Fast optical transients with Gaia

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CU5 (Hodgkin et al.) & CU7 (Eyer et al.)

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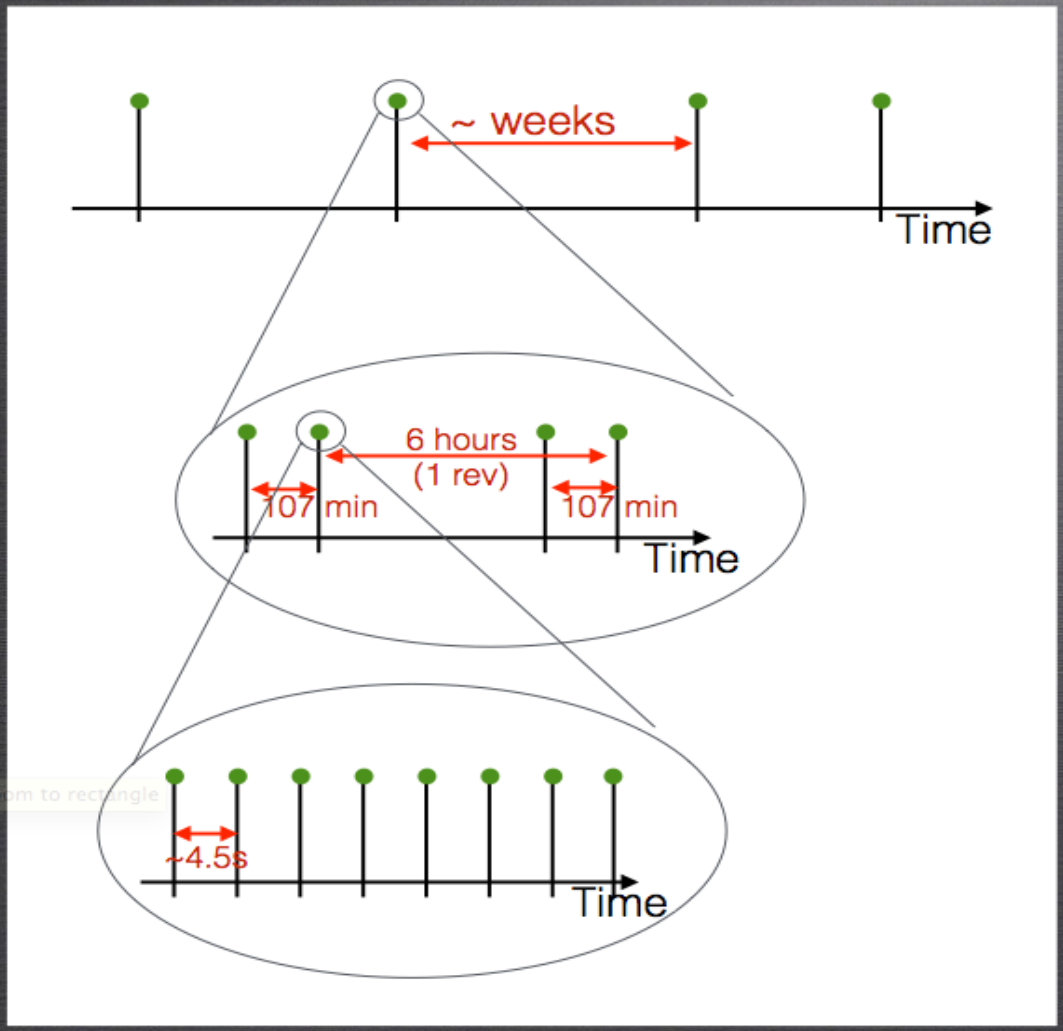
SAMPLING OF LIGHT CURVE



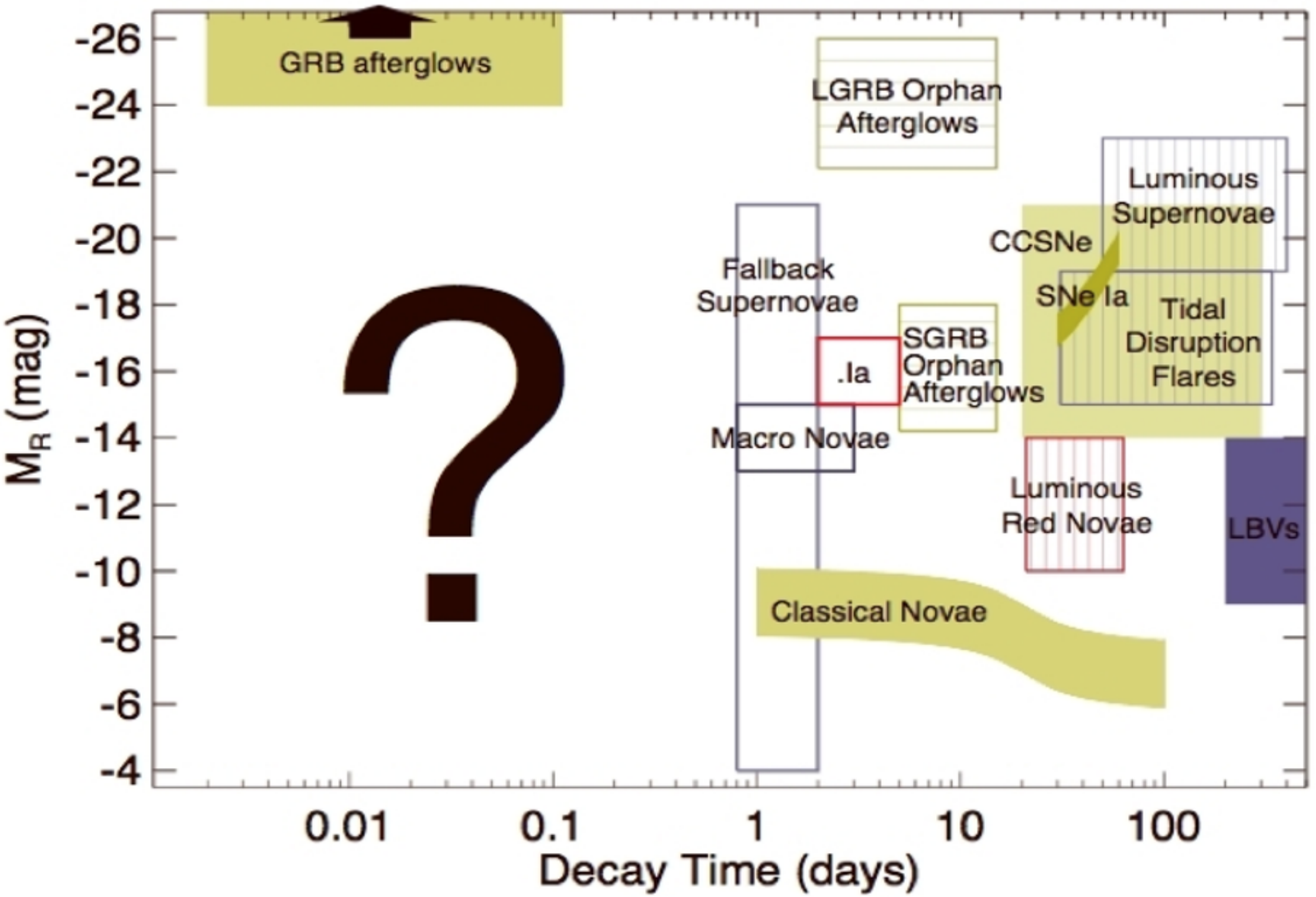
Each source observed many time in mission; sampling is predictable but uneven

Each visit,typically 2 transits in each of 2 fields of view: FoV transit → avg. mag

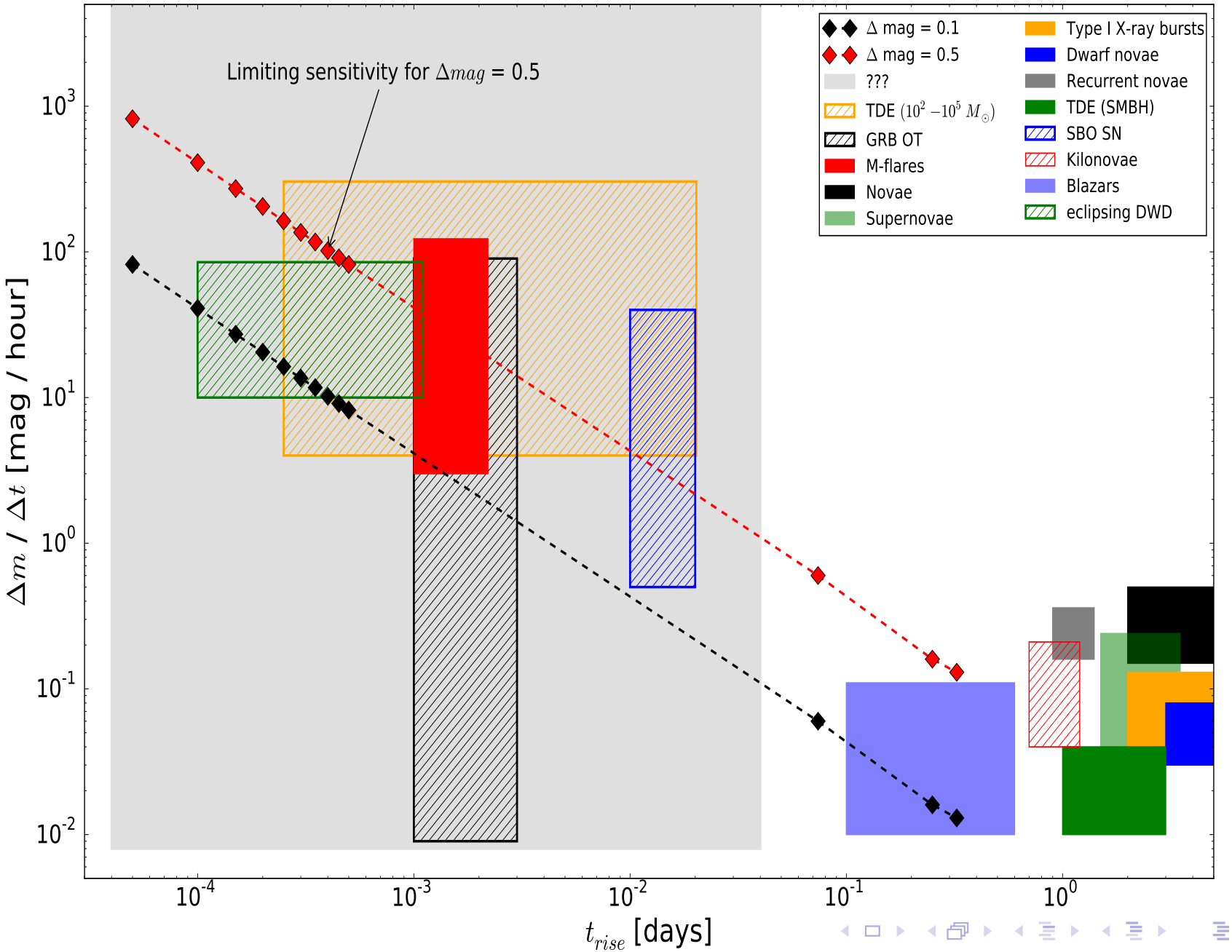
Each FoV includes up to 9 equivalent flux samples that can be averaged or used separately

Slide from Lukasz Wyrzykowski

‘Classical’ transient phase space (taken from LSST science book):



Rate of rise vs. t_{rise}



Disrupting a white dwarf around a massive BH

- Star enters tidal radius of BH: differential gravity leads to disruption
- A fraction of the material remains bound and accretes onto the BH

Typical fallback timescale (Lodato & Rossi, 2011):

$$t_{peak} \sim 41 \times m_{star,\odot}^{-1} \times r_{star,\odot}^{1.5} \times M_{BH,6}^{1/2} days \quad (1)$$

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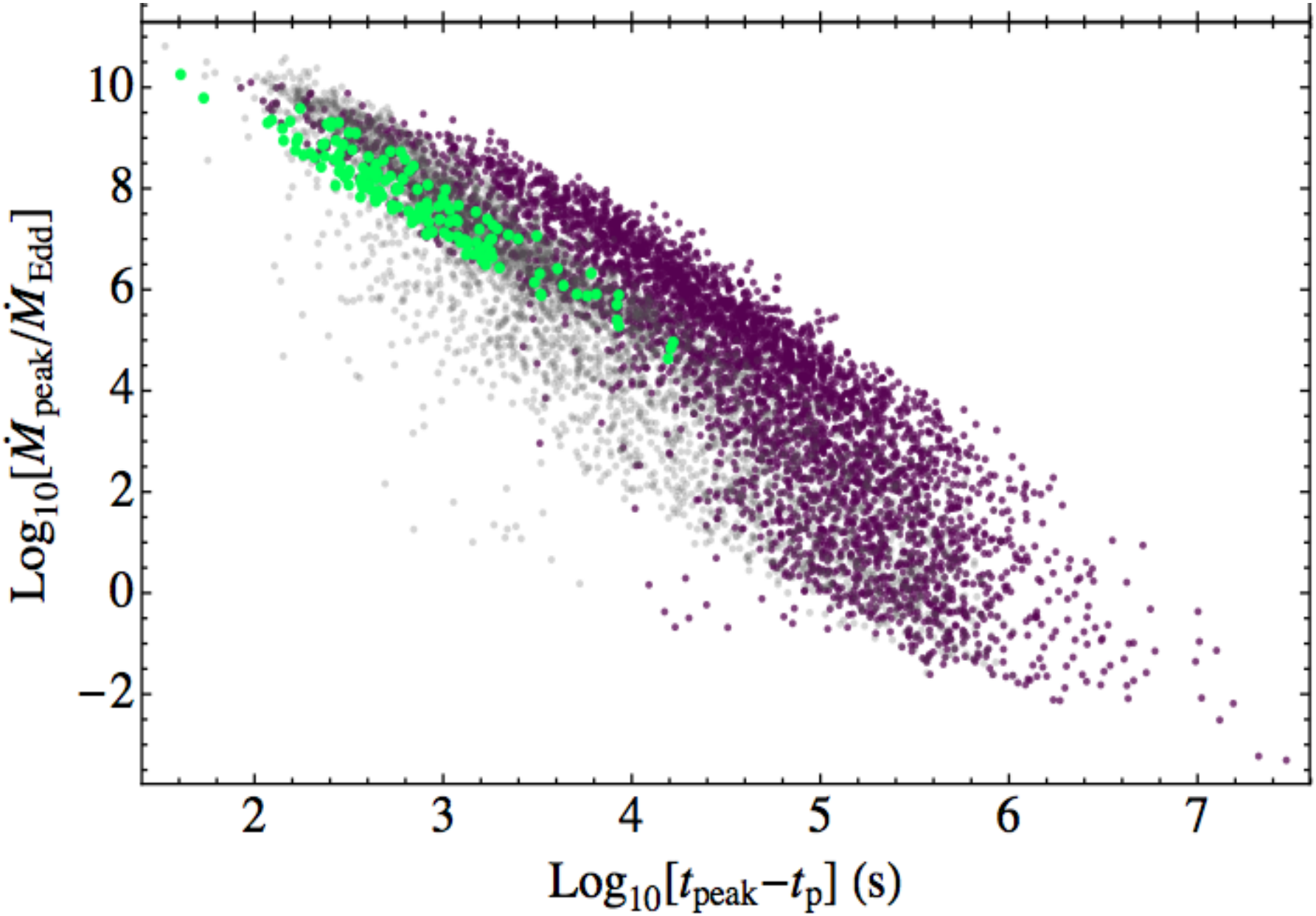
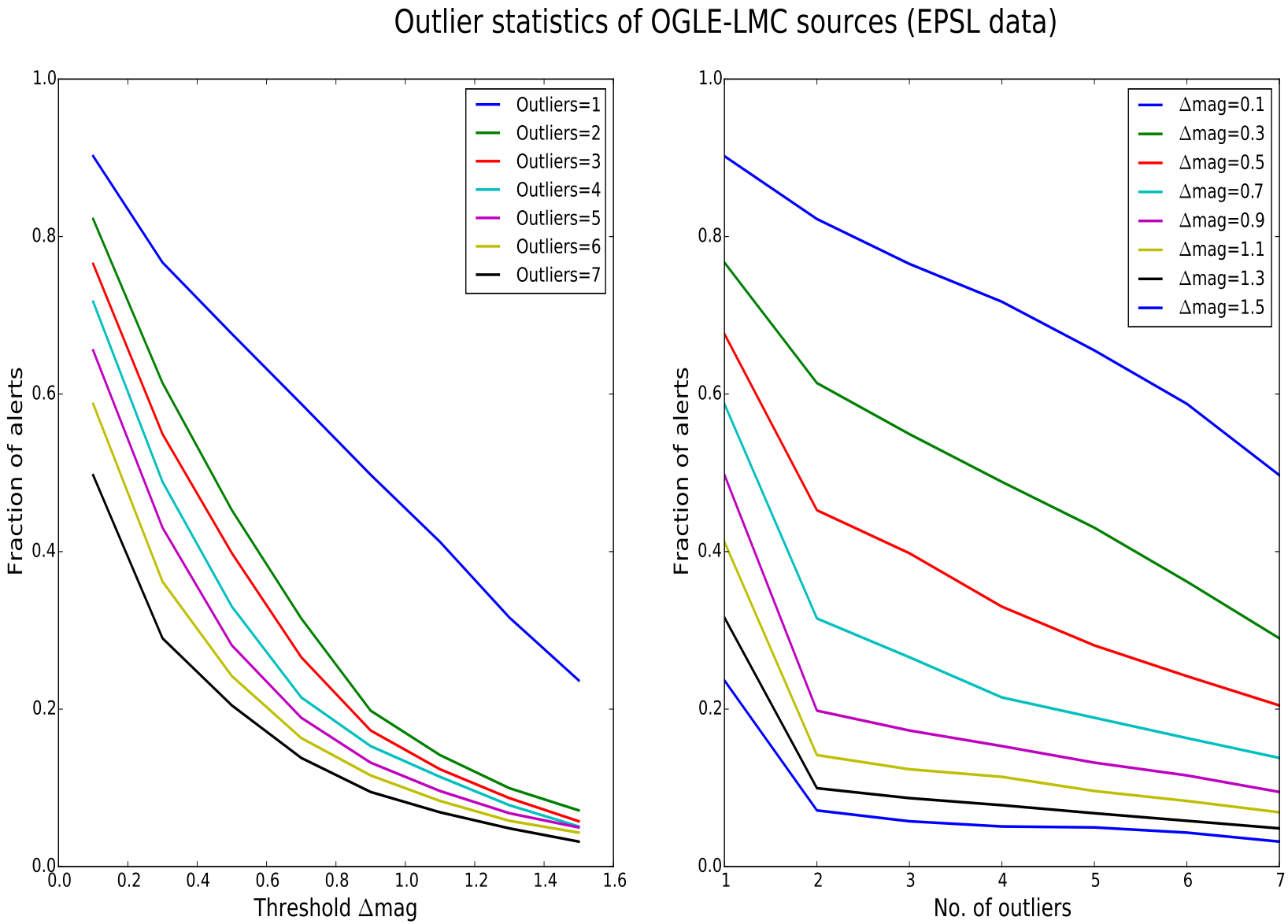
For a 0.6 $M_\odot$ WD:

- tens - 1800 sec for $M_{BH} \sim 100$ - $10^5 M_\odot$



Macleod, arXiv:1508.02399

A naive delta-mag detector



Detection algorithm

- Important to separate between variables and transients
- More sophisticated than threshold detector
- Fast

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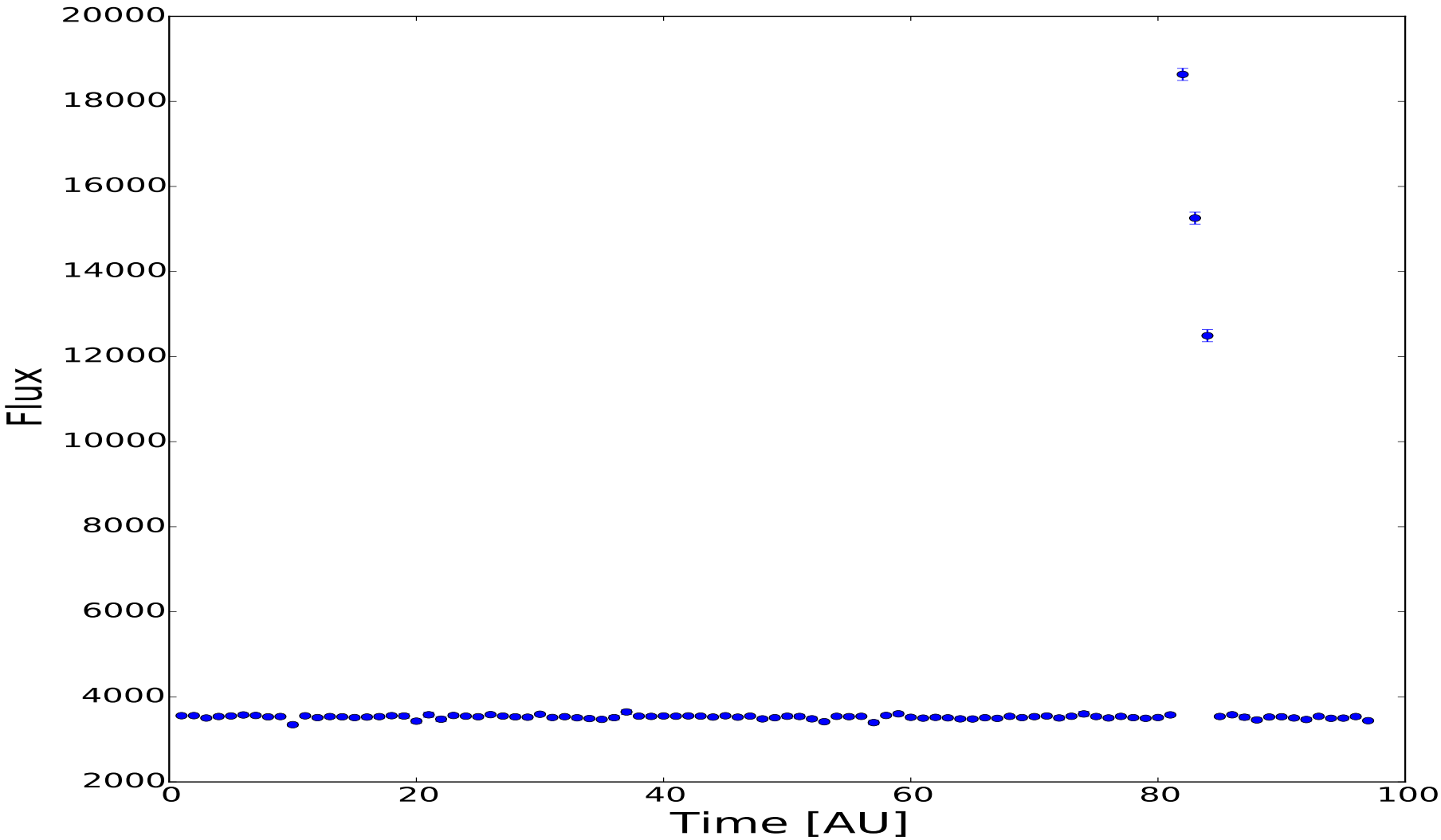
2 metrics

- Reduced χ^2 of the mean:
  variability
- Skewness:
  outliers

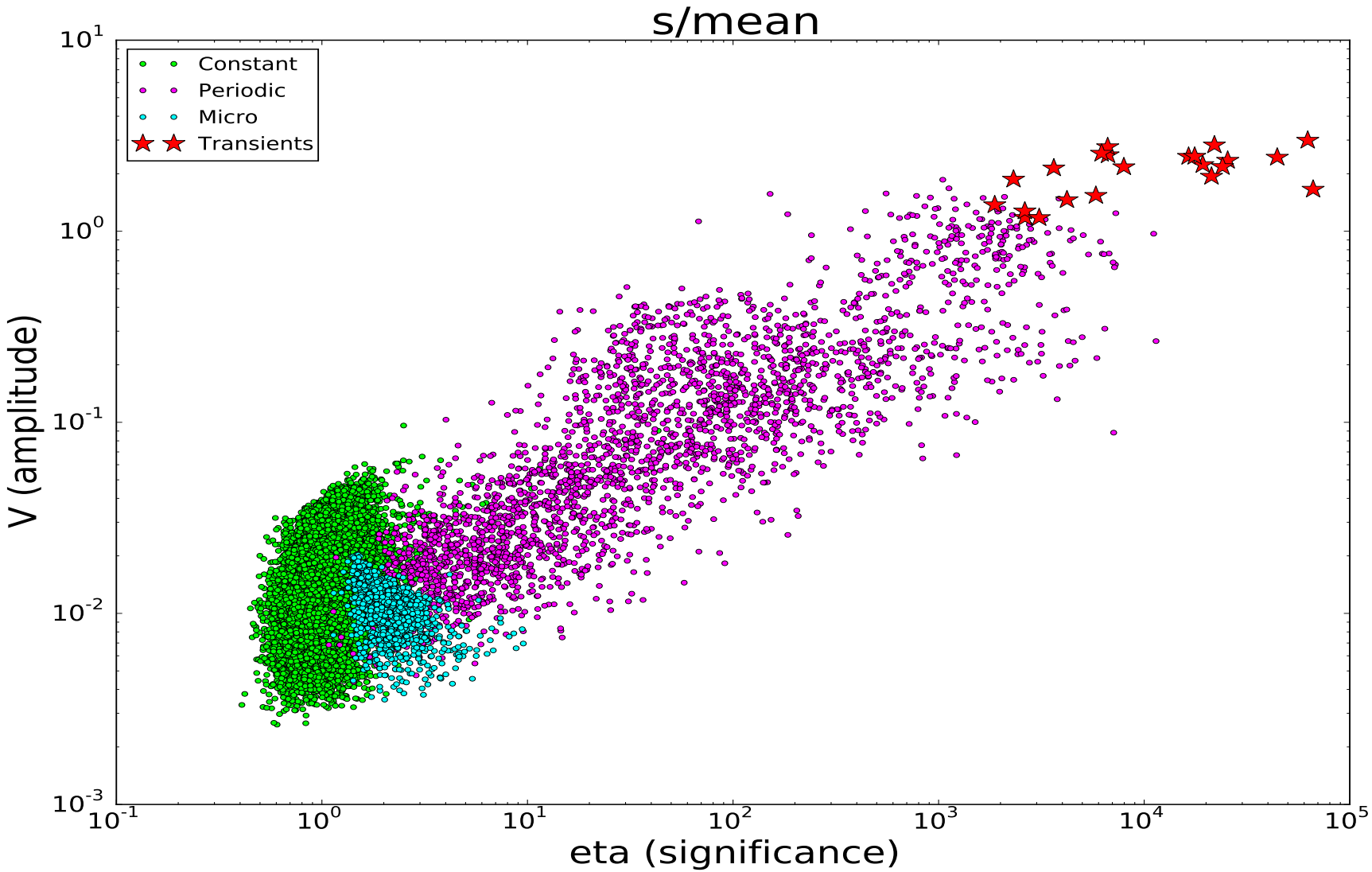
Validation on Hipparcos data

- We add artificial transients to random Hipp lightcurves
- Random trigger time
- Random flux increase (between factor 2 - 50 = 0.75 - 4 in mag)
- Exponential decay with random decay-time (2-8 obs)
- Try to recover these events in the data

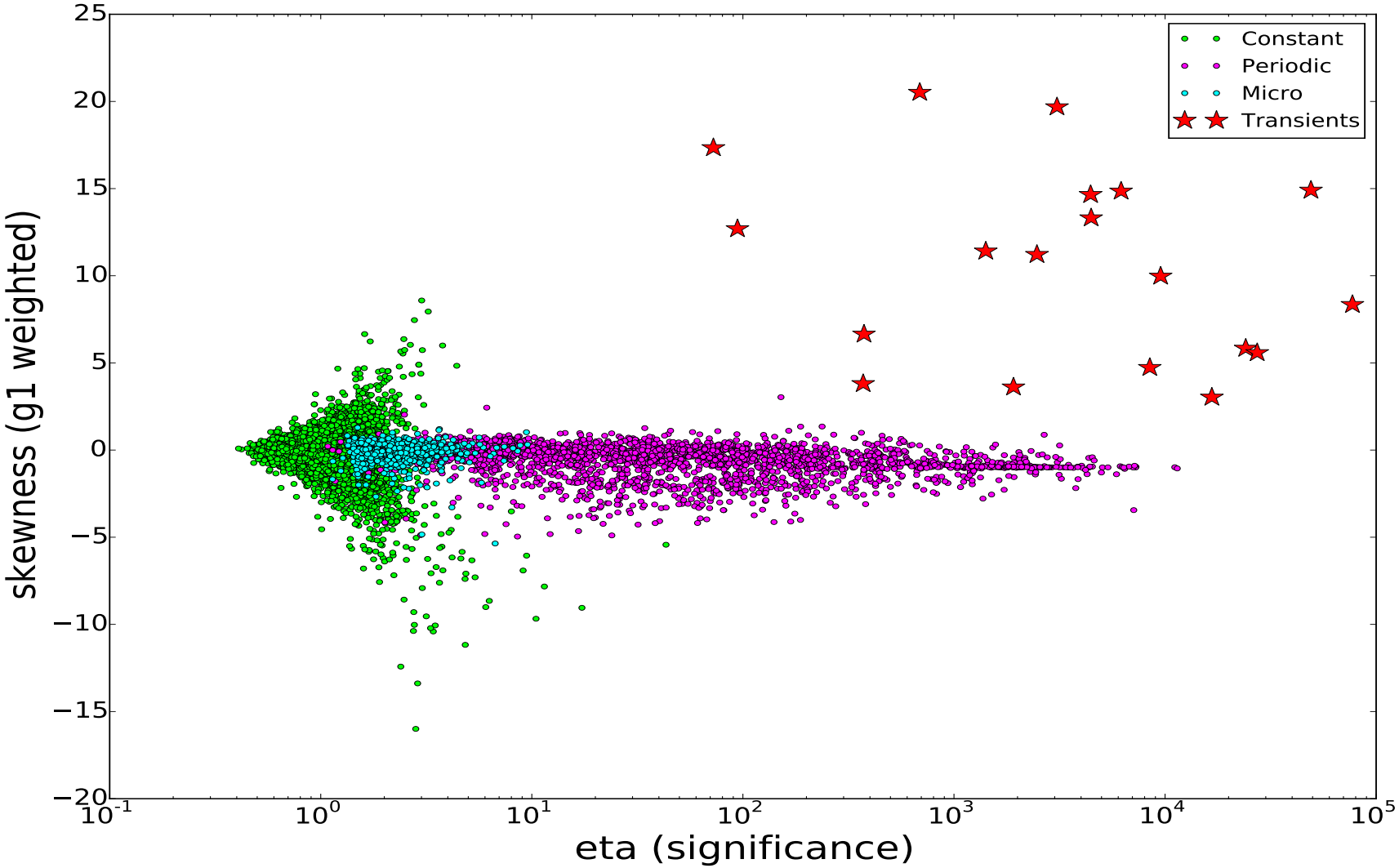
Testing on Hipparcos data



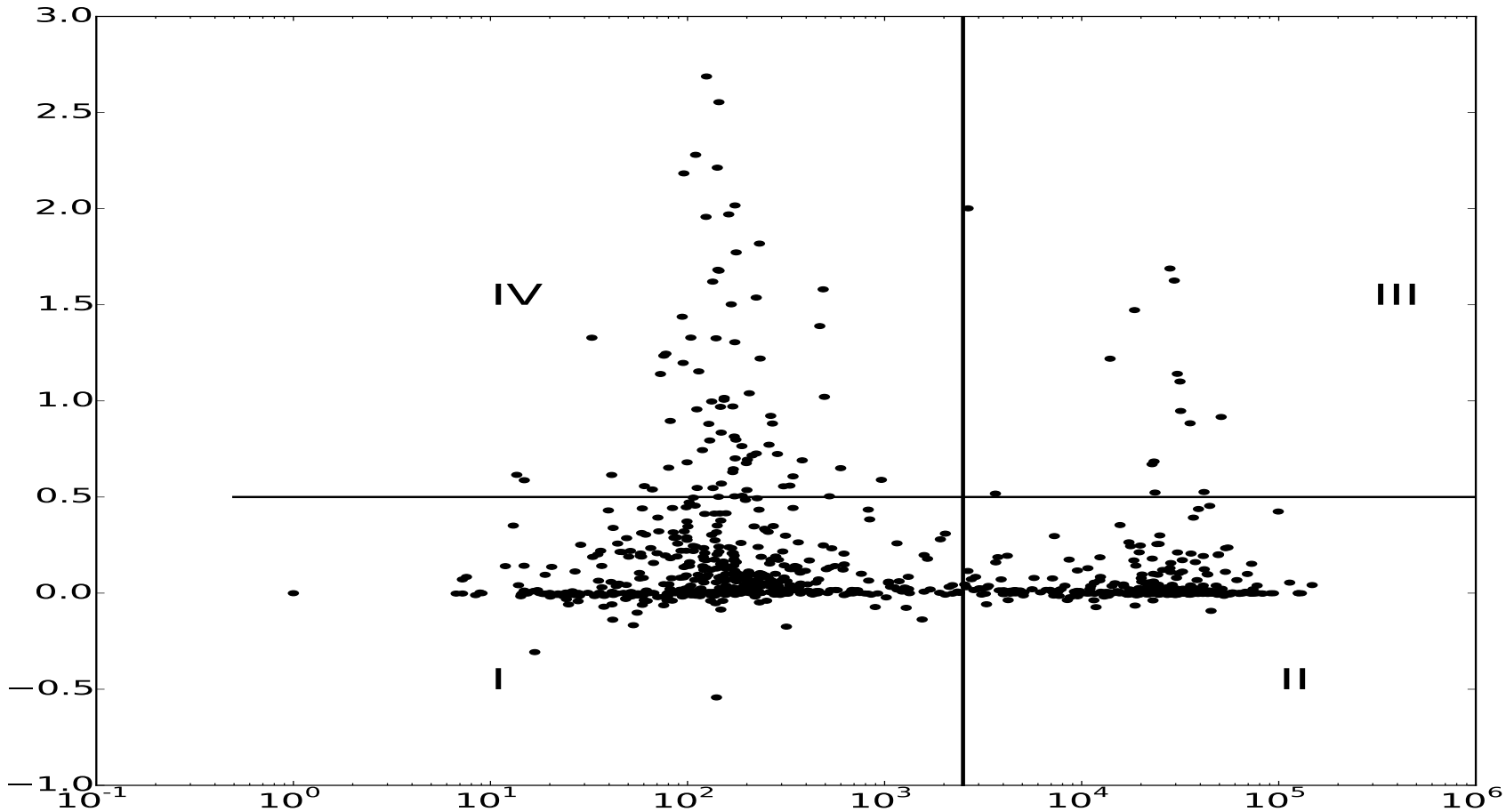
Stddev/mean (original)



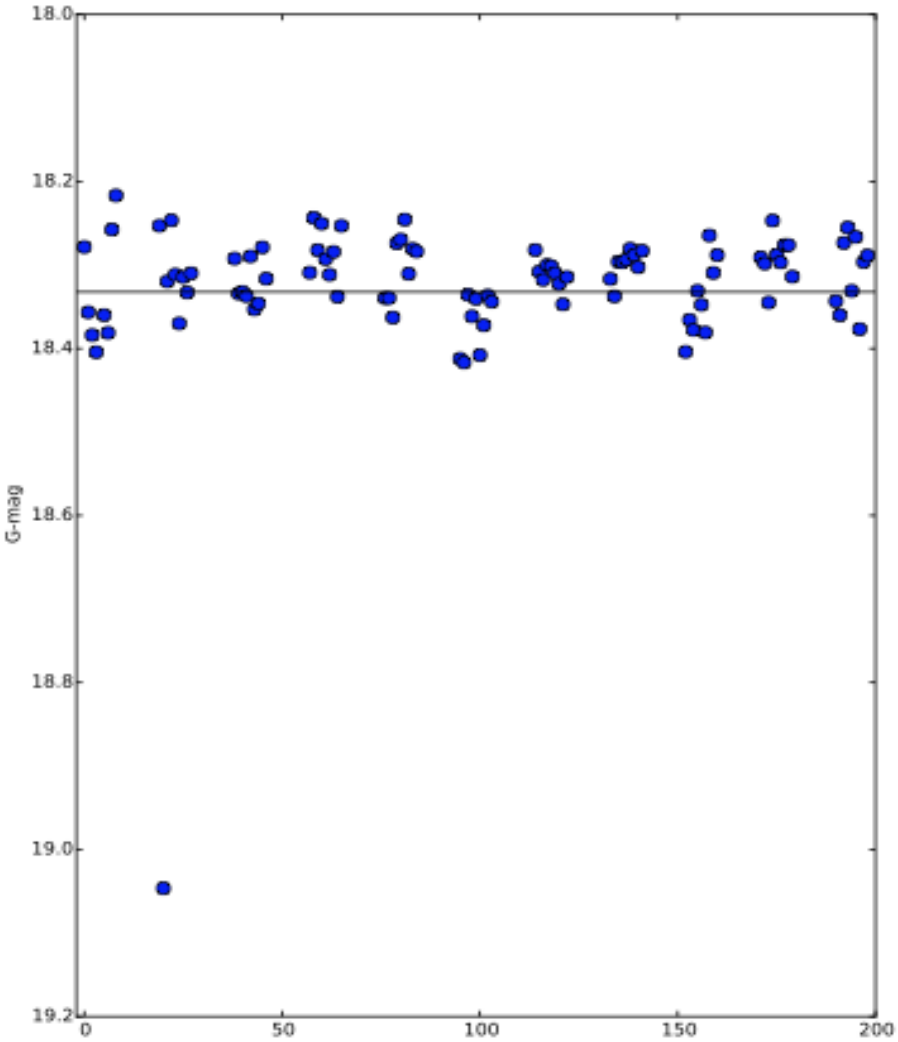
Standardized skewness



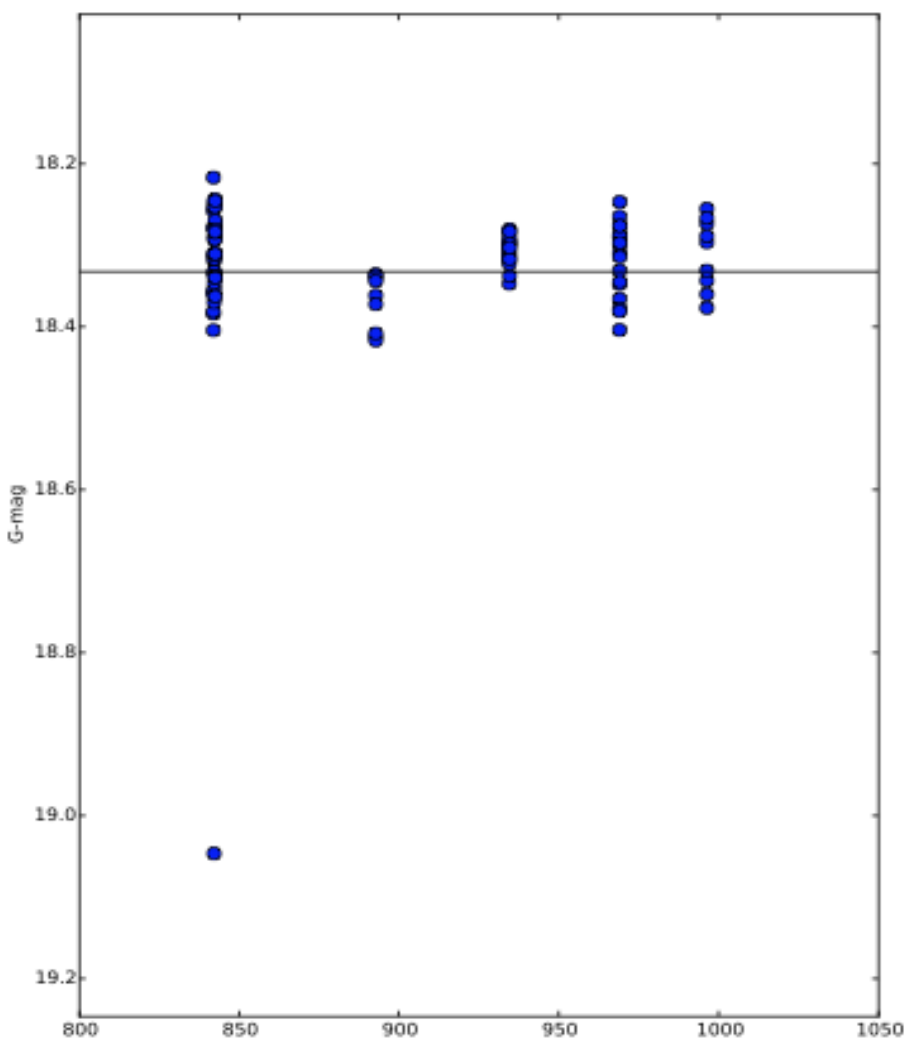
What about Gaia data?



Quadrant I

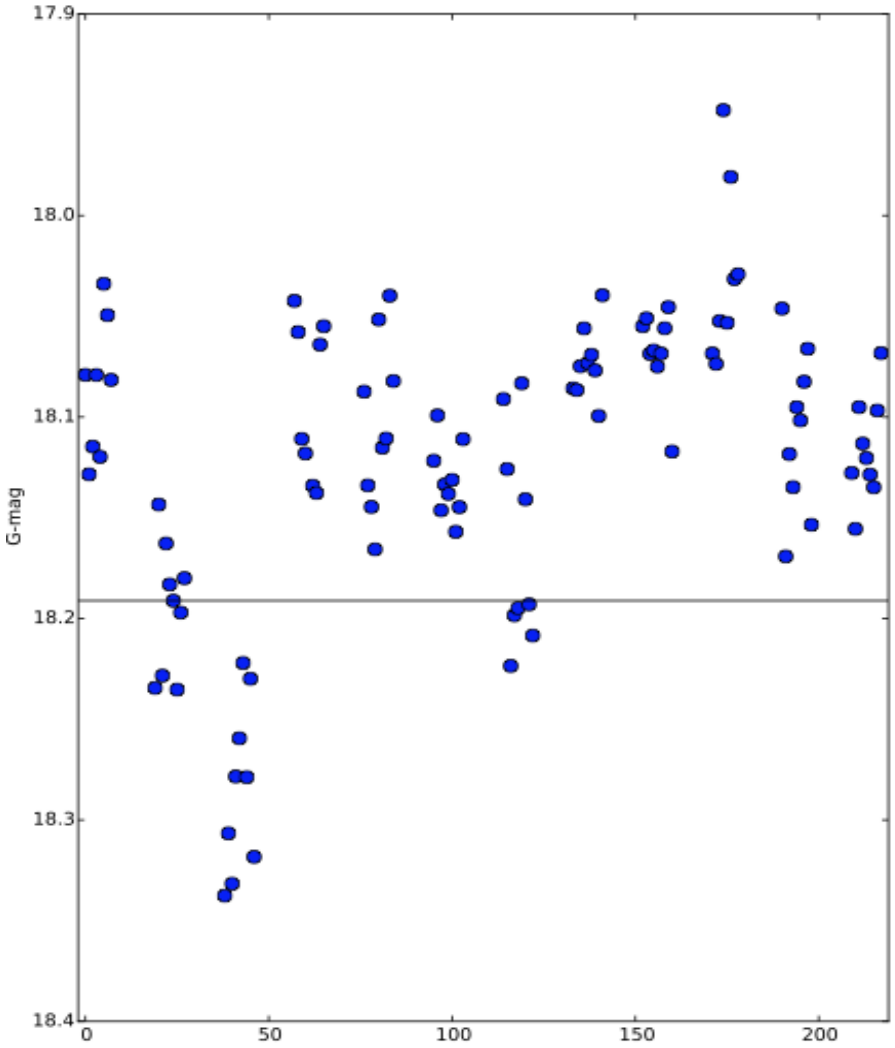


CCD number



Time [days]

Quadrant II



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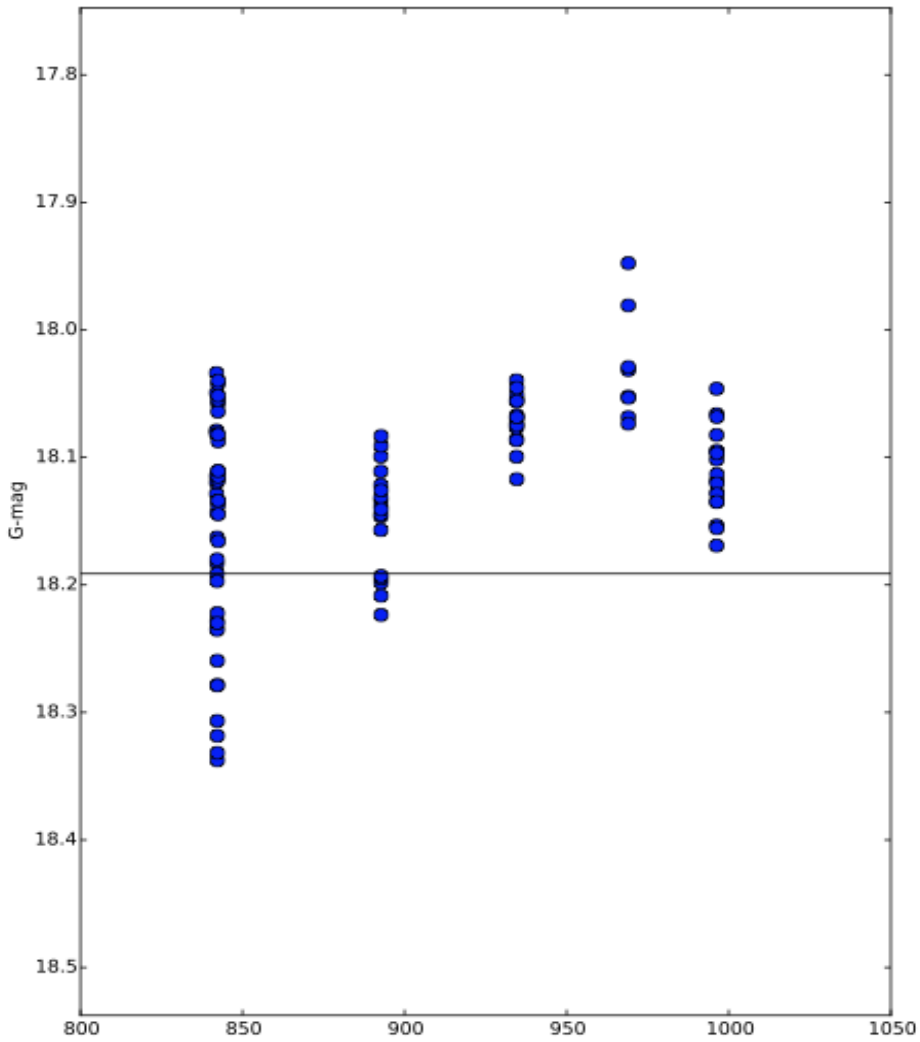
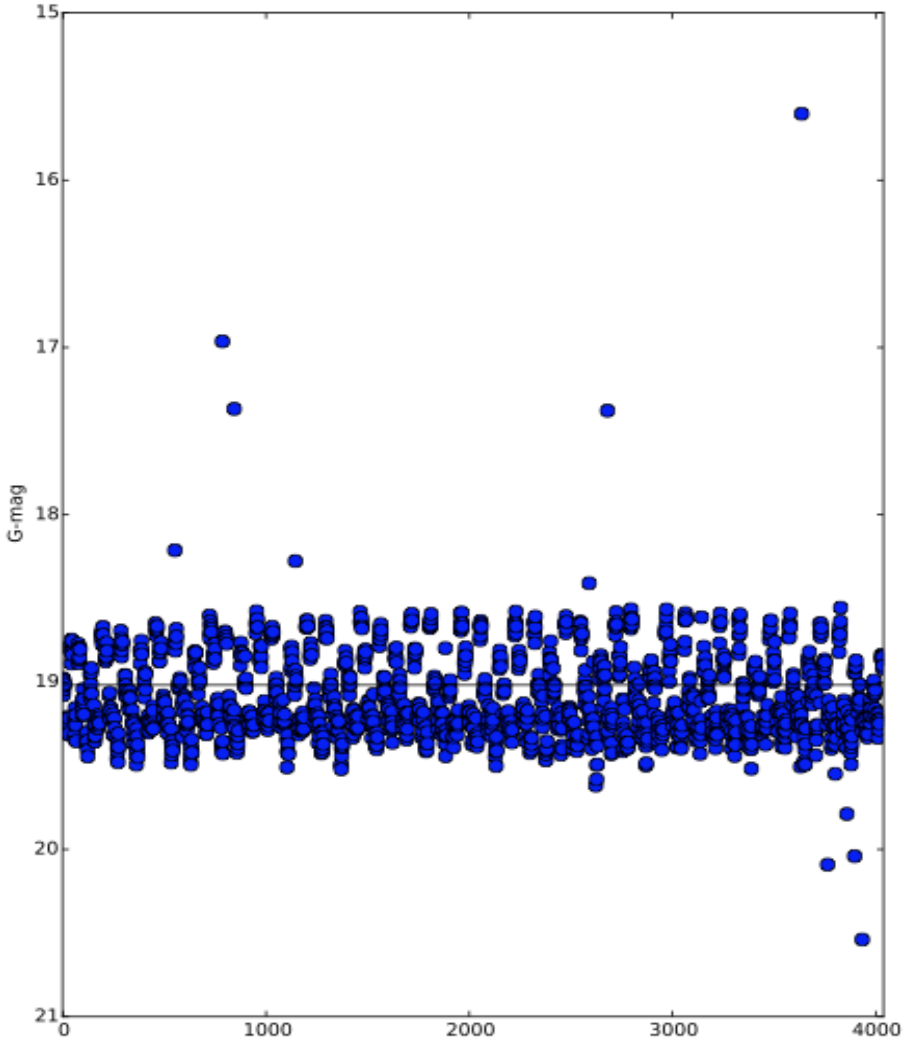


Time [days]

Quadrant III



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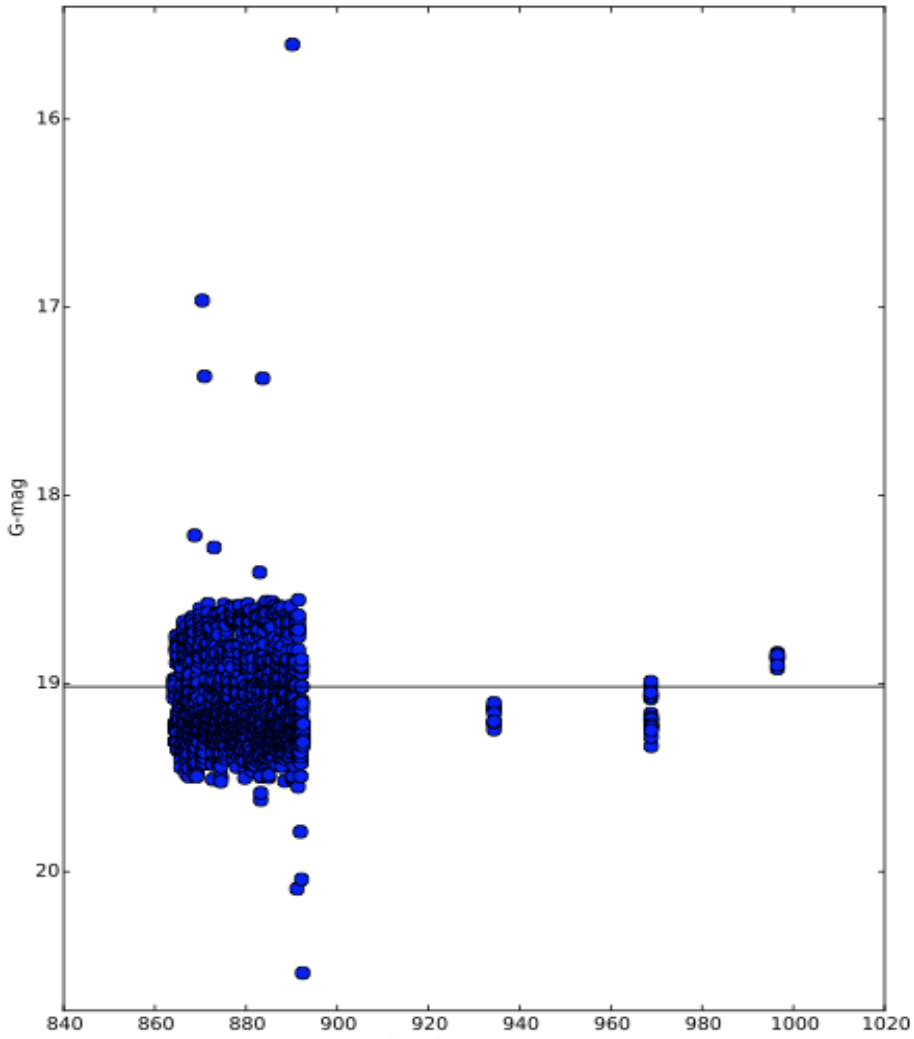
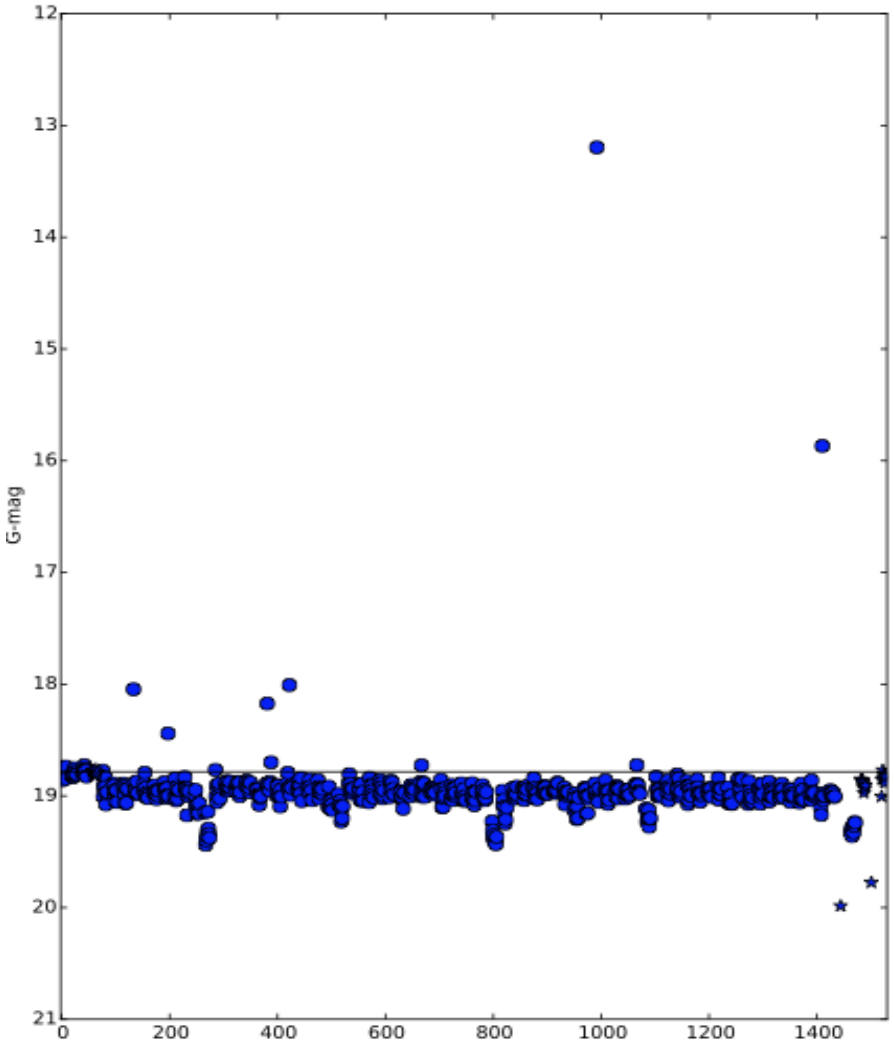
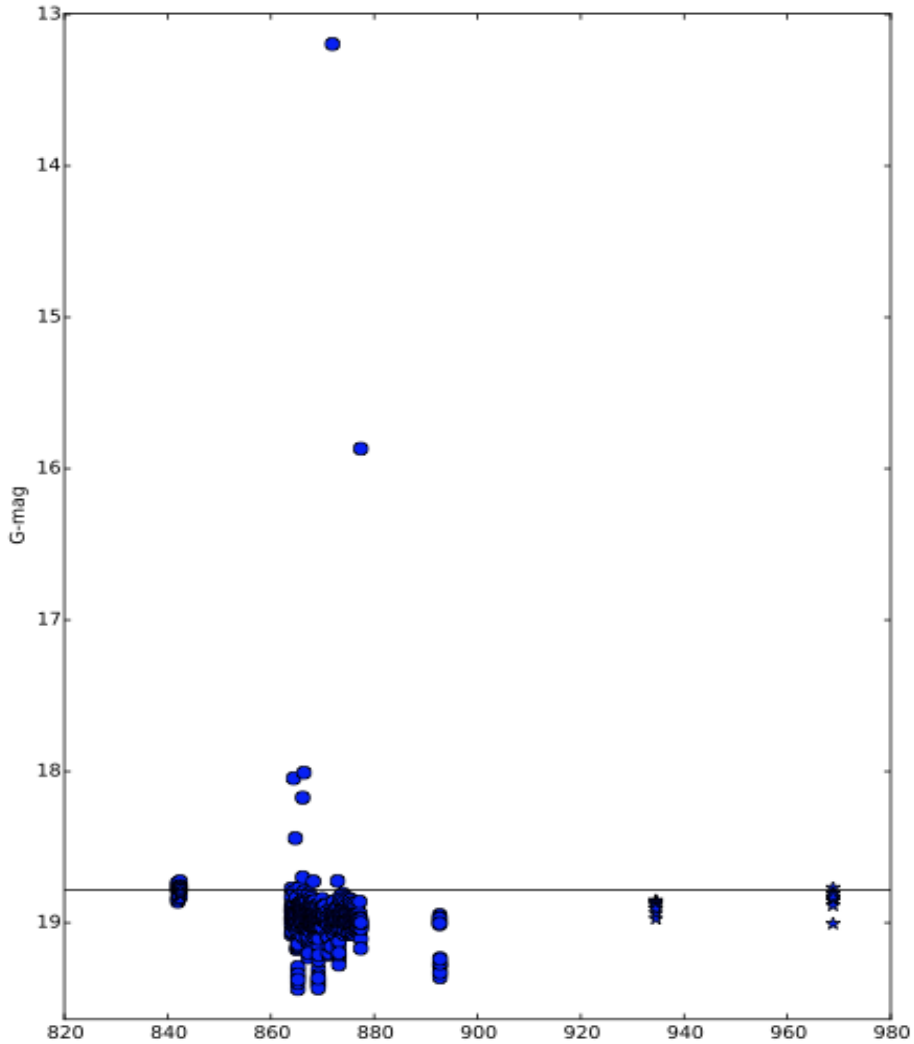


Time [days]

Quadrant IV



CCD number



Time [days]

Summary

- Gaia has the potential to discover new, fast things
- E.g. TDEs, eclipsing WD, other exotic things (unknowns)
- Algorithm looks very promising
- Further testing on e.g. CRTS data
- Segmenting the lightcurves
- Flag only consecutive outliers