

# ASTERIA

## High-Precision Photometry in a Small Package



**Jet Propulsion Laboratory**  
California Institute of Technology

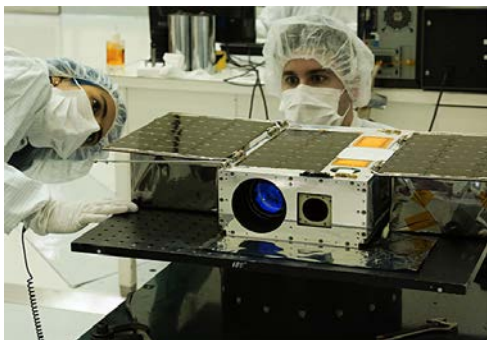
Matthew W. Smith<sup>1</sup>, Amanda Donner<sup>1</sup>, Mary Knapp<sup>2</sup>, Christopher Pong<sup>1</sup>, Colin Smith, Jason Luu<sup>1</sup>, Peter Di Pasquale<sup>1</sup>, Robert L. Bocchino Jr.<sup>1</sup>, Brian Campuzano<sup>1</sup>, Jessica Loveland<sup>1</sup>, Cody Colley<sup>1</sup>, Alessandra Babuscia<sup>1</sup>, Mary White<sup>1</sup>, Joel Krajewski<sup>1</sup>, Sara Seager<sup>2</sup>

<sup>1</sup>Jet Propulsion Laboratory, California Institute of Technology, California, United States

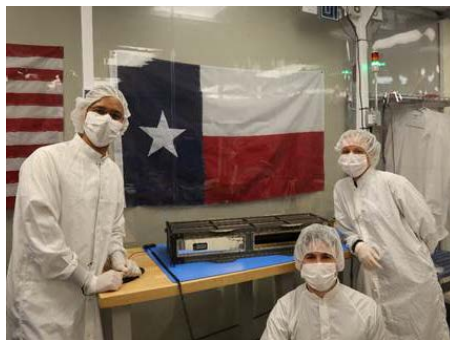
<sup>2</sup>Massachusetts Institute of Technology, Massachusetts, United States

# Mission Overview

- Prime mission: Demonstrate precision pointing and thermal control technologies
- Extended mission: Conduct dedicated science observations, further characterize hardware and software components
- 6U built, tested, operated at JPL; science team at MIT (S. Seager, PI) and U. Bern
- Funded through JPL's Phaeton Program for early career training plus MIT contributions to operations
- 250+ days of operation in space



**Development**  
Dec 2014 through Jun 2017



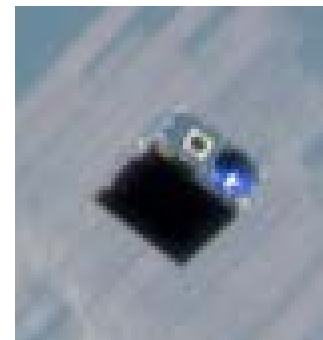
**Delivery**  
1 Jun 2017



**Launch**  
14 Aug 2017



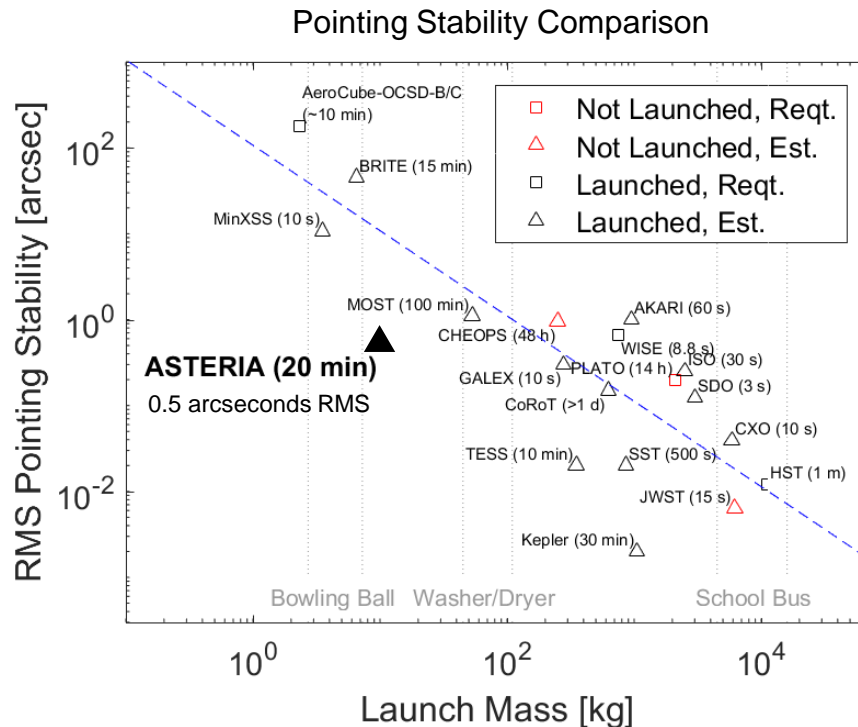
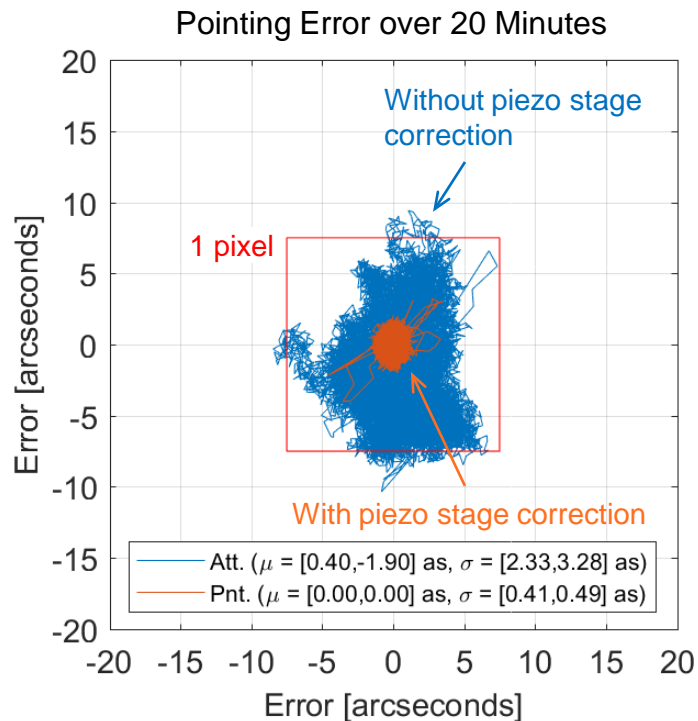
**Deployment**  
20 Nov 2017



**Operations**  
Through Sep 2018

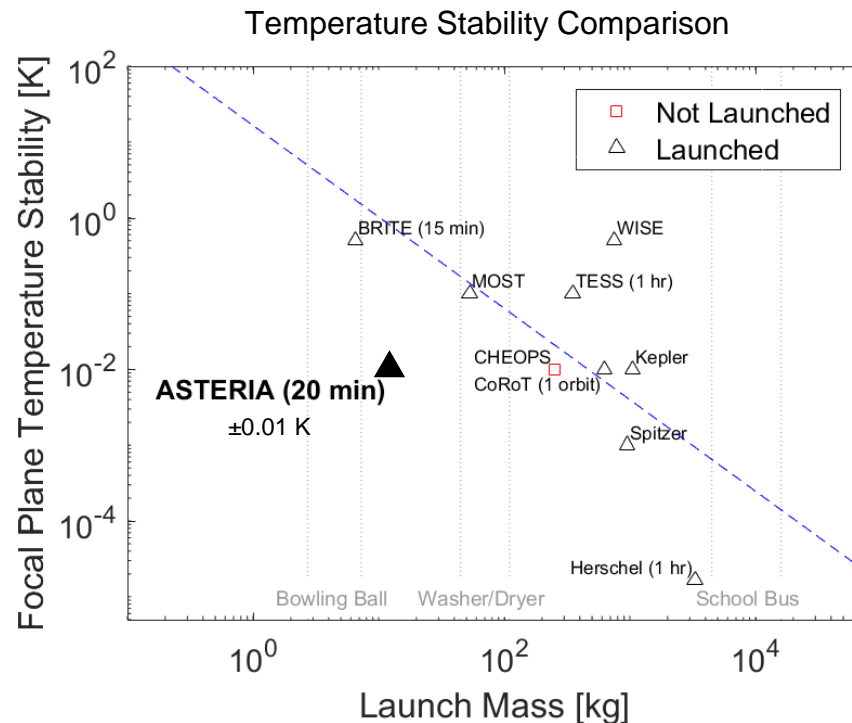
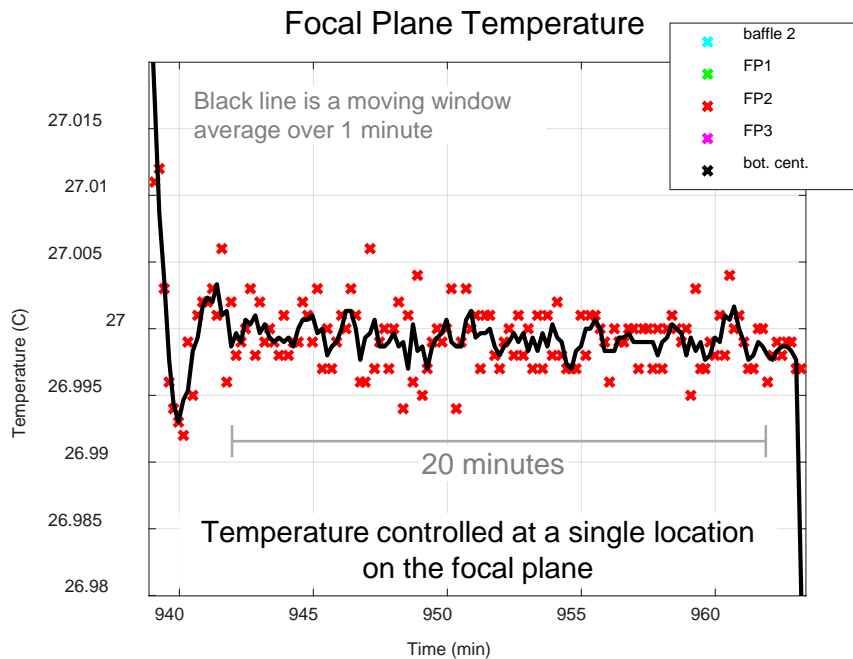
# Pointing Control Results

Achieved pointing error < 0.5 arcseconds RMS over 20 minutes



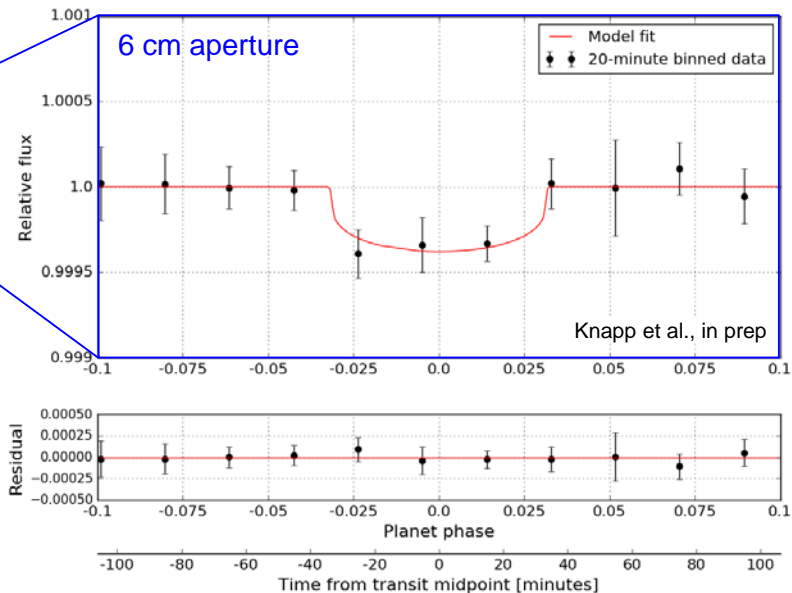
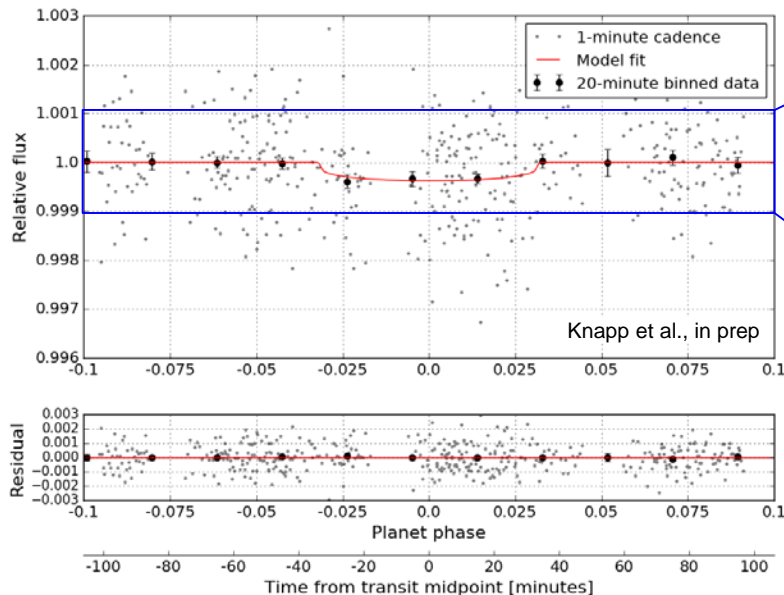
# Thermal Control Results

Achieved focal plane thermal control  $< \pm 0.01$  K over 20 minutes



# Exoplanet Transit Detection

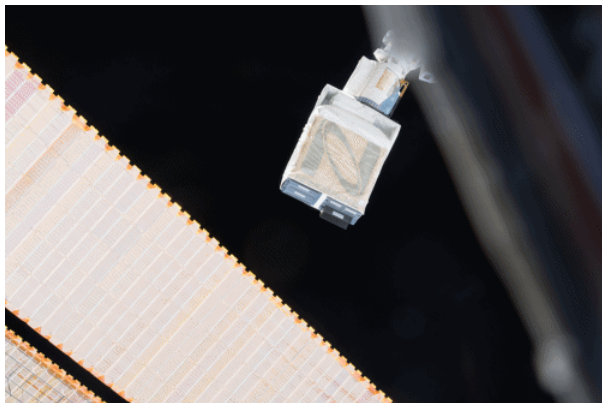
Observed the known transit of super-Earth exoplanet 55 Cancri e



*410 ppm transit observed at SNR=3, super-Earth exoplanet ( $2R_E$ ) around a  $V=5.95$  Sun-like star.  
Photometric precision is 730 to 1140 ppm/min.*



# Conclusion and Next Steps



- Achieved significant improvements in pointing and thermal control for small spacecraft
  - Pointing stability:  $< 0.5$  arcseconds RMS over 20 minutes
  - Pointing repeatability: 1 milliarcsecond RMS from orbit to orbit
  - Thermal stability:  $\pm 0.01$  K over 20 minutes at the focal plane
- Performed the first exoplanet transit detection by a CubeSat
  - Observed the known transit of super-Earth 55 Cancri e
  - Sub-mmag photometry on 1-minute time scales at  $V=6$
- Currently conducting an extended mission to seek new exoplanet transits

*“If successful, missions such as this will enable the high-precision photometry required for transiting exoplanet detection.”*

- National Academy of Sciences 2016 report “Achieving Science with CubeSats: Thinking Inside the Box”, on ASTERIA