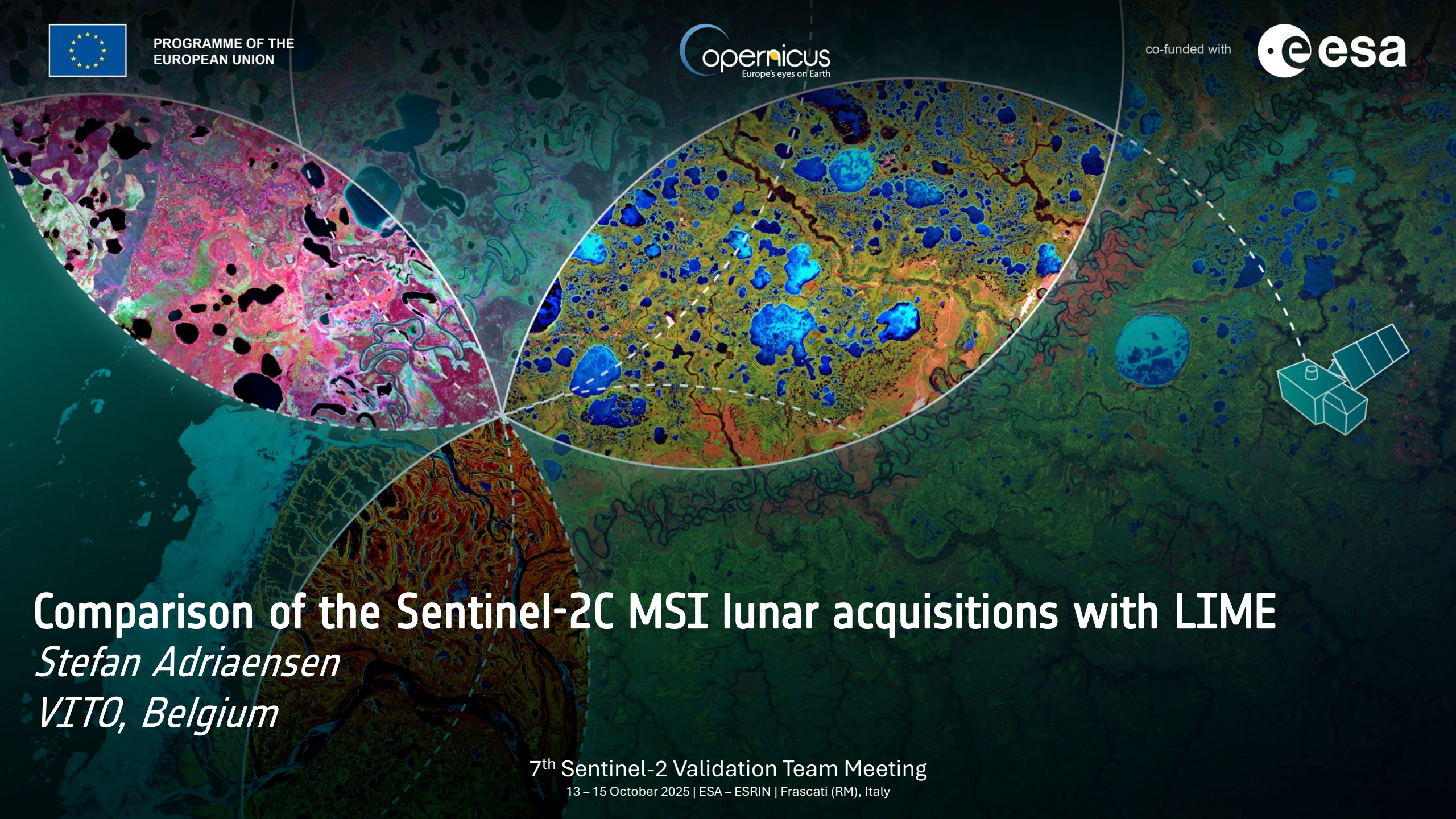


Comparison of the Sentinel-2C MSI lunar acquisitions with LIME

Stefan Adriaensen
VITO, Belgium

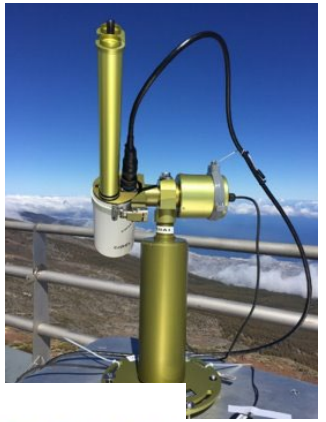
7th Sentinel-2 Validation Team Meeting
13 – 15 October 2025 | ESA – ESRIN | Frascati (RM), Italy

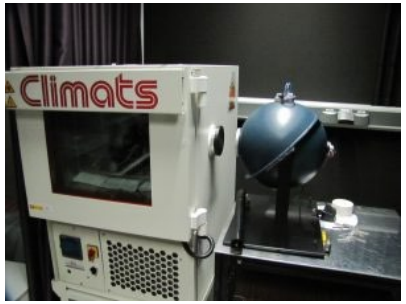
Outline

- LIME model
- Current processing baseline
  - Assumptions
  - Workflow
  - Solid angle grid
- Comparison S2C
  - Spectral
  - Temporal
  - Phase

LIME model development

- Lunar photometer (modified CIMEL AERONET instrument CE318-TP9):
  440, 500, 550, 675, 780, 870, 935, 1020, 1640 nm
- Polarimetric measurements (through polariser filters)
- Calibrated at NPL in absolute irradiance responsivity
- Additional characterization: reference plane location, linearity, temperature dependence, spectral response function.
- Data collection: about 500 clear nights since 2018 from Pico Teide / Izana observatory in Tenerife (Spain)
- Measurement principle: Langley plot





LIME model development

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OPT-MPC

- Measurements of the exo atmospheric lunar irradiance with CIMEL instrument :
  - 440, 500, 550, 675, 780, 870, 935, 1020, 1640 nm
- Include CIMEL channel around 2µm to expand model spectrally
- 2 ASD measurement campaigns to replace internal reflectance model
- DoLP and AoLP model developments
- LIME TBX is available, update to be released
  - Optimization speed (uncertainties)
  - Spectral plots

Irradiance Measurement

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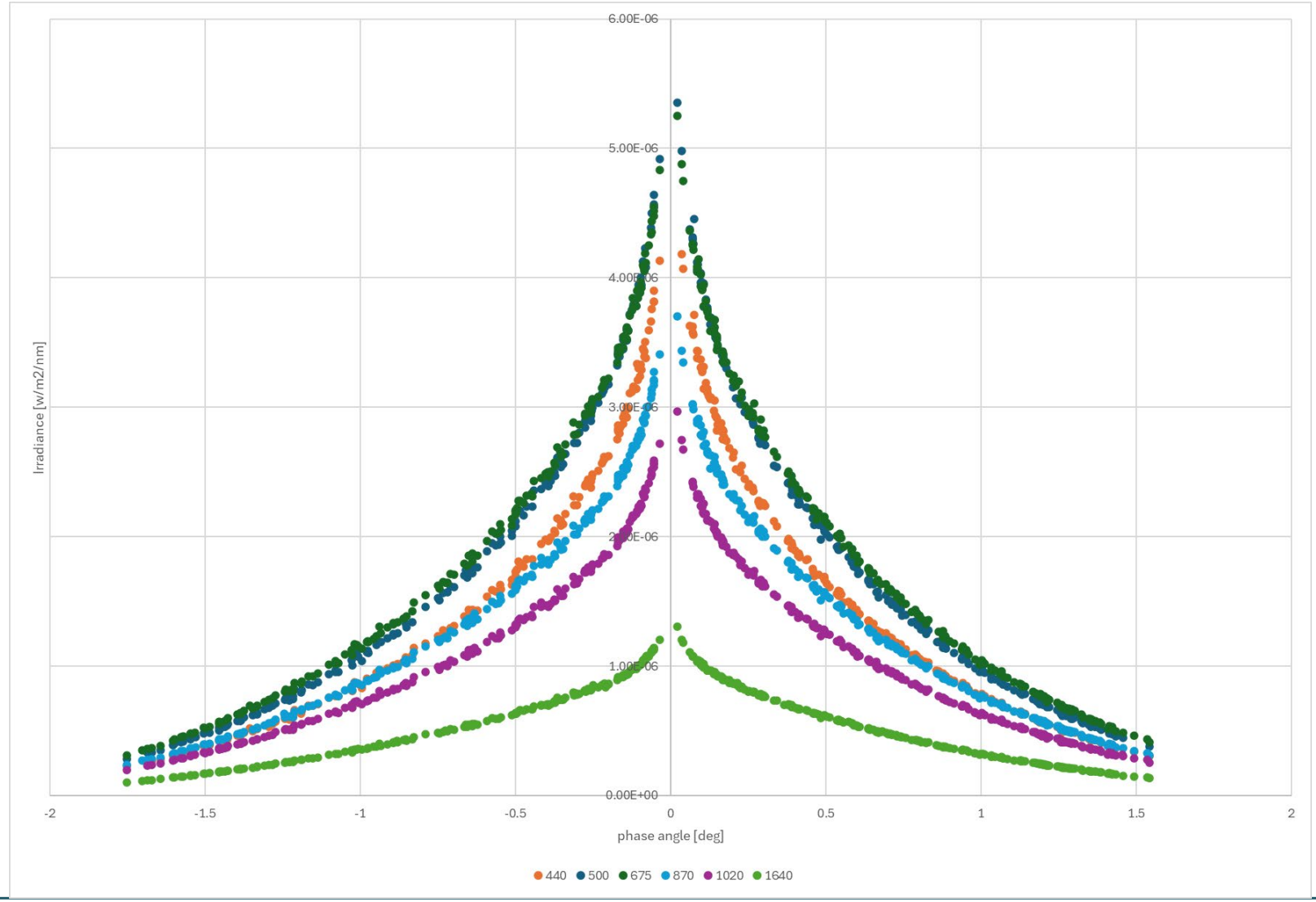
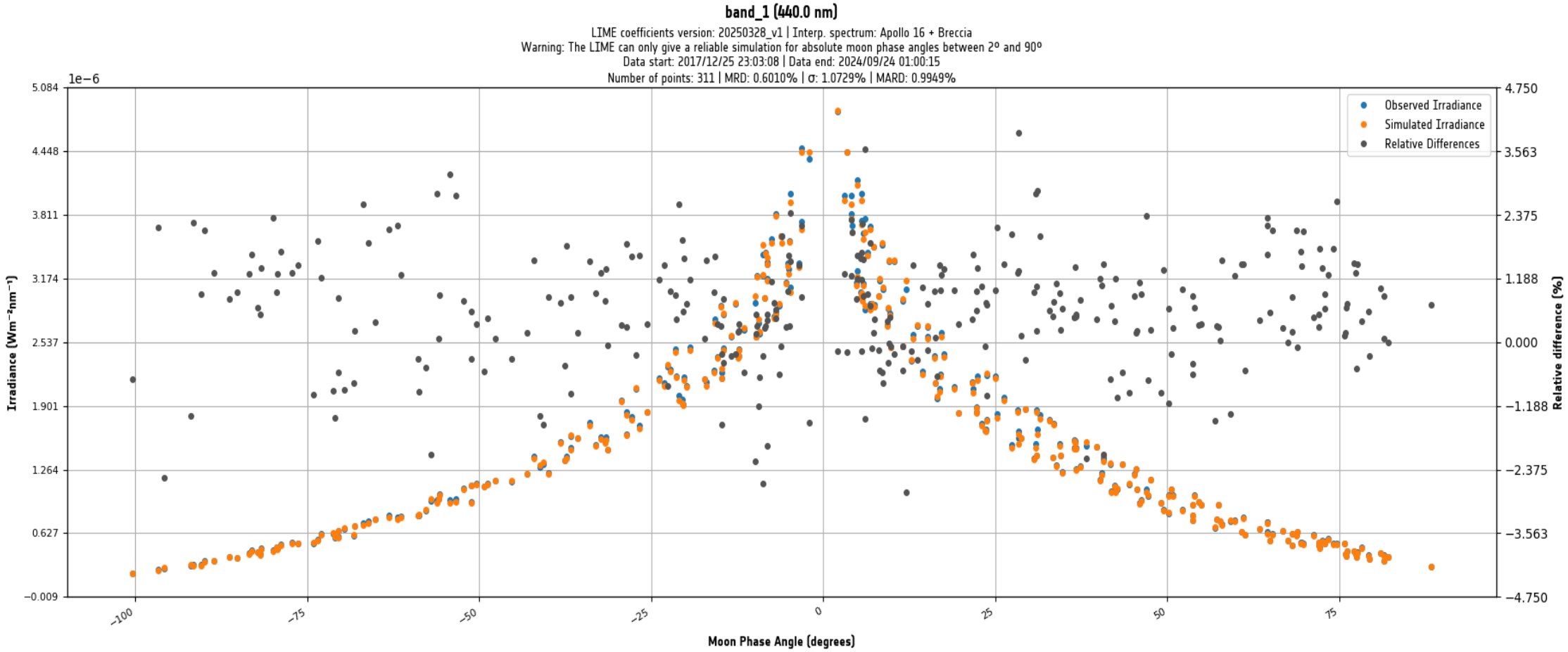


Residuals measurement/model

OPT-MPC
n Performance Cluster



Residuals measurement/model

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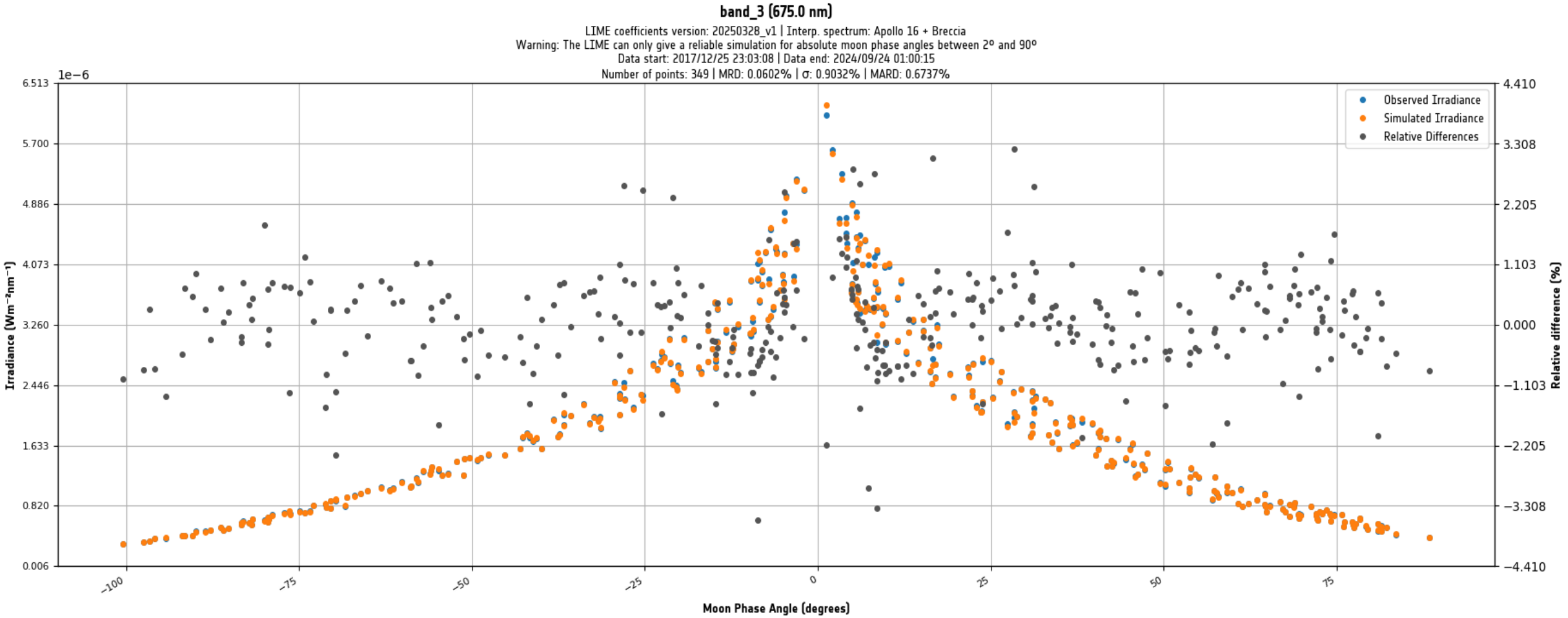
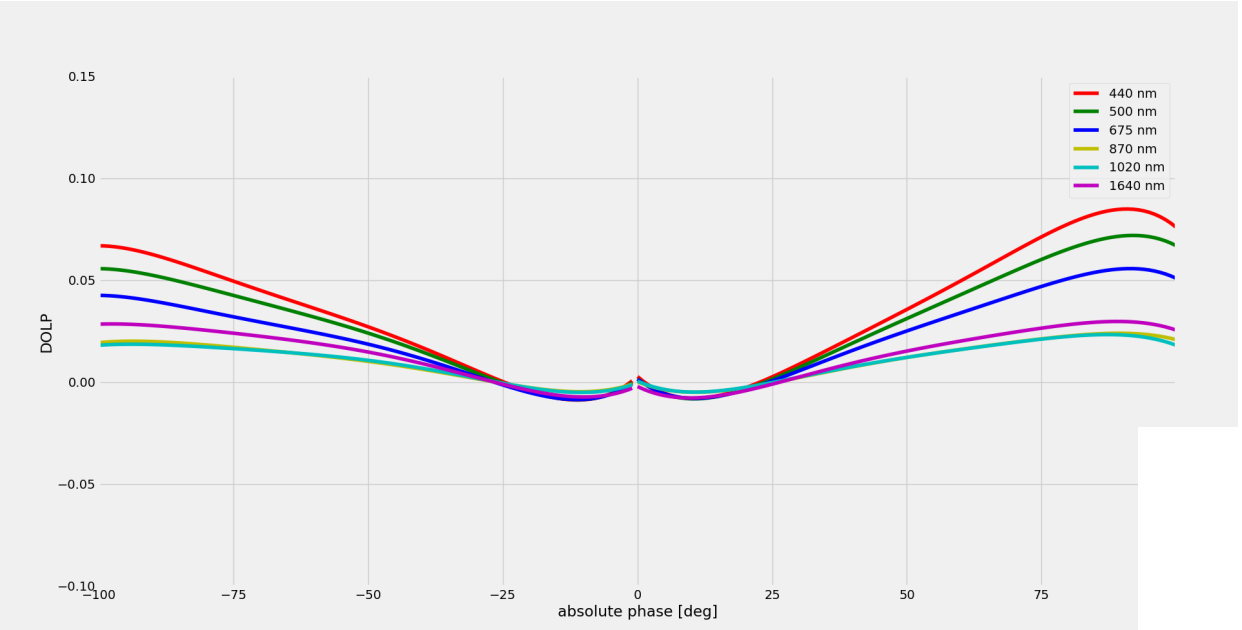
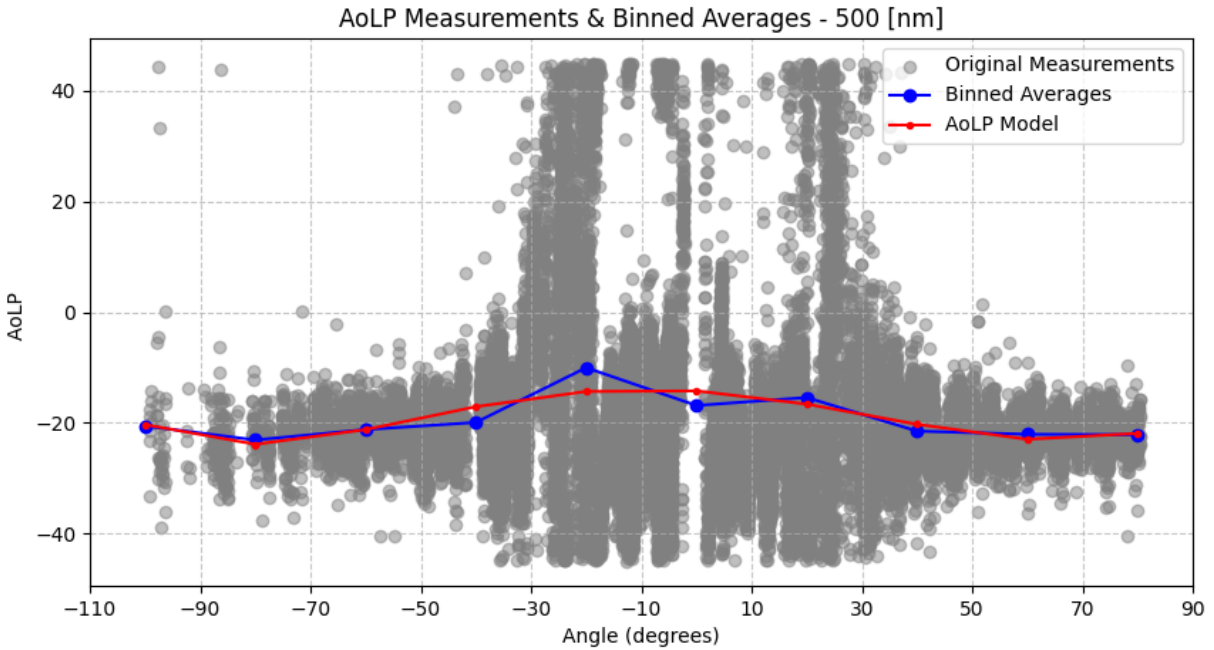
OPT-MPC



DoLP and AoLP





Comparison S2C lunar acquisitions to LIME

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OPT-MPC Optical Mission Performance Cluster

Commissioning phase + operational

#	Timestamp	Filename
1	20240920T065101	S2C_OPER_PRD_MSIL1B_PDMC_20250826T072634_R076_V20240920T065101_20240920T065253.SAFE
2	20241118T071929	S2C_OPER_PRD_MSIL1B_PDMC_20250624T101649_R092_V20241118T071929_20241118T072121.SAFE
3	20241216T232438	S2C_OPER_PRD_MSIL1B_PDMC_20250623T141202_R073_V20241216T232438_20241216T232630.SAFE
4	20250318T001453	S2C_OPER_PRD_MSIL1B_PDMC_20250623T171113_R087_V20250318T001453_20250318T001645.SAFE
5	20250417T001047	S2C_OPER_PRD_MSIL1B_PDMC_20250623T140359_R087_V20250417T001047_20250417T001239.SAFE
6	20250516T154550	S2C_OPER_PRD_MSIL1B_PDMC_20250623T174420_R082_V20250516T154550_20250516T154742.SAFE
7	20250614T161833	S2C_OPER_PRD_MSIL1B_PDMC_20250623T160825_R068_V20250614T161833_20250614T162025.SAFE
8	20250812T083629	S2C_OPER_PRD_MSIL1B_PDMC_20250813T072137_R049_V20250812T083629_20250812T083821.SAFE
9	20250910T022904	S2C_OPER_PRD_MSIL1B_PDMC_20250911T050604_R032_V20250910T022904_20250910T023052.SAFE

vito

Assumptions

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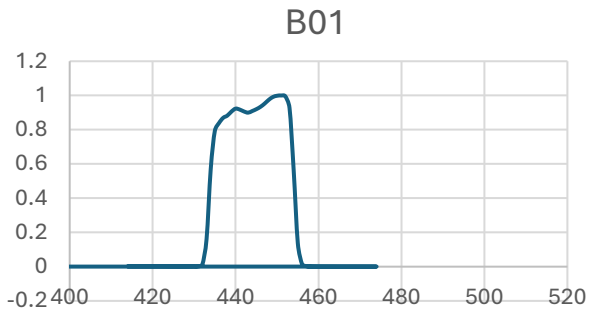
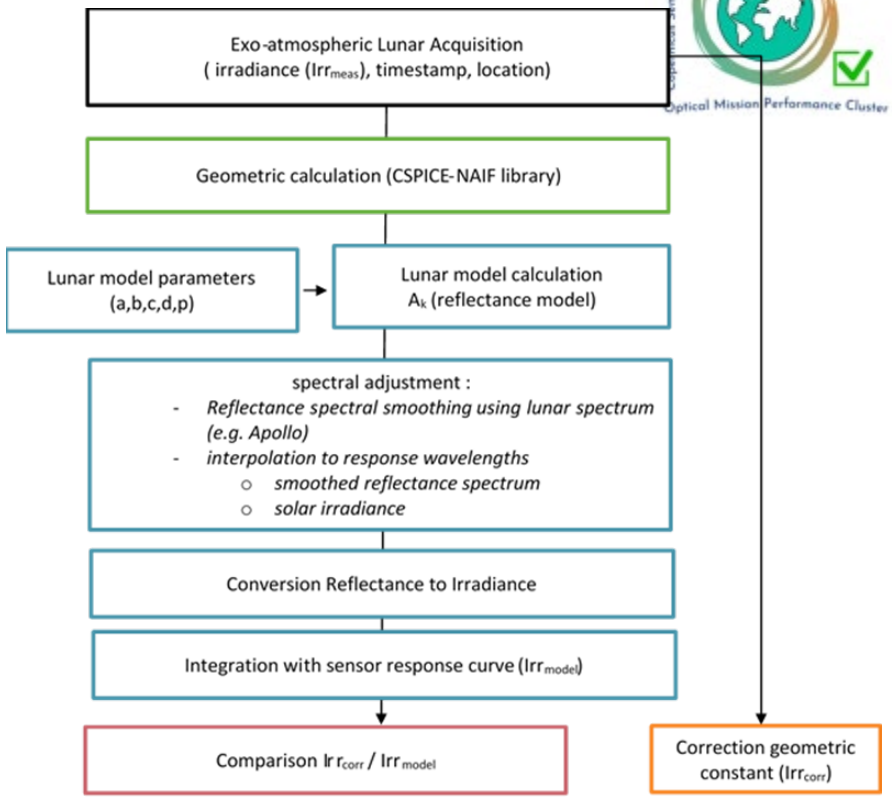
- Moon center timestamp from product xml : per band
  <Center_UTC_Time>2024-12-16T23:25:23.825Z</Center_UTC_Time>
- Satellite Position taken from product xml
- Attitude omitted
- OSF : image based -> not used in processing
- Solid Angle grid :
  Taken from product

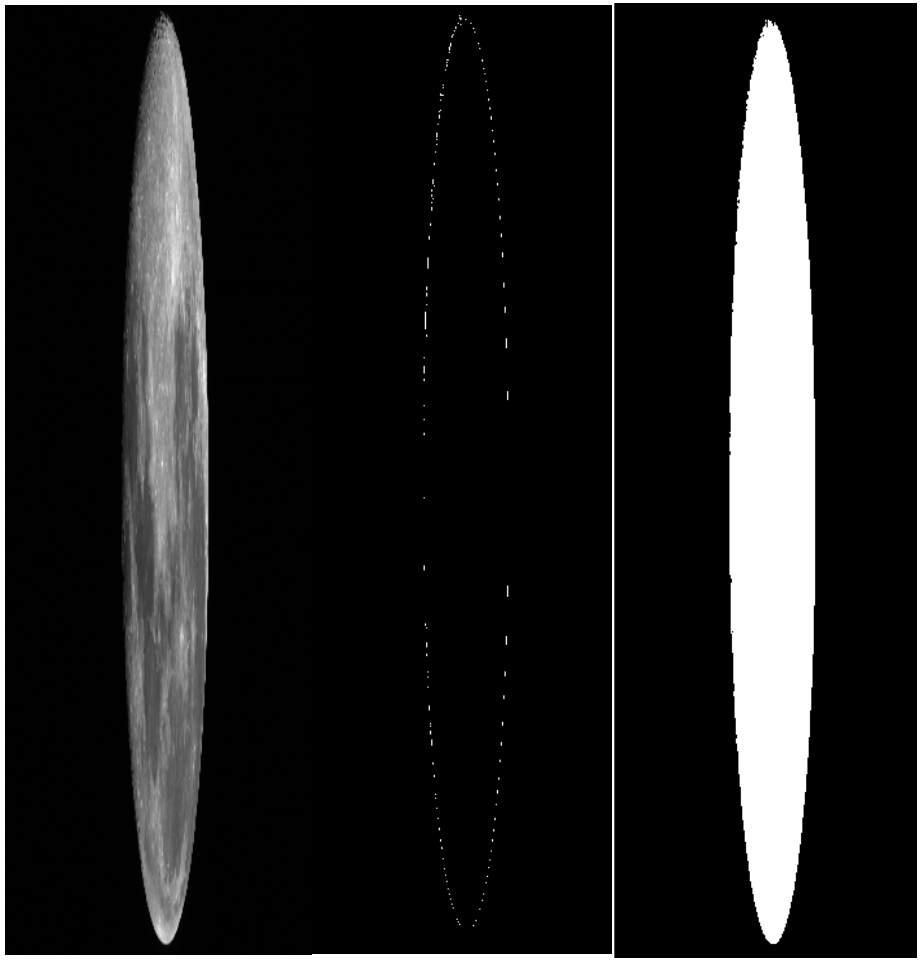
Assumptions

- Average response from product
- used TSIS :
  - TSIS applied to derive LIME model reflectance coefficients
  - Use same Irradiance model to go to irriadiance
  - Radiance level from CIMEL instrument





Title



Product extraction

Moon detection Camera

channel

Radiance image reconstruction

Solid angle image reconstruction

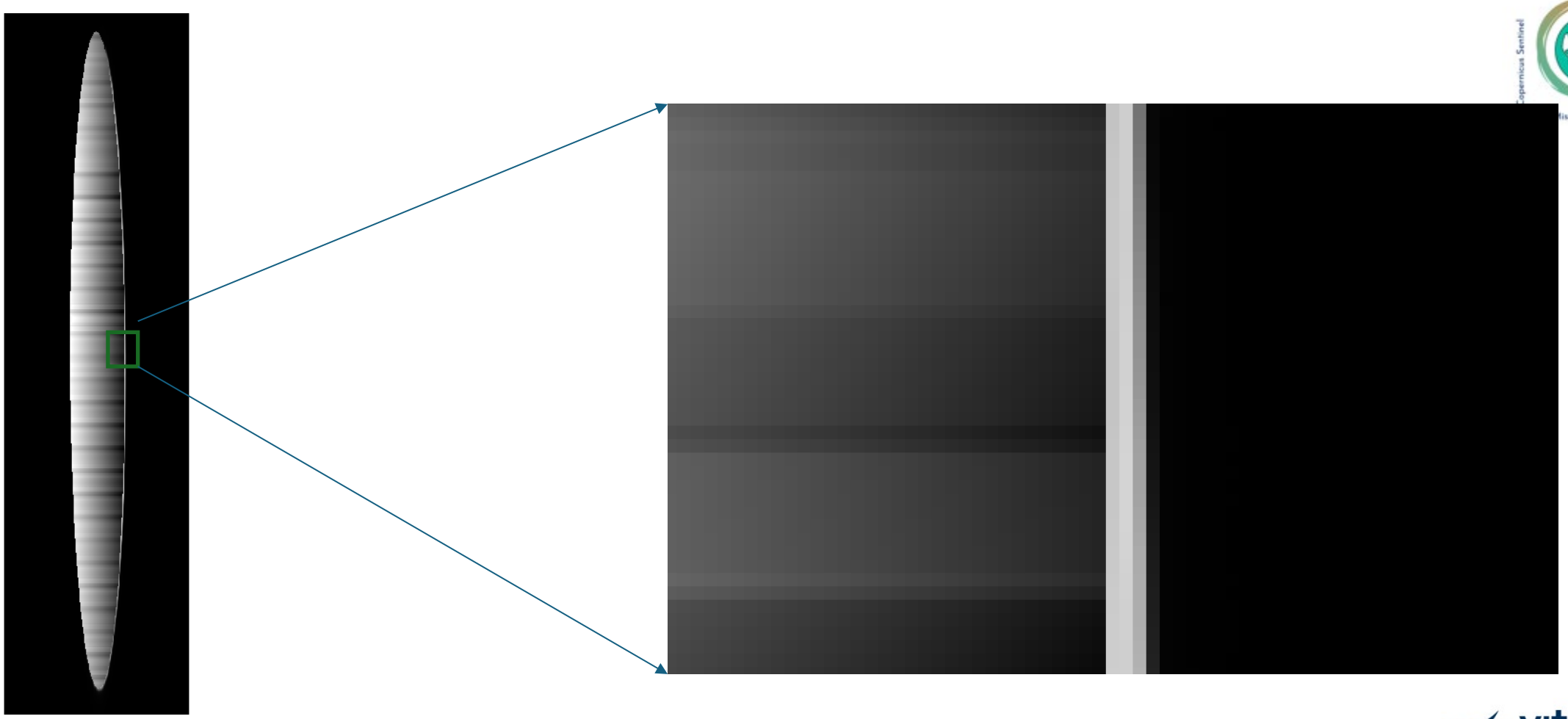
Moon masking and integration

Navatt location

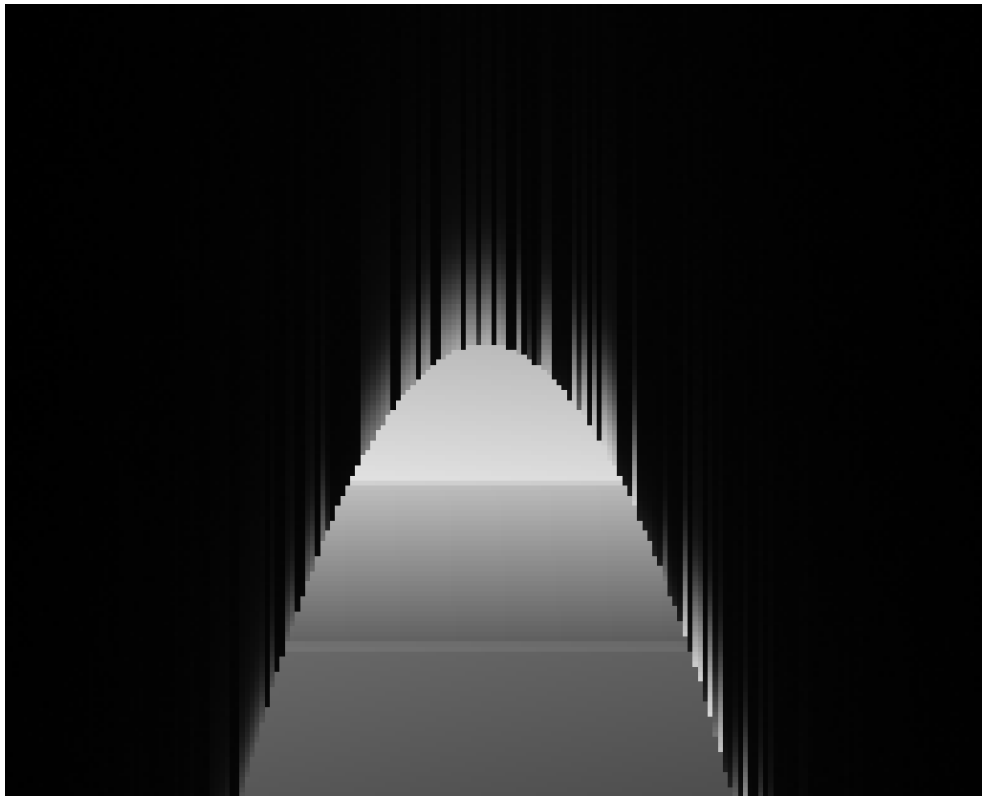
Run LIME

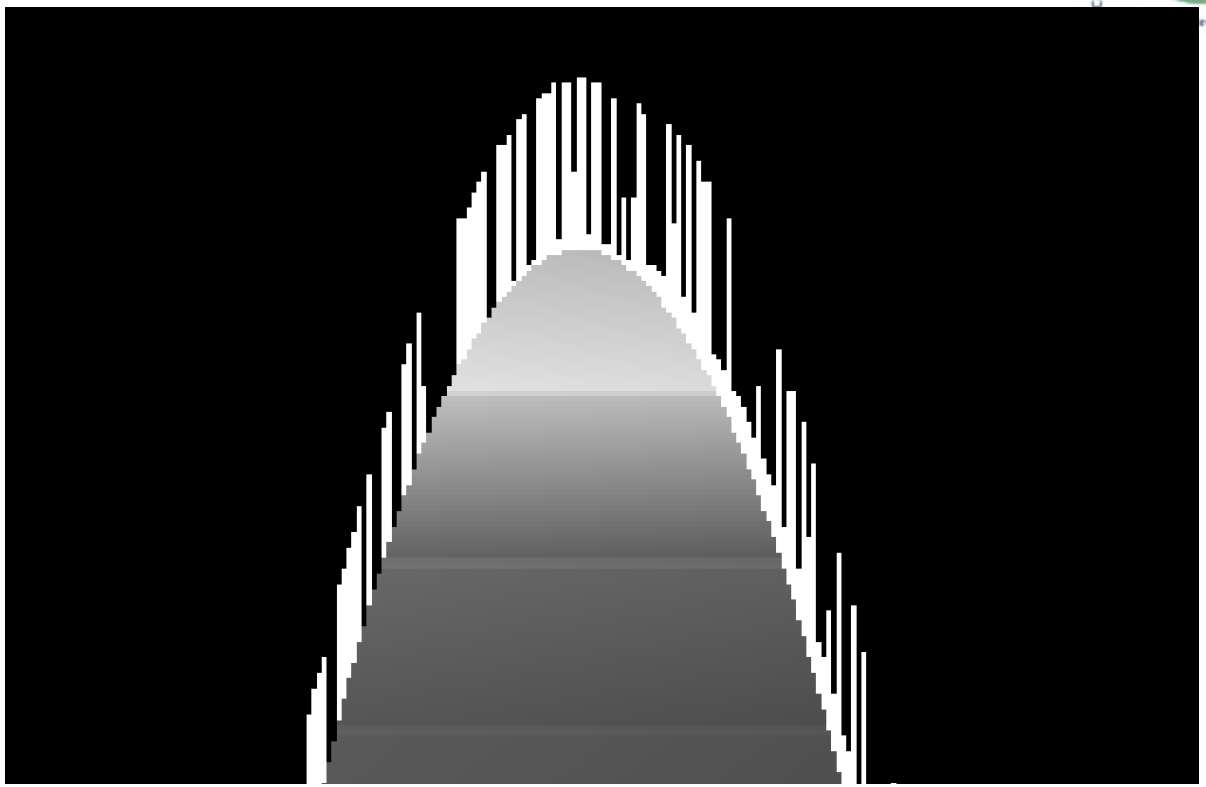
Comparison

Alignment of the solid angle grid B10

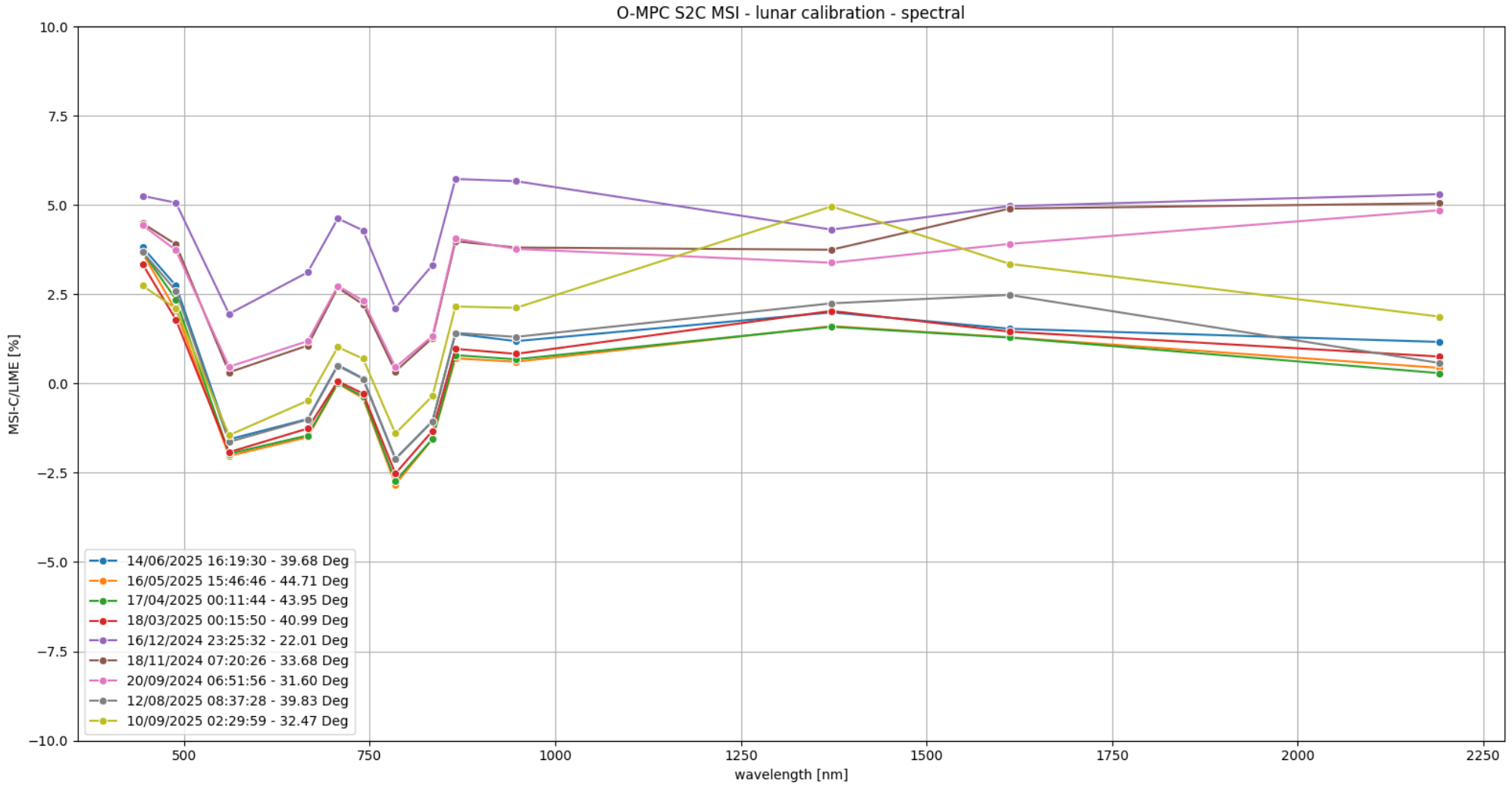


Masking / solid angle – swir bands

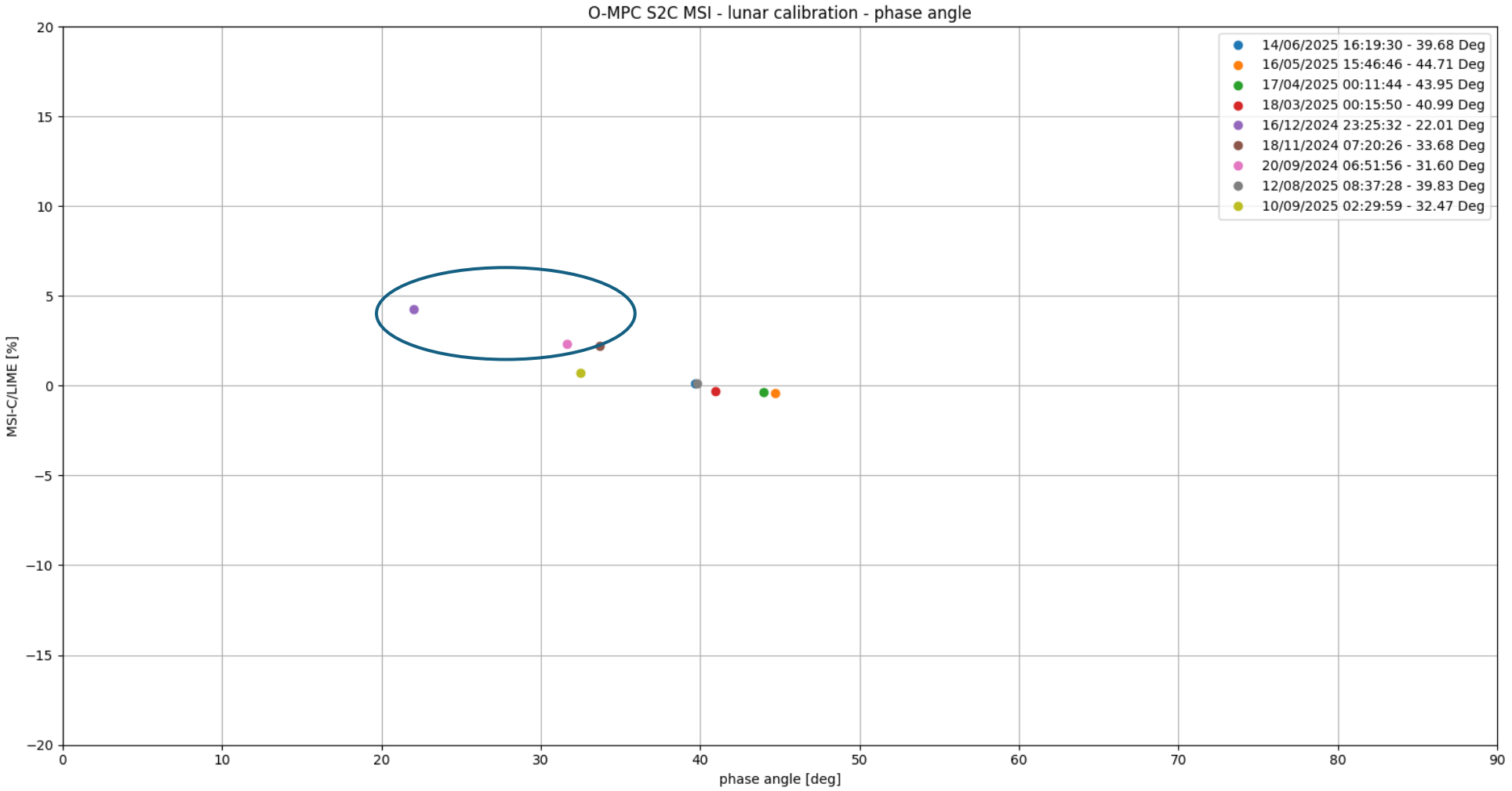




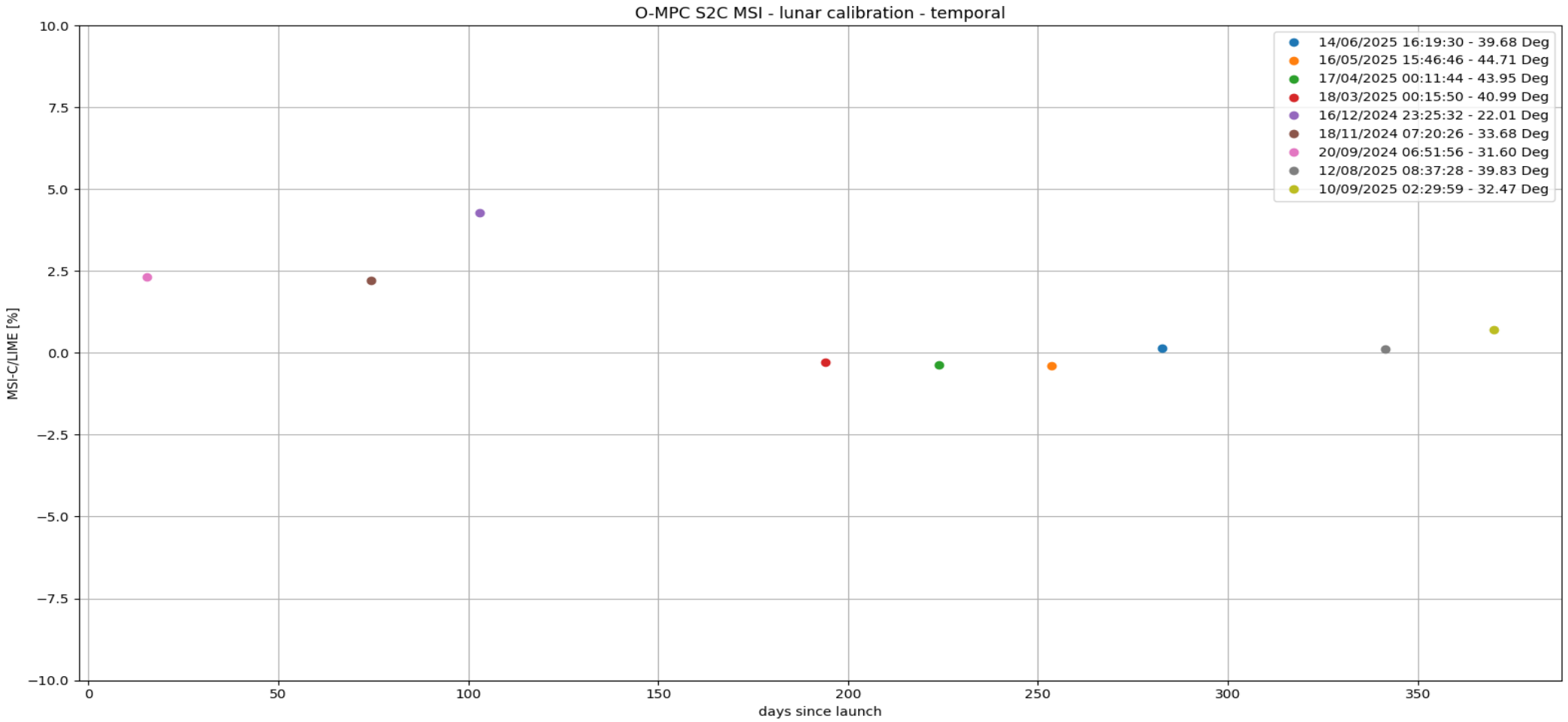
Spectral plot all results



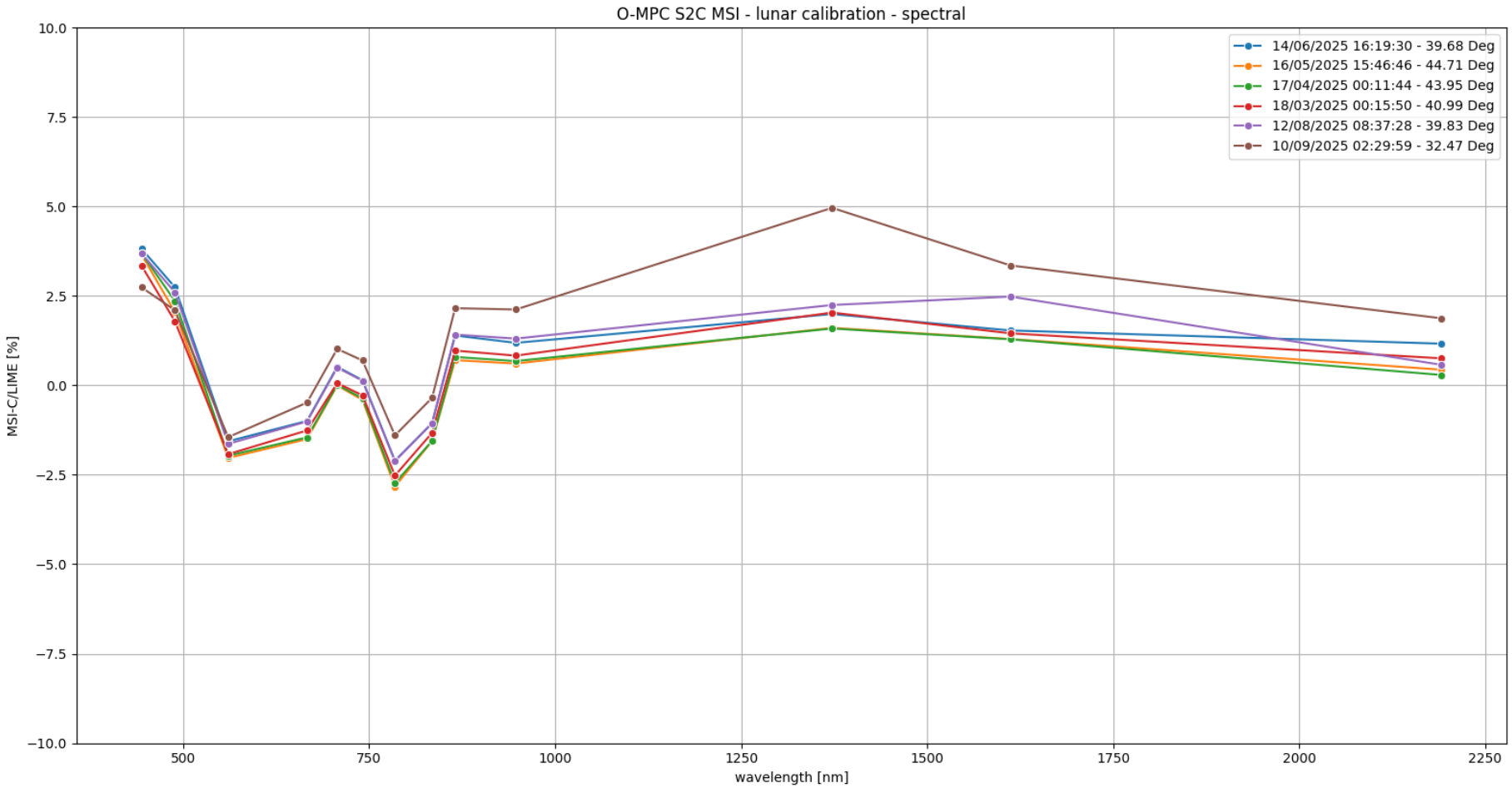
Phase angle [B06]



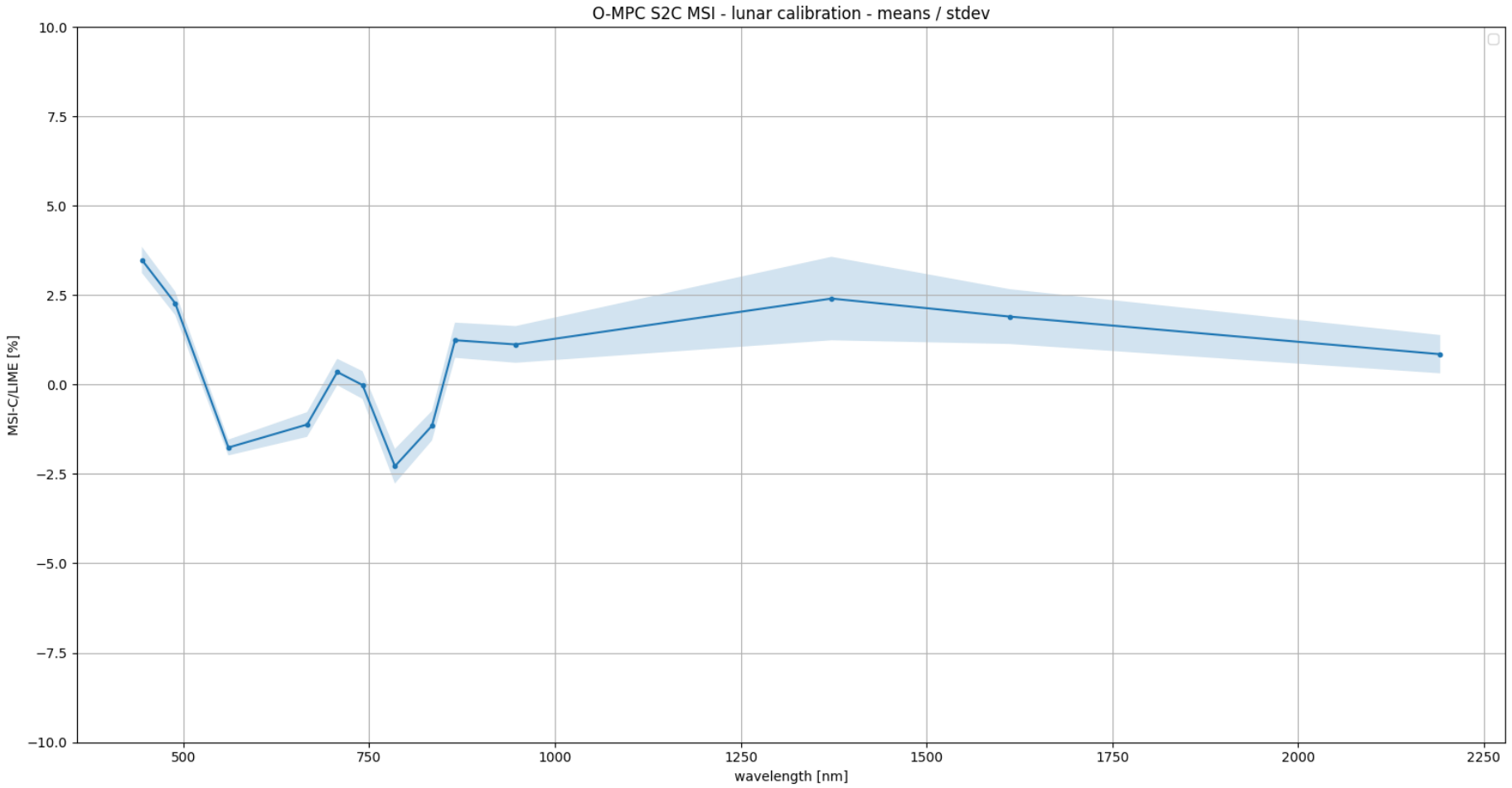
Temporal plot all results [B06]



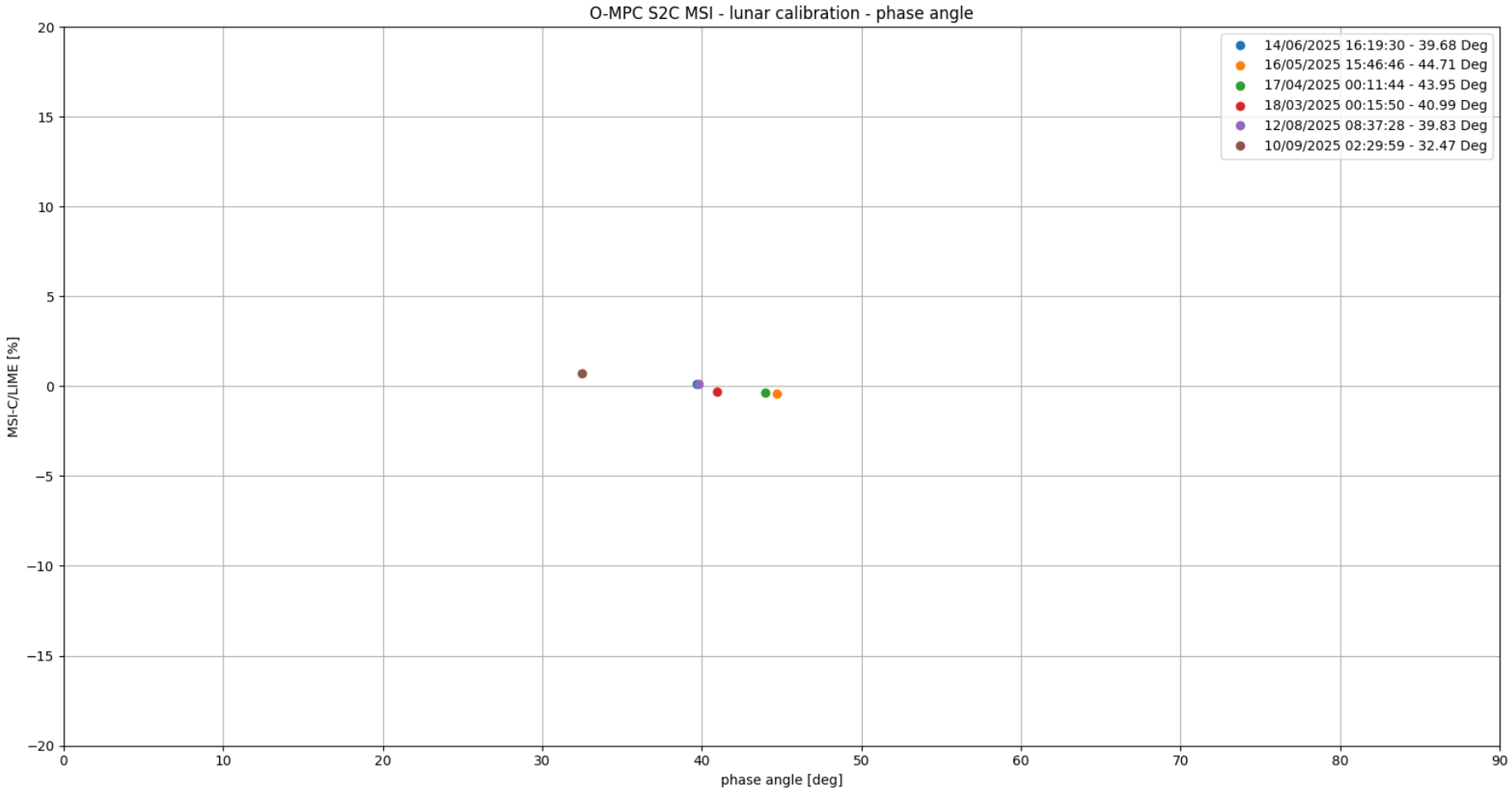
Spectral plot - operations



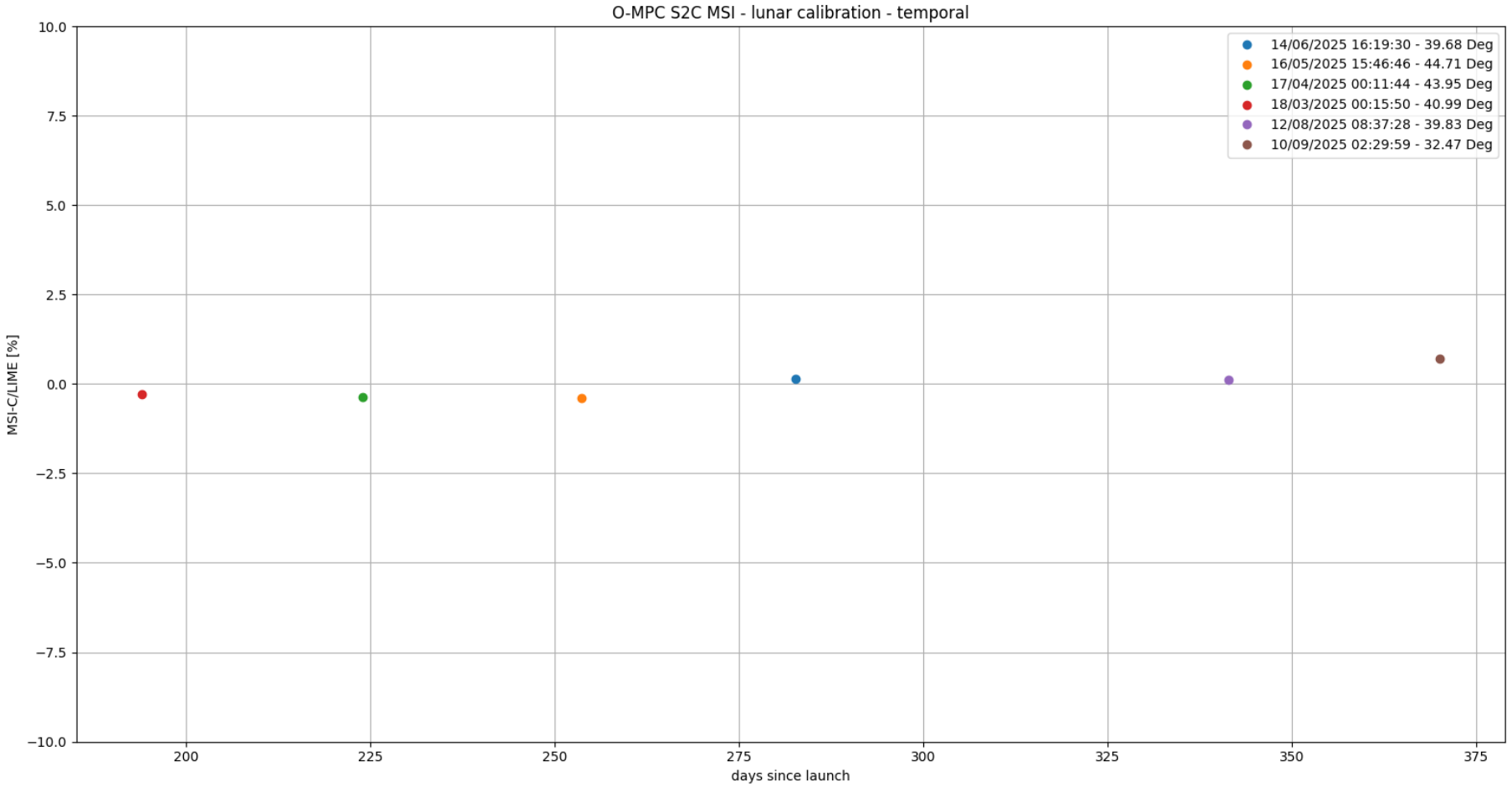
Spectral plot – mean stdev - operations



Phase angle [B06] – operations



Temporal plot all results B06 – operations



Conclusions

- Overall radiometric level fine
  - Spectral shape
  - LIME Model release with new lunar reflectance spectra (ASD)
- Temporal stability is ok (B06) for visual, swir tbd
- Use actual solid angles from product
- Phase angle dependencies
  - Recommendations : keep acquisition phase angle stable (as possible)

Thanks !