DIAS
Institiúid Ard-Léinn Bhaile Átha Cliath | Dublin Institute for Advanced Studies

The 18 January 2026 eruption and its severe solar energetic particle event

Quasi-periodic pulsations from STIX hard X-rays to a severe SEP event: A work-in-progress case study

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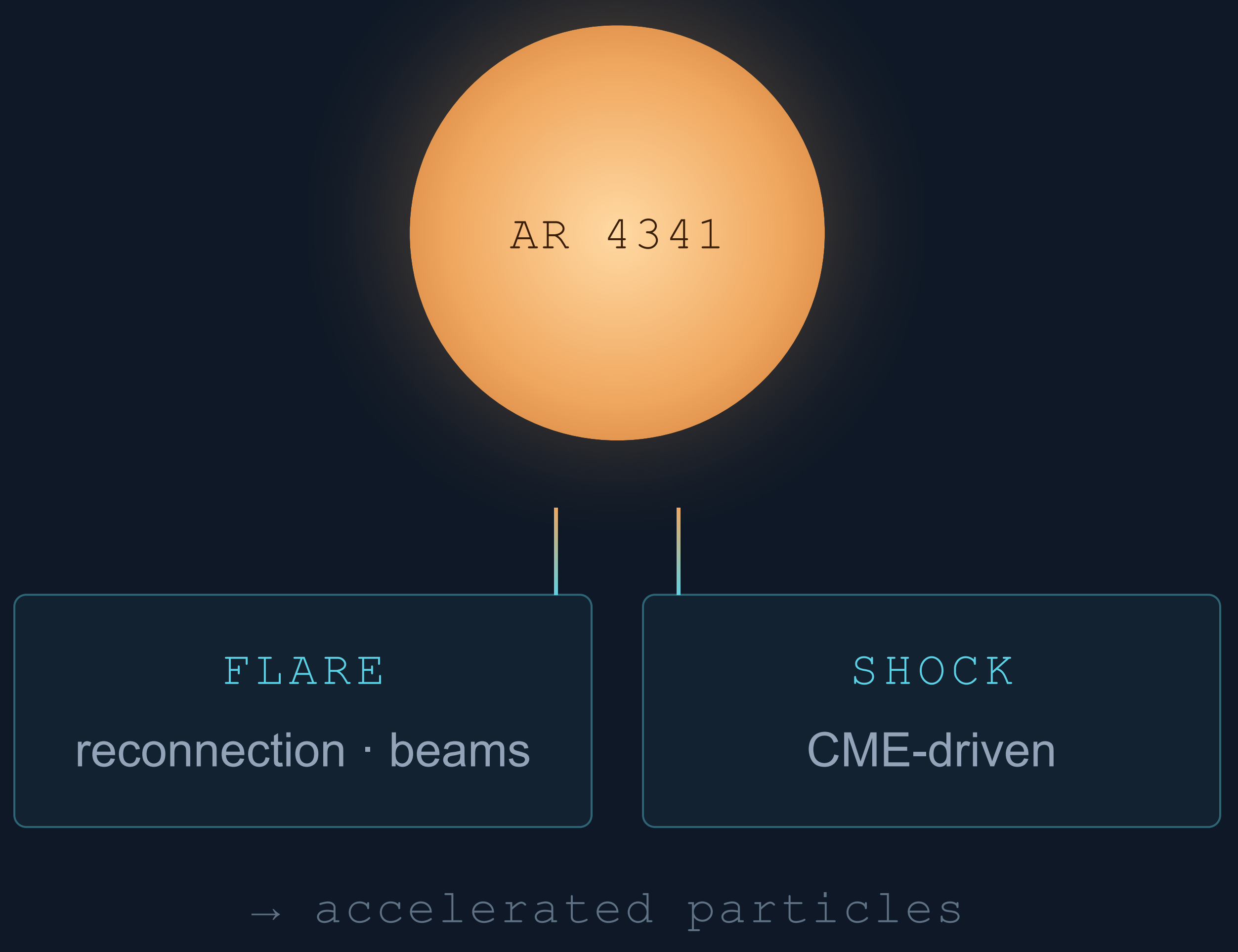
■ STIX Meeting · DIAS · DUBLIN · 24 July 2026

Motivation and the open question

In a large eruption, where and when are electrons and protons accelerated?
in the flare, or at the CME-driven shock?

- — QPPs mark **repeated episodes** of energy release and electron acceleration
- — If the same rhythm recurs across wavelengths and in situ, **bursty reconnection** may govern particle escape
- — A well-observed test case: X-class flare + fast halo CME + severe SEP event

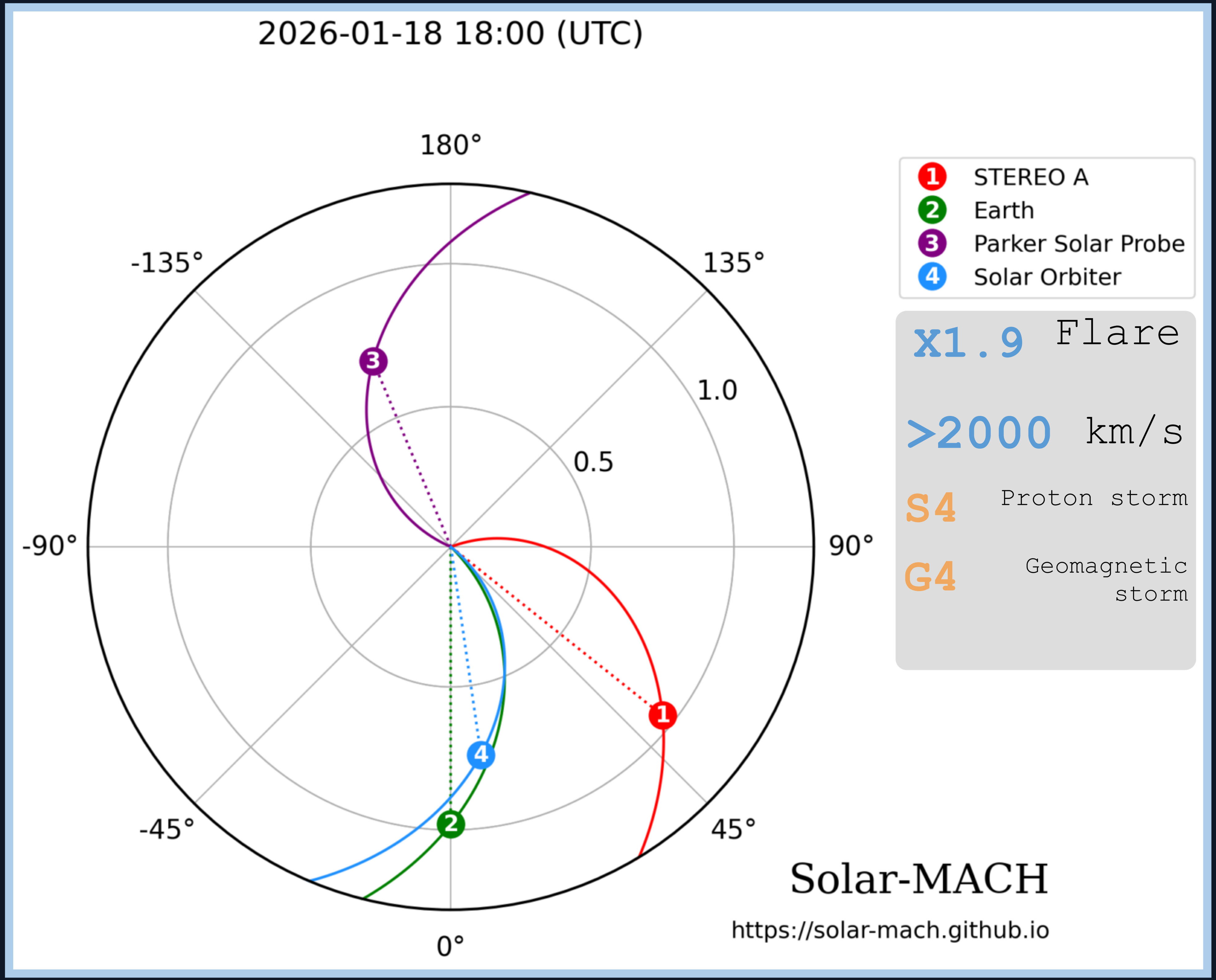


Observations and data

INSTRUMENT	MEASUREMENT
SolO / STIX	Hard X-rays 4–150 keV
EOVSA	Microwave spectra
OVRO-LWA	Low-freq dyn. spectra + imaging (~10 s)
SDO / AIA + HMI	EUV imaging + magnetograms
LASCO + STEREO-A/COR2	White-light coronagraphs
GOES	Soft X-rays + >10 MeV protons
SolO / EPD	In-situ electrons & ions
L1 monitors	Solar wind & IMF
Ground-based (Antarctic, Rozhen)	VLF/HF · B-field · neutron monitor

No European radio: flare peaked after local sunset — I-LOFAR did not observe. Radio rests on dayside OVRO-LWA + EOVSA

The 18 January 2026 event at a glance

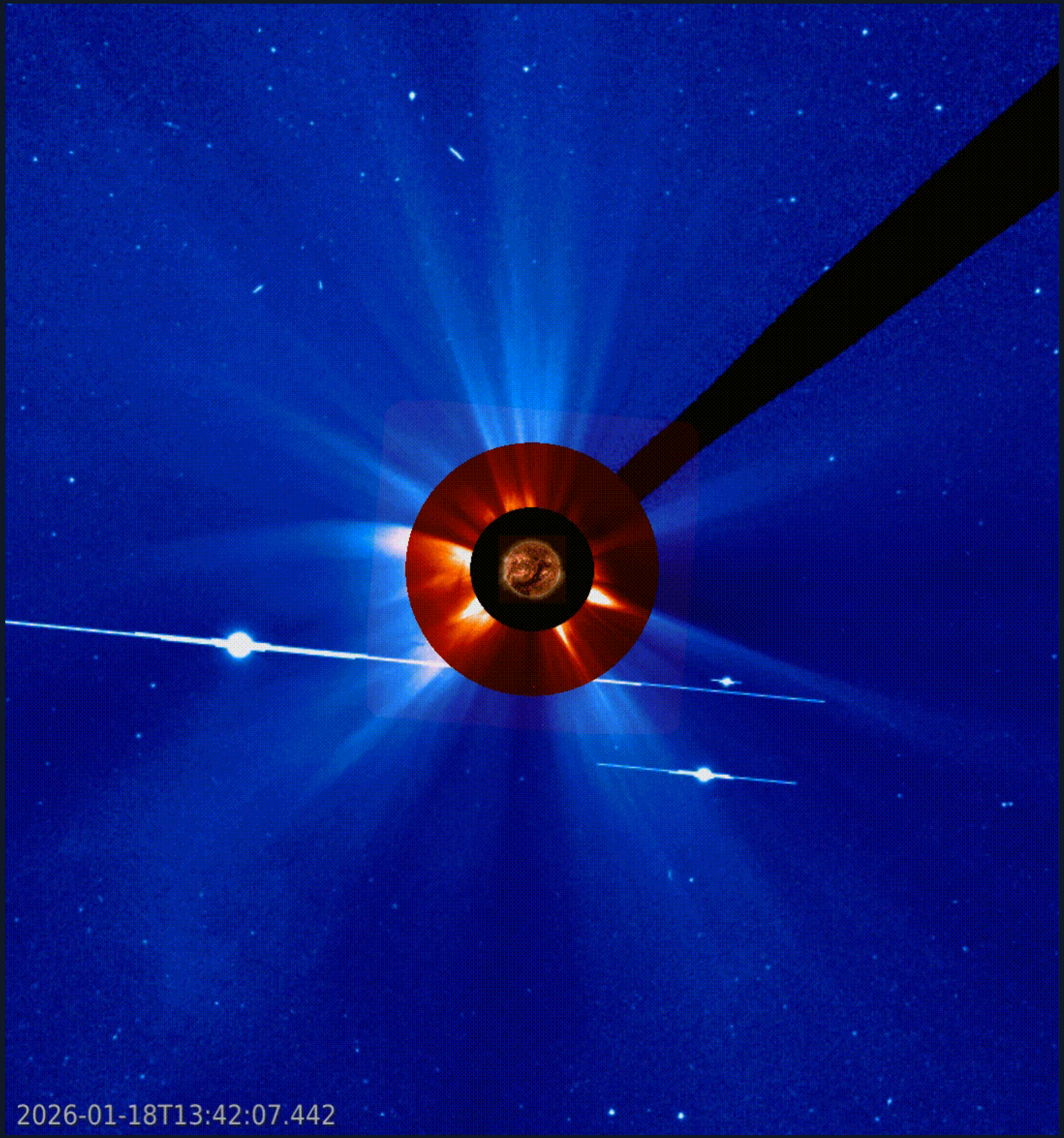


X1.9 Flare

>2000 km/s

S4 Proton storm

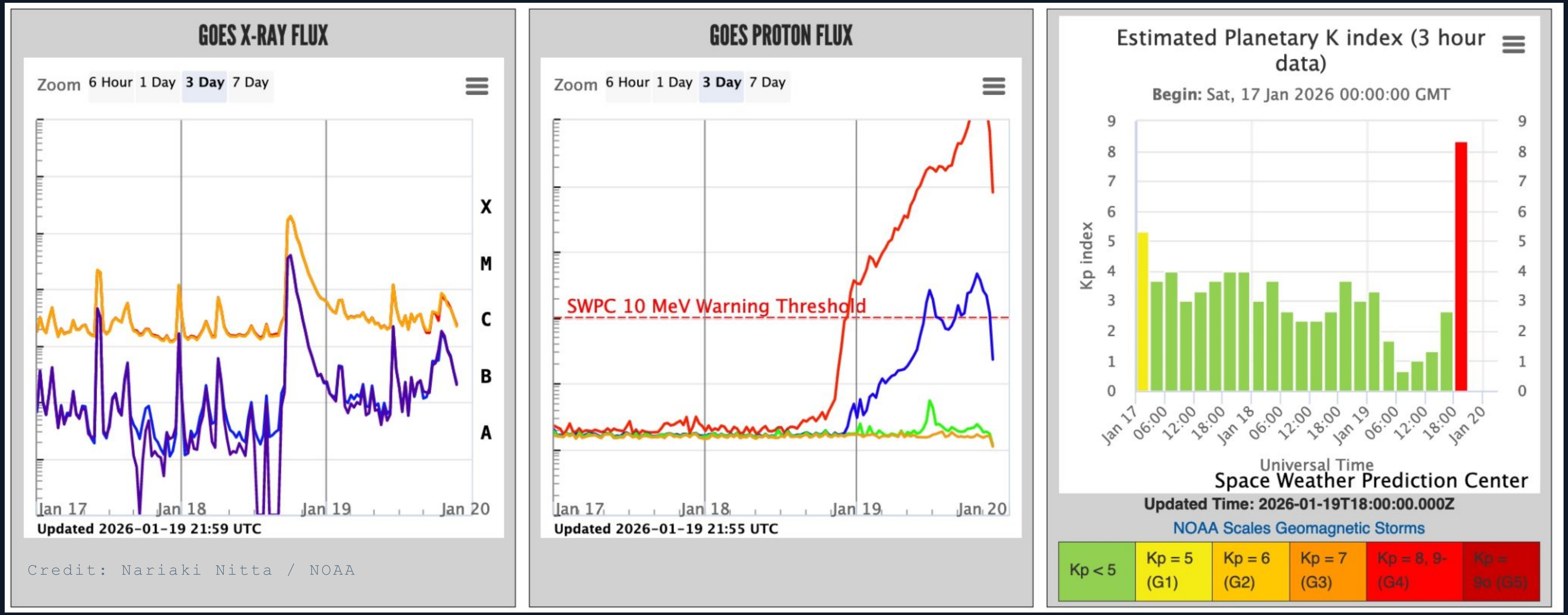
G4 Geomagnetic storm



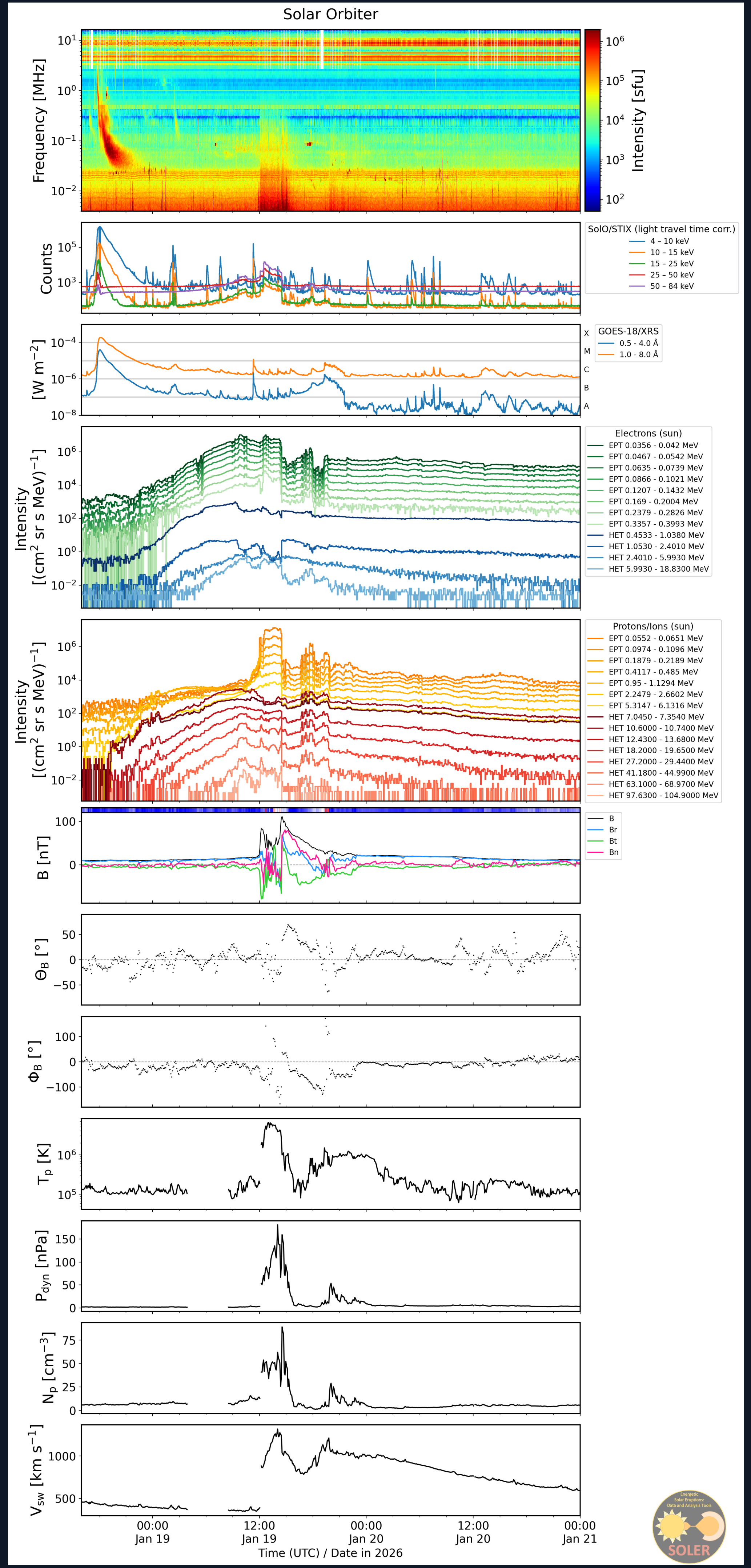
Credit: ESA

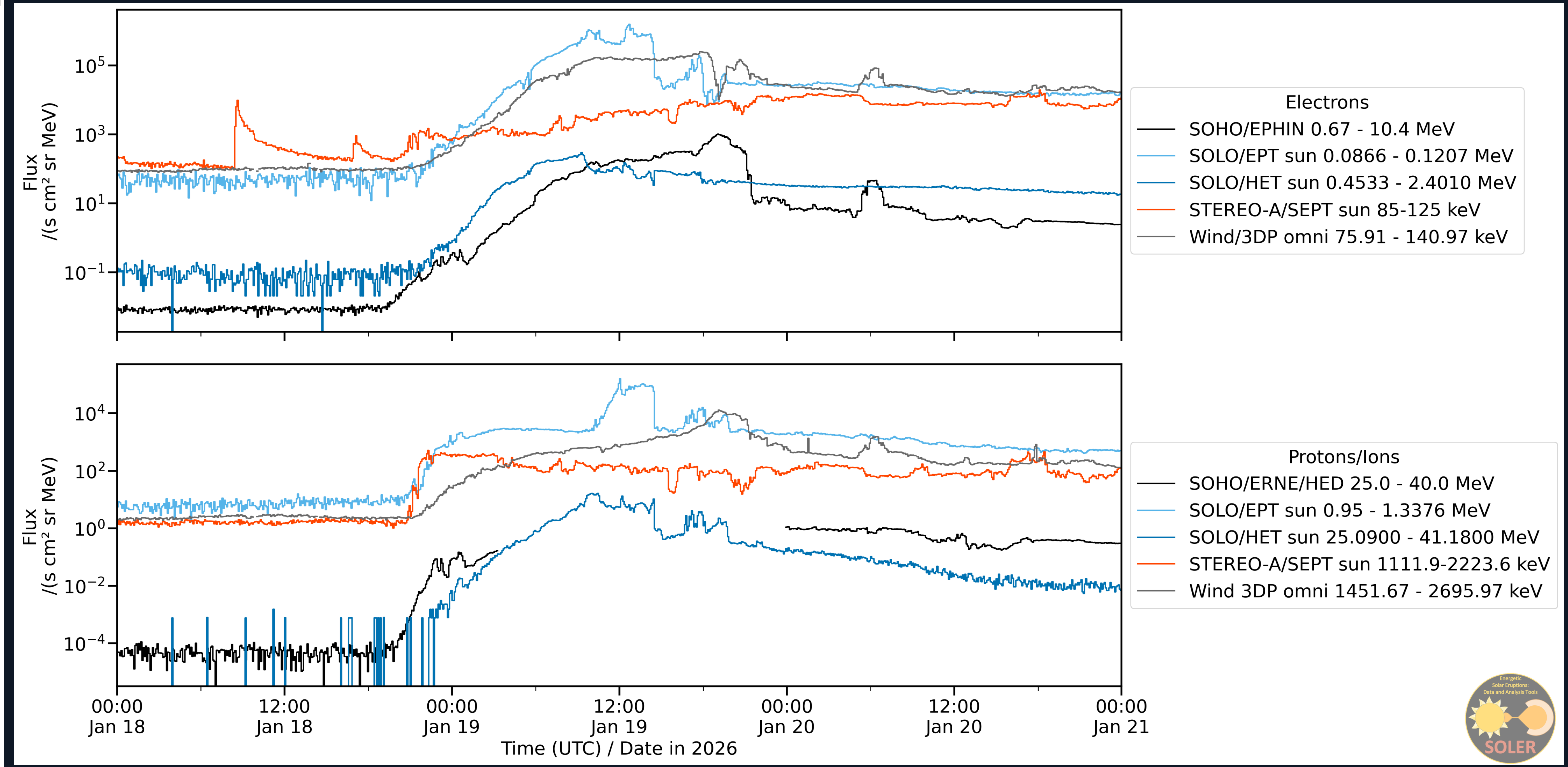
Timeline: from flare to geomagnetic storm

- **17:27** · 18 Jan — Flare onset
- **18:09** · 18 Jan — X1.9 peak · STIX HXR · QPPs
- **~18:10** · 18 Jan — Halo CME · >2000 km/s
- **19:03** · 19 Jan — Shock at L1
- **19:15** · 19 Jan — >10 MeV peak · S4
- **19–20** · Jan — G4 storm · Dst −158 nT

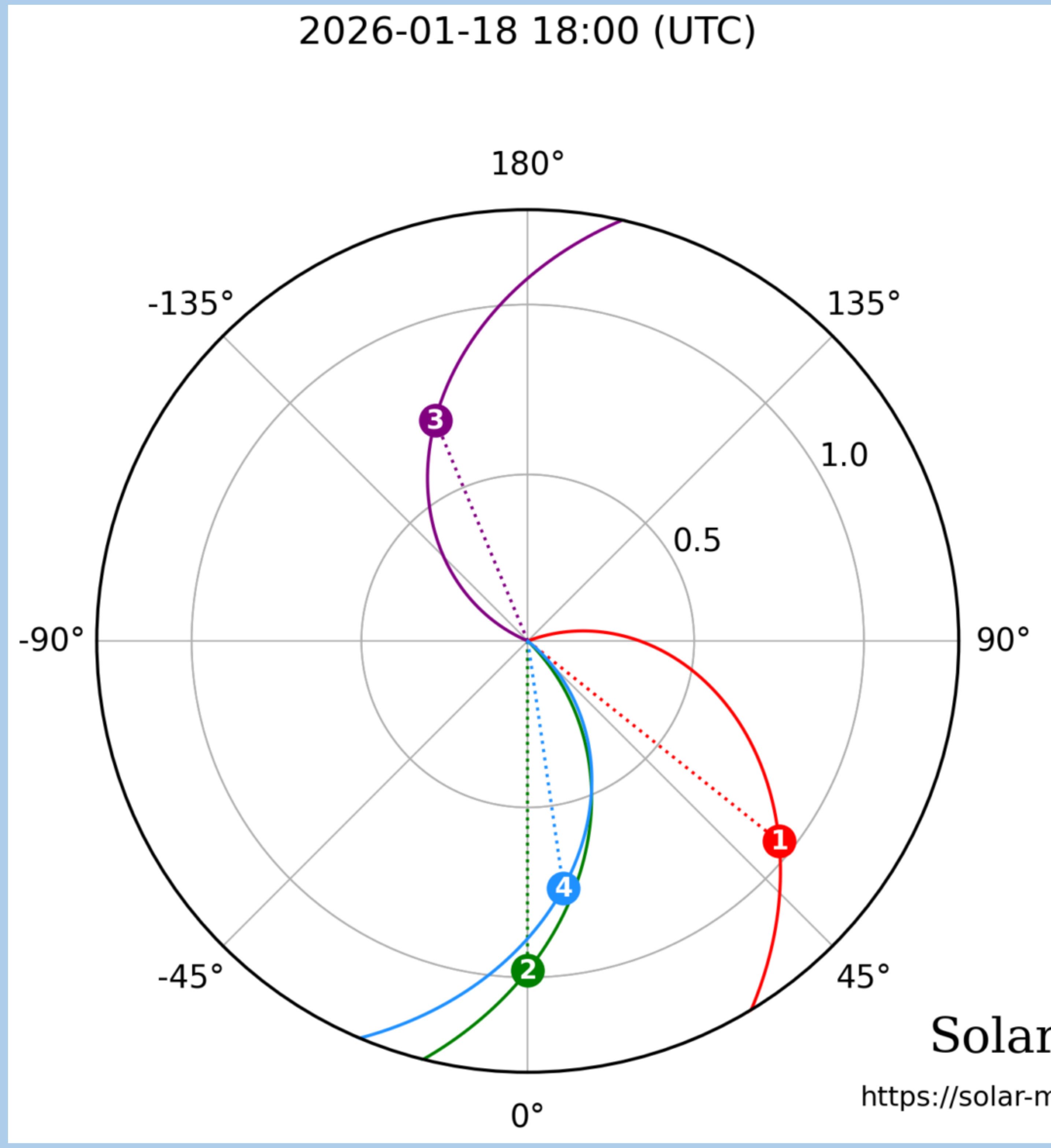


Credit: Nariaki Nitta / NOAA


Solar Orbiter
Frequency [MHz]
Intensity [sfu]
Counts
SolO/STIX (light travel time corr.)
4 - 10 keV
10 - 15 keV
15 - 25 keV
25 - 50 keV
50 - 84 keV
[W m^-2]
GOES-18/XRS
0.5 - 4.0 Å
1.0 - 8.0 Å
Electrons (sun)
Protons/Ions (sun)
Intensity [(cm^2 sr s MeV)^-1]
B [nT]
B
Br
Bt
Bn
Tp [K]
Pdyn [nPa]
Np [cm^-3]
Vsw [km s^-1]
00:00 Jan 19
12:00 Jan 19
00:00 Jan 20
12:00 Jan 20
00:00 Jan 21
Time (UTC) / Date in 2026


Flux /(s cm² sr MeV)
Electrons
SOHO/EPHIN 0.67 - 10.4 MeV
SOLO/EPT sun 0.0866 - 0.1207 MeV
SOLO/HET sun 0.4533 - 2.4010 MeV
STEREO-A/SEPT sun 85-125 keV
Wind/3DP omni 75.91 - 140.97 keV
Protons/Ions
SOHO/ERNE/HED 25.0 - 40.0 MeV
SOLO/EPT sun 0.95 - 1.3376 MeV
SOLO/HET sun 25.0900 - 41.1800 MeV
STEREO-A/SEPT sun 1111.9-2223.6 keV
Wind 3DP omni 1451.67 - 2695.97 keV
00:00 Jan 18
12:00 Jan 18
00:00 Jan 19
12:00 Jan 19
00:00 Jan 20
12:00 Jan 20
00:00 Jan 21
Time (UTC) / Date in 2026

Vantage points: remote sensing and in situ



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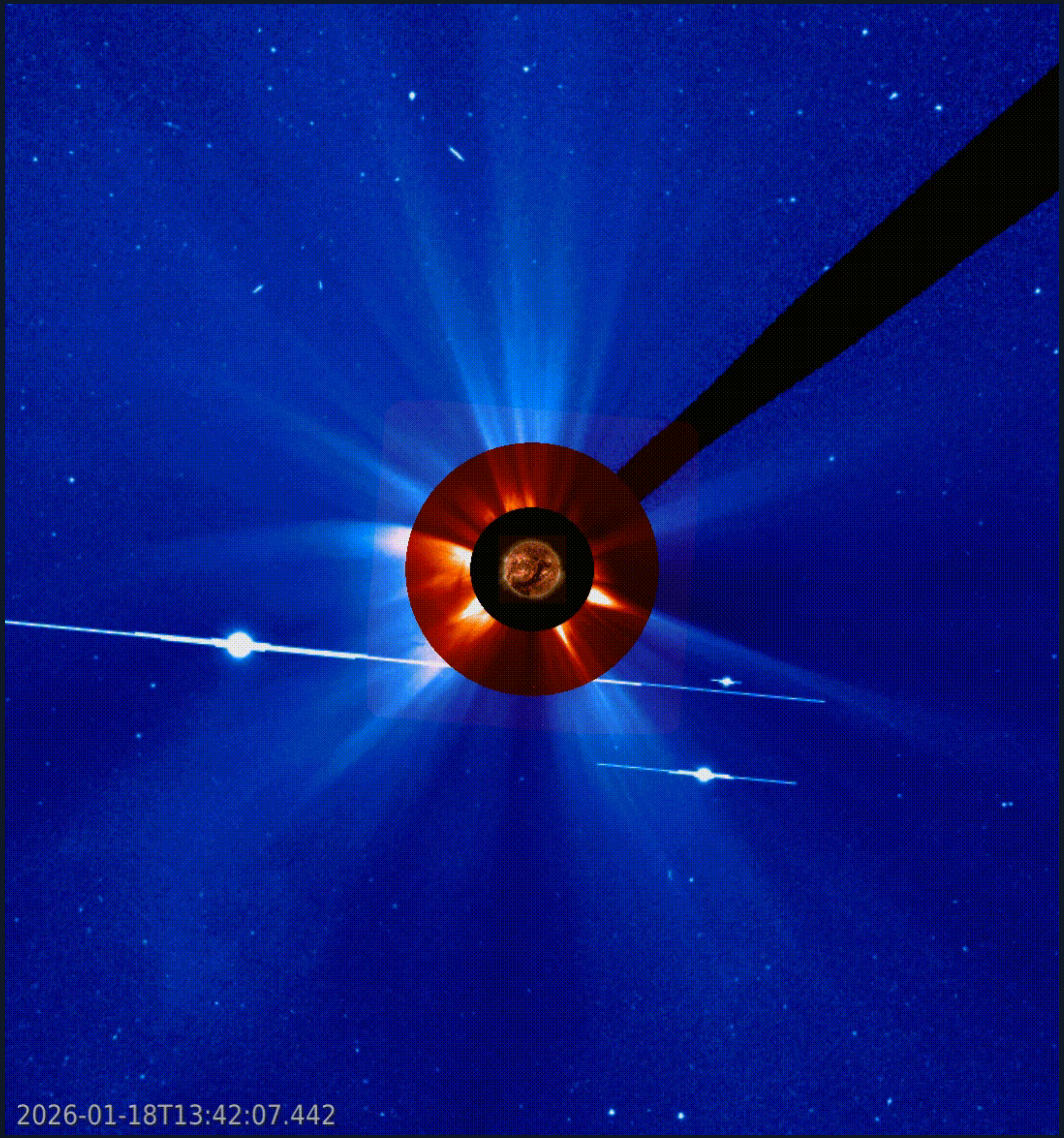
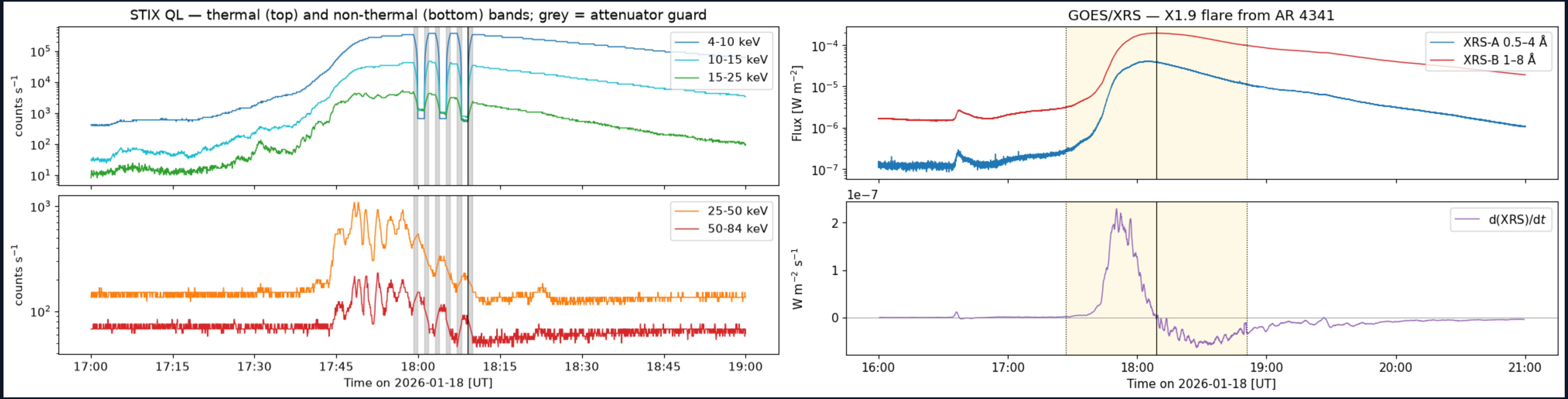


Credit: ESA

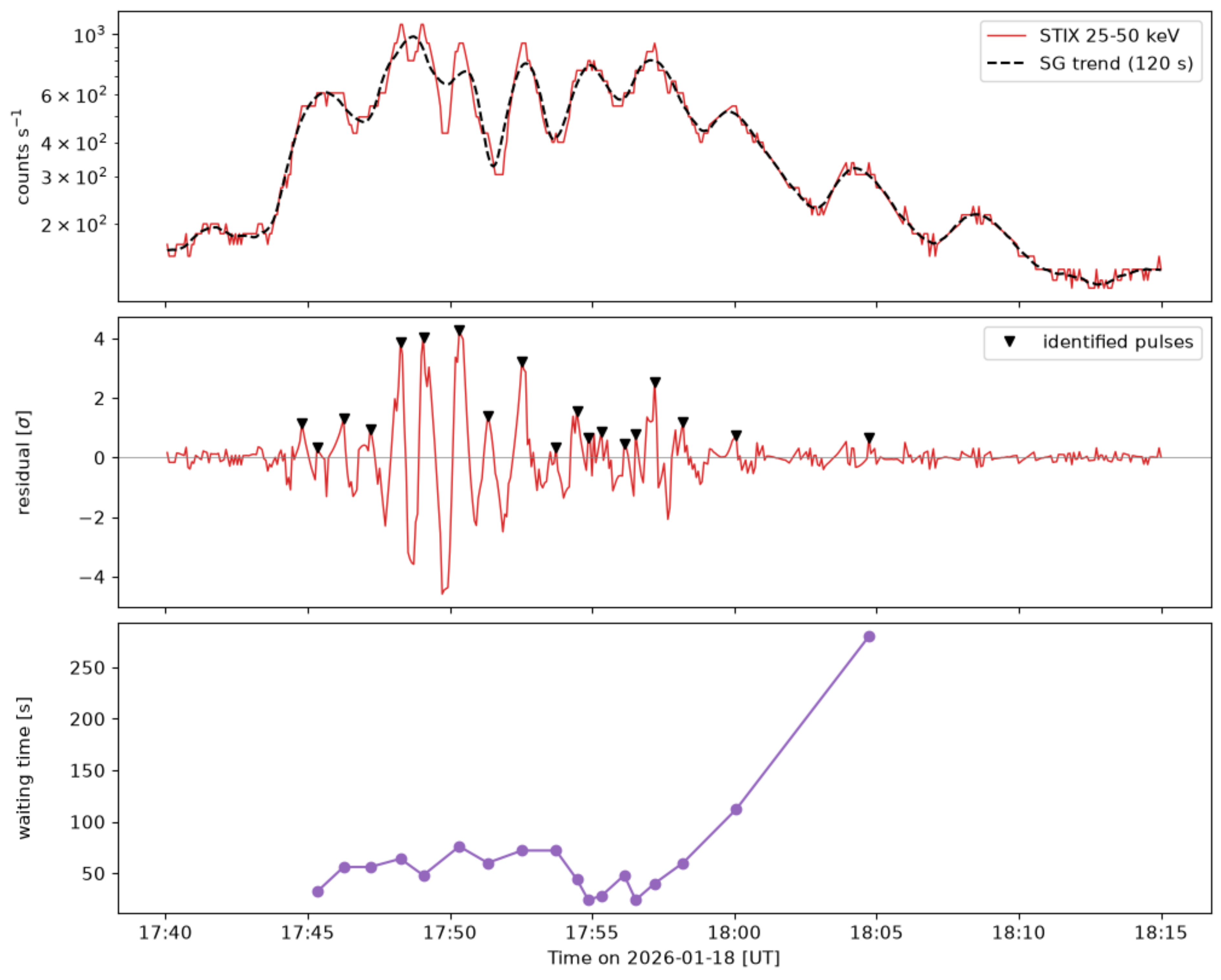
STIX: quasi-periodic pulsations in hard X-rays

A train of quasi-periodic pulsations in the non-thermal bands (`25–84 keV`) runs through the impulsive phase

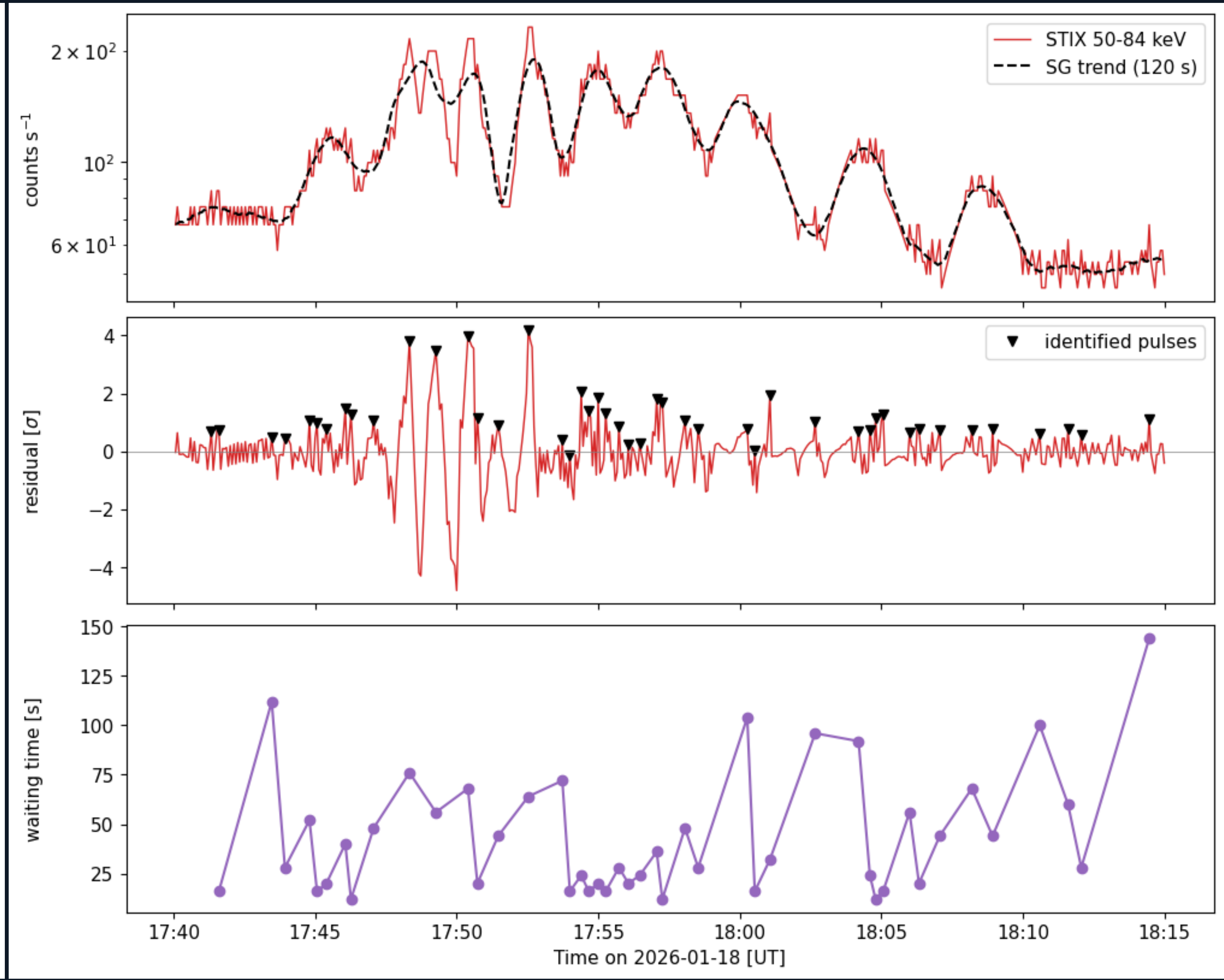


STIX: quasi-periodic pulsations in hard X-rays

19 pulses; median waiting time 56 s



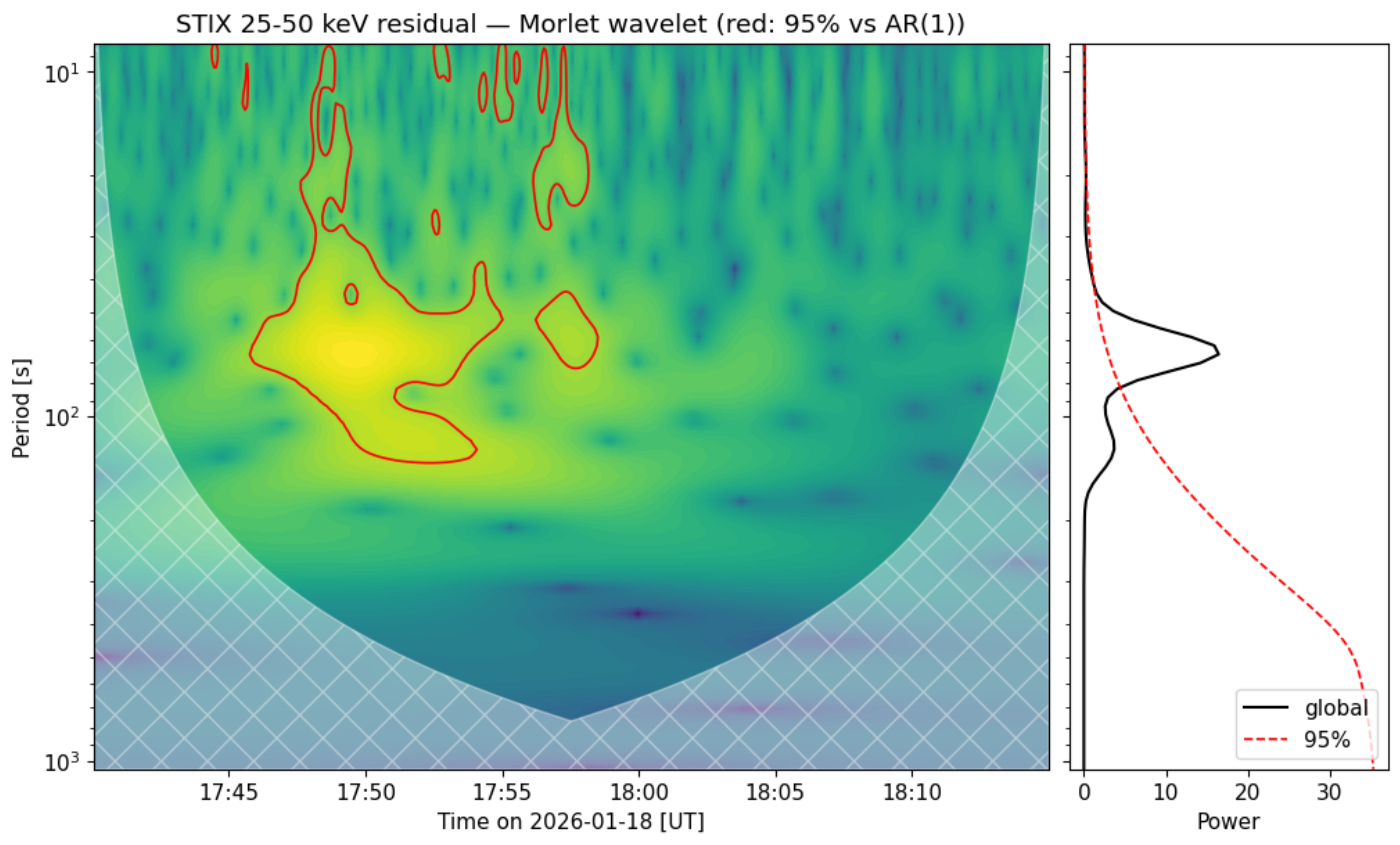
46 pulses; median waiting time 32 s

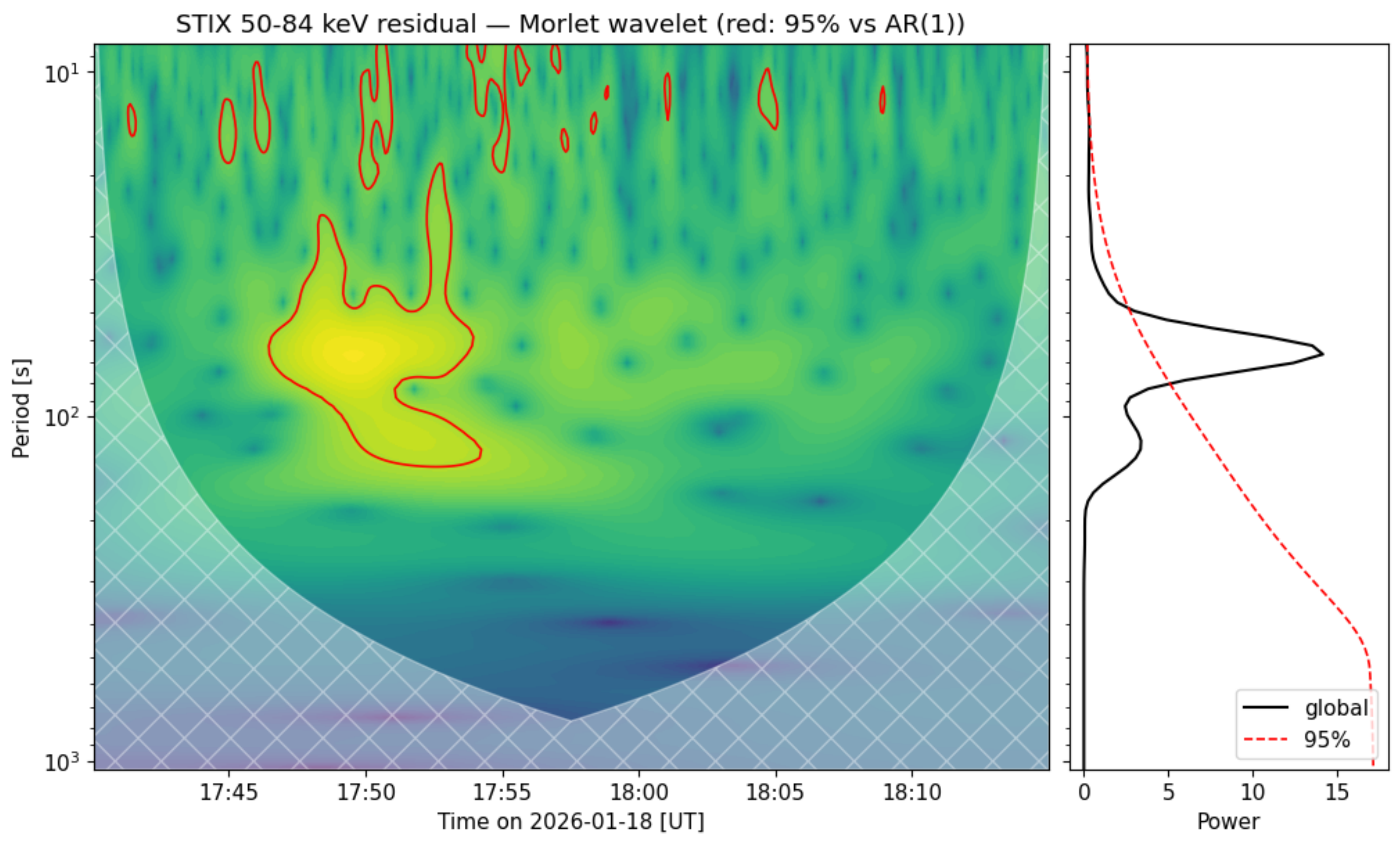


Characterising the pulsations

1. Detrend the non-thermal light curves; identify pulses by SG fitting
2. Extract the period via wavelet
3. Cross-correlate with EOVSA, OVRO-LWA & the GOES SXR derivative

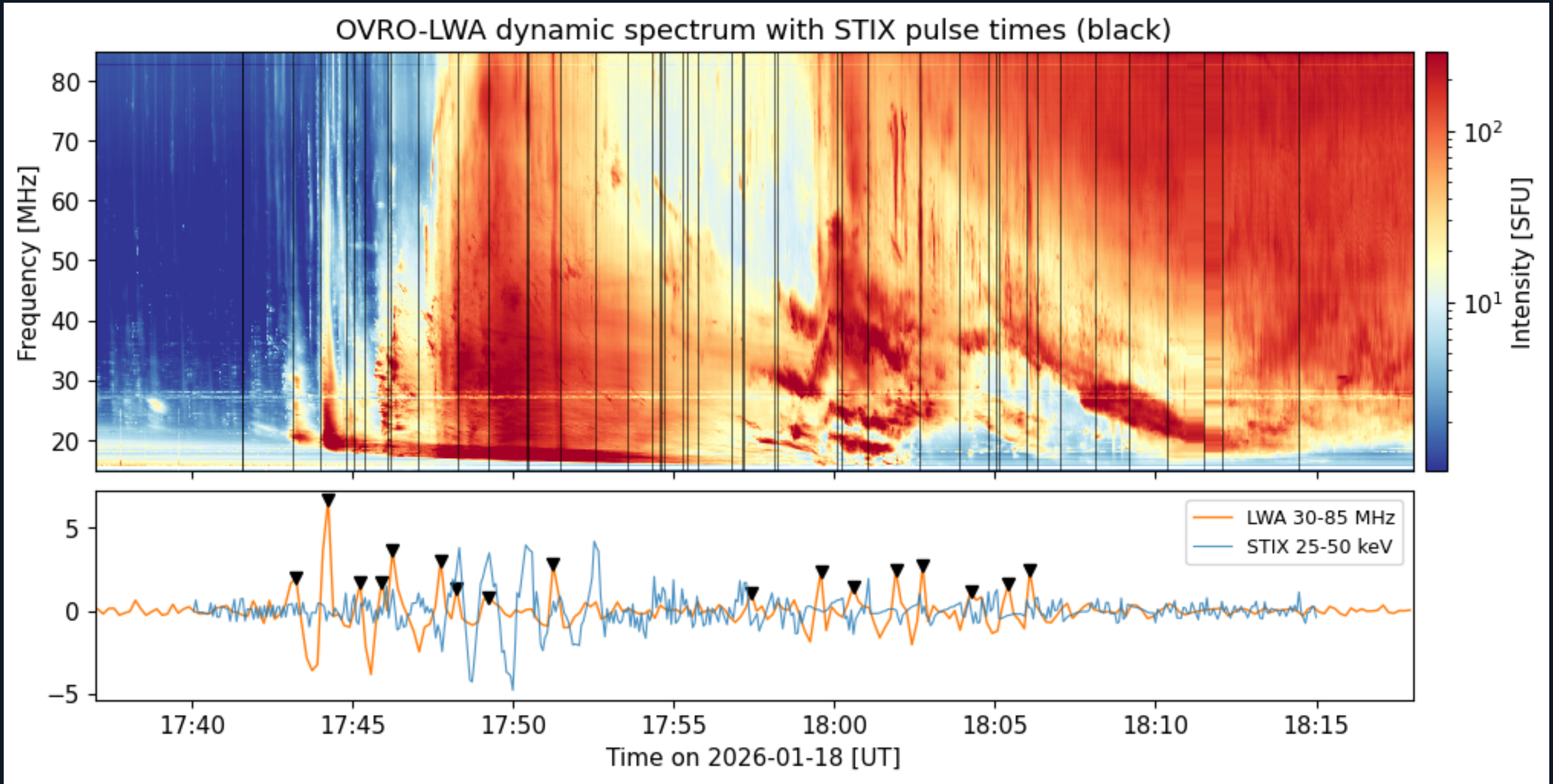
Dominant significant wavelet period: 66.1 s





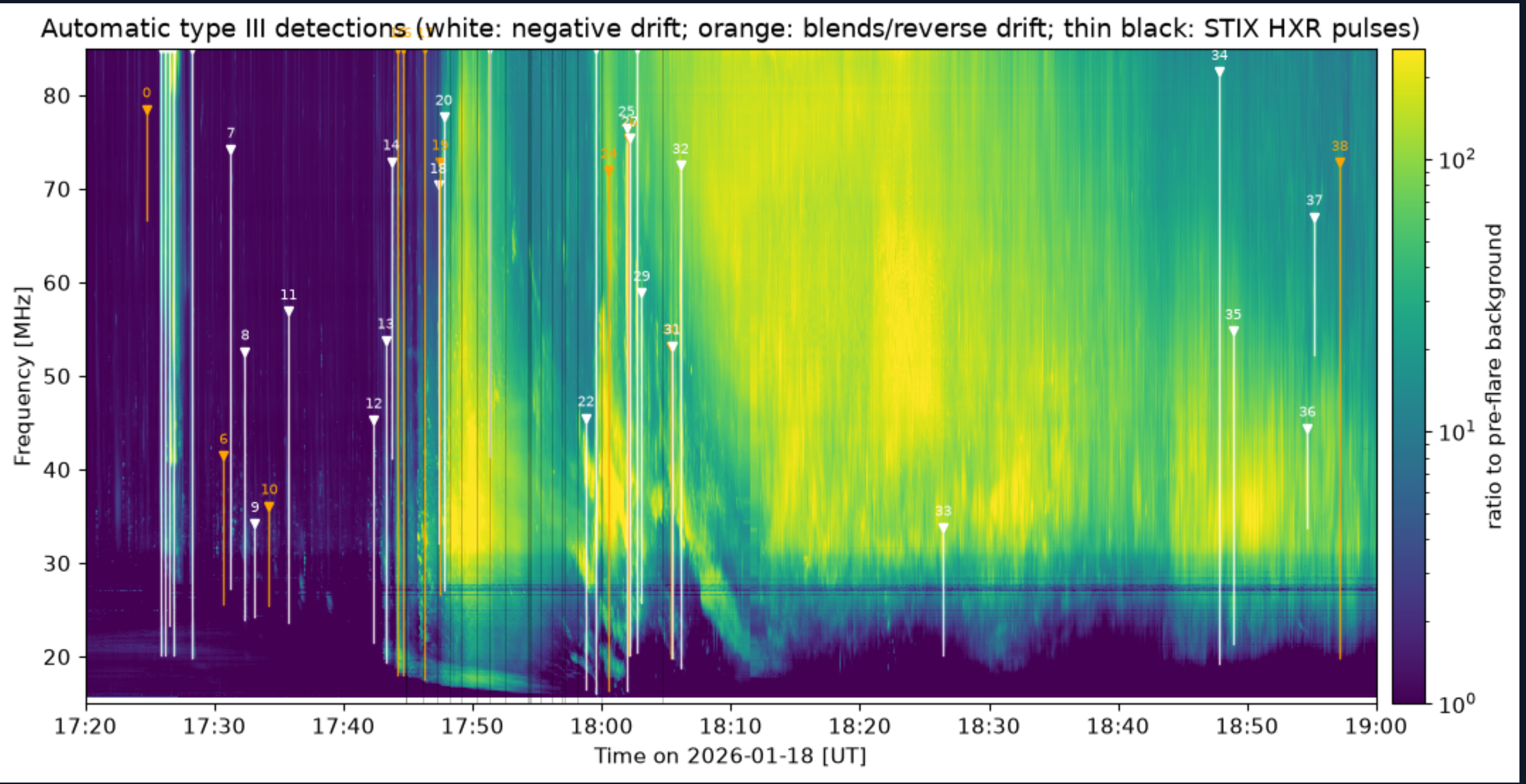
Radio: the low-frequency picture

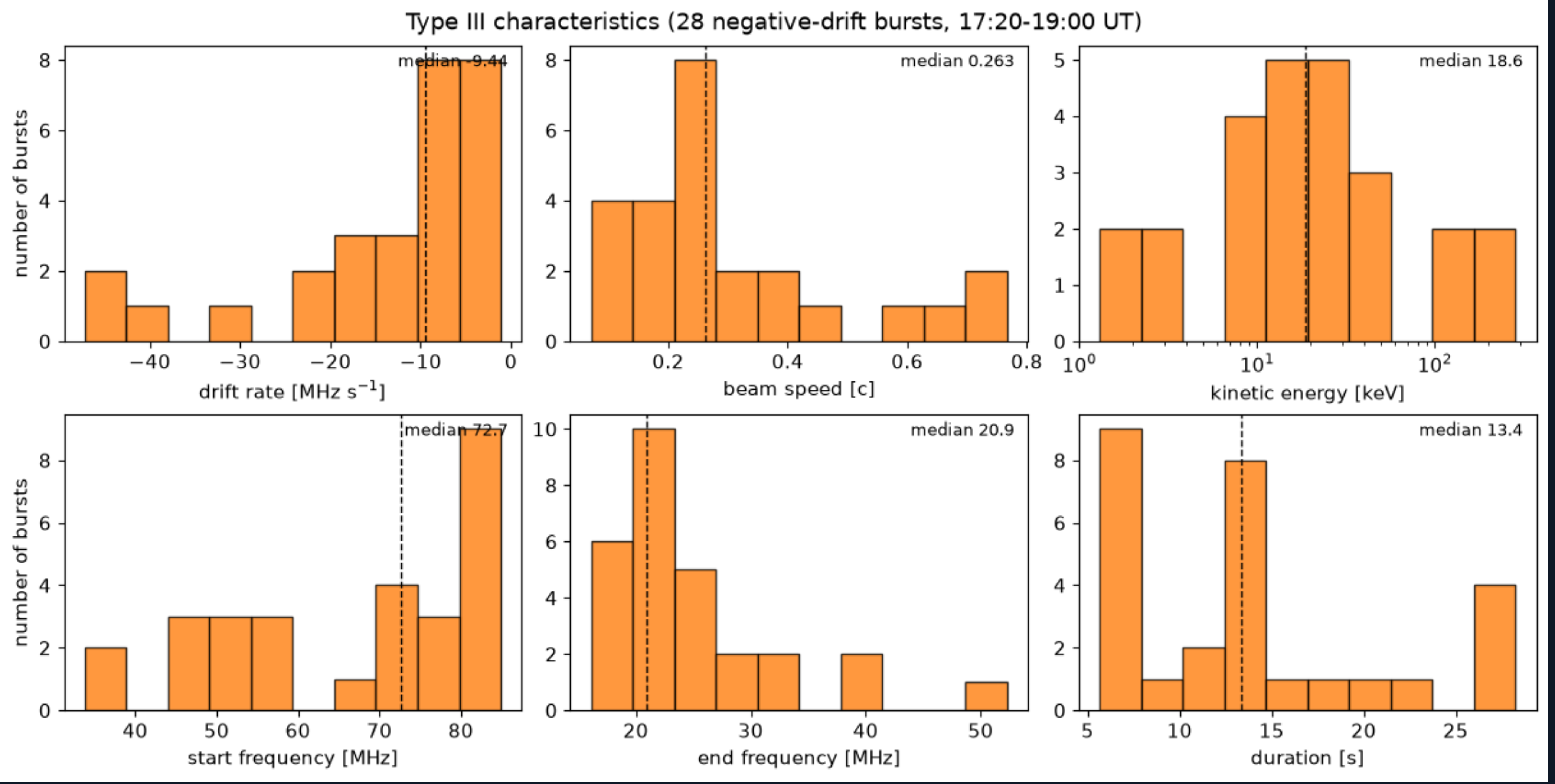
17 type IIIs; 65% matched to an HXR pulse within ±15 s



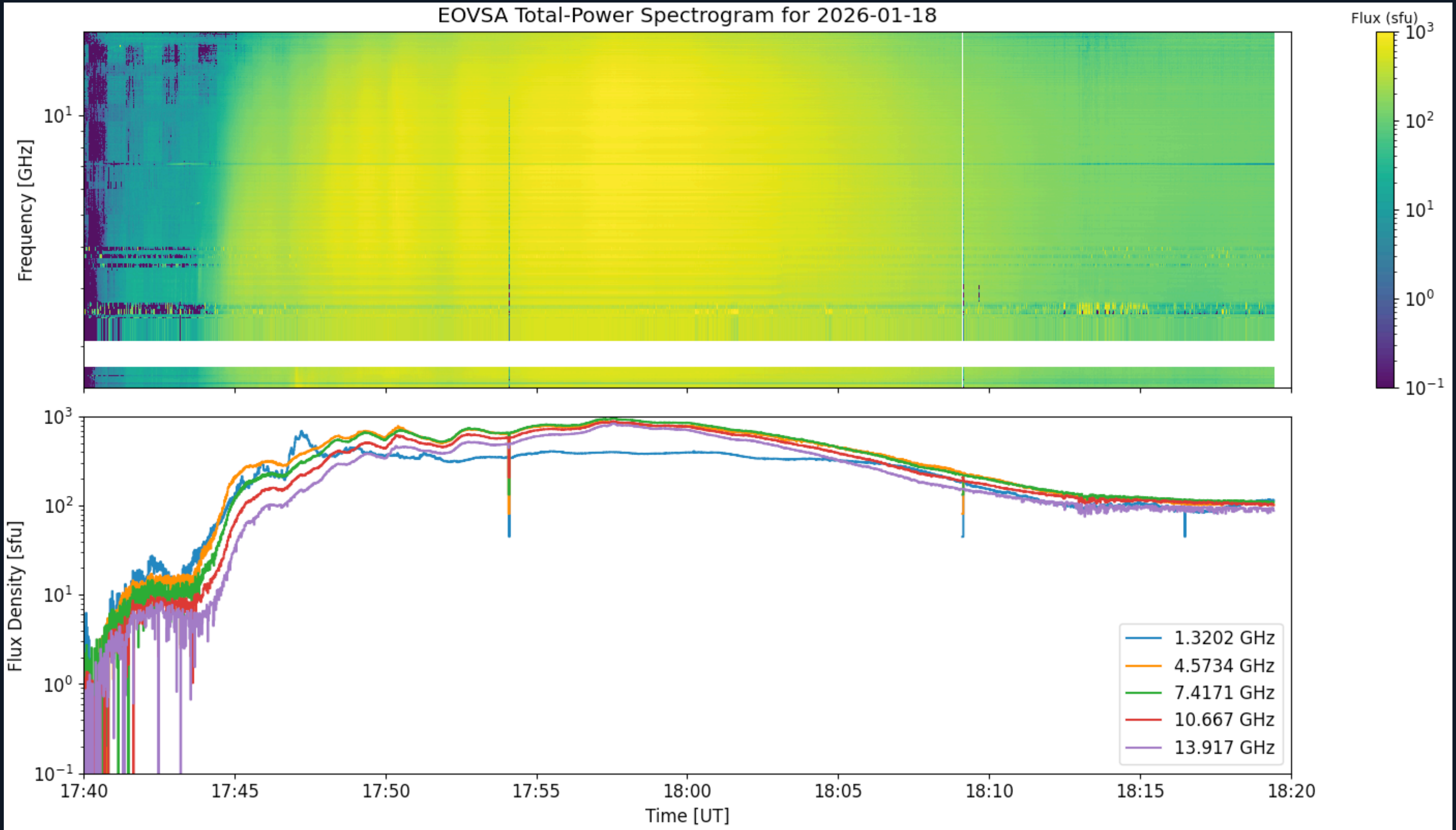
Probabilistic-Hough detection of fast-drift lanes

- 32 burst groups from 169 Hough segments
- Density model for the exciter kinematics: 1 x Newkirk
- Fundamental plasma emission assumed
- 39 bursts (28 with negative drift); median drift -9.44 MHz/s, median v 0.263 c, median E 18.6 keV



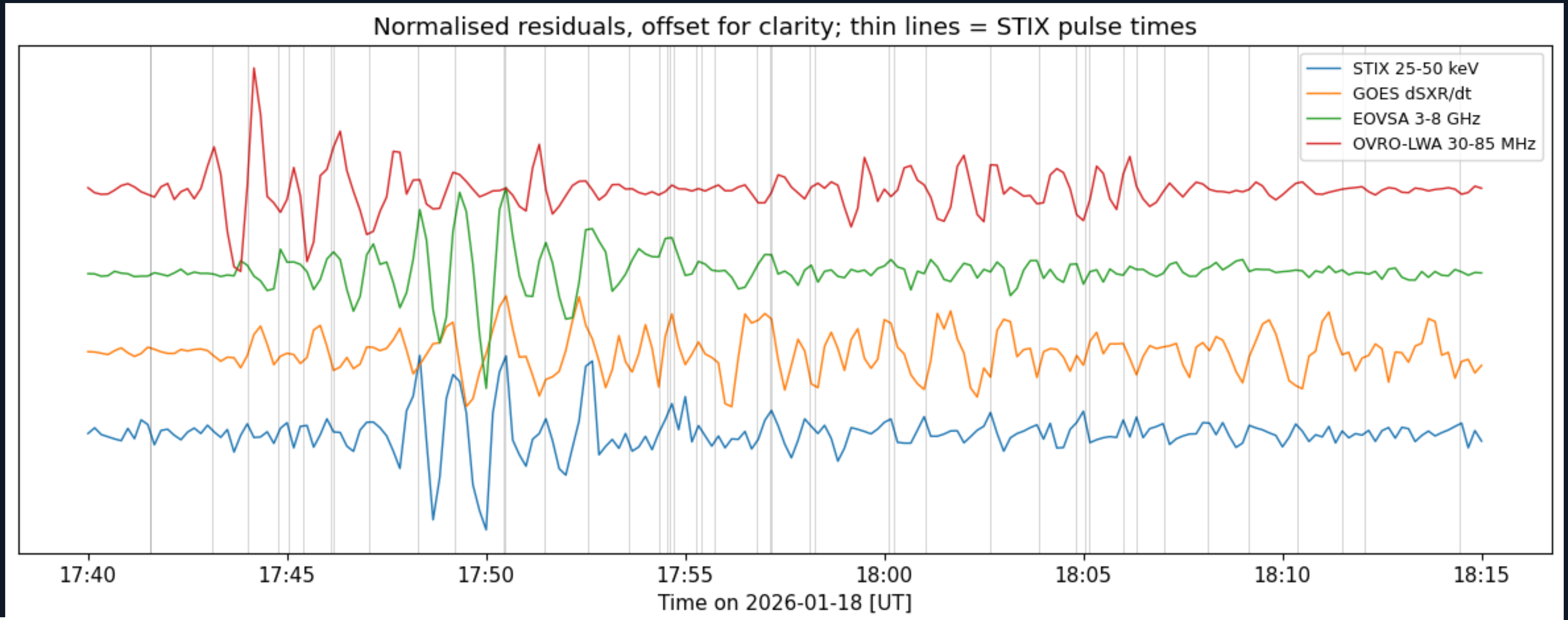


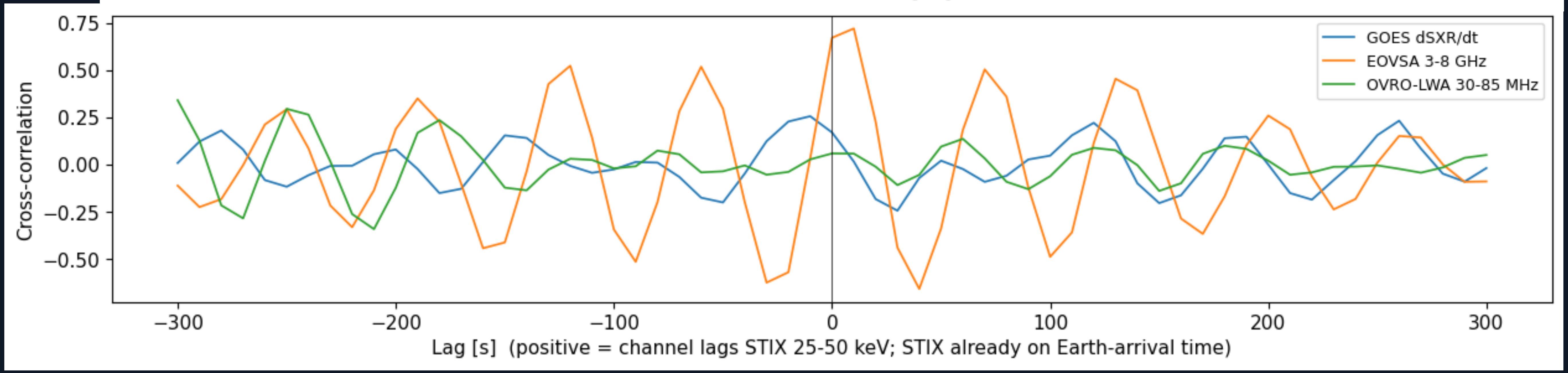
Microwave emission



Bursty Reconnection & Particle Transport

- Frequency-averaged light curves
- Per-channel background comes from quiet pre-flare interval

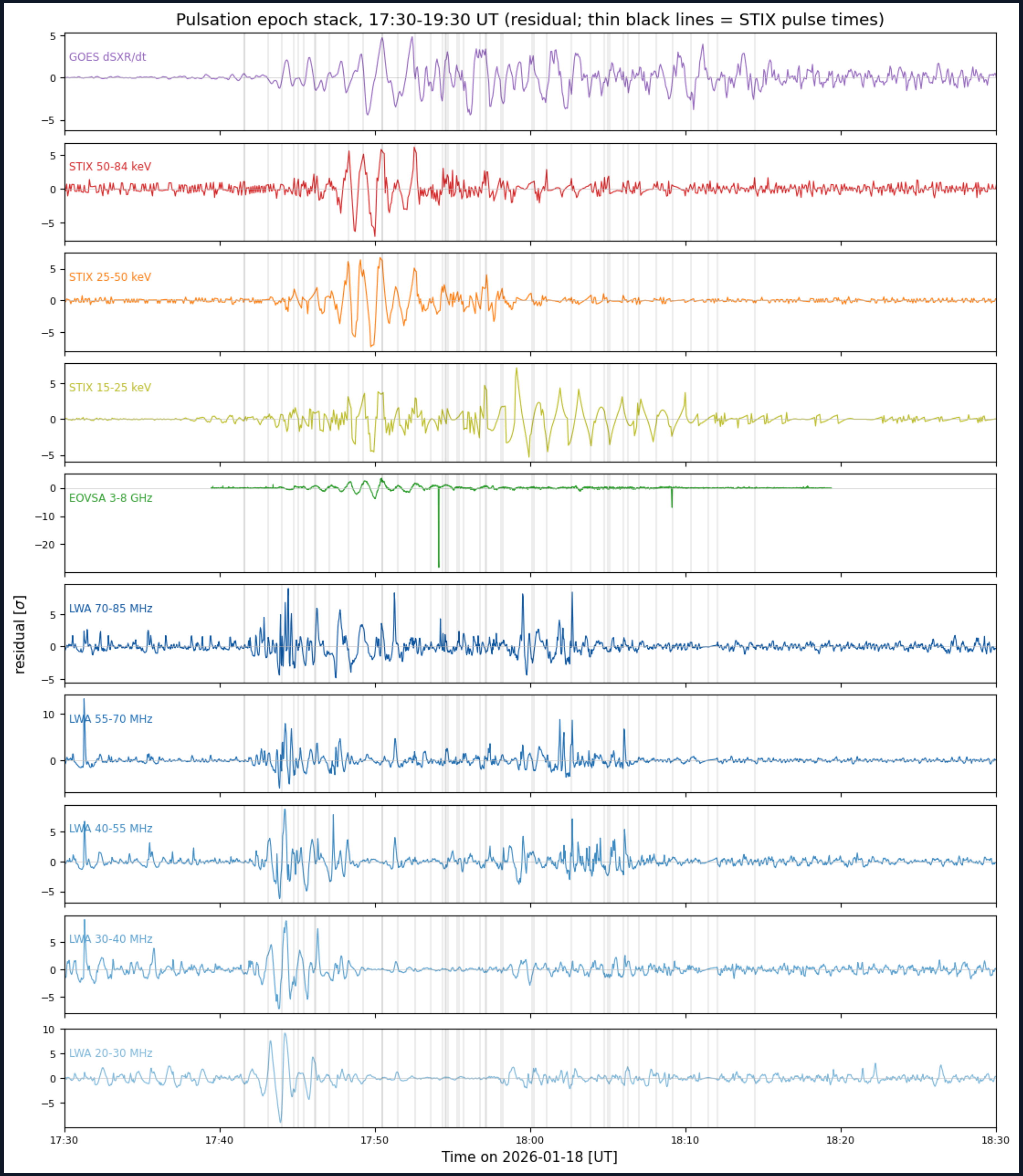




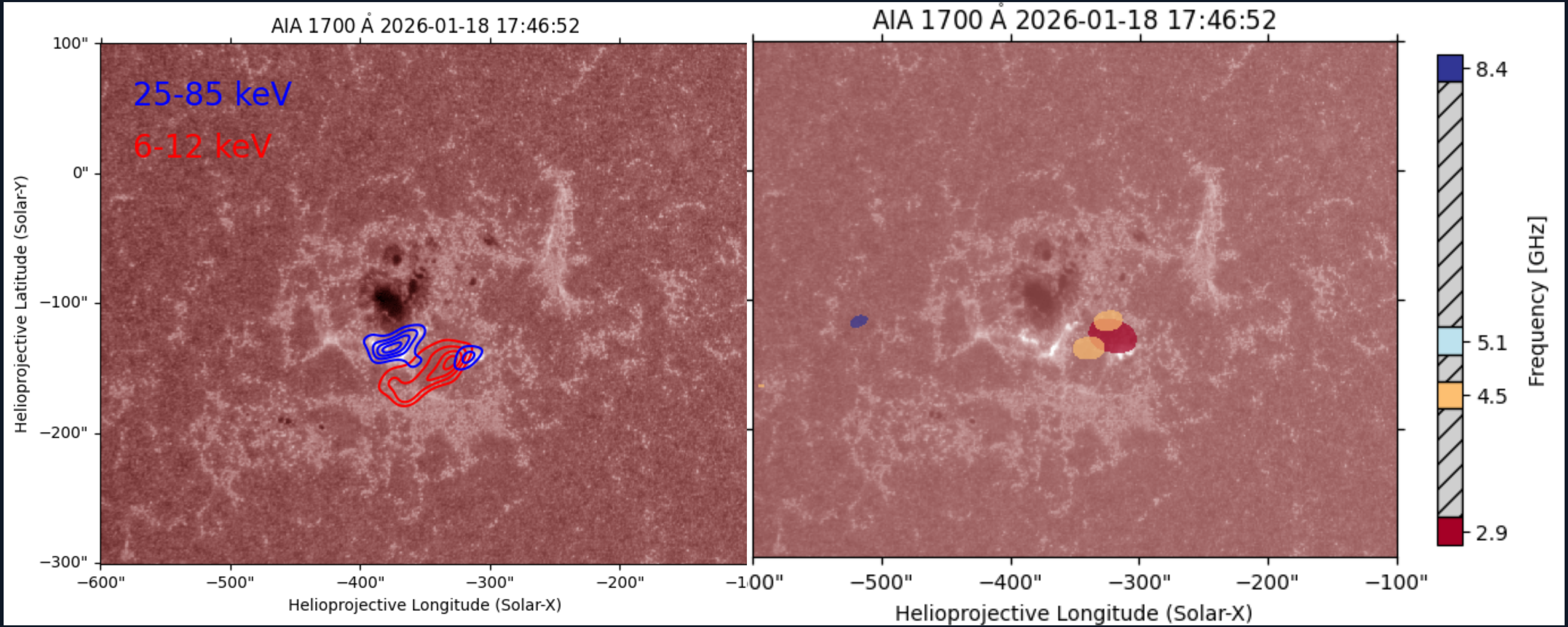
Epoch View: stacked lightcurves across frequencies

- Each panel is SG-detrended in units
- Background-ratioed LWA dynamic spectrum over the same window

Frequency-averaged light curves.
Per-channel background comes from quiet pre-flare interval.



STIX vs EOVSA imaging



Conclusions

WHAT WE HAVE

— Great case study of a X1.9 flare + halo CME + S4 SEP event

— Clear **QPP train** in STIX hard X-rays as the entry point

— Full remote + in-situ chain between Sun to 1 AU

NEXT STEPS

— STIX spectroscopy

— Type-III & Type-II bursts / HXR timing + LWA polarimetry

— CME/shock reconstruction · EPD/GOES SEP connectivity

— SEP event analysis

Open questions

— SolO connectivity & field-line mapping

— QPP significance vs STIX instrumental artifacts

— SEP attribution: flare vs shock