ASTERIA: A CUBESAT ENABLING HIGH PRECISION PHOTOMETRY IN A SMALL PACKAGE

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ASTERIA (Arcsecond Space Telescope Enabling Research In Astrophysics) is a 6U CubeSat that advances the state of the art in nanosatellite capabilities for astrophysical measurements. The 6U CubeSat (approximately 10 x 20 x 30 cm, 10 kg) was deployed from the International Space Station (ISS) in November 2017 and has completed its nominal 90-day mission. ASTERIA’s objective was to demonstrate enabling technologies for high precision photometry in a CubeSat form factor. Specifically, ASTERIA demonstrated arcsecond-level line-of-sight pointing stability and repeatability and highly stable milliKelvin-level focal plane thermal control.

Light spot motion over detector pixels can cause variations in measured stellar flux since both the between-pixel (interpixel) and within-pixel (intrapixel) responses vary across the detector. ASTERIA’s pointing control is achieved through a two-stage approach. A set of reaction wheels provides coarse three-axis control of the spacecraft body, holding an inertial attitude that points the payload to a target star. Within the payload, a two-axis piezoelectric stage provides an additional level of fine control by making small, rapid adjustments to the detector position to keep the target star stationary.

The second technology demonstrated by ASTERIA is milliKelvin-level temperature stability of the imaging detector. The gain of each pixel is temperature sensitive, so tight thermal control reduces instrumental photometric variation that could otherwise be mistaken as an astrophysical signal. Precision thermal control is achieved by isolating the payload from the spacecraft bus and passively cooling the detector using a space-facing radiative surface. Thermal sensors and trim heaters located on the detector then act in closed loop to perform small temperature corrections over the course of an observation, maintaining stability to the required precision.

ASTERIA’s design, operations, and technology demonstration results from the 90-day nominal mission will be described in this talk. I will also describe the photometric precision ASTERIA achieved for stars with known exoplanets. Finally, I will compare the photometric precision obtained with and without ASTERIA’s fine pointing and thermal control systems active to
highlight the value of these technologies for future small space telescopes.