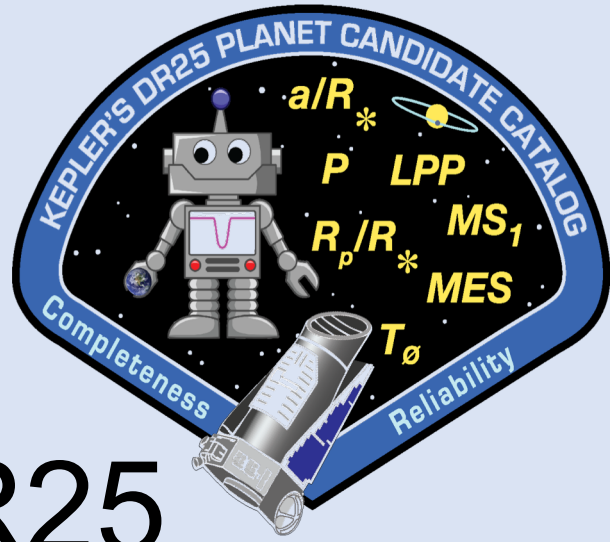


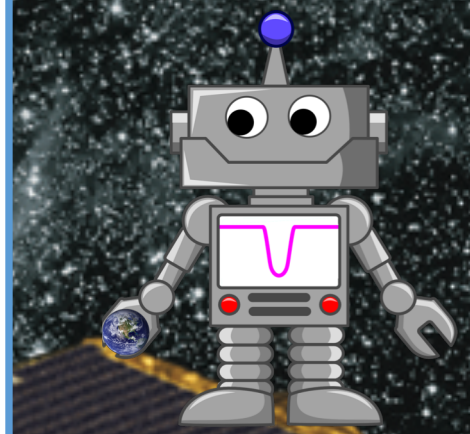
Reliability of the Kepler DR25 Candidate Catalog

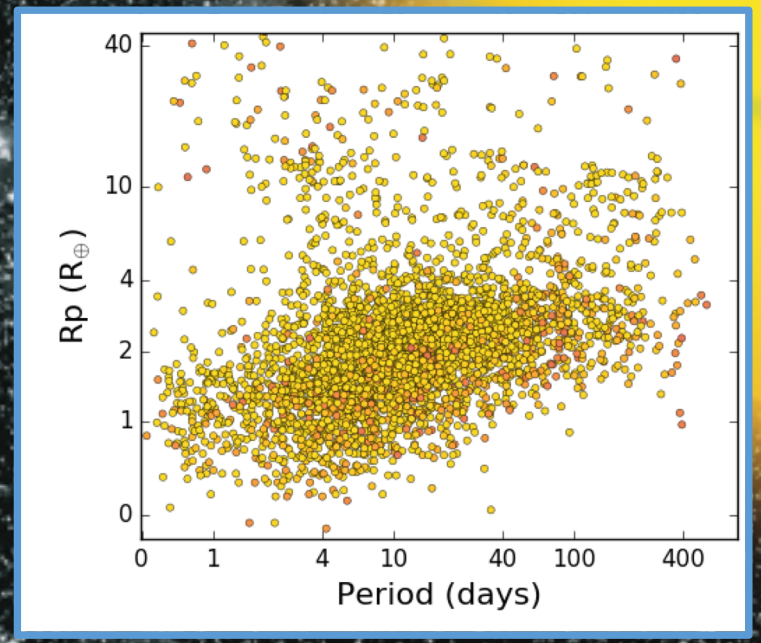
Susan E. Mullally, STScI
Jeff L. Coughlin, SETI Institute
Steve Bryson, NASA Ames
The Former Kepler Team

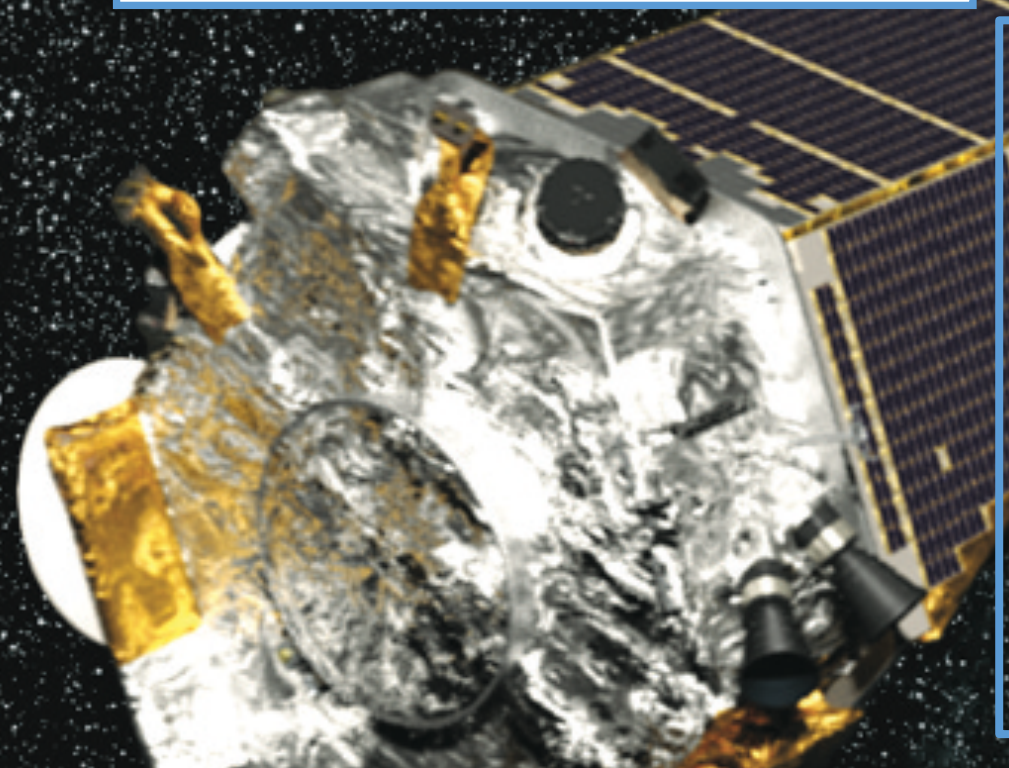
DR25 Catalog Overview

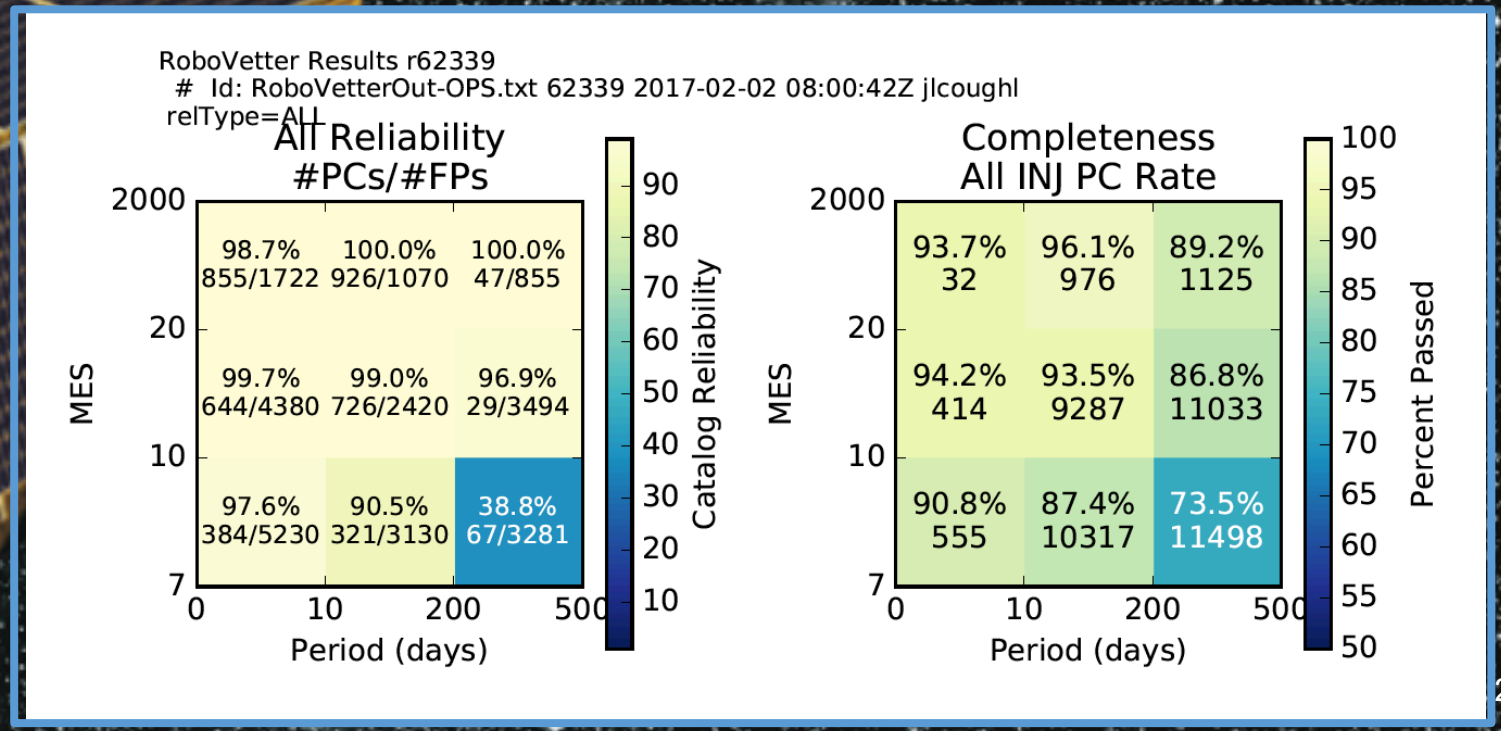
Overall Statistics

- ~32,500 TCEs
- 8054 KOIs
- 4034 Planet Candidates
- 219 New Candidates
- ~85% Catalog Completeness
- ~97% Catalog Reliability

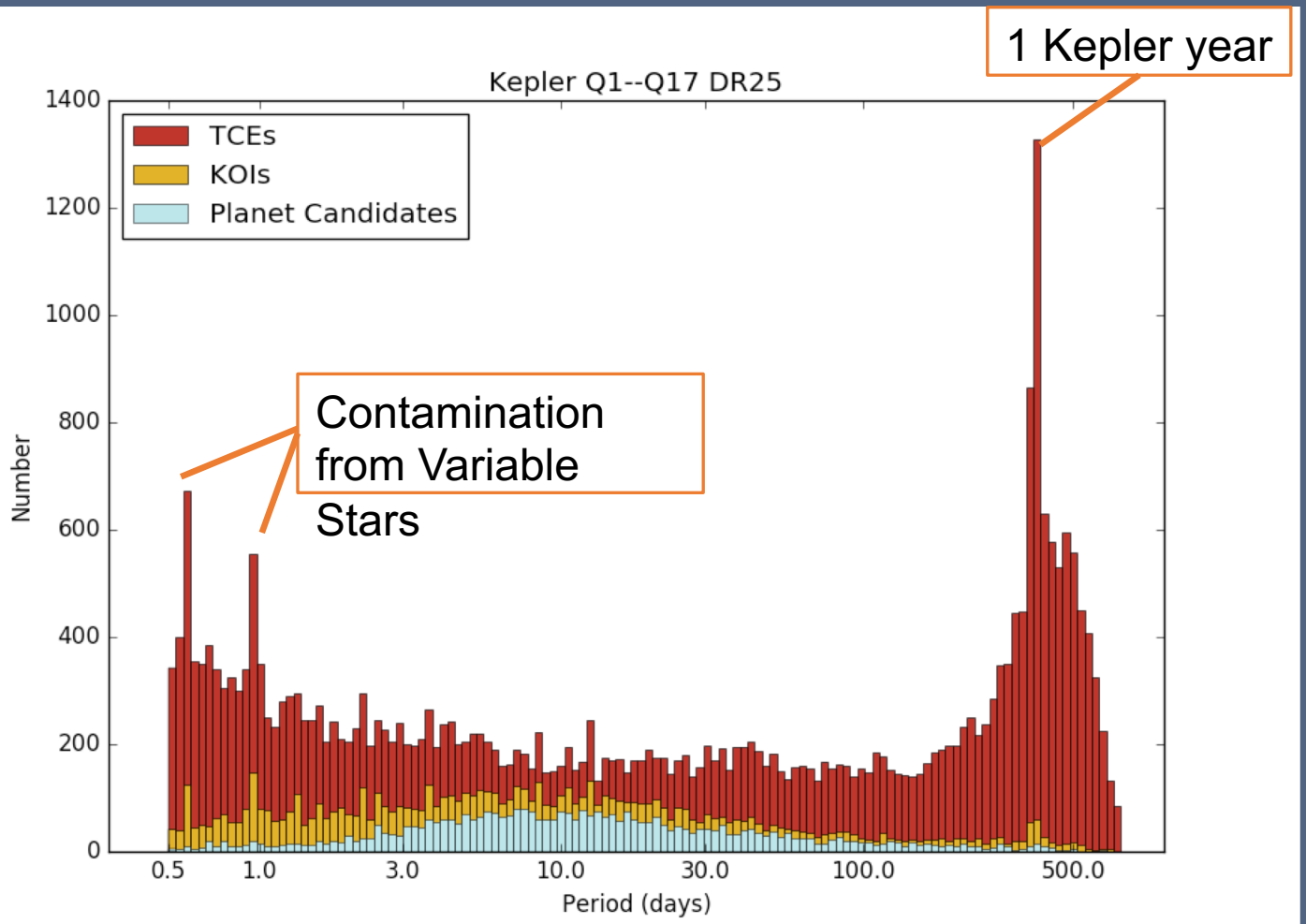




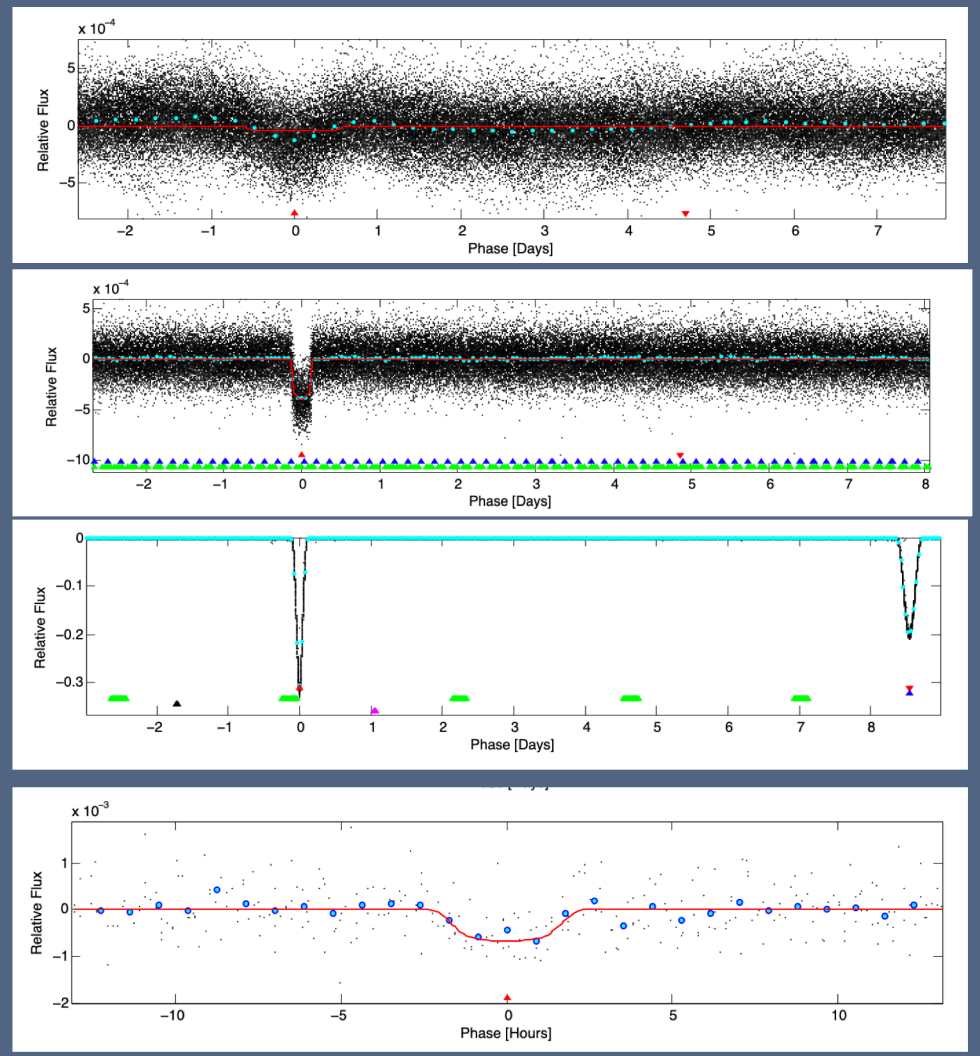




Pipeline Detections -- TCEs



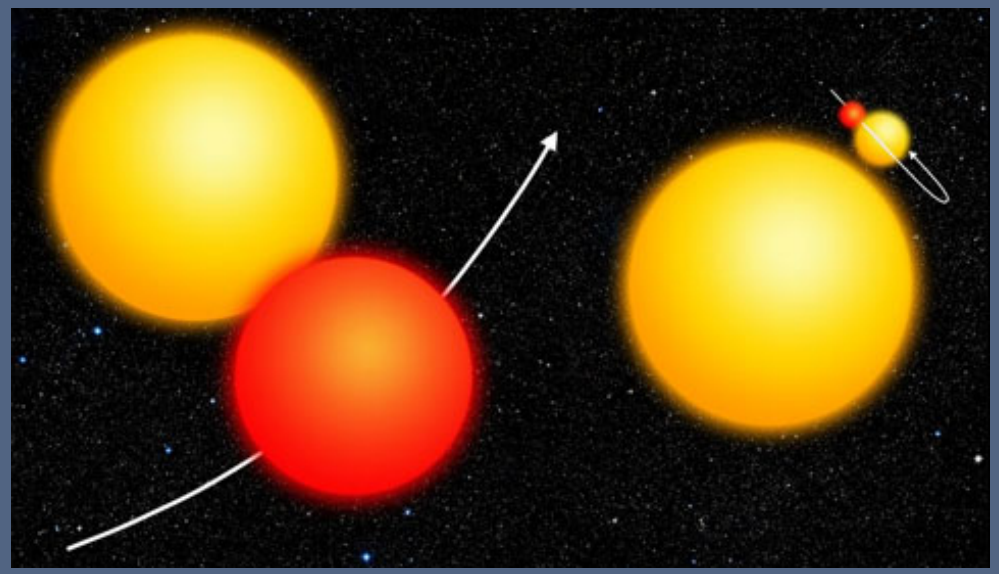
Folded Light Curve TCEs



What Causes The False Positives?

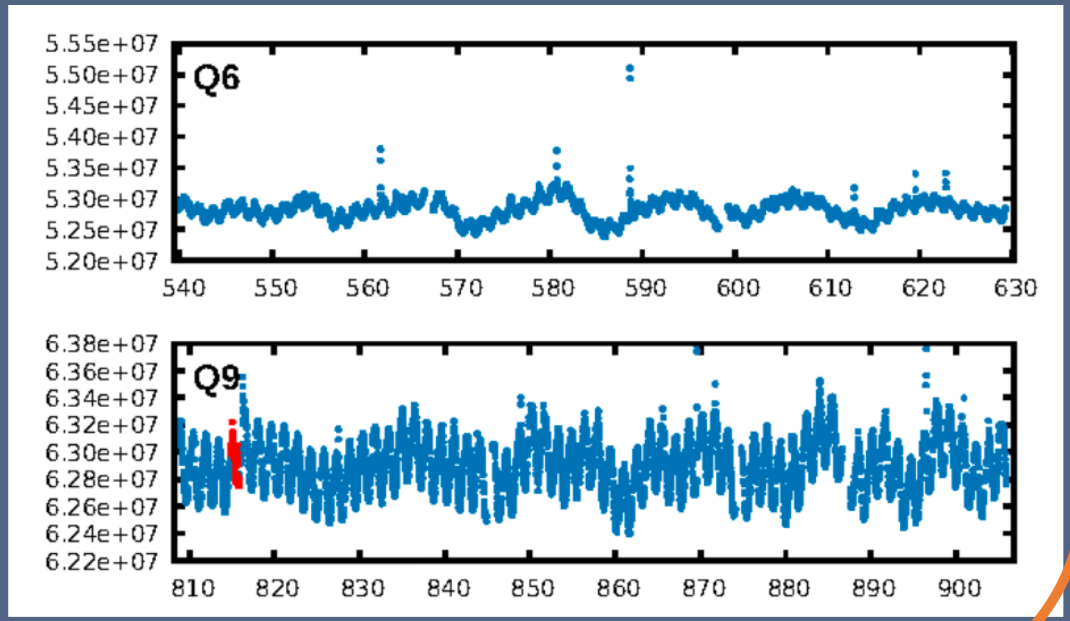
Astrophysical False Positives

- Binary Stars
- Background Binary Stars



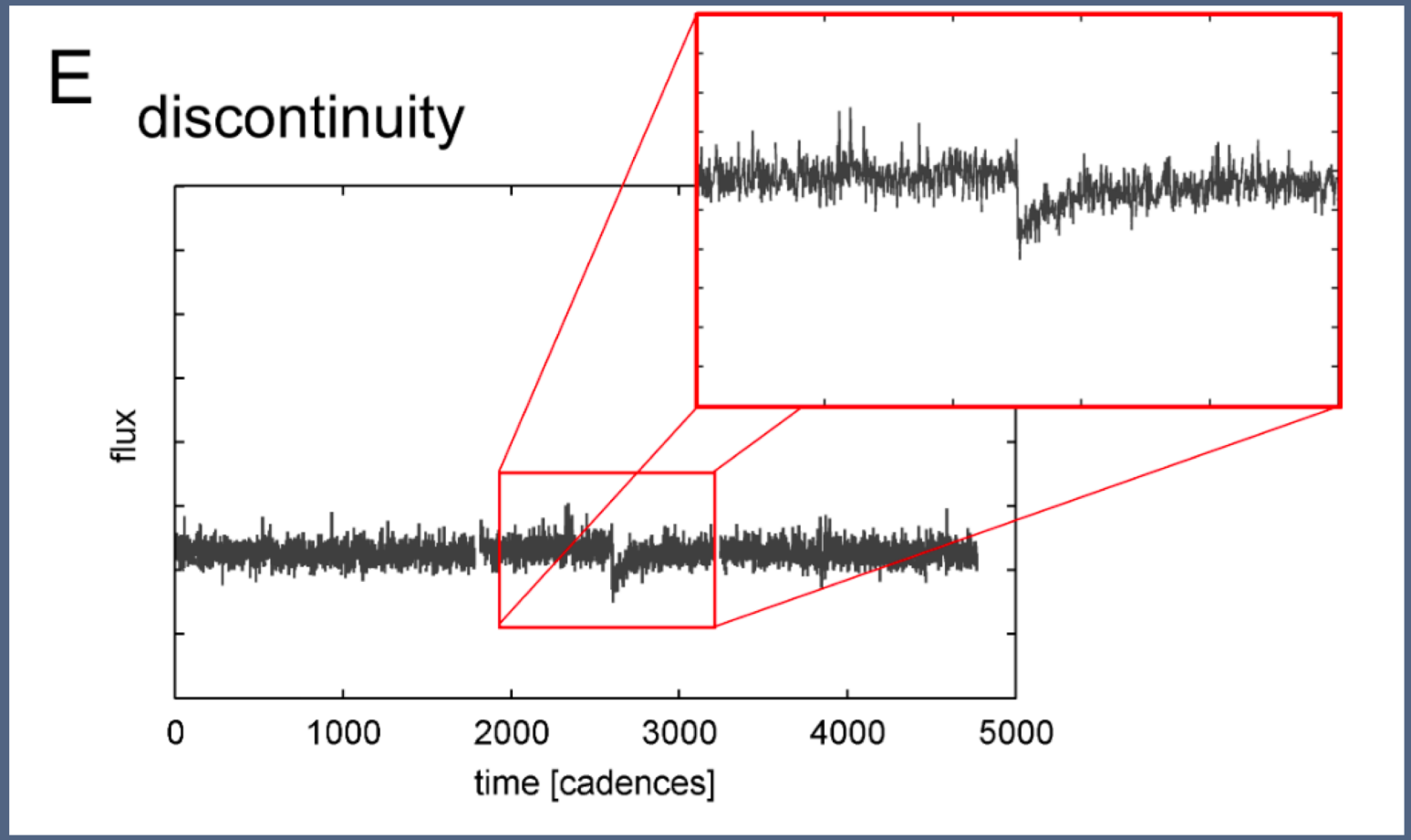
Non-Perfect Stellar Light Curves

- Instrumental Noise
- Stellar Variability



Example False Positives

Sudden Pixel Sensitivity Dropouts (SPSD)



Stumpe et al. 2012

Example False Positives

Rolling Band

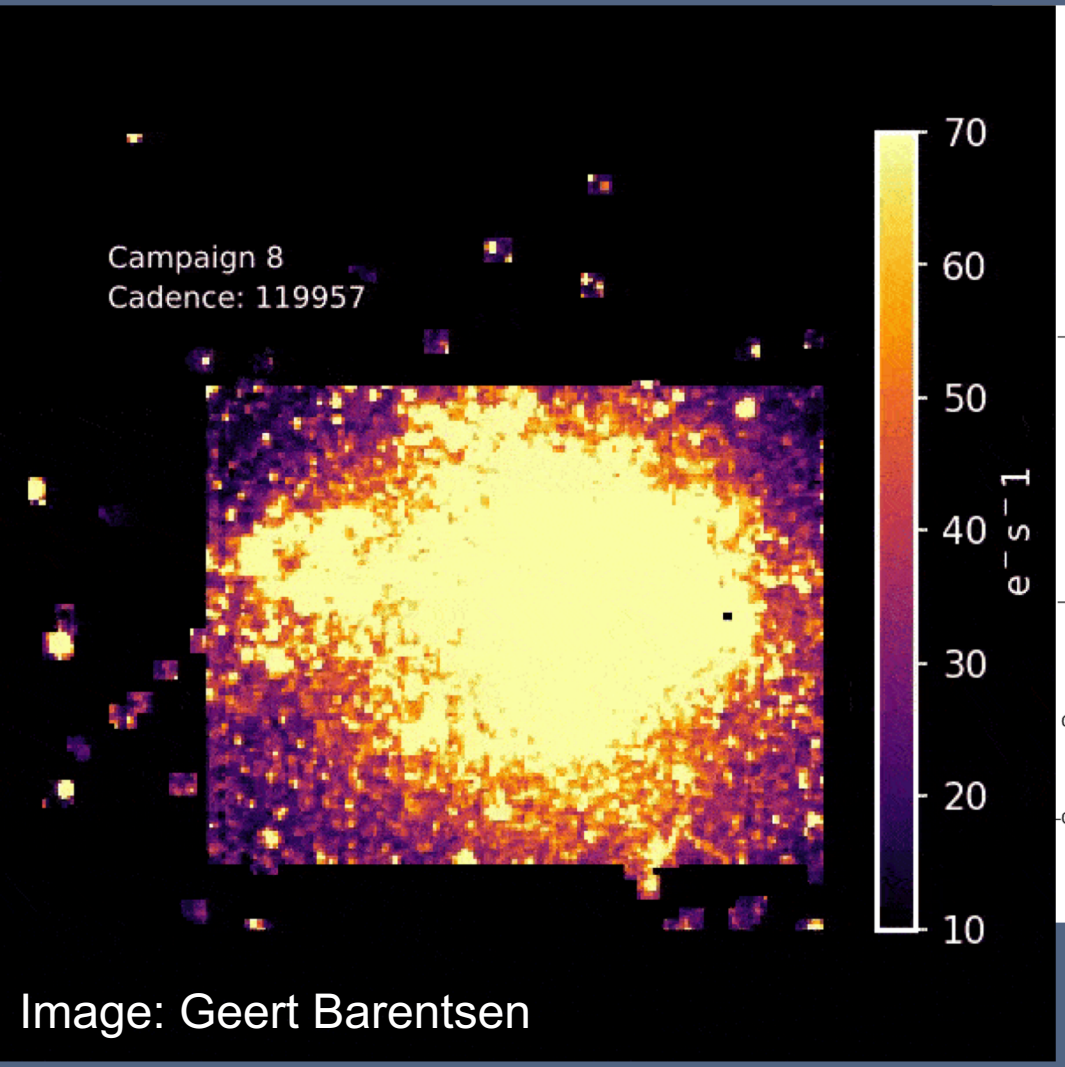
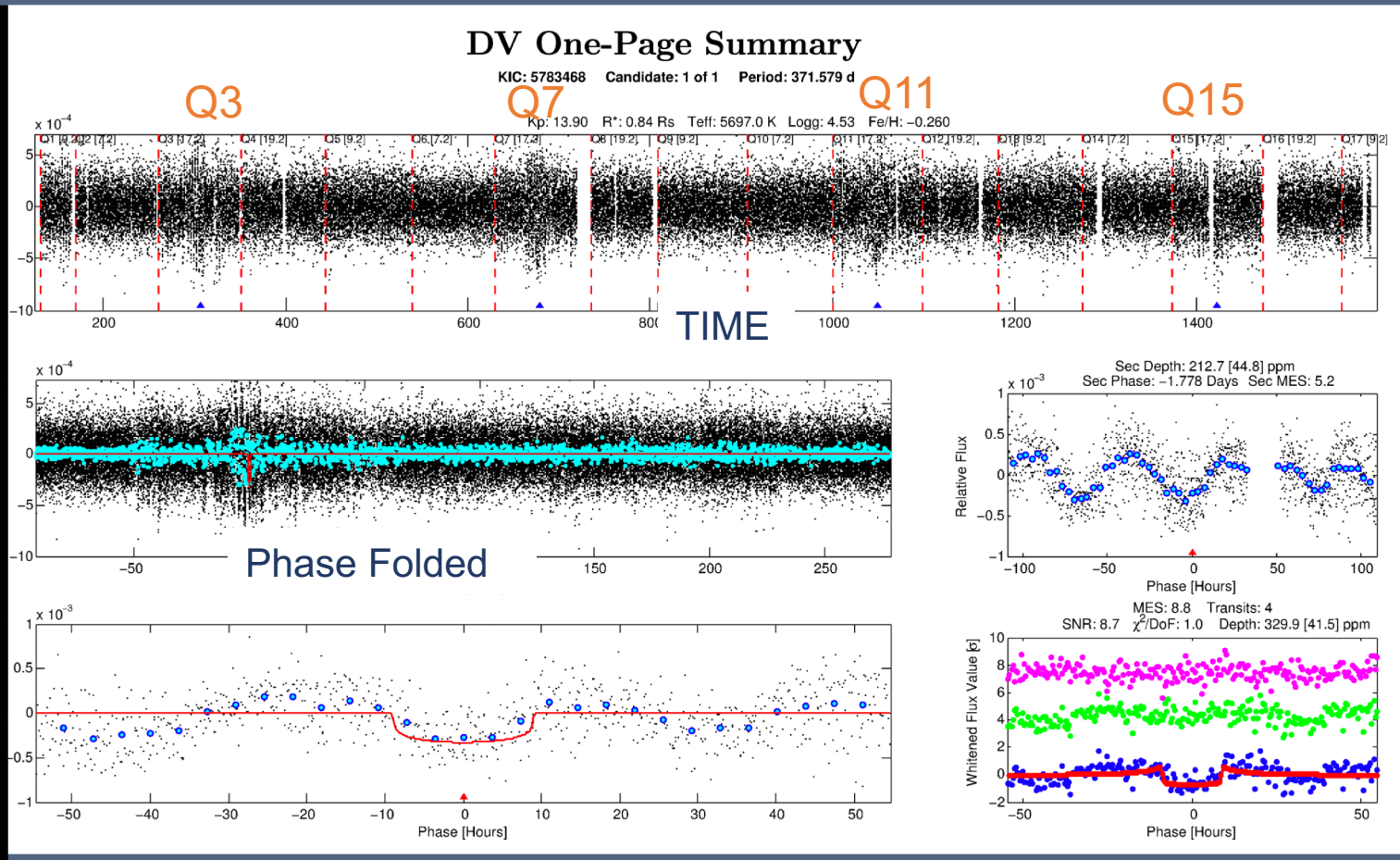
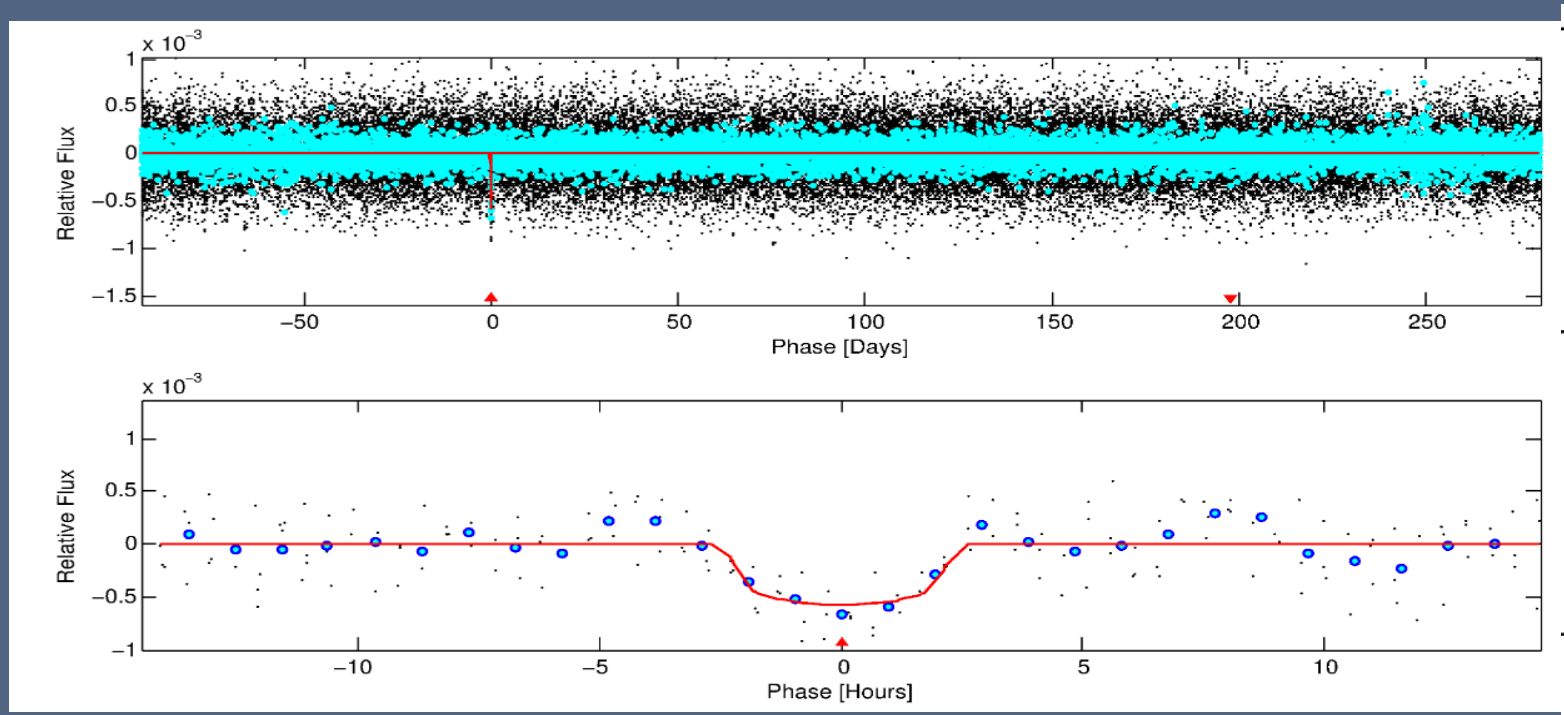


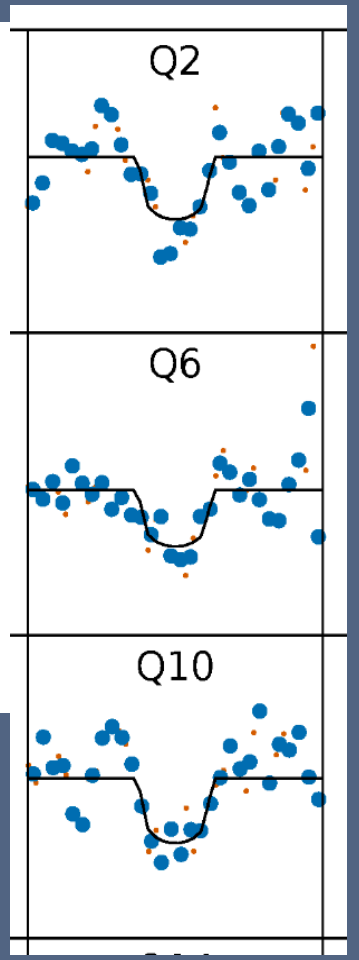
Image: Geert Barentsen



Low Signal To Noise Events

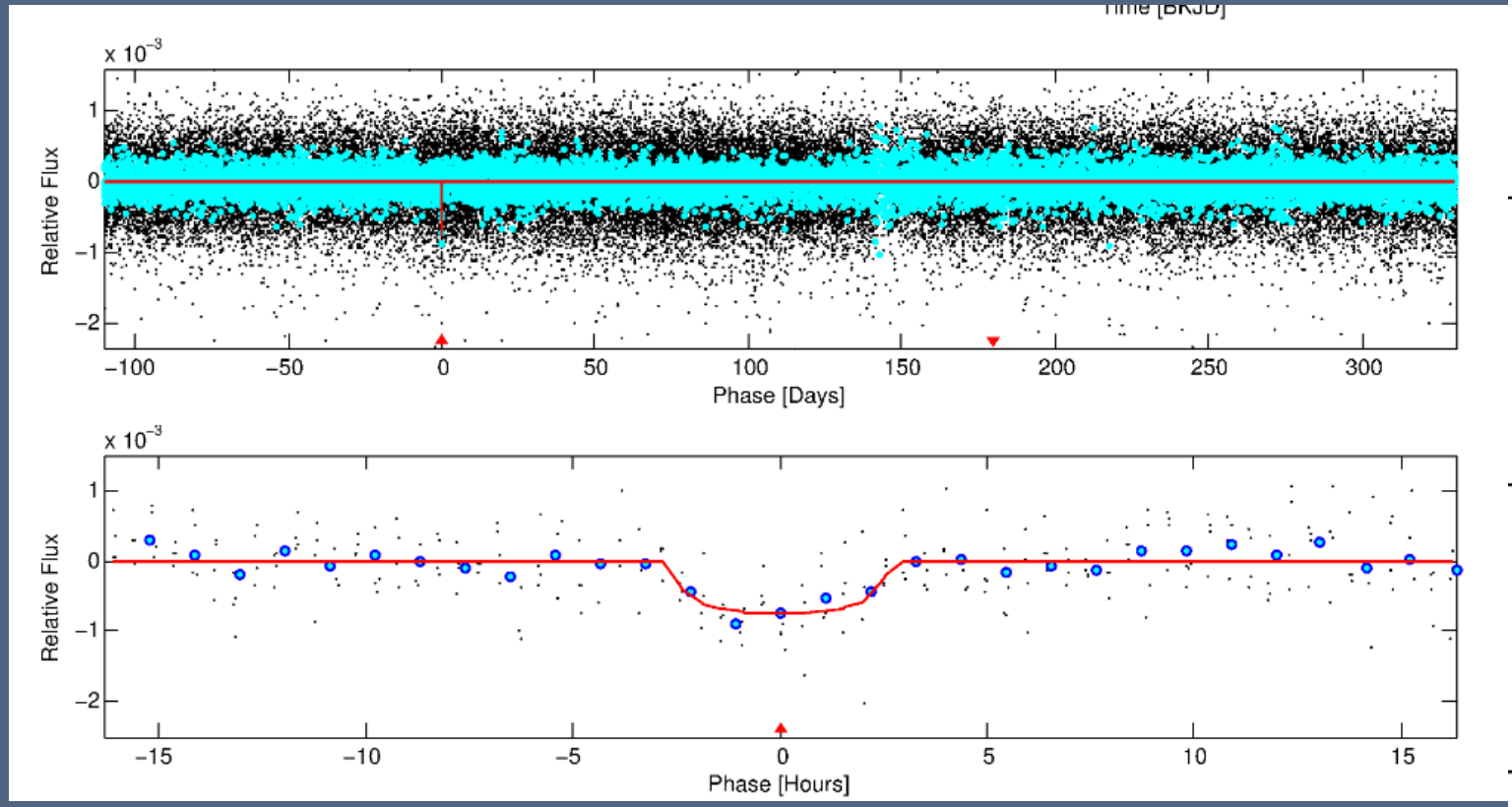
1

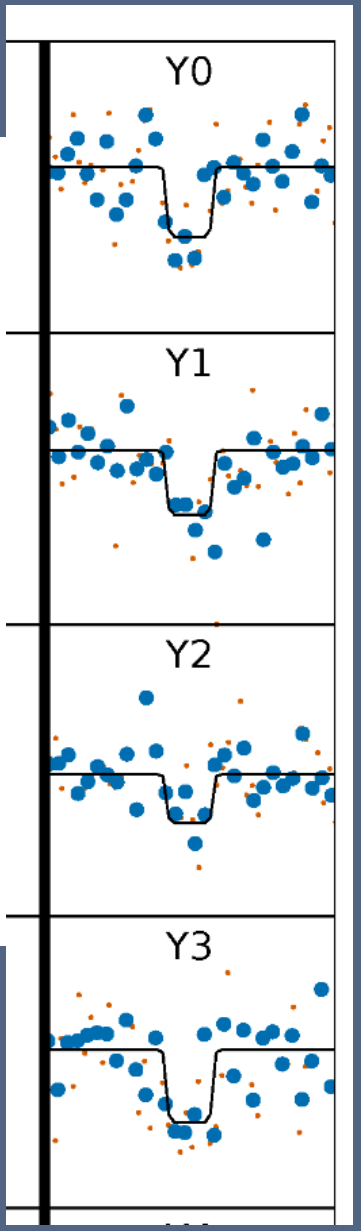




Low Signal To Noise Events

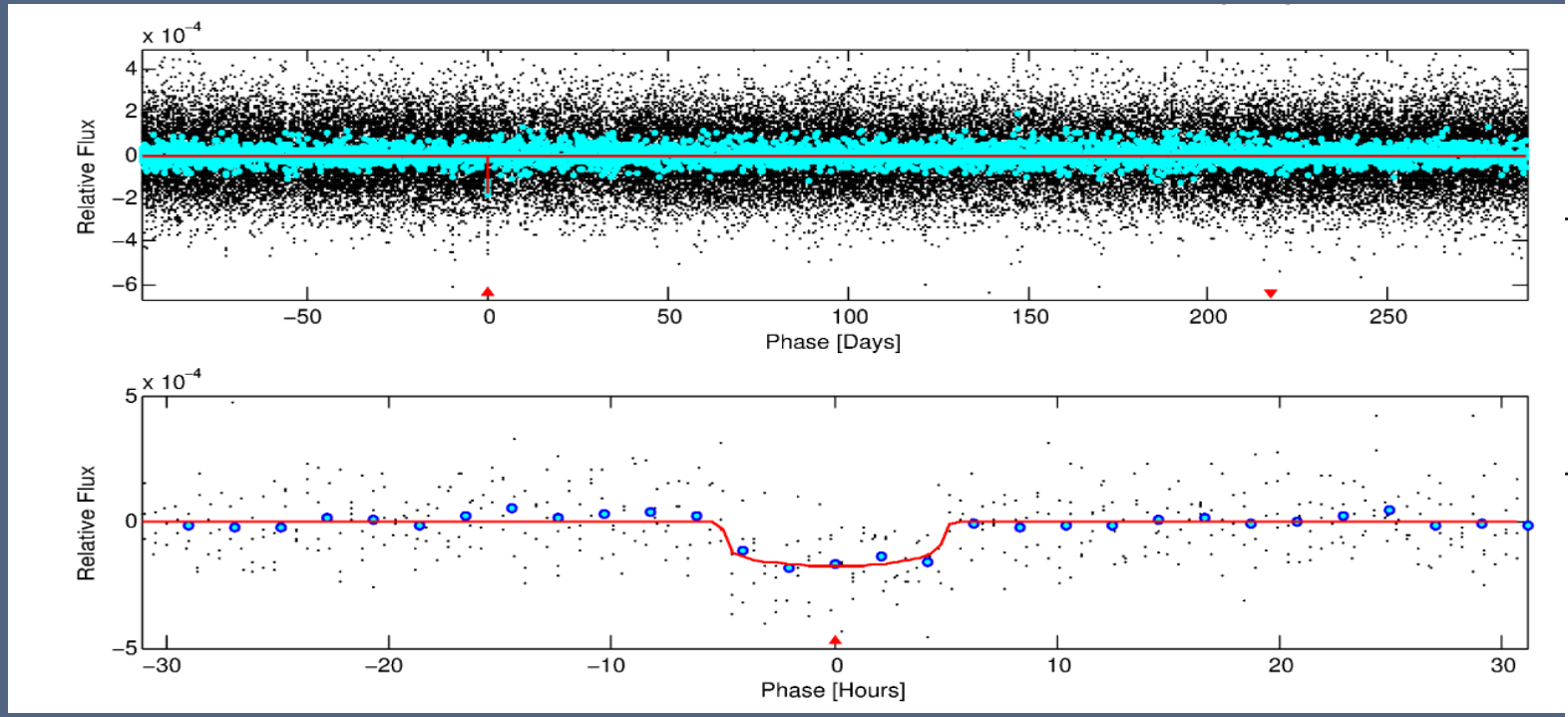
2

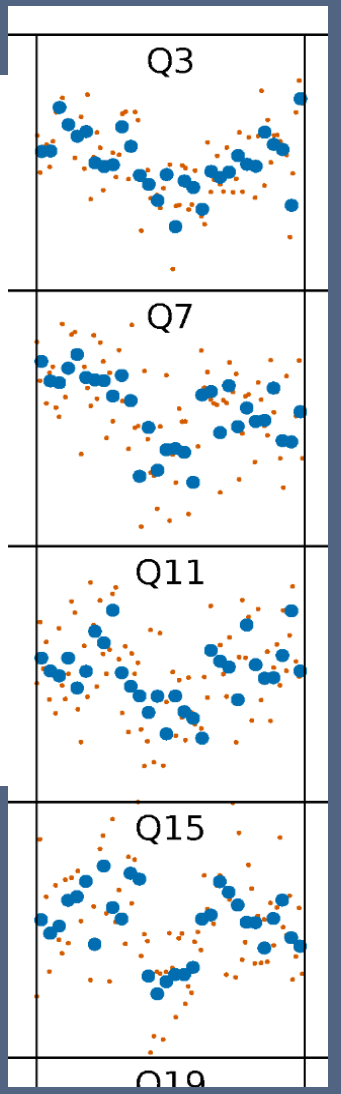




Low Signal To Noise Events

3

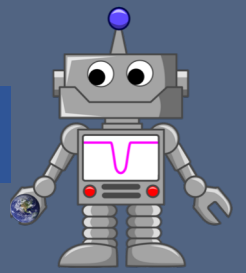




Simulating False Alarms

Create False Alarm TCEs that Emulate Type and Frequency of True False Alarms

Vet those TCEs with the Robovetter

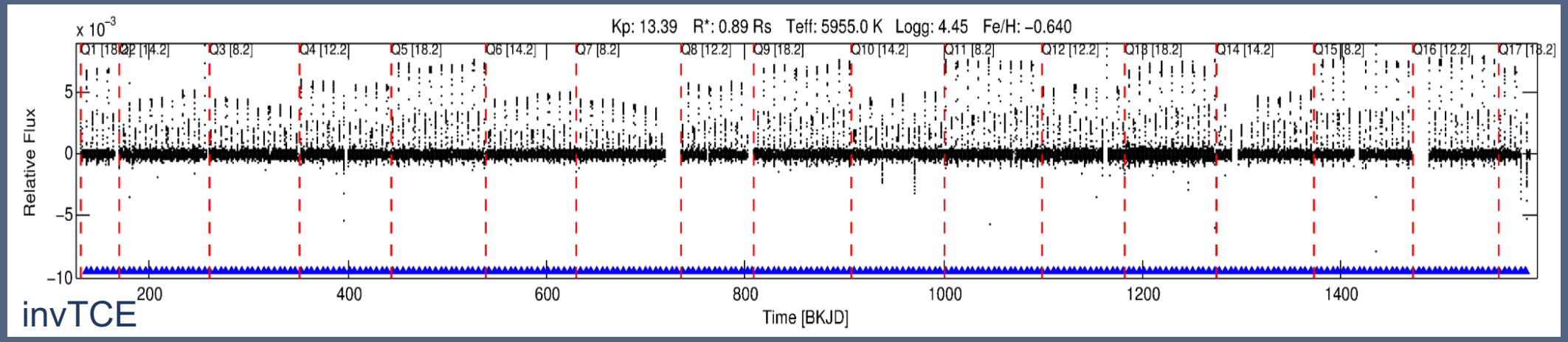


Measure Catalog Reliability

Simulating False Alarms

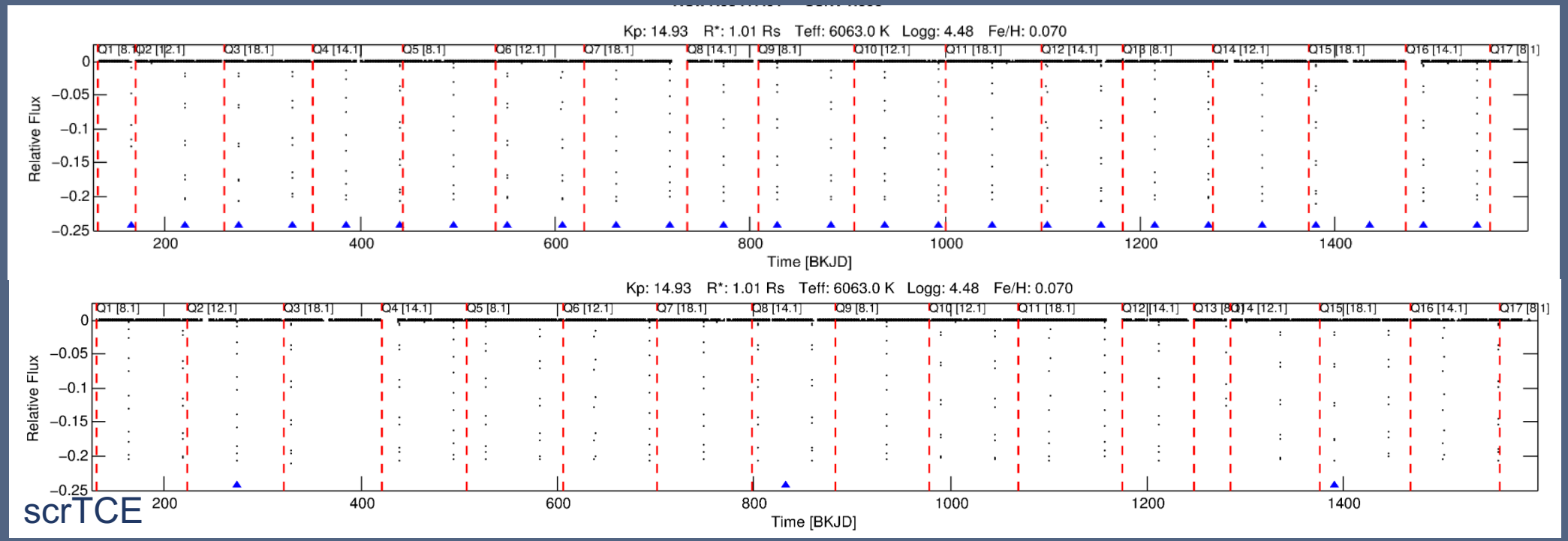
All invTCEs and scrTCEs are available at NExScI

Inversion



invTCE

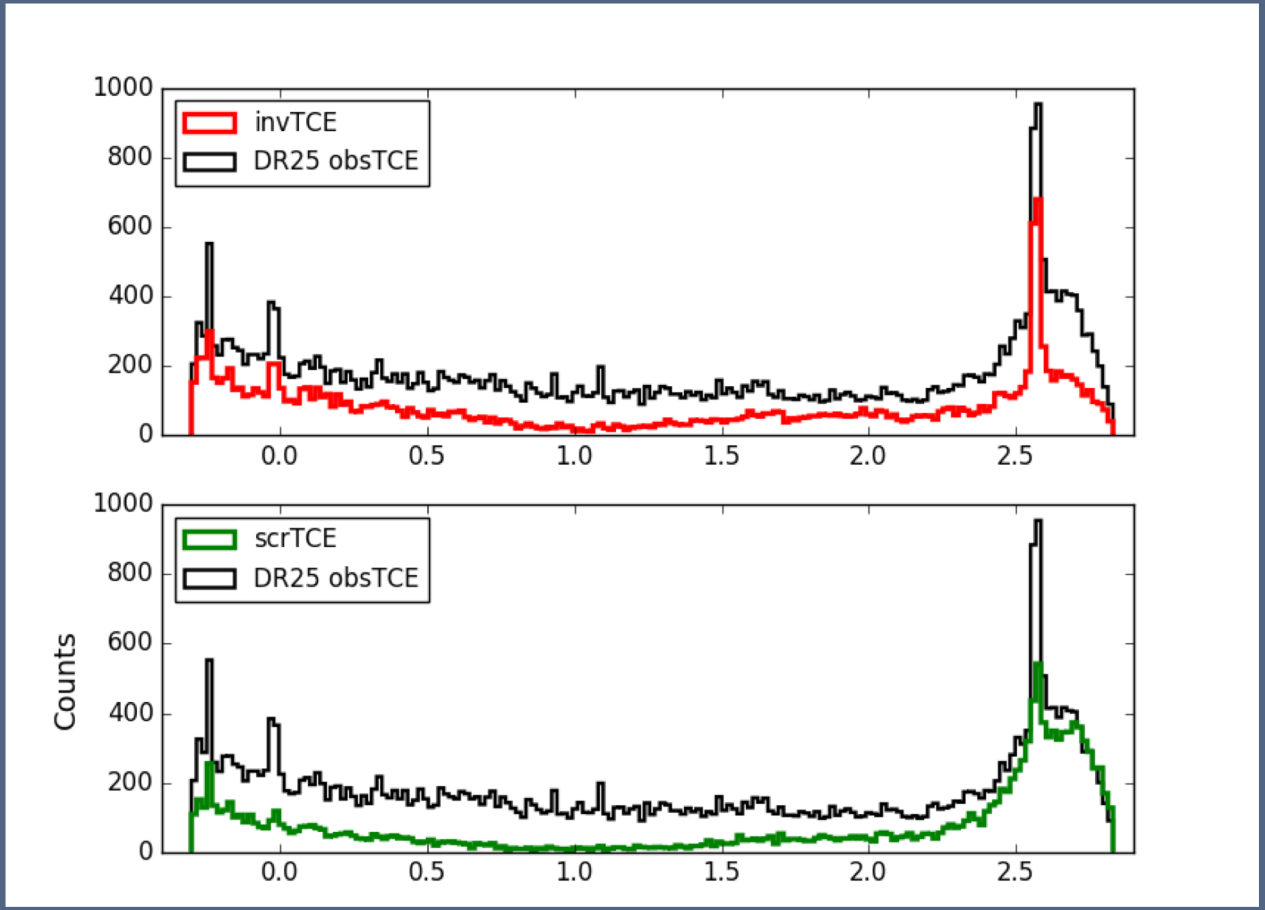
Scrambling



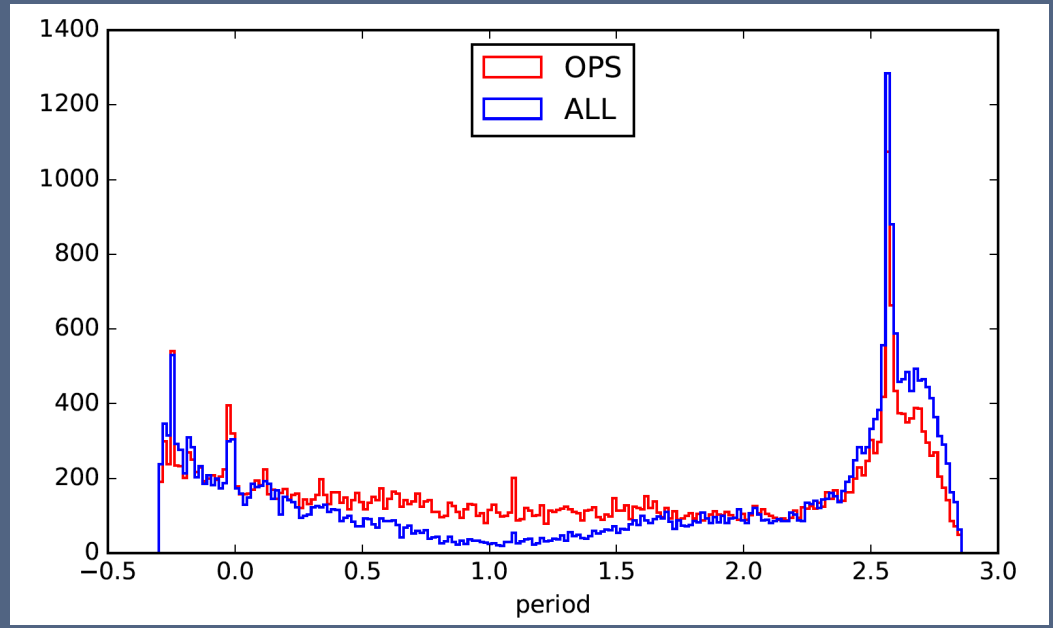
scrTCE

Simulating False Alarms

Needs to match types of false alarms in data set

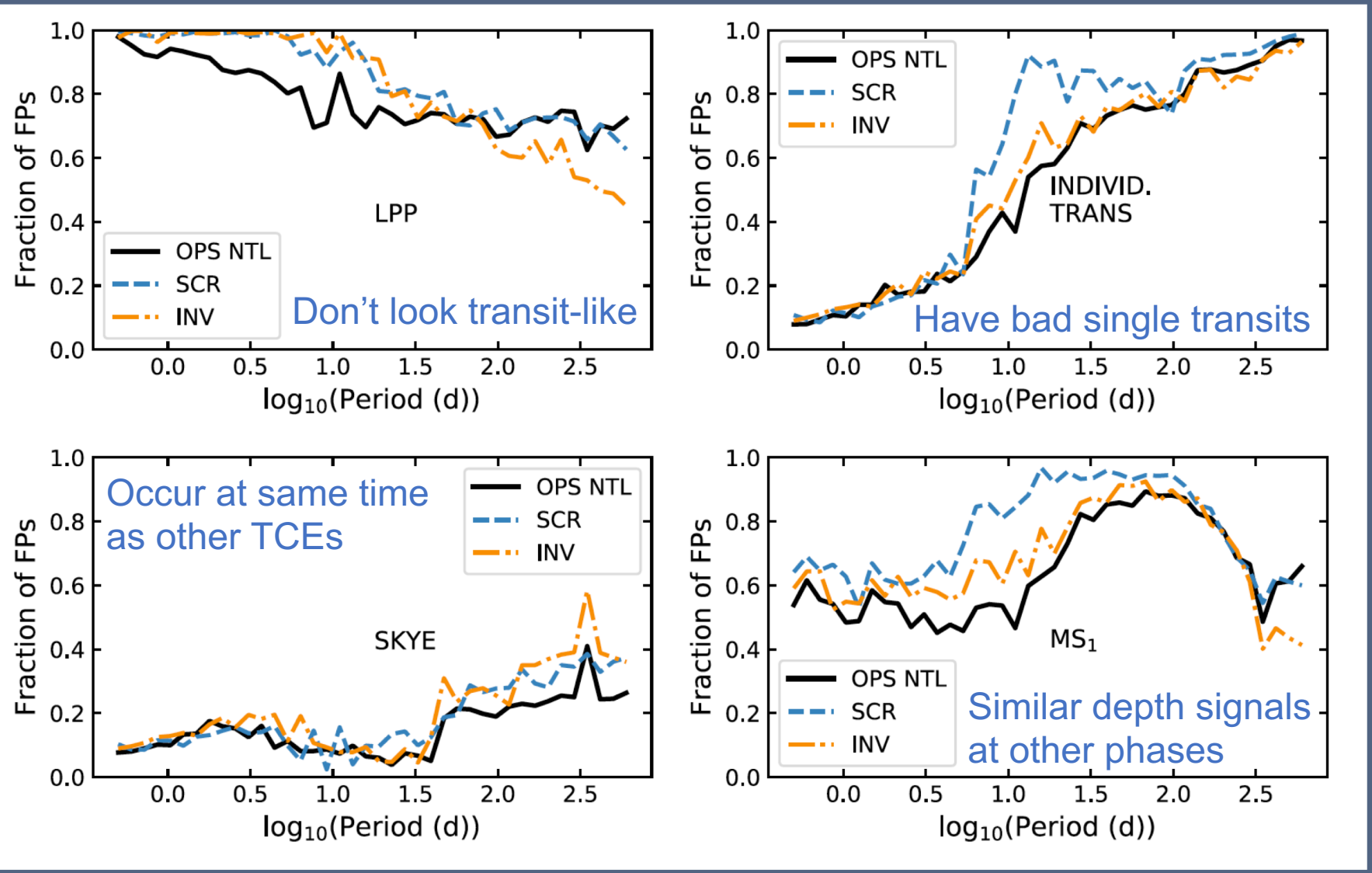


- Inversion simulates 1-year peak
- Scrambling simulates long period hump



Simulating False Alarms

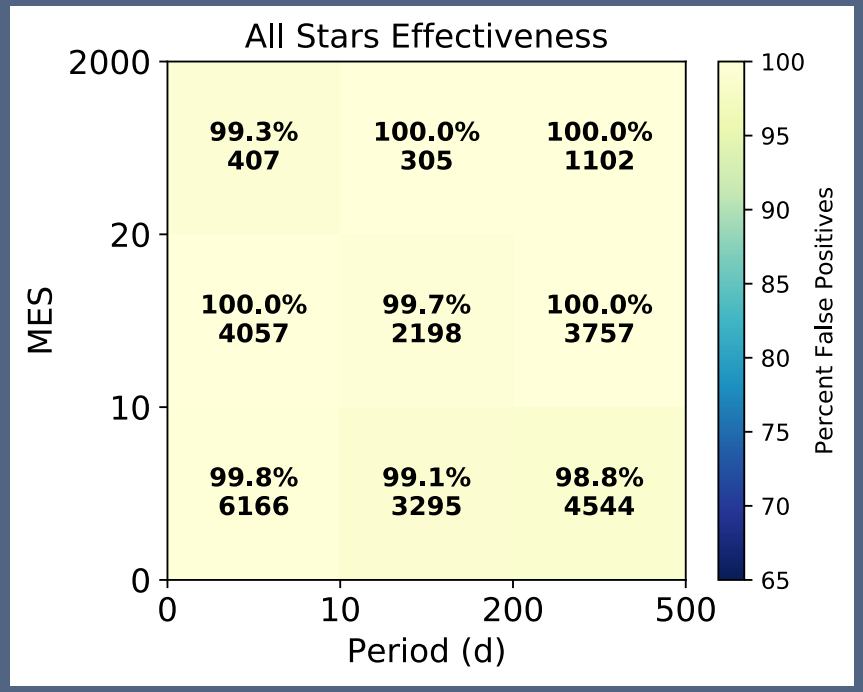
Simulated TCEs fail for the same reasons

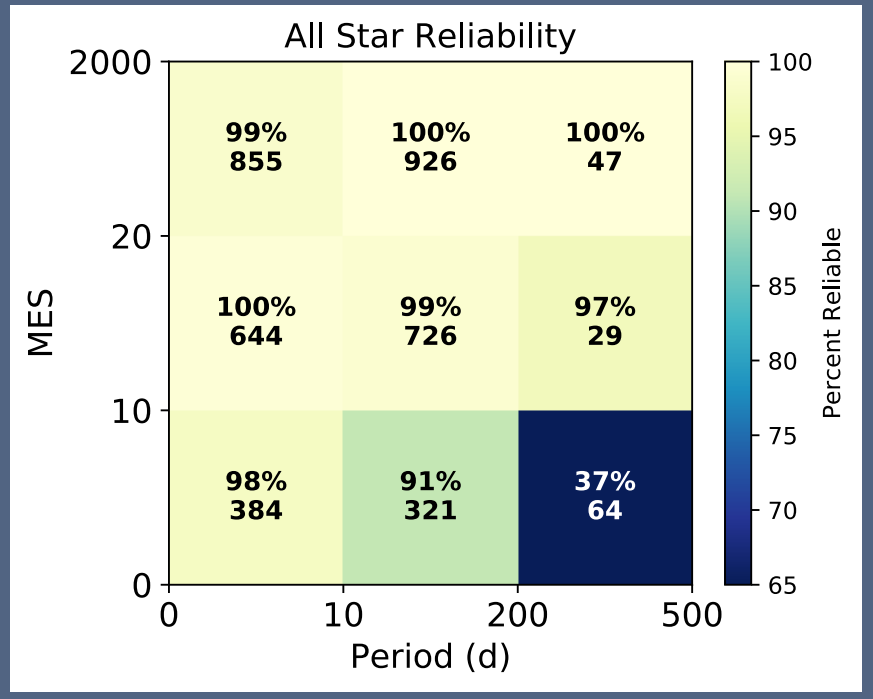


Fraction of TCEs that fail a certain Robovetter test.

Catalog Reliability

Effectiveness vs. Reliability





Robovetter correctly identified 99% of the FPs

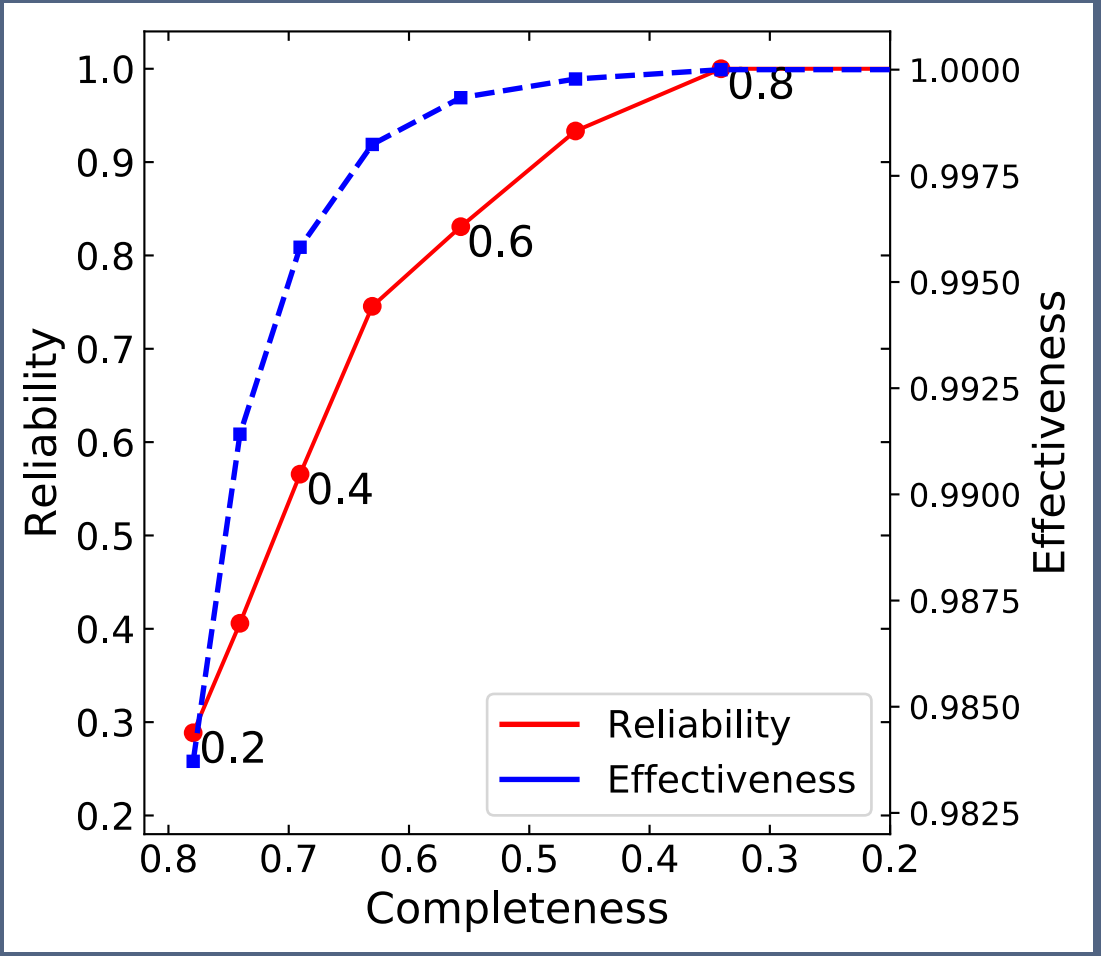
But.. With so few candidates, the catalog reliability is low.

The DR25 Catalog – Disposition Score

Disposition Score:

- Measure an error on Robovetter metrics using injections.
- Do a Monte Carlo simulation.
- Score is fraction of runs that create a Candidate.

if use Score > 0.7
90% reliability (35% completeness)



Kepler Catalog Reliability Conclusions

Inverted and Scrambled light curves do not perfectly emulate all Kepler False alarms

- e.g. Lensing binaries
- Other Noise Sources

Reliability can be improved by

- Working with FGK dwarf stars
- Using PCs with a high score
- Using different Robovetter thresholds

Catalog reliability and completeness must be accounted for when calculating occurrence rates of small planets in orbital periods longer than 100 days.

See Bryson's talk next showing one method to calculate occurrence rates using DR25 + completeness & reliability.