

Solar Orbiter Major Flare Campaigns EUV - EUV short exposures

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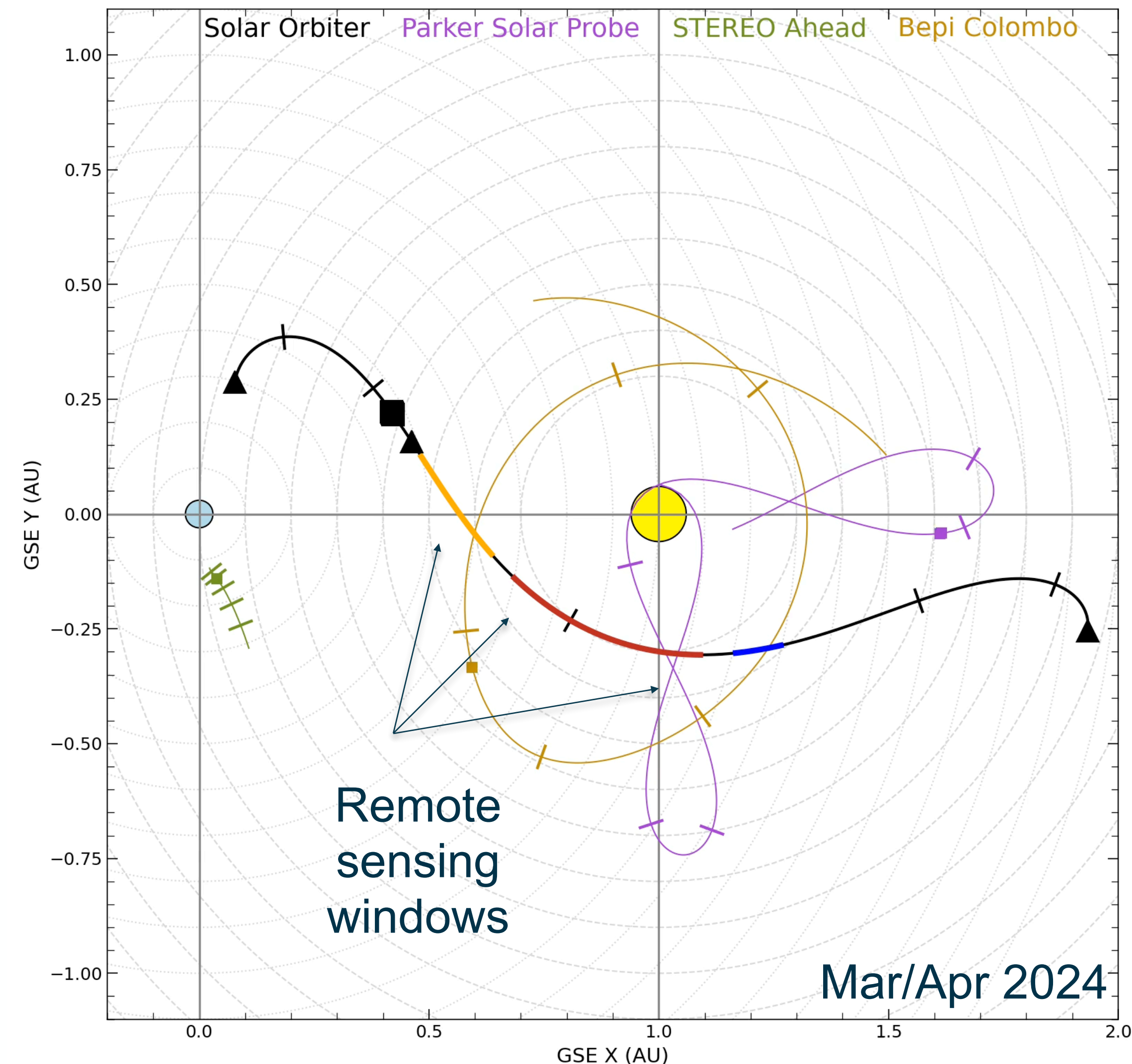
Major flare high resolution campaigns

- **SOOP = “Solar Orbiter Observing Plan”**
 - Coordinate observations with high-resolution operating modes with specific science goal

Major Flare SOOP:

- Flare focused SOOP to point at flaring region
- Combined **EUI/HRI + STIX + SPICE** (+PHI)

Aims: for *first ever high-cadence, short exposure high resolution EUV flare observations*, coupled hard X-rays and UV spectroscopic



SOLAR ORBITER MAJOR FLARE SOOP

Primary Instruments

STIX – Non-thermal X-ray imaging spectroscopy (obtain information about accelerated electrons).

EUI/HRI_{EUV} – High-cadence **short-exposure**, saturation free EUV imaging.

SPICE – High-cadence EUV spectroscopy, spanning 10kK – 10MK (sit-and-stare mode).

PHI – High-res magnetograms and WL context images.

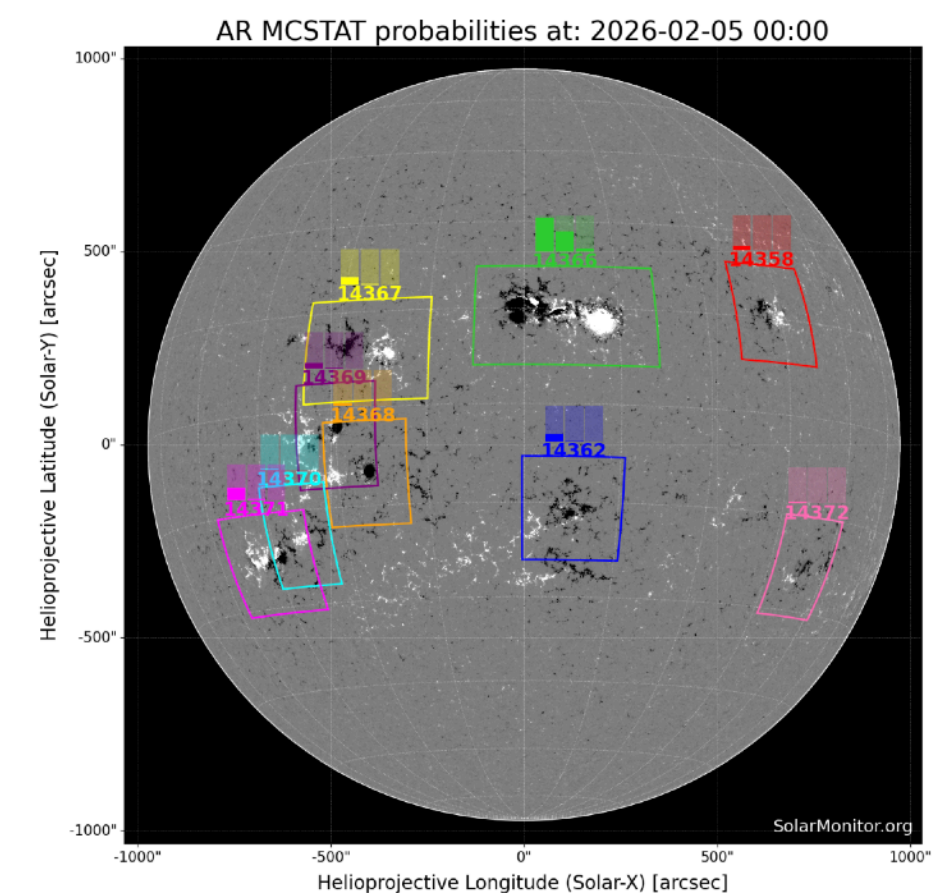


Coordinations

- IRIS, Hinode/XRT + EIS
- DKIST, SST
- EOVSa, ILOFAR

Targets:

- Active regions most likely to flare (i.e. have they flared recently)
- Also use STIX + low-latency PHI/EUI to decide



EUI OBSERVING MODES

Short + Long Exposure Images

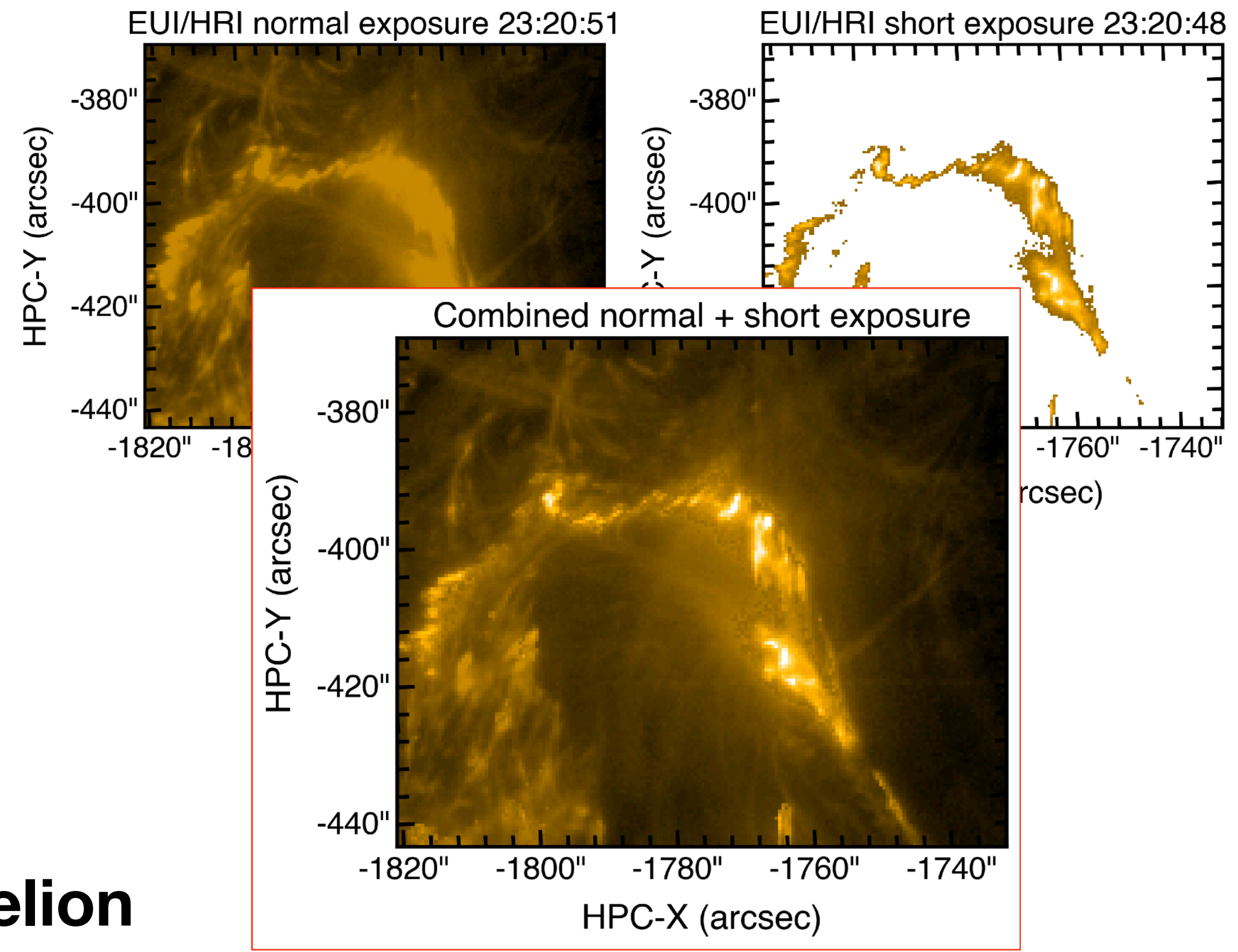
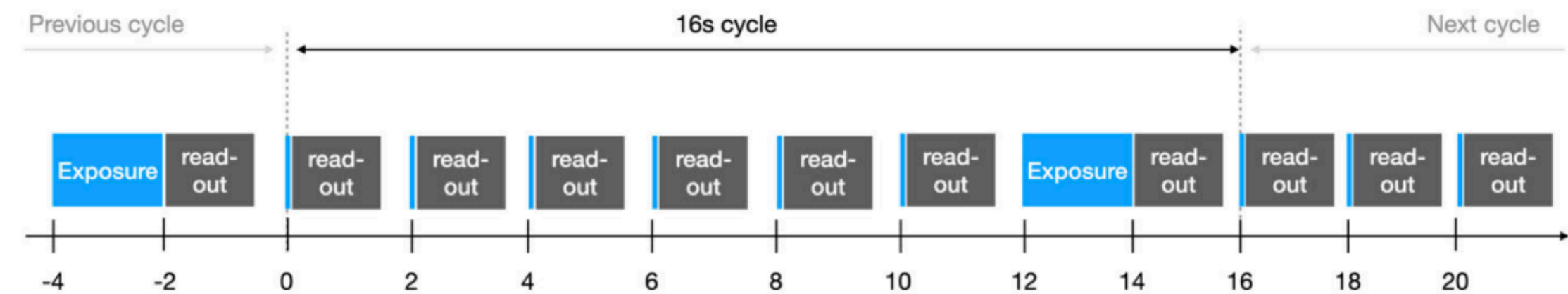
- “regular” image = 2s exposure time and lossy high-quality compression (x7.4) giving 1 MiB images
- “shorts” image = 0.04s exposure time and lossy strong compression (x124) giving 0.06 MiB images

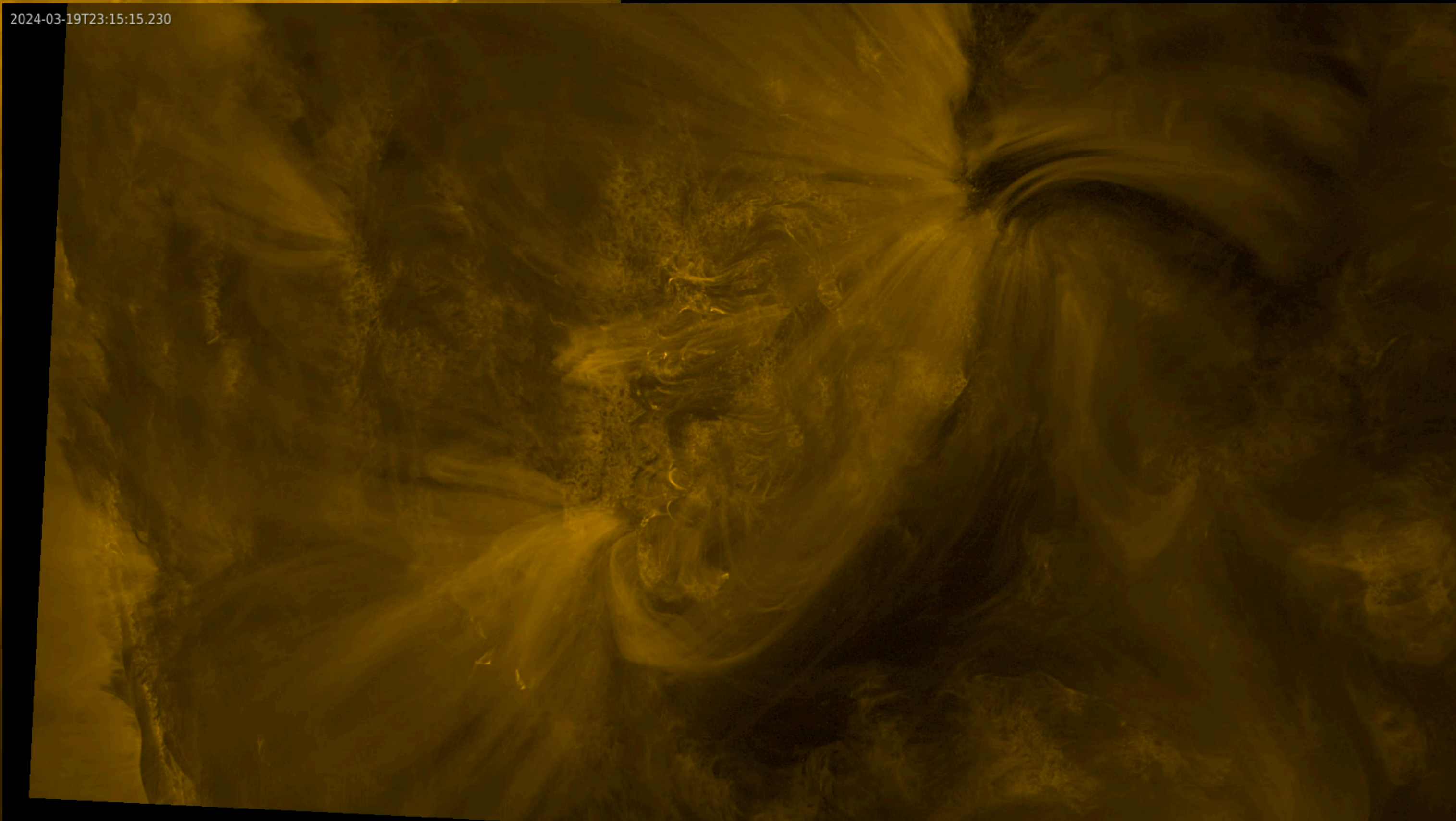
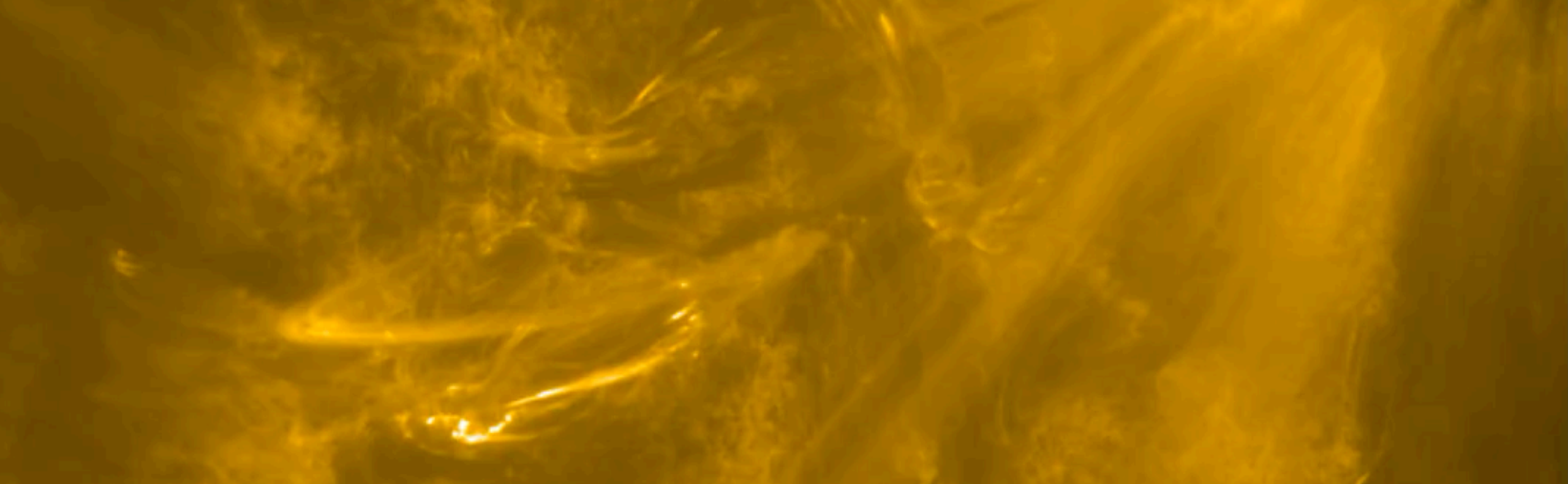
Different EUI/HRI_{EUV} Flavours

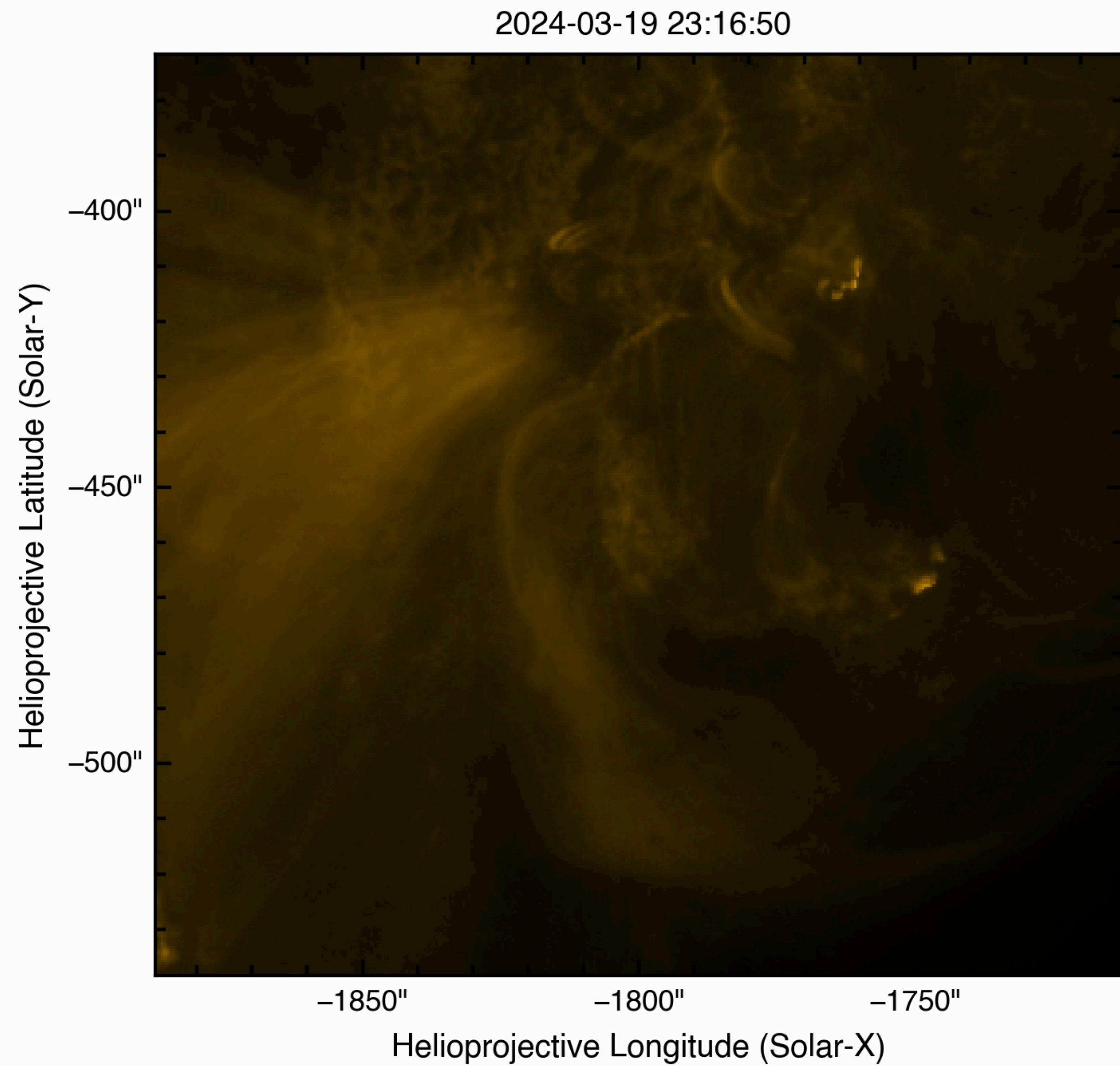
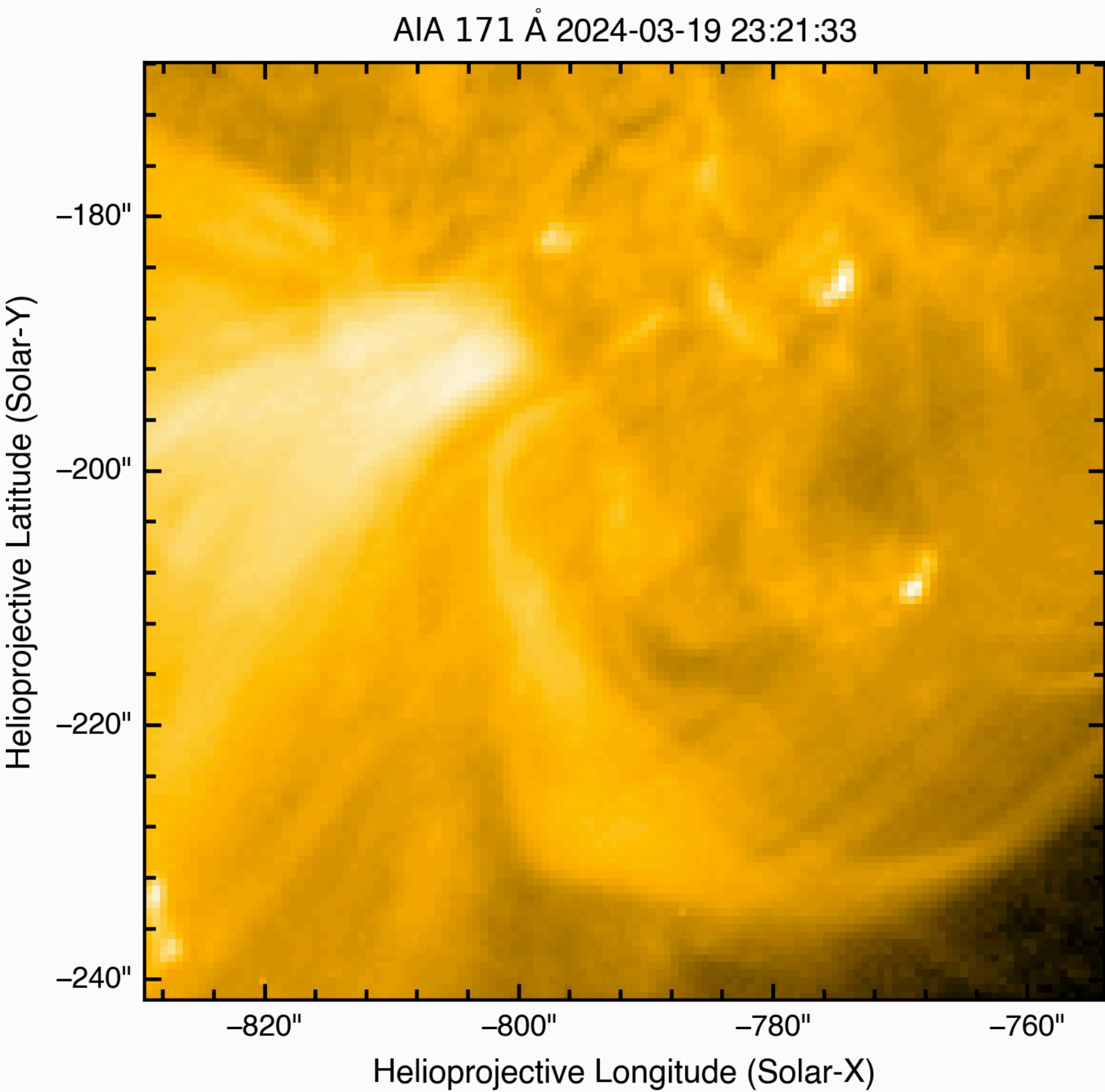
- 16s cycle consisting of 6 shorts every 2s, followed by 1 regular taking 4s (typically 4h = 1224 MiB=3600 shorts and 900 regulars).
- 60s cycle consisting of 18 shorts every 3s, 1 short during 2s, followed by 1 regular taking 4s (typically 7h duration = 899 MiB=7980 shorts and 420 regulars)
- 60s cycle consisting of 18 shorts every 3s, 1 short during 2s, followed by 1 regular taking 4s (typically 7h duration = 899 MiB=7980 shorts and 420 regulars)

EUI 174 Å

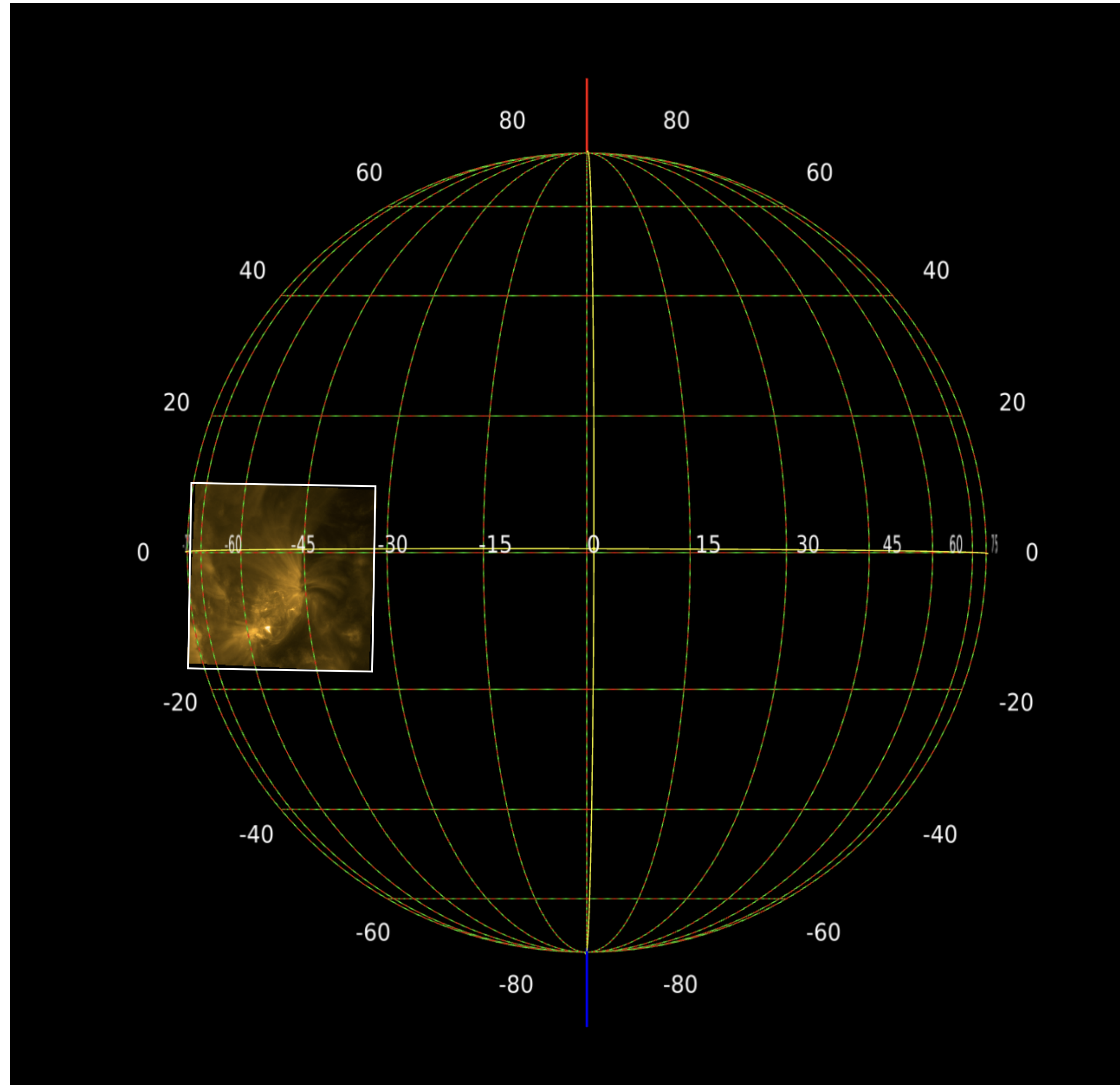
- 2s or 2s cadence
- Spatial resolution is 0.492” ~ 0.145” at perihelion
- (100-150km pixel size, PSF~2 pixels)







MAJOR FLARE CAMPAIGN MODE



- Normal major flare campaigns, EU, SPICE, PHI all in flare-focused mode
- Point at active region, defined set of time (based on telemetry) Usually 4-6 hour slots, near perihelion during main RSWs
- Cross-fingers and hope for flare! 🤞

INSTANCES

April 2023 (RSW #8)

1 instance (SPICE only, test of the flare-optimised SPICE studies)

- Pointing mishap with SPICE slit (offset was in applied in the wrong direction) meant that SPICE’s slit was not within the targeted active region.

Spring 2024 (RSW #13, #14)

6 instances

- Very successful campaign, 22 >C-M class flare + several B class flares observed jointly by STIX & EUV/HRI_{EUV}
- Four flares co-observed by STIX, EUV/HRI_{EUV} and SPICE (SPICE slit mostly crossed flare loops, but though two < C class events with footpoints).
- IRIS and EIS coordination, plus EOVSa available.

Autumn 2024 (RSW #17)

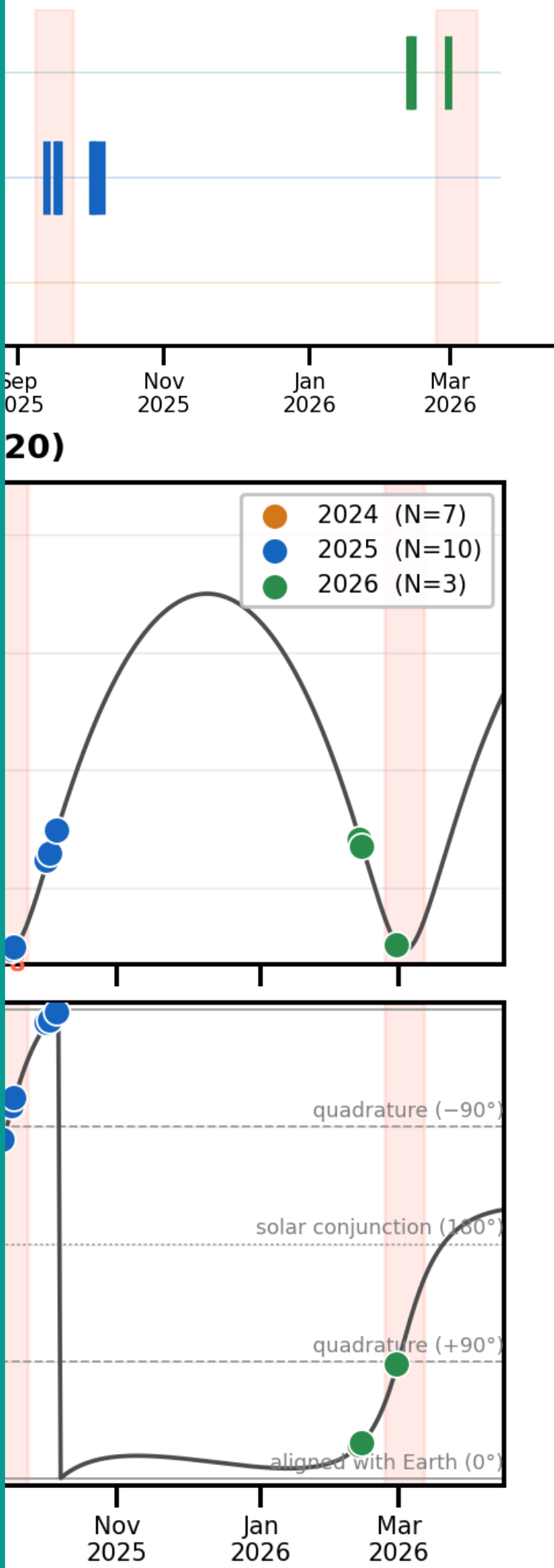
1 instance

- Several flares caught by EUV/HRI_{EUV} + STIX, and by S
- M-class event caught by EUV/HRI_{EUV} and STIX, with EIS coordinated observations.

Major Flare SOOP Executions 2024 - 2026 (N = 20)

Table 3 Flares jointly observed by STIX and EUV/HRI_{EUV} during the Solar Orbiter Major Flare campaign. Events listed in **bold font** are those have confirmed SPICE observations of the flare sources. Additional instruments that observed each flare are listed in the right-most column.

Label	Date	Time ^a [UT]	GOES class	Joint observations
A	2024-03-19	23:21	M2.2	EOVSA, GOES, IRIS slit, SDO, XRT (Be-med & Be-thick), EIS
B	2024-03-23	22:44	C5.9	GOES, IRIS slit, SDO, XRT (Be-med)
C		22:54	C8.0	GOES, IRIS slit, SDO, XRT (Be-med)
D		23:41	M2.5	EOVSA, GOES, IRIS slit, SDO, XRT (Be-med), EIS
E	2024-03-24	00:53	C9.9	EOVSA, GOES, IRIS slit, SDO, XRT (Be-med)
F		01:48	M2.2	GOES, IRIS slit, SDO, XRT (Be-med)
G		02:09	M2.7 ^b	GOES, IRIS slit, SDO, XRT (Be-med)
H	2024-04-02	20:55	~B5 ^c	Not seen from Earth
J		20:59	~B3 ^c	
K		21:32	~B6 ^c	
L	2024-04-04	20:05	C2.5 ± 0.3 ^c	Not seen from Earth
M		20:12	C5.0 ± 0.6 ^c	
N		21:16	M1.0 ± 0.1 ^c	
P		21:42	C3.2 ± 0.3 ^{b,c}	
Q	2024-04-05	20:11	C9.9 ± 1.1 ^c	Not seen from Earth
R		21:46	C1.4 ± 0.2 ^c	
S		22:19	C1.1 ± 0.1 ^c	
T		23:45	~B5 ^c	
U	2024-10-15	16:24^d	C2.6	GOES, IRIS slit, SDO, XRT (Be-thin), EIS
V		18:27	M2.1	GOES, SDO, XRT (Be-thin), EIS
W		19:48	C4.0	GOES, SDO, IRIS slit, XRT (Be-thin)
X		23:08^d	C9.4	GOES, SDO, IRIS slit, XRT (Be-thin), EIS



Ryan et al. 2025

INSTANCES

Spring 2025 (RSW #19, #20)

4 instances

- Small eruption co-observed by EUI/HRI and SPICE at ~21:30 UT on 2025-03-14.

Autumn 2025 (RSW #23, #24)

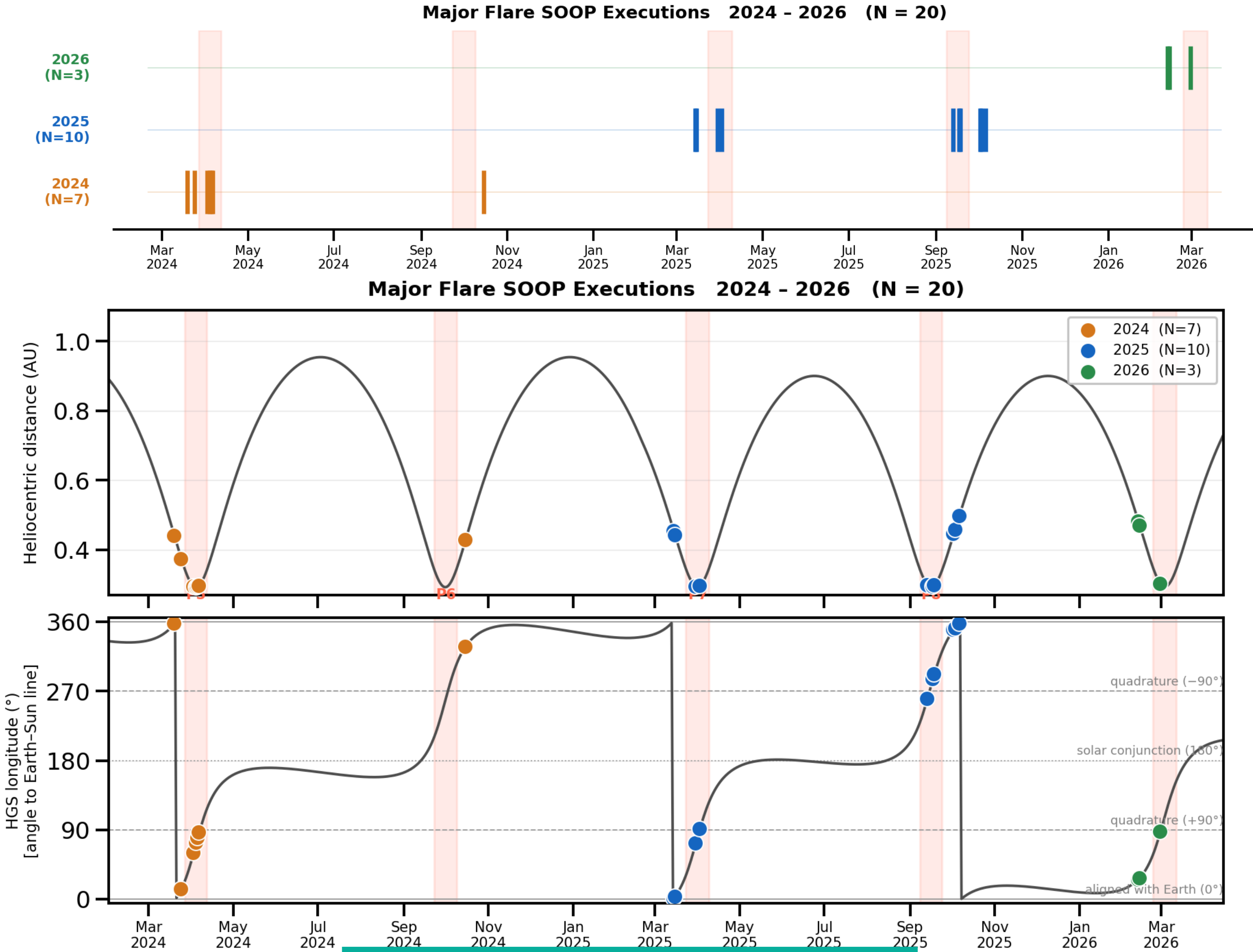
6 instances

- Instances on 2025-10-02 and 2025-10-03 were not pointed at the planned target due to vSTP upload error on the SOC side.
- C5.1 flare observed by EUI/HRI during 2025-10-06 instance. SPICE co-observed.

Winter 2026 (RSW #25 & #26)

3 instances

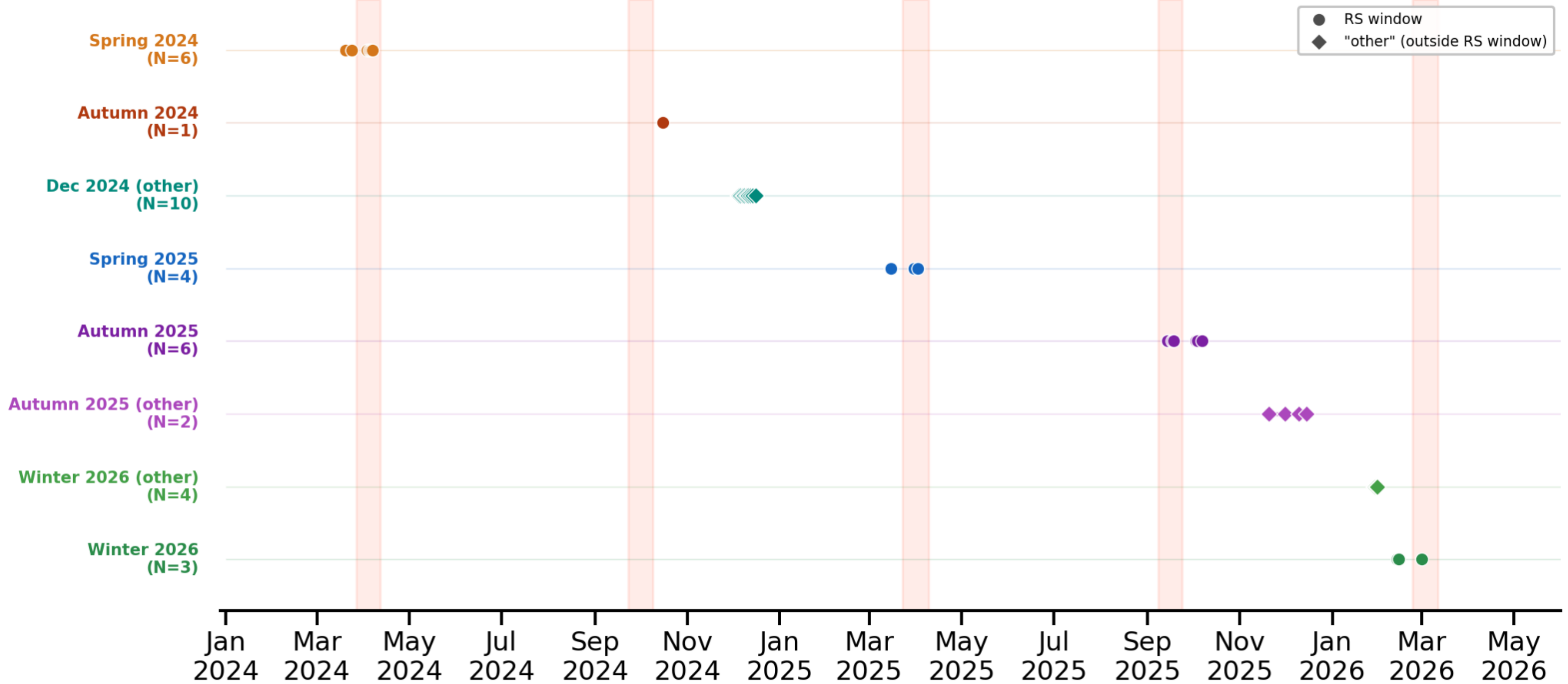
- Coordination with IRIS, EIS, and Big Bear Solar Observatory (observing out of s
- 12th / 13th / 28^t February did not have flares during the campaign window.



Summer 2026 planned 🙌

- 4 instances will run
- 2026-08-18, 19, 20 and
- 2026-09-18

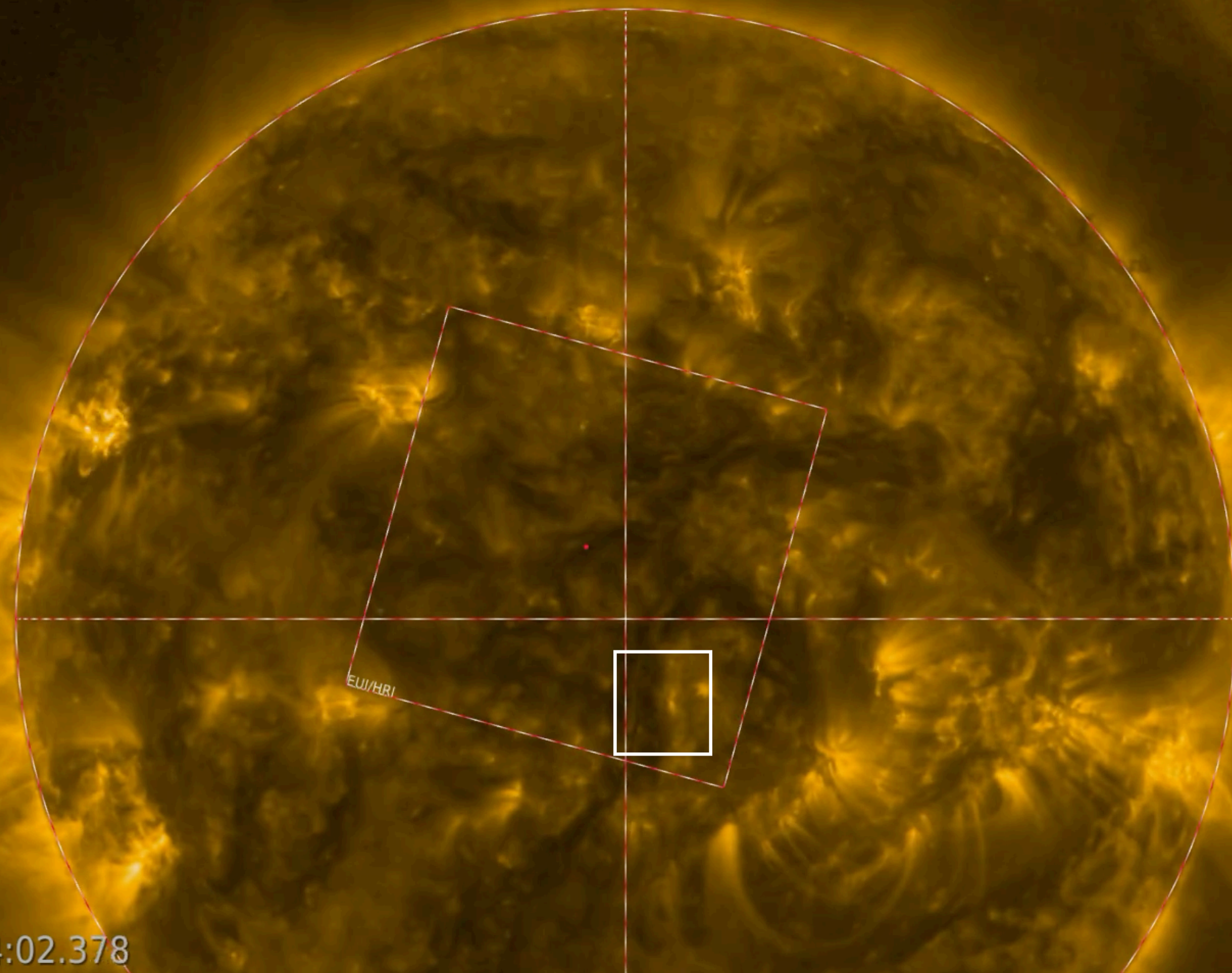
MFC EUI observing windows + Dec 2024 sequence (N = 36)



FLARE TRIGGER (HUNTING) MODE

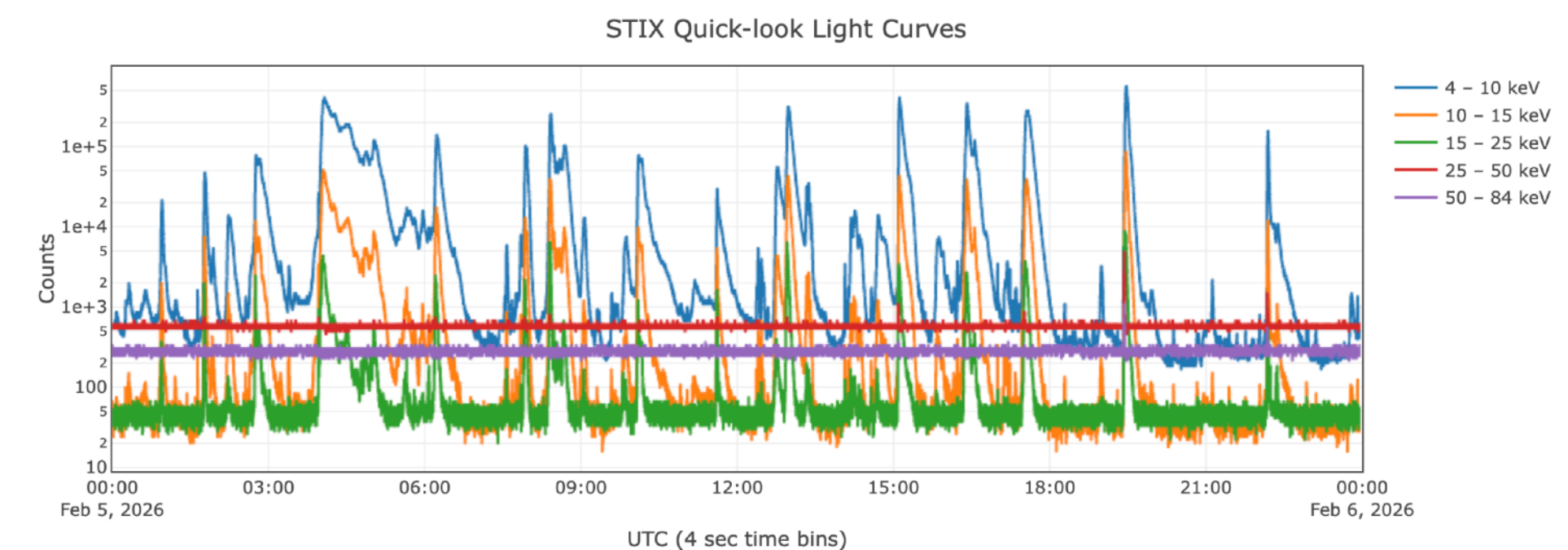


NOAA
4366



2026-02-01T00:44:02.378

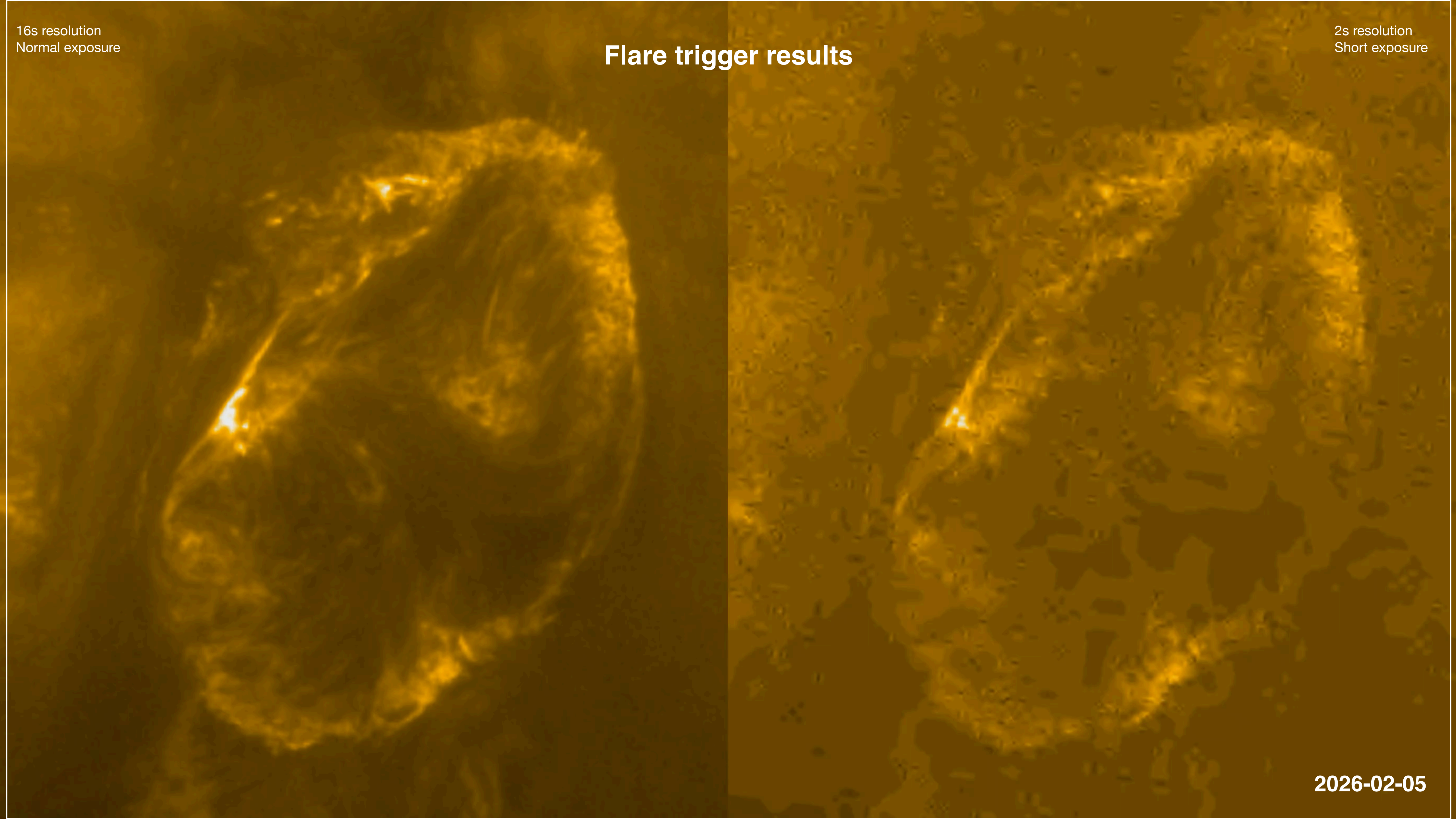
- Outside main RSWs
- Bosus science!
- Point at disk center, and wait for flare
- If flare measured by STIX, then store data
- Service 20 mode between instruments



16s resolution
Normal exposure

Flare trigger results

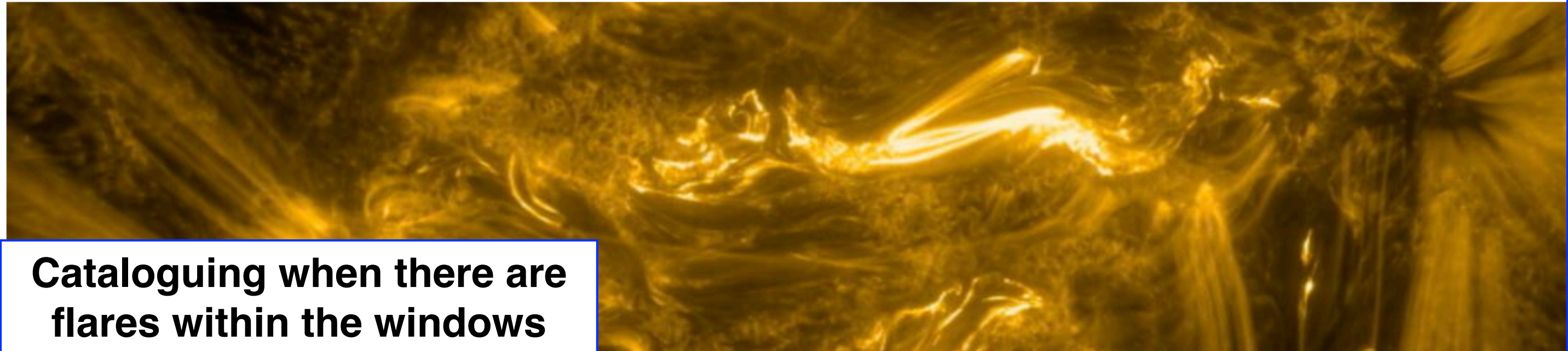
2s resolution
Short exposure



Maximising Science from Solar Orbiter's Solar Flare Campaigns

ISSI Team 25-641 led by Hayes L. & Collier H.

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Cataloguing when there are
flares within the windows

Cataloguing when the major flare
campaigns ran (in both flavours)

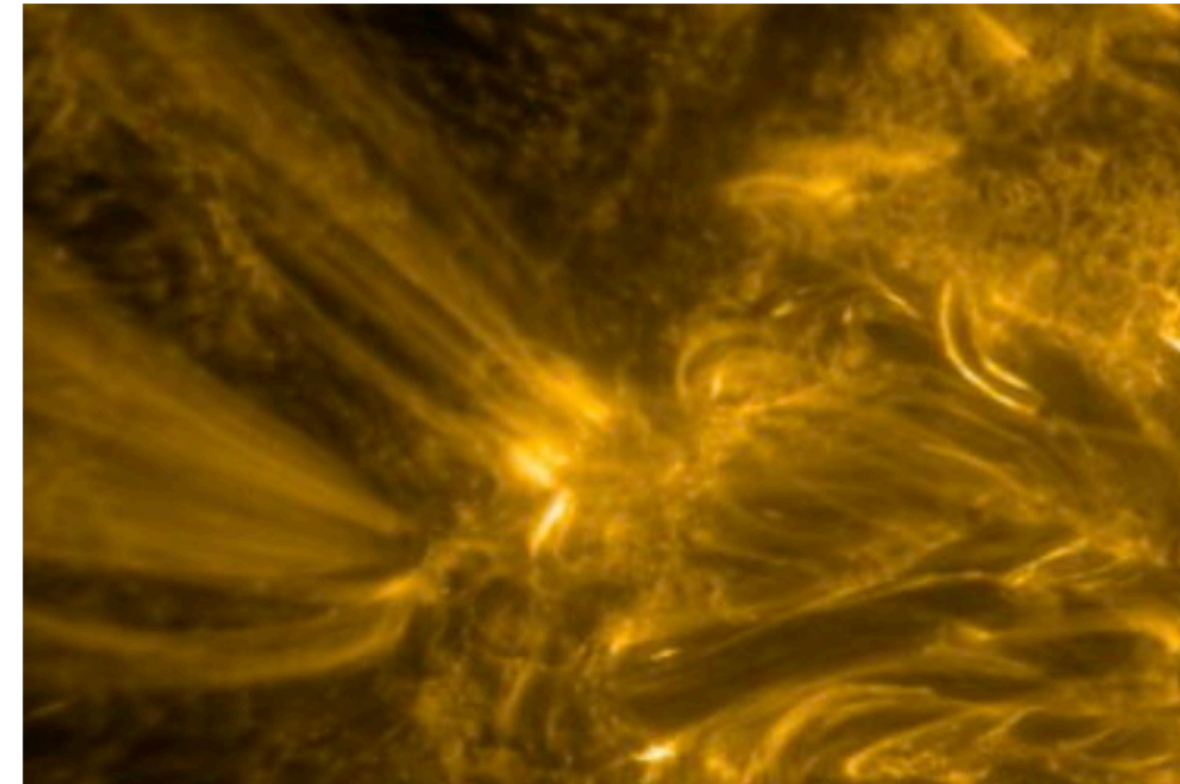
Flare start time EUJ	Flare start time STIX	Flare peak time (STIX 4-10keV)	Flare end time STIX	Flare end time EUJ	Approximate location in HPC from SoLO	GOES class
2024-03-19	20:00-00:00					
19/03/2024 23:10:00	19/03/2024 23:15:00	19/03/2024 23:21:00	20/03/2024 00:10:00	00:00:00 (end of window)	-1800, -400	M2.2
2024-03-23	22:30-02:30					
23/03/2024 22:38:00	23/03/2024 22:39:00	23/03/2024 22:44:00	23/03/2024 22:50:00	23/03/2024 22:49:00	-650, -260	C5.9
23/03/2024 22:52:00	23/03/2024 22:50:00	23/03/2024 22:54:09	23/03/2024 23:00:00	23/04/2024 23:00:00	-650, -260	C7.9
23/03/2024 23:26:00	23/03/2024 23:30:00	23/03/2024 23:30:00	23/03/2024 23:52:00	24/03/2024 00:44:00	-540, -340	
23/03/2024 23:32:00	23/03/2024 23:22:00	23/03/2024 23:42:09	24/03/2024 00:47:00	24/03/2024 01:27:00	-400, -150	M2.5
24/03/2024 00:40:00	24/03/2024 00:44:00	24/03/2024 00:54:21	24/03/2024 01:35:00	24/03/2024 01:40:00	-500, -300	M1.5
24/03/2024 01:30:00	24/03/2024 01:43:00	24/03/2024 01:49:17	24/03/2024 02:30:00	24/03/2024 02:18:00	-500, -300	M2.7
24/03/2024 2:04:00	24/03/2024 02:08:00	24/03/2024 02:09:00	24/03/2024 02:10:00	24/03/2024 02:18:00	-630, -290	M2.7

Date	Time	EUI Mode	Notes
Spring 2024			
2024-03-19	20:00-00:00	16s cycle	
2024-03-23	22:30-00:00	16s cycle	same window as below
2024-03-24	00:00-02:30	16s cycle	same window as above
2024-04-02	20:00-00:00	16s cycle	
2024-04-03	20:00-00:30	8s, 2s, 8s	
2024-04-04	20:00-00:00	16s	
2024-04-05	20:00-00:00	16s	
2024-04-06	20:00-00:00	16s	
Autumn 2024			
2024-10-14	09:00-10:07	6s	trigger
2024-10-15	09:00-10:07	6s	trigger
	18:00-22:00	16s	may be -22:30
	17:00-11:00	15s	trigger
	00:00-04:00	15s	trigger
	03:00-03:00	15s	trigger
	03:00-17:00	16s	trigger
	00:00-14:00	16s	trigger
	01:00-00:00	15s	trigger same window as below
	00:00-01:00	15s	same window as above
	01:00-05:00	16s	trigger
	01:00-15:00	16s	trigger
	00:00-04:00	16s	trigger
	09:00-23:00	15s	trigger
	16:10-23:10	60s	
2025-03-15	12:00-16:00	16s	

Maximising Science from Solar Orbiter's Solar Flare Campaigns

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Home

This ISSI team brings together an international group of scientists. Solar Orbiter's Extreme Ultraviolet Imaging Spectrometer (EUI) observations provide the first clear, high-speed observations of solar flares from instruments, revealing fine detail in how flares

Watch this space
Live soon! 🌞

The catalogue is becoming a science map

One entry point links the flare, spacecraft operating mode and coordinated context.

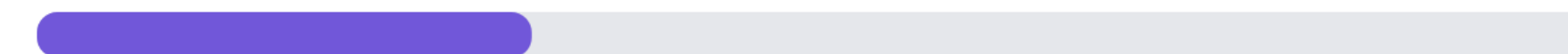
41 IDENTIFIED FLARES

11 M · 24 C · 4 B · 2 unclassified



GOES / STIX class distribution in the cleaned flare list

13 events already have specific radio coverage documented



LWA · EOVS · RPW · NRH · ORFEES · Learmonth · I-LOFAR · Ondřejov

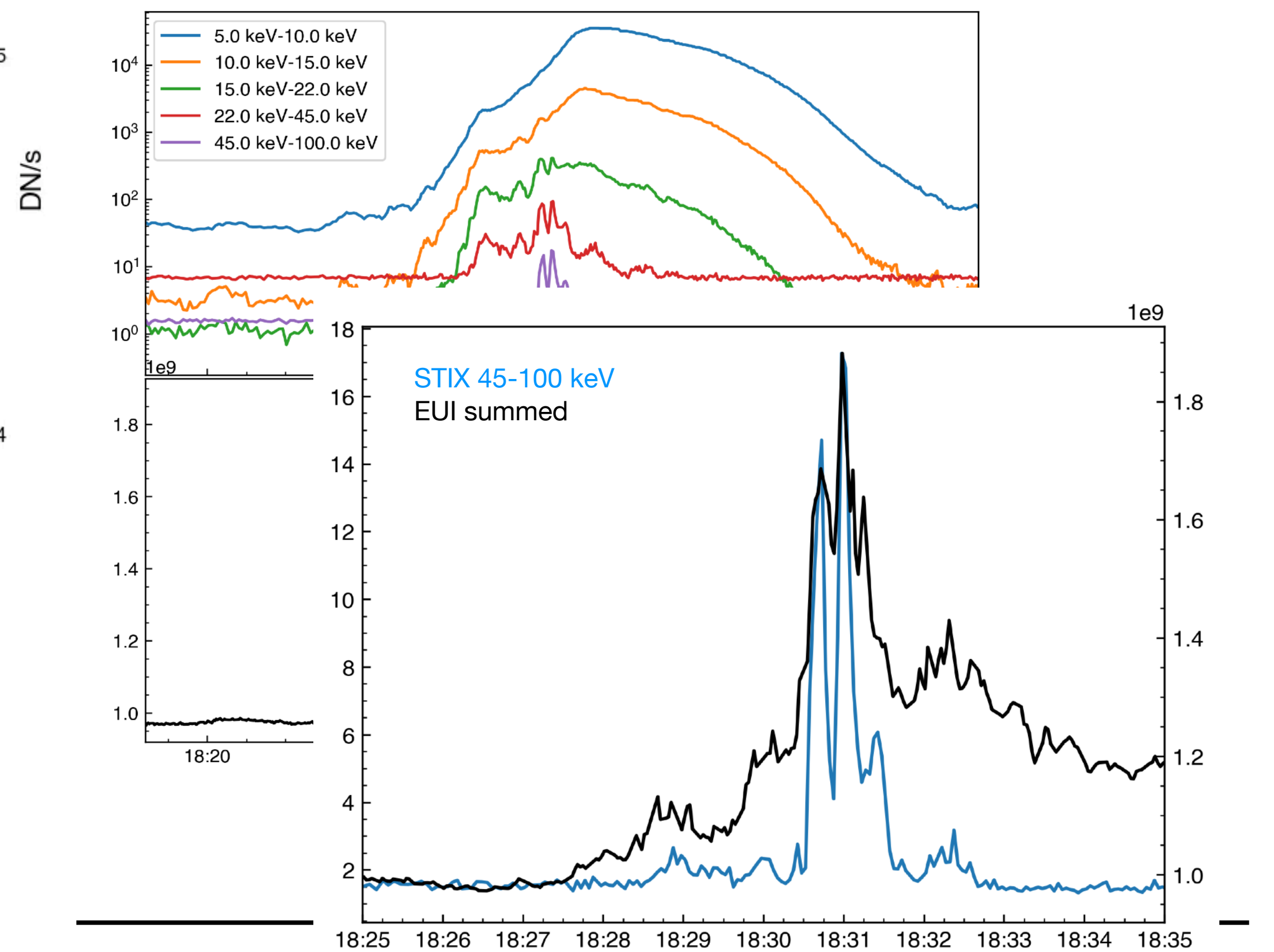
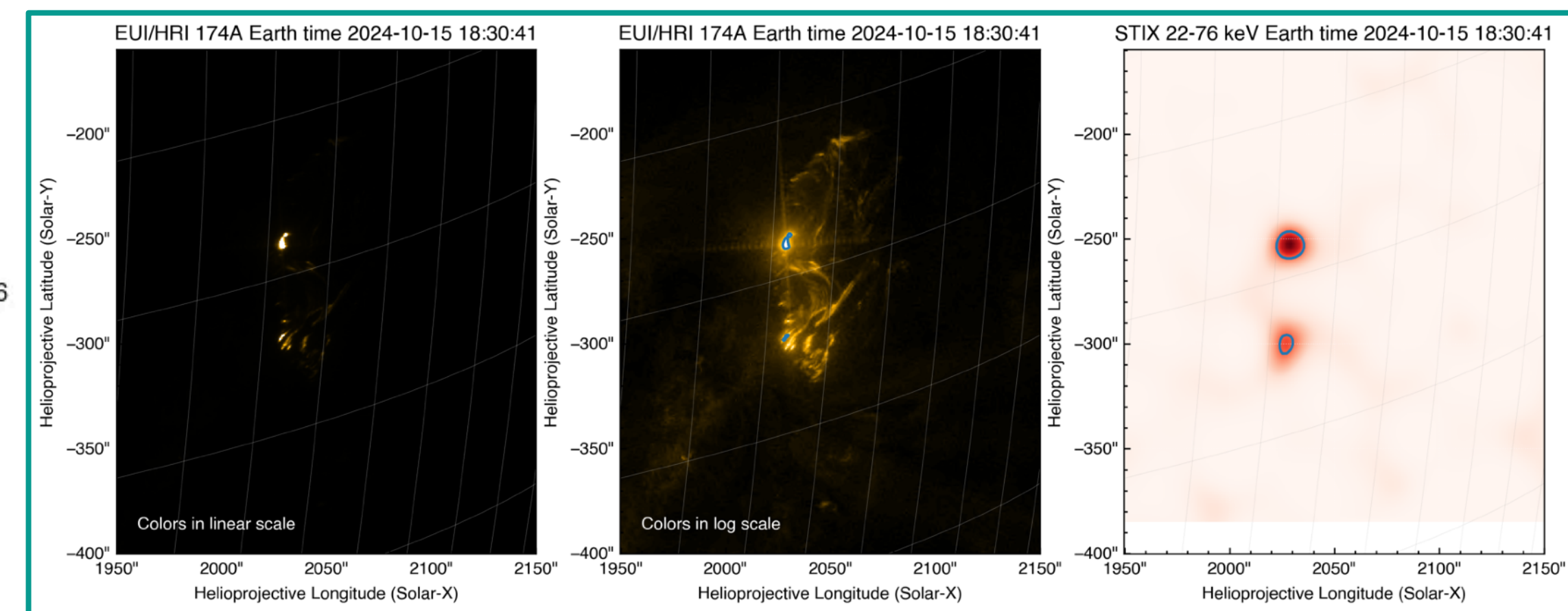
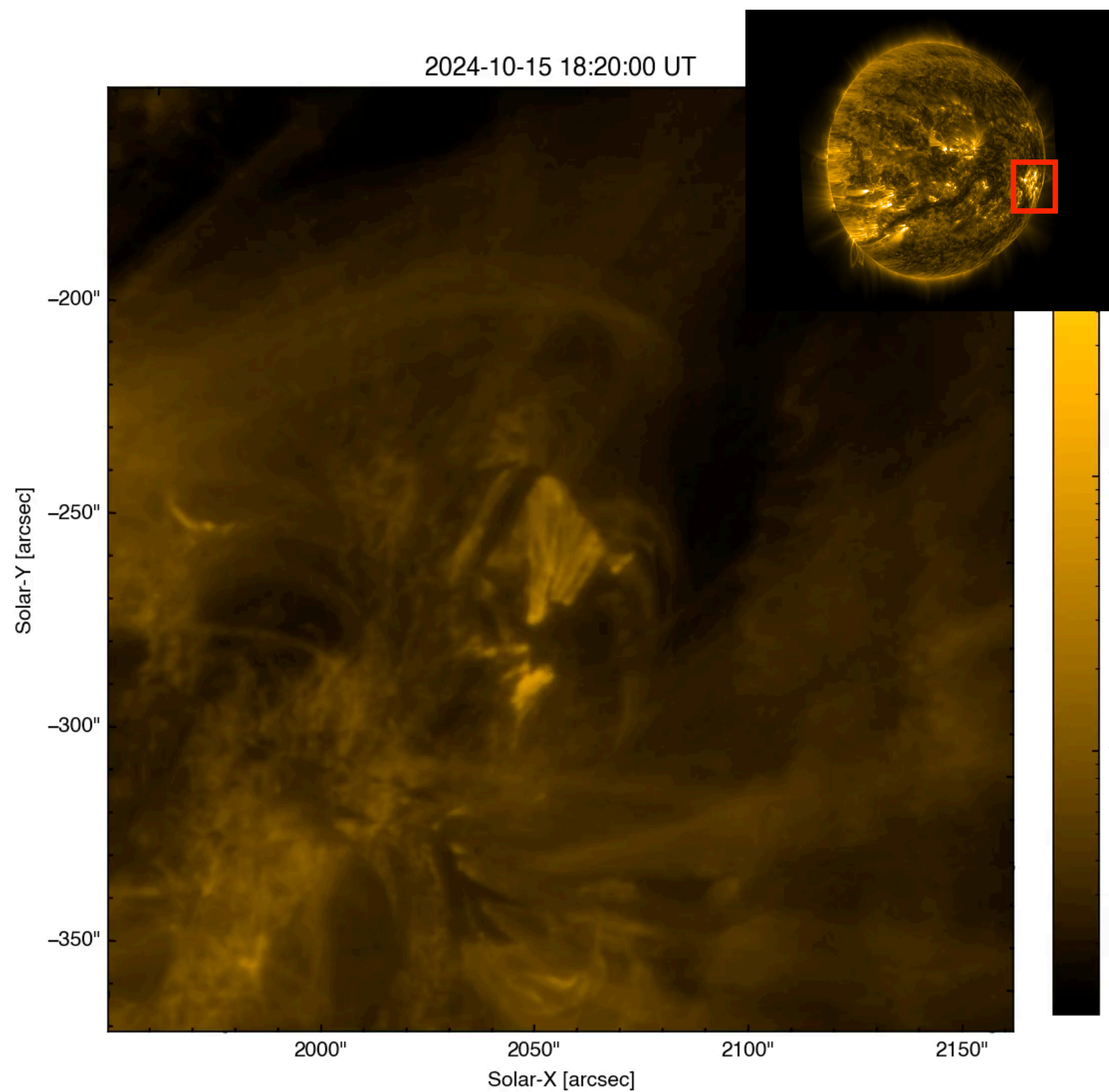
An EPD coverage field has also been added for future flare–particle links.

Each catalogue entry connects

- EUI and STIX start, peak and end times
- Flare class and Solar Orbiter coordinates
- HRI_EUV cadence, mode and trigger state
- Radio, IRIS, Hinode, PHI and SPICE context
- Movie, processing and publication status

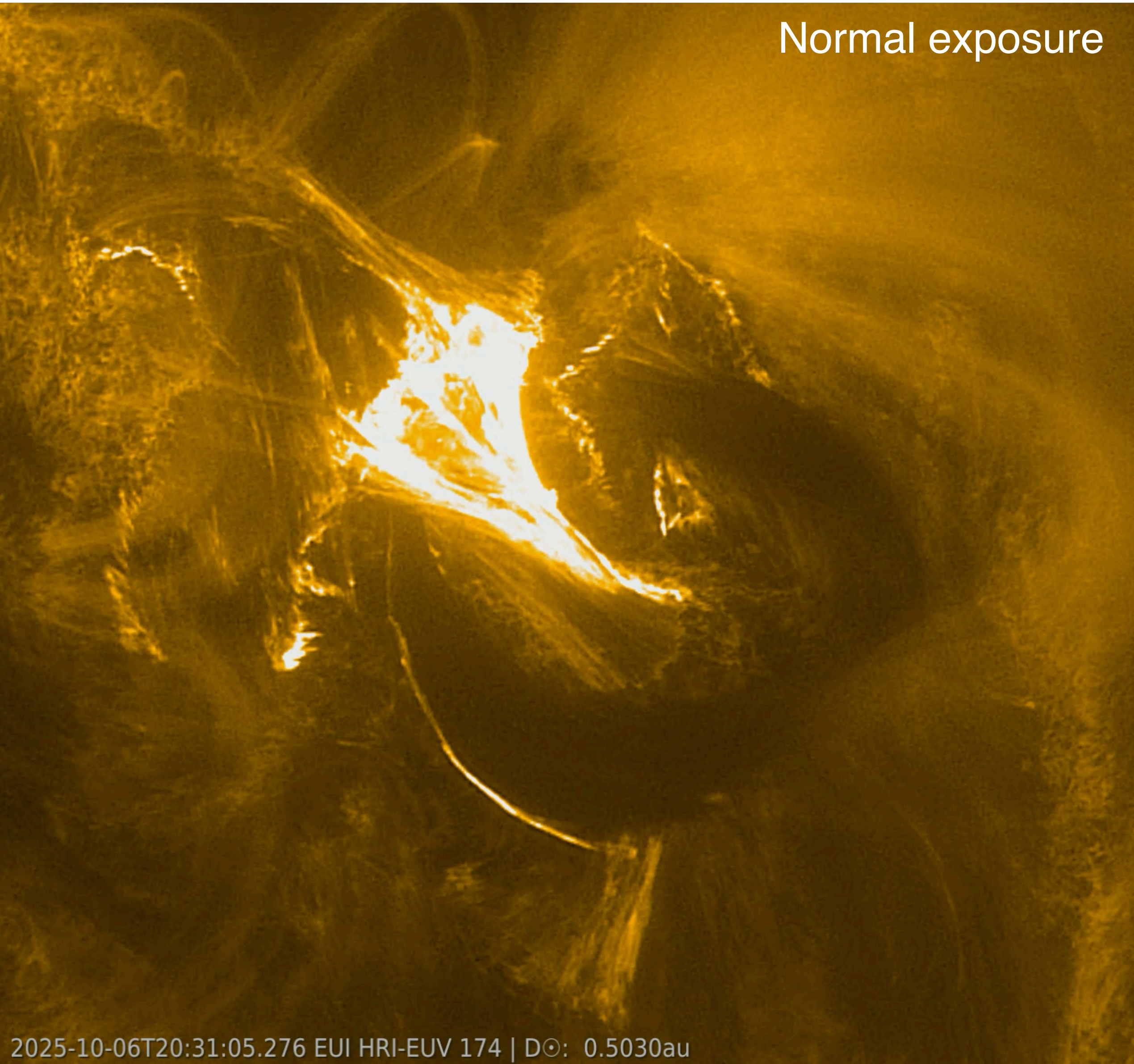
Public catalogue + community paper

What this unlocks kernels & ribbons · EUV–HXR timing / QPPs · loop cooling & flows · white-light triggers · population studies

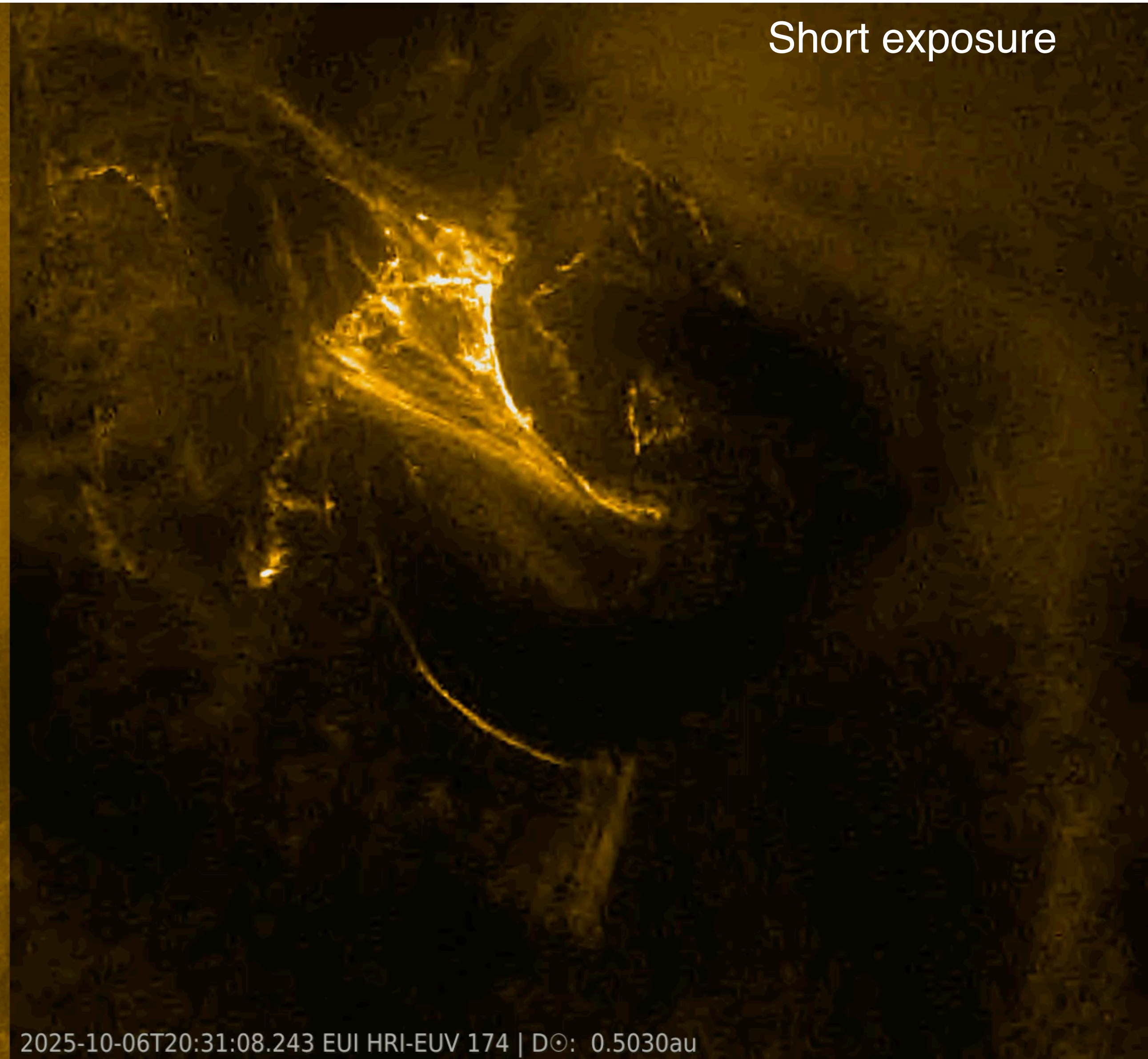


Oct 6 2025

Normal exposure



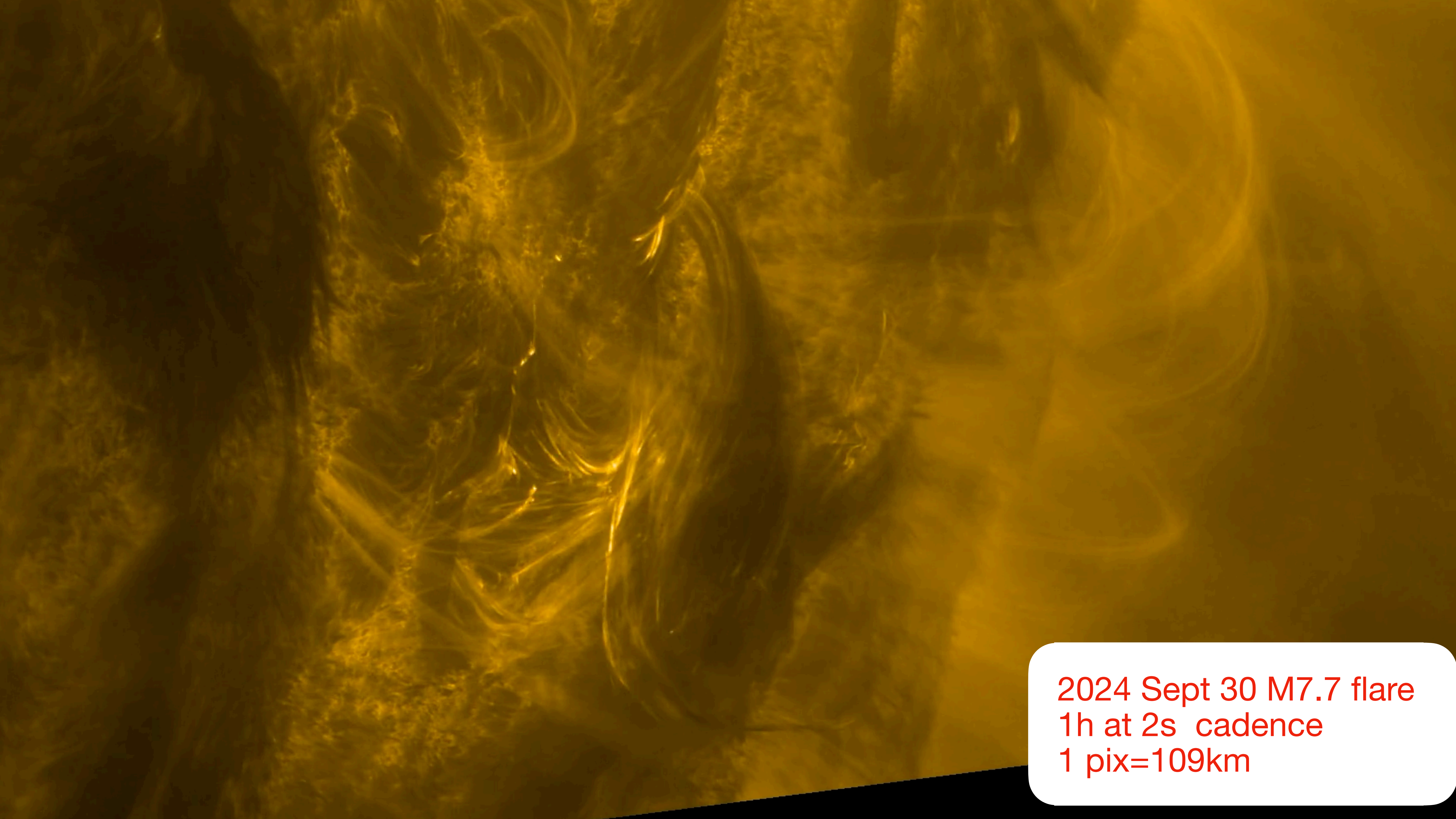
Short exposure



2025-10-06T20:31:05.276 EUI HRI-EUV 174 | D_☉: 0.5030au

2025-10-06T20:31:08.243 EUI HRI-EUV 174 | D_☉: 0.5030au

With lossy compression



2024 Sept 30 M7.7 flare
1h at 2s cadence
1 pix=109km