PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

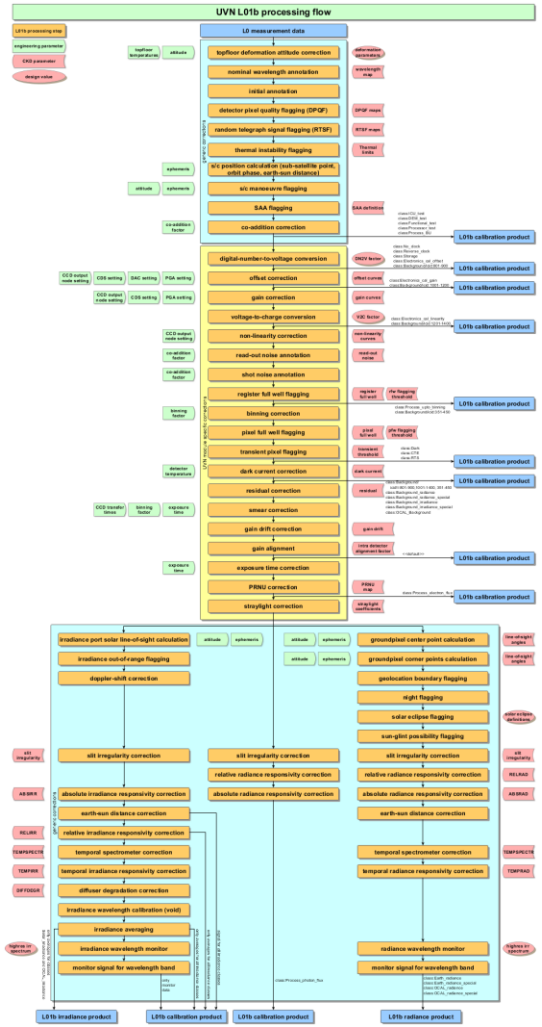
Calibration features in the TROPOMI L0-1b data processor

Nico Rozemeijer[1,2], Antje Ludewig[1], Erwin Loots[1], Emiel van der Plas[1], Jonatan Leloux[1,2], Tim van Kempen[3], Richard van Hees[3], Mirna van Hoek[1], Simon Spronk[1,2] and Pepijn Veefkind[1]

[1]KNMI (Royal Netherlands Meteorological Institute), Utrechtseweg 297, 3731 GA De Bilt, Netherlands
[2]TriOpSys B.V., Computerweg 5, 3542 DP Utrecht, The Netherlands
[3]SRON Netherlands Institute for Space Research, Niels Bohrweg 4, 2333 CA Leiden

Calibration data vs. the L01b

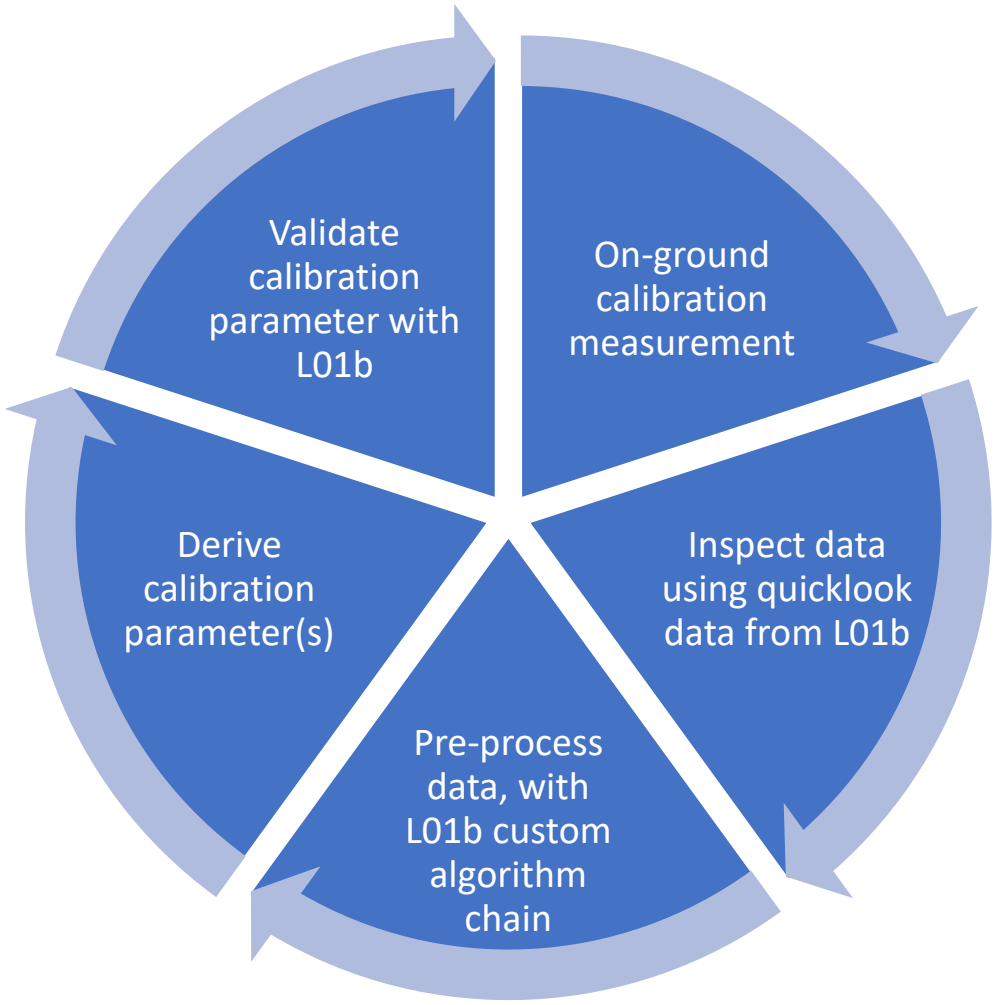
PROGRAMME OF THE EUROPEAN UNION
opernicus Europe's eyes on Earth
co-funded with esa



- Many of the algorithms in the L0-1b use calibration key data (CKD) as input
- Quality of the calibration key data has direct impact on the quality of the L1b data
- Quality needs to be maintained throughout the mission, on-ground as well as in-flight
- Consistency between L01b and CKD crucial
- Calibration has been taken into account in the development of the L01b from the start

Use of L01b in on-ground calibration

PROGRAMME OF THE EUROPEAN UNION
Copernicus Europe's eyes on Earth
co-funded with esa



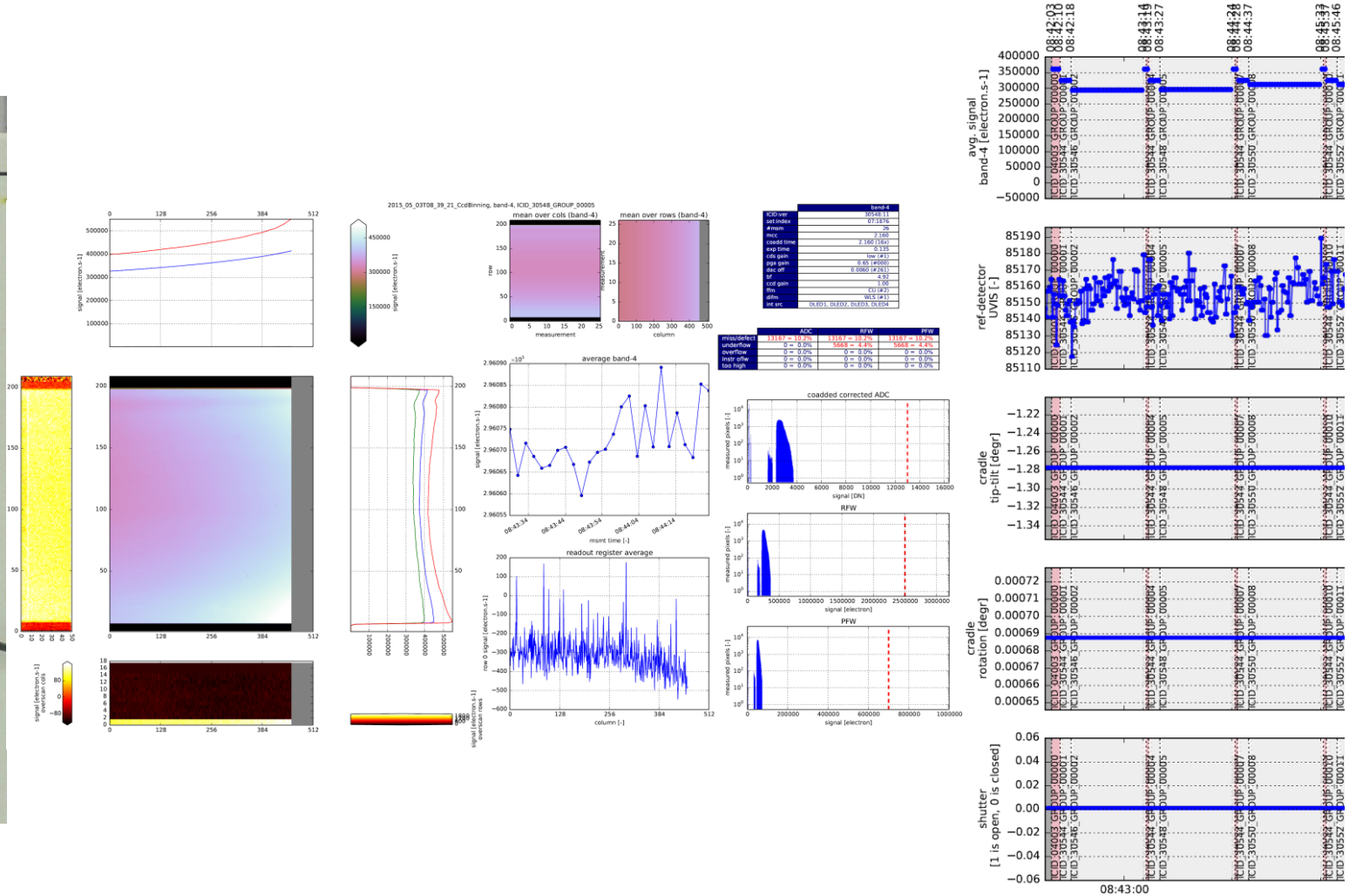
L01b features:

- Generating quick-look output (NRT)
- Custom data processing
- Processing up-to specific (intermediate) processing level
- Processing of OGSE / MGSE / EGSE data
- Closed loop validation

Netherlands Space Office
Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management
SRON Netherlands Institute for Space Research
AIRBUS DEFENCE & SPACE
TNO innovation for life
cosine measurement systems
nlr Dedicated to innovation in aerospace
s[&]t Making sense of data
TriOpSys MISSION CRITICAL IT

Use of L01b in on-ground calibration

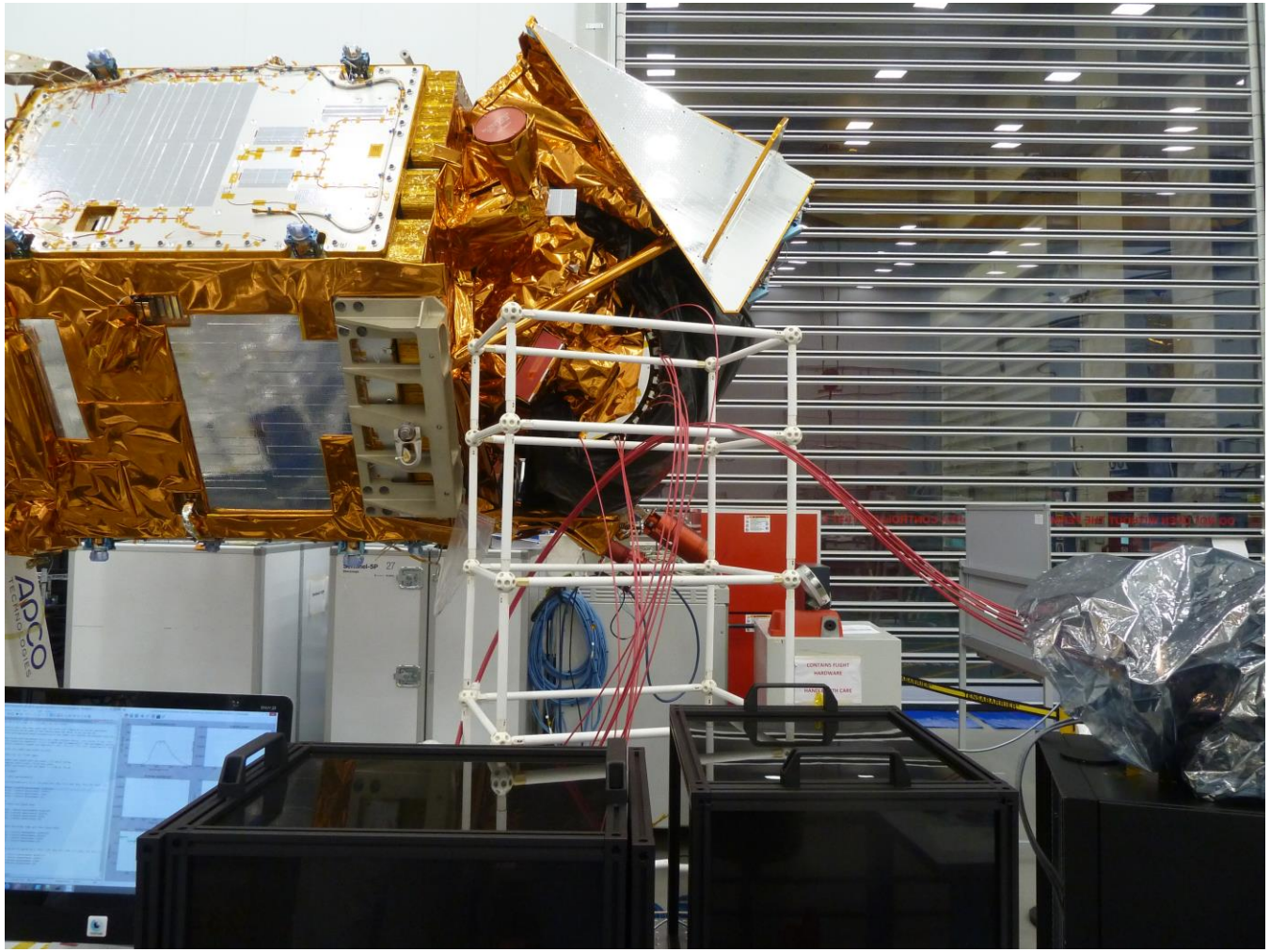
PROGRAMME OF THE EUROPEAN UNION
opernicus Europe's eyes on Earth
co-funded with esa



Netherlands Space Office
Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management
SRON Netherlands Institute for Space Research
AIRBUS DEFENCE & SPACE
TNO innovation for life
cosine measurement systems
nlr Dedicated to innovation in aerospace
s[&]t Making sense of data
TriOpSys MISSION CRITICAL IT

NIR-OOB-SL: Flexibility needed

PROGRAMME OF THE EUROPEAN UNION
copernicus Europe's eyes on Earth
co-funded with esa



L01b features:

- Dedicated processing setup, for measurements in ambient
- Custom data processing
- Processing up-to specific (intermediate) processing level
- Generating quick-look output (NRT)
- Processing of OGSE / MGSE / EGSE data

Netherlands Space Office
Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management
SRON Netherlands Institute for Space Research
AIRBUS DEFENCE & SPACE
TNO innovation for life
cosine measurement systems
nlr Dedicated to innovation in aerospace
s[&]t Making sense of data
TriOpSys MISSION CRITICAL IT

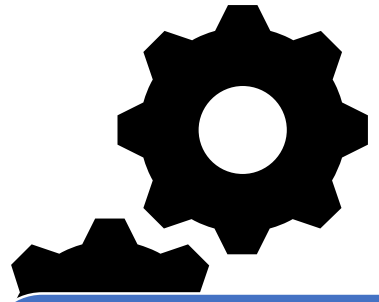
Use of L01b for in-flight calibration

PROGRAMME OF THE EUROPEAN UNION

co-funded with

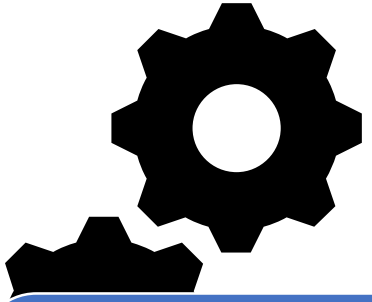
L01b processor

- In-orbit calibration
- Data reduction
- Quick look generation
- Trending / monitoring data generation



ICAL processor

- Multi-orbit (calibration) analysis
- Dynamic Calibration Key Data generation
- Additional trending / monitoring data generation



IDAF

- Trending / monitoring / calibration database for entire mission
- Complex calibration algorithms
- Off-line analysis
- Website / Visualisation
- Auxiliary Calibration Key Data updates

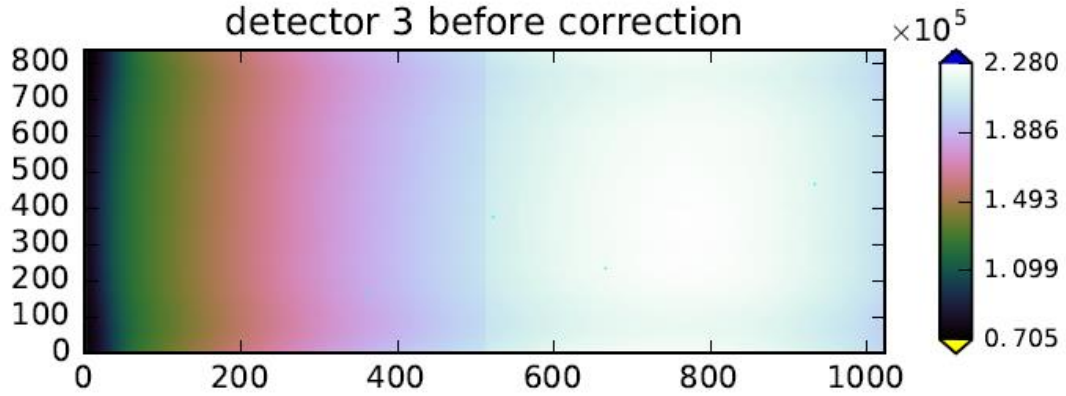
Calibration key data updates

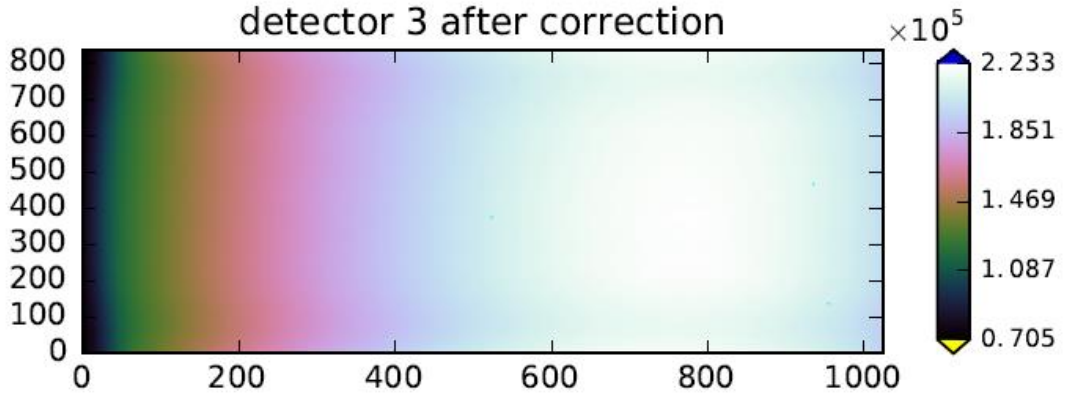
L01b in-orbit calibration

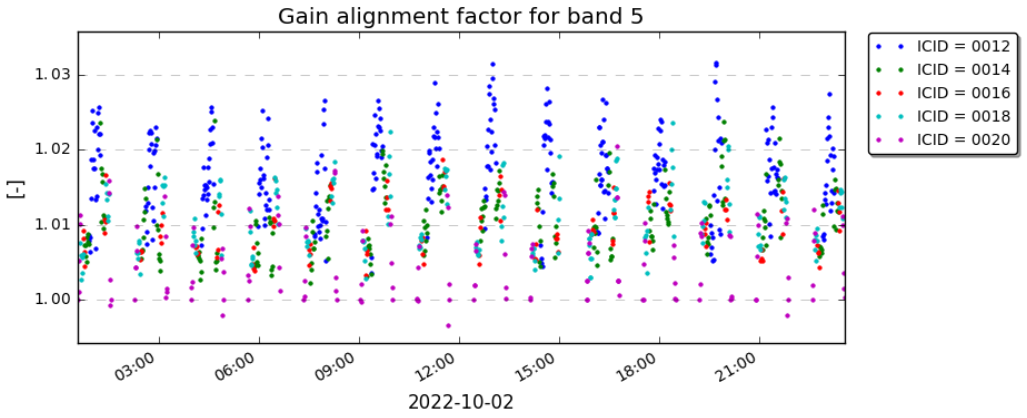
PROGRAMME OF THE EUROPEAN UNION

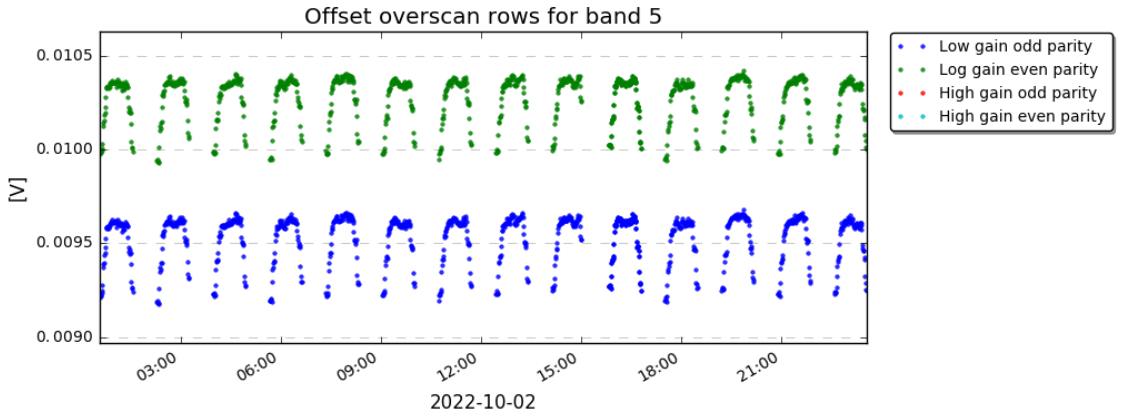
co-funded with esa

Dynamic in-orbit calibration of UVN offset and UVN gain alignment









Netherlands Space Office · Royal Netherlands Meteorological Institute, Ministry of Infrastructure and Water Management · SRON Netherlands Institute for Space Research · AIRBUS DEFENCE & SPACE · TNO innovation for life · cosine measurement systems · nlr Dedicated to innovation in aerospace · s[&]t Making sense of data · TriOpSys MISSION CRITICAL IT

In-flight calibration chain

PROGRAMME OF THE EUROPEAN UNION
co-funded with esa

Derivation of calibration key data for UVN detectors gain drift

L01b processor

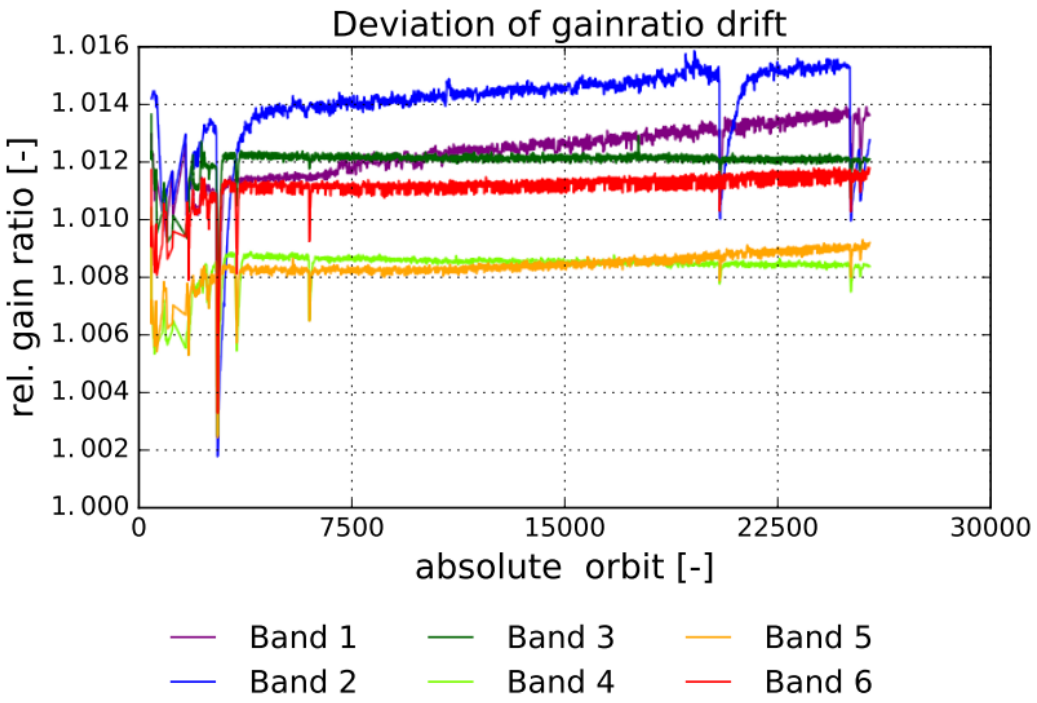
- Dedicated processing level
- Data reduction (averaging)

ICAL processor

- Combination of different gain measurements
- Derivation of gain factor and gain drift for single orbit

IDAF

- Off-line analysis to derive trend and CKD over the entire mission
- Off-line report, QA check, and testing and integration with L01b processor

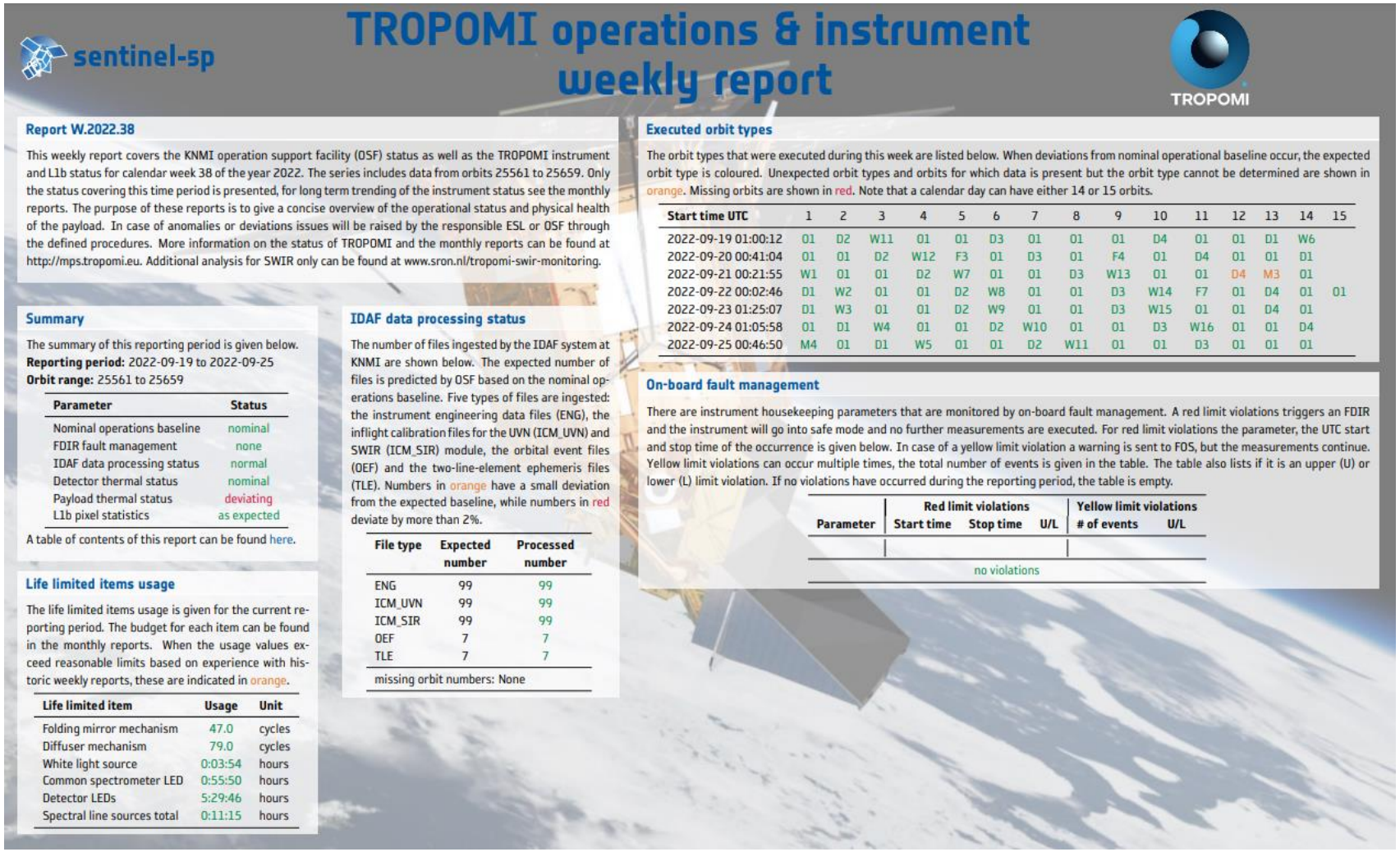


Netherlands Space Office
Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management
SRON Netherlands Institute for Space Research
AIRBUS DEFENCE & SPACE
TNO innovation for life
cosine measurement systems
nlr Dedicated to innovation in aerospace
s[&]t Making sense of data
TriOpSys MISSION CRITICAL IT

In-flight calibration reporting

PROGRAMME OF THE EUROPEAN UNION

co-funded with



sentinel-5p

TROPOMI operations & instrument weekly report

TROPOMI

Report W.2022.38

This weekly report covers the KNMI operation support facility (OSF) status as well as the TROPOMI instrument and L1b status for calendar week 38 of the year 2022. The series includes data from orbits 25561 to 25659. Only the status covering this time period is presented, for long term trending of the instrument status see the monthly reports. The purpose of these reports is to give a concise overview of the operational status and physical health of the payload. In case of anomalies or deviations issues will be raised by the responsible ESL or OSF through the defined procedures. More information on the status of TROPOMI and the monthly reports can be found at http://mps.tropomi.eu. Additional analysis for SWIR only can be found at www.sron.nl/tropomi-swir-monitoring.

Summary

The summary of this reporting period is given below.
Reporting period: 2022-09-19 to 2022-09-25
Orbit range: 25561 to 25659

Parameter	Status
Nominal operations baseline	nominal
FDIR fault management	none
IDAF data processing status	normal
Detector thermal status	nominal
Payload thermal status	deviating
L1b pixel statistics	as expected

A table of contents of this report can be found here.

Life limited items usage

The life limited items usage is given for the current reporting period. The budget for each item can be found in the monthly reports. When the usage values exceed reasonable limits based on experience with historic weekly reports, these are indicated in orange.

Life limited item	Usage	Unit
Folding mirror mechanism	47.0	cycles
Diffuser mechanism	79.0	cycles
White light source	0:03:54	hours
Common spectrometer LED	0:55:50	hours
Detector LEDs	5:29:46	hours
Spectral line sources total	0:11:15	hours

IDAF data processing status

The number of files ingested by the IDAF system at KNMI are shown below. The expected number of files is predicted by OSF based on the nominal operations baseline. Five types of files are ingested: the instrument engineering data files (ENG), the inflight calibration files for the UVN (ICM_UVN) and SWIR (ICM_SIR) module, the orbital event files (OEF) and the two-line-element ephemeris files (TLE). Numbers in orange have a small deviation from the expected baseline, while numbers in red deviate by more than 2%.

File type	Expected number	Processed number
ENG	99	99
ICM_UVN	99	99
ICM_SIR	99	99
OEF	7	7
TLE	7	7

missing orbit numbers: None

Executed orbit types

The orbit types that were executed during this week are listed below. When deviations from nominal operational baseline occur, the expected orbit type is coloured. Unexpected orbit types and orbits for which data is present but the orbit type cannot be determined are shown in orange. Missing orbits are shown in red. Note that a calendar day can have either 14 or 15 orbits.

Start time UTC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2022-09-19 01:00:12	O1	D2	W11	O1	O1	D3	O1	O1	O1	D4	O1	O1	D1	W6	
2022-09-20 00:41:04	O1	O1	D2	W12	F3	O1	D3	O1	F4	O1	D4	O1	O1	D1	
2022-09-21 00:21:55	W1	O1	O1	D2	W7	O1	O1	D3	W13	O1	O1	D4	M3	O1	
2022-09-22 00:02:46	D1	W2	O1	O1	D2	W8	O1	O1	D3	W14	F7	O1	D4	O1	O1
2022-09-23 01:25:07	D1	W3	O1	O1	D2	W9	O1	O1	D3	W15	O1	O1	D4	O1	
2022-09-24 01:05:58	O1	D1	W4	O1	O1	D2	W10	O1	O1	D3	W16	O1	O1	D4	
2022-09-25 00:46:50	M4	O1	D1	W5	O1	O1	D2	W11	O1	O1	D3	O1	O1	O1	

On-board fault management

There are instrument housekeeping parameters that are monitored by on-board fault management. A red limit violations triggers an FDIR and the instrument will go into safe mode and no further measurements are executed. For red limit violations the parameter, the UTC start and stop time of the occurrence is given below. In case of a yellow limit violation a warning is sent to FOS, but the measurements continue. Yellow limit violations can occur multiple times, the total number of events is given in the table. The table also lists if it is an upper (U) or lower (L) limit violation. If no violations have occurred during the reporting period, the table is empty.

Parameter	Red limit violations Start time	Stop time	U/L	Yellow limit violations # of events	U/L
no violations					

IDAF Daily and weekly reports summarize the main instrument performance and calibration parameters and are the basis for further analysis

Conclusions

- Integration of calibration functionality, the use of the L01b processor during on-ground and in-flight calibration, and great teamwork have resulted in high quality Level 1B data products from day 1 of the mission
- Continuous monitoring, trending and data analysis have allowed to further improve Level 1B data quality, and to correct for temporal variations in instrument performance / behaviour.
- The ongoing calibration activities by the dedicated L1B and calibration team will ensure high quality data for hopefully many years of mission still to come.

Post-launch event 13 October 2017