FRAM

Jan Ebr for the FRAM team:
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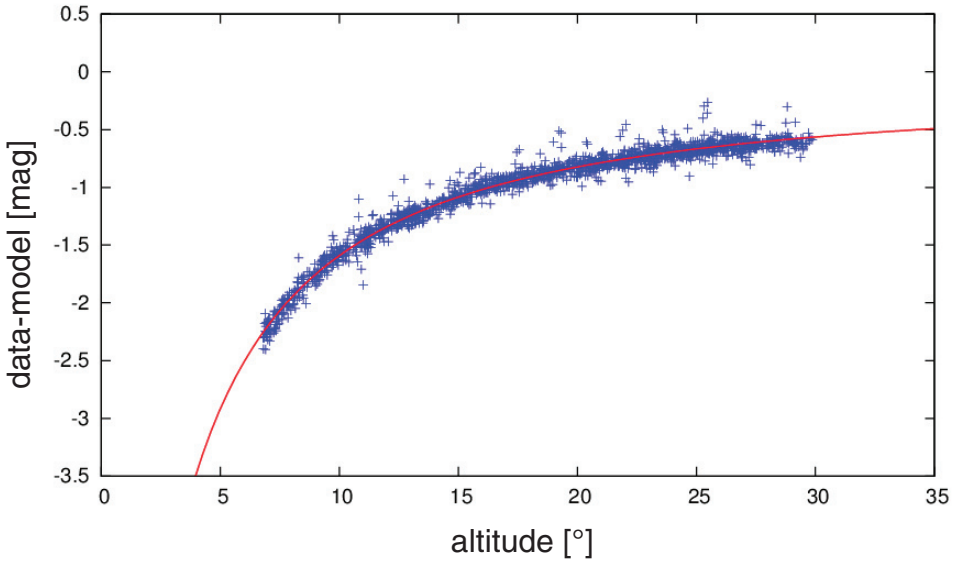
Jakub Juryšek, Jiřina Prokopová,
Michael Prouza

Michael sends his regards and promises:

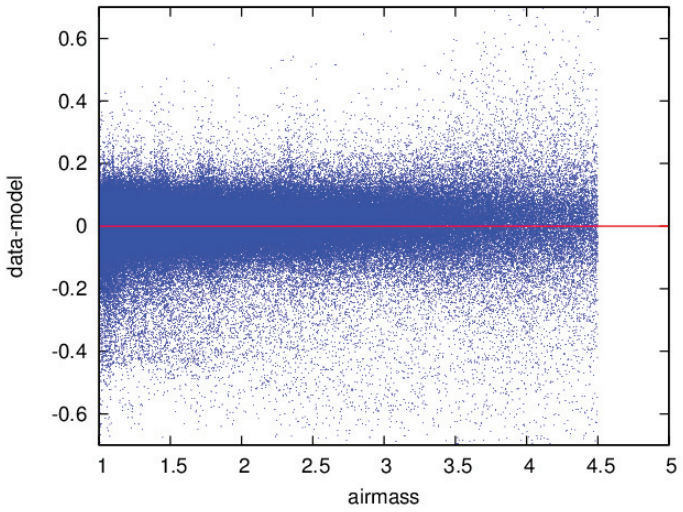
- the second FRAM for S before the end of the year (in Prague)
- FRAM for N in 1st half of 2018
- Ceilometer during 2018
  - discuss the location, S preferable, but is IR laser: rules?
  - who buys the second one? cooridnate?
- Sun/Moon Photometer not funded in 2018
  - maybe 2019 or 2020
  - or someone else?

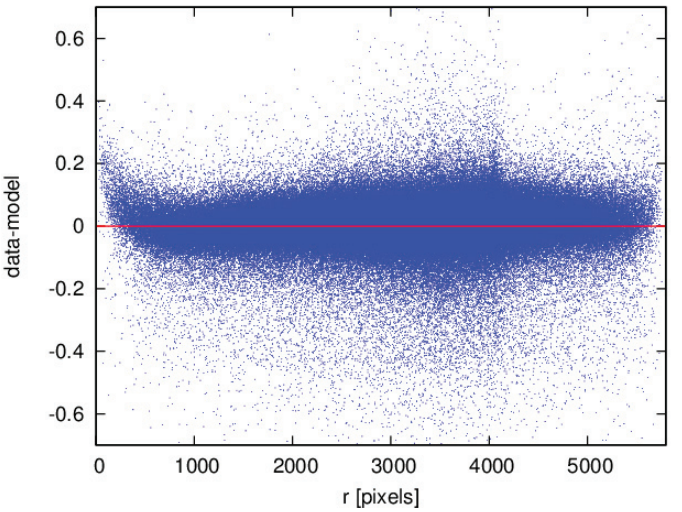
Where were we?

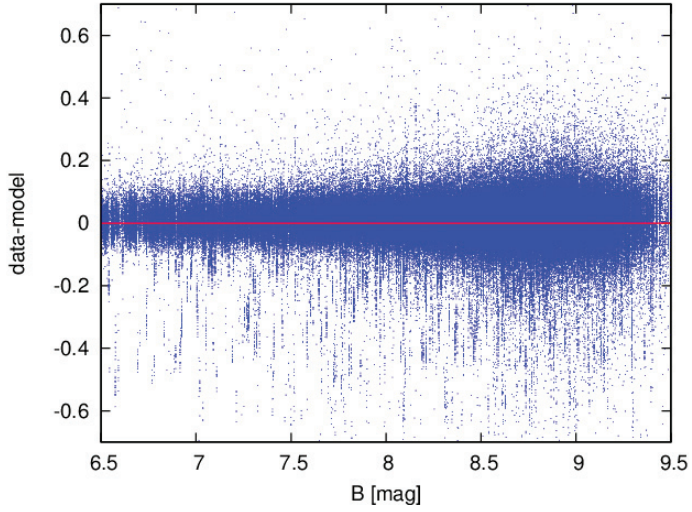


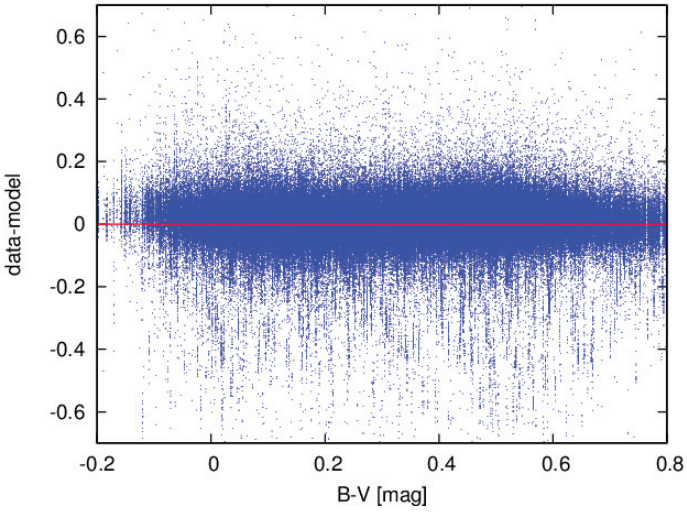
$$m_{inst} = M m_{cat} + Z_i + k_i A + c_1 (B–V)(c_2 (B–V) + 1) + R_1 r (R_2 r + 1) + k_C A (B–V)$$
$$= m_{model} + k_i A$$

- A: airmass $B–V$: color index ($m_{cat} = B$) r: radial position on frame
- M, c_1, c_2, R_1, R_2, k_C constant, barring small slow changes (tracked)
- (Z,k)-pair for each altitude scan


data-model
airmass

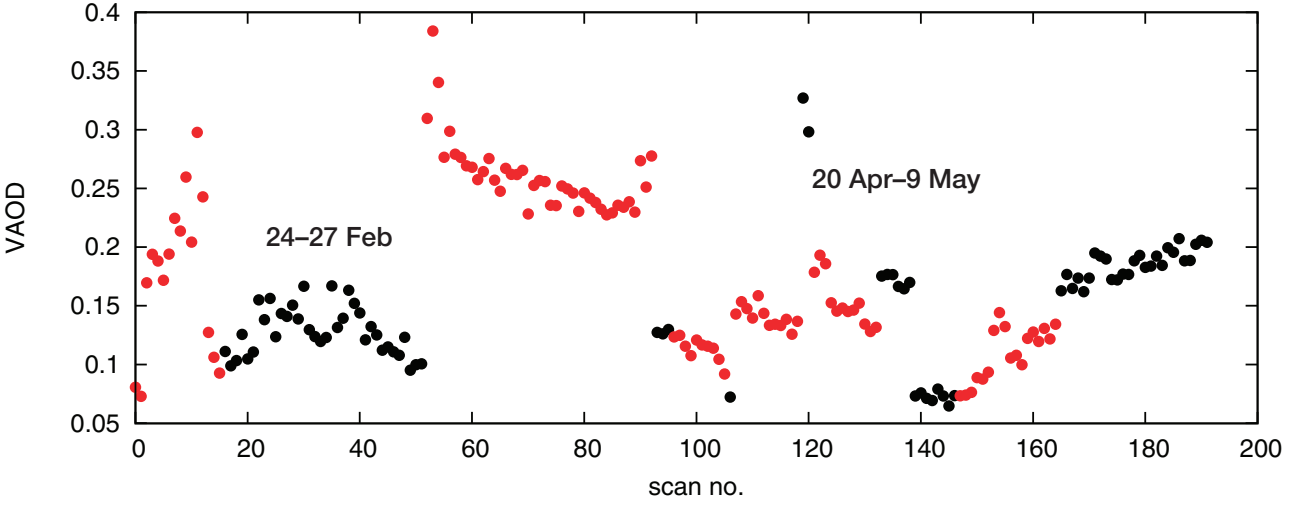

data-model
r [pixels]

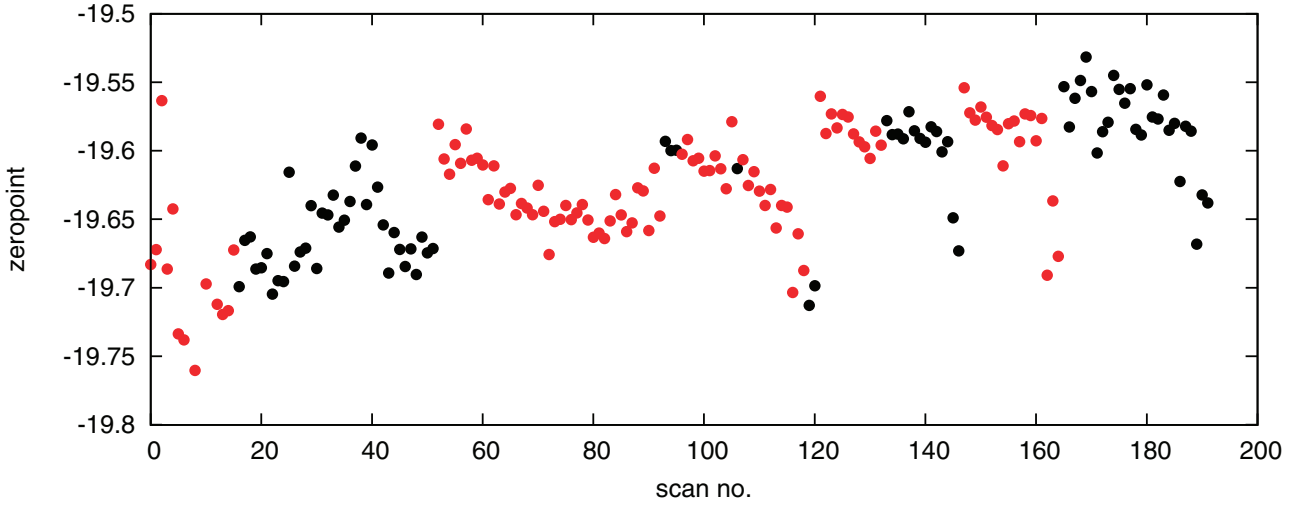

data-model
B [mag]


data-model
B-V [mag]

RMS ~ 0.09 mag

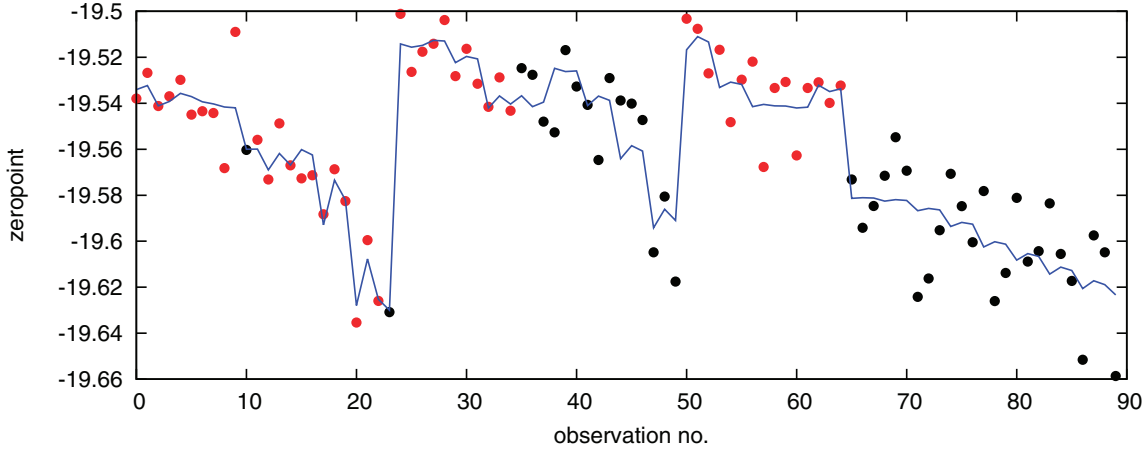
Results of altitude scans: VAOD and zeropoint

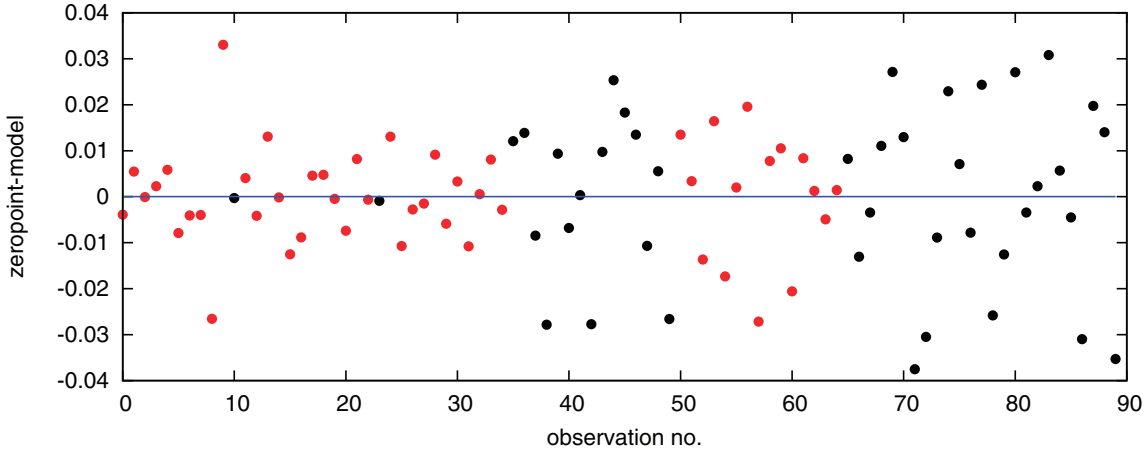




Single-field operation

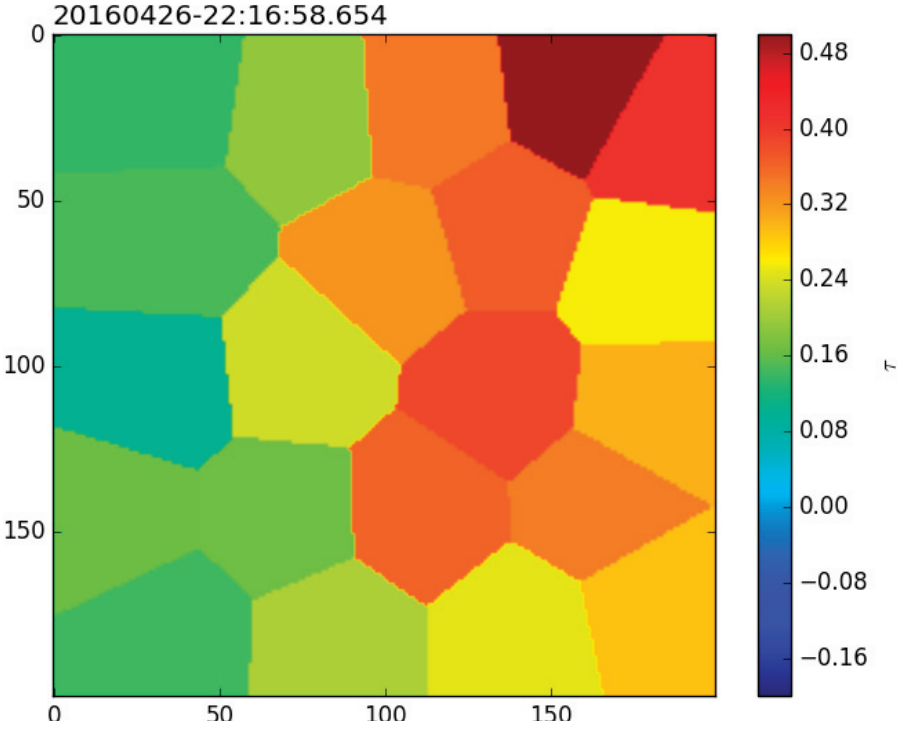
- zeropoint clearly non-constant: self-calibration using altitude scans





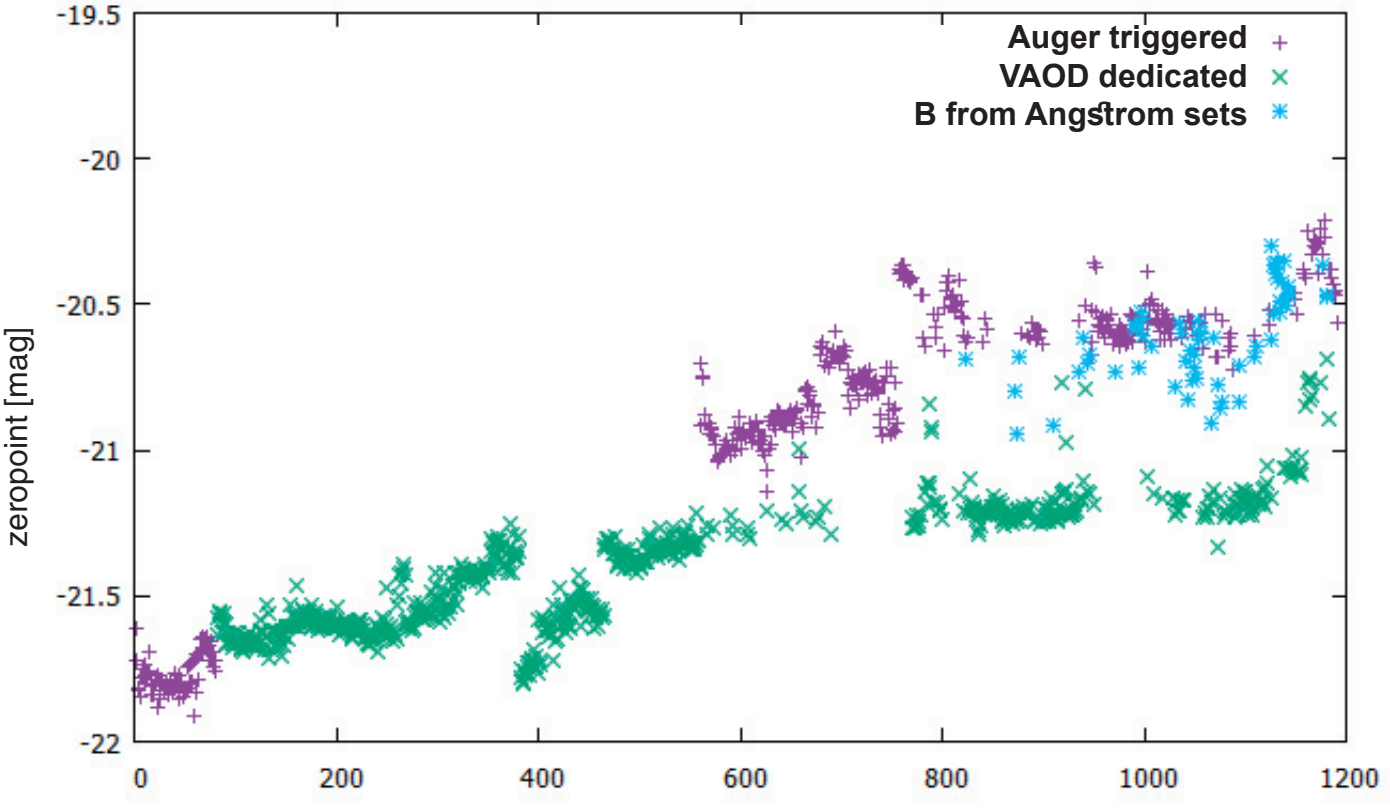
VAOD maps

- main FRAM product during CTA operation
- average of ($m_{inst} - m_{model}$) / *airmass* × 0.921 – $\tau_{Rayleigh}$ over stars in bin
  - estimated „statistical“ error 0.02 mag
- using mean zeropoint calibrated by altitude scans
  - est. error 0.02 mag
- est. prec. 0.03 in VAOD



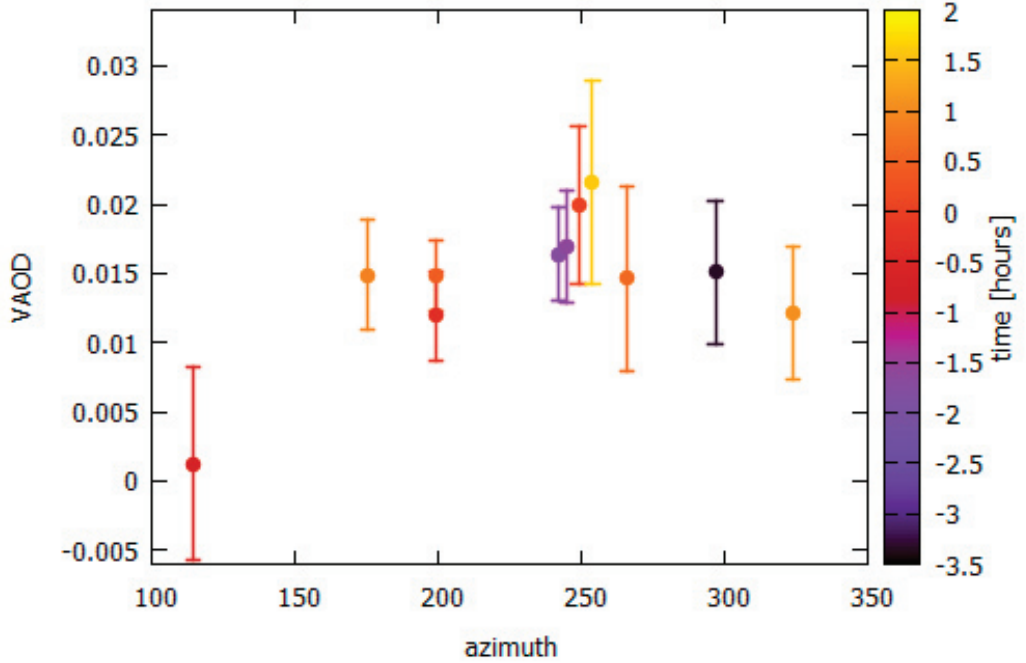
What next?

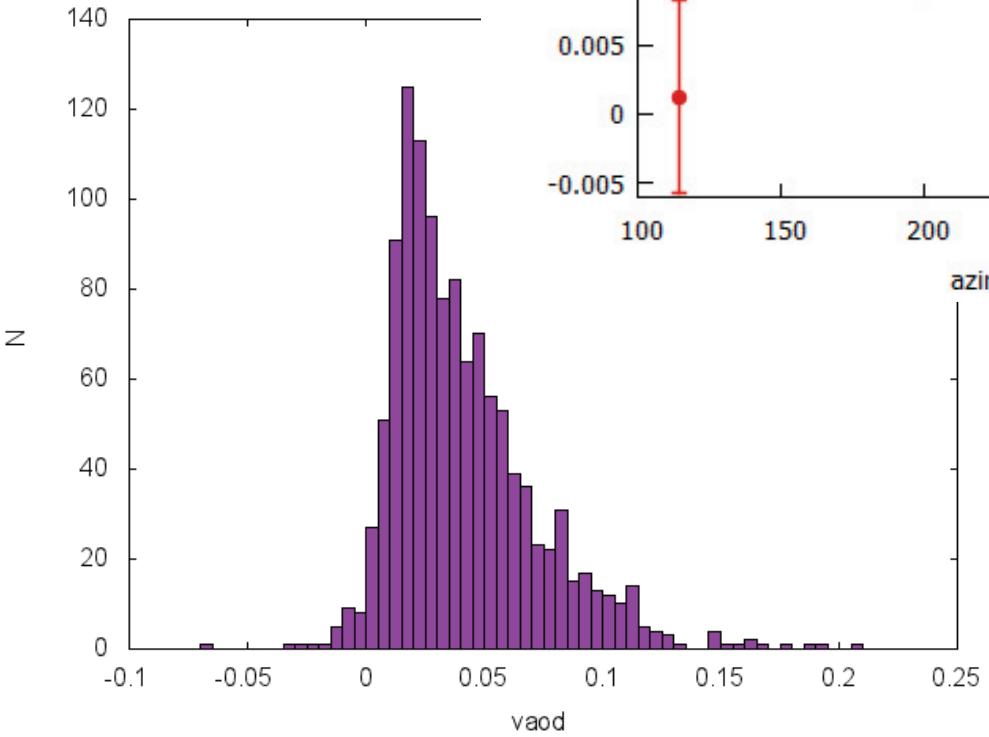
- develop using Auger FRAM data
- interesting issues to be found there



Negative VAOD?

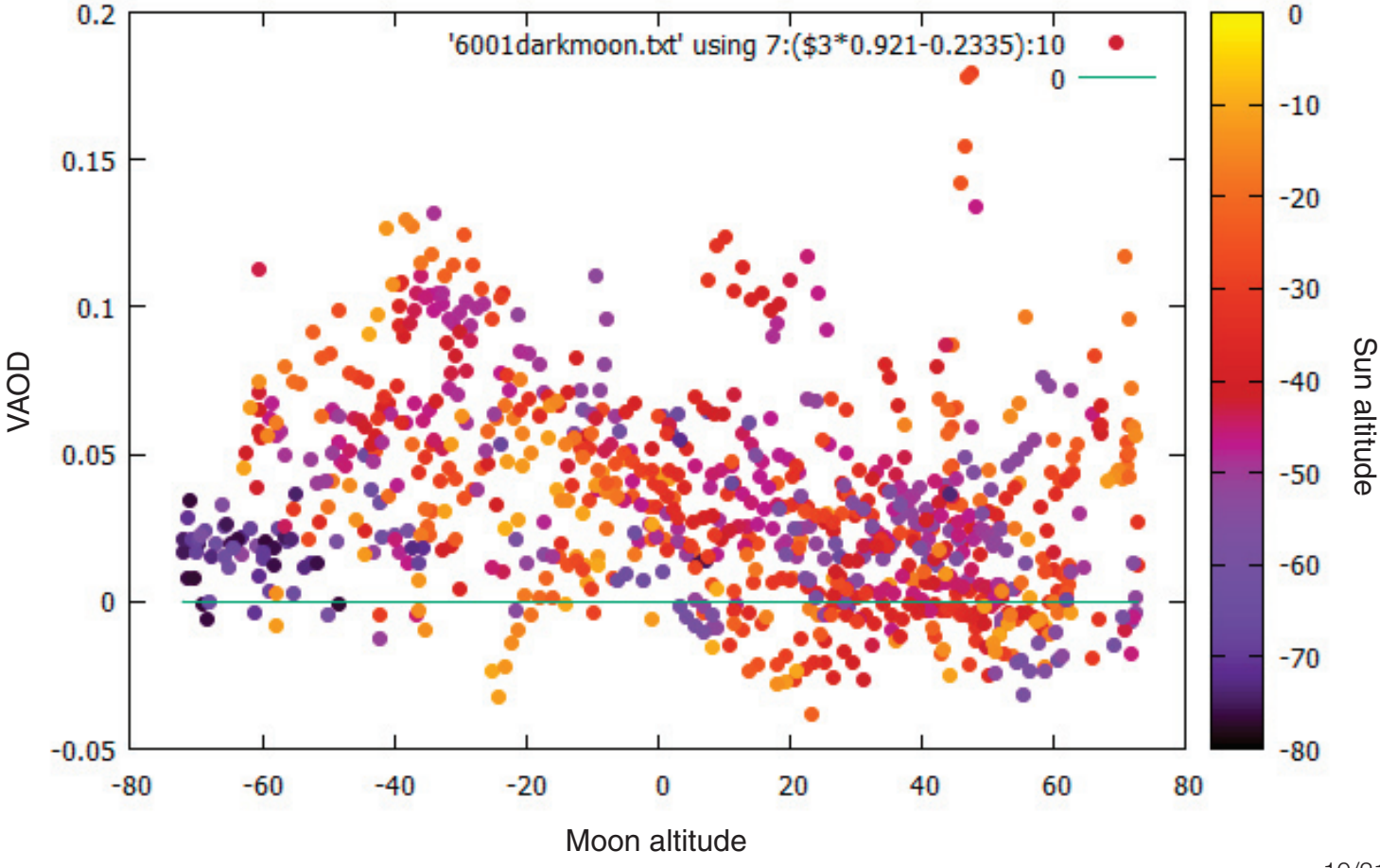
- Malargue town
  - light pollution?



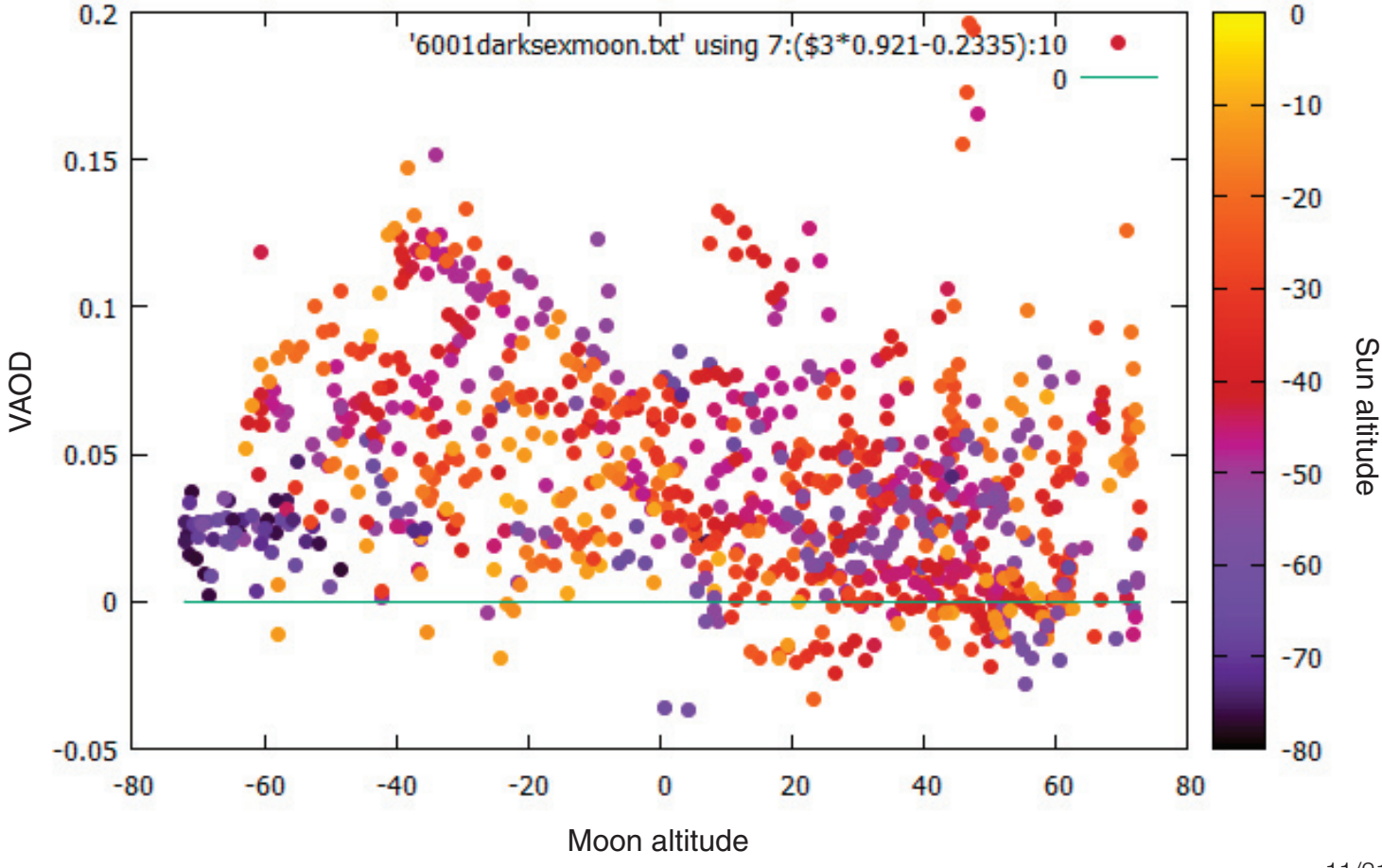


- non-Auger showers taken also under Moonlit sky

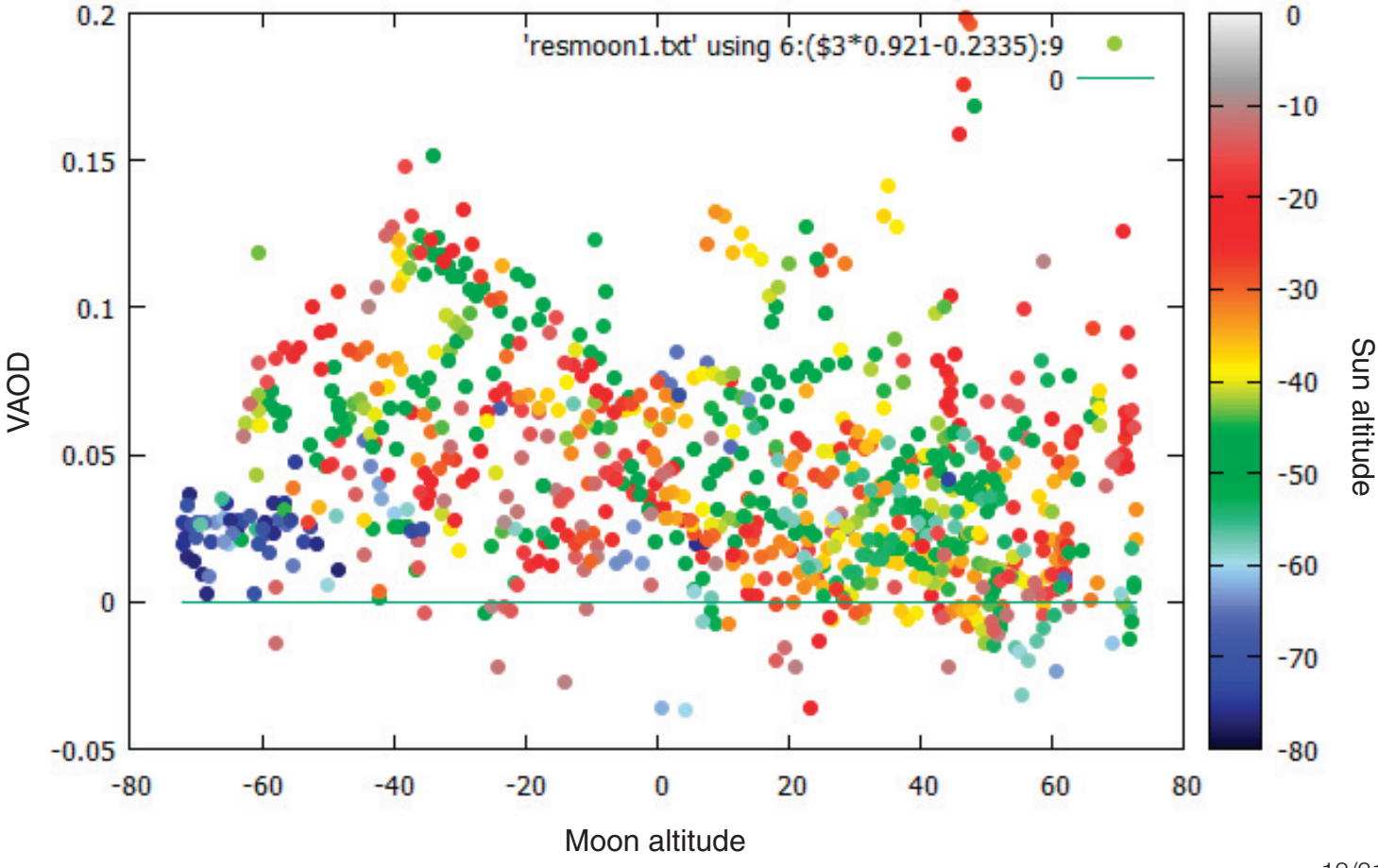
IRAF photometry (fixed aperture)



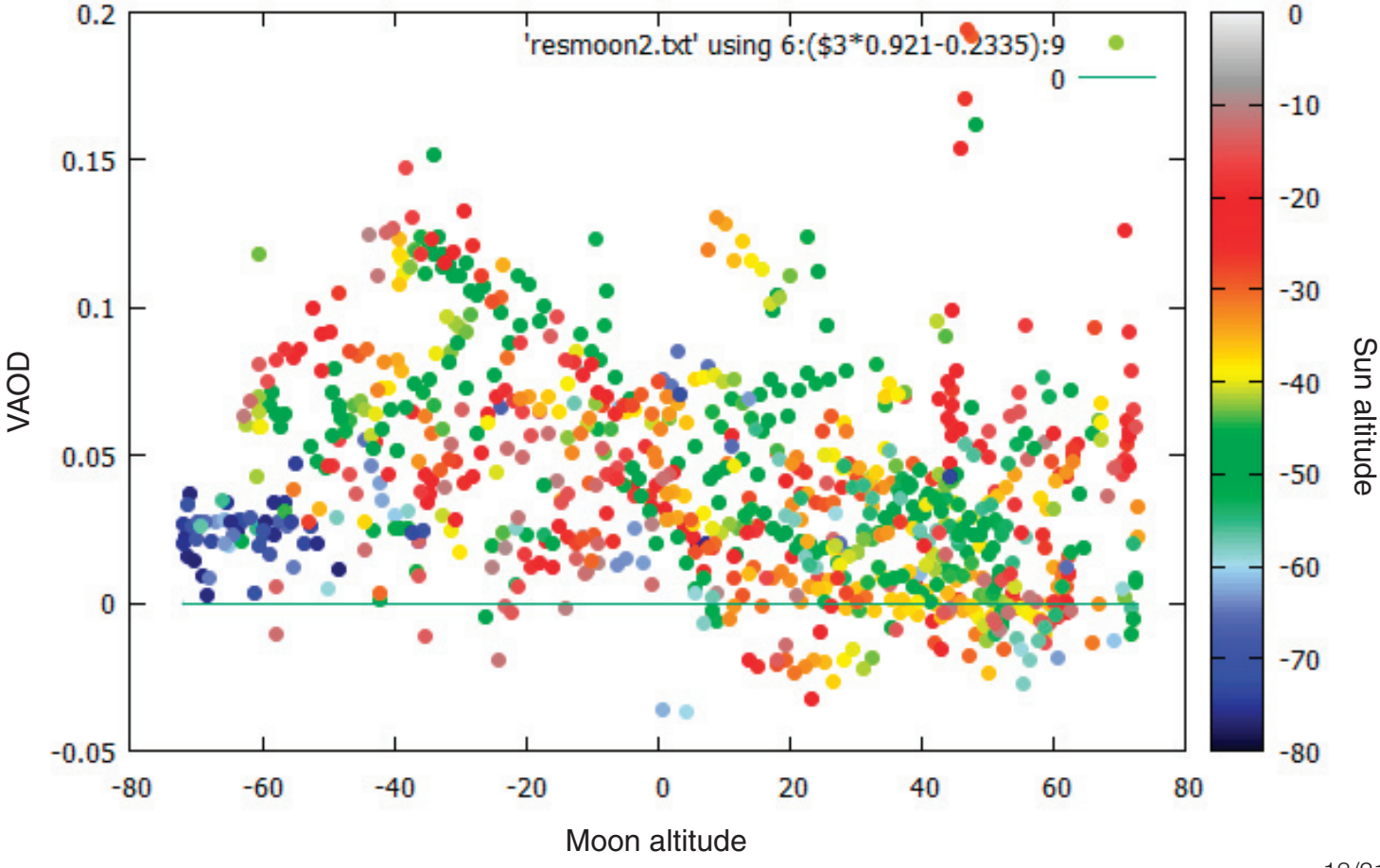
SExtractor photometry (Krohn fitting)



SEx + local bckg. fit (linear in magnitudes)

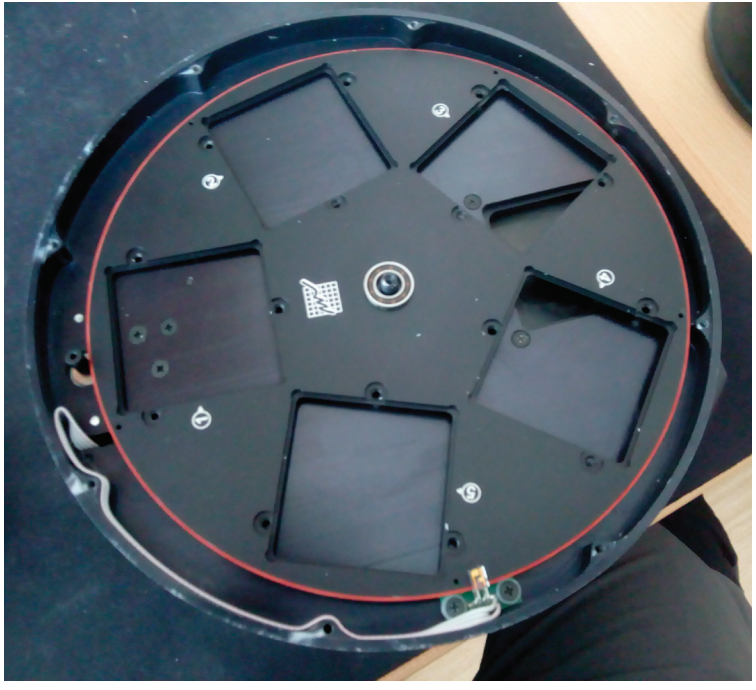


SEx + local bckg. fit (linear in fluxes)



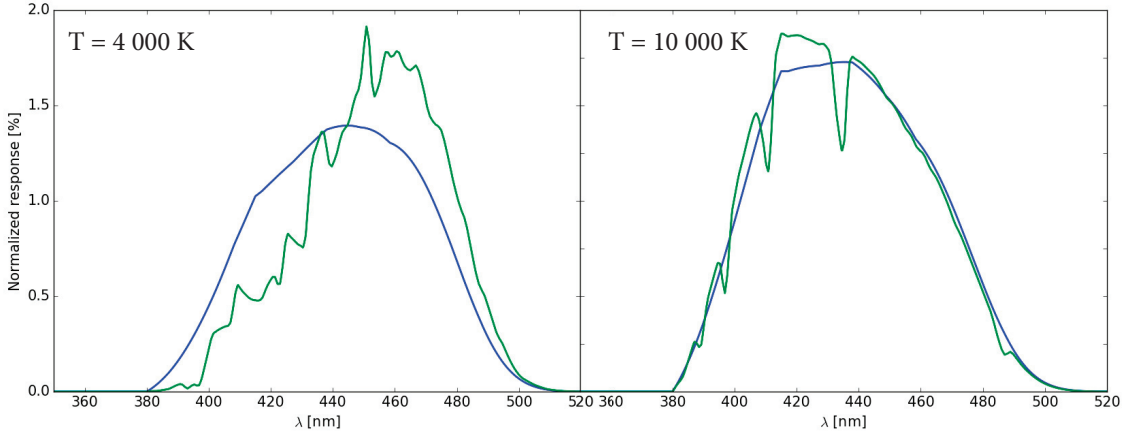
Filter wheel issues: images taken with wrong filter

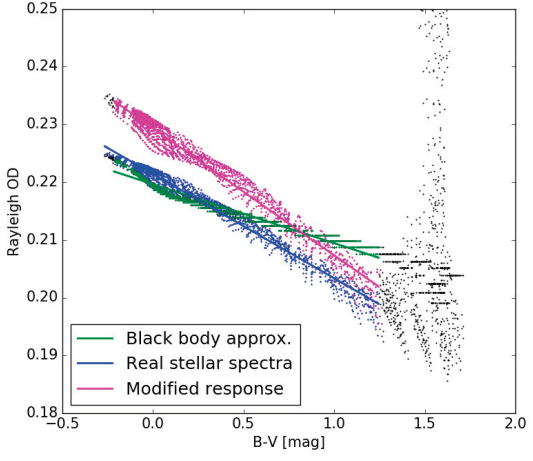
- camera does not report an error
- tested in office using mainly elementary school knowledge
- one-position shift: ABCDE -> ACDEA -> BDEAA ...

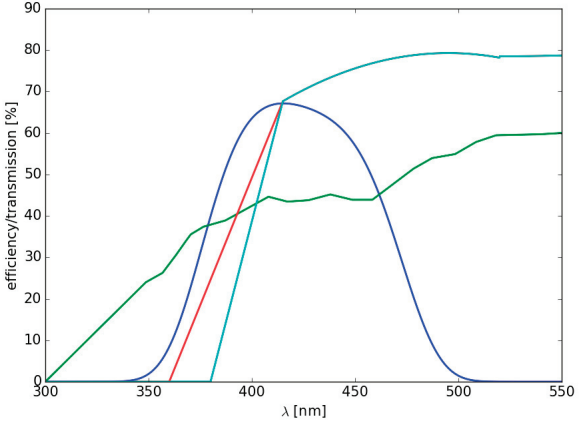


Actual improvements

- real stellar spectra instead of black-body approximations

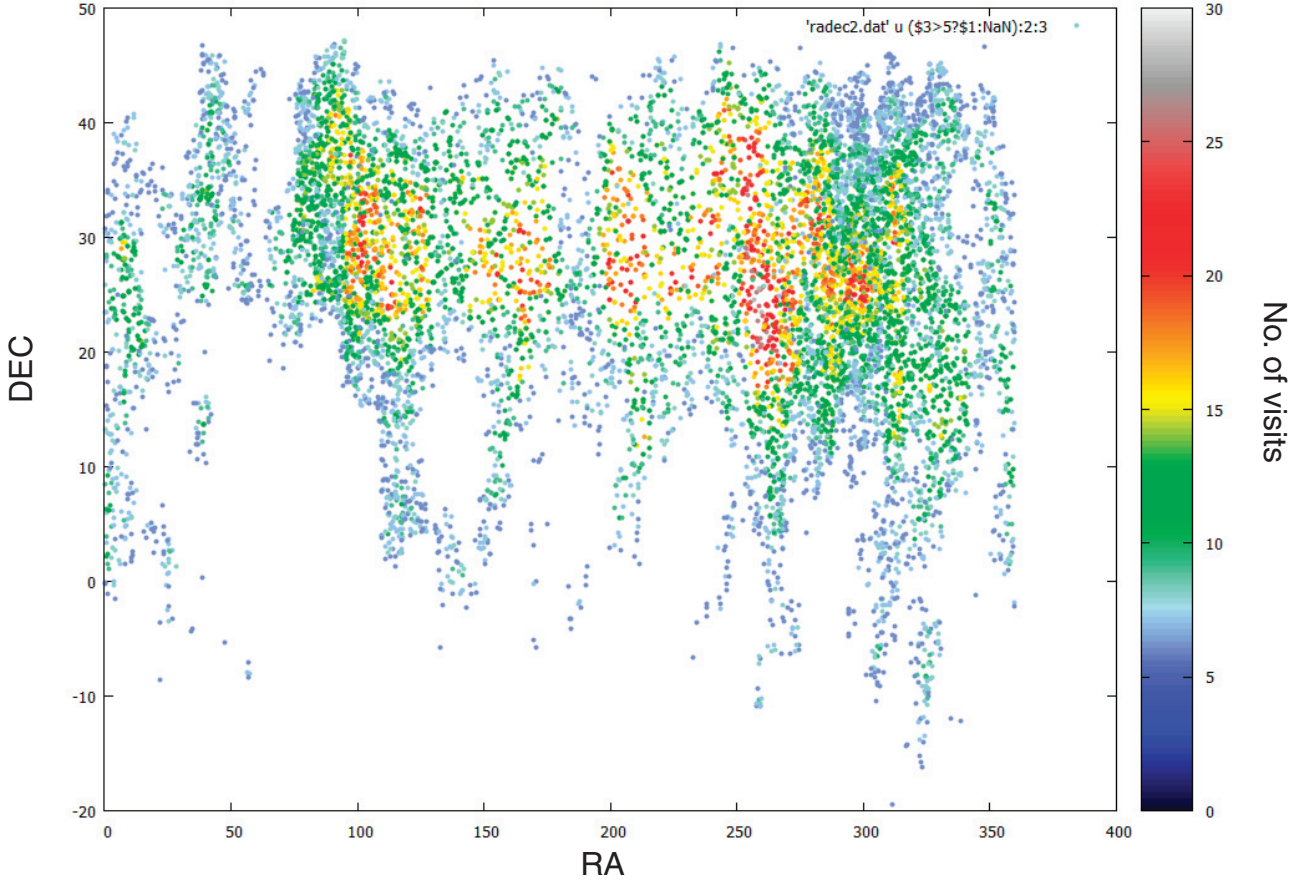


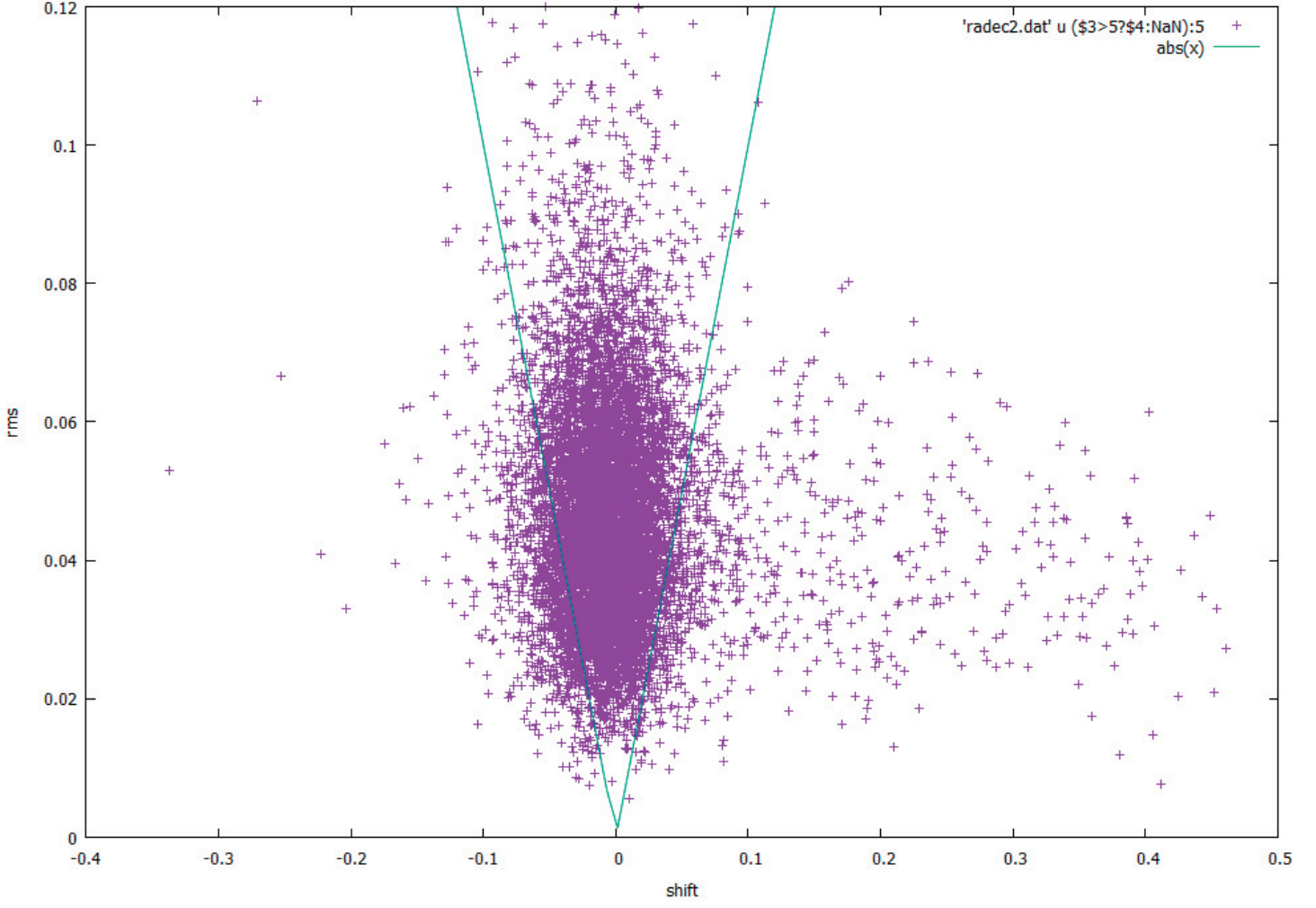




Possible improvements

- multiple visits of the same stars?



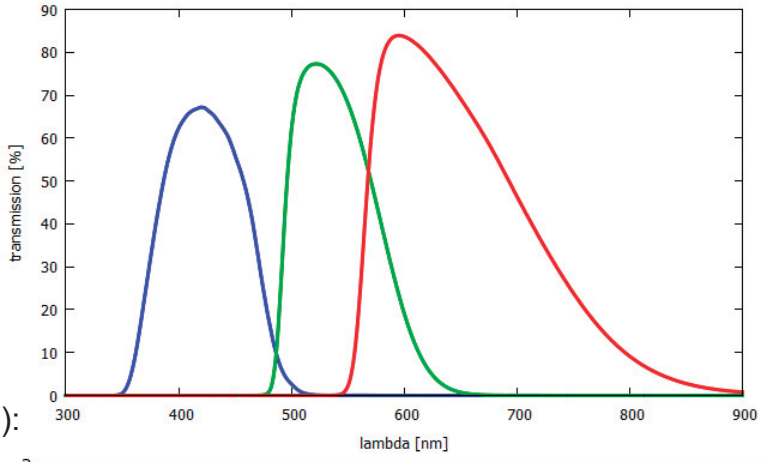

'radec2.dat' u ($3>5?$4:NaN):5
abs(x)
rms
shift
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5

$$\frac{\tau_1}{\tau_2} = \left(\frac{\lambda_1}{\lambda_2}\right)^{-\alpha}$$

$$\Delta\alpha = \frac{\ln(1+\delta\tau_1) + \ln(1+\delta\tau_2)}{ln\lambda_1 - ln\lambda_2} \approx \frac{\delta\tau_1 + \delta\tau_2}{ln\lambda_1 - ln\lambda_2}$$

Effective wavelengths for aerosols (α=1):

B	431 nm
V	539 nm
R	629 nm



Max $\delta\tau_1 + \delta\tau_2$ for $\Delta\alpha$ <0.5

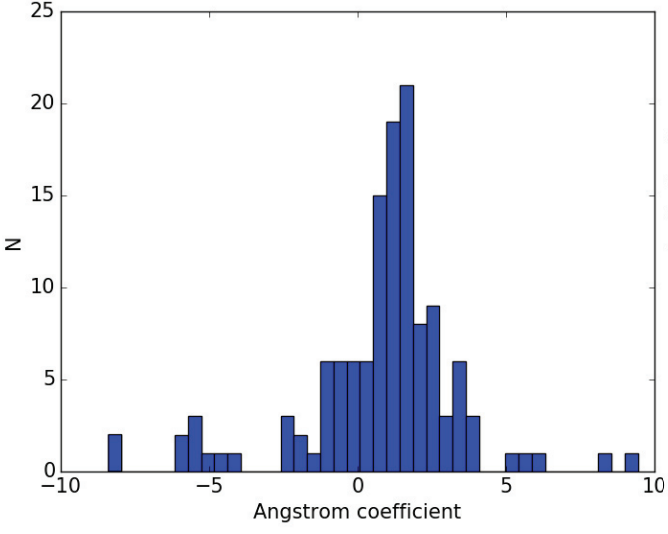
B/V: 12 %

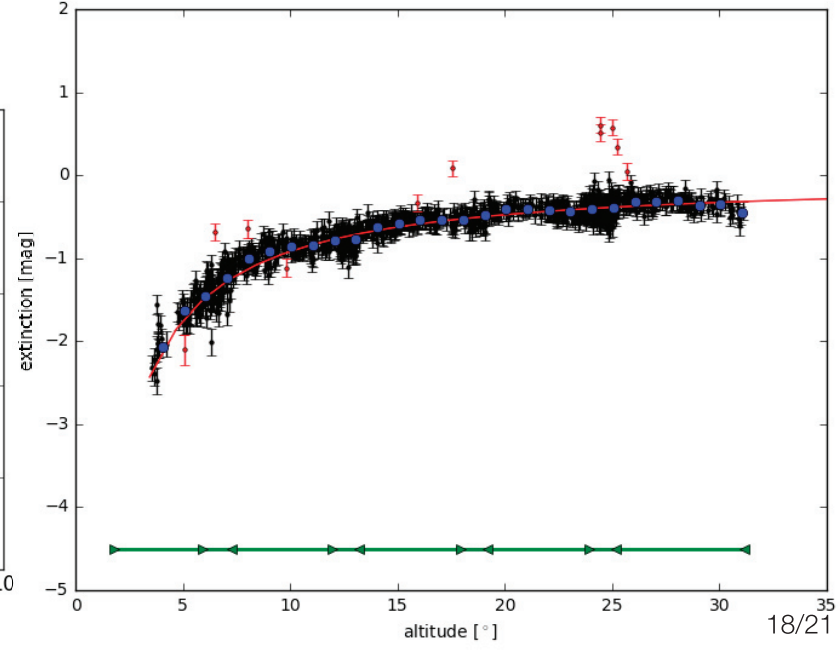
B/R: 21 %

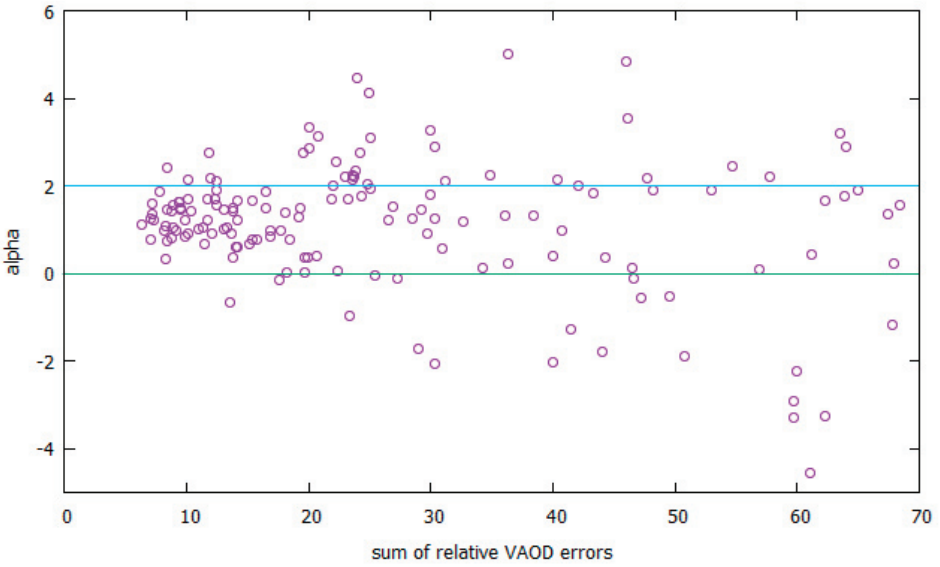
Passed (from 188):

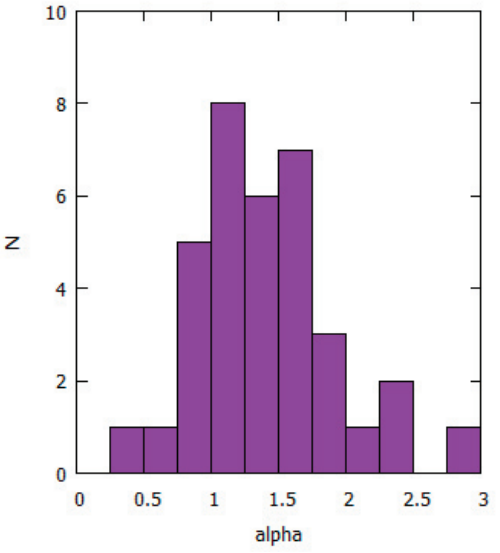
B/V: 35

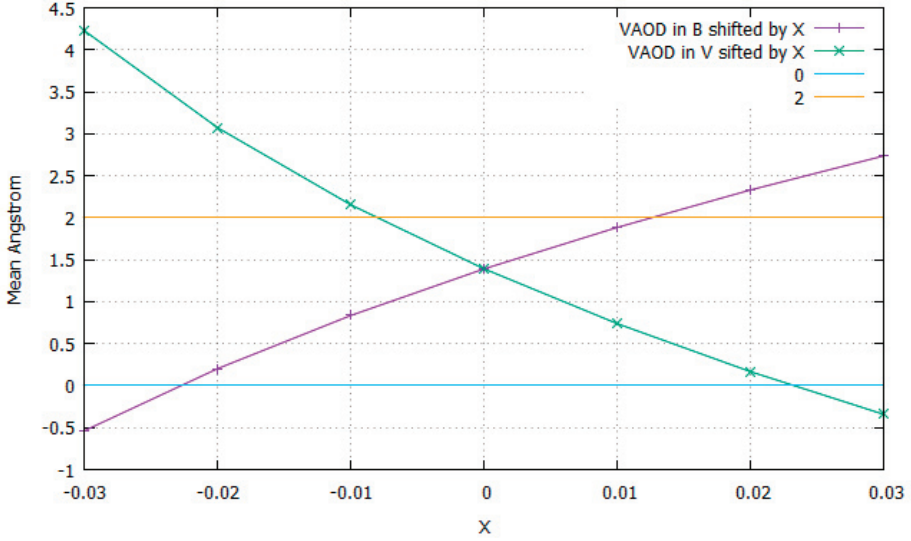
B/R: 24

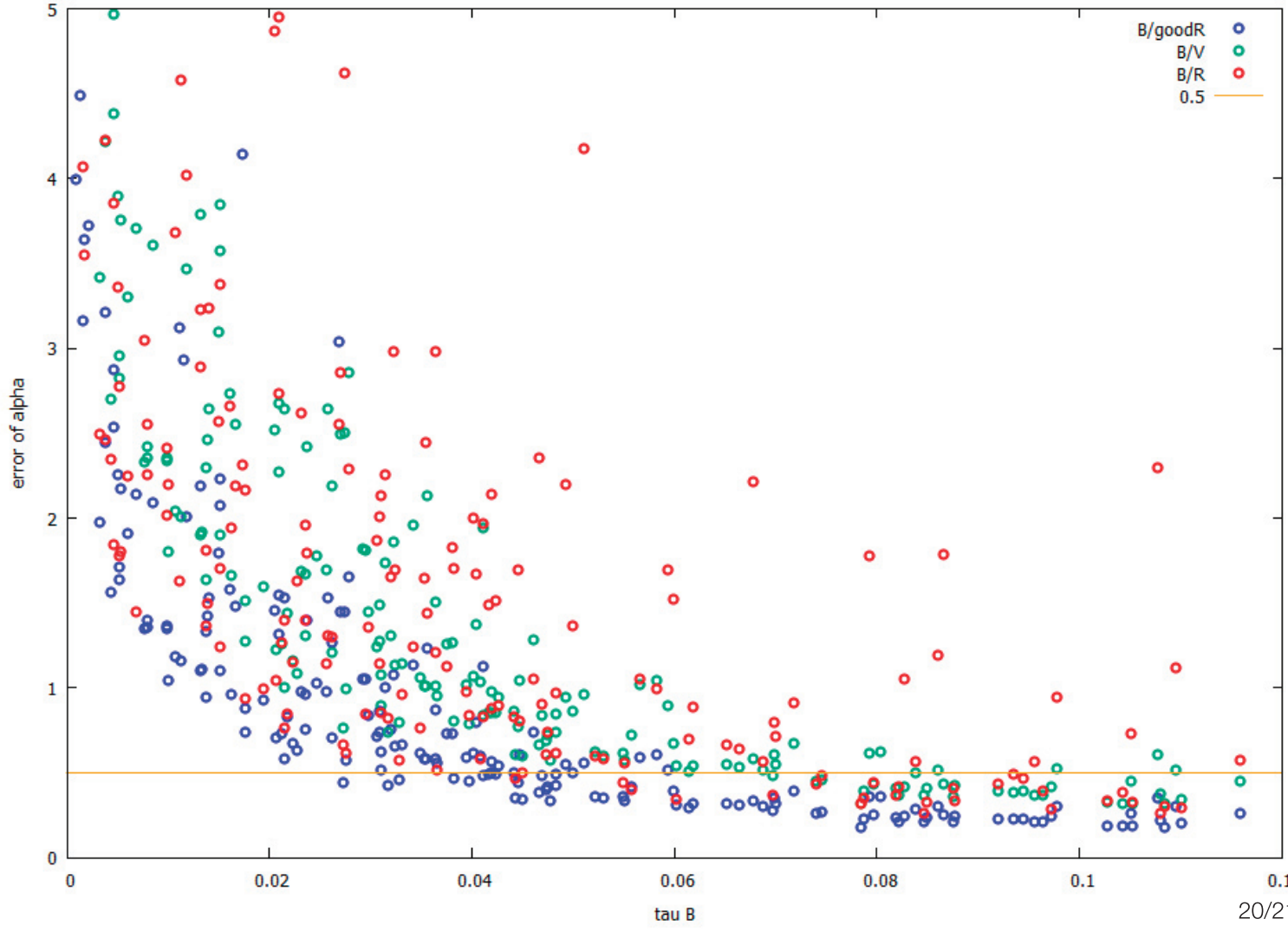





alpha
sum of relative VAOD errors


N
alpha


VAOD in B shifted by X
VAOD in V sifted by X
0
2
Mean Angstrom
X


B/goodR
B/V
B/R
0.5
error of alpha
tau B
0
1
2
3
4
5
0
0.02
0.04
0.06
0.08
0.1
0.12