The coronal and Heliospheric 19 May 2007 event: CME, EUV Wave, Radio Bursts and Energetic Electrons

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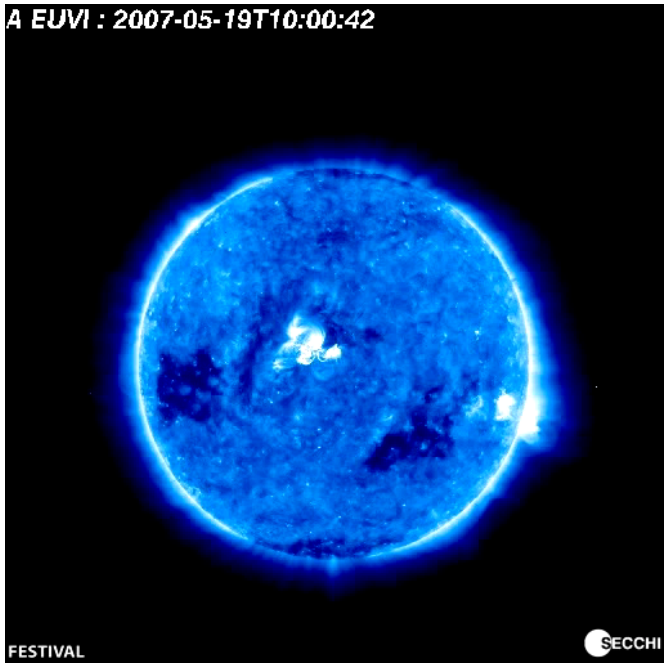
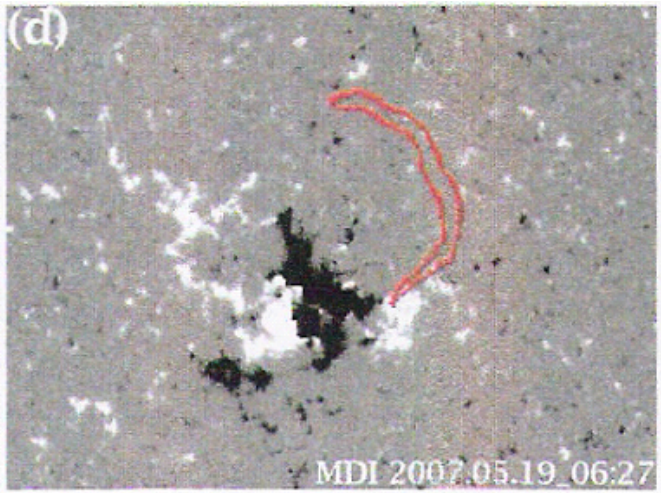
CONTEXT





Li et al., 2008

- **Flare** N01 W05 12:48 UT, AR 10956
- **Filament eruption**
- **EUV dimming, coronal wave**
- **Multi front CME**: 1 PA 260° 960 km/s, 2 PA 310° 260 km/s

19 May 2007 event

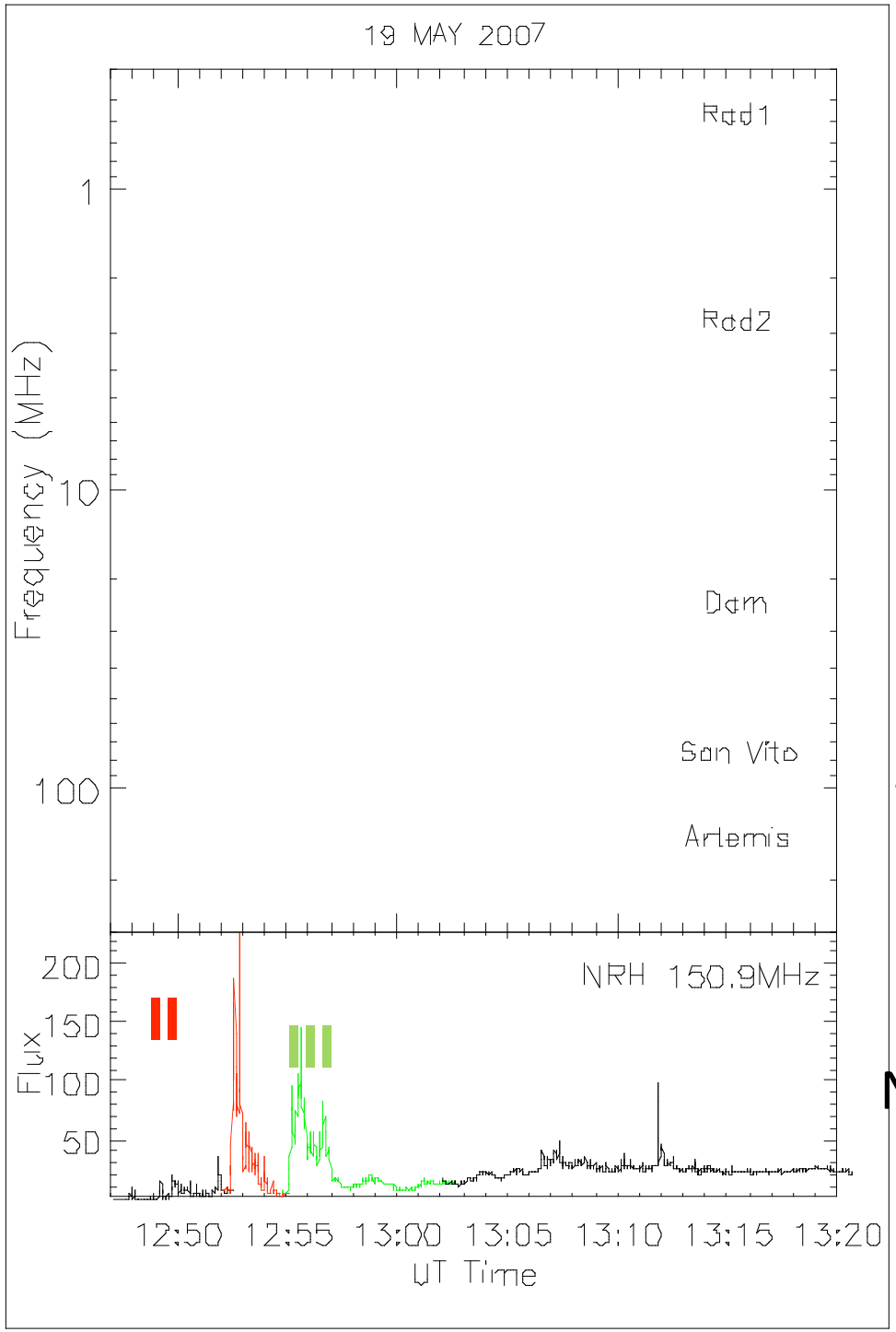
	Stereo B	Earth	Stereo A
Longitude	-2.8°	0	5.6°
Latitude	-2.8°	-2.19°	1.43°
Distance AU	1.05	1.01	0.95

- **Study the large scale development of the on-disk event**
- **Investigate the origin and escape of energetic electrons**

→ IP radio bursts and → SEP electron event

Data analysis

- **Radio spectral and imaging with STEREO /EUV I**
- **High cadence of EUV imagers**
- **Direction finding capabilities on Wind/Waves**



RAD1

RAD2

DAM

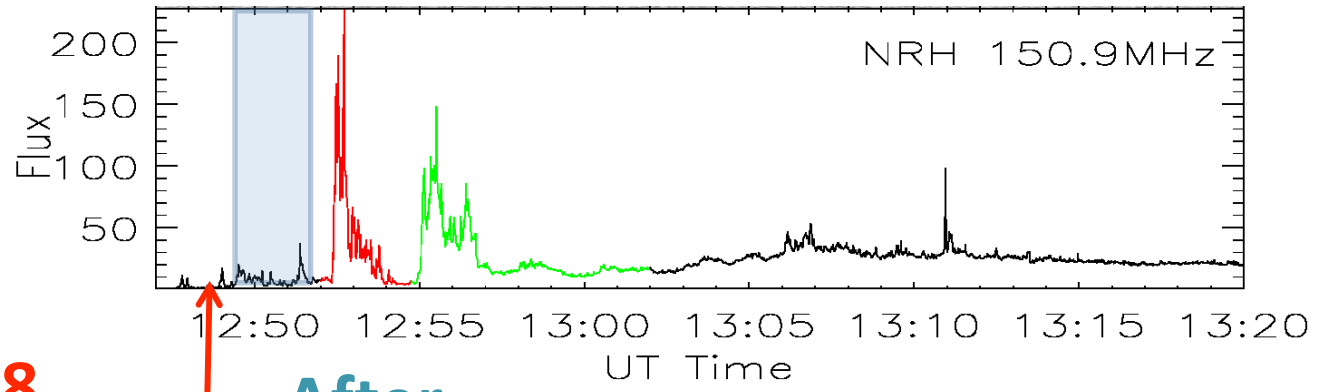
SAN VITO

ARTEMIS

NRH 150 MHz

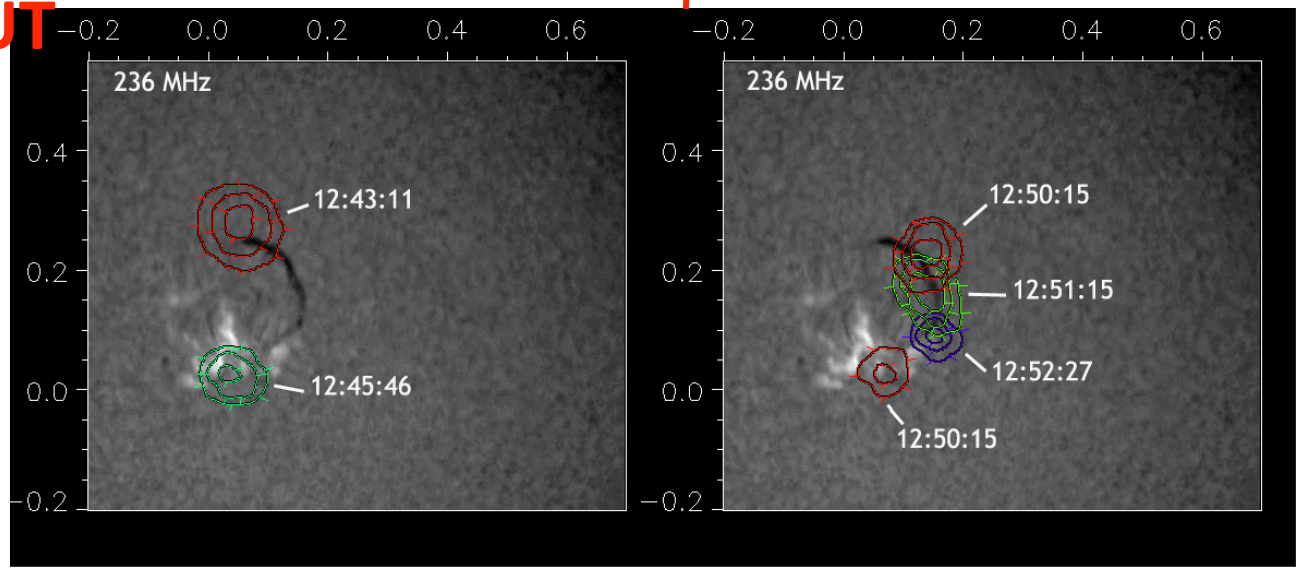
Pre-eruptive period

Filament eruption, initiation mechanisms (Li et al., 2008; Liewer et al., 2009; Bone et al., 2009)

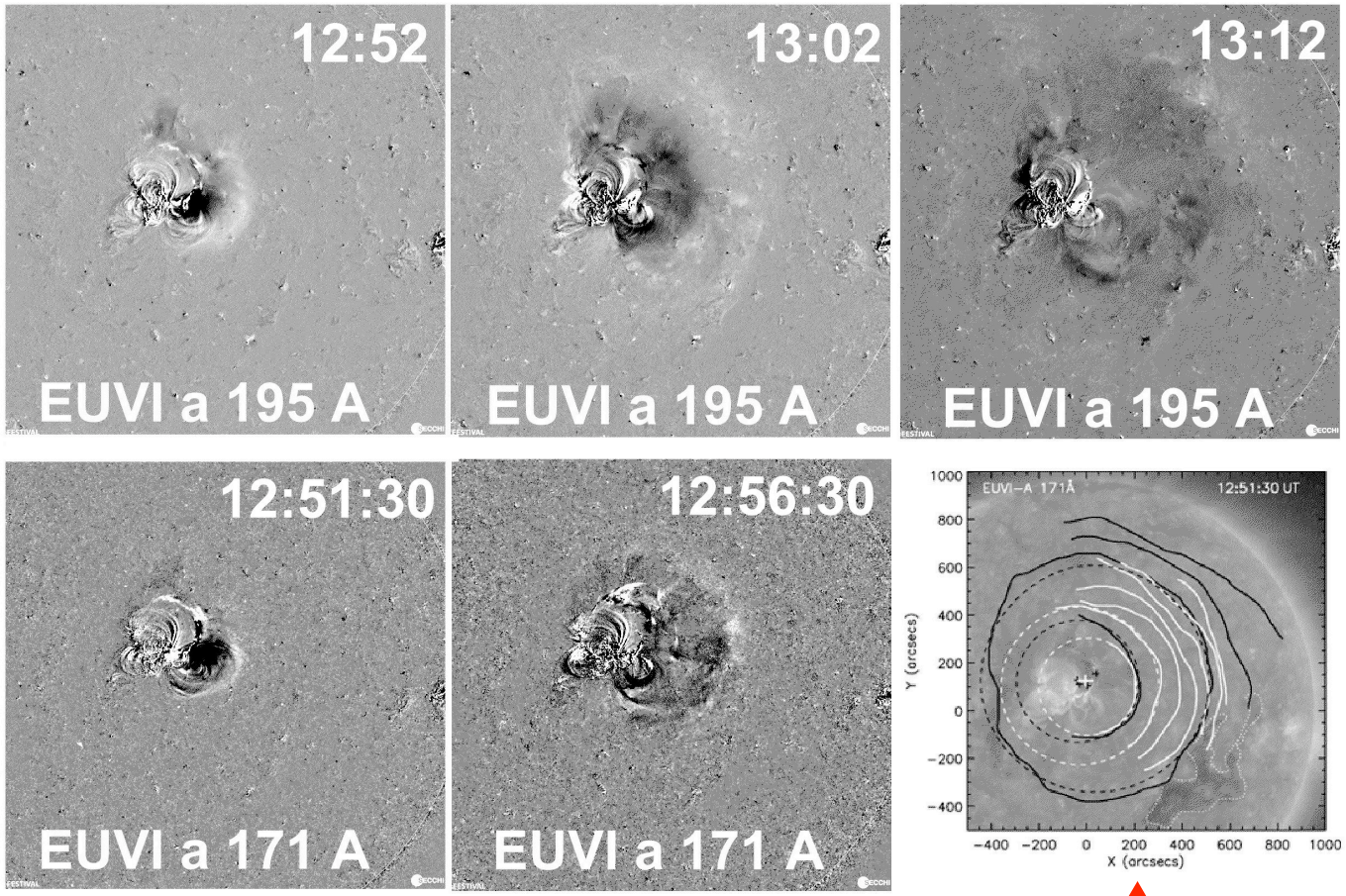


Flare onset 12:48 UT

After

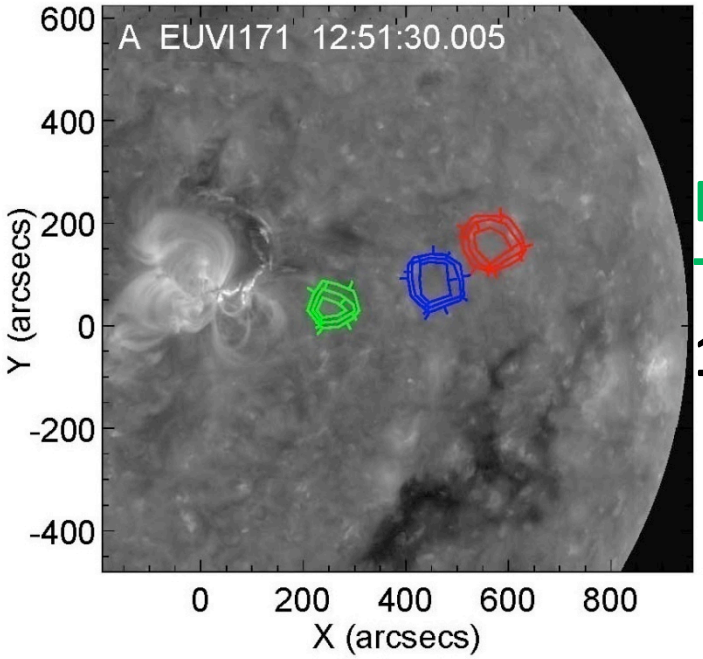


The eruptive event: EUV wave



Veronig et al., 2008

Westward then northward

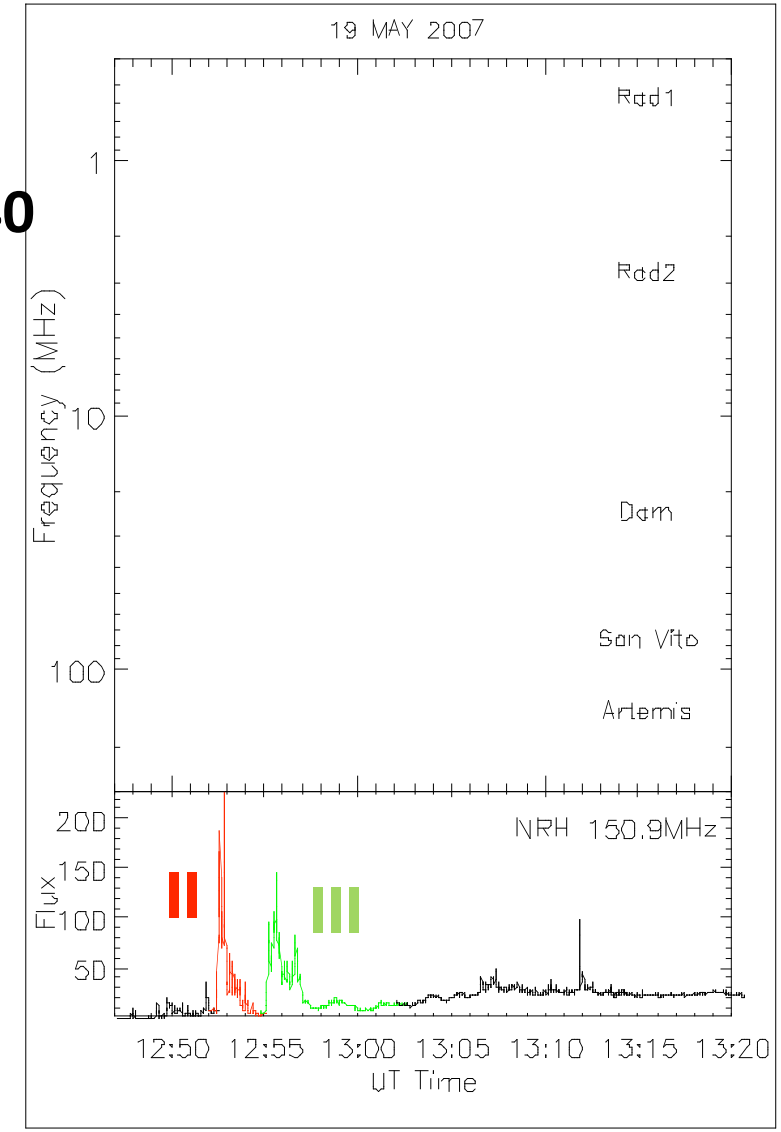


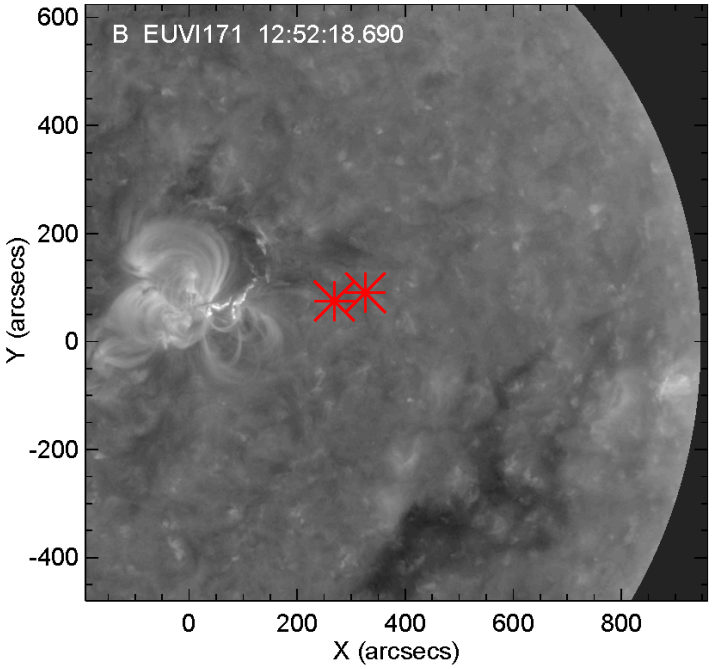
STA

Electron beams

Type III's

12:53:40-12:56:40





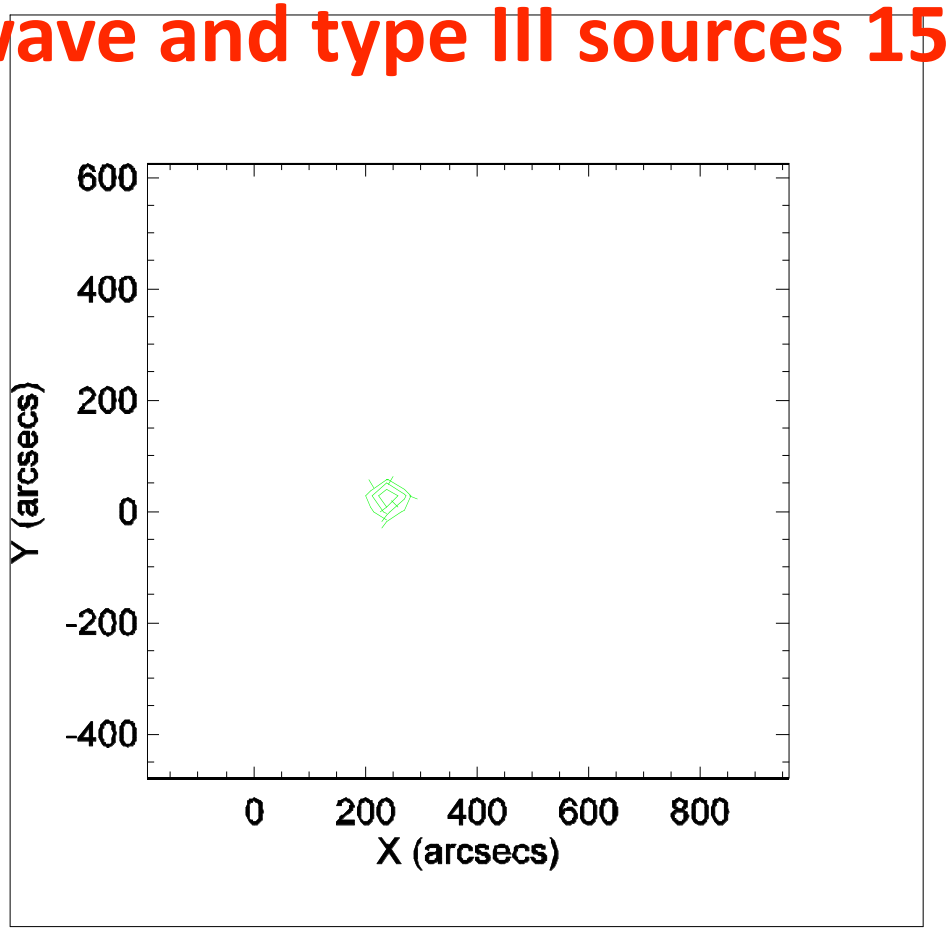
STB

Shock, Type II

2nd harmonic

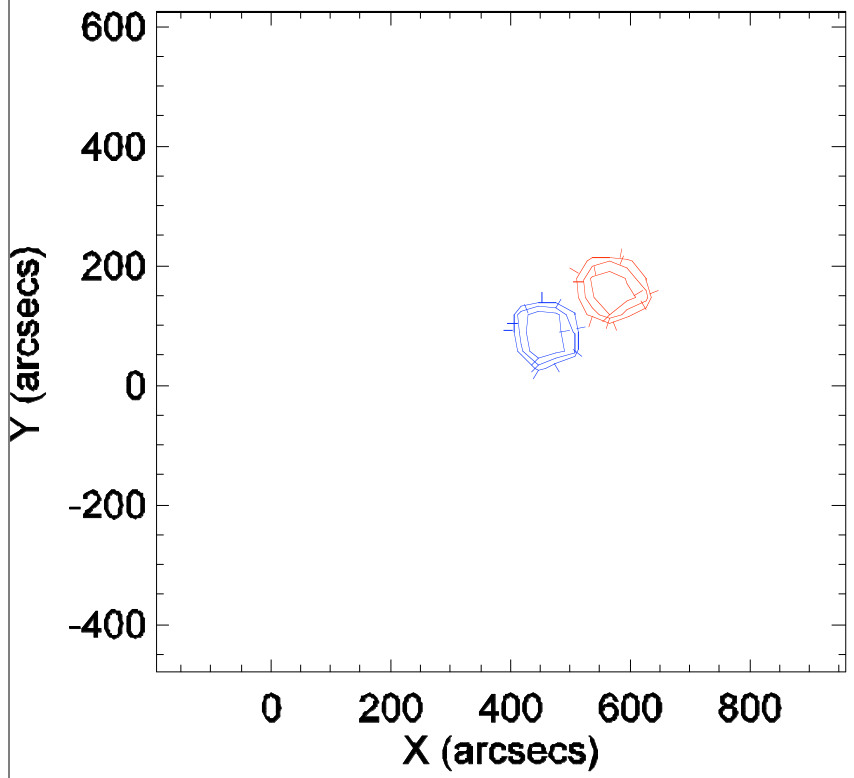
First IP type III burst group

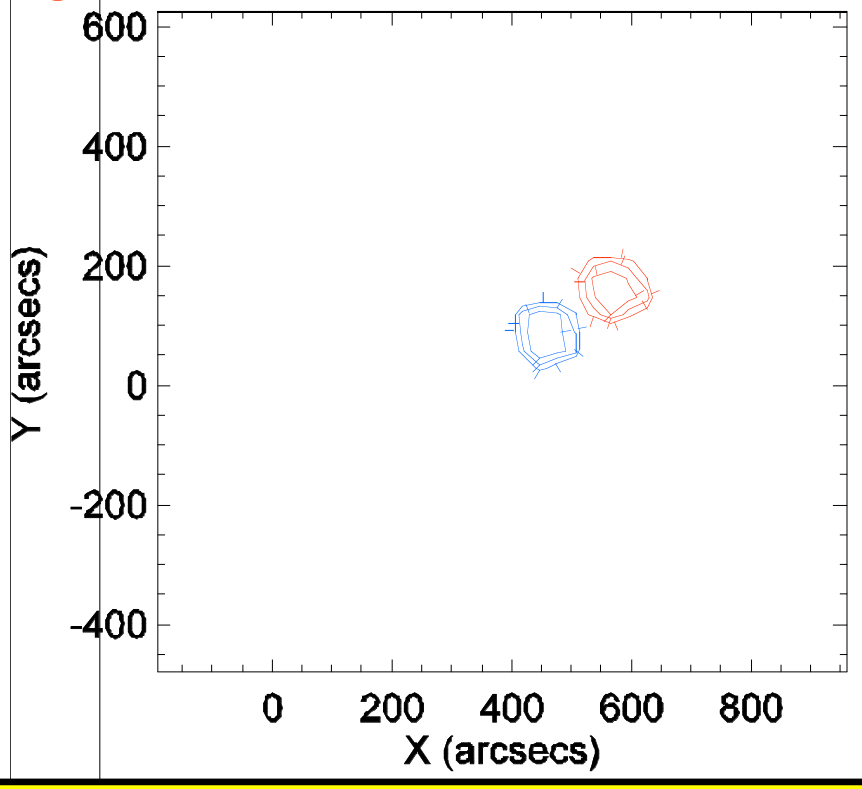
EUV wave and type III sources 150 MHz



First IP type III burst group

EUV wave and type III sources



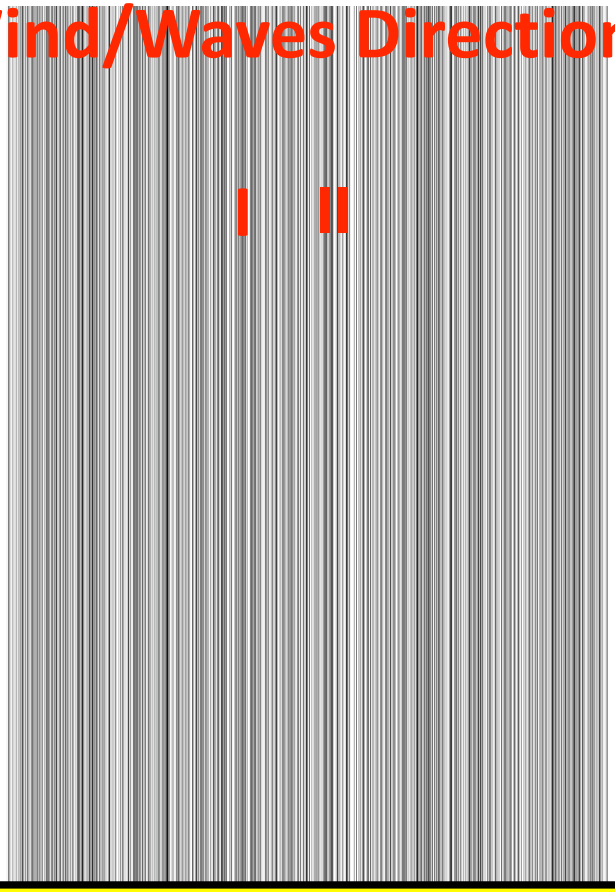


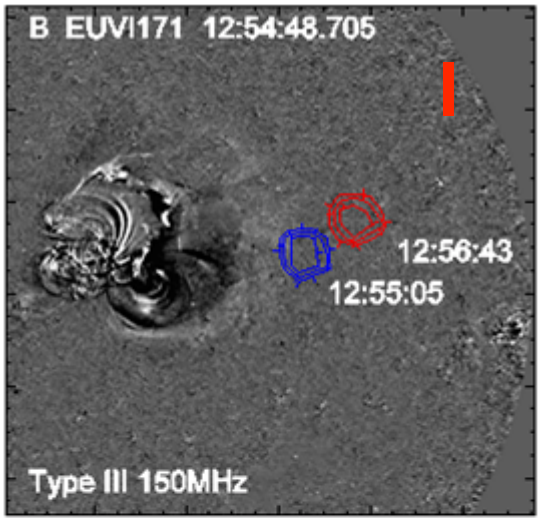
First IP type III burst group

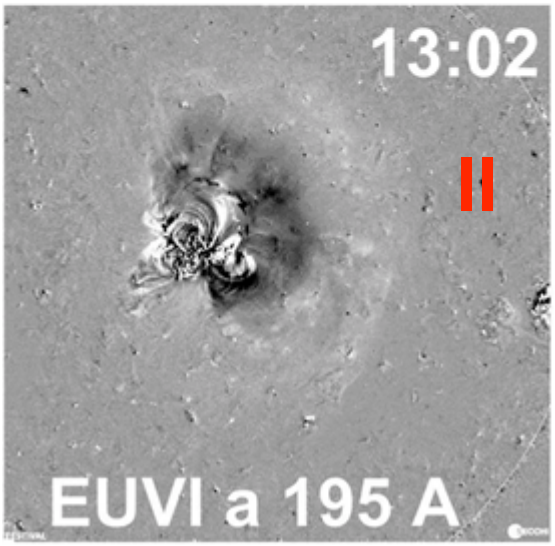
- **Spatial and temporal association with EUV wave**
- **Association with the CME expanding flank**
- **Electron beams: Interaction closed and open field lines**

First and second groups of IP type III Bursts

Wind/Waves Direction finding

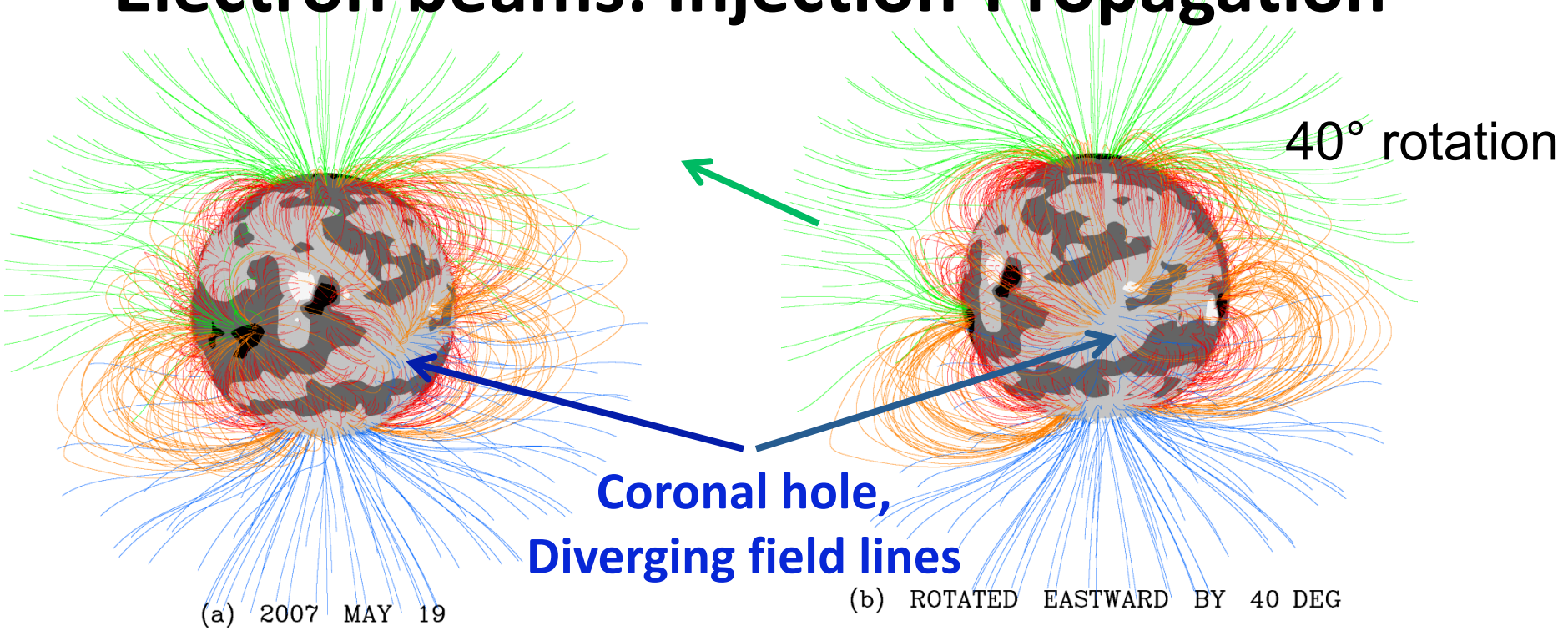






- **IP burst group I**
  - Sun-Wind direction
  - Wind-Ulysses timing difference : 0.15 AU
- **IP burst group II**
  - 5° East 5° North (distinct region)

Electron beams: Injection-Propagation



PFSS extrapolation (Wang & Sheeley 1992)

IP burst group I

Polarization (DAM, NRH): propagate outwards along B field lines of south polarity; field lines from CH diverging, inward direction.

IP burst group II

Other field lines eastwards

CR 2056 map PFFS extrapolation

IP Burst group I

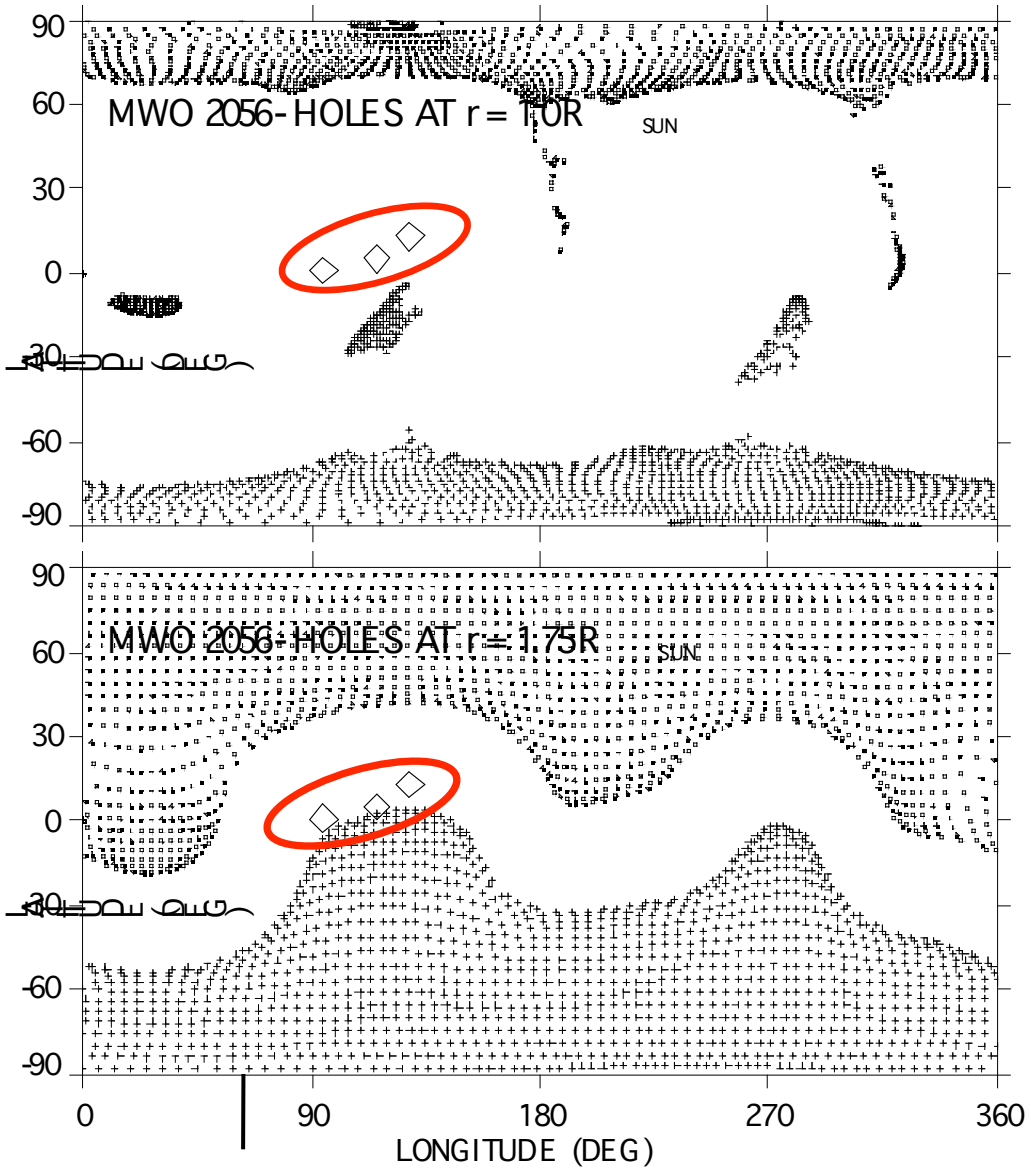
Positions type III burst sources

Open field line region above coronal holes

Open field line extension above coronal holes

Altitude 0.75 Rs

~8 times density of Saito model



ACE/EPAM 38-315 keV electrons

- **Quite strong event**
- **No velocity dispersion**
- **Release time: 13: 05:00 ± 10** min

Conclusions

- **Compact flare with almost no radio counter part followed by the eruptive event**
- **Coronal shock (type II) related to the expansion of the CME**
- **IP type III bursts : Electron acceleration and injection in IP medium, delay after the flare**
  - **Spatial and temporal association with the EUV wave and CME expansion**
  - **Two accelerations at two different sites corresponding to two different trajectories in the IP medium**
  - **B field restructuring: between closed B field lines at the edges of CME and open field lines from coronal hole.**

Acceleration process

First type III burst group:

- Observations in favor of reconnection process between expanding loops and open field lines emerging from CH. (type II emission frequency much lower than the starting. frequency of type III bursts)

Second group of type III burst group:

- Coronal shock or reconnection ?

The type II coronal shock travels toward the west of AR and the electron beams originate from a north region

Concluding Remark on origin of energetic electrons

- Results exploit high time resolution images in the corona and the direction finding in the IP medium.
- Illustrate the difficulty to draw conclusions on type III burst electron beam and SEP origin from statistical study based on flare location and low frequency radio spectra (for a review see Pick and Vilmer 2009)