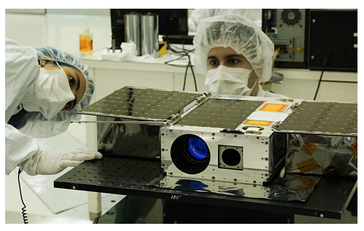
National Aeronautics and Space Administration

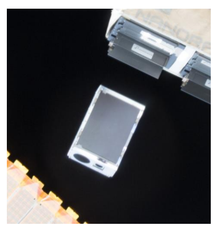
# Photometric Performance Validation for the ASTERIA Space Telescope


**Principal Investigator: Matthew W. Smith (313)**
**Co-Is: Sara Seager (MIT), Akshata Krishnamurthy (MIT)**
**Strategic University Research Partnership**


## Background

The ASTERIA spacecraft deployed into low-Earth orbit in November 2017 to perform a 90-day technology demonstration mission.

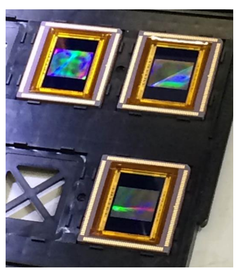


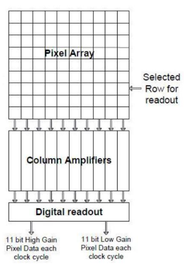


More recently, the ASTERIA extended mission has been searching for exoplanets around nearby stars using the transit method.

Due to its status as a technology demonstrator, full detector characterization and end-to-end photometric performance validation was not performed prior to launch.

ASTERIA uses CMOS focal plane technology that requires a different calibration approach compared to traditional CCDs.





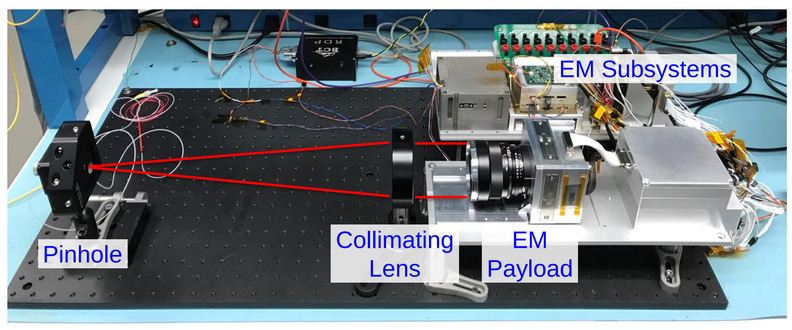

## Project Objective

The goal of this effort is to evaluate and improve the photometric performance of ASTERIA through a combination of laboratory experimentation and flight data analysis.

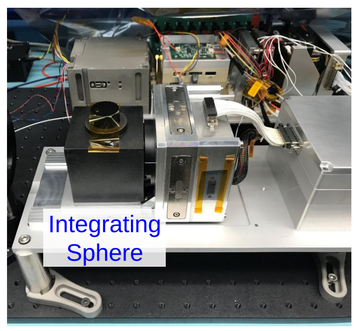
## FY18/19 Results

**Laboratory Testing:** Developed a testbed to characterize the engineering model detector in ways not feasible the flight model on orbit.

- Adjustable illumination: synthetic star or flat field (both using a HeNe laser at 633 nm)
- Allows for the collection of star images, bias frames, dark frames, and flat field frames

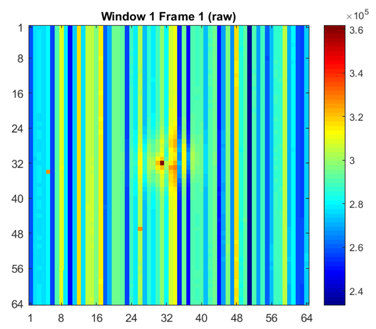


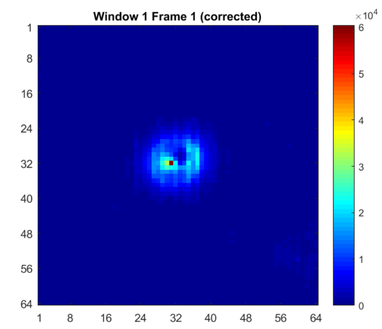

*Testbed in star simulator configuration*

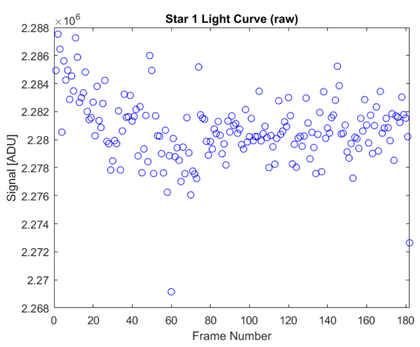


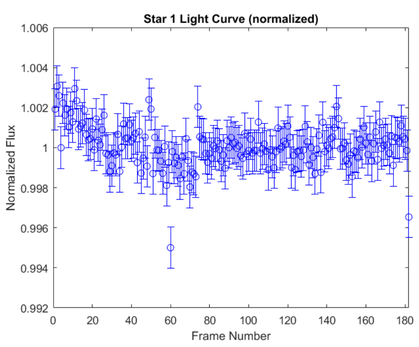

*Testbed in flat field configuration*

**Flight Data Analysis:** Characterized the photometric performance of the flight detector and developed a photometric processing pipeline.




## Benefits to NASA and JPL

In the short- to medium-term this research maximizes the potential scientific return from ASTERIA by increasing the feasibility of detecting transiting exoplanets during the extended mission. This effort increases the scientific productivity of a spacecraft currently in flight, allowing JPL to conduct long-duration photometric monitoring of nearby bright stars.

In the medium- to long-term, this research demonstrates the feasibility of using scientific-grade CMOS devices for space-borne instruments. CMOS devices offer advantages in terms of dark current, radiation tolerance, on-chip processing capabilities, and simpler electrical or software integration. However, CMOS architectures require a different approach to photometric data reduction due to column and pixel-dependent amplifiers.

This research benefits upcoming cubesat- and smallsat-class projects such as the Star-Planet Activity Research CubeSat (SPARCS) mission. JPL is providing the SPARCS camera and ASTERIA's experience with post-launch photometry validation via this activity is informing the SPARCS V&V campaign.

## Publications


A. Krishnamurthy, "An Integrated Approach to Systematics Calibration for Space-Based Telescopes," *PhD Thesis,* Massachusetts Institute of Technology, in preparation.


## PI Contact Information


Matthew W. Smith, PhD
matthew.w.smith@jpl.nasa.gov
818-354-1319 (desk)
626-665-3201 (mobile)



**National Aeronautics and Space Administration**
**Jet Propulsion Laboratory**
California Institute of Technology
Pasadena, California

**www.nasa.gov**




**Poster No. RPC-182**