

CLUSTER OBSERVATIONS OF A FLUX TRANSFER EVENT (FTE)

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On Jan. 26th, 2001, around 11:31 UT, Cluster crossed an isolated FTE.

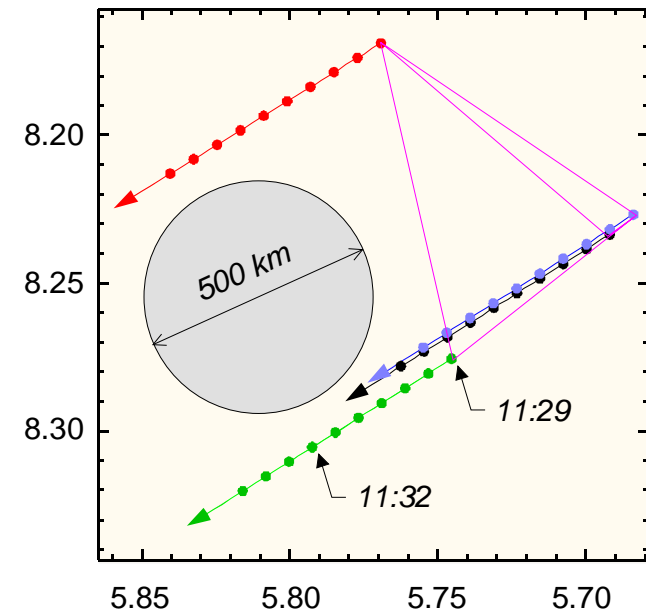
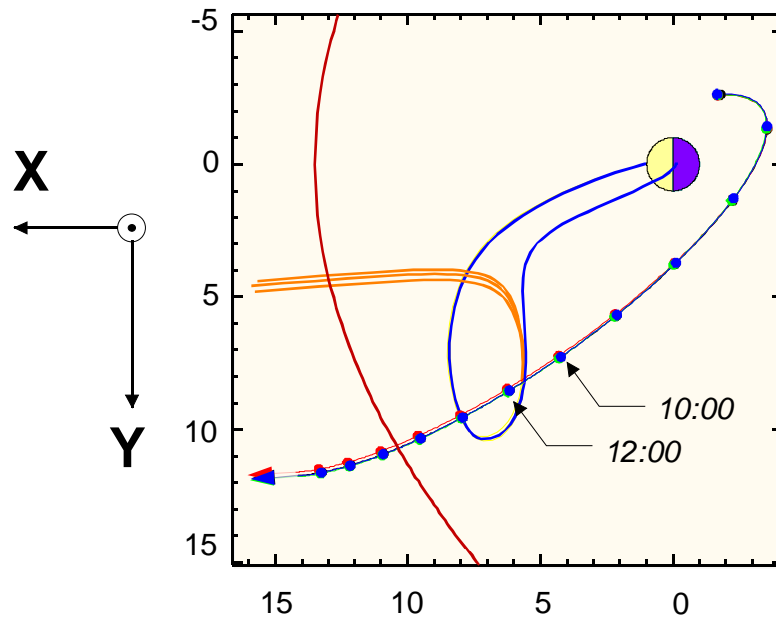
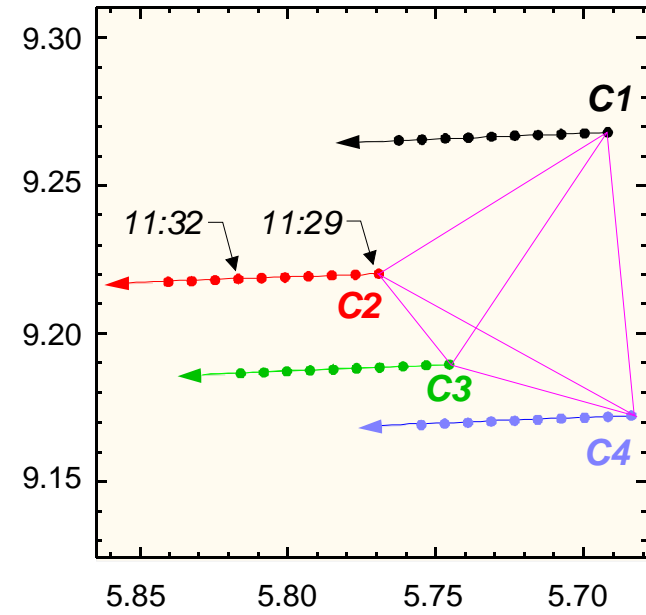
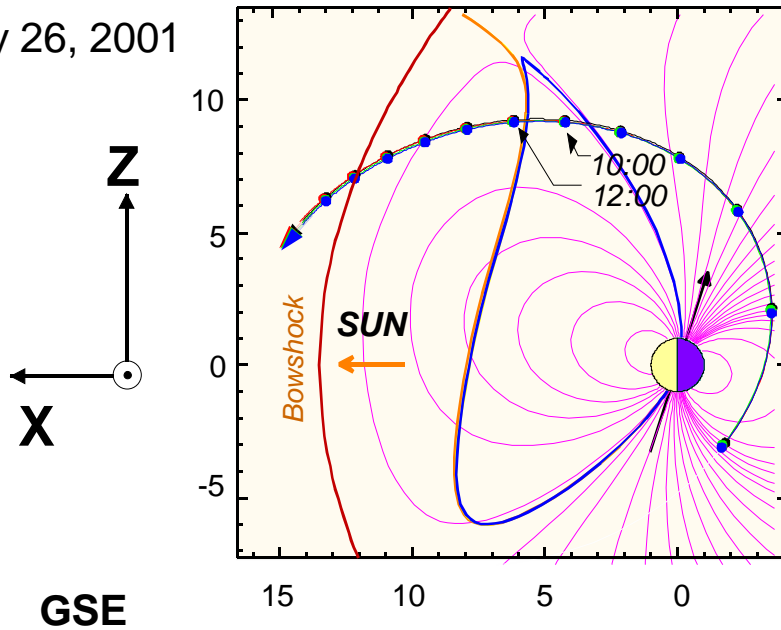
Data from several instruments on Cluster (PEACE, CIS, EFW, FGM, WHISPER and STAFF) are used to investigate the structure and the dynamics of this FTE.

- Data from FGM are used to identify the FTE, determine the current density, and identify main discontinuities between different regions of space.
- Data from Particule experiment are used to identify the regions of space between the discontinuities.

The analysis of Field and particules data suggest a scenario, different from previous interpretations, based on a bulge propagating along the magnetopause, and leaving behind it open magnetic field lines

1 – Context of the event from orbital data

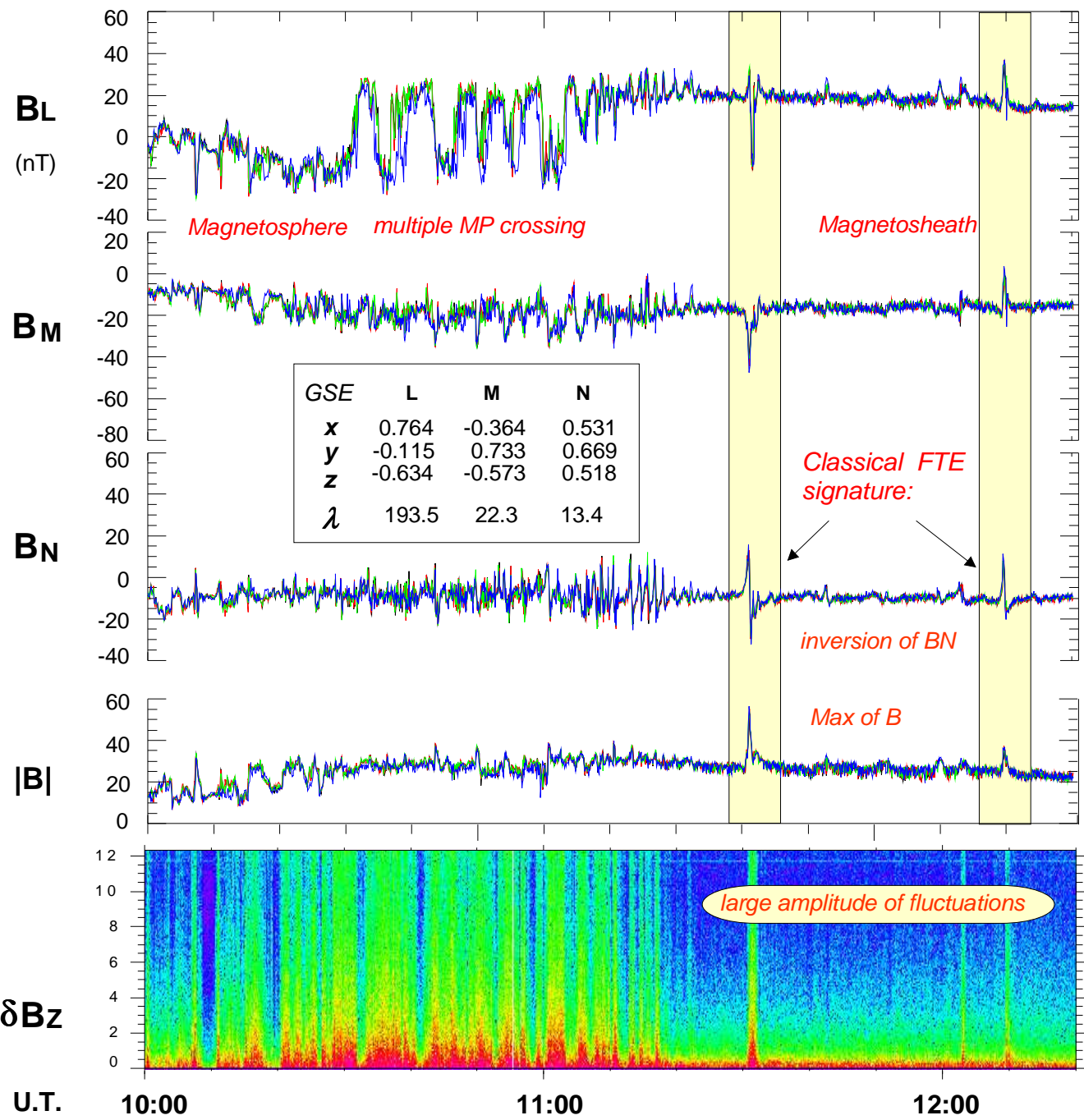
January 26, 2001



2
 Identification
 of a FTE by
 magnetic signature

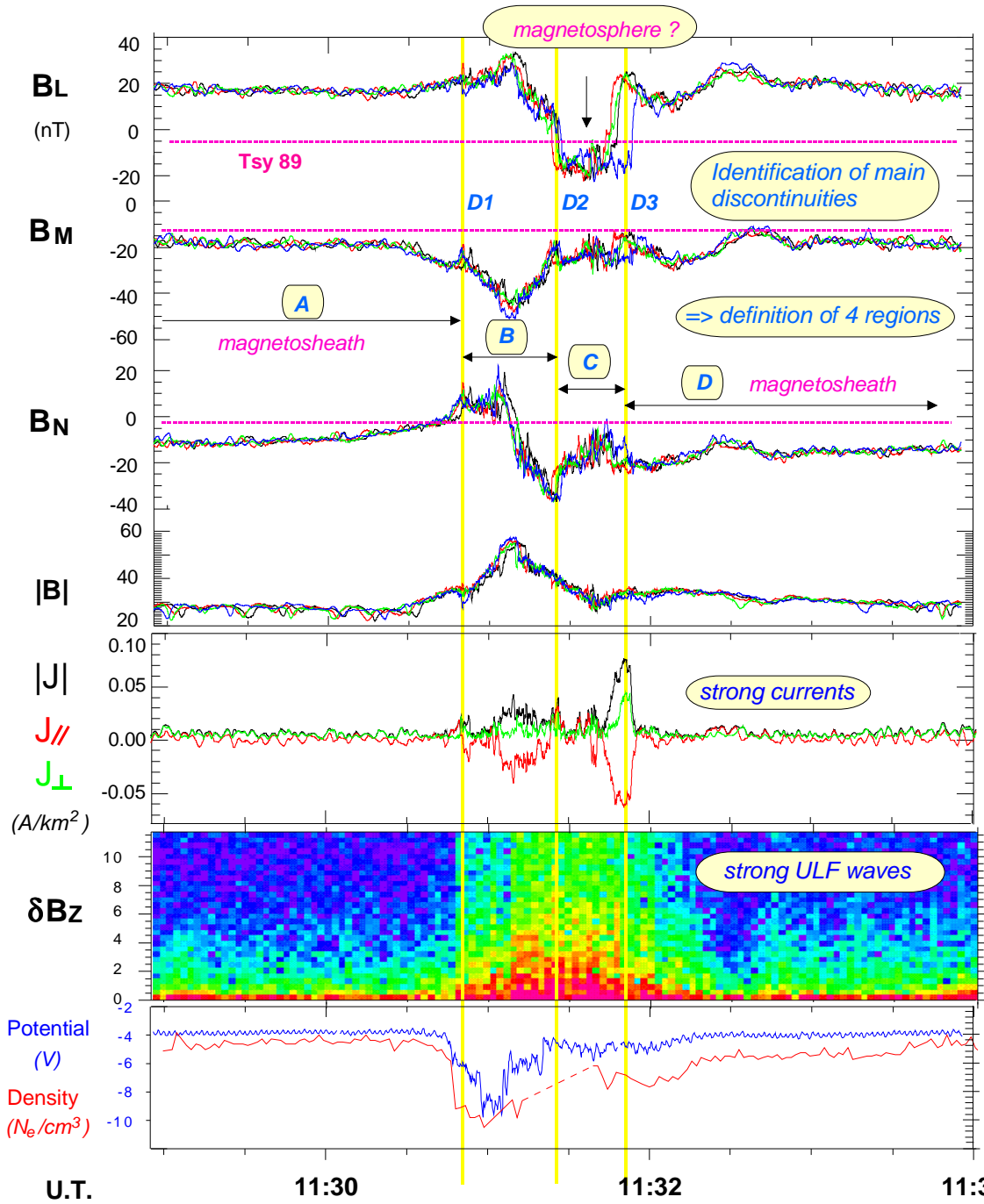
FGM
 4 S/C

STAFF
 Cluster 3



3
Zoom on field data:
Identification of
discontinuities

FGM
4 S/C



STAFF
Cluster 3

EFW
WHISPER
Cluster 3

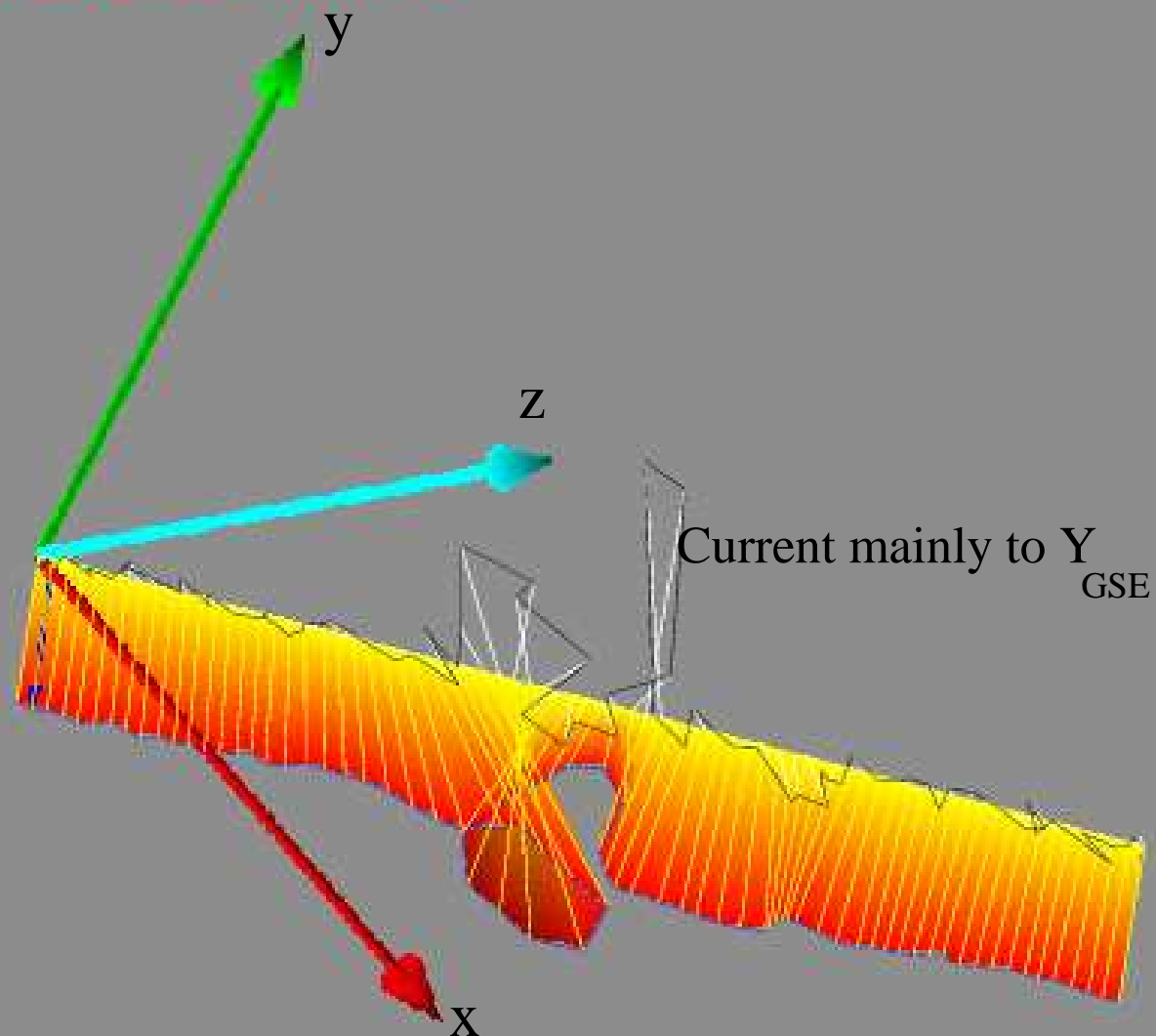
Potential
(V)
Density
(N_e/cm^3)

U.T. 11:30 11:32 11:34

CLUSTER/FGM

1

2001_Jan_26_11:29:07.902



CETP

Zoom on particule data :
Identification of
region and boundaries

CIS
C 1

mainly energetic anti // ions
=> escaping
=> open field lines

accelerated magnetosheath ions

typical magnetospheric ions

typical magnetosheath ions

no energetic elect.
=> zero foot line

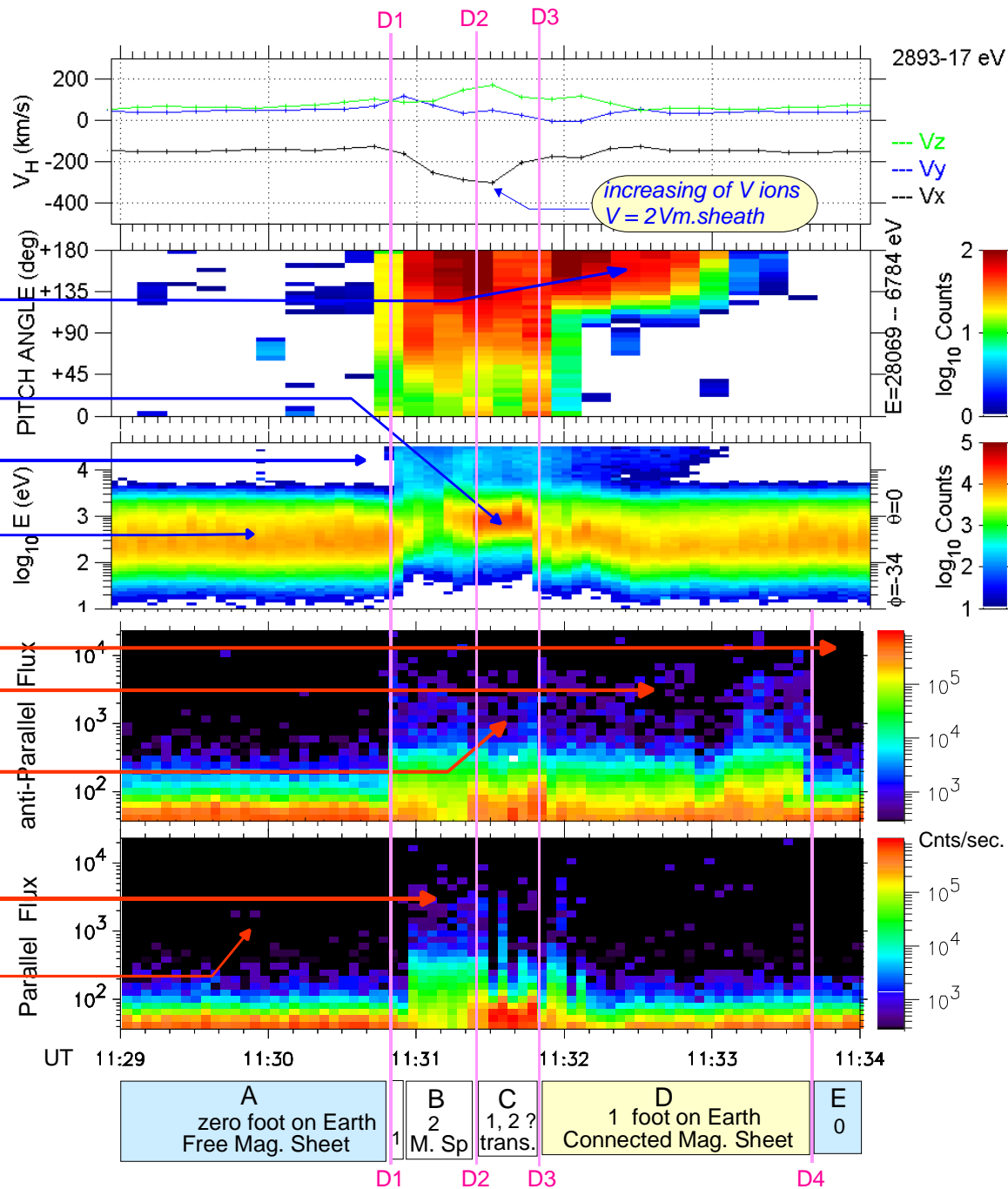
only anti //
=> 1 foot on Earth

unclear !
=> 1 or 2 feet ?

elec. anti // & //
=> 2 feet on Earth

no energetic elect.
=> zero foot on Earth

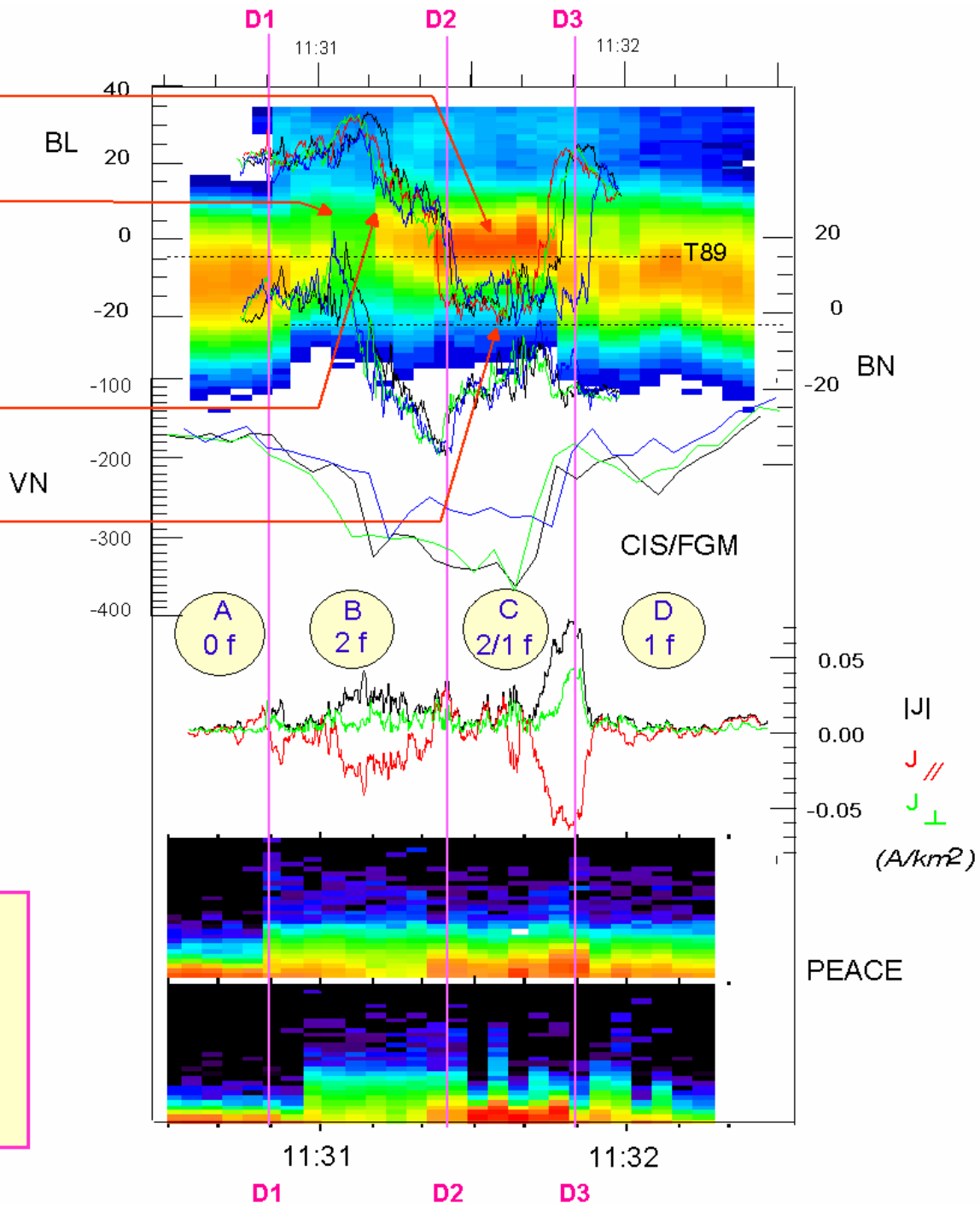
PEACE
C 1



- ions acceleration due to increasing V_i
- but acceleration on closed field lines, inside mag. sphere !!
=> penetration of ions on closed field lines
- Mag field different from T89 but field lines closed !!
- Mag field near T89 but field lines alternatively open / closed !!
(Perfect fit with B in TPN system)

Apparent contraction between Field and particle data

5
Zoom again on the FTE itself, both with field and particules data to try to understand...



6

Suggest a model based on propagation of a bulge along L

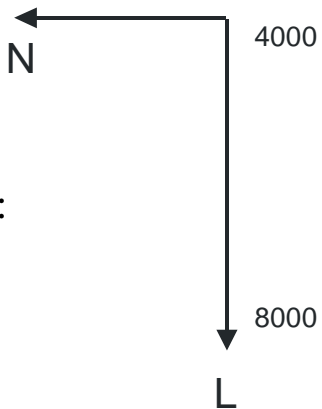
VDL : along the L axis

VDt : tangent to the discontinuity plane

VDn : normal to the discontinuity plane

$$\vec{VDL} = \vec{VDt} + \vec{VDn}$$

VP: Plasma



Tang. Discont. :

$$V_n = 0$$

$$B_n = 0$$

$$\Delta B_t \neq 0$$

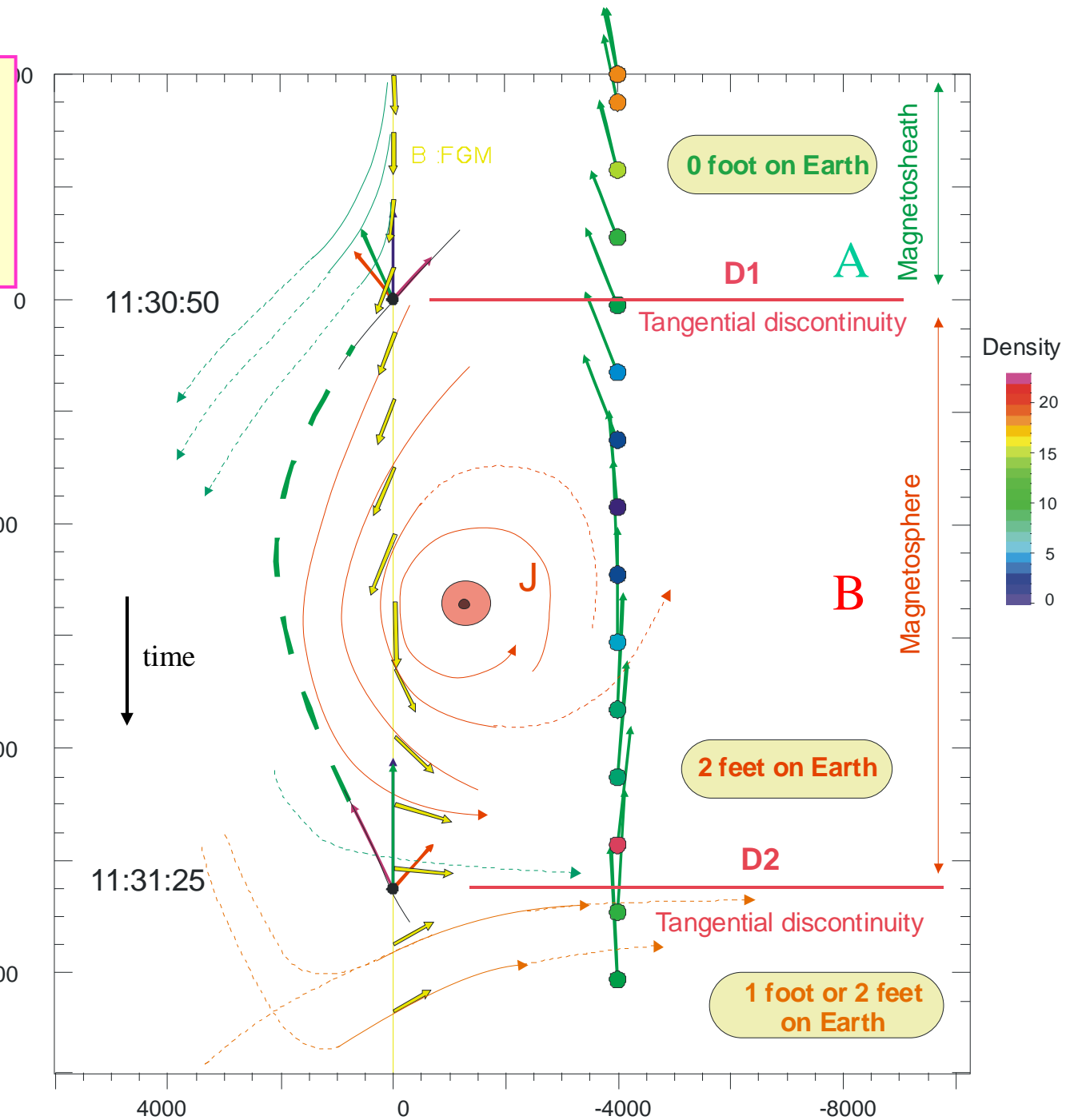
Rot. Discont. :

$$V_n \neq 0$$

$$B_n \neq 0$$

$$\Delta B_t \propto \Delta V_t$$

$$\text{Dens. } n_1 = n_2$$



The bulge leaves behind it
open field lines

VDL : along the L axis
VDt : tangent to the discontinuity plane
VDn : normal to the discontinuity plane

$$\vec{VDL} = \vec{VDt} + \vec{VDn}$$

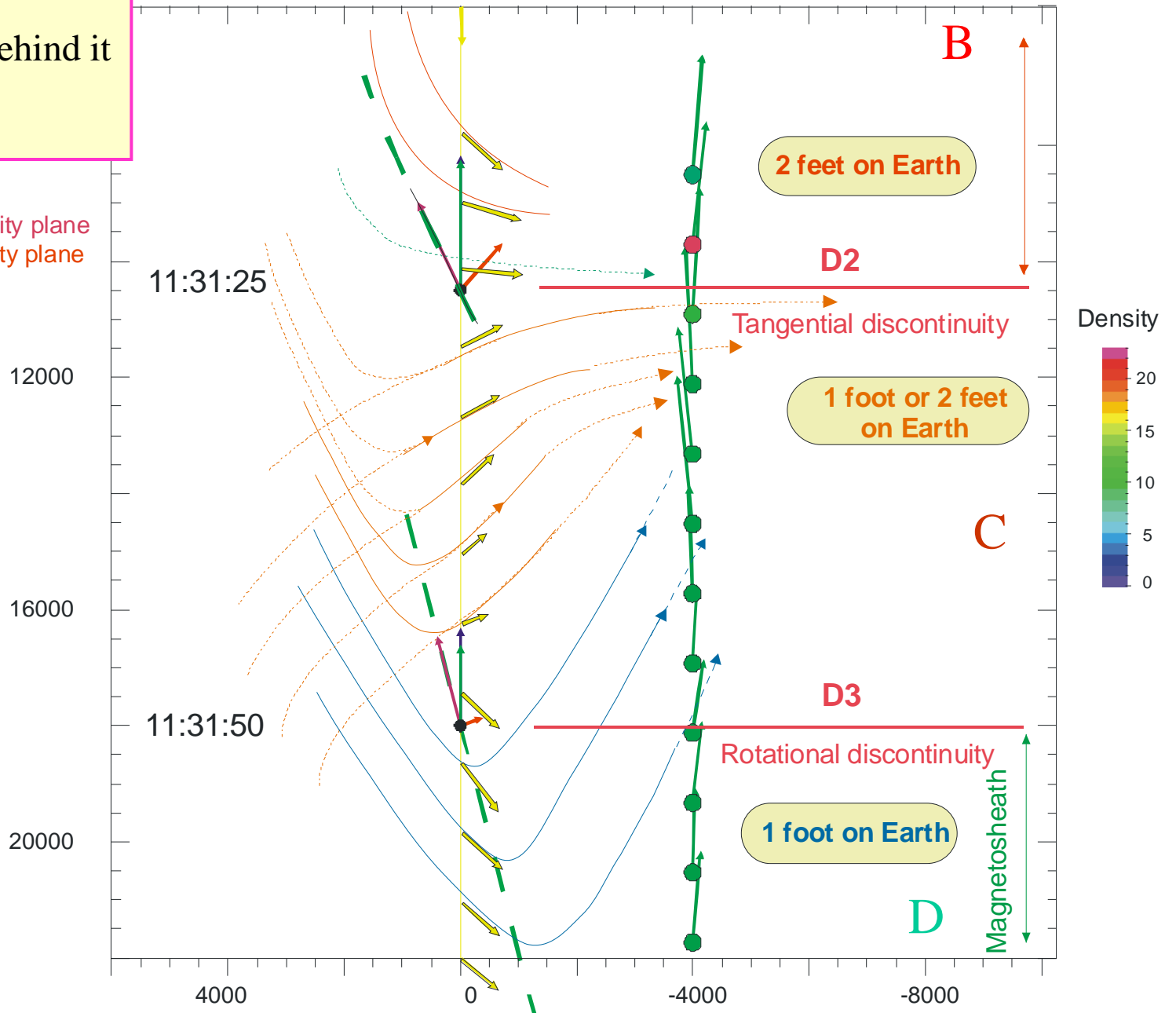
VP: Plasma

Tang. Discont. :

$$\begin{aligned} V_n &= 0 \\ B_n &= 0 \\ \Delta B_t &\neq 0 \end{aligned}$$

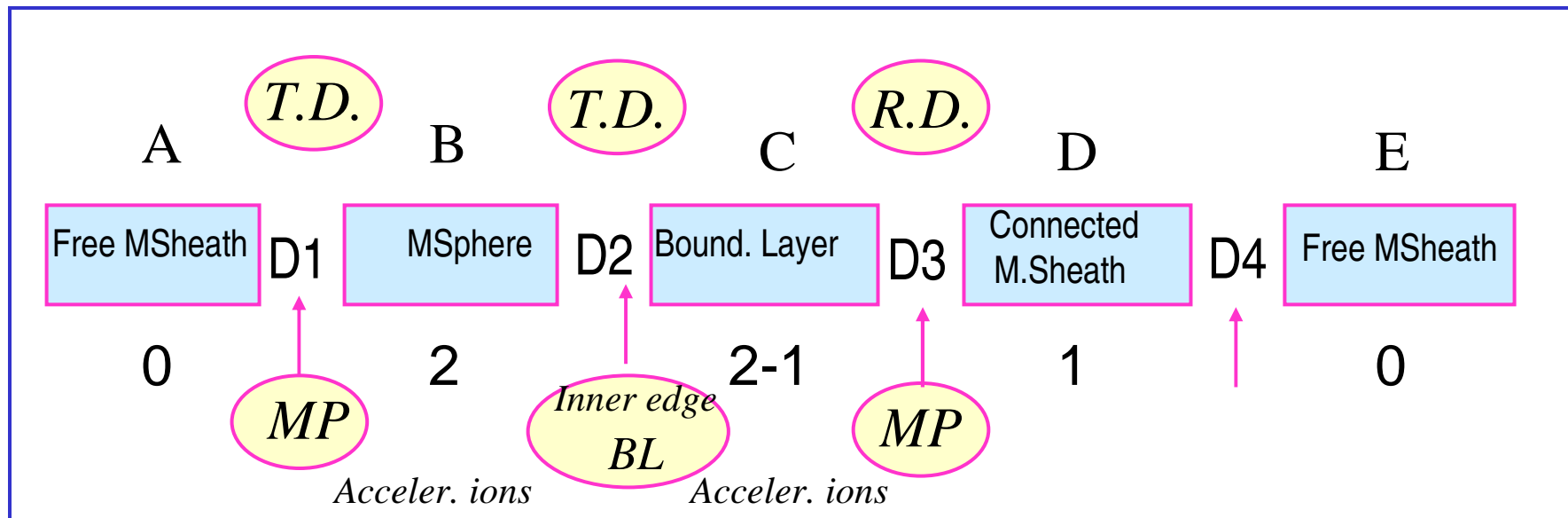
Rot. Discont. :

$$\begin{aligned} V_n &\neq 0 \\ B_n &\neq 0 \\ \Delta B_t &\propto \Delta V_t \\ \text{Dens. } n_1 &= n_2 \end{aligned}$$



SUMMARY

1. The FTE is a force free current density structure ($J \sim J_y$). Signatures of sharp discontinuities are superimposed.
2. As expected from standard FTE model, accelerated magnetosheath ions are observed on open field lines (with 1 magnetic footprint on Earth), in region C
3. Against expectation, accelerated magnetosheath ions are also observed on closed field lines, in region B. This is not consistent with standard FTE model.



4. Penetration of magnetosheath plasma through Tangential discontinuity (D1 and D2) is consistent with diffusion. $V_{diff} \sim 30$ km/s at D2, computed from the observed level of fluctuations ($\sim 3-5$ nT).

CONCLUSIONS

FTE is not simply a reconnected flux tube moving along magnetopause ; it is more complex. A possible scenario is:

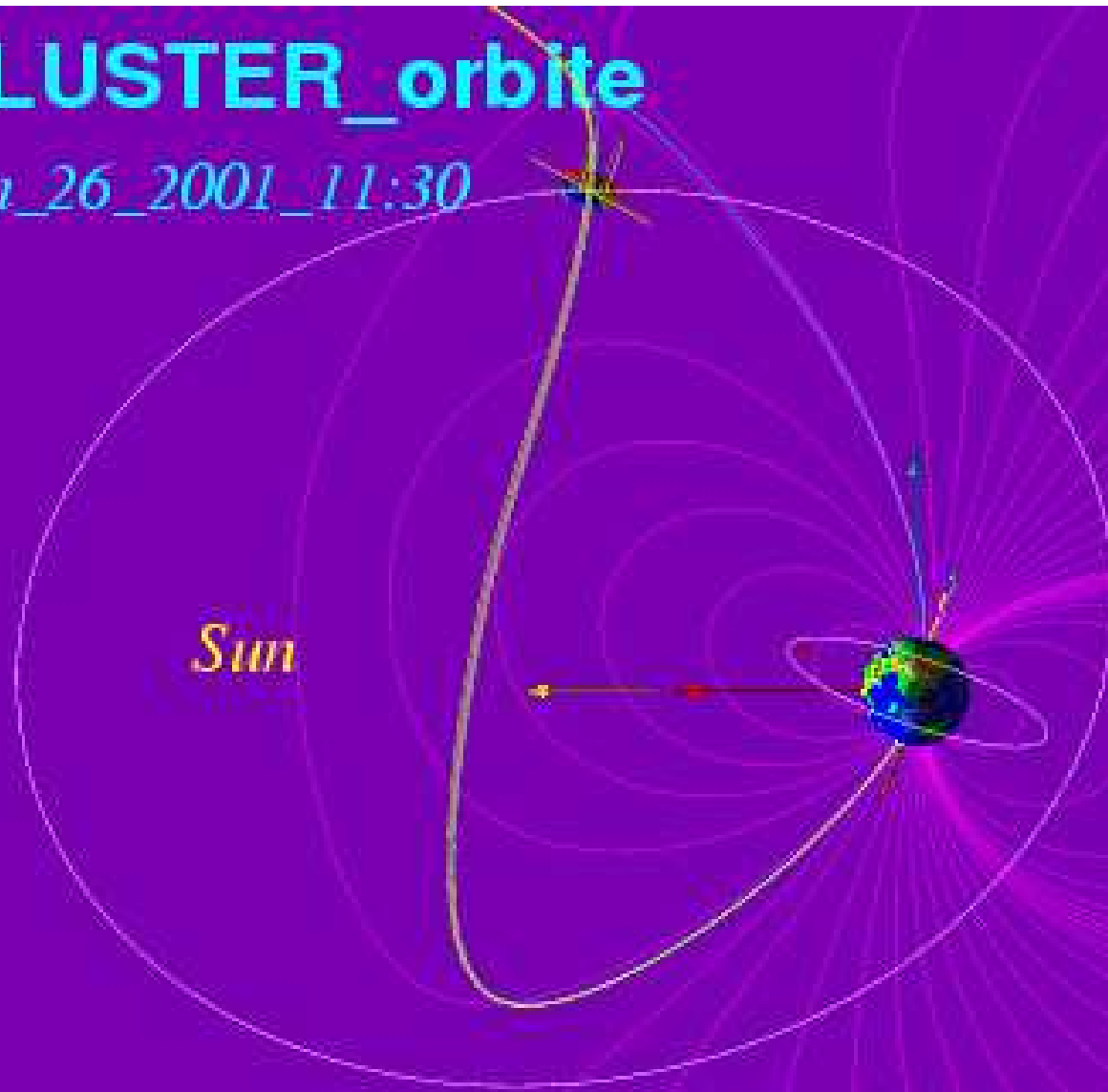
- A magnetic pressure pulse moves along magnetopause (as in Sibeck's model)
- At its trailing edge, magnetosheath plasma penetrates diffusively on closed field lines
- Fast diffusion might lead to the opening of magnetospheric field lines: Indeed, opening of FL is easy because B_x and B_z change sign at D2, while B_y (guide field) is constant.
- Field line bending (at D3) accelerates ions, as in standard FTE model.

The bulge propagating along the magnetopause, and leaving behind it open magnetic field lines, plays role of a field line cutter

CLUSTER_orbite

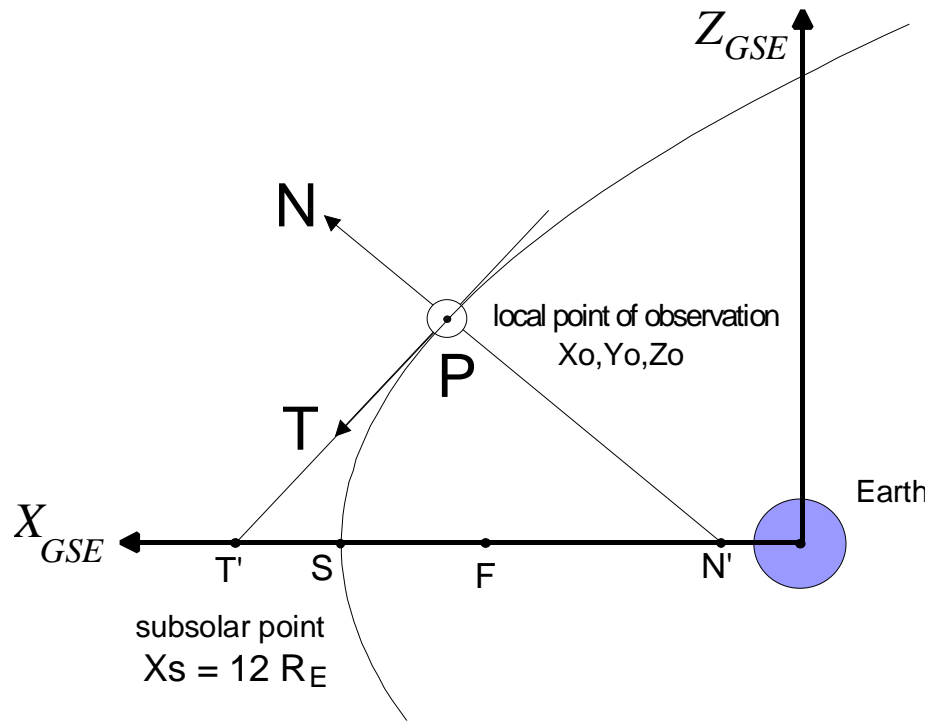
46

Jan_26_2001_11:30



CETP

3 - Remark : LMN coordinate system is close to TPN system



The paraboloid is defined by its summit and the point of observation

The TPN system is defined as:

- \vec{T} = local tangent toward the summit
- $\vec{P} = \vec{N} \times \vec{T}$
- \vec{N} = outward normal

GSE	L	M	N	T	P	N
x	0.764	-0.364	0.531	0.713	0.000	0.701
y	-0.115	0.733	0.669	-0.467	0.746	0.475
z	-0.634	-0.573	0.518	-0.523	-0.666	0.532
λ	193.5	22.3	13.4			

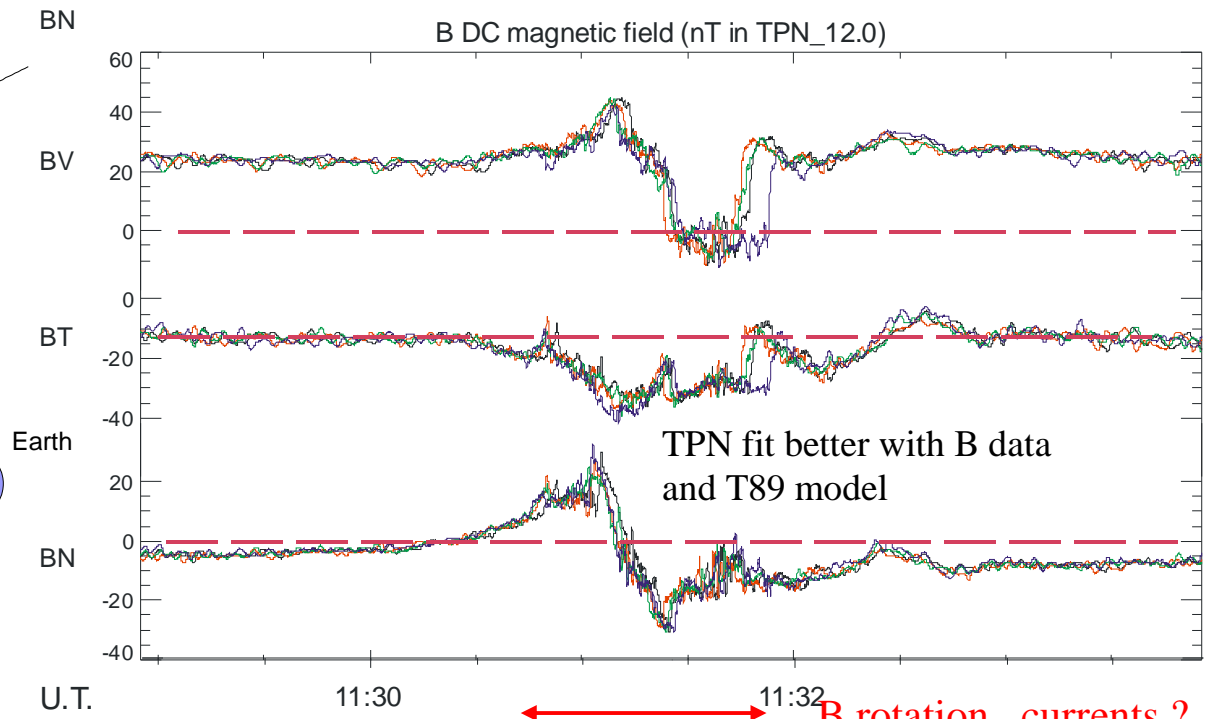
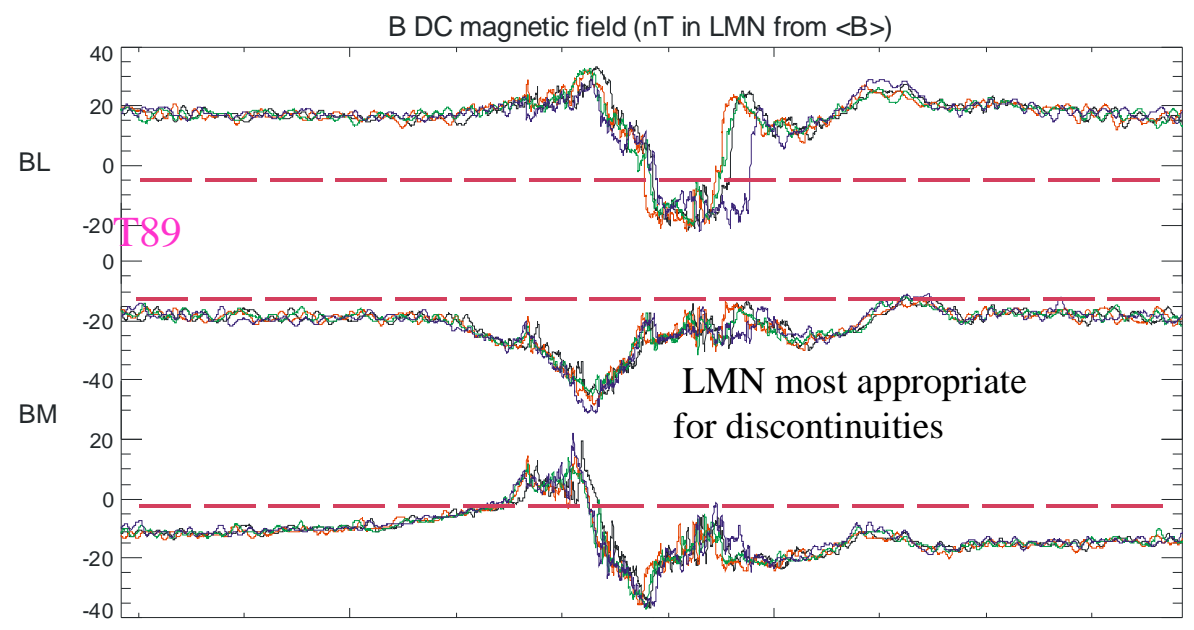
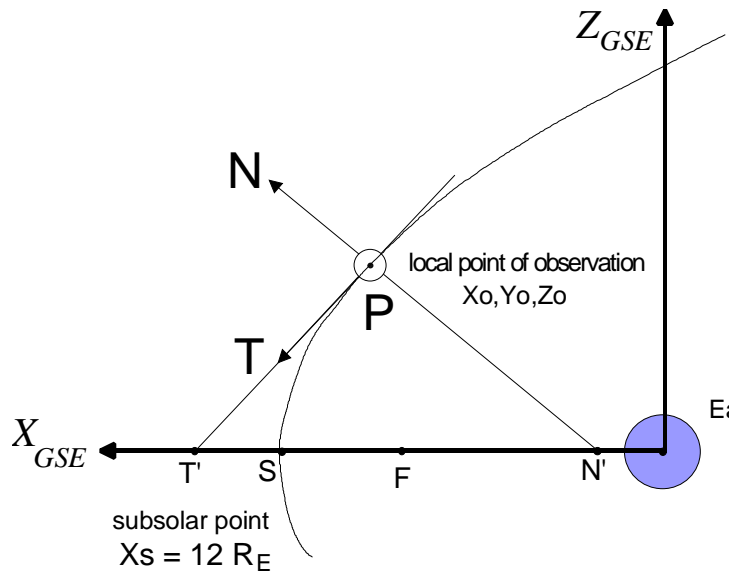
$$(L, T) = 21.5^\circ$$

$$(M, P) = 15^\circ$$

$$(N, N) = 21.8^\circ$$

LMN or TPN?

(L,T)= 21.5°
 (M,P)= 15°
 (N,N)= 21.8°



←→ B rotation, currents ?

CLUSTER/FGM

2001_Jan_26_12:10:13.890

40

