Knockout Solar Science: SunCET with PUNCH

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SUNCET

SUN CORONAL EJECTION TRACKER

SunCET

Form Factor 6U CubeSat

Launch 2025 October Vandenberg, CA

Prime Mission ≥8 months

Orbit Altitude = 510 km
Sun Sync MLTAN = 17:00

FOV $\pm 5.34\ R_\odot \times \pm 4\ R_\odot$

Bandpass 17-20 nm

Exposure Times
0.035 sec (on disk)
15 seconds (off disk)

Spatial Resolution 20 arcsec

Exposure Times 2×10^6

Cadence 1 minute

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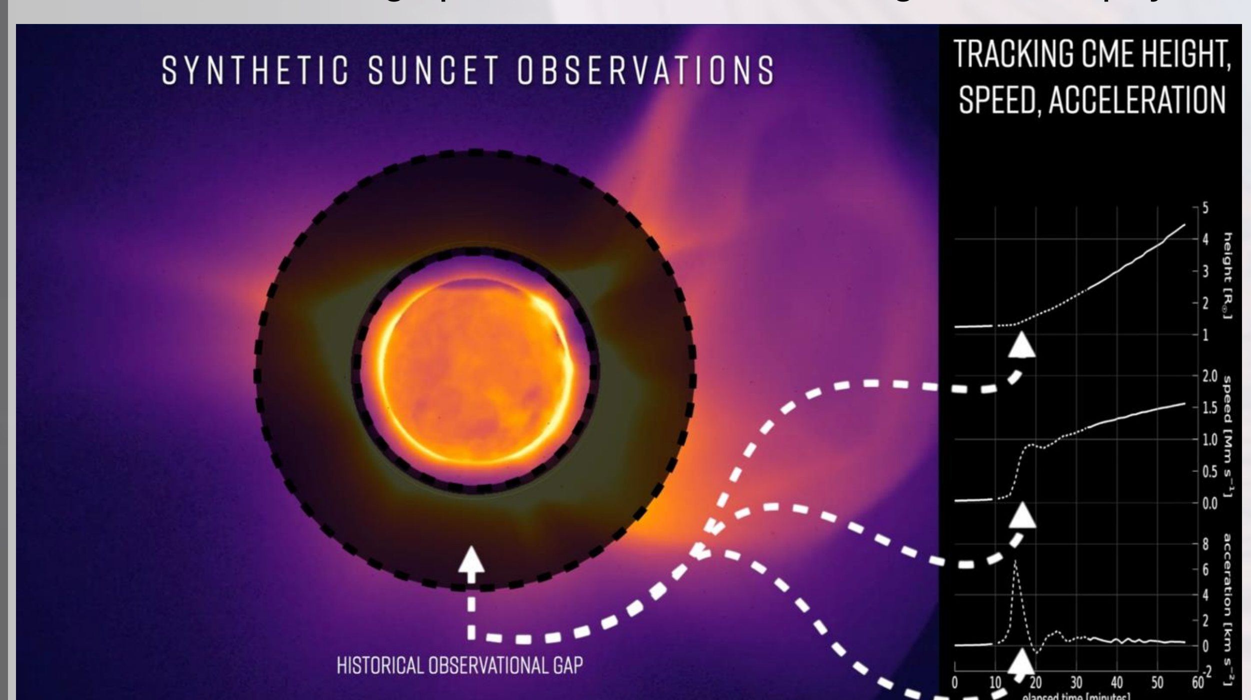
Introduction to SunCET - SunCET (Sun Coronal Ejection Tracker) is a cutting-edge CubeSat mission jointly led by the Johns Hopkins Applied Physics Laboratory (APL) and University of Colorado, Boulder Laboratory for Atmospheric and Space Physics (CU/LASP) designed to advance our understanding of the Sun's dynamic behavior. Utilizing compact, state-of-the-art instrumentation, SunCET focuses on tracking coronal mass ejections (CMEs) and observing extreme ultraviolet (EUV) emissions from the solar corona. These observations are vital for improving our ability to predict space weather eruptive events that can impact Earth's technology and infrastructure. As a cost-effective platform, SunCET exemplifies innovation in heliophysics research, combining high-quality science with the agility of small-satellite technologies.

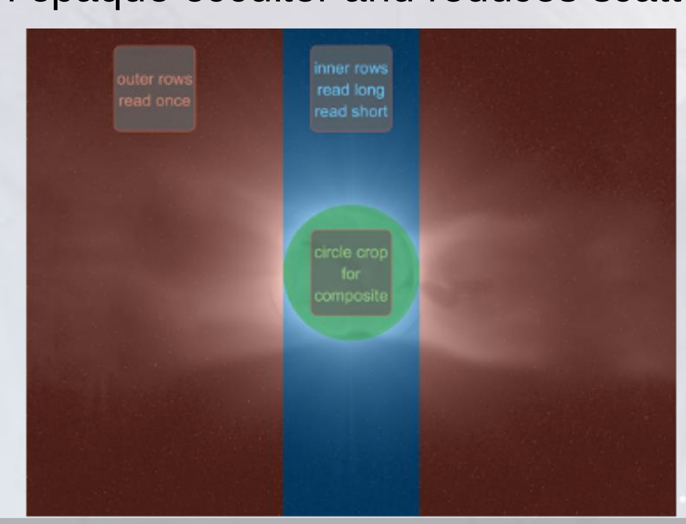
SunCET is a 6U CubeSat, about the size of a shoebox. It carries a bespoke wide-field extreme ultraviolet (EUV) telescope and a dual Sun position sensors. It is equipped with precision attitude control, and x-band data transmission, supporting a prime mission of ≥8 months in a 510 km Sun-synchronous orbit.

Why SunCET? – SunCET combines wide-field imaging of coronal mass ejections (CMEs) with extreme ultraviolet (EUV) observations in a compact CubeSat. Detailed observations of the middle corona—often overlooked by traditional instruments—are key to tracking CME acceleration and dynamics. SunCET captures CME evolution and solar atmospheric processes, such as eruptions and heating, with exceptional resolution and dynamic range. By integrating these capabilities, the mission provides vital insights into the Sun's behavior, advancing space weather forecasting and heliophysics research.



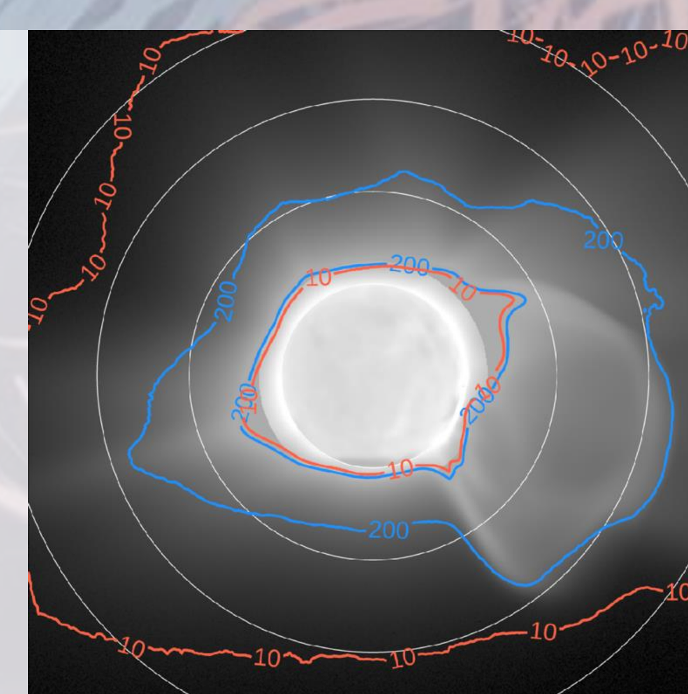
Peak acceleration of CMEs typically occurs at low heights, often below 0.5 solar radii, where existing instruments struggle with spatial coverage and dynamic range limitations. SunCET will capture the full acceleration profile of CMEs.

How SunCET? – SunCET introduces a novel Simultaneous High Dynamic Range (SHDR) detector and algorithm that overcomes the challenges of capturing solar phenomena spanning vast brightness ranges with high signal to noise. Traditional high-dynamic-range imaging relies on sequential exposures or multiple sensors, which can compromise temporal dynamics, increase complexity, or require costly systems. SunCET's innovative detector allows for region-specific integration times on a single sensor, enabling simultaneous imaging of the bright solar disk with short exposures and the faint middle corona with long exposures. This capability eliminates the need for an opaque occulter and reduces scattered light interference, critical in the EUV range at its central wavelength of 18.5 nm. Currently in the integration stage, the satellite has all but two of its flight parts delivered and will be sharing a launch vehicle with TSIS-2.



The SHDR scheme enables capture both the bright solar disk and faint corona in a single image. Columns corresponding to the solar disk use short exposures, while columns imaging the corona use longer exposures to enhance signal capture.

SunCET Enabling Your Science in Synergy with PUNCH – SunCET and PUNCH collectively target fundamental questions about coronal mass ejections (CMEs), bridging observations from the Sun's middle corona to the outer corona and heliosphere. By focusing on the underexplored region where most CME acceleration and deflection occur, SunCET addresses how torus instability, magnetic reconnection, and other physical processes evolve with altitude and time. Its high-dynamic range EUV observations will capture complete acceleration profiles, providing critical constraints on CME initiation and propagation models. These findings naturally complement PUNCH's larger-scale observations, linking CME evolution into the heliosphere. SunCET will make its data products—including calibrated images, kinematic profiles of CME events, and processed movies—publicly available daily through NASA's and LASP's data archives. The data will be formatted to facilitate easy integration with other heliophysics datasets, including PUNCH observations, and will include detailed metadata for comprehensive analysis and modeling. By ensuring open and timely access to these data, SunCET aims to foster collaboration, enabling the community to fully exploit the synergy between SunCET and PUNCH in advancing our understanding of solar eruptions and space weather.



SunCET has been extensively modeled and is set to achieve an exceptional signal-to-noise (S/N) ratio, exceeding 40 for faint coronal mass ejections (CMEs) even at the edge of its field of view (4 solar radii). This will enable high-quality observations of both bright and faint solar features. Contours to the left show the S/N ratio predicted.

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