SCM calibration status, feedback from the calibration campaign

SCM Teams

Overview

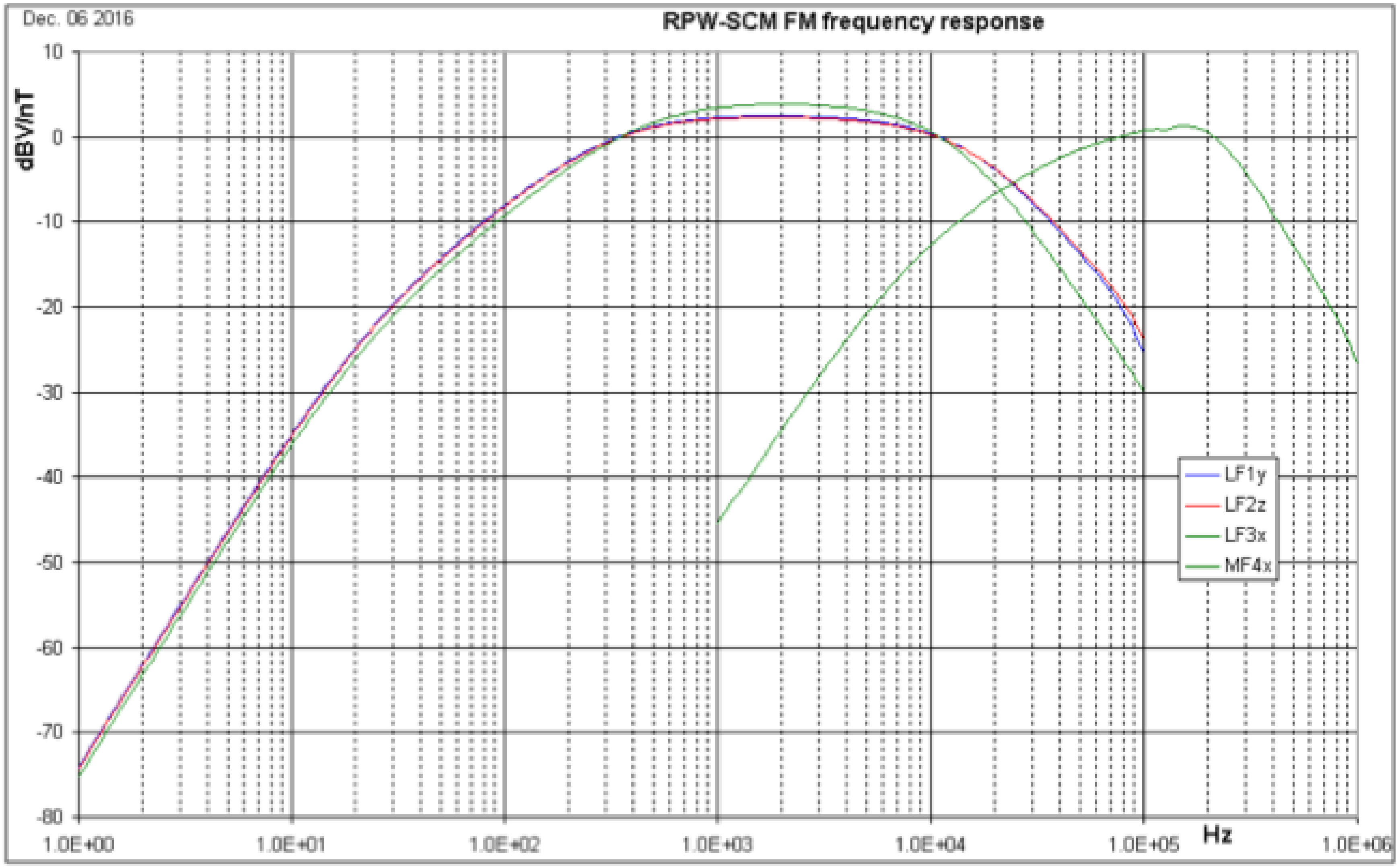
- Calibration status
  - SCM stand alone calibration is ok
  - Calibration campaign results on Gain
  - Calibration campaign results on Phase

- Software responsibilities discussion:
  - pro, cons, and conditions

SCM stand alone calibration

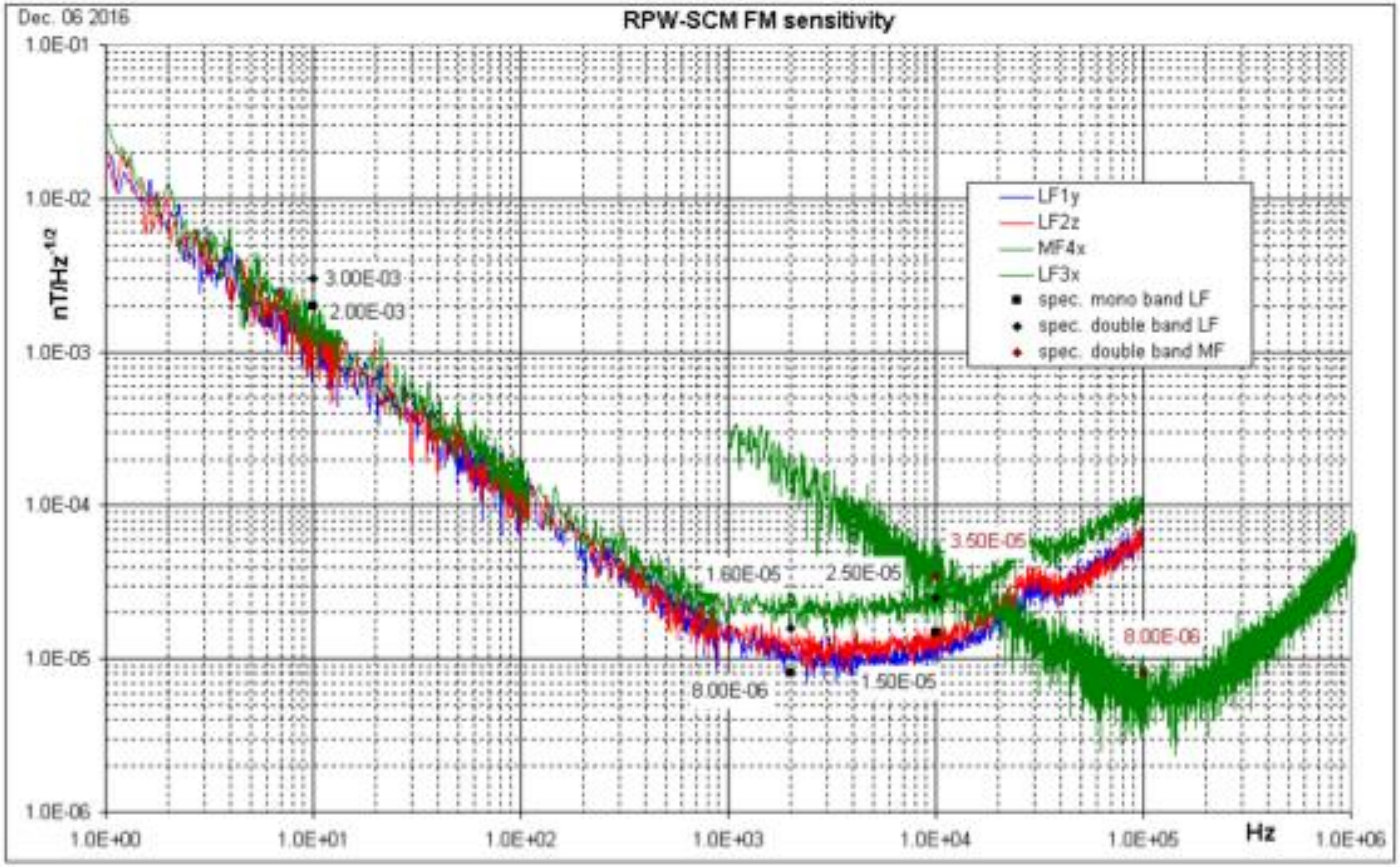
- Stand alone calibration is ok.
- Investigation on the « eye » calibration is on-going at LPC2E, but this is clearly a difficult task.

SCM FM Stand alone calibration



- conform to specifications.

SCM FM sensitivity

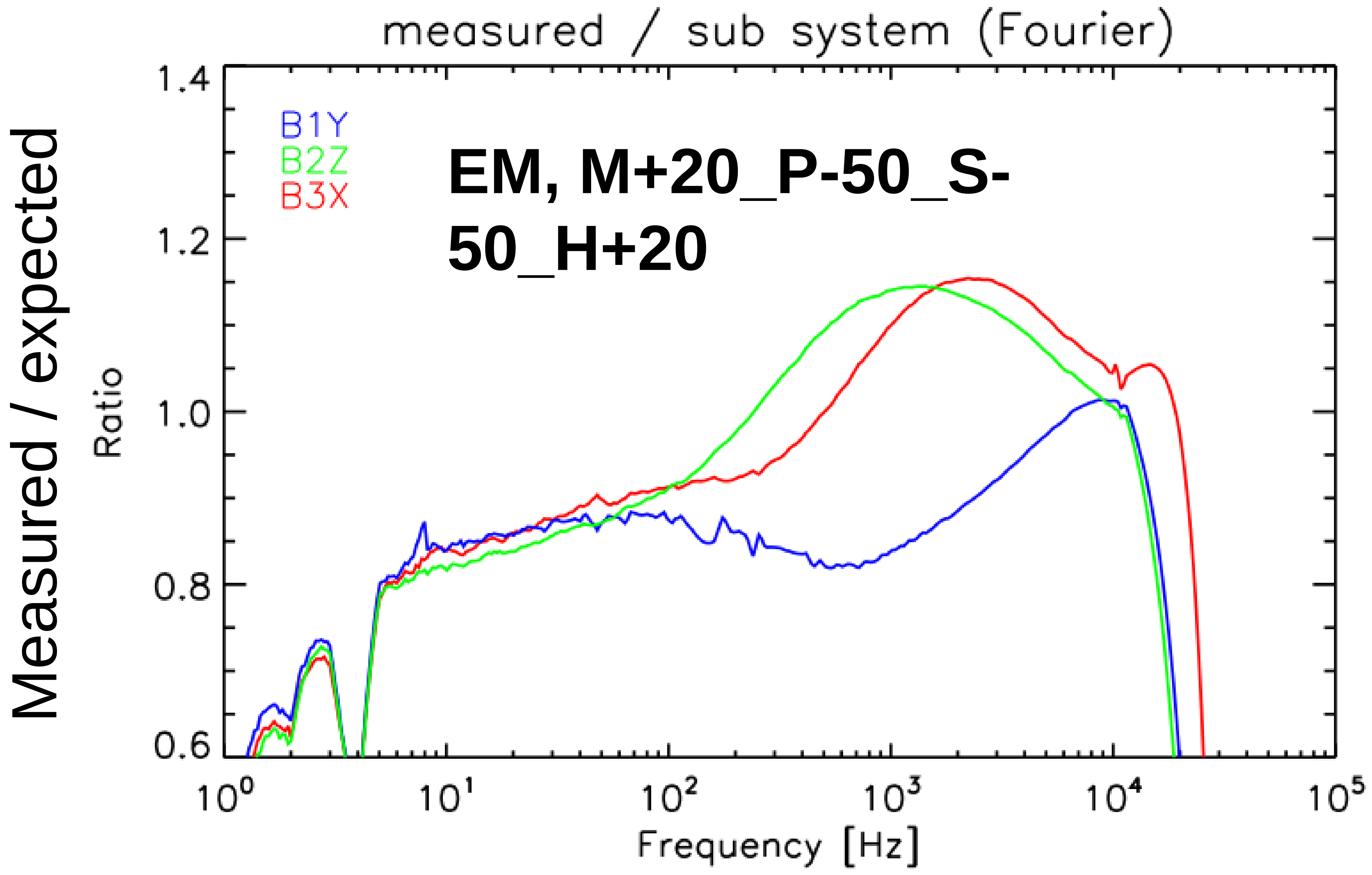


- As expected except at 2kHz :
  - Mono band : 10fT/Hz$^{-1/2}$ instead of 8fT/Hz$^{-1/2}$ expected
  - Double band : 20fT/Hz$^{-1/2}$ instead of 16fT/Hz$^{-1/2}$ expected
- Acceptable

Calibration campaigns

- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » changes between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

Calibration campaigns

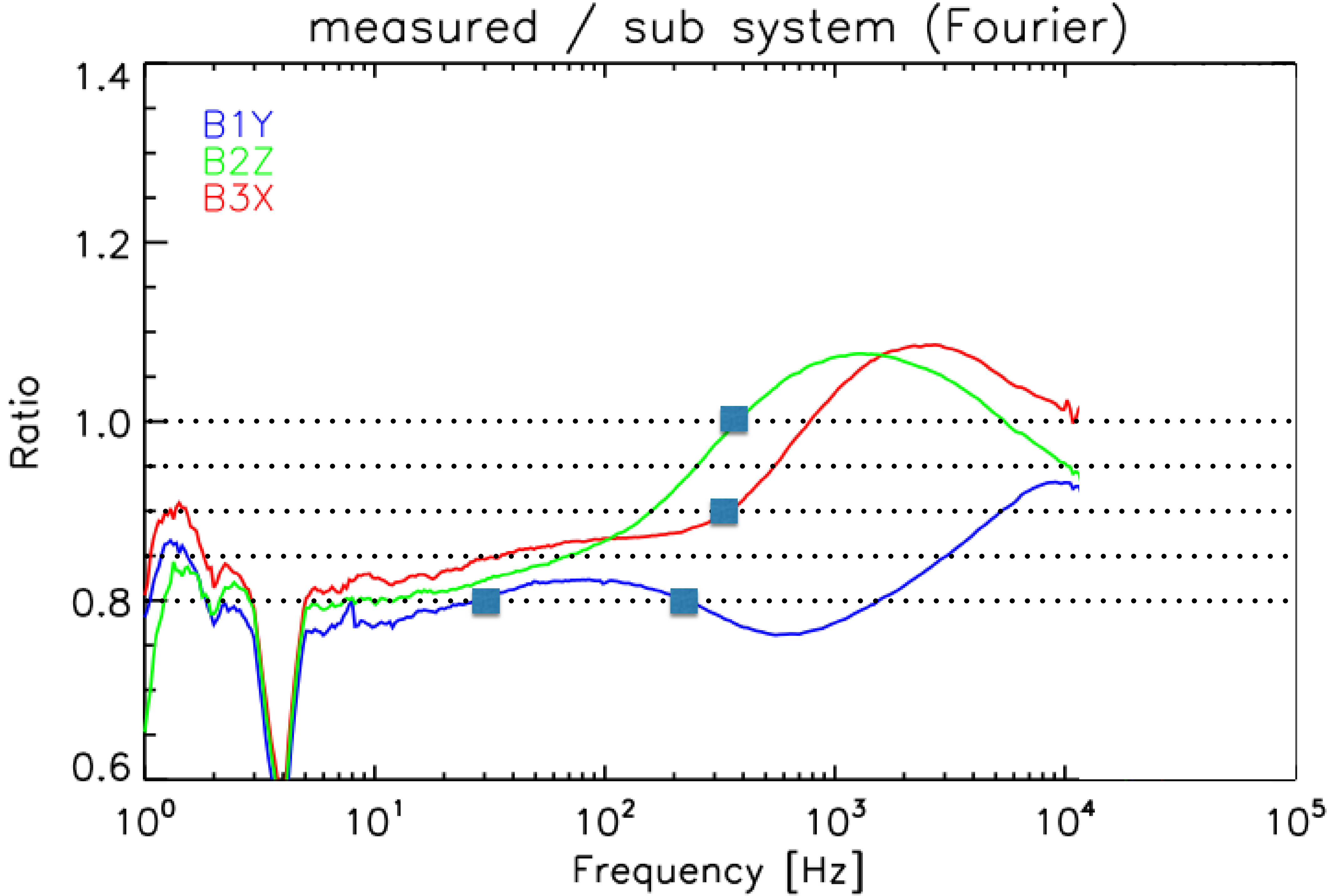


- Minor variations with temperature (a few %)

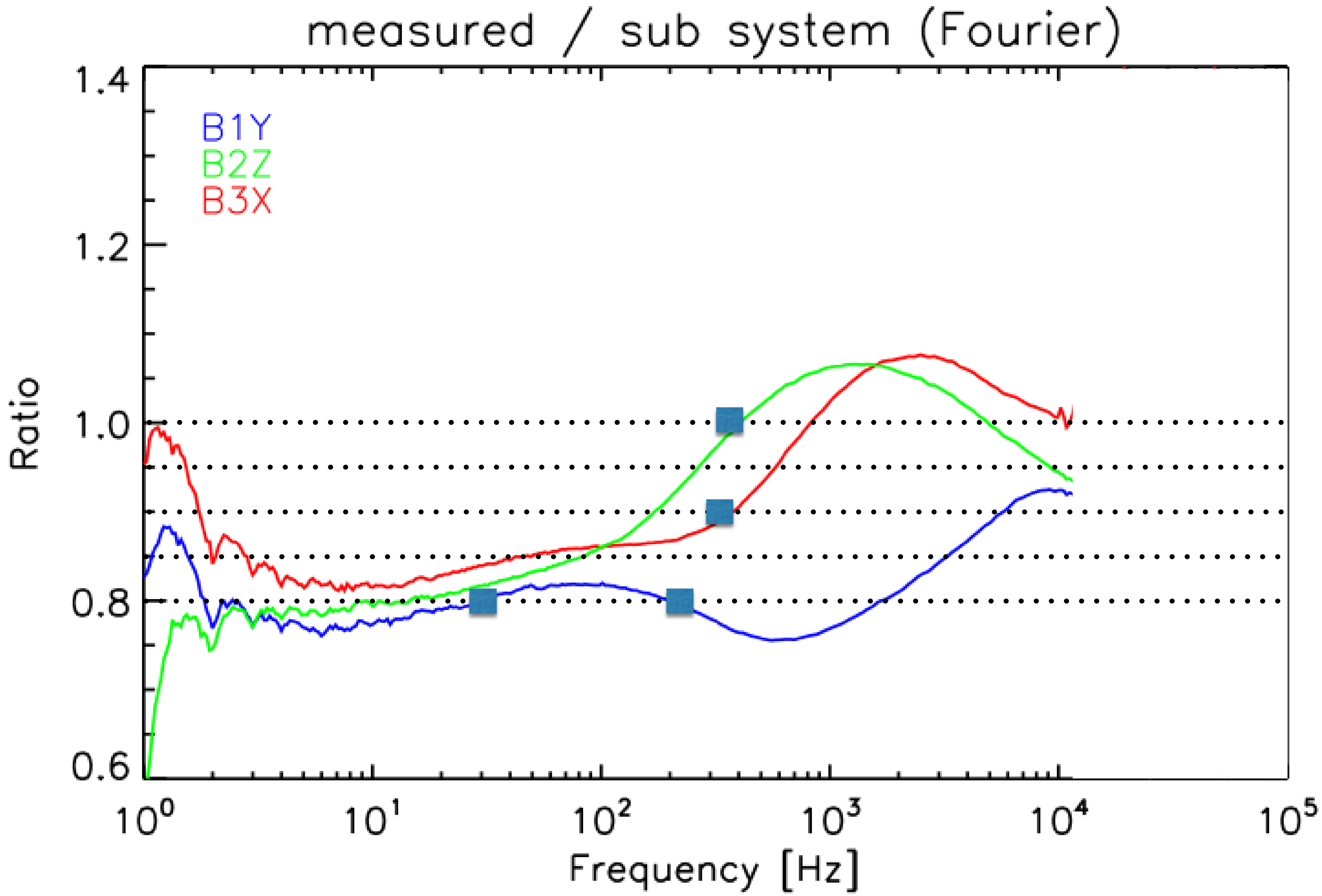
Calibration campaigns: Results on gain

- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » changes between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

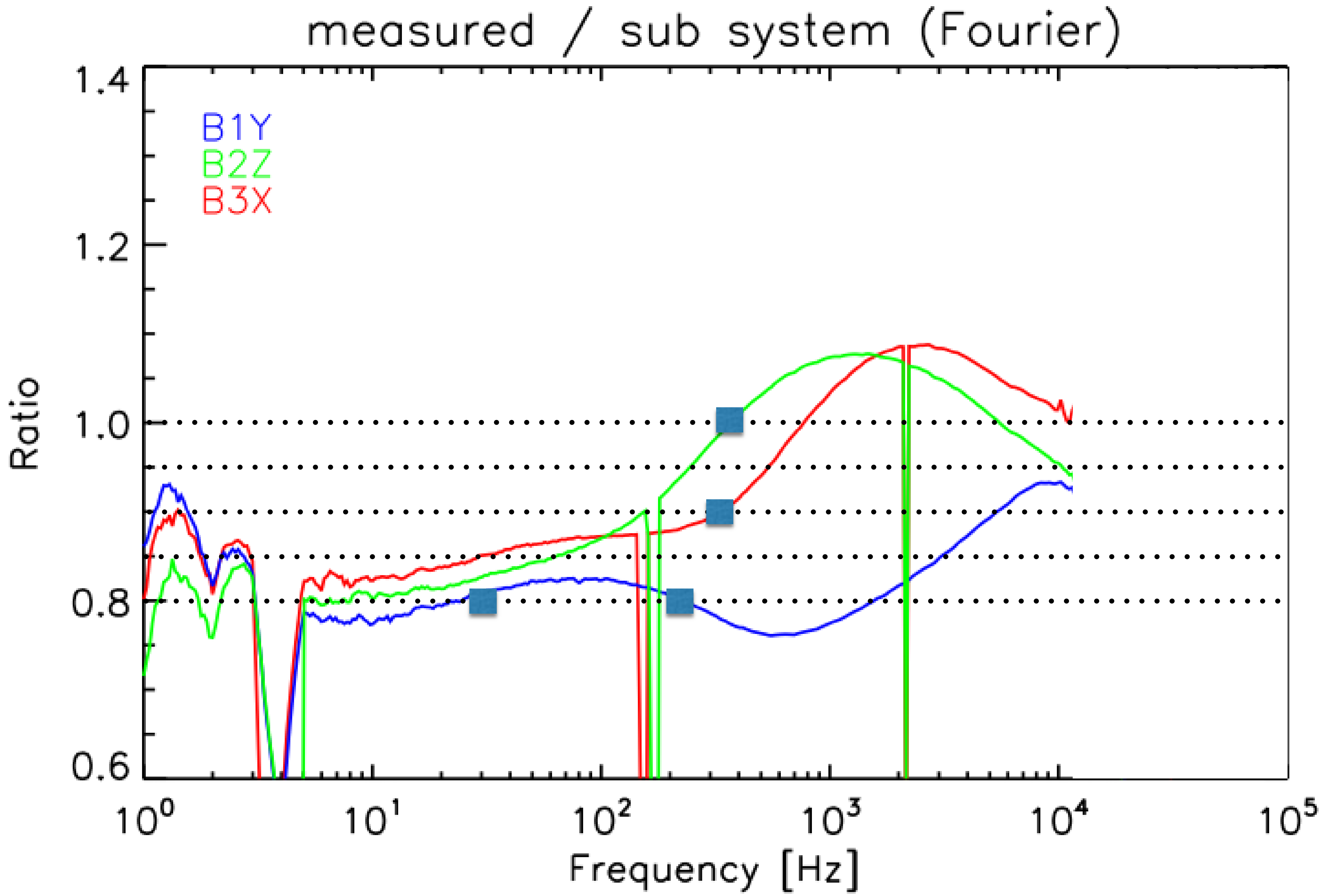
EM, M+20_P-50_S-50_H+20



EM, M-20_P+20_S-50_H+20



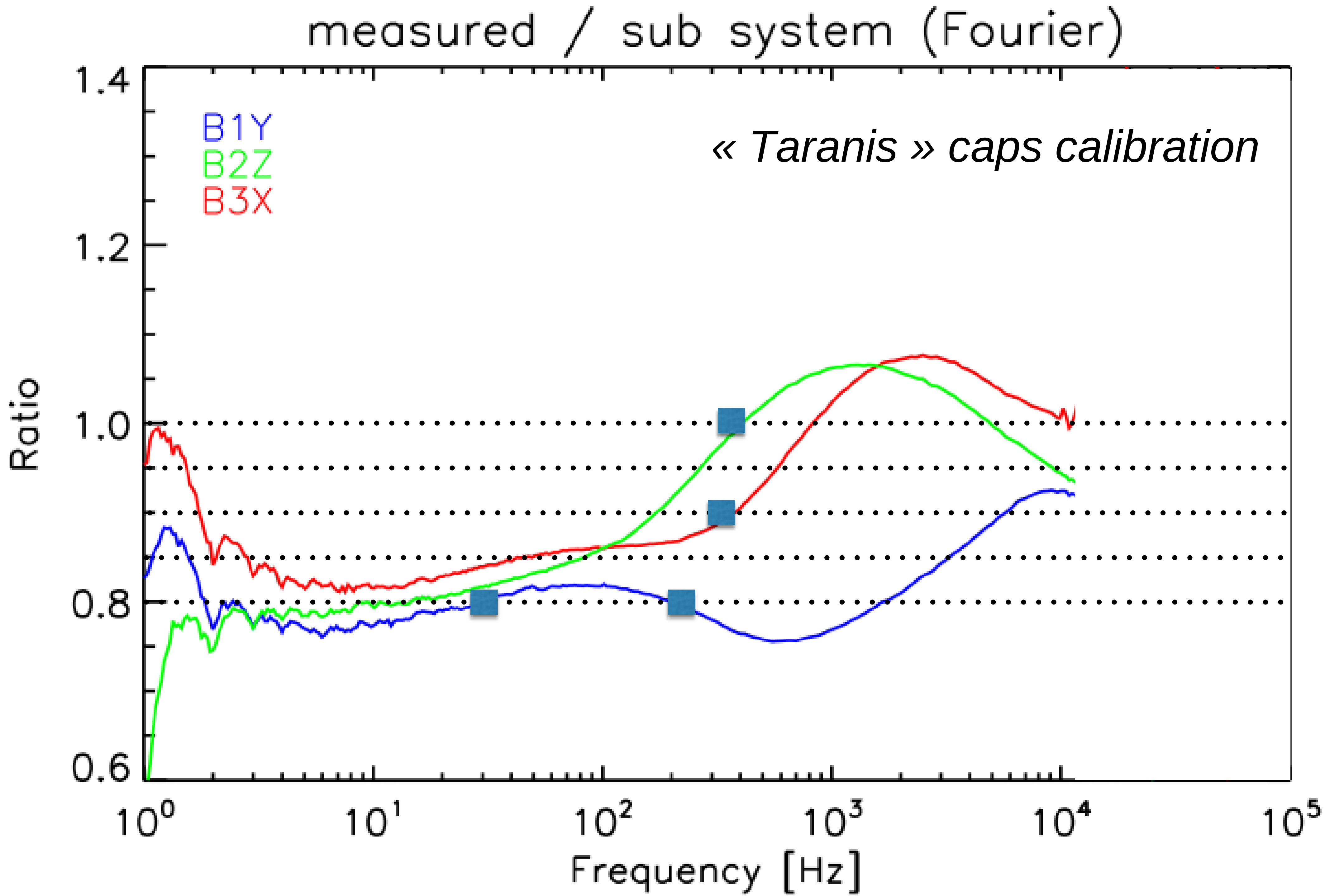
EM, M+50_P+20_S-50_H+20



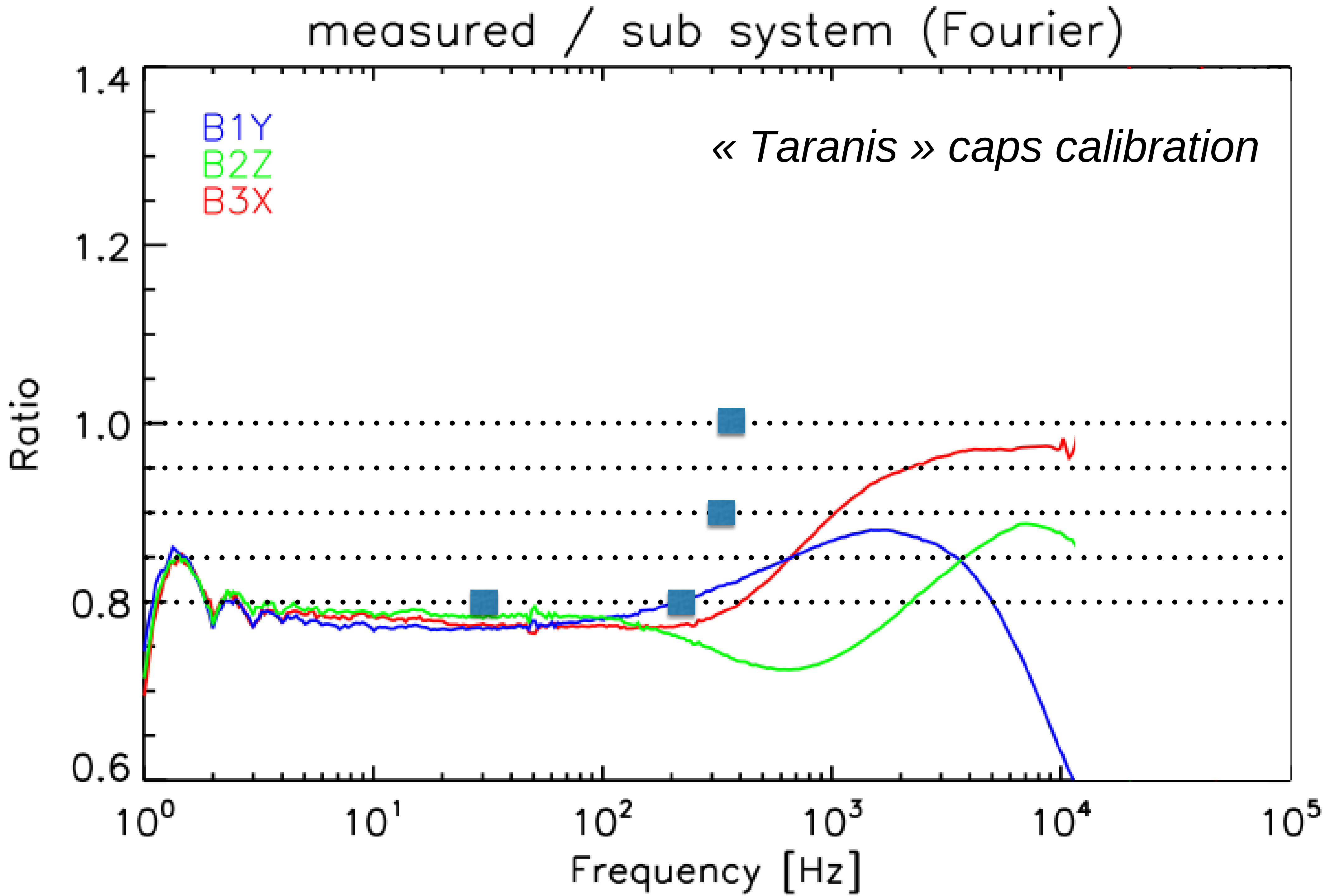
Calibration campaigns: Results on gain

- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » changes between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

EM, M-20_P+20_S-50_H+20



FM, M-20_P+20_S-50_H+20

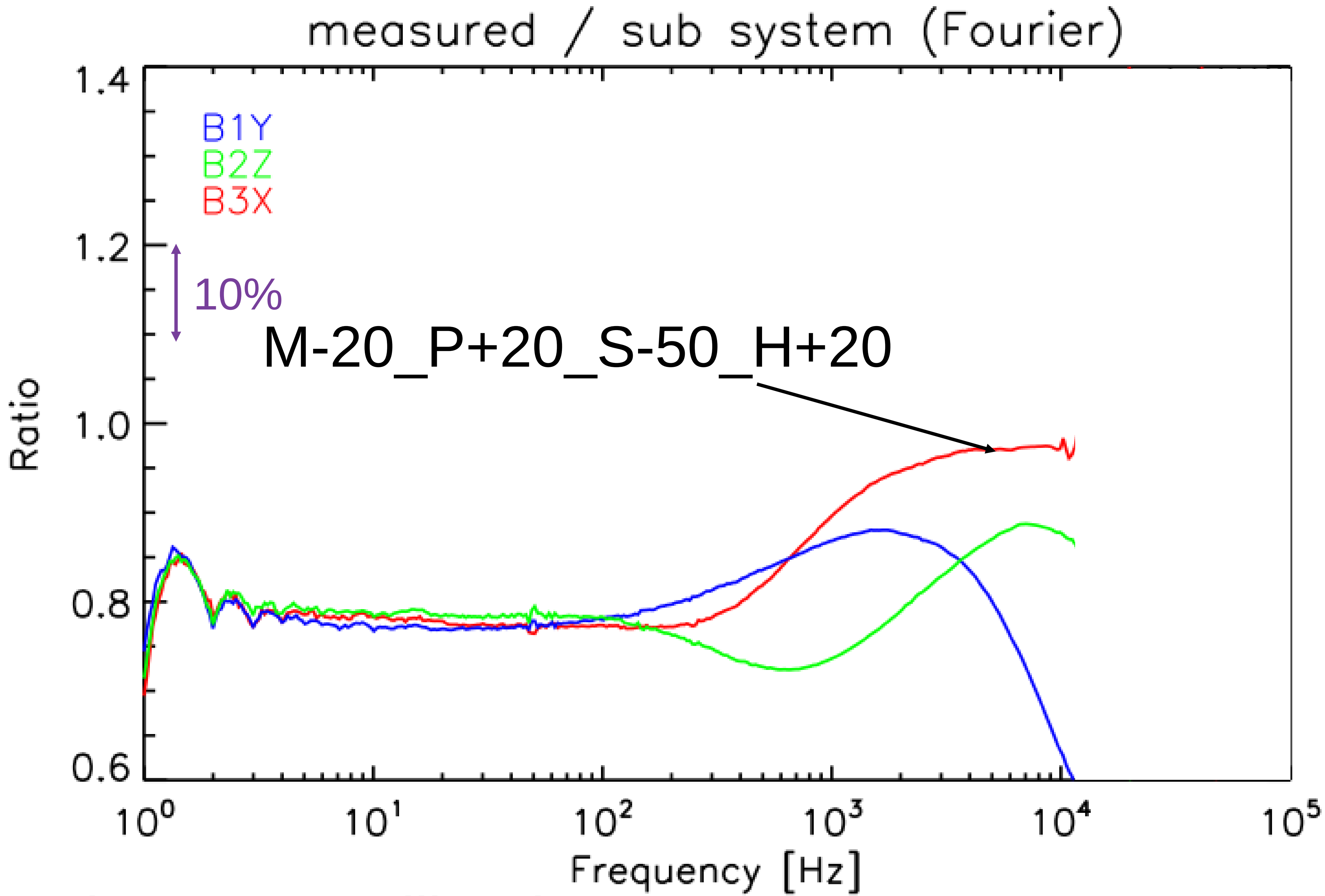


- « Eye » changes between EM and FM..
- More flat below 100Hz.
- By/Bz Antenna ambiguity to clarify

Calibration campaigns: Results on gain

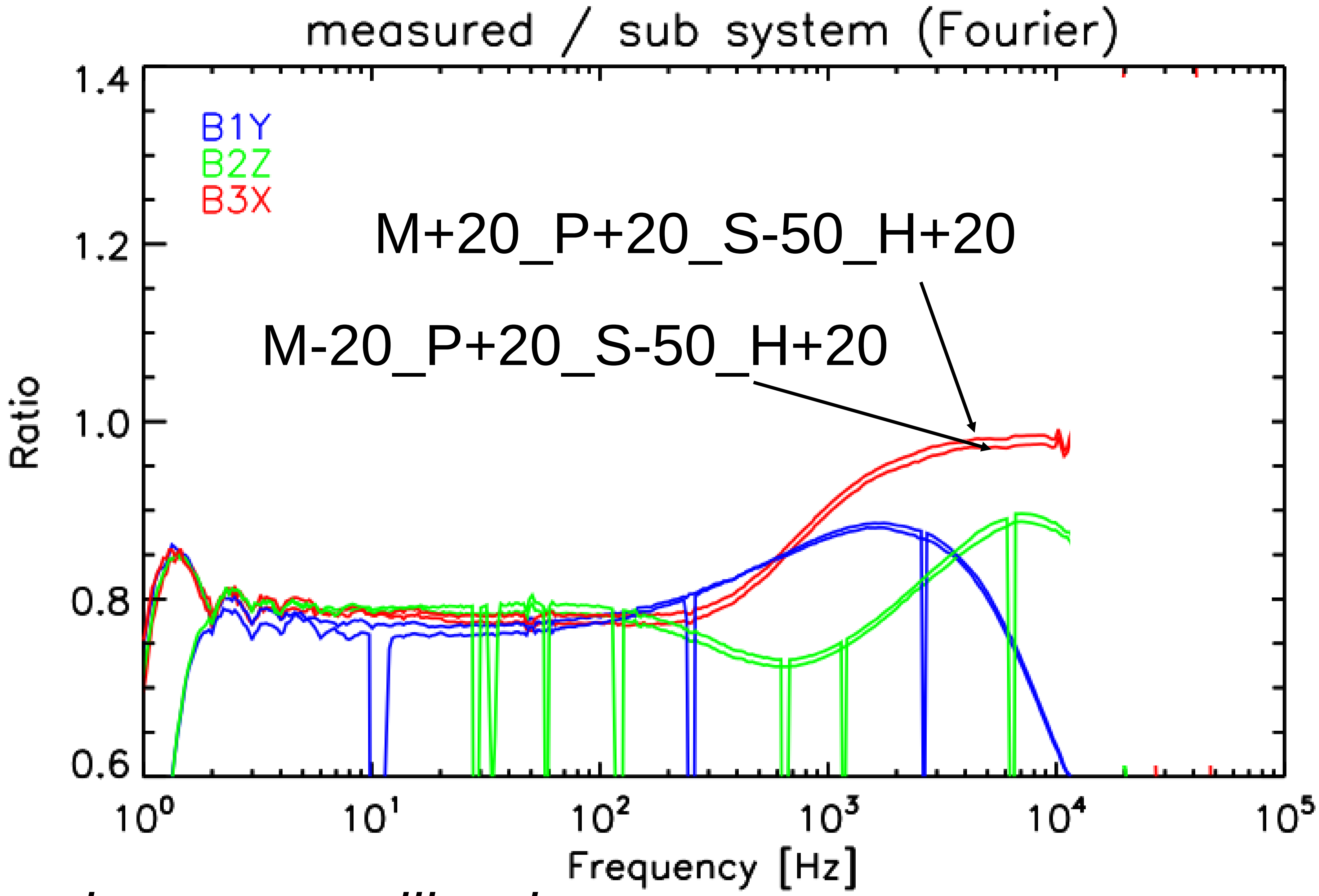
- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » change between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

FM, M-20_P+20_S-50_H+20



« Taranis » caps calibration

FM, M+20_P+20_S-50_H+20



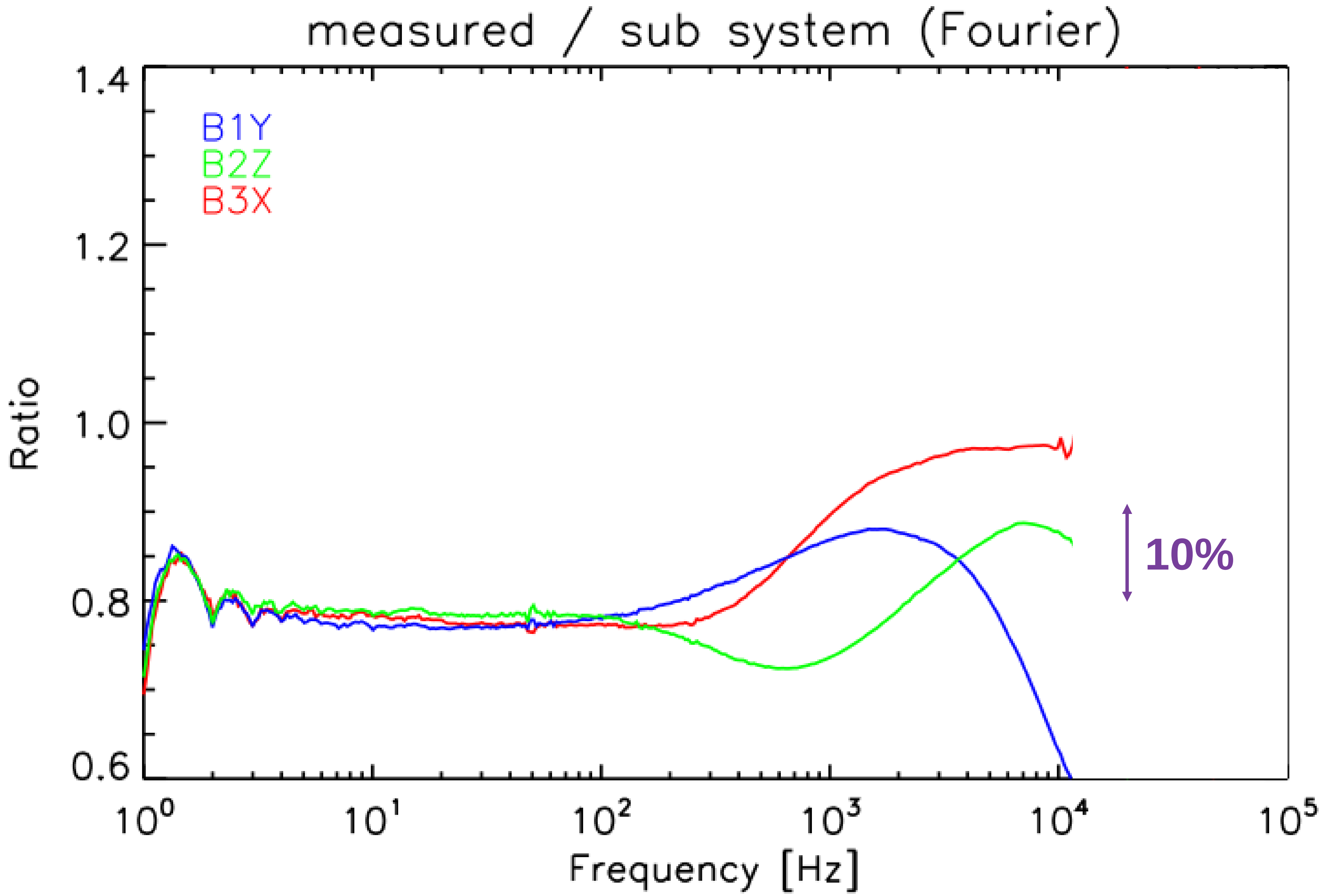
« Taranis » caps calibration

→ few % temperature change for FM..

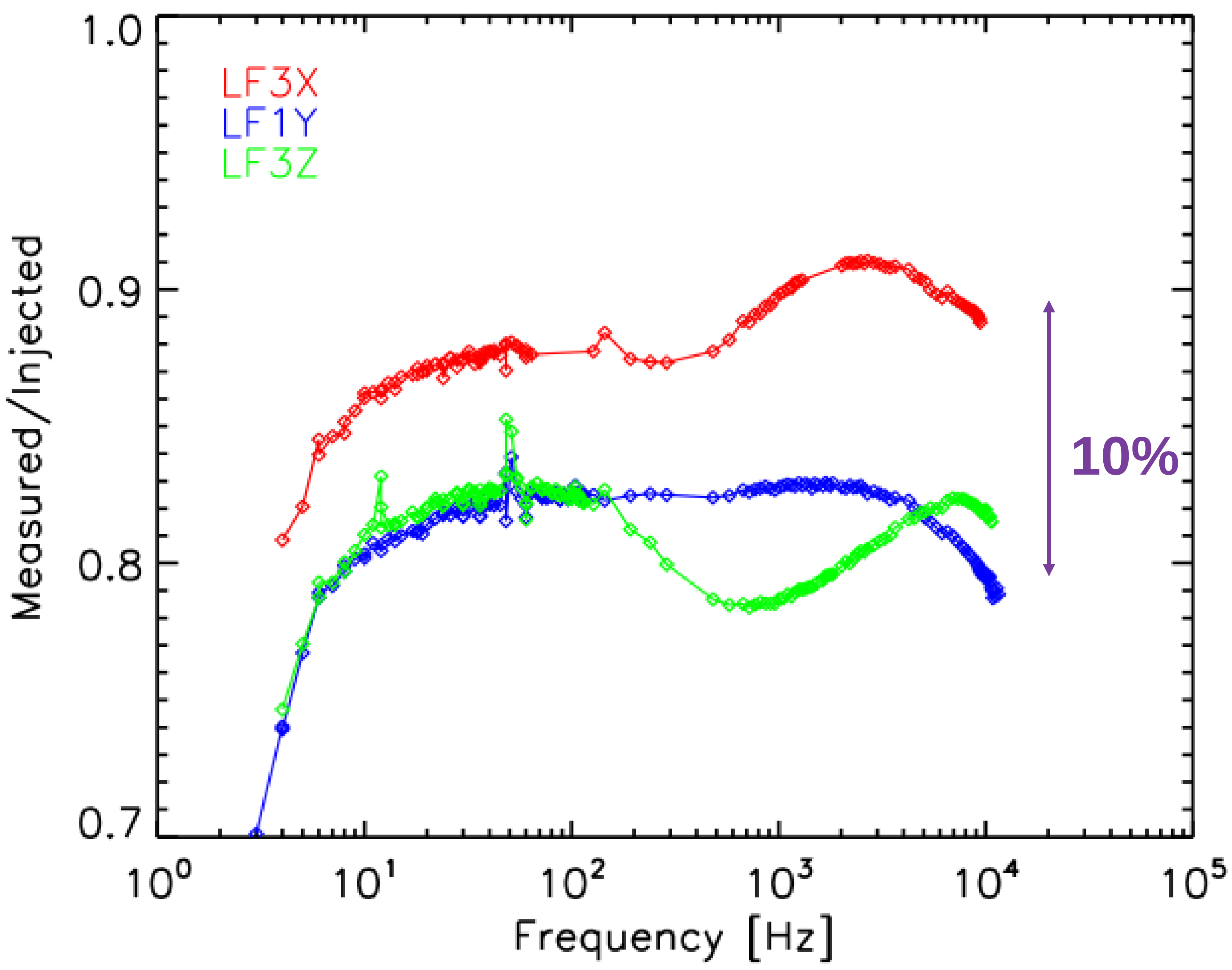
Calibration campaigns: Results on gain

- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » change between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

Sweep injected on 3 antenna together

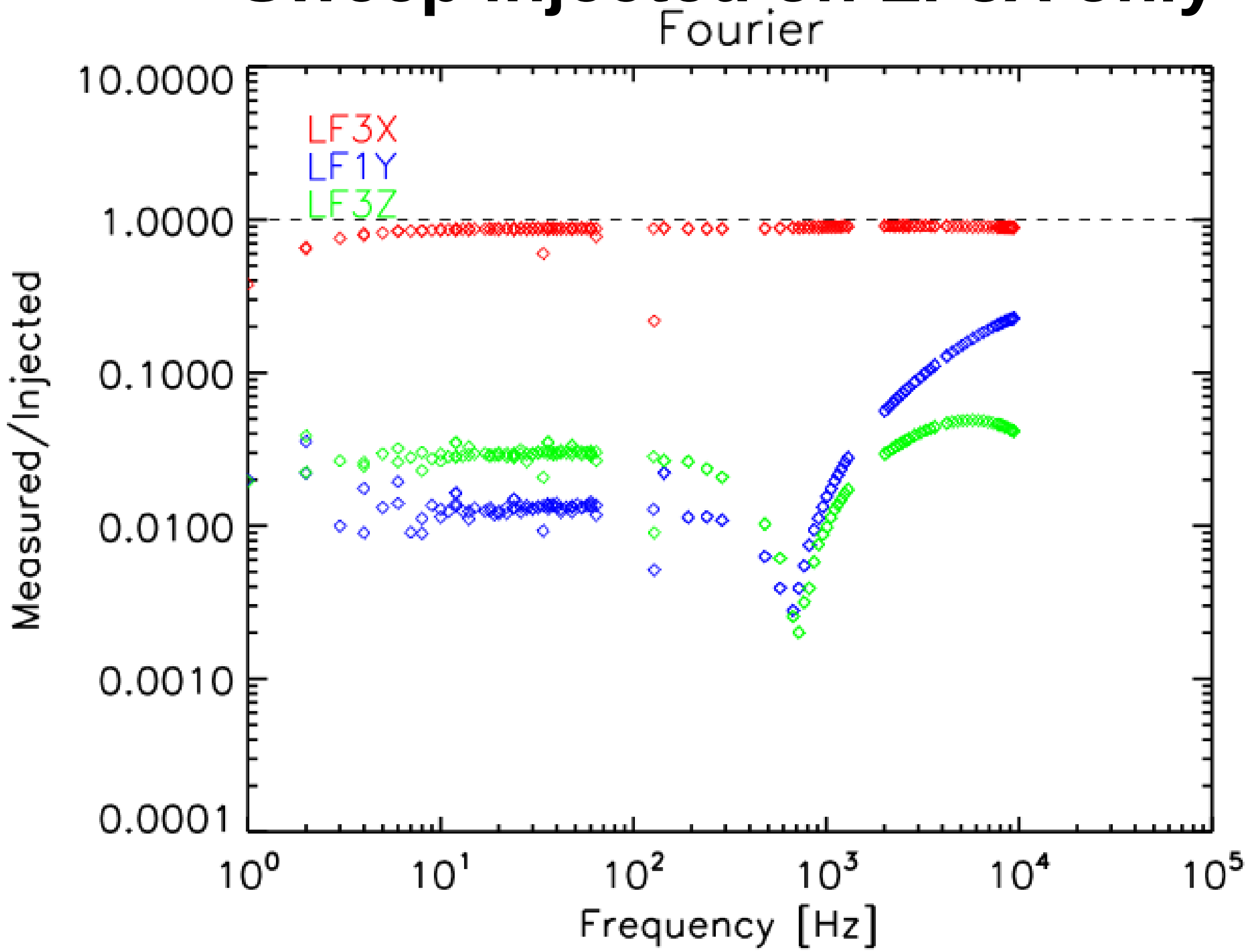


Sweep injected on each antenna separately

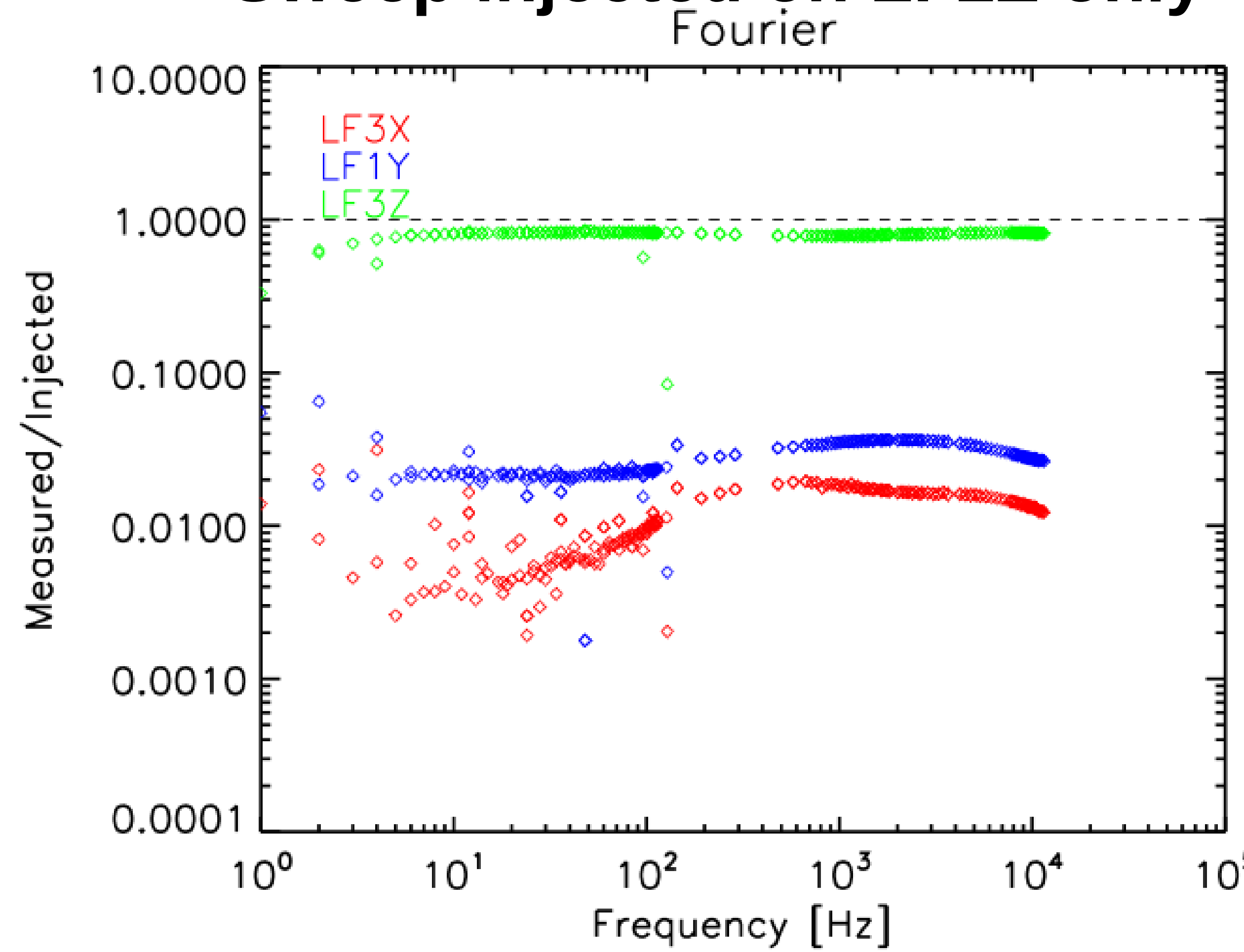


Made with caps deduced from FM.

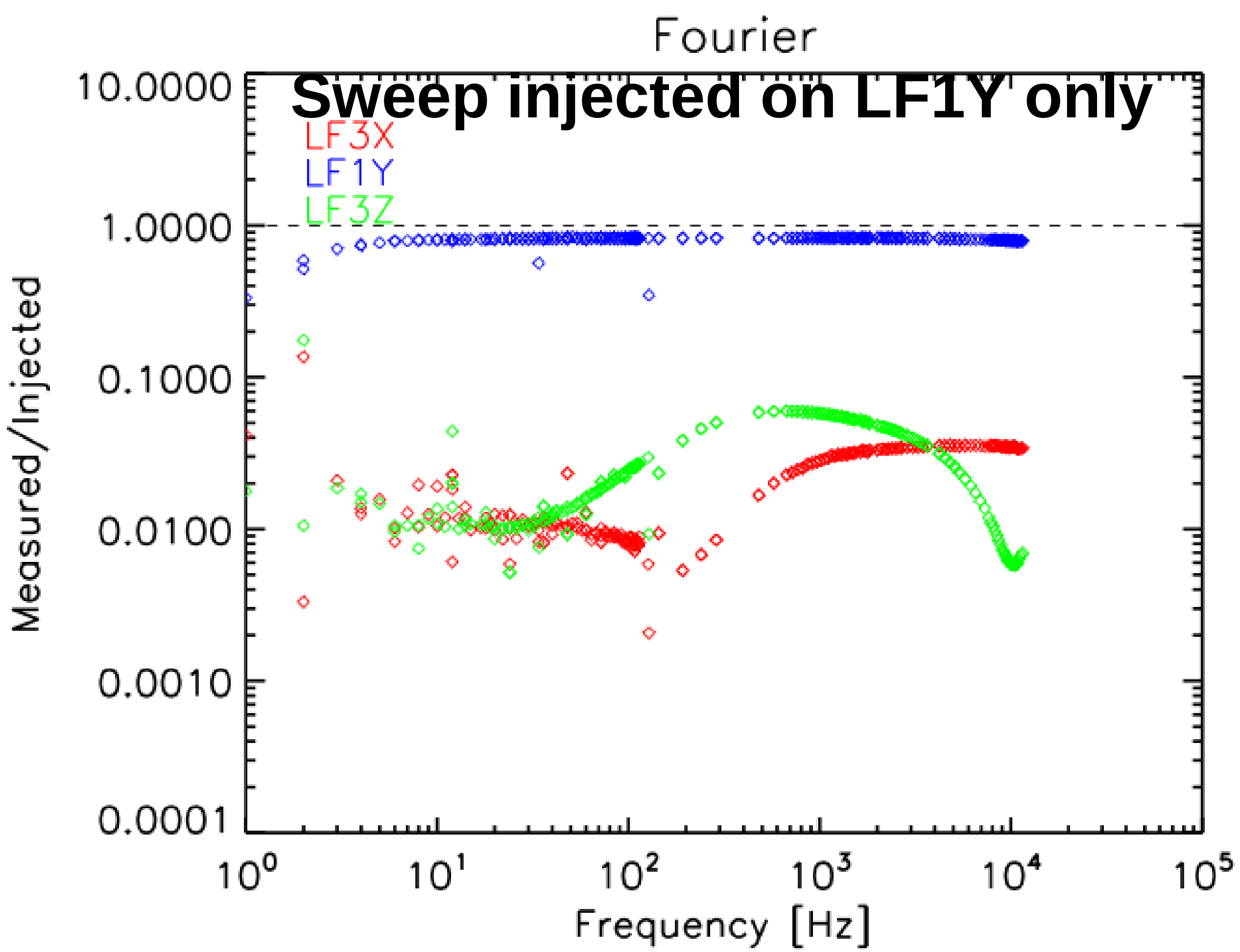
Sweep injected on LF3X only



Sweep injected on LF2Z only



Sweep injected on LF1Y only

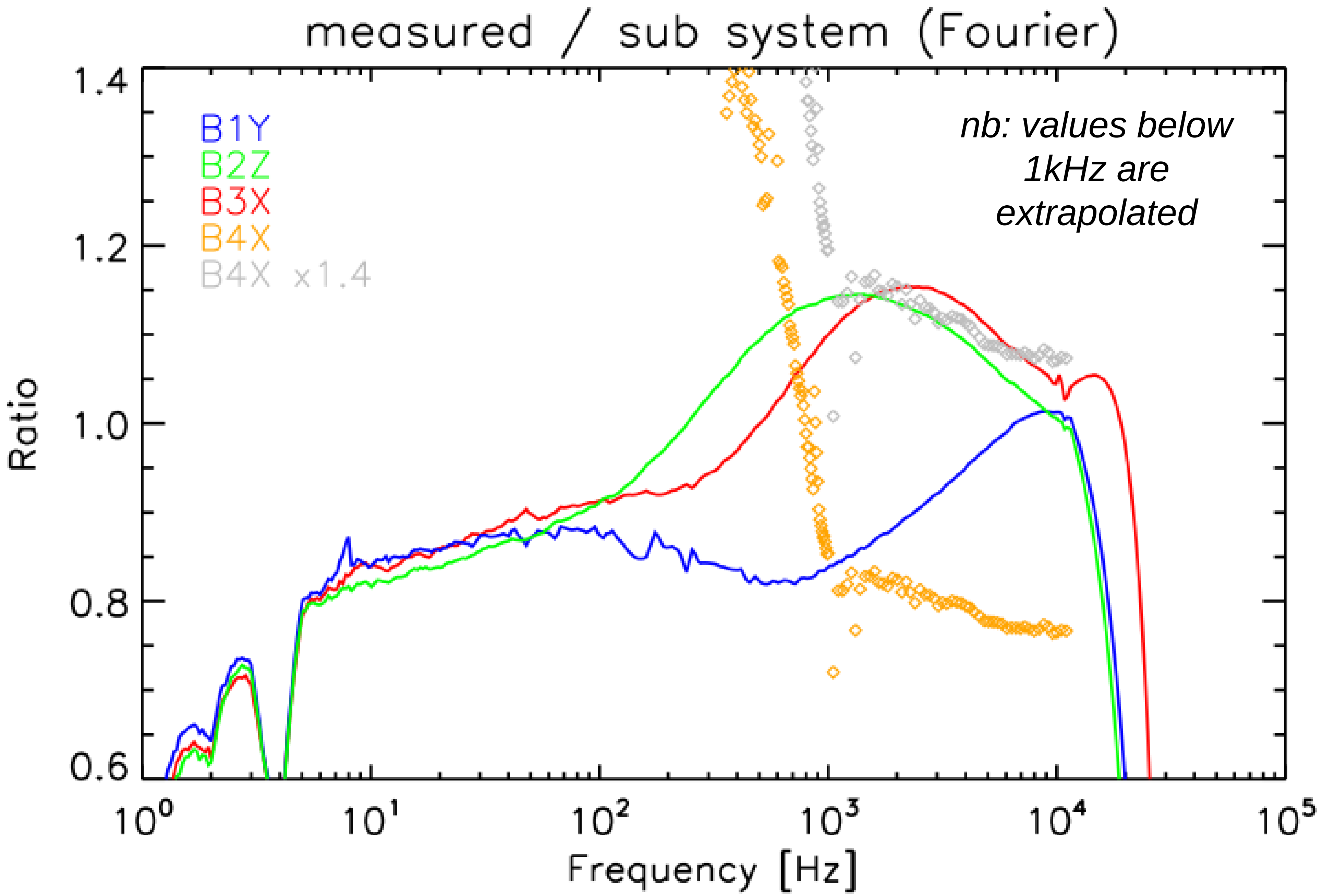


- Large influence of Bx on By and (less) Bz
- <3% influence of Bz on Bx and By
- <10% influence of By on Bx and Bz

Calibration campaigns: Results on gain

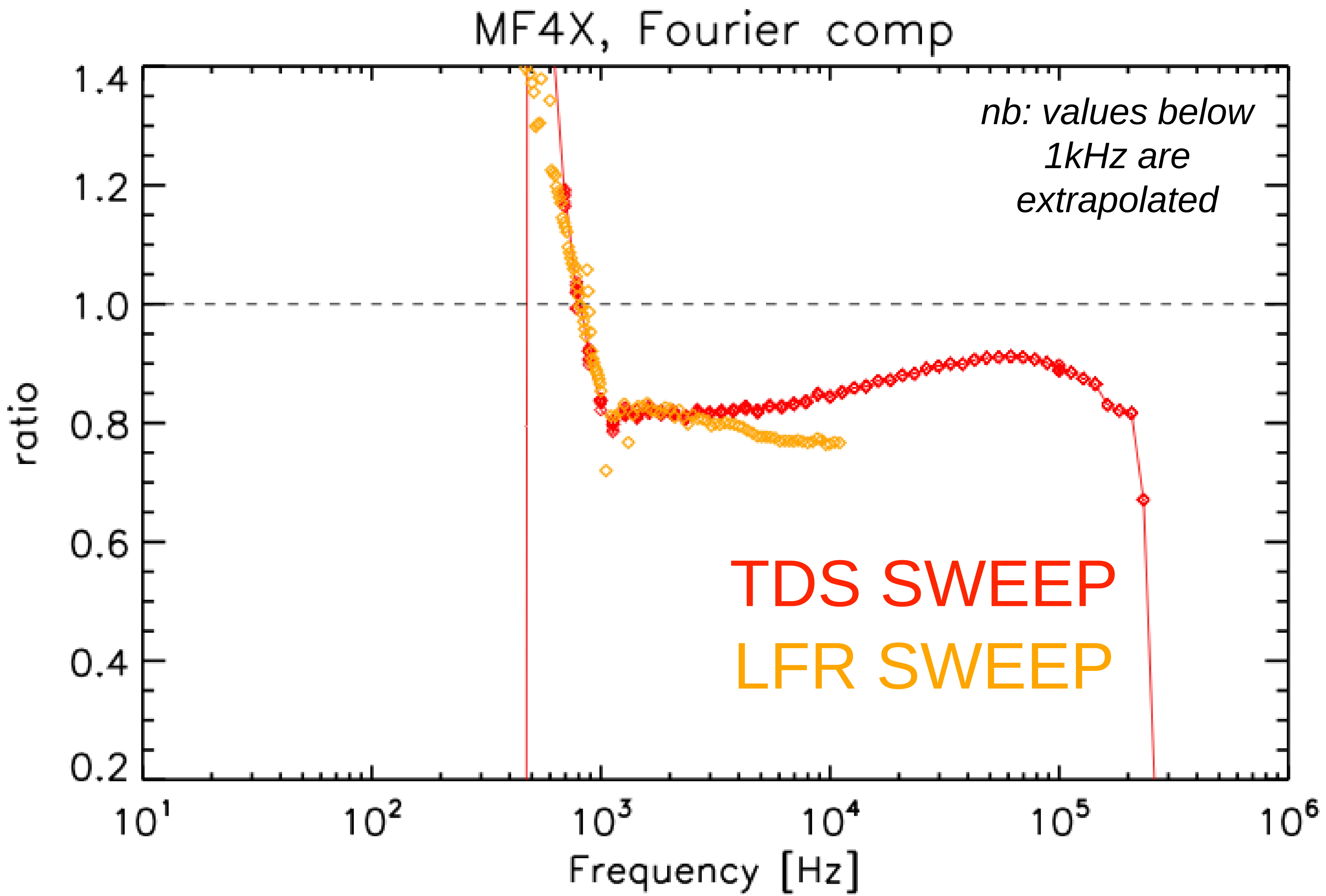
- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » change between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?

TDS Bx_mf / LFR Bx_lf comparison issue



Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain.

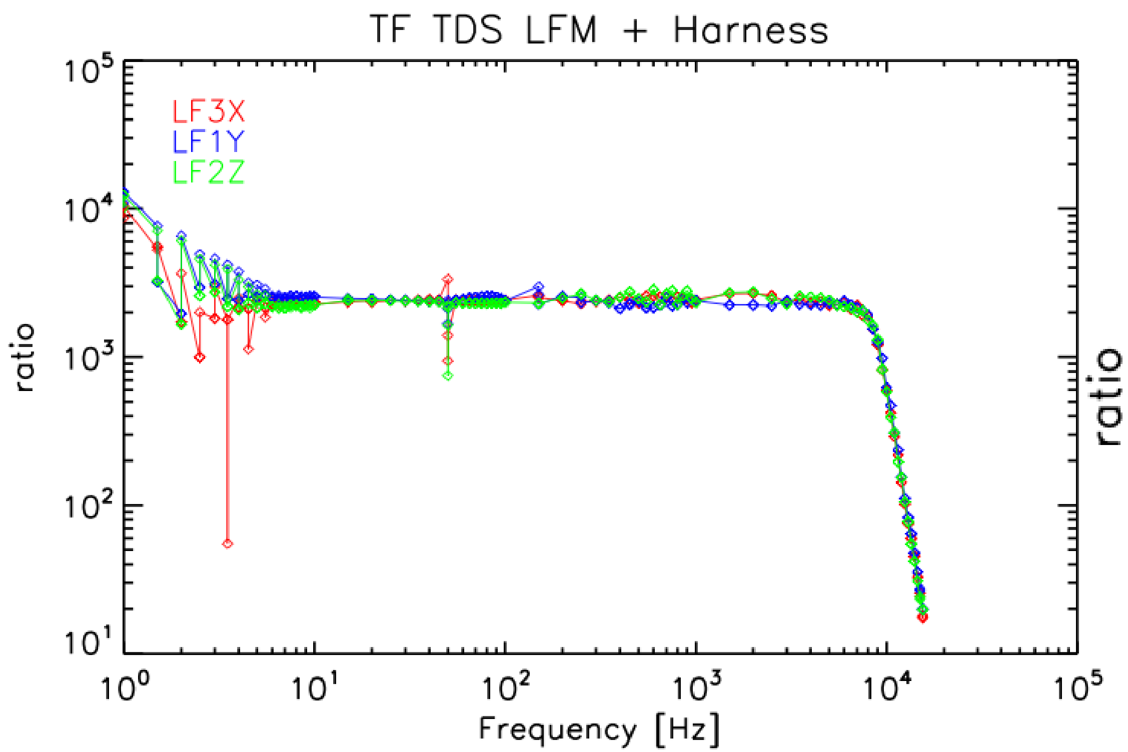
TDS B_xmf / LFR Bxlf comparison issue

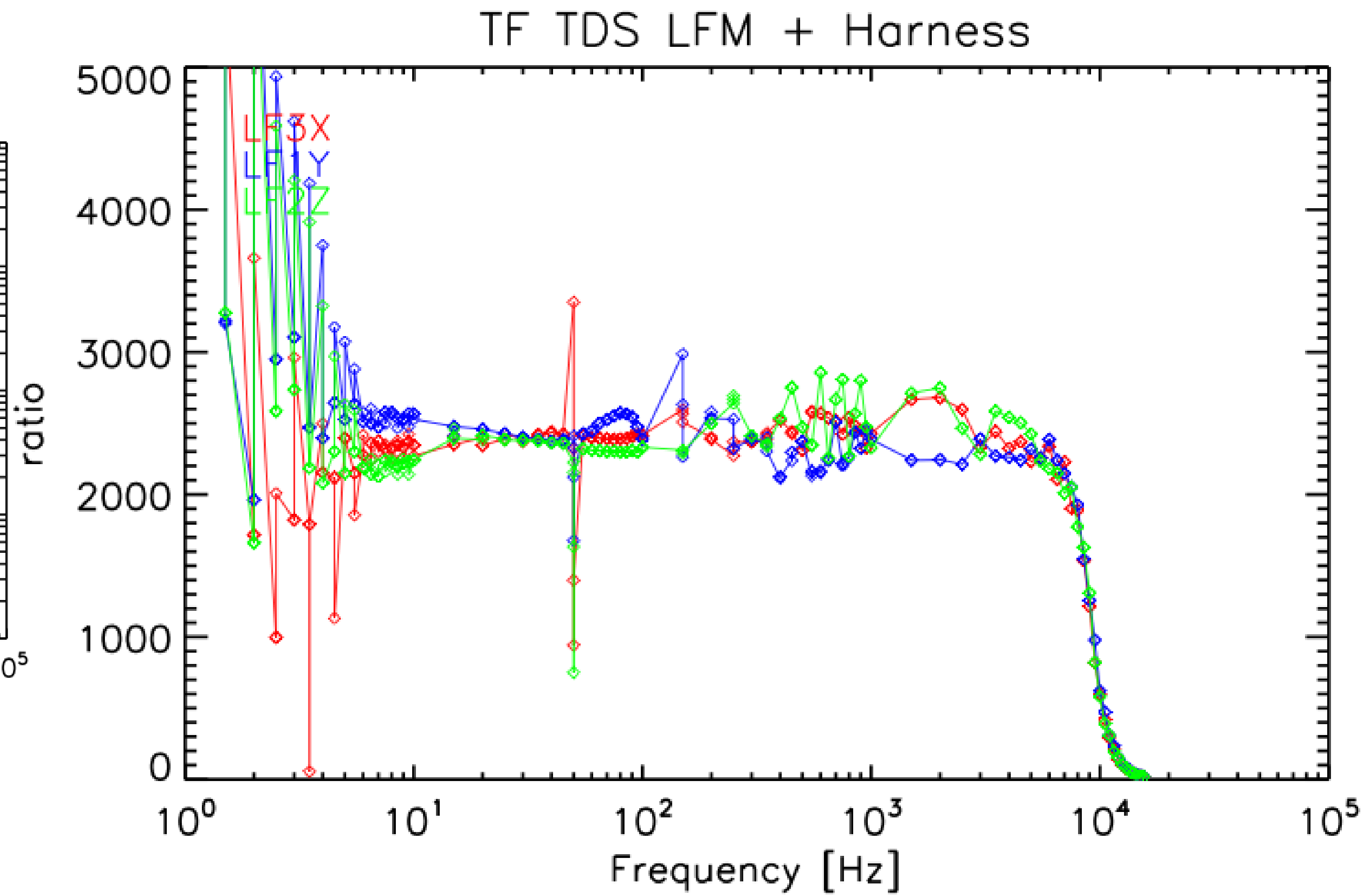


Bx_mf for LFR sweep and TDS sweep (kind of) agree.
B_xmf not (less) affected by others antenna ?

Calibration campaigns: Results on gain

- « Eye » figure on EM.
- Minor variations with temperature (a few %) seen on EM.
- « Eye » change between EM and FM..
- Minor variations with temperature (a few %) seen on FM. **TBC**
- Eye is largely reduced when the signal is injected on each antenna separately.
- Discrepancy with Bx_lf and Bx_mf for LFR sweep to explain. Not affected the same way by the other antennas/caps ?
- B_MF response has lower gain as measured with TDS_RSWF.
- TDS LFM sweep not exploitable.



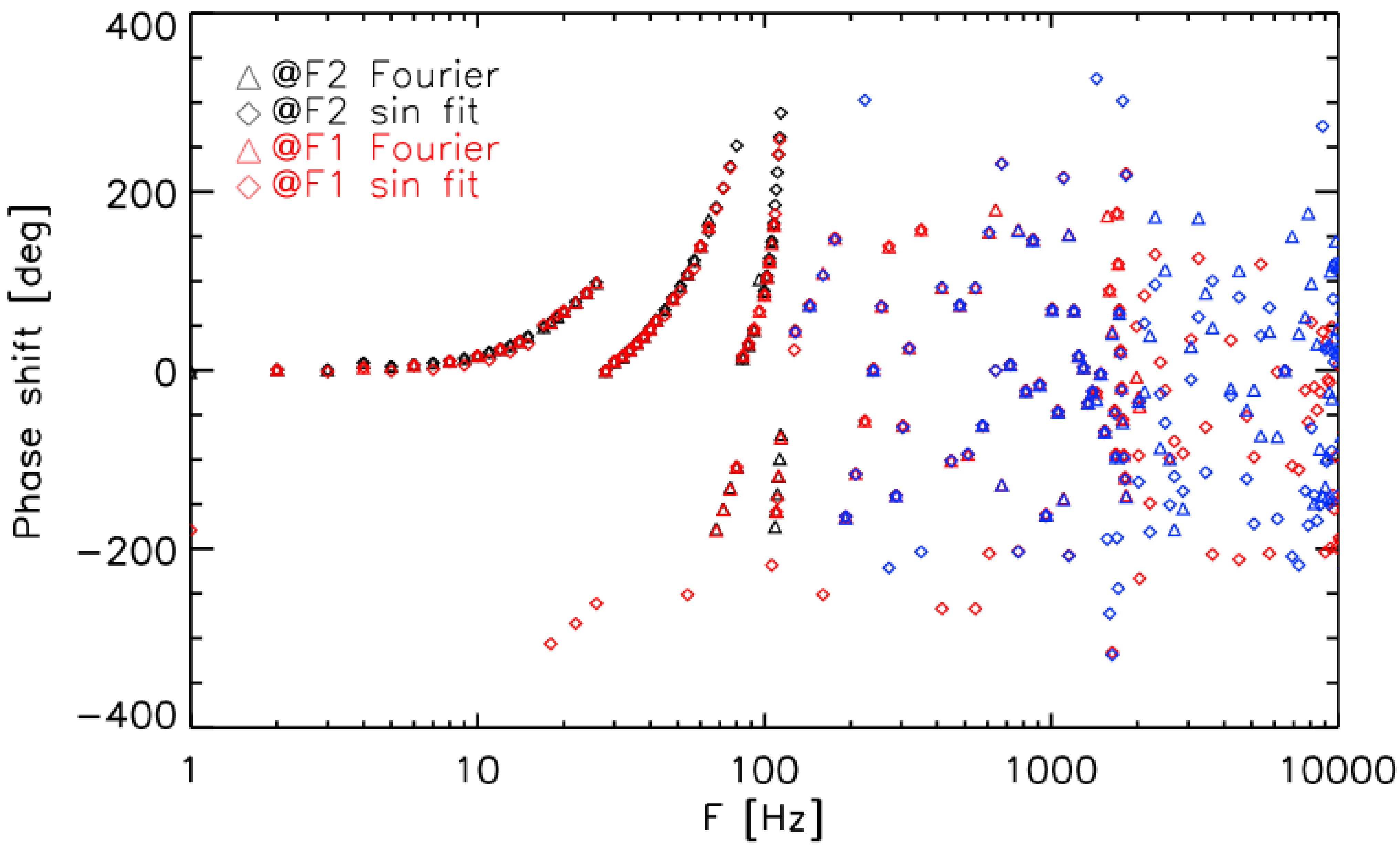


- TDS LFM sweep not exploitable, probably because injected frequencies are multiple of 50Hz.
- Eye probably present but too much noise to be quantify.
- To be corrected in April but will not be available in temperature.

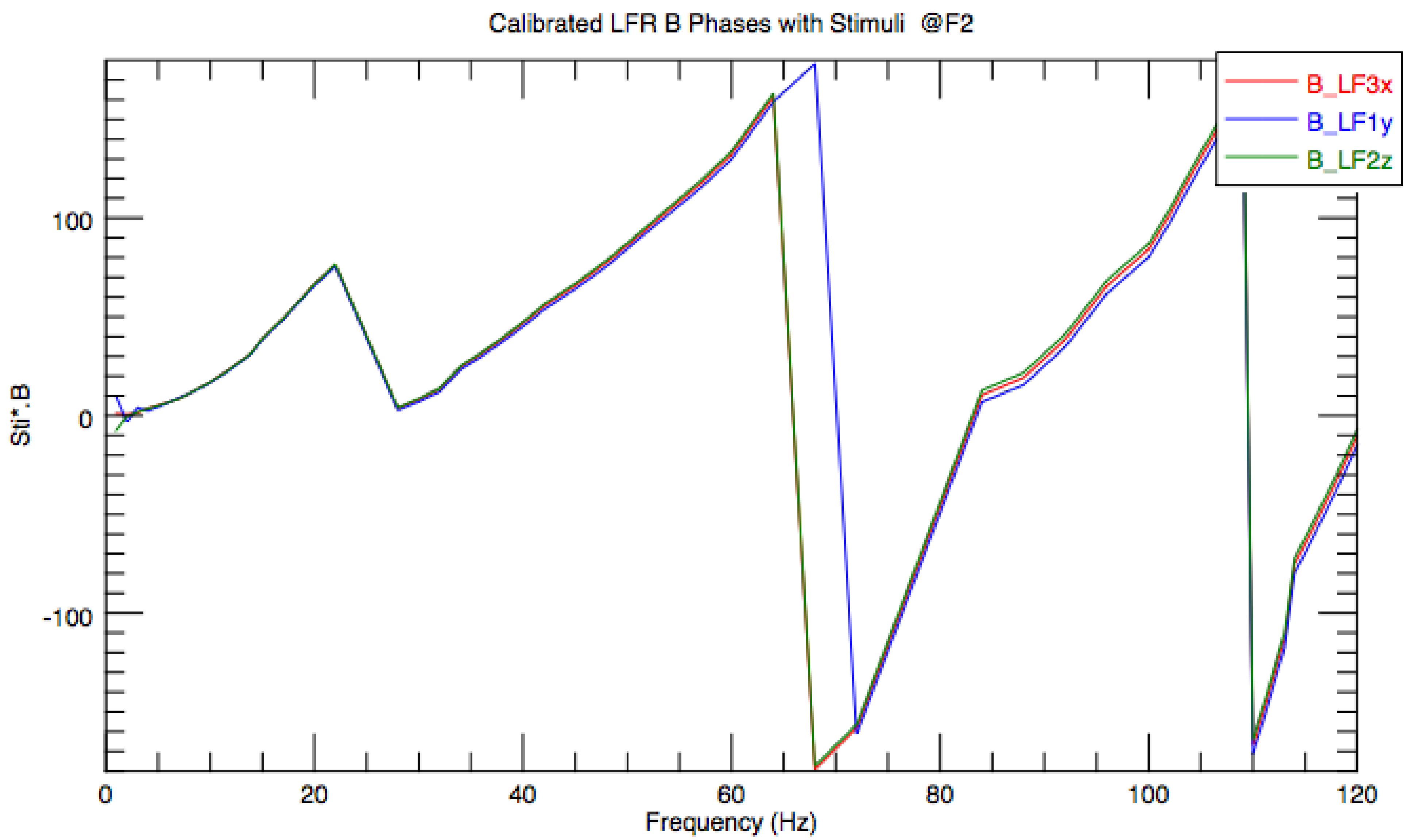
Calibration campaigns: Results on phase

- Unexpected phase shift when comparison between stimuli and observed waveform is made.
- Probable explanation: time drift of 20ppm between signal generator clock and RPW clock.

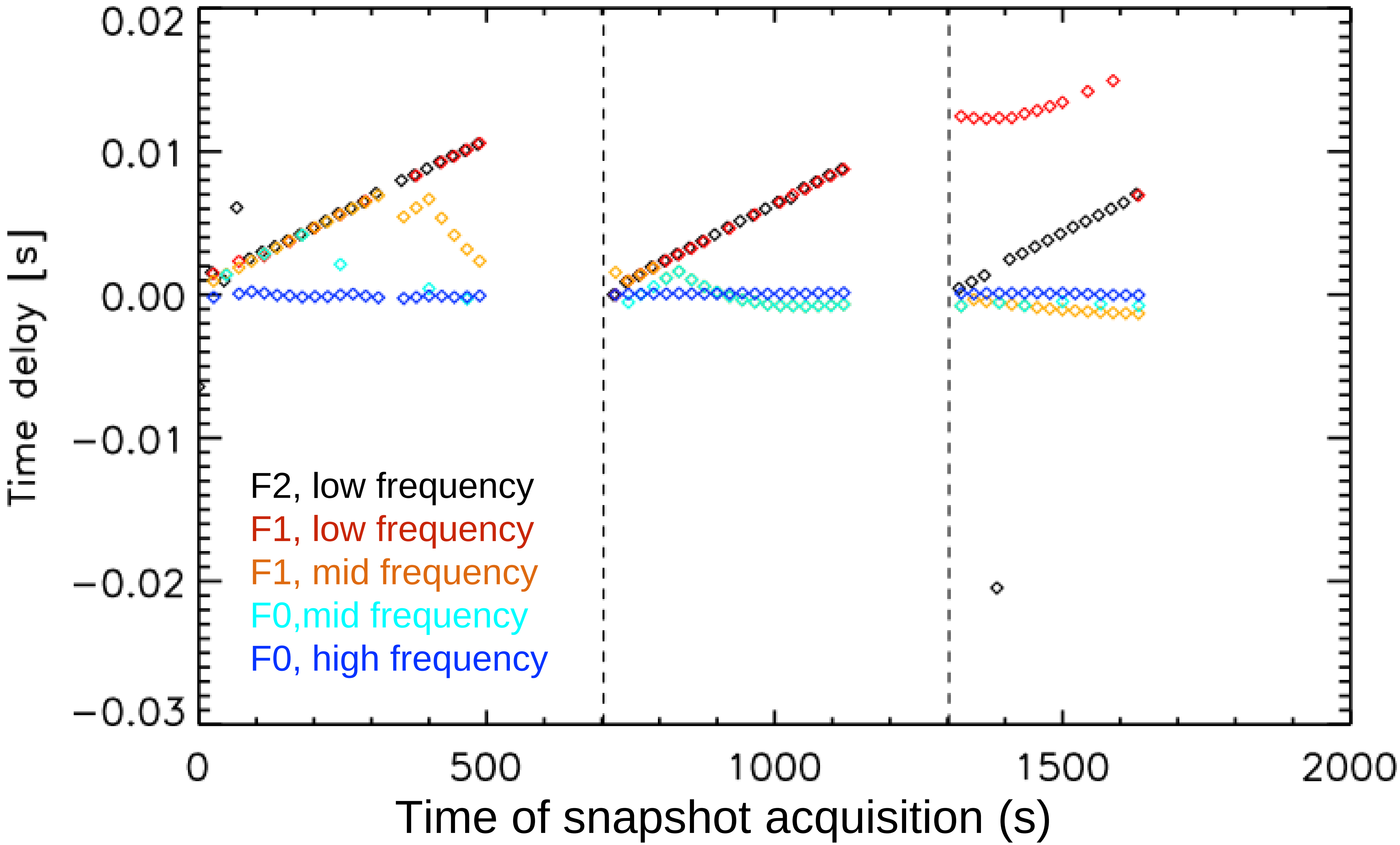
EM - LFR Sweep - Ambiant temp



➡Important phase shift at all frequency



➞Confirm by independent computation



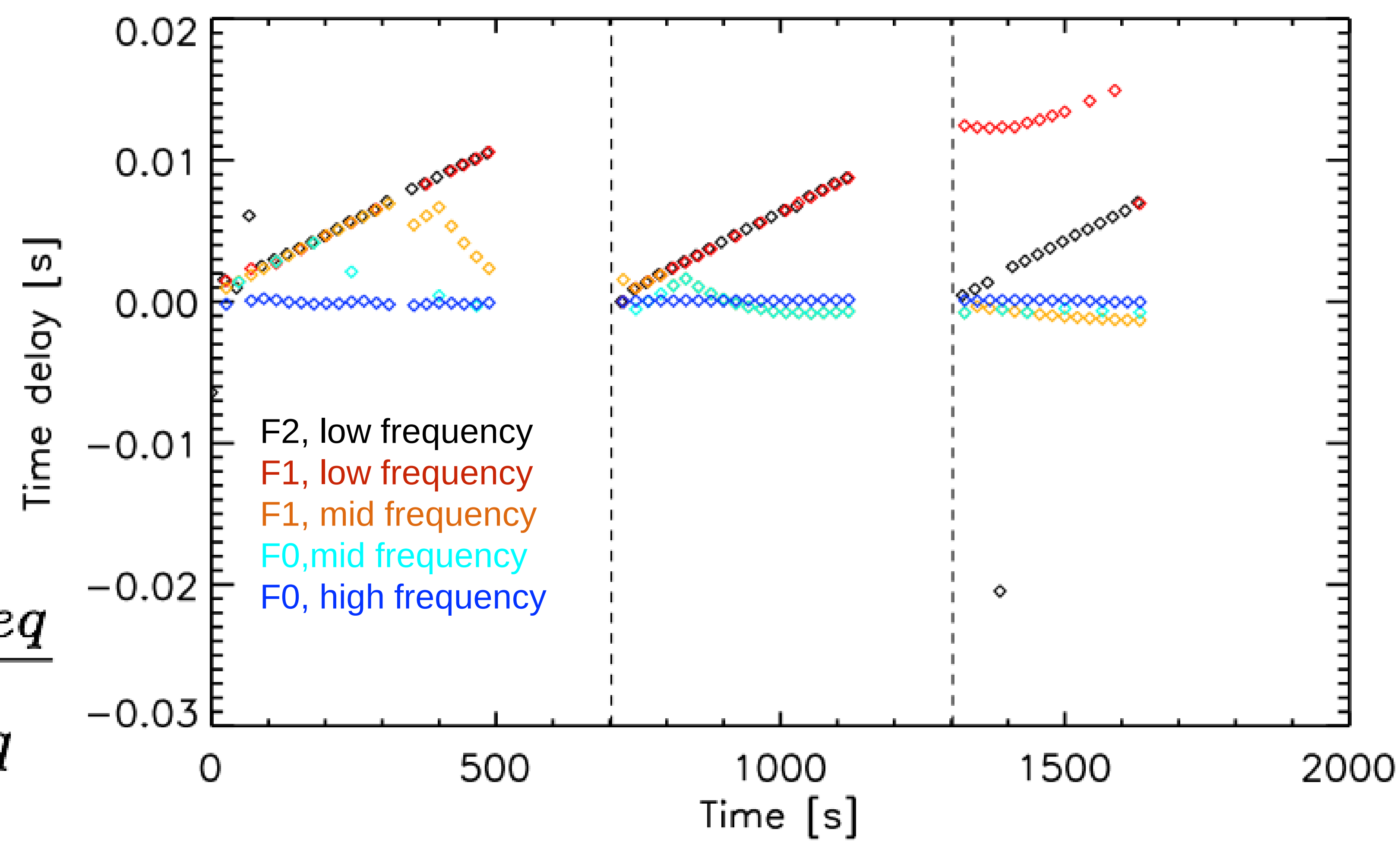
➡ Phase shift can be converted in time delay

➡ Trend is independent of frequency

➡ Looks like a time shift between clocks

- The slope gives a time drift of ~20 micro-s per s.

$$t = n\frac{1}{f_{eq}} \Rightarrow \Delta t = n\frac{\Delta f_{eq}}{f_{eq}^2}$$



- For 1s, $n=f_{eq}$: $\Delta t = n\frac{\Delta f_{eq}}{f_{eq}^2} = \frac{\Delta f_{eq}}{f_{eq}}$ $=20\ 10^{-6}$ s per second

- ***Needed error to explain the drift:***

- In **LFR**:
  - @F2: Delta_Feq= 0.005Hz
  - @F1: Delta_Feq=0.082Hz
  - @F0: Delta_Feq=0.49Hz
- on **EGSE sampling freq**: 2.18 Hz
- **Elsewhere**: Delta_T= 20 micro_s/s

Conclusion on campaign calibration (as of today)

- Gain does not appear to depend significantly on temperature - but this is to be confirmed !
- The eye figure does not allow to use the campaign calibration results to calibrate SCM data in gain for now.
  → Keep the possibility L1-> L2R -> L2S in calibration software (needed in anycase)
  → Investigate if this can be corrected.
- The time drifts between clocks does not allow to use the campaign calibration results to calibrate SCM data in phase for now.

→ More work is needed to conclude on this

Software responsibilities for waveform data.

- Previously agreed (with involved RH)
  - Analysers: L1 -> L2R, SCM: L2R-> L2S

- Changes in responsibilities imply changes in Human ressources and must be approved by the labs and the CNES.

- We discussed internally (LPC2E) the possibility to perform the calibration of waveform data products from L1 directly.

Software responsibilities for waveform data.

- Calibration sub-system per sub-system (L1 -> L2R -> L2S) is compulsory :
  - campaign results (Transfer function) must be validated by sub-system calibration, at least at ambiant temperature.
  - On-flight calibration investigation requires such a scheme.

→ A software L1-> L2S must be able to apply sub-system transfer function individually as well as global transfer function.

→ Depending on parameters, this can be very complex.

→ **A software L1-> L2S must be able to apply sub-system transfer function individually as well as global transfer function.**

1. *Required from analysers teams:*
   - The transfer functions (**including time delays**) for all relevant analyser configuration (with dependency on analysers parameters such like acquisition frequency, multiplexers,…)
   - The relevant documentation.
   - To be delivered to LPC2E and CNES at a date to be fixed.

2. *Required from the consortium.*
   - A list of parameters determining the global transfer function to use and the relevant transfer function, for each parameters combination.
   - Example: Temp(SCM), LFR(@F2), B1(FM) → global-TF gains and phases

3. *Transfer function are gains and **phases** responses.*

→ Anticipated Relevant parameters for global transfer function

1. SCM Antenna

2. LFR
   - Antenna.
   - acquisition frequency.

3. TDS: unkwnown (antenna, multiplexers, modes, … ?)

4. Temperature**s** (MEB, Harness, SCM)
   - Might not be relevant for calibration in Gain. Unknown for calibration in phase.
   - It appears unprovable that we will have usable global transfer functions for all temperatures and configuration.
   - If the calibration procedure depends on temperatures, these temperatures must be present in the RPW magnetic waveform L1 product.

- Example: 3 SCM antenna, 4 LFR acquisition frequencies, 4 temperatures -> **48 global transfer functions !**

Software responsibilities for waveform data.

- LPC2E might (TBC internally after the meeting) agree to perform L1-> L2S calibration **if**

  → The sub-system and global transfer function for each combination of relevant parameters are delivered with documentation by the consortium to LPC2E and CNES.

  → We need increased human ressources for this (optional 3rd year of IR needs to be accepted).

  → Coordination (ROC or CNES) is needed.

Thank you