Amateur photometric measurements of variable stars

Oss, 20 oktober 2018

Petra van der Meijs

Agenda

- Introduction
- Citizen Science
- Variable stars
- My amateur project
- My results

Who am I?

Collaboration between amateurs and professionals

Professional data

- Time is scarce
- Time is expensive
- Equipment has fixed capabilities
- High quality data

Amateur data

- Nearly unlimited time (weather permitting ☹)
- Large variability of sources
- No influence on data quality

Collaboration between amateurs and professionals (2)

nature.com > nature > letters > article

nature
International journal of science

Altmetric: 51 Citations: 59 More detail »

Letter

A giant thunderstorm on Saturn

G. Fischer, W. S. Kurth, D. A. Gurnett, P. Zarka, U. A. Dyudina, A. P. Ingersoll, S. P. Ewald, C. C. Porco, A. Wesley, C. Go & M. Delcroix

Nature **475**, 75–77 (07 July 2011)
doi:10.1038/nature10205
Download Citation
Giant planets

Received: 10 February 2011
Accepted: 17 May 2011
Published online: 06 July 2011

Acknowledgements

G.F. was supported by the Austrian Science Fund (FWF). Cassini research at the University of Iowa was funded by NASA/JPL. We thank A. Sánchez-Lavega for launching an alert on the webpage of the Planetary Virtual Observatory and Laboratory (http://www.pvol.ehu.es), and the amateur astronomers who subsequently observed the storm on Saturn, namely, T. Akutsu, T. Barry, J. Castella, D. Chang, D. Gray, J. B. Jovani, W. Kivits, T. Kumamoto, F. J. Melillo, D. Parker, D. Peach, J. Phillips, J. J. Podpeau, J. Sussenbach, K. Yunoki and S. Walker. S. Ghomizadeh and T. Ikemura were the first to observe the storm before the alert.

The Astronomical Journal, 140:962–967, 2010 October doi:10.1088/0004-6256/140/6/962

STELLAR TIDAL STREAMS IN SPIRAL GALAXIES OF THE LOCAL VOLUME: A PILOT SURVEY WITH MODEST APERTURE TELESCOPES

David Martínez-Delgado[1,2], R. Jay Gabany[3], Ken Crawford[4], Stefano Zibetti[1], Steven R. Majewski[5], Hans-Walter Rix[1], Jürgen Fliri[2,6], Julio A. Carballo-Bello[2], Daniella C. Bardalez-Gagliuffi[2,7], Jorge Peñarrubia[8], Taylor S. Chonis[9], Barry Madore[10], Ignacio Trujillo[2], Mischa Schirmer[11], and David A. McDavid[5]
[1] Max Planck Institut für Astronomie, Heidelberg, Germany
[2] Instituto de Astrofísica de Canarias, La Laguna, Spain
[3] Black Bird Observatory, Mayhill, NM, USA
[4] Rancho del Sol Observatory, Modesto, CA, USA
[5] Department of Astronomy, University of Virginia, Charlottesville, VA 22904-4325, USA
[6] GEPI, Observatoire de Paris, Meudon Cedex, France
[7] Massachusetts Institute of Technology, Cambridge, MA, USA
[8] Institute of Astronomy, University of Cambridge, UK
[9] Department of Astronomy, University of Texas, Austin, TX 78712-0259, USA
[10] The Observatories of the Carnegie Institution for Science, 813 Santa Barbara Street, Pasadena, CA 91101, USA
[11] Argelander Institut für Astronomie, Universität Bonn, Germany
Received 2010 April 11; accepted 2010 July 21; published 2010 September 7

Monitoring the Continuing Spectral Evolution of Nova Delphini 2013 (V339 Del) with Low Resolution Spectroscopy

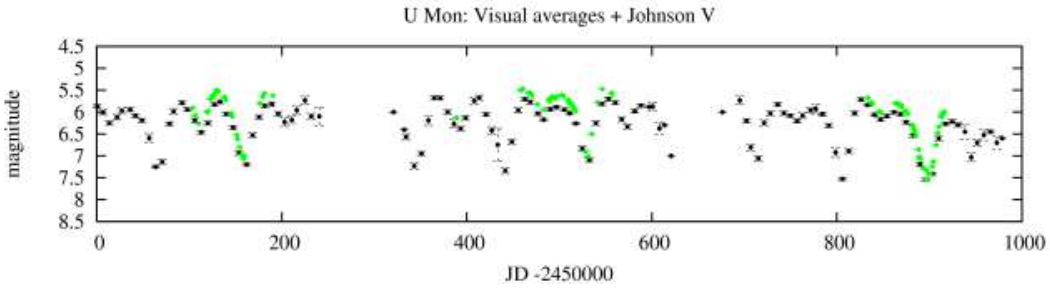
Howard D. Mooers
William S. Wiethoff
Department of Earth and Environmental Sciences, University of Minnesota Duluth, Duluth, MN 55812; send email correspondence to hmooers@d.umn.edu

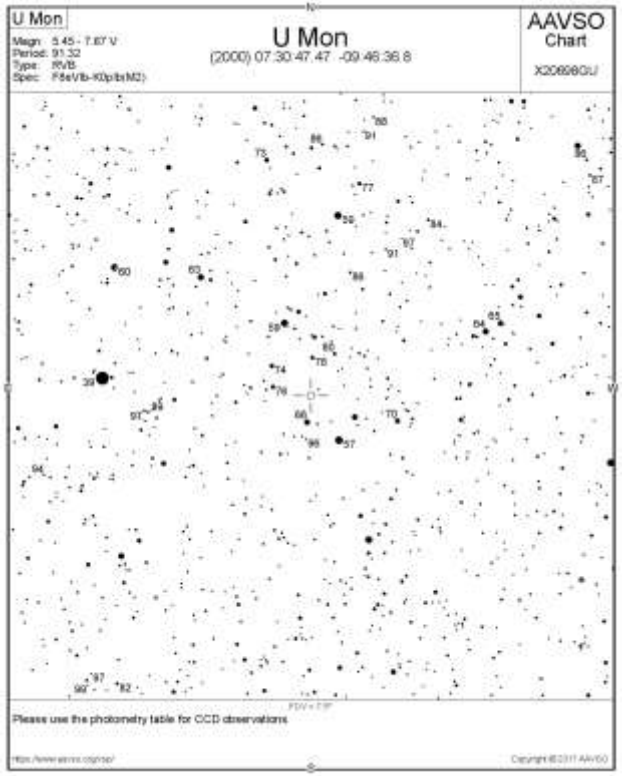
Alexander Evich
Department of Physics and Astronomy, University of Minnesota Duluth, Duluth, MN 55812

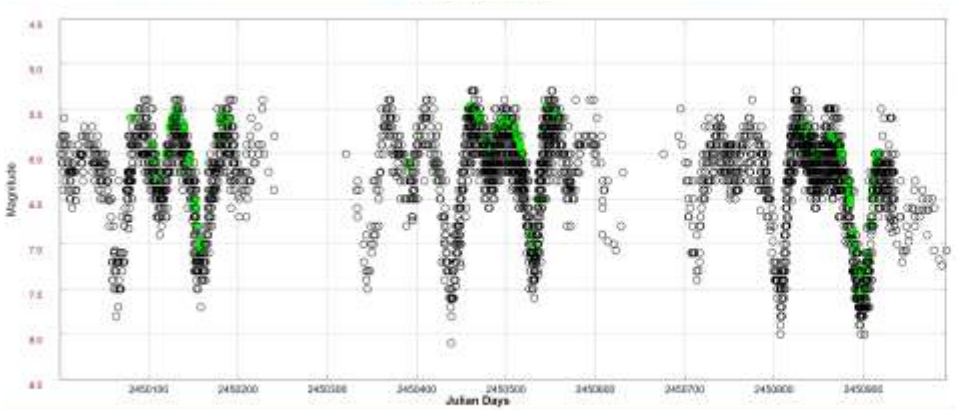
Received December 7, 2015; accepted December 31, 2015

Abstract The continuing spectral evolution of Nova Delphini 2013 (V339 Del) is presented with low-resolution spectroscopy collected with a 100 line per millimeter diffraction grating. Spectra were collected on 3 July 2014, and 14 September 2015, 321 and 759 days after peak visible brightness on 16 August 2013. An imaging system was mounted on an equatorially-mounted, 14-inch Schmidt-Cassegrain telescope. The continuum is no longer visible in the spectra, however, OIII (5007 Å) and Hα (6563 Å) are prominent and NII (5755), Hγ (4340 Å) and CIII/NIII (4640 Å) can still be discerned at +759 days.

Variable Stars







Variable Stars

Different types require different approach

- (Visual) magnitude
  - Naked eye, binoculars, telescope
- Availability of reference stars
- Period
- “Why is it varying?”
  - Binaries, planetary systems, stellar evolution
  - Regulars, (super)novae, end-of-life

My project

Equipment: anything available

- Camera: Canon DSLR
- Lens: Canon EF 200mm
- Timer
- Mount: SkyWatcher StarAdventurer
- Tripod

My Project

Data: anything available

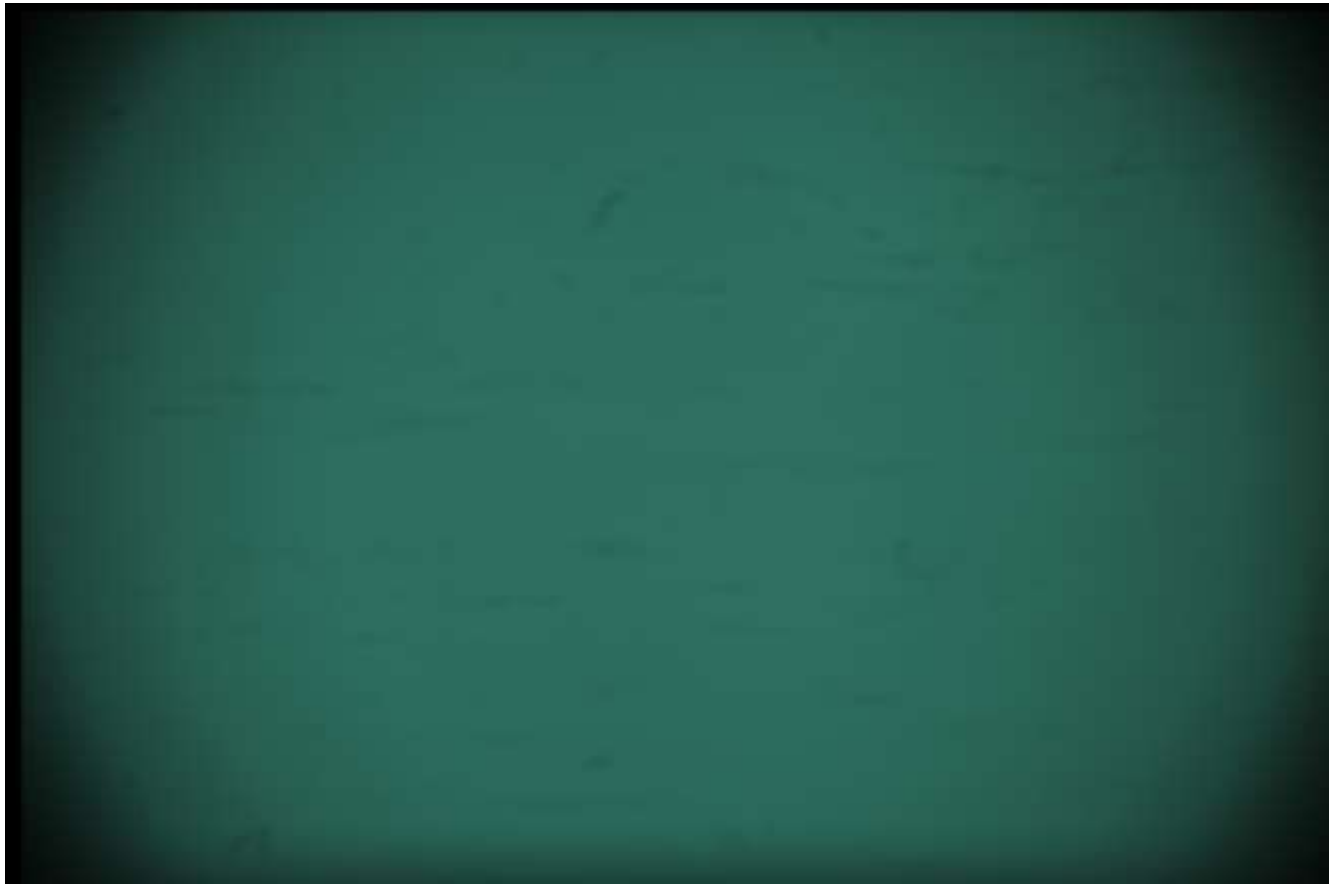
My Project

Data

- 84 subs @ 45” each
- Stacked in 14 groups of 6
- Calibrated

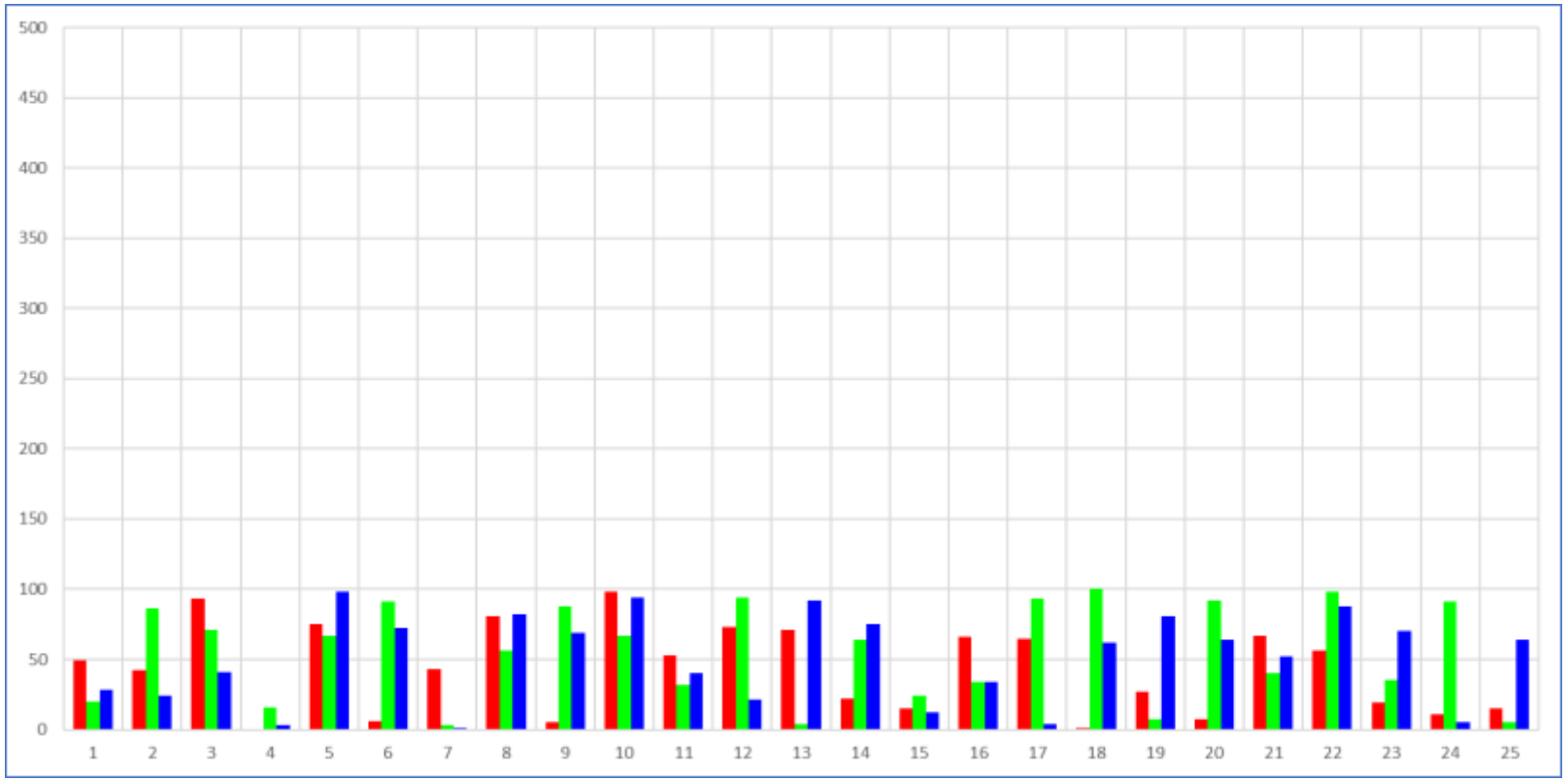
Why calibrate

Flat-field



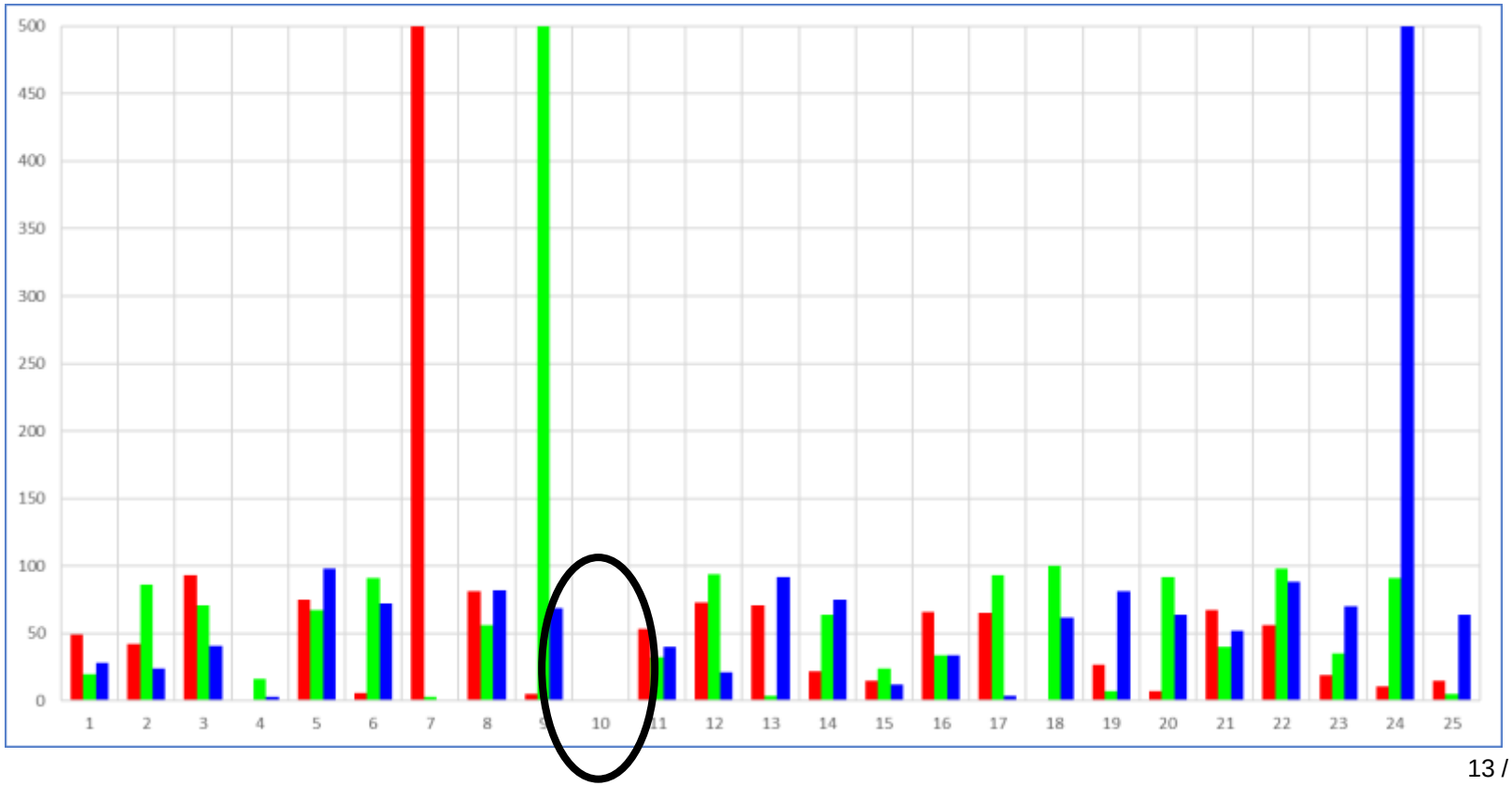
Why calibrate

Bias



Why calibrate

Dark (or: bad pixel map)



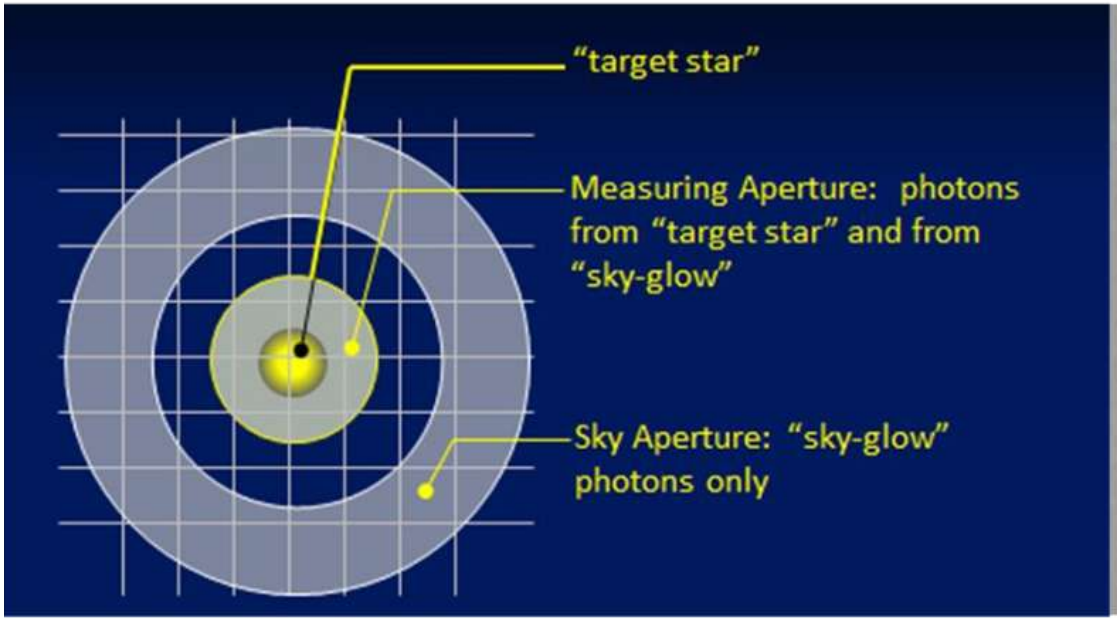
My project

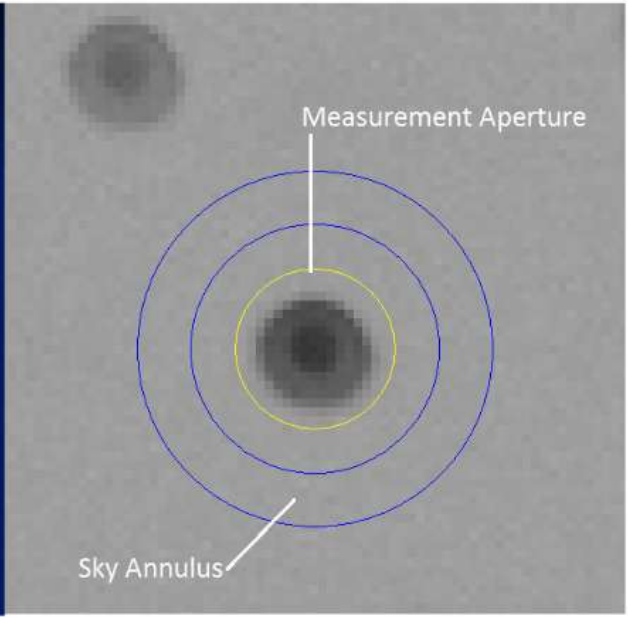
- Find reference stars in photo
- Measure intensity of each star
- Look up catalog magnitude for each star
- Fit measured intensities to known magnitude
- Measure intensity of object-of-interest
- Use fit to find magnitude of object-of-interest

Plate solving

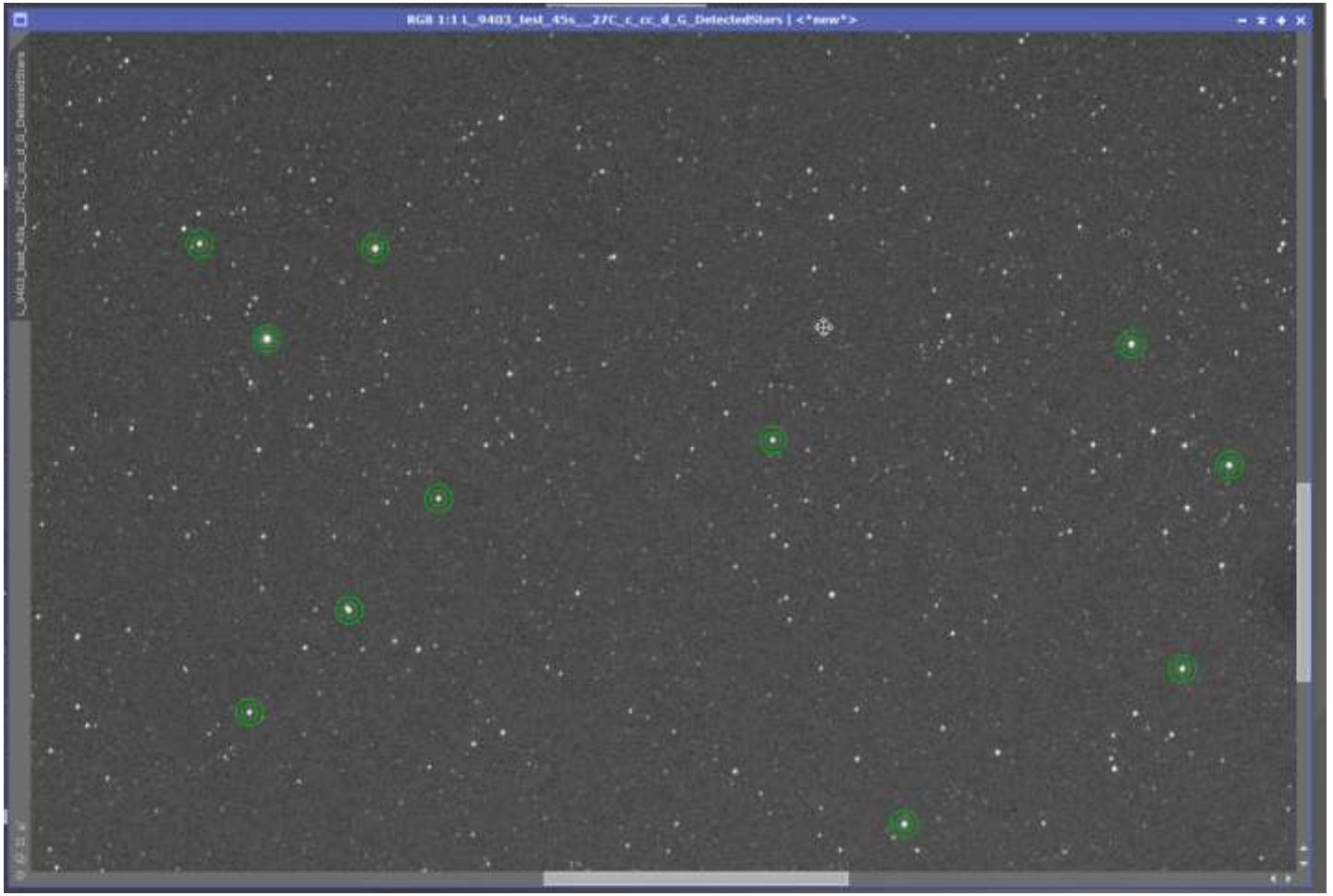
```
Image Plate Solver script version 5.0
================================================================================
Referentiation Matrix (Gnomonic projection = Matrix * Coords[x,y]):
          +0.000213463         +0.00190614            -4.08422
           -0.00190371         +0.00021356            +4.83942
                    +0                   +0                  +1
Projection origin.. [2748.009889 1835.052866]px -> [RA:20 58 37.444 Dec:+67 59
21.69]
Spline order ...... 2
Num. ControlPoints. 88
Resolution ........ 6.901 arcsec/px
Rotation .......... -96.431 deg
Focal ............. 194.29 mm
Pixel size ........ 6.50 um
Field of view ..... 10d 32' 6.2" x 7d 2' 5.5"
Image center ...... RA: 20 58 37.378  Dec: +67 59 21.72
Image bounds:
   top-left ....... RA: 20 04 47.929  Dec: +72 20 43.09
   top-right ...... RA: 20 33 48.575  Dec: +62 15 55.13
   bottom-left .... RA: 21 39 00.267  Dec: +73 19 49.26
   bottom-right ... RA: 21 34 15.633  Dec: +62 53 54.13
================================================================================
```

Aperture photometry

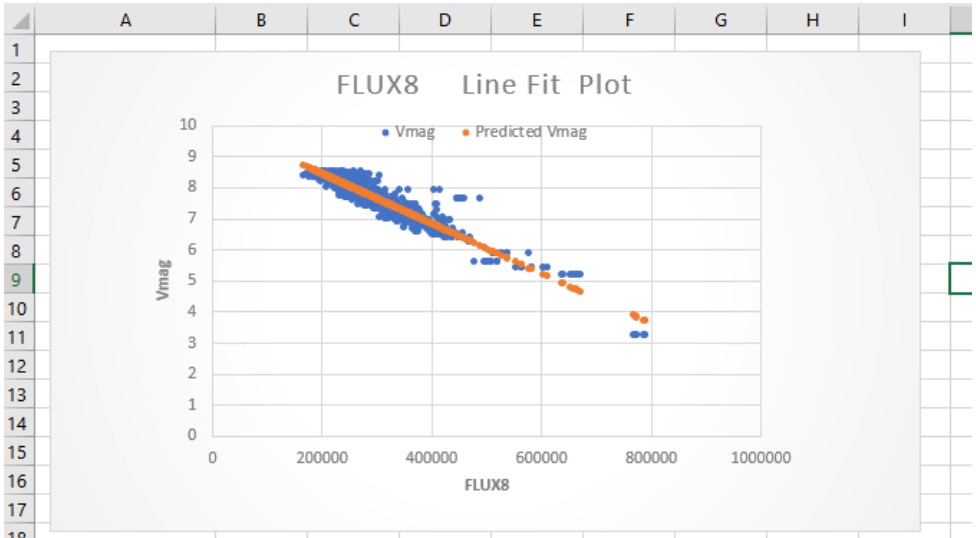




Photometry on solved img



Output: one big dataset



SUMMARY OUTPUT

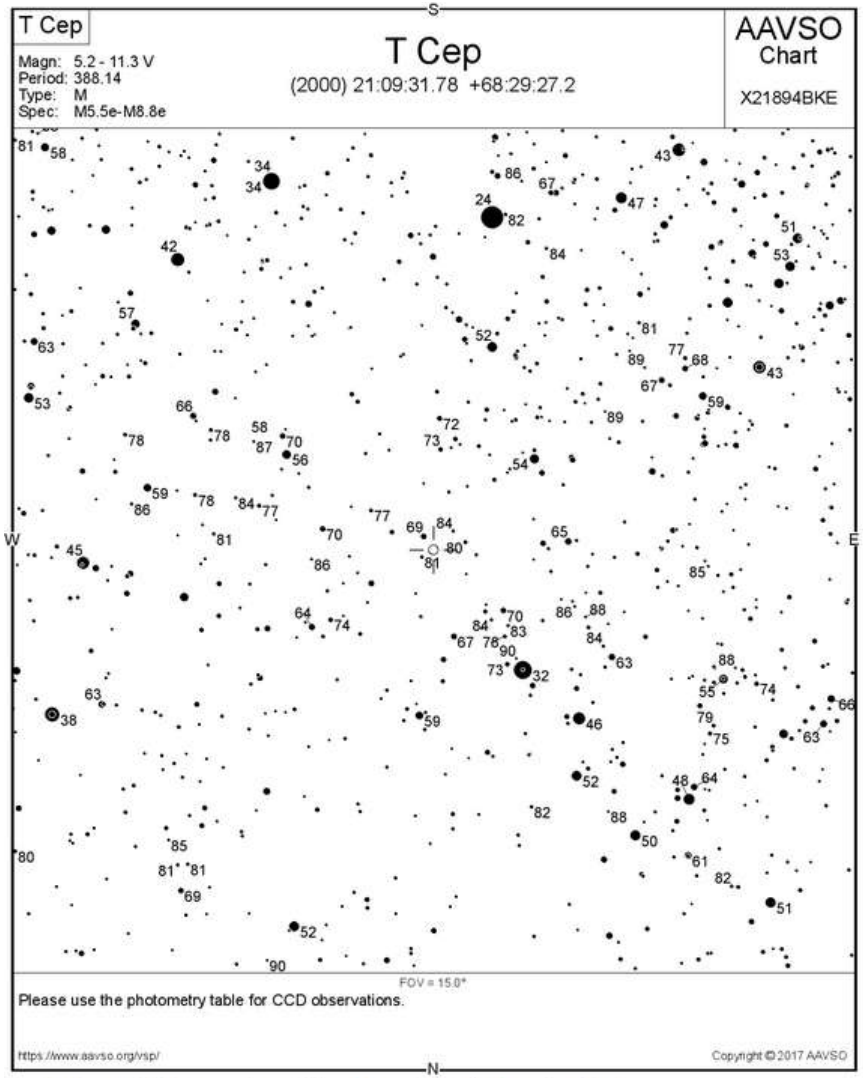
Regression Statistics	
Multiple R	0,942935
R Square	0,889125
Adjusted R Square	0,888995
Standard Error	0,266209
Observations	851

ANOVA

	df	*SS*	*MS*	*F*	*gnificance F*
Regression	1	482,486	482,486	6808,306	0
Residual	849	60,1663	0,070867		
Total	850	542,6523			

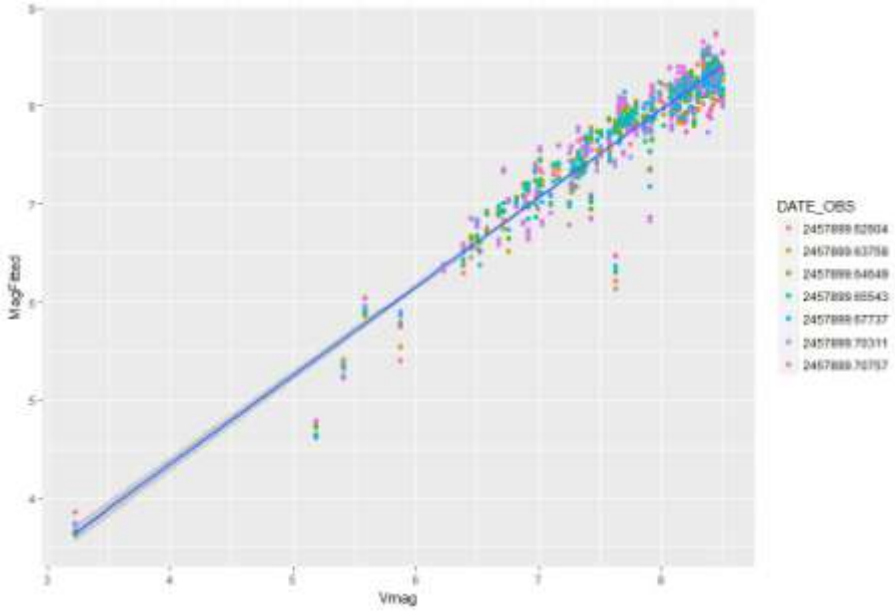
	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95,0%*	*pper 95,0%*
Intercept	10,04528	0,030202	332,602	0	9,986	10,10456	9,986	10,10456
FLUX8	-8,1E-06	9,76E-08	-82,5125	0	-8,2E-06	-7,9E-06	-8,2E-06	-7,9E-06

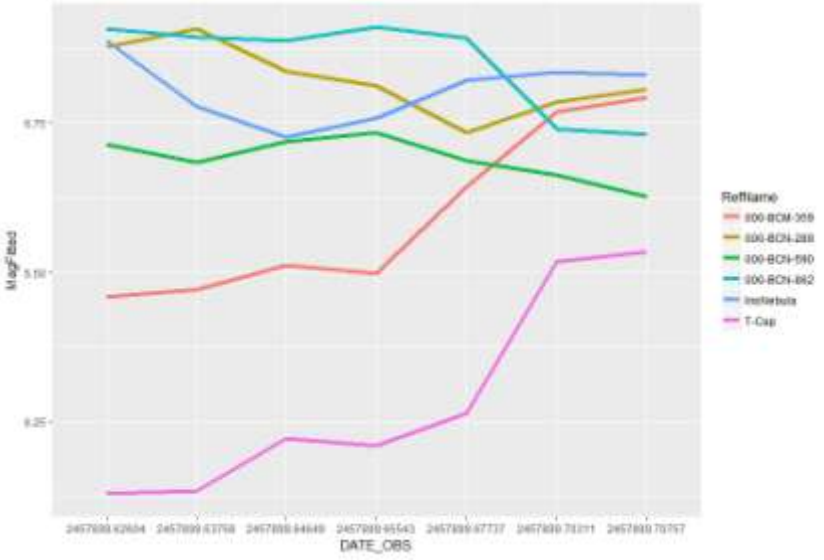
Limiting to reference stars



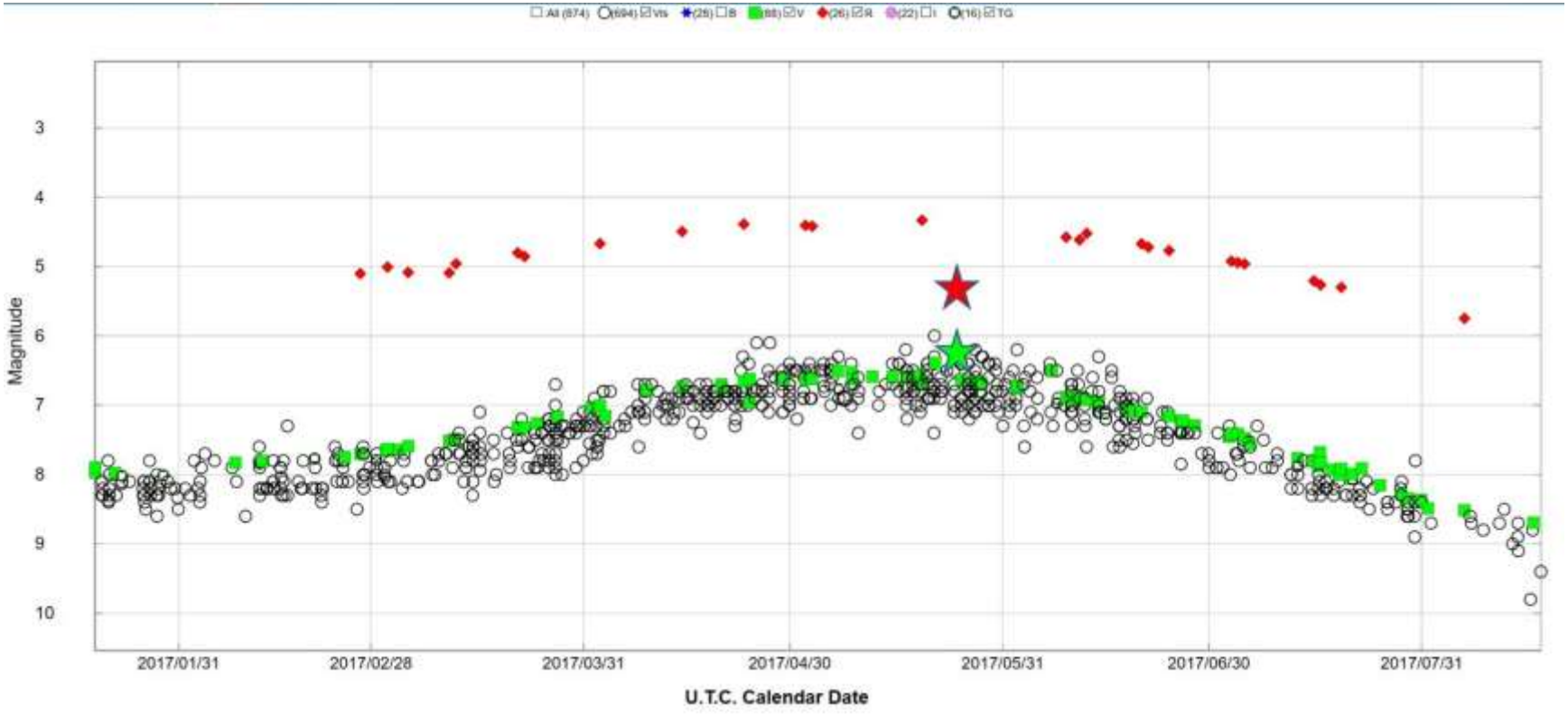
	A	B	C	D
1	NAME	REFNAME	AAVSO_MAG_V	AAVSO_MAG_R
2	202756.1+675239	81_000-BCL-581	8,133	8,133
3	203027.6+660324	78_000-BCL-681	7,841	7,841
4	203301.5+671834	84_000-BCL-823	8,358	8,358
5	203704.0+673015	77_000-BCL-989	7,687	7,687
6	204248.4+661936	70_000-BCM-254	7,033	6,976
7	204311.0+663926	56_000-BCM-277	5,58	5,396
8	204433.0+694506	64_000-BCM-359	6,41	5,701
9	204825.5+680158	70_000-BCM-558	7,022	6,686
10	204829.6+693928	74_000-BCM-562	7,424	7,424
11	210623.3+712554	59_000-BCN-231	5,87	5,536
12	210716.4+683654	81_000-BCN-258	8,105	8,105
13	210740.8+681514	69_000-BCN-289	6,883	6,798
14	211036.7+660929	72_000-BCN-441	7,153	6,295
15	211051.0+664234	73_000-BCN-455	7,323	7,323
16	211319.0+680923	84_000-BCN-579	8,421	8,421
17	211347.1+700139	67_000-BCN-590	6,727	6,051
18	211542.5+682107	80_000-BCN-661	7,973	7,621
19	211922.2+645218	52_000-BCN-716	5,18	5,075
20	212127.6+694239	84_000-BCN-773	8,407	8,407
21	212344.9+693203	70_000-BCN-862	6,959	6,88
22	212423.9+695935	78_000-BCN-876	7,754	7,754
23	212452.7+694741	83_000-BCN-884	8,28	8,28
24	212516.7+702839	73_000-BCN-887	7,288	7,288
25	212746.1+664832	54_000-BCN-951	5,44	5,477
26	212839.6+703338	32_000-BCN-968	3,23	3,379

Prelim. results





Prelim. results

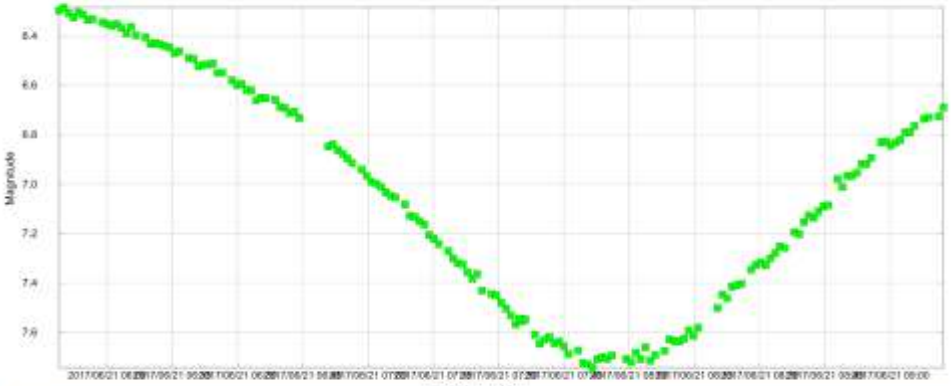


“Possible improvements”

- Proper reference stars
  - Both fainter and brighter than object of interest
- Slightly out-of-focus data
  - Reduce undersampling
  - Take care to select large enough aperture circles!
- Green channel only
- More data
- More interesting subject

RZ Cassiopeia

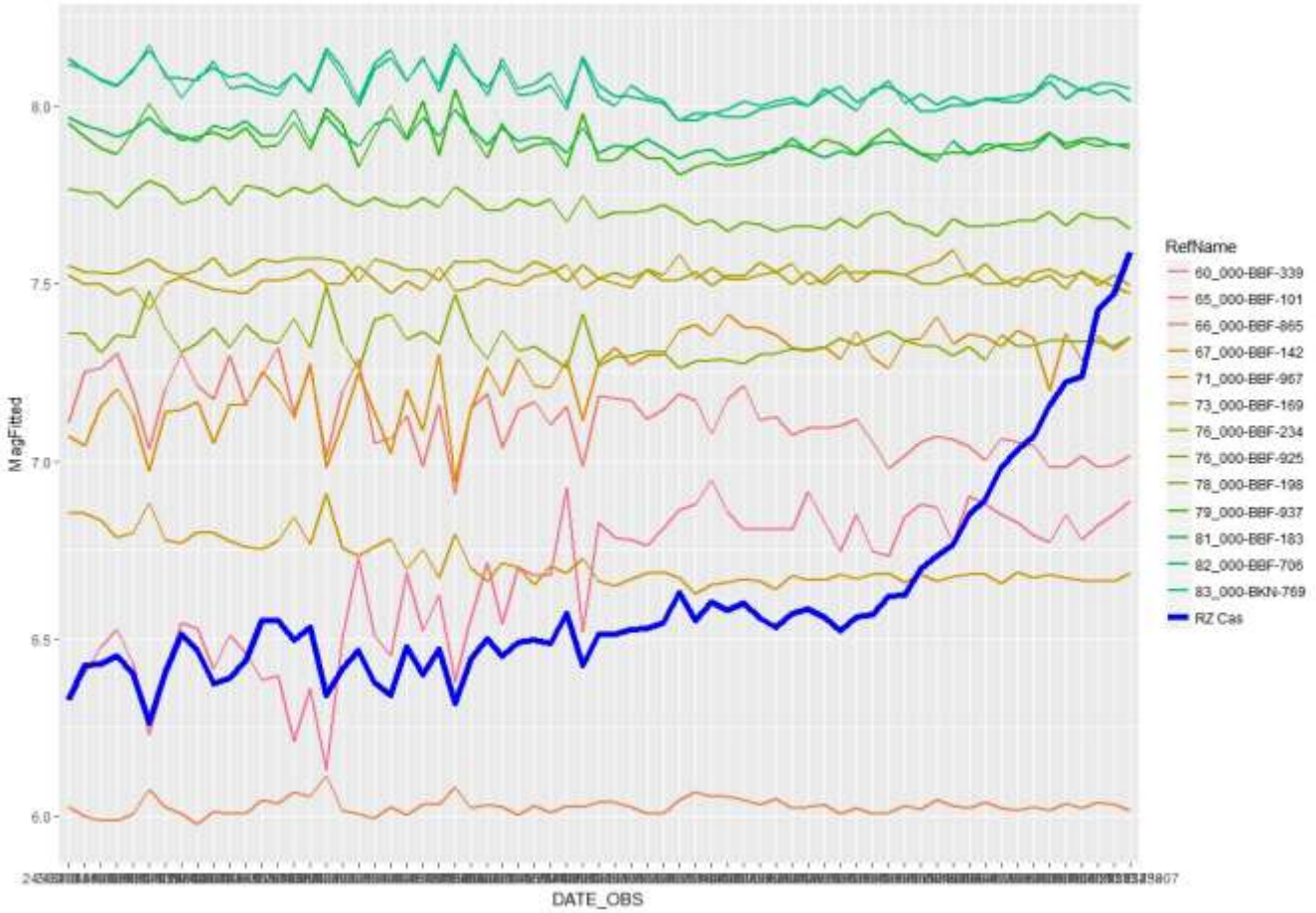
- Eclipsing binary of Algol type
- Period 1.19 d
- Duration ‘dip’ 4h 53m
- Magnitude 6,18 – 7,72



Setup:

- Eclipse: 20 Sept 2017, around 04:00 GMT
- Observations: 19/9 23:00 – 20/7 06:00
- 30” subs, every 5 min.
  - 67 usable frames, 14 thrown out: dew
- (from ca. 01:40) protection from dew
  - cold night

Final result



Future improvements

- GMT ≠ CEST !!!
- Set camera date to GMT for proper dating.
- Check for dew and other flaws more often

- Do this again ☺ ☺ ☺

Questions?