



The Cambridge Photometric Calibration Server 2.0

new automatic tool for time domain astronomy

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Involved People

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Przemysław Bruś

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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

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](#)

Cambridge Photometric Calibration Server (current version)

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

Please sign-in with your hashtag

PZielinski_3bb298.....

Submit

- Unique authorization hashtag obtained from Łukasz Wyrzykowski

- http://gsaweb.ast.cam.ac.uk/followup/list_of_alerts

CPCS - List of alerts

id	ivorn	published	ra	dec	nfollowup	LC	data
27149	ivo://Gaia18cnx	2018-09-19 06:44:42	85.7320833333	18.9288888889	12	LC	data
27148	ivo://Gaia18com	2018-09-19 05:43:05	71.7457916667	17.0438055556	10	LC	data
27147	ivo://Gaia18cnj	2018-09-19 04:27:02	41.4972083333	42.5415	12	LC	data
27146	ivo://Gaia18cos	2018-09-19 04:07:07	39.4684166667	28.8025	12	LC	data
27145	ivo://Gaia18con	2018-09-19 03:25:54	9.120625	39.1703888889	7	LC	data
27144	ivo://Gaia18cof	2018-09-19 03:05:57	11.0825	41.4905	9	LC	data
27143	ivo://Gaia18cow	2018-09-17 04:49:14	28.3395	34.1488888889	77	LC	data
27142	ivo://Gaia18cor	2018-09-17 01:41:10	313.158	30.553	79	LC	data
27141	ivo://Gaia18coz	2018-09-16 22:30:38	300.56	31.6096111111	7	LC	data
27137	ivo://Gaia18cnz	2018-09-14 13:19:58	281.78935	1.46838	6	LC	data
27136	ivo://Gaia18coj	2018-09-12 00:12:20	275.394	2.05194444444	118	LC	data
27135	ivo://Gaia17asr	2018-09-11 18:46:15	290.33233	8.37824	14	LC	data
27134	ivo://Gaia18cnp	2018-09-11 04:05:36	31.2515833333	46.0938888889	83	LC	data
27133	ivo://Gaia18cjb	2018-09-10 06:28:20	99.7814166667	0.148472222222	3	LC	data
27132	ivo://Gaia18cdg	2018-09-10 05:58:10	109.33	52.3066111111	3	LC	data
27131	ivo://Gaia18cju	2018-09-10 01:50:02	289.885	35.3788055556	6	LC	data
27130	ivo://Gaia18cju	2018-09-10 01:29:04	290.356	34.2413055556	6	LC	data
27129	ivo://Gaia18cmk	2018-09-09 22:08:11	307.14938	22.83047	149	LC	data
27128	ivo://Gaia18cik	2018-09-09 22:04:59	278.37988	-3.40325	22	LC	data
27127	ivo://Gaia18ckn	2018-09-09 06:41:45	104.596	35.8406944444	3	LC	data

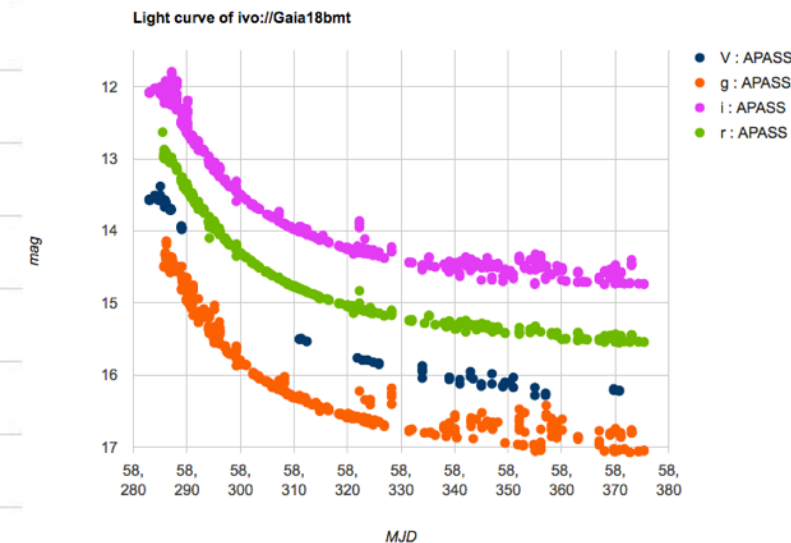
- http://gsaweb.ast.cam.ac.uk/followup/list_of_alerts

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27147	ivo://Gaia18cnj	2018-09-19 04:27:02	41.4972083333	42.5415	12	LC	data
27146	ivo://Gaia18cos	2018-09-19 04:07:07	39.4684166667	28.8025	12	LC	data
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27142	ivo://Gaia18cor	2018-09-17 01:41:10	313.158	30.553	79	LC	data
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27132	ivo://Gaia18cdg	2018-09-10 05:58:10	109.33	52.3066111111	3	LC	data
27131	ivo://Gaia18cjb	2018-09-10 01:50:02	289.885	35.3788055556	6	LC	data
27130	ivo://Gaia18cju	2018-09-10 01:29:04	290.356	34.2413055556	6	LC	data
27129	ivo://Gaia18cmk	2018-09-09 22:08:11	307.14938	22.83047	149	LC	data
27128	ivo://Gaia18cik	2018-09-09 22:04:59	278.37988	-3.40325	22	LC	data
27127	ivo://Gaia18ckn	2018-09-09 06:41:45	104.596	35.8406944444	3	LC	data

only alerts in the database
can be calibrated

light curve with all data for
a given object

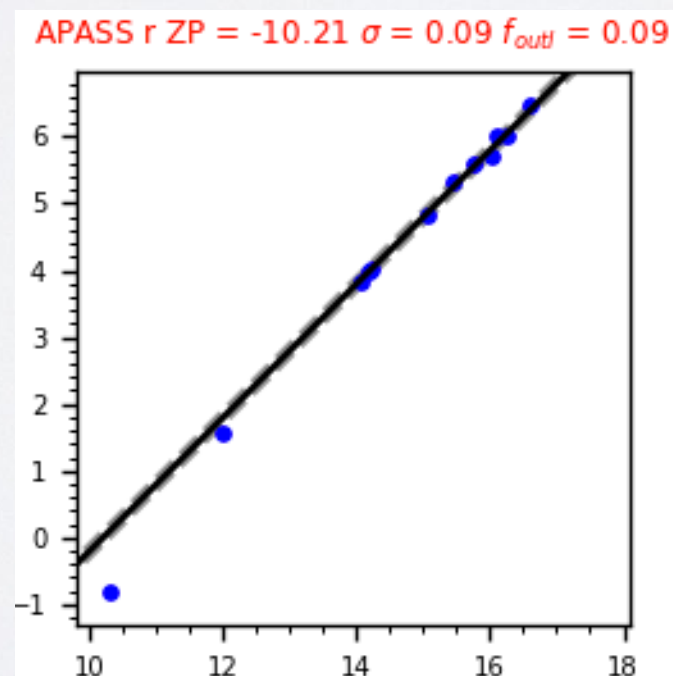


all data in JSON format
available only after login

- http://gsaweb.ast.cam.ac.uk/followup/list_of_followups

CPCS - List of follow-up data

id	IVORN	Observatory	MJD	mag	mag_err	calib_err	npoints	Catalog	Filter	mode	Calibration date	Image+Data
122113	ivo://Gaia18cvx	LCOGT2m, F.Lewis	58397.6877795	16.5232	0.01	0.01	9	APASS	i	FORCED	2018-10-07 21:17:02	ID
122112	ivo://Gaia18cvx	LCOGT2m, F.Lewis	58397.6867246	16.6585	0.00	0.09	12	APASS	r	FORCED	2018-10-07 21:08:37	ID
122111	ivo://Gaia17bdd	PIRATE Meredith Morrell	57896.2123946	17.7694	0.12	0.04	206	APASS	g	AUTO	2018-10-07 16:10:18	ID
122110	ivo://Gaia17bgj	PIRATE Meredith Morrell	57896.1611724	20.1707	-1.00	0.06	754	APASS	V	AUTO	2018-10-07 16:10:10	ID



plot with the best
matching filter taken from
catalogue
-> **zero point correction**

original file with data
delivered by observer

- <http://gsaweb.ast.cam.ac.uk/followup/observatories>

CPCS - List of observatories

id	Name	Longitude	Latitude	Observations
110	AAVSO	0.0	0.0	731
18	admin	None	None	6
132	Akeno,Ryosuke Itoh	138.3	35.47	0
49	Aleks Scholtz James Gregory Telescope 0.94 St.Andrews,UK	-2.8	56.3	0
16	Alex Ball-SMARTS1.3	70.815	-30.16527778	145
76	Anna Hourihane	0.0	0.0	898
1	AnonymousFollowUpAccount	0.0	0.0	0
129	Aries1.04,Goran Damljanovic	79.68	29.35	23
160	Aristarchos, Kirill Sokolovsky	22.1982	37.986	0
161	Aristarchos, Kirill Sokolovsky	22.1982	37.986	60
96	Aristarchos, Nikos Nanouris	22.1982	37.986	0
9	AshishMahabalEulerLaSillaChile	-70.73	-29.257	28
7	AshishMahabalGOIndia	73.666667	19.083333	0
10	AshishMahabalP60	-116.863889	33.355833	0
8	AshishMahabalSAAO1.9SA	20.811642	-32.378961	0
15	AshishMahabal-SMARTS1.3	70.815	-30.16527778	0
112	ASV1.4 Goran Damljanovic	21.55	43.15	297
130	AUT25,Volkan Bakis	30.656254	36.89838	354
92	A.Zubareva 0.6m SAI	34.02	44.7	70
27	BAS NAO 2m Rozhen	24.74	41.7	120
28	BAS NAO 60cm Rozhen	24.74	41.7	0

- <http://gsaweb.ast.cam.ac.uk/followup/uploader>

CPCS - uploading new data

Follow-up Data Uploading Form

Event ID:

MJD OBS:

Exposure time (sec):

Comment(optional):

SExtractor catalog
(ASCII, FITS, FITS-
LDAC): Nie wybrano pliku.

Matching radius:

Force filter:

Dry Run (no data will be
stored in the database): ☐

- Input data:
ASCII file with
RA, DEC, Mag, MagErr

- <http://gsaweb.ast.cam.ac.uk/followup/uploader>

CPCS - uploading new data

Follow-up Data Uploading Form

Event ID:

MJD OBS:

Exposure time (sec):

Comment(optional):

SExtractor catalog
(ASCII, FITS, FITS-
LDAC):

Przeglądaj...

Nie wybrano pliku.

Matching radius:

1 arcsec
✓ 2 arcsec
4 arcsec
6 arcsec

Force filter:

No (automatic determination)

Dry Run (no data will be
stored in the database):

☐

Submit

Maximum distance allowed
for cross-matching the
objects with the database
(reflects the astrometric
accuracy)

- <http://gsaweb.ast.cam.ac.uk/followup/uploader>

CPCS - uploading new data

Follow-up Data Uploading Form

Event ID:	<input type="text"/>	
MJD OBS:	<input type="text"/>	
Exposure time (sec):	<input type="text"/>	
Comment(optional):	<input type="text"/>	
SExtractor catalog (ASCII, FITS, FITS- LDAC):	<input type="button" value="Przeglądaj..."/> Nie wybrano pliku.	
Matching radius:	<input type="text" value="2 arcsec"/>	
Force filter:	<input type="text" value="No (automatic determination)"/>	
Dry Run (no data will be stored in the database):	<input type="checkbox"/>	
<input type="button" value="Submit"/>		

PS1/i
PS1/r
PS1/z
PS1/g
APASS/i
APASS/r
APASS/B
APASS/g
APASS/V
VSTATLAS/i
VSTATLAS/r
VSTATLAS/u
VSTATLAS/z
VSTATLAS/g
OGLE3/I
OGLE3/V
USNO/R1pg
USNO/R2pg
USNO/B1pg
USNO/lpg
USNO/B2pg
GAIA/G
SDSS/B
SDSS/g
SDSS/i
SDSS/l
SDSS/r
SDSS/u
SDSS/V
SDSS/R
SDSS/z
2MASS/H
2MASS/K
2MASS/J
any/B
any/V
any/R
any/u
any/g
any/r
any/i
any/z

Output filter:
select the best matching filter
to your filter

CPCS - result of calibration

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

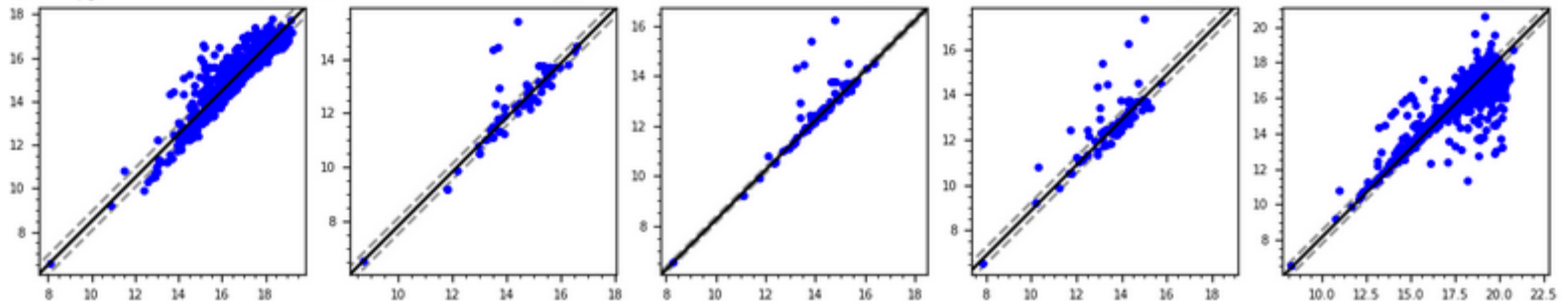
Matching radius[arcsec]: 2.0

Dry run: True

- Photometric standardisation from instrumental magnitudes

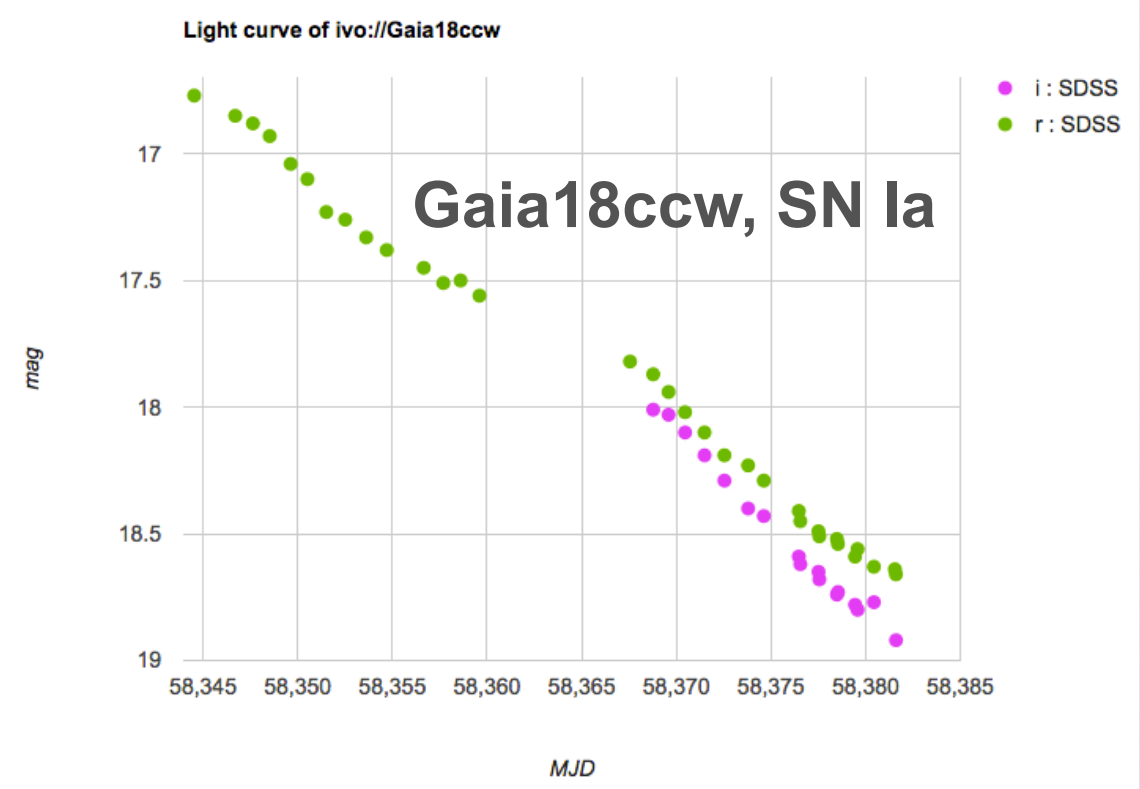
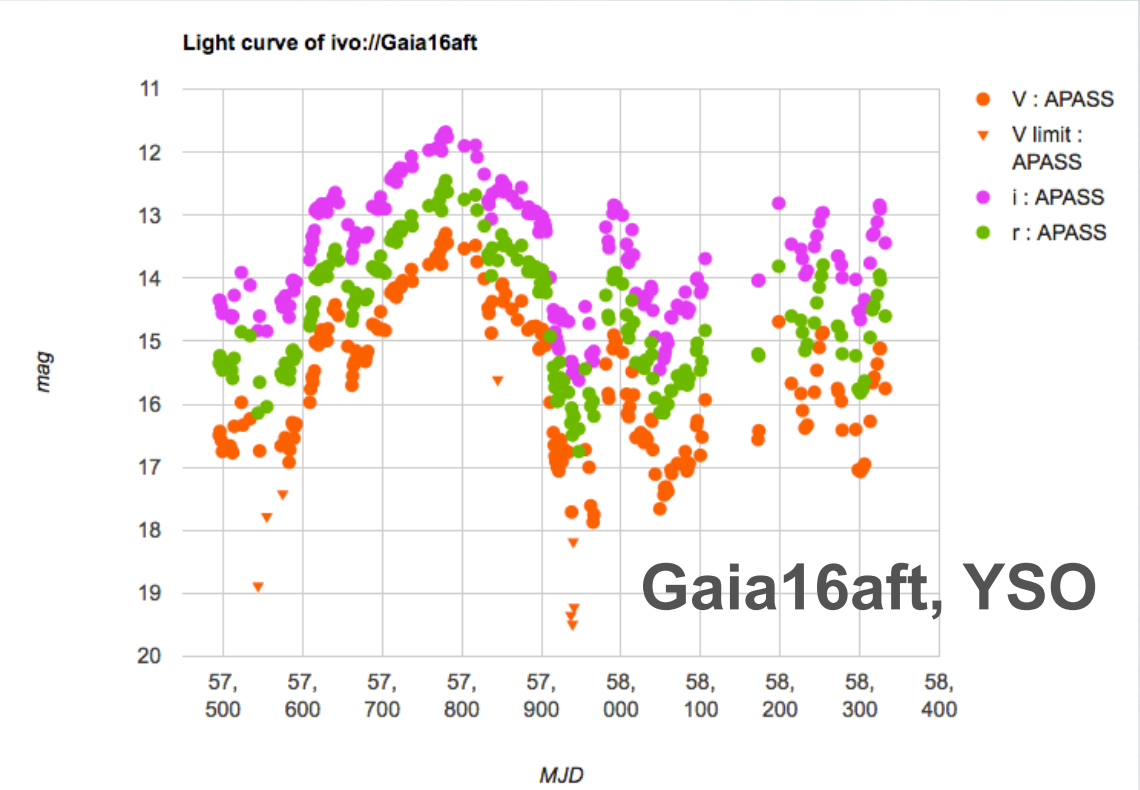
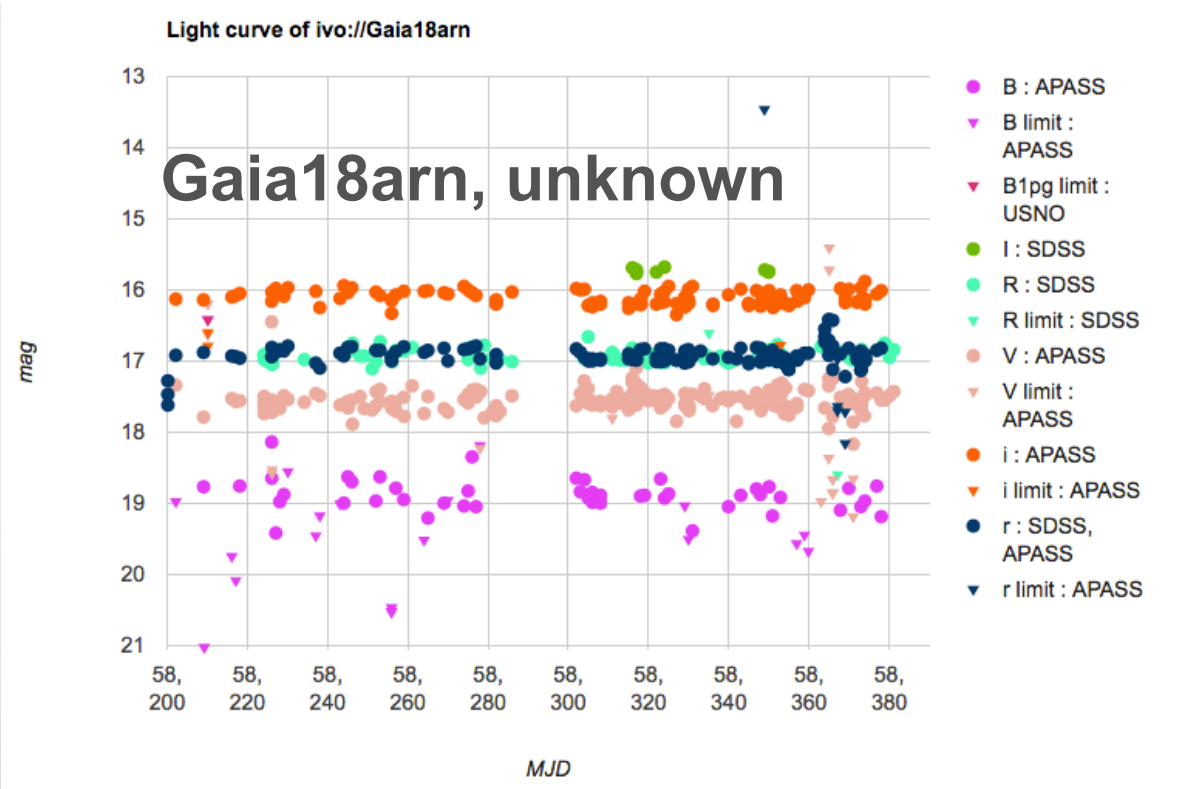
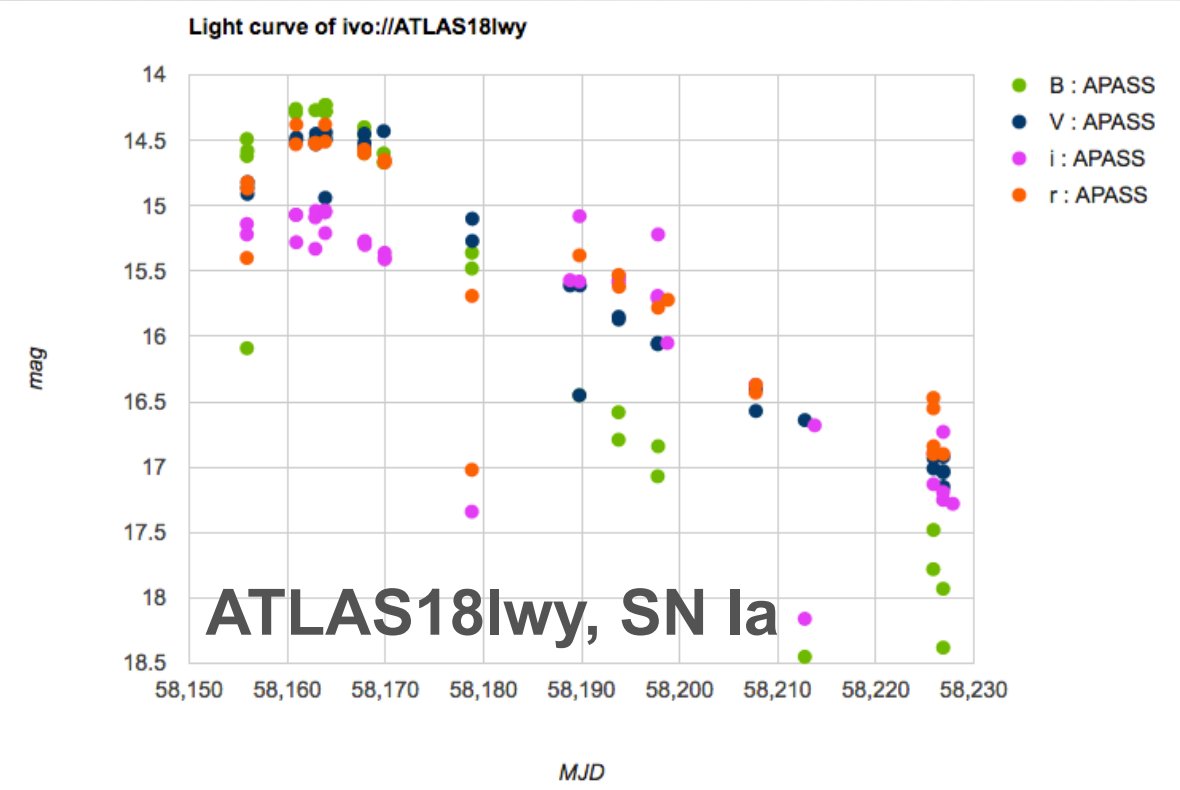
- Calibration plot for each filter found in catalogues

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



Time spend calibrating 2.48750901222 s

CPCS - example light curves



CPCS - automated uploading

Automated submission

You can also do that from the command line using HTTP POST protocol

```
curl -F matchDist=2 -F EventID='ivo://110610' -F sexCat="@path_to_your_sex_catalog_with_filename;filename=test.cat"
-F "hashtag=XXXX" -F "MJD=2" -F expTime=1 -F noPlot=1
-F forceFilter=no -F dryRun=1 -F outputFormat=json "http://gsaweb.ast.cam.ac.uk/followup/cgi/upload"
```

Parameters of the <http://gsaweb.ast.cam.ac.uk/followup/cgi/upload>

- matchDist -- matching radius in arcseconds
- hashtag -- your authorization key
- MJD -- mjd of the observations
- expTime -- exposure time
- comment -- comments
- EventID -- the ivorn of the alert
- dryRun -- the value of 1 allows you to check the results of the calibration without inserting anything into our DB
- forceFilter -- "no" means that the calibration will be fully automated. But You can also specify APASS/V if you want to calibrate using a particular survey/filter
- sexCat -- that's the Sextractor catalog you are trying to submit
- outputFormat -- at the moment the only allowed values are json and html

https://www.ast.cam.ac.uk/ioa/wikis/gsawgwiki/index.php/Calibration_Server

- <http://gsaweb.ast.cam.ac.uk/followup/newevent>

CPCS - adding an event

Creating New Event Form:

Logged in as Pawel Zielinski

IVORN:

Gaia16aye

RA:

295.00474

Dec:

30.13149

URL(not needed if the
event is on skyalert.org):

<http://gsaweb.ast.cam.ac.uk/alerts/alert/Gaia16aye/>

Submit

- <http://gsaweb.ast.cam.ac.uk/followup/delpoint>

CPCS - deleting the data

Delete a followup point Form:

Logged in as Pawel Zielinski

ID of the followup point:

Submit



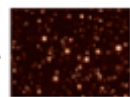
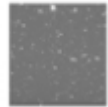
122041	ivo://Gaia18clv	Moletai1.65- Pawel Zielinski	58370.8218913	18.0254	0.02	0.10	63	APASS	V	FORCED	2018-10-05 15:50:12	I D
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Cambridge Photometric Calibration Server 2.0

Network
of telescopes



FITS images

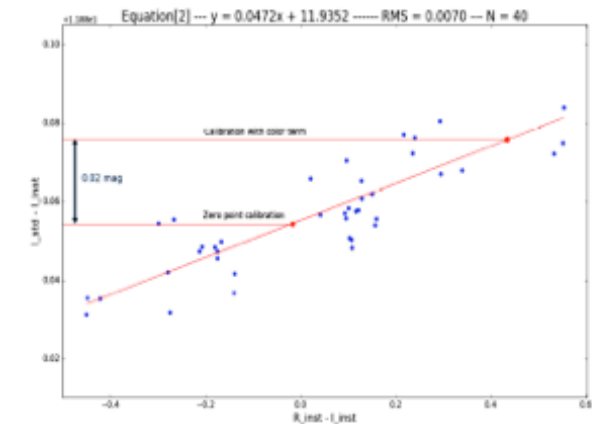


CPCS 2.0

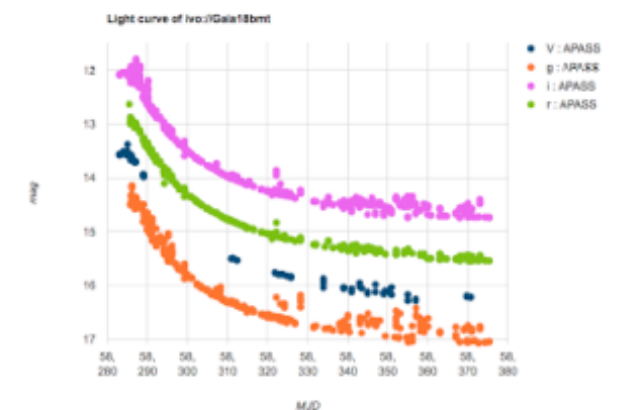
Data storage



Photometric
standardization



Light curves



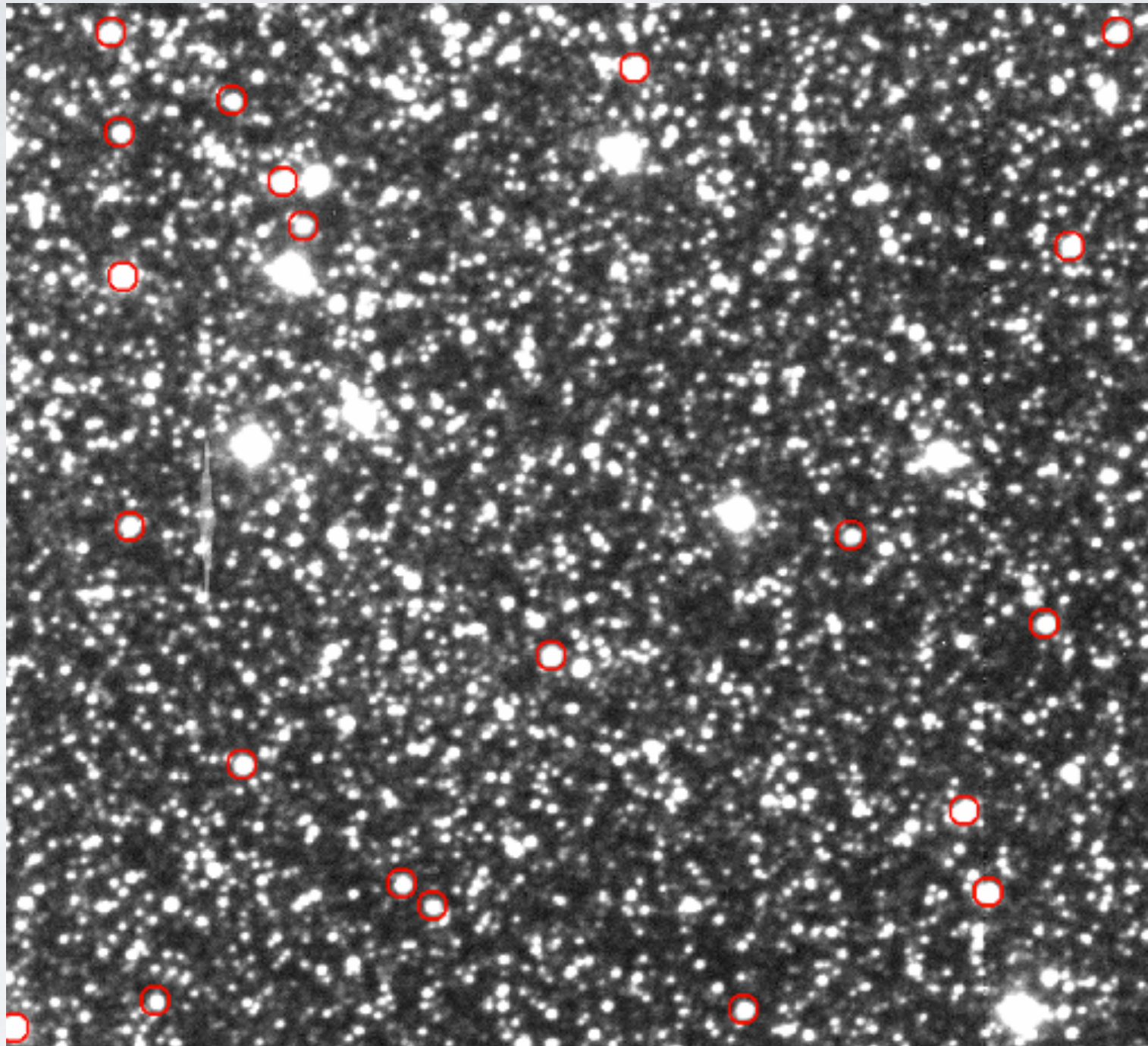
Cambridge Photometric Calibration Server 2.0

- 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, Pyfits, python-2.7(or higher)
- 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

FITS headers standardisation

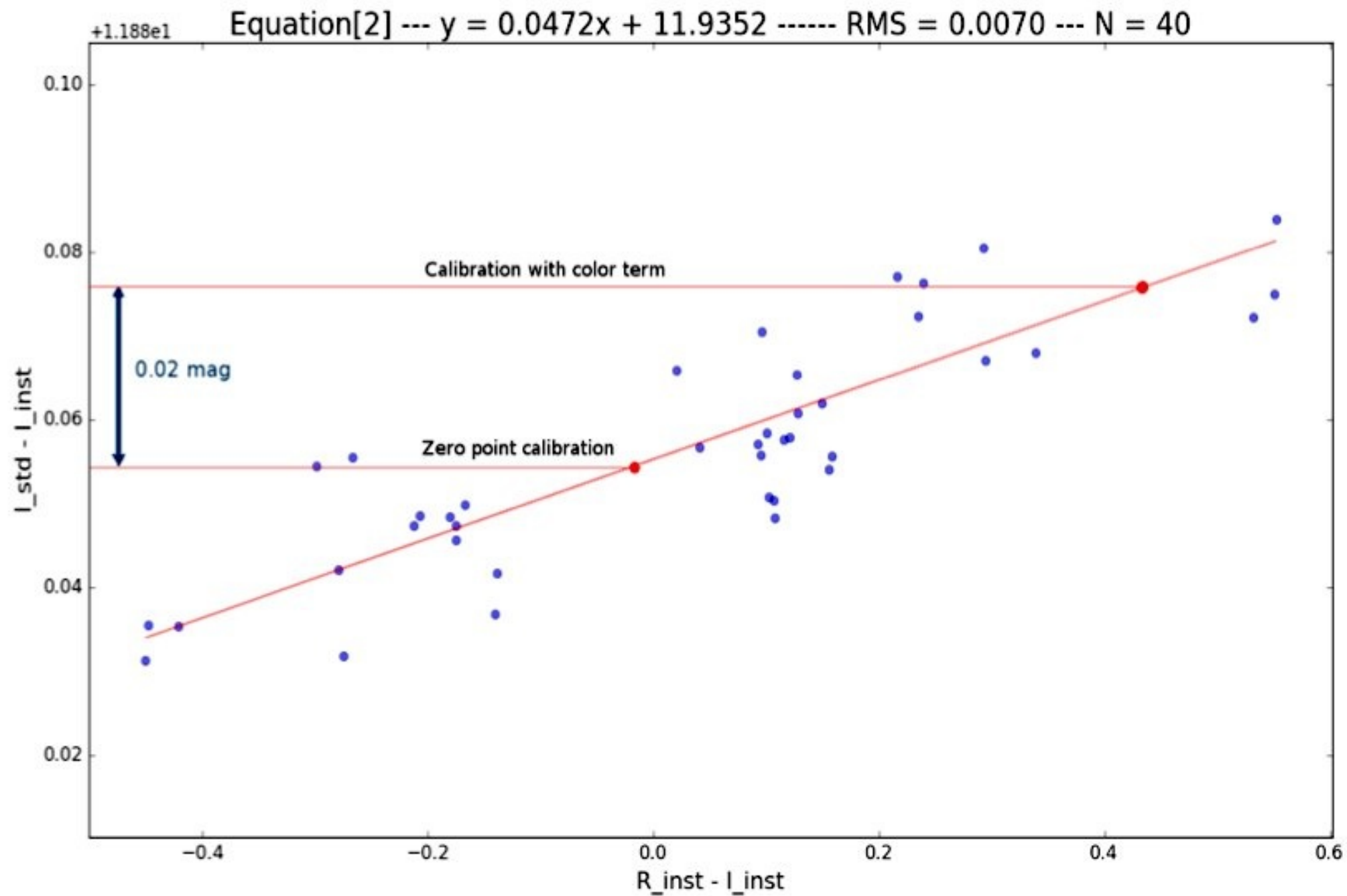
#	DESCRIPTION	KEYWORD (in FITS)	KEYWORD (standard)	FORMAT	VALUE(s)	COMMENT
#	-----					
#	OBSERVATORY					
	Observatory	: -	: OBSERVAT	: str	: LOIANO	: -
	Observer	: OBSERVER	: OBSERVER	: str	: -	: -
	Observatory longitude [deg]	: -	: LONGITUD	: float	: 348.66611	: -
	Observatory latitude [deg]	: -	: LATITUDE	: float	: 44.25917	: -
	Observatory altitude [m]	: -	: ALTITUDE	: float	: 785.0	: -
	Telescope	: TELESCOP	: TELESCOP	: str	: 1.52	: -
	Organization	: ORIGIN	: ORIGIN	: str	: Bologna_Astronomical_Observatory	: -
#	TIME (start of exposition)					
	Time system	: -	: TIMESYS	: str	: UTC	: -
	Date	: DATE-OBS	: DATE-OBS	: yyyy/mm/dd	: -	: "-"
	Time	: UT	: TIME-OBS	: hh:mm:ss	: -	: ":"
	Julian date	: JDMID	: JD	: float	: -	: middle of exp.
	Exposition time	: EXPTIME	: EXPTIME	: float	: -	: -
#	INSTRUMENT					
	Instrument name	: INSTRUME	: INSTRUME	: str	: BFOSC	: -
	Detector X size [pix]	: NAXIS1	: NAXIS1	: int	: 1341	: -
	Detector Y size [pix]	: NAXIS2	: NAXIS2	: int	: 1300	: -
	Binning	: -	: BIN	: int	: 1	: -
	Instr. mode, readout speed	: -	: READTIME	: int	: -	: ns/pix
	Gain	: -	: GAIN	: float	: 2.22	: e/ADU
	Read-out noise	: -	: RDNOISE	: float	: 1.38	: ADU
	Saturation limit	: -	: SATURATE	: int	: 52000	: ADU
	Pixel scale along x-axis	: -	: CDELTA1	: float	: 0.58	: deg/pix
	Pixel scale along y-axis	: -	: CDELTA2	: float	: 0.58	: deg/pix
	Position angle	: -	: ORIENTAT	: float	: 0.0	: deg
	Image type	: IMAGETYP	: OBSTYPE	: str	: object	: -
	Filters	: FILTERS	: FILTER	: str	: 2 7 g-Gunn r-Gunn	: -
	Pixel size along x-axis	: -	: PIXSIZE1	: float	: 22.5	: microm
	Pixel size along y-axis	: -	: PIXSIZE2	: float	: 22.5	: microm
	X reference pixel (center)	: -	: CRPIX1	: int	: 625	: -
	Y reference pixel (center)	: -	: CRPIX2	: int	: 575	: -
#	OBJECT & WCS					
	Object name	: OBJECT	: OBJECT	: str	: -	: -
	Epoch of coord. system	: EPOCH	: EQUINOX	: float	: 2000.0	: year
	Coord. system	: -	: RADESYS	: str	: FK5	: -
	Coord. type projection RA	: -	: CTYPE1	: str	: RA---TAN	: -
	Coord. type projection DEC	: -	: CTYPE2	: str	: DEC--TAN	: -
	Coord. unit RA	: -	: CUNIT1	: str	: deg	: -
	Coord. unit DEC	: -	: CUNIT2	: str	: deg	: -
	Right Ascension	: RA	: RA	: float	: -	: hours
	Declination	: DEC	: DEC	: float	: -	: deg
	Right Ascension WCS	: -	: CRVAL1	: float	: -	: deg
	Declination WCS	: -	: CRVAL2	: float	: -	: deg

Automatic selection of stars to PSF model



• Credit: P. Bruś

Transformation to standard photometric system

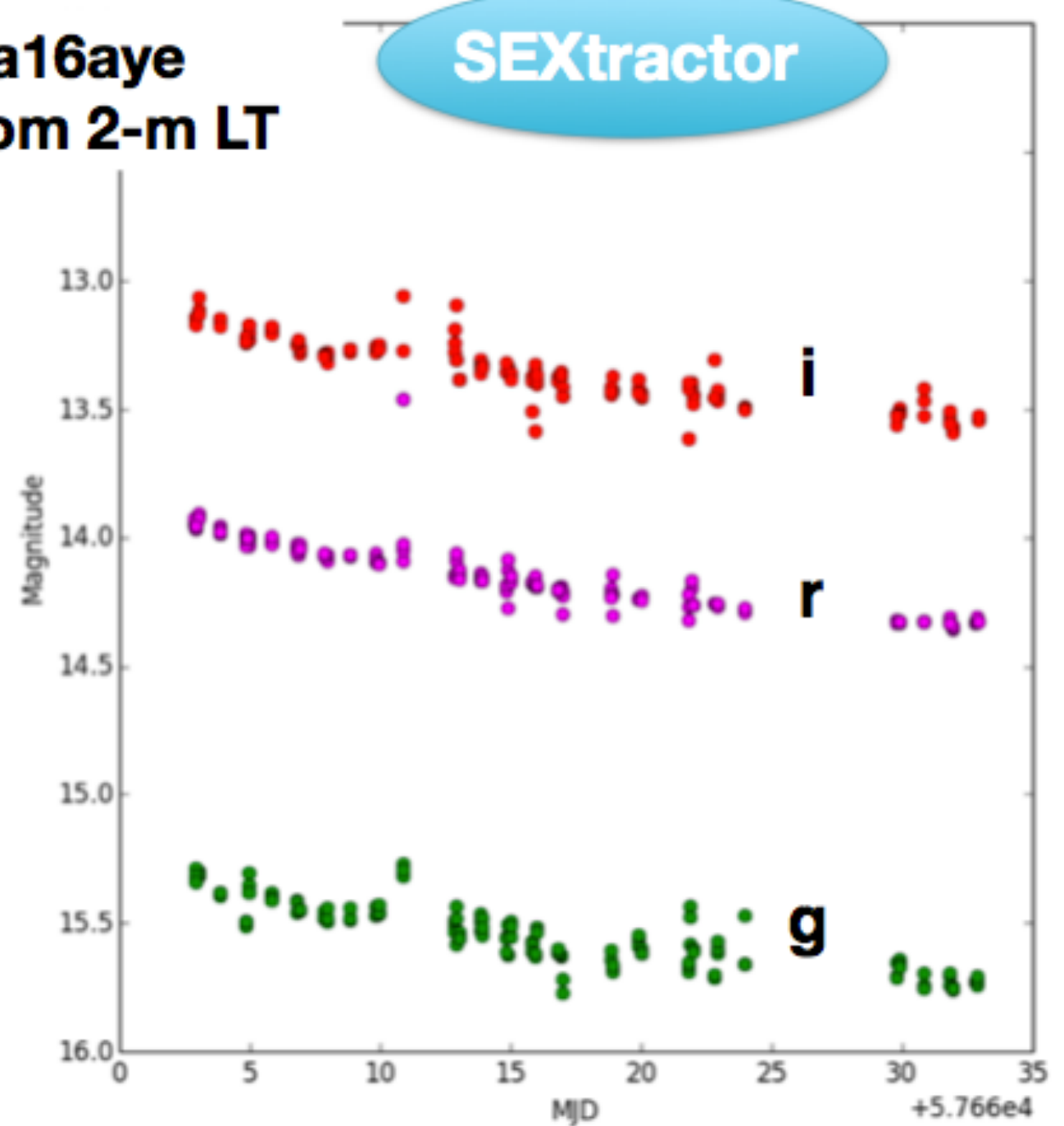
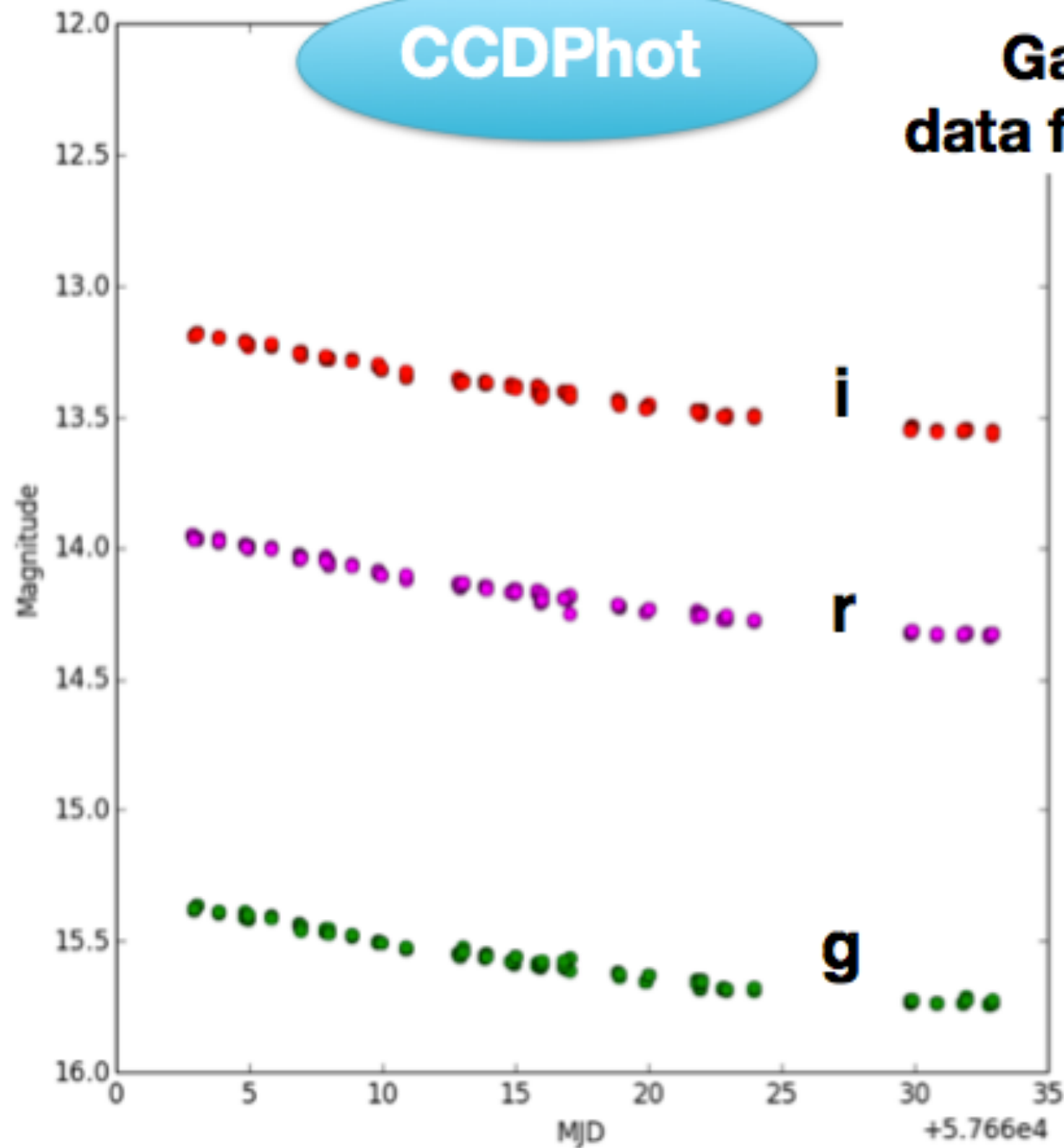


Precise photometry of CCDPhot

CCDPhot

Gaia16aye
data from 2-m LT

SEXtractor



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!

Paweł Zieliński
pzielinski@astrouw.edu.pl