RHESSI and STEREO observations of a partially disk-occulted flare

STEREO B

STEREO A

Earth, RHESSI

flare site
E102

photosphere

C8 class flare on December 31, 2007

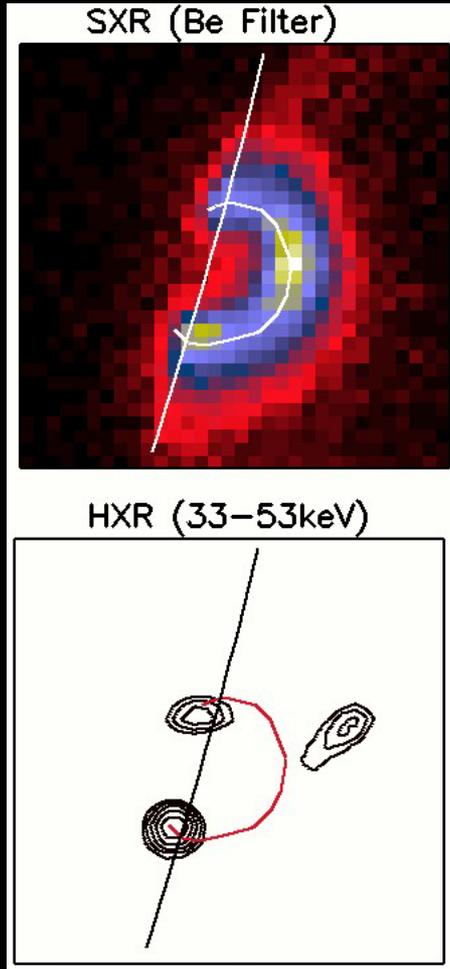# RHESSI and STEREO observations of a partially disk-occulted flare

STEREO B

STEREO A

Earth, RHESSI

flare site

Direct Observations of the Electron Acceleration Region of a Solar Flare

Säm Krucker, H.S. Hudson, J.-P. Wuelser, S. White, R.P. Lin
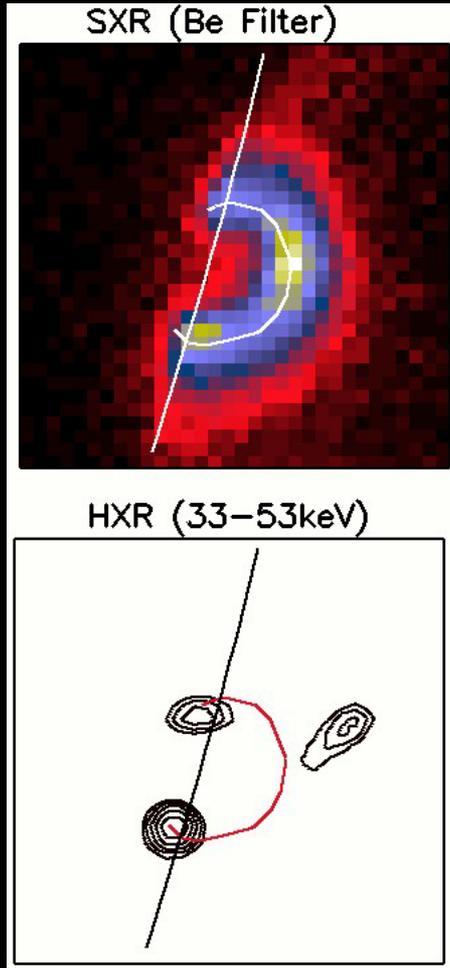
Above-the-loop-top HXR sources

SXR (Be Filter)

HXR (33−53keV)

Ambient (thermal) density is low
n ~ 10^9 cm^{-3} or even smaller

number of HXR producing electrons
(instantaneous)
$N_{HXR} \sim n^{-1}$

Masuda et al. 1994, 2000

Above-the-loop-top HXR sources
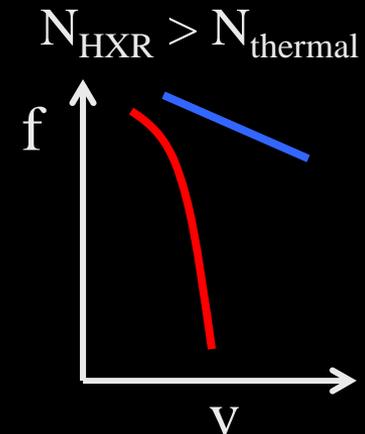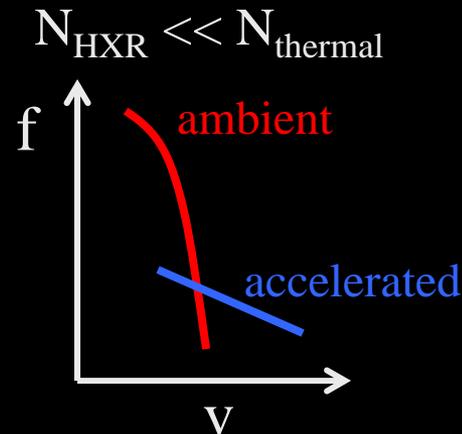

SXR (Be Filter)

HXR (33-53keV)

Masuda et al. 1994, 2000

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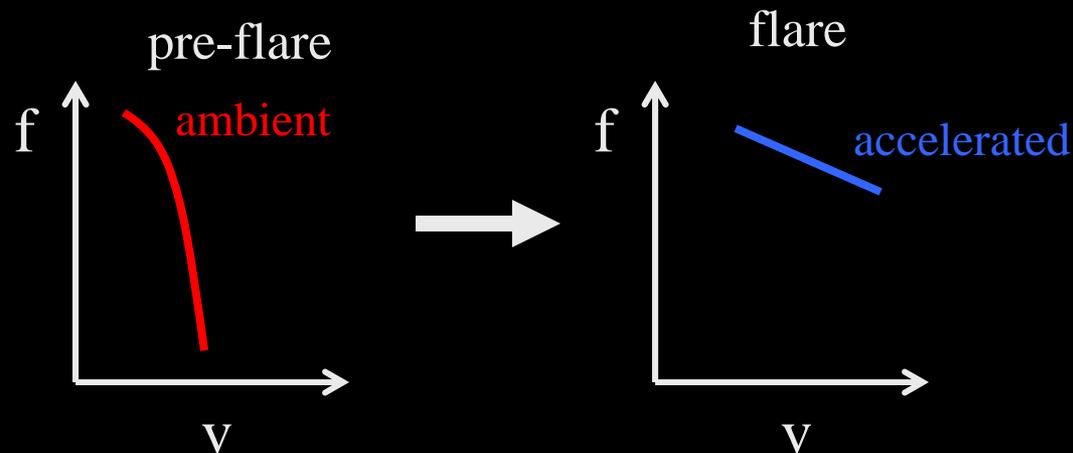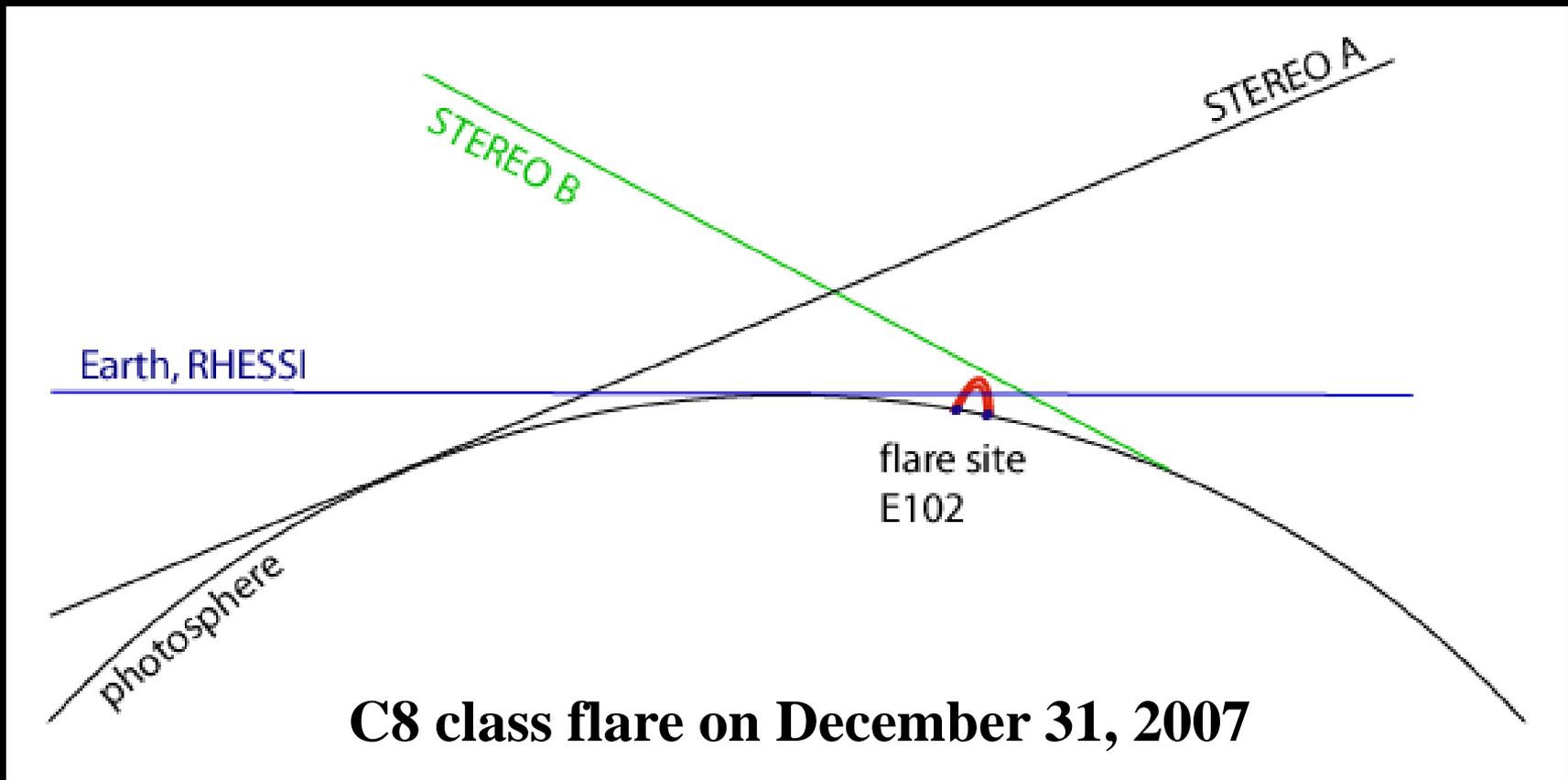Masuda flare: $N_{HXR} > 5* N_{thermal}$

$N_{HXR} << N_{thermal}$

f
ambient
accelerated
v

$N_{HXR} > N_{thermal}$

f
v

$N_{HXR} \gtrsim N_{thermal}$ means

- almost all energy is in accelerated electrons ($<E_{acc}>\sim 20$ keV vs $E_{thermal}\sim 0.2$ keV)
- collisional heating is fast (~ 5 keV/s)

→ ALL electrons are accelerated

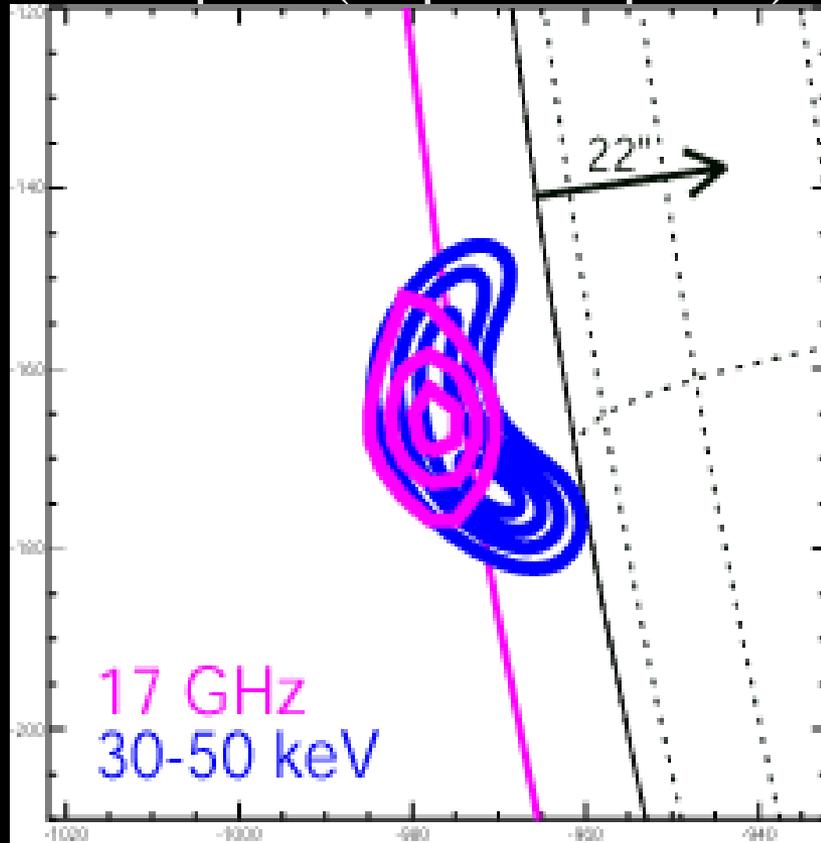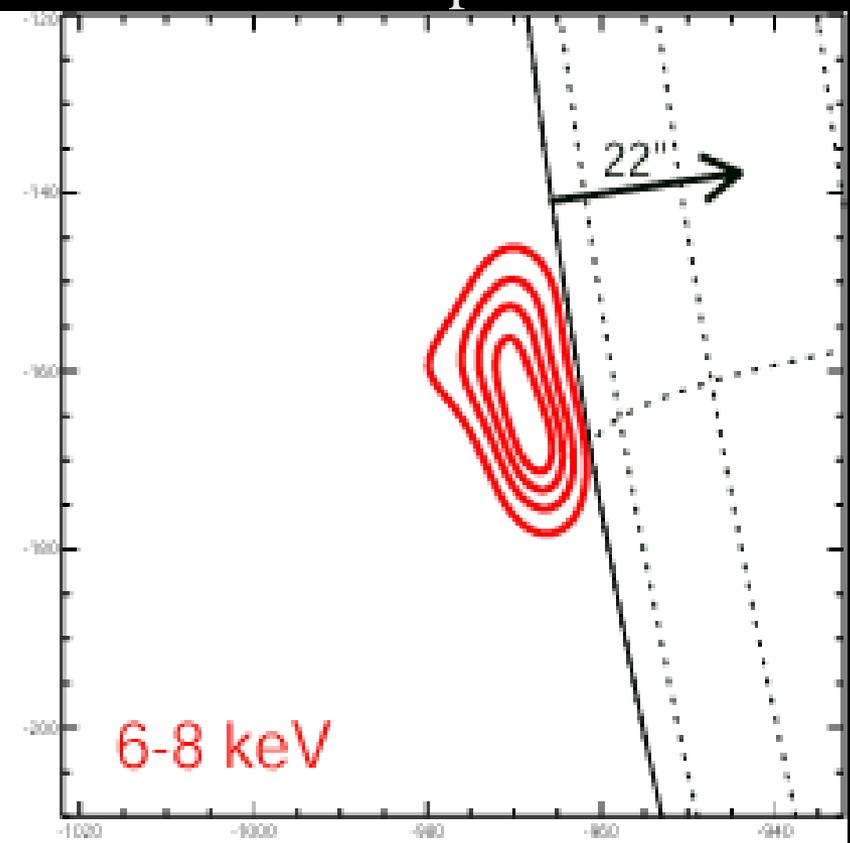# RHESSI and STEREO observations of a partially disk-occulted flare

C8 class flare on December 31, 2007
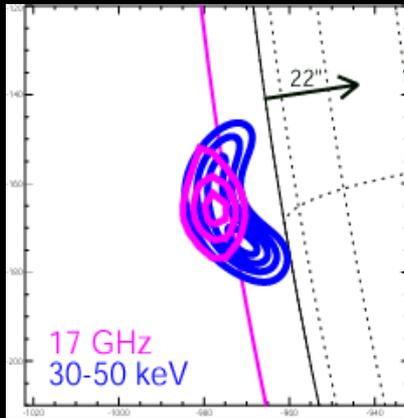
Partially disk-occulted flare of 2007Dec31
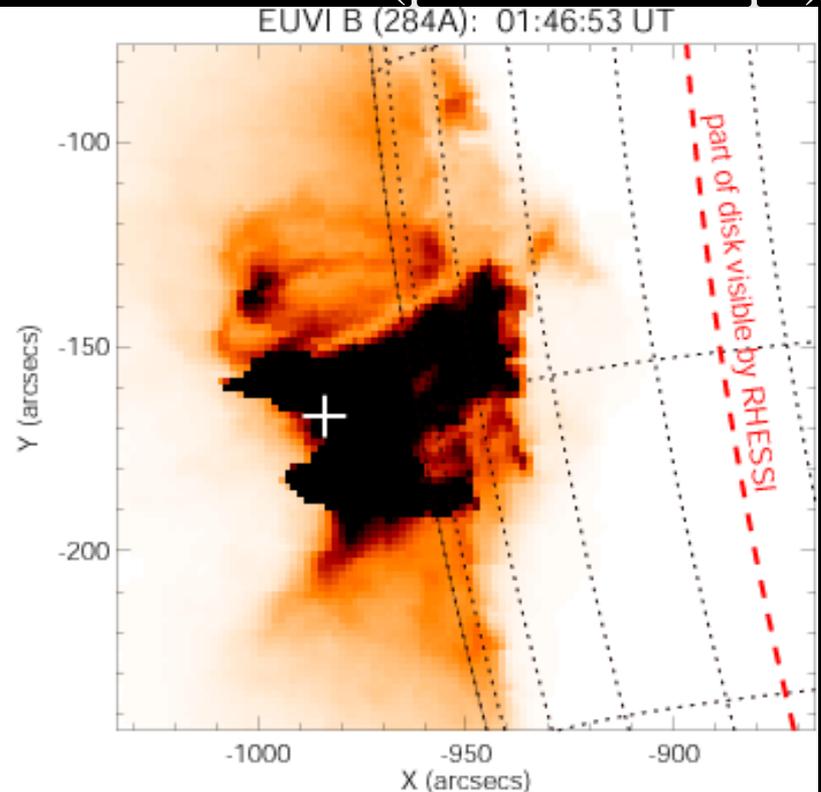
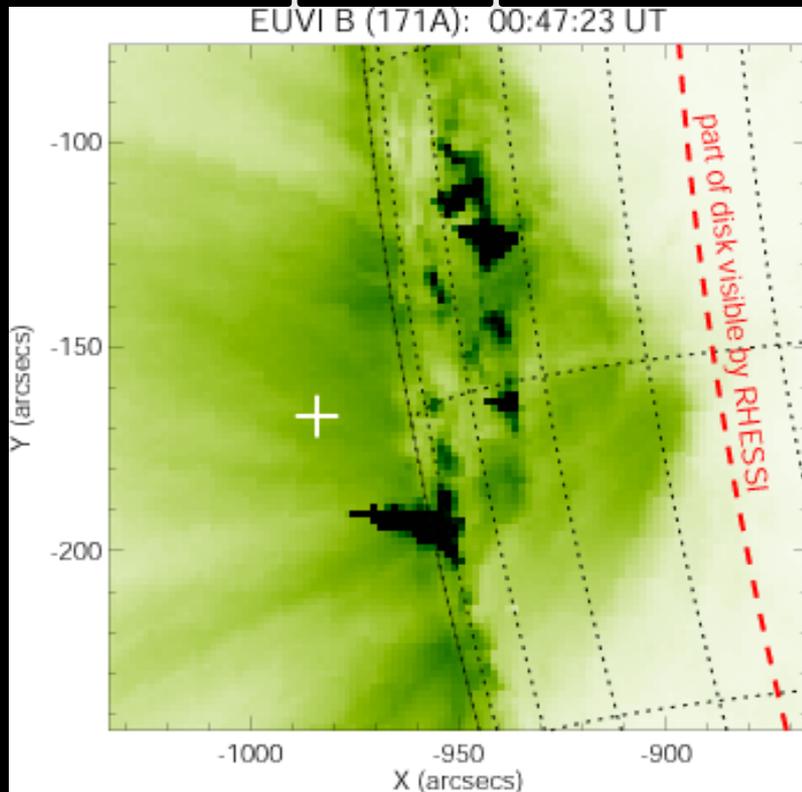microwave limb is higher up, 17 GHz source is co-spatial.

STEREO view shows flare ribbons and post flare loops

above-the-loop-top source could be along the flare arcade
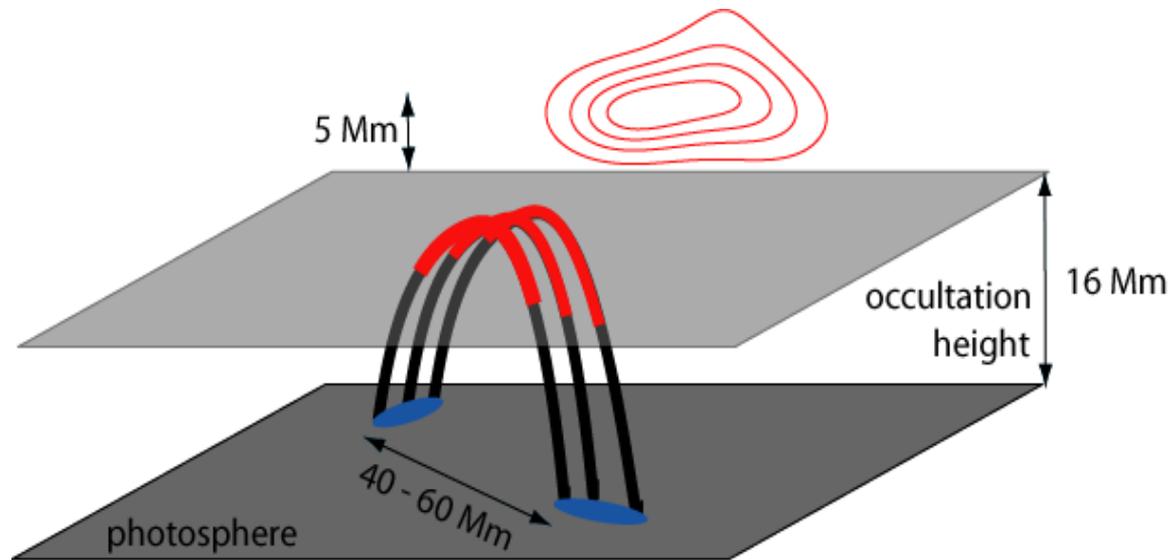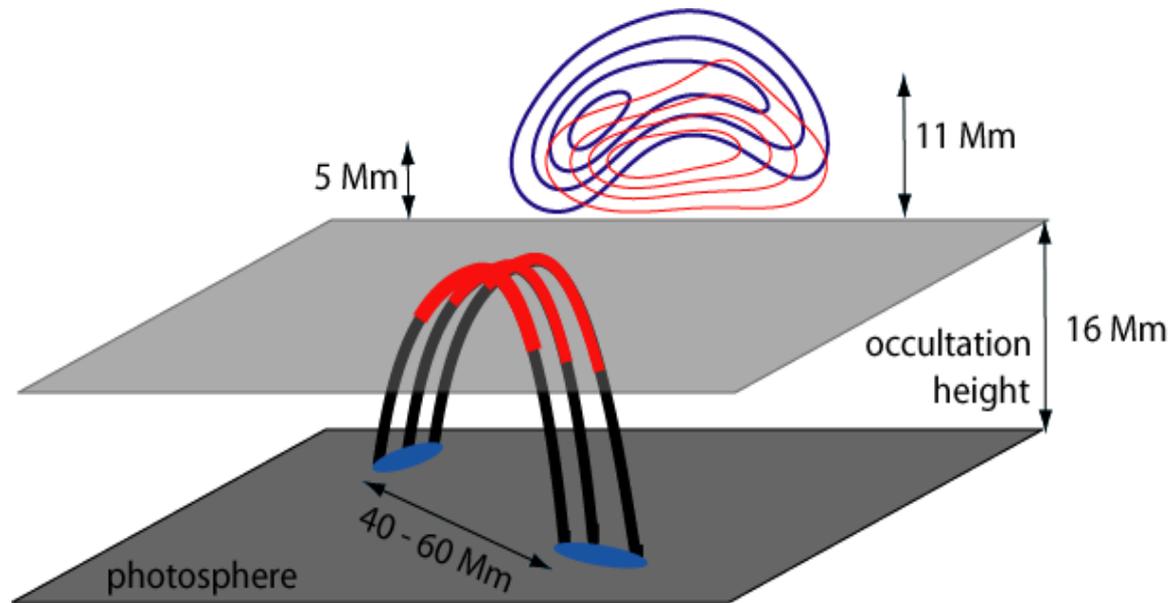

17 GHz
30-50 keV

impulsive phase

1 hour later (post flare loops)

EUVI B (171A): 00:47:23 UT

part of disk visible by RHESSI

EUVI B (284A): 01:46:53 UT
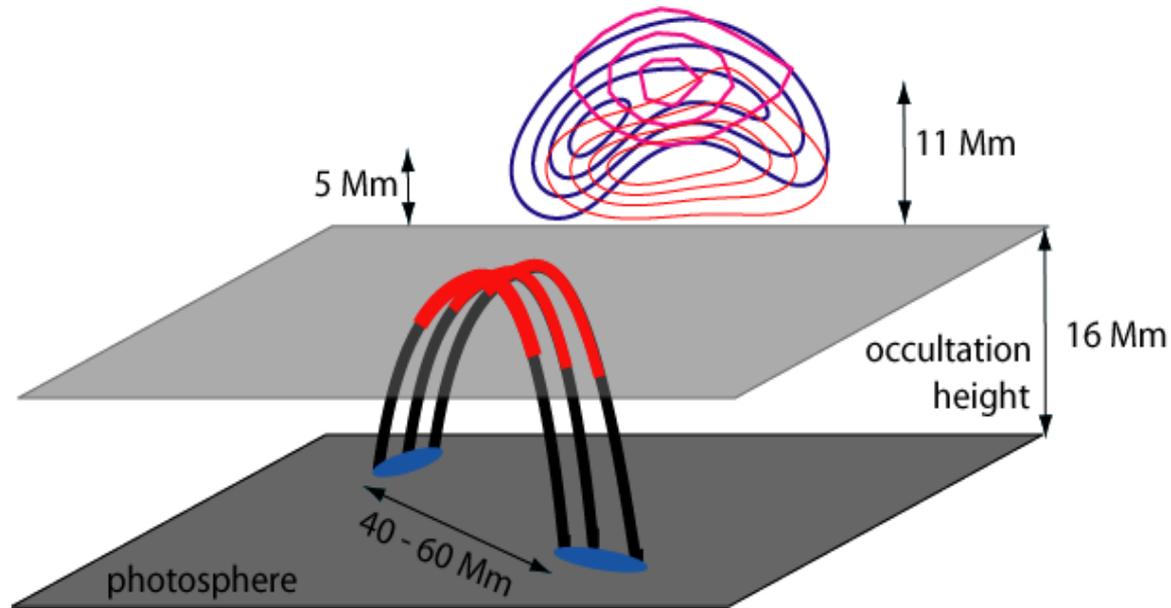
part of disk visible by RHESSI
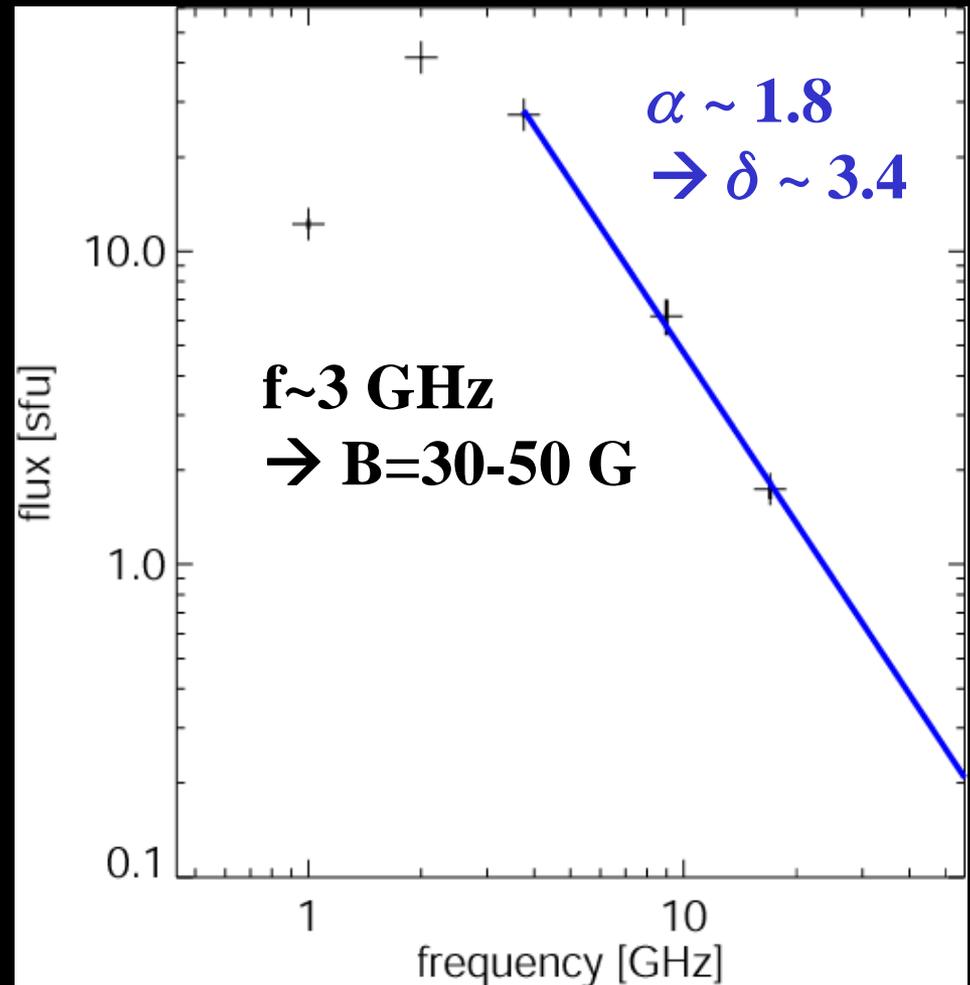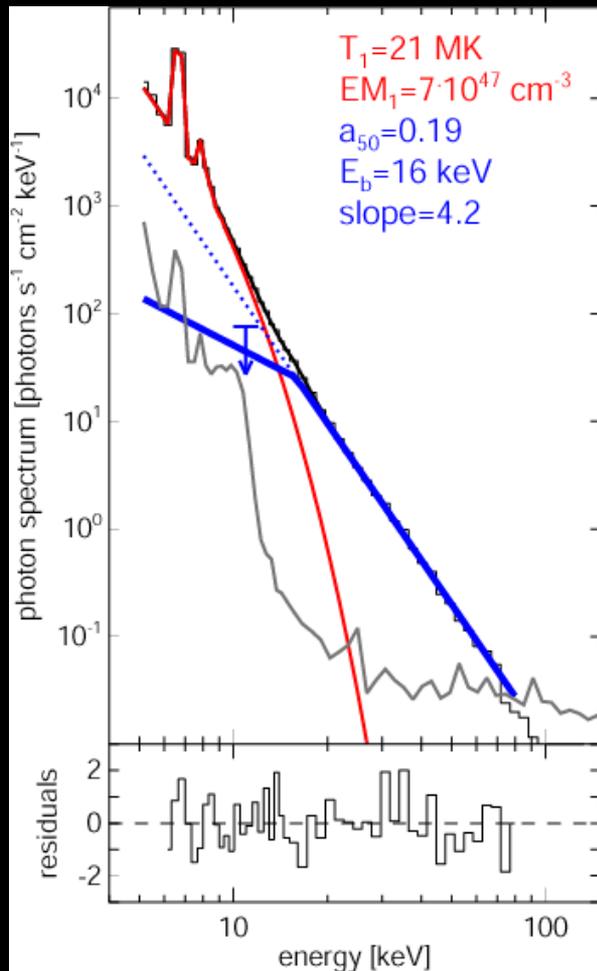
Flare geometry

Flare geometry

Flare geometry

HXR and microwave spectra

Distribution of accelerated electrons are non-thermal;
power-law from ~10 keV up to relativistic range (few MeV)

T_1=21 MK
EM_1=7·10^{47} cm^{-3}
a_{50}=0.19
E_b=16 keV
slope=4.2

$\alpha \sim 1.8$
$\rightarrow \delta \sim 3.4$

f~3 GHz
$\rightarrow$ B=30-50 G

Summary: measured parameters

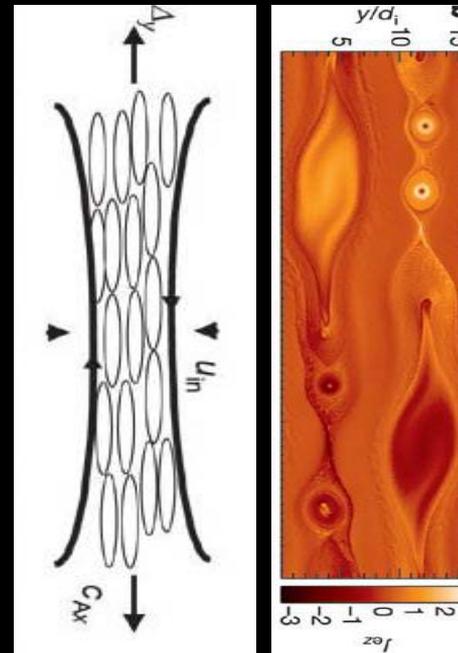|	
pre-flare density	$\sim 2{\cdot}10^9$ cm^{-3}
volume	$\sim 8{\cdot}10^{26}$ cm^3
magnetic field strength B	$\sim$ 30-50 G
pre-flare β (T=2 MK)	$\sim$ 0.01
acc. electron density	$\sim 2{\cdot}10^9$ cm^{-3}
power law distribution with δ	$\sim$ 3.4
from ~15 keV up to a few MeV	
β during HXR burst	$\sim$ 1

$\rightarrow$ energy density of the accelerated electrons is comparable to that of the magnetic field

ions?

Discussion of models
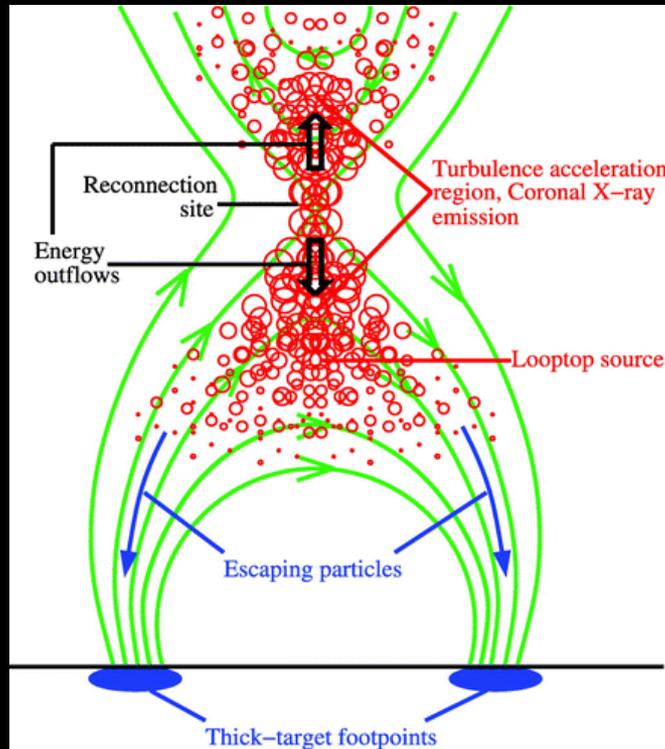
turbulence
(e.g. Liu et al. 2007)

Contracting islands
(Drake et al. 2006)

time evolution given by acceleration and release process.

Conclusions

- above-the-loop-top source itself is the acceleration region

- ALL electrons are accelerated (non-thermal distribution)

- plasma beta $\beta \sim 1$