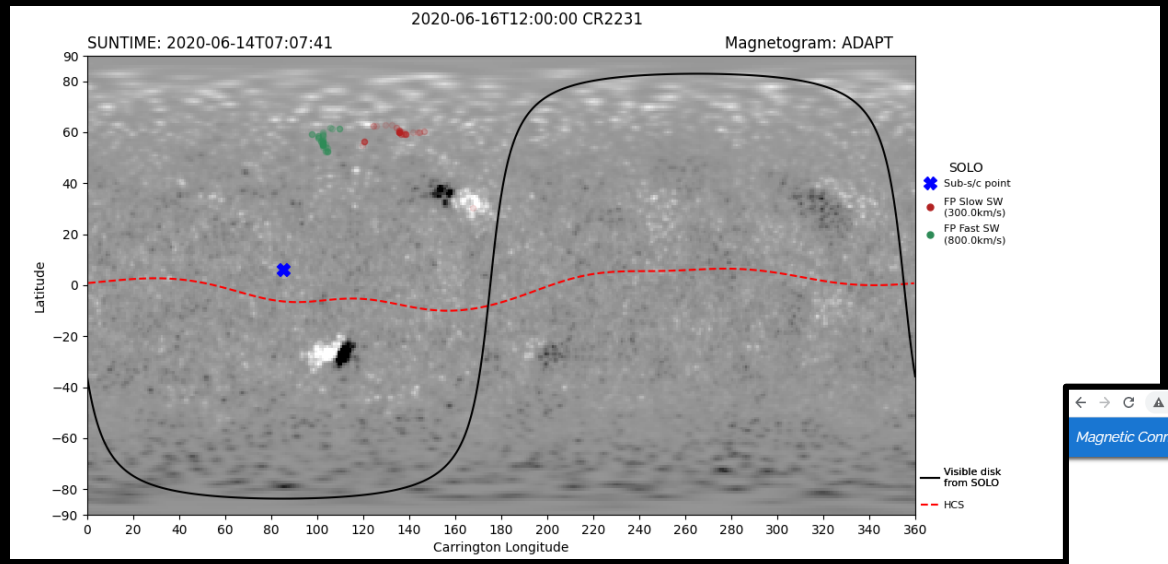
Royal Observatory of Belgium

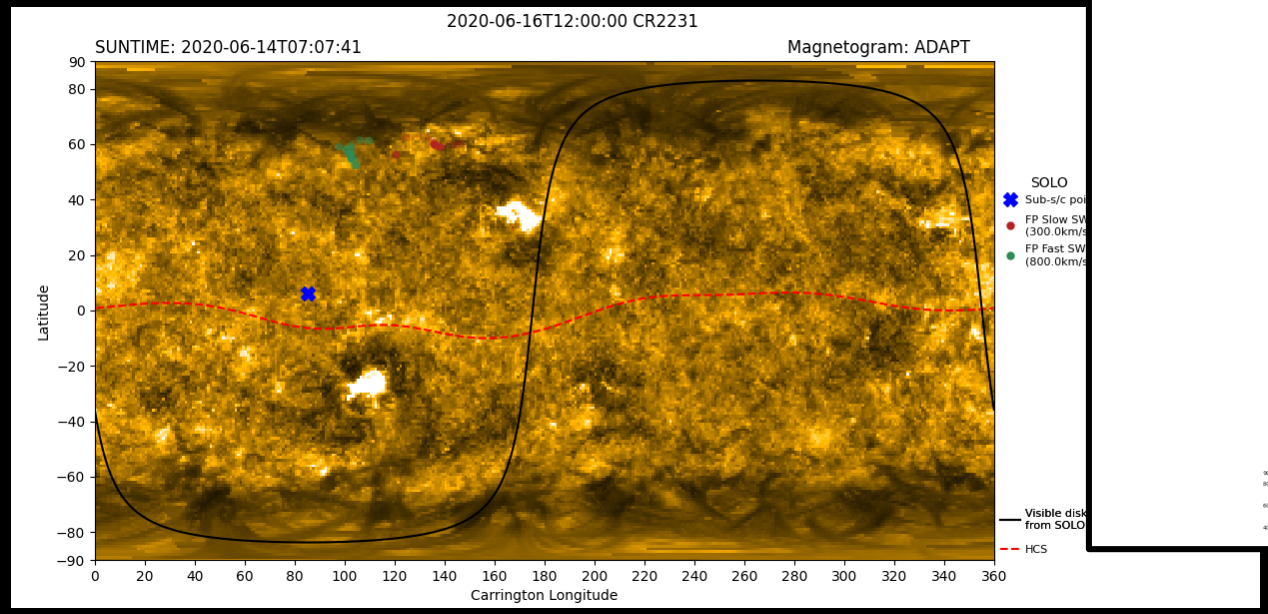
Ongoing efforts w.r.t. remote sensing/in situ connection science

Luciano Rodriguez and the EUI team

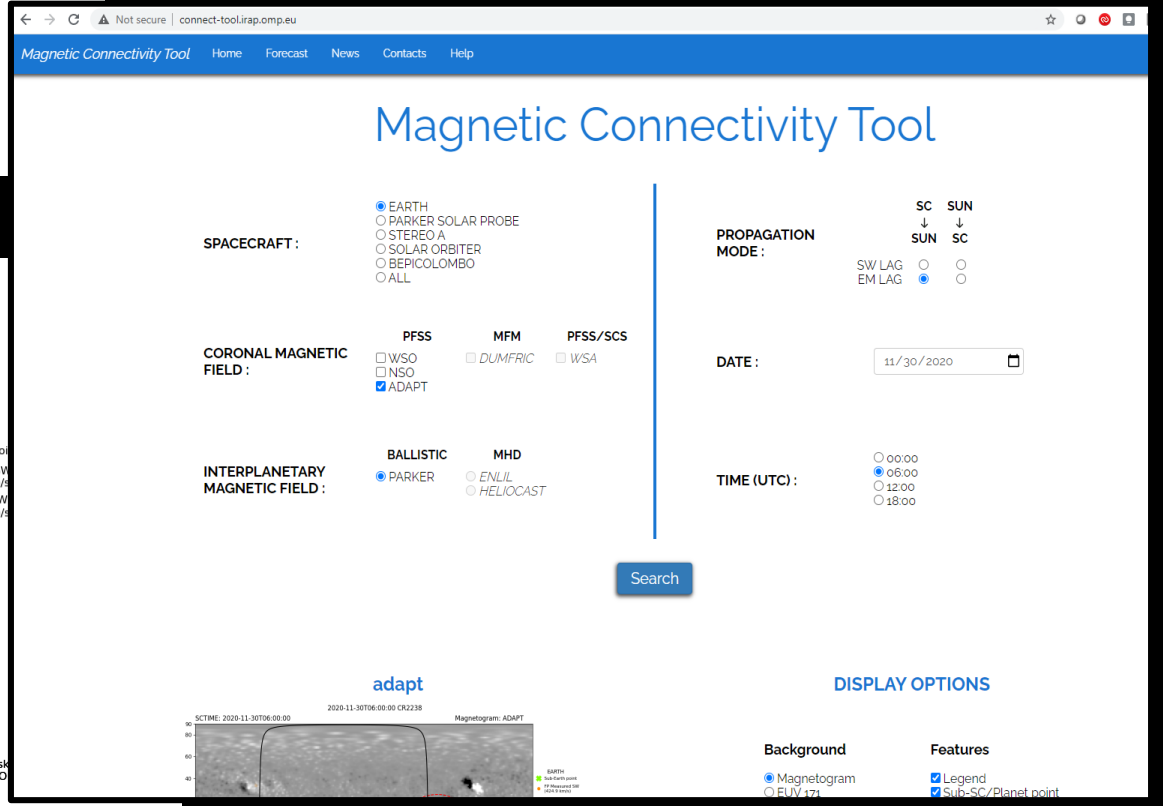
EUI Consortium Meeting, May 2022, Brussels

Sources of the solar wind: EUI - MAG

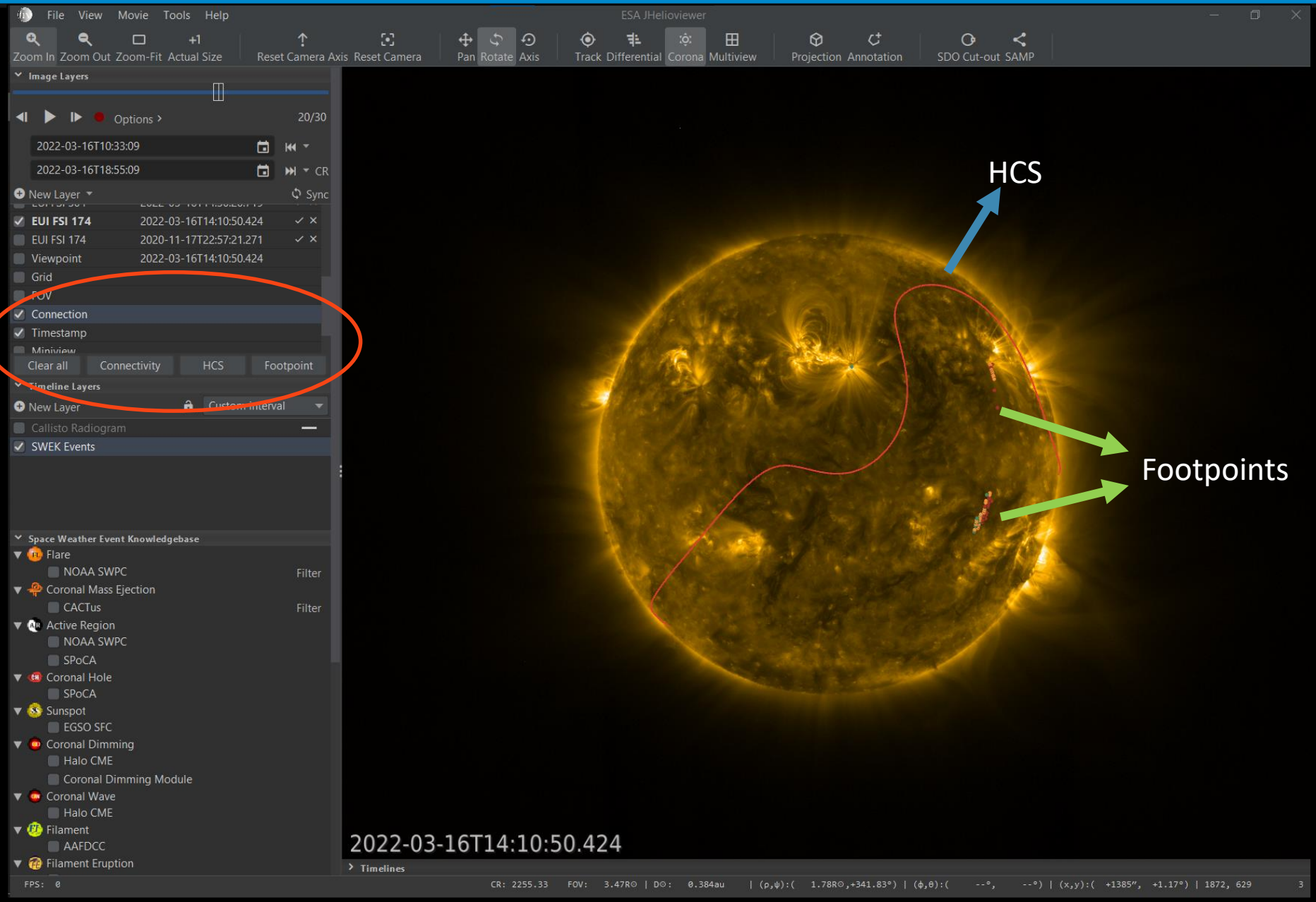




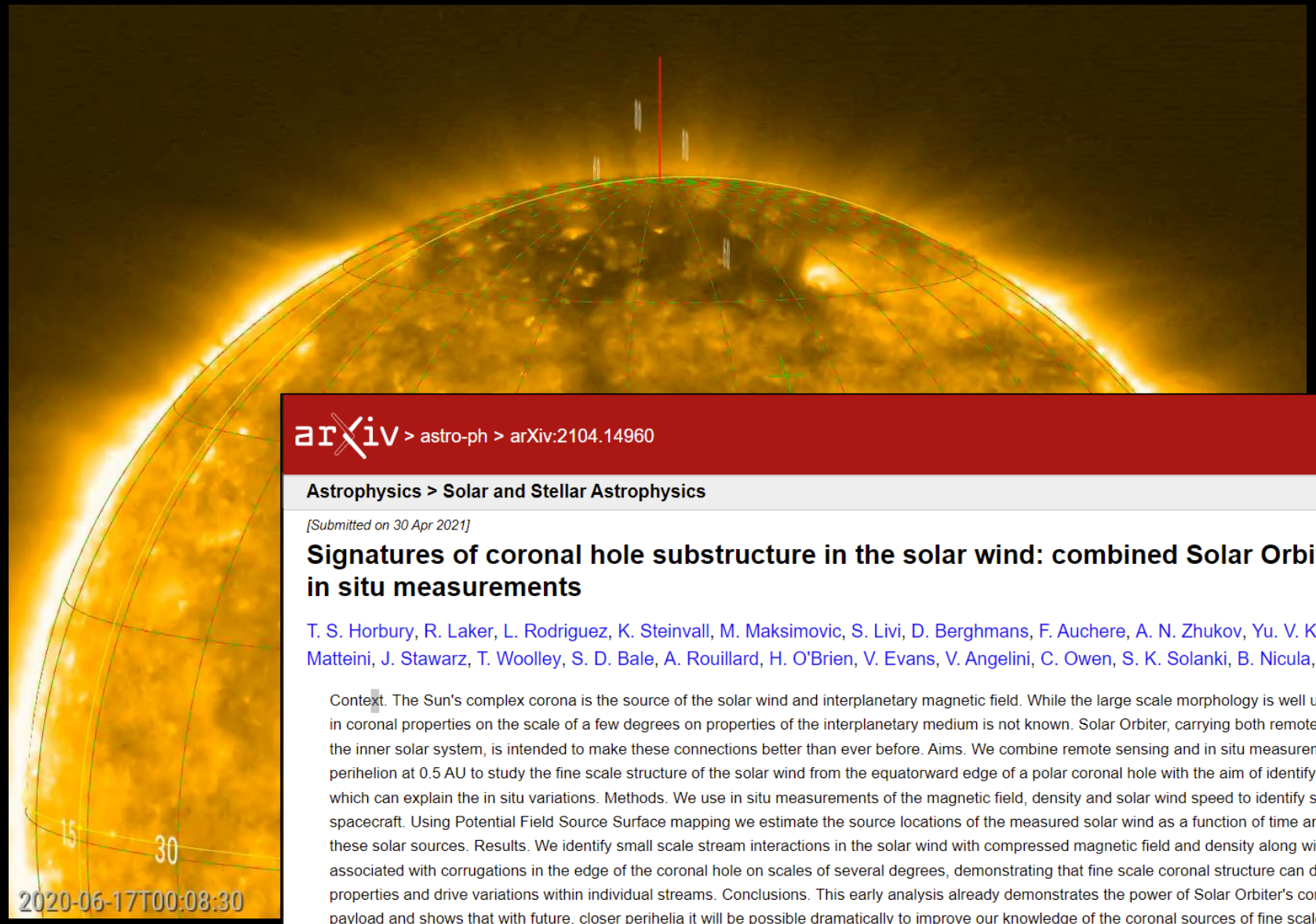
http://connect-tool.irap.omp.eu/



Connectivity data in JHV



Sources of the solar wind: EUI - MAG



arXiv > astro-ph > arXiv:2104.14960

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Astrophysics > Solar and Stellar Astrophysics

[Submitted on 30 Apr 2021]

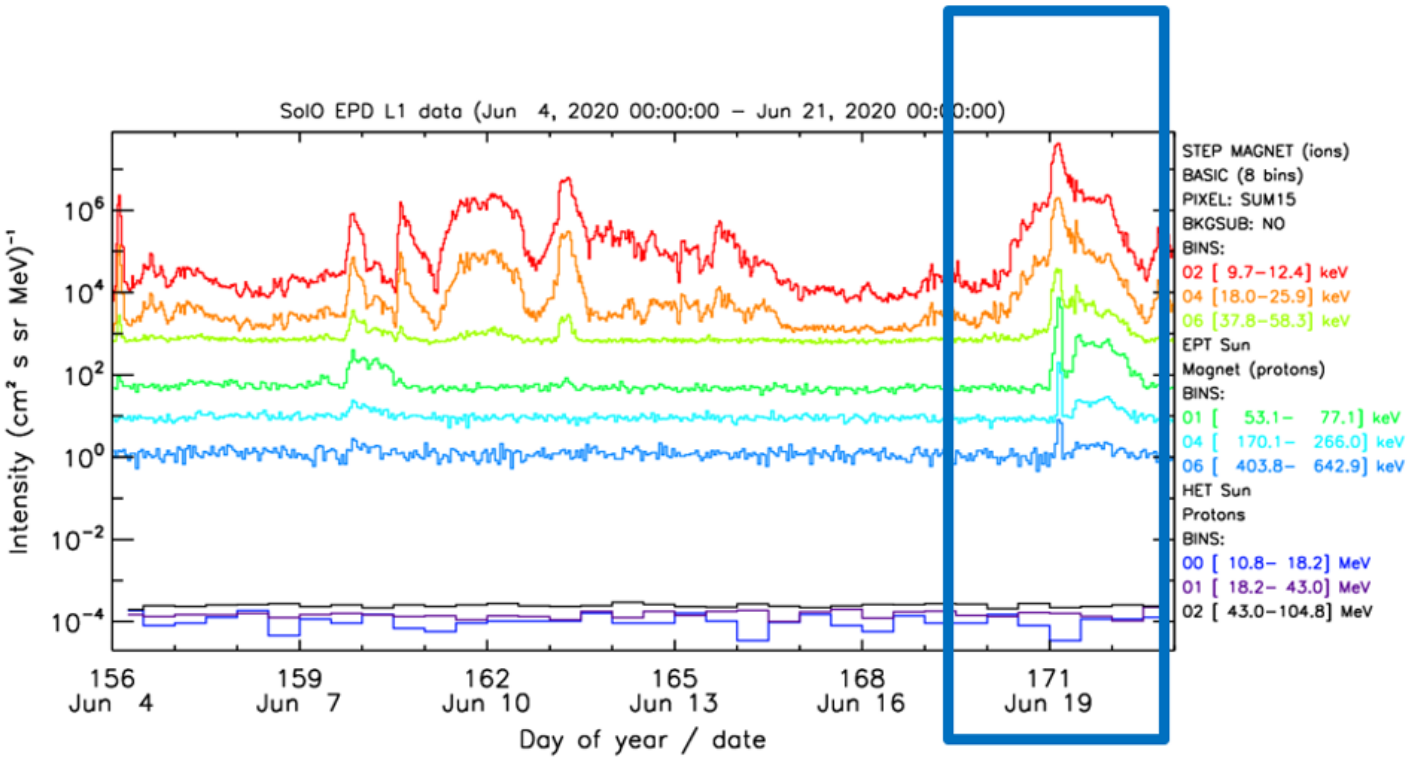
Signatures of coronal hole substructure in the solar wind: combined Solar Orbiter remote sensing and in situ measurements

T. S. Horbury, R. Laker, L. Rodriguez, K. Steinvall, M. Maksimovic, S. Livi, D. Berghmans, F. Auchere, A. N. Zhukov, Yu. V. Khotyaintsev, L. Woodham, L. Matteini, J. Stawarz, T. Woolley, S. D. Bale, A. Rouillard, H. O'Brien, V. Evans, V. Angelini, C. Owen, S. K. Solanki, B. Nicula, D. Muller, I. Zouganelis

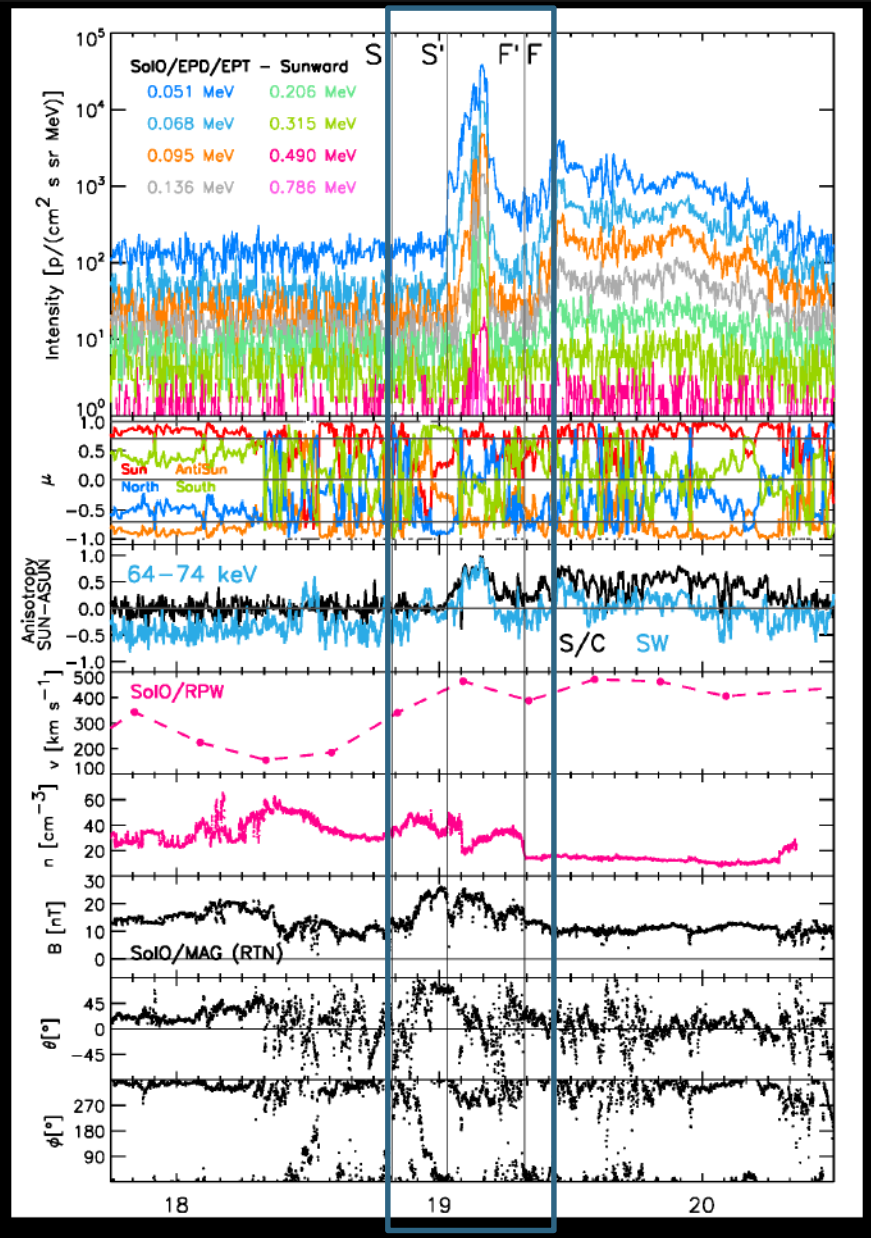
Context. The Sun's complex corona is the source of the solar wind and interplanetary magnetic field. While the large scale morphology is well understood, the impact of variations in coronal properties on the scale of a few degrees on properties of the interplanetary medium is not known. Solar Orbiter, carrying both remote sensing and in situ instruments into the inner solar system, is intended to make these connections better than ever before. Aims. We combine remote sensing and in situ measurements from Solar Orbiter's first perihelion at 0.5 AU to study the fine scale structure of the solar wind from the equatorward edge of a polar coronal hole with the aim of identifying characteristics of the corona which can explain the in situ variations. Methods. We use in situ measurements of the magnetic field, density and solar wind speed to identify structures on scales of hours at the spacecraft. Using Potential Field Source Surface mapping we estimate the source locations of the measured solar wind as a function of time and use EUI images to characterise these solar sources. Results. We identify small scale stream interactions in the solar wind with compressed magnetic field and density along with speed variations which are associated with corrugations in the edge of the coronal hole on scales of several degrees, demonstrating that fine scale coronal structure can directly influence solar wind properties and drive variations within individual streams. Conclusions. This early analysis already demonstrates the power of Solar Orbiter's combined remote sensing and in situ payload and shows that with future, closer perihelia it will be possible dramatically to improve our knowledge of the coronal sources of fine scale solar wind structure, which is important both for understanding the phenomena driving the solar wind and predicting its impacts at the Earth and elsewhere.

Acceleration of particles: EUI - EPD

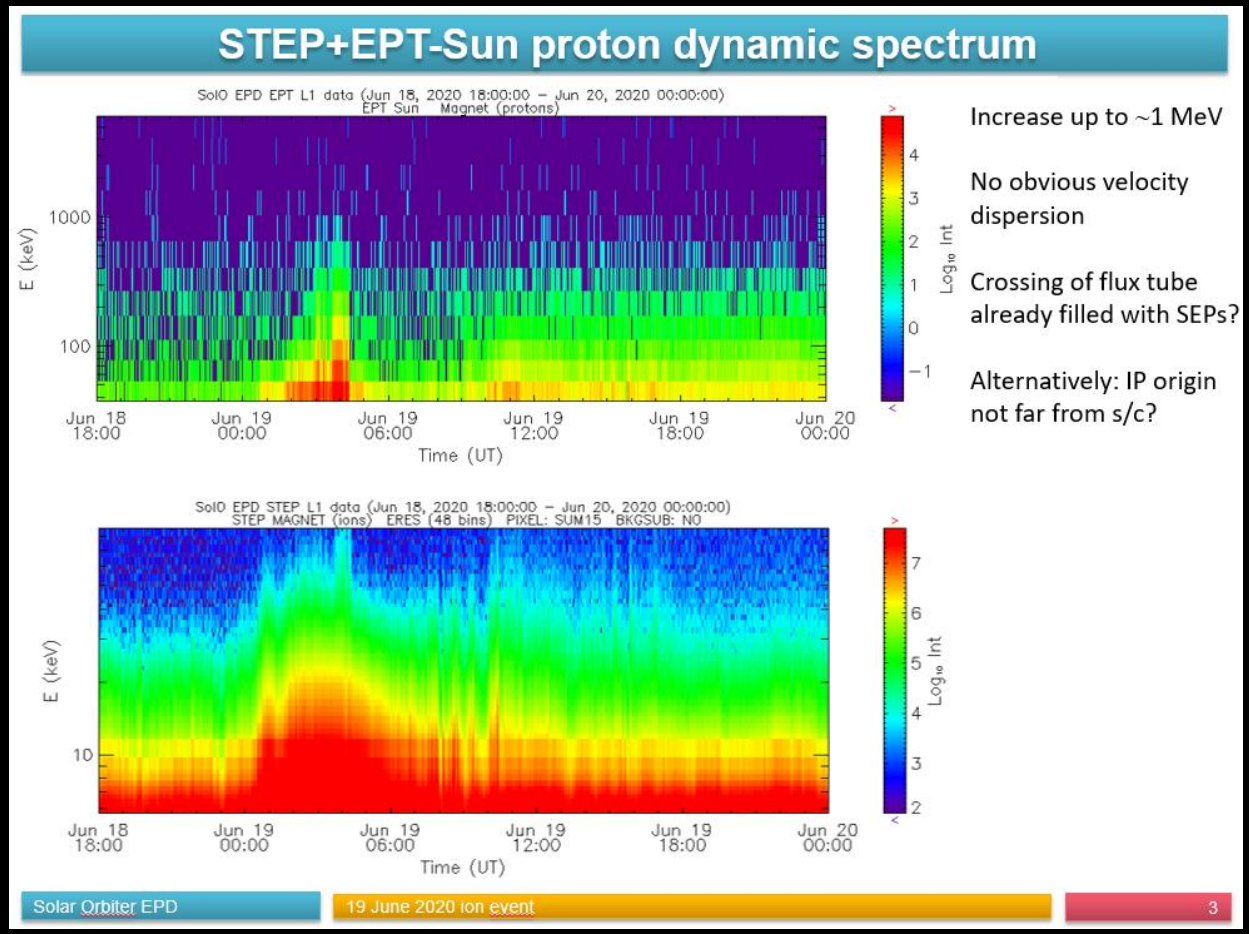
Summary of STEP, EPT and HET proton observations



Sources of SEPs: EUI-EPD-MAG-(RPW)



EPD saw a particle event, when SolO was at 0.51 AU



Sources of SEPs: EUI - EPD

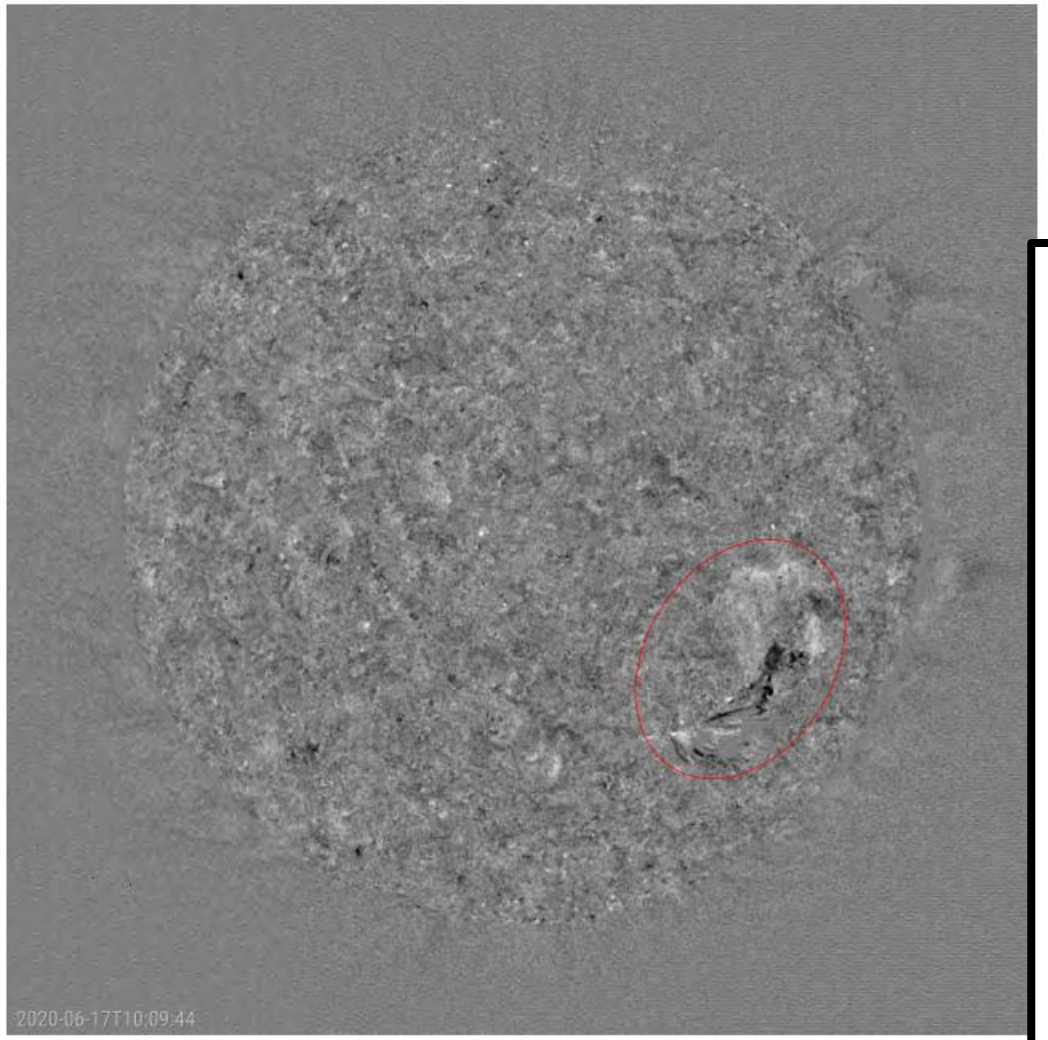


Fig. B.2. SolO/EUI running difference image showing the location of the filament and the coronal dimming seen by EUI. The temporal evolution is available as an **online movie**.

- CIR+CME at the origin of the particle accelerations

A&A 656, L10 (2021)
https://doi.org/10.1051/0004-6361/202140966

Astronomy & Astrophysics
Special issue

Solar Orbiter First Results (Cruise Phase)

LETTER TO THE EDITOR

Evidence for local particle acceleration in the first recurrent galactic cosmic ray depression observed by Solar Orbiter

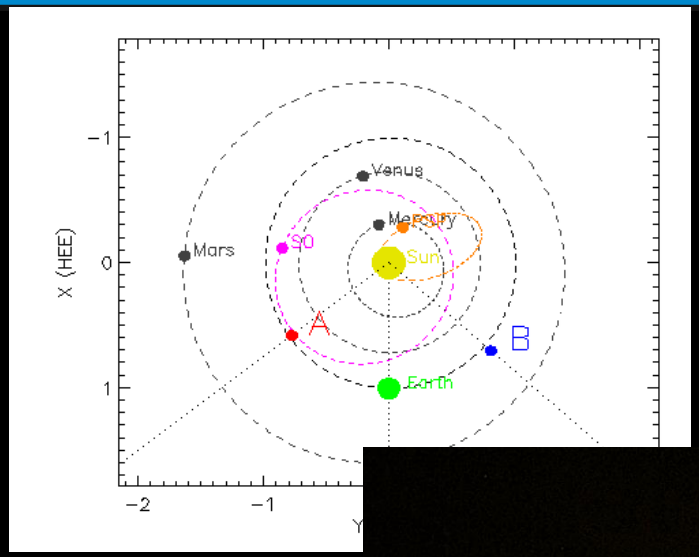
The ion event on 19 June 2020★

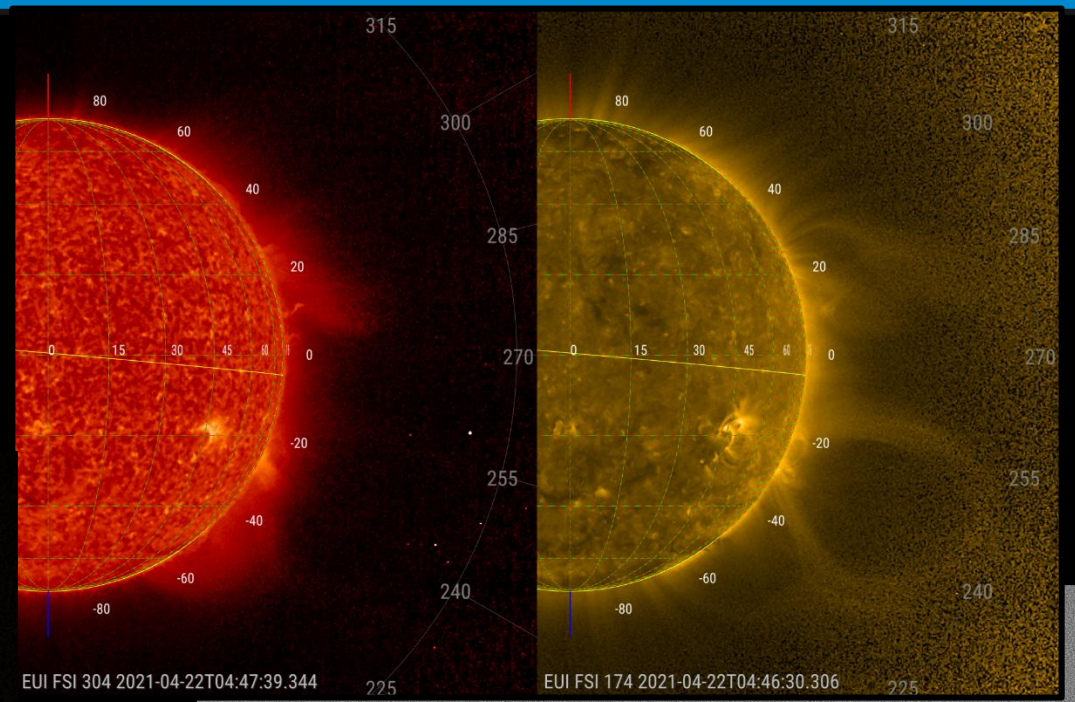
A. Aran[1], D. Pacheco[2], M. Laurenza[3], N. Wijsen[4], D. Lario[5], S. Benella[3], I. G. Richardson[5,6], E. Samara[4,7], J. L. Freiherr von Forstner[2,8], B. Sanahuja[1], L. Rodriguez[7], L. Balmaceda[5,9], F. Espinosa Lara[10], R. Gómez-Herrero[10], K. Steinvall[11,12], A. Vecchio[13,14], V. Krupar[15,5], S. Poedts[4,16], R. C. Allen[17], G. B. Andrews[17], V. Angelini[18], L. Berger[2], D. Berghmans[7], S. Boden[2,19], S. I. Böttcher[2], F. Carcaboso[10], I. Cernuda[10], R. De Marco[3], S. Eldrum[2], V. Evans[18], A. Fedorov[20], J. Hayes[17], G. C. Ho[17], T. S. Horbury[18], N. P. Janitzek[21], Yu. V. Khotyaintsev[11], A. Kollhoff[2], P. Kühl[2], S. R. Kulkarni[2,22], W. J. Lees[17], P. Louarn[20], J. Magdalenic[4,7], M. Maksimovic[13], O. Malandraki[23], A. Martínez[10], G. M. Mason[17], C. Martín[2,24], H. O'Brien[18], C. Owen[25], P. Parra[10], M. Prieto Mateo[10], A. Ravanbakhsh[2,26], J. Rodriguez-Pacheco[10], O. Rodriguez Polo[10], S. Sánchez Prieto[10], C. E. Schlemm[17], H. Seifert[17], J. C. Terasa[2], K. Tyagi[17,27], C. Verbeeck[7], R. F. Wimmer-Schweingruber[2], Z. G. Xu[2], M. K. Yedla[2,26], and A. N. Zhukov[7,28]

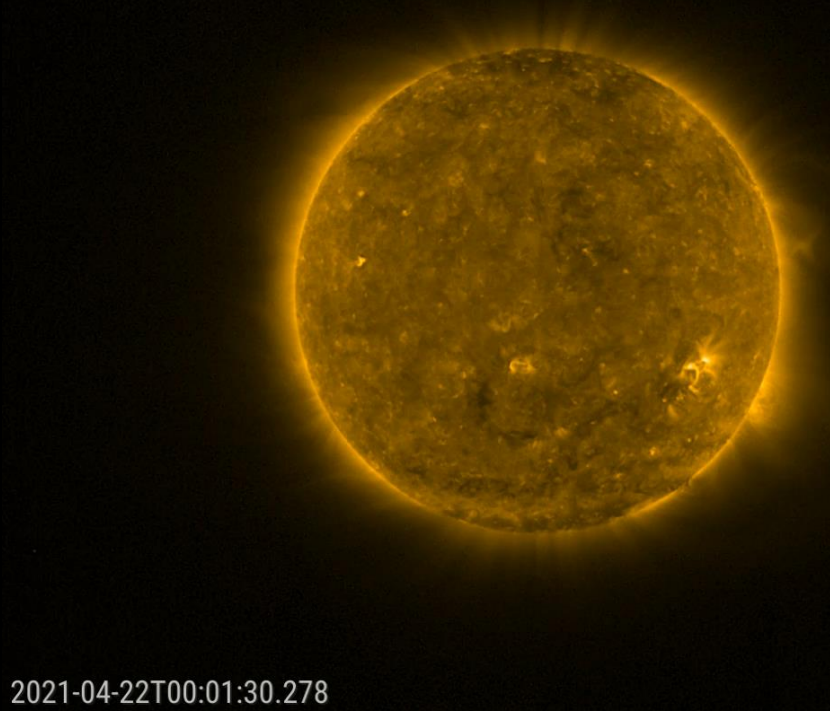
(Affiliations can be found after the references)

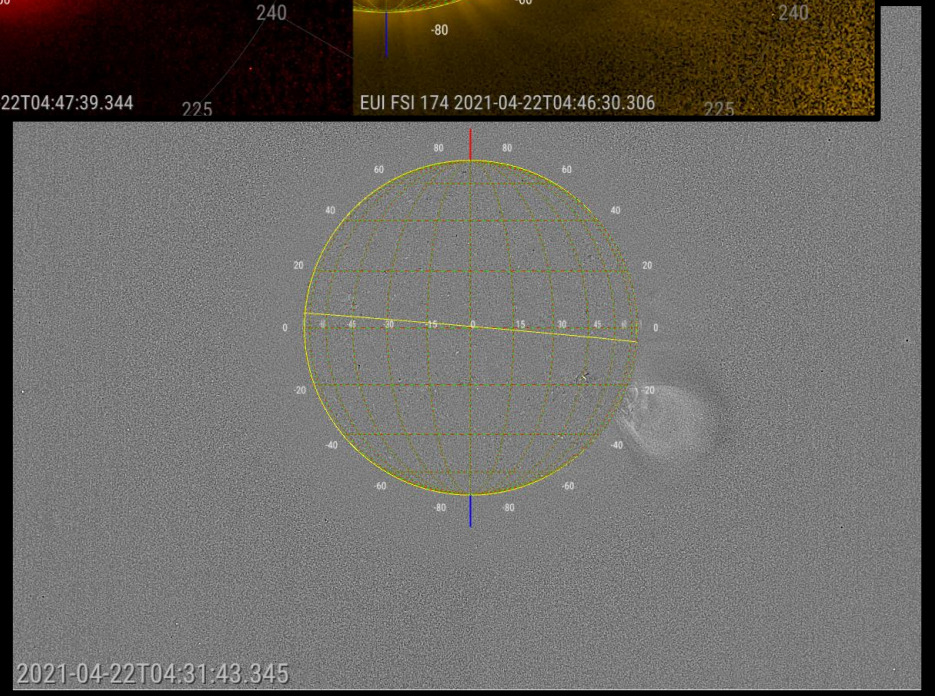
Received 31 March 2021 / Accepted 1 August 2021

The 22 April 2021 event: EUI-Metis-STIX-STEREO-Earth

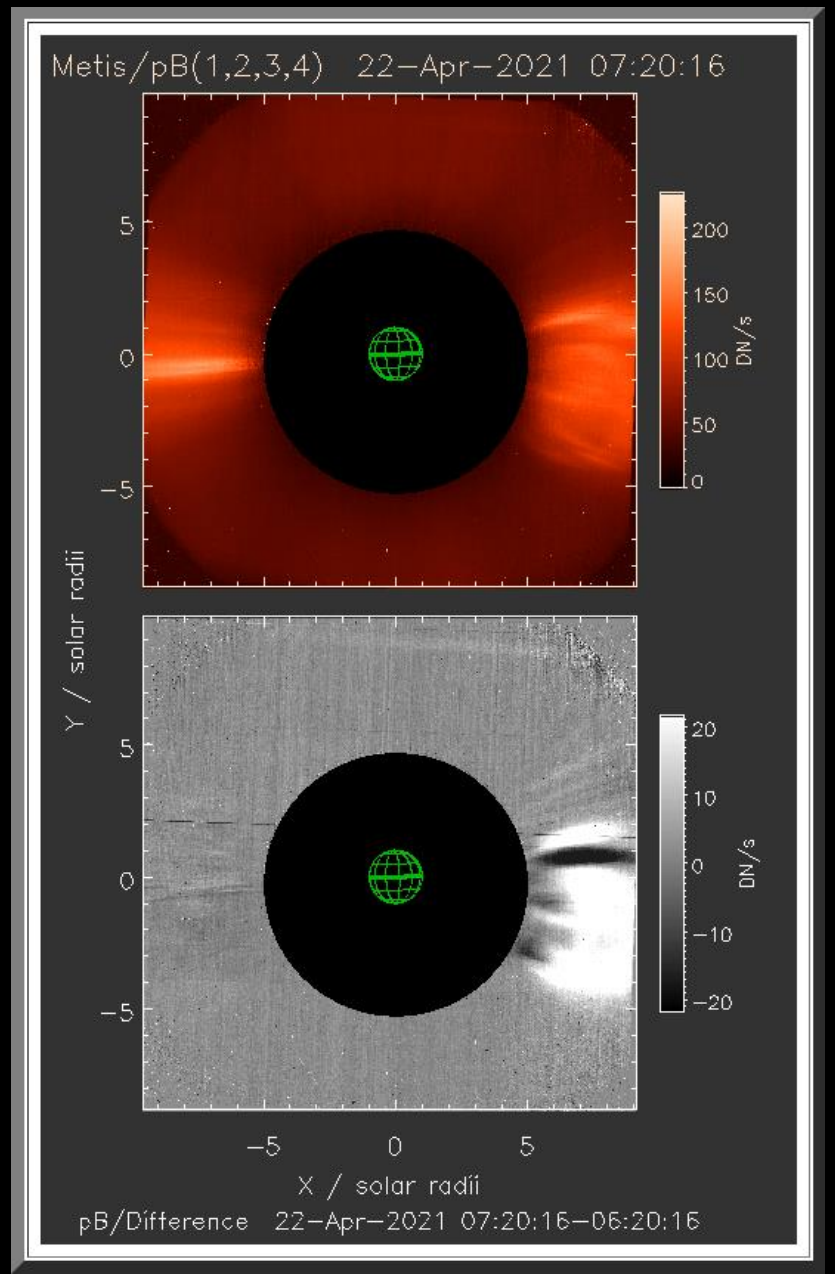








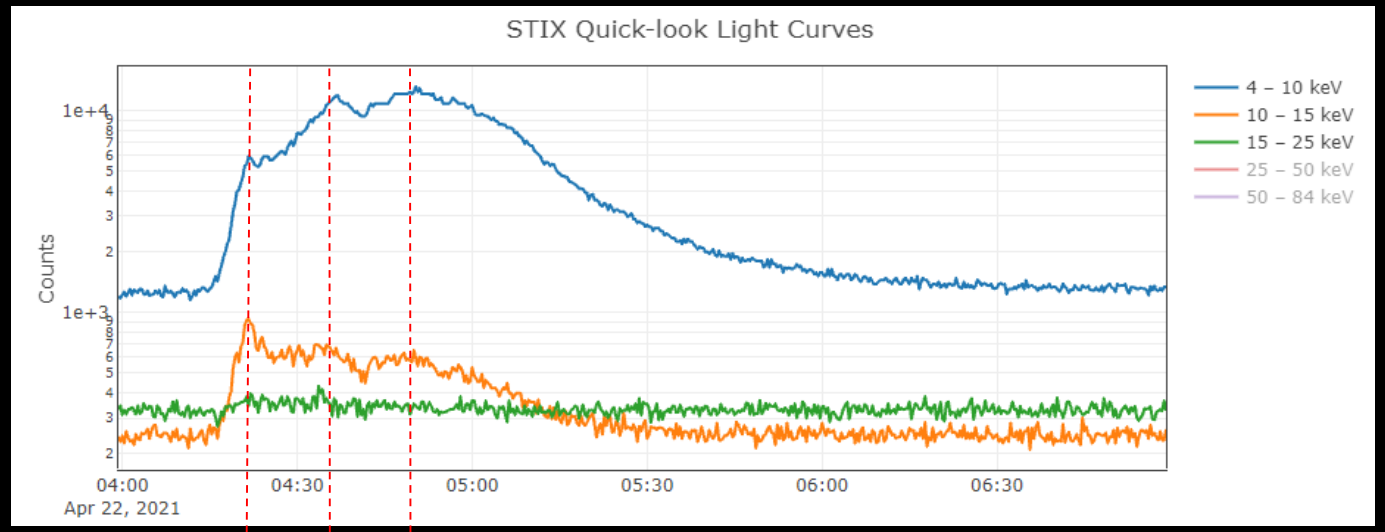
The 22 April 2021 event: EUI-Metis-STIX-STEREO-Earth

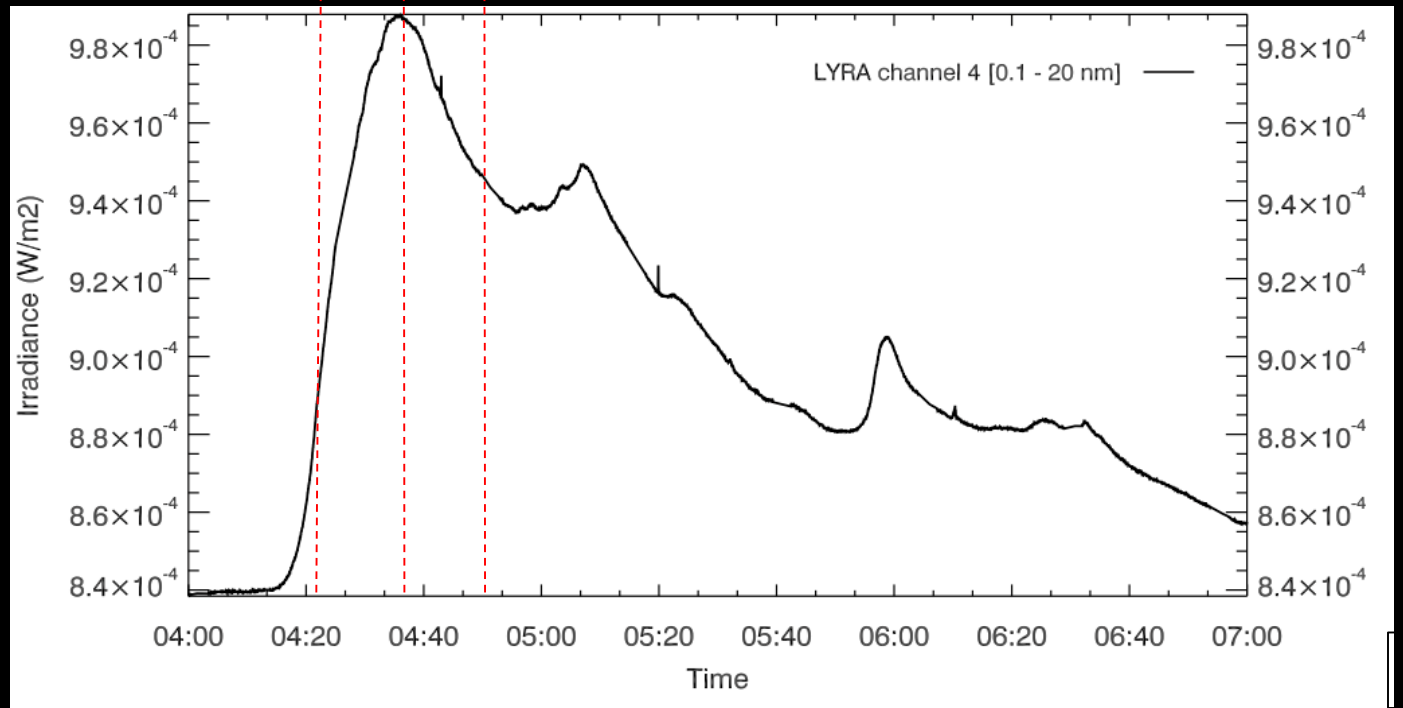


Metis, pb 1h cadence

V. Andretta

The 22 April 2021 event: EUI-Metis-STIX-STEREO-Earth





Each peak in the STIX thermal X-ray emission reflects a heating event.

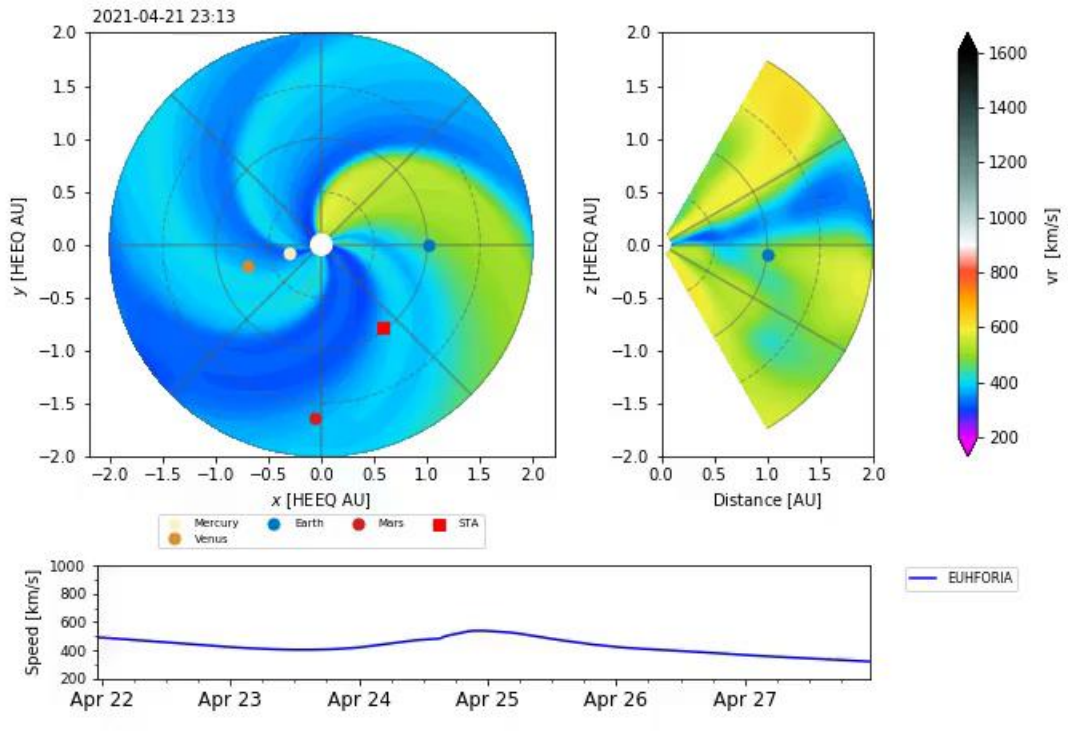
Correlation with UV emission:

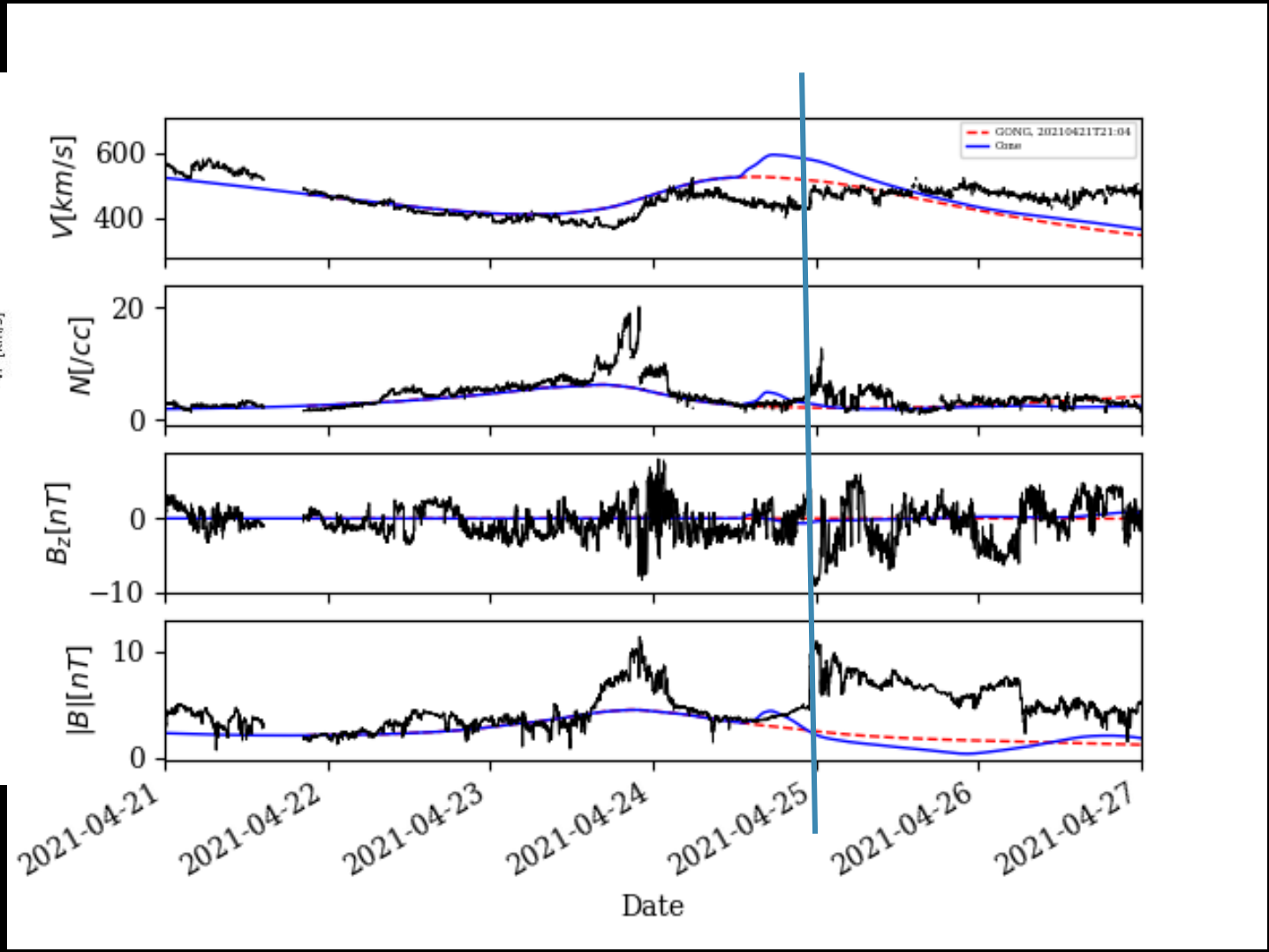
1. in steeply rising phase of UV
2. around peak of UV
3. after peak of UV (small bump)

Later UV peaks are not seen in X-rays –from different locations fully occulted for STIX

Main peak (2):
X-rays are delayed by ~100 s with respect to UV – typical timesale for chromospheric evaporation

The 22 April 2021 event: EUI-Metis-STIX-STEREO-Earth





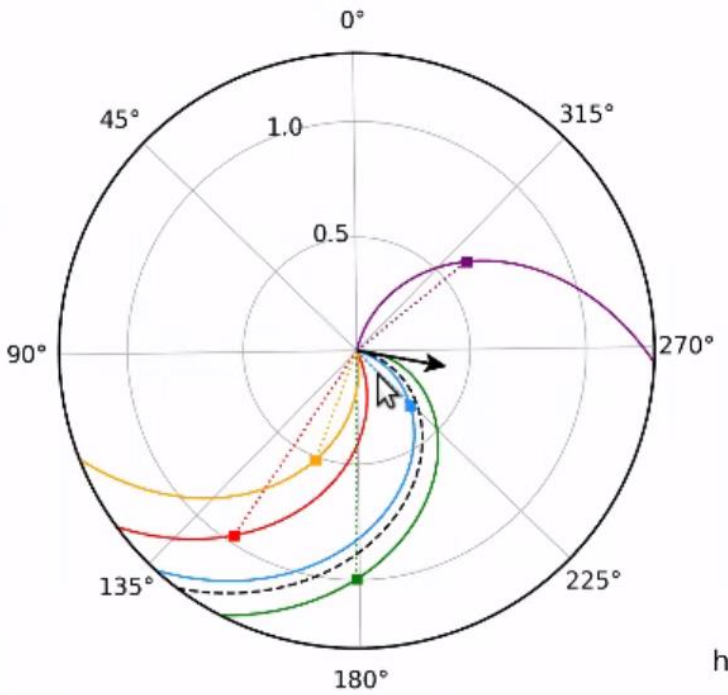
A. Maharana, A. Niemela

Overview of 21 March 2022 event observations

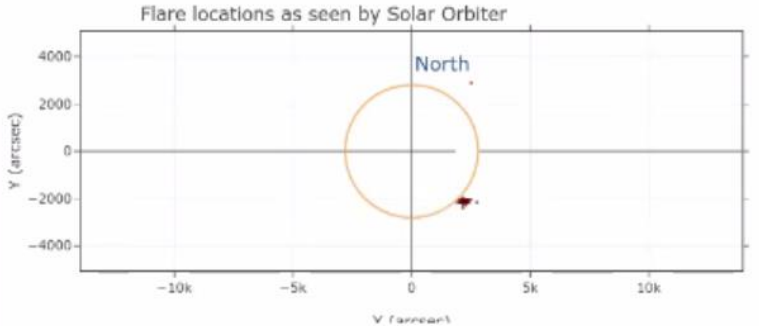
Daniel Pacheco, Alexander Kollhoff, David Lario, Athanasios Kouloumvakos, Athanasios Papaioannou, Luciano Rodríguez, Monica Laurenza & the study team of the 21 March 2022 event

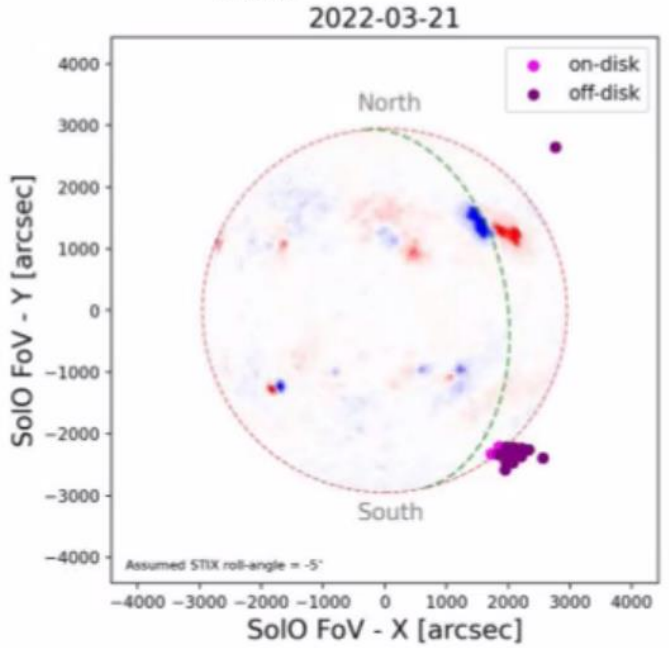
pacheco@physik.uni-kiel.de

21 March event



Solar-MACH
https://solar-mach.github.io

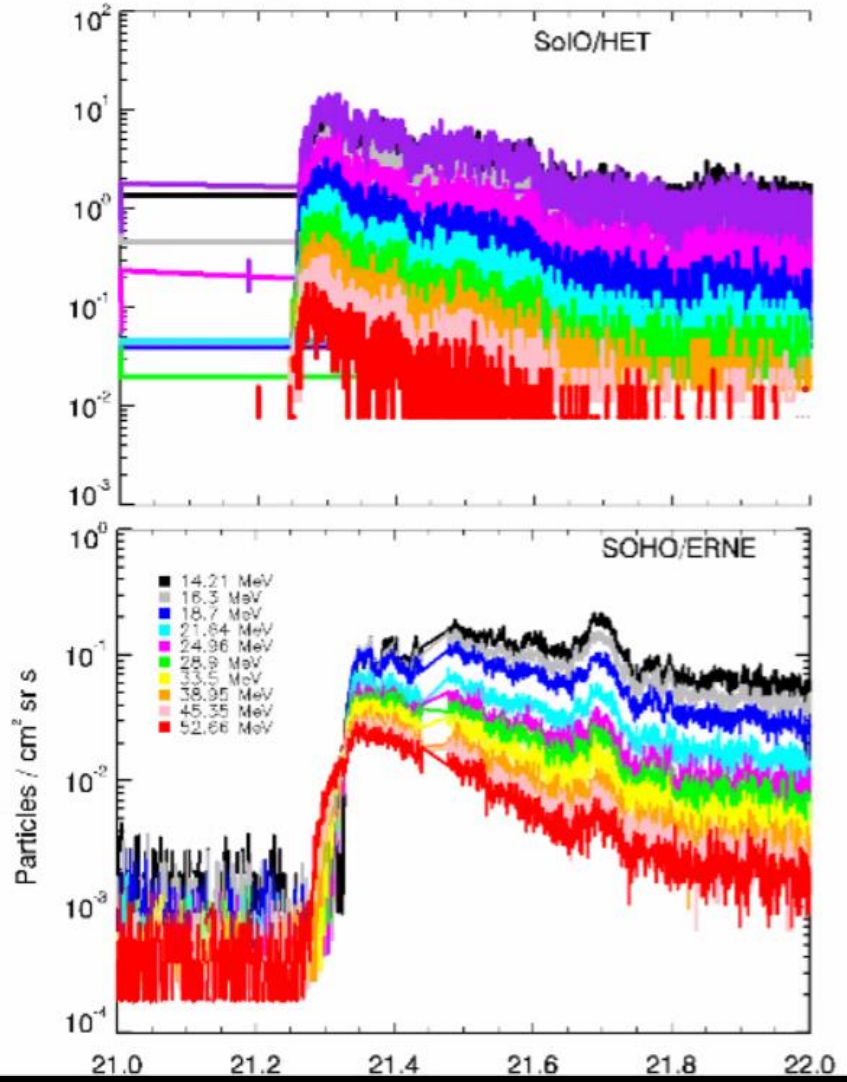




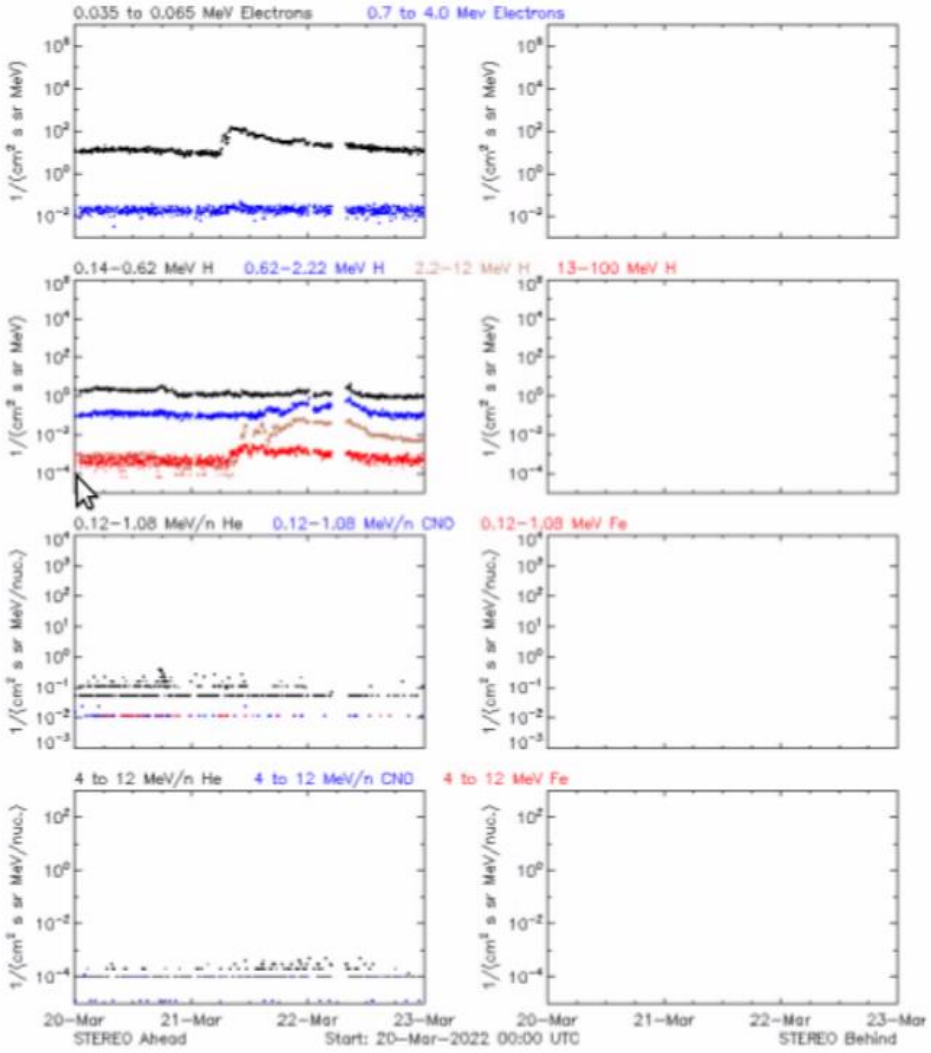
@RuipSol (twitter)

21 March event

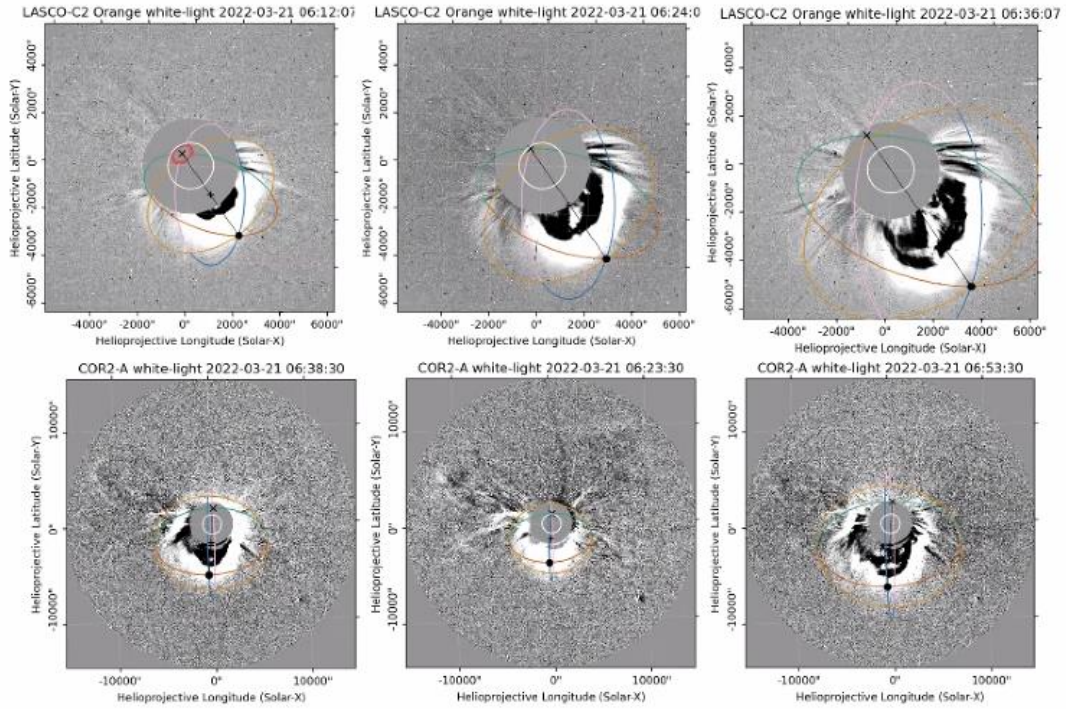
Solar Orbiter - SOHO



STEREO A



The SEP Event on 2022-03-21 | Shock Kinematics

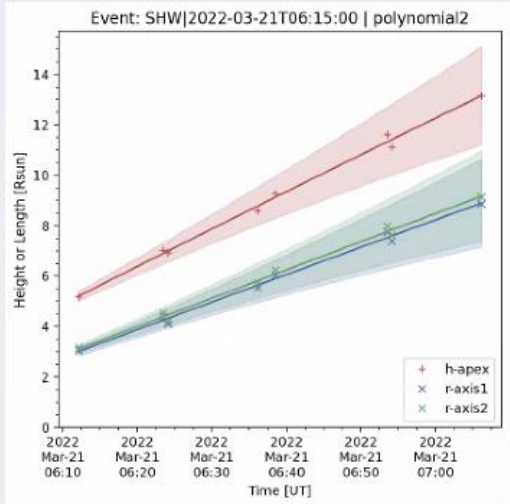


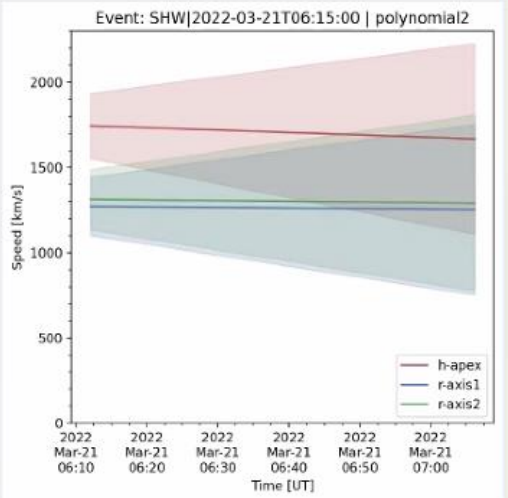
PyThea

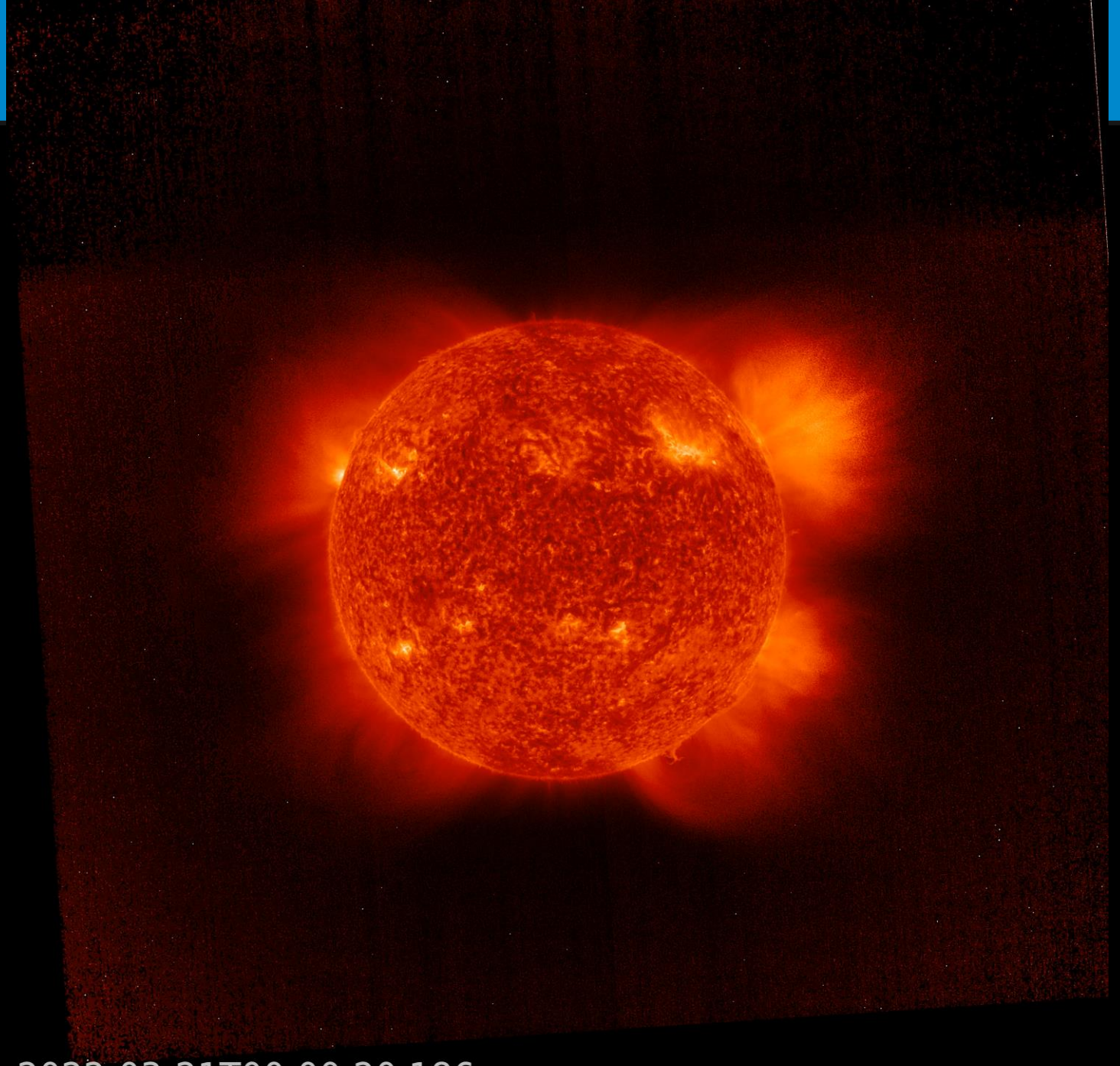
Reconstruct the 3D structure of CMEs and shock waves

> Shock speed: 1600 to 1900 km/s

> The problem is that the shock apex is not well constrained. Maybe with SolO/EUI



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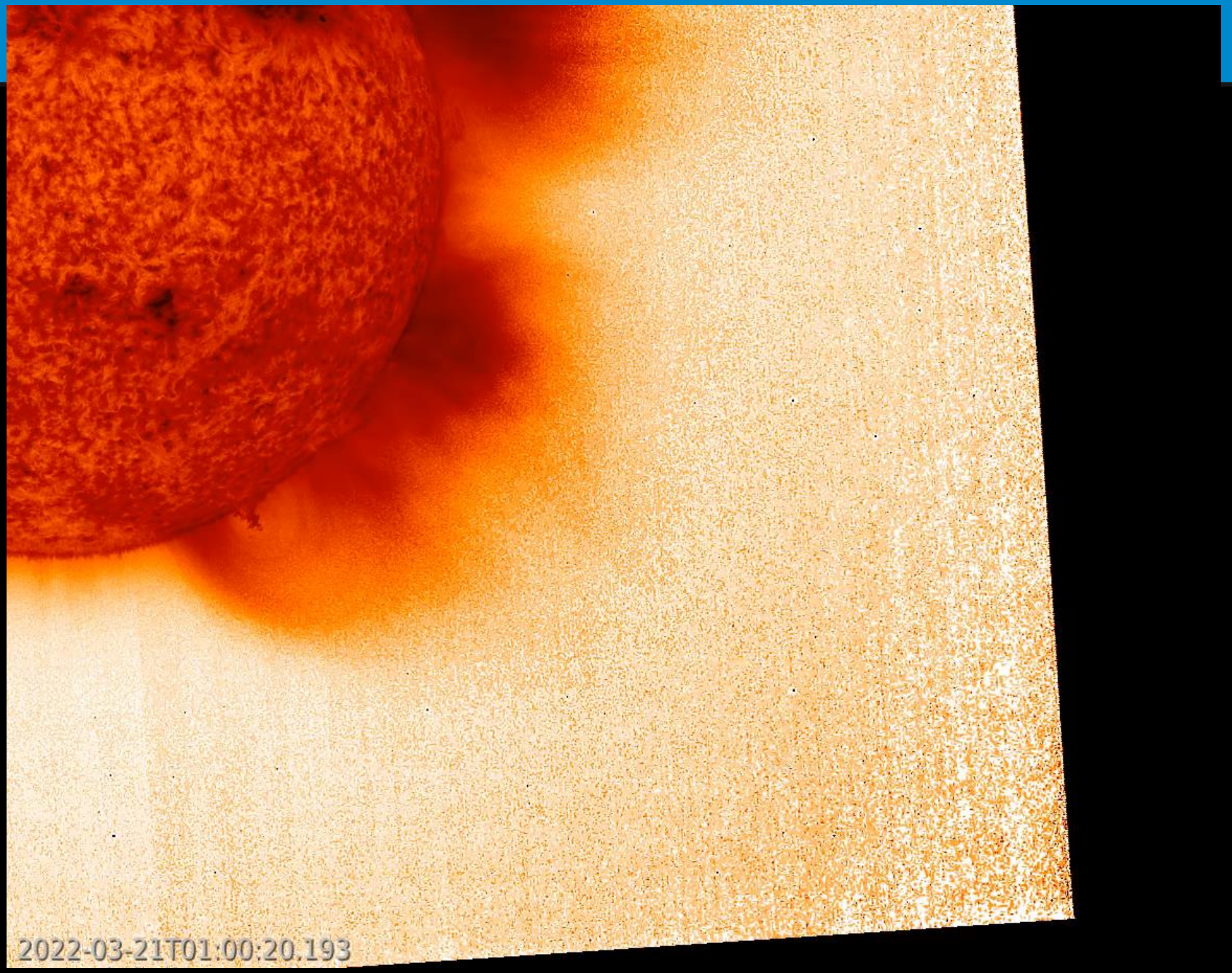
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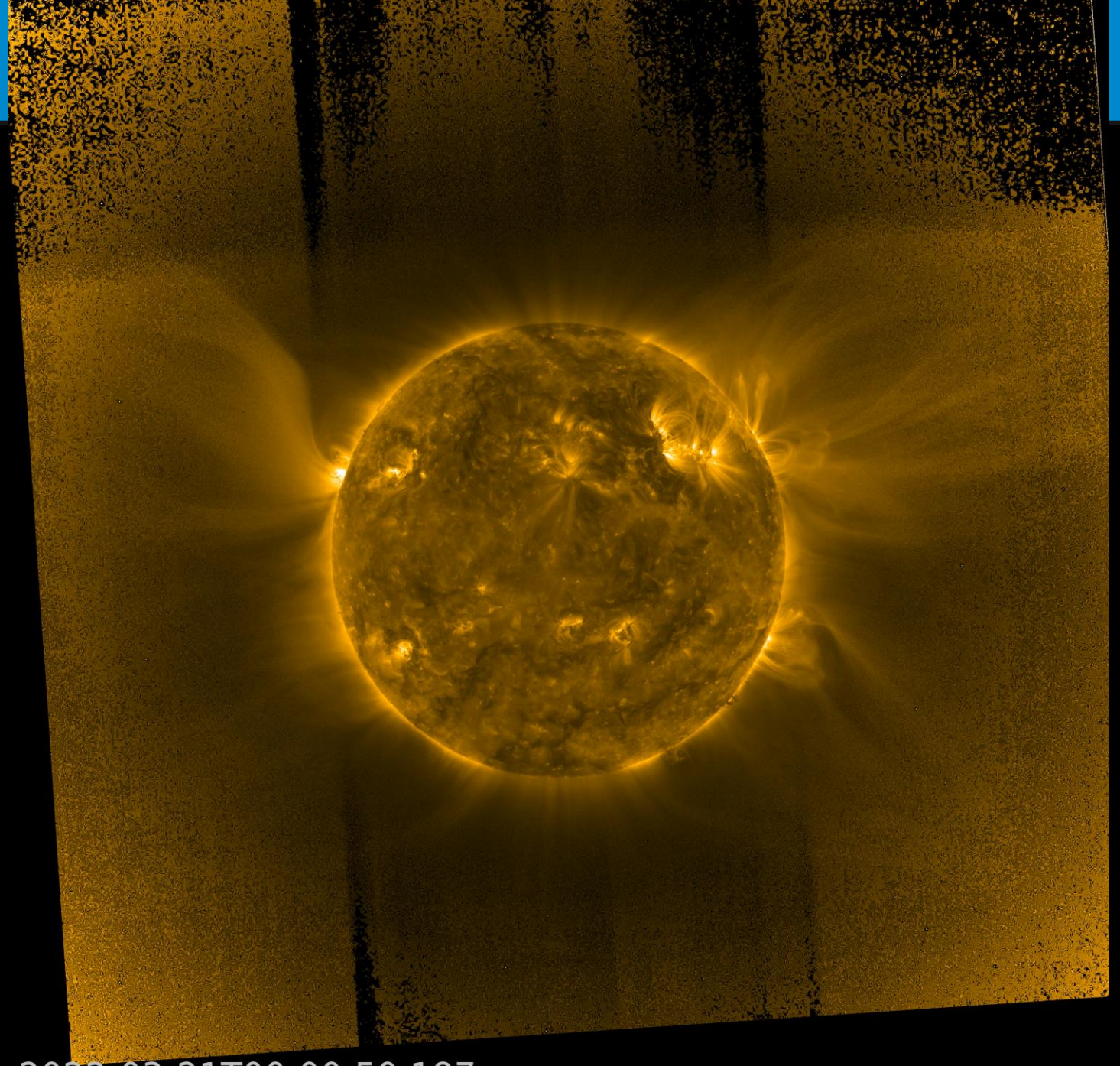
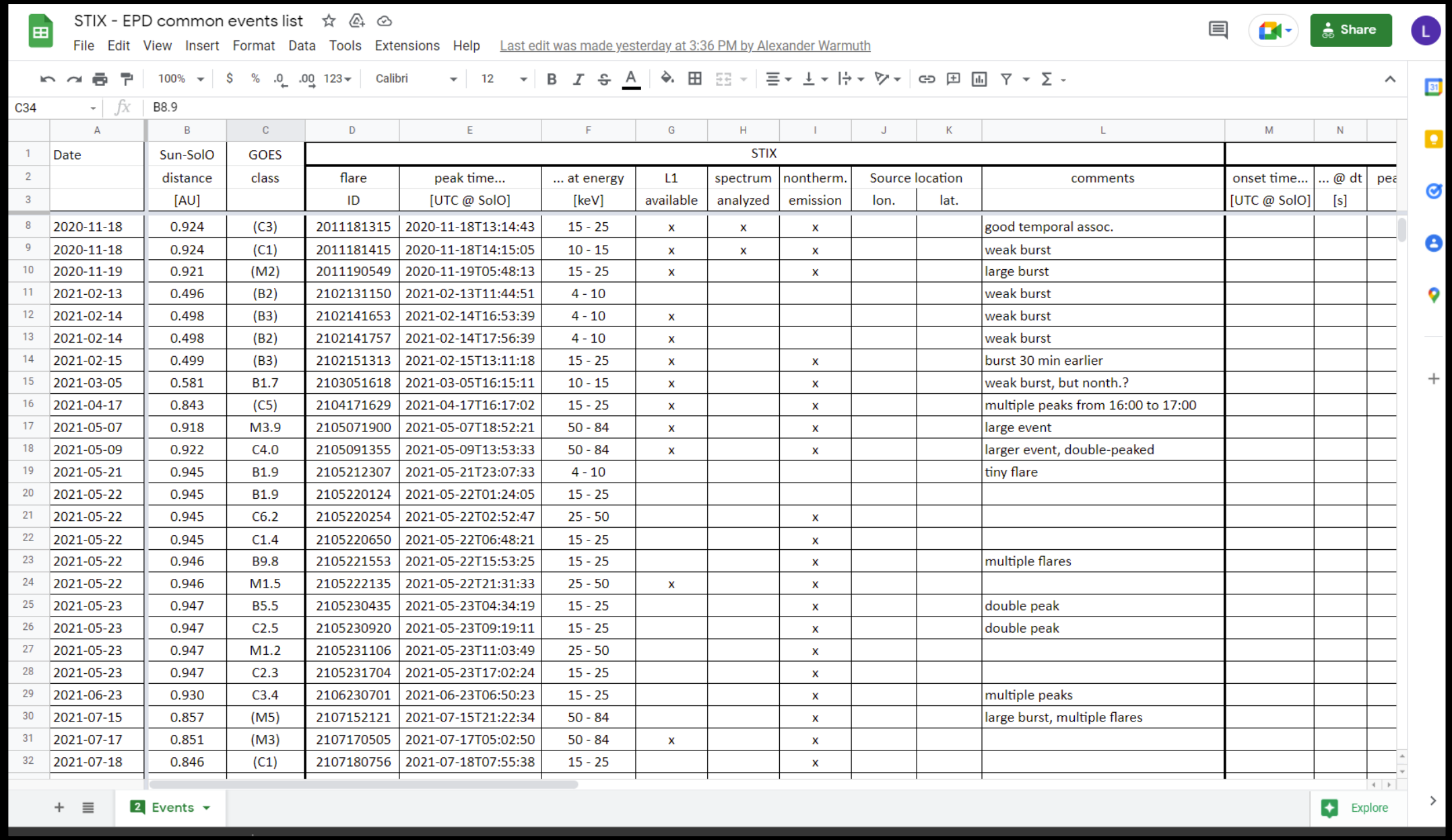


2022-03-21T00:00:50.187

EPD-STIX list events



STIX - EPD common events list

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C34 B8.9

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Date	Sun-SolO	GOES	STIX										
2		distance	class	flare	peak time...	... at energy	L1	spectrum	nontherm.	Source location		comments	onset time...	... @ dt
3		[AU]		ID	[UTC @ SolO]	[keV]	available	analyzed	emission	lon.	lat.		[UTC @ SolO]	[s]
8	2020-11-18	0.924	(C3)	2011181315	2020-11-18T13:14:43	15 - 25	x	x	x			good temporal assoc.		
9	2020-11-18	0.924	(C1)	2011181415	2020-11-18T14:15:05	10 - 15	x	x	x			weak burst		
10	2020-11-19	0.921	(M2)	2011190549	2020-11-19T05:48:13	15 - 25	x		x			large burst		
11	2021-02-13	0.496	(B2)	2102131150	2021-02-13T11:44:51	4 - 10						weak burst		
12	2021-02-14	0.498	(B3)	2102141653	2021-02-14T16:53:39	4 - 10	x					weak burst		
13	2021-02-14	0.498	(B2)	2102141757	2021-02-14T17:56:39	4 - 10	x					weak burst		
14	2021-02-15	0.499	(B3)	2102151313	2021-02-15T13:11:18	15 - 25	x		x			burst 30 min earlier		
15	2021-03-05	0.581	B1.7	2103051618	2021-03-05T16:15:11	10 - 15	x		x			weak burst, but nonth.?		
16	2021-04-17	0.843	(C5)	2104171629	2021-04-17T16:17:02	15 - 25	x		x			multiple peaks from 16:00 to 17:00		
17	2021-05-07	0.918	M3.9	2105071900	2021-05-07T18:52:21	50 - 84	x		x			large event		
18	2021-05-09	0.922	C4.0	2105091355	2021-05-09T13:53:33	50 - 84	x		x			larger event, double-peaked		
19	2021-05-21	0.945	B1.9	2105212307	2021-05-21T23:07:33	4 - 10						tiny flare		
20	2021-05-22	0.945	B1.9	2105220124	2021-05-22T01:24:05	15 - 25								
21	2021-05-22	0.945	C6.2	2105220254	2021-05-22T02:52:47	25 - 50			x					
22	2021-05-22	0.945	C1.4	2105220650	2021-05-22T06:48:21	15 - 25			x					
23	2021-05-22	0.946	B9.8	2105221553	2021-05-22T15:53:25	15 - 25			x			multiple flares		
24	2021-05-22	0.946	M1.5	2105222135	2021-05-22T21:31:33	25 - 50	x		x					
25	2021-05-23	0.947	B5.5	2105230435	2021-05-23T04:34:19	15 - 25			x			double peak		
26	2021-05-23	0.947	C2.5	2105230920	2021-05-23T09:19:11	15 - 25			x			double peak		
27	2021-05-23	0.947	M1.2	2105231106	2021-05-23T11:03:49	25 - 50			x					
28	2021-05-23	0.947	C2.3	2105231704	2021-05-23T17:02:24	15 - 25			x					
29	2021-06-23	0.930	C3.4	2106230701	2021-06-23T06:50:23	15 - 25			x			multiple peaks		
30	2021-07-15	0.857	(M5)	2107152121	2021-07-15T21:22:34	50 - 84			x			large burst, multiple flares		
31	2021-07-17	0.851	(M3)	2107170505	2021-07-17T05:02:50	50 - 84	x		x					
32	2021-07-18	0.846	(C1)	2107180756	2021-07-18T07:55:38	15 - 25			x					

Events

Explore

EUI-STIX list events, now includes EUI

STIX - EPD common events list

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AD48 | at limb; (cad: FSI 174 -2 min; FSI 304 - 30min)

	Date	EPD						EUI				
		path length (VDA) [AU]	spectrum analyzed	charact.	composition	anisotropy	comments	Data available FSI 174	FSI 304	HRI 174	HRI 216	comments
4	2020-11-17		x	i?		no MAG data	VD, rather diffuse	x				at limb & at disk, (img. cad 1h), 3AR
5	2020-11-17		x	i		no MAG data	good VD	x				at limb & at disk, (img. cad 1h), 4AR
6	2020-11-18			i		no MAG data	VD, low high-energy cutoff	x				at limb (strong) & at disk, (img. cad 1h),4AR
7	2020-11-18		x	i		no MAG data	smaller event, rather diffuse	x				at limb (strong) & at disk, (img. cad 1h), 4AR
8	2020-11-18		x	i		no MAG data	good VD	x				at limb & at disk, (img. cad 1h), 4AR
9	2020-11-18		x	i		no MAG data	VD, small event	x				at limb, (img. cad 1h), 4AR
10	2020-11-19			i		no MAG data	VD, small event, contamination	-	-	-	-	Obs close in time only (FSI 304 -obs. 50 min b
11	2021-02-13			i		not observed in EPT	VD	x				at disk., > 1 eruptions, (img. cad.30 min)
12	2021-02-14			i		not observed in EPT	VD	x				at disk. (img. cad. 30 min)
13	2021-02-14			i		not observed in EPT	VD	x				at disk. (img. cad. 30 min)
14	2021-02-15		x	g		small	VD	x				at disk. (img. cad. 30 min)
15	2021-03-05			i		small	VD					
16	2021-04-17			g		small	long-duration wide-spread event					
17	2021-05-07			g		medium	VD, long duration					
18	2021-05-09			?		large, SolO inside MC	VD					
19	2021-05-21					very strong						

Krzysztof Barczynski

Summary

- Several studies involving EUI and other instruments are ongoing

- Feel free to contact me to participate, or to propose new ones