

Provisional Sumi-NPP OMPS SDR

Chunhui Pan

ESSIC, University of Maryland, College Park, MD 20740

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Outline

- Overview of Ozone Mapper Profiler Suite (OMPS) Instrument
- Provisional status of the Sensor Data Records (SDRs)
- Instrument Performance
- IDPS SDR performance
- Summary

Mission and Activity

Nadir Technical Specification

One telescope w/ two separate grating CCD spectrometers Nadir Profiler (NP) and Nadir Mapper (NM)

NM: 2800 km (35 cells, 50 km)

NP: 250 km (single cell)

NM: 110 x 0.27 deg

NP: 16.7 x 0.25 deg

NM: 300 to 380 nm

NP: 250 to 310 nm

NM: 2.4 pixels per FWHM

NP: 2.4 pixels per FWHM

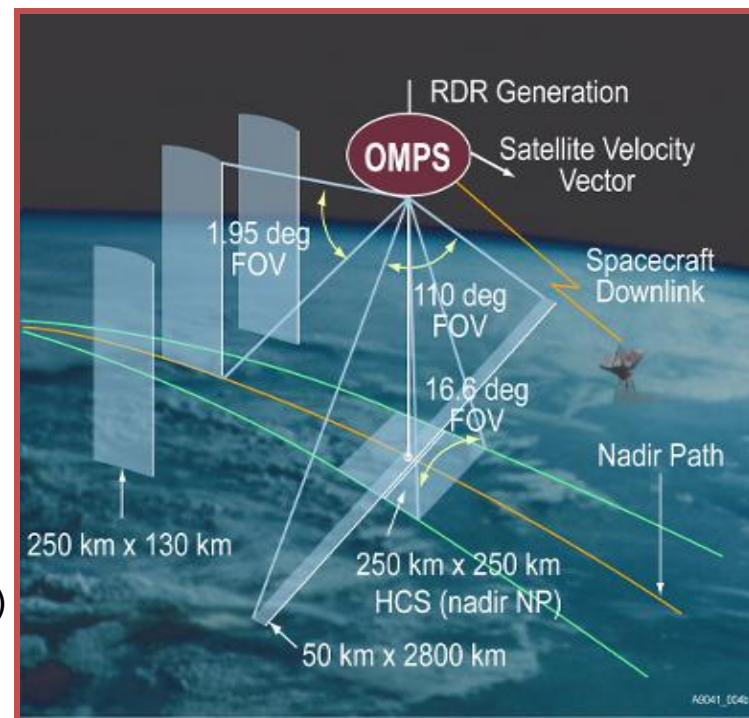
NM: 1.0 nm

NP: 1.0 nm

Thermo-Electric Coolers (TECs)

NM: -45.0 C

NP: -30.0 C



- On-board light-emitting diodes (LEDs) and dual Solar diffusers.
- Dark, bias, linearity and gain correction, data binning, hot pixel removal.
- Stability maintained by periodic solar observations with reflective diffusers

Telescope

Swath Width

Field of View (FOV)

Spectral Range

Spectral Sampling Interval

Spectral Resolution

CCD Detector Cooling Operational set point

Calibration

OMPS SDR Products (SDRs)

NPP Interface Data Processing Segment (*IDPS*) produces Raw Data Records (RDRs), Temperature Data Records, (TDRs), Sensor Data Records (SDRs) and Environmental Data Records (EDRs), as well as Intermediate Products (IPs). Data are available via NOAA CLASS <http://www.class.ncdc.noaa.gov>

Science SDR	
SOMTC_NPP	OMPS Nadir Total Column Science SDR
SOMPS_NPP	OMPS Nadir Profile Science SDR
Calibration SDR	
SOMSC_NPP	OMPS Nadir Total Column Calibration SDR
SOMNC_NPP	OMPS Nadir Profile Calibration SDR

- Earth View SDR and Calibration SDR are produced by separate SDR Algorithm processes in HDF5 format, includes Calibrated sensor data, Geolocation data, Quality flags, Metadata at the granule and aggregation level.
- The basic SDR processing includes signal correction, calibration analysis, and calibration application. Intervention is required only for approving upload tables and the synchronized configuration tables used in the ground system.
- Alternative products are generated by Ozone PEATE Detailed information can be found from <https://omiwww.gsfc.nasa.gov/omps/>
- The OMPS EV SDR was assigned Beta status in early May and is currently in the provisional status.

SDR System Performance Matrix (1)

Requirement Summary	Spec Value	Predicted Performance	Orbit Performance
RADIOMETRIC ACCURACY			
Absolute irradiance calibration accuracy	< 7%	<7%	average ~ 7% NM 5% NP 1-10%
Absolute radiance calibration accuracy	<8%		< 5%
Non-linearity	< 2% full well	< 2% full well	< 0.46%
Pixel-Pixel Radiometric Calibration	< 0.5%	0.1%	average 0.5%
Non-linearity	< 2% full well	< 2% full well	< 0.46%
Non-linearity knowledge	< 0.5%	0.1%	Meet requirement
The on-orbit wavelength calibration	< 0.01 nm	NM: 0.003 nm RMS	
Stray Light NM Out-of-Band + Out-of-Field response	For NM \leq 2%	<2%	average ~ \pm 2%
Intra-orbit Wavelength Stability	Allocation (flow down from EDR error budget) = 0.02 nm	0.01 nm	<0.012 nm
RADIOMETRIC PRECISION ERROR TERMS			
SNR	1000	NM: Compliant	> 1000 from SV and EV
Inter-orbital Thermal Wavelength Shift	Allocation (flow down from EDR error budget) = 0.02 nm	0.01 nm	0.013 nm
CCD DETECTOR ERROR TERMS			
Read Noise		60 -e RMS	< 25 -e RMS
Detector Gain		43 for NP and 46 for NM	45 for NP and 42 for NM

SDR System Performance Matrix (2)

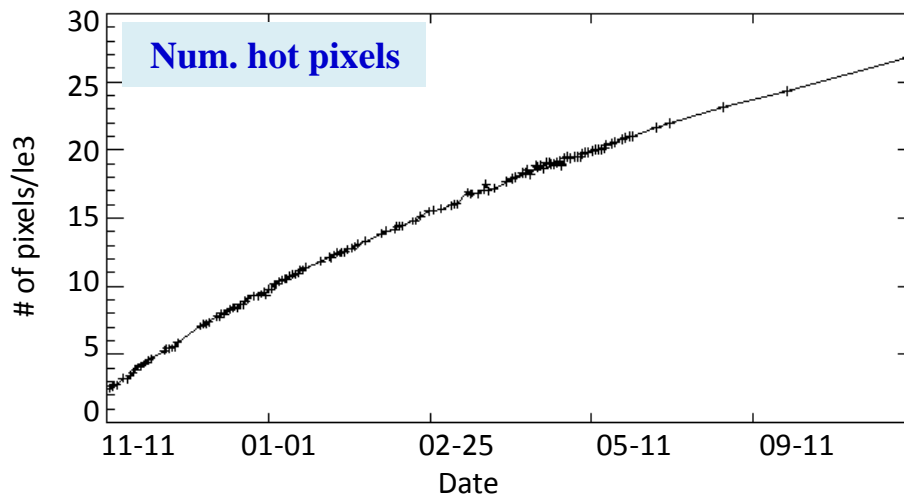
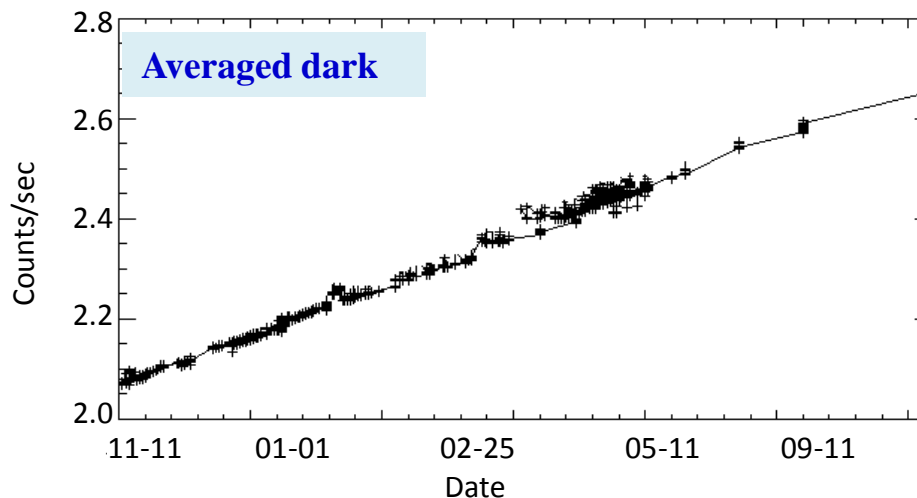
Requirement Summary	Requirement ID	Spec Value	Predicted Performance	Orbit Performance
SPATIAL PROPERTIES				
Cross-track modulation transfer functions (MTF) measured at nadir	SYS1198	NM Spatial MTF > 0.5 at 0.01 cycles/km (≥ 0.5 @ 0.144 cycles/deg for 50 km HCS and 3.44 degree macropixel IFOV)	NM MTF = 0.69 @ 0.144 cycles/deg	
Cross-track Total Column macropixel IFOV at nadir	SYS1212	≤ 3.44 degrees	3.15 degrees	
Cross-track Total Column FOV	SYS1239	≥ 110 degrees	110.3 degrees	
RADIOMETRIC ACCURACY				
Band pass Shape Knowledge	N/A	Allocation (flow down from EDR error budget) spectral response FWHM shall vary < 2% 1- sigma due to ground to orbit and intra-orbit effects	TC: 1.49%	
Band pass Limits Nadir Total Column Nadir Profile	SYS1209	50% < 1 nm (full width) 10% < 1.9 nm (full width) 1% < 3.1 nm (full width)	TC: Compliant	
Albedo Calibration Accuracy	SYS1216			
wavelength independent (WLI) albedo cal accuracy		WLI ≤ 2.0% RMS	WLI = 1.72%	
wavelength dependent (WLD) albedo cal accuracy		WLD ≤ 0.5% RMS	WLD = 0.5%	
Linear Polarization				
The linear polarization sensitivity at nadir	SYS1216	< 5 %	TC center: <2.1%	
The linear polarization sensitivity at EOS		< 5 %	TC edge: <1.6%	
GEOLOCATION ERROR TERMS				
Boresight alignment knowledge uncertainty between the nadir instrument interface and the nadir alignment reference	NPP-1907	< 160 arcsec (1/4 pixel) in both cross-track and along-track, 1 sigma	Static CBE is 90 arc-sec per axis	
Total cumulative boresight alignment shift (shift between final ground calibration and on-orbit operations)	NPP-1918	< 500 arcsec, 3 sigma, per axis	Estimate by analysis: Azimuth = 95 arc-sec Elevation = 222 arc-sec (includes 1-G sag, thermal, vibration, and air/vacuum changes) TC: 28 arcsec	
Database interpolation error	N/A	Allocation (flow down from EDR error budget) < 40 arcsec	17 arcsec (Azimuth or cross-track) 22 arcsec (Elevation or in-track)	

Dark Performance

- Sensor on-orbit behavior are monitored through NOAA STAR Integrated Calibration and Validation Systems (ICVS).

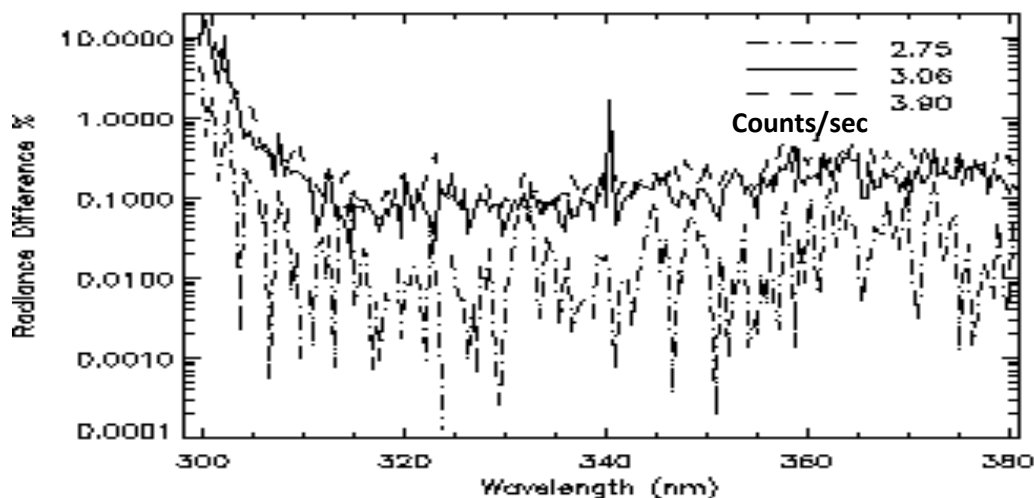
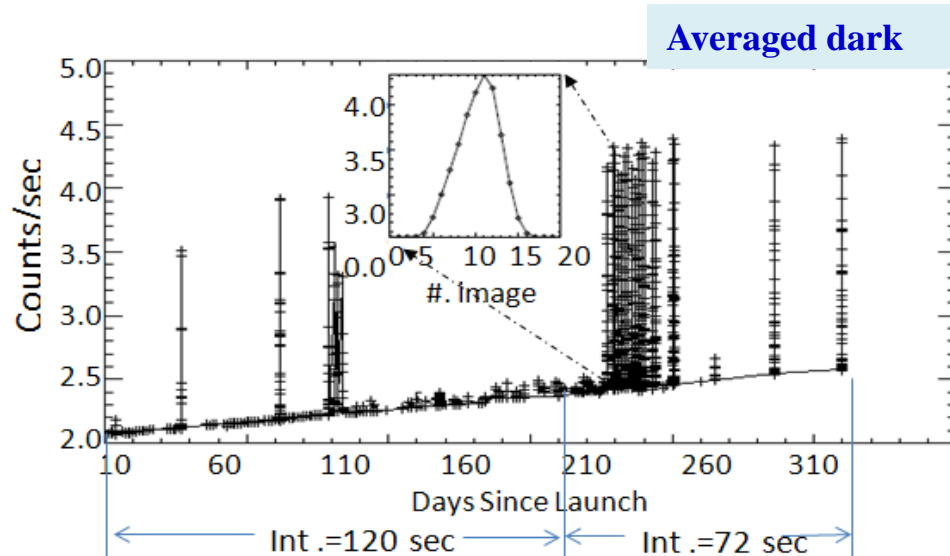
- Influenced by the hot pixels, the orbit dark images exhibit a higher signals level.

- Averaged dark signals constantly increase nearly 0.1% daily, indicating a slowly degraded CCD performance.

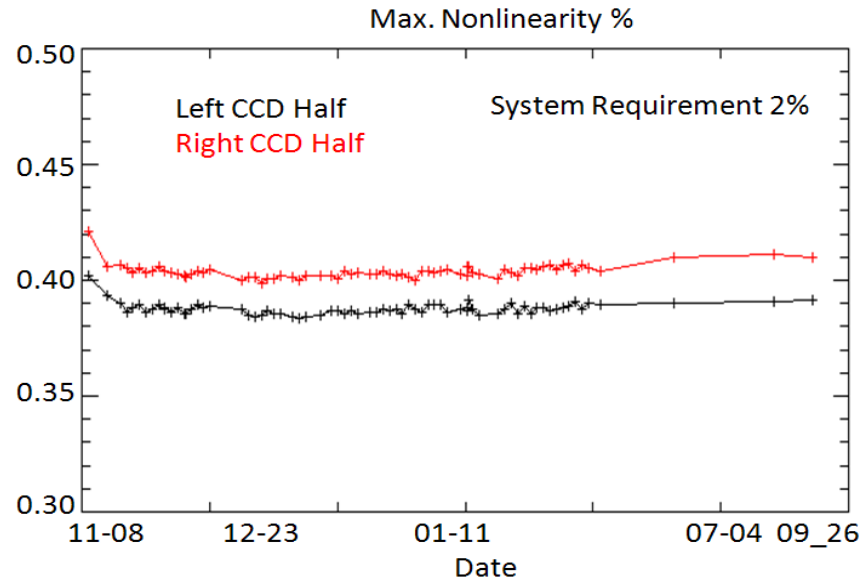
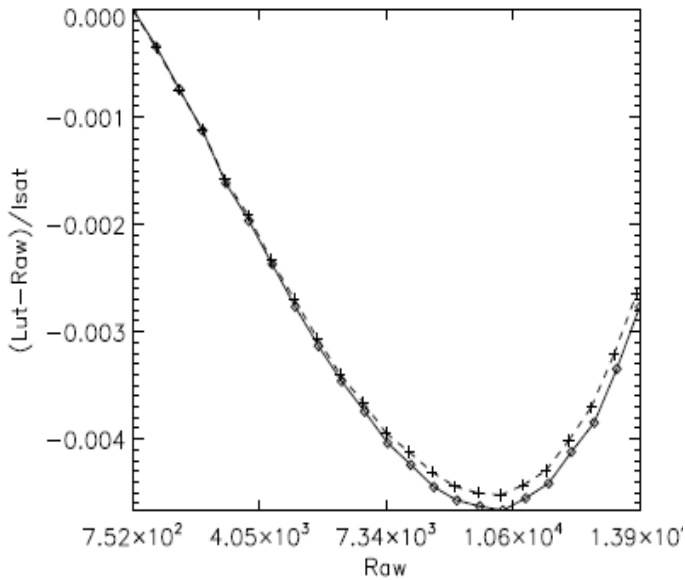


Influence of Transients from Dark Image

- Inside of SAA region, high energy particles hit CCD FPA, causing multiple spikes and high dark signals - transients.
- Consequently, transients cause significant radiance error in wavelength range < 300 nm

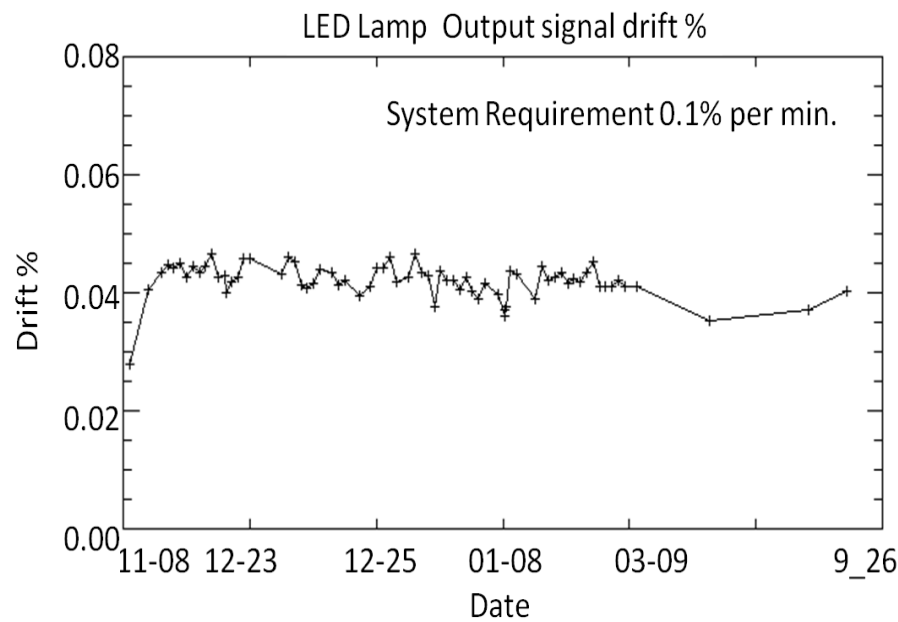
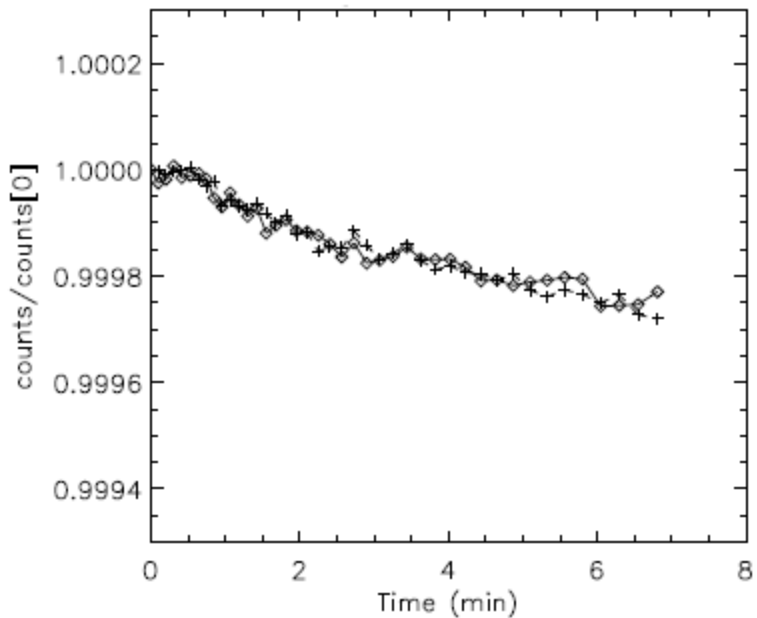


System Nonlinearity



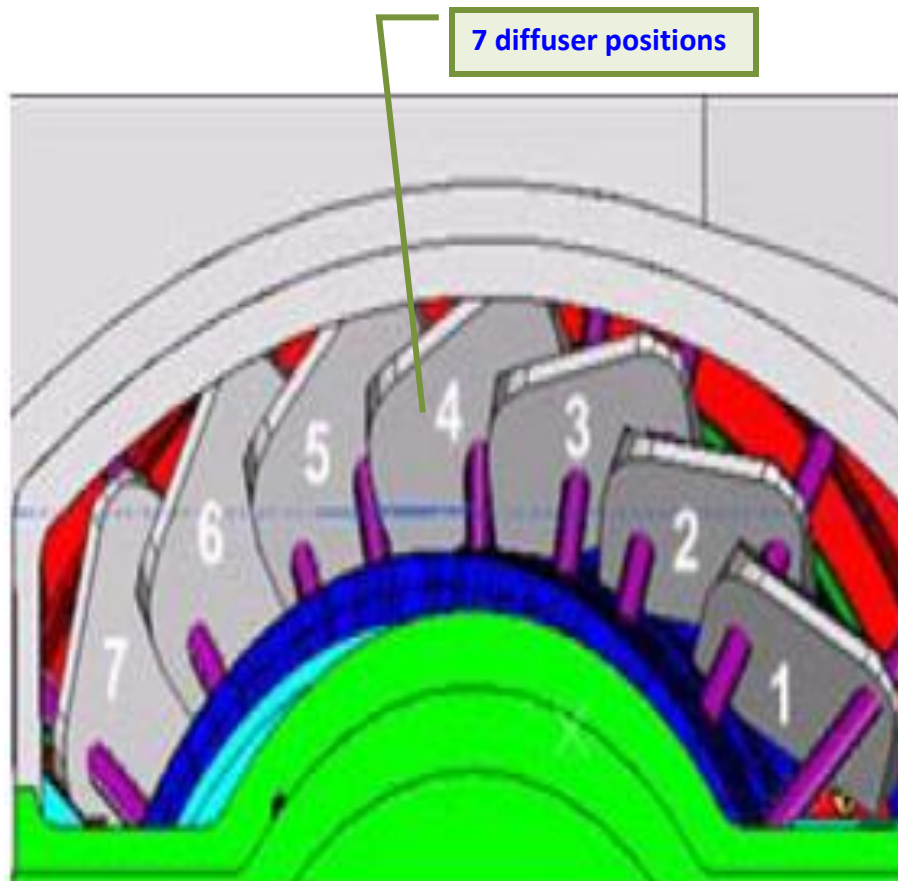
- The maxim non-linearity of the nadir sensor is no more than 0.42%, which meets the system requirement of 2% of full well
- The sensor non-linearity performance vs. time shows excellent stability.

Sort Term Stability of LED Lamp Output



Solar Calibration

- The Nadir telescope diffuser has seven positions that cover the 110 deg FOV; position 4 illuminates the entire NP FOV.
- The diffuser response was mapped over a β_{AZ} range of 12 to 31.5 deg and a β_{EL} range of -10.4 to 10.4 deg.
- On orbit, the working diffuser is deployed once every week and the reference diffuser is nominally deployed every six months to monitor the degradation of the working diffuser.

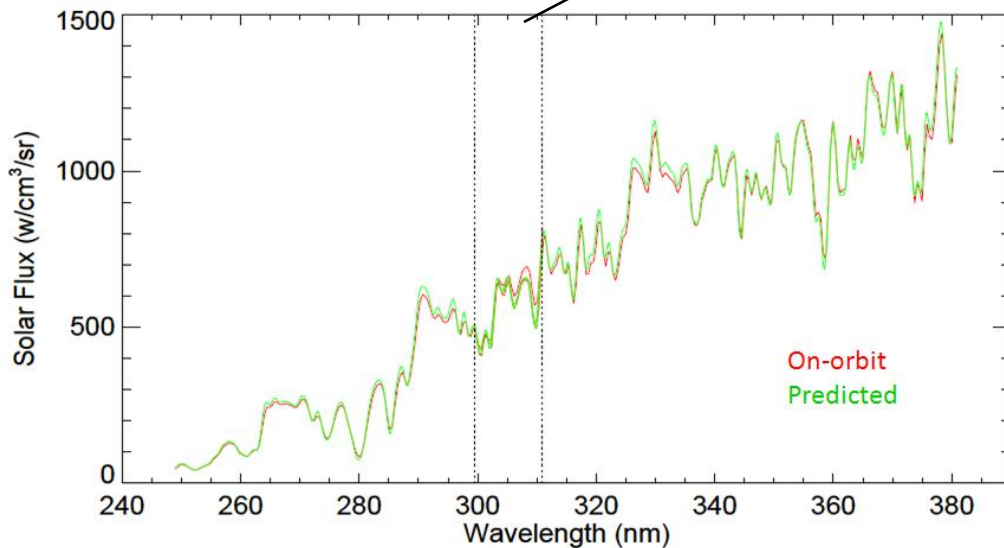
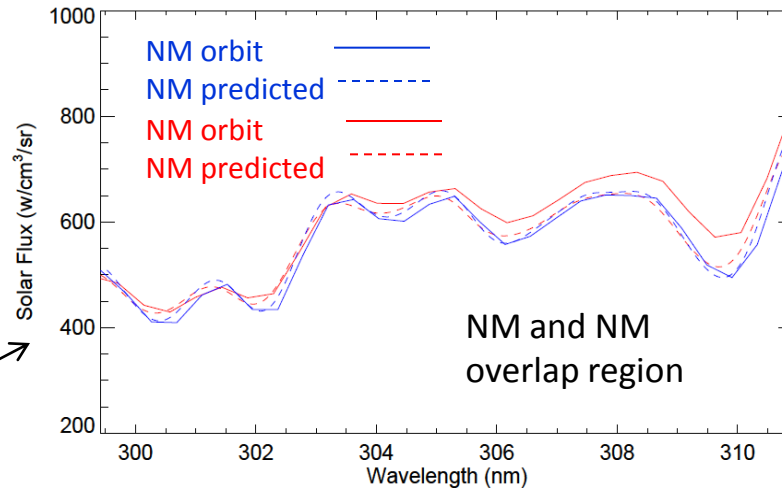


courtesy of BATC

On-orbit Observed Solar Flux

Observed solar irradiance is within an average of 2% of predicted synthetic solar spectra:

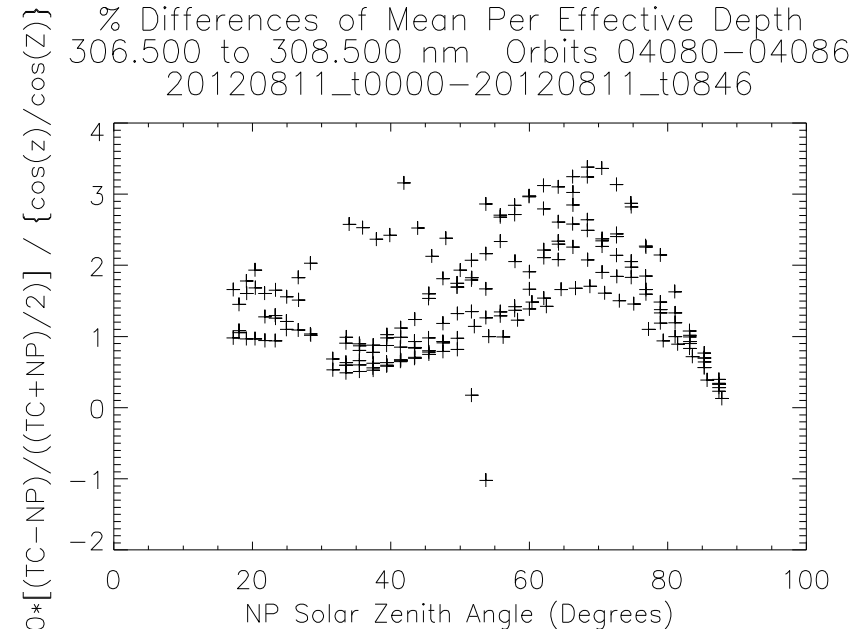
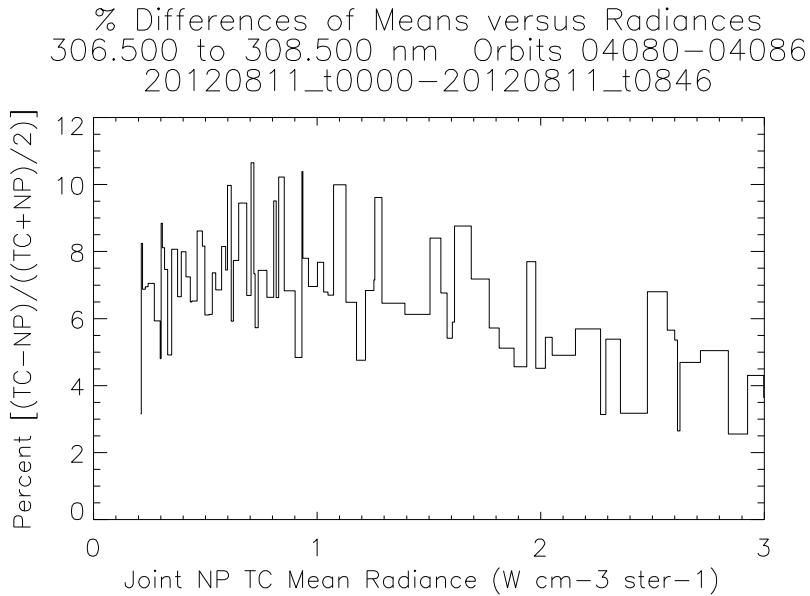
- NM is on average $\pm 4\%$ with small scale variations
- NP is less than 2% on average with several percent variations in region of wavelength < 300 nm



- Observed solar flux from NM and NP shows up to 14% discrepancy in the overlap region
- The discrepancy increases with wavelength.
- Identification of the root cause is a challenge issue - being investigated.

EV Radiance in NP-NM Overlap Region

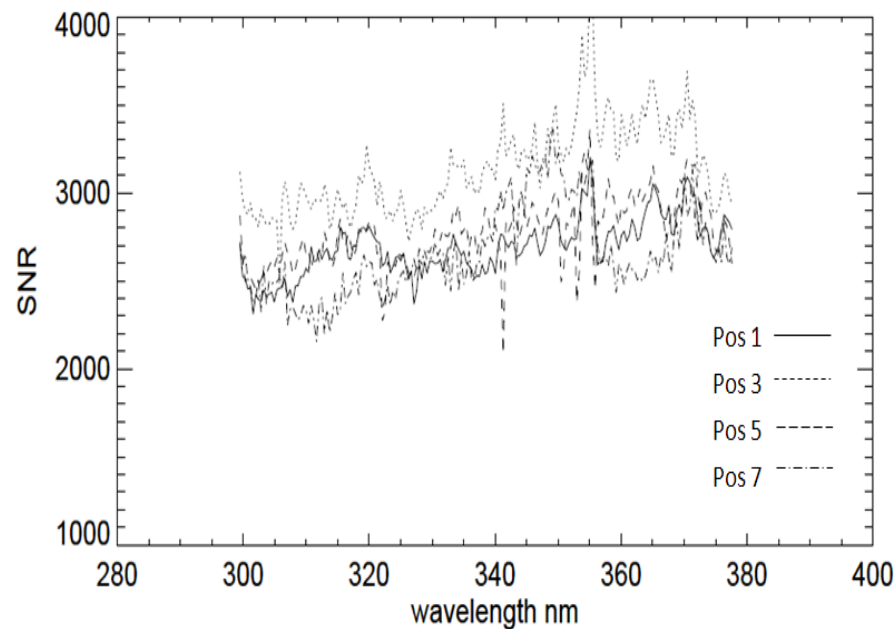
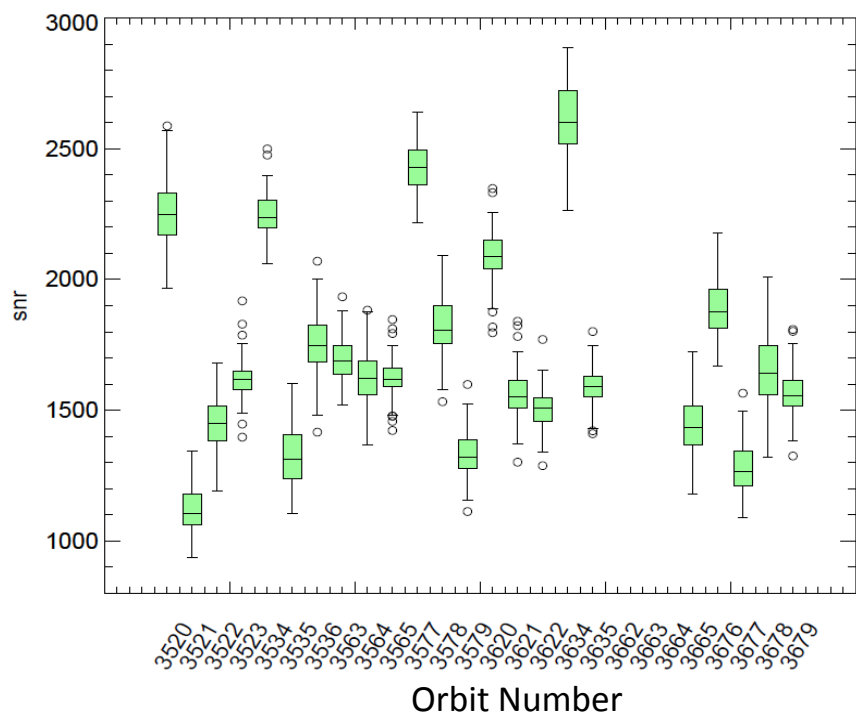
Courtesy of Rich Buss



Large % differences occur both at low radiance levels and also at high solar zenith angles as might be expected from stray light. The % differences are much less for brighter radiances that occur at low and medium solar zenith angles.

- The Earth radiance TC-NP differences are $\sim 3.8\%$ on average and $\sim 1.6\%$ for bright radiances, remaining within the operational radiance calibration requirement of $< 2\%$ over all wavelengths. However, at high solar zenith angle, the TC-NP difference is about $8 \pm 2\%$, too high to ignore.
- Discrepancy between NP and TC in overlap region remains poorly understood; Non-linear shift at NP long wavelengths and straylight contamination could two of the contributors. – This issue present a problem for NP retrievals.

System Noise from EV and SV

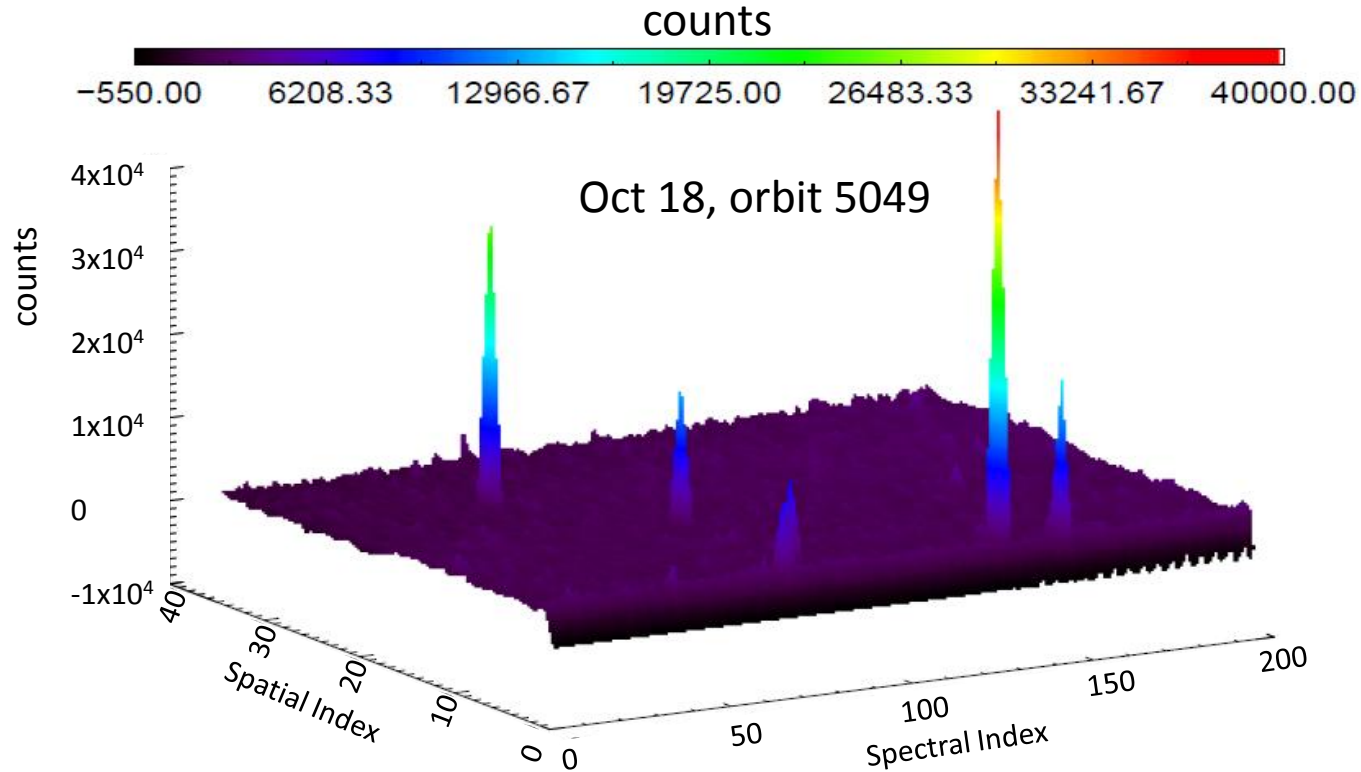


Data was collected from Greenland region w/ PID 170, TPG 158.

Data was collected from June 27

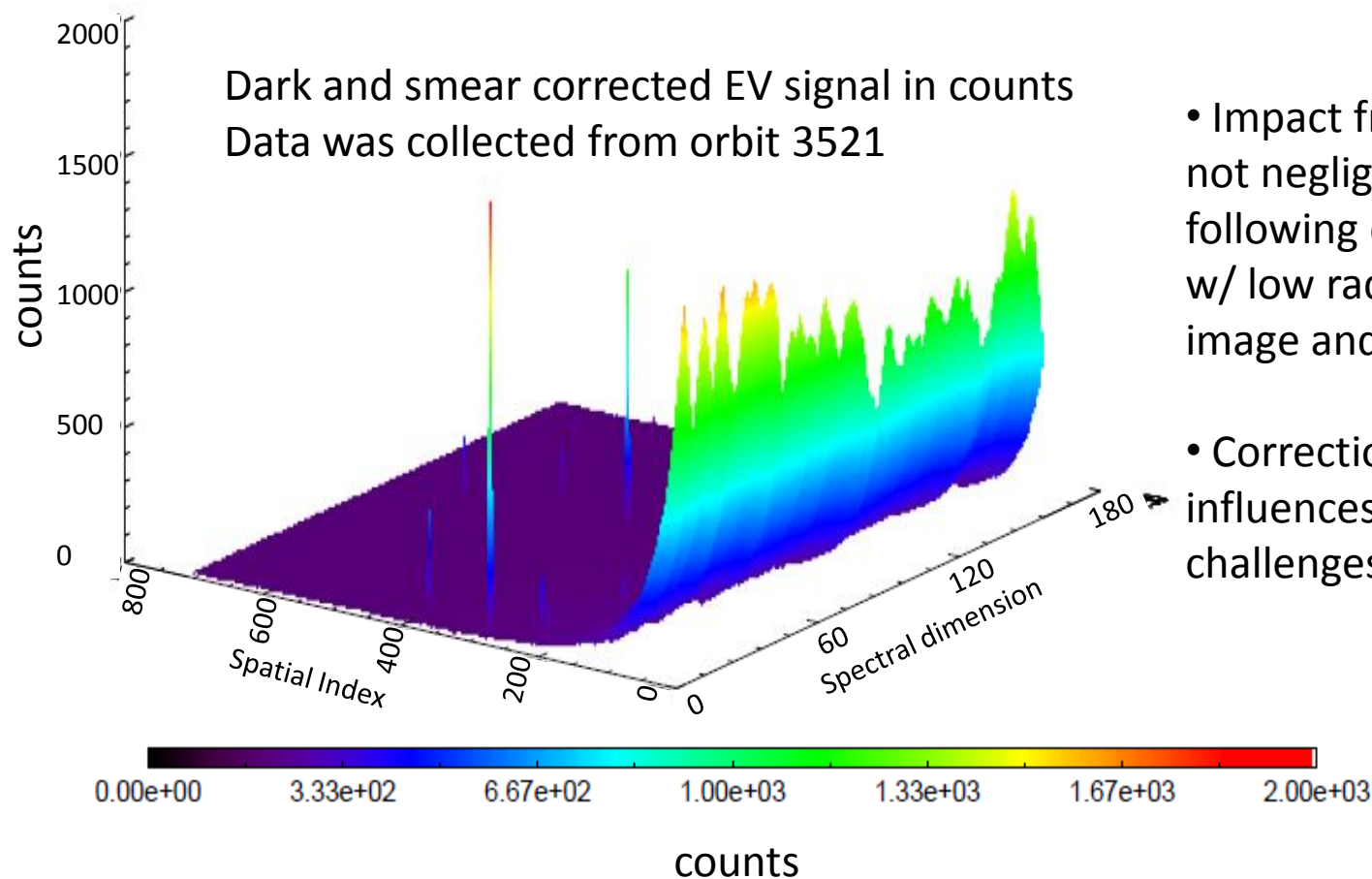
Negative Dark Current from IDPS EV SDR

A Fundamental data processing error in EV radiance retrieval



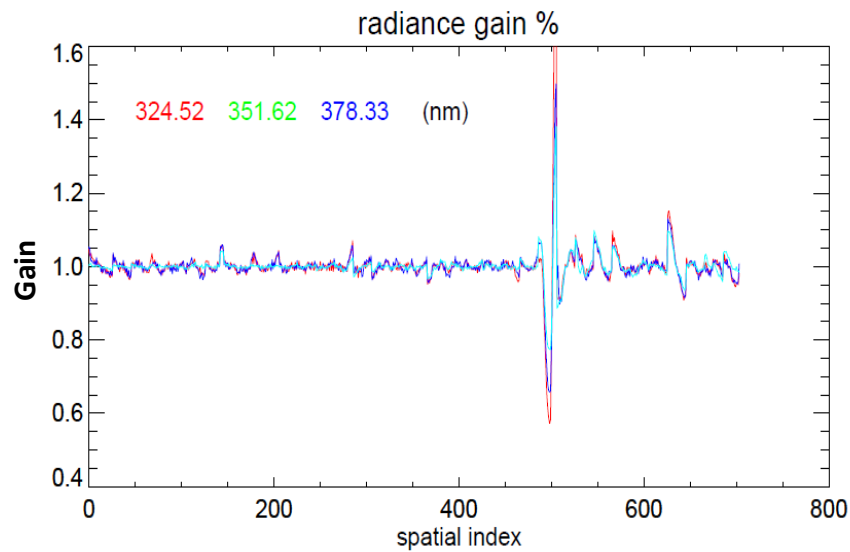
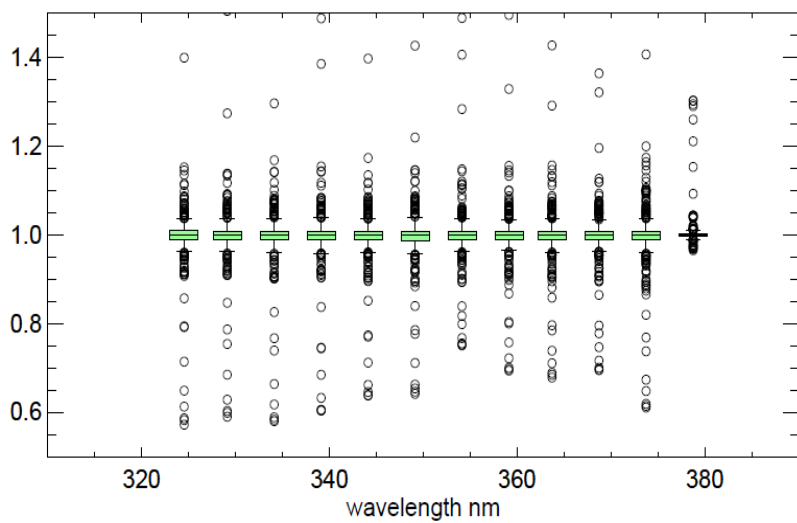
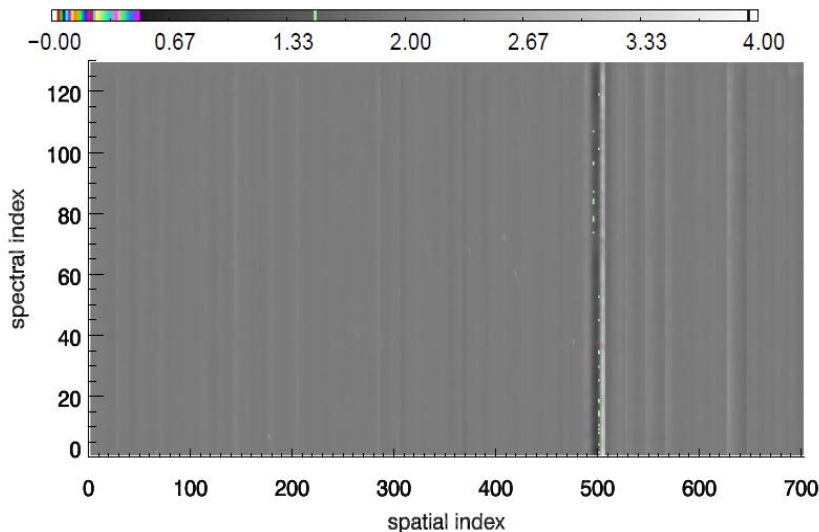
- Dark current from EV SDRs has been monitored
- Since early March, negative values are found at a particular EV macro-pixel across all spectral channels – a critical error in SDRs
- Root cause is to be understood.

Transients from EV Present a Challenge

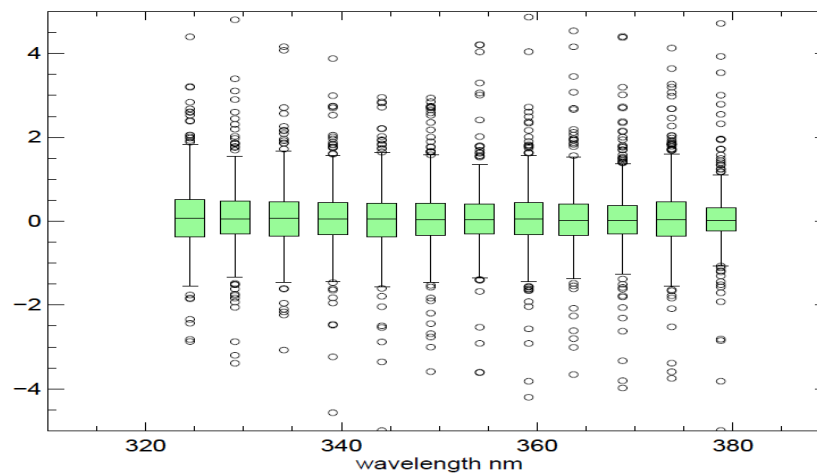
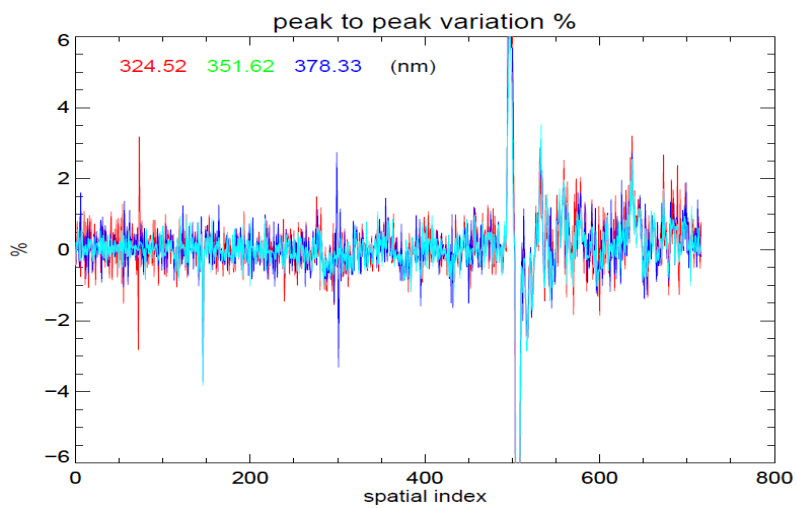
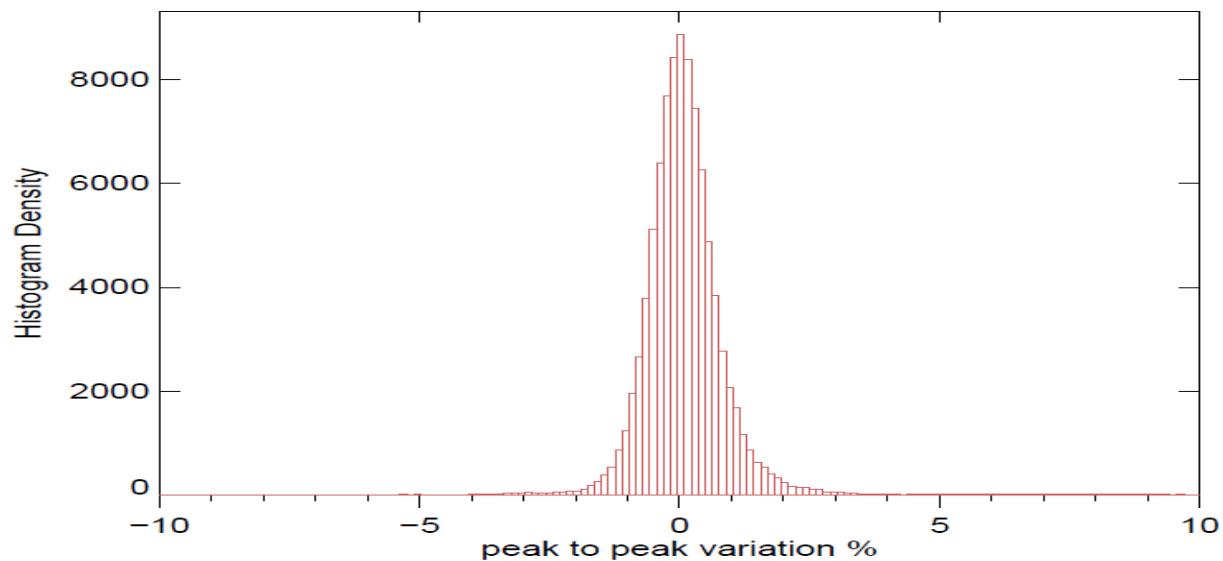


- Impact from transients are not negligible at the following circumstances: EV w/ low radiance level; Dark image and EV smear
- Correction of the influences presents challenges impacts

Radiance Gain Preliminary



Flat-field Preliminary



Summary

- Instrument performance is stable and meet system requirement in general.
- IDPS SDR data processing and its algorithm discrepancies are the major challenge and the path forward is to better understand the Ops codes.
- OMPS SDRs was assigned Beta version in early March, and now is recommended for the provisional status. More than 10 system requirements to be validated.

FY12 Accomplishments: DRs

Closed DRs

Open DRs

There is a total of 34 of which 18 are closed and the rest have been open and assigned.

DR #	Short Description
4879	NP and TC Darks need to be updated
4861	OMPS Effectivity time table update FT
4823	NP straylight straylight needs to be corrected.
4818	Smears in error - Smears show negative and unexpected values
4800	CalSDR generation of Darks inconsistent with EV SDR
4799	Inconsistent structure between OAD and EV SDR
4797	NP solar day 1 need to be updated with on orbit results.
4792	OMPS wavelength and cf-earth update . Needed every 29th days
4757	OMPS wavelength and cf-earth update . Needed every 29th days
4751	Unable to access NP Aps
4750	Dark tables updated from Aps to GND-Pis
4749	OMPS darks have negative values
4725	CDFCB has incorrect GND-PI wavelength
4722	OMPS wavelength and cf-earth update
4694	CDFCB Vol VIII had incorrect dark dimensions
4693	CalSDR stratgy study
4676	Radiance error associated with aggregation
4673	Correction for different linearit slope Tup for CCD2
4672	Linearity correction update for xml file
4671	OMPS Data quality threshold tables non existend for SDR
4650	OMPS wavelength and cf-earth update . Needed every 29th days
4627	Quantization introduced by linearity correction error - Cal SDR
4617	wavelength and cf-earth update . Needed every 29th days updates
4616	TC Solar flux update for day 1
4615	Transient filter issue
4564	Assign beta maturity to OMPS SDR
4562	Solar flux in TC SDR is missing and products are fill
4559	OMPS wavelength and cf-earth update . Needed every 29th days
4536	Sample table update to include extra pixel to monitor straylight
4516	NewGND-Pis Wavelength and cf-earth need to be updated every 29 days