

SOL2014-02-25

An amazing gamma-ray and white-light event

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²FHNW, CH

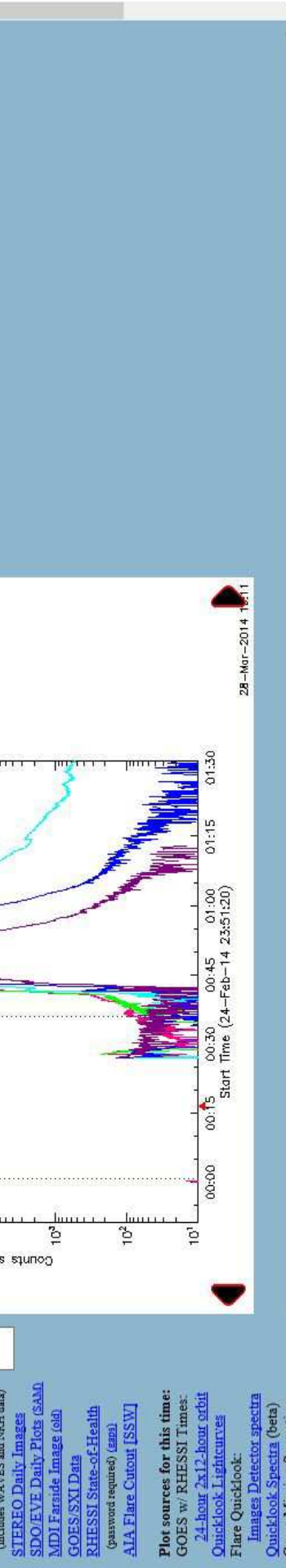
18th RHESSI Workshop, WG 2
Graz, 26-30 July 2016



“The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 606862 (F-CHROMA)”



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NEW PLOTS: We now include the new set of flare-based cross-mission plots from Ryan Milligan's Solar Flare Finder tool, also available via SSW/IDL. Check out "w/

SOL2014-02-25T00:49:53

X5.0 (data, not NOAA list)

Fermi/GBM (NaI, BGO)

Fermi/LAT

RHESSI

NoRP/NoRH/RSTN

SDO

EVE MEGS-A

STEREO-B

Microwaves:

Optically thick spectrum

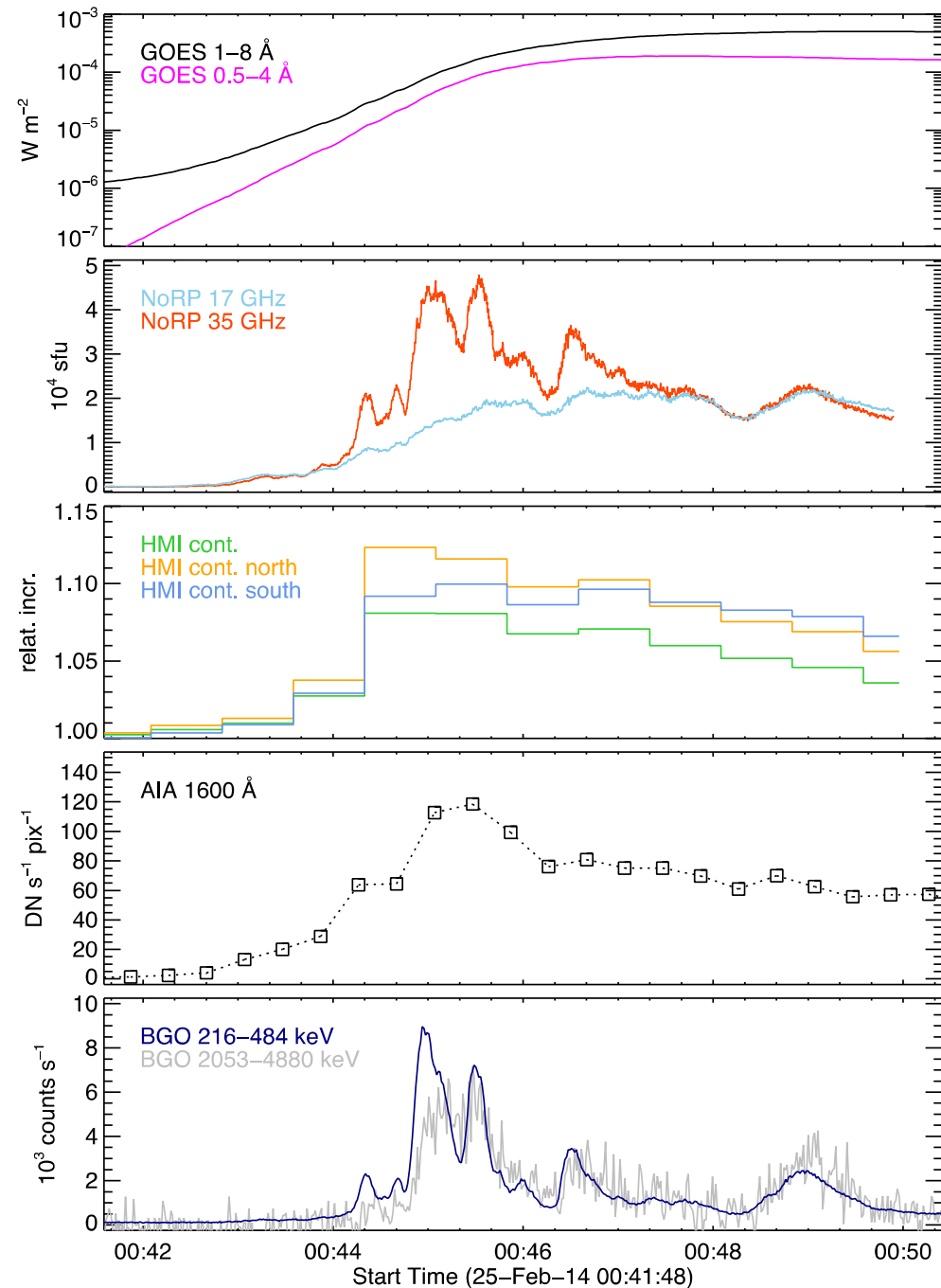
$F > 40,000$ sfu

Indicate very strong B field

and/or high density of MeV electrons

35 GHz is possibly thin enough

No 80 GHz!! (only very early phases)

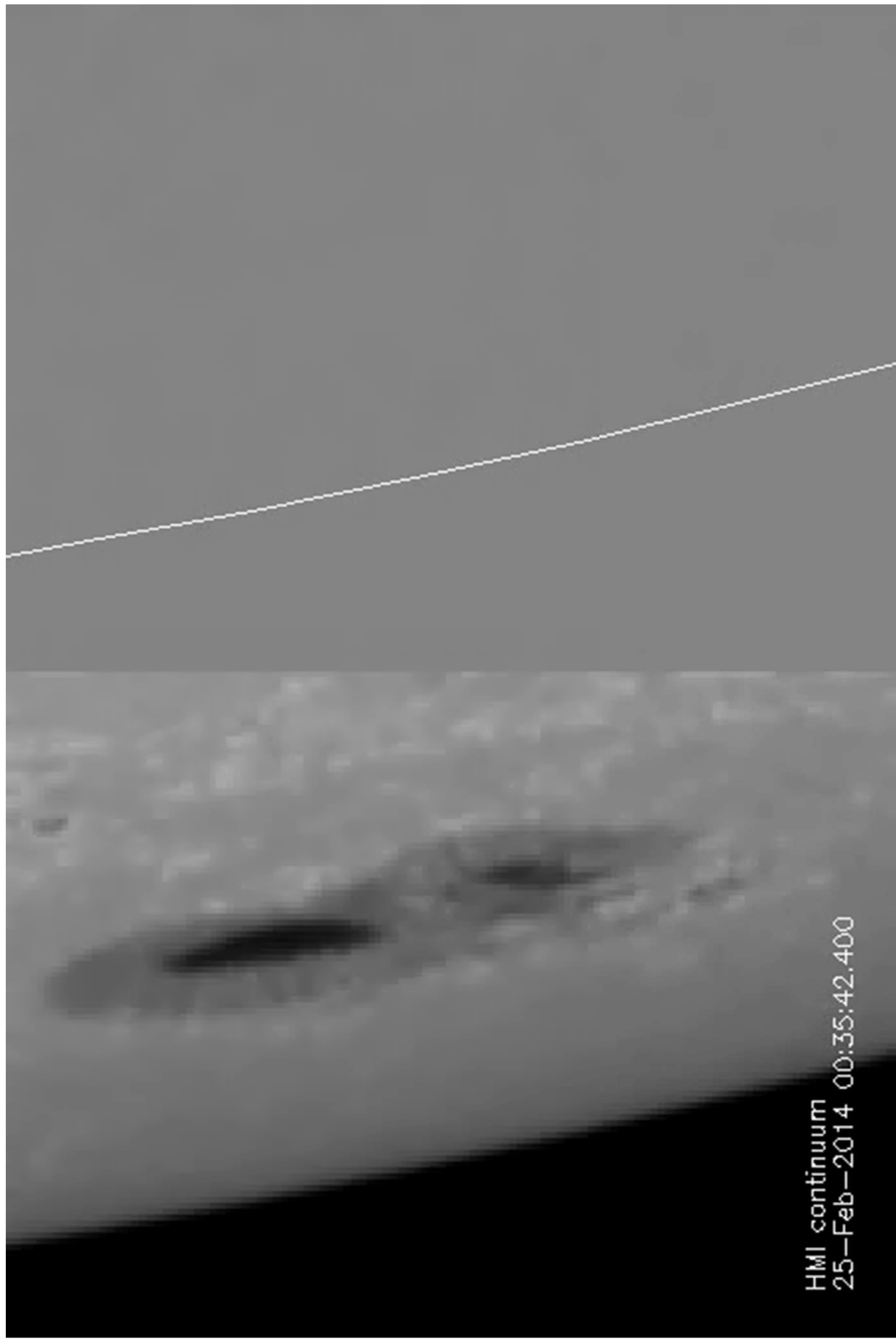


SDO AIA_4 304 25-Feb-2014 00:35:07.120 UT

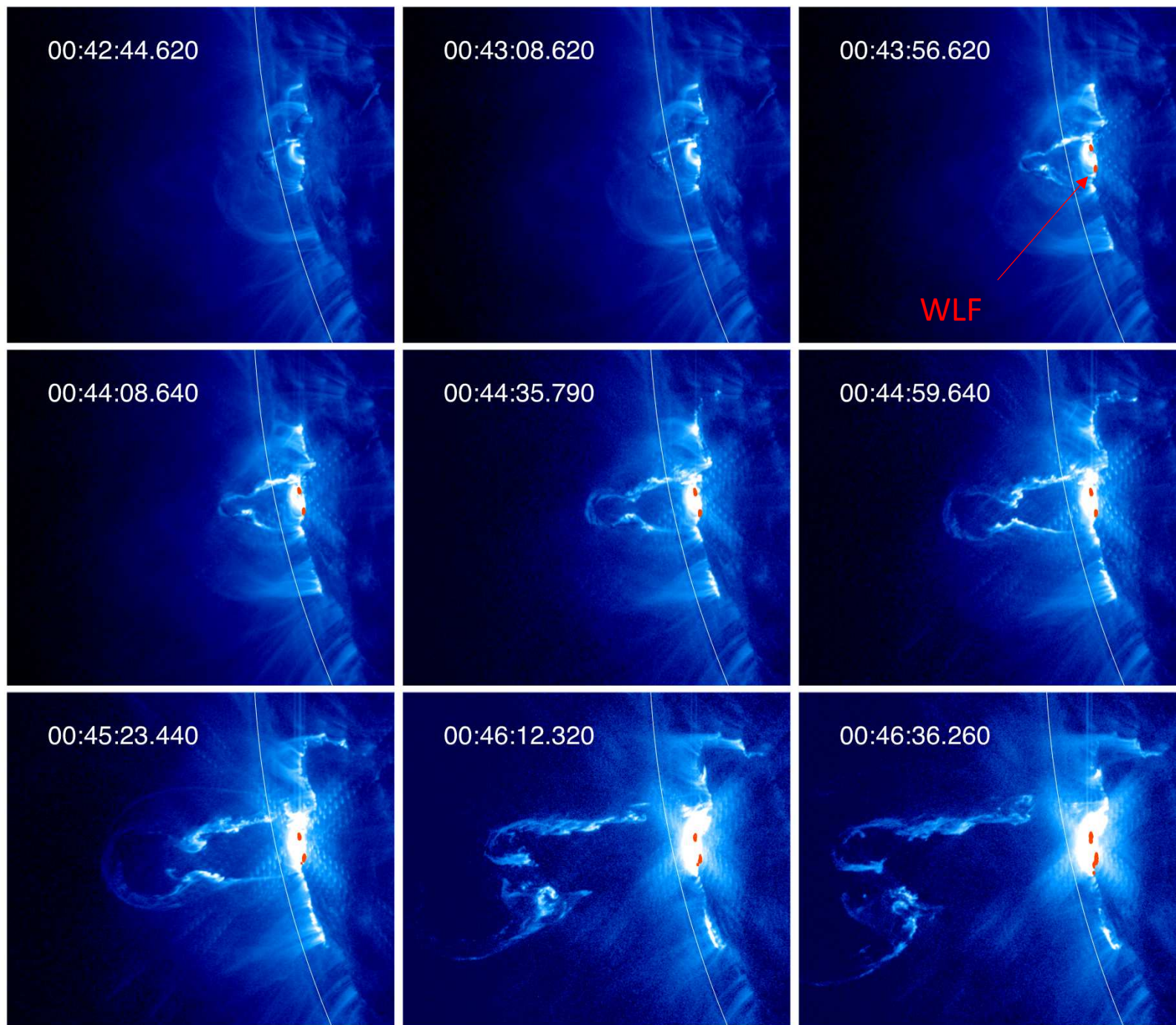


-100

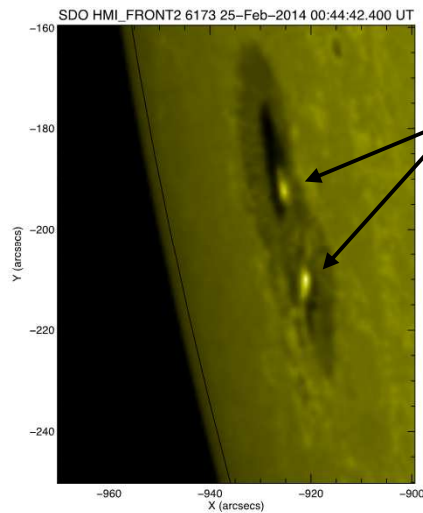
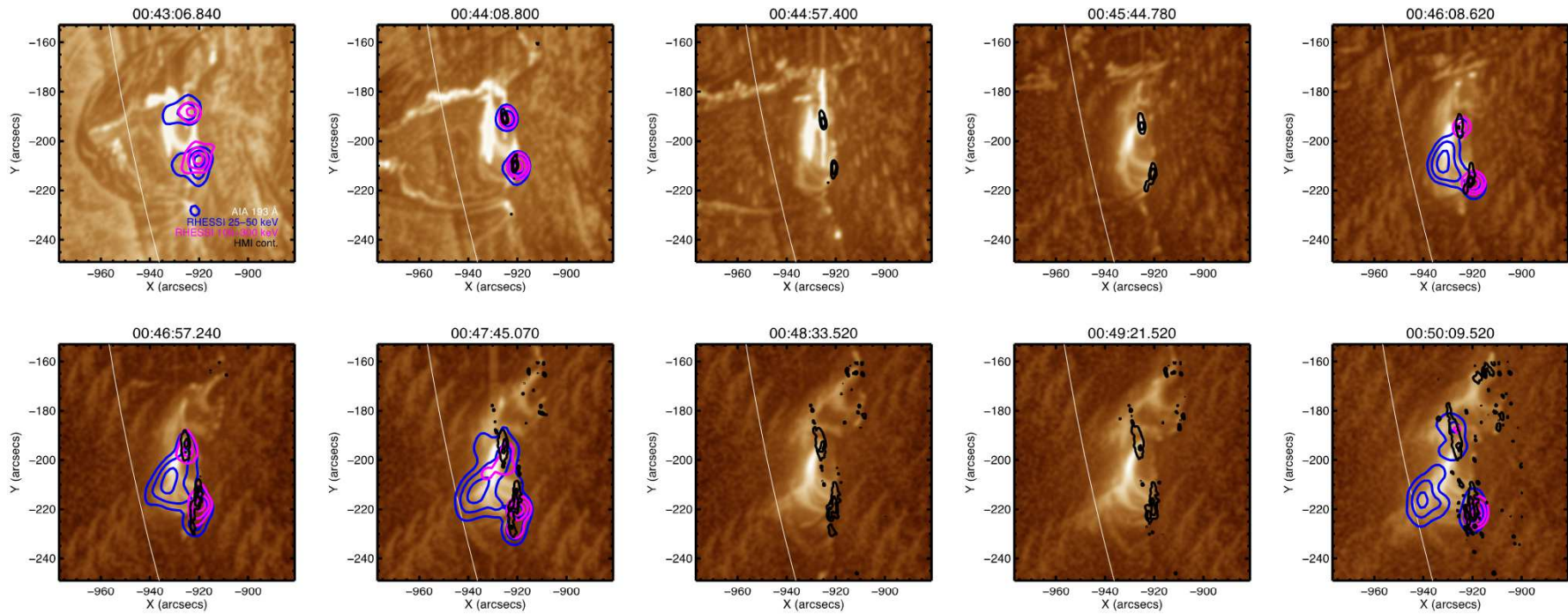




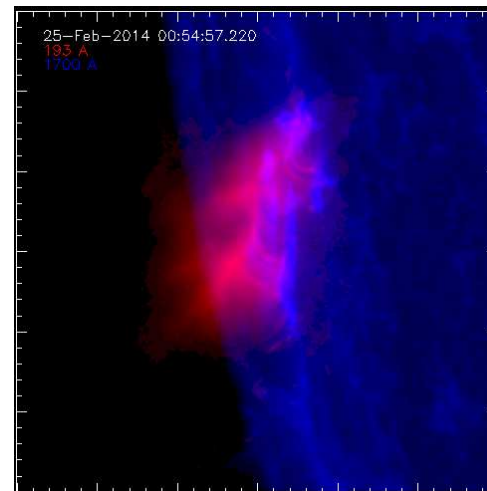
HMI continuum
25-Feb-2014 00:35:42.400



HXR and WL



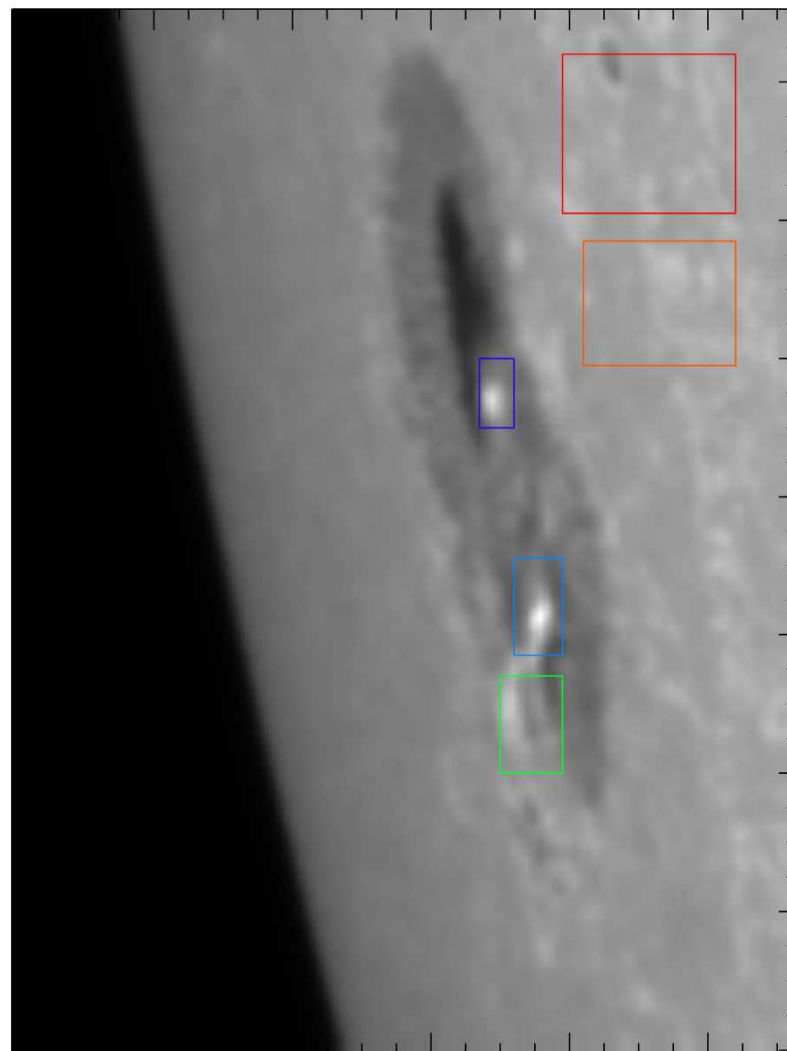
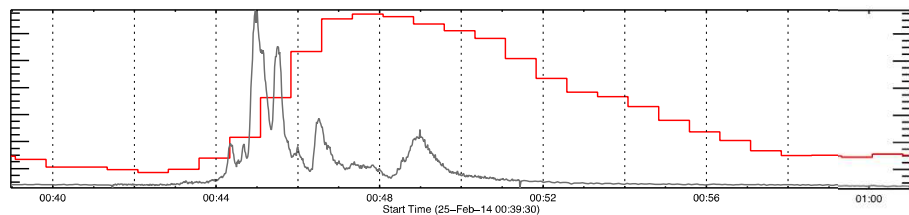
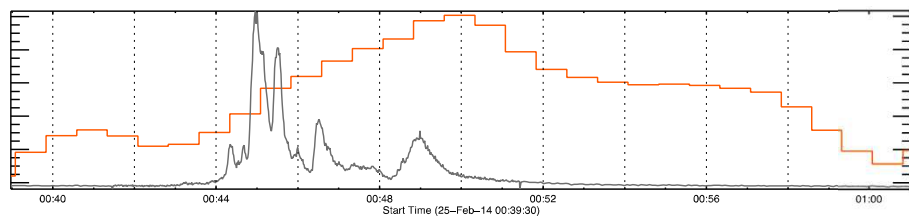
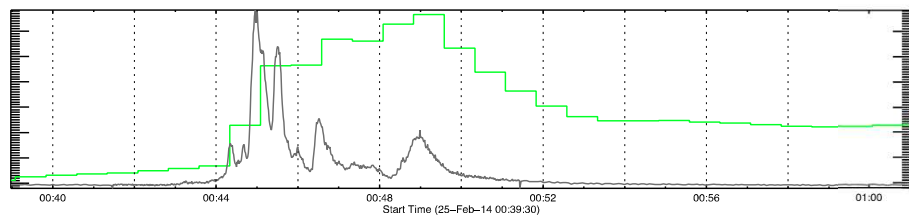
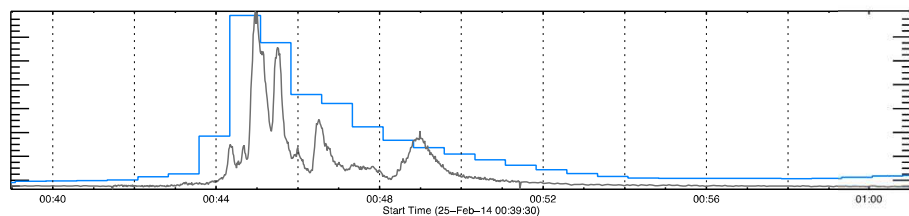
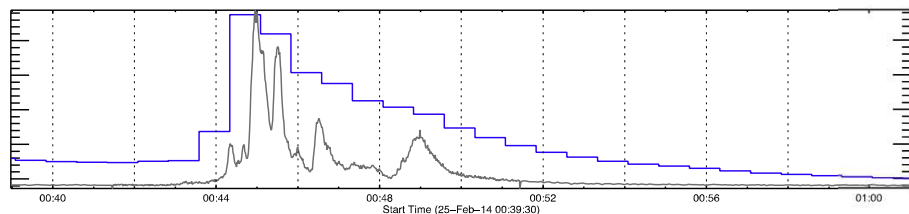
HMI cont. flare visible without applying running differences.



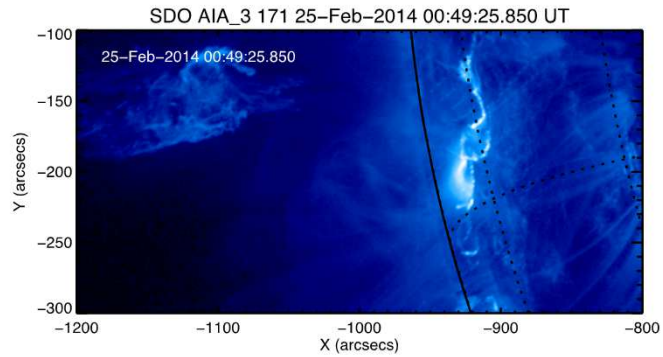
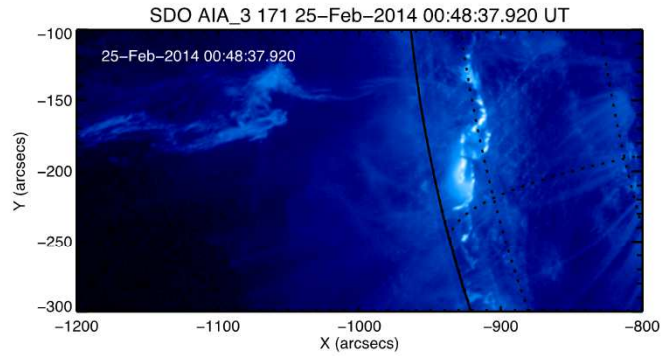
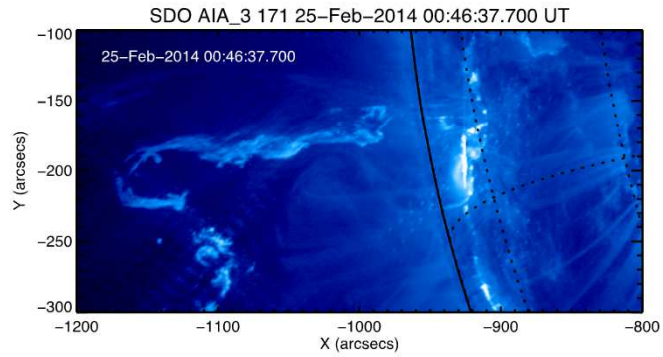
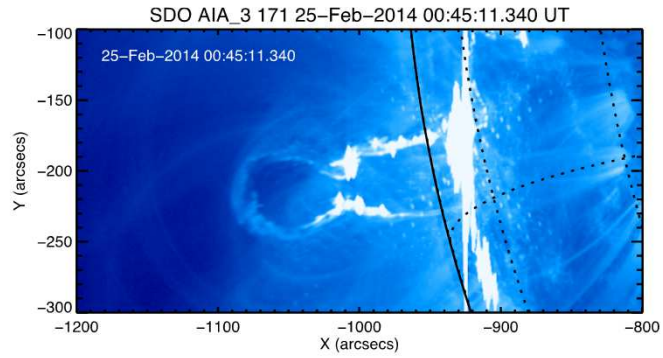
HMI cont.
HXR 25-50 keV
HXR 100-300 keV

Postflare: two sets of ribbons+arcades

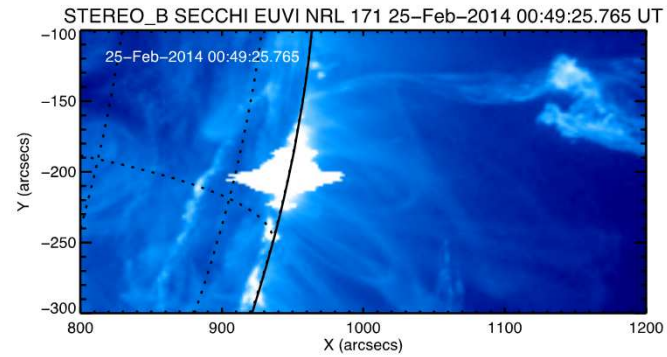
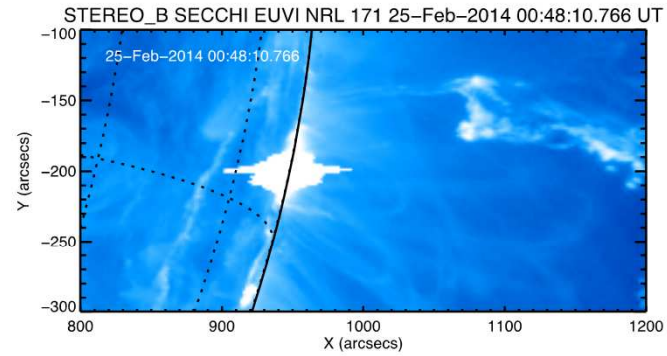
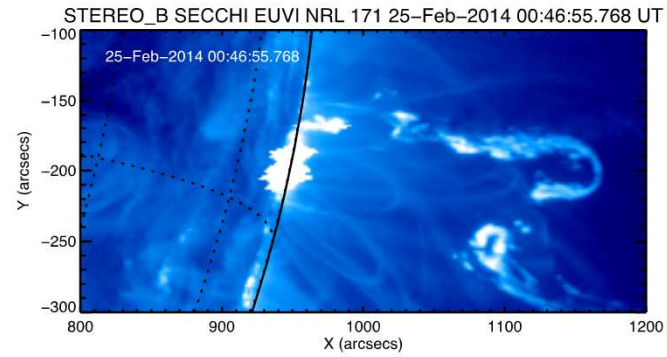
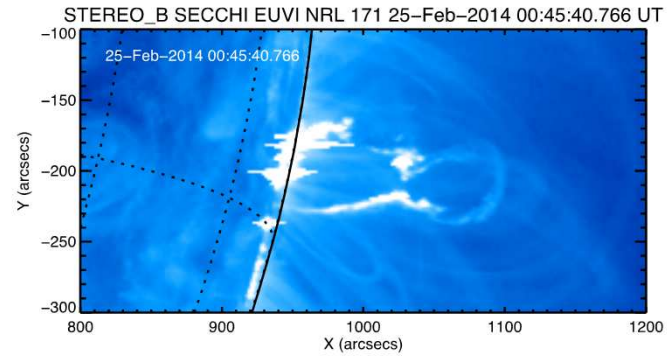
WL: isolating different sources



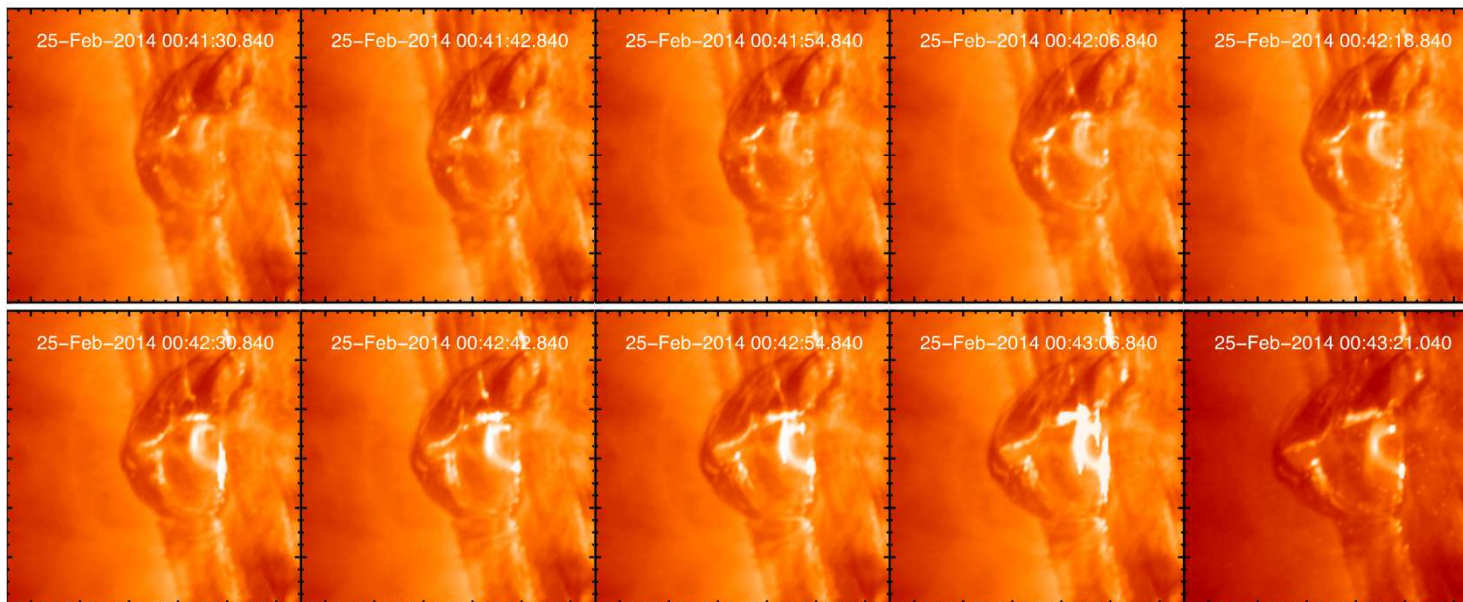
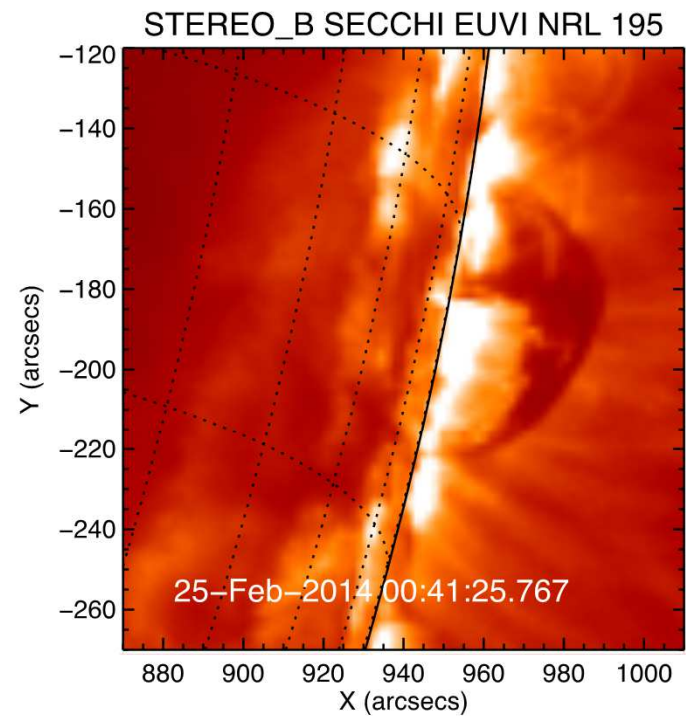
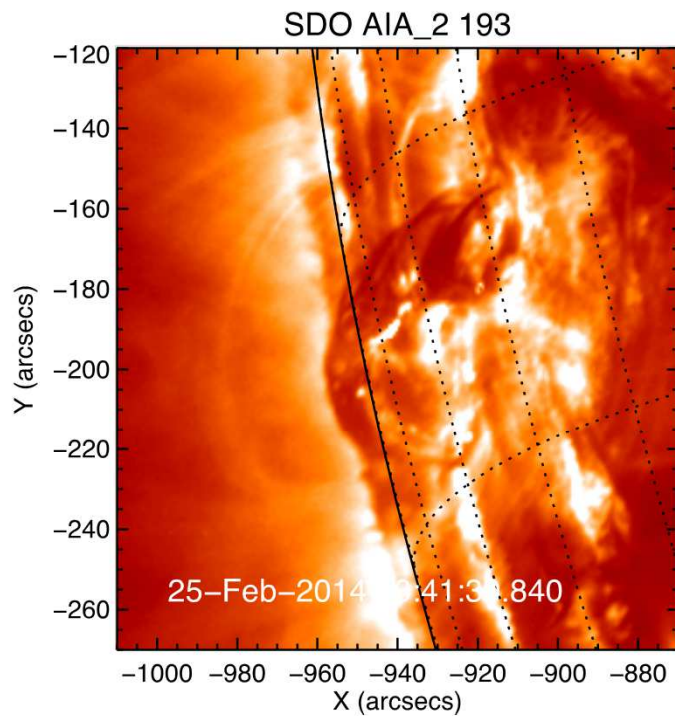
AIA



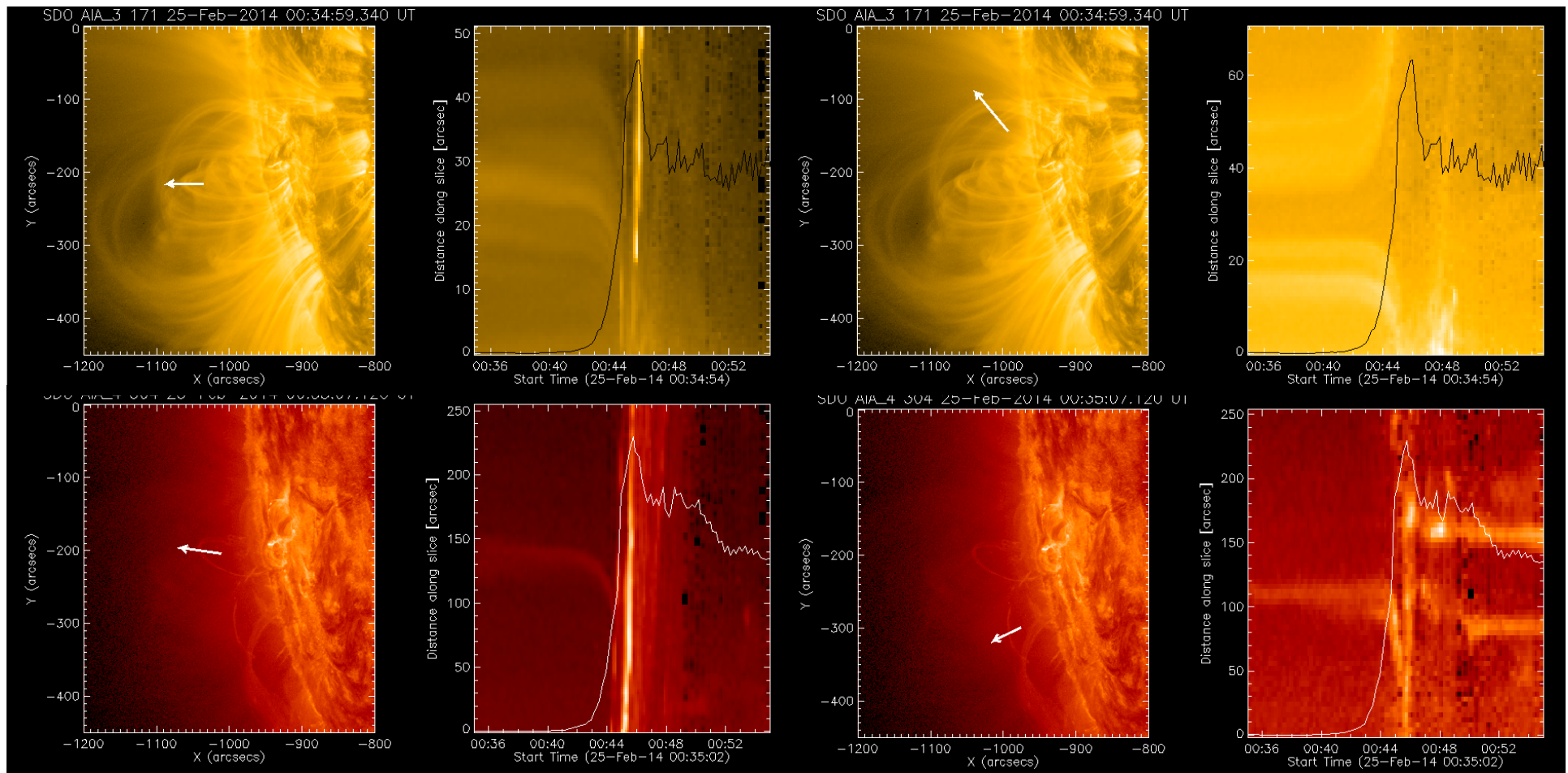
STEREO B



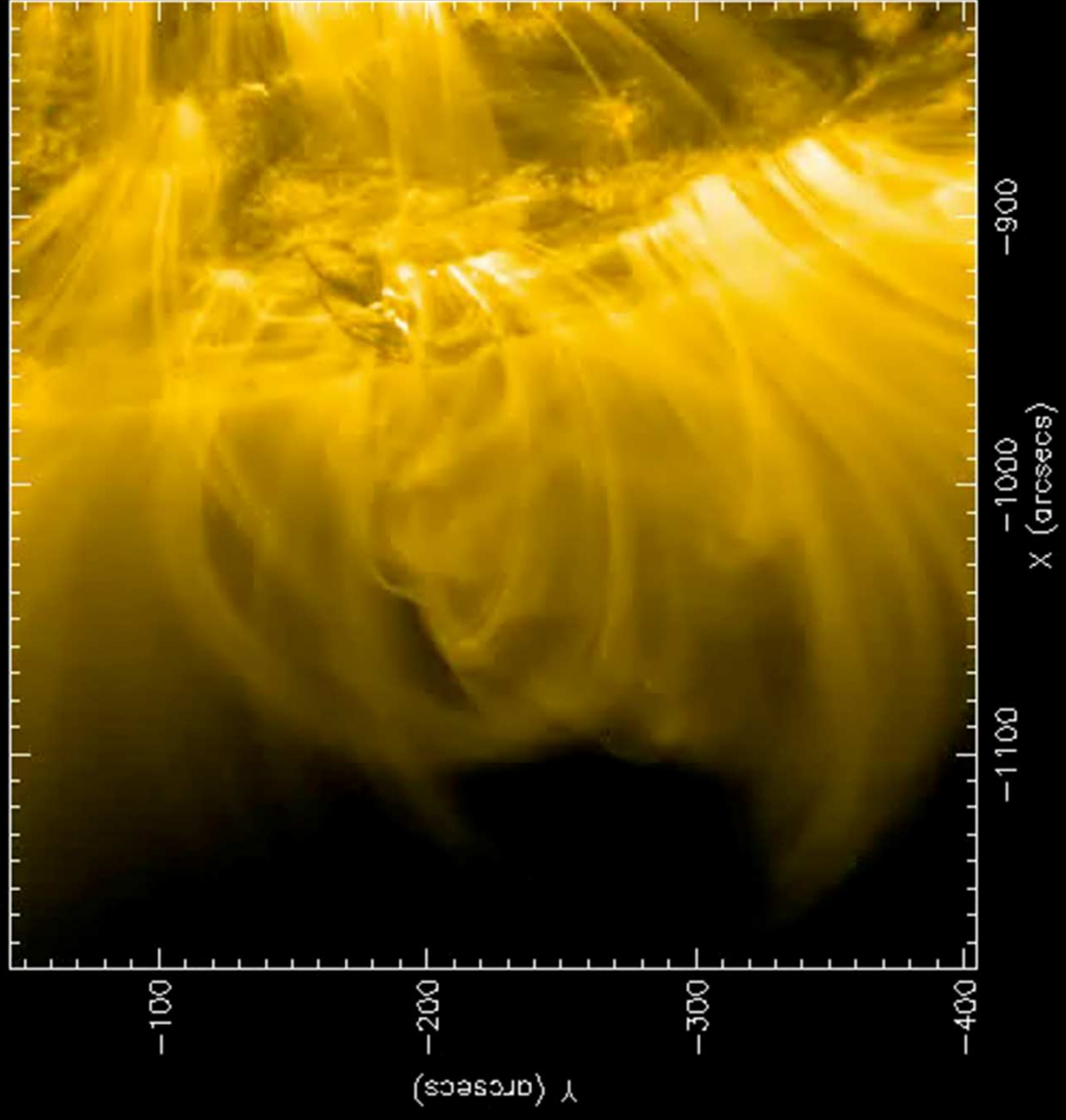
Initial rise and
Writhe of the
filament



Implosion: contraction of many loops “around” the flaring core.
(e.g. Hudson 2000, Simões et al. 2013)



SDO AIA_3 171 25-Feb-2014 00:41:11.340 UT



SOL2014-02-25T00:49:53

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Fermi/LAT

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Optically thick spectrum

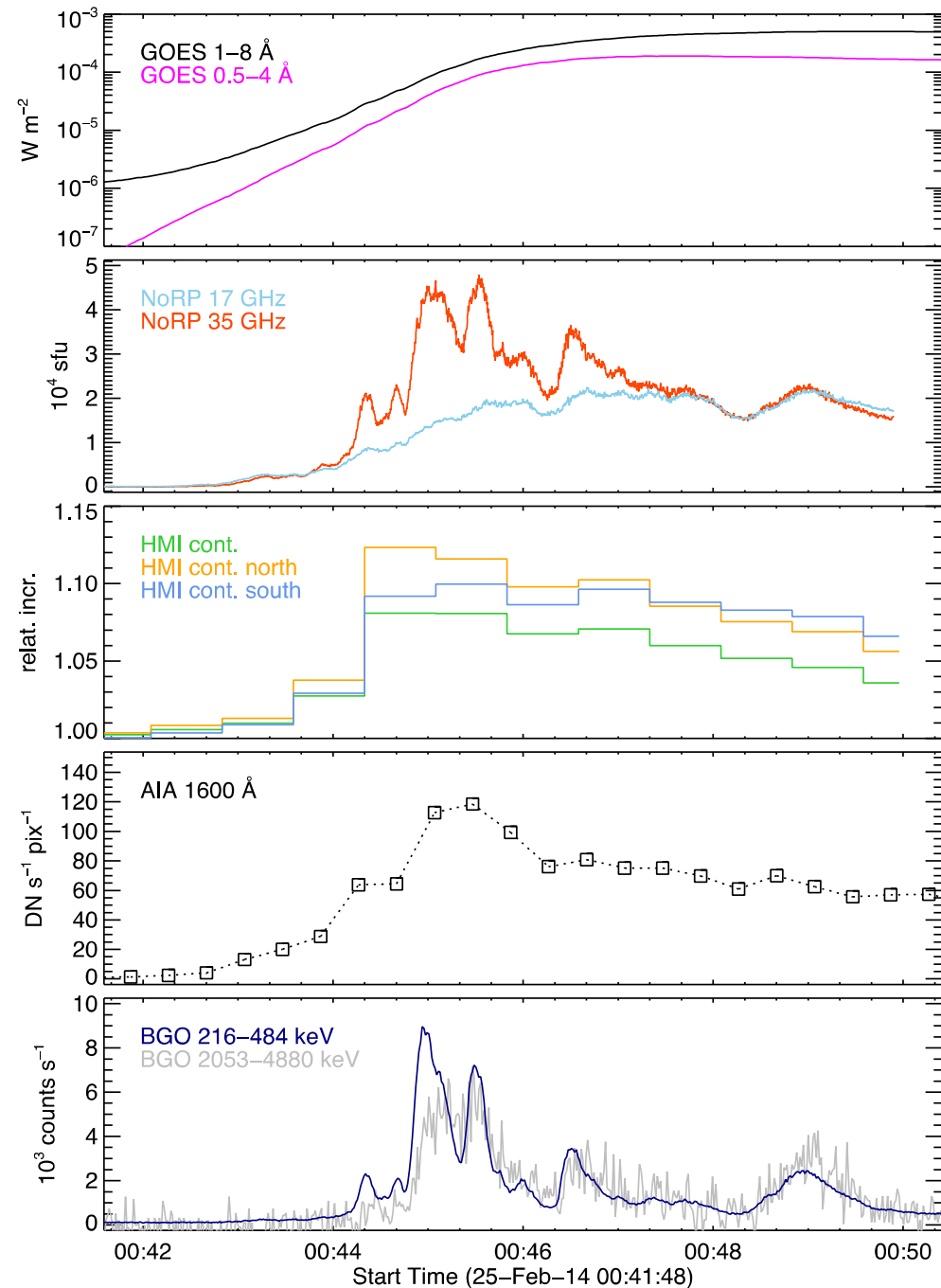
$F > 40,000$ sfu

Indicate very strong B field

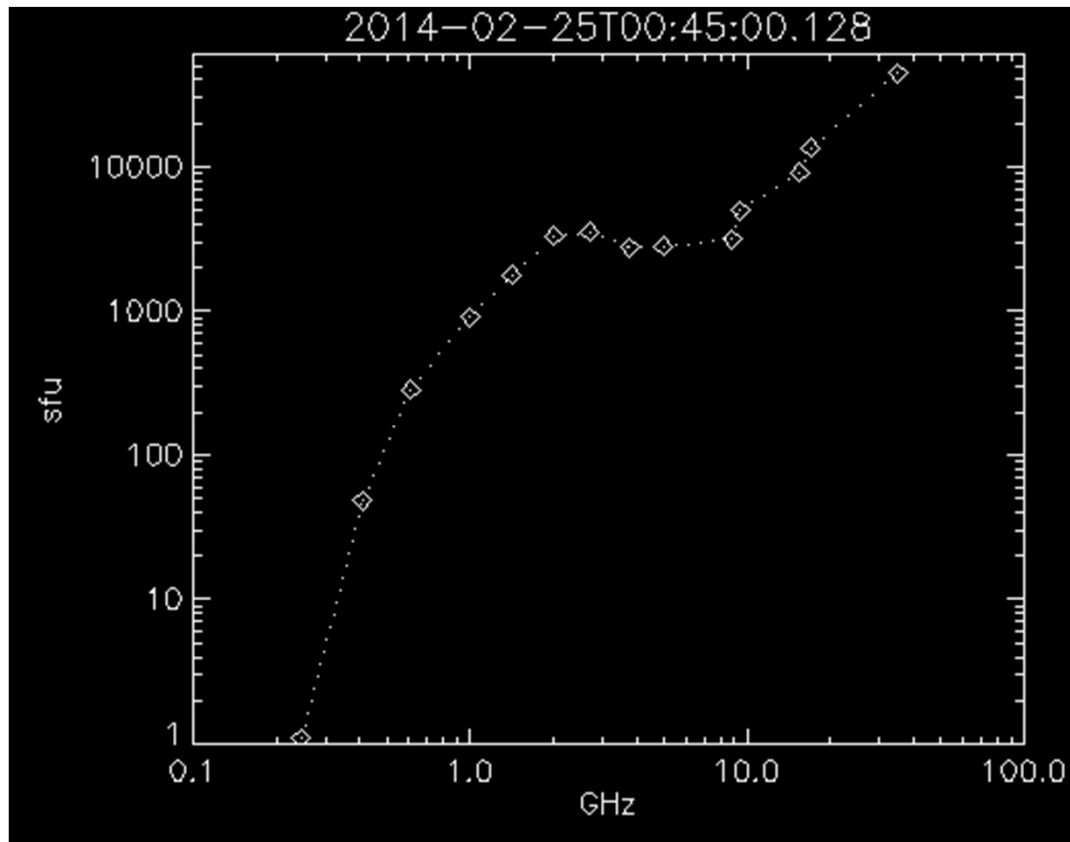
and/or high density of MeV electrons

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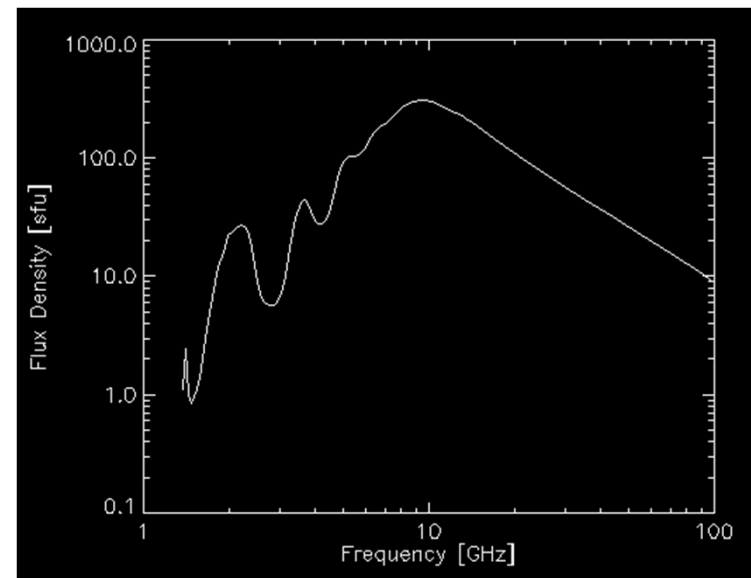
No 80 GHz!! (only very early phases)



Observed radio spectrum at flare peak (NoRP+RSTN)



A theoretical gyrosynchrotron spectrum

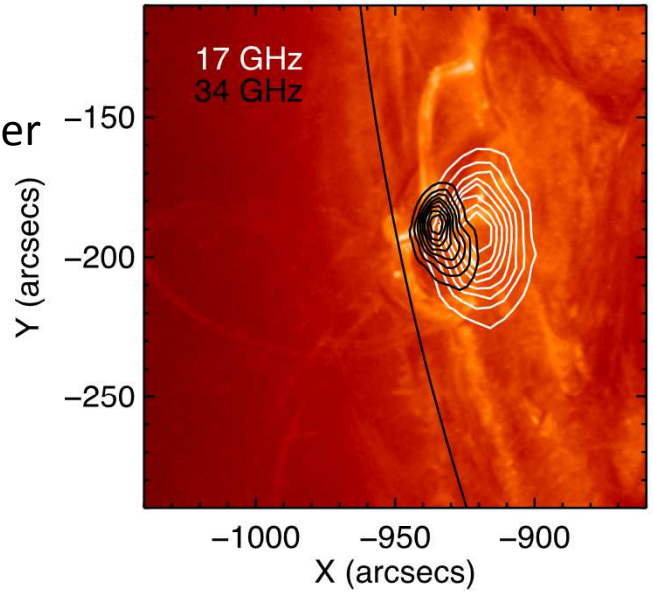


Nobeyama
Radio interferometer
maps

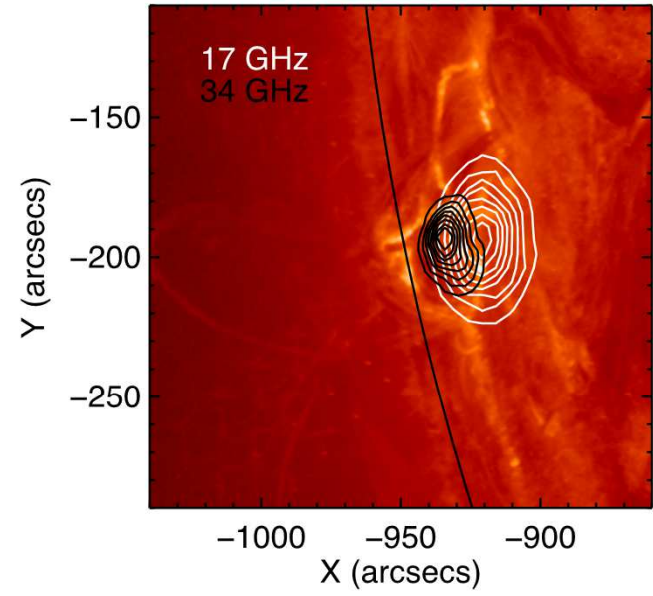
Maybe ok up
to ~00:44UT

34 GHz source
higher
than 17 GHz?
not sure yet:
Maybe problem
with imaging
algorithm

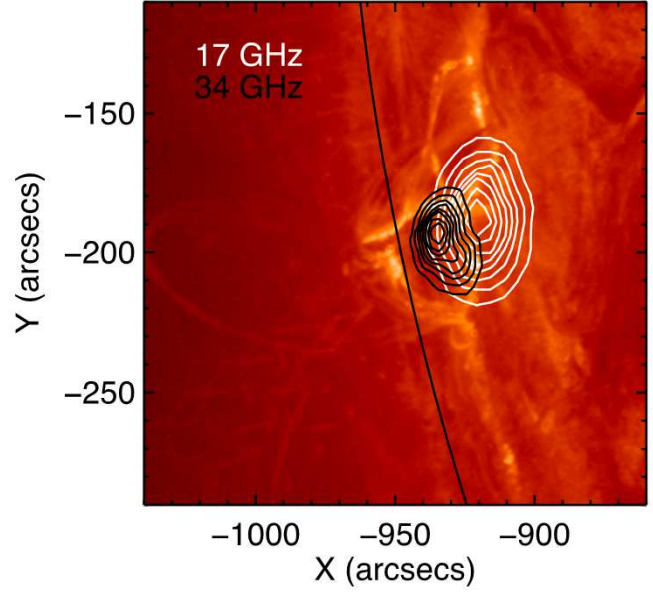
00:41:43.776



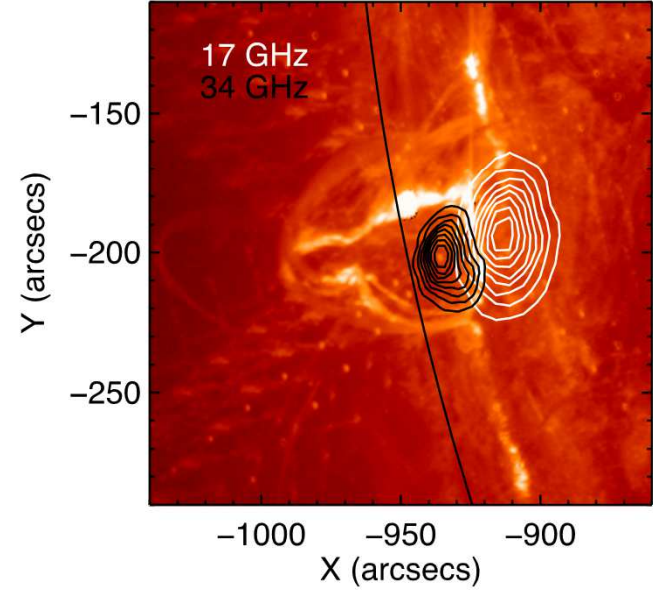
00:42:33.776



00:42:58.776



00:43:49.776



Gamma-rays
Fermi/BGO

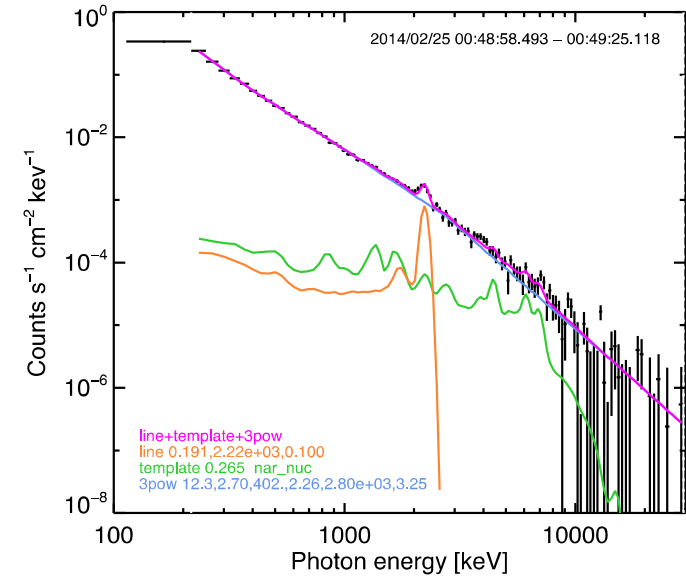
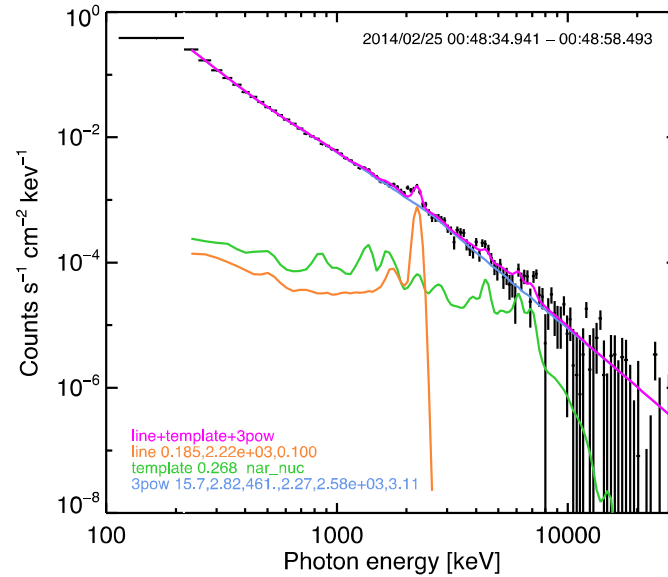
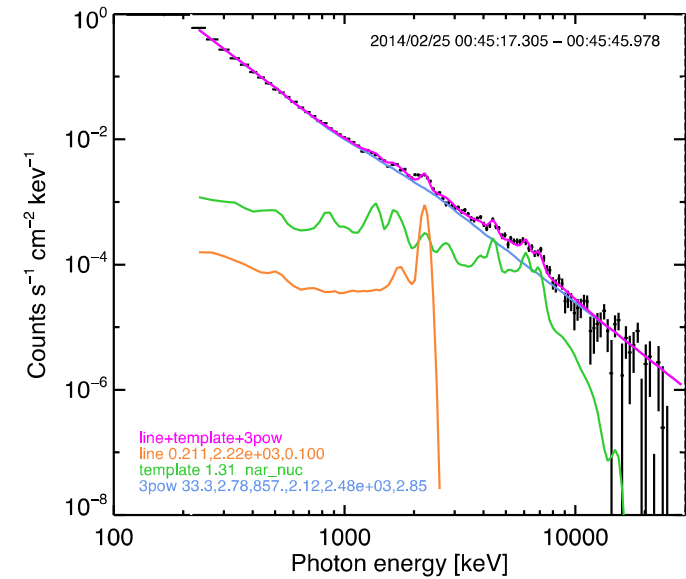
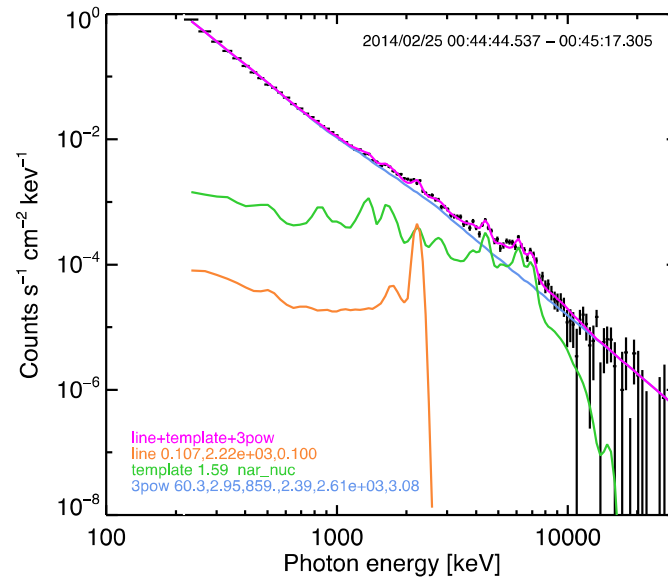
Time evolution
of 2.2MeV line
and nuclear lines

Experimenting
different time
integration times

Maybe possible
to isolate individual
lines (4.4, 6.3, etc.)

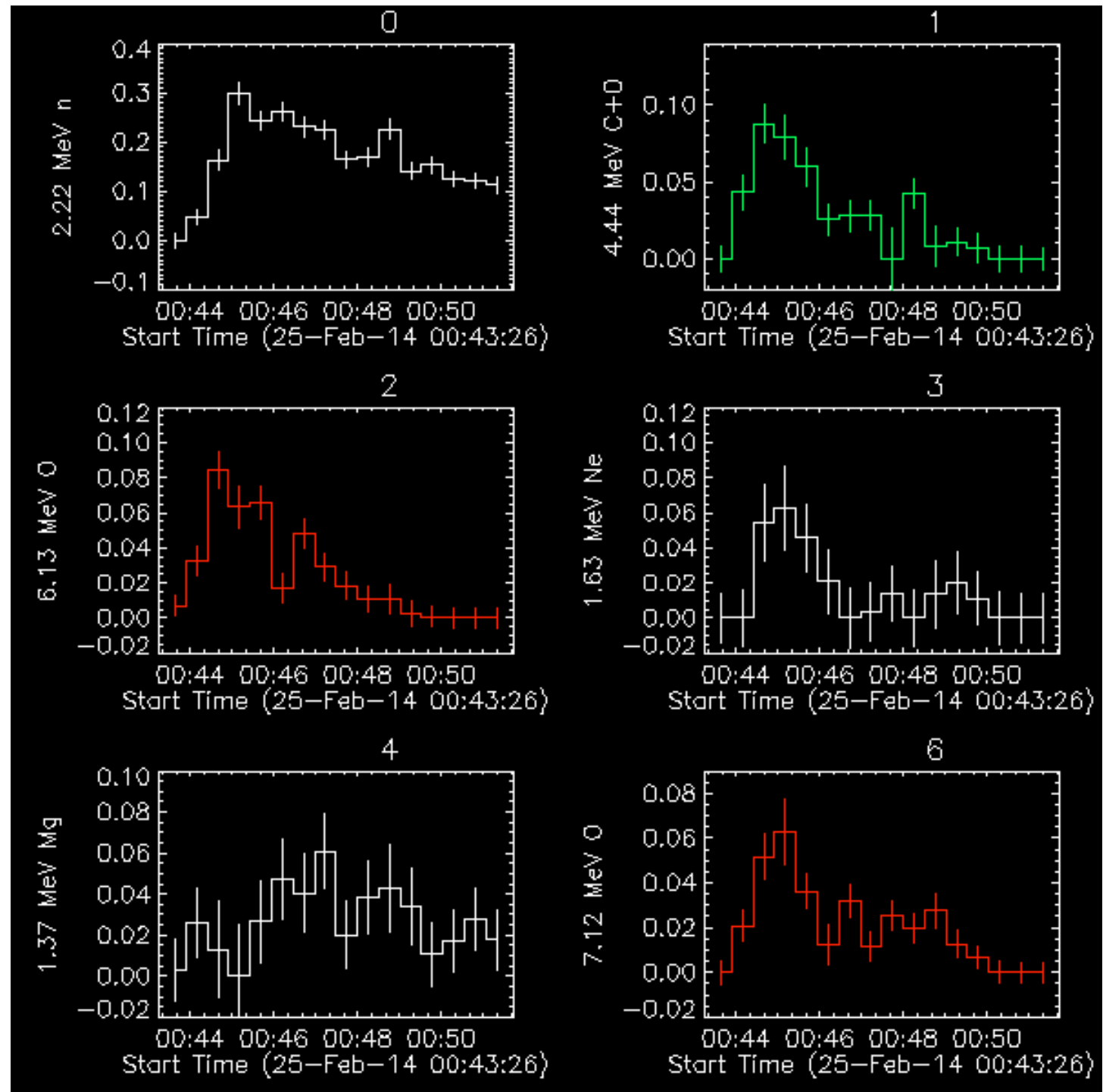
These spectra:
fitted with template
of narrow lines

Lack of the 511 keV
line

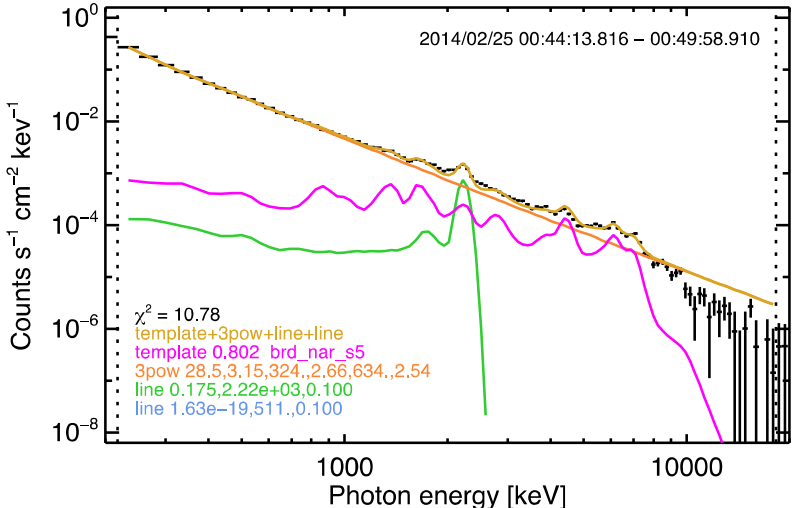
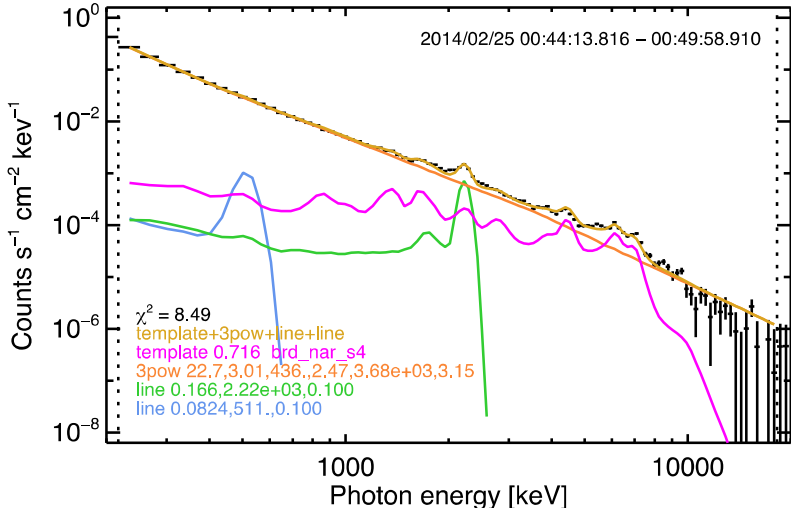
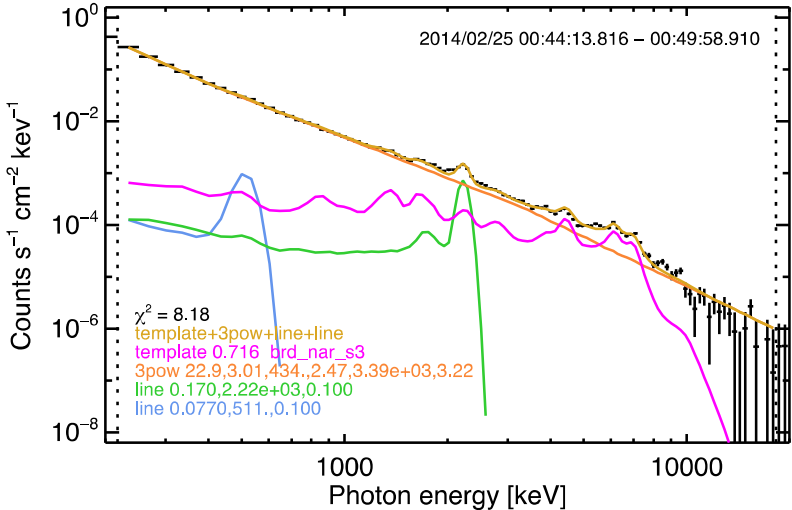
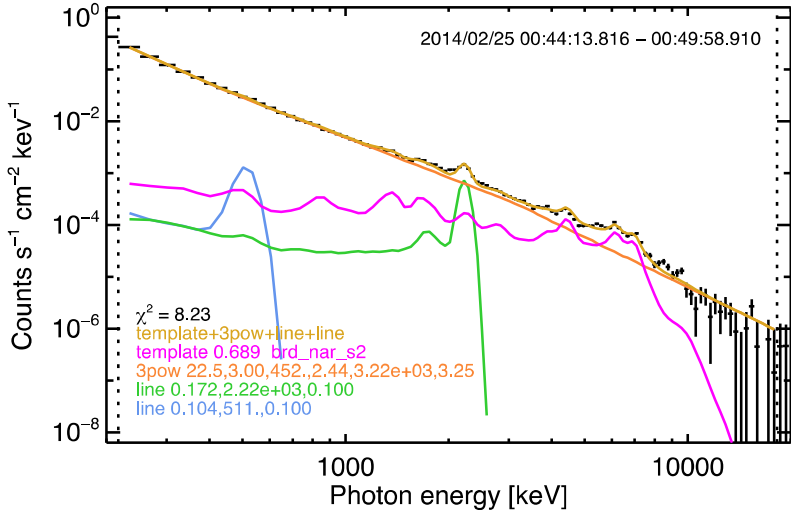


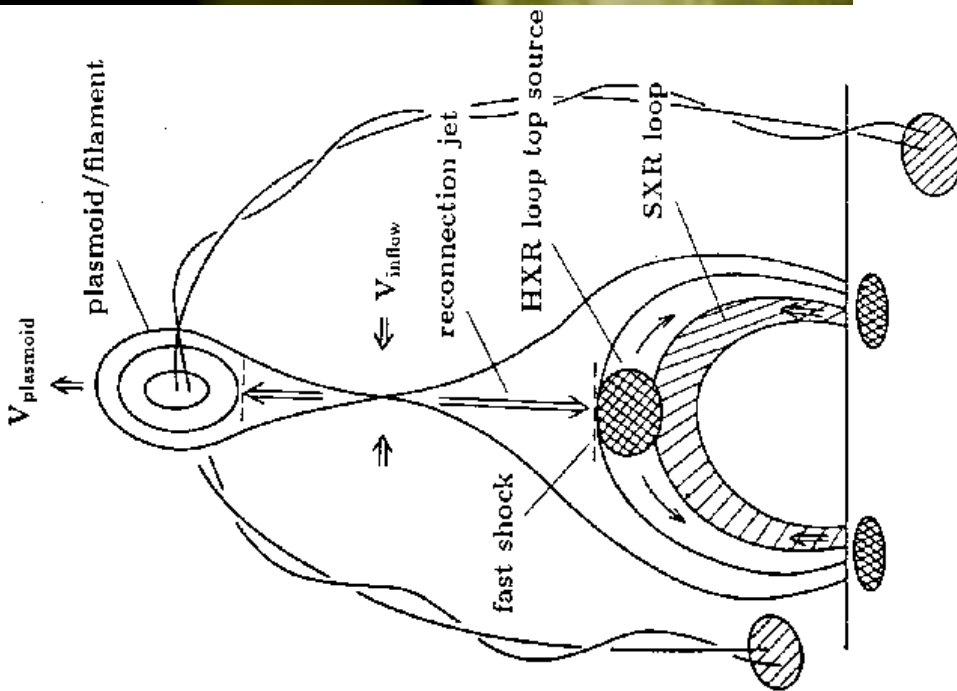
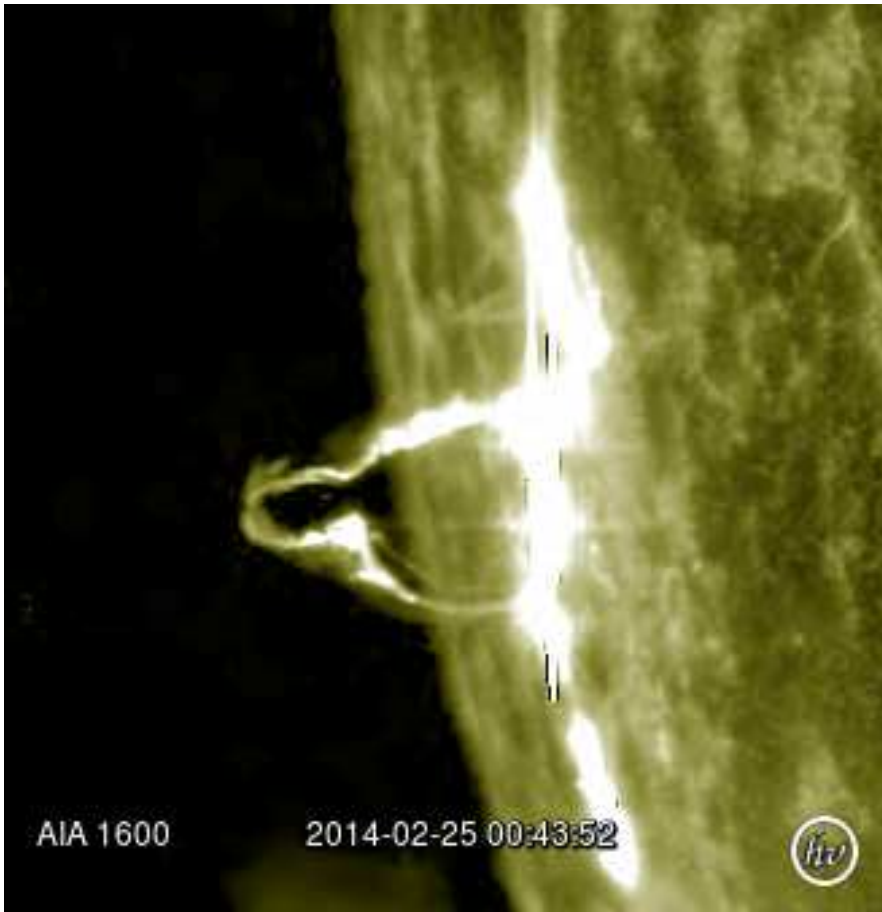
Preliminary
tentative
fitting
results
to isolate
the nuclear lines

Triple power-law
Plus
Gaussian lines



Investigating spectrum of ions:
 Using different templates (varying ion spectral index) (thanks to Ron Murphy)





Conclusions

- SOL2014-02-25 was a remarkable, intense gamma-ray flare
- Well observed in many wavelength ranges by many leading edge instruments
- Looks like classic (“Shibata”) eruptive event
- Locate gamma-ray burst and ion acceleration in context of well-developed flare model

Fermi/BGO X-class flares in 2011-2014

2011-08-09 08:00 UT

2011-09-06 22:00 UT (NoRH)

2011-09-07 22:40 UT (NoRH)

2011-09-24 09:30 UT

2012-10-23 03:15 UT (NoRH)

2013-05-13 16:00 UT

2013-05-14 01:00 UT (NoRH)

2013-10-28 02:00 UT (NoRH)

2013-11-19 10:15 UT

2014-02-24 00:45 UT (NoRH) event presented here

2014-06-10 12:45 UT

2014-06-11 09:10 UT

(times are approximate)

12 out of 34 X-flares in the period 2011- June 2014

Still need to check 2015.

And M-class flares 2011-2015. (e.g. SOL2012-03-13 M7.9, Trottet et al. 2015)