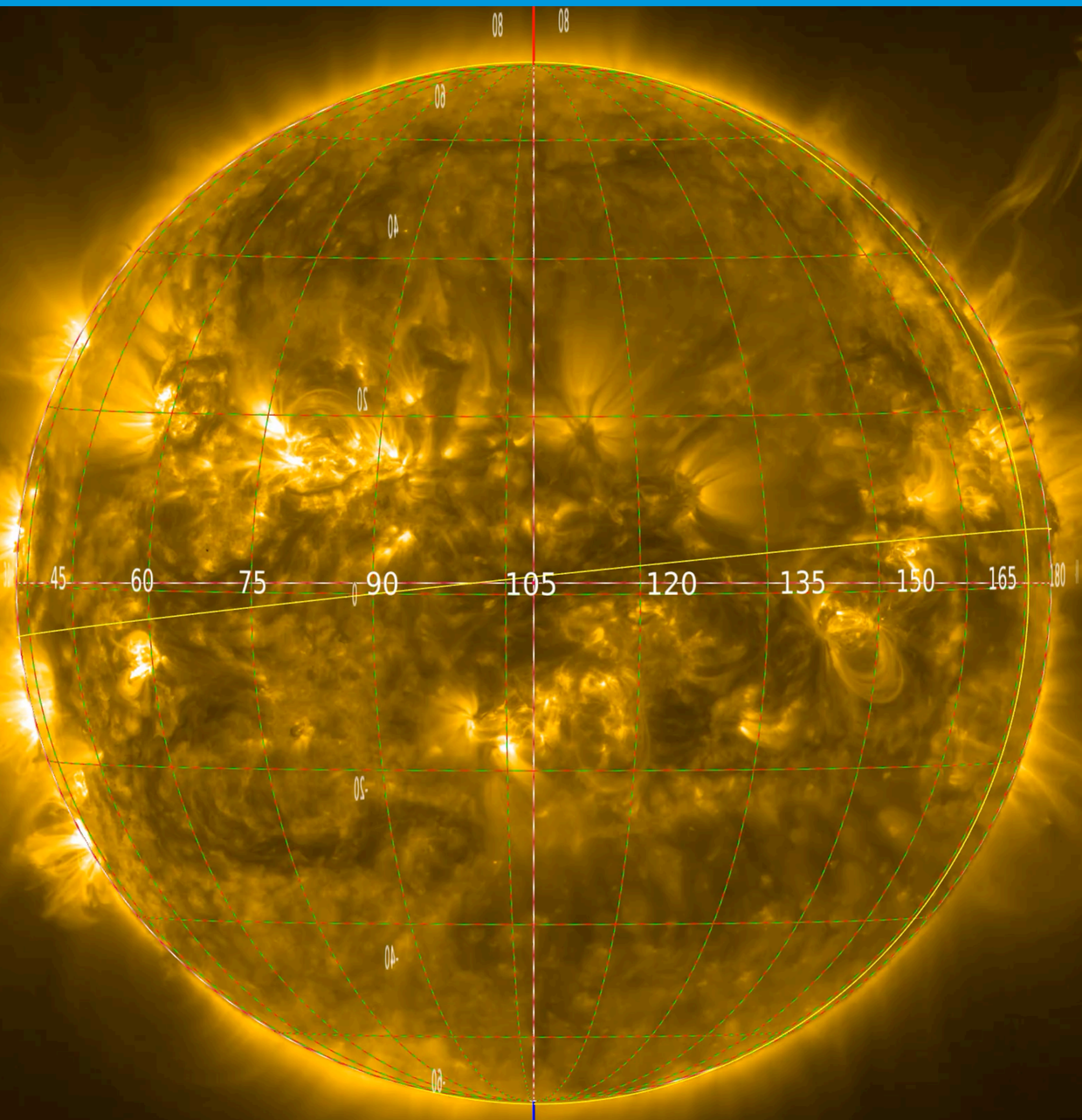
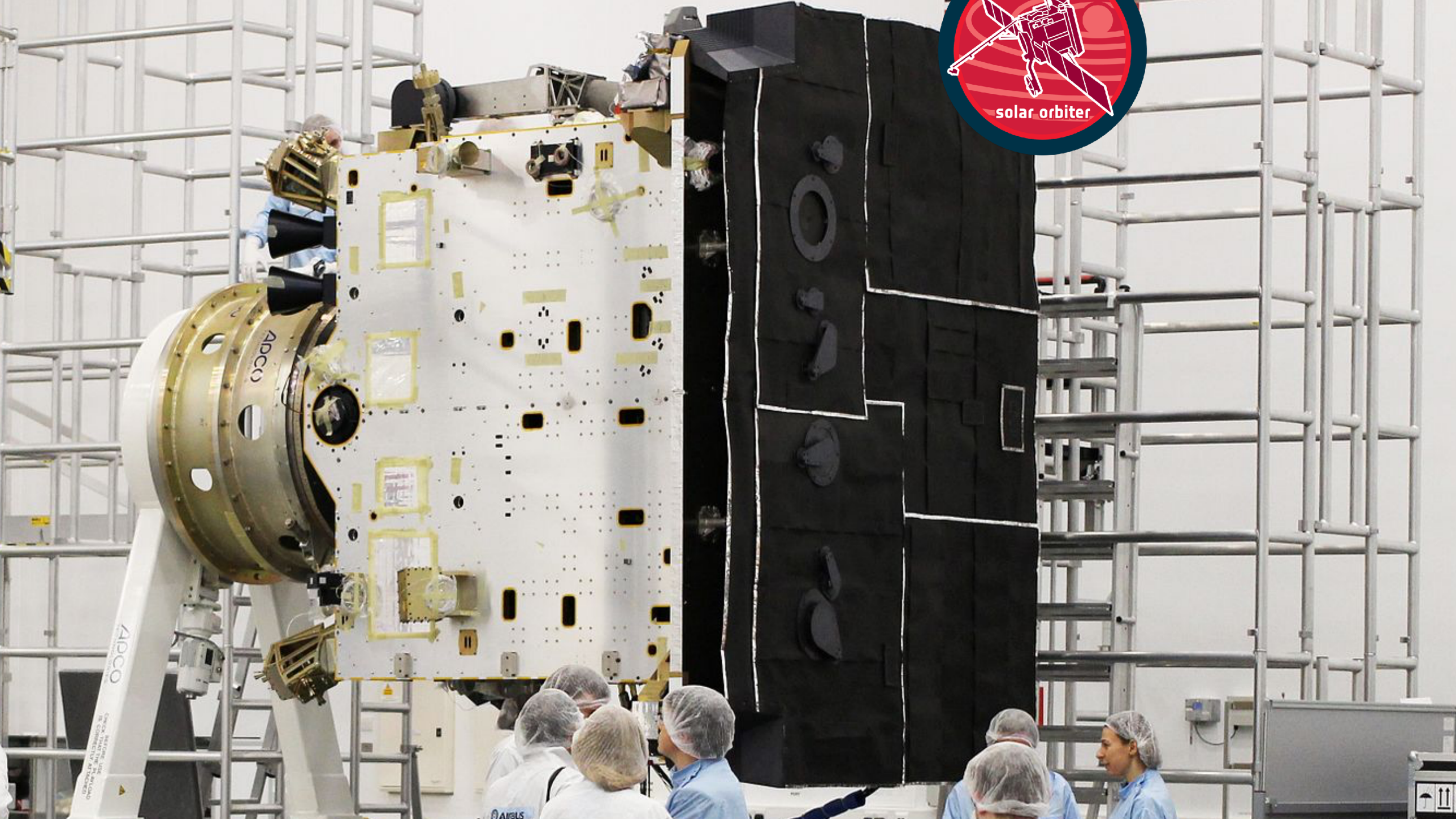
# Overview EUI &Lessons Learned

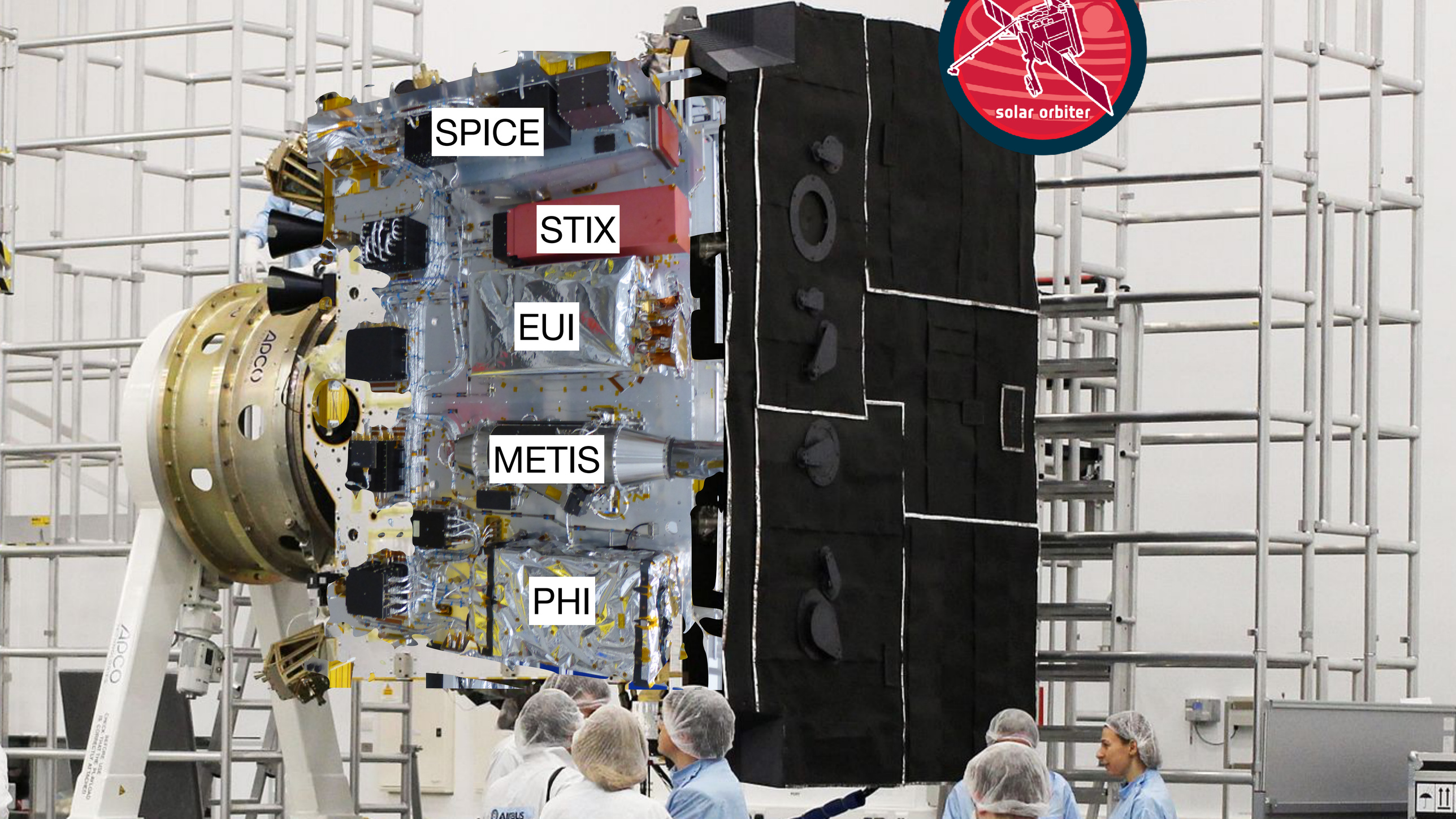
D. Berghmans

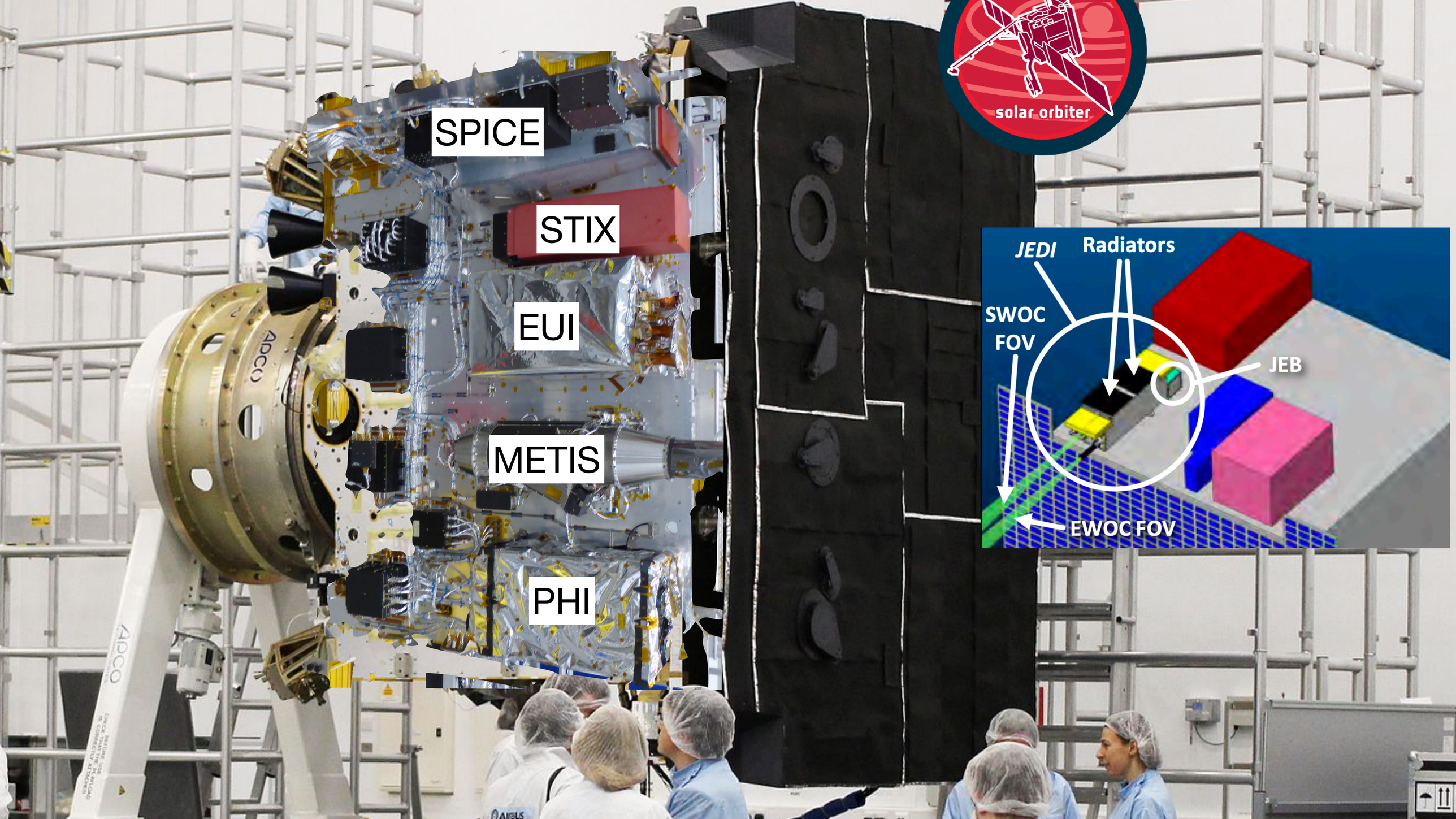


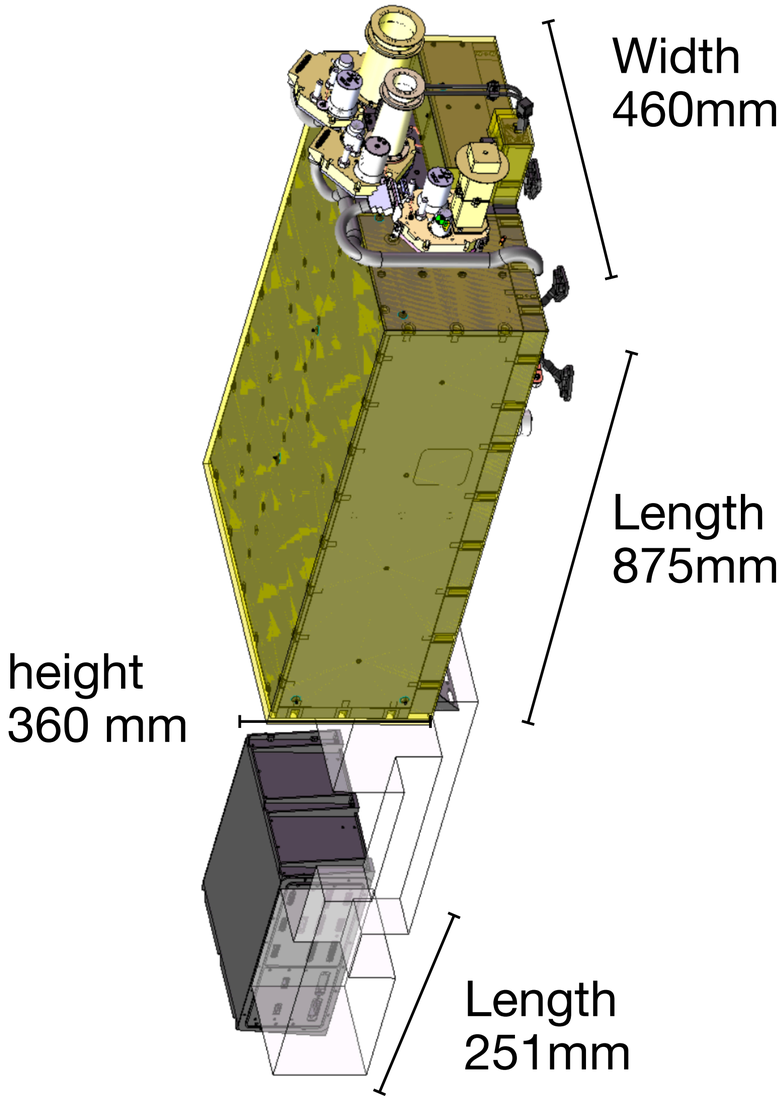
# Overview

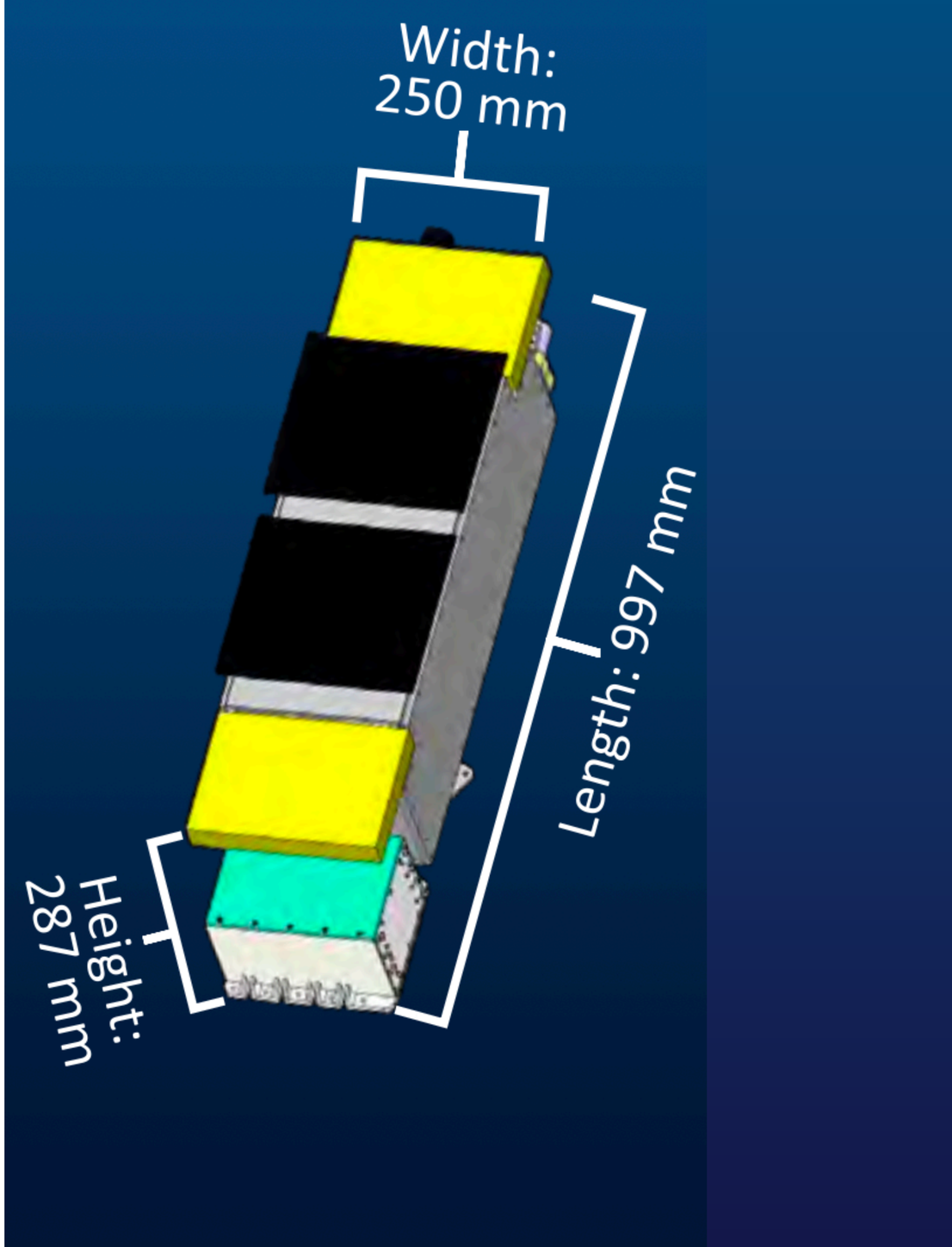
1. Overview EUI
2. Science Highlights FSI
3. Aging
4. Lessons learned

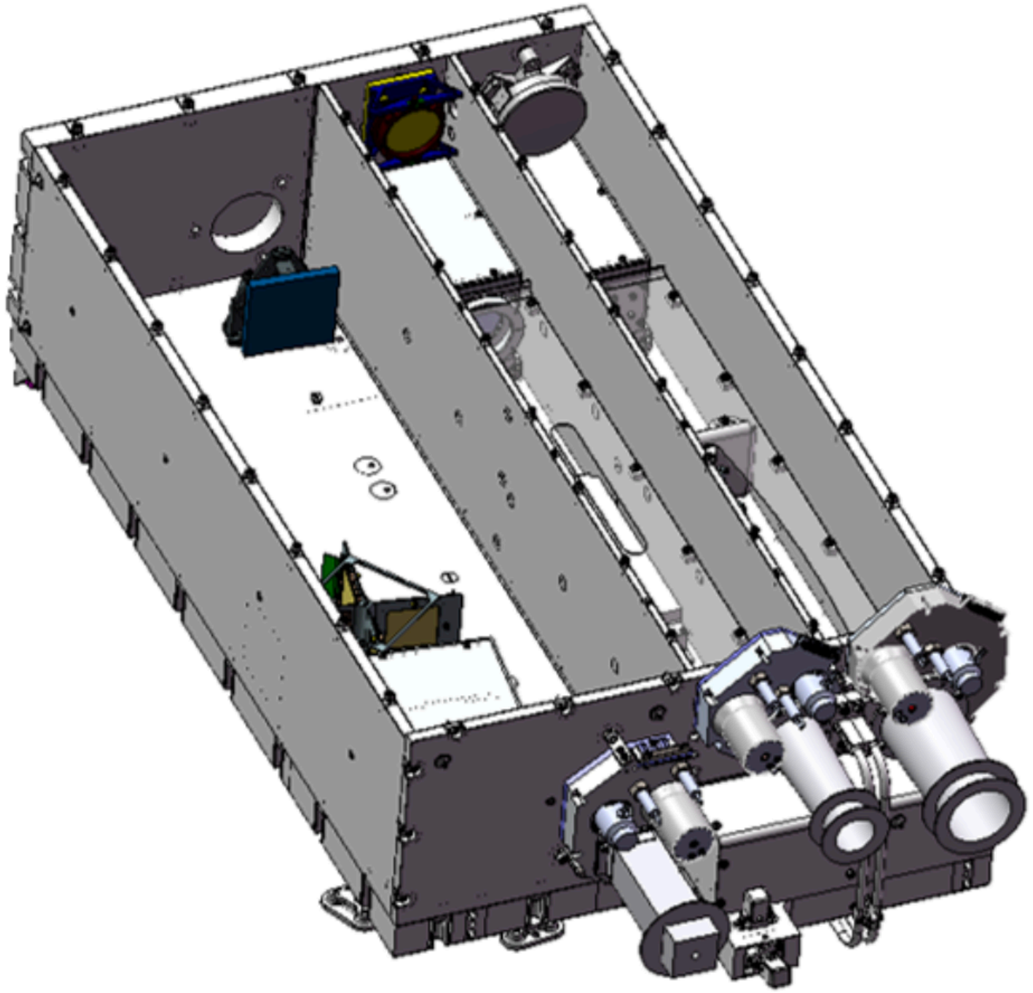

solar orbiter

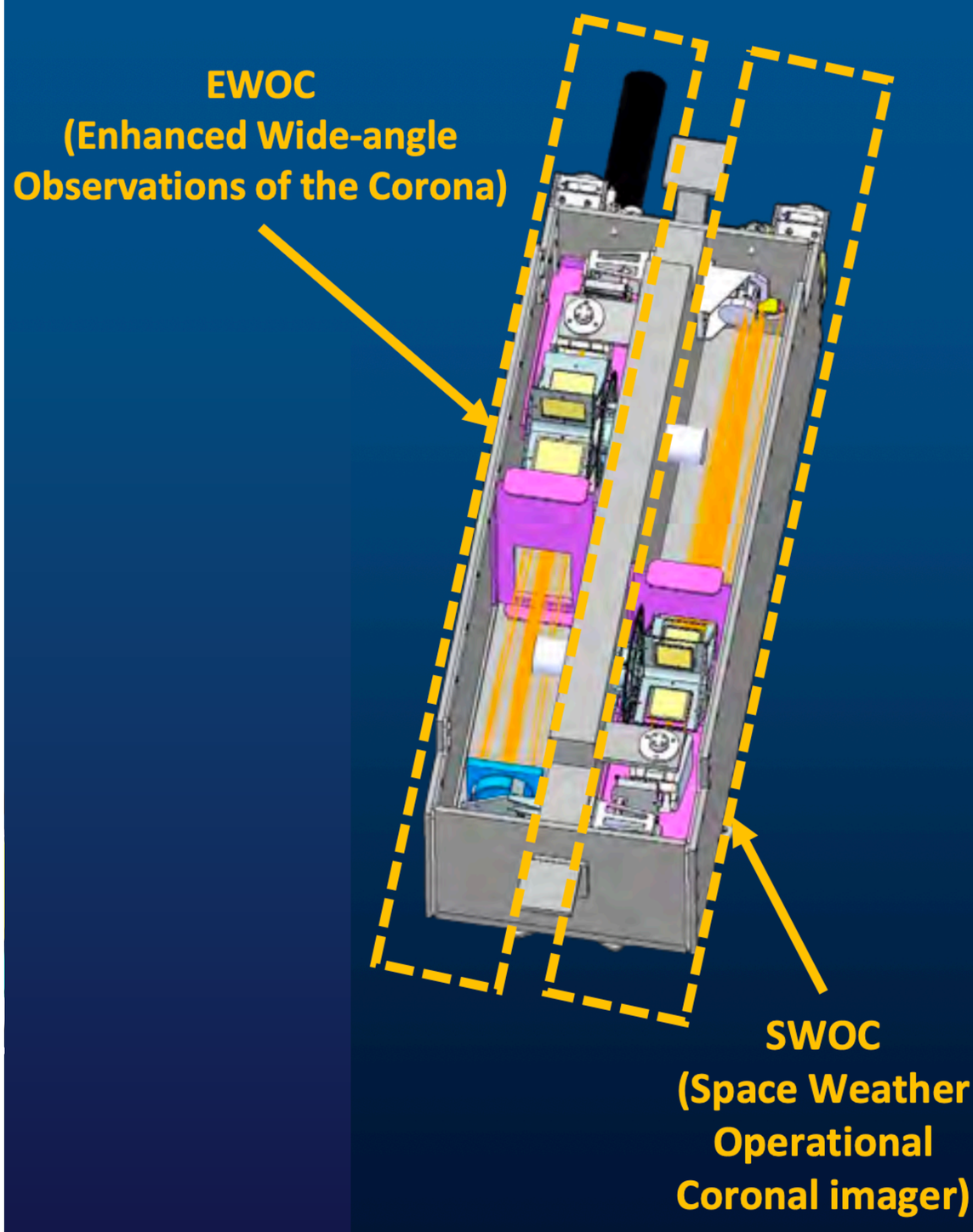

SPICE
STIX
EUI
METIS
PHI
solar orbiter

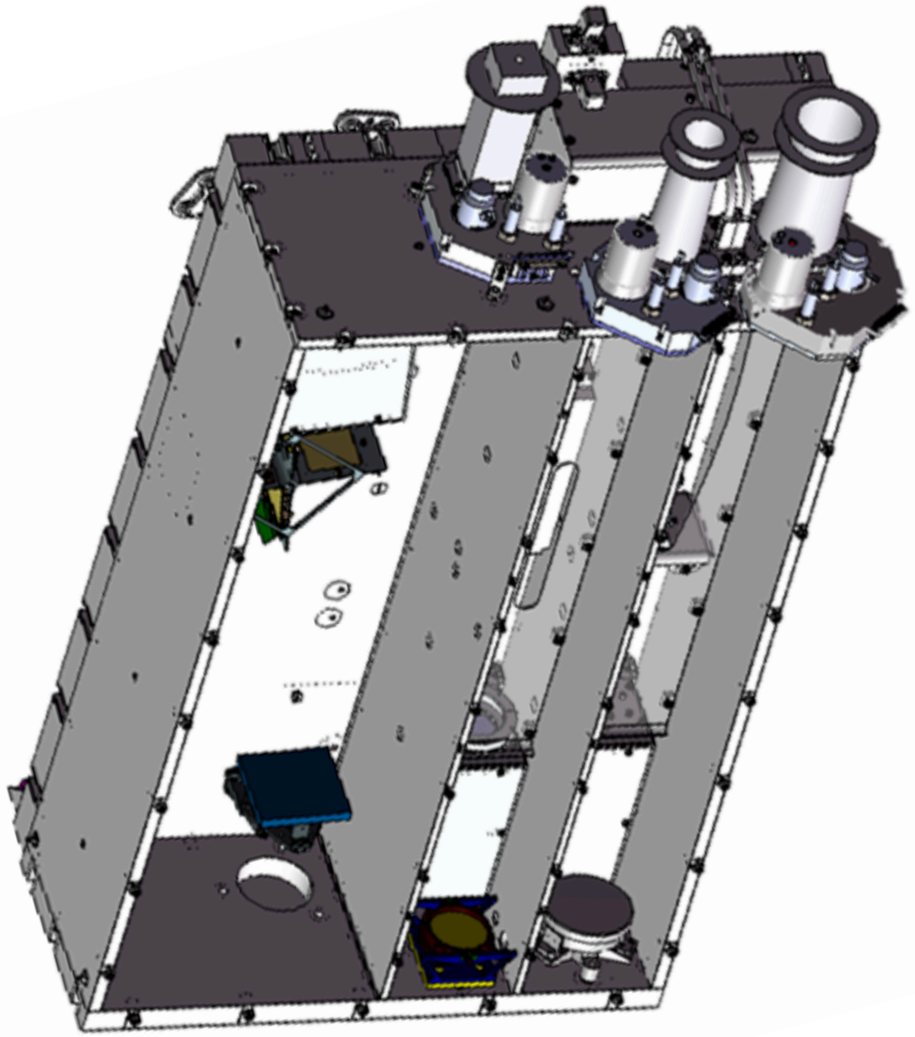

SPICE
STIX
EUI
METIS
PHI
solar orbiter
JEDI
Radiators
SWOC
FOV
JEB
EWOC FOV

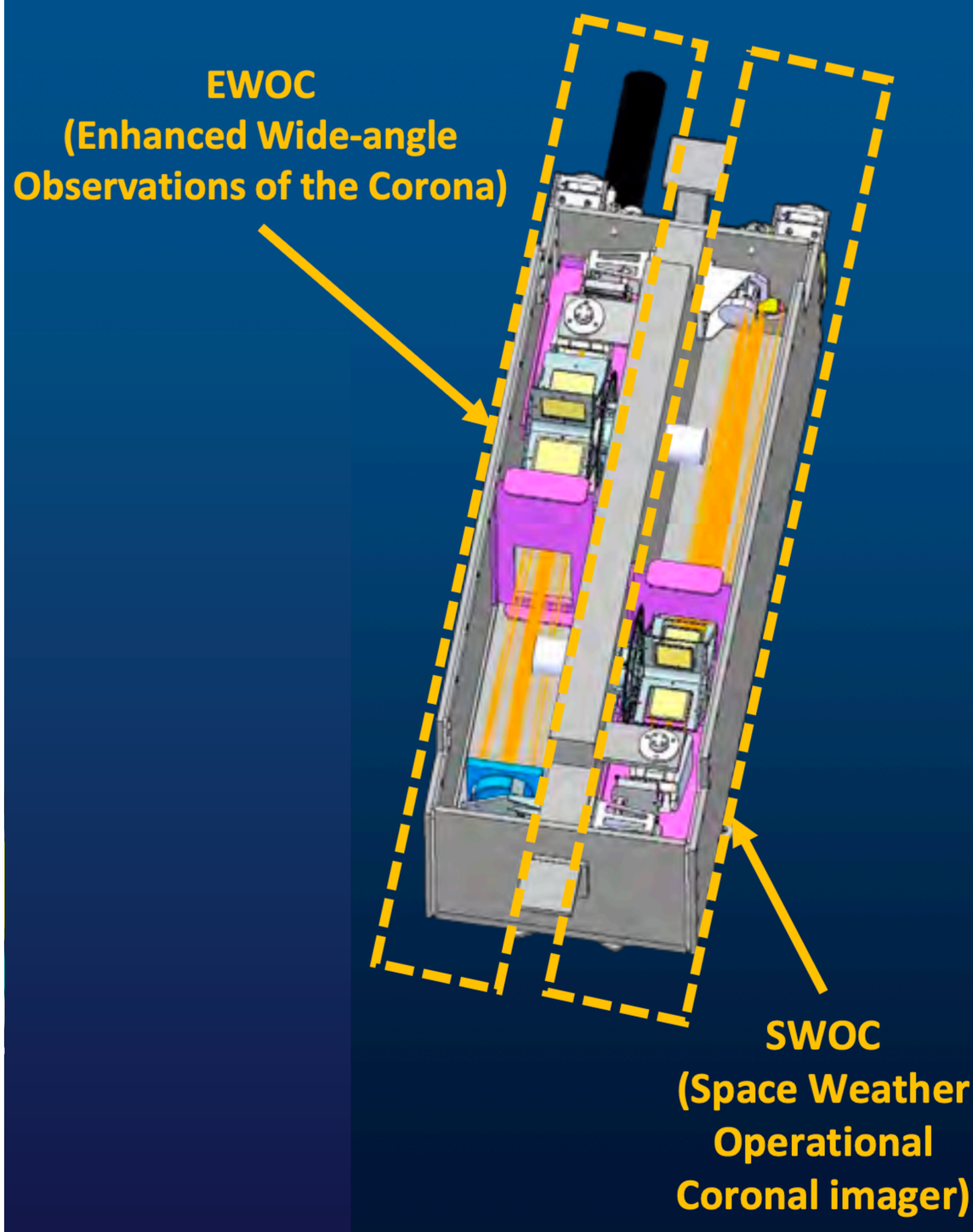

Width
460mm
Length
875mm
height
360 mm
Length
251mm

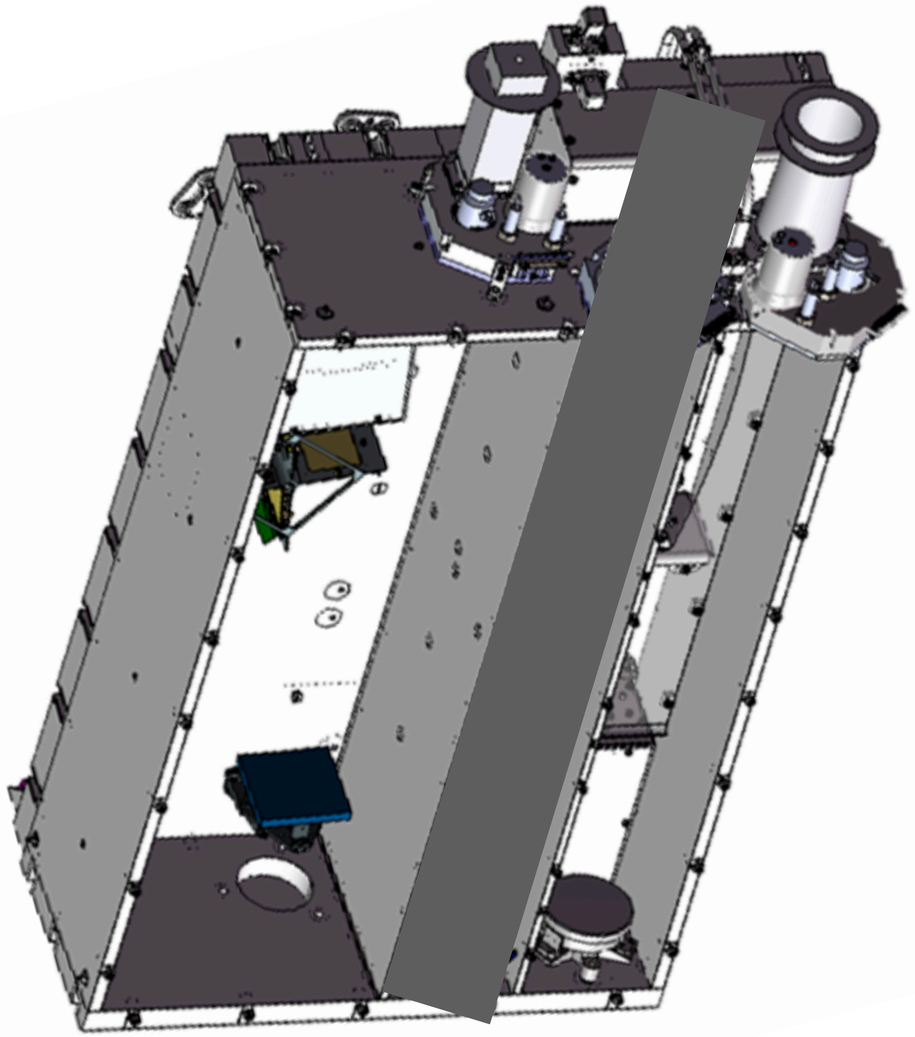

Width:
250 mm
Length: 997 mm
Height:
287 mm

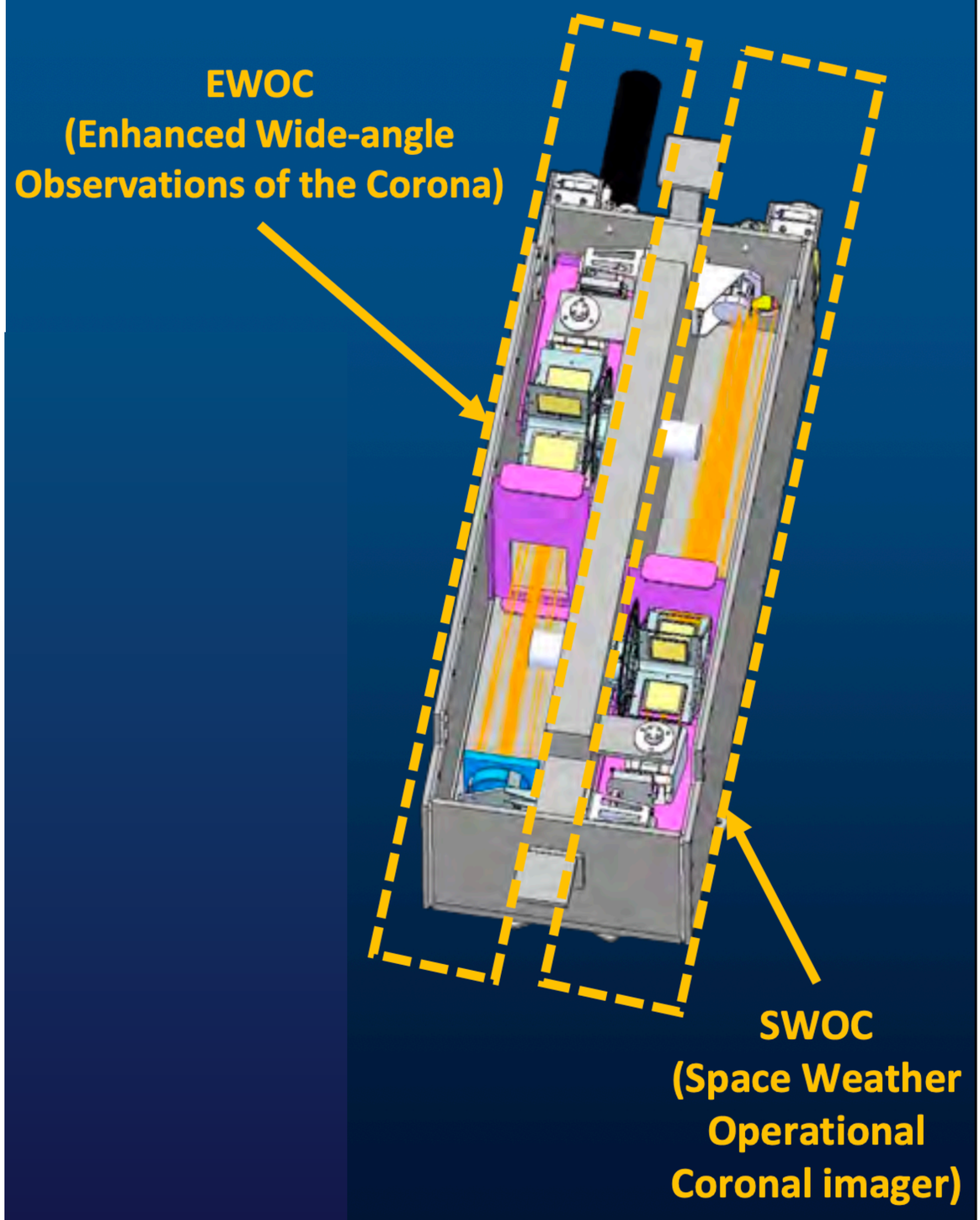



EWOC
(Enhanced Wide-angle
Observations of the Corona)
SWOC
(Space Weather
Operational
Coronal imager)

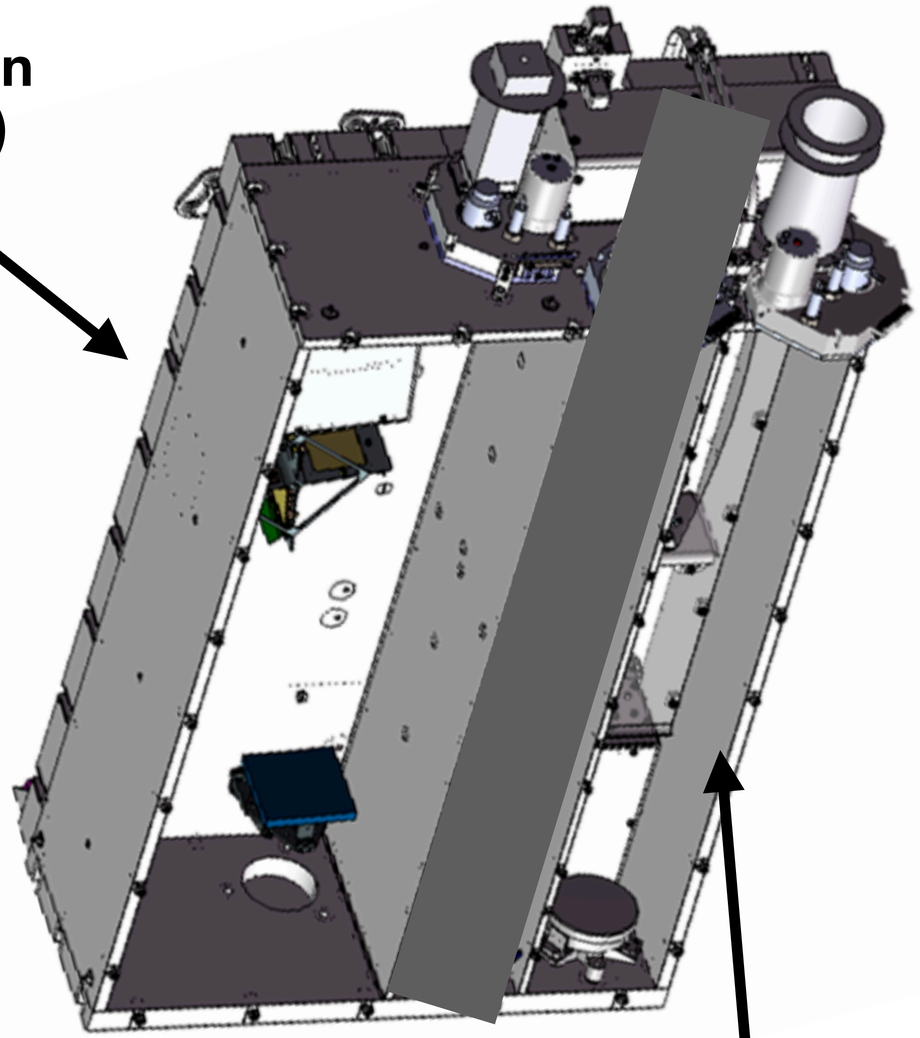



EWOC
(Enhanced Wide-angle
Observations of the Corona)
SWOC
(Space Weather
Operational
Coronal imager)




EWOC
(Enhanced Wide-angle
Observations of the Corona)
SWOC
(Space Weather
Operational
Coronal imager)

FSI
(Full Sun
Imager)



HRIEUV
(High Resolution
Imager in the EUV)

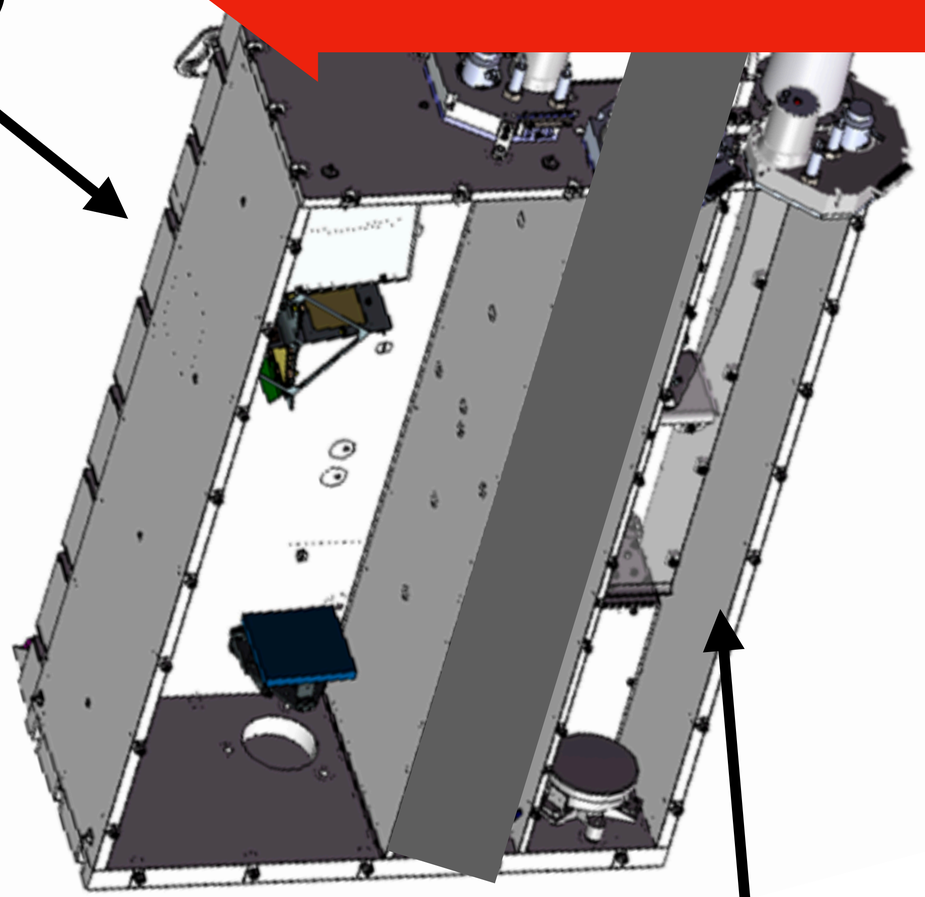
EWOC
(Enhanced Wide-angle
Observations of the Corona)

SWOC
(Space Weather
Operational
Coronal imager)

FSI
(Full Sun
Imager)

S/N EWOCS/FSI: 10-15

EWOC
(Enhanced Wide-angle
Observations of the Corona)

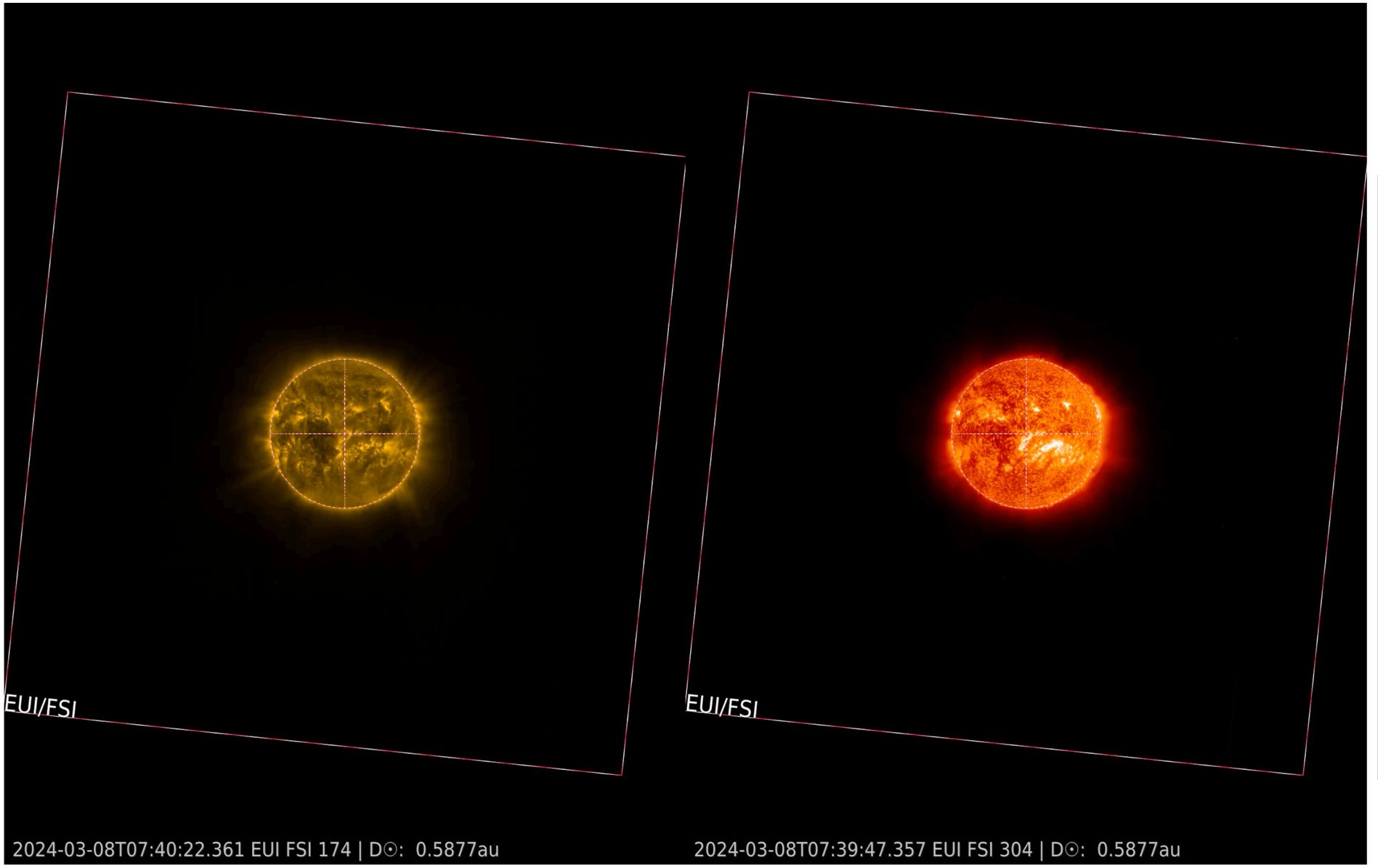


HRIEUV
(High Resolut
Imager in the E

HRIEUV: small FOV & high res;
17.4 nm only
SWOC: full disc & medium res;
13.3, 19.5, 30.4 nm

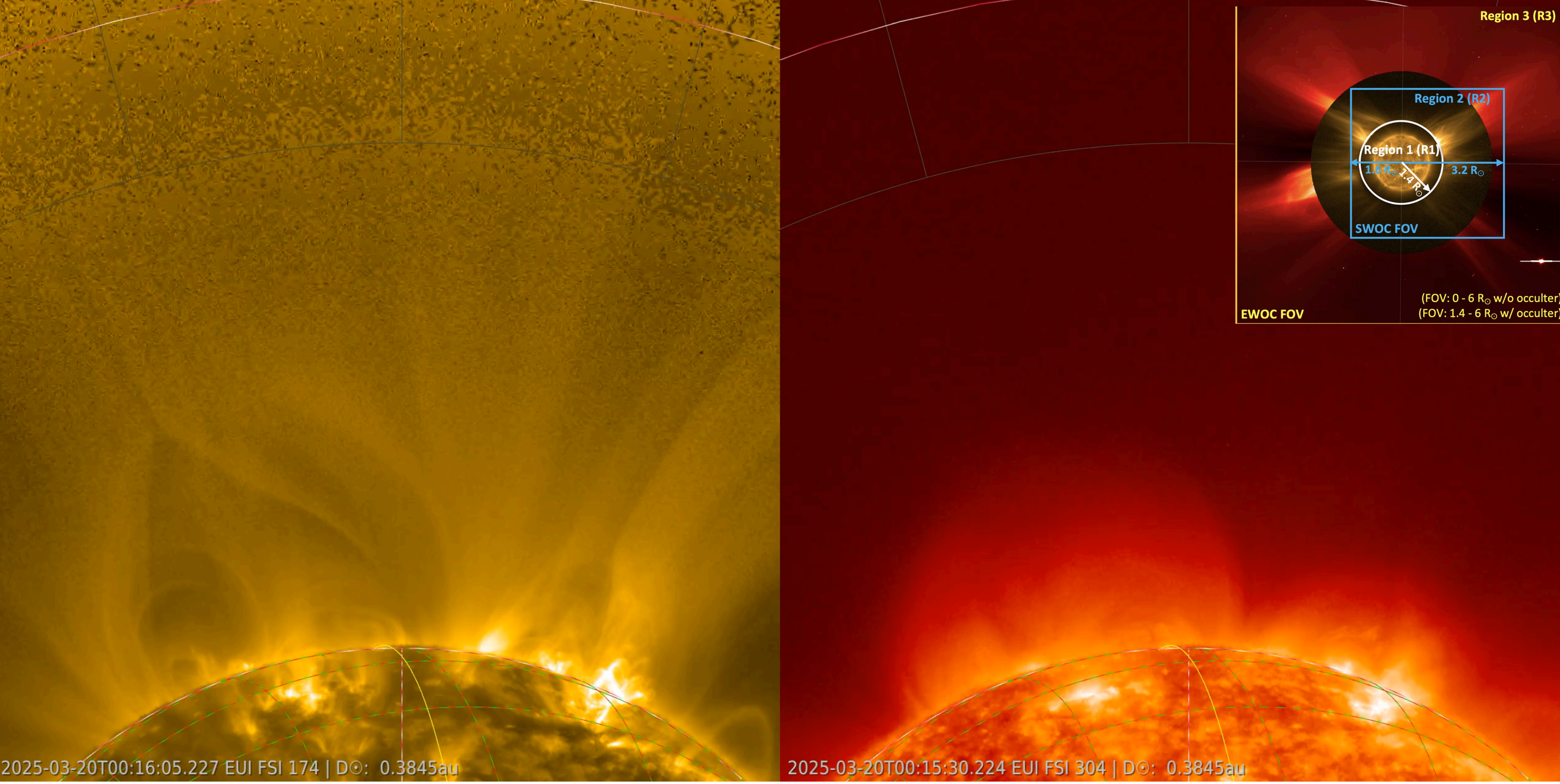
SWOC
(Space Weather
Operational
Coronal imager)

# Full Sun Imager (17.4 & 30.4 nm)

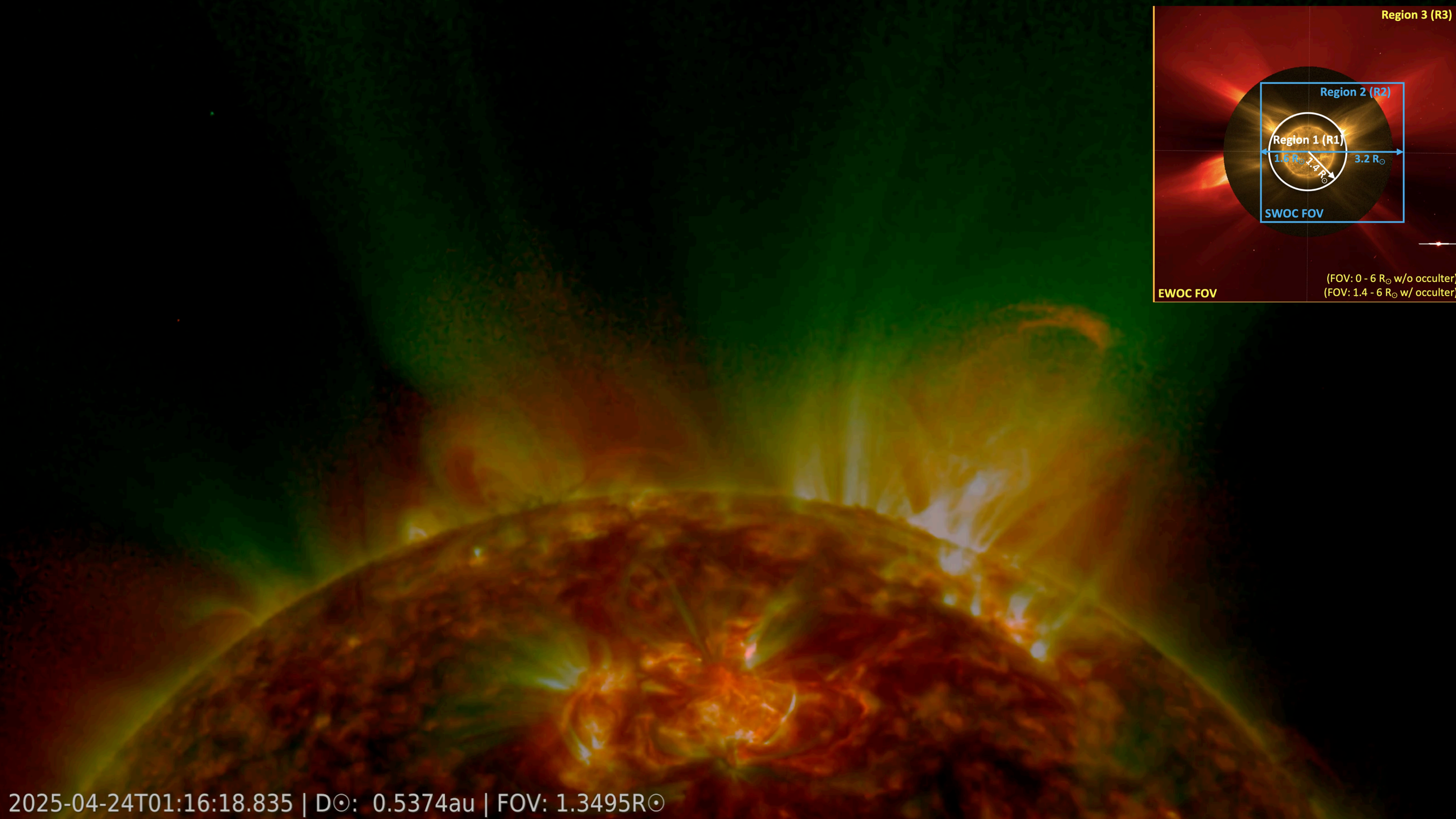



3072x3072 sensor

| | **Aphelion** | **Perihelion** |
|---|---|---|
| FOV | 3.8 deg<br>**>14 Rs** | 3.8 deg<br>**~ 4 Rs** |
| Pixel size | ~4.5 arcsec<br>>**3000km** | ~4.5 arcsec<br>**~1000km** |
| Exposure Time | 10s | |
| Cadence | 30s - 10min | |

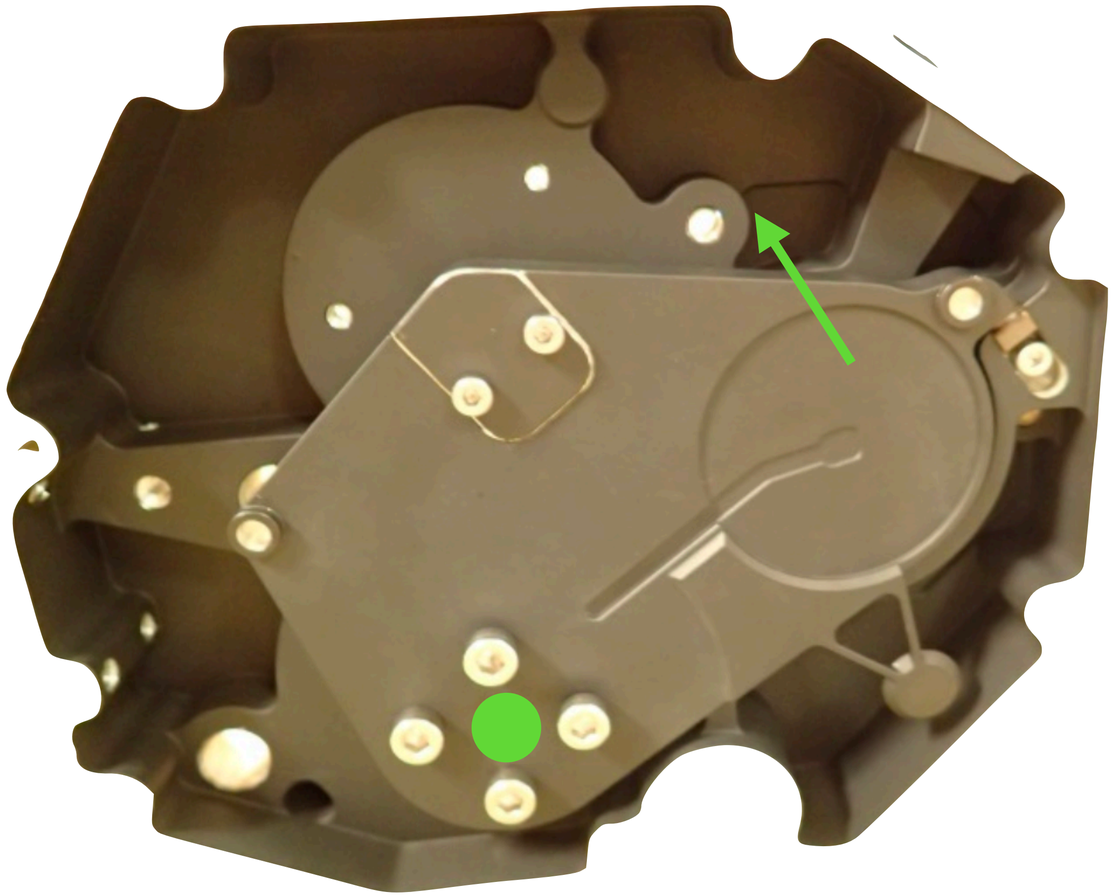


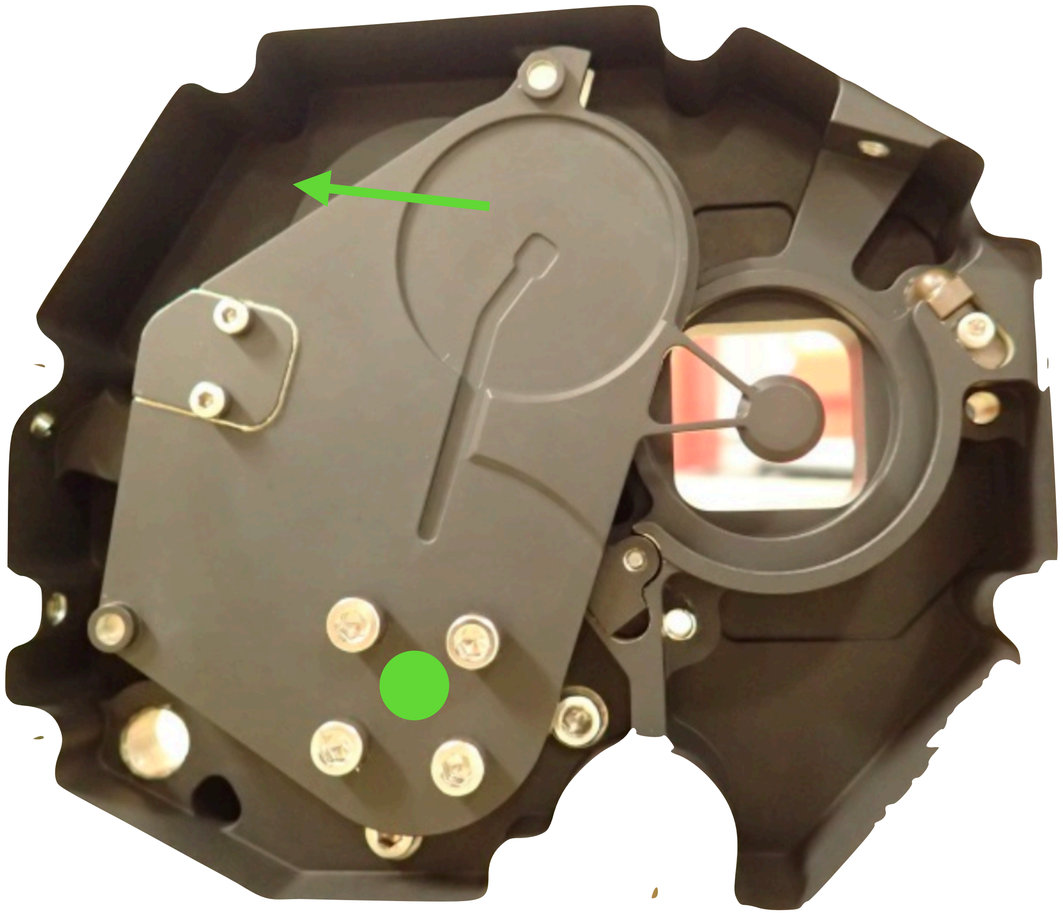

r^3 off-limb enhancer in JHelioviewer applied


Region 3 (R3)
Region 2 (R2)
Region 1 (R1)
1.5 R⊙
1.4 R⊙
3.2 R⊙
SWOC FOV
EWOC FOV
(FOV: 0 - 6 R⊙ w/o occulter)
(FOV: 1.4 - 6 R⊙ w/ occulter)
2025-04-24T01:16:18.835 | D⊙: 0.5374au | FOV: 1.3495R⊙

→ THE EUROPEAN SPACE AGENCY

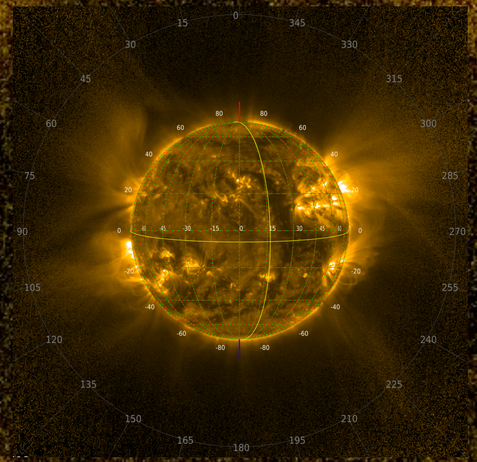
# Camera ‘hack’ lets Solar Orbiter peer deeper into Sun’s atmosphere



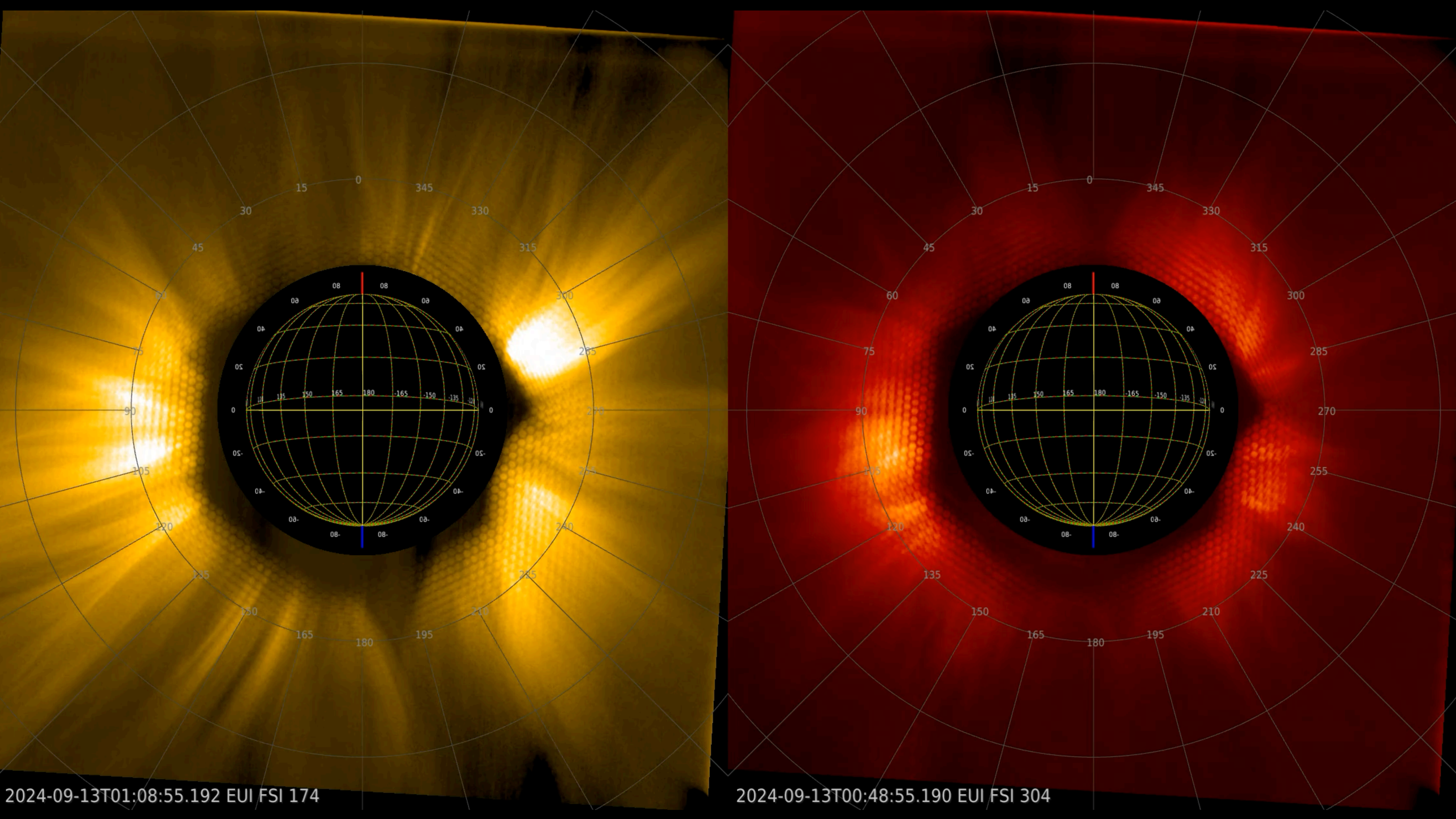


Auchère et al 2023 AA 674 A127

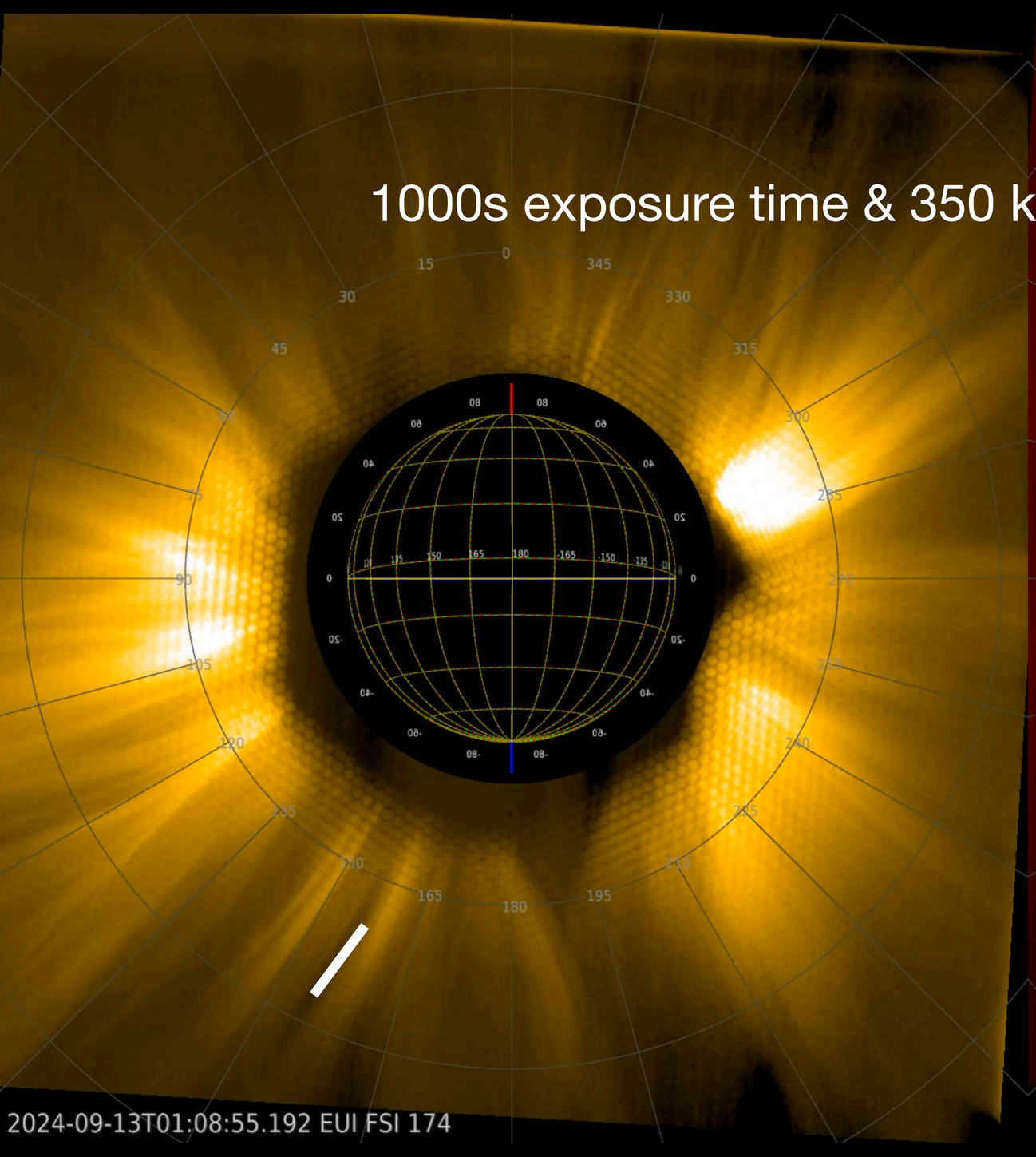
1000s exposure time
HG only
2x2 binned

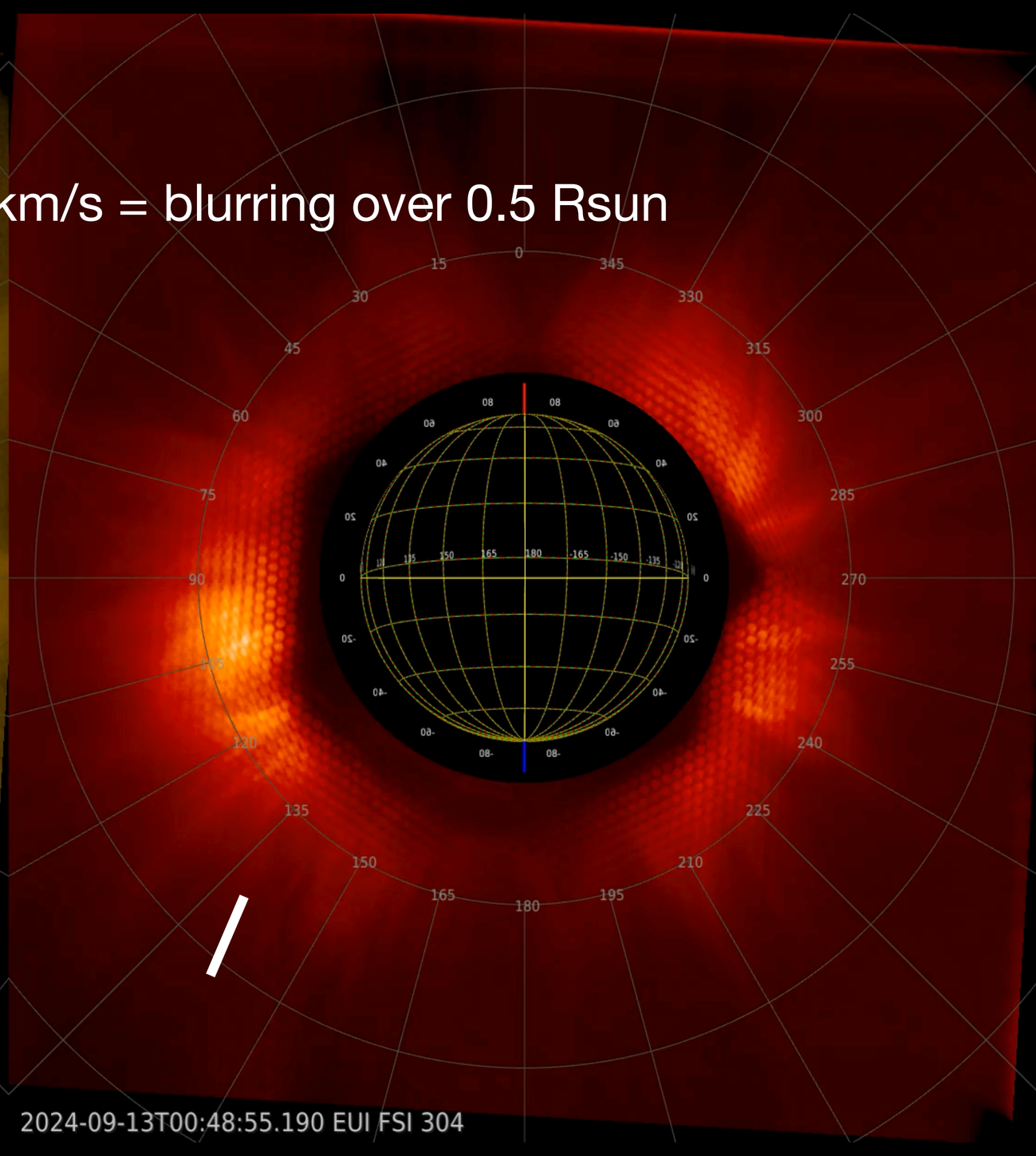



2022-12-05T04:00:55


2024-09-13T01:08:55.192 EUI FSI 174
2024-09-13T00:48:55.190 EUI FSI 304

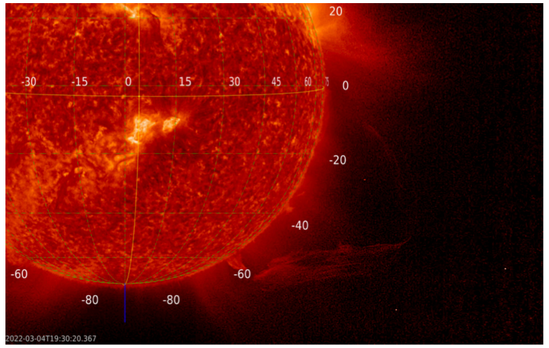
# 1000s exposure time & 350 km/s = blurring over 0.5 Rsun

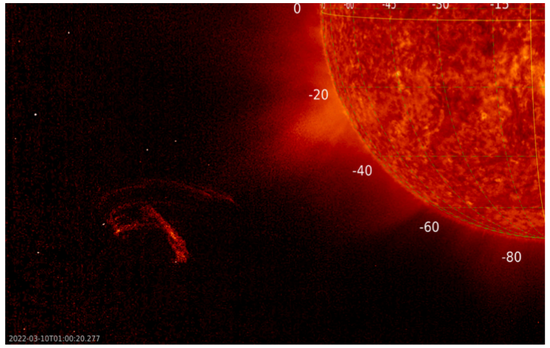


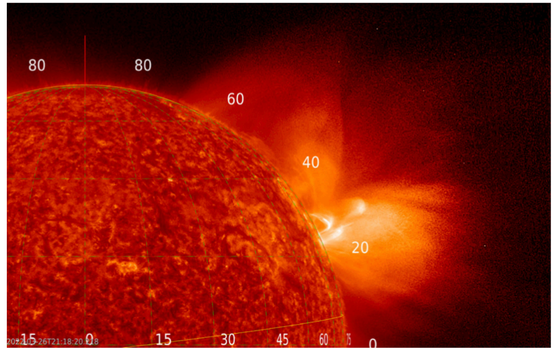



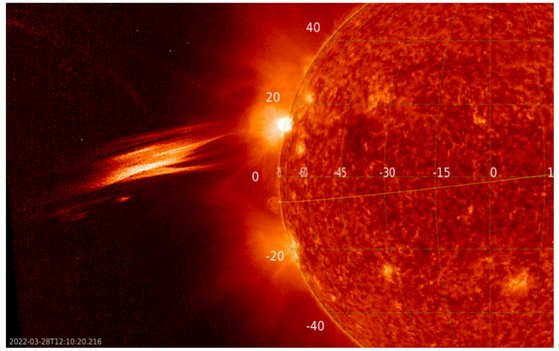
https://www.sidc.be/EUI/solar-eruptions

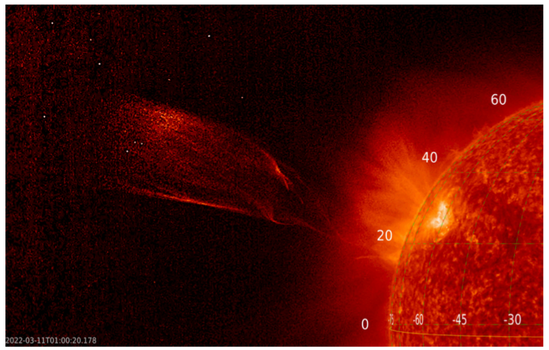
# 2022 March eruptions

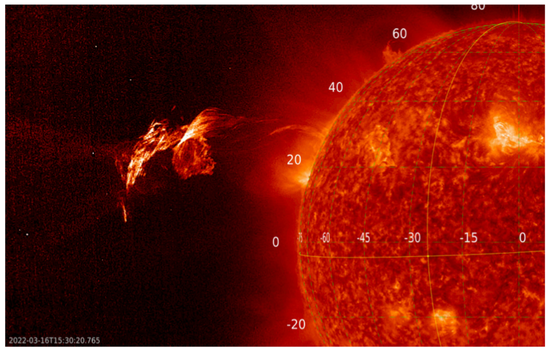


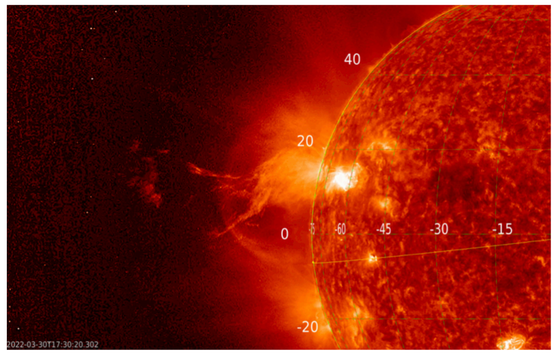



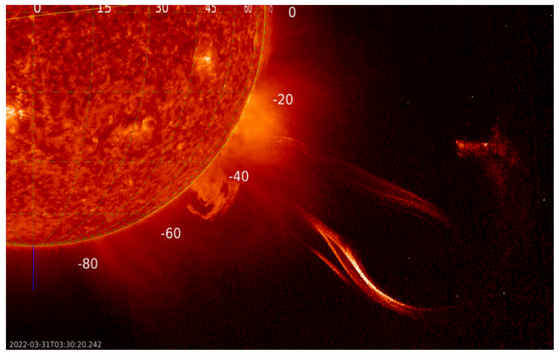



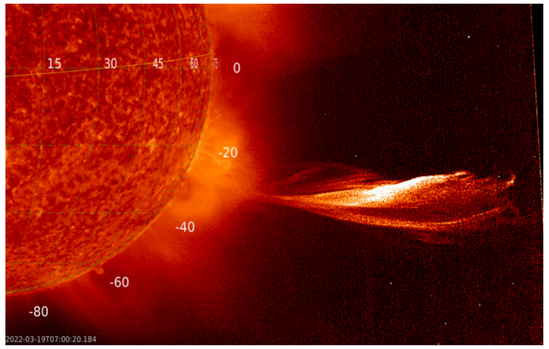


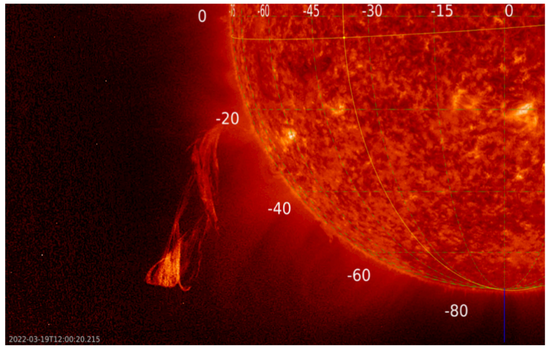



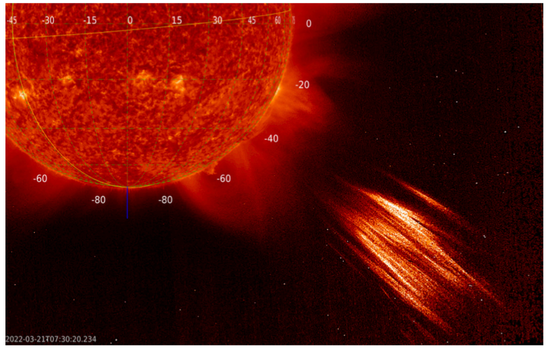



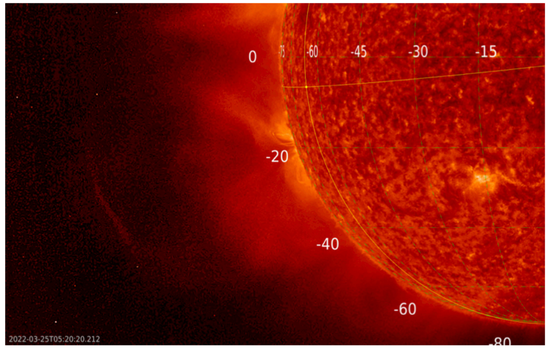



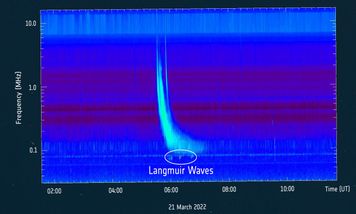



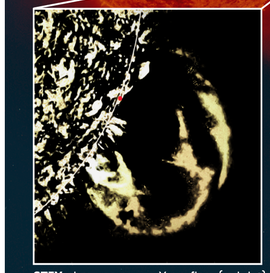

## JOINING THE DOTS

Solar Orbiter traced an energetic particle event on 21 March 2022 from the Sun through the solar wind



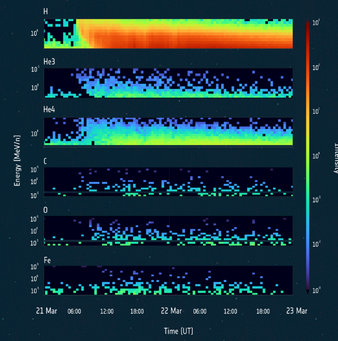

**RPW** detects radio signals of accelerated particles and plasma oscillations

Particles spiraling out on Sun's magnetic field lines reach Solar Orbiter



**STIX** observes source X-ray flare (red dot), **EUI** a shock wave (green)

EUI: Extreme Ultraviolet Imager
EPD: Energetic Particle Detector
RPW: Radio and Plasma Waves
STIX: X-ray Spectrometer/ Telescope

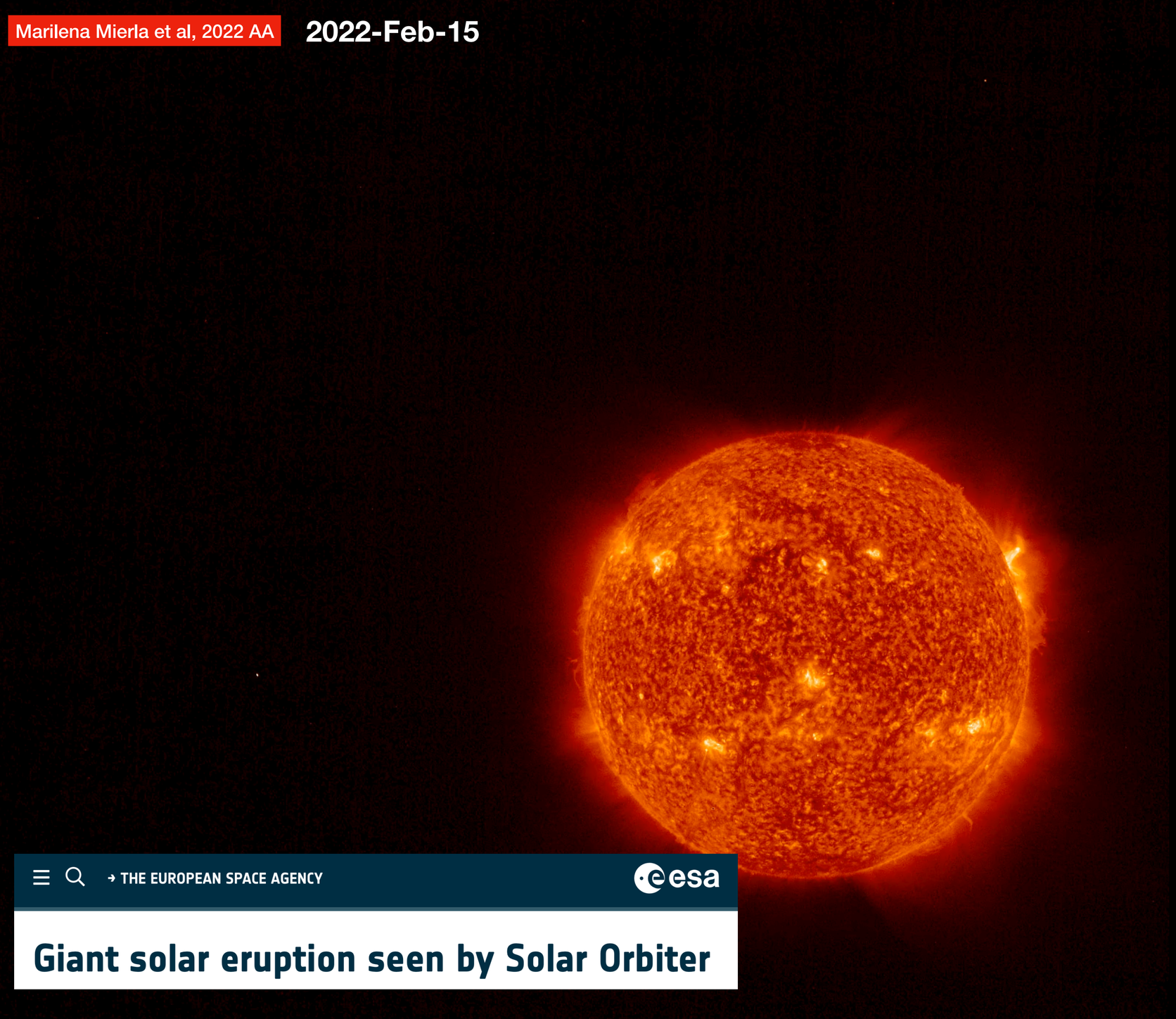



**EPD** detects particles with various composition and energy

ESA & NASA/Solar Orbiter/EPD, EUI, RPW & STIX Teams

Marilena Mierla et al, 2022 AA

2022-Feb-15



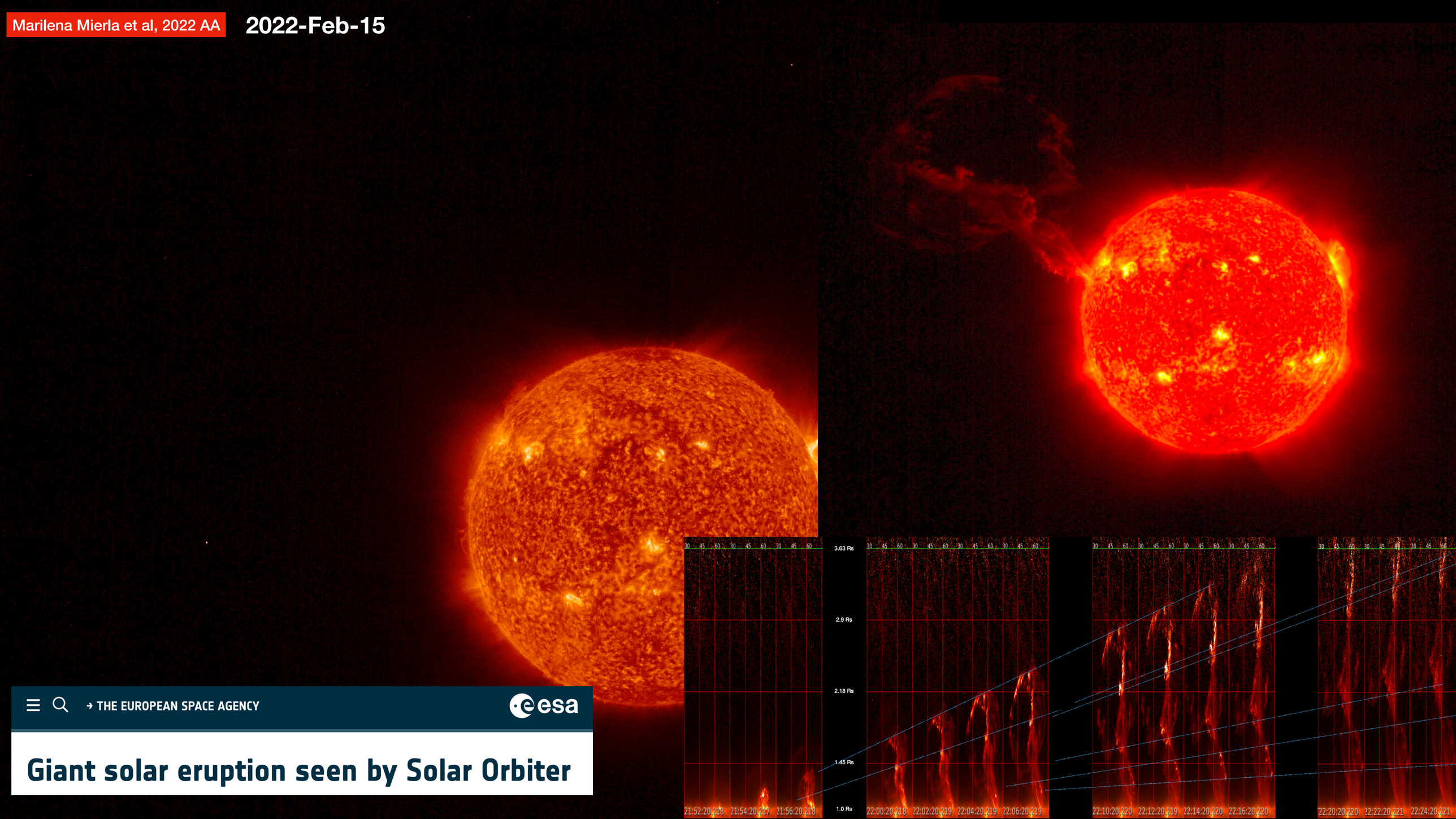
→ THE EUROPEAN SPACE AGENCY

esa

# Giant solar eruption seen by Solar Orbiter

Marilena Mierla et al, 2022 AA

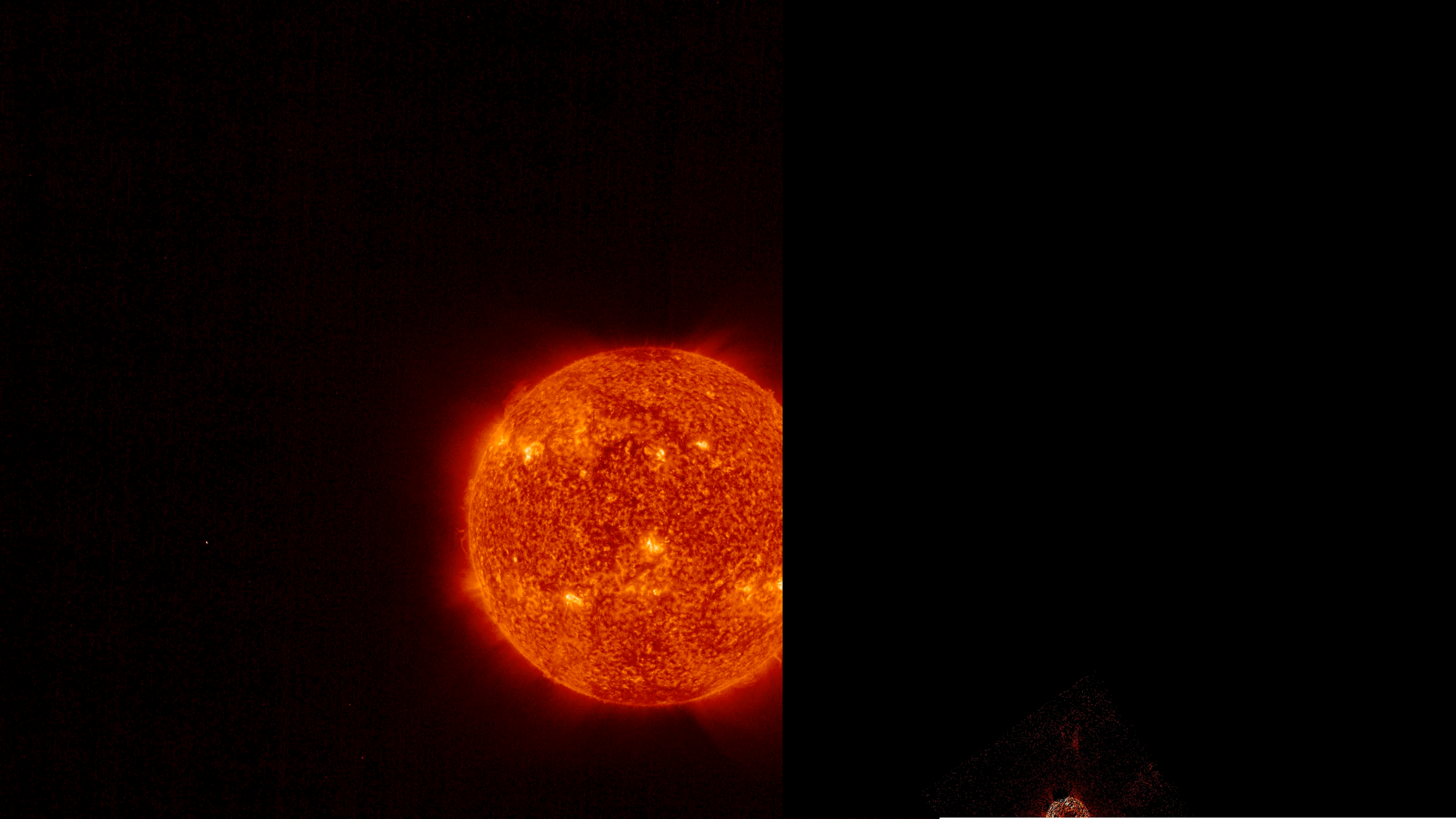
2022-Feb-15



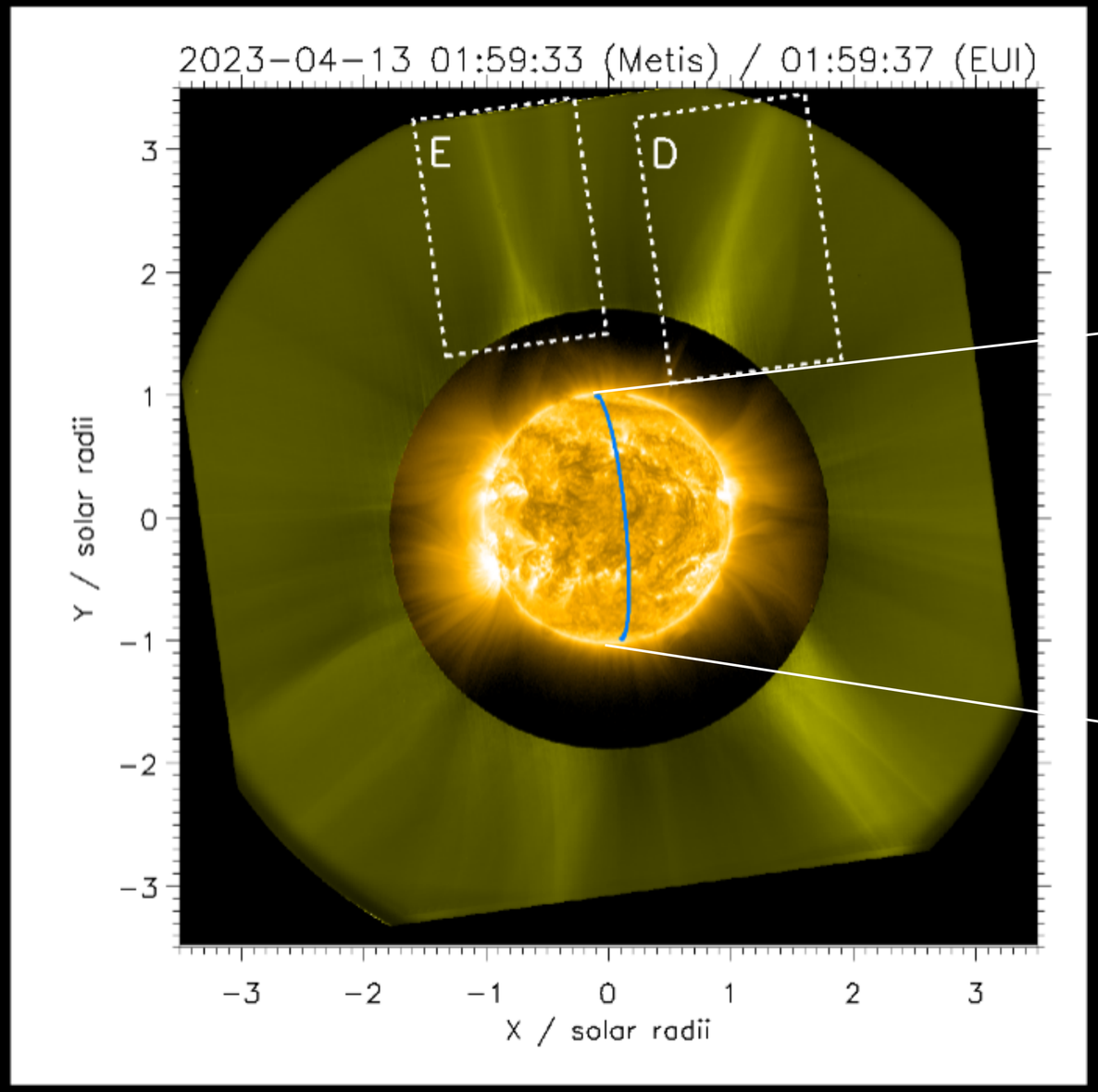

→ THE EUROPEAN SPACE AGENCY

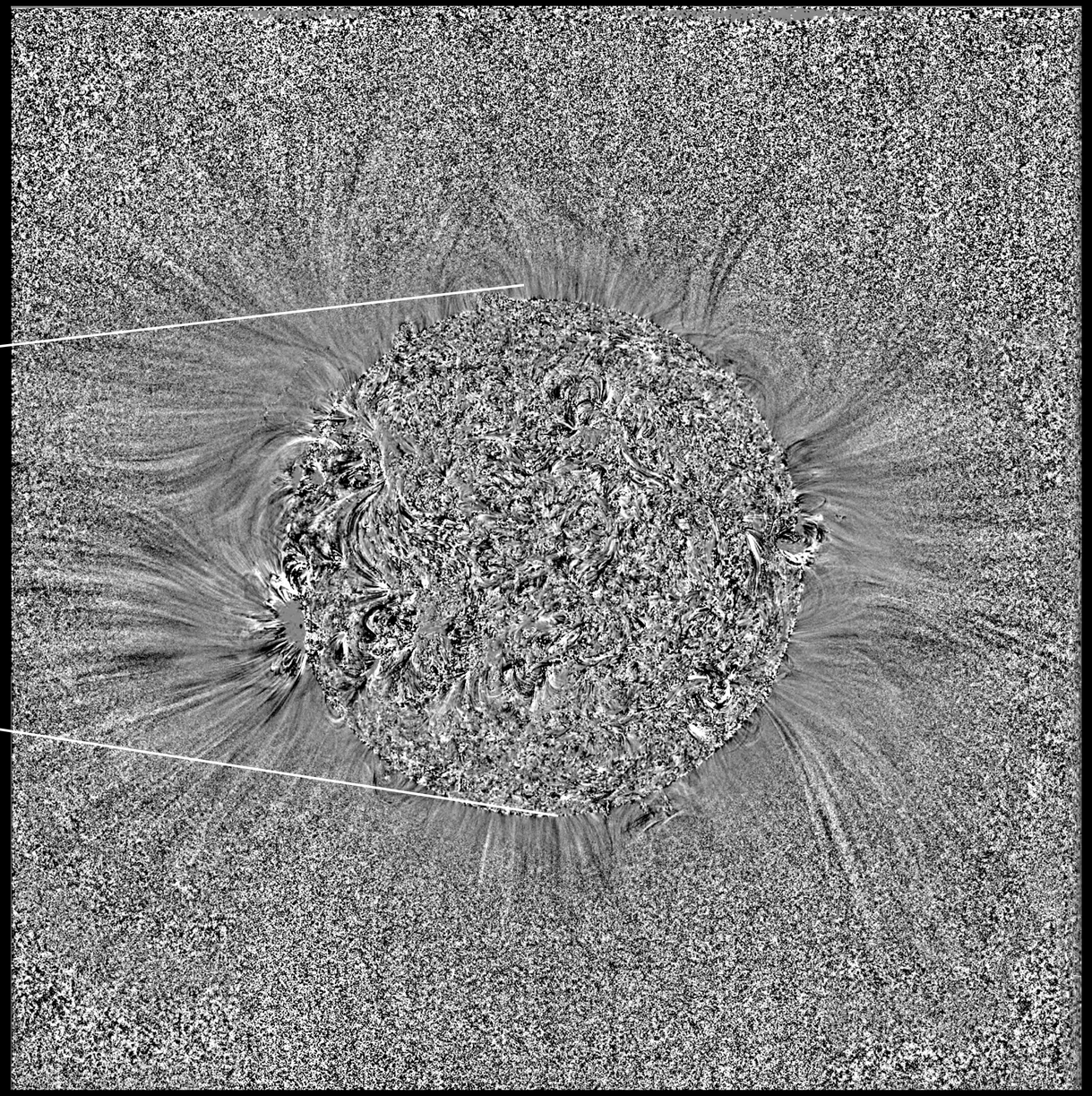
esa

# Giant solar eruption seen by Solar Orbiter



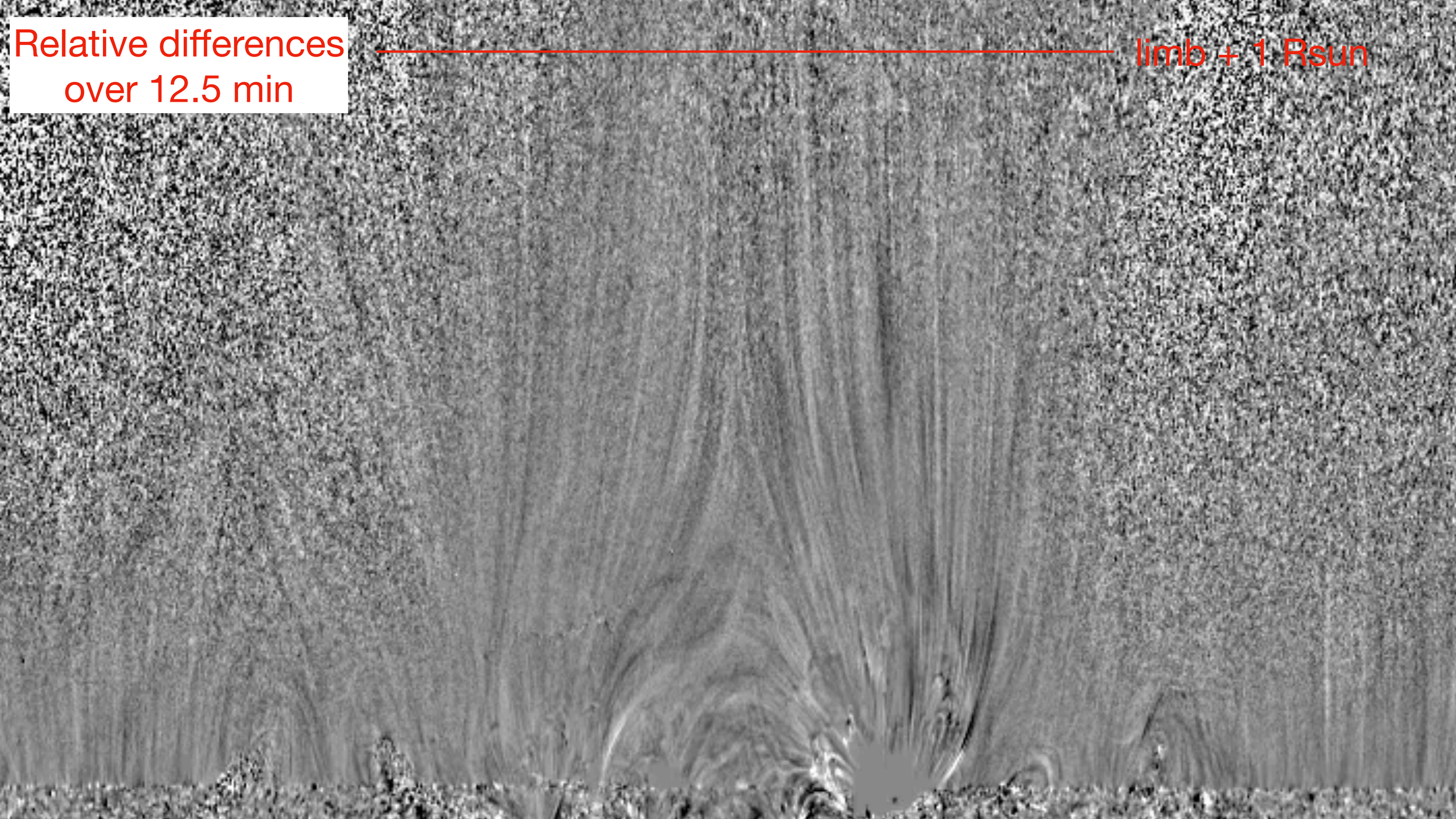
# 2023-04-13 Density Fluctuations SOOP

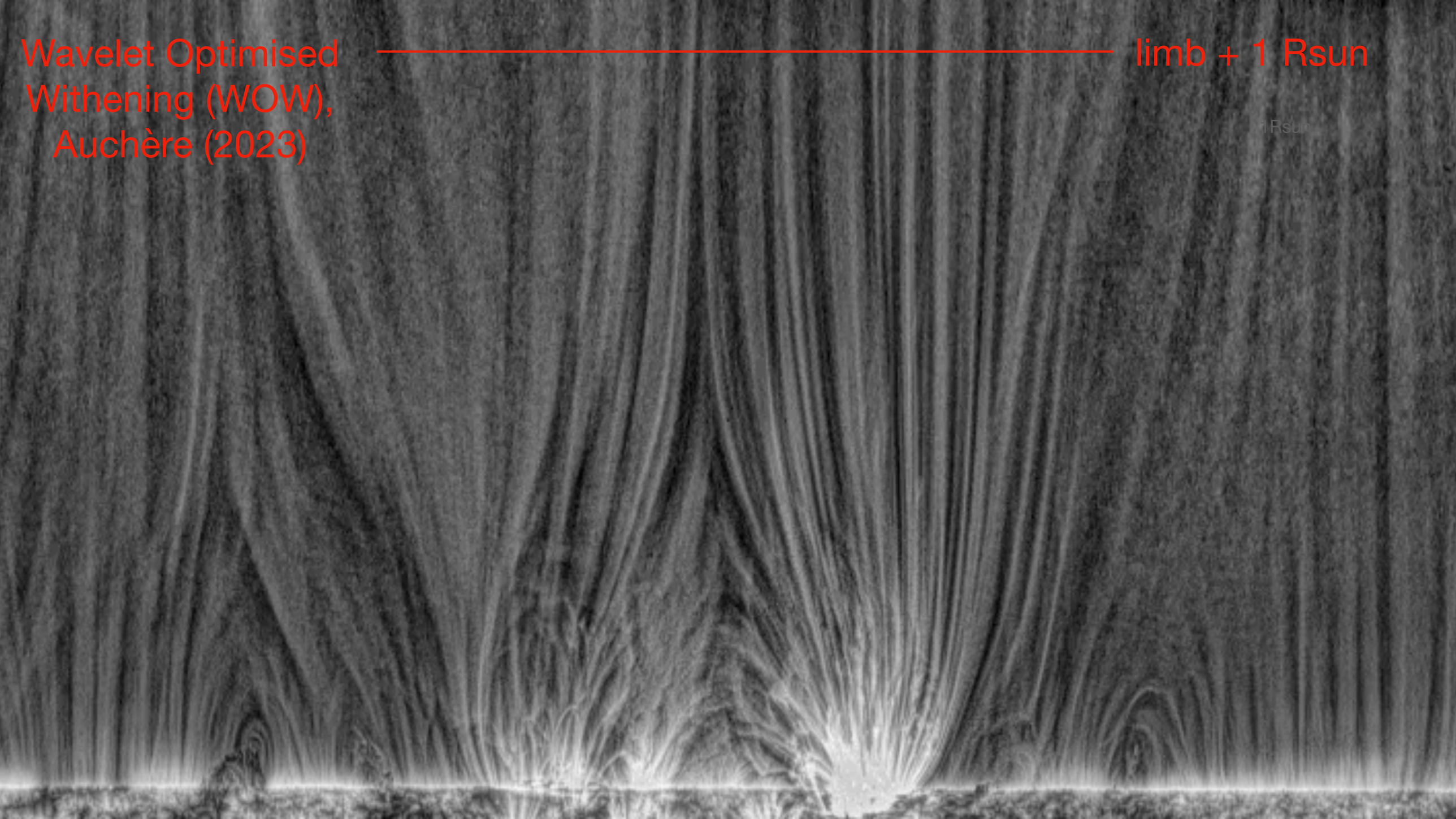


METIS , V. Andretta (2024) in preparation

EUI/FSI-17.4nm , 2x exposure time

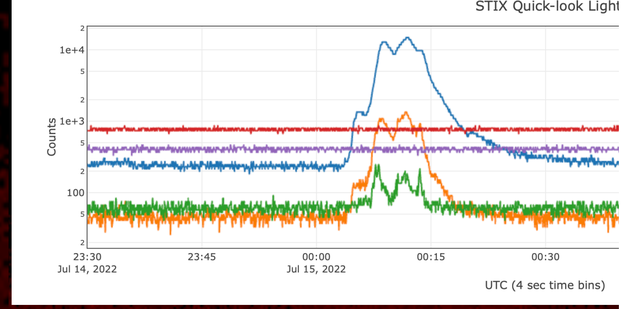

Relative differences
over 12.5 min
limb + 1 Rsun

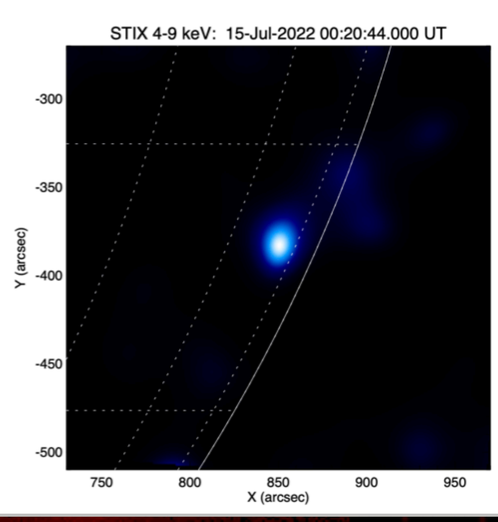

Wavelet Optimised Withening (WOW), Auchère (2023)
limb + 1 Rsun
1 Rsun

2023-01-06
alternating 0.2s/10s

Emil
Kraaikamp

2022 July 15




10s exposure

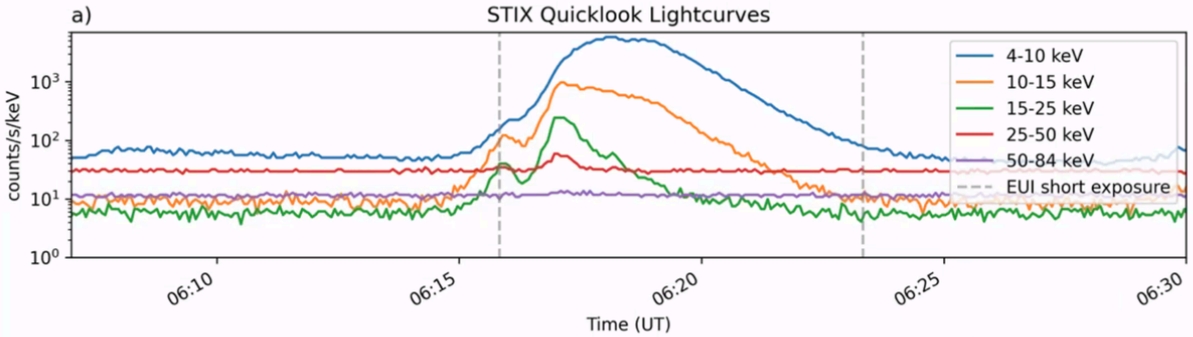
saturation at 32000 DN

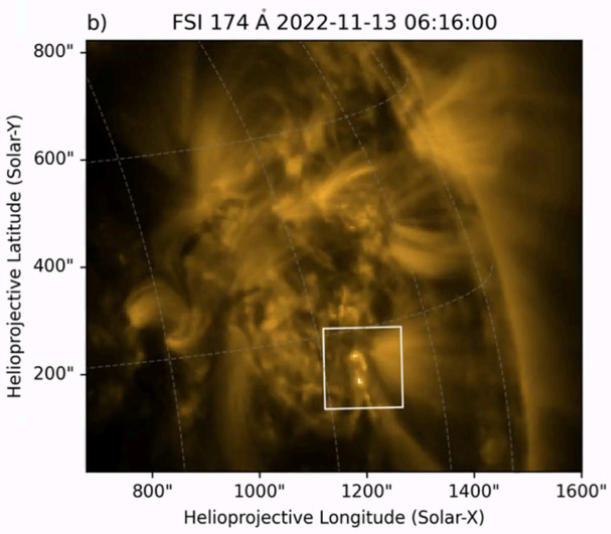
0.2s exposure

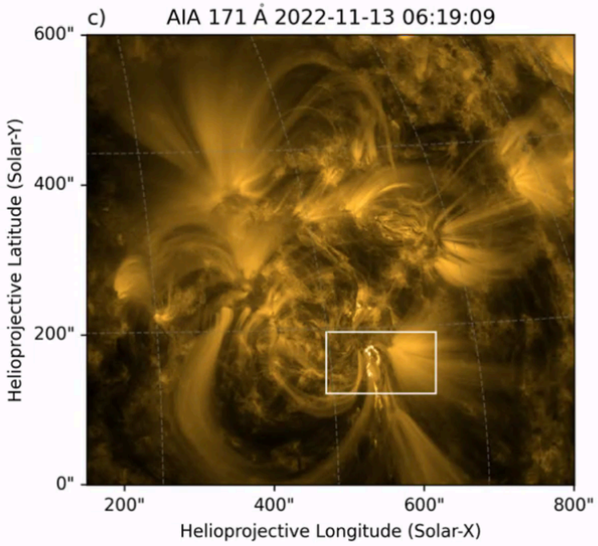
2556 DN

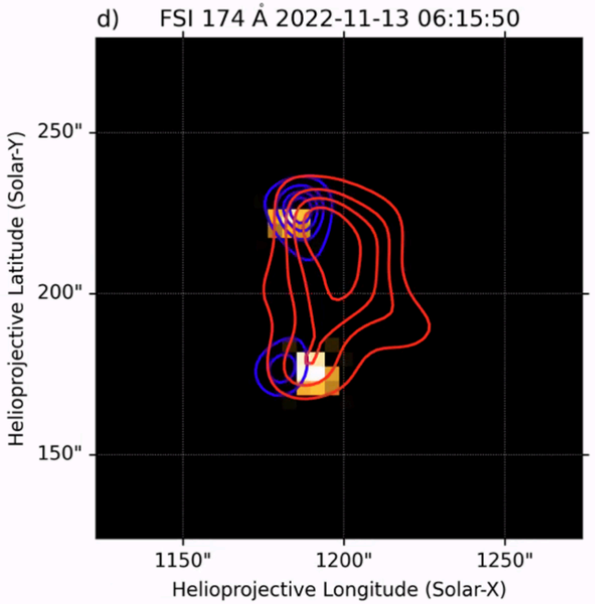
*(127800 DN in 10 s)*

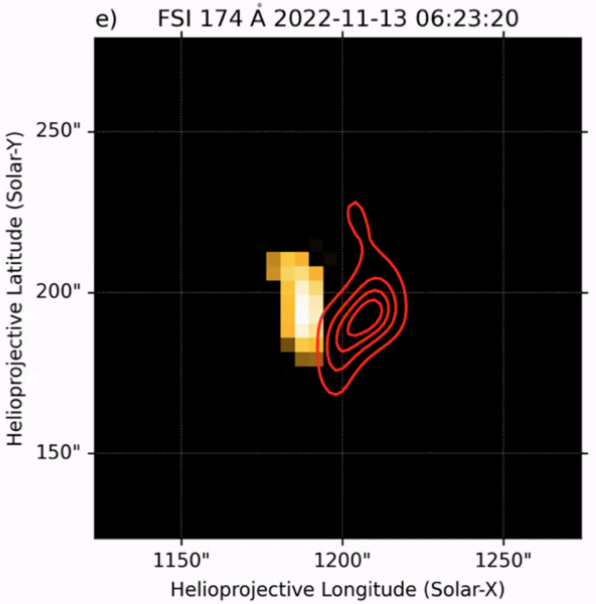
# A simple flare




**20-76 keV**

**6-10 keV**

Laura Hayes, Sam Krucker, Hannah Collier, Dan Ryan

# 3. Aging

# EUI doors

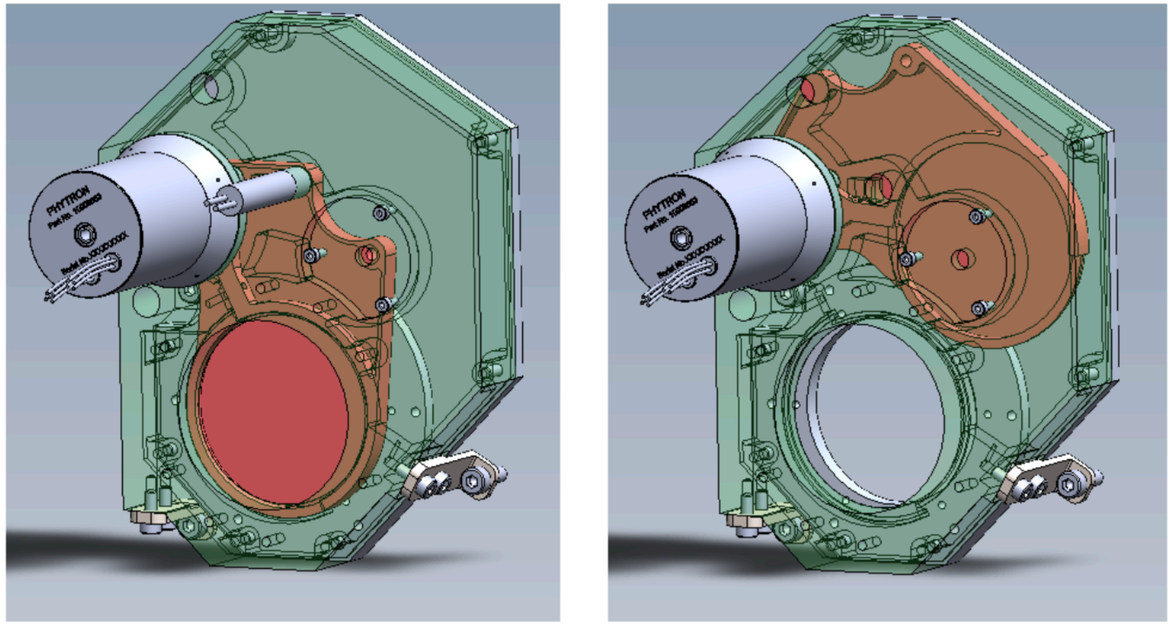


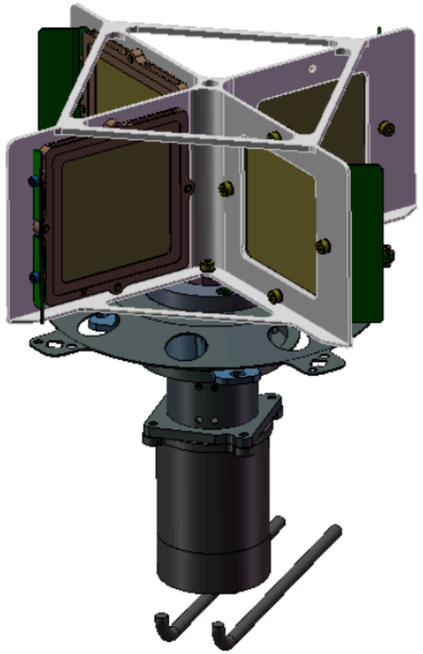
Figure 2.81: Layout of EUI $HRI_{Ly\text{-}\alpha}$ door assembly; closed (left) and open (right).

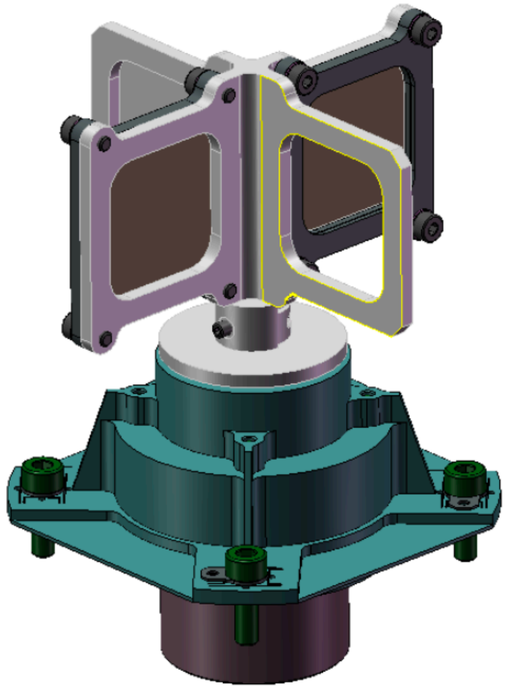
EUI QM door was tested for 5760 open/door cycles (= qualification for 720 open/close cycles.).

The status on 2025 April 7 was

- FSI door: 80 open/close cycles performed
- EUV door: 200 open/close cycles performed
- LY door: 84 open/close cycles performed

# EUI Filter Wheels

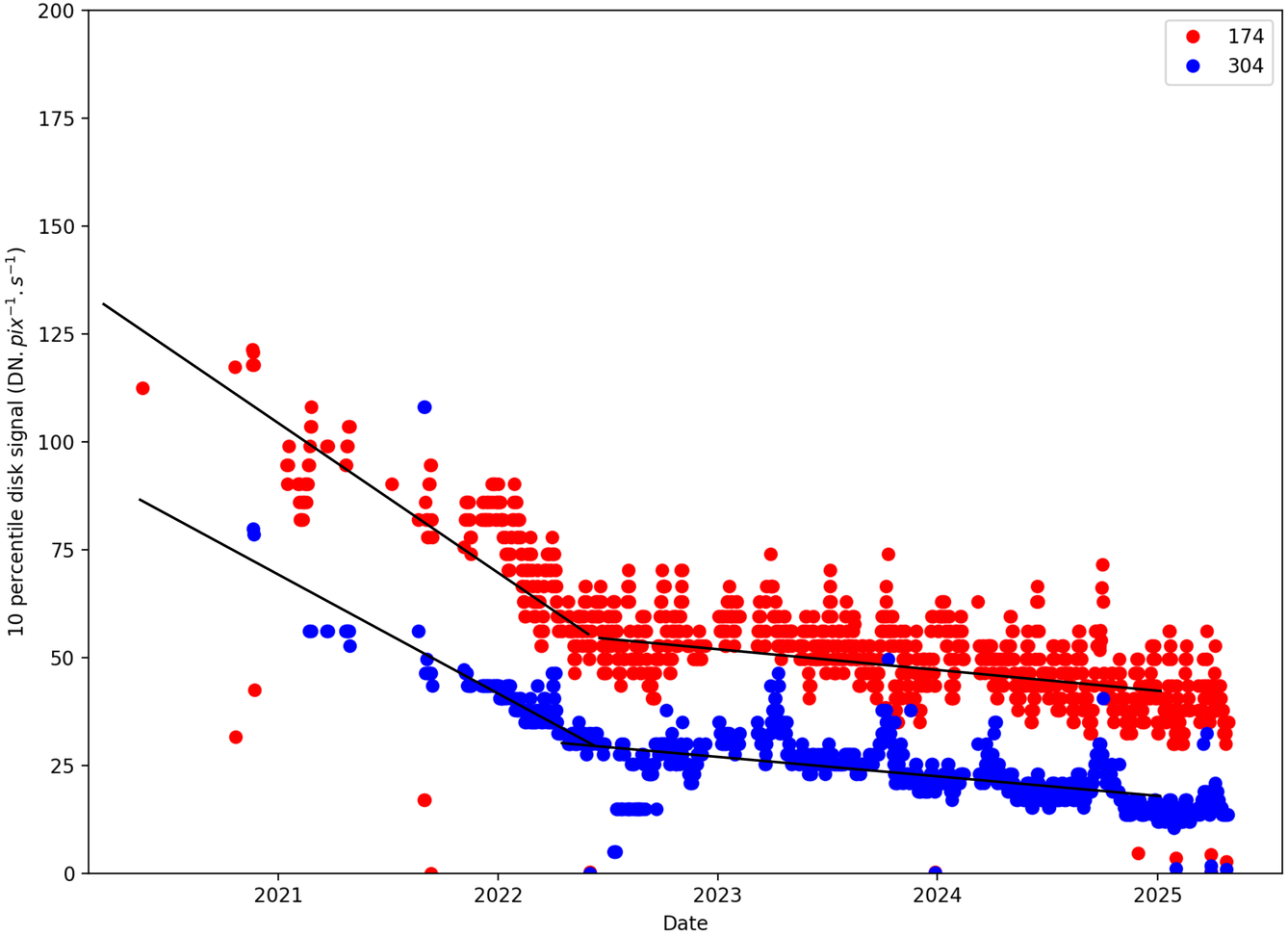


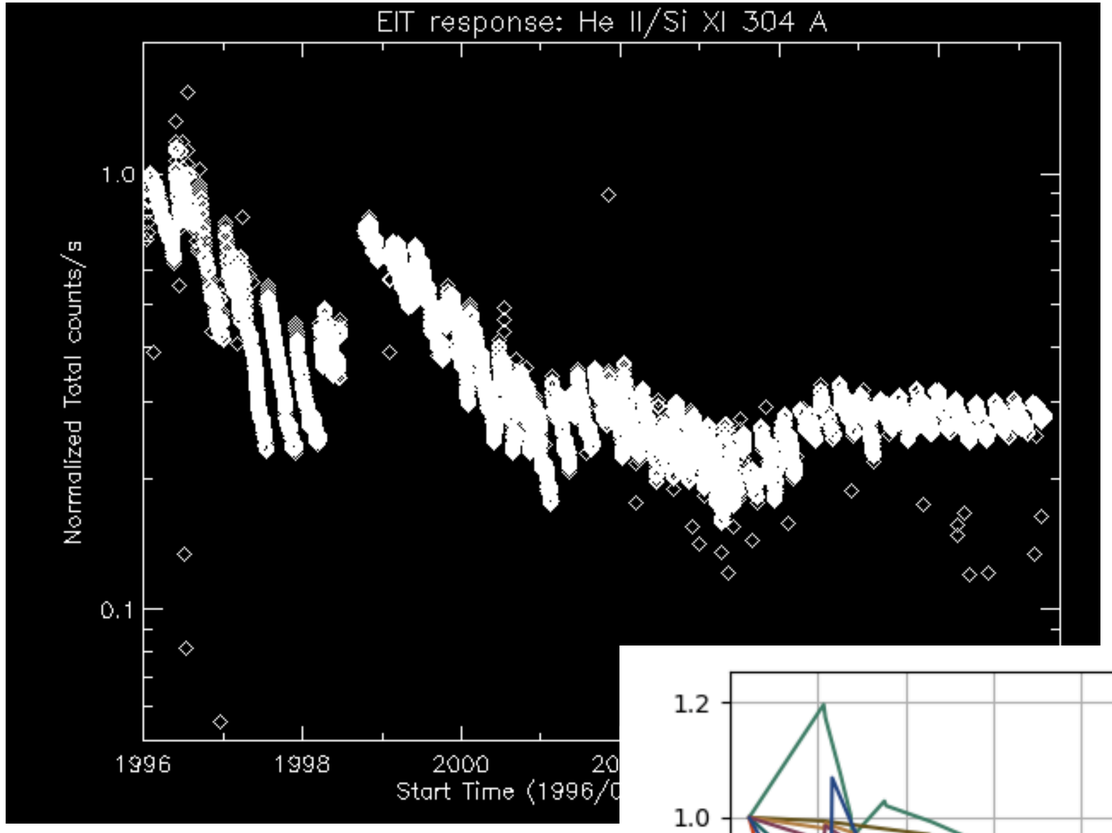


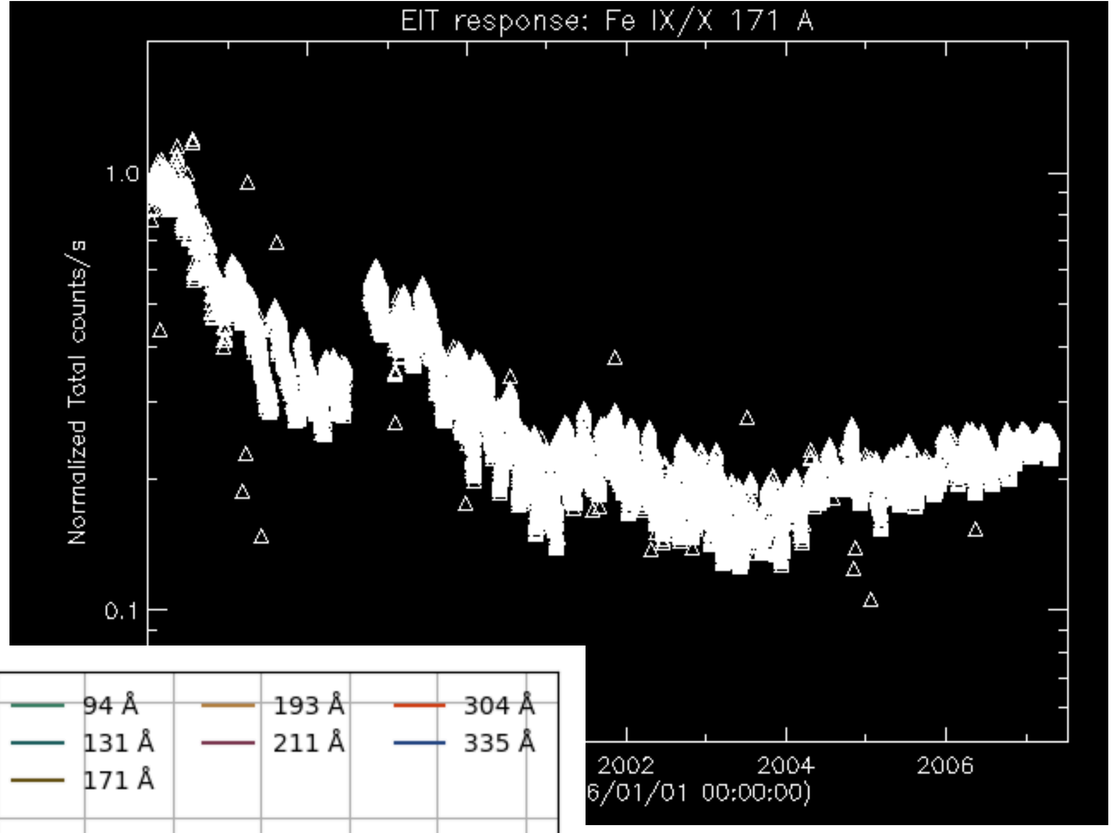
| | Full rotations tested on the ground | Full rotations operated in space (2025 April 7) |
|---|---|---|
| FSI filter wheel | 250000 | 127907 |
| HRIEUV filter wheel | 1000 | 382 |

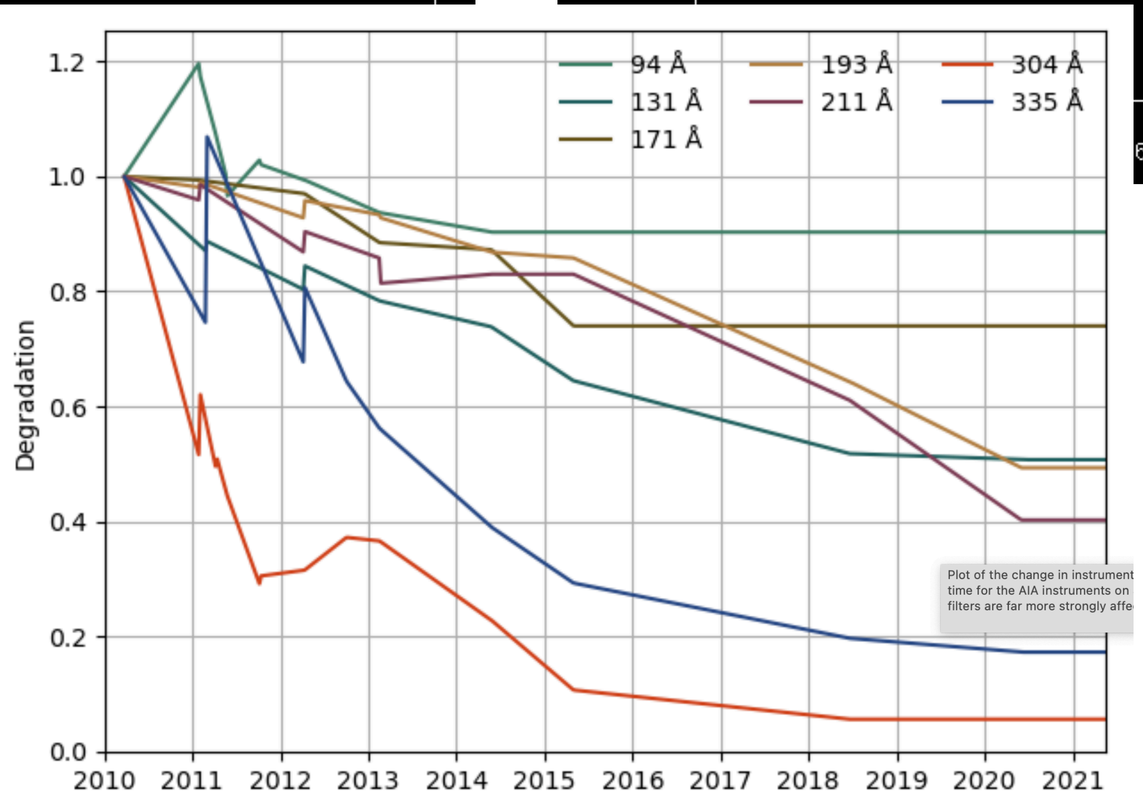
Figure 2.25: EUI FSI (left) and $\mathrm{HRI_{EUV}}$ (right) filter wheels.

# FSI response degradation

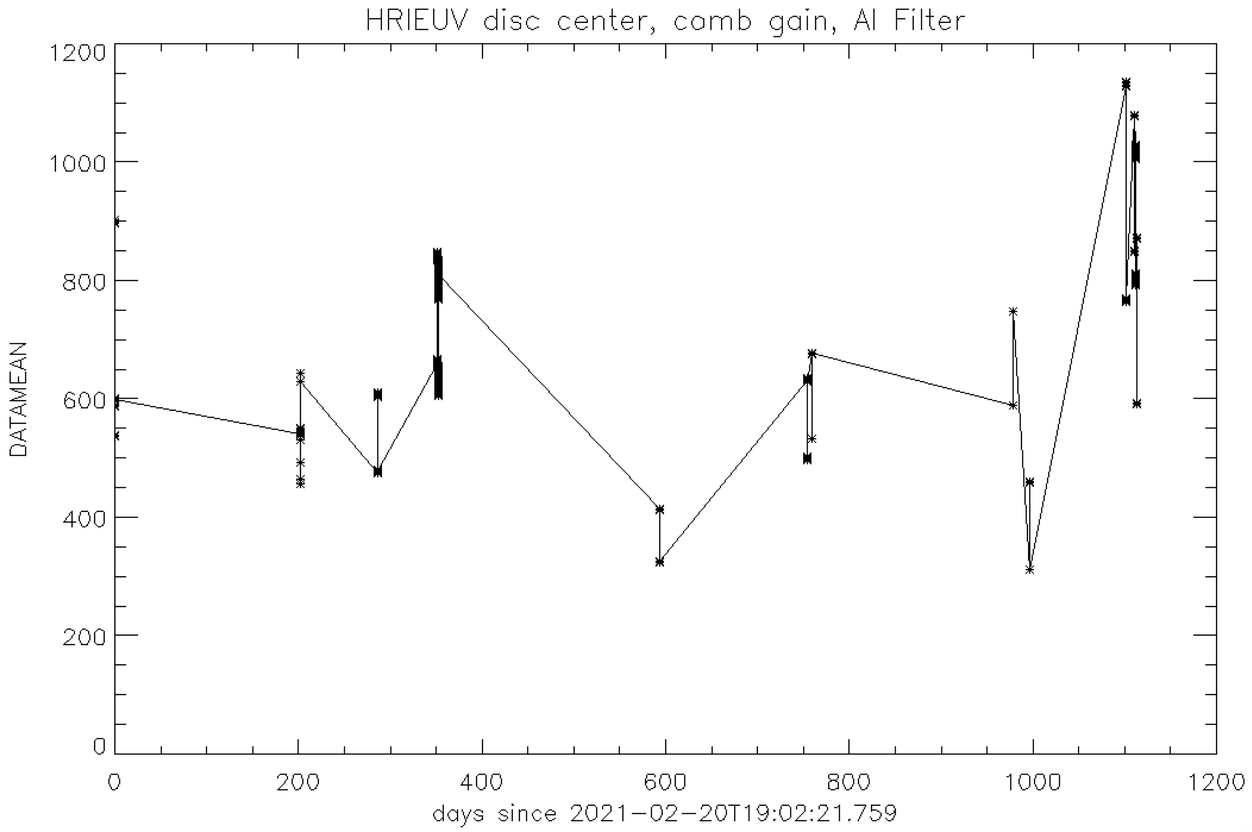




EIT response: He II/Si XI 304 A
Normalized Total counts/s
1.0
0.1
1996
1998
2000
Start Time (1996/0


EIT response: Fe IX/X 171 A
Normalized Total counts/s
1.0
0.1
2002
2004
2006
6/01/01 00:00:00)


94 Å
131 Å
171 Å
193 Å
211 Å
304 Å
335 Å
Degradation
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Plot of the change in instrument
time for the AIA instruments on
filters are far more strongly affe

# 4. Channel response degradation: HRIEUV



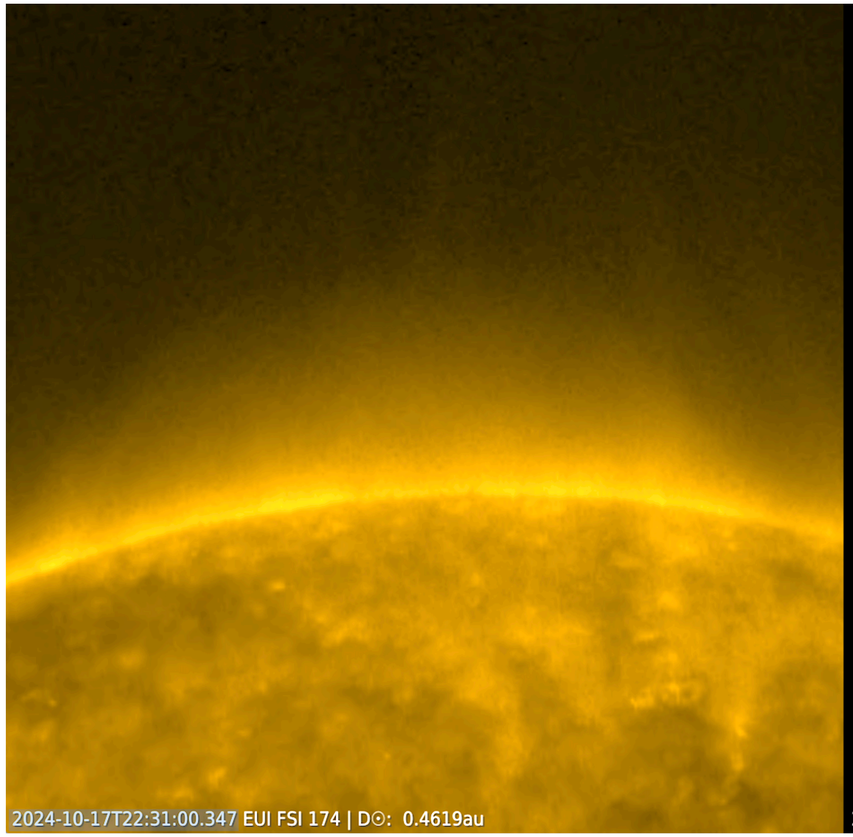

No obvious degradation can be seen in average HRIEUV solar signals but this can be obscured by variable scenes and increasing solar activity. Average HRIEUV LED signals go down by 0.5% for every perihelion but this could also be due to LED aging.

The typical FSI synoptic program (two 10s exposures per 10 min) results in ~300 hours exposure/year.

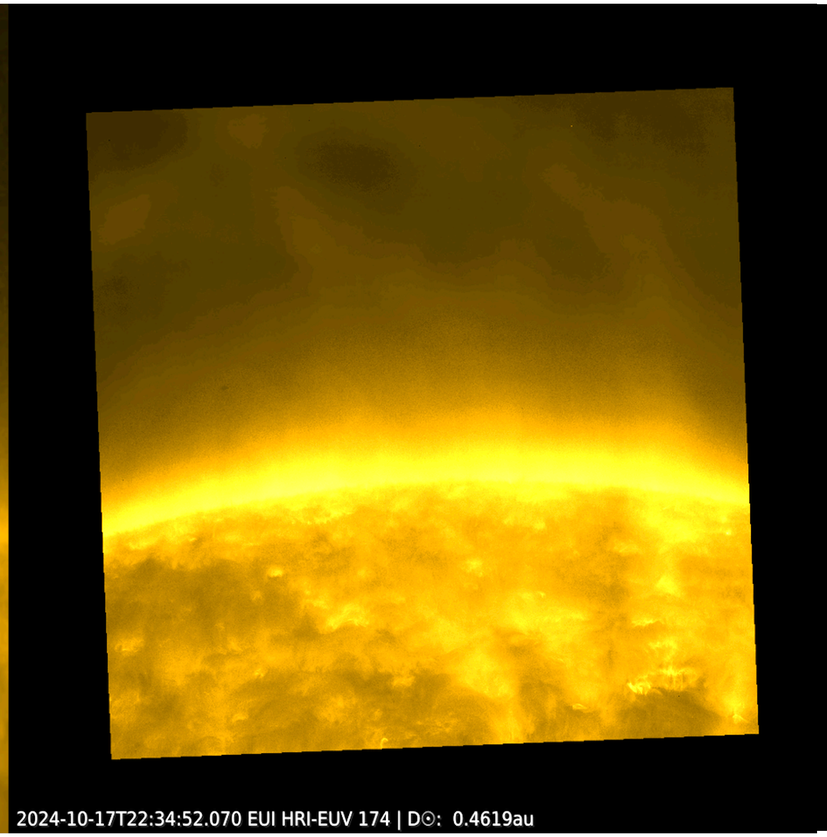
The typical HRIEUV campaigns of 1h/day limited to RSWs results  in ~60 hours exposure/year.

# Front filter pinholes

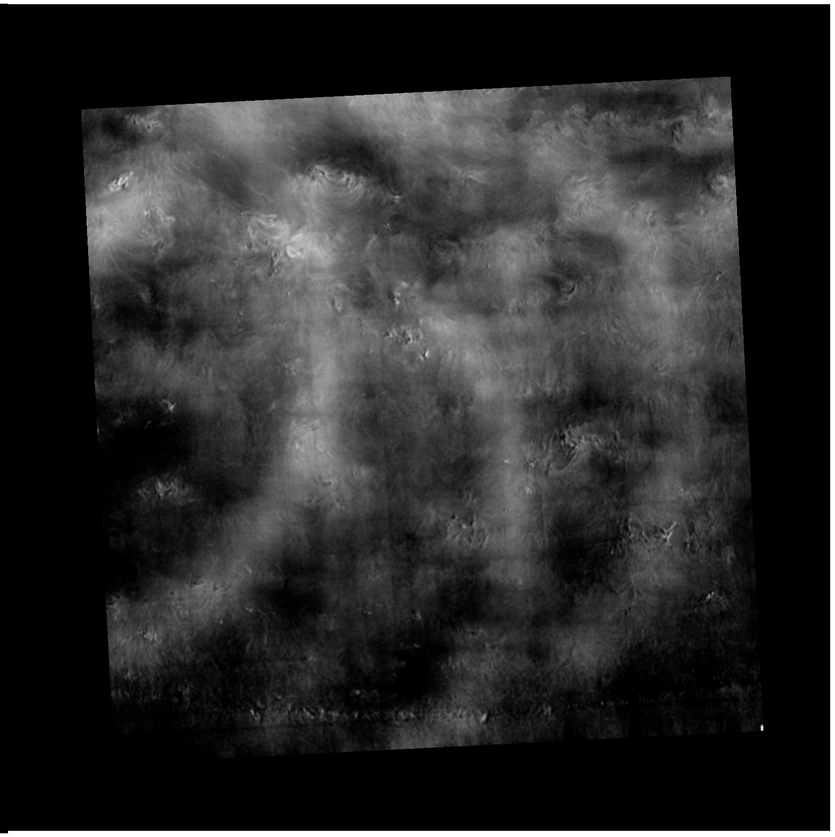
FSI




HRIEUV

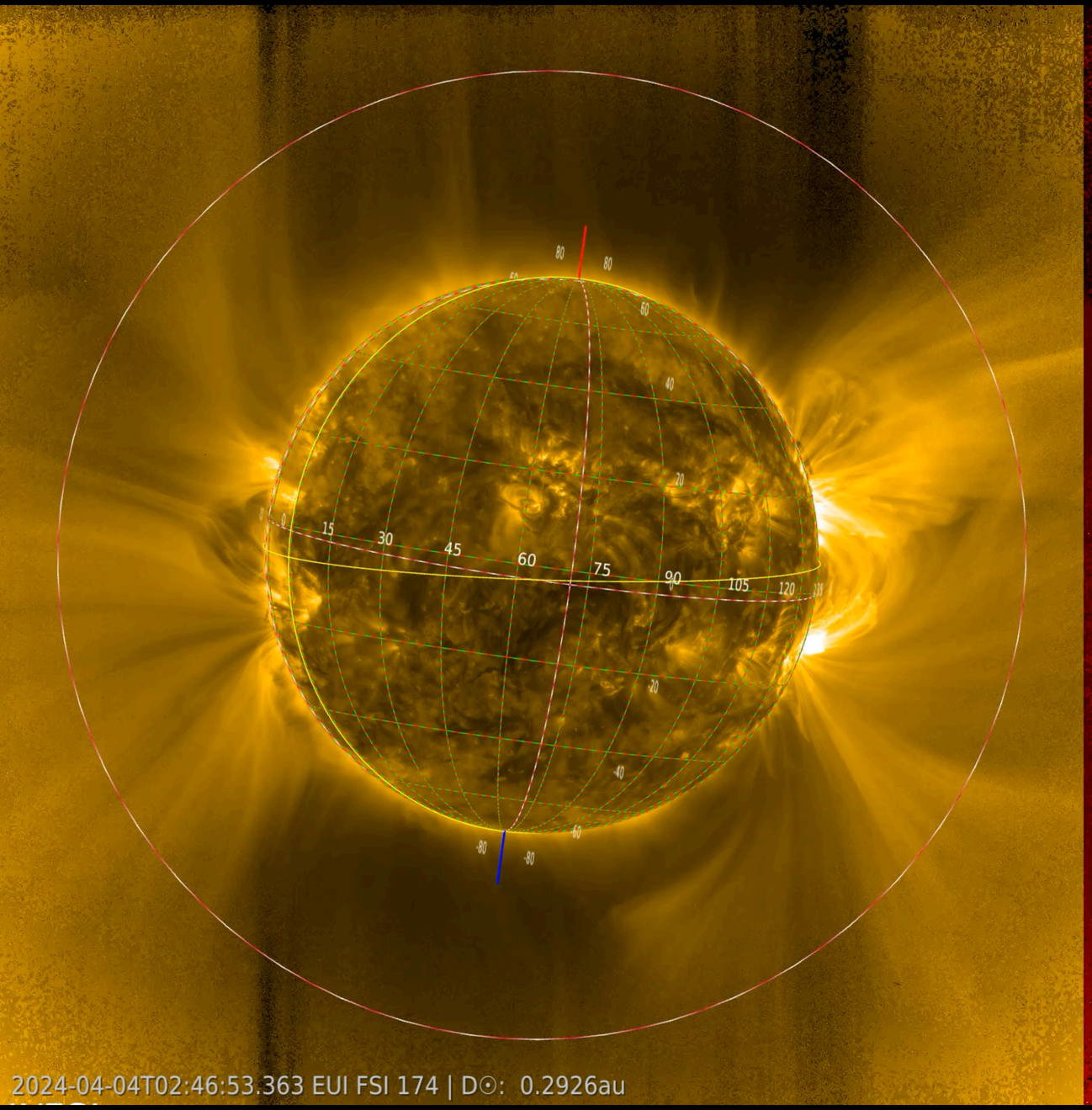


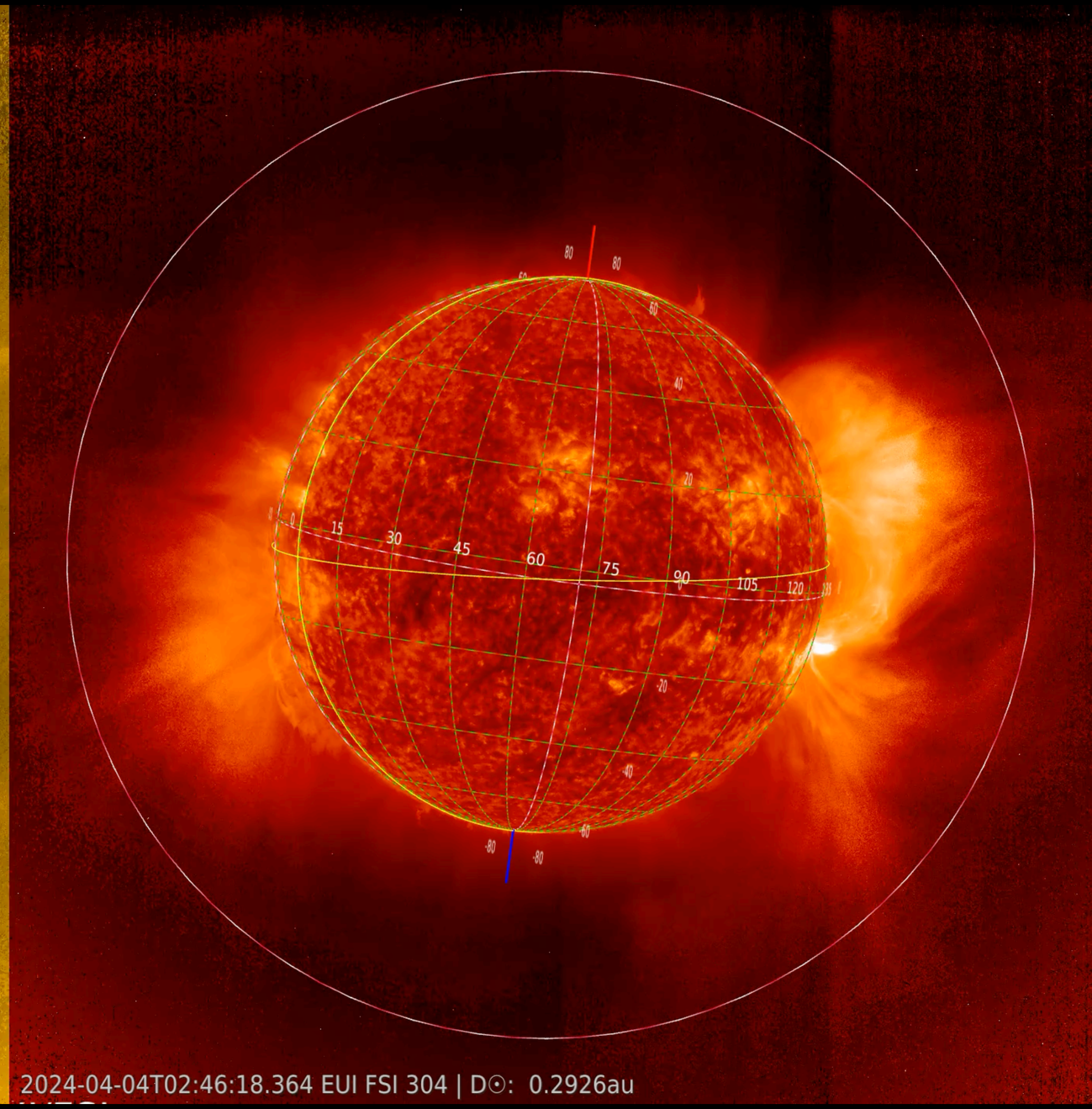

Delta

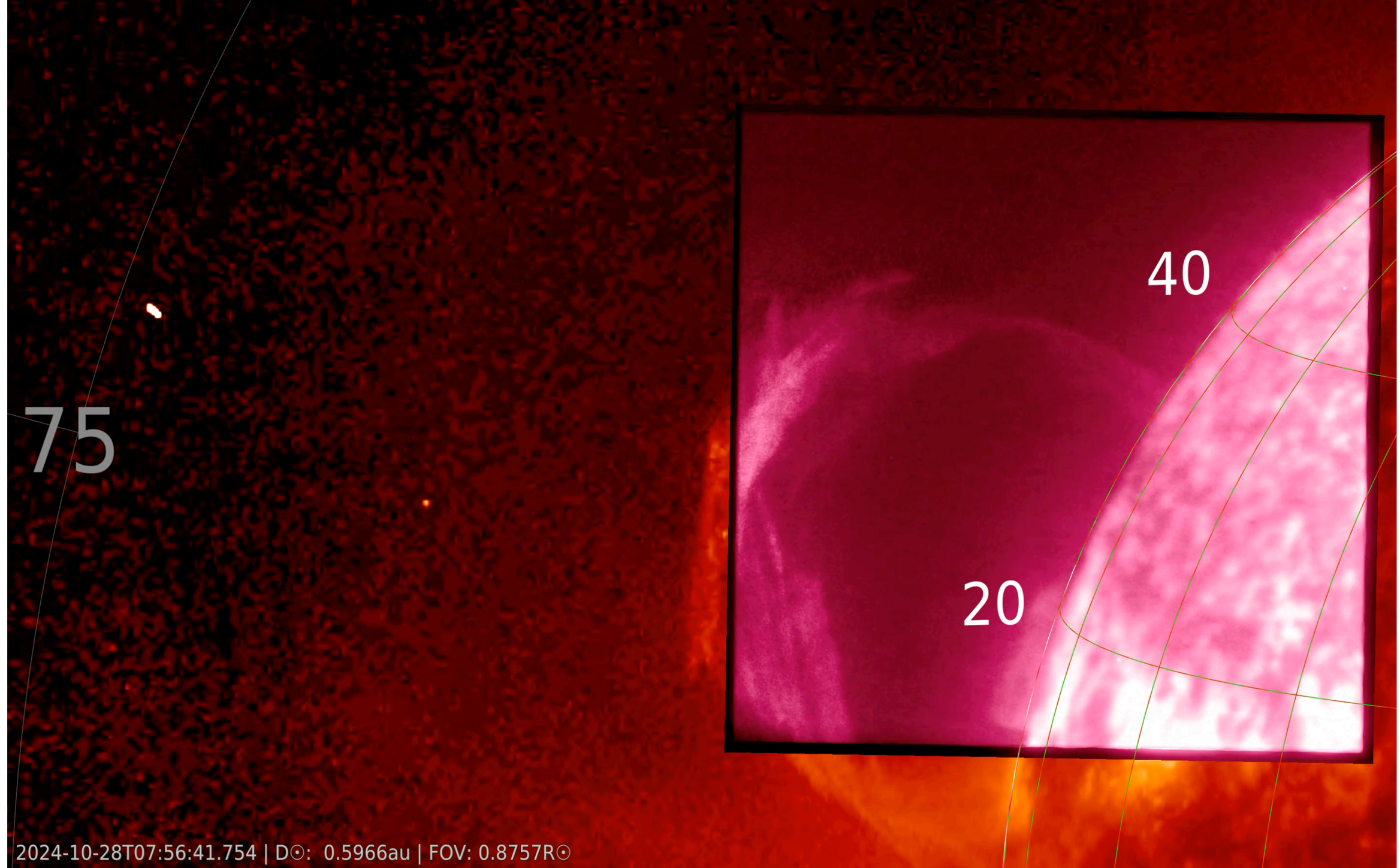


# Wrap-up

- JEDI will see more particles than EUI, because it is outside the spacecraft
- Because S/N of JEDI > S/N of EUI:
  - JEDI will be able to trace back the internal motions of an erupting flux rope
  - JEDI will trace the outflows/waves into the solar wind
- Denoising / spatial filters are important
- Short exposures+ aggressive compression make flare people happy
- EUI has survived 5 years in space, degradation is flattening for FSI. Pinholes…


2024-04-04T02:46:53.363 EUI FSI 174 | D☉: 0.2926au


2024-04-04T02:46:18.364 EUI FSI 304 | D☉: 0.2926au


75
40
20
2024-10-28T07:56:41.754 | D⊙:  0.5966au | FOV: 0.8757R⊙