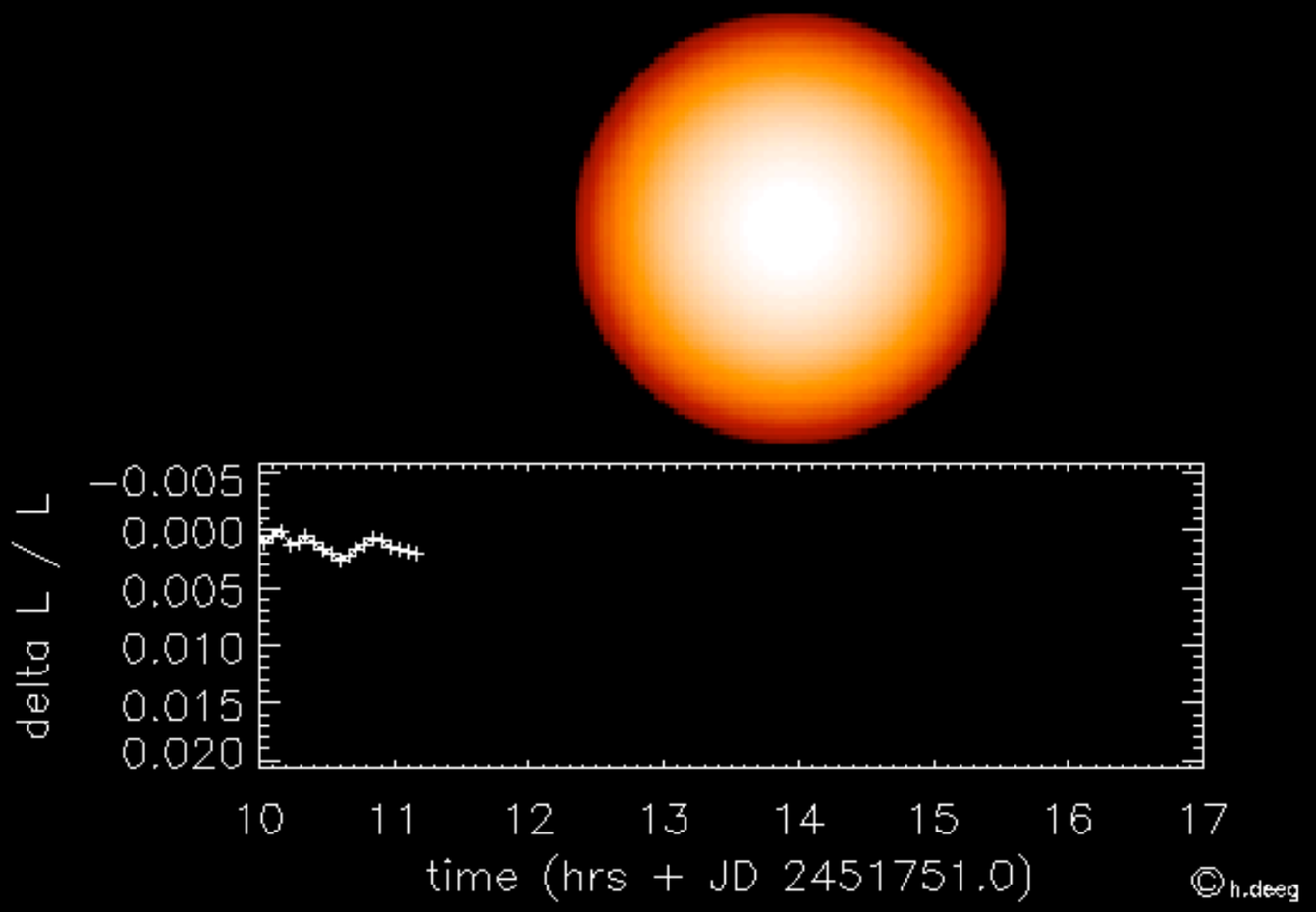
Searching for Occultations in the WFCAM Transit Survey



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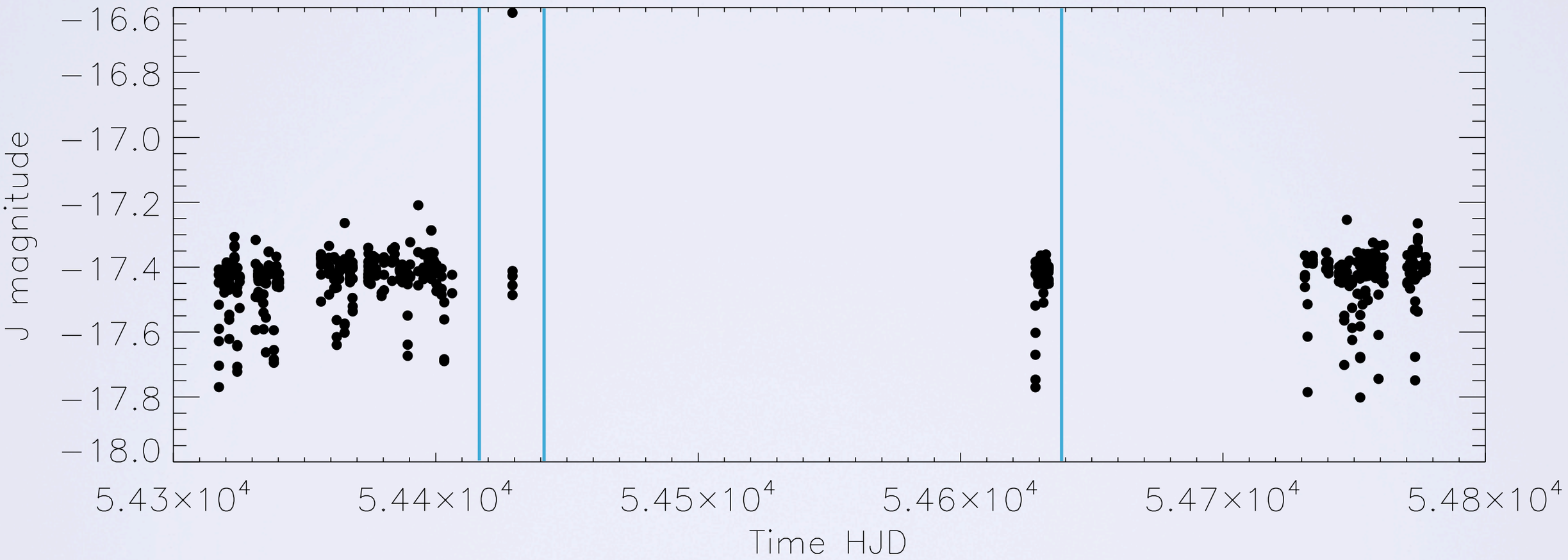
Outline

1) Light Curves
   - Intrinsic Variability & Correlated Noise
2) Occultation Detection
   - Automated Candidate Selection
3) Candidate Assessment and Prioritisation
4) Candidate Follow-Up Strategy
5) Summary

Light Curves

- For one paw-print we observe ~20,000 stellar objects with J < 19.

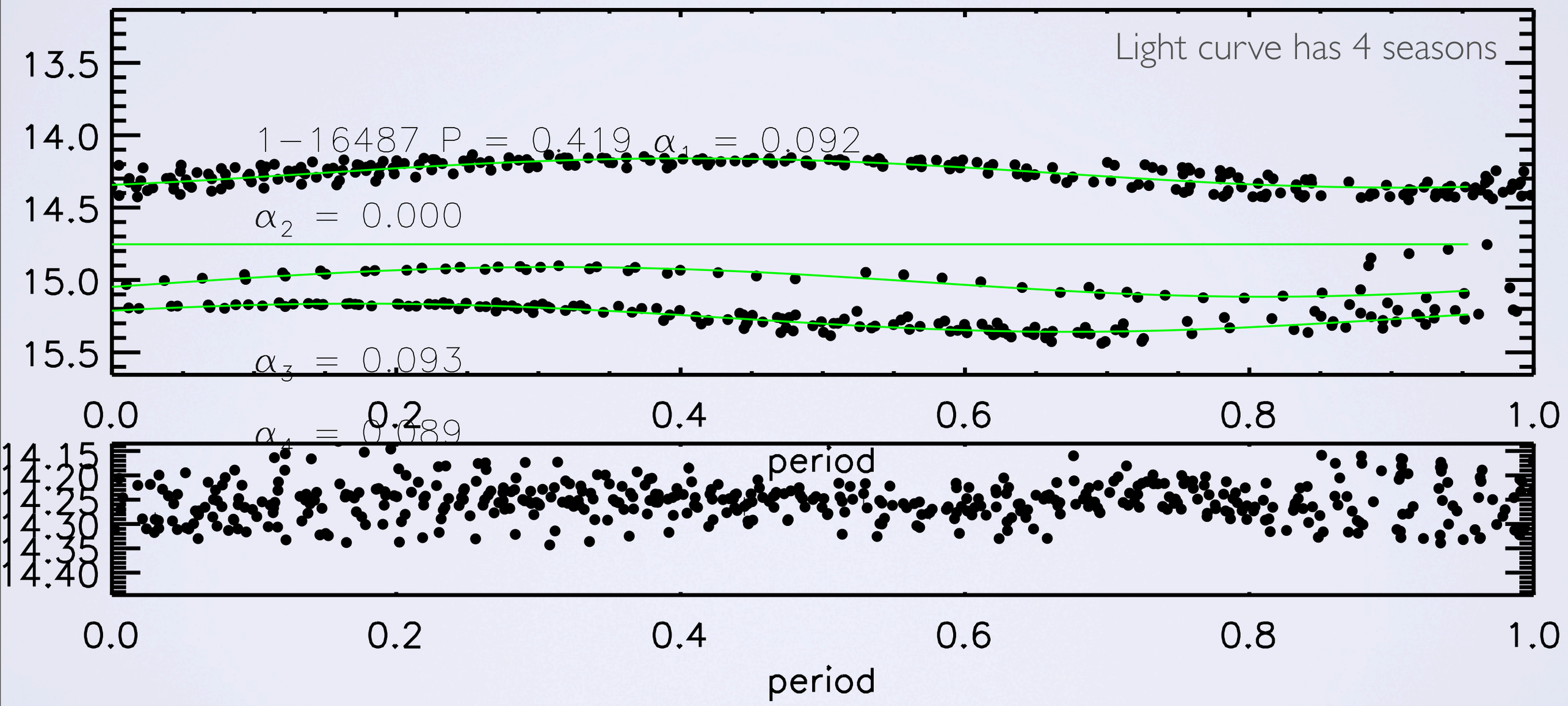
Example light curve from WTS



= New season

Variability Filter (Rotation)

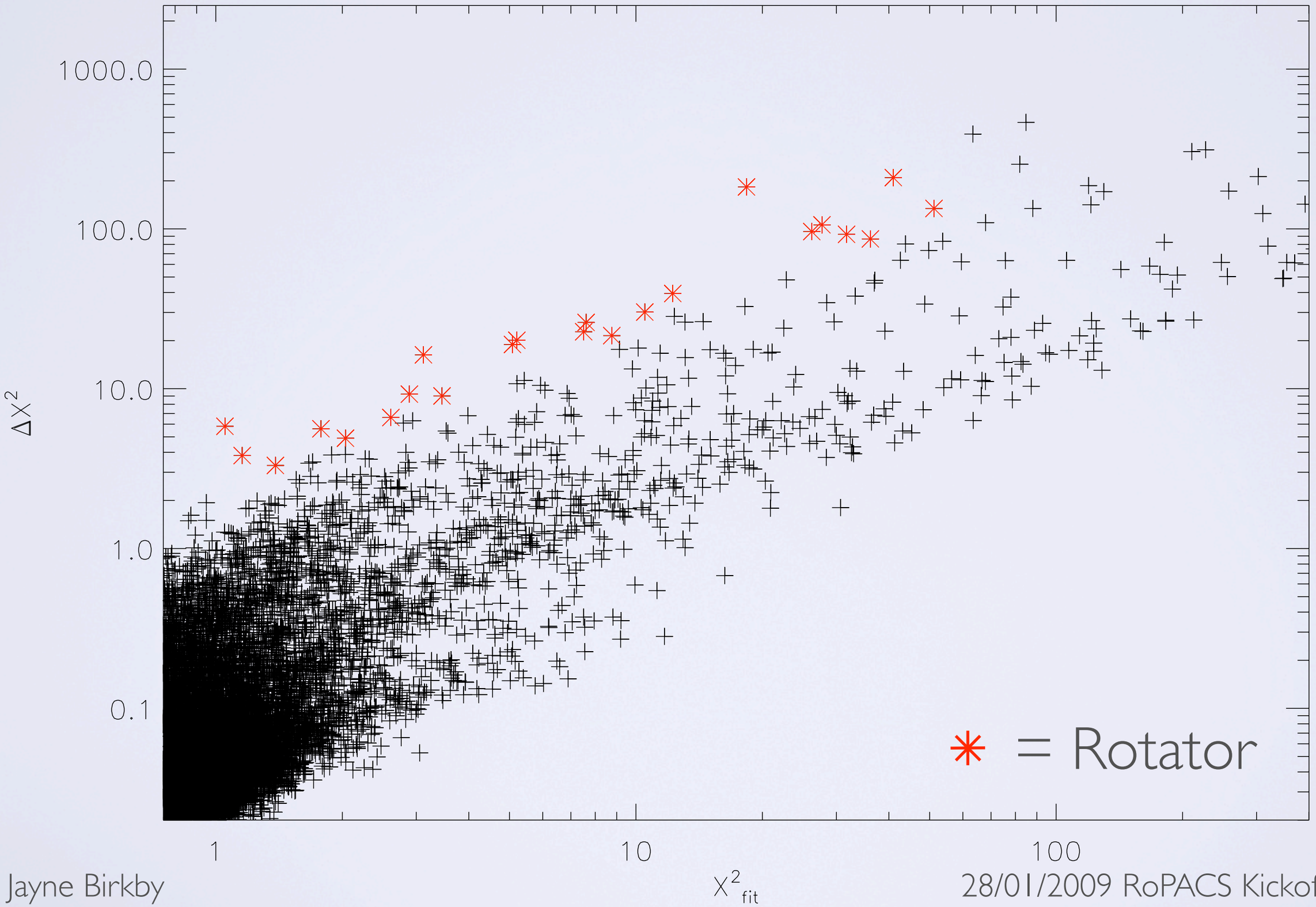
- We allow phase and amplitude to vary over gaps > 21 days (a season) but the period must remain fixed as rotation rate on expected to vary much on these timescales.



= Sinusoidal fit to light curve

Resulting light curve is relatively flat

Rotator Selection

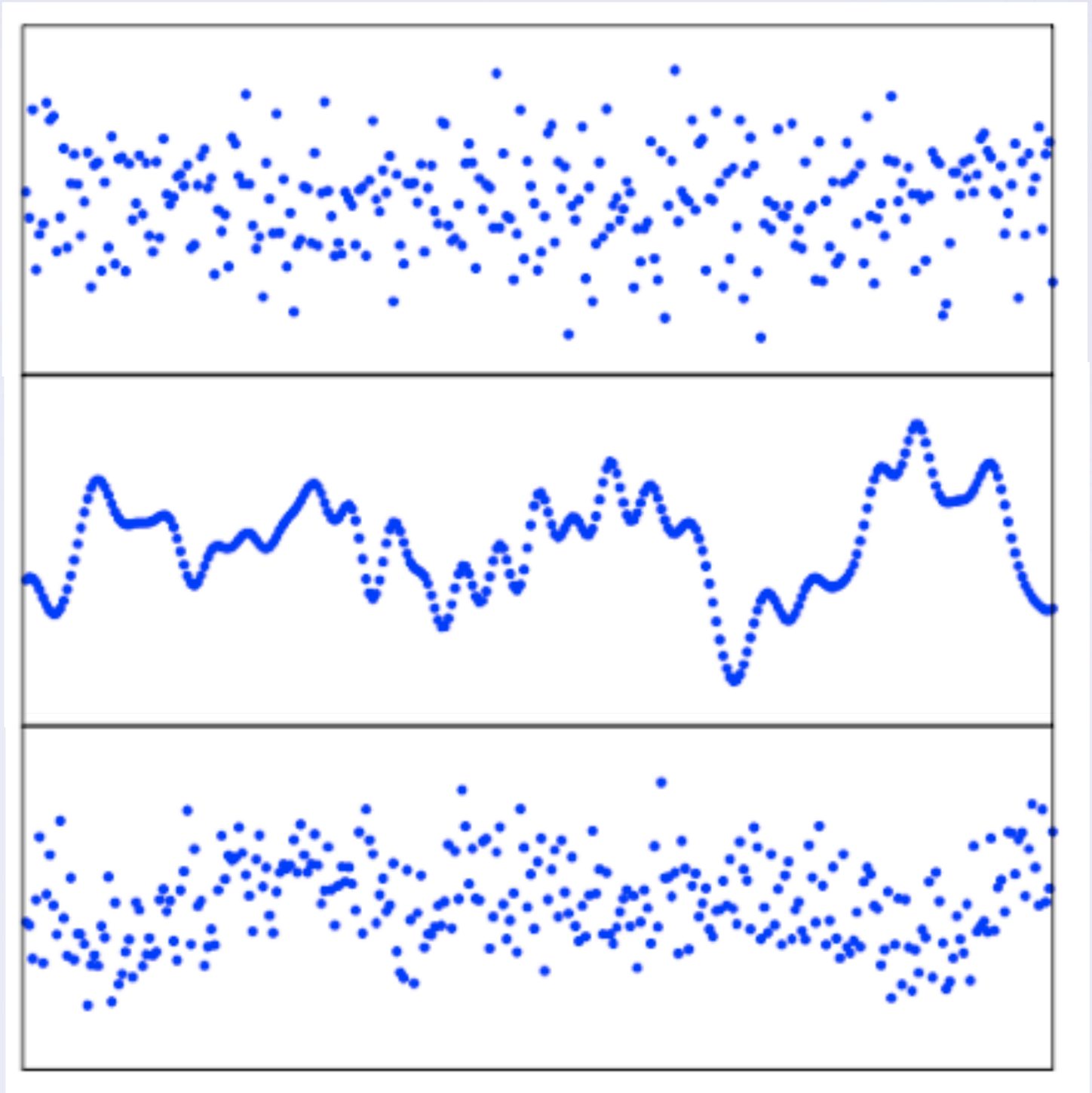


Correlated (Red) Noise

White

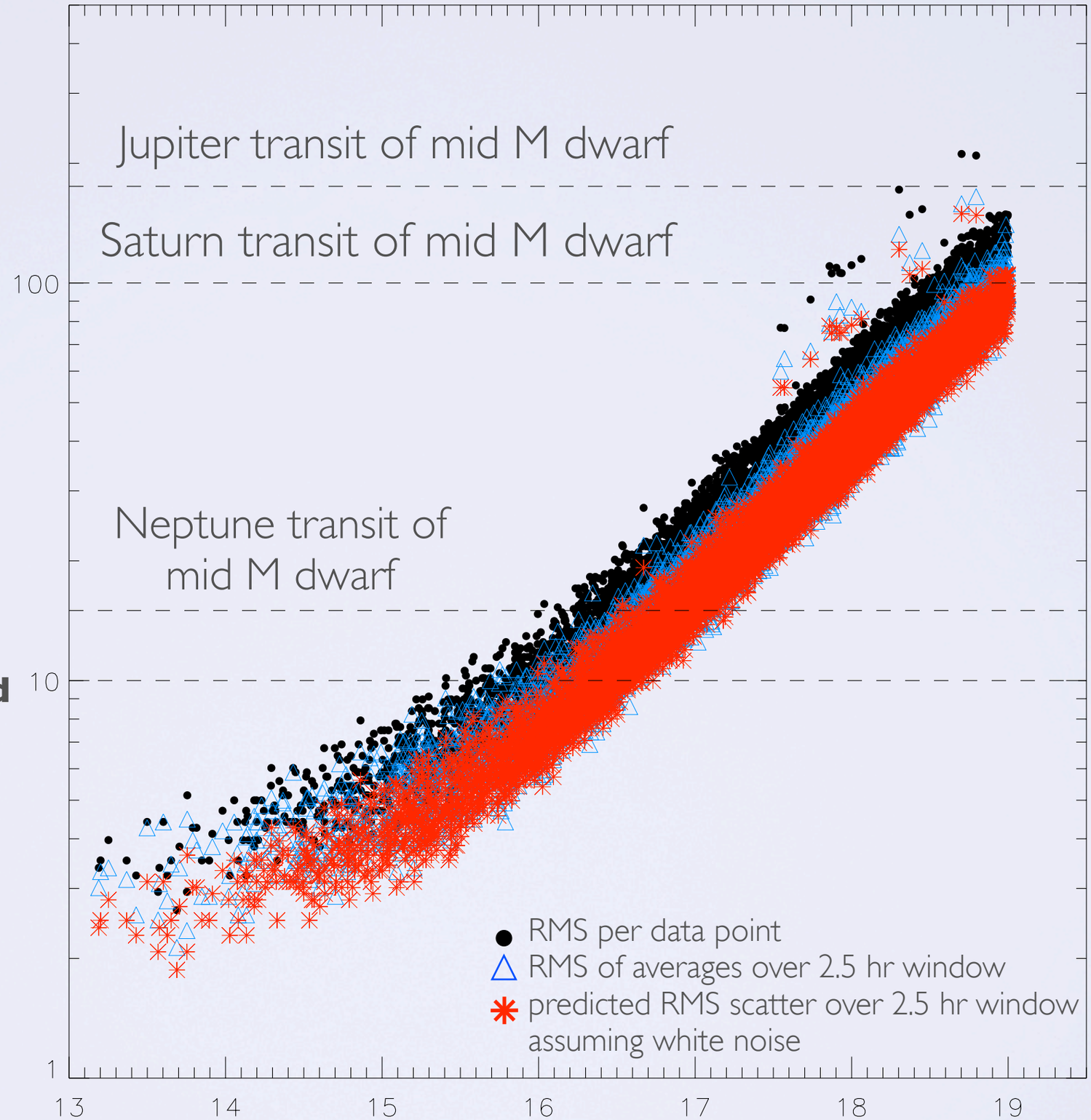
Red

OGLE
light curve



Pont et al. 2006

Correlated (Red) Noise



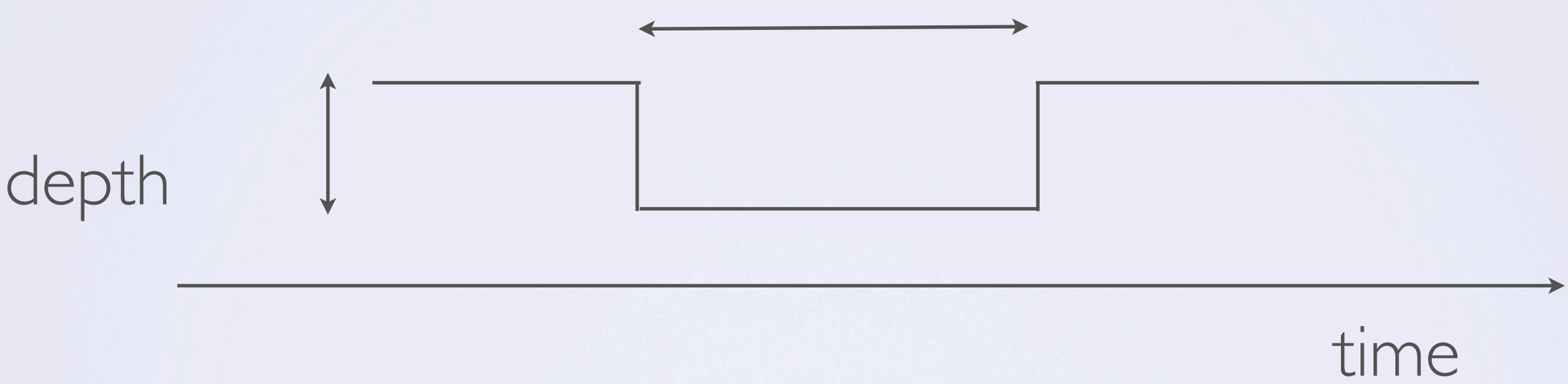
Large rocky transit of mid M dwarf or Earth-like of late M dwarf

Aigrain & Irwin, 2004

Occfit: transit detection algorithm

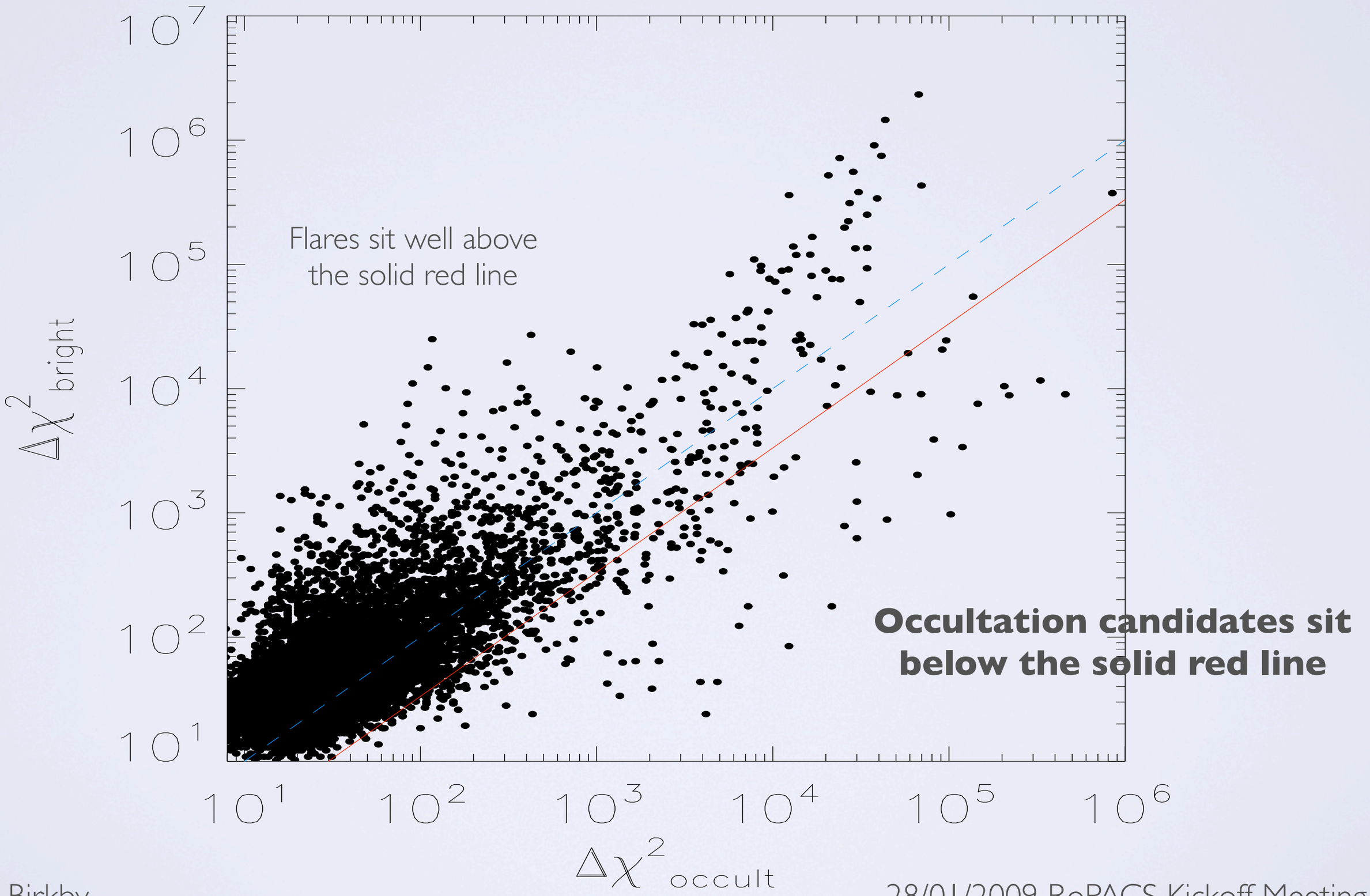
This is for occultation detection only. We distinguish between EBs and transits later by modelling.

Box-least-squares fitting algorithm

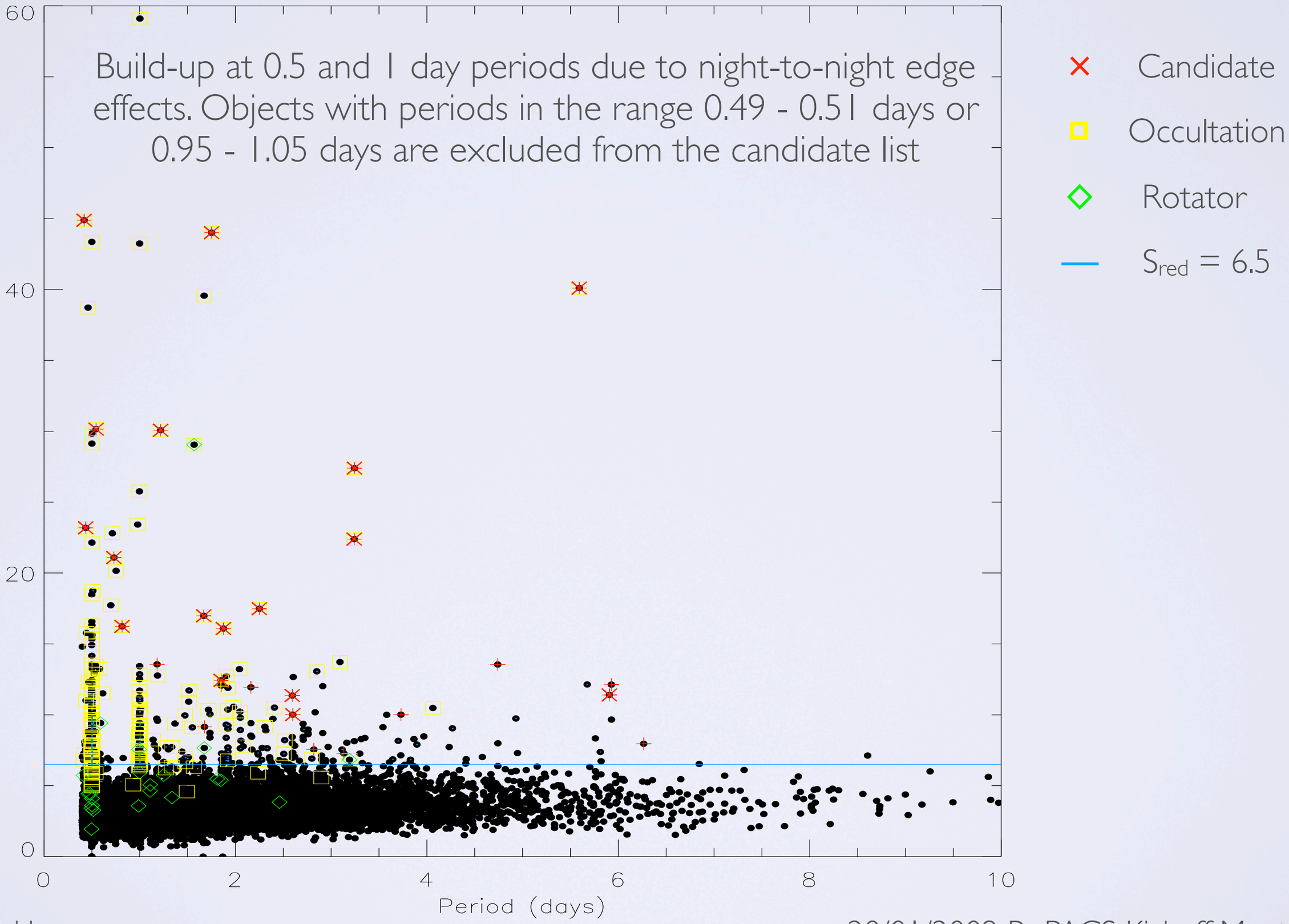


Input parameters i) Period 0.4 -10 days ii) parameter that keeps a physically plausible duration to period ratio (range 0.4-1.67)

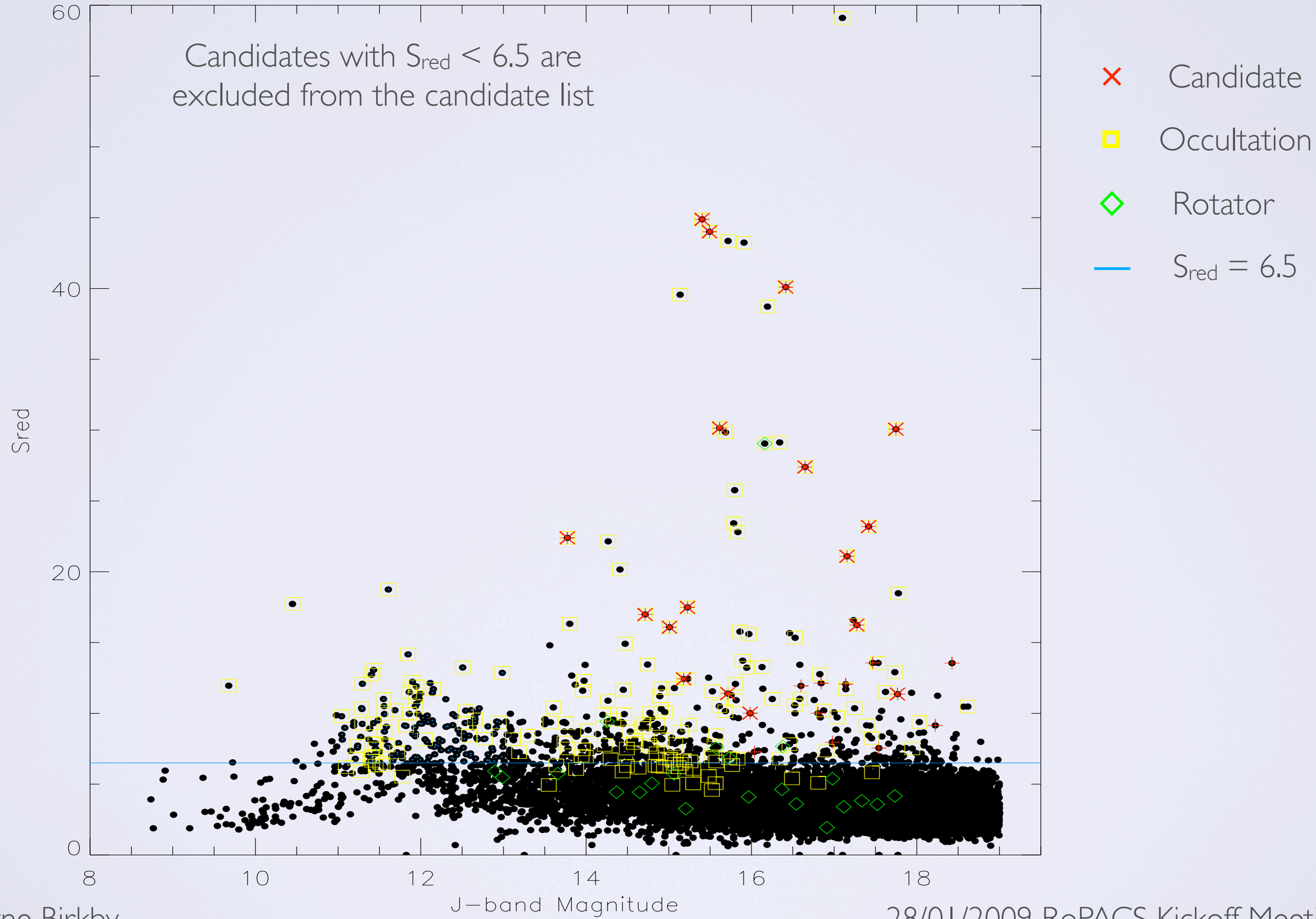
Occultation vs. Brightening



SNR vs Period



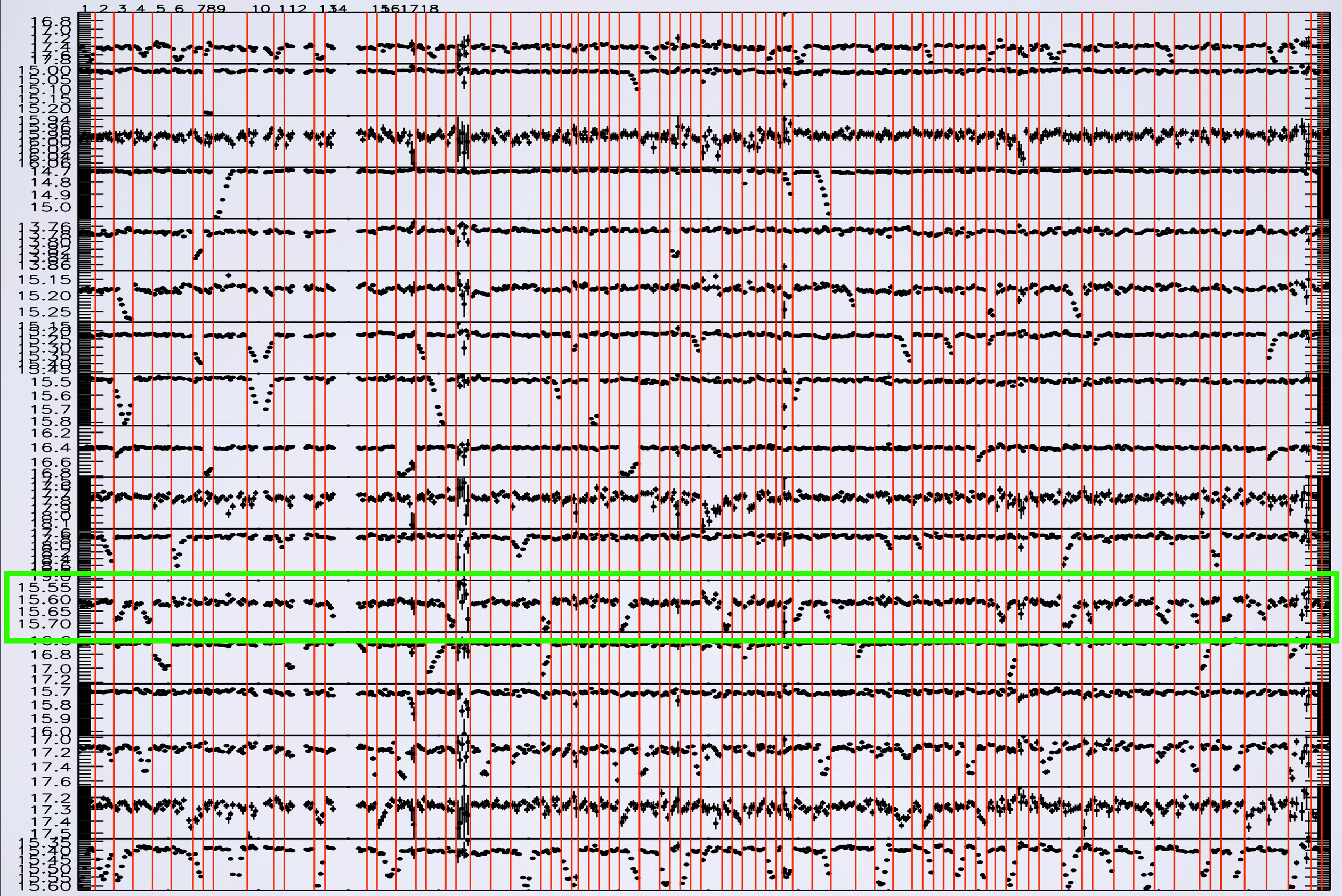
SNR vs. J-band Magnitude



Candidates

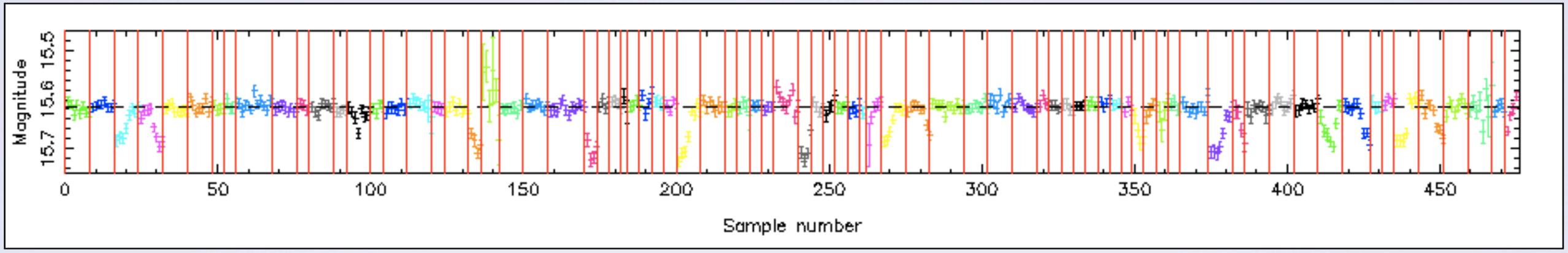
- It took 4 days to run Occfit on ~20,000 light curves with J magnitude < 19.
- Automated cuts yield 27 candidates. 10 are false positives due to bad data on one night therefore we need to reject some frames based on DQC parameters: e.g. zero-point, seeing, ellipticity and sky brightness
- Our final sample contains **17 transiting or EB candidates**.

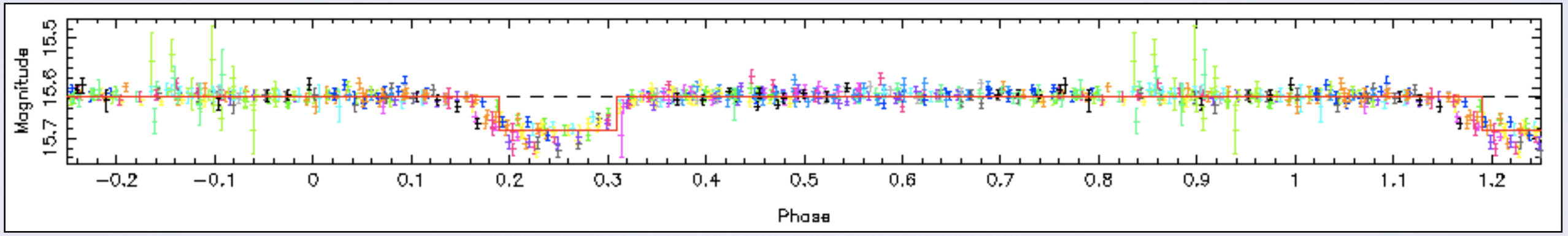
Candidates



Candidates

WTS-3-9148

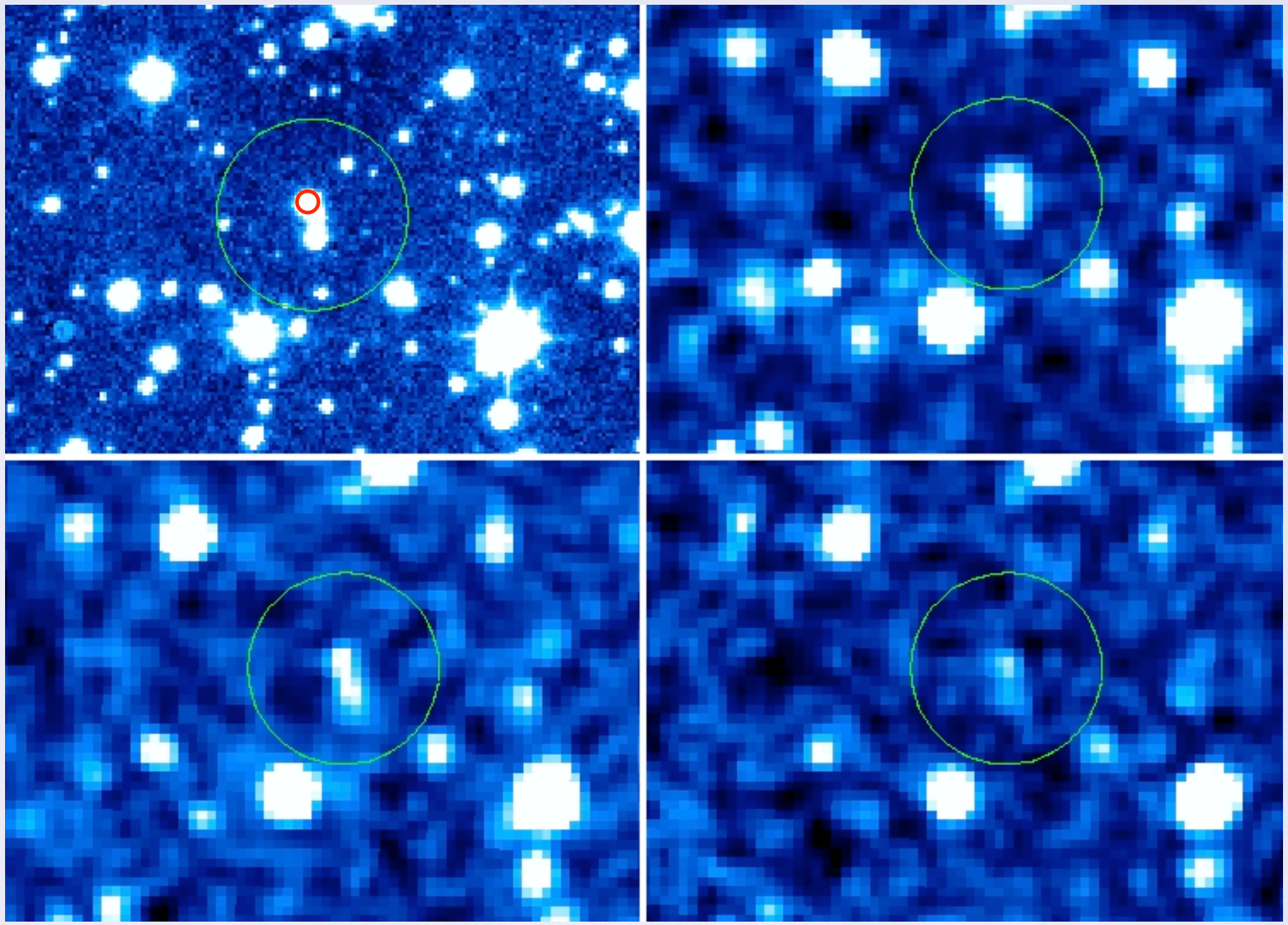




- J = 15.6 mag Depth = 0.06 Period = 0.554 days $R_p/R_* \sim 0.25$

Issues...

WFCAM



J

H

K

~33% of candidates are blended

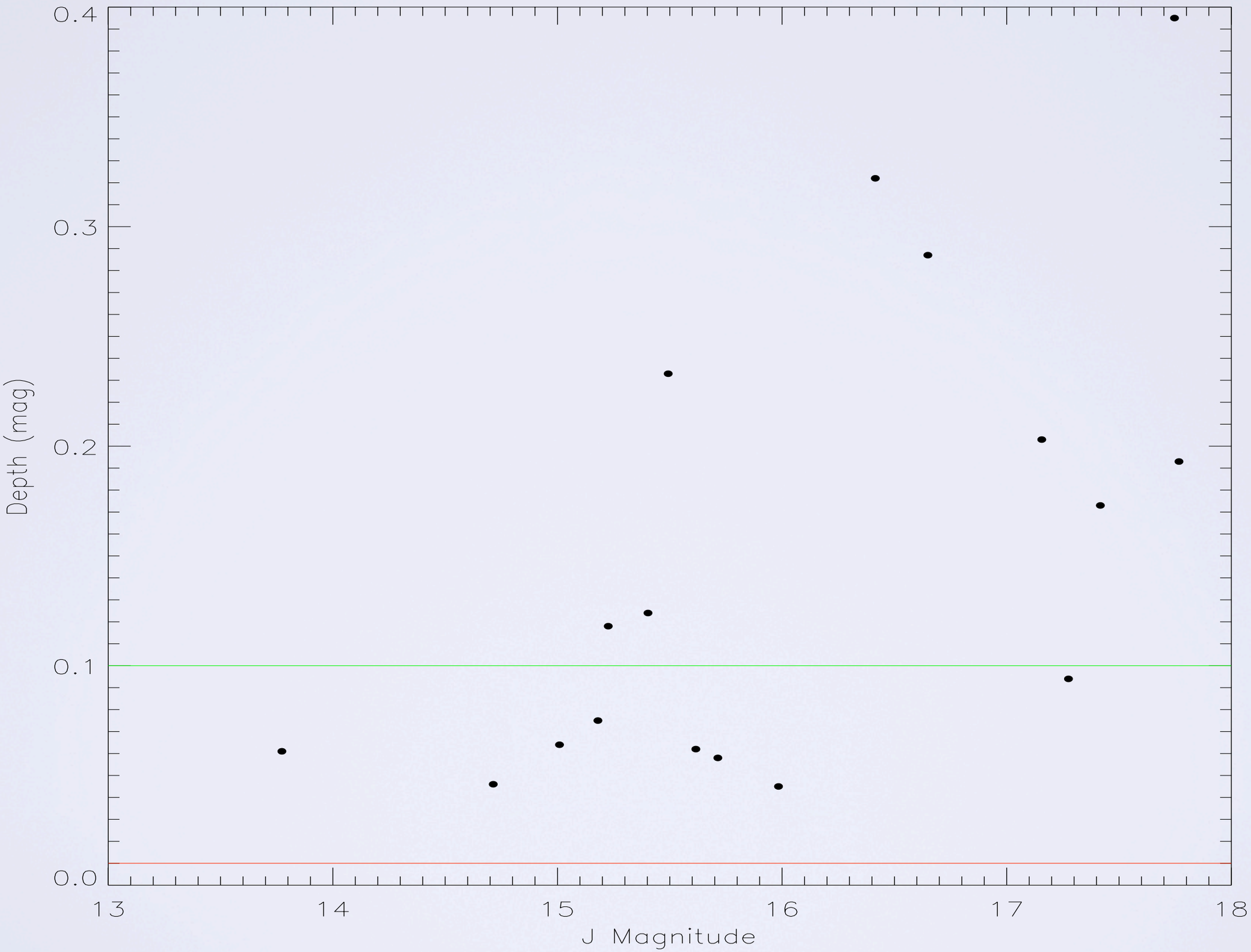
Candidate Assessment

- 1) Estimate spectral type and luminosity class from optical and infrared colours e.g. WTS H & K, 2MASS JHK, SDSS...
- 2) Quantify third light contamination
- 3) Estimate radius primary and planet/secondary
- 4) Devise a method for initial classification and prioritisation of candidates for follow-up

Follow-up

- Required follow-up is based on candidate properties:
  - High res imaging to resolve objects
  - Robust period from additional light curves
  - Transit morphology (multi-wavelength)
  - Determine radius based on spectroscopy
  - Measure low precision RVs for EBs
  - Measure high precision RVs for planets

Transit depth as a function of J magnitude



Summary

- We have an end-to-end candidate extraction system that works successfully on the WTS. The entire process for a single pointing (from raw images to candidate selection) takes ~5 days.

- We find 17 planet/EB candidates from ~20,000 stars in one paw-print. This scales to ~550 candidates in the entire survey.

- We need to devise a simple, concise and effective scheme that prioritises candidates for follow-up.