Plasma diagnostics of a CME-associated current sheet

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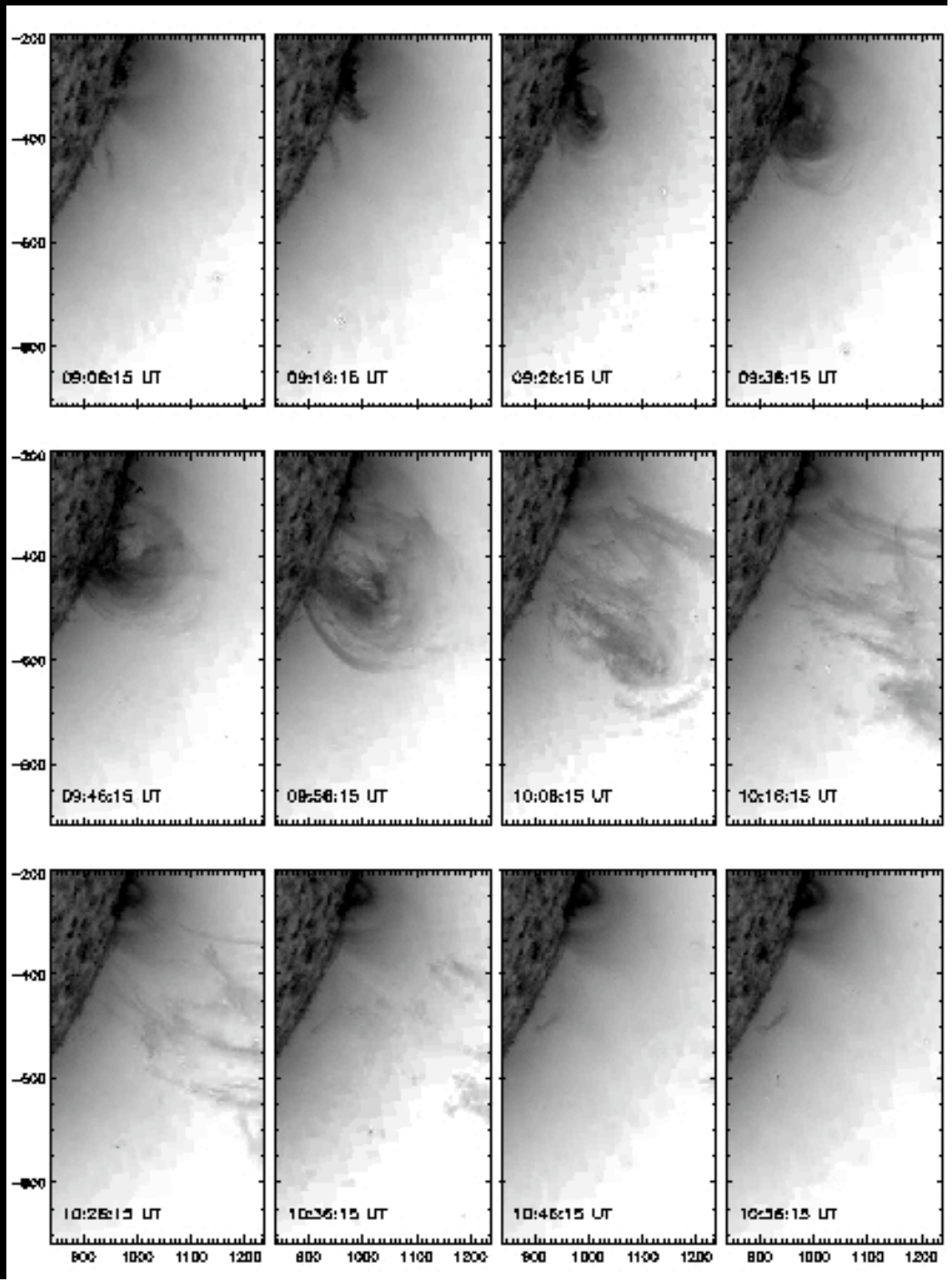
Observations

Instruments we were using:

- Hinode — EIS, XRT
- STEREO — EUVI, COR-1, COR-2
- SOHO — EIT, LASCO, UVCS

Event date: 9 April 2008

EIS data: Full spectral scans
Sit'n'stare
10 minute cadence



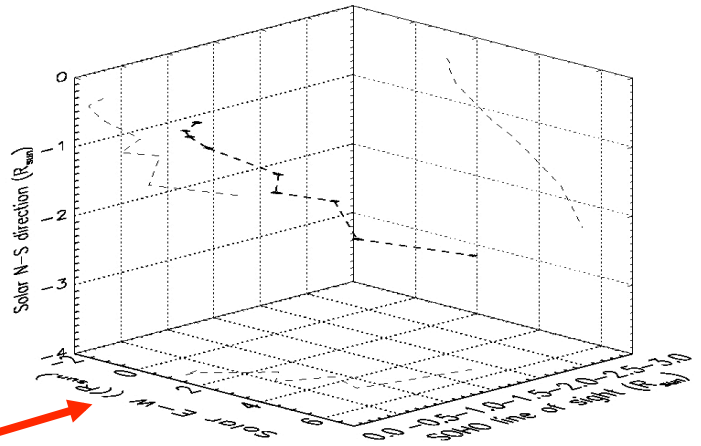
Diagnostics of the core

Landi et al. (2010)

3-D dynamics

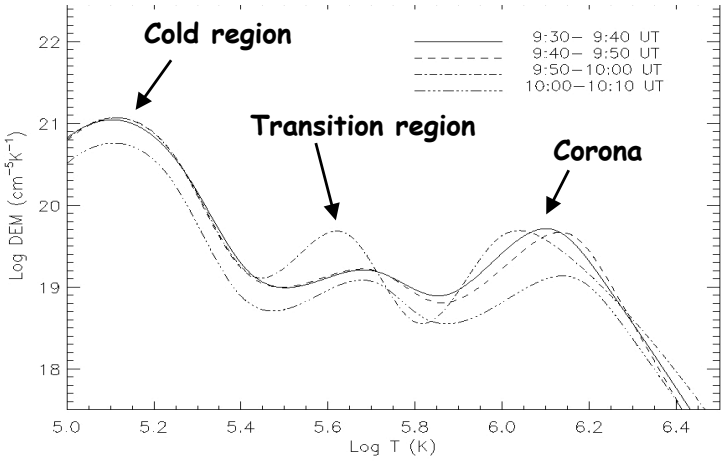
Initial change of direction
Acceleration up to 5 R_{sun}

Earth's direction



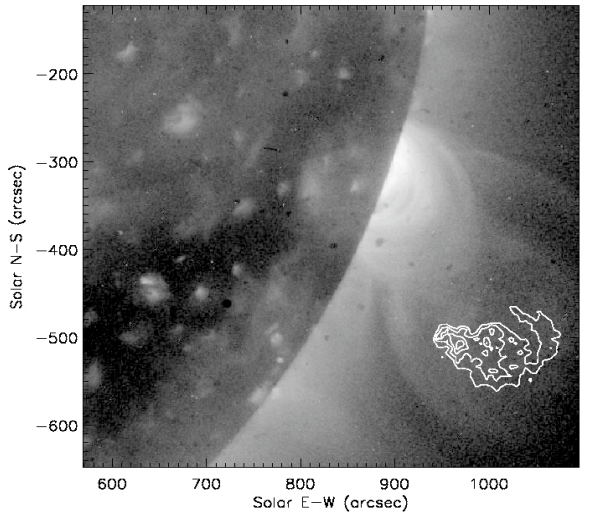
Core thermal structure

Three distinct components
Little temporal variations
Corona is only background



Trailing hot plasma

XRT plasma trails EIT/EIS plasma
Log T ~ 6.8-7.0



Looking at the other half of the event

The active region should generate loops:

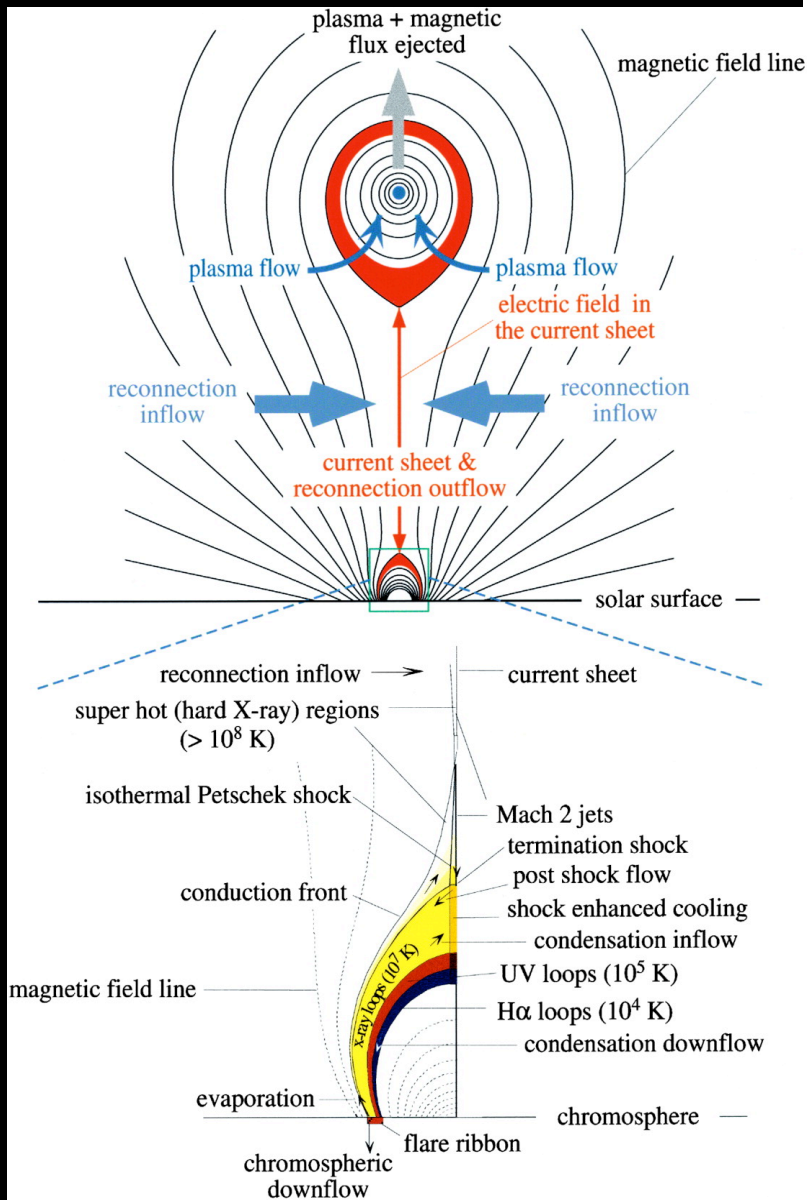
- Hot loops form below current sheet

- Colder loops form by cooling

Can EIS and XRT see them?

EIS loops	He II	H-alpha
EIS	Si VI-Fe IX	UV loops
EIS loops	Fe XIV-XVII	X-ray
XRT		X-ray loops

Lin 2004

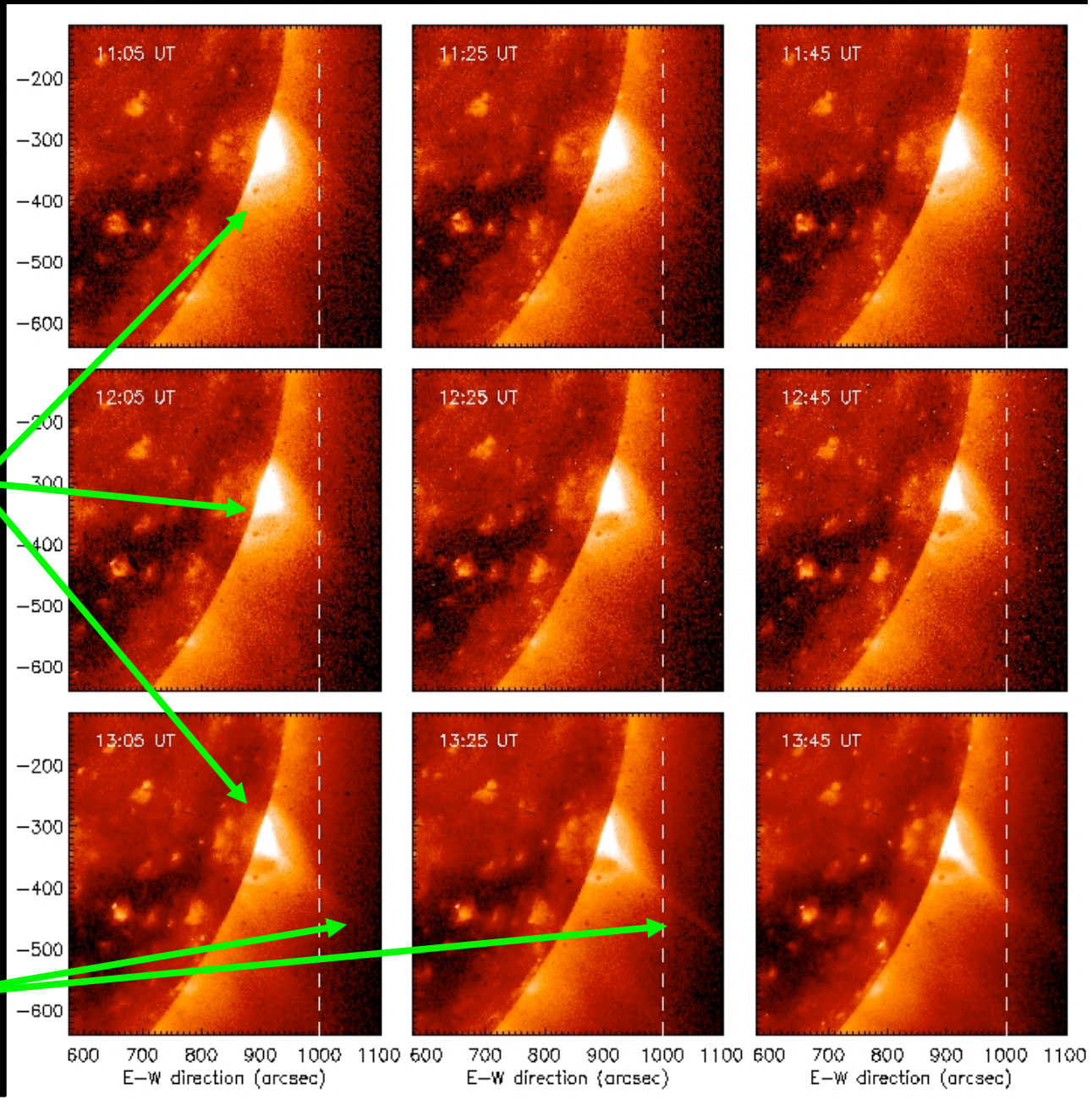


The active region after the event

The active region reorganizes itself:

- System of loops shrinks

- A current sheet forms



Evolution of the active region with EIS

EIS time-intensity images

Fixed-pointing observations provide no images

Can build monochromatic *time-intensity* images

1 - Measure line intensity profile along the slit
2 - Place consecutive intensity profiles one after the other

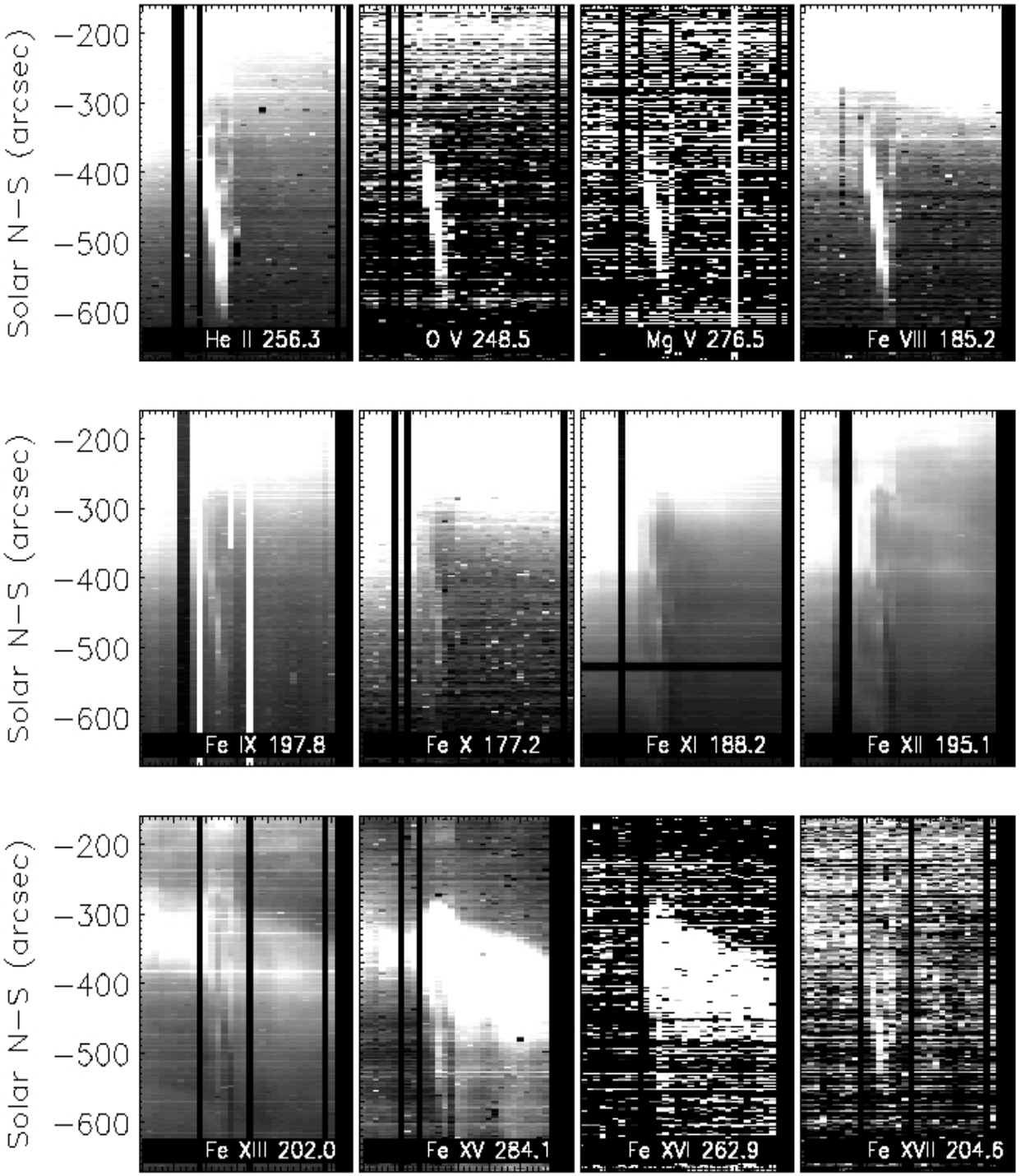
→ Build a 2-D image of slit profile vs. time

EIS line intensities

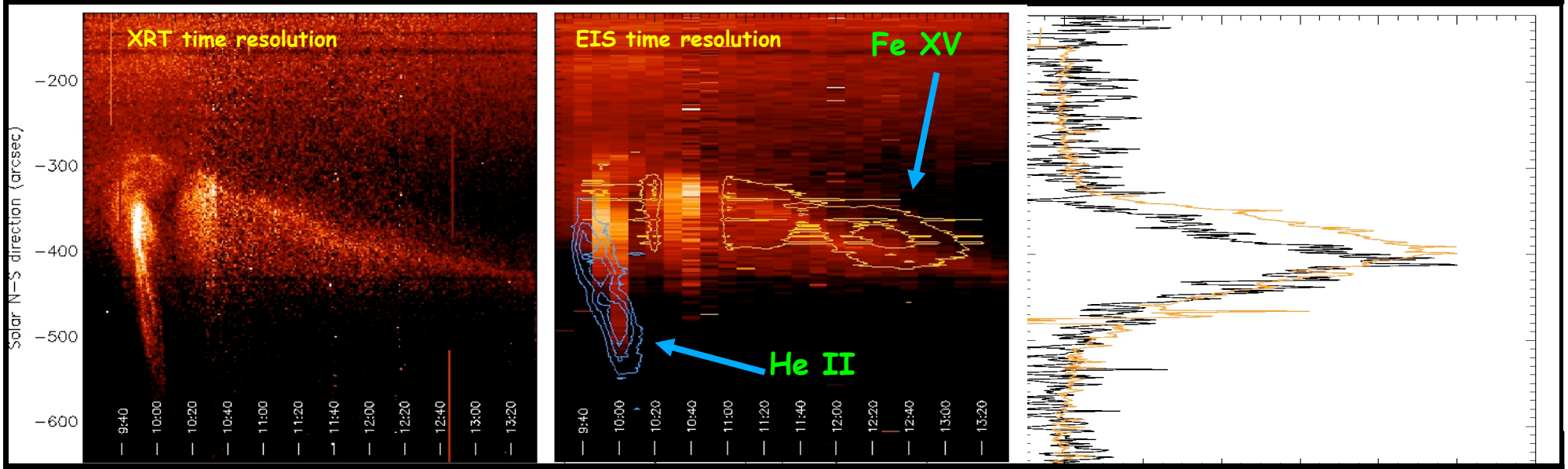
- TR temperatures only see the ejecta

- The corona does not participate to the event

- Hot plasma reorganizes and moves towards the centre



XRT time-intensity maps



Create time-intensity images with XRT

- Current sheet gets thinner with time
- Hot EIS emission overlaps XRT emission

Carry out plasma diagnostics in the current sheet with EIS

- Electron density
- Thermal structure

Plasma conditions – electron density

- Coronal loops:

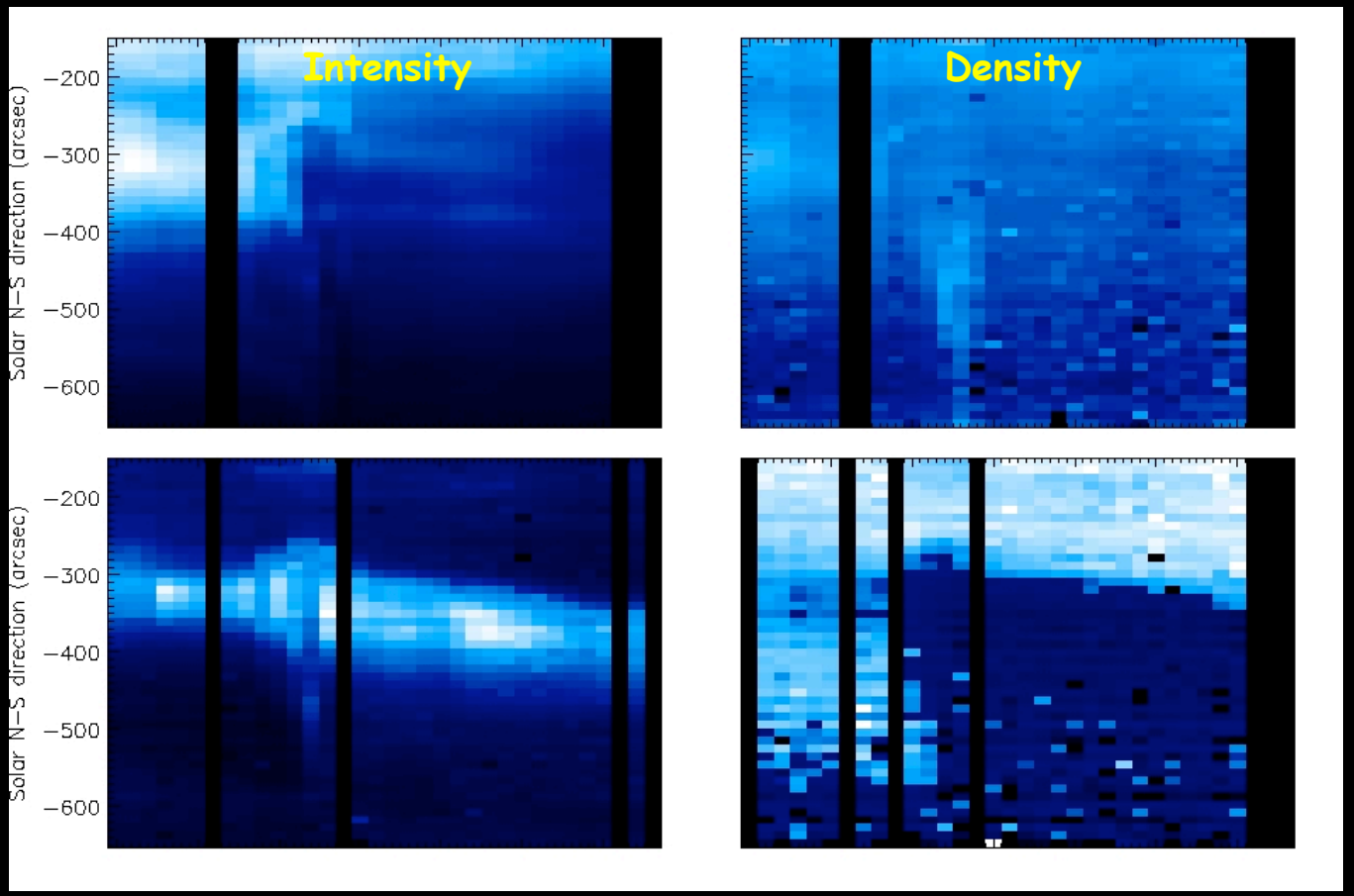
Decrease intensity
Density is constant

- Hot, post-event loops:

Enhanced intensity
Decrease in density

Fe XII – 1.5 MK

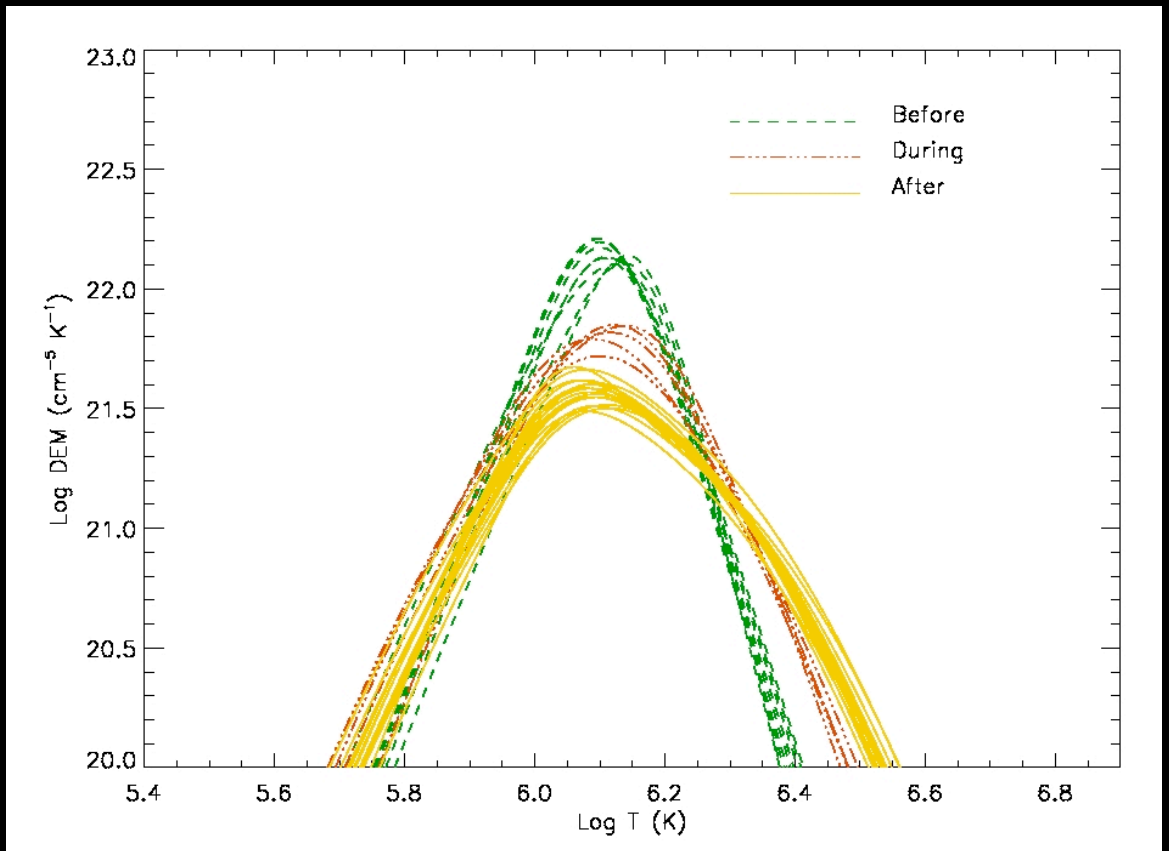
Fe XIV – 2.5 MK

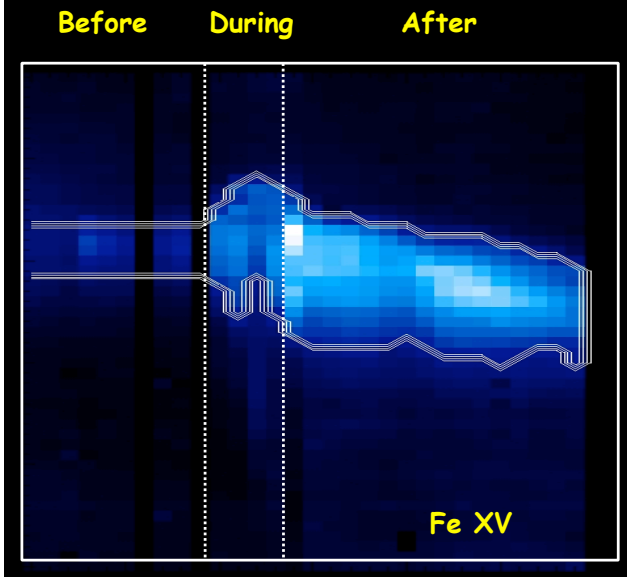


Plasma conditions - DEM curves

Measured DEM curves as a function of time

- Decrease quiet pre-CME plasma (T ~ 1 MK)
- Increase in hot plasma (T ~ 2-3 MK)
- Do not see very hot plasma (T > 4 MK)
- Stable with time





XRT count rates

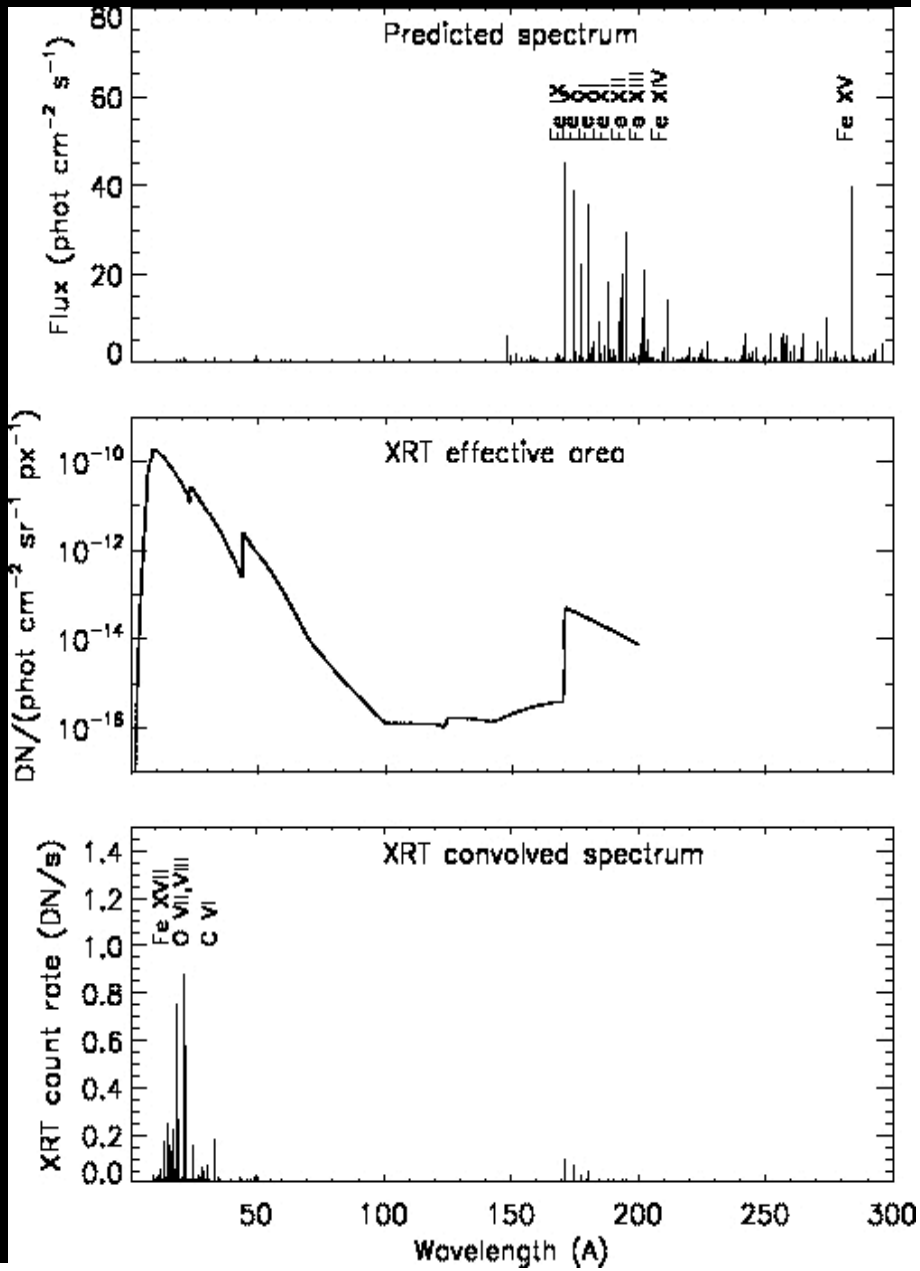
Use EIS DEM to predict XRT count rates

1 – Predict the spectrum
2 – Fold it through the effective area
3 – Compare predicted and measured XRT count rates

Results

1 – EIS DEM *accounts for all XRT counts*
2 – Current sheet plasma T < 4 MK

→ Hotter, subflare plasma is absent



Conclusions

1. CME triggers the formation of *a current sheet*

   - Low density plasma
   - Log T < 6.6

2. Entire event resembles theoretical models

   - Trailing very hot plasma
   - Hot loops left behind

Lin 2004