

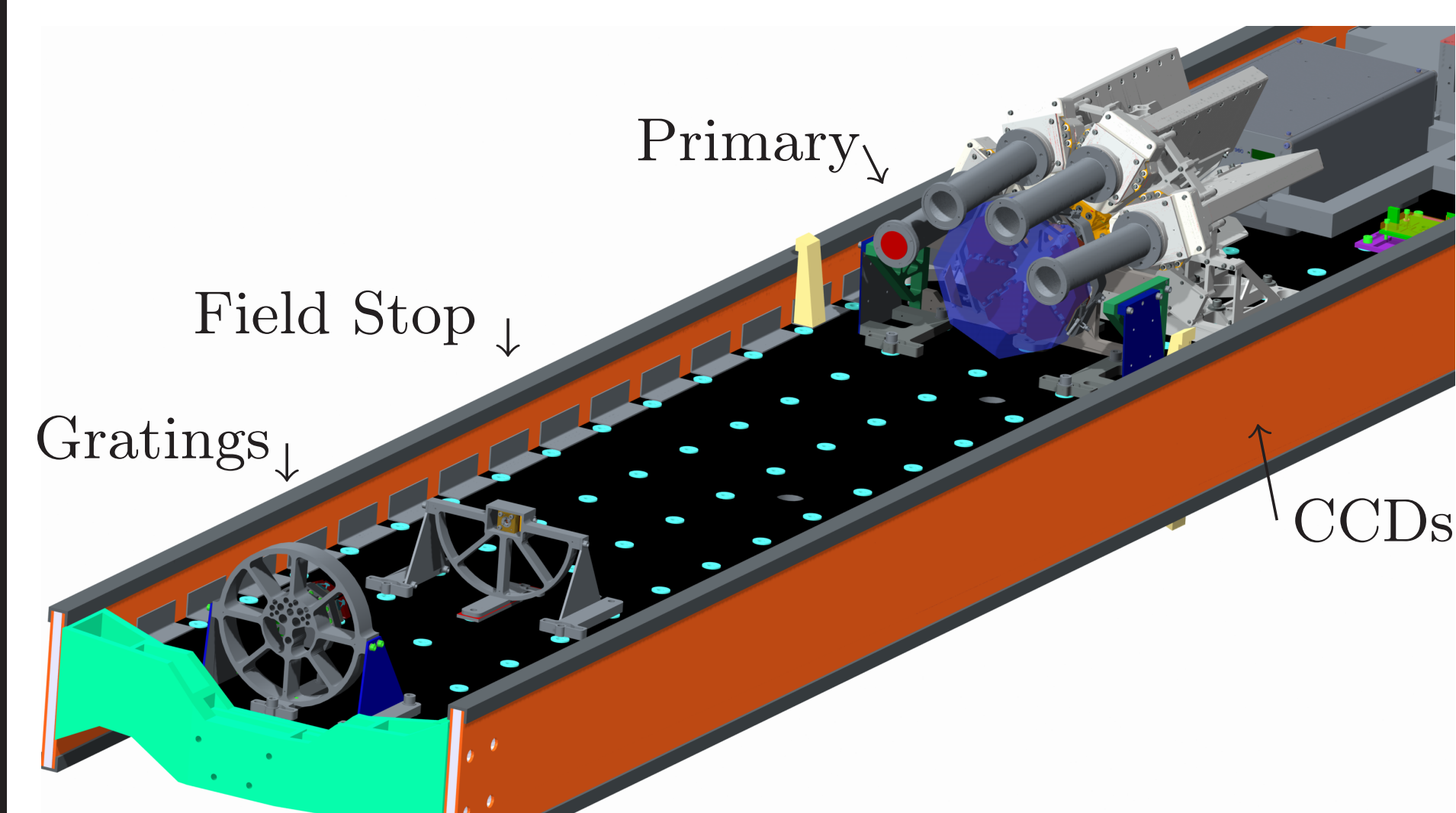
A Preliminary Survey of Data From the ESIS Sounding Rocket Flight on Sept 30th 2019

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Abstract

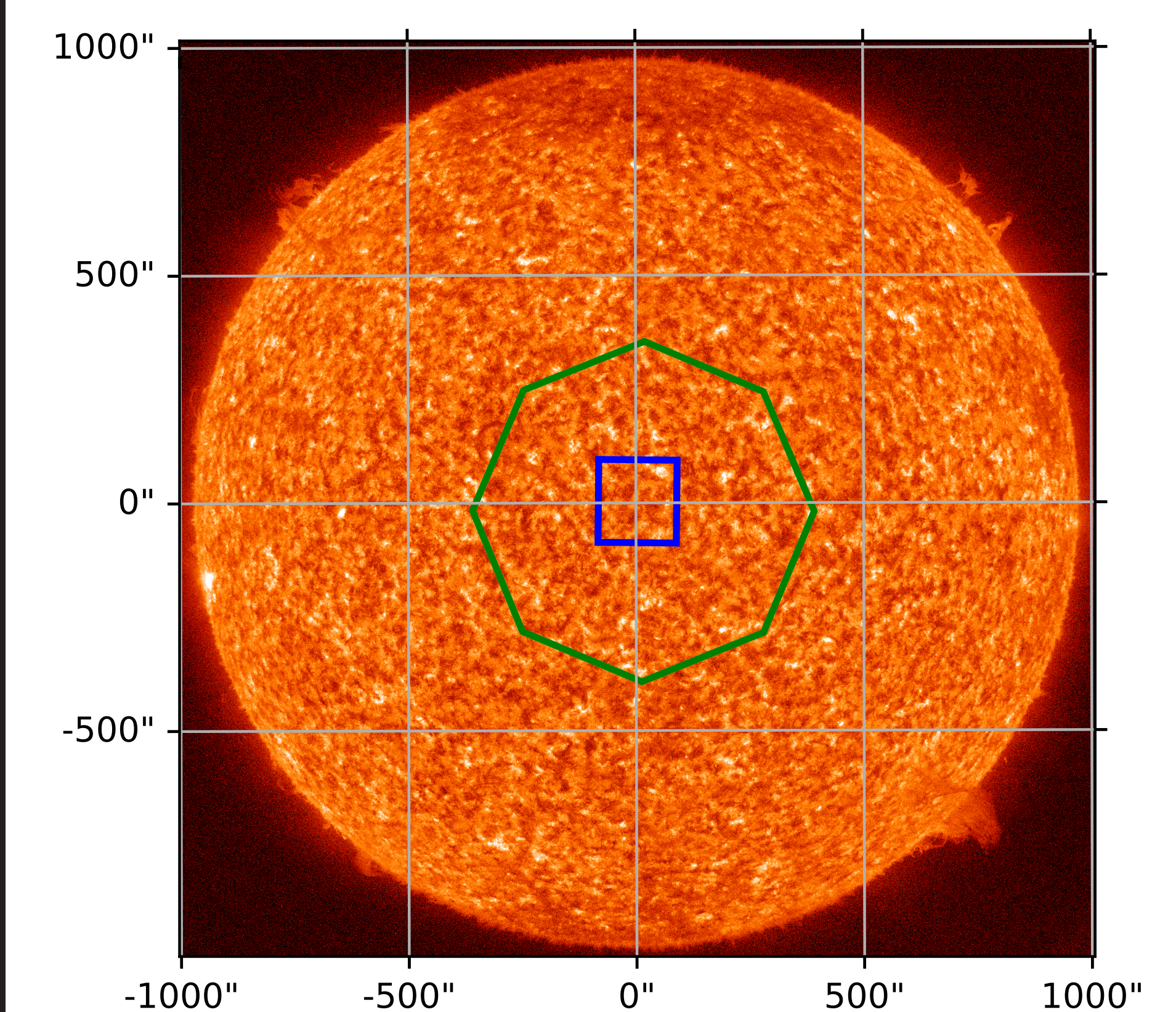
The *EUV Snapshot Imaging Spectrograph* (ESIS) was launched on board a sounding rocket on September 30th 2019 from White Sands Missile Range. ESIS is an array of slitless spectrographs that captures line profiles over an extended field of view in a single "snapshot". By measuring spectral data over a large field of view in a single image ESIS can better describe the evolution of solar events that evolve more quickly than traditional slit spectrographs can raster. We present a preliminary study of small transient brightenings in the lower solar atmosphere captured by ESIS.

ESIS Instrument



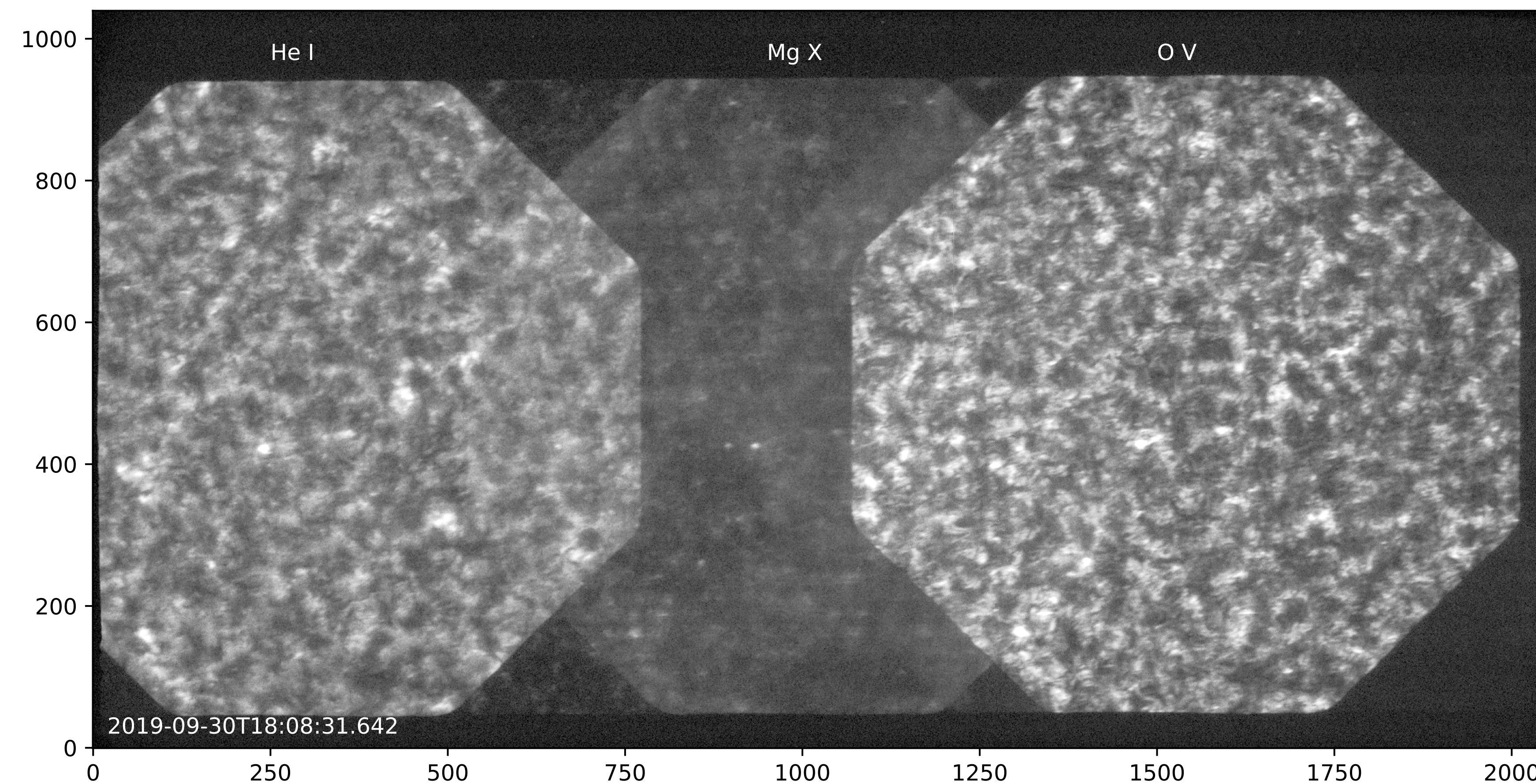
The *EUV Snapshot Imaging Spectrograph* (ESIS) consists of a single parabolic primary mirror, an octagonal field stop, four concave spherical secondary gratings, and 4 CCD cameras. Incoming light is focused by the primary mirror to an intermediate focal plane at the octagonal field stop. Then each spherical grating reimages the field stop onto its corresponding CCD. Each ESIS image is a unique projection through a spatial spectral cube and provides additional information needed to invert for line profiles over the ESIS field of view.

Pointing Summary

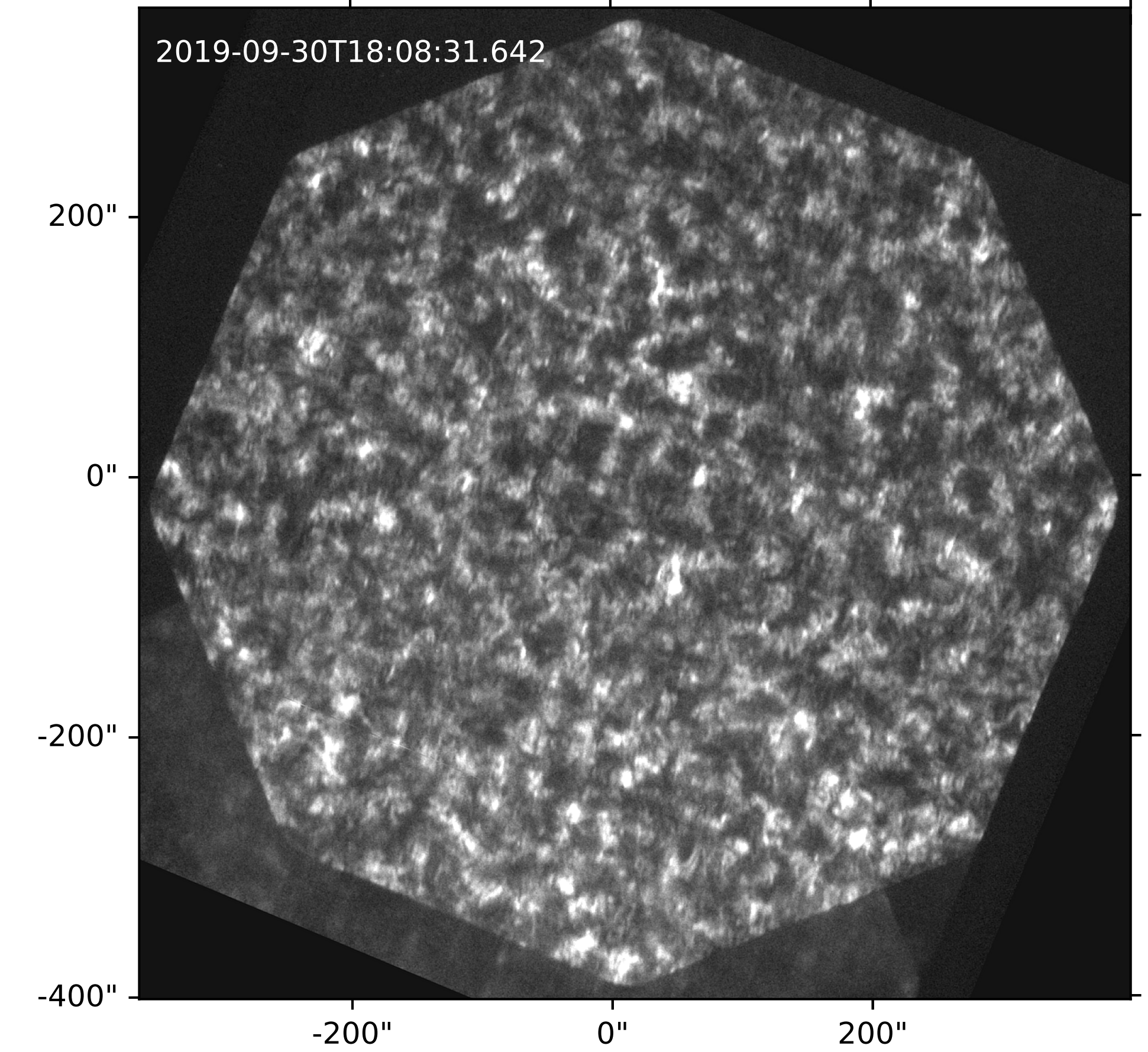


AIA captured this He II 304 Å image at 18:08:29UT on September 30th, right in the middle of the ESIS image sequence. The overlaid octagon in green shows the ESIS pointing and field of view. The blue square marks the field of view of the IRIS slitjaw imager. Hinode EIS, XRT, and SOT also co-observed with ESIS and were pointed toward disk center, more work is needed to determine their exact pointing and fields of view. Despite a very quiet sun, a few small dynamic events were captured by multiple instruments and are great candidates for future study.

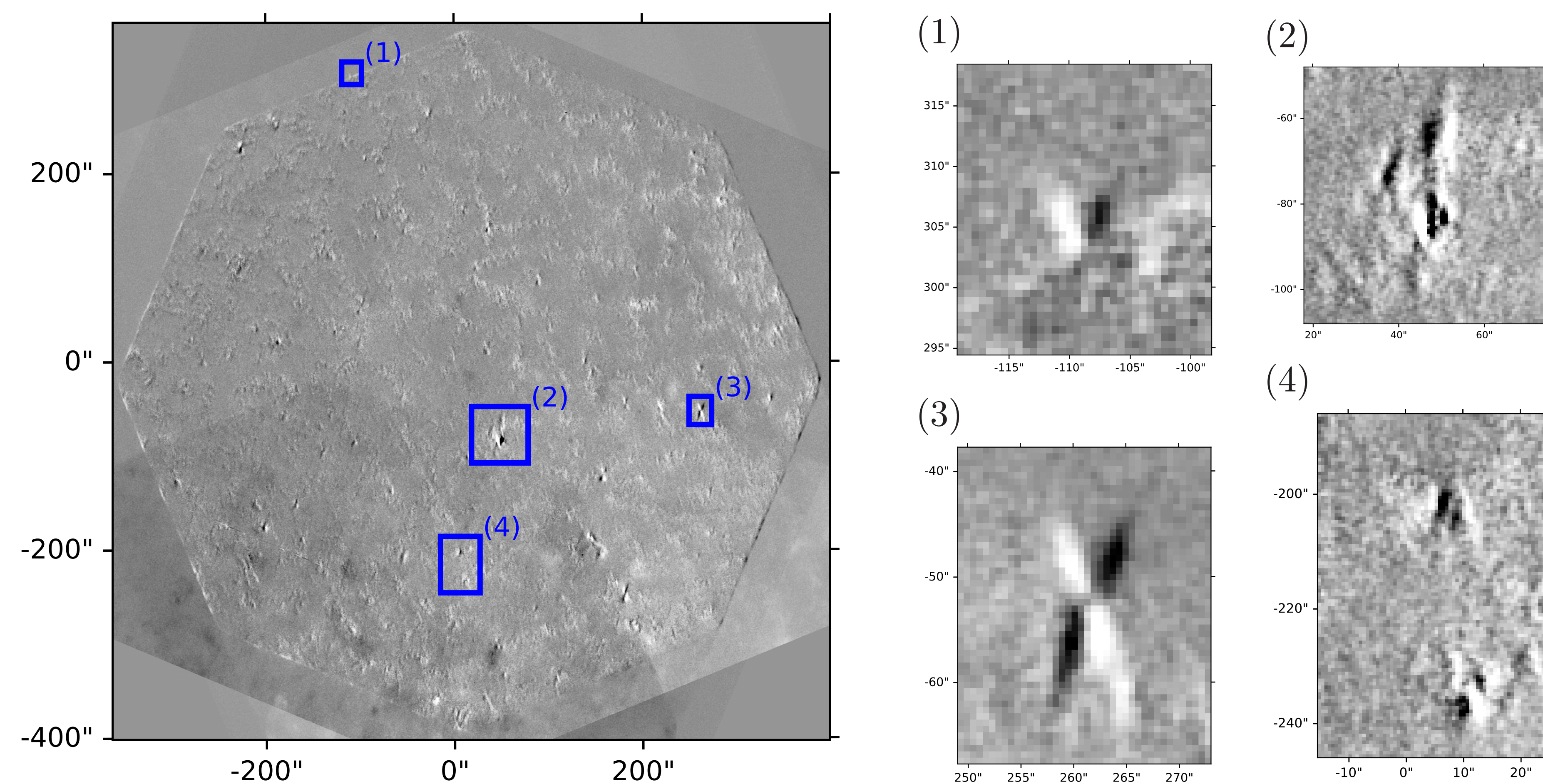
ESIS Images



This level 1 ESIS image (left) taken by camera two of four is a great example of a properly aligned ESIS channel. ESIS' primary observing wavelength, O V 630 Å is centered on the right half of the CCD and contributions from shorter wavelength lines fall to the left, the brightest being Mg X 610 Å and He I 584 Å. This level 1 image has been background and bias subtracted as well as despiked. Each ESIS channel contains a different copy of the octagonal sun that has been rotated and dispersed along a different edge of the octagon. In order to more easily compare ESIS channels we isolated the O V half of the CCD and then coaligned to AIA He II 304 Å (right). Remnants of the faint Mg X are still visible at the bottom left of the image and indicate the axis of dispersion.



Difference Image



Taking the difference of two spatially coaligned ESIS images reveals solar features that have been spectrally dispersed. This particular image is the difference between ESIS camera 2 and camera 3. In the bottom half of the image a faint black and white octagon are visible from Mg X and shows the dispersion axis for each channel, misaligned by 45 degrees. Boxed in blue are four highlighted events in the image: (1) shows a significant redshift at the very edge of the field stop, showing almost pure line of sight Doppler shift, (2) a small yet fantastic eruption with ejected material, (3) a classic explosive event with significant broadening in the red and blue wings, (4) spatially close red and blue shifts indicate a flow from one loop foot point to another. The ESIS difference images are riddled with interesting features so **make sure to check out the movie** to find other events and see the temporal evolution, particularly of event two.

Movies!



ESIS Camera 2 Level 1 Movie



Difference Movie: Camera 2 minus Camera 3

Work In Progress

Difference images make it easy to identify solar features with interesting Doppler shift but are only quantitatively useful for features with limited spatial extent. Finding line profiles over extended objects with ESIS requires information from each channel to invert the data. Aligning to AIA did a decent job of co-aligning the ESIS channels but fails to account for non-linear optical distortion effects. We are developing a more accurate distortion model and several techniques to invert the corrected data. AIA, IRIS, and Hinode all took data before, during, and after the launch. We hope to compare line profiles from IRIS and EIS with those measured by ESIS to help validate our inversion methods and track plasma motions through multiple layers of atmosphere. Imaging data and magnetograms from AIA, XRT, HMI, and SOT will provide context needed to unravel the events behind spectral signatures measured by ESIS.

Acknowledgment

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