RHESSI and AIA observations of the FERMI behind-the-limb flare on 2014 September 1

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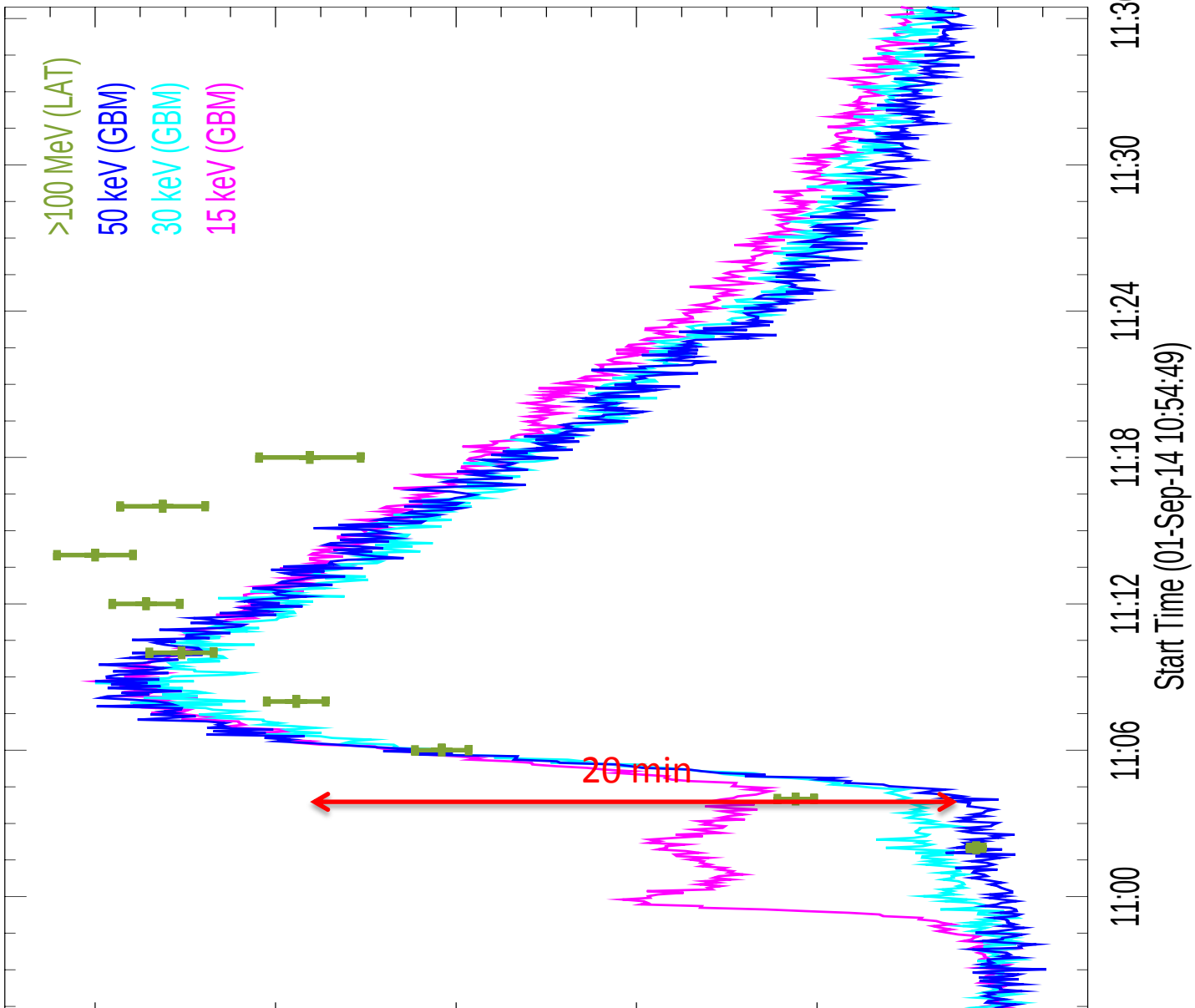
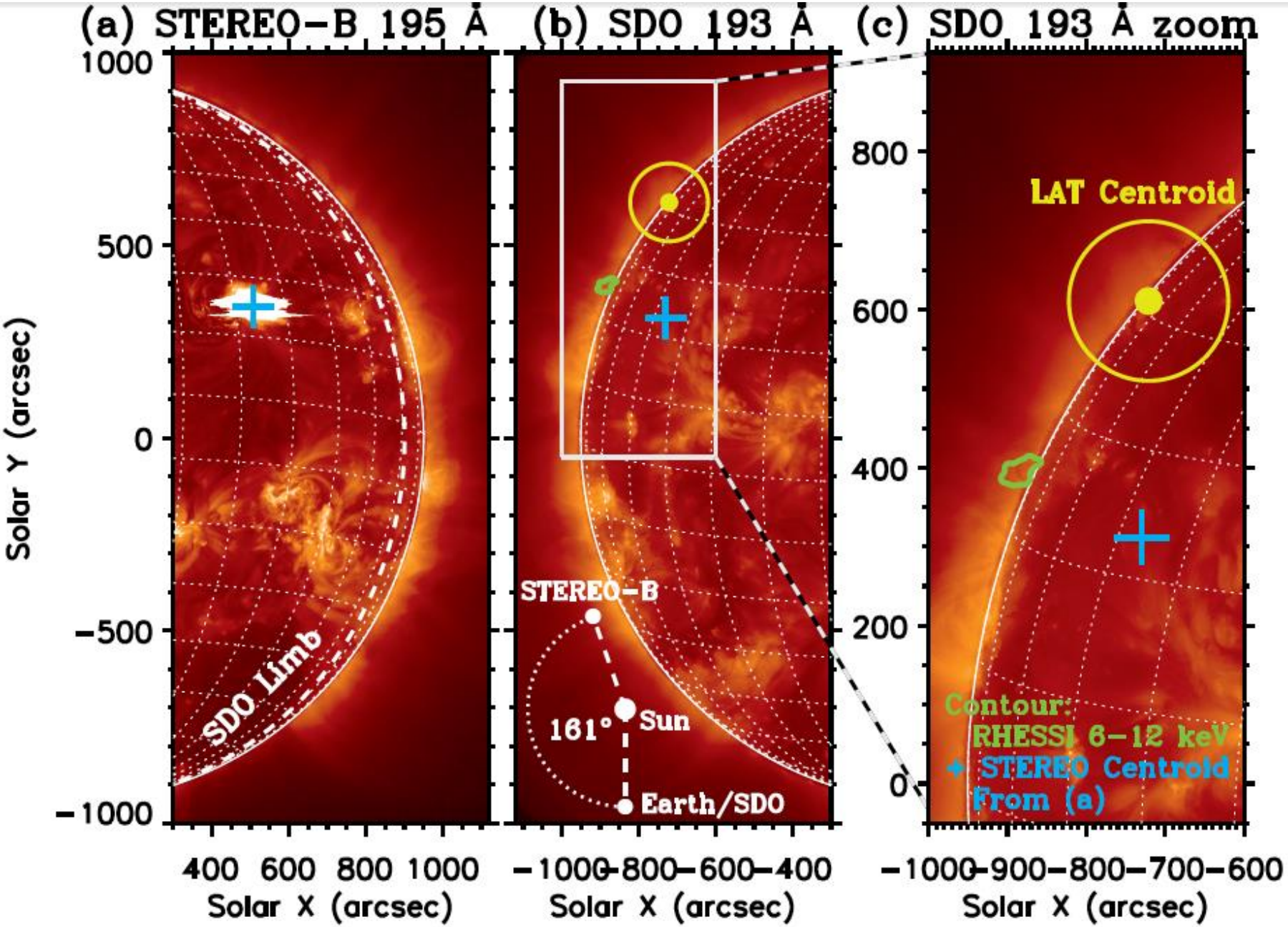
Outlook

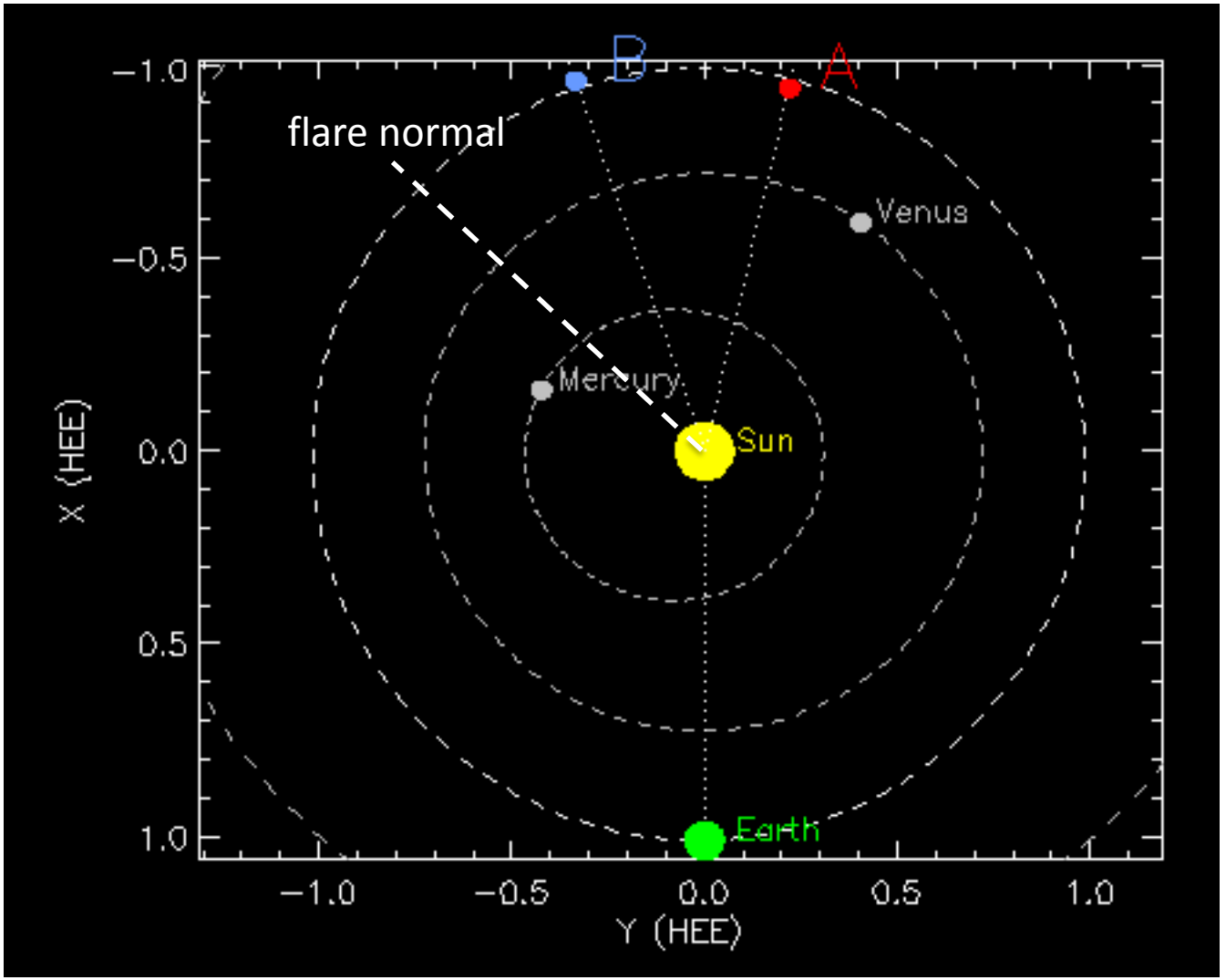
- Sep 1, 2014 behind the limb event (Melissa's talk)
- Compare time profiles and spectra between FERMI and RHESSI
- RHESSI source locations compared to >100 MeV centroid location
  - Thermal
  - Non-thermal
- AIA observations

Fermi time profiles

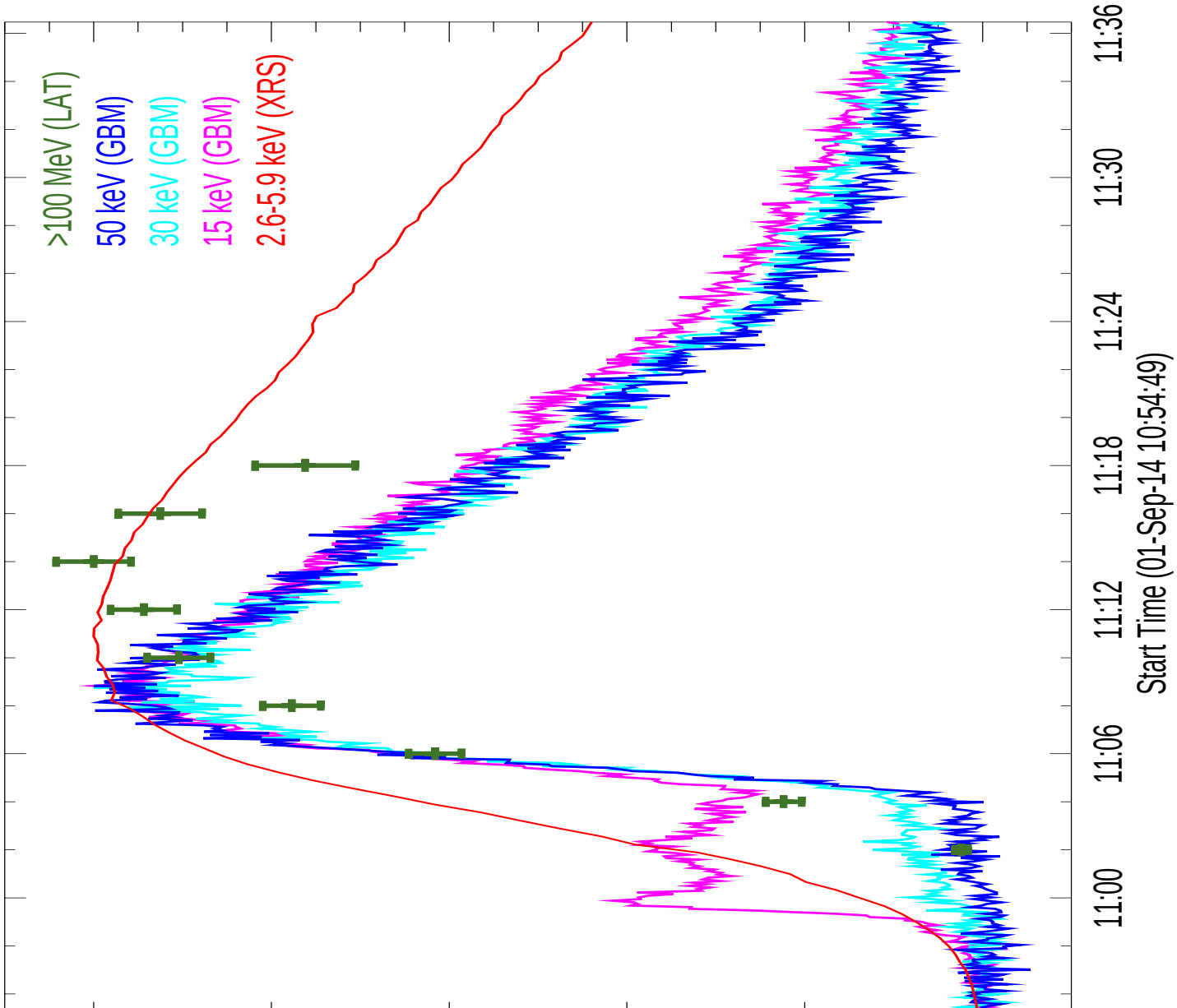



(a) STEREO-B 195 Å
(b) SDO 193 Å
(c) SDO 193 Å zoom
Solar Y (arcsec)
1000
500
0
−500
−1000
SDO Limb
STEREO-B
161°
Sun
Earth/SDO
LAT Centroid
800
600
400
200
0
Contour:
RHESSI 6−12 keV
+ STEREO Centroid
From (a)
400 600 800 1000
Solar X (arcsec)
−1000−800−600−400
Solar X (arcsec)
−1000−900−800−700−600
Solar X (arcsec)

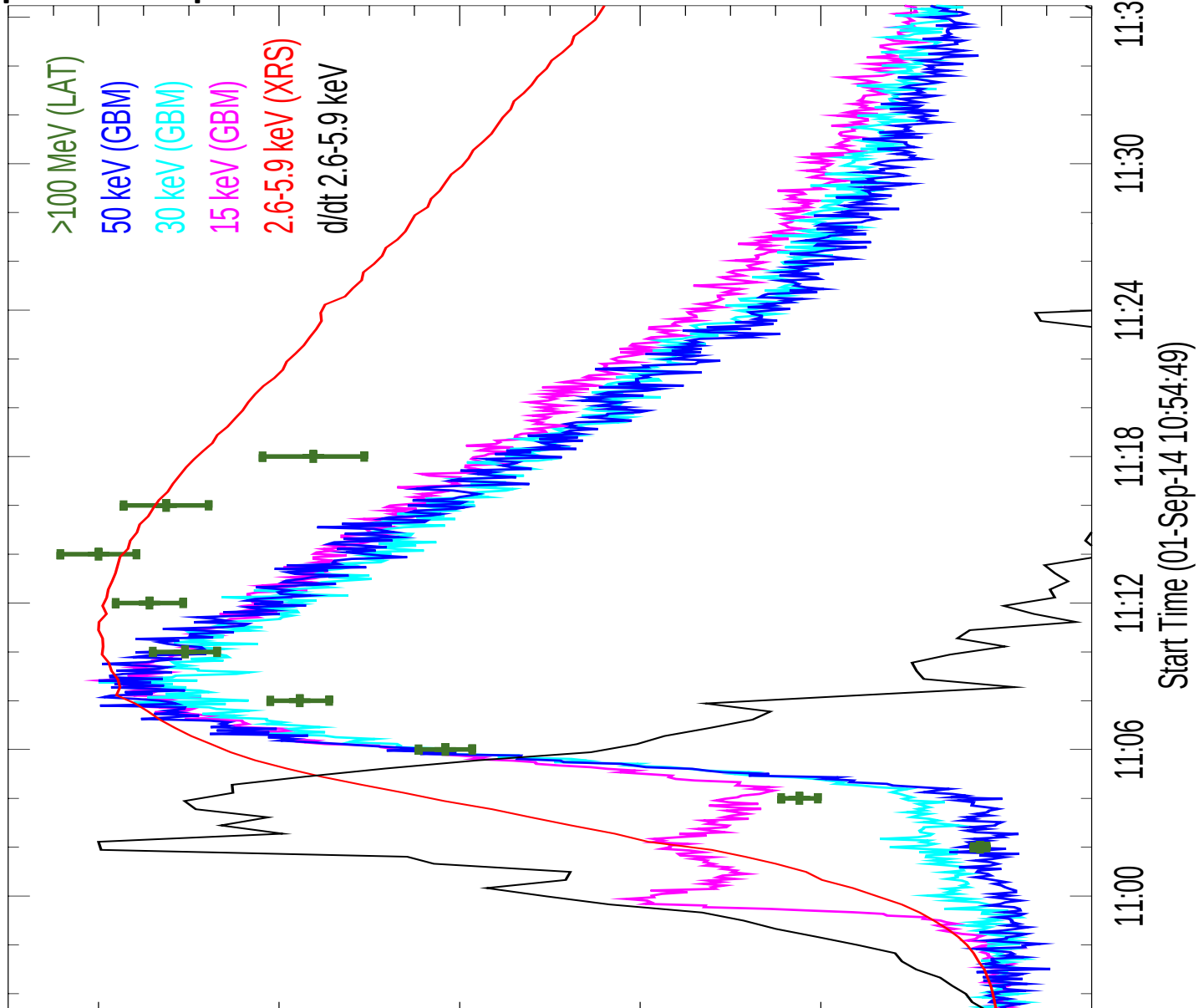
Messenger XRS sees flare on disk



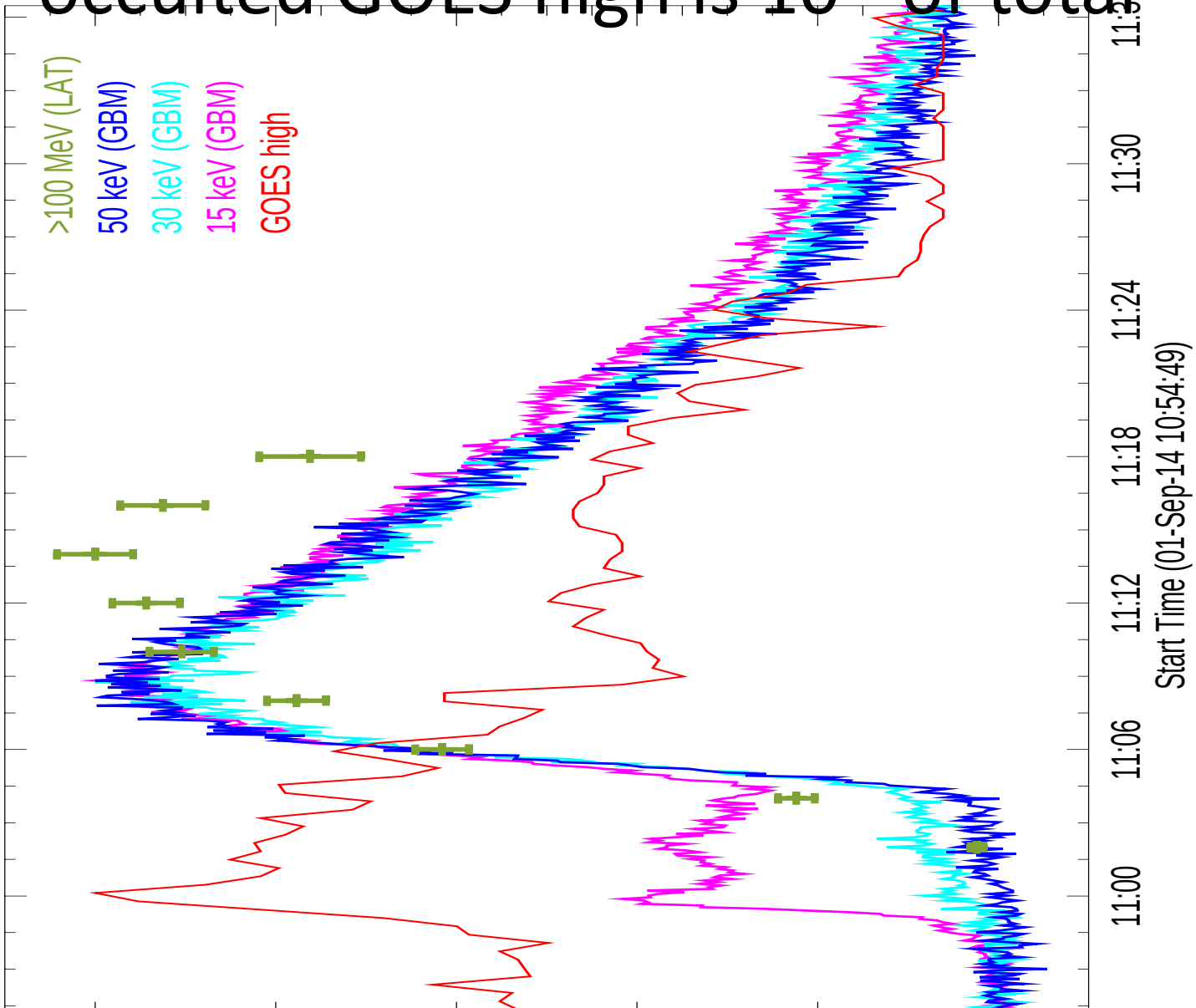
XRS fits gives EM=4x10^{49} cm^{-3} & T=30 MK → GOES X1.3



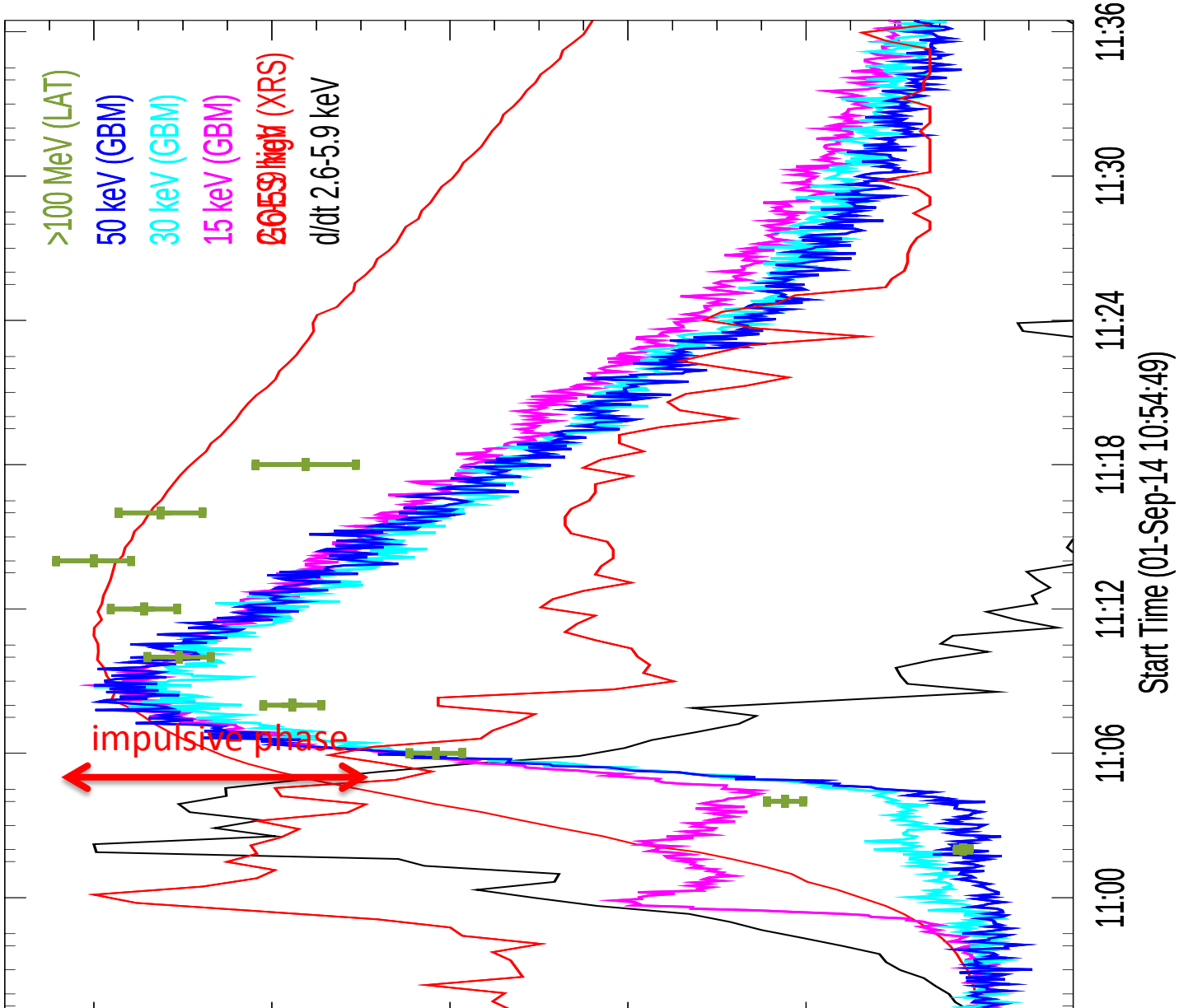
SXR derivative:
impulsive phase is before HXR and >100 MeV bursts

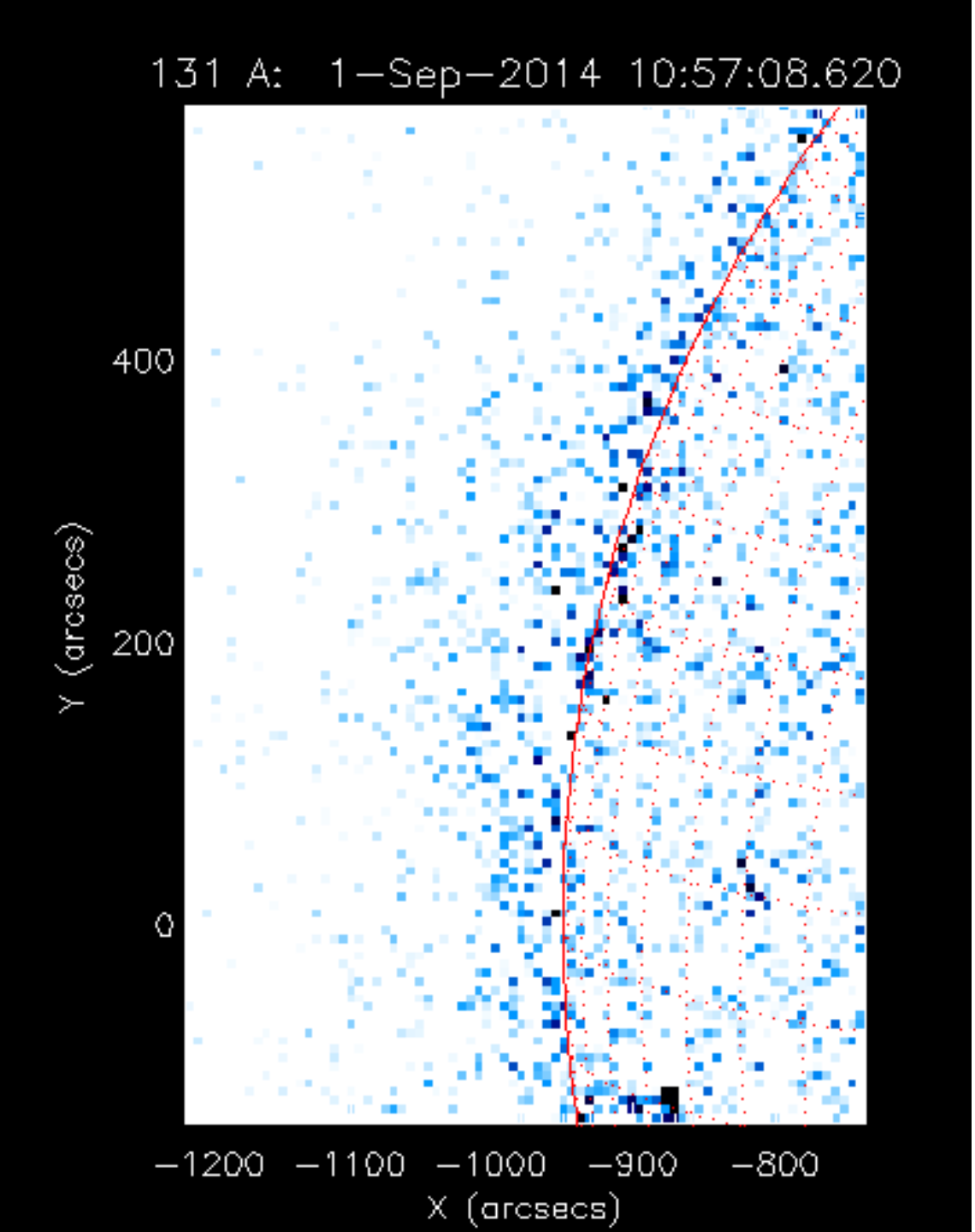


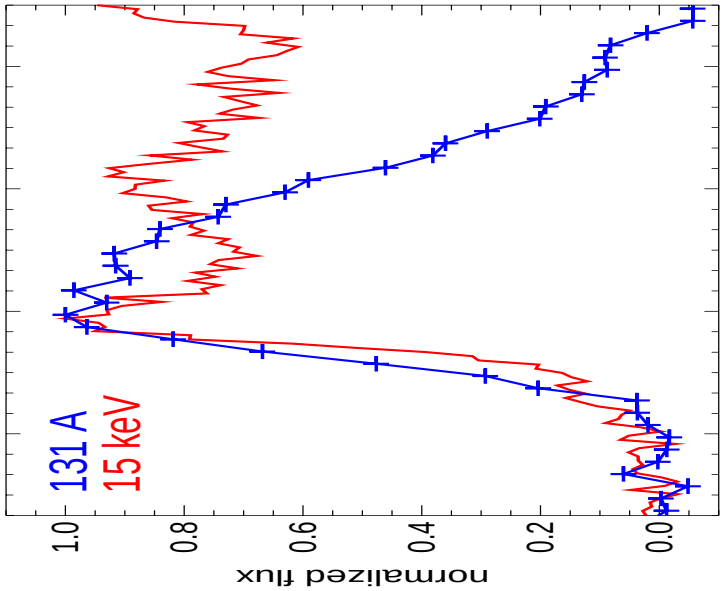
GOES high shows initial increase occulted GOES high is 10^{-4} of total



GOES high emission from impulsive phase!







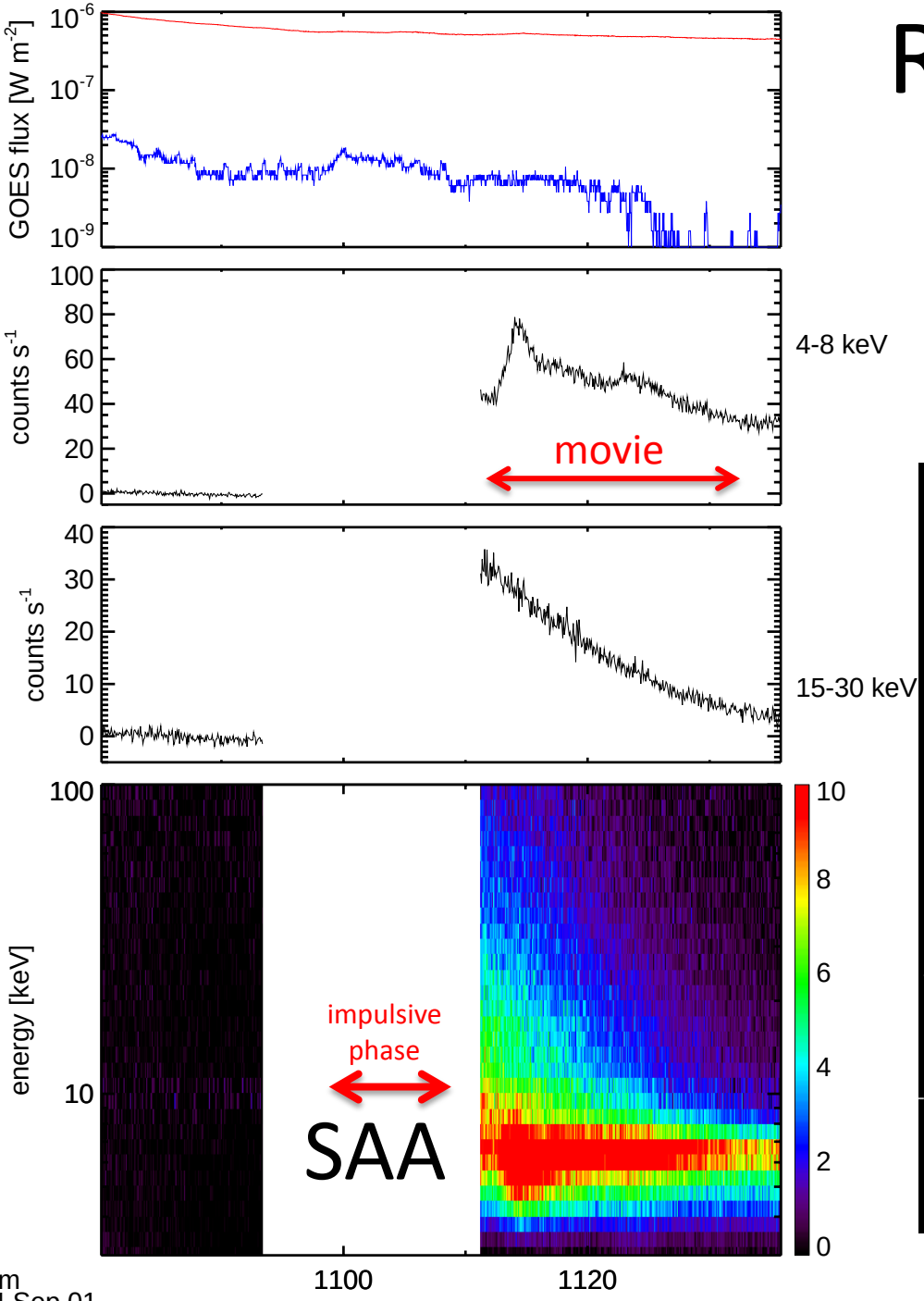
Same onset as 15 keV and GOES high.

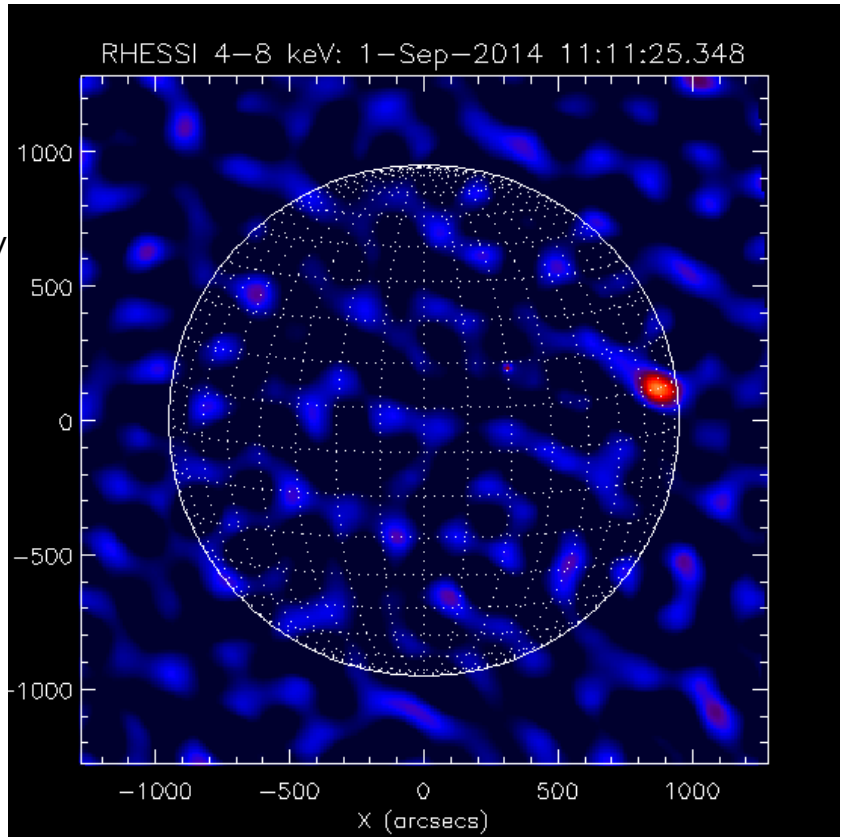
Escaping hot structure.

RHESSI coverage

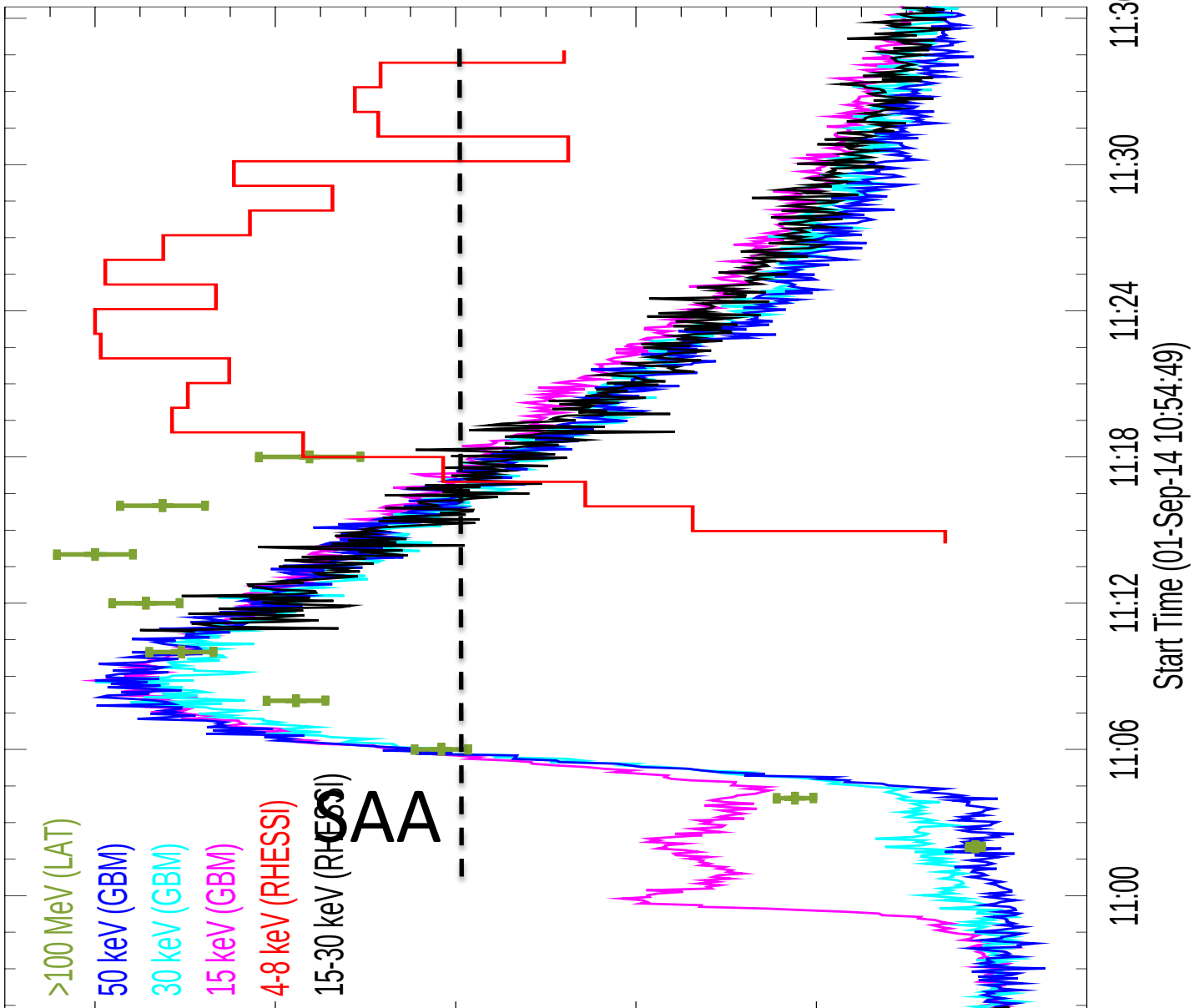
RHESSI thermal emission originates from three different locations:

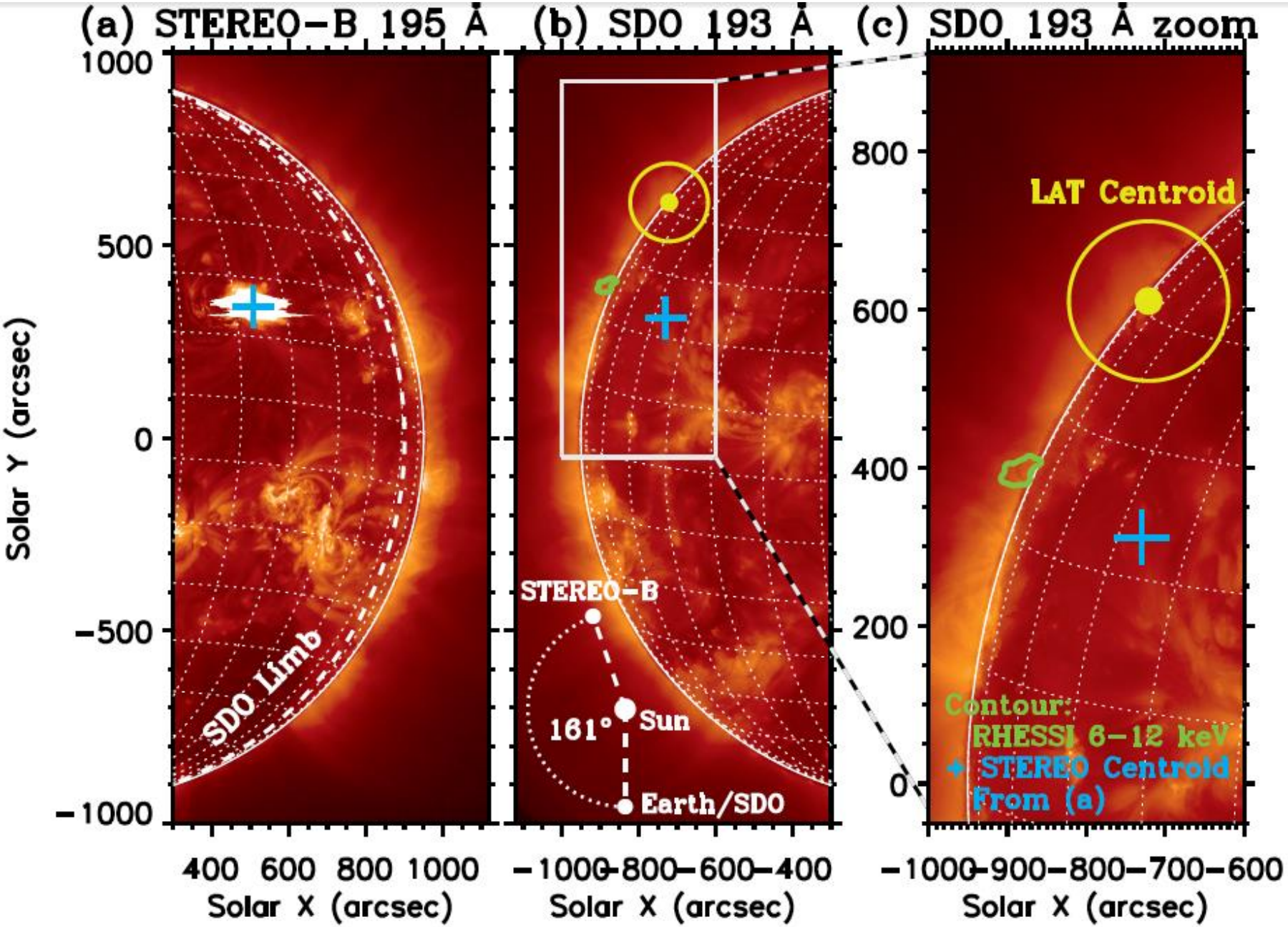
- Western limb AR
- Disk AR
- Behind the limb event





Fermi & RHESSI time profiles

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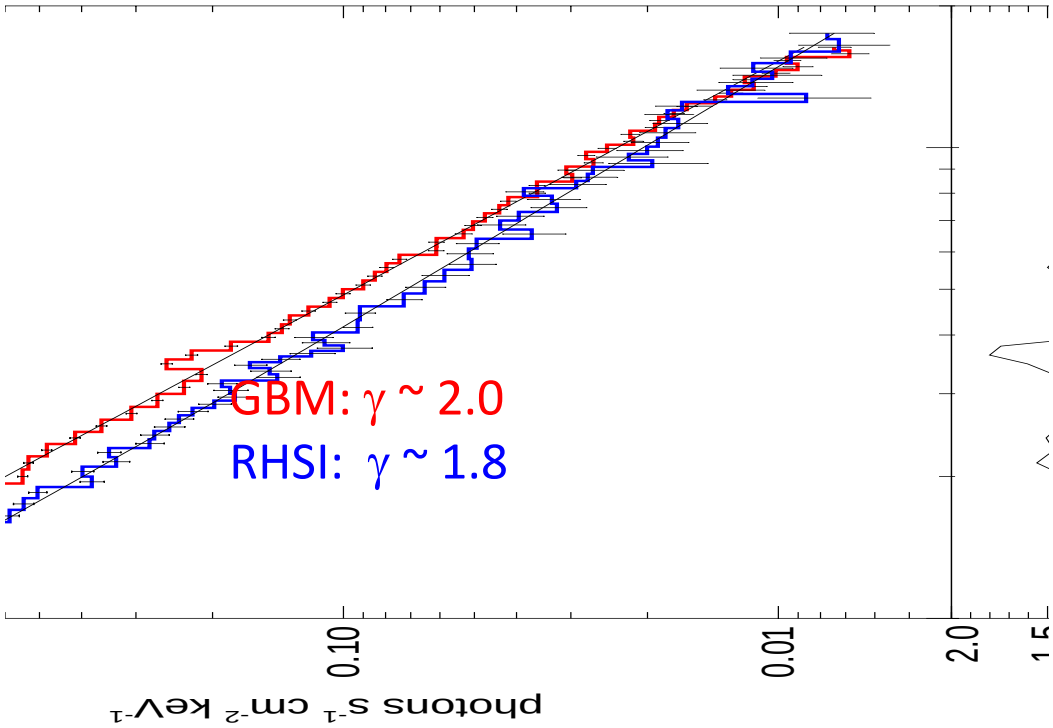
From (a)
400 600 800 1000
Solar X (arcsec)
−1000−800−600−400
Solar X (arcsec)
−1000−900−800−700−600
Solar X (arcsec)

11:10:56 to 11:13:20 UT

GBM and RHESSI HXR spectra

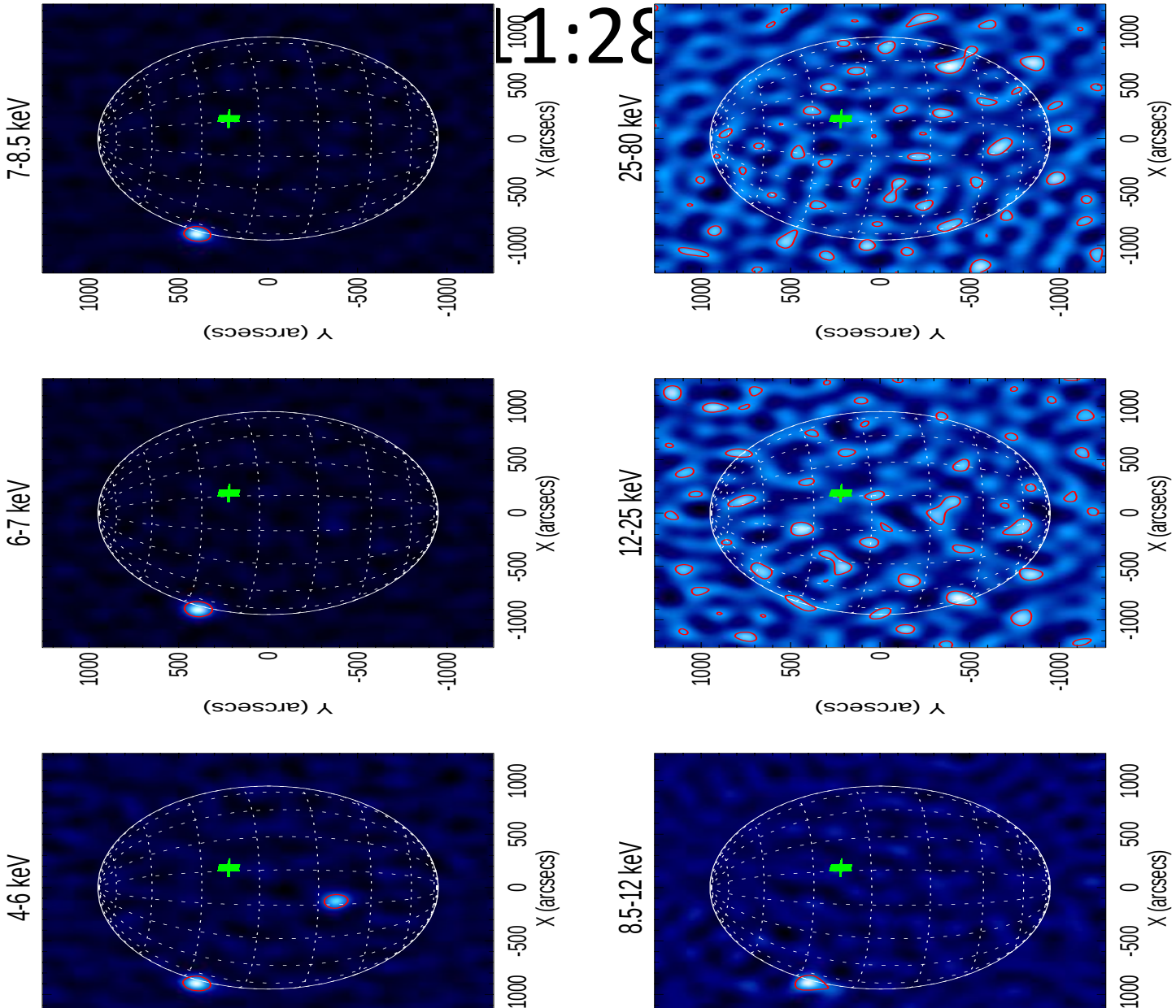


- Power law!
- High energy (>500 keV) electrons alone cannot reproduce the spectra.
- ~3 orders of magnitude fainter than largest flares (e.g. Dec 6, 2005 with flux of 100 ph/s/cm2/keV at 30 keV)
- Instantaneous electrons above 20 keV: 1.0×10^{36} (10^{8}/n) electrons.
- Thick target: 2×10^{26} erg/s for electrons above 20 keV.

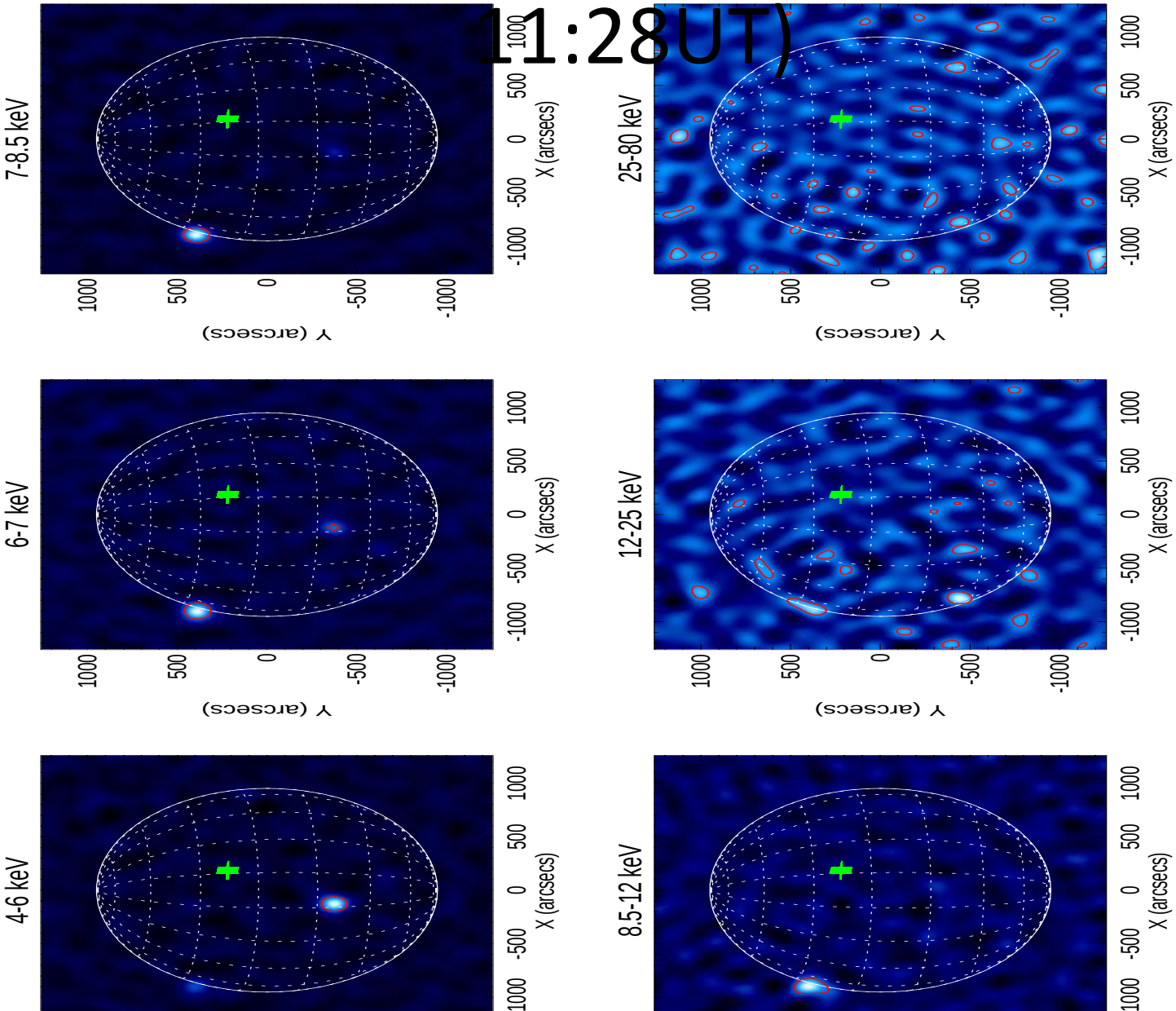
Number of counts above 15 keV is 2000 cts/min/det

→ more than enough for imaging

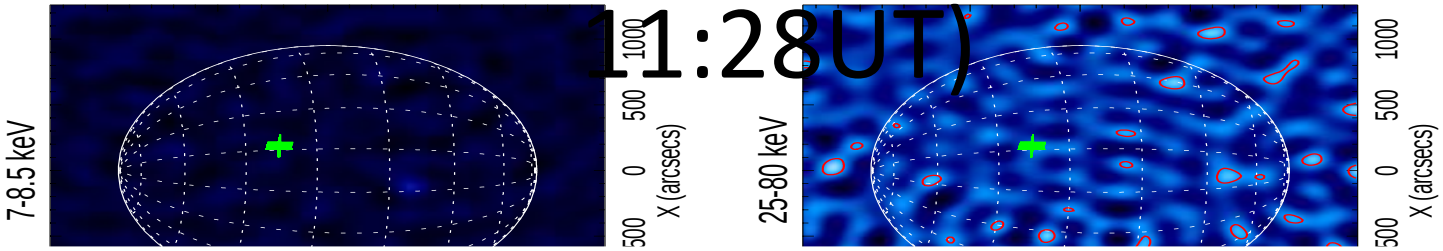
Coarse resolution imaging (11:18-11:28



Coarse resolution imaging (11:11-11:28UT)

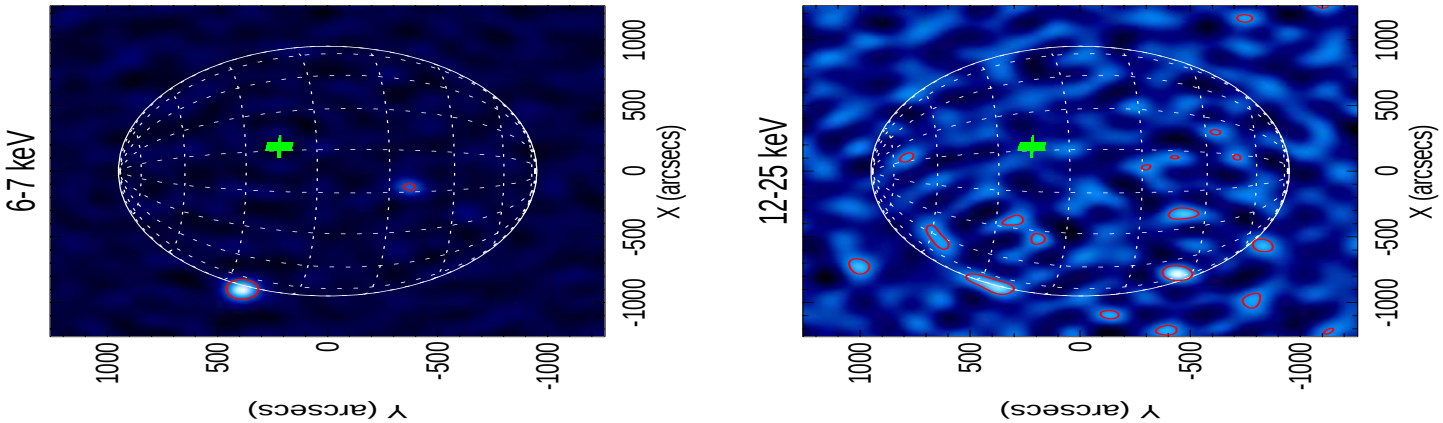


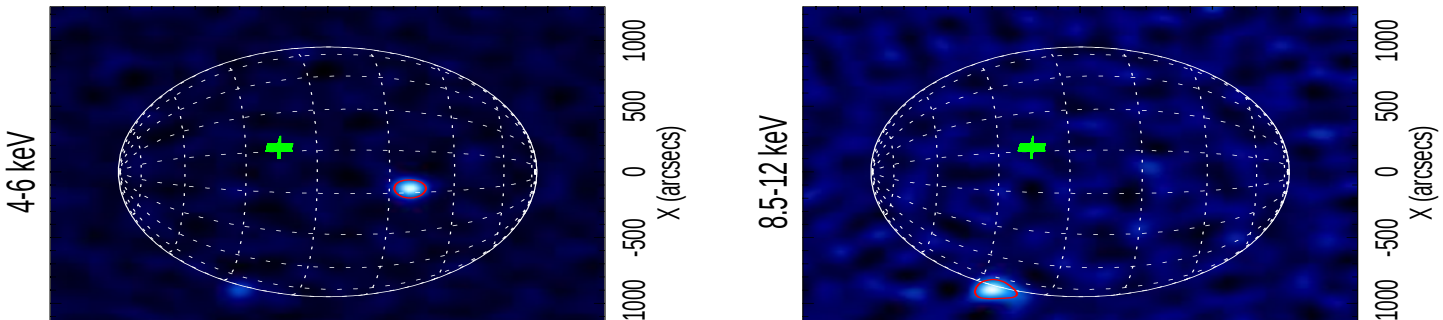
Coarse resolution imaging (11:11-11:28UT)



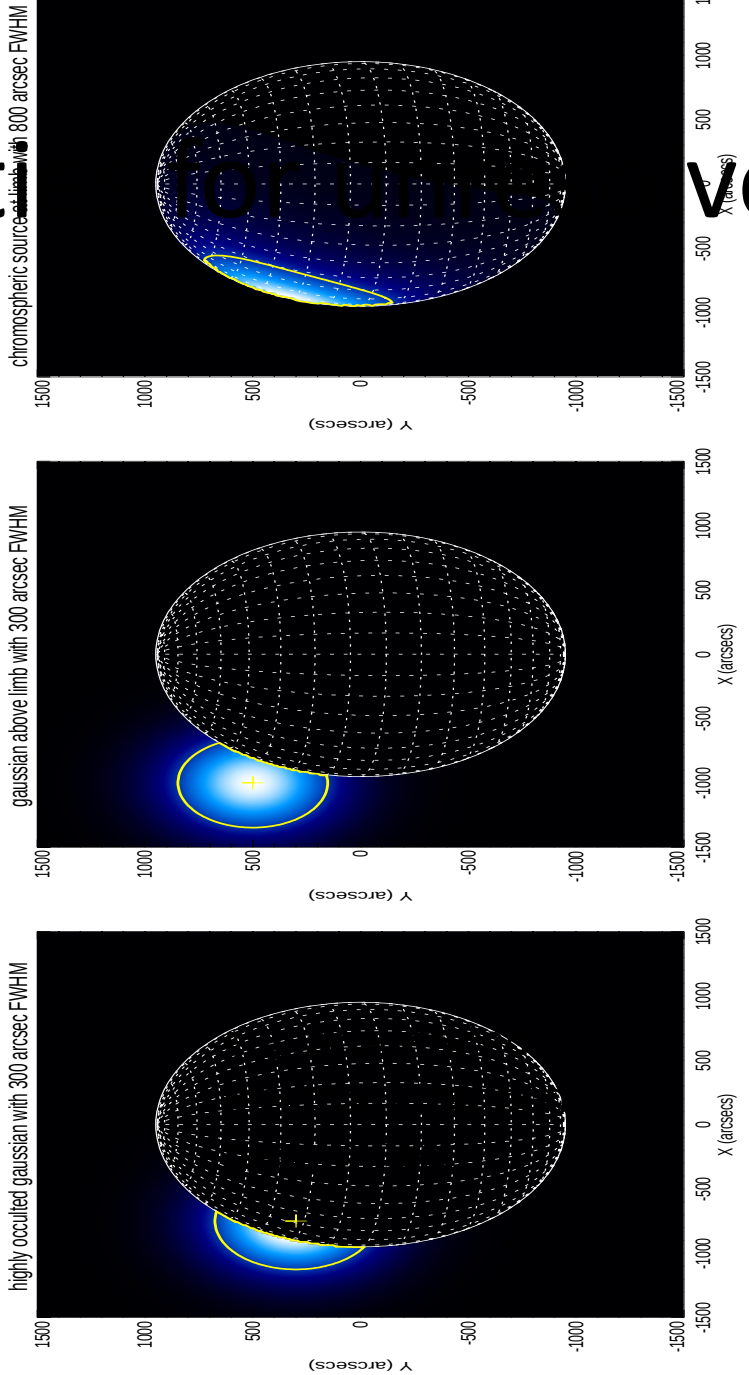
No image above 15 keV despite large number of counts

→ Source significantly larger than s/c 9 resolution of 180”





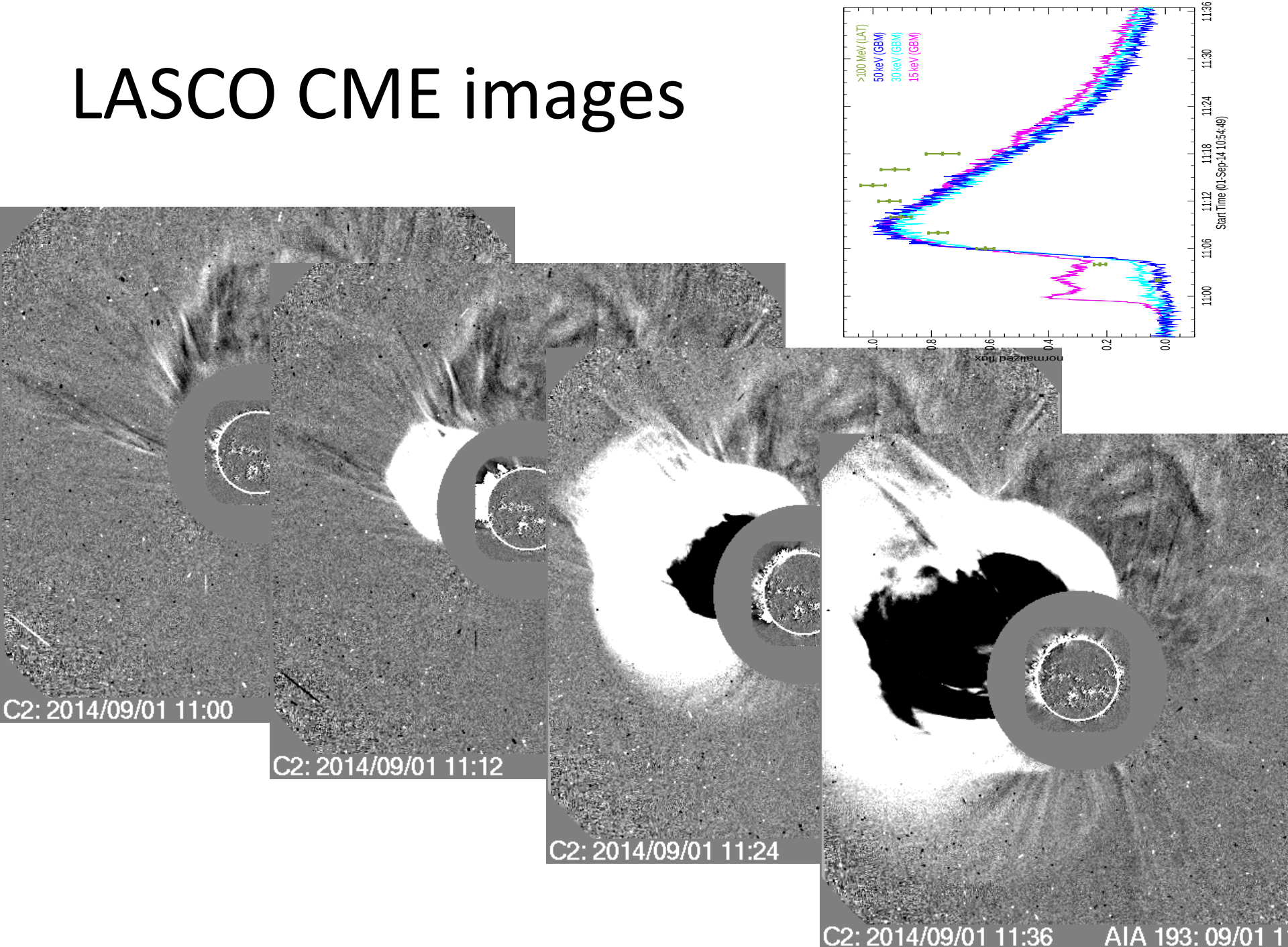
Possibilities for unresolved source

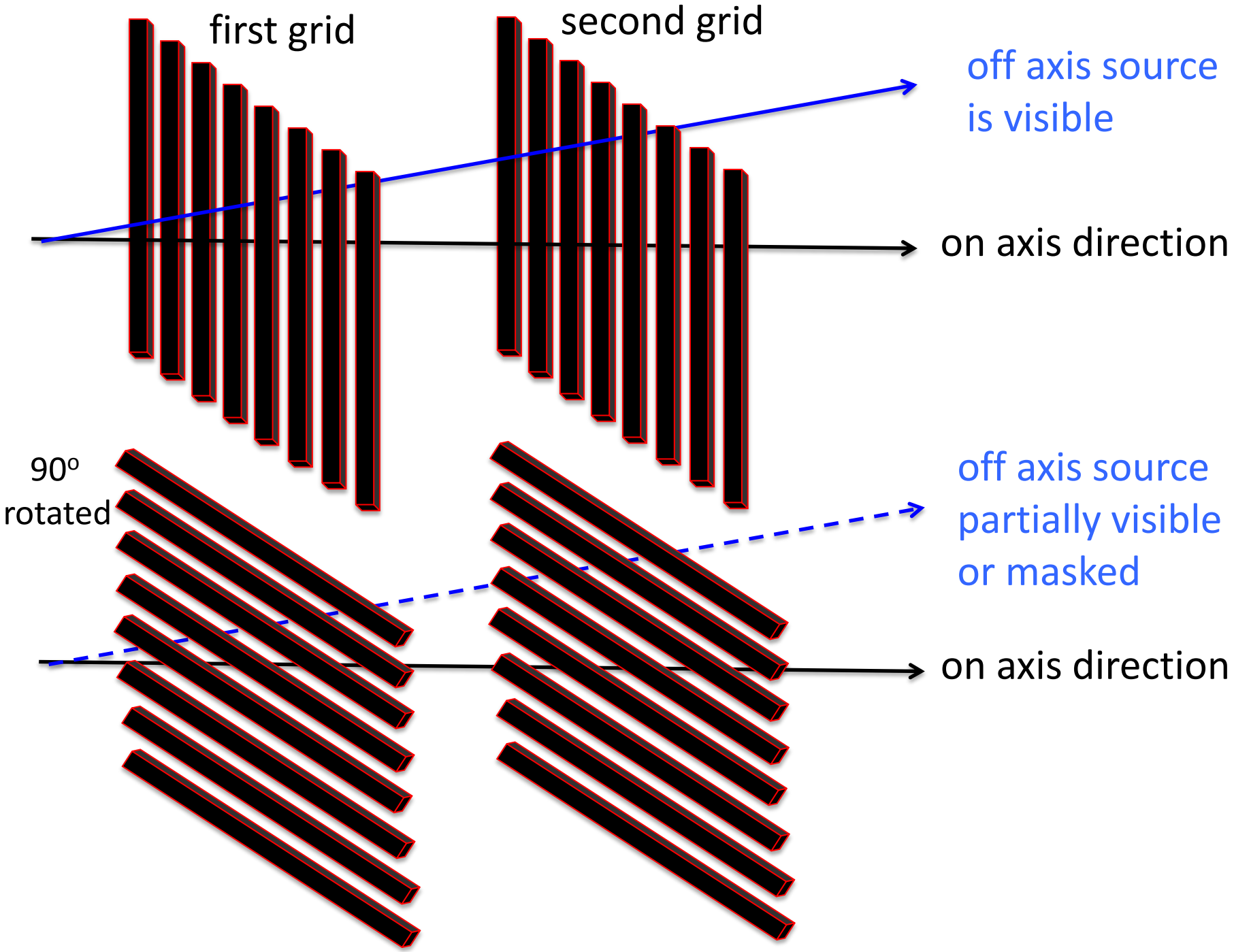


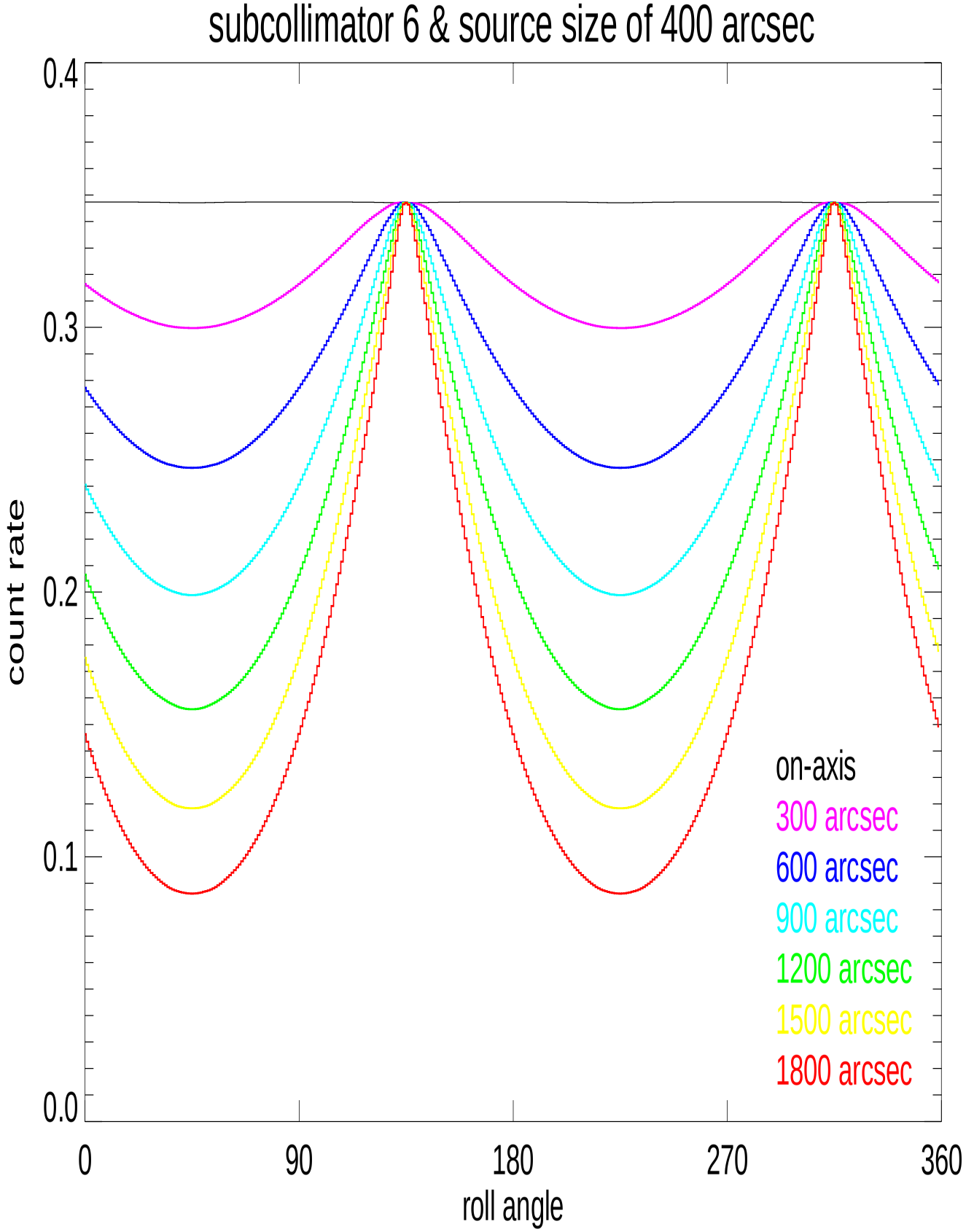
e.g. accelerated electrons trapped above flare site

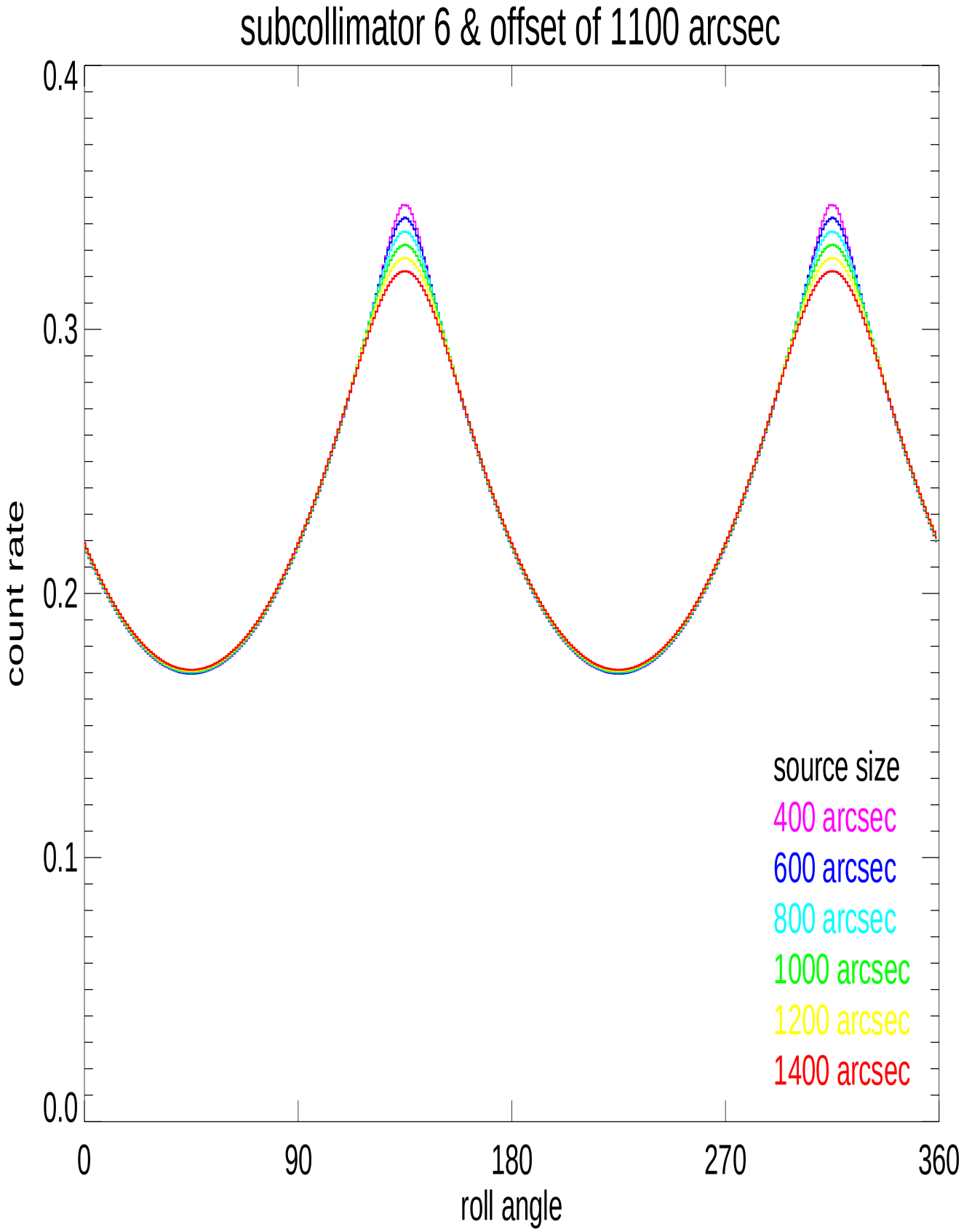
e.g. shock-accelerated electrons getting access to visible part of disk

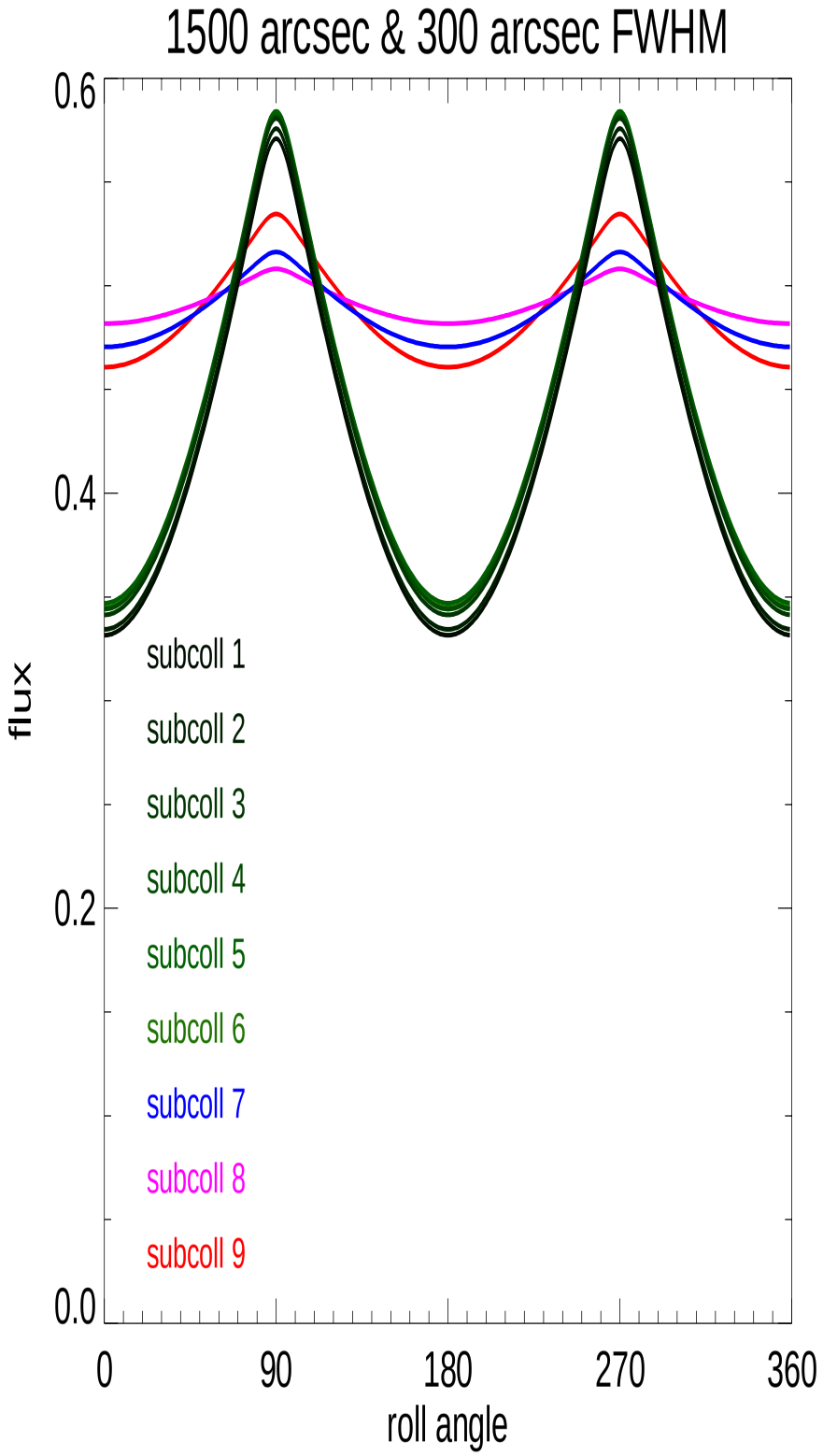
LASCO CME images



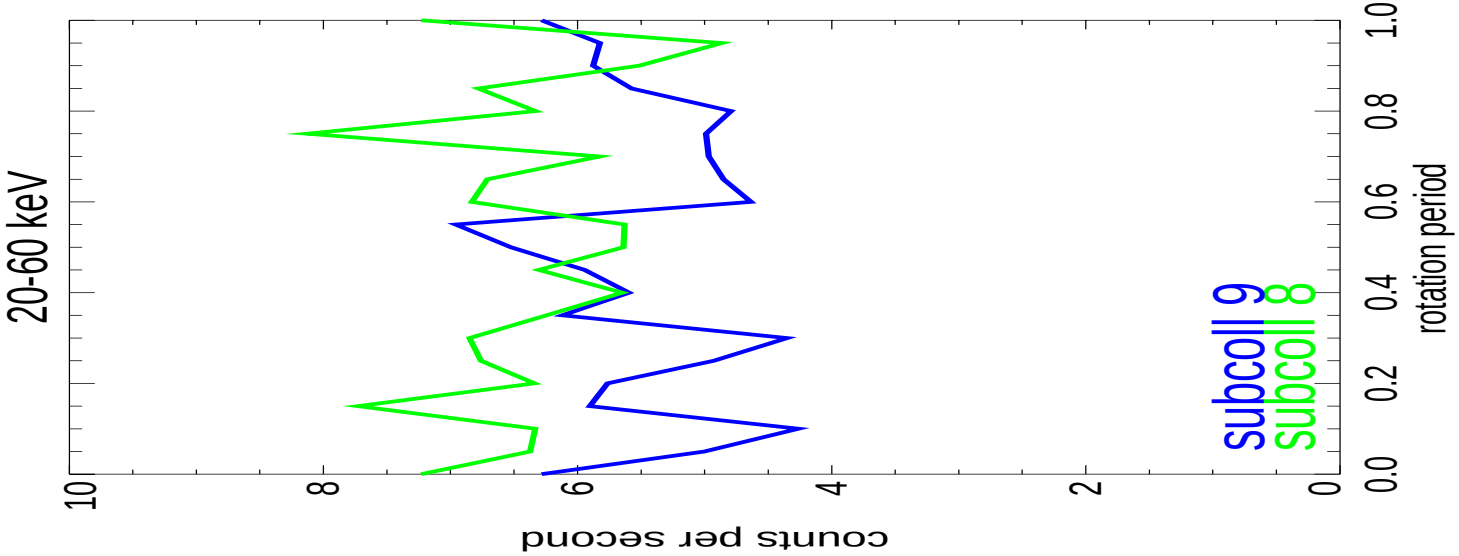

first grid
second grid
off axis source
is visible
on axis direction
90°
rotated
off axis source
partially visible
or masked
on axis direction

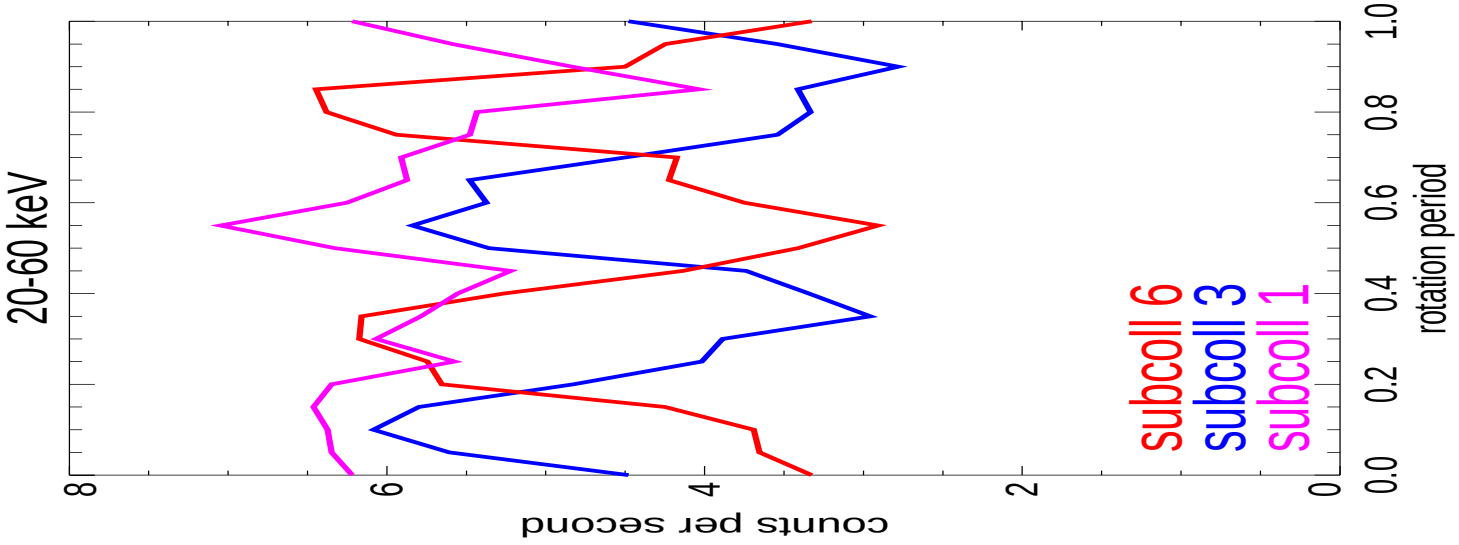

subcollimator 6 & source size of 400 arcsec
0.4
0.3
0.2
0.1
0.0
count rate
0
90
180
270
360
roll angle
on-axis
300 arcsec
600 arcsec
900 arcsec
1200 arcsec
1500 arcsec
1800 arcsec


subcollimator 6 & offset of 1100 arcsec
count rate
0.4
0.3
0.2
0.1
0.0
0
90
180
270
360
roll angle
source size
400 arcsec
600 arcsec
800 arcsec
1000 arcsec
1200 arcsec
1400 arcsec

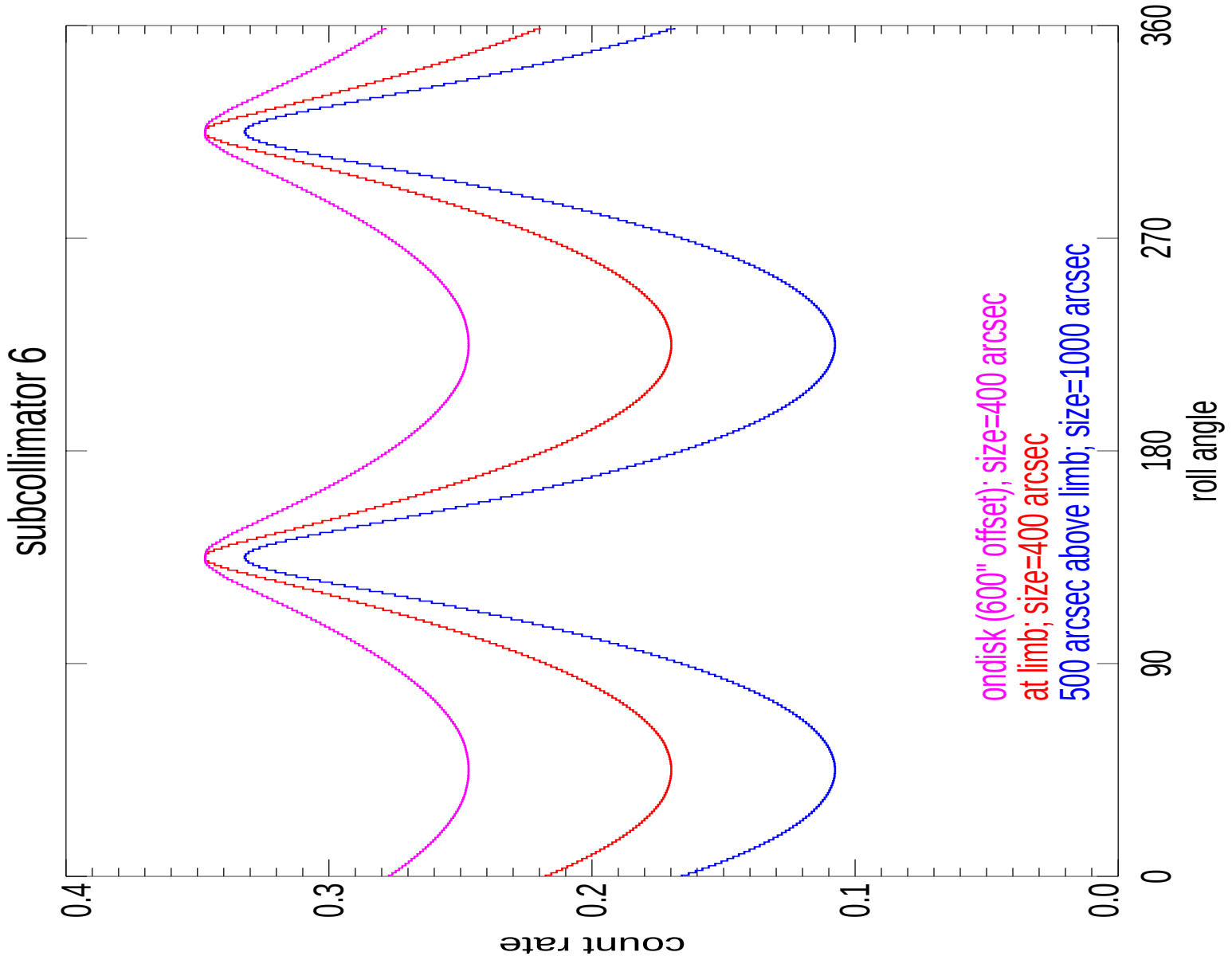

1500 arcsec & 300 arcsec FWHM
0.6
0.4
0.2
0.0
flux
0
90
180
270
360
roll angle
subcoll 1
subcoll 2
subcoll 3
subcoll 4
subcoll 5
subcoll 6
subcoll 7
subcoll 8
subcoll 9

RHESSI observations (no bkg subtr.)

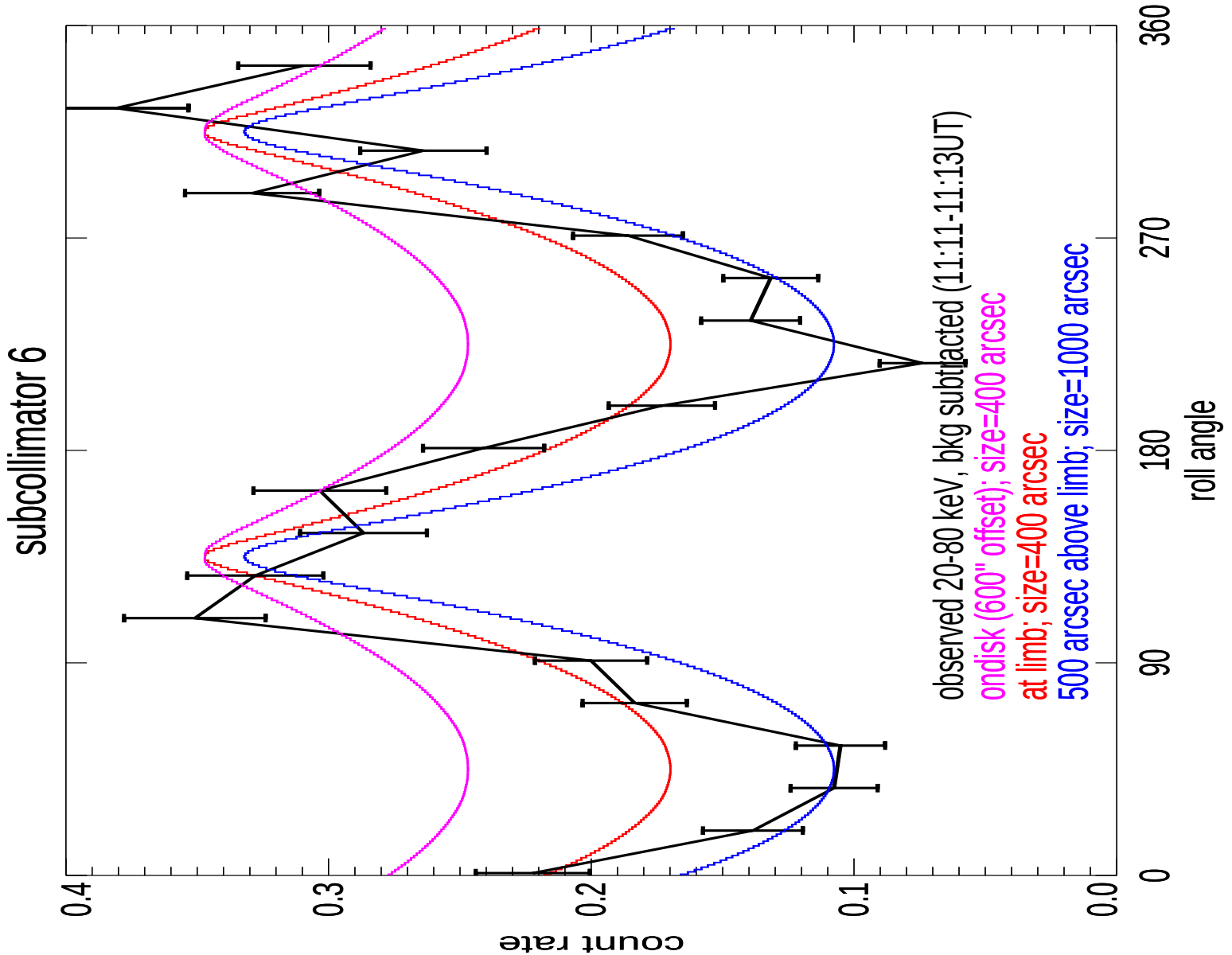




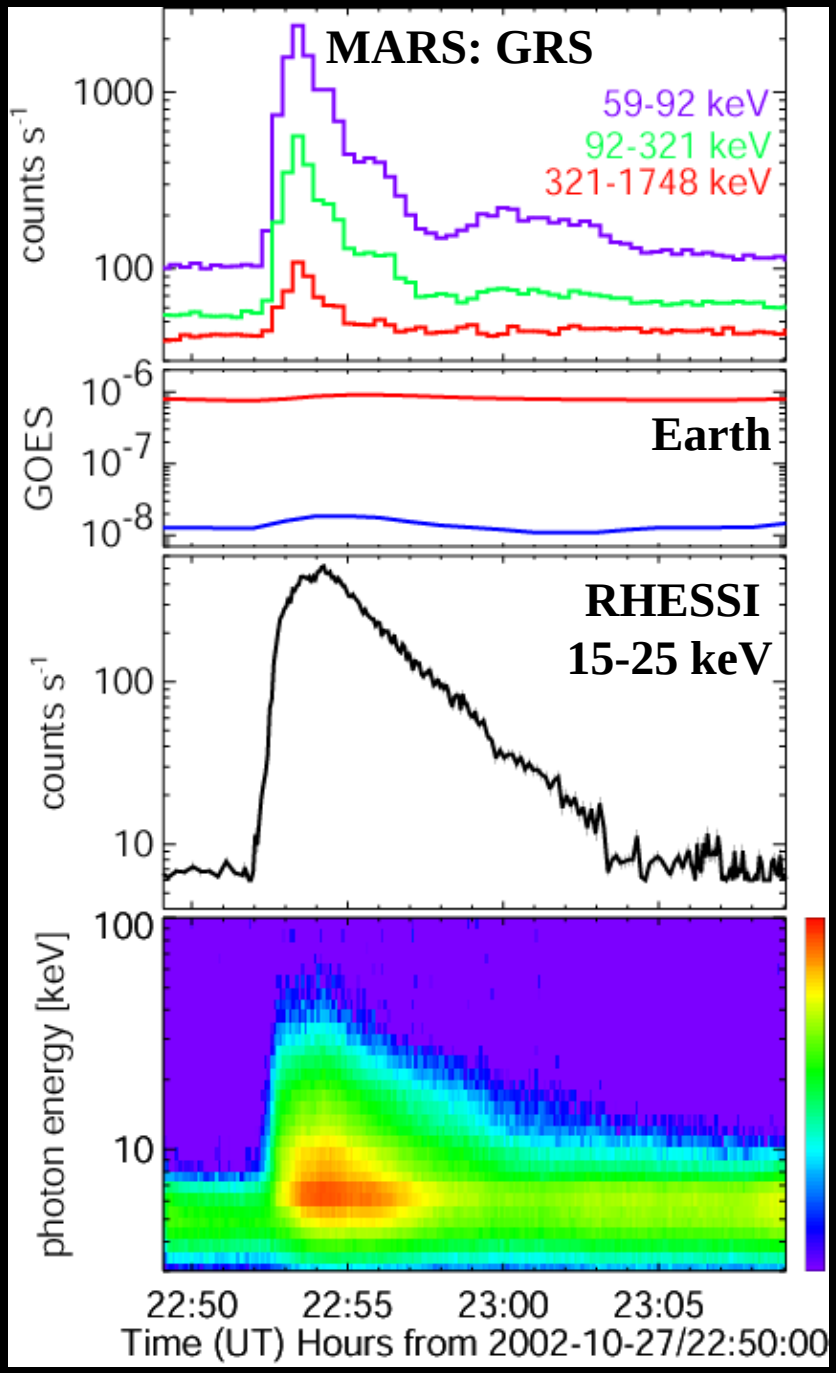
Expected profiles (3 cases)

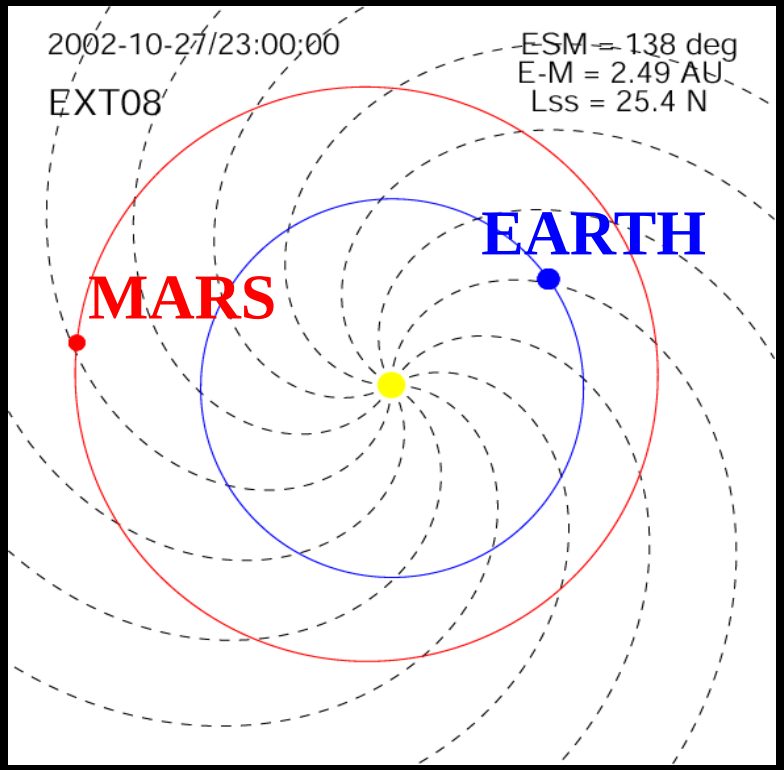


Expected profiles (3 cases)



2002 Oct 27 flare



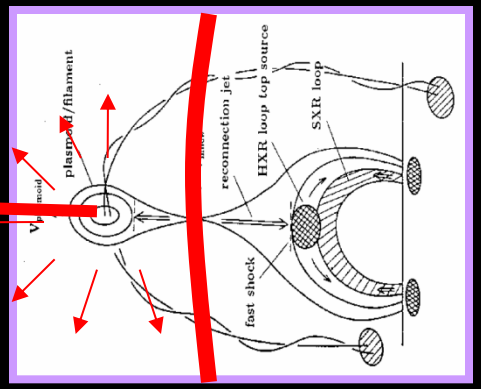


giant flare seen by GRS (MARS)

same onset as emission seen by RHESSI!

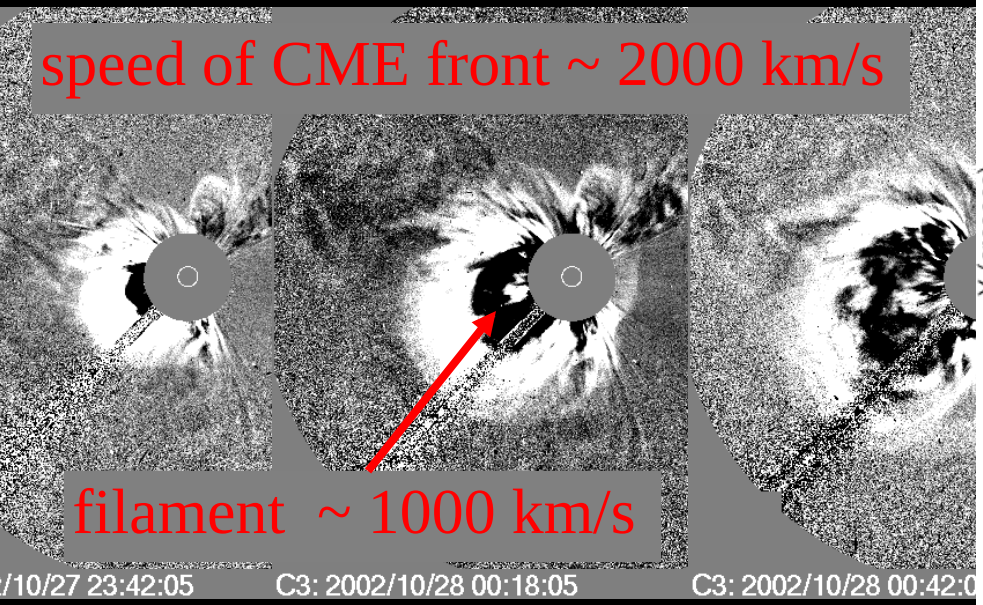
Krucker, White, & Lin 2007

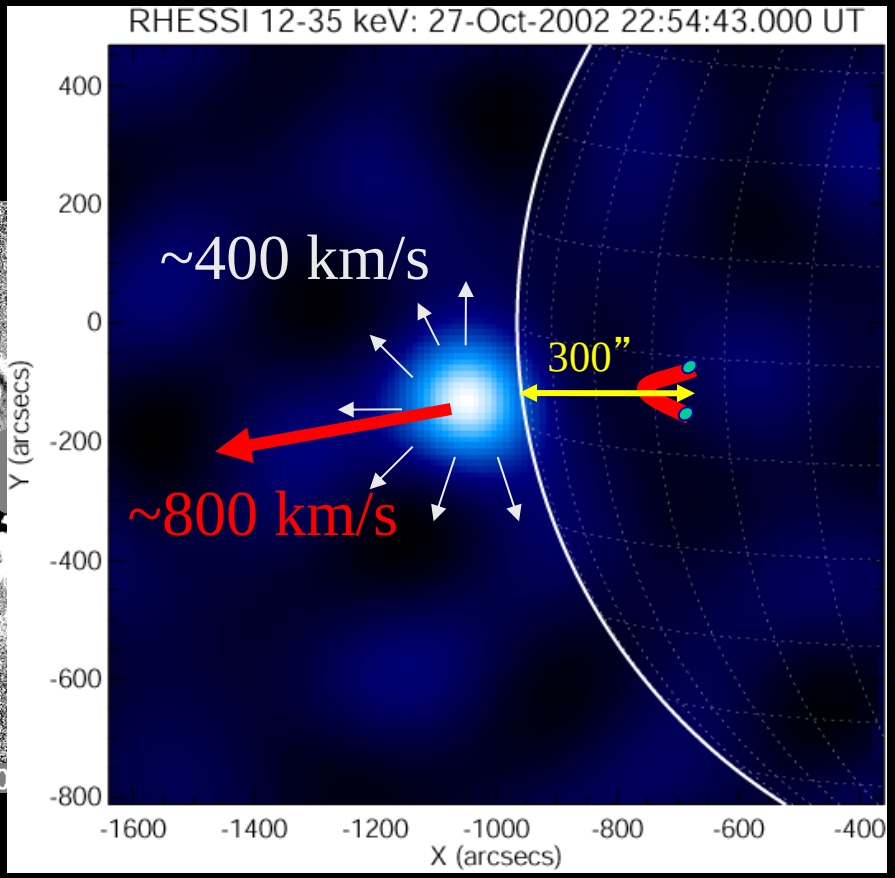
HXR from CME



very large source (>200 arcsec)
expanding and rising

HXR emission from electrons in magnetic structures within coronal mass ejections.





Krucker, White, & Lin, ApJL, 2007