Serendipitous ALI Stray Light Measurements

During the Solar Calibration Aperture Selector Malfunction

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EO-1 SVT Meeting

21 November 2002

ALI Stray Light Background

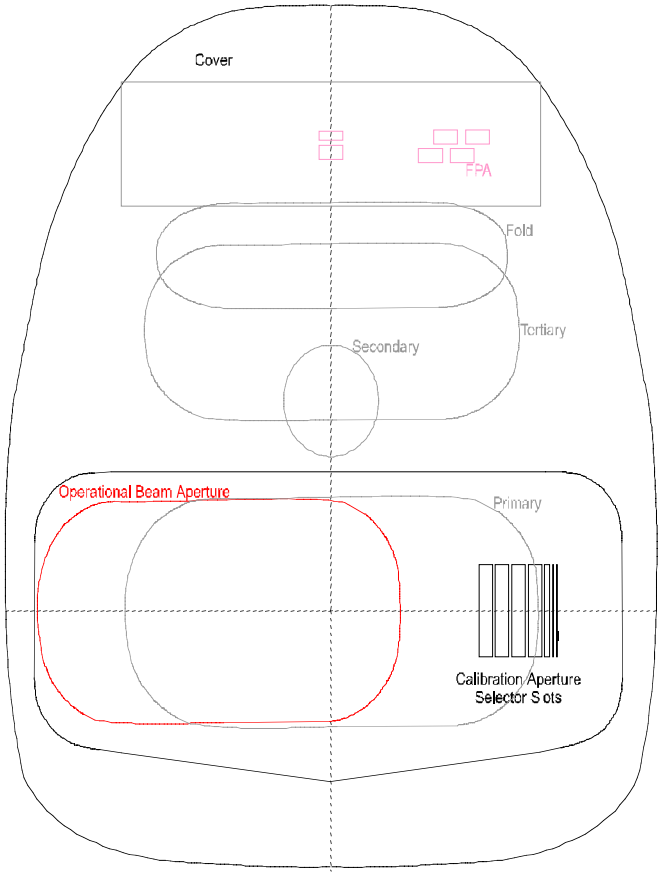
- Extensive preflight component testing and system modeling
- BRDF measurements at 0.633 and 3.39μm
- Two system analyses
  - Lambda Research Corporation
  - Computational Physics Applications, Inc.
- Key stray light characterization functions
  - Point Source Transmittance (PST)
  - Point Spread Function (PSF)

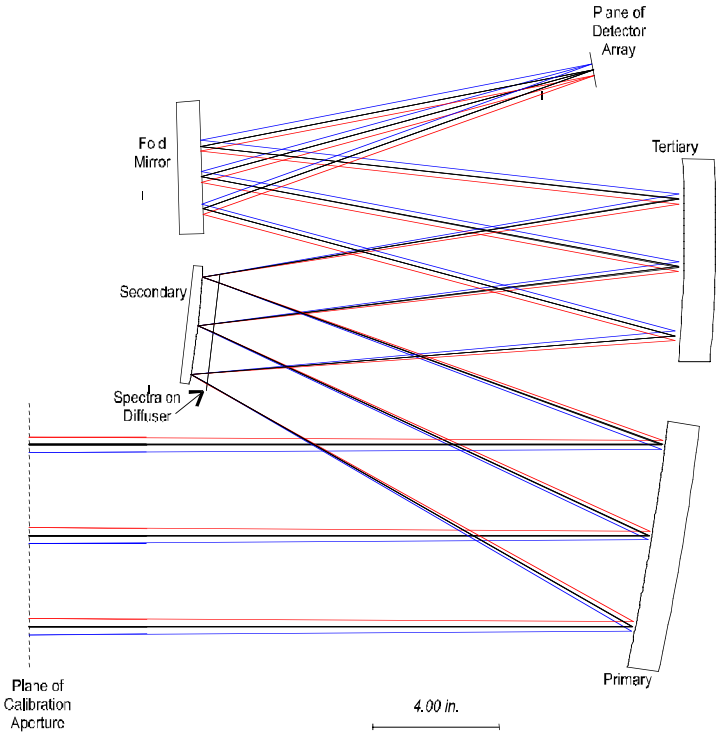
Aperture Selector Malfunction Event

5 July 2002

- Aperture selector mechanism failed partially open
- ALI imaged sun during dark current measurement
  - Solar power into ALI = 2.2 W
  - Irradiance at focal plane = 4.2 W/cm^2
- Solar image was ~ 12^{O} from center of populated SCA
- Serendipitous opportunity to verify stray light predictions
  - Point Source Transmittance
  - Point Spread Function
- Major caveats
  - Solar irradiance did not fully illuminate open ALI aperture
  - Only one point source direction measured

EO1 ALI Optical System





Point Source Transmittance (PST)
Point Spread Function (PSF)

The PST is the ratio of the stray spectral irradiance at the detector to the spectral irradiance incident on the instrument :

$$dE^{\lambda}_{stray} = PST \cdot dE^{\lambda}_{0},$$

Where,

$$PST = [f_1(\theta)S_1(\theta) + f_2(\theta)S_2(\theta) + f_3(\theta)S_3(\theta) + f_4(\theta)S_4(\theta)]\frac{\pi}{4F^2}$$

The *f* functions are the BRDFs of the mirrors, and the S functions are the shading functions for each mirror.

The equivalent stray spectral radiance is

$$dM^{strayeqivalent}_{\lambda} = \frac{4F^2}{\pi} PST \cdot dE^{\lambda}_{0}$$

$$PSF = \frac{4F^2}{\pi} \cdot PST$$

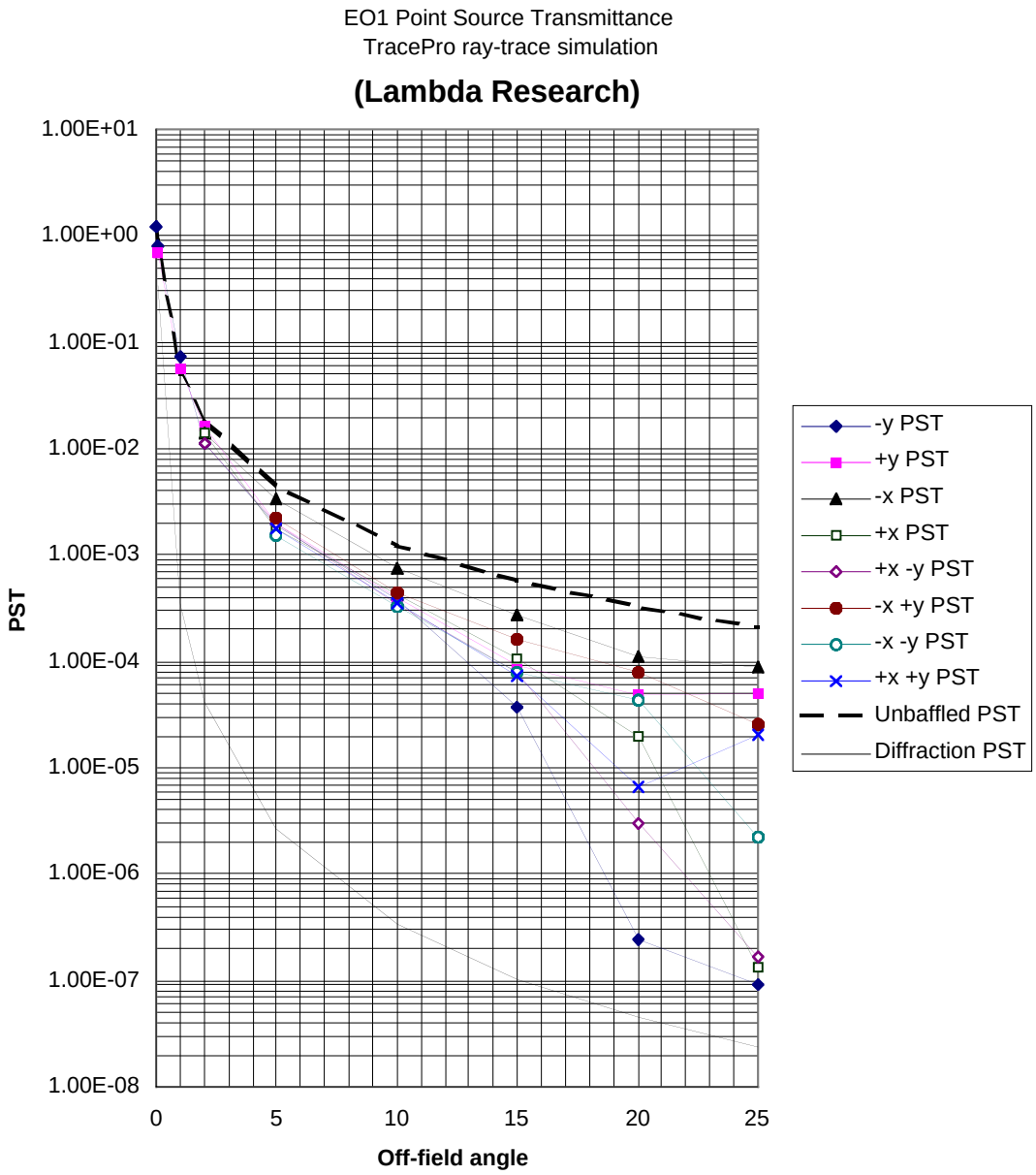


Figure 1 PST predicted by TracePro for EO-1 band 3

ALI Scattered Light Study

(Computational Physics Applications, Inc.)

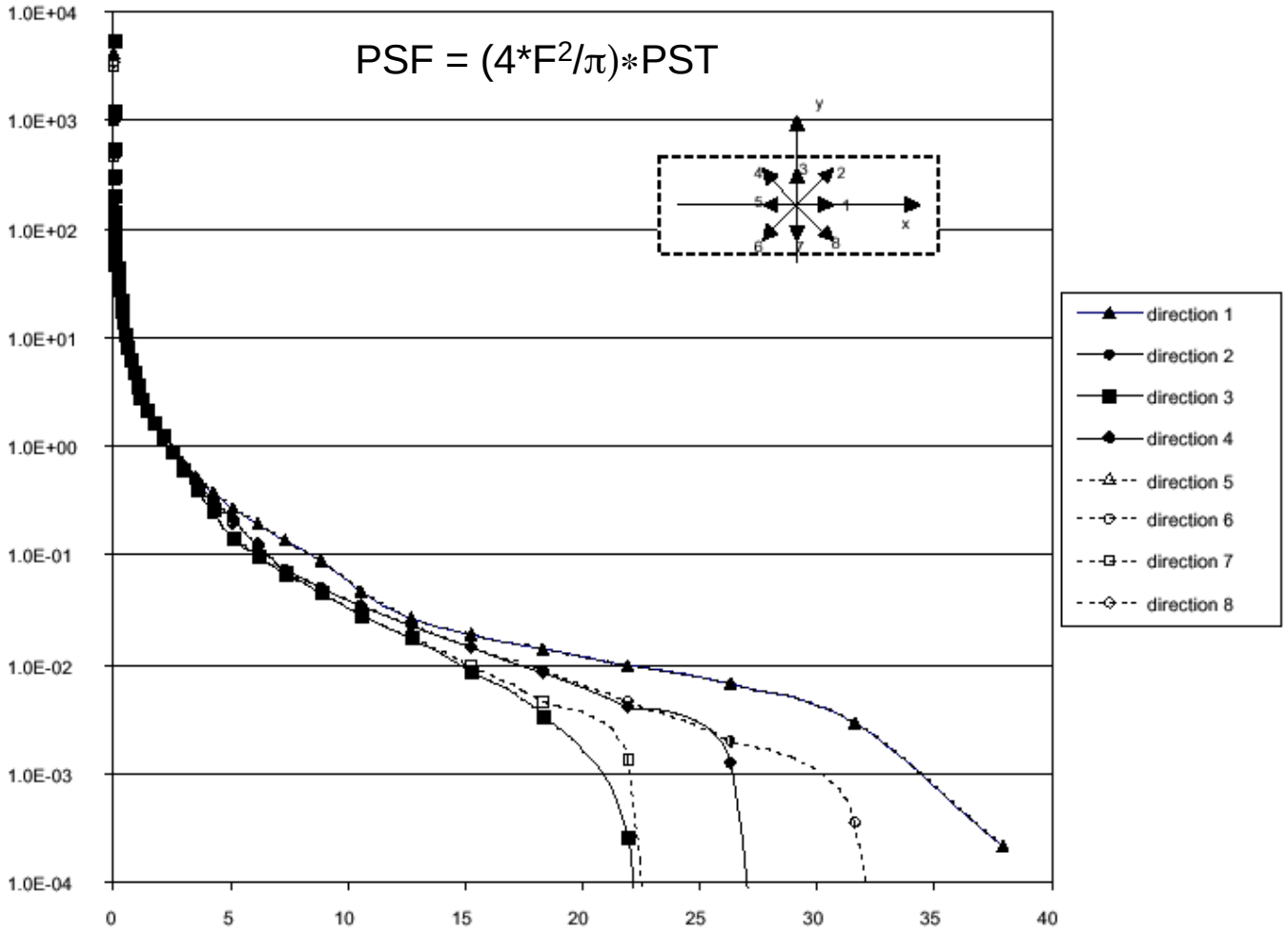
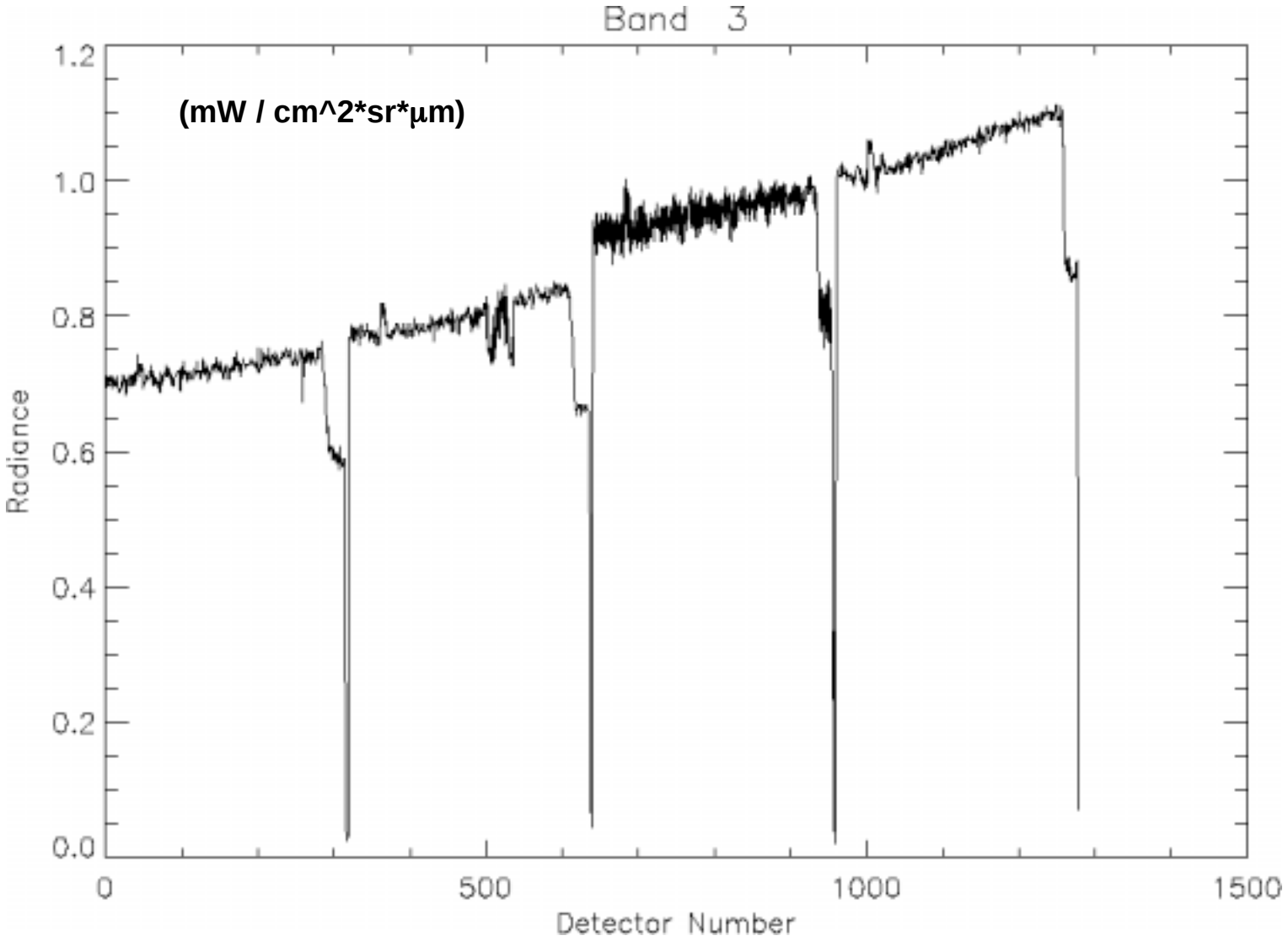
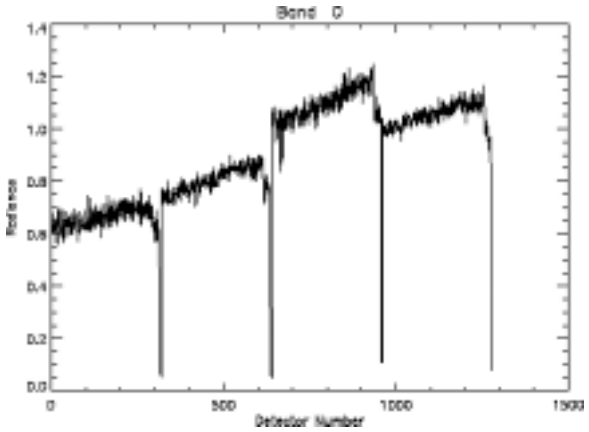


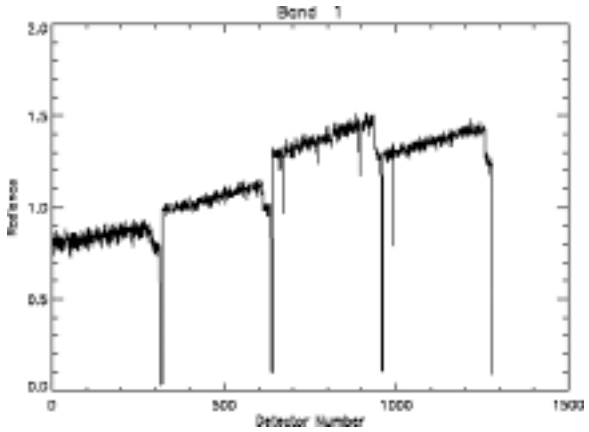
Figure 4.6 $PSF^{stray}(\mathbf{s},\mathbf{t}=0)$ for the ALI along the 8 directions defined in Figure 4.1.

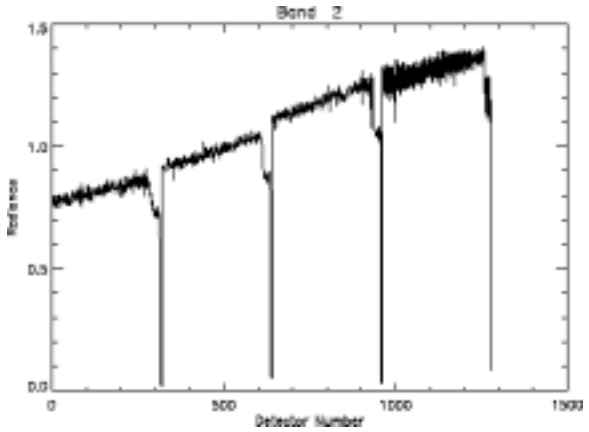
Effective Stray Radiance

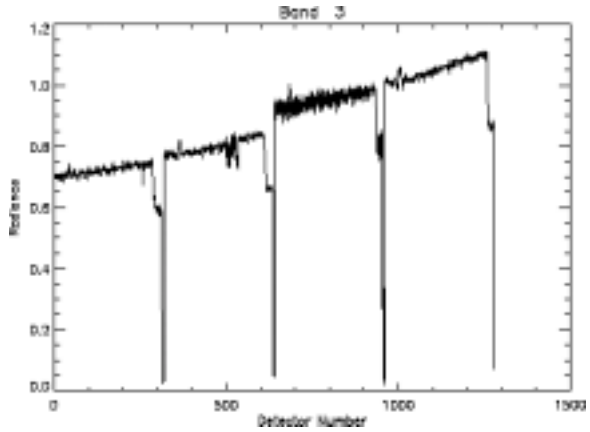
Solar Source Imaged at -6°

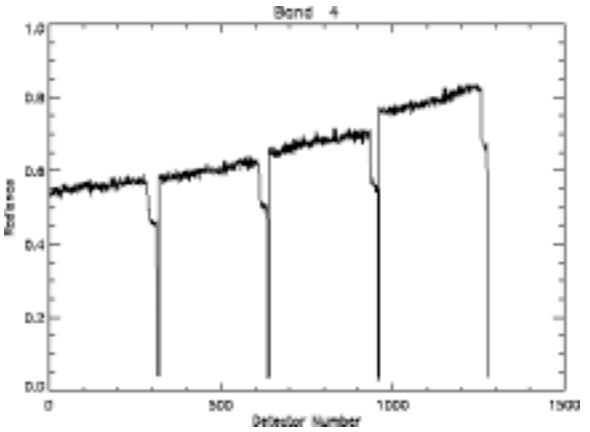


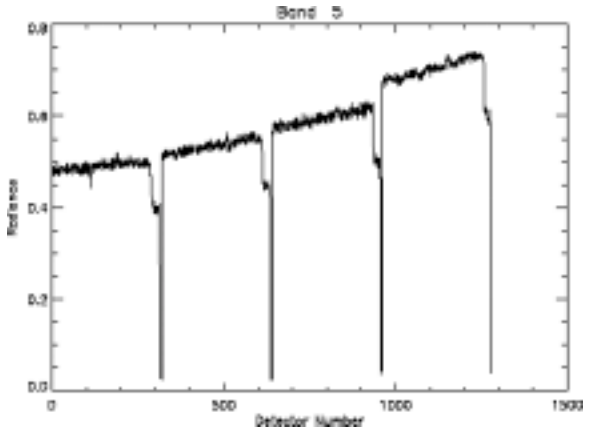

Band 0
Radiance
Detector Number

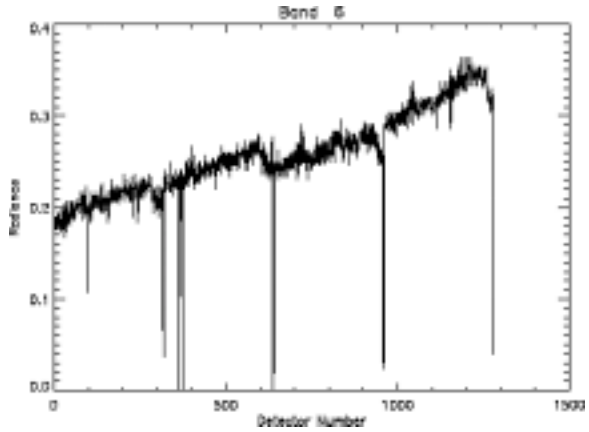

Band 1
Radiance
Detector Number

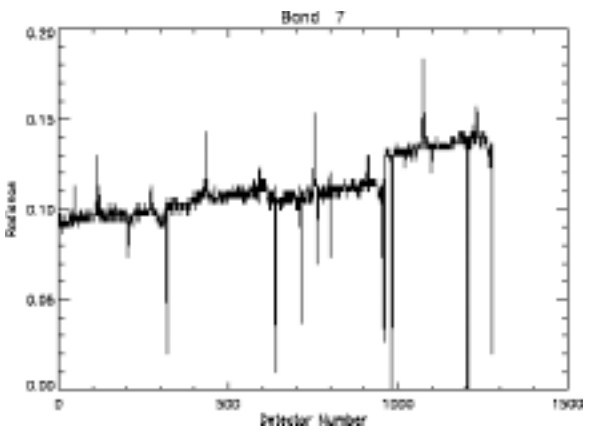

Band 2
Radiance
Detector Number

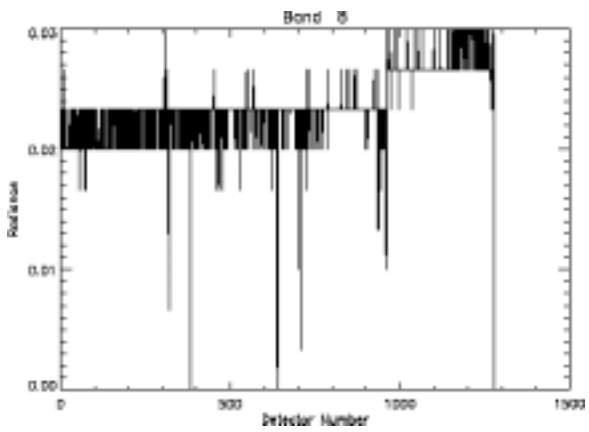

Band 3
Radiance
Detector Number


Band 4
Radiance
Detector Number

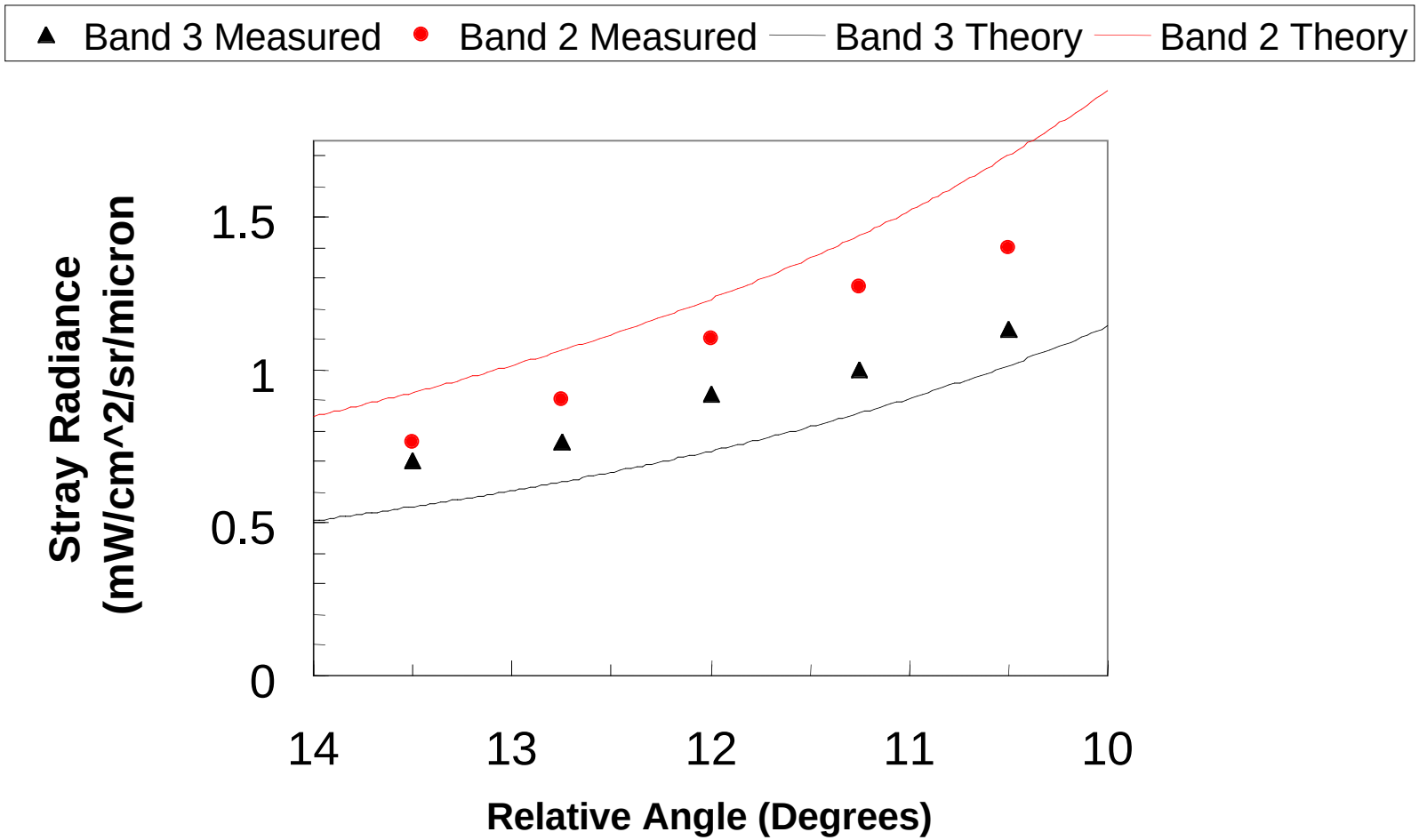

Band 5
Radiance
Detector Number


Band 6
Radiance
Detector Number

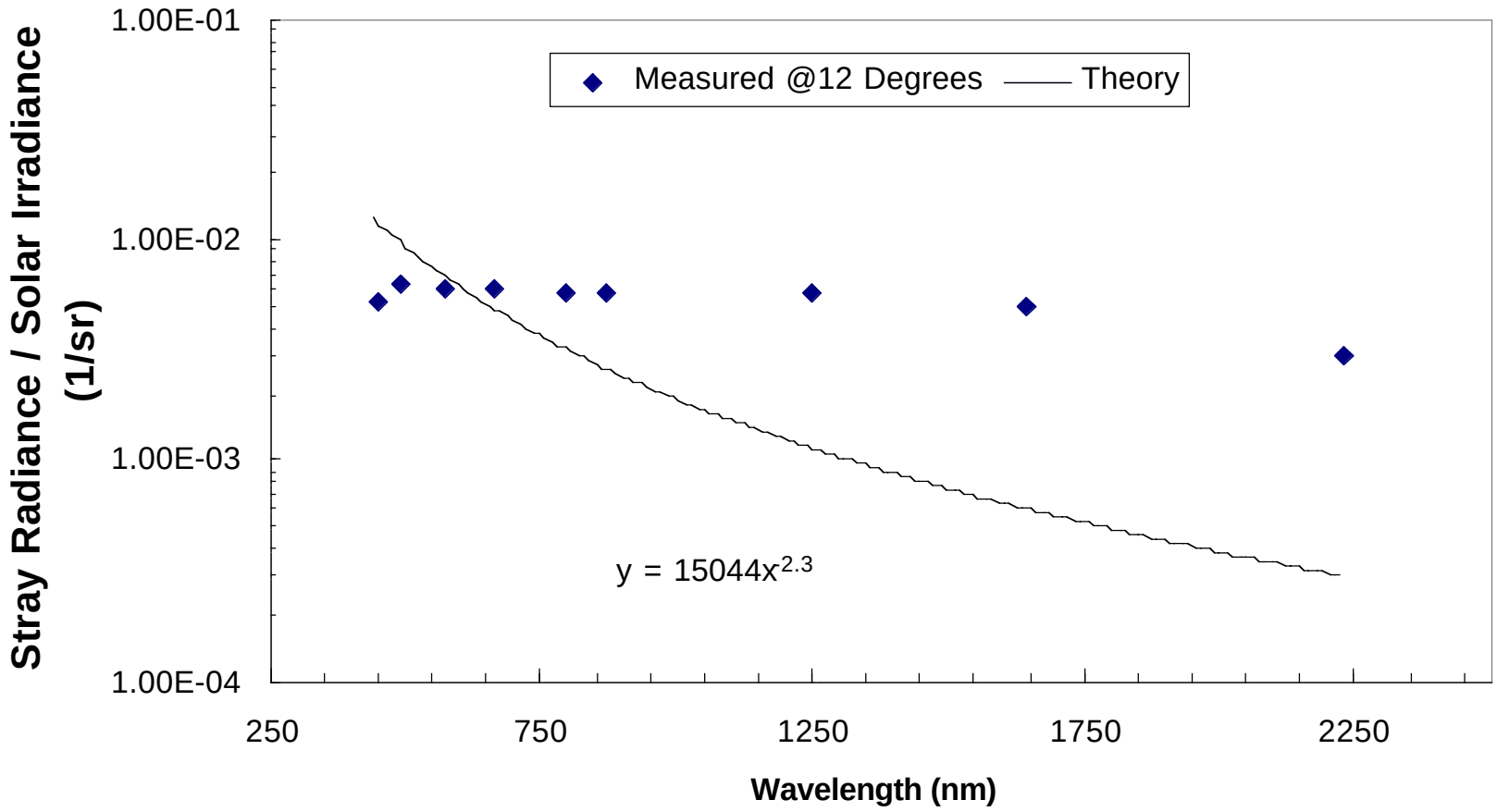

Band 7
Radiance
Detector Number


Band 8
Radiance
Detector Number

Stray Radiance From Off Axis Solar Illumination



Stray Light Wavelength Dependence



Tentative Conclusions

- Measured stray light consistent with predictions for bands close to 633 nm
  - Magnitudes
  - Angular dependences
- Observed magnitudes fairly insensitive to wavelength
  - Lambda Research predicted ~ $\lambda^{-2.3}$ dependence
  - BRDF measurements at 0.633 μm and 3.39 μm indicate ~ λ^{-1} dependence
  - Computational Physics Applications made no prediction
- Theoretical wavelength scaling needs confirmation by LRC