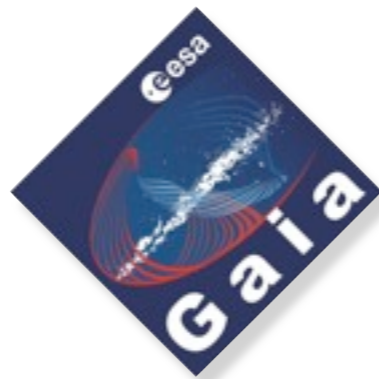


Microlensing with Gaia satellite

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*15th Microlensing Conference
Salerno, 22 January 2011*

Gaia in brief

- GAIA is a scanning mission operating between 2012/2013 and 2018

- ◆ no pointing, no change in the schedule, uniform coverage of the sky

- Simultaneous astrometry, photometry and spectroscopy

- Astrometry ($V < 20$) - MAIN TARGET:

- ◆ completeness to 20 mag: 10^9 stars

- ◆ parallax accuracy: 7 μas at <10 mag; 12–25 μas at 15 mag 100–300 μas at 20 mag

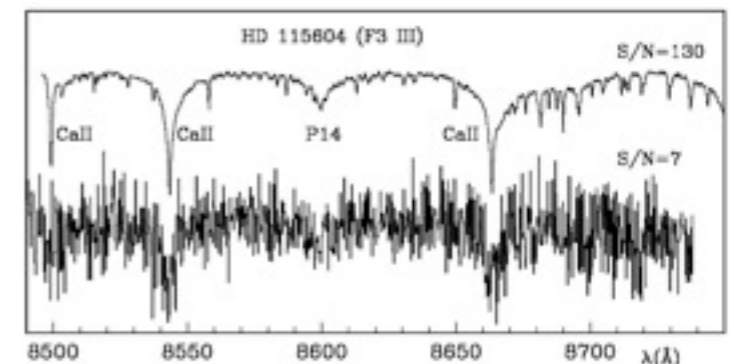
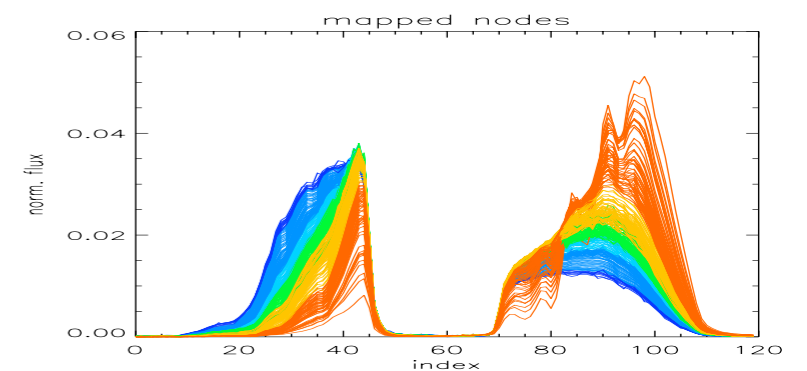
- Photometry ($V < 20$):

- ◆ broad-band “G” filter - 8–20 mmag at 15 mag

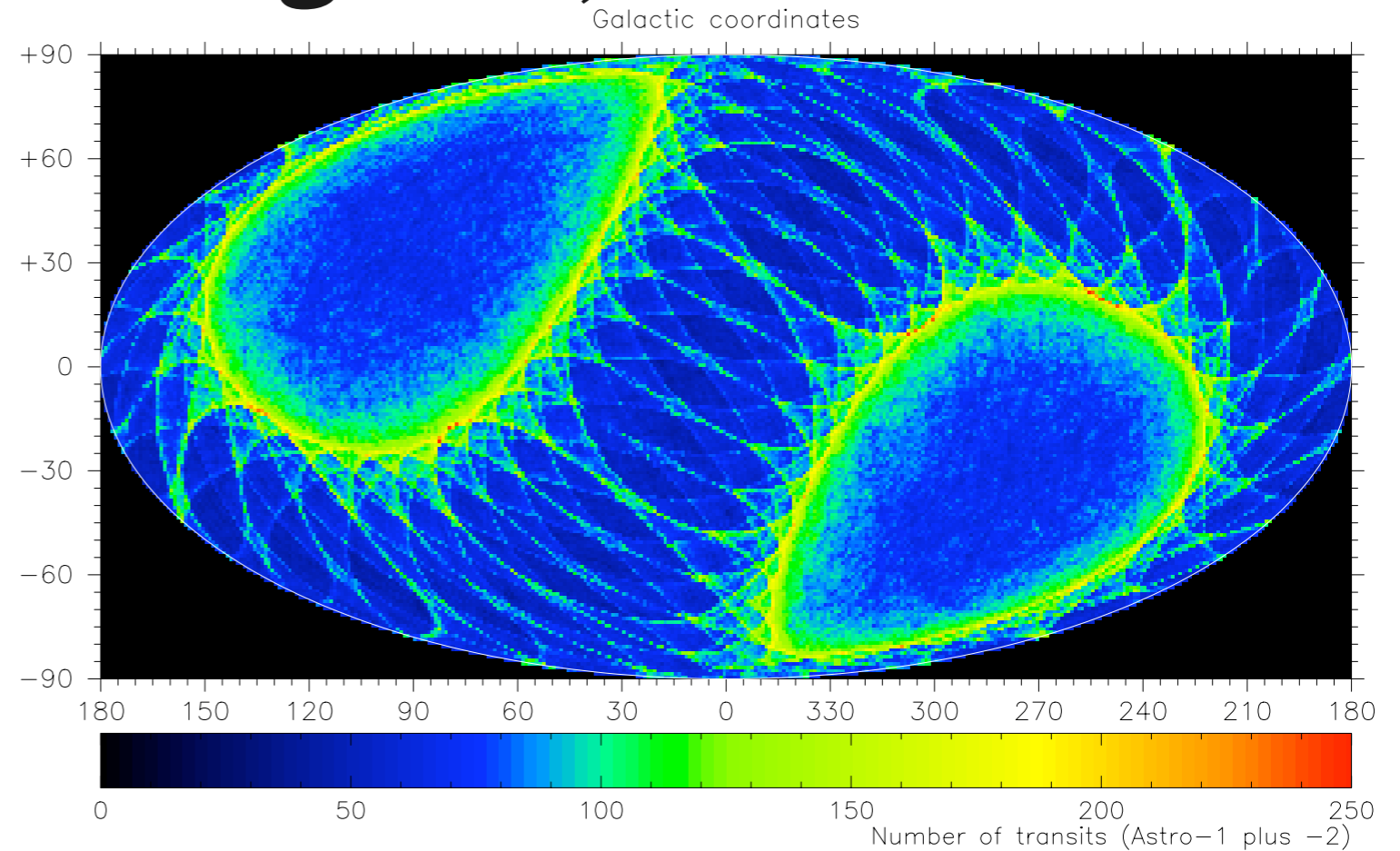
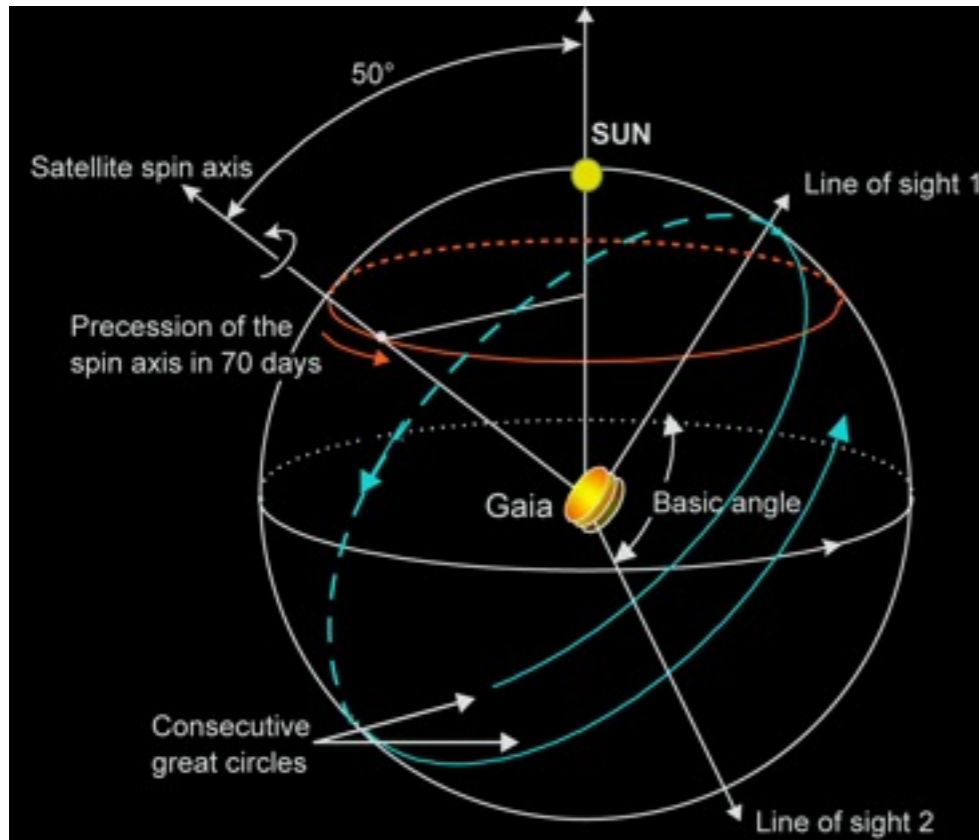
- ◆ low-dispersion spectro-photometry

- Radial velocity ($V < 16.5$ –17):

- ◆ <1 km/s at 13–13.5 mag and <15 km/s at 16.5–17 mag

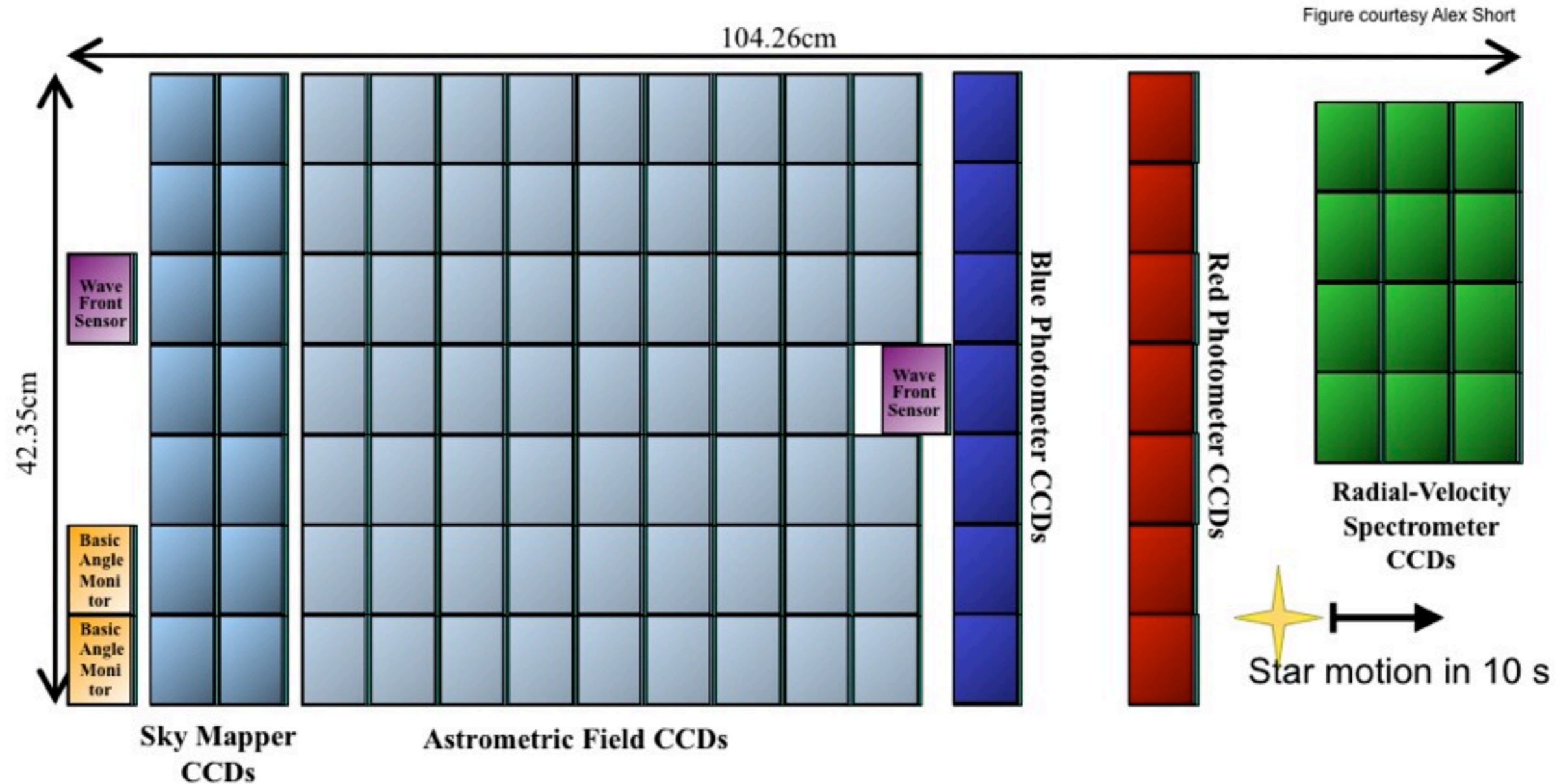


Sampling characteristics (scanning law)



- Two telescopes - time between subsequent FoVs: **106.5m**
- Time between successive scans: **6 h**
- Field revisited every **~50 days**
- Each object measured **~80** times (200 at the nodes)

Gaia's Focal Plane



- Chip transit: 4.4s
- Field transit (9 astrometric CCDs): 40s

Timeline for the data flow

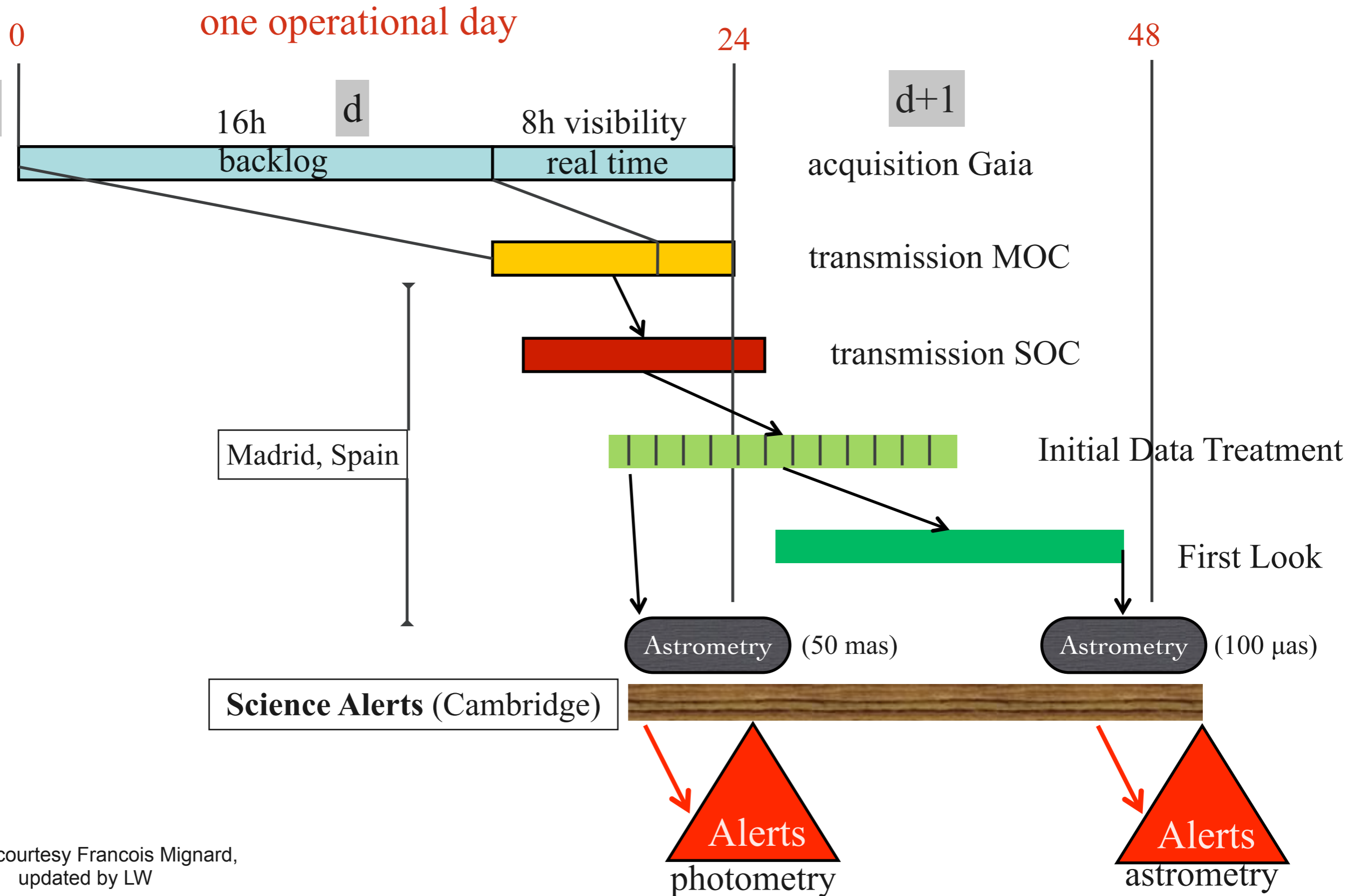


Figure courtesy Francois Mignard,
updated by LW

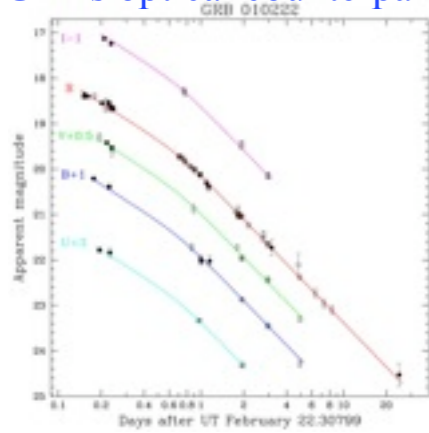
Lukasz Wyrzykowski, IoA Cambridge UK

Saturday, 22 January 2011

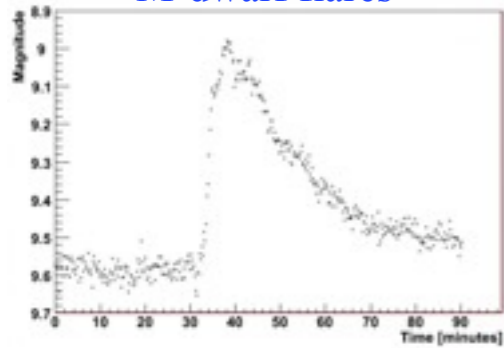
Microlensing with Gaia satellite

Potential Triggers

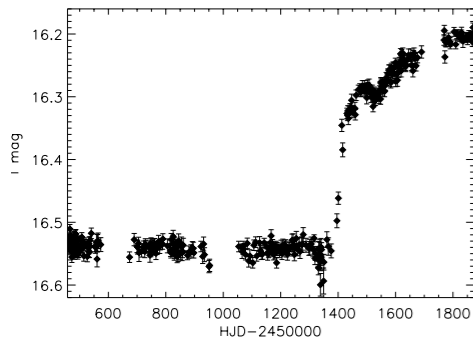
GRBs optical counterparts



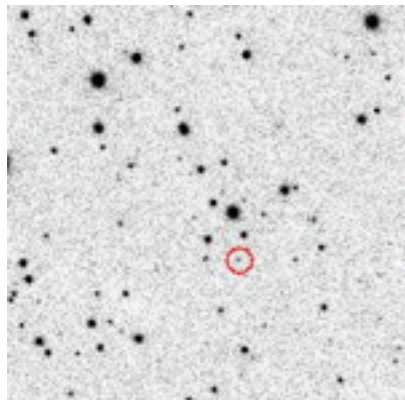
M-dwarf flares



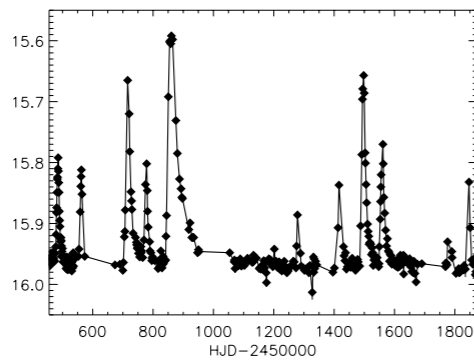
Be stars



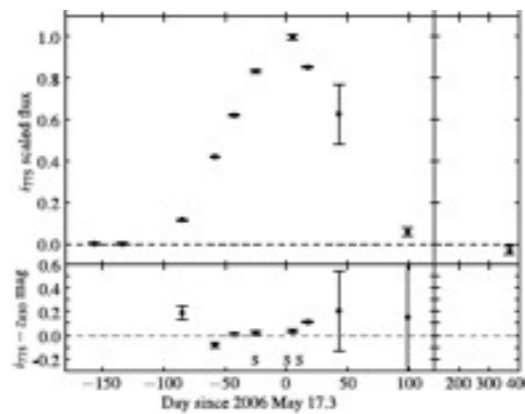
Asteroids



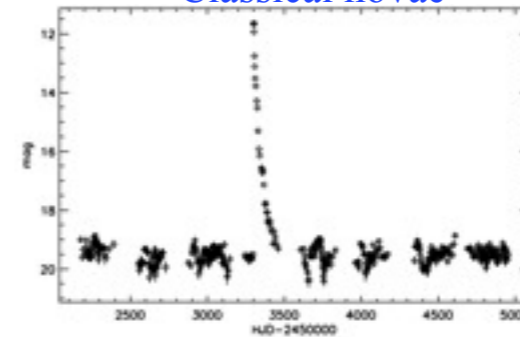
Dwarf novae



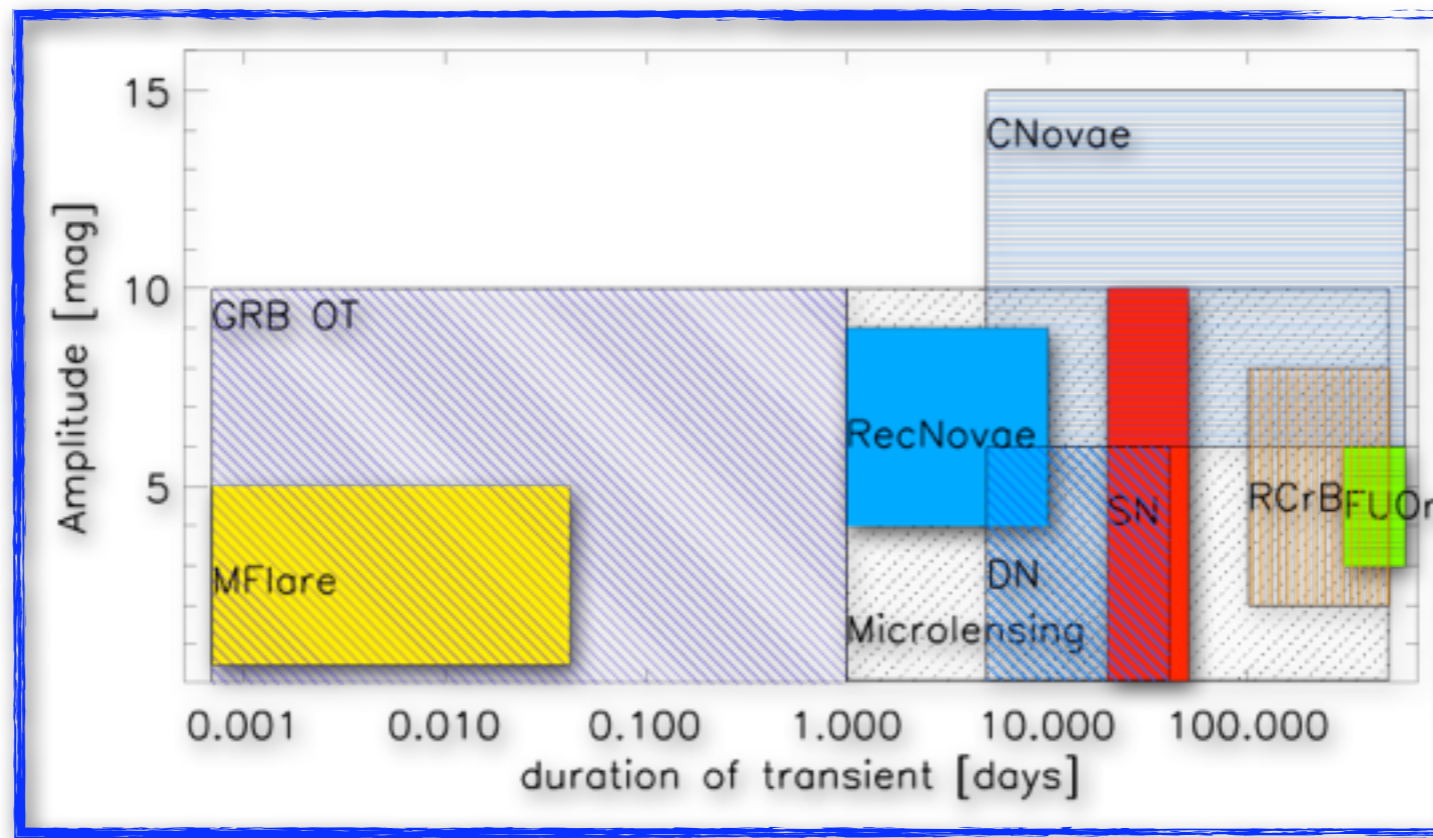
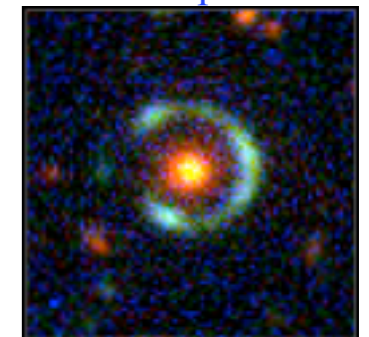
NEW THINGS??



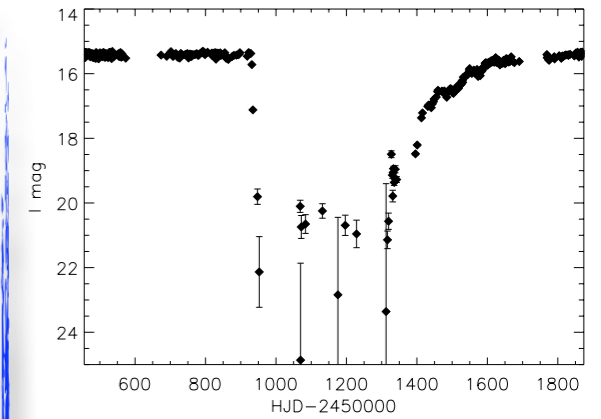
Classical novae



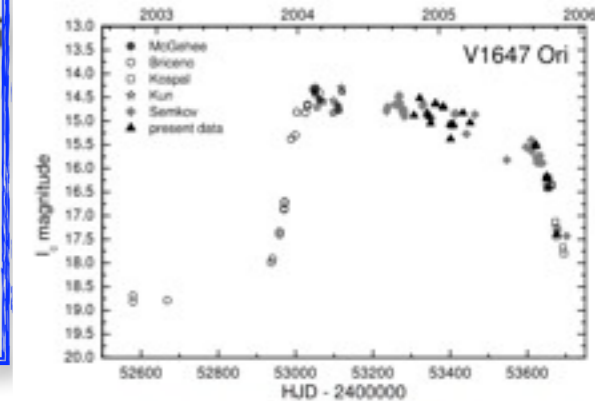
Lensed supernovae



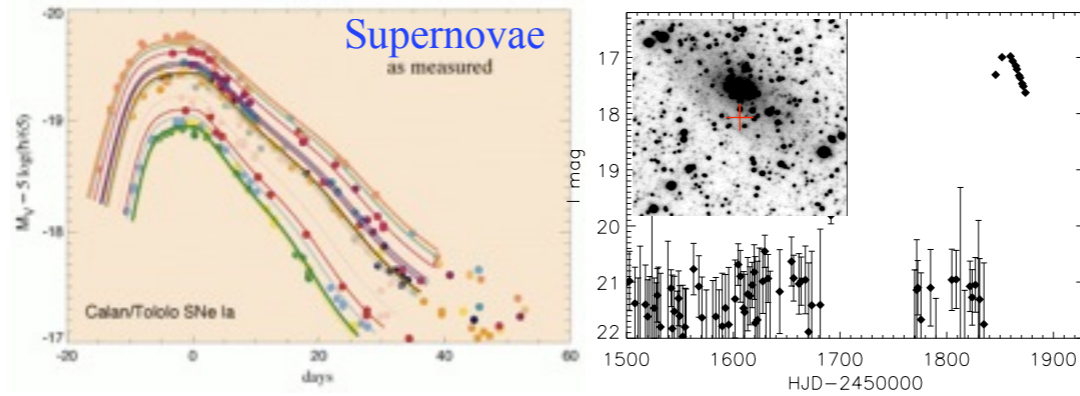
R Coronae Borealis



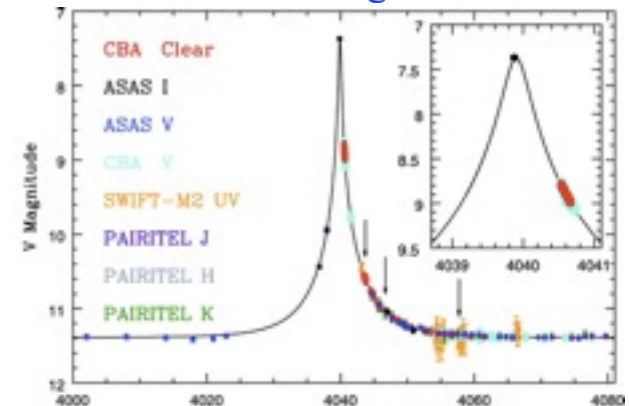
FU Orionis and similar



Supernovae

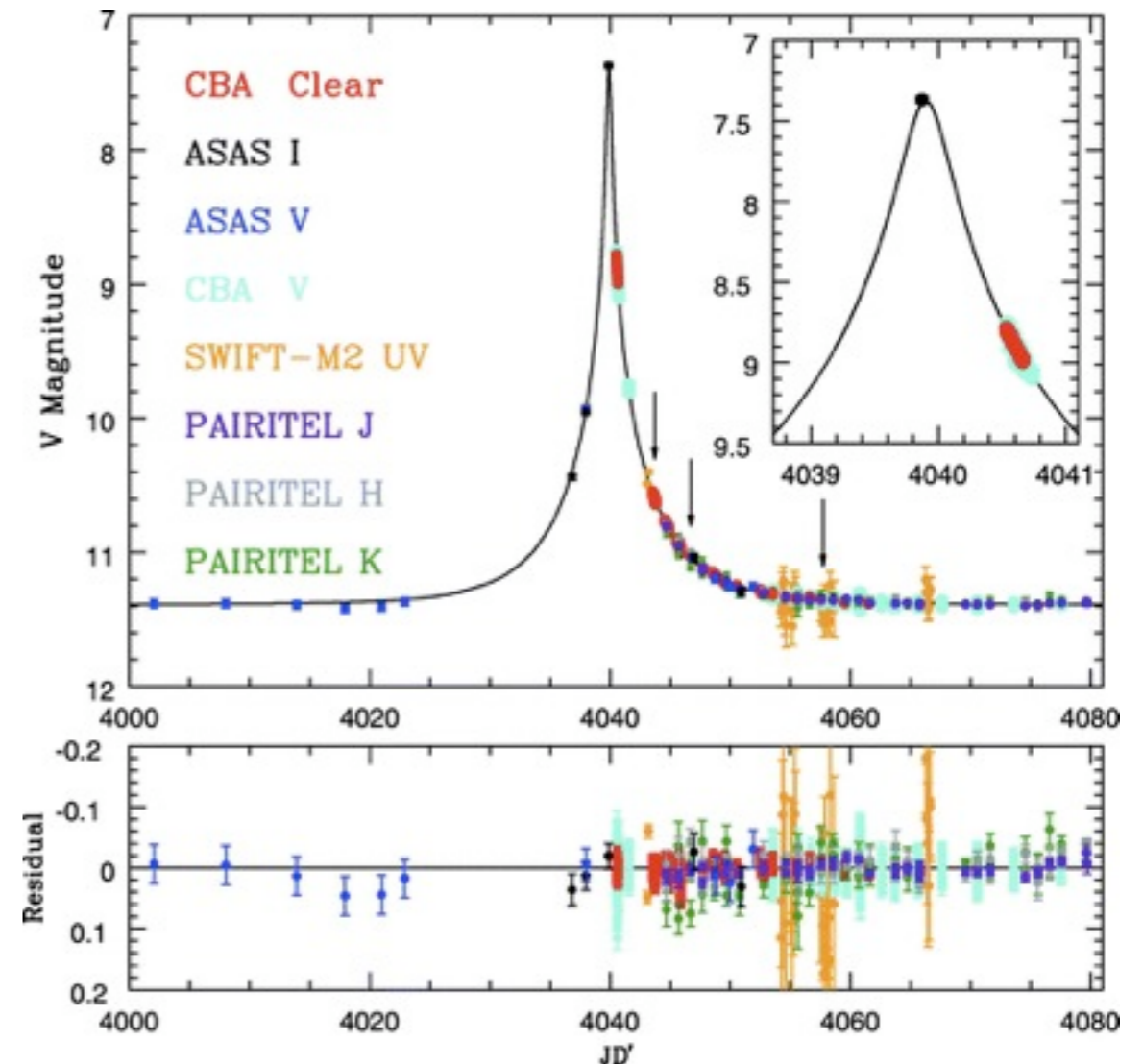


Microlensing events

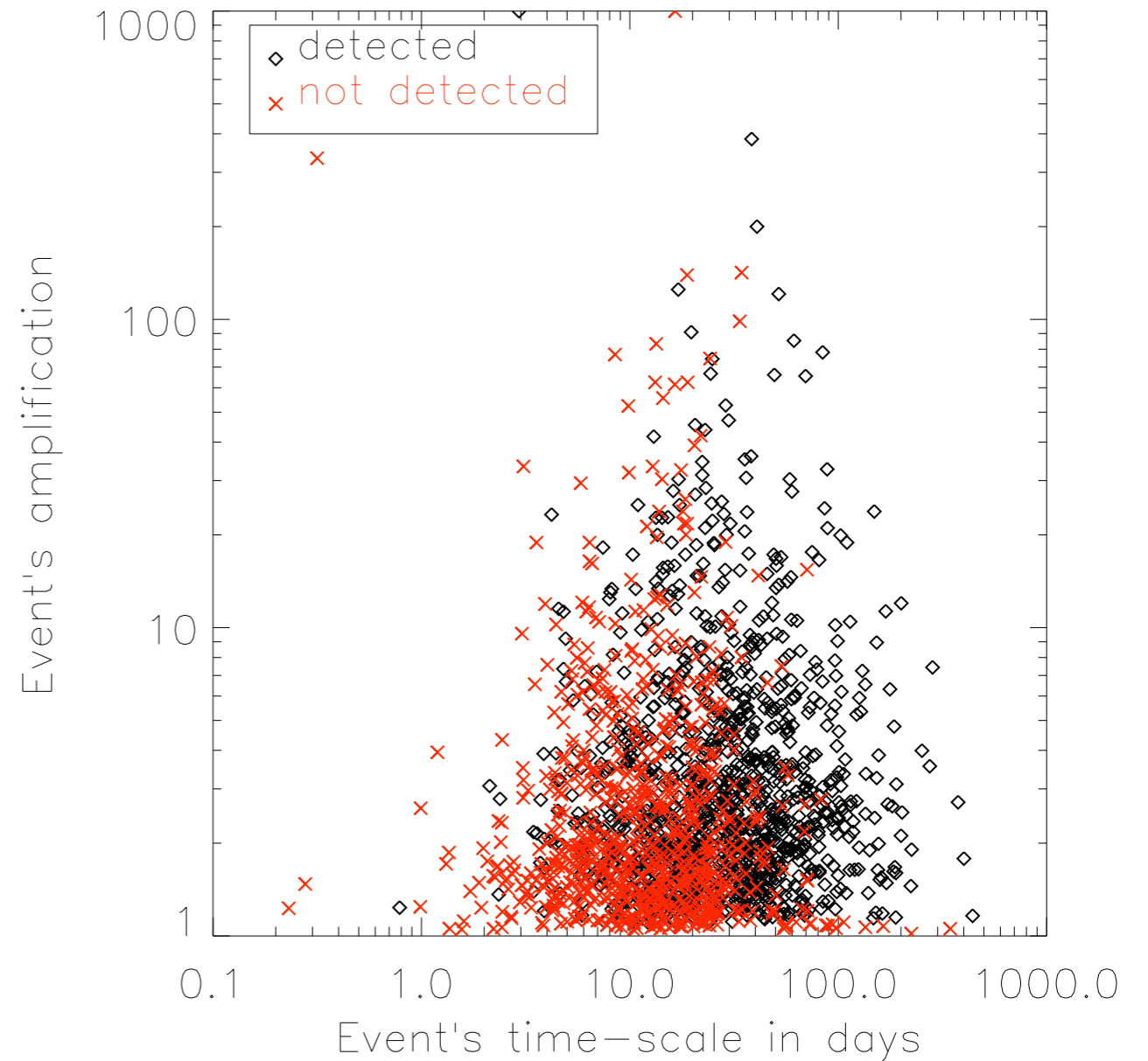
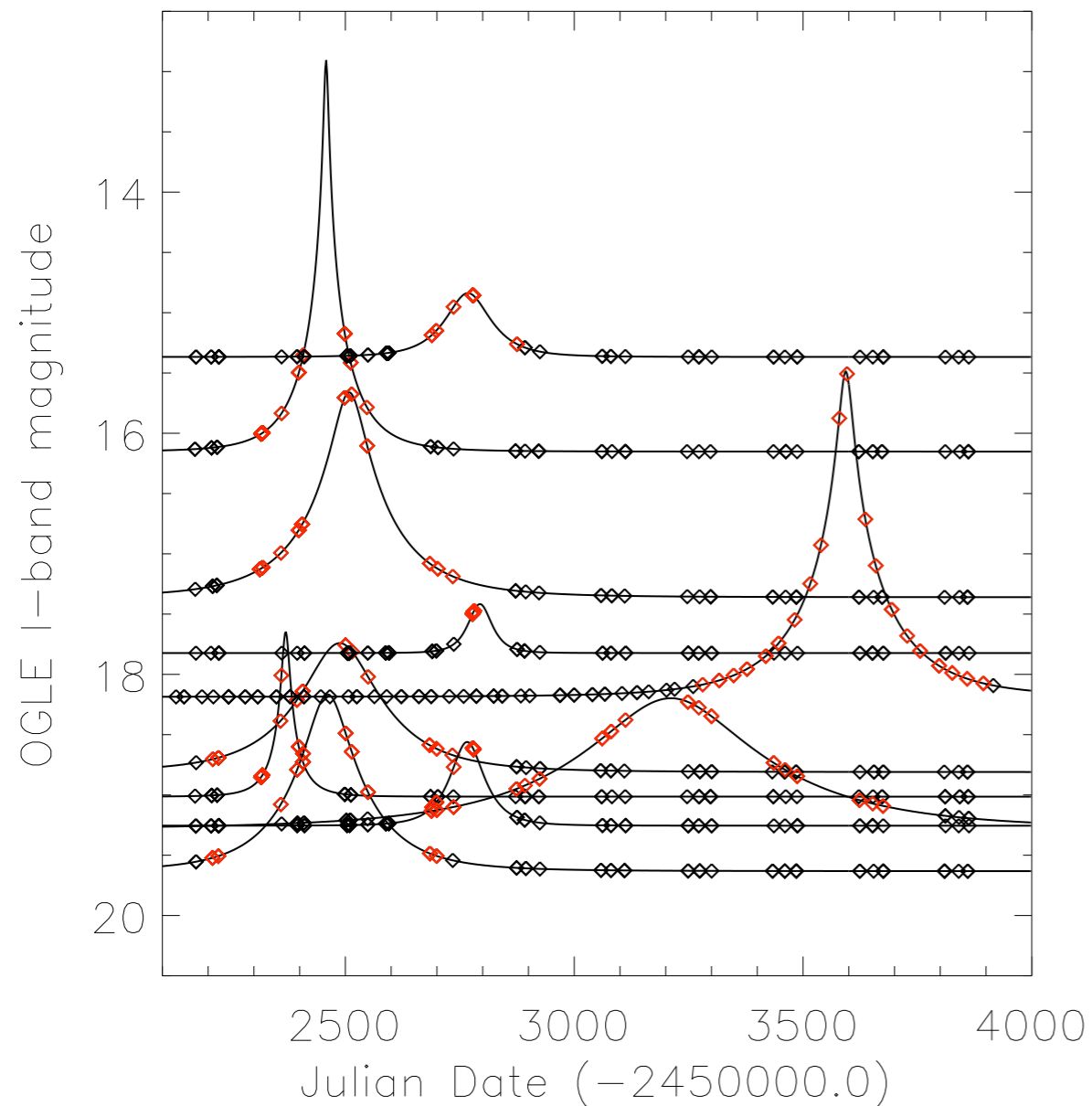


Photometric Microlensing Events

- **7500** events expected to occur during the 5-year of mission over the whole sky
- **>3000** events expected towards the bulge, but many lost due to **crowding**
- **Baade's Window** observed more frequently (special arrangements)
- photometric alerts expected on **1000+** events
- **one** field event detected so far
GSC3656-1328 (Gaudi 2007)
11 mag field star at 1kpc
- apart from photometry, there is also low-dispersion spectroscopy available immediately - **lower false-alert rate**



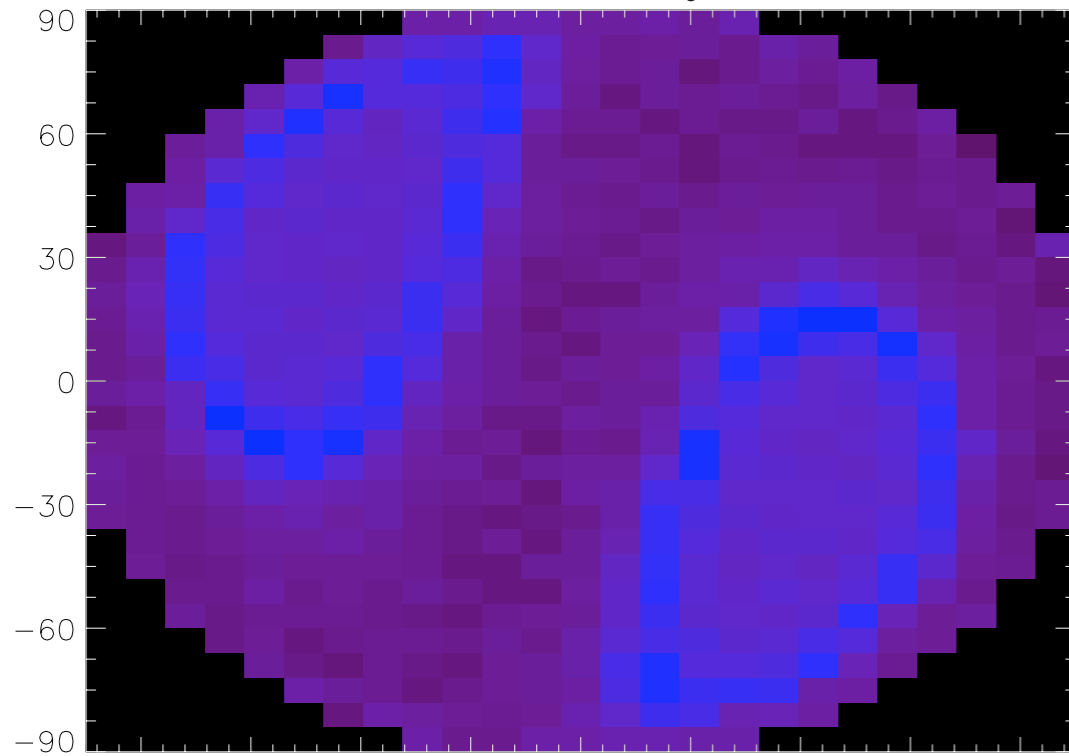
OGLE-III events “observed” by Gaia



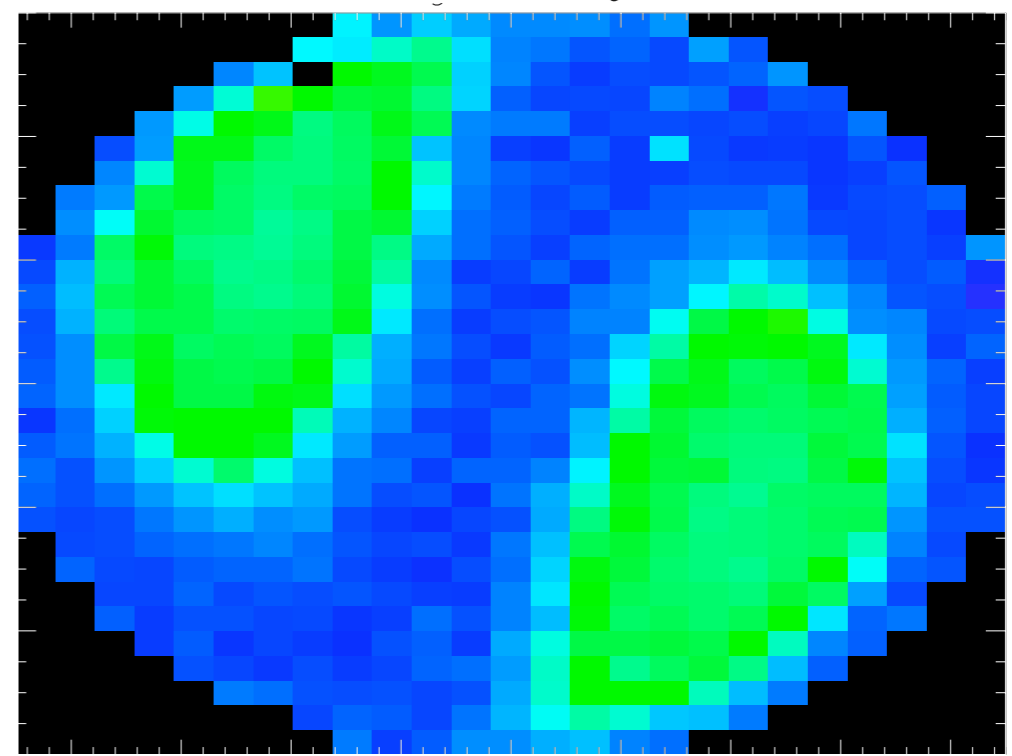
Towards the bulge most events with $t_E > 30d$ will have at least one Gaia measurement

Detection efficiency before the peak

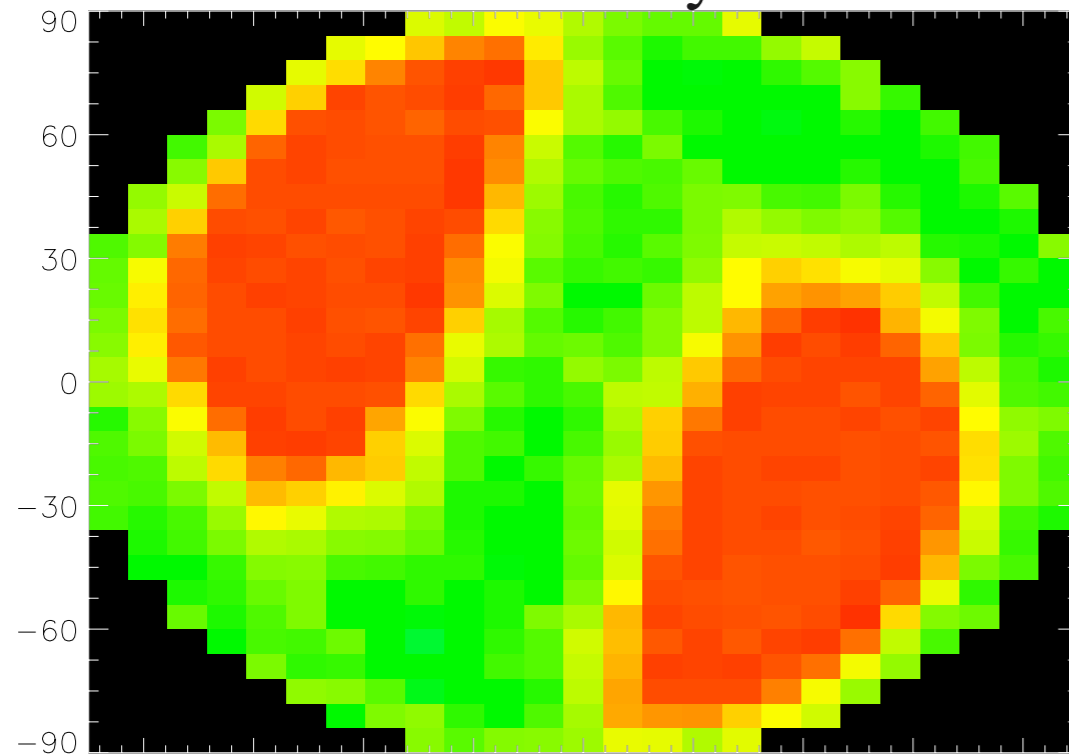
$t_E=15$ days



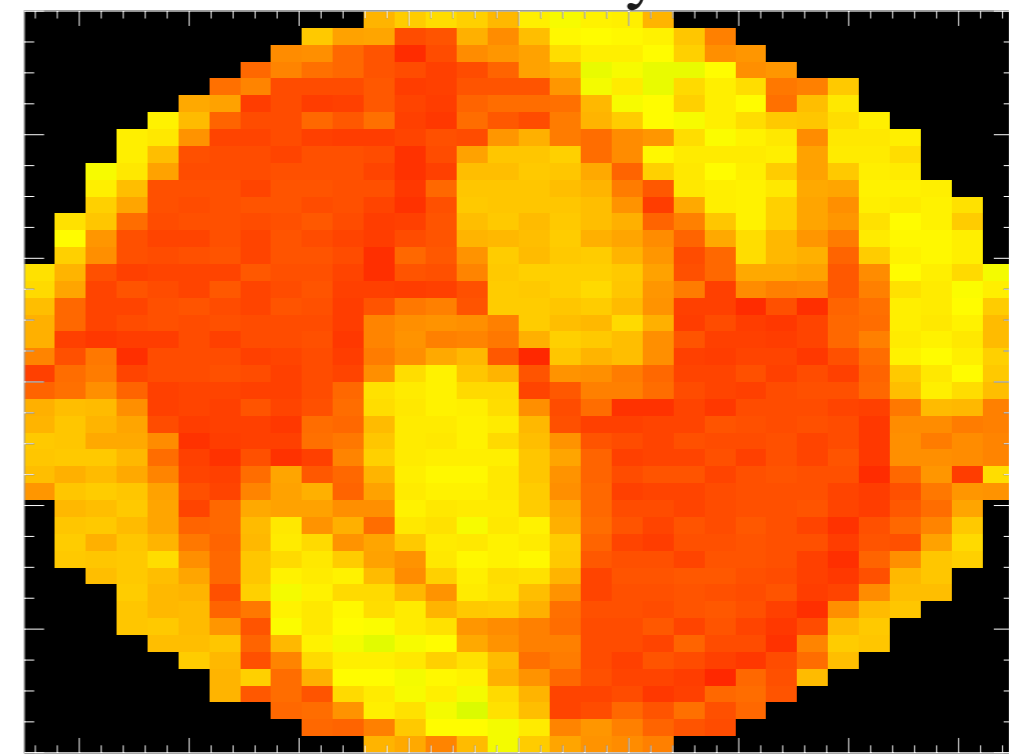
$t_E=30$ days



$t_E=60$ days



$t_E=100$ days



efficiency

1.0

0.8

0.6

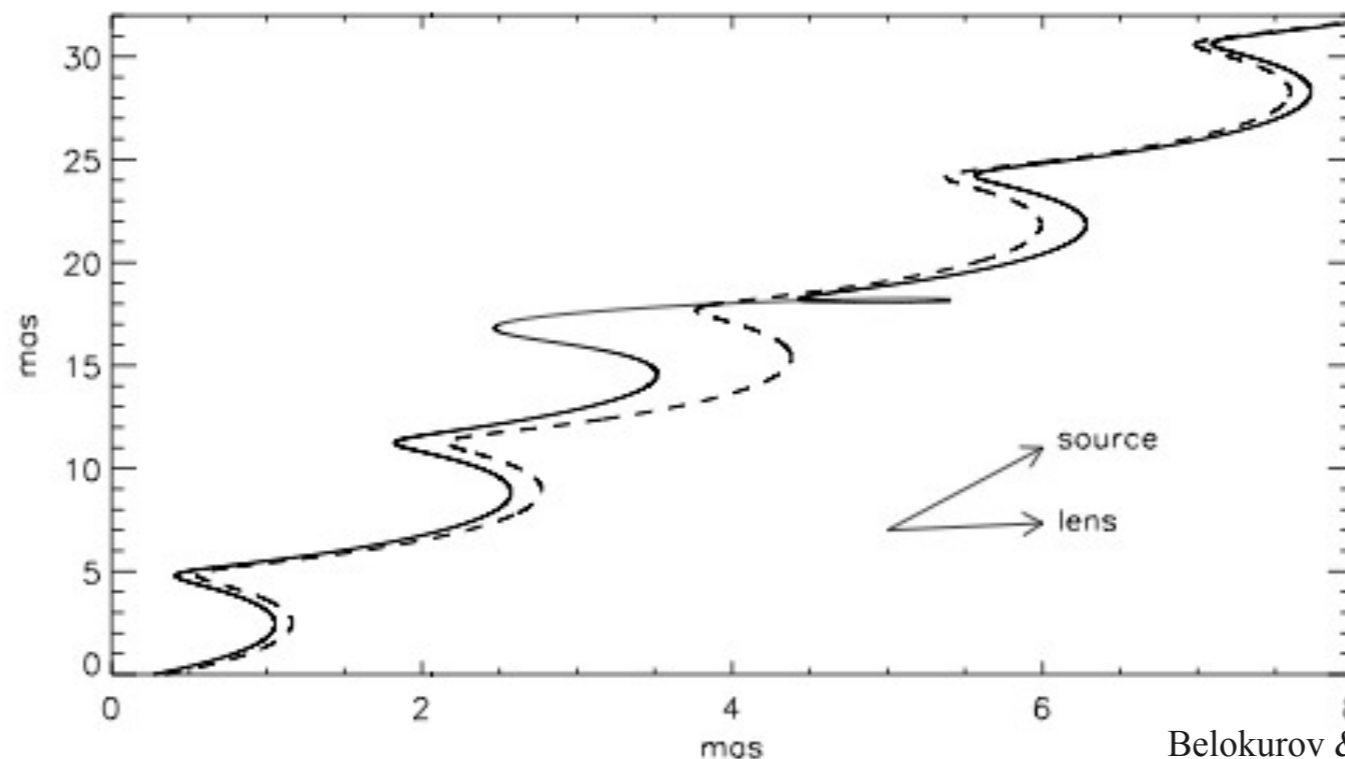
0.4

0.2

0

Astrometric Microlensing Events

- Gaia is predominantly an astrometric mission with unprecedented resolution
- astrometric accuracy: **<50 μas** at <14mag, **400 μas** at 18mag
- astrometric microlensing has optical depth $\tau \sim 10^{-5}$ towards the bulge
- astrometric microlensing events last **2-3** times longer than photometric (start earlier!)
- **15,000** astrometric events expected to occur during 5 years of the mission
- mainly those with **nearby** or **massive** lens detectable (Belokurov&Evans 2002)

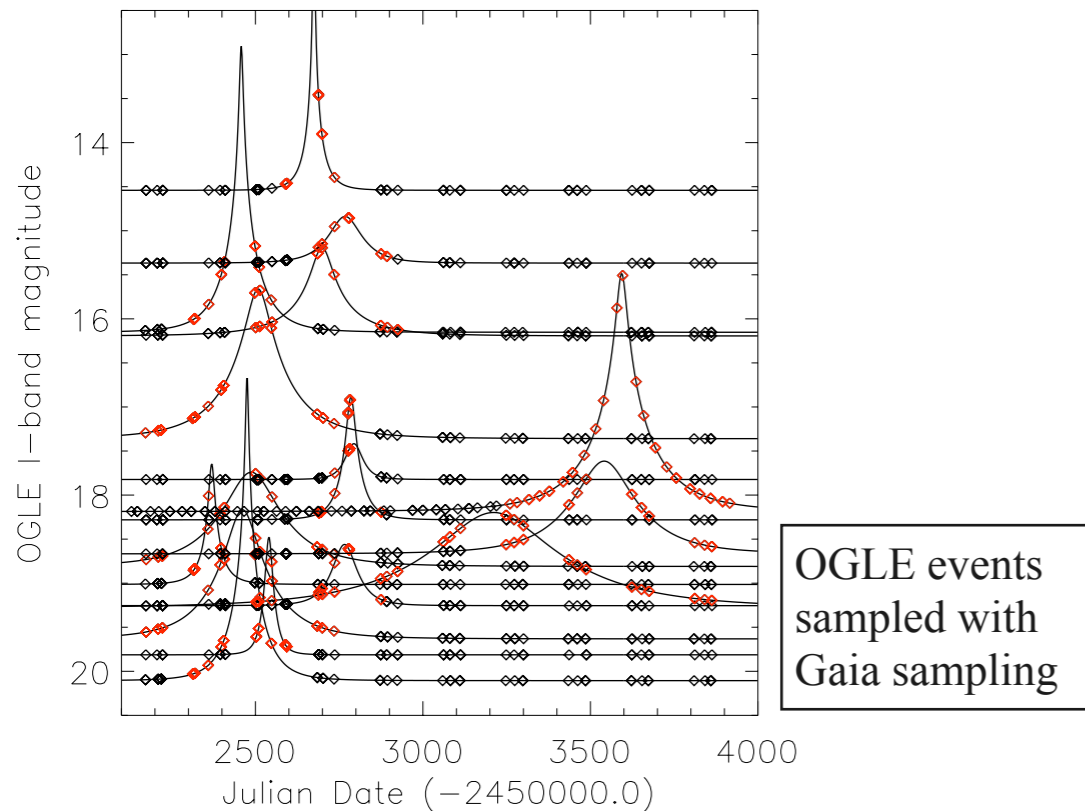
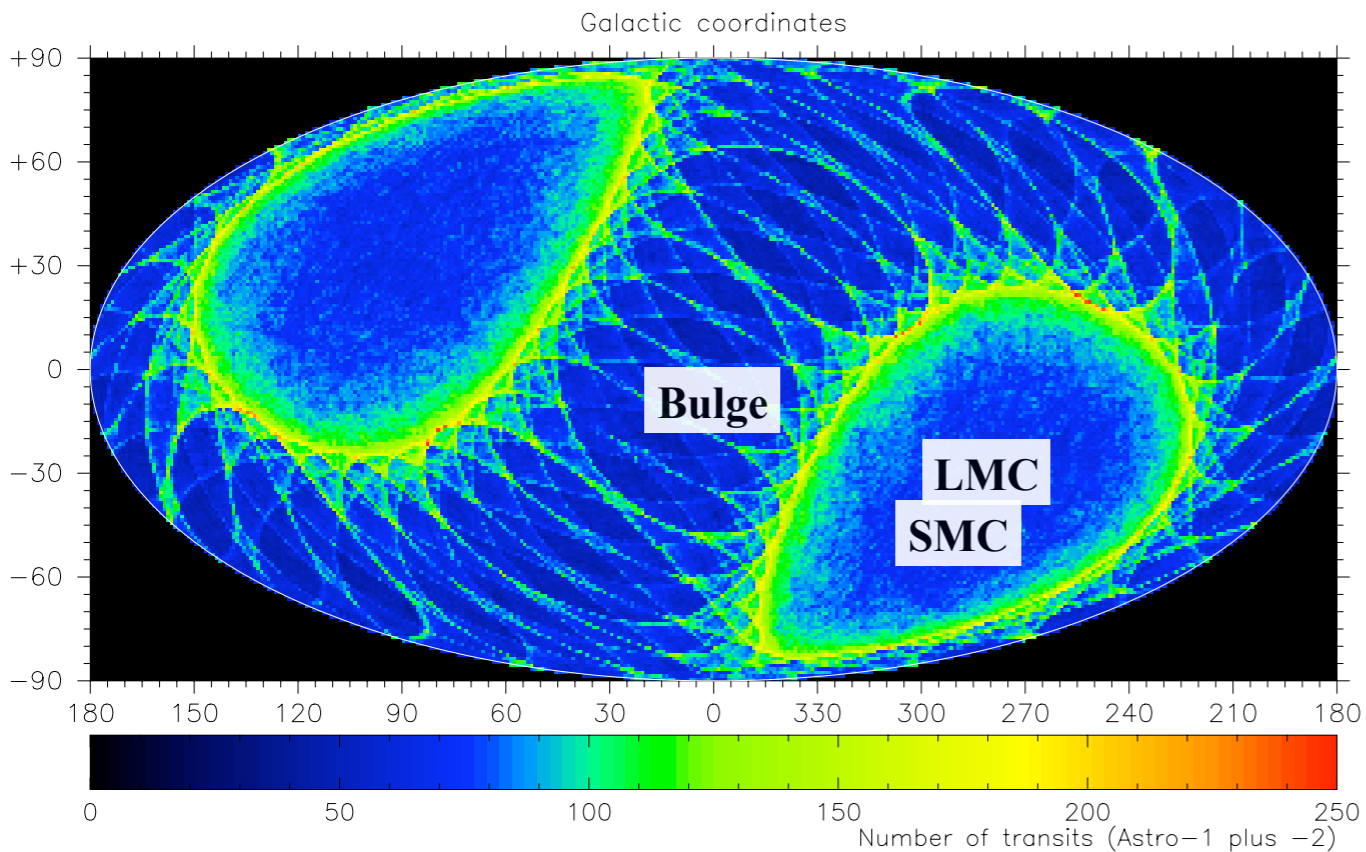


Path of the source
with annual parallax,
proper motion
and with/without
microlensing deviation

Belokurov & Evans 2002

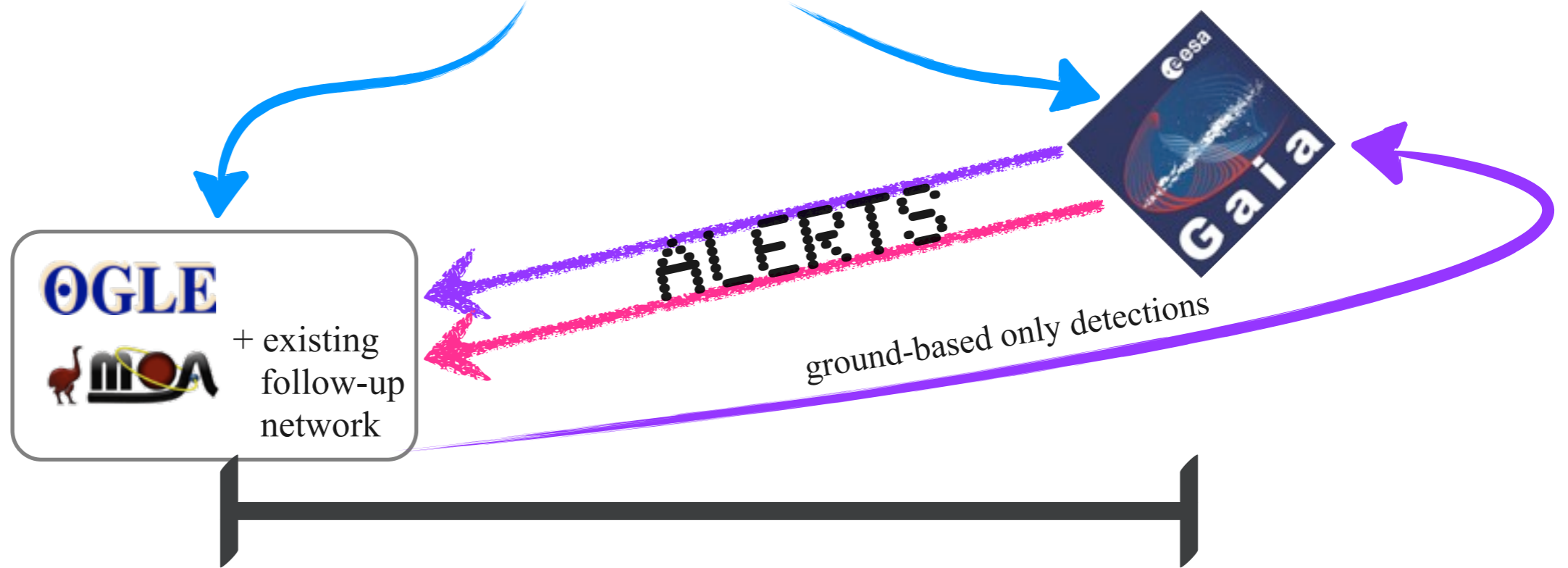
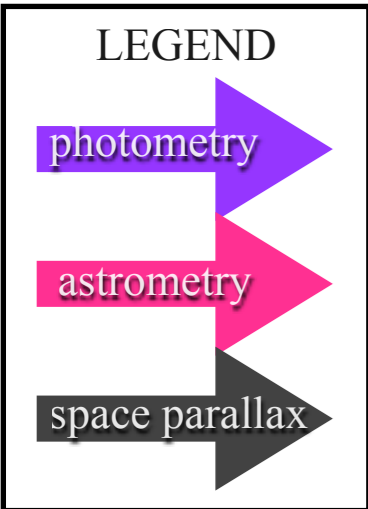
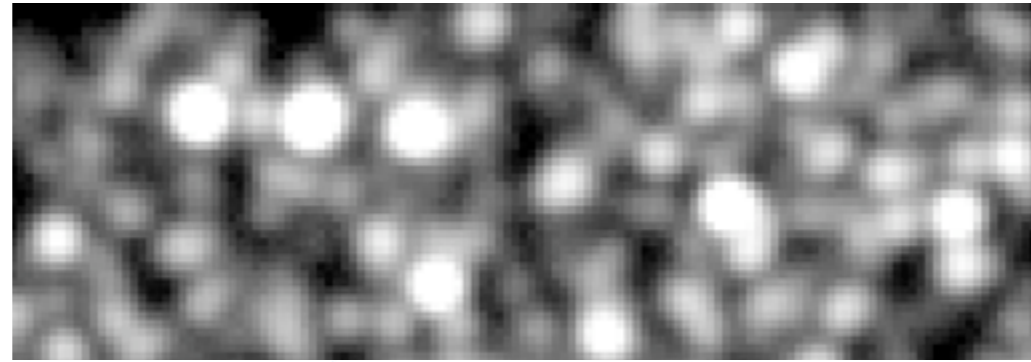
- **Alerting** astrometric system possibly in place from **2014/2015**

Gaia with follow-up can do better!



- Only **~50** data points in the bulge
- a bit better for LMC/SMC (**~80**)
- Among **15,000** astrometric and **7,500** photometric events only a fraction suitable for measuring mass of the lens with Gaia alone
- FOLLOW-UP: alerts released via *SkyAlert.Org* and *VOEvent*
- around **1000** masses to be measured with the follow-up
- errors on parameters decreased by factor of **10**
- astrometric deviation starts **earlier** than photometric - enough time to prepare follow-up
- photometric microlensing alerts can have very low threshold to assure high detection efficiency
- CVs and other contaminants classified prior the alert thanks to **immediate spectra**

Microensing Events



- ★ masses of hundreds of lenses - local mass function
- ★ massive stellar remnants (BHs, NSs)
- ★ microlensing extrasolar planets over whole sky

<http://www.ast.cam.ac.uk/research/gsaWG/>



Main Page

Welcome to the web site of the Gaia Science Alerts Working Group!

navigation

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- [Recent changes](#)
- [Random page](#)
- [Help](#)

science

- [Triggers](#)
- [Contaminants](#)

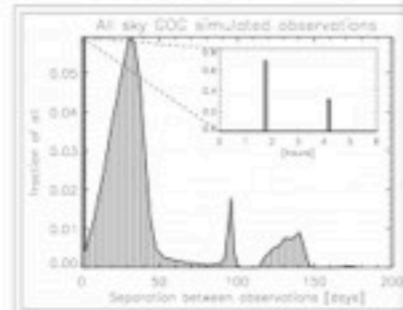
alerts

- [Detection System](#)
- [Verification phase](#)
- [Follow-up](#)

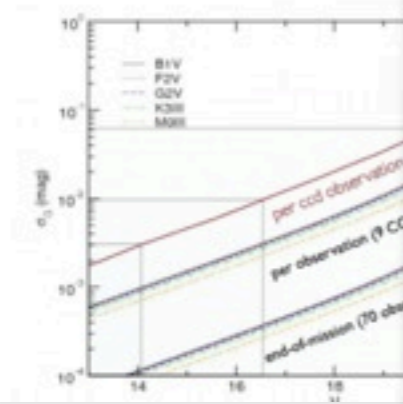
Sampling properties of Gaia

Detections will be strongly affected by sampling properties of the Gaia. These are induced by characteristic "scanning law" (see figure). Gaia will be equipped with 2 telescopes, therefore there will usually be two subsequent observations of an object, separated by 106 minutes. Next scan comes after 6h after the first (4.5h after the last observation), so there may be another set of two fields of view observations, unless the satellite processes enough to move to another bit of the sky. Then the same object may be observed after 4.5h.

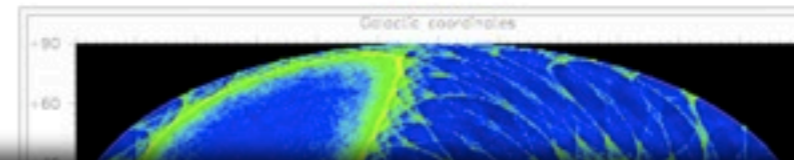
Such cadence allows for detection of objects between observations, but after the sequence of observations.



Sampling distribution over the whole sky from Gaia simulator



exploding and eruptive stars,



Workshop's agenda

Abstract book can be downloaded [here](#). The titles are linked to pdf versions of the talks.

All presentations were also video recorded and are available in AVI format.

Wednesday 23 June 2010

time	session	title	speaker
10:30		Coffee and registration	
11:00		Welcome address recording	Rob Kennicut
11:05		Welcome and update on GREAT recording	Nick Walton
11:15	Gaia	Gaia status	Timo Prusti
11:35		The Gaia mission: a primer recording	Francois Mignard
12:00		Science Alerts recording	LW/STH
12:25		Asteroid Alerts recording	Paolo Tanga
12:45		Q+A/Discussion	
13:00		Lunch	
14:00	Surveys	Transient and Supernovae searches with PS1 recording	Stephen Smartt
14:25		High energy transients recording	Paul O'Brien
14:45		Explosive Transient Detection in the Era of Synoptic Sky Surveys recording	Przemek Wozniak
15:10		The Palomar Transient Factory recording	Eran Ofek
15:30		Tea	
16:00		PTF - The reduction, subtraction, detection, and classification pipelines + some results recording	Dovi Poznanski
16:20		Optical transients detected by the Wide Angle Search for Planets (WASP) recording	Peter Wheatley

Preliminary advert

Gaia Alerts Verification and Follow-up Workshop

Institute of Astronomy
University of Cambridge
June 2011

more details on Gaia Science Alerts WG wiki:

<http://www.ast.cam.ac.uk/research/gsaWG/>