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Vicarious calibration of PROBA-V : One year in orbit

Stefan Adriaensen(a), Wouter Dierckx(a), Jan Dries(a), Stefan Livens(a), Sindy Sterckx(a), Tanja Van Achteren(a), Marc Bouvet(b)

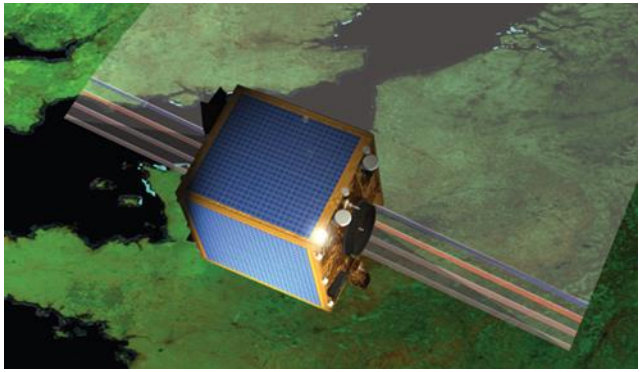
(a) VITO, Remote Sensing, Boeretang 200, Mol, Belgium

(b) ESA/ESTEC, Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands

CALCON , August 11 - 15 2014, Utah, USA

PROBA-V In-flight calibration

- Variations in the characteristics of the instrument are likely to occur in orbit due to
  - outgassing phenomena during launch
  - aging of the optical parts
  - cosmic ray damage
  - …



- **NO** on-board calibration devices such as lamps, solar diffuser panels, LEDs,..

- vicarious calibration techniques to meet requirements
  - 5 % absolute accuracy
  - 3 % relative accuracy
    - inter-band
    - multi-temporal

RC – IQC: Vicarious Calibration Concept

OSCAR* (Optical Sensor Calibration with simulated Radiances)

» Relies on combination of various vicarious calibration methods to reduce uncertainty in the calibration results and to verify the different requirements

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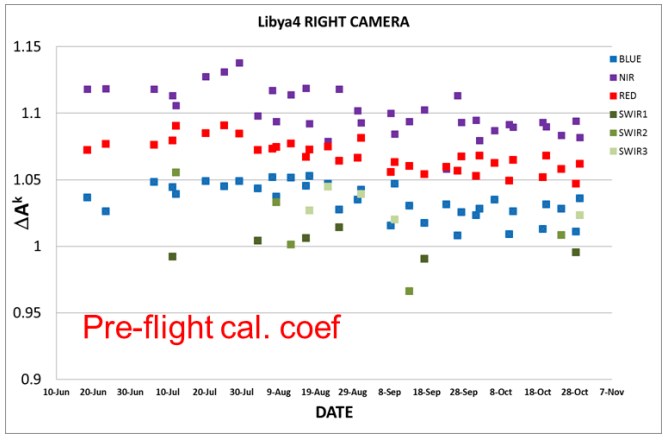
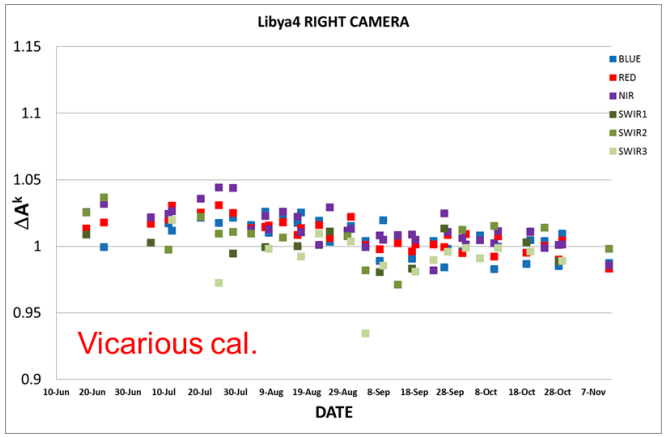
*Sterckx *et al.* IJRS, 2014; Sterckx *et al.* , TGARS, 2013; Govaerts *et al*., RSL, 2013

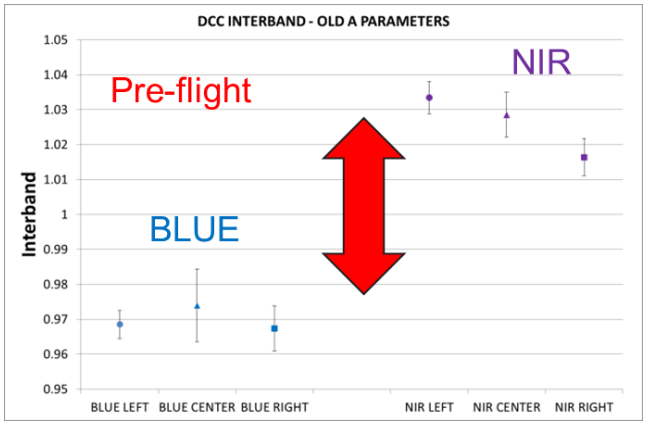
Absolute calibration coefficient

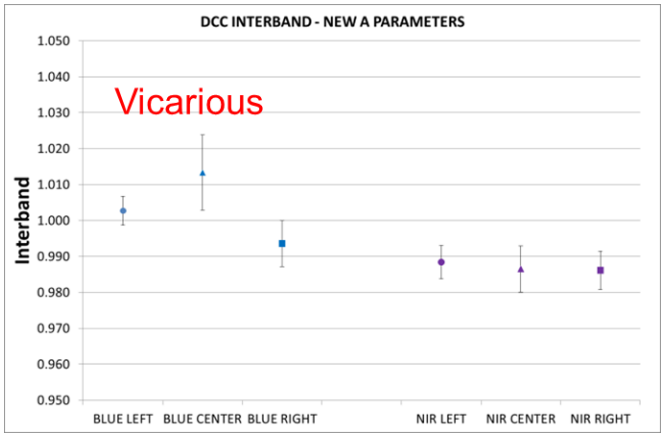
Assessment absolute calibration



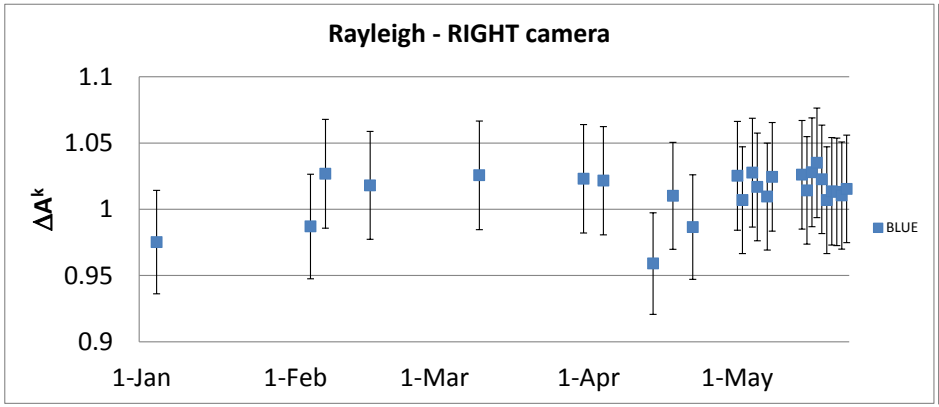


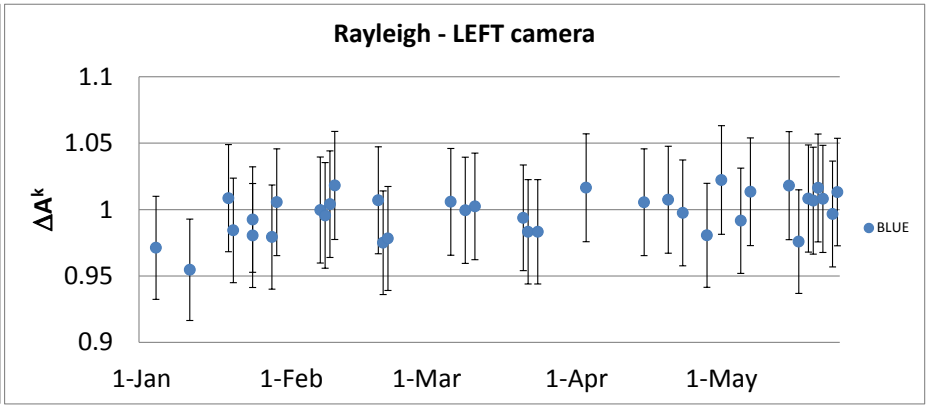
Assessment interband calibration

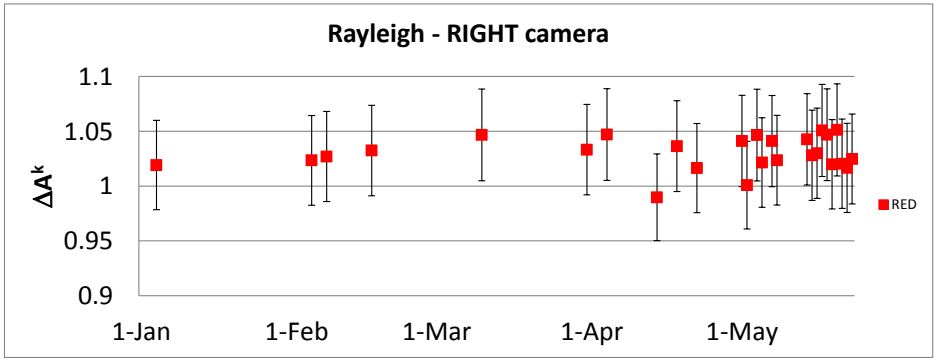


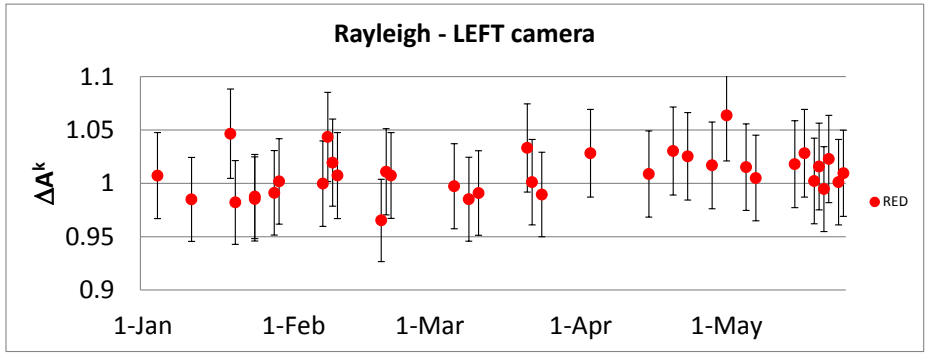


RAYLEIGH

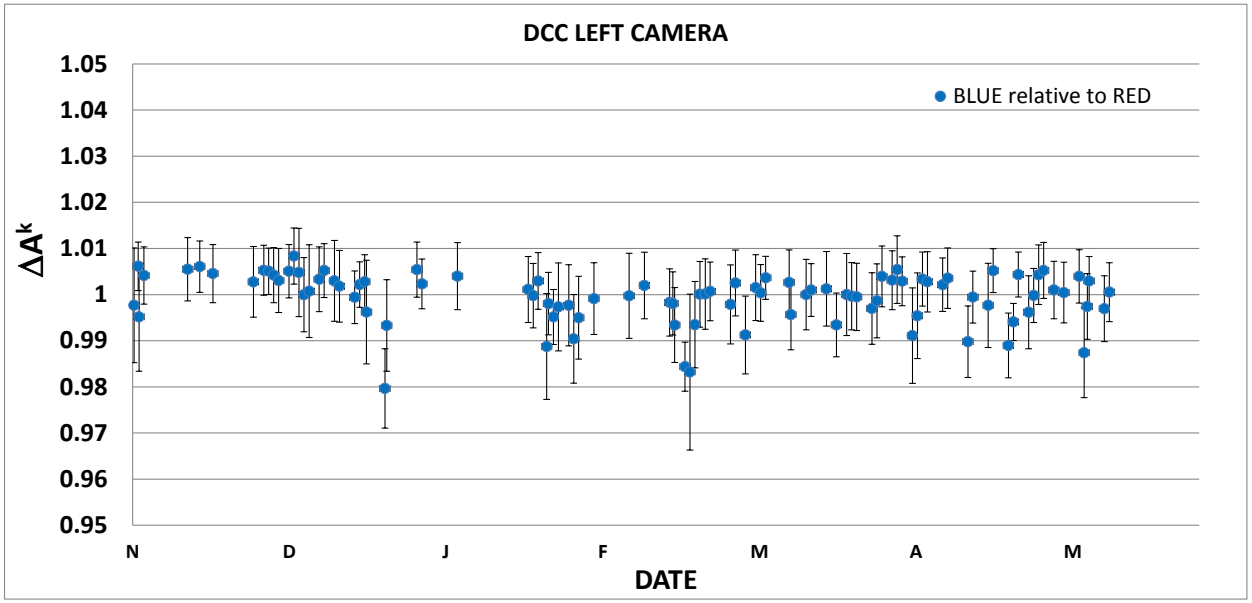


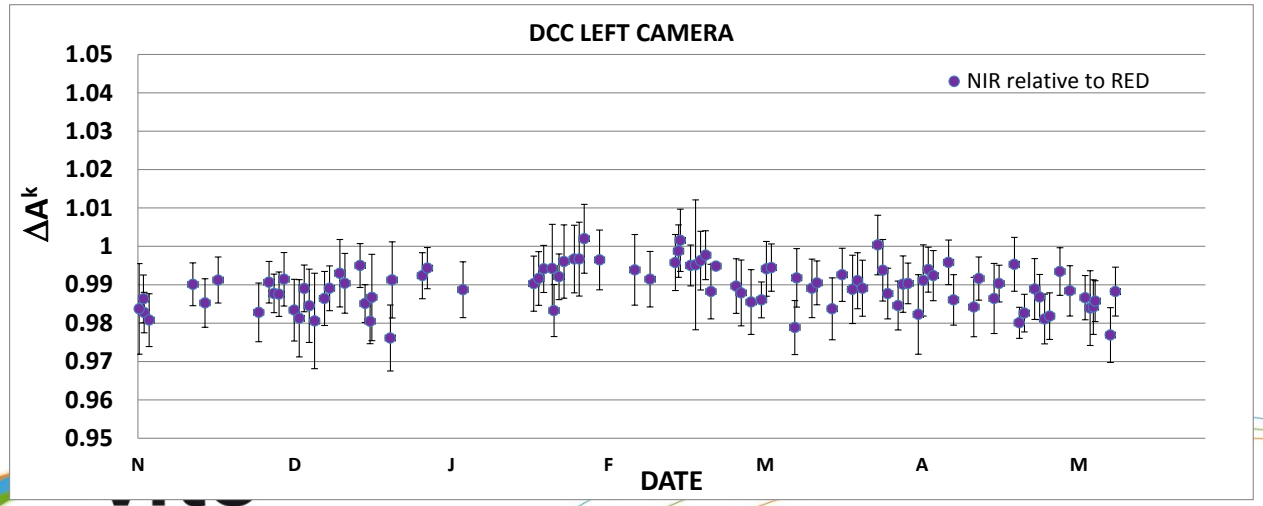


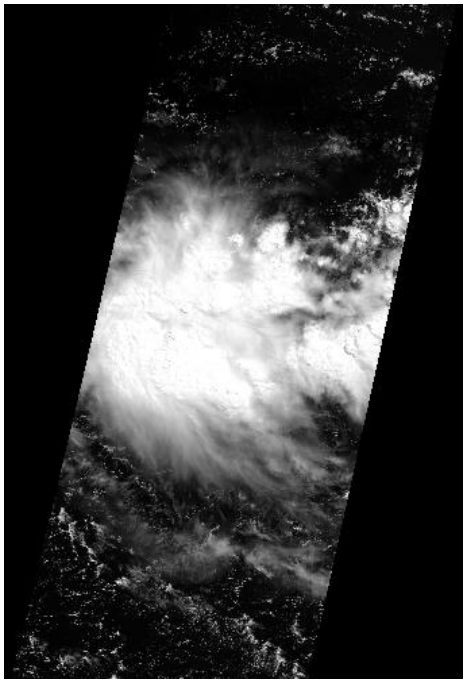




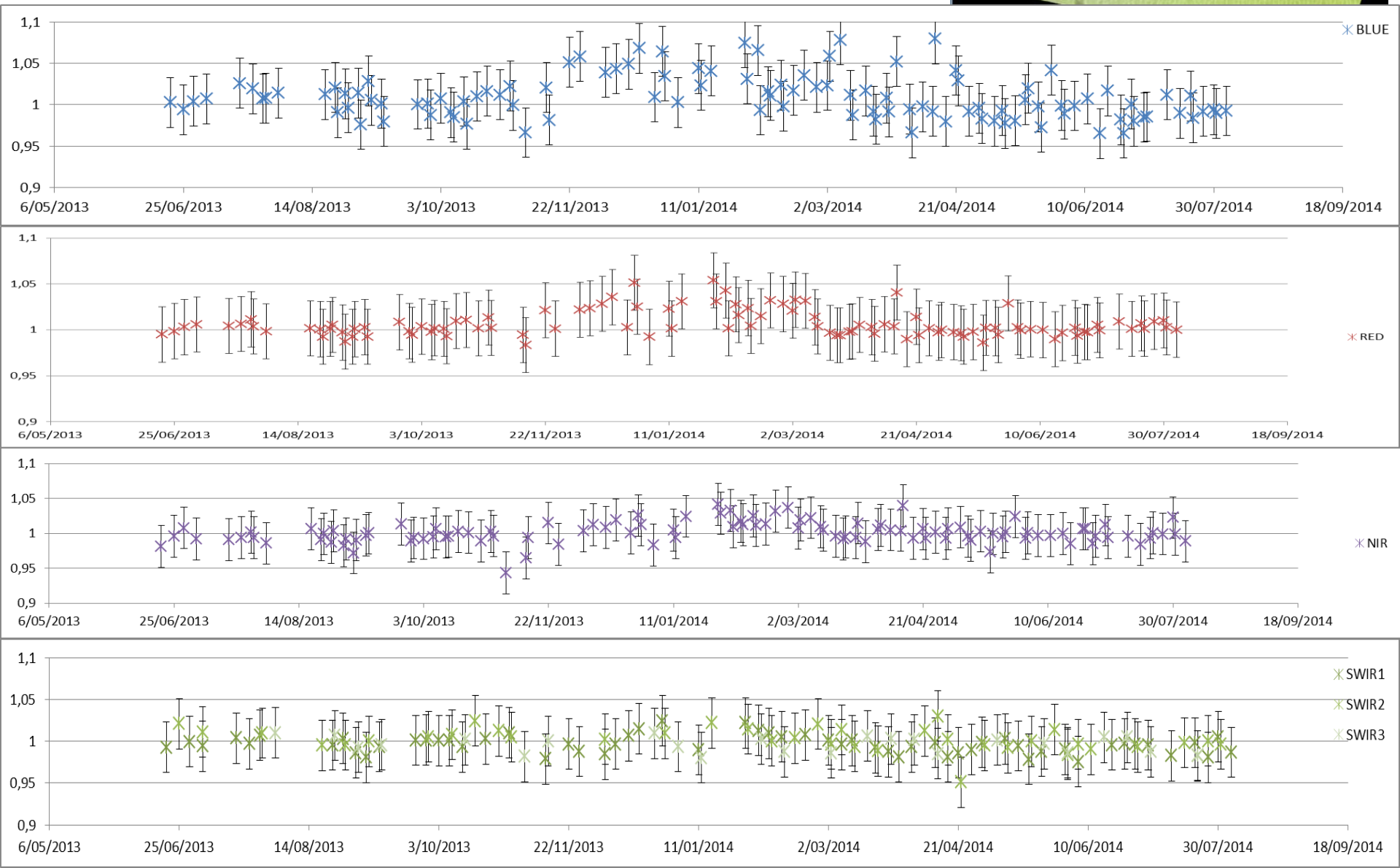
DCC Inter-band



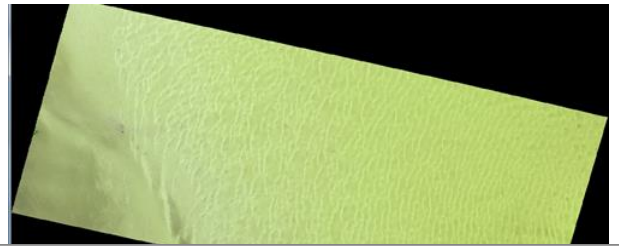


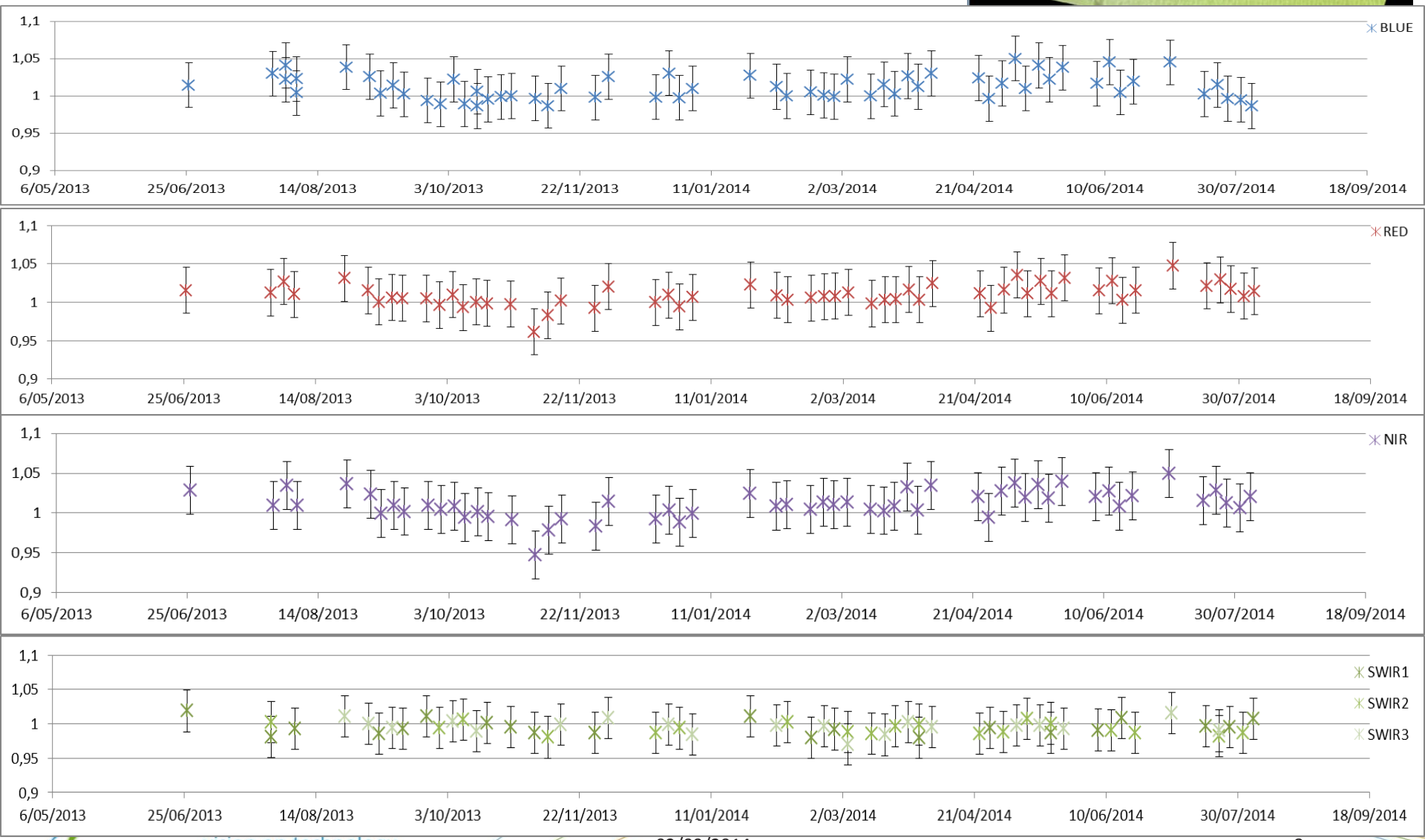


Oscar Libya-4 calibration - LEFT

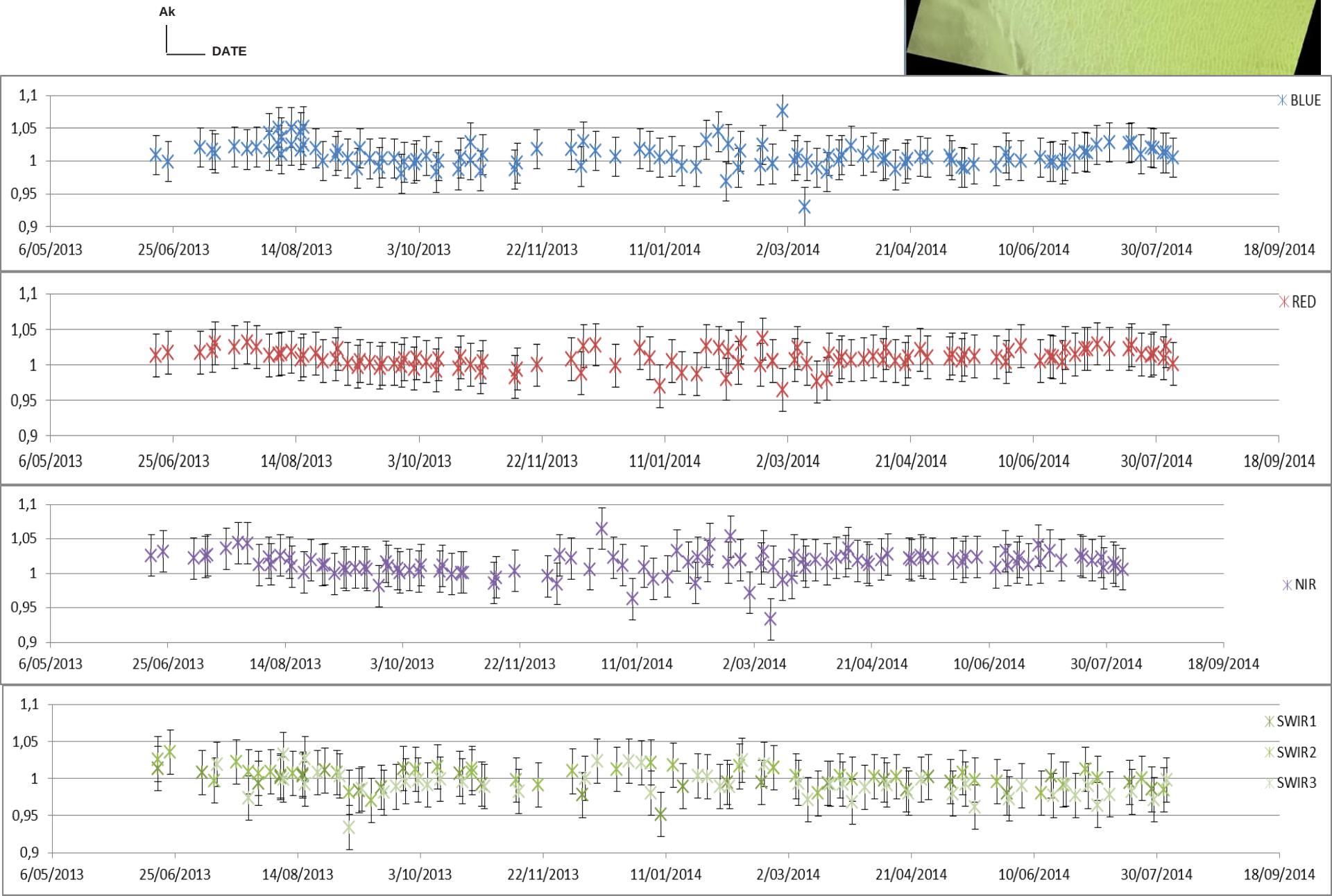


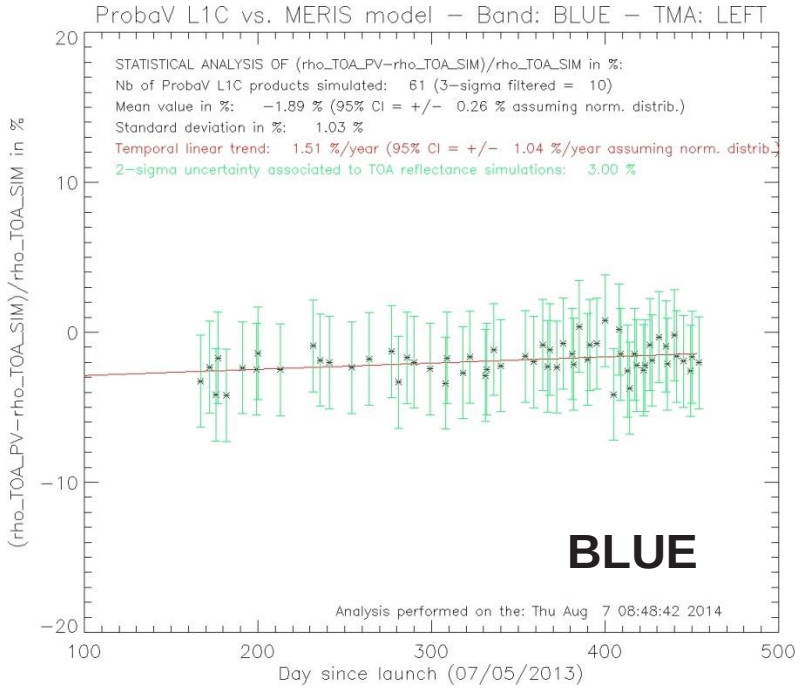
Oscar Libya-4 calibration - CENTER

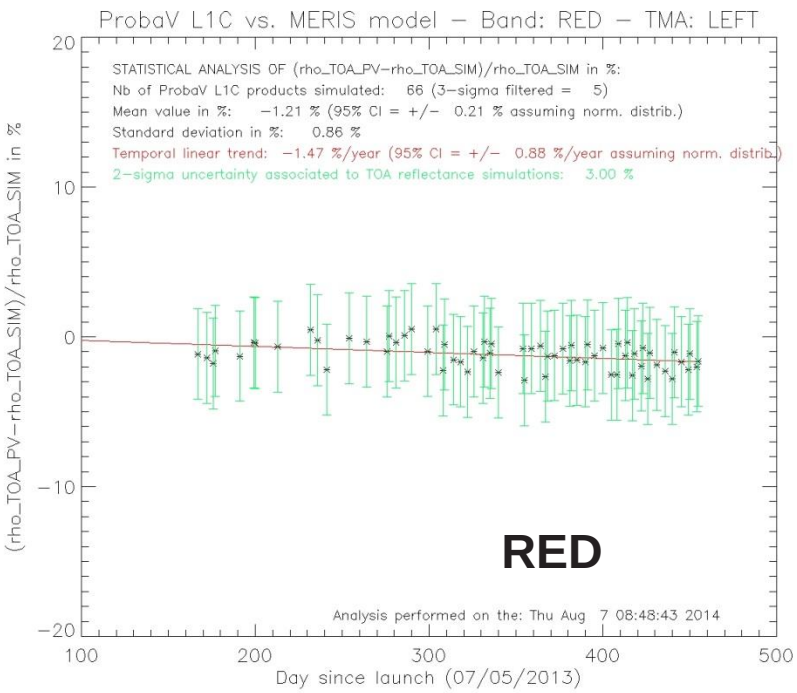


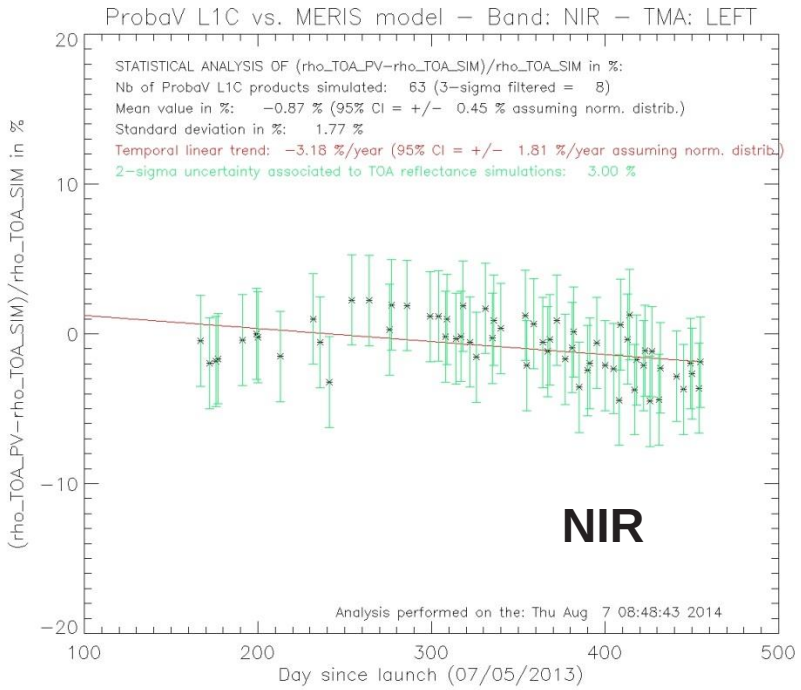


Oscar Libya-4 calibration - RIGHT





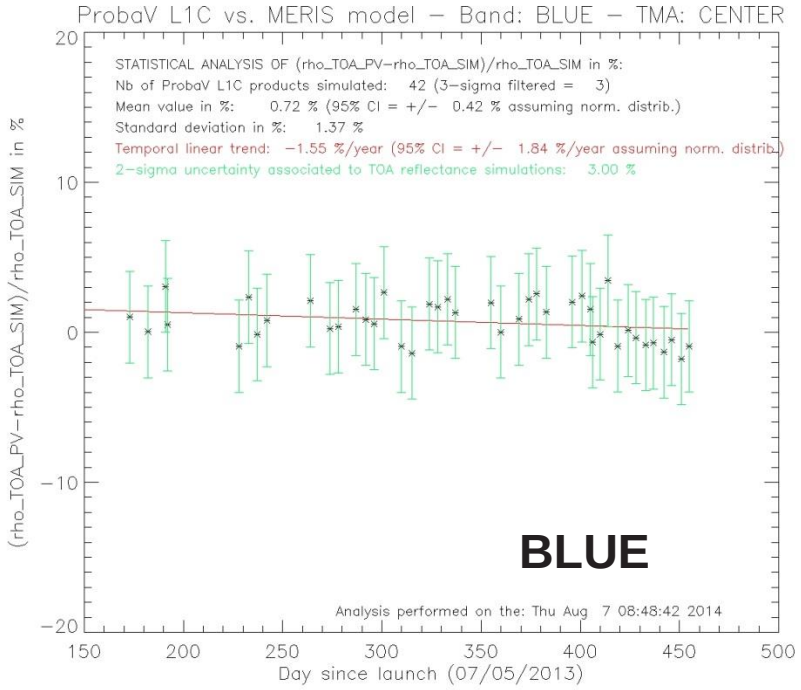


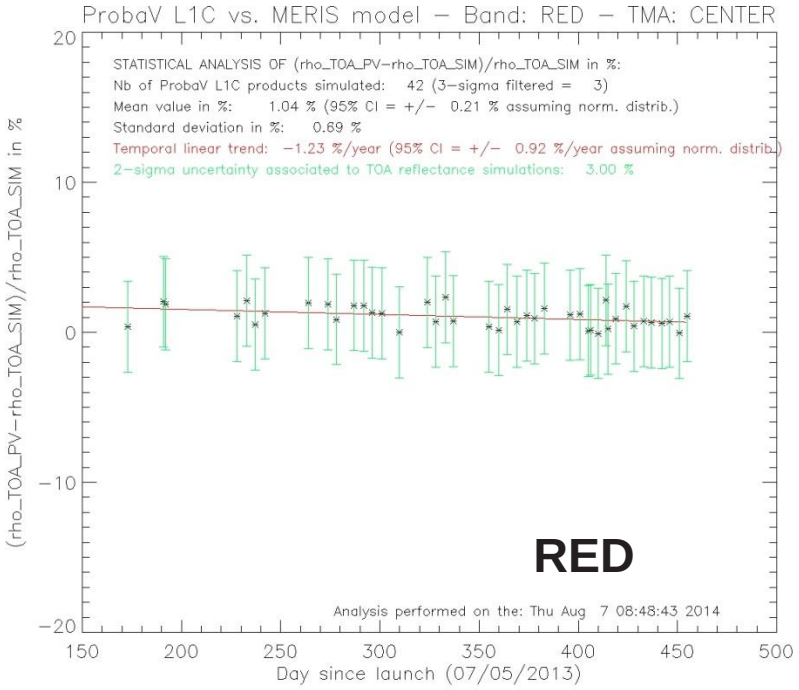


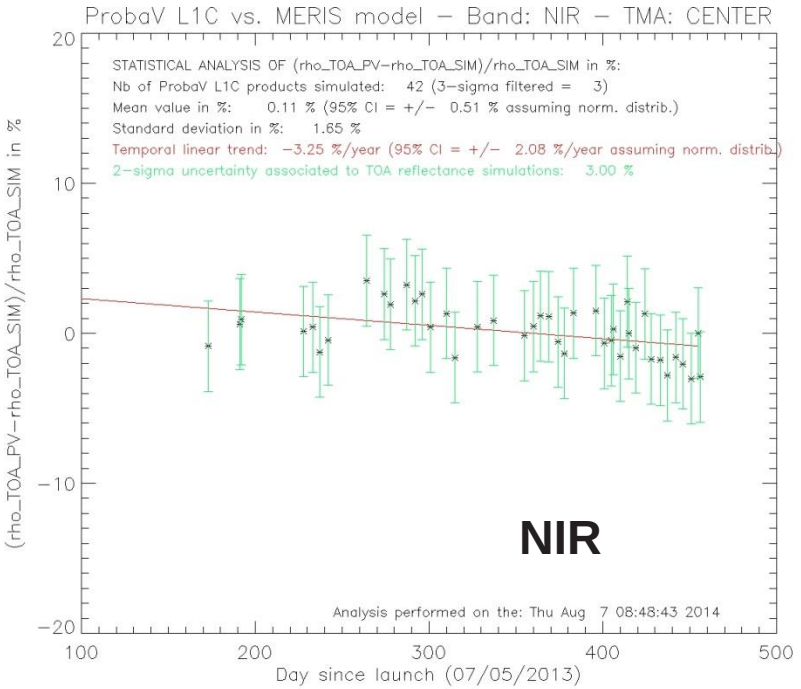
Libya-4 - LEFT

PROBA-V vs MERIS 3rd repr.

Bouvet M., RSE,140, 2014.



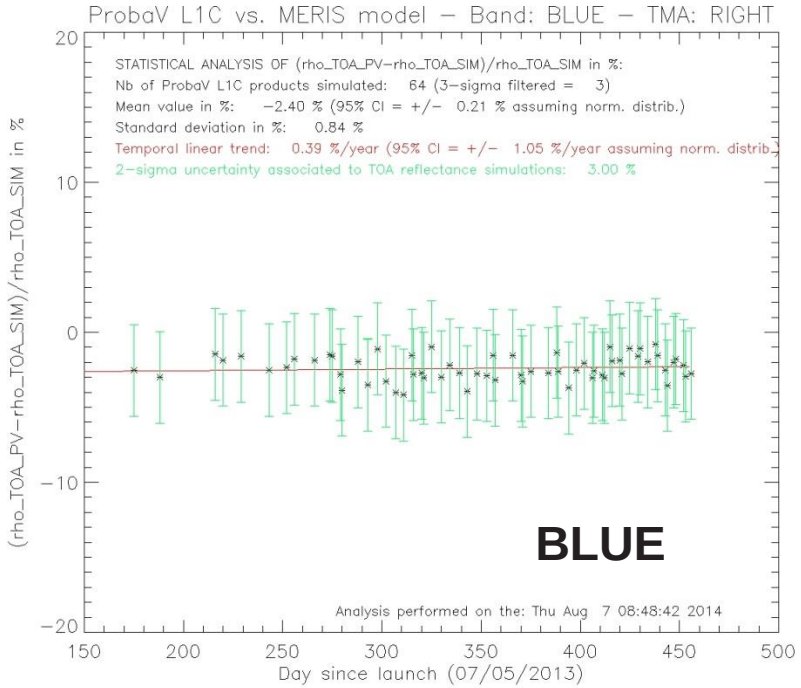


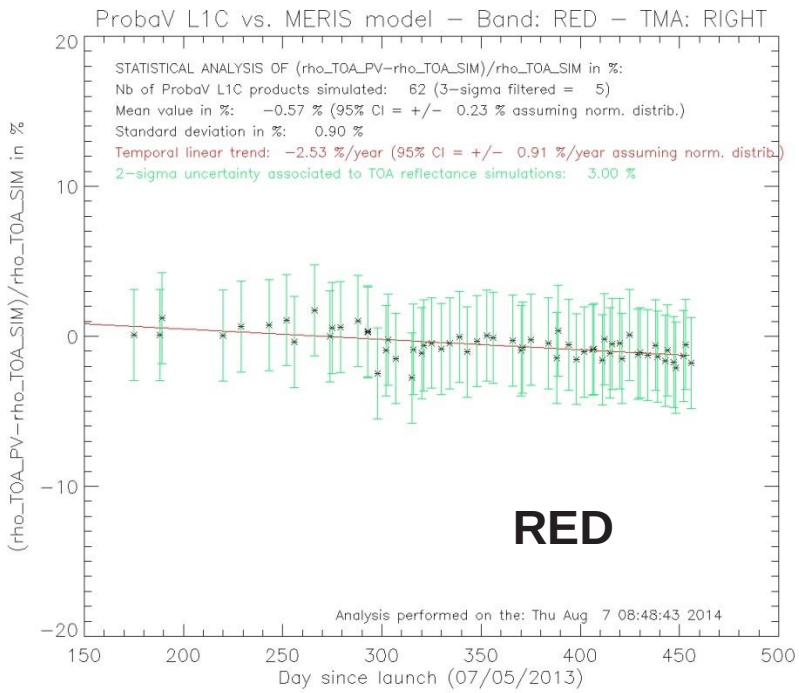


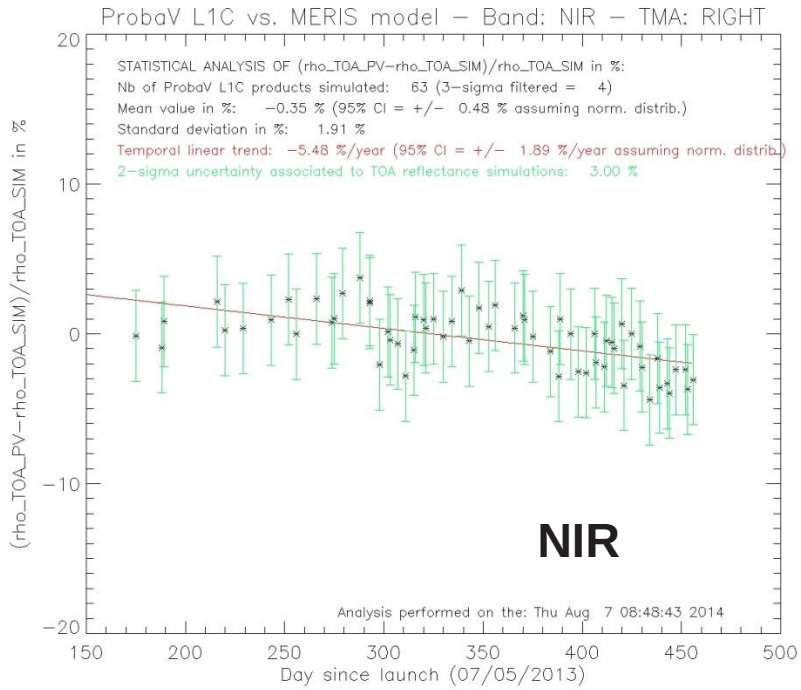
Libya-4 - CENTER

PROBA-V vs MERIS 3rd repr.

BOUVET M., RSE,140, 2014.







Libya-4 - RIGHT

PROBA-V vs MERIS 3rd repr.

BOUVET M., RSE,140, 2014.

Lunar Calibration

Moon = stable over thousands of years

Usage : stability monitoring

Implementation :

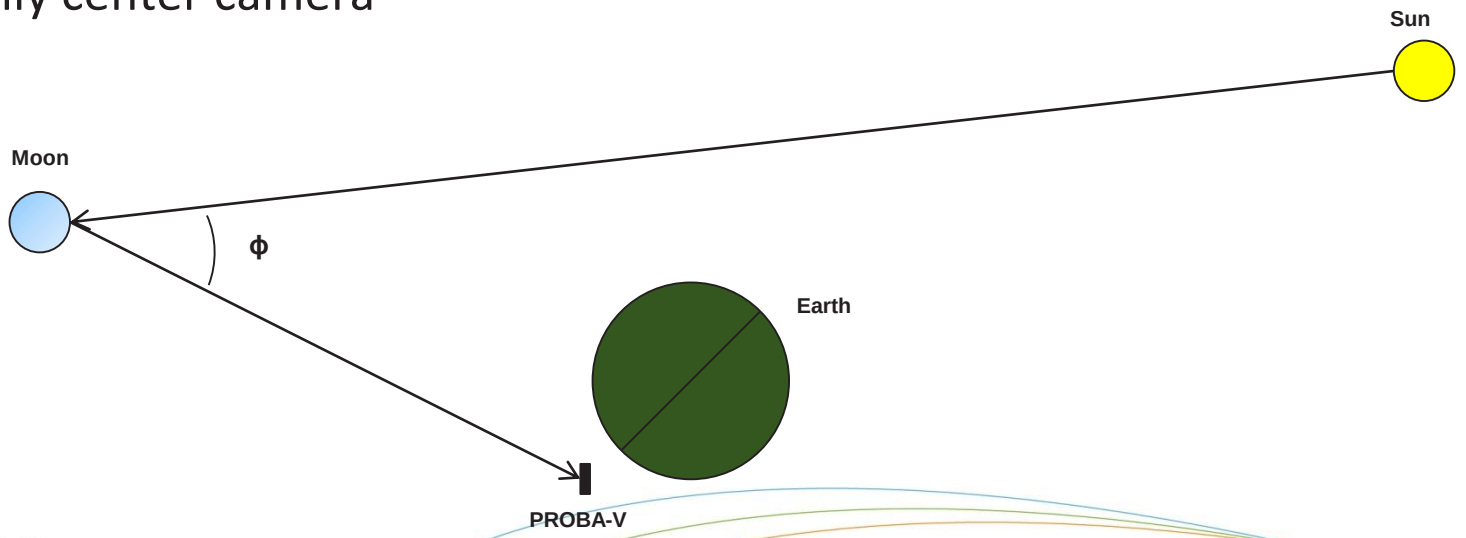
- Compute integrated irradiance
- Convert integrated irradiance to full disc reflectance and compare with a lunar reflectance model
- Monthly acquisition at same phase angle to reduce uncertainty

Other usage :

- MTF
- Dark current validation
- Straylight assessment

Observations

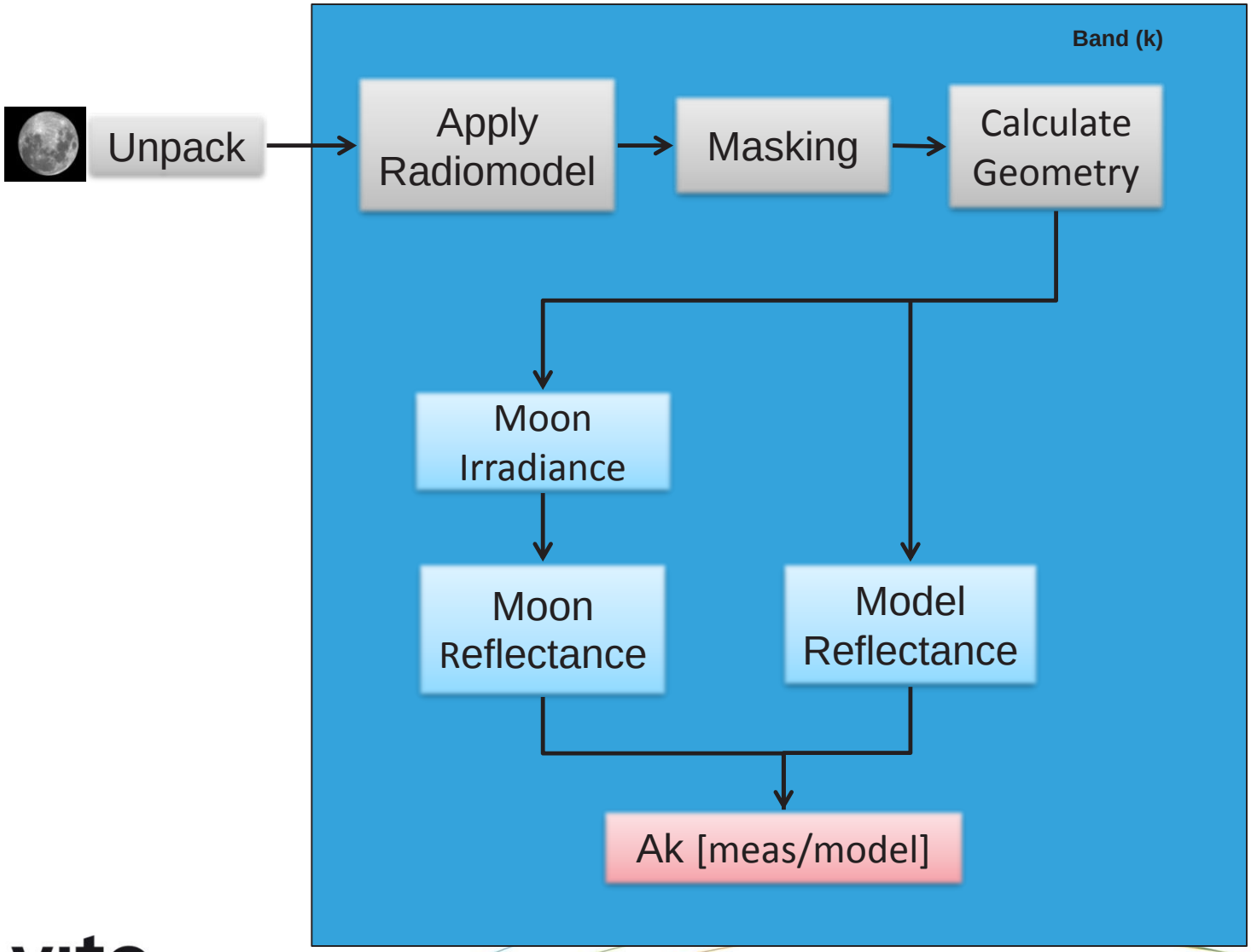
- Observation of the moon :
  - Phase angle 7° +/- 0.5 degrees (moon - observer - sun angle)
  - Waxing and waning
  - Pitch maneuver : 360 degrees rotation at approx. 0.2 degrees/s
  - Oversampling of +/-1.8
  - Only center camera



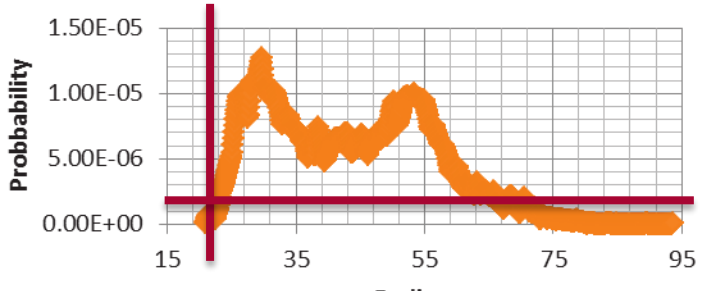
Lunar reflectance model

- USGS ROLO model implemented (311g)
  - **Kiefer and Stone, 2005**
  - Based on thousands of automated lunar observations
- Main model Input parameters :
  - Phase angle
  - Sun selenographic longitude
  - Observer selenographic lat and lon
  - Response curve
- Model returns ‘disc equivalent reflectance’
  - Smoothed to Apollo sand reflectance
  - Corrected for distance observer – moon and sun – moon

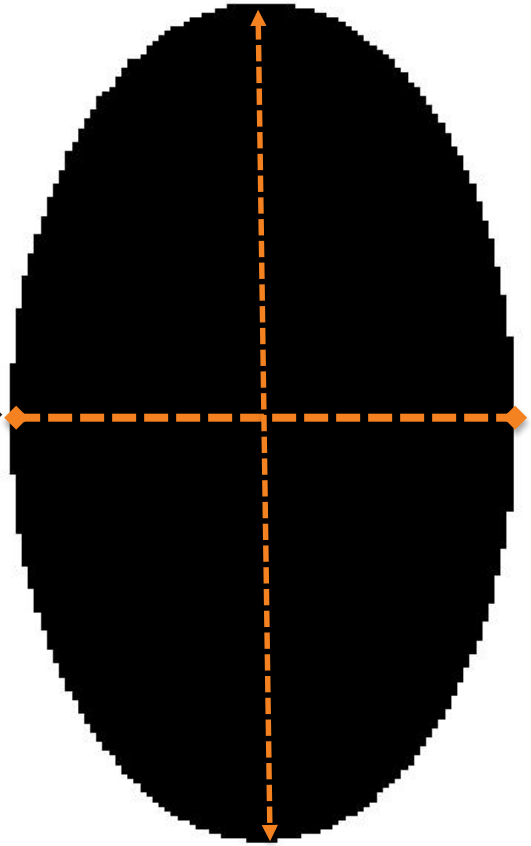
Workflow



Masking



mask



Pixel solid angle

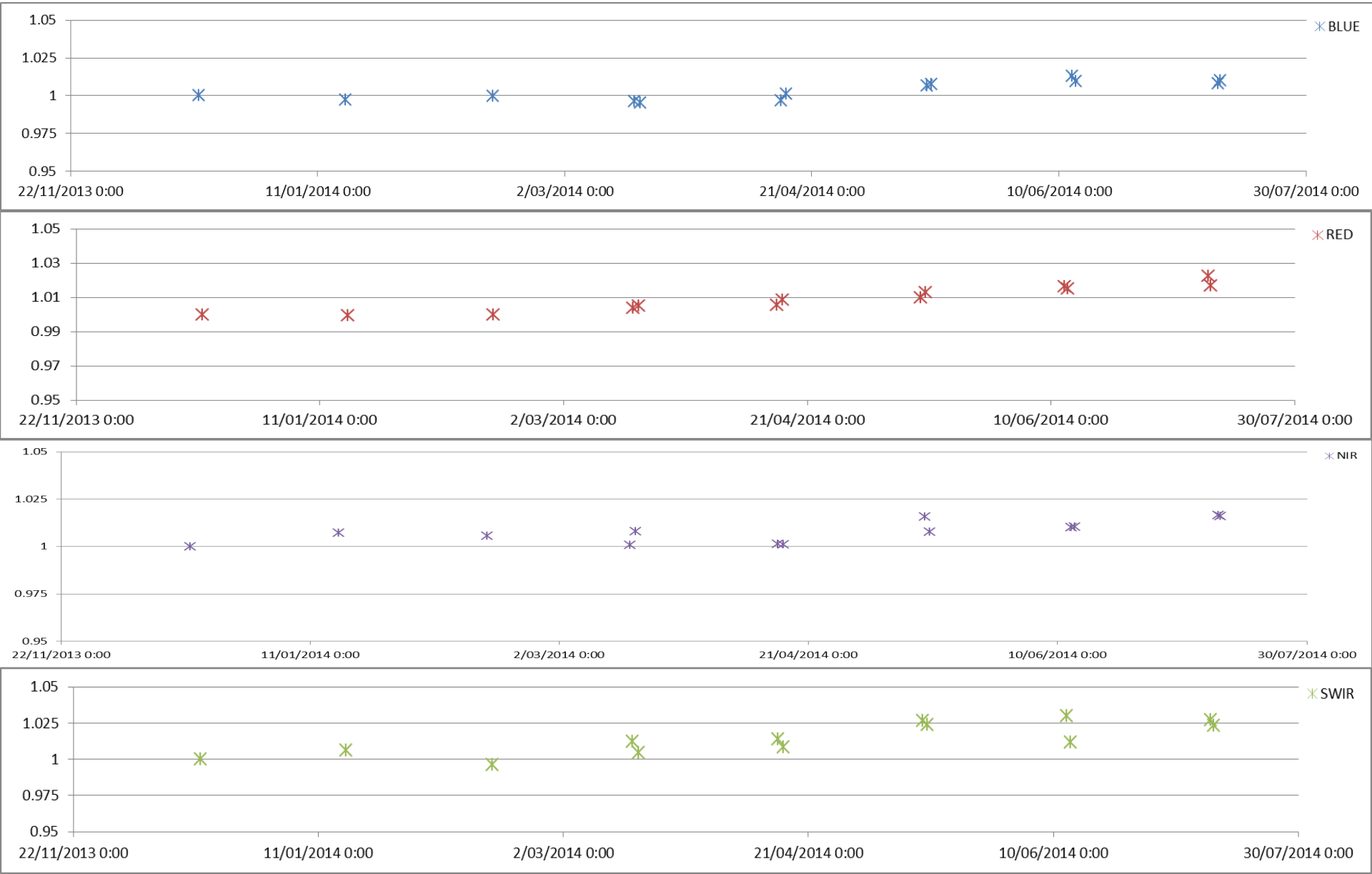
Center of observation

timestamp

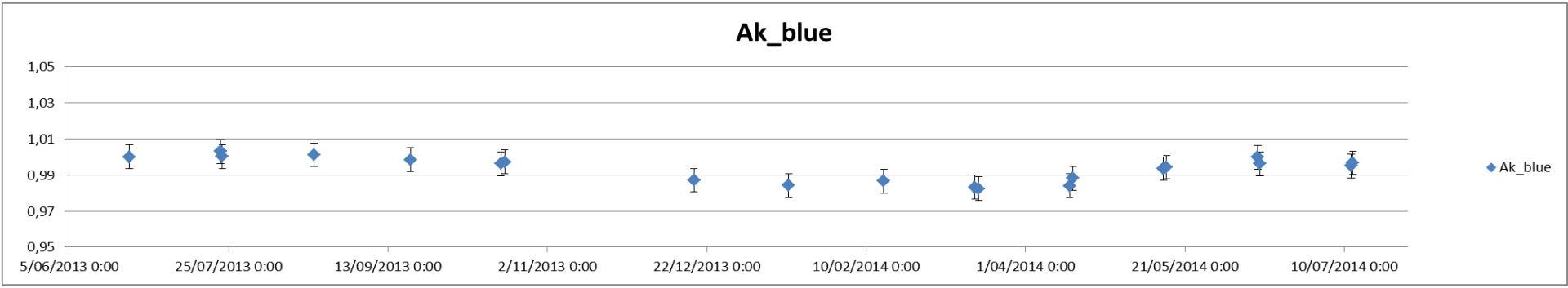
Masking

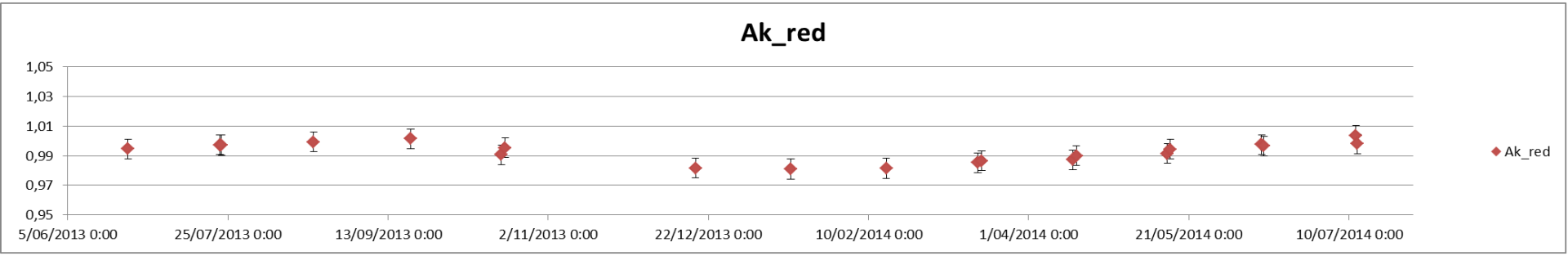
- Result strongly depend on correct masking
- Geometry :
  - Timestamp center line of the moon
  - Position of the moon, sun, earth and platform
  - Distances and angles between them
- Define pixel solid angle along track :
  - Conversion from radiance to disk eq reflectance :
    - pixel solid angle
    - integrate over disc

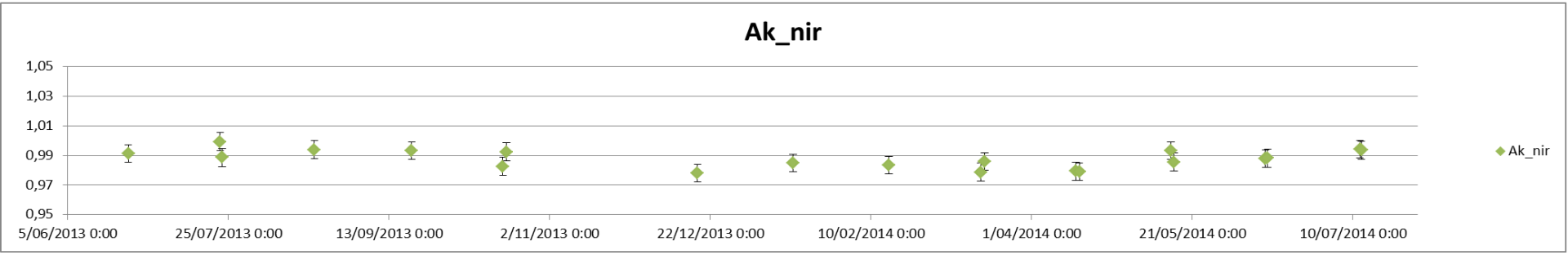
Stability monitoring lunar observations



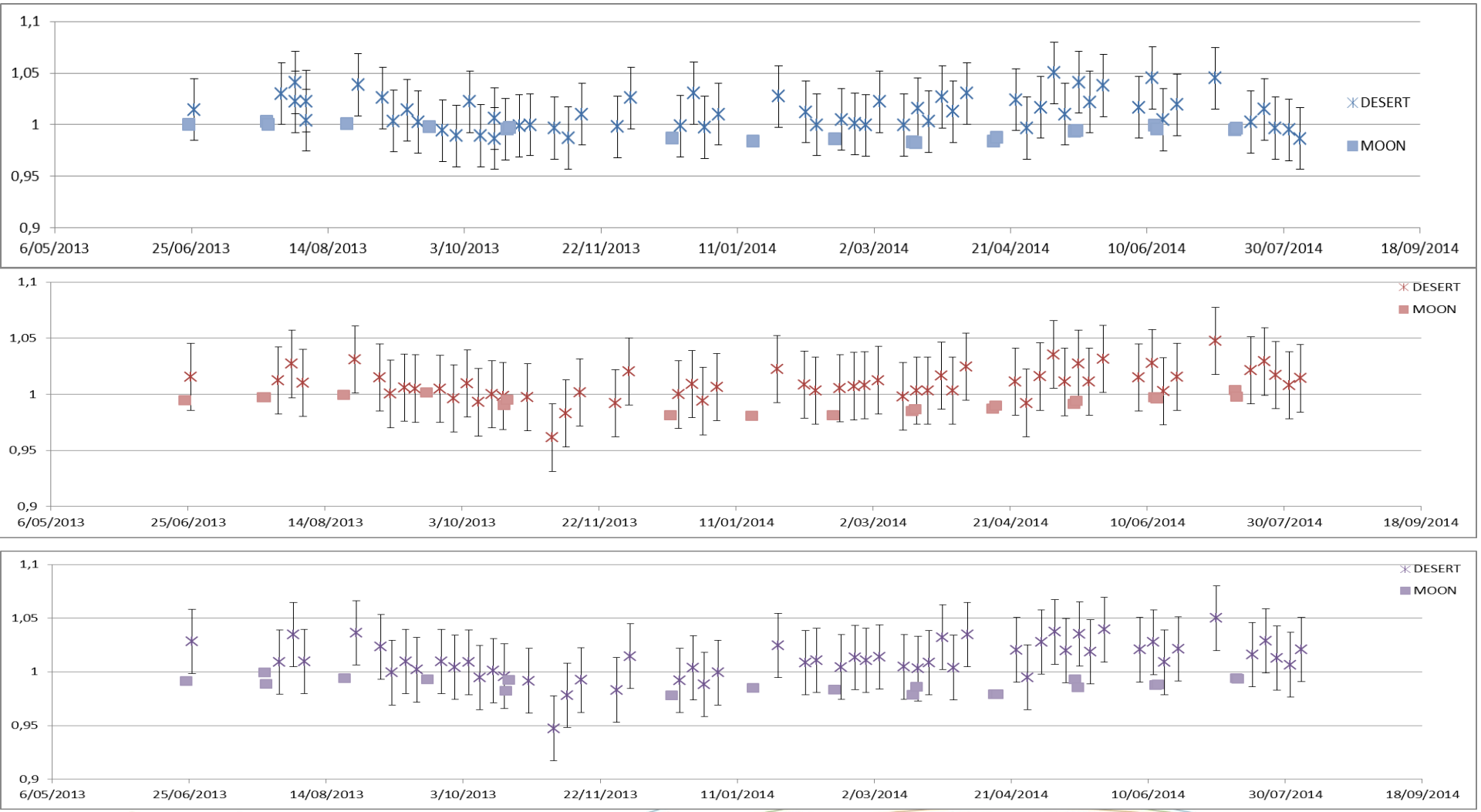
Absolute Calibration



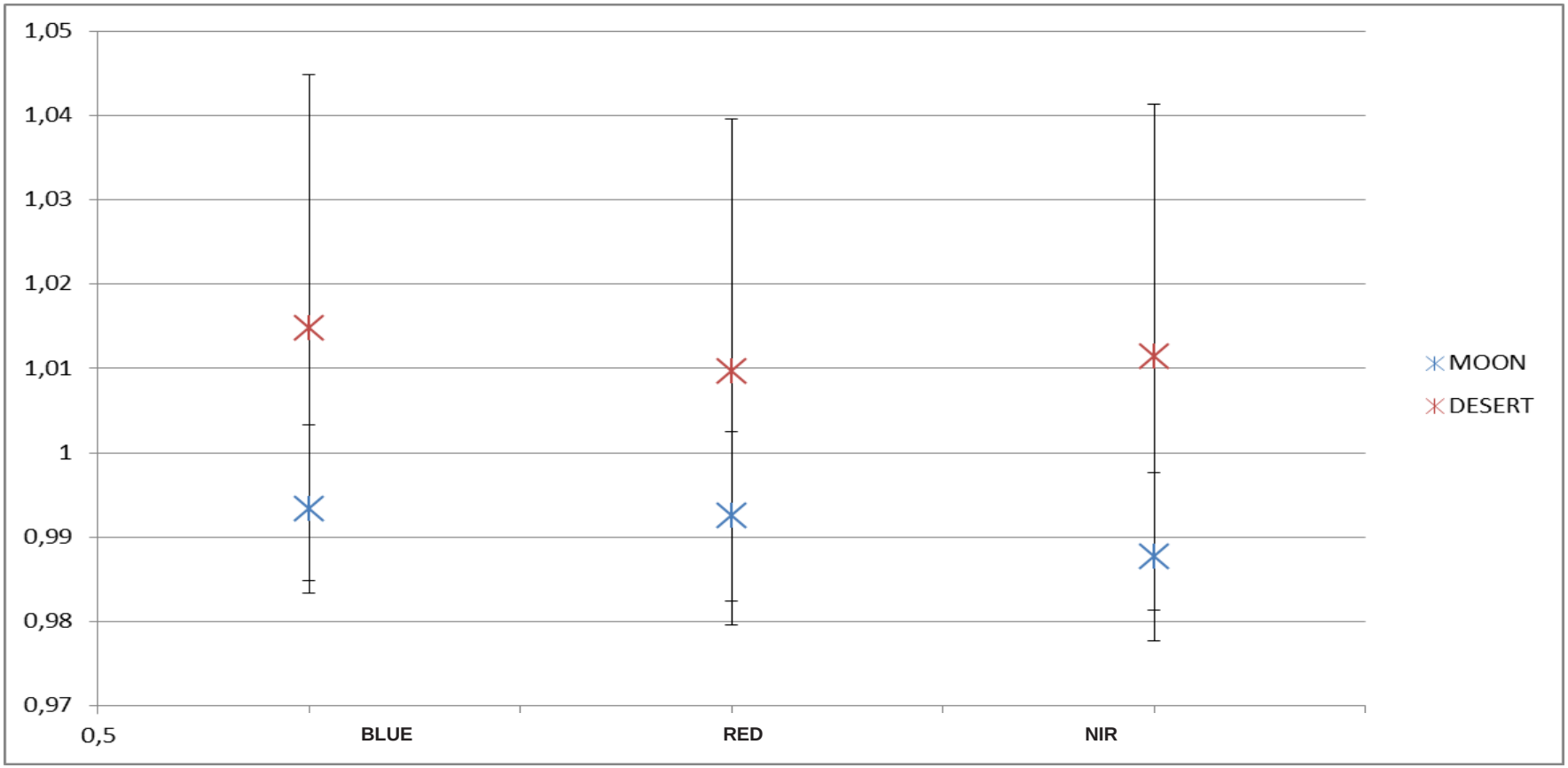




Comparison with desert



Comparison with desert



Conclusions

- PROBA-V behaves well !
- Lunar reflectance model is implemented and applied successfully
- It can be used for temporal stability monitoring
- Results for absolute calibration moon are in line with desert method.
- Verification/validation of the implementation still necessary
  - Participate Lunar Calibration Workshop organized by GSICS later this year.
- SWIR results

- Acknowledge :
  - T. Stone (USGS)

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