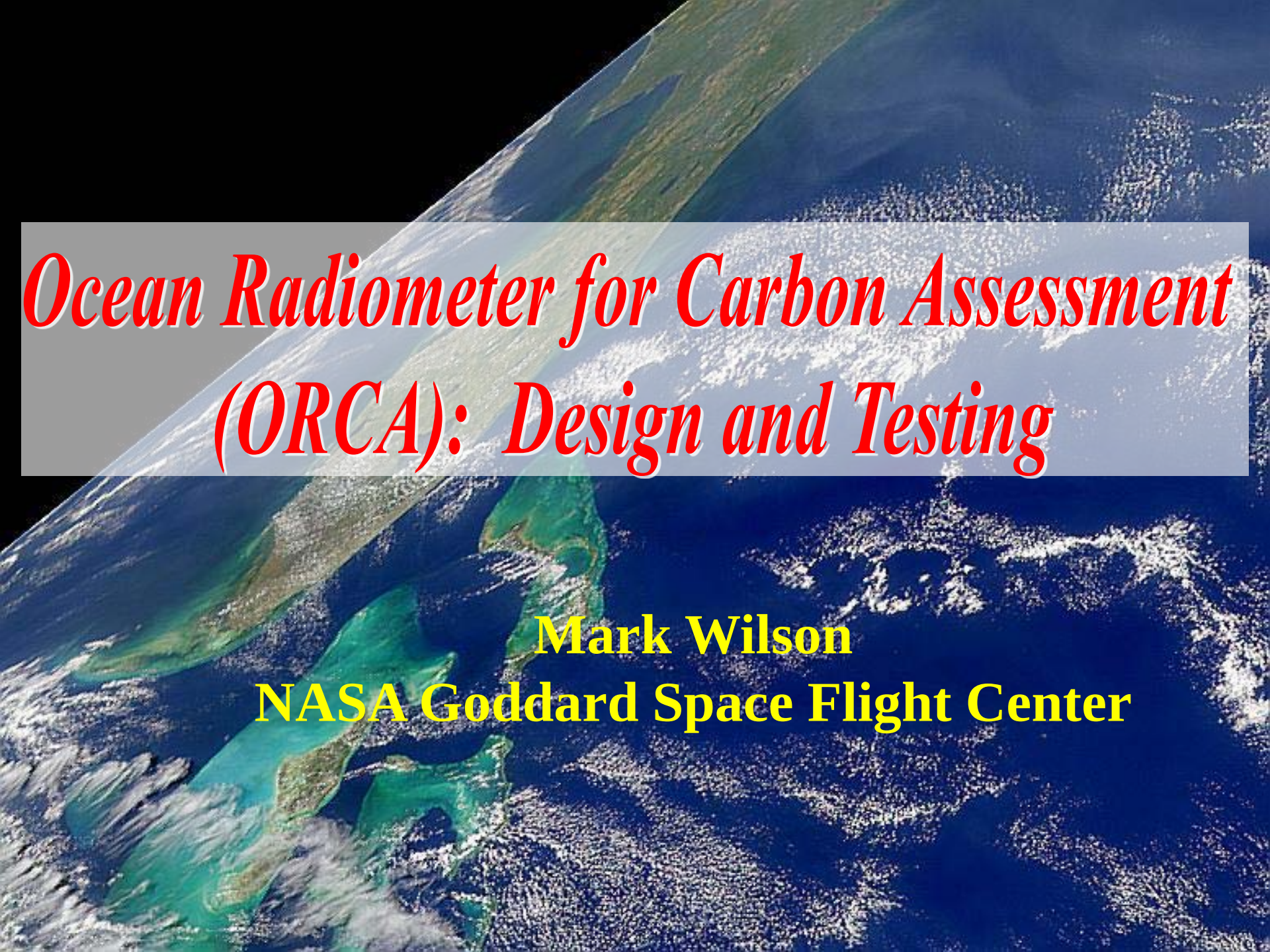

Ocean Radiometer for Carbon Assessment (ORCA): Design and Testing

Mark Wilson
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ORCA Organization

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Optics, Eugene Waluschka/NASA GSFC
Optics, Patrick Thompson/NASA GSFC
Systems, Bryan Monosmith /NASA GSFC
Science, Gerhard Meister/NASA GSFC
Manager, Leroy Sparr/NASA GSFC
Mechanical lead, Ken Blumenstock/NASA GSFC
Calibration and test, Steven Brown/NIST
Calibration and test, Keith Lykke/NIST
Mech. Designer, Brian Martin/SGT, Inc.
Consultant, Alan Holmes/SeaWiFS

All ORCA IIP Objectives Met

- Refine component specifications and compliance test requirements
- Design & package ORCA in a flight-like optical/mechanical configuration
- Conduct system-level calibration & characterization at NIST

ORCA Designed to meet ACE Requirements

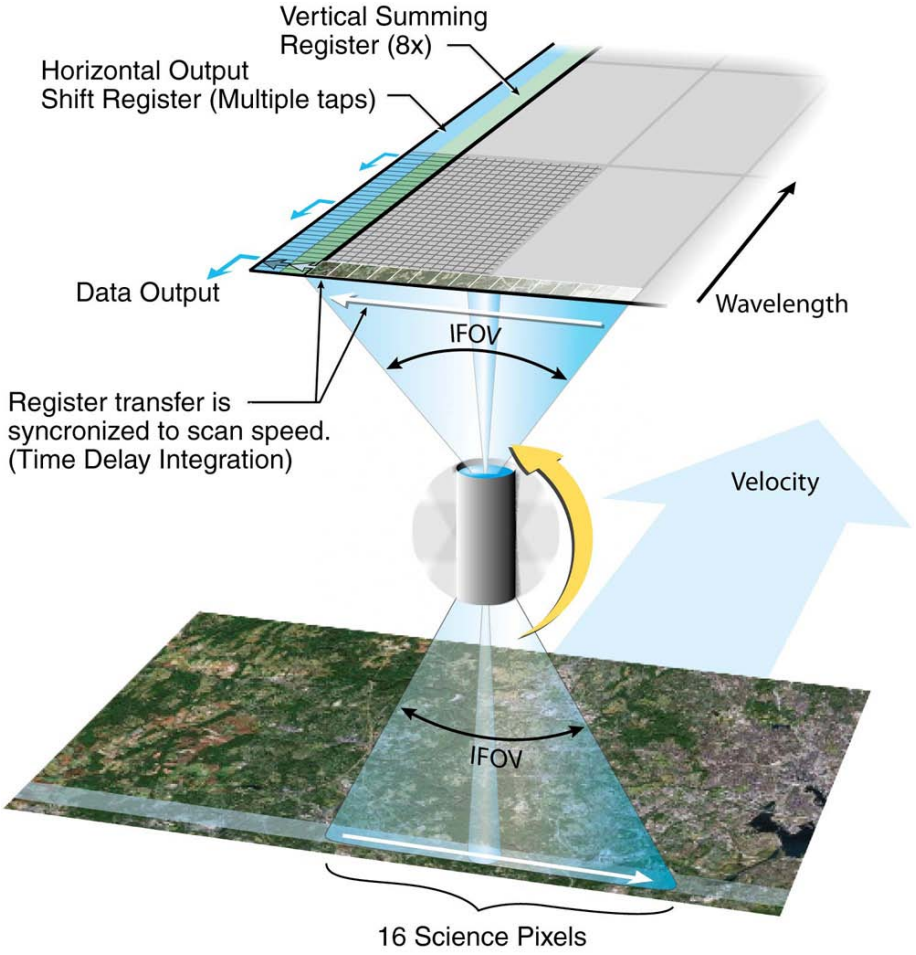
ORCA is a hyperspectral imager with System Design Requirements of:

- Wide spectral range, from 340 nm to 2130 nm
- Spectral resolution of 5 nm in UV & VIS/NIR
- 1 km ground resolution
- SNR >1000 in UV & VIS/NIR
- Scan Angle range +/- 58 deg
- Polarization sensitivity <1% in UV & VIS/NIR
- Low optical crosstalk

ORCA meets scanning, spectral, & SNR requirements

- Large angle scan coverage using a SeaWIFS-like rotating telescope
    - Synchronization of rotation mechanism, electronics, and detectors – implemented in second IIP starting Feb 2011
- Spectral resolution using conventional diffraction gratings in UV & VIS/NIR
- High SNR values achieved using Time Delay Integration (TDI) from UV through NIR

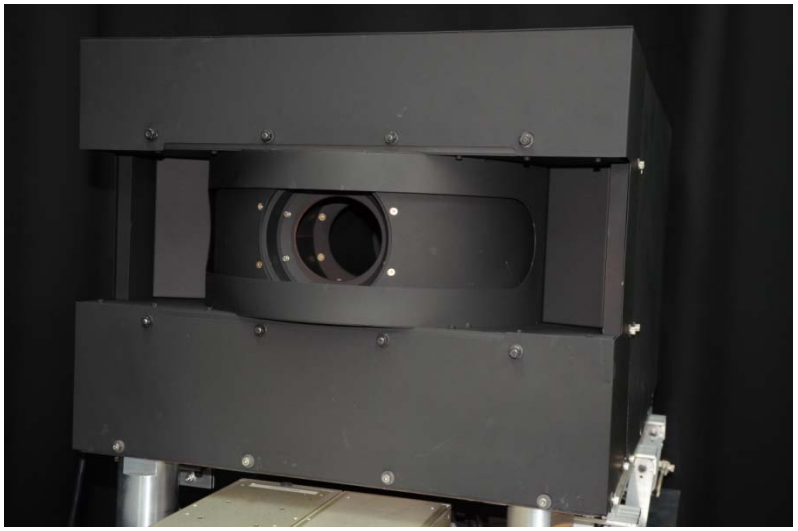
ORCA Scan & TDI Operation



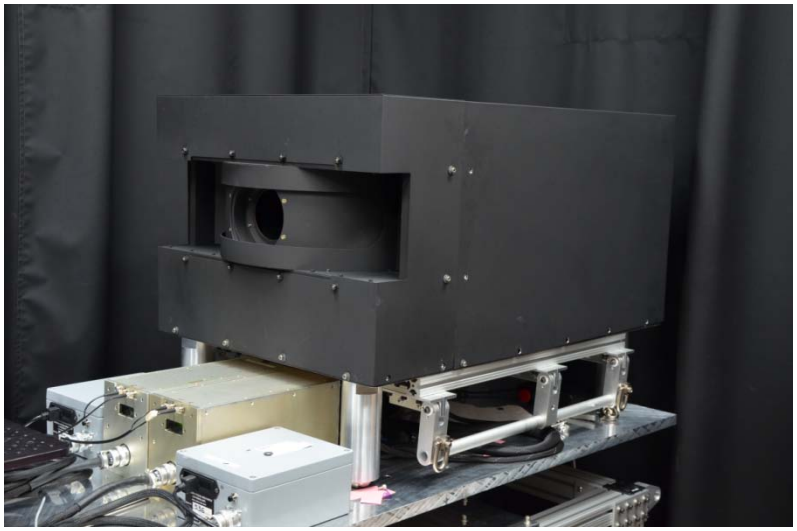
ORCA Prototype: Accomplishments over past year

- Final prototype fabrication
- Optical alignment
- Rotary cart design & fabrication
- Optical performance testing
  - Polarization
  - Spectral resolution & linearity
  - Image quality (point spread functions)
  - Straylight
- Second IIP proposed & selected
  - Flight-like focal planes & electronics
  - System synchronization at flight scan/data rates

Views of instrument hardware

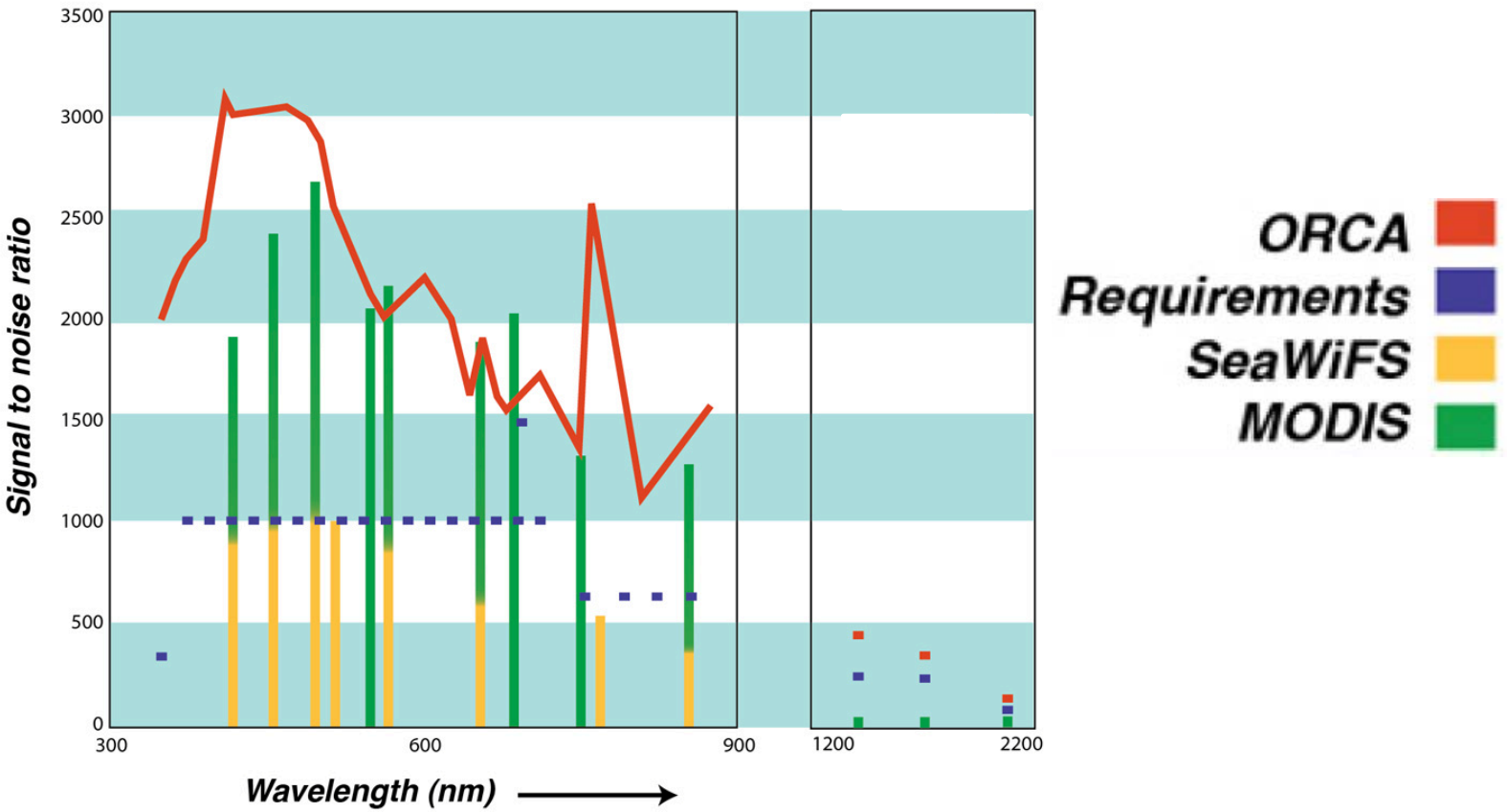


Front



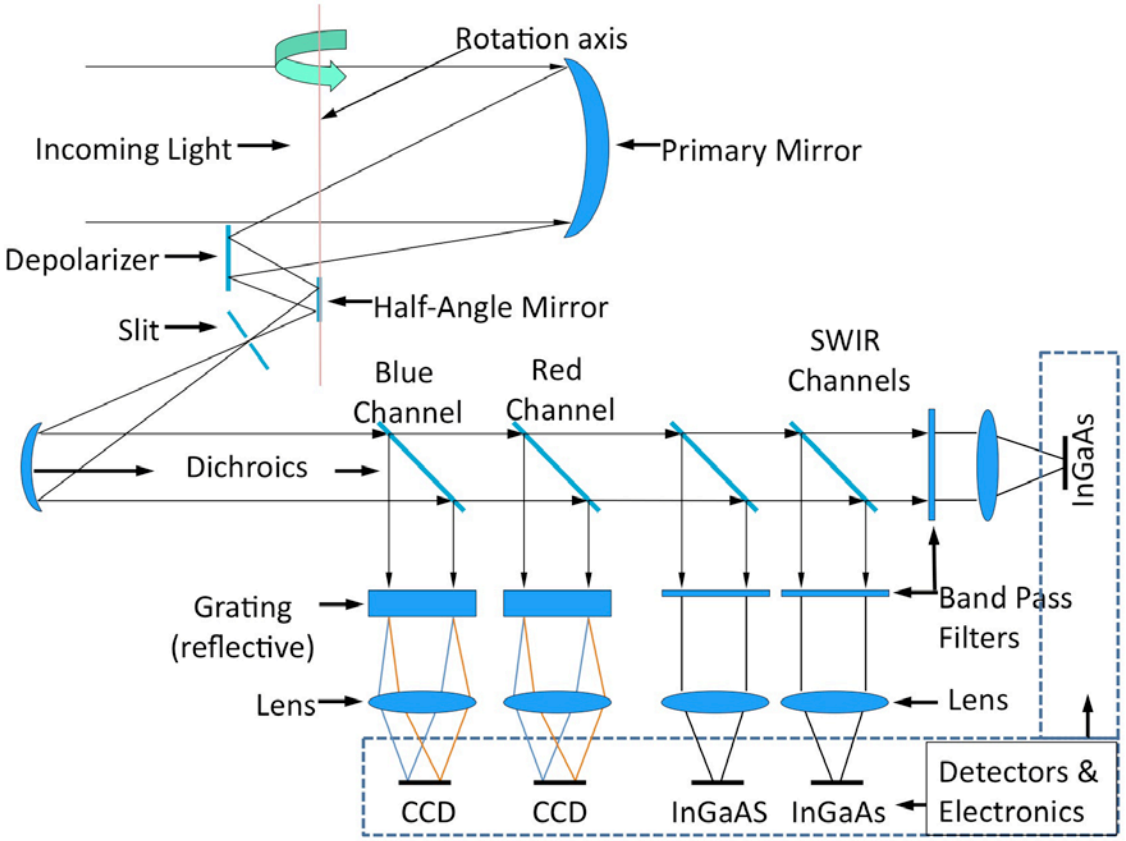
Side

Signal-to-Noise Exceeds Requirements

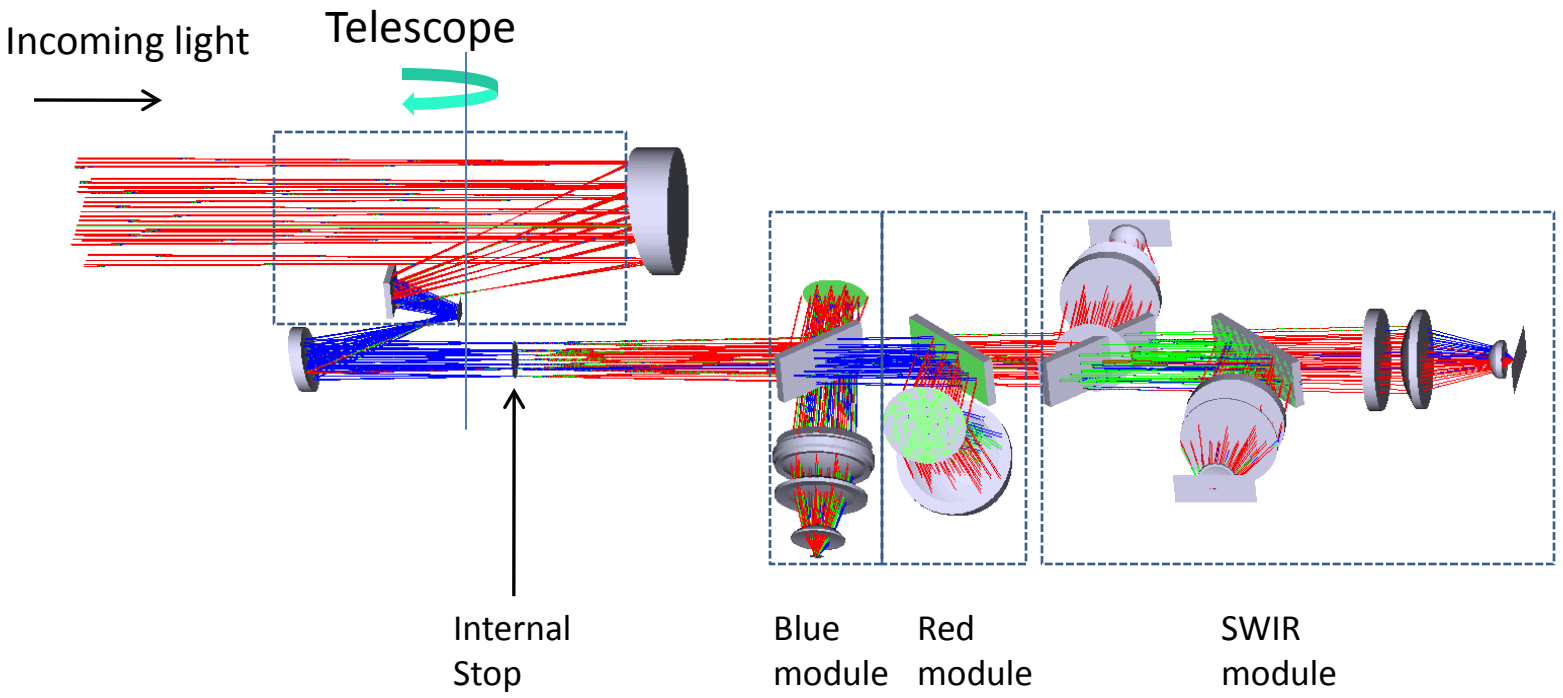


ORCA Optical Layout

Blue channel = 340 - 565 nm
Red channel = 575 - 885 nm



ORCA Optical Design

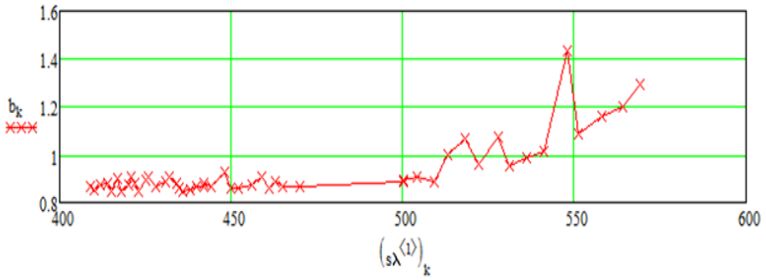


Blue & Red channels show excellent image quality

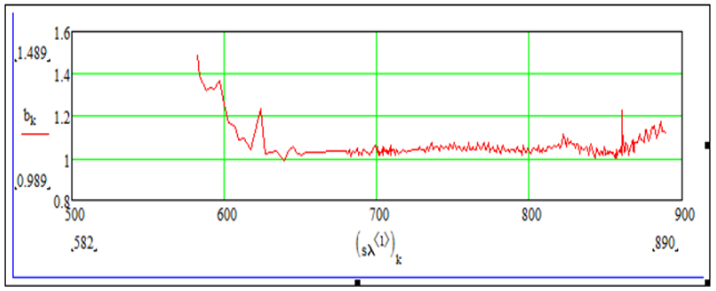
~3X better than SeaWiFS!

- PSF FWHM (average) = 1.86 detector pixels diameter
  - Note: 1 ground pixel = 8x8 detector pixels
- 80% encircled energy diameter range from 5 to 5.5 detector pixels
- Some broadening at longer wavelengths due to source

Blue (FWHM radius vs λ)



Red (FWHM radius vs λ)



Note: vertical axis is the radius in pixels of the 1/e point of the PSFs

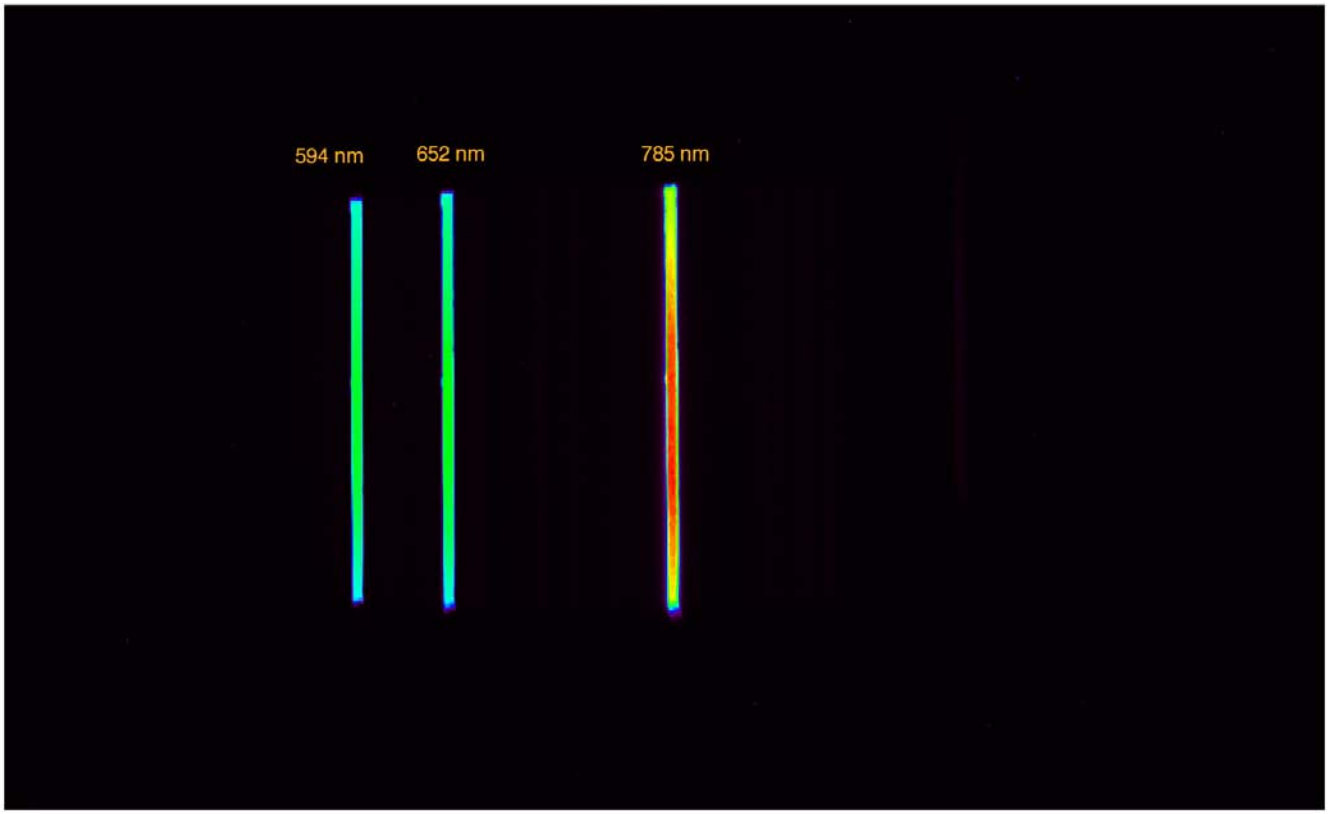
Similar spectral resolution across Blue & Red channels

- For blue channel, linear dispersion was 0.633 nm/pixel, the FWHM of the slit image was 9.5 detector pixels – **the spectral resolution is 6.0 nm**

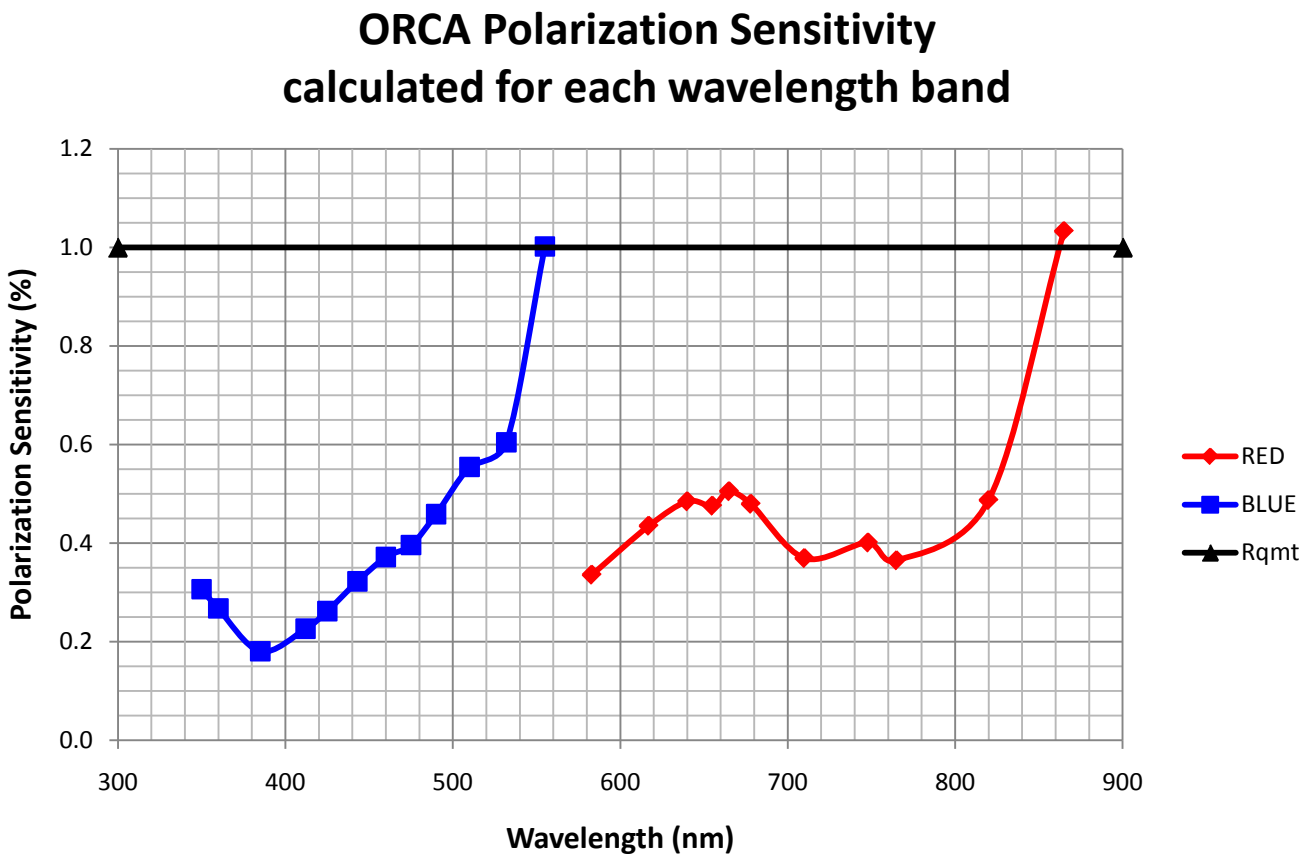
- For the red channel, linear dispersion was 0.77 nm/pixel, the FWHM of the slit image was 8.3 detector pixels – **the spectral resolution is 6.5 nm**

Examples of slit images in red channel

RED CHANNEL FULL SLIT IMAGES 07 JUNE 2011



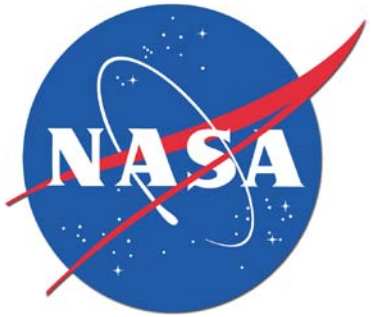
Excellent Red & Blue channel polarization sensitivity



List of lessons learned

Tests conducted show no significant design issues

- Excellent Image Quality
- Depolarizer ghost
  - solution: wedged front-face
- No other out of field stray light observed
  - measurements and testing continues
- Spectral resolution close to goal
- Continue analysis of dichroic design
  - optimize polarization long wavelength transition



Conclusions

- Optical design is robust
  - Layout, components, and alignment all successfully implemented
  - Polarization, spectral resolution, spatial resolution, and image quality specs met
- Full characterization methodology demonstrated
  - Cooperative assessment done at NIST