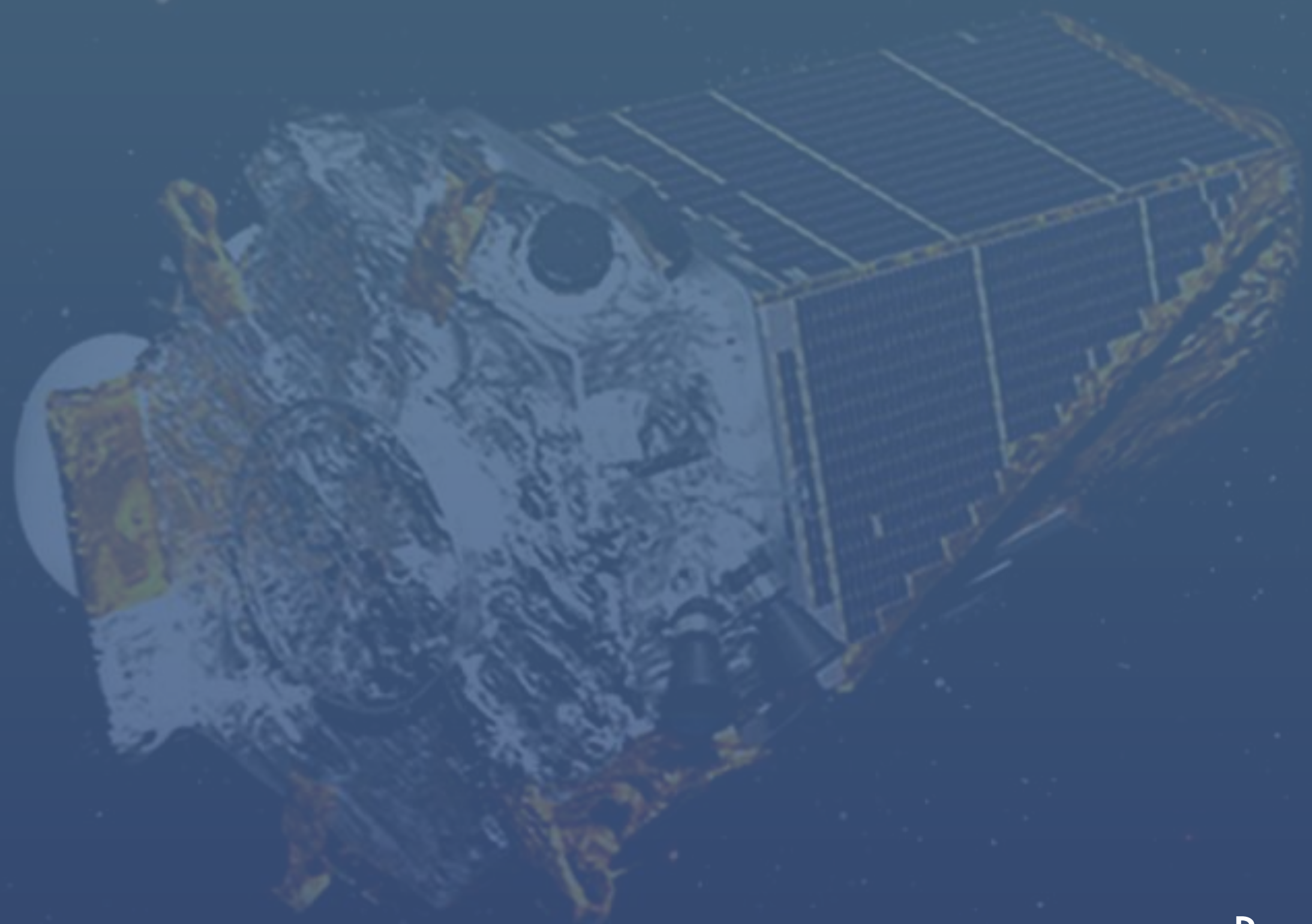


# Searching for Circumbinary Planets via Apsidal Precession



Benjamin Montet

Scientia Senior Lecturer

School of Physics, University of New South Wales

9 July 2025



**UNSW**  
SYDNEY





**Riley White (2024 BSc)**



**Margo Thornton (UNSW  
PhD Student)**



# Locations of Kepler Planet Candidates

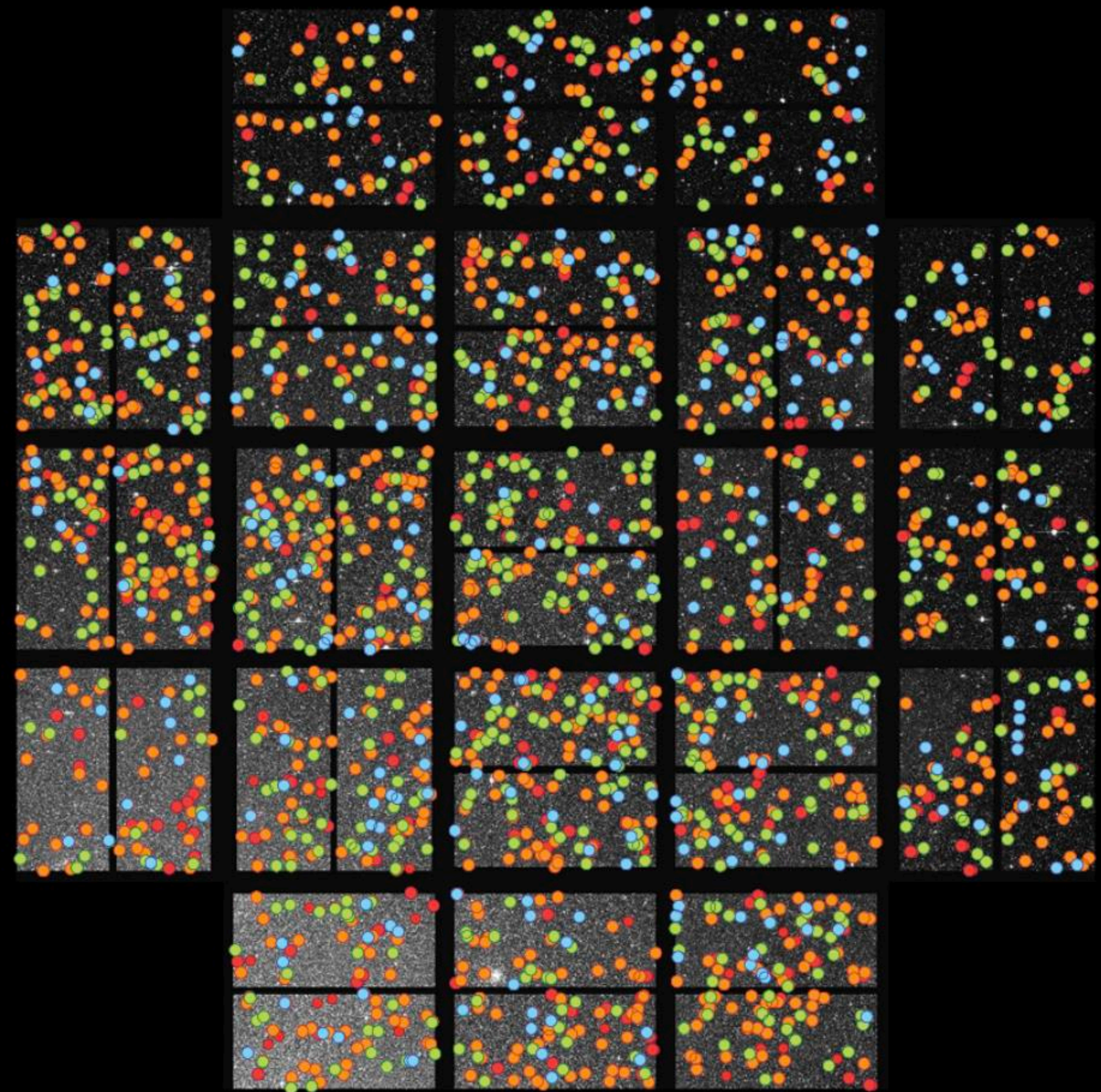


Total Count - >4,500

We can point to thousands of stars that we know have planets

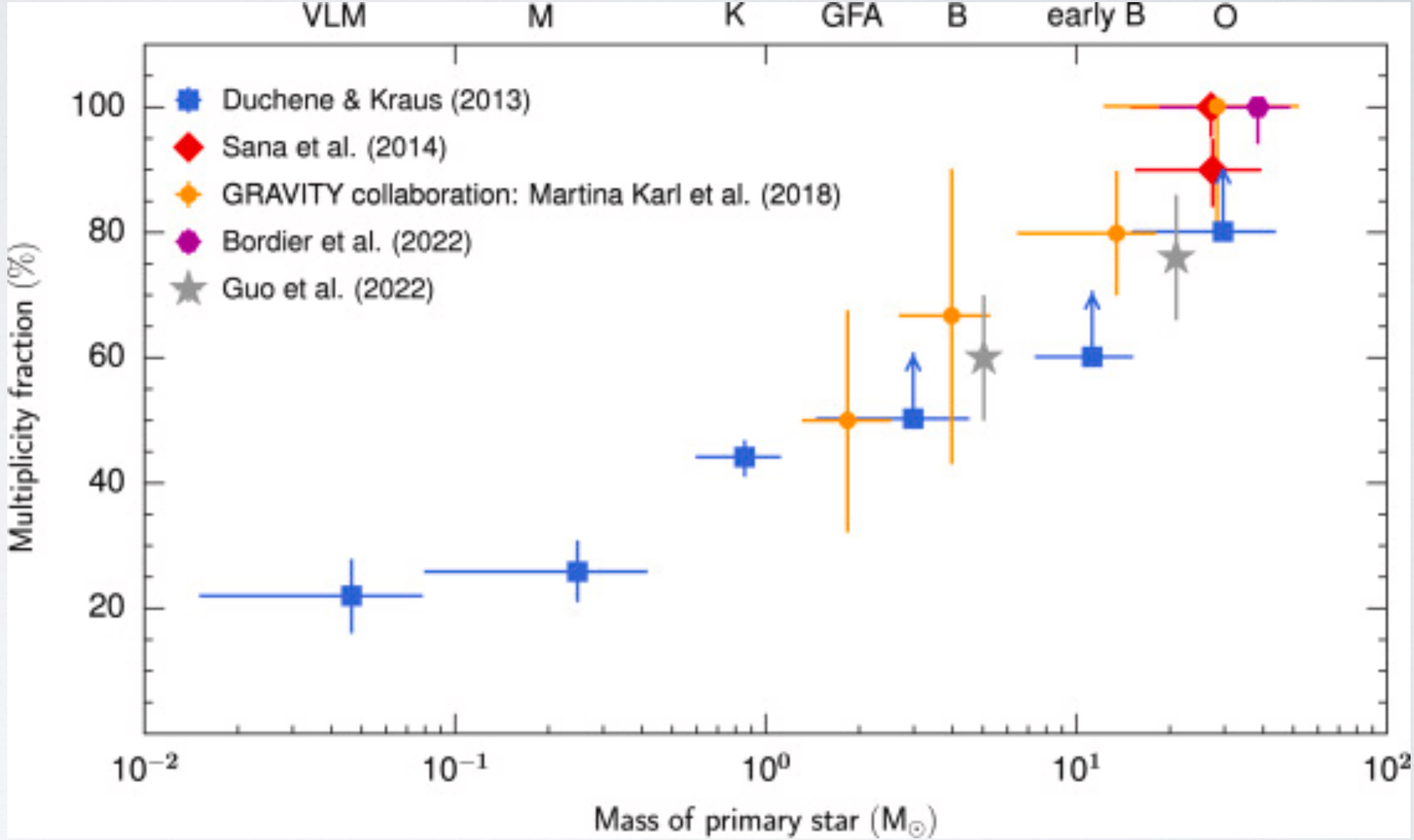
But we're (possibly) missing a big population

- Earth-size
- Super-Earth size  
1.25 - 2.0 Earth-size
- Neptune-size  
2.0 - 6.0 Earth-size
- Giant-planet size  
6.0 - 22 Earth-size



We can point to thousands of stars that we know have planets

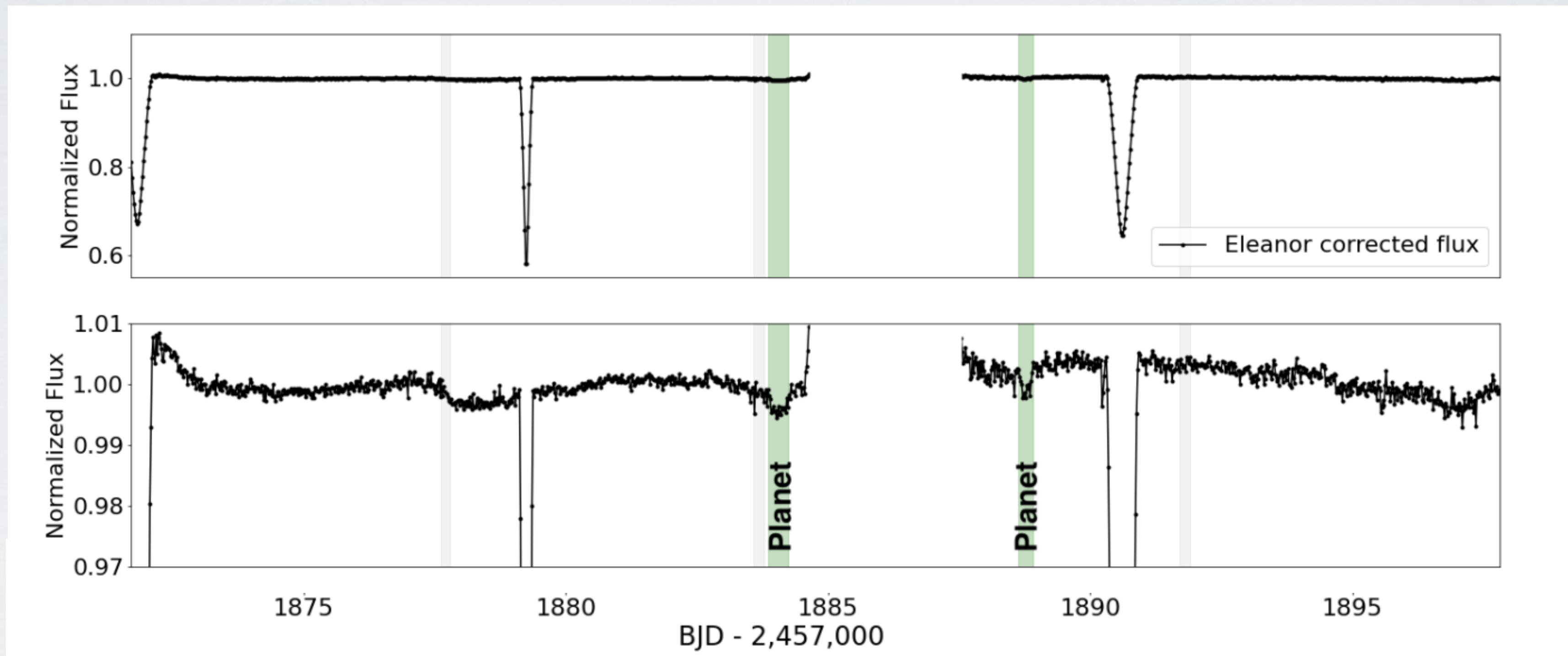
But we're (possibly) missing a big population



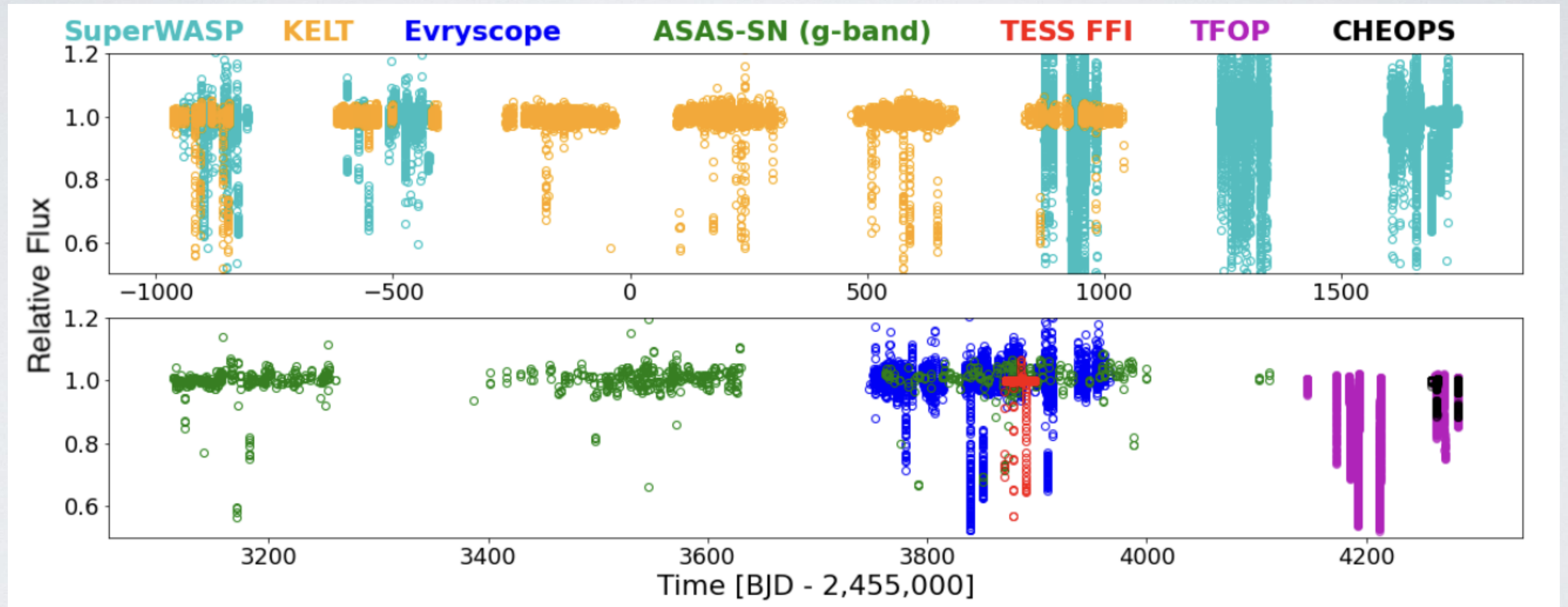
# CBP Occurrence Rate is poorly constrained



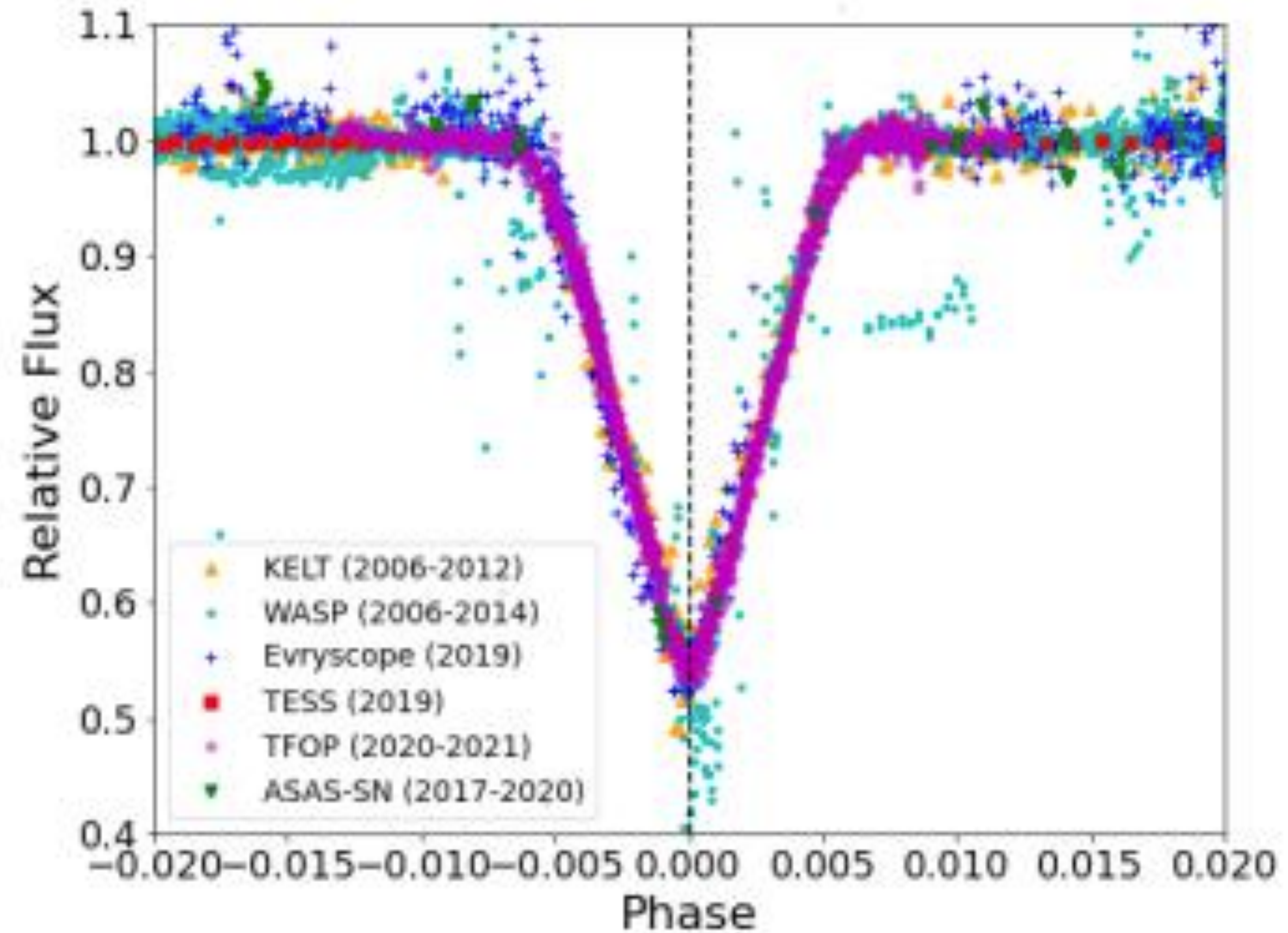
# Circumbinary planets are hard to find



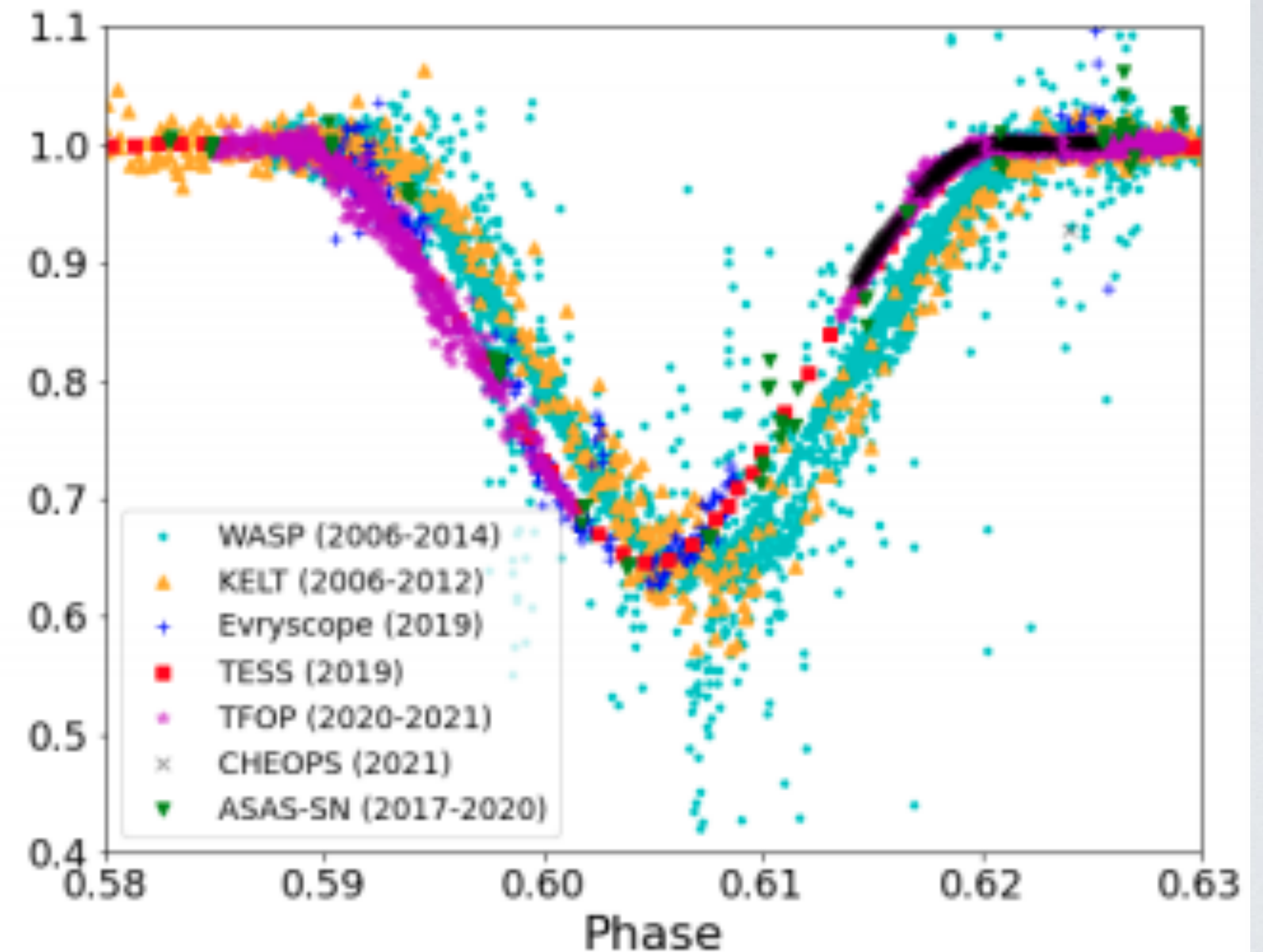
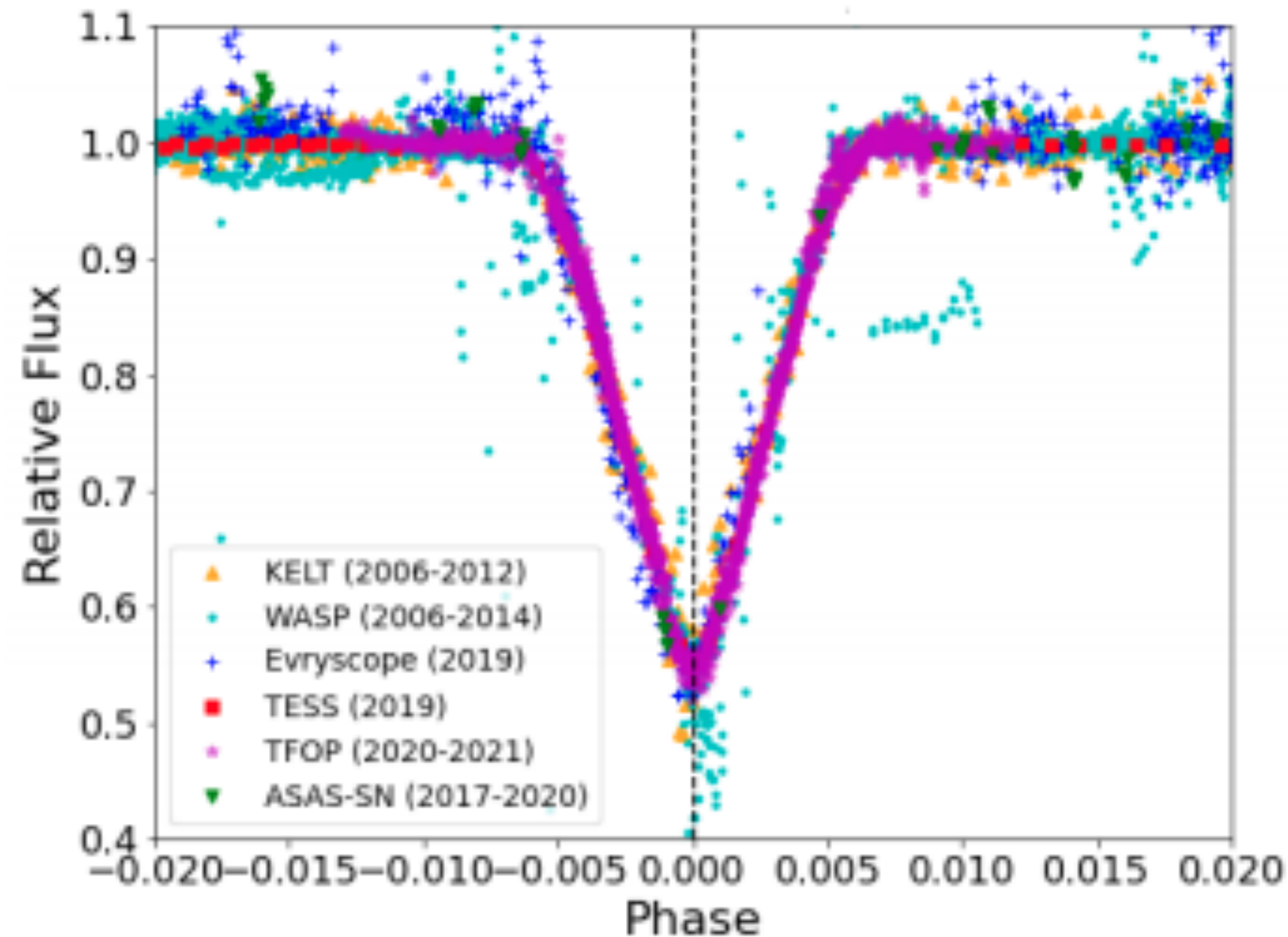
# But eclipses of their host stars are easy to find



# We can observe eclipses over many years



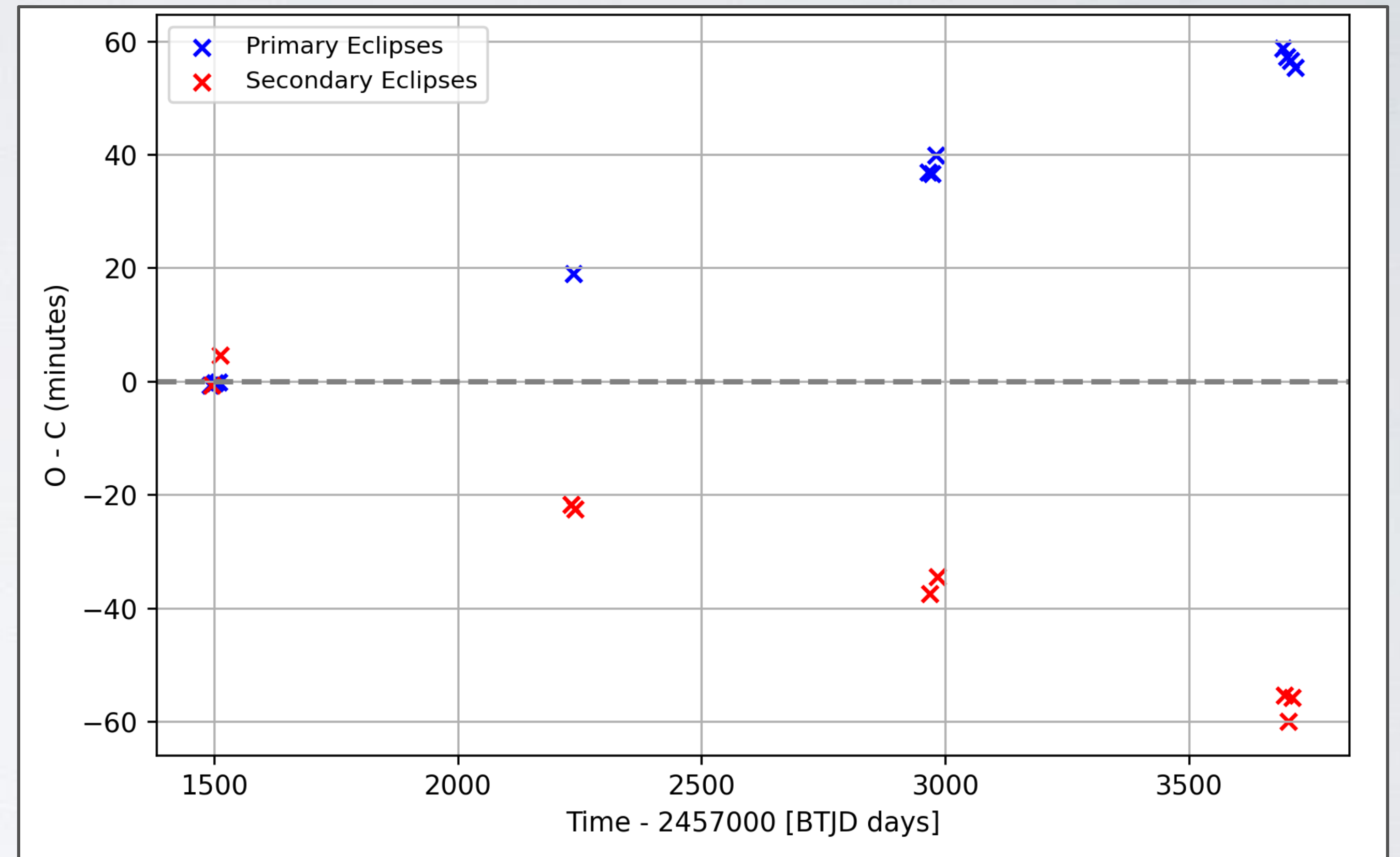
# We can observe eclipses over many years



# We can observe eclipses over many years

TESS baseline is longer than  
*Kepler!*

Let's flip the detection  
strategy: Can we identify  
CBPs from the precession  
they induce?



# There are many eclipses to look at!

## **Gaia Data Release 3**

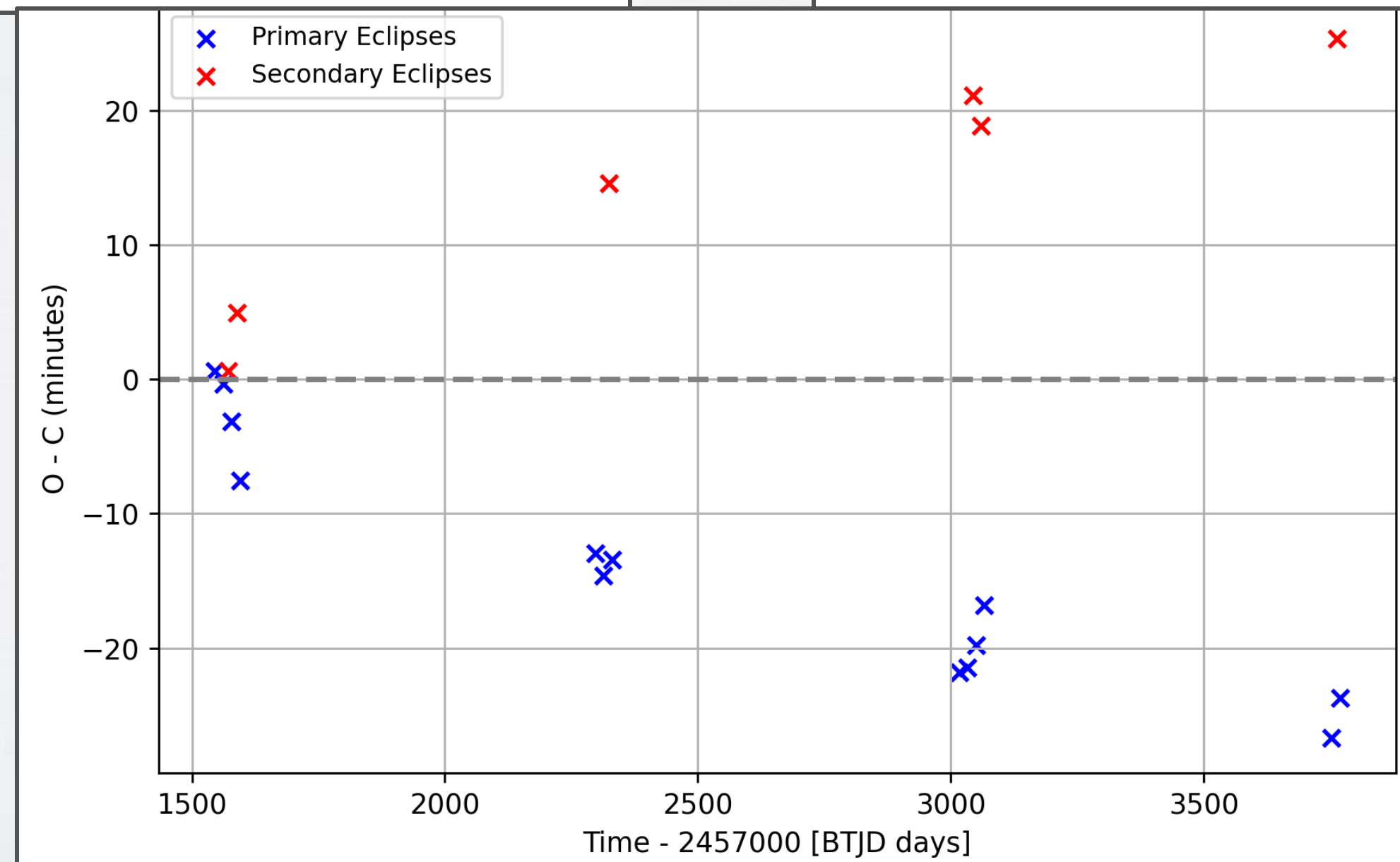
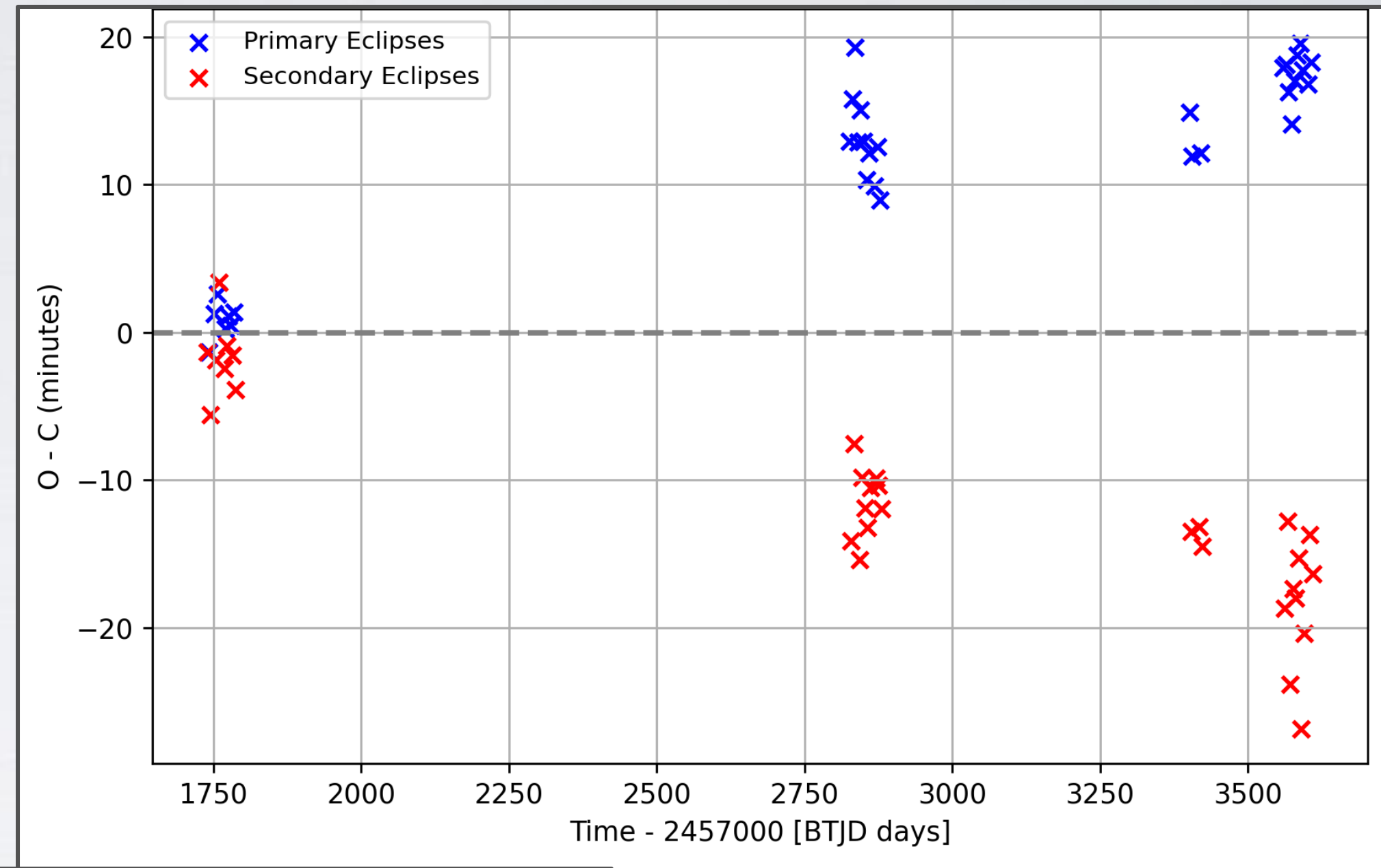
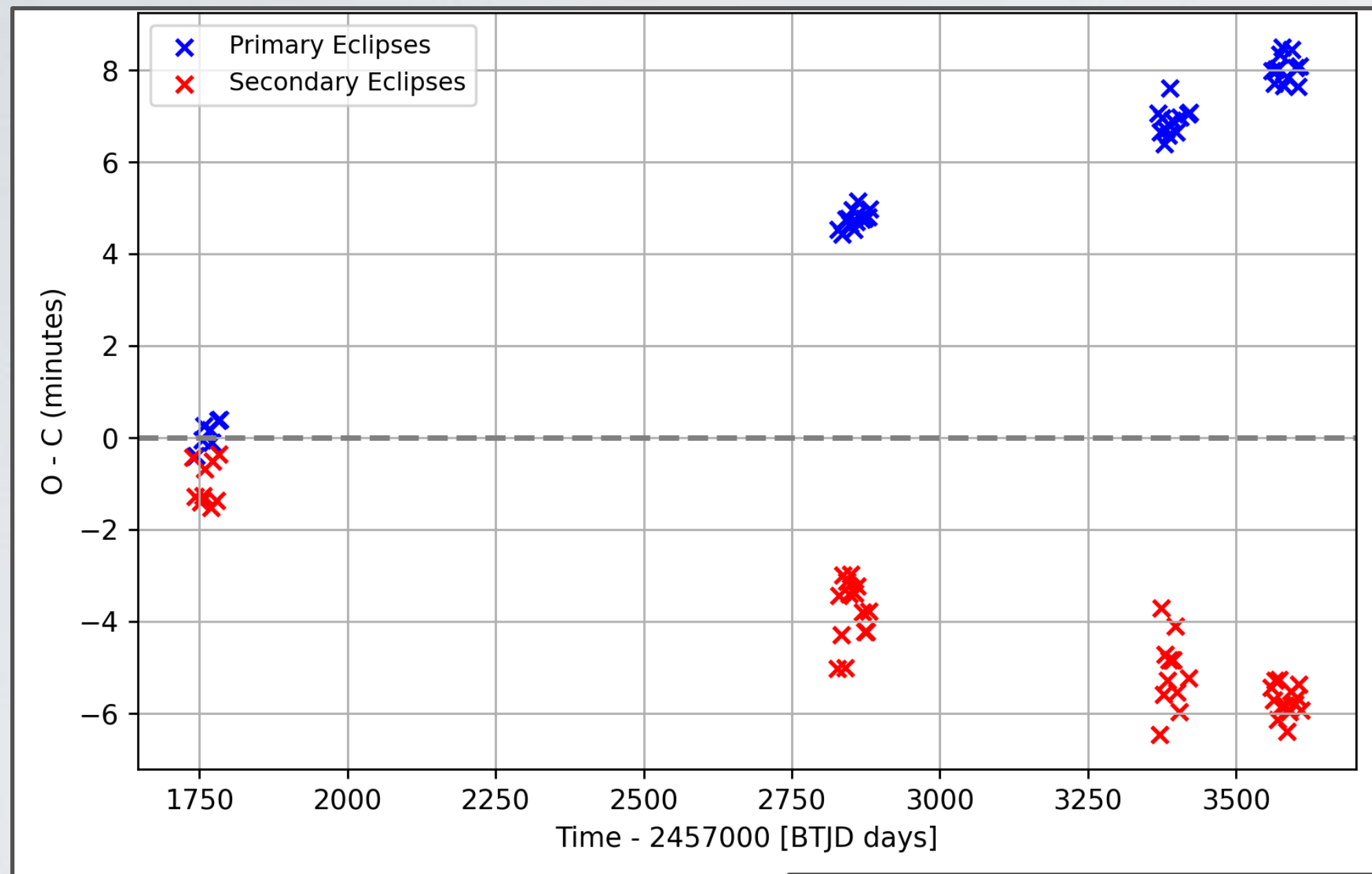
### **The first *Gaia* catalogue of eclipsing binary candidates**

N. Mowlavi<sup>1,2,\*</sup>, B. Holl<sup>1,2</sup>, I. Lecœur-Taïbi<sup>2</sup>, F. Barblan<sup>1</sup>, A. Kochoska<sup>3</sup>, A. Prša<sup>3</sup>, T. Mazeh<sup>4</sup>, L. Rimoldini<sup>2</sup>, P. Gavras<sup>5</sup>, M. Audard<sup>1,2</sup>, G. Jevardat de Fombelle<sup>2</sup>, K. Nienartowicz<sup>2,6</sup>, P. García-Lario<sup>7</sup>, and L. Eyer<sup>1,2</sup>

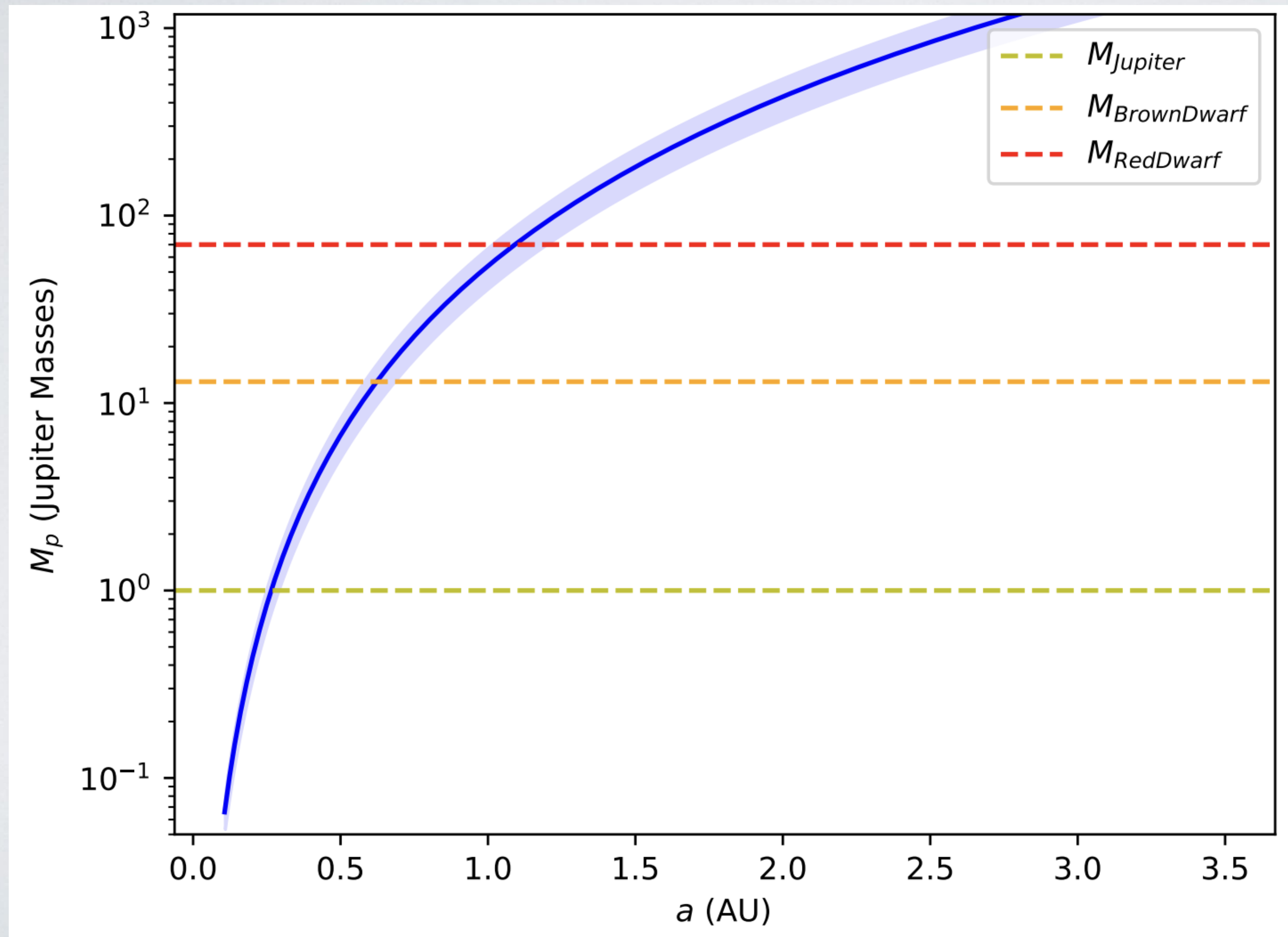
Selection Criteria	EBs Remaining
$m_G < 18$	947,083
Parallax $> 1$ mas	75,934
Non-Ellipsoidal	39,711
Main Sequence	35,008
TESS Light Curve Already on MAST	16,870



# We have a few dozen candidate systems so far

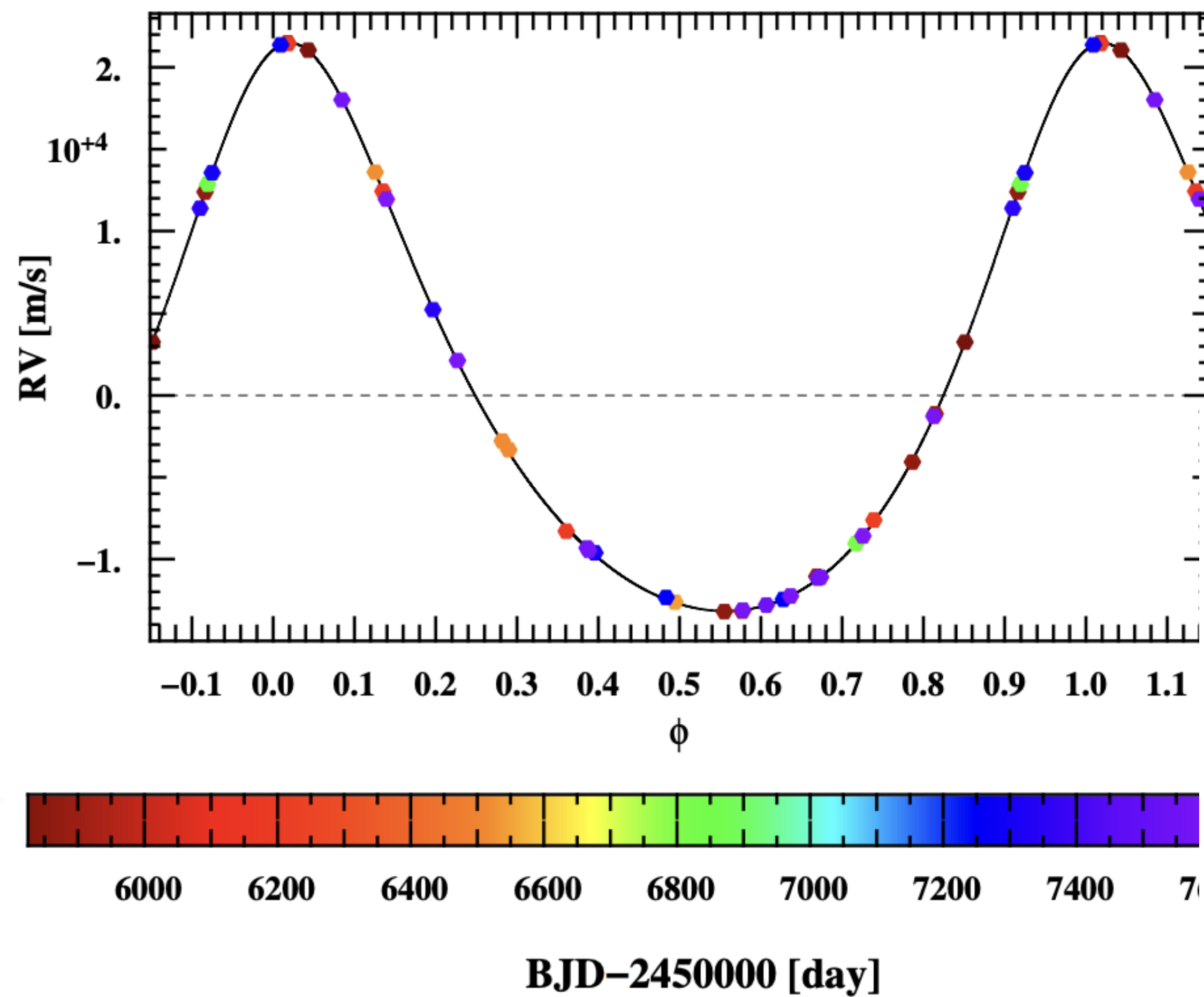


# We can quantify the companion precisely-ish

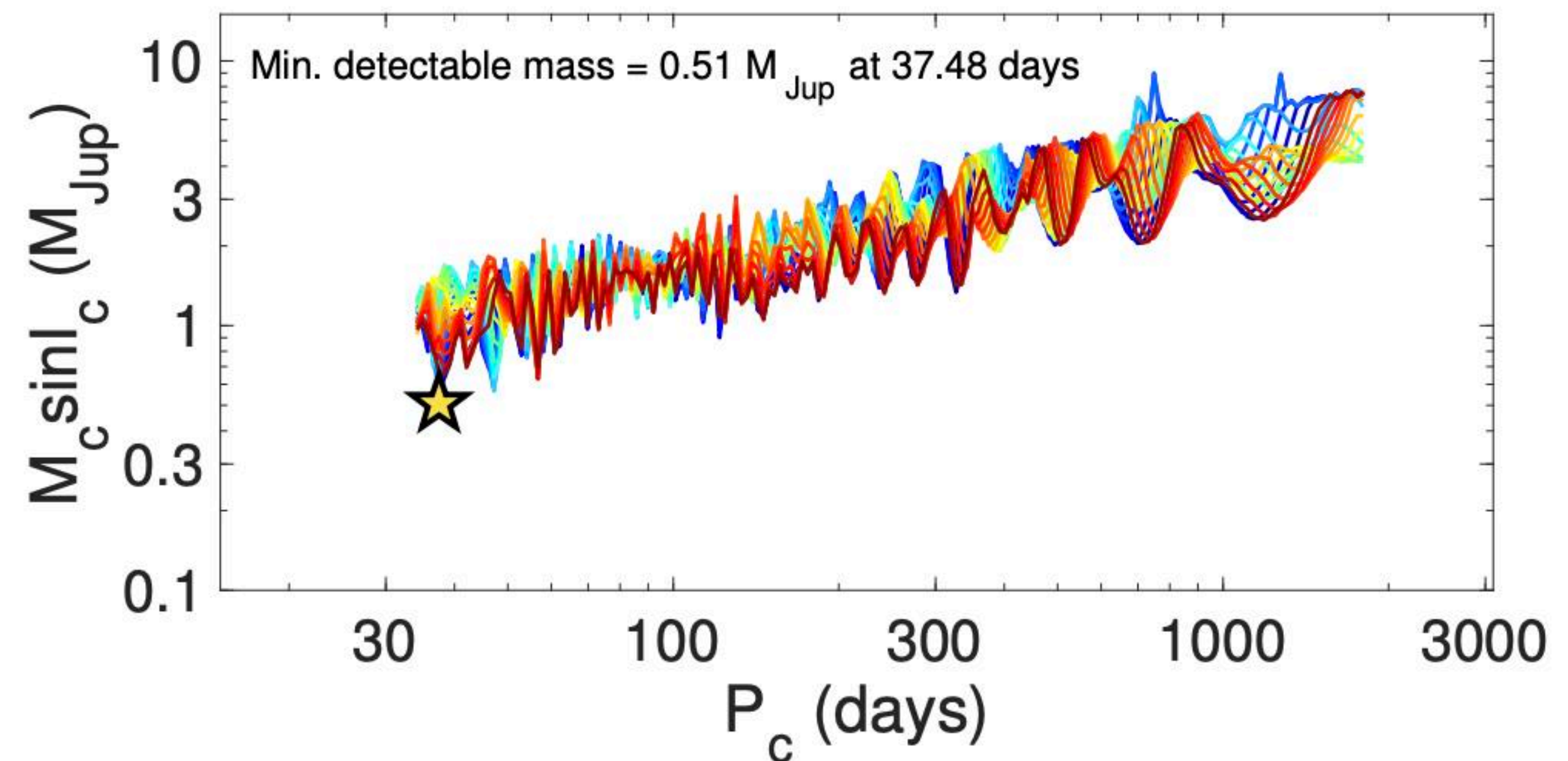


More data needed: RV follow up? Tenable for some! Some fraction will have visible transits too

# Next steps: spectroscopy



What are the other ways  
we can measure the  
companion?

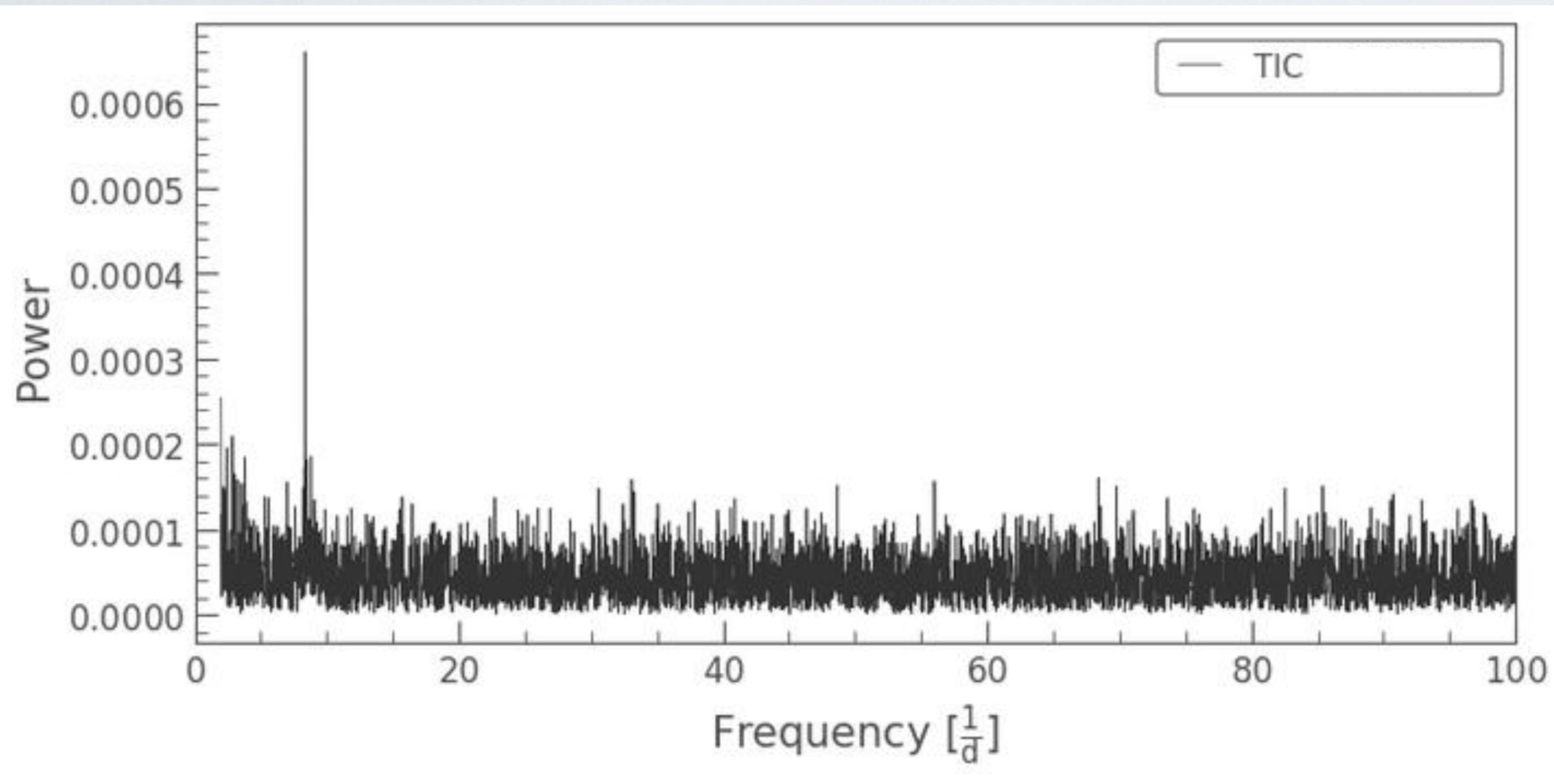


# Next steps: spectroscopy or avoiding spectroscopy

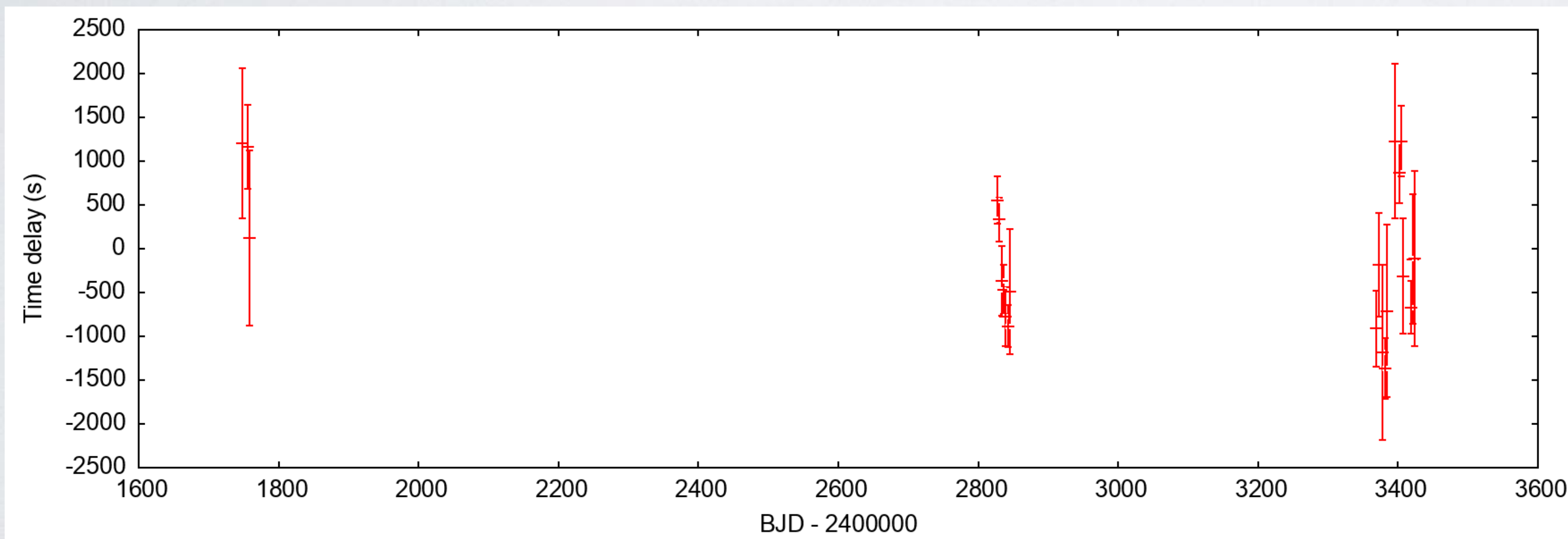
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# Next steps: spectroscopy or avoiding spectroscopy

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# Next steps: spectroscopy or avoiding spectroscopy



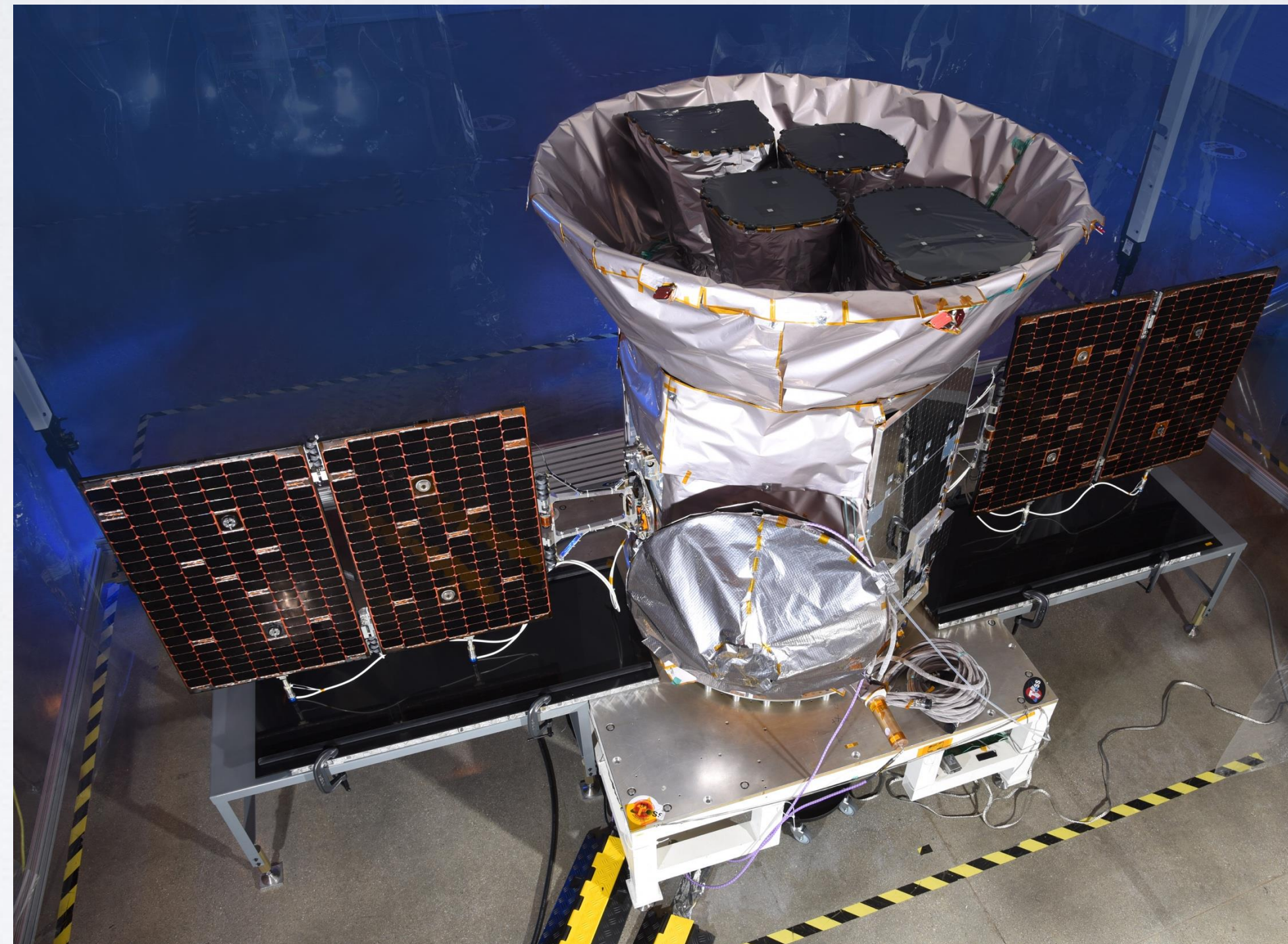
**This companion might be  
stellar**

**More TESS data  
imminent**

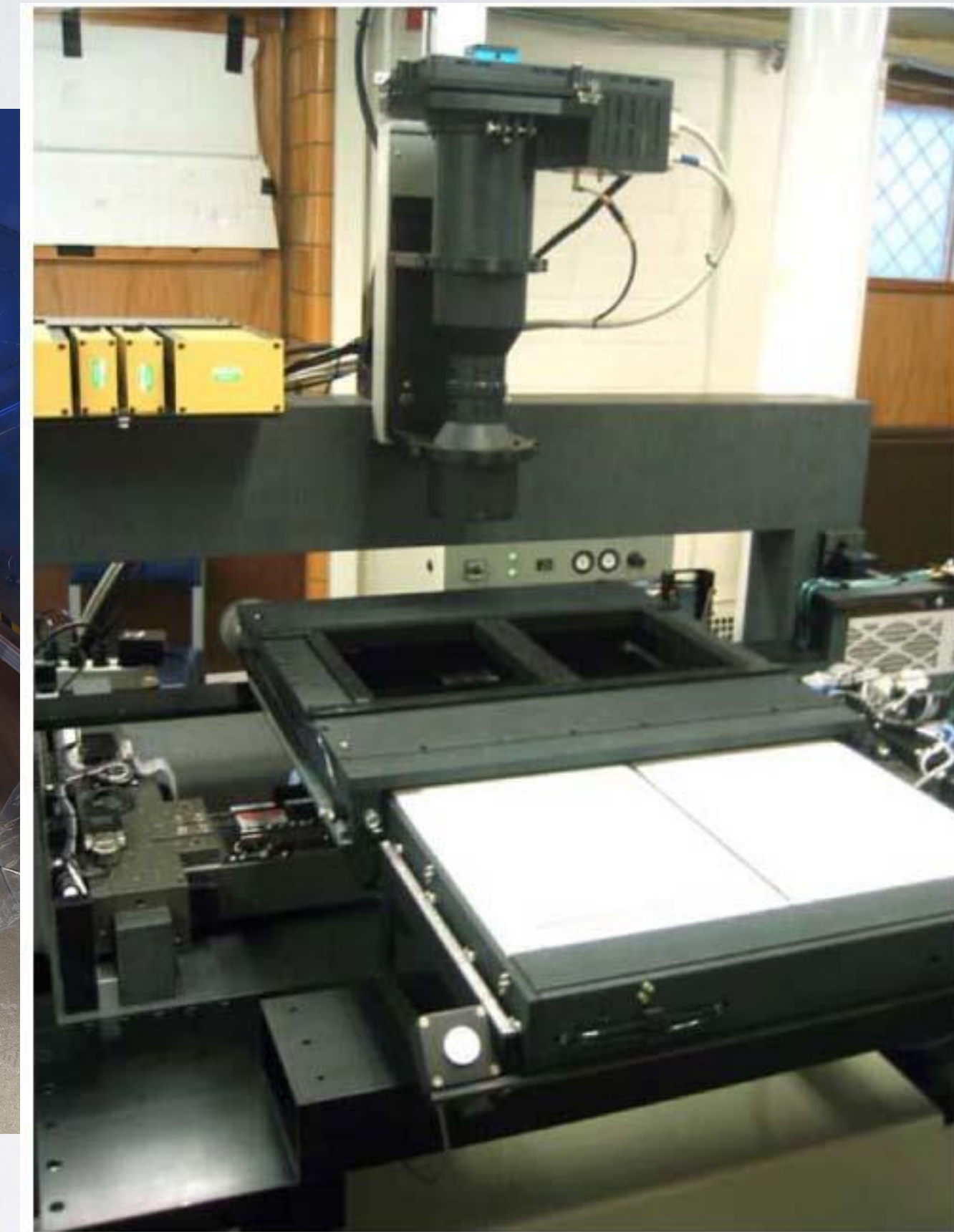
# There's a lot of data to explore



ASAS-SN "Brutus"

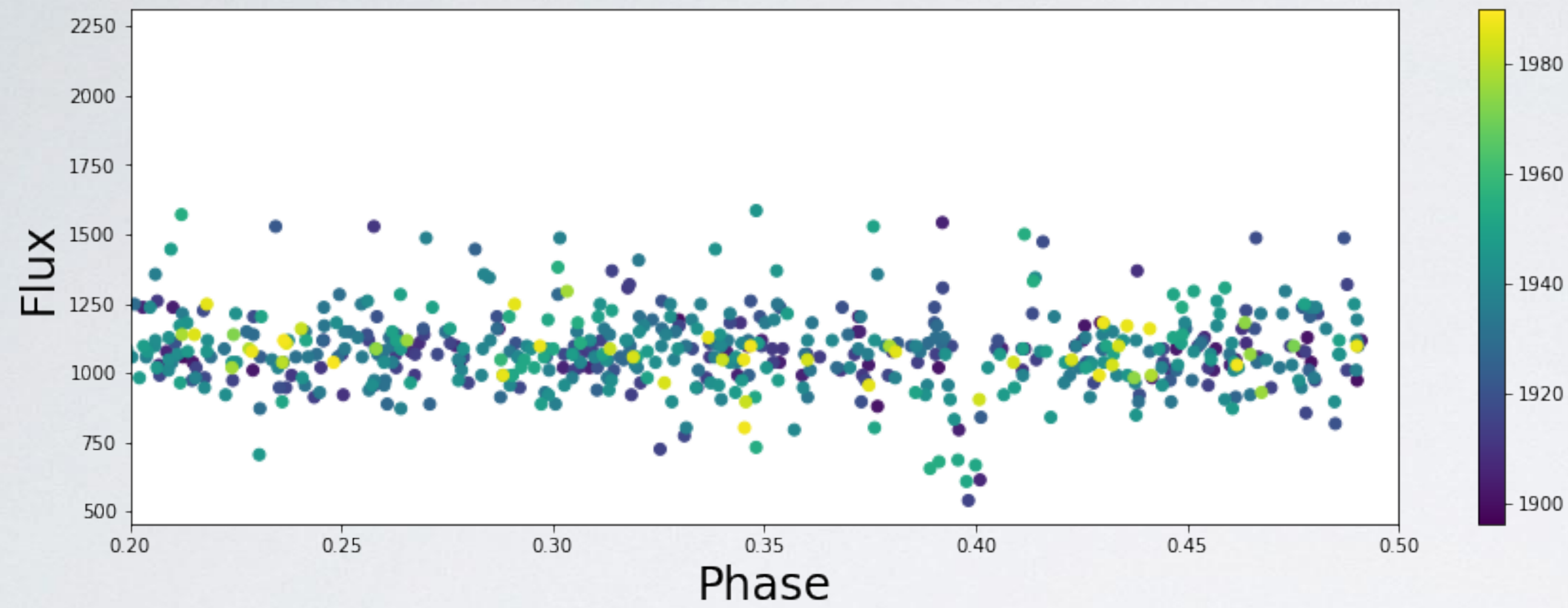


TESS



DASCH

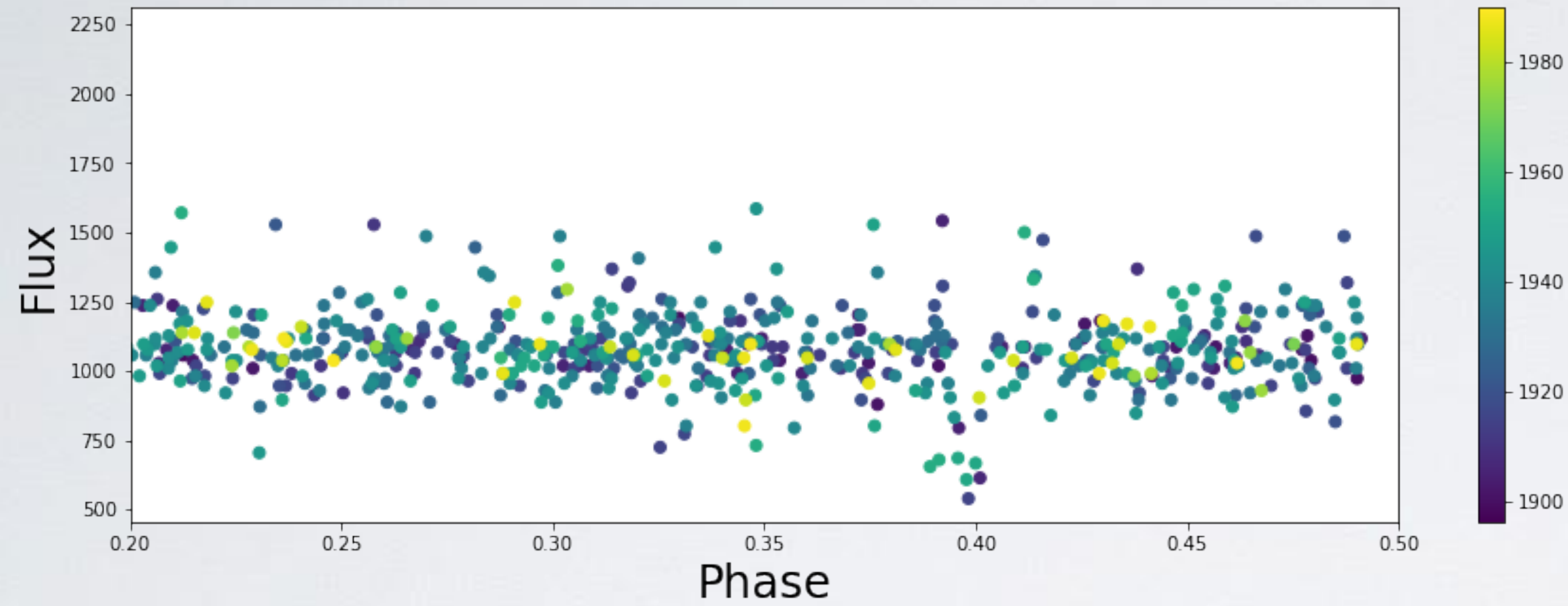
# We can observe eclipses over many years



Secondary Eclipse

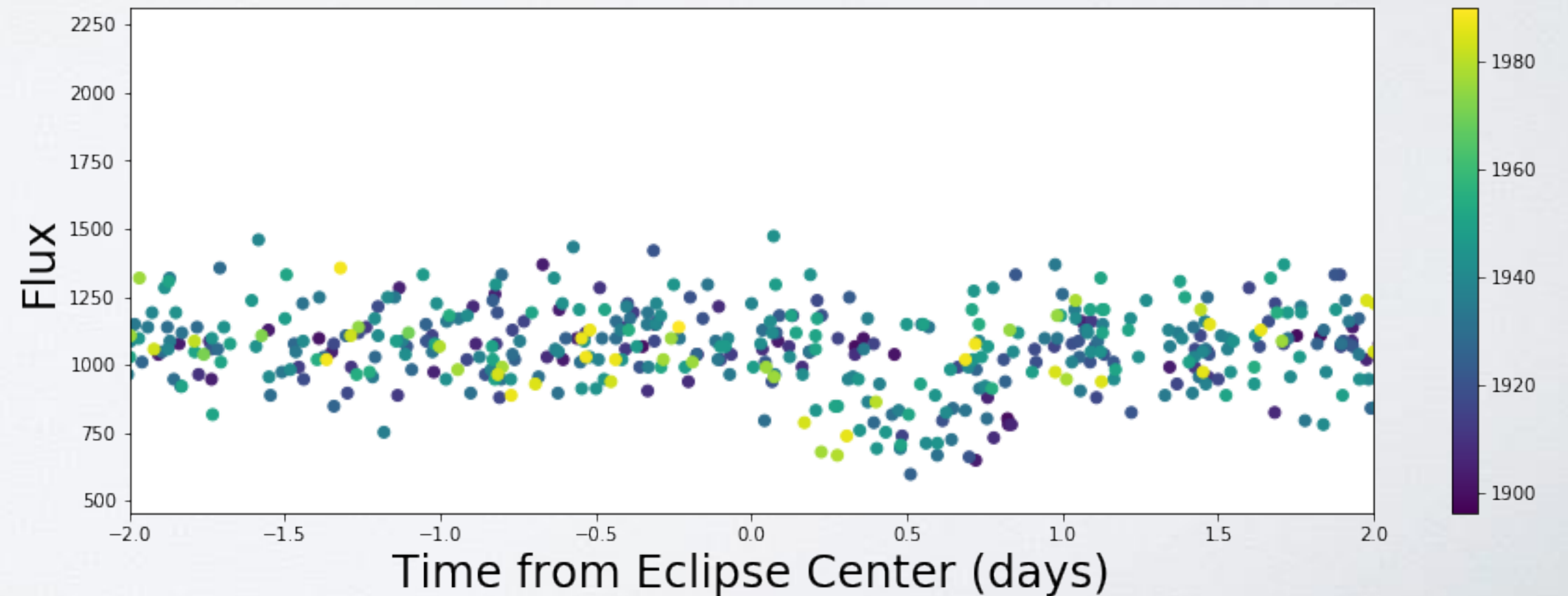
Primary Eclipse (centred on Secondary phase)

# We can observe eclipses over many years



Primary Eclipse (centred on Secondary phase)

Secondary Eclipse



# TESS and ground-based facilities are great for identifying precession

We have too many candidates – lots of companions  
to be found in the data!

We need more RV follow-up  
(especially in the North)

Gaia DR4 will be a game-changer too

Thank you!