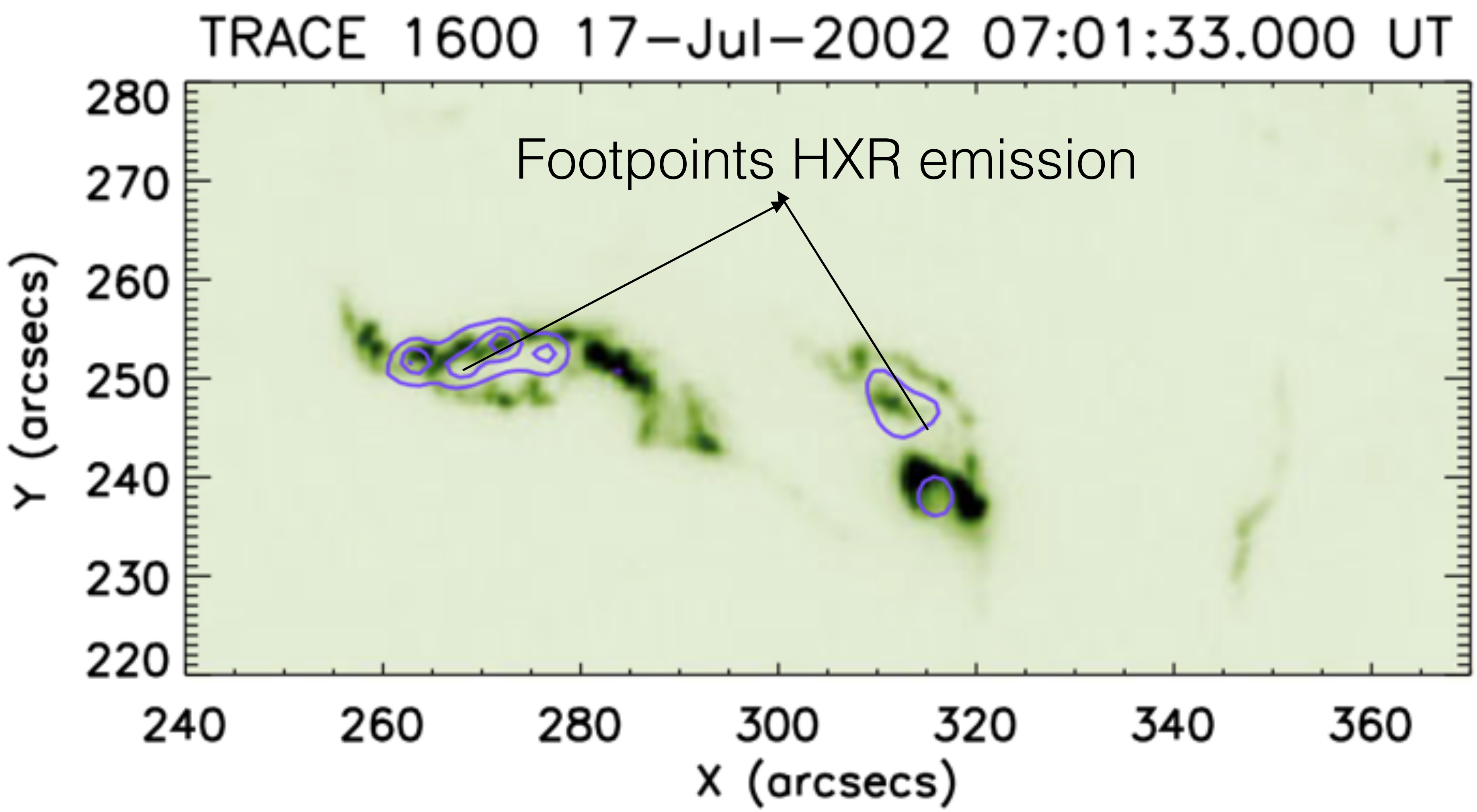
Inverse Compton and KH Instability?

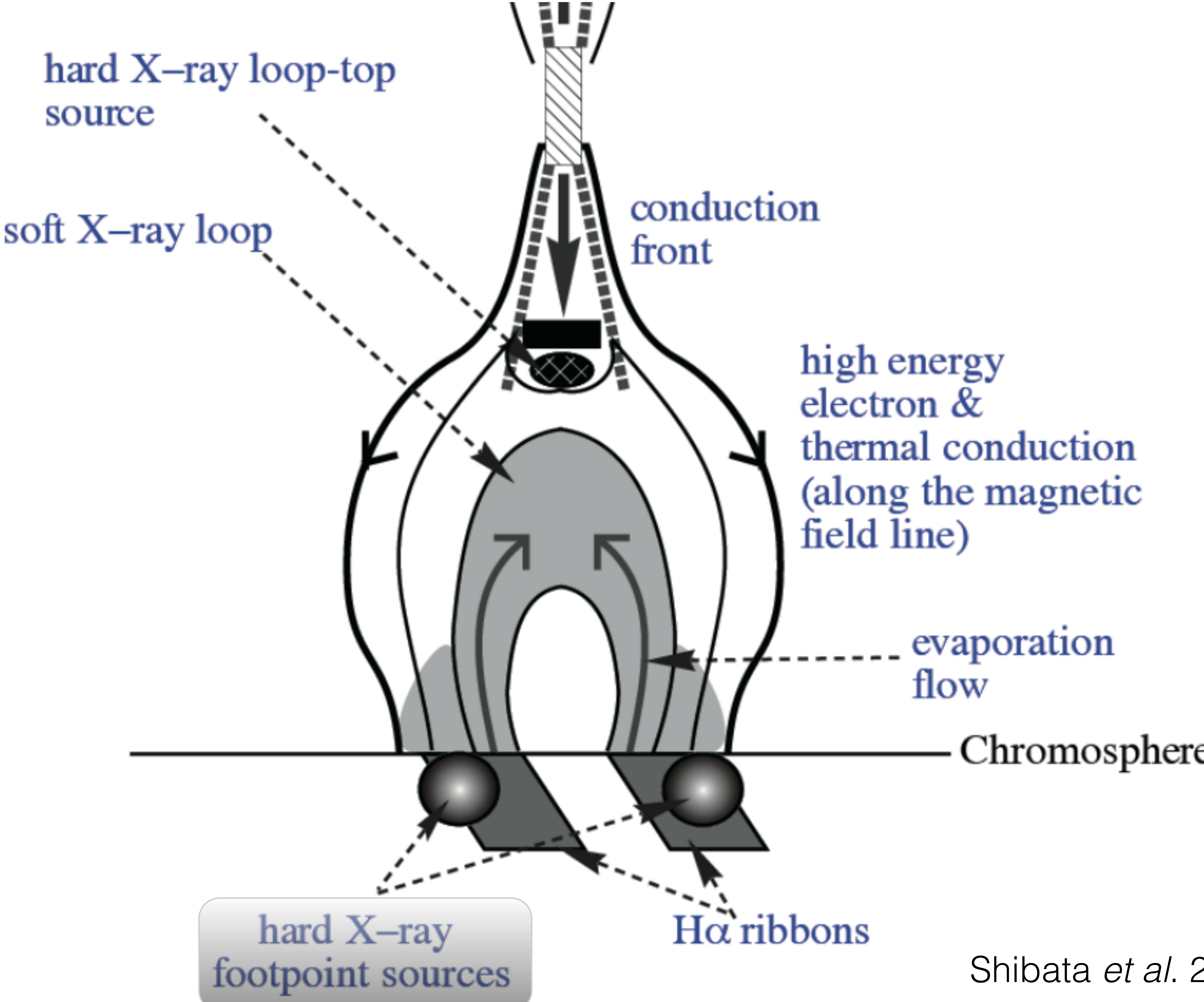
for Coronal HXR sources

Xia Fang
Tom Van Doorsselaere
Rony Keppens
CmPA, KU Leuven, Belgium

Footpoints HXR emission



RHESSI (blue contours, 25–50 keV) and TRACE (image,1600) observation of SOL2002-07-17T07:13 (M8.5) by Krucker *et al.* 2008



Shibata *et al*. 2011

Footpoints HXR emission

Thick target model (Brown 1971):

free-free (bremsstrahlung) emission,

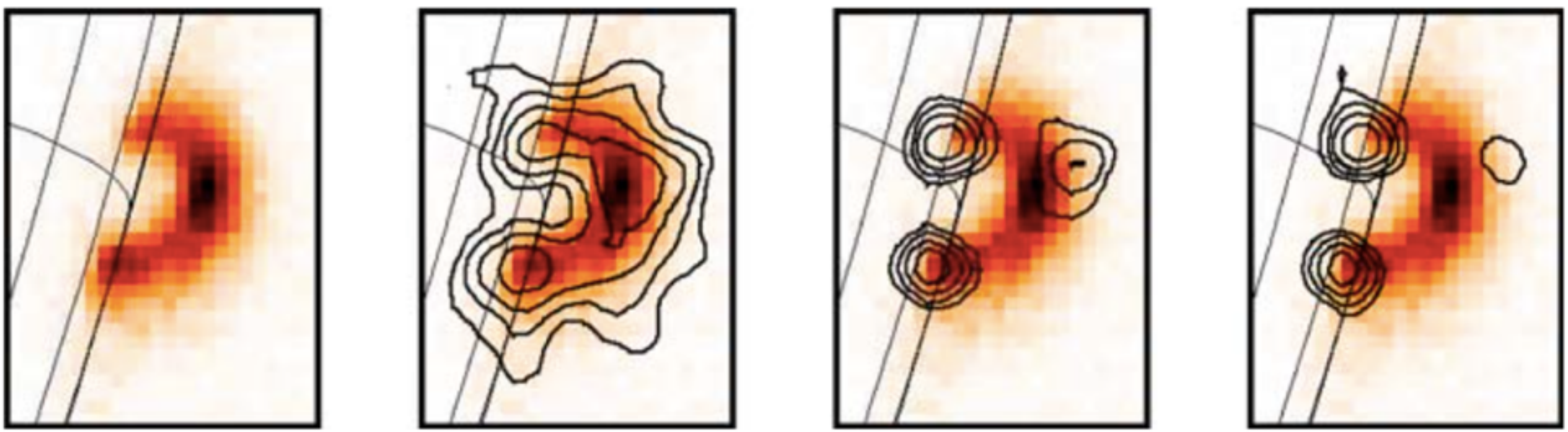
between non-thermal particles and chromosphere plasma

Column depth (Emslie 1978):

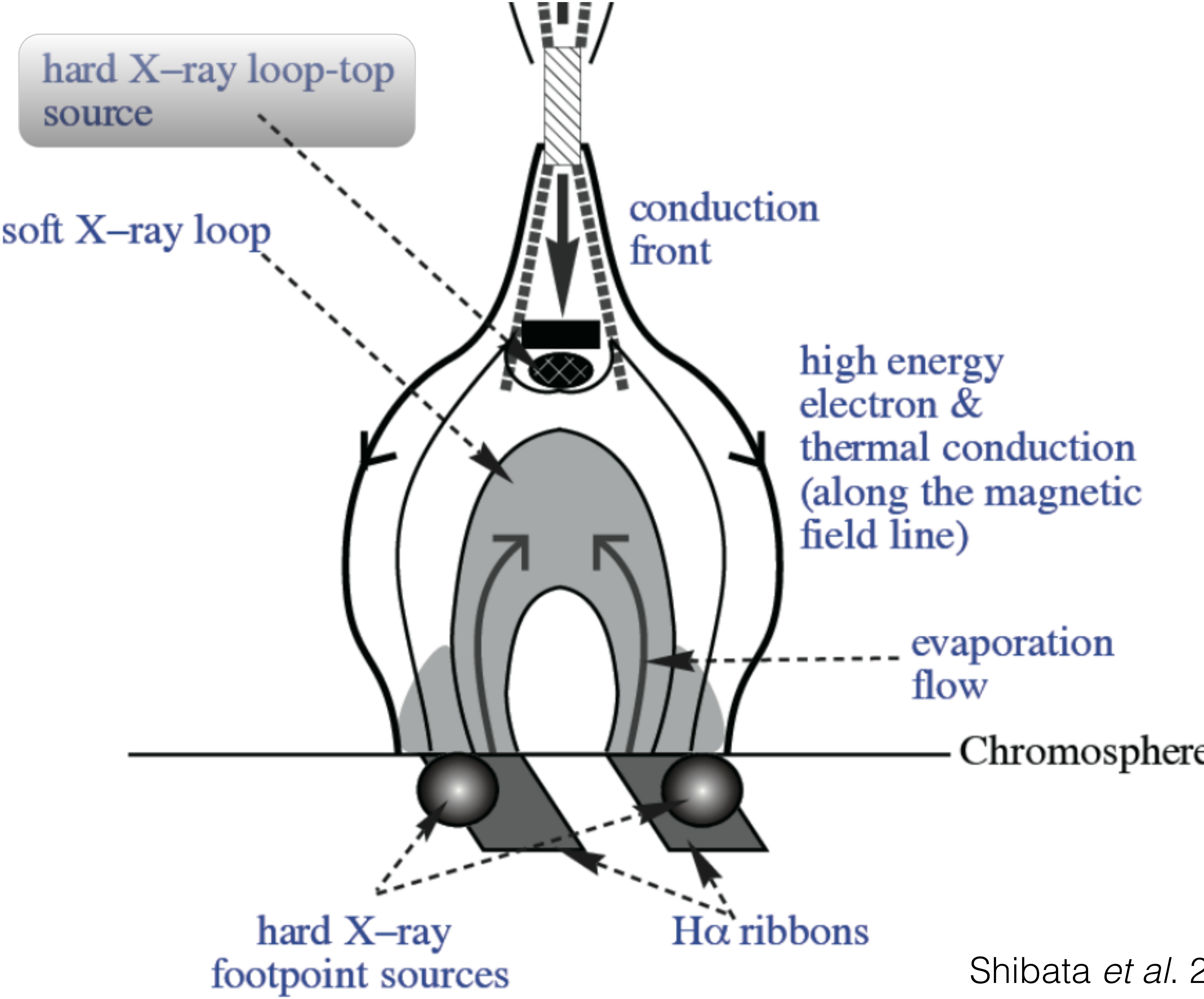
a non relativistic electron of initial energy *E* (keV) stops completely

$$N_s(E) = 1.5 \times 10^{17}\mathrm{cm}^{-2}\ (E/\mathrm{keV})^2$$

Coronal HXR Sources

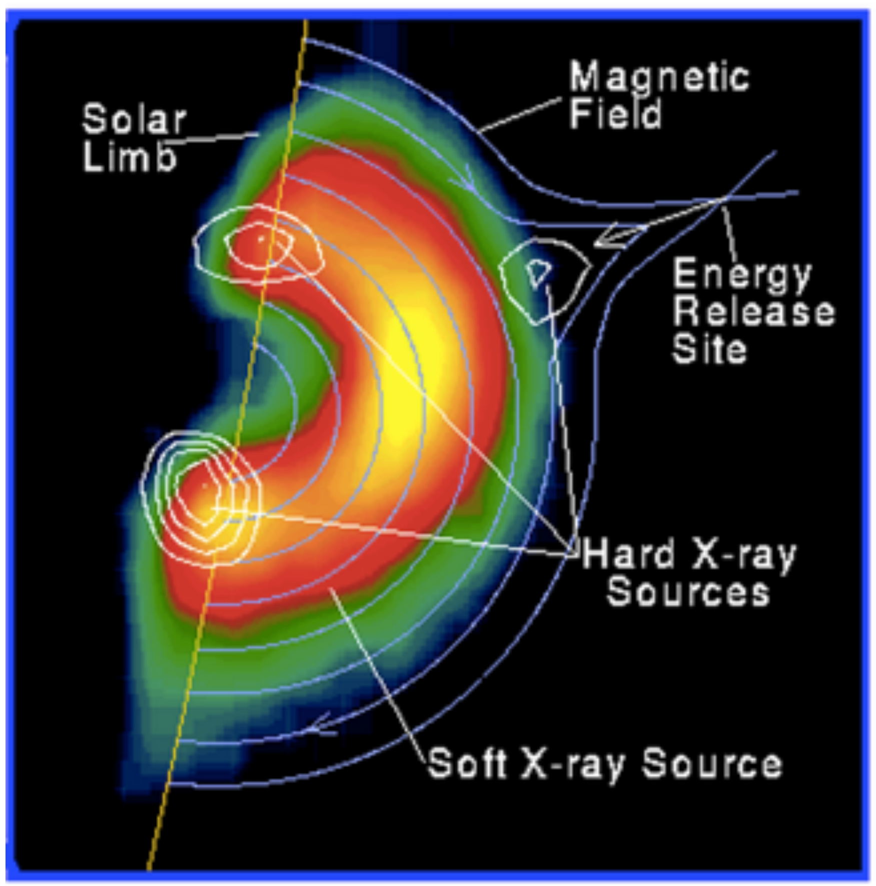


Hard X-ray Contour and soft X-ray images of the 13 January 1992 flare, taken with the *Yohkoh*/SXT (Masuda et al. 1994). The field of view is 59"× 79" for all panels.



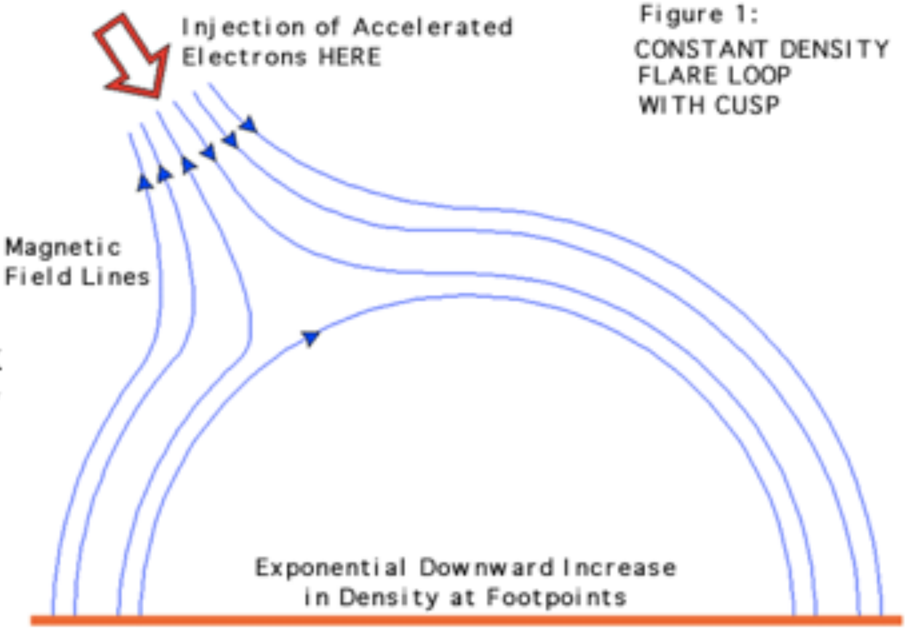
Shibata *et al*. 2011

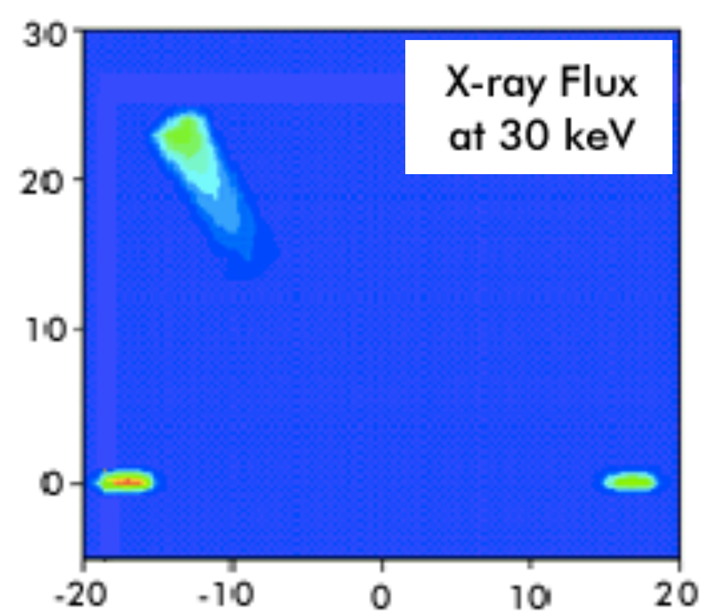
Masuda Flare



Holman 1996

X-ray Flux at 30 keV

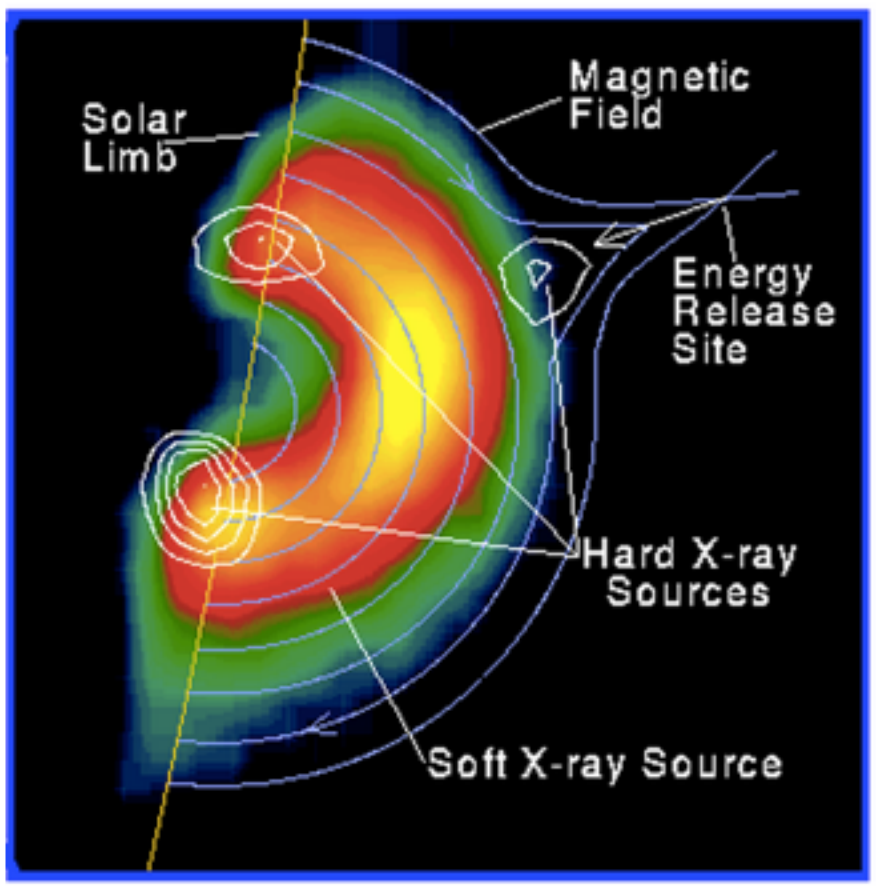




It seems that Standard model can explain everything perfectly.

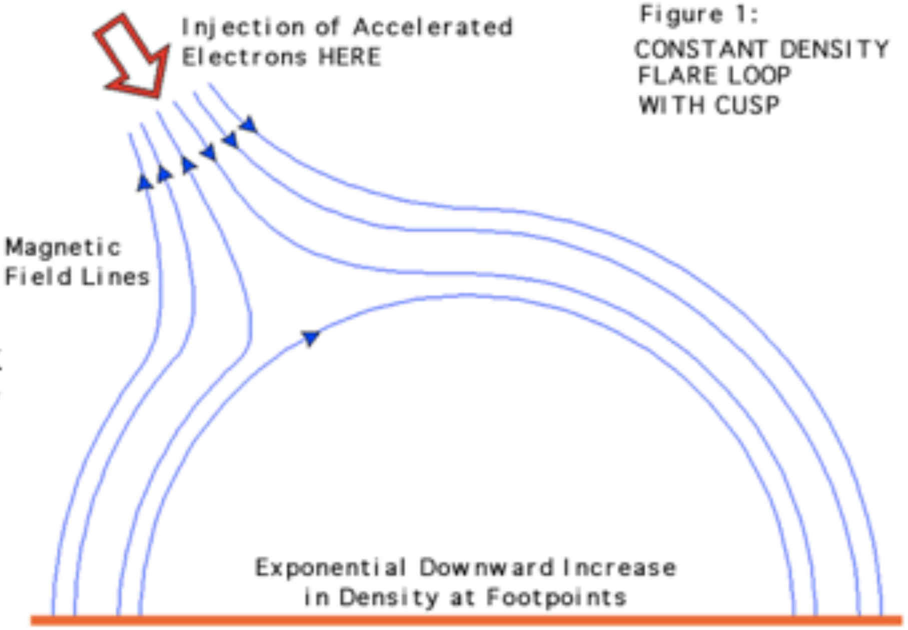
Is it?

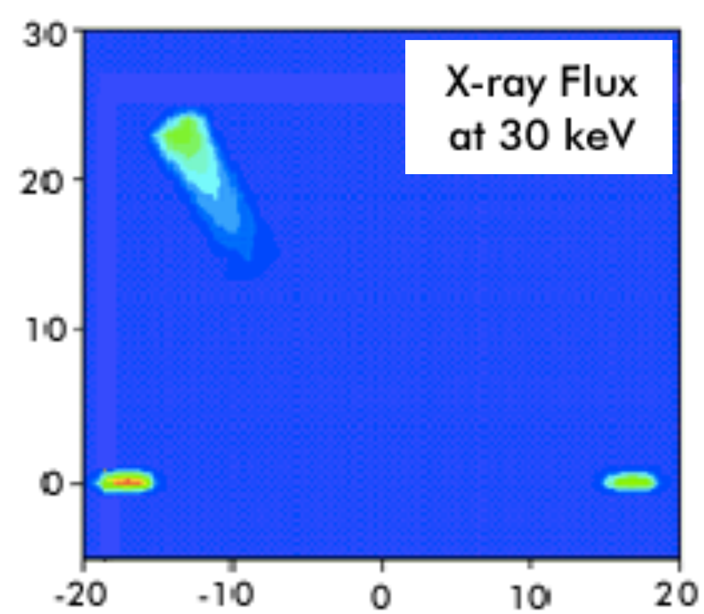
Masuda Flare



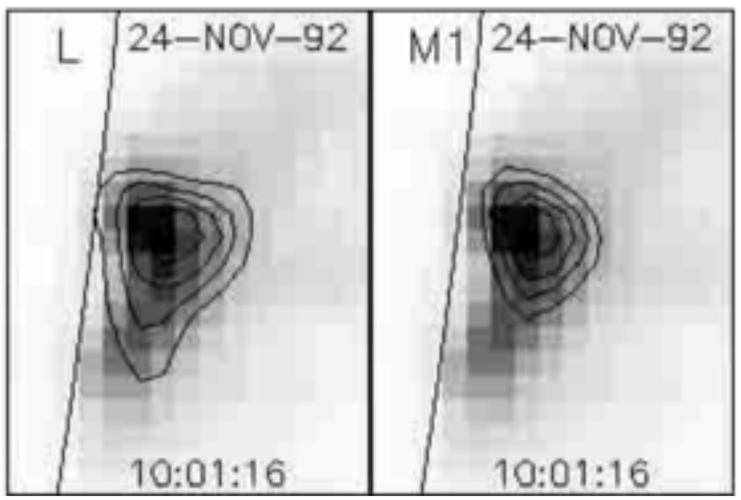
Holman 1996

X-ray Flux at 30 keV

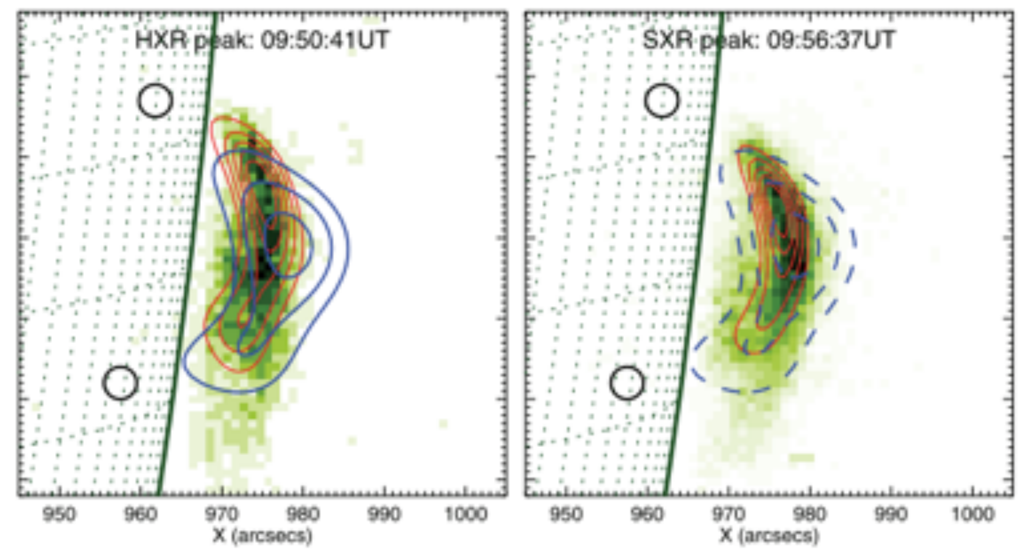




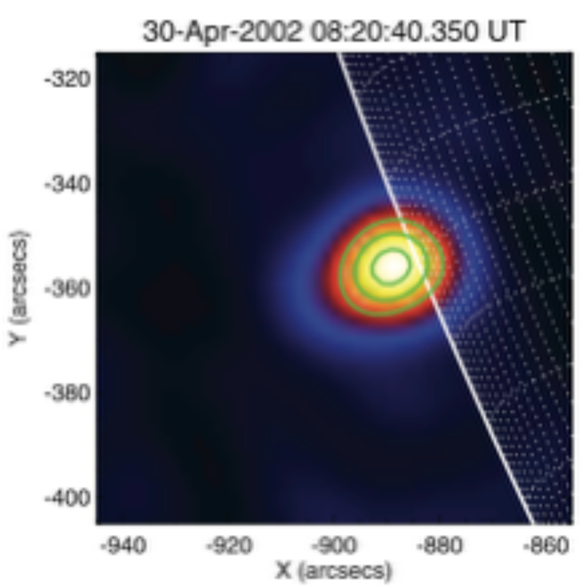
Loop-top HXR Sources



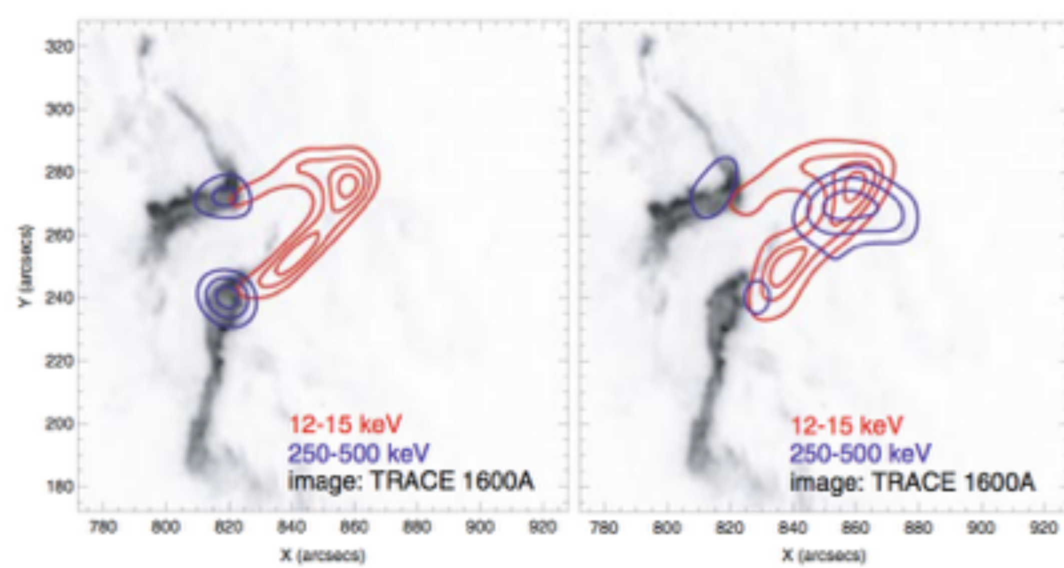
Tomczak 2001



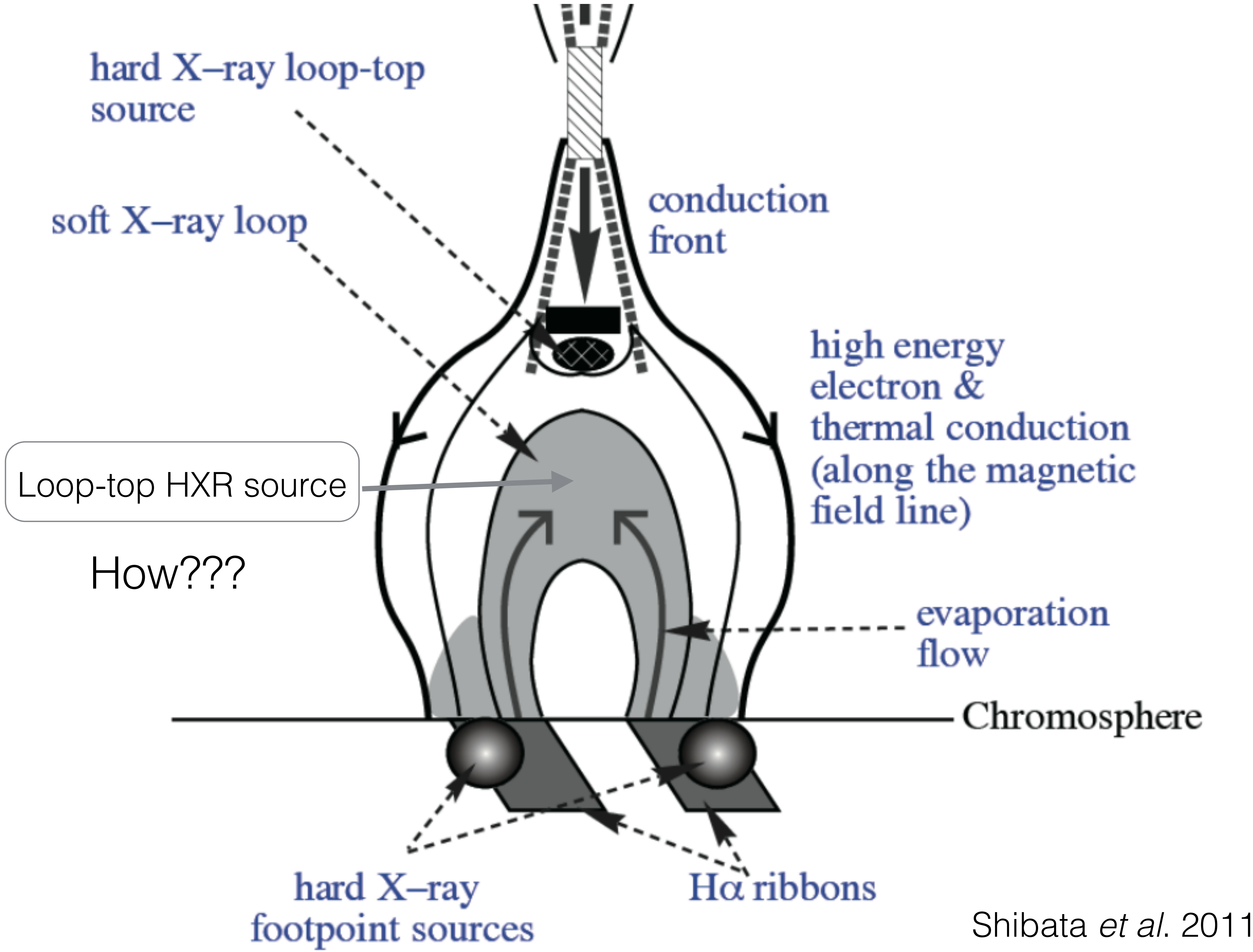
Krucker *et al.* 2007



Krucker *et al.* 2008



Hurford *et al.* 2002


hard X–ray loop-top source
soft X–ray loop
conduction front
high energy electron & thermal conduction (along the magnetic field line)
Loop-top HXR source
How???
evaporation flow
Chromosphere
hard X–ray footpoint sources
Hα ribbons
Shibata et al. 2011

Loop-top HXR Sources

Loop-top conditions:

low plasma density (normally 10^9~11/cm^3) and surrounded by plenty of soft X-ray photos

The temporal variant is the order of minutes and is most prominent during the rise of the thermal emission

???

Loop-top HXR Sources

Loop-top conditions:

low plasma density (normally 10^9~11/cm^3) and surrounded by plenty of soft X-ray photos

The temporal variant is the order of minutes and is most prominent during the rise of the thermal emission

Inverse Compton Emission (Korchak 1967, 1971):

An inverse Compton contribution might sometimes be significant, particularly in the low ambient density conditions relevant here.

$$\frac{j_{\mathrm{IC}}(\epsilon)}{j_{\mathrm{BR}}(\epsilon)} = \frac{3}{2\alpha}\frac{n_\nu}{n_p}(2\delta - 1)Q(\delta)\left(\frac{\epsilon}{4\epsilon_i}\right)^{(1-\delta)/2}\left(\frac{\epsilon}{m_e c^2}\right)^{\delta-1/2}$$

Loop-top HXR Sources

non-thermal Particles:

How can we accelerate the particles and trap them at loop-top?

In the order of minutes.

???

Loop-top HXR Sources

non-thermal Particles:

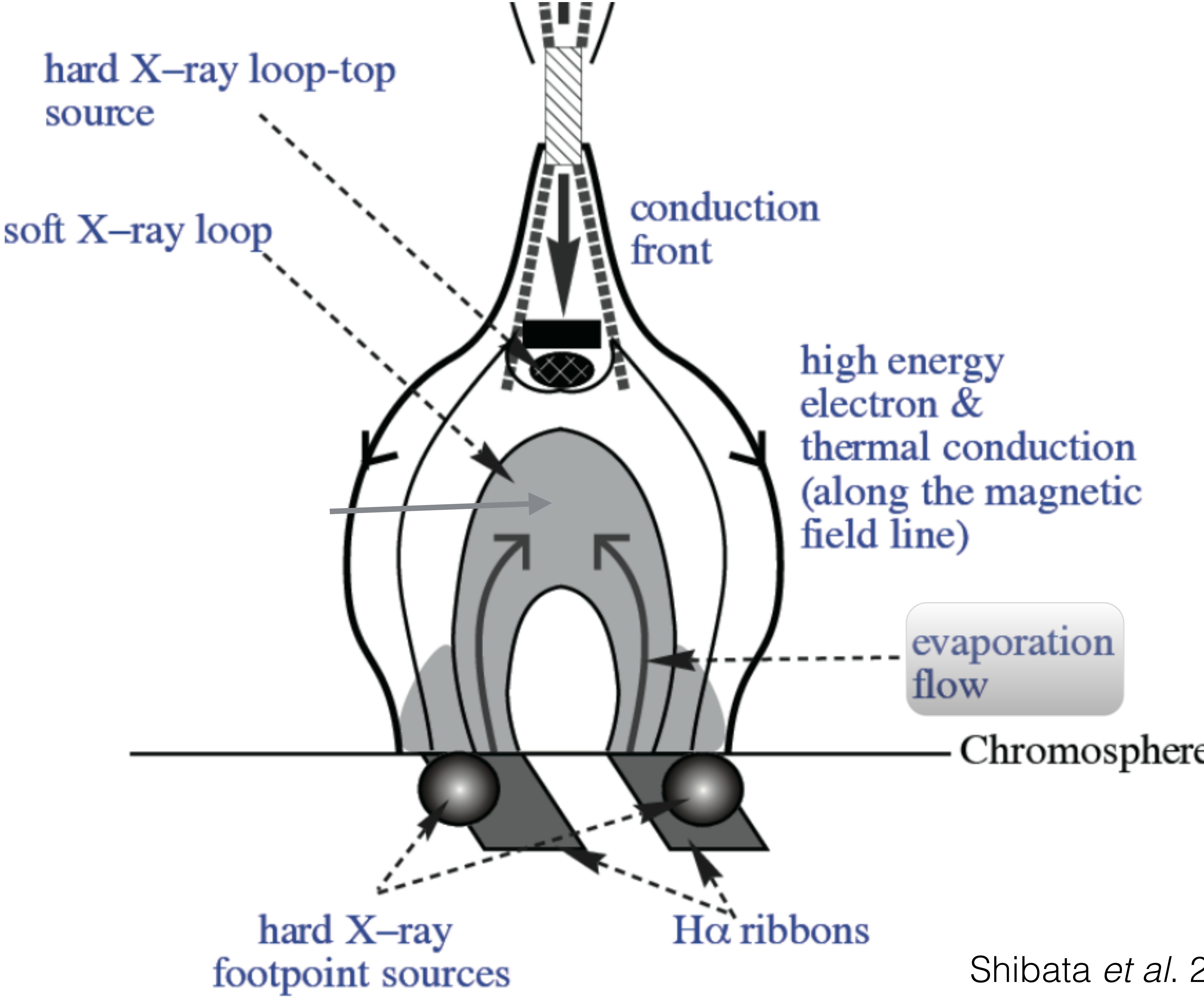
How can we accelerate the particles and trap them at loop-top?

In the order of minutes.

waves and turbulences (Liu 2006,Krucker 2008):

How can we trigger the waves and turbulences?

???

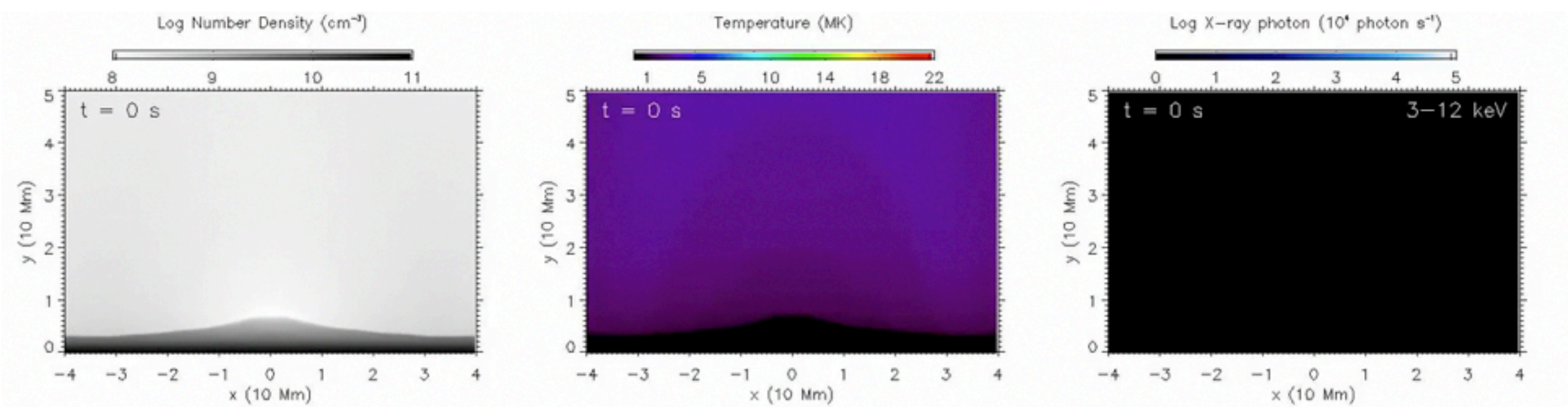


Shibata *et al*. 2011

Numerical Result

Add asymmetric flare energy at two footpoints for 3 mins

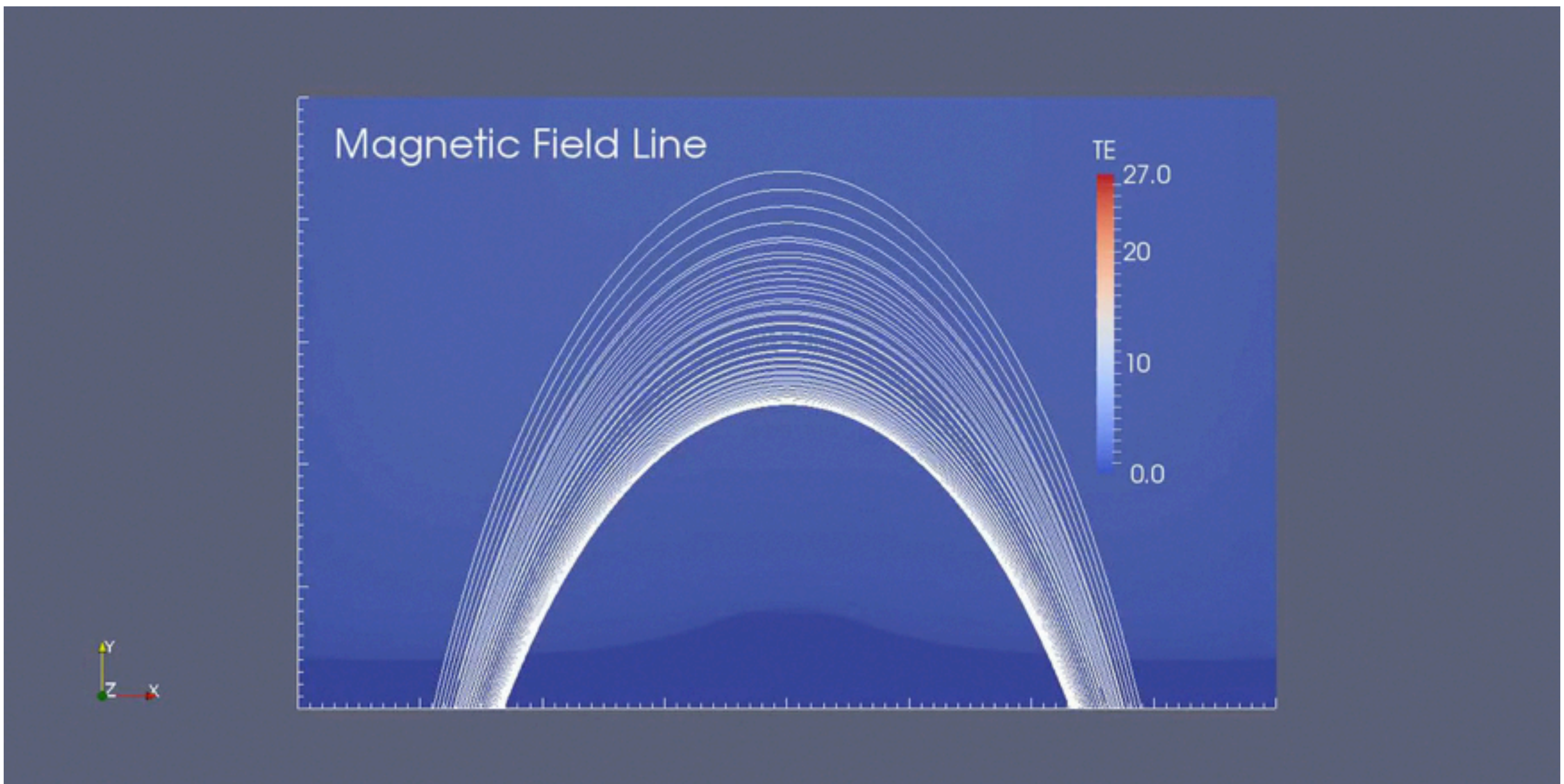
40G at the height of 30 Mm



Numerical Result

Magnetic islands formation

Turbulence, shocks



Future

Add particle guiding center method

Accelerate the particles to non-thermal particles

Maybe 3D, if I have time…

Thank You For Attention