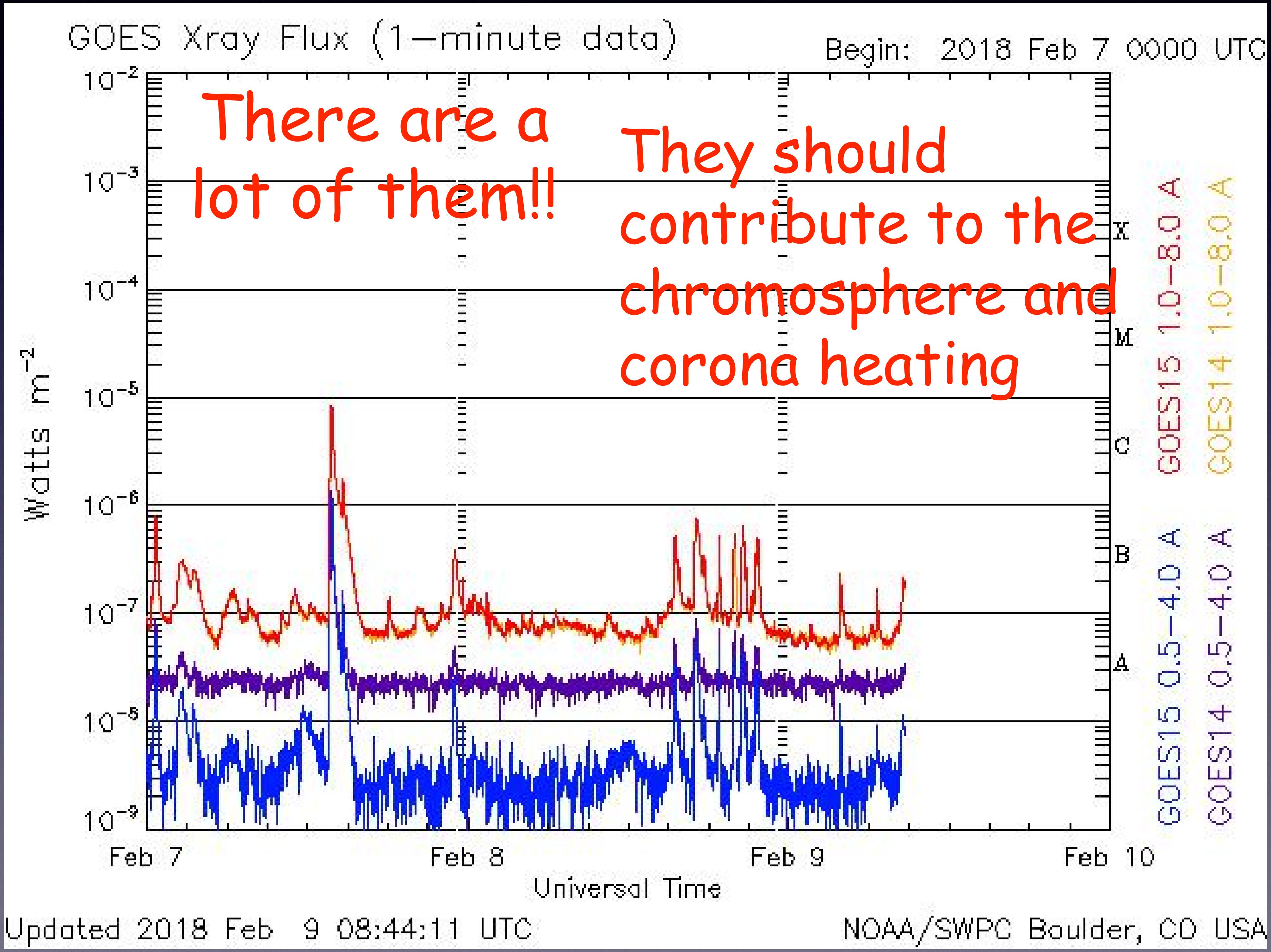
Why we are interesting in study in weak solar flares?

L. Kashapova, D. Zhdanov, S. Lesovoi,
A. Kudryavtseva and Lomonosov BDRG collaboration

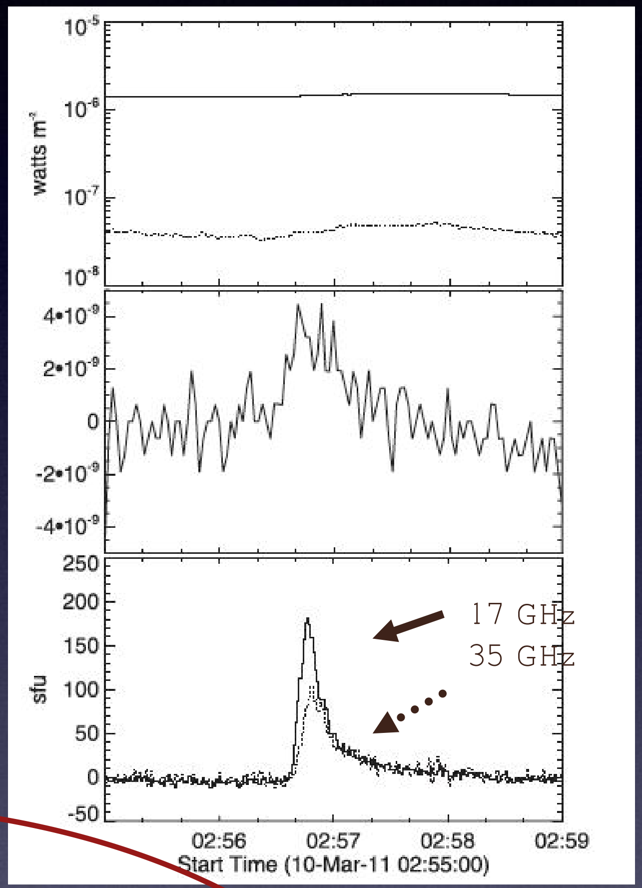
GOES class flares…
C, B, A….

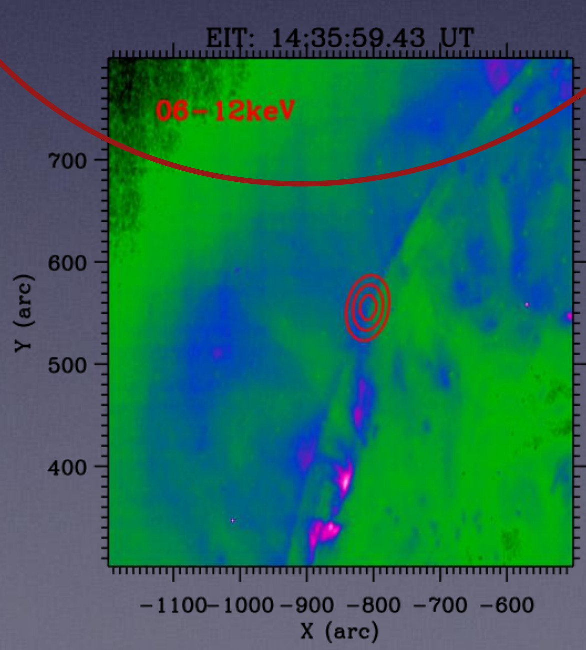


Are weak flares really "weak" events?

Behind-the-limb, occulted and partly occulted flares: Kruker el al ,2007; Vybornov et al ,2012; Ackermann et el 2107,Effenberger et al. 2017;

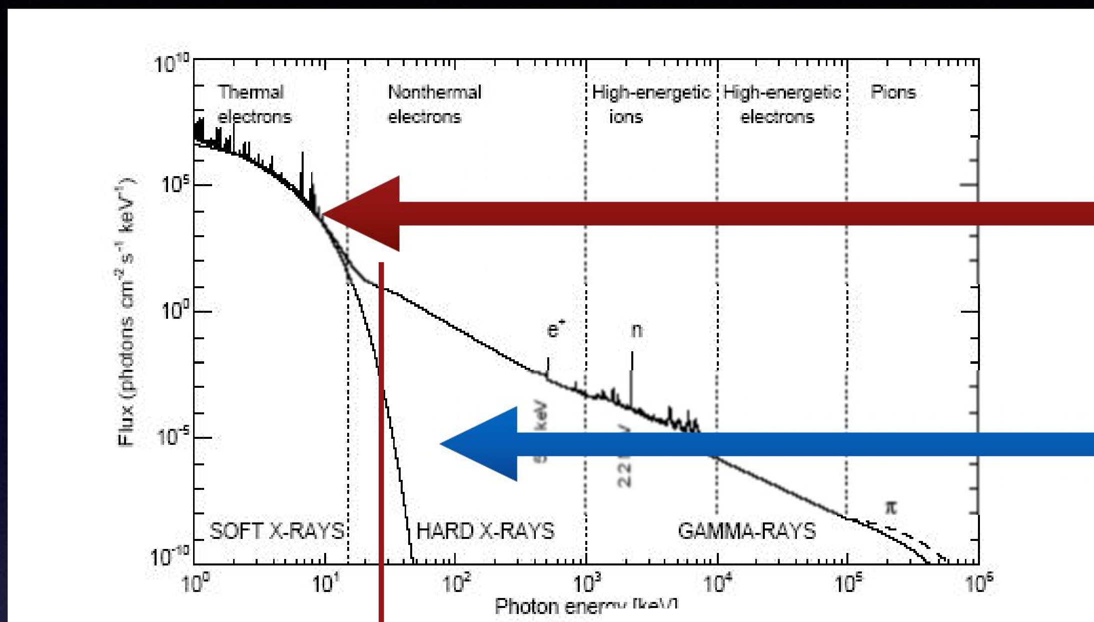
«Cold flares» : Bastian et al. 2007; Fleishman et al. 2011, 2016; Masuda et al. 2013)

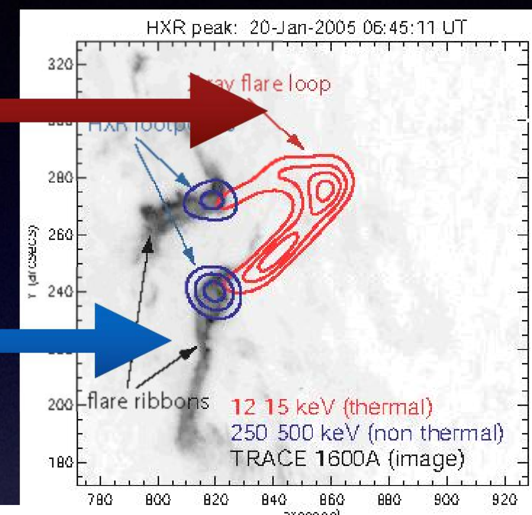




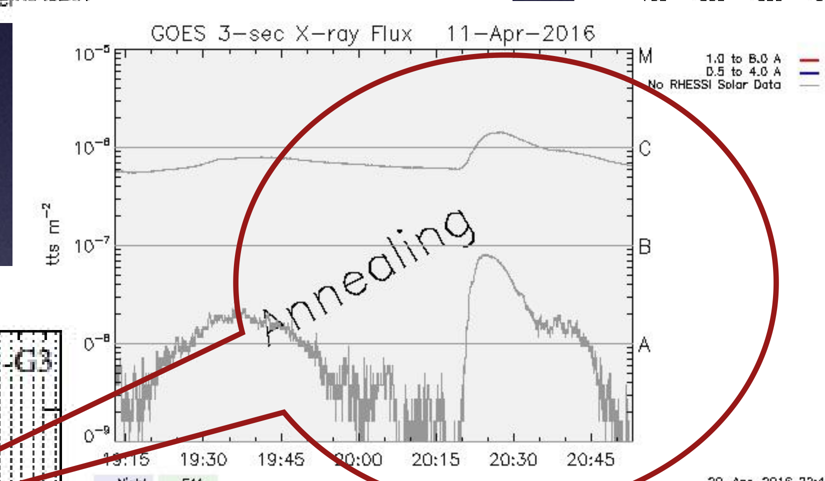
Geoeffective events - weak flares initiating coronal вmass ejection and powerful geoeffective events(for example, 11 April 2004)

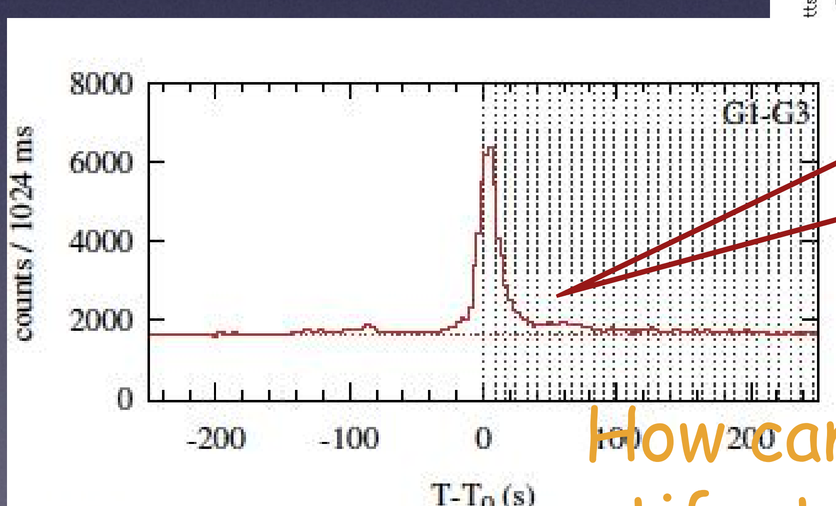
X-ray observations





GOES C1.4/
Konus-Wind





Weakness :

Low level of emission

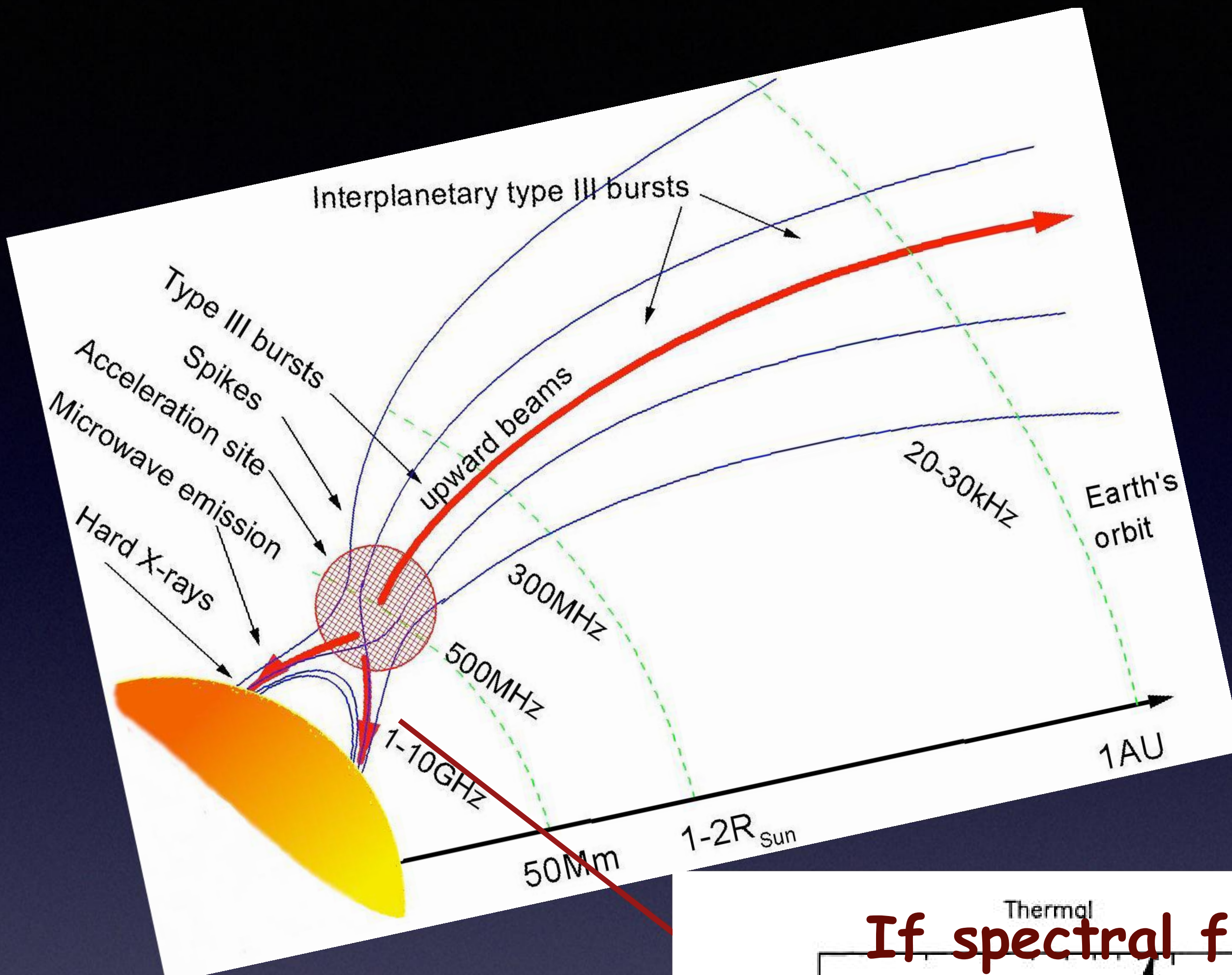
Outlet:

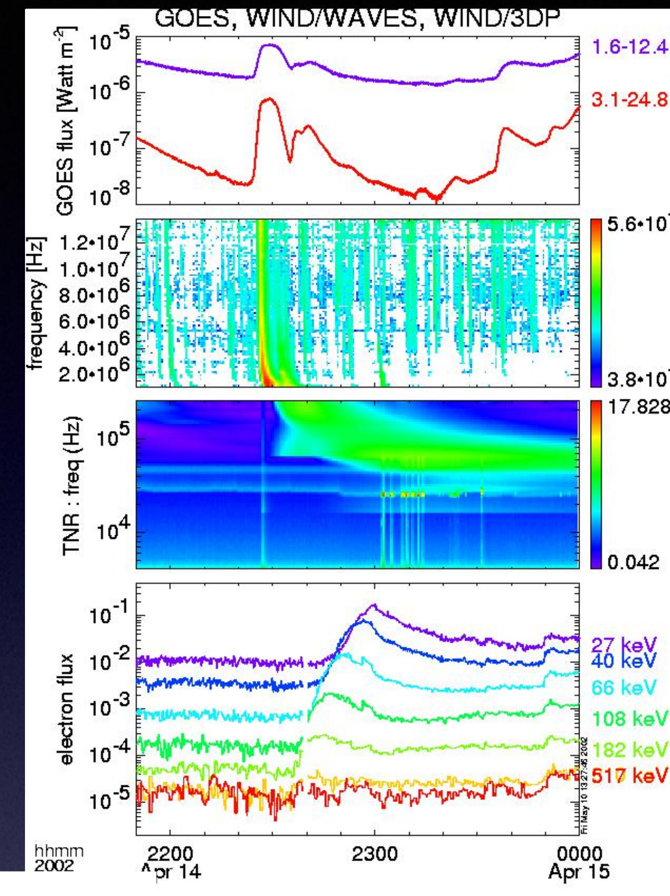
1-D temporal profiles and spectral-observations Konus-Wind, FERMI/GMB,RELEK,Lomonosov

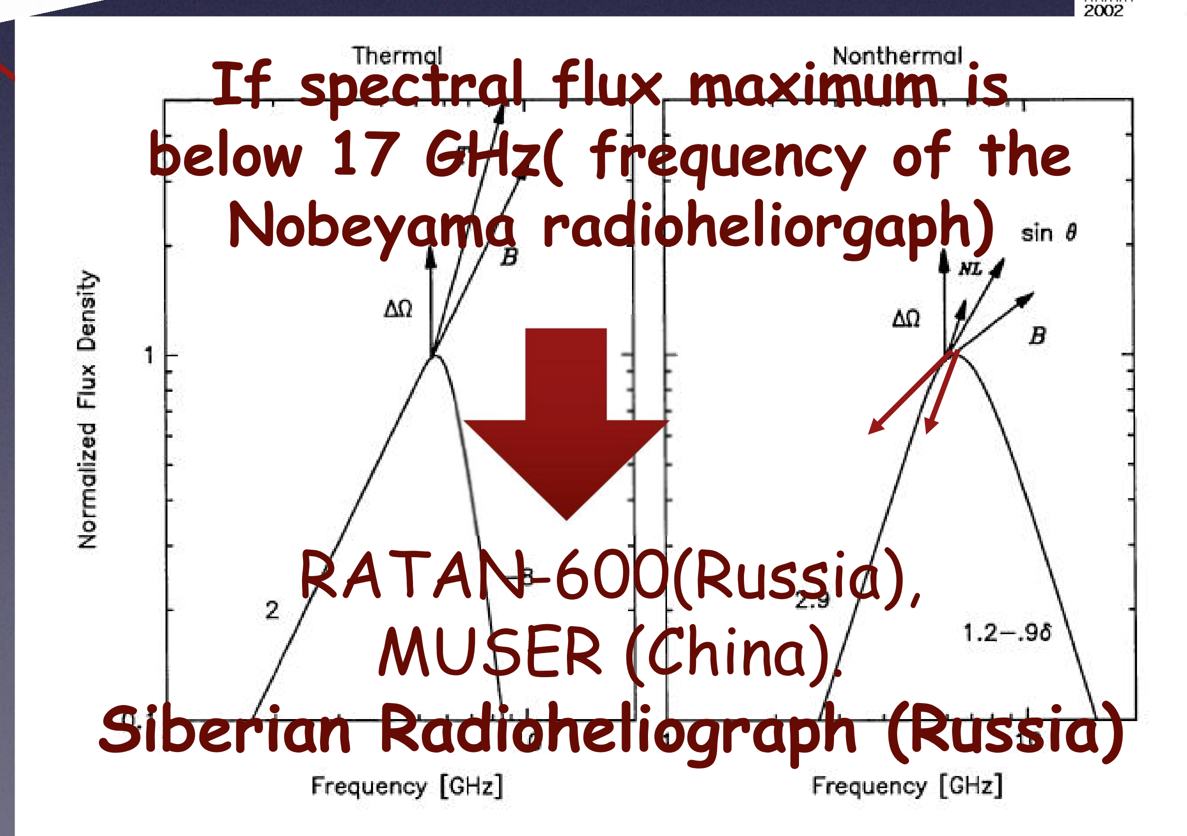
How can we be sure that an event is not artifact if it is absent in GOES catalogue?
location of an event (coordinates)
-2 Devolution

Observations in radio range

Radio observations



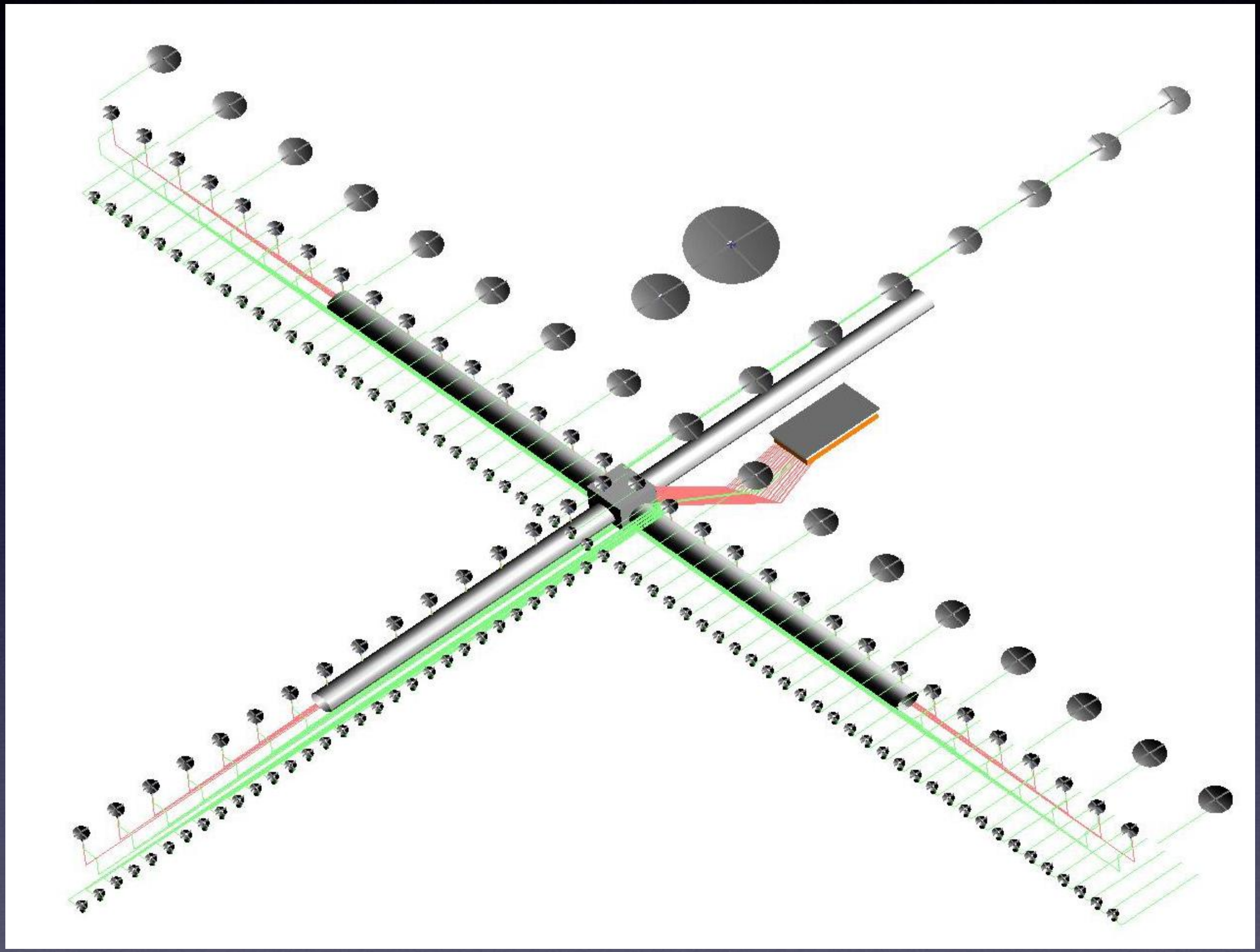




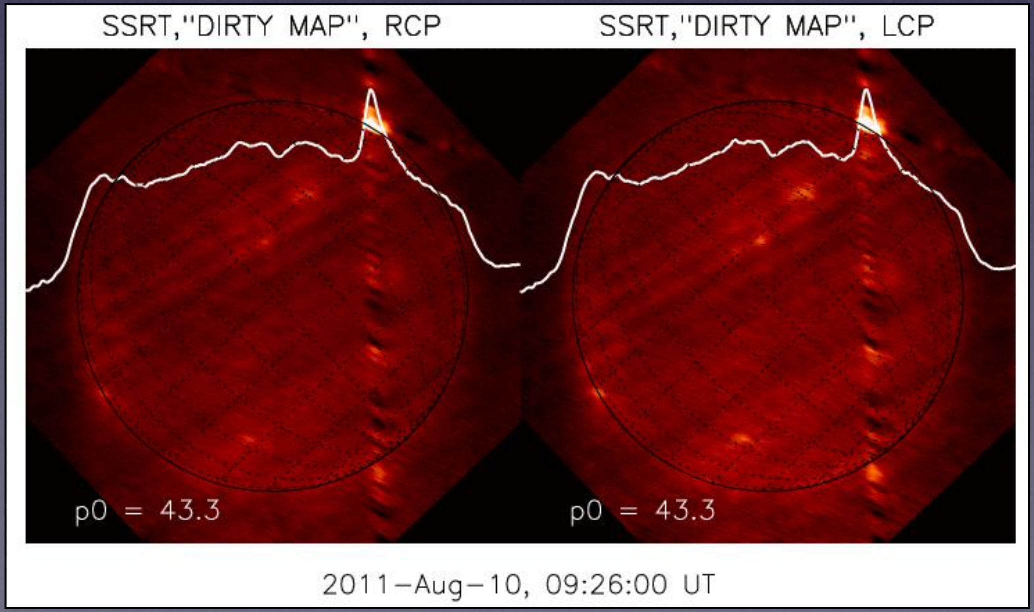
If spectral flux maximum is below 17 GHz(frequency of the Nobeyama radioheliorgaph)

RATAN-600(Russia),
MUSER (China),
Siberian Radioheliograph (Russia)

Radio heliographs (RH)



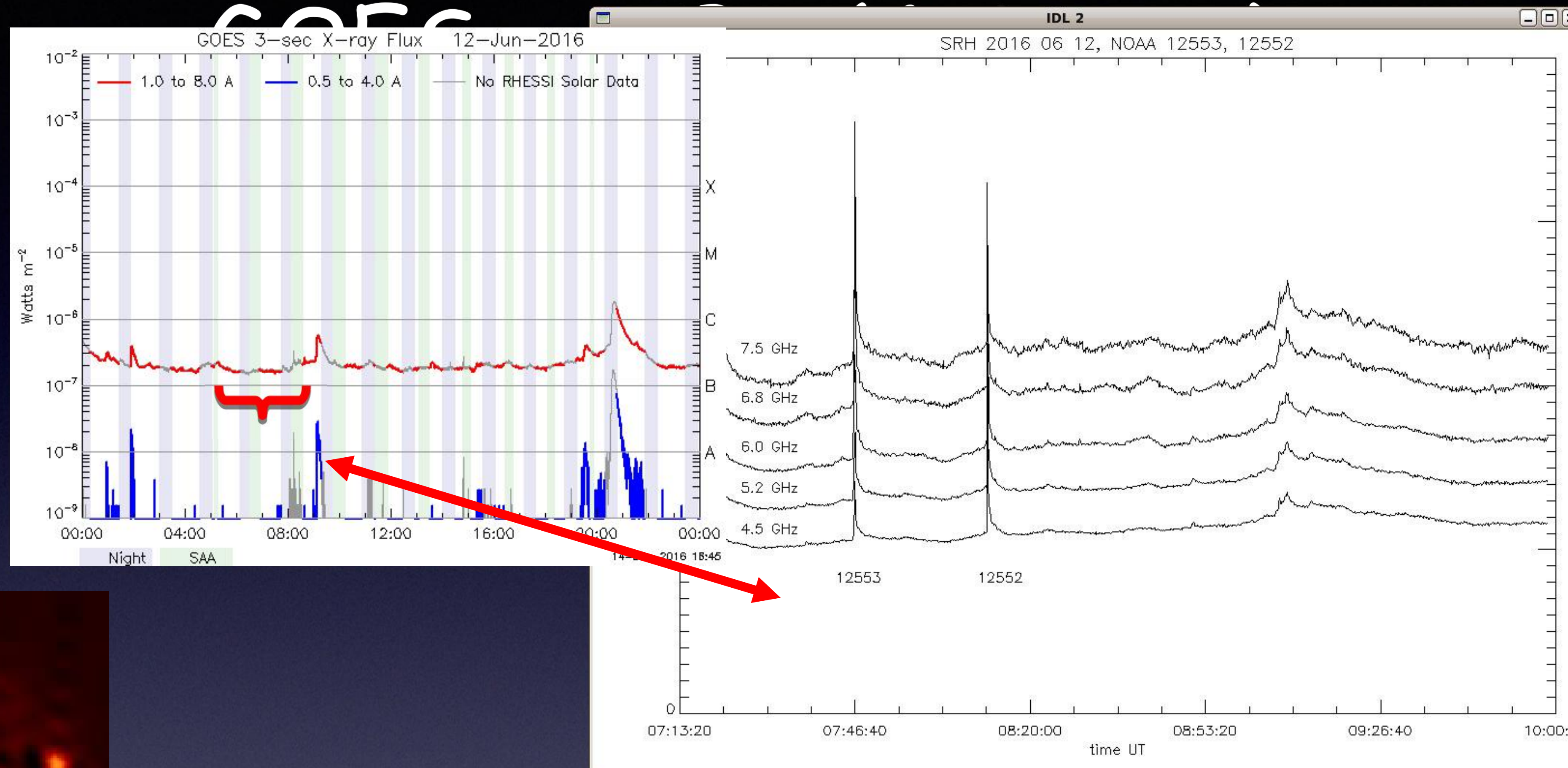
- Nobeyama RH (17&34 GHz)
- Nancey RH (meter range)
- Siberian Solar Radio Telescope (5.7 -> 4-8 GHz_
- LOFAR RH (meter range)
- MUSER (

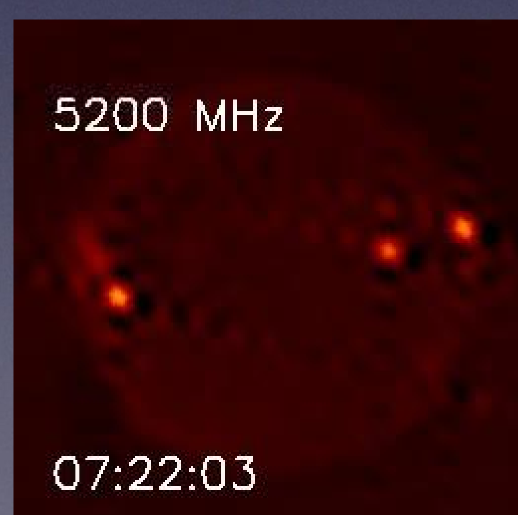


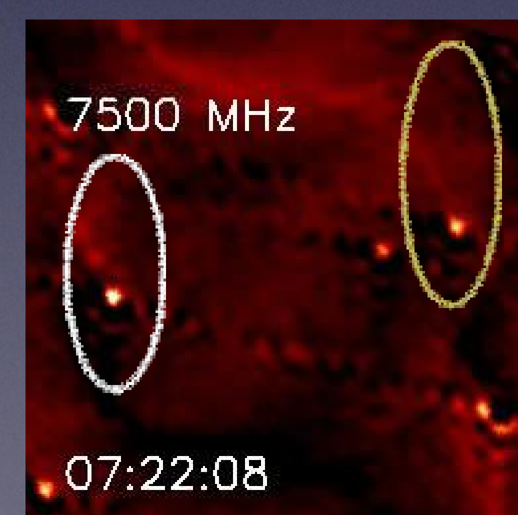
Siberian Radioheliograph (updated SSRT)

Located in Eastern Siberia, Badary Valley, 220 km from Irkutsk (N51 E102).
Utilizes partially the infrastructure of the former Siberian Solar Radio Telescope.
SRH antenna – 1.8 m diameter
(old SSRT antenna – 2.5 m)

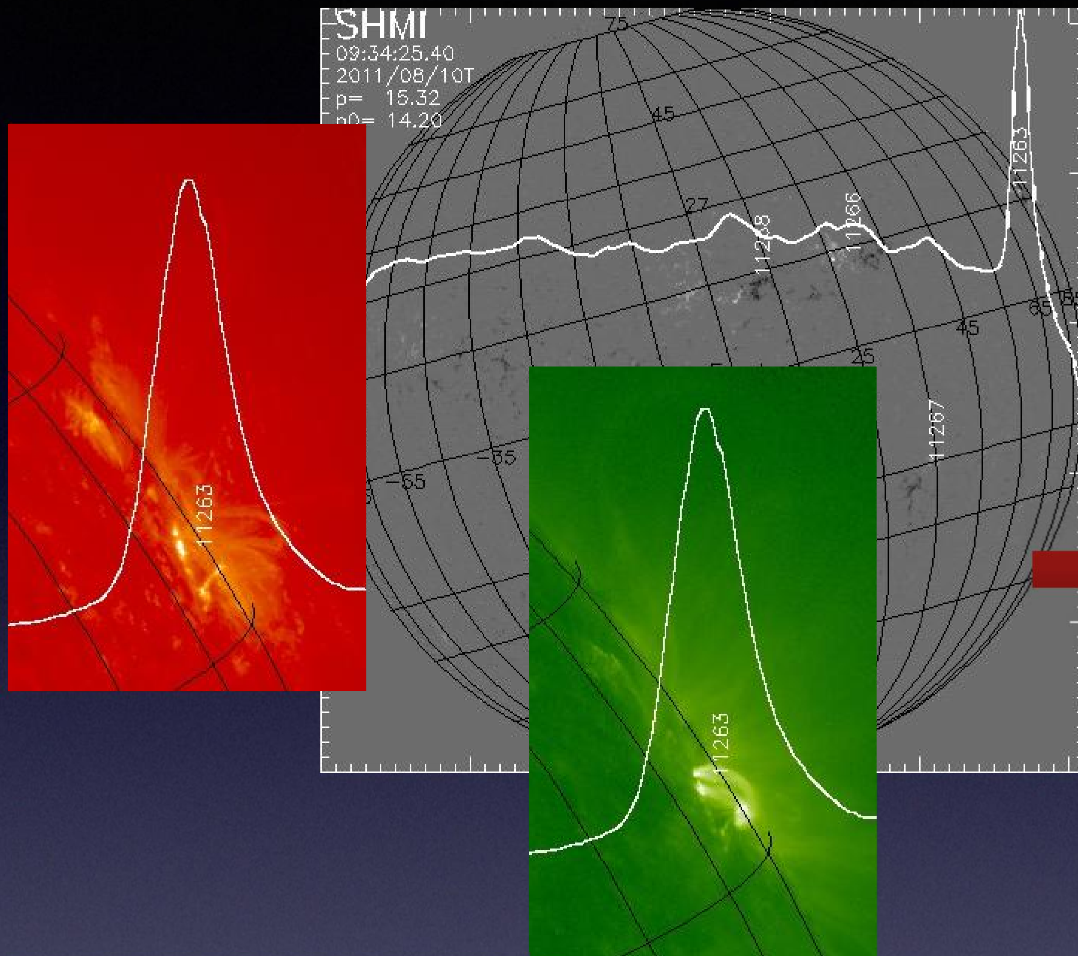
Solar flares 2016-Jun-12 (B2 + B4 flares)

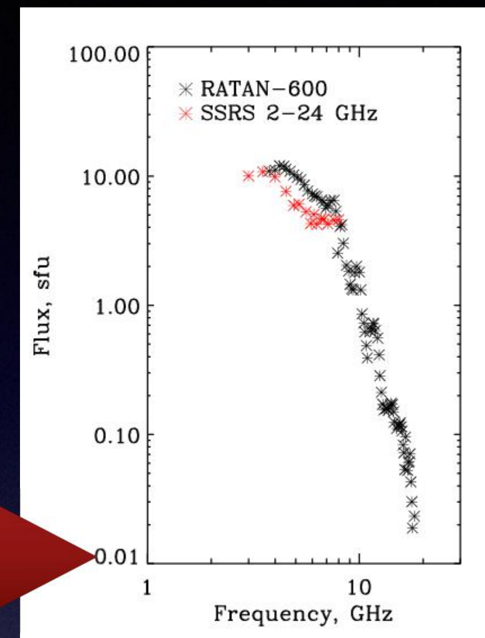


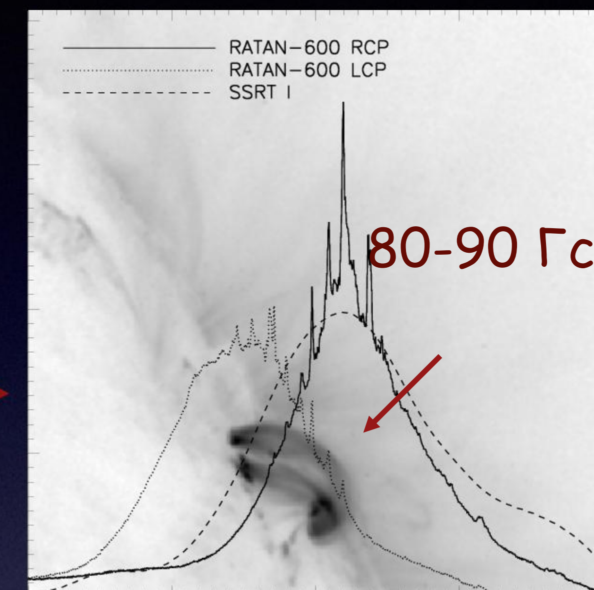


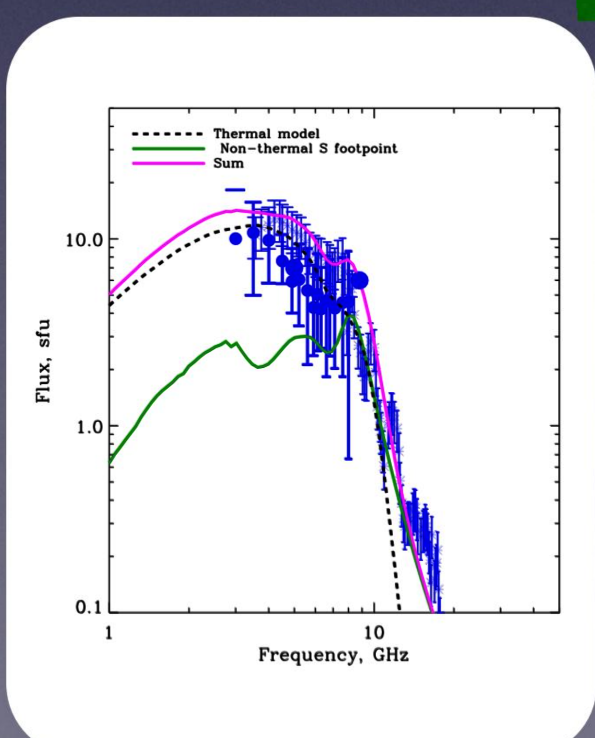


Examples of «weak flare» analysis: SOL2011-Sep-10T9:33 /C2.4 H.Meszarosova et. al, 2016

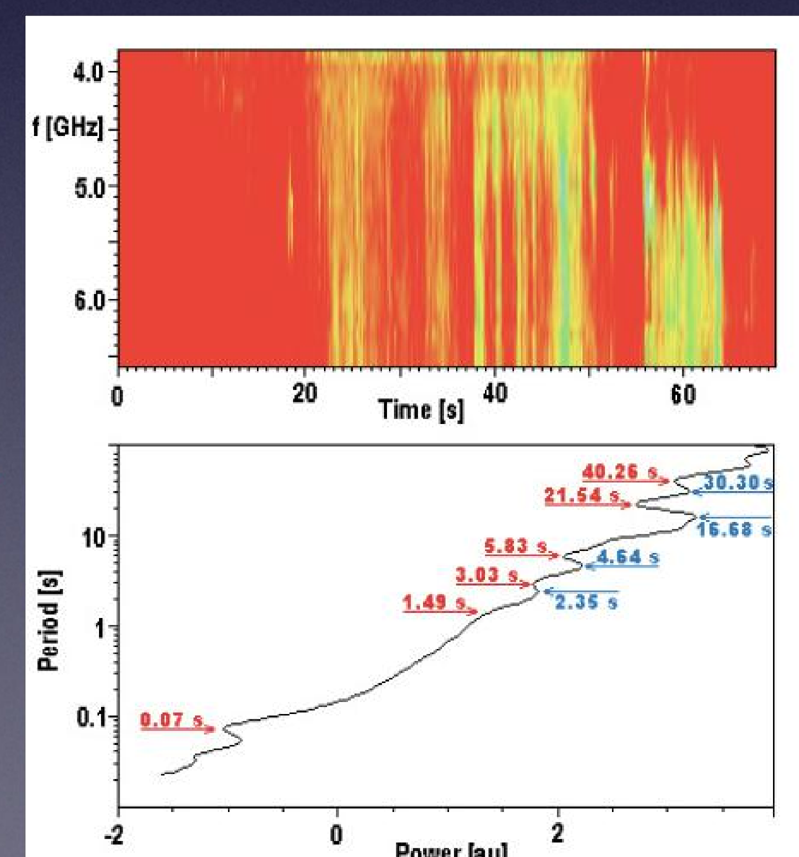








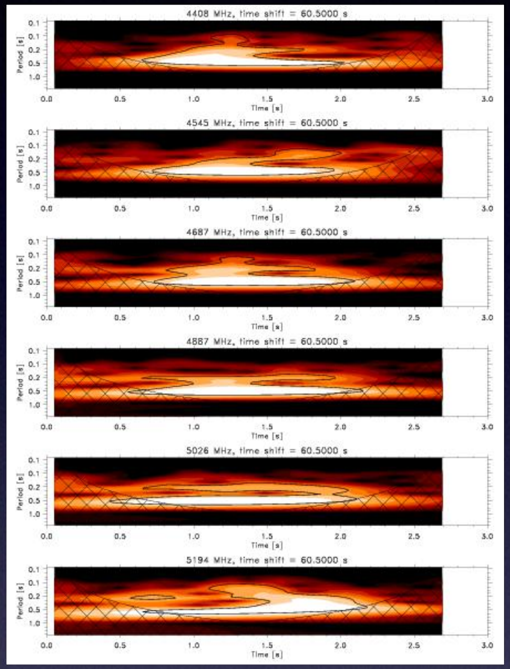
High temperature model Te= 4×10 7 K,the fine structure: domination of the plasma mechanisms



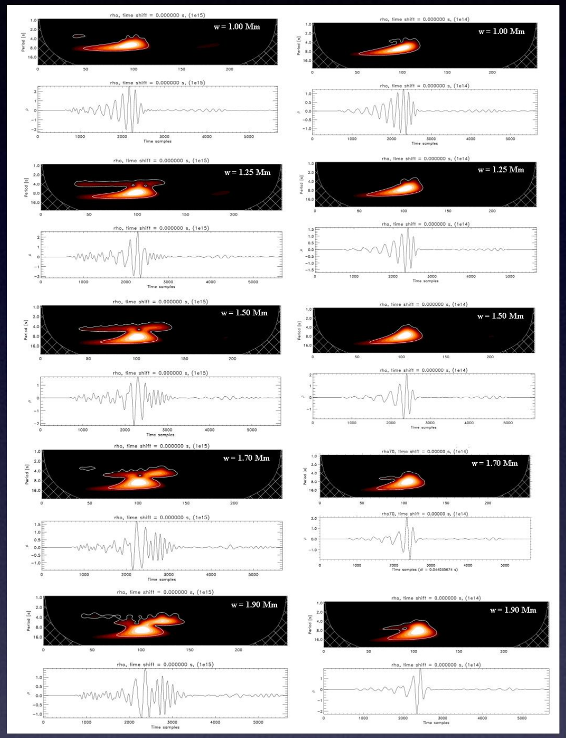
SOL2011-Sep-10T9:33 /C2.4

H.Meszarosova et. al, 2011

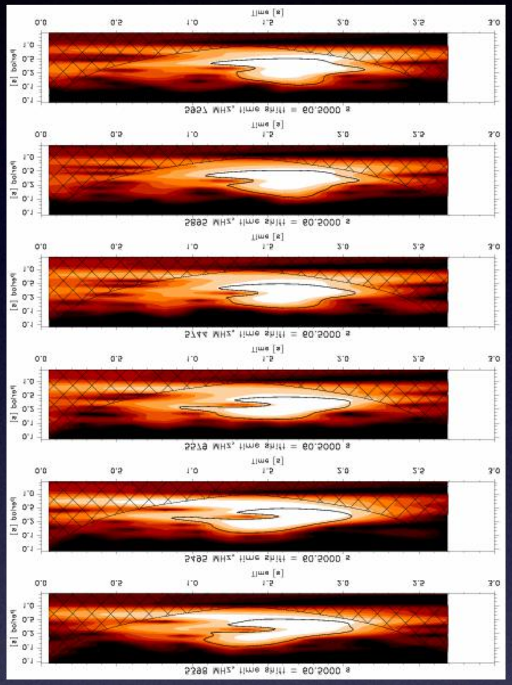
Loop

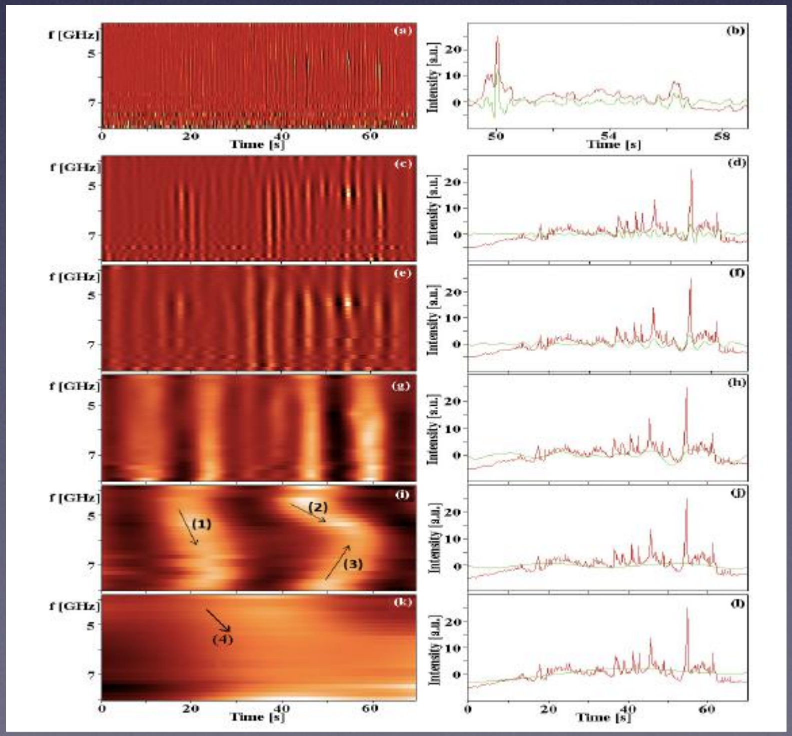


MHD modeling



Current sheet





Magnetoacoustic waves,
Magnetic field
80/20 G
Magnetic field
430 G
(gyrosynchrotron)

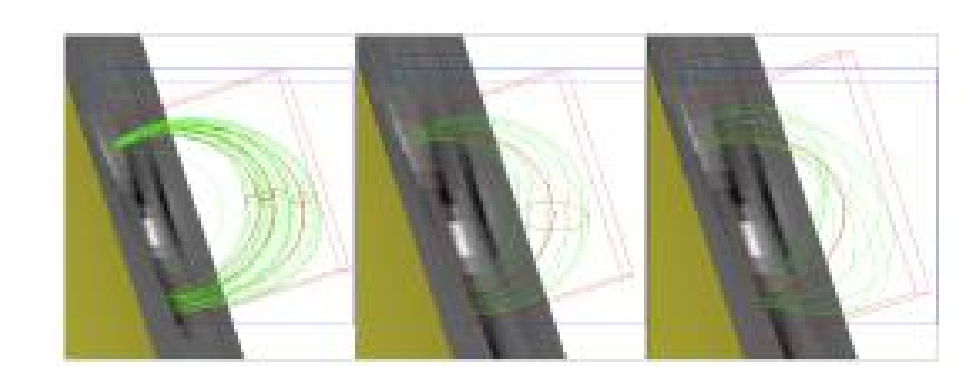
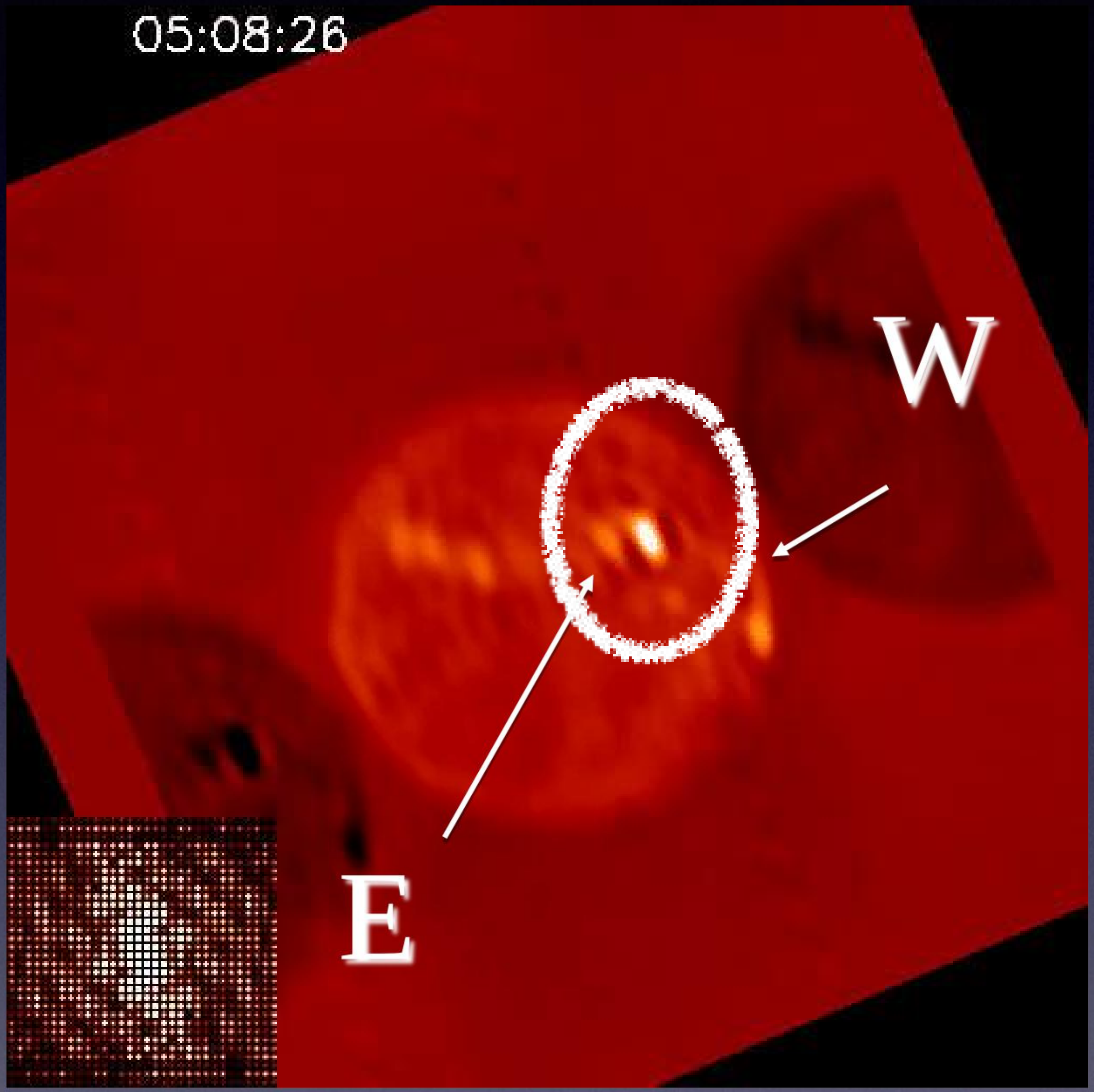
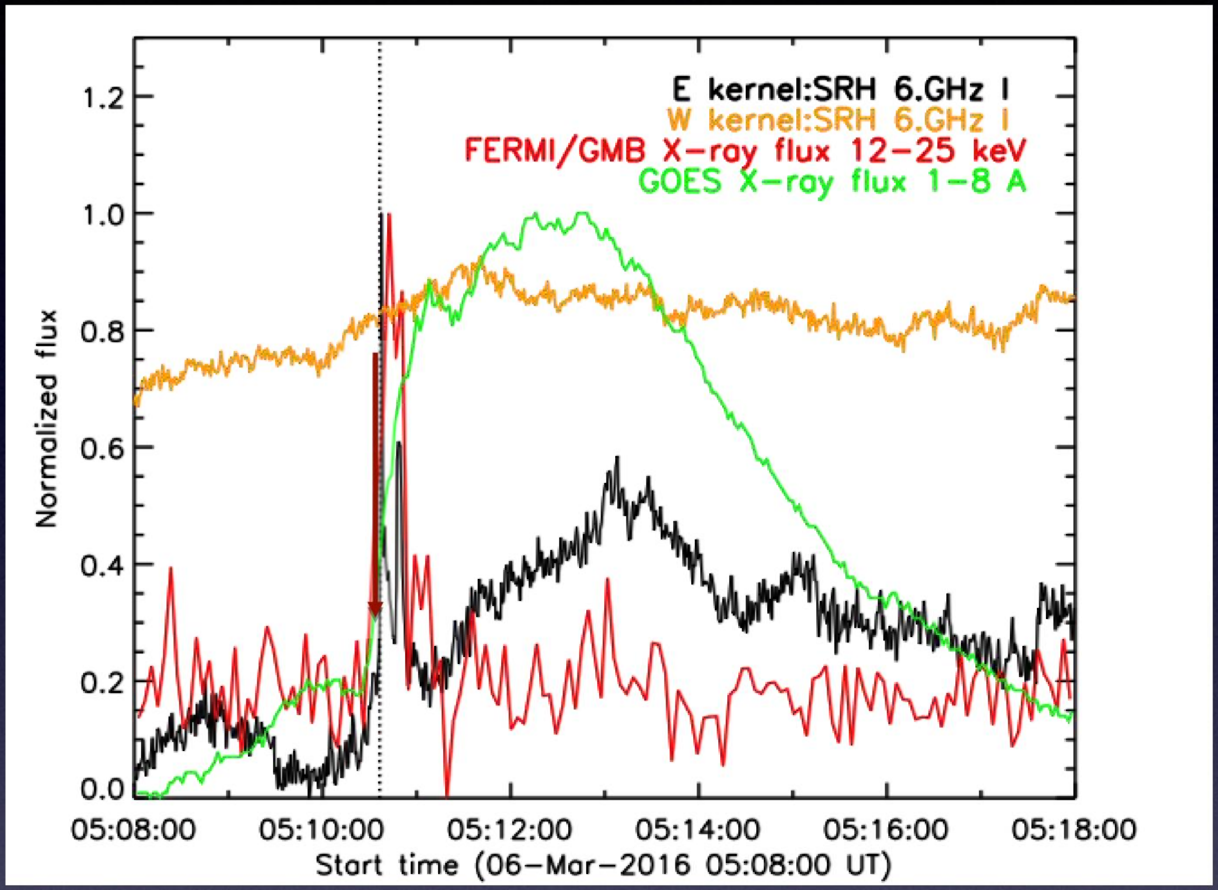


Fig. 8. Three dimensional two-loops model of magnetic field line configuration obtained from potential extrapolation in *GX simulator*. Individual panels show reconstructed magnetic field lines of 20–40 G (panel *a*), 80 G (panel *b*), and 450 G (panel *c*).

SOL2016-Mar-06T5:12 / B7.2

05:10:36 UT

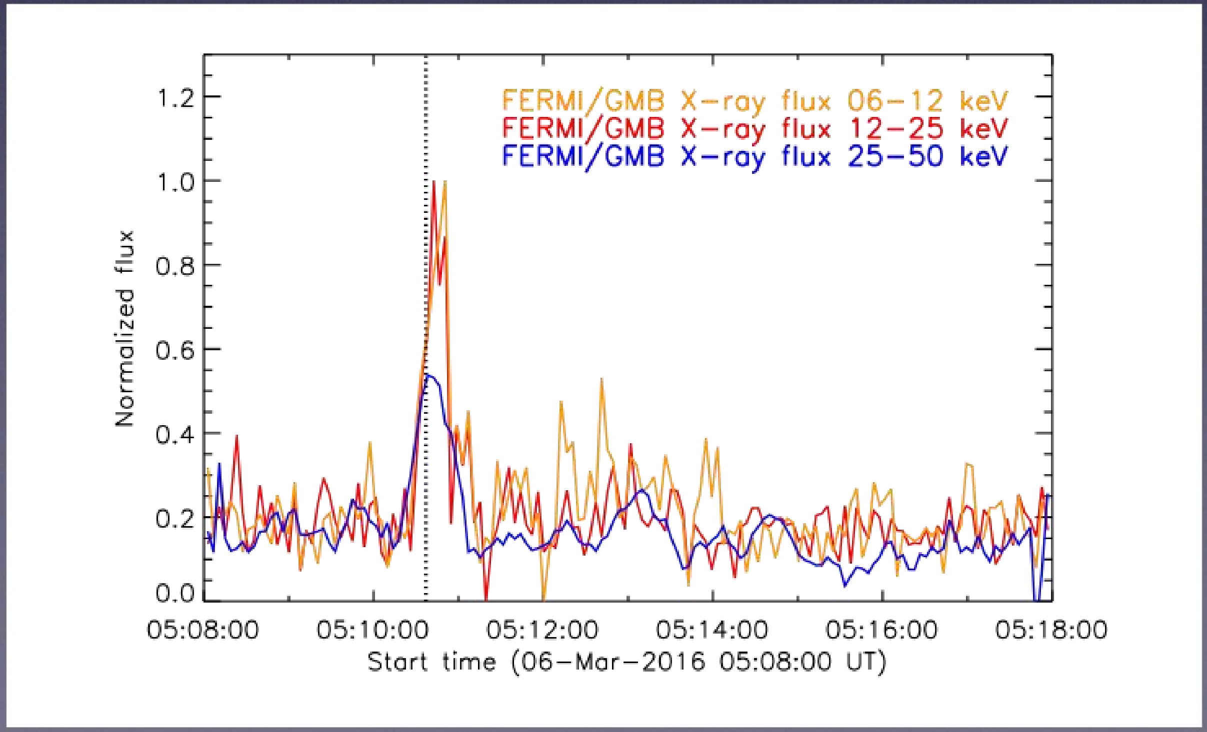




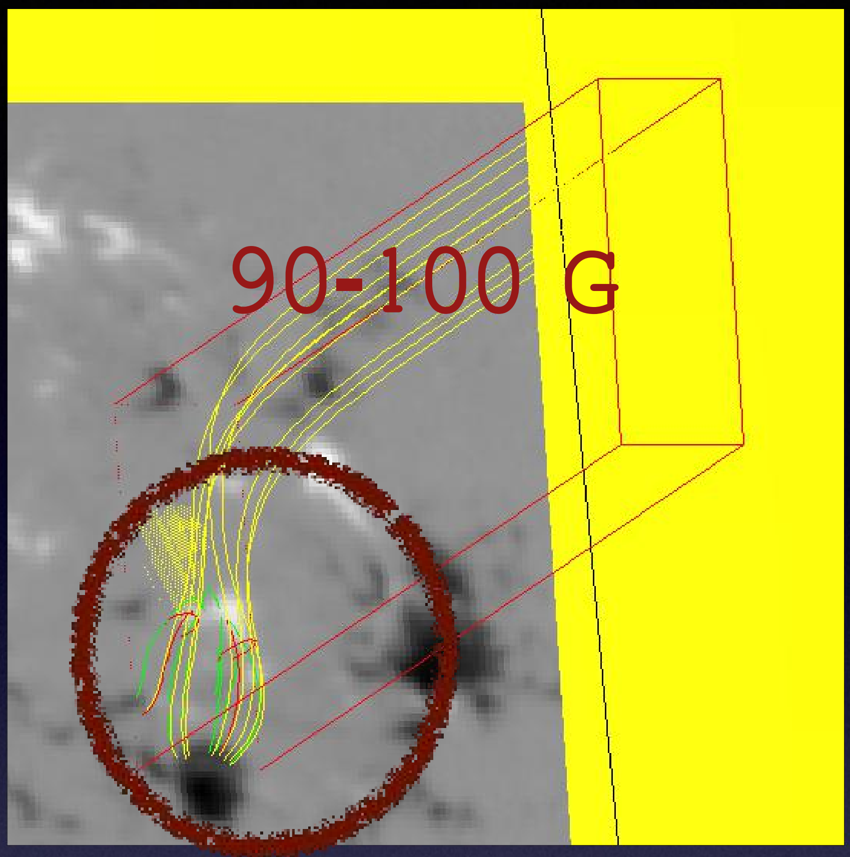
Plasma parameters

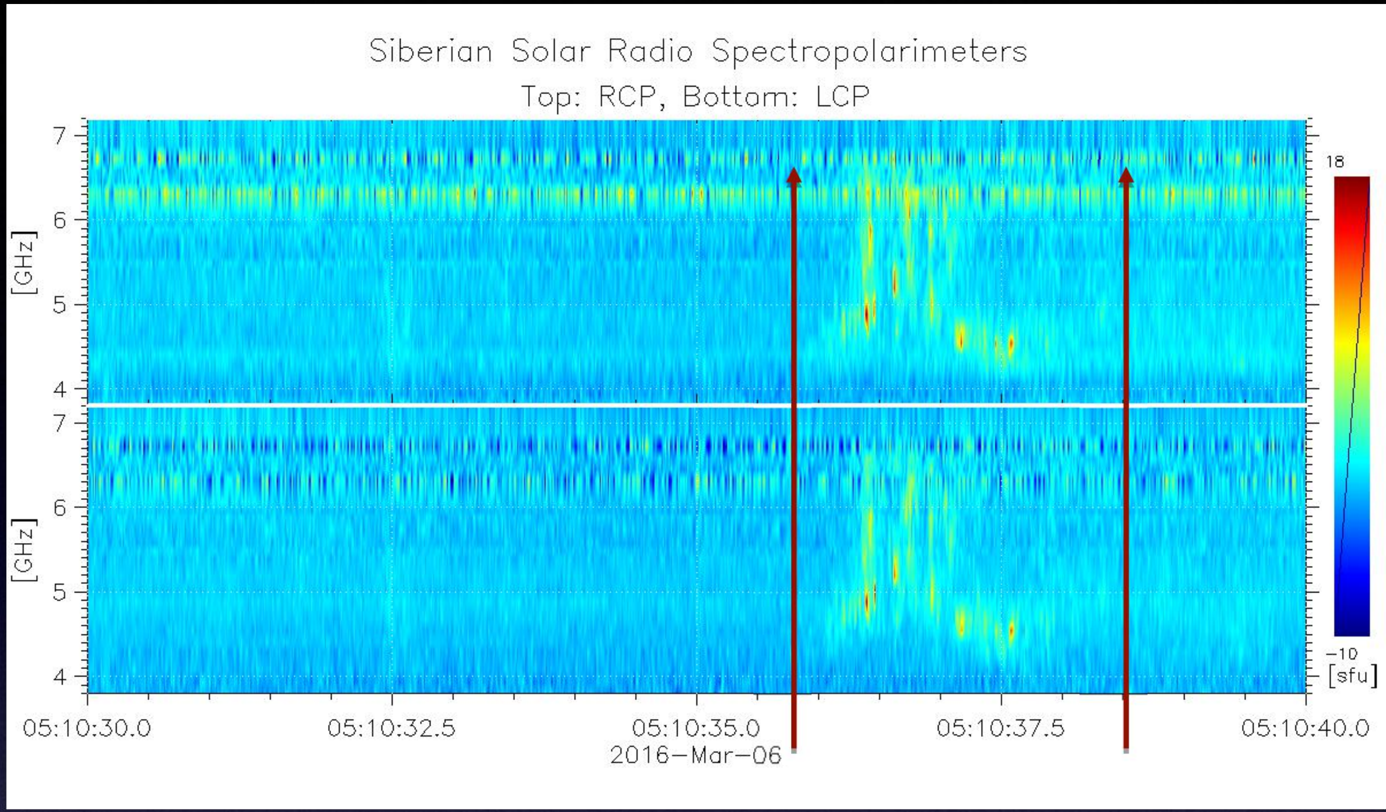
Te=43 MK

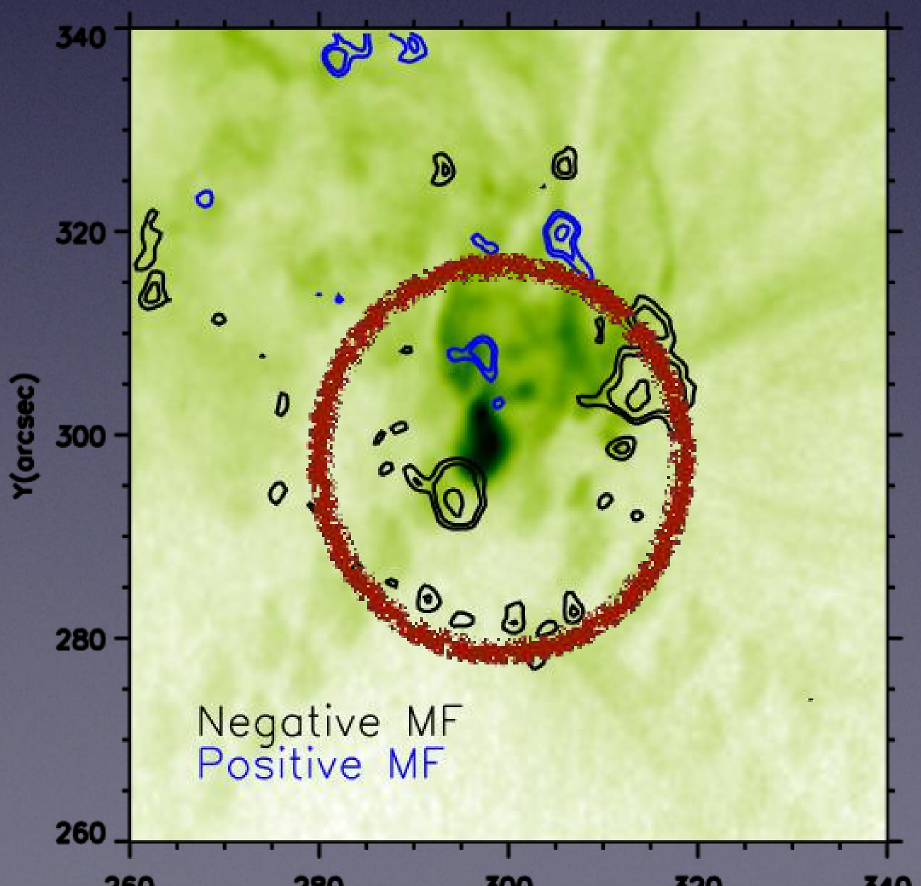
EM=1.7 10^{44} cm-3



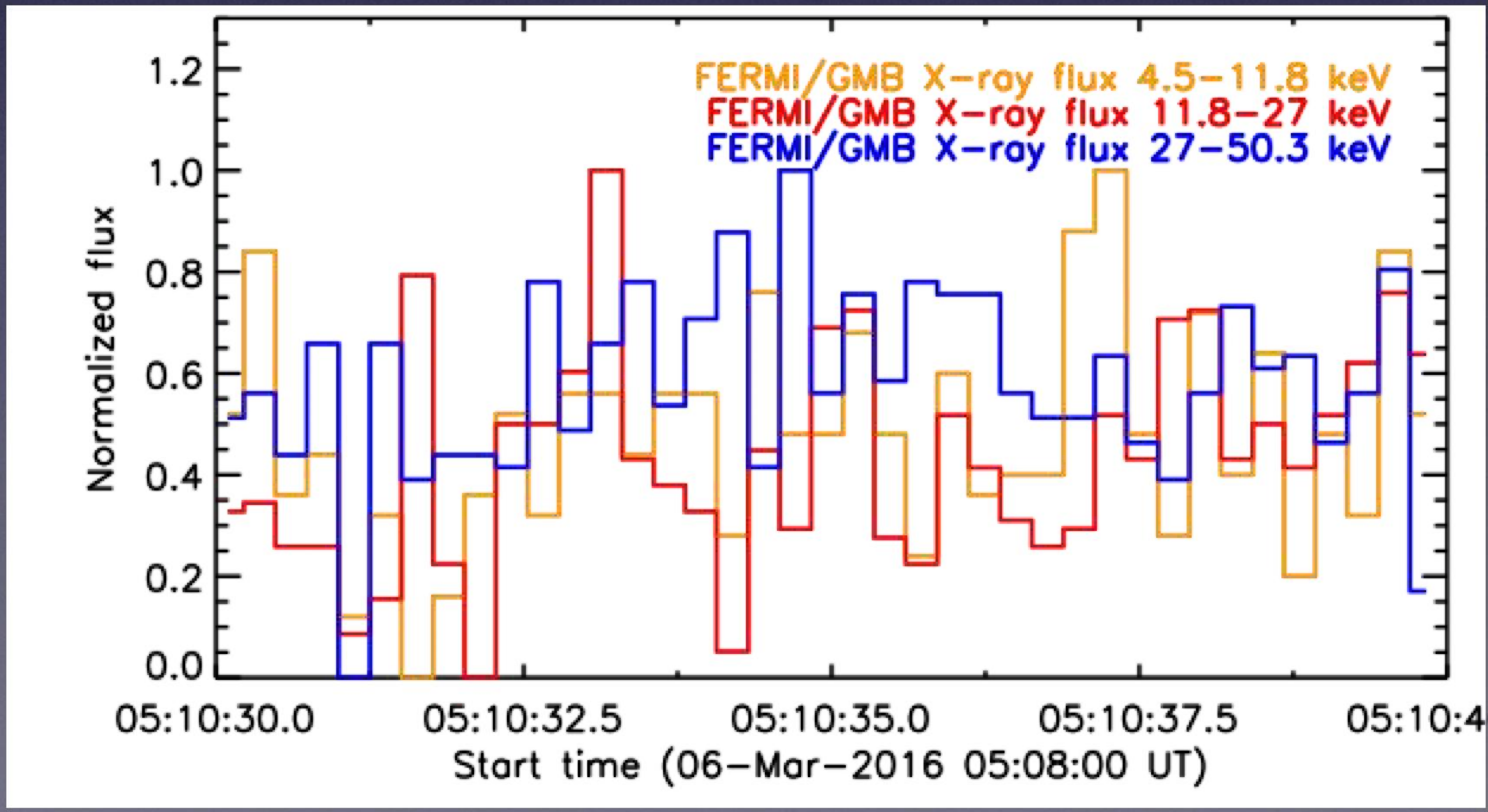
SOL2016-Mar-06T5:12 :fine structure



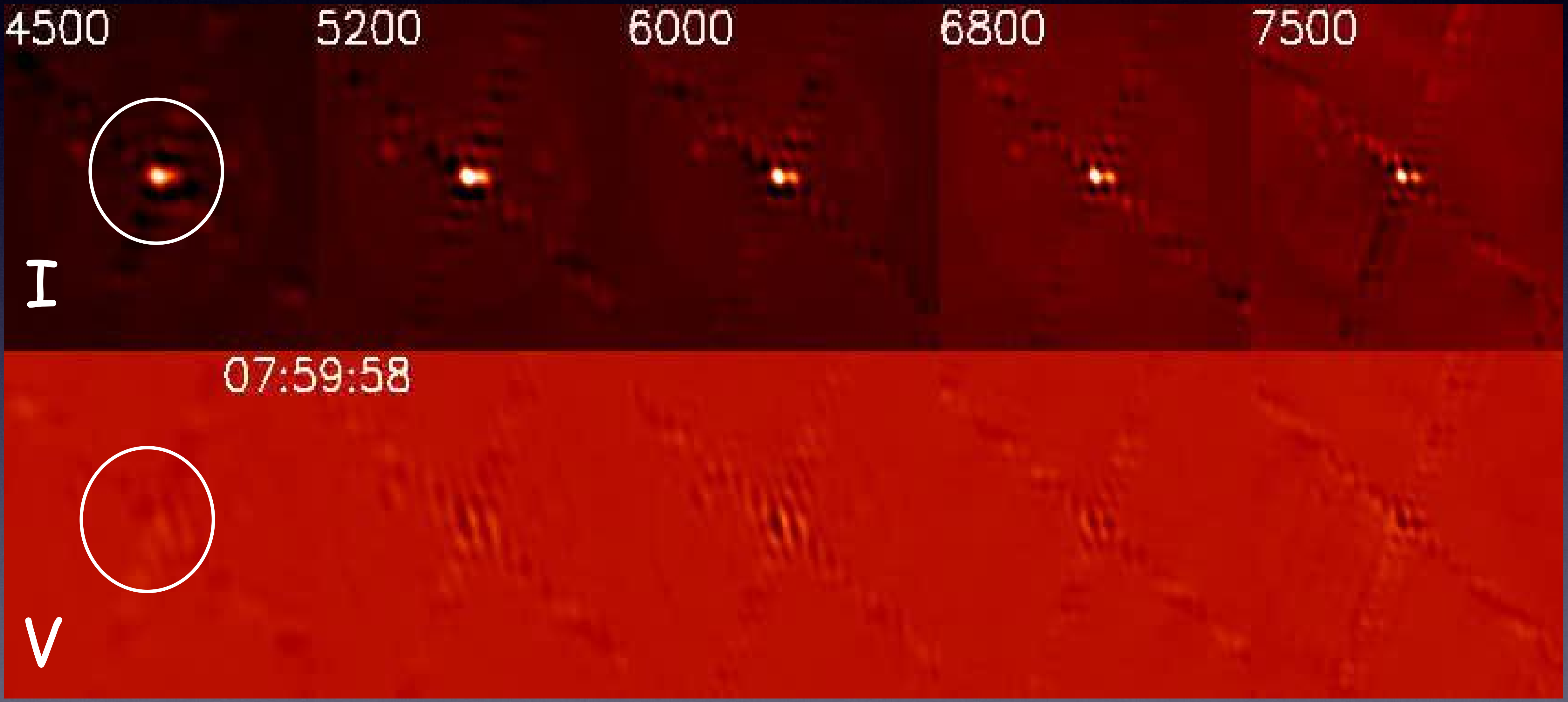




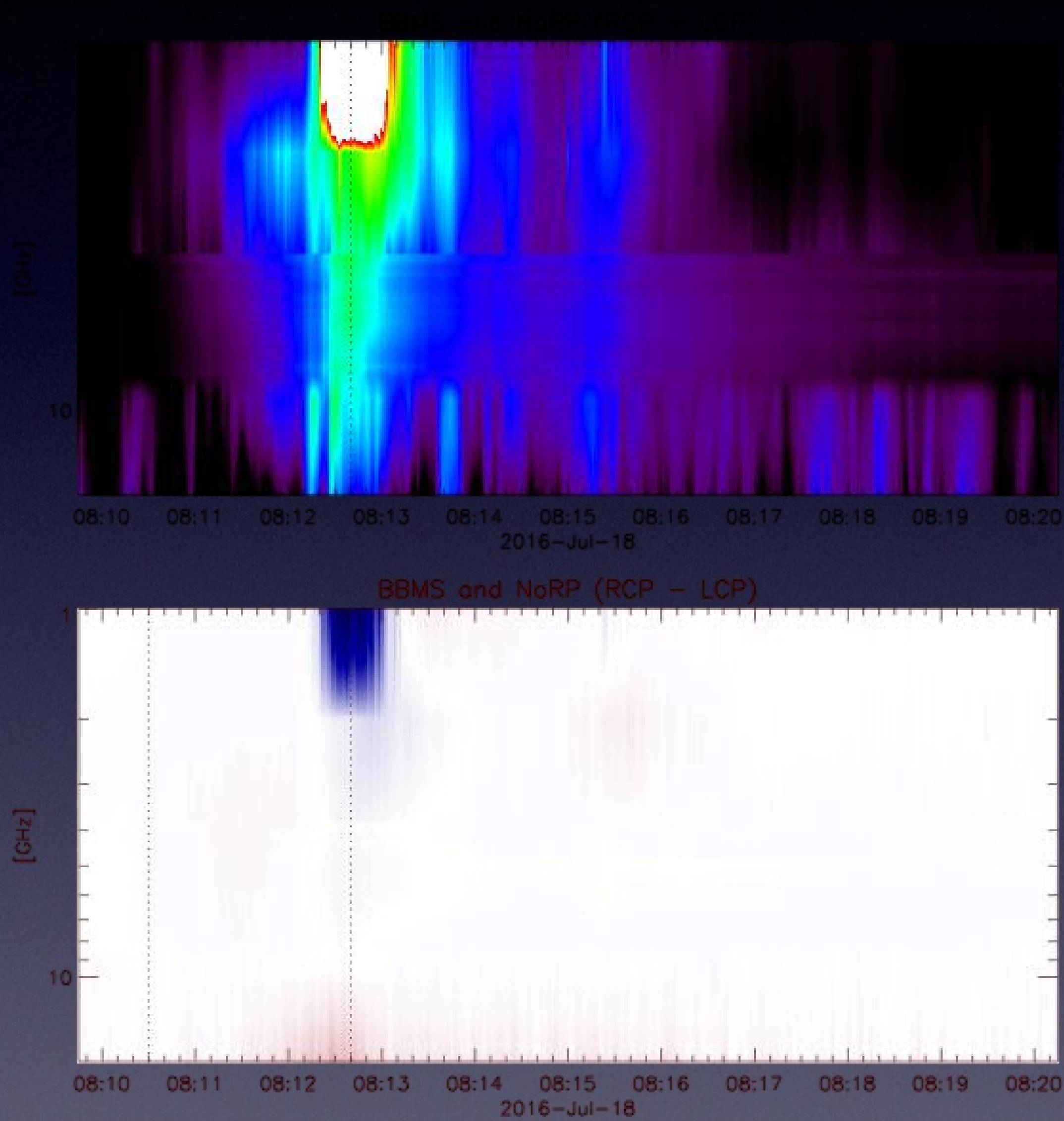
FERMI/GMB

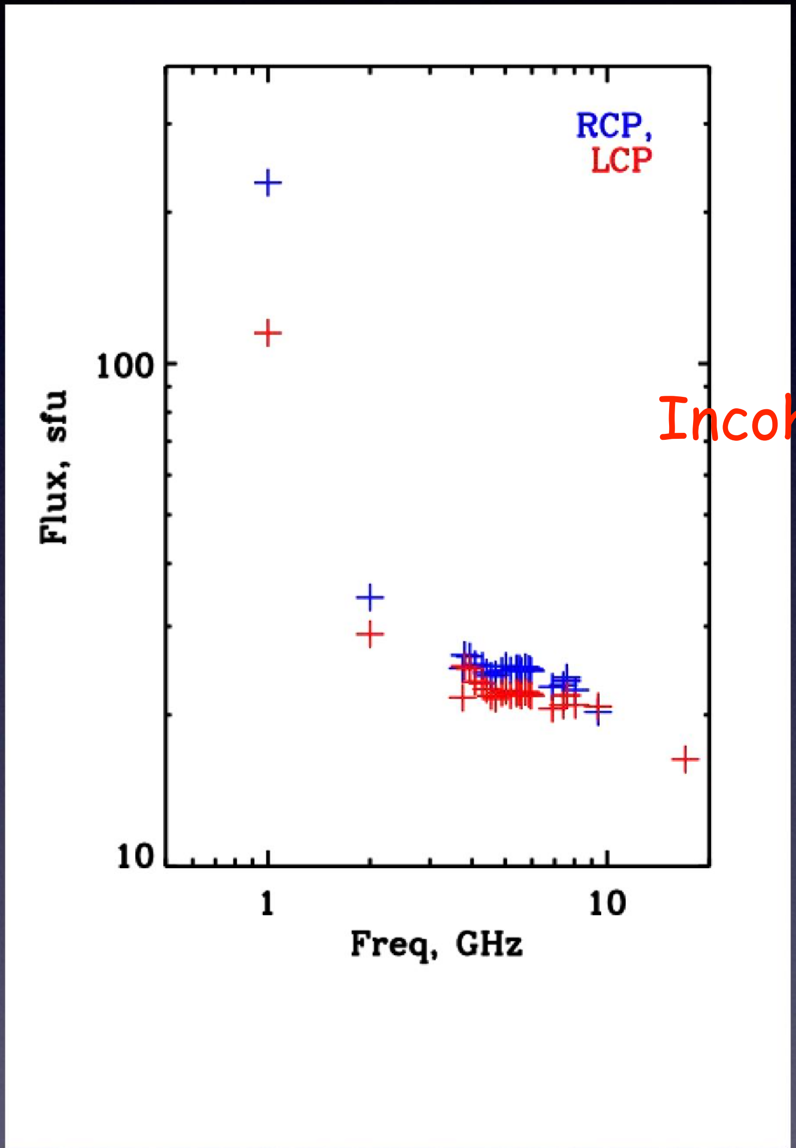


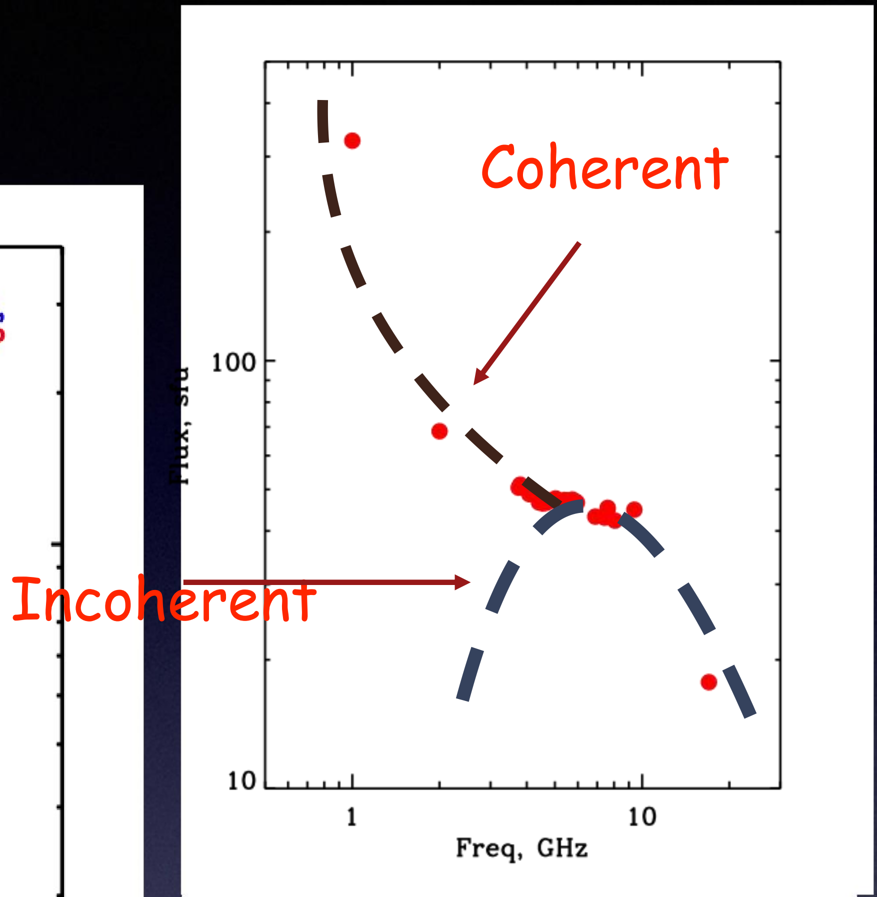
SOL2016-Jul-18/C4.4

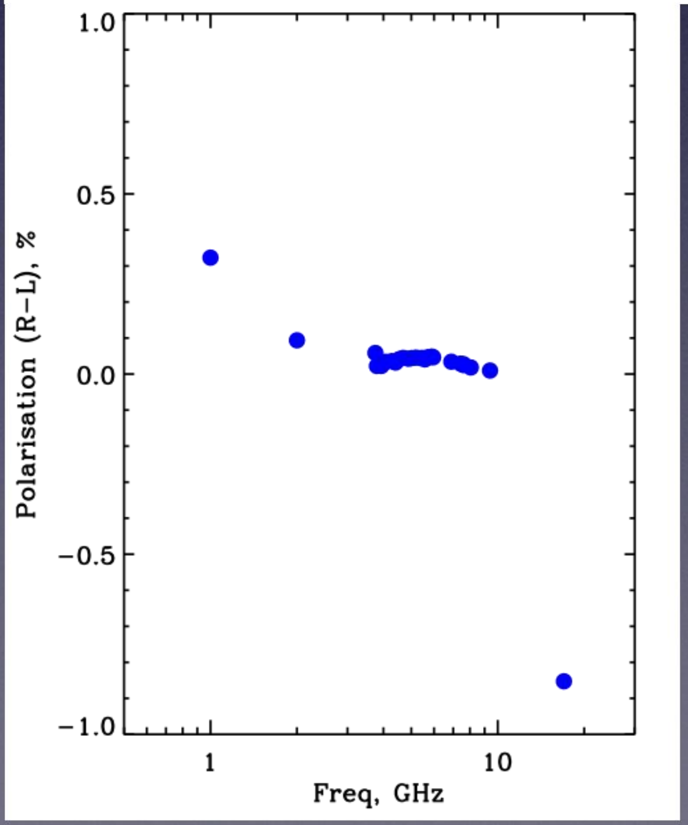


Radio(microwaves) spectrum

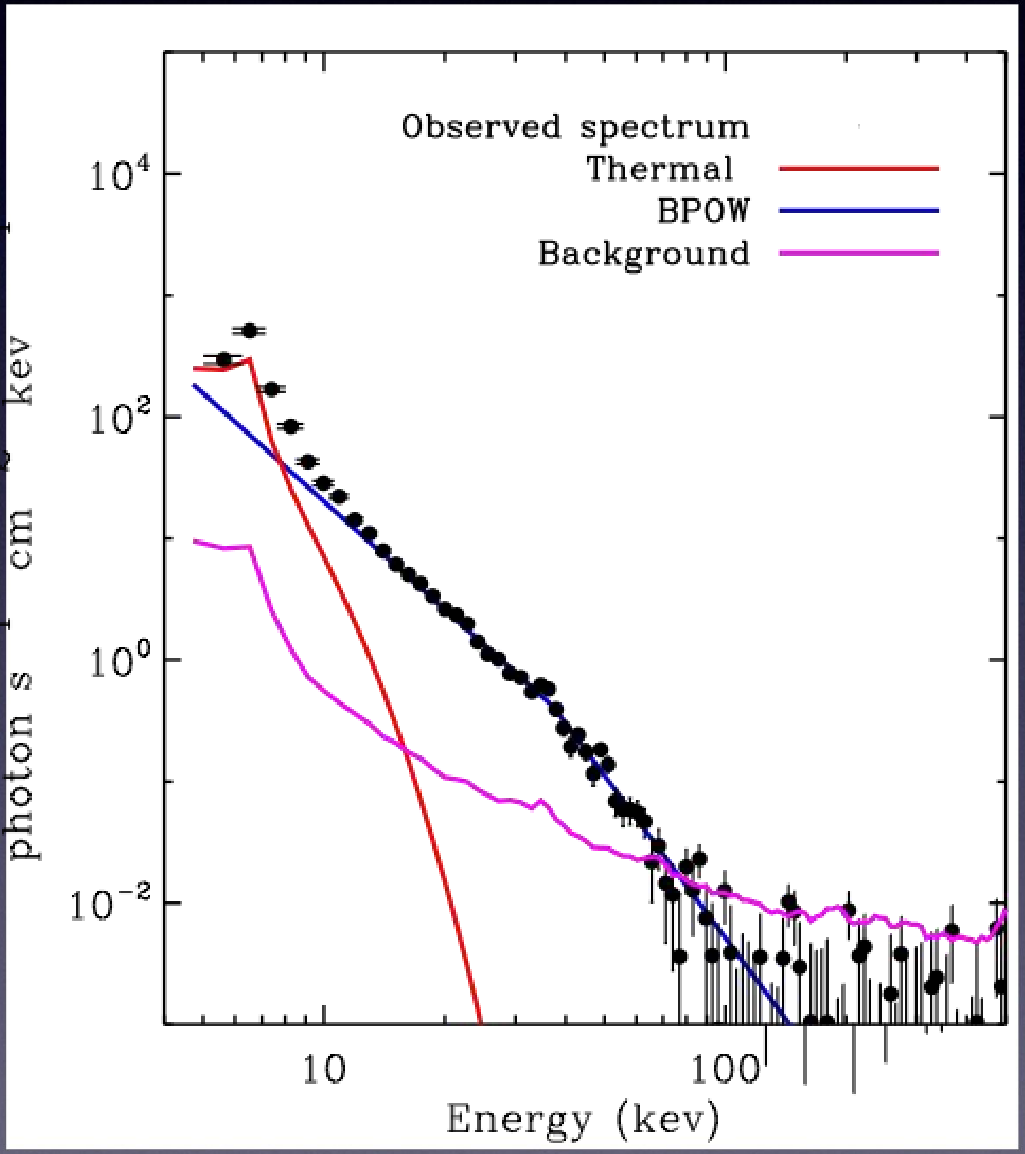


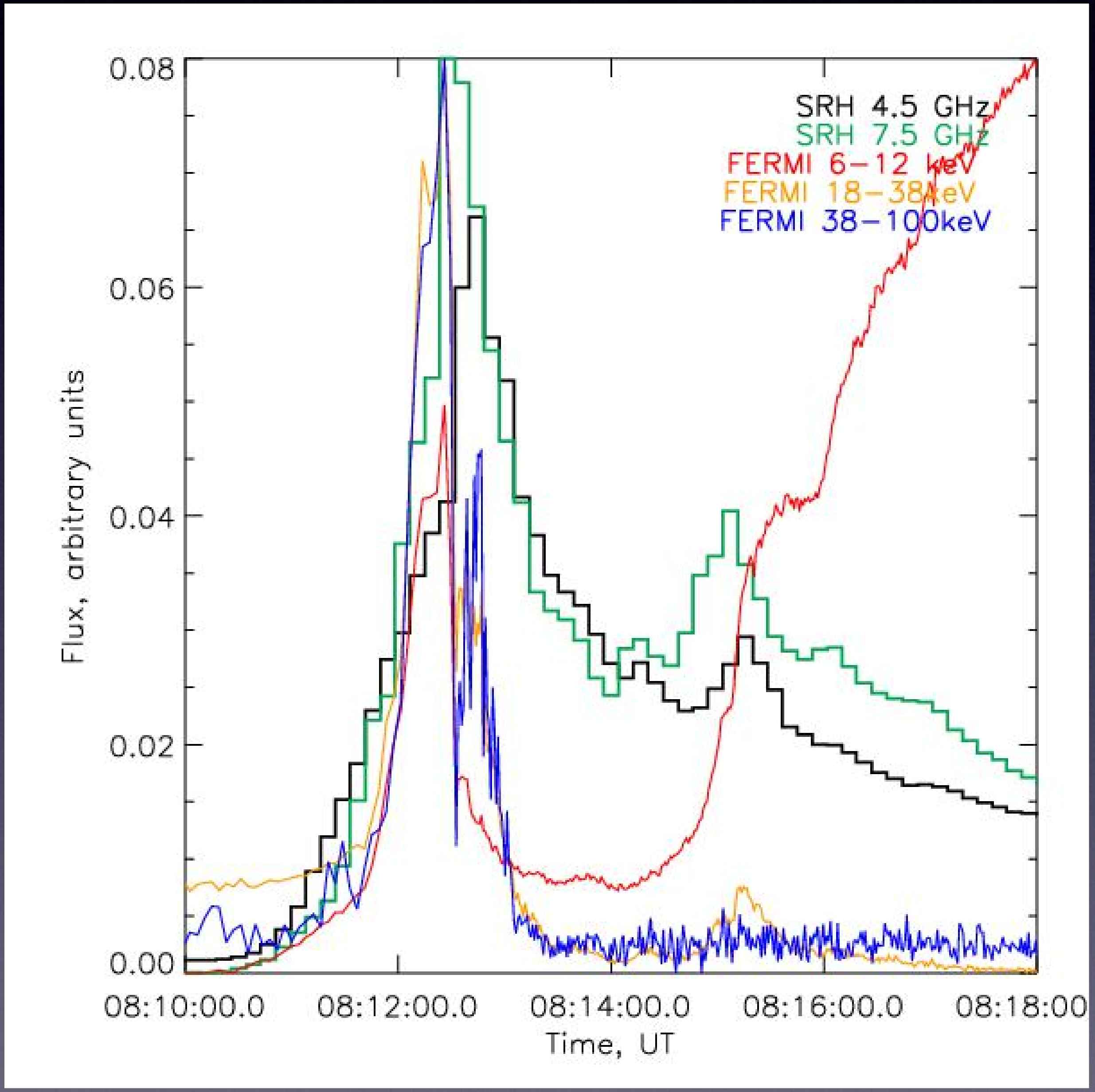






Relationship between X-rays and microwave emissions



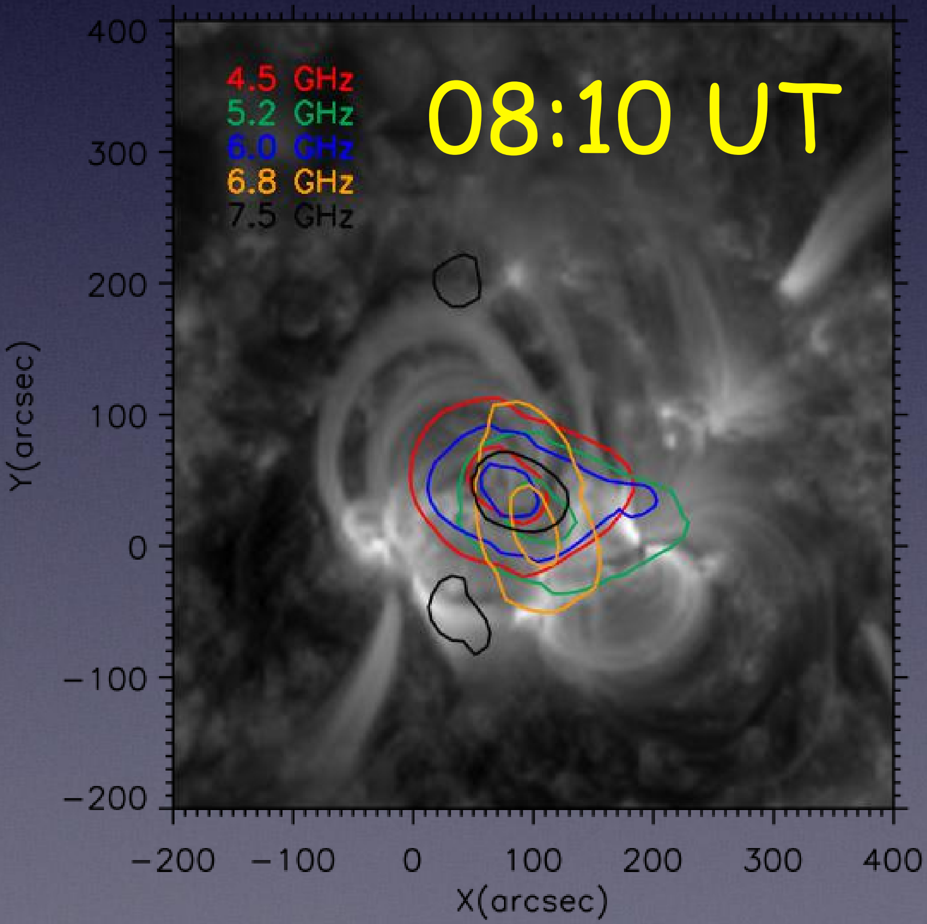


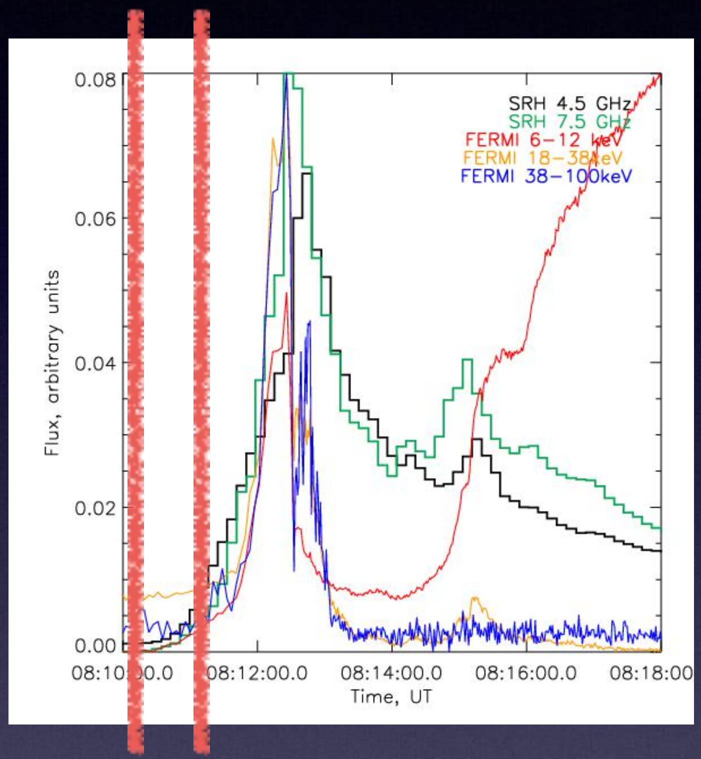
Theraml plasma: EM=1.5e+46 cm^{-1}, ;Te= 1.83 (22 MKT)

Non-thermal broken power law: γ 1=2.7, Ebr=38 keV, γ 2= 3.9

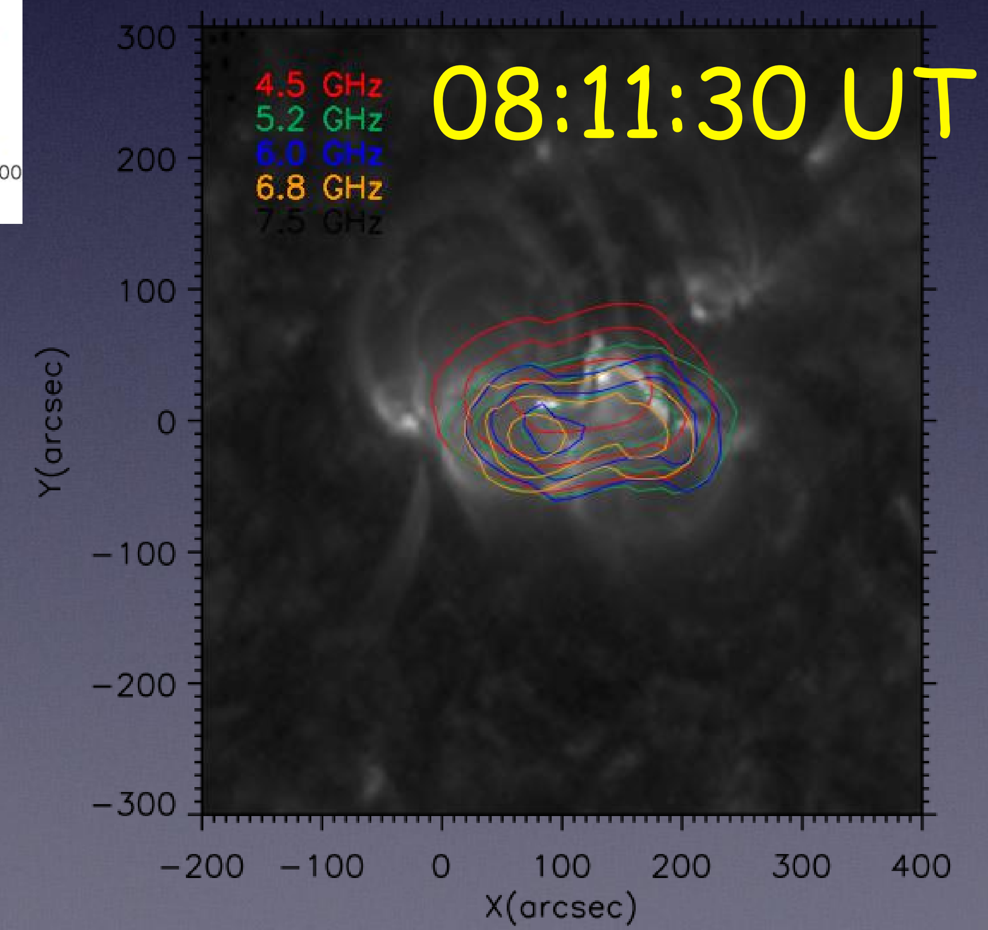
Topology and evolution of microwave source

171 A (SDO/AIA)

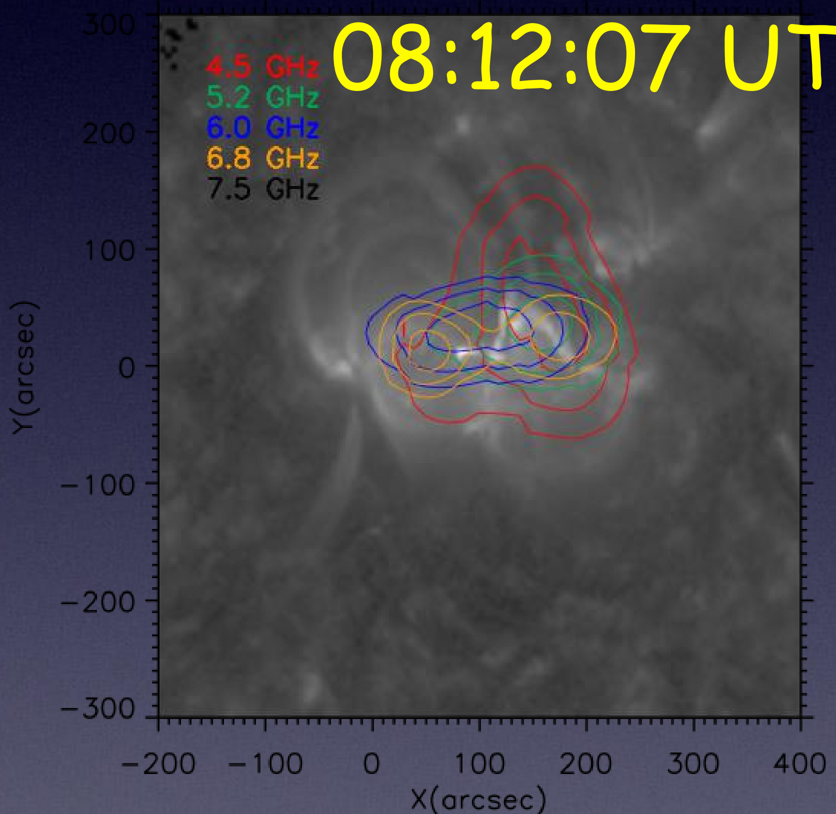


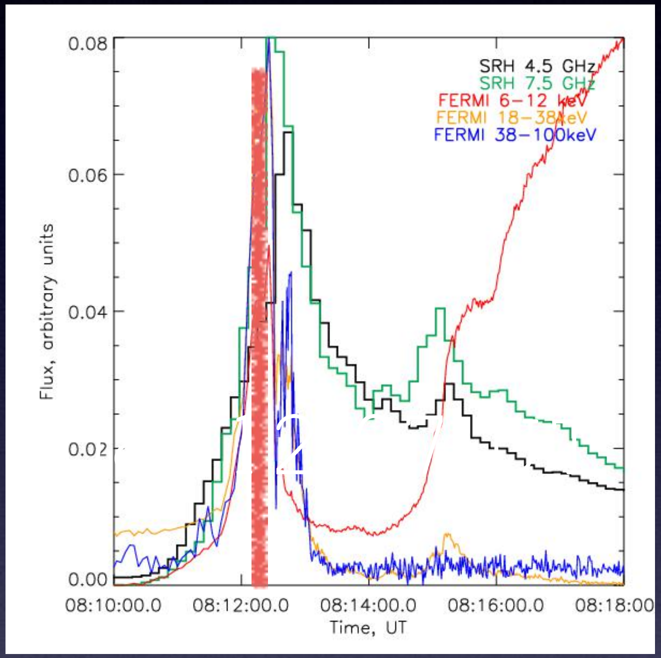


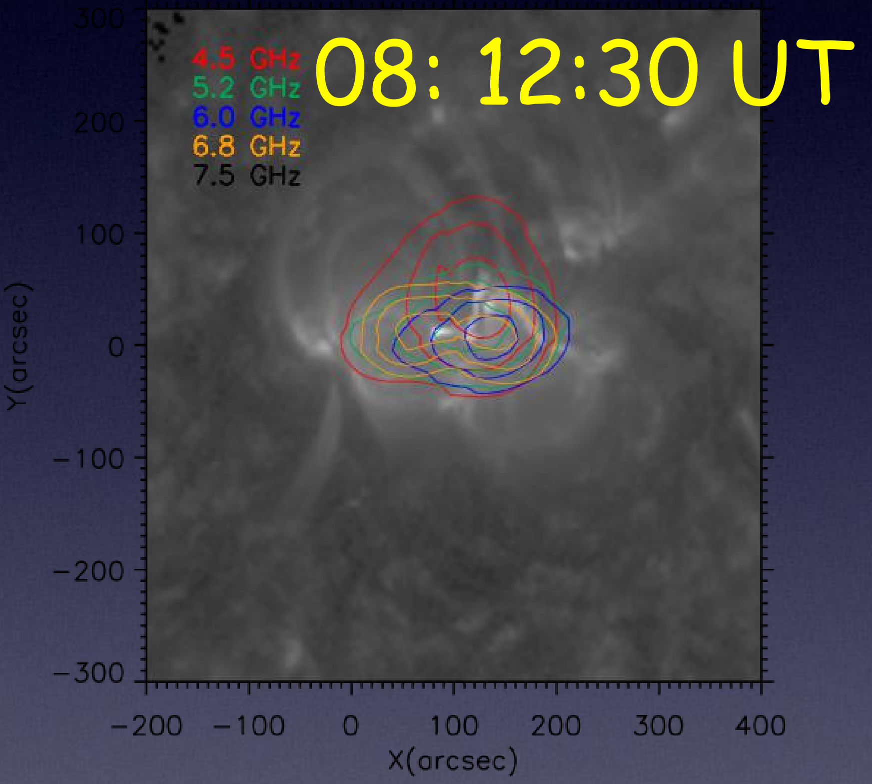
131 A (SDO/AIA)

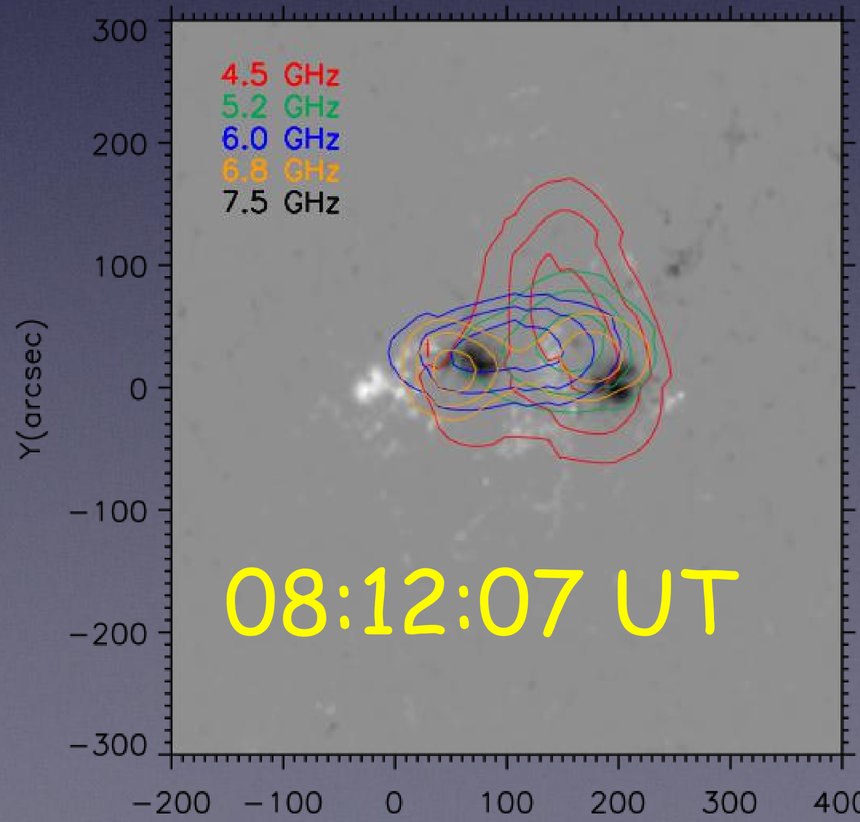


Topology and evolution of microwave source









Weak flares are not borrowing flares

Weak solar flares show the presence of various emission mechanisms - heating (thermal)/accelararted particles, gyrosynchrotron / plasma radio emission mechanisms and extra high-temperature plasma

We observe the fine structure in radio and X-rays more often than not.

Combination of 1D X-ray time profiles with observations of the modern radio heliographs/spectrographs allows revealing processes in weak flares successfully.

Thank you for attention!!