

Supported by:



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EnMAP Moon observations

Miguel Pato^{1,*} on behalf of the EnMAP Consortium

GSICS Lunar Calibration Subgroup
Web meeting, 13.11.2025

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OHB



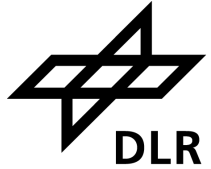
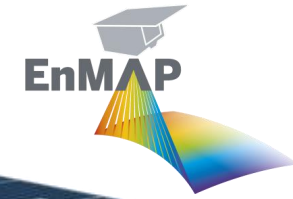
GFZ



DLR

EnMAP mission: requirements and fact sheet

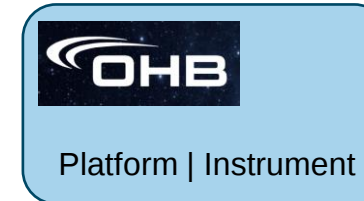
<https://www.enmap.org/>



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
Spectral stability	0.5 nm	
Spectral smile	<0.2 pix	
Signal-to-noise ratio	>500 (at 495 nm)	>150 (at 2200 nm)
Radiometric accuracy	<5%	
Radiometric stability	<2.5%	
Geometric accuracy	1 pix (30 m) with GCPs, otherwise 100 m	
VNIR/SWIR co-registration	0.2 pix	
L2AOT, WV, BOA (land, water)	see Storch et al 2023	
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	

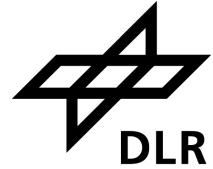
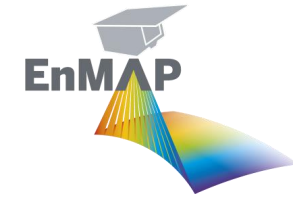


Source: DLR



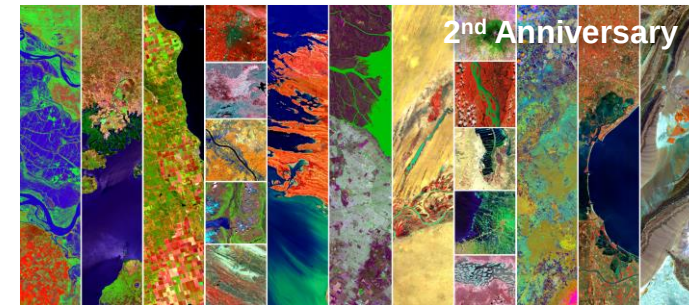
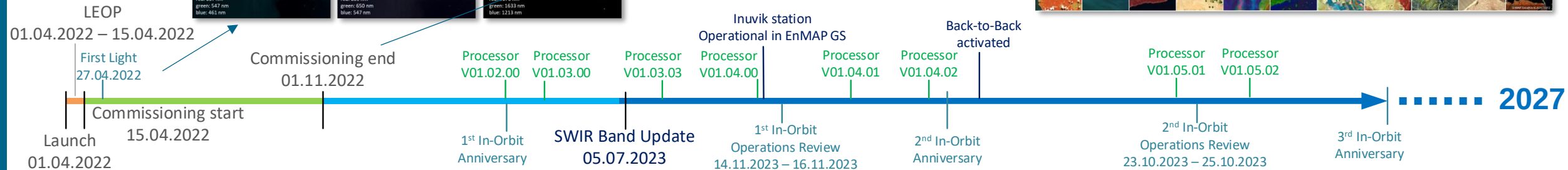
In-orbit calibration type	Mechanism	Frequency
Relative radiometric (lamp)	white spectralon	1x / week
Absolute radiometric (Sun)	Sun diffuser	1x / 2 months
Spectral	doped spectralon	1x / fortnight
Linearity	focal plane LEDs	1x / month
Deep space	dark sky	1x / month
Dark frames	closed shutter	before/after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

EnMAP mission: timeline



First EnMAP
image 27.04.2022

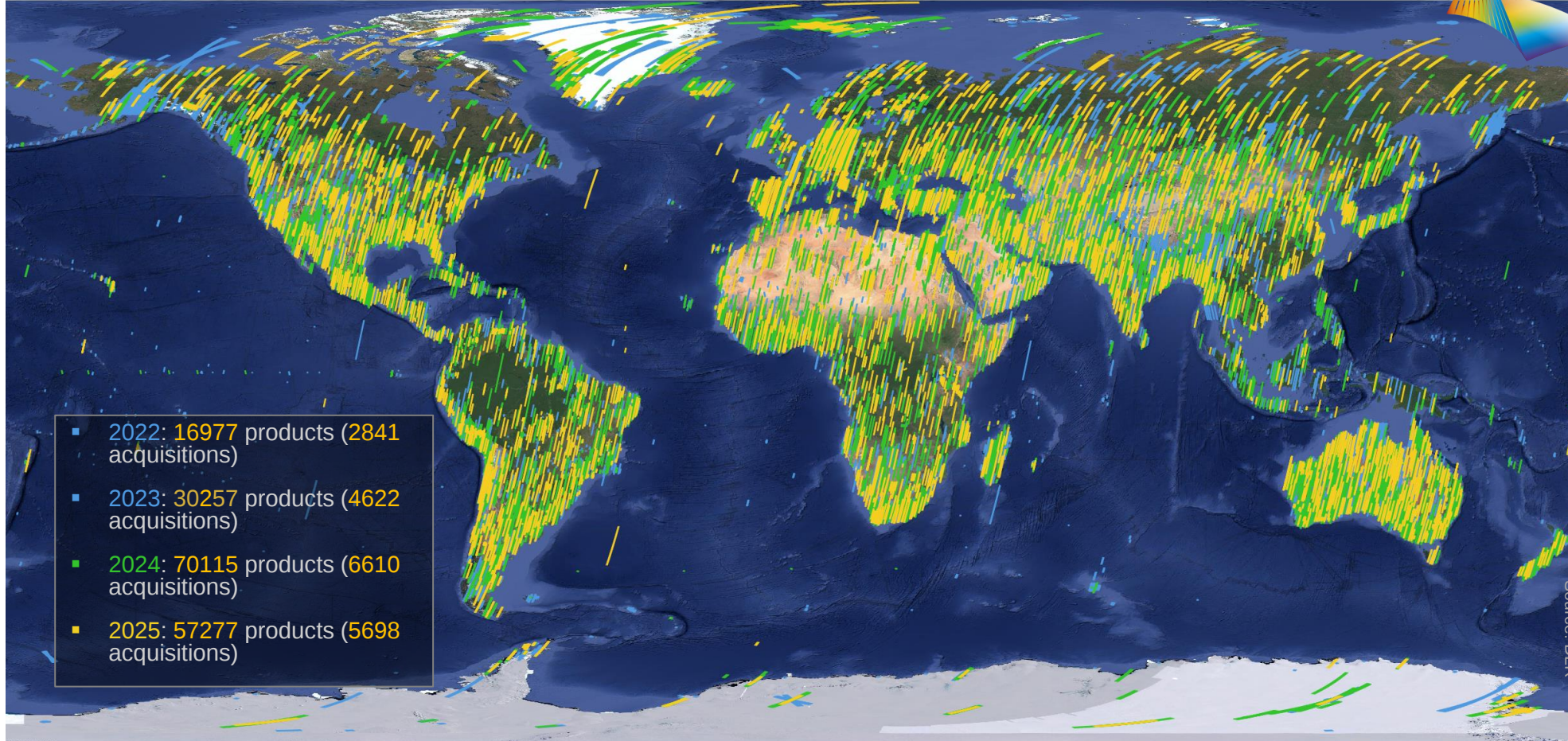
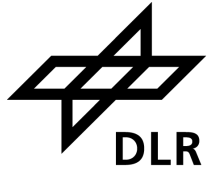
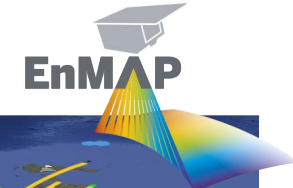
Results at the end of
commissioning phase
published in *Remote
Sensing of Environment*
294 (2023) 113632



- Nominal mission is planned for 5.5 years (until Sep 2027).
- Preparations are currently underway to request a 5-yr extension of the mission (Oct 2027 – Sep 2032). Instrument and ground systems assessments indicate no obstacles to continue operations.

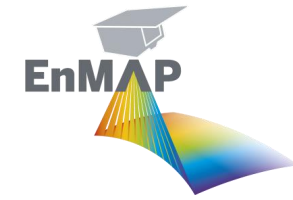
EnMAP mission: data catalog

until Q3 2025



- 19 768 Earth acquisitions
- 174 481 Earth products archived and available for ordering
- 327 Calibrations (Sun, Deep Space, Lamp, Spectral, Linearity) and 10 Moon Observations

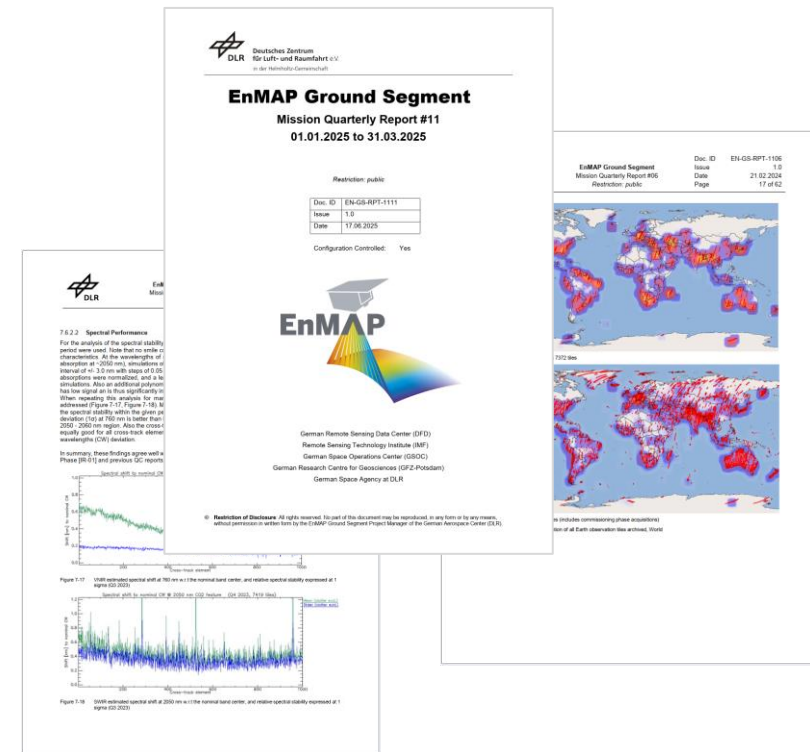
EnMAP mission: information and data access



- News concerning operations published at the EnMAP Website

- Tutorials, ATBDs, FAQs, Ground Tracks, Example Data, MQRs, FG Mission, etc.

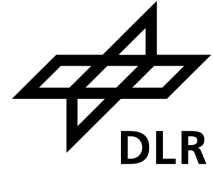
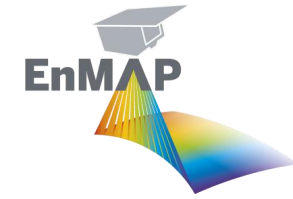
- Mission Quarterly Reports (MQRs) with detailed information about the mission status, calibration and data quality



- All information available at www.enmap.org



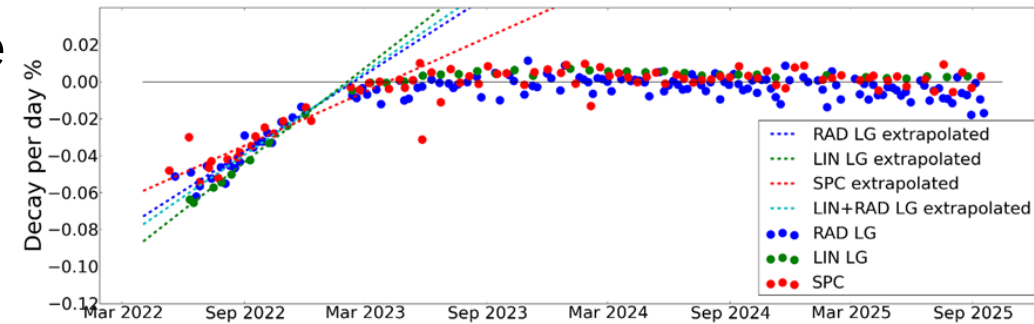
Radiometric performance



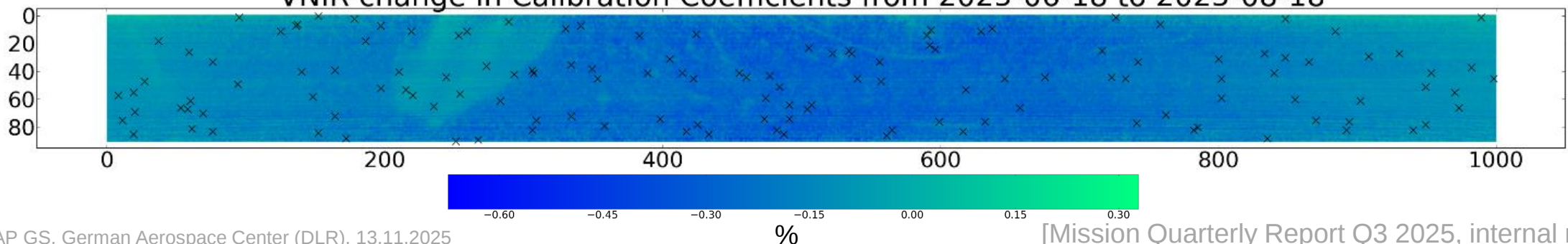
Highlight: Continuous monitoring of sensor performance with regular in-orbit calibration

Actions / results:

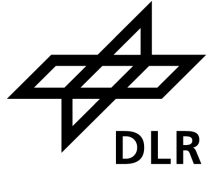
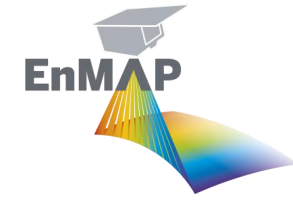
- Fast VNIR degradation observed during first year slowed down by Mar 2023 but with differences across focal plane.
- VNIR changes are offset by regular absolute calibrations (as per design).
- SWIR sensor is very stable since launch.
- Dark signal is remarkably stable since launch.



VNIR change in Calibration Coefficients from 2025-06-18 to 2025-08-18



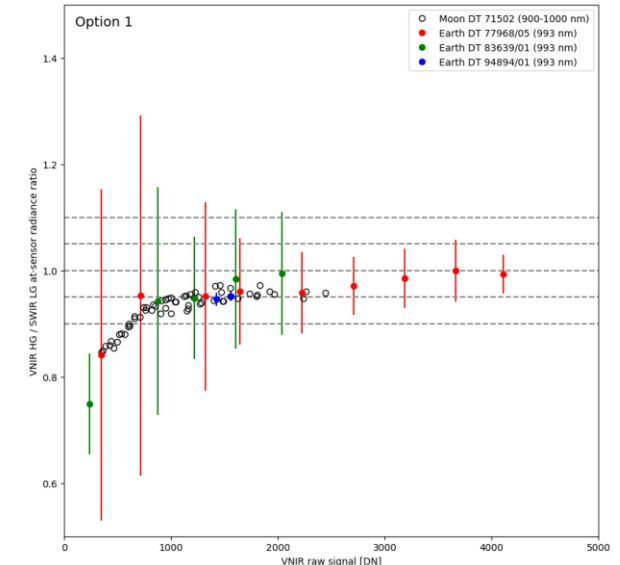
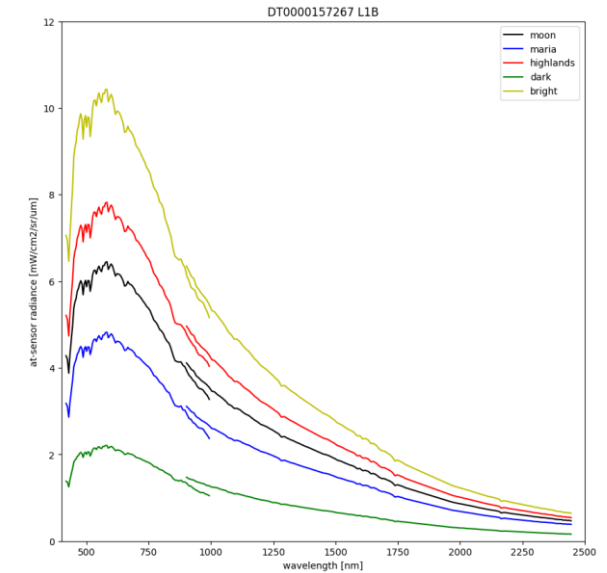
Radiometric performance



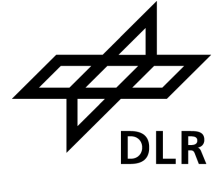
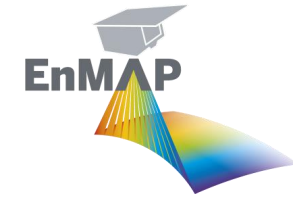
Highlight: Continuous monitoring of sensor performance with regular in-orbit calibration

Actions / results:

- VNIR/SWIR mismatch at 900–1000 nm is especially strong at low signals, but also present at large signals.
- Root cause not identified, but likely related to imperfect VNIR non-linearity correction and unidentified inconsistency between Sun calibration and Earth scenes.
- Intensive effort dedicated to solve issue, but all calibration-based solutions are only partially successful.
- Correction proposal being consolidated based on Earth and Moon validation results. Calibration update is expected in the coming quarters.



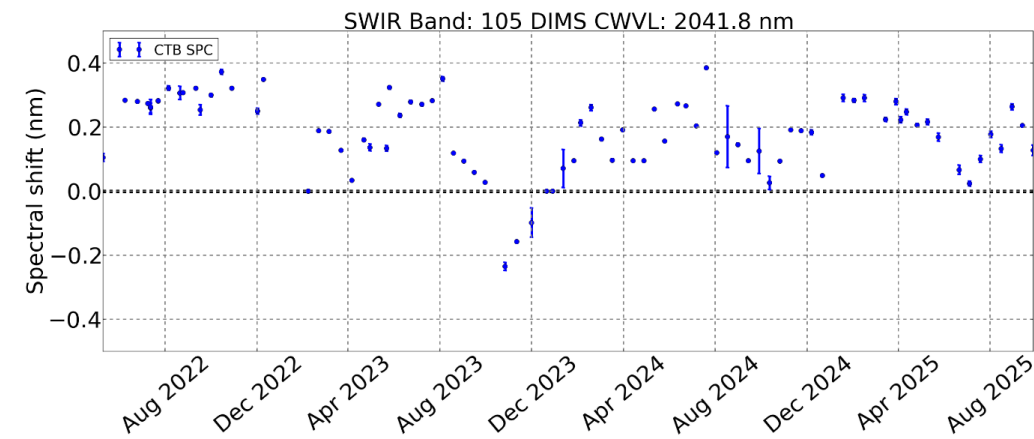
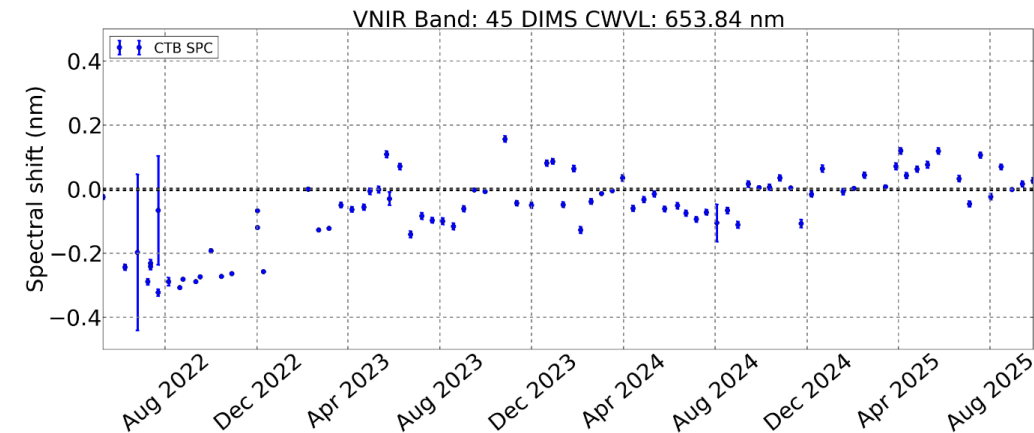
Spectral performance



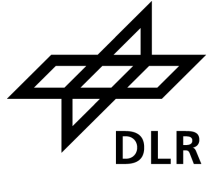
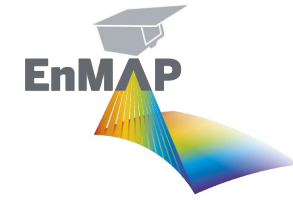
Highlight: Good spectral stability since beginning of mission

Actions / results:

- Spectral updates are performed whenever shifts above 0.5 nm are detected in spectral calibration.
- After a few updates during commissioning, the last spectral update is from Feb 2023.
- Spectral stability since last update is better than 0.2 nm for VNIR and 0.4 nm for SWIR.
- Vicarious spectral checks at 760 nm and 2050 nm performed quarterly.

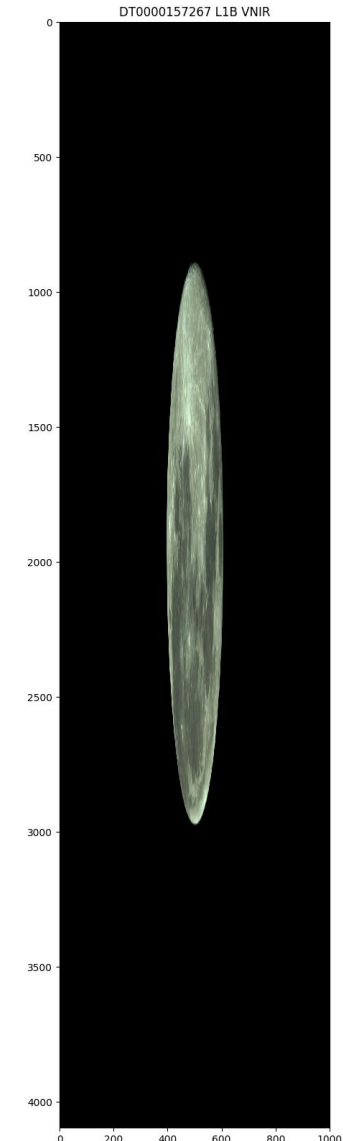


EnMAP Moon observations

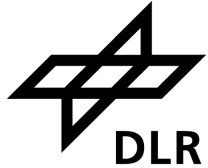
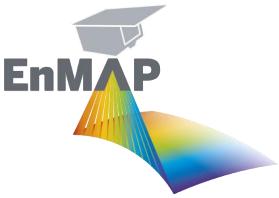


- Moon observations are not part of EnMAP routine operations, but they are useful for calibration and dedicated Cal/Val studies.
- Ten Moon observations acquired and commitment to observe every two months. Next: early Dec 2025.
- Imaging strategy:
 - along-track scan of Moon with 10x oversampling
 - Earth observation mode used (not all SWIR bands transmitted, see below)
- Spectral data:
 - VNIR: 418–993 nm, 91 bands, SSD 5–8 nm, FWHM 6–11 nm
 - SWIR: 902–2445 nm, 133 bands, SSD 7.5–12 nm, FWHM 7–11 nm

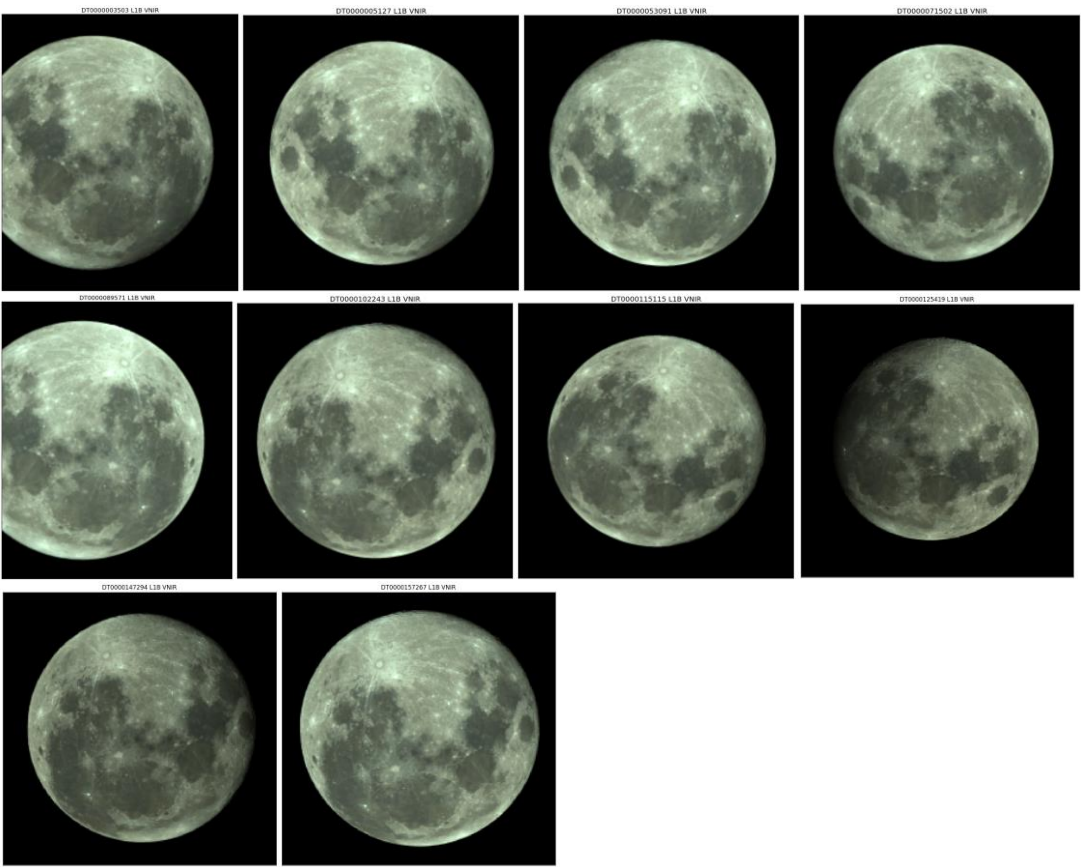
spectral gaps: 1391–1461 nm, 1760–1939 nm (<05.07.2023)
1391–1449 nm, 1780–1968 nm (>=05.07.2023)



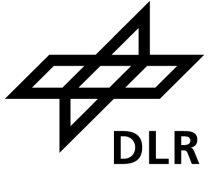
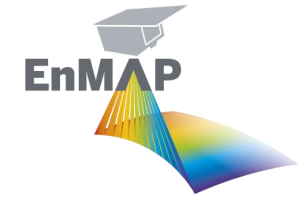
EnMAP Moon observations



Datatake ID	Date	Number of tiles*	Approximate lunar phase [°]
3503	09.09.2022	3	-8.2
5127	07.11.2022	4	-6.2
53091	27.11.2023	12	5.6
71502	24.04.2024	4	6.8
89571	19.08.2024	4	3.4
102243	16.11.2024	4	7.7
115115	13.02.2025	4	10.7
125419	10.04.2025	4	-23.0
147294	10.08.2025	4	15.4
157267	07.10.2025	4	7.4

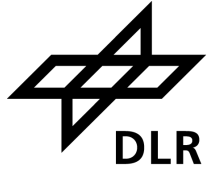
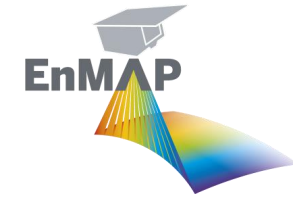


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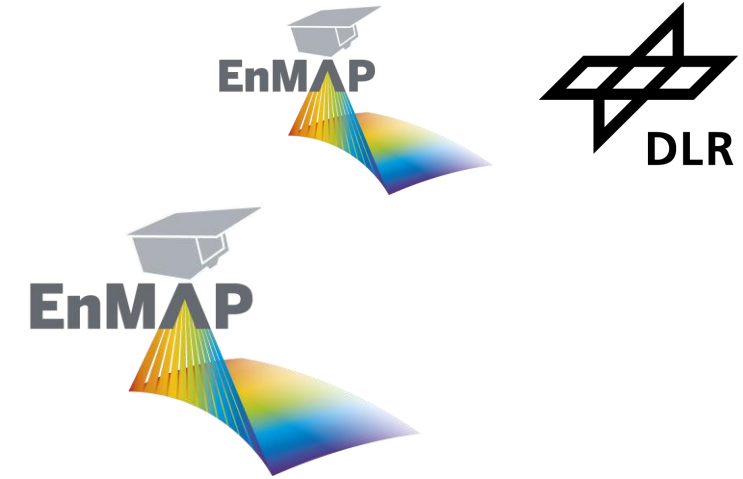
Note: Preliminary Moon results omitted since they are not yet published.

Outlook



- After more than 3.5 years in space, EnMAP is in a mature phase with deep knowledge of instrument performance.
- All in-orbit calibration facilities and both VNIR and SWIR instruments working nominally and stable.
- Five-year mission extension (Oct 2027 – Sep 2032) currently being considered.
- Moon observations routinely performed every two months and analysed offline in a best-effort basis.
- There are no plans to make EnMAP Moon data public.

Acknowledgements



This research was supported by the DLR Space Agency with funds of the German Federal Ministry of Economic Affairs and Climate Action on the basis of a decision by the German Bundestag (50 EE 0850, 50 EE 1923 and 50 EE 2108).

Useful links:

- Tasking orders and catalog browsing:
<https://planning.enmap.org/>
- Mission quarterly reports:
<https://www.enmap.org/mission/>
- ICDs, ATBDs, FAQ, change log:
https://www.enmap.org/data_access/

<https://www.enmap.org/>

