ATBD L1 evolutions

Updates of the ATDB

1. Update of the definition of the IRS L1 spectral sampling
2. Update of the monitoring description
3. Optimization of the spectral calibration correction
4. Scene heterogeneity

Update of the spectral sampling

Update of the spectral sampling

- As per the recommendation from the MAG, the spectral sampling of the final products has been modified to stick to the instrument sampling
- The on-ground maxOPD is slightly different in the two bands (0.828 and 0.829 cm), yielding a slightly different spectral sampling
- The sampling interval is anyway not a rational number

Update of the spectral sampling

- The L1 product format will be updated so that instead of a wavenumber scale, the start and end channel index will be given, namely:

	Start		End	
	Channel #	Wn (cm^{-1})	Channel #	Wn (cm^{-1})
LWIR	1127	679.9517	2005	1210.145
MWIR	2653	1599.517	3606	2175.513

- The users can then compute the wavenumbers to the precision they need using the simple relations:

wn_step = 1/(2*maxOPD)

wavenumber(k)= wn_step * (start_number+k-2)

IRS monitoring review and re-organisation

IRS L1 processing monitoring

- Status in November 2018:
  - Description inherited from the IQT i.e.:
    - Mainly aiming at verification of the high-levels requirements
    - Algorithm description sometimes imprecise/unreliable
    - No consideration of what is online/offline
      - Availability of “external calibration” data? “no scheduled outage” requirement ?
      - What about TM, L0 science data, “engineering products”?

Monitoring re-organization and re-writing

- The algorithms need to be corrected and/or completed, and
- A significant restructuring is necessary:
  - **The online monitoring:**
    - gives an information on the processing
    - flags the products

    using as input the routine measurements (i.e. runs on every dwell)

    Part of IDPF-S processing
  - **The offline monitoring:**
    - assesses the processing performances
    - performs a characterization of the on-board/on-ground processing to possibly update it

    Both require dedicated sets of measurements and are thus run at a low frequency

    Part of the "IRS-TEC"

Online monitoring

- Integral part of the L1 processing:
  - Use of the engineering packets: BITTR, SPIKE, METRO, LASER
  - Routine check of the various algorithms e.g.
    - Gain & offset quality check in the radio. cal.
    - Spectral uncertainty from the spectral cal.
  - Dedicated checks:
    - Pointing performances
  - Although not explicitely mentioned, the SRF model is contributing to the monitoring of the observables e.g. IFG axis position

Offline monitoring

- Distinction between
  - Periodic characterizations that may (but not necessarily) require dedicated set of measurements e.g.
    - Flip-in mirror charact. (no special measurements)
    - Scan mirror reflectivity charact. (series of E-W cold spaces)
  - Special monitoring that absolutely require dedicated measurements e.g.:
    - Straylight
  - “Routine” offline monitoring: is not part of the IDPF-S and is not used to flag the products but provides insights on their quality:
    - Onboard processing replication
    - Intercalibration with other instruments: IASI, IASI-NG, CrIS
  - The IASI experience is contributing to the definition of the monitoring e.g.:
    - Corner cube speed monitoring
    - Out-of-band noise characterization

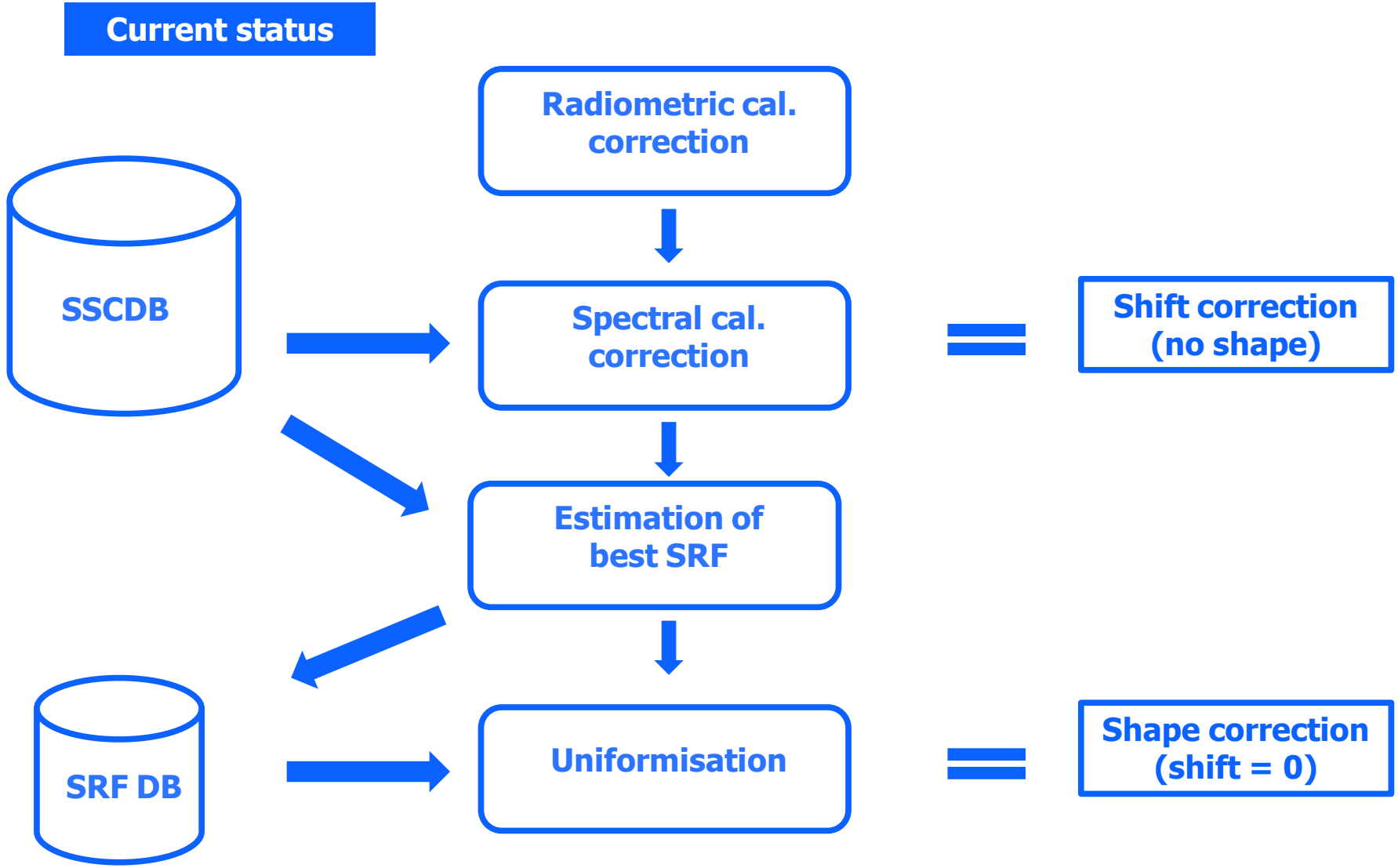
    Would be beneficial to the mission

Offline monitoring

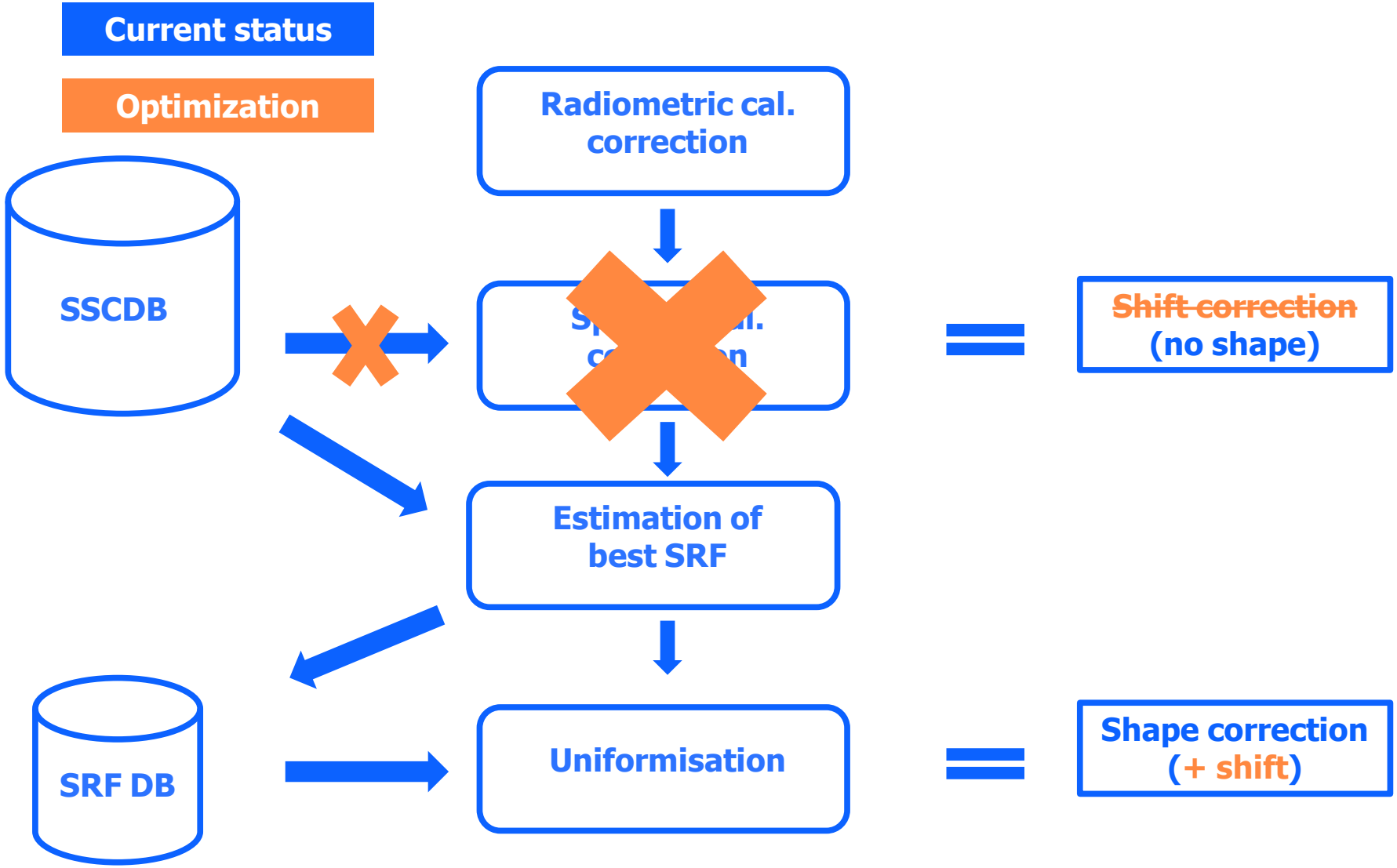
	Algorithm	Freq.	Ext Cal
Parameters characterization	FIM characterization	Year	-
	FS transmission characterization	Year	DS2
	Scan mirror reflectivity law	Year	DS2 E-W
	Chromatism determination	Low	-
Instrument and on-board monitoring **NB: the output of the SRF-EM will also be used for monitoring purposes**	Non-linearity check (super-pixel level)	Low	BB in EXP mode (?)
	Spike filter threshold monitoring	Low	TBC depending on spike rate
	On-board processing	Continuous but outside IDPF-S	-
Radiometric accuracy	In-field straylight	Low	
	Out-of-field straylight	Low	DS2 with straylight
	Out of band signal characterisation	Low	BB in EXP mode (?)
	Complex radiometric calibration monitoring	Continuous but outside IDPF-S	-
	Noise characterization (incl. covariance)		BB
Spectral monitoring	Absolute spectral calibration monitoring	month	EV
End-to-end check	Verification IF end-to-end quality check	month	
Inter-calibration	Inter-calibration with IASI (and possibly with CrIS and IASI-NG)	Continuous but outside IDPF-S	

Optimization for Spectral calibration correction

Spectral correction and uniformisation



Optimization of the spectral correction (shift + shape)



Scene heterogeneity

Scene heterogeneity: context

- MAG has recommended that an estimate of the scene heterogeneity at sub-pixel level is provided
- Images were not used in the core processing (except for geo-location) and no performance requirements exist
- It has thus been necessary to assess the performances of the imager mode

Image mode calibration

- Images are not corrected for non-linearity (in fact no processing is applied on board)
- Integration time is very short (400 μs) and is a single snapshot of the IFG baseline➔performances hampered by:
  - Noise
  - Spectral content
  - IFG baseline being not a constant

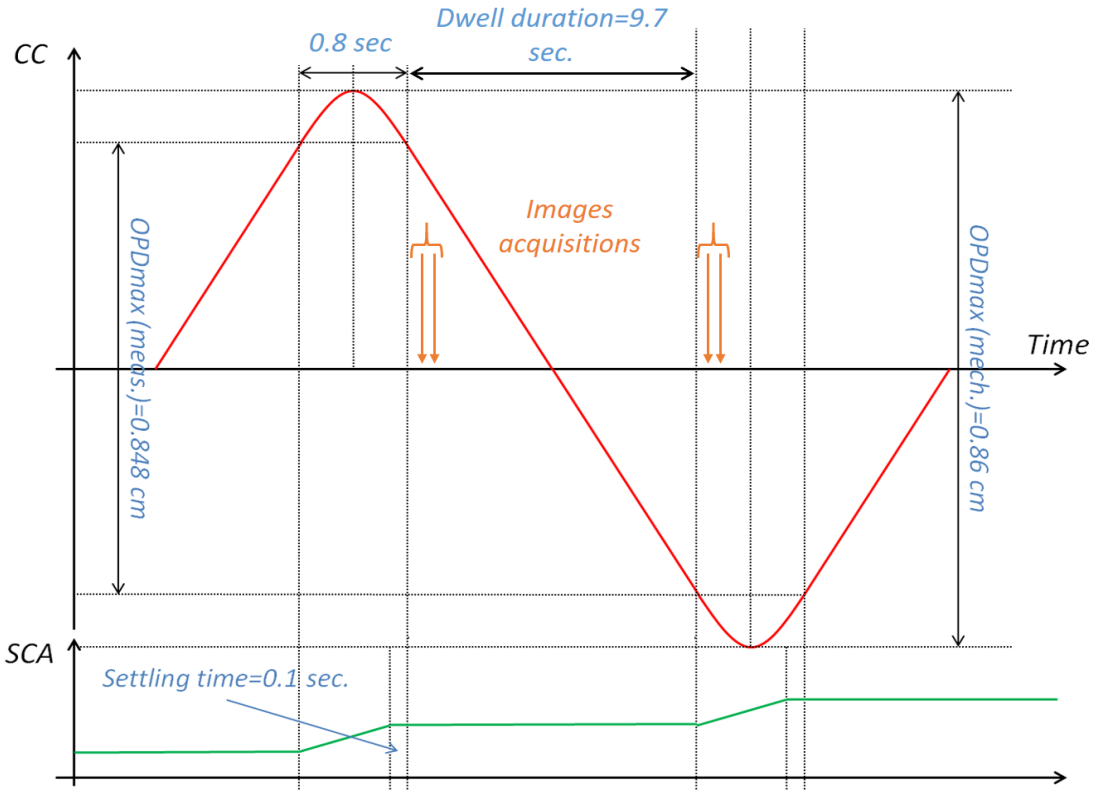


Image mode calibration

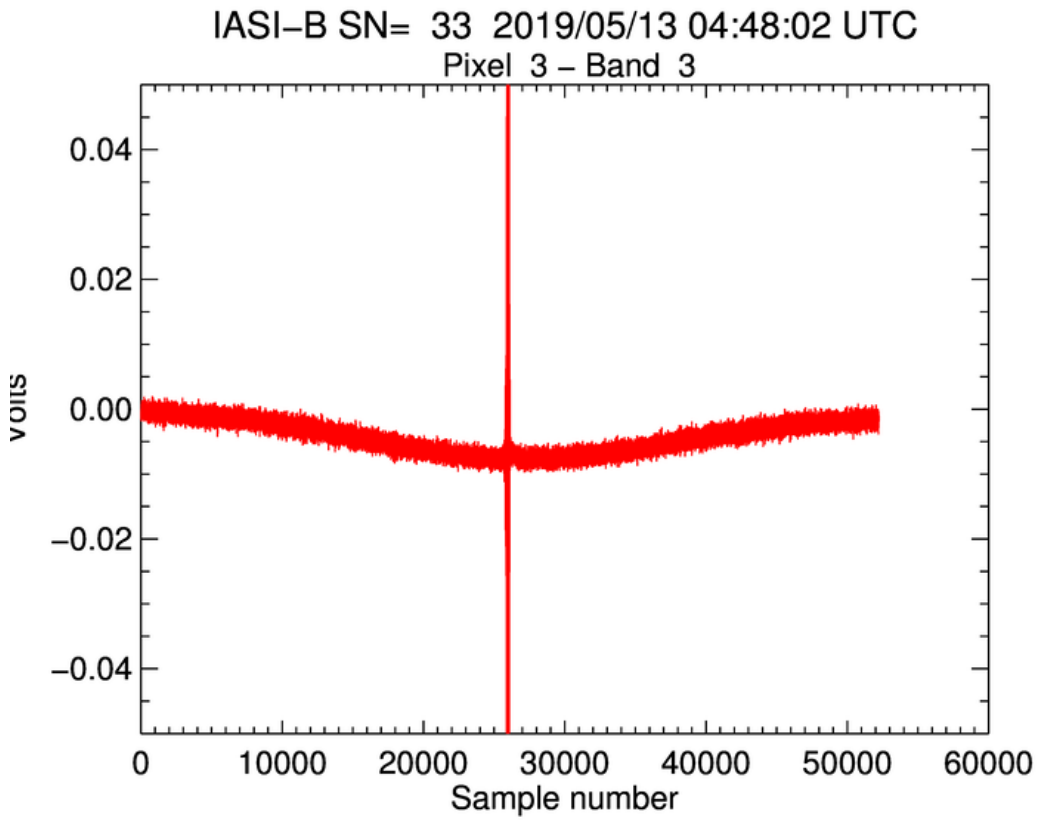
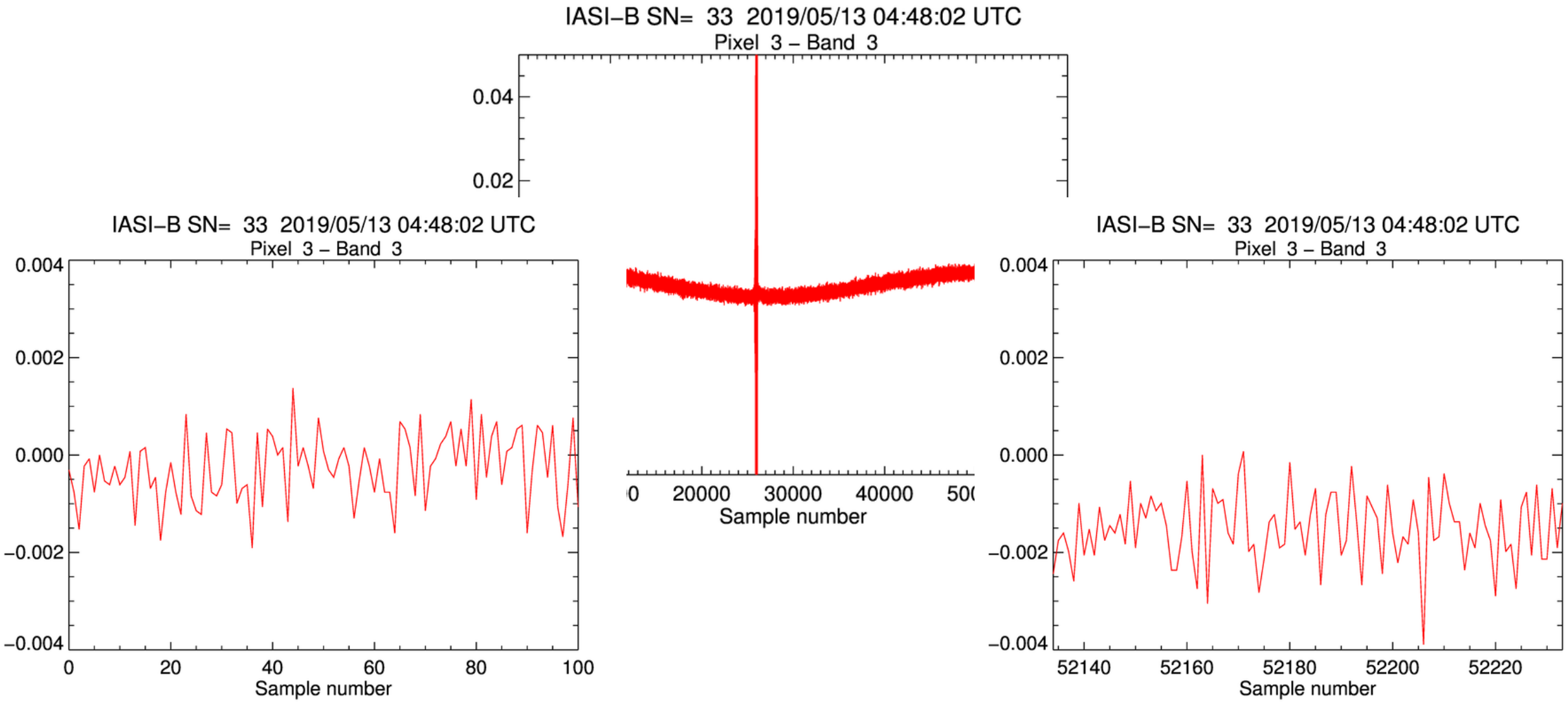


Image mode calibration



Non-linearity correction in IM mode

- Images can be corrected for NL provided that the latter is characterized at sub-pixel level

- The possibility to do that in flight is limited➔we must rely on the on-ground + maybe Cal/Val characterization

Image mode calibration

- Simulations have shown that a SNR of the order of 1300 is to be expected in LWIR
- Calibration performances/concept doubtful➔more investigations (and more info) needed
- An heterogeneity index is however proposed in the ATBD

Scene heterogeneity index

- Standard deviation and mean over the calibrated radiances:

$$HI_V[i,j,b] = \frac{1}{N_{ii} \cdot N_{jj}} \cdot \left[\sum_{ii=1}^{Nii} \sum_{jj=1}^{Njj} \left(L^{EV}_{ii,jj}[i,j,b] \right)^2 - \left(\sum_{ii=1}^{Nii} \sum_{jj=1}^{Njj} L^{EV}_{ii,jj}[i,j,b] \right)^2 \right]$$

$$HI_M[i,j,b] = \frac{1}{N_{ii} \cdot N_{jj}} \cdot \sum_{ii=1}^{Nii} \sum_{jj=1}^{Njj} L^{EV}_{ii,jj}[i,j,b]$$

- Mean value is useful for:
  - Conversion in BT or NEdT
  - Quick discrimination between hot and cold scenes
  - A verification of the consistency between IM and NORM mode

- If the images cannot be properly calibrated, we could use the relative sub-detector variations

Summary

- The IRS L1 ATBD is still evolving:
  - Major rewriting of the monitoring;
  - Optimization of the spectral calibration
  - Calibration of imager mode (and thus the estimation of the heterogeneity) still needs investigation

  All these taking into account comments from the MAG

- A version will be released in May. The description of:
  - The offline monitoring (the IRS-TEC)
  - The imager mode calibration

  will however not be completed by then.