



The Cambridge Photometric Calibration Server 2.0

new automatic tool for time domain astronomy

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Involved People

Łukasz Wyrzykowski	Warsaw University (PL)
Krzysztof Rybicki	Warsaw University (PL)
Zbigniew Kołaczkowski	N. Copernicus Astronomical Center (PL)
Przemysław Mikołajczyk	University of Wrocław (PL)
Przemysław Bruś	University of Wrocław (PL)
Sergey Koposov	Carnegie Mellon University (USA)
Katarzyna Kruszyńska	Warsaw University (PL)
Mariusz Gromadzki	Warsaw University (PL)
Gaia Science Alerts Team	University of Cambridge (UK)

~20 observatories spread over the world

OPTICON

Optical Infrared Coordination Network for Astronomy

Horizon 2020



<http://www.astro-opticon.org/>

OPTICON - Time Domain Astronomy

- Networking Activity WP13: Time Domain Astronomy
- networking (workshops)
- coordination of scientific goals in time domain
- support in observations and data processing
- observing trips
- robotic telescopes in TNA support

Time Domain Astronomy? What is it?

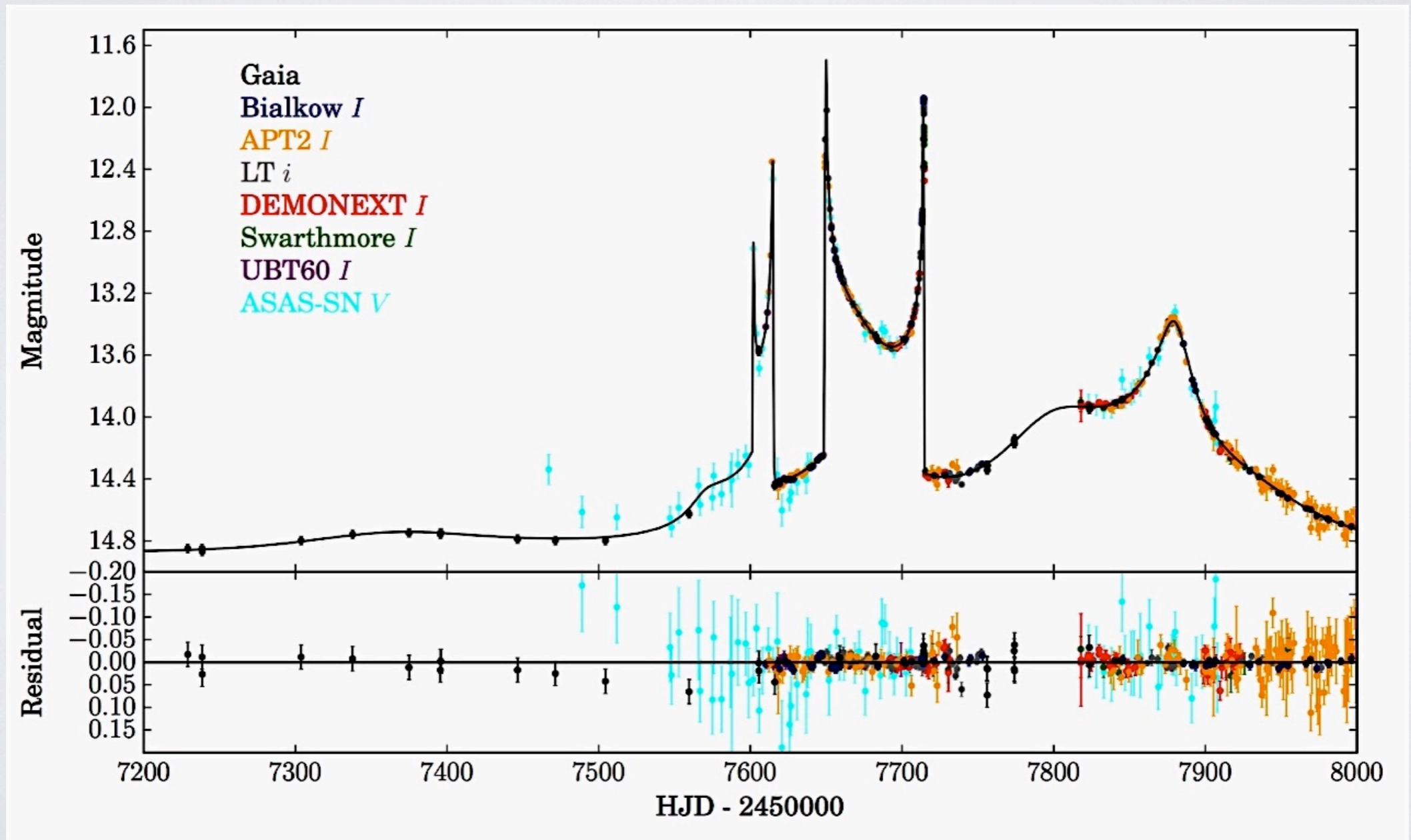
- Long-term monitoring programs of known or new, temporal objects
- Rapid follow-up observations (photometric or spectroscopic)
- Interesting targets:
 - periodic variables, exoplanets, CV, asteroids
 - transients: novae, supernovae, microlenses, TDEs, gravitational wave optical counterparts

Follow-up network



Gaia16aye

- first binary microlensing event in the Galactic disk
Wyrzykowski et al, in prep. (model by P. Mróz)
- more than 20 000 data points!!!



Cambridge Photometric Calibration Server (current version)

Welcome to the Cambridge Photometry Calibration Server (CPCS)

Not logged in

[Login](#) into the system
[List of alerts \(observed only\)](#)
[List of followup data](#)
[List of observatories](#)
[Upload](#) new followup data
[Enter](#) new event
[Delete](#) a followup point from the system
[Logout](#)

- gsaweb.ast.cam.ac.uk/followup/

[Manual](#)

- Input data - ASCII files with **RA, DEC, Mag, MagErr**

Cambridge Photometric Calibration Server (current version)

Upload done from IP 37.249.110.19

EventId : ivo://Gaia18bmt

Ra : 214.01478

Dec : -56.9134

Filter: APASS / r

Magnitude: 15.47 +/- 0.01 mag

ZP: -1.78 mag

Scatter: 0.12 mag

Number of datapoints used for calibration: 79

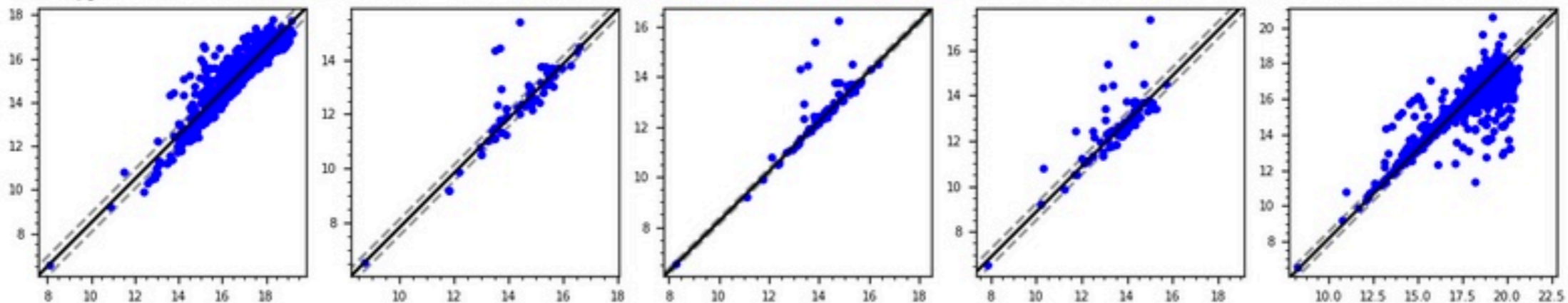
Outlier fraction: 0.15

Matching radius[arcsec]: 2.0

Dry run: True

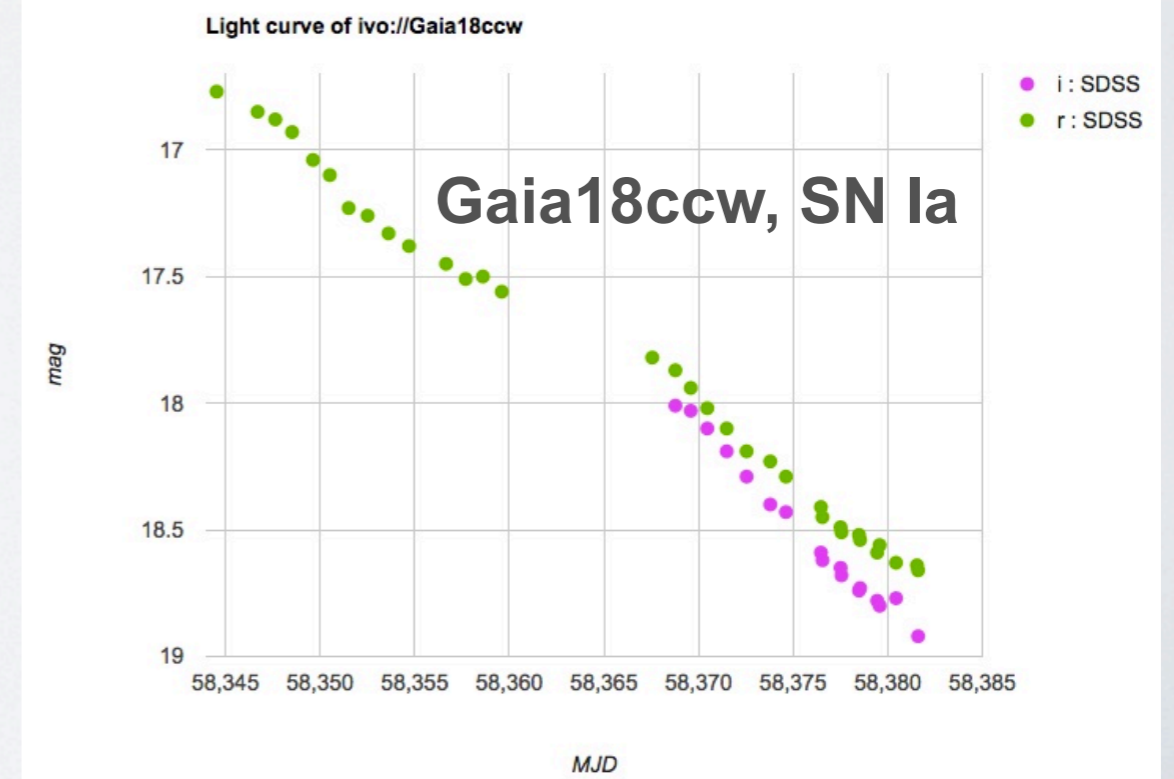
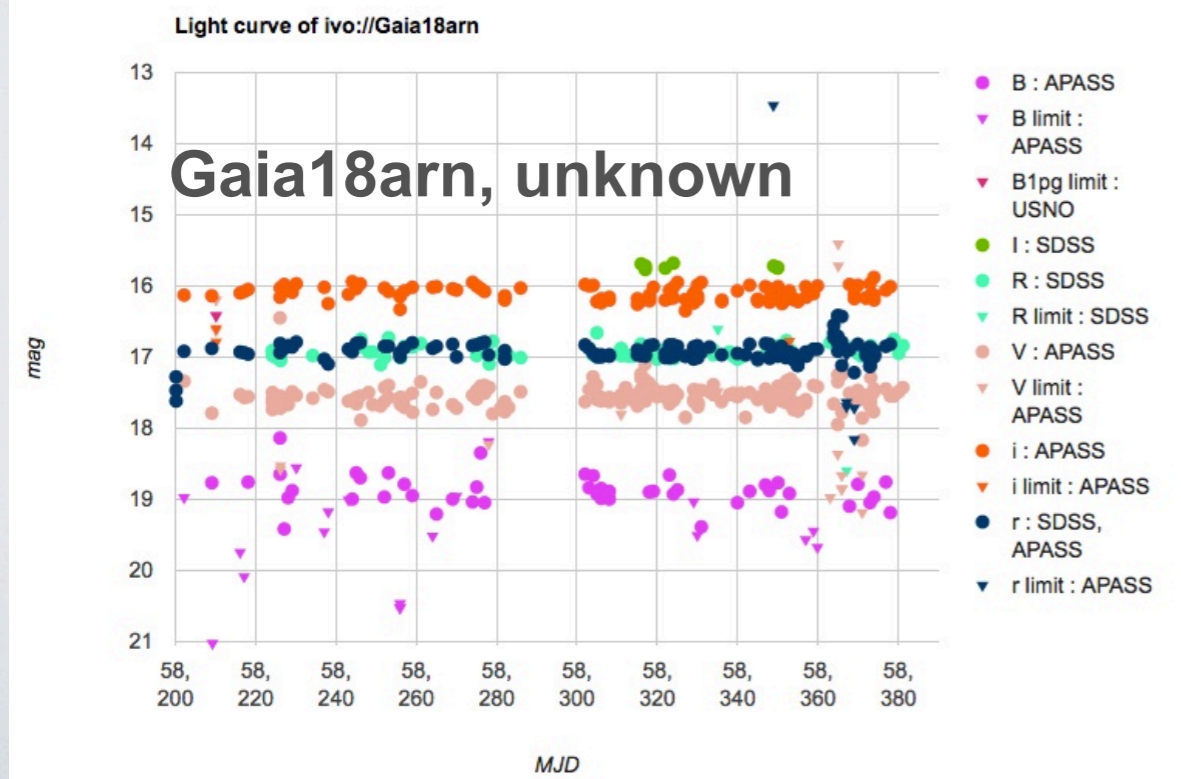
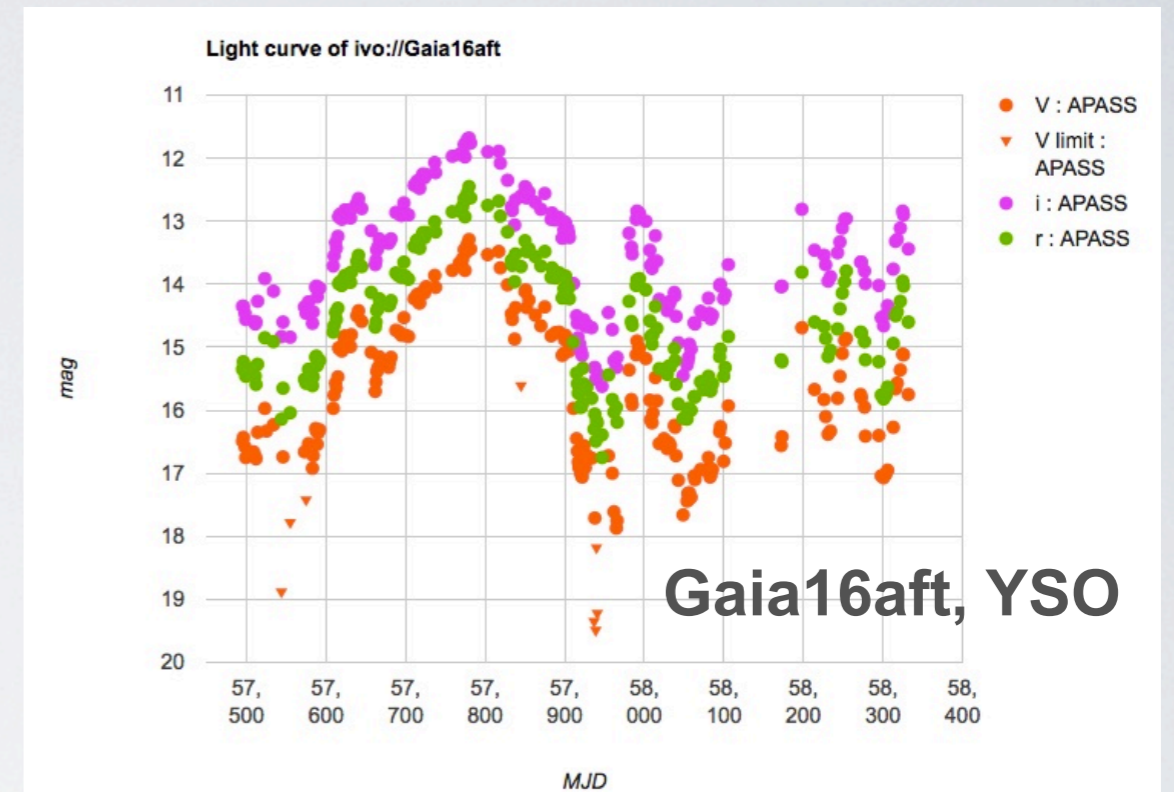
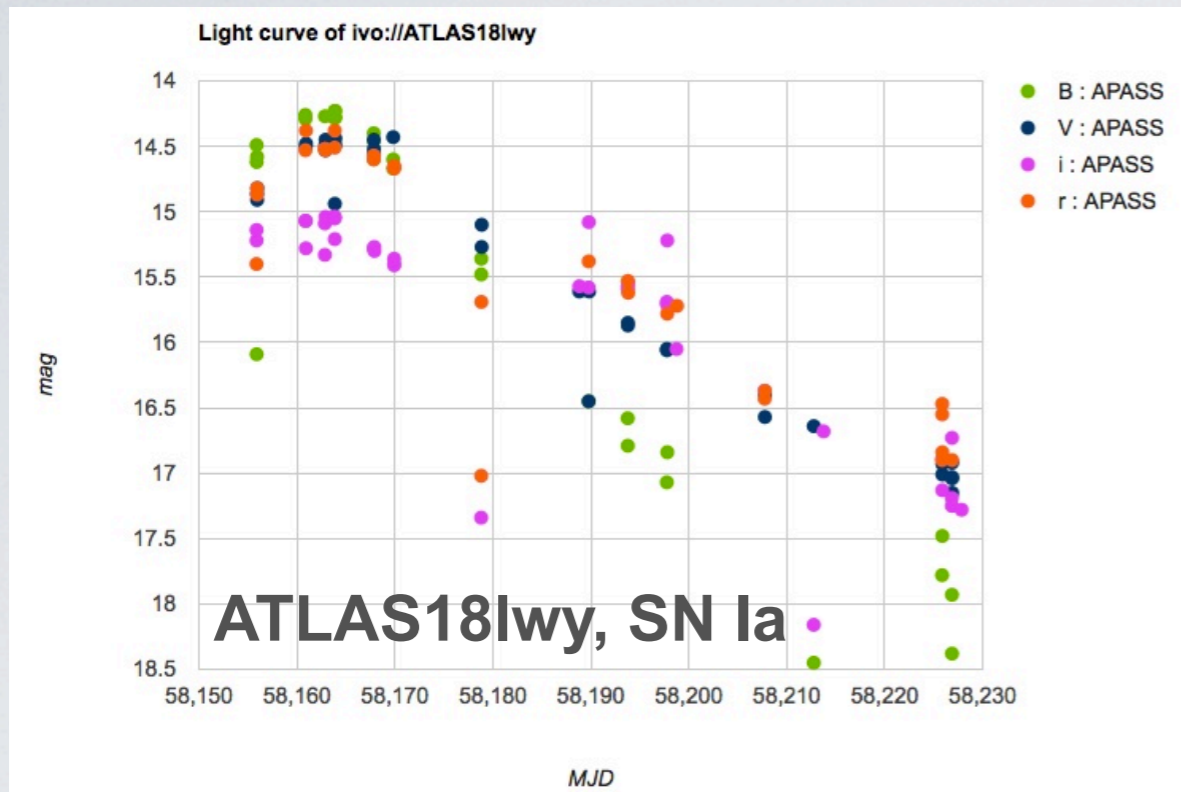
- Photometric standardization from instrumental magnitudes
- Calibration plot for each filter founded in catalogues

USNO R1pg ZP = -1.52 σ = 0.44 f_{out} = 0.02 APASS V ZP = -2.16 σ = 0.29 f_{out} = 0.07 **APASS r ZP = -1.78 σ = 0.12 f_{out} = 0.15** APASS i ZP = -1.13 σ = 0.36 f_{out} = 0.12 GAIA G ZP = -1.84 σ = 0.38 f_{out} = 0.05



Time spend calibrating 2.48750901222 s

Cambridge Photometric Calibration Server (current version)

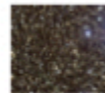
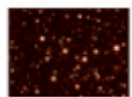
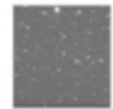


Cambridge Photometric Calibration Server 2.0

Network of telescopes



FITS images

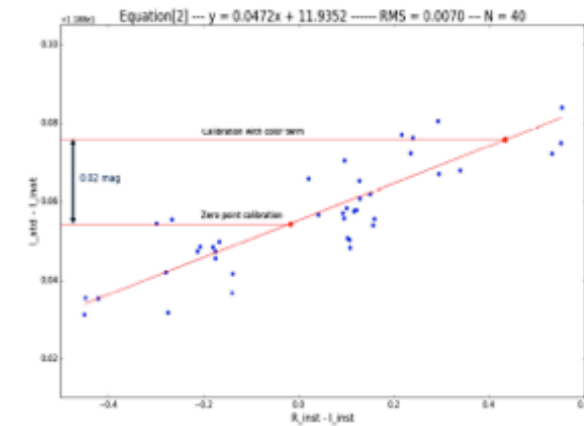


CPCS 2.0

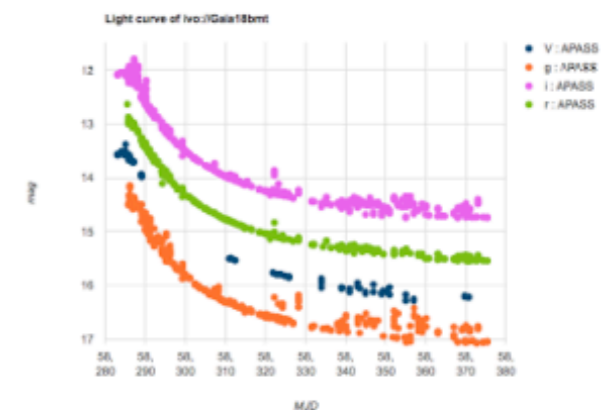
Data storage



Photometric standardization



Light curves



Cambridge Photometric Calibration Server 2.0

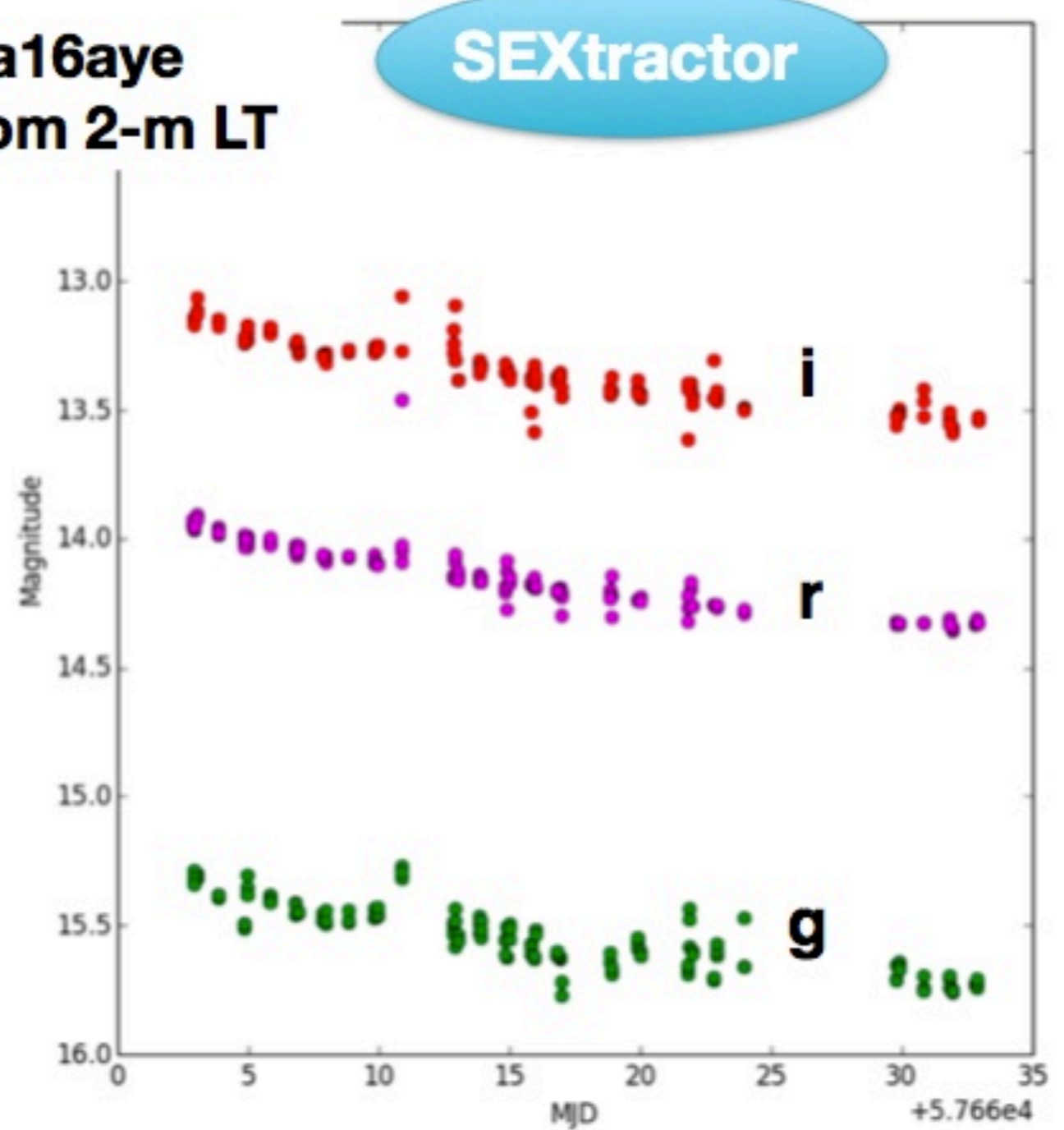
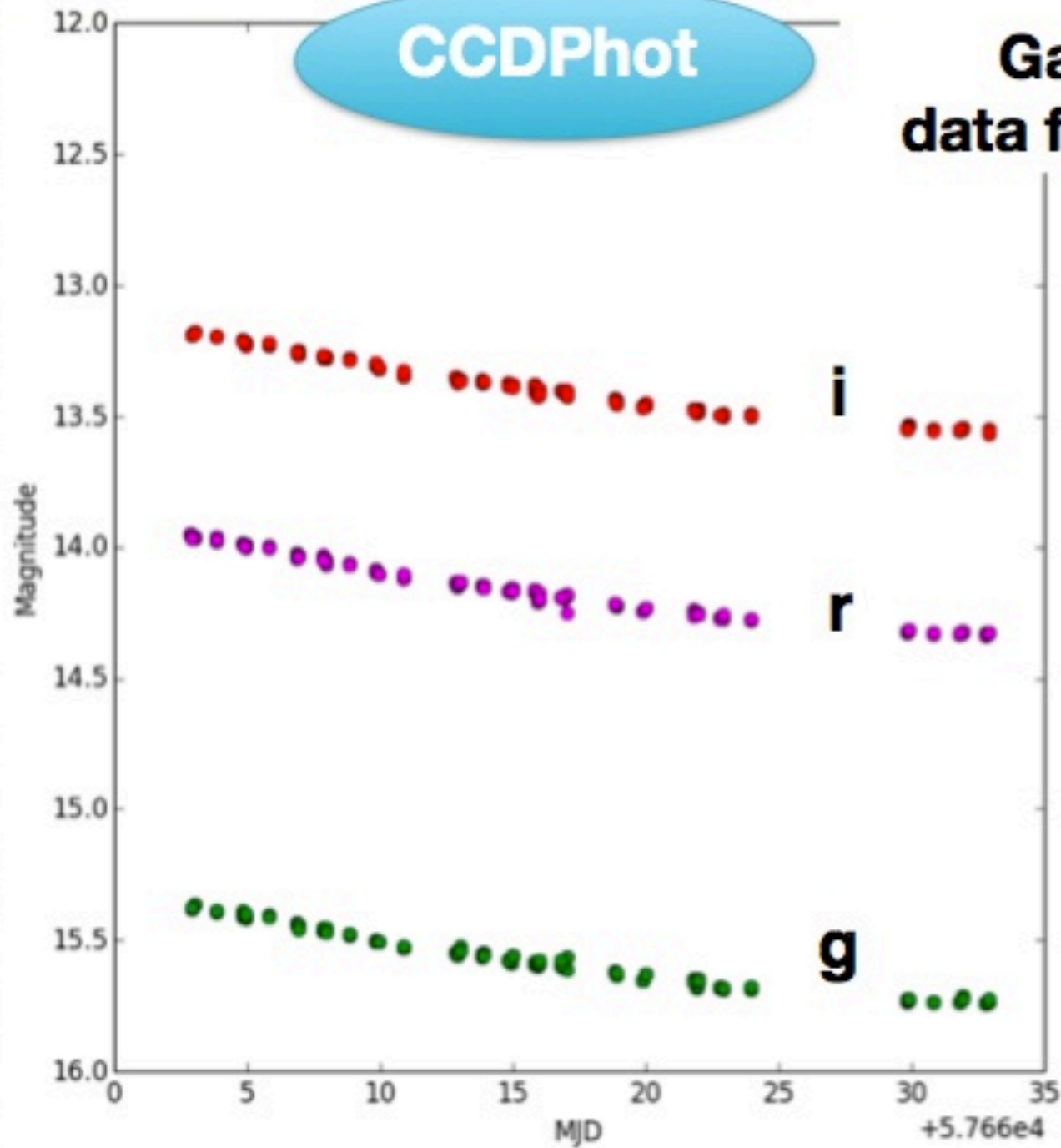
- Web-based tool to get photometric and astrometric solutions from FITS images
- Precision of **photometric** measurements **~0.01 mag**,
astrometric measurements **~0.01 arcsec**
- **CCDPhot** as a kernel of CPCS 2.0
it uses DAOPhot, WCStools, IRAF/PyRAF, SEXtractor, SCAMP
- Scripts for standardisation of FITS headers
- Scripts for automatic selection of PSF stars
- Scripts for transformation of instrumental magnitudes to standard system, reference catalogues: APASS, SDSS, PS1, DES, 2MASS
- Astrometric references: URAT-1, UCAC-4, USNOB1 and Gaia-DR2
- Automatic uploading of the data possible (by using shell scripting)

Precise photometry of CCDPhot

CCDPhot

Gaia16aye
data from 2-m LT

SEXtractor

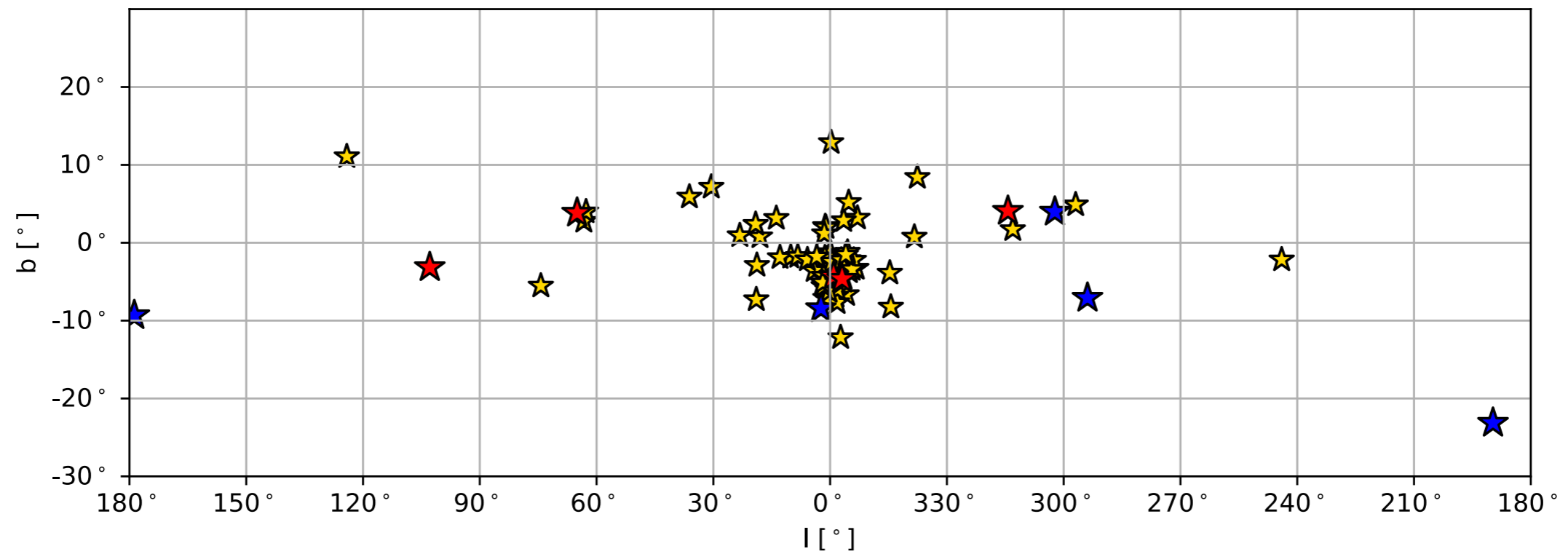


Photometric microlensing - searching for BH

- data from Gaia, ASAS-SN arrives, alert candidates published
- interesting targets identified (microlensing, TDEs)
- information on the mailing list
Gaia Science Alerts Working Group #10 - Photometric Follow-up
- observers monitor the targets
- follow-up observations going to the CPCS

Microlensing candidates

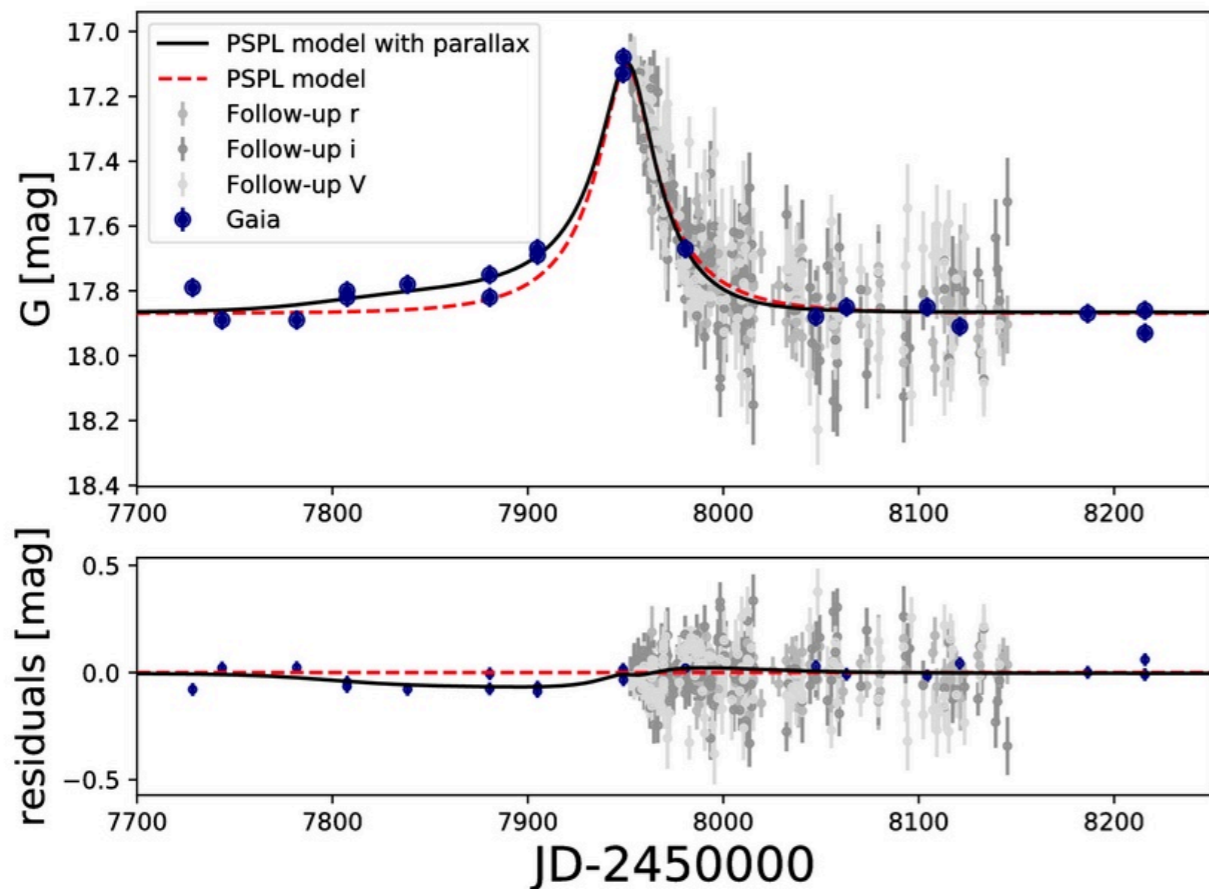
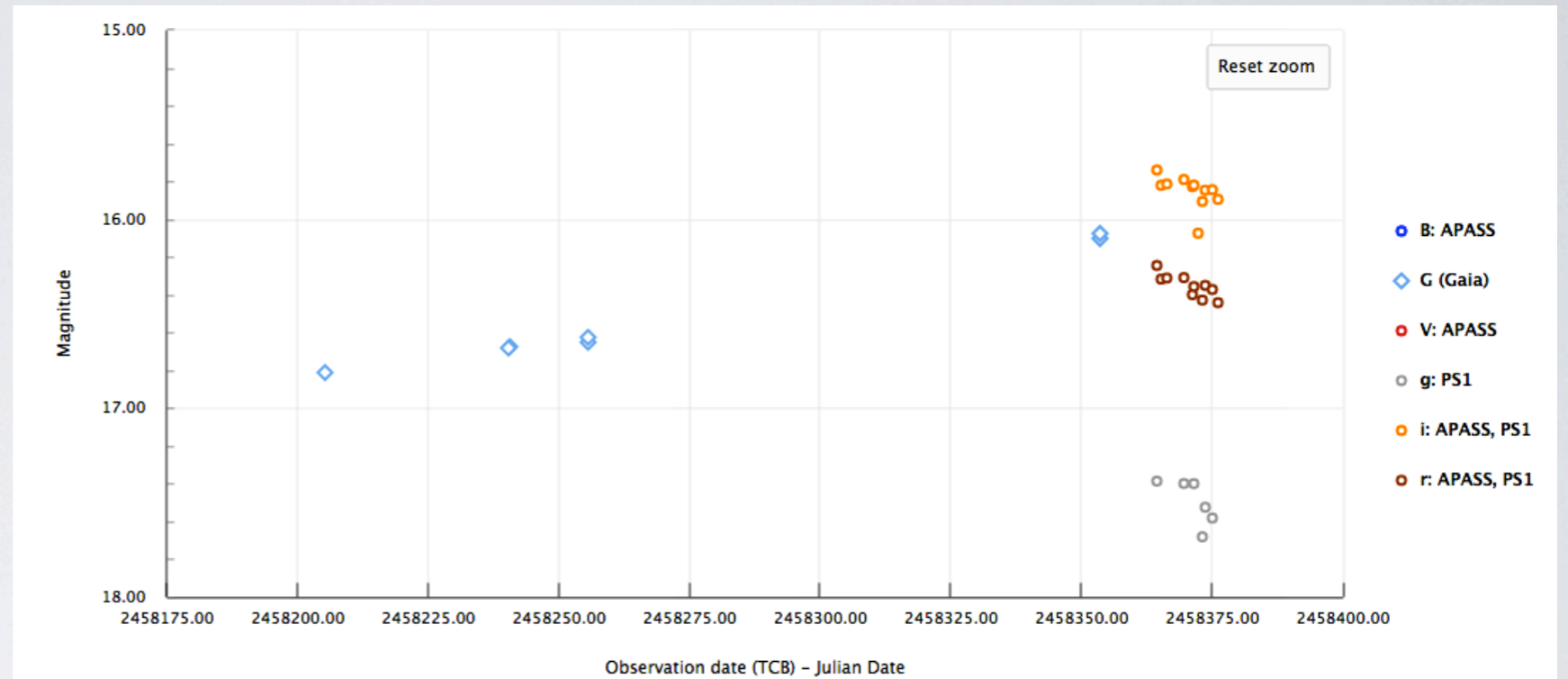
Events gallery



- ★ All candidates (68)
- ★ Candidates brighter than $G=16.5\text{mag}$ (5)
- ★ Non-Gaia Candidates (5)

Microlenses - BH candidates

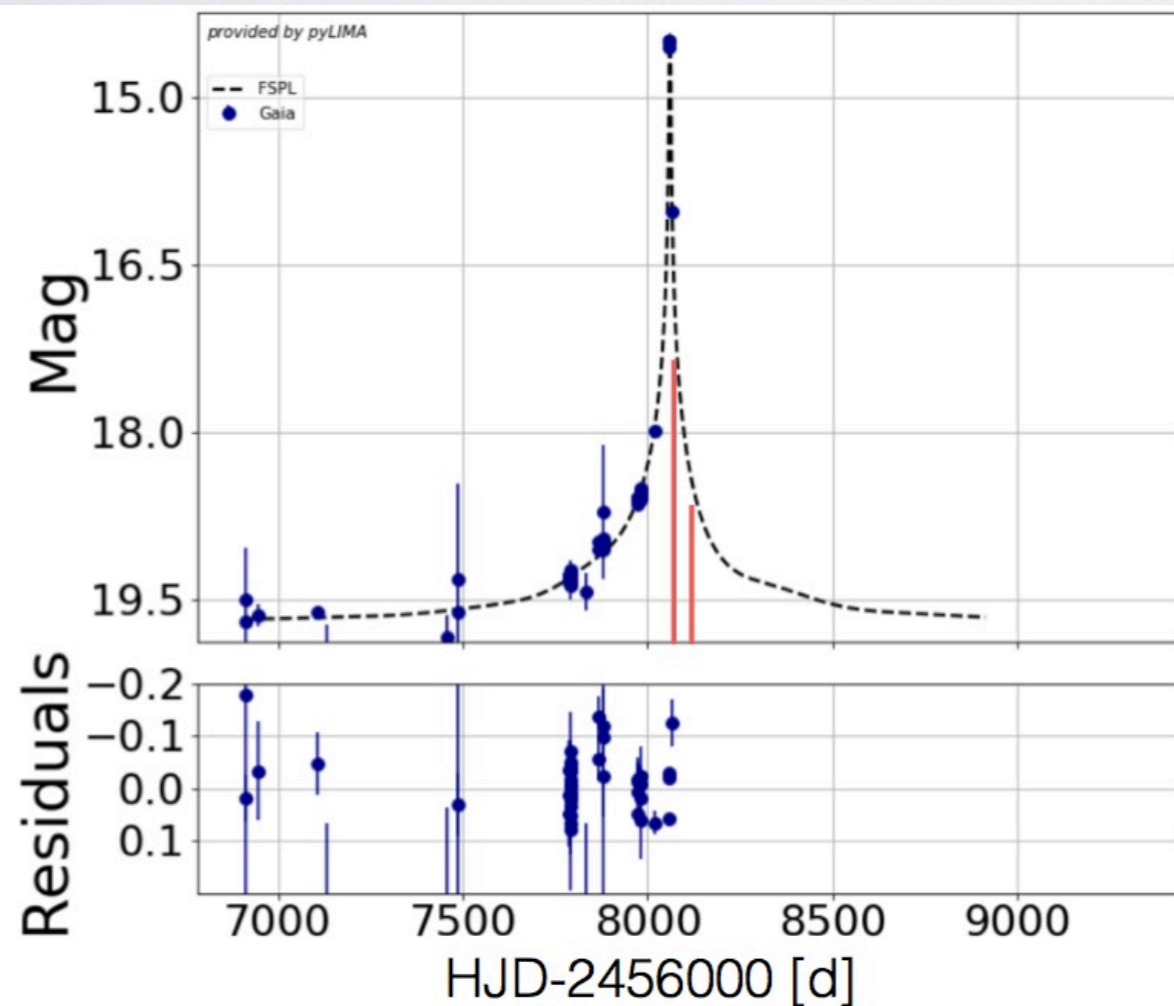
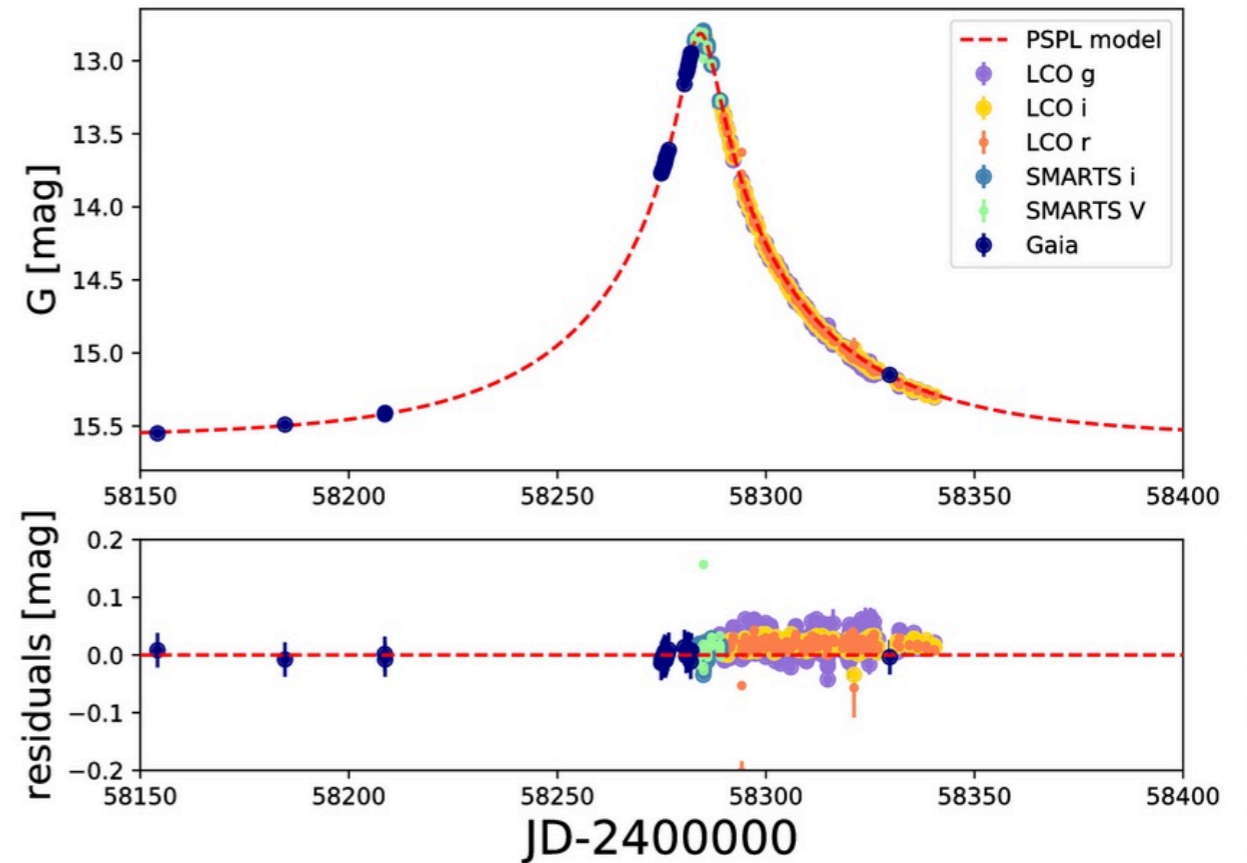
Gaia18cjk - long term brightening of ~ 1 mag source in Galactic plane



Gaia17bts - source near Galactic plane brightens by ~ 0.7 mag (model by K. Rybicki)

Microlenses - BH candidates

Gaia18bmt - >2 mag rise on a red star in the Galactic plane
(model by K. Kruszyńska)



Gaia17ctl - source near Galactic plane brightens by 4.5 mag
(model by K. Kruszyńska)

Summary

- **CPCS 2.0** is tested on various data from different telescopes/instruments, old website rebuilt, work in progress...
- Feel invited to cooperation in the follow-up network!
- Join our mailing list GSAWG#10 - Photometric Follow-up contact **Łukasz Wyrzykowski**: lw@astrouw.edu.pl
- You can use it for your own research independently!

Thank you!

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