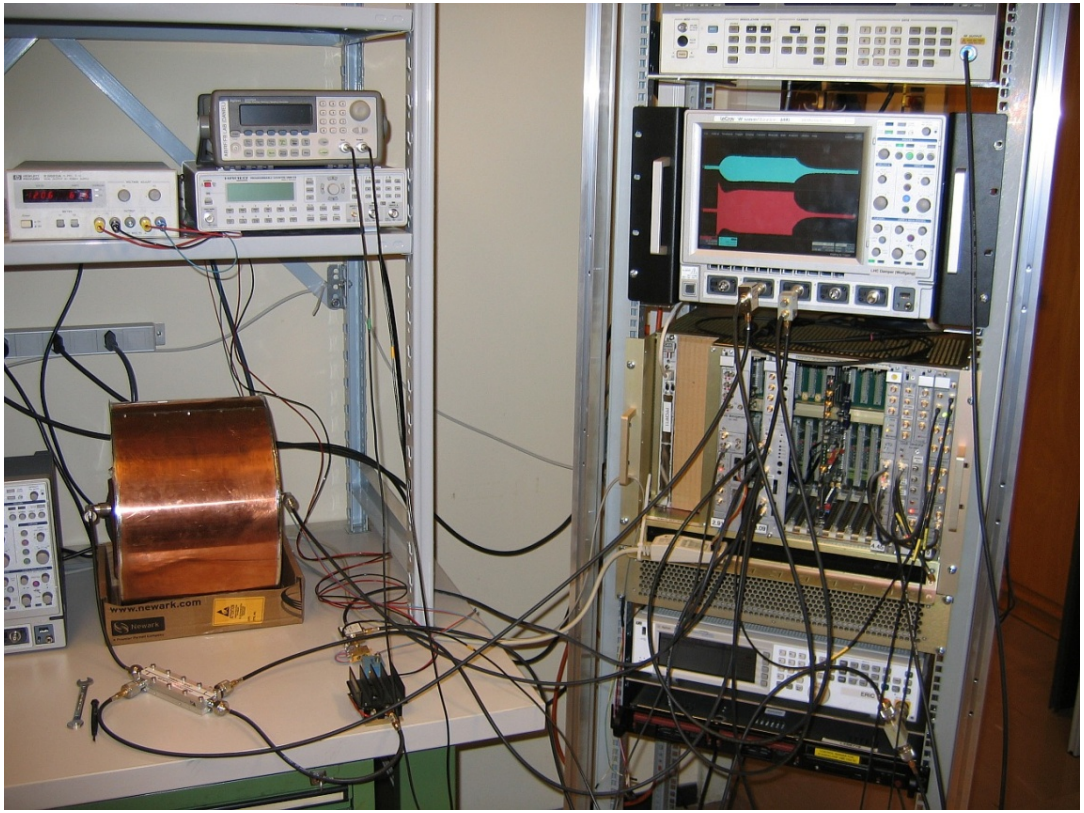
Measurement setup for cavity detuning and microphonics evaluation



Motivation

- A set of LHC hardware was modified to get a stand-alone test setup to measure and characterize superconducting cavity detuning.
- VME modules modified from 400 MHz to the SPL RF frequency of 704.4MHz.
- A stand alone Linux computer was set up to provide boot over the network and control functionality to the VME crate.

Measurement procedure

- Tune state of the cavity **without beam** can be calculated from the cavity forward and antenna signals.

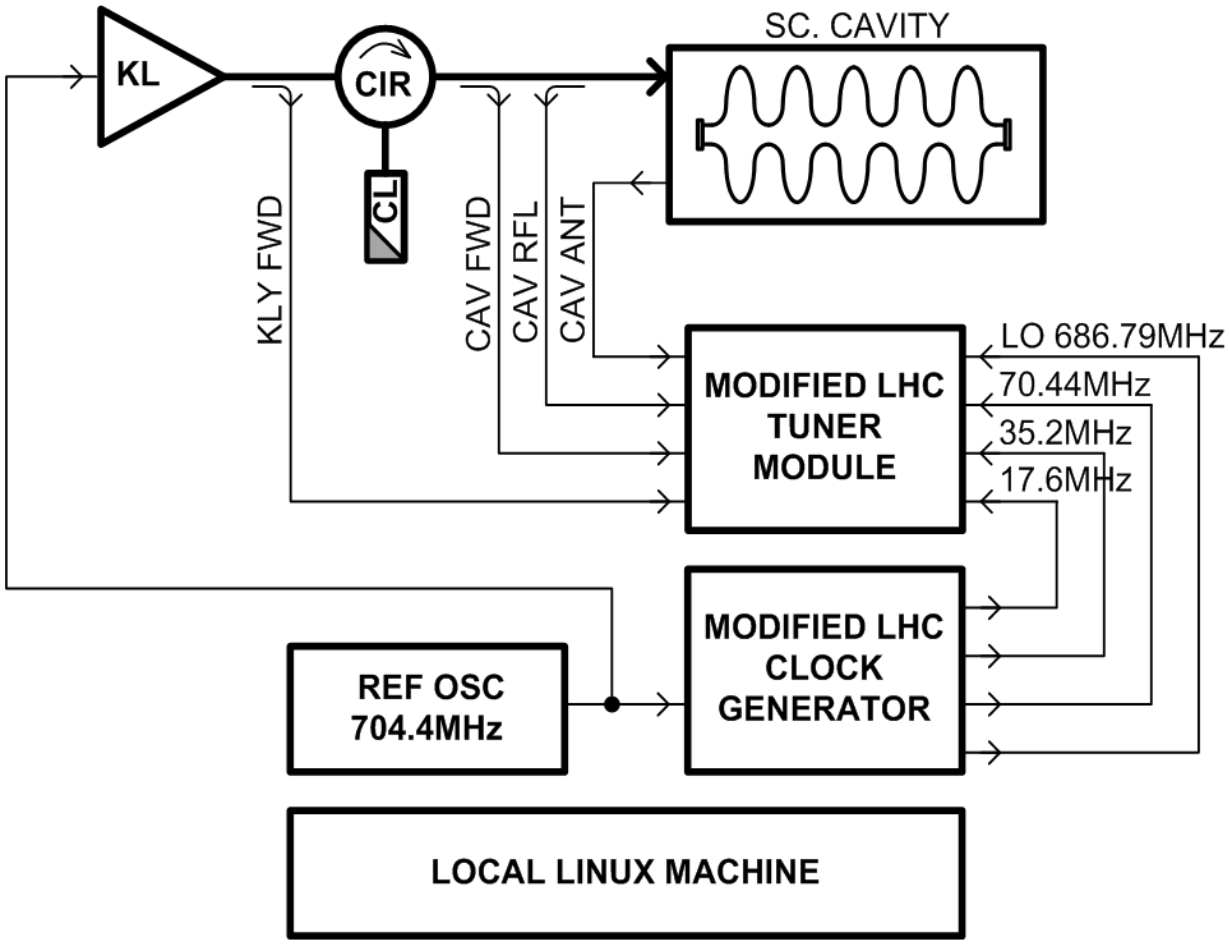
$$\Delta\omega = \frac{d\phi_{ANT}}{dt} - \omega_{12}\frac{V_{FWD}}{V_{ANT}}\sin\left(\phi_{FWD} - \phi_{ANT}\right)$$

Term1 - Cavity without RF drive (e.g. decaying field)

Term2 - Cavity with RF drive

- Tune state of the cavity **with beam** can be calculated from the cavity forward, cavity reflected and antenna signals. Math still to be finished.

Measurement setup

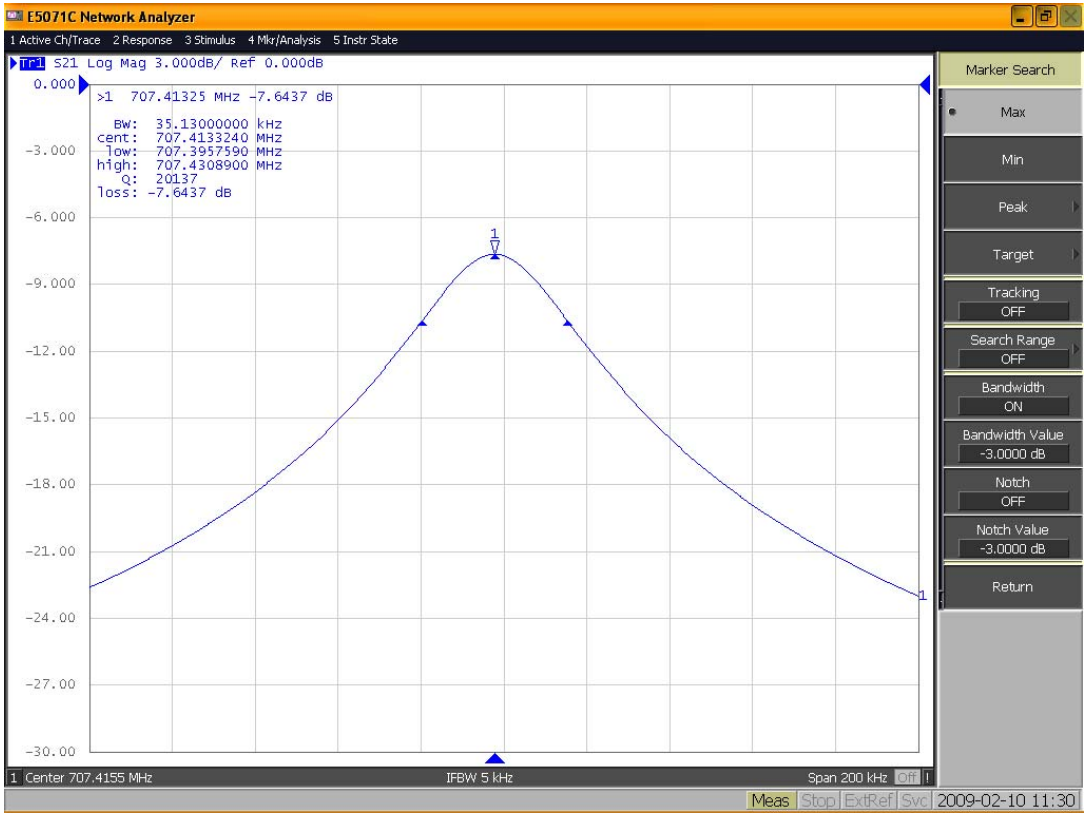


Technical parameters

- Four input RF channels
- Nominal input power 0 dBm
- RF Frequency 704.4 MHz (but input itself is wideband)
- LO frequency 39/40*RF
- Observation memory 128k data points for each channel
- Max. observation rate 35.22 Msps
- Decimation in powers of two
  - 0 (full rate), resolution 28.4 ns/point, record length 3.7 ms
  - 2 (half rate, offset compensation), resolution 56.8 ns/point, rec. length 7.4 ms
  - Down to 32768, resolution 0.93 ms/point, record length 122 s
- External/internal triggers (observation start, observation freeze)
- Large FPGA available on the board. Presently used only as a simple vector receiver, a function generator to drive the piezo or “on-fly” detuning calculation can be implemented

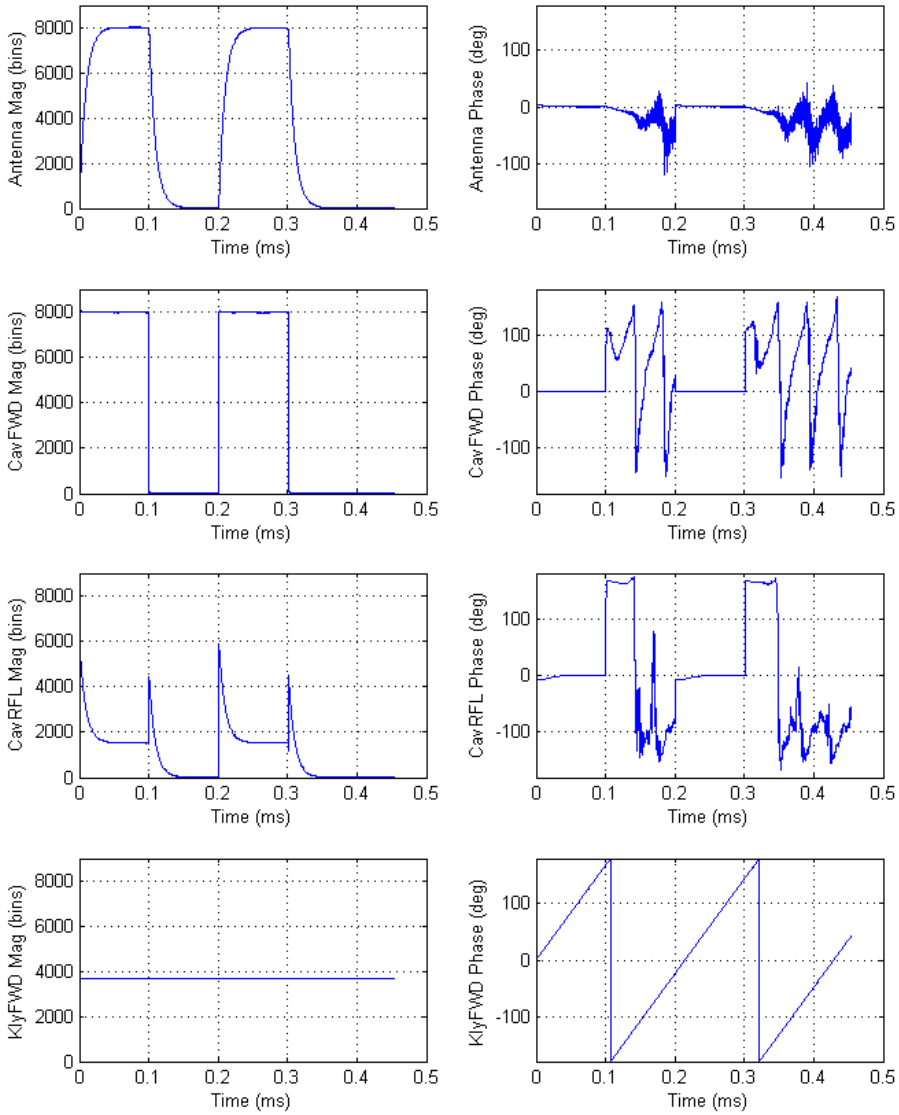
Technical parameters

- Copper pill-box cavity
- R/Q ~250 (?)
- Q ~20 000
- Fc ~707.4 MHz
- Slightly under-coupled



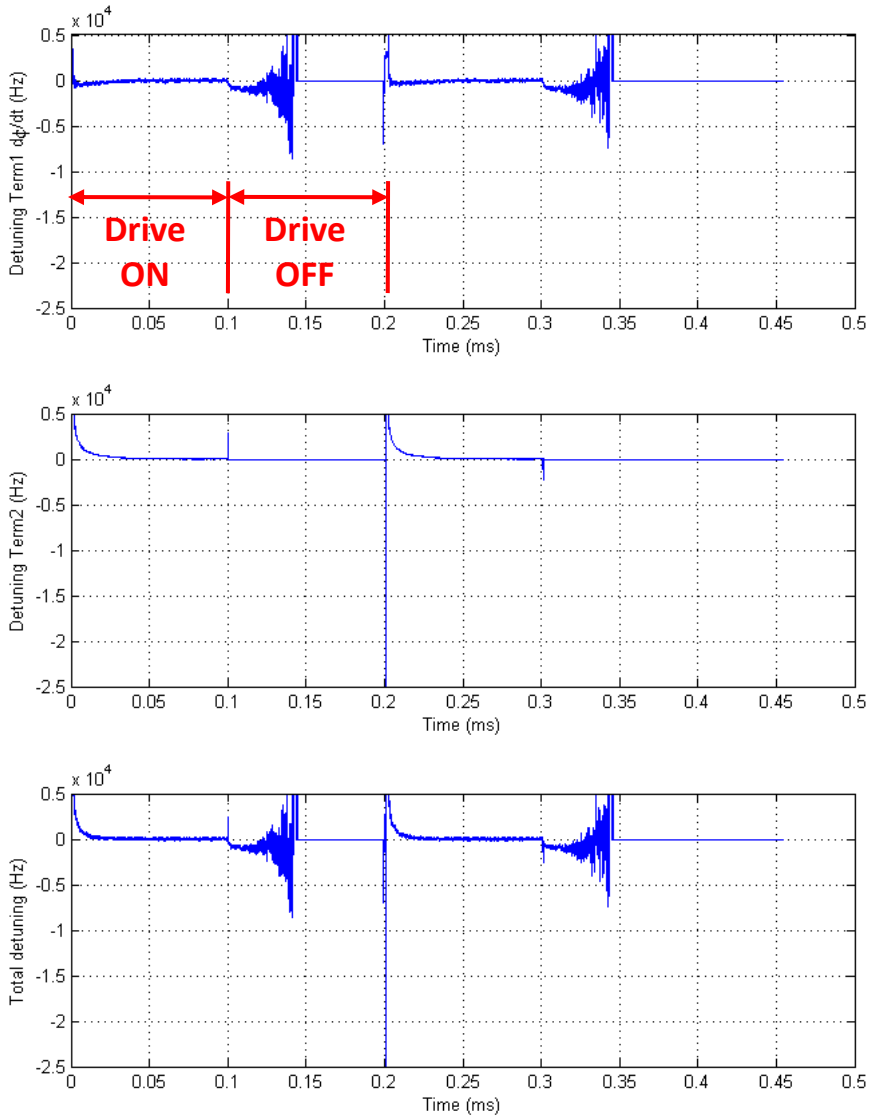
Example measurements

- Cavity filling transient
- Cavity **on-tune**
- Data are already calibrated and corrected for klystron FWD phase
- Decimation by 2,
  i.e. 17.6 Msps, 56.8 ns/point



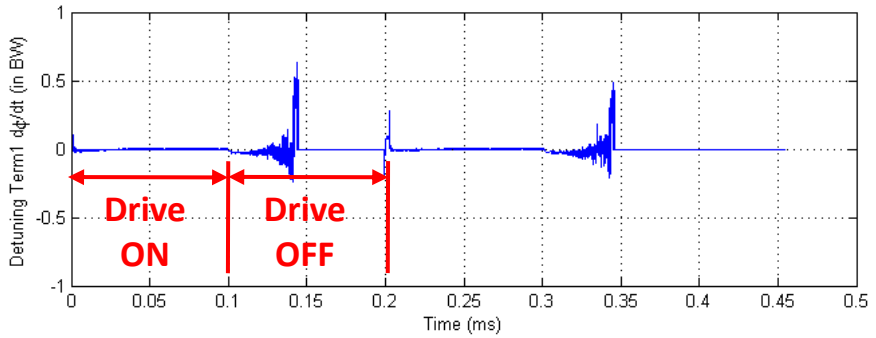
Example measurements

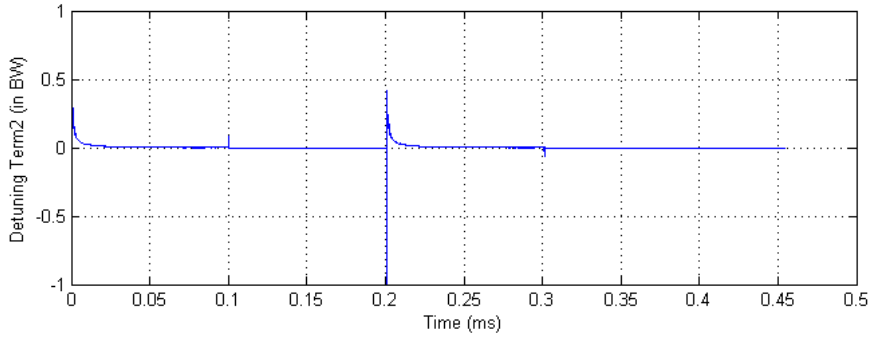
- Calculated cavity detuning state in Hz

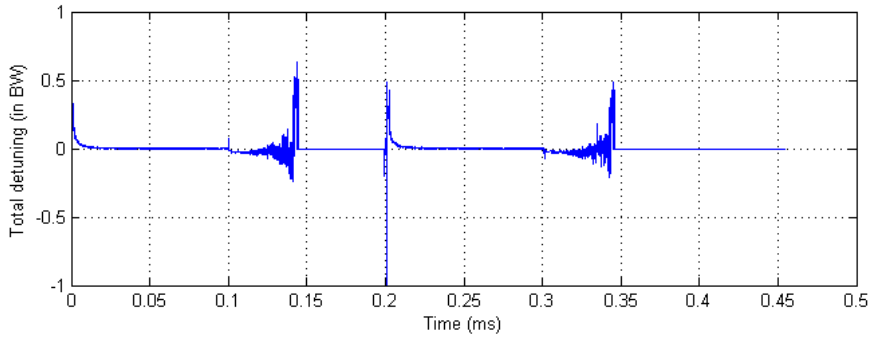


Example measurements

- Calculated cavity detuning state in fractions of bandwidth

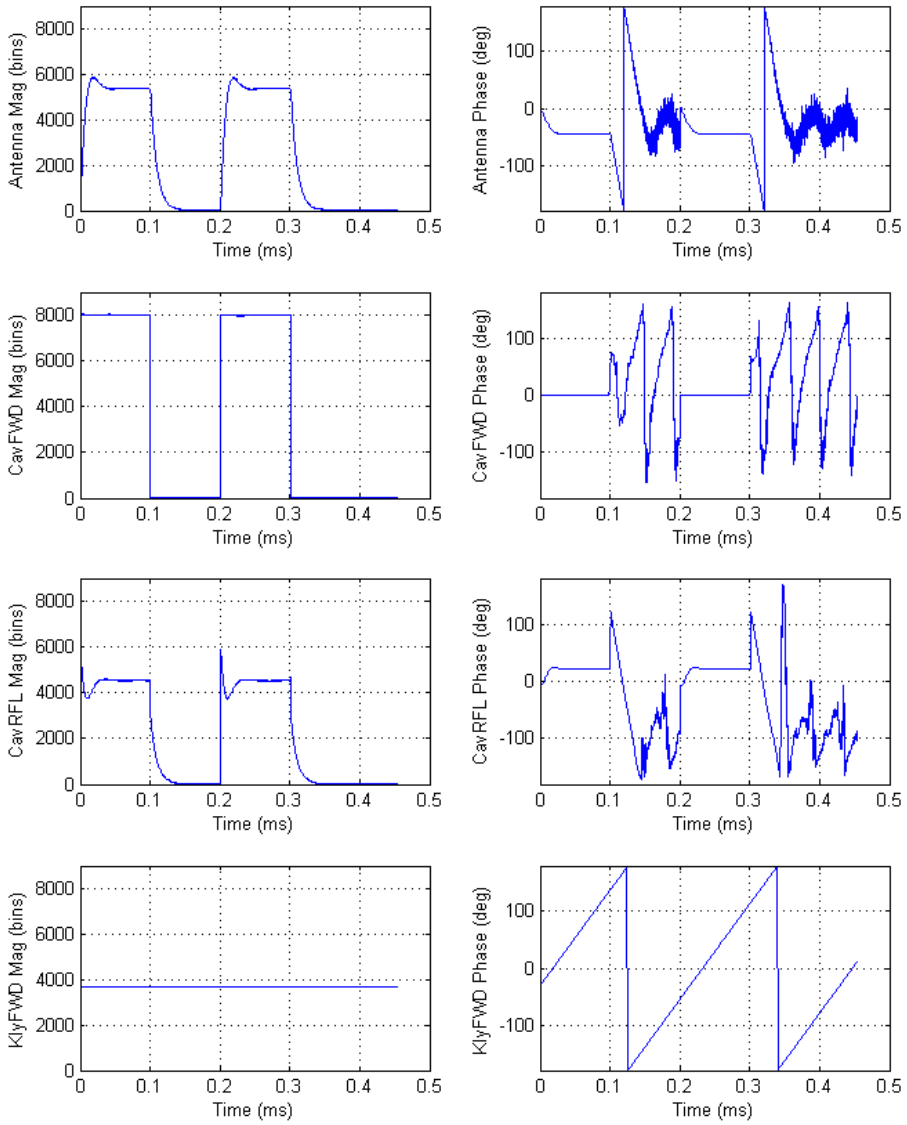






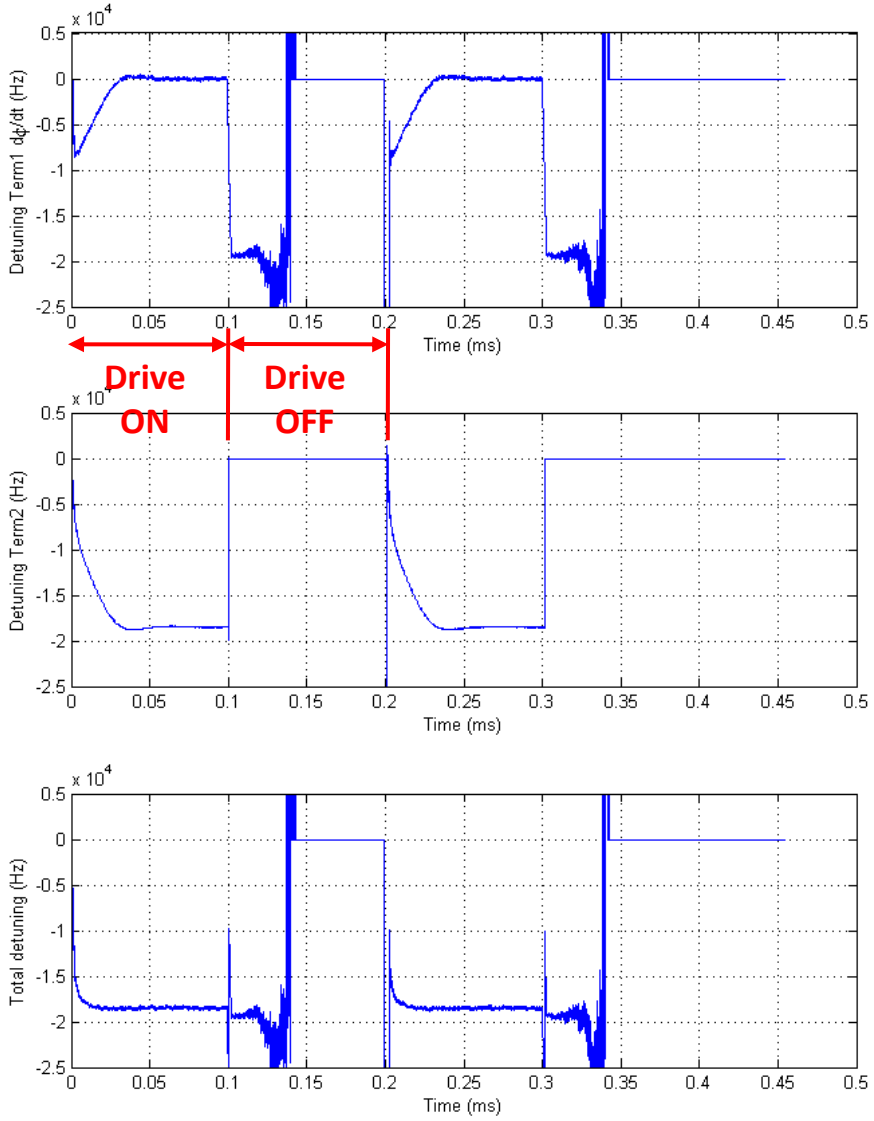
Example measurements

- Cavity filling transient
- Cavity deliberately **detuned by 1/2BW**
- Data are already calibrated and corrected for klystron FWD phase
- Decimation by 2, i.e. 17.6 Msps, 56.8 ns/point



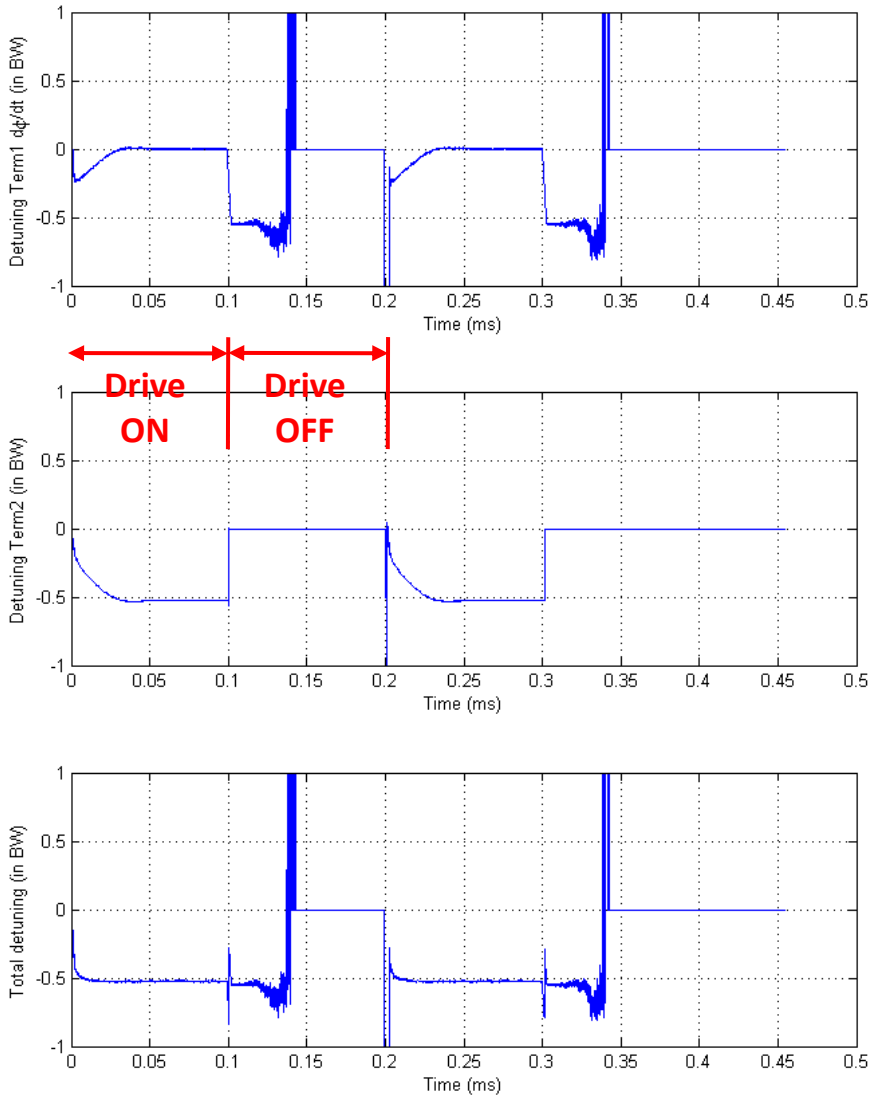
Example measurements

- Calculated cavity detuning state in Hz



Example measurements

- Calculated cavity detuning state in fractions of bandwidth



Example measurements

- Mechanical excitation of the cavity by burst of 60Hz signal
- Provoked detuning ~1 BW
- Decimation by 1024, i.e. 17.6 ksps, 56.8 μs/point