

# Hundreds of Planet Candidates from K2

Ethan Kruse

 @ethan\_kruse

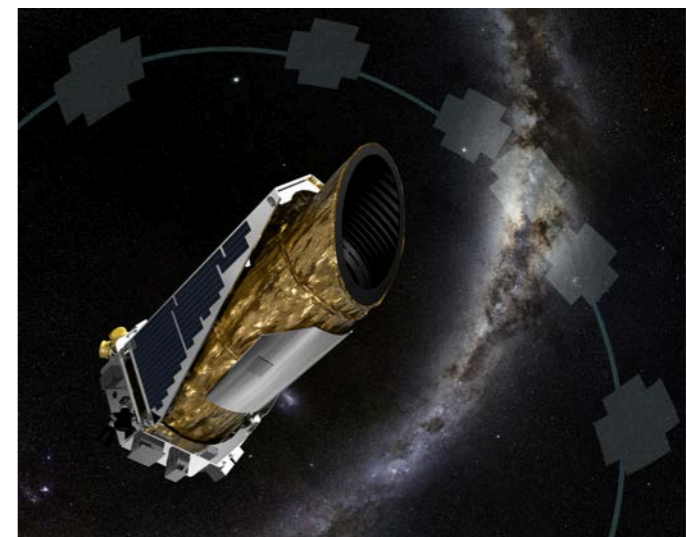
4 June 2018

---

**W** UNIVERSITY *of*  
WASHINGTON

BLUE WATERS

Collaborators:  
Eric Agol  
Rodrigo Luger  
Dan Foreman-Mackey



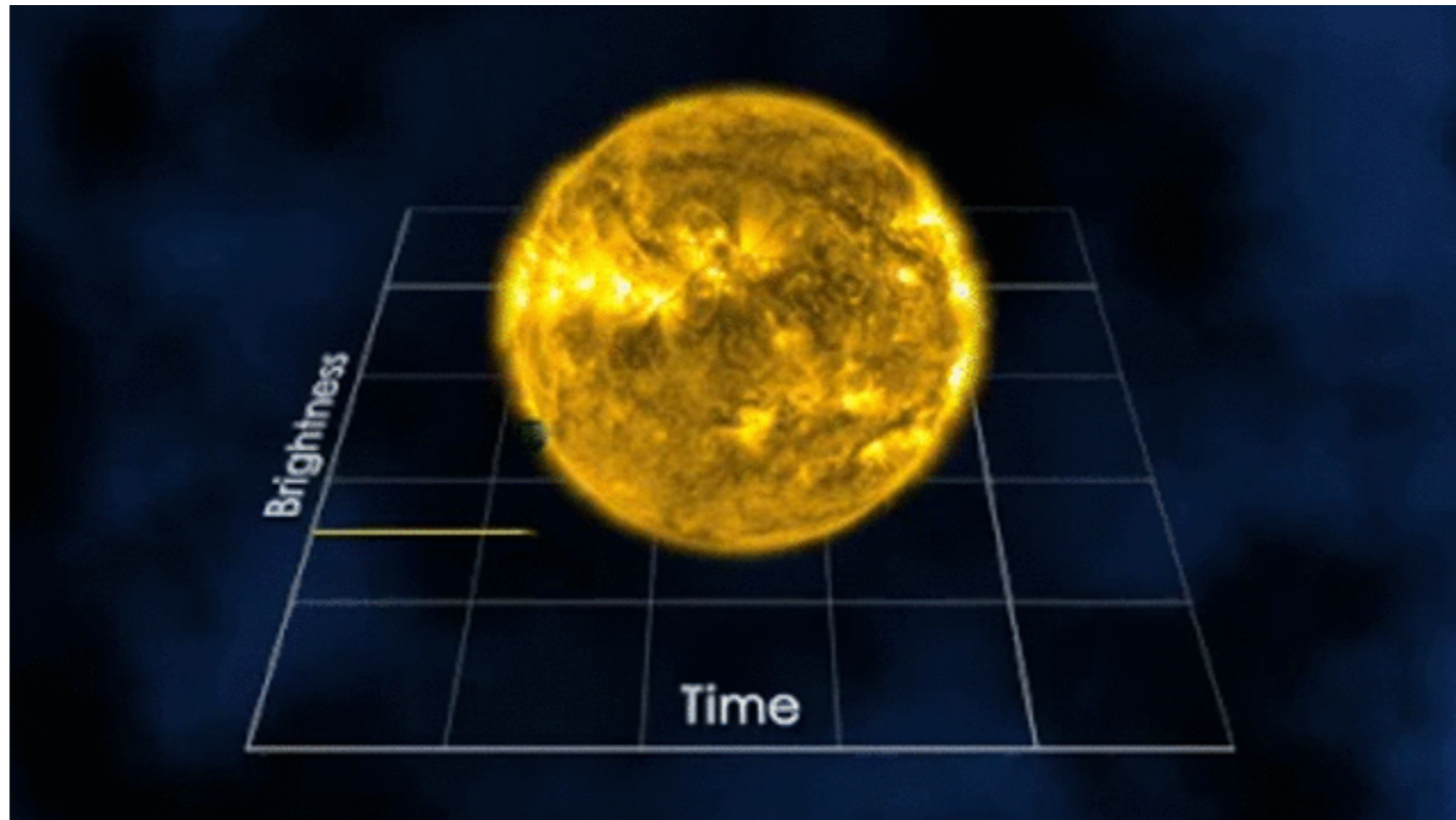
# Outline

---

- ◆ Intro to Kepler & K2
- ◆ Methods & Why Blue Waters
- ◆ Results & Future Plans

# Finding Transiting Planets

---



## ◆ Depths

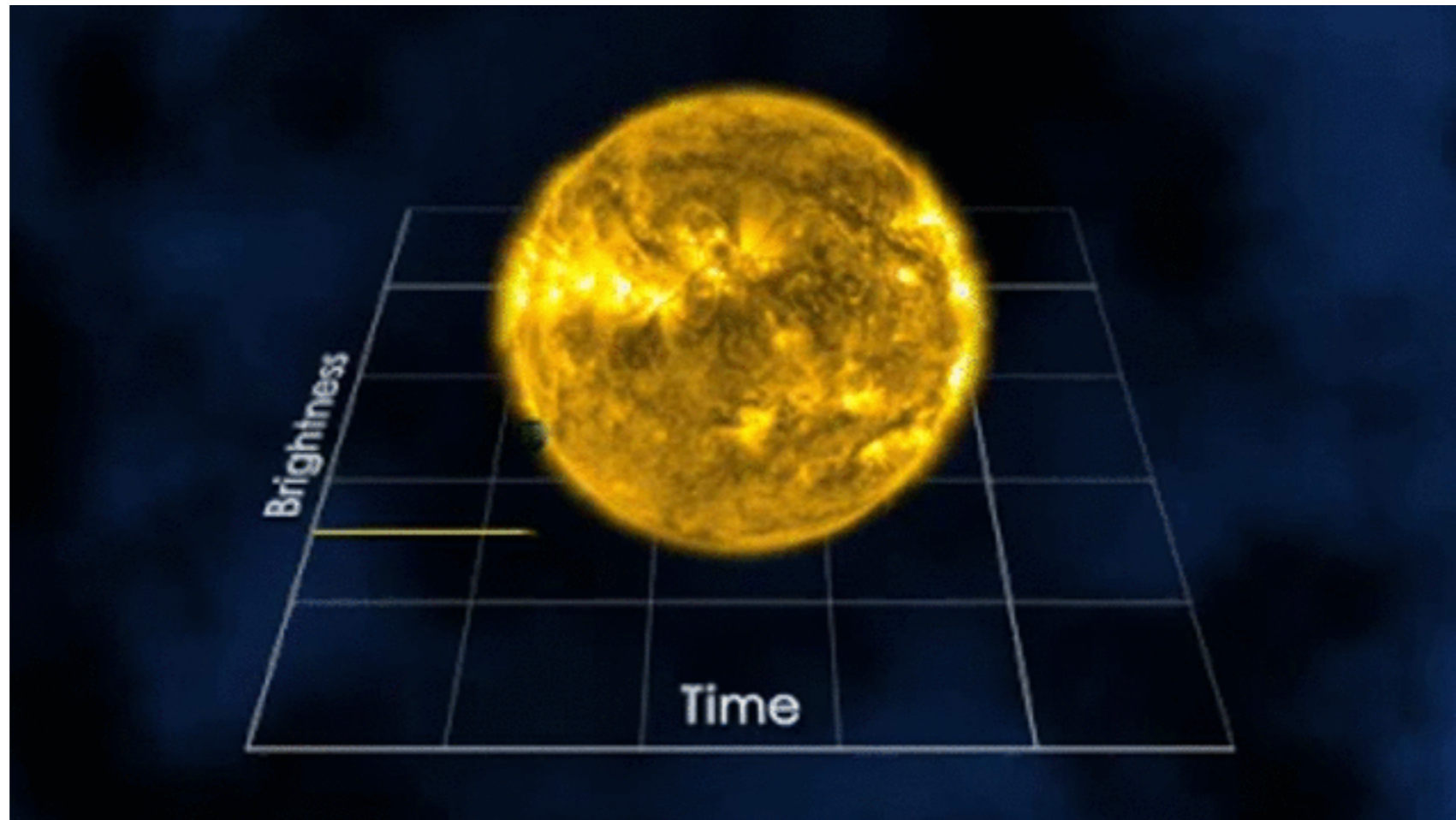
◆ Earth: 0.01%

◆ Jupiter: 1%

◆ Odds of transit at  
1 AU: 1 in 200

# Finding Transiting Planets

---



## ◆ Depths

◆ Earth: 0.01%

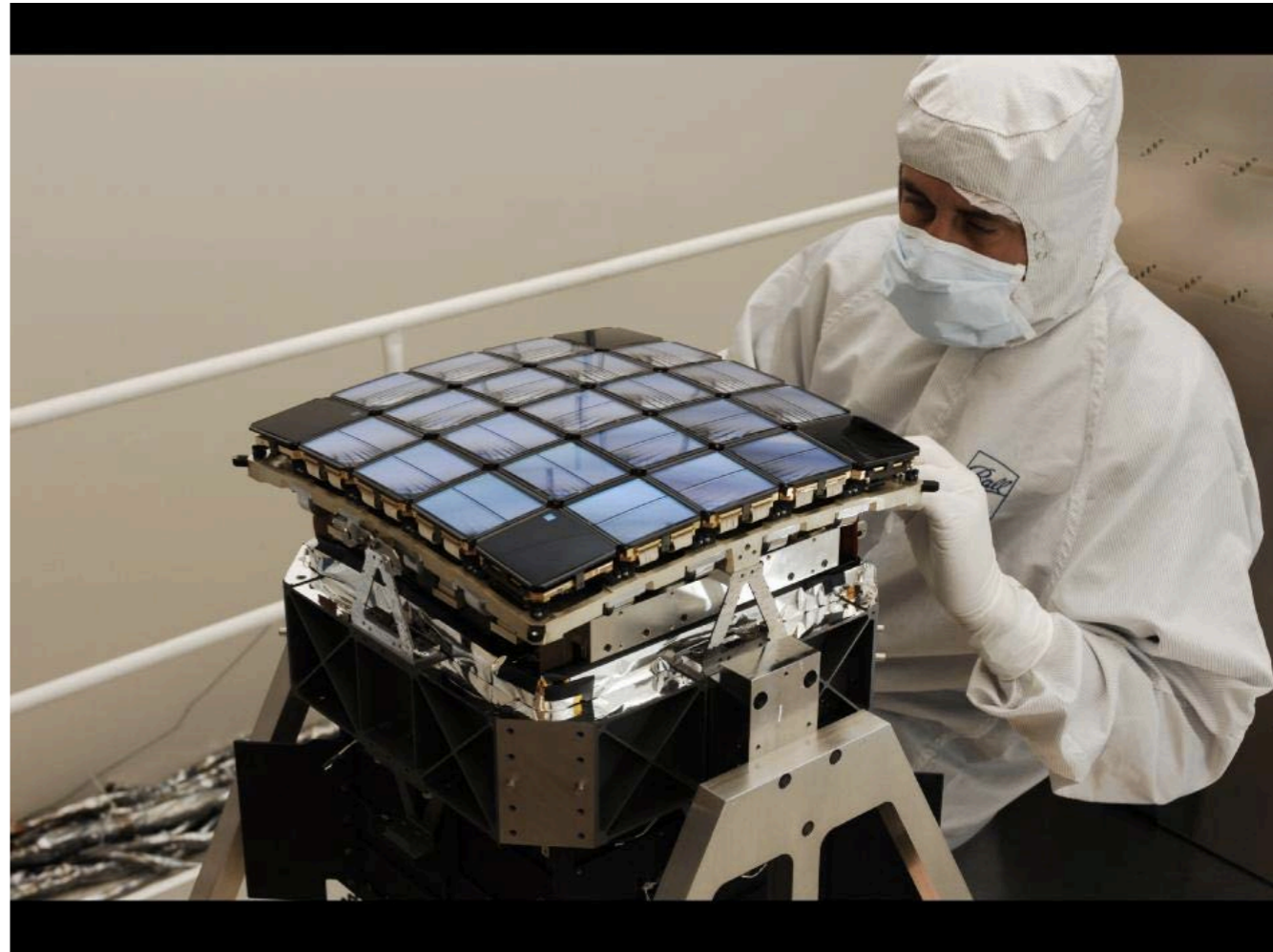
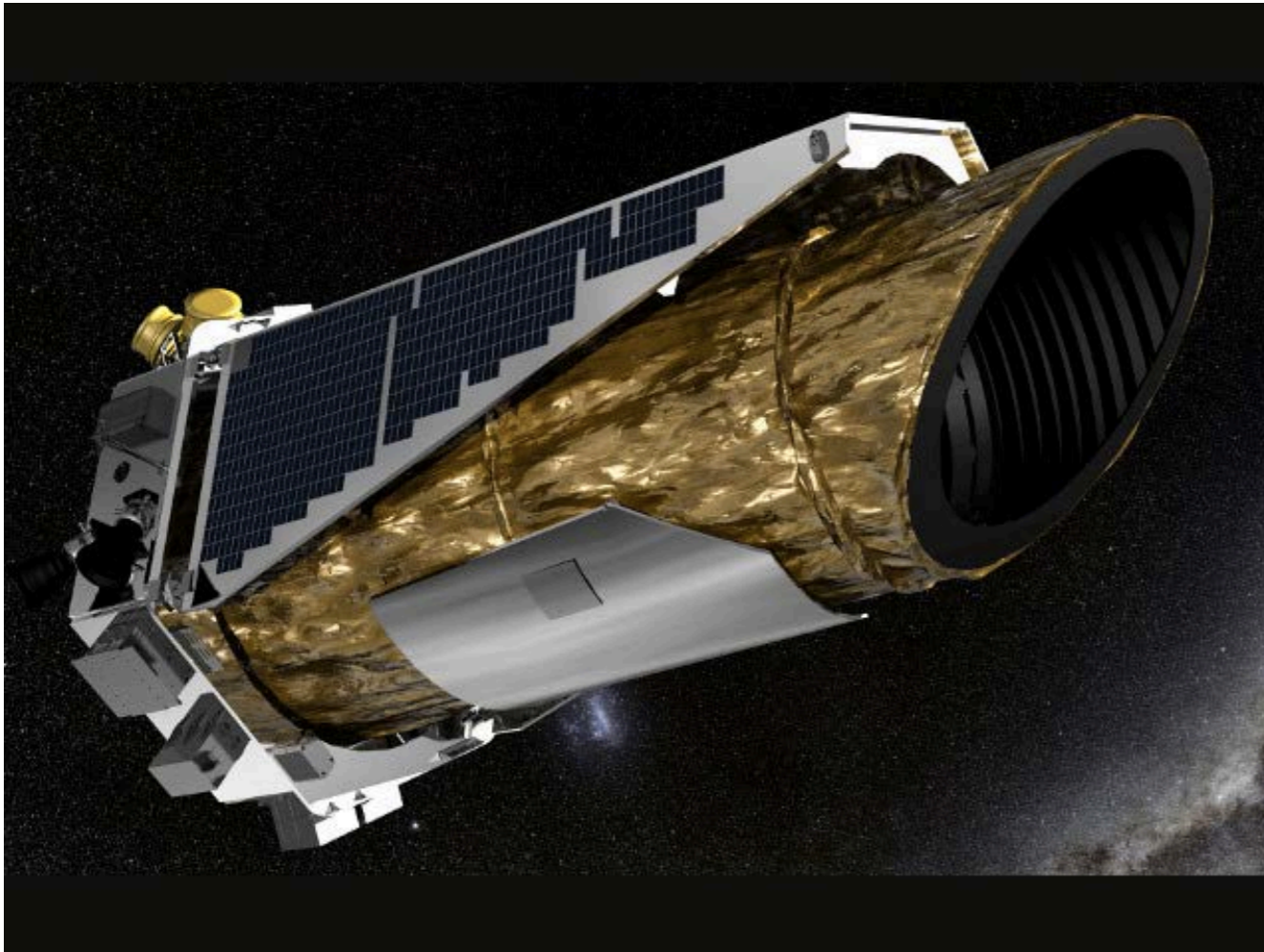
◆ Jupiter: 1%

◆ Odds of transit at  
1 AU: 1 in 200



# Kepler Telescope

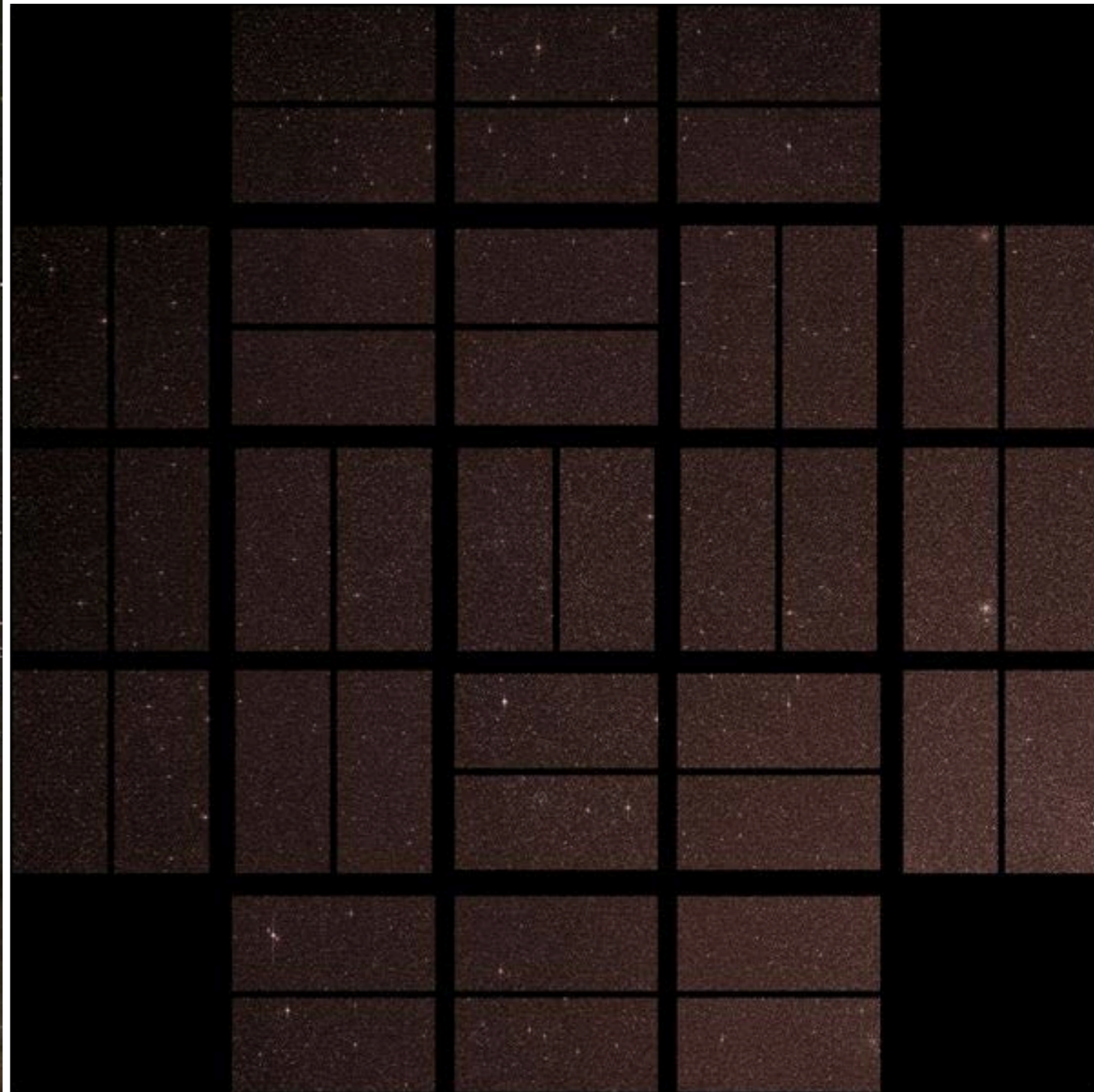
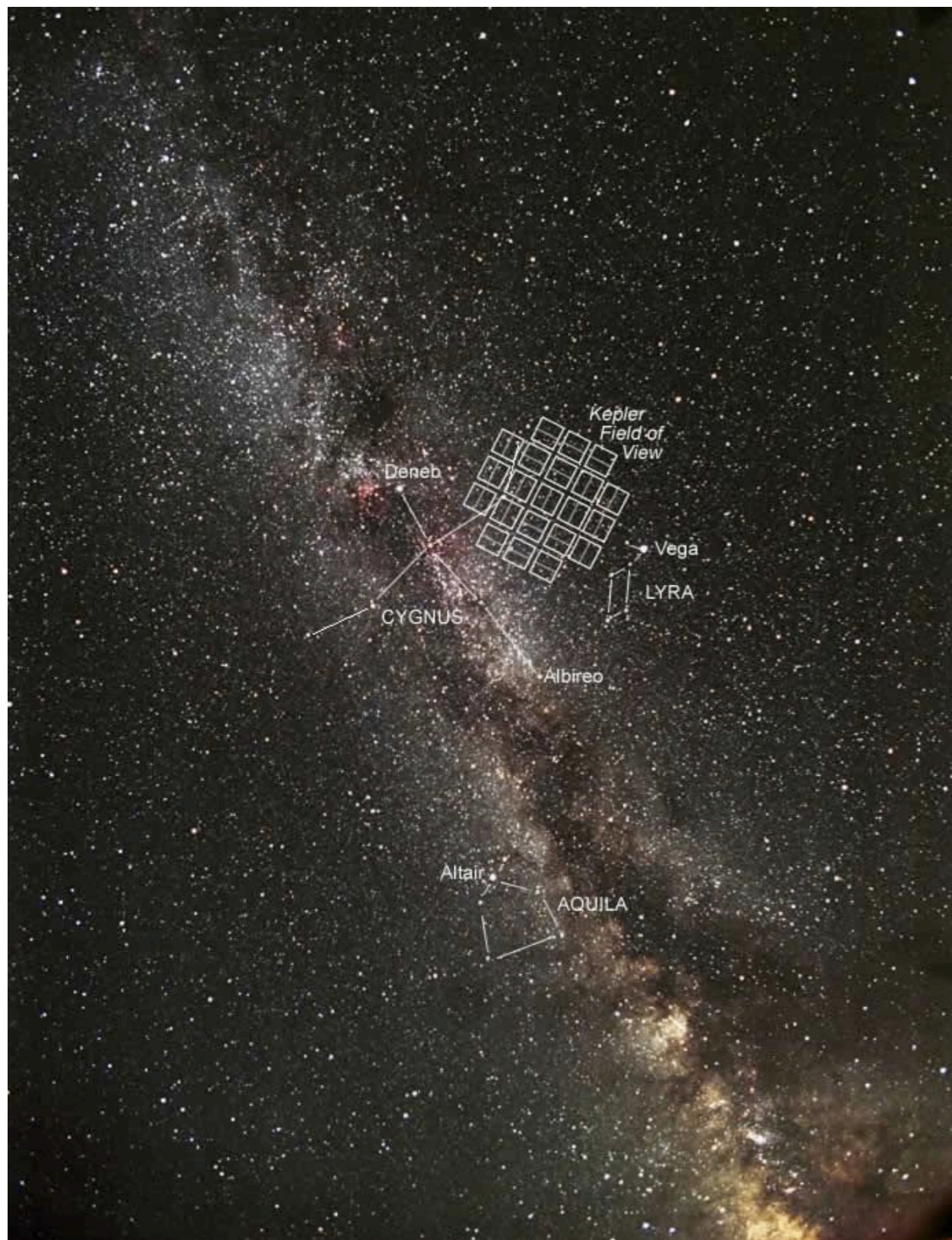
---



- ◆ Launched 2009
- ◆ 1.4 m mirror
- ◆ 96 Megapixel camera

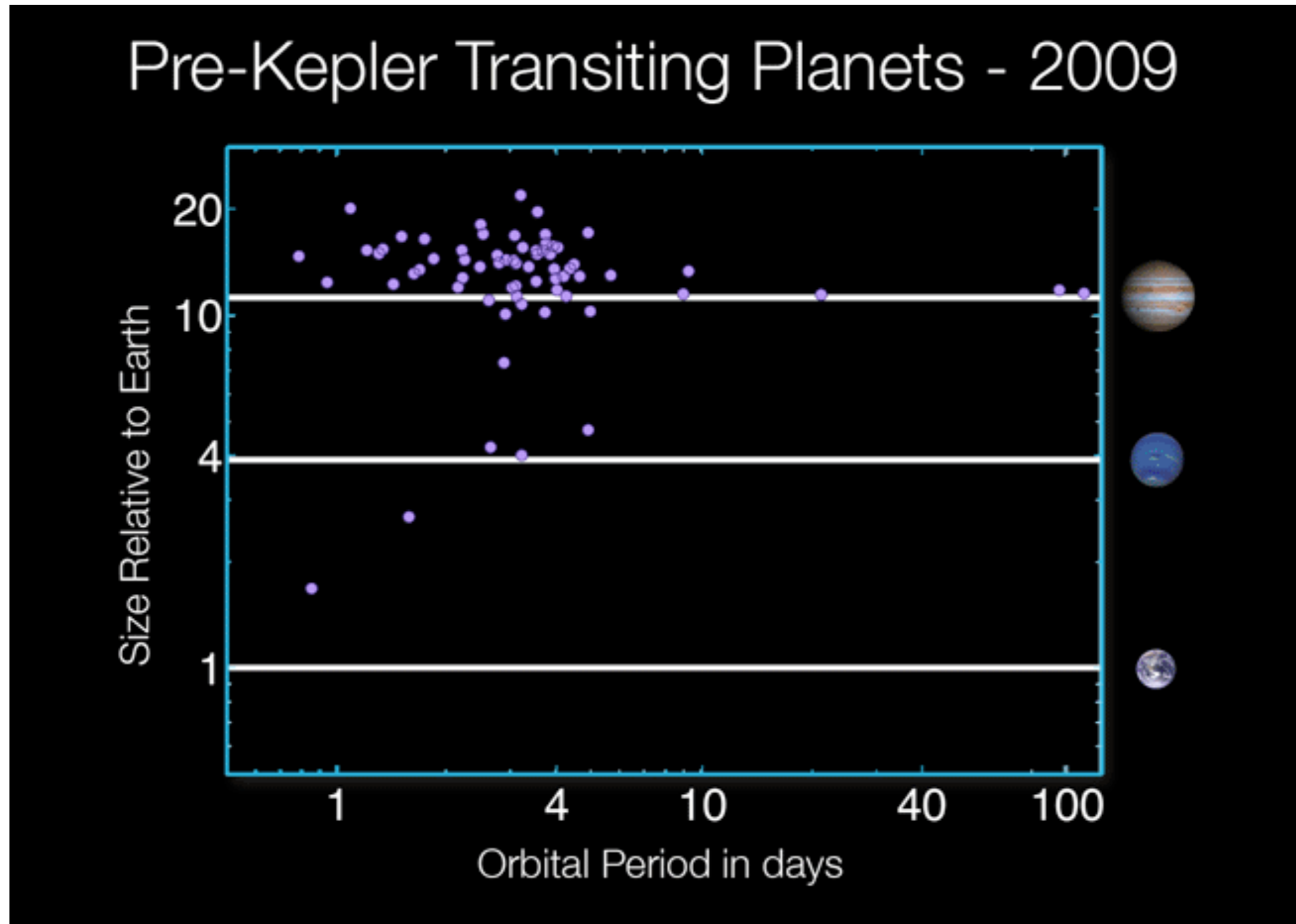


# Kepler Field of View

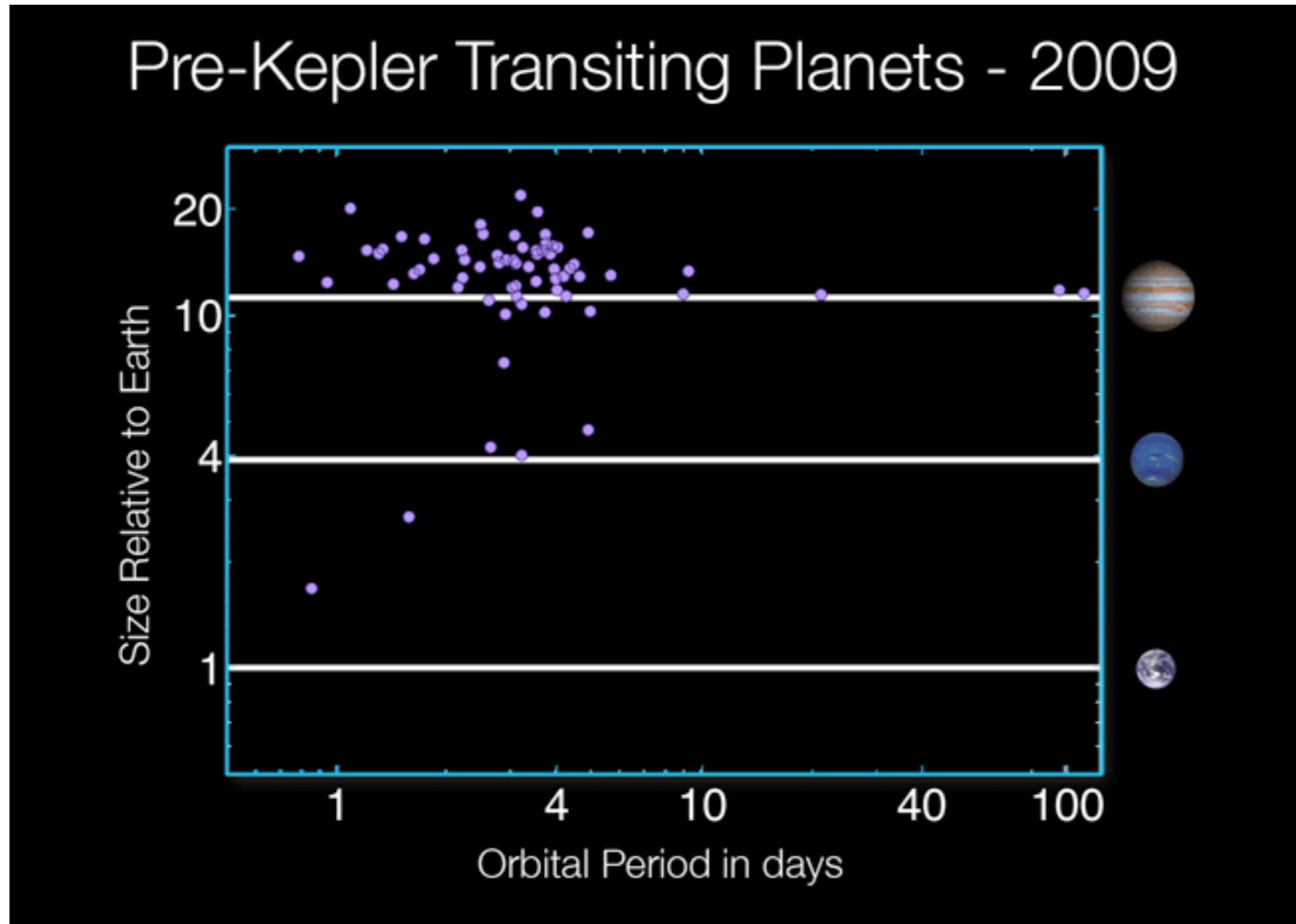




# Kepler Planets (2009-2011)



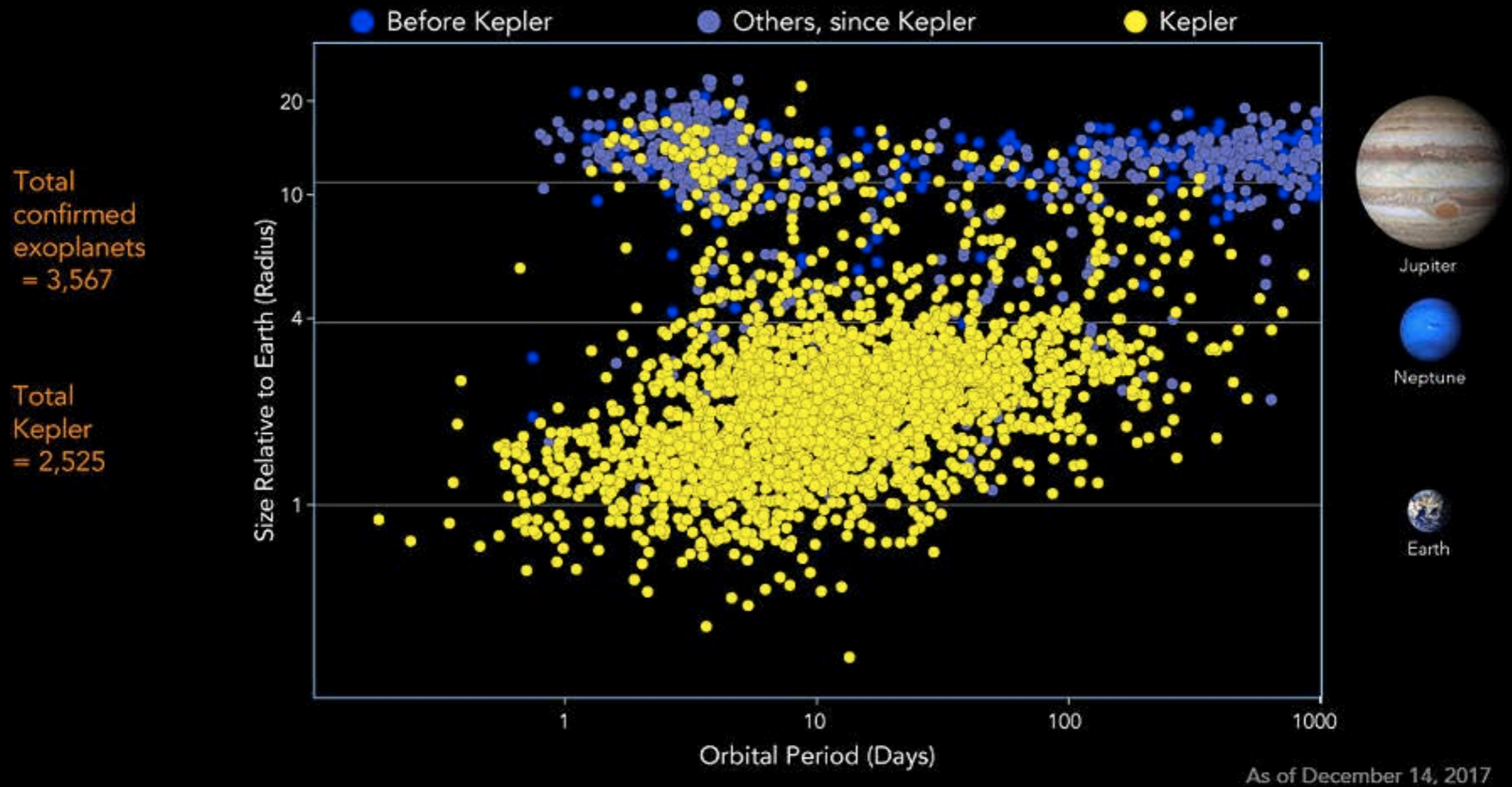
# Kepler Planets (2009-2011)





# Kepler Planets (2009-2013)

## Exoplanet Discoveries



# 2013 Disaster

---





# 2013 Disaster

---

## *Breakdown Imperils NASA's Hunt for Other Earths*

---

By DENNIS OVERBYE MAY 15, 2013

---

# 2013 Disaster

---

## *Breakdown Imperils NASA's Hunt for Other Earths*

---

By DENNIS OVERBYE MAY 15, 2013

---

Health & Science

## NASA's Kepler space telescope malfunction may end hunt for planets



# 2013 Disaster

---

## *Breakdown Imperils NASA's Hunt for Other Earths*

---

By DENNIS OVERBYE MAY 15, 2013

---

Health & Science

## NASA's Kepler space telescope malfunction may end hunt for planets



### The wheels come off Kepler

Space telescope's mission to find planets outside the Solar System is probably over.

Ron Cowen

21 May 2013

# 2013 Disaster

---

## *Breakdown Imperils NASA's Hunt for Other Earths*

---

By DENNIS OVERBYE MAY 15, 2013

---

Health & Science

## NASA's Kepler space telescope malfunction may end hunt for planets



### The wheels come off Kepler

Space telescope's mission to find planets outside the Solar System is probably over.

Ron Cowen

21 May 2013

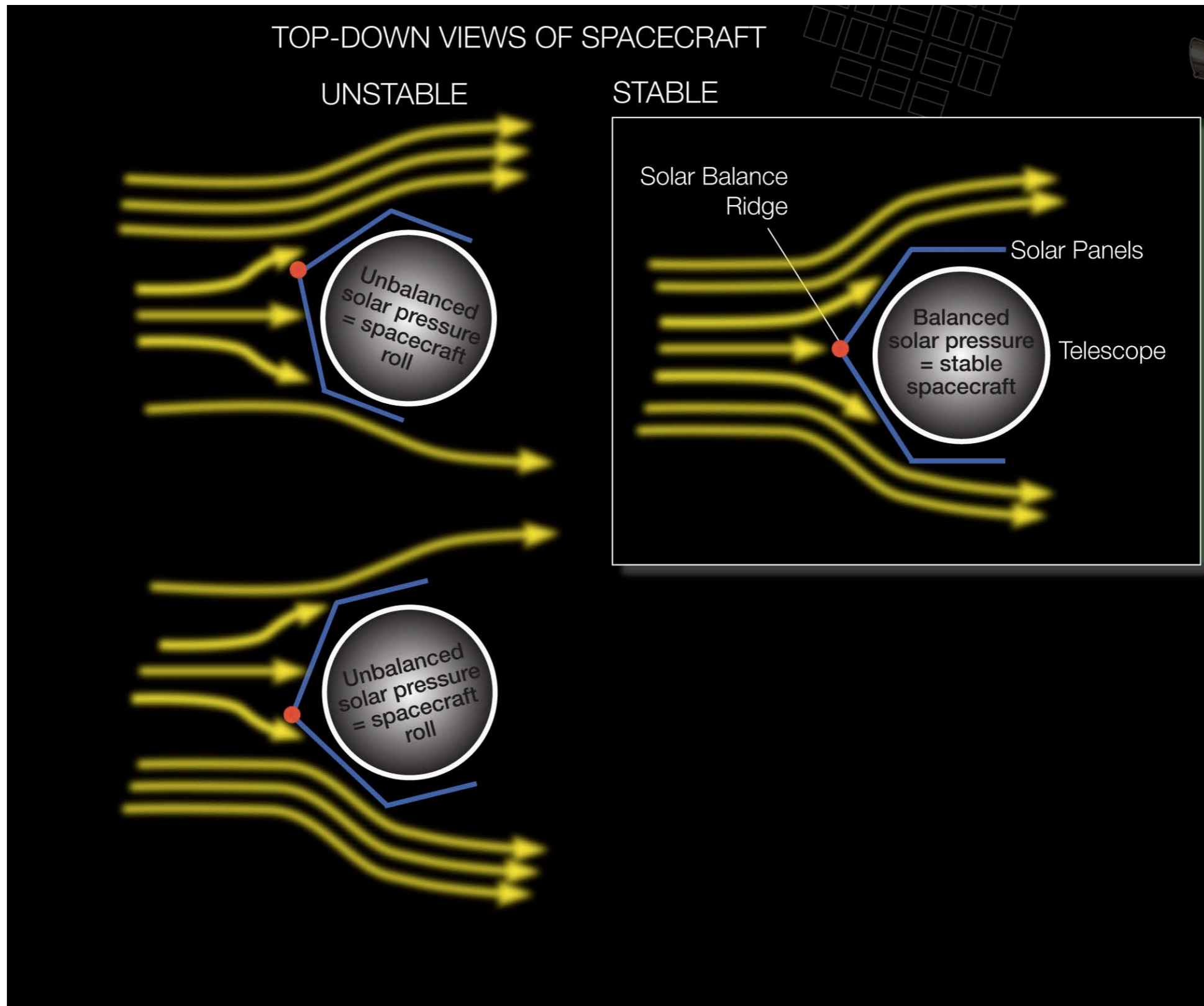
## Kepler Goes Down — and Probably Out

By: Kelly Beatty | May 15, 2013

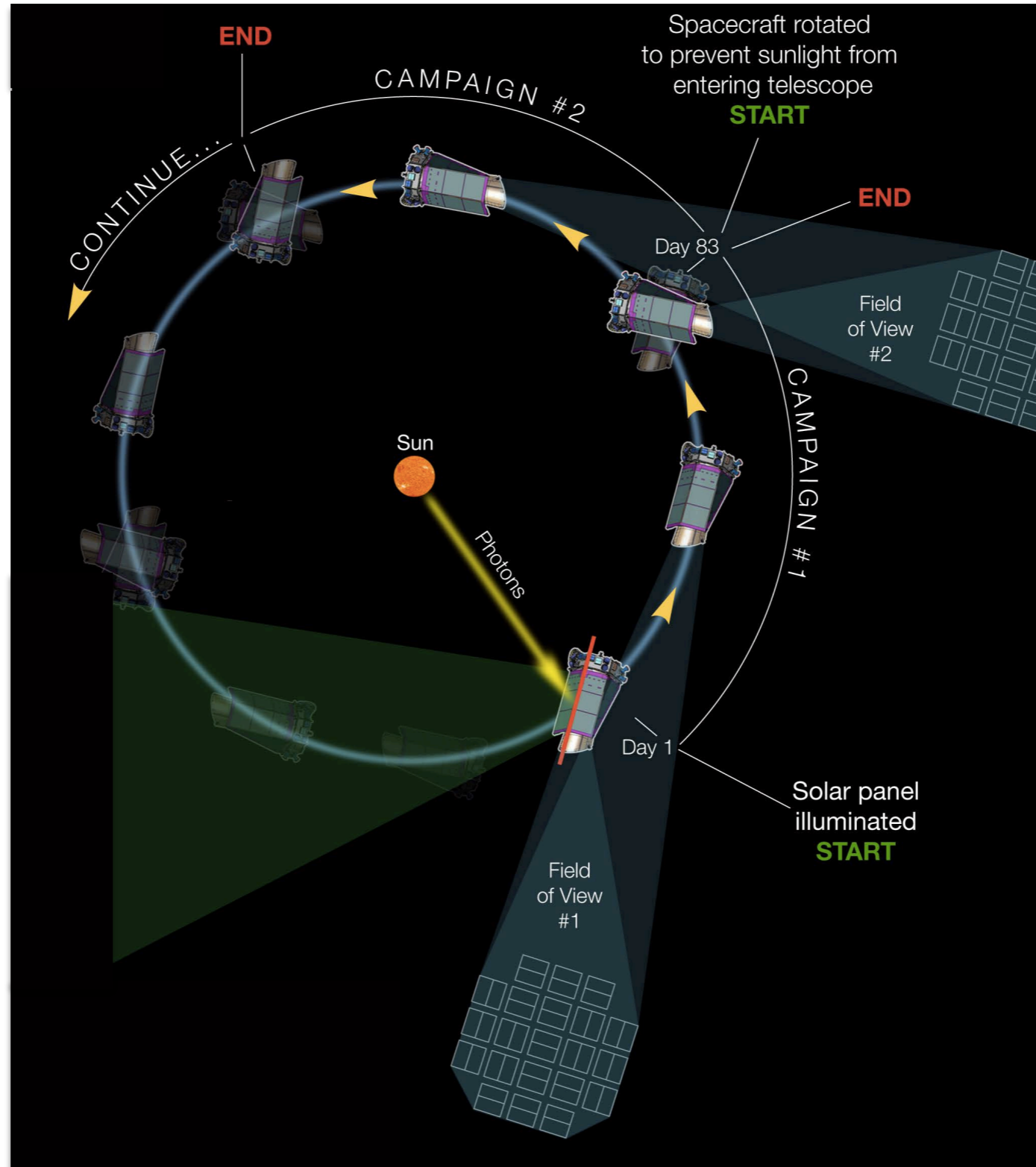
---



# K2 Overview

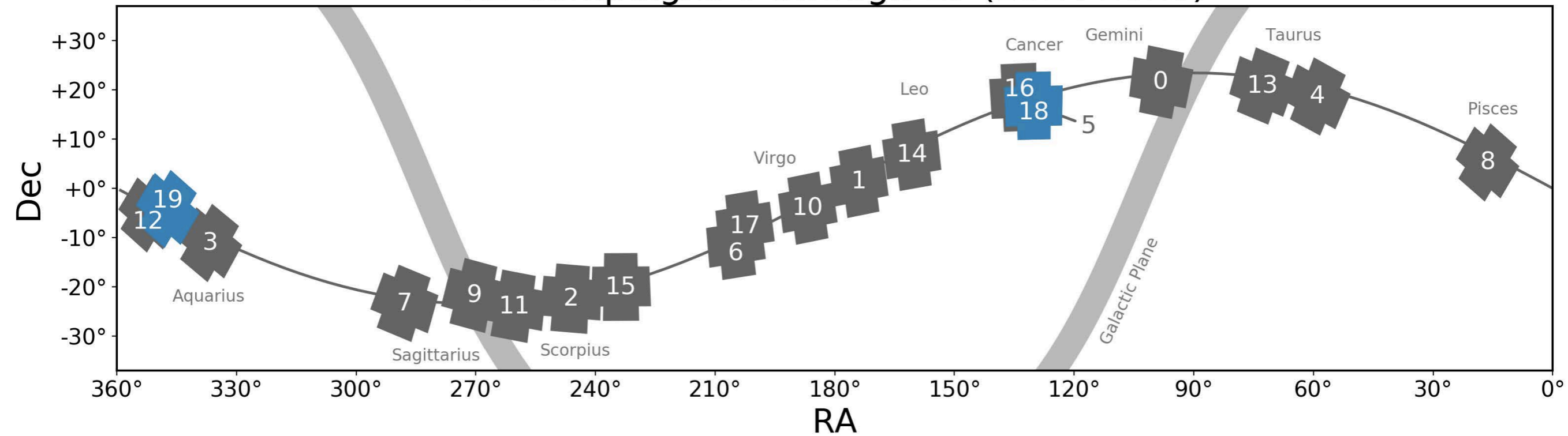


# K2 Overview



# K2 Overview

K2 Campaigns 0 through 19 (2014-2018)

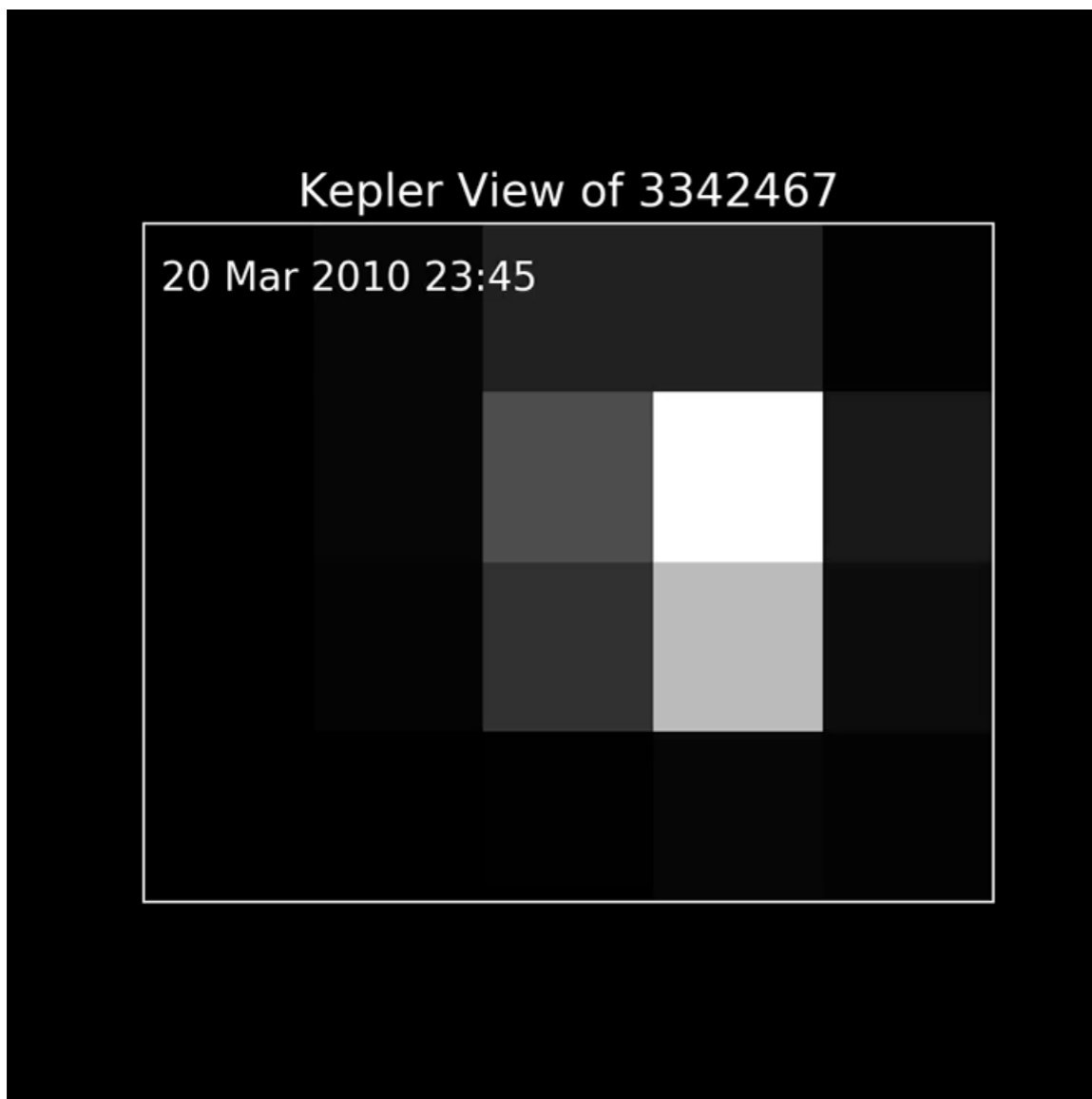




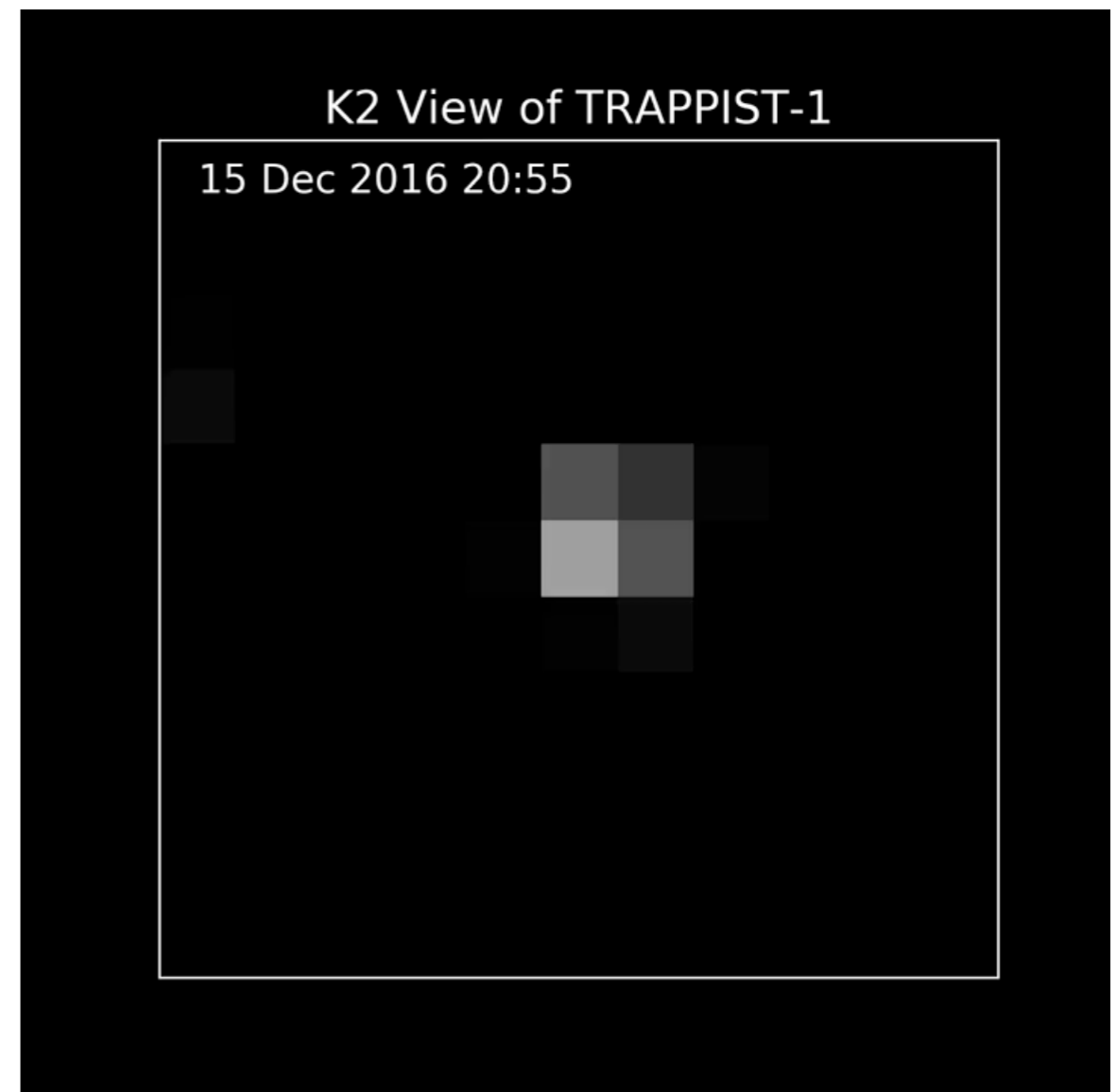
# K2 Degraded Quality

---

Kepler star  
(4x5 pixels)



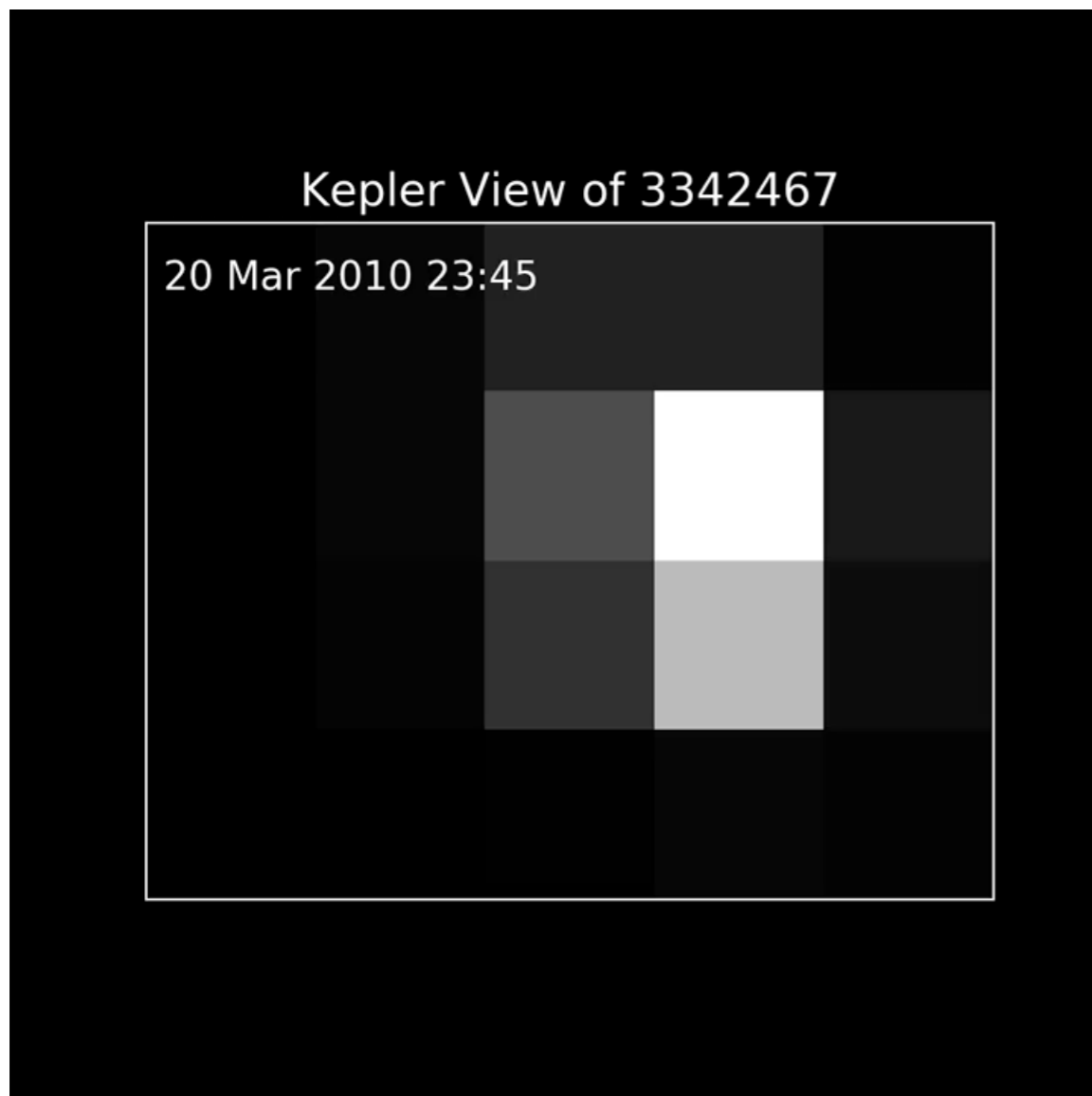
K2:TRAPPIST-1  
(11x11 pixels)



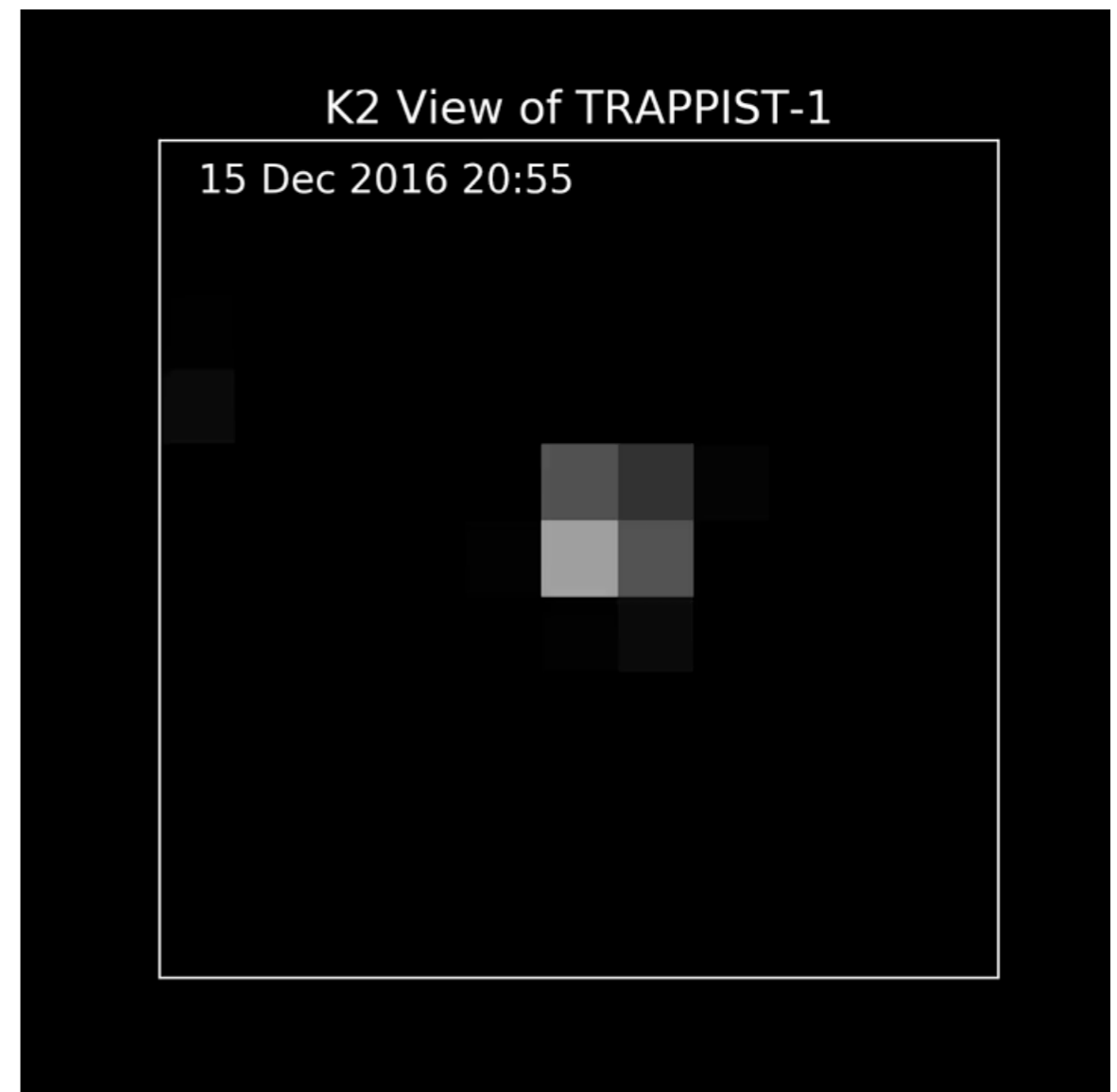
# K2 Degraded Quality

---

Kepler star  
(4x5 pixels)



K2:TRAPPIST-1  
(11x11 pixels)



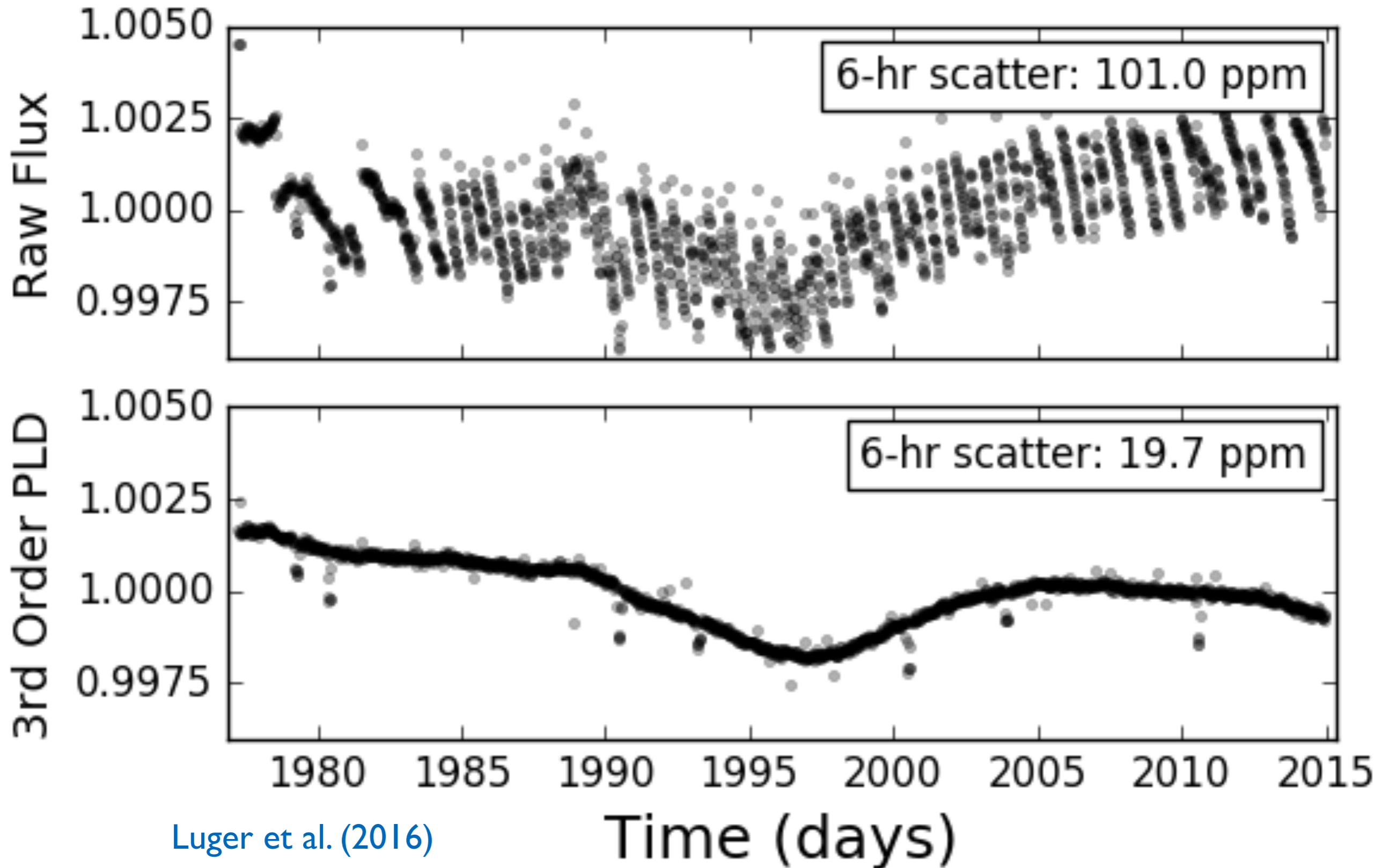
# Outline

---

- ◆ Intro to Kepler & K2
- ◆ Methods & Why Blue Waters
- ◆ Results & Future Plans



# EVEREST: Fix K2's Data Quality



Luger et al. (2016)



# Finding Planets

---

- ◆ Unknown parameters:
  - ◆ Depth (~10)
  - ◆ Duration (16)
  - ◆ Period + Phase (7000)

# Blue Waters Assist

---

- ◆ 4D grid of parameters to search
- ◆ ~1 million grid points per star
- ◆ Searching 1 star takes ~30 minutes
- ◆ 500,000 stars to search

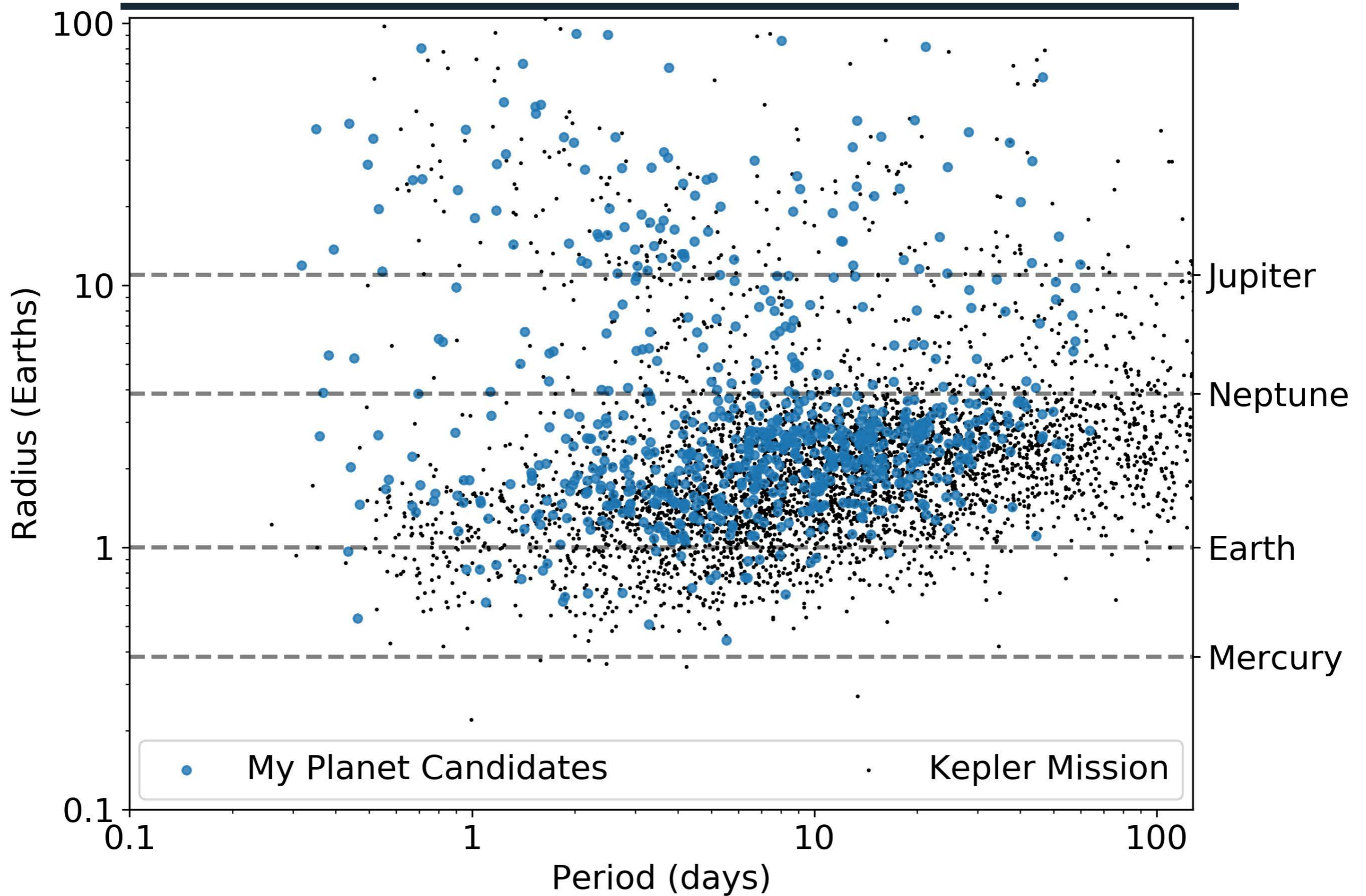


# Outline

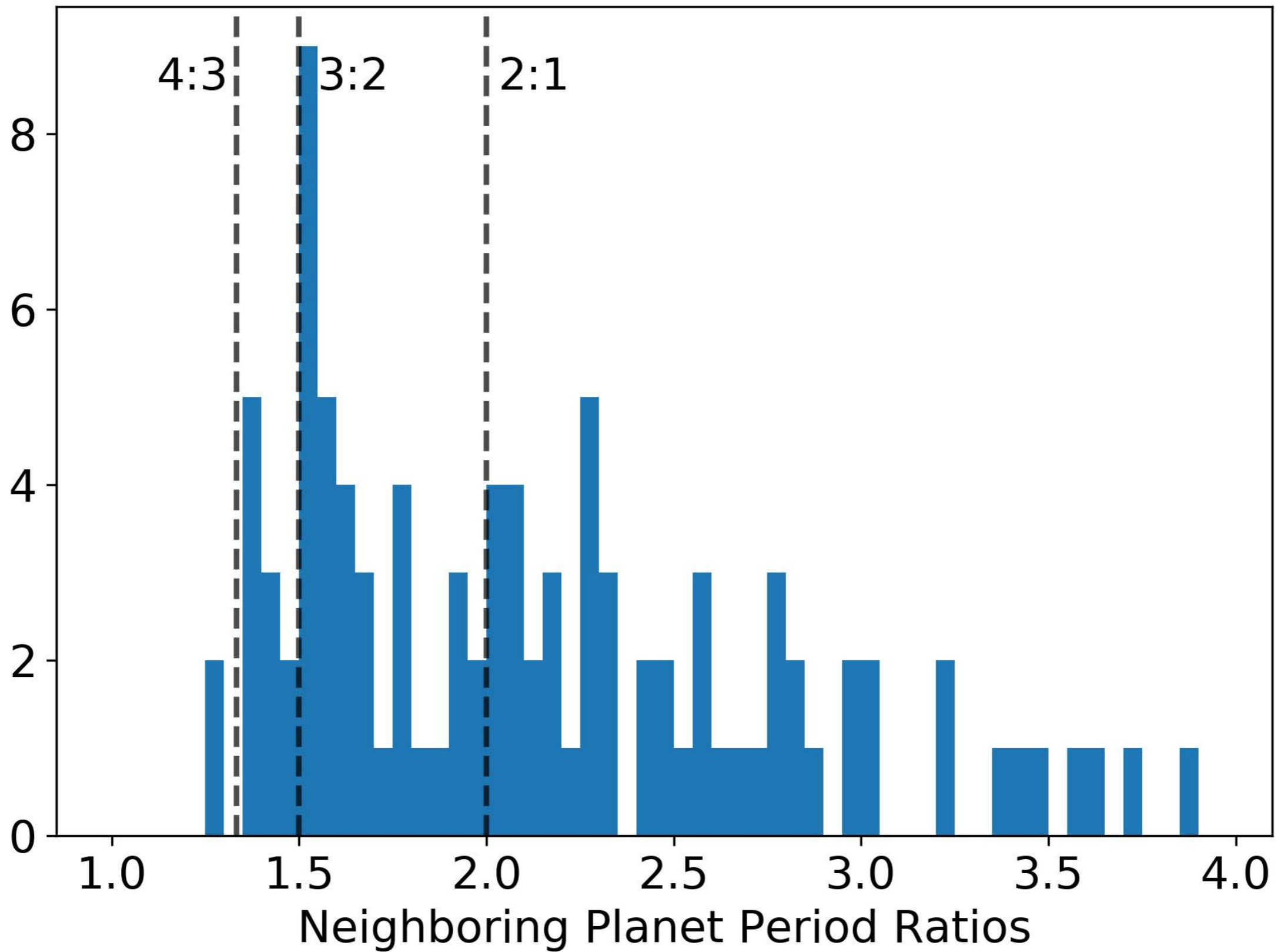
---

- ◆ Intro to Kepler & K2
- ◆ Methods & Why Blue Waters
- ◆ Results & Future Plans

# My K2 Planet Candidates



# Period Ratios





# What's Next: TESS

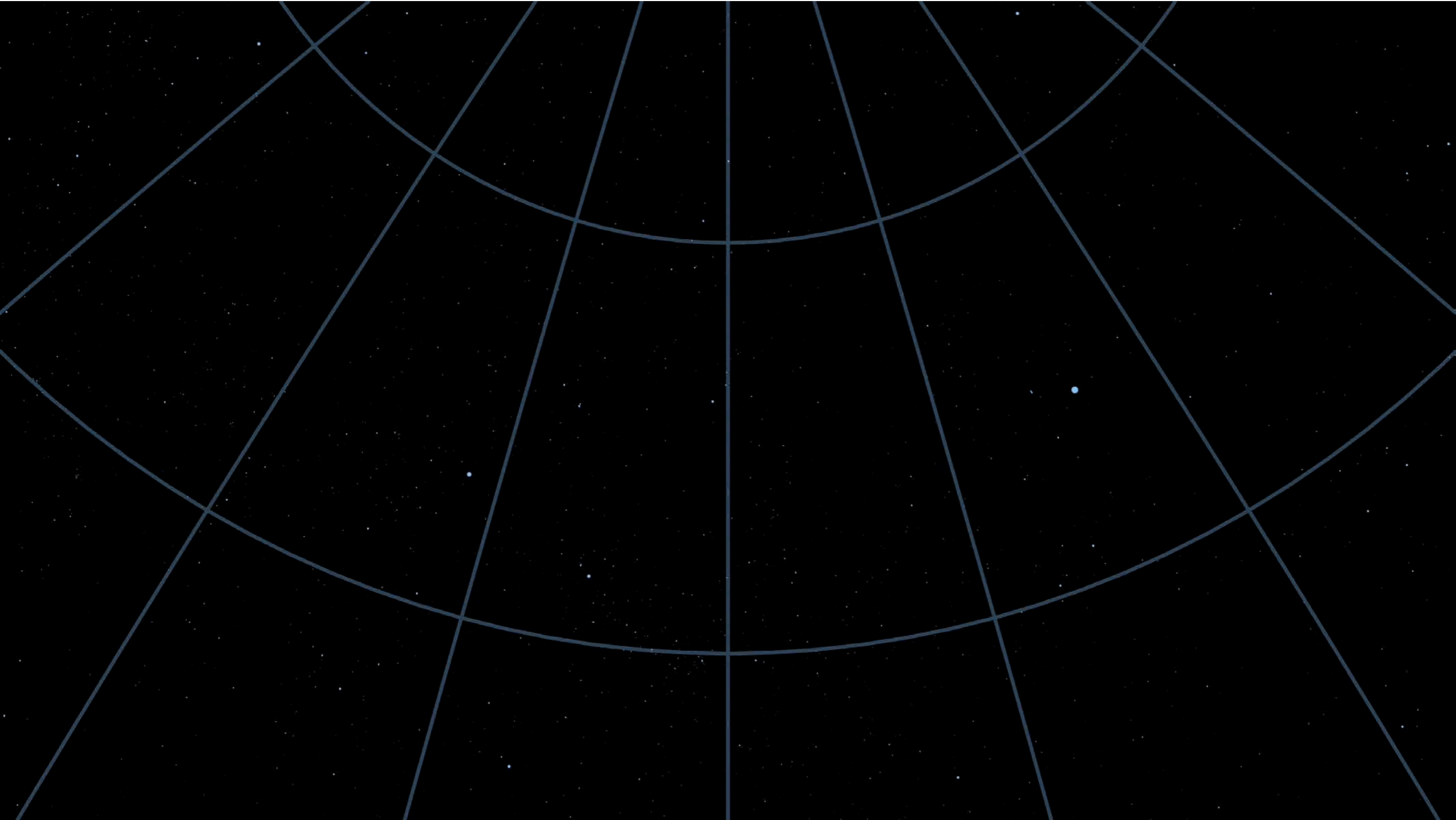
---





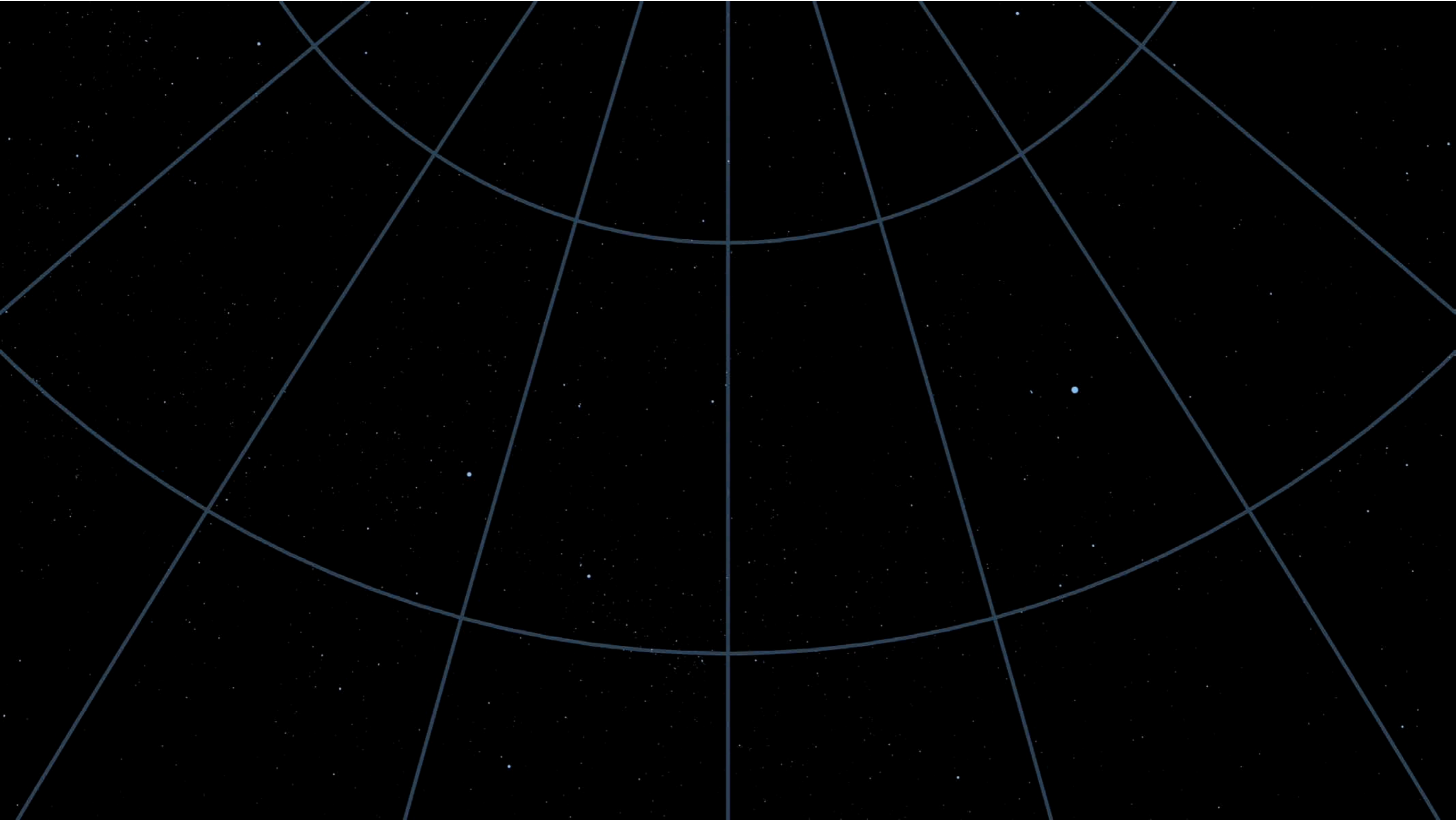
# TESS Data Challenge

---



# TESS Data Challenge

---

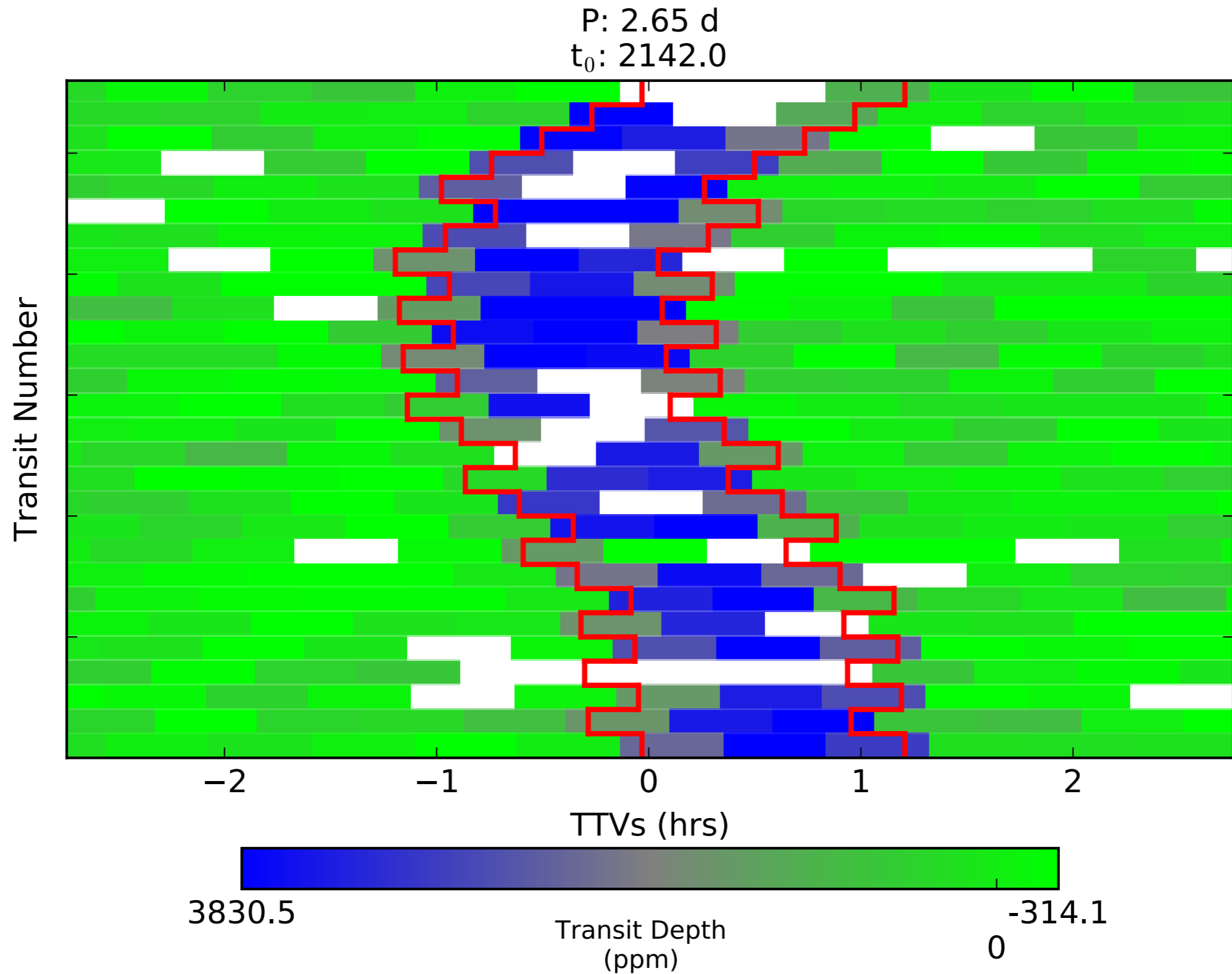


# Conclusions

---

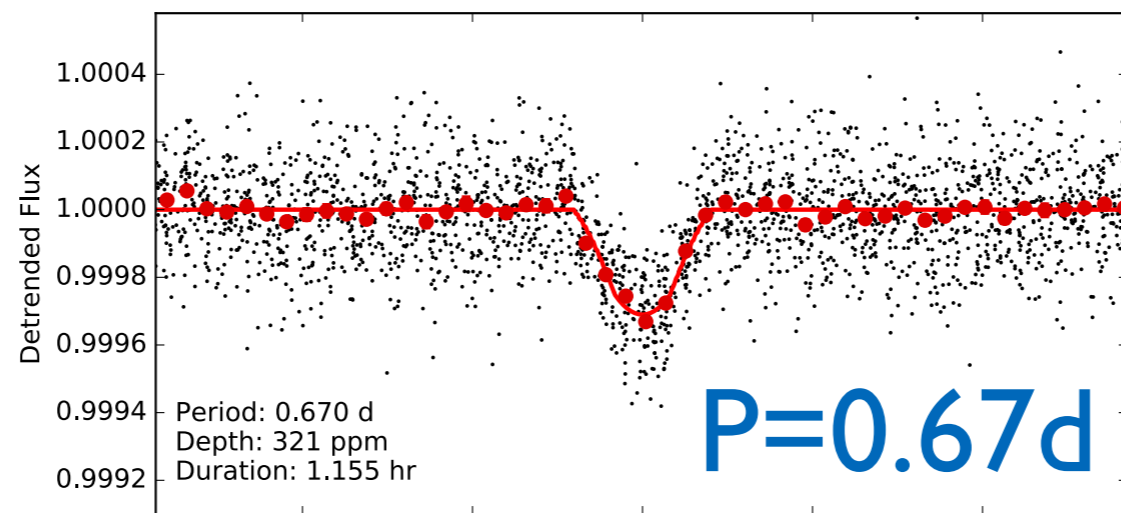
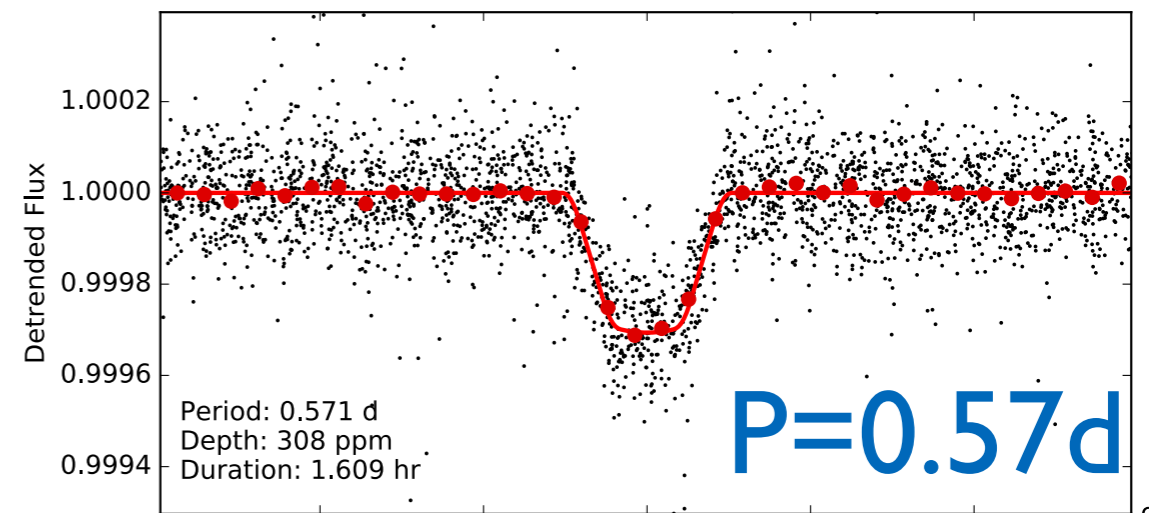
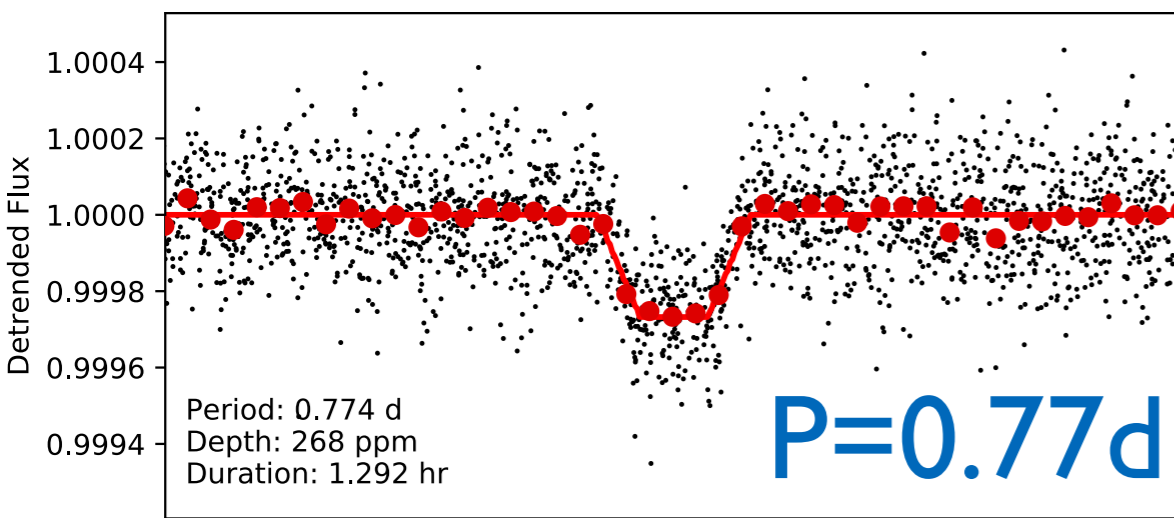
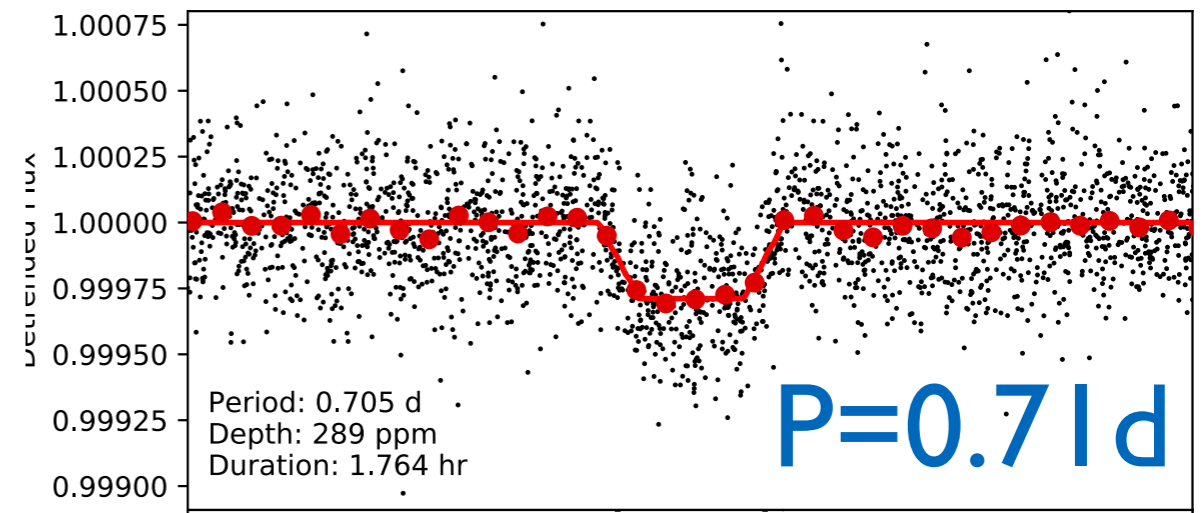
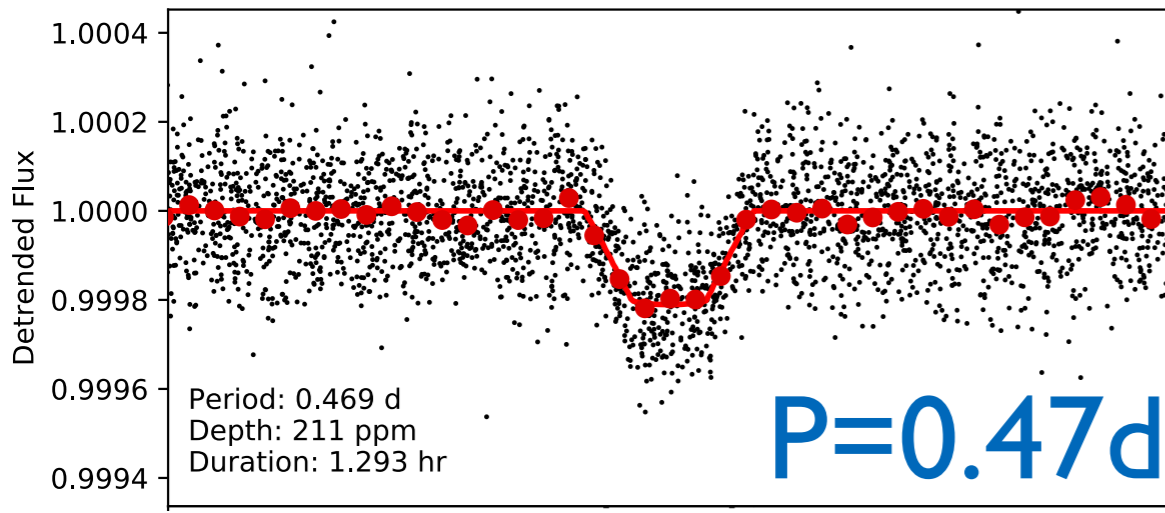
- ◆ EVEREST returns K2 data to Kepler's quality
- ◆ I've found lots of multi-planet & dynamically active systems in K2
- ◆ Only half of K2 data analyzed so far: hundreds more planets to come!
- ◆ TESS is about to change everything

# TTVs





# Ultra Short Periods



# Single Transits

