TDS calibration update

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Delta calibration data analysis (Apr-June 2017)

**Two issues discovered during December 2016 calibration:**

- Strange noise in LFM SCM data
  - Attributed to 50 Hz harmonics
  - New set of sweep frequencies designed for delta calibration.
- No phase synchronization in HF frequency sweeps
  - *Attempted solution:* AWG sweeps = frequency sweeps executed with EGSE phase synchronized to allow determination of absolute phase

TDS HF sweeps

- AWG sweep data clean.
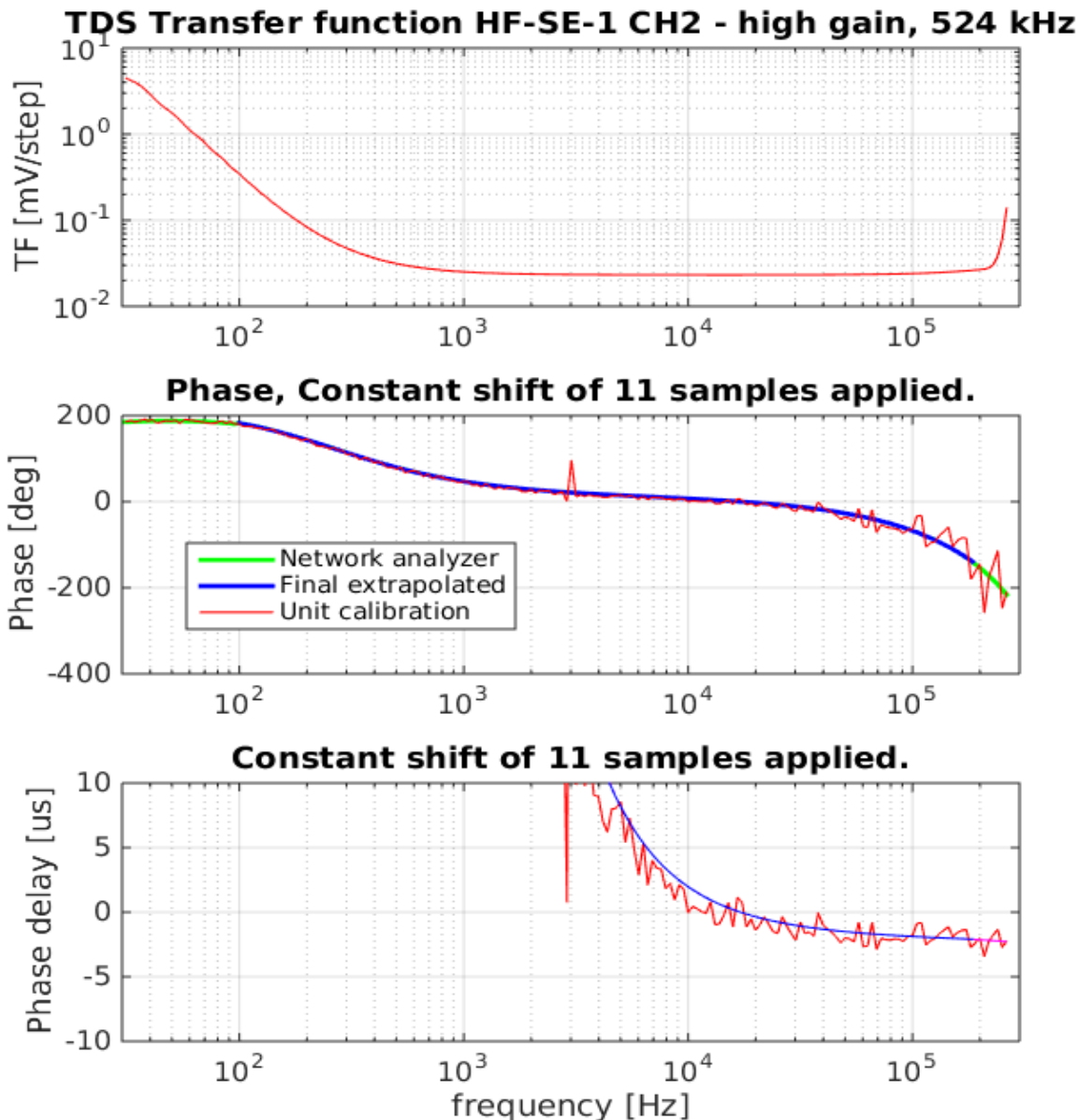- Relative gain/phase between channels looks good.
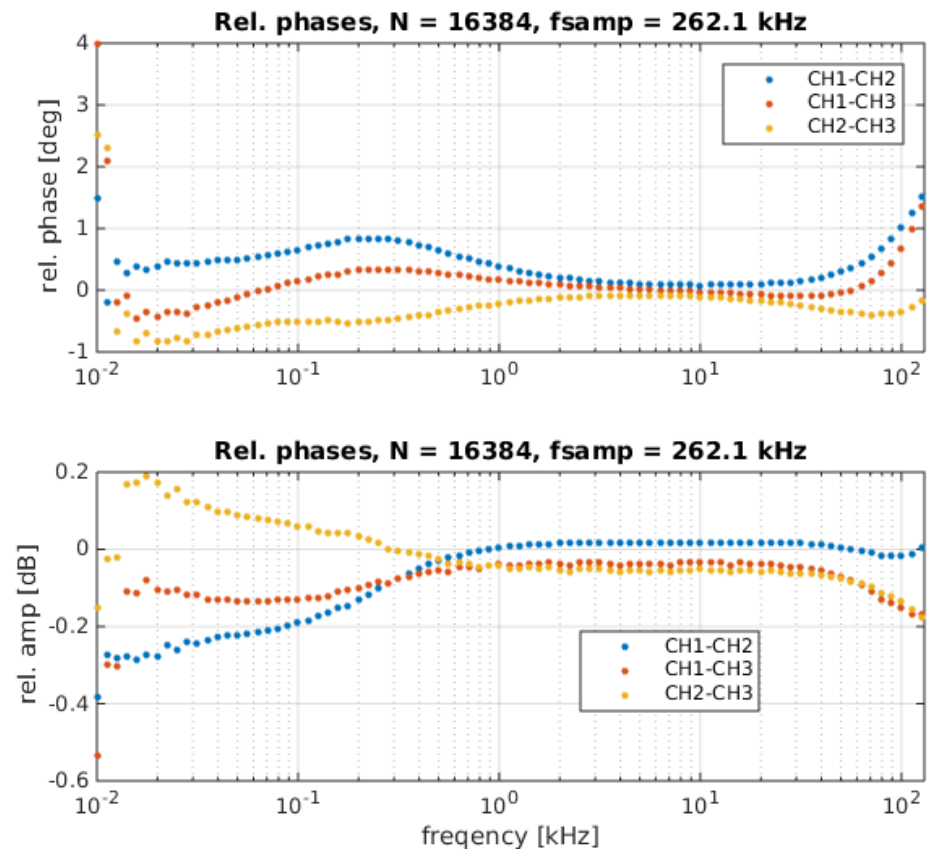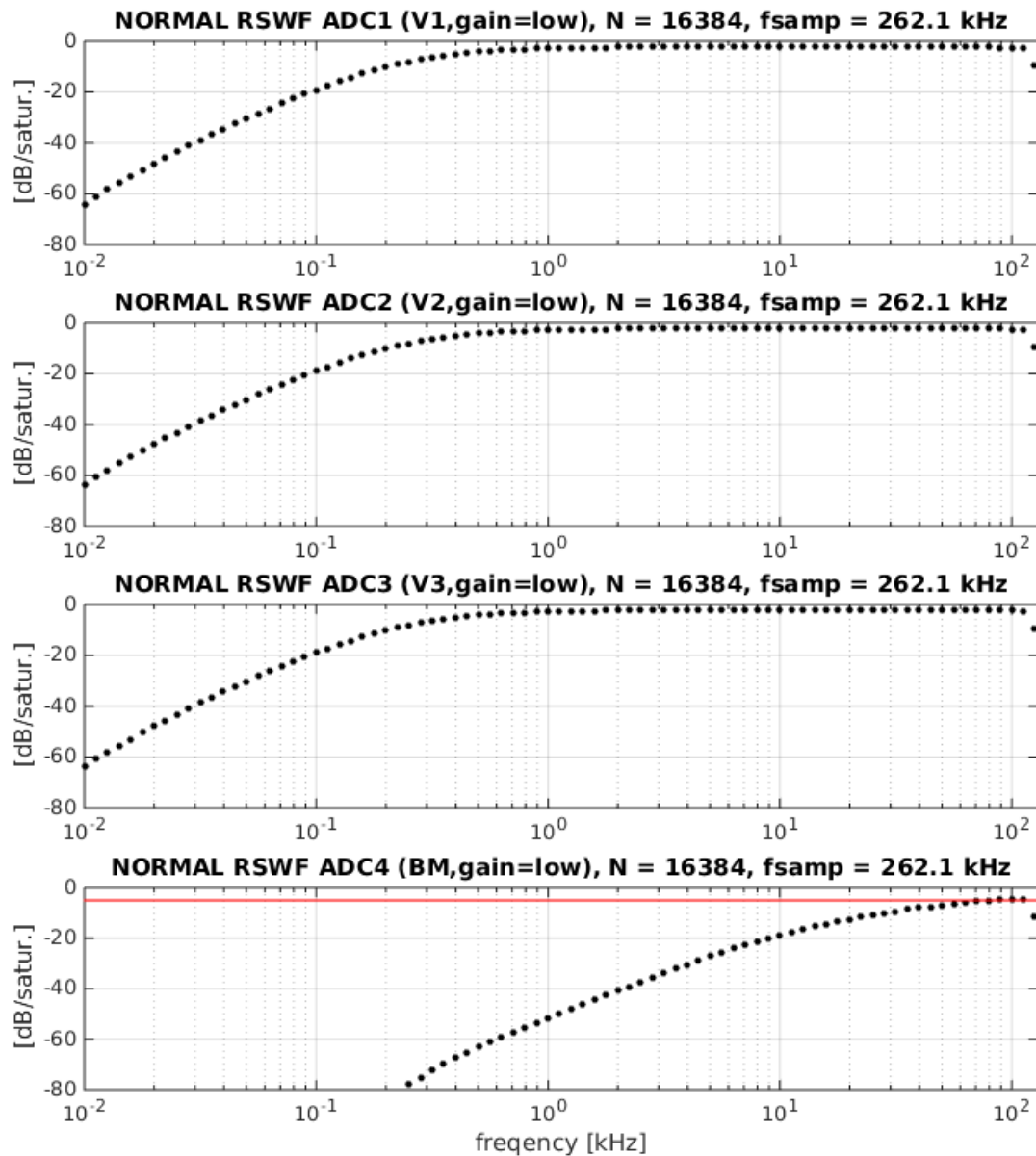
TDS HF sweeps
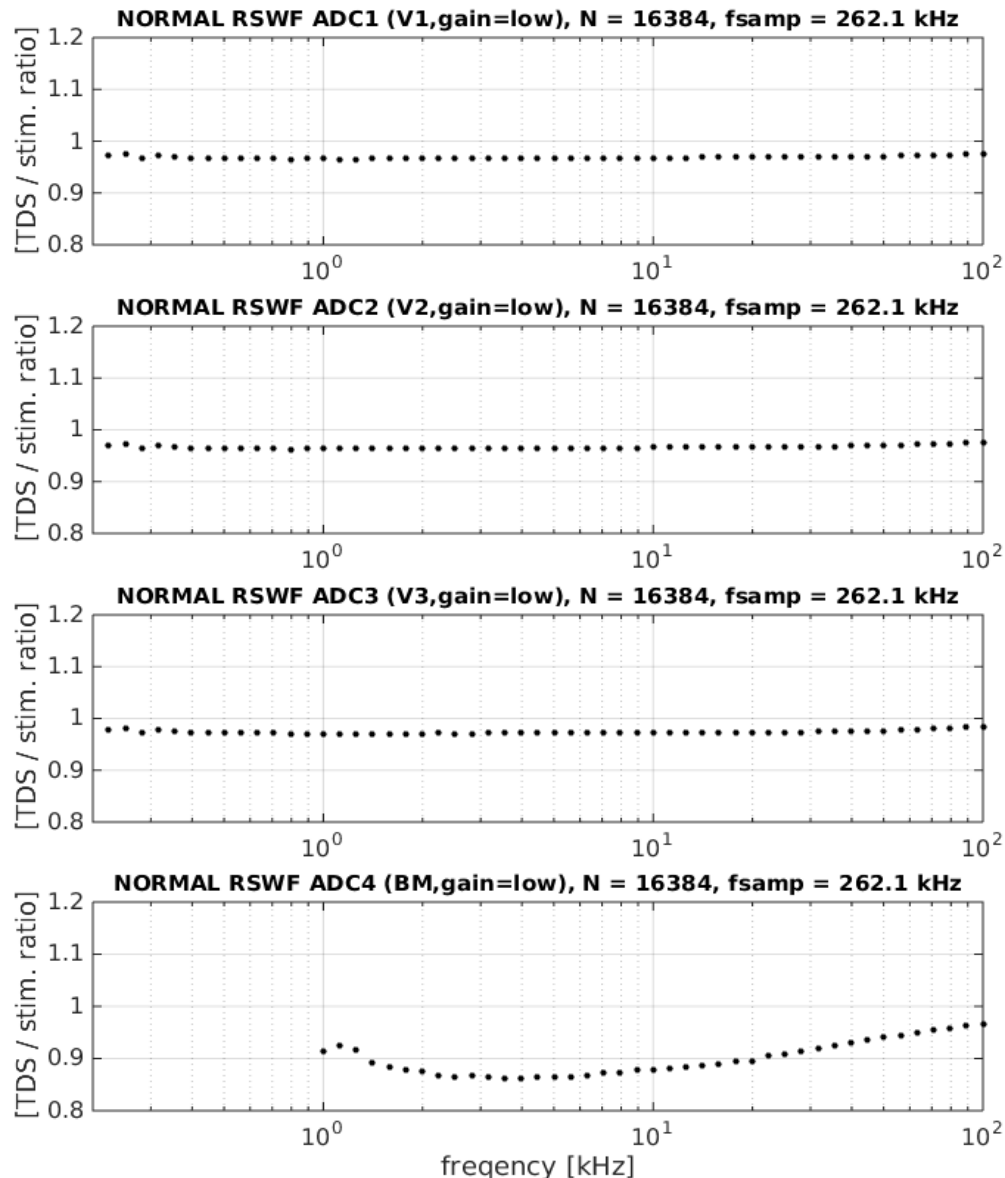
- Ratio between TDS measurement and stimuli plotted.

- TDS, SCM and preamp transfer functions applied.

- Good match for V_HF channels. Reasonable for B_MF.

- Absolute phase can be recovered to some extent, but with a large random error. Shall be only used for low frequencies.

- Phase from TDS unit calibration is essential!

# Extracting TDS transfer function

- Unit level calibration performed on TDS before delivery. Two types of phase measurements:

- Network analyzer:

  - Not full frequency range (only up to 180 kHz)
  - Only the analog part characterized

- Calibration sweeps with our GSE (time synchronized)

  - Full characterization, but measurement is affected by a phase jitter due to the finite time accuracy of TDS (+-1 us).

- Combination of measurements used

TDS phase response

TDS Transfer function HF-SE-1 CH2 - high gain, 524 kHz

Phase, Constant shift of 11 samples applied.
- Network analyzer
- Final extrapolated
- Unit calibration

Constant shift of 11 samples applied.

- Network analyzer phase fits the unit calibration nicely, once we apply a time shift of ~ 5 us due to digital electronics

- Network analyzer phase extrapolated to full frequency range

- **Transfer function for magnetic field already provided in ROC compatible format.**

TDS LFM calibration

TDS LFM transfer function - B channels
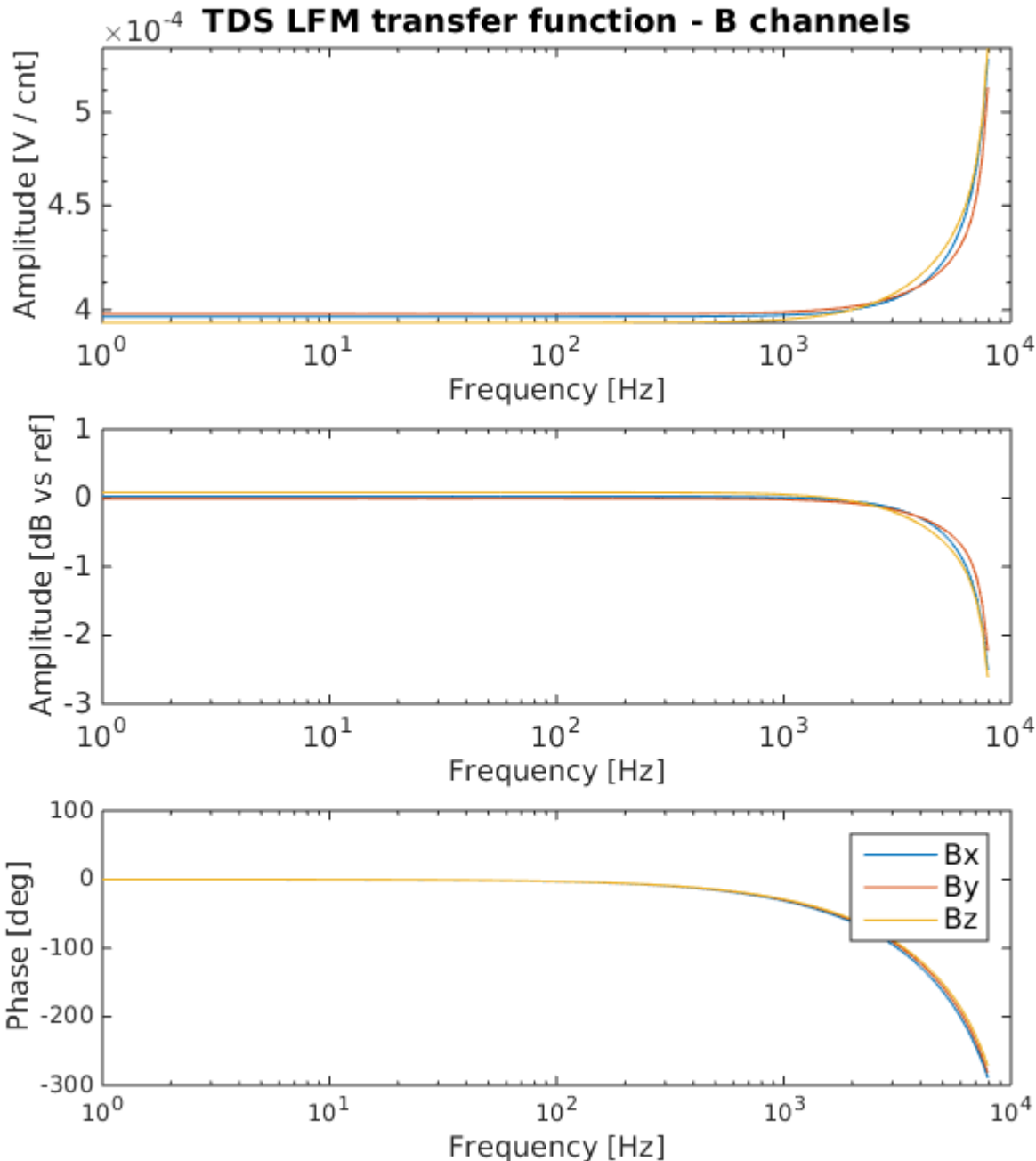
- Calibration derived from unit calibration (Network analyzer + sweeps)

- Absolute phase delay of the order of milliseconds not relevant – in degrade mode, LFR is not running.

- **Calibration functions already produced in ROC compatible CDF file.**

TDS calibration – LFM sweeps

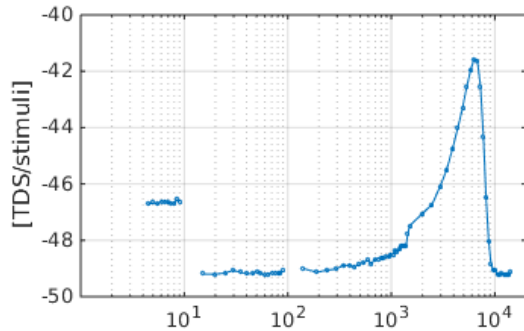- In December clibration, strange "Noise" was observed on SCM channels above 100 Hz (up to 2 dB !)
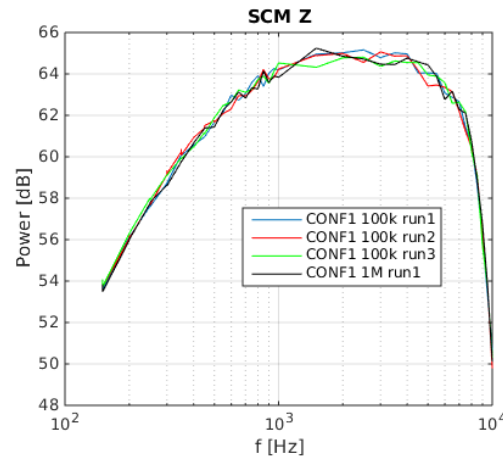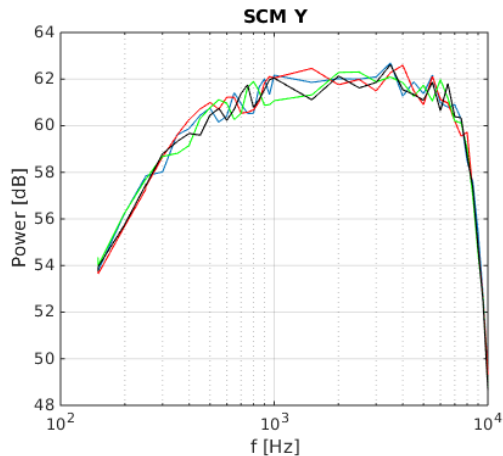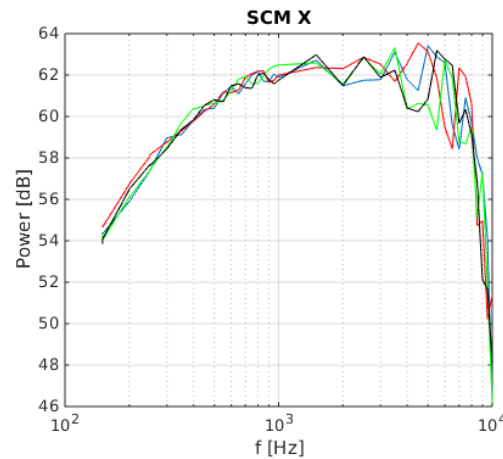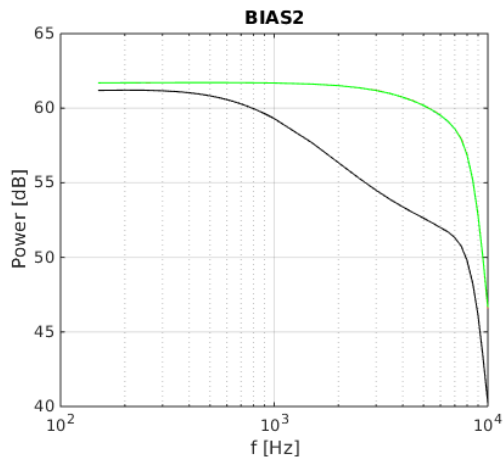
- ➡ BIAS channels clean
- ➡ SCM amplitude fluctuated as a function of frequency
- ➡ All stimuli frequencies were multiples of 50 Hz. Interference with the power line harmonics ?
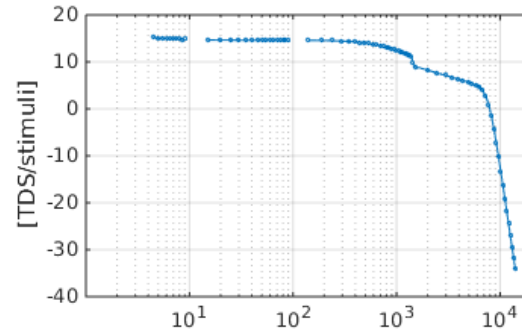- ➡ **Tests re-run in June during delta calibration.**
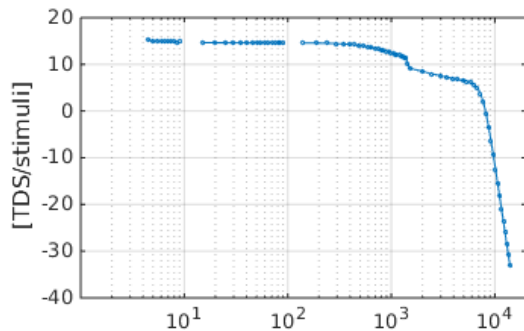
TDS calibration – LFM sweeps
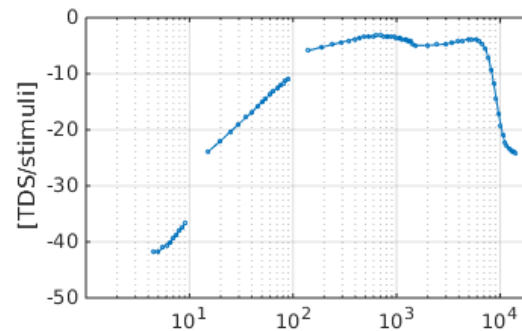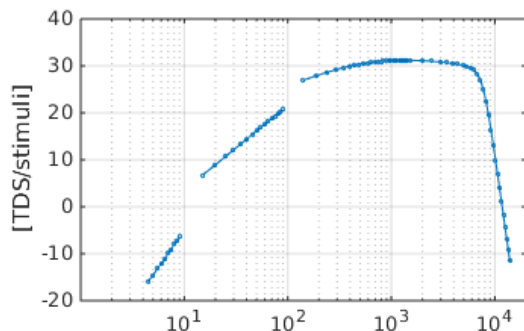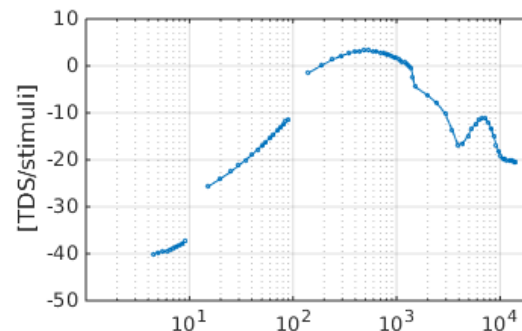
November 2017 presentation:

Stimuli frequencies moved away from multiples of 50 Hz.
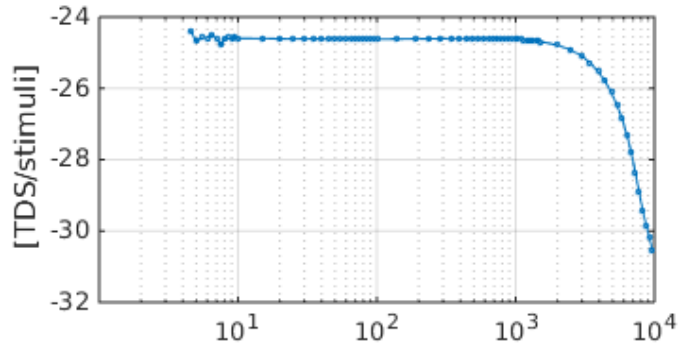
Noise disappeared !

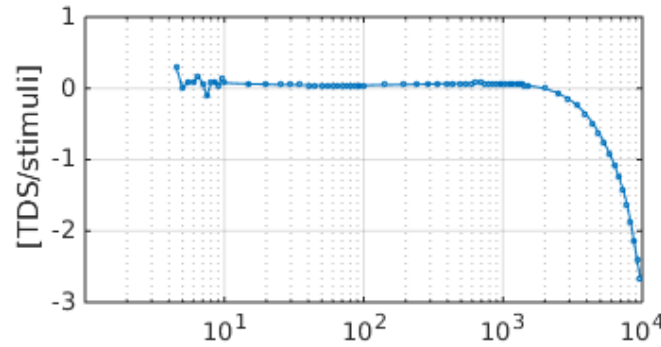Some inconsistency in amplitude between individual segments found.

Strange shift between frequencies and GSE times.

TDS calibration – LFM sweeps

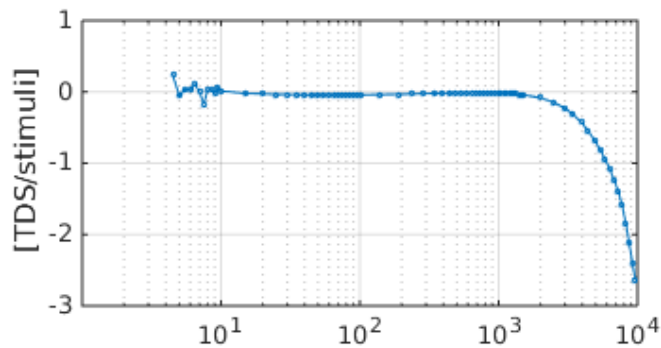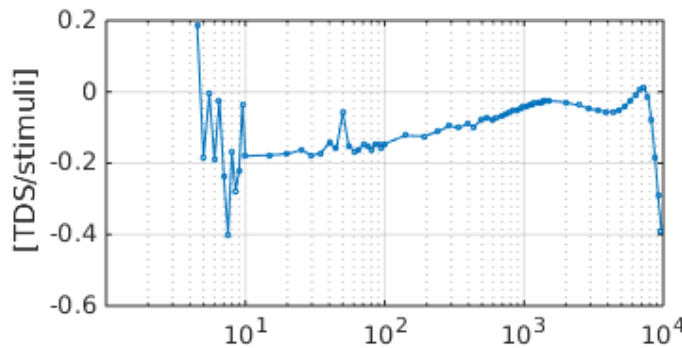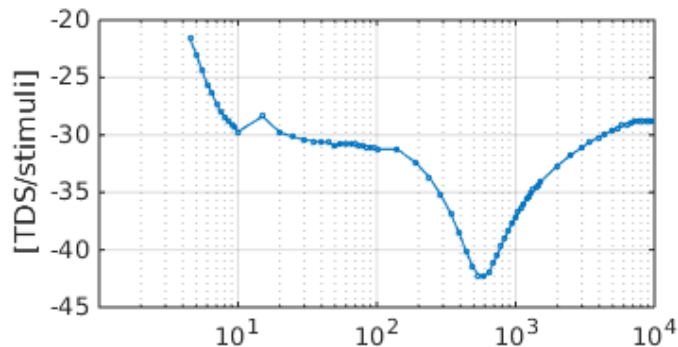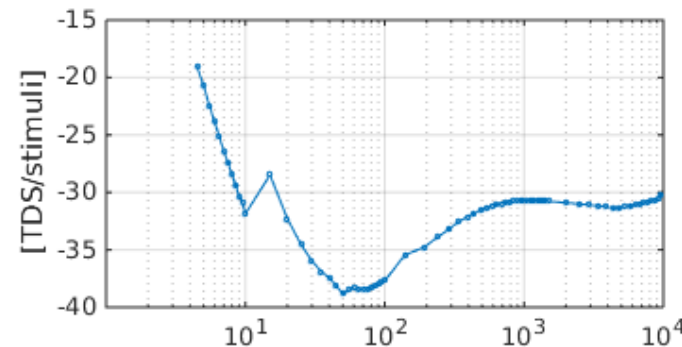**Further analysis showed the issue is in the epoch in CDF files.**

➡ When raw acquisition time from TDS packets was used, problem disappeared.

➡ We will check the issue with ROC.

➡ Very good agreement between stimuli found when all transfer functions applied (EGSE, SCM, TDS)

TDS calibration summary

- HF mode

  - Good correspondence with expectations in amplitude
  - Phase not easily recovered from RPW calibration, but unit level tests were used

- LF mode

  - De-synchronization issue tracked to epoch in CDF files
  - Calibration functions produced from unit calibration
  - Correspondence with delta calibration looks good.

- Calibration functions for ROC

  - SCM HF and LF transfer functions now available in CDF
  - LFM mode transfer function for bias channels also available
  - For HF mode snapshots, it is not decided who will be responsible.

TDS calibration status

- Calibration functions for ROC

  - SCM HF and LF transfer functions now available in CDF
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- Calibration of TDS HF snapshots: three transfer functions need to be applied:

  - TDS transfer function (easy)
  - HF preamp transfer function (easy, but temperature dependent)
  - Antenna effective lengths and directions
    - Between 1 kHz and 200 kHz, a constant matrix will probably provide good approximation.

- Either IAP or LESIA team can take charge if inputs from other team are provided.

TDS funding status

- Current contract until October 2018

  - No cost extension possible
  - Some travel budget remains...
  - No manpower funded since mid 2017.

- New contract

  - We will attempt submit a proposal to PRODEX to gain some support until commissioning
  - Result uncertain.
  - Other funding sources will be pursued if needed

- Either way, work will continue.