

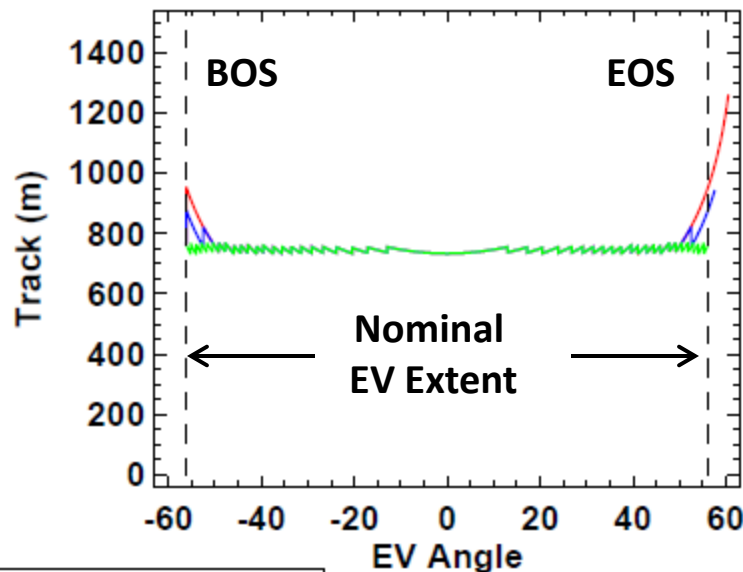
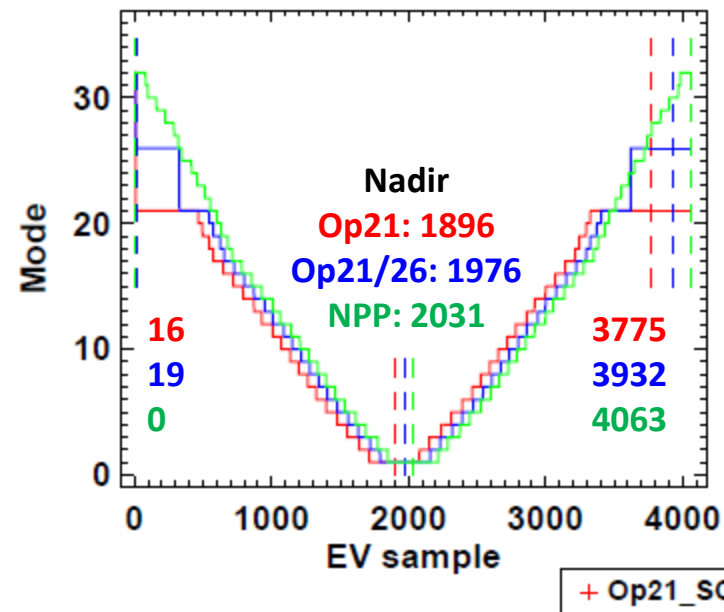
J1 VIIRS DNB Unique Features

Shihyan Lee
SSAI/JPSS

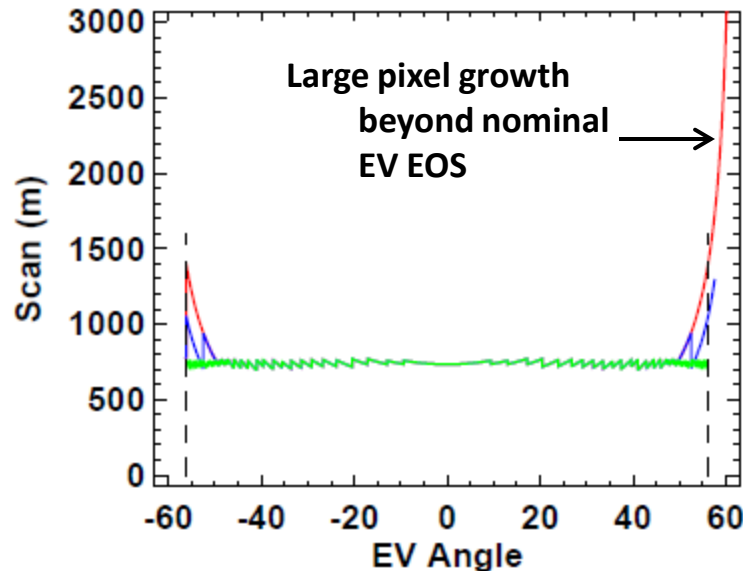
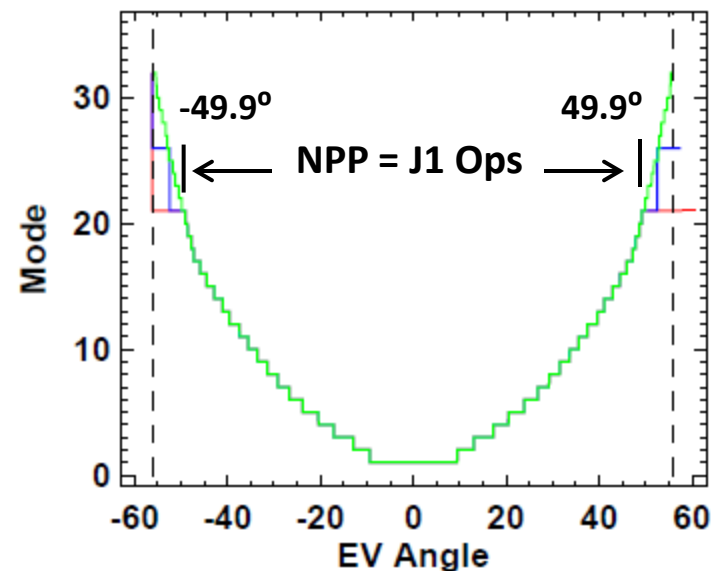
Aug 26, 2015

- Cause: J1 DNB radiometric nonlinearity
- Mitigation: remove DNB agg mode with severe nonlinear behavior
 - J1 Op21: J1 DNB Aggregation Option 21
 - J1 Op21/26: J1 DNB Aggregation Option 21/26
 - NPP vs. J1 options
- Impact:
 - Imagery
 - Calibration

J1 DNB Aggregation Options



Simulated DNB
EV pixel
growth based
on nominal
parameters

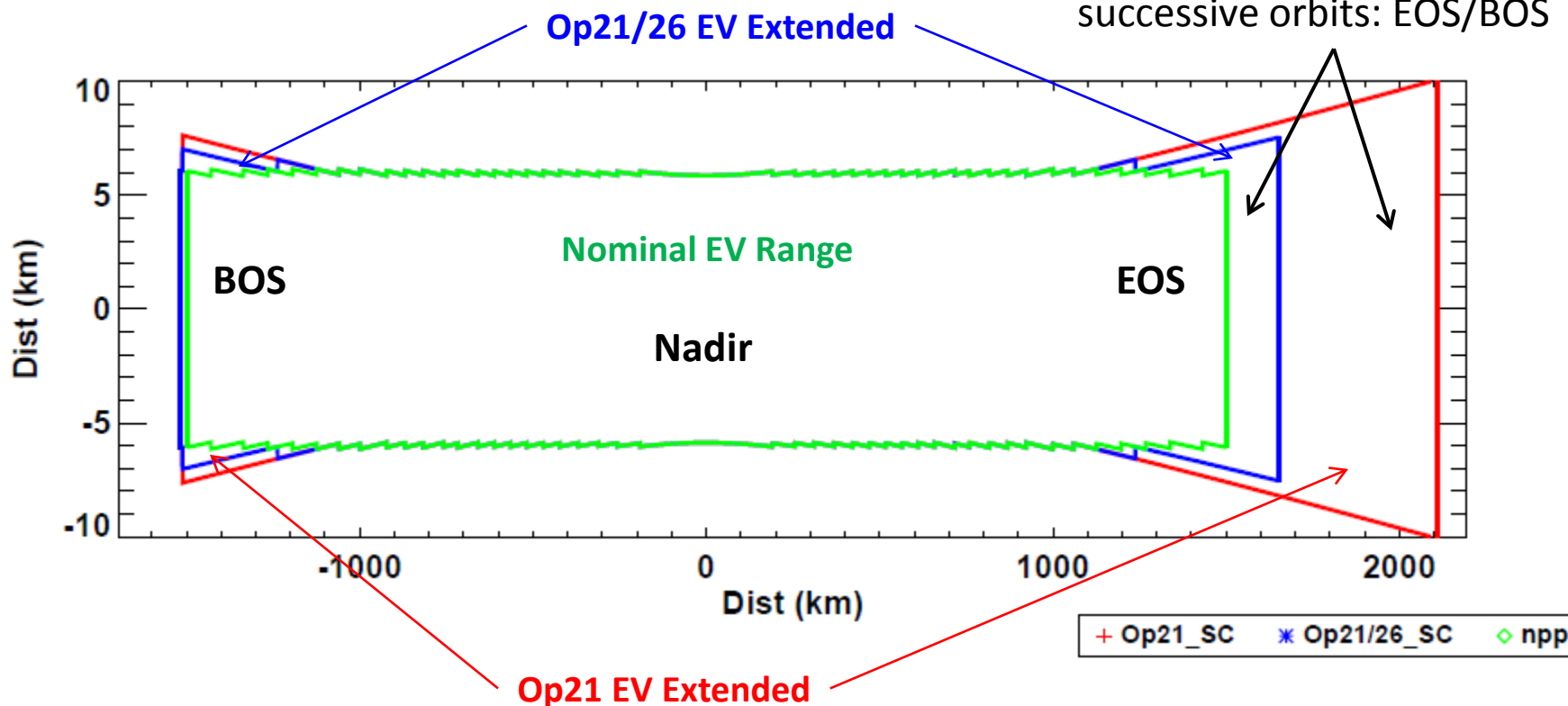


J1 DNB Options EV Extent

Simulated DNB EV data extents

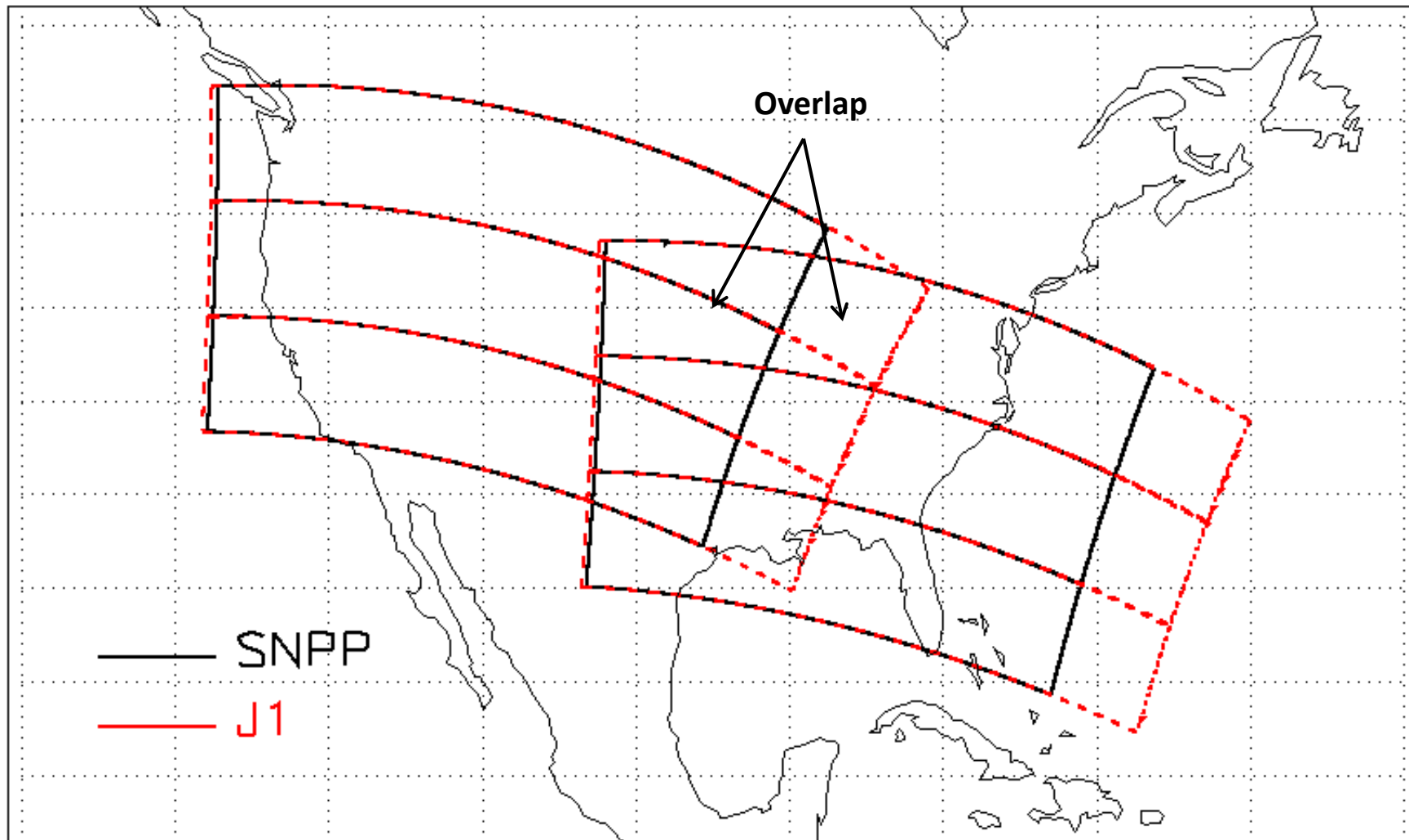
Reduced resolution at high scan angles

Increase coverage overlaps:
successive scans: Bowtie
successive orbits: EOS/BOS

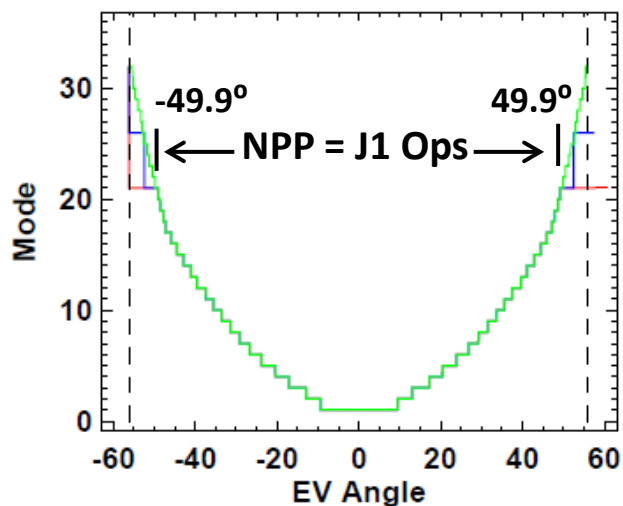
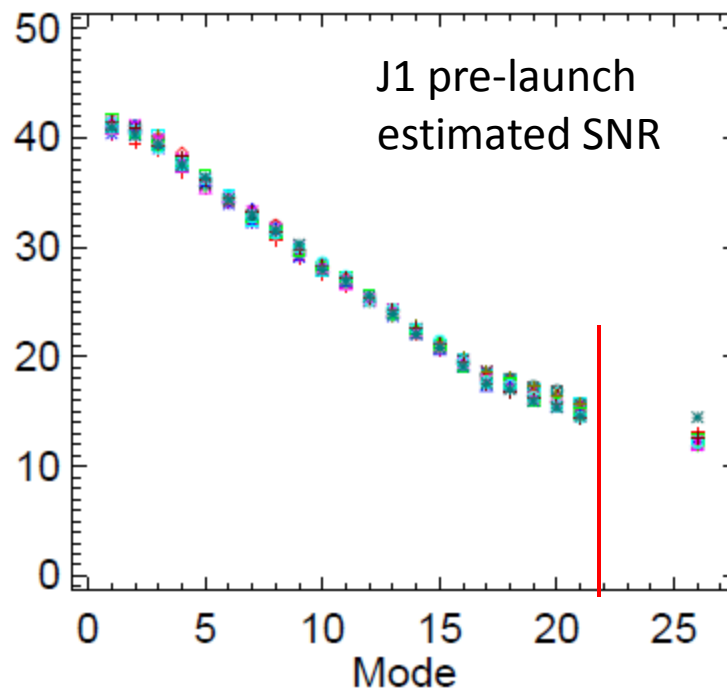
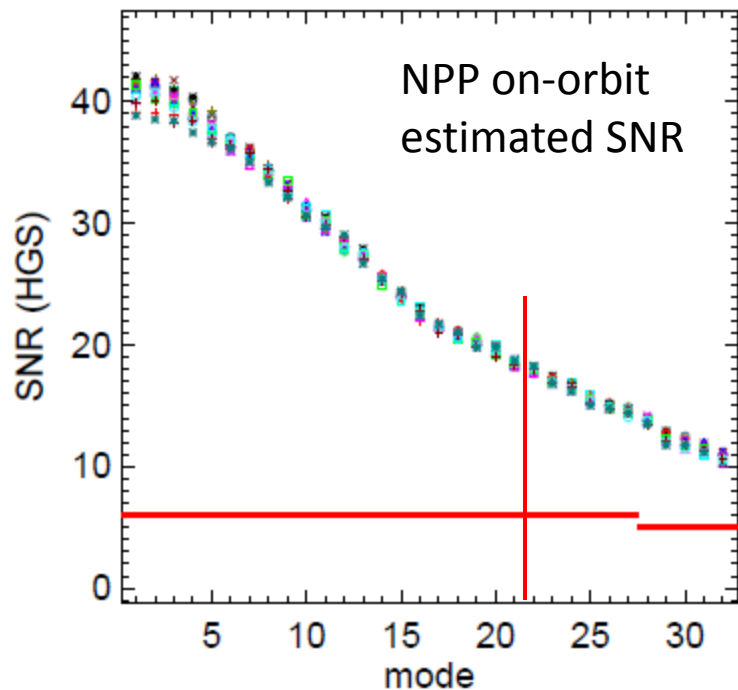


J1 DNB EV Extended pixels can be turn on/off by LUT updates

J1 DNB Options EV Extent

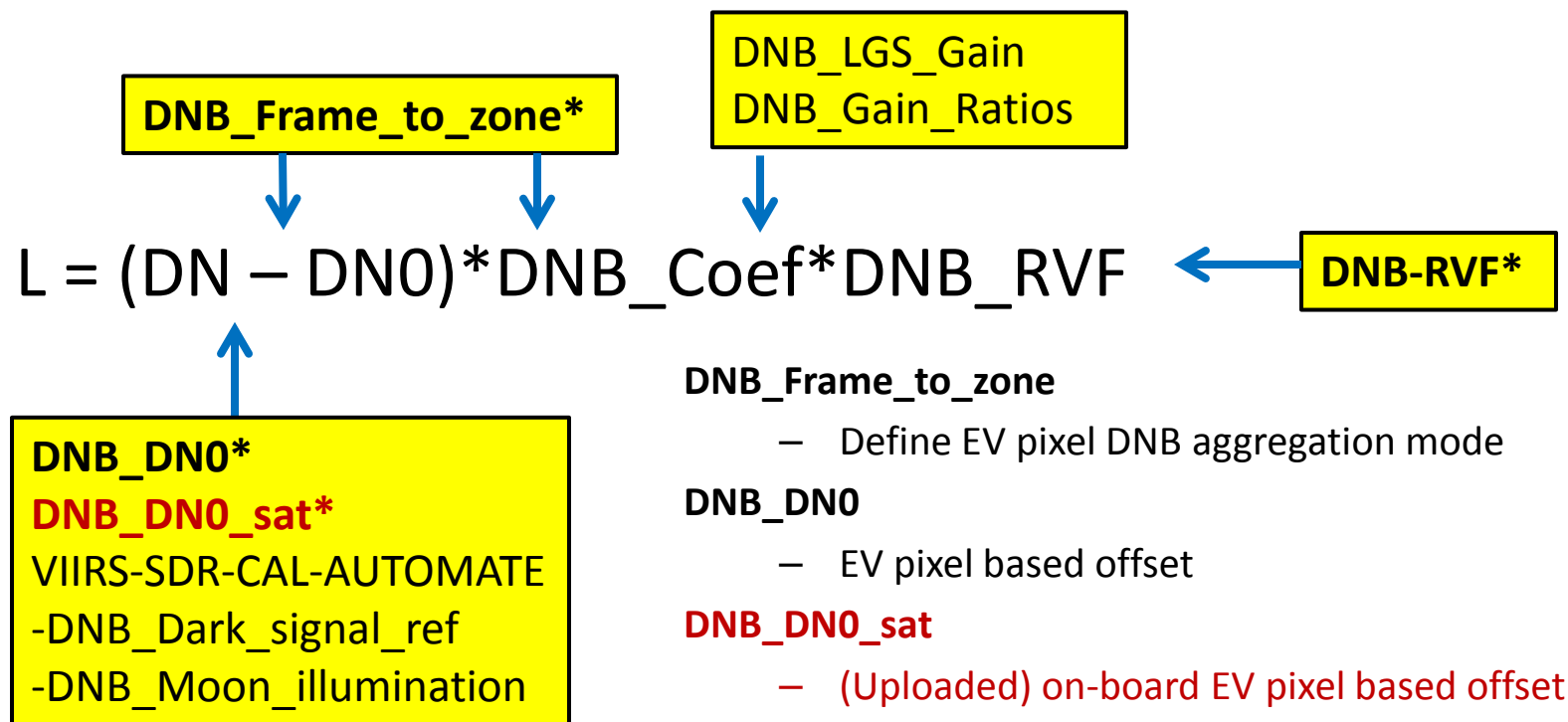


DNB SNR: NPP vs. J1



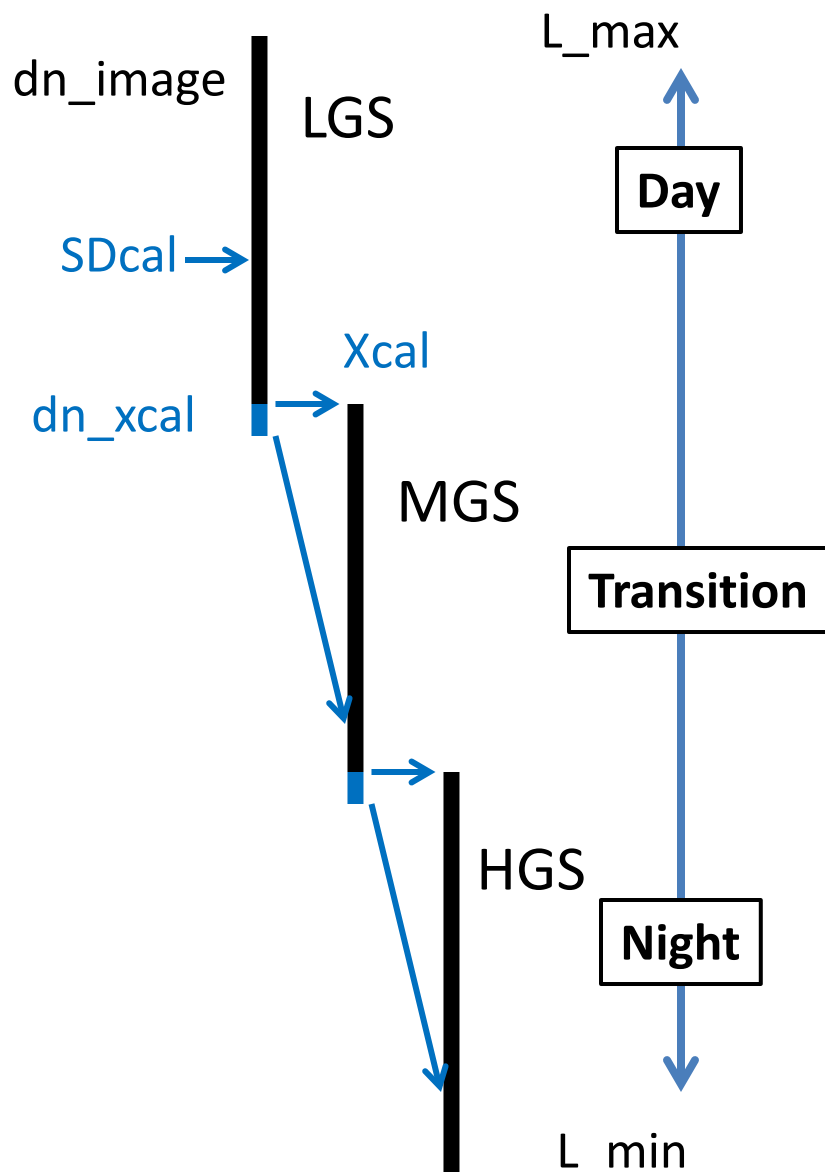
- J1 DNB Options vs NPP at high scan angles:
 - lower spatial resolution
 - higher SNR

SDR Calibration: J1 Options



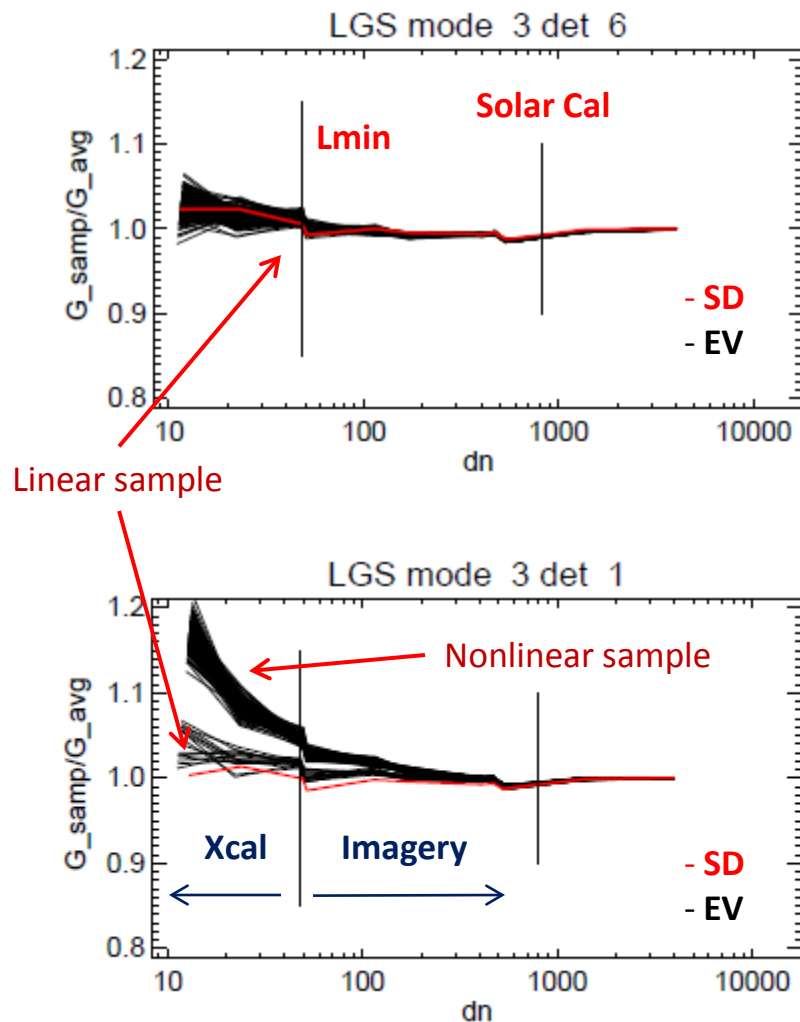
* DNB Option specific LUT needed

DNB On-Orbit Cal & SDR



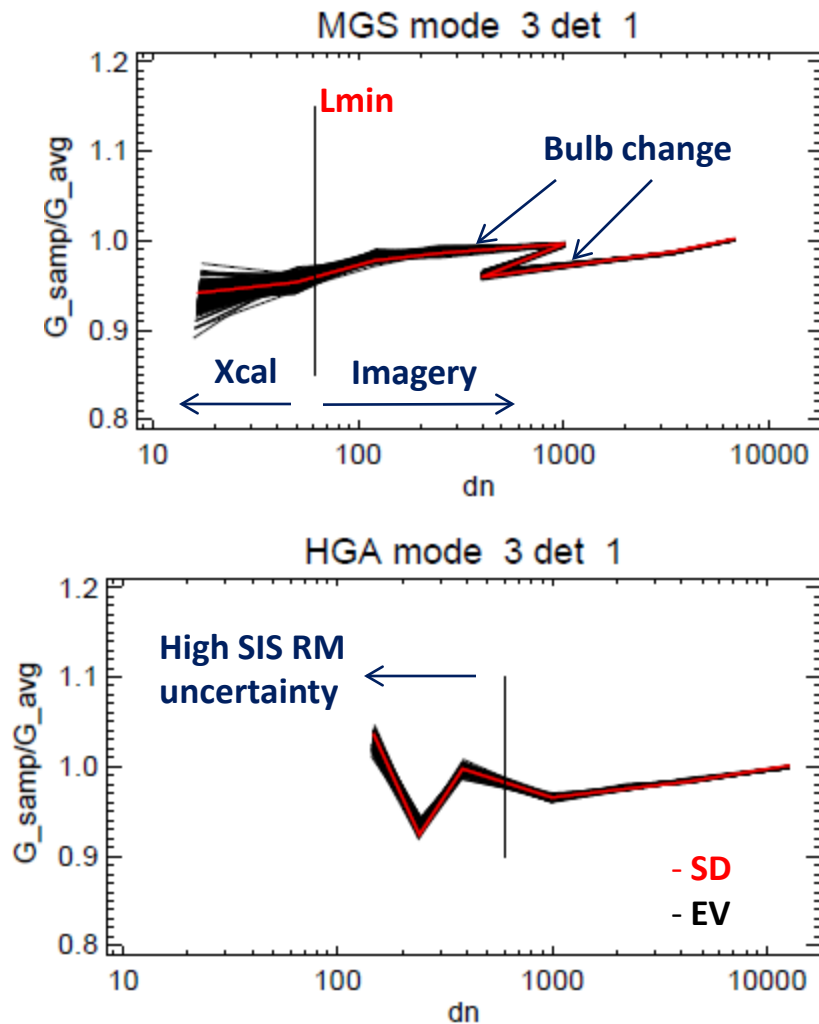
- Three gain stages
- LGS gain:
 - SD during Solar Calibration
 - SD vs. EV gain at SD cal?
 - EV gain linearity?
- MGS and HGS gain:
 - Gain transfer using transitional signal ($Xcal$)
 - $MGS = LGS * MGS/LGS$
 - gain ratios determined by EV vs. SD?
- Nonlinearity
 - dn_xcal : $Xcal$
 - dn_image : SDR & $Xcal$
- Current Cal: linear gain
- What is the impact of nonlinearity on SDR calibration?

DNB LGS Characteristics



- Normalized EV (pixel) and SD (mode) gain
- Some LGS detectors show different response behavior among pixels within the same agg mode
- Nonlinear: sample dependent, worse at lower dn
- The gain is more linear in SD than EV
- $SD \sim EV$ gain at Solar Calibration
- Nonlinearity above L_{min} (small): imagery
- **Nonlinearity below L_{min} (large): Xcal**
- Mode based calibration can not resolve nonlinearity at sample space?

DNB MGS/HGS

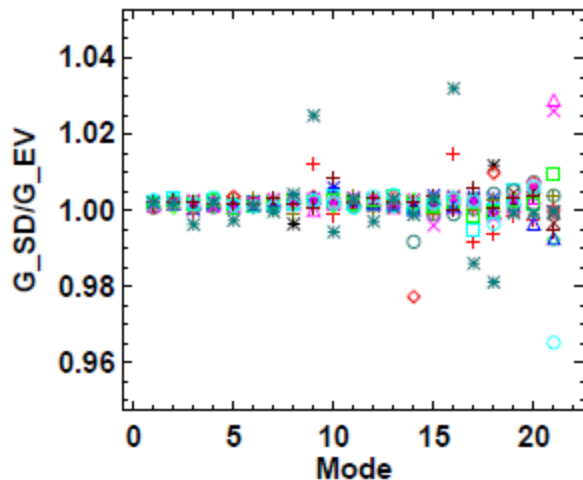


- Normalized EV (pixel) and SD (mode) gain
 - $SD \sim EV$ gain
 - No EV sample dependency as observed in LGS
 - SIS radiance uncertainty: discontinuity in MGS due to bulb change
- Uncertainty in determine HGA low dn radiance

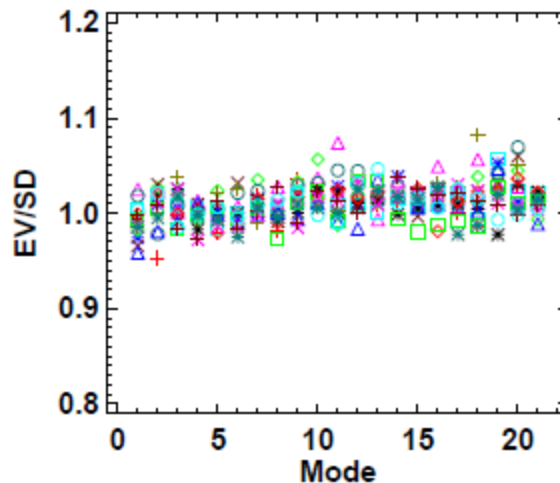
Difficult to conclude the severity of MGS and HGS nonlinearity

EV vs. SD

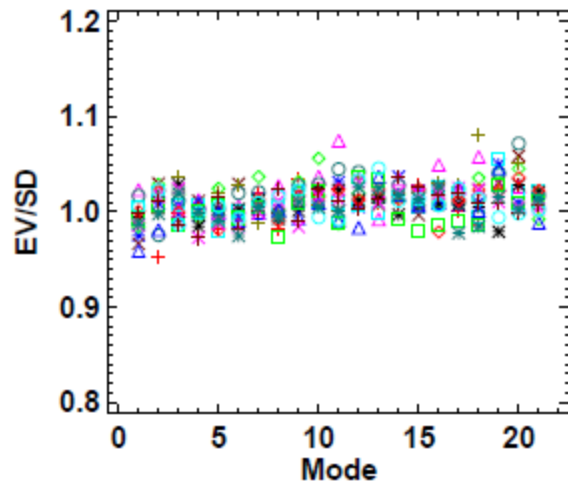
L at SD cal



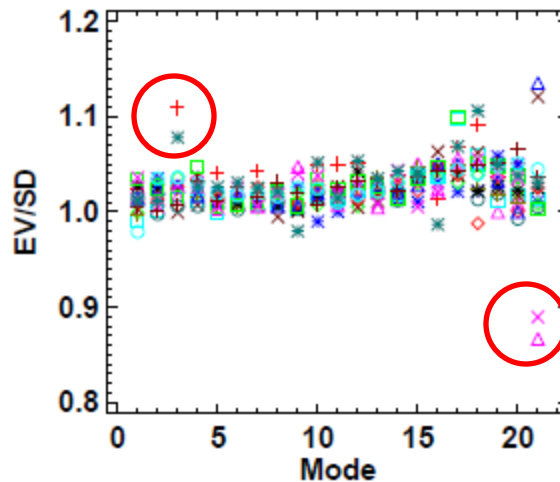
HGA/MGS



HGB/MGS



MGS/LGS



- EV vs. SD for each DNB mode/det

Solar Cal (LGS)

- EV gain \sim SD gain, few detectors/mode has up to 3% differences

Xcal

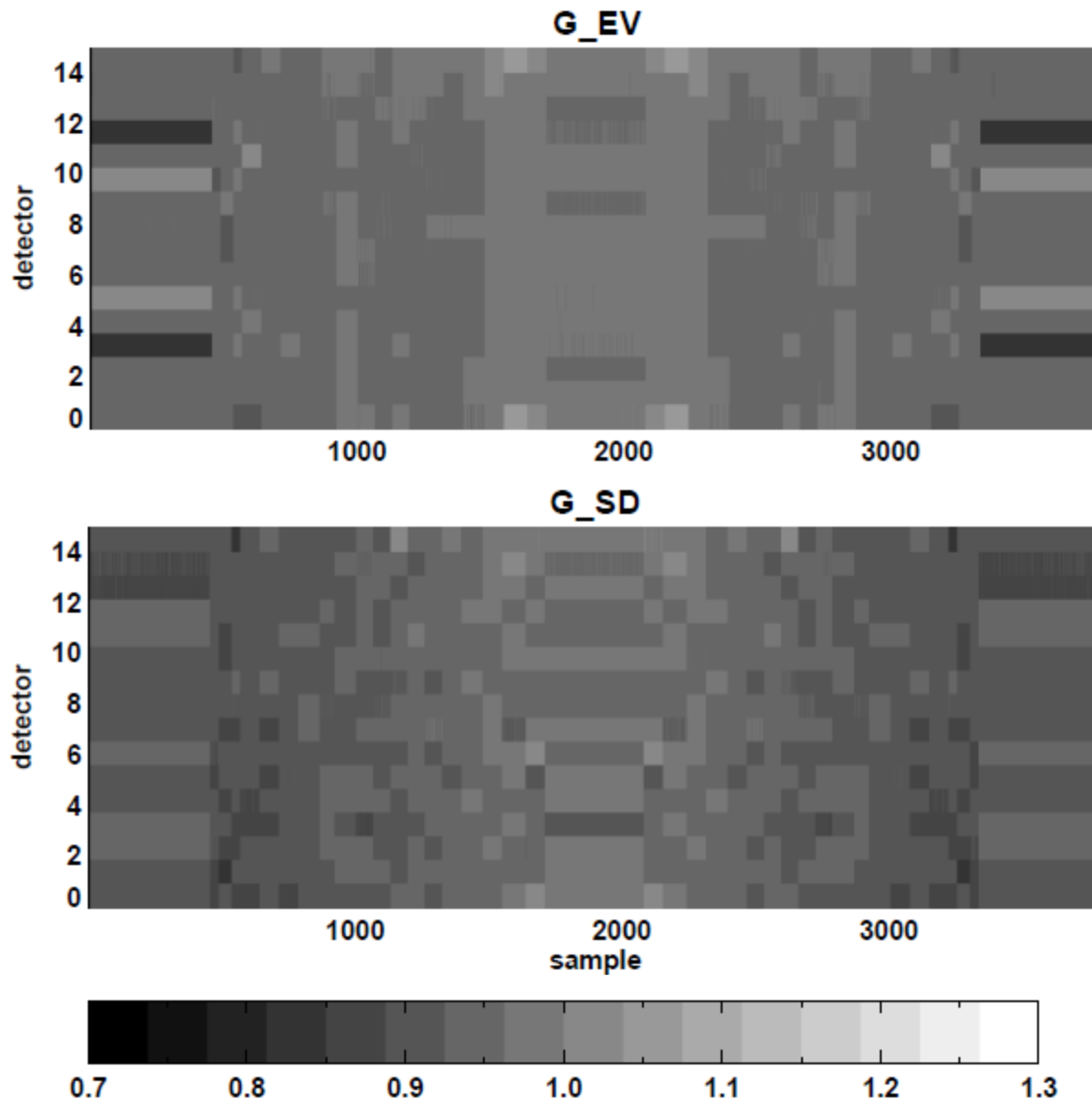
- LGS/MGS: some mode/det has large SD/EV difference

Uncertainty:

- Few calibration view samples
- limited dn levels in Xcal

+ 1 * 2 ◇ 3 △ 4 □ × 6 ○ 7 + 8 * 9 ◇ 10 △ 11 □ × 13 ○ 14 + 15 * 16

SDR Impact



Calibrated/measured
Gain

Top: Xcal by EV data

Bot: Xcal by SD data

Horizontal striping

- Cross detector variation

Vertical striping

- Cross mode variation

Additional uncertainty
from HGS
nonlinearity

Summary

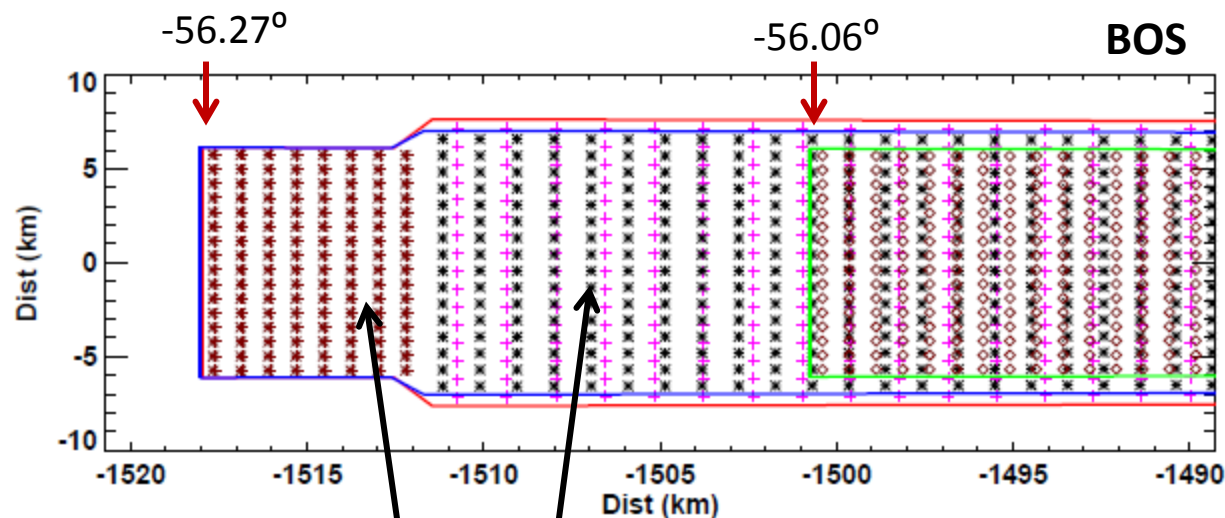
- J1 DNB aggregation options
 - No change for scan angle within ~50 degree of nadir
 - Use mode 21 (Op21) or mode 21/26 (Op26) from ~50 to EOS.
- Impact on Imagery
 - Pixels at high scan angle will have reduced spatial resolution, higher SNR
 - Larger EV extent, increase overlaps
- Impact on Calibration
 - Some LUTs will need to be J1 Option specific
 - The nonlinearity could have significant impact on nighttime SDR due to gain ratio biases
 - The calibration bias could cause horizontal/vertical striping in DNB nighttime images due to detector/sample gain dependency
- Needs further investigation after J1 launch
 - Gain ratios computed using EV vs. SD data
 - EV sample dependency
 - Algorithm change: Sample base cal, quadratic fit.



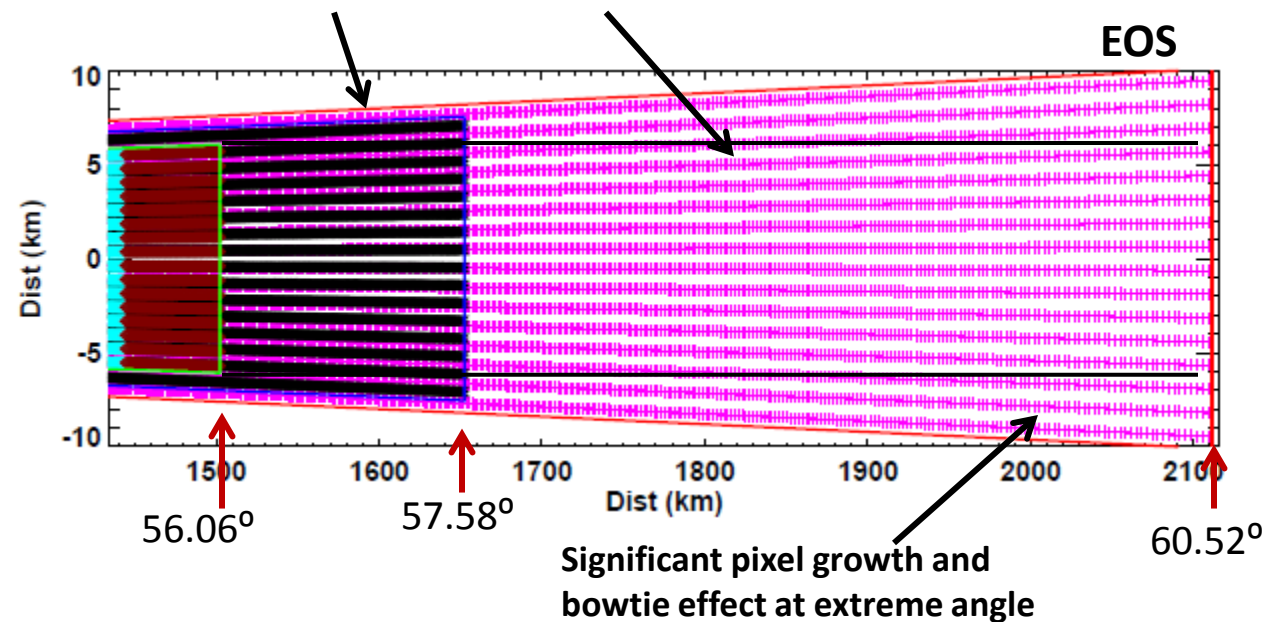
backup



J1 DNB Extended EV



Option of setting as fill values in SDR through LUTs (Tested)



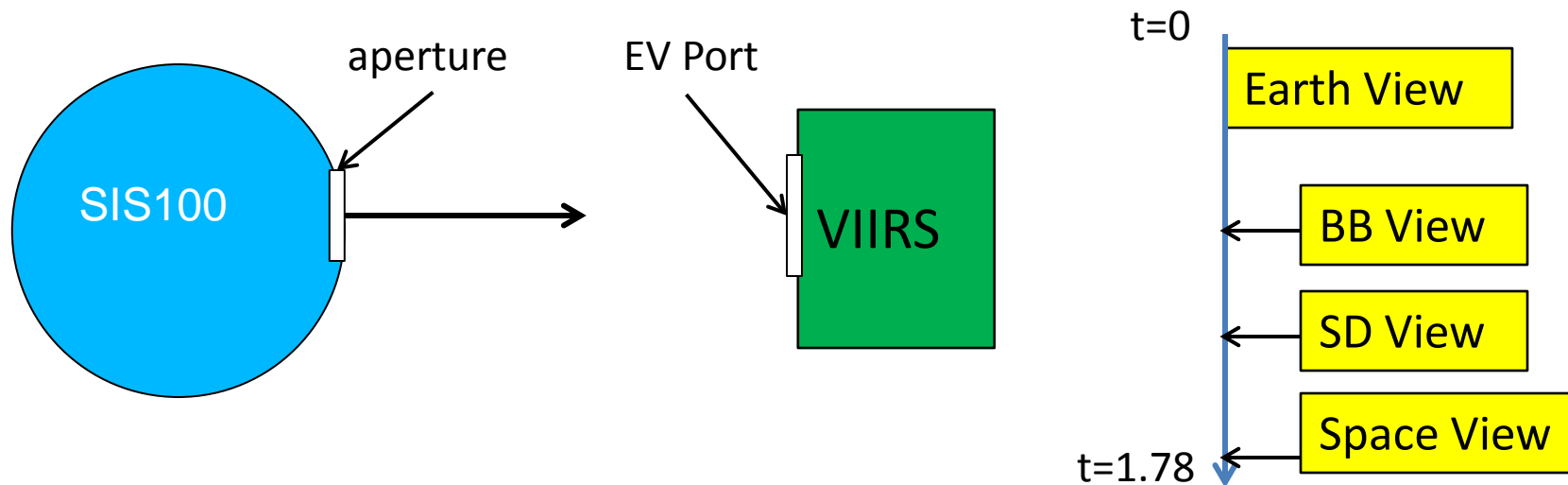
BOS:

- NPP: -56.06°
- J1 Ops: -56.27°
- Op21 Extended EV samp: 8 (mode 32) + 8 (mode 21)
- Op21/26 Extended EV: 8 (32) + 10 (26)

EOS:

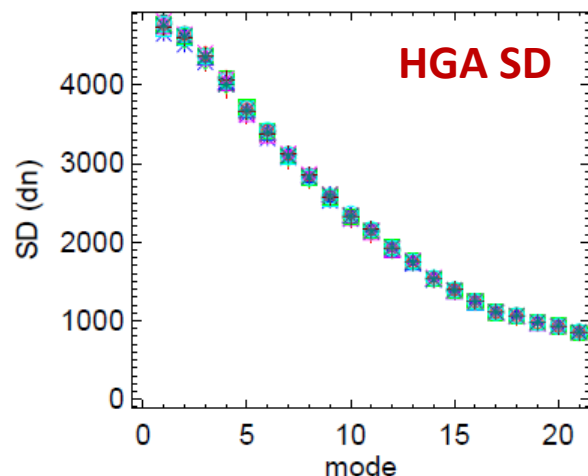
- NPP: -56.06°
- Op21: 60.52°
- EV Extended samp: 288 (21)
- Op21/26: 57.58°
- EV Extended samp: 131 (26)

Test: RC2 Part4

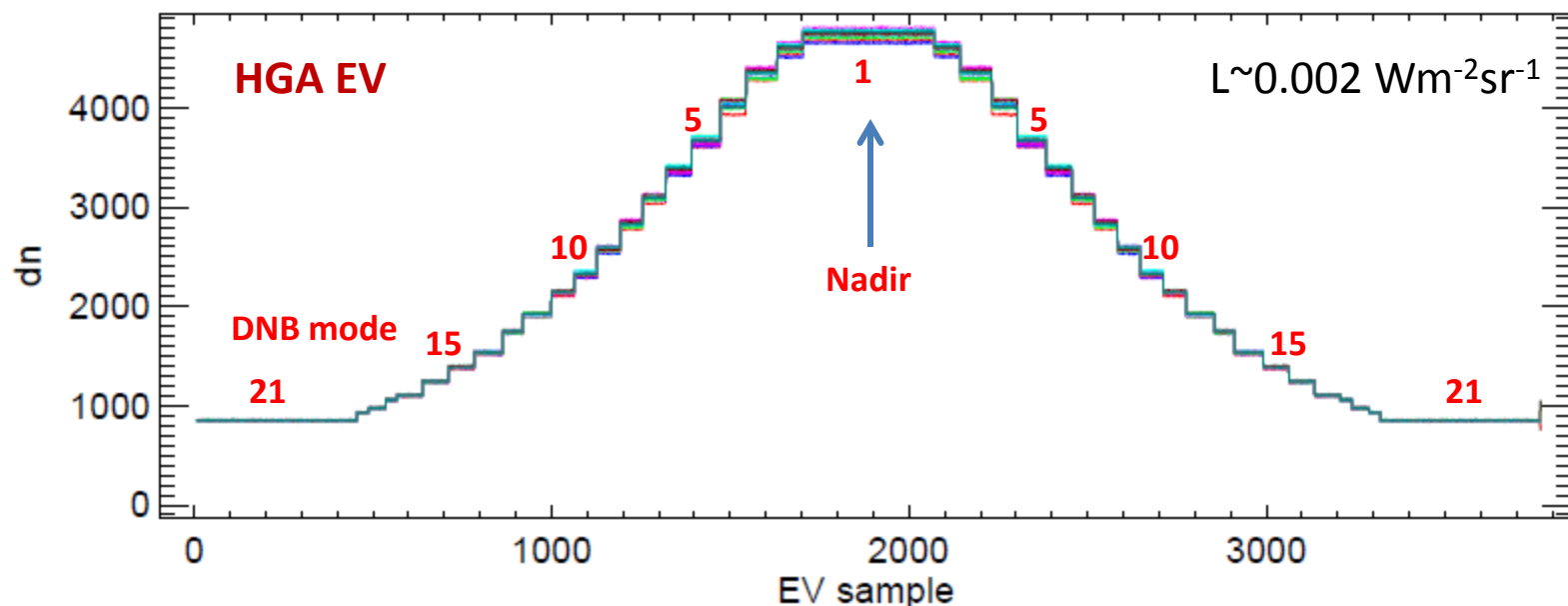


- RTA fixed, staring at SIS100
- 27 source levels to cover from the DNB dynamic range
 - 3 collects at each level: Attenuator (in/out), dark
- Staring at the same source output
 - All DNB EV samples (aggregation modes) are recorded
 - All calibration views (SV/BB/SD) are recorded, DNB modes cycled from 1-36
 - All DNB gain stages are recorded
- Enable single source comparison for all DNB modes/stages/detectors

Test Data: TV Hot Op21

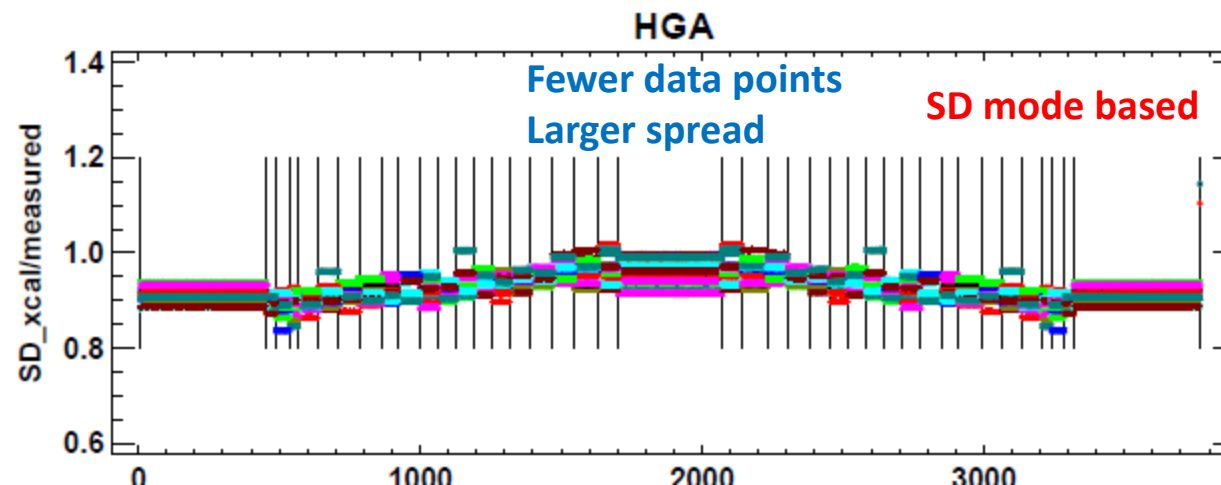
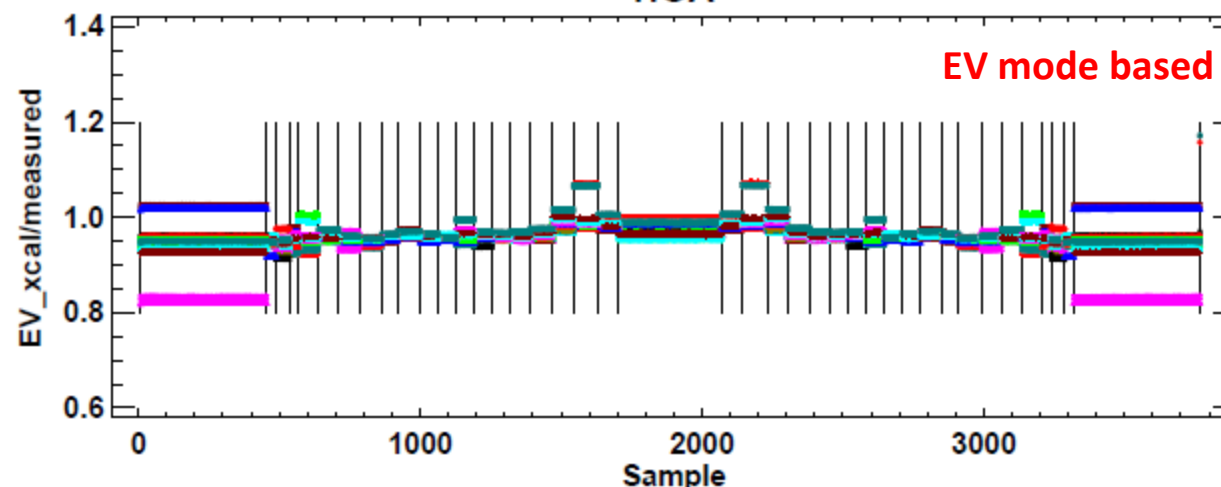
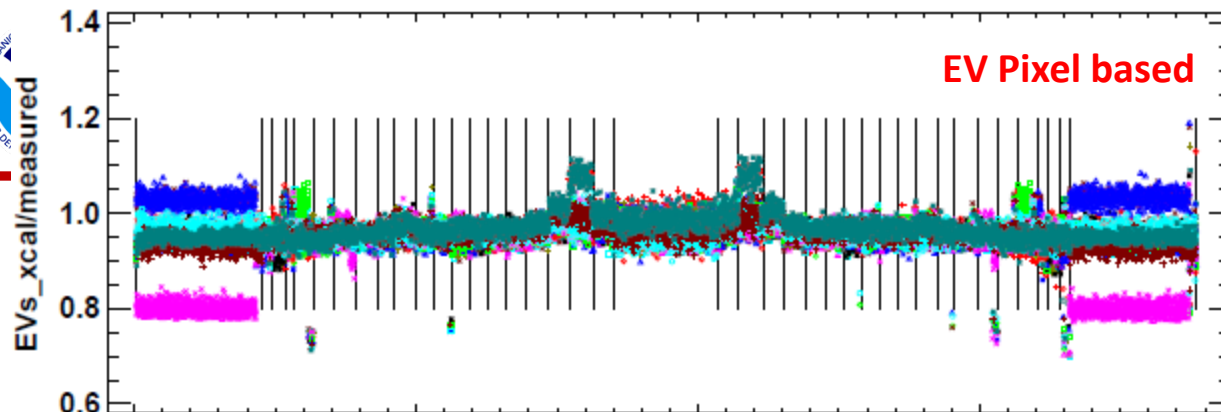


- TV_Hot_Op21: HGA example
- Characterize EV per DNB sample
- Characterize EV/Cal View per DNB mode
- Cross examination of EV/Cal View behavior
- Cross-stage calibration (Xcal)
- Assess operational calibration strategies



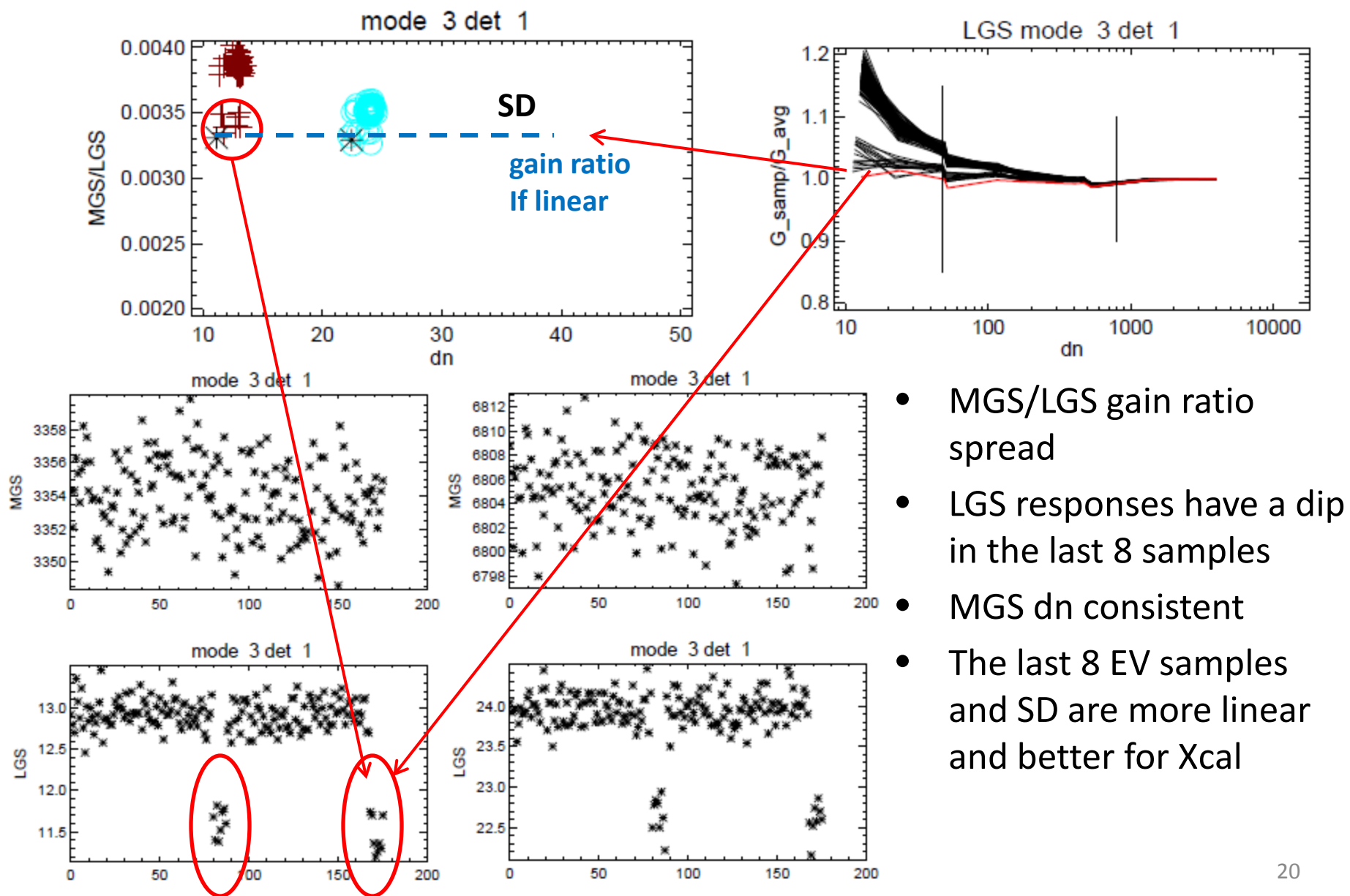
SDR Impact Analysis

- Compute EV gain: per sample/mode
- Compute SD gain: per mode
 - Gain = dn/L_{SIS} (linear)
- Compute the calibrated DNB gain using the measured LGS gain and gain ratios
 - EV vs. SD at SD calibration
 - EV vs. SD gain ratios
- Compared calibrated vs. measured HGS gain
 - Calibration impact on nighttime SDR

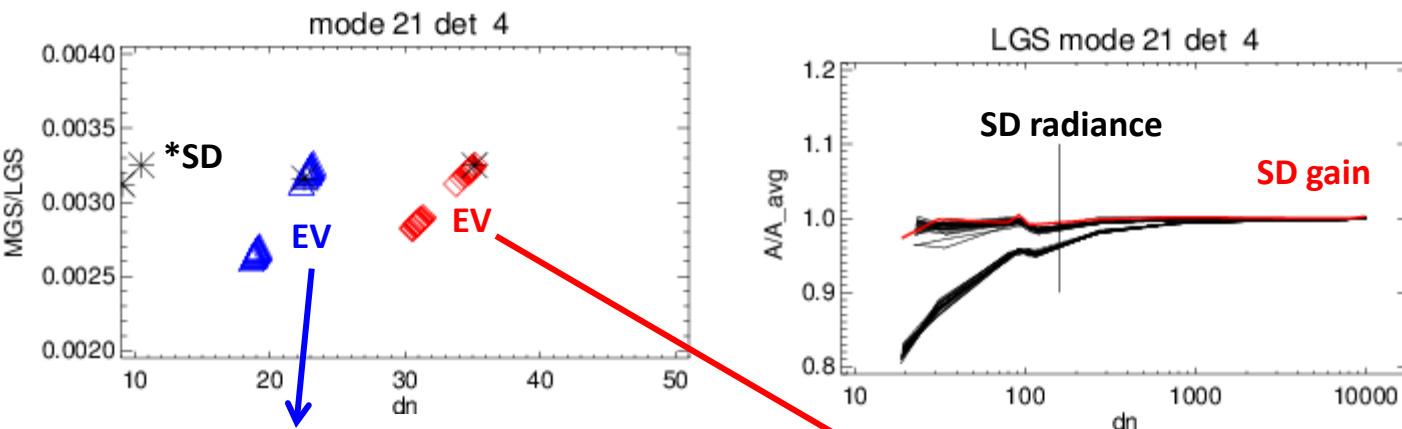


- Calibrated vs. measured HGA gain
- EV_xcal: $LGS * EV_xcal$
- SD_xcal: $LGS * SD_xcal$
- EV_xcal: some mode/detector show large biases due to LGS nonlinearity
- EV pixel based Xcal can't solve the issue
- SD_xcal: more spread (fewer data points), fewer outliers

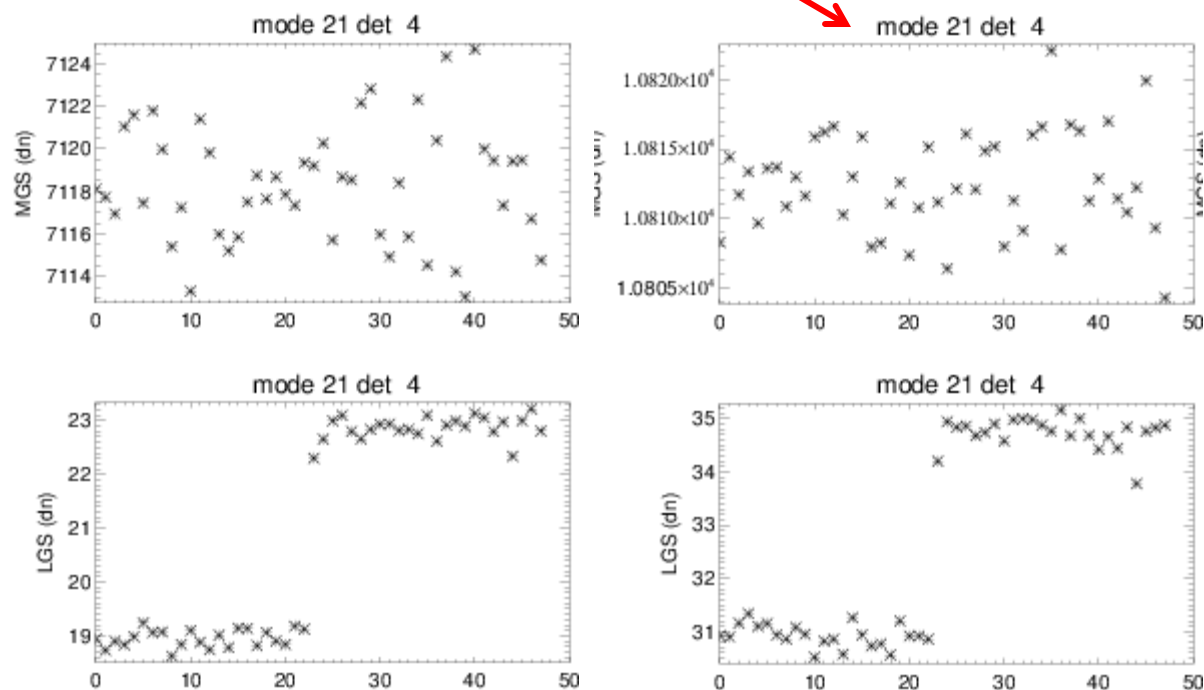
DNB Mode 3, Detector 1



Non-linearity: R & D



TV-Cold
Mode 21, Detector 4



- MGS/LGS gain ratio not consistent over EV sample and radiance level
- LGS: higher last 25 samples
- MGS: consistent
- LGS gain: last 25 samples are in-family with the mean and SD gain
- Non-linearity only in certain samples
- Cal method (Code) change required to address this
- On-orbit update?