How to do photometric follow-up of Gaia alerts

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with
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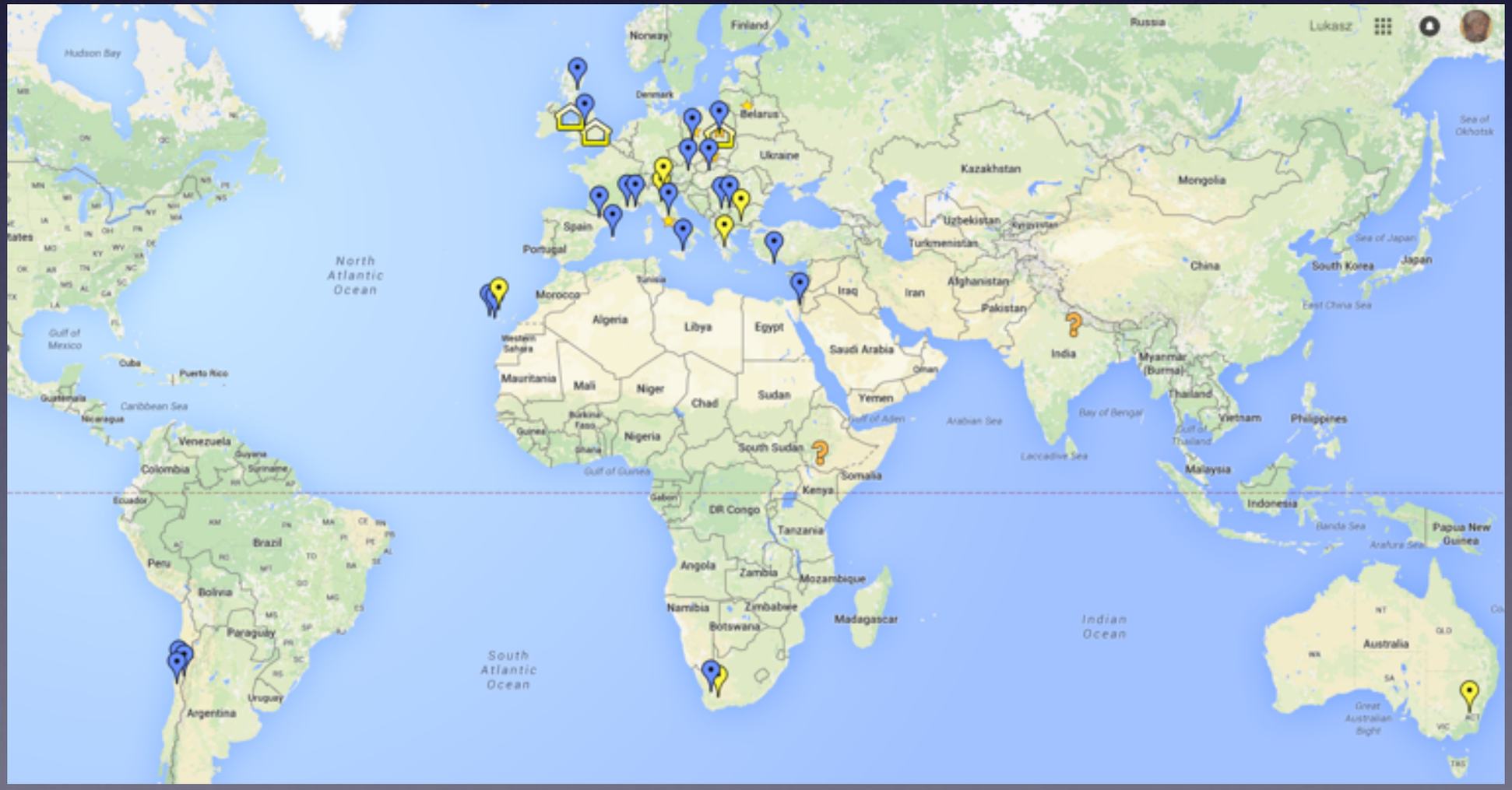
6th Gaia Science Alerts Workshop, Liverpool, 13.Nov.2015

Gaia-FUN-TO

- composed of ~15 active observatories



Gaia-FUN-TO

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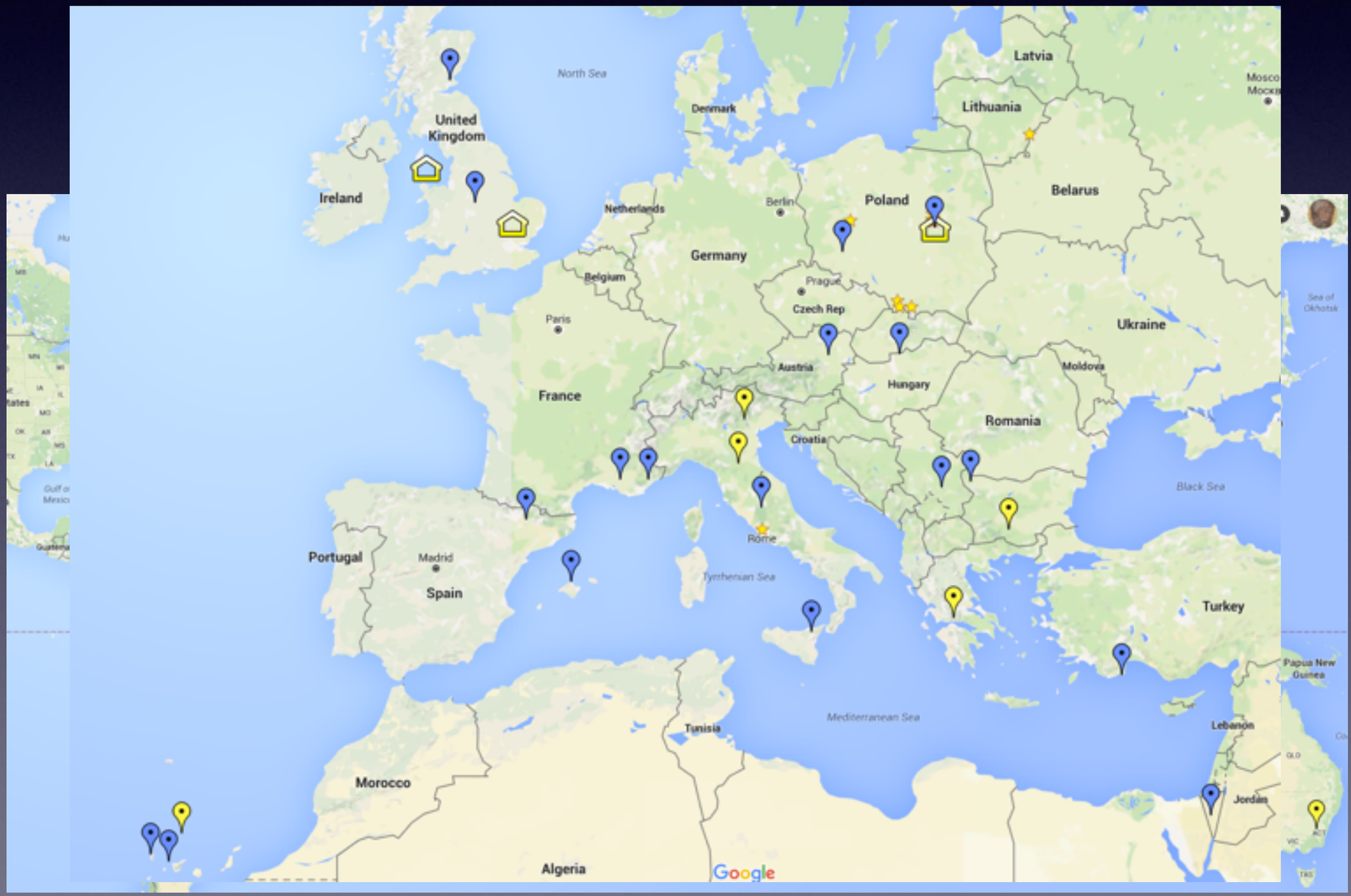


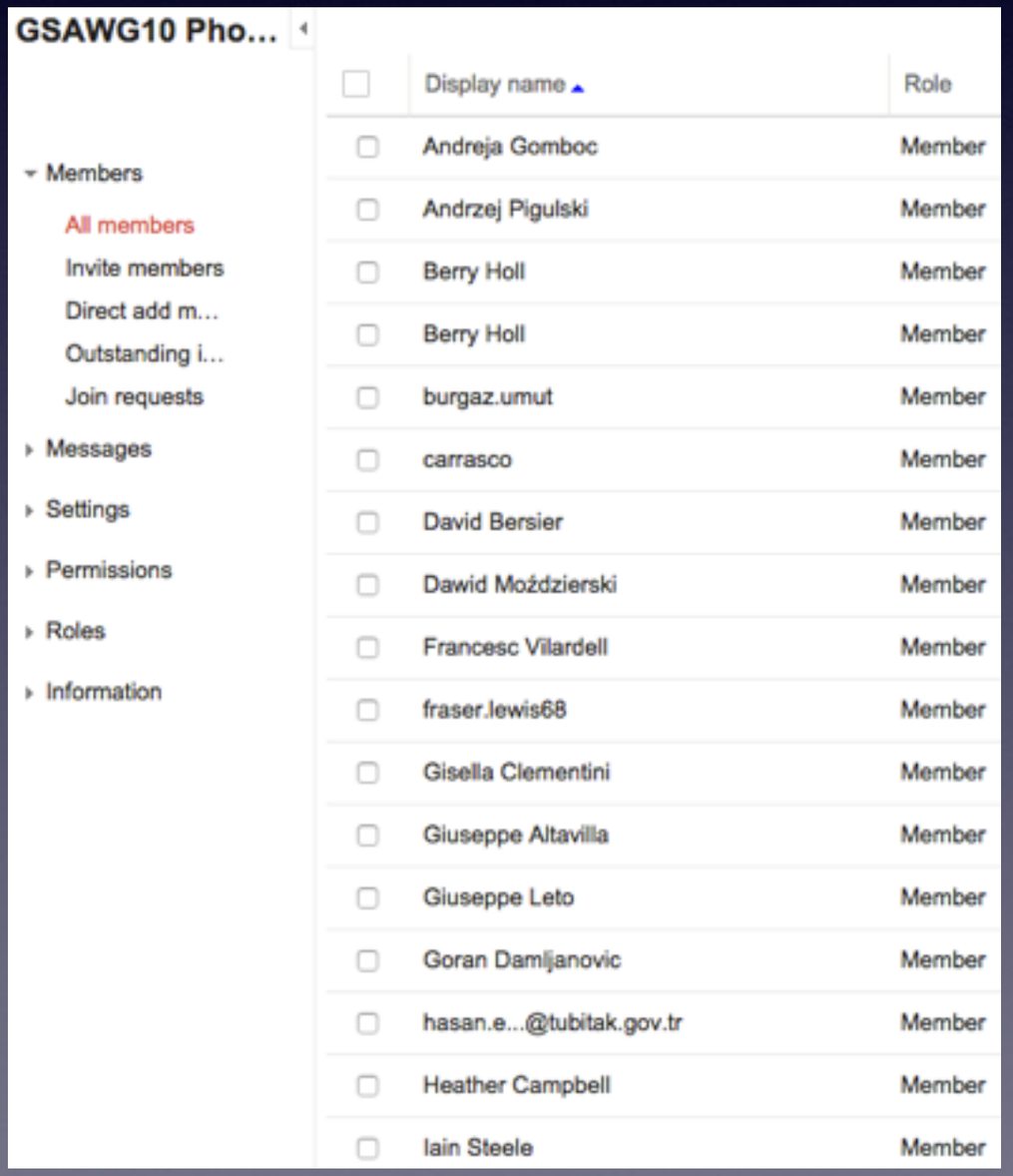
Gaia-FUN-TO

1	Telescope/obse name	Location	Longitude (+ for E, - for W)	Latitude (+ for N, - for S)	Altitude [m]	Size [m]	ıld-of-view, [deg^2]	Limit DEC	Limit HA	instruments	CCD scale [arcsec/pix]	limiting magnitude (R or equivalent)	filters	spectral range	spectral resolution	time available for alerts follow-up	scientific interests of people running the telescope and main users	mean eeing 'csec]	No of clear nights
57	TJO	Spain	0.72944	42.03472	1570	0.8	207x0.207	-38deg to +90deg	-6h to 6h	2k x 2k CCD	0.364	20	UBVRI	300nm to 1000 nm		100 hours per year	Variable stars, supernovae, asteroids, exoplanets	1.5	200
58	Univ. of Leicester Observatory	United Kingdom	-1.073656	52.61148	112	0.5	12'x9'			Plavewave 20" CDK, SBIG ST2K (usually using 2x2 binning)	0.89	R~20 mag (10 mins exposure)	B,V,R,I,Ha			no limit	education, transients, exoplanets	2.5"	~30-50
59	BART	Ondrejov, Czech Rep.	14.781876	49.909041	530	0.25 / 0.1	28'x28' / 95'x63'			CCD FLI cm2-1 / CCD MII G2-1600	1.64 / 3.71		B,V,R,RG850 / clear			upon request from the GAIA	GRBs, CVs, AGNs, HE-sources in general, variable stars		~130
60	D50	Ondrejov, Czech Rep.	14.781355	49.909379	527	0.5	20'x20'			CCD FLI IMG 4710	1.18	19.2 mag (20s exposure, 3sigma detection limit)	B,V,R,I,clear			upon request from the GAIA	GRBs, CVs, AGNs, HE-sources in general, variable stars		~130
61	Watcher	Boyden Observatory, South Africa	26.40472	-29.03889	1430	0.4	10'x10'	40 to -90		Andor iXon EM+	0.6	~19	V,R,g',r',i',OIII, clear			Flexible	GRBs, AGNs, Transients		~250

instruments	CCD scale [arcsec/pix]	limiting magnitude (R or equivalent)	filters	spectral range	spectral resolution	time available for alerts follow-up	scientific interests of people running the telescope and main users	mean eeing 'csec]	No of clear nights	Observing mode: robotic/manual	data reduction pipeline, incl. time to process	allocation mode (every N months, long term possible, etc.)	contact person	notes
	0.22"		BVRI				Supernovae and Novae	2.2					Gisella Clementini	Ritchey-Chretien
													M. Ibrahimov	
													M. Ibrahimov	
													M. Ibrahimov	
2k x 2k CCD	0.364	20	UBVRI	300nm to 1000 nm		100 hours per year	Variable stars, supernovae, asteroids, exoplanets	1.5	200	Robotic	Automatic pipeline at the end of the night	long term possible	Francesc Vilardell	Ritchey-Chrétien
Plavewave 20" CDK, SBIG ST2K (usually using 2x2 binning)	0.89	R~20 mag (10 mins exposure)	B,V,R,I,Ha			no limit	education, transients, exoplanets	2.5"	~30-50	manual	semi-automatic, ~1 day.		Klaas Wiersema	Modified Dall-Kirkham. Telescope often used for teaching, training.
CCD FLI cm2-1 / CCD MII G2-1600	1.64 / 3.71		B,V,R,RG850 / clear			upon request from the GAIA	GRBs, CVs, AGNs, HE-sources in general, variable stars		~130	robotic	semi-automatic		Rene Hudec, Jan Strobl	consists of two telescopes on one mount
CCD FLI IMG 4710	1.18	19.2 mag (20s exposure, 3sigma detection limit)	B,V,R,I,clear			upon request from the GAIA	GRBs, CVs, AGNs, HE-sources in general, variable stars		~130	robotic	semi-automatic		Rene Hudec, Jan Strobl	
Andor iXon EM+	0.6	~19	V,R,g',r',i',OIII, clear			Flexible	GRBs, AGNs, Transients		~250	Robotic	Semi-automatic		Lorraine Hanlon, David Murphy	www.watchertele

GSAWG #10

- photometric follow-up working group
- mailing list
- join to receive discussion on selected targets
- 50 members now



GSAWG #10

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number name ra dec [deg] alert_mag comment and priority

1.	Gaia15ads	251.47004	32.11807	18.63	SN, faint, medium
2.	Gaia15adr	126.73336	24.36601	18.39	SN, high
3.	Gaia15adq	125.01679	22.15763	18.13	SN, high
4.	Gaia15adp	167.91901	53.98508	18.23	SN Ia, high
5.	Gaia15ado	347.09059	-50.72458	17.38	could be CV, south,daytime, hard to observe
6.	Gaia15adn	214.25299	62.91193	18.25	SN, high
7.	Gaia15adm	190.33095	57.50171	18.15	SN, high
8.	**Gaia15adl**	**250.32064**	**39.29131**	**18.62**	**SN? faint, needs confirmation, high**
9.	**Gaia15adk**	**328.22464**	**-42.24069**	**18.74**	**weird red transient in a galaxy, faint, HIGH, south evening**
10.	Gaia15adj	67.36885	-48.07016	18.42	SN, currently at 17.8mag, south
11.	Gaia15adi	328.15360	-75.04241	18.70	SN, could be currently at 16 mag even, south
12.	Gaia15adh	258.12870	48.47000	18.60	SN, faint, med
13.	Gaia15adg	22.89100	-51.40722	17.67	SN, high south morning
14.	Gaia15adf	124.90039	19.26105	16.20	CV, bright, low
15.	Gaia15ade	302.62192	-14.74344	18.49	SN/CV, south, medium
16.	Gaia15add	115.68023	-57.42870	18.47	SN, faint, medium, south
17.	Gaia15adc	49.36990	-65.20292	17.68	young, SN, bright, med (=OGLE15-074) south
18.	Gaia15adb	257.44182	62.97424	17.22	SN Ia (=ASASSN-15fa), med
19.	Gaia15ada	175.25858	65.04259	18.45	SN, med
20.	Gaia15acz	137.75675	34.74089	17.99	SN, high
21.	Gaia15acy	128.95364	28.88332	18.84	SN, faint, med
22.	Gaia15acx	134.89546	45.92583	17.28	known SN Ia, high

GSAWG10 Pho…

Members

All members

Display name	Role
Andreja Gomboc	Member
Andrzej Pigulski	Member
Berry Holl	Member
Berry Holl	Member
burgaz.umut	Member
carrasco	Member
David Bersier	Member
Dawid Moździerski	Member
Francesc Vilardell	Member
fraser.lewis68	Member
Iain Steele	Member

For the North I recommend the following targets:

Gaia15aeq about 18-19 mag, actually it first requires confirmation if real.
Gaia15aer about 17 mag, type Ic

For the South:

Gaia15aes - about 17 mag, SN type II, quite old
Gaia15aep - about 17 mag in Gaia now, SN Ia, should be on decline

Verification phase (I) 2014-2015

- >15,000 observations taken on Gaia targets!

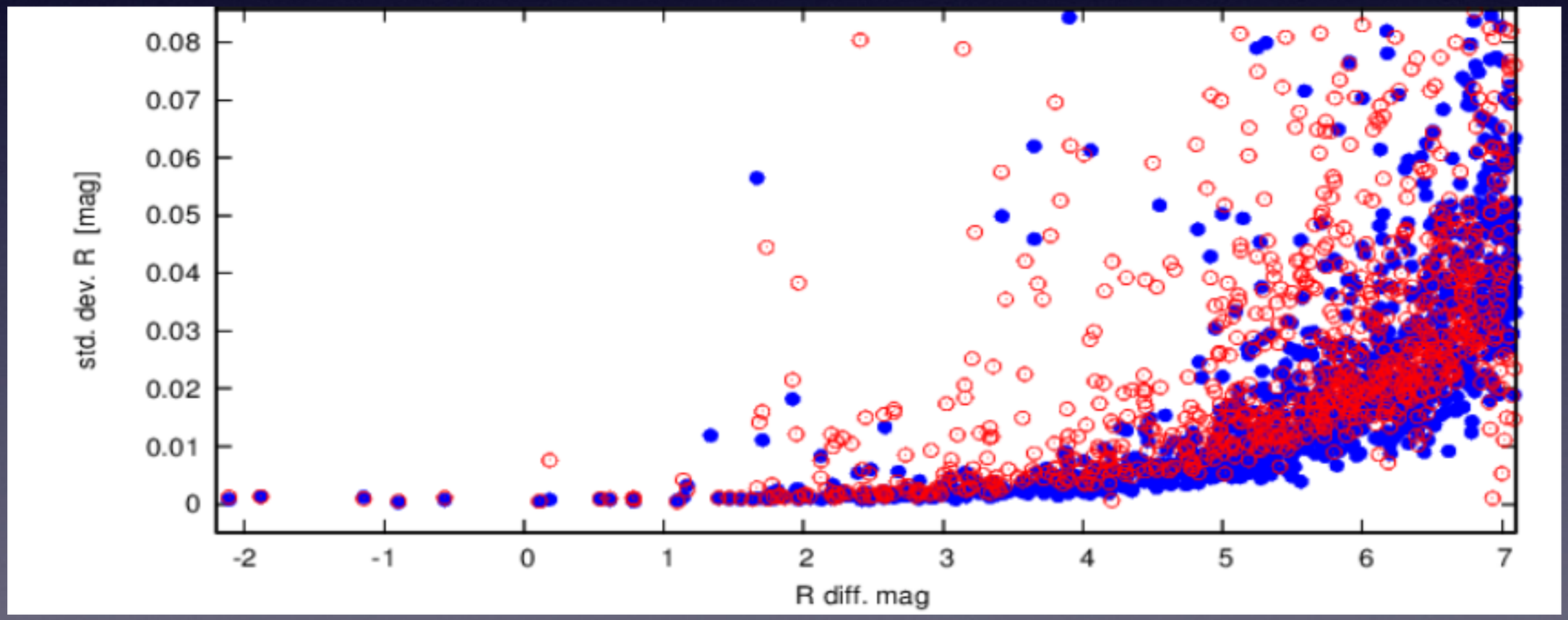
6	GiuseppeAltavillaToppoNaplesItaly	15.463333	40.817778	0
43	Giuseppe Leto APT2 Catania	14.974722	37.693056	26
26	Goran Damljanovic, ASV, Serbia	21.55	43.15	619
36	Heather Campbell	0.0	0.0	7782
41	Irek Khamitov T100	2.02222	36.825278	50
42	Irek Khamitov T60	2.02222	36.825278	10
79	J.Japelj-LT	-17.8816389	28.7606389	2
77	J.Jarvis,PIRATE	2.949	39.6623	0

Photometric re-reductions

- re-reduce original FITS (PSF photometry instead of aperture)
- remove galaxy background (difference imaging or PSF+background)
- calibrations to include colour term
- desired accuracy <0.1 mag

comparing photometry

Sextractor - DAOPHOT

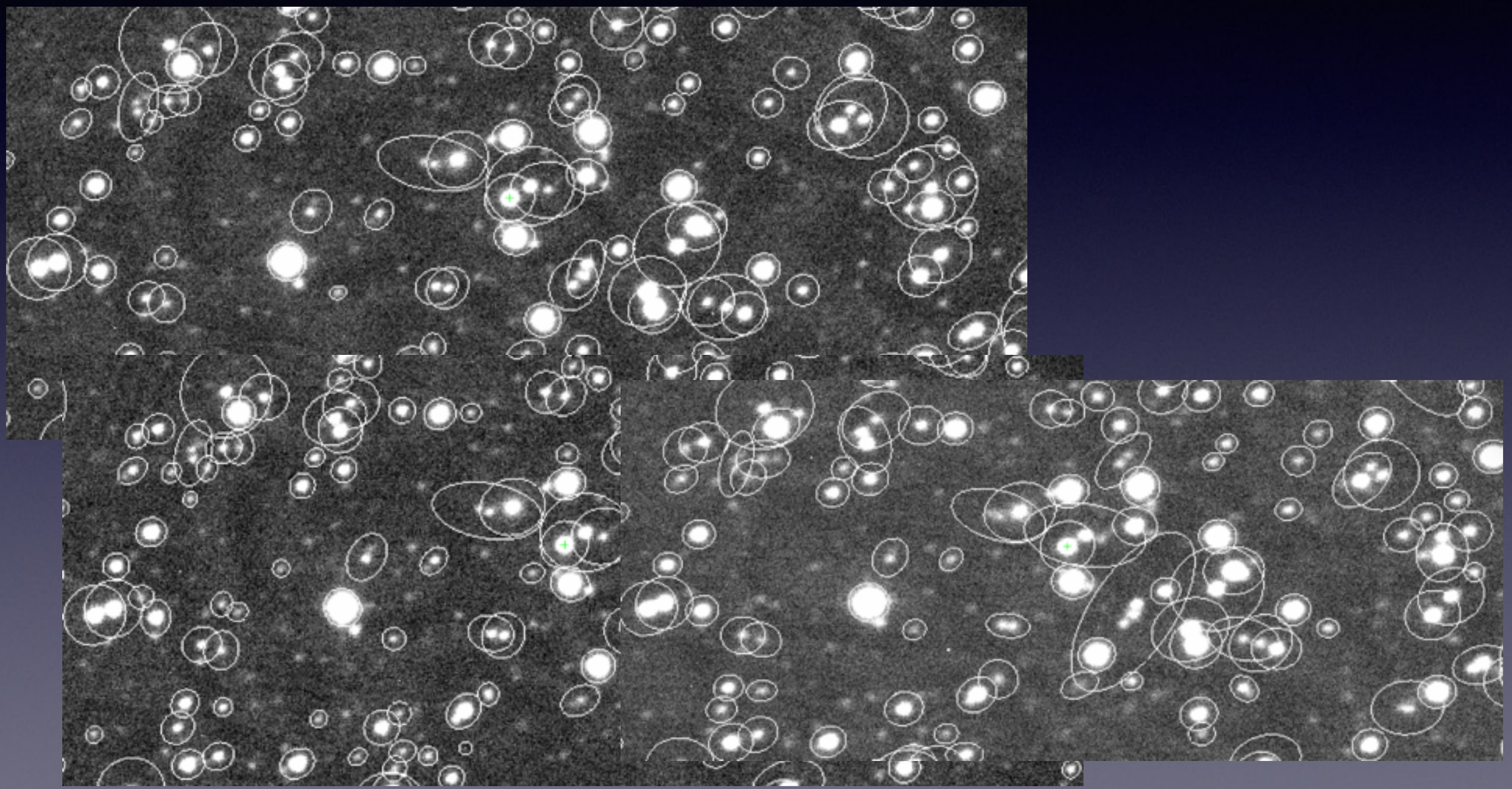


Sextractor Daophot

credit: Zbyszek Kołaczkowski/Wrocław Obs.

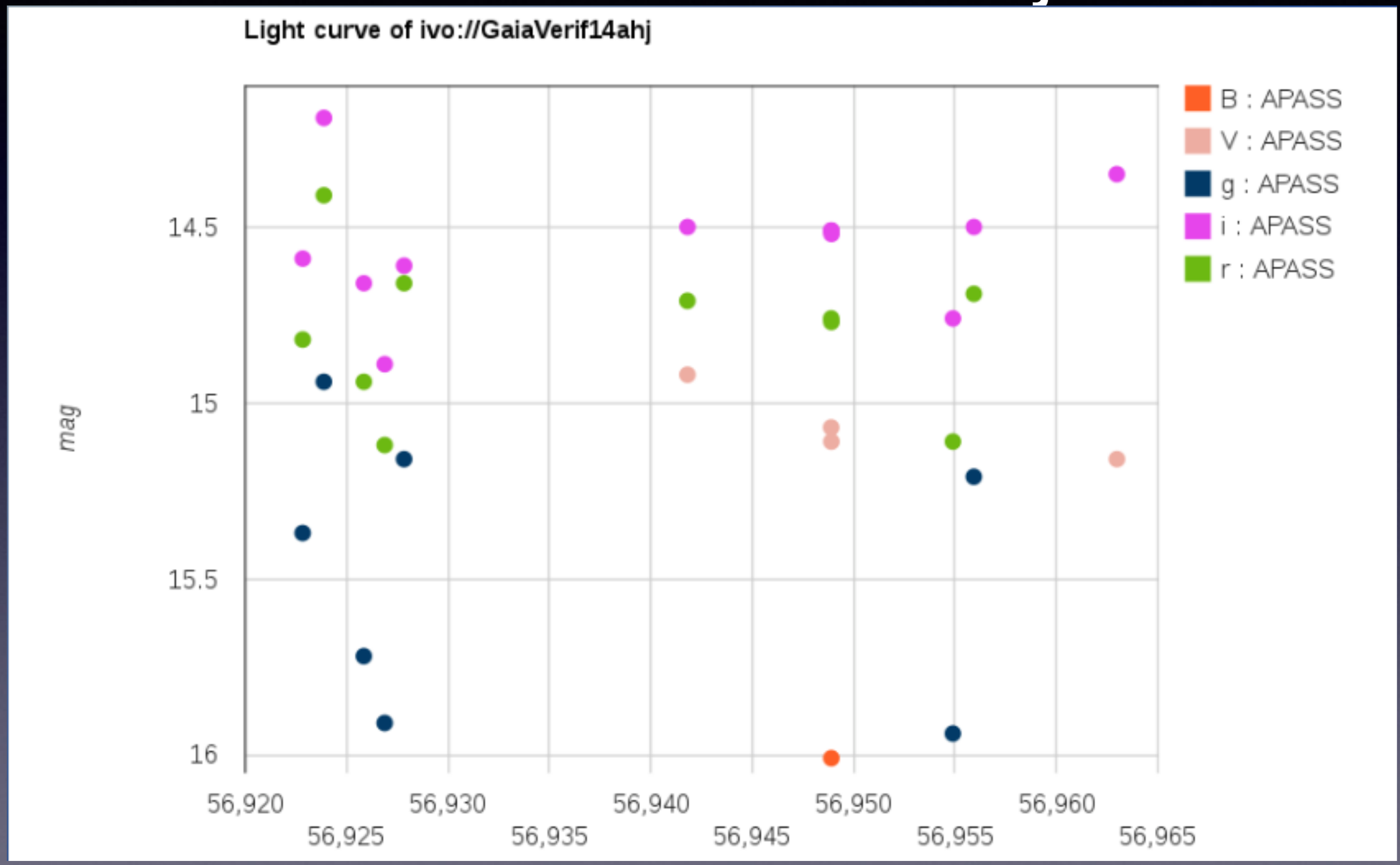
comparing photometry

Sextractor - DAOPHOT



credit: Zbyszek Kołaczkowski/Wrocław Obs.

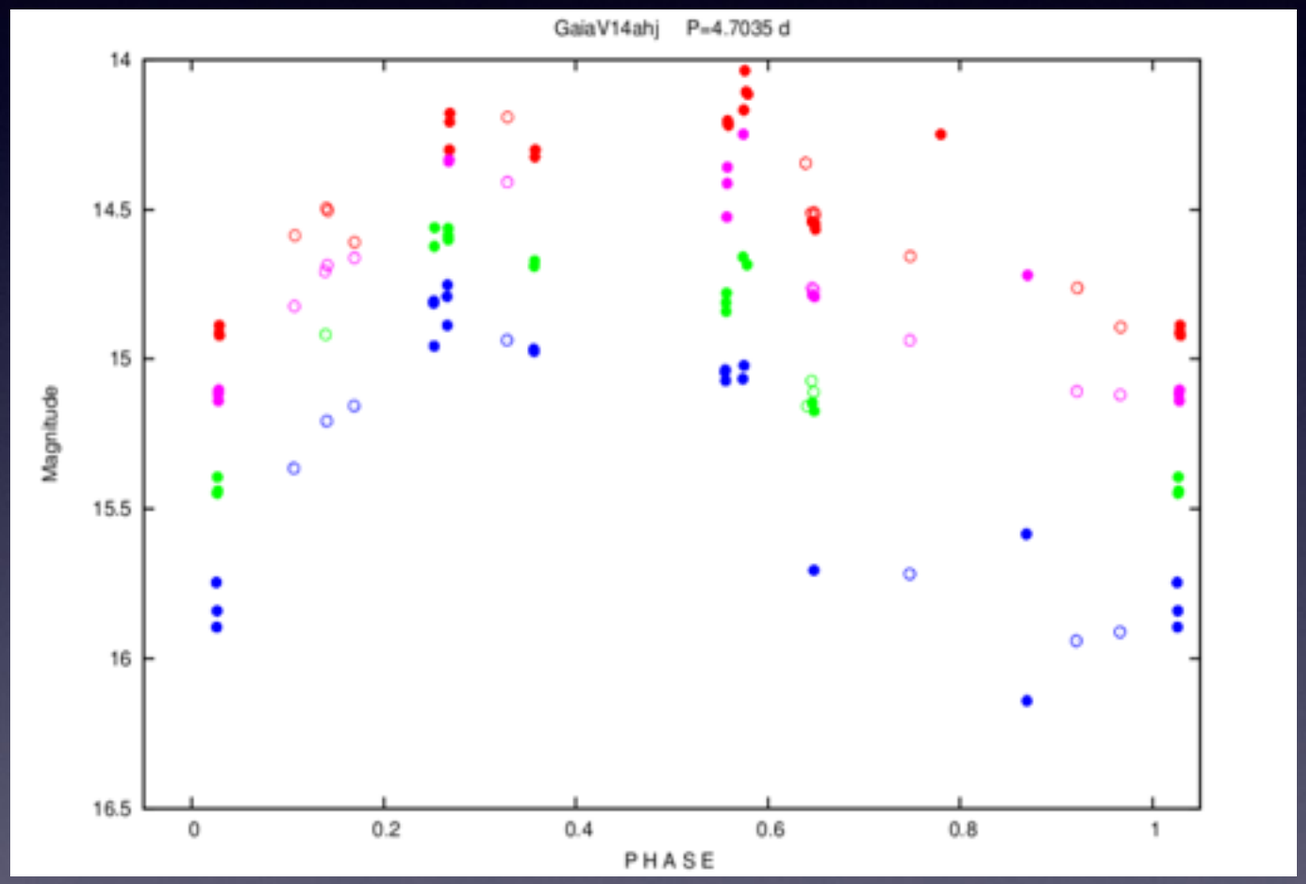
Photometric re-reductions GaiaVerif14ahj



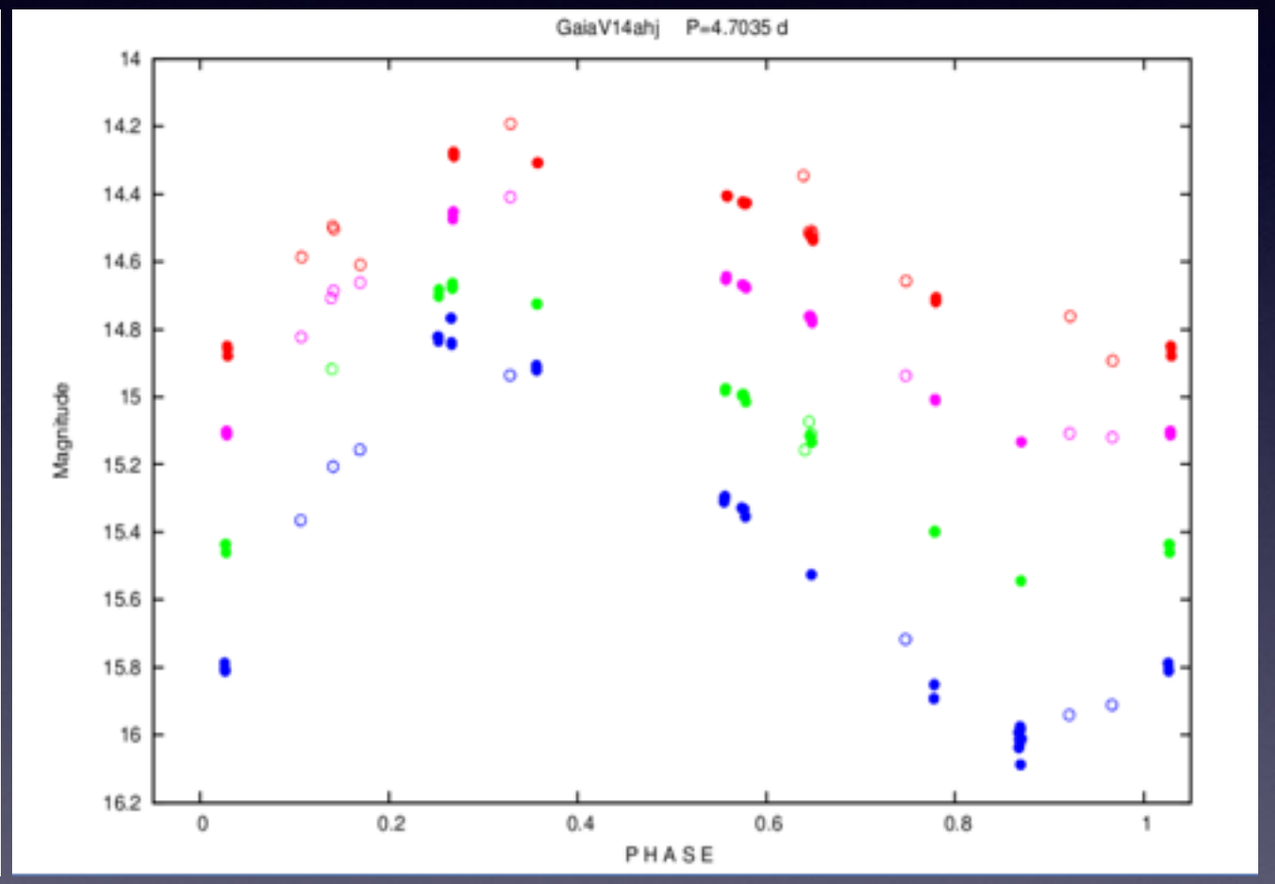
credit: Zbyszek Kołaczkowski/Wrocław Obs.

Photometric re-reductions GaiaVerif14ahj

rough calibration



new calibration

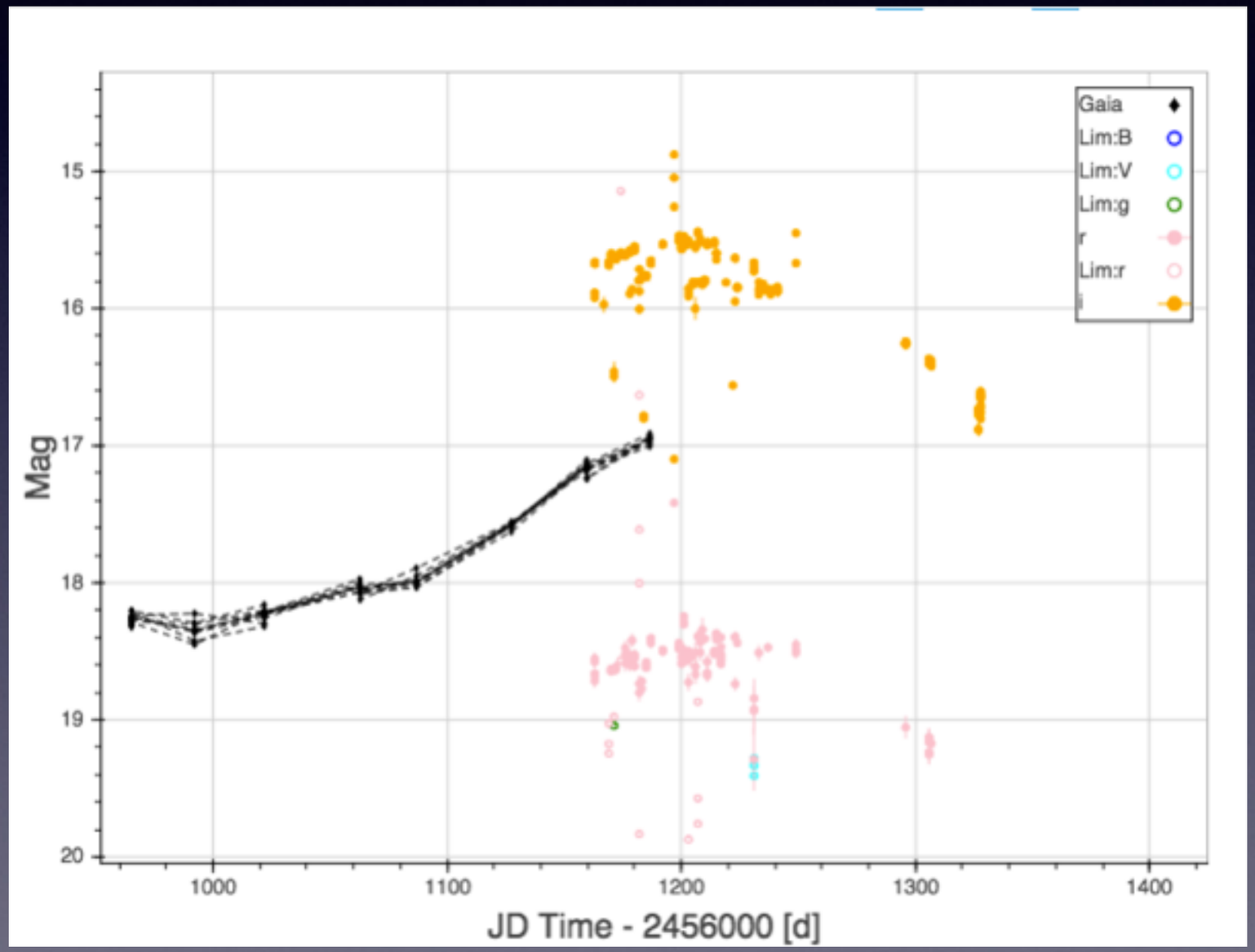


phase folded

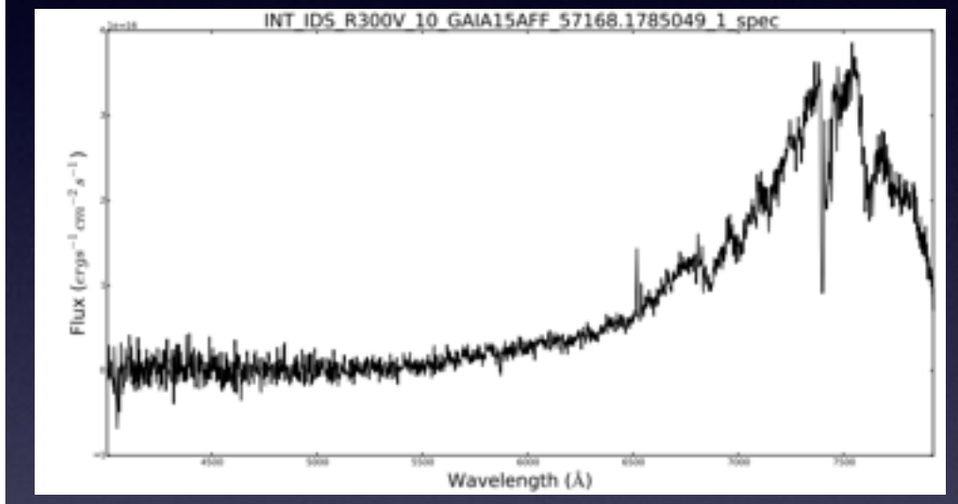
credit: Zbyszek Kołaczkowski/Wrocław Obs.

Photometric re-reductions Gaia15aff

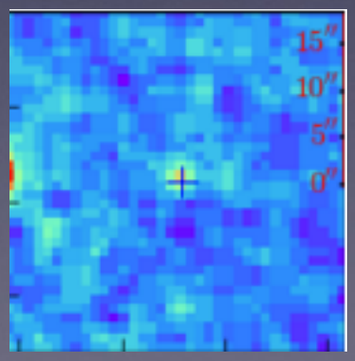
microlensing or unusual Mira-type variable or young stellar object?



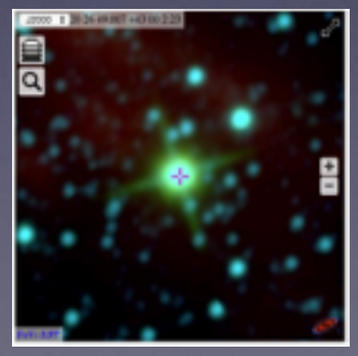
WHT (Thomas Wevers)



DSS

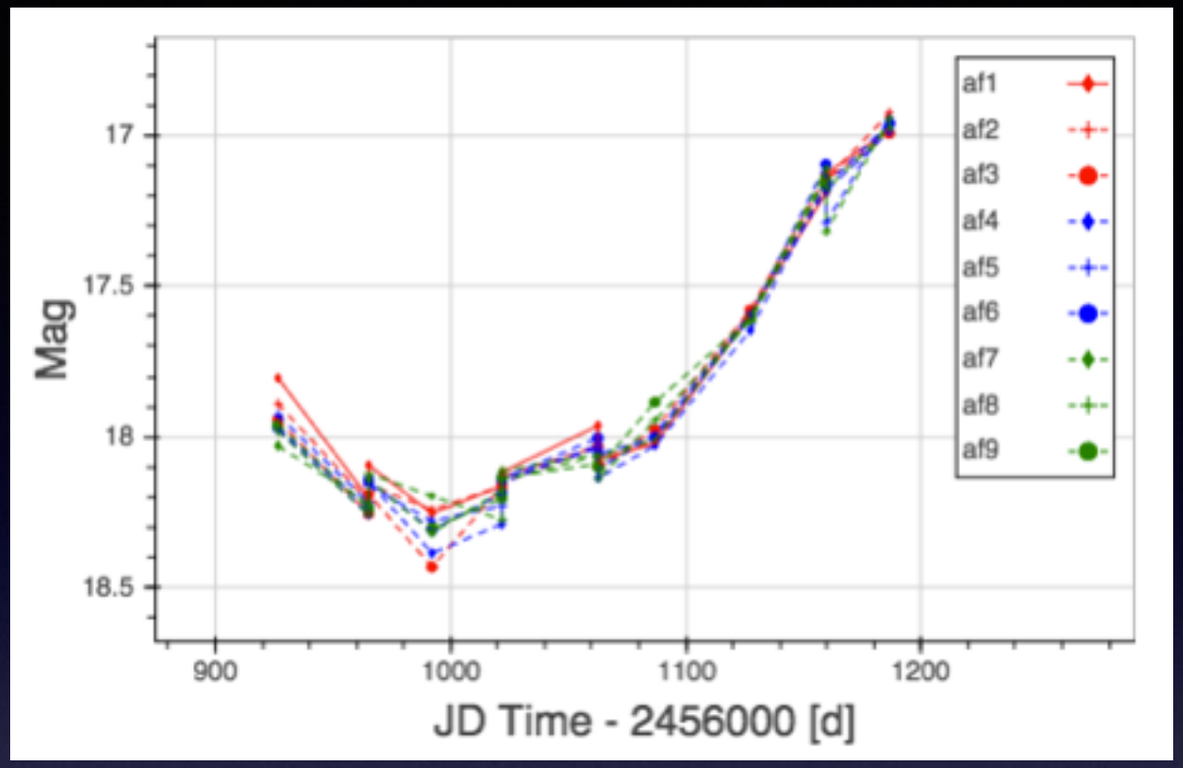


WISE

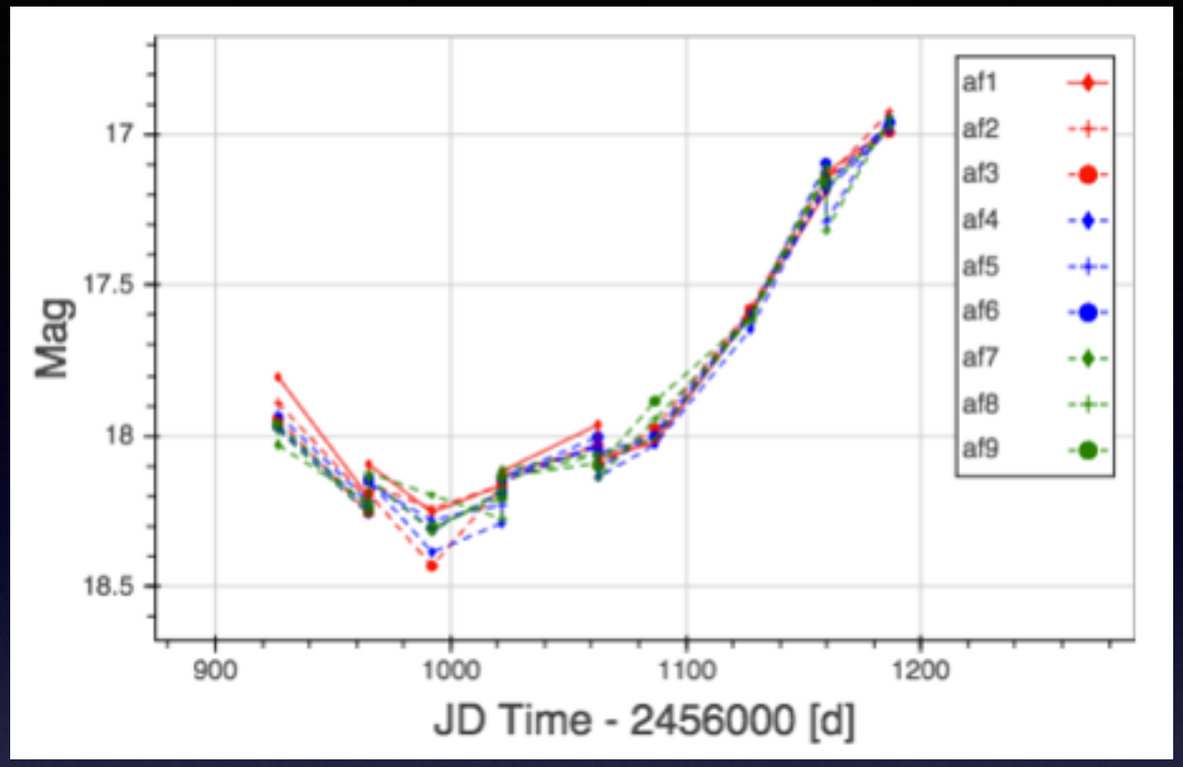


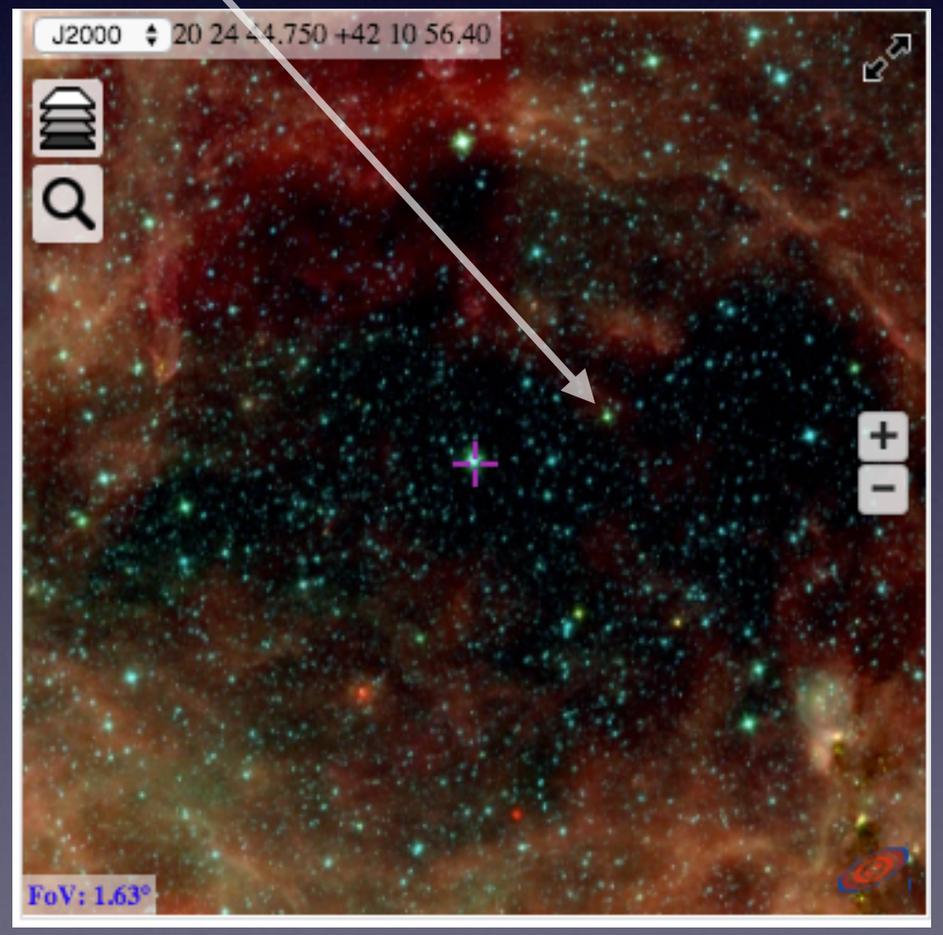
credit: Zbyszek Kołaczkowski/Wrocław Obs.

Gaia15aff


Mag
17
17.5
18
18.5
900
1000
1100
1200
JD Time - 2456000 [d]
af1
af2
af3
af4
af5
af6
af7
af8
af9

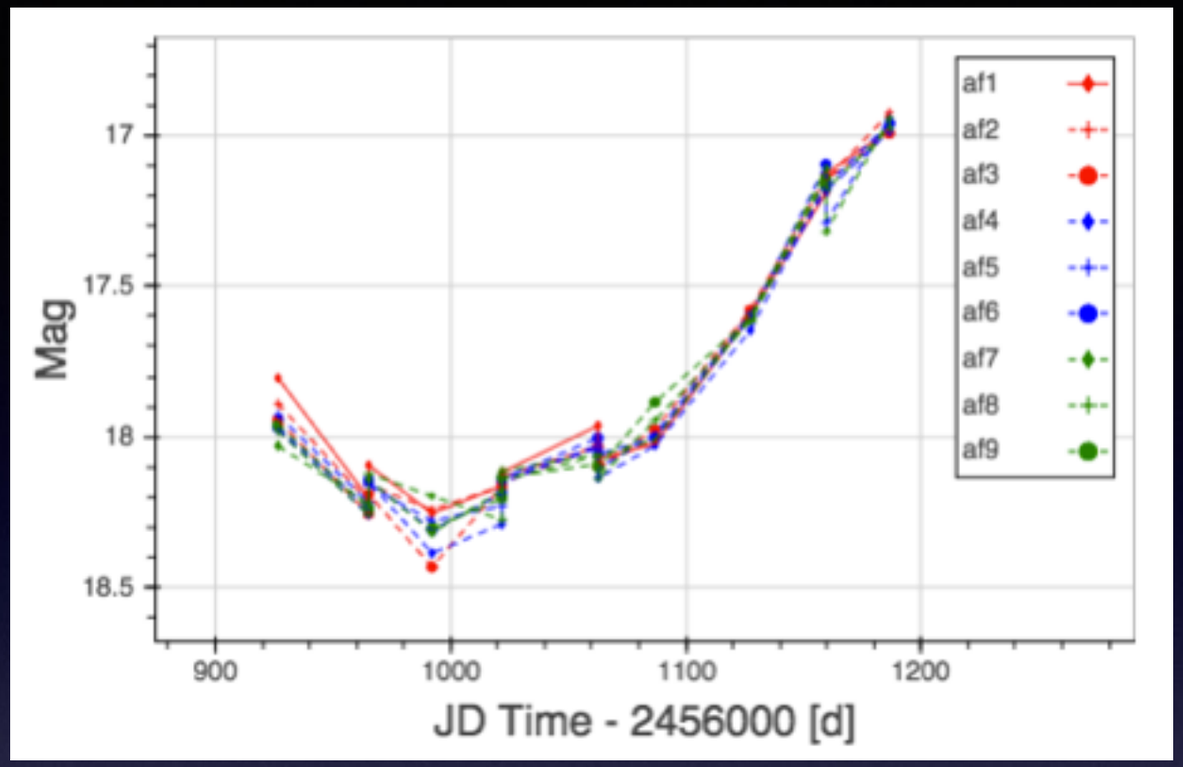
Gaia15aff

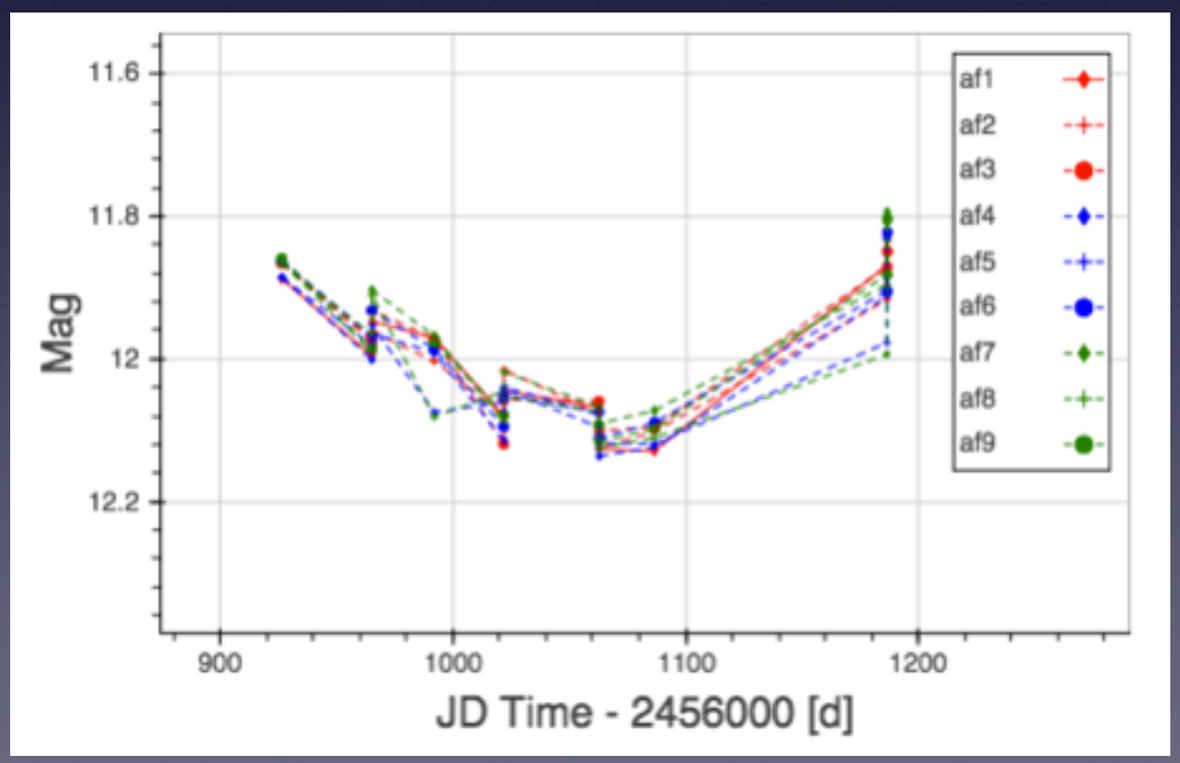

Mag
17
17.5
18
18.5
900
1000
1100
1200
JD Time - 2456000 [d]
af1
af2
af3
af4
af5
af6
af7
af8
af9

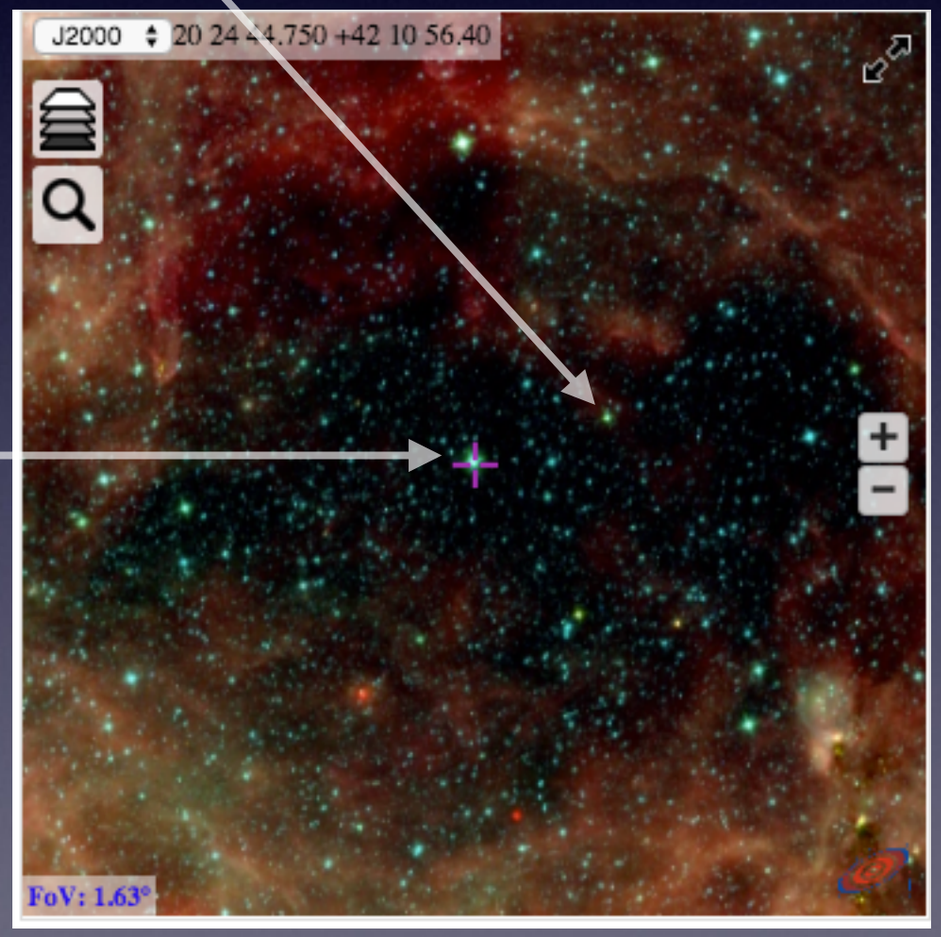

J2000
20 24
4.750 +42 10 56.40
FoV: 1.63°

Gaia15aff

~20' away







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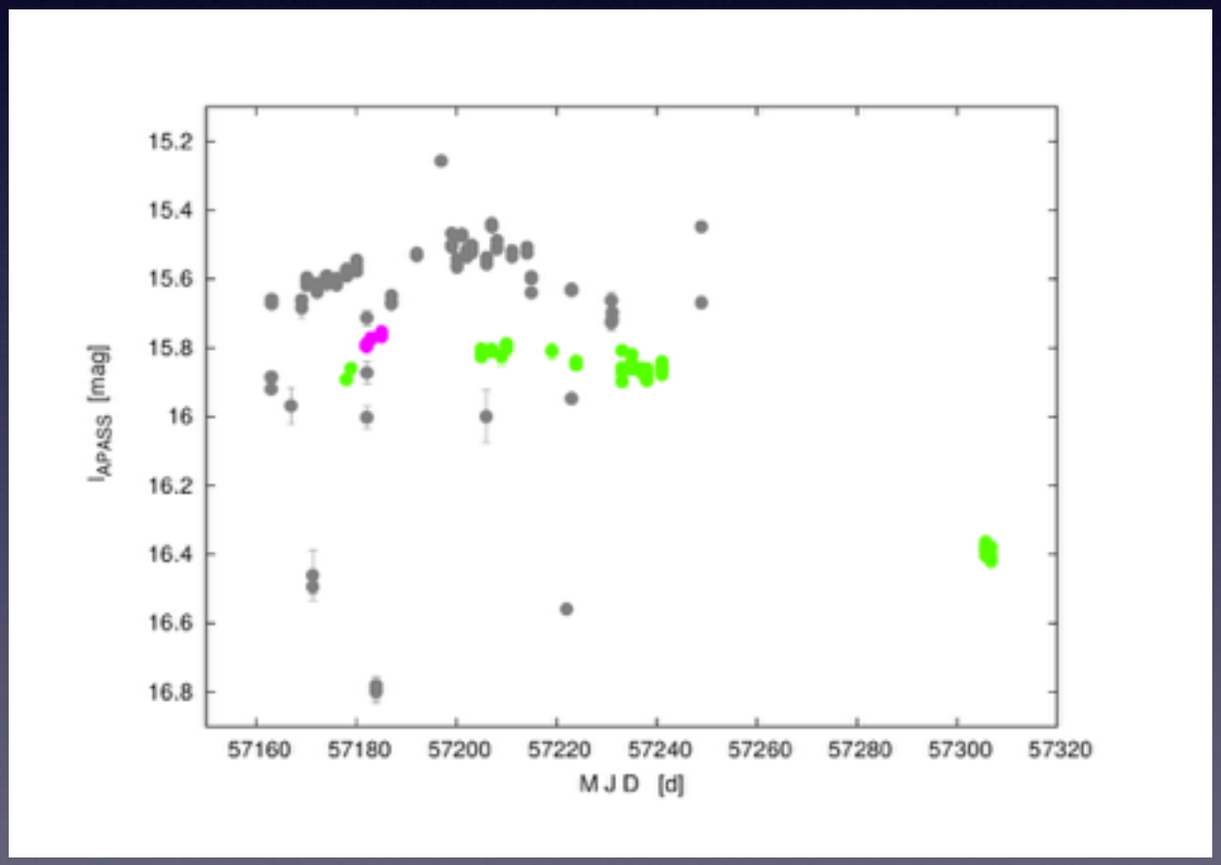
C* 2905 -- Carbon Star

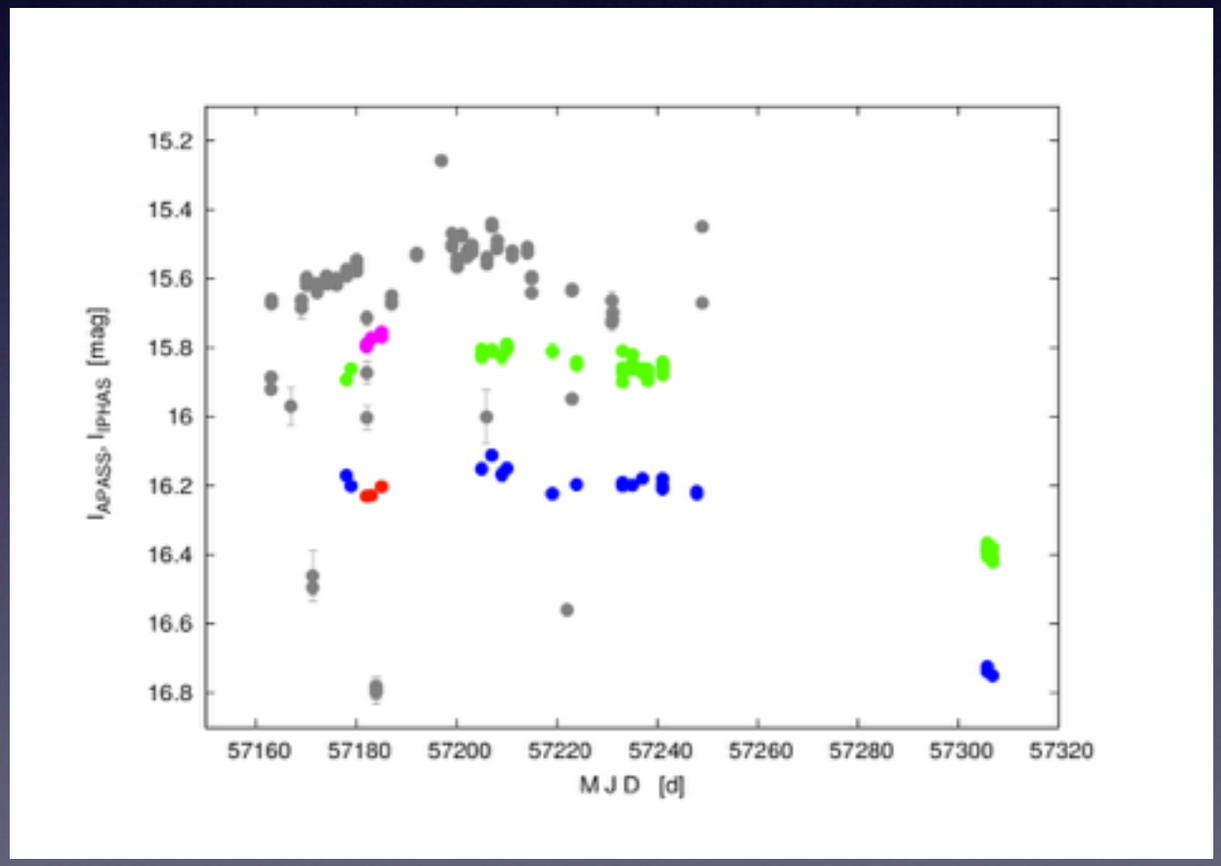
Photometric re-reductions Gaia15aff

microlensing or unusual Mira-type variable or young stellar object?

rough calibration



new calibration



credit: Zbyszek Kołaczkowski/Wrocław Obs.

selecting targets

- http://www.rochesterastronomy.org/snimages/index.html

All active SN over mag 17.0

Name	Mag	Type
ASASSN-15pz	13.8	Ia
J08241	15.0*	II-pec
ASASSN-15so	15.1	Ia
J22151	15.2*	Ia
ASASSN-15sb	15.3	Ia
J16345	15.5	unk
ASASSN-15rw	15.5	Ia
ASASSN-15sr	15.6	CV
ASASSN-15rq	15.7	Ia
PS15cpt	16.0	CV?

LATESTSUPERNOVAE

Some groups are not reporting all of their discoveries to CBAT.

- ASAS-SN: Transients, Supernovae
- Catalina Real-Time Transient Survey: Categorized page, All disc only), Supernova hunt page
- La Silla-QUEST (no published list)
- Gaia Photometric Science Alerts programme
- MASTER robotic Net List of optical transients, Supernovae
- OGLE-IV wide field survey Discovery images
- Intermediate Palomar Transient Factory (no published list)
- PS1 Science Consortium Discoveries
- ROTSE collaboration: Discoveries page

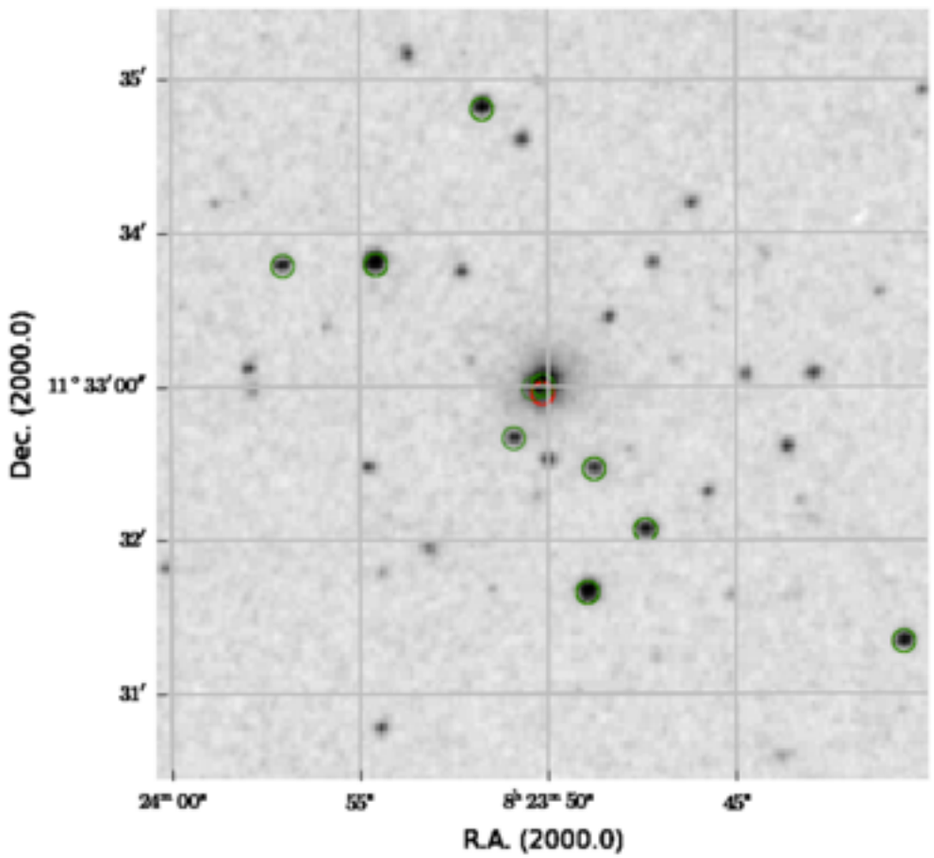
selecting targets

Target at ra,dec= 125.958978 11.549259

DATA from USNO (10 brightest)

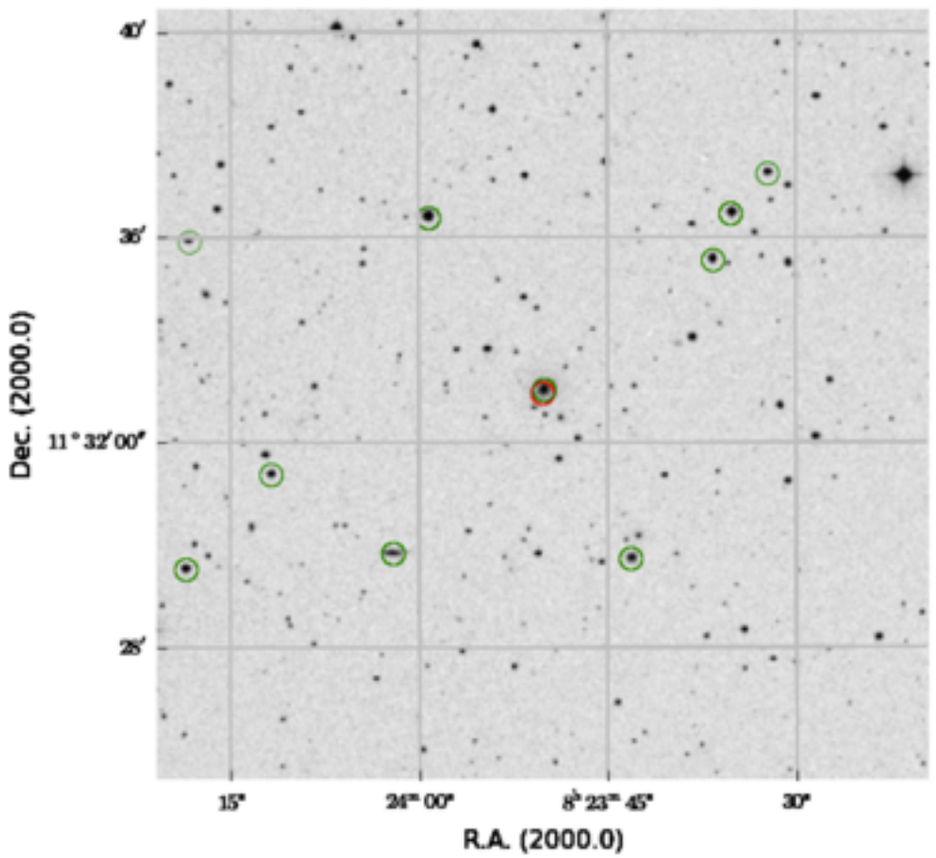
5x5arcmin

RA[deg]	Dec[deg]	mag
125.958917	11.550239	10.085
125.977494	11.563386	14.155
125.953986	11.527797	14.205
125.947694	11.534472	14.800
125.965672	11.580206	15.155
125.953294	11.541142	15.320
125.919072	11.522428	15.350
125.987753	11.563078	15.945
125.962164	11.544456	16.045
125.960117	11.549878	16.230



15x15arcmin

RA[deg]	Dec[deg]	mag
125.958917	11.550239	10.085
125.997019	11.606589	12.260
126.009044	11.497250	12.545
125.896611	11.607719	12.695
125.929897	11.495644	12.845
126.077344	11.492328	13.215
125.902806	11.592583	13.285
126.049158	11.522989	13.450
125.884750	11.620642	13.490
126.076456	11.598839	13.555



planning observations

- http://www.astrouw.edu.pl/~kulaczyk/ephem/

Upload updated file with the list of observatories (name latitude longitude elevation) : Choose File No file chosen

	Observatory	Latitude [deg]	Longitude [deg]	Elevation [m]
☑	Roque de los Muchachos Observatory, ES	28:45:38.3	-17:52:53.9	2396
☐	Las Campanas Observatory, CL	-29:00:36.0	-70:42:06.0	2270
☐	Cerro Tololo Inter-American Observatory	-30:10:10.8	-70:48:23.5	2200
☐	Paranal Observatory, CL	-24:37:38.0	-70:24:15.0	2635
☐	Siding Spring Observatory, AU	-31:16:24.0	149:3:52.0	1165
☑	Loiano Observatory, IT	44:16:00.0	11:19:00.0	785
☐	W. M. Keck Observatory, US	19:49:34.9	-155:28:30.0	4160
☐	Mount John Observatory, NZ	-43:59:12.0	170:27:54.0	1027
☐	SAAO, ZA	-32:22:41.9	20:48:37.8	1450
☐	Palomar Observatory, US	33:21:21.0	-116:51:50.0	1712
☐	Thai National Observatory, TH	18:35:26.0	98:29:11.6	2457
☐	Wise, IL	34:45:46.8	30:35:42.0	875
☐	Ostrowik Observatory, PL	52:05:16.9	21:24:58.9	200
☐	Wroclaw Observatory, PL	51:28:48.0	16:39:36.0	140
☑	Tubitak, TR	36:49:27.0	30:20:08.0	2450

Time: Now Date: 01 01 2014 Hour: 00 00

Display altitudes in range from 0 to 90 degrees

Twilight ends when the Sun is : 12 degrees below the horizon.

Moon proximity warning when separation is smaller than 15 degrees.

Number of days for calculations: 14

Objects list (ID {RA[h]} {DEC[deg]} or ID d{RA[deg]} {DEC[deg]}):
(default: trying to fetch from http://gsaweb.ast.cam.ac.uk/followup/list_of_alerts)

Get Validation Phase Gaia alerts | Get recent alerts from the calibration server

```
Gaia15agm d358:59:10.43 -43:43:26.83
Gaia15agl d337:47:35.77 -37:49:38.46
Gaia15agk d337:42:23.76 -43:2:50.35
Gaia15agj d147:44:48.55 37:58:0.26
Gaia15agi d43:4:54.52 60:34:34.97
Gaia15agh d181:1:16.79 14:4:4.98
Gaia15agg d64:6:3.78 -28:29:40.7
Gaia15agf d330:37:20.5 -20:19:46.02
Gaia15age d83:28:55.52 -20:47:20.04
Gaia15agd d171:34:20.82 28:22:2.03
Gaia15agc d184:35:48.26 35:37:5.66
```

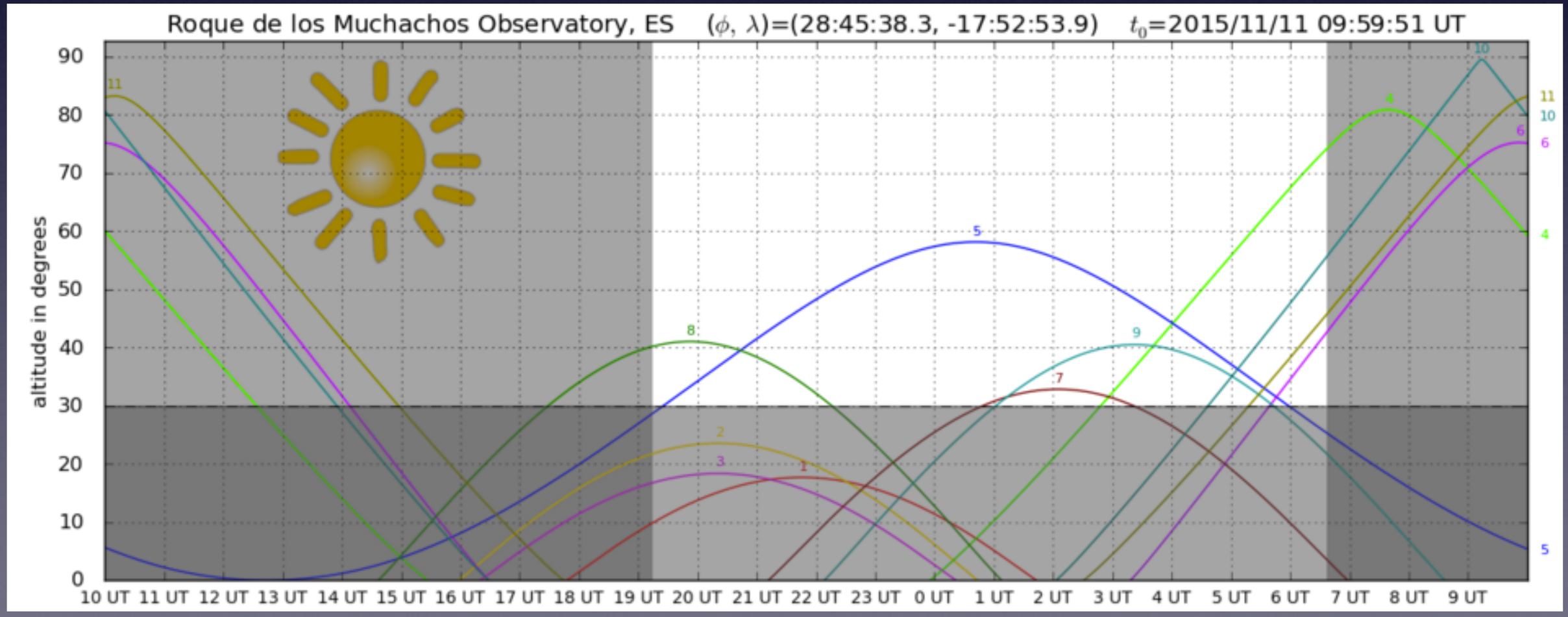
Calculate

Reset

planning observations

- http://www.astrouw.edu.pl/~kulaczyk/ephem/

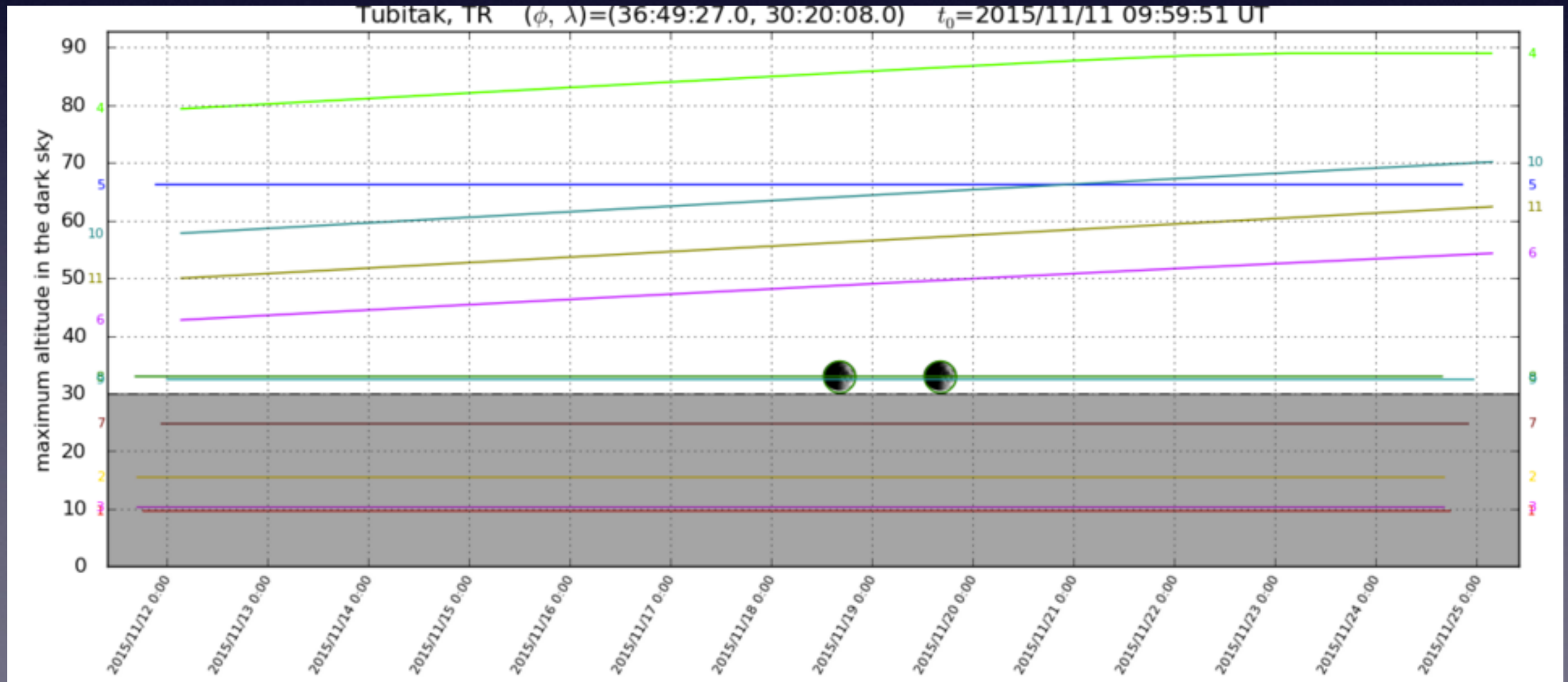
current visibility for many targets



planning observations

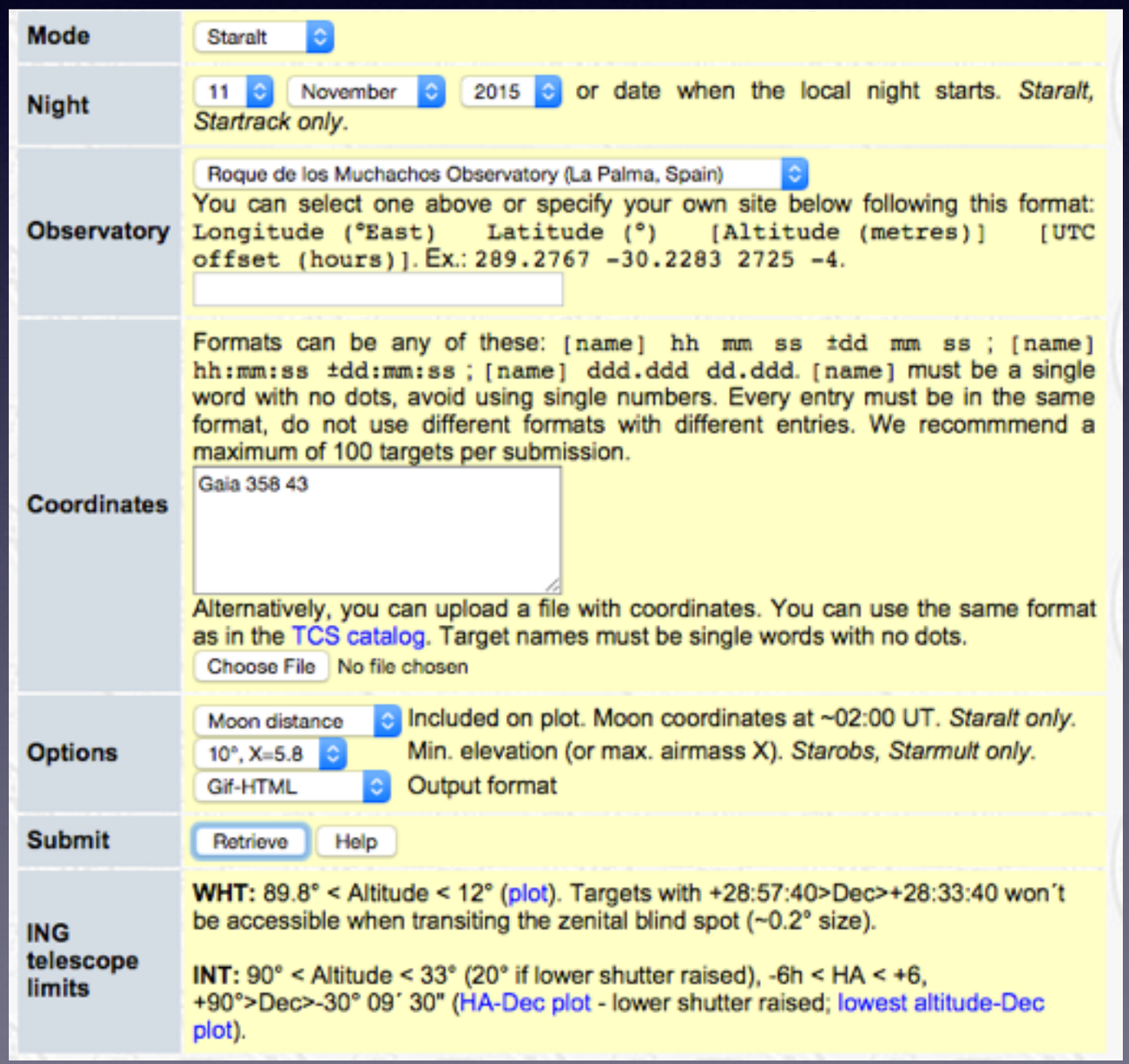
- http://www.astrouw.edu.pl/~kulaczyk/ephem/

14 days perspective



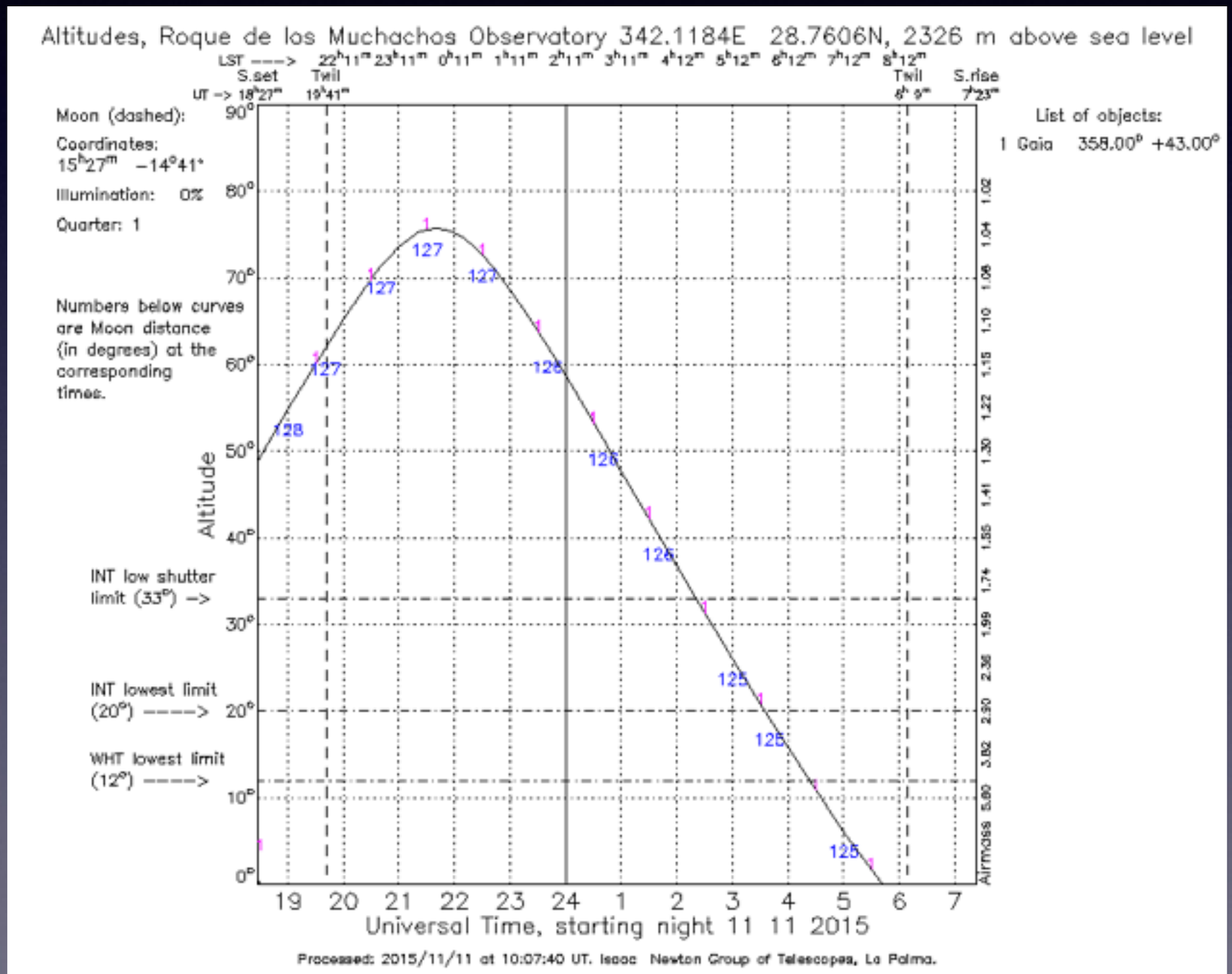
planning observations

- http://catserver.ing.iac.es/staralt



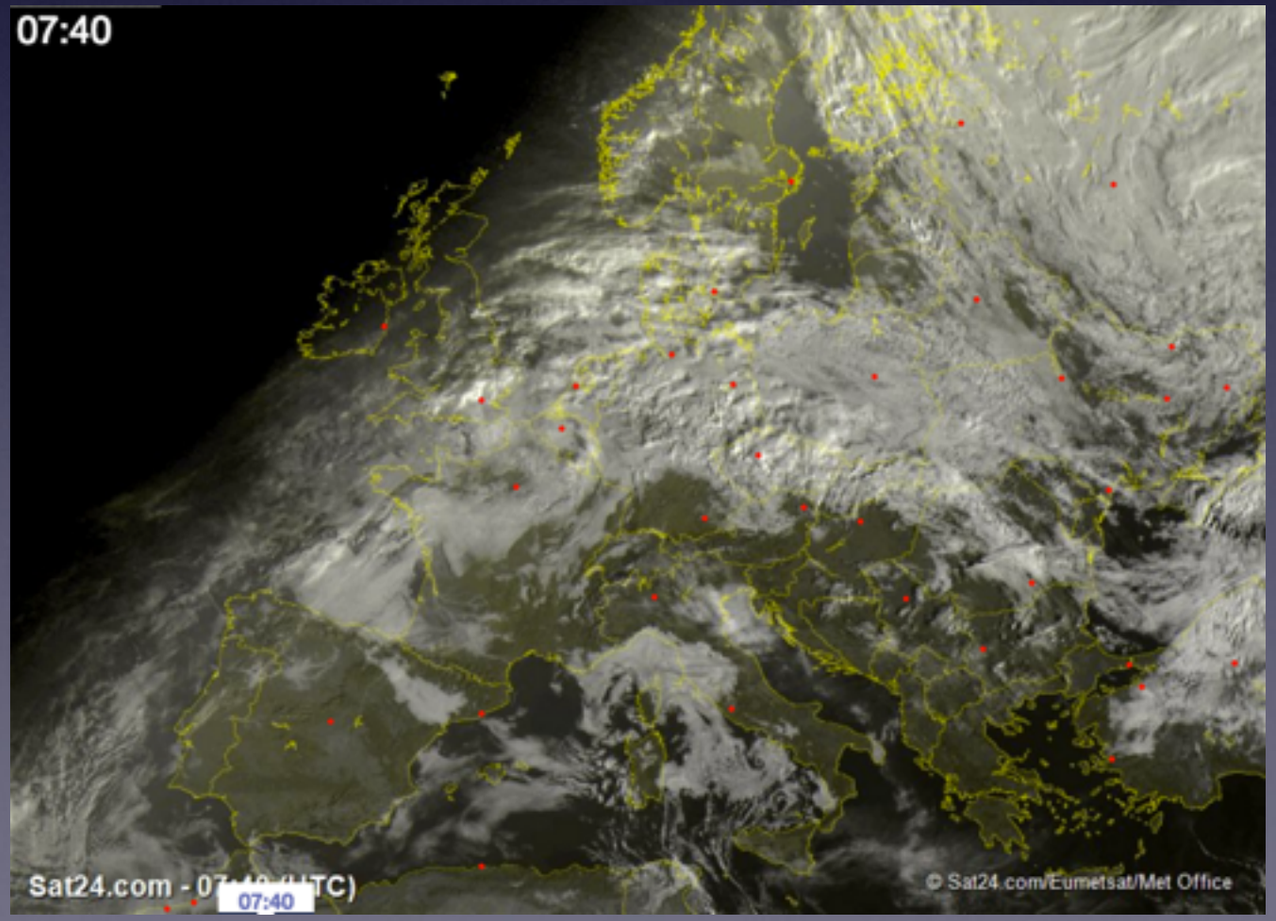
planning observations

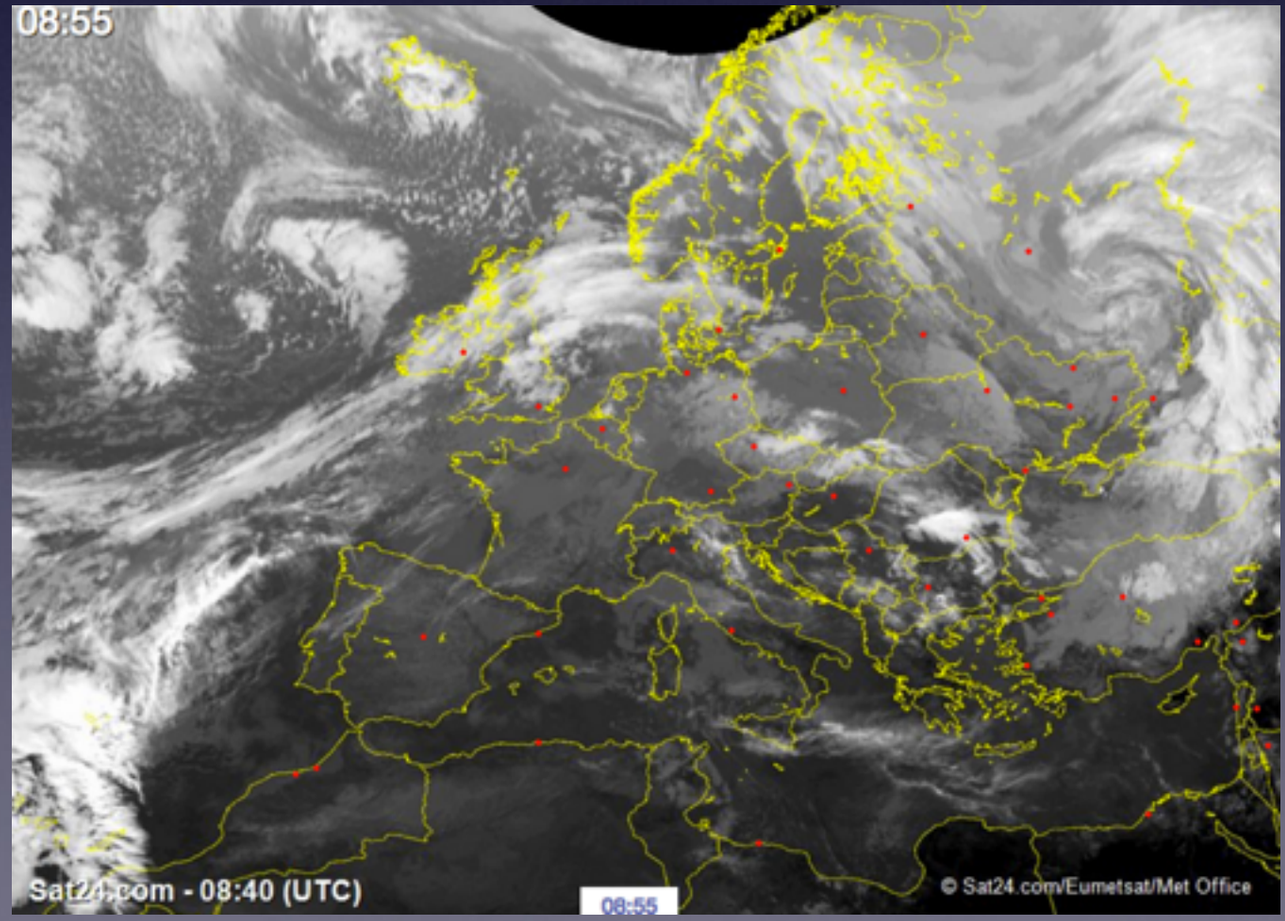
- http://catserver.ing.iac.es/staralt



weather

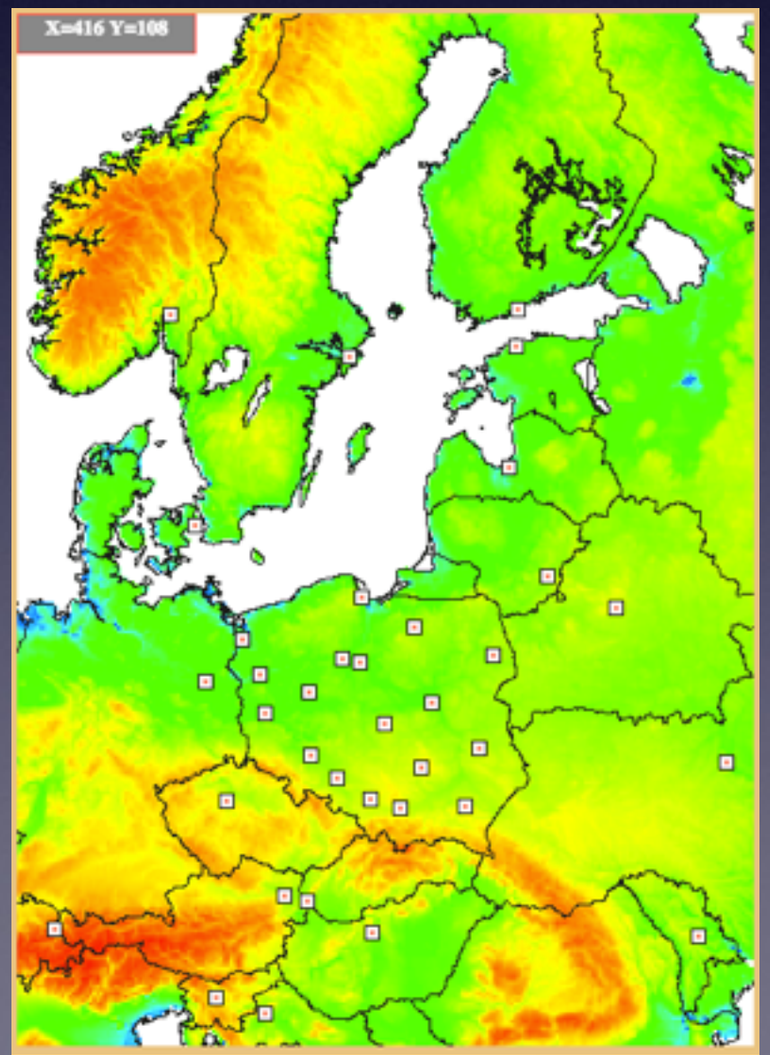
- http://en.sat24.com/en/

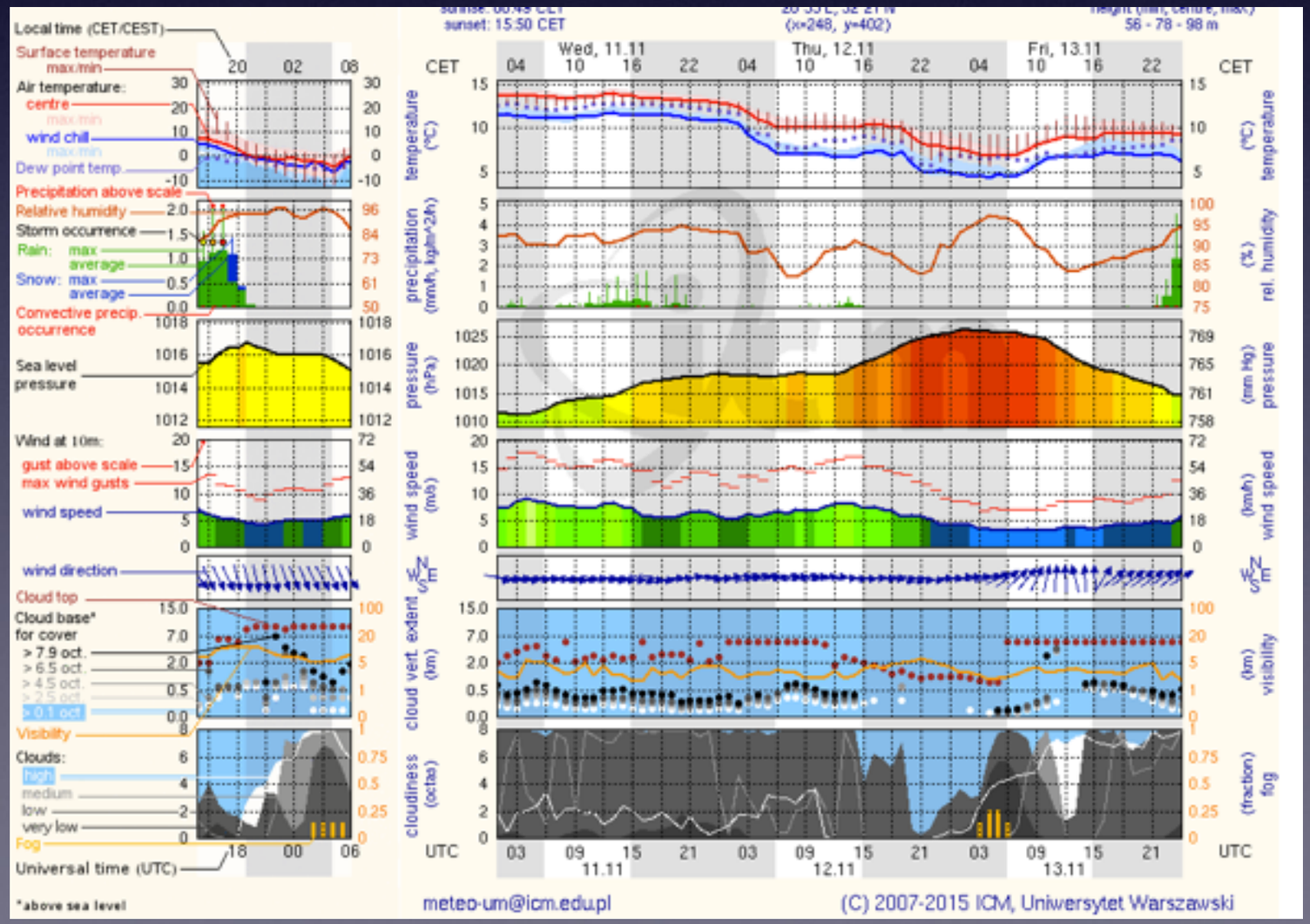




weather

- http://www.meteo.pl/index_en.php





while observing

- wide field of view = more stars for calibration
- good flats
- correct objects' NAMES in headers
- filters' names in headers

plans for OPTICON-H2020

- CPCS-2: ingesting fits after bias/dark/flat
- automated optimised photometry and astrometry
- dealing with galaxy backgrounds (DIA/PSF+bkg)
- calibrated photometry
- publication-ready lightcurves
- (public??)

plans for OPTICON-H2020

- help remotise/robotise European+ telescopes
- hardware
- people, support
- network a la LCOGT, but of heterogenous tels
- centralised time allocation, ToO on network

plans for OPTICON-H2020

- “spreading SPRATs”: emphasis on spectroscopy
- spectra-time-series
- calibration server for spectra(?)