Comparison of ULF waves at magnetopause crossings at different latitudes, as seen by the Cluster and Double STAR STAFF experiments

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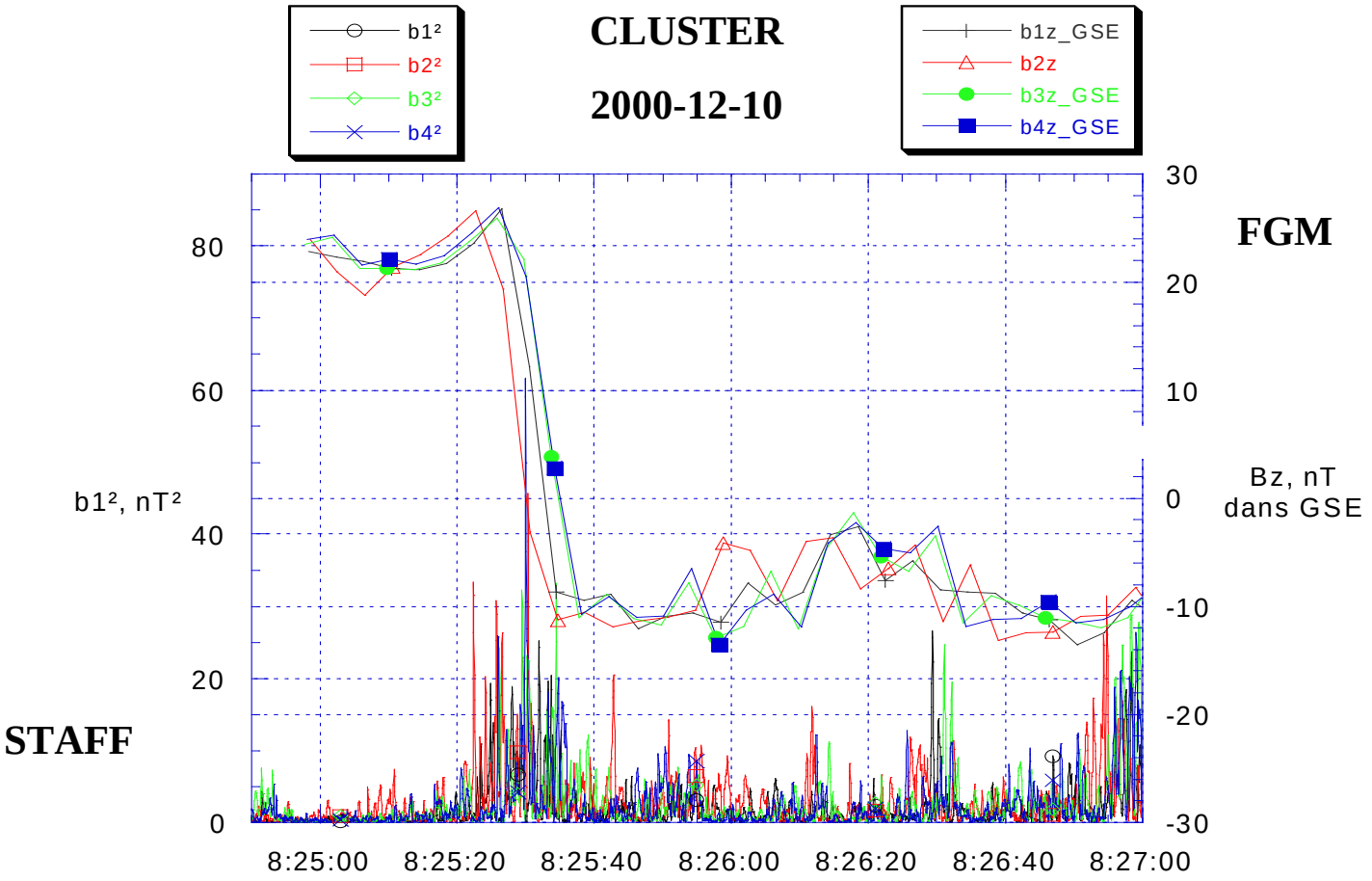
Magnetopause :

- One of the key regions for entry of Solar Wind particles into the magnetosphere:
- Which physical processes ?
- What is the role of ULF waves ?

- **What do we learn with Cluster ?**
- **What do we/will we learn by comparing Cluster and DSP ?**

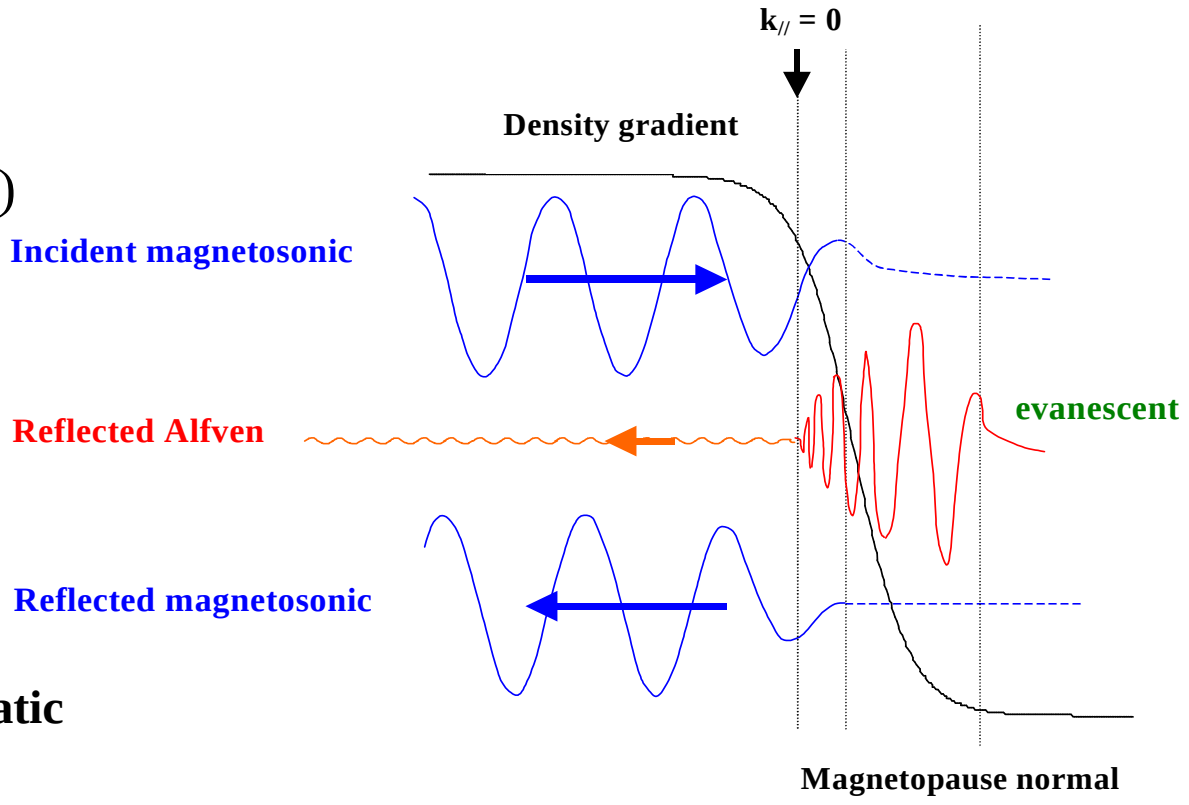
Role of ULF waves at the magnetopause ?



ULF power maximizes at the magnetopause crossing

Model

(Belmont and Rezeau, 2001)

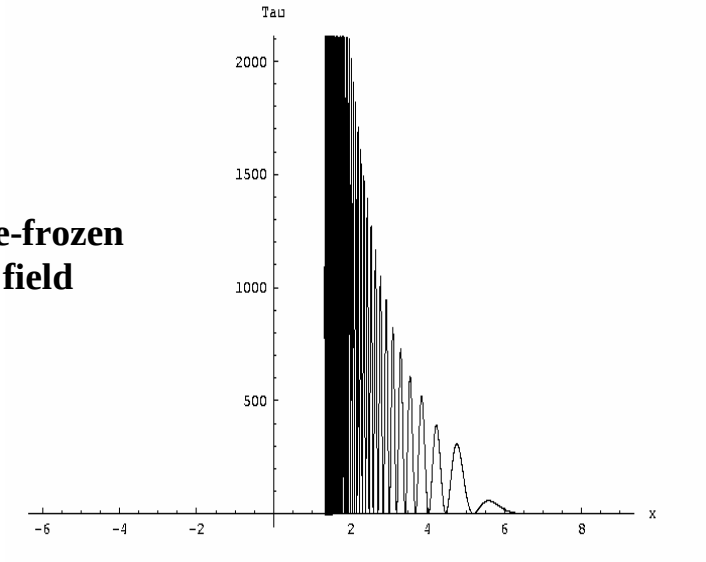


- **Propagation of a monochromatic wave from the magnetosheath towards the magnetopause**
- **Warm plasma**
- **Non-zero frequency**

} **use of MHD-Hall**

- **Rotation of B field**

Rate of de-frozen magnetic field



Some Cluster Results

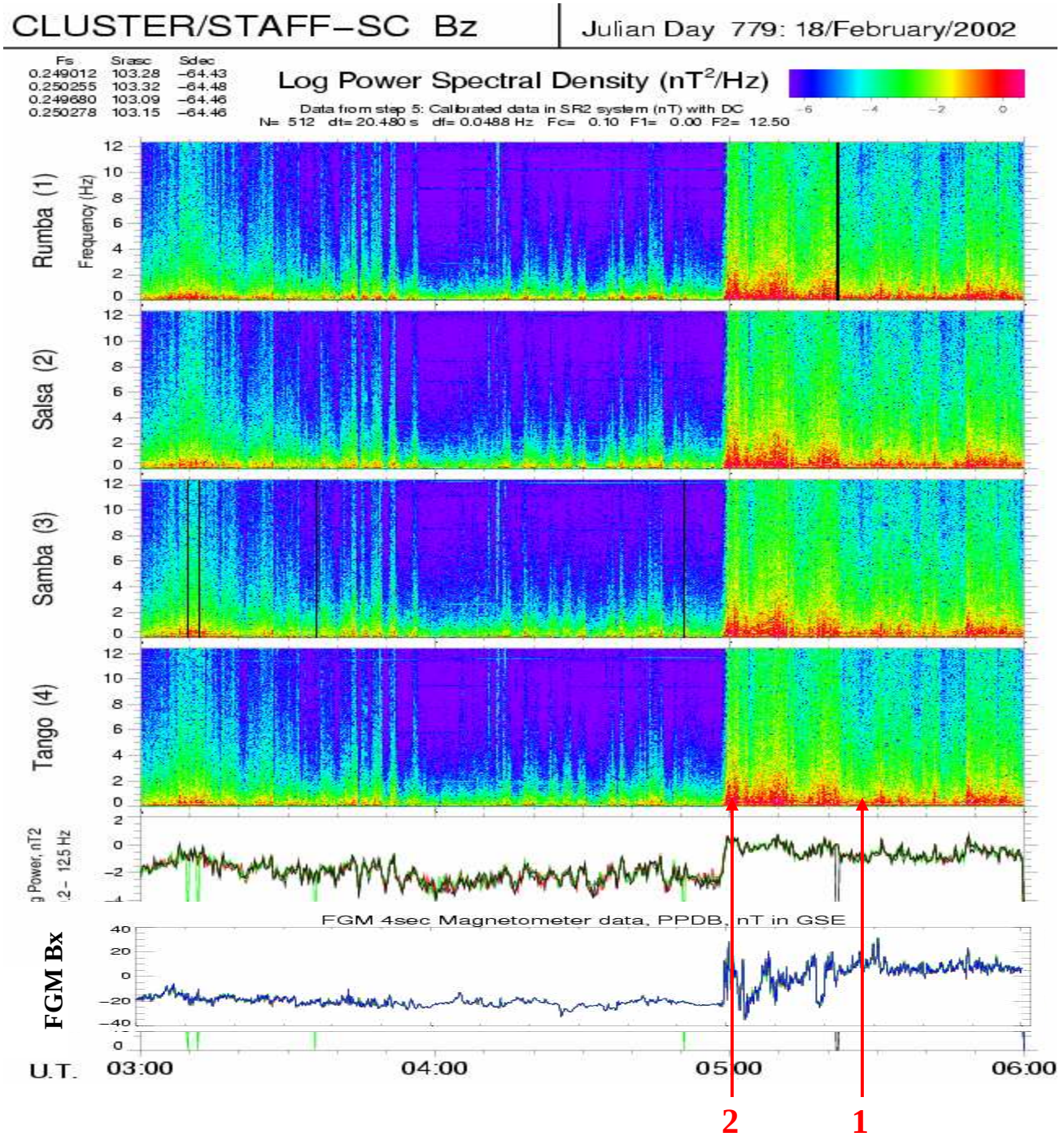
A case study

Turbulent like wave spectra :

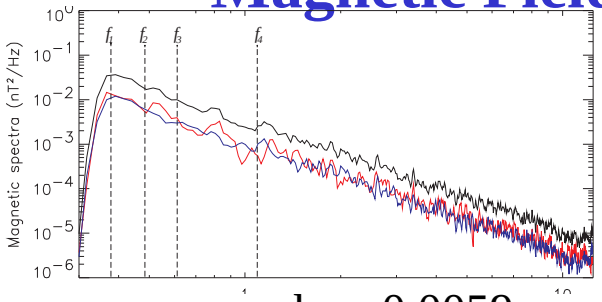
Mode identification

Cluster tetrahedron :

100 km separation



Magnetic Field Energy Distribution in kx-ky planes



Method : **Pinçon and Lefeuvre, 1991, Pinçon, 1999**

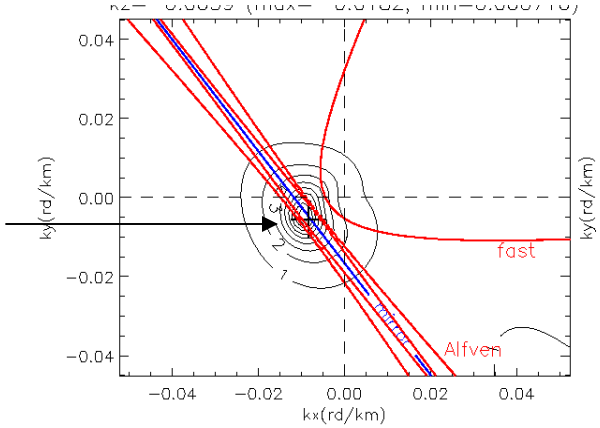
Application : **Sahraoui et al, 2003&**

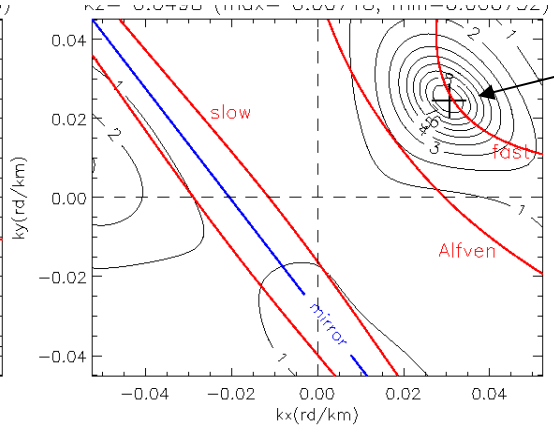
1

kz=-0.0059

kz= 0.049

Mirror mode



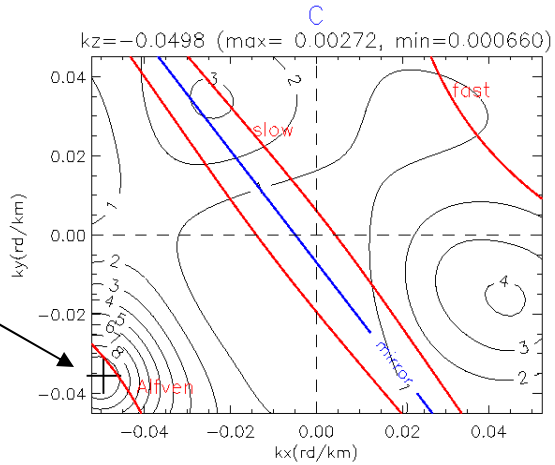


Fast magnetosonic mode

F=0.366 Hz in the satellite frame

Fci=0.329 Hz

Alfven mode



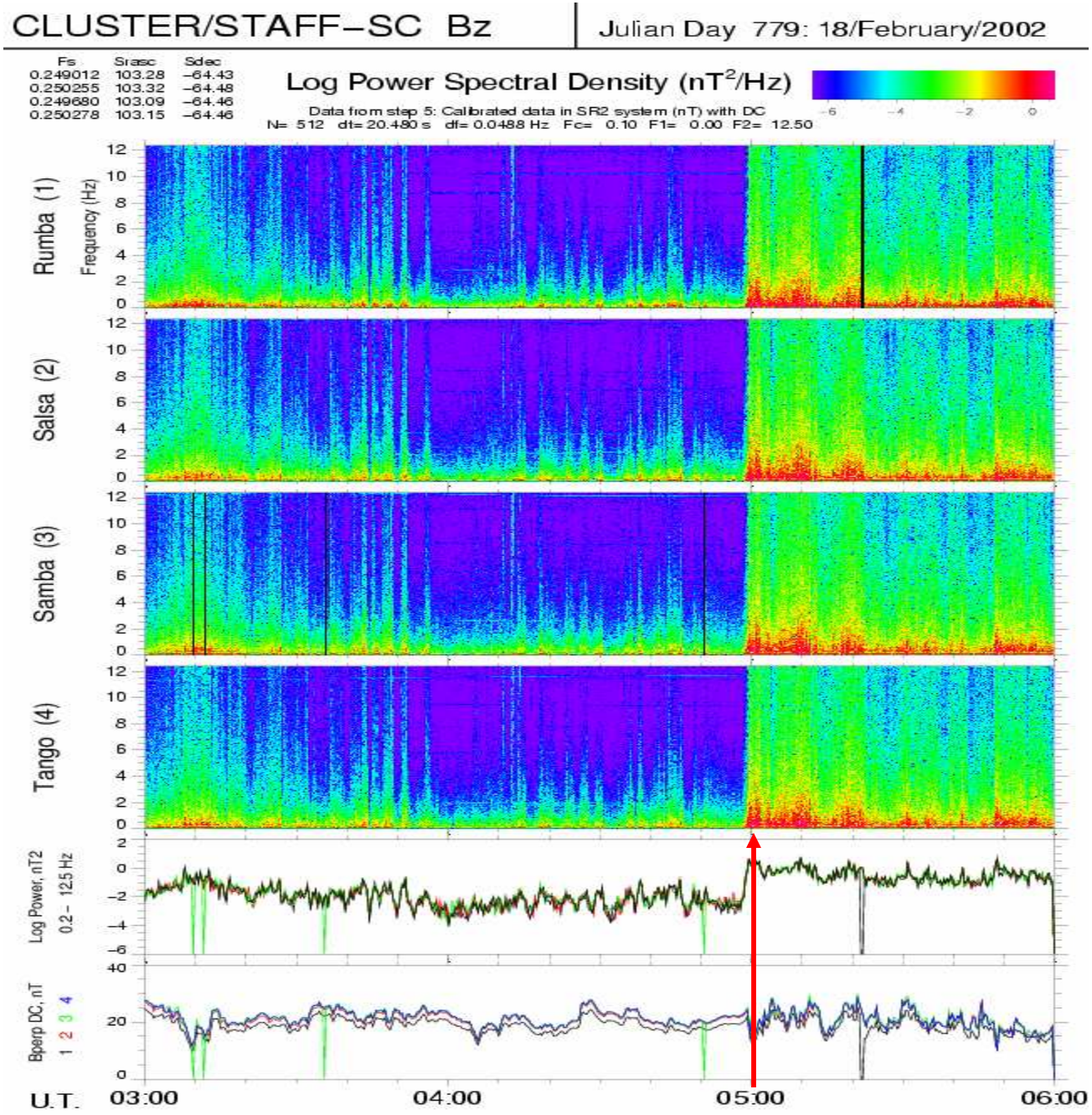
kz=-0.049

\+

Measured maximum power

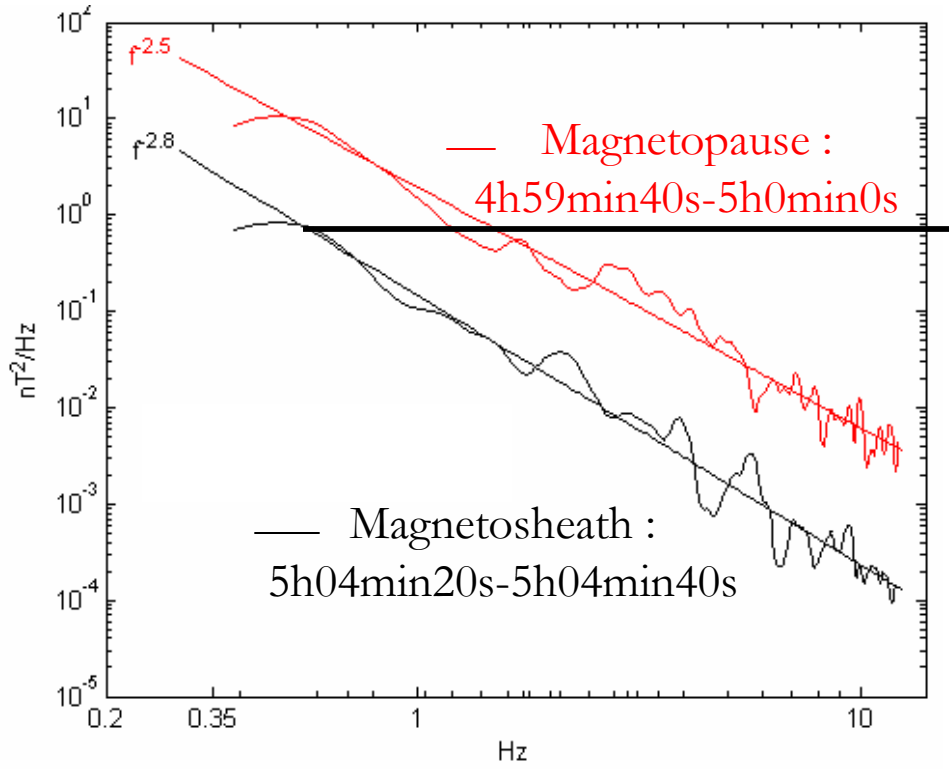
Theoretical dispersion curves (with measured plasma parameters)

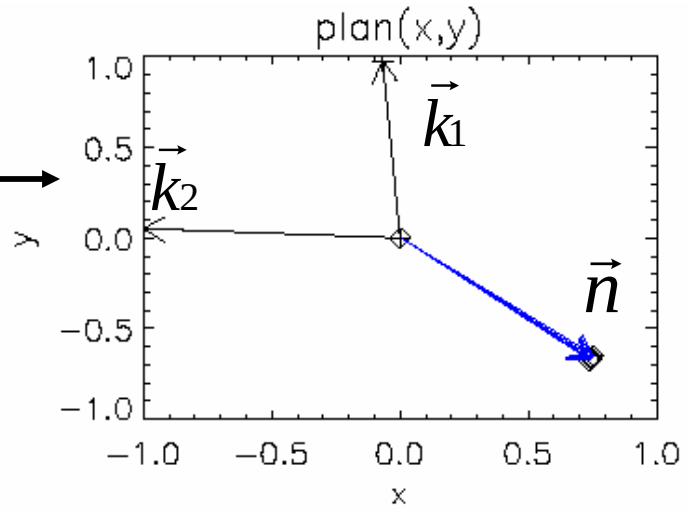
Study in the close vicinity of the magnetopause



Analysis close to the magnetopause

CLUSTER - STAFF SC, 18/02/2002, power spectrum along the direction normal to the magnetopause and k filtering analysis

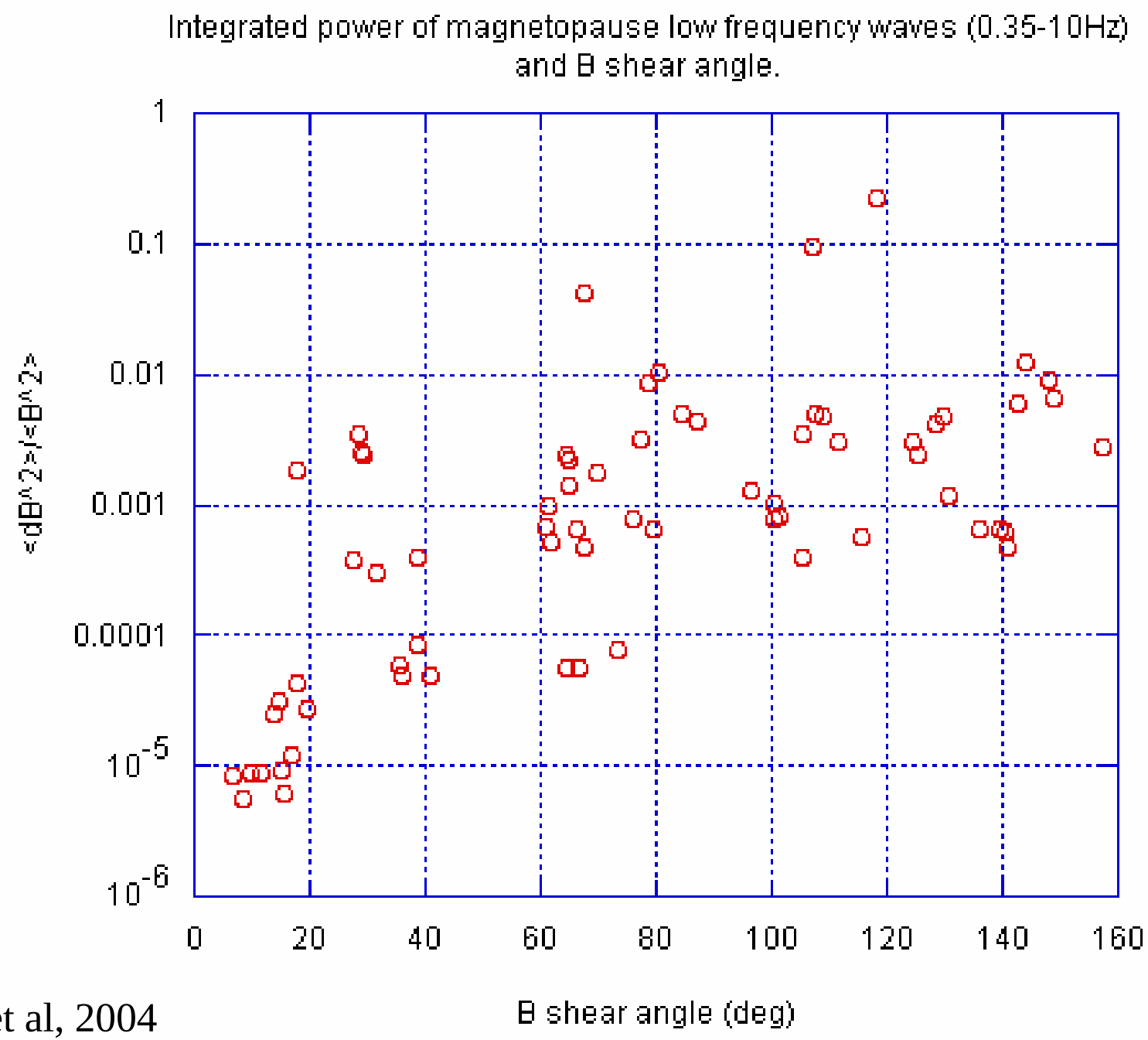




Dominant : mirror mode

Reflection at the magnetopause

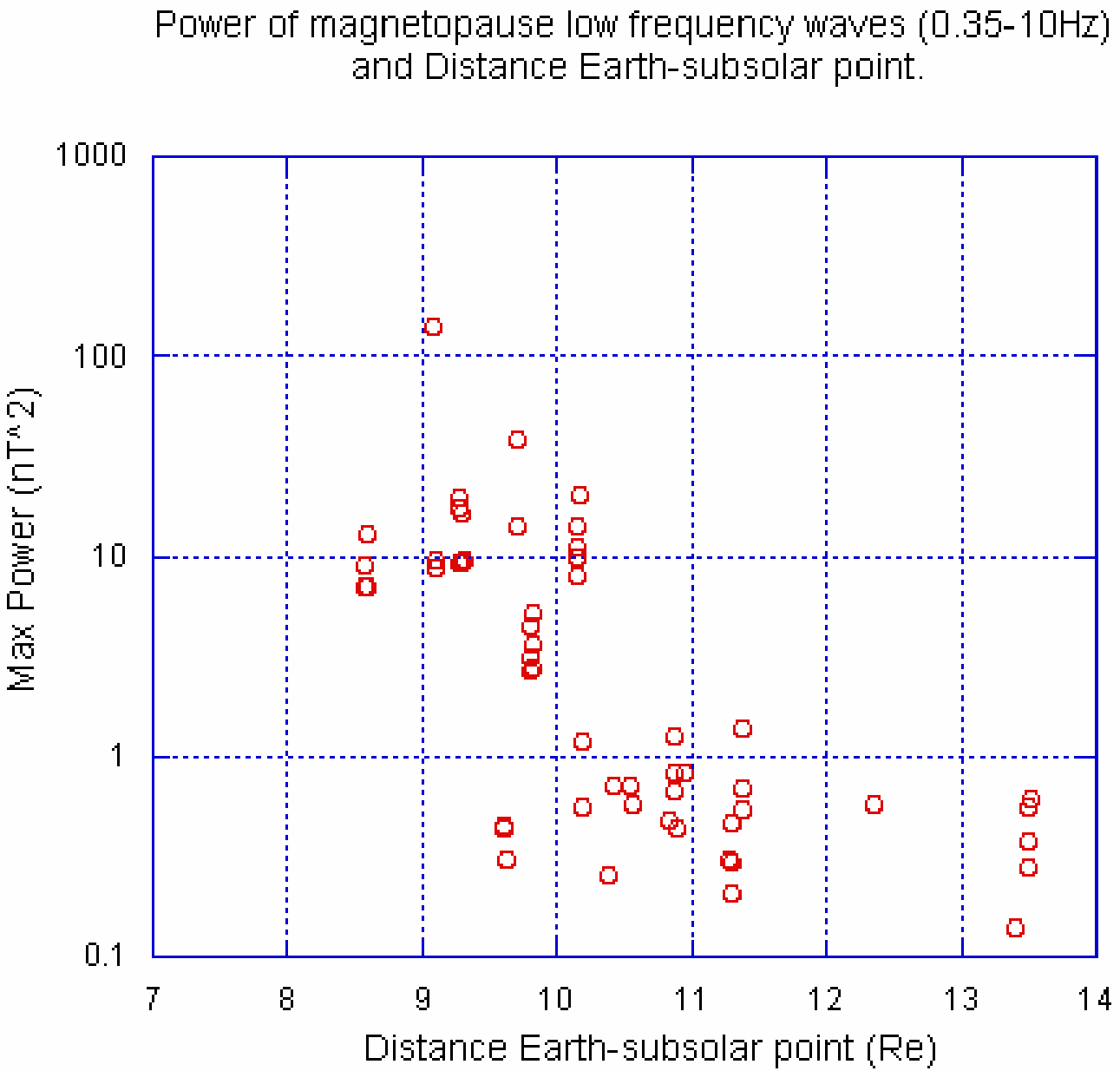
Attié et al, 2004



Attié et al, 2004

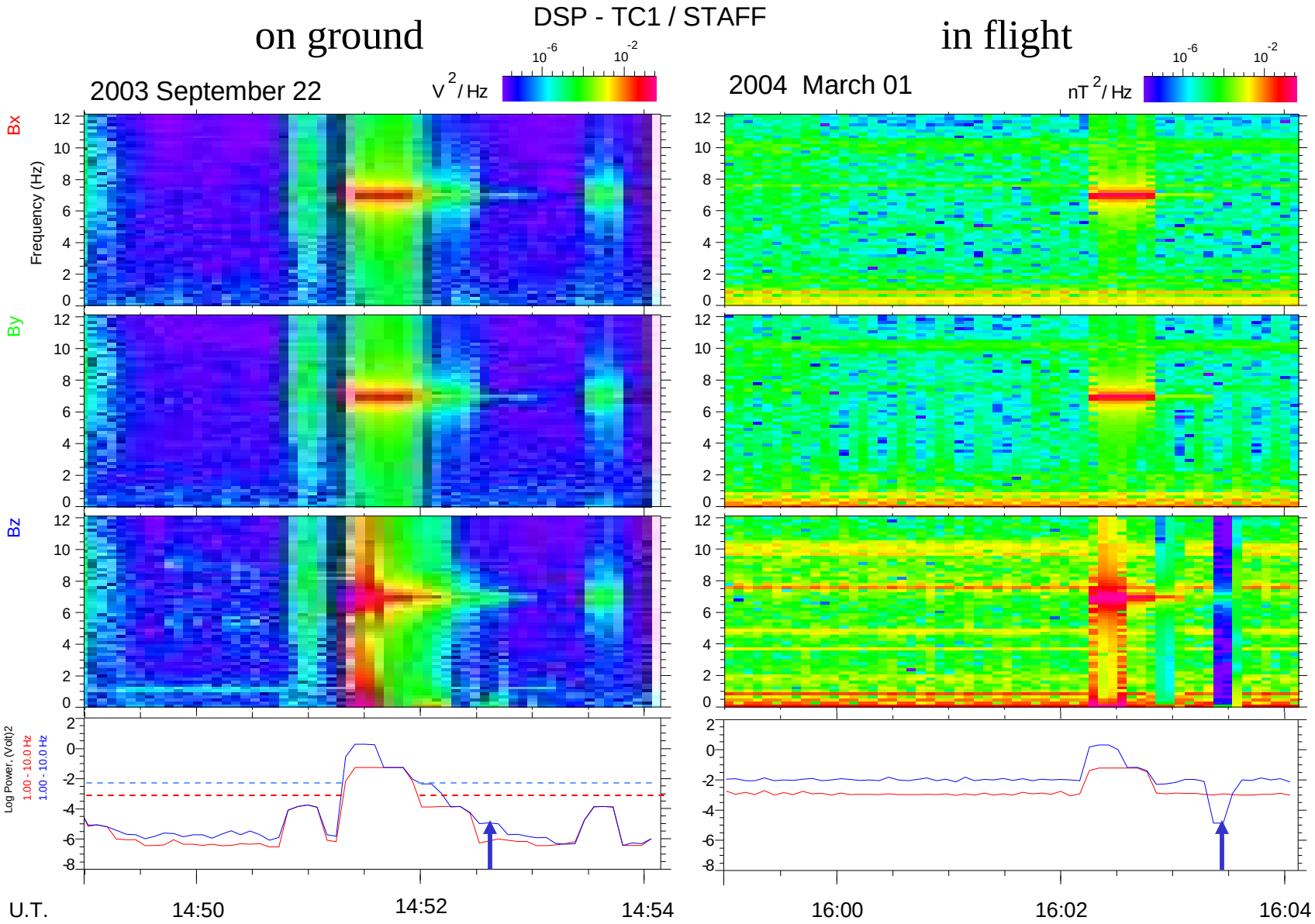
The magnetopause subsolar point is calculated from Cluster position thanks to Sibeck model.

The distance is linked to the Solar Wind pressure



DSP –Cluster comparisons

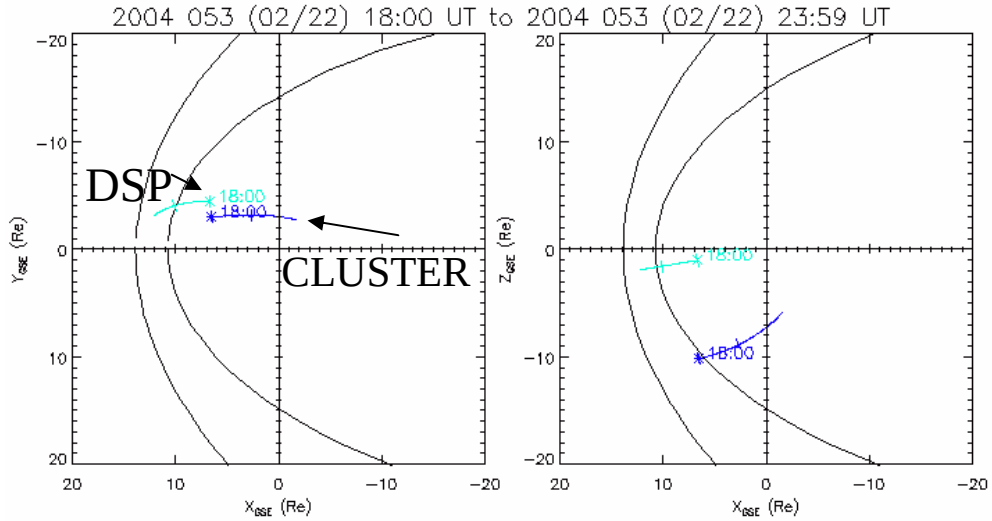
On board calibration

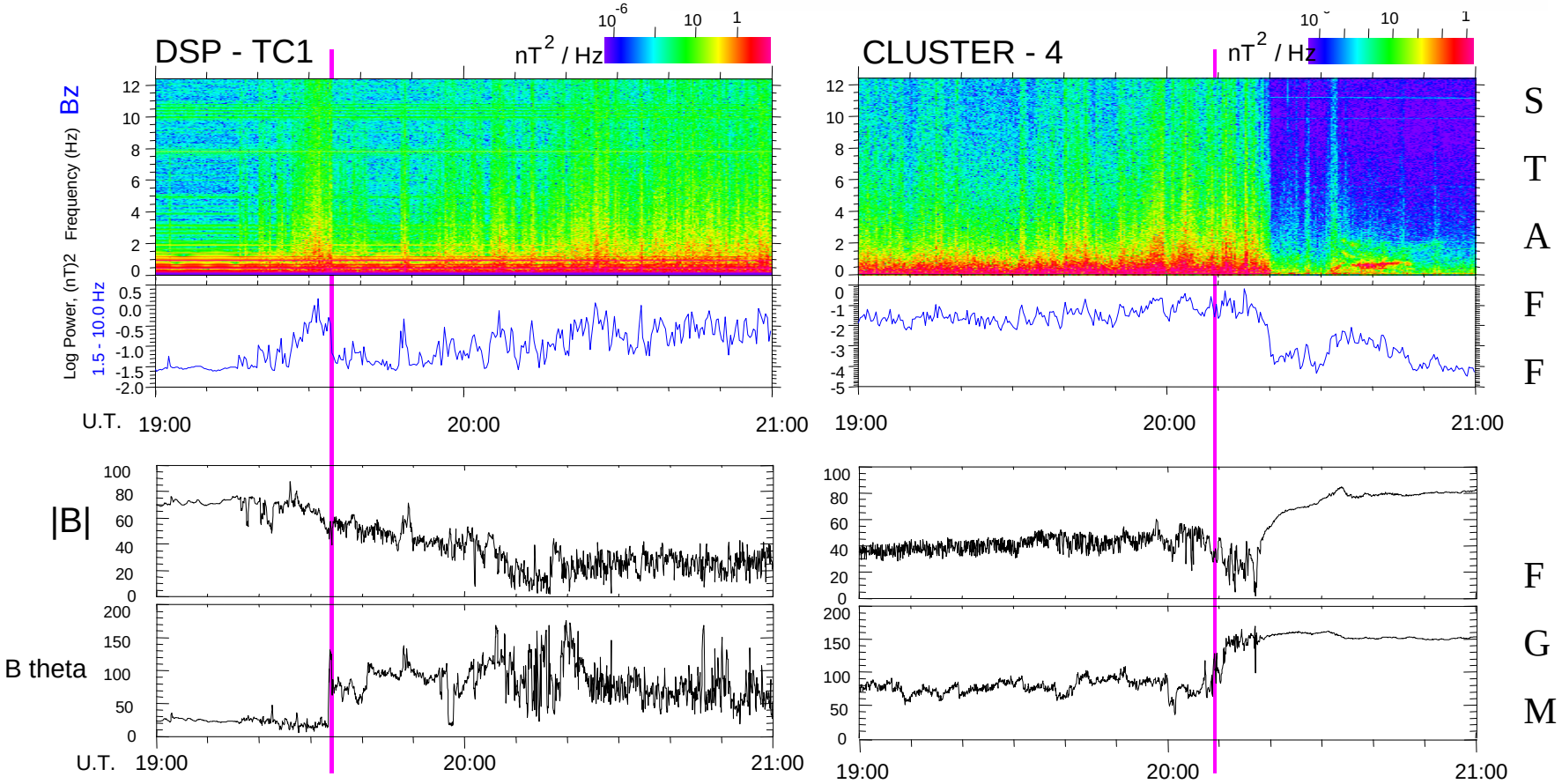


Coordinated magnetopause crossings by both Cluster and DSP-TC1

- 21 coordinated crossings between 21-02-2004 and 22-05-2004
- 17 are within one hour
- Half of the events : determination of subsolar point identical +/- 10%
- 4 Cluster ~identical : separation 200 km

An example of coordinated Magnetopause crossing by DSP-TC1 and CLUSTER



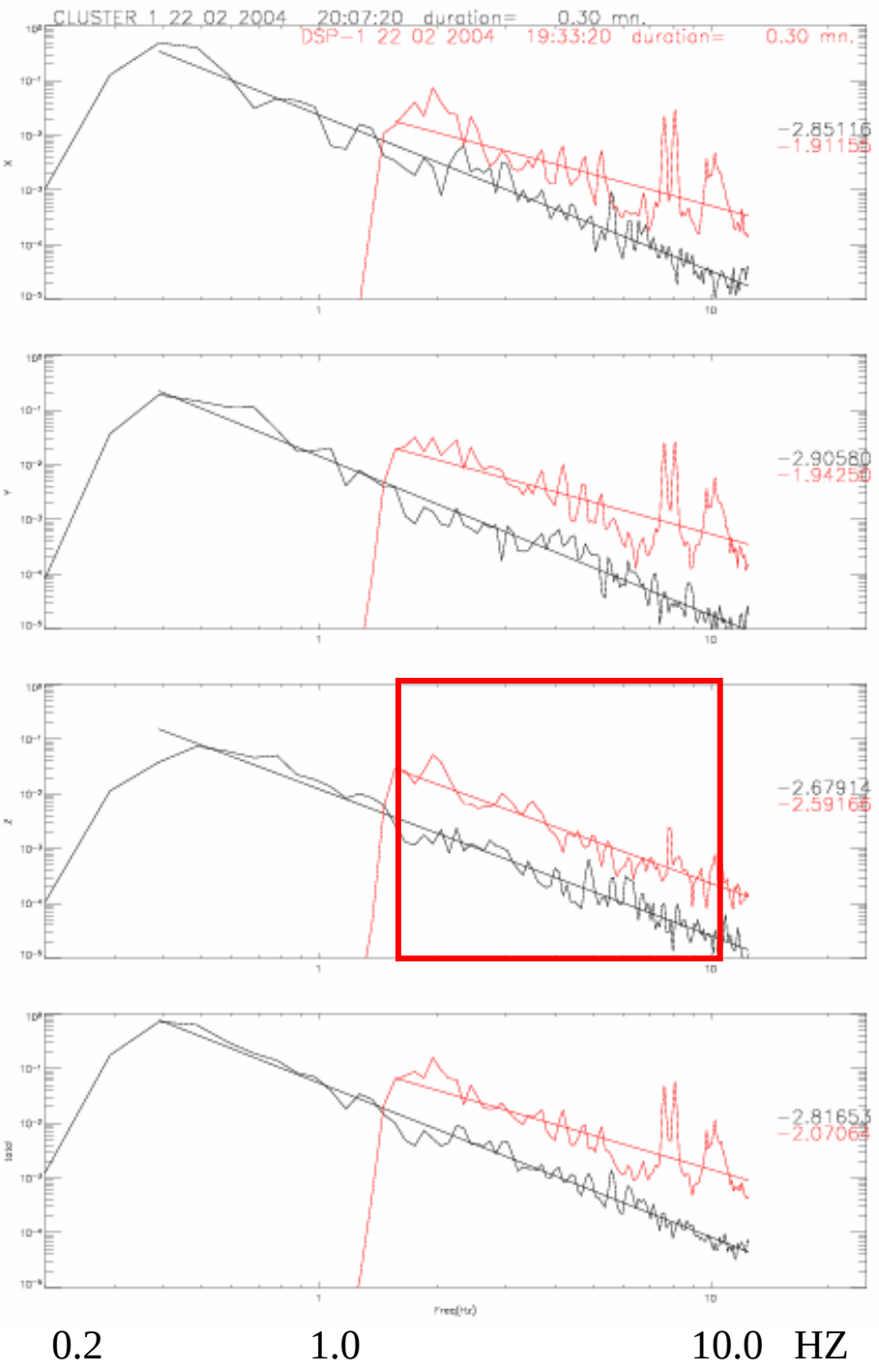


Cluster

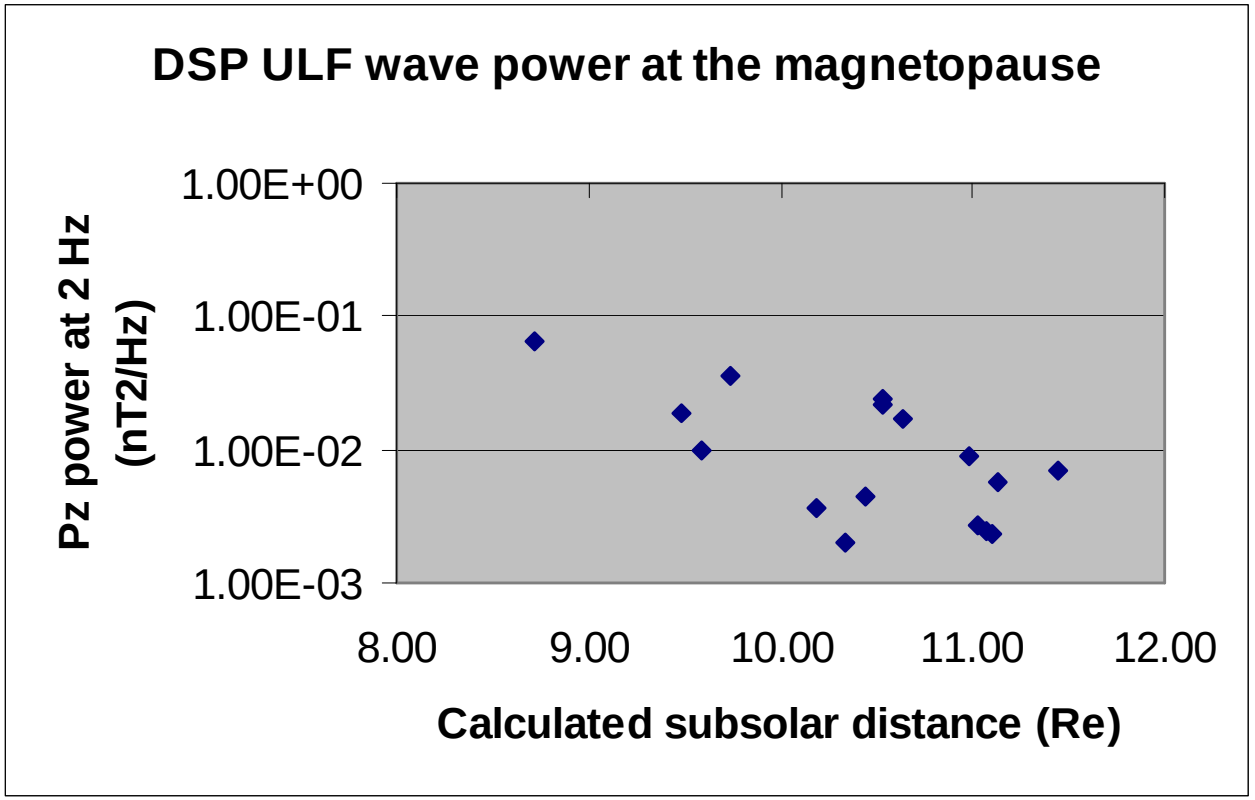
DSP

22-02-2004

Power spectra

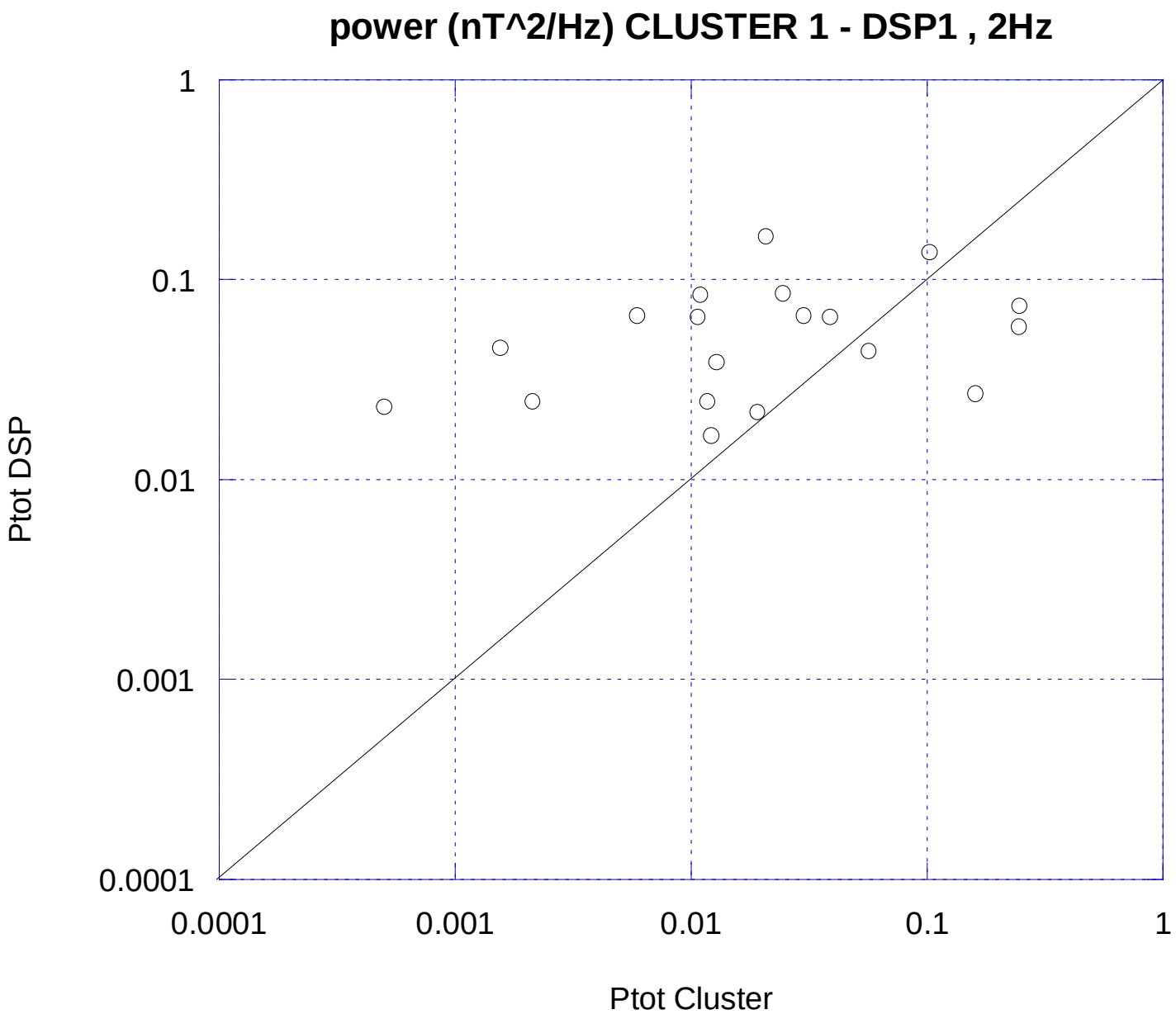


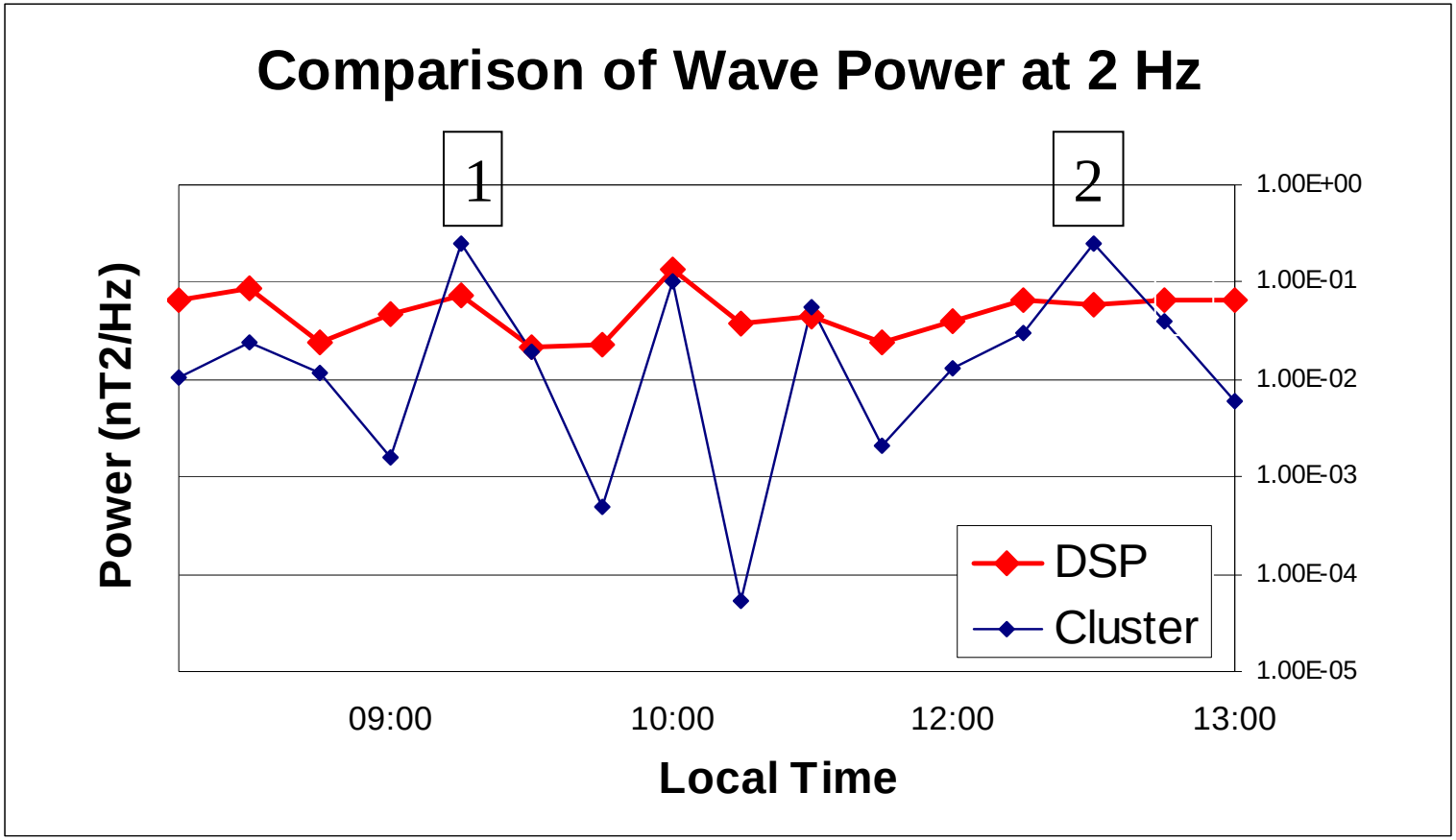
In what follows we will consider Bz, from 2-10 Hz, or the total power at 2 Hz



The same tendency as for CLUSTER is found : the ULF wave power increases when the MP subsolar point distance diminishes

For most events the power at DSP (low latitude) is higher than at Cluster

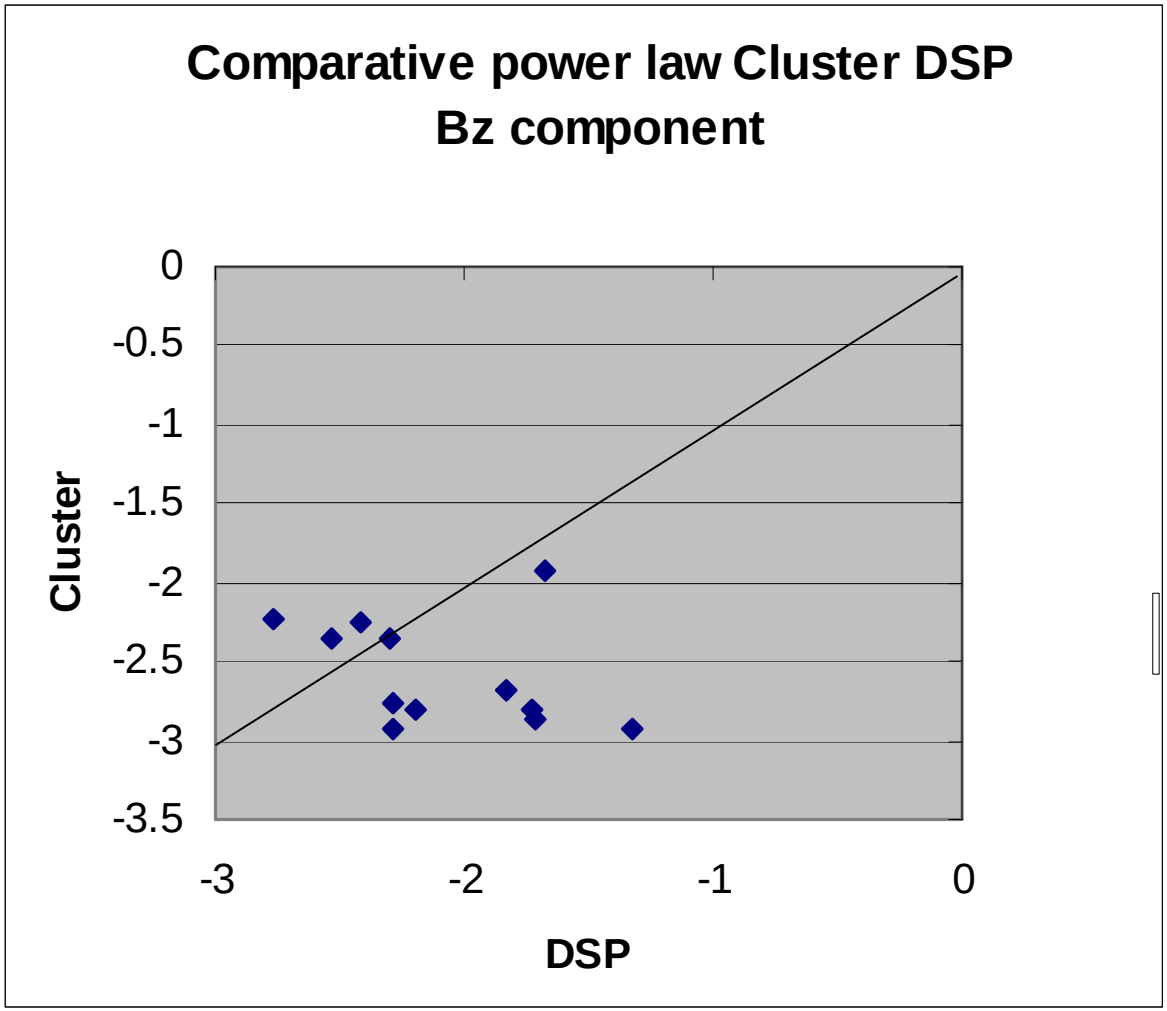




DSP : no Local time dependence

The power is stronger at Cluster (high latitude) when Solar Wind pressure increases, the magnetosphere get compressed

e.g., 1, on 10/04/04, an IP Shock reaches Earth between DSP and Cluster MPXing, and the subsolar point has decreased by 3 Re


Comparative power law Cluster DSP
Bz component
Cluster
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-3
-2
-1
0
DSP

Present results from Cluster and DSP

- Refection of waves at the magnetopause
- Increase of ULF wave power with B field rotation angle
  - Consistent with the model of Belmont and Rezeau, but:
- Modes ? Presence of Alfven and fast magnetosonic modes. But mirror mode is dominant

- Both Cluster and DSP show the role of the Solar Wind pressure

First results of comparisons between Cluster and DSP

- **ULF power at magnetopause crossing is generally stronger on DSP, at lower latitude**
- **Smaller slopes of the frequency spectrum on DSP**
- **Variations : no systematic law found up to now**
- **No LT dependence found at DSP**
- **When the power is stronger at Cluster, it is mostly explained by the solar wind activity, or by a big time delay : are then the same wave modes in the turbulent spectrum ?**

Questions

- **Respective role of the different modes? How the mirror mode cascade is created ?**
- **Future work : mode determination for more cases, different plasma conditions (e.g. low β value)**
- **Continue to look at the difference between low and high latitude**

- **Consequences of comparison with low latitude results on the understanding of the mechanism of turbulence generation and its role on particle entry into the magnetosphere ?**
- **Comparison for 2004 and 2005 are complementary , due to the different CLUSTER separations, but only with 2004 data we have access to the wave modes in the "turbulent" spectra**

Comparison of STAFF Search Coils sensitivity and transfer function on Cluster and DSP