POLO
Pleiades Orbital Lunar Observations
Status

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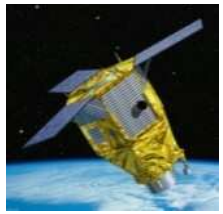
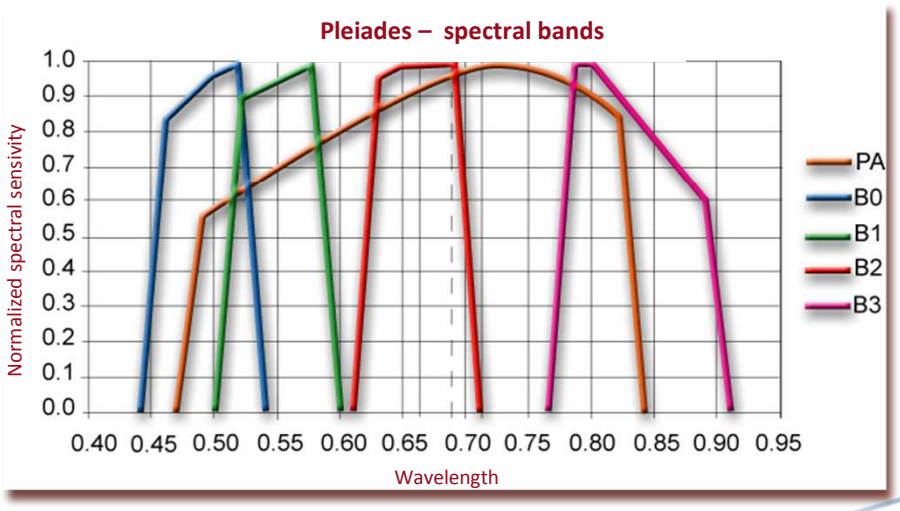
PLEIADES satellites



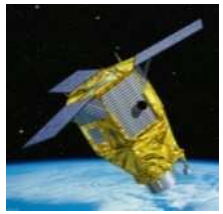
System of two satellites:
PLEIADES-1A and PLEIADES-1B
launched at the end of 2011 and 2012

Swath 20 km, agile Satellite

Spatial resolution:
0.70 m PA, 2.80 XS (4 spectral bands VIS-NIR)



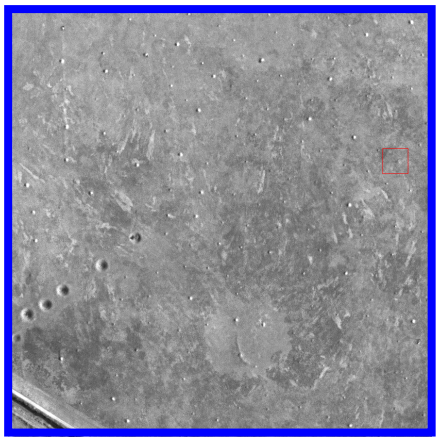
PLEIADES radiometric calibration



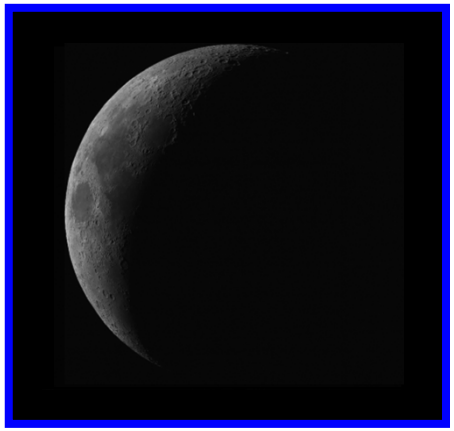
Goal: absolute calibration < 5% - Drift monitoring < 1%

Calibration sites:

Deserts

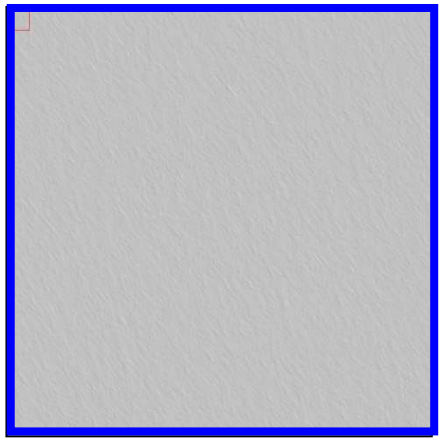


Crau



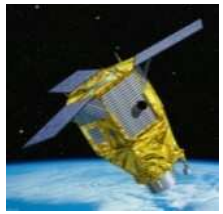
Moon

Oceans



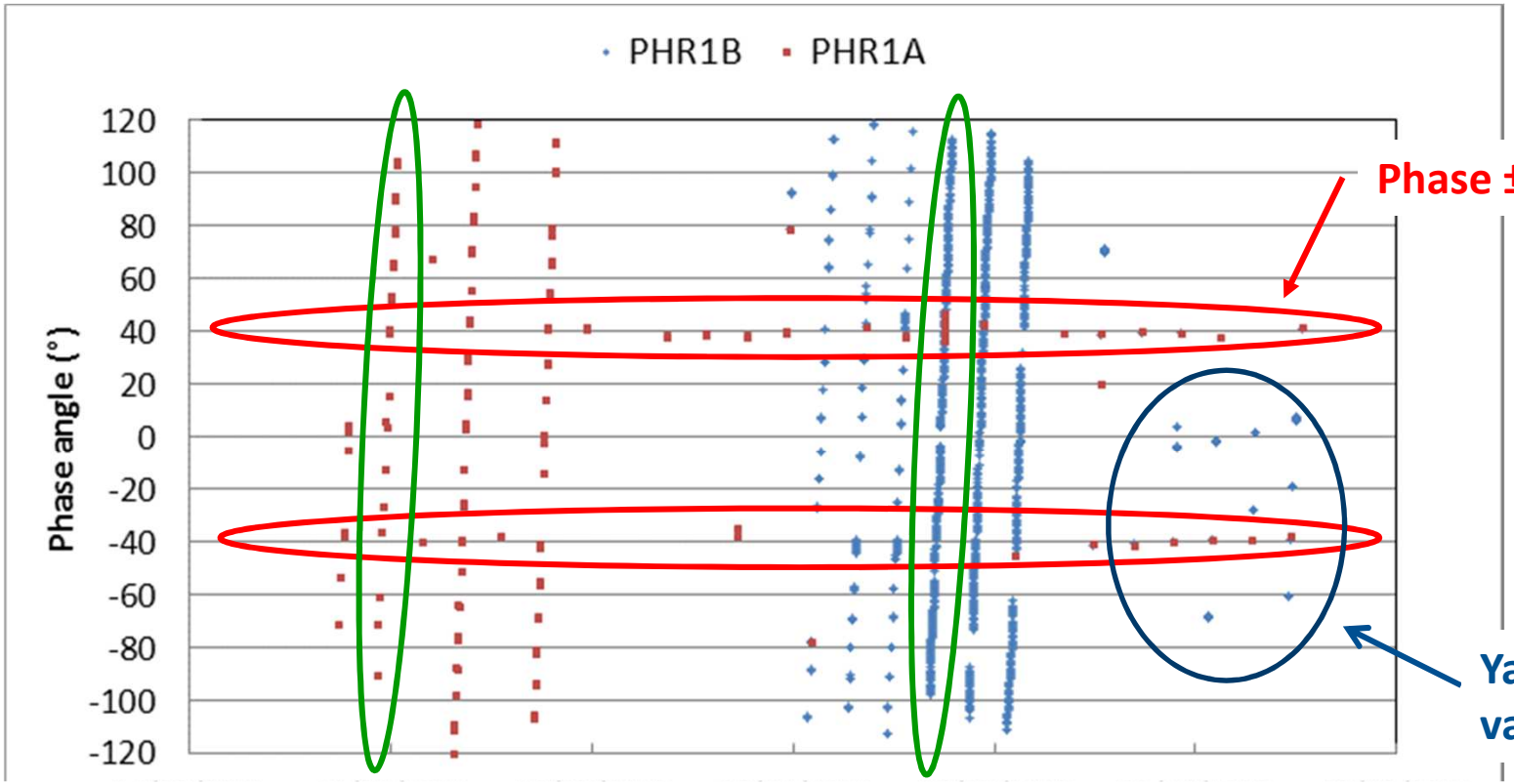
Antarctica

PLEIADES Lunar acquisitions

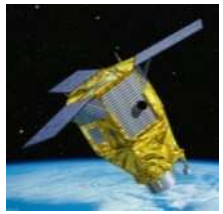


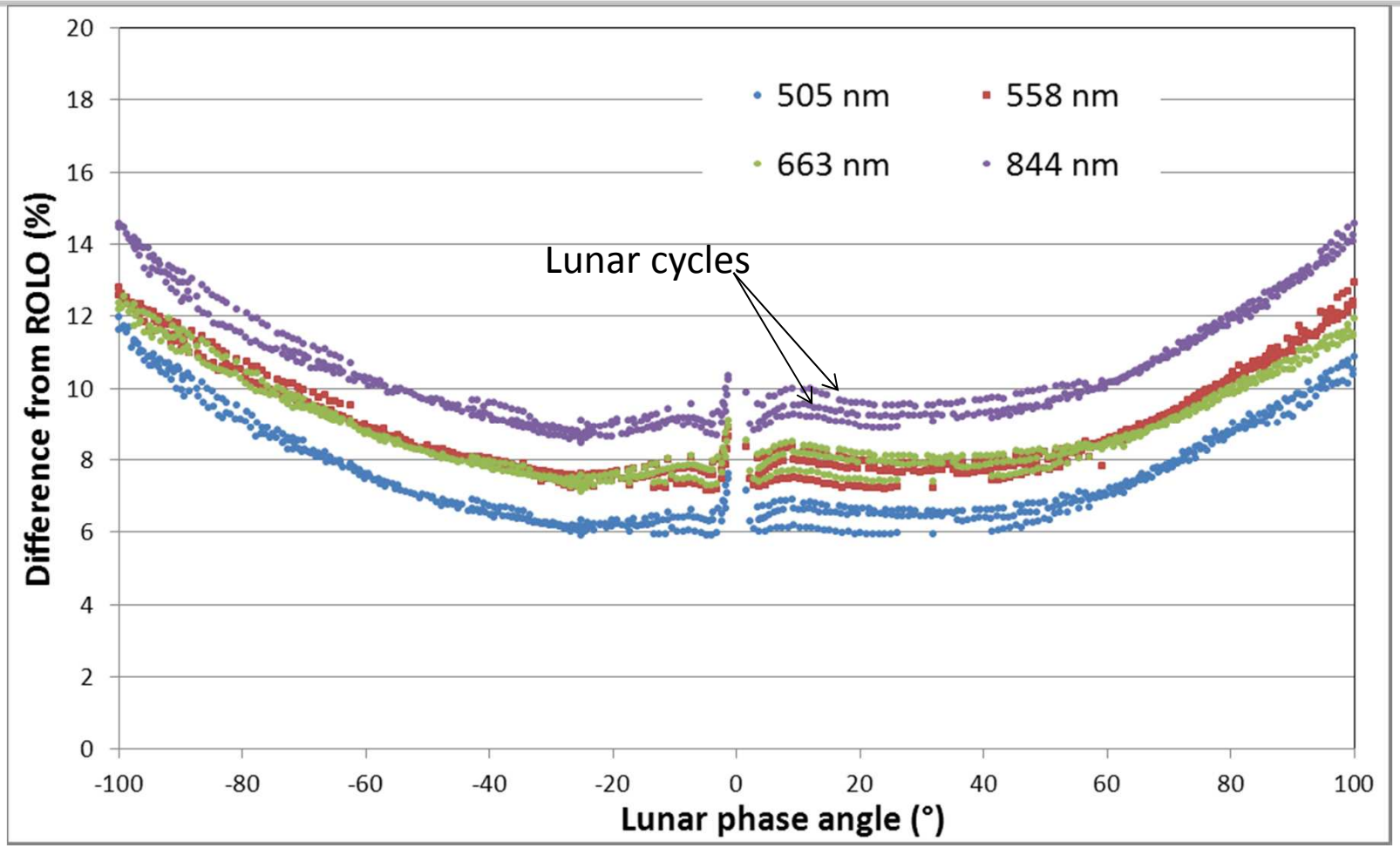
→ **167 images acquired by PLEIADES-1A since its launch (12/2011)**

→ **1069 images acquired by PLEIADES-1B since its launch (12/2012)**



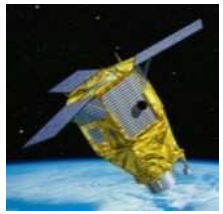
Sensitivity to the phase angle





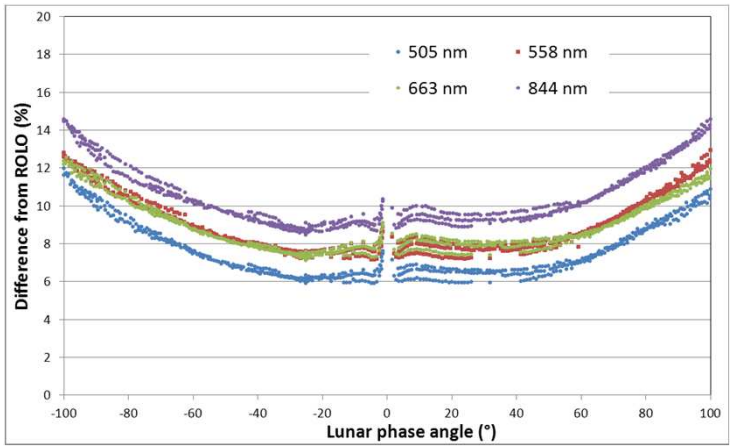
→ **Confirmation of ROLO sensitivity to the phase angle (up to 6%)**
→ **Large absolute difference (up to 14%) with ROLO**
→ **Weak noise**

PLEIADES-1B Lunar acquisitions



→ **Uncertainties due to the processing estimated better than 0.5% (see CALCON 2013)**

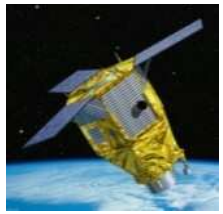
- consideration of the background signal
- computation of the integrated Moon signal
- consideration of the solid angle variation within the field of view of the instrument
- calculation of the ancillary variables (body-fixed coordinates)



BUT no accurate estimation of the impact of the sensor yaw angle on the calibration results.

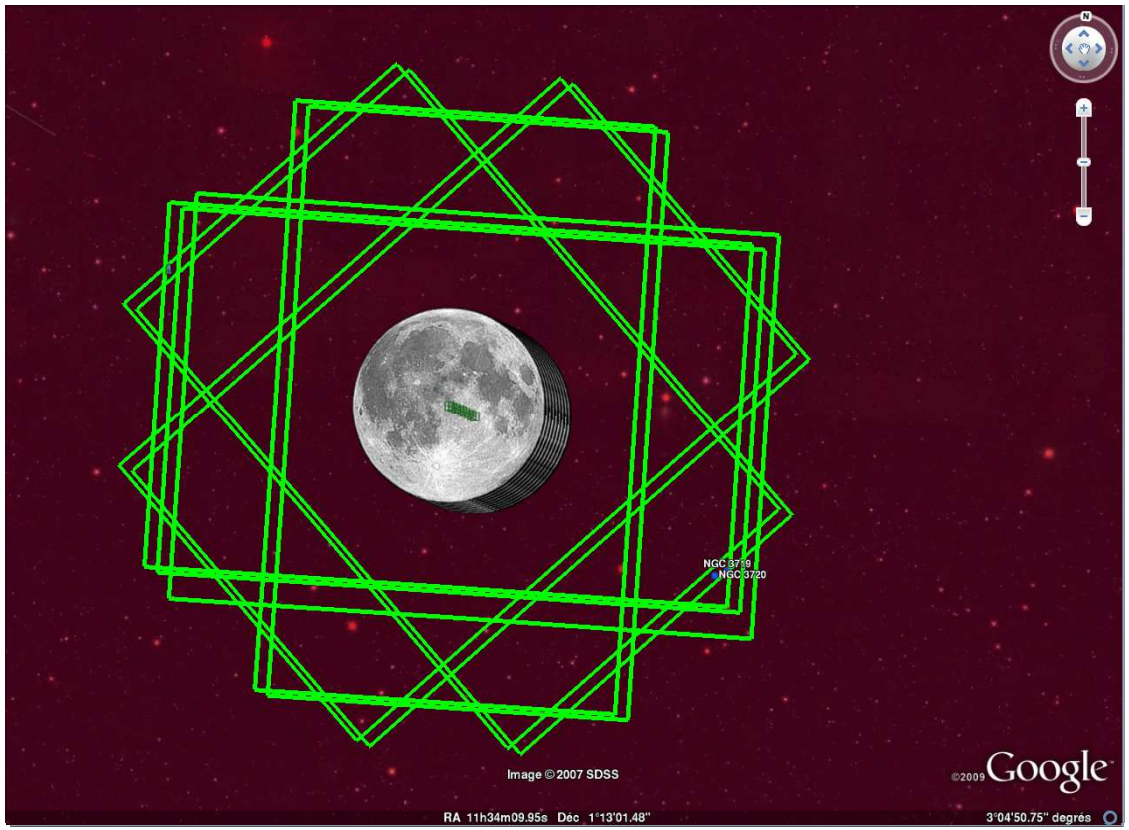
→ new experiments to assess this effect

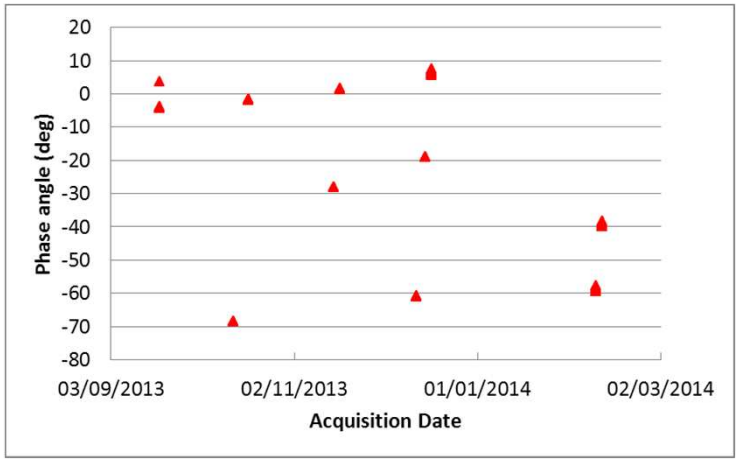
Impact of the moon orientation



- Moon views every minute with a 45° yaw angle variation between each image

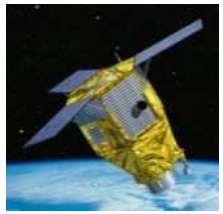
☞ Variation of the phase up to 1.5°



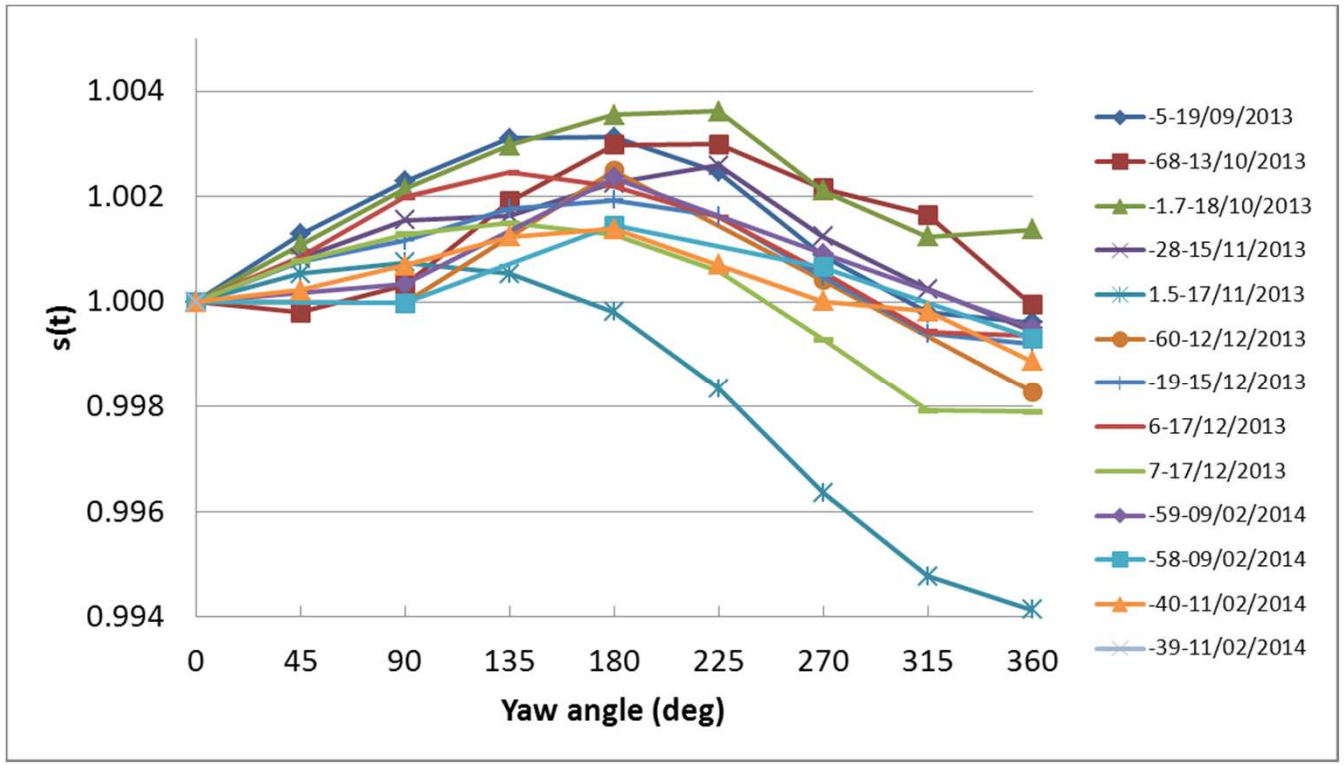


13 Experiments performed for different phase angles of the Moon

Impact of the moon orientation

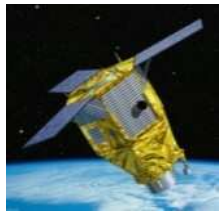


Results for PHR-1B red band : variation from 0.2% to 0.6%

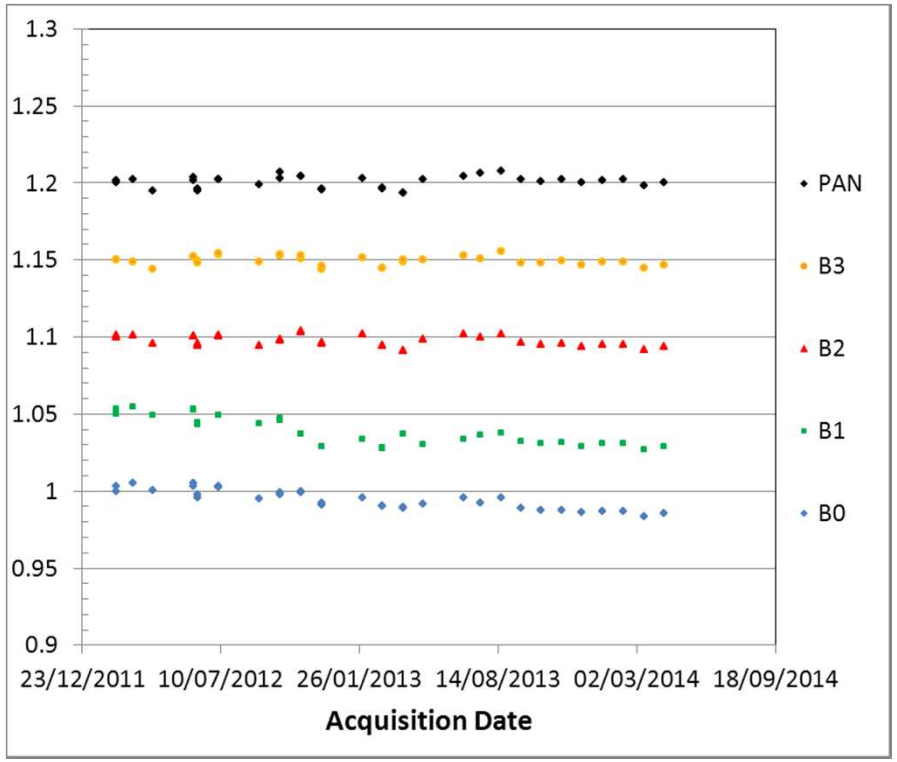


- **Sensitivity to the phase angle all the more important as the phase angle is small (max for full moon conditions)**
- **Same signature in reference to the sensor yaw angle : 0.2% variation (estimated for a minimum phase angle dependence)**

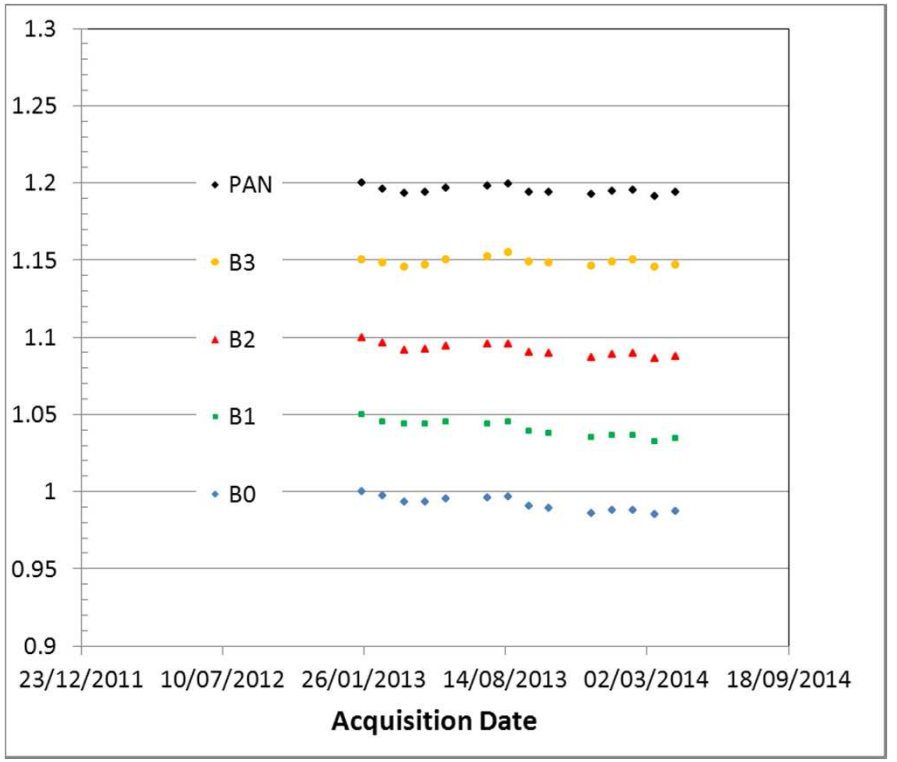
The moon for PLEIADES calibration monitoring



PHR-1A

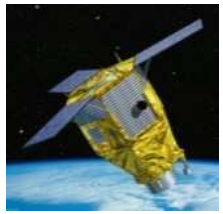


PHR-1B

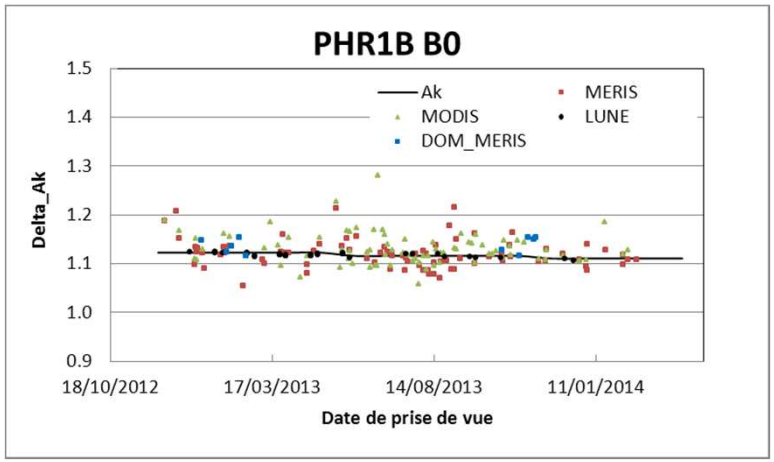


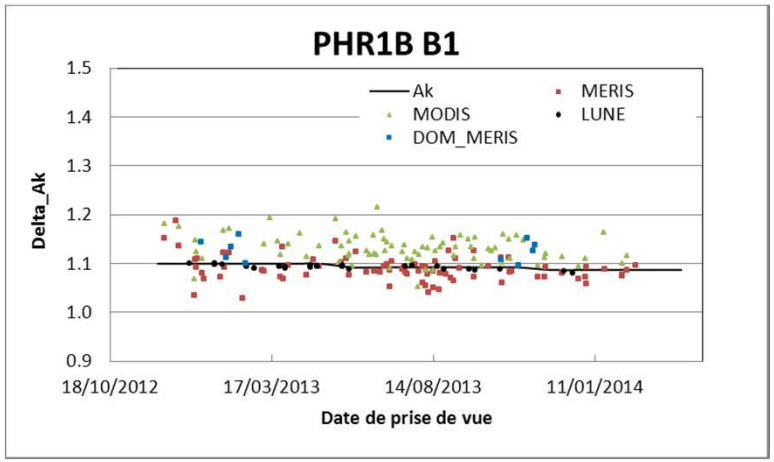
→ **Selection of the lunar acquisitions with a phase of 40 (0.5)**
→ **Similar behaviour for the 2 instruments**
→ **Weak dispersion of the measurements**

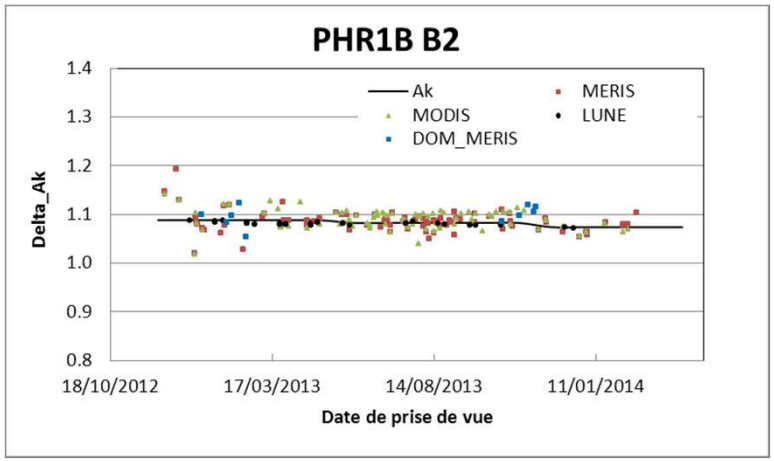
PLEIADES radiometric calibration

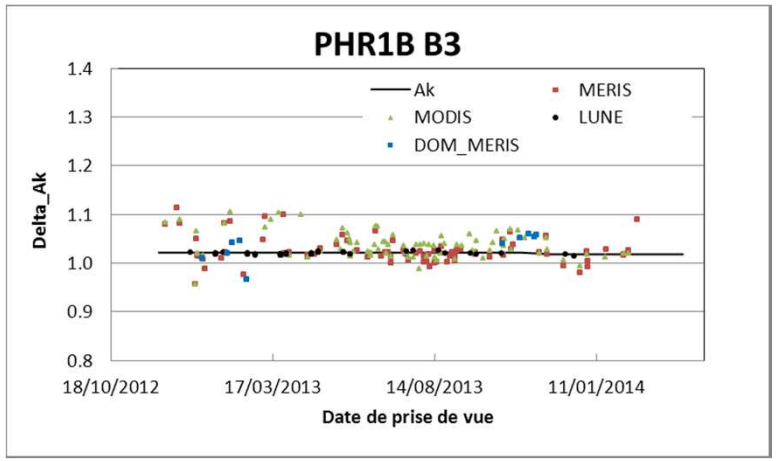


PHR1B calibration results: Moon, Desert, Antarctica







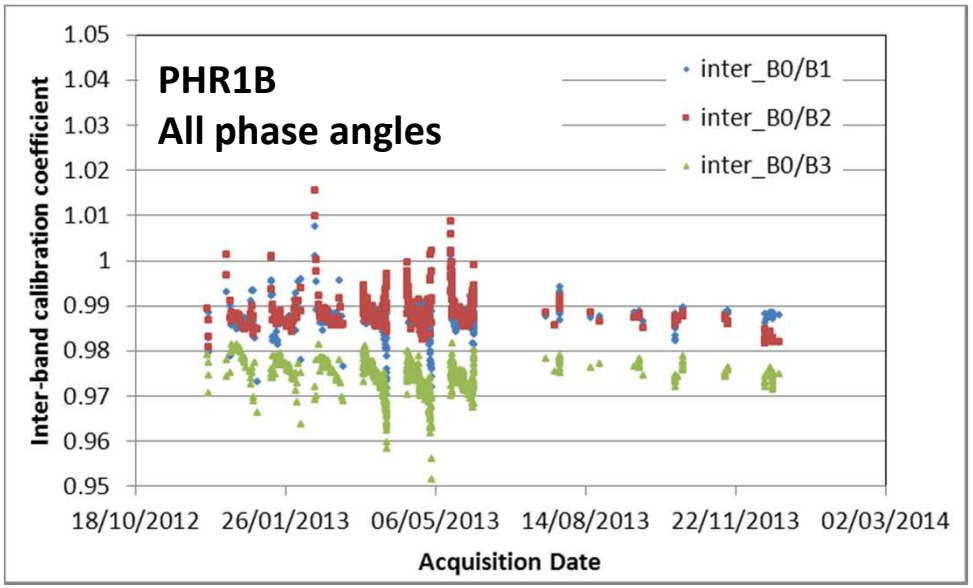


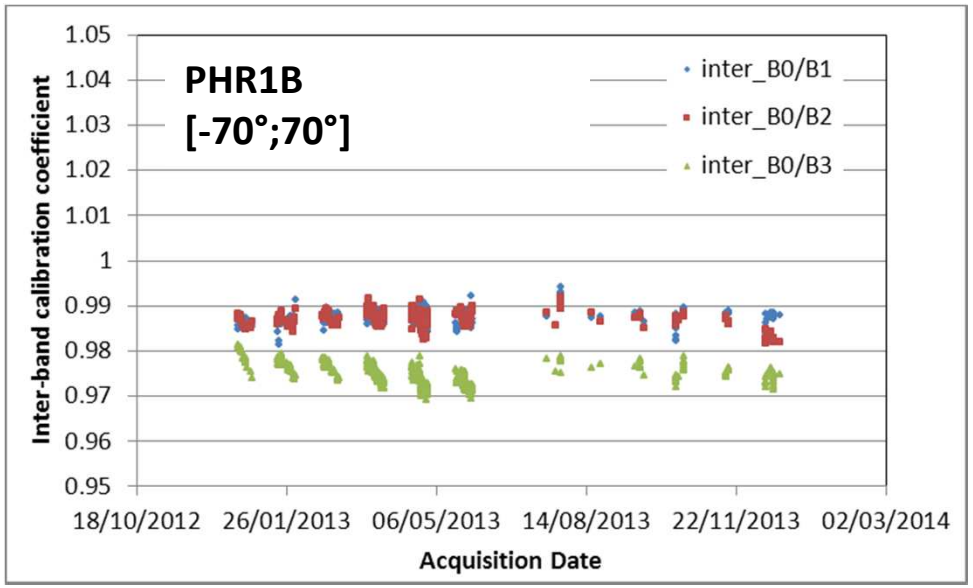
→ **Good agreement between the calibration methods**

→ **Retrieve the observed biais between MERIS and MODIS (Lachérade et al., IEEE, 2013)**

Cross band calibration – Phase dependence

PHR1B B0 band cross-calibration in reference to the other spectral bands





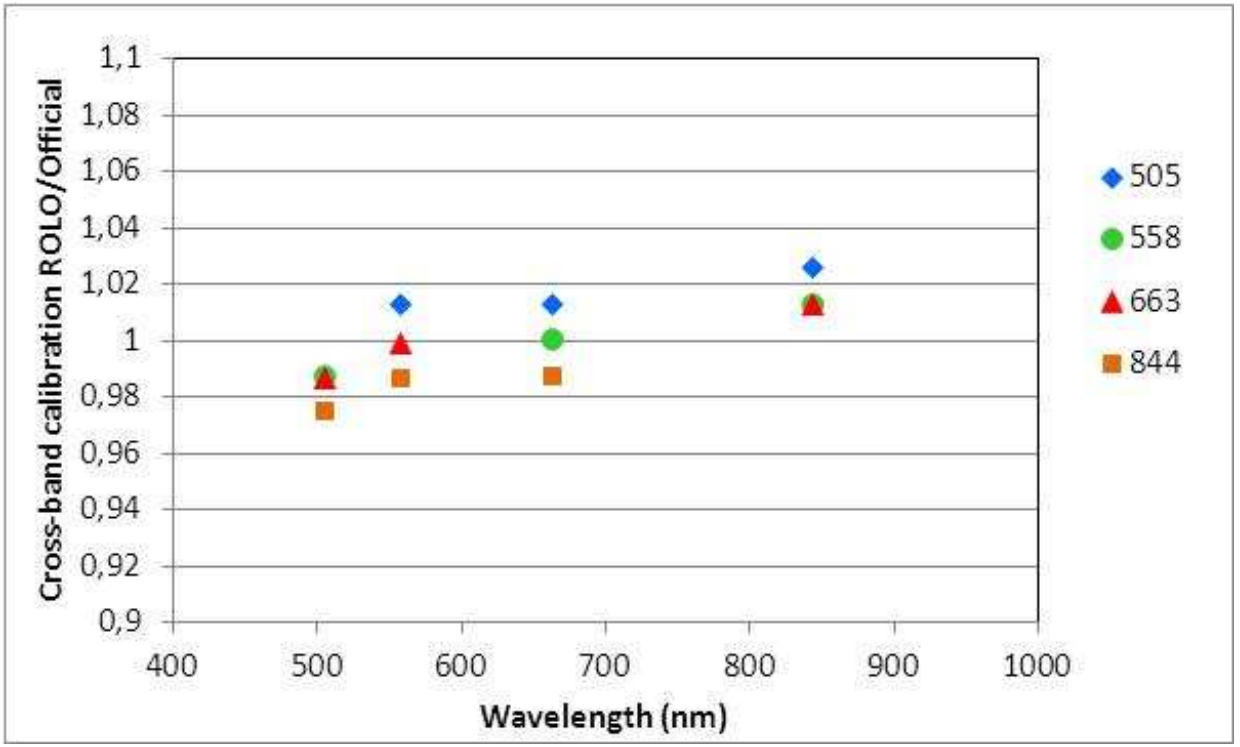
→ **ROLO phase dependence has less influence on cross band calibration than on temporal calibration: 2% versus 5% for phase ∈ [-100 :100]**

→ **Accurate cross band calibration whatever the phase is**

→ **Useful for sensors which cannot choose their acquisition phase angle**

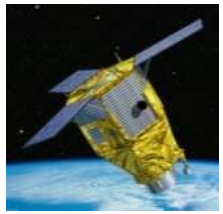
Cross band calibration – Spectral dependence

Cross band calibration results for PHR1B (phase angles range: [-70 ;70])

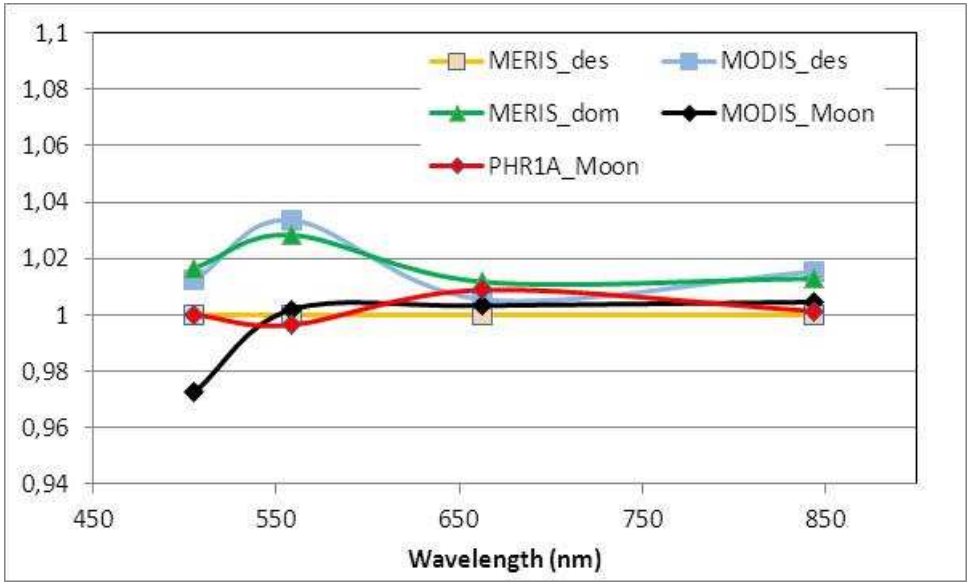


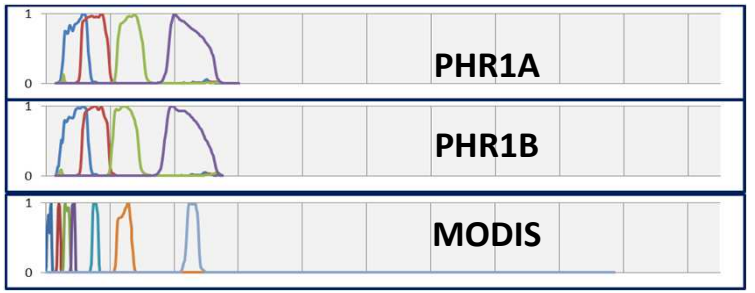
Maximum dispersion: 2.5% according to the reference band → combines official cross-band calibration errors and ROLO spectral errors

Sensors cross-calibration results



PHR-1B cross calibration in reference to PHR-1A and AQUA/MODIS over the moon (phase angle=55):



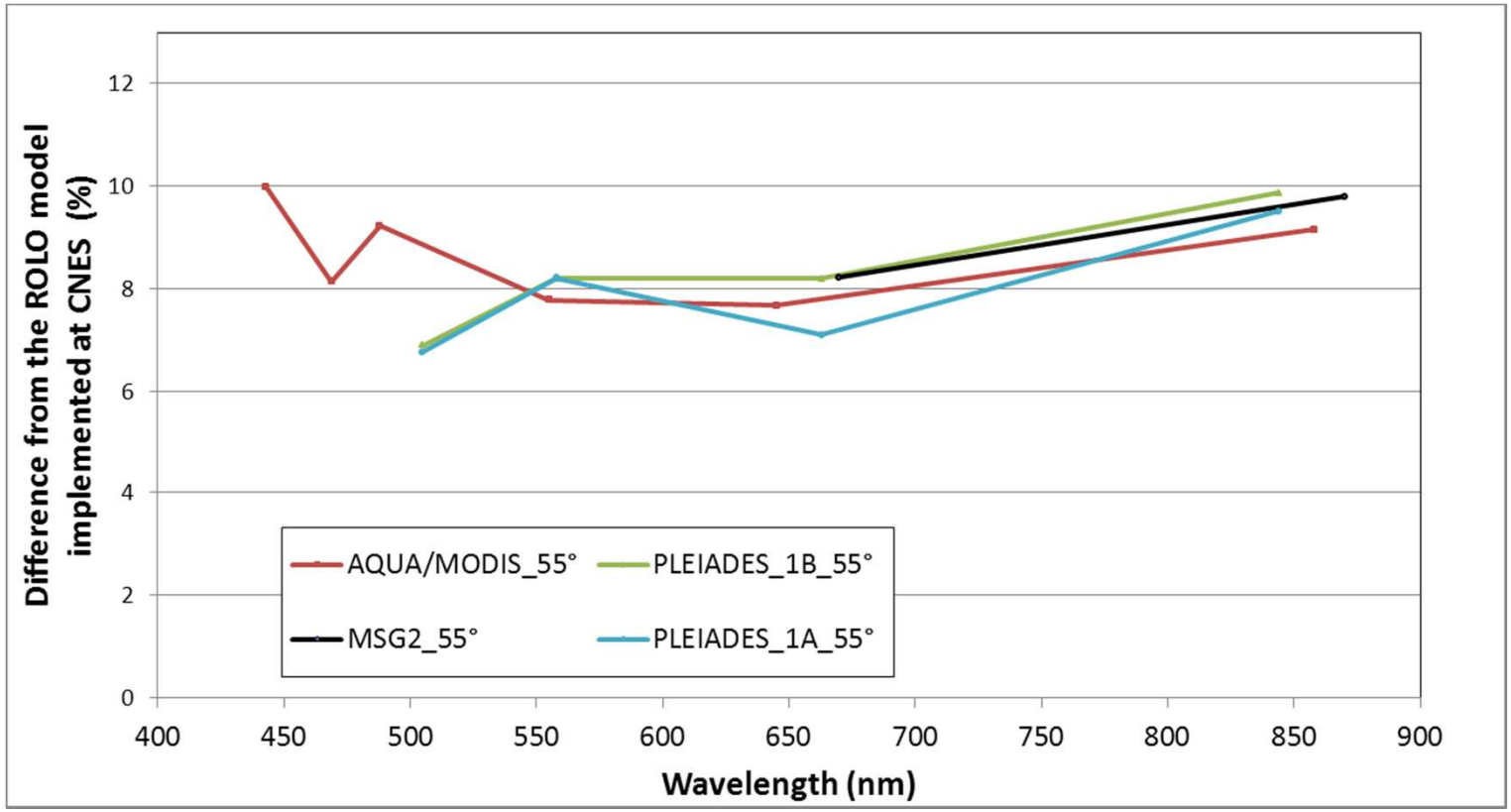


→ **Cross calibration over the moon:**

- **very good consistence for 558nm, 663nm and 844nm**
- **3% difference for 505nm between MODIS and PHR-1B**

→ **Cross-calibration performance to be improved through a spectral correction (cross-calibration method currently limited to a band-to-band cross-calibration)**

Absolute calibration
ROLO versus on-orbit measurements



→ **Very good agreement between AQUA/MODIS, PHR1A, PHR1B and MSG2**

(PHR-1A and PHR-1B calibration based on ENVISAT/MERIS)

(MSG2 calibration based on desert cross-calibration methods)

→ **Uncertainty of the absolute calibration of the ROLO implementation up to 10% at 55**

SADE data base: Lunar observations

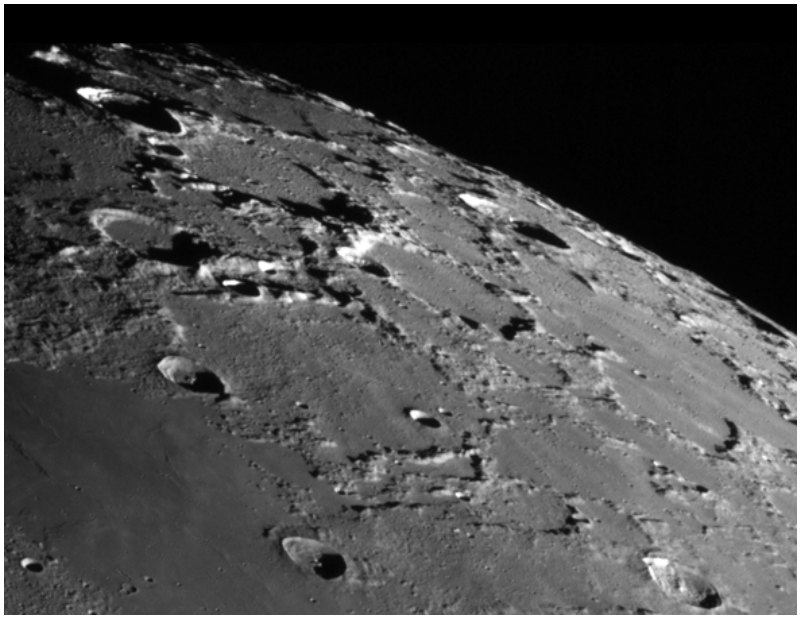
SENSOR	Spectral range	Nb of spectral bands	Spatial resolution	Acquisition Dates	Phase angle range	Number of measurements
PHR-1A	Vis-Nir	4	2.80m	2012-2013	[-115°;115°]	167
PHR-1B	Vis-Nir	4	2.80m	2013	[-115°;115°]	1069
AQUA/MODIS	Vis-Nir	7	250-500m	2002-2013	[51°;55°]	108
MSG1	Vis-Nir-Swir	3	2500m	2003-2012	[-150°;152°]	393
MSG2	Vis-Nir-Swir	3	3000m	2006-2013	[-145;145]	366
LANDSAT8*	Vis-Nir-Swir	8	30m	2013	-7° and +8°	148

→ A lot of sensors with different characteristics: spatial and spectral resolution, phase angle range, radiometric absolute accuracy,…

*Results on-going !

Conclusion

- **The PLEIADES dataset**
  - **takes benefits from:**
    - **High spatial resolution**
    - **High phase angle range [-115 ,+115]**
    - **High satellite agility**
      (rotation of the satellite to acquire the Moon every minute)
  - **is used to accurately quantify the calibration errors**
    (data and method including ROLO model)

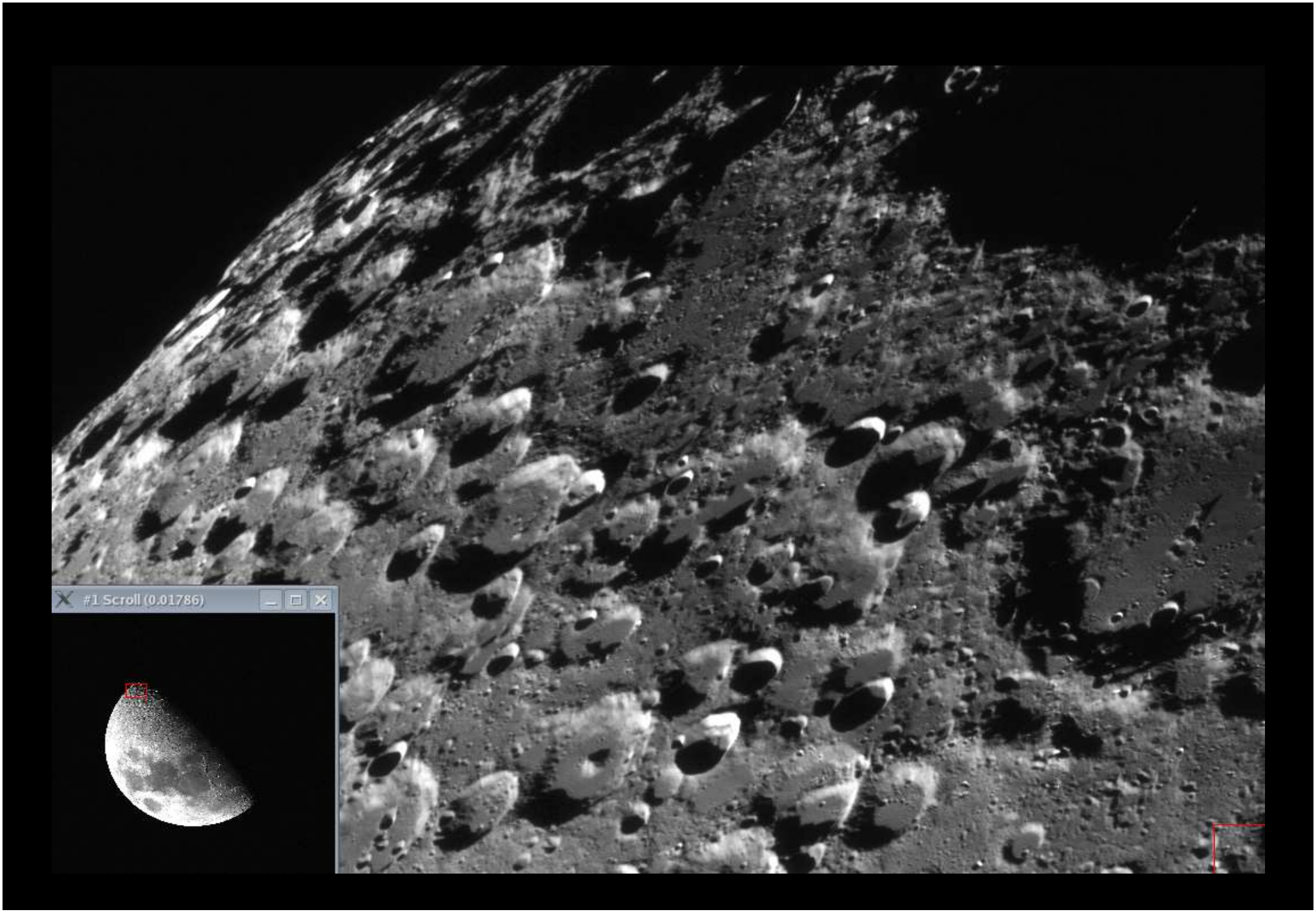


Future work:

- **ROLO model phase angle dependence correction**
- **ROLO model as an absolute reference**
- **Spectral resampling for satellite cross calibration**

The Moon seen by PLEIADES

More than 4 million of pixels !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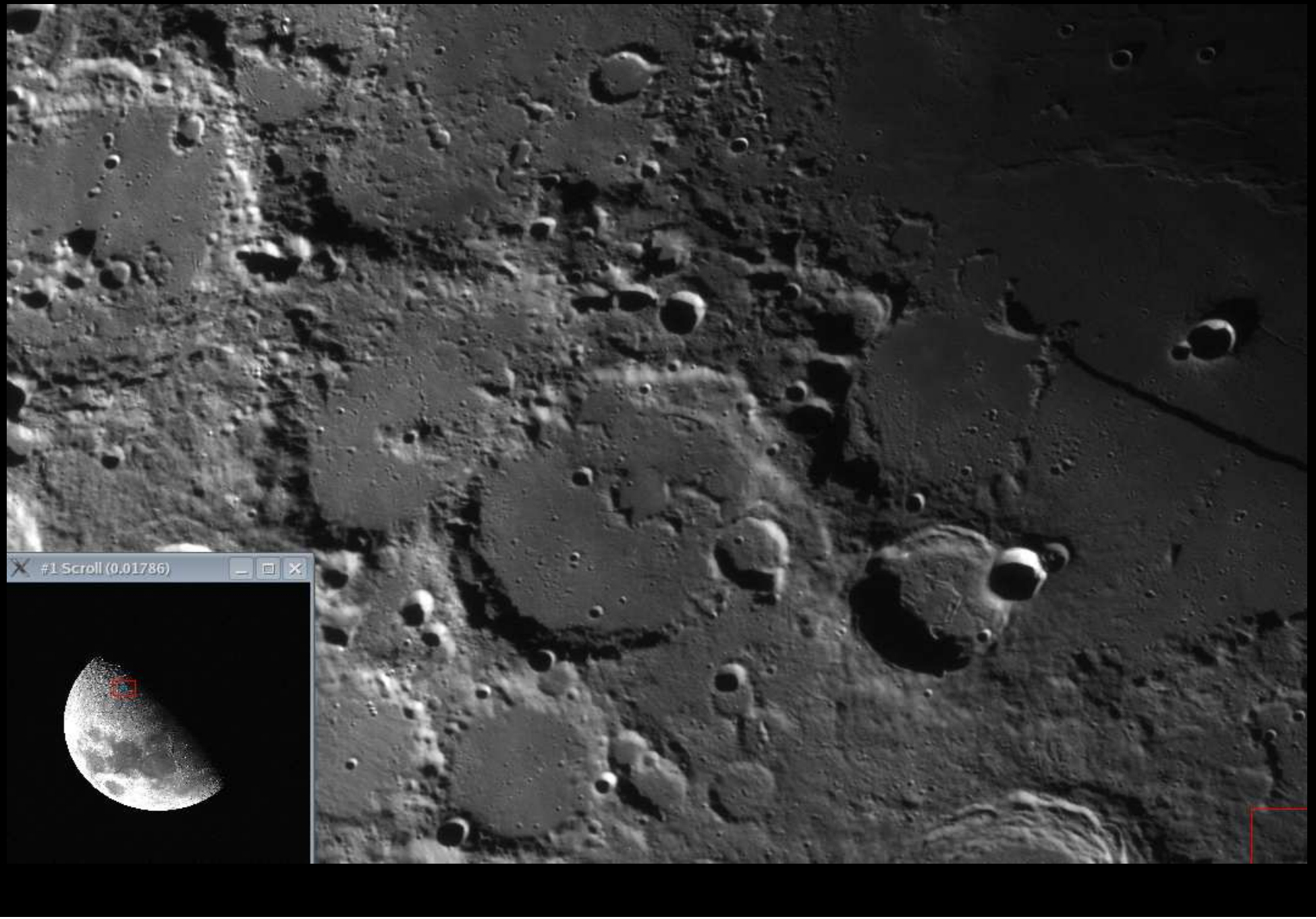
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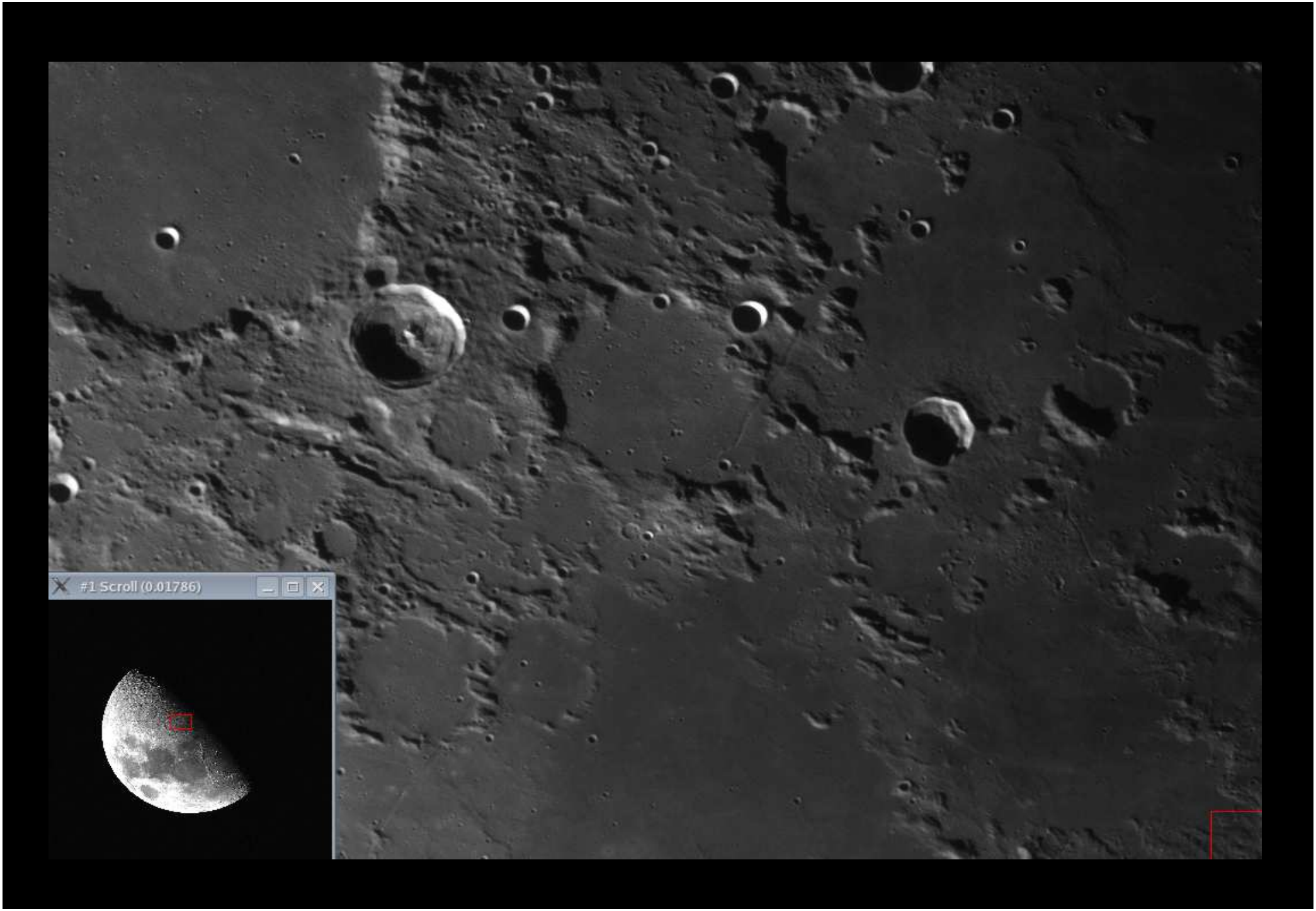
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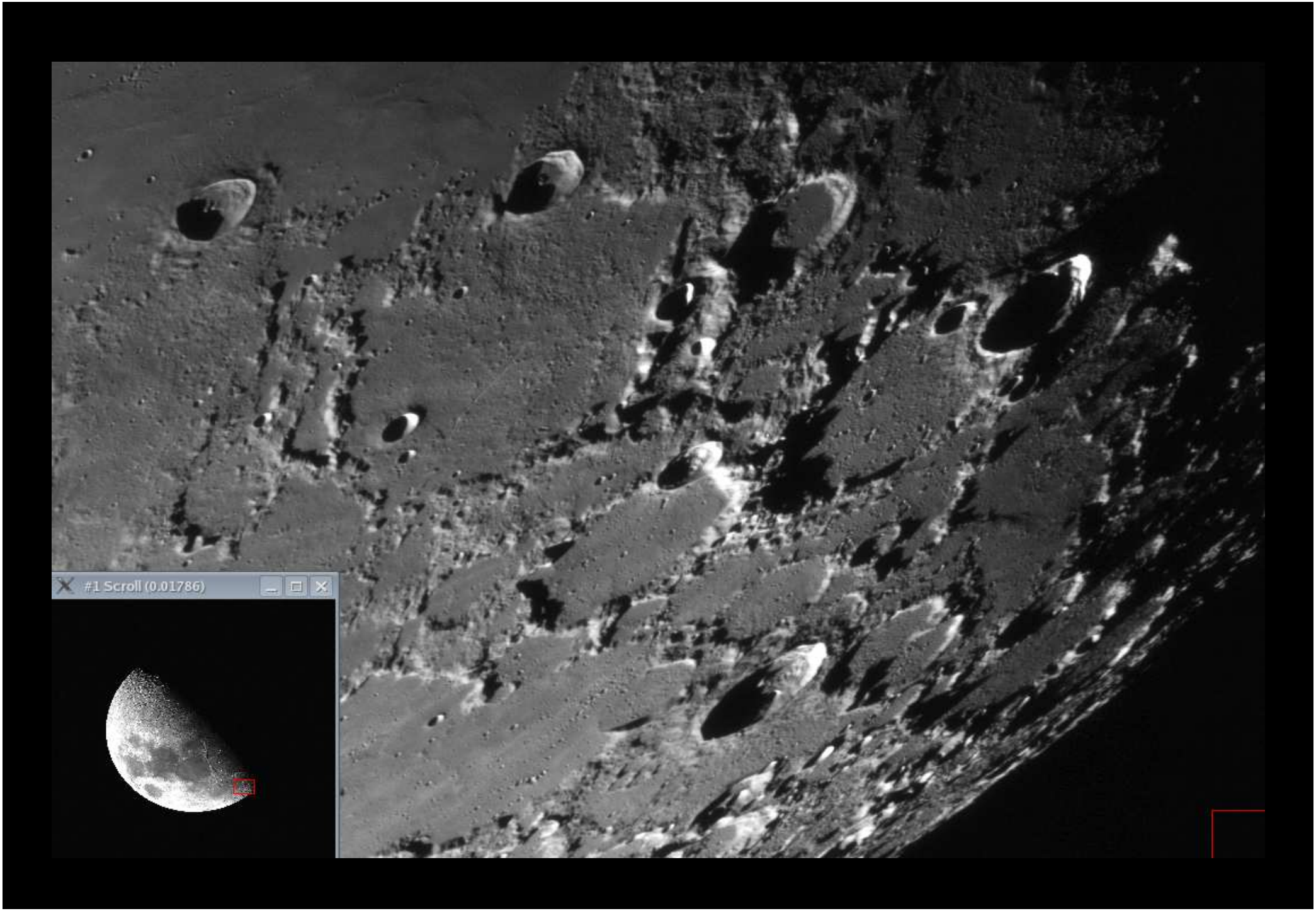
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