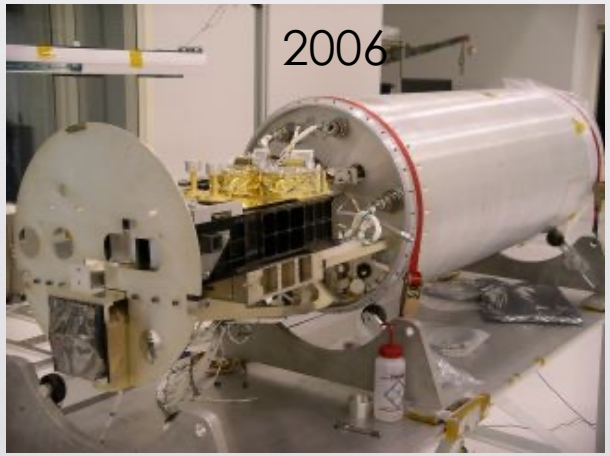
SDO EVE Underflight Calibration Experiment

Overview and History



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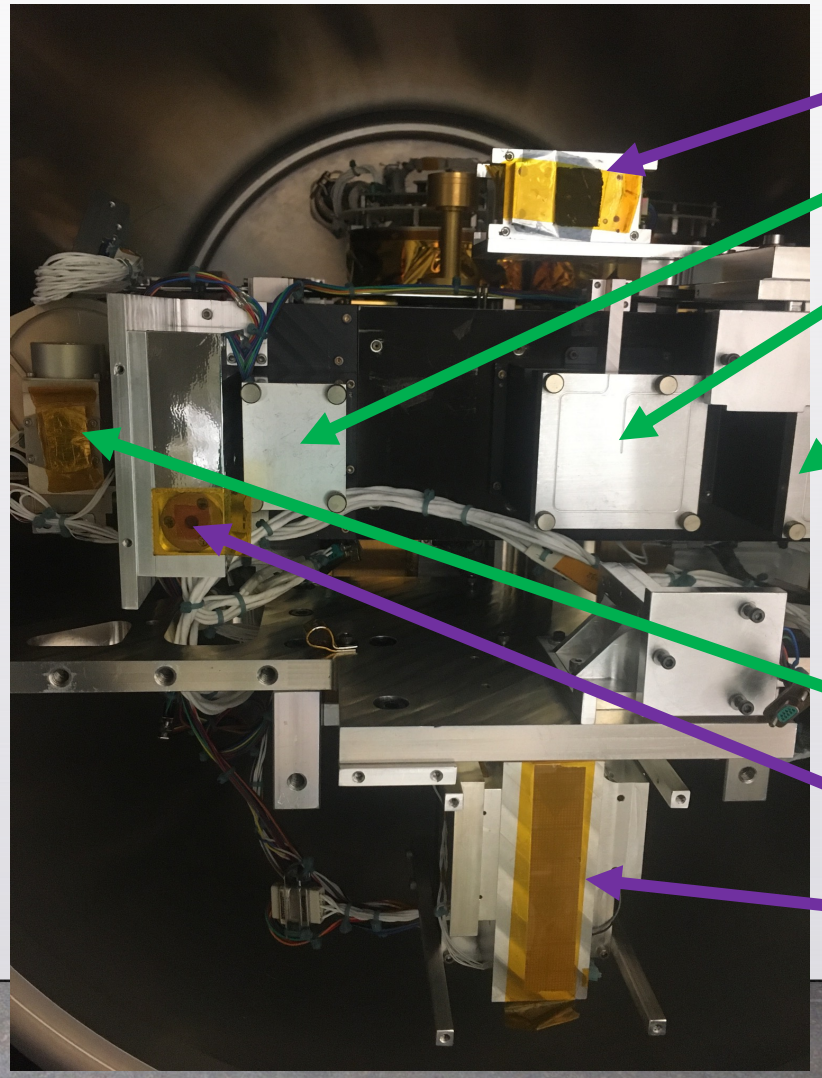
Mission Overview / Objectives

- Primary goal is to provide underflight calibration for the EUV Variability Experiment (EVE) aboard the NASA Solar Dynamics Observatory (SDO) satellite.
  - EVE channels include MEGS-A, MEGS-SAM, MEGS-B, MEGS-P, and ESP
- Also provides underflight calibration for TIMED SEE, SOHO SEM, and GOES EXIS irradiance instruments
- Also provides underflight calibrations for solar EUV imagers aboard SDO, STEREO, GOES, and Hinode
- Secondary goal is to provide technology demonstration for other underflight calibration experiments that also benefit SDO EVE calibrations
  - MinXSS & DAXSS; Amptek X123 Spectrometers used for SXR calibration
  - GOES-R XRS; calibration for GOES XRS and technology demonstration of new technology for the X-Ray Sensor (XRS)
  - Compact SOLSTICE (CSOL); final calibration for SORCE SOLSTICE and technology demonstration for LASP's CMOS camera
  - Dual-SPS; improved Lyman-alpha calibration and technology demonstration for upcoming SunCET, CubIXSS, and OWLS cubesats

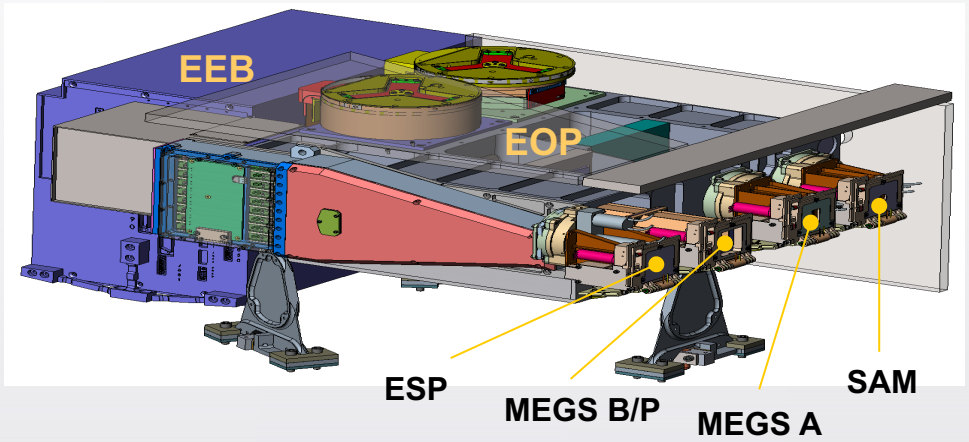
NASA 36.389 Solar Instruments

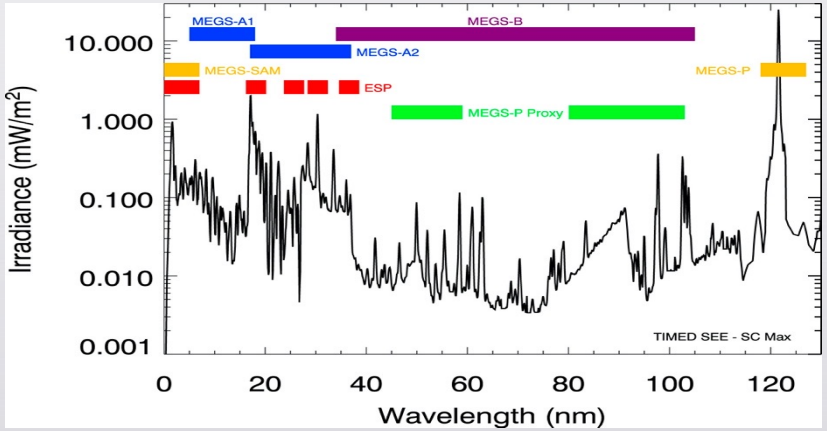
Instrument	Range
MEGS-A spectrometer	5-38 nm
MEGS-B spectrometer	33-106 nm
MEGS-SAM X-ray imager	1-7 nm
MEGS-P Lyman-alpha	121.6 nm
ESP: EUV QD and photometers	1-38 nm
XRS: Visible SPS	300-900 nm
XRS: 3 EUV Photometers	XRS-A & -B, Ly-alpha
XRS: X55 X-ray spectrometer	0.5-12 keV
SPS: visible quad diode	300-900 nm
SPS: PicoSIM 6 CMOS-filter channels	VIS-NIR



SDO EUV Variability Experiment (EVE)

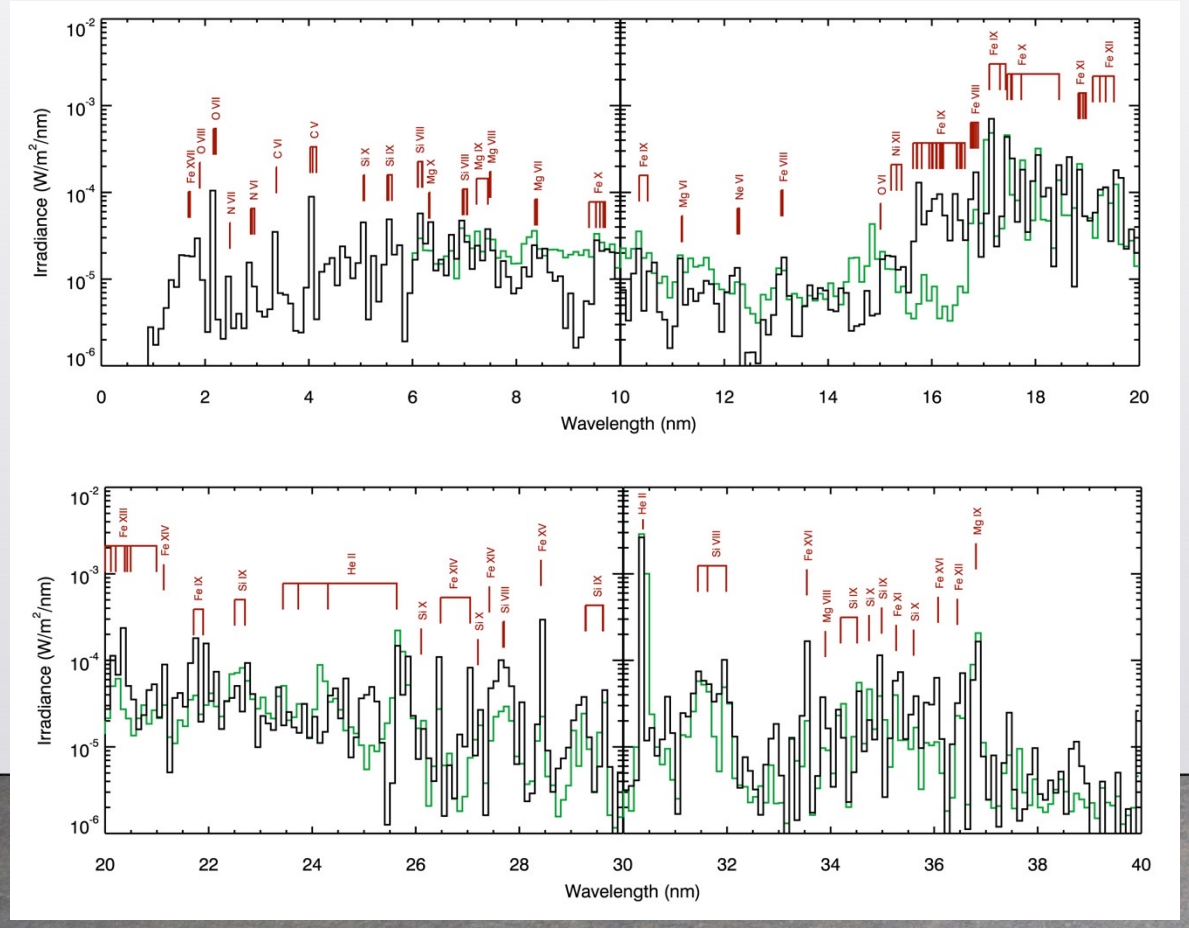
- EVE Channels
  - Multiple EUV Grating Spectrograph (MEGS)
    - A-1: 5-18 nm, 0.1 nm res.
    - A-2: 17-37 nm, 0.1 nm res.
    - SAM (A): 0.1-7 nm, 0.1-1 nm res.
    - B: 35-105 nm, 0.1 nm res.
    - P (B): Ly-α (121.6 nm)
  - EUV SpectroPhotometer (ESP)
    - ESP Zeroth Order: 0-7 nm
    - ESP First Order: 17-38 nm, 2 nm res.
- EVE Optical Package (EOP) and all channels are flown on rocket
- EVE Electronics Box (EEB) is not flown on rocket
- SDO launch was in Feb. 2010 and has 9 supported calibration rockets (2010-2021). NASA 36.389 flight in 2023 will the eighth calibration rocket for SDO.

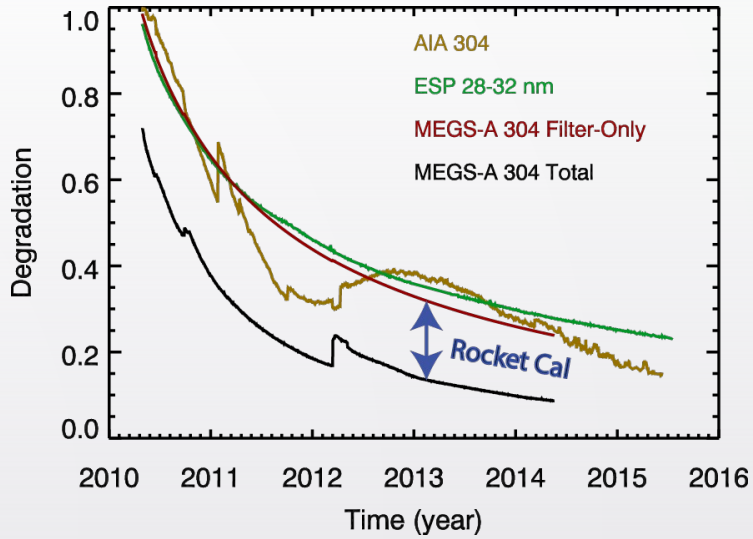




EVE measures solar EUV irradiance

Rocket EVE observations are critical for precisely tracking the degradation trends of the SDO satellite instruments (EVE and AIA)



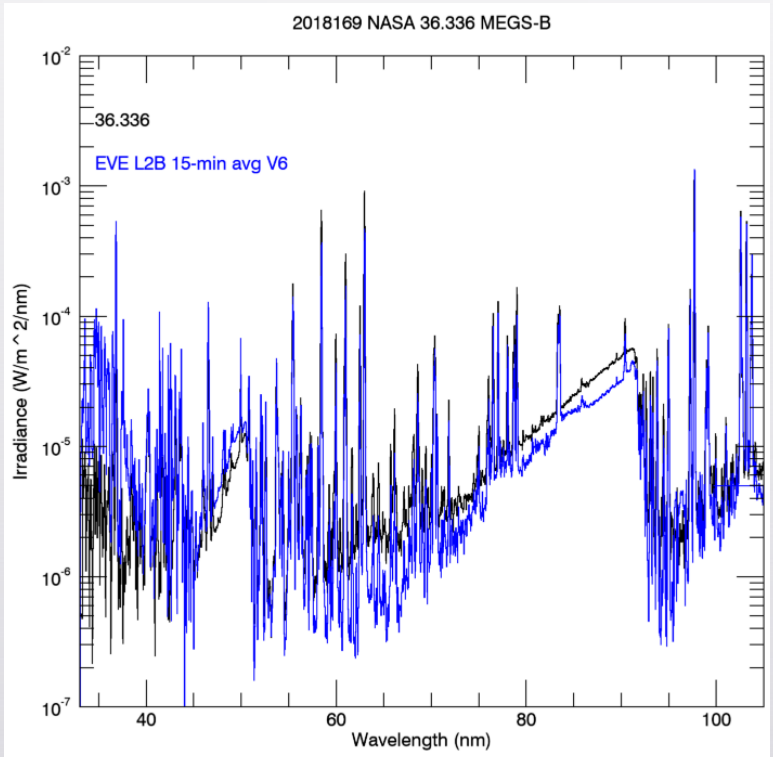


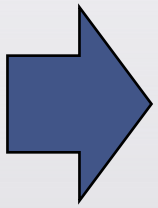
On-board calibrations provide relative degradation trends; underflight experiments provide absolute calibrations.

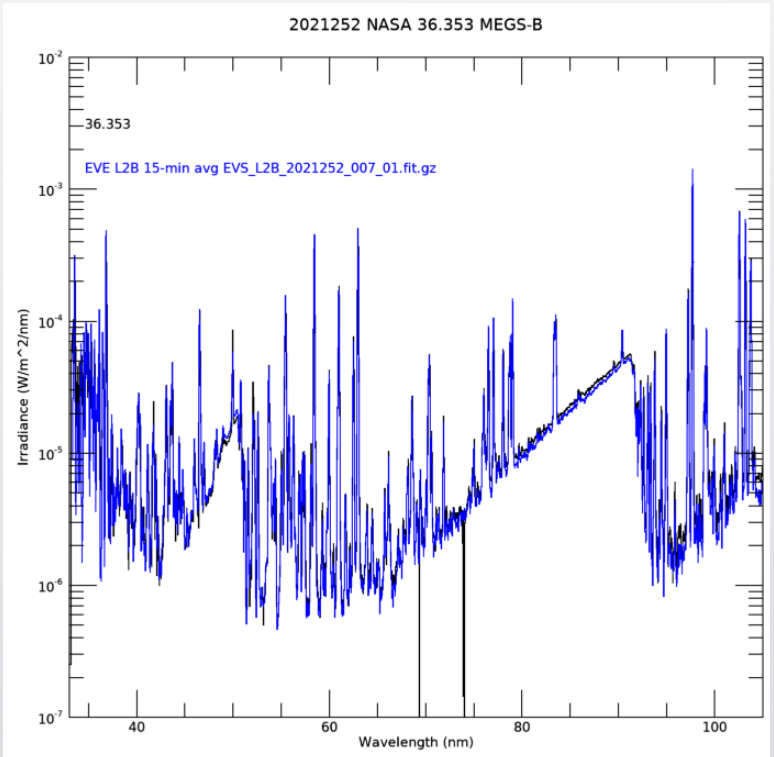
Example spectrum as measured by Prototype EVE MEGS-A in April 2008 (36.240)

Data Improvements from Calibration

The measurements were validated using simultaneous SDO-EVE measurements. 37- 105 nm are shown. The significant differences are quantitatively corrected in SDO-EVE version 7 products.



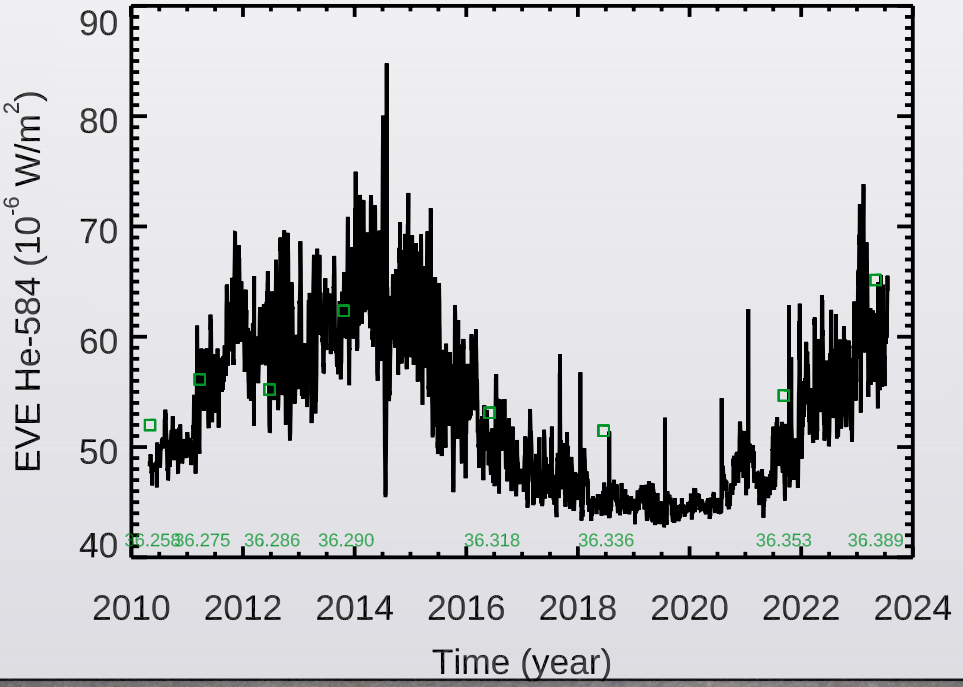




Courtesy of
Don Woodraska

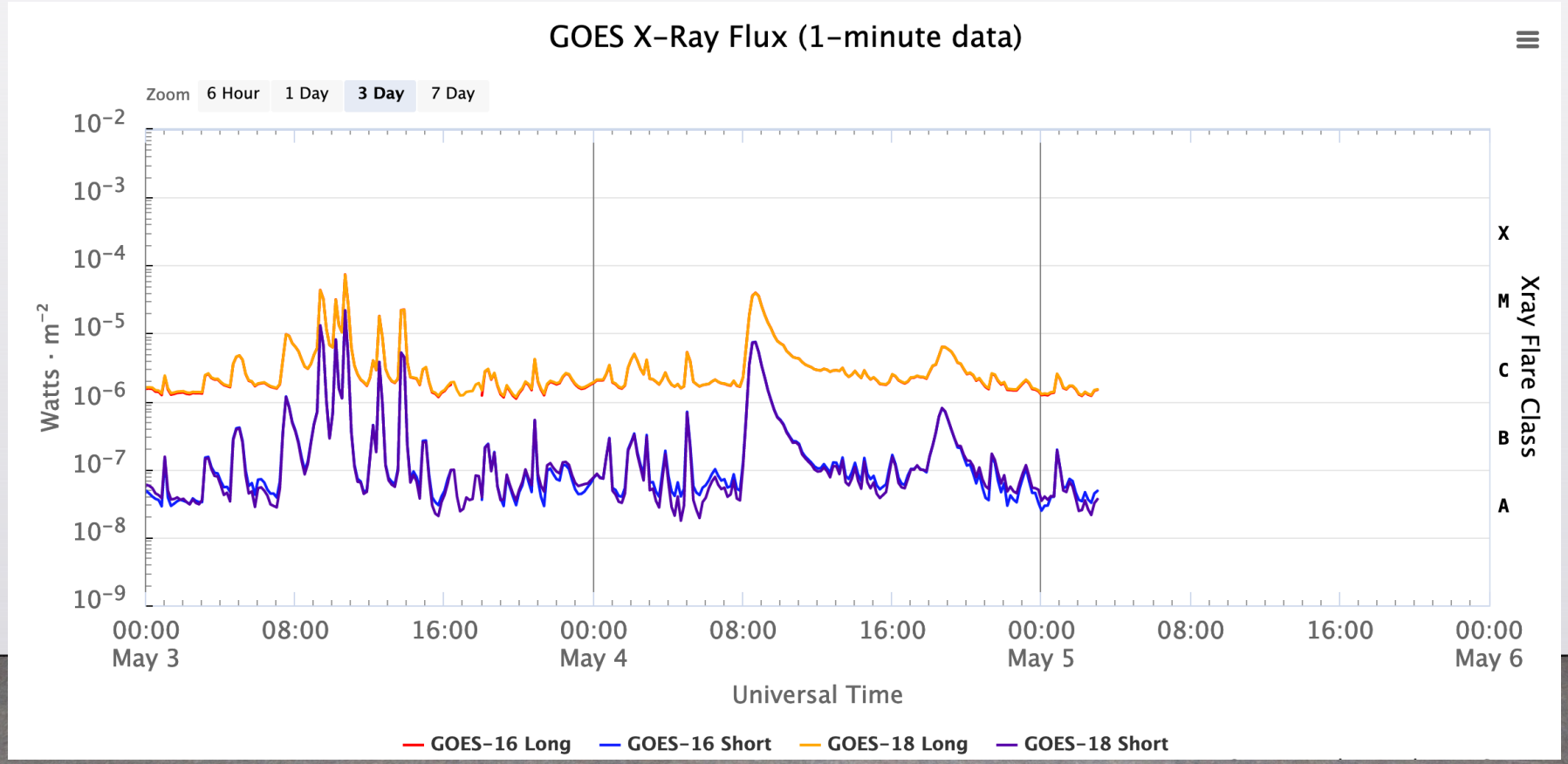
SDO EVE Underflight Calibration Experiment

- NASA 36.389 is most recent rocket calibration flight on May 3, 2023 from White Sands Missile Range
- Future flight is planned for June 2025 (*pending SDO 2022 Senior Review results*)
- WARNING: Version 7 EVE products do not include latest rocket calibration results !



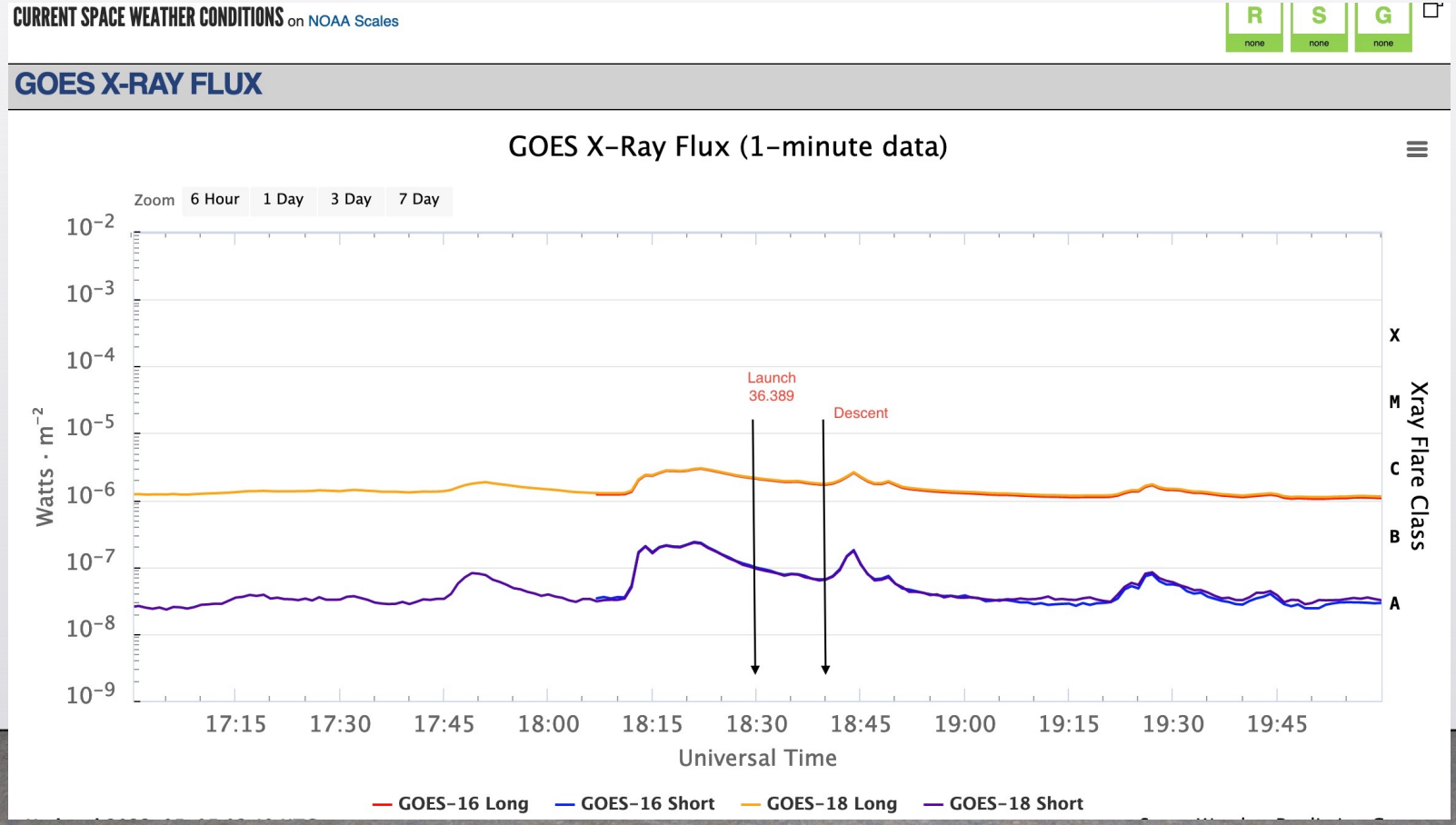
GOES X-rays over May 3, 2023

- Sun was active with 6 M-class flares, ~15 C-class flares, and long channel irradiance was > C1 class for entire day.



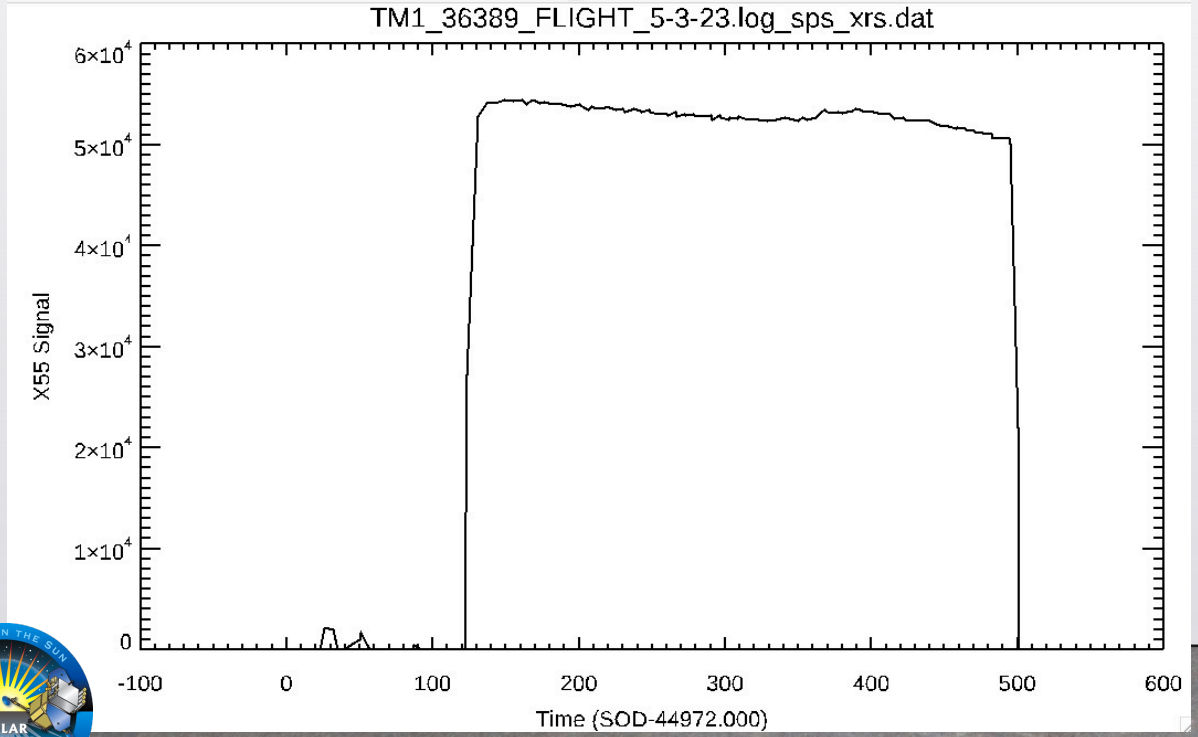
GOES X-rays during flight

- X-ray flux started near C2.1 at launch time and decreased to C1.7

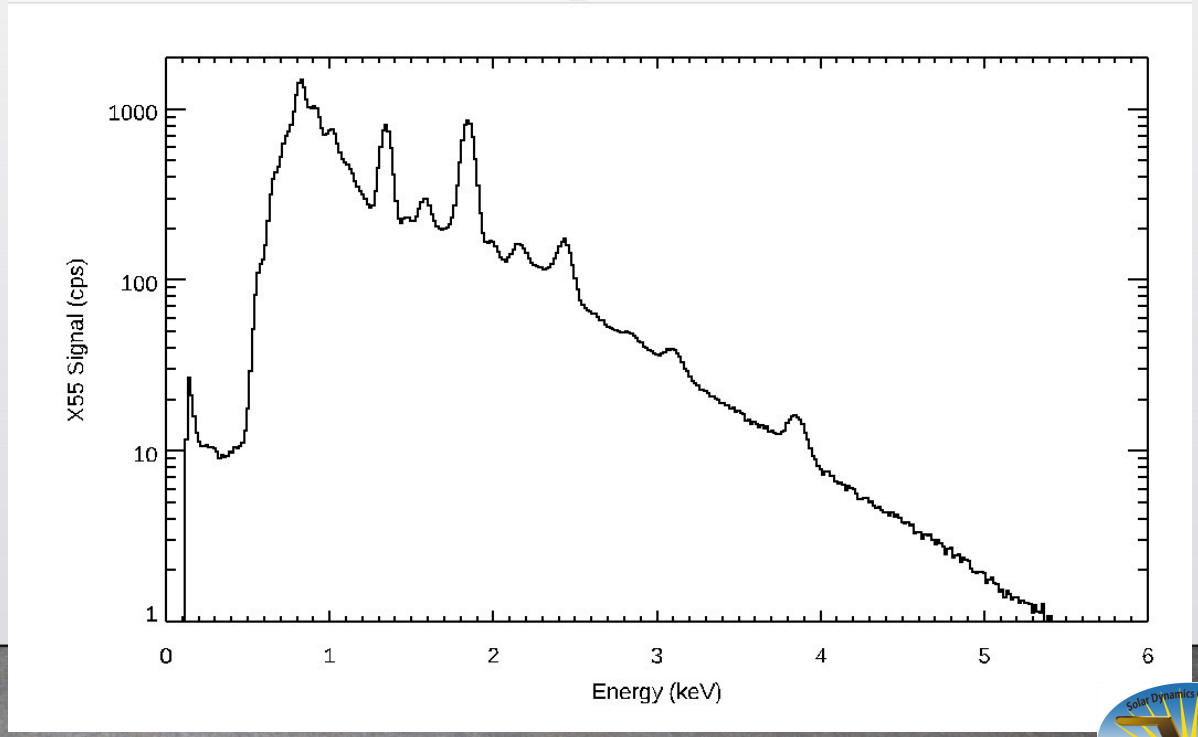


Rocket X55 is "DAXSS-2"

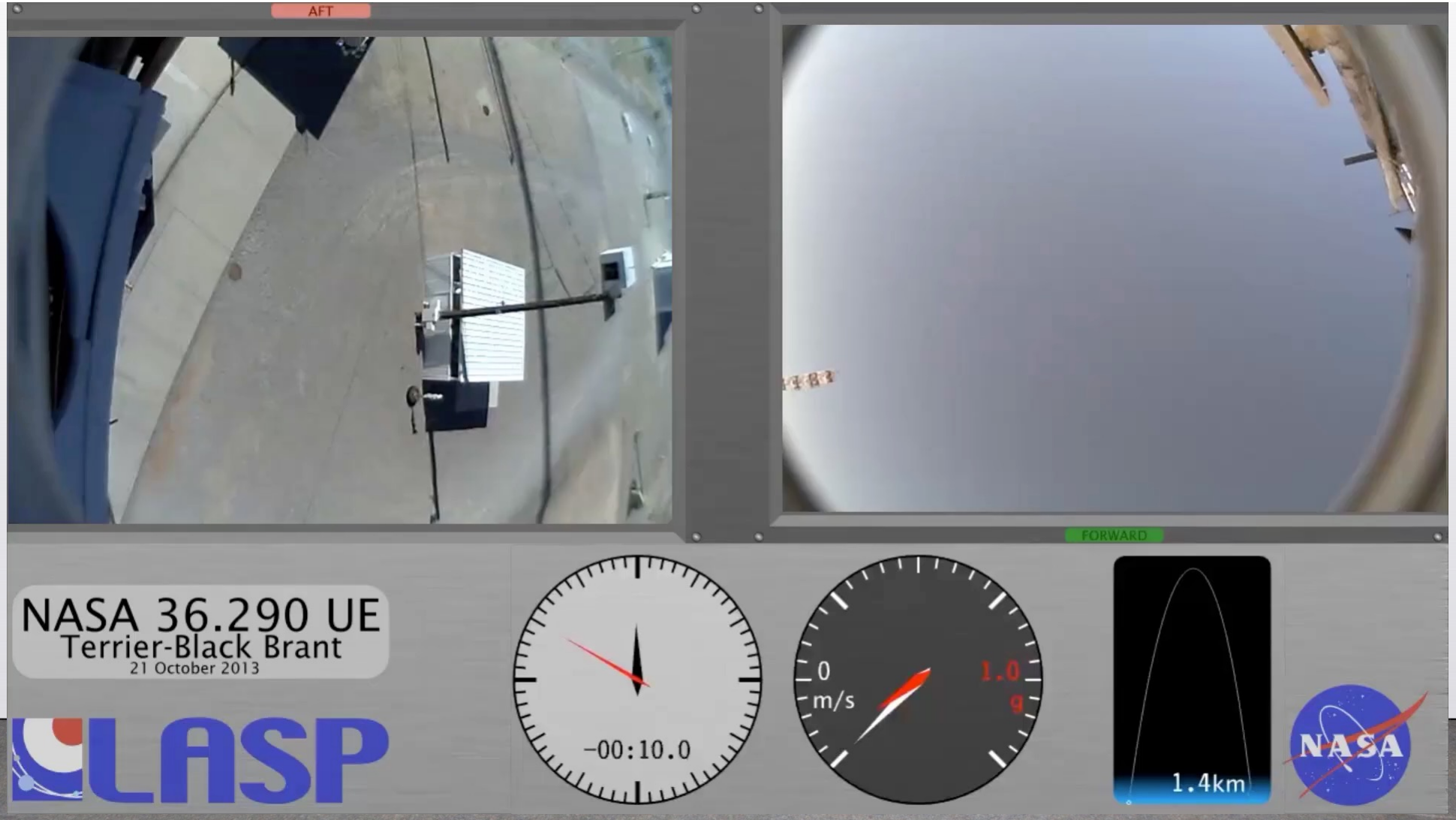
X55 Slow Counts (integrated signal) shows that X-ray flare irradiance is decreasing during the flight. There appears to be a small variation / offset after 90° roll.



X55 has strong signal out to 5 keV. This is expected for C2 level. Full range is out to 16 keV.



- LASP flew **Aspect Cameras** on its airglow experiment sounding rockets in the 1990s to provide improved roll angle information and has continued flying the cameras on the solar EUV calibration payload. Here is example video from them.



Summary and Future Plans

- SDO EVE project has flown its underflight calibration experiment 10 times to provide calibrations for SDO EVE, TIMED SEE and other satellite instruments
  - 2015 flight had failure due to S-19 guidance anomaly; others were very successful
- NASA 36.389 launched successfully on May 3, 2023 is the most recent flight for rocket EVE
- Heliophysics Senior Review in 2023 will determine the future for SDO and if rocket EVE will continue underflight calibrations in 2025 and 2027