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Tuesday 17:15-17:30

STEREO and RHESSI Observations of Electron Acceleration in a Partially Disk-Occulted Solar Flare

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RHESSI hard X-ray observations of partially-disk occulted solar flares provide crucial information on faint coronal hard X-ray sources in the absence of generally much brighter emissions from footpoints of flare loops. Coronal hard X-ray sources can differ fundamentally from the classical footpoint sources of the flare impulsive phase and provide unique information about the supra-thermal electrons closest to the site in the corona where their acceleration is believed to occur. The different view-angles provided by the STEREO spacecraft allow us to put the partially occulted hard X-ray sources observed by RHESSI in context with the EUV flare ribbons and the EUV emission from CME observed by STEREO/EUVI.

In this presentation we report on the GOES C8 flare observed on December 31, 2007 peaking around 01:11UT. From Earth-view (RHESSI), the flare occurs about 12 degrees behind the eastern limb giving an occultation height of 16 Mm. From STEREO B, the flare ribbons are seen on the disk (about 10 degrees from the limb), while the flare is highly occulted (130 Mm) for STEREO A observations so that emissions related to the associated CME are seen. Despite the occultation, RHESSI observes strong non-thermal emissions up to 100 keV that entirely originate from the corona. Initially, the coronal hard X-ray emission is seen from above the EUV flare ribbons similar to what is reported in the Masuda flare. Later on, emissions from a radially extended (approximately 20 Mm) source is seen. The radial extension is in the same direction as the current sheet of the outward moving CME suggesting that the HXR emission might be a direct signature of electrons accelerated in the reconnection process.

STEREO & RHESSI observations of electron acceleration in partially disk-occulted solar flare (December 31, 2007)

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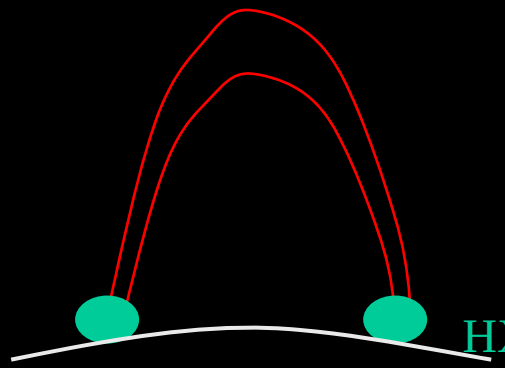
HXR emission as diagnostics of electron acceleration in solar flares

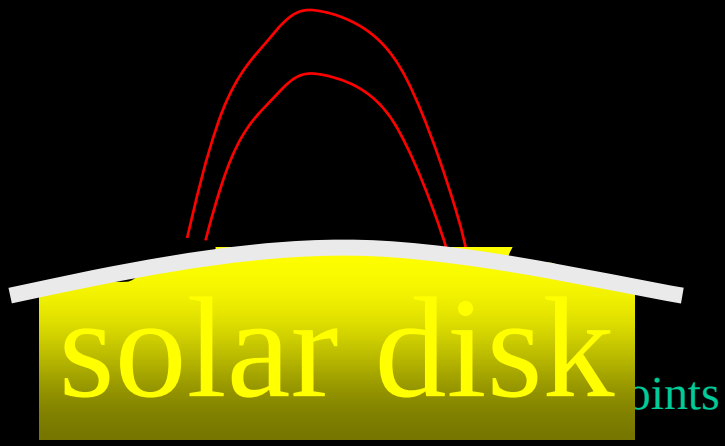
Standard flare scenario:
high density chromosphere
→ HXR footpoints

low density corona
→ very weak HXR emission



HXR emission as diagnostics of electron acceleration in solar flares

partially disk-occulted flares
→ purely coronal emission
can be studied



Statistical studies:
Roy & Datlowe 1975, McKenzie 1975,
Mariska et al. 1996,
Tomzcak 2001, Krucker & Lin 2008

HXR emission as diagnostics of electron acceleration in solar flares

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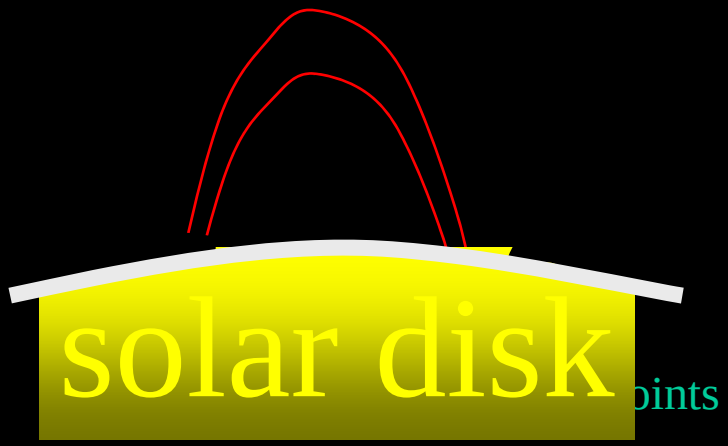
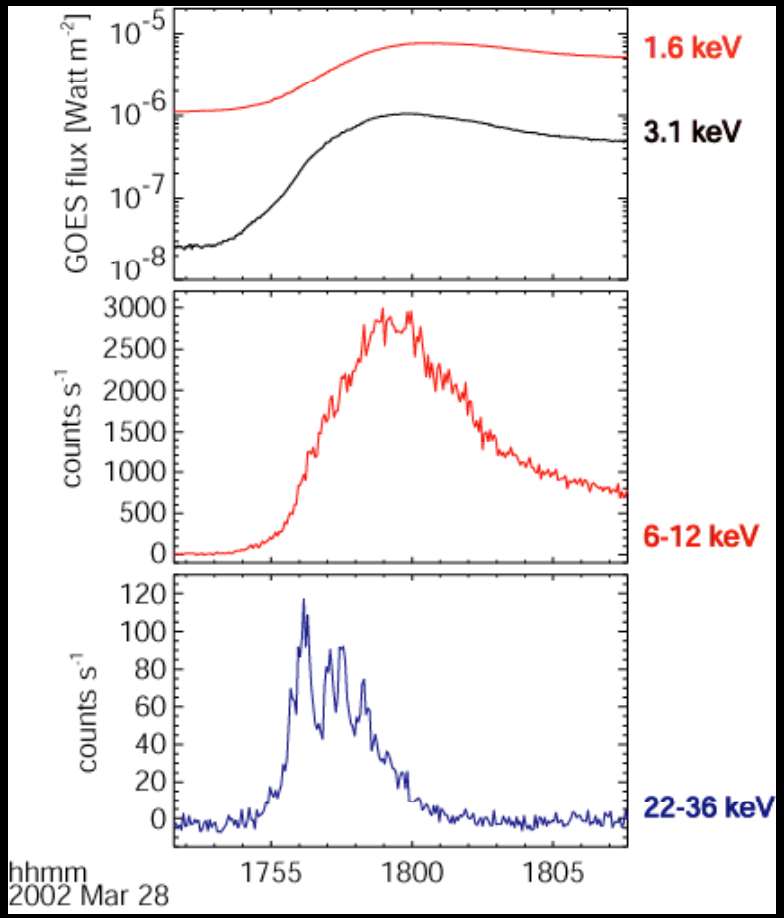
The different view-angles provided by the STEREO mission reveal location of EUV flare ribbons.

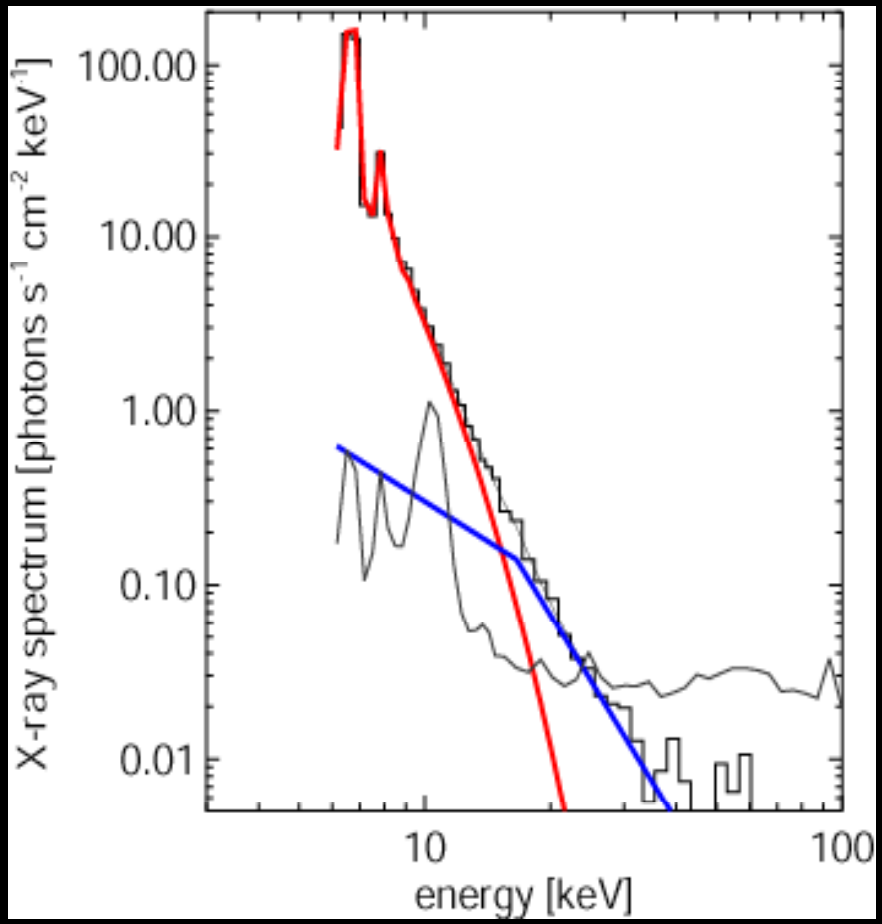


Statistical studies:
Roy & Datlowe 1975, McKenzie 1975,
Mariska et al. 1996,
Tomzcak 2001, Krucker & Lin 2008

typical example of partially disk-occulted flare

Statistical study of partially occulted flares (Krucker & Lin 2008):
~90% of flares show non-thermal emission from corona

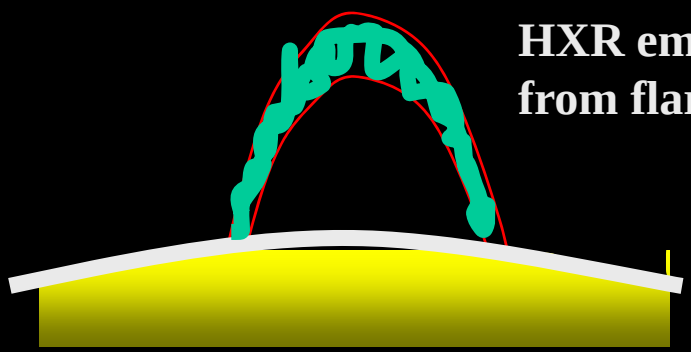




RHESSI observations

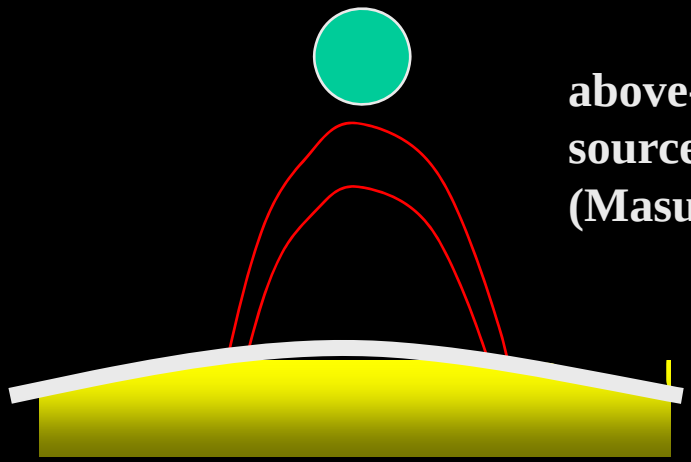
Statistical study of partially occulted flares (Krucker & Lin 2008):
~90% of flares show non-thermal emission from corona

often seen:



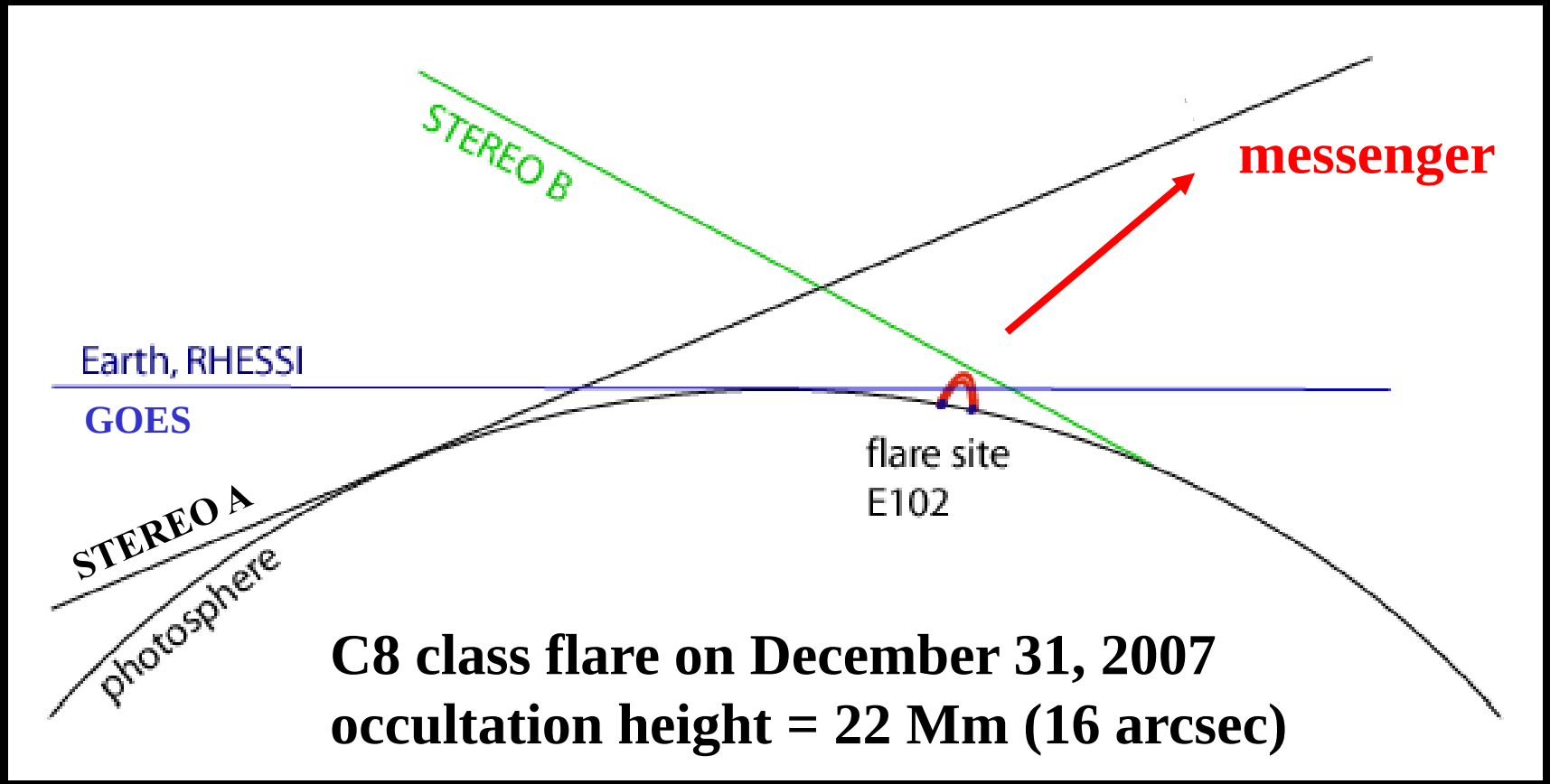
HXR emission from flare loop

rarely seen:



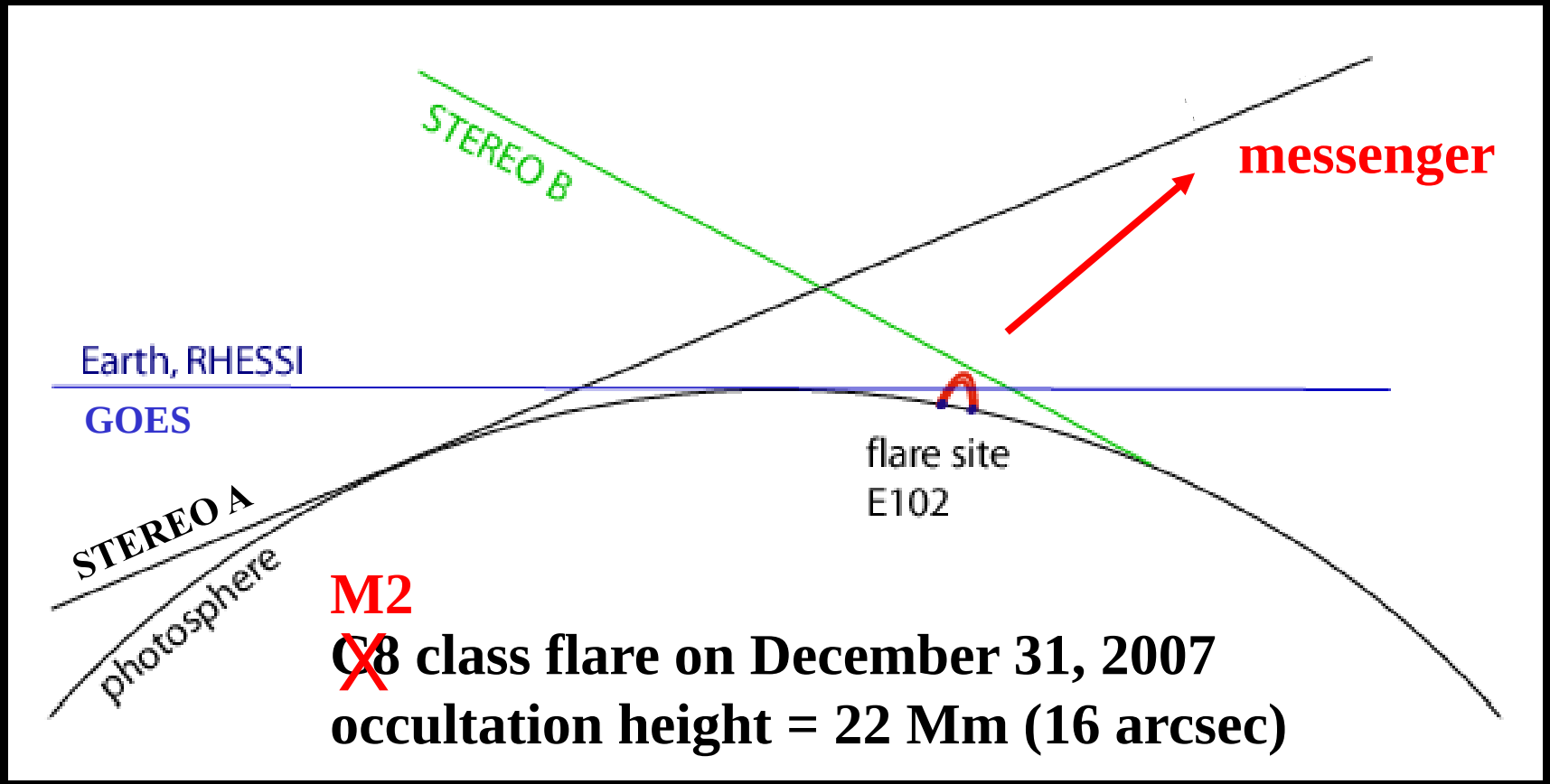
above-loop-top source (Masuda flare)

RHESSI and STEREO observations of a partially disk-occulted flare



C8 class flare on December 31, 2007
occultation height = 22 Mm (16 arcsec)

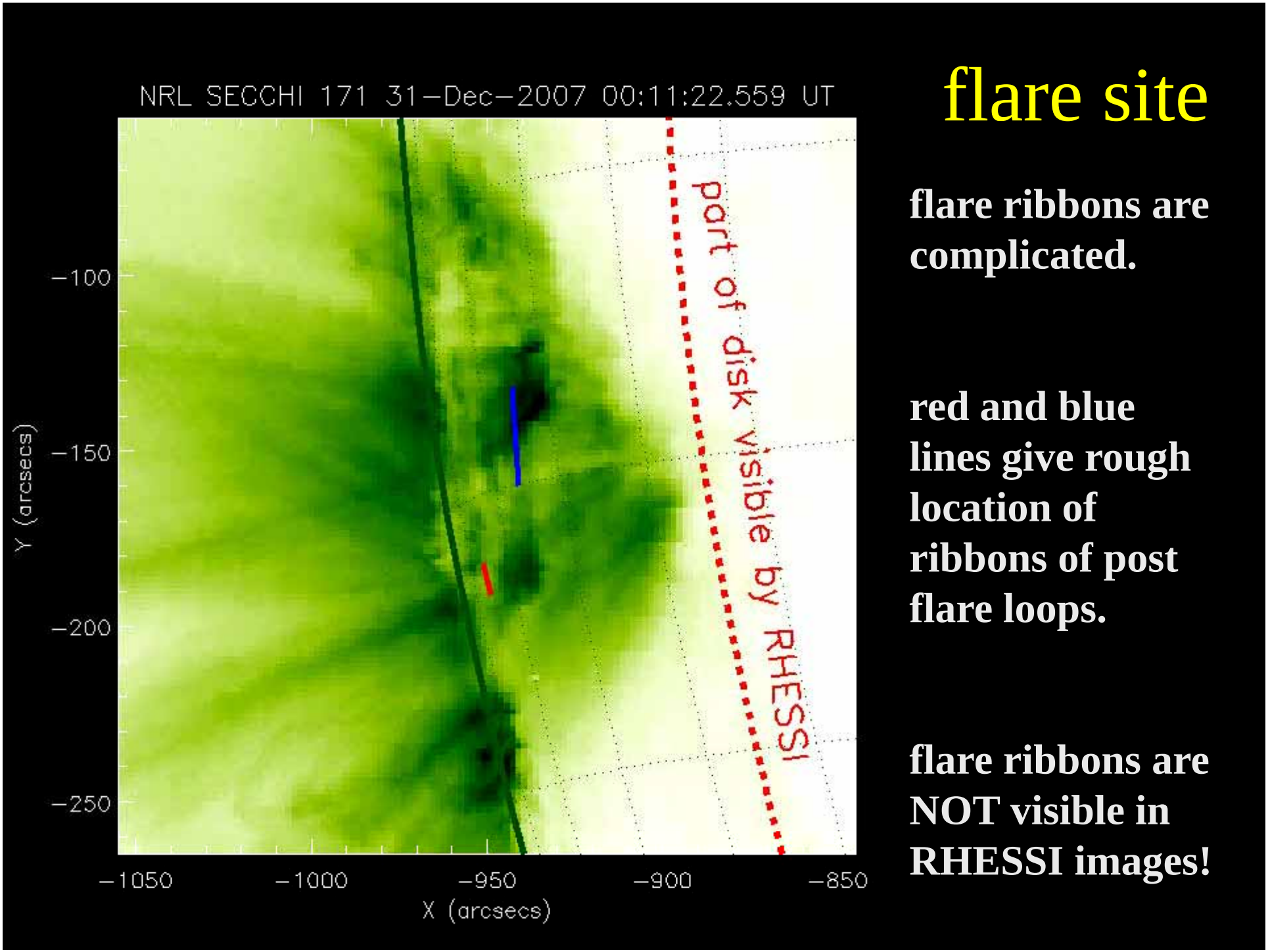
RHESSI and STEREO observations of a partially disk-occulted flare



M2

~~X~~8 class flare on December 31, 2007

occultation height = 22 Mm (16 arcsec)



flare site

flare ribbons are complicated.

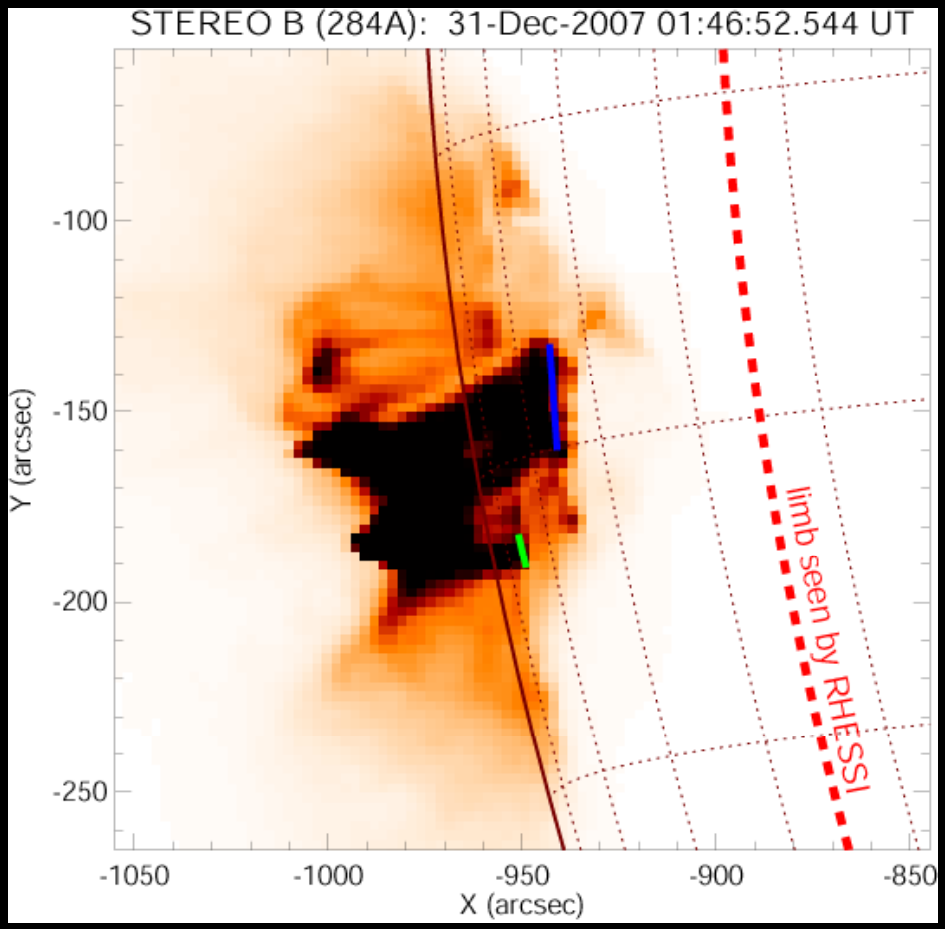
red and blue lines give rough location of ribbons of post flare loops.

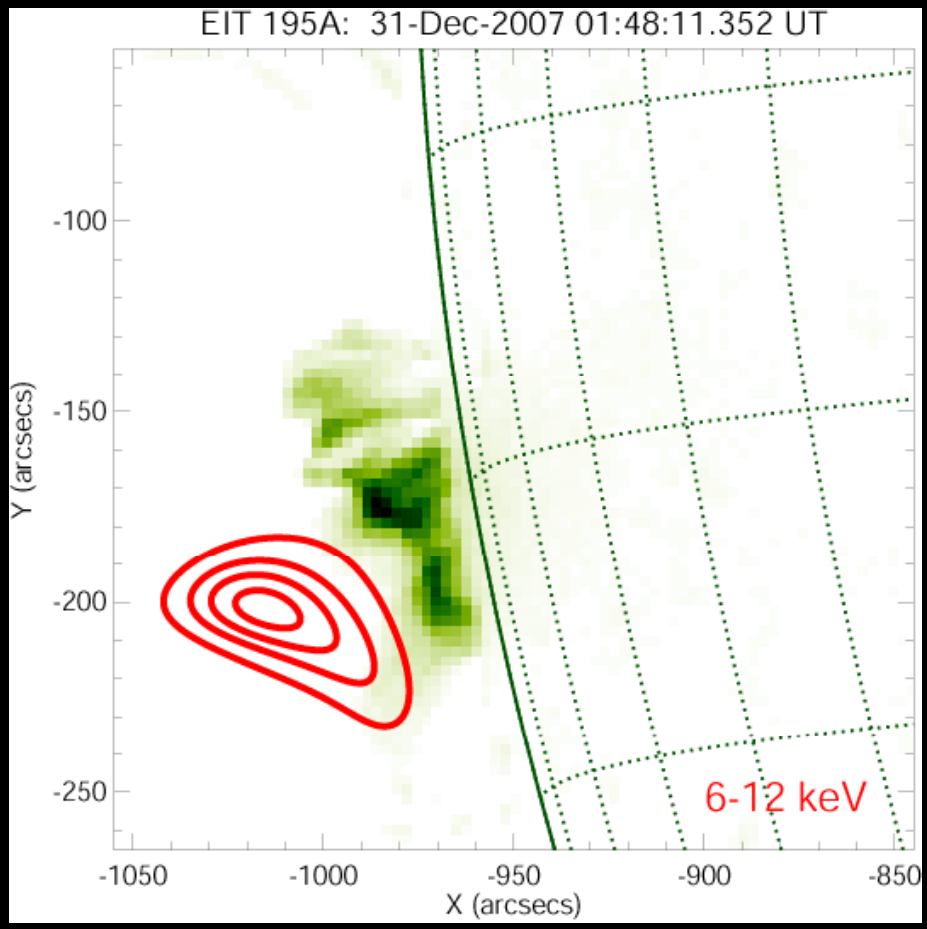
flare ribbons are NOT visible in RHESSI images!

Post flare loops (~1 h after onset)

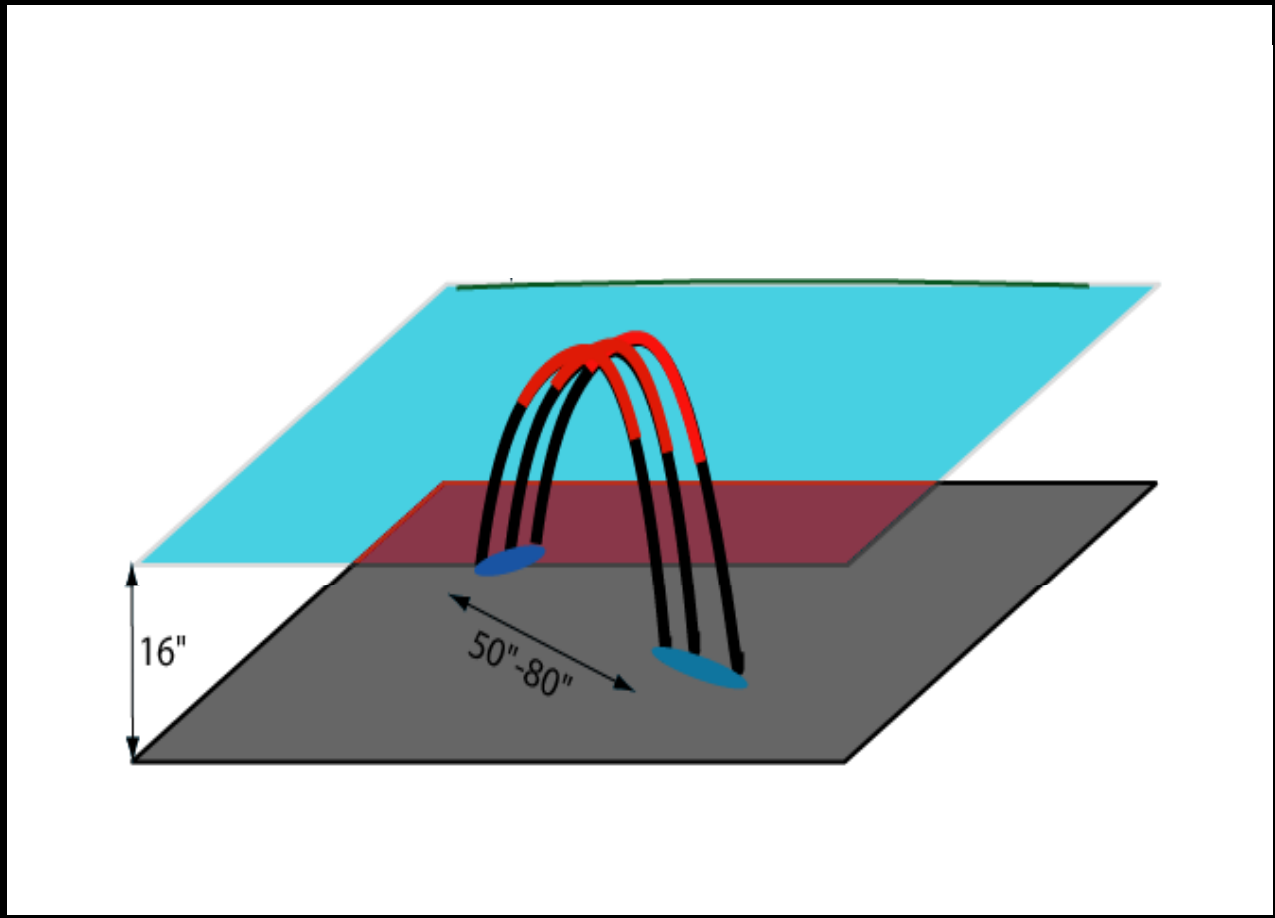
STEREO B (284A)
post flare loops at ~45°

top of loops seen from Earth

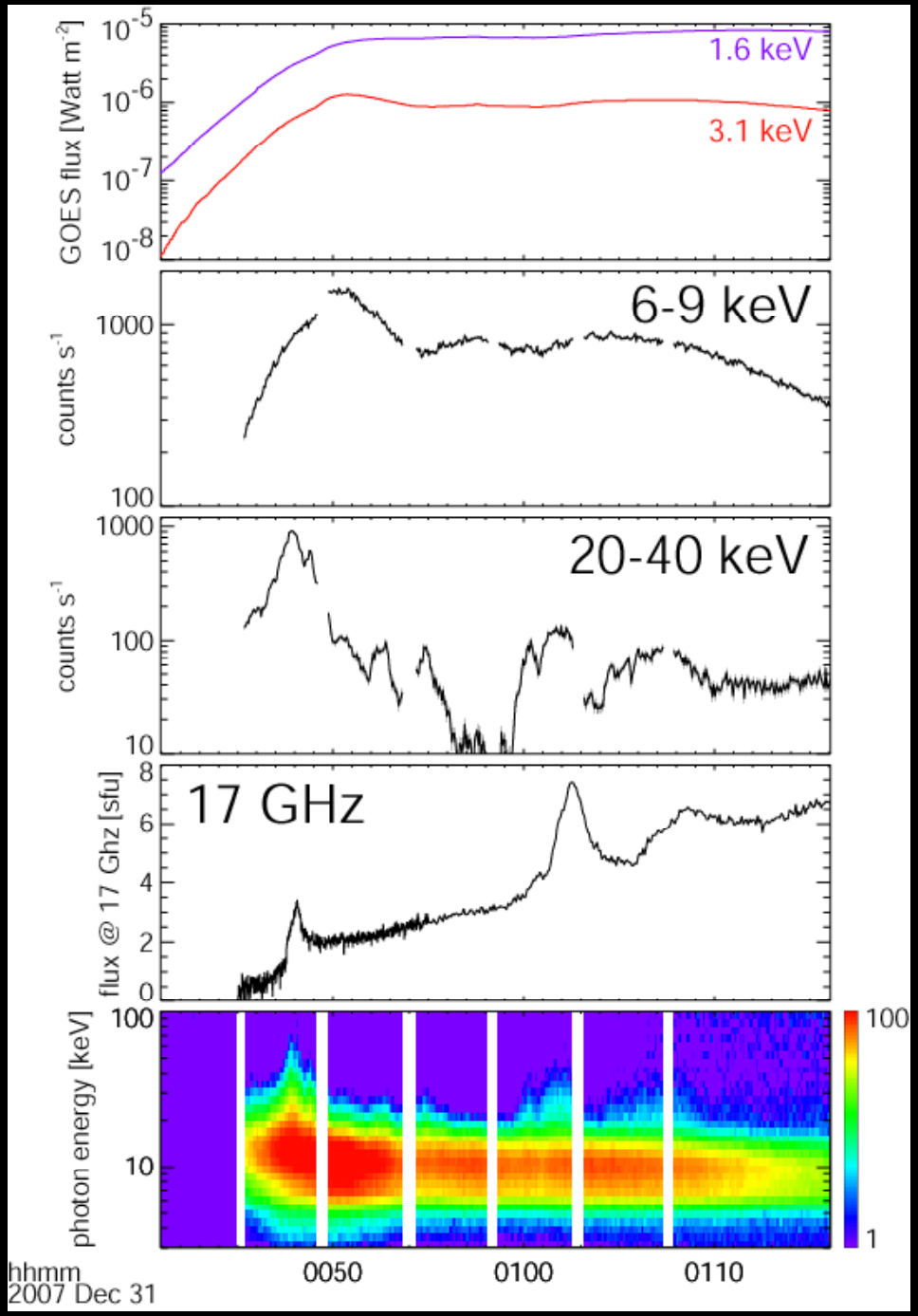




Flare geometry



event is much more complicated than this simple cartoon.



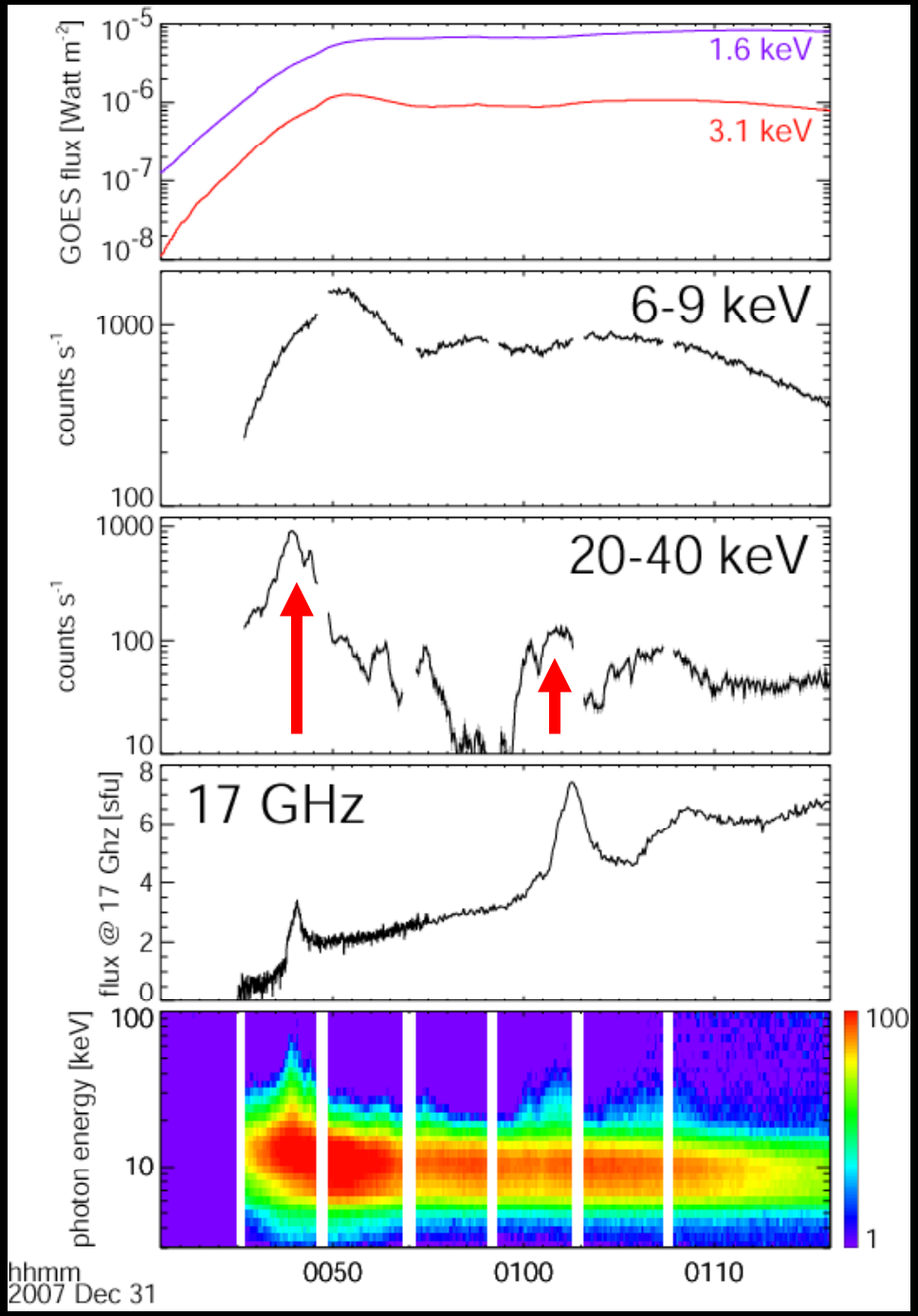
RHESSI time profiles

Hard X-ray observations:

Non-thermal emission above 20 keV
up to ~80 keV
unusually intense (for occulted event)
spectral slope between 3.5 and 4.5

Radio observations:

microwave emission with decreasing spectrum (non-thermal)



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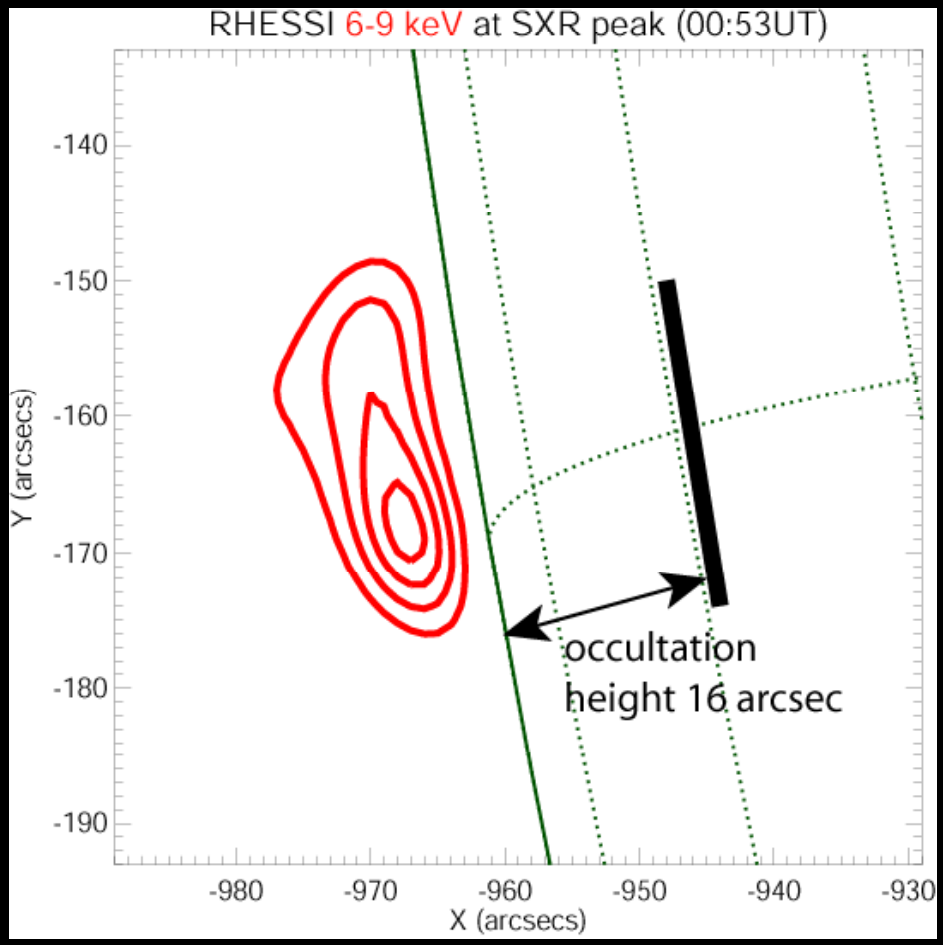
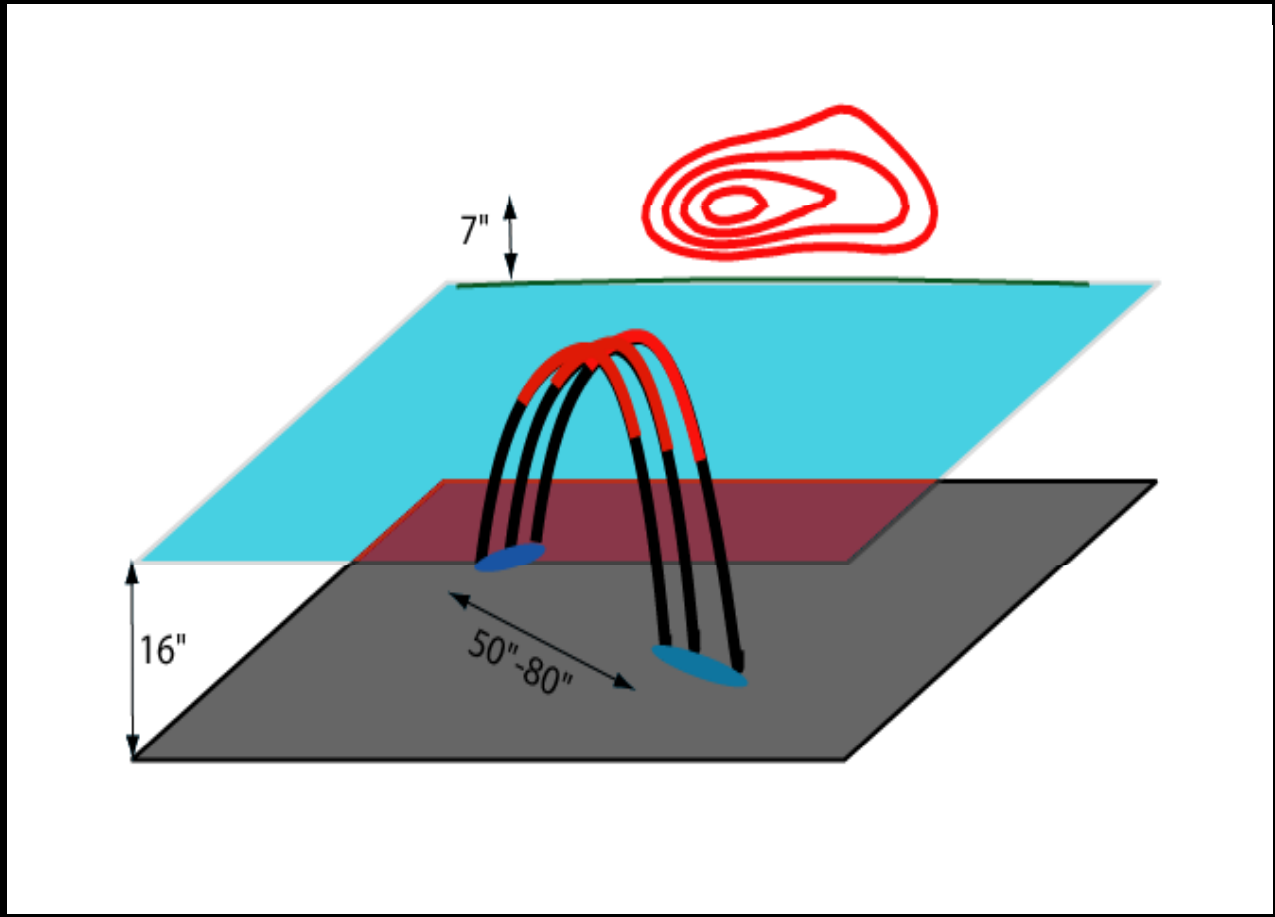
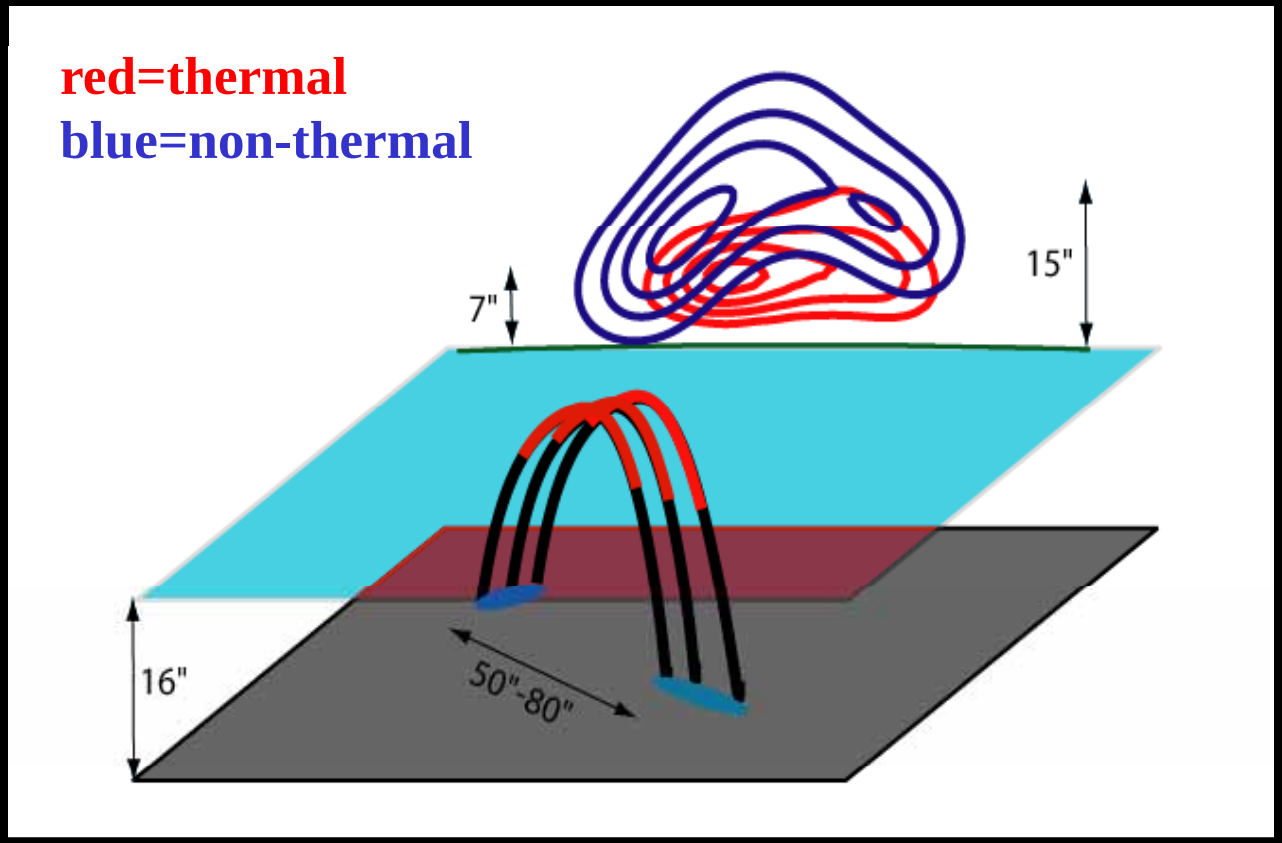
Flare geometry (main peak)



Flare geometry (main phase)



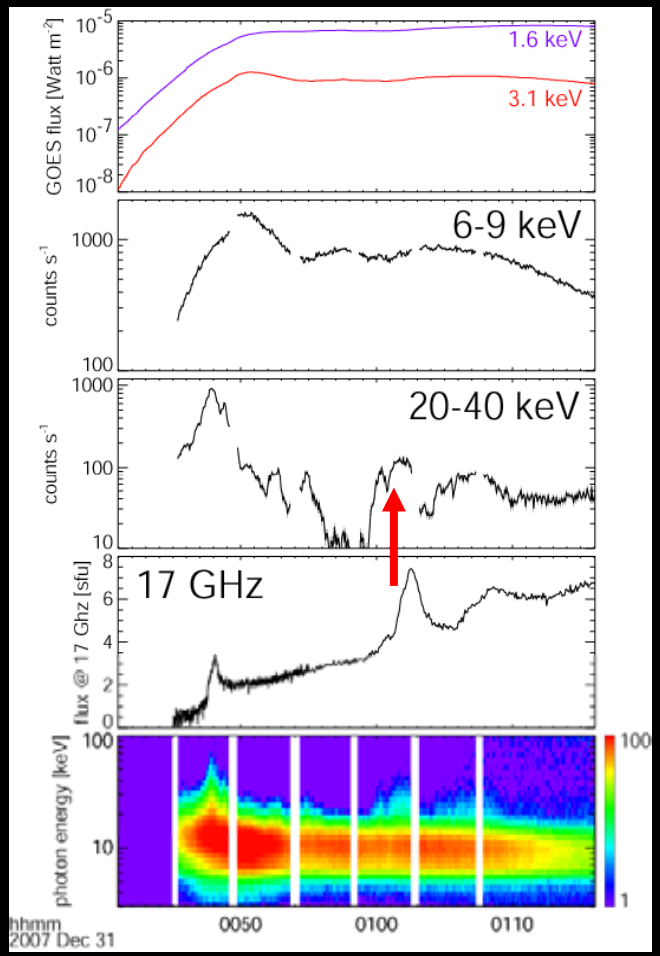
Flare geometry (main phase)

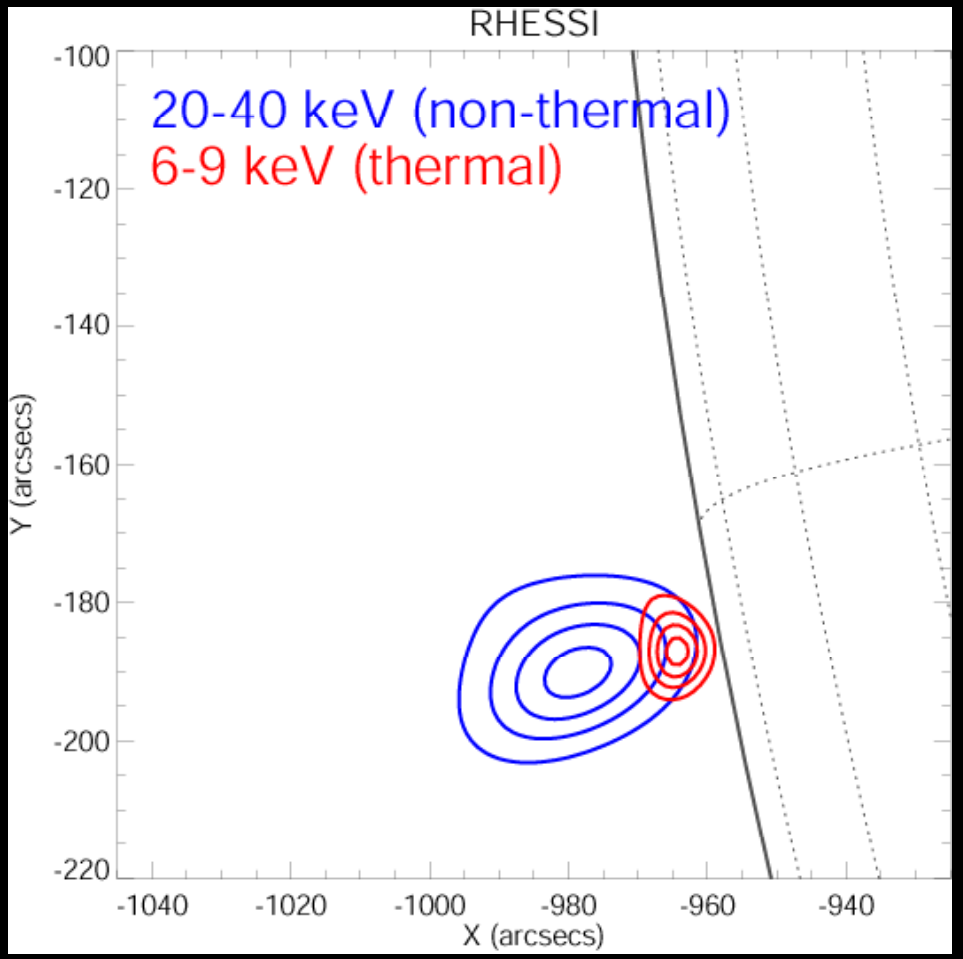


this is a rear case of an above-the-loop-top source (Masuda flare). low coronal density at the location of the HXR source makes explanation difficult.

later HXR emission

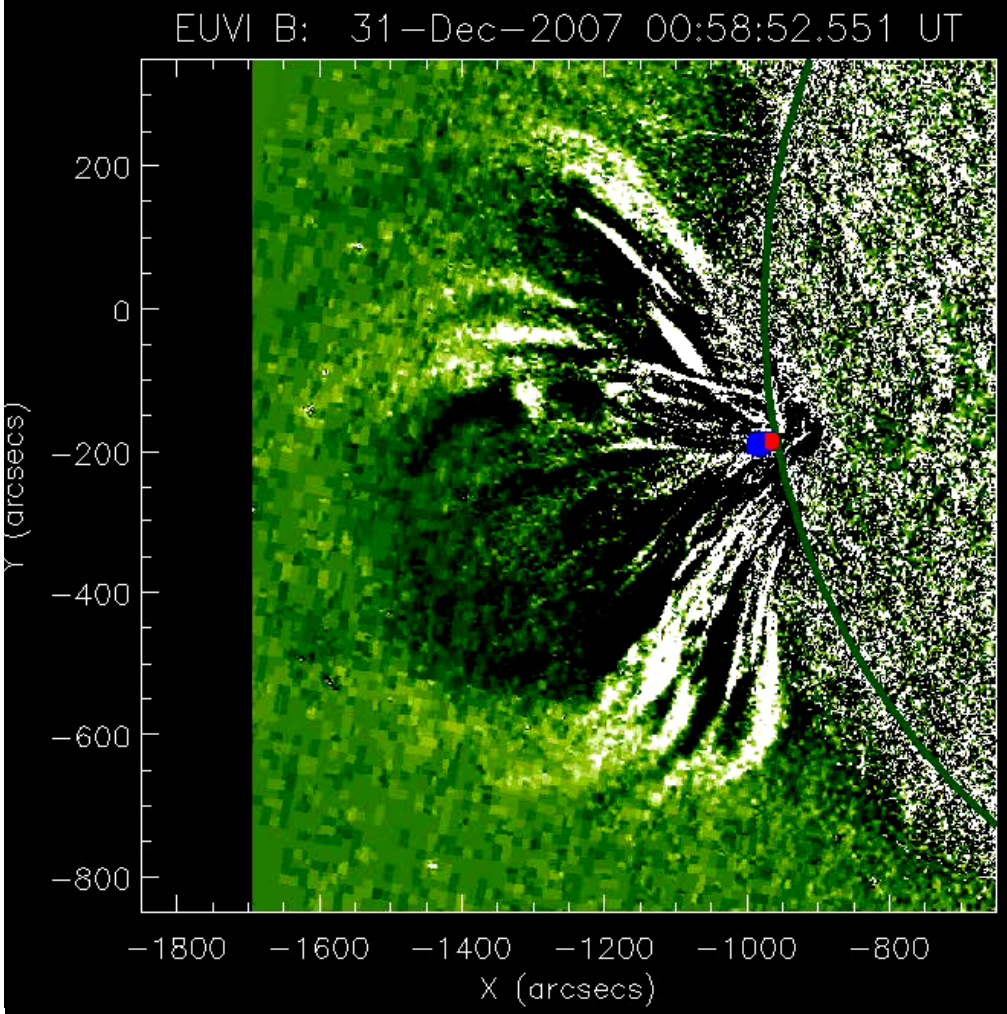
elongated HXR source above thermal loops!



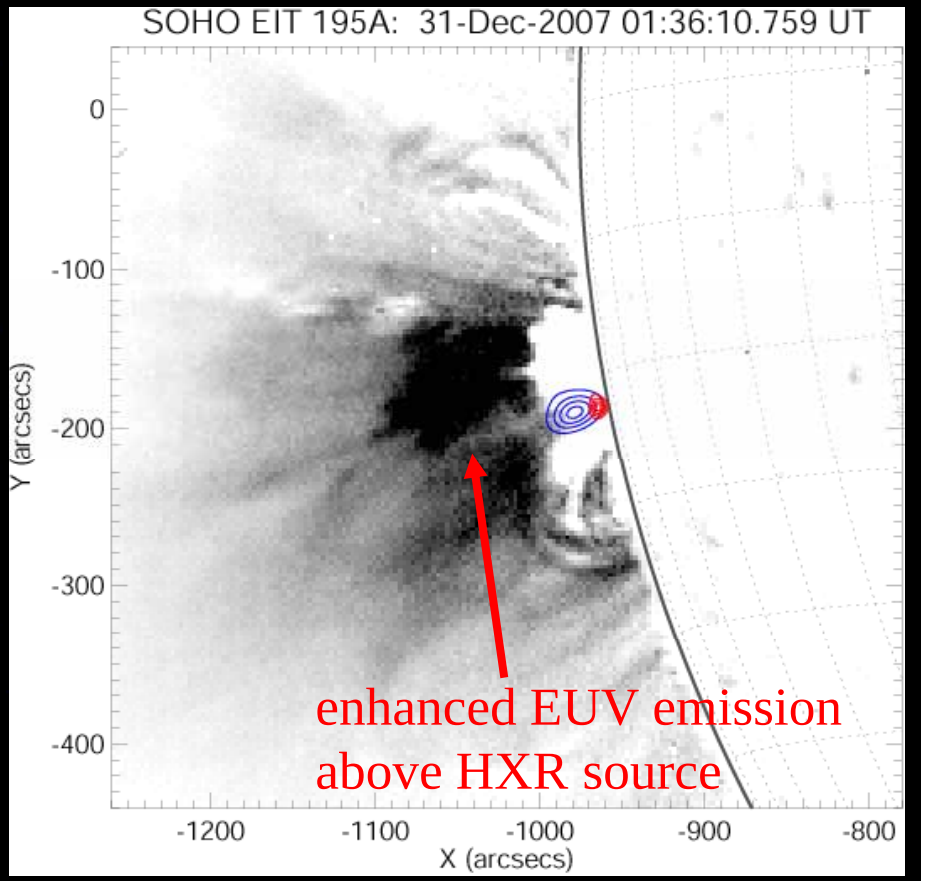


Comparison with EUV imaging

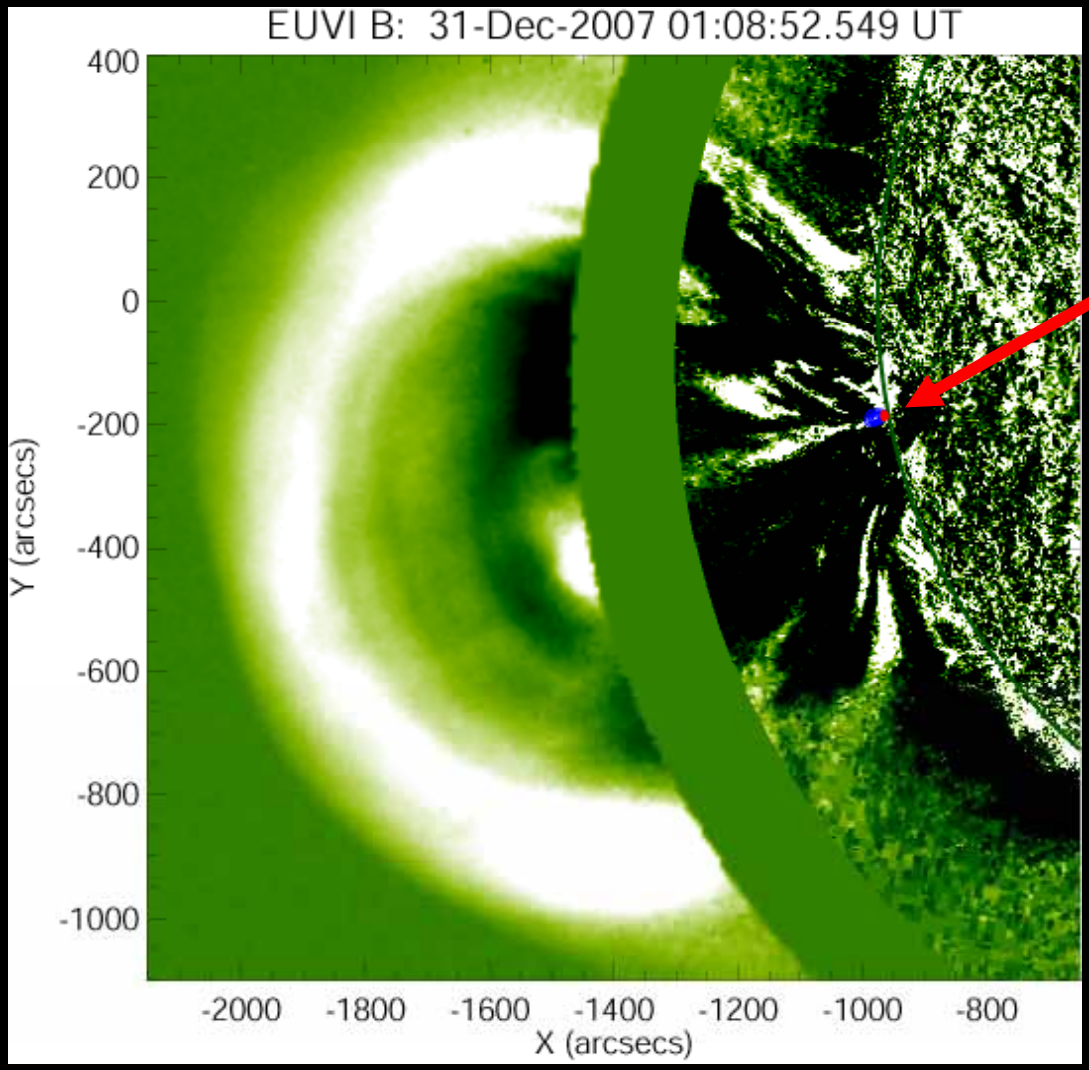
STEREO B 171A:
difference movie



EIT 195A difference image:

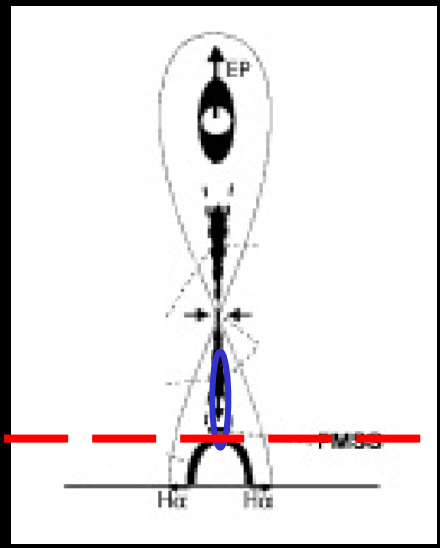


COR1, EUVI, RHESSI



rough location of HXR sources

Is coronal HXR emission related to reconnection outflow/termination shock?



Summary

- Partially disk-occulted flare observations suggest that all flares show coronal HXR emission (i.e. large number of flare-accelerated electrons are in the corona). Review in A&AR, Krucker et al. 2008

- 2007 Dec 31 event: STEREO & RHESSI
- impulsive phase: above loop top source
- late phase emission related to CME/currrent sheet?