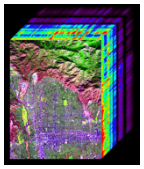


NEON Imaging Spectrometer:

A Configuration Focused on Science Performance and Stability



Summary



- The NEON Imaging Spectrometer has the minimum elements required to deliver the high uniformity and high signal-to-noise ratio science measurement required for the NEON AOP.
- The NEON science measurement is extremely challenging: High uniformity, high SNR with excellent calibration and stability.
- This implementation draws upon five unique enabling capabilities held at JPL
  - Mouroulis Design,
  - Electon beam lithography gratings
  - Electron beam lithography air slits
  - Finely adjustable mounts that can be locked with fraction of a micron precision and accuracy
  - Alignment and calibration sources and methodologies to achieve requirements.