Realising the Science Potential from Gaia

Gerry Gilmore

Gaia launch is scheduled for three years from this week. Maybe earlier
Much follow-up science effort needs to be prepared.
Many of us are a little busy with other Gaia responsibilities already...

Gaia data products will be staged releases. what will be able to do to get full value?

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- Assumption 2: nothing will happen unless someone plans it*.

- *first law of planning – make sure all your text fits on a single line

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- Assumption 3: telescopes and research funding are already heavily oversubscribed: to get a lot of Gaia exploitation, we need to get organised: scientifically, financially, politically.

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- Context one: Gaia data products will be staged releases. We need to match plans appropriately: full astrometry is a decade away...
- Context two: Europe's mid-sized telescopes are being restructured right now, with Gaia science as a primary driver for their continued operation and development.

European telescope strategy review committee

- Europe's 2-4m telescopes are being reviewed
- *To identify those goals of the Astronet Science Vision that are most effectively delivered by 2-4m optical/infrared telescopes;*
- *Identify which observational capabilities are required;*
- *...*
- *Among the science tasks, consider the appropriate balance between large-scale survey-type projects, including complementary ground-based programmes in support of European space missions, and individual access;*
- *It is anticipated that a similar pan-european exercise will be done around 2015-2018 for 8-10m telescopes with significant European ownership. ETSRC should take this into account.*

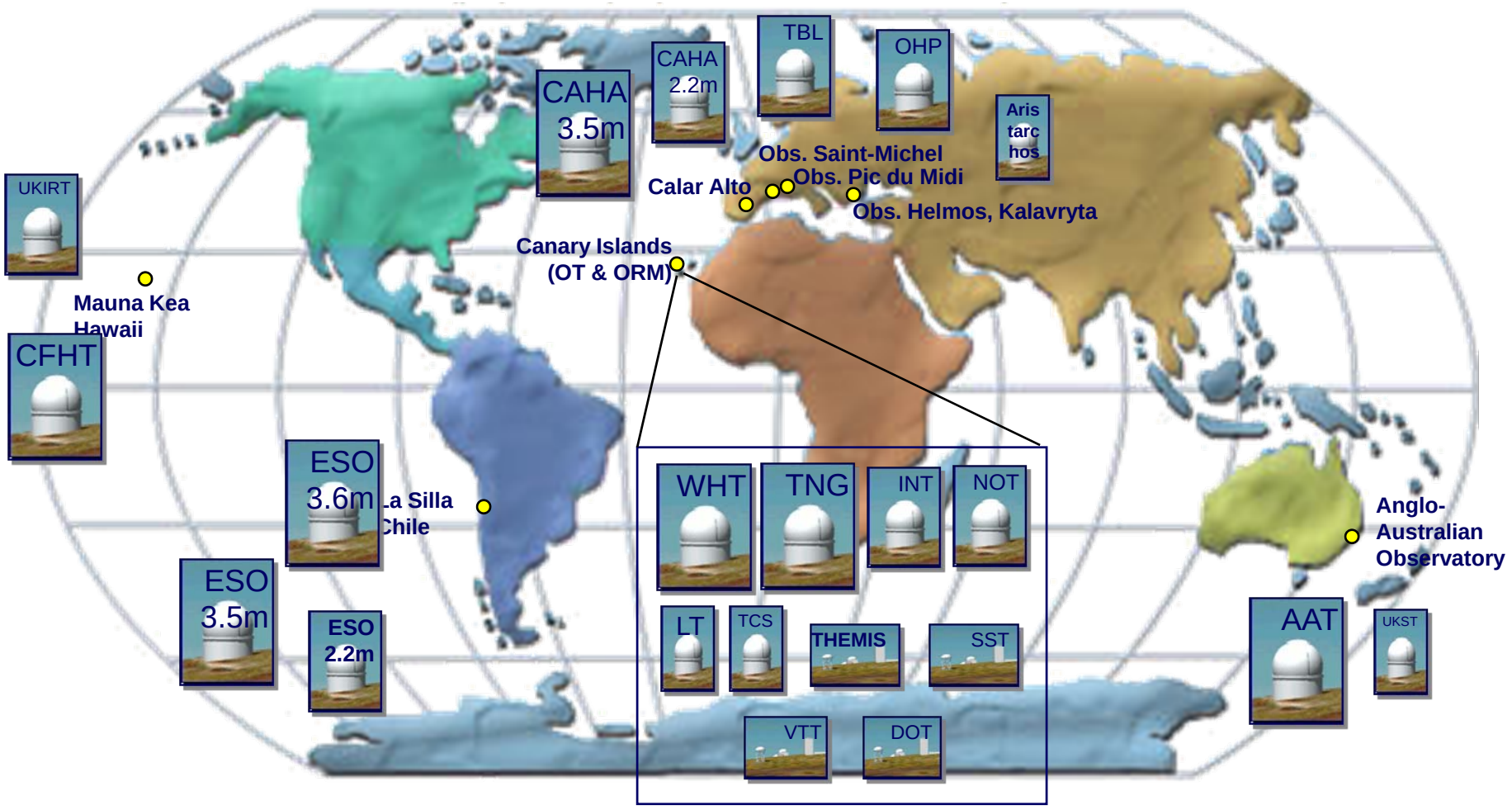
Why is there a review?

"THE ONLY PART OF THE UNIVERSE WHICH ISN'T EXPANDING IS THE BUDGET FOR THIS PLACE."

European agencies (part) own ~20 2-4m telescopes

[these are the OPTICON Access Programme]

plus VLT,LBT,GTC,Gemini



European Telescope Strategy Review Committee

AstroNet body, Opticon implementation assistance

- PEOPLE
- Janet Drew (chair)
- Jacqueline Bergeron (Co-Chair)
- Jerome Bouvier
- Margarida Cunha
- Angeles Diaz
- Geza Kovacs
- Andreas Quirrenbach
- Clive Tadhunter
- Massimo Turatto
- Pepe Vilchez

- TELESCOPES
- CAHA 3.5m, CAHA 2.2m
- CFHT
- OHP 2.2m
- TBL
- WHT, INT
- UKIRT
- LivTel
- ESO 3.6, ESO NTT, ESO VISTA, ESO VST
- Rohzen 2m
- Aristarchos
- TNG
- NOT
- MPG (ex-ESO) 2.2

- AAT +UKST already assumed lost to europeans;
- ESO restructuring presuming panel outcomes

European telescope strategy review committee

- *Among the science tasks, consider the appropriate balance between large-scale survey-type projects, including complementary ground-based programmes in support of European space missions, and individual access;*
- *GAIA* science is accepted as a primary driver for future telescope use.

- The current TAC model, one per telescope in isolation, will end
- Telescopes will be more coordinated, more collaborative, more specialised
- *Faster, cheaper, better.....*

- We may assume that significant observing resources, if necessary on many observatories, will be made available as a strategic priority, to properly-prepared projects: just like cosmology surveys

- New optimised instrumentation proposals can be considered: a specific need for massive spectroscopic surveys is recognised, and a new WG is planned.

- In that context, what will we have from Gaia

Gaia-related data

- Since Gaia affects almost all astrophysics, almost everything is Gaia-related – there is nothing `special' about being Gaia-relevant
- Exclude here pure `calibration` [GBOG]
- All science advances advance Gaia science*
- And *vice versa***

- So here just consider sources detected by Gaia, and being ***studied because of a Gaia detection***

- **** people complain scientific euro-english has a vocabulary of only 100 words – actually, even fewer are apparently adequate...***
- ***** Latin doesn't count***

Gaia data products (tentative!!)

this is only a planning hypothesis, prior to CU9!!!

- Alerts: quasi real-time flux alerts from mid 2012
- *then:*
- Photometric all-sky catalogue
- Limited precision astrometry (cut at mas-level?)
- BP/RP spectrophotometry
- Brighter-star spectroscopy
- Alerts from mid-2012
- All-sky data to be bundled in stages 2014-2018(tbc)

Gaia data products
first– alerts

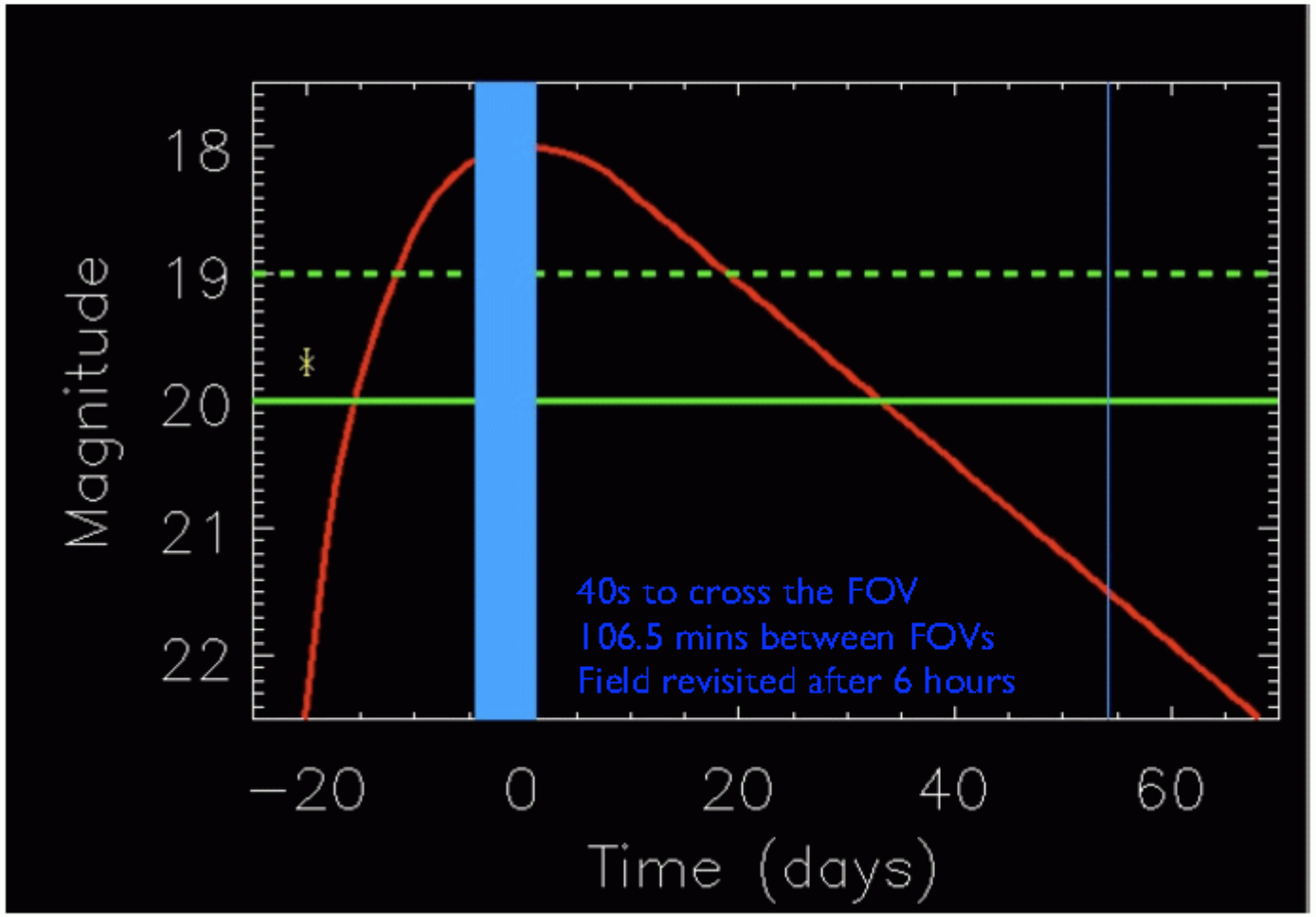
- Alerts: quasi real-time flux alerts, starting early
- How will/can we prepare for these?
- Leave aside alert verification process, which is CU internal
- Wide range of public sources, but which is which?:
  - It needs a lot of observing time, much to identify sources of interest only to others... ➔ teams are needed?;
  - It can be pre-planned – like SNae factory – so needs special arrangements with observatories
  - It really needs all-sky coverage
  - Do we just tell the world, and leave them to it?
  - Or organise?

SNae are the basic Dark Energy calibration, through Gaia Cepheids ➔ critical science

should we have a cosmology/Dark Energy WG, for distance indicators...?

Test Case: Supernova Ia

Science case: map the true SN luminosity DF, from Cepheid distances



- Host galaxy contribution determines whether source is new to Gaia.
- Successive transits will measure consistency and slope.
- Threshold for new source detection - about 1 mag above GAIA limit.

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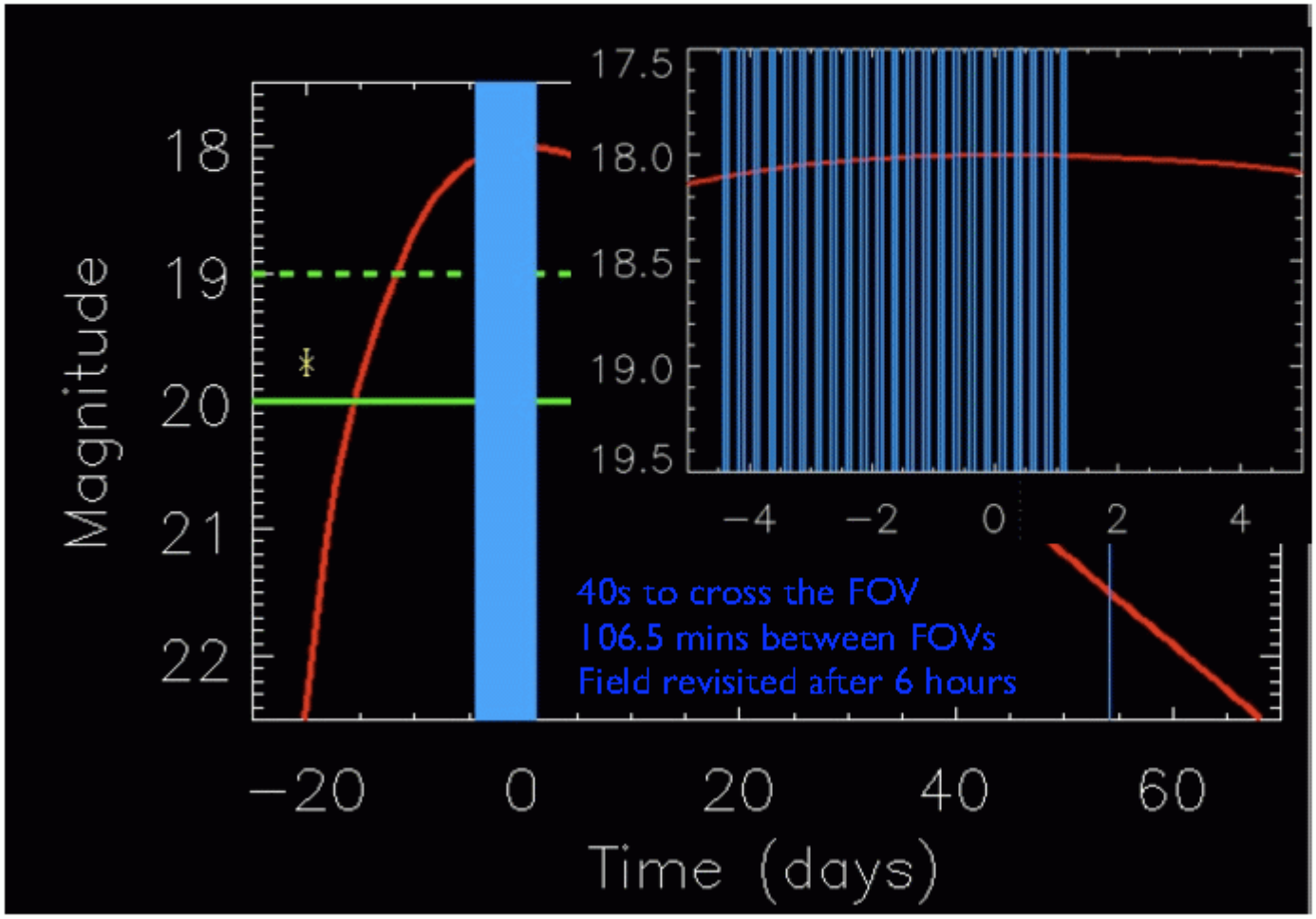

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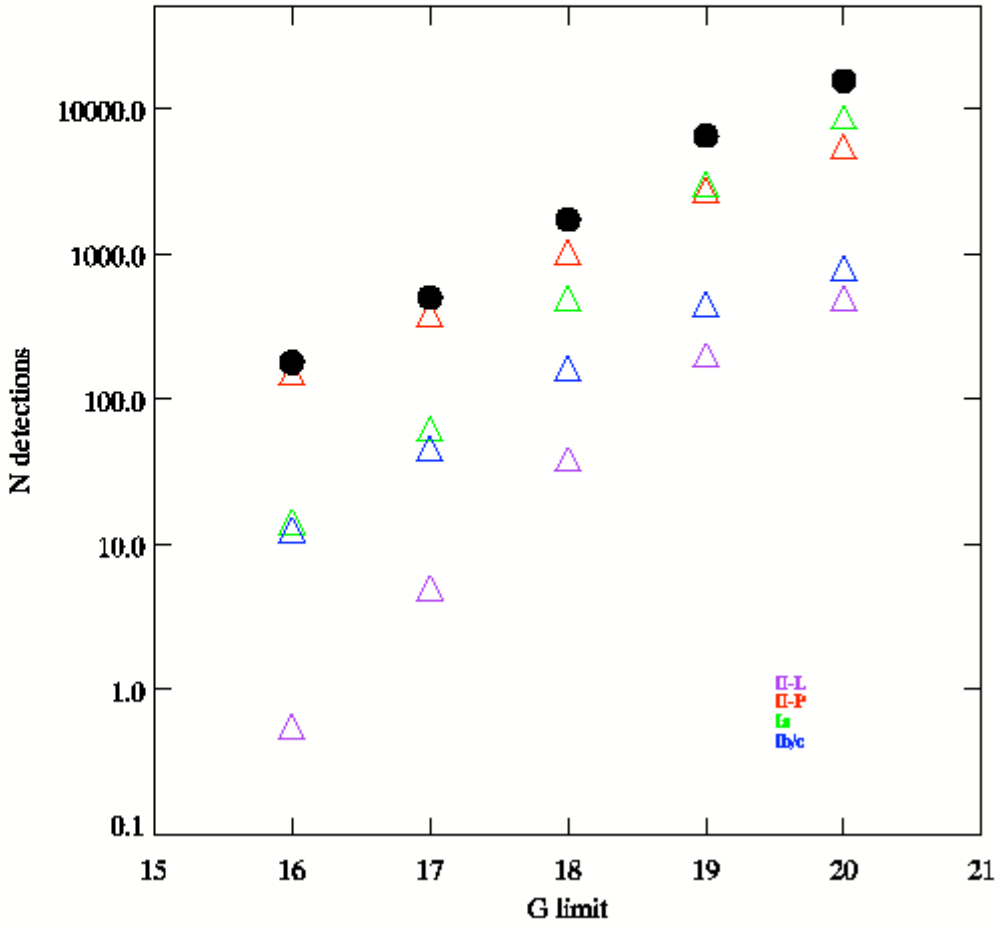
Faint as possible matters ➔ early, before CCD decay

Supernova Catch

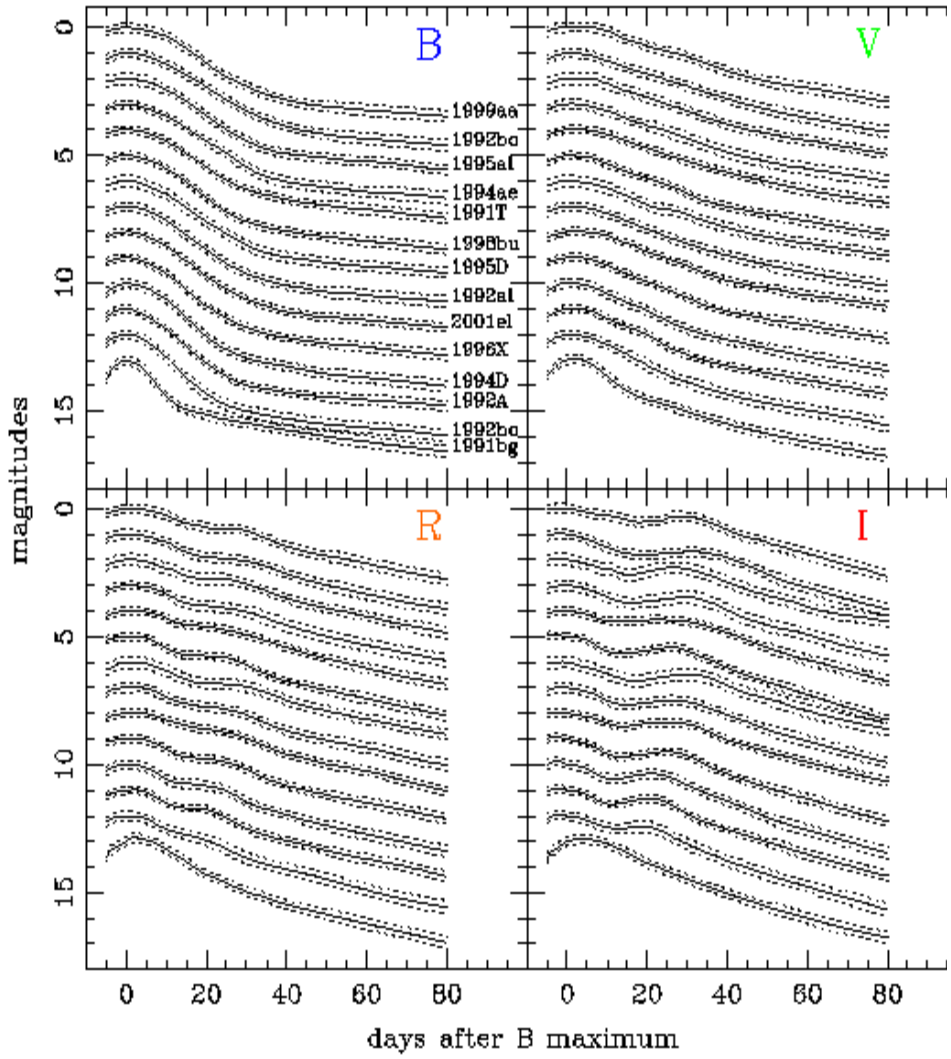
cf KAIT finds ~80 SNae/year to 19mag: Gaia is an order of magnitude gain

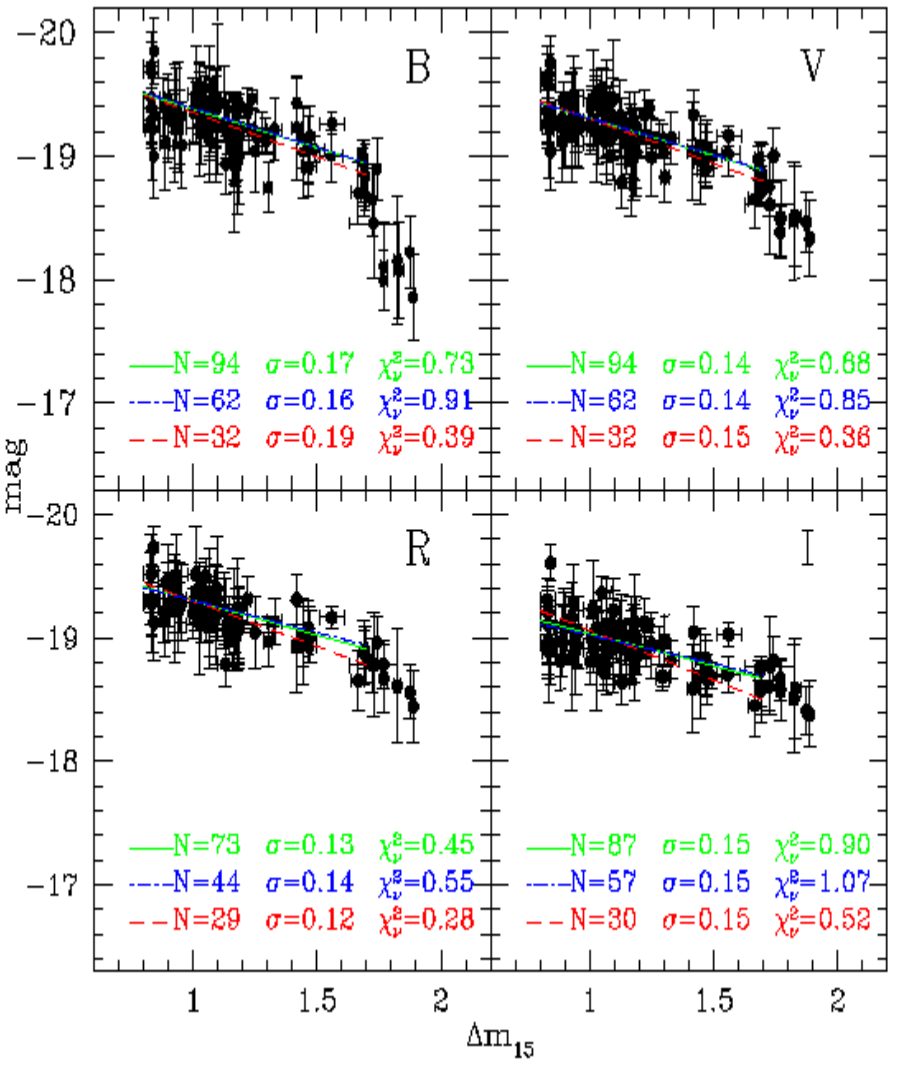
- Update to Belokurov & Evans
- 6000 SNe to G=19
- Around 1/3 before maximum



Belokurov V.A. & Evans N.W., 2003, MNRAS, 341, 569

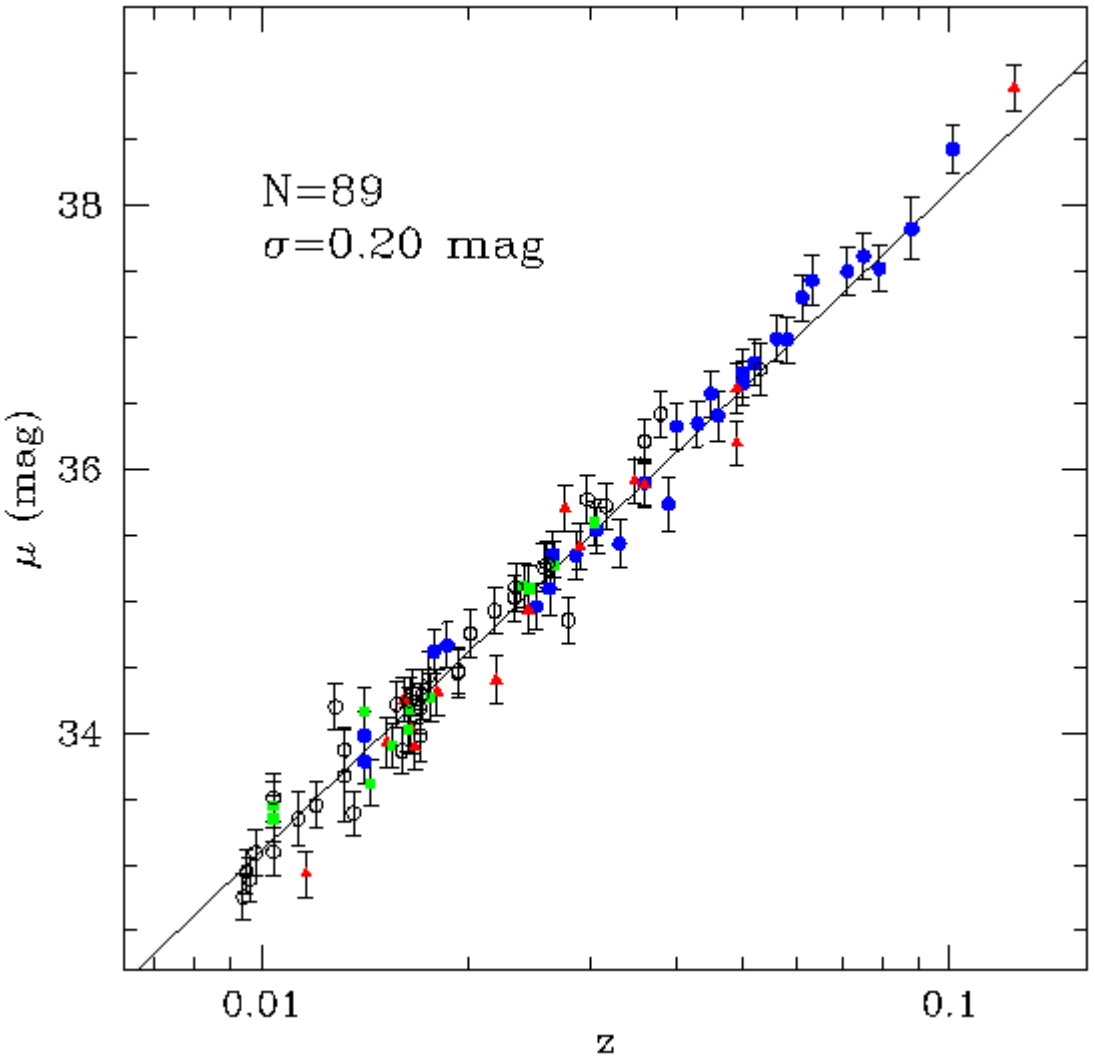
Systematic change of SNIa L_max with decline rate: empirical amplitude ~10x cosmological dark energy effect…





Current supernova calibration set (Prieto etal ApJ 647 501 2006)

The Gaia supernova discoveries require good follow-up light curves for cosmology

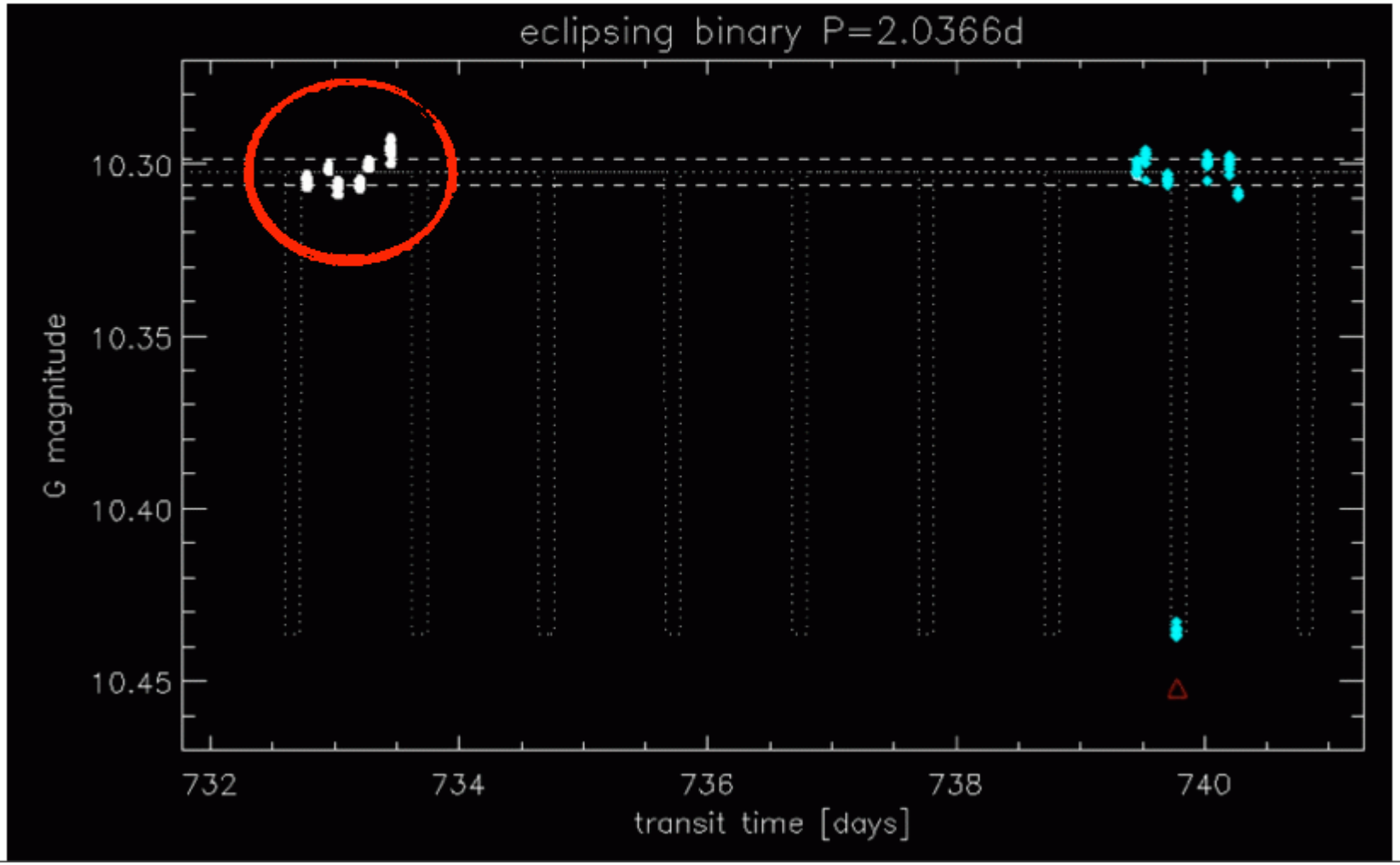


Gaia SNIa detection limit

G=19 Gaia SNIa alerts limit

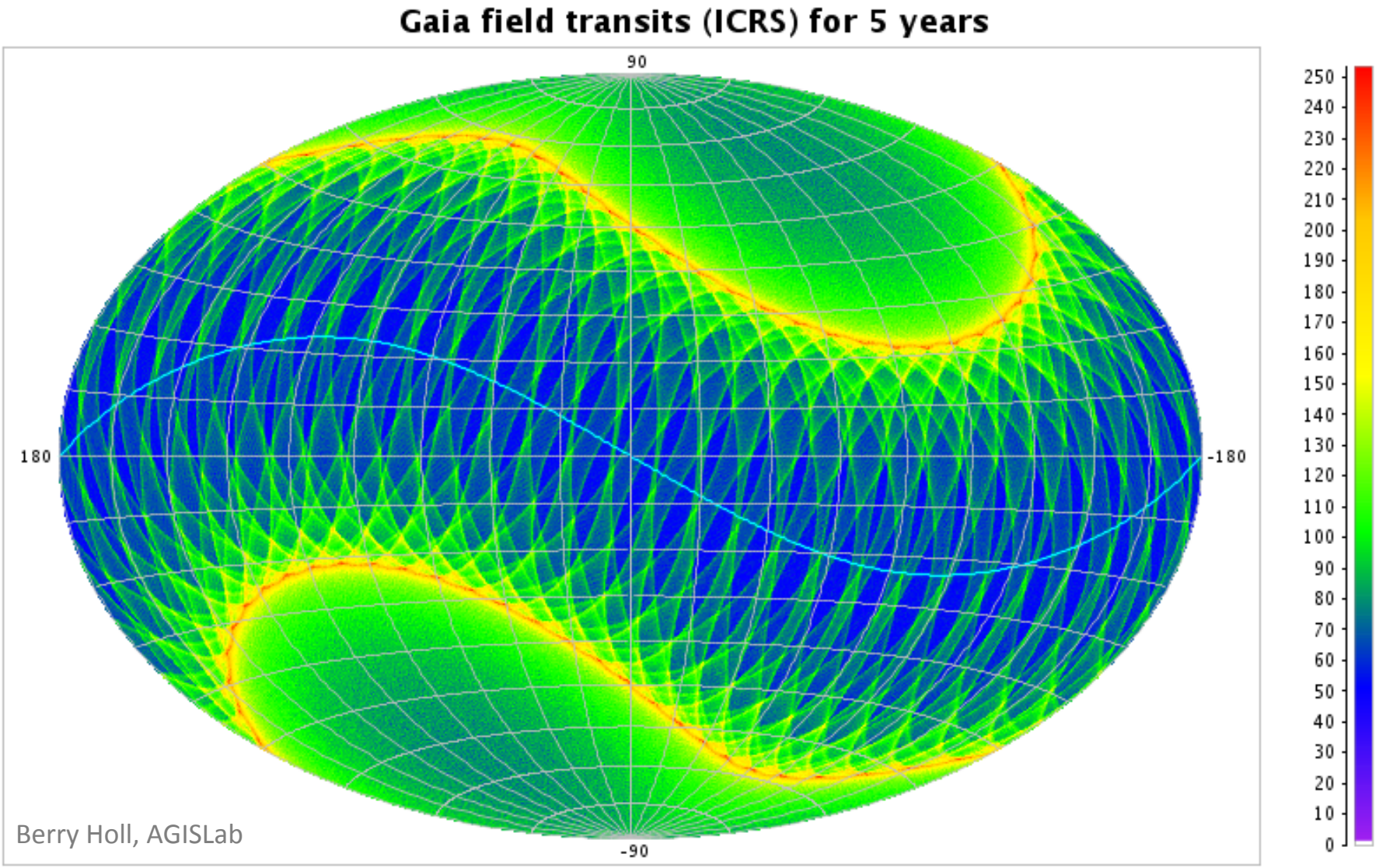
Of course, lots and lots and lots of different variables can be found – stars to QSOs

Cycle3Fv example



Should we prepare ``follow-up'' surveys along the high cadence areas?

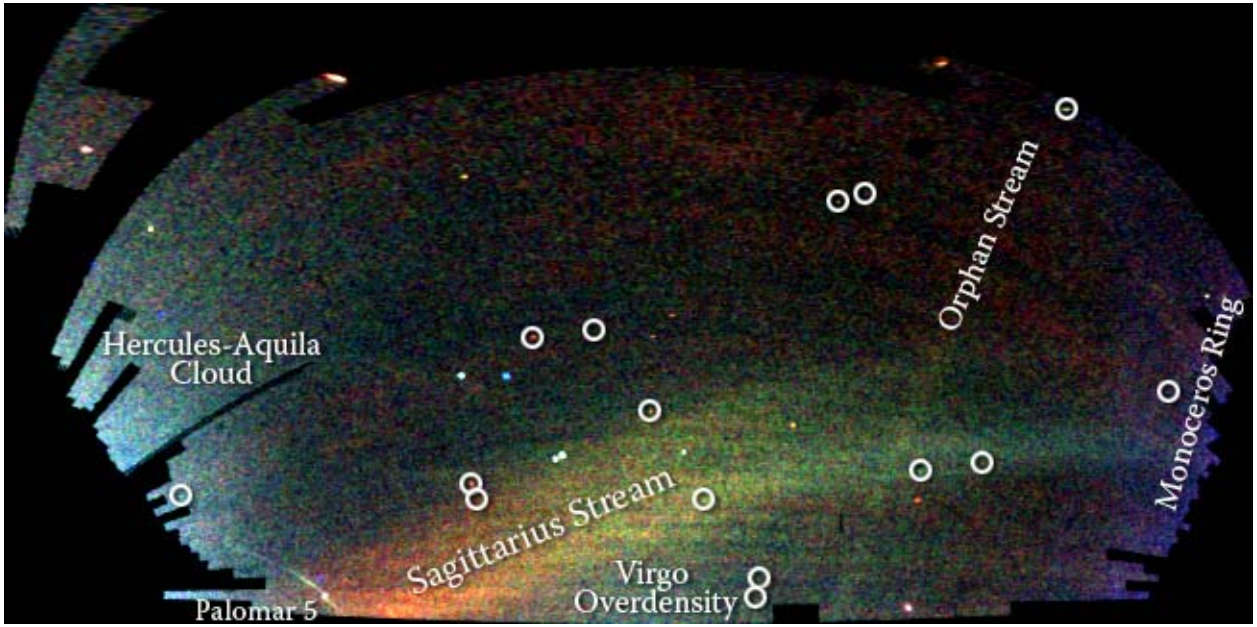
The Nominal Scanning Law

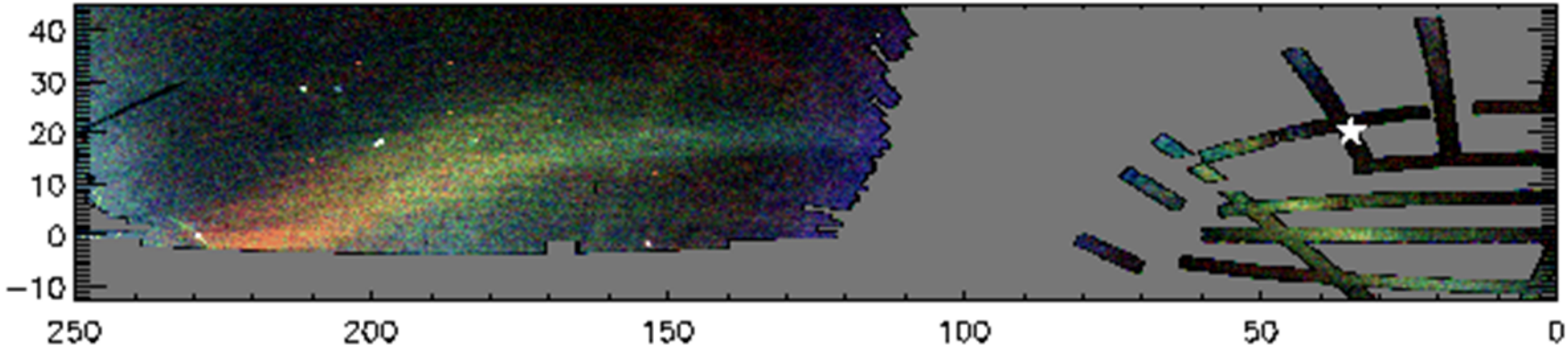


How will Gaia behave in crowded regions? We have no prior data!
much of the sky is complex.. But LMC and M31 interestingly seen

But there is a lot to do, even in the easy clean high-latitude sky

Field of Streams - updated



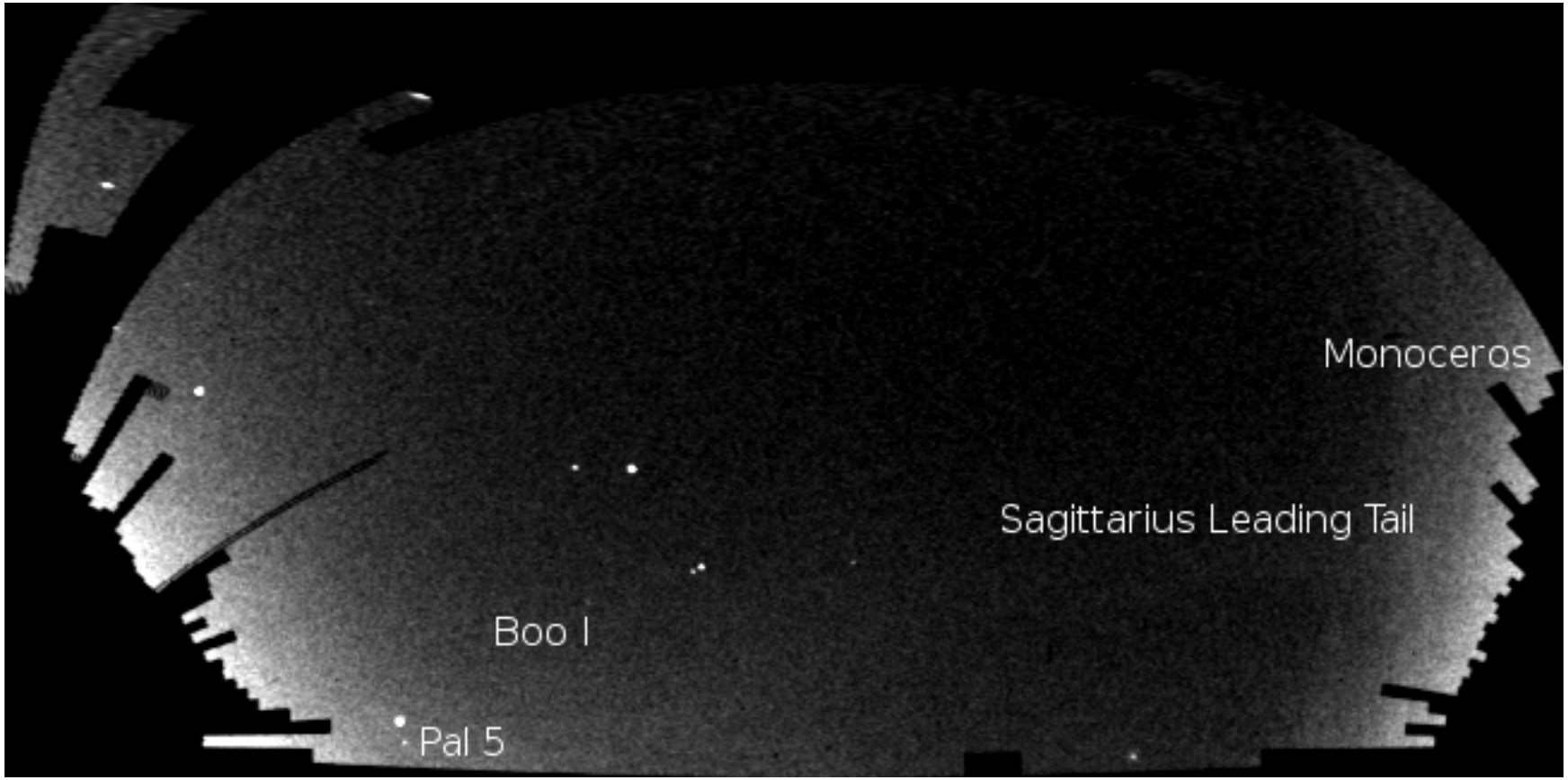


Segue-2 discovery paper : Belokurov etal arXiv: 0903.0818

This is the Gaia view – photometry only to g=20

``only'' photometry is still a powerful tool in Galactic structure

At low latitudes it will be much more complex



summary

- Getting full value from Gaia will take considerable organisation
- The observatory `system' is being reorganised, with Gaia science a driver – this is a valuable opportunity to negotiate Gaia needs with observatories and agencies
- Science will be possible soon after operation, with alerts – if you're ready
- There are aspects of high-priority science which can be delivered only with coordinated large-scale follow-up.

- This is a really great* opportunity for european science – if we get organised.

* sorry...