

Related Solar Imaging and Near-Earth In-situ Observations of an ICME

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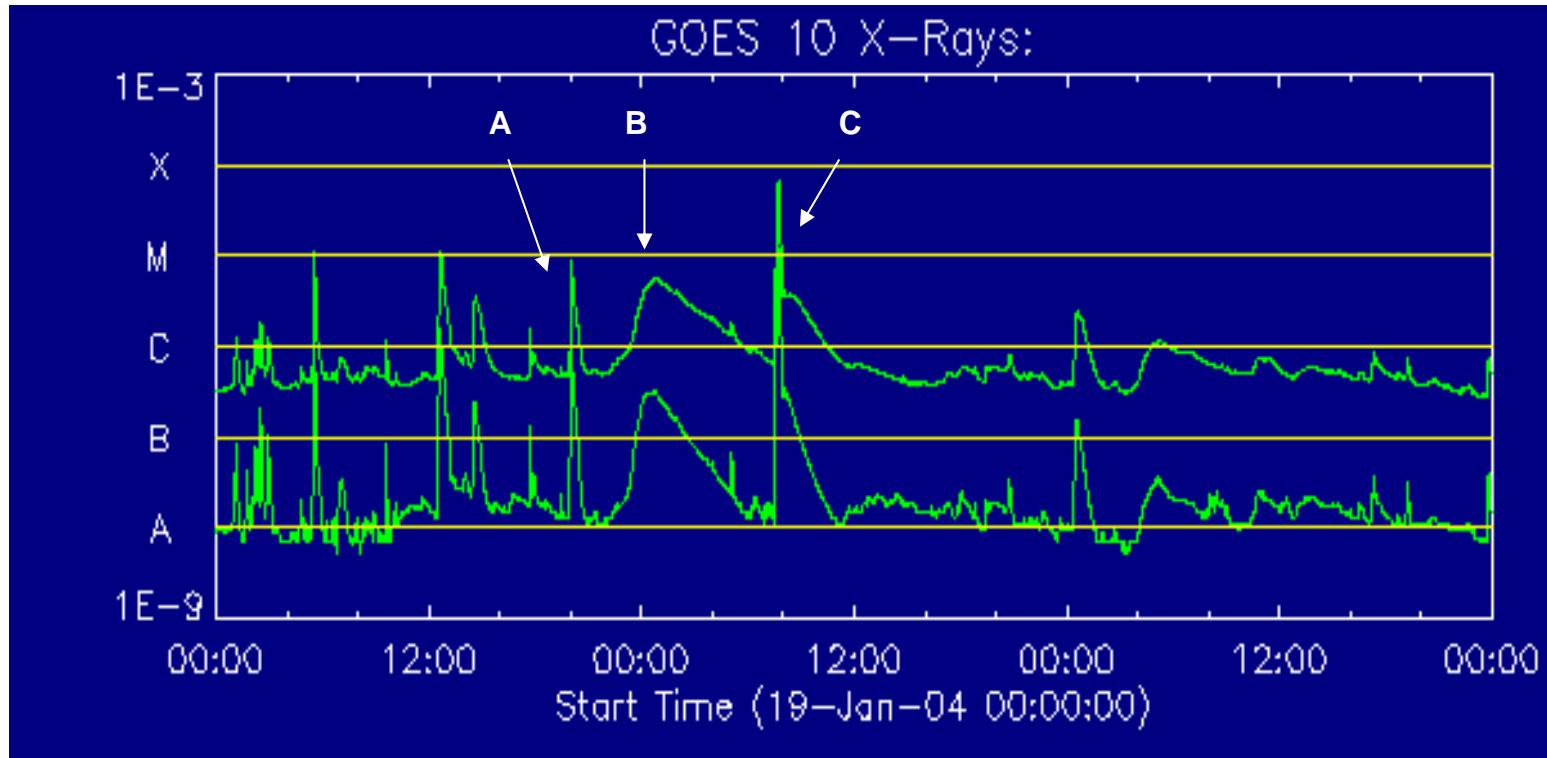
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Recently published by Fazakerley et al in GRL, 2005

1. Solar Remote Sensing Observations

GOES 10: X-ray Light Curves



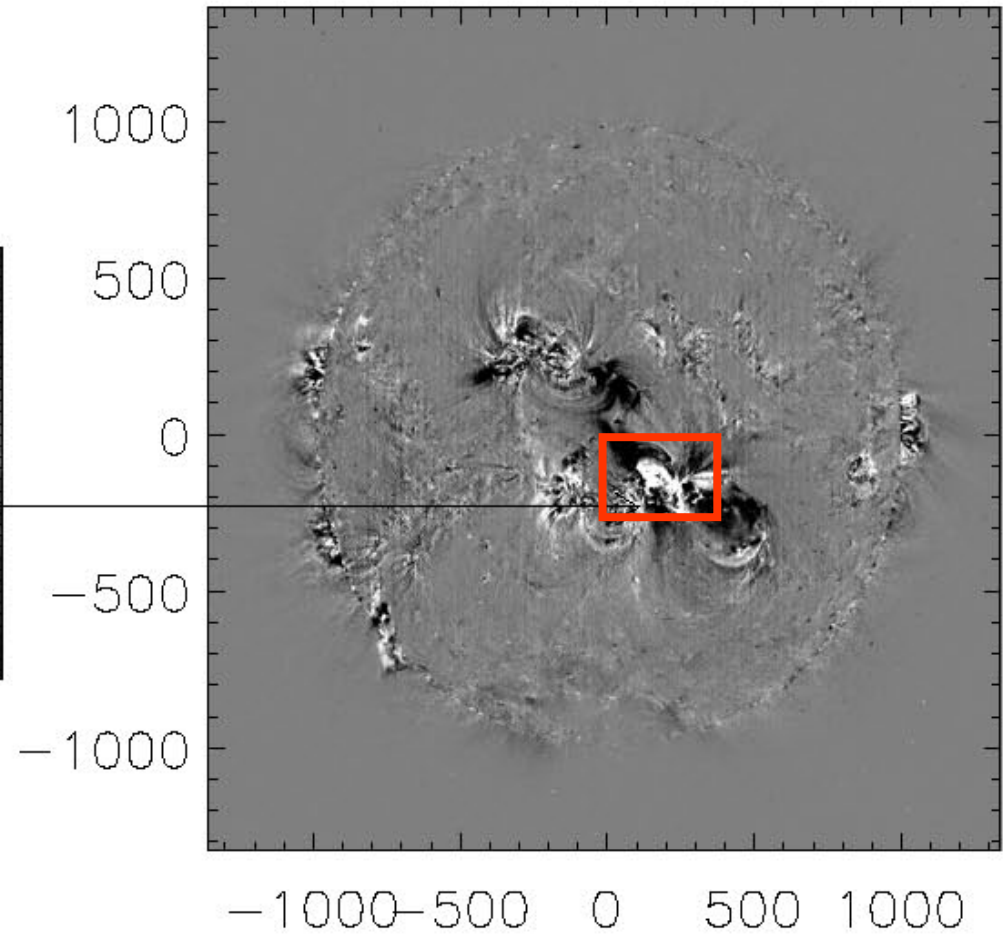
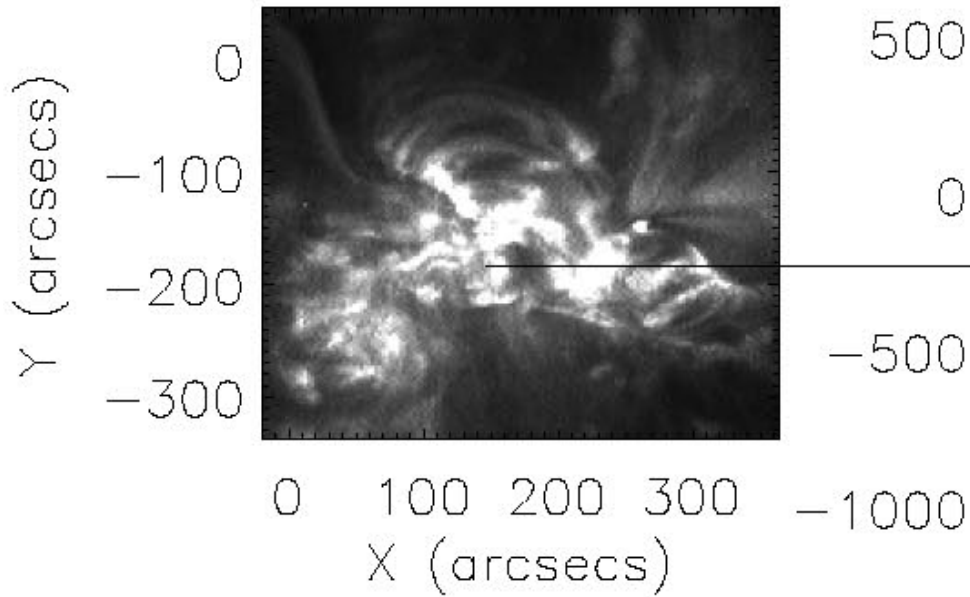
We focussed on three events:

A: M class flare

B: Long duration C class flare \Rightarrow ***related to the ICME***

C: Series of three flares (GOES M – M – C) class

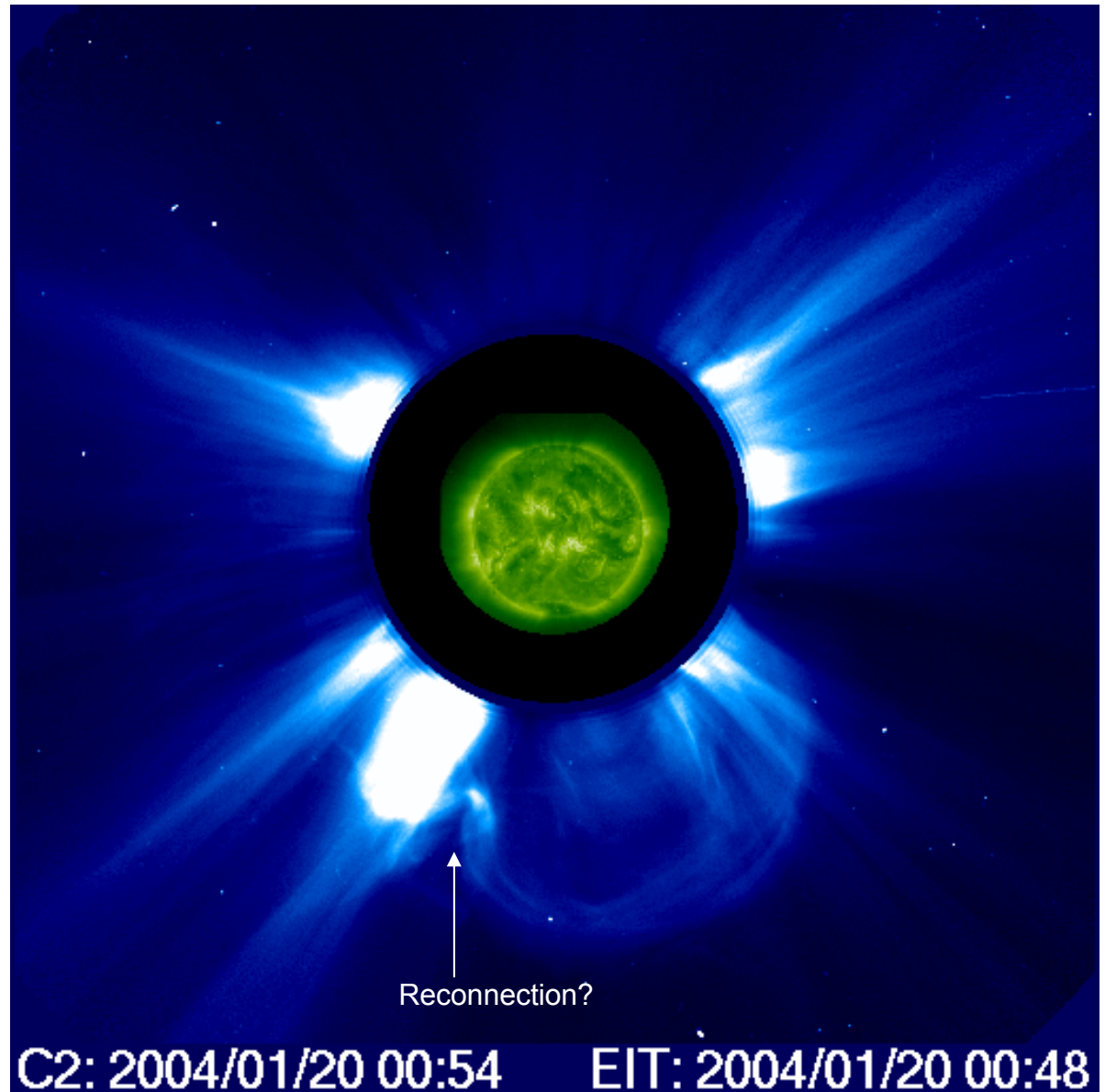
**SOHO:
EIT**



(left) EIT 195 Å image of **Flare B** showing coronal arcade loops
 (right) EIT difference image showing “dimming regions” and aligned filament channel

**SOHO:
LASCO**

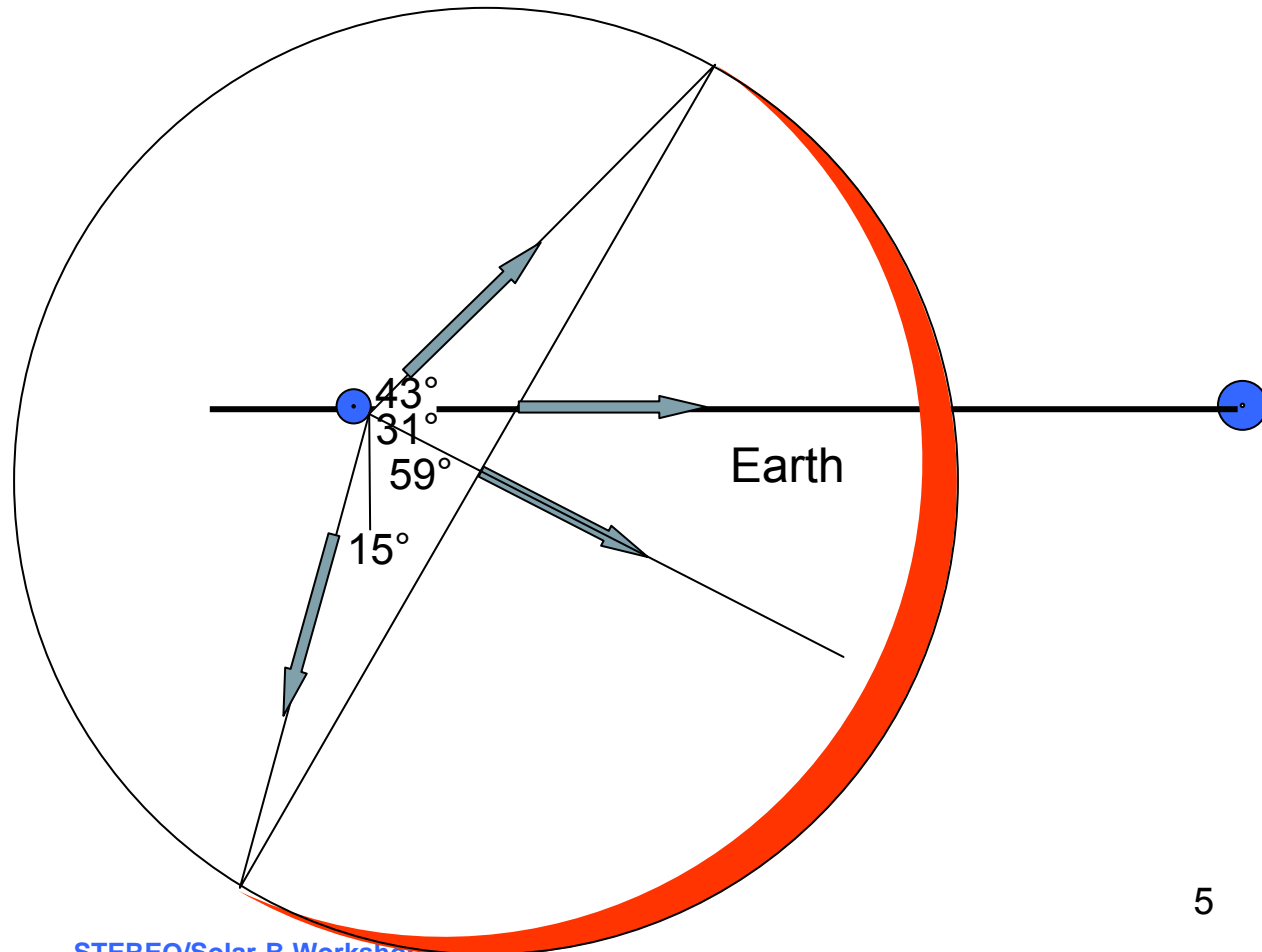
**Halo CME
associated
with Flare B**



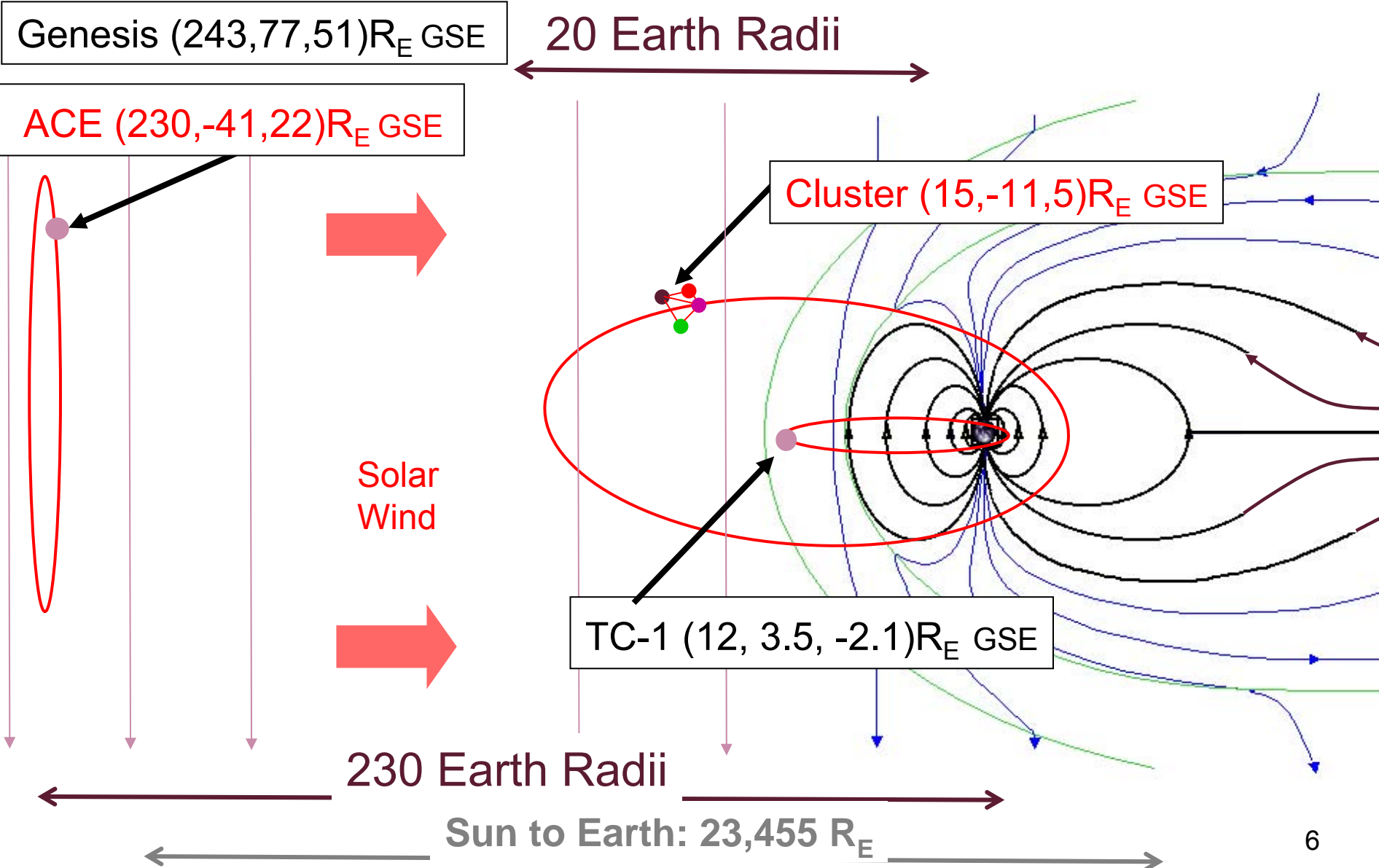
SOHO: LASCO

Cone Model:
(Michalek et al, 2003)

Estimation of CME speed,
($V \sim 910$ km/s), cone axis
orientation, point of origin,
using LASCO first/last
detections of CME crossing
the limb



2. Near Earth Observations: ACE, SOHO, Genesis, Cluster & Double Star TC-1

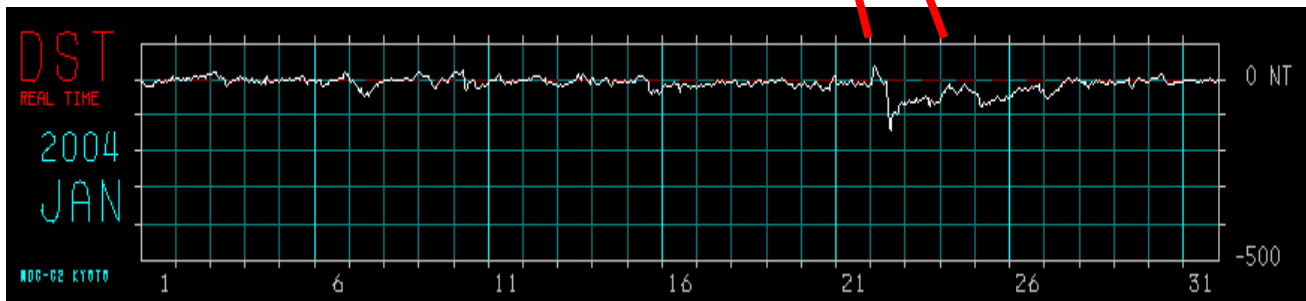
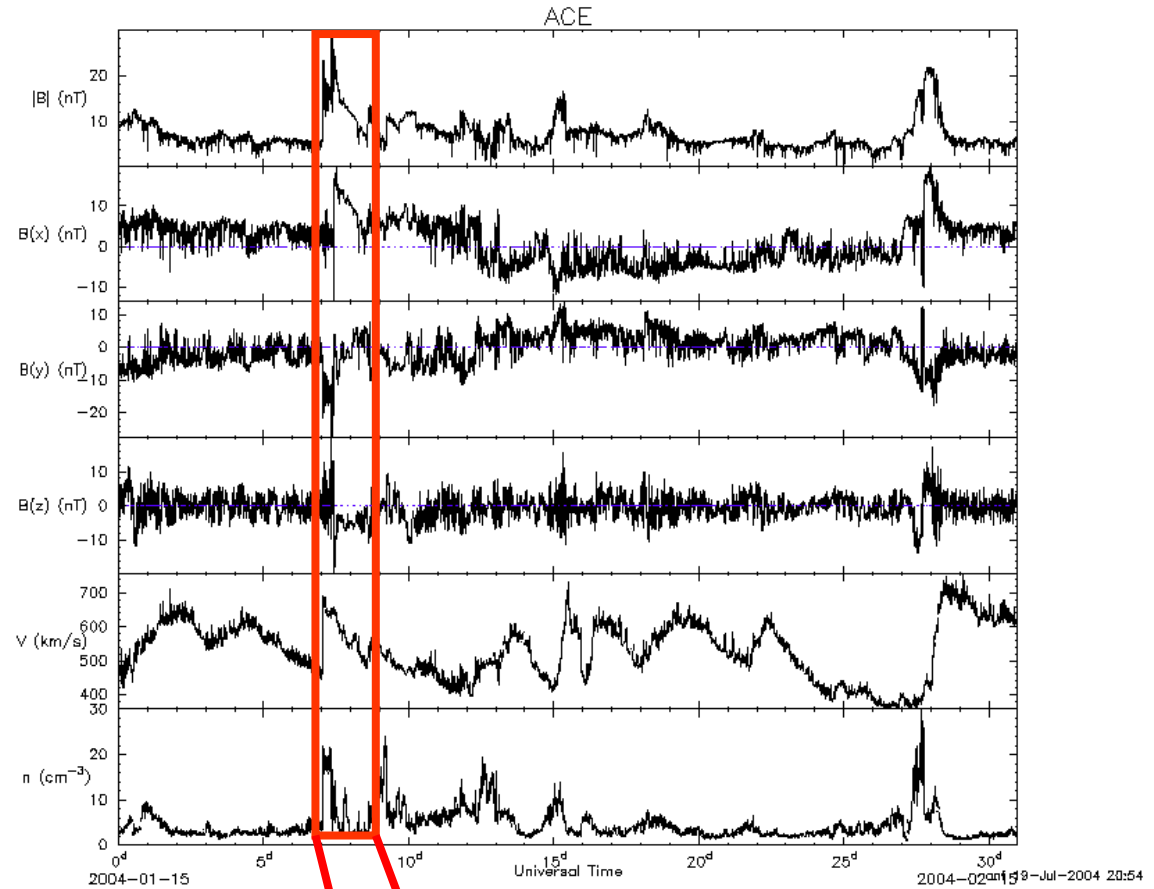


ACE: Magnetic Field Instrument (MFI)

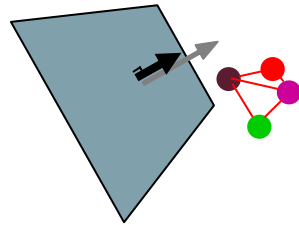
Jan 15 to Feb 15
2004

No shocks for
a week before 22nd
Jan

Significant magnetic
storm at Earth



Cluster:
FGM, CIS



Shock Normal Determination

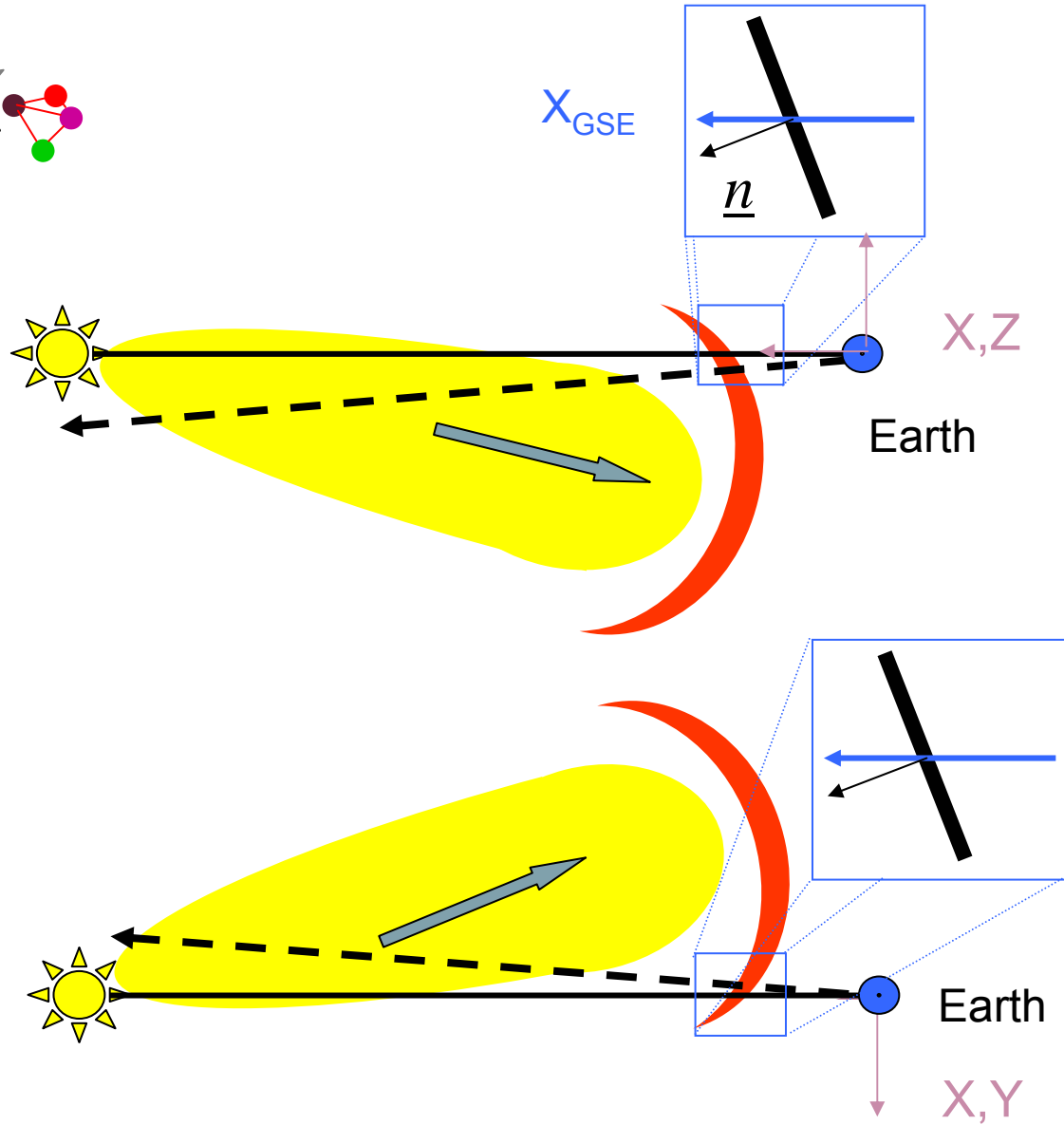
Spacecraft in 200 km tetrahedron
Data resolution 22 vec s⁻¹

Shock normal in the GSE frame
(Cluster timing analysis)

$\underline{n} = [0.905, -0.313, -0.288]$
tilted at **25°** to the Sun-Earth line

This is consistent with the main body of the ejecta passing south and dawnward of the Earth

Shock speed in the GSE frame:
→ **740 km s⁻¹ along the shock normal**

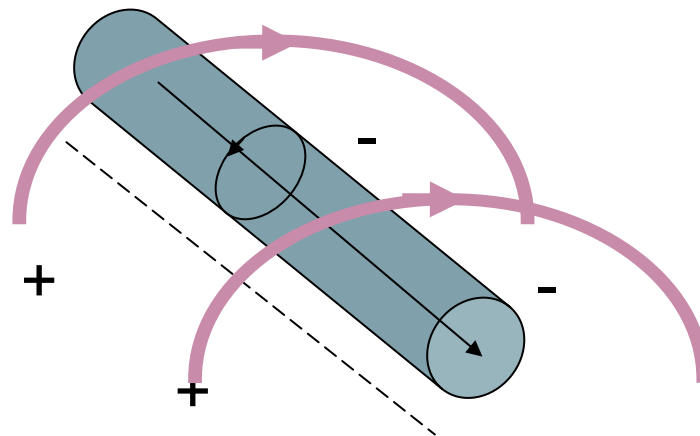
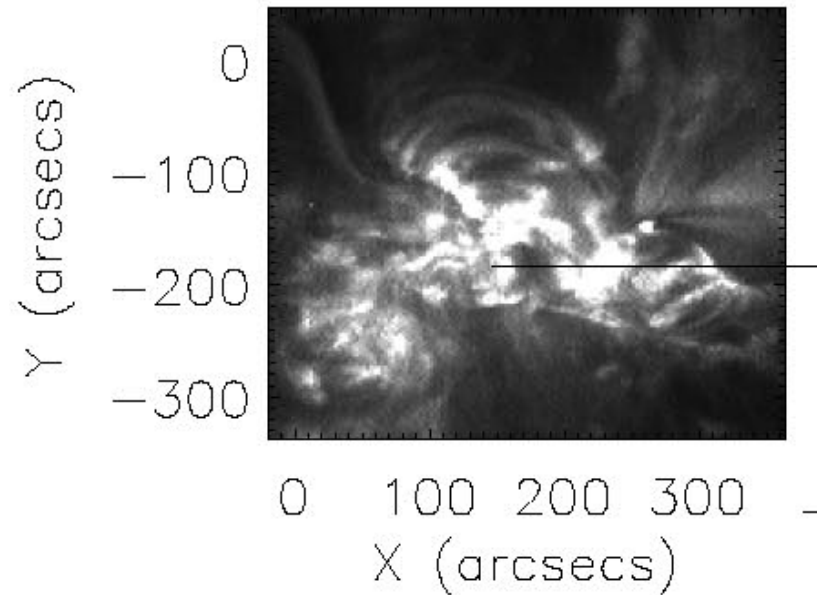


3. Combined Data Sets

Coronal Magnetic Fields

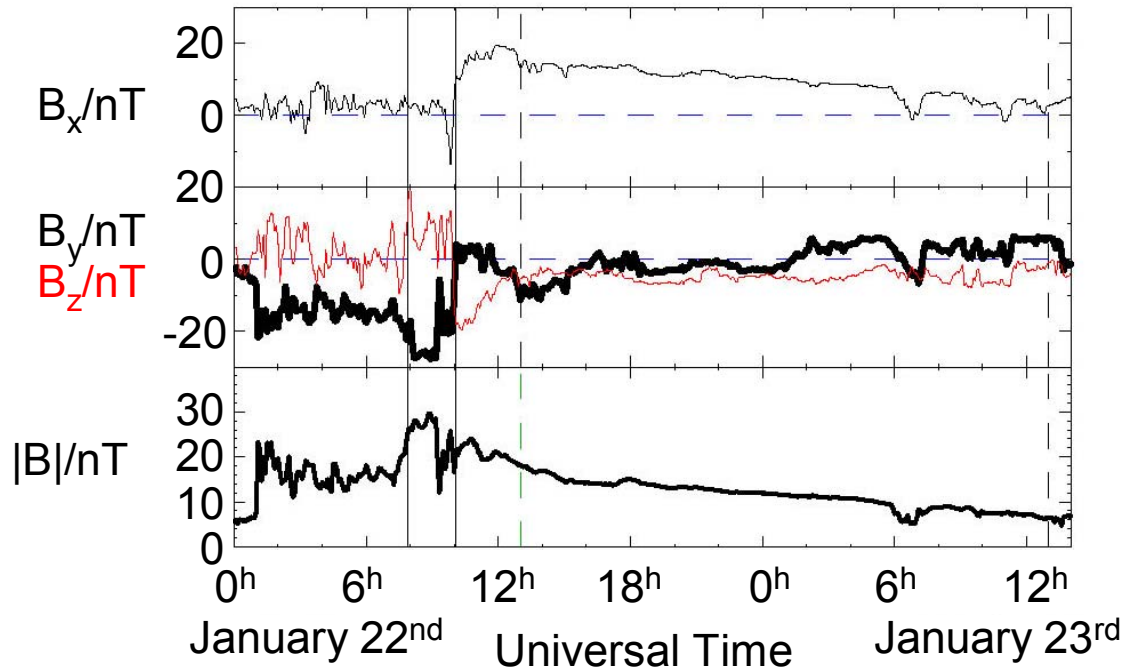
Magnetic polarity from MDI
Coronal arcade from EIT

Orientation of flux rope can be determined from these data
(Martin, 2003)



Near-Earth Magnetic Fields

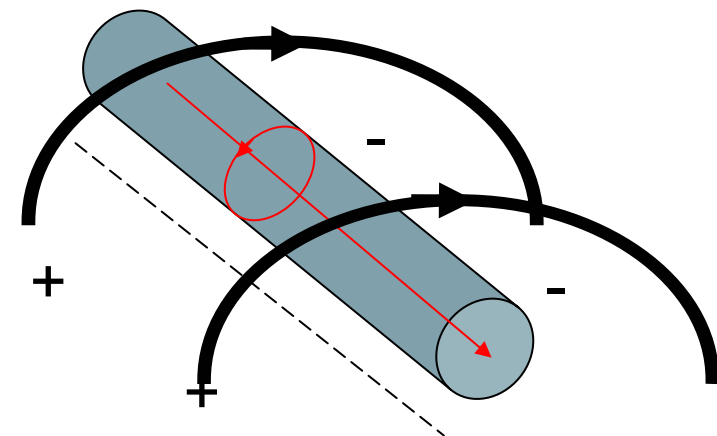
Before 01:35 Solar Wind
01:35 - 08:30 “sheath”
08:30 - 10:40 ICME Part (i)
10:40 & after ICME Part (ii)



Interpretation:

Flux rope (NNE-SSW orientation) erupts
seen as ICME Part (ii)

Overlaying coronal arcade material
(E-W orientation) carried ahead of
flux rope - *seen as ICME Part (i)*

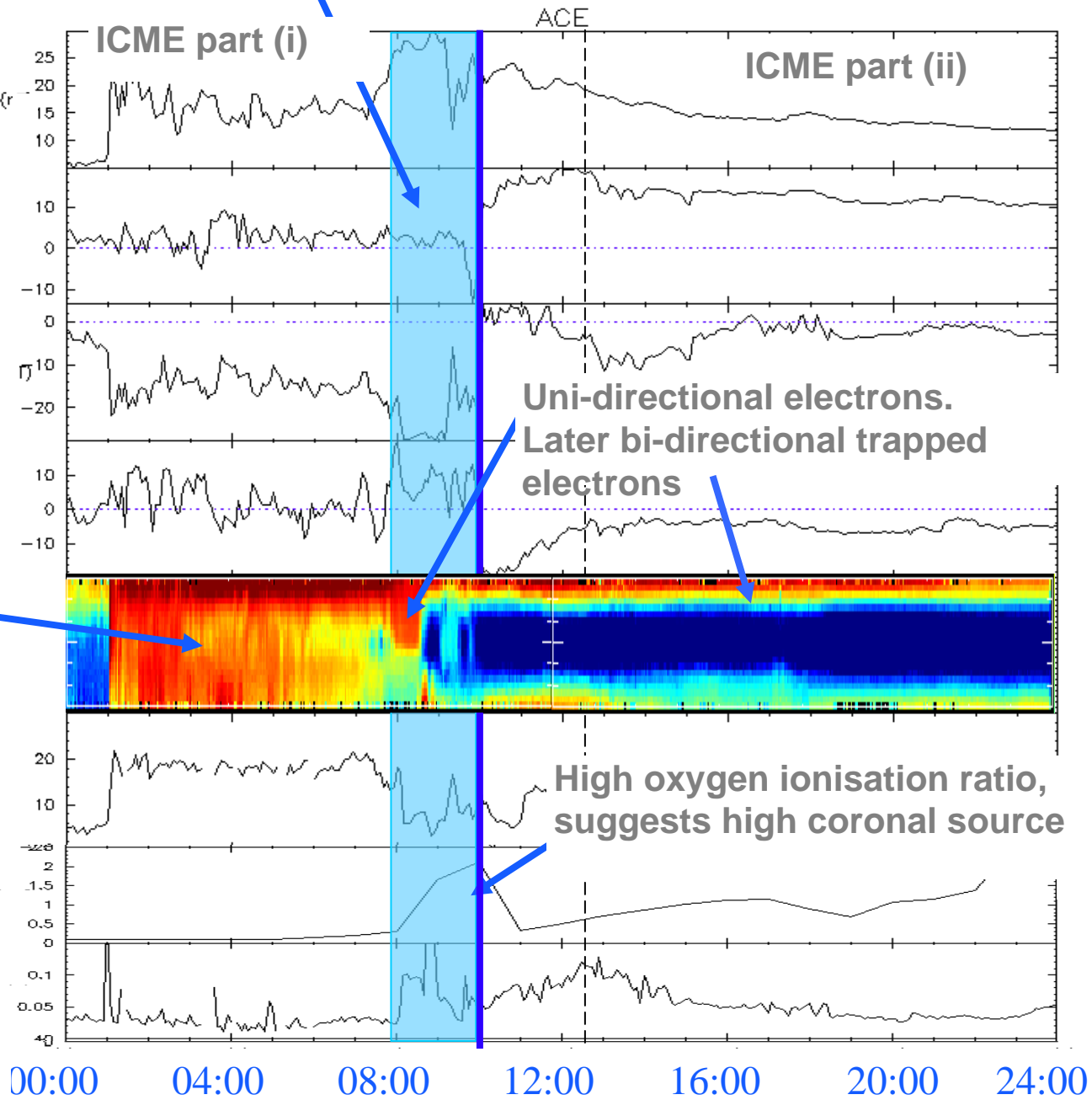


ACE:
MFI
SWICS

“Sheath”
Ahead
of CME

Electron p.a. 372 eV

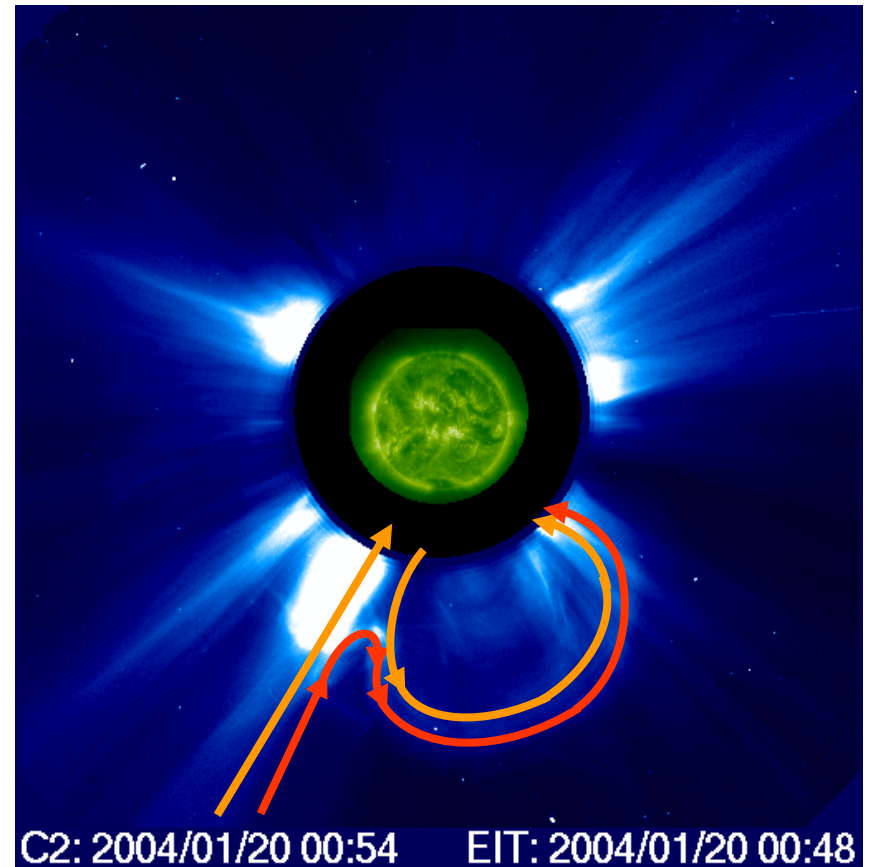
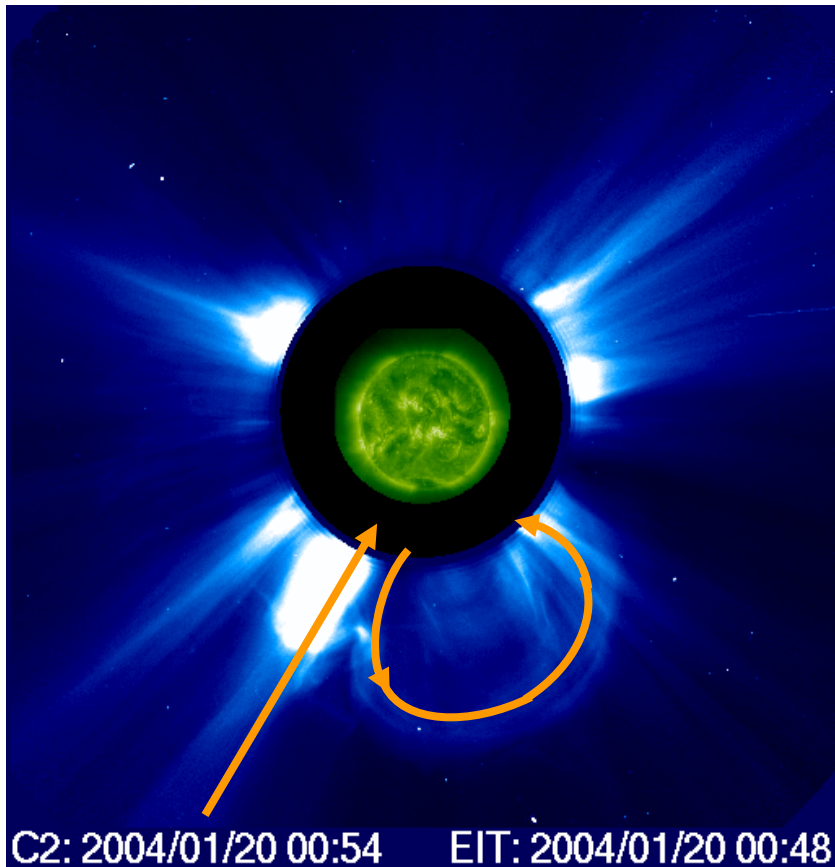
$|B|$ (nT)
 B_x GSE (nT)
 B_y GSE (nT)
 B_z GSE (nT)
 n_p (cm⁻³)
 O^{7+}/O^{6+}
 He^{2+}/H^+ (%)



SOHO: LASCO

Expanding CME magnetic field reconnects with oppositely directed streamer field to produce open field-lines

- temporary disconnection from Sun allows uni-directional electron streaming



Summary

- ICME seen near-Earth Jan 22nd 2004
- Unambiguous identification of coronal source event (erupting flux rope)
- Determination of coronal magnetic fields
- Good match to in-situ magnetic fields
- The geomagnetic storm may have been predictable
- More effort needed on ICME interaction in IPM

END OF TALK