ZOOMING IN ON THE CORONAL POLES WITH SOLAR ORBITER

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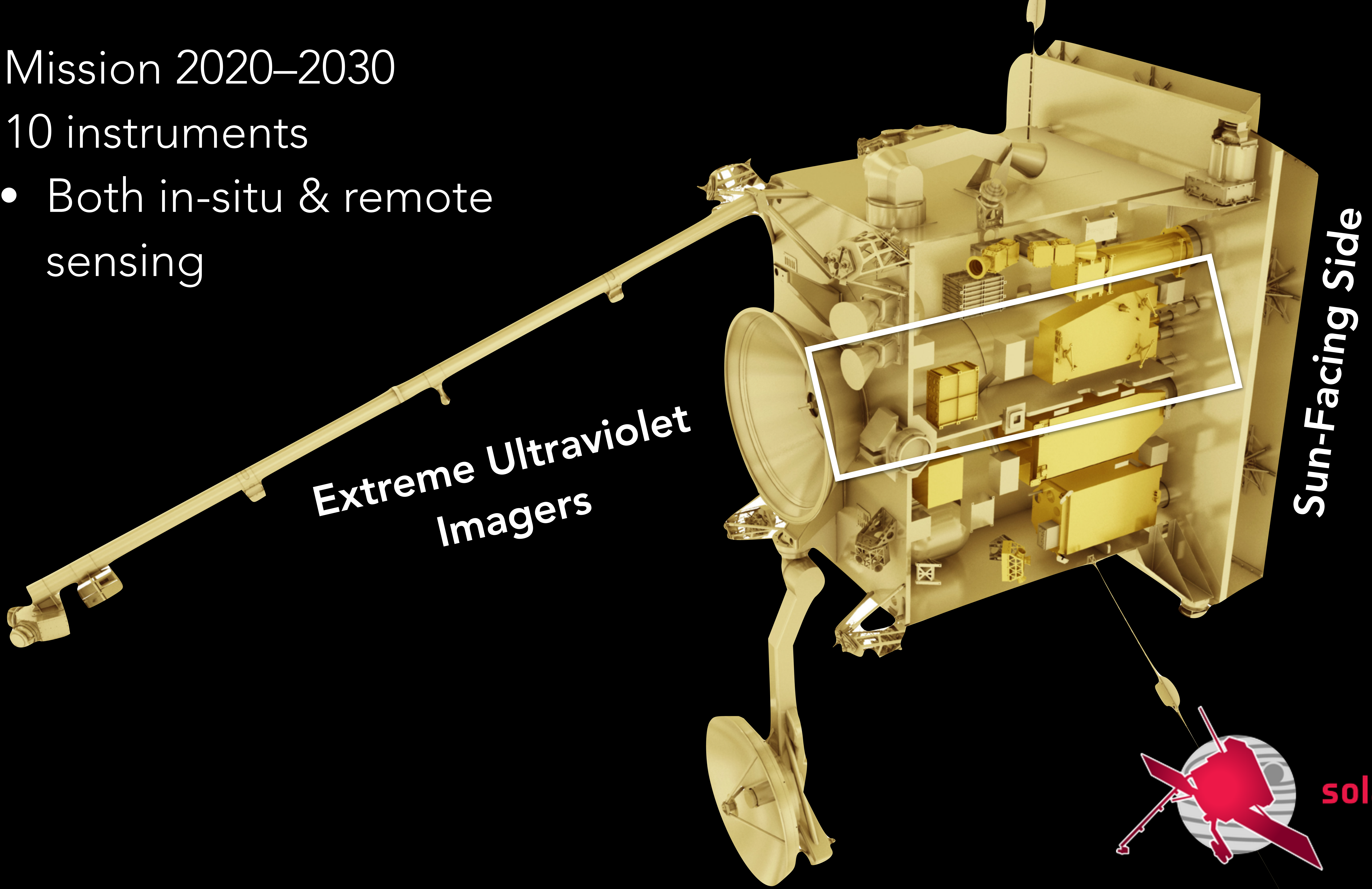
esa solar orbiter CIRES Boulder

SOLAR ORBITER OVERVIEW

- Mission 2020–2030
- 10 instruments
  - Both in-situ & remote sensing



solar orbiter

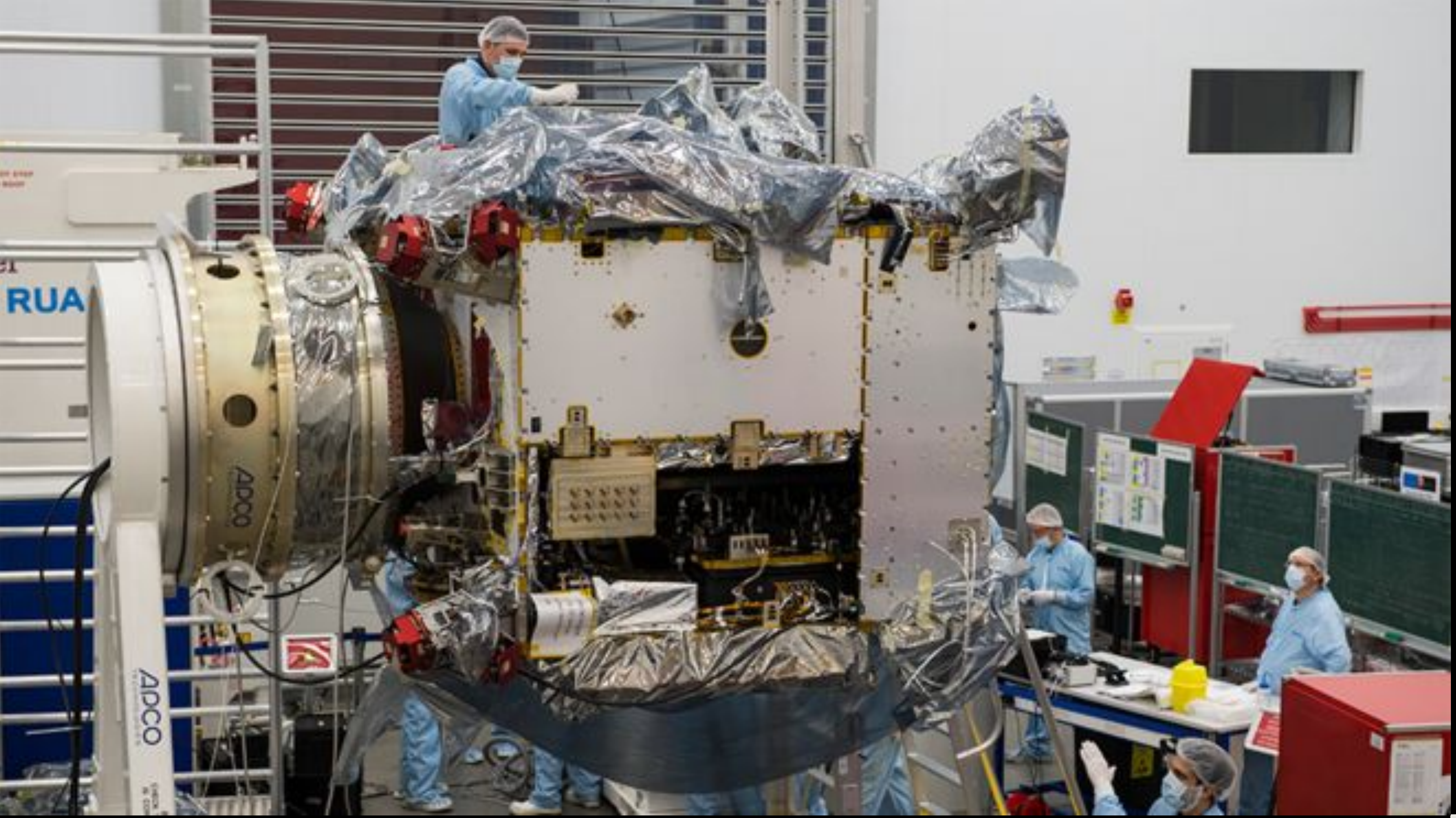
INSTRUMENTATION

In Situ

- EPD: Energetic Particle Detector
- MAG: Magnetometer
- RPW: Radio and Plasma Waves
- SWA: Solar Wind Analyzer

Remote Sensing

- EUI: Extreme Ultraviolet Imager
- METIS: Coronagraph
- PHI: Polarimetric and Helioseismic Imager
- SoloHI: Heliospheric Imager
- SPICE: Spectral Imaging of the Coronal Environment
- STIX: X-ray Spectrometer/Telescope



Solar Orbiter has shipped for its pre-flight test campaign in Germany as of this week.

Solar Orbiter’s heat shield with openings for remote-sensing instruments


AIRBUS
DEFENCE & SPACE
APCO
APCO
TECHNOLOGIES

Solar Orbiter Orbits 4/2020 – 12/2030

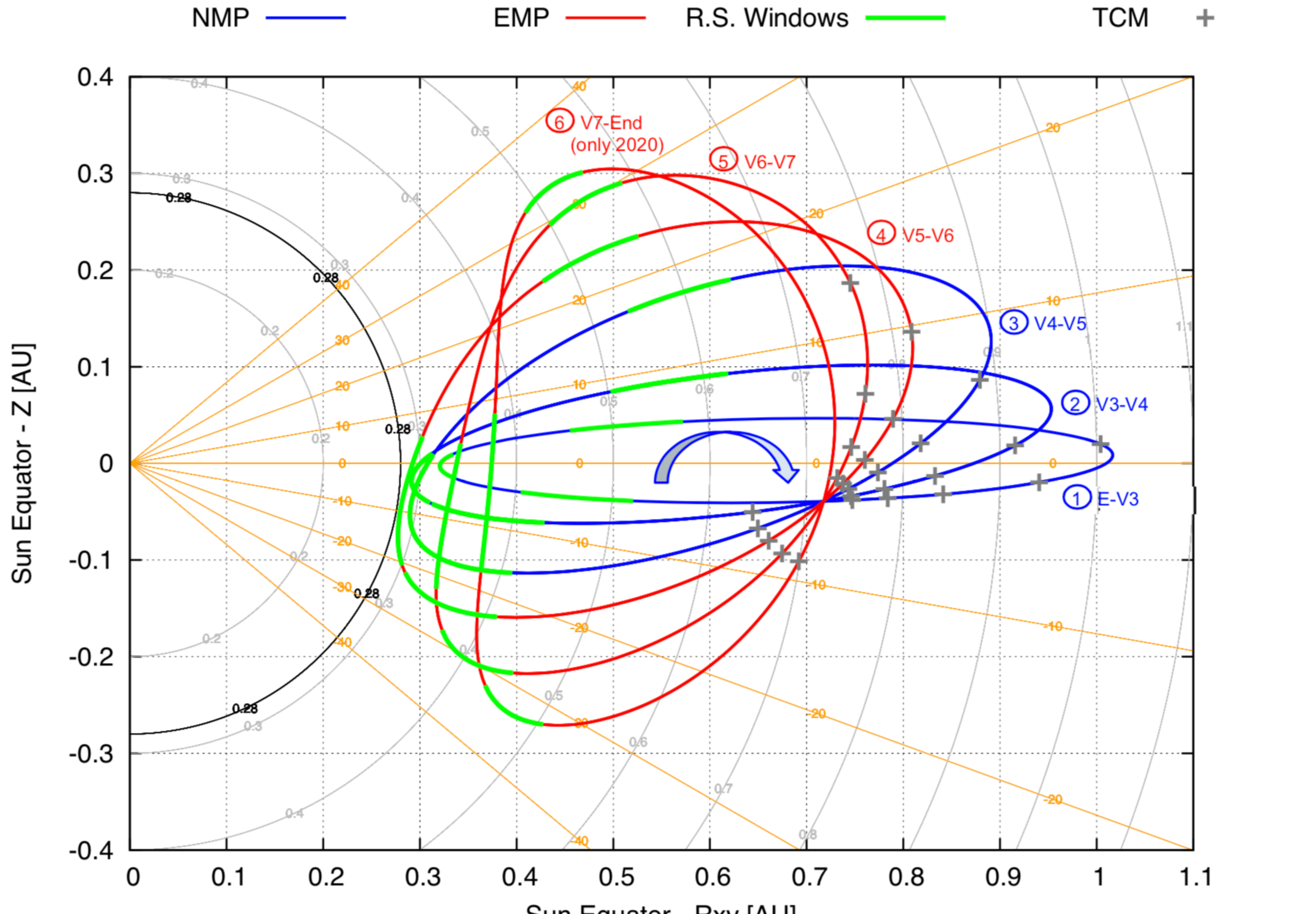
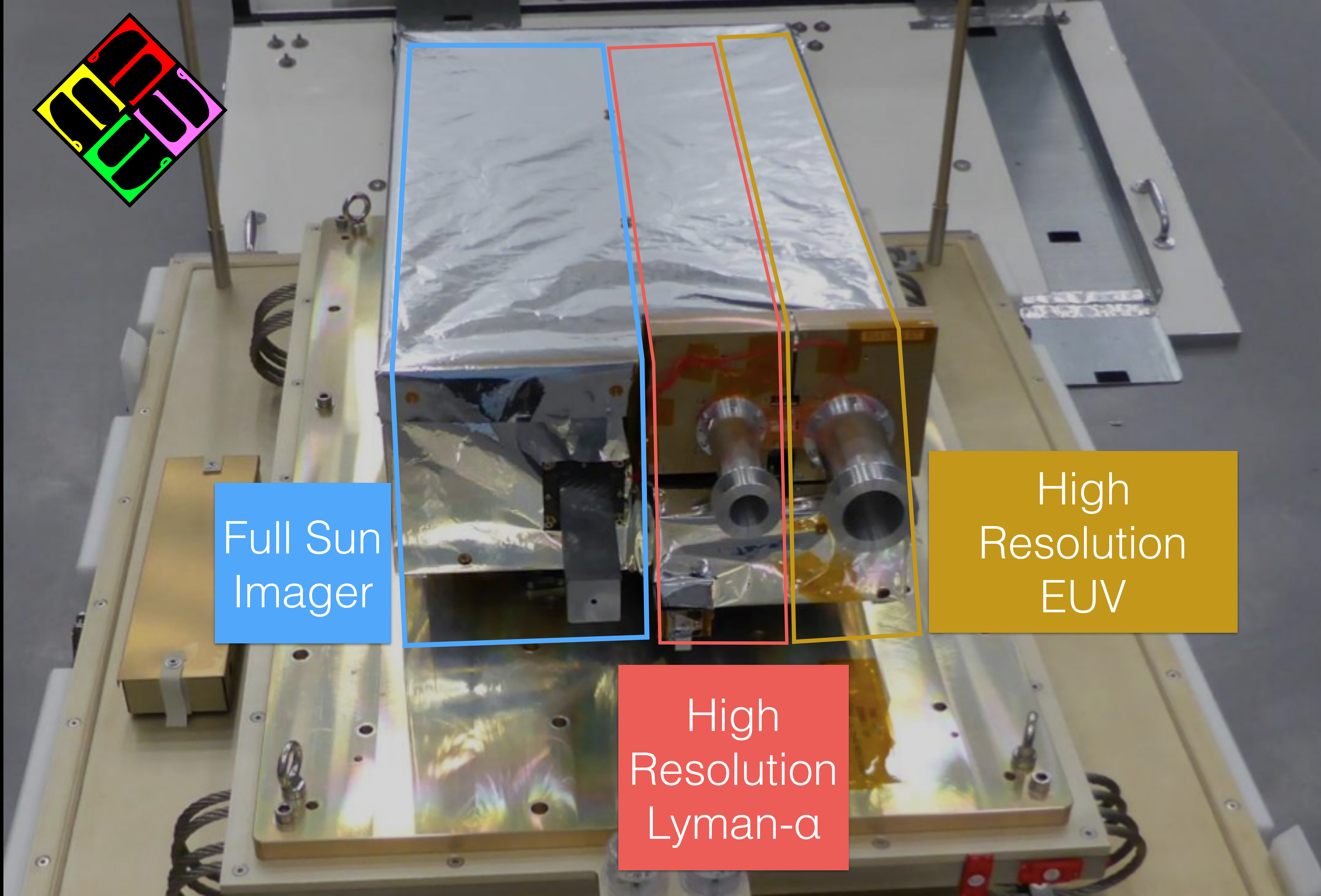


Image Courtesy ESA, 'CREMA report'

EXTREME ULTRAVIOLET IMAGER

Extreme Ultraviolet Imager Overview



EUI = 3 Telescopes

High Res.
EUV

17nm

High Res.
Lyman-α

121nm

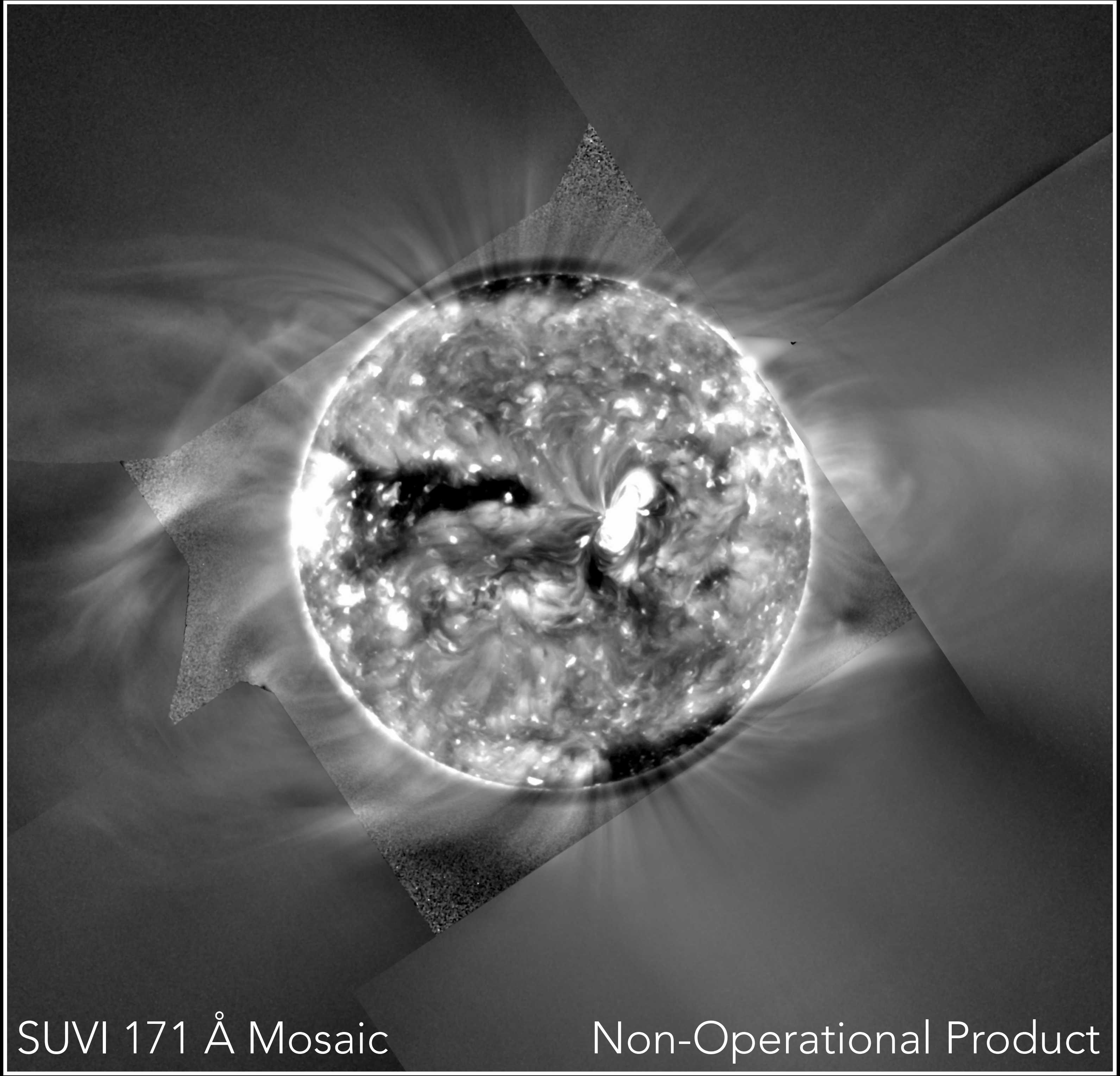
Full Sun
Imager (FSI)

17nm
30.4nm

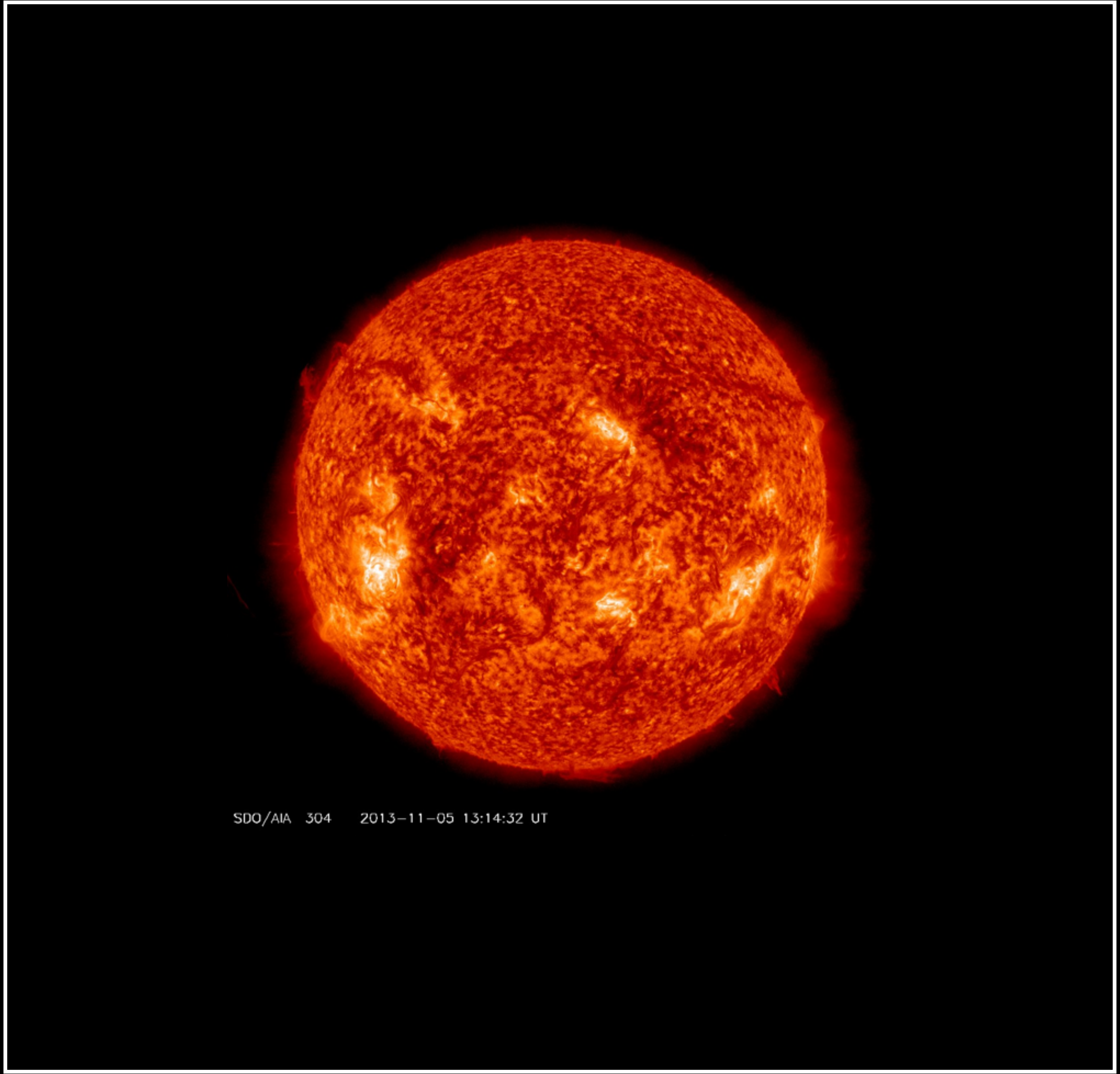
FSI: Full Sun Imager

FOV: 3.8°x3.8°, @ 0.28 AU: 4 Rsun × 4 Rsun

17nm



30.4nm



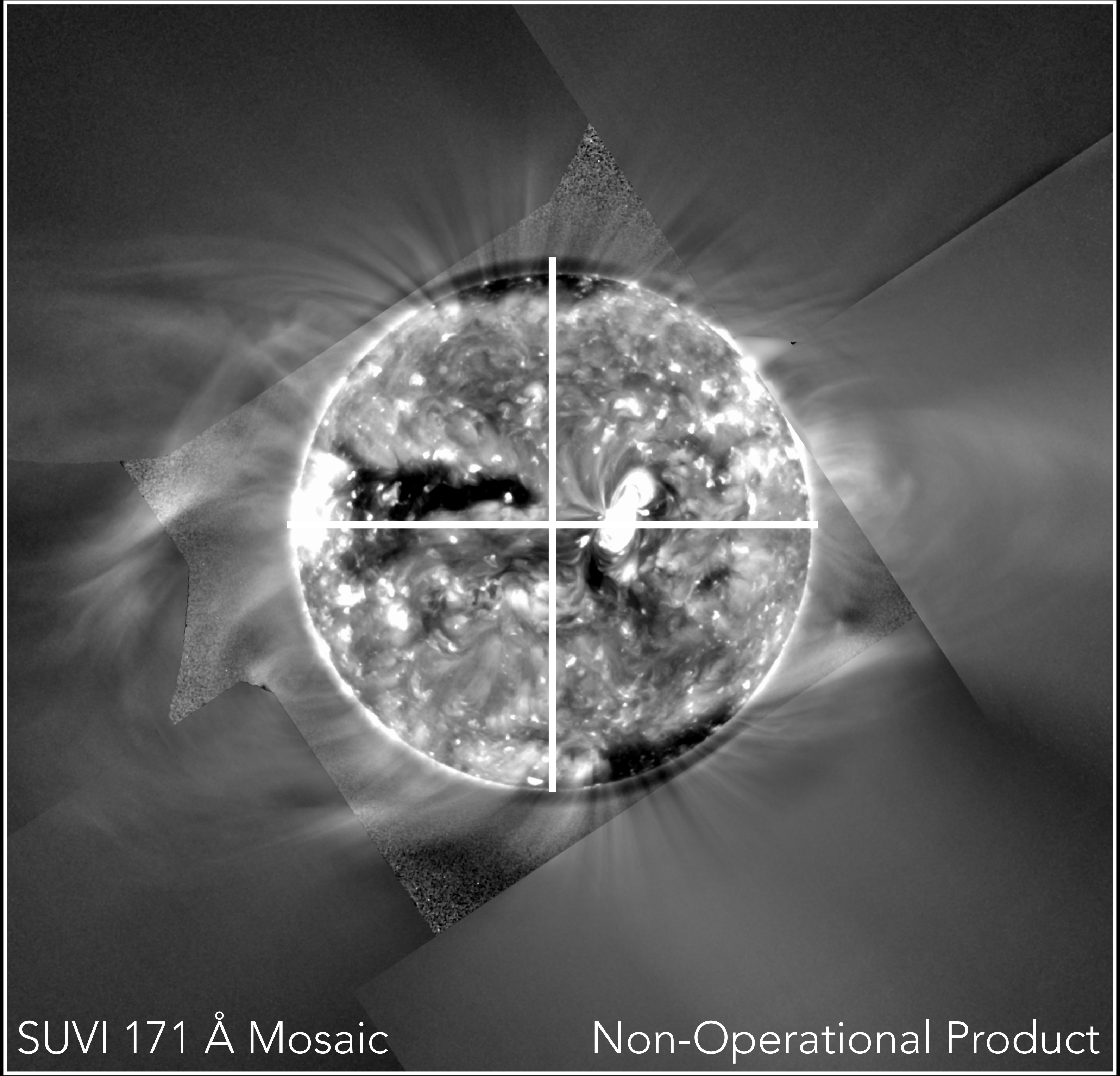
resolution: 9 arcsec on 2 pixels

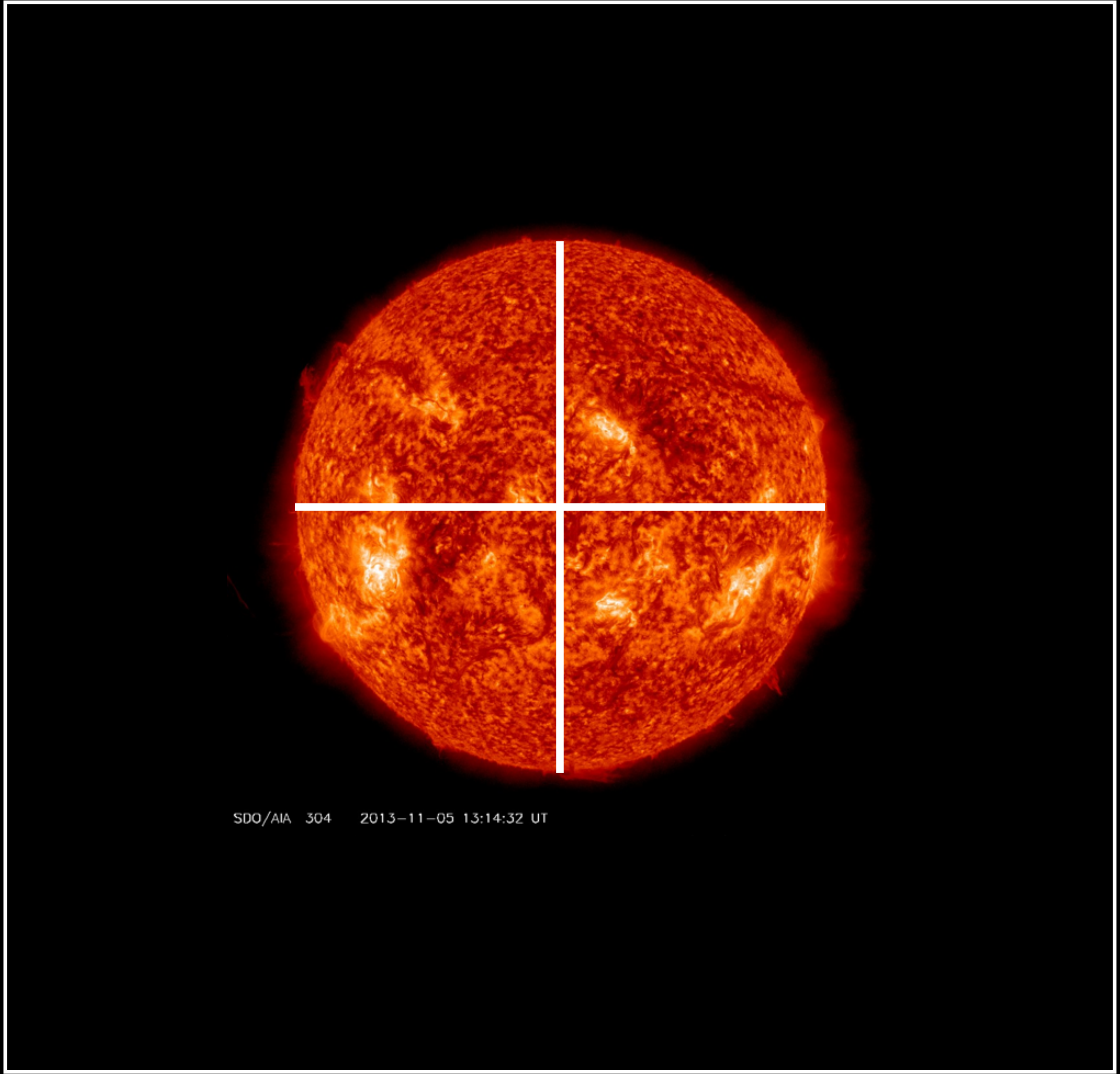
@ 0.28 AU =1830 km on 2 pixels

FSI: Full Sun Imager

FOV: 3.8°x3.8°, @ 0.28 AU: 4 Rsun × 4 Rsun

17nm





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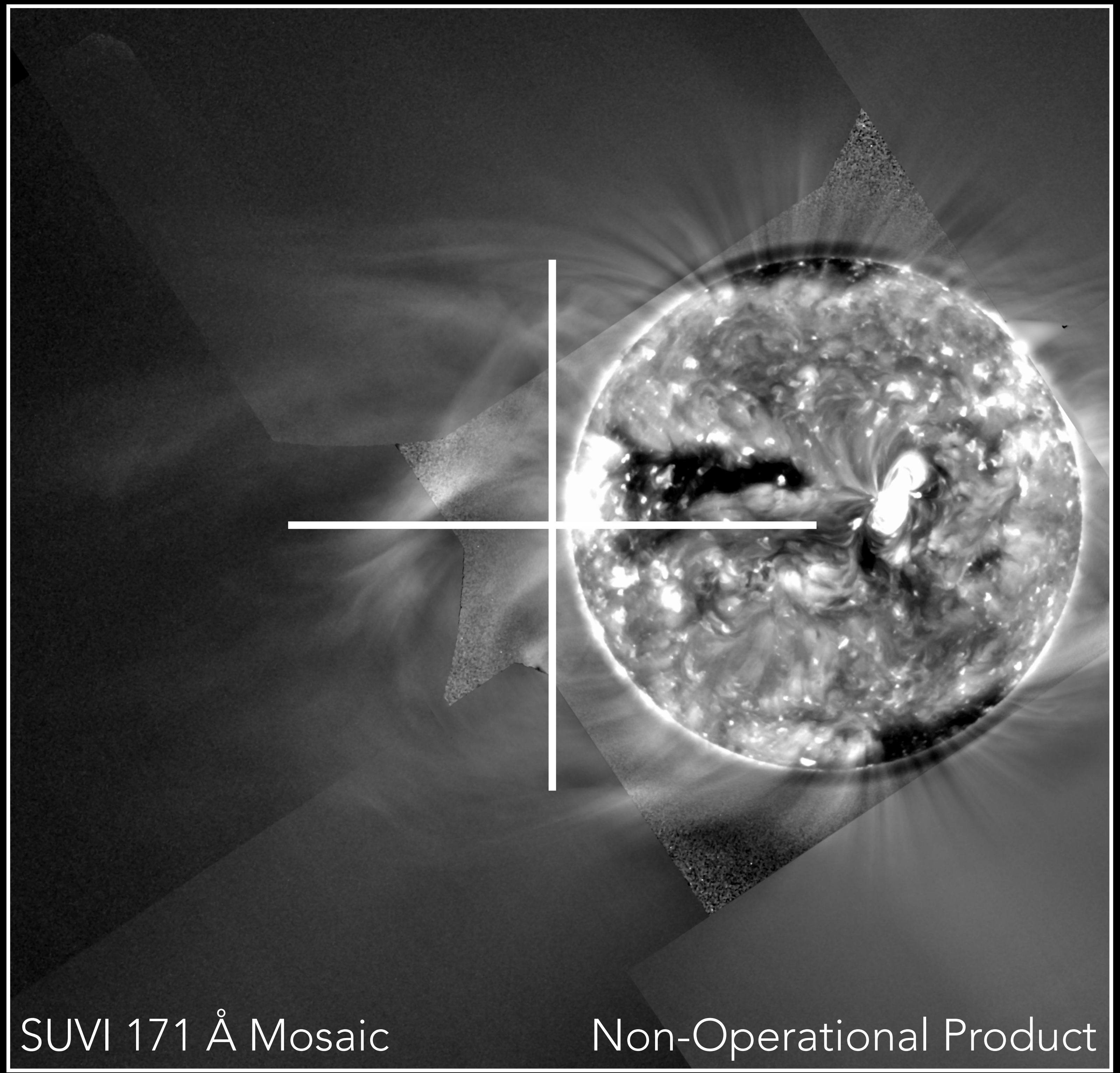

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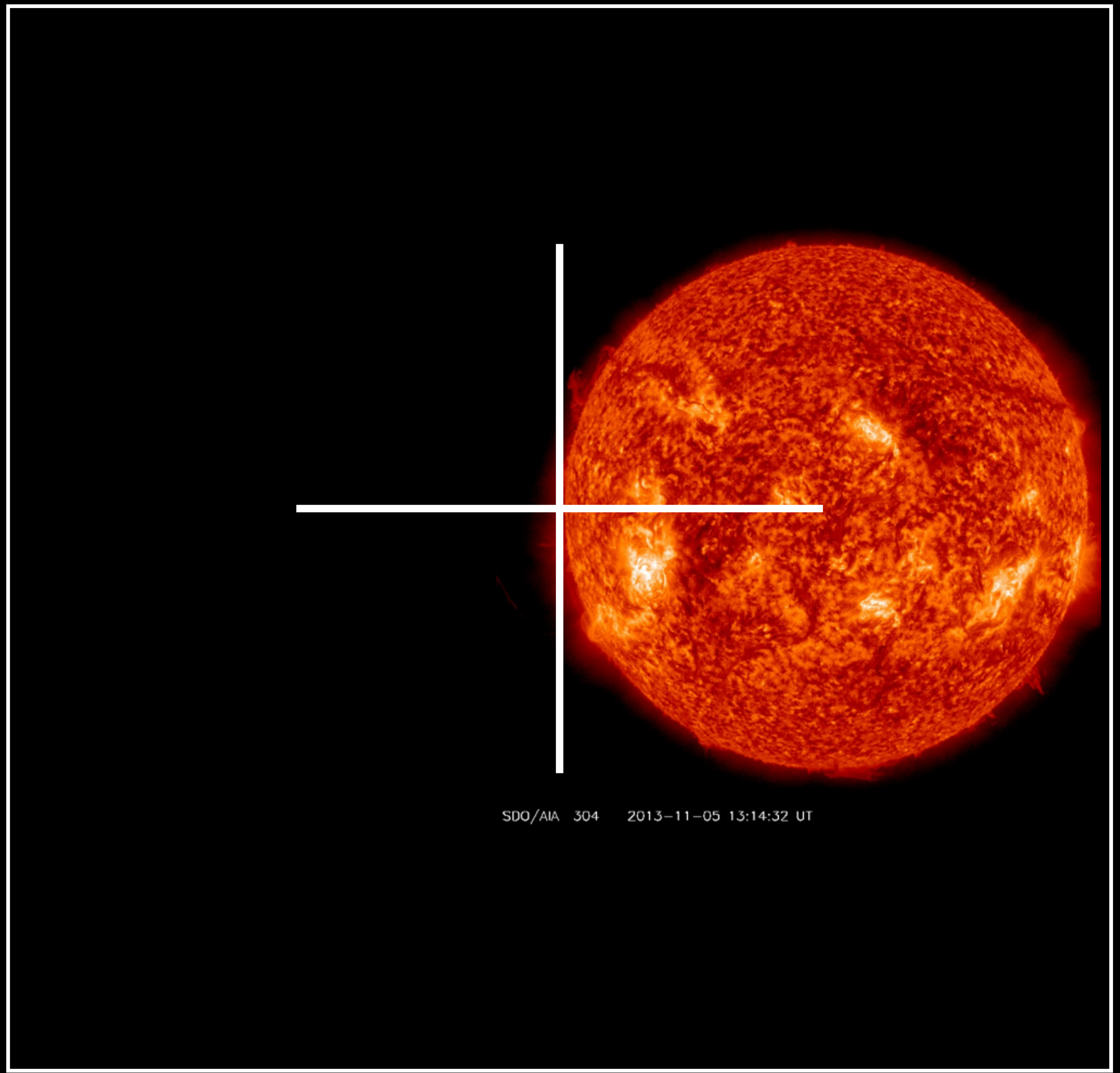

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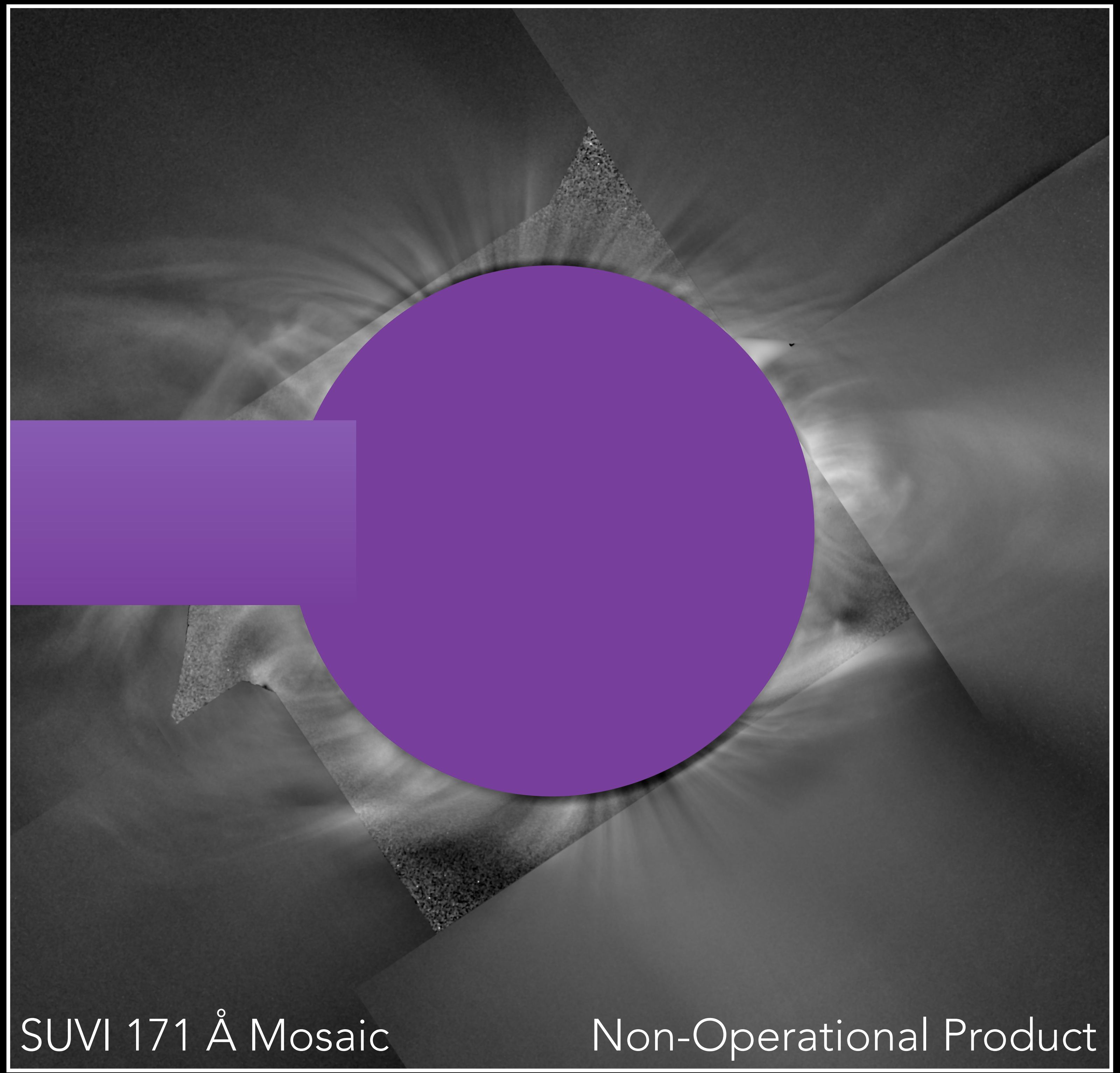
17nm



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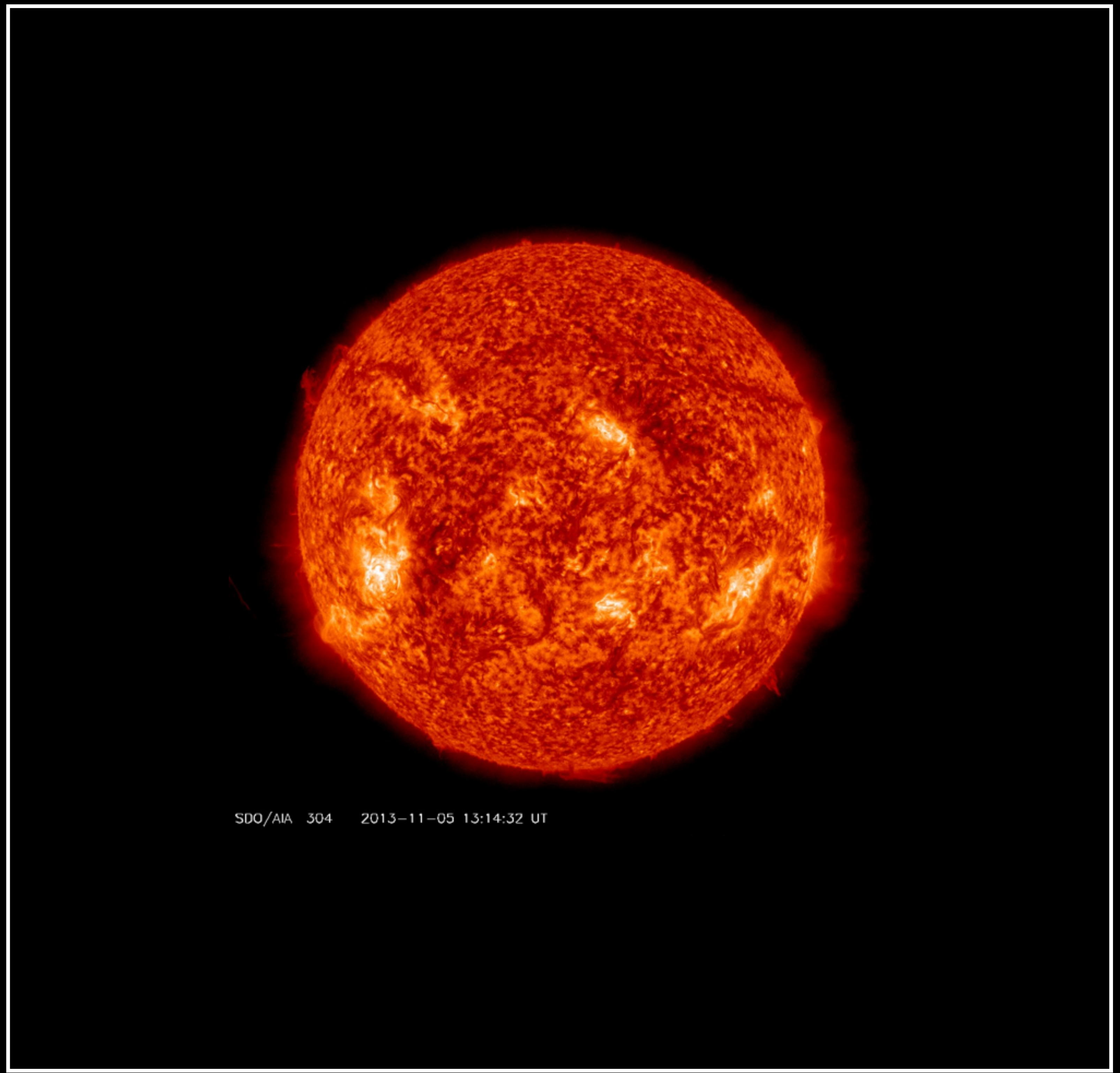
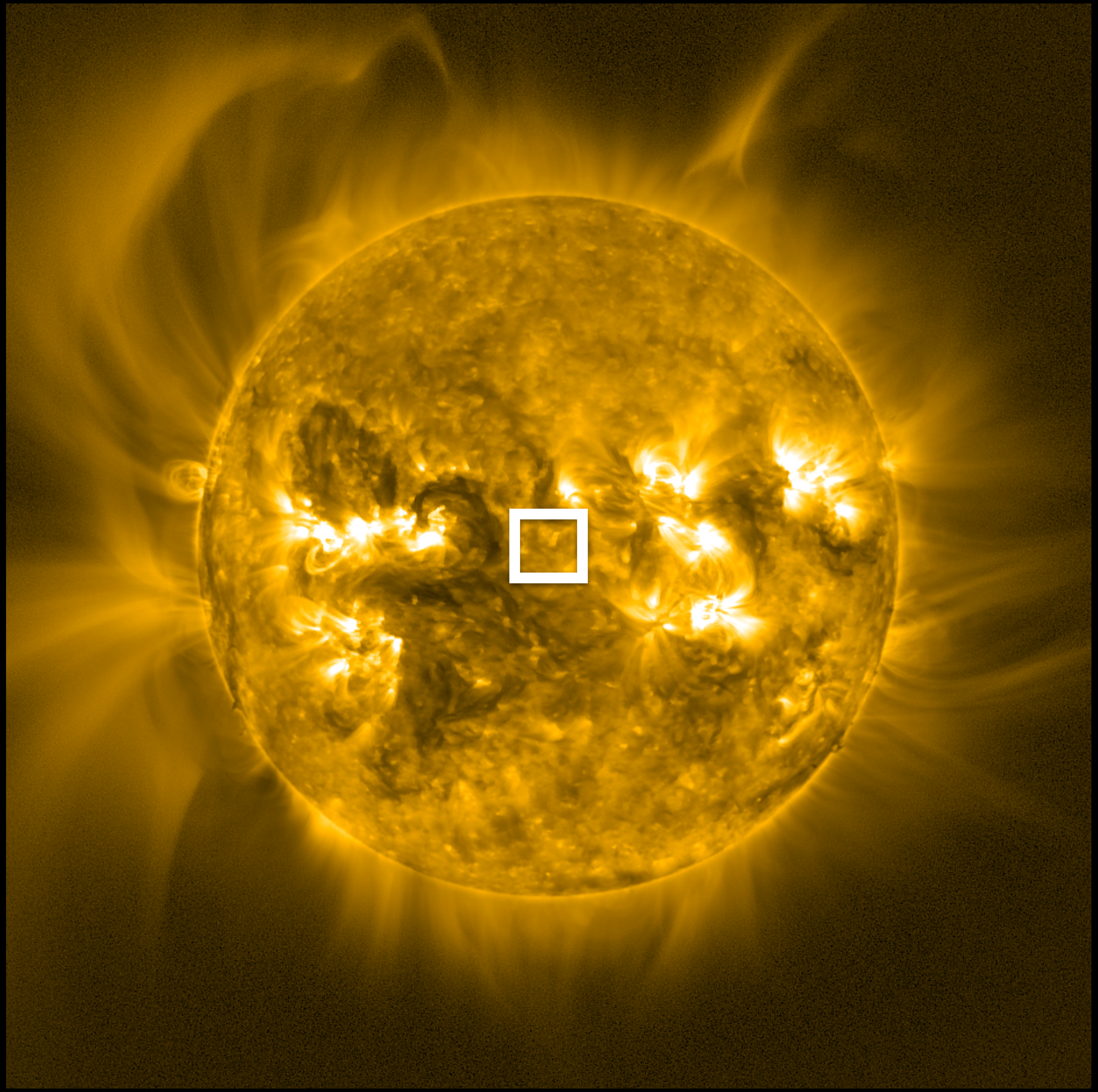


resolution: 9 arcsec on 2 pixels

@ 0.28 AU =1830 km on 2 pixels

HRI:High Resolution Imagers



FOV:

$17' \times 17'$

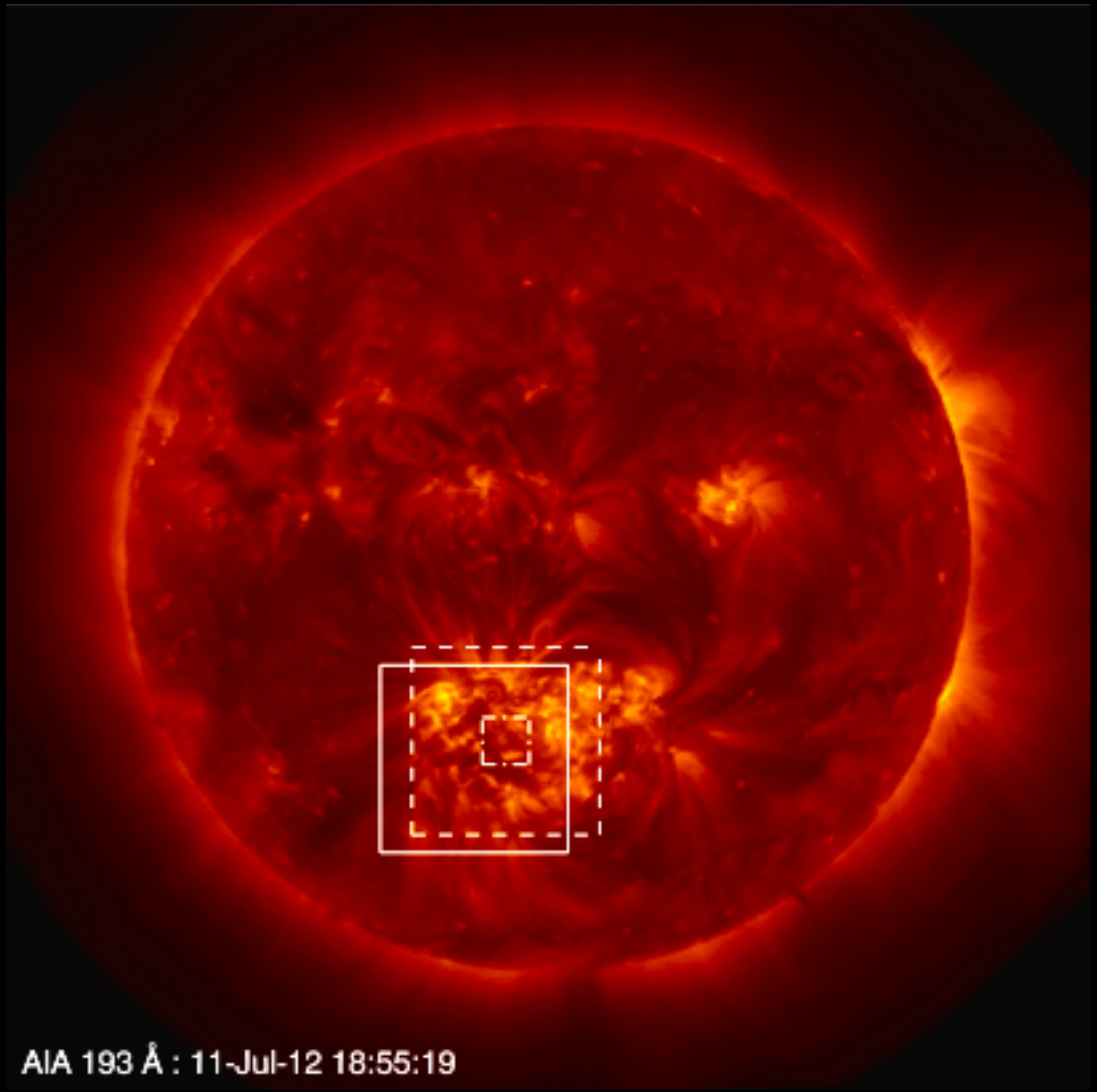
@ 0.28 AU = $(0.16\ R_{Sun})^2$

resolution:

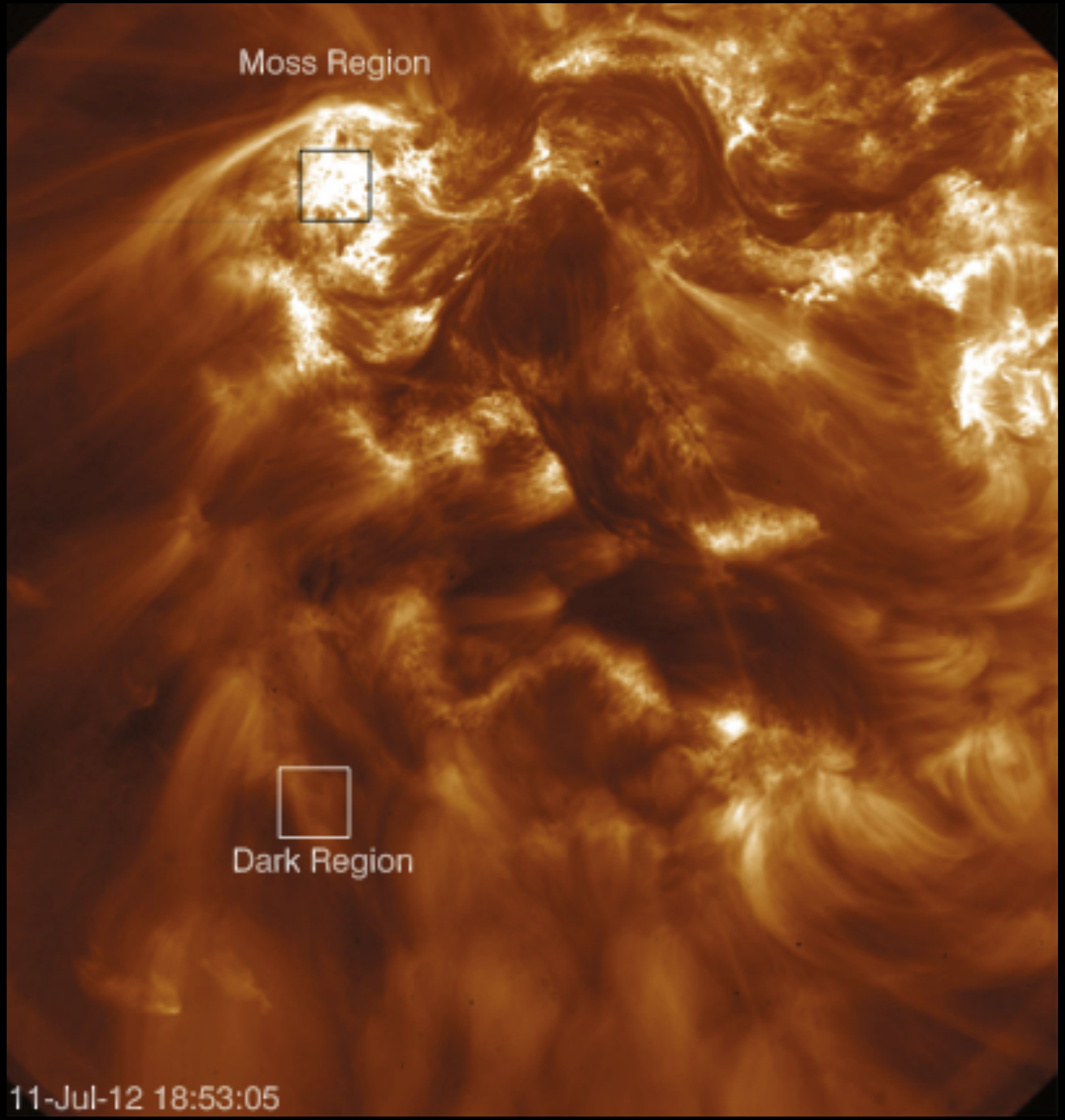
1 arcsec on 2 pixels

@ 0.28 AU = 200km

Hi-C Sounding Rocket



SDO/AIA

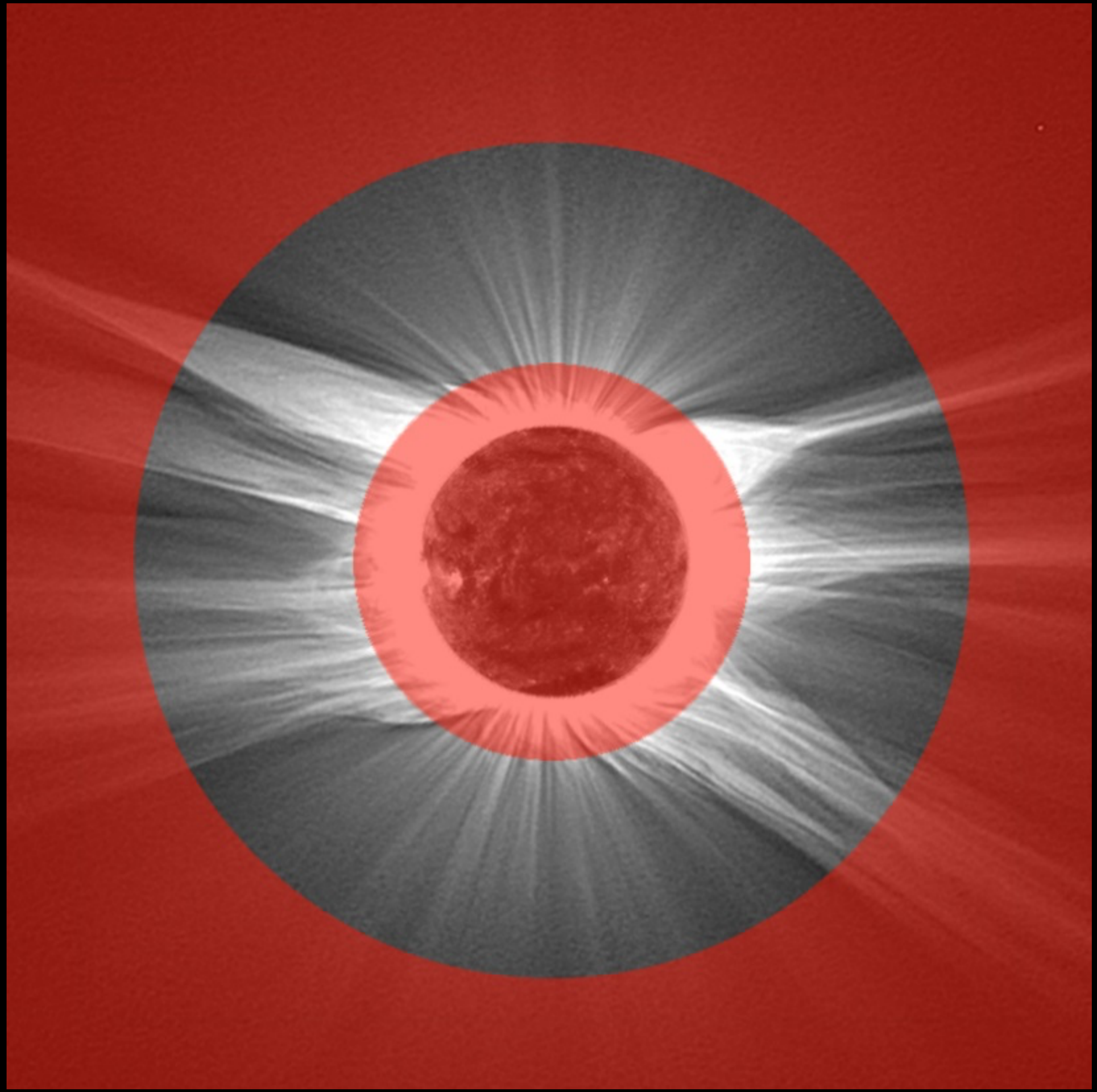


Hi C

Hi-C gives us a preview of what we will see with HRI EUV

METIS CORONAGRAPH & POLARIMETRIC AND HELIOSEISMIC IMAGER

- PHI provides full-disk and high res (up to 150 km) vector magnetic field and LOS velocity maps
- METIS observes the WL corona between 1.6 and 3.0 R_{Sun} at closest approach



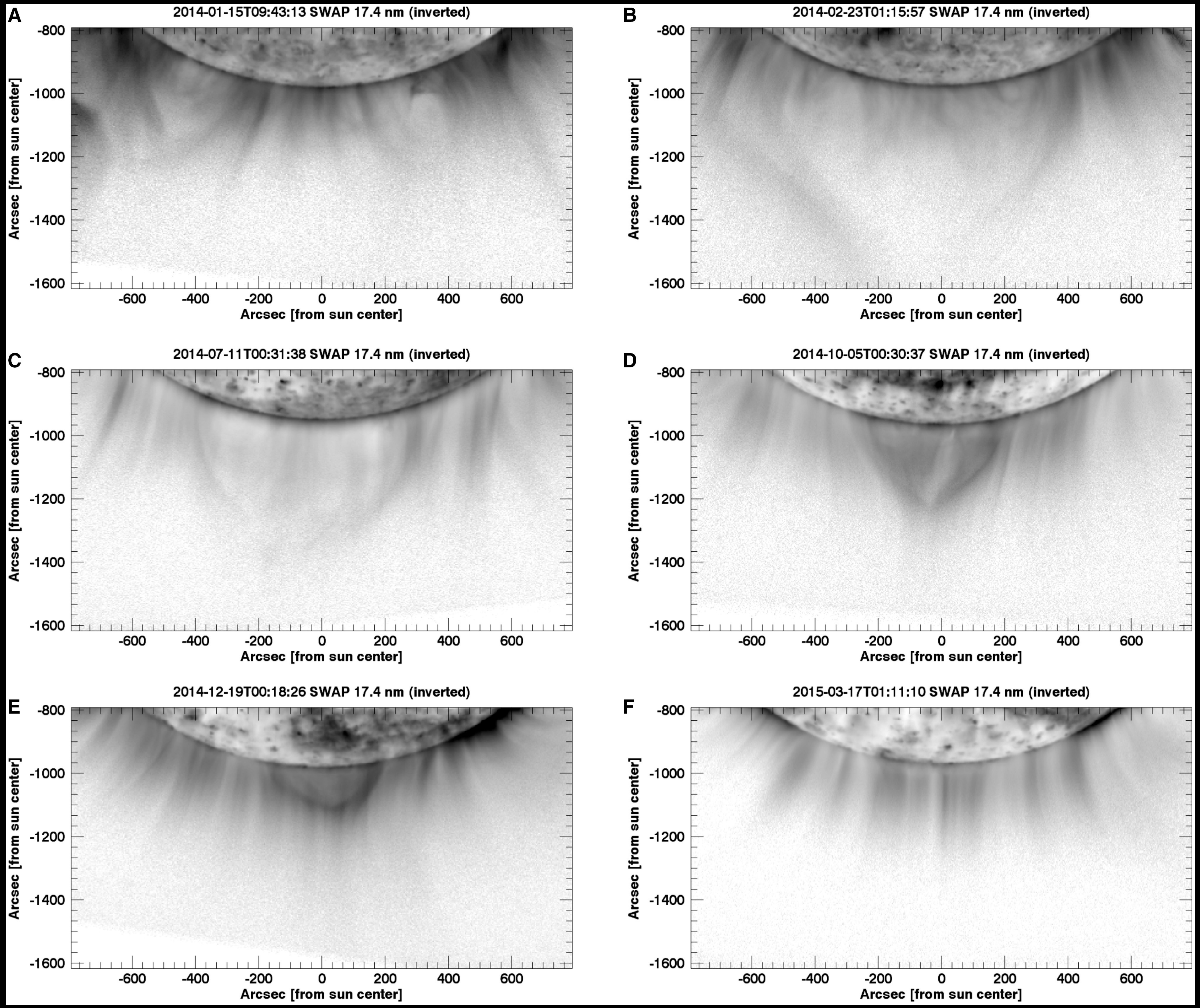
ZOOMING IN ON THE POLES

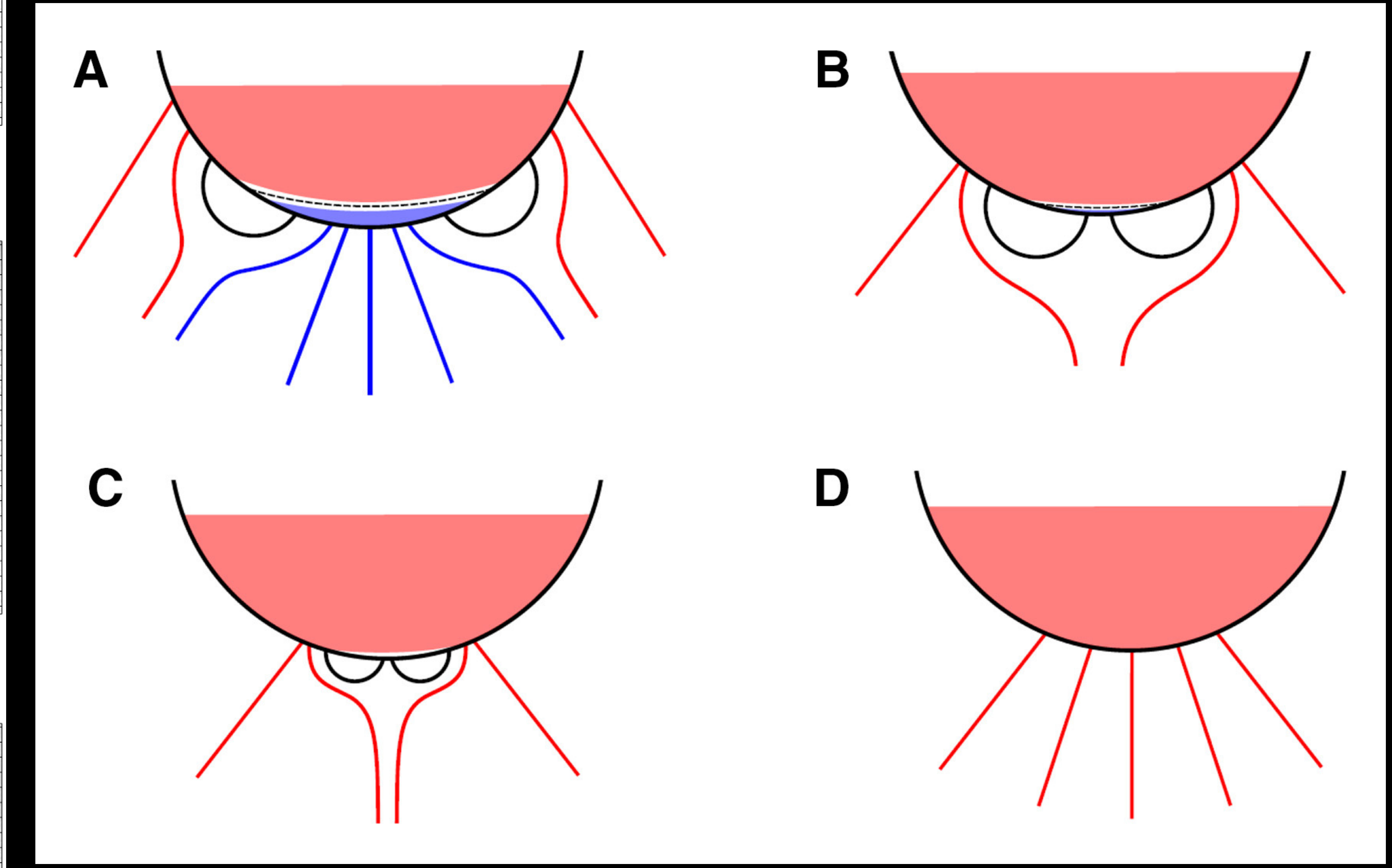
Like Juno: Discovery Science!

NASA/JPL-Caltech/SwRI/ASI/INAF/JIRAM

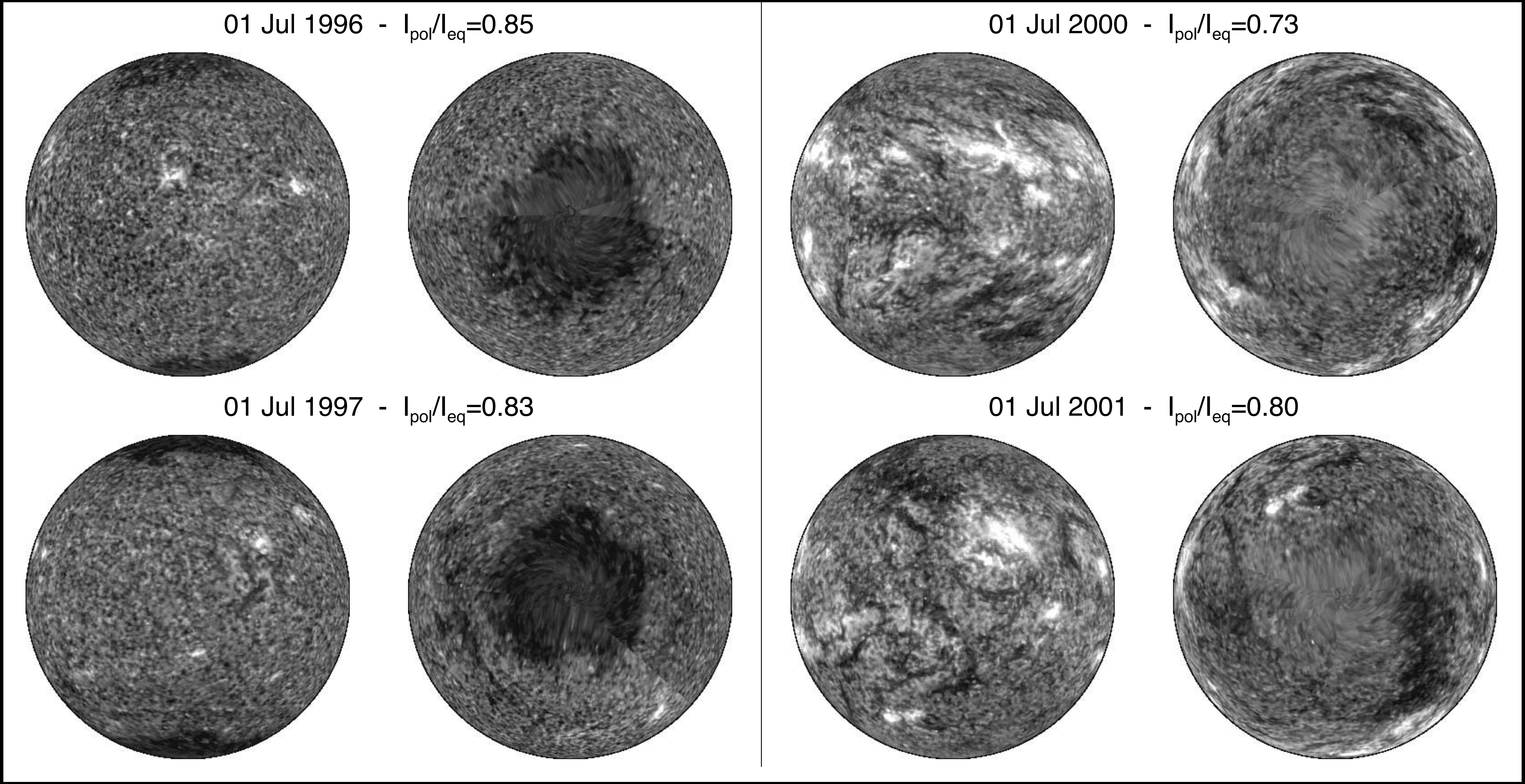
QUESTIONS FOR A NEW VIEW

- Are polar coronal holes different from low-latitude coronal holes? How and why?
- Polar coronal holes don’t experience differential rotation, the environment is much more static and PCH’s are largely stable for much of the solar cycle. What does that mean for their evolution?





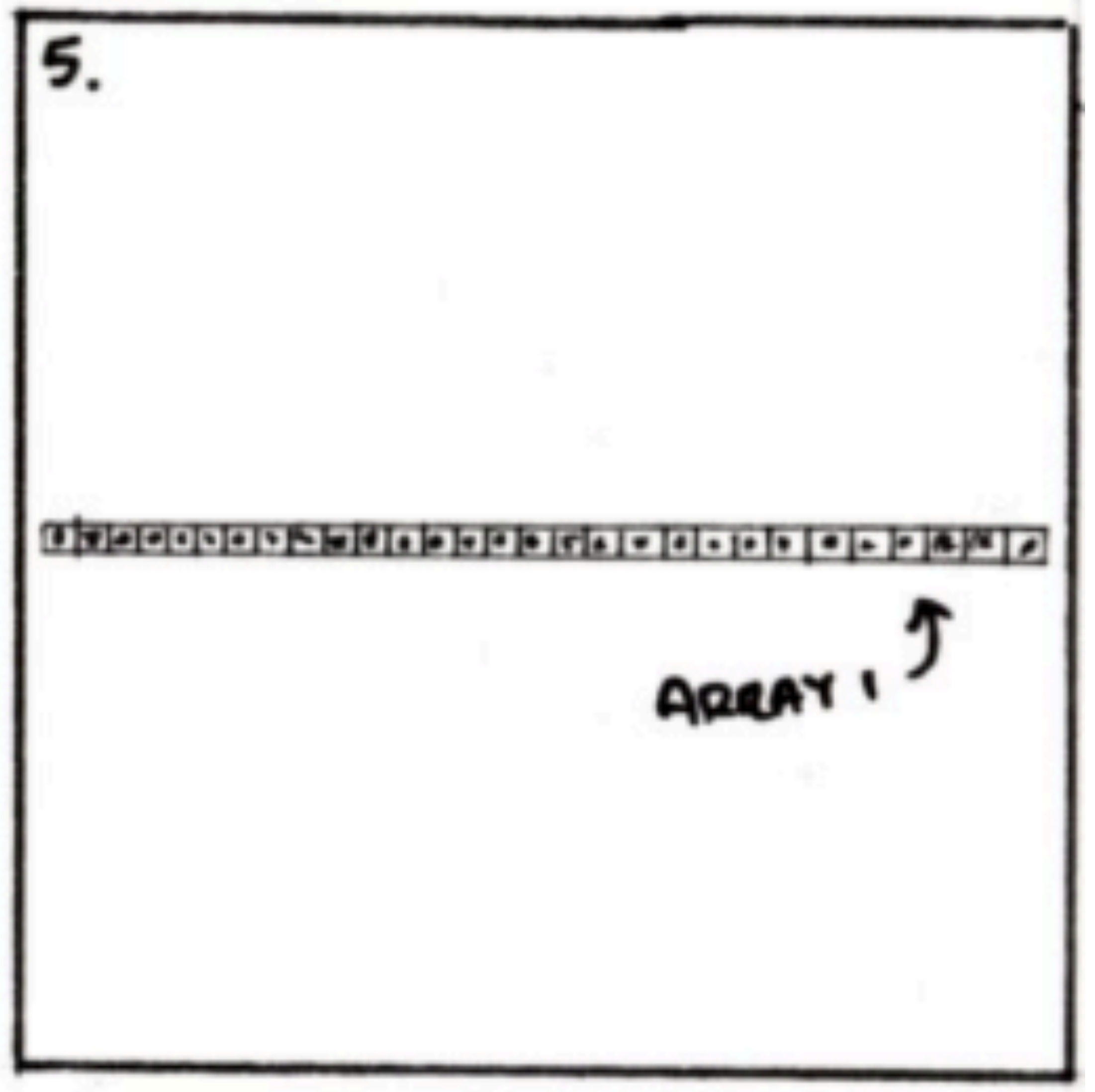
Guennou, Rachmeler et al. 2016



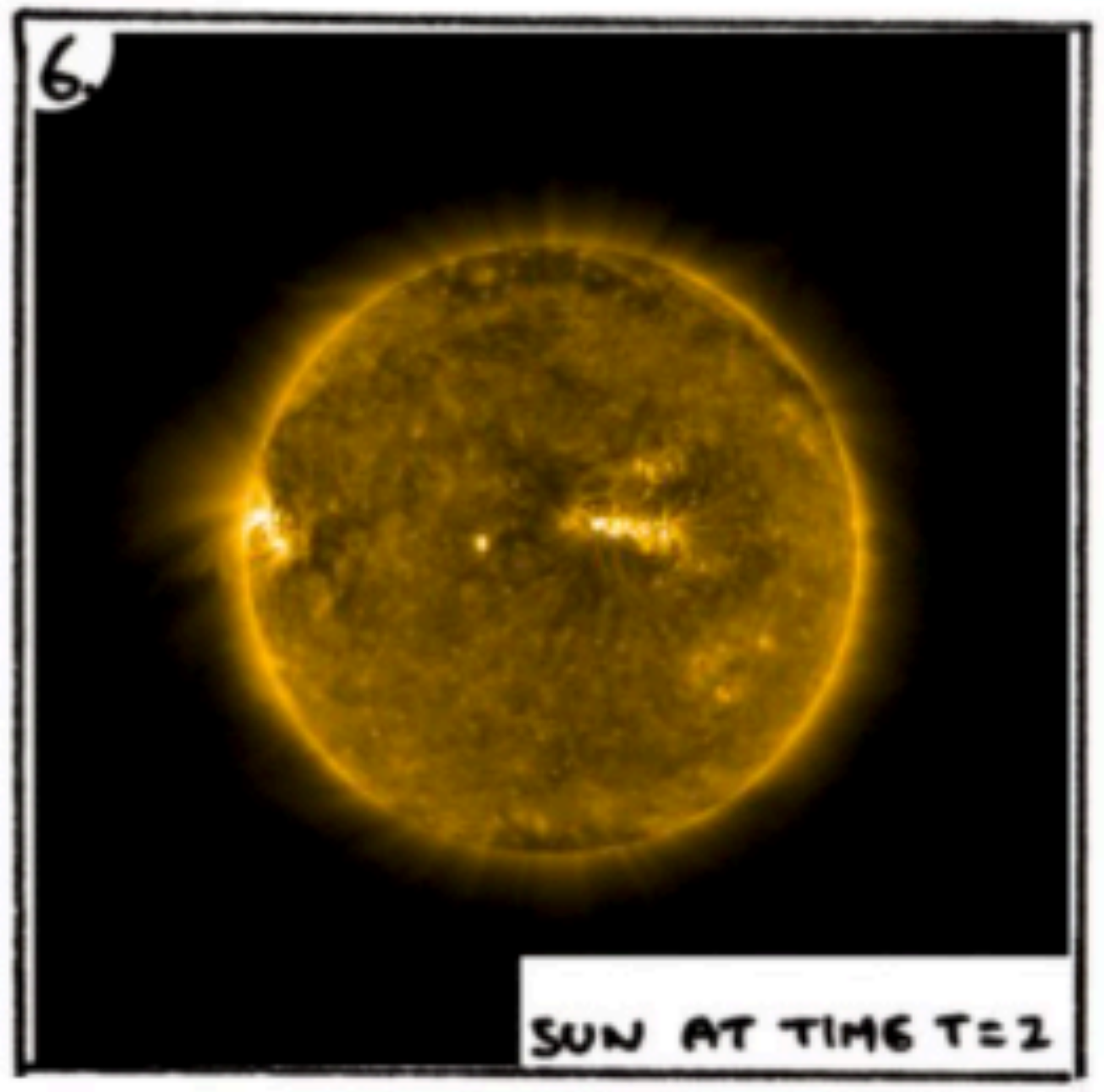
SOHO/EIT 304 Å

Auchère et al. 2005

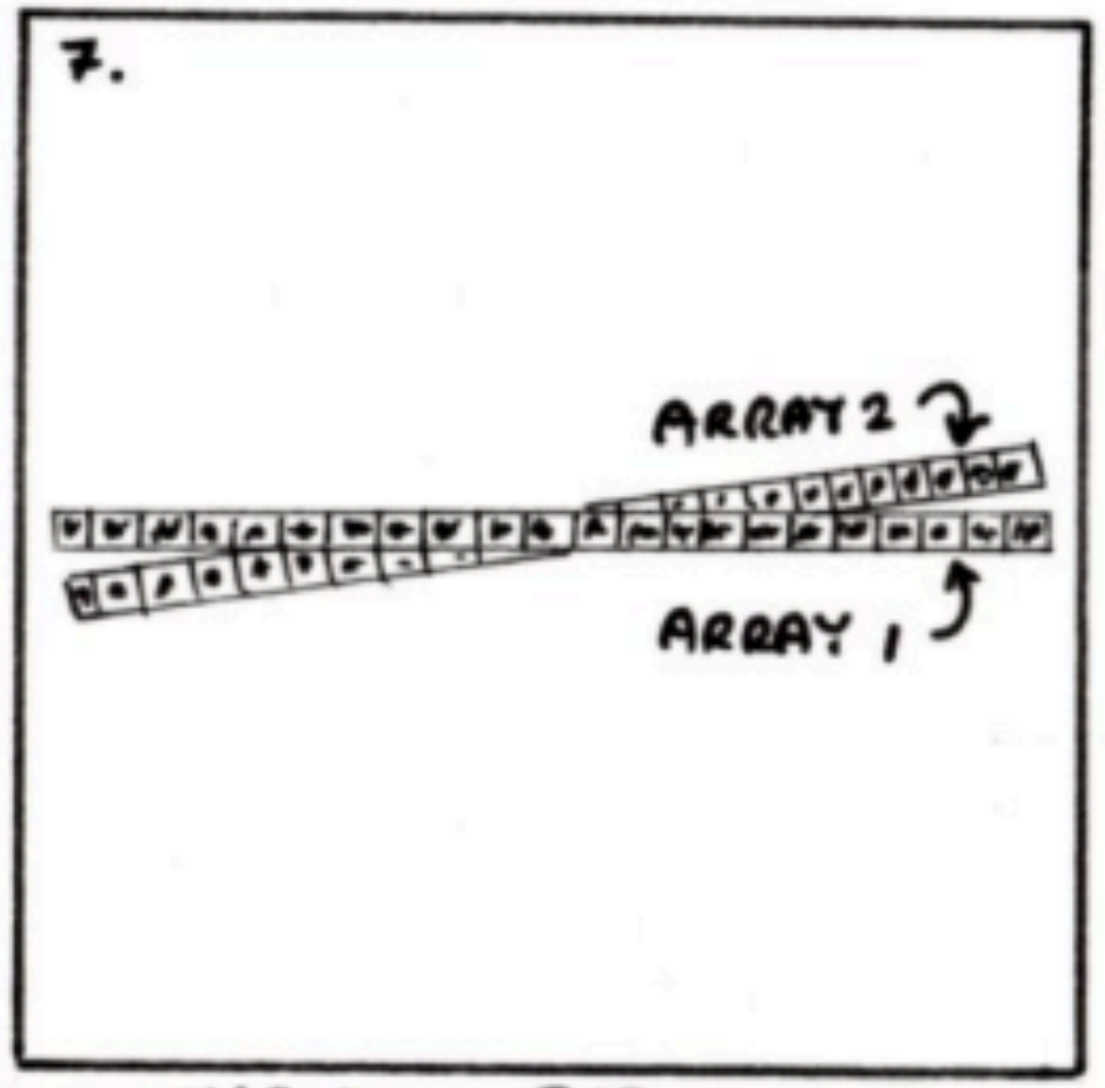

WE START BY TAKING AN IMAGE OF THE SUN AT TIME T=1
1.
SUN AT TIME T=1
WE REMOVE THE SOLAR DISK, AND THE SIGNAL BELOW
2.
NOTHING TO SEE HERE
NEXT READ EACH 'COLUMN' OF PIXELS IN THE IMAGE, SUM THEM, AND READ INTO AN ARRAY.
3.
FULL ARRAY 1
4



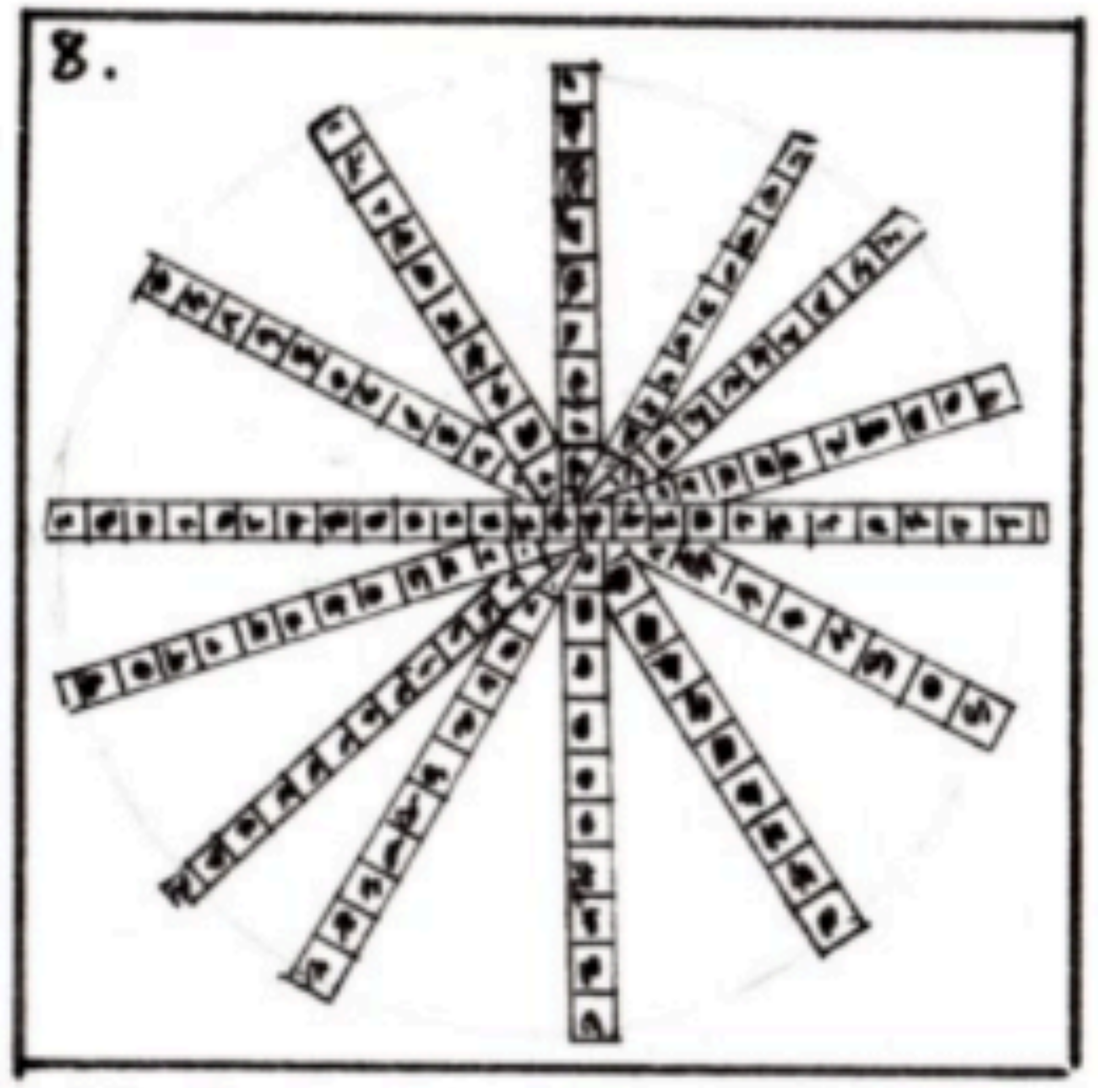
WE THEN PUT ARRAY 1 IN THE MIDDLE OF A NEW IMAGE



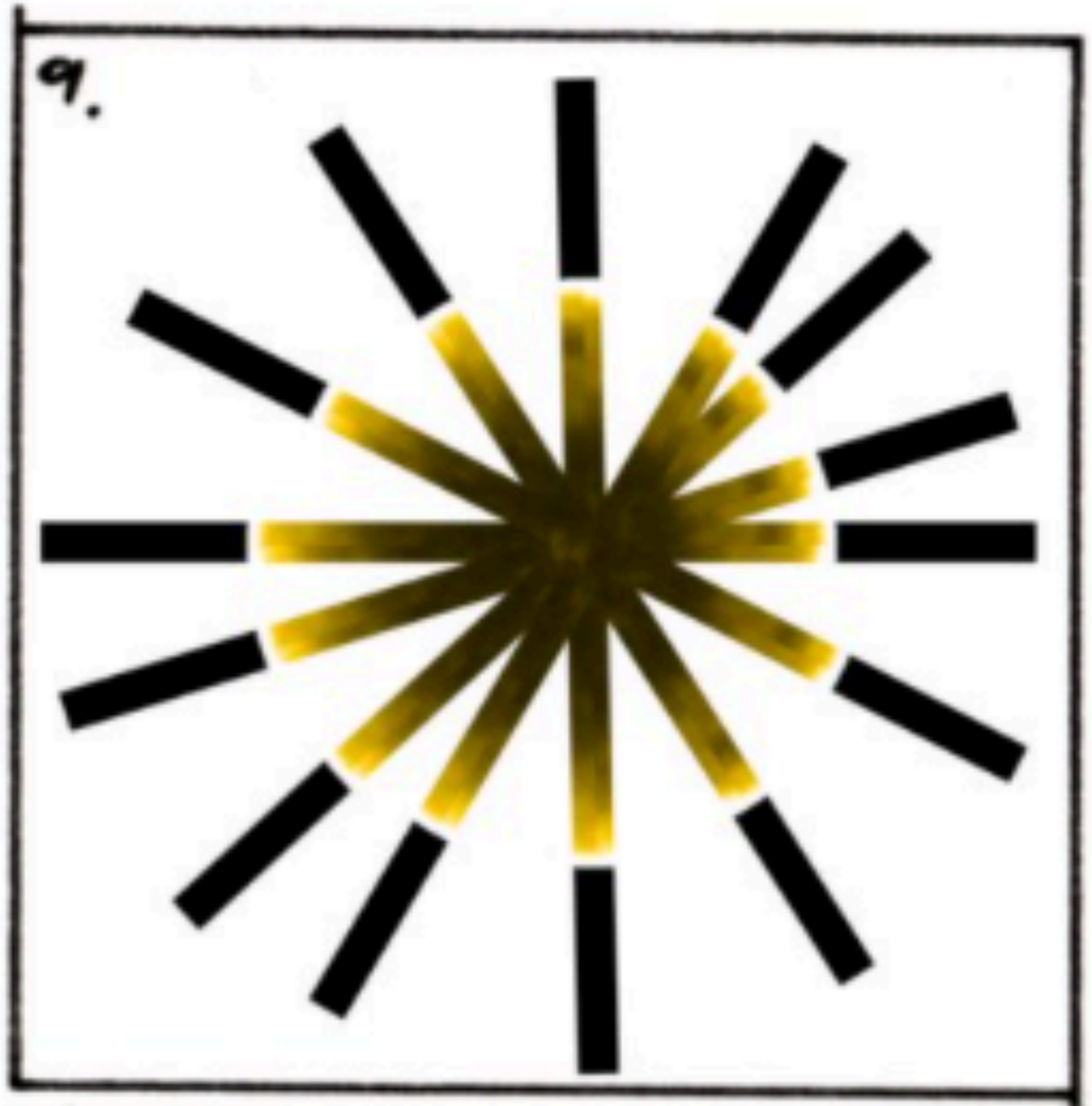
WE REPEAT STEPS 1. TO 4. USING AN IMAGE AT A SLIGHTLY LATER TIME, T=2, CREATING ARRAY 2.



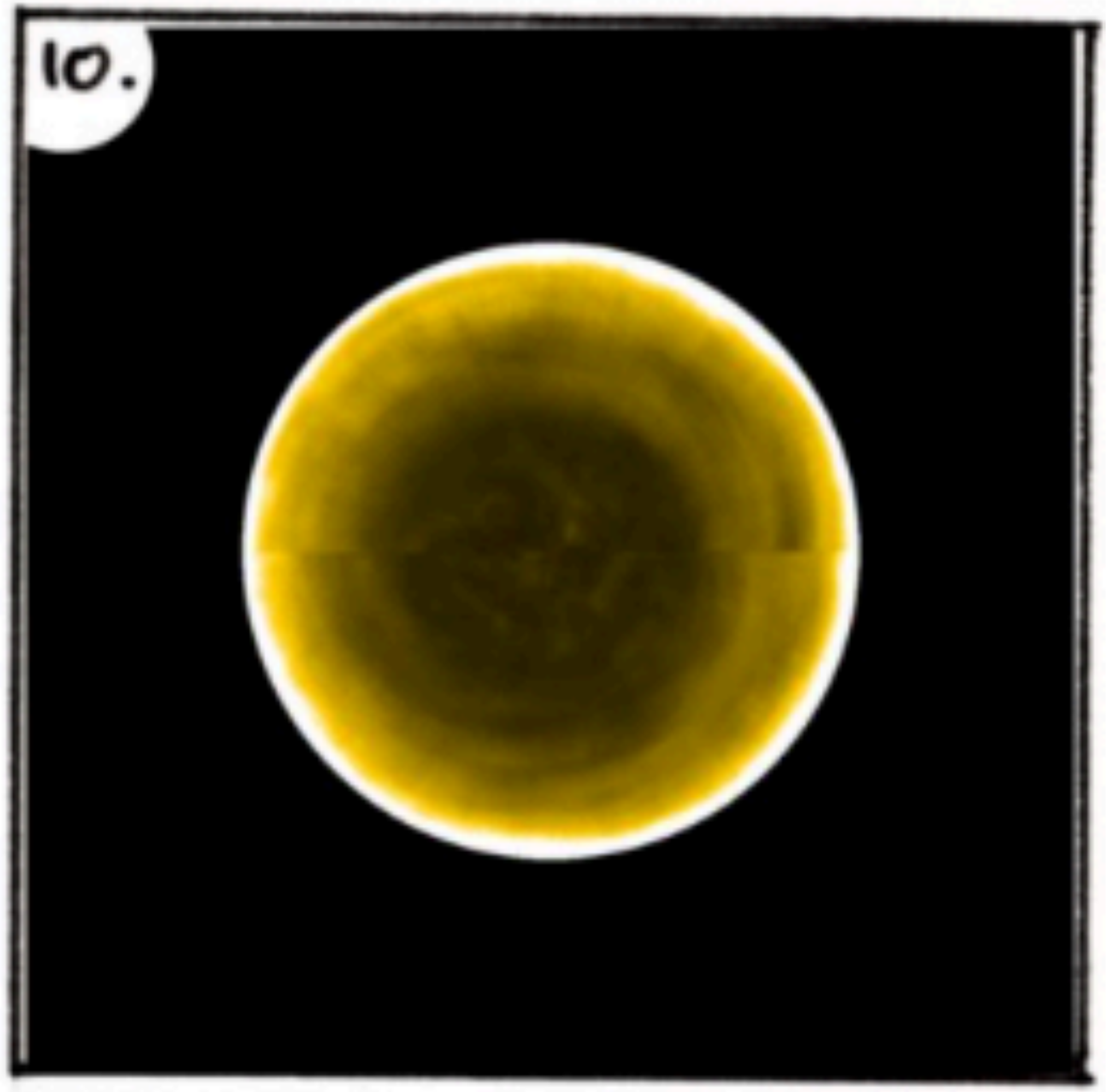
IN THE TIME BETWEEN T=1 AND T=2 THE SUN WILL HAVE ROTATED BY ANGLE θ. WE COMBINE ARRAY 1 AND 2 USING THE ANGLE OF ROTATION θ.



WE REPEAT STEPS 1 TO 4 UNTIL WE HAVE ENOUGH IMAGES TO COVER ½ A CARRINGTON ROTATION (½ A SOLAR ROTATION).



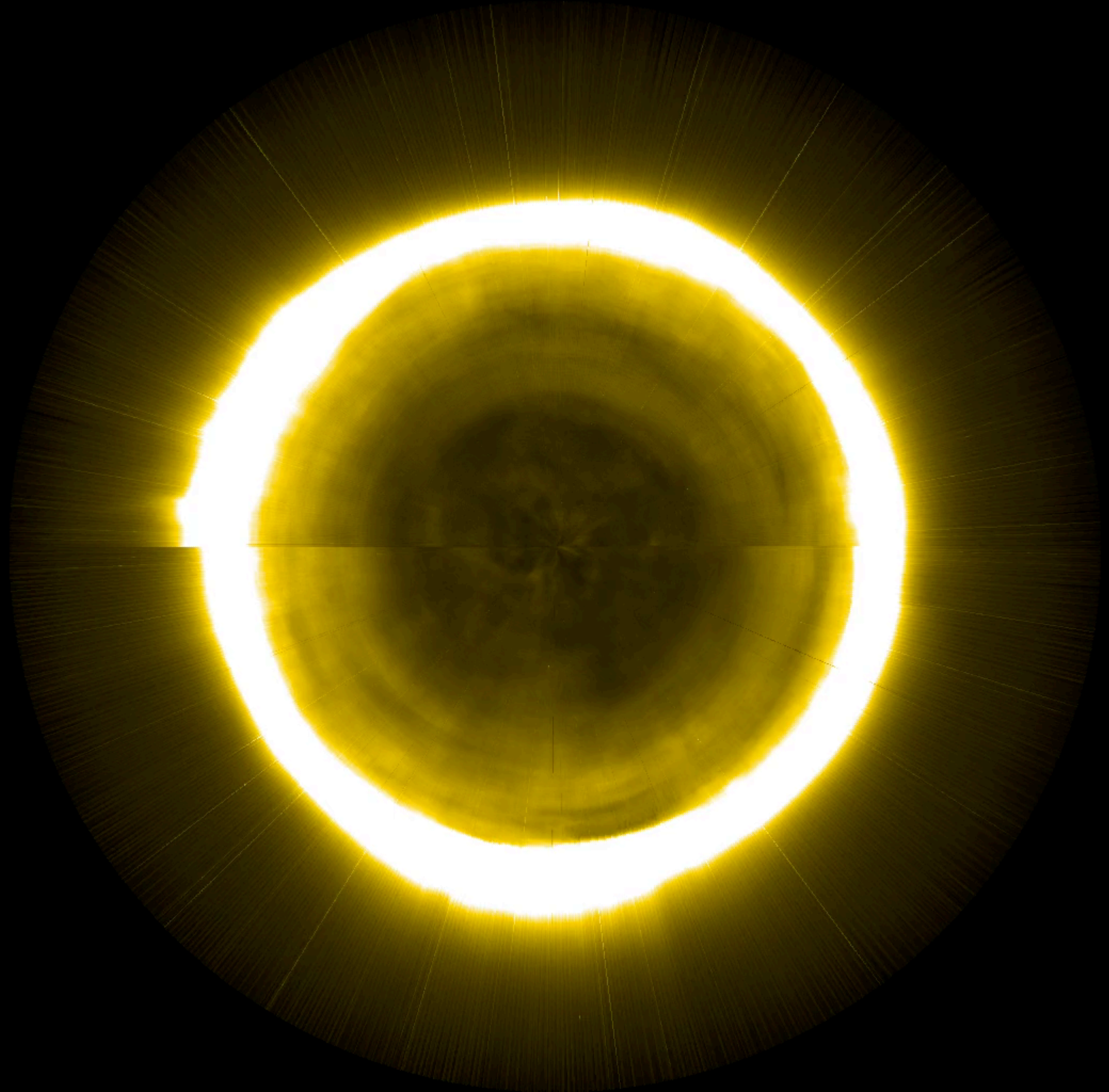
THIS IS DONE AT A FAR FINER SCALE IN REALITY CREATING A POLAR IMAGE WITH SOME CLEVER SCALING AND INTERPOLATION



IF DONE QUICKLY THE IMAGE WOULD BE SEEMLESS. BUT WE SEE SOME CHANGES OVER THE CARRINGTON ROTATION.

PROBA2 SWAP 174 Å
EUV Polar View

June 2018 – September 2018



SOLAR ORBITER MISSION PLANNING

- **Operations must be planned far in advance (>6 months)**
- Solar Orbiter Operation Plans (SOOPs)
  - Other instruments can join and plan accordingly, but SO can't alter advance planning, so early science suggestions are welcome
- Remote Sensing: 10 day perihelion passes, 10 days high latitude (N/S), so 30 days per orbit with remote sensing
- In Situ: available all the time

DATA AVAILABILITY

- **Limited Telemetry:** ≈16,000 images per orbit, ≈320,000 mission lifetime
- Open data policy
- Low Latency data arrives within days (comparable to STEREO Beacon Data)
  - Used for identifying important/disposable data
  - Still in the planning stages
- Other data can be available in as long as six months – available to the community on arrival, no embargo

EUI SCIENCE LEADS

- **Pierre Rochus (PI, Belgium)**
- David Berghmans (Co-PI, Belgium)
- Louise Harra (UK)
- Udo Schühle (Germany)
- Frederic Auchère (France)
- Werner Schmutz (Switzerland, Emeritus)