VIIRS On-orbit Spectral Throughput Degradation: A Physical Model with Specific Guidance on Handling Sensor Characteristics for EDR Development

B. Guenther
Stellar Solutions at JPSS
bguenther@stellarsolutions.com
240 393-1186

Look at the sensor

Review once again what was observed and what it means

BACKGROUND

Rendering Cut Away of VIIRS

What should we see in the Rendering

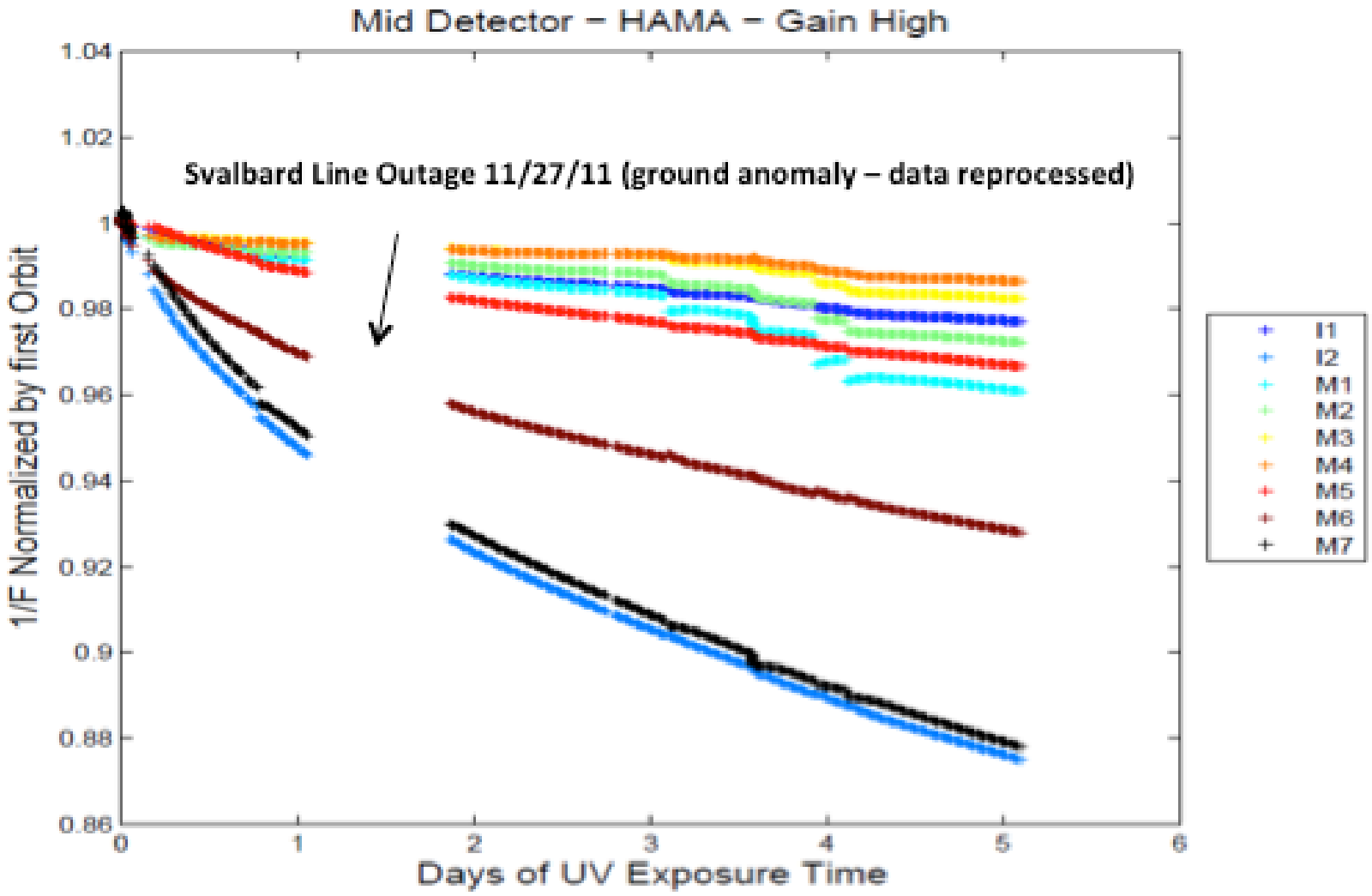
- Nadir, where the Earth is seen, is down
- Scanning done with Rotating Telescope (RTA)
- Design involves 4 mirror Rotating Telescope
  - 3 mirrors have optical power, one is a flat
- Light reflects from telescope onto mirror rotating at half speed of RTA (Half Angle Mirror, HAM)
  - Couples scene observations into fixed optics
- Light then enters second telescope, spectral discrimination optics and electro-optics elements

What should we see in the Rendering

- Nadir, where the Earth is seen, is down
- Scanning done with Rotating Telescope (RTA)
- **Design involves 4 mirror Rotating Telescope**
  - **3 mirrors have optical power, one is a reflecting flat**
- **Photons reflect from telescope onto HAM**
- Then light enters **second telescope**, **spectral discrimination optics and electro-optics elements (multiple vendors)**

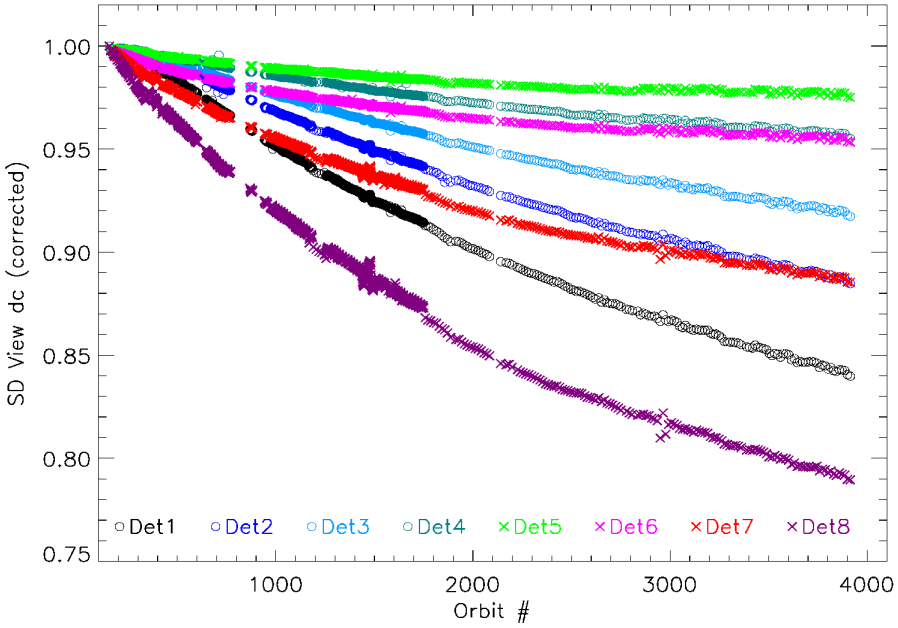
Rendering Cut Away of VIIRS

What did we see on-orbit?

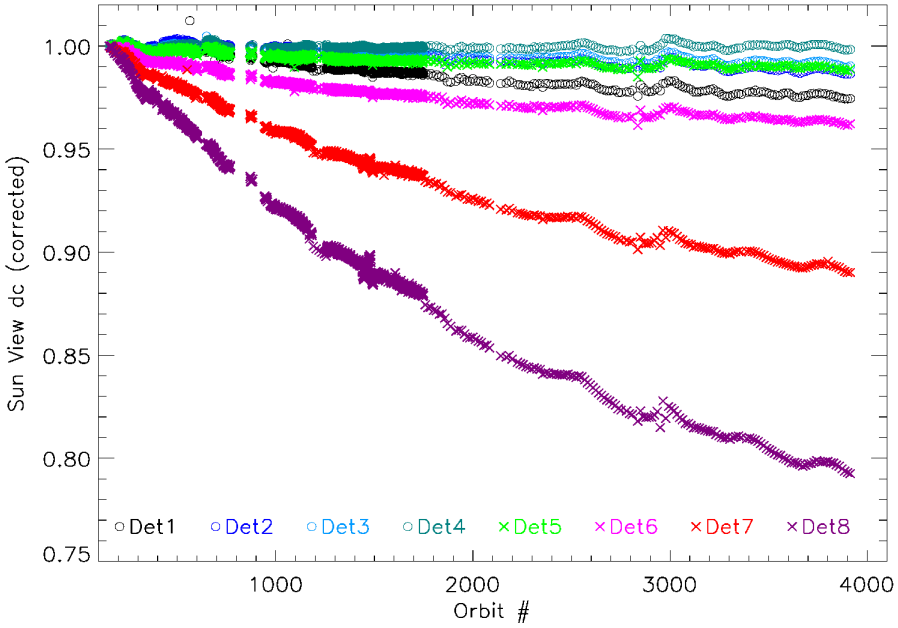


VIIRS SDSM Response On-Orbit

Solar Diffuser View



Sun View



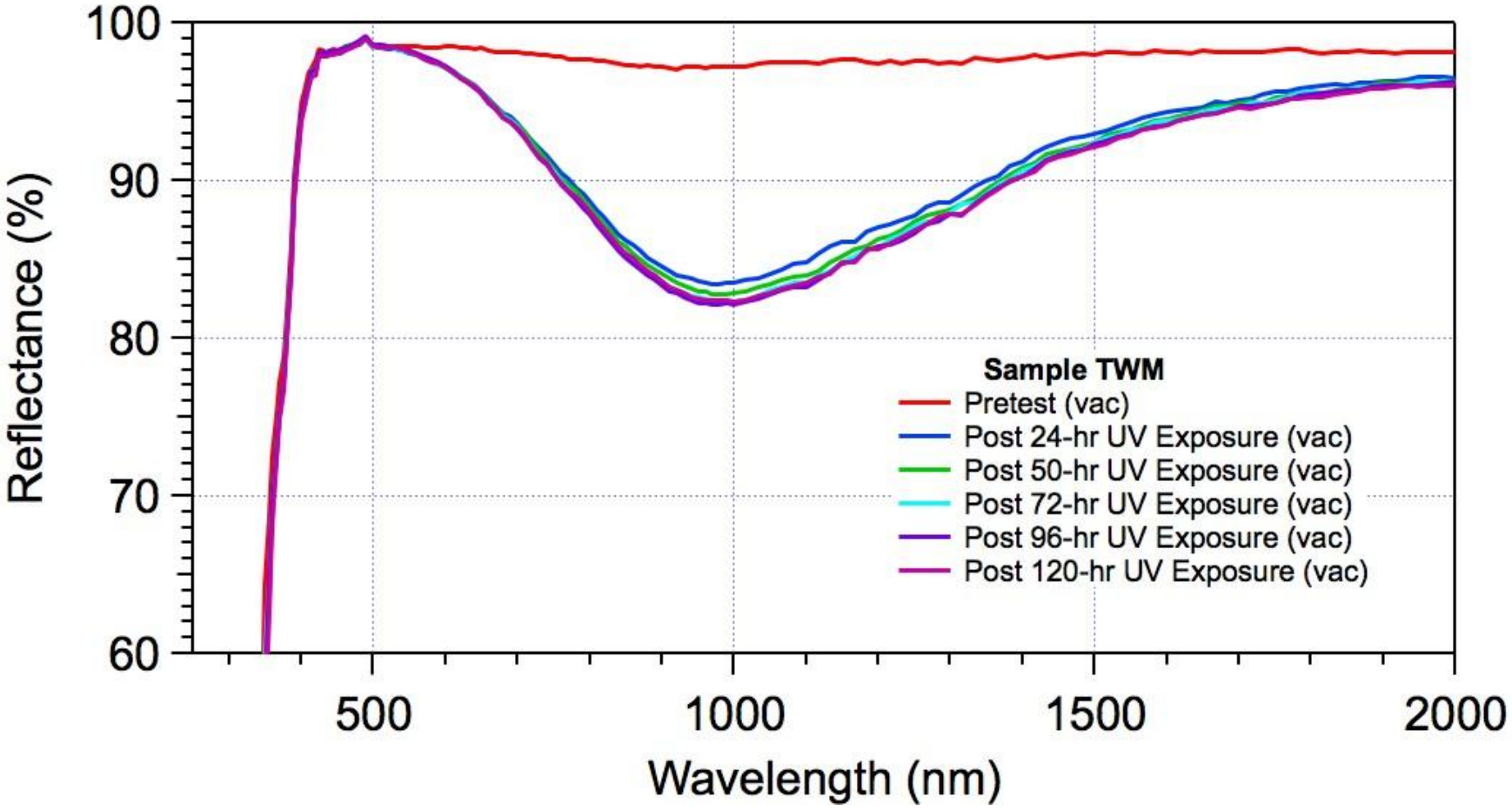
Sun View (right): SDSM detector degradation

SD View (left): Both SDSM detector degradation and SD degradation

Note WU/CD events around Orbit 1500 and 3000.

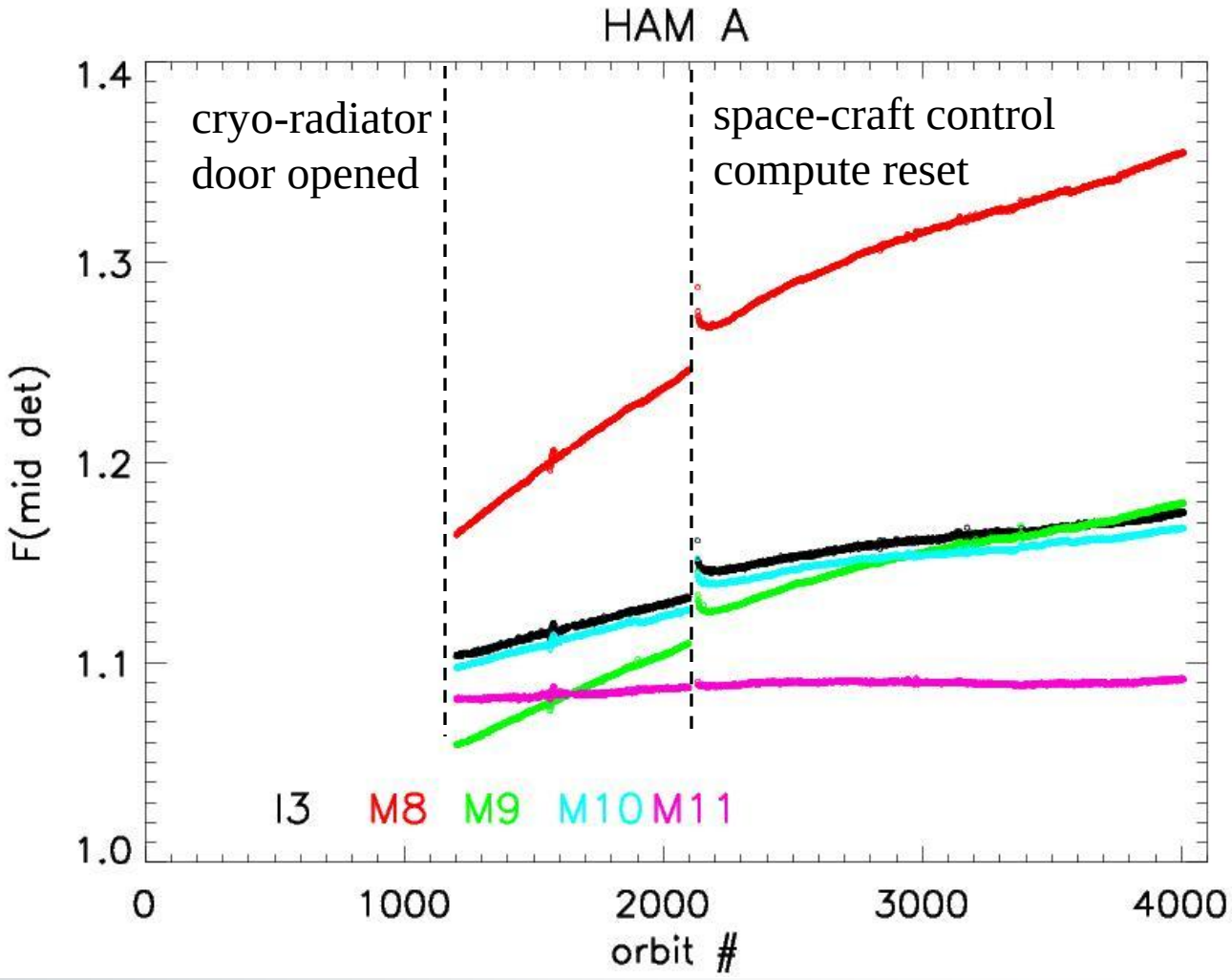
Fulbright, et. al., SPIE 2012

TWM Reflectance – Absorption loss caused by UV

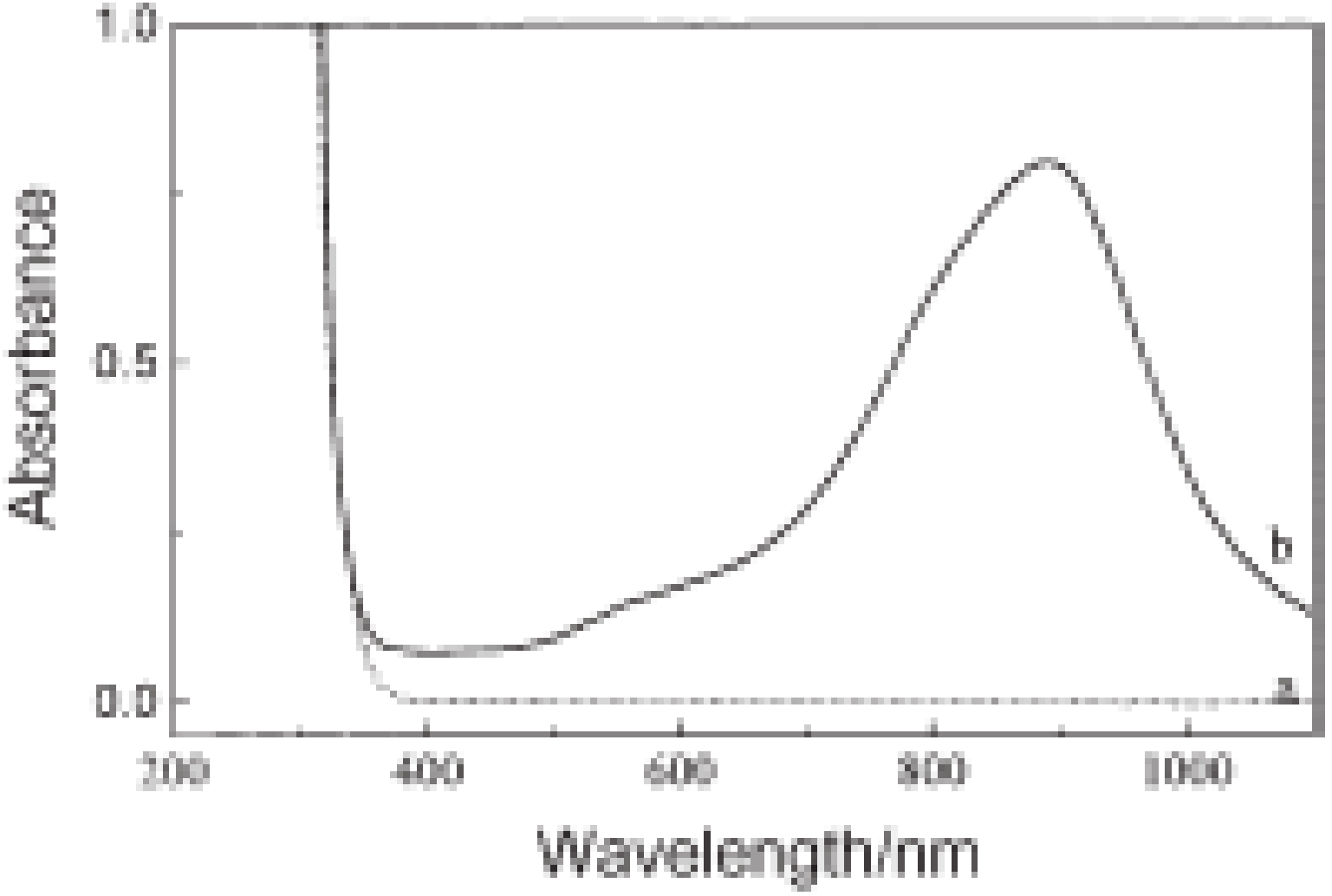


The VIIRS witness mirror degradation saturated after several days of exposure.

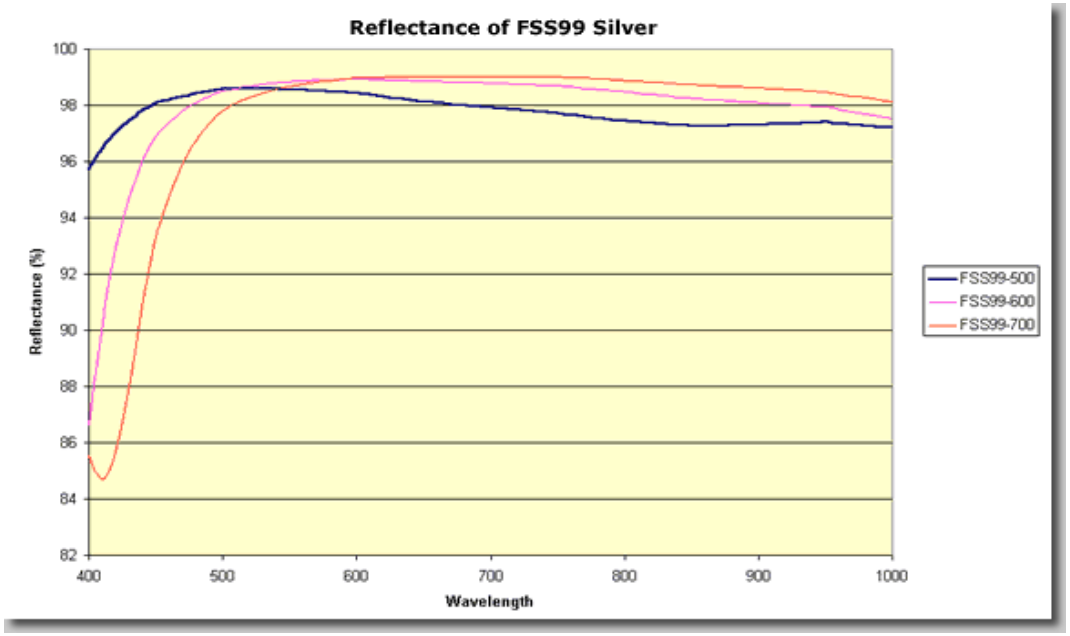
Results: Short Wave Infrared Bands



UV absorption of tungsten oxides occurs about 350nm and below



What do the mirror surface reflectance coating look like, new?

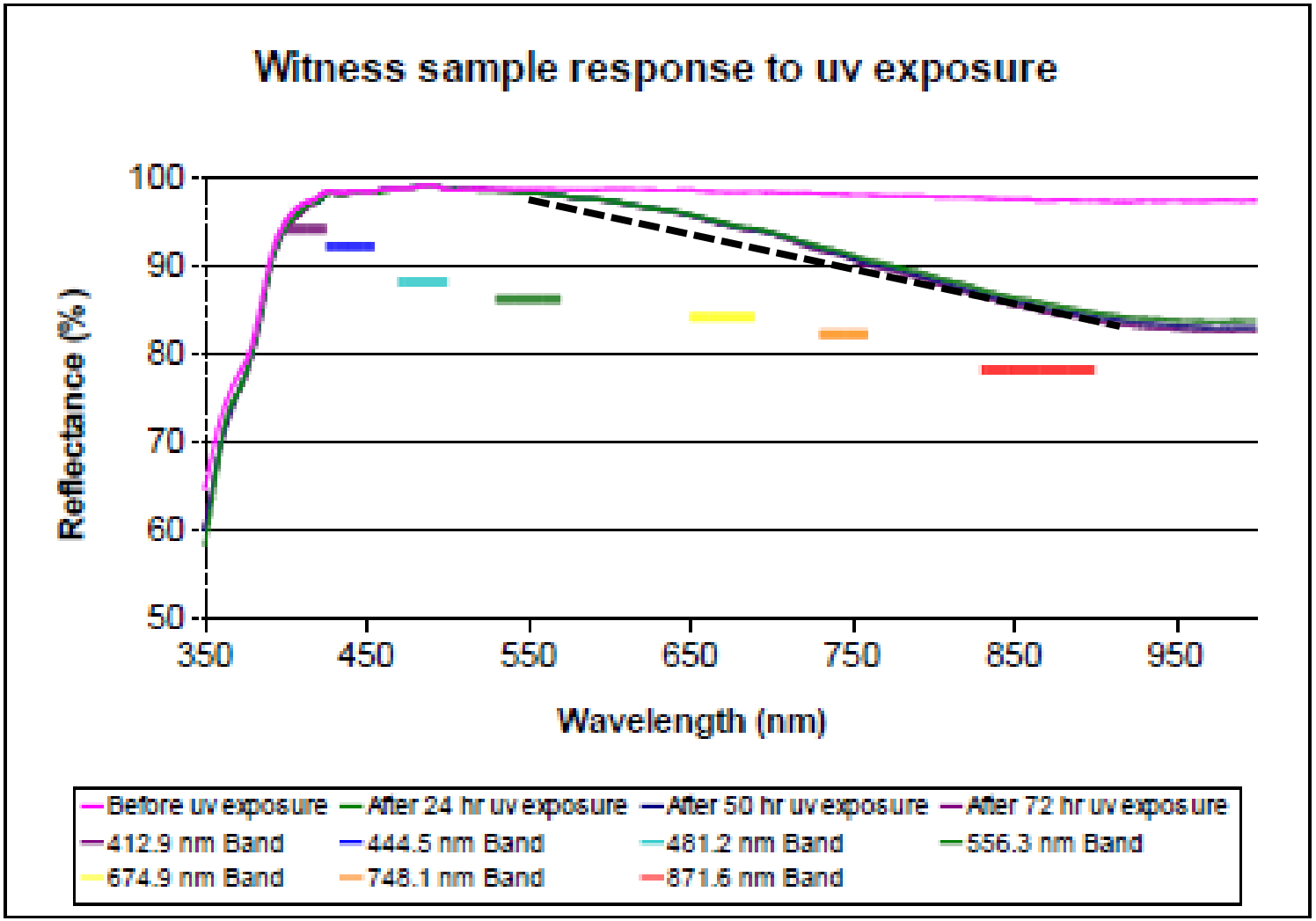


Looking for simple physical model that mimics effects

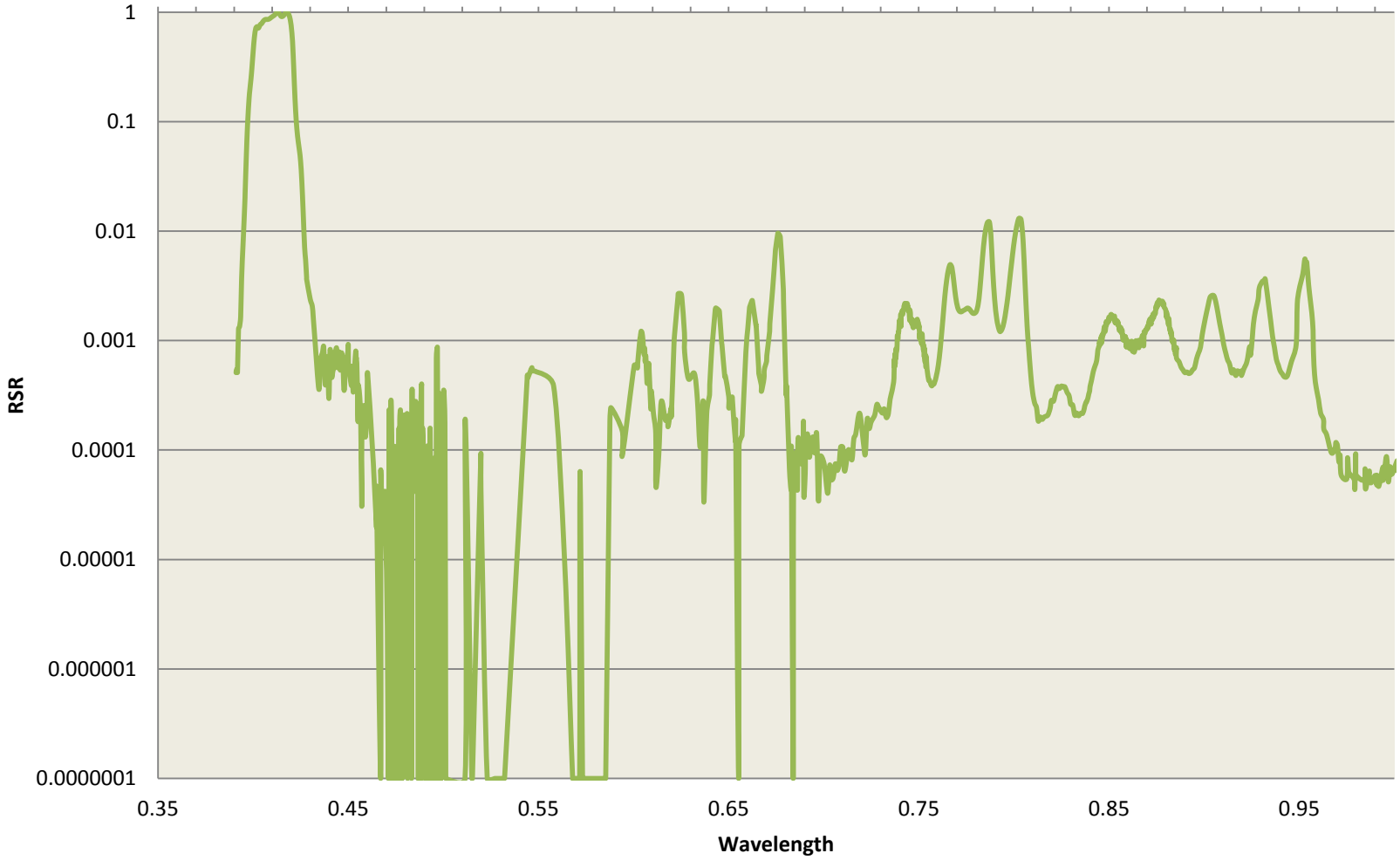
But for which simple computations will provide “truthing” for more complex computations

MY WAY TO LOOK AT THIS STUFF

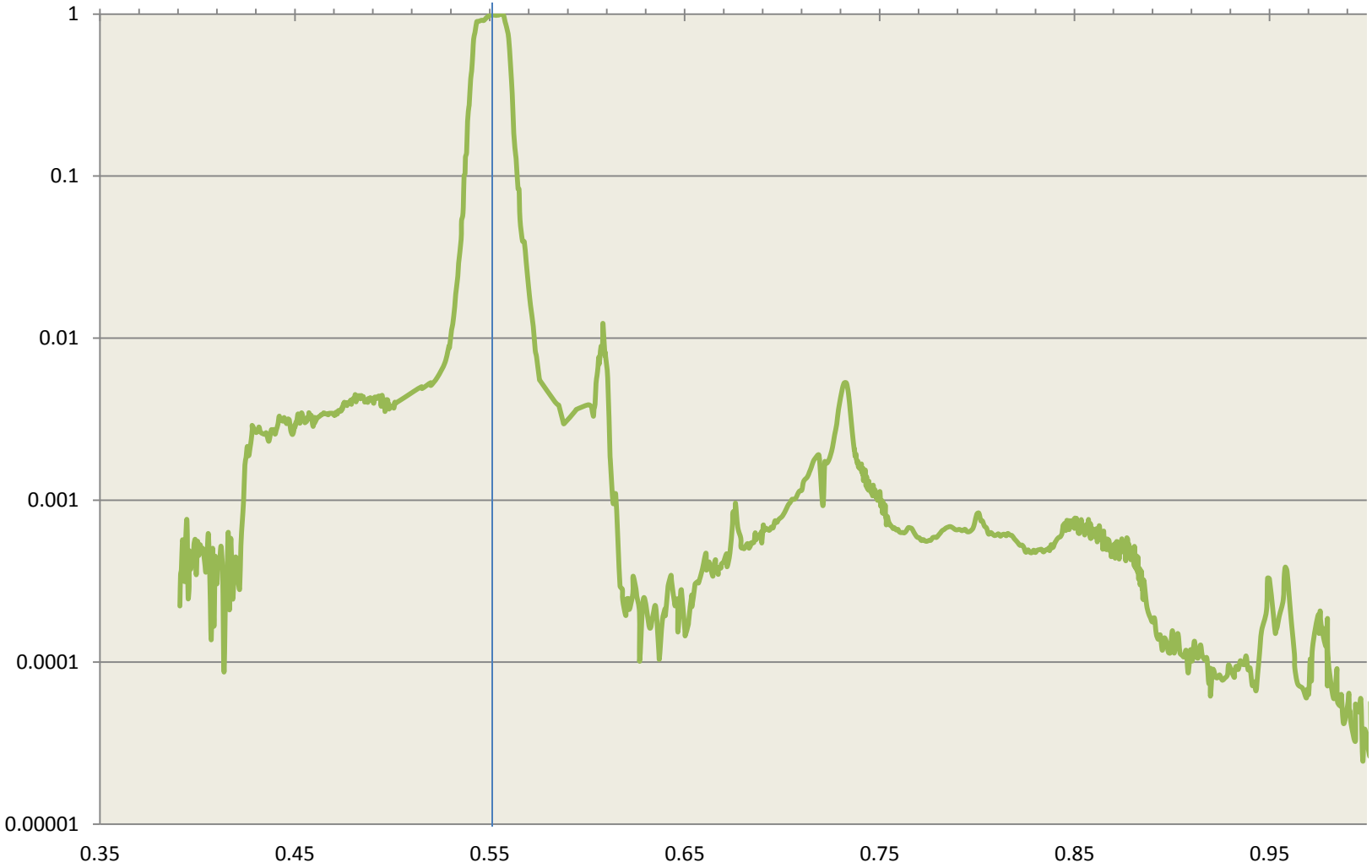
What Did Aerospace Find?



RSR Band M1, 412 nm center



RSR Band M4, 555 nm center



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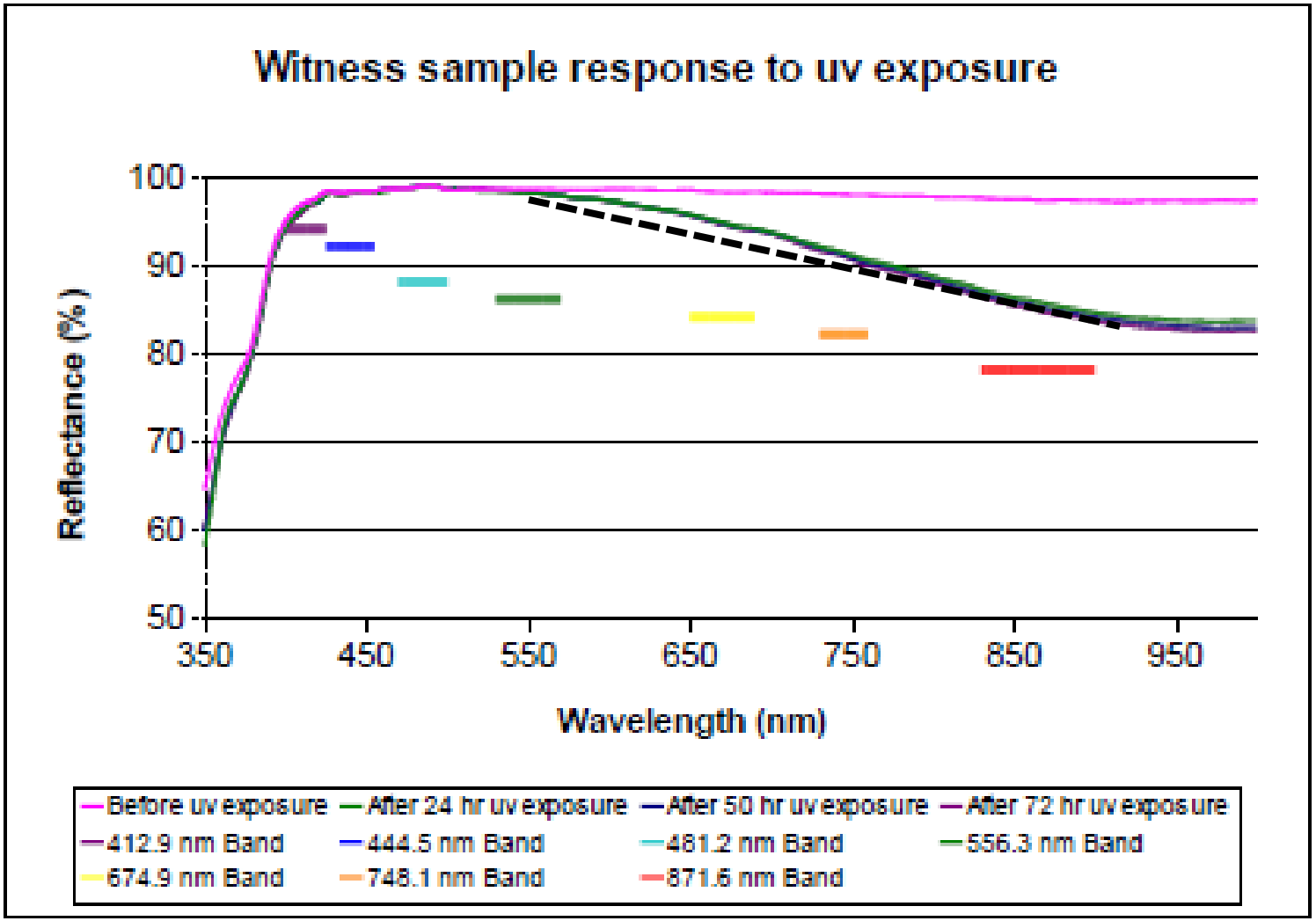
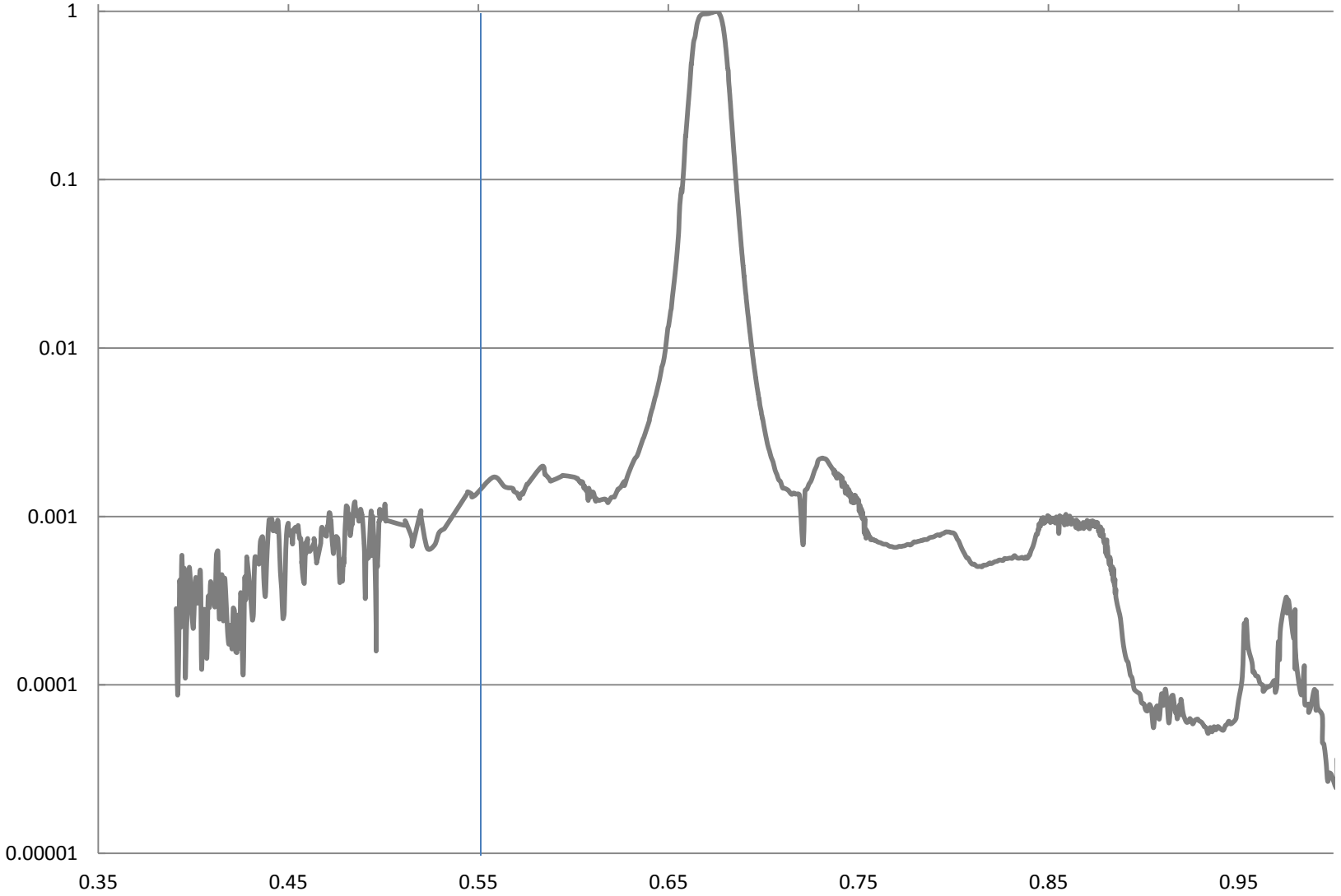


RSR Band M5, 675 nm center



What did I find in my model?

Center wavelength (CW) (nm)	Full Bandwidth (between 1% points) (nm)	Signal OOB at launch (%)	Response degradation with "30% gain" degradation (%)	Change to in-band response with this gain degradation model	Signal OOB after "30% gain degradation (%)	RSR Skew over Full Bandwidth (%)
412.9 (M1)	31	2.7	0.3	<0.1	2.3	
444.5 (M2)	23	1.9	<0.1	<0.1	1.9	
481.2 (M3)	23	1.1	1.2	<0.1	1.0	
556.3 (M4)	35	3.7	0.4	1	3.5	1.8
674.4 (M5)	36	4.2	10	10	4.3	4
742.2 (M6)	20	1.5	17	17	1.6	2.7
850.9 (M7)	60.5	0.6	27	27	0.2	6.0

Where this calculation leads me

And is it just fun to push at my teammates with different ways to do things or do I actually anticipate any science benefits from this work

AND SO

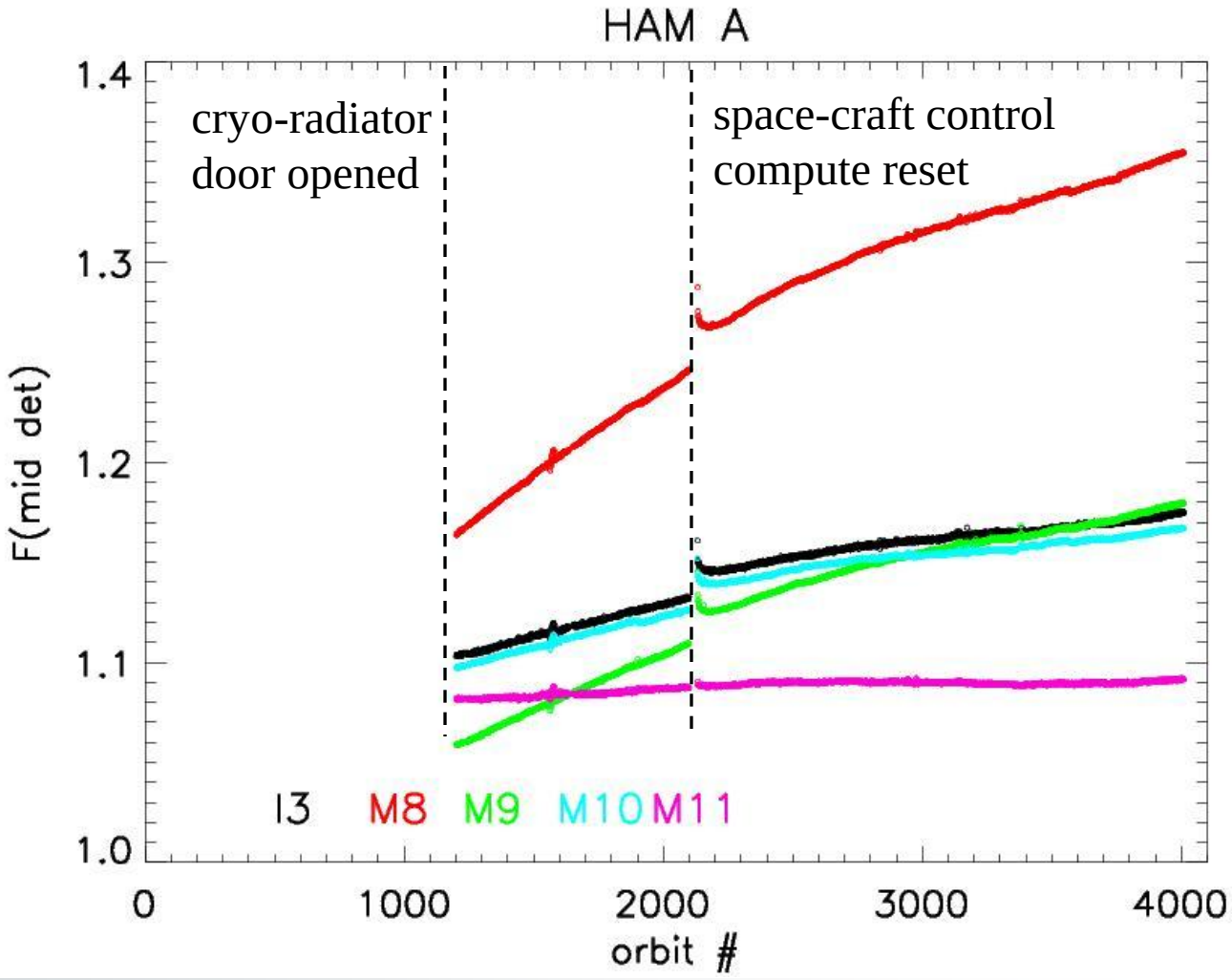
Path Forward

- OK to be guided by witness sample measurements but quantitative values must be based on the (SD) observations
- Mirrors are not expected to be identical, and will degrade ‘each in its own way’
- Moving toward development of an analytical model of throughput degradation based on uv-flux degradation of the (individual) surfaces

Why all this extra work?

- We have paradigm shift possible for calibration on VIIRS to use Absolute Spectral Response computations because the laser calibration provides ‘perfect’ cal knowledge
  - Physical model of degradation seems essential to preserve these possibilities
- See also others comments about *Transparency and Documentation*
- Other dirty little secrets that we are not talking about yet

Results: Short Wave Infrared Bands



Conclusions (anything new?)

- There have been NUMEROUS presentations now on this topic
- The operational team updating RSR and LUT for a ”July 2012” status
  - Caution still needed for EDR retrievals where scene has structure within sensor bandpass
    - Looking at chlorophyll?
- Operational products now are doing perfectly fine
- VIIRS has I-bands and M-bands, and M7 and I2 actually share an interference filter
  - One will recover all degradation in M7 SNR due to this transmission anomaly by aggregating M7 and I2 observations

Isaac came on shore this morning, here is a VIIRS DNB image from the U. Wisconsin team from Tuesday while storm still in the Gulf

LEAVE THEM WITH A PRETTY PICTURE AND A SMILE ON THEIR FACE

Meet Isaac, as seen by VIIRS Day Night Band Panchromatic