

USSP2021 Final Presentation

Searching for radio associations with solar energetic particles

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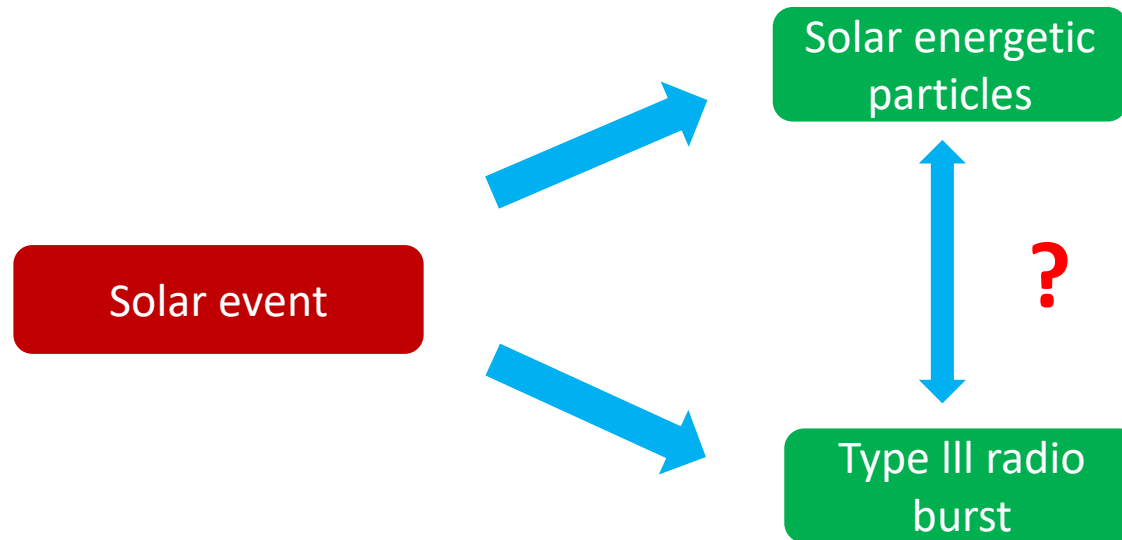
August 31, 2021

Outline

- Motivation
- Introduction
 - Solar radio burst-Type III radio burst
 - Solar Energetic Particles (SEPs)
- Data source
 - Parker Solar Probe
- Analysis
- Discussion
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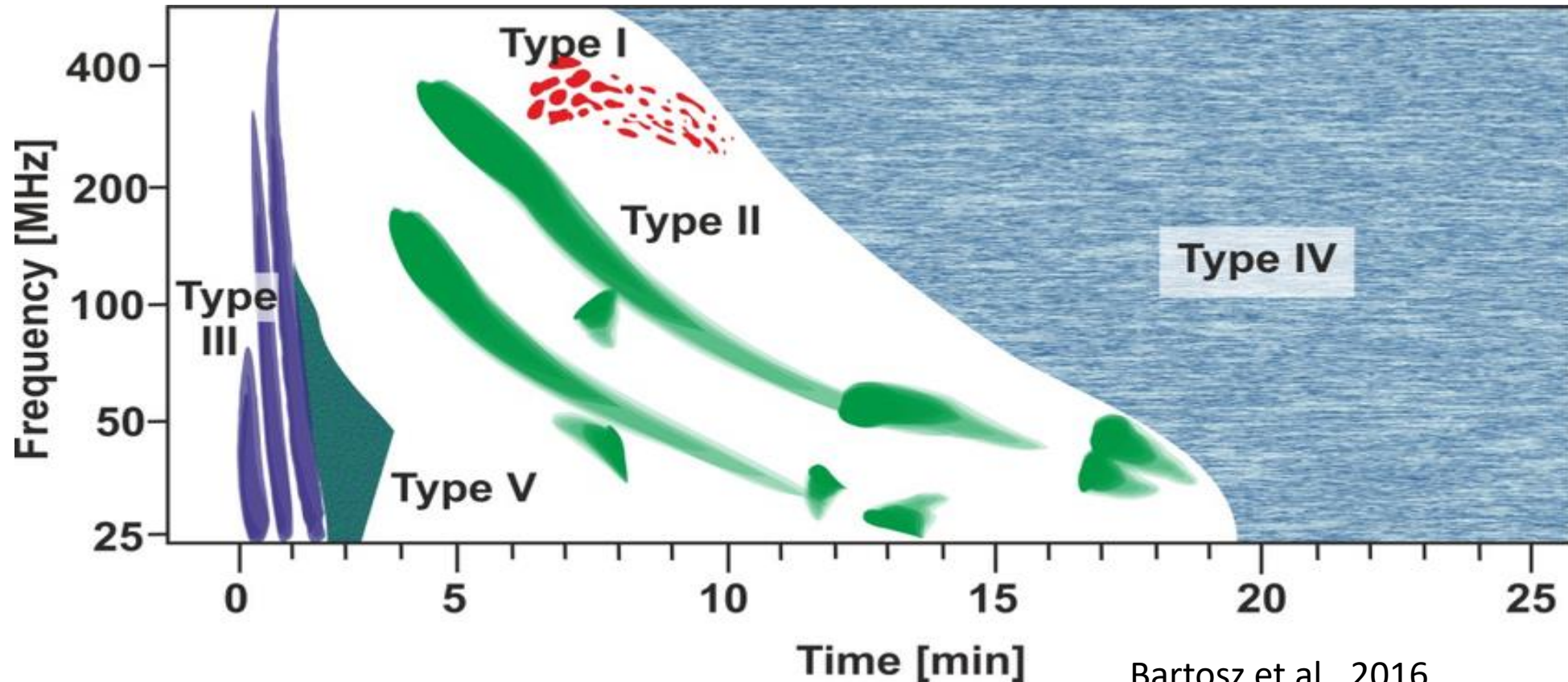
Motivation

- To analyze the association between type III radio burst and the solar energetic particles.

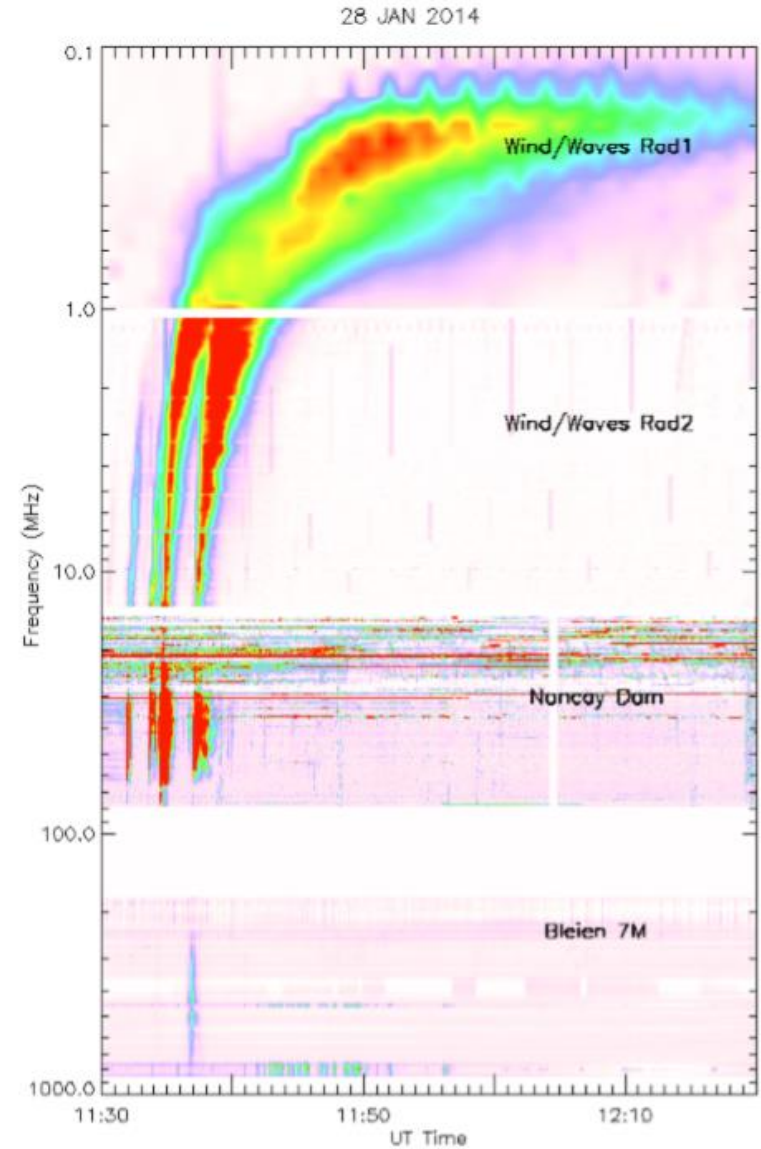
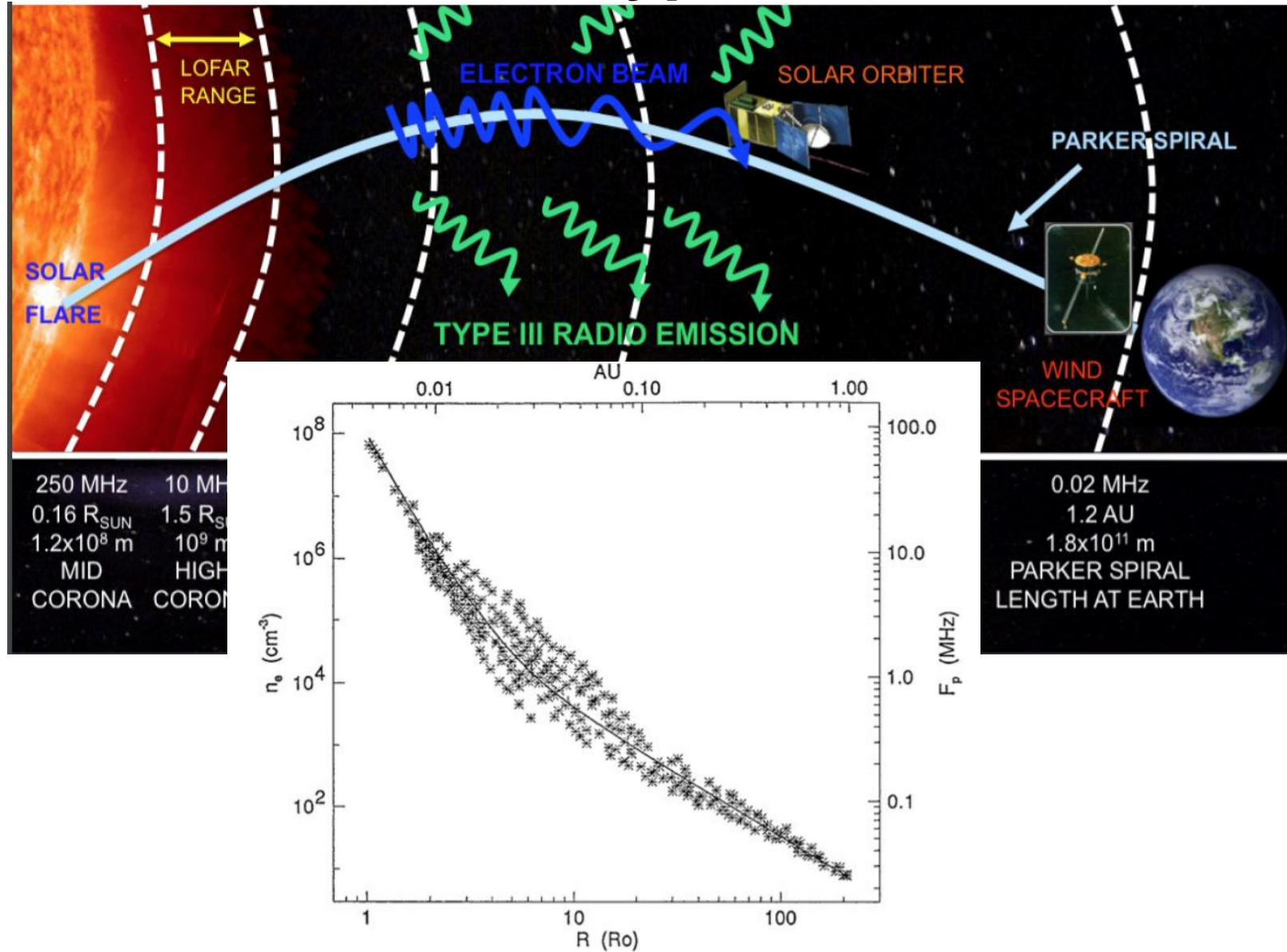


Introduction-Solar Radio Burst

The normal solar radio burst is a structure that the frequency varies with time from high to low.

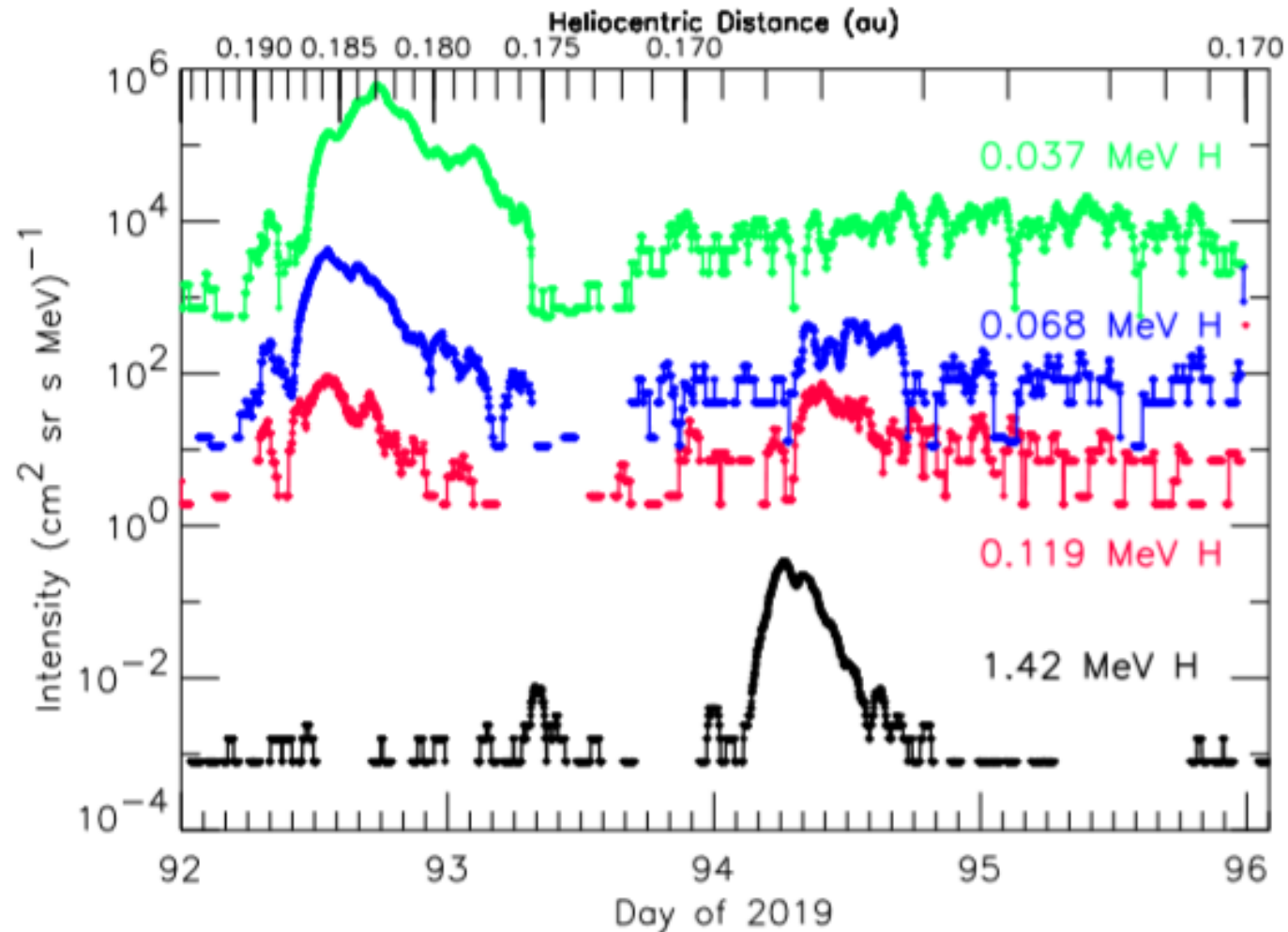


Introduction-Type III radio burst



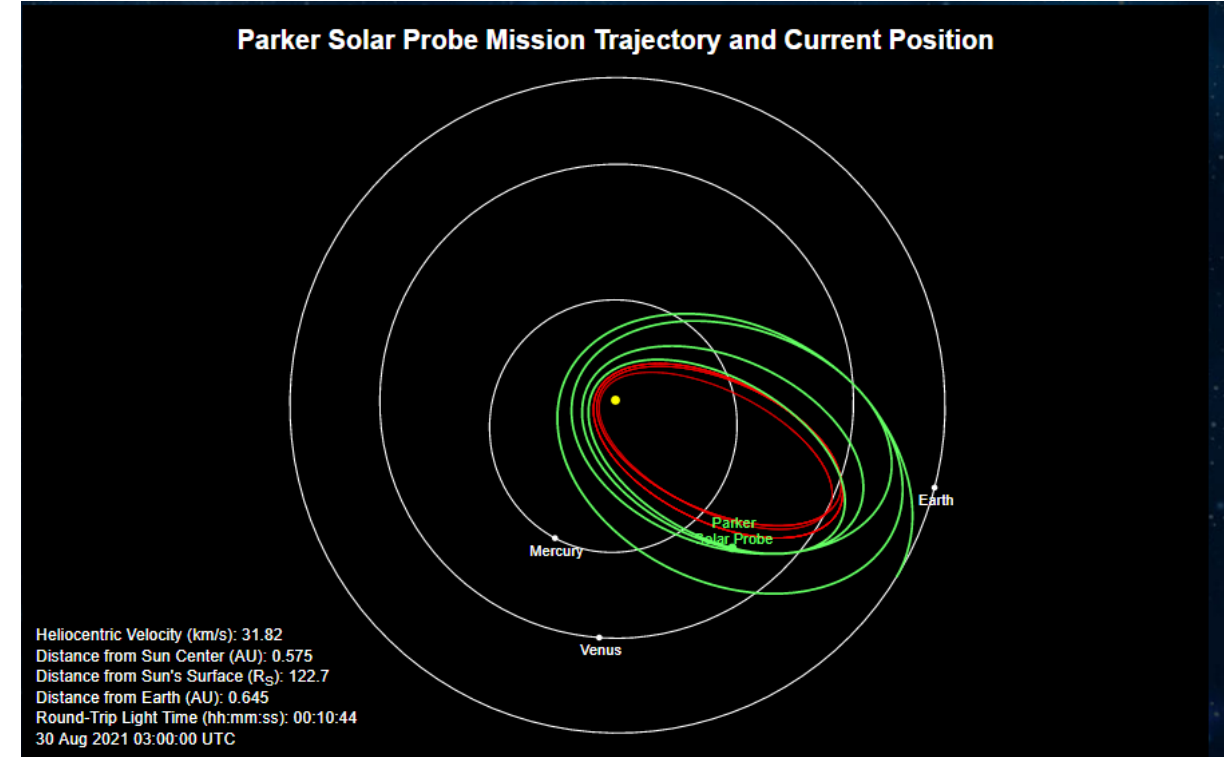
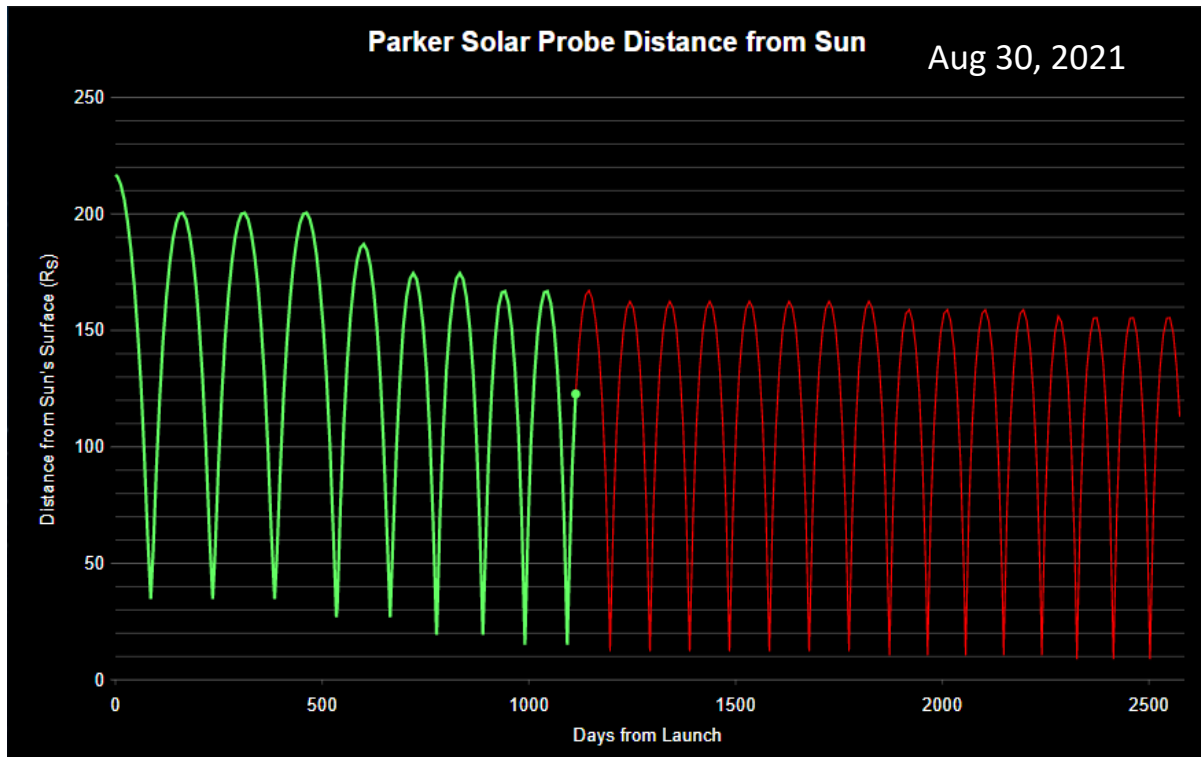
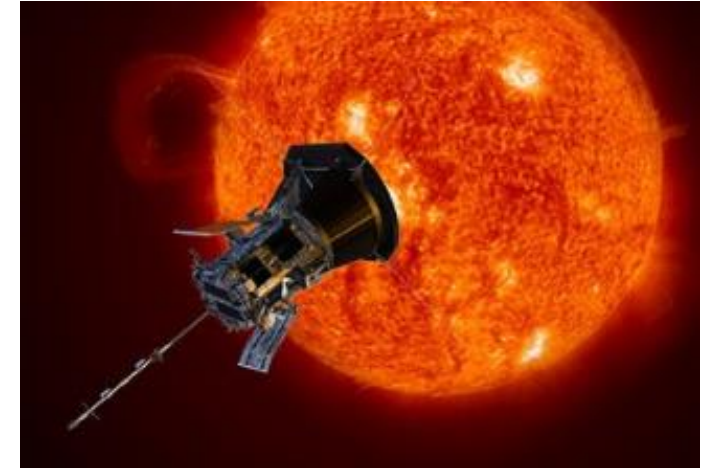
Introduction-Solar energetic particles (SEPs)

- Species : proton, helium, electron, heavy ions
- Energy range : 10s of keV \sim GeV



Data source-Parker Solar Probe

- Launch time : August 12, 2018
- Encounter : the distance between the sun and parker solar probe is smaller than 0.25 AU
- Cruise : distance larger than 0.25 AU



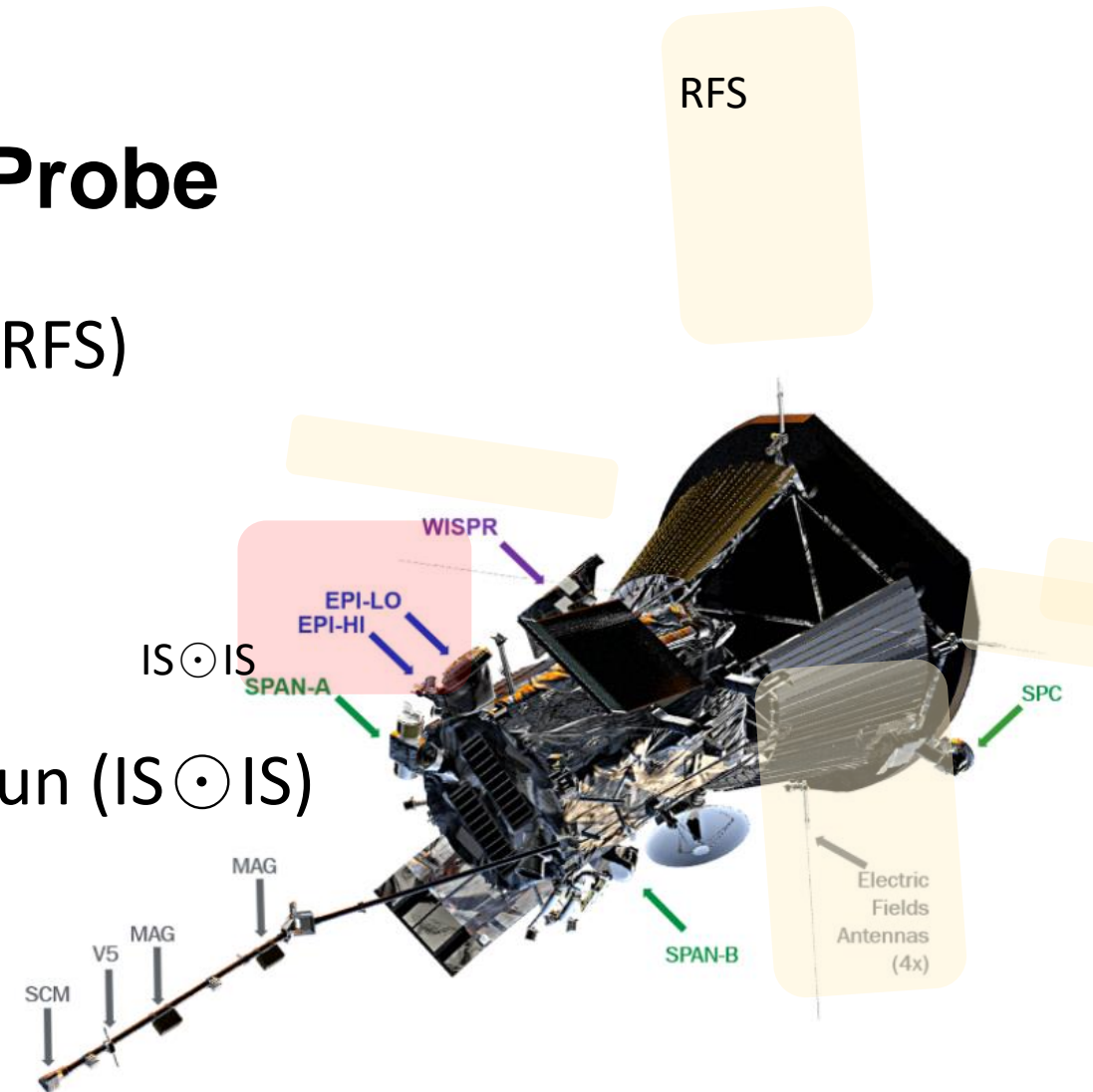
Data source-Parker Solar Probe

- FIELDS–Radio Frequency Spectrometer (RFS)
 - Observation : radio waves
 - Frequency range : 10 kHz – 19.2 MHz
 - Time resolution : 7 s (encounter)

- Integrated Science Investigation of the Sun (IS \odot IS)
 - Observation : the flux of energetic particle

	Time resolution	Energy range
Proton&Helium	1 min	1 MeV – 50 MeV
Electron	1 min	0.5 MeV - 6 MeV

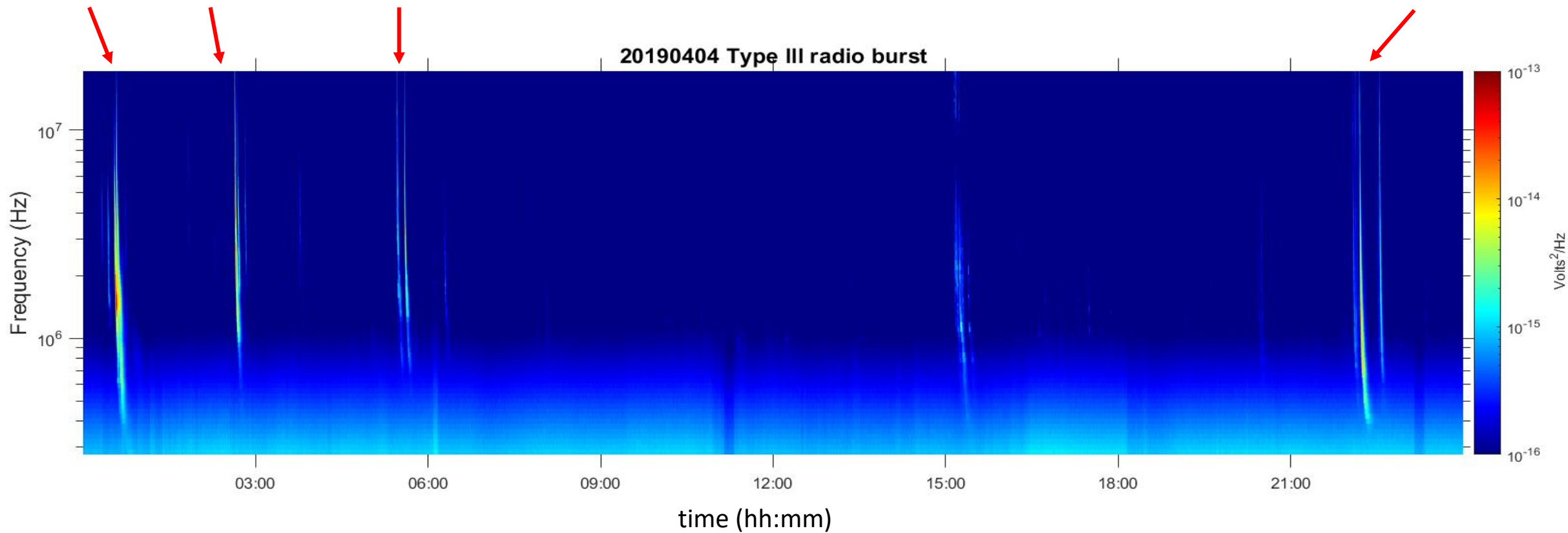
- Event time : 2019/4/4



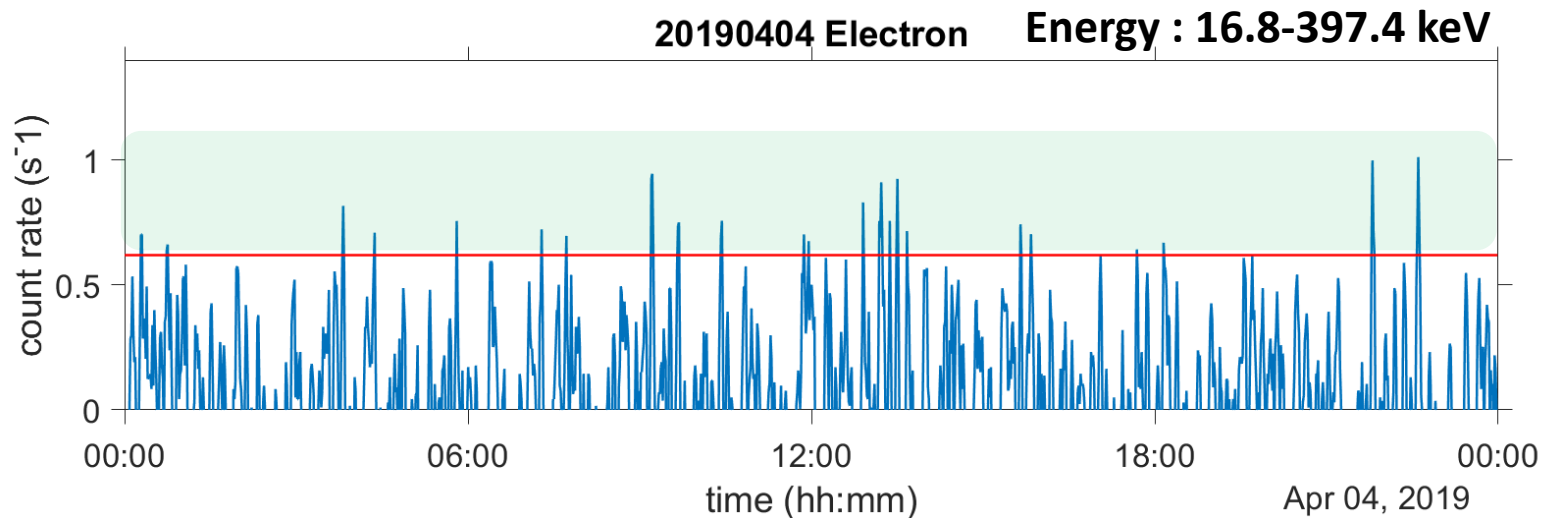
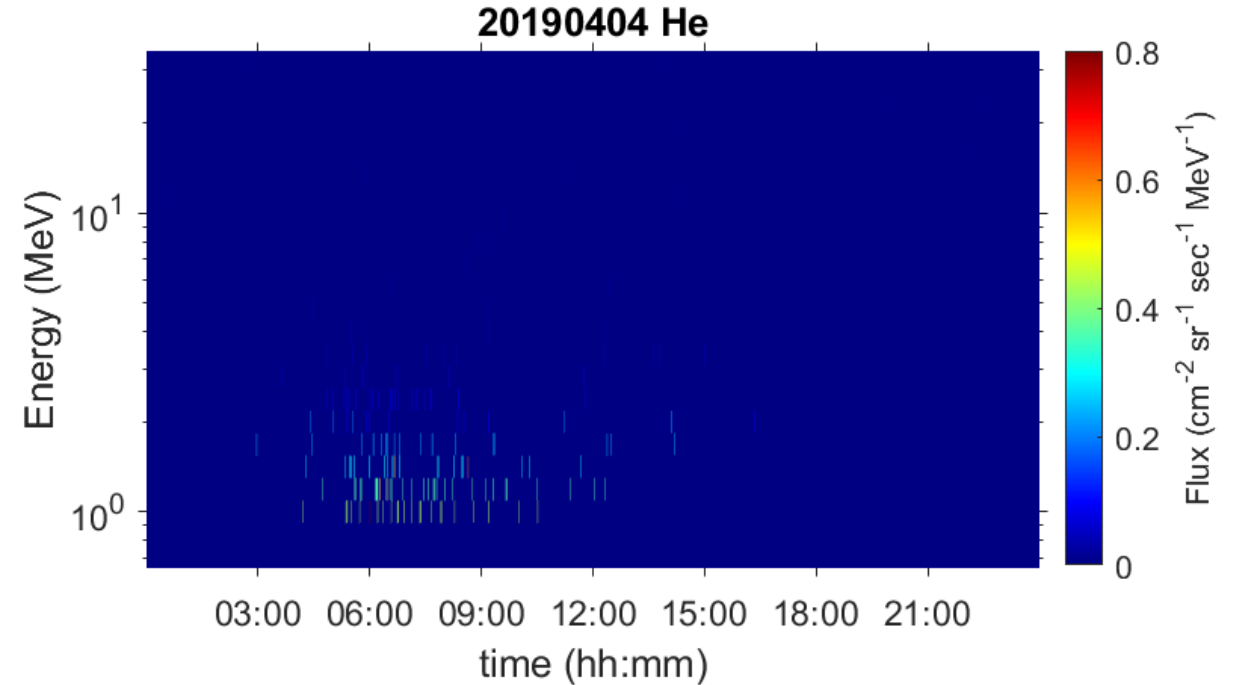
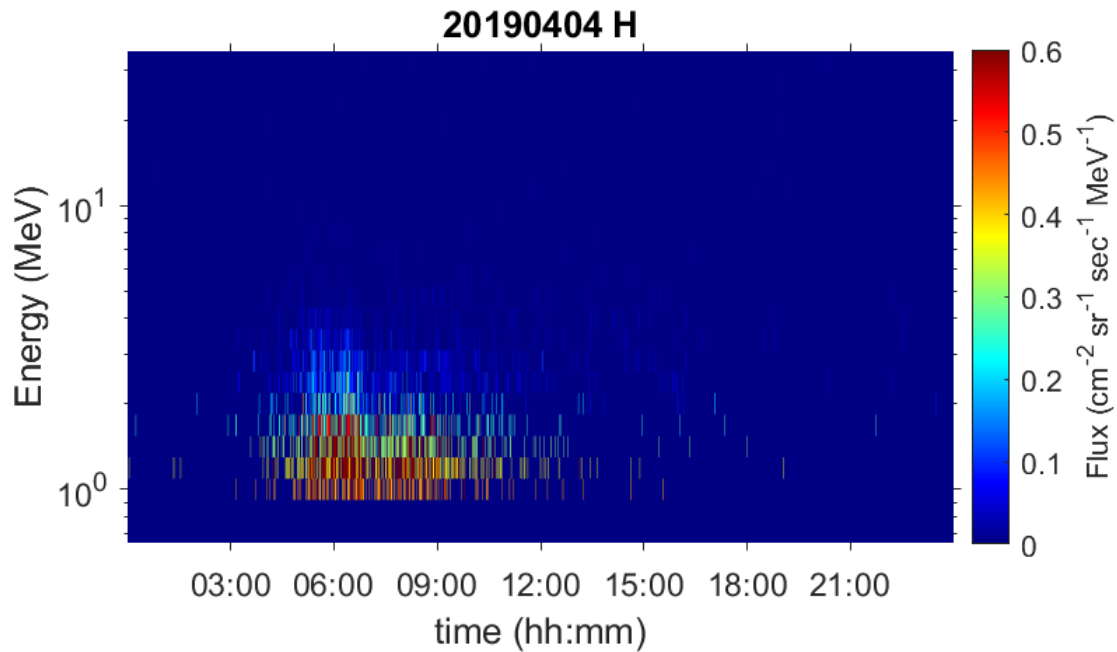
http://sweap.cfa.harvard.edu/PSP_Spacecraft.html

Analysis-2019/4/4 (during encounter 2)

	Event 1	Event 2	Event 3	Event 4
Time	00:32-00:45	02:38-02:52	05:27-05:44	22:11-22:36



Analysis-2019/4/4 (during encounter 2)



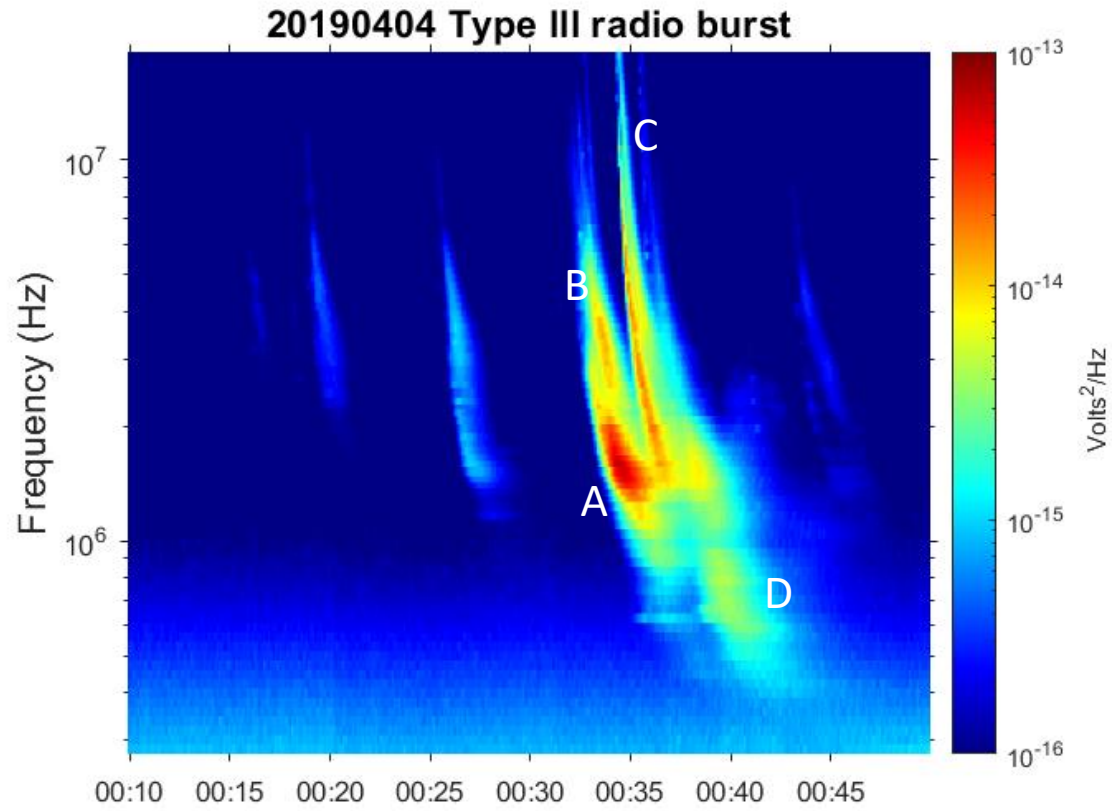
Background time : 3/31-4/10

Type III radio burst

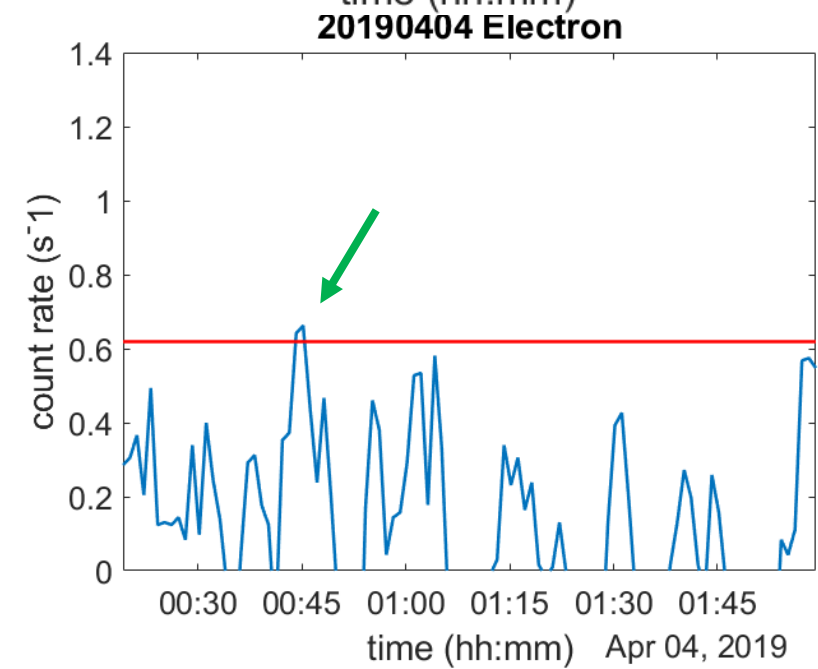
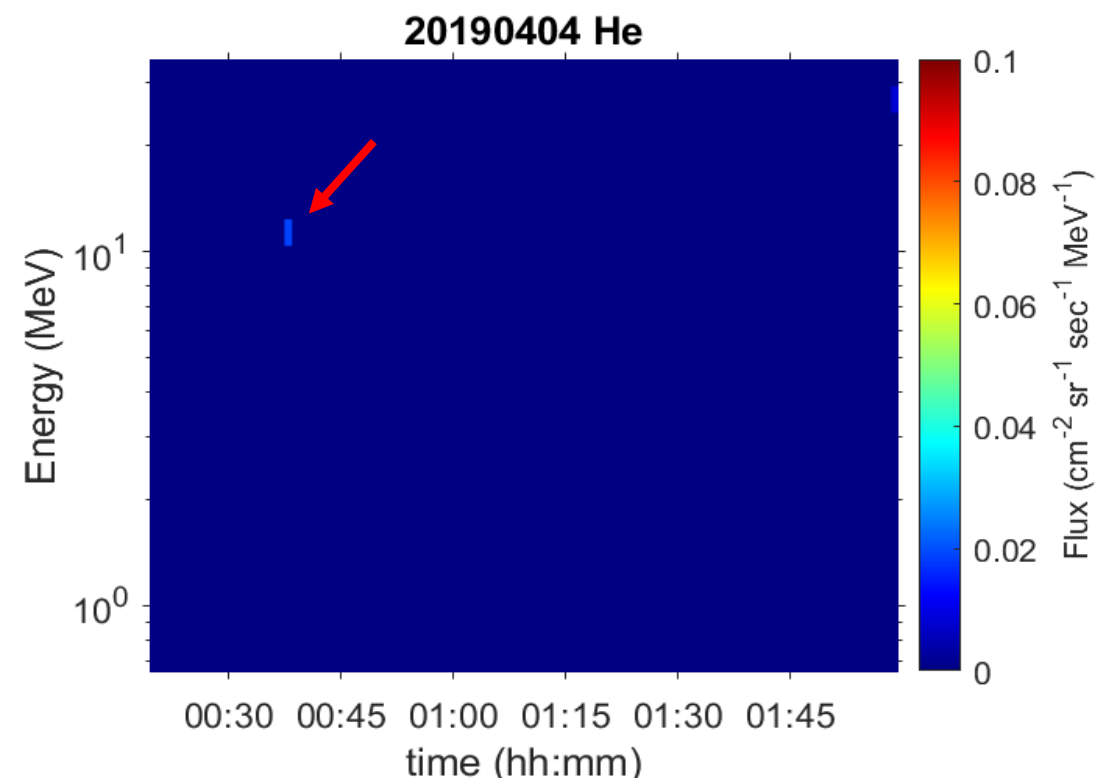
? Delay time ?

SEPs

Analysis-Event 1 00:32-00:45

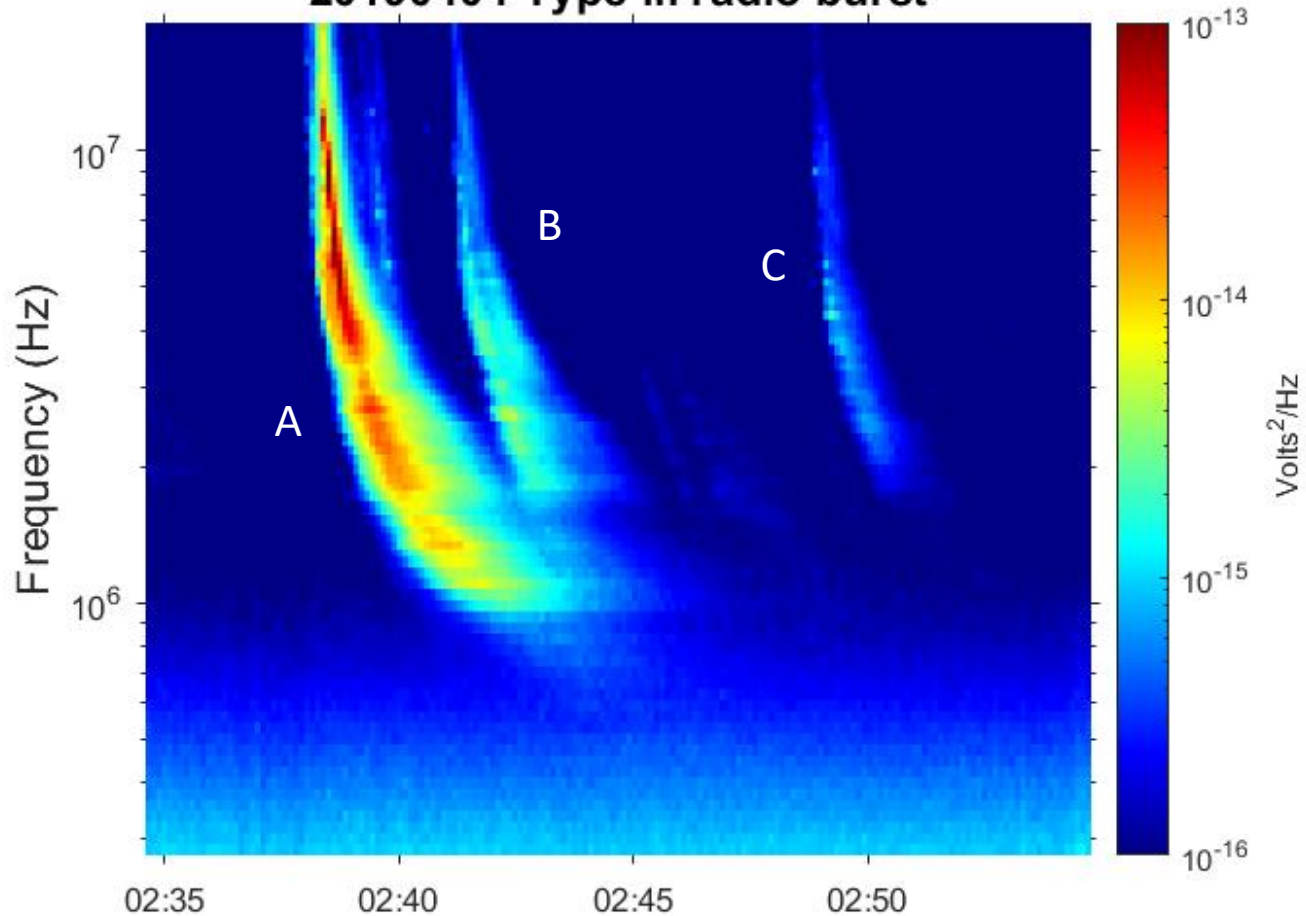


	Bandwidth (MHz)	Duration
A	$3.2 \times 10^6 \sim 0.8 \times 10^6$	4 min 10 sec
B	$6.8 \times 10^6 \sim 2.1 \times 10^6$	2 min 30 sec
C	$19.1 \times 10^6 \sim 1.1 \times 10^6$	3 min 30 sec
D	$5.0 \times 10^6 \sim 0.4 \times 10^6$	5 min 30 sec

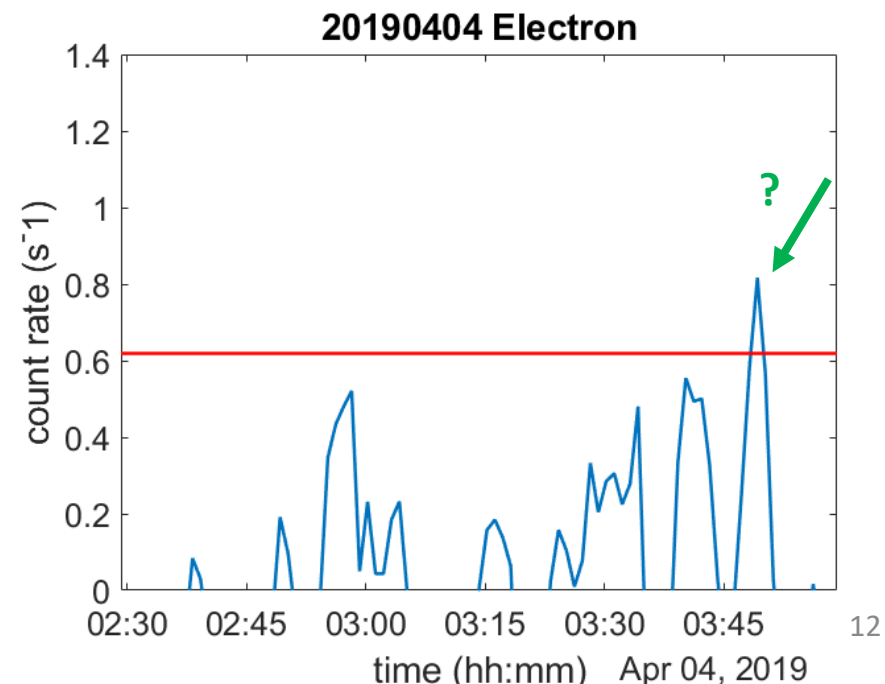
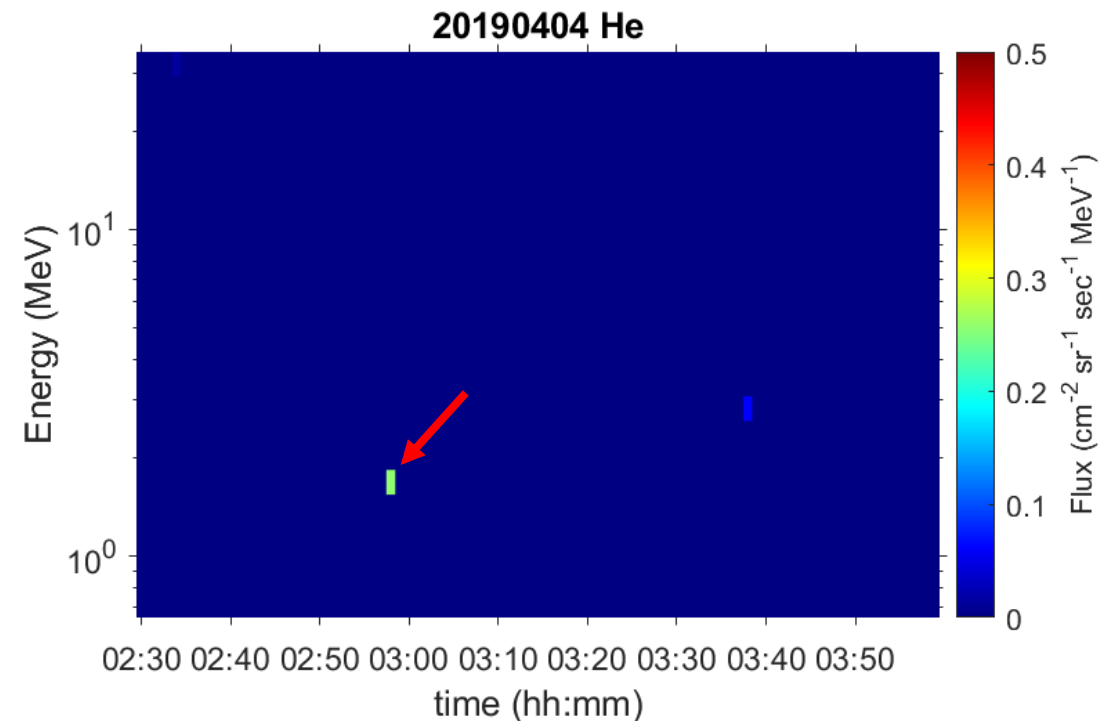


Analysis-Event 2 02:38-02:52

20190404 Type III radio burst

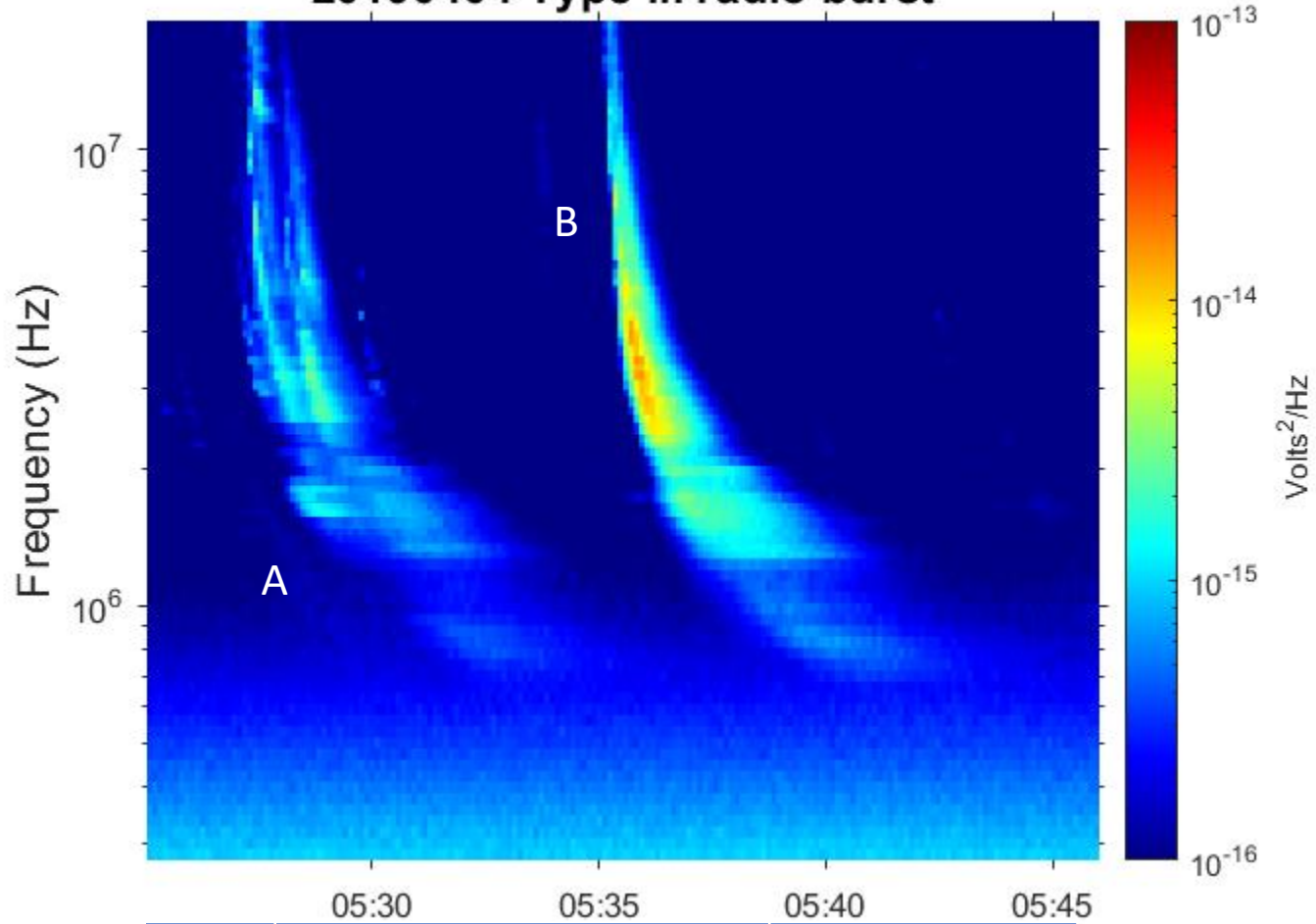


	Bandwidth (MHz)	Duration
A	$19.1 \times 10^6 \sim 0.95 \times 10^6$	4 min 40 sec
B	$9.6 \times 10^6 \sim 1.6 \times 10^6$	3 min 20 sec
C	$8.5 \times 10^6 \sim 1.5 \times 10^6$	2 min 30 sec

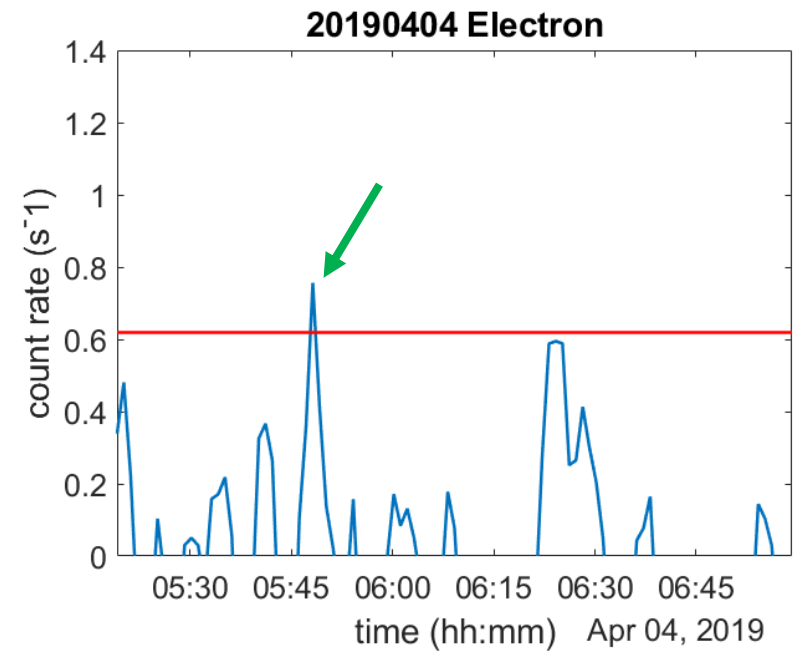
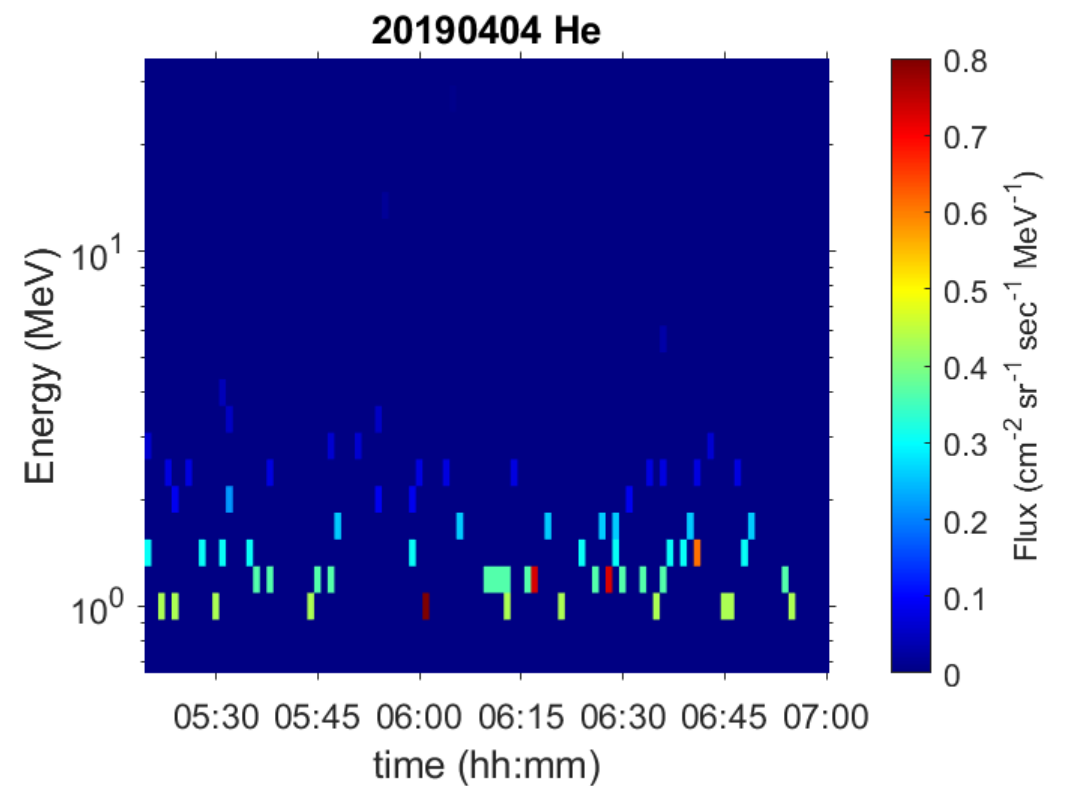


Analysis-Event 3 05:27-05:44

20190404 Type III radio burst

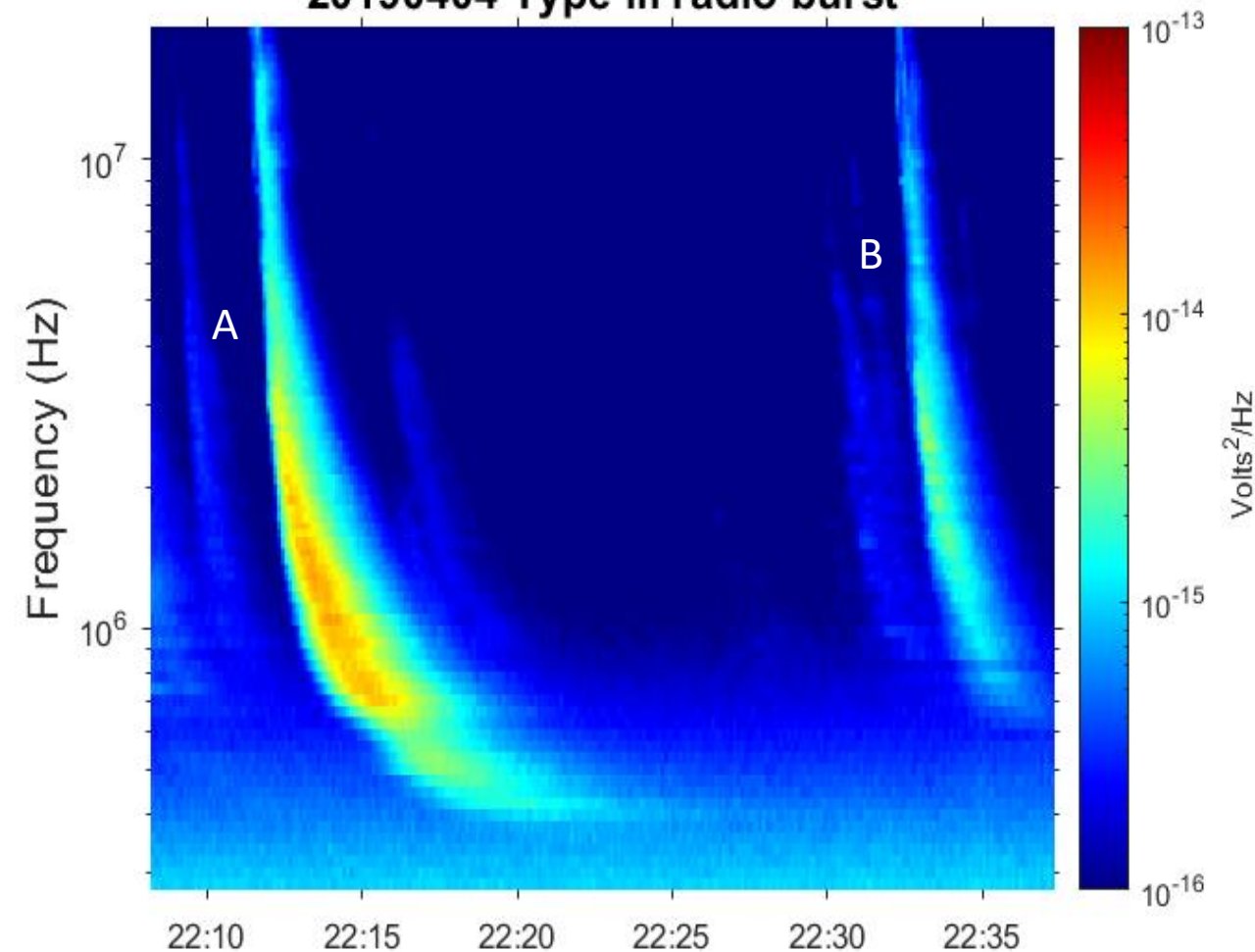


	Bandwidth (MHz)	Duration
A	$19.17 \times 10^6 - 1.21 \times 10^6$	8 min 30 s
B	$19.72 \times 10^6 - 1.23 \times 10^6$	9 min 30 s

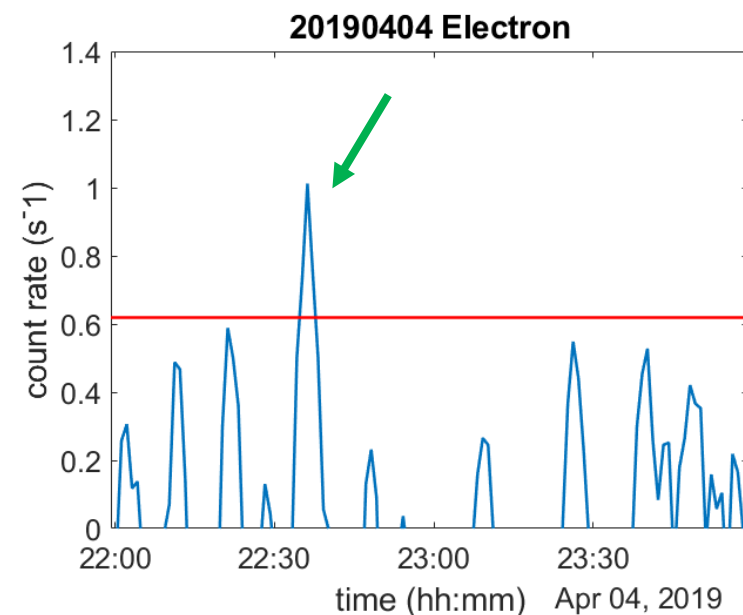
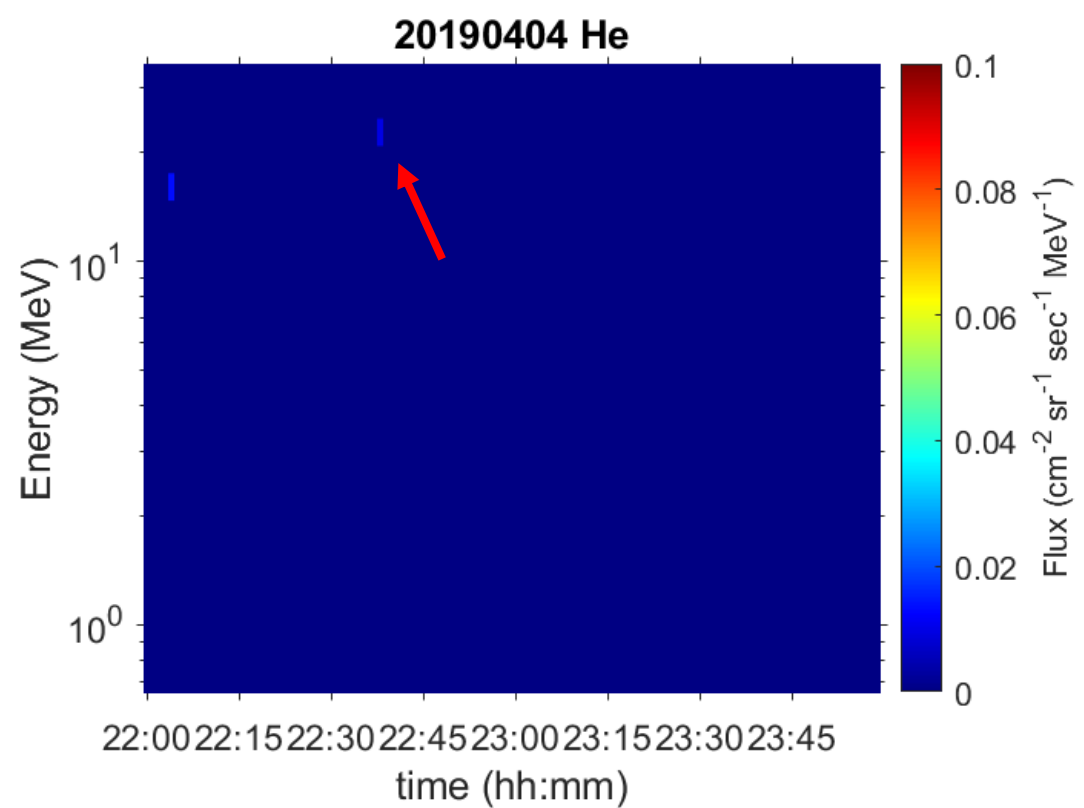


Analysis-Event 4 22:11-22:36

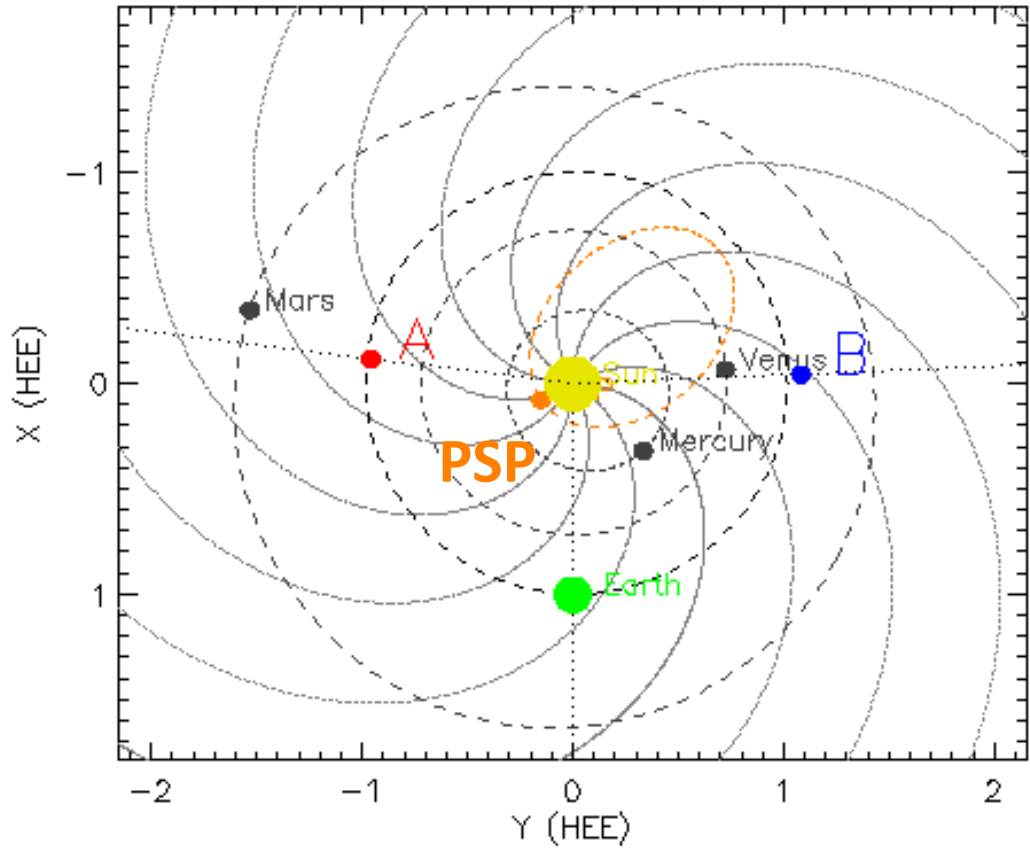
20190404 Type III radio burst



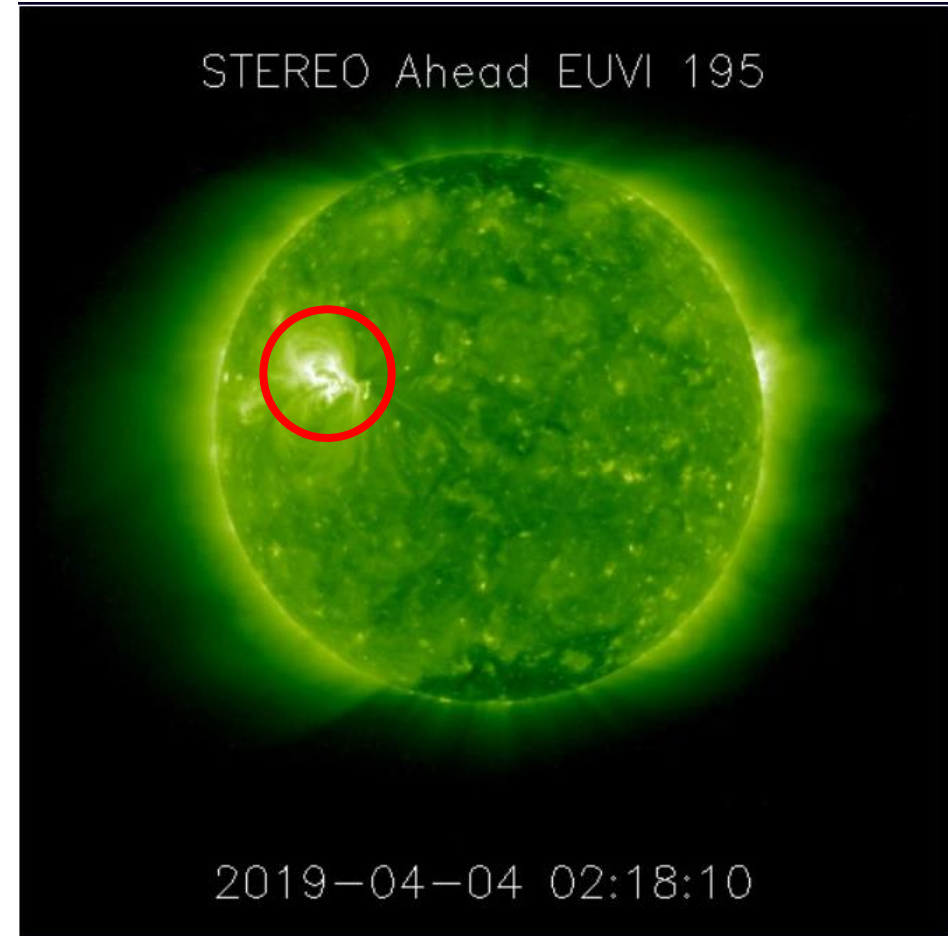
	Bandwidth (MHz)	Duration
A	$15 \times 10^6 \sim 0.4 \times 10^6$	10 min 30 sec
B	$10.2 \times 10^6 \sim 0.73 \times 10^6$	3 min 40 sec



Discussion-STEREO A



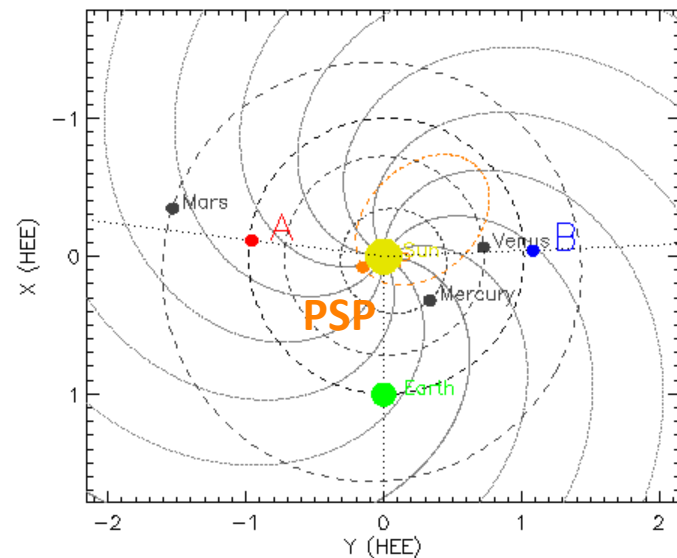
https://stereo-ssc.nascom.nasa.gov/cgi-bin/make_where_gif



<https://stereo-ssc.nascom.nasa.gov/cgi-bin/images>

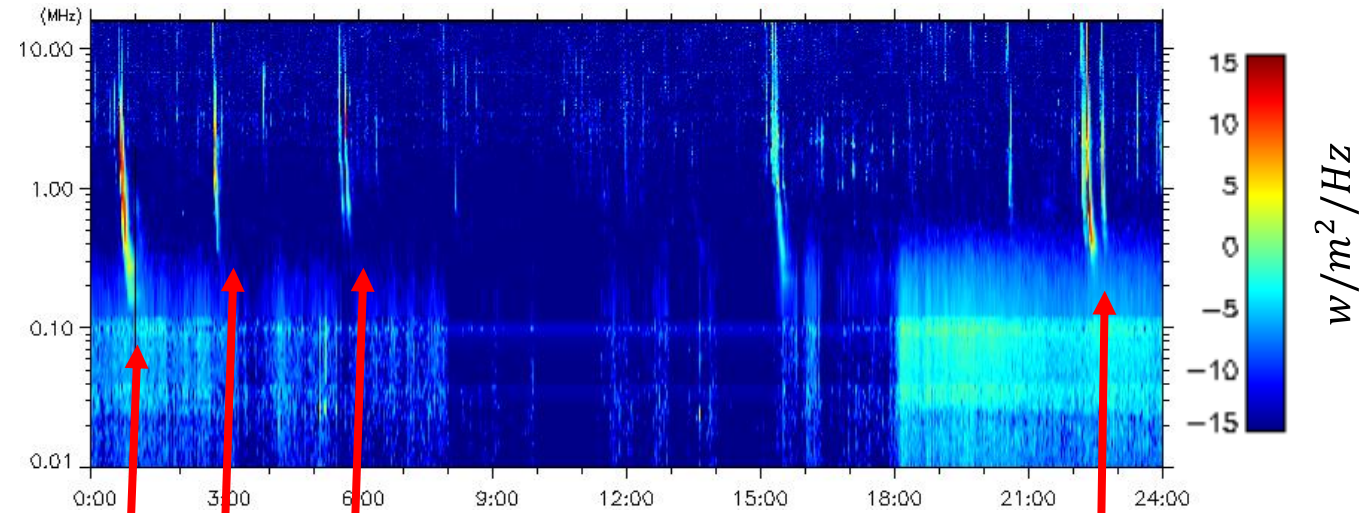
Discussion-STEREO A

We can observe the type III radio burst without SEPs from STEREO A.



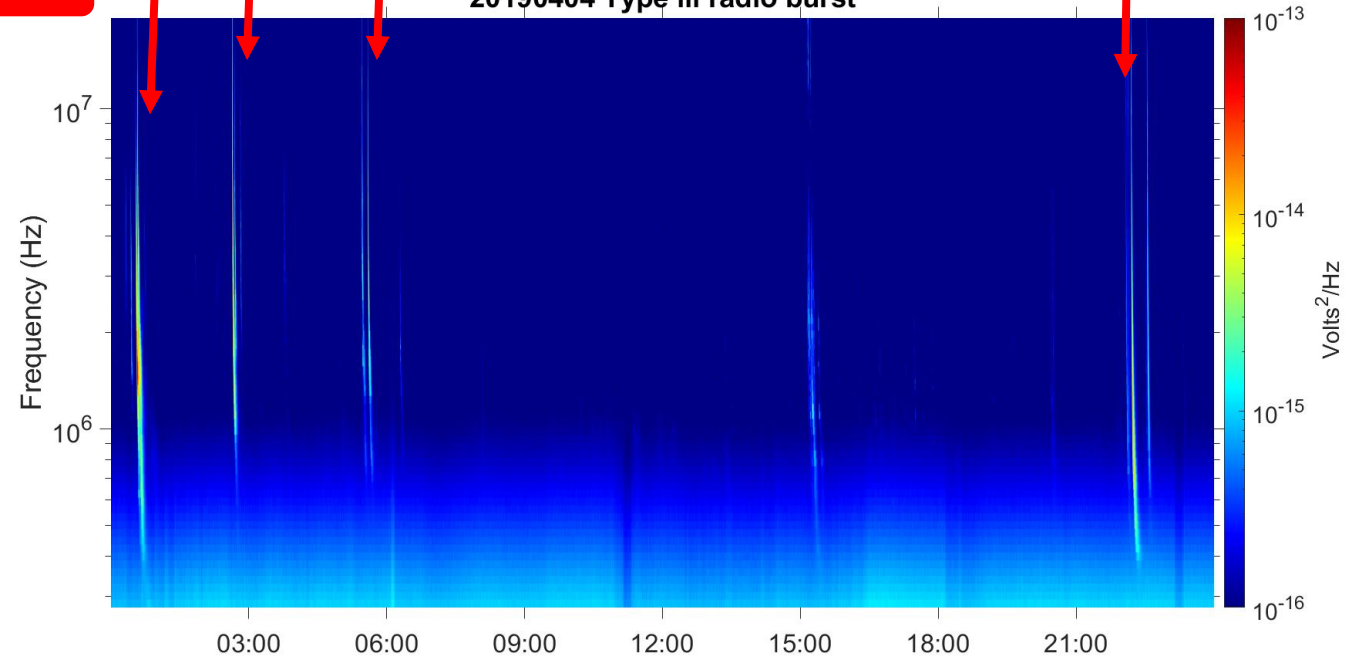
STEREO A

20190404 Type III radio burst



PSP

20190404 Type III radio burst



Conclusion

- After type III radio burst happens, we can observe the energetic particles.
- The delay time for energetic electron may be associated with the max signal intensity of type III radio burst.

	Event 1	Event 2	Event 3	Event 4
H	48 min	16 min 30 sec	-	4 min 30 sec
He	4 min	19 min 30 sec	-	25 min 30 sec
electron	12 min	72 min 30 sec	20 min	14 min 30 sec
The order of max. signal intensity ($Volts^2/Hz$)	10^{-13}	10^{-13}	10^{-14}	10^{-14}

Thanks for your listening