EnMAP mission overview

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EnMAP Ground Segment, Processor and Calibration Segment
German Aerospace Center (DLR), Earth Observation Center, Oberpfaffenhofen

Infrared and Visible Optical Sensors (IVOS) 35
CEOS, Working Group on Calibration and Validation (WGCV)
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Federal Ministry
for Economic Affairs
and Climate Action

Outline

EnMAP mission overview:

- Mission status — Miguel Pato — Miguel.FigueiredoVazPato@dlr.de
- In-orbit calibration — David Marshall Ingram — David.Marshall@dlr.de
- Data quality control — Martin Bachmann — Martin.Bachmann@dlr.de

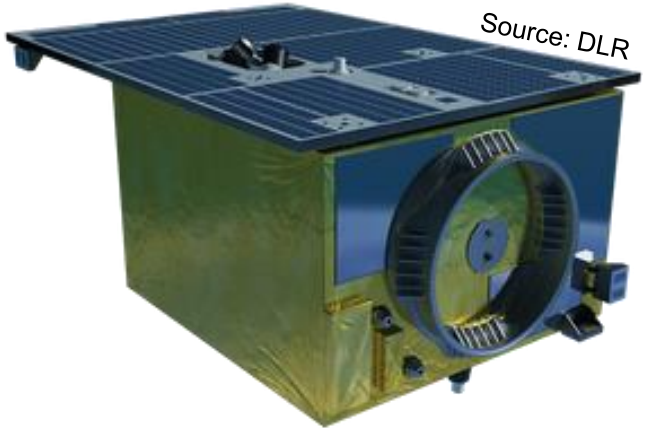
EnMAP GS manager: Emiliano Carmona

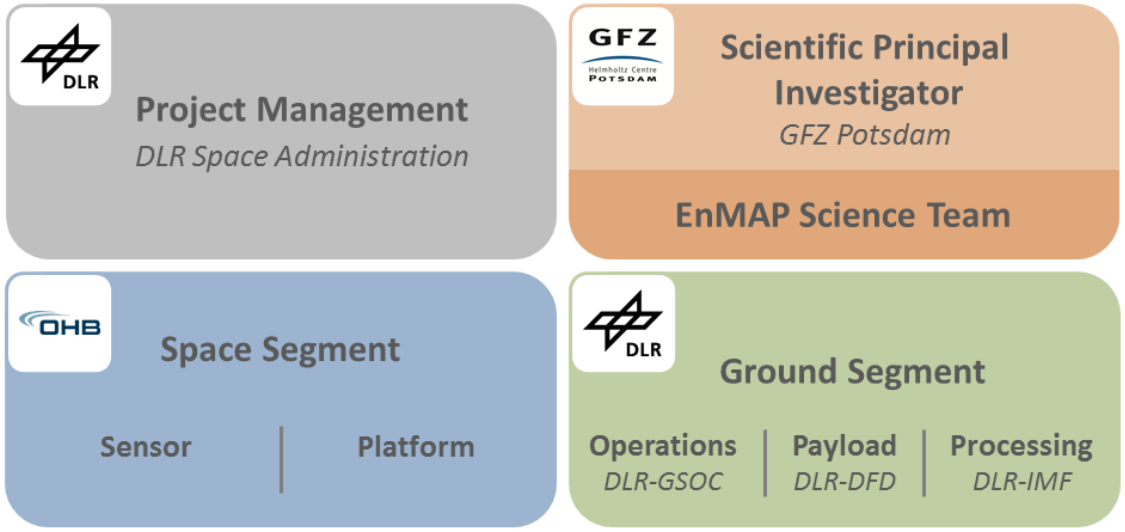
EnMAP PCV team:

- Processors — Peter Schwind, Miguel Pato (L0/L1B), Mathias Schneider (L1C), Raquel de los Reyes (L2A), Maximilian Langheinrich (L2A)
- Calibration — David Marshall Ingram, Helge Witt
- Quality control — Martin Bachmann, Martin Habermeyer, Stefanie Holzwarth, Mathias Schneider
- Instrument monitoring — Birgit Gerasch

EnMAP (Environmental Mapping and Analysis Program)

https://www.enmap.org/





- EnMAP is a German hyperspectral satellite mission that monitors and characterizes Earth's environment on a global scale.
- EnMAP measures geochemical, biochemical and biophysical variables providing information on the status and evolution of terrestrial and aquatic ecosystems.
- The mission's main objective is to provide high-quality, regional scale hyperspectral data to improve our understanding of coupled environmental processes and to assist in the sustainable management of Earth's resources.

EnMAP (Environmental Mapping and Analysis Program)

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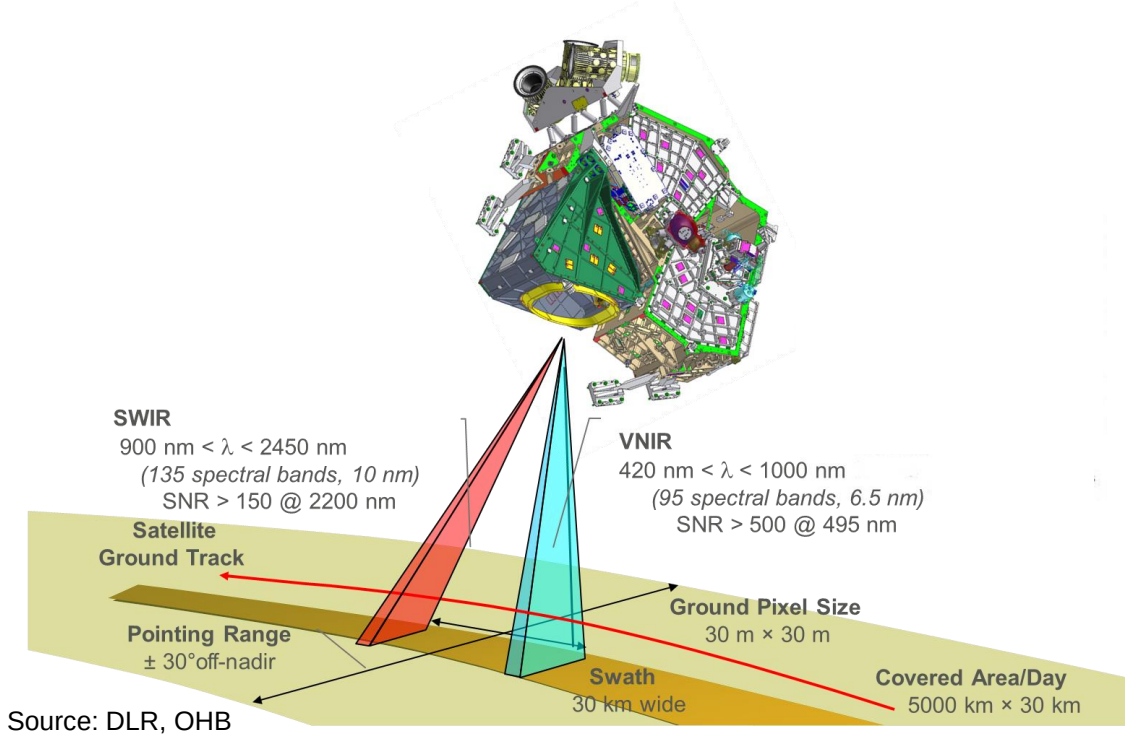
EnMAP specification	VNIR	SWIR
Spectral range	420 – 1000 nm	900 – 2445 nm
Number of spectral bands	91	133
Spectral sampling distance	6.5 nm	10 nm
Spectral full width at half maximum	6 – 11 nm	7 – 11 nm
Spectral accuracy	0.5 nm	1 nm
Radiometric accuracy	<5%	
Radiometric stability	<2.5%	
Orbit type, altitude and inclination	Sun-synchronous, 653 km, 97.96°	
Orbit period and repeat cycle	1.6 h, 398 revolutions in 27 days	
Local time descending node	11:00 h ± 18 min	
Revisit time	4 days (±30° off-nadir tilt) 21 days (±5° off-nadir tilt)	
Ground sampling distance	30 m (at nadir; sea level)	
Swath width	30 km (2.63° across track)	
Swath length	1000 km / orbit; 5000 km / day	
Product size	30 km x 30 km	

Mission fact sheet (abbreviated)

In-orbit calibration type	Mechanism	Frequency
Relative radiometric (lamp)	white spectralon	4x / month
Absolute radiometric (Sun)	Sun diffuser	1x / month
Spectral	doped spectralon	2x / month
Linearity	focal plane LEDs	1x / month
Deep space	dark sky	1x / month
Dark frames	closed shutter	before/after imaging



Source: DLR, OHB

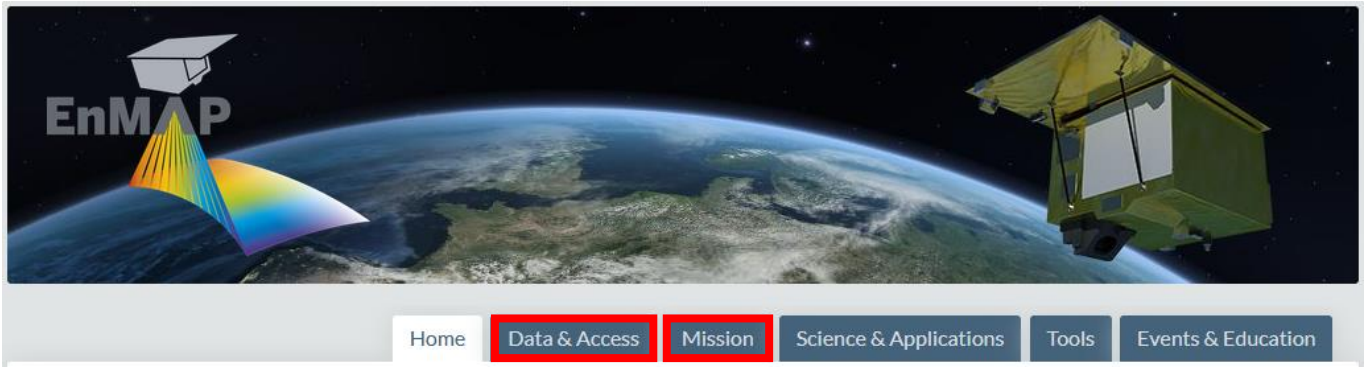
EnMAP mission status

Mission timeline:

- Launch: Apr 1, 2022
- Commissioning: Apr – Oct 2022
- Flight Qualification Review (FQR): Oct 2022
- Operations started in Nov 2022
- Mission open to global users

Useful links:

- Tasking orders and catalog browsing:
  https://planning.enmap.org/
- Mission quarterly reports:
  https://www.enmap.org/mission/
- Product specification and ATBDs:
  https://www.enmap.org/data_access/



https://www.enmap.org/

EnMAP mission status

Challenges:

▪ SWIR loop heat pipe (1 of 3) failed	→	delay of commissioning	**use as-is**
▪ Turn-off due to diffuser switch	→	outage Dec 22 – Feb 23	**solved**
▪ Acquisition conflicts over Europe	→	not all orders fulfilled	**under discussion**
▪ VNIR degradation	→	dynamic coefficients	**solved**
▪ Across-track striping	→	destriping algorithm	**solved**
▪ Geometric performance	→	reprocessing of old data	**solved**

EnMAP mission status

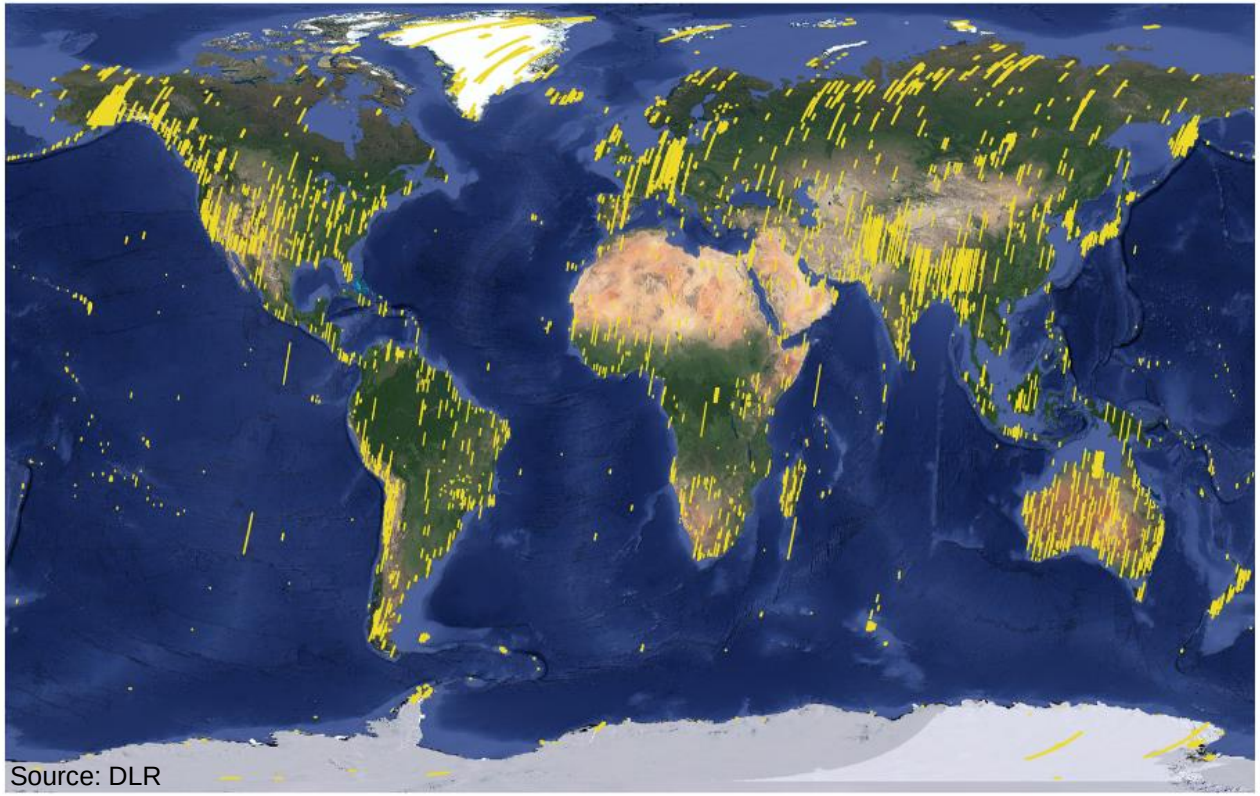
Registered users (as of 30.06.2023):

- Total: 1584
- Europe: 910 (Germany: 429)
- Asia: 228
- N America: 198

Archived data (as of 25.09.2023):

- Calibration: 147 datatakes
- Earth: 42677 tiles / 7062 datatakes
- Moon: 2

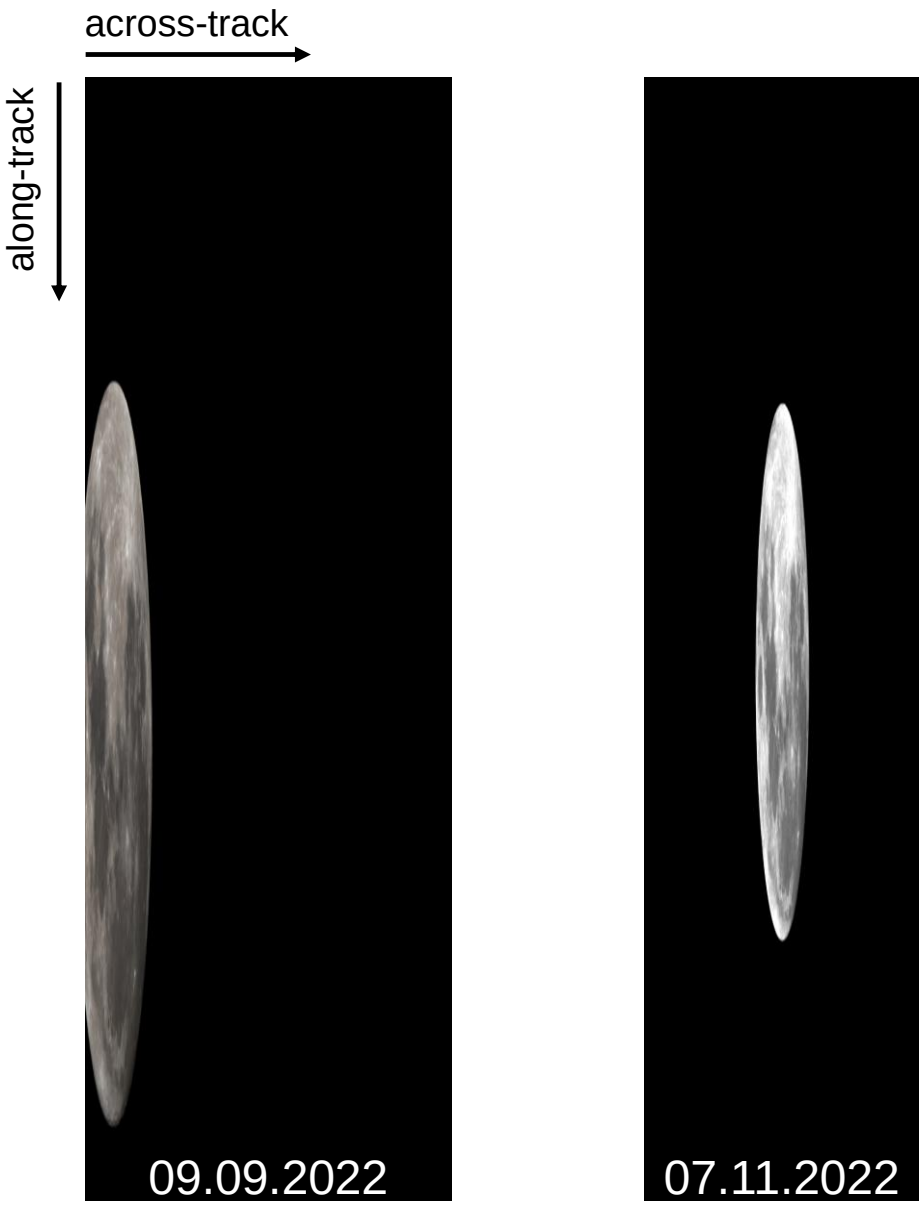
EnMAP acquisitions June 2023

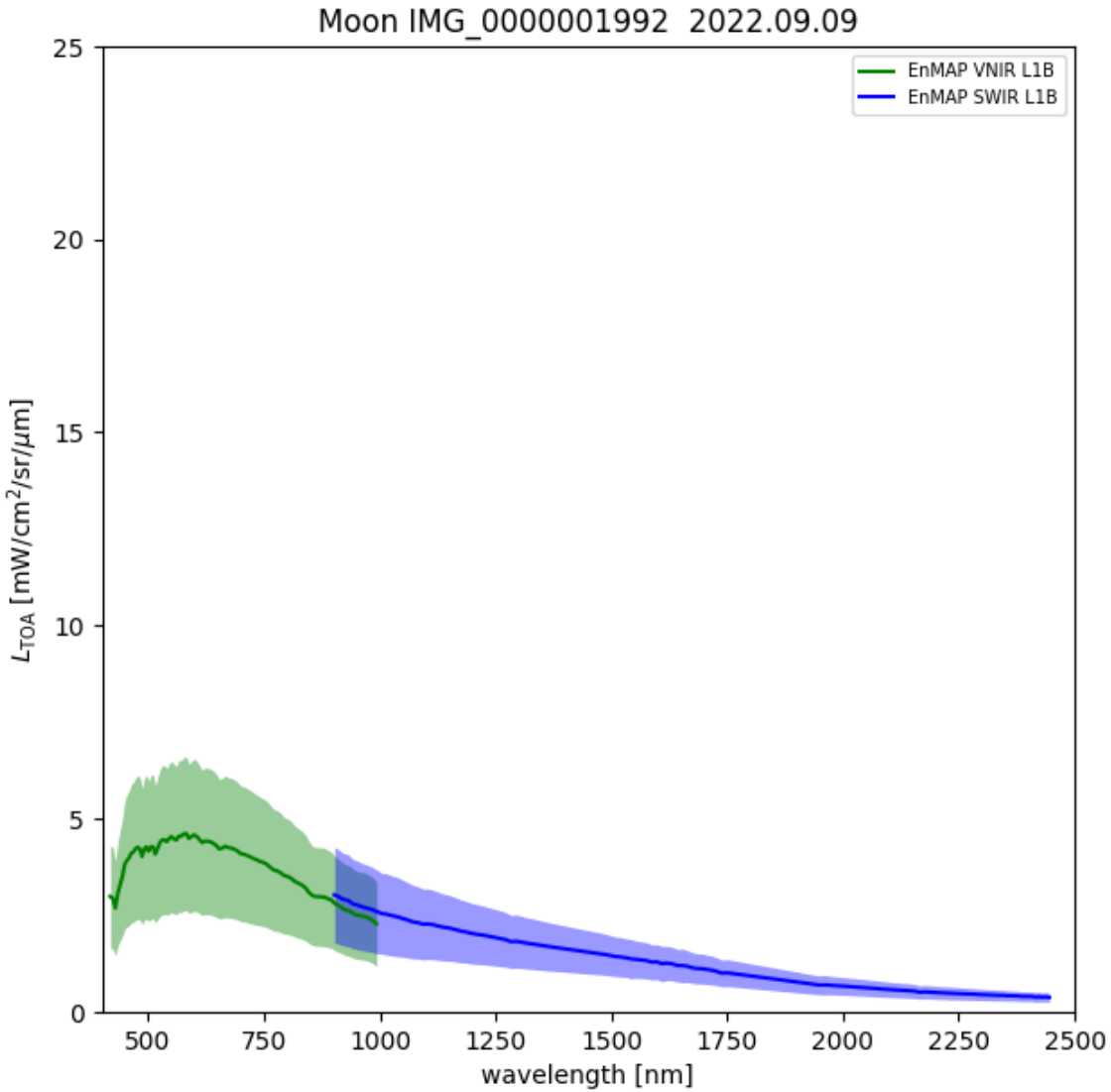


EnMAP: Moon observations

- Moon calibrations not part of EnMAP calibration procedures, but commitment to acquire two Moon observations during commissioning.
- We are considering acquiring more Moon acquisitions in the future.
- EnMAP Moon observations so far:
  - Strategy: along-track scan of the Moon with 10x oversampling in ascending orbit.
  - Dates: 09.09.2022, 07.11.2022 (both ~7° phase).
  - Pointing problem on first observation, fixed for second observation.
  - Internal products only, not distributed to users.
- Applications:
  - Straylight studies (during commissioning).
  - Check of VNIR/SWIR mismatch (during commissioning and operations).
  - On-going discussion with USGS and GFZ for comparison to ROLO model.

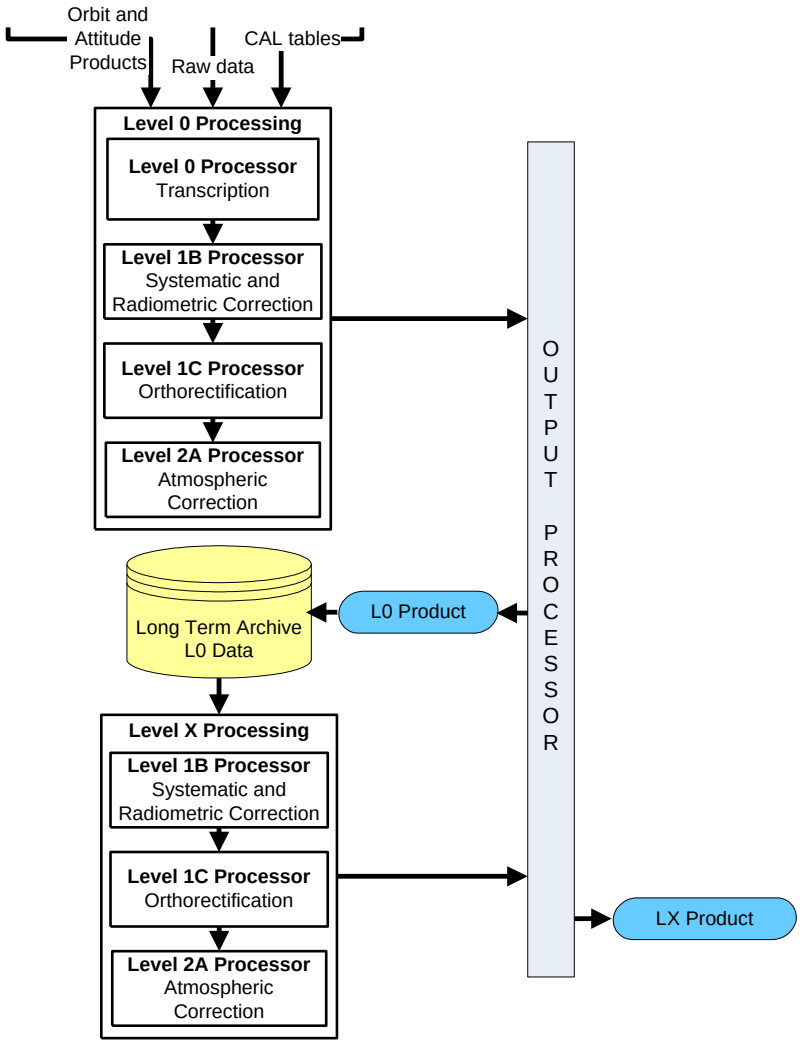
EnMAP: Moon observations





EnMAP: Processors

- A complex processing chain has been developed by the PCV team to calibrate the raw EnMAP data.
- The chain and processing algorithms are under continuous improvement.
- The following higher level EnMAP products are generated and archived:
  - L0 raw data (internal only)
  - L1B top-of-atmosphere radiances
  - L1C orthorectified top-of-atmosphere radiances
  - L2A orthorectified bottom-of-atmosphere reflectances



EnMAP: Processors

Processor improvements since FQR (Oct 2022):

- Implemented across-track destriping algorithm at L1B level for both VNIR and SWIR.
- Implemented dynamic radiometric coefficients to deal with VNIR degradation.
- Improved geolocation and VNIR/SWIR co-registration of L1C/L2A products.
- Fixed and improved L2A processing in specific cases (e.g., snow, water).
- Suported new SWIR band configuration uplinked in July 2023.

Ongoing work:

- SWIR along-track striping in bands with strong spectral slope.
- Mismatch between VNIR and SWIR in overlapping spectral range.
- Investigation of L2A scenes based on user feedback.