



SEUSHI: A Novel Compact Instrument for Early Flare and CME Alerts

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What is SEUSHI?

- The **Solar Extreme Ultraviolet Spectrograph and High-energy Imager (SEUSHI)** is a compact Soft X-ray (SXR) imaging spectrometer and Extreme Ultraviolet (EUV) spectrograph for delivering early flare nowcast alerts, CME alerts, and active-region spectral diagnostics.
- SEUSHI is currently under development for flight aboard the SDO-EVE calibration sounding rocket in August 2026.

Why is SEUSHI needed?

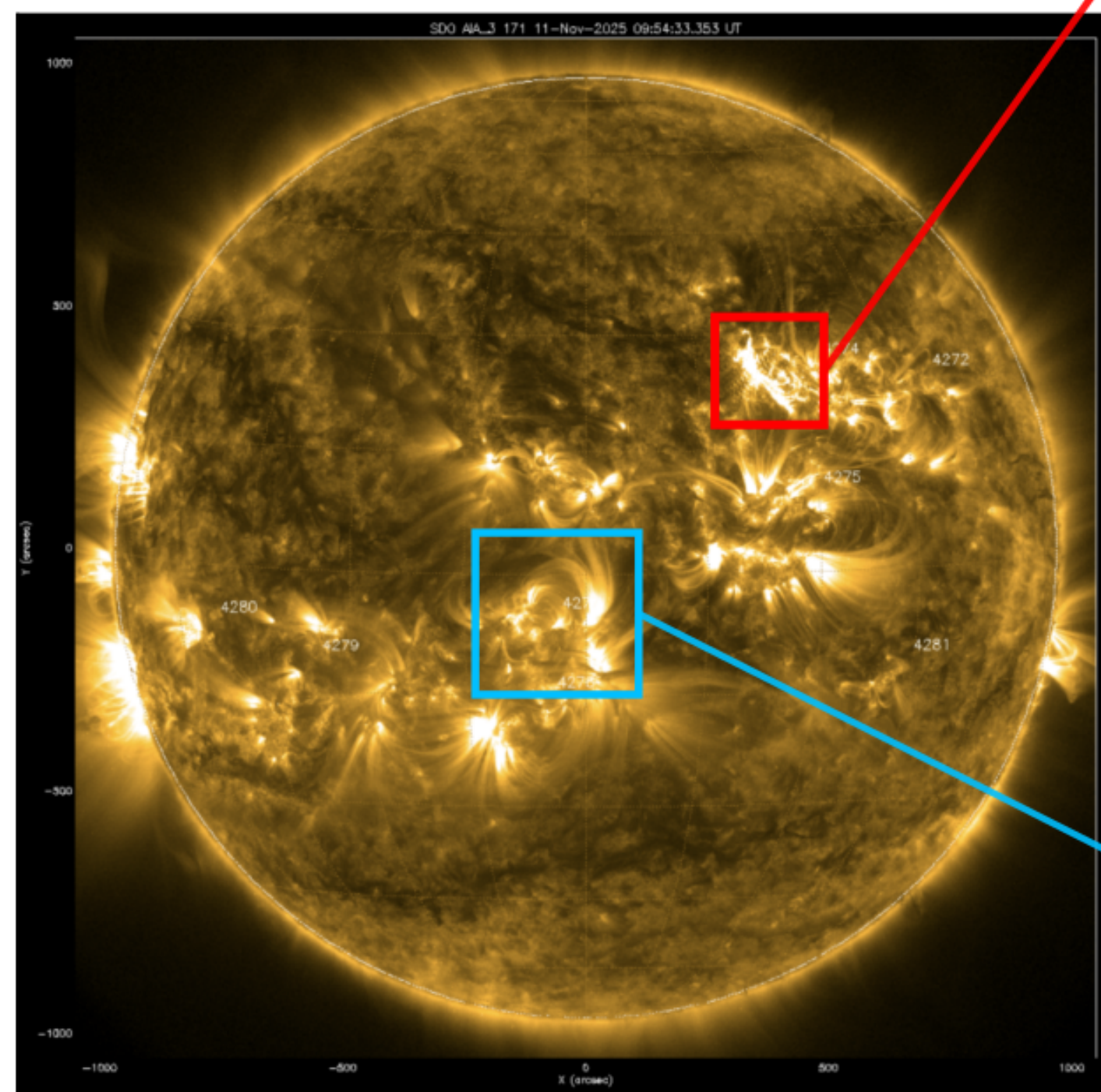
- Current flare alerts (e.g., NOAA radio blackout alerts) are issued only during the impulsive phase of a solar flare, after the event has already begun.
- The SEUSHI instrument with its new technology capabilities enables earlier flare nowcasting through compact soft X-ray imaging spectroscopy of flare precursor signatures

SEUSHI Measurement Capabilities

- **HOPE effect based Early Flare Alerts:** SEUSHI utilizes the recently discovered Hot Onset Precursor Event (HOPE) phenomenon [1,2] to generate early flare nowcast alerts. Previous studies have shown that the HOPE effect based nowcast alerts consistently appear 10-15 minutes prior to current flare alerts [3,4].

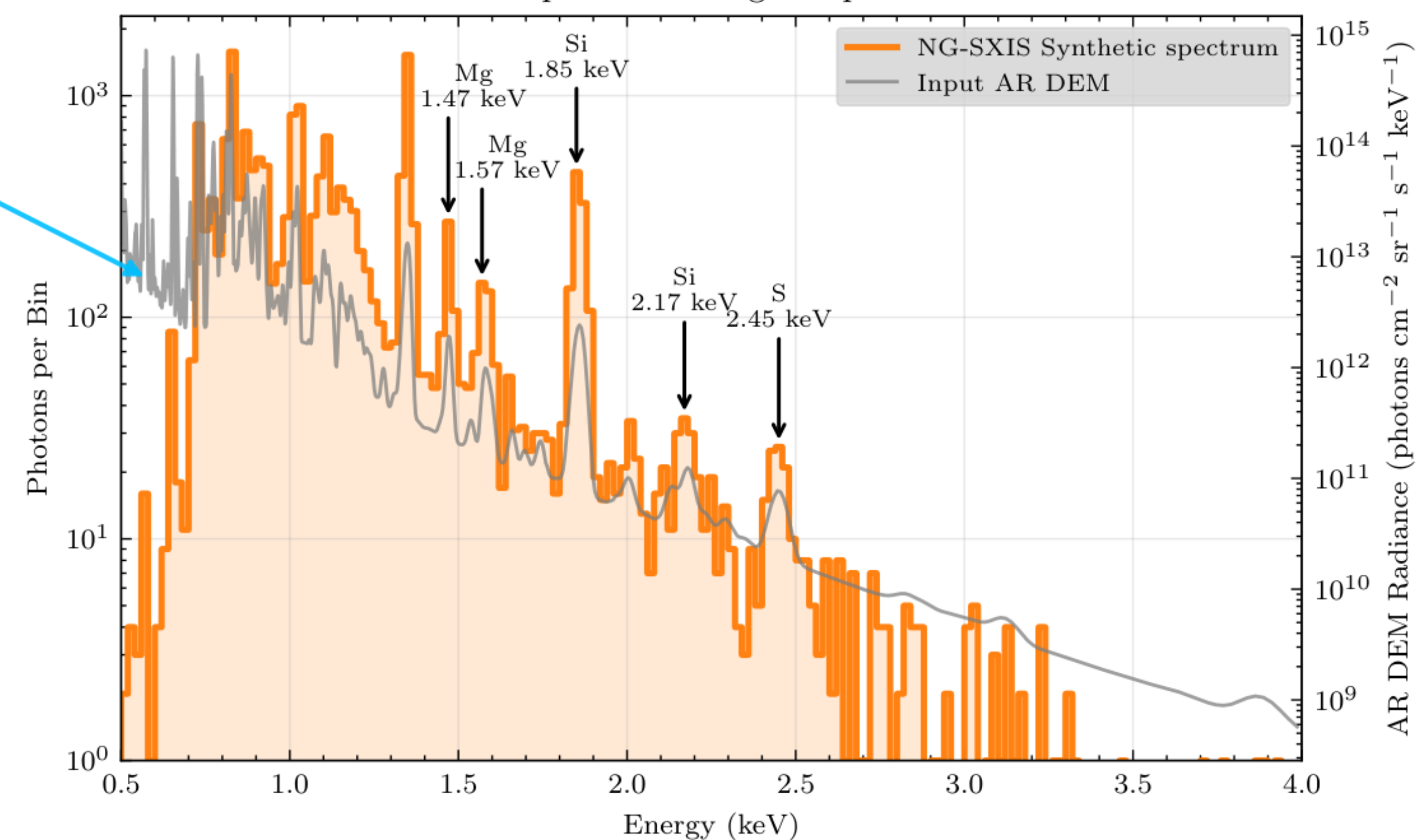
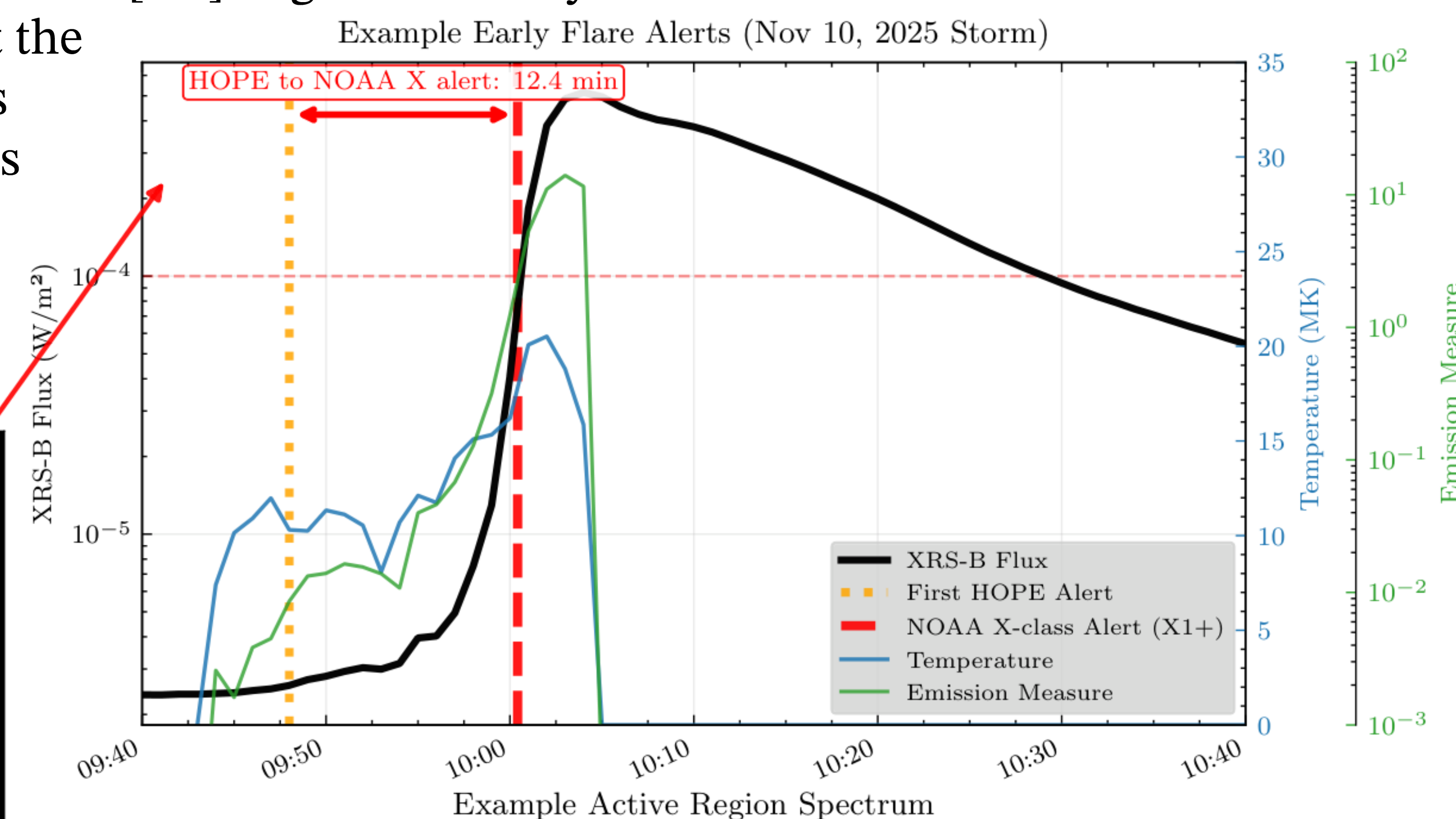
Measurement Gap 1: HOPE Effect Early Flare Alerts at the Pixel Level

AIA 193 Å (2025-11-11)



Measurement Gap 2: Spatially Resolved Active Region Spectra

- **Photon-counting to determine Active Region Spectra:** SEUSHI performs fast readout of selected sensor rows to determine spatially resolved active region plasma properties (temperature, emission measure, abundances) which are a key diagnostic of coronal heating.

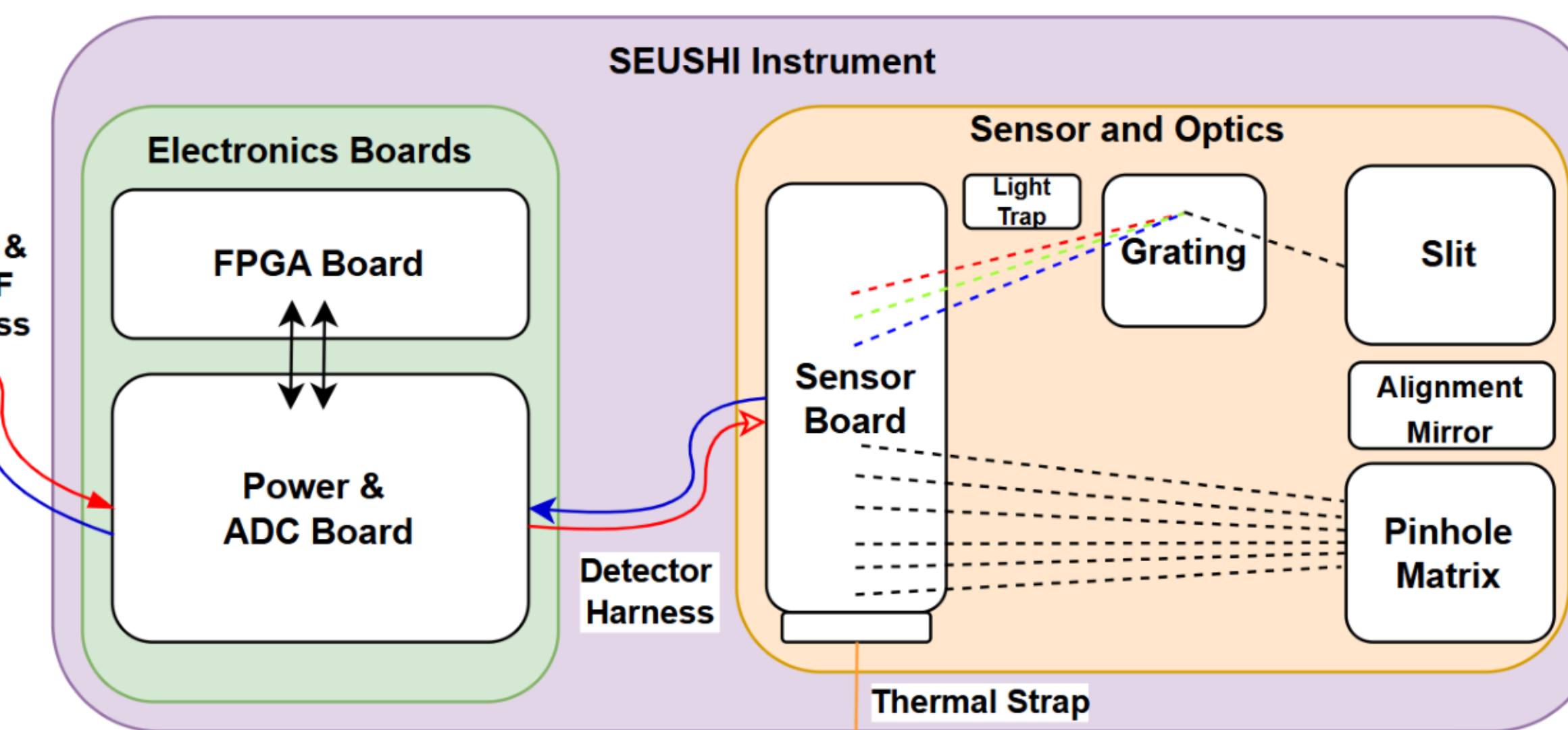


- **Coronal dimming based CME Alerts:** SEUSHI utilizes the coronal dimming observed in EUV spectra and flare/CME location from SXR images, to estimate CME magnitude, velocity, and direction.

SEUSHI Instrument Overview

SEUSHI consists of two complementary channels on a shared CMOS sensor:

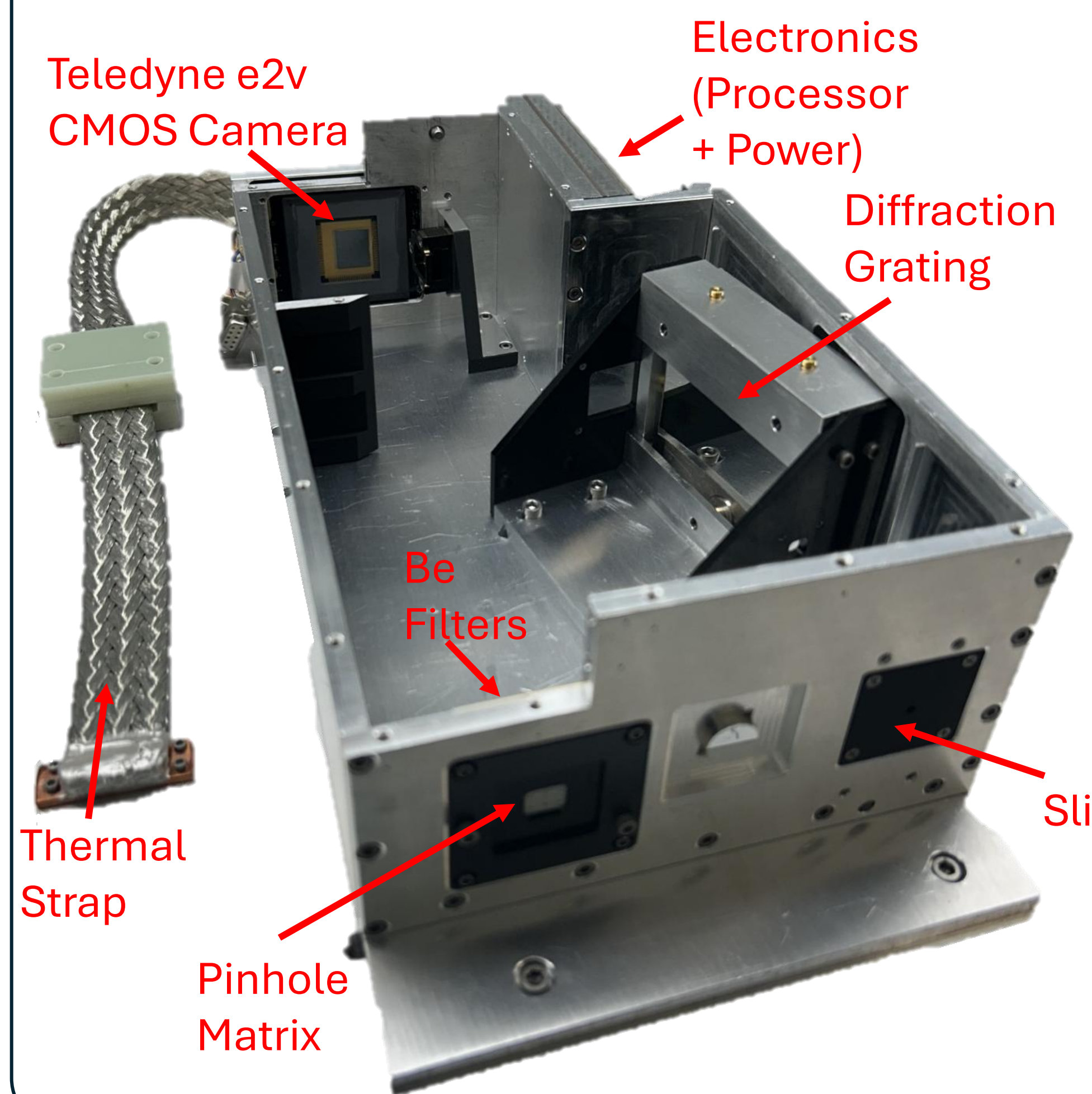
- A multi-pinhole SXR imaging spectrometer
- A grazing-incidence EUV spectrograph



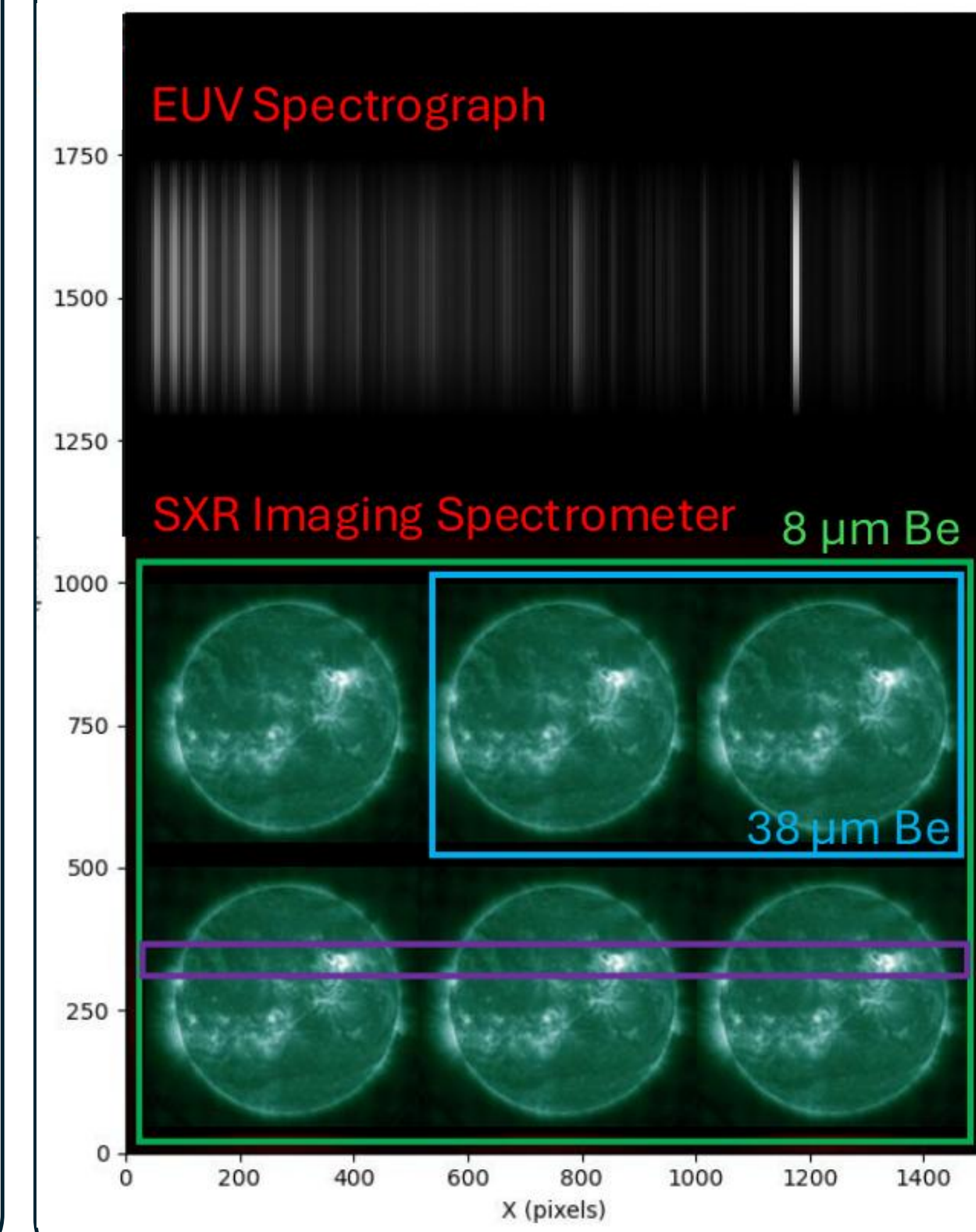
Mass: 3.5 kg; Power: 3.7 W; Volume: 350 x 165 x 110 mm³

- By performing onboard ratios of simultaneous images with different SXR passbands, SEUSHI delivers spatially resolved temperature and emission measure maps to identify flare HOPEs and provide flare location on the solar disk.

Instrument Optical Layout

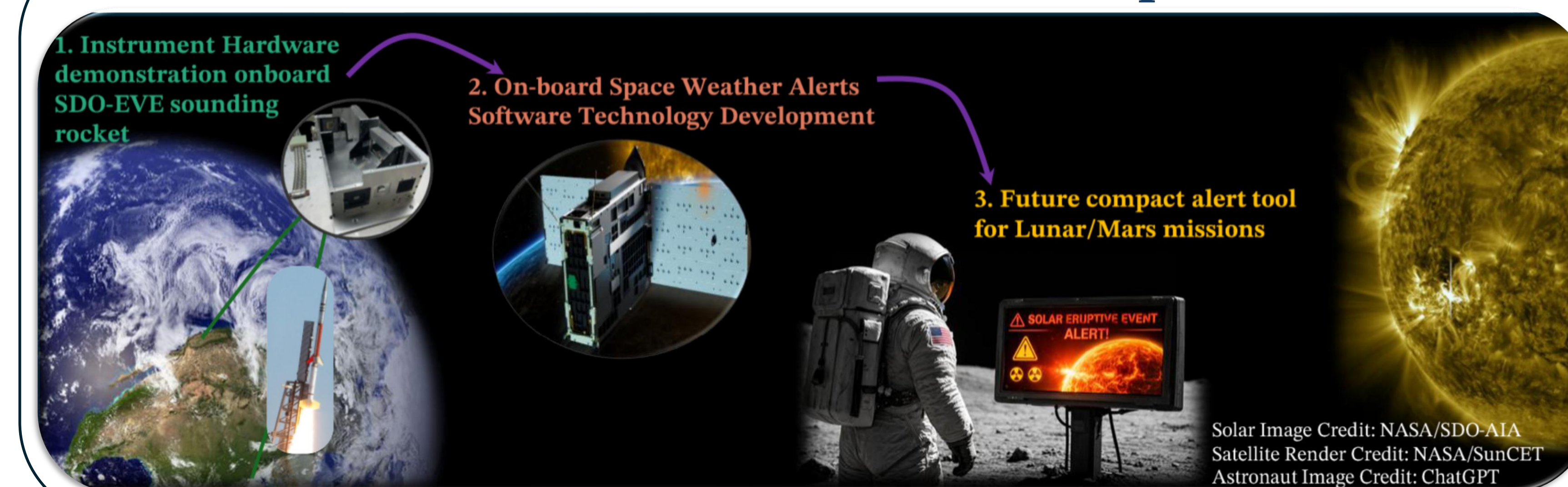


Example Data Products



Projected Performance
EUV Spectra:
 Range: 16.1 – 33.8 nm
 Resolution: 0.2 nm
 Cadence: 5 sec
 SNR: 200 at 19.3 nm
SXR Imaging:
 Range: 1.1 – 6.9 keV
 FoV: 1.3 Rs
 Spatial Res.: 57"
 Cadance: 5 sec
 SNR: 130 at M1
SXR Spectra:
 Energy Res: 0.08 keV
 Cadance: 10 mins
 SNR: 57 (for single 2 keV photon)

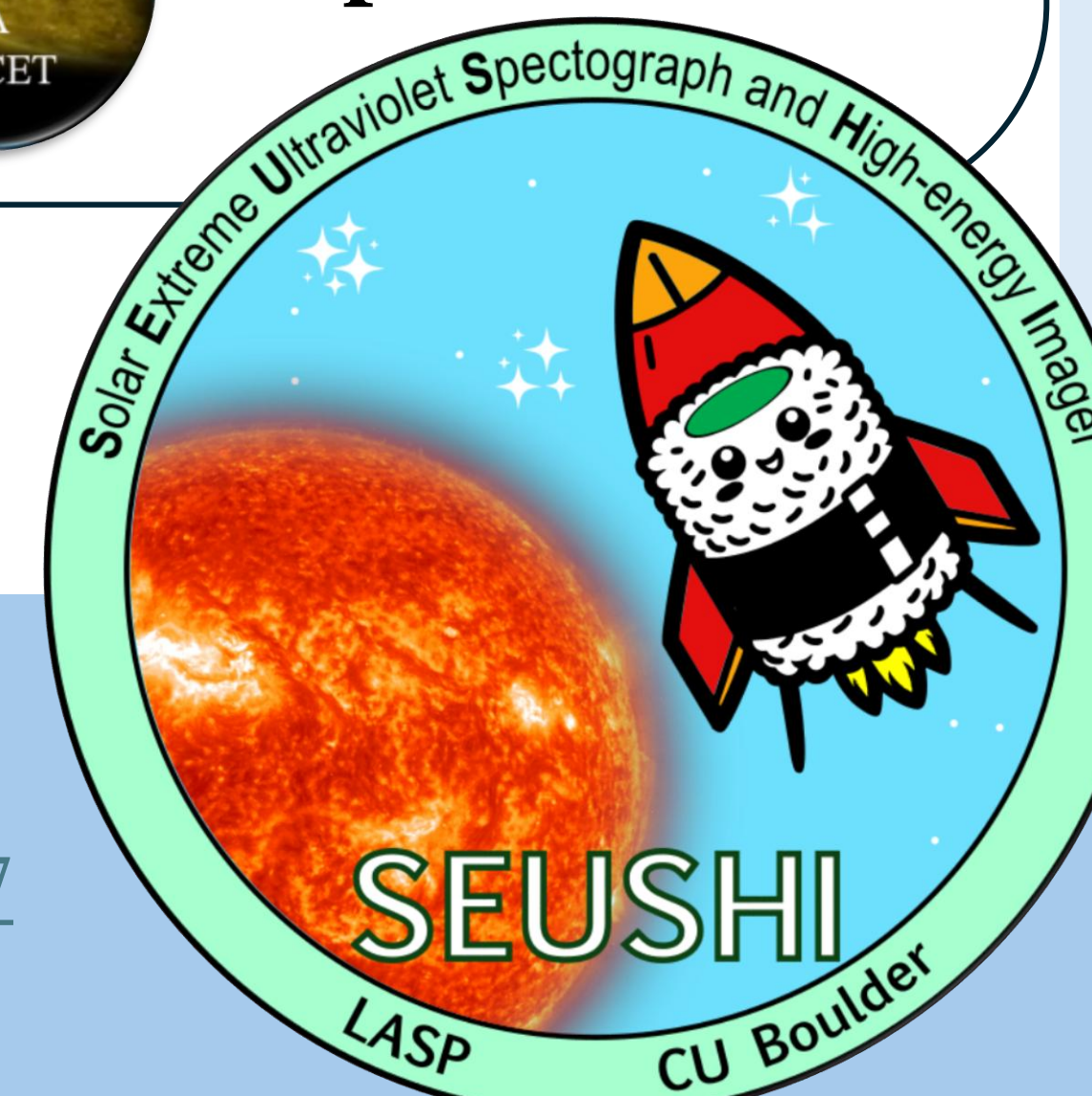
SEUSHI Roadmap



SEUSHI directly supports future human and robotic exploration of the Moon and Mars by enabling earlier warning of hazardous solar eruptive events.

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For more details of the SEUSHI instrument design, signal model, and calibration see: Telikicherla et. al., "Solar Extreme Ultraviolet Spectrograph and High-energy Imager (SEUSHI): Design, Development, and Pre-Flight Calibration", <https://arxiv.org/abs/2604.07537>



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Key References:

- [1] Hudson et. al, 2021, MNRAS
- [2] Battaglia et. al, 2023, A&A
- [3] Hudson et. al, 2025, Sol. Phys.
- [4] Telikicherla et. al, 2025, ApJ