

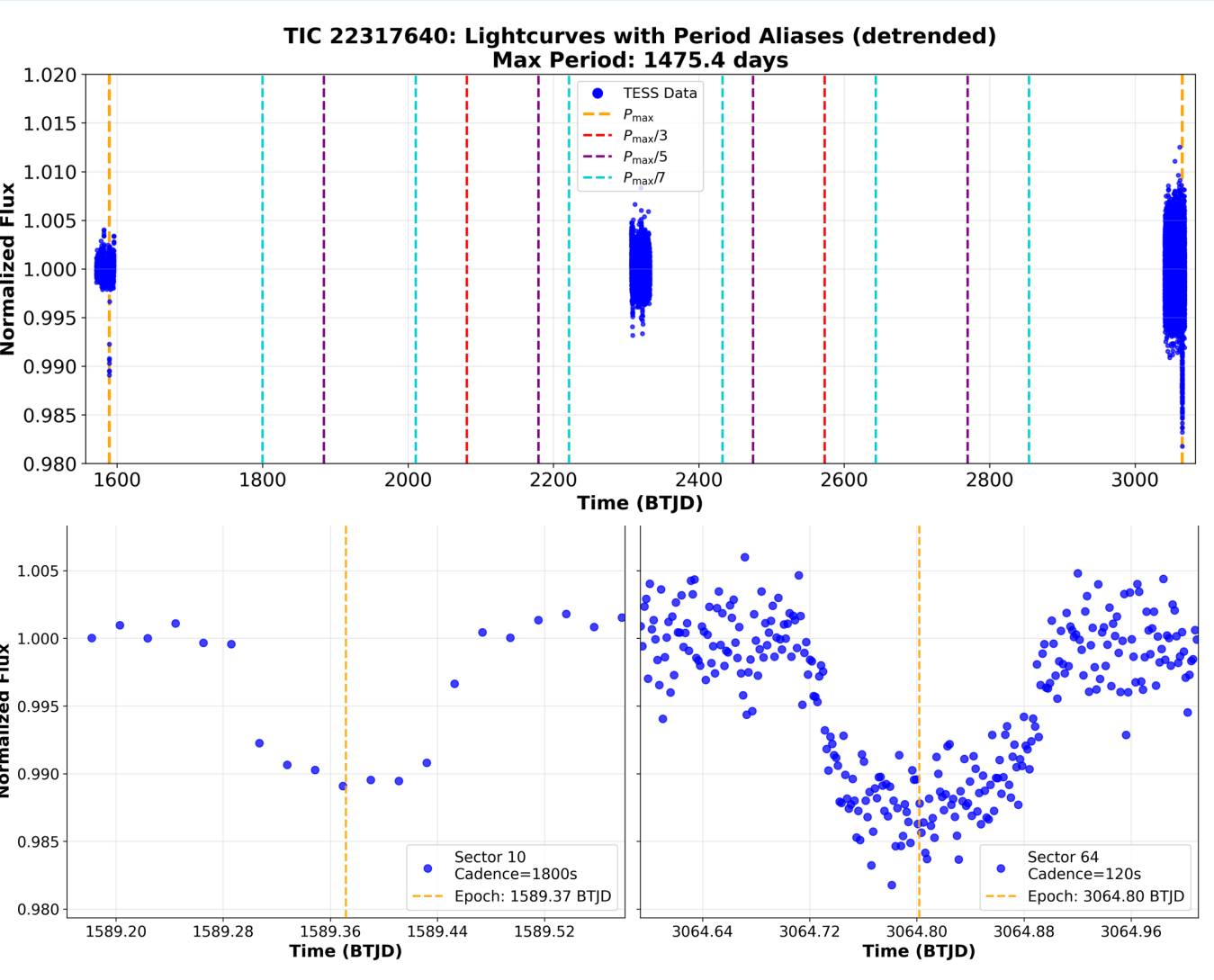
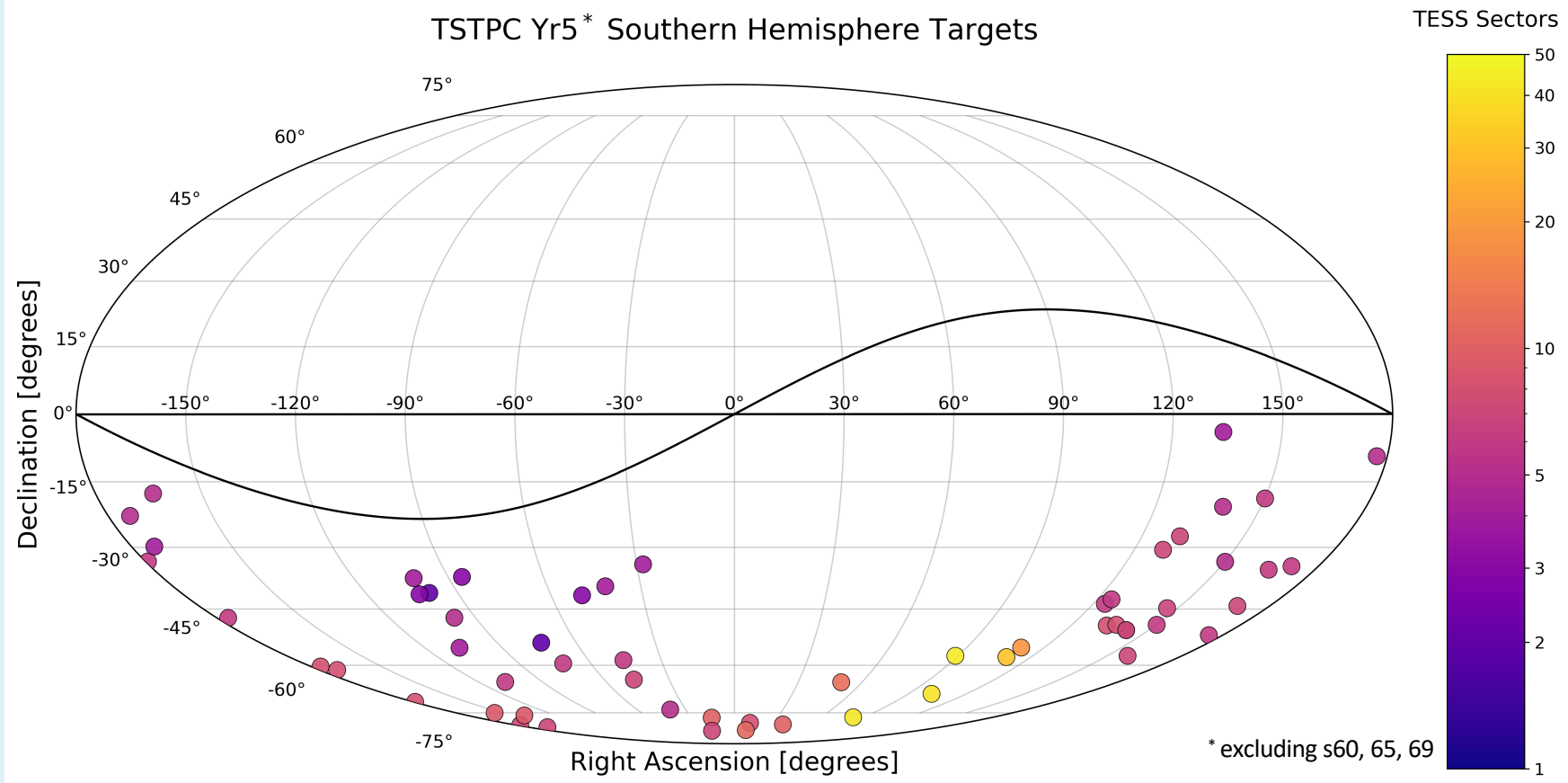
Uncovering Long-Period Exoplanets in TESS Data Through Single-Transits

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TESS & Single-Transit Exoplanets

While over 6,000 exoplanets have been confirmed, the demographic is biased against long-period planets like those in our Solar System. **The the transit method inherently favors finding short-period planets.** The Transiting Exoplanet Survey Satellite (TESS) is designed to find planets around bright, nearby stars. However, its observation strategy presents a challenge for finding long-period planets:

- TESS typically observes a portion of the sky for only ~27 days at a time, so a planet with an orbital period longer may transit only once, or not at all, in a single observing sector.
- These **single-transit events** are the primary signature of long-period exoplanets in TESS data. Subsequent observations could reveal additional transits, leading to “**duo**” or “**multi**”-transit candidates.



The large gap between two transits creates unresolved orbital periods, leading to a set of “period aliases”. Our work solves these aliases to determine true periods, bridging the gap between the known exoplanet population and our Solar System's architecture.

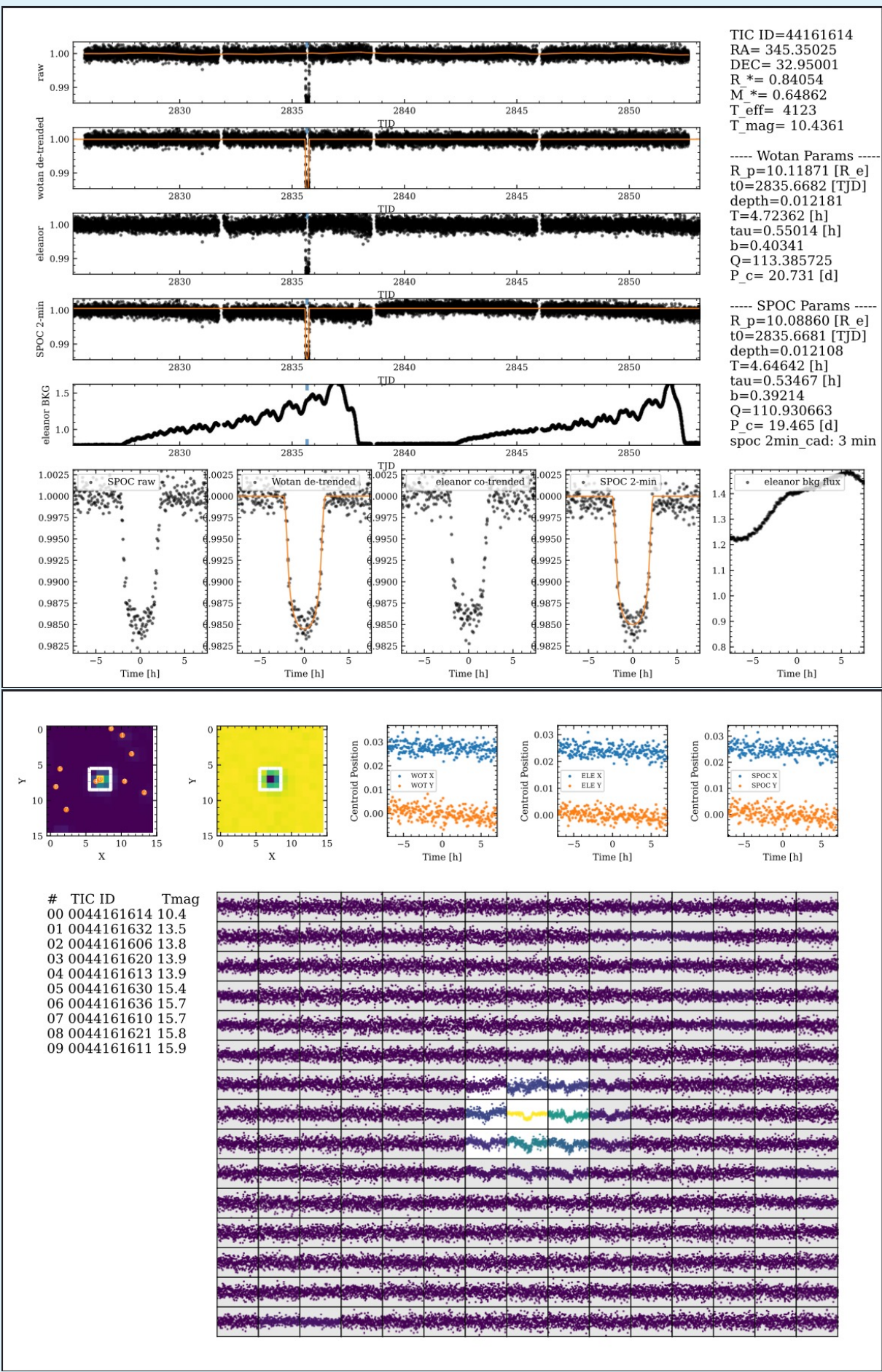
Single Transit Search Pipeline

The **Single Transit Search (STS)** pipeline, developed at the University of New Mexico, systematically discovers long-period exoplanet candidates in TESS data.

It performs a blind search of over 150,000 stars per sector, validating signals through a multi-step workflow:

- **Detect:** Deep-Transit¹ identifies transit shapes.
- **Isolate:** BLS iteratively removes periodic signals.
- **Validate:** SNR, radius, and stellar variability checks.
- **Model:** MCMC fits transits on two light curve data products.
- **Report:** DV report with light curves, parameters, and diagnostics.

These reports help further vet signals for our collaborators before they are included in our single transit catalog for follow-up observations!

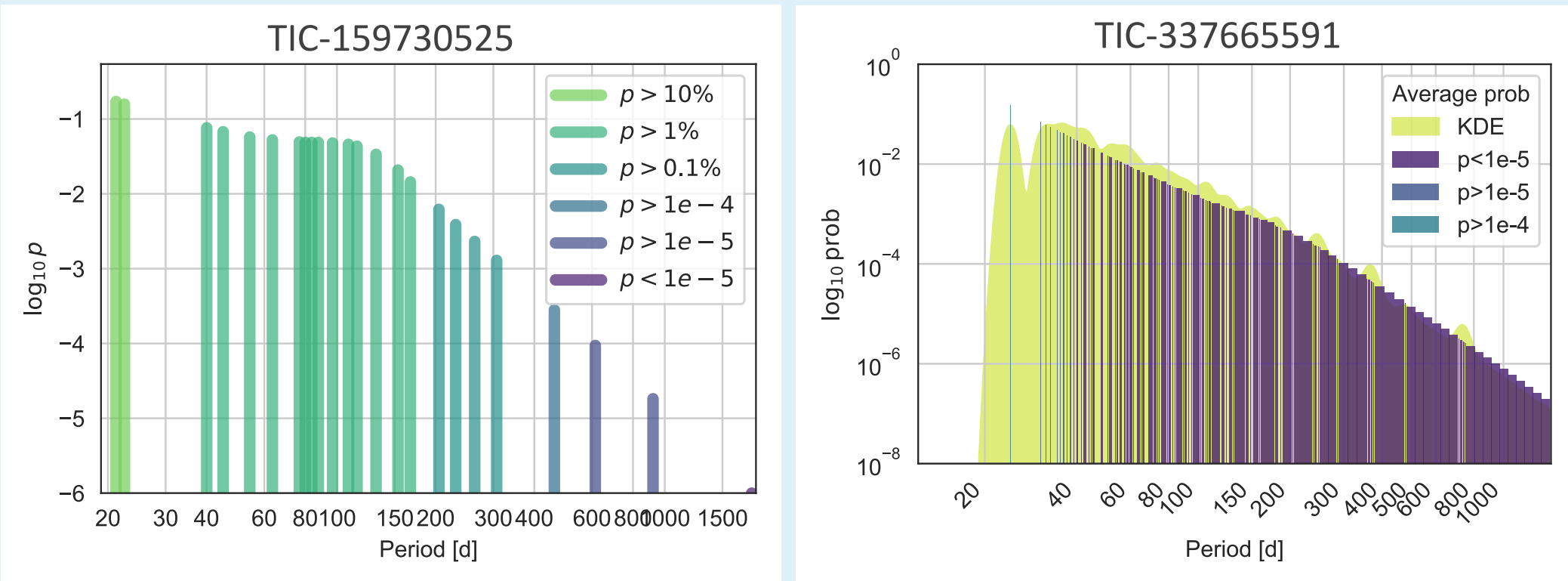


Period Alias Results

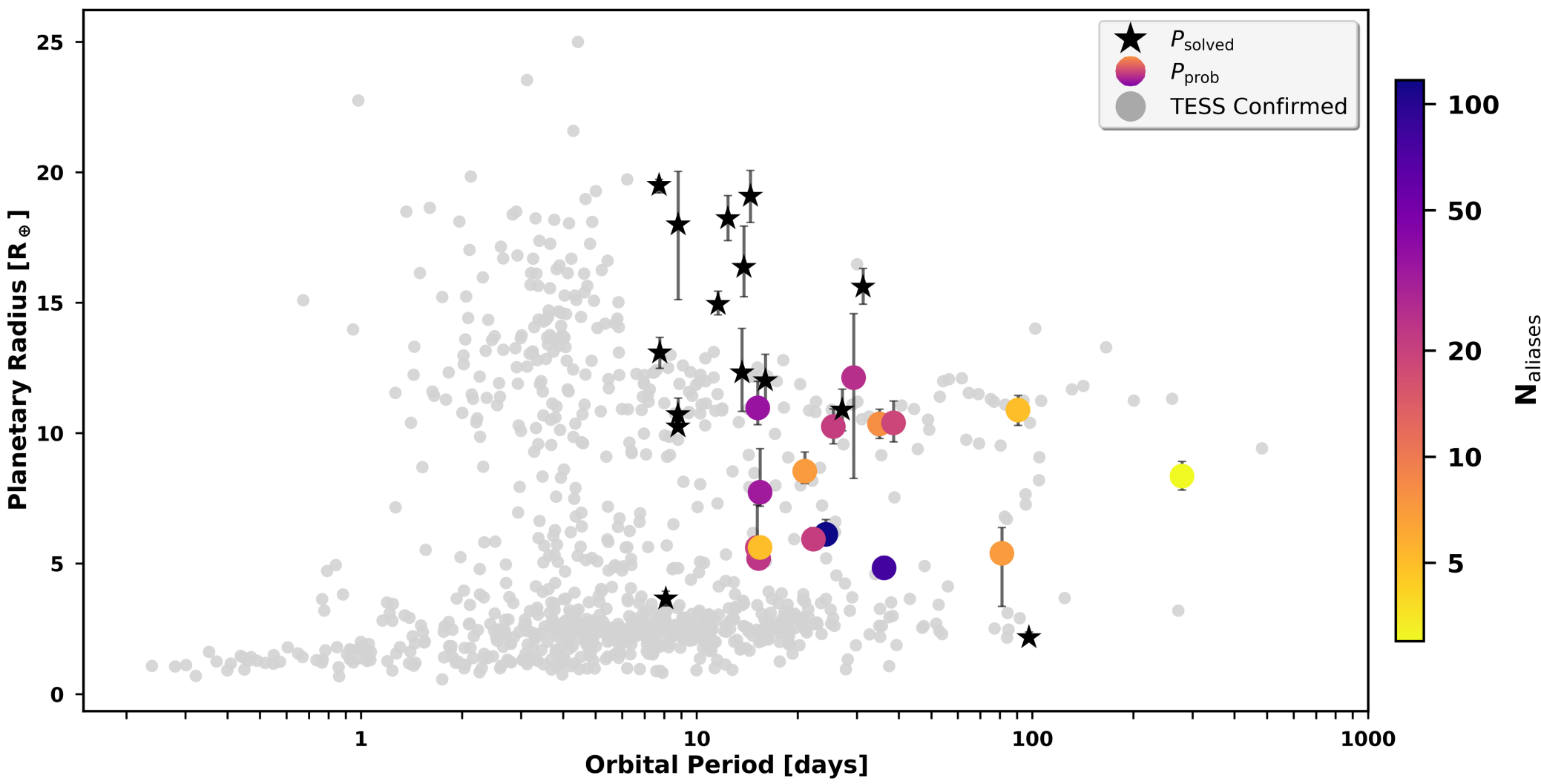
Using the STS pipeline as the foundation and our collaboration's single transit candidates as the input, I have developed a **PeriodSearch Pipeline** to specifically search for mono-, duo-, and multi-transits using all the observed TESS sectors for each candidate:

- **Compile** the targets and update their current validation status.
- **Download** all sector data for each target, prioritizing shorter cadences
- **Re-Search** for single-transits among every sector for initially missed events using our STS pipeline.
- **Group** similar transit depth/duration to link events for the same candidate.
- **Calculate** period alias probabilities using **MonoTools**², using sectors with no signals to eliminate invalid periods.

From our initial sample of 62 single-transit candidates, we found **11 Mono**, **11 Duo**, **39 Multi-transit** candidates, of which 27 have been successfully processed utilizing **MonoTools** to produce period alias distribution plots when periods could not be solved.



TSTPC: PeriodSearch Processed Period Results



Conclusions and Future Work

We have submitted 5 unsolved targets to the ExoFOP-TESS Follow-Up Observing Program³, so other observers can aid in eliminating their aliases and solving their true periods. Beyond these, we are processing the remaining mono, duo, and multi-candidates in effort towards:

- **Identify Long-Period Planets** to build a more diverse complete exoplanet demographic.
- **Discover Solar System Analogs**, moving beyond the current bias towards short-period exoplanets.
- **Establish Exoplanets as a Benchmark** to investigate the formation and evolution of our own Solar System.

Acknowledgements & References

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[1] Cui, K., Liu, J., Feng, F., & Liu, J. 2022, , 163, 23
[2] Osborn, H. P., Bonfanti, A., Gandolfi, D., et al. 2022, , 664, A156
[3] <https://exofop.ipac.caltech.edu/teess/>