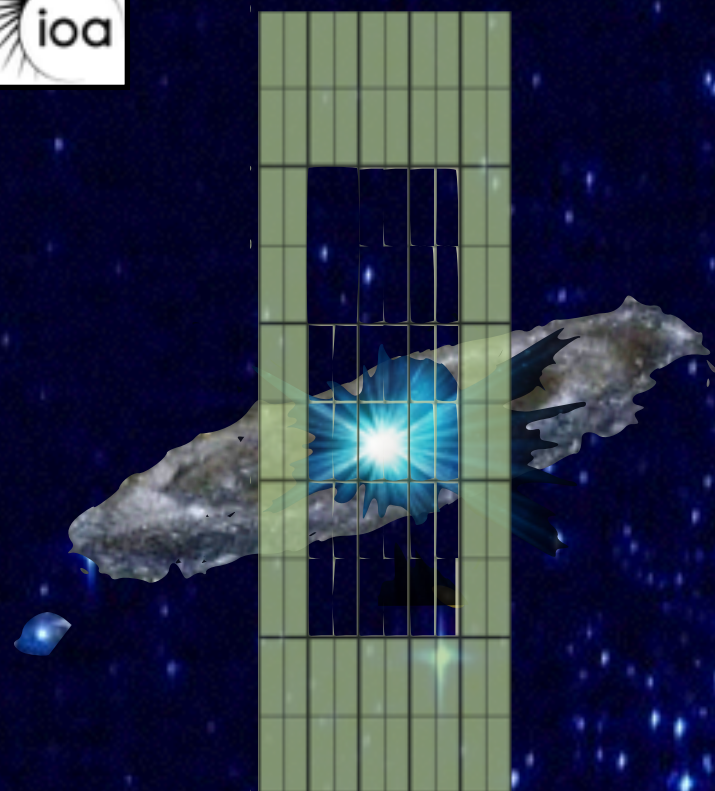
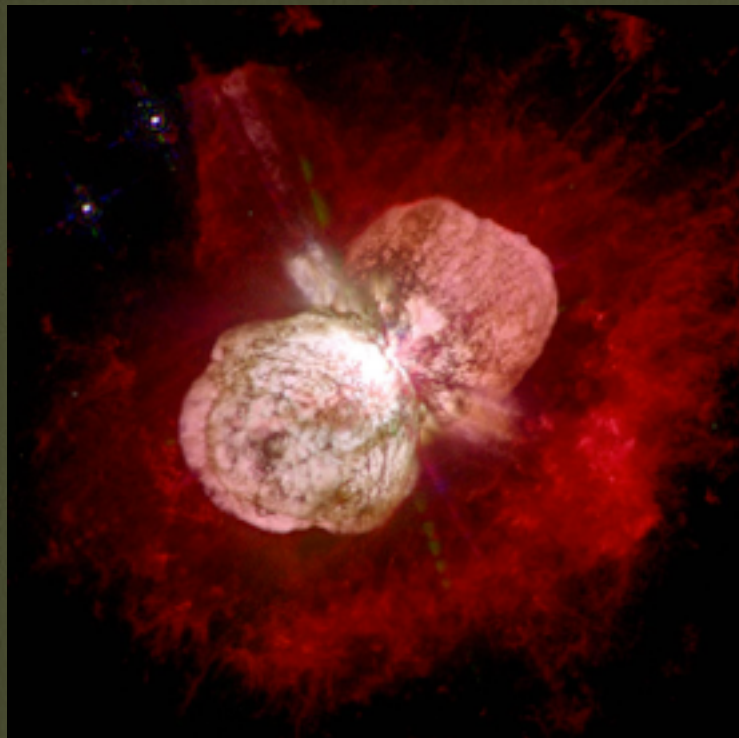


(Nuclear) Transient detection/characterisation with Gaia

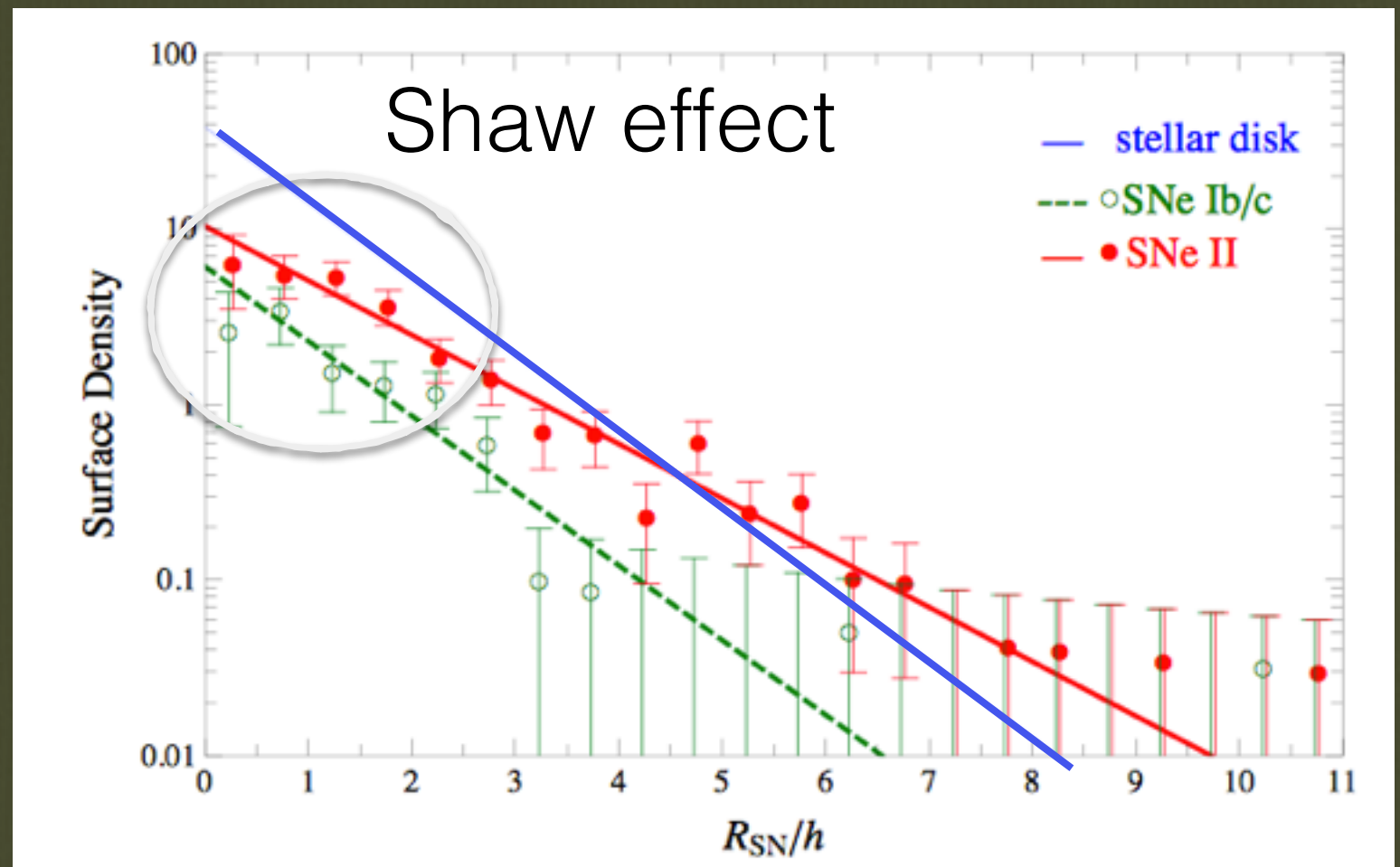
Gaia Science Alerts workshop, 11th November 2015

Nadejda Blagorodnova (Caltech)
& Gaia Science Alerts DPAC team



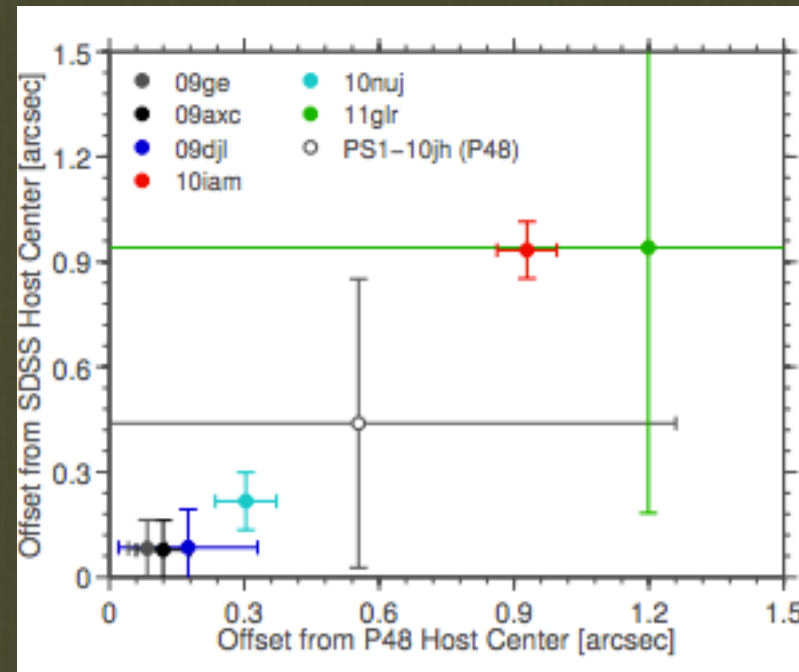
Nuclear Supernovae

- ☐ Lack of CCSN in central regions:
 - ☐ Different IMF?
 - ☐ Intrinsically fainter?
 - ☐ Dust?
 - ☐ Metallicity?
 - ☐ Bias in ground-based surveys?

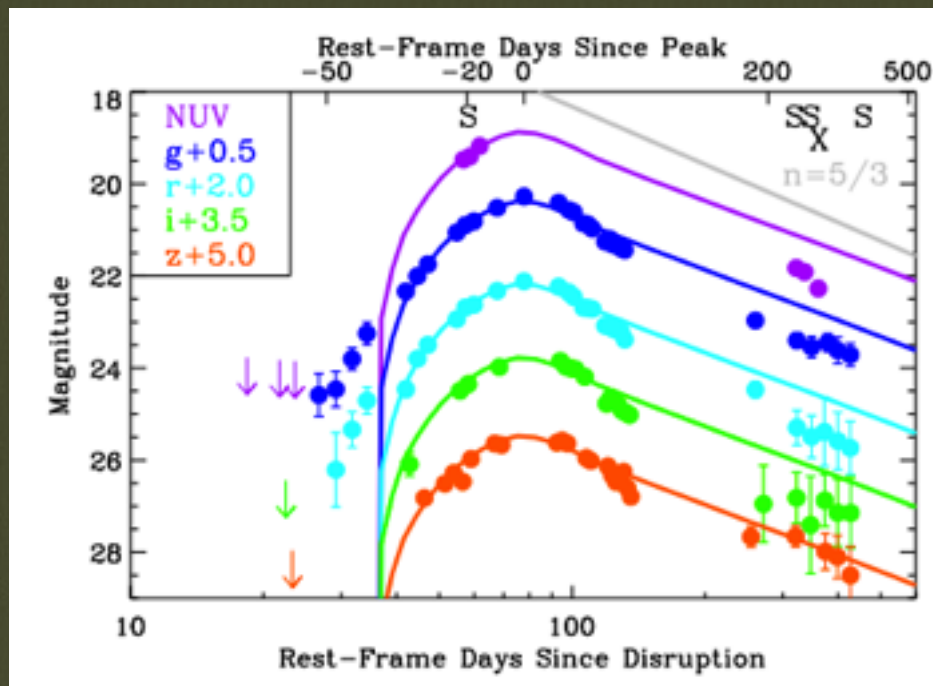


Hakobyan et. al, 2008

Tidal Disruption

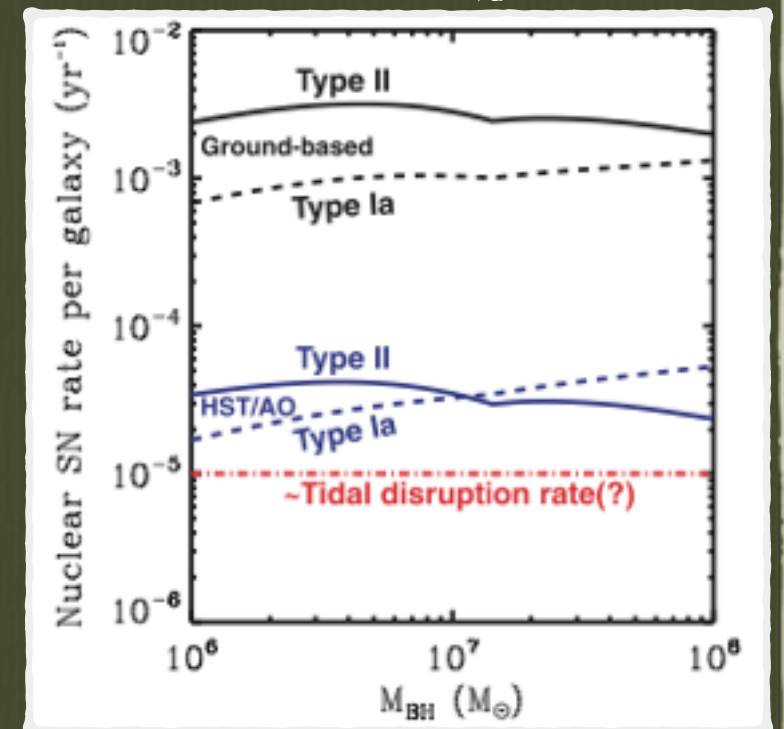


Arcavi et. al., 2014



Gezari et. al., 2012

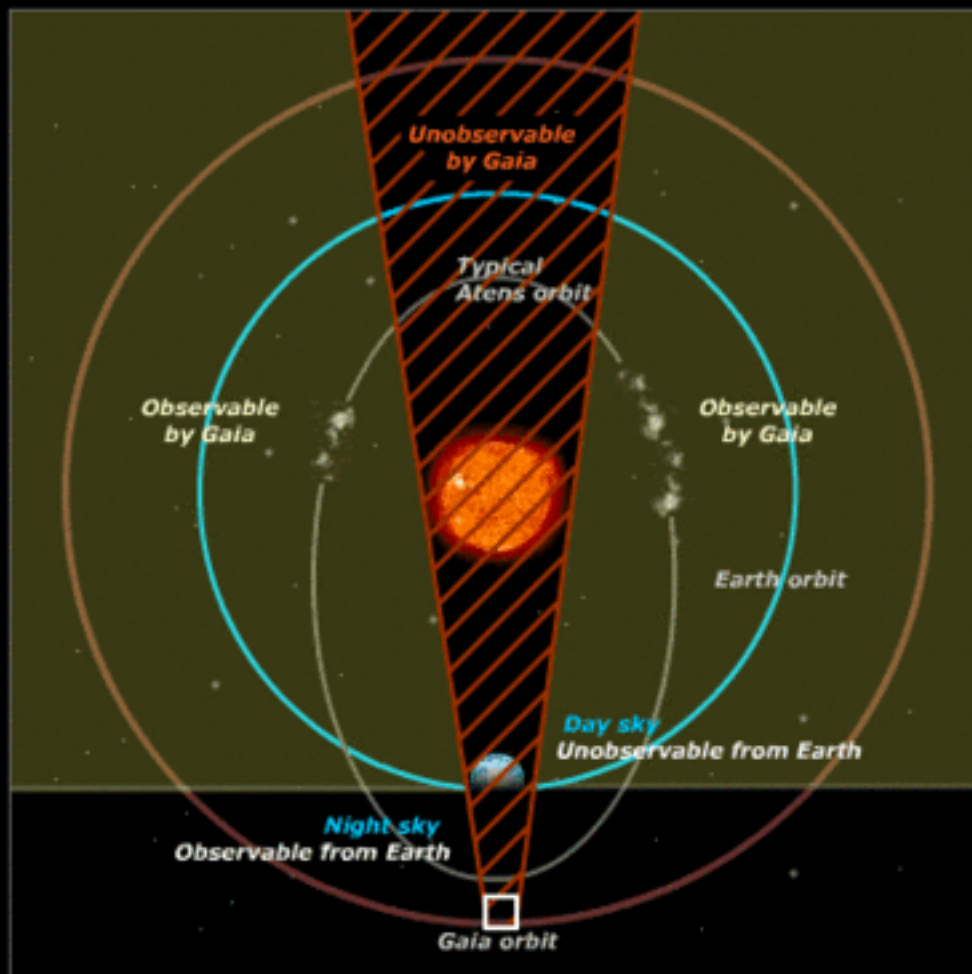
Strubbe and Quataert, 2012



- ☐ SMBH population for non-active galaxies: mass, spin
- ☐ Accretion disk geometry in SMBH

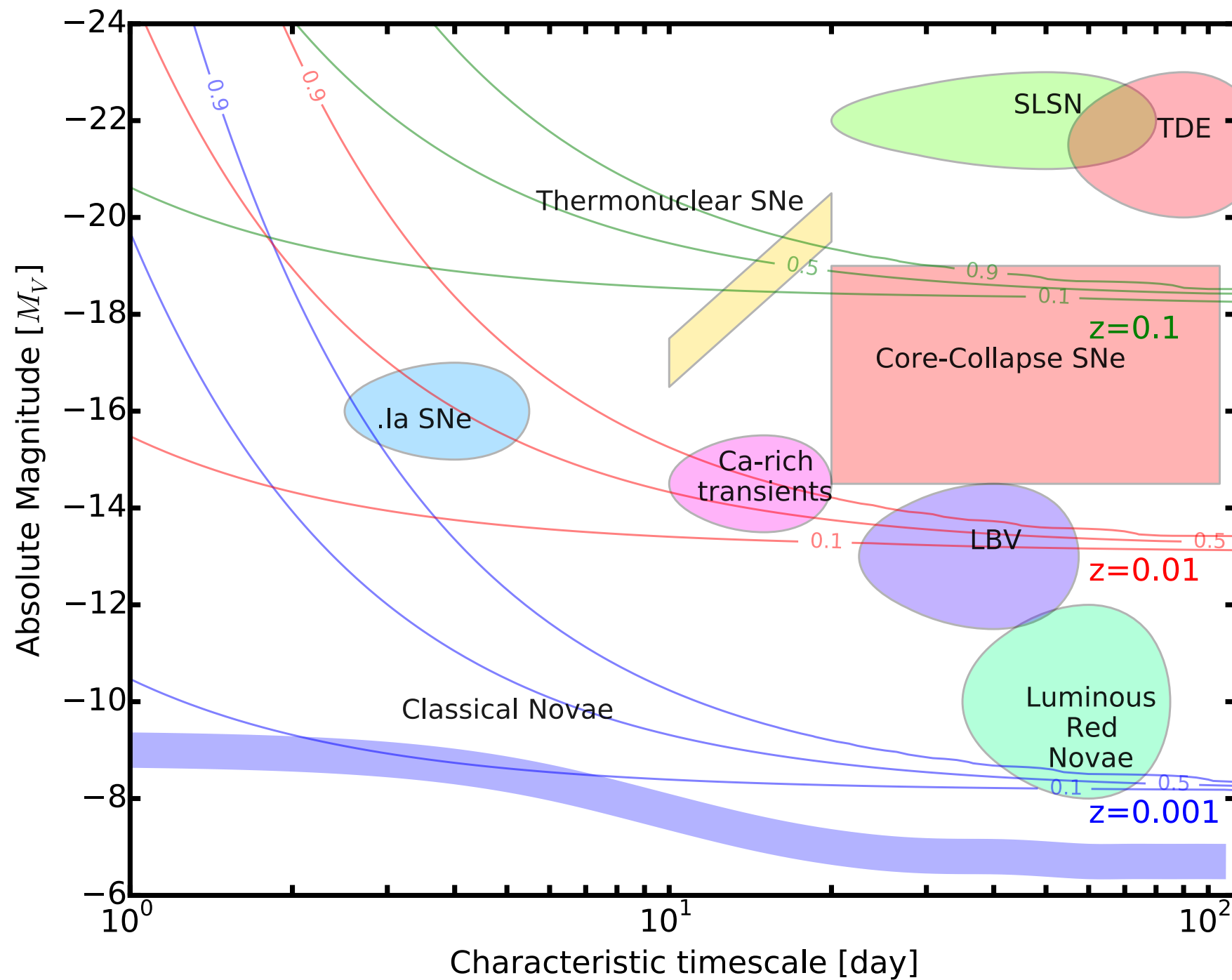
Sun

Earth



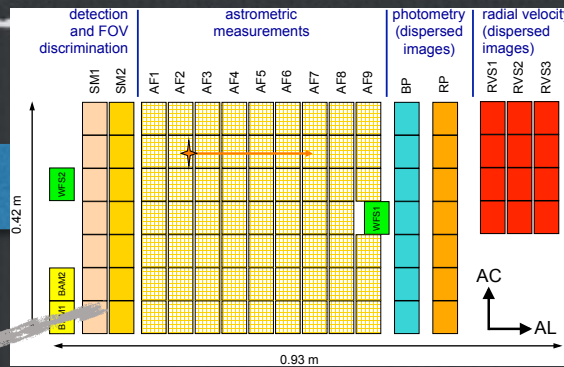
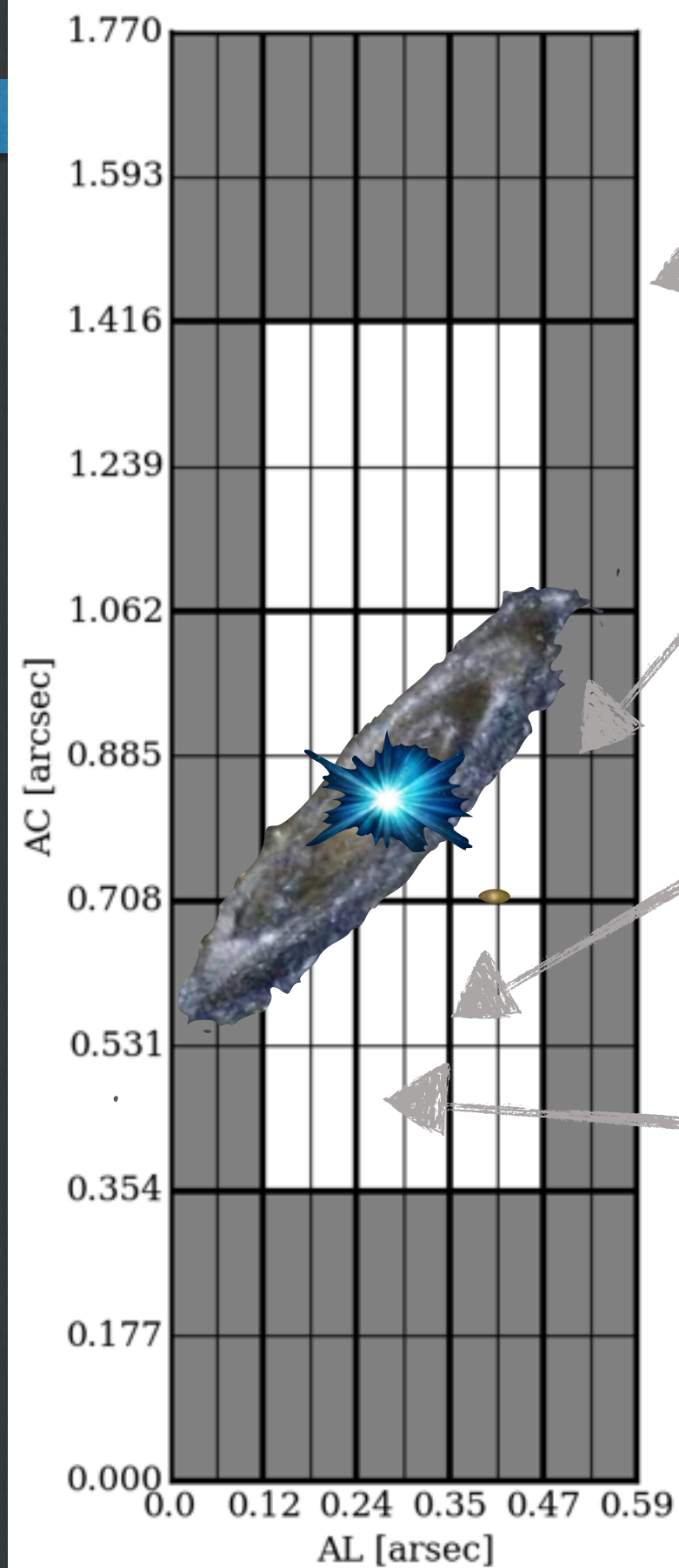
L2

Gaia parameter space



Limiting mag:
20.5mag
Cadence:
~35d

Original diagram in Kasliwal et. al, 2011



Background estimation:

- 5th lowest value of 16 samples

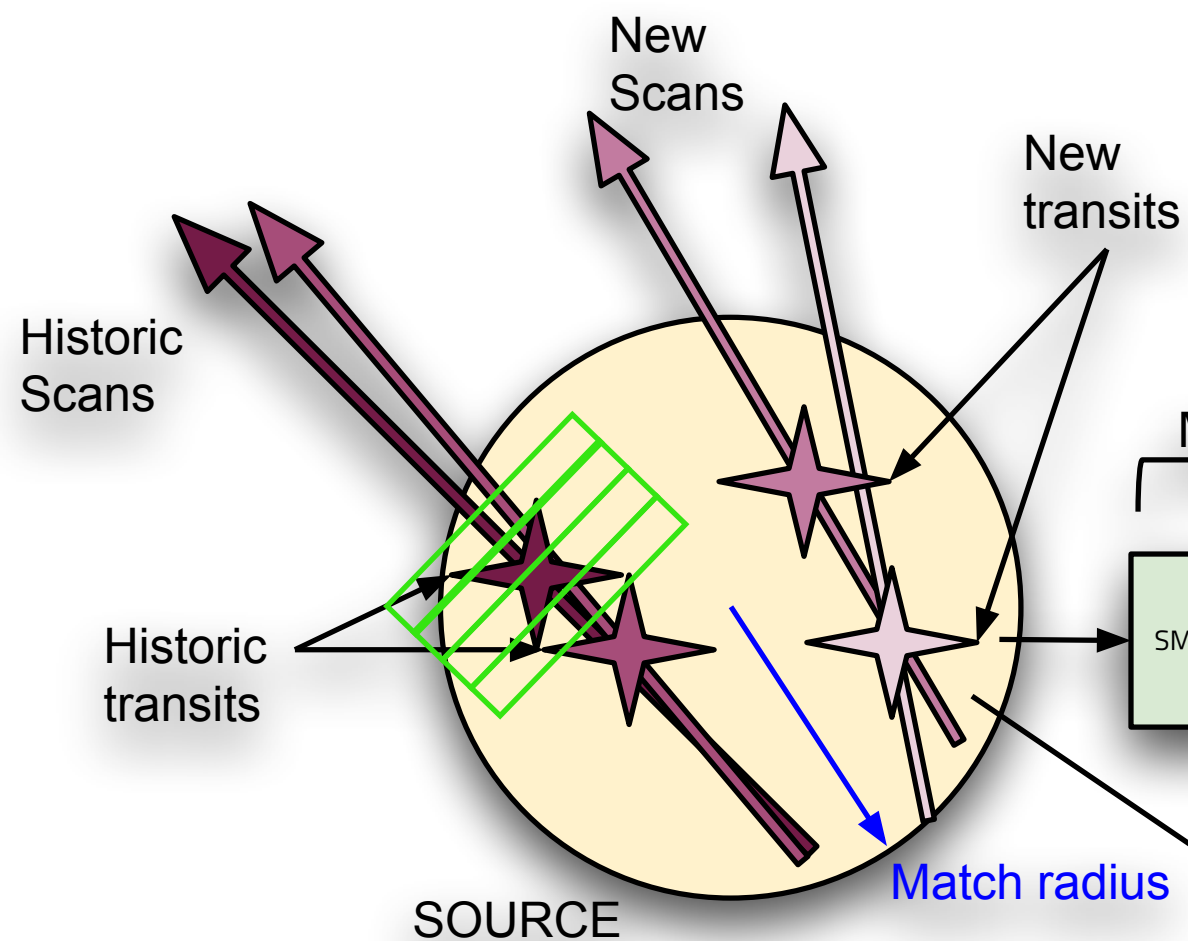
Flux estimation:

- Central 3x3 - background

Source detection:

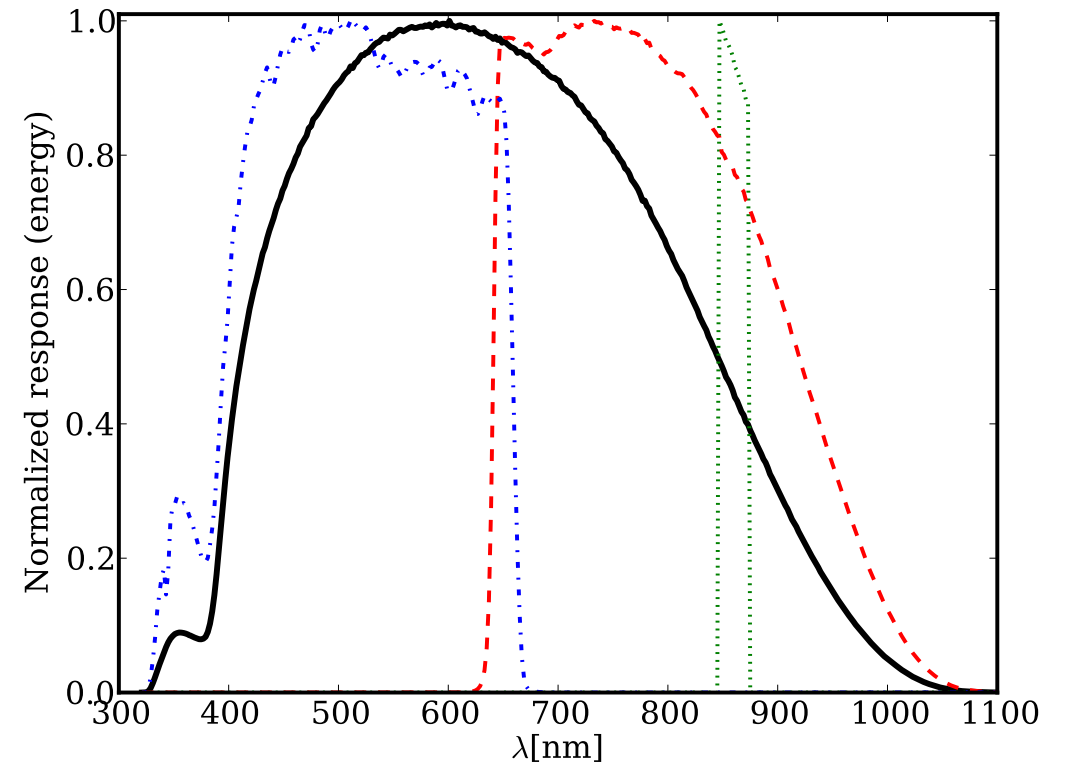
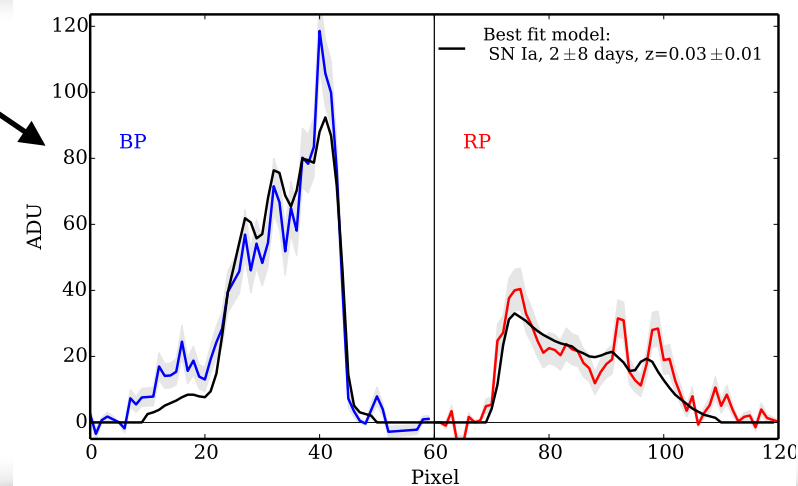
- Flux
- Geometry 3x3 window

The catalogue...



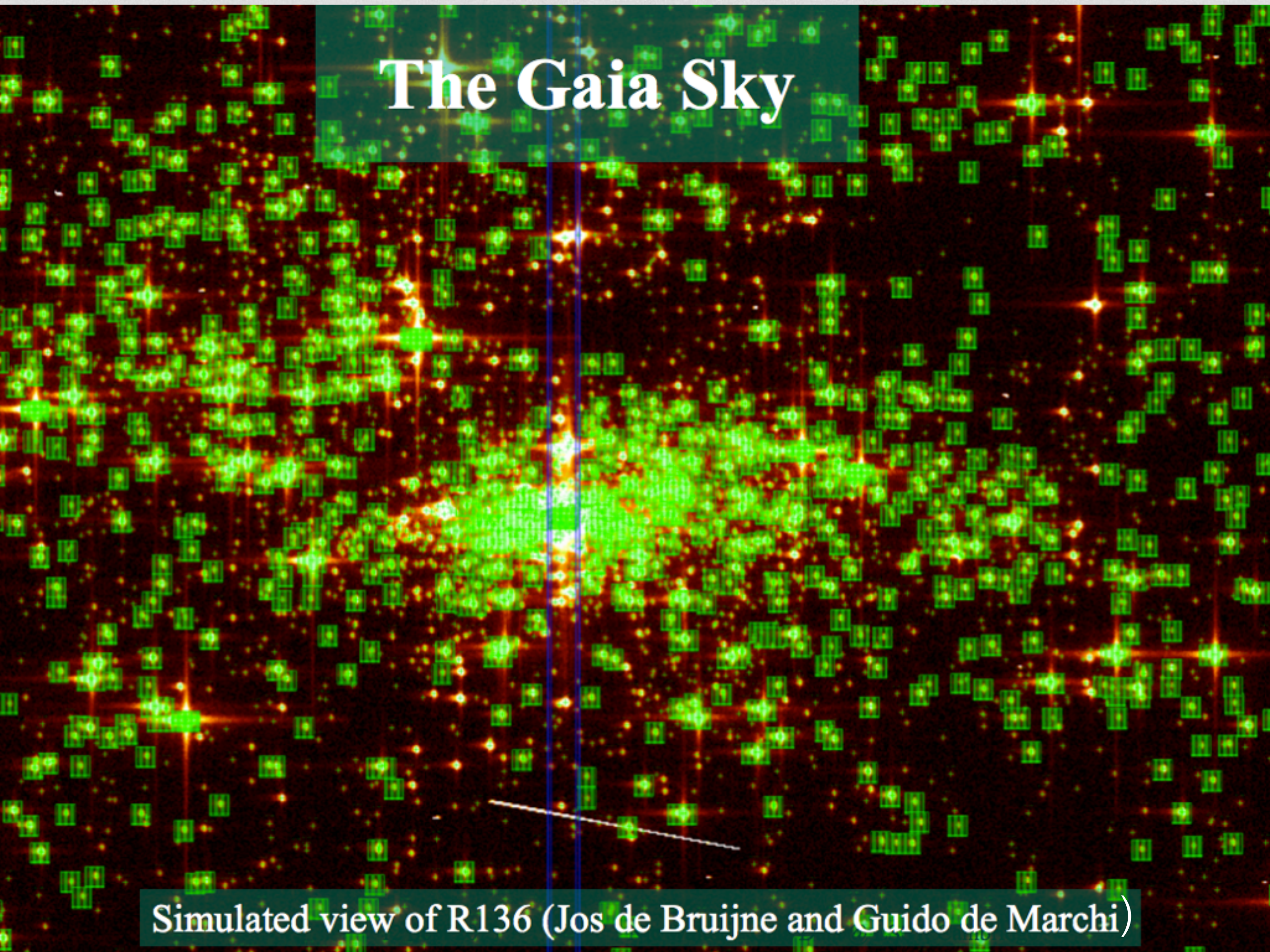
Measurements for each transit

SM	AF 1	AF 2	AF 3	AF 4	AF 5	AF 6	AF 7	AF 8	AF 9
----	------	------	------	------	------	------	------	------	------



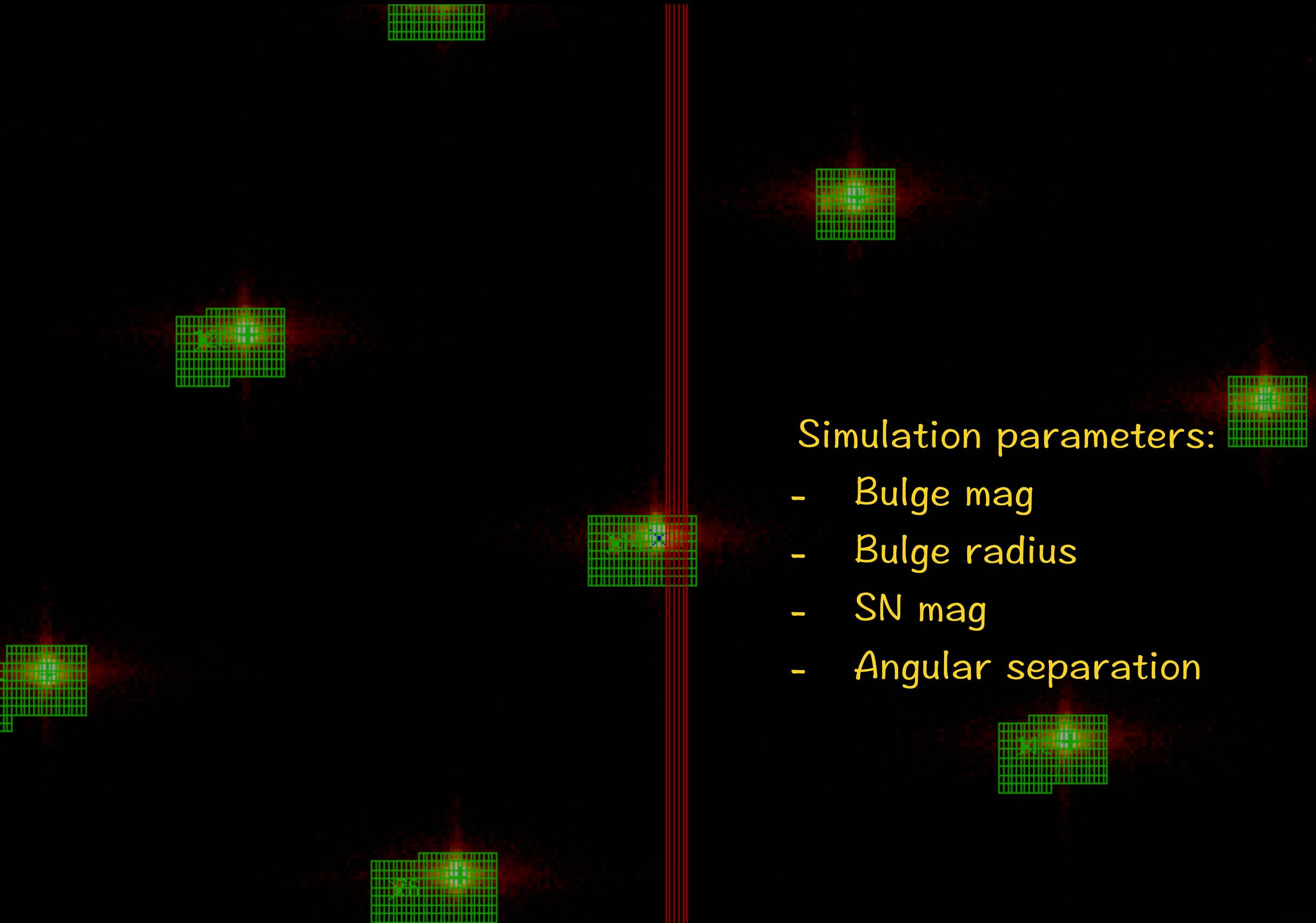
50M
day⁻¹

The Gaia Sky

The image is a simulated view of the Gaia Sky, showing a vast field of stars. Each star is represented by a small, bright, multi-colored point of light. Surrounding each star is a green rectangular box, which likely represents the Gaia's field of view or a specific data region. The stars are densely packed in the center and become sparser towards the edges. A bright, glowing region is visible in the center, suggesting a high concentration of stars or a specific astronomical feature. The overall color palette is dominated by the green of the boxes and the multi-colored (yellow, orange, red, blue) of the stars, set against a dark background.

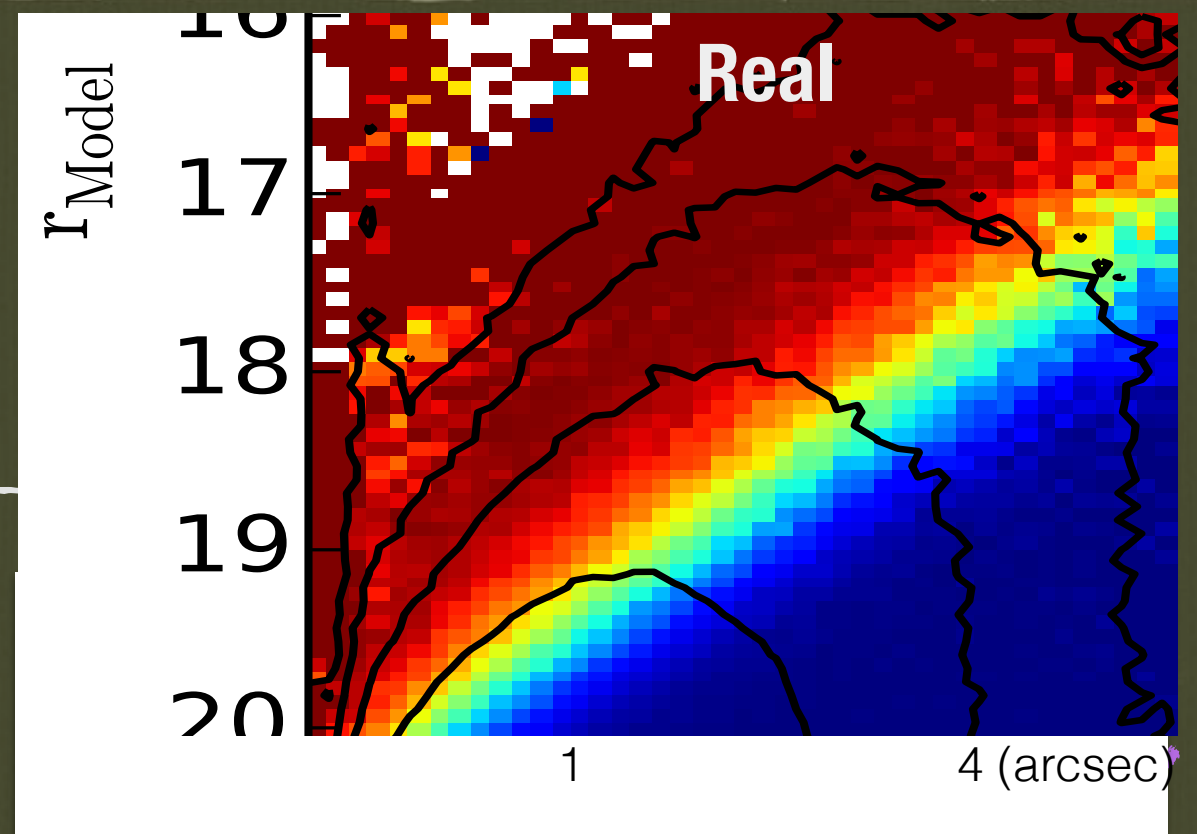
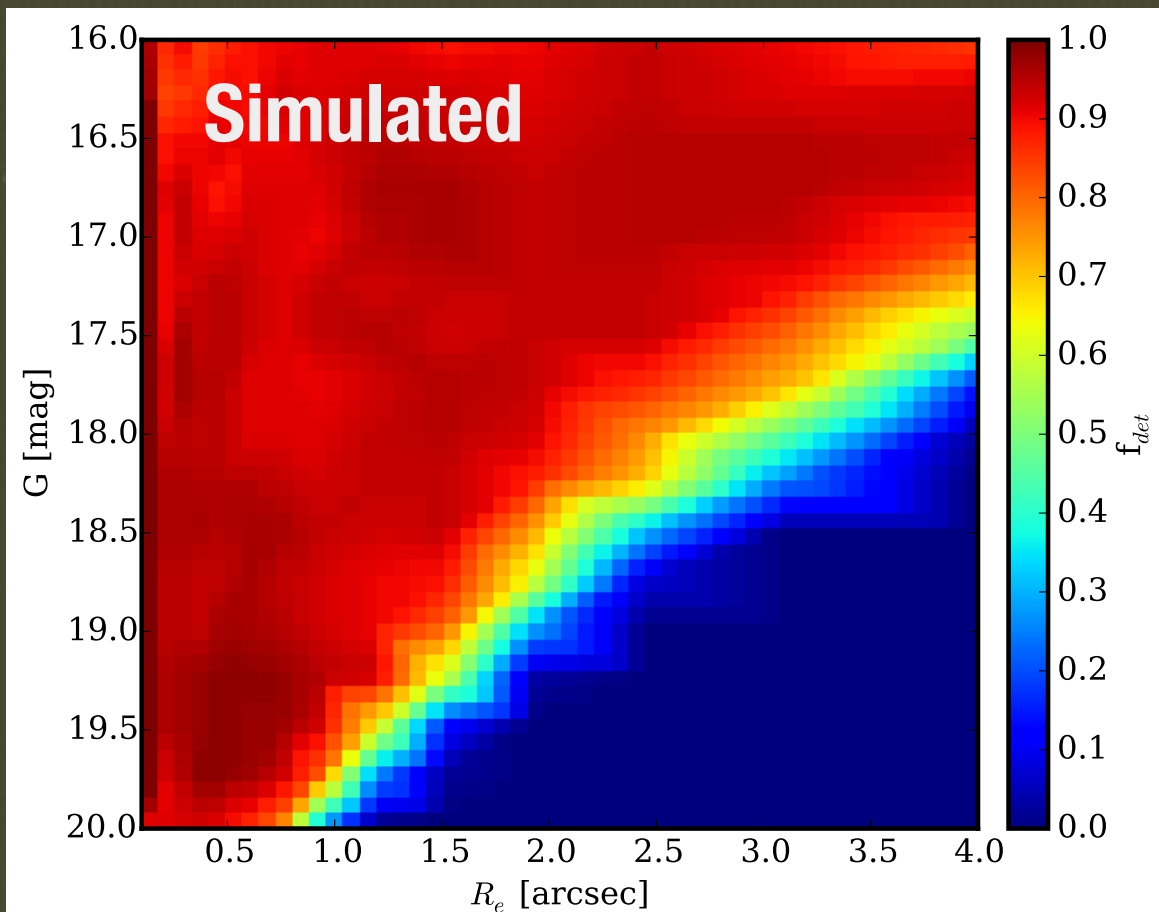
Simulated view of R136 (Jos de Bruijne and Guido de Marchi)

GIBIS: Gaia Instrument and Basic Image Simulator



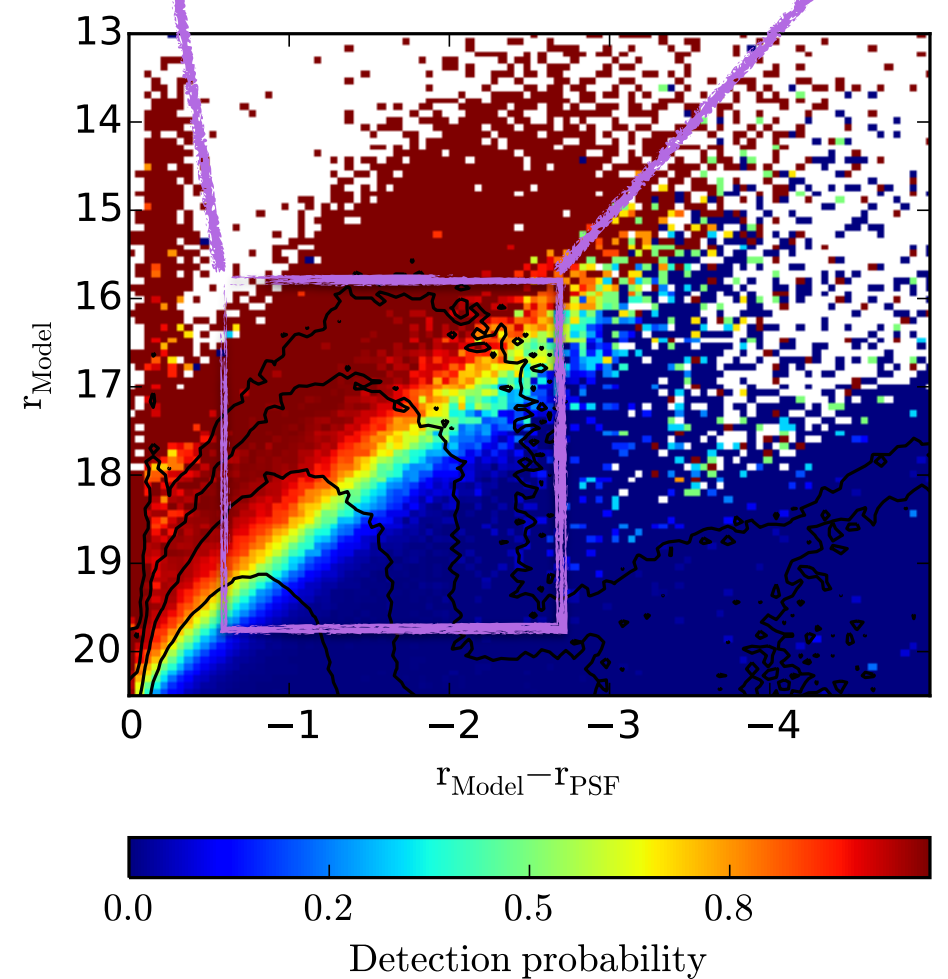
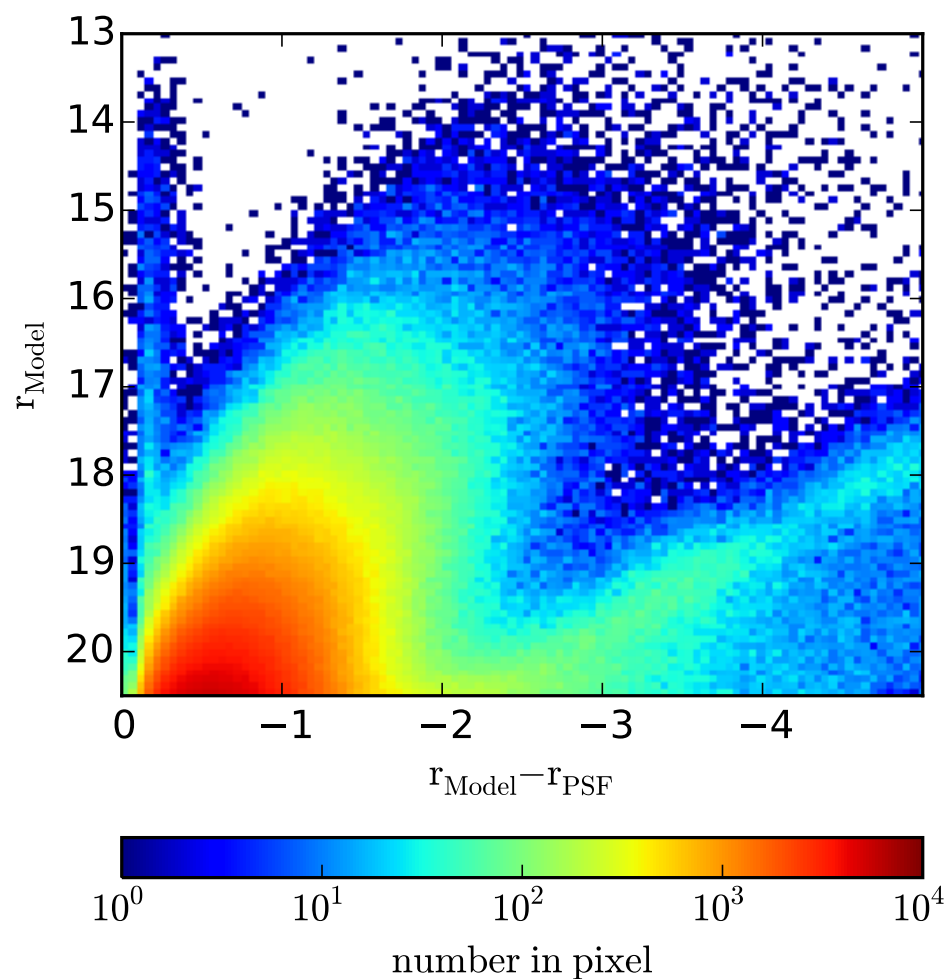
Simulation parameters:

- Bulge mag
- Bulge radius
- SN mag
- Angular separation

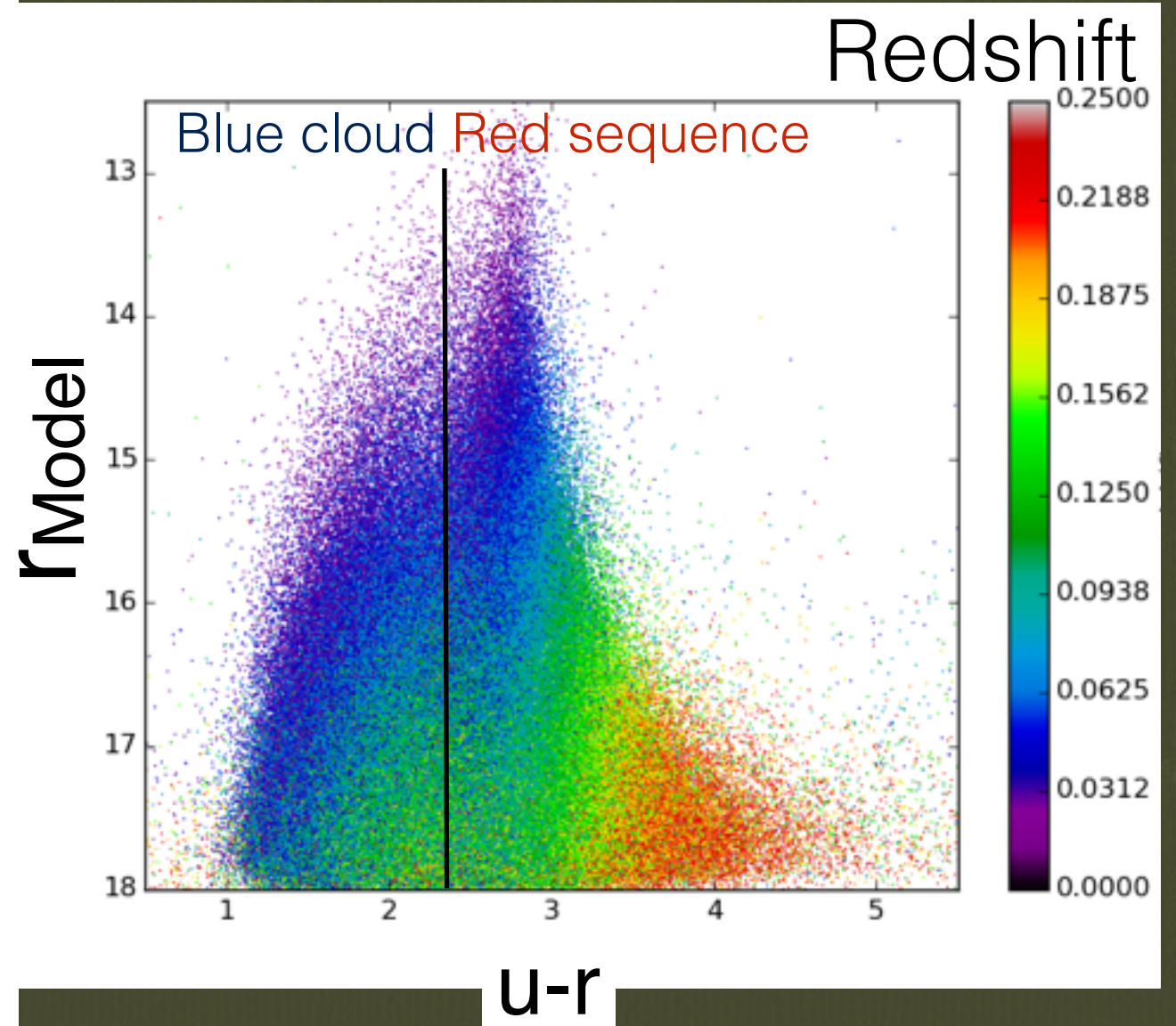
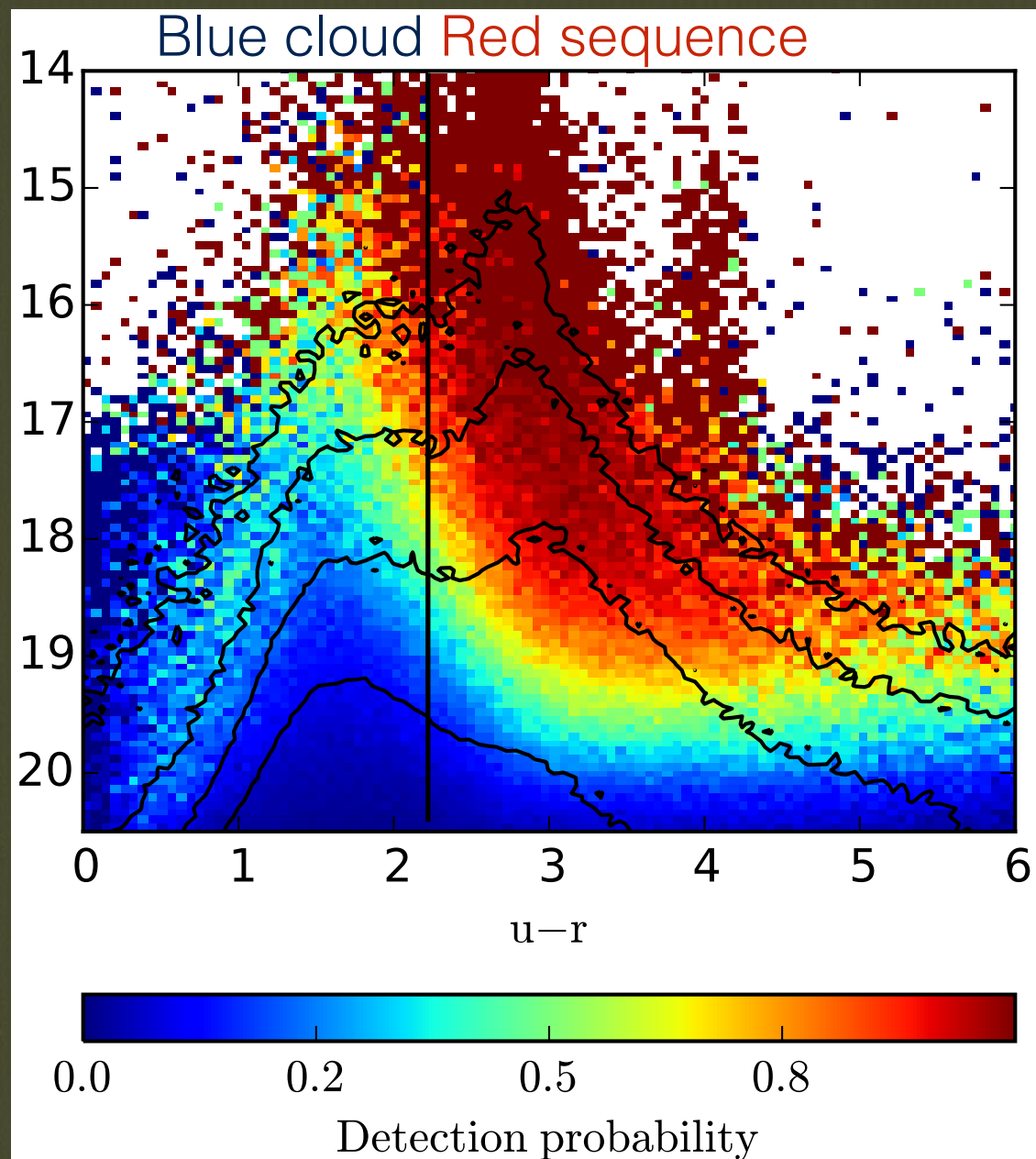


**1.3M from
SDSS
mag < 20**

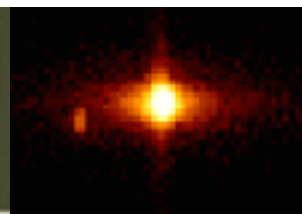
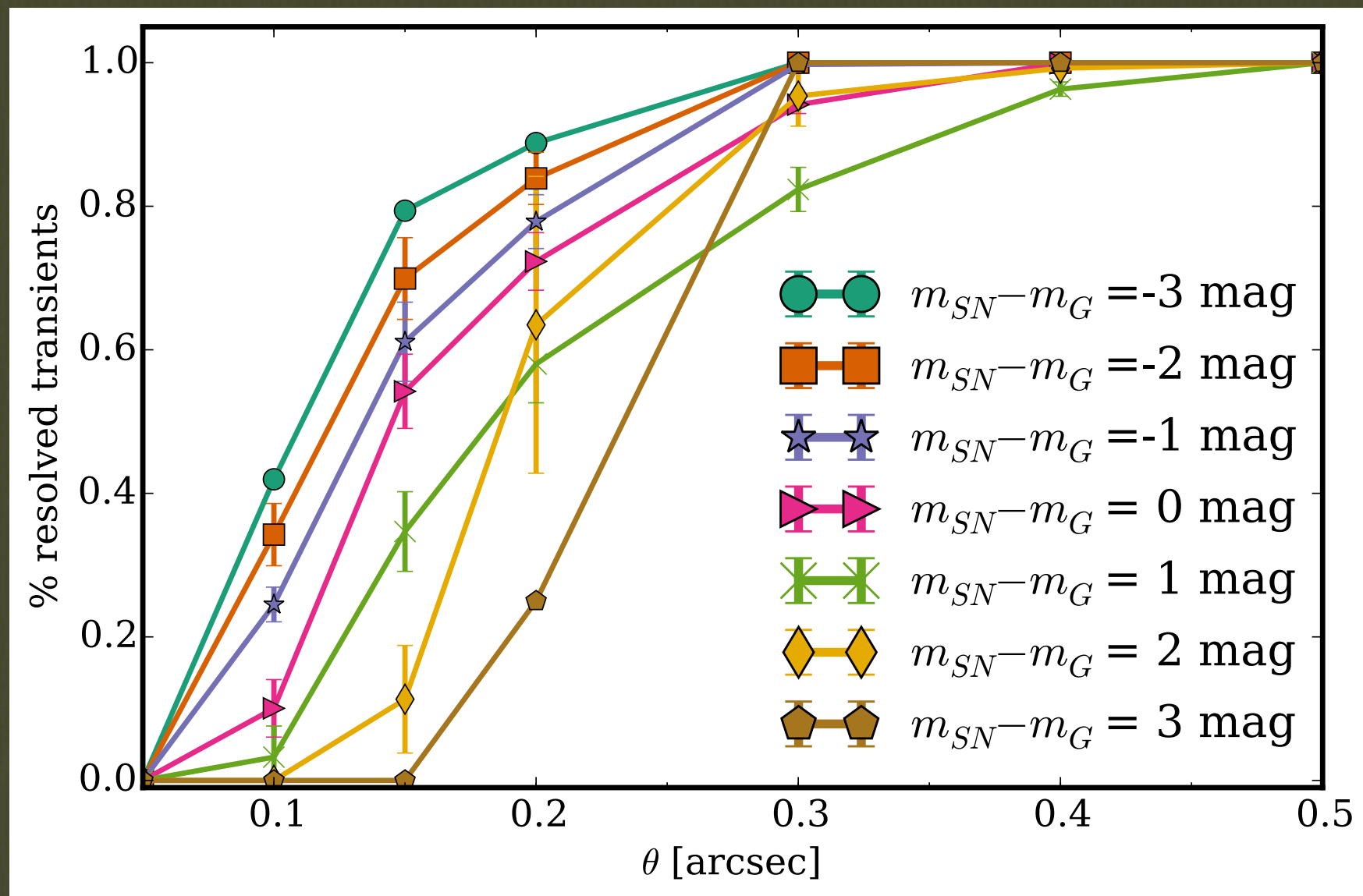
**~25%
galaxies
detected**

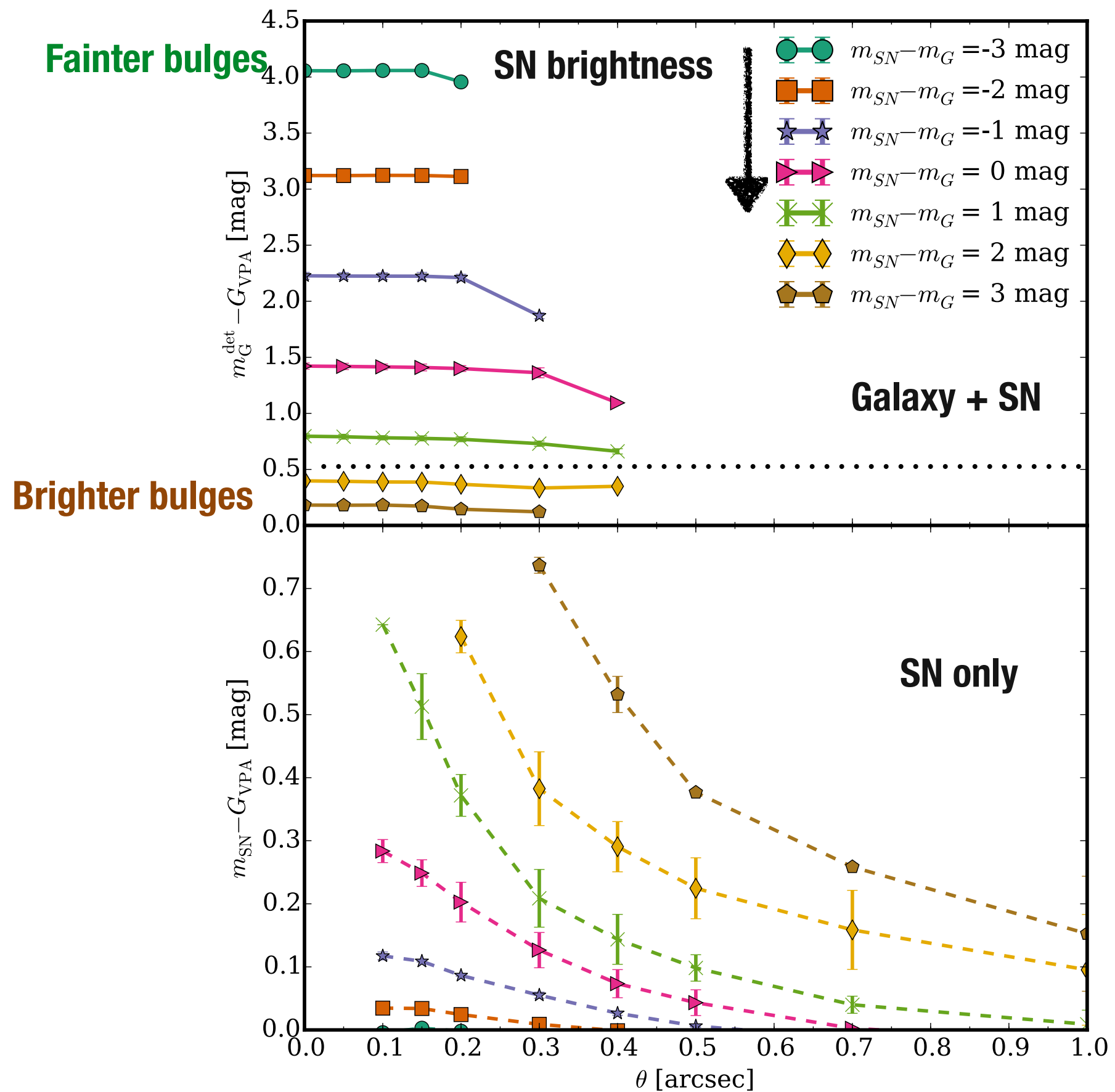


What galaxies are detected?

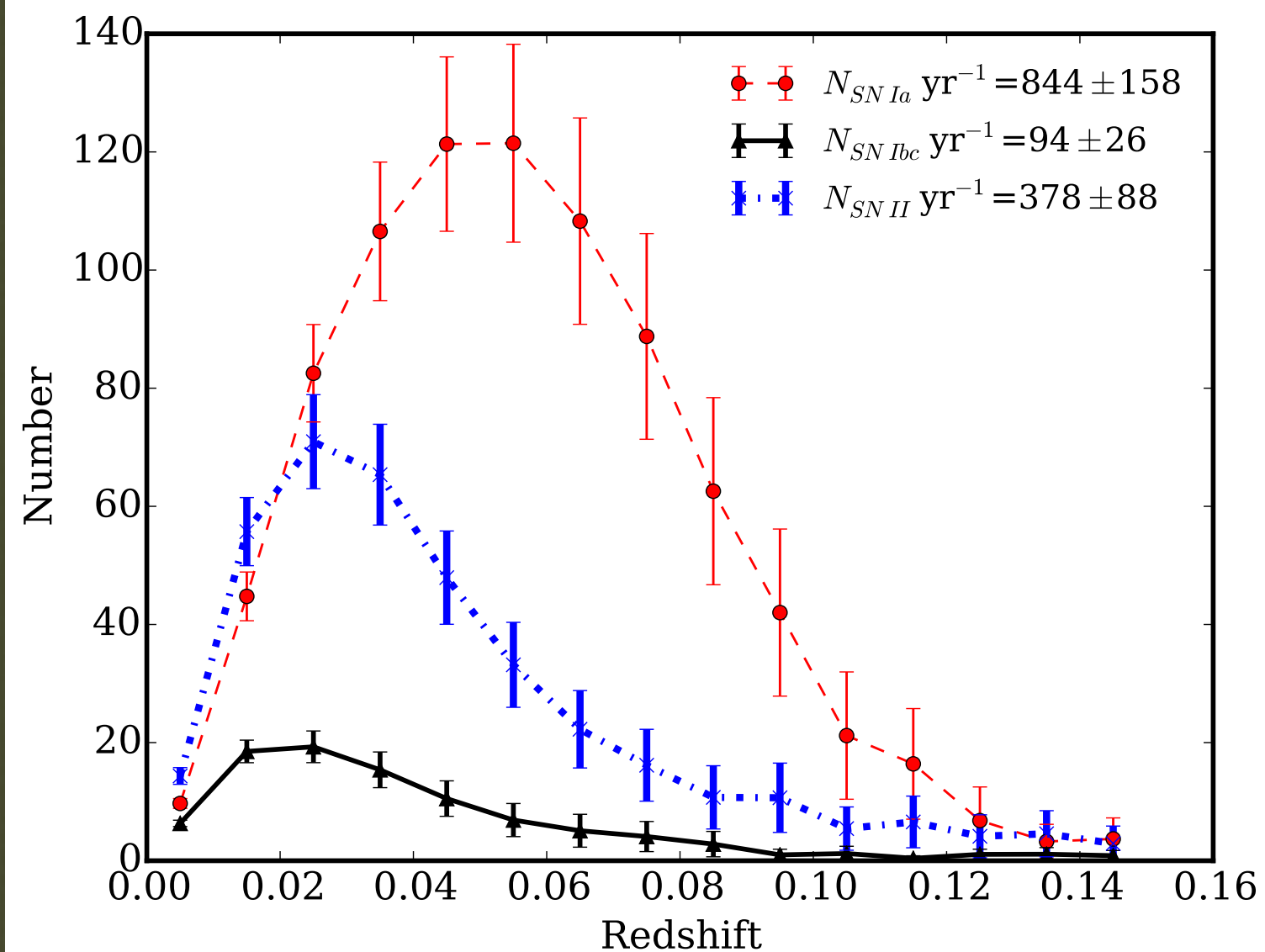


% resolved in function of magnitude difference bulge-SN





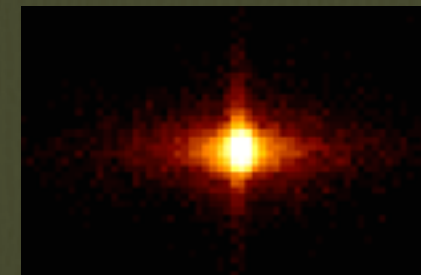
Expected number of SNe. Limiting Magnitude=19



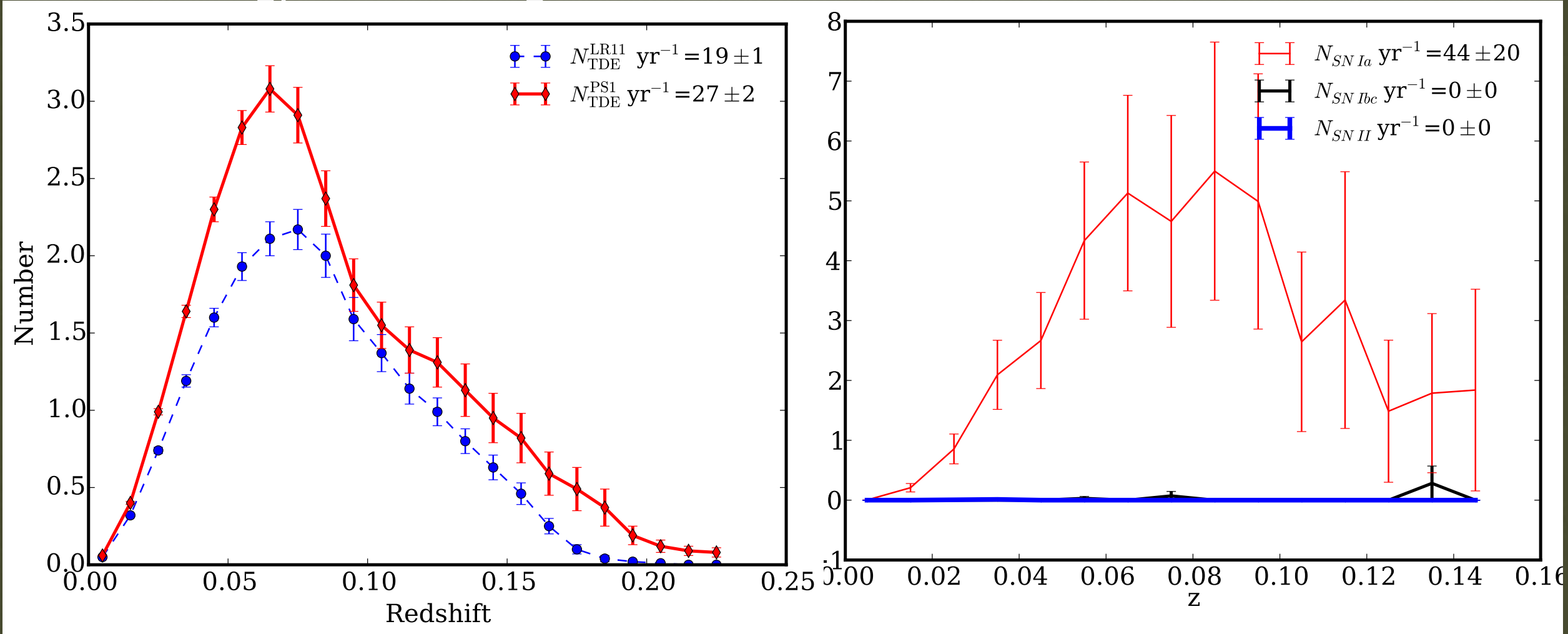
Orphan in Gaia:

75% SN Ia
90% CCSN

TDE vs. SN - nuclear case

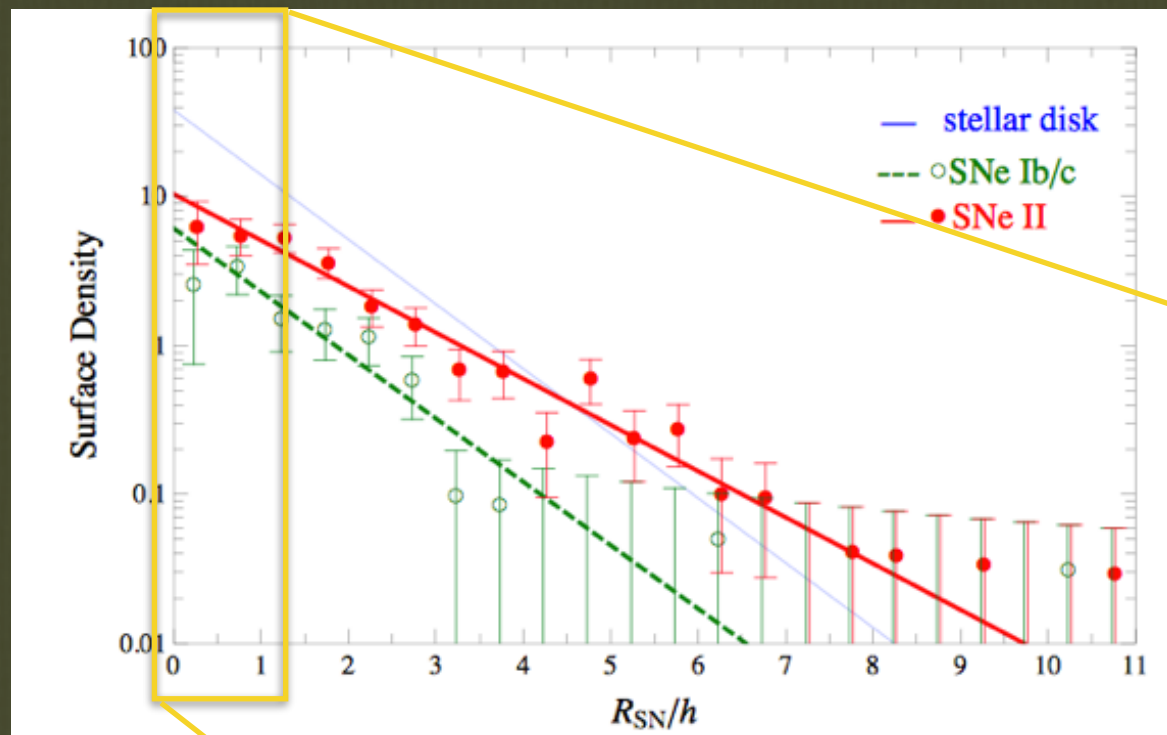


$m_{\text{lim}} = 19\text{mag}, \Delta m = 0.5\text{mag}$



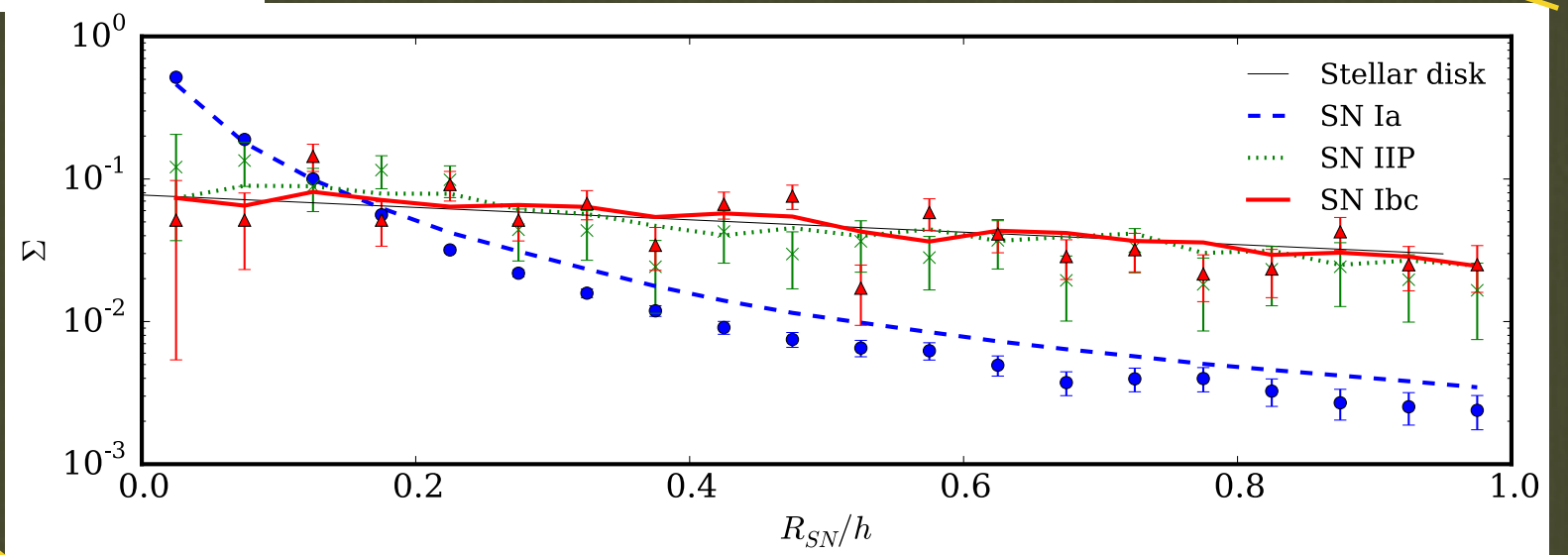
Detected TDE ~ Detected unresolved SN
 -> Low contamination!

SN density distribution



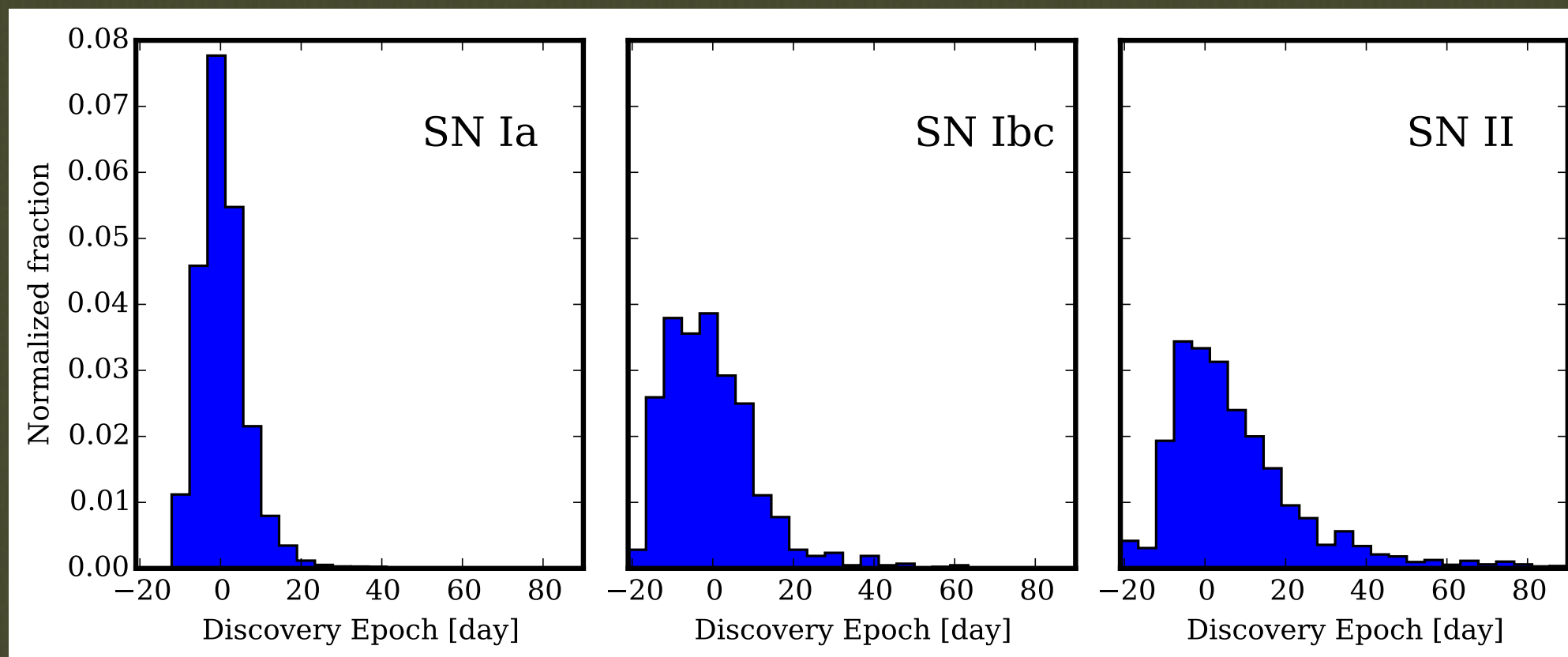
Hakobyan et. al, 2008

No noticeable decrease
in the number of detections
close to nucleus



Blagorodnova et. al. 2015

SN epoch at discovery

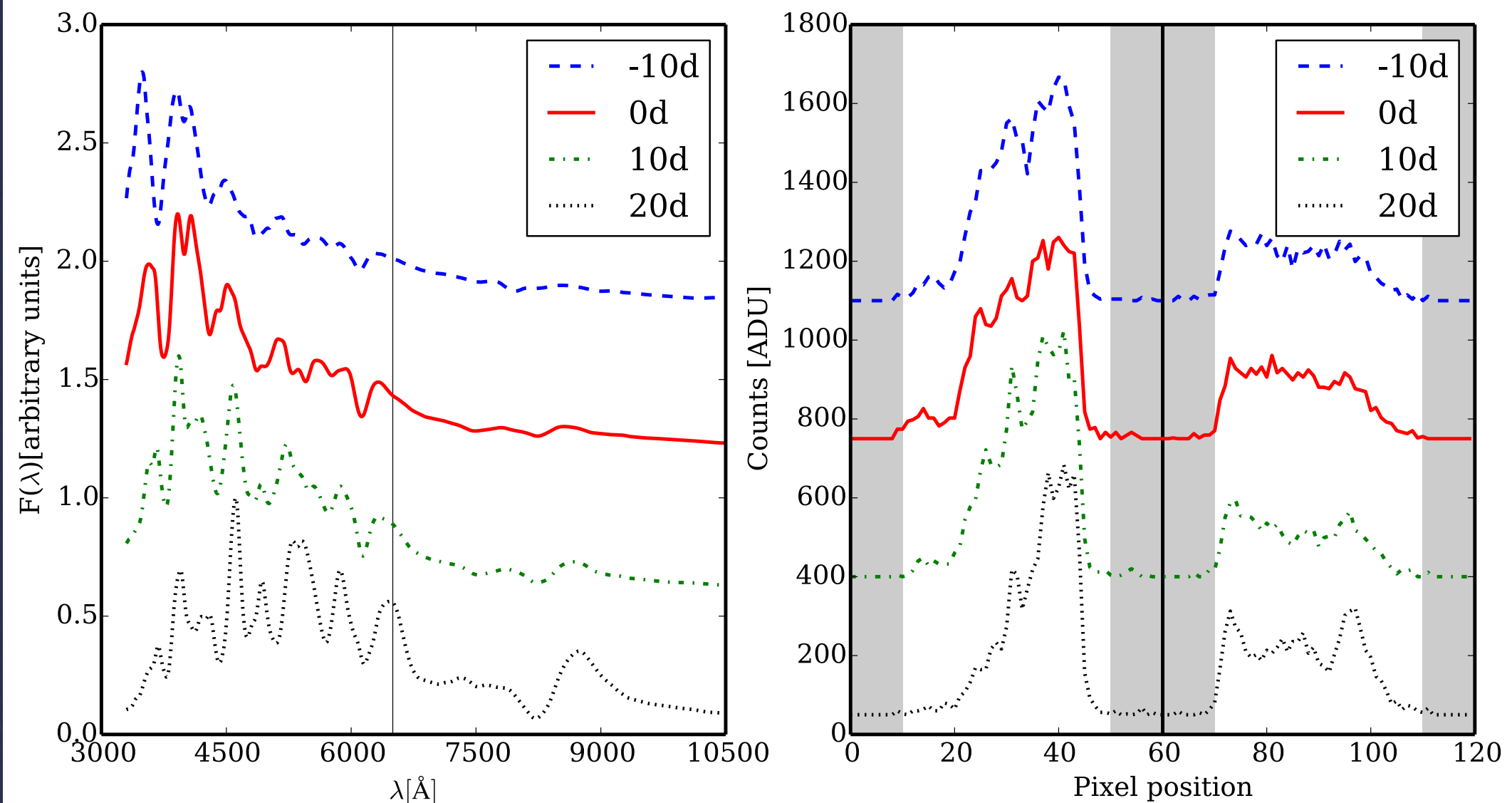


**Existing low resolution
spectra for classification!**

Gaia Transient Classification

Blue

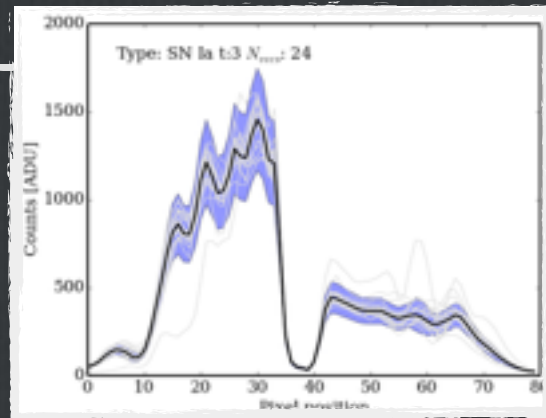
Red



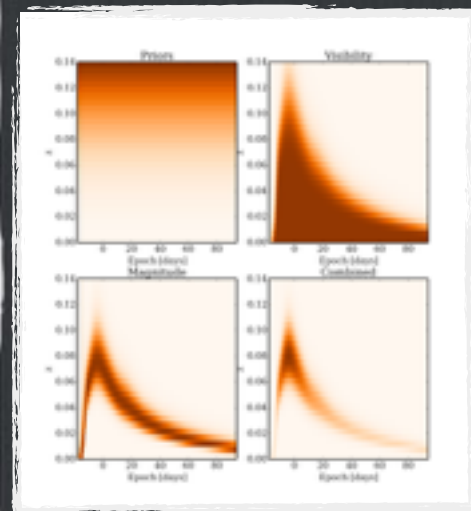
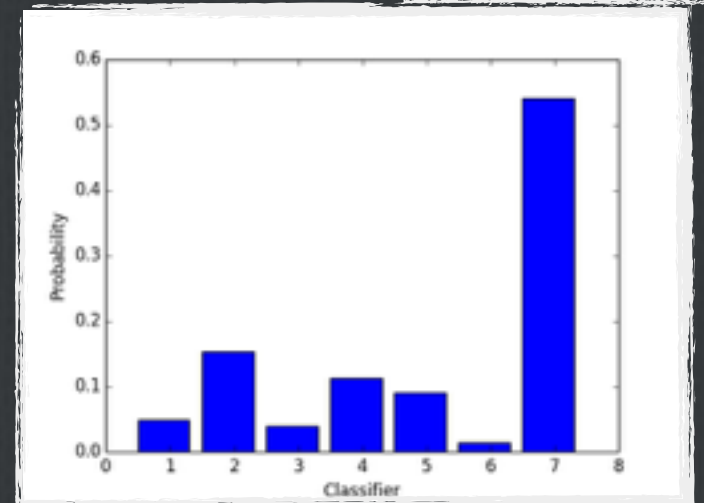
SN Ia templates from Hsiao et. al 2007

GSTEC-Gaia Spectrophotometry Transient Event Classifier

P(type)



Spectral libraries

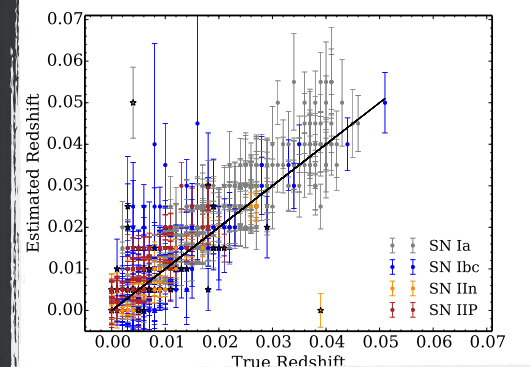


Priors

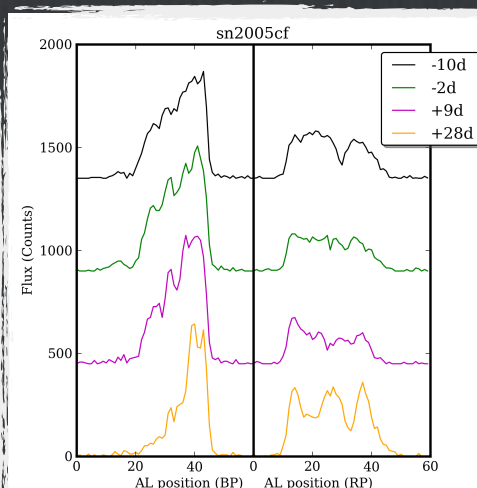
GS-TEC

$$P(M|D, m_G, v) = \frac{P(D, m_G, v|M)P(M)}{\int P(D, m_G, v|M)P(M)dM}$$

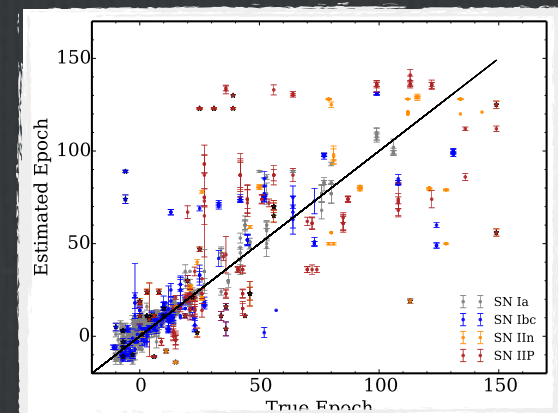
z



**Input
spectra**

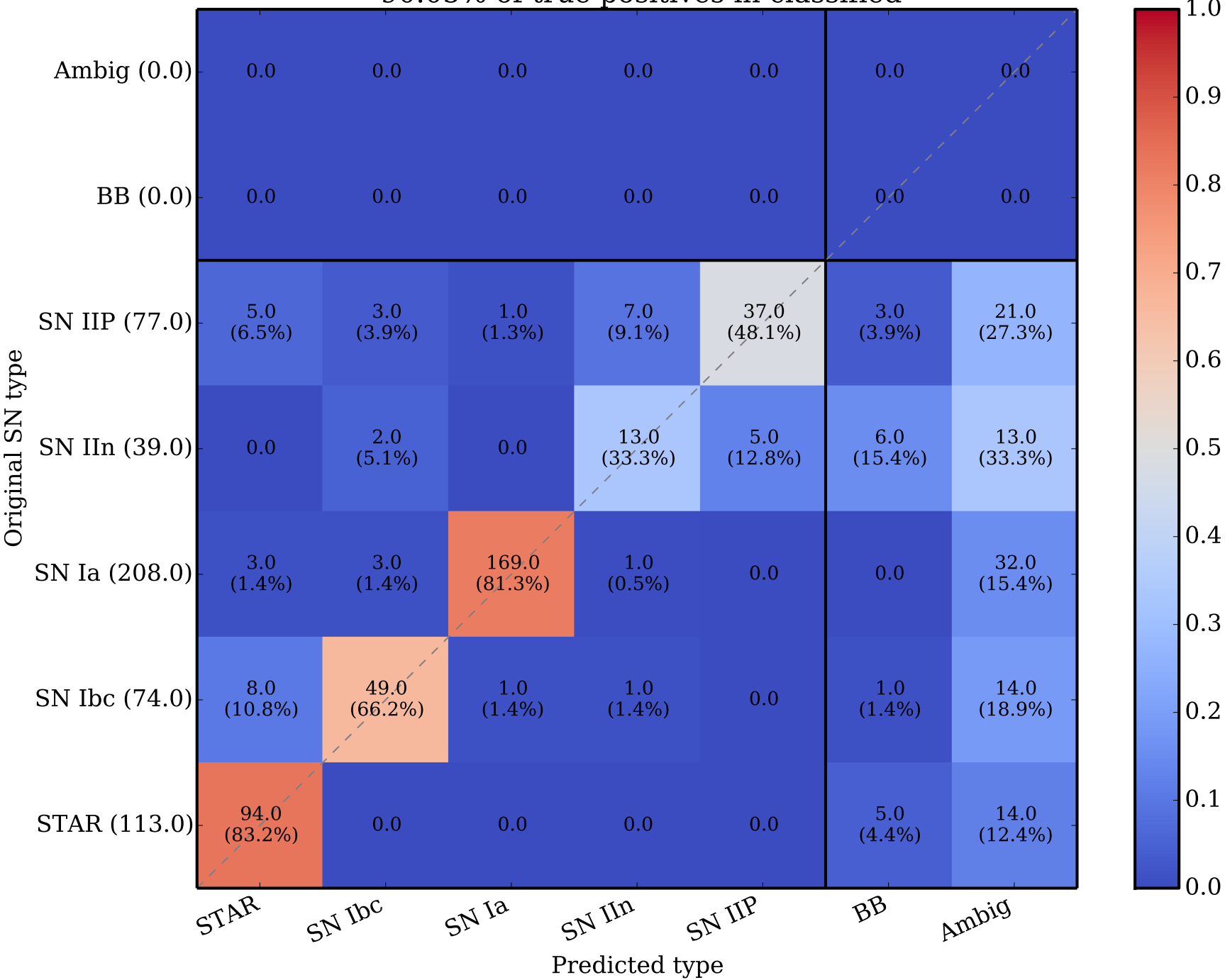


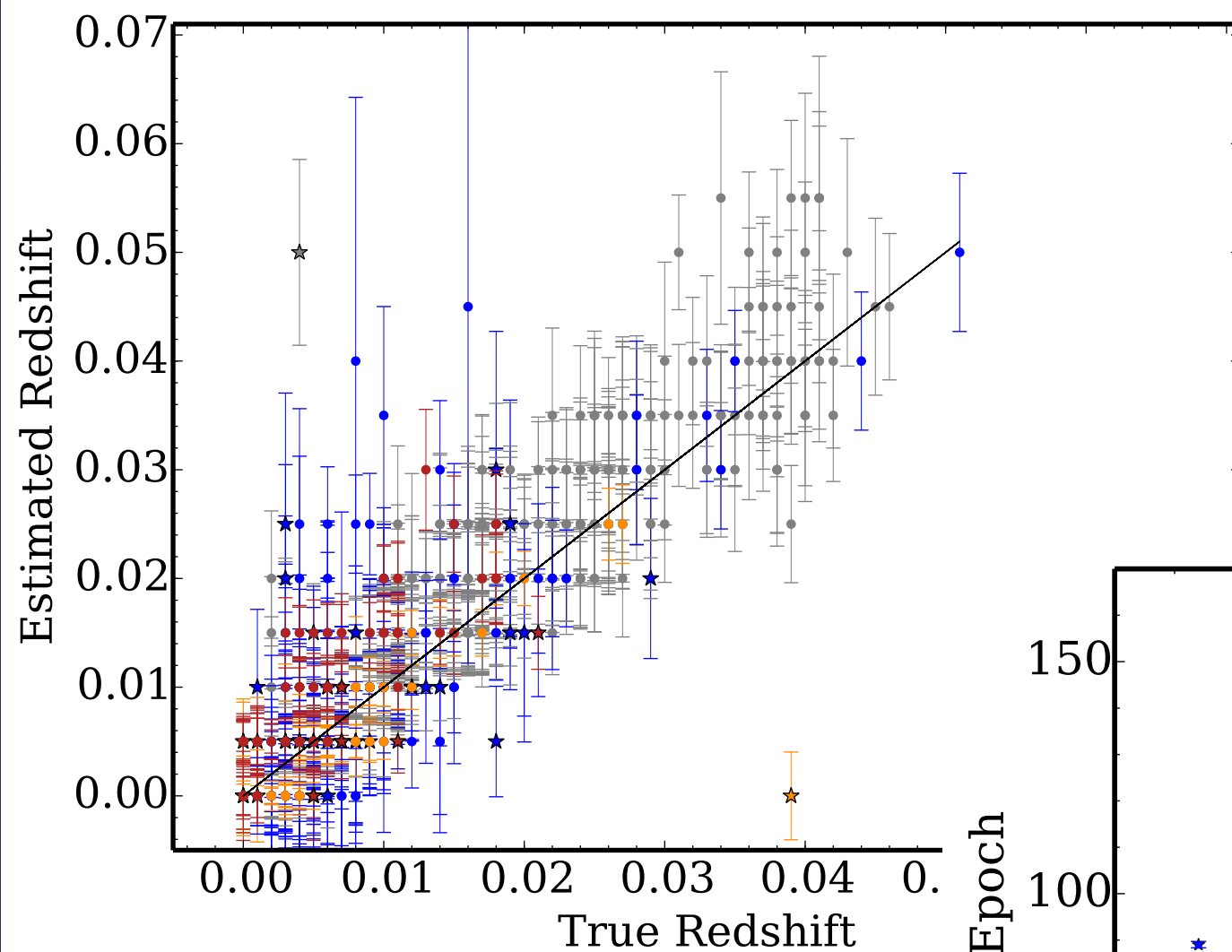
Blagorodnova et. al. 2014



epoch

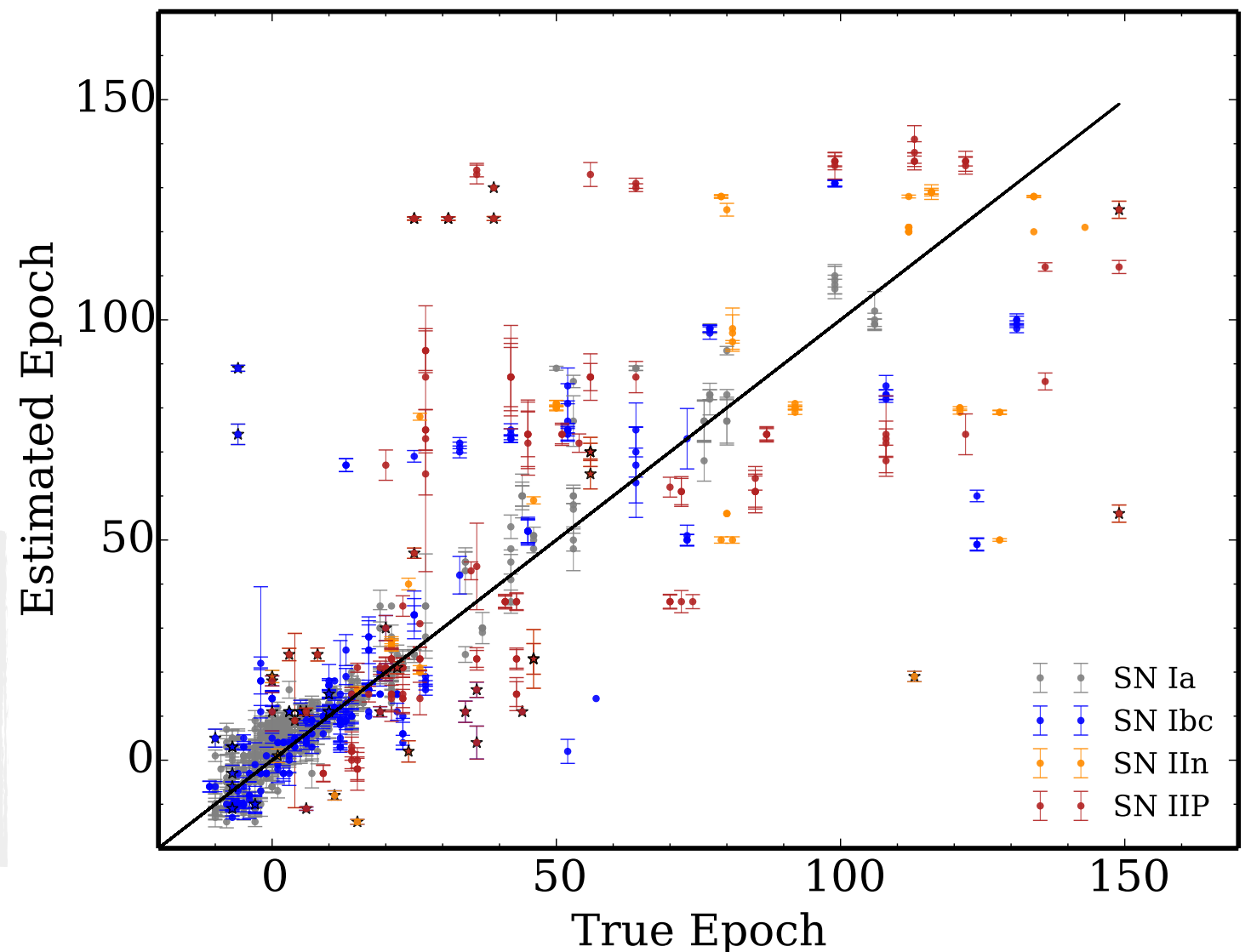
Confusion Matrix for G=18mag.
21.33% unclassified (BB or Ambig)
90.05% of true positives in classified





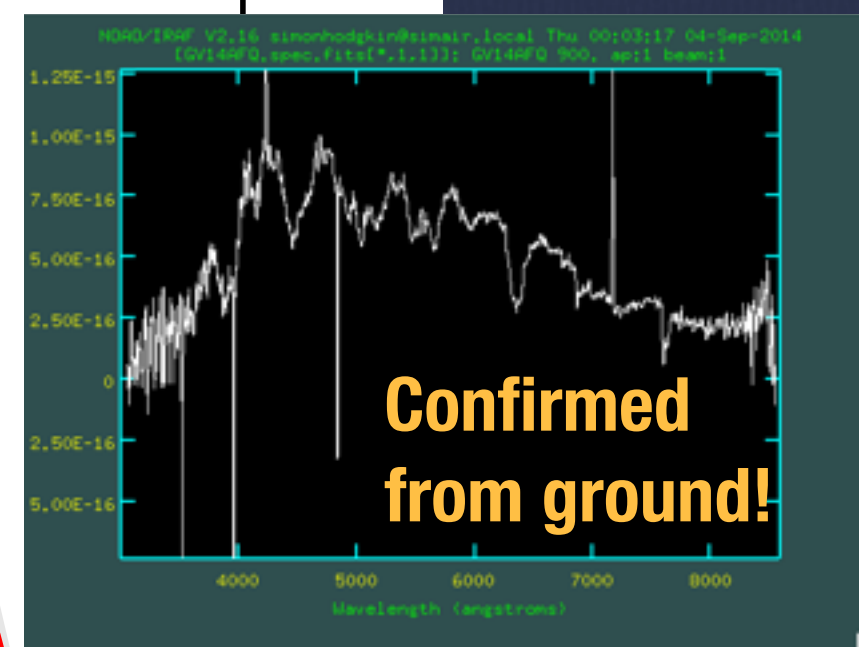
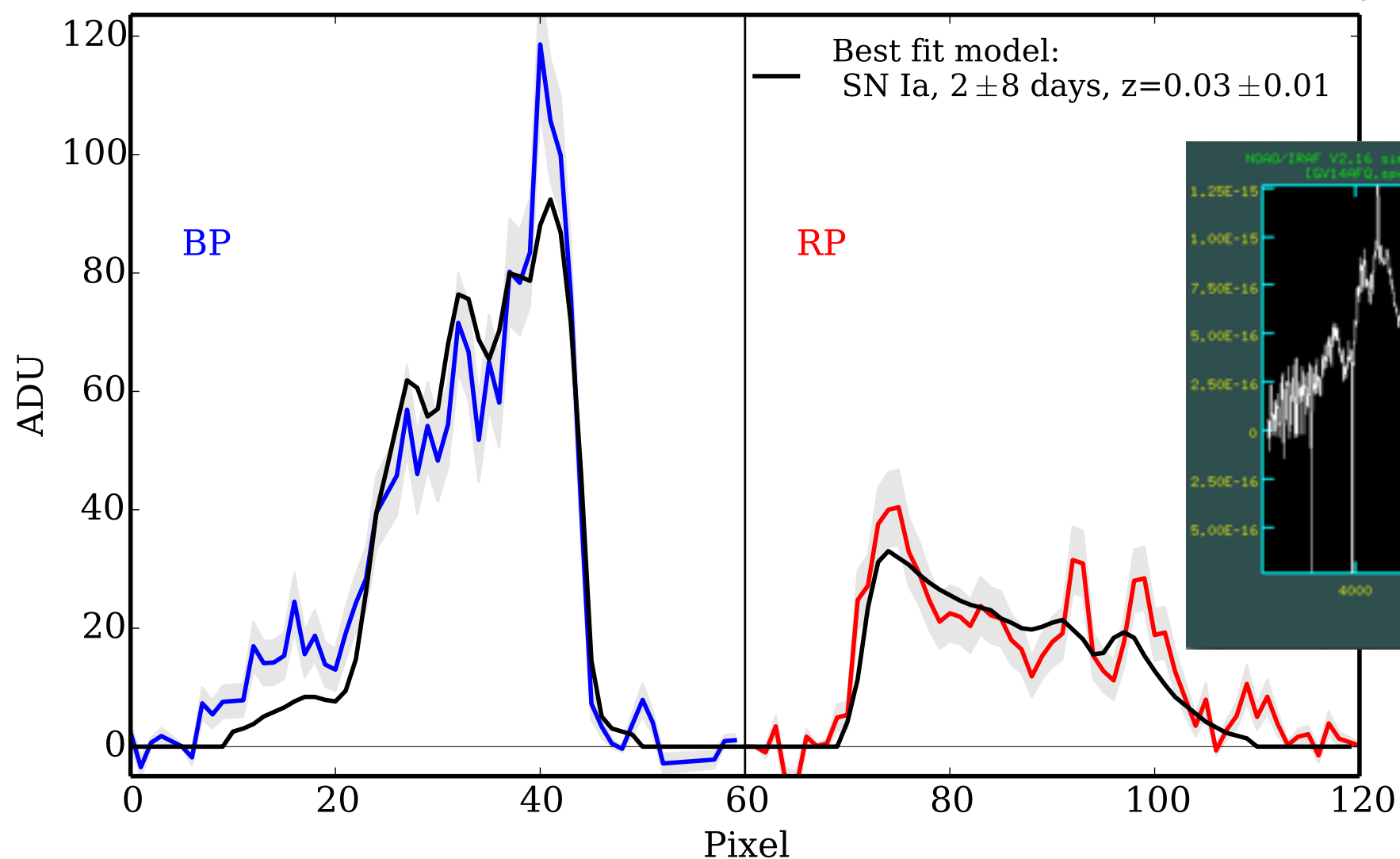
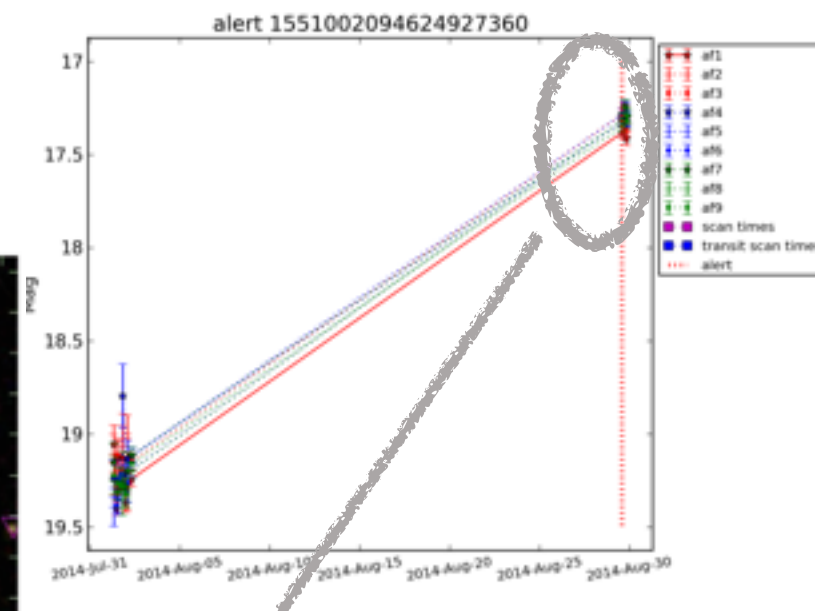
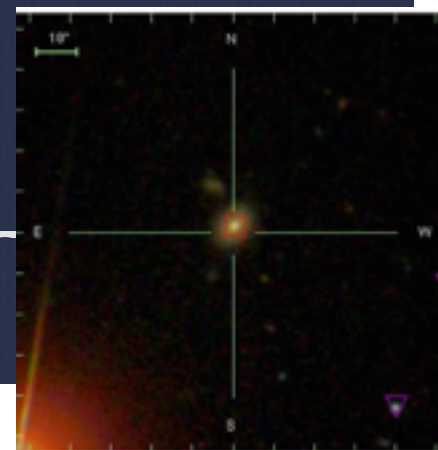
Redshift estimation

Epoch estimation

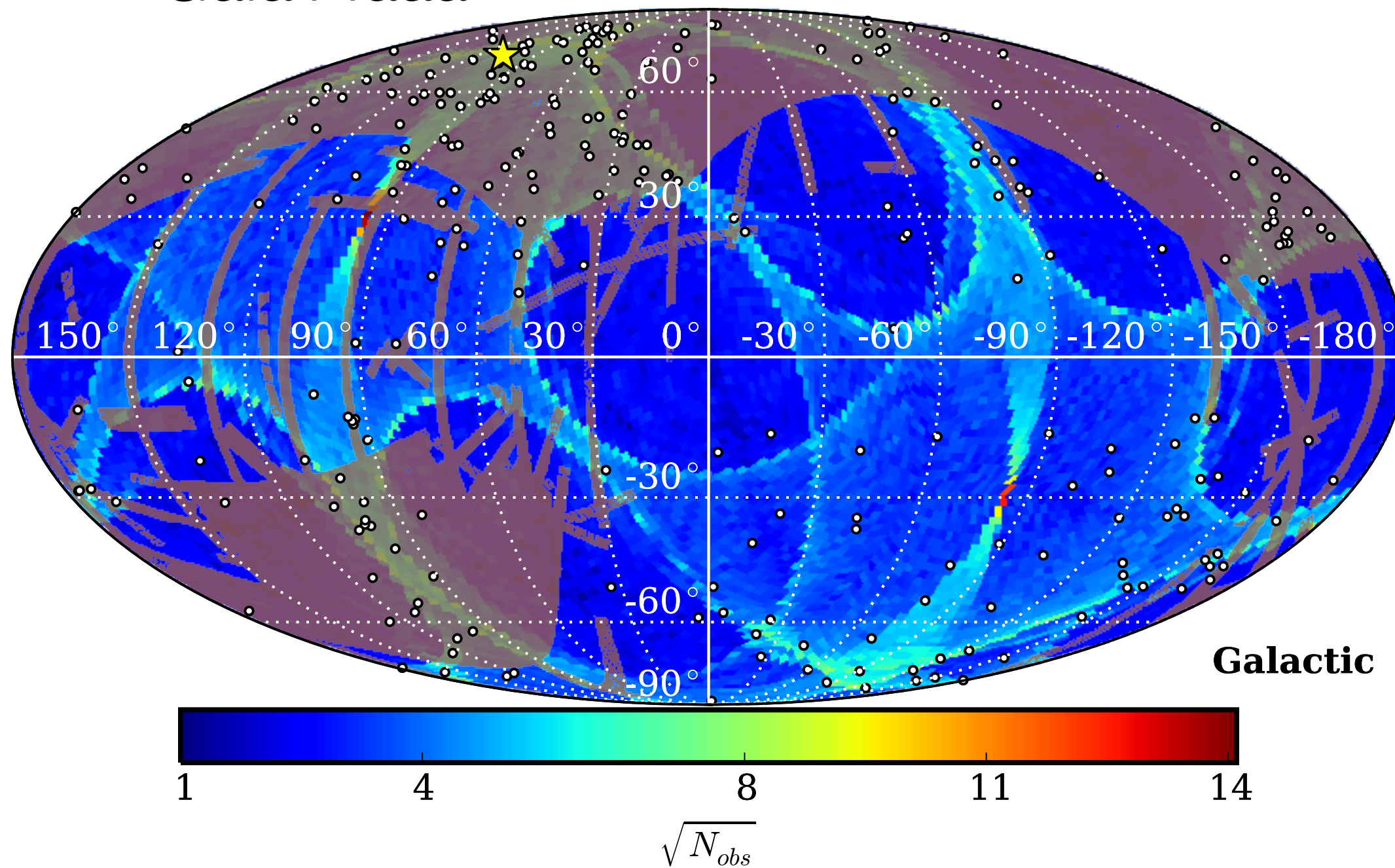


First Gaia SN BP/RP classification!

Identification of the
first Gaia SN as SN Ia at $z=0.03$!



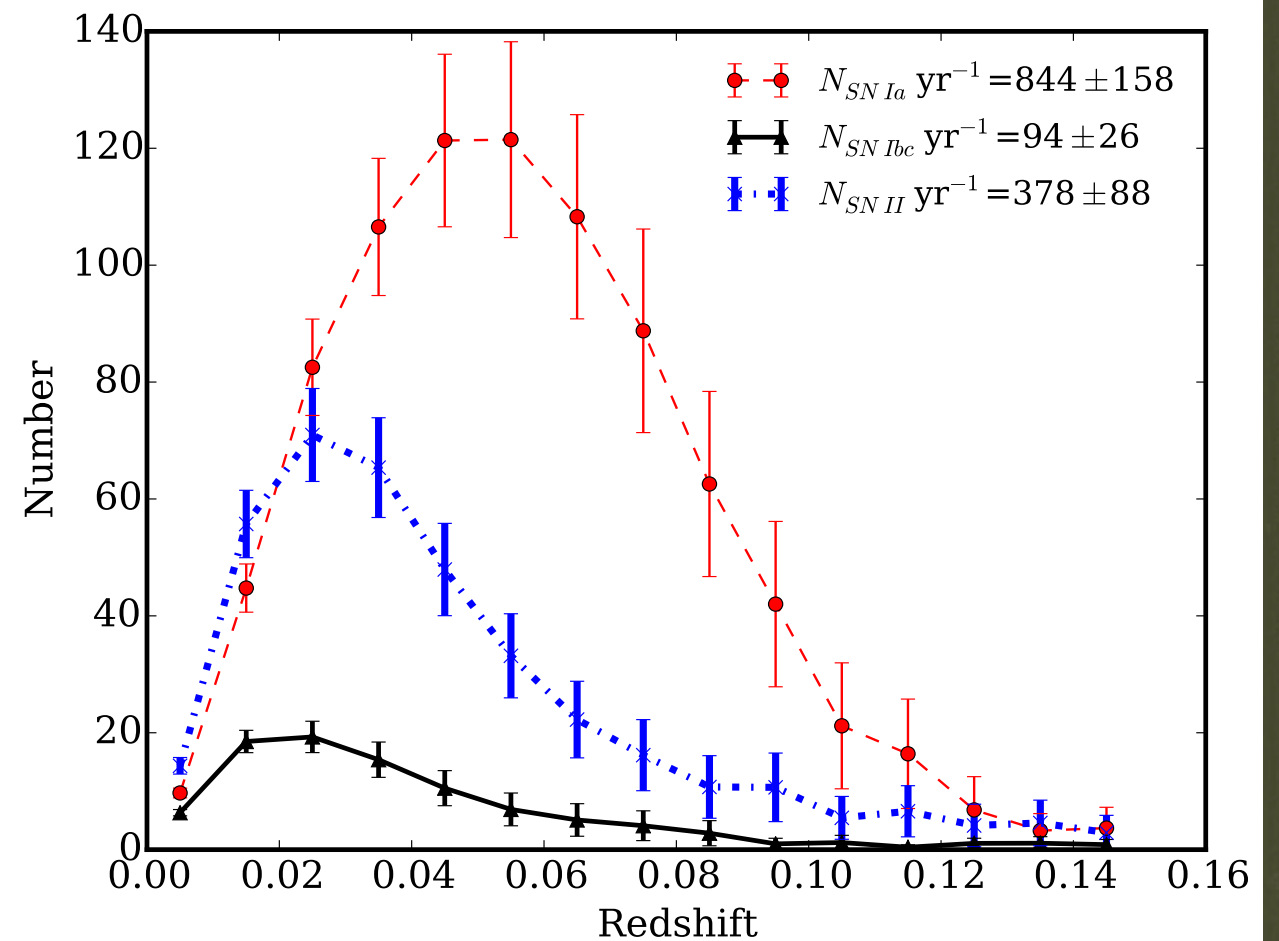
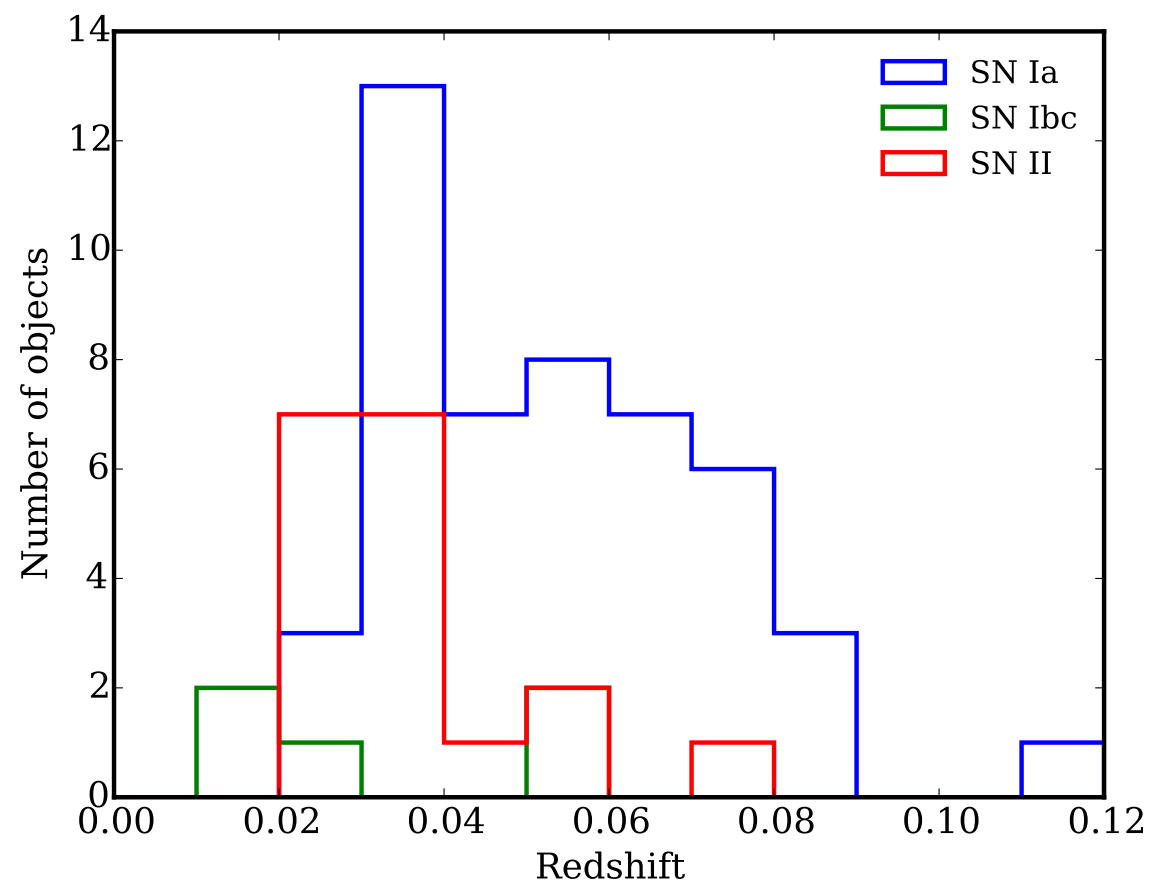
Gaia14aaa



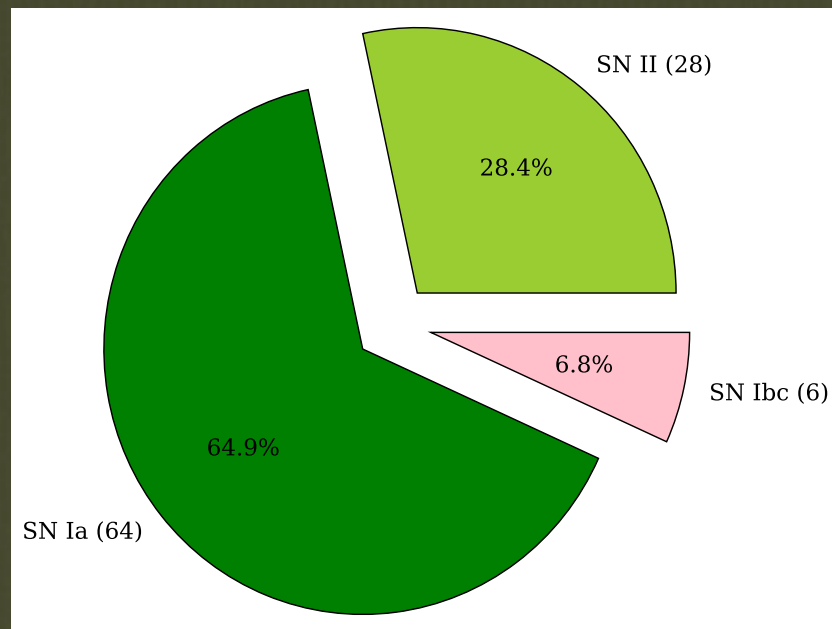
Density of observations until June 2015

Gaia Alerts (so far)

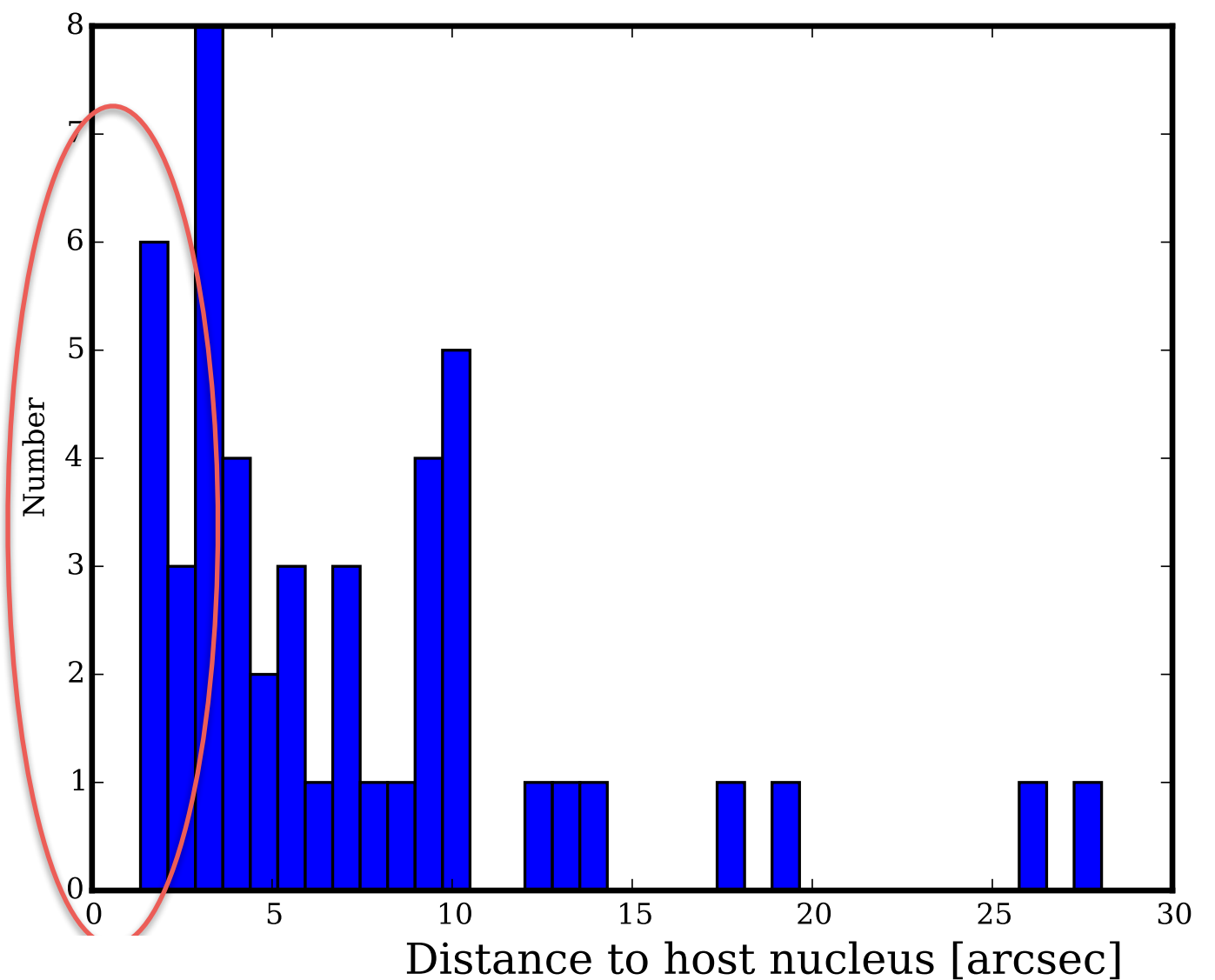
- 275 published alerts until June 2015
- 98 spectroscopically confirmed SN



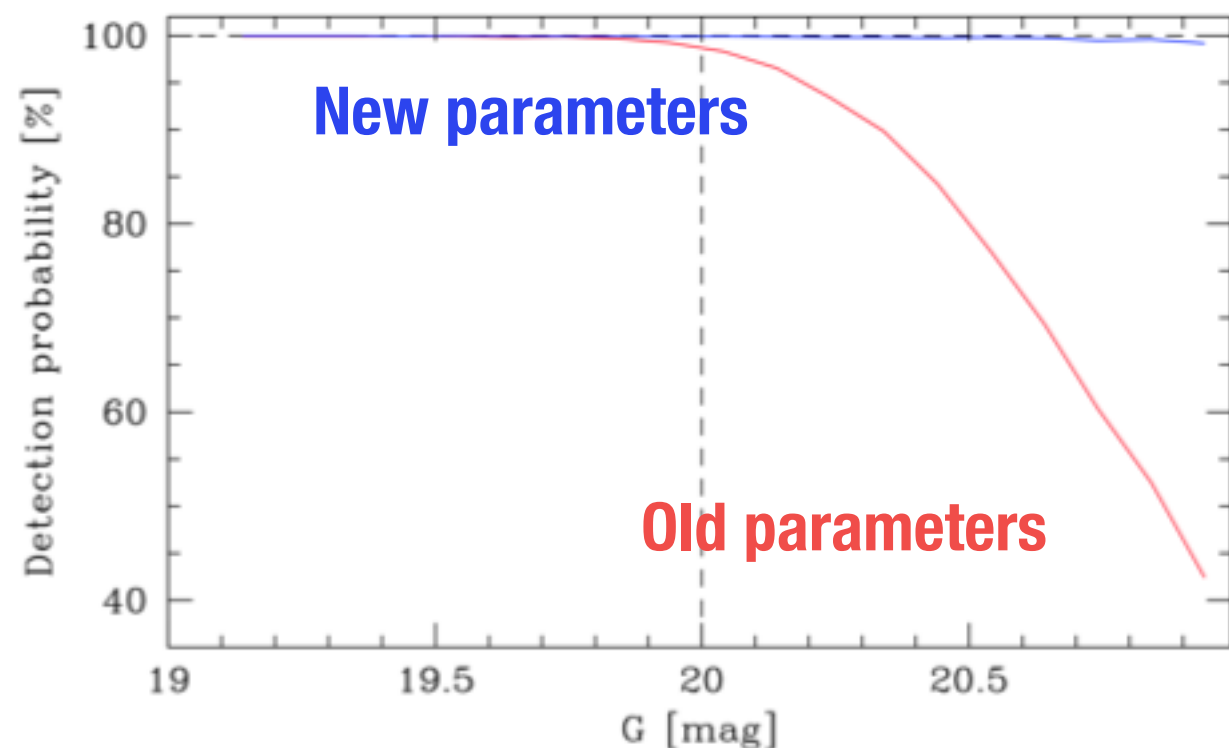
Gaia Alerts (so far)



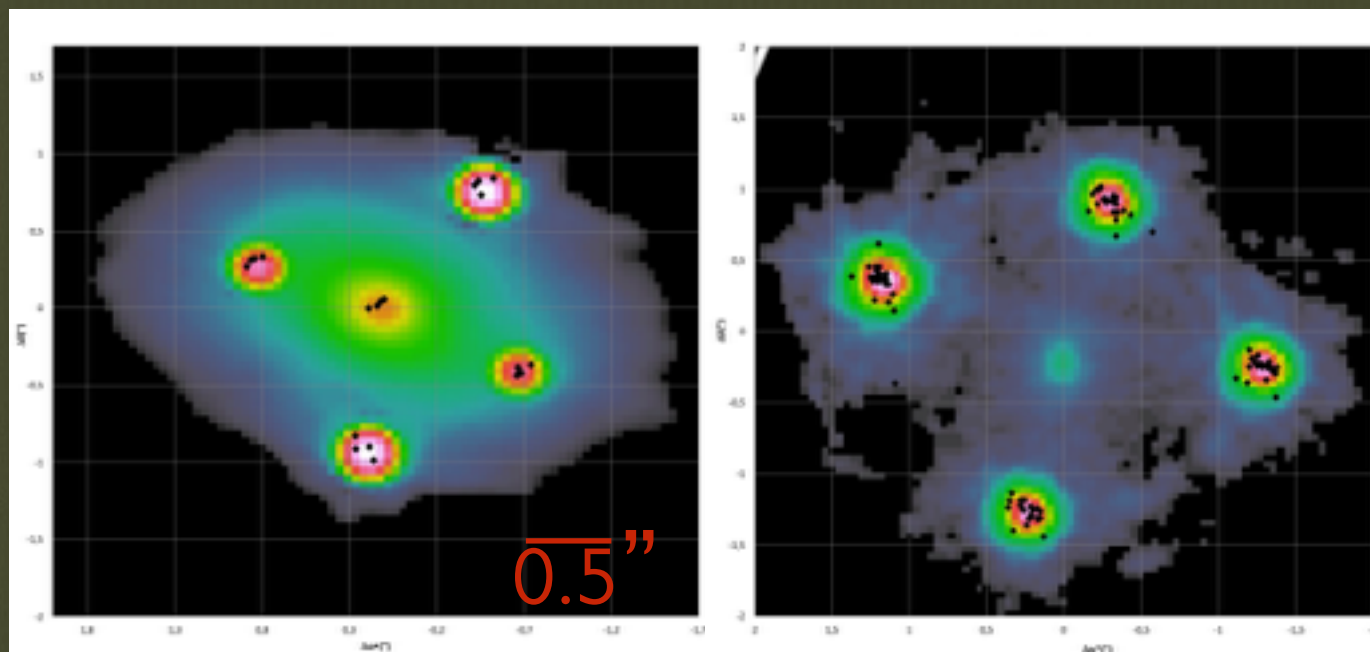
<1 arcsec?



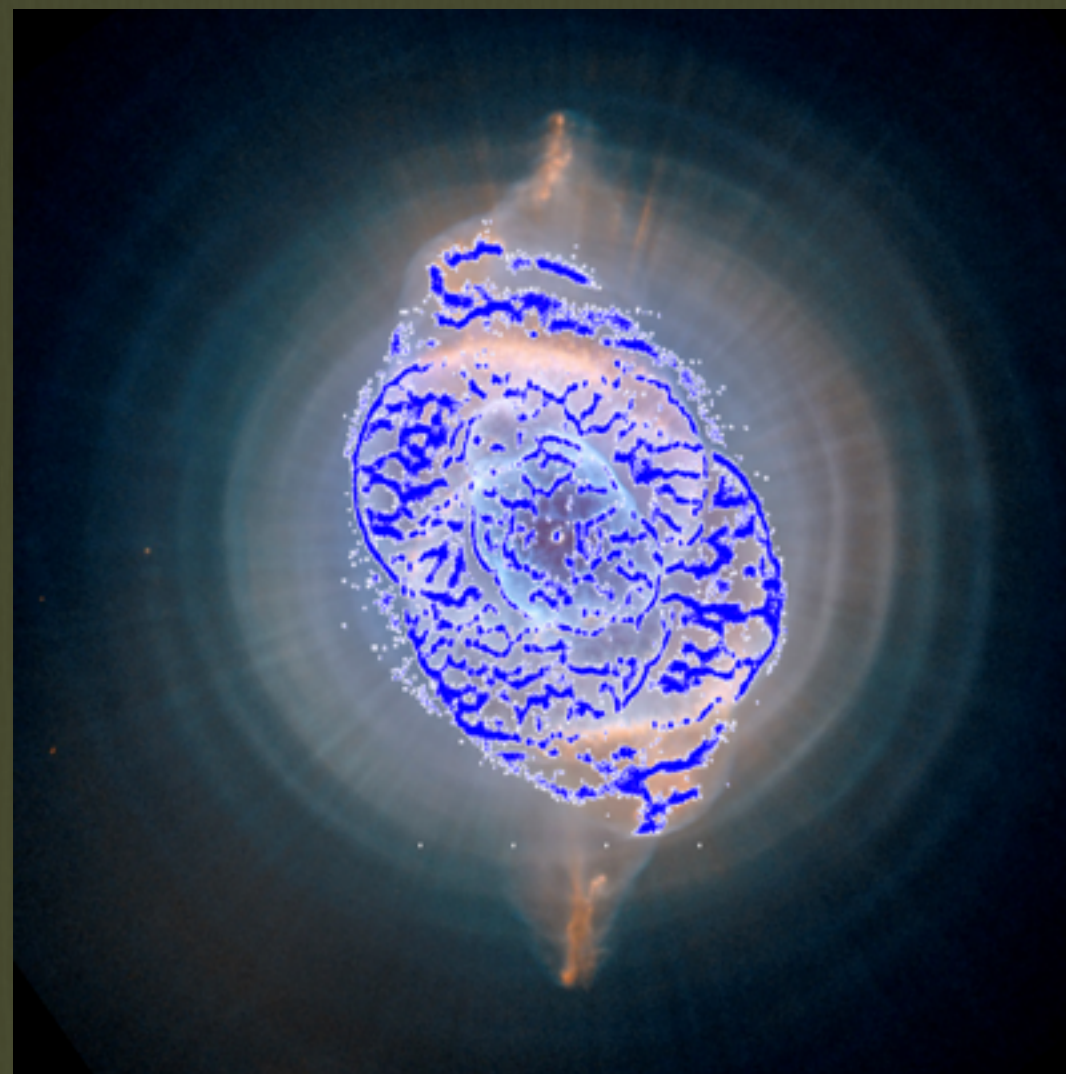
On-board parameters



De Bruijne et. al, 2015



http://www.cosmos.esa.int/web/gaia/iow_20150409



http://www.cosmos.esa.int/web/gaia/iow_20141205

Validation phase and improvements

gaia.ac.uk/selected-gaia-science-alerts

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Taking the Galactic Census

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You are here: [Home](#) » Gaia Photometric Science Alerts: Validation Phase

Gaia Photometric Science Alerts: Validation Phase

10/7/2015 update: The Gaia Alerts Validation Phase is now complete, and we are currently pausing publication of Gaia Alerts. The full Gaia Alerts system will become operational by mid November 2015.

Currently, a number of improvements are being implemented, based on our experience with the validation phase. We will provide information that you as the Gaia Alerts Followup community has requested.

The full operational system will include:

1. Links to new tables
2. Inclusion of links
3. Results of
4. Connect
5. Public

Further information will be available in the future.

If you publish any results, please acknowledge the Gaia Alerts Team along the lines of: "We used the Gaia Alerts system" (<http://gaia.ac.uk/selected-gaia-science-alerts>)

Alerts science

- Guest Stars with Gaia
- Exploding stars
- Variable stars
- Cosmology with Supernovae
- Supernovae in one minute
- History of Supernovae detections movie

Alerts downloads

- [Download FUGA-William Herschel Telescope follow-up spectra tarball](#) (353KB)

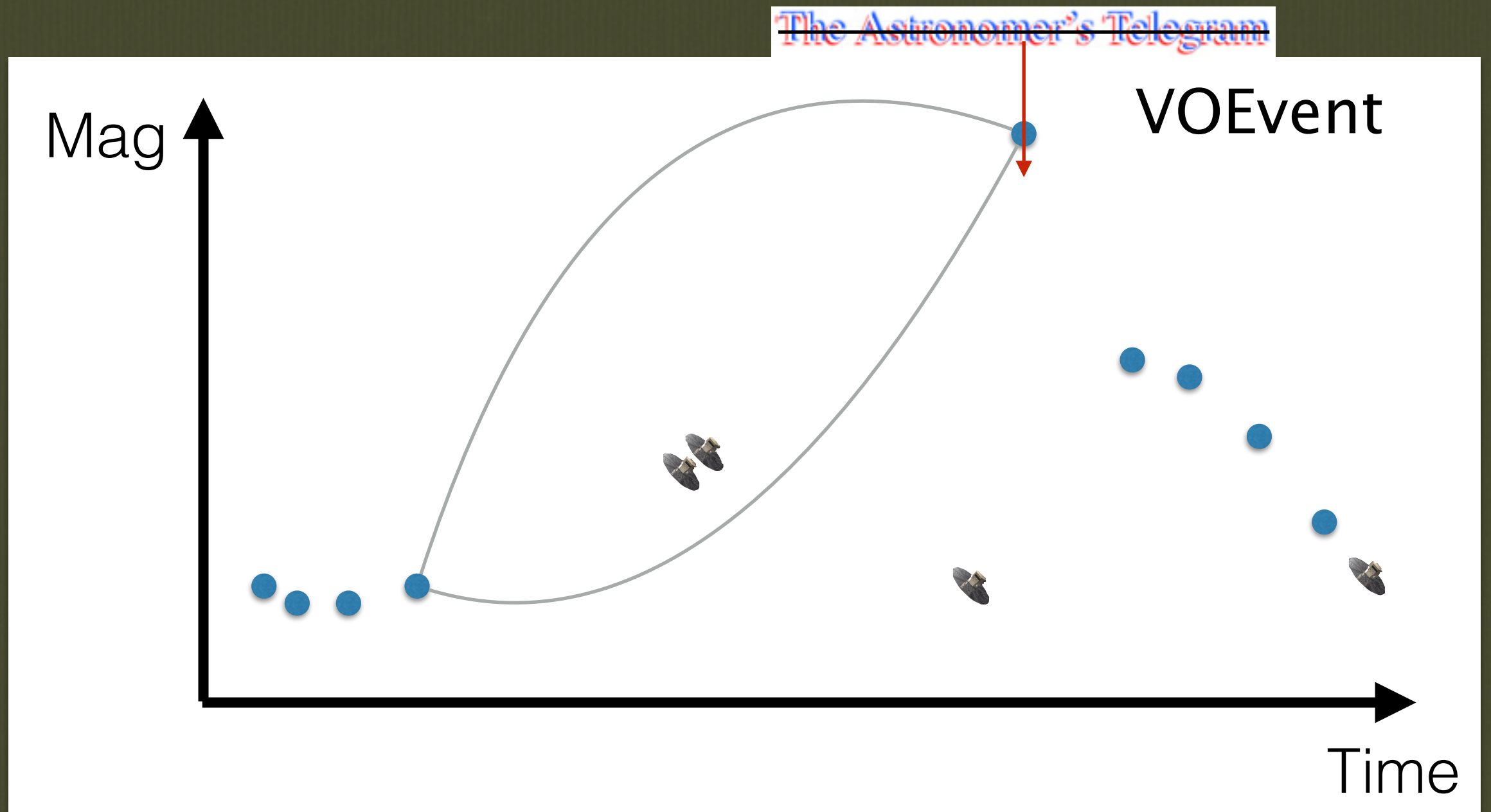
  

 **Gaia DPAC** Gaia Data Processing and Analysis Consortium (DPAC)

 **gaia GENIUS** Gaia European Network for Improved User Services (GENIUS)



Dream... watch-list?



Conclusions

- **Gaia is a** suitable tool for high-accuracy measurements of slow-rising transients.
 - FREE low-resolution classification.
 - Observations close to the Sun.
 - Observations on low-profile days.
- Change in on-board detection parameters has **increased** the **number of “fake” detections**.
- **Currently**, changes in pipeline focus on **cleaning the sample and approaching the nucleus!**



&

Heather Campbell

Morgan Fraser

Gerry Gilmore

Diana Harrison

Simon Hodgkin

Mike Irwin

Seppo Mattila

Sergey Koposov

Rubina Kotak

Guy Rixon

Sjoert Van Velzen

Lukasz Wyrzykowski

Nicholas A. Walton

Thank you!

