Calibration and software status for SCM
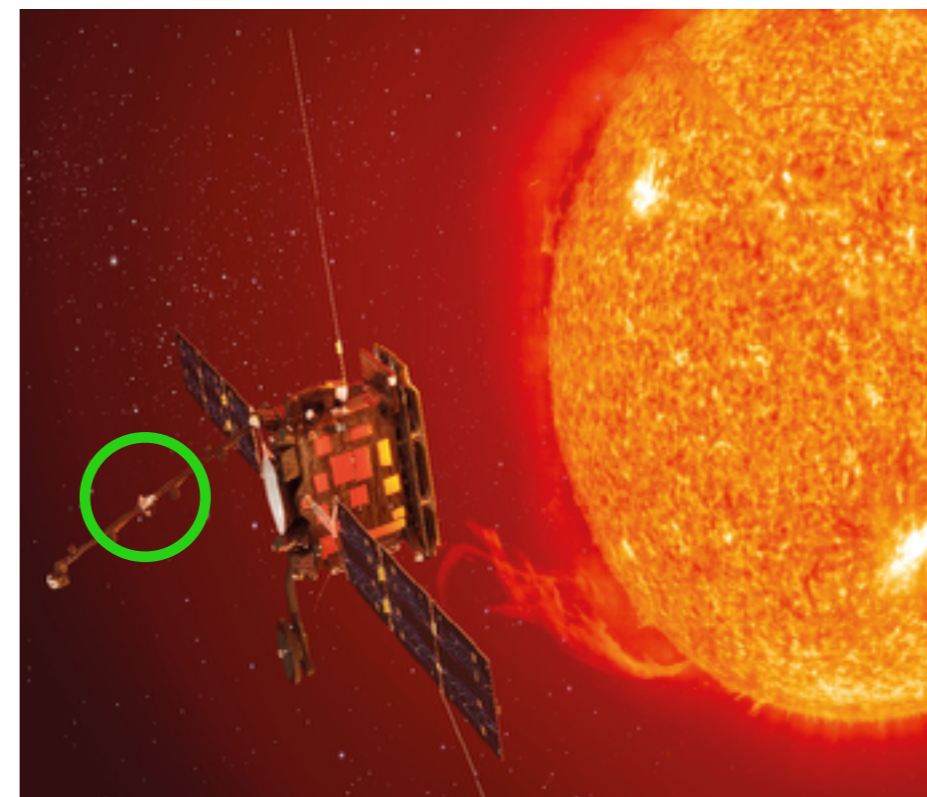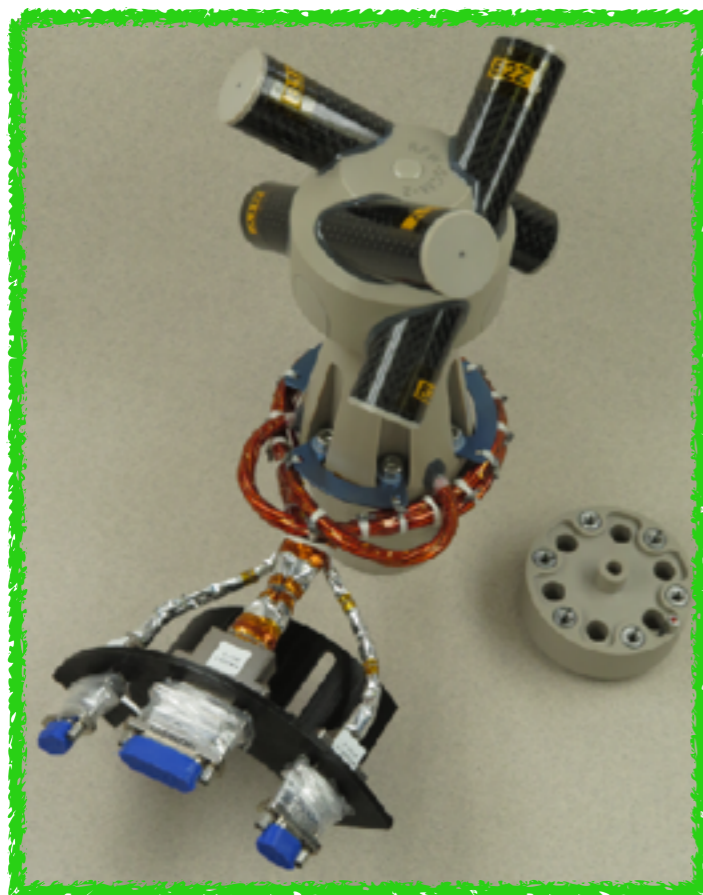
M. Kretzschmar & the SCM team
LPC2E, CNRS & University of Orléans, France

« Ahi quanto a dir qual era è cosa dura

…

Ma per tratar del ben ch'i vi trovai
*Diro del'altre cose ch'i vo scorte »*

Summary

- ✦ SCM FS to be delivered to Airbus next week

- ✦ Calibration.
  - ✤ yes we can. I show how.
  - ✤ If calibration matrix will be measured at Airbus.

- ✦ Next
  - ✤ Measure at Airbus
  - ✤ Temperature dependence
 - ✤ Onboard cal
  - ✤ Interferences

SCM + MEB cross talk

✦ Reminder (2017)

✤ FS (FM2) will be delivered to ESA next week. Better than FM1 because does not have the weakness to temperature stress observed on PSP.

✤ The « eye » figure (20% variations wrt to expected results) is caused by cross-talk between channels when SCM is loaded with the analyzers.
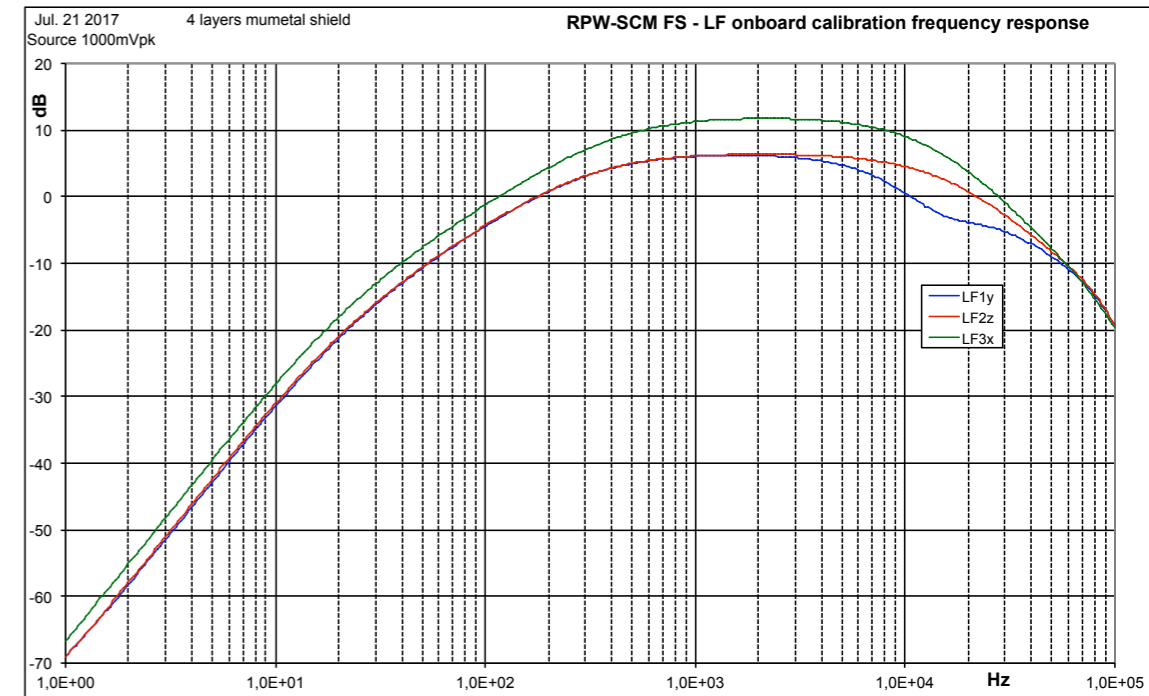
✦ **New since last consortium meeting.**

✤ Cross-talk is modified by the load of the analyzers; it varies with different model of the MEB. Need to measure it with MEB-PFM

✤ Cross-talk is linear. Seen on SCM FM + MEB PFM and SCM FS + MEB EM

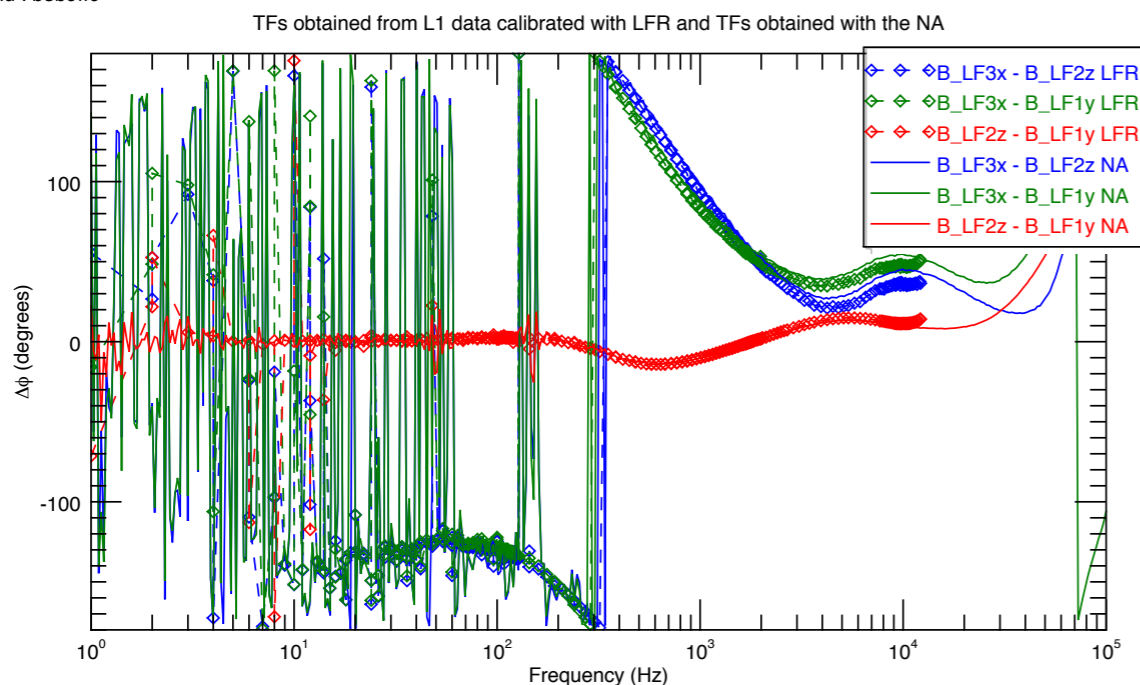✤ RPW/B can be calibrated if the cross talk is measured.
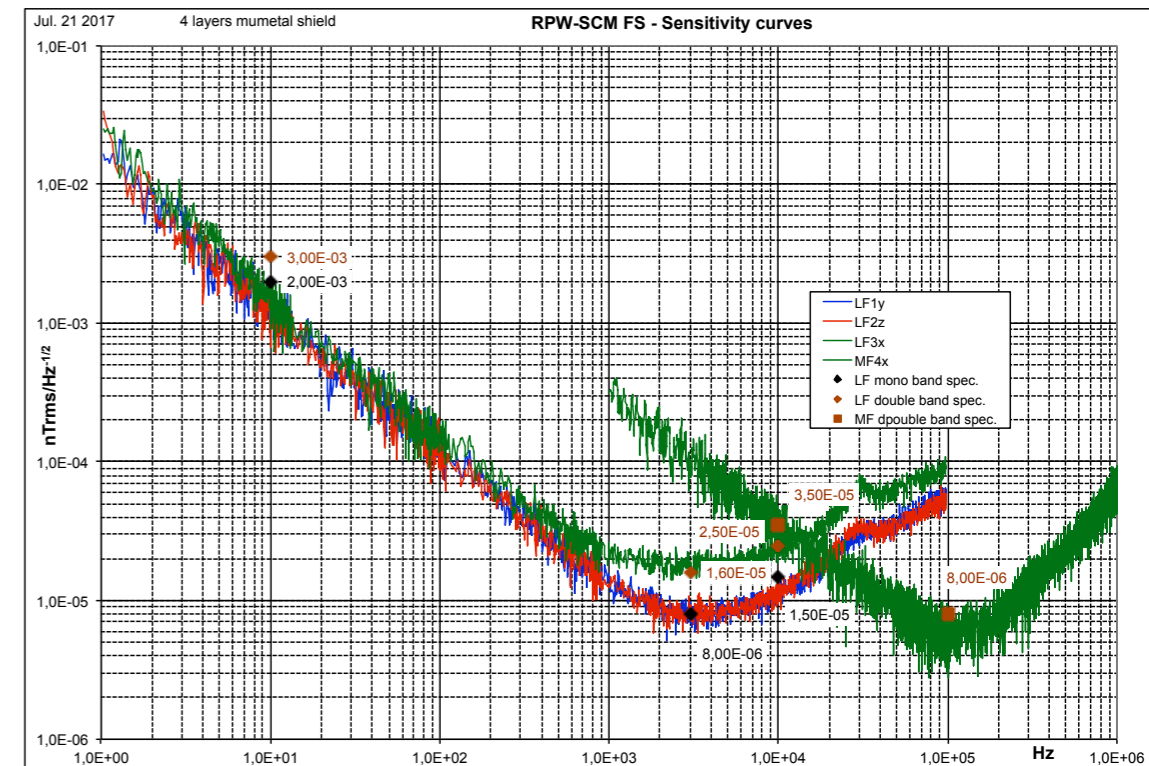
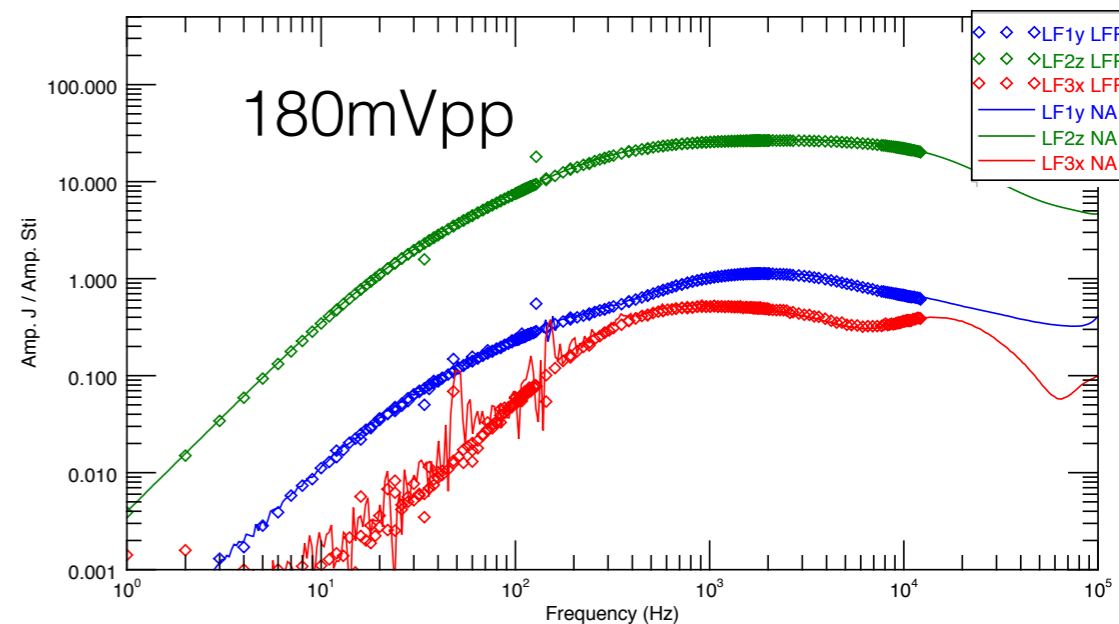# Cross-talk is linear

- ✦ Measurements with SCM FS + MEB EM 1.
  - ✤ The gain and cross phase measured on each antenna do not vary with the injection level.
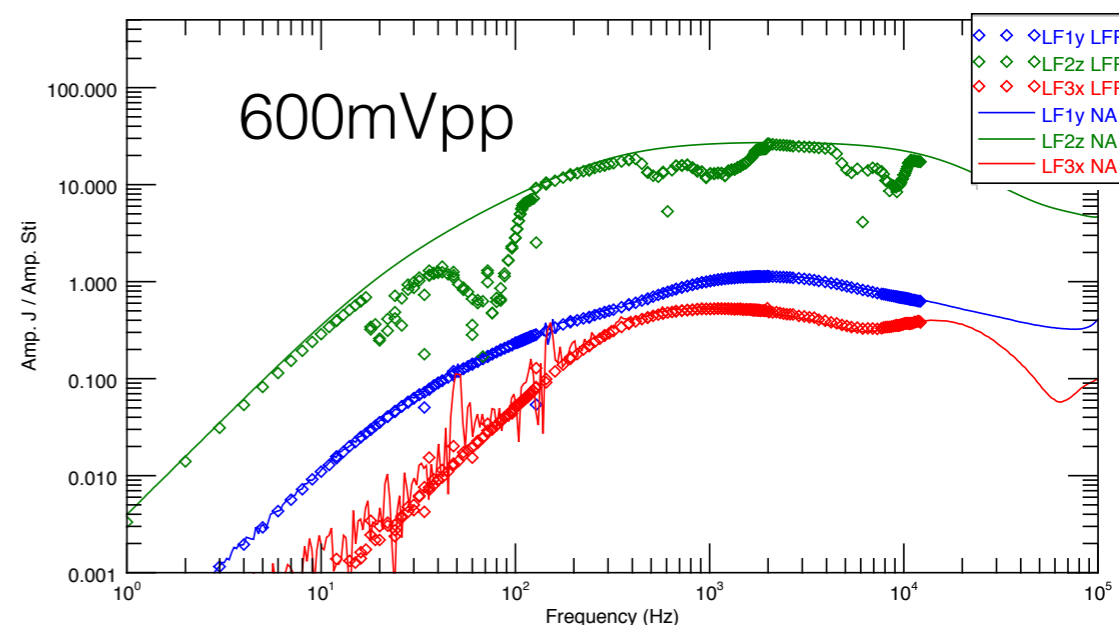 - ✤ Also seen on SCM FS alone.

Relative phase

TFs obtained from L1 data calibrated with LFR and TFs obtained with the NA
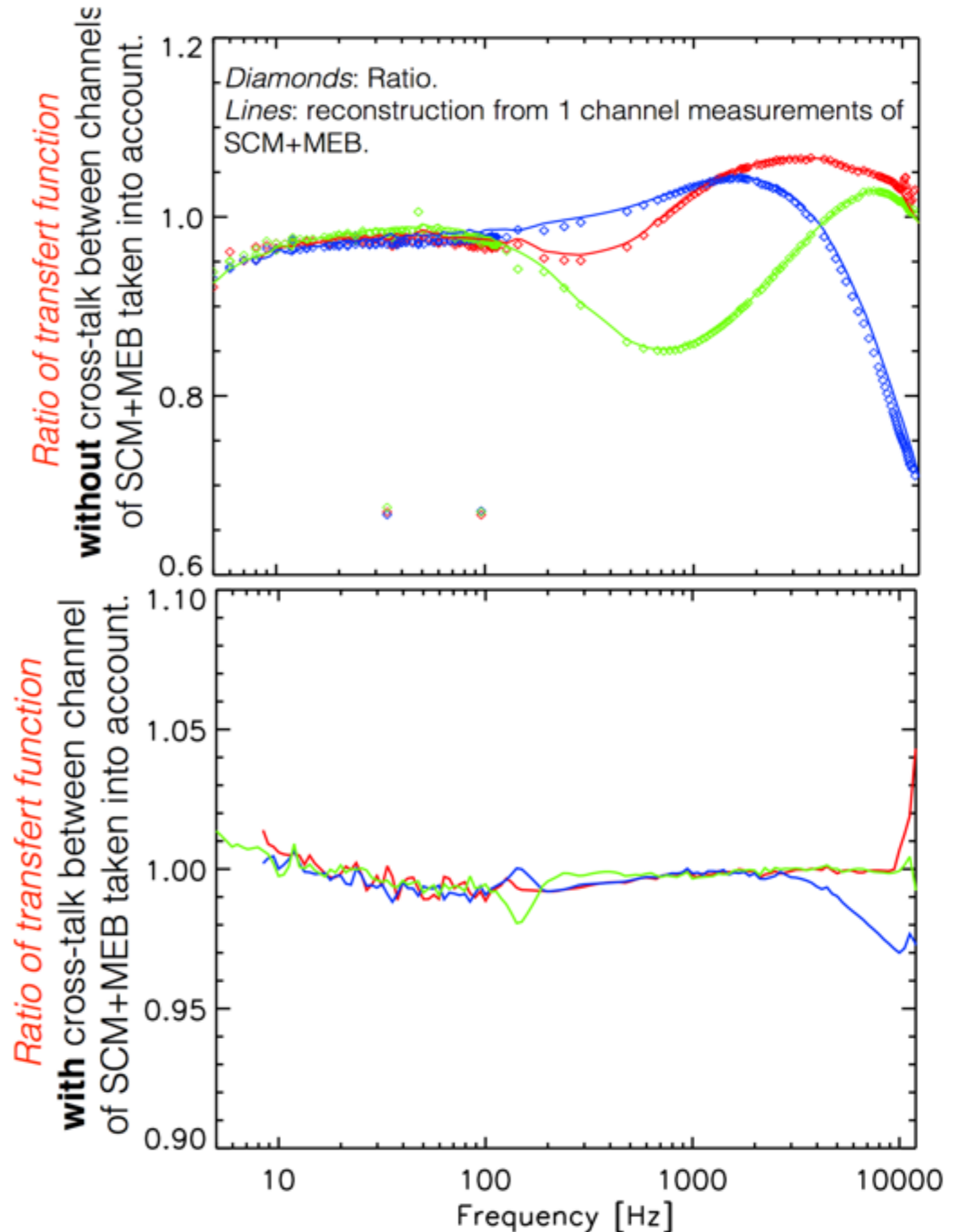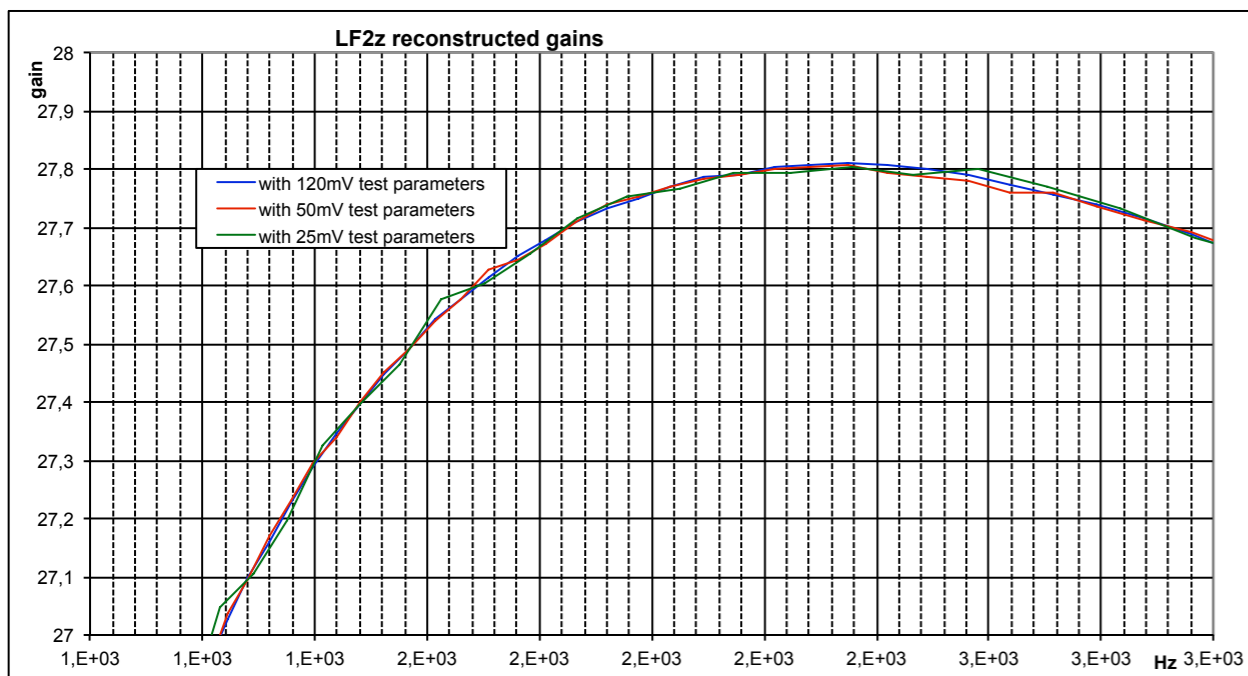
180mVpp

TFs obtained from L1 data calibrated with LFR and TFs obtained with the NA

300mVpp

600mVpp
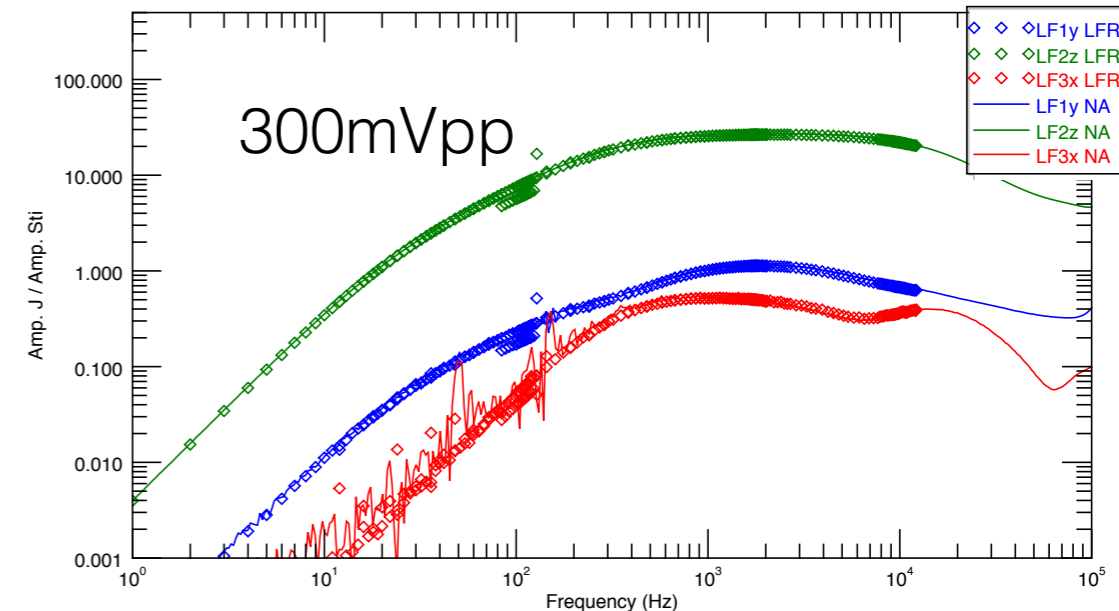
$$Sx^2 = A_{xx}^2 + A_{xy}^2 + A_{xz}^2 + 2A_{xx}A_{xy}\cos(\phi_{xy}) + 2A_{xx}A_{xz}\cos(\phi_{xz}) + 2A_{xy}A_{xz}\cos(\phi_{yz})$$

Output voltage can be reconstructed

Reconstructed gain using cross talk measurements at different injection level

B can be calibrated

✦ Output voltage of SCM depends on the 3 B components:

$$\begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix} = \begin{bmatrix} R_{xx} & R_{xy} & R_{xz} \\ R_{yx} & R_{yy} & R_{yz} \\ R_{zx} & R_{zy} & R_{zz} \end{bmatrix} \begin{bmatrix} B_x \\ B_y \\ B_z \end{bmatrix}$$

✦ Basic algebra leads to :

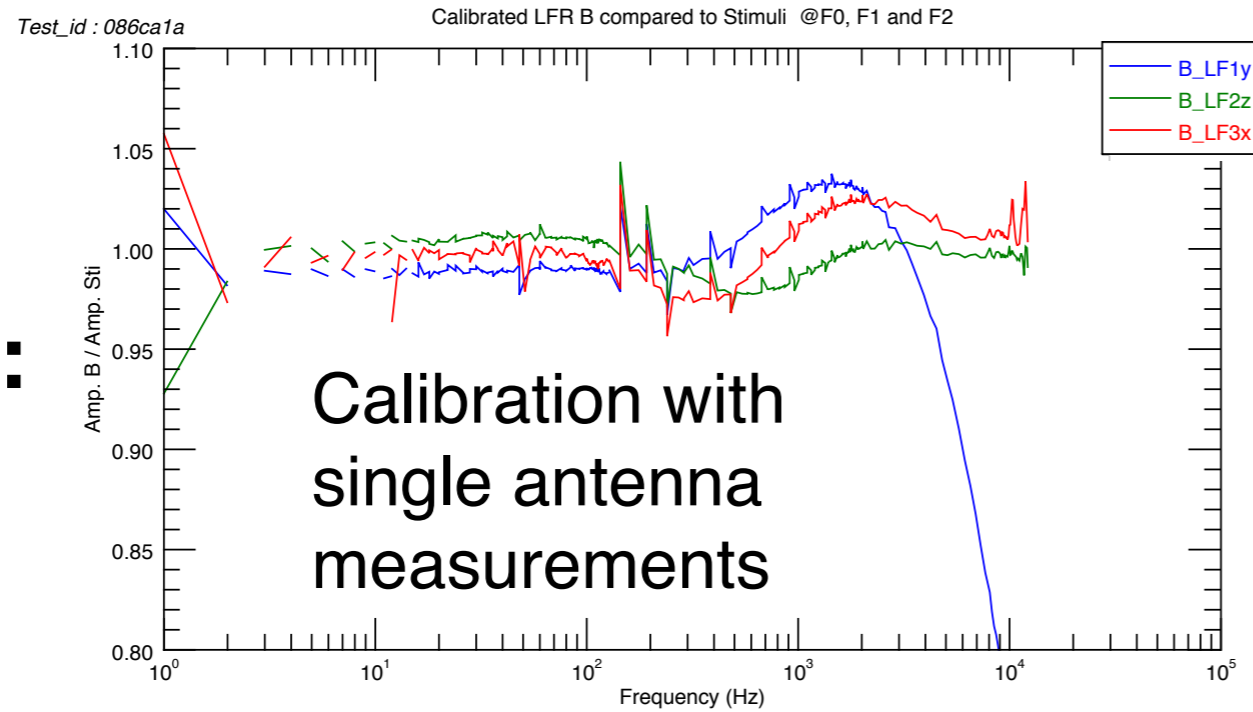$$\begin{bmatrix} B_x \\ B_y \\ B_z \end{bmatrix} = \begin{bmatrix} R'_{xx} & R'_{xy} & R'_{xz} \\ R'_{yx} & R'_{yy} & R'_{yz} \\ R'_{zx} & R'_{zy} & R'_{zz} \end{bmatrix} \begin{bmatrix} V_x \\ V_y \\ V_z \end{bmatrix}$$

leads to $\quad R'_{xy} = \dfrac{1}{\det \boldsymbol{R}} (R_{xz} R_{zy} - R_{xy} R_{zz})$

B can be calibrated

EYE:

First test on SCM FS + MEB EM1
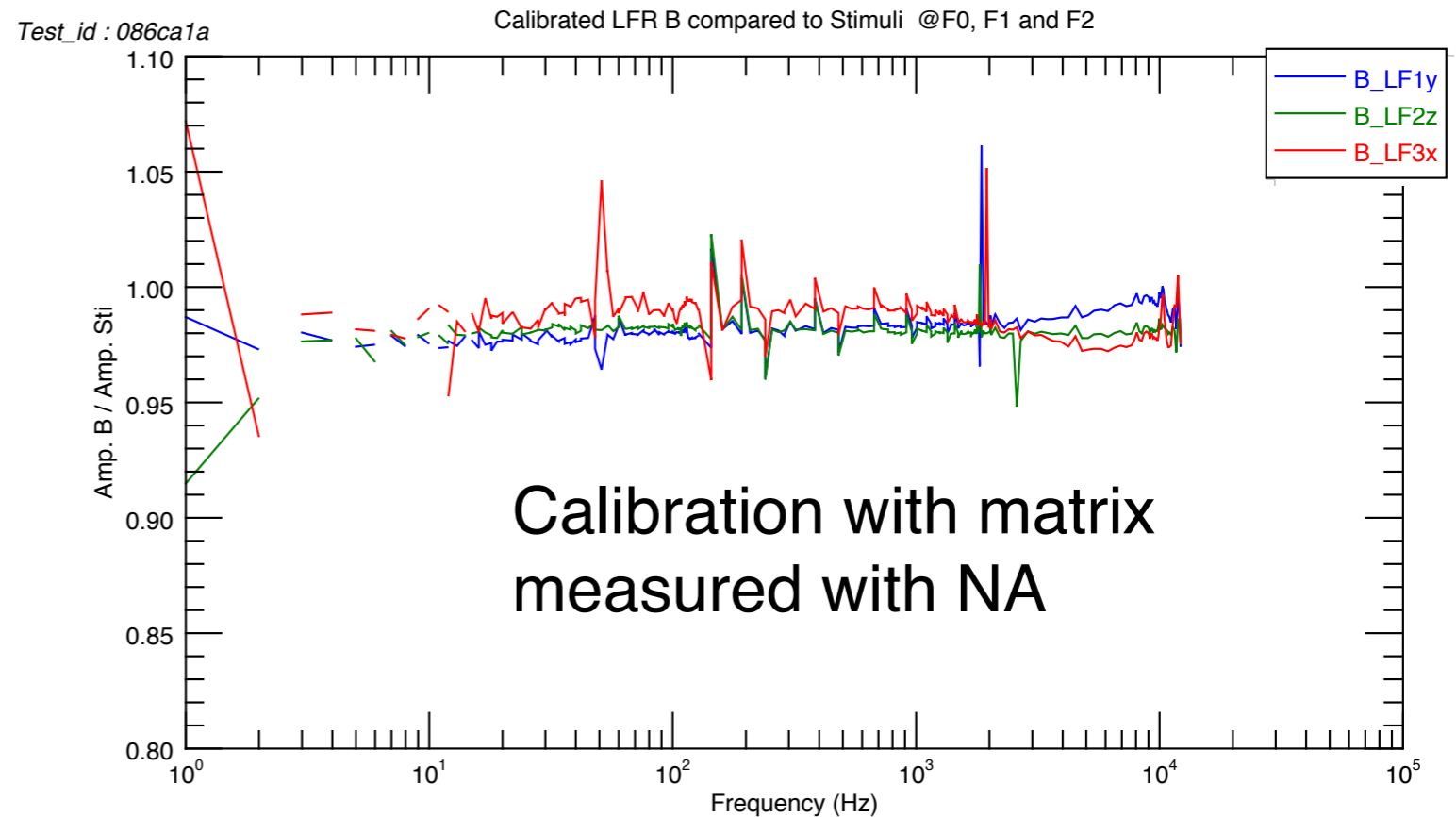
NO EYE:

courtesy Gamil CC

Configuration for spectral matrix measurements at Airbus

✦ Test with SCM EM and MEB EM1 have shown that
  ❖ Thanks to LESIA, LFR, and CNES Team.
  ❖ Measurements of the cross talk with NA and MEB on is enough.
  ❖ To be done.
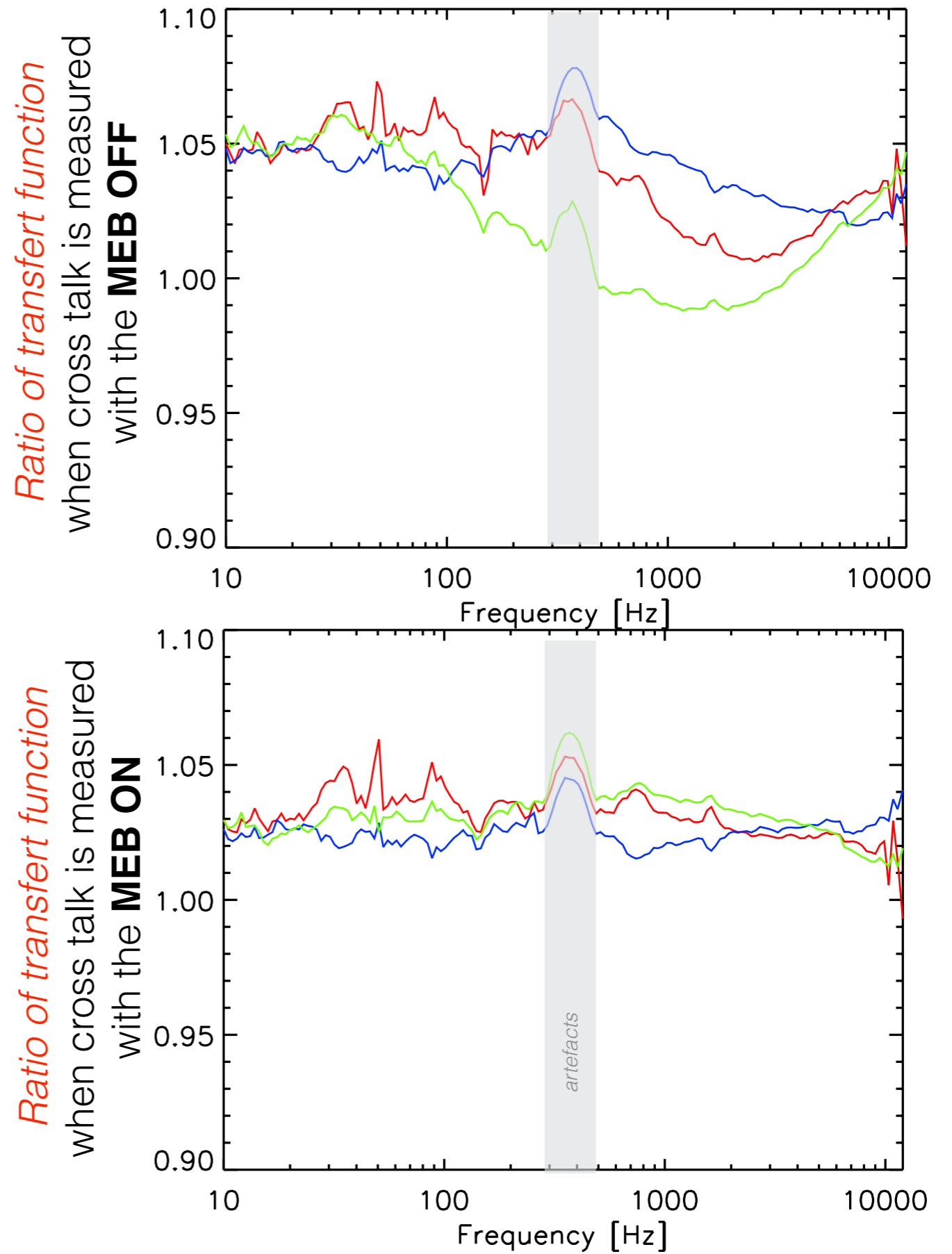
Analyser dependence

✦ Calibration matrix depends on the load

  ✤ and therefore on the connected analyzers

  ✤ In backup model, LFR is disconnected and TDS is connected to LFM channel

NA TDSLFM LFRON SMALL vs NA MEB ON SMALL

Loaded by TDS LFM + LFR

NA TDSLFM LFROFF SMALL vs NA MEB ON SMALL

Loaded by TDS LFM Alone (back up mode)

➡ **Need to measure SCM FS + TDS LFM with LFR disconnected**

Temperature dependence

Calibration matrix will be measured at ambiant.

- Need to extrapolate measurements at -50°.
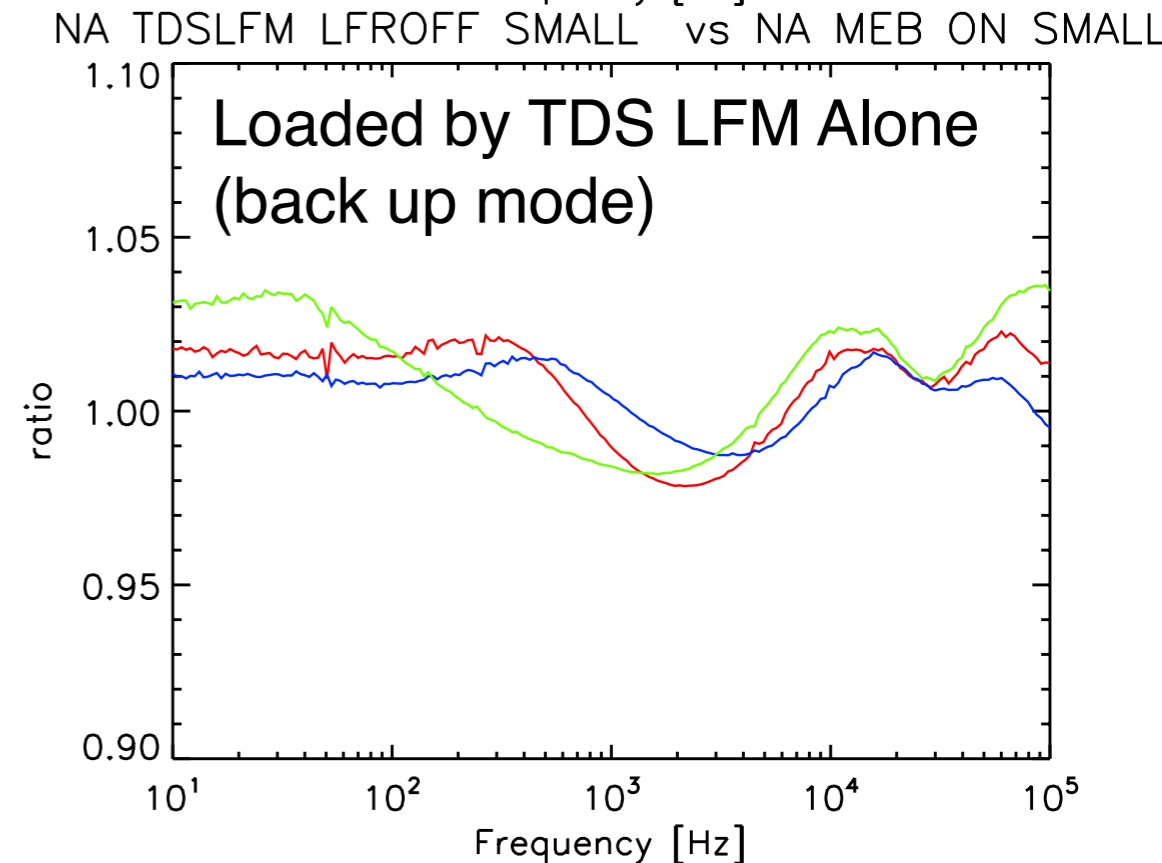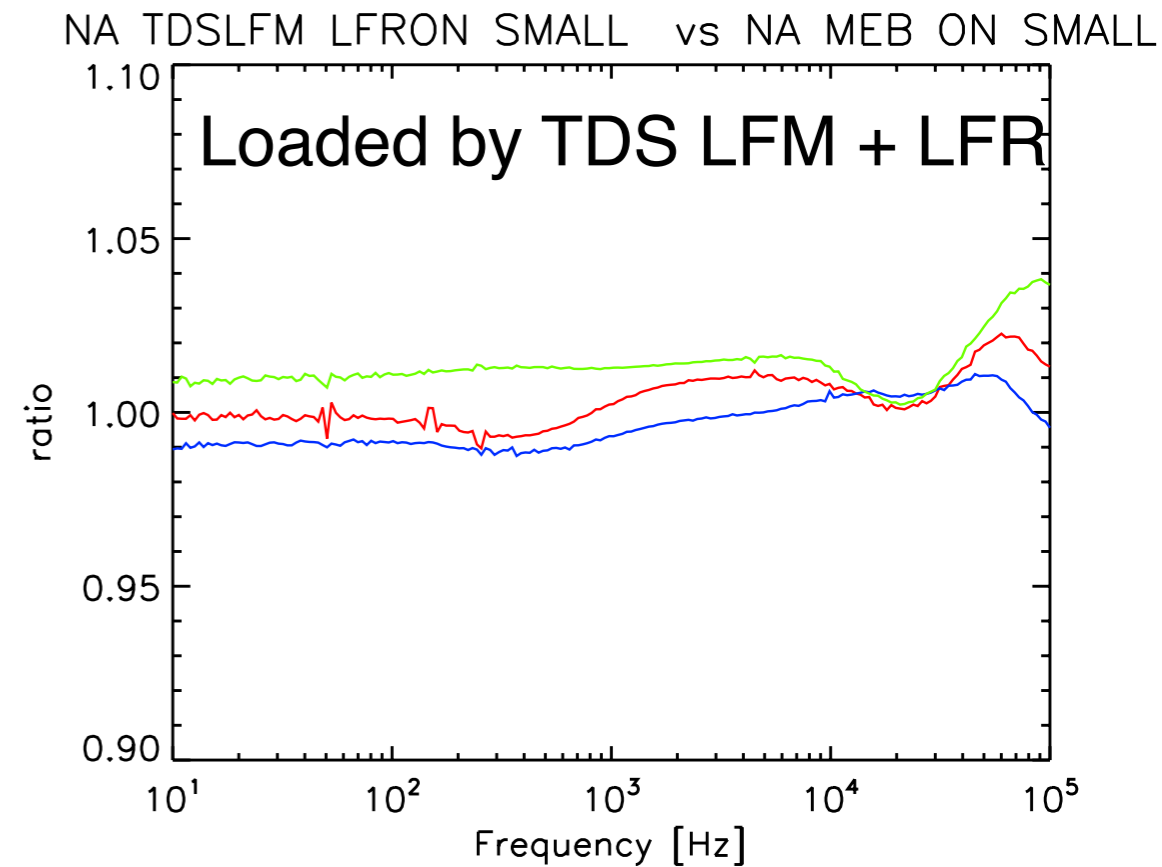- Temperature dependency has been measured and is similar on all SCM models

LF3X

preamplifier cycling [−55°C ; −53°C], antennas −83°C
preamplifier cycling [−55°C ; −53°C], antennas −85.5°C
preamplifier cycling [−55°C ; −53°C], antennas −84.3°C
preamplifier +35.6°C, antennas +37.1°C
preamplifier −37.9°C, antennas −41.7°C
preamplifier −35.8°C, antennas −39.0°C

FS alone

EM −50
FM −50

with MEB PFM

Ratio to FT standalone at ambiant — Frequency [Hz]
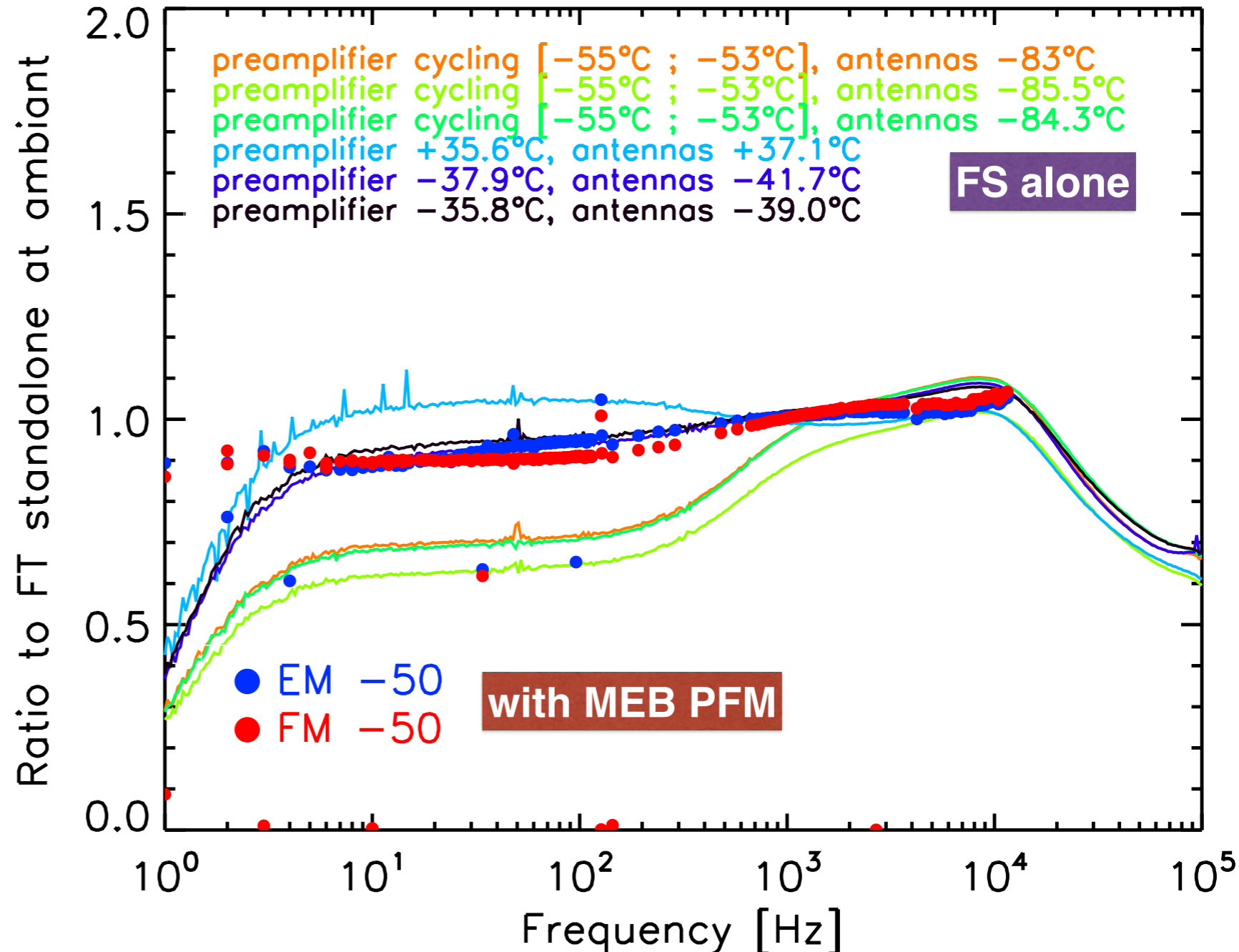
➡ **SCM Calibration matrix will depend on temperature**

- Need for these two parameters in LFR and TDS L1R
  - HK_LFR_TEMP_SCM
  - HK_LFR_CALIB_ENABLED

Onboard Calibration

- ✦ Only 2 frequencies are currently planned: 626Hz and 10kHz

- ✦ We can have 10… (Thanks, LFR team !)
  - ✤ snapshot1: 10016; 626
  - ✤ snapshot2: 5008; 313
  - ✤ snapshot3: 2504; 156.5
  - ✤ snapshot4: 1252; 78.25
  - ✤ snapshot5: 626; 39.125
  - ✤ Snapshot every 22s, calibration once /week, 0.25% of snapshot.
  - ➡ Much better

- ✦ Needs software update on LFR, to be tested on EM1

- ✦ Important work on ground to check SCM transfert function vs Temperature.
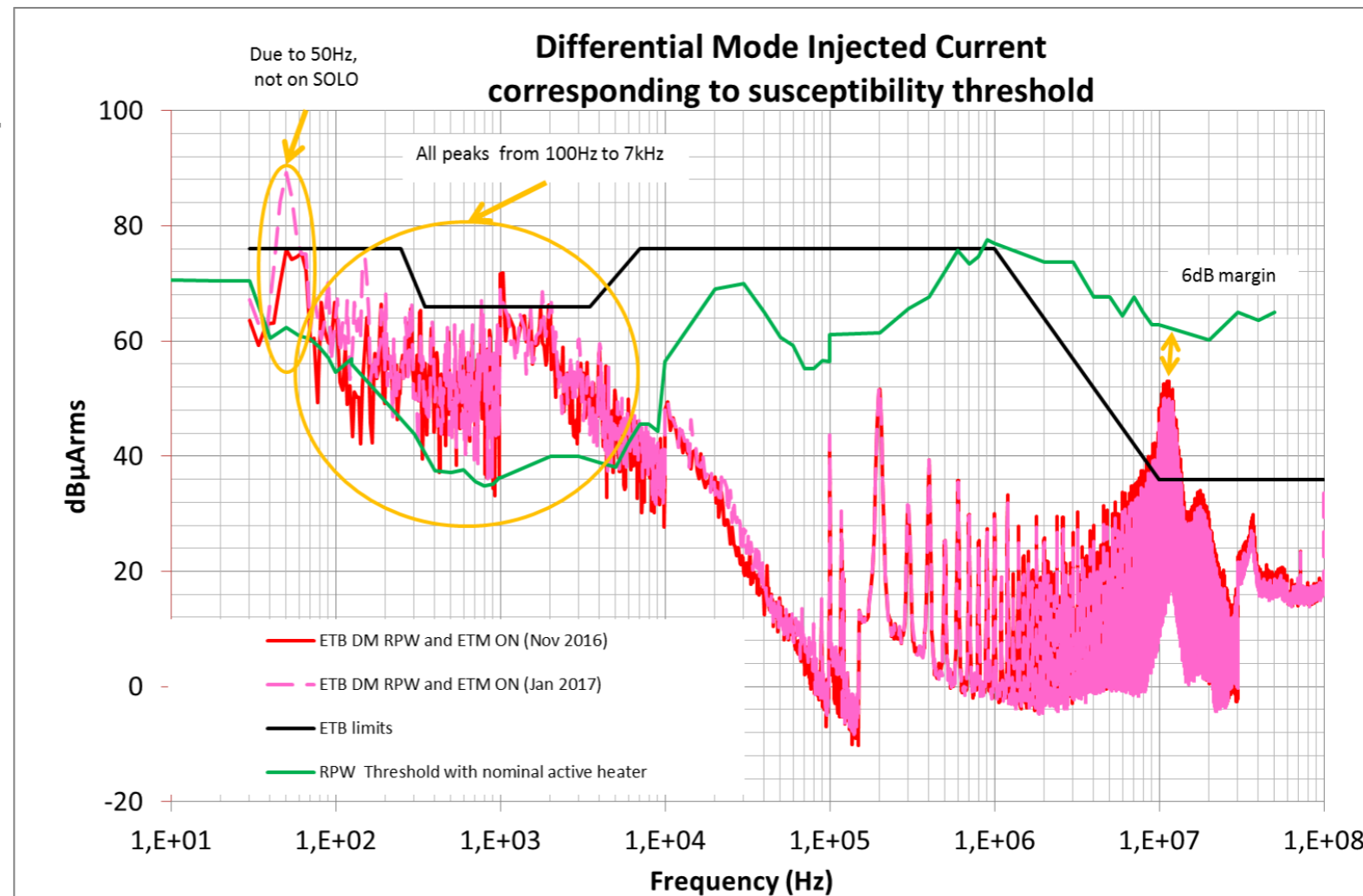
Interferences

Conducted Susceptibility

Differential Mode : 100Hz and 7kHz are out of margin. Elsewhere, no susceptibility is expected on RPW => When SCM heaters are active

✦ Conducted S/C interferences by the heater

- ✤ Worst with survival heaters.
- ✤ duty cycle: 43% ON far from the Sun, 0% at perihelia.
- ✤ Will be measured during fft
- ✤ Important work of denoising on ground.
- ✤ Or soft to detect working heater and synchronize Snapshot WF

Differential Mode Injected Current corresponding to susceptibility threshold

Due to 50Hz, not on SOLO

All peaks from 100Hz to 7kHz

6dB margin

— ETB DM RPW and ETM ON (Nov 2016)
- - - ETB DM RPW and ETM ON (Jan 2017)
— ETB limits
— RPW Threshold with nominal active heater
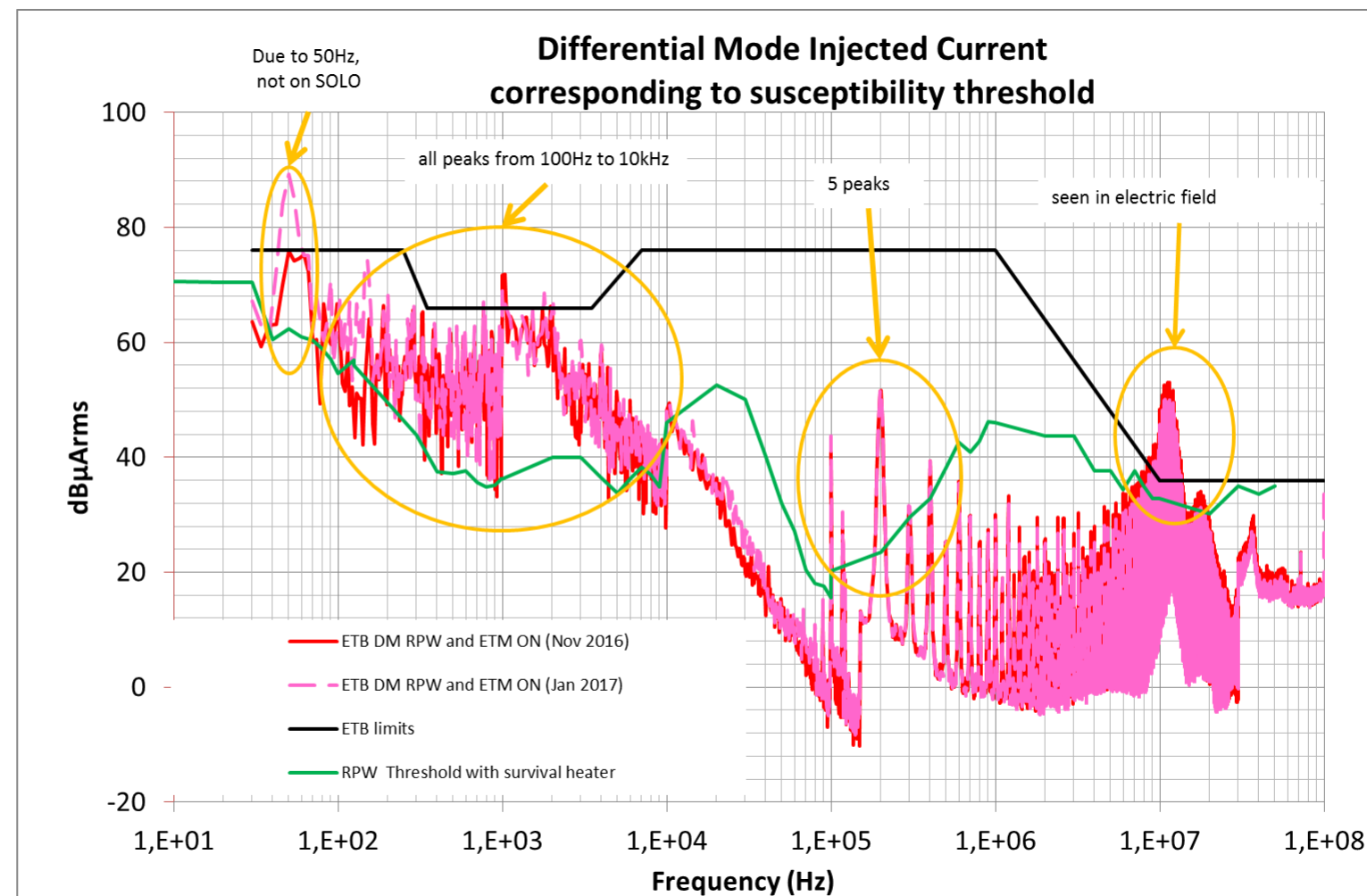
dBµArms

Frequency (Hz)

RPW

cnes

Next : Interferences

Conducted Susceptibility

Differential Mode : 100Hz and 10kHz are out of margin, idem fbetween 100kHz to 500kHz and 10MHz could be detected by antennas => When survival heaters on SCM
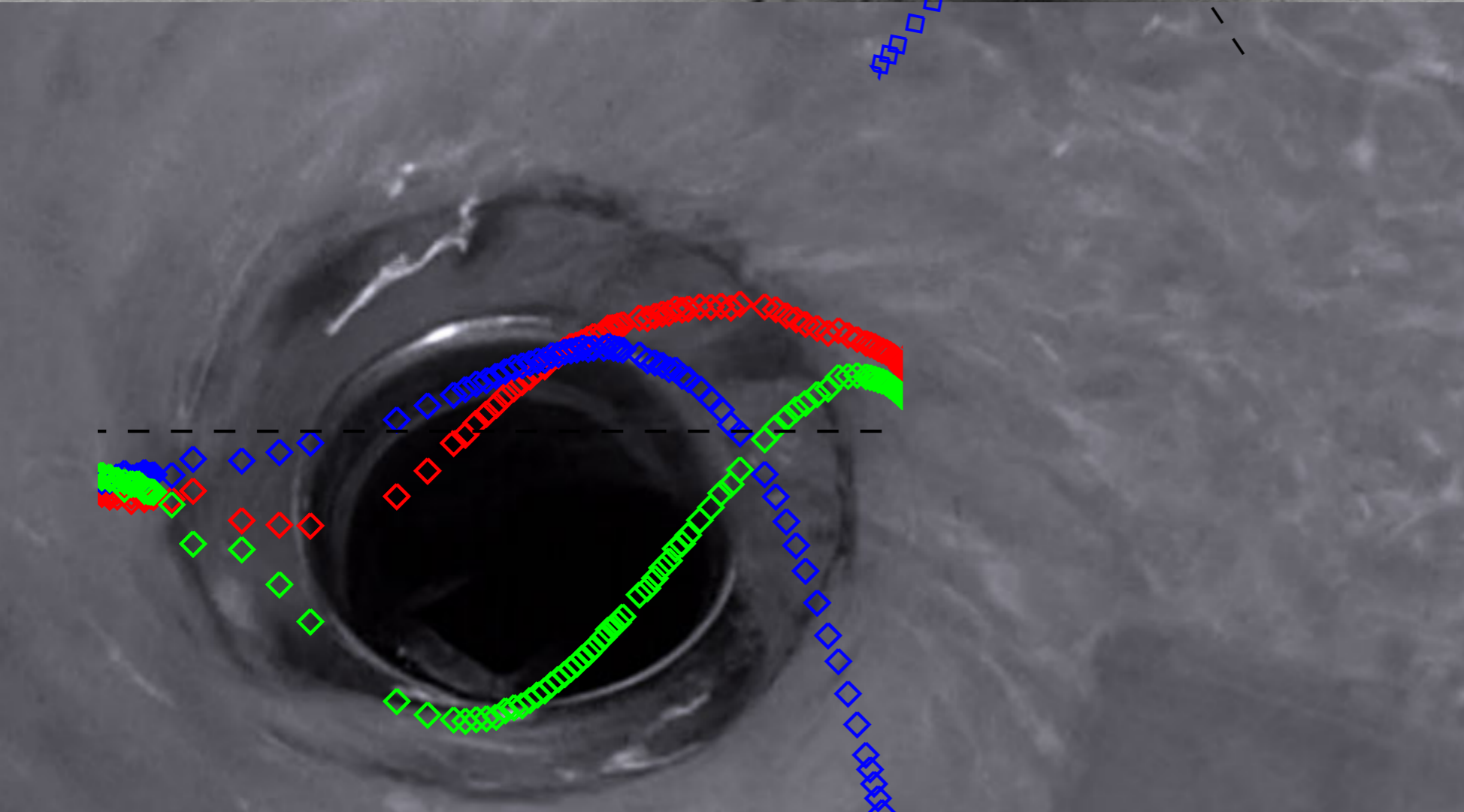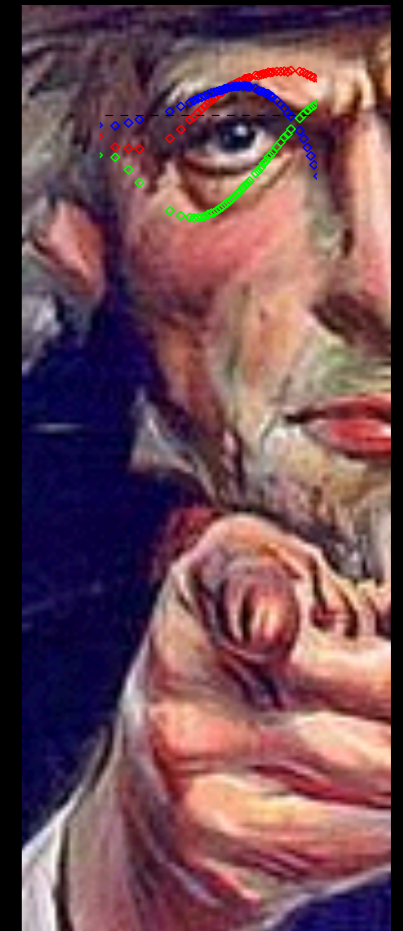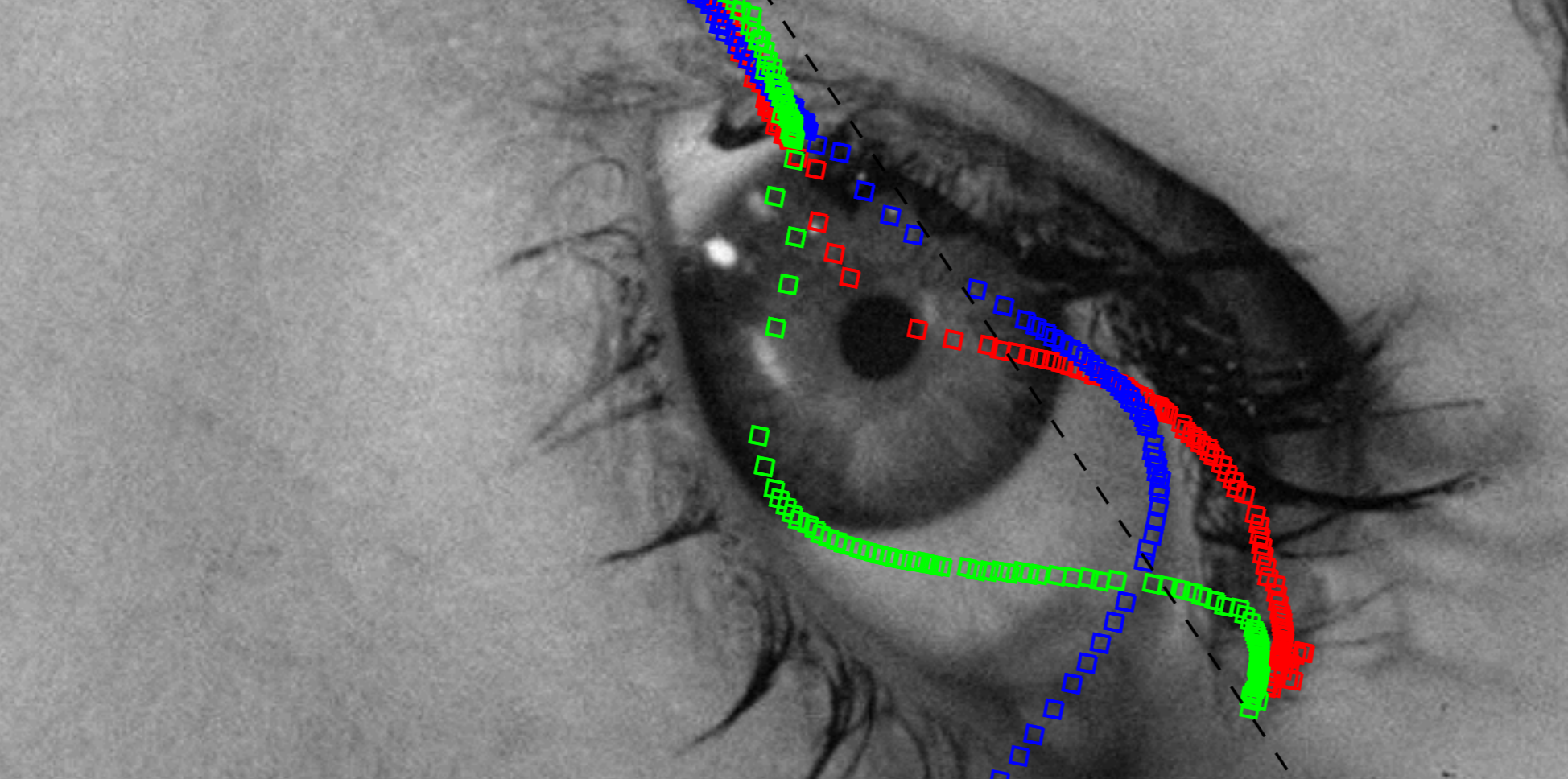
✦ Conducted S/C interferences by the heater

  ✤ Worst with survival heaters.
  ✤ Will be measured during fft
  ✤ Important work of denoising on ground.
  ✤ Or soft to detect working heater and synchronize Snapshot WF

Differential Mode Injected Current corresponding to susceptibility threshold

Due to 50Hz, not on SOLO

all peaks from 100Hz to 10kHz

5 peaks

seen in electric field

— ETB DM RPW and ETM ON (Nov 2016)
– – ETB DM RPW and ETM ON (Jan 2017)
— ETB limits
— RPW Threshold with survival heater

dBµArms

Frequency (Hz)

Conclusion and To do List

✦ SCM will be calibrated with requested accuracy

✦ To do
  ✤ measurements of SCM FS + MEB PFM on at Airbus.
  ✤ Temperature dependence and.
  ✤ Calibration software: implementation of matricial transfert function, temperature dependence, and the different modes.
  ✤ Onboard calibration: LFR onboard software modification
  ✤ Preparation of exploitation on ground:
    ✤ Calibration: onboard cal & temperature
    ✤ Interferences (heater, reaction wheels, ..)

    ✤ **Reminder: Need** for these two parameters in LFR and TDS L1R
      ✤ HK_LFR_TEMP_SCM
      ✤ HK_LFR_CALIB_ENABLED

Thank you !