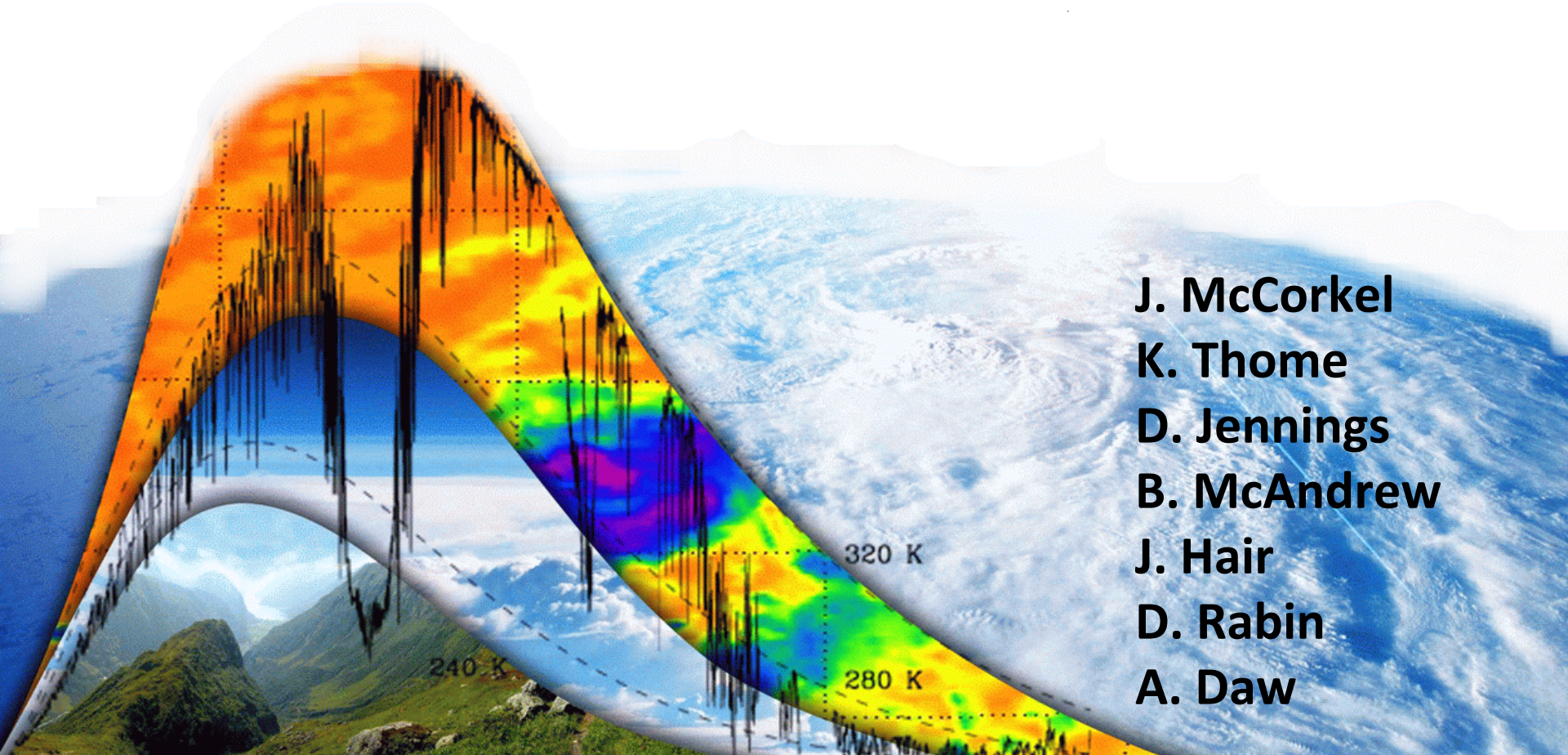
National Aeronautics and Space Administration
Goddard Space Flight Center

Reflected Solar Calibration Demonstration System Update



J. McCorkel
K. Thome
D. Jennings
B. McAndrew
J. Hair
D. Rabin
A. Daw

Calibration Demonstration System

- SOlar, Lunar for Absolute Reflectance Imaging Spectrometer (SOLARIS)
  - Technology demonstration of
    - Design and production of optics
    - Depolarizer technology
  - Test prelaunch calibration methods
  - Evaluate reflectance retrieval
  - Demonstrate transfer-to-orbit error budget showing SI-traceability

Last report (April 2012)

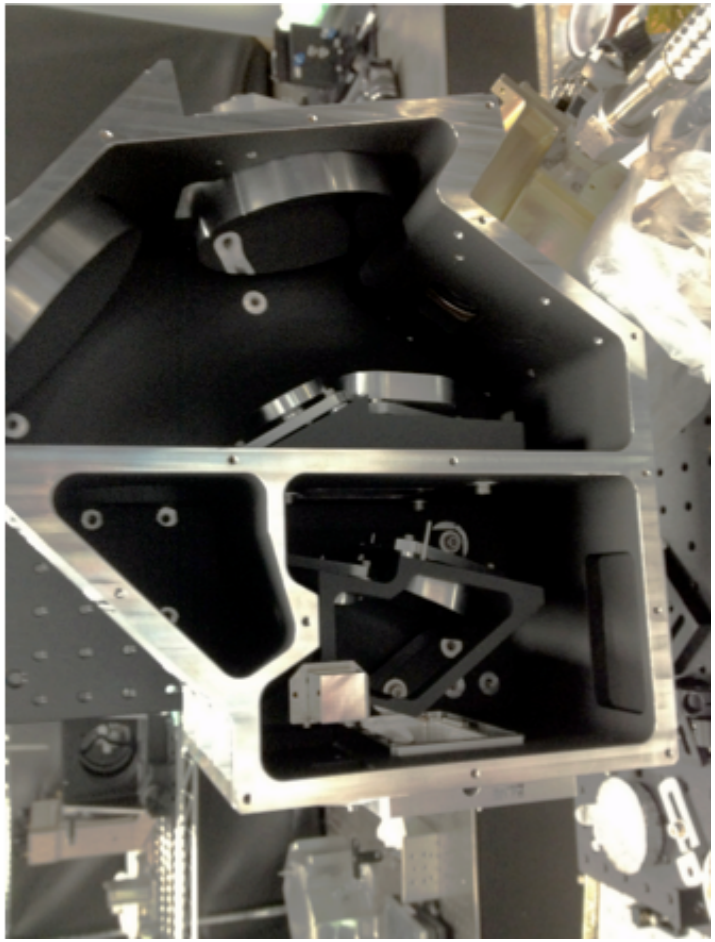
- Last time (April 2012)
  - First light in laboratory, Oct 2011
  - First reflectance outside, Dec 2011
  - Spectral characterization with Hg lamp
  - Radiometric calibration
  - Lunar collection
  - Solar collection
  - SOLARIS + SIRCUS first light

Current news

- Improved 'Blue' box
  - Final grating
  - Cooled and stabilized detector
  - High detector bias voltage for improved spatial performance
  - Order-sorting filter
  - Signal linearization
- SIRCUS
  - Silicon trap radiometers
  - 560-979 nm scan at 1-nm steps
- Other
  - Summer intern work
  - Goddard IRAD funding
  - Goddard Science Task Group

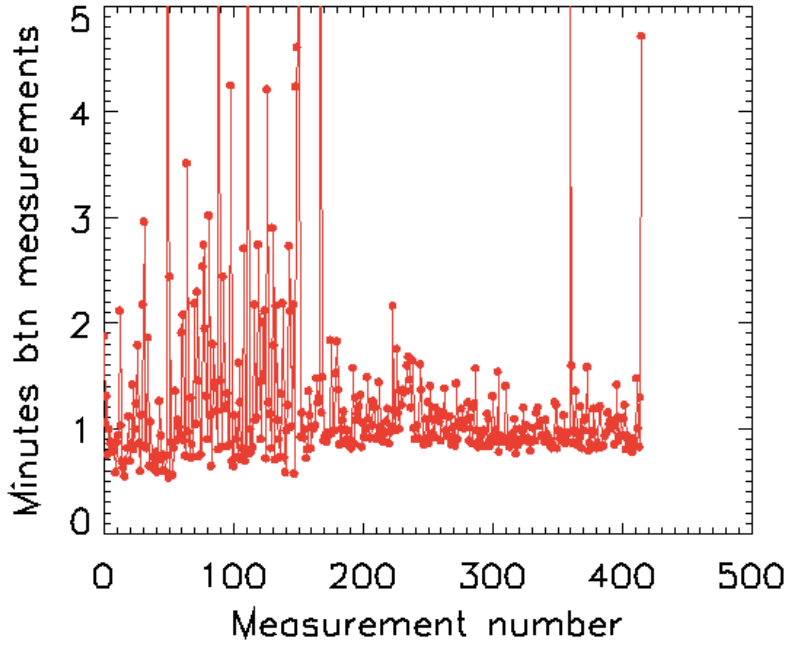
CDS build status

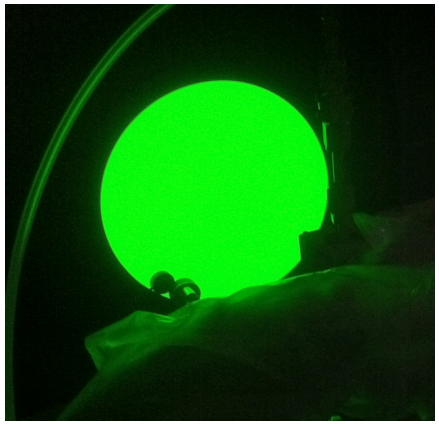
- Improved blue box
  - Optics and assembly finished
  - Cooled silicon detector
- Red box
  - Optics finished including final red grating
  - MCT detector undergoing tests and at detector branch
  - Thermal system tests
- Third box
  - COTS high resolution detector package
  - Telescope and slit aligned
  - Two mirrors need re-turning
  - Mechanical detector interface

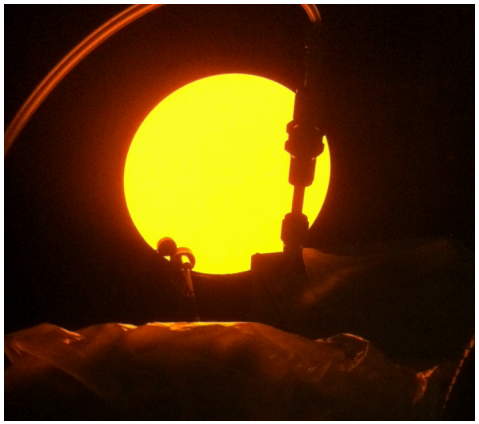


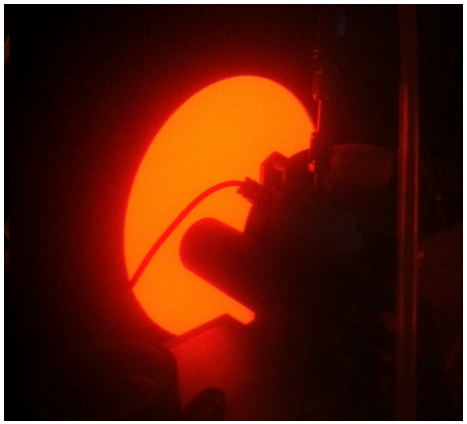
Recent SIRCUS measurement

- September 25-27
- 560-979 nm in 1-nm steps
- Instruments viewing sphere
  - SOLARIS
  - ASD spectroradiometer
  - Silicon trap radiometer

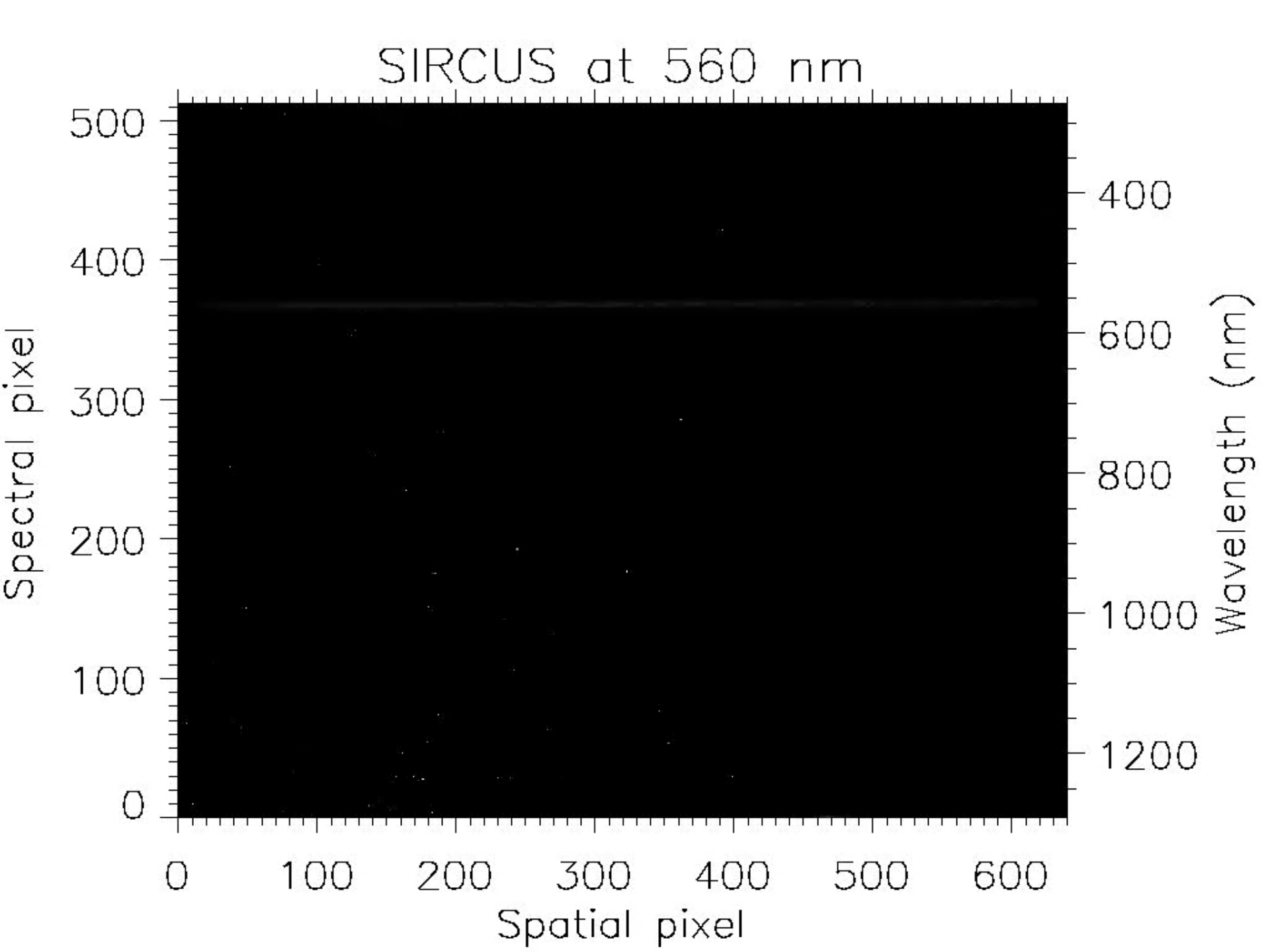




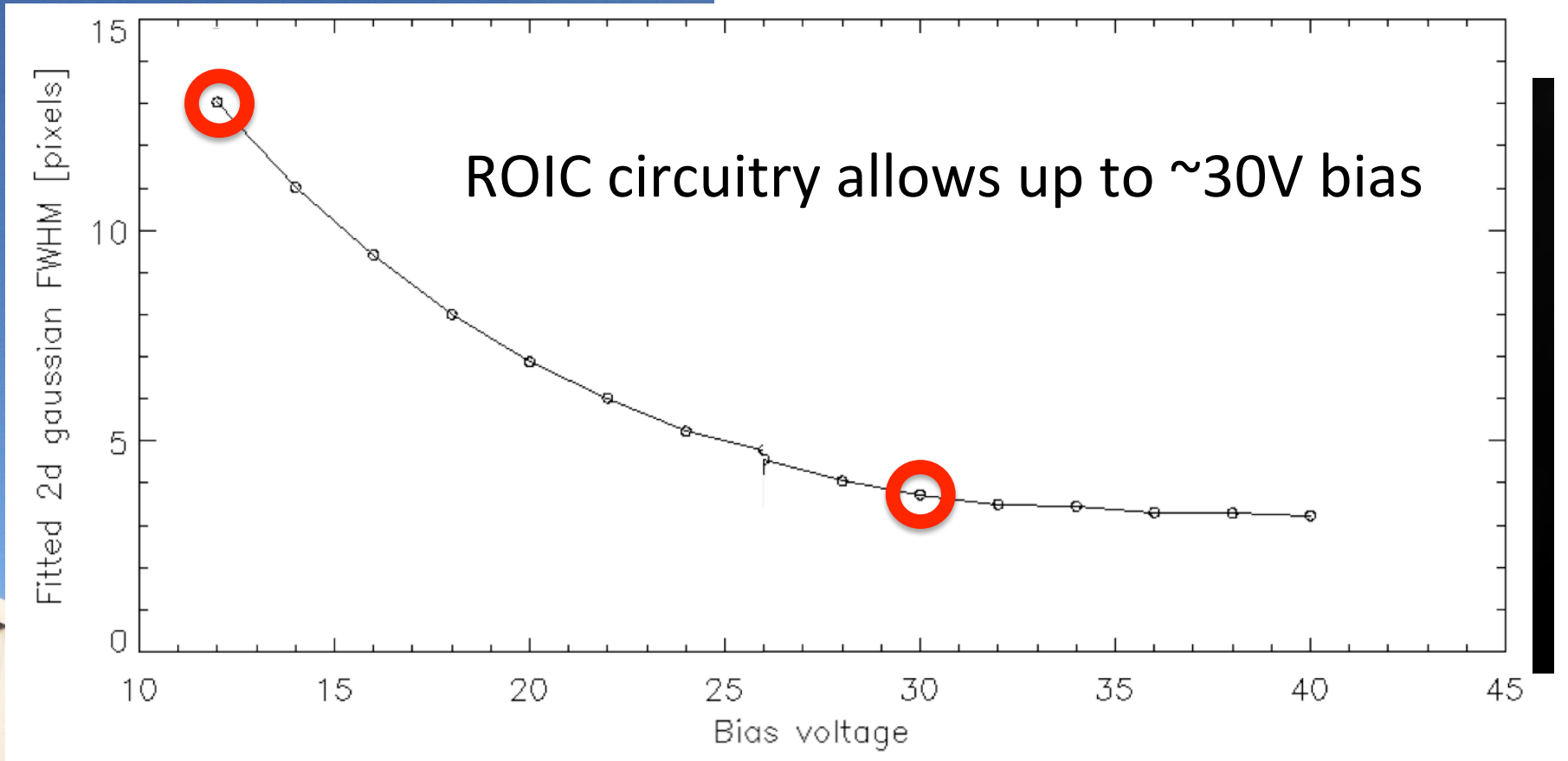


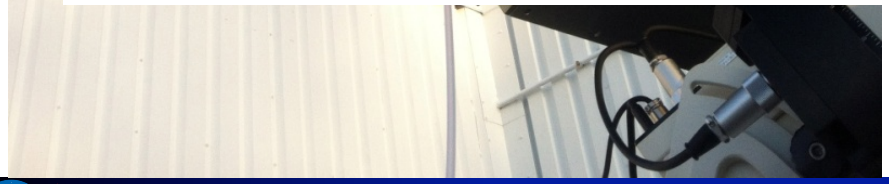


SIRCUS setup


SIRCUS at 560 nm
Spectral pixel
Wavelength (nm)
Spatial pixel
0
100
200
300
400
500
600
400
600
800
1000
1200

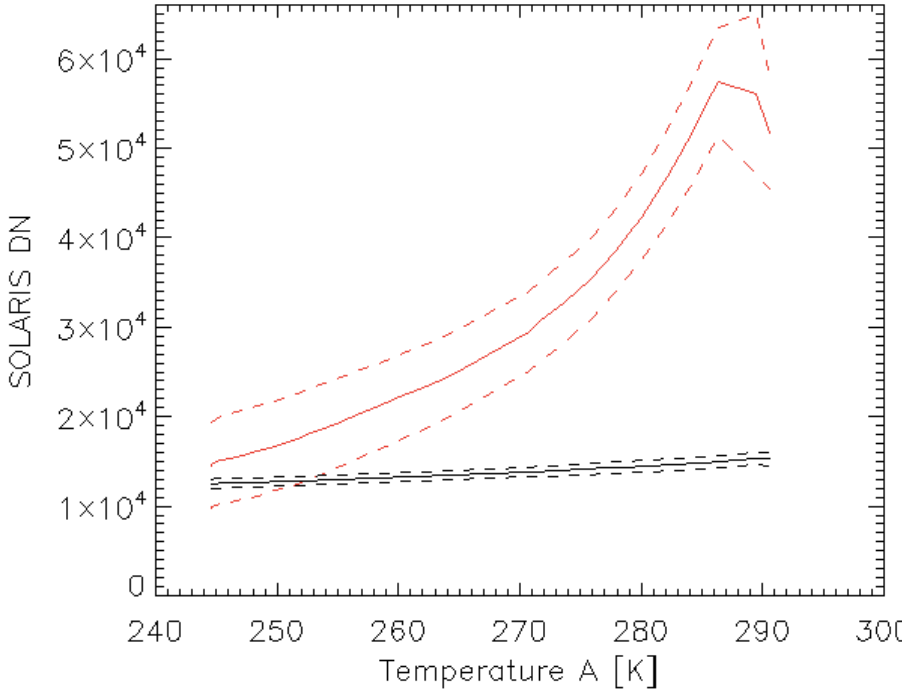
Detector bias voltage



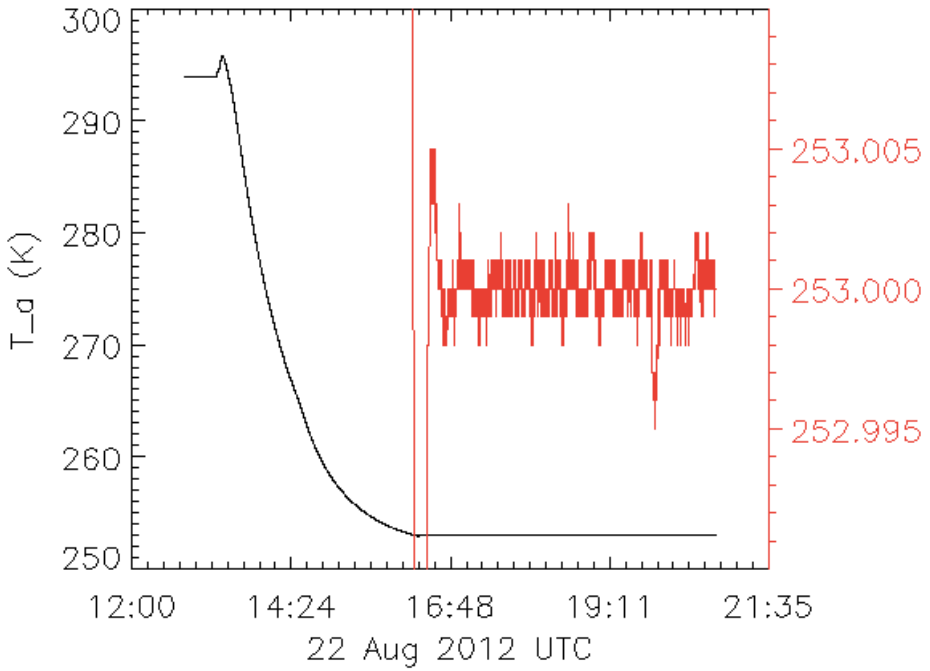


Blue box thermal system

Dark current VS detector temperature

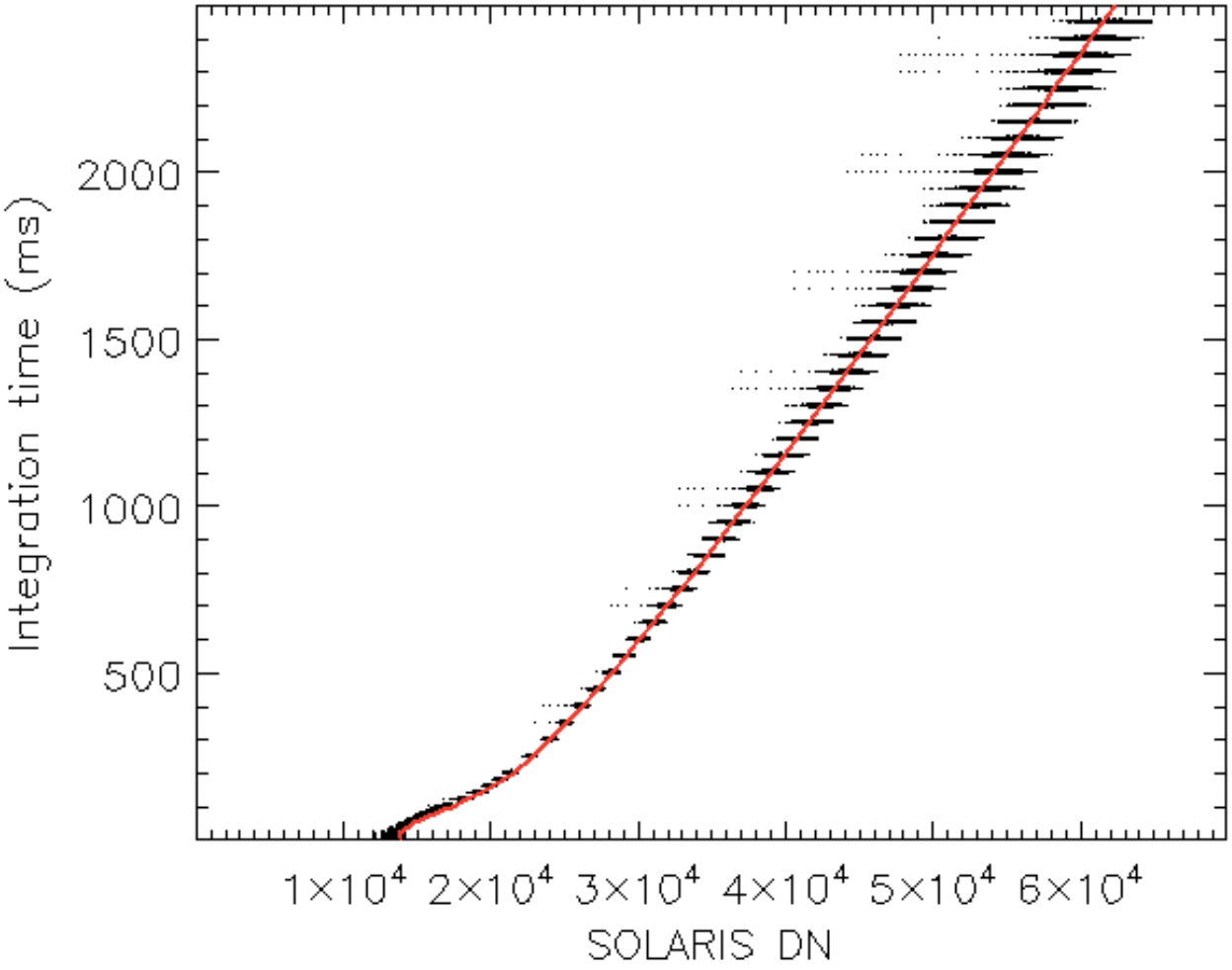


Thermal stability of 'improved' blue box



Results – Linearization

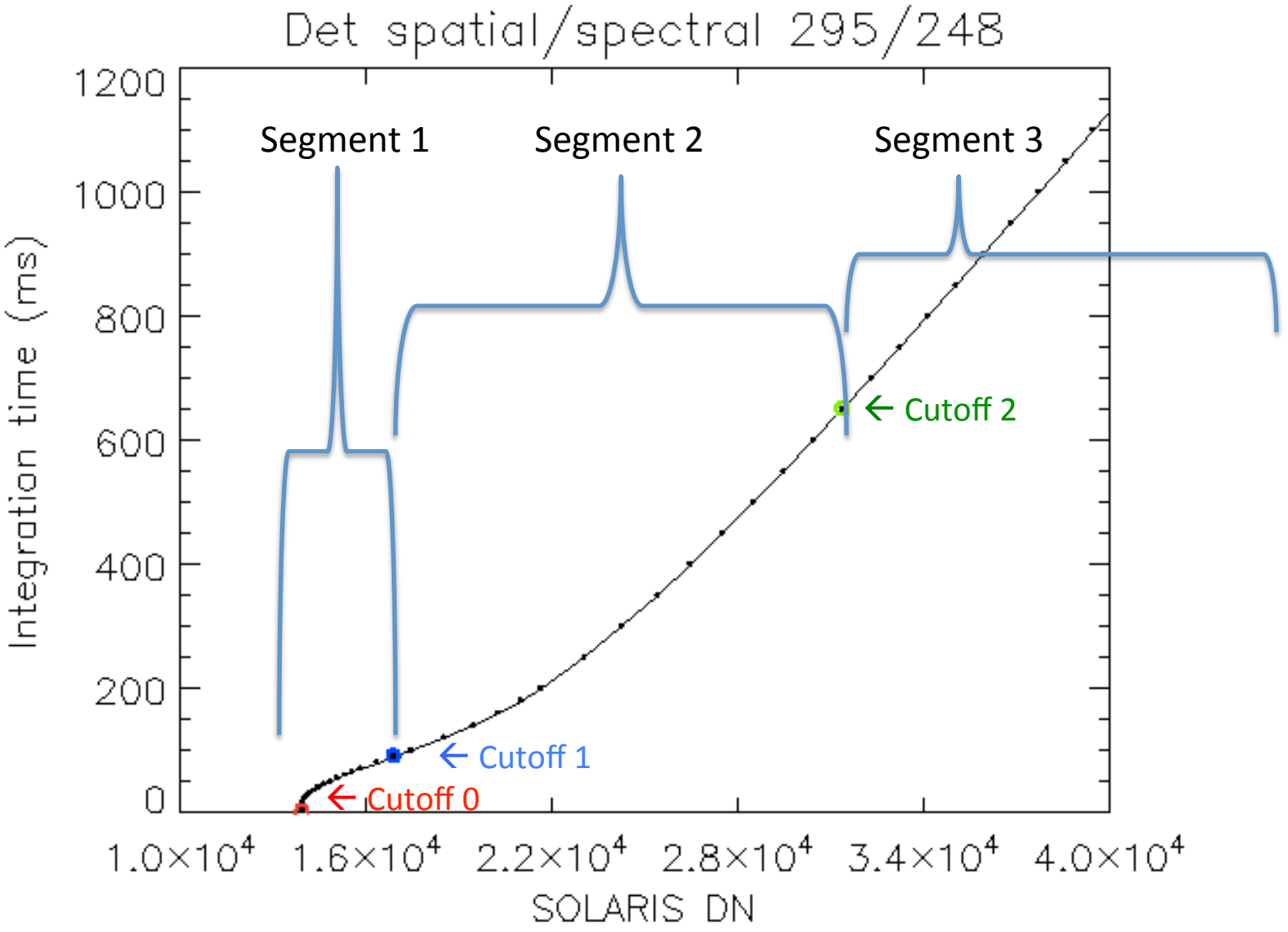
- Integration time sweep of dark current



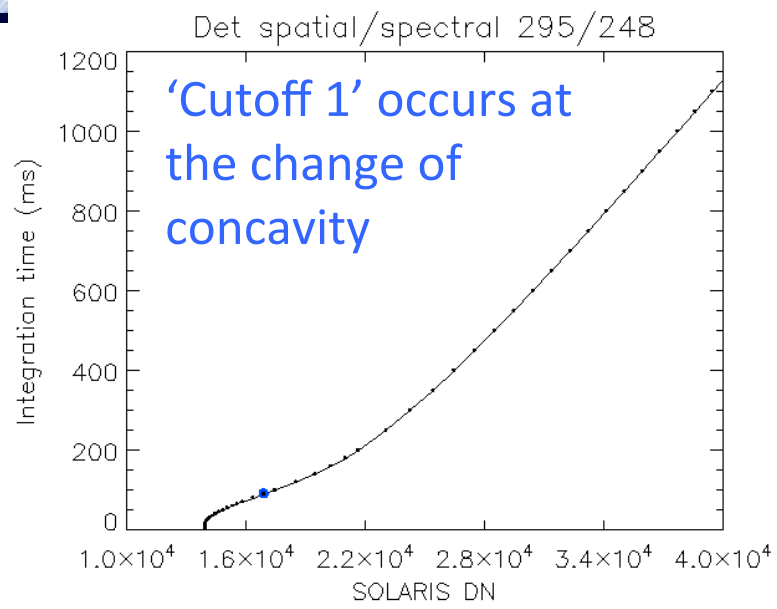
Red line: pixel 295/248

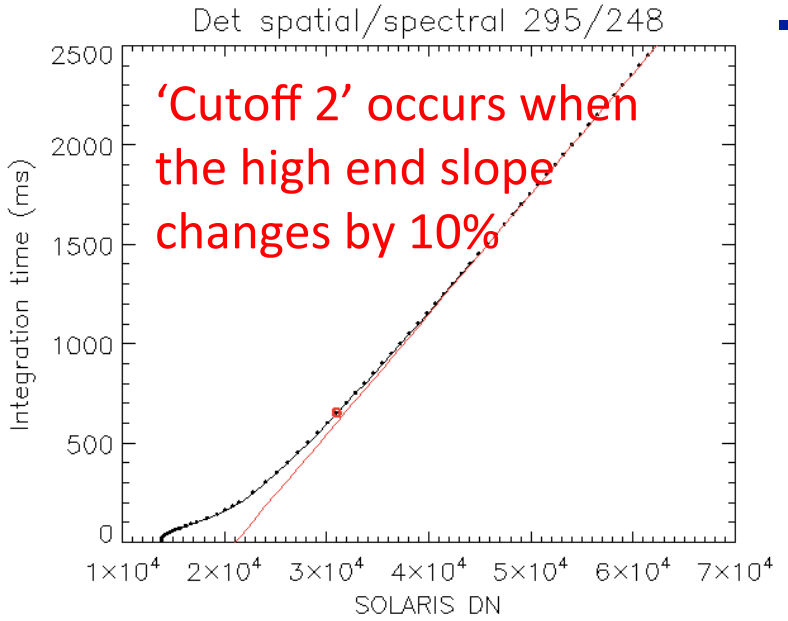
Black lines: Histogram-like plot of all pixels

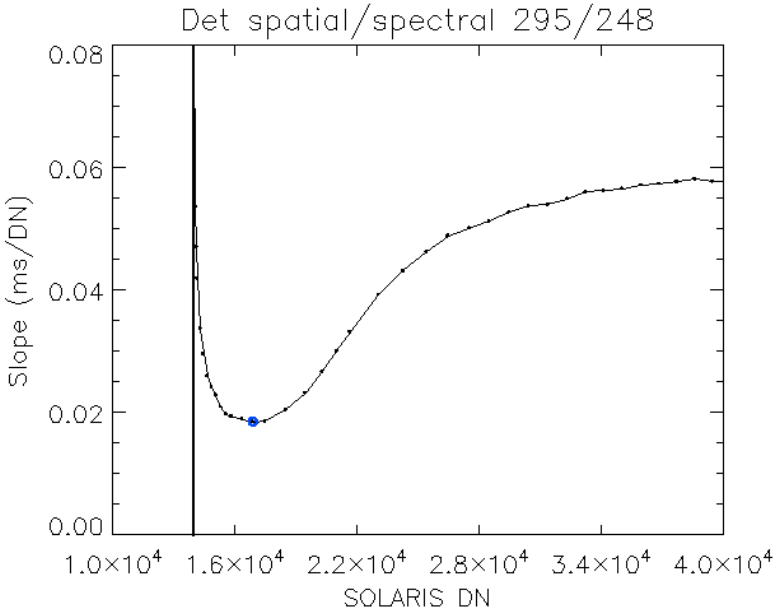
Results – Linearization

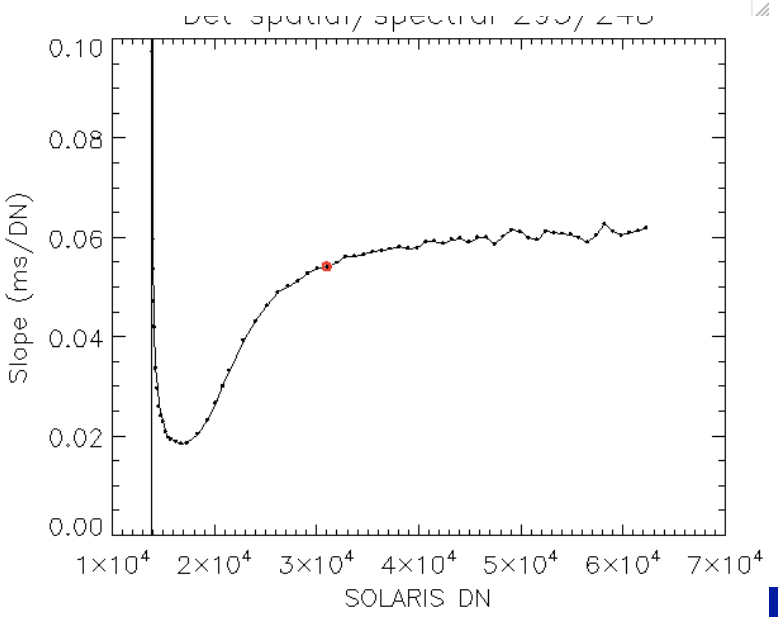


Linearization – cutoff 1 and 2

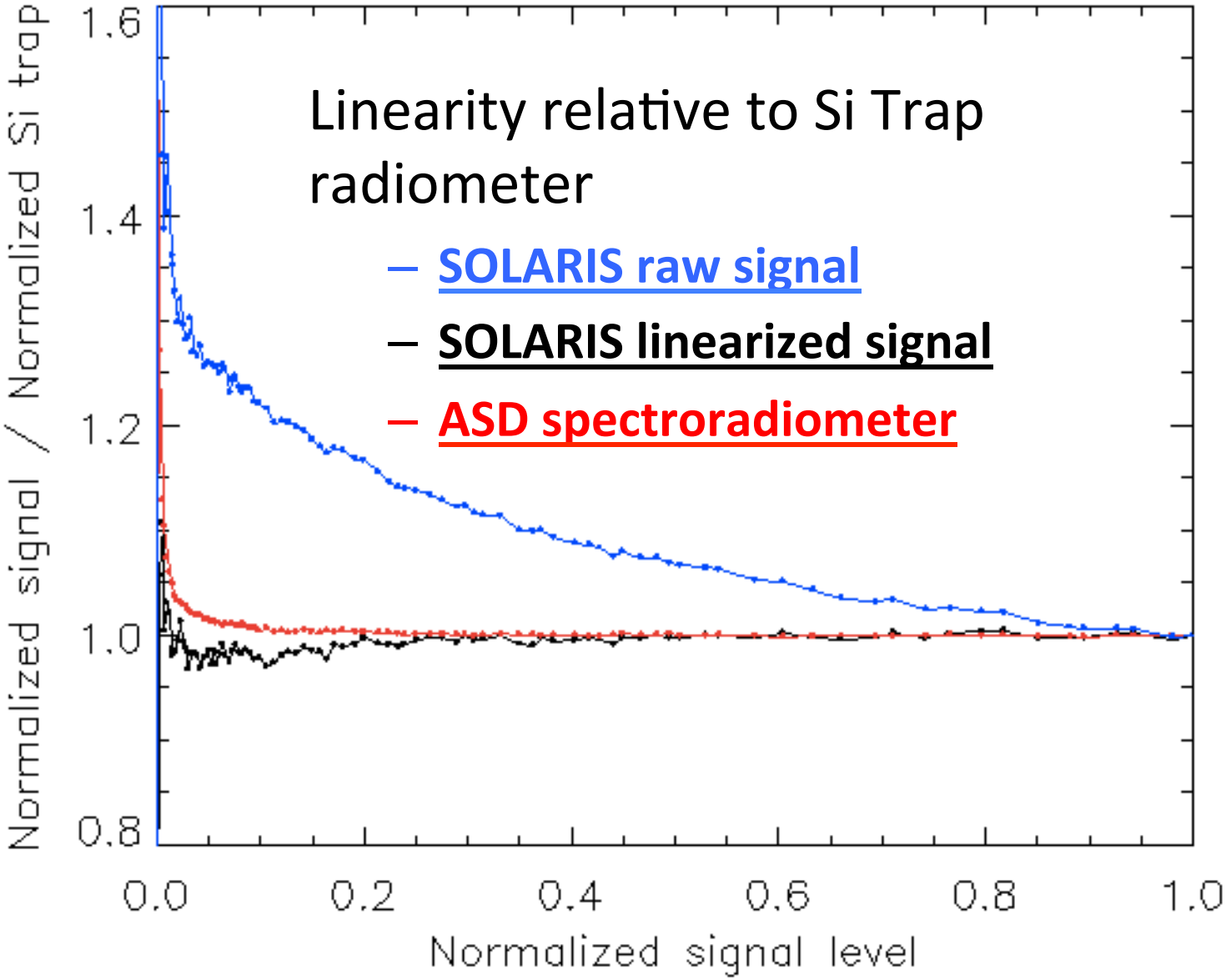




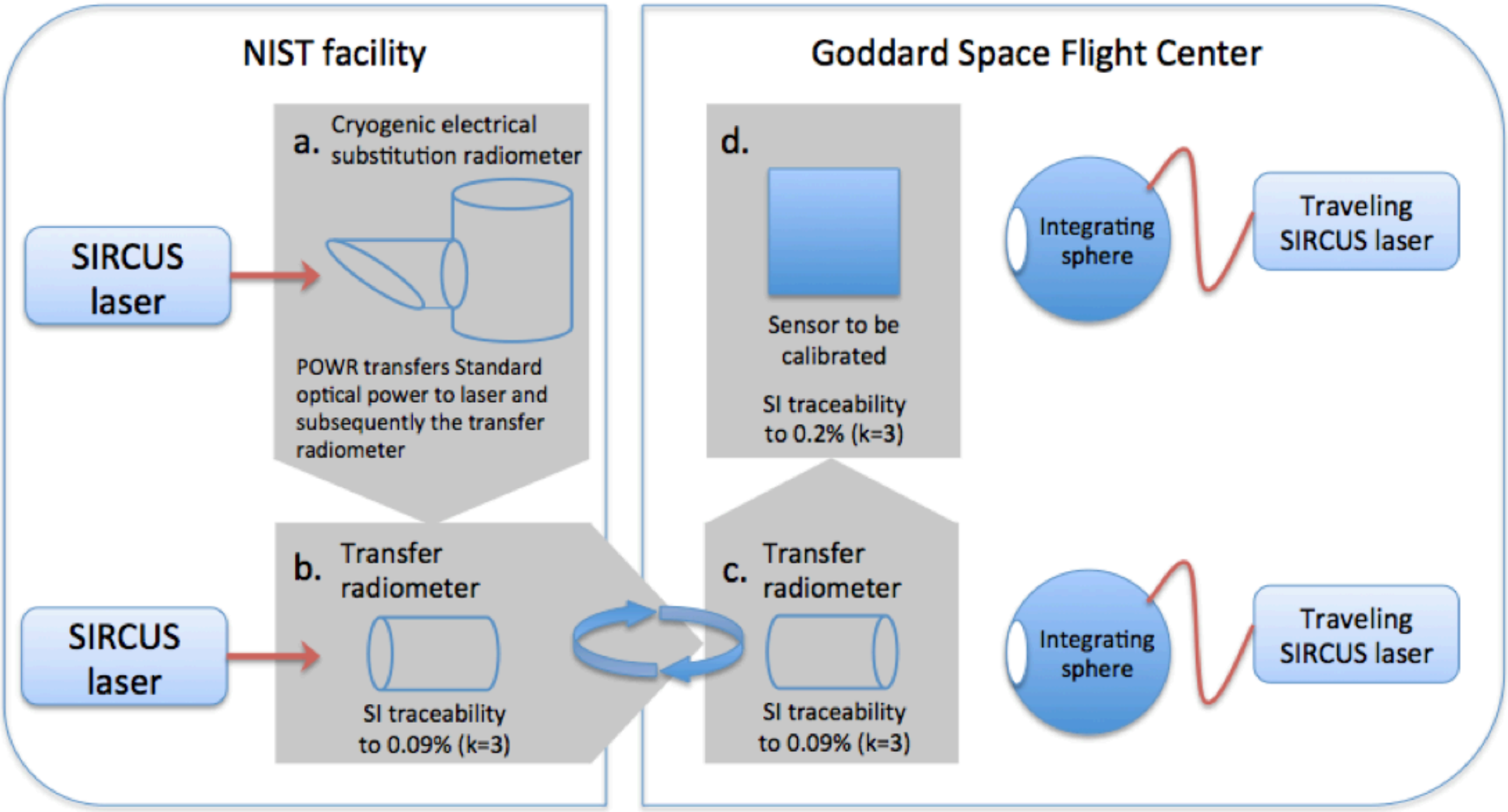




Linearization results



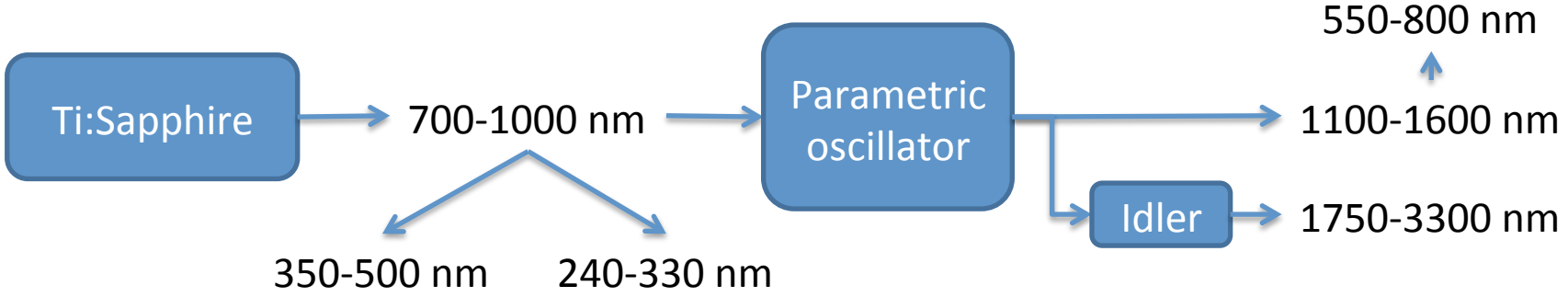
Calibration



SIRCUS instrumentation

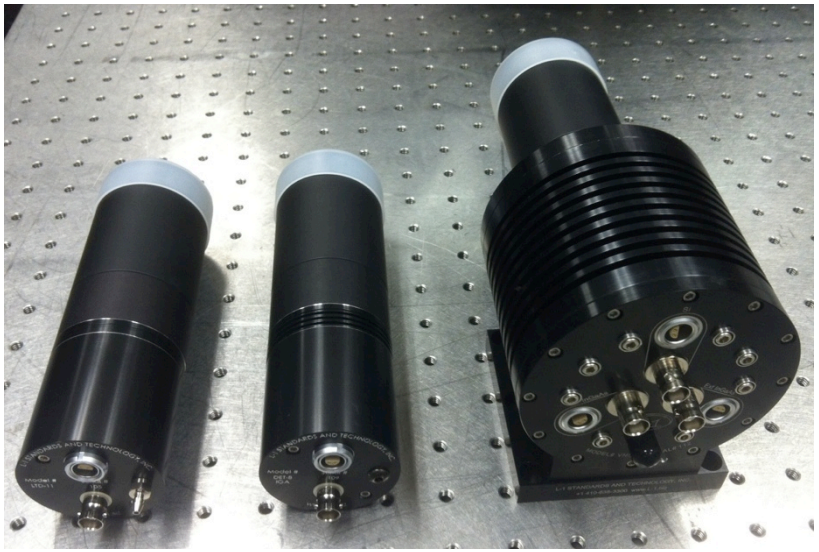
Fancy light bulb: SIRCUS

Spectral irradiance and radiance responsivity calibrations using uniform sources (SIRCUS)

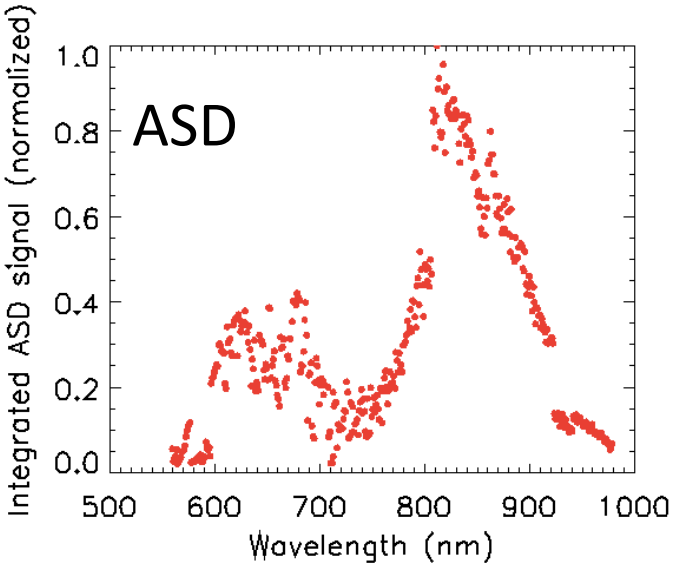


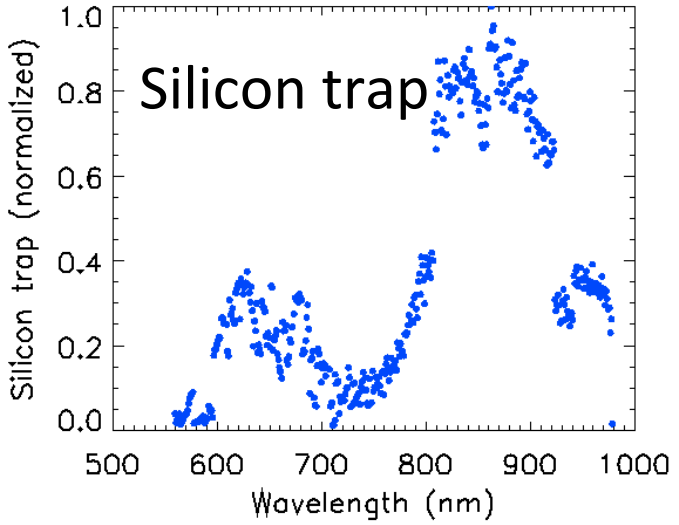
Transfer radiometers

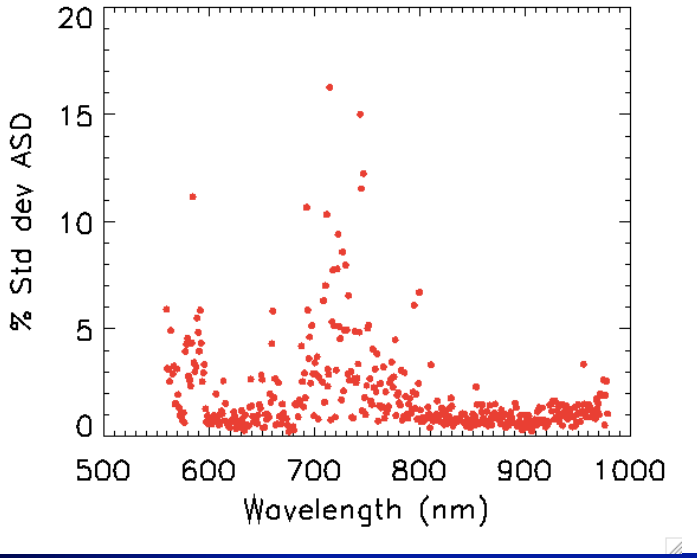
- Recently took delivery of 15 transfer radiometers
  - 5 Silicon trap detectors
  - 5 InGaAs detectors
  - 5 sphere (Si, IGA, extended IGA detectors)
  - each has thermal controller hardware
- Near-term tests include stability monitoring and connect/reconnect stability
- Radiometers will be sent to NIST for characterization

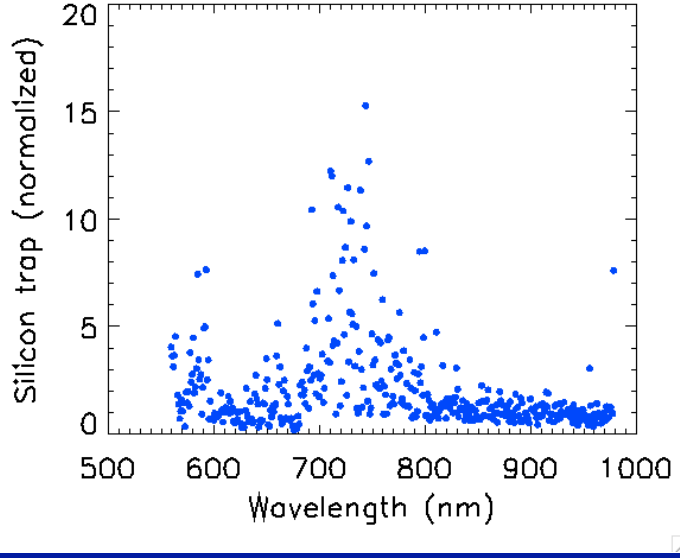


SIRCUS reference measurements

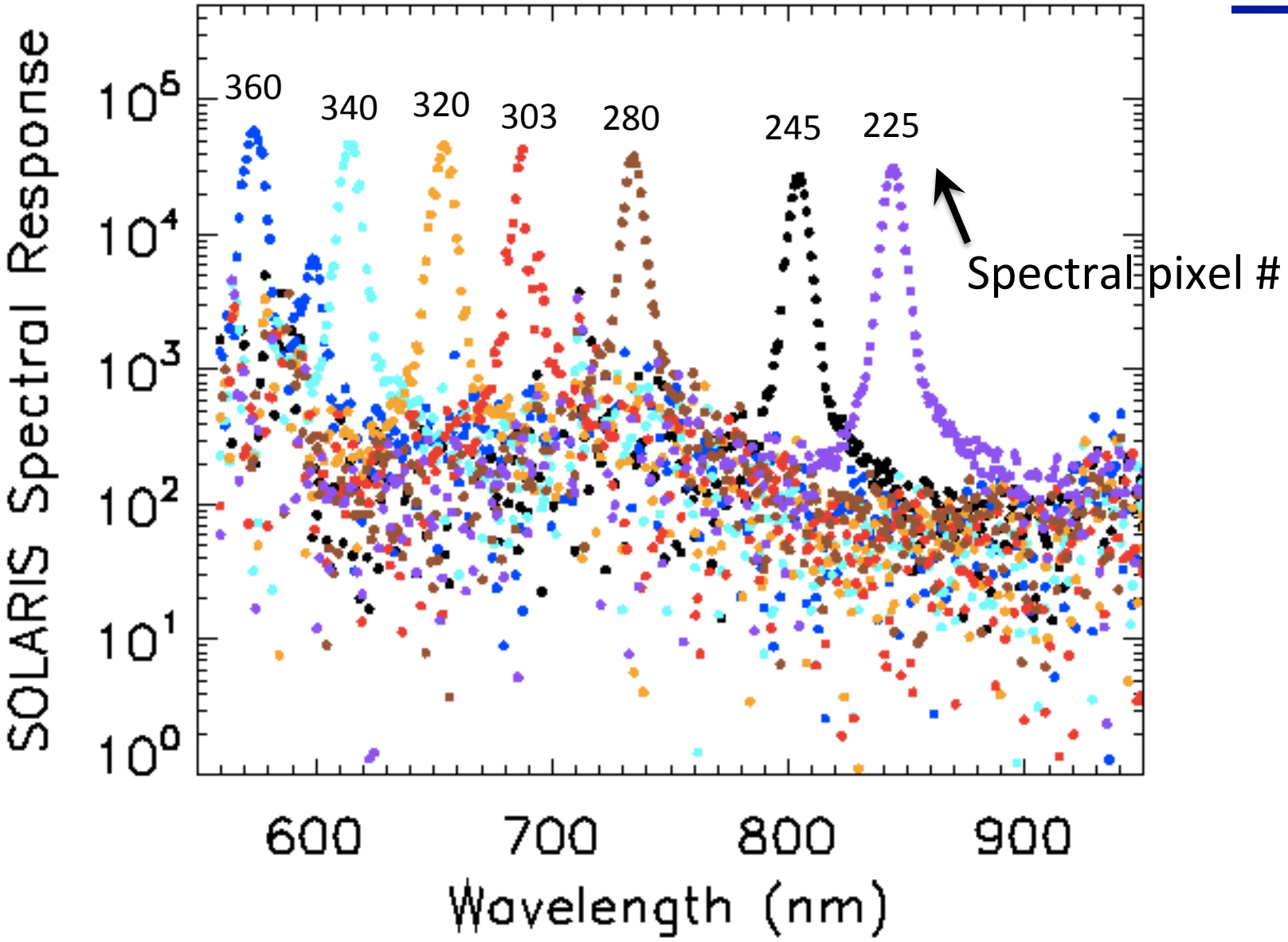








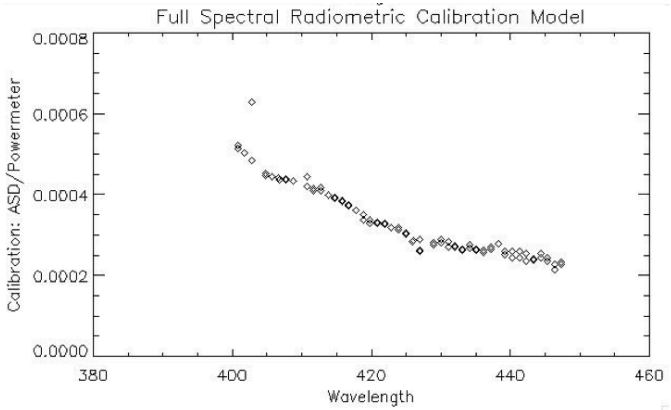
Spatial pixel #298



Summer intern projects

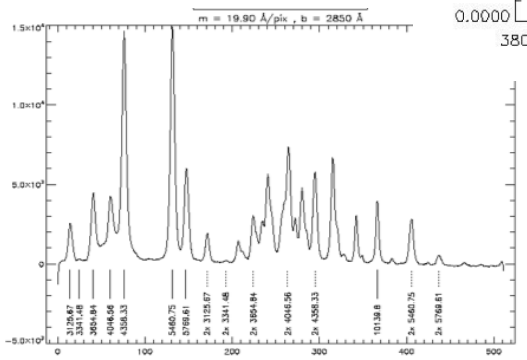
- Rachel

  Radiometric calibration transfer



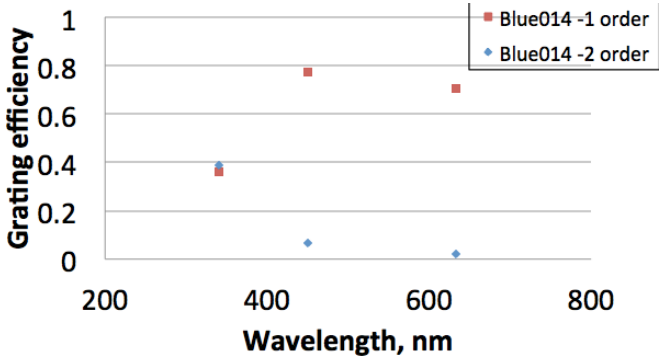
- Nirvan

  Spectral calibration



- Mae Kate

  Grating efficiency



Goddard IRAD funding

IRAD titled "**Spectral and radiometric calibration using tunable lasers**" was selected for funding under GSFC IRAD program

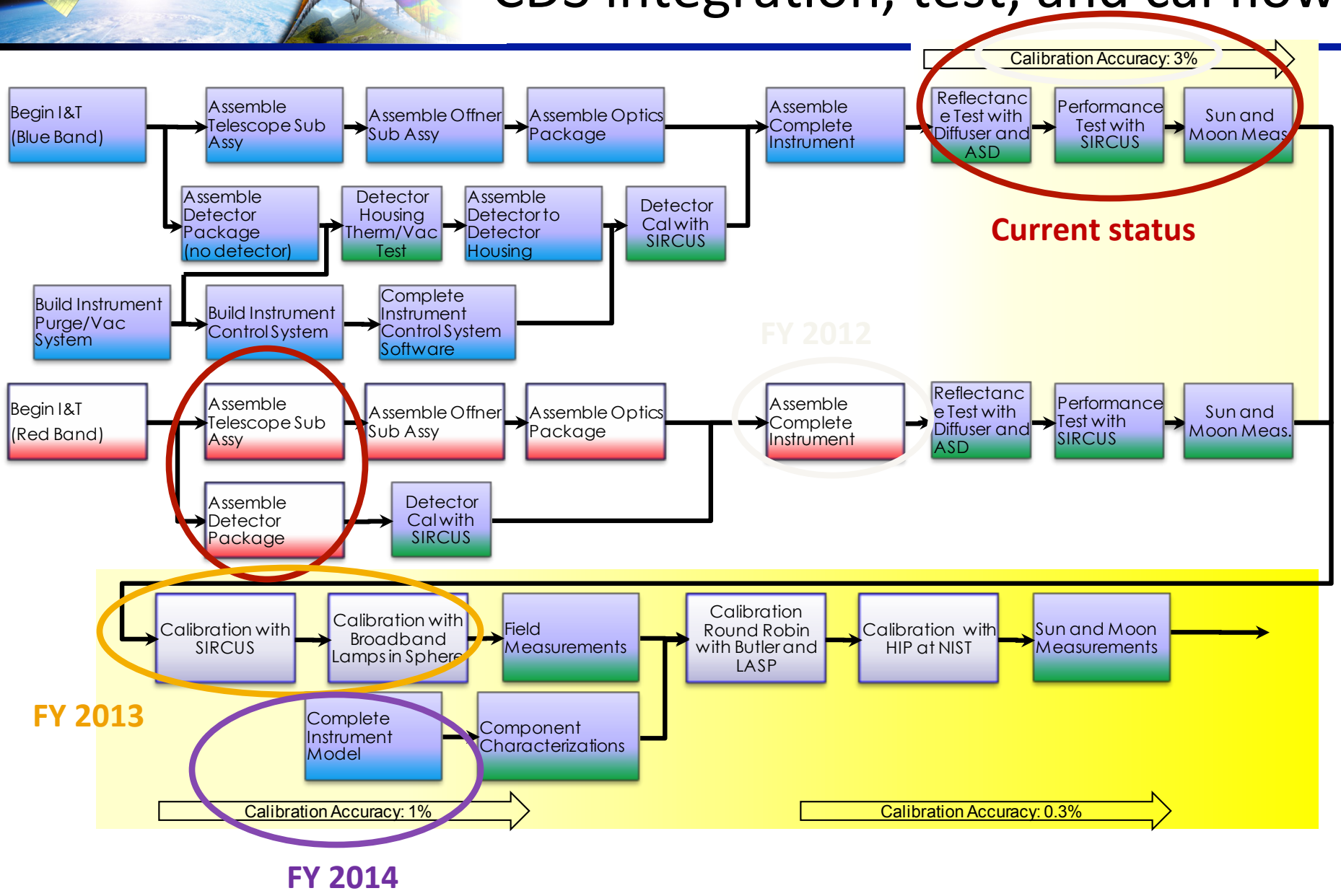
- Participants: Joel McCorkel (618), Brendan McAndrew (551), Gene Waluschka (551) and Bruce Cook (618)
- Set up system to maintain transfer radiometer NIST-traceability at GSFC
- Characterization of three Goddard-based sensors: SOLARIS, ORCA, and G-LiHT

Goddard Science Task Group

Multi-mission, Multi-disciplinary working group on calibration and validation

- Mentoring of new instrument and calibration scientists,
- Development of SI-traceable error budgets
- Improved approaches that simplify instrument design without loss of data quality
- Members from across Science Directorate
  - Solar physics
  - Planetary
  - Earth science

CDS integration, test, and cal flow



Summary

Goal for FY 2012 was to demonstrate a 2-3% calibrated instrument

- Initial blue box completed in Oct 2011 with prototype grating and uncooled detector
  - First light
  - Moon and Sun images
  - Reflectance retrieval
  - SIRCUS test
- Improved blue box completed in August 2012 with final grating and thermally stabilized detector
  - Linearity characterization
  - SIRCUS-based characterization (400+ nm sweep)
- Red box CDS optics are complete, waiting on final grating, final thermal system, and detector

Summary

- Plans for FY2013 and beyond concentrate on taking SOLARIS to the 1% plateau
  - Successful CDS effort will
    - Develop and test sensor model development
    - Demonstrate error budget for reflectance retrieval
    - Produce a peer-reviewed SI-traceability for CLARREO-like measurements
    - Evaluation of absolute solar irradiance calibration
    - Lunar model verification from ground-based collects

Summary

- SOLARIS CDS will play key role demonstrating CLARREO-quality error budgets
  - Collaborative efforts with NIST will continue to be critical
    - 'Operational' use of SIRCUS
    - Extension to wavelengths > 1 micrometer
    - Broadband calibration approaches (HIP)
  - Calibration approaches will be demonstrated
    - Laboratory calibration protocols
    - Error budget demonstration
  - Reflectance retrieval
    - Stray light characterization
    - Instrument model assessment