

CLUSTER / STAFF

- **status of calibration and archiving activities**
- **archiving plan until summer 2010**

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LPP: Laboratoire de Physique des plasmas since 1st January 2009.

1. Status of data production: STAFF-SC and STAFF-SA.
2. Status of open action items.
3. Status of Calibration.
4. Status of Cross-Calibration activities.
5. Data delivery plan for measurements from years 2006-2010.
6. Conclusions and perspectives.

1. Status of data production:

a. STAFF-SC

✧ Monthly produced on LPP web site:
<http://www.lpp.polytechnique.fr>

Product	Content	Level	Mode	Num. of files	Produced and Delivered to CAA
C?_CP_STA_DWF_NBR	Decommutated Waveform	1	All	1 file/ 1 sat./24h	<u>Version 02</u> 01 Jan 2001 to 31 Dec 2006
C?_CP_STA_DWF_HBR					
C?_CP_STA_CWF_NBR	Calibrated waveform	2	All	1 file/ 1 sat./24h	None
C?_CP_STA_CWF_HBR					
C?_CP_STA_CS_NBR	Calibrated Spectra	2	All	1 file/ 1 sat./24h	<u>Version 02</u> 01 Jan 2001 to 31 Dec 2005
C?_CP_STA_CS_HBR					
CL_CG_STA_SC_SPECTRO_NBR	Spectrograms plots ✧	3	All	1 file/ 4 sat./3h	<u>Version 02</u> 01 Jan 2001 to 31 Dec 2007
CL_CG_STA_SC_SPECTRO_HBR					

All: NBR and HBR

1. Status of data production:

a. STAFF-SC

- ❑ **Calibrated Spectra:** A new version (03) of the production chain is under development. Once written, the 2006 CS will be produced.
- ❑ **TCOR:** once we get time calibrated data for 2007, DWF and then CS will be produced and delivered.
- ❑ **Spectrogram plots:** produced with a version 01 software (no TCOR, calibration signal extracted).

1. Status of data production:

b. STAFF-SA

✂ Note that 24 hours of CPU time are required to process one month of data
Version 3 has a best decom since CD are concatenated (less waste)

Product	Content	Level	Mode	Num. of files	Produced and Delivered to CAA
C?_CP_STA_AGC	Automatic Gain control	2	All	1 file / 1 sat. / 24h	<u>Version 3</u> 01 Jan 2001 to 31 Aug 2008
C?_CP_STA_PSD	Power Spectral Density				
C?_CP_STA_SM	Spectral Matrix ✂				

For information :

- ❑ STAFF-SC
 - L1 waveform: 4.2 Go/month.
 - L2 complex spectra: 3. Go/month.
- ❑ STAFF-SA
 - L2 AGC, PSD, SM : 11. Go/month.

2. Status of open action items:

a. 2008 Review Board Recommendations

- ❑ T1: About caveat information⇒ short term activities.
 - PSD negative values: a note will be given in the next User Guide about how to deal with it. A caveat will be delivered soon. It has been decided not to re-process all the data now. They will be replaced by a fillvalue on the next delivery.
Only 0.002% of the data are affected but nearly every day.
 - SM caveat files: K. Yearby suggests to create them considering that the SRP (Sun Reference Pulse) times is not recorded in the S/C housekeeping in eclipse umbra.
- ❑ T2: (cf T1). The housekeeping data S/C are necessary to check the data consistency, and have to be available at CAA.
- ❑ T3: Calibration report: a first draft has been sent in january 2009. Available on CAA website.
- ❑ T4: User Guide: idem.
- ❑ T5: All data from year 2001-2009 will be provided before June 2010 depending on TCOR availability.
- ❑ T13: SC complex spectra, and SA PSD/SM have been provided for years 2001-2005.

2. Status of open action items:

b. Since 8th Cross-Calibration Meeting (1)

- CC8-AI-1:
 - Magnetic Field: one paper divided in 2 parts: *STAFF-SC/FGM and STAFF-SC/STAFF-SA*.
 - Electric Field: one paper: *STAFF-SA/EFW/Whisper*.(STAFF-SA suggests that WBD initiates the comparisons between STAFF-SA-WBD).
- CC8-AI-6:
 - Comparison STAFF-SC/FGM:
 - * *The 2 spin-plane DC field components* in SR2 system (time resolution: a few spin period).
 - * *Filtered waveform components* (time resolution: 1/25Hz and $0.5\text{Hz} < F < 4\text{Hz}$).
 - Comparison FGM/STAFF-SC/STAFF-SA:
 - * *Power spectra* on one plot from low frequencies up to 4kHz average on a time scale chosen by the user.
 - *Spectrograms of the fluctuations power* from the lowest frequency to 4 kHz in a reference system (SR2, ...) chosen by the user: in electric (x, y, x+y) and in magnetic (x, y, z, x+y+z).

2. Status of open action items:

b. Since 8th Cross-Calibration Meeting (2)

- ❑ CC8-AI-7: Survey parameters (1-minute averages)
 - STAFF-SC: total power inferior to the ion gyrofrequency, between the ion and the electron gyrofrequency, and on all band.
 - STAFF-SA: total power for frequency inferior to electron gyrofrequency and superior to electron gyrofrequency.
- ❑ CC8-AI-9: multi-experiment plots:
 - For wave: on the whole frequency range.
 - For particles: on the energy range.
- ❑ CC8-AI-13: feasible to produce data files from the commissioning phase.
 - STAFF-SC: Sept. 2000-Jan. 2001.
 - STAFF-SA: Electric: from Dec. 2000.
Magnetic: Sept. 2000-Jan. 2001.
- ❑ CC8-AI-45: STAFF-SA suggests that WBD initiates the cross-calibration study between STAFF-SA and WBD.
- ❑ STA08-AI-1 and AI-2: SM and PSD datasets caveat : cf T1.

3. Status of Calibration:

a. S/C #1 problem: Reason identified

Case Study:

Low inter-S/C distance
⇒ similar field intensity.

$B_{\perp}$ for S/C #1 is 10% lower than
for the 3 other S/C. Always true.

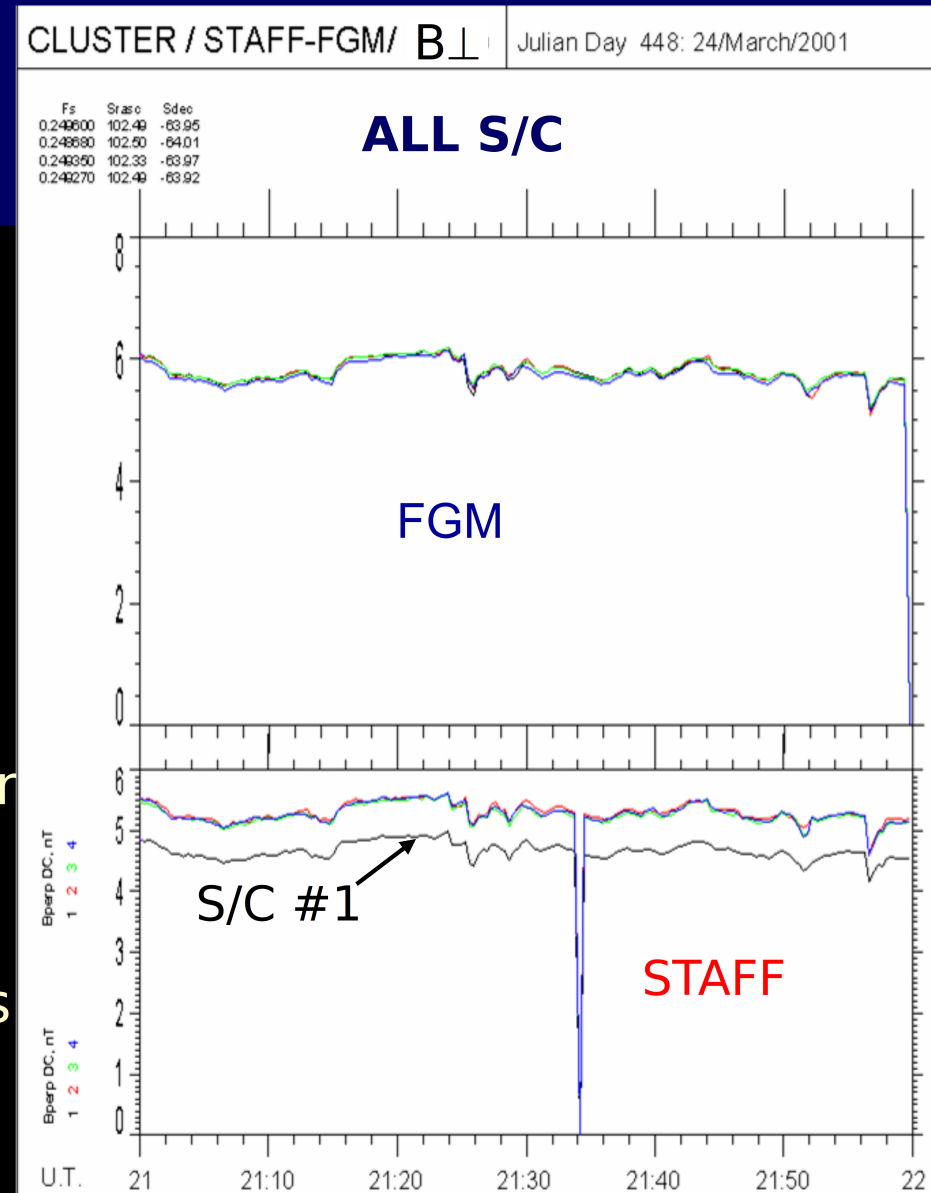
□ Reason:

After investigation, it is due to a
sensor initial calibration mistake on
ground (before launch).

□ Conclusion:

S/C #1 transfer function suspicious

⇒ to be corrected.



3. Status of Calibration

b. In flight calibration

- Up to now: verification of the calibration signal intensity stability.
- General: Calibration signal
Antenna signal and reference signal are recorded.
⇒ re-calculated the transfer function at 7Hz and its time evolution.
- Calibration Data: have to be exploited.
- Software: for detailed analyses, remains to be developed.
- Goal:
 - To explain the 10% difference between S/C #1 and the other S/C (2, 3, 4) for STAFF-SC.
 - To improve STAFF-SC calibration.
 - To justify the discrepancy between STAFF-SC and FGM.

4. Status of Cross-Calibration Activities:

a. Comparisons STAFF-SC/FGM

Context

Re-started since the 8th Cross-Cal. meeting.

- Comparison:
 - (i) on the DC field from the spin signal.
 - (ii) on the spectra to study a possible frequency effect.
 - (iii) on the waveforms themselves.
- STAFF-SC data:
L2 produced with the new software version, from same L1 delivered at CAA.
- FGM Data: retrieved from CAA.

⇒ updated and consistent dataset!!

a. Comparisons STAFF-SC/FGM

(i) the DC field ($B_{\perp}$)

Study performed on several cases:

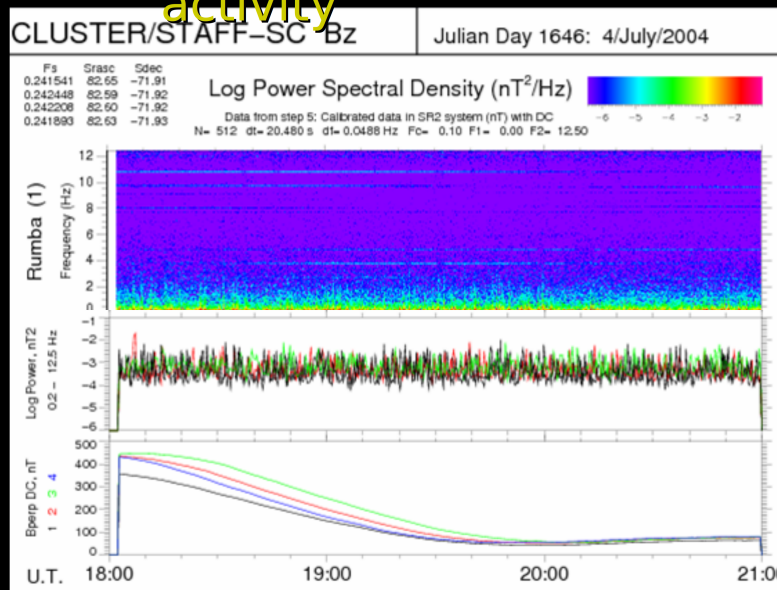
- ❑ From 2001 to 2006.
- ❑ Different seasons.
- ❑ Different conditions:
 - Strong fields.
 - Weak fields.
 - Within or not a high magnetic wave activity environment.
- ❑ FGM interpolated on STAFF time resolution.
- ❑ Statistics on 1H-event: Average and STD.

Constant difference

(i) the DC field ($B_{\perp}$)

Case study:

Strong DC field, weak magnetic wave activity



No event

Noise level

Very high
up to
400nT

$$\langle \Delta B_{\perp} / B_{\perp} \rangle \pm \sigma_{B_{\perp} / B_{\perp}} = 21.65 \pm 0.08$$

$$\langle \Delta \varphi \rangle \pm \sigma_{\Delta \varphi} =$$

CLUSTER Rumba #1

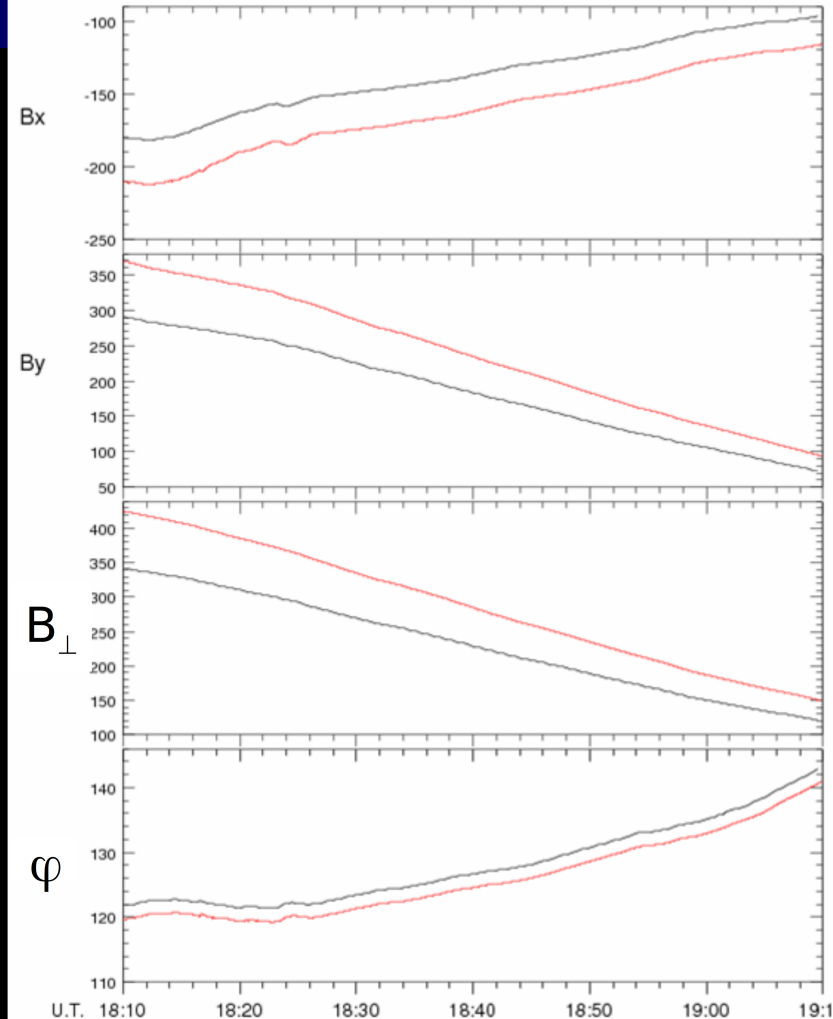
2004 July 04 (Julian day 1646)

Starting time: 18:10:11.649.585
Ending time: 19:02.469.0
Starting time: 18:10:02.469.0
Ending time: 19:02.469.0

N = 175 NBR Fc = 0.1 Hz Fs = 0.241541 Hz
N = 869 SPI Fc = 0.1 Hz Fs = 0.241541 Hz
GEI Spin Rasc= 82.65 GEI Spin Dec= -71.91
GEI Spin Rasc= 82.65 GEI Spin Dec= -71.91

STAFF-SC
FGM

DC field in SR2 system [nT]

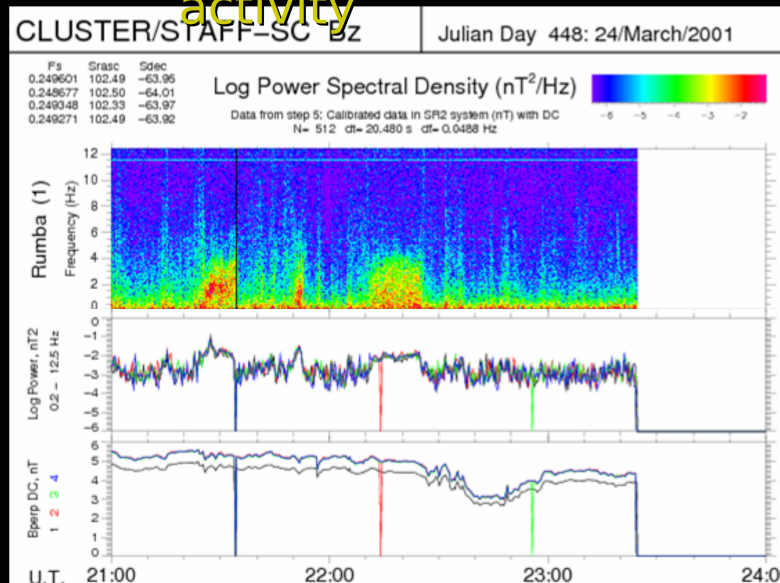


Constant difference even with strong waves

(i) the DC field ($B_{\perp}$)

Case study:

Weak DC field, strong magnetic wave activity



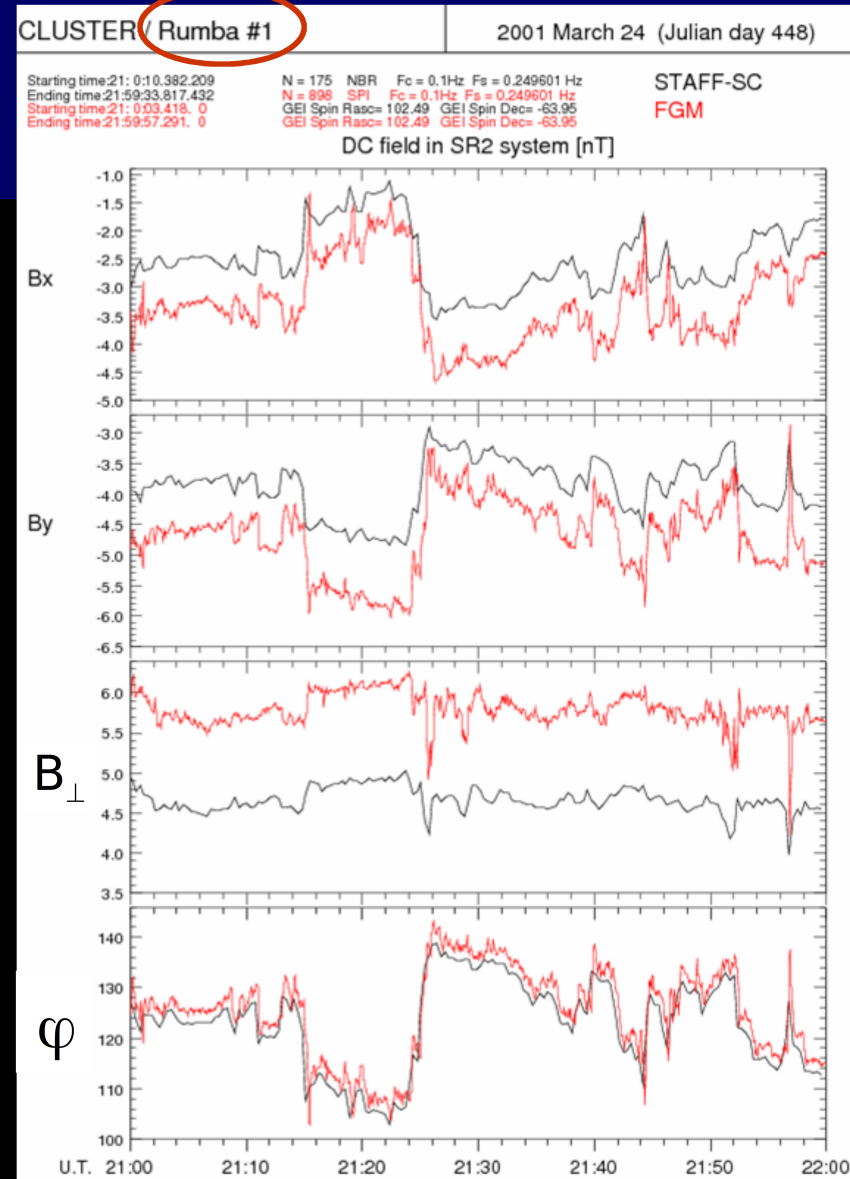
Strong event

Above noise level

Very low
~5nT

$$\langle \Delta B_{\perp} / B_{\perp} \rangle \pm \sigma_{\Delta B_{\perp} / B_{\perp}} = 21.66 \pm 1.66$$

$$\langle \Delta \varphi \rangle \pm \sigma_{\Delta \varphi} =$$



Evolution with time (1)

(i) the DC field ($B_{\perp}$)

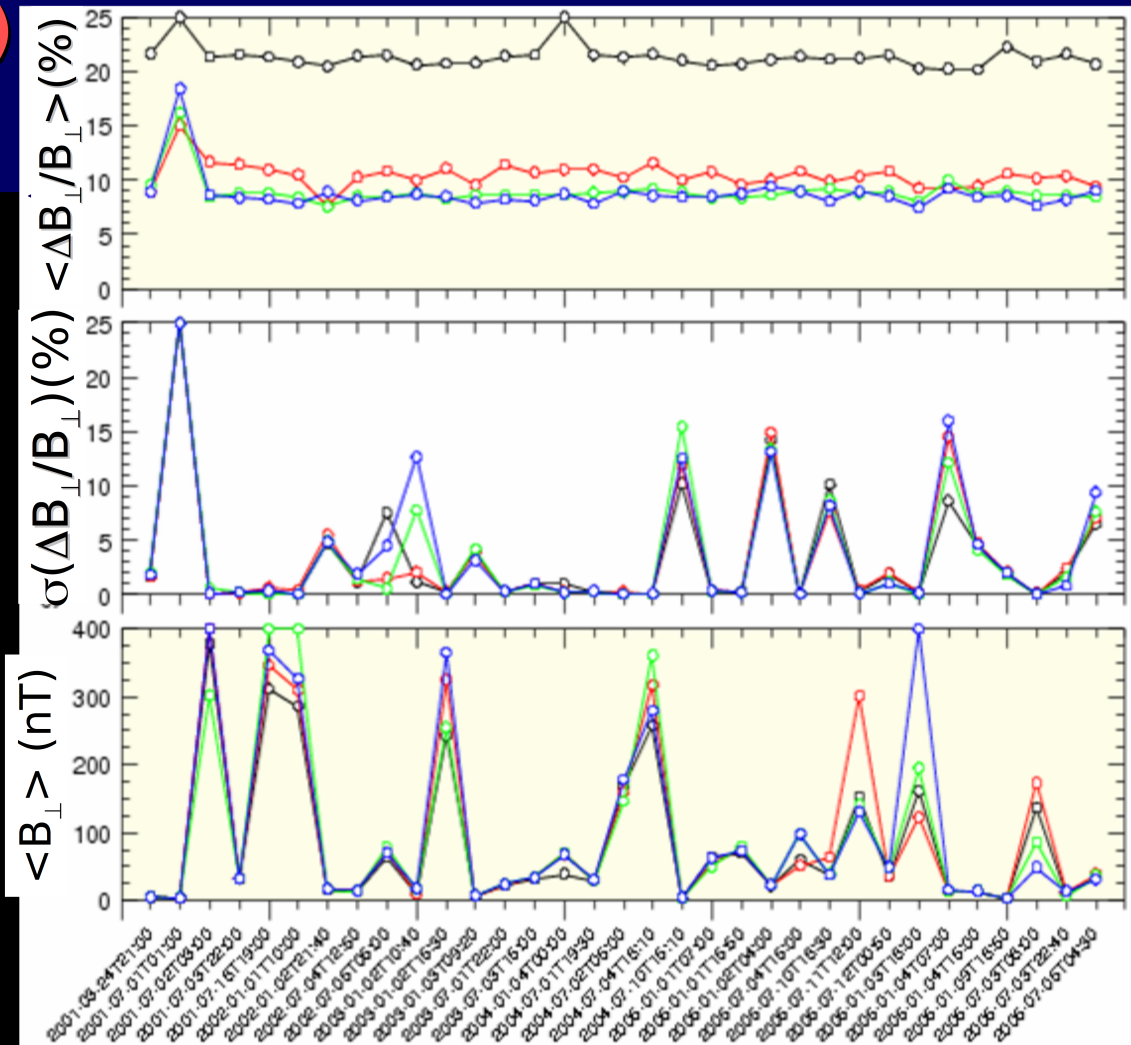
Amplitude

□ $\langle \Delta B_{\perp} / B_{\perp} \rangle$: (FGM-STAFF)

Constant despite of the conditions. Always true.

□ STAFF-SC S/C #1:
21% lower than FGM.

□ S/C # 2,3, and 4:
11% lower than FGM.



2001
2006

- Cover all the mission period -

Evolution with time (2)

(i) the DC field ($B_{\perp}$)

Direction: phase difference

□ $|\langle \Delta\varphi \rangle|$:

Constant despite of the conditions.

Always true.

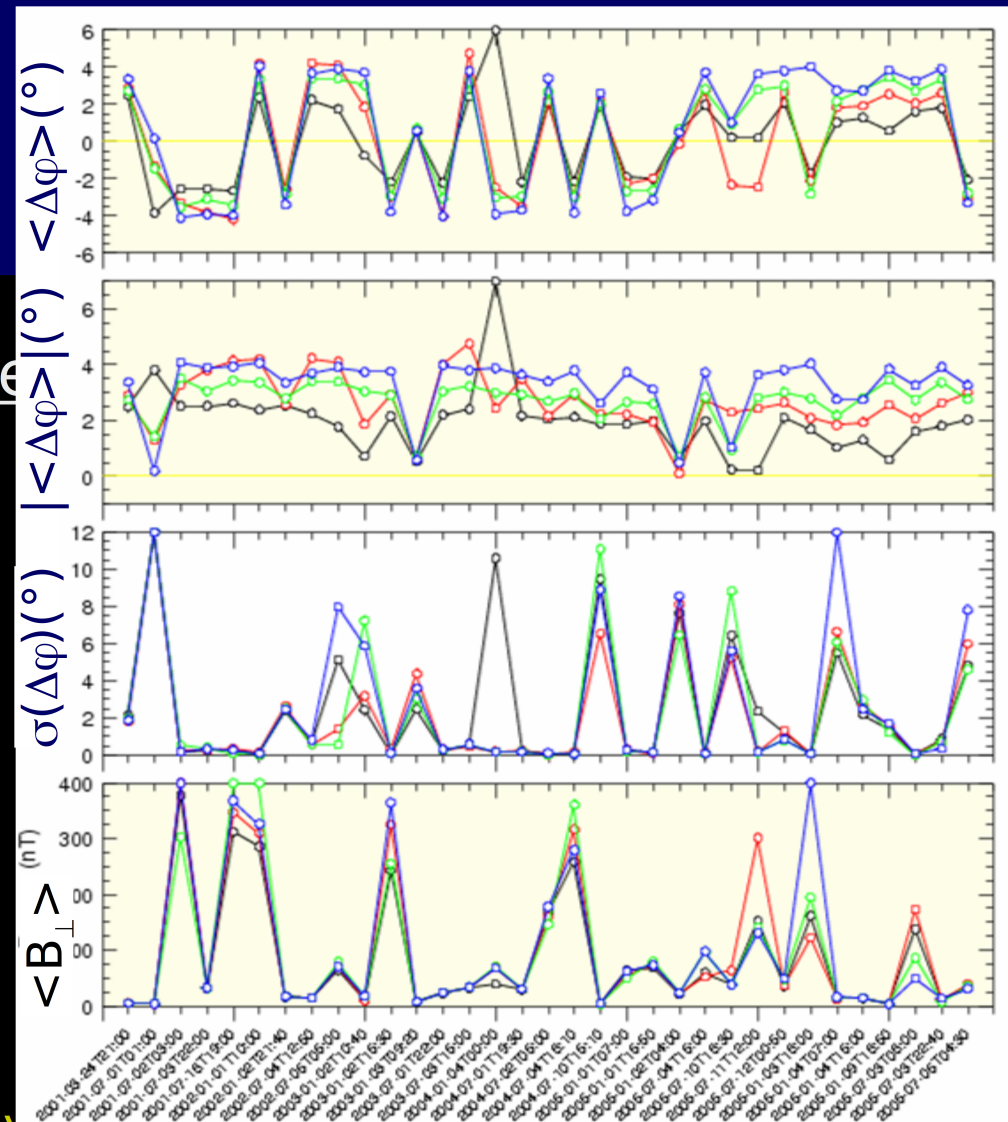
□ Problem on $\langle \Delta\varphi \rangle$:

Regular sign inversion.

□ S/C #1, 2, 3, and 4:

Roughly the same results.

⇒ Correction on S/C # 1:
transfer function amplitude only.



2001 - Cover all the mission period -
2006

On the common frequency band

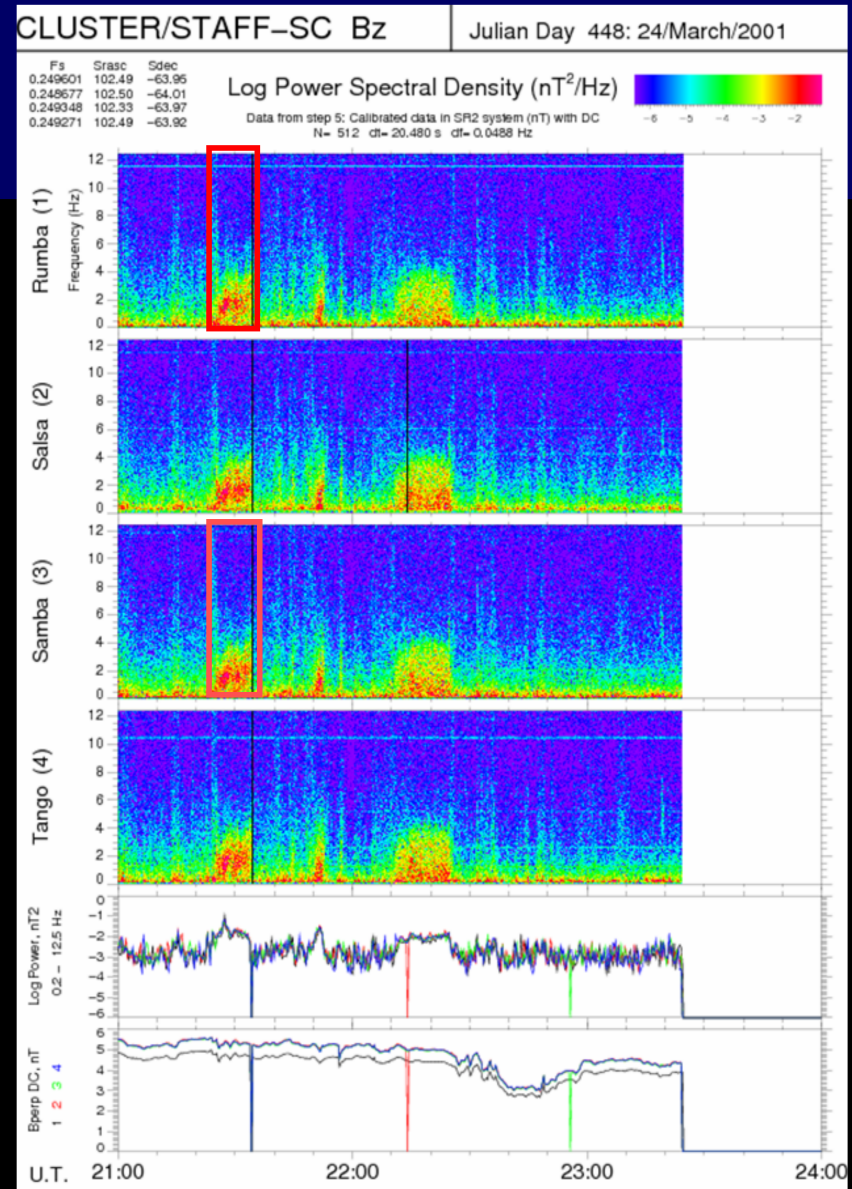
a. Comparison STAFF-SC/FGM: (ii)the Spectra

Introduction:

STAFF-SC and FGM are both sensitive to intense low frequencies waves.

⇒ Case study: Waves in a limited:

- Frequency band range.
- Time interval.

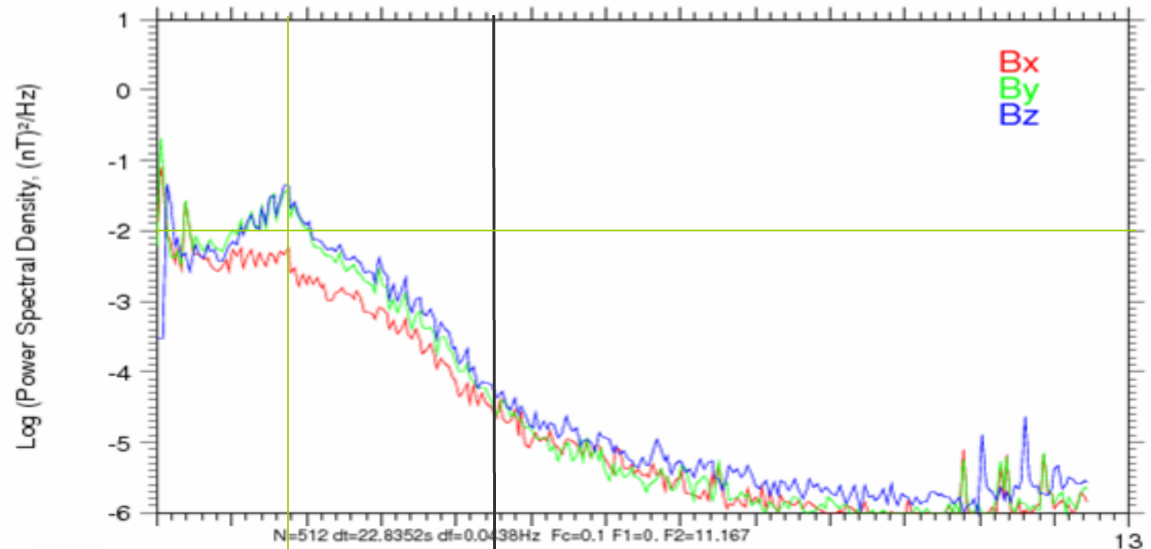


S_dec S_rasc S_freq
-63.95 102.49 0.249601

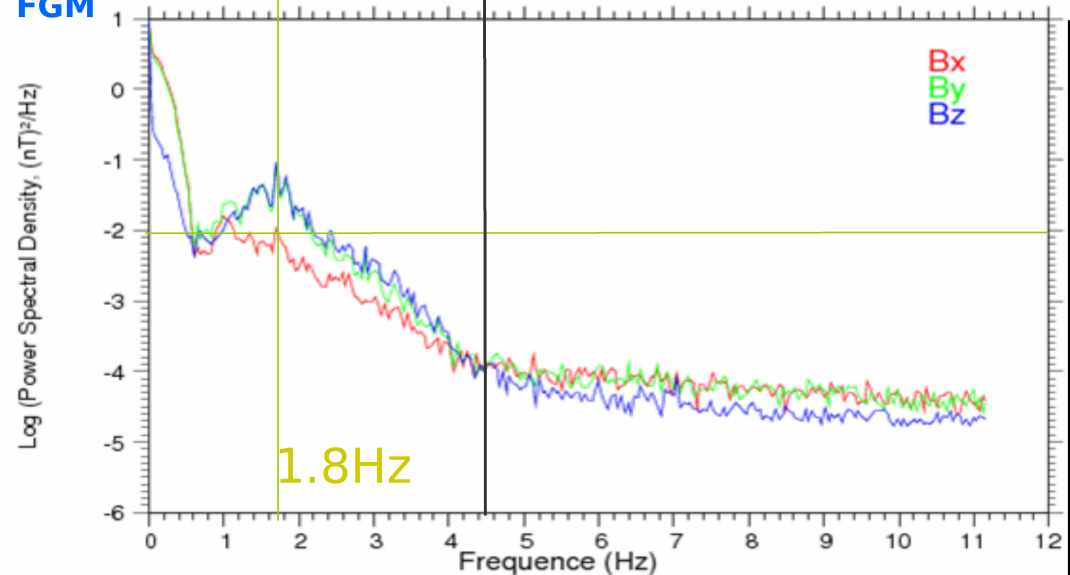
Log Power Spectral density, (nT)²/Hz

Data from Step 4: Data in SR2 system [nT] without DC (0.-12.5003 Hz, Fc=0.1 Fdet=0.)

N=512 dt=20.4795s df=0.0488Hz Fc=0.1 F1=0. F2=12.4515



FGM

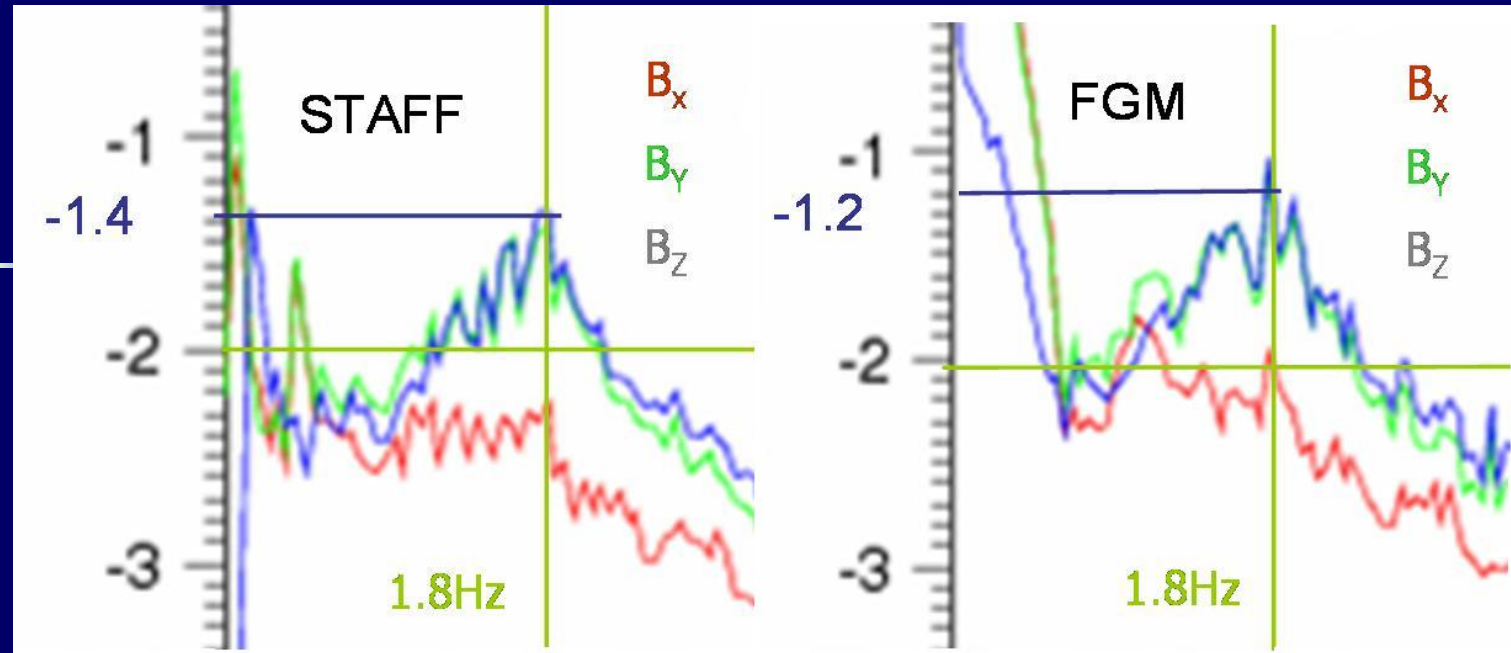


(ii) the Spectra

On the common
frequency band

Results on S/C #1 : zoom on previous spectra

nT^2/Hz



At 1.8Hz: $\text{Log}(\text{FGM}^2) - \text{Log}(\text{STAFF}^2) = 0.2 \Rightarrow \text{Roughly } 20\%$.

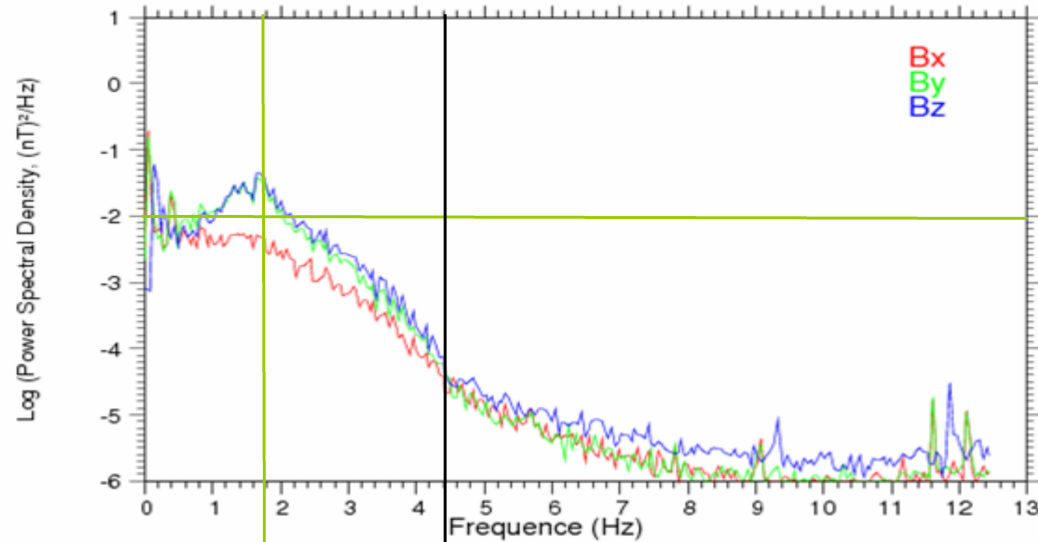
□ S/C #1: STAFF is 20% lower than FGM at $\sim 2\text{Hz}$ as previously observed at the spin frequency (0.25Hz) for the DC field.

$\Rightarrow$ it seems not to be frequency dependant.

S_dec S_rasc S_freq
-63.97 102.33 0.249348

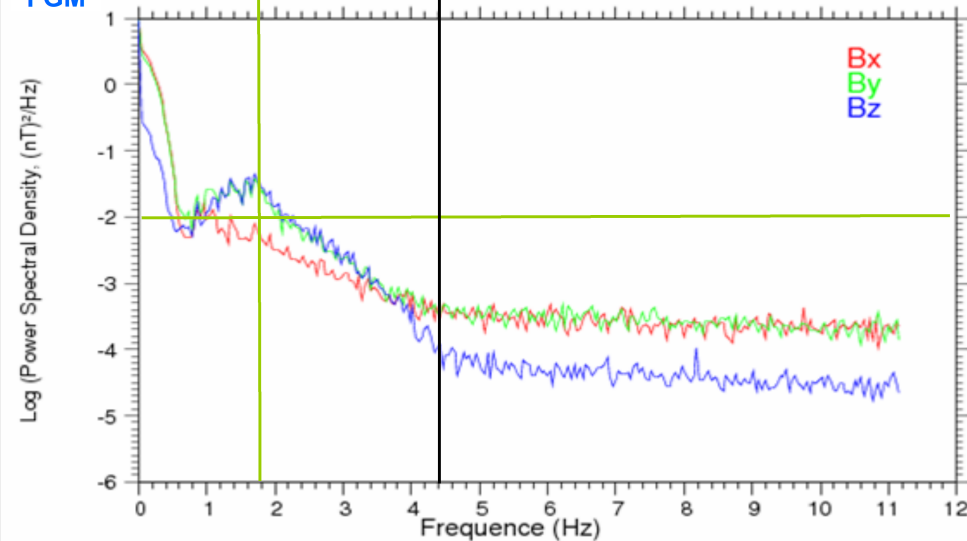
Log Power Spectral density, (nT)²/Hz

Data from Step 4: Data in SR2 system [nT] without DC (0.-12.5001 Hz, Fc=0.1 Fdet=0.)
N=512 dt=20.4799s df=0.0488Hz Fc=0.1 F1=0. F2=12.4513



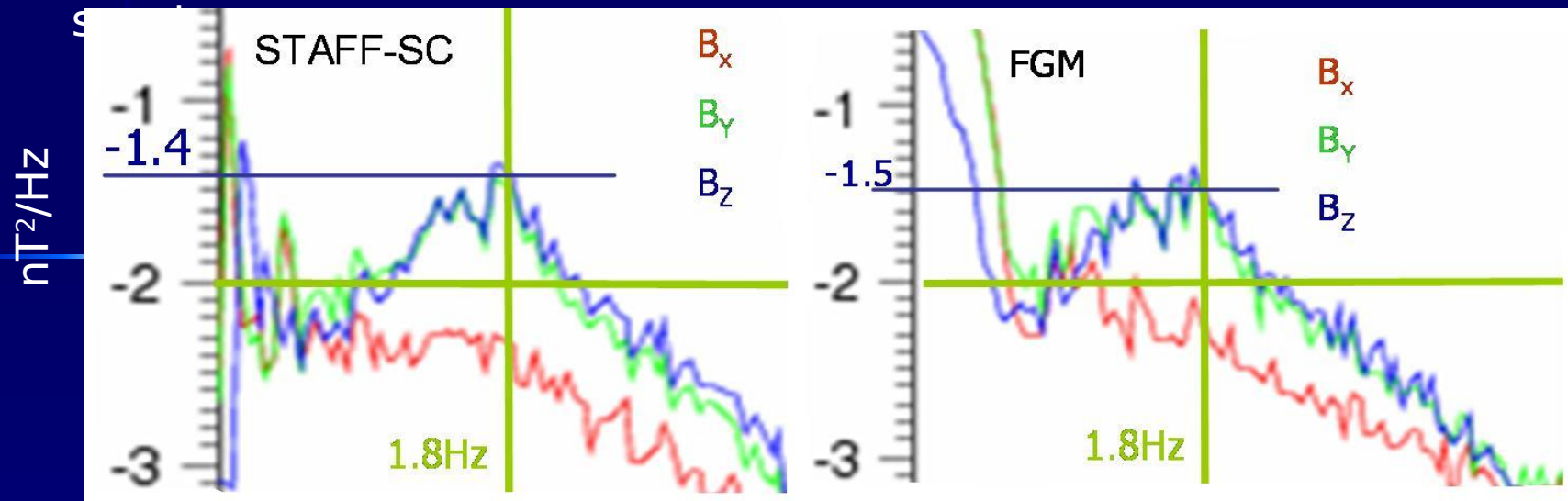
N=512 dt=22.8351s df=0.0438Hz Fc=0.1 F1=0. F2=11.167

FGM



(ii) the
Spectra
On the common
frequency band

Results for S/C #3: zoom on previous



$$\text{Log}(\text{FGM}^2) - \text{Log}(\text{STAFF}^2) = 0.1 \Rightarrow \text{Roughly } 10\%.$$

□ S/C #3: STAFF is 10% lower than FGM at ~2Hz (as previously observed at the spin frequency (0.25Hz) for the DC field).

⇒ It seems not to be frequency dependant.

□ Results for S/C # 2, and 4 are the same.

□ Deepend the study: to be more precise.

Plots on several cases, FGM/STAFF on the same plot, statistics...

a. Comparison STAFF-SC/FGM: (iii) Waveforms

Direct Waveform comparison :

- FGM converted in SR2.
- STAFF calibrated without DC and any filtering:

Arbitrary offset to a better visibility:

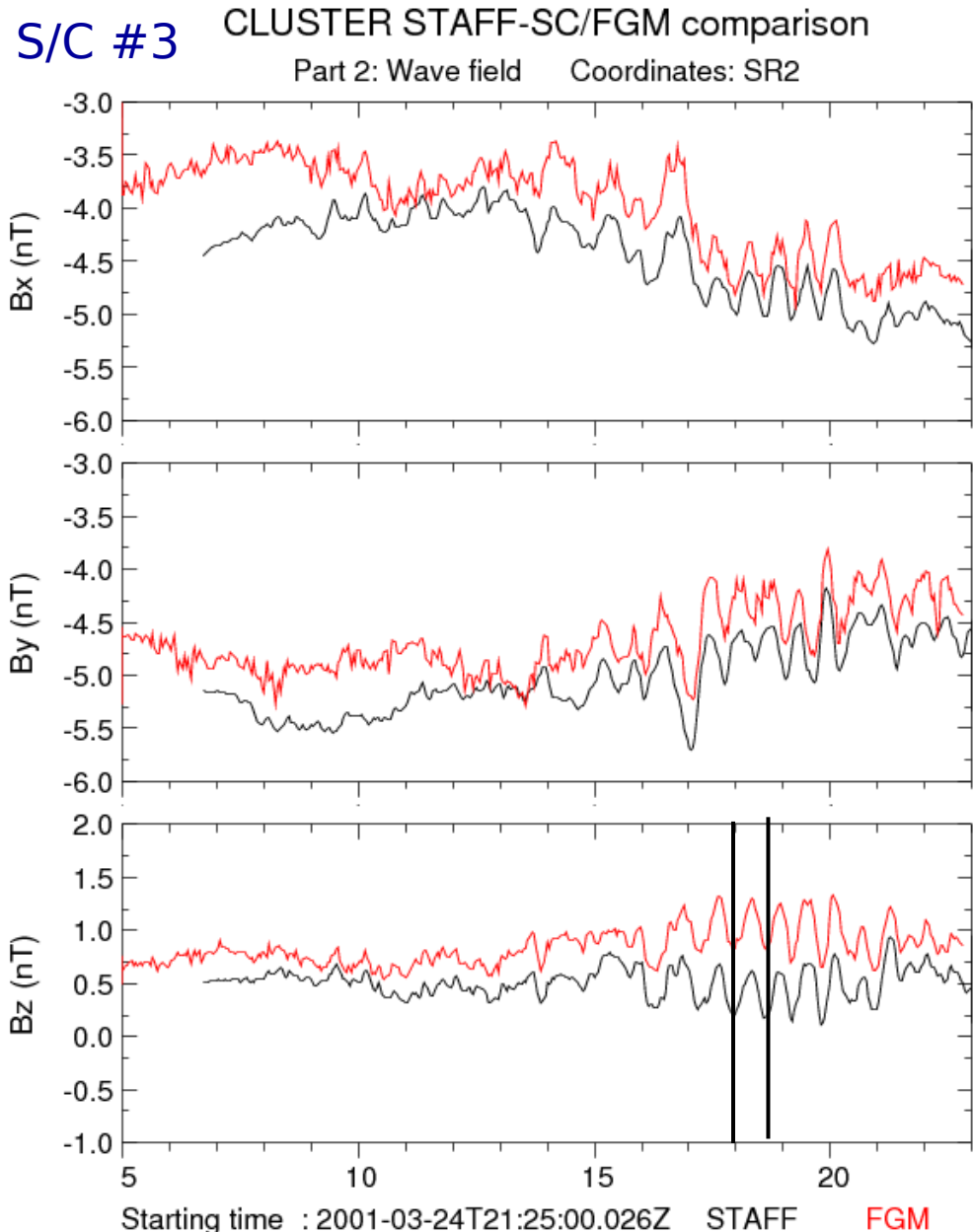
$$\begin{cases} B_x = -4.5 \\ B_y = -5. \\ B_z = +0.5 \end{cases}$$

Results:

- Very similar shape.
- Long period looks different.
- STAFF fluctuations amplitude ~ 1 Hz: ~ 10 - 12% lower than the one of FGM.

⇒ Once again, same conclusion than for the DC field.

NO FREQUENCY DEPENDANCE!!!



(iii) Waveforms

- Aim: a more precised comparison remains to be done. Some software have to be developed.
- Case Study:
 - Select strong events between 1-4Hz.
 - The 2 databases should be filtered in a common frequency range.

⇒ A processing is required:

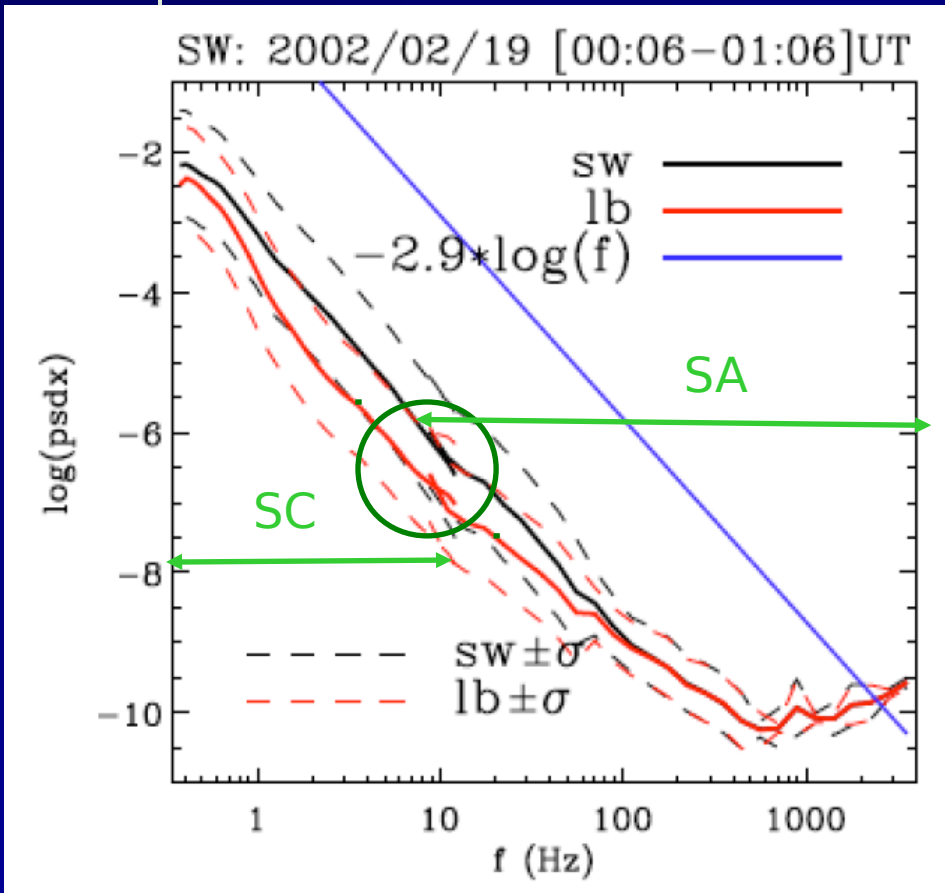
- Remove high frequencies on STAFF-SC.
- Remove low frequencies on FGM.

b. Comparison STAFF-SA/STAFF-SC:

B_x Spectra

in the Solar Wind (black) and
in the magnetospheric lobes (red).

STAFF-SA has a logarithmic internal response.

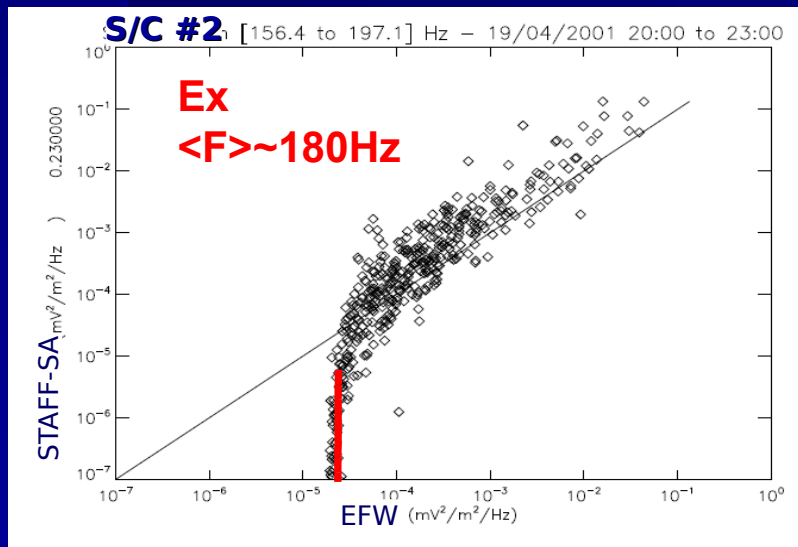
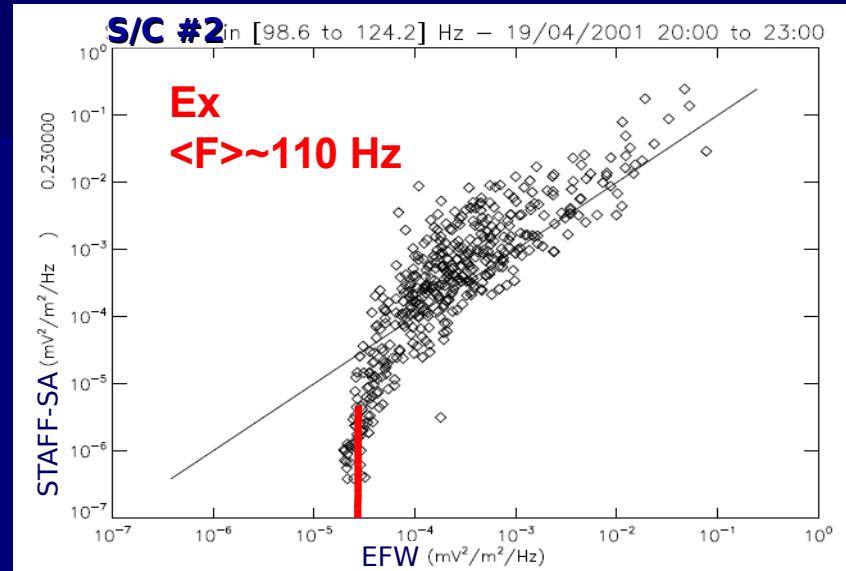
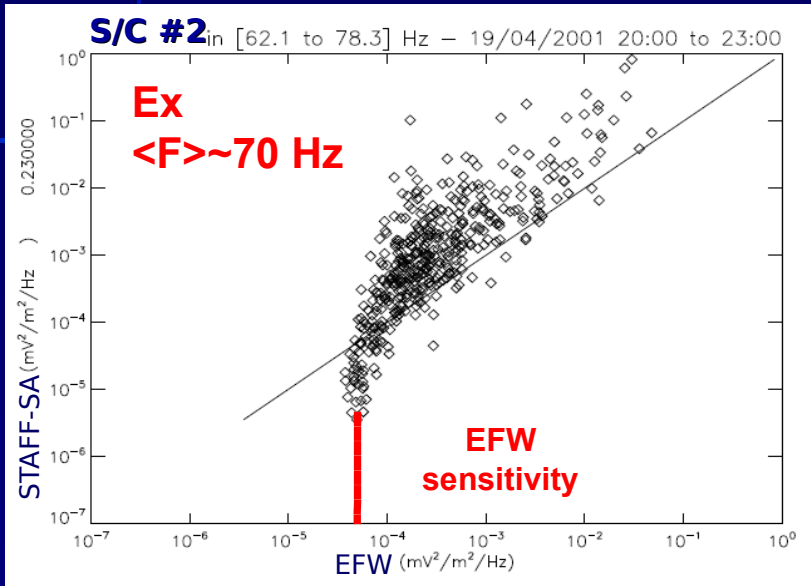


- 2 ways to calculate an AVERAGE:
 - geometrical mean: $\langle \log(S_{SC}) \rangle$
 - arithmetical mean: $\log(\langle S_{SC} \rangle)$

□ On the figure:
Good continuity between STAFF-SC and STAFF-SA due to the choice of GEOMETRICAL MEAN for STAFF-SC for SW and LB.

c. Comparison STAFF-SA/EFW

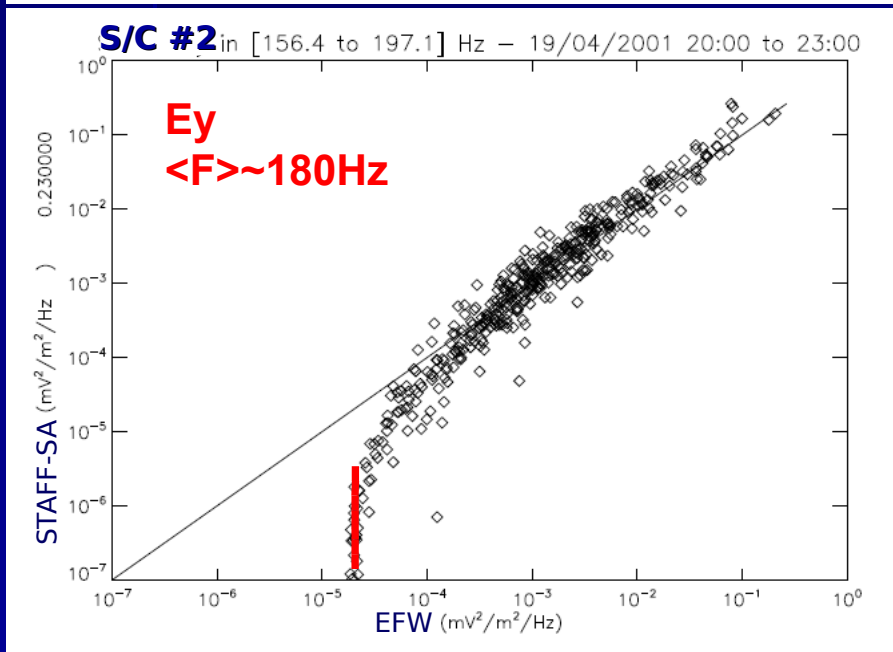
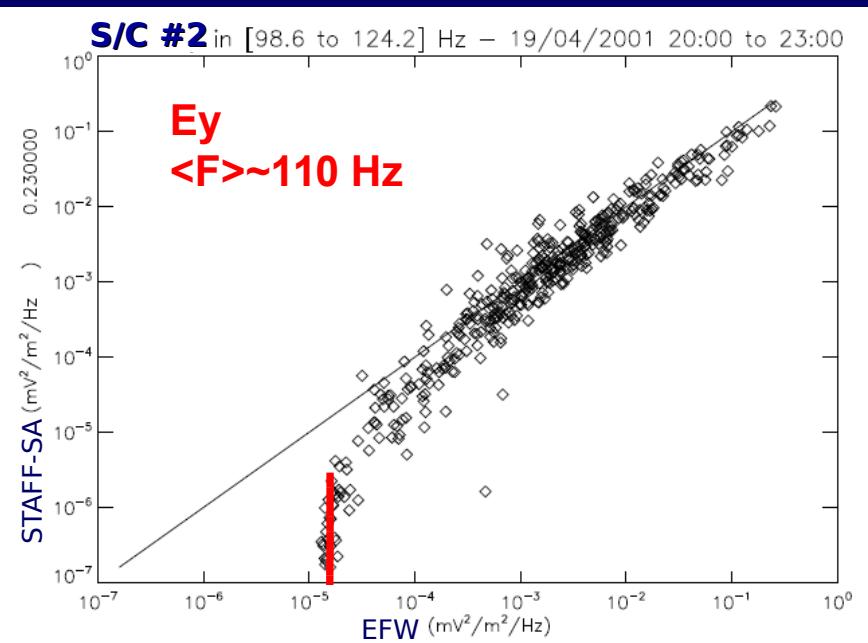
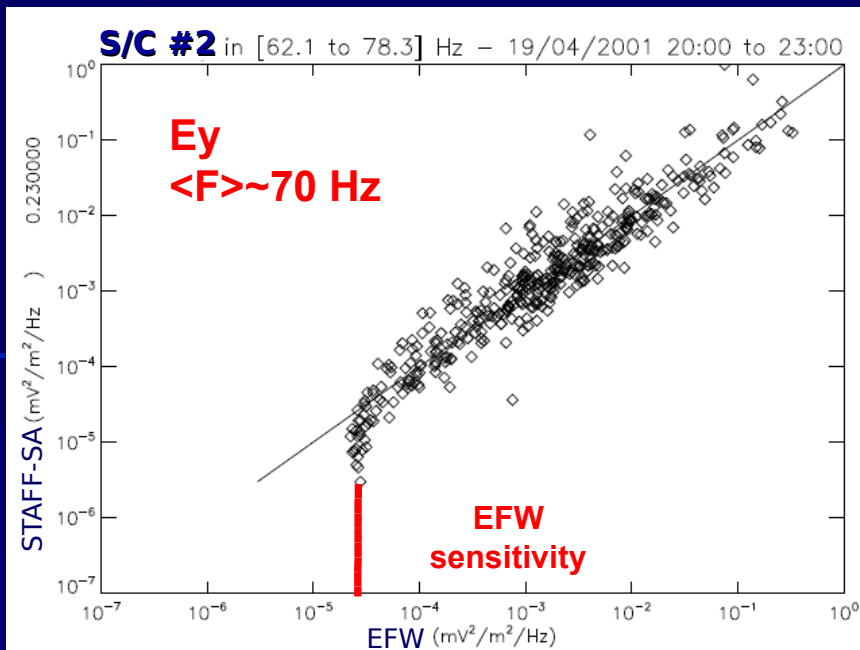
New results : Comparisons of the Power Spectral Densities (PSD) at higher frequency : in burst mode



Case Study: 19 Avr. 2001, 20:00 to 23:00.

□ EFW sensitivity:
around 10^{-5} – 10^{-4} ($\text{mV}^2/\text{m}^2/\text{Hz}$).

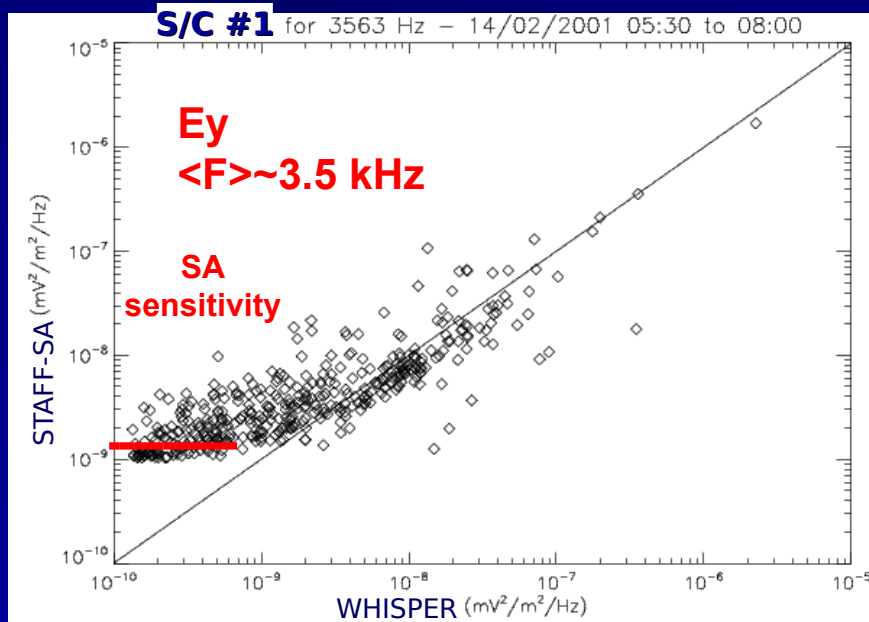
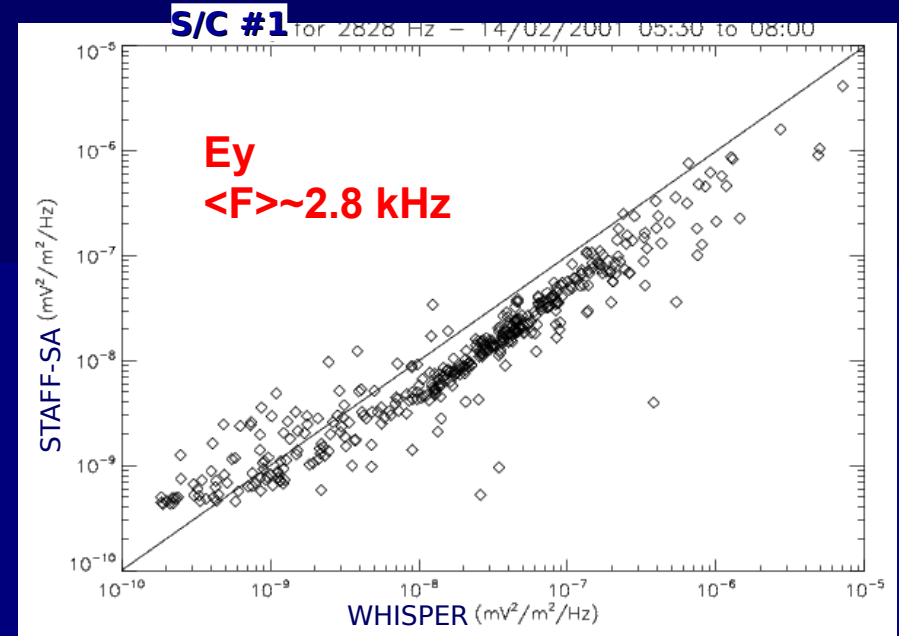
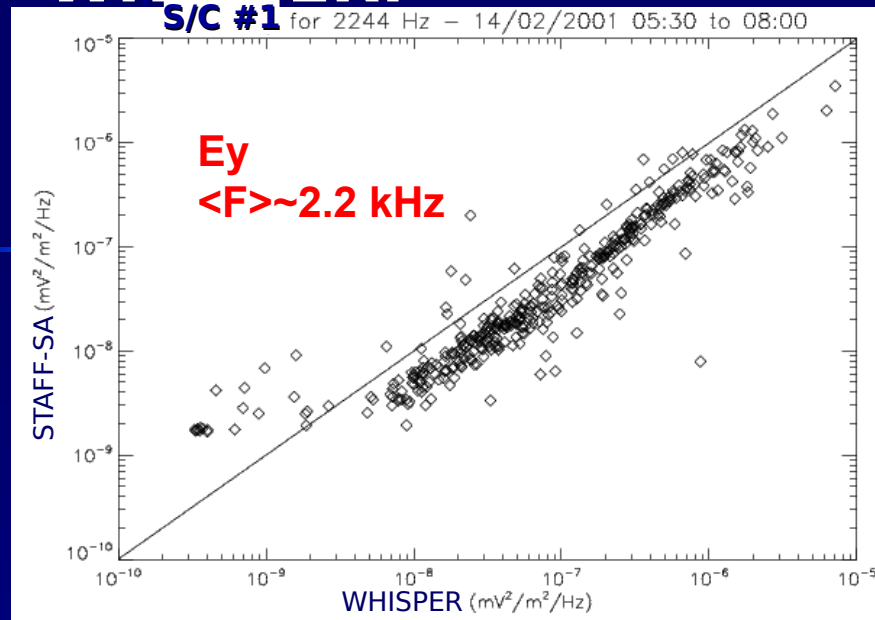
□ Agreement between SA & EFW:
is improving with increasing
frequency.



Case Study: 19 Avr. 2001, 20:00 to 23:00.

- EFW sensitivity:
 - around 10^{-5} – 10^{-4} ($\text{mV}^2/\text{m}^2/\text{Hz}$).
 - ⇒ same as on Ex.
 - Agreement between SA & EFW:
 - Better on Ey than on Ex:
- Probably due to wake effects on Ex.*

d. Comparisons between STAFF-SA and WHISPER:



Case Study: 14 Feb. 2001, 05:30 to 08:00.
Comparison between 2 and 4kHz.

□ Agreement between SA & Whisper:
Good Up to ~3 kHz (slope ~1), but with
a constant shift.

□ STAFF-SA sensitivity:
Around 10^{-9} ($\text{mV}^2/\text{m}^2/\text{Hz}$) at high freq.

5. Data delivery plan for measurements from years 2006-2010.

Planning for the second phase

Year	Until now	2009	2010
Product			
SC DWF	2006	2007-2008	2009
SC Complex spectra			
SC Images	2007	2008	2009
SC CWF New		2001	2002 - 2009
SA AGC/ PDS / SM	01/2001 – 08/2008	End of 2008	2009
SA Polarisation/ Propagation New		2001	2002-2009

Conclusion and perspectives

a. General

- All existing data production lines:
 - are operational, and currently running.
 - some update on the STAFF-SC production line are under development.
 - computing STAFF-SC polarisation data (and plots) are already existing; only the mass-production chain and CEF formatting remains to be done.
- Documentation:
 - 2 papers on cross-calibration study:
 - * **Magnetic field**: STAFF-SC/FGM and STAFF-SC/-SA.
 - * **Electric field**: STAFF-SA/-SC/EFW/Whisper.
 - Calibration report and user guide have been produced and delivered. Both will be updated soon.

Conclusion and perspectives

b. STAFF-SC, comparison STAFF-SC/FGM:

- Continuous calibration:

The new STAFF-SC method remains to be developed. This will require a lot of work, especially the validation with the present one. The work will be done for the end of 2009.

- STAFF-SC S/C #1: The function transfer has to be re-calibrated.

- FGM comparison:

- For the DC field, $\langle \Delta B_{\perp} / B_{\perp} \rangle$ is constant despite of the conditions during all the mission.

- The waveform and spectra comparison seem to lead to the same conclusions. A more complete study will be performed.

- Priority between continuous calibration and cross-calibration activity should be defined.

Conclusion and perspectives

c. Comparison STAFF-SA with other experiments

- ❑ Agreement between SA & SC:
Better when the «geometrical» mean is computed for STAFF-SC.
- ❑ Agreement between SA & EFW:
 - Is improving with increasing frequency.
 - Is better on E_y than on E_x (possible wake effects on E_x).
- ❑ Agreement between SA & Whisper:
Good up to ~ 3 kHz (slope ~ 1), but with a constant shift.
- ❑ Volunteers for the intercomparisons between WBD/SA/WHISPER ?

The End.