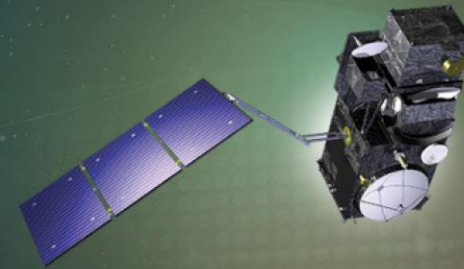




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HyperInSPACE: A Community Processor for Above-Water Radiometry with FRM standards

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- 1: ACRI-ST
- 2: NPL
- 3: TARTU
- 4: EUMETSAT

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Objectives:

- To provide a user friendly community processor that will generate above water Fiducial Rrs, namely qualified radiometry with SI-traceable uncertainty budget.
- To ensure a long-lasting community requirement for a common processing baseline.

Processor inputs:

SI-traceable and fully characterised radiometer measurements.

Acknowledgment:

PySciDON: M. Costa, N. Vanderberg (U. Victoria)
<https://ieeexplore.ieee.org/abstract/document/8121926>

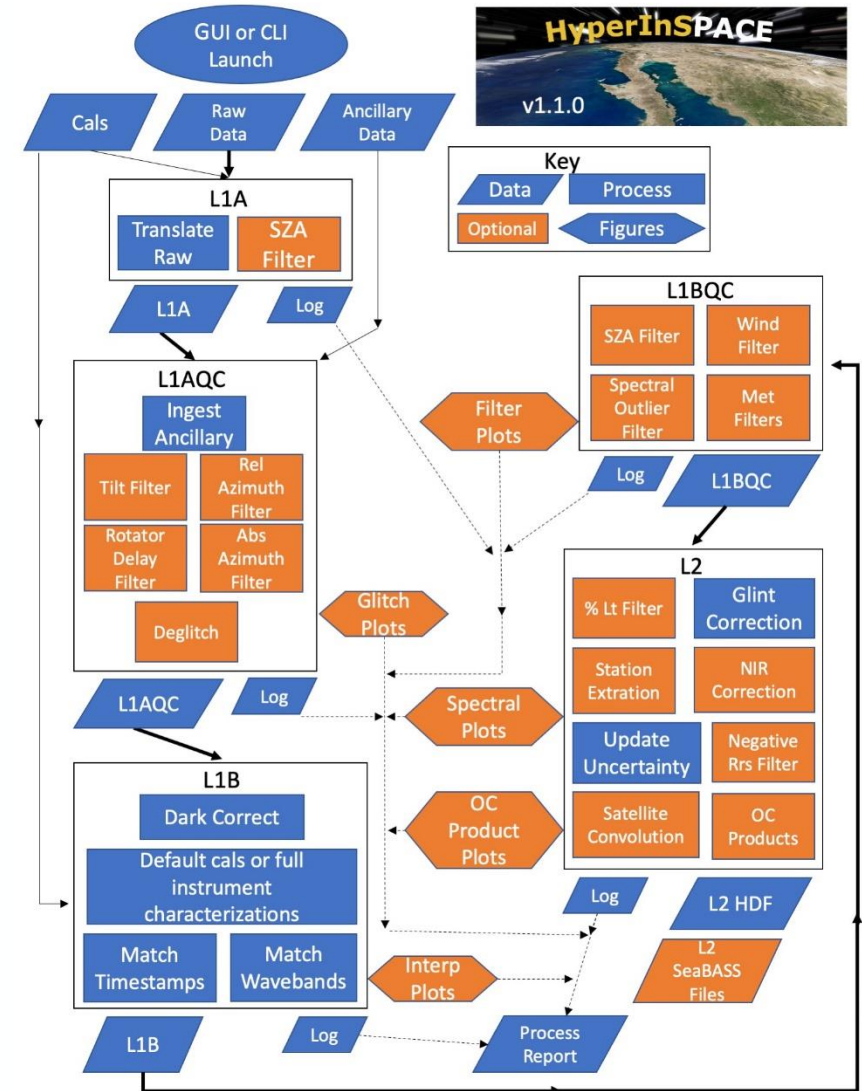


HyperInSPACE: D. Aurin (NASA)
<https://github.com/nasa/HyperInSPACE>



CP additional features (with regards to nominal HyperInSpace):

- General feature: New instrument supported (TriOS RAMSES)
- FRM feature:
 - SI-traceable uncertainty computation (supervised by NPL)
 - Additional correction for Straylight, Temperature response, non linearity, polarisation and cosine effect.



Main Processing steps



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L1A

Raw radiometer data formatting in HDF file

L1AQC

Ingests and formats ancillary data
Performs 1st QC step

L1B

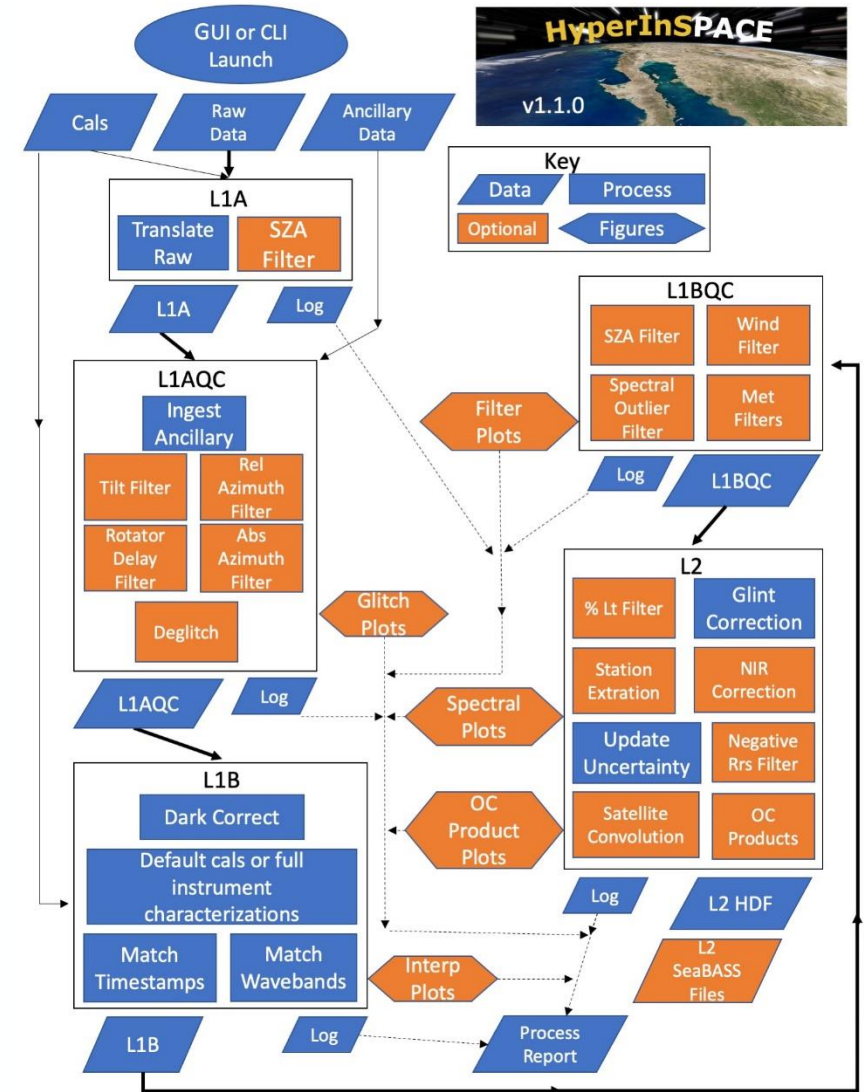
Radiometric calibration
Dark correction
Conversion to physical unit (radiance)

L1BQC

Performs 2nd QC step

L2

NIR correction
Reflectance computation
Writing output file



What's new from current HyperInSPACE



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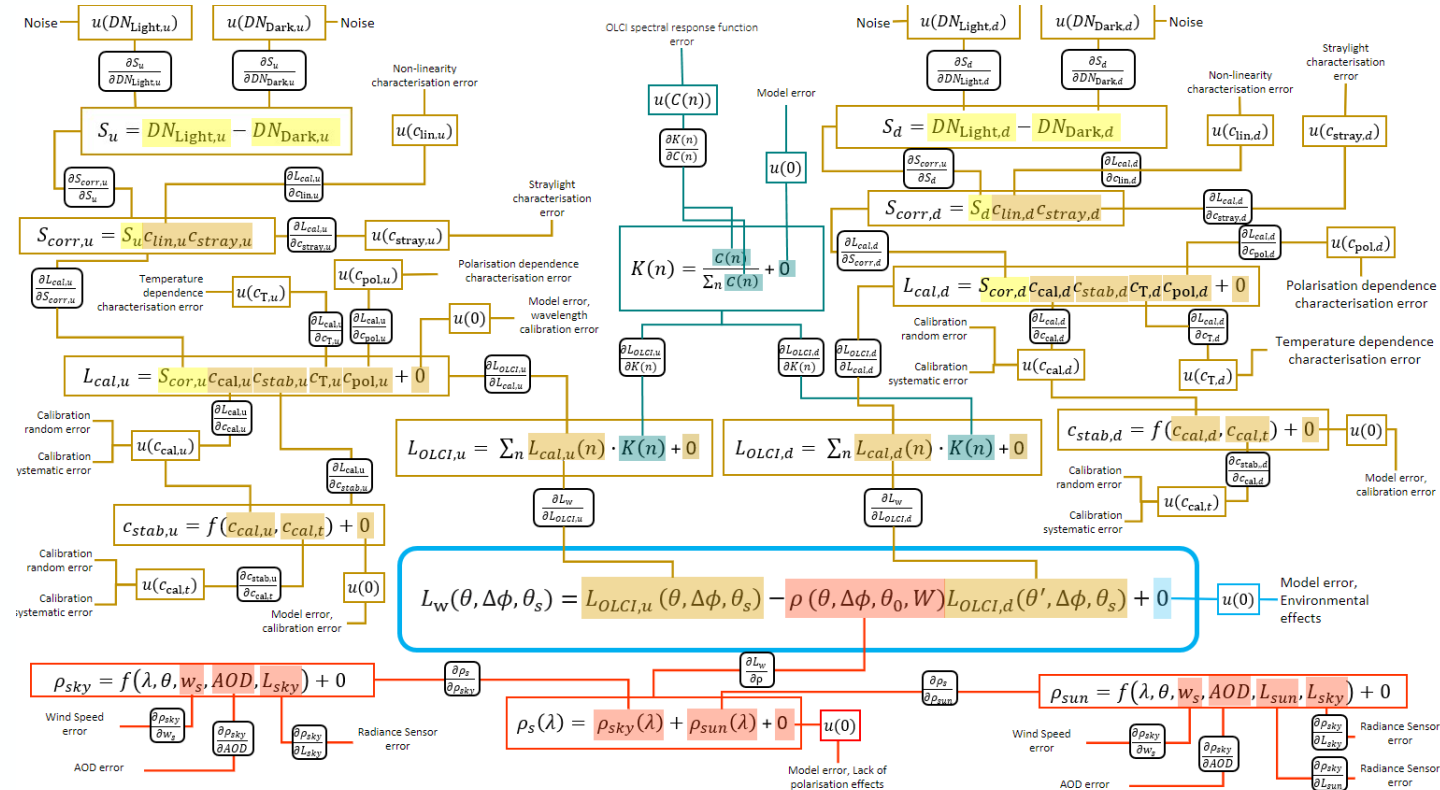


TriOS RAMSES devices are now fully supported.

Uncertainty computation following the GUM is implemented, uncertainty analysis is provided by the NPL. The following uncertainty contributors are foreseen:

- Absolute radiometric calibration
- Spectral straylight
- Temperature sensitivity
- Polarisation sensitivity (radiance)
- Cosine response (irradiance)
- Calibration stability.
- Detector non-linearity

➔ Next step is to correct data from those effects and to update the uncertainty computation.



Uncertainty tree diagram for water leaving radiance
Bialek et al. 2020



Radiometers measurements

- Seabird HyperOCR: both “.raw” and ascii export are supported.
- TriOS RAMSES: both multi-frame and single-frame acquisition are supported.

Ancillary data

GPS information, Solar angle, pointing, Station information, Meteo, ...

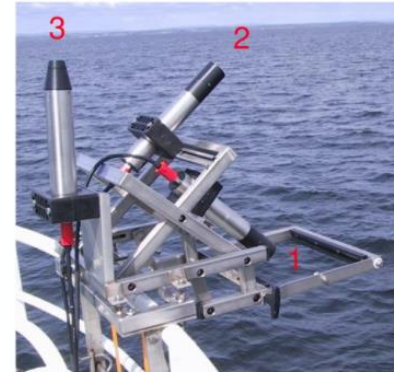
Calibration files

Absolute calibration factor files.

Full instrument characterization is performed at TARTU laboratory

Uncertainty coefficients

- Absolute calibration factor uncertainty
- Additional uncertainty parameters : Generic Class-based coefficients available for all instruments. Or fully characterized coefficients coming from the instrument characterization.



FRM standards require uncertainty parameters for all the contributors. They are obtained thanks to the TARTU full characterization.

Developed in Python3, for Linux computer.
Open-Source project.

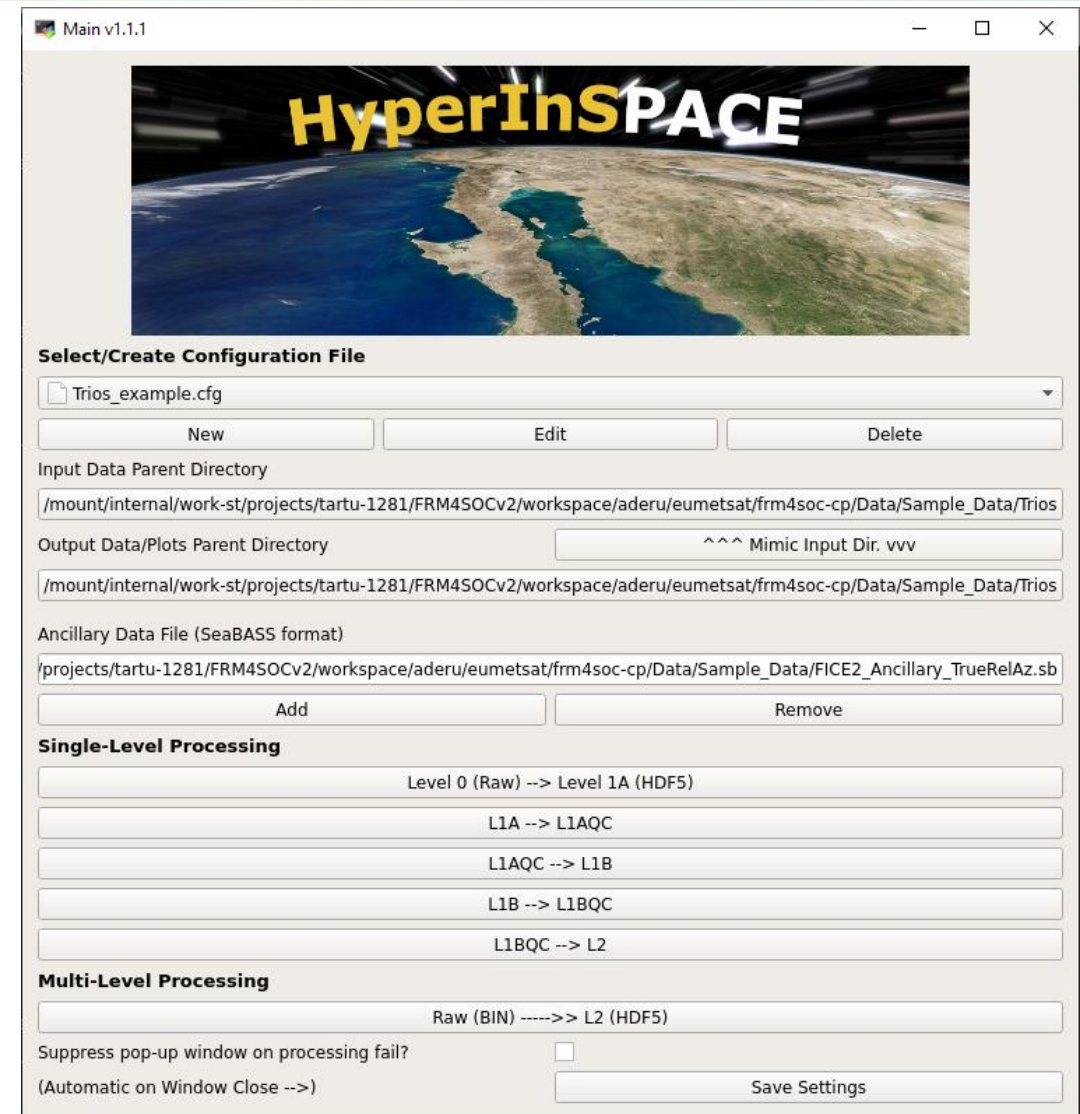
Processor can be launched with command line or with GUI

- Selection of input files.
- Selection of output directory.
- Configuration of the processing.
- step-by-step or multi-level processing.

Configuration file

- JSON file editable with the GUI or by hand.
- Per level configuration options.

The processor as been successfully tested on real data thanks to the FICE-2 participants.



Configuration: Trios_example.cfg

Sensor Type:
Trios

Add Cals Remove Cals

SAM_8166.ini Enabled

Frame Type:
LI

Level 1B Processing
Dark offsets, calibrations and corrections. Interpolate to common timestamps and wavebands.
Select calibration/correction regime:
 Default/Factory Full Characterization
 Interpolation Interval (nm) 3.3
 Generate Plots ({"OUTPATH"}/Plots/L1B_Interp/)
 Plot Interval (nm) 20.0

Level 1BQC Processing
Data quality control filters.
GMAO MERRA2 ancillary data are required for Zhang glint correction and can fill in wind for M99 and QC.
WILL PROMPT FOR EARTHDATA CREDENTIALS
Download Ancillary Models [Register here](#)
Fallback values when no model available:
 Default Wind Speed (m/s) 5.0
 Default AOD(550) 0.5
 Default Salinity (psu) 35.0
 Default SST (C) 26.0
 Eliminate where Lt(NIR)>Lt(UV)
 Max. Wind Speed (m/s) 10.0
 SZA Minimum (deg) 20.0
 SZA Maximum (deg) 60.0

Enable Spectral Outlier Filter & Plots
 Filter Sigma Es 5.0
 Filter Sigma Li 8.0
 Filter Sigma Lt 3.0

Enable Meteorological Filters
 Cloud Li(750)/Es(750)> 1.0
 Significant Es(480) (uW cm⁻² nm⁻¹) 2.0
 Dawn/Dusk Es(470/680)< 1.0
 Rain/Humid. Es(720/370)< 1.095

Level 2 Processing
Temporal binning, glitter reduction, glint correction, residual correction, QC, satellite convolution, OC product generation, SeaBASS file output.

L2 Ensembles
Extract Cruise Stations
 Ensemble Interval (secs; 0=None) 300
 Enable Percent Lt Calculation
 Percent Lt (%) 5.0

L2 Sky/Sunglint Correction (p)
 Mobley (1999) p Zhang et al. (2017) p
 Groetsch et al. (2017) Your Glint (2021) p

NIR Residual Correction
 Mueller and Austin (1995) (blue water)
 SimSpec. Ruddick et al. (2006) (turbid)
 Your NIR Residual (2021) (universal)

Remove Negative Spectra
L2 Products
 Convolve to Satellite Bands:
 AQUA * Sen-3A V-NPP
 TERRA Sen-3B V-JPSS
 * Automatic for Derived Products

Generate Spectral Plots
 Rrs nLw Es Li Lt

Derived L2 Ocean Color Products

Save SeaBASS Files
 Edit SeaBASS Header

Write PDF Report

Launch Anomaly Analysis

Save/Close Save As Cancel

**All products are in HDF5 format
At L2, groups organized as follow**

- ANCILLARY
- IRRADIANCE
- RADIANCE
- REFLECTANCE
- UNCERTAINTY_BUDGET

Both Seabird and TriOS data follow the same organization.

The screenshot shows the HDFView 3.1.3 application window. The file tree on the left displays a hierarchy for a TriOS data file, with the following groups expanded:

- Trios_20220715T112459Z_20220715T
 - ANCILLARY
 - IRRADIANCE
 - RADIANCE
 - REFLECTANCE
 - UNCERTAINTY_BUDGET

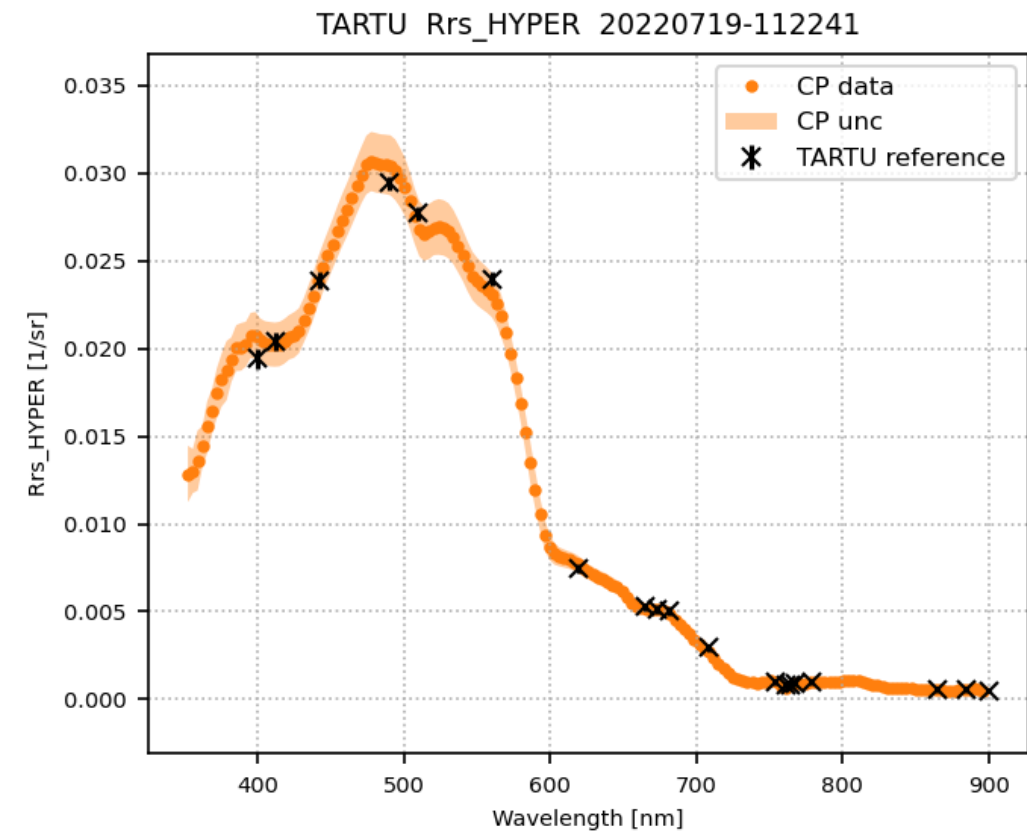
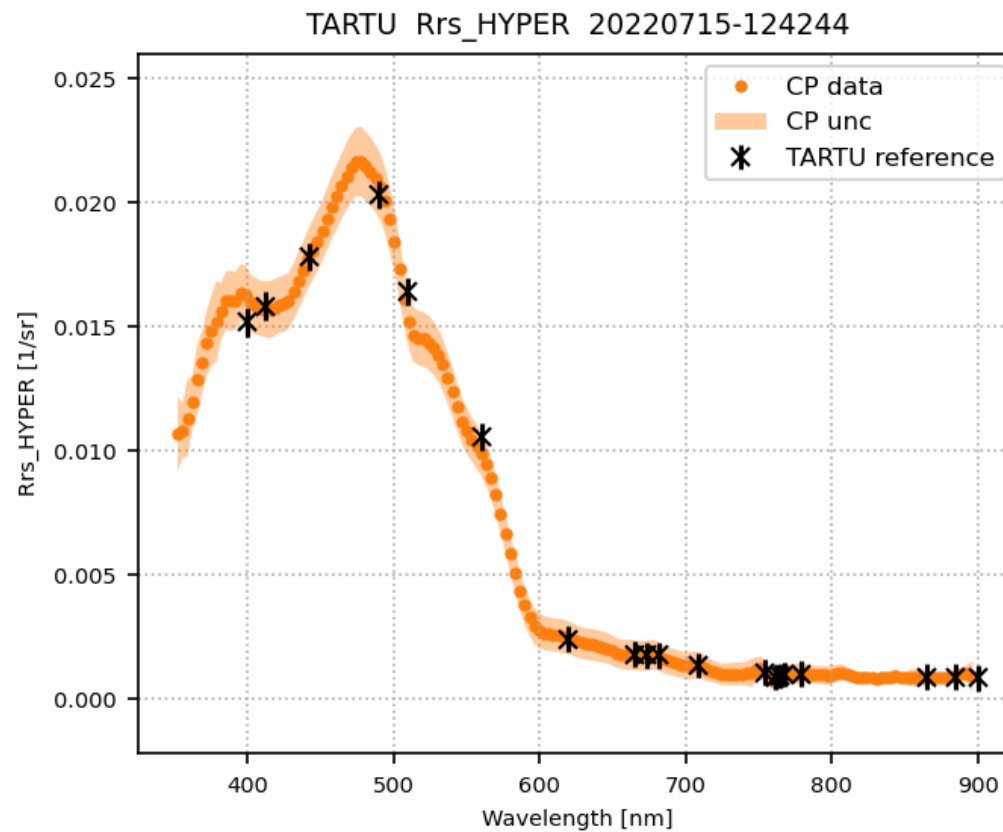
The right pane shows the 'Object Attribute Info' for the selected object. It displays the following table of attributes:

Name	Type
CAL_TYPE	String, length = 15, padding = H5T...
DATETAG_UNITS	String, length = 7, padding = H5T...
ENSEMBLE_DURATION	String, length = 7, padding = H5T...
FILE_CREATION_TIME	String, length = 20, padding = H5T...
HOME_ANGLE	String, length = 3, padding = H5T...
HYPERINSPACE	String, length = 5, padding = H5T...
In_Filepath	String, length = 158, padding = H5T...
L1AQC_DEGLITCH	String, length = 3, padding = H5T...
PROCESSING_LEVEL	String, length = 1, padding = H5T...
RAW_FILE_NAME	String, length = 537, padding = H5T...
RELATIVE_AZIMUTH_MAX	String, length = 5, padding = H5T...
RELATIVE_AZIMUTH_MIN	String, length = 4, padding = H5T...

The status bar at the bottom of the window shows the current object path: HOME_ANGLE at / [Trios_20220715T112459Z_20220715T112459Z_L2.hdf in I:\work-st\projects\startu-1281\FRM...

Very preliminary results from TARTU laboratory: TriOS acquisitions from the FICE-2 field experiment

Remote sensing reflectance processed by HyperInSPACE (in orange) and compare to TARTU reference (in black)



Data presented with the courtesy of Riho Vendt (TARTU)

Community processor developed in collaboration with NASA's HyperInSPACE processor

- It now supports TriOS RAMSES instrument, in addition to the Seabird HyperOCR device.
- It now includes an uncertainty propagation following the GUM.

**Uncertainty computation requires additional inputs for each identified contributors.
The TARTU full instrument characterization is able to provide those additional inputs.**

First tests on real field data show a good consistency with the institute processing.

Next step: Additional instrument based corrections and propagation of residual uncertainties

Thank you for listening.