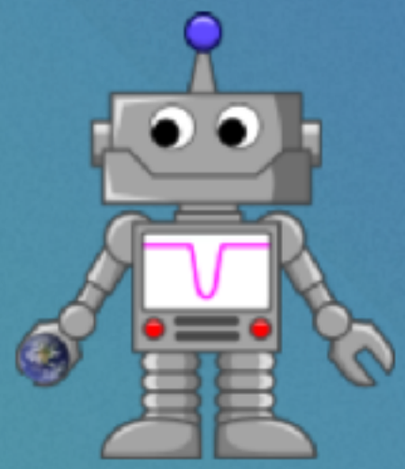
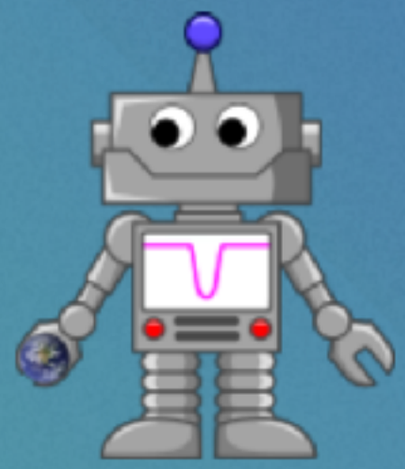


Welcome to DAVE:

Discovery and Vetting of K2 Exoplanets

Susan Mullally, Space Telescope Science Institute
Veselin Kostov, Goddard Space Flight Center
and
DAVE Team



Welcome to DAVE:

Discovery and Vetting of K2 Exoplanets

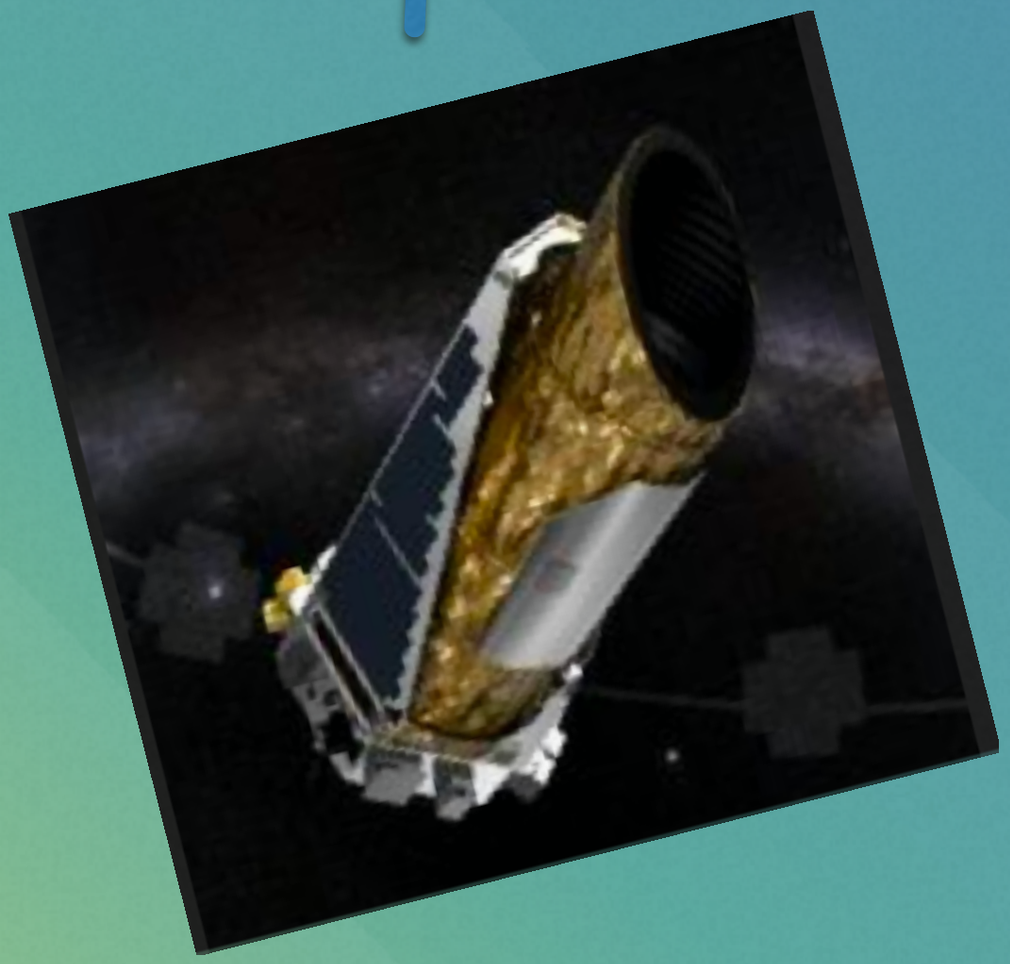
- Semi-automated exoplanet vetting pipeline
- Adapts vetting tools developed for the Kepler mission to K2 planet candidates.

K2's Road to Planets

Light Curve Generation → Signal Detection → Signal Vetting → High Reliability Catalog

Signal Vetting → Efficient Follow-up Observations → Confirmed Planets

High Reliability Catalog → Measured Catalog Biases → Better Occurrence Rates

Light Curve Generation ← 

DAVE Catalog: Benchmarking K2 Vetting Tools

http://keplertcert.seti.org/DAVE/

- Campaigns 1 through 10 examined — NASA Exoplanet Archive
- 4 detrending pipelines (K2SC, Everest, PDC, SFF)
- 772 K2 detections examined with DAVE
- Human experts + DAVE pipeline metrics
- **60 new False Positives**

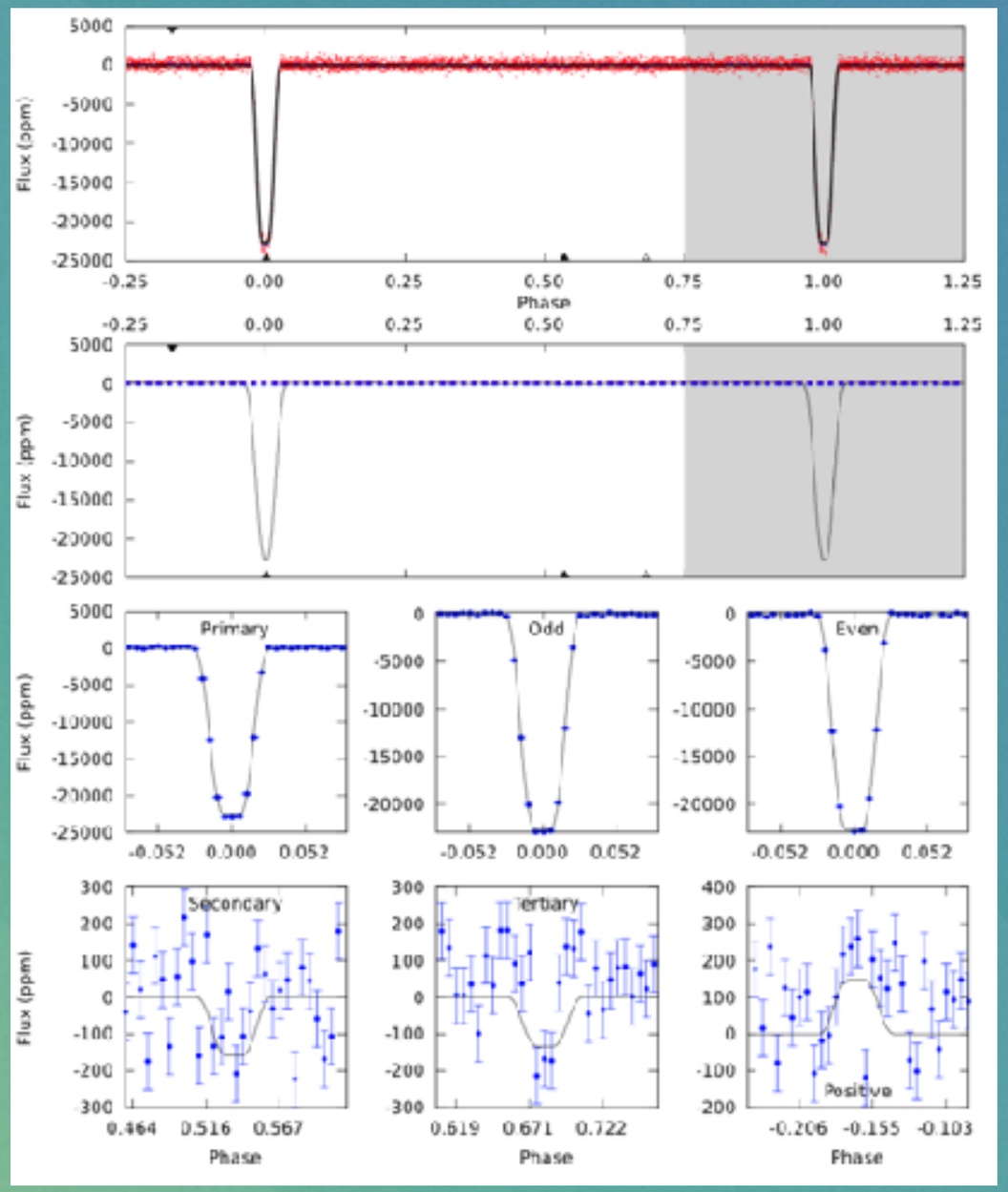
EPIC ID	Period (Days)	Epoch (BKJD)	Disp	Notes	Link to Vetting Plots
201092629	26.82	2778.038285	PC		http://keplertcert.seti.org/DAVE/K2/Output/201092629/
201102594	6.514	2785.817742	PC		http://keplertcert.seti.org/DAVE/K2/Output/201102594/
201110617	0.813	2787.558078	PC		http://keplertcert.seti.org/DAVE/K2/Output/201110617/
201111557	2.302	2789.126628	PC		http://keplertcert.seti.org/DAVE/K2/Output/201111557/
201126503	1.195	2018.000386	PC		http://keplertcert.seti.org/DAVE/K2/Output/201126503/
201127519	6.179	2789.621187	PC		http://keplertcert.seti.org/DAVE/K2/Output/201127519/
201128338	32.648	2775.643605	PC		http://keplertcert.seti.org/DAVE/K2/Output/201128338/
201130233	0.365	2791.097072	PC		http://keplertcert.seti.org/DAVE/K2/Output/201130233/
201132684	10.06	2787.669047	PC		http://keplertcert.seti.org/DAVE/K2/Output/201132684/
201155177	6.687	2015.11929	PC		http://keplertcert.seti.org/DAVE/K2/Output/201155177/
EPIC ID	Period (Days)	Epoch (BKJD)	Disp	Notes	Link to Vetting Plots

Showing 1 to 10 of 772 entries

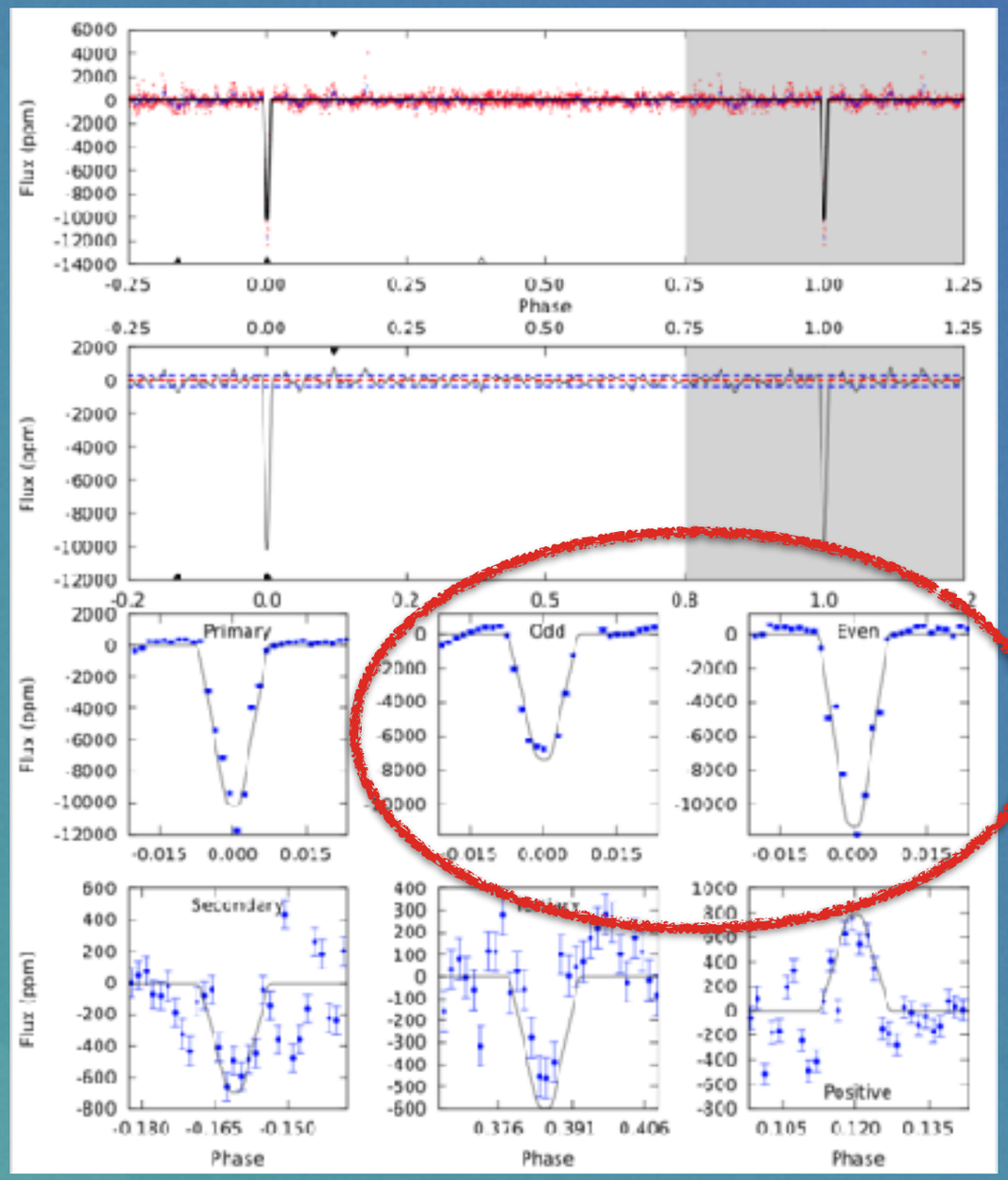
Previous 1 2 3 4 5 … 78 Next

Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Modshift** — Is there evidence that it is an eclipsing binary?
  - (odd/even, secondary)



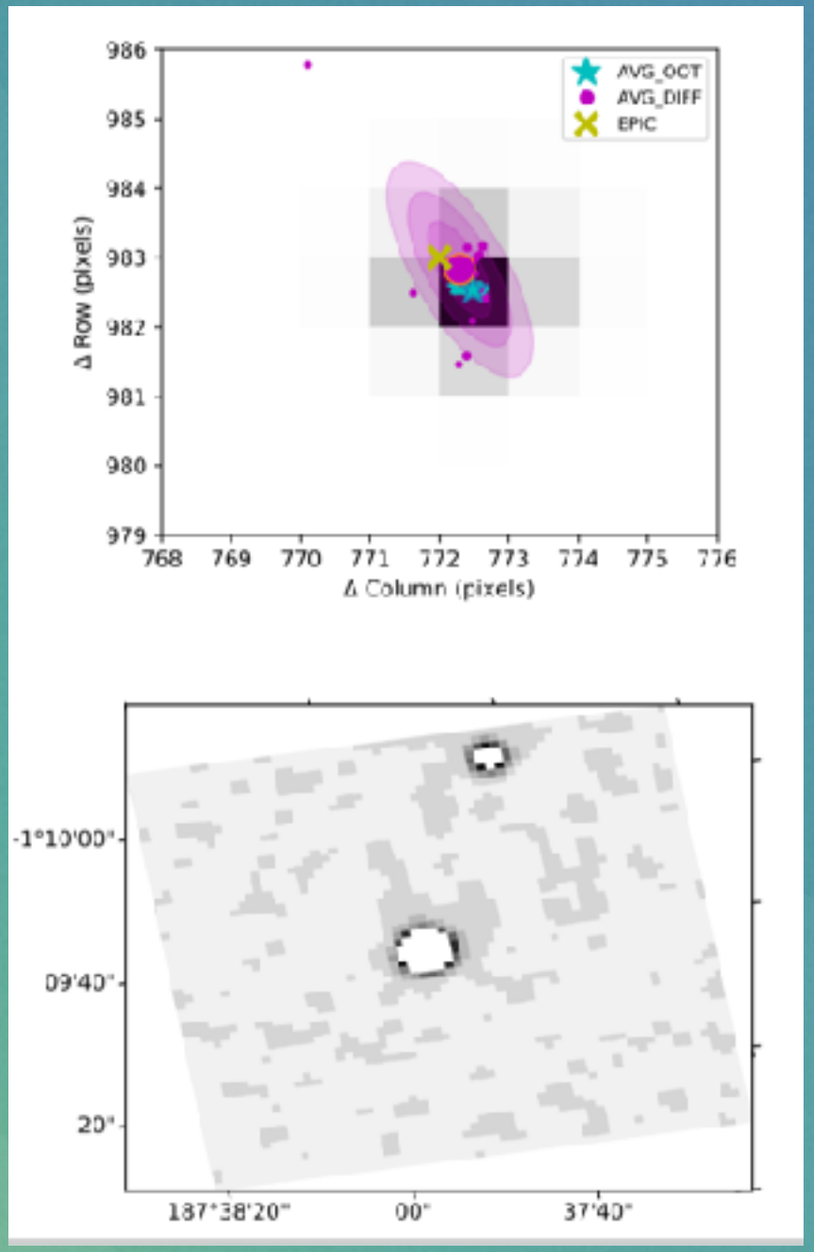
planet candidate, EPIC 201345483



EB, EPIC 212443457 (odd-even difference)

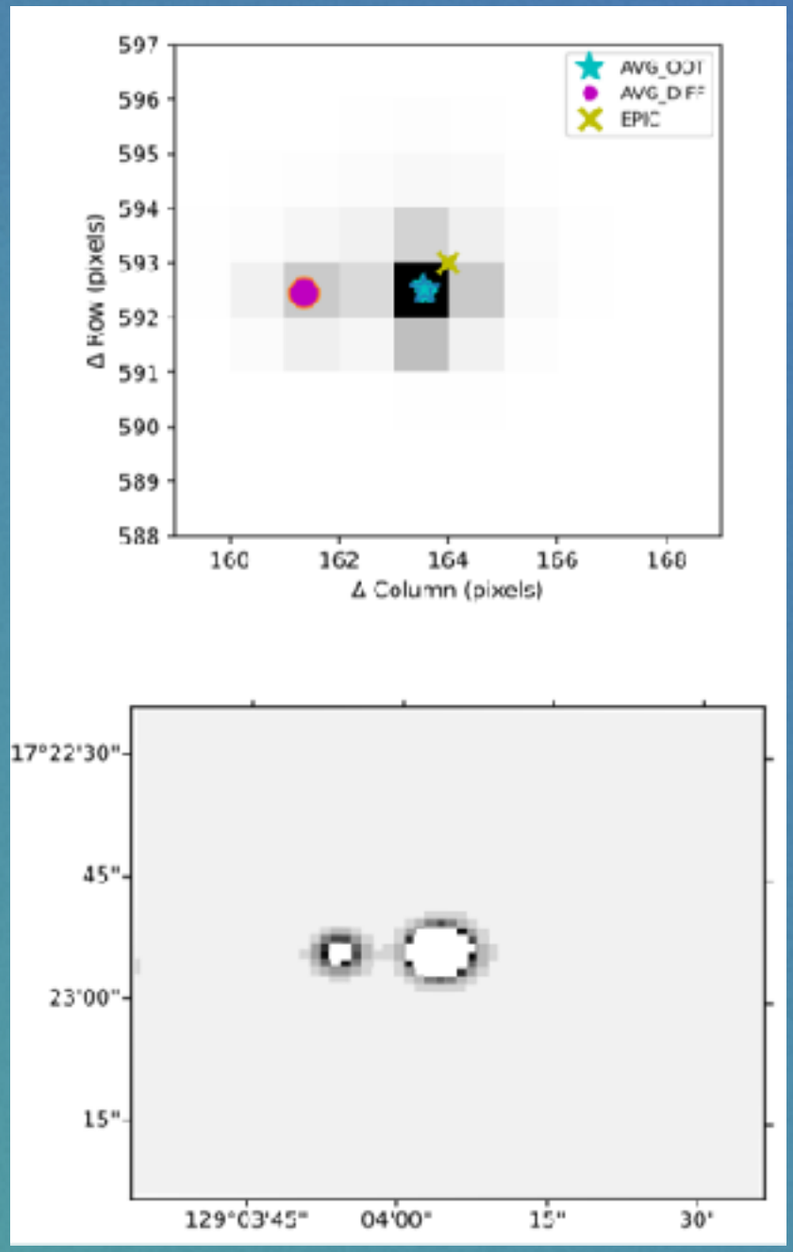
Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Photocenters** — Is there evidence the signal comes from a background star?



No photocenter shift

EPIC 201345483

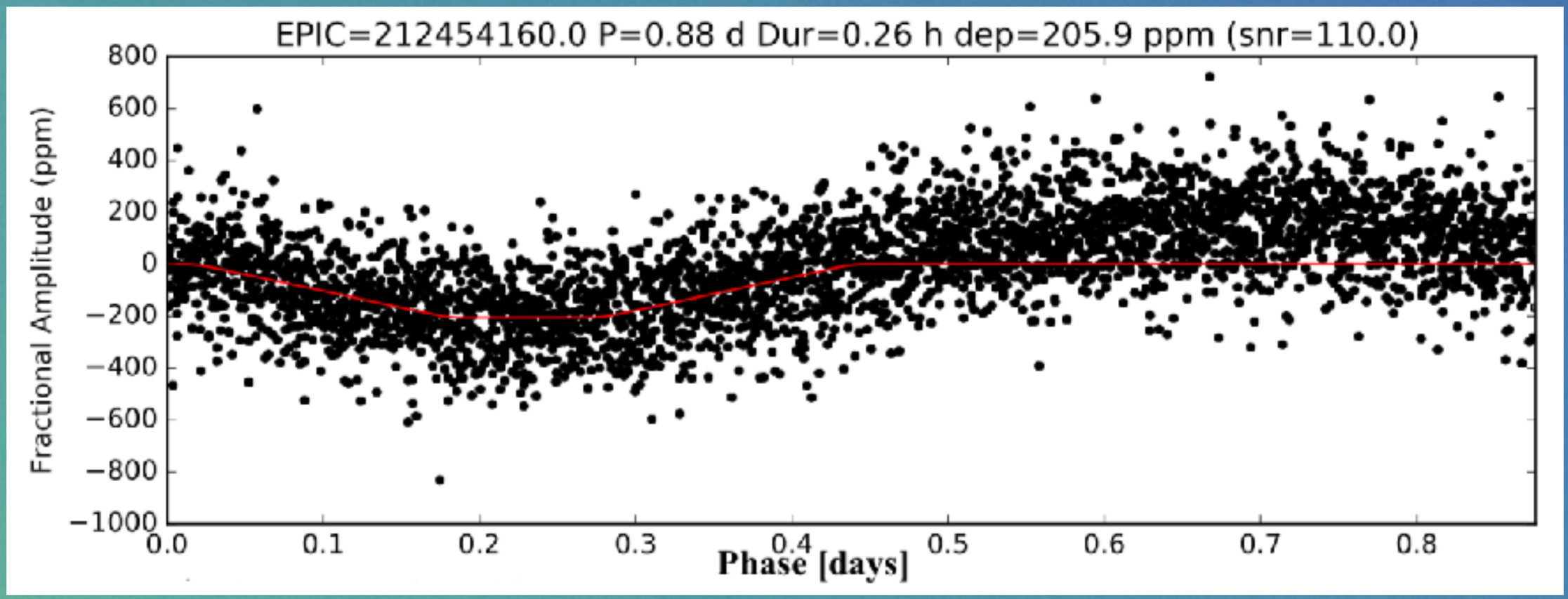


Photocenter shift

EPIC 211804579

Three main modules: Modshift, Photocenters, Transit-shape Metrics

- **Transit-shape Metrics** — Is the signal found shaped like a transit?



Quasi-sinusoidal modulations masquerading as a transit signal (EPIC 212454160.01)

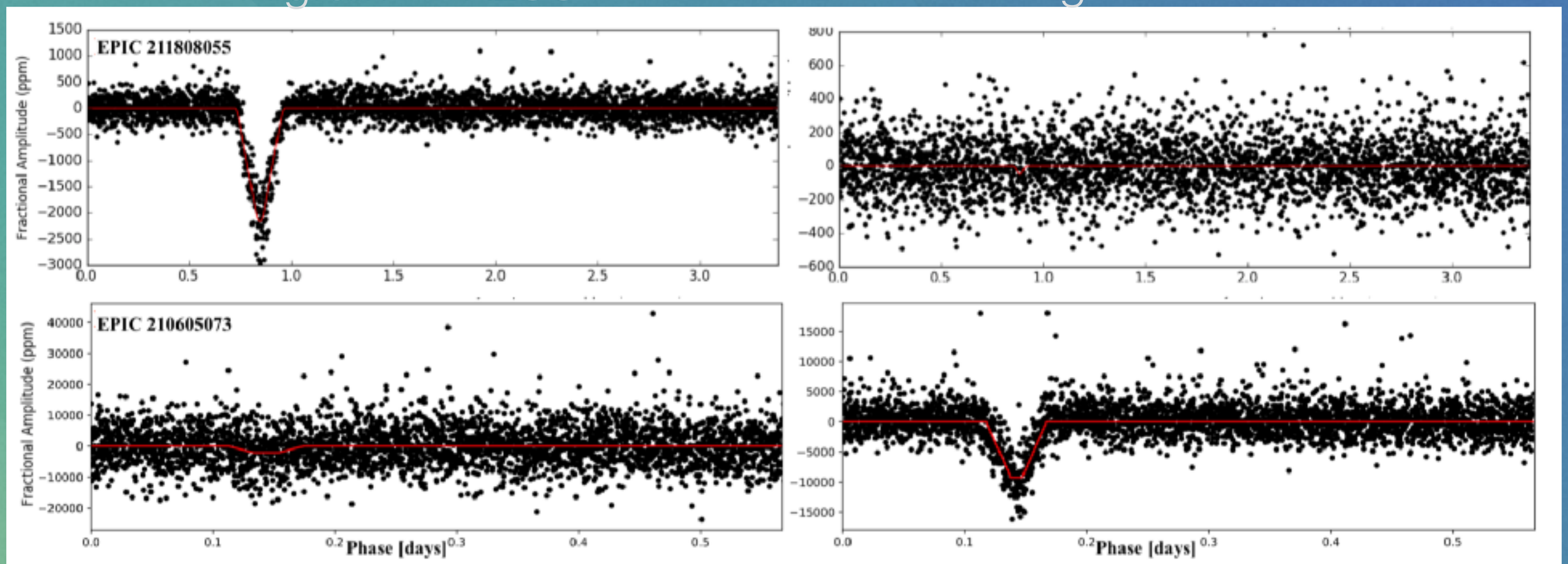
- LPP Transit Metric — Compares signal to Kepler transits
- SWEET — Fits sine-wave to signal to see if it is a simpler model.

DAVE Catalog: Benchmarking K2 Vetting Tools (http://keplertcert.seti.org/DAVE/)

- Comparison between detrending pipelines:

Aigrain — K2SC

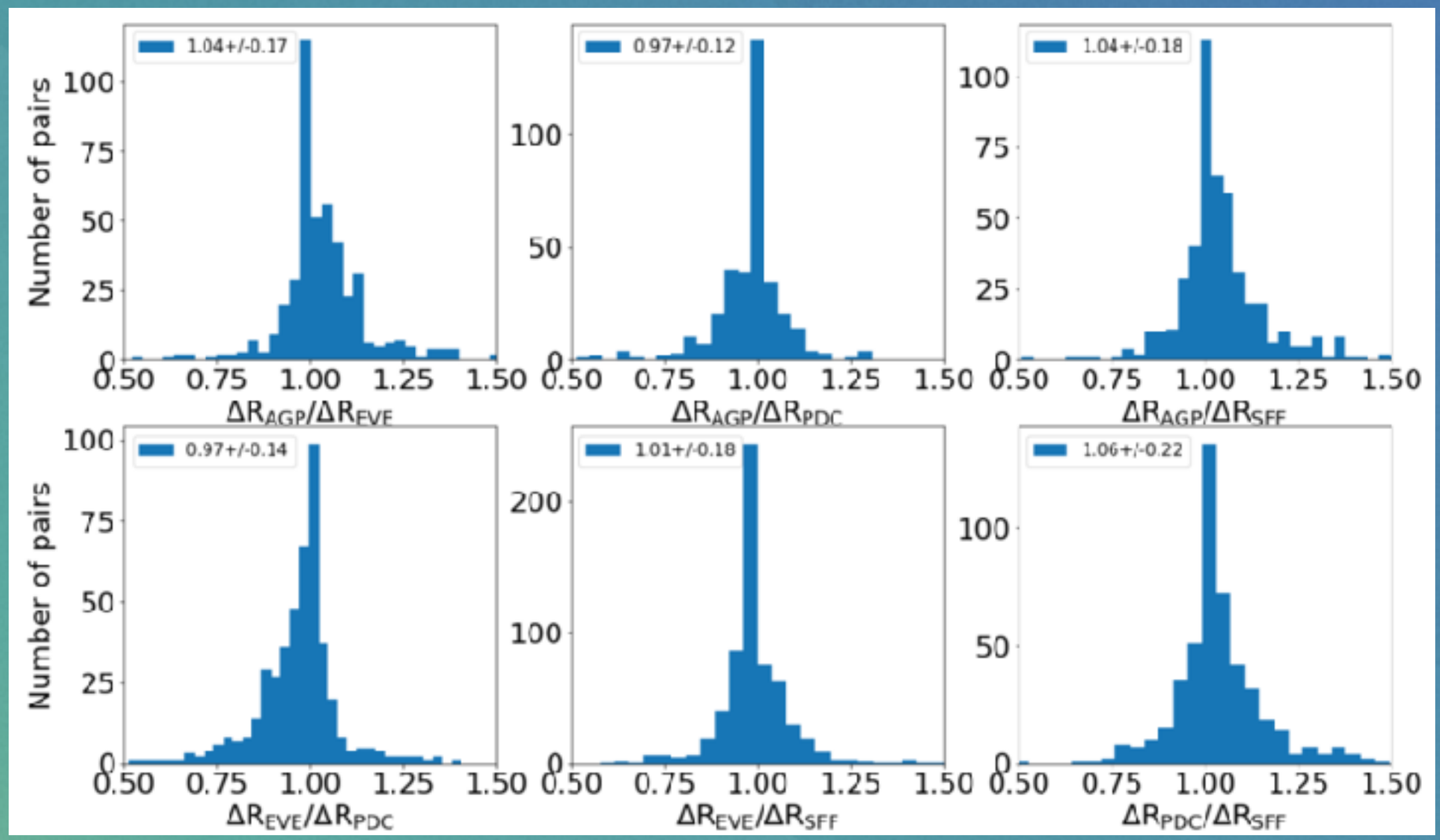
Luger — Everest



AGP (left panels) vs EVEREST (right panels) light curves for EPIC 211808055.01 (upper panels) and EPIC 210605073.01 (lower panels).

DAVE Catalog: Benchmarking K2 Vetting Tools (http://keplertcert.seti.org/DAVE/)

- Comparison between detrending pipelines:



Ratio of planet-star radius ratios, e.g. (Rplanet /Rstar)K2SC/(Rplanet /Rstar)EVE , for the candidates that show significant transits in the respective pair of datasets. There is no apparent trend with radius ratio and light curve detrending pipelines.

K2 Vetting and Catalog Generation

Lessons Learned

- K2's systematics are unique. (6-hr roll, single campaign) Blindly using Kepler trained metrics is dangerous.
- We find that there is no one-size-fits-all recipe to choose one detrending over another. Consider them all.

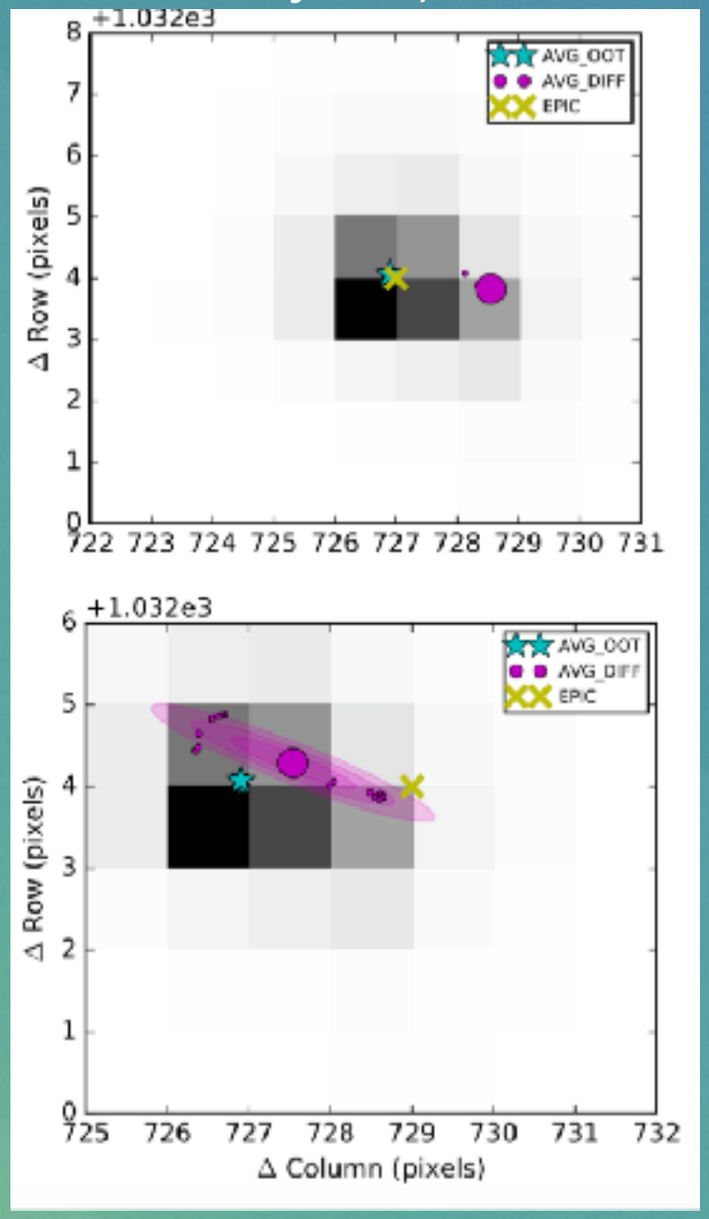
Future Work

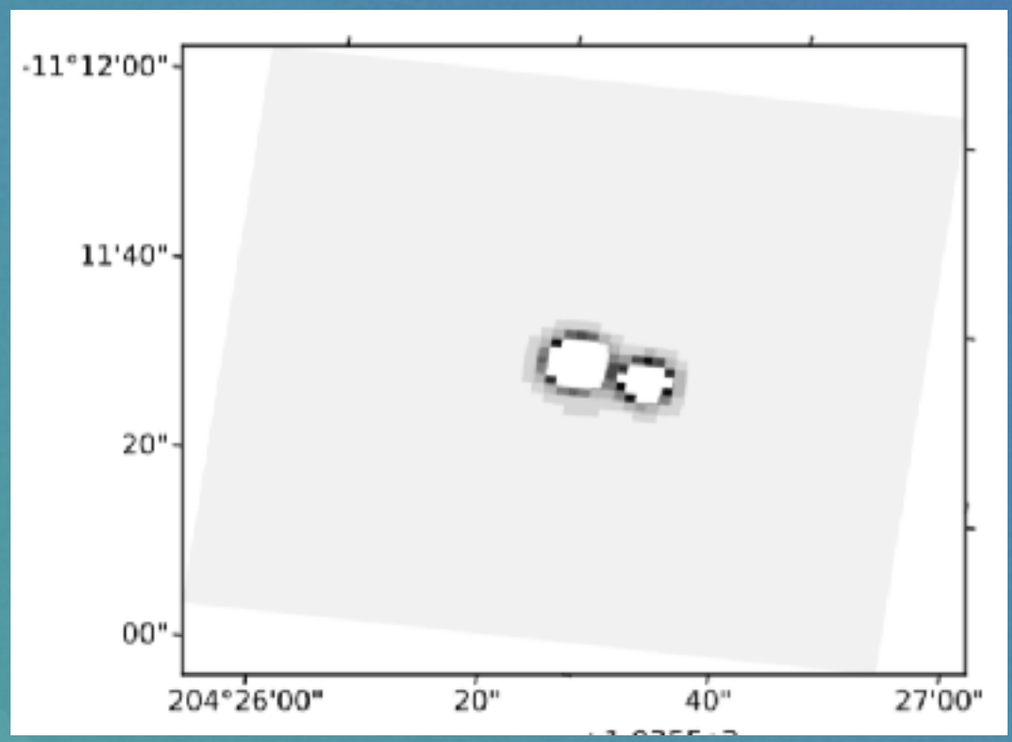
- K2 Campaigns 11-20 remain
- Multi-campaign search/vetting will create new challenges.
- Improve Automation and Usability of Code
- Generate a full consistent catalogs

http://keplertcert.seti.org/DAVE/

DAVE Catalog: Benchmarking K2 Vetting Tools (http://keplertcert.seti.org/DAVE/)

- Comparison between targets with overlapping apertures (photocenter analysis):

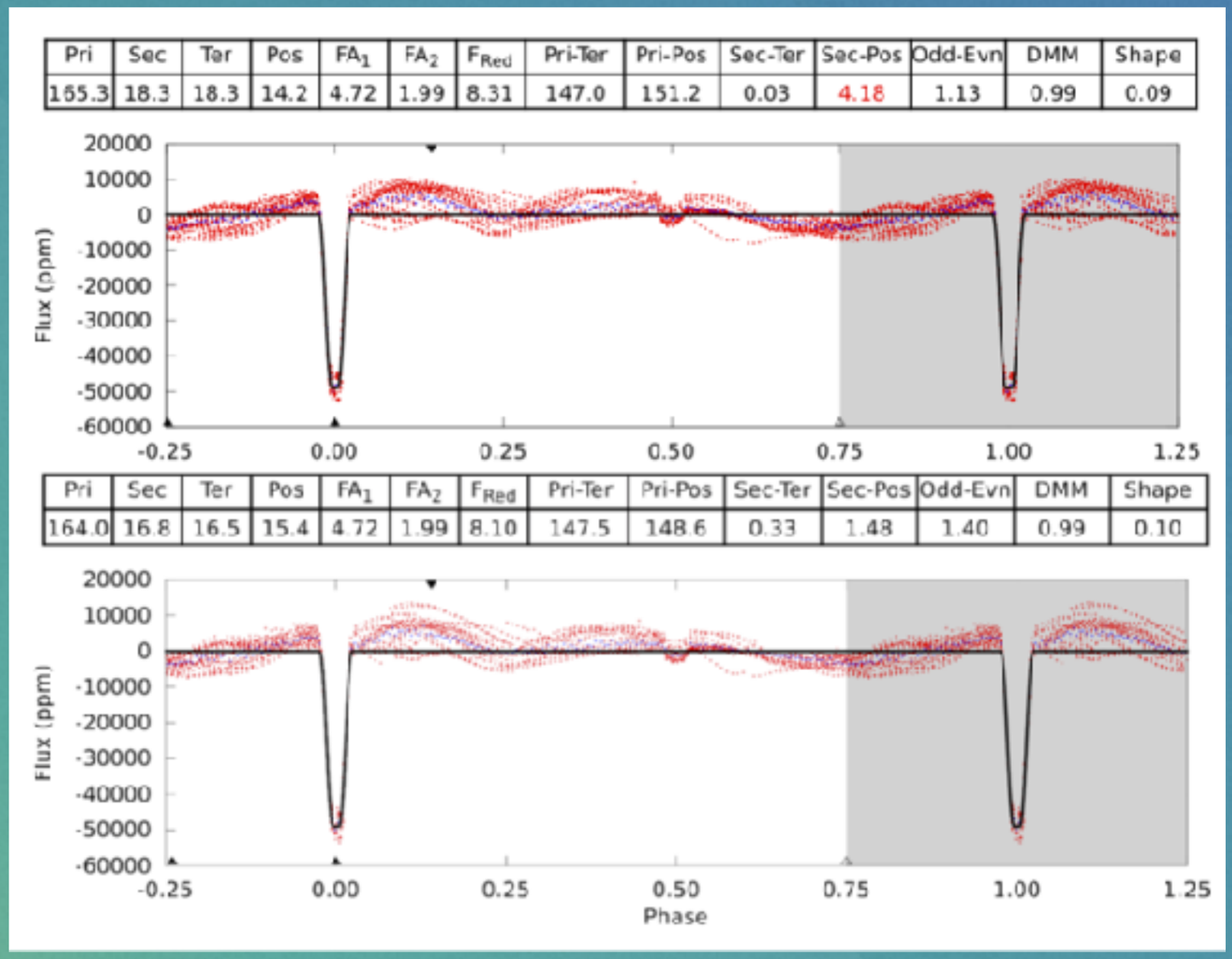




EPIC 212572439.01 (brighter, FP) and 212572452.01 (fainter, PC).

DAVE Catalog: Benchmarking K2 Vetting Tools (http://keplertcert.seti.org/DAVE/)

- Complementary visual inspection: 2609 DAVE dispositions humans agree, 277 disagree



DAVE missing a clear secondary eclipse (EPIC 206135267.01, EVEREST upper, PDC lower).