

CLUSTER / STAFF

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

P. Robert, N. Cornilleau-Wehrlin, M. Maksimovic, L. Mirioni, V. Bouzid,
Y. De Conchy, C. Burlaud

0. Short reminder of STAFF-SC and STAFF-SA experiment
 - I. status of open action items
 - II. status of data production
 - III. status of calibration
 - IV. status of cross-calibration activities
 - V. data delivery plan for measurements from years 2006-10

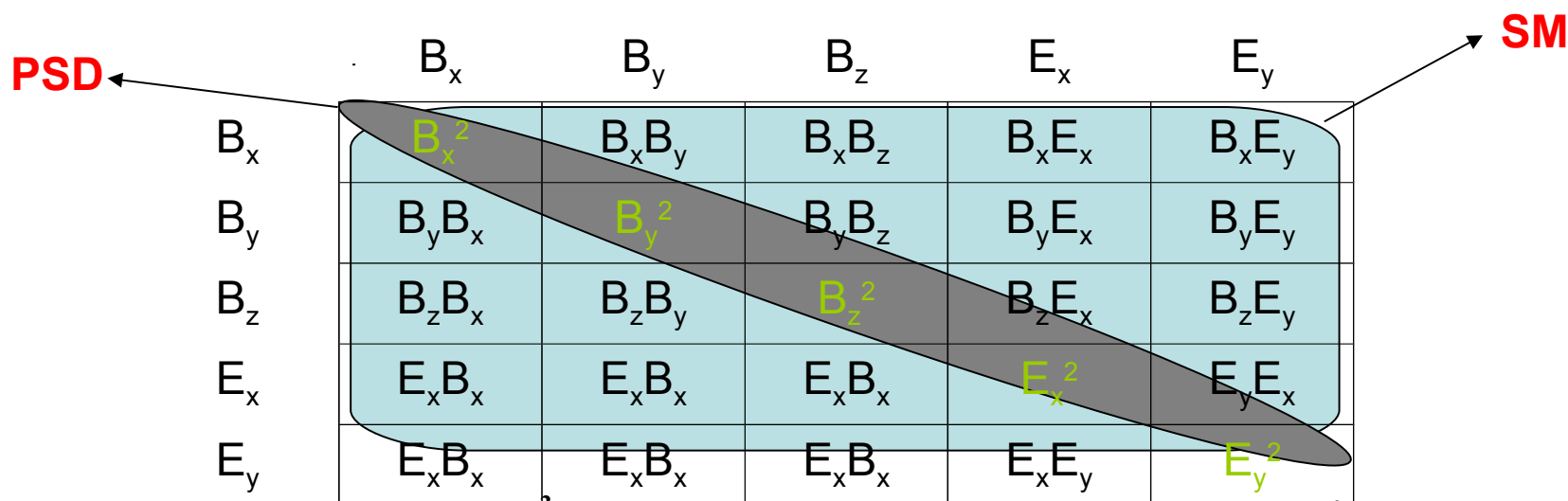
0. Short reminder of STAFF-SC and STAFF-SA experiment

1. STAFF-SC

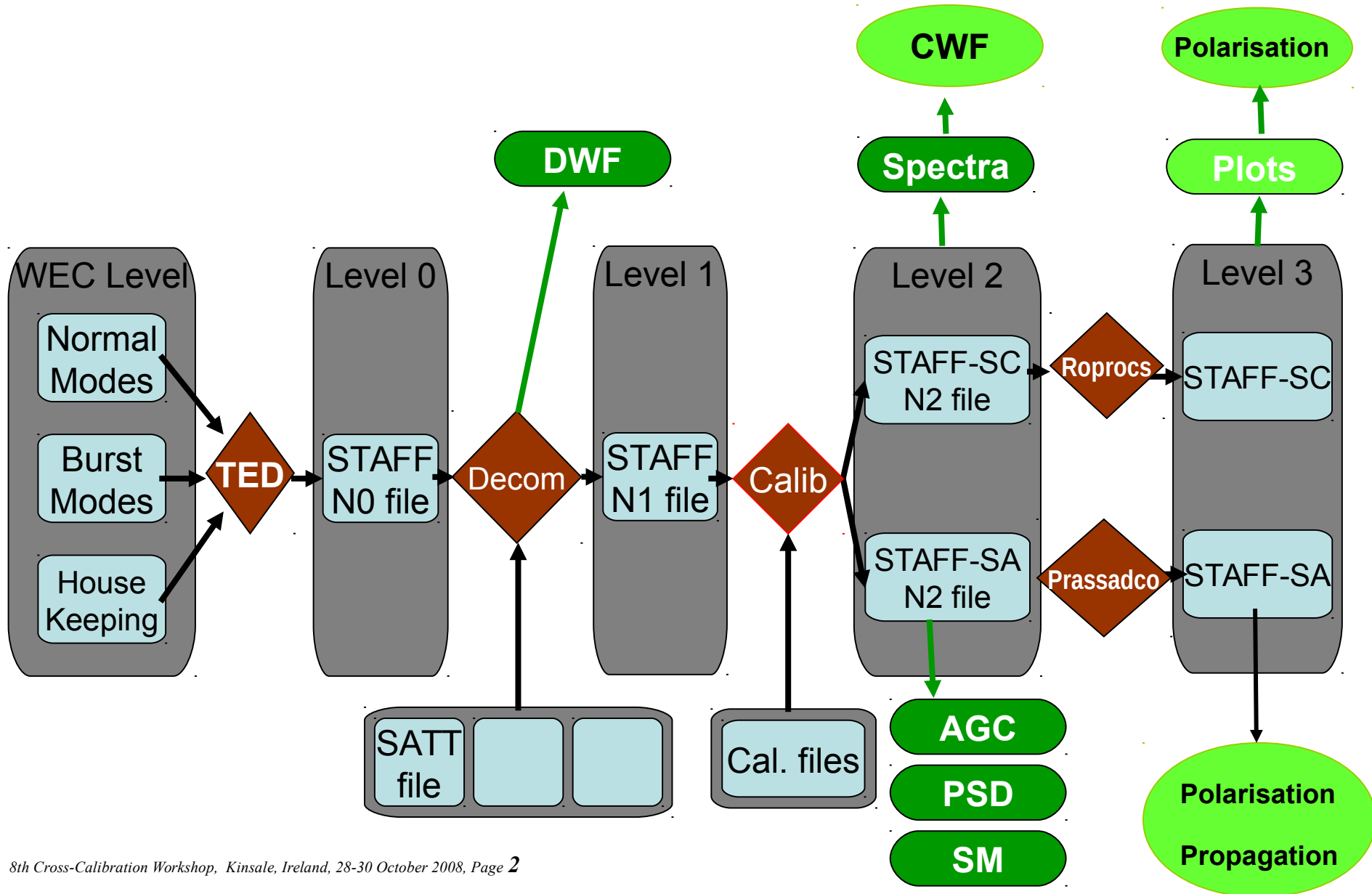
- The 3 wave form from the pre-amplifier Bx, By, Bz, are filtered in either of the two bandwidths, 0-10 Hz and 0-180 Hz.
- The filtered signals are digitized by three 16 bits sampling and hold devices synchronised by DWP and sent to the DWP experiment.
- The A/D converters are the same for STAFF and EFW and synchronized by DWP in order to facilitate further combined data analysis
- Due to the telemetry limitation, a compression from 16 to 12 bits is performed inside DWP for STAFF wave form data.

2. STAFF-SA

- The spectrum analyser is designed to calculate the complete cross spectral matrix for the 5 available components , $3 \times B + 2 \times E$, in the 8Hz-4 kHz range,
- The analysis band is divided into 3 logarithmically distributed frequency sub-bands of 9 frequencies each.
- For each sub-band there are 3 automatic gain control (**AGC**): one for Bx channel and one for each couple of spinning components (By, Bz and Ey, Ez respectively).
- For the Spectrum Analyser, the different modes are the combination of 3 parameters : the time resolution, the number of frequencies computed (2 or 3 bands), the number of wave components considered.



3. GROUND PROCESSING



I. Status of open action items

1. OVERALL SUMMARY OF SHORT-TERM ACTIVITIES

- Corinne Burlaud is the new engineer since September 1st, after 10 month of absence of technical support (F. Drapeau leaved in November 2007).
- The STAFF_SA delivery was stopped, following the result of the cross calibration study between STAFF SC and STAFF SA polarisation parameters. Error has been found. (error on the sign of an angle).

The main activity was to start the reprocessing of the whole data set, after having made corrections to the S/W. The new production has been validated. The delivery of version 3 of the STAFF SA L2 products has started.

- An error on the label of the units in SC complex spectra has been discovered ($\text{nT}/\sqrt{\text{Hz}}$, instead of nT). A shell script allowing correction of the CEF files already delivered will be written and send. Software correction has been done, and next files will be correct.
- Corinne has already done the Software to plots the complex spectra, showing the error in units, and confirmed that now the complex spectra plots are in harmony with the spectrogram plots already delivered.
- A version 3.0 of the ICD will be delivered before the end of the year (description of complex spectra products will be added).

2. OVERALL SUMMARY OF MIDDLE-TERM ACTIVITIES

- Studies to develop a method for producing continuously STAFF-SC calibrated waveform has re-started (see section “status of calibration” further). In a first approach, classical method has already been improved to get a more efficient despining, and so a better calibration (work in progress).
- Anomaly on the transfer function of STAFF-SC on S/C#1 (*shown on Cross calibration workshop of February 2006*) ask new studies, and requires to take again the first comparisons done with FGM data. We plan to do a theoretical model of each transfer function, allowing rejection of undesirable effects and adjustment of filter parameters.
We hope to obtain a good agreement both with 3 others S/C, and with FGM. But the work remains to be done.

II. status of data production

1. STAFF-SC

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

✖ For 2007 and after, requires time correction, could be delivered by Sheffield

☒ 2006 ready, except a leap sec. to correct (another for 2008)

☒ delivery temporarily stopped, error on units

☒ Monthly produced on CETP web site : <http://www.cetp.ipsl.fr>

* One file is missing

** Nine files are missing
(synchronisation problem).

2. STAFF-SA

Product	Content	Level	Mode	Num. of files	Produced	Delivered to CAA
C?_CP_STA_AGC	Automatic Gain control	2	All	1 file / 1 sat. / 24h	<u>Version 01</u> 01 Jan 2001 to 31 Dec 2006	<u>Version 01</u> 01 Jan 2001 to 31 Dec 2006
C?_CP_STA_PSD	Power Spectral Density	2	All		<u>Version 02</u> 01 Aug 2006 to 31 Oct 2007	<u>Version 02</u> 01 Aug 2006 to 31 Oct 2007
C?_CP_STA_SM	Spectral Matrix 	2	All		<u>Version 3</u> 01 Jan 2001 to 31 Dec 2002 & 01 Jan 2005 to 31 Jun 2006	<u>Version 3</u> 01 Jan 2001 to 31 Dec 2007

For information :

 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)

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

Note on last open action : 2001-2005 products have been redelivered for STAFF SA and STAFF SC calibrated complex spectra have been delivered too.

III. status of calibration

1. CONTINUOUSLY STAFF-SC CALIBRATED WAVEFORM

- Studies to develop a method for producing continuously STAFF-SC calibrated waveforms has re-started.
- There are currently two ways to produce continuously STAFF-SC calibrated waveforms :
 - 1- take again the IDL continuous calibration program of THEMIS/SCM data developed in association with Berkeley university, with support of NASA.

Principe of calibration is based on a linear convolution done in a sliding window.
Some difference with CLUSTER/STAFF-SC must be changed, but this program should be deeply tested because the kernel of the application has been written by Berkeley.
 - 2- take again the first development started 2 years ago in CETP, started in F90, and based on the classical method (FFT, frequency correction, FFT-1) but with a sliding point-to-points window with a Gaussian windowing.

This is a more safe method, but require time to finish development.
Furthermore, as all software of the CLUSTER data processing chain are written in F90 with some part in C, it could be not convenient to include IDL components.
- Probably the more safe thing should be to process in competition the 2 ways, and compare results of the two methods by respect to the classical one.

Choice could be done after, for inclusion in the general software package.

2. TWO POSSIBLE METHODS FOR CONTINUOUSLY CALIBRATION

a) CLUSTER STAFF-SC classical method

1) get Level 1 waveform (in Volts) as a series of successive windows

→ *Selecting time length of the windows determine the $\Delta t, \Delta f = 1$ resolution*

→ *TM count to Volt conversion ([0-65536] => [-5, +5 V])*

- Calibration step # 1: Volts, spinning sensor system, with DC field

2) "Cleanning" raw waveforms in the spinning Sensor system (SSS)

→ *remove the high spin tone signal before windowing and FFT*

(~ nt up to ~ 5-600 nT, compared to ~ nT for the useful signal).

→ *Possible to calibrate the X-Y spin plane components → FGM comparisons*

- Calibration step # 2: Volts, spinning sensor system, without DC field

3) Calibration of each component in a given window

→ *Light windowing, centering, FFT, Correction of transfer function by $*1/G(f)$, cut-off at low frequency, FFT-1*

- Calibration step # 3: nTesla, spinning sensor system, without DC field

4) Get calibrated time series data in nT, in the fixed SR2 system

→ *Apply the appropriate matrix, but require delicate spin phase computation from the Sun pulse*

- Calibration step # 4: nTesla, fixed SR2 system, without DC field, [Fmin, Fmax]
→ *Waveform transformation from DSL to GSE, or other (GSM, MAG, GEO...)
Possible since we have Right asc, dec., & Rcotlib software*

5) Add DC filed values on X and Y

- Calibration step # 5: nTesla, fixed DSL system, with xy DC field

b) CLUSTER STAFF-SC continuously method (to be finished)

Principle is the same as classical method, but data are processed as a series of successive windows but spaced by 1 TM count (25 or 450 Hz)

- *Same processing as classical method, but a Gaussian windowing is applied*
- *Only the central point, corresponding to the submit of the Gaussian, is kept*
- *Next window is taken by a time shift of only 1 TM count*

This method avoid the discontinuity on the edge of each window, so we obtain a continuously calibrated waveform.

Require much CPU time.

- Note : In a first approach, classical method has already be improved by a more efficient despin, and so a better calibration (work in progress).

c) THEMIS SCM continuously method (currently running under IDL)

Previous despin, detrend and filtering are the same than Cluster method.
But calibration remain in time domain, by a linear convolution product :

CLUSTER method is $\text{out}(t) = \text{FFT}^{-1} \{ \text{FFT} [\text{in}(t)] / T(f) \}$ *$T(f)$ = transfer function of the antenna*

THEMIS method is $\text{out}(t) = \text{in}(t) * \check{T}(t)$ *where $\check{T}(t) = \text{FFT}^{-1}[1 / T(f)]$*

- The choice of the sample size is important, because it must be higher than the width of the impulse function *$\check{T}(t) = \text{FFT}^{-1}[1 / T(f)]$*
- It seems there is no limitation to the sample size, except CPU time.
Test and various check must be done.

IV. Status of cross-calibration activities

1. PROBLEM OF CALIBRATION TABLE FOR STAFF-SC ON S/C #1 (Samba)

- Problem identified after launch :
The perpendicular DC-field measured by the spinning spacecraft at the spin frequency is not the same from S/C #1 than the other S/C:
Difference of ~ **8 to 20 %**.
- S/C# 1 gives always lower values than other S/C.
- Difference is confirmed by FGM.
- Plots hereafter retrieved from Cross Calibration meeting of 2-3 february 2006 (ESTEC).

CLUSTER / STAFF-FGM/ Bperp

Julian Day 448: 24/March/2001

Fs	Sraso	Sdeo
0.249600	102.49	-63.95
0.249680	102.50	-64.01
0.249350	102.33	-63.97
0.249270	102.49	-63.92

Bperp ALL S/C

P. Robert, Croos Cal WS, 2006-02-02, ESTEC

FGM

Bperp DC, nT

1 2 3 4

*Pb on S/C # 1**Sometimes up to 20%
When strong DC field*

STAFF

Bperp DC, nT

1 2 3 4

U.T. 21 21:10 21:20 21:30 21:40 21:50 22

_ROPLDT/cospectro/visuspectro_4Bz.ps - Rproc_Wave V 3.2

Production date: Fri Jan 27 11:47:06 2006

CLUSTER / STAFF-FGM/ Bperp

Julian Day 448: 24/March/2001

Bperp SC1 and SC2

SC1

FGM

STAFF

1) STAFF < FGM,
Diff=1 nT or 16% on SC1,
Diff=0.5 nT or 8% on SC2

U.T. 21 21:10 21:20 21:30 21:40 21:50 22

SC2

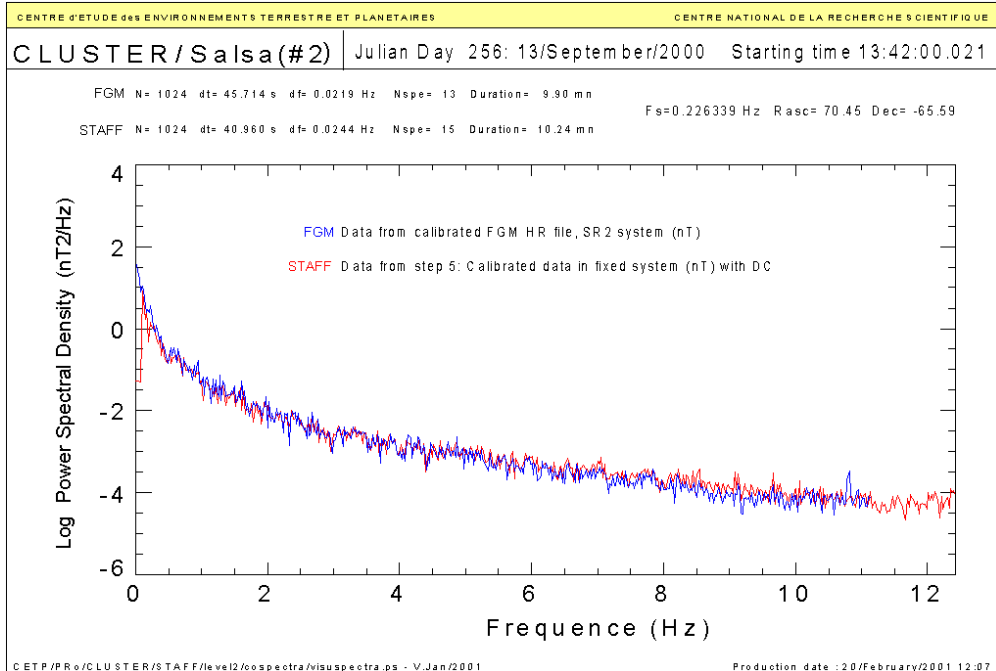
FGM

STAFF

U.T. 21 21:10 21:20 21:30 21:40 21:50 22

2. STAFF-SC & FGM COMPARISON

- No progress since 2006 (lack of manpower)
- WE hope to make comparison again during continuous calibration development
- Plots hereafter are retrieved from Cross Calibration meeting of 2-3 february 2006 (ESTEC).



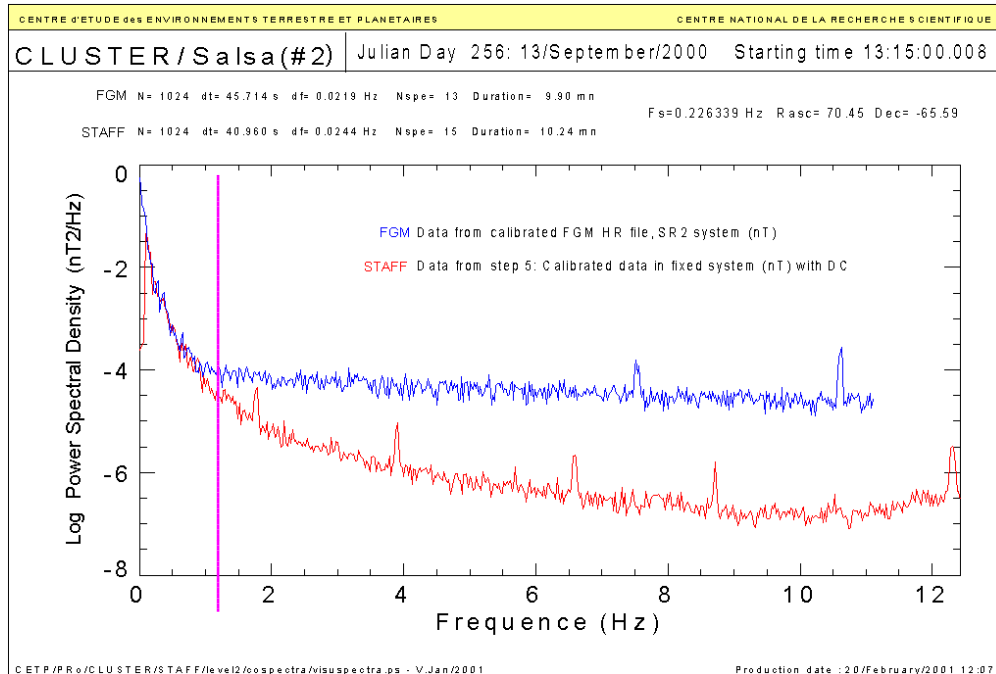
A. Old comparisons (IC, London, February 2001)

P. Robert, Croos Cal WS, 2006-02-02, ESTEC

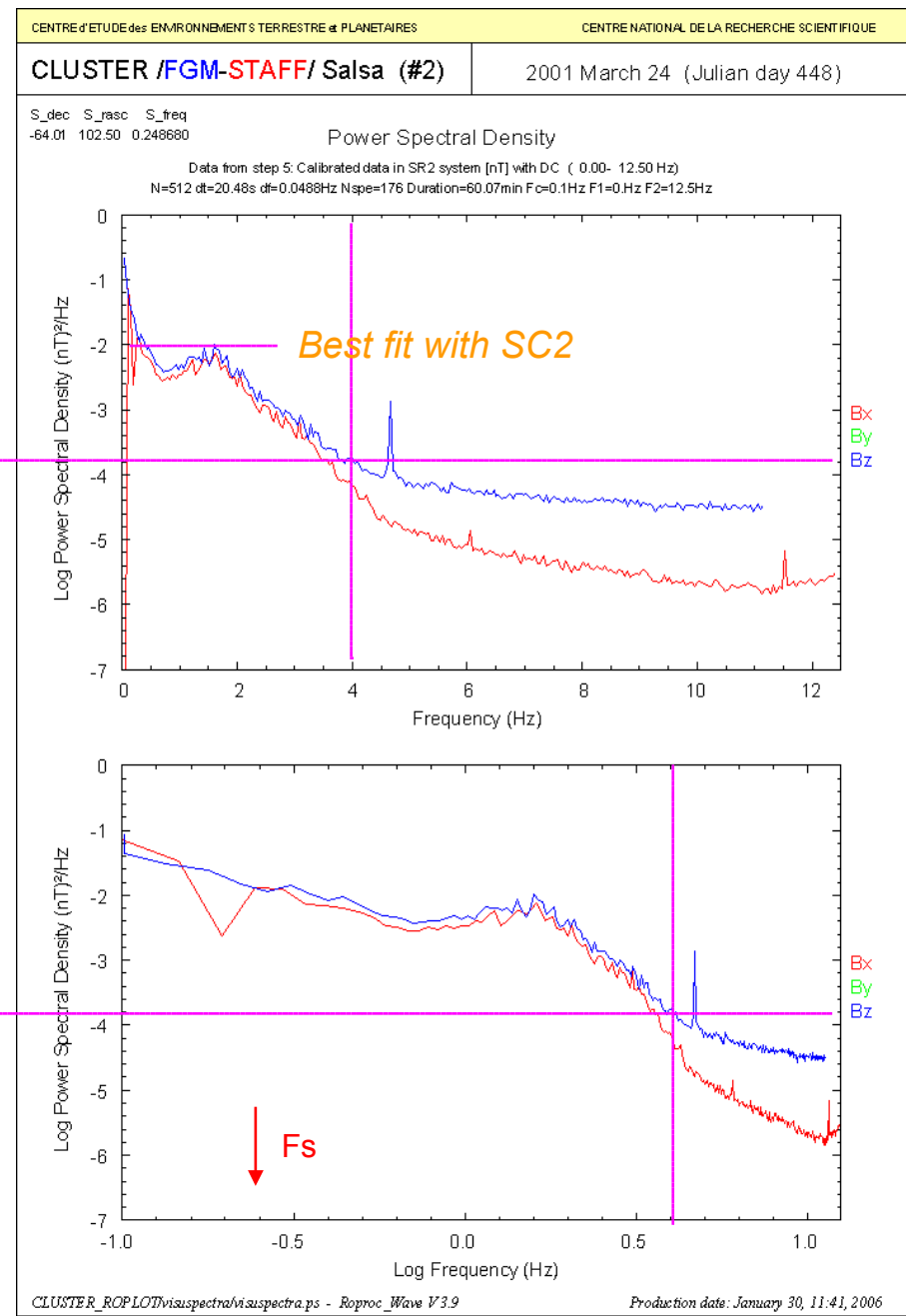
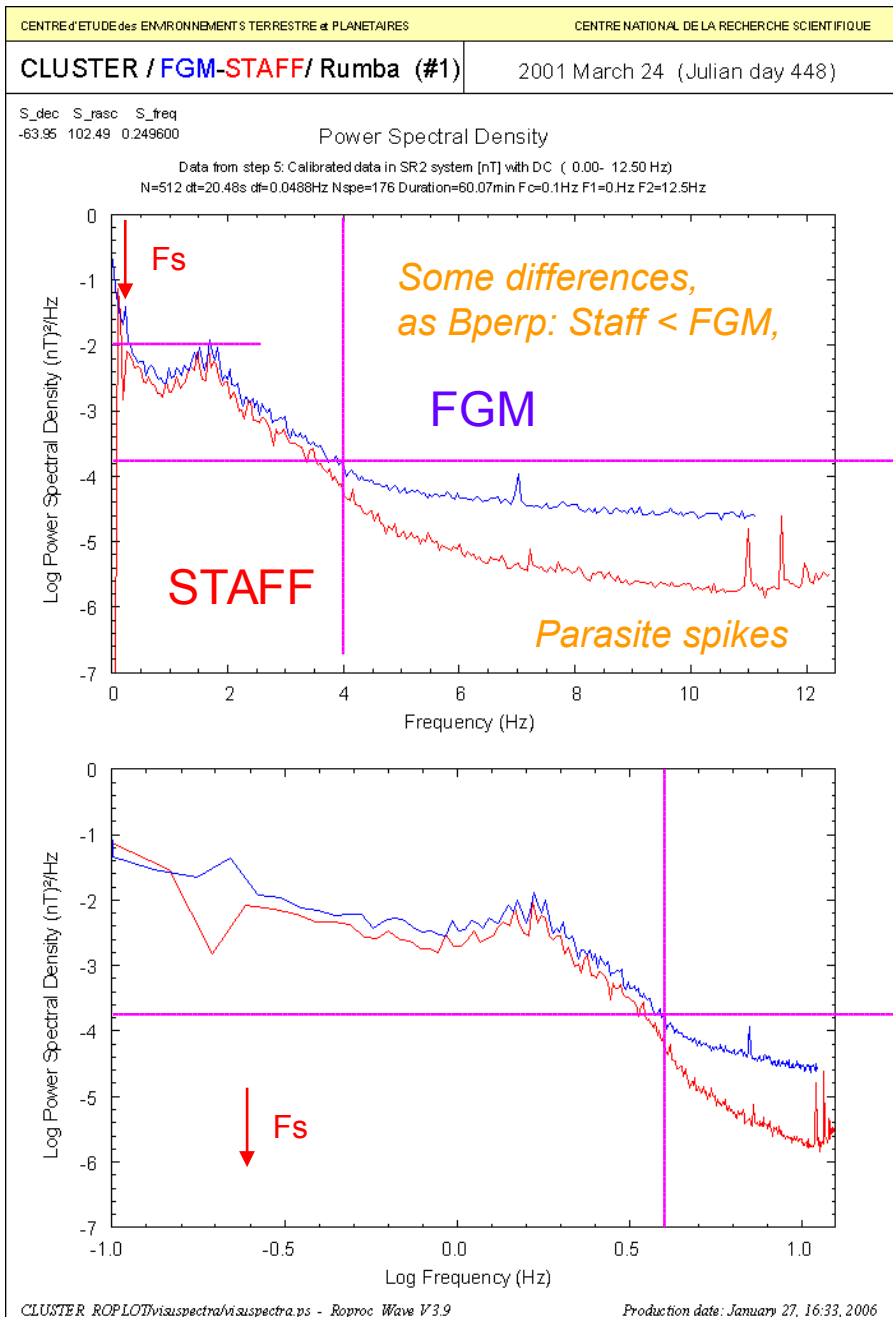
A.2 Average Spectra

*Original FGM High res. Files
provided by M. Dunlop*

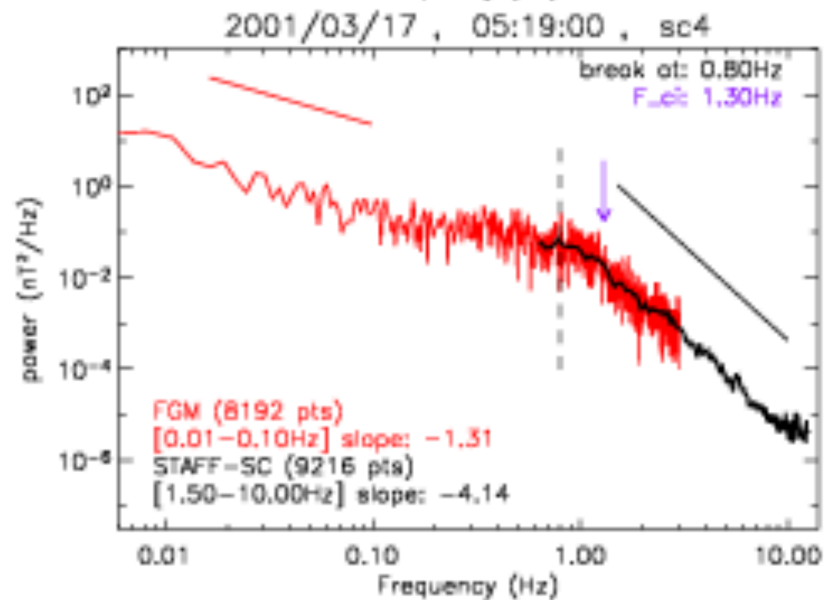
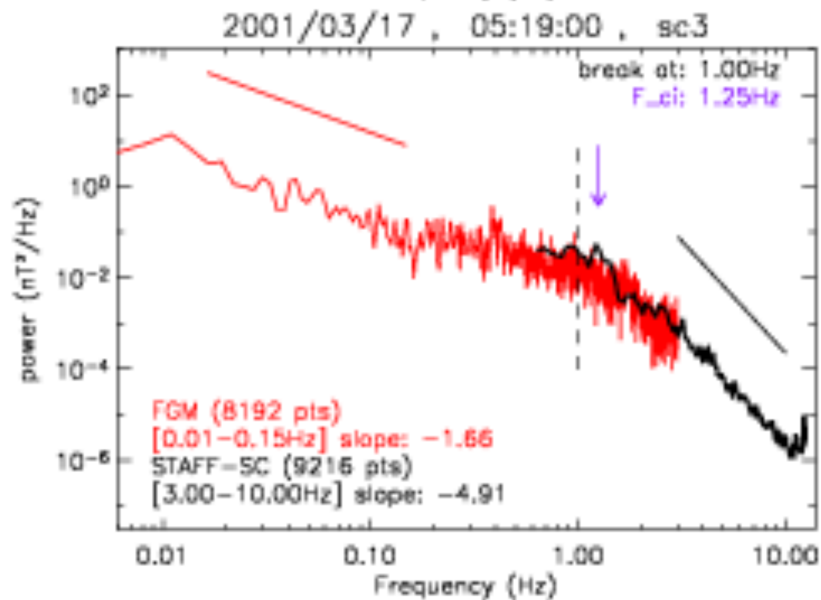
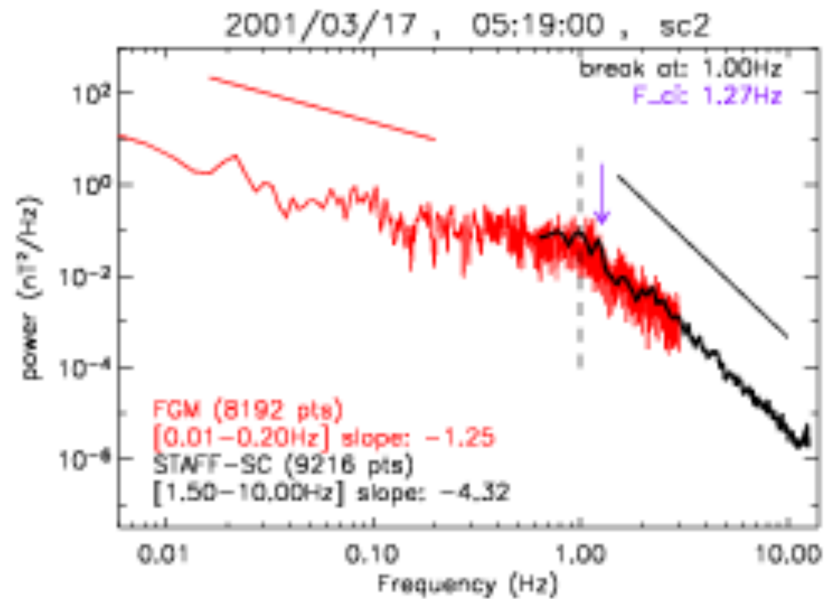
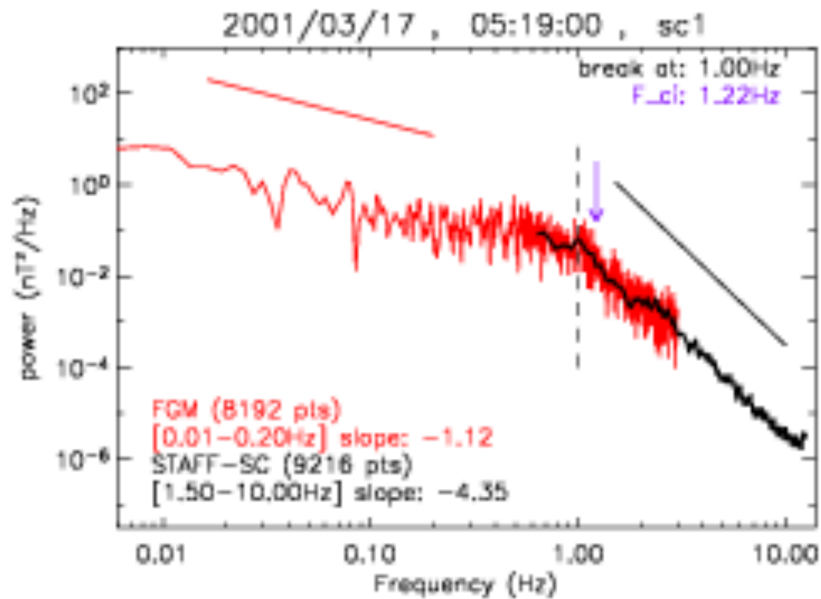
*Rather good agreement
Between STFF-FGM
When strong event*



*Sensitivity differs beyond 1 Hz
(no event)*



FGM – STAFF spectra continuity (from B. Grison et al, 2006)



CLUSTER / FGM-STAFF / Salsa (#2)

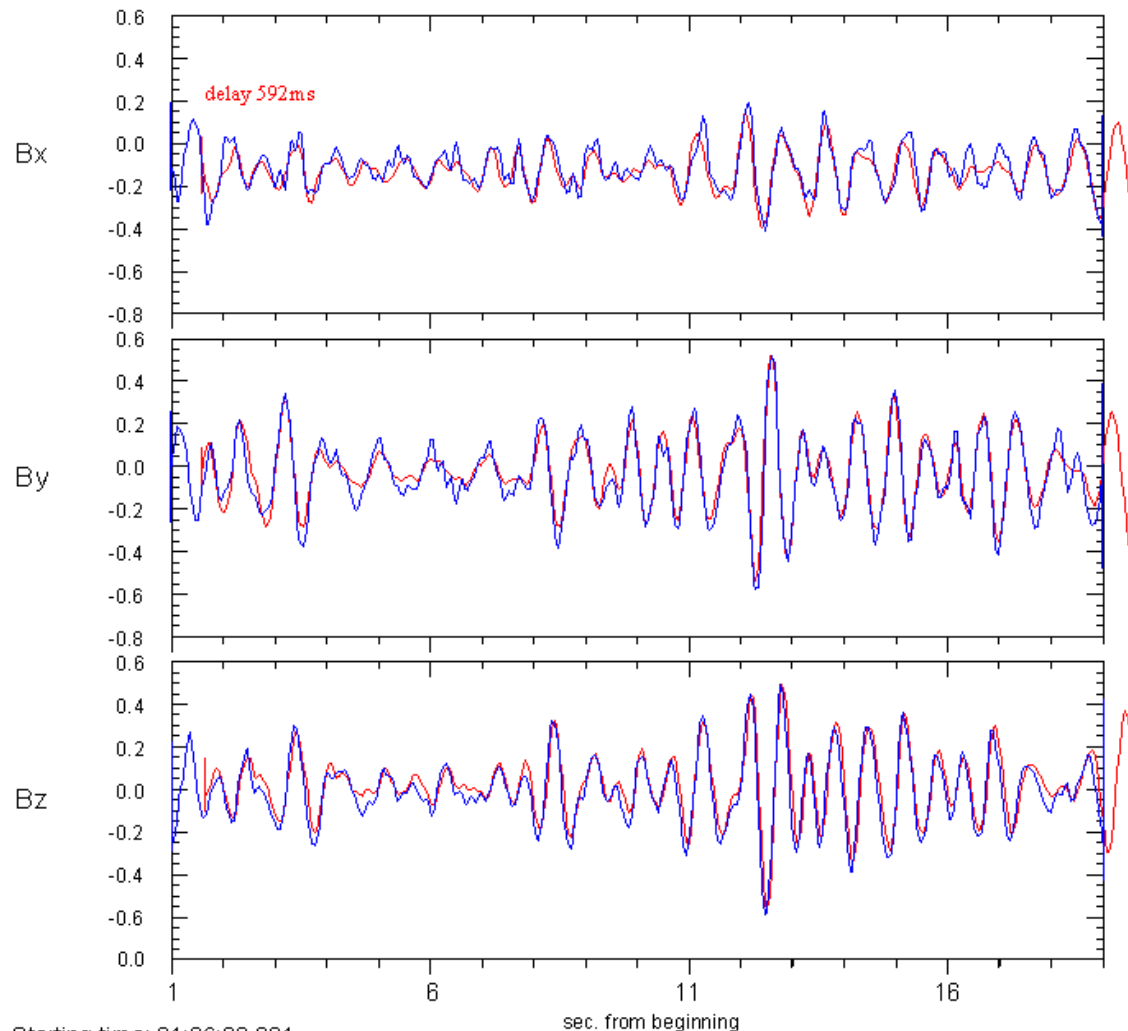
2001 March 24 (Julian day 448)

N=512 NBR Fc=0.0000E+00 Hz Range [1.00- 6.00] Hz F $\approx$ 0.249601 Hz

Duration: 22.835 sec

GEI Spin Rasc= 102.49 GEI Spin Dec= -63.95

B DC magnetic field [nT] in SR2 system (1.00- 6.00 Hz)



CLUSTER_ROPLOTvisuwave/visuwave.ps Page 1 (Roproc_Wave V3.9)

Production date: January 27, 17:30, 2006

III.3 ZOOM on Filtered Bx,By,Bz, SC2

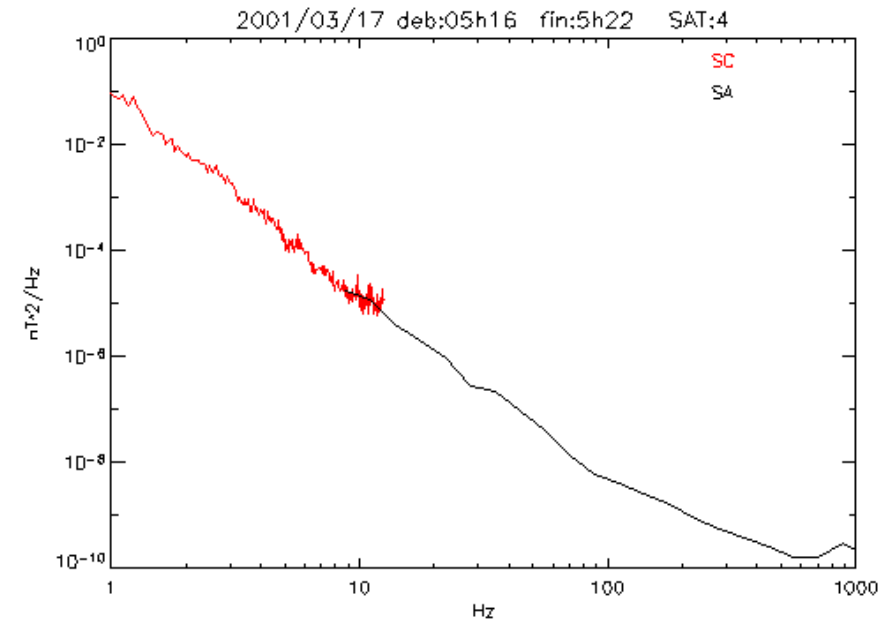
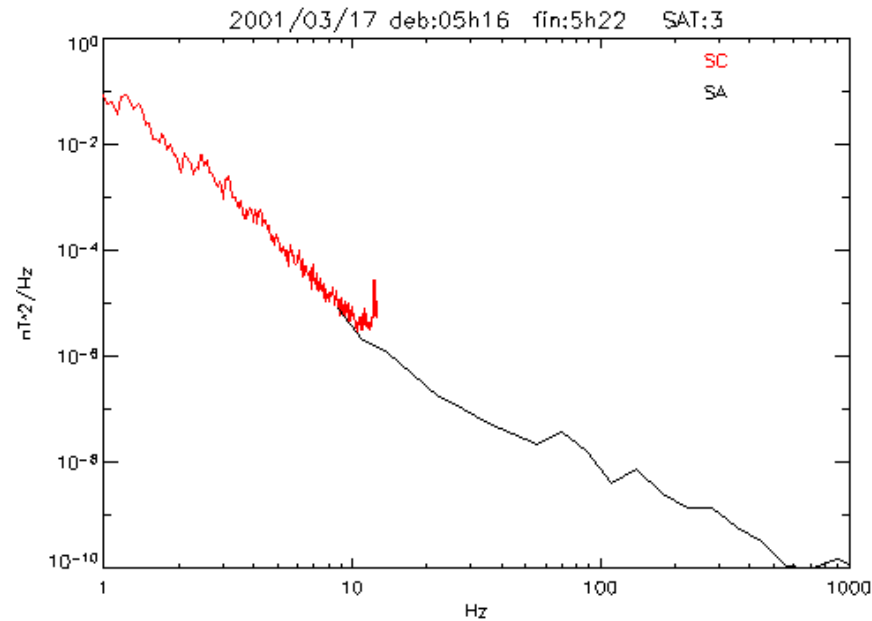
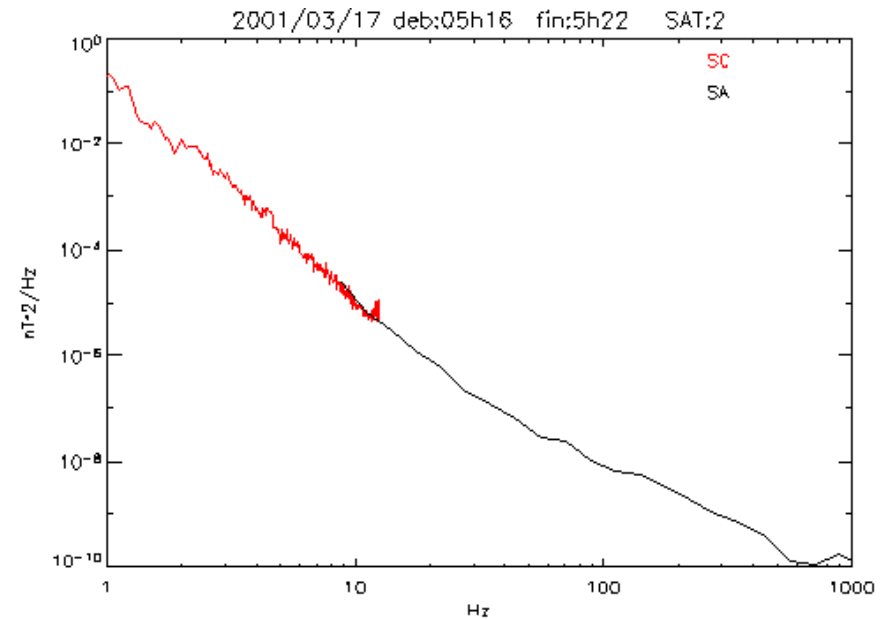
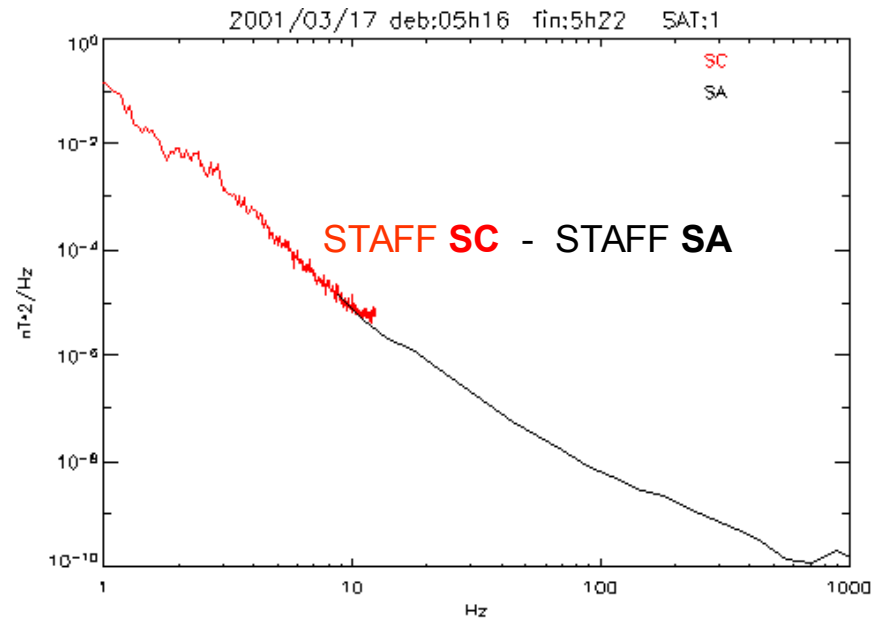
P. Robert, Croos Cal WS, 2006-02-02, ESTEC



*Best fit: About 5 %
But not everywhere*

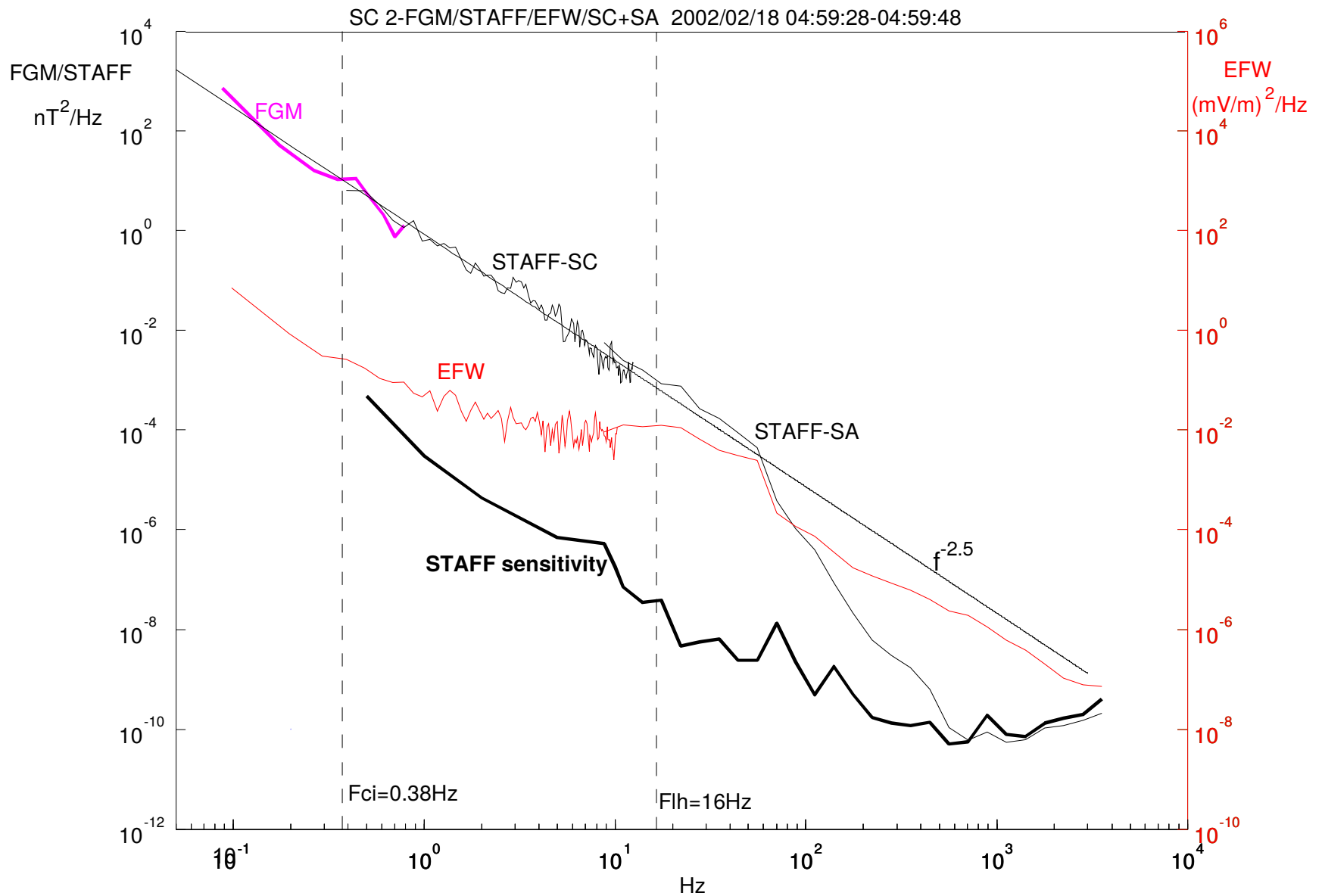
3. CONTINUITY BETWEEN STAFF-SC and STAFF-SA

(from B. Grison)



4. CONTINUITY BETWEEN FGM, STAFF-SC, STAFF-SA and EFW

(From B. Grison & D. Attié)



5. STAFF-SA COMPARISON WITH OTHER WEC INSTRUMENT

See presentation done by Milan Maksimovic and the STAFF Team
During the Cluster Cross-calibration workshop, ESTEC 02/May/2006

Conclusions were :

- **Comparisons between STAFF-SA and STAFF-SC** : the agreement is good, provided the magnetic fluctuation level at around 8.8 Hz is larger than $10^{-5} \text{ nT}^2/\text{Hz}$. This means that magnetic PSD data, around this frequency, with values smaller than this threshold should be used with caution.

- **Comparisons between STAFF-SA and EFW** : the agreement is good provided the electric fluctuations level at around 8.8 Hz is larger than $6 \text{ to } 10 \times 10^{-4} (\text{mV/m})^2/\text{Hz}$. As this latter value is known to be close to the sensitivity of the EFW experiment, this means that electric PSD data, around this frequency, with values smaller than this threshold should be retrieved preferentially from the STAFF-SA experiment.

- **Comparisons between STAFF-SA and WHISPER** : the agreement is good on the average

V. Data delivery plan for measurement from years 2006-2010

1. SHORT TERM NEW DEVELOPMENT

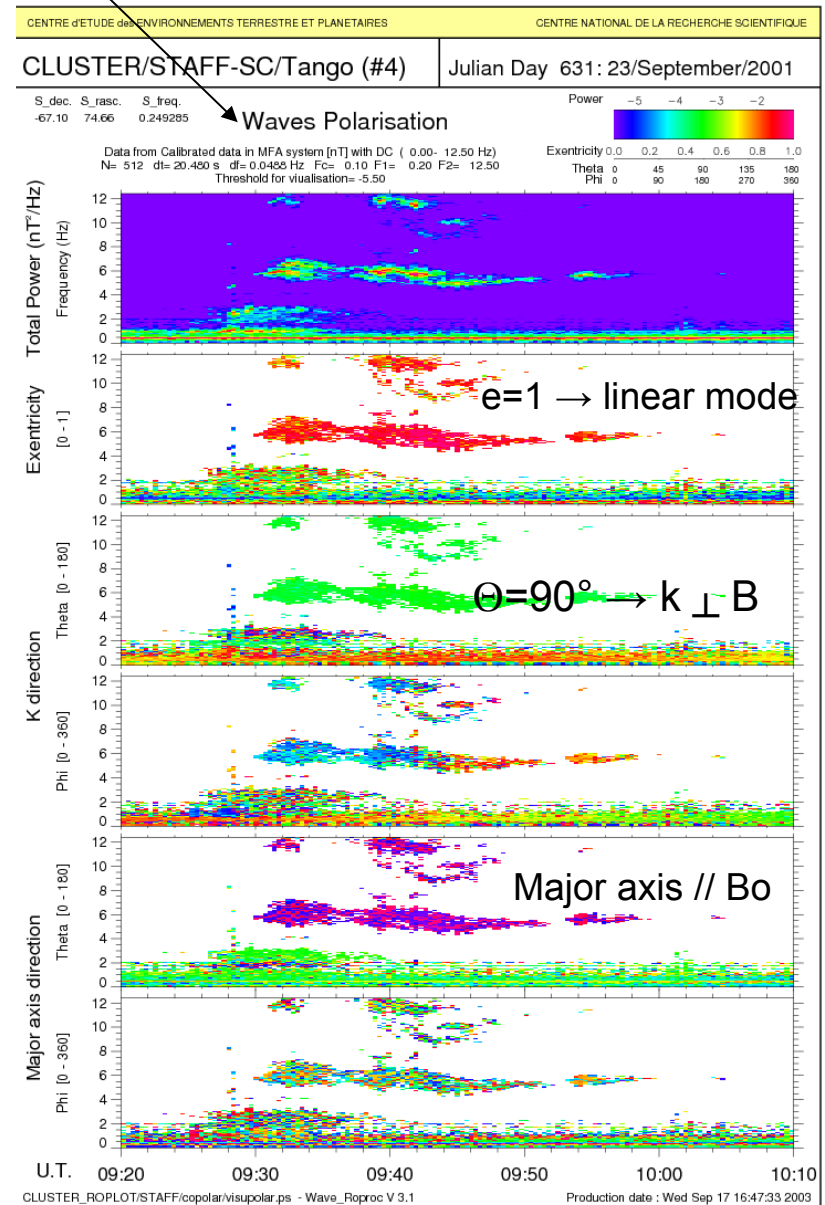
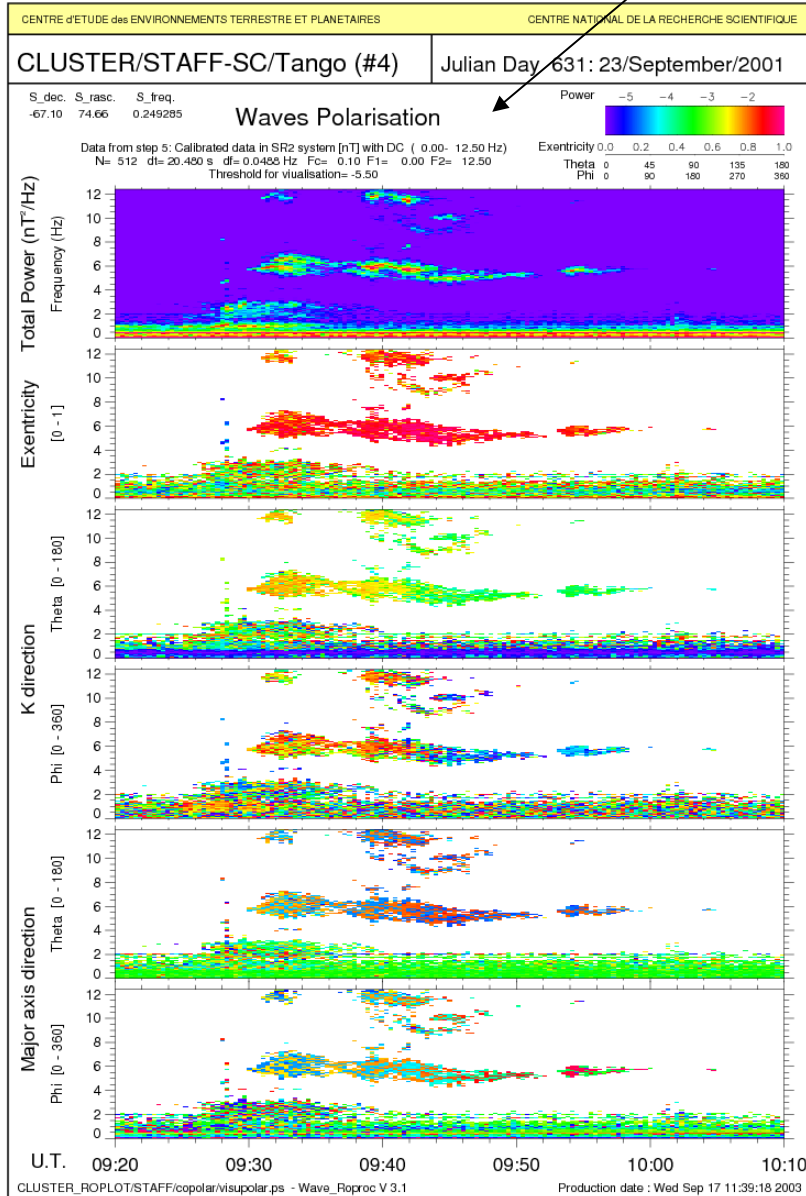
- Finish the delivery of current products.
- Solve problem of calibration table of S/C 1.
- Modelisation of transfer function.
- Continuously calibration software, development, test validity (L2)
- Make deeper STAFF-SC & FGM comparison.
- Update the documentation.
- STAFF-SC polarisation diagrams (L3)
(ellipticity, k vector and axis direction, etc ➡ Roproc).
- STAFF-SA polarisation and propagation parameters (L3)
(ellipticity, k vector degree of polarisation, etc ➡ Prassadco).

Example of STAFF-SC level 3 data

(but so clear events are rare on Cluster orbit)

SR2

MFA



2. Planning of delivery for the second phase

Product \ Year	2008	2009	2010
SC DWF	2006 - 2007	2008	2009
SC Complex spectra	2006 - 2007	2008	2009
SC Images	2007	2008	2009
SC CWF New		2001	2002 - 2009
SA AGC	2001 - 2005	2006 - 2008	2009
SA PDS / SM	2001 - 2005	2006 - 2008	2009
SA Polarisation/ Propagation New		2001	2002-2009

CONCLUSION

- All existing data production lines are operational, and currently running.
- The new STAFF-SC continuous calibration software remain to develop. This will require a lot of work, especially for test and checking with present results. Another data production line will be done.
- In any case, the STAFF-SC level 1 data must always be kept.
- Comparison with FGM should be made again.
- Software computing STAFF-SC polarisation data (and plots) are already existing; only the mass-production chain and CEF formatting remains to be done.
- Same for STAFF-SA.

⇒ **CETP** end at Dec 31, 2008

Atmosphere part → **LATMOS**, with SA laboratory, Guyancourt

Plasma part → **LPP**, with LPTP Polytechnique, Palaiseau