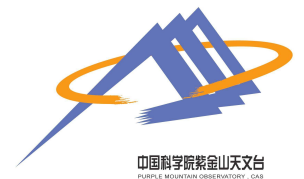


Reconnection Region and Accelerated Electron Numbers in Solar Flares

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Purple Mountain Observatory

9th RHESSI Workshop, Sept. 1-5, 2009, Genova



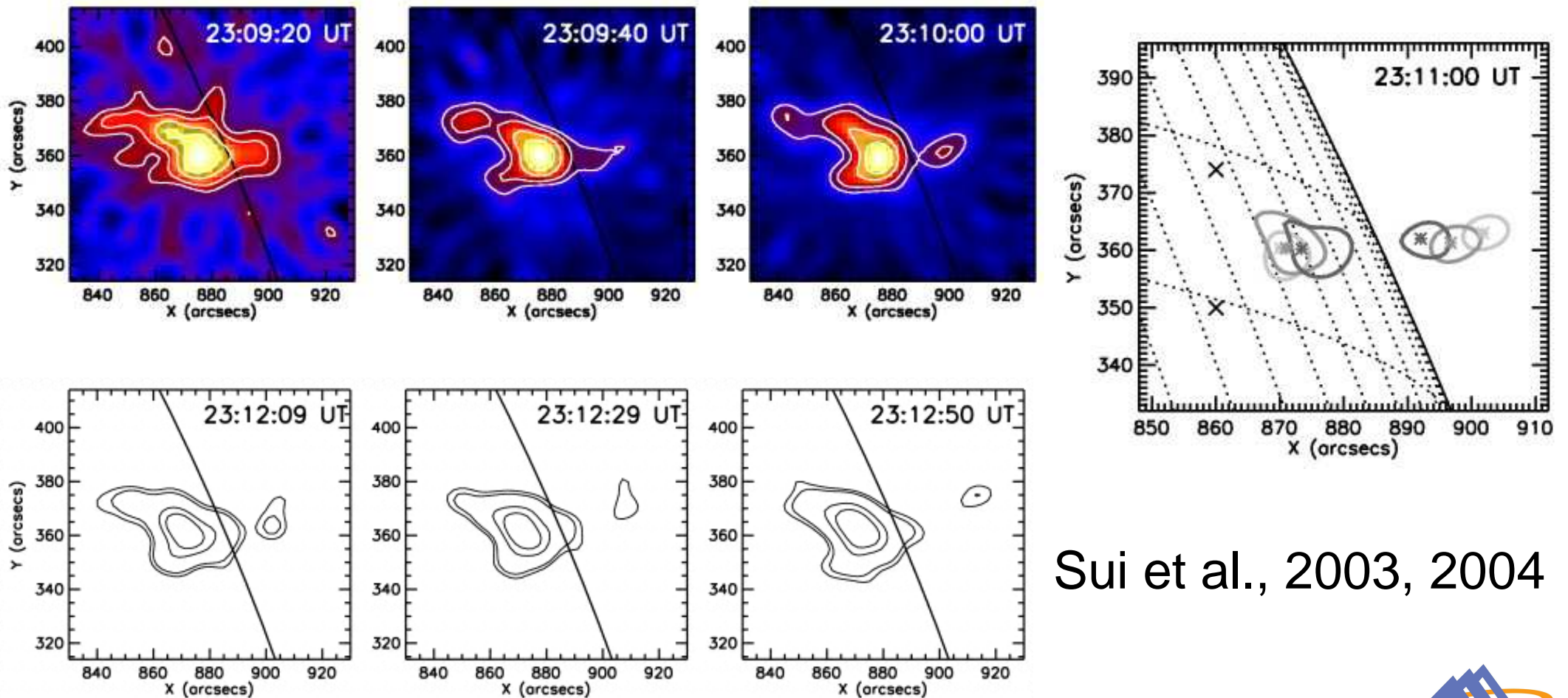
■ Introduction

A well-known problem: where does the huge number of hard X-ray producing electrons come from?

Miller et al. (1997): for an X-class event, the energetic electron flux of $10^{37}/s$ and total number of 10^{39} are required; while in a typical flaring loop system, only 10^{37} electrons exist there!

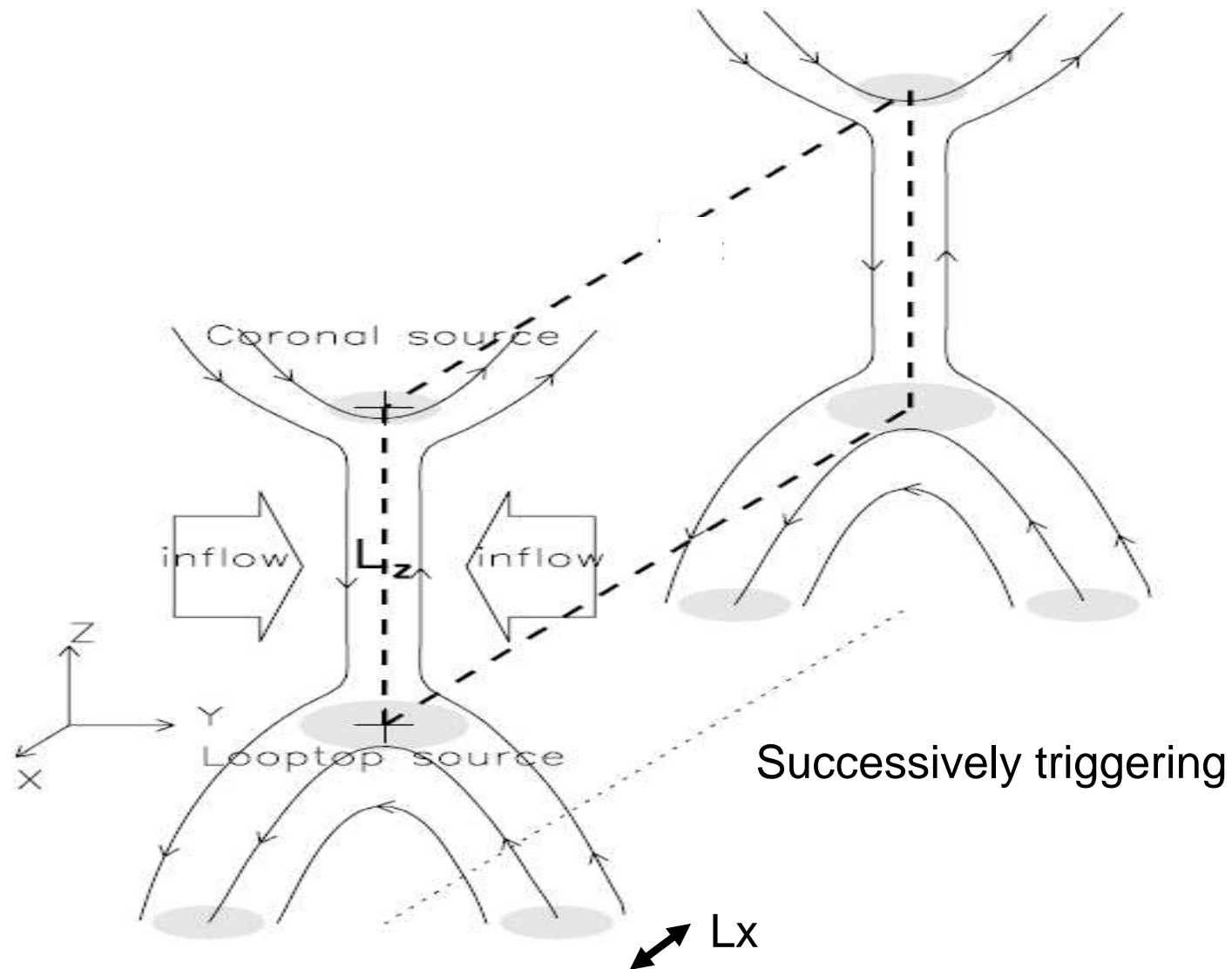
RHESSI: provides us a new chance to revisit this problem

■ Reconnection region observed by RHESSI



Sui et al., 2003, 2004

RHESSI observation defines better the size of the reconnection region



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The speed of influx:

Theoretic model: 10-20 km/s (Petschek 1964)

Observations:

Yokoyama et al. (2001) $\sim 5 \text{ km s}^{-1}$

Narukage & Shibata (2006) 2.6-38 km s^{-1}

Isobe et al. (2005) 30-130 km s^{-1}

Lin et al. (2005) 10.5-106 km s^{-1}

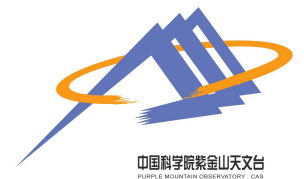
Nagashima & Yokoyama (2006) tens of km s^{-1}

Hara et al. (2006) 3 km s^{-1}

.....

**in our studies influx speed of 50 km s^{-1} and
coronal density of 10^{10} cm^{-3} are taken**

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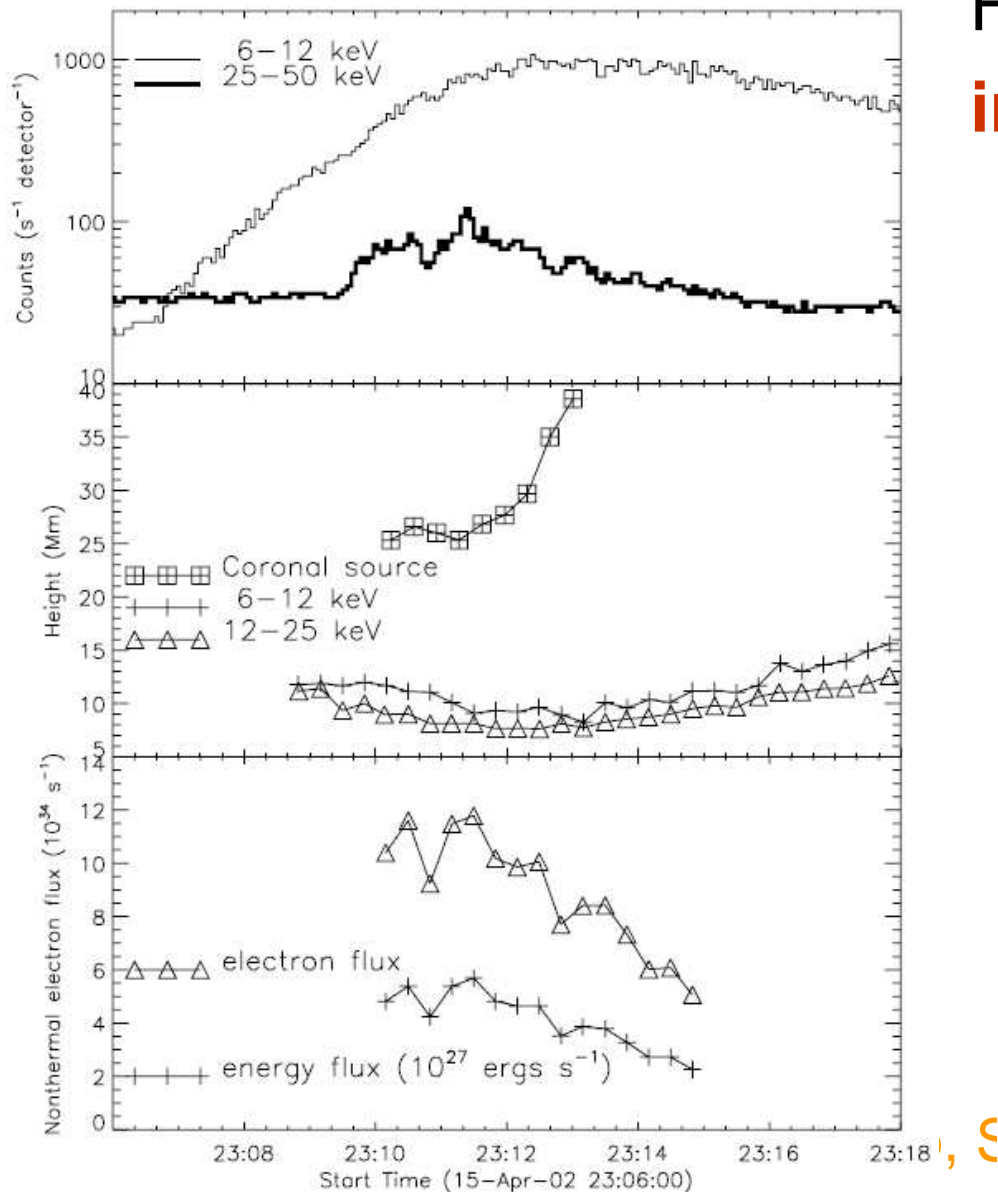


3 RHESSI events / 1

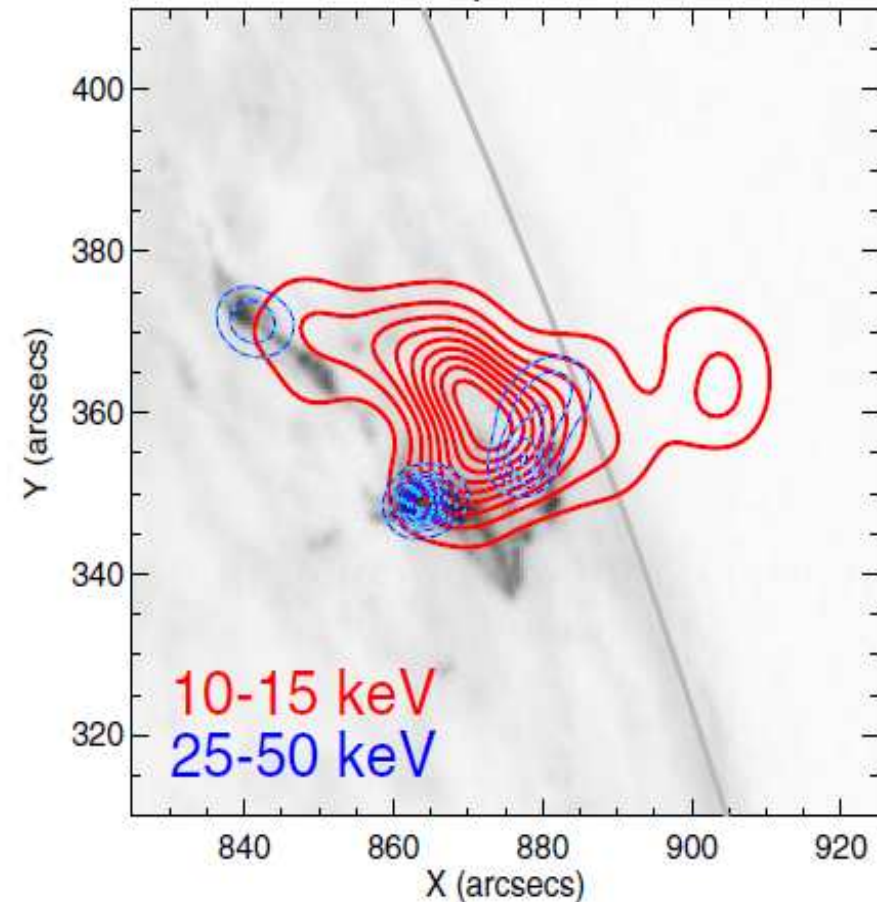
Apr. 15, 2002: $L_z \sim 13000$ km; $L_x \sim 7000$ km $\rightarrow 9 \times 10^{34}$ /s

HXR spectral fit $\rightarrow 1.1 \times 10^{35}$ /s

influxed number is smaller



TRACE 1600A: 15-Apr-2002 23:10:52.000 UT



3 RHESSI events / 2

Apr. 16, 2002:

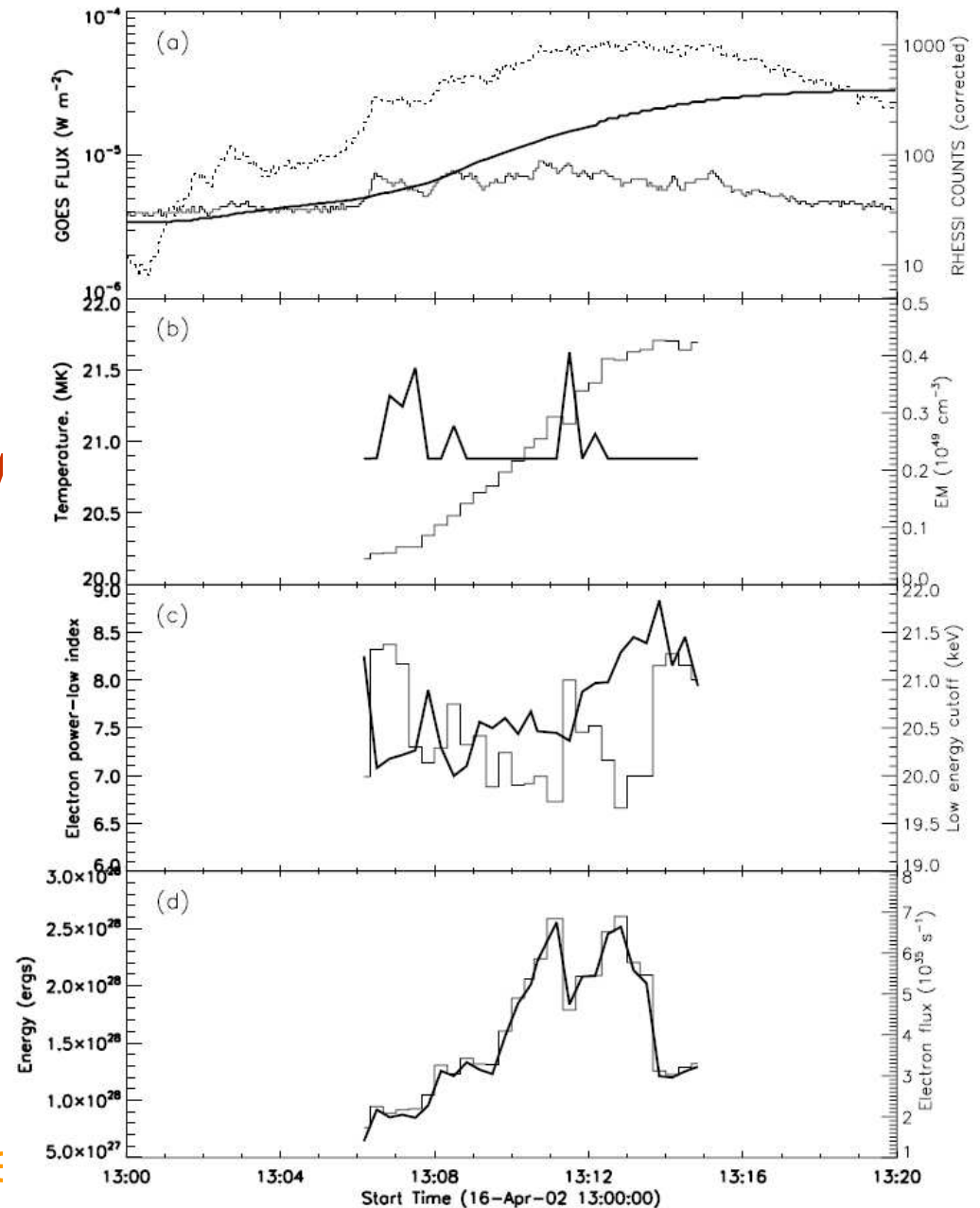
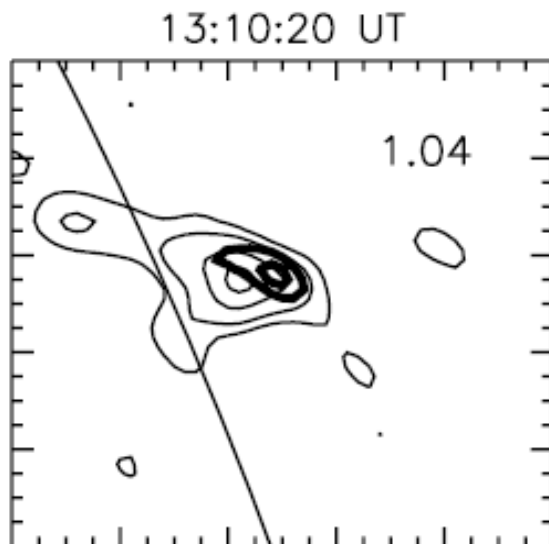
Lz ~ 20000 km;

Lx ~ 7000 km →

$1.4 \cdot 10^{35}/s$

HXR spectral fit → $5 \cdot 10^{35}/s$

influxed number is obviously smaller

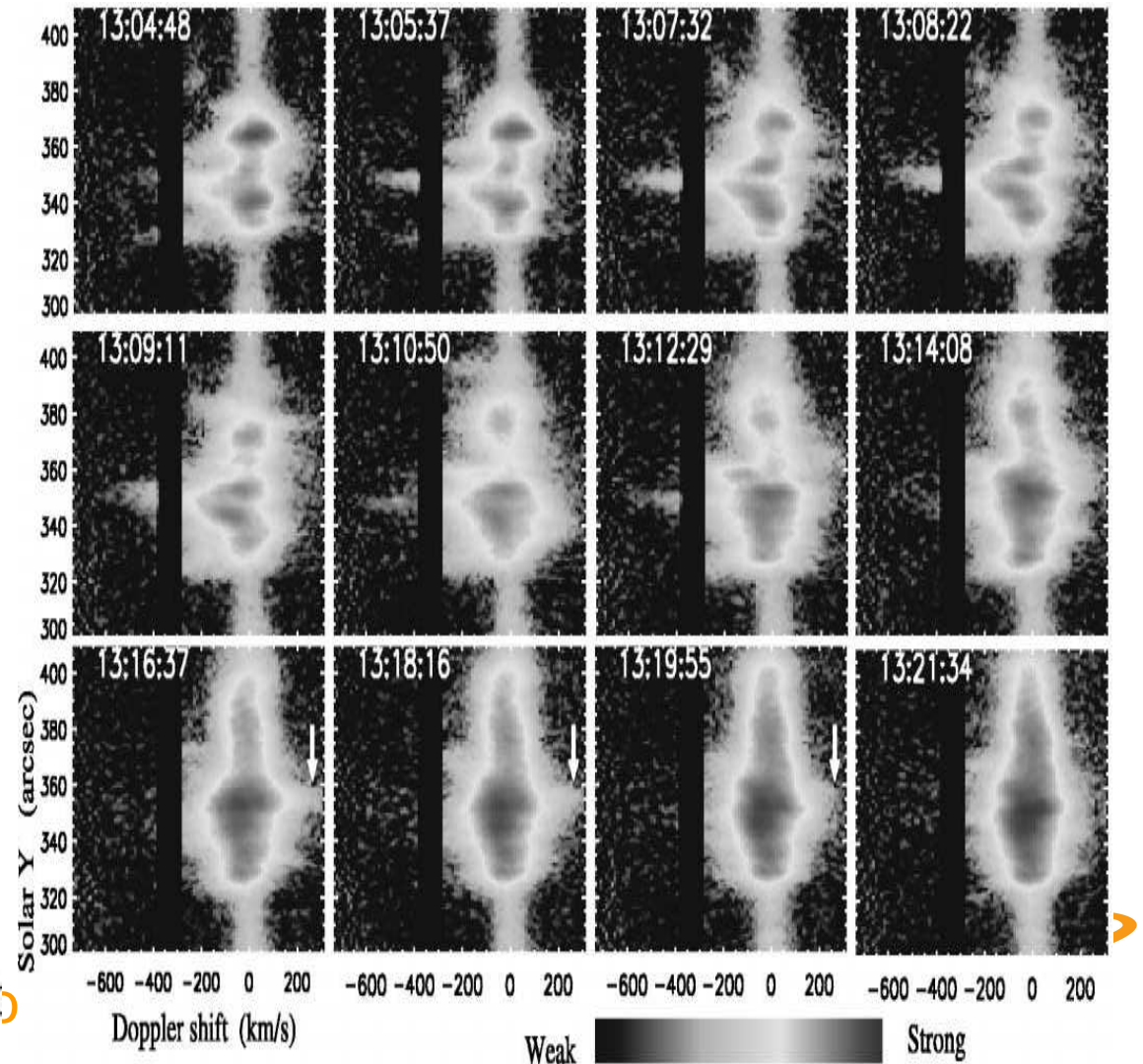
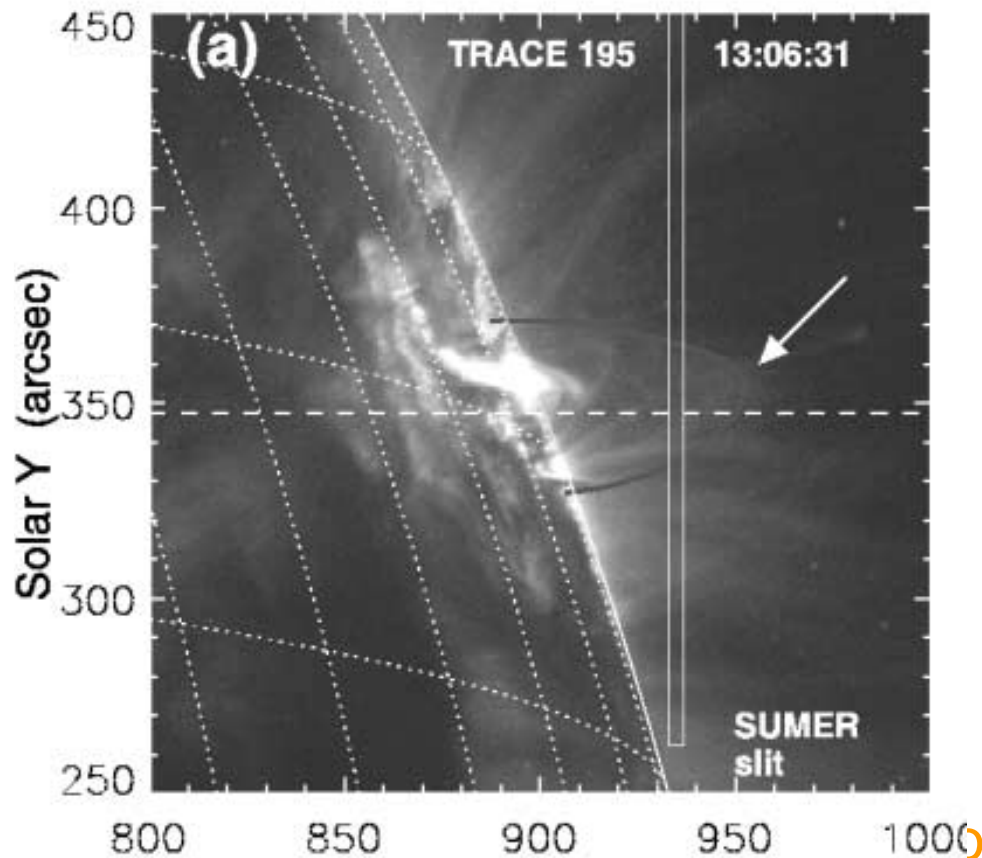


Another estimate of L_z (Wang et al. 2007; Goff et al. 2005), observed with SUMER/SOHO \rightarrow

$L_z \sim 10000 \text{ km} \rightarrow$

influxed number is even smaller!

$7 \cdot 10^{34}$ versus $5 \cdot 10^{35}$



■ 3 RHESSI events / 3

Apr. 30, 2002:

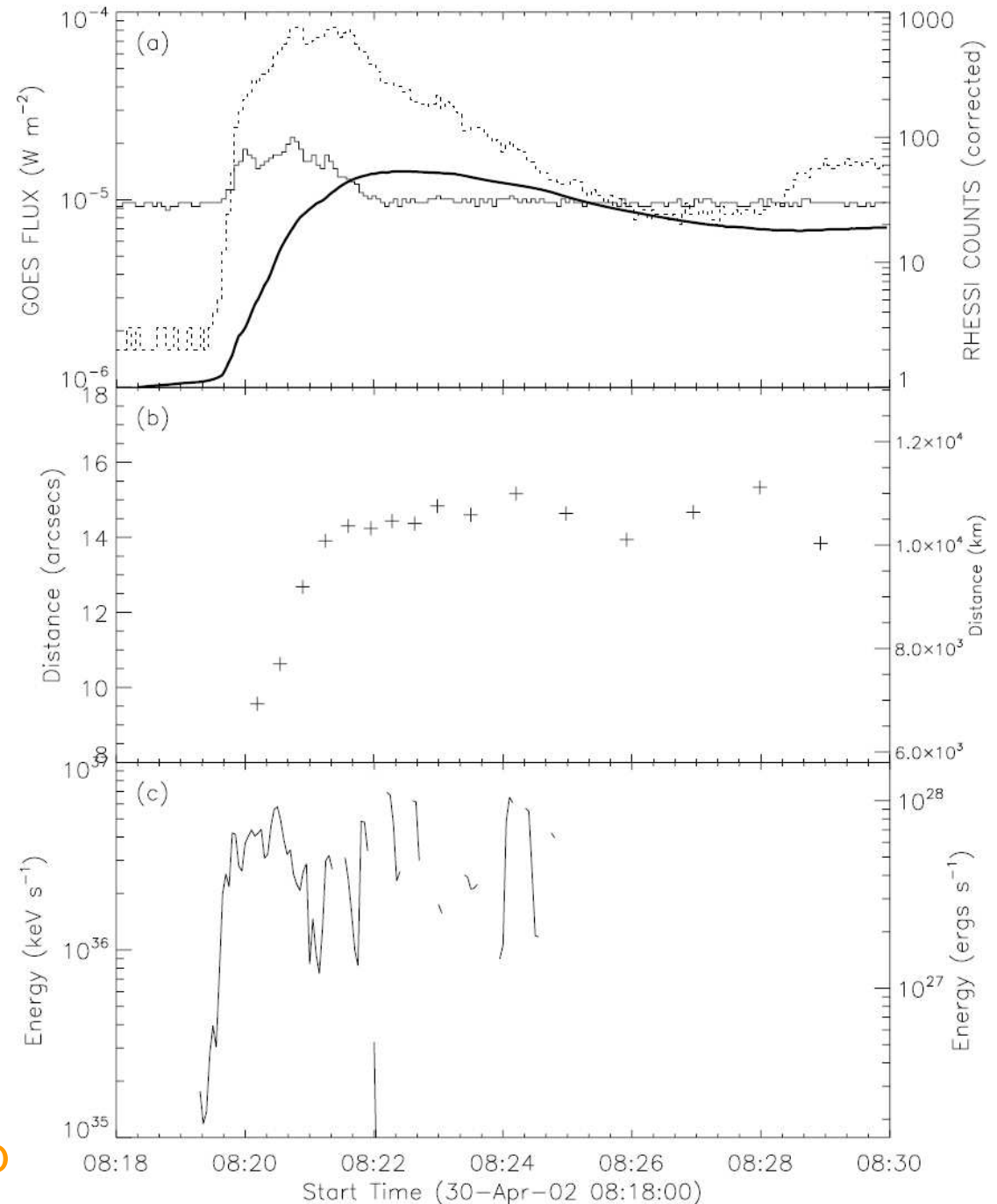
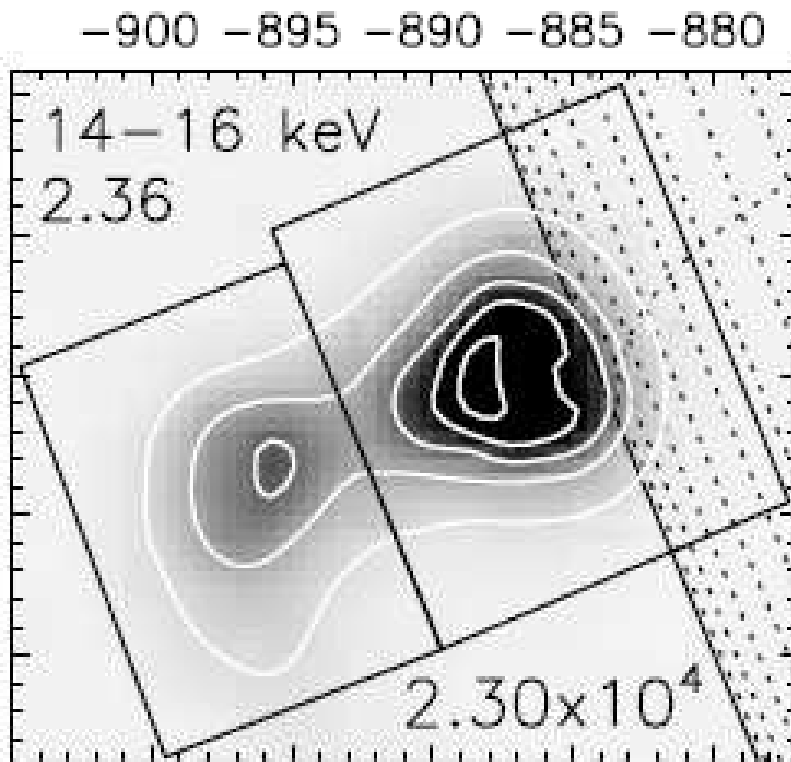
Lz ~ 10000 km

Lx ~ 7000 km →

$7 \cdot 10^{34} \text{ s}^{-1}$

Thermal energy rate is estimated $4 \cdot 10^{36} \text{ keV/s} \rightarrow$

$1.3 \cdot 10^{35} \text{ s}^{-1}$



op

■ Conclusions and discussions

With RHESSI observations, we confirmed that the influxed number of electrons into the reconnection region is not enough to provide the hard X-ray producing electrons.

Possible solutions:

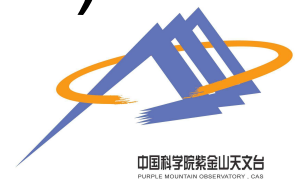
Alfven waves (Fletcher & Hudson, 2008):

Acceleration may happen at chromosphere

LRTTM (Brown et al. 2009, 9th RHESSI workshop)

High lower energy cutoff (Gan et al. 2001)

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Thank you!

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