

Residual correlations in the solar diffuser measurements of the MODIS Aqua ocean color bands to the sun yaw angle

Presentation for SPIE meeting, August 2005

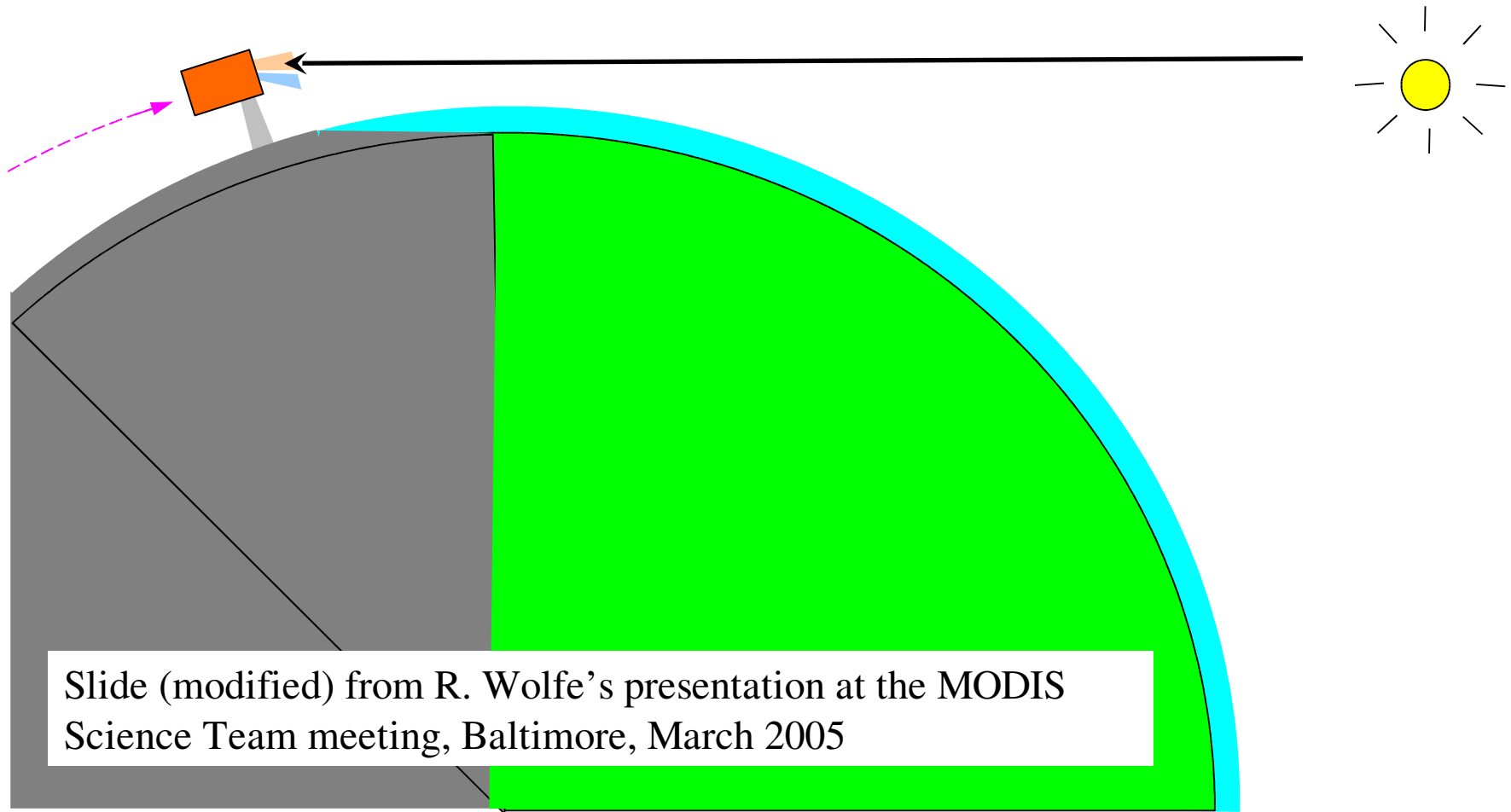
Gerhard Meister(*), Frederick Patt, Jack Xiong, Junqiang Sun, Xiaobo Xie, and Charles McClain

(*): presenting

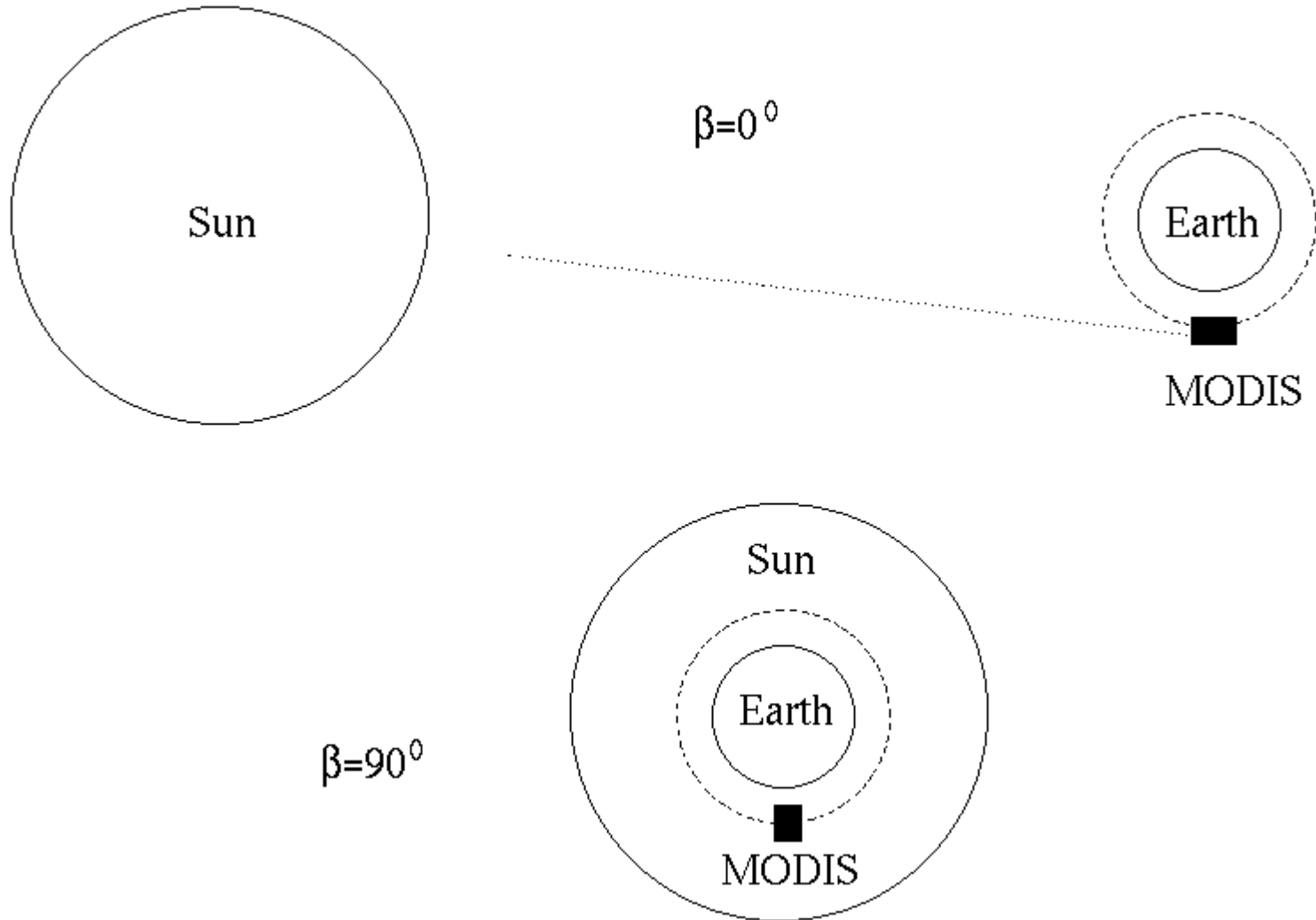
Overview

- Introduction
- Detector Ratios
- Vignetting Function
- Correction
- Summary

Simplified Solar Diffuser Geometry



'Sun-yaw' or beta angle



MODIS SD Measurement Setup (Waluschka et al., 2004)

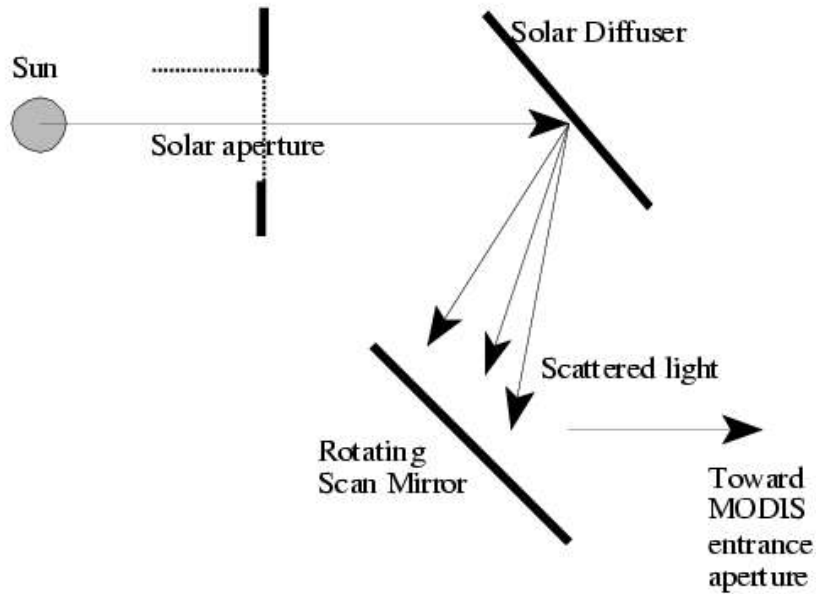


Fig. 4: Light path

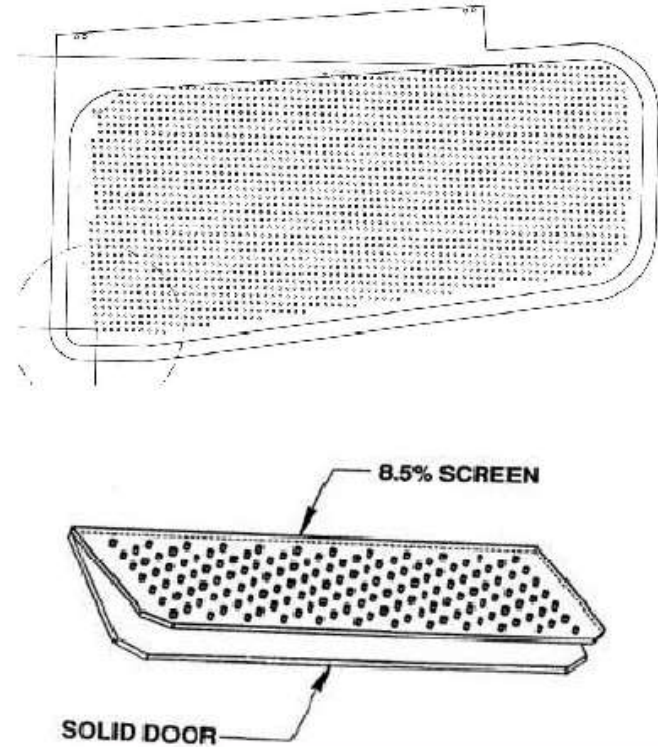


Fig. 5: Attenuation screen

MODIS Focal Planes

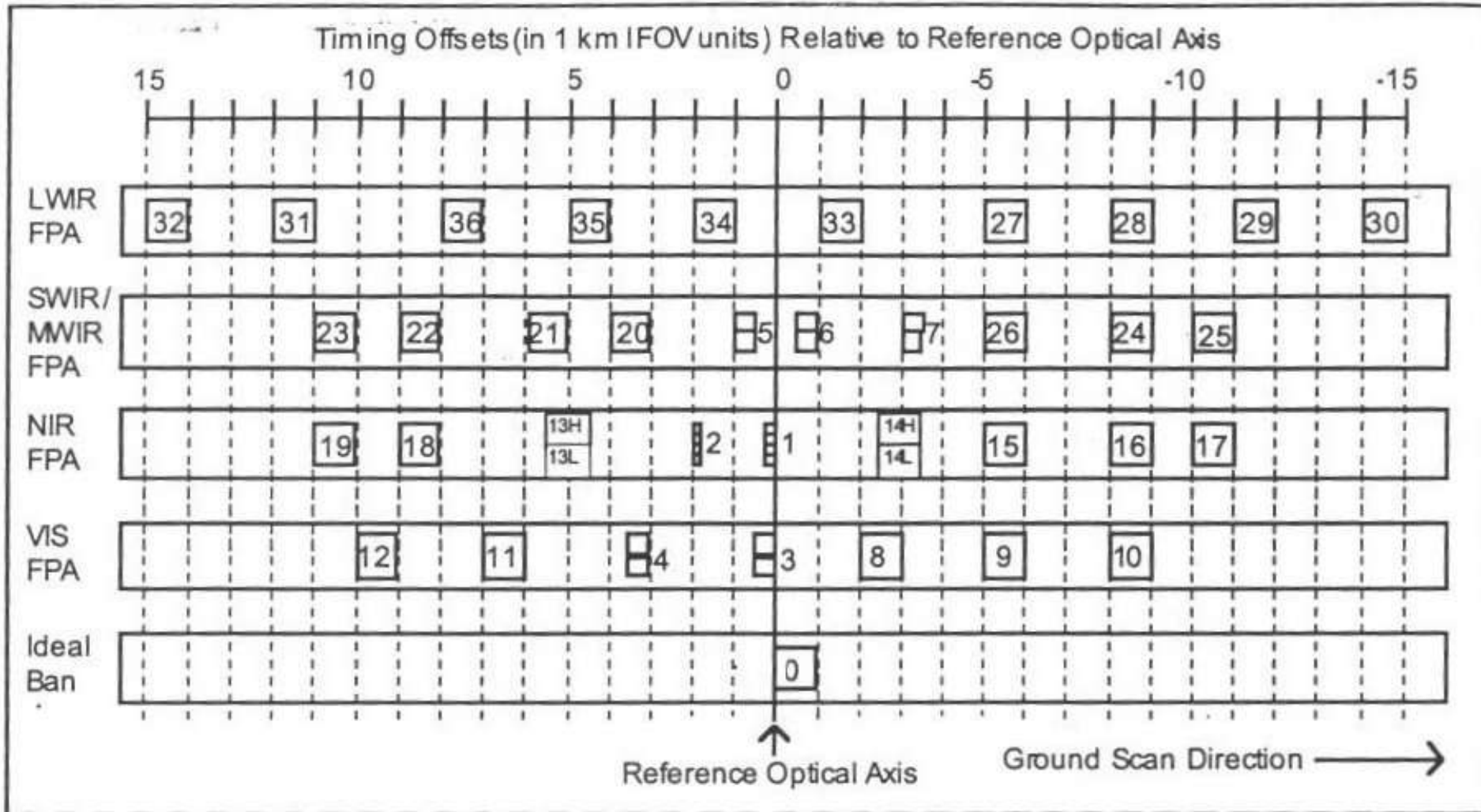


Figure 3-11. Offset of Each Band Relative to the Reference Optical Axis

Next slide: m1 measurements

- Provided by MCST
- Not used in calibration LUTs
- Calculated with:

$$m1 = \text{BRF} * \cos \theta * \Gamma * \Delta / (\text{dn}^* * d_{\text{ES}}^2)$$

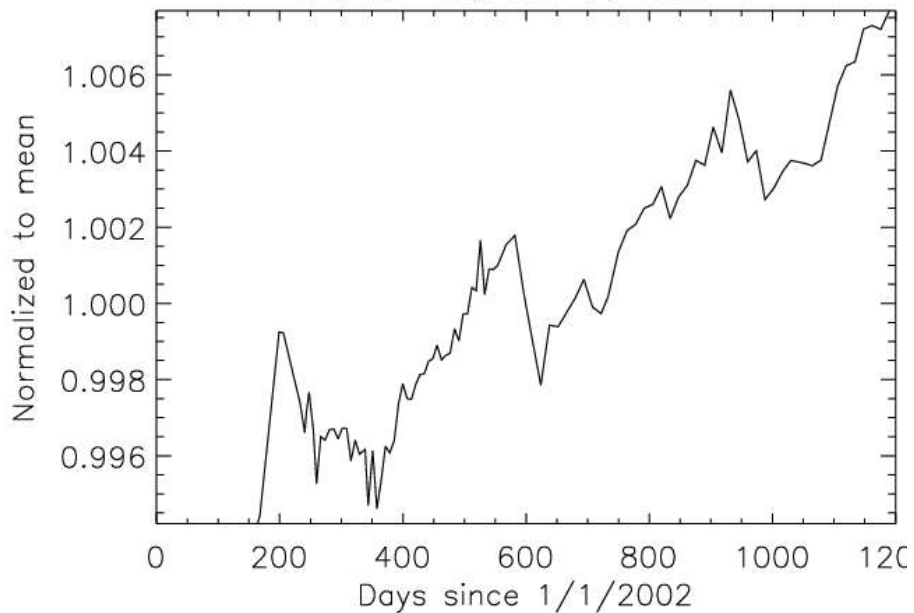
Γ = vignetting function from SD screen

Δ = SD degradation measured by SDSM

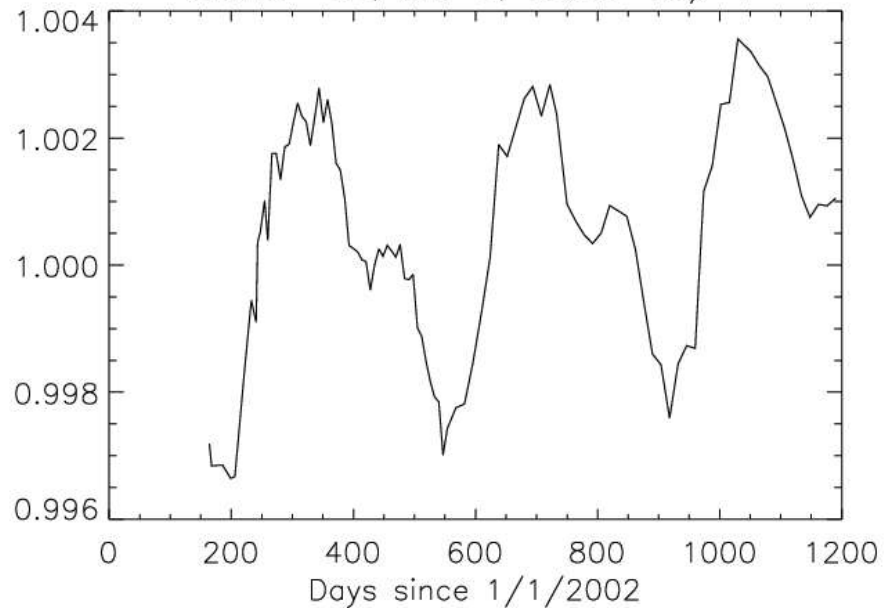
dn^* = measured counts minus dark current (temperature corrected)

d_{ES} = distance Earth-Sun

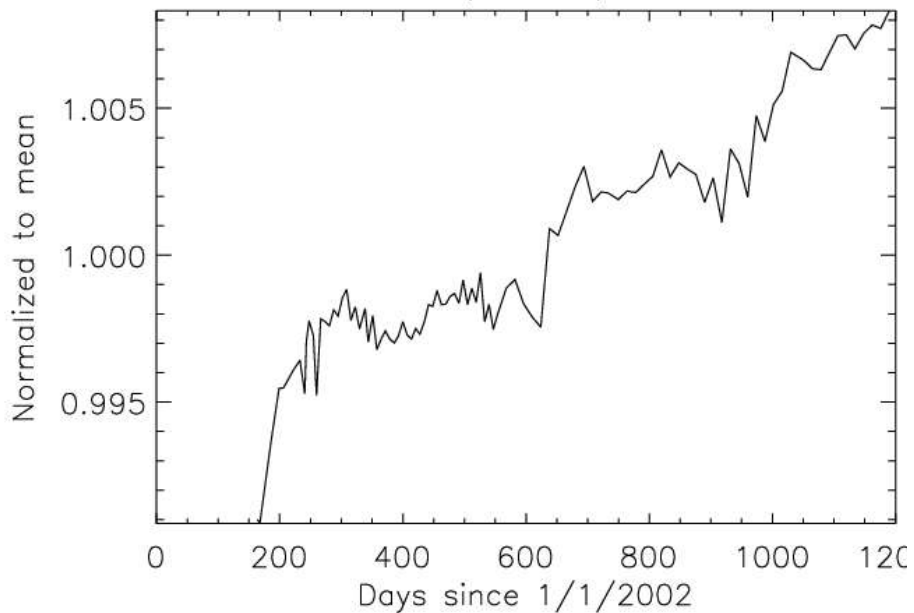
Band 12, MS 1, Det. 1



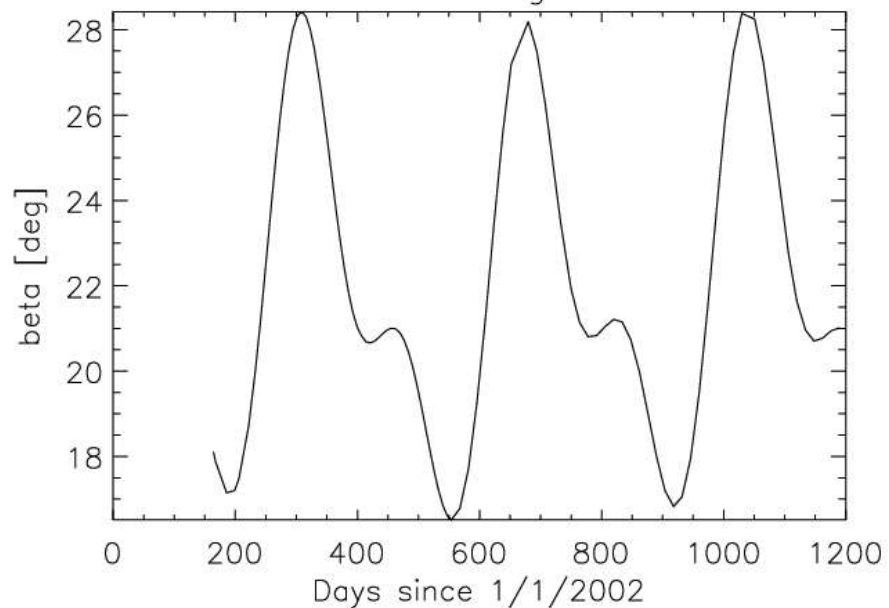
Band 12, MS 1, Ratio 10/ 1



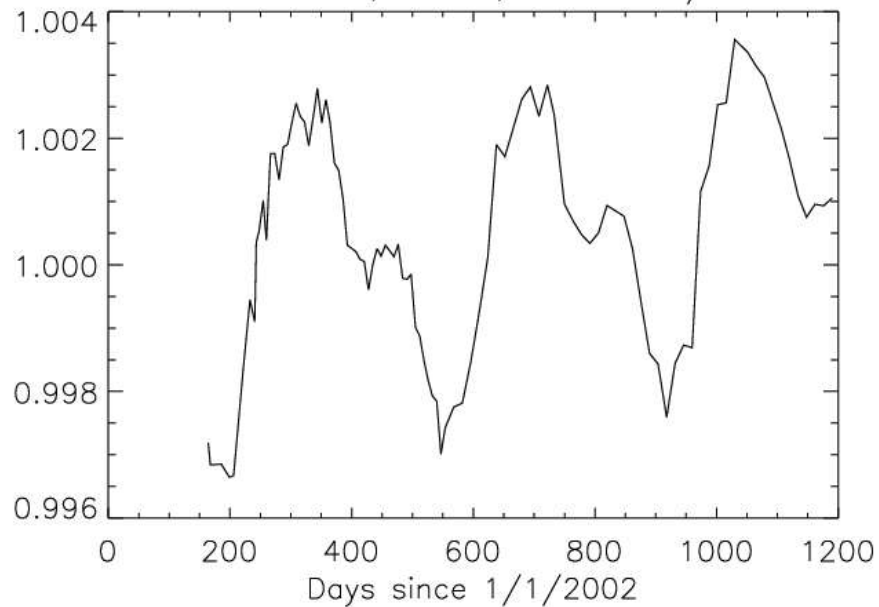
Band 12, MS 1, Det. 10



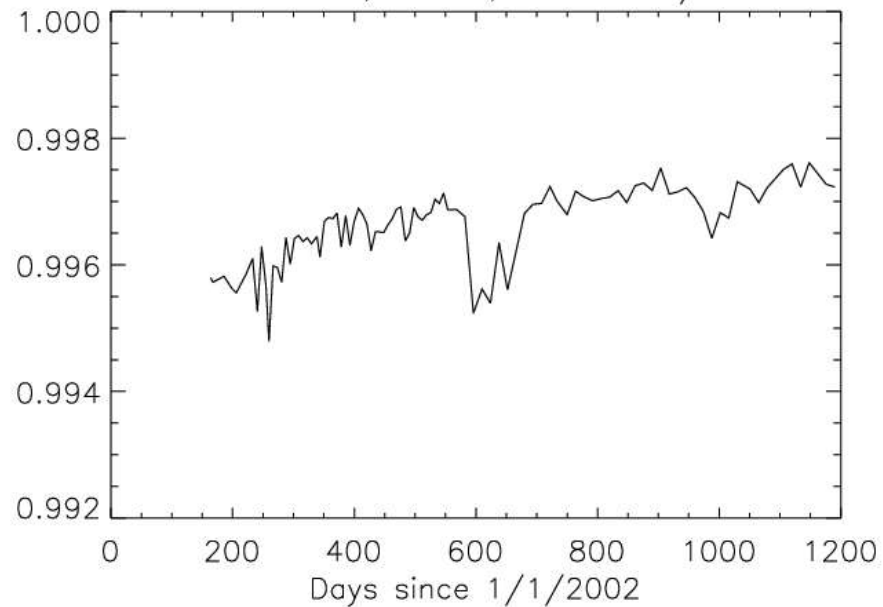
beta angle



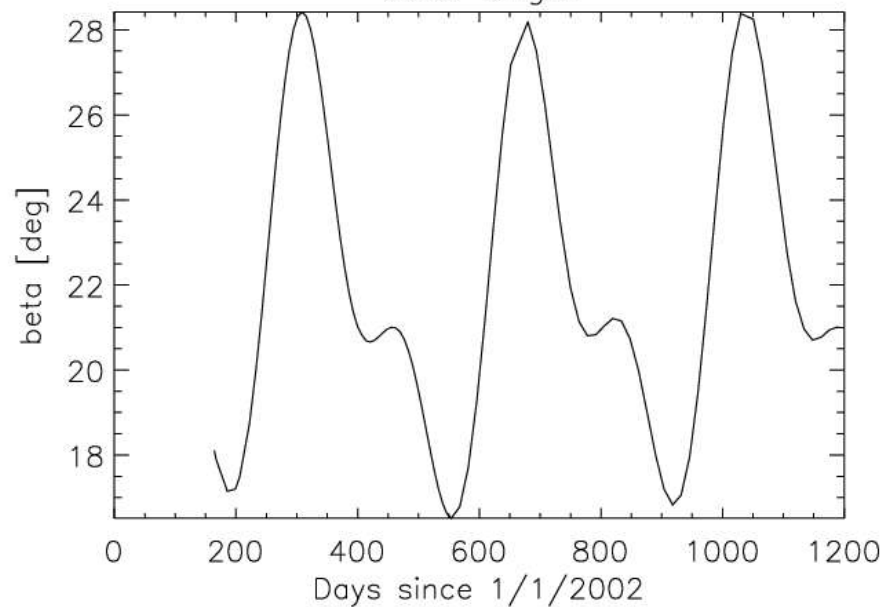
Band 12, MS 1, Ratio 10/ 1



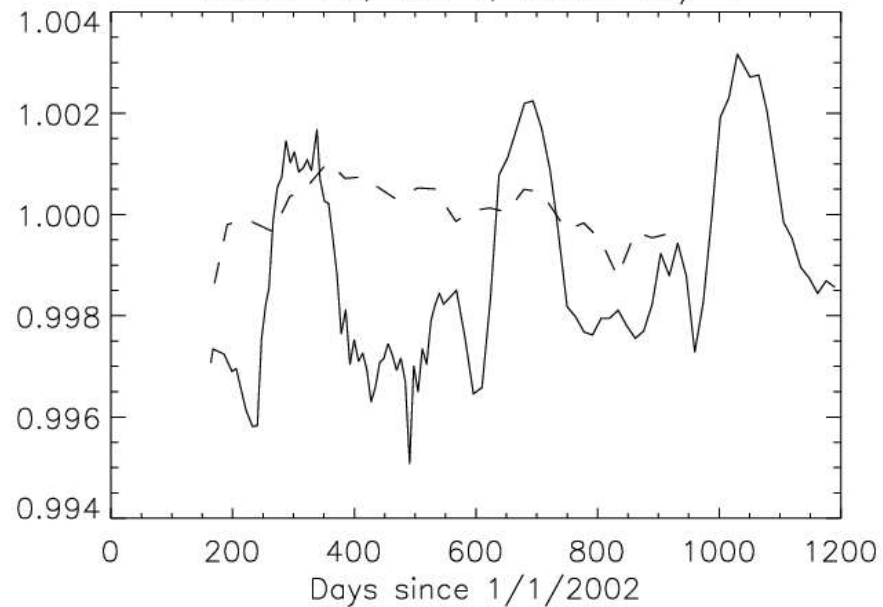
Band 19, MS 1, Ratio 10/ 1



beta angle

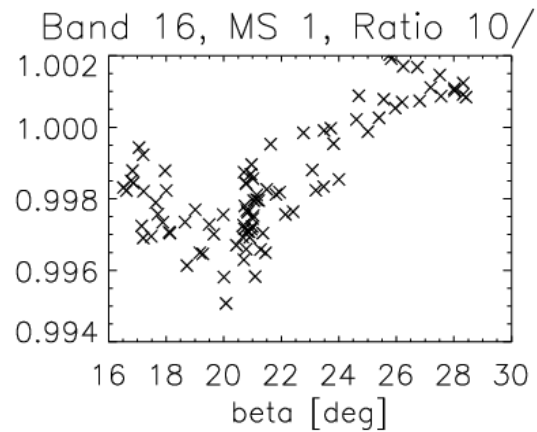
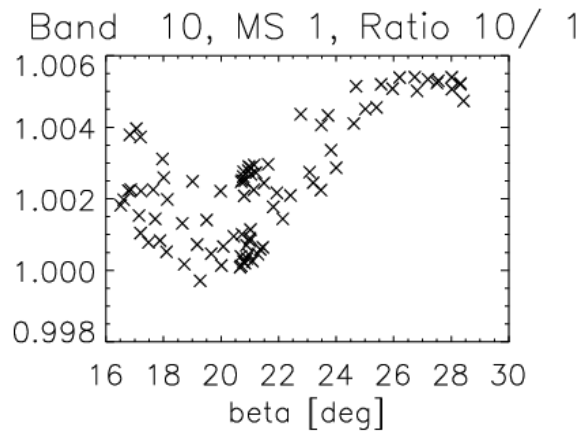
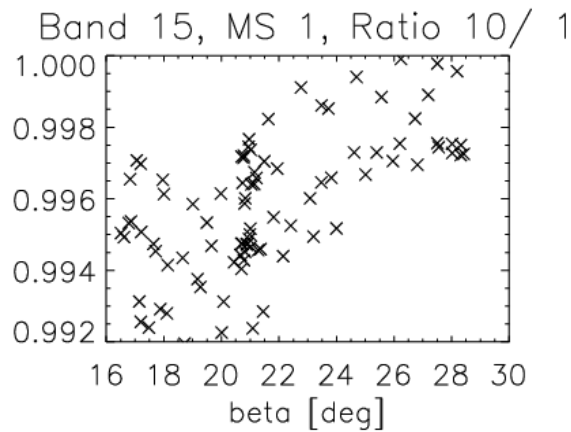
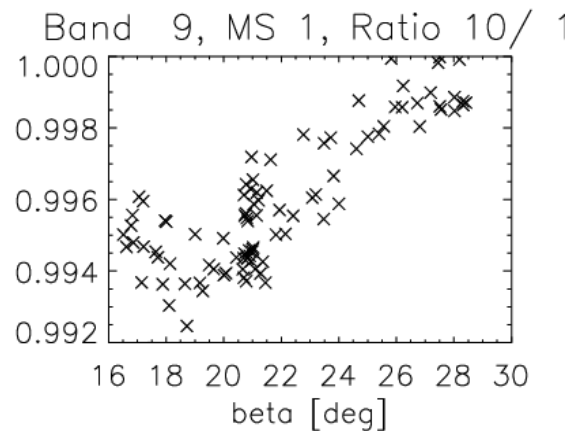
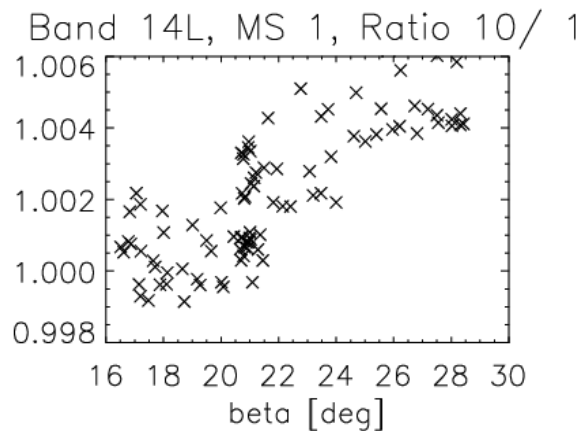
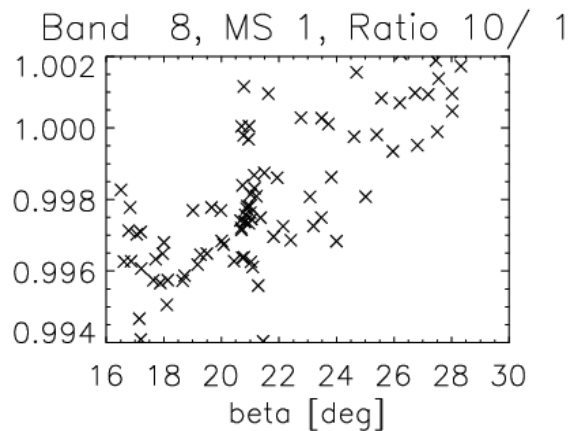
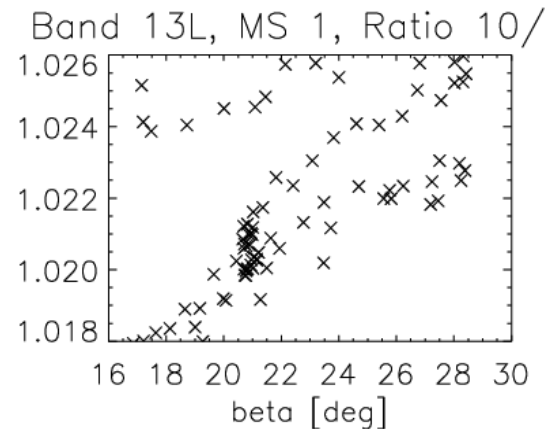
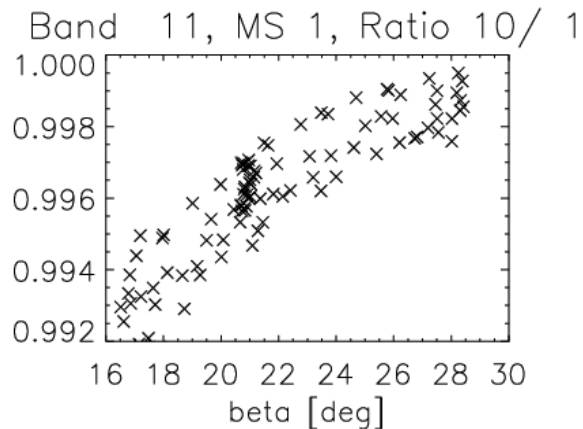
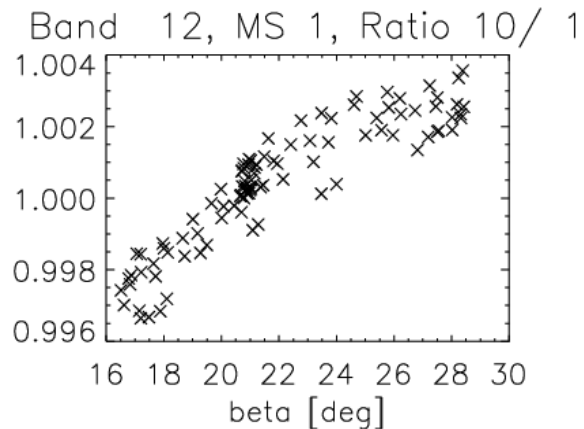


Band 16, MS 1, Ratio 10/ 1



Discussion of the beta angle correlation in the m1 detector ratios:

- it occurs only for bands calibrated with solar diffuser screen
- it does not occur for any band in the SRCA measurements
- **=> it is caused by the modeling of the solar diffuser screen (vignetting function)**



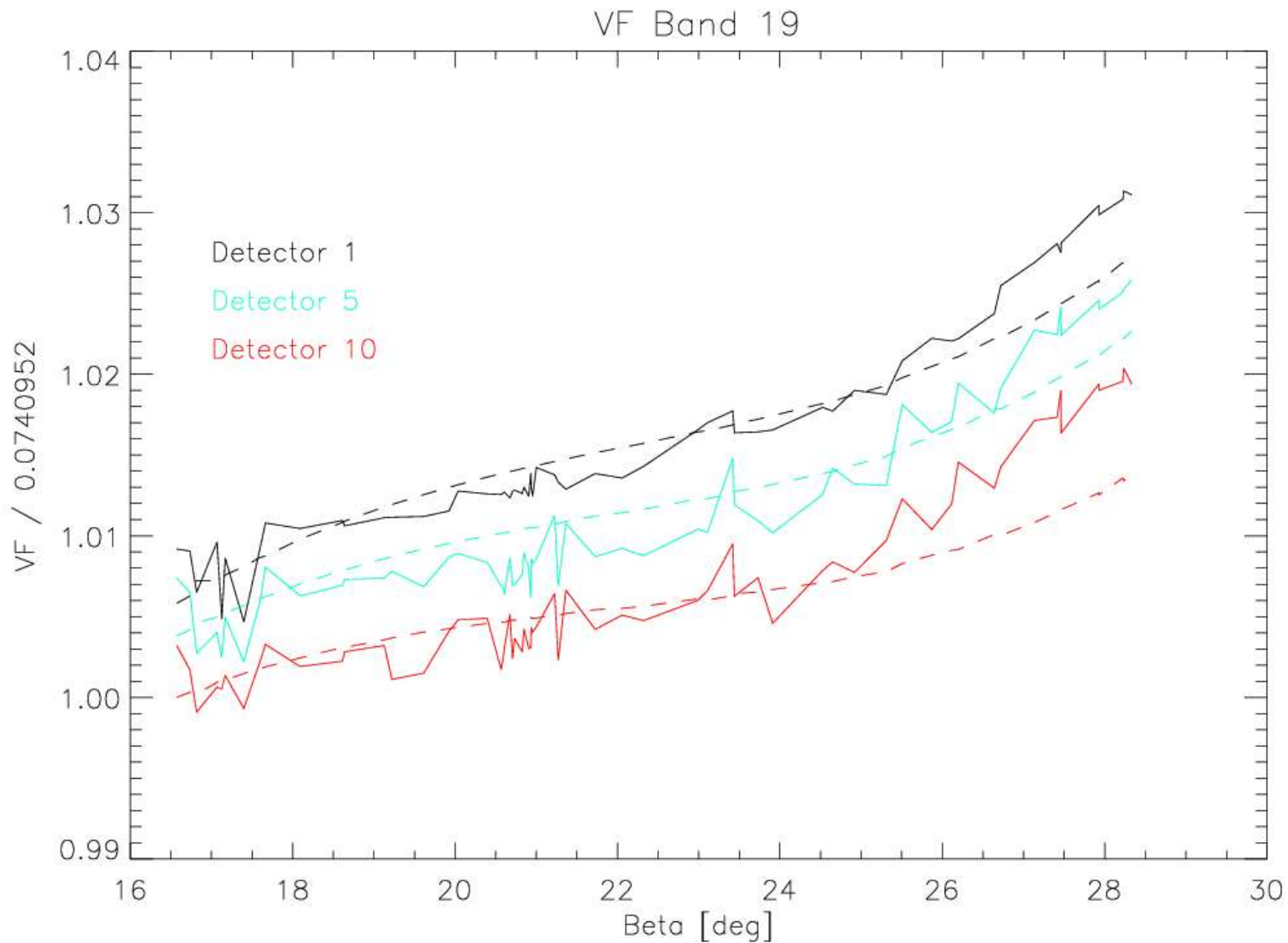
Conclusions:

- True vignetting function is detector dependent ($\sim 0.5\%$ effect)
- This detector dependence is probably band dependent ($\sim 0.2\%$ effect, determined by position on the focal plane)
- Open question: is the detector-averaged vignetting function also band dependent ?

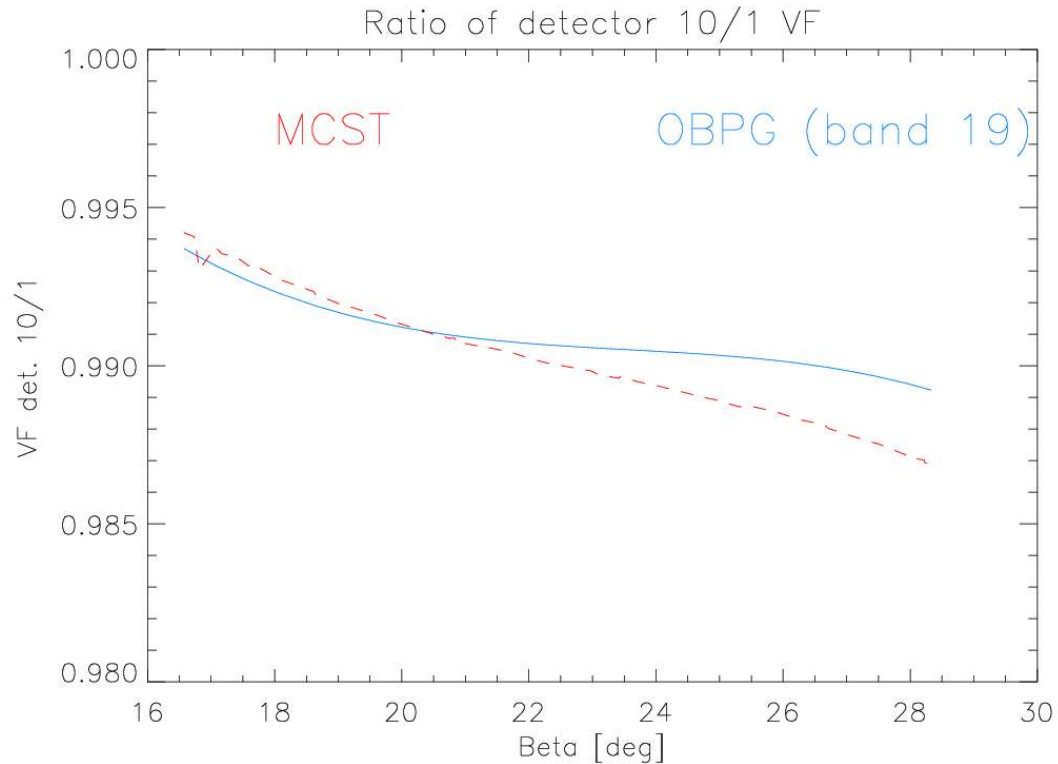
Vignetting function:

- Calculated by dividing screen measurements by no-screen measurements (bands 1-4, 17-19)
- Derived from early-mission yaw maneuver, averaged over bands and detectors
- Can also be derived from biweekly calibration measurements

Vignetting function: (dashed line: MCST (band average), solid line: OBPG)

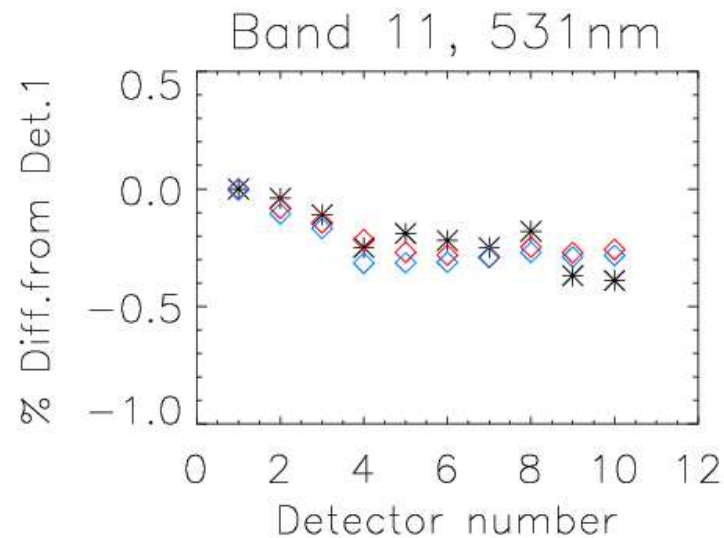
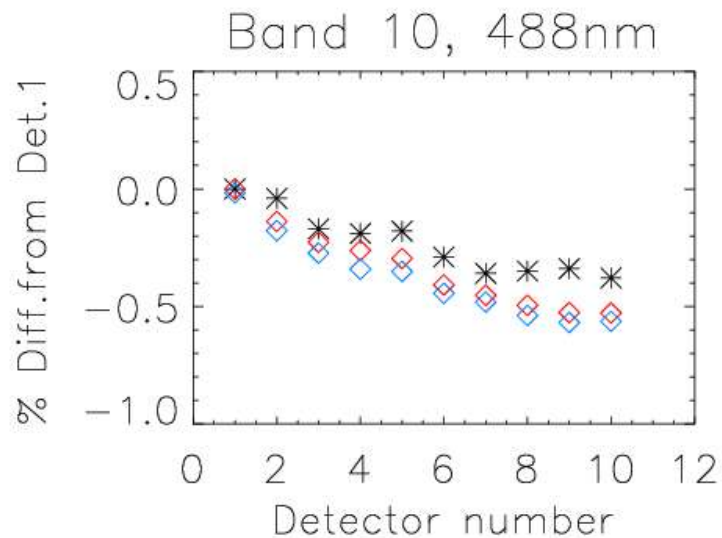
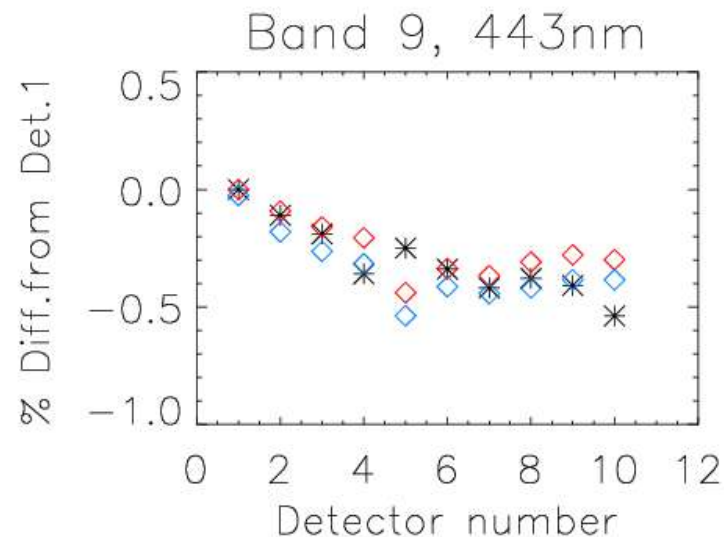
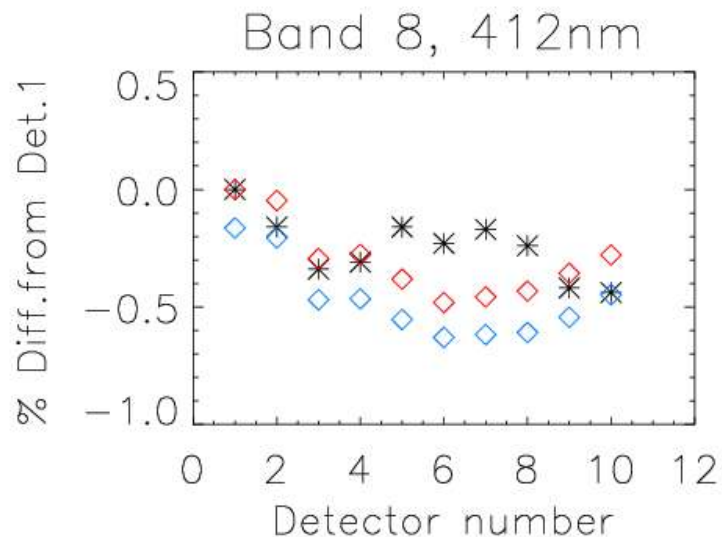


Detector 10/1 ratio from detector-dependent VF corrects detector ratio beta angle dependence...

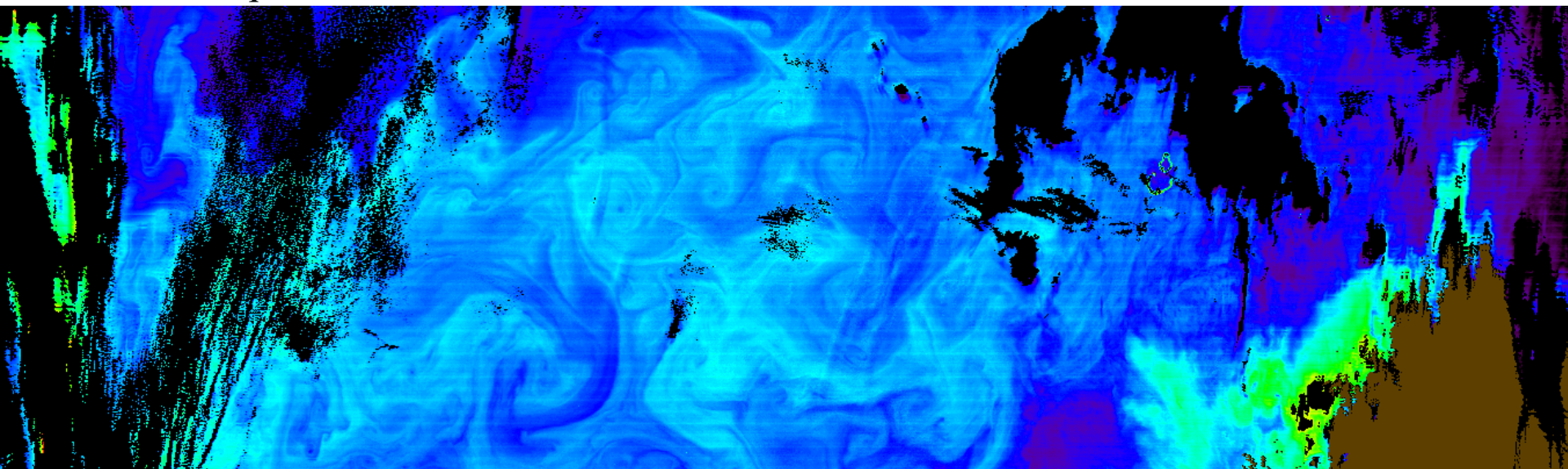


... but makes striping worse !

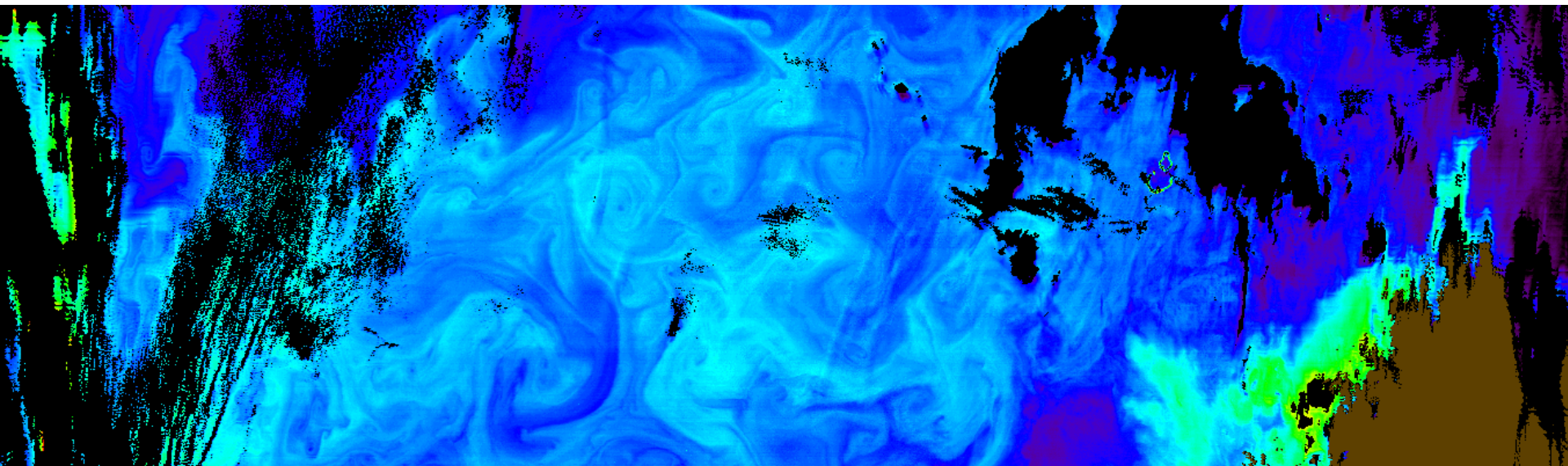
Comparison of TOA analysis (red and blue diamonds for two mirror sides) to lunar analysis of MCST (*):



MODIS Aqua nLw 412nm, before correction:



After correction:



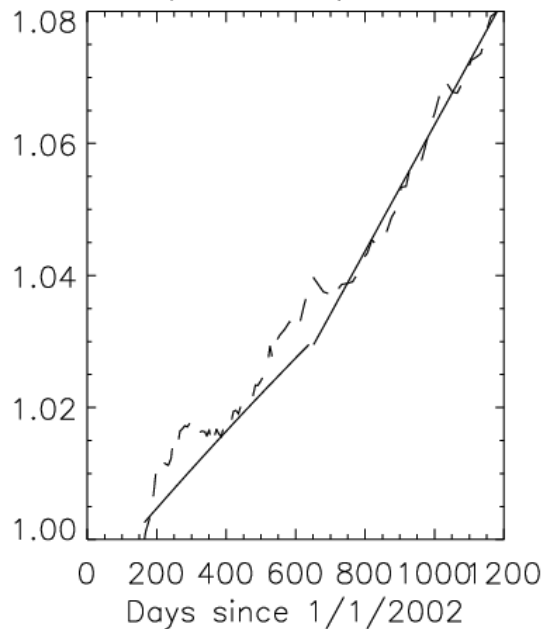
Discussion:

- Detector dependent vignetting function reduces beta angle dependence in detector ratio, but increases striping
- Beta angle dependence of the detector ratio is similar for both yaw-maneuver and biweekly vignetting function
- Raytracing study (D. Moyer, E. Waluschka) predicts vignetting function independent of band and detector

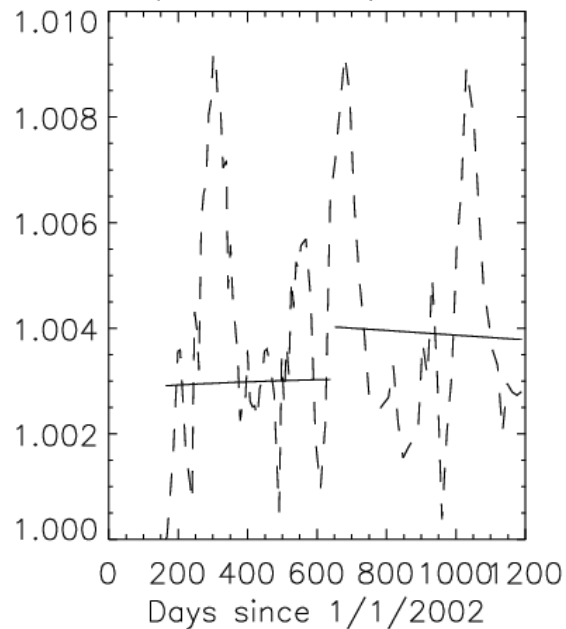
Correction of calibration measurements:

- Beta angle influences SD (BRF) and screen (vignetting function) modeling
- Beta angle should not directly influence detector/optics degradation
- => remove **all** correlations to the beta angle from calibration measurements

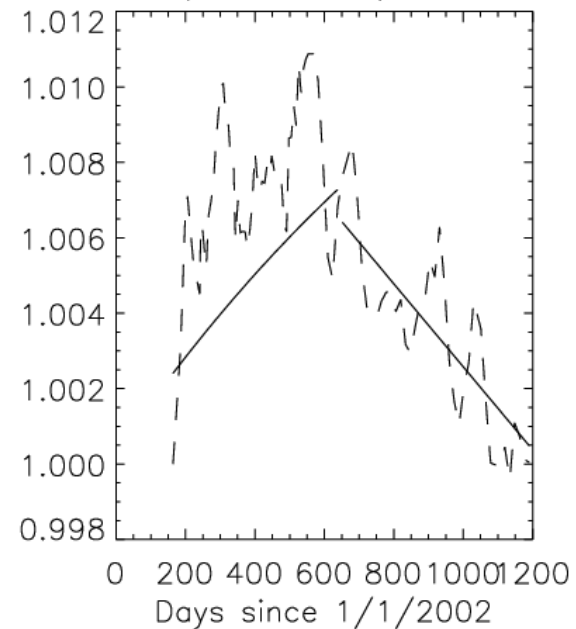
m1, band 8, Det. 5



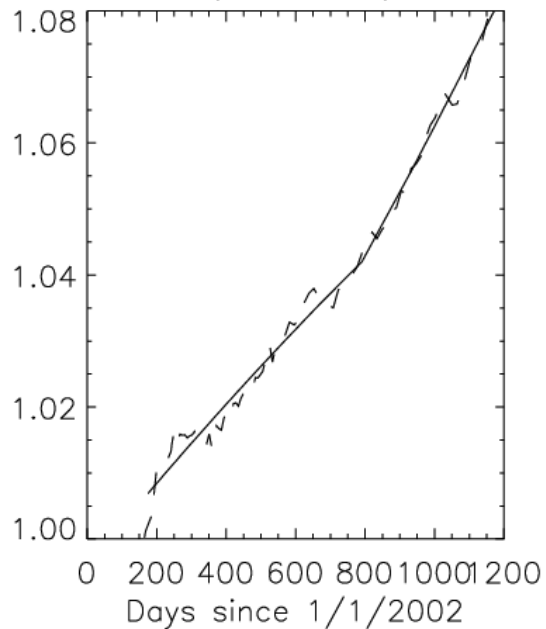
m1, band 14L, Det. 10



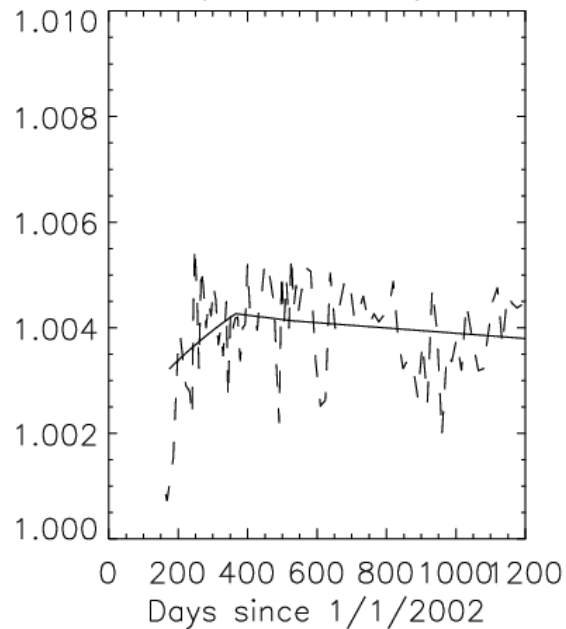
m1, band 15, Det. 1



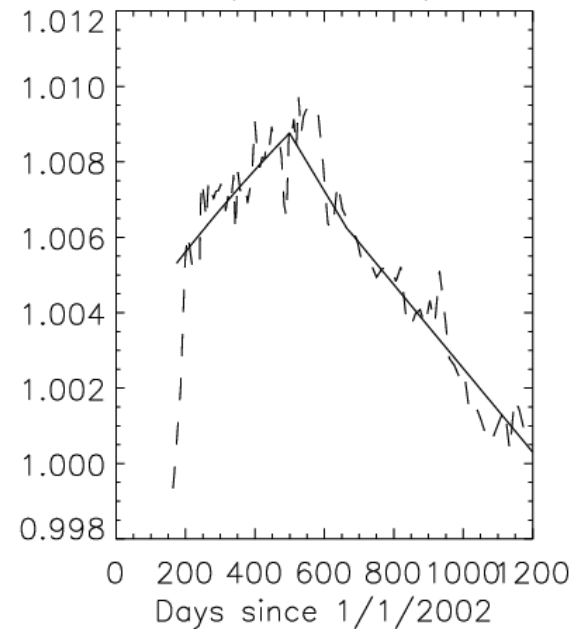
Corr.m1, band 8, Det. 5



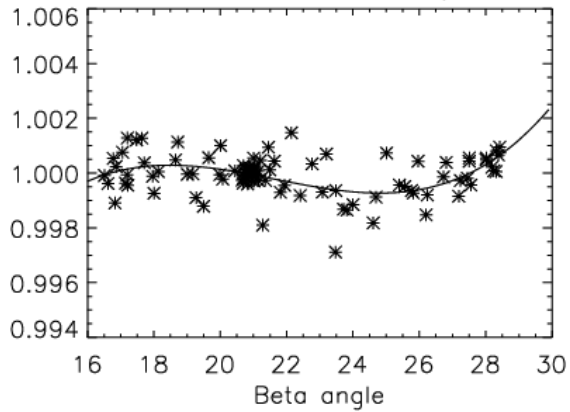
Corr.m1, band 14L, Det. 10



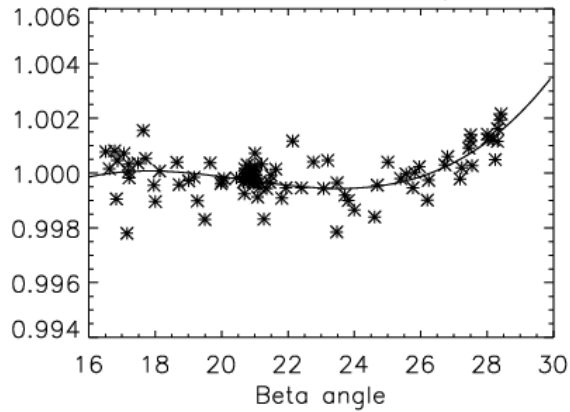
Corr.m1, band 15, Det. 1



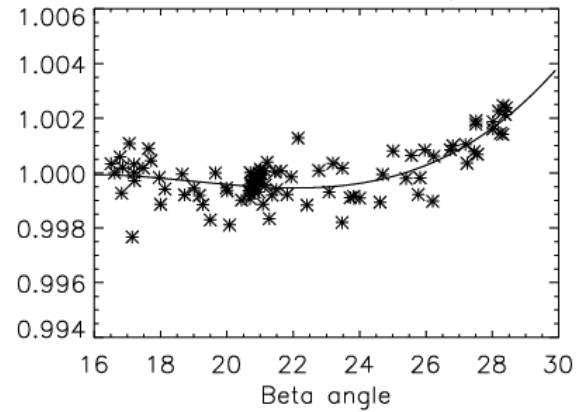
Residuals for Band 12, Det. 5



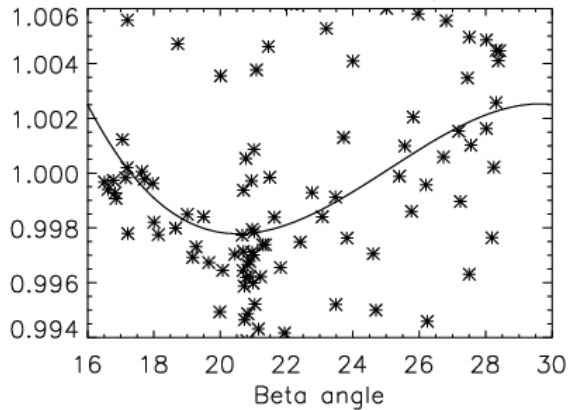
Residuals for Band 11, Det. 5



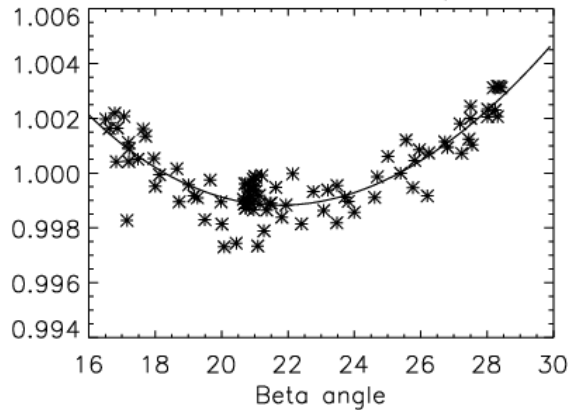
Residuals for Band 13L, Det. 5



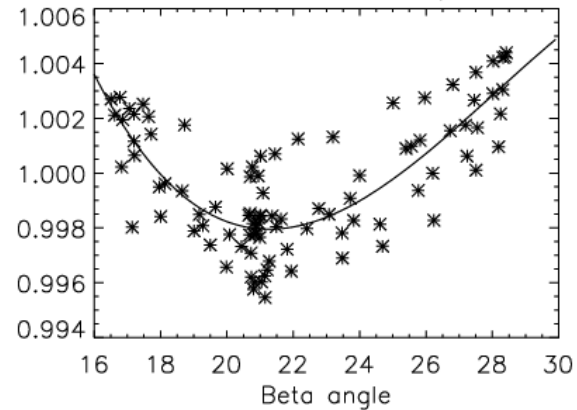
Residuals for Band 8, Det. 5



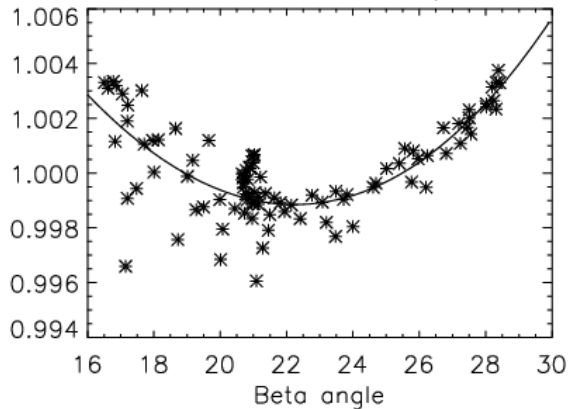
Residuals for Band 14L, Det. 5



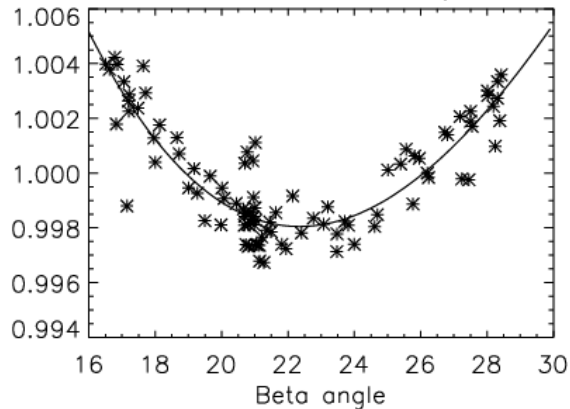
Residuals for Band 9, Det. 5



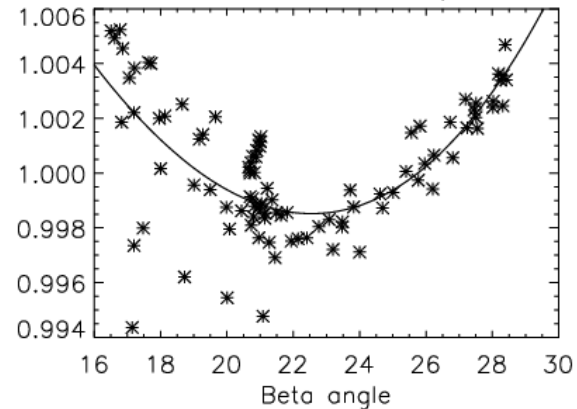
Residuals for Band 15, Det. 5



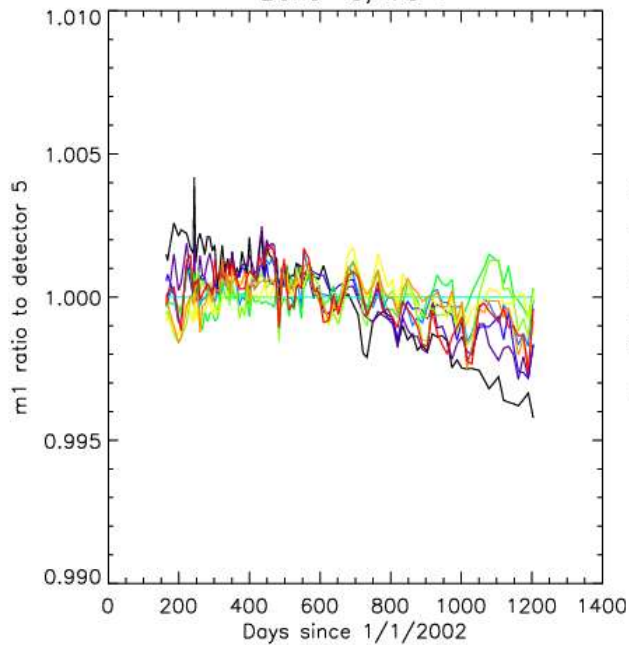
Residuals for Band 10, Det. 5



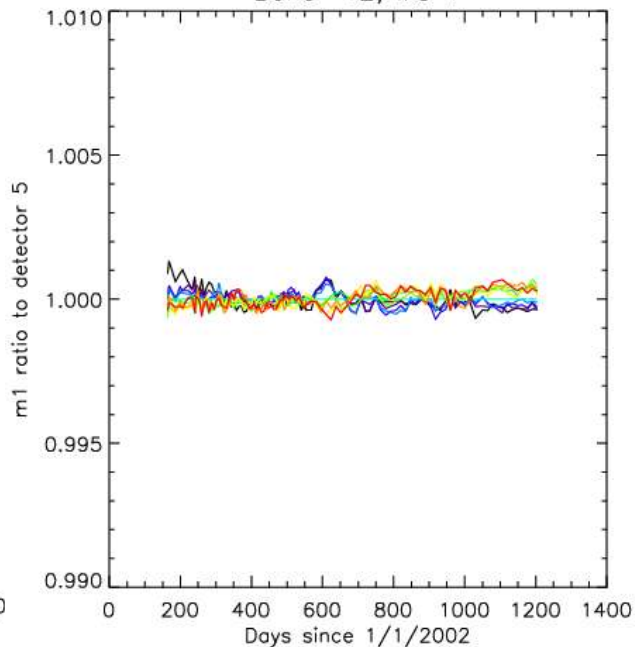
Residuals for Band 16, Det. 5



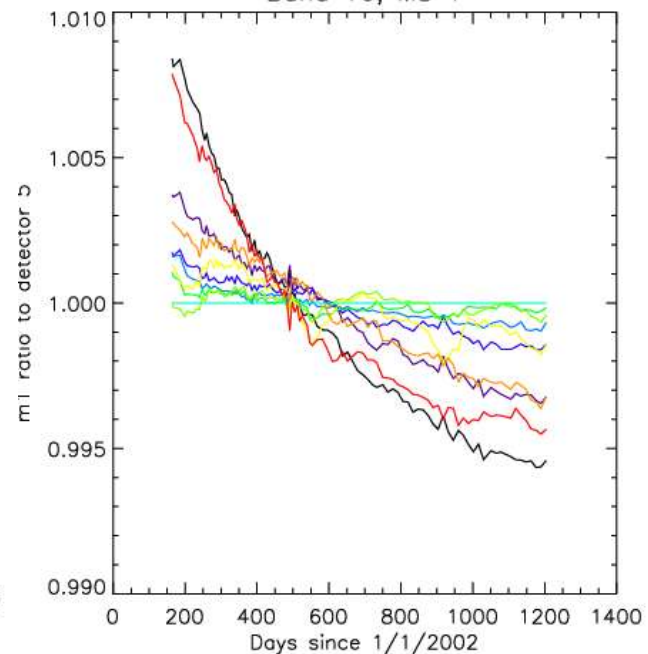
Band 8, MS 1



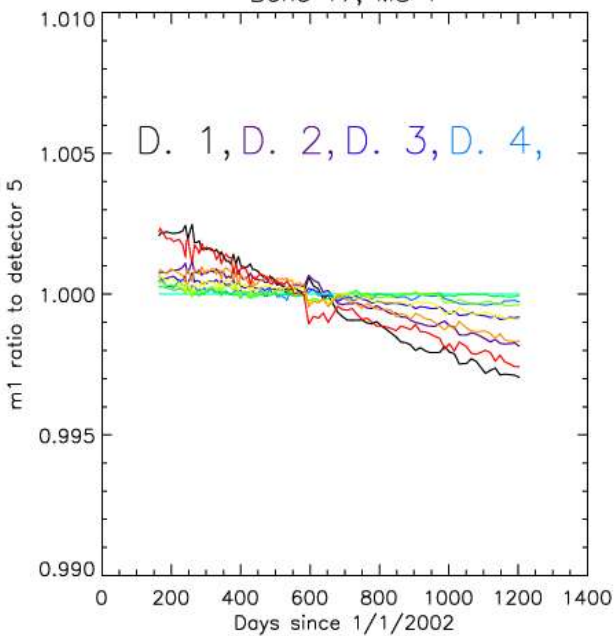
Band 12, MS 1



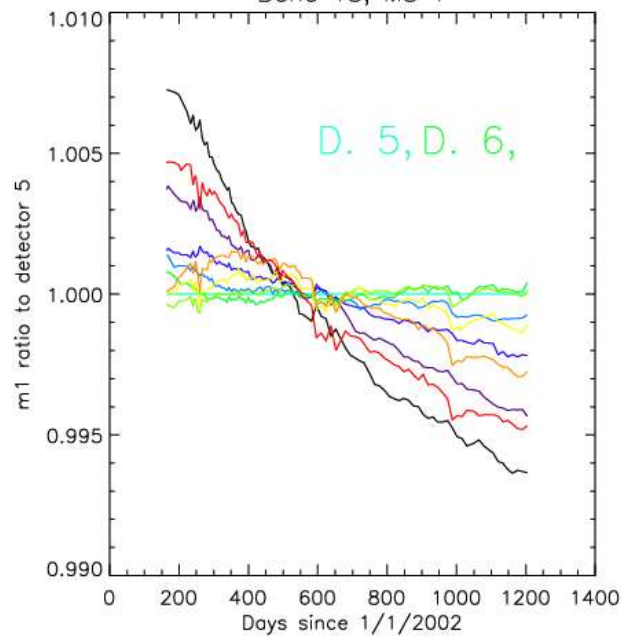
Band 16, MS 1



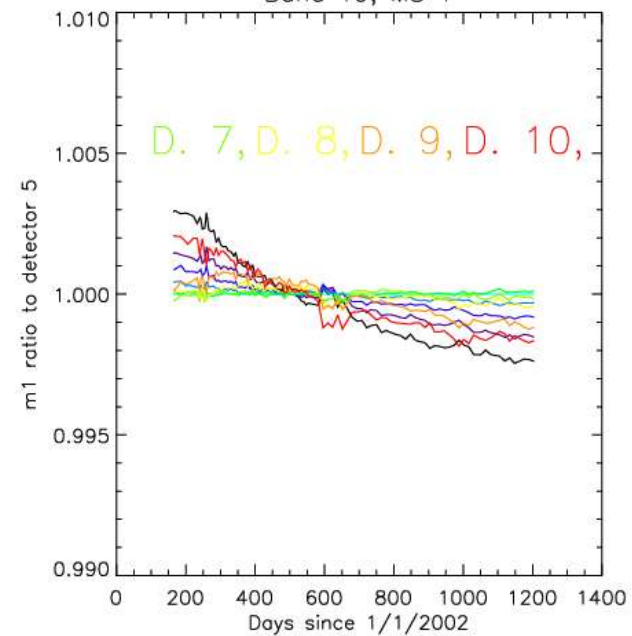
Band 17, MS 1



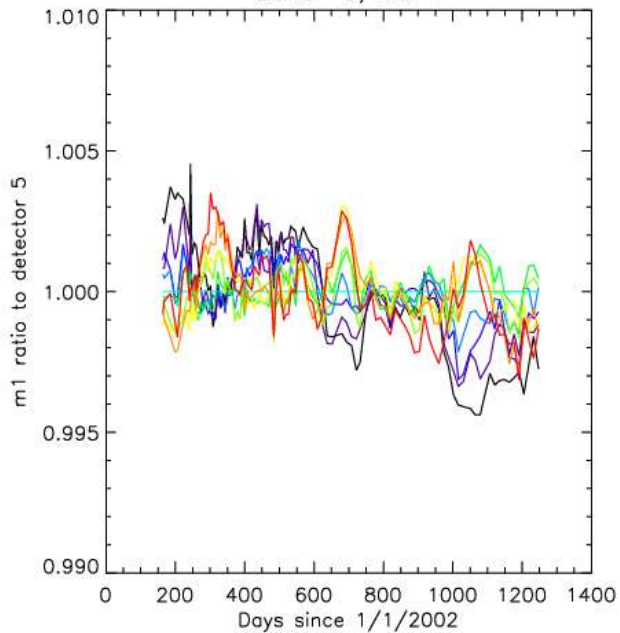
Band 18, MS 1



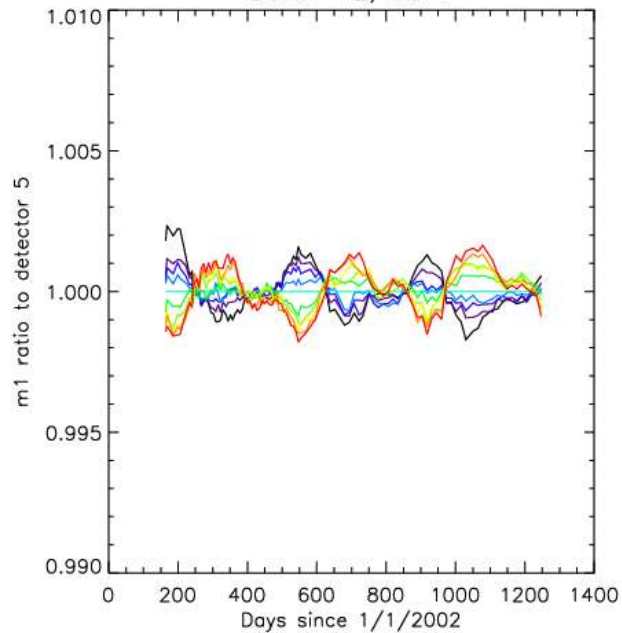
Band 19, MS 1



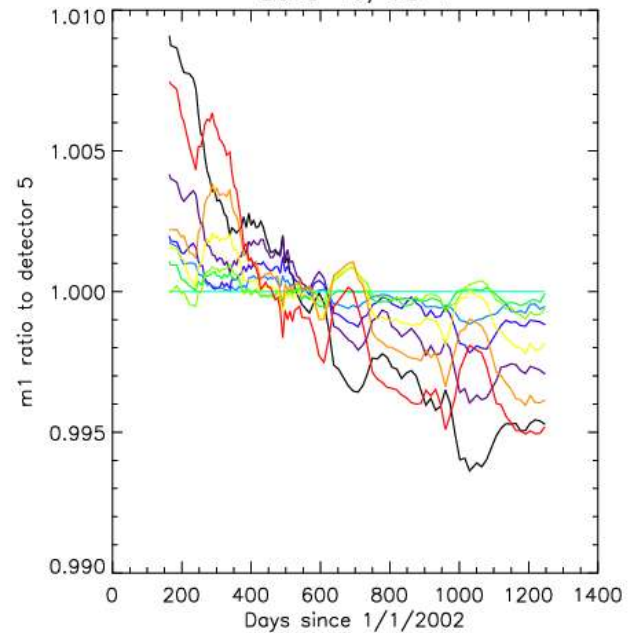
Band 8, MS 1



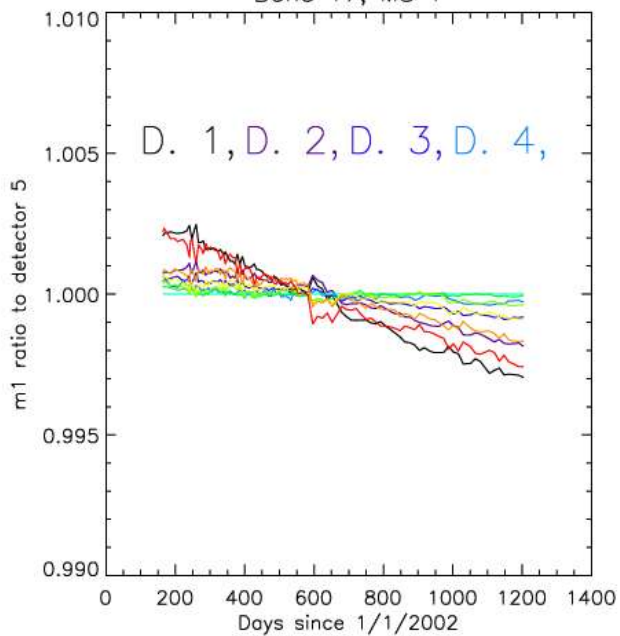
Band 12, MS 1



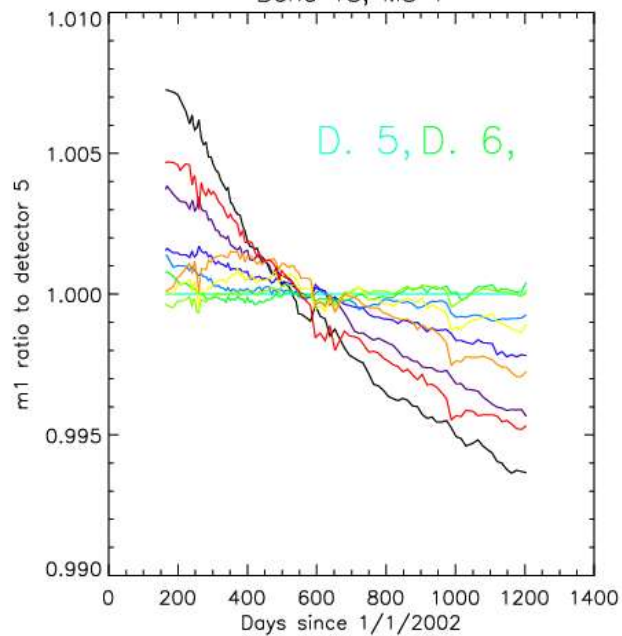
Band 16, MS 1



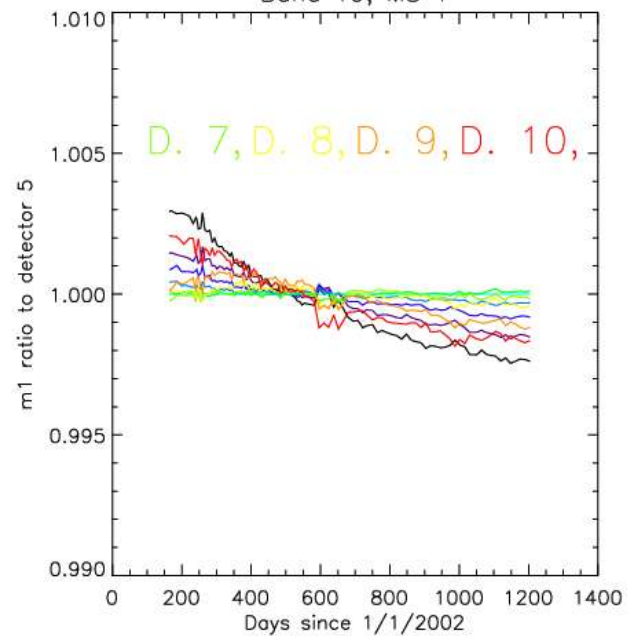
Band 17, MS 1



Band 18, MS 1



Band 19, MS 1



Summary

- m1 measurements with SD screen contain yaw angle correlation in the detector 10/1 ratios
- possibly the bands have a different yaw angle correlation, depending on focal plane position of band
- removal of beta angle correlation has minimal impact on retrospective m1 fitting, but valuable for interpretation of most recent m1 regarding prediction into future
- Several issues remain unresolved (striping, ray tracing simulation)