Laser Ranging Interferometer at JPL

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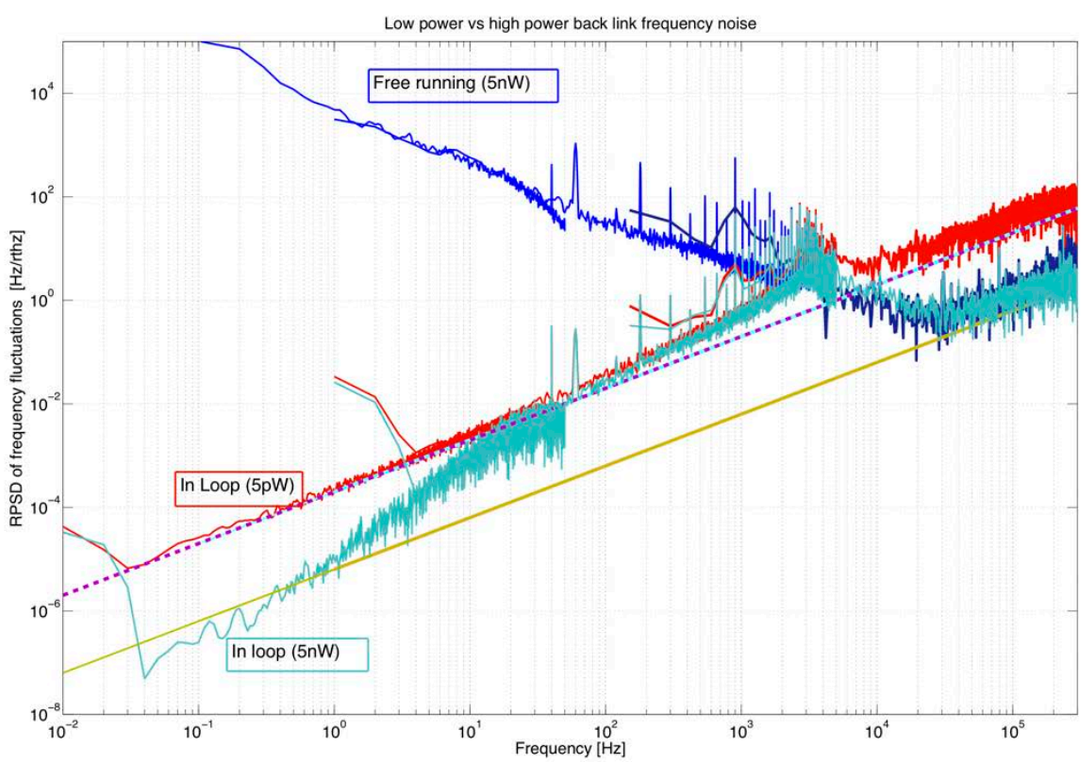
Heron Island Workshop
4 September, 2012

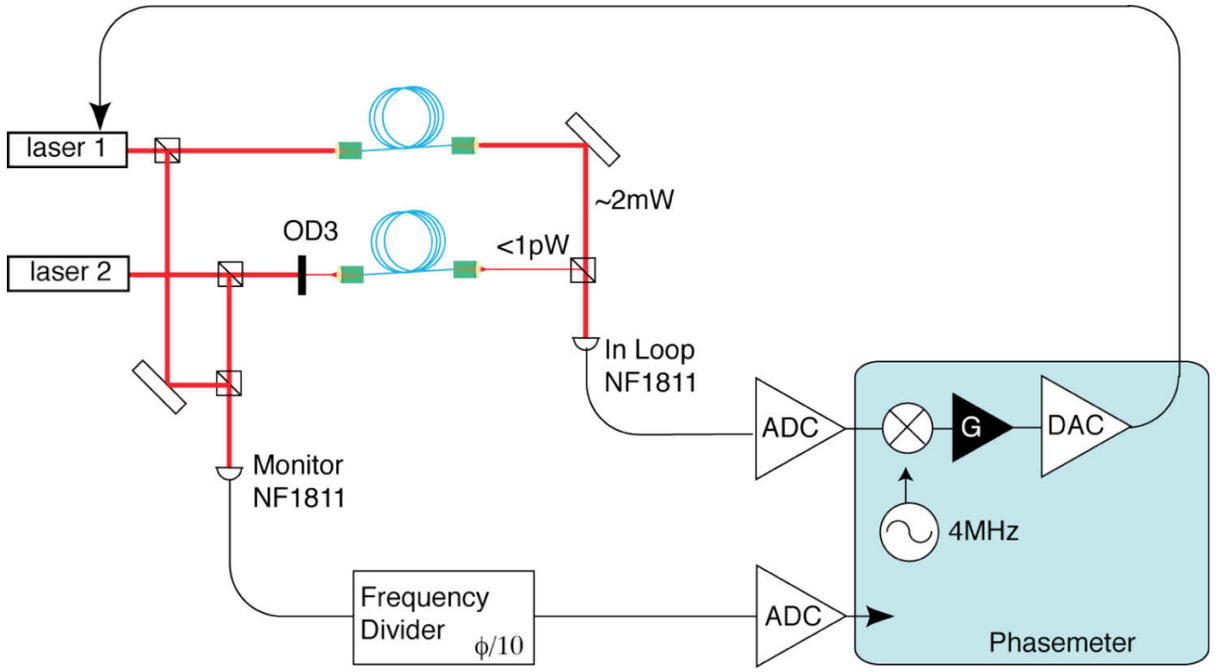
Low Signal Power Phase Locking

- Goal: Test the limits of low optical power phase locking.
  - Understand experimental factors that limit operation at low signal powers.
  - Are different software or hardware settings required to operate at low power?
  - Understand how much margin we have for acquisition.

Experiment (to be updated)

Stable operation at 5 pW



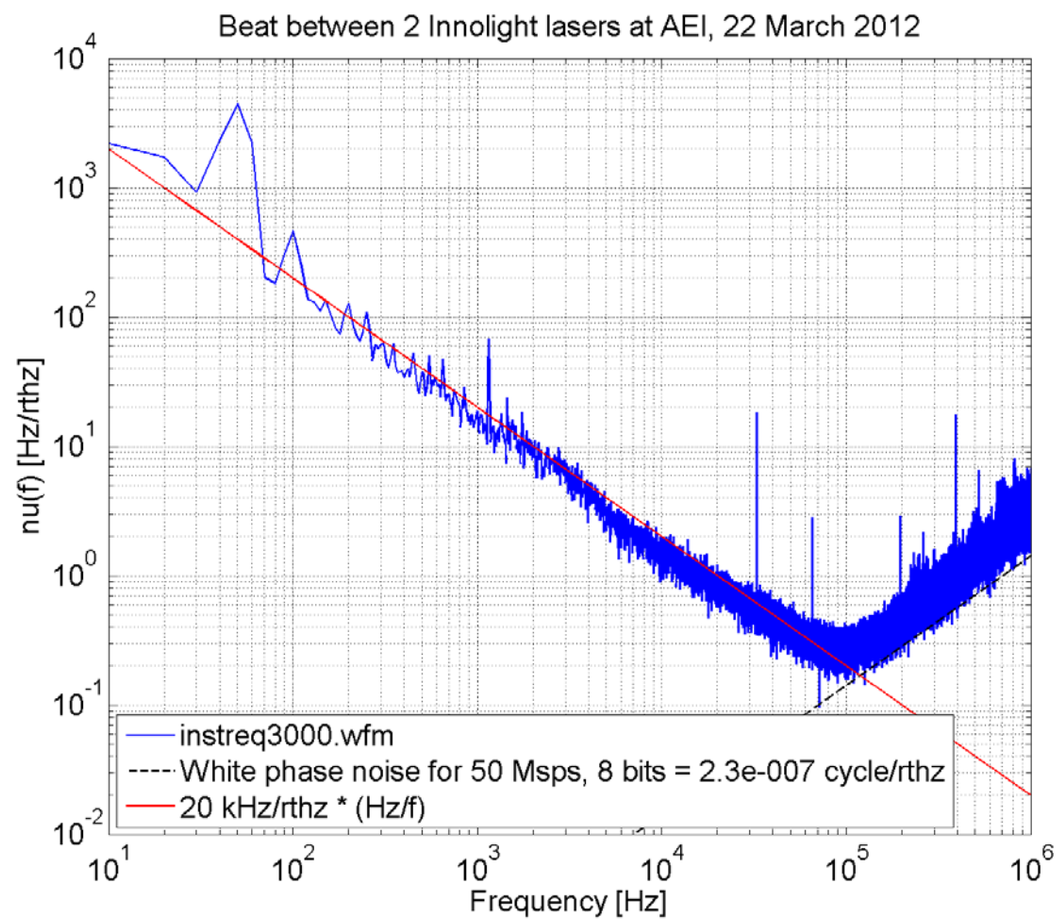


Tesat laser

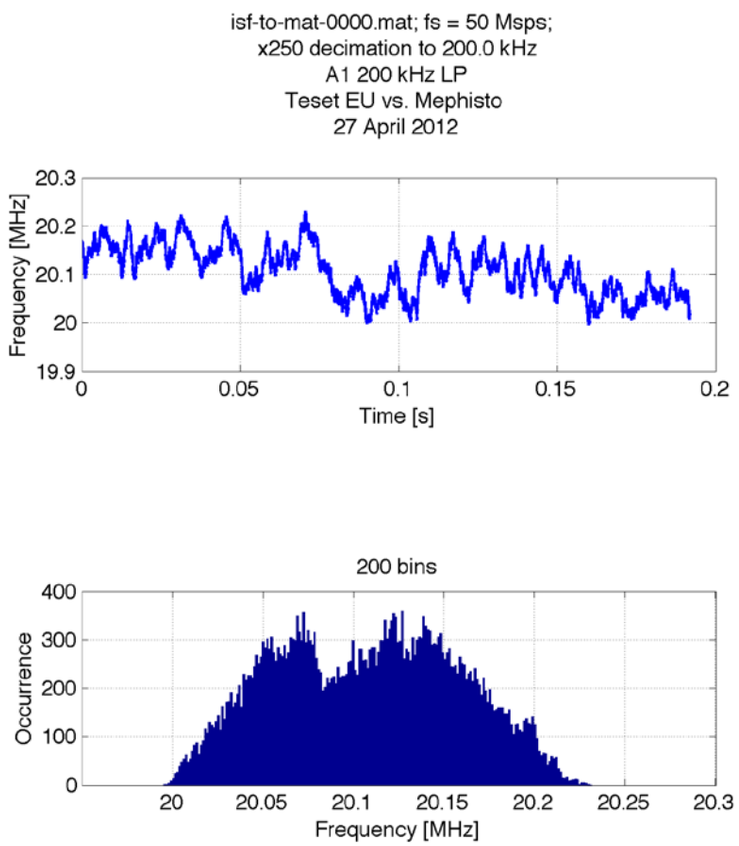
- free running laser frequency noise
- stability
- ability to lock with DPLL for phase locking and phase measurement
- ability to lock to flight-like Ball cavity
- noise characteristics - regions of increased noise
- LTP EM is the only Tesat laser available for test

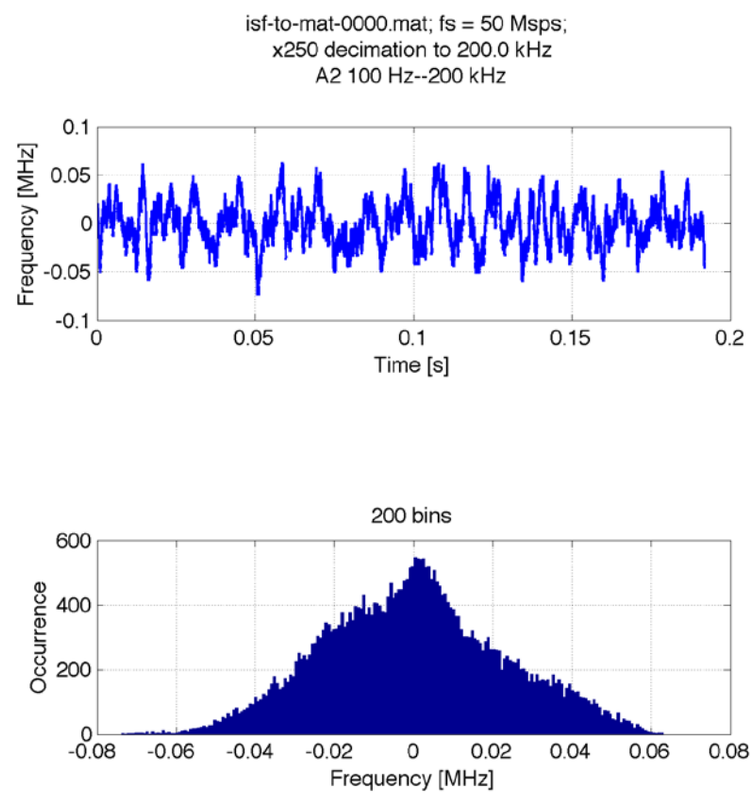
High-frequency frequency noise

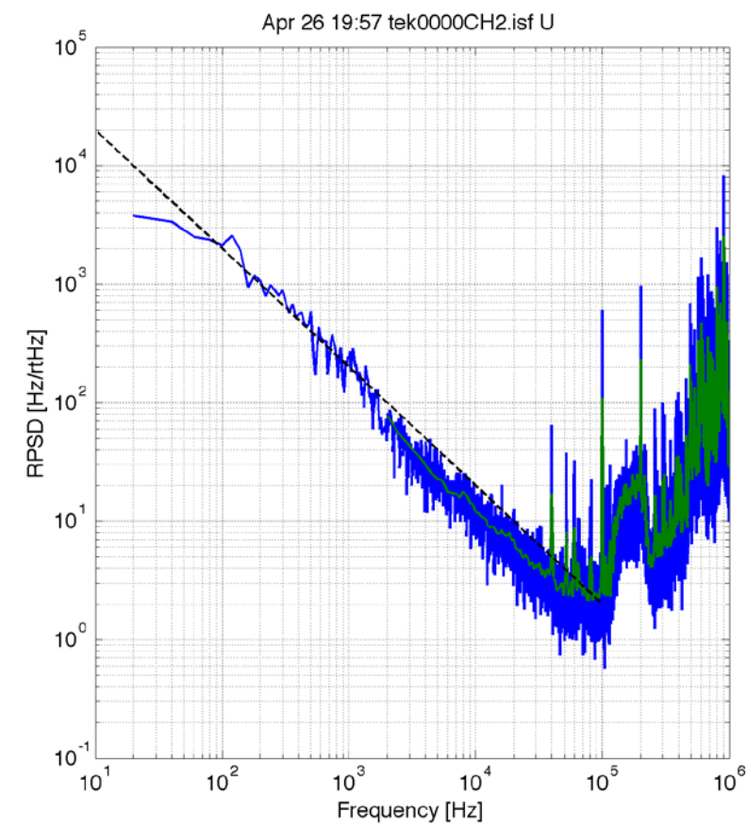
- Heterodyne signal, off-line analysis
- Amplitude(time) converted to Phase(time) by Hilbert transform
- Measurement of quiet lasers (Mephisto vs. Mephisto):



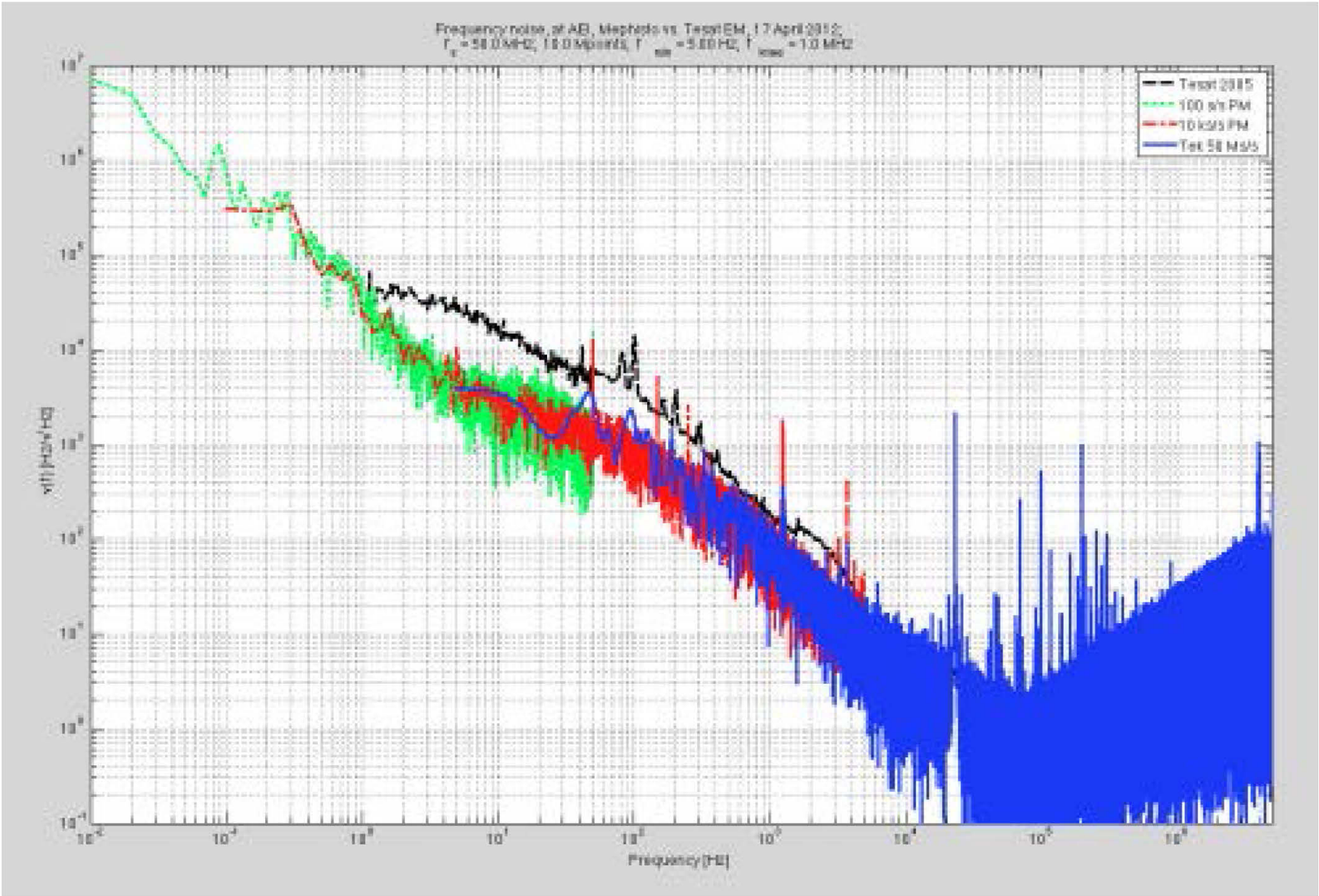
Tesat EU vs Mephisto



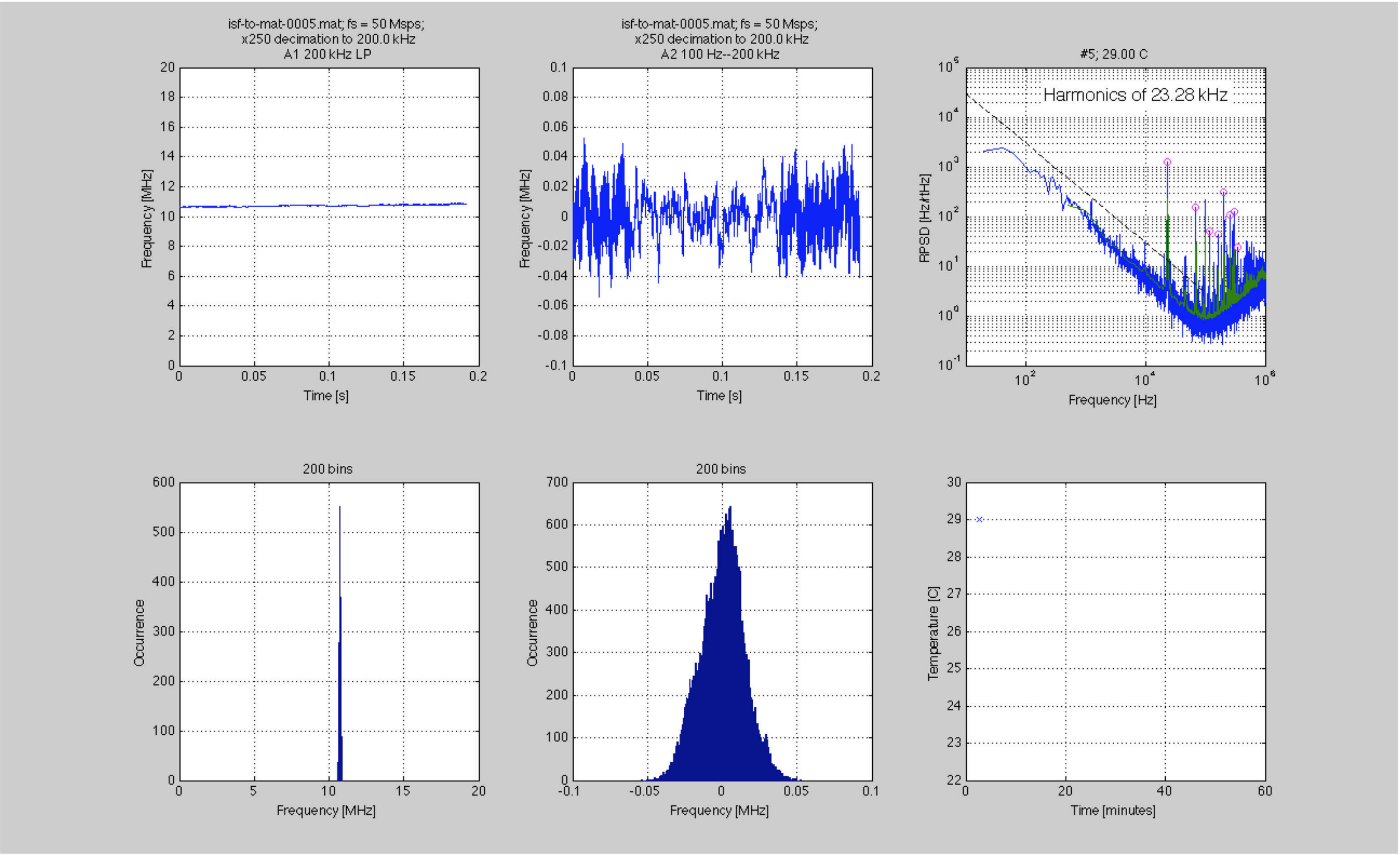




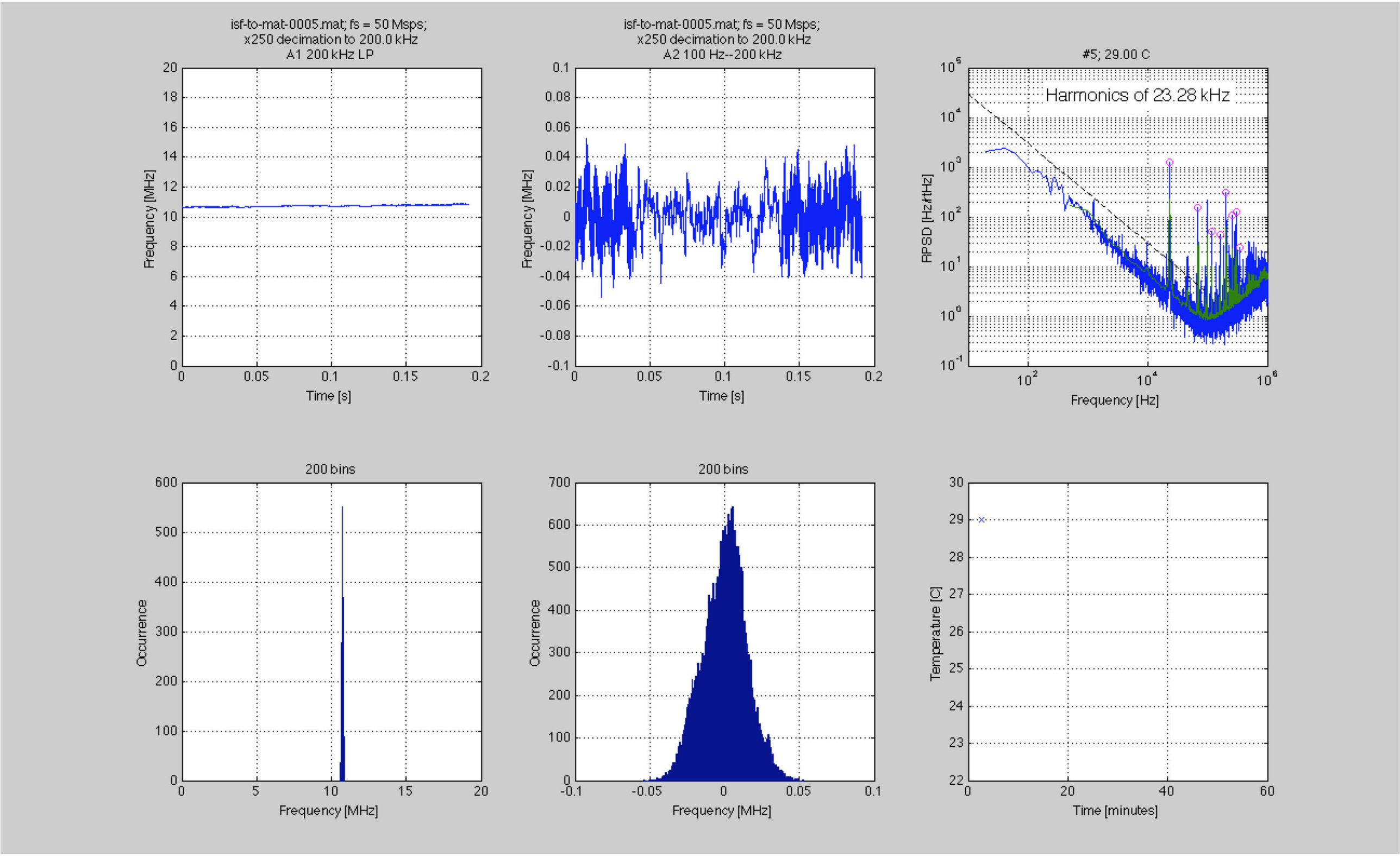
Tesat laser frequency noise - April 2012



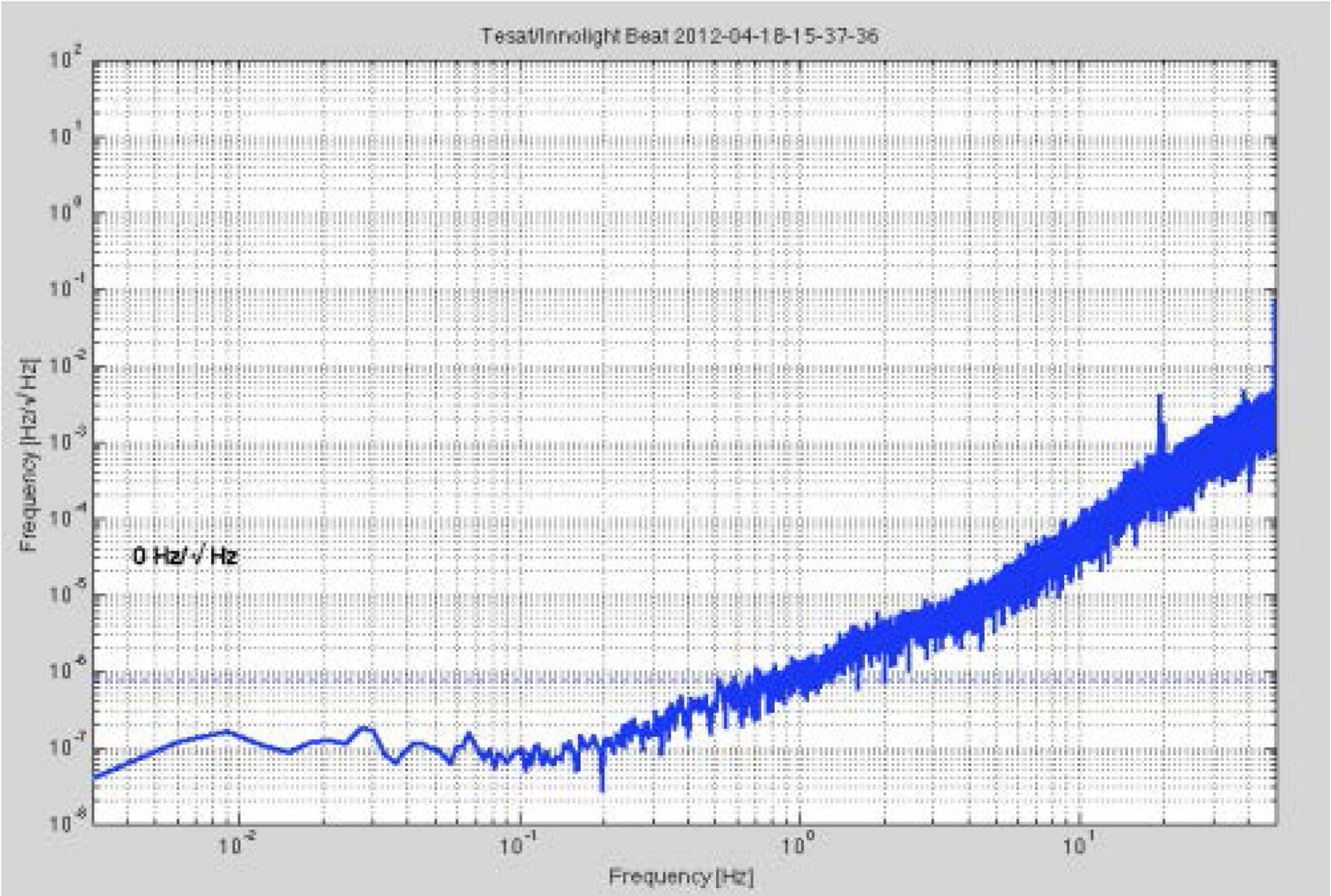
Thermal ramp (15 FPS)



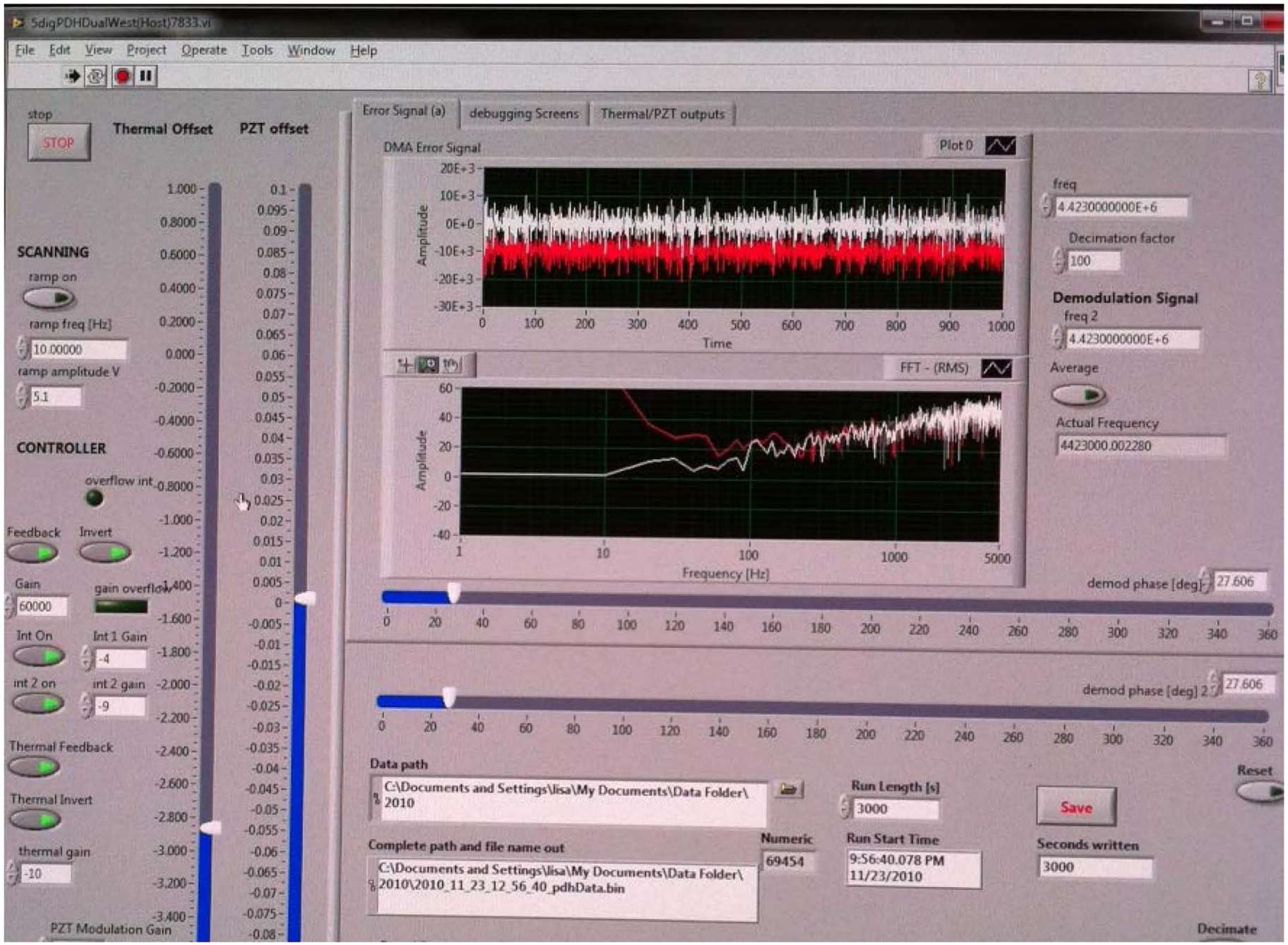
Thermal ramp (1 FPS)



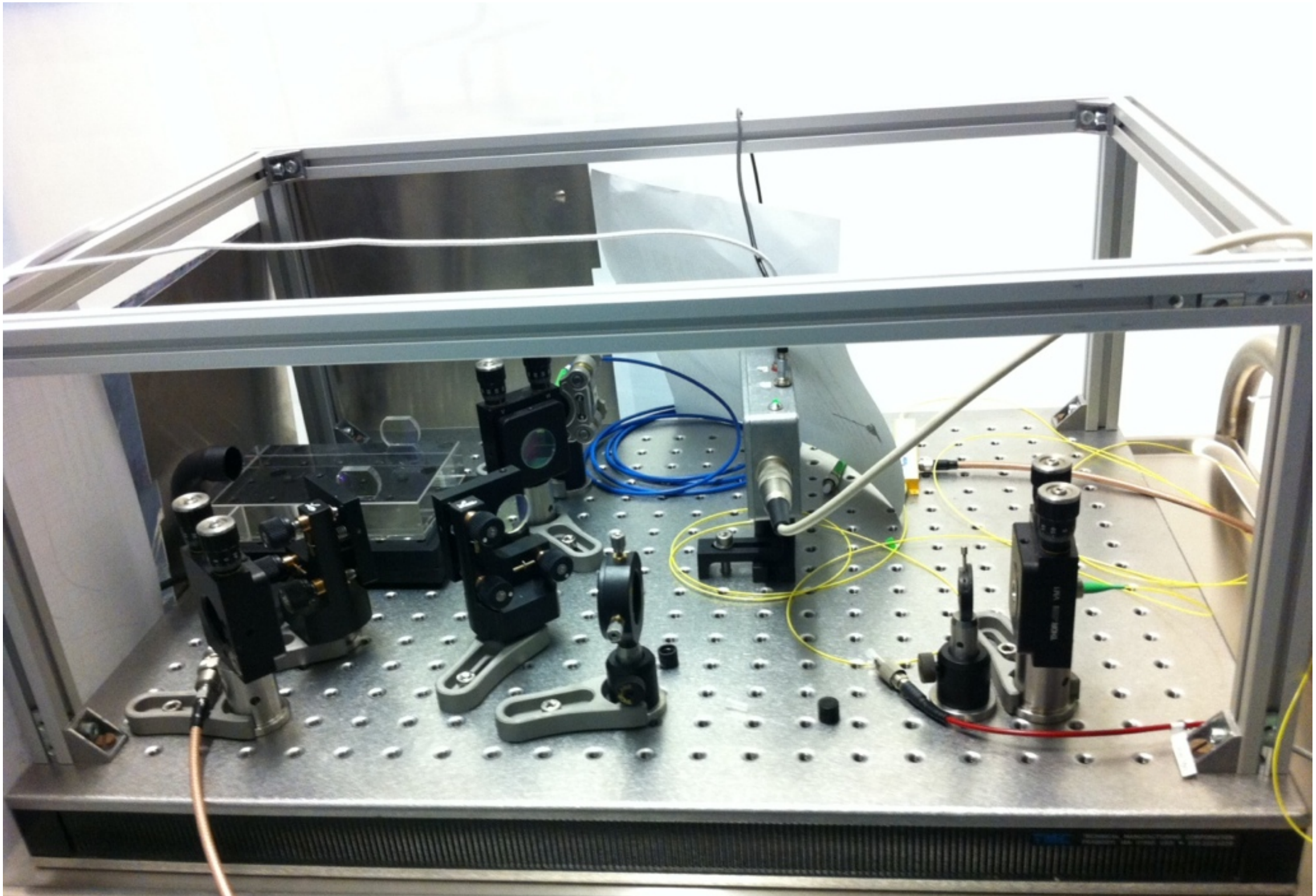
Phase locking spectra



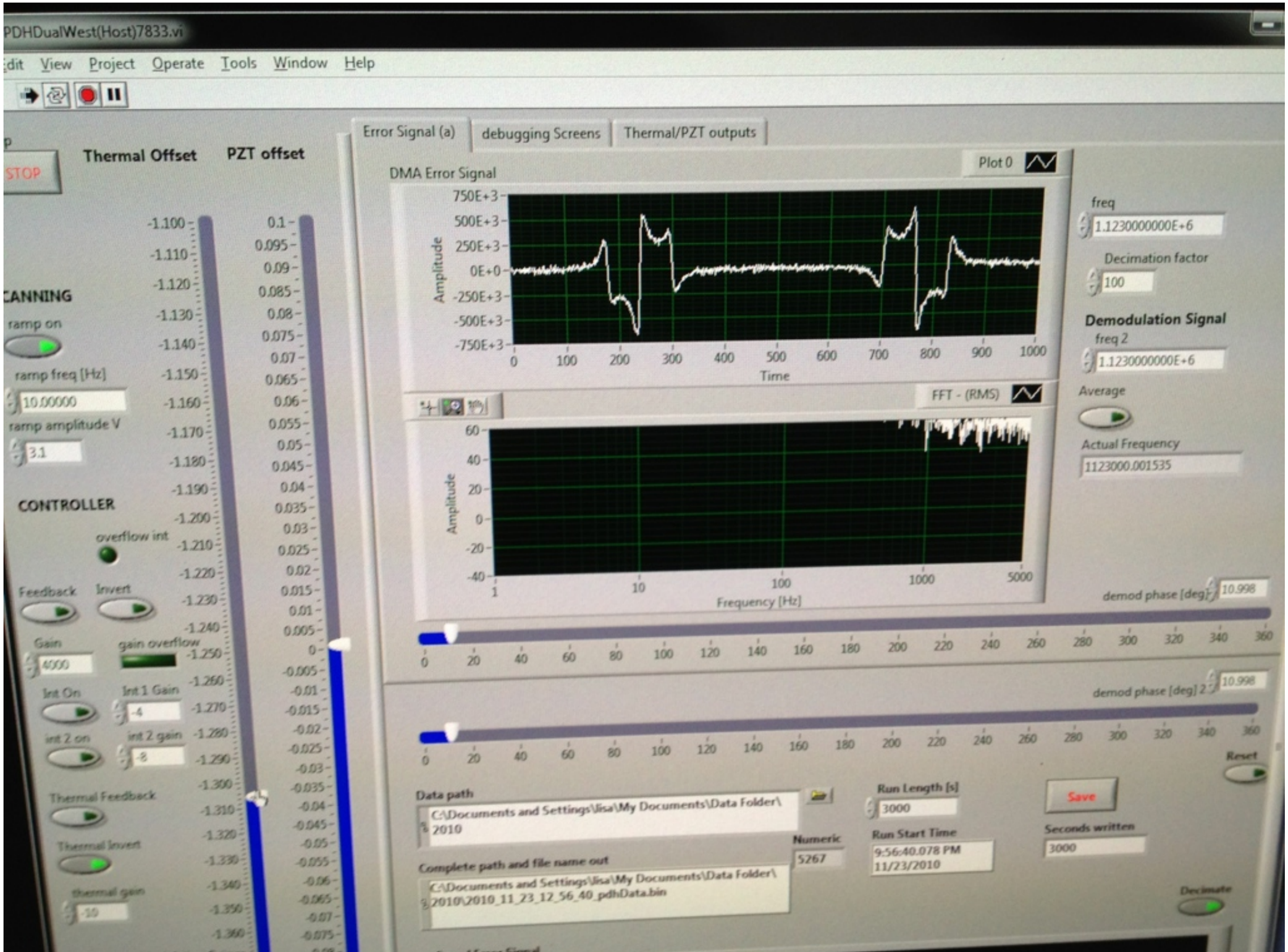
PDH lock to ULE cavity



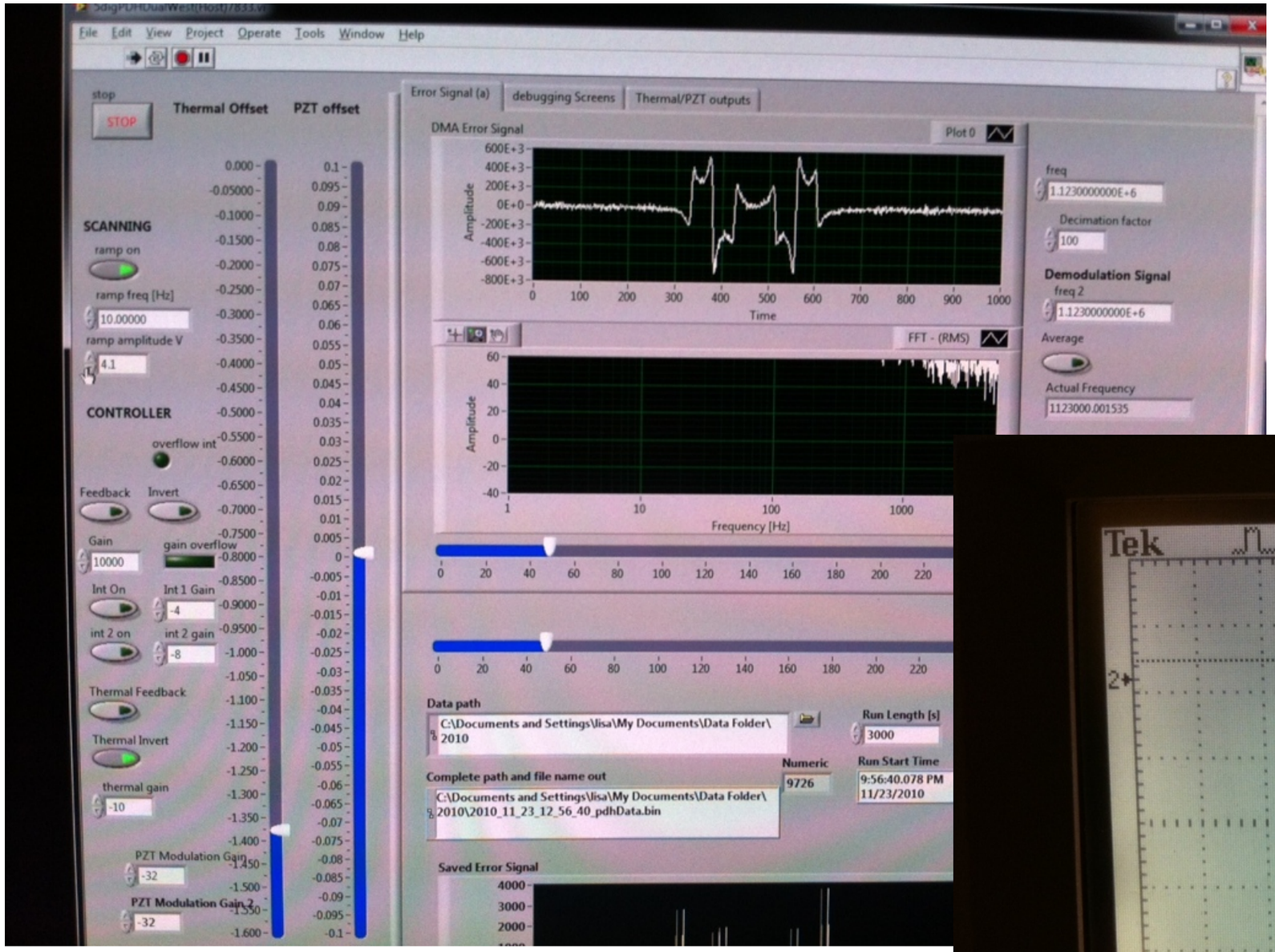
ULE cavity

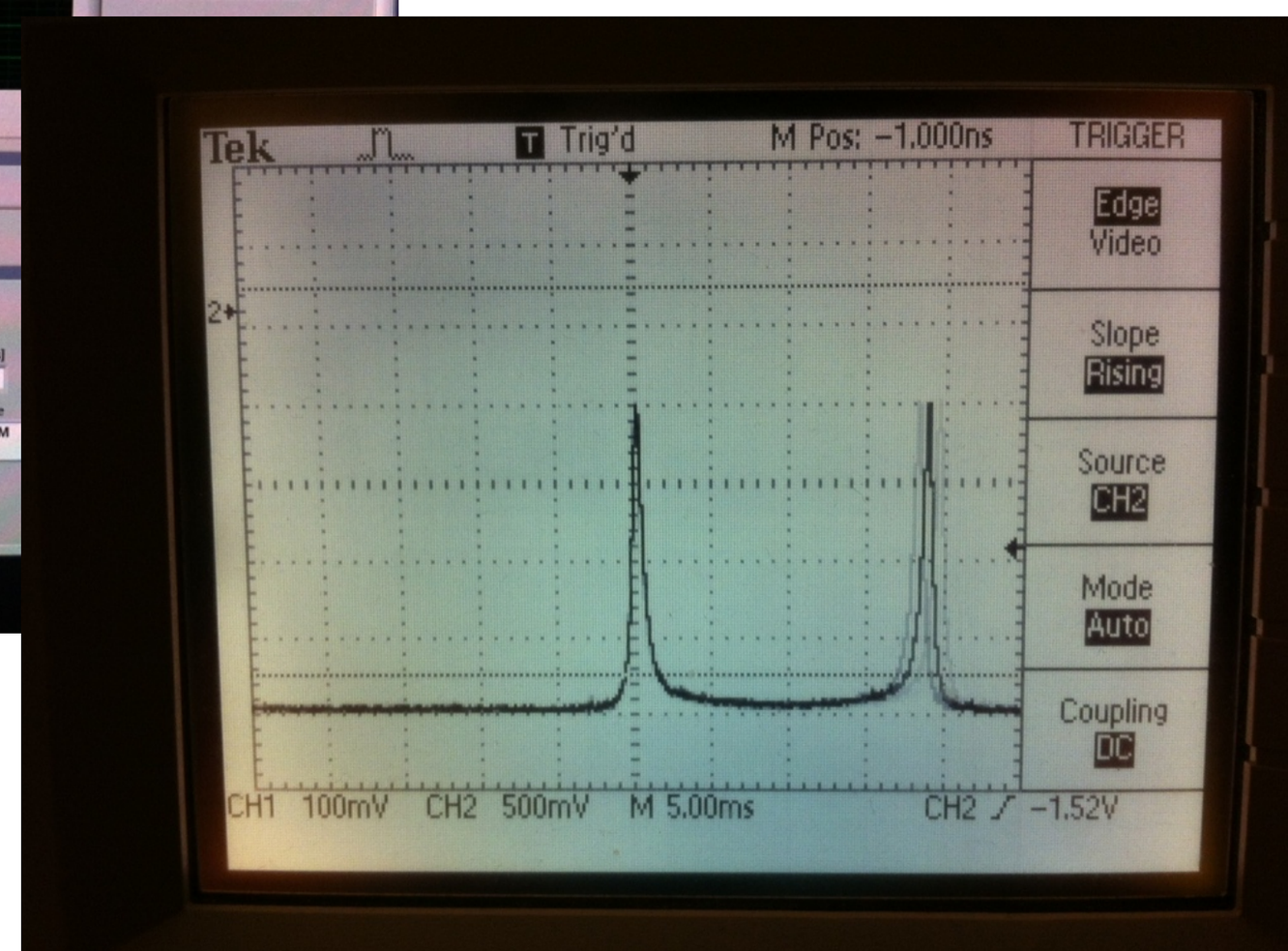


Tesat PDH with Ball cavity

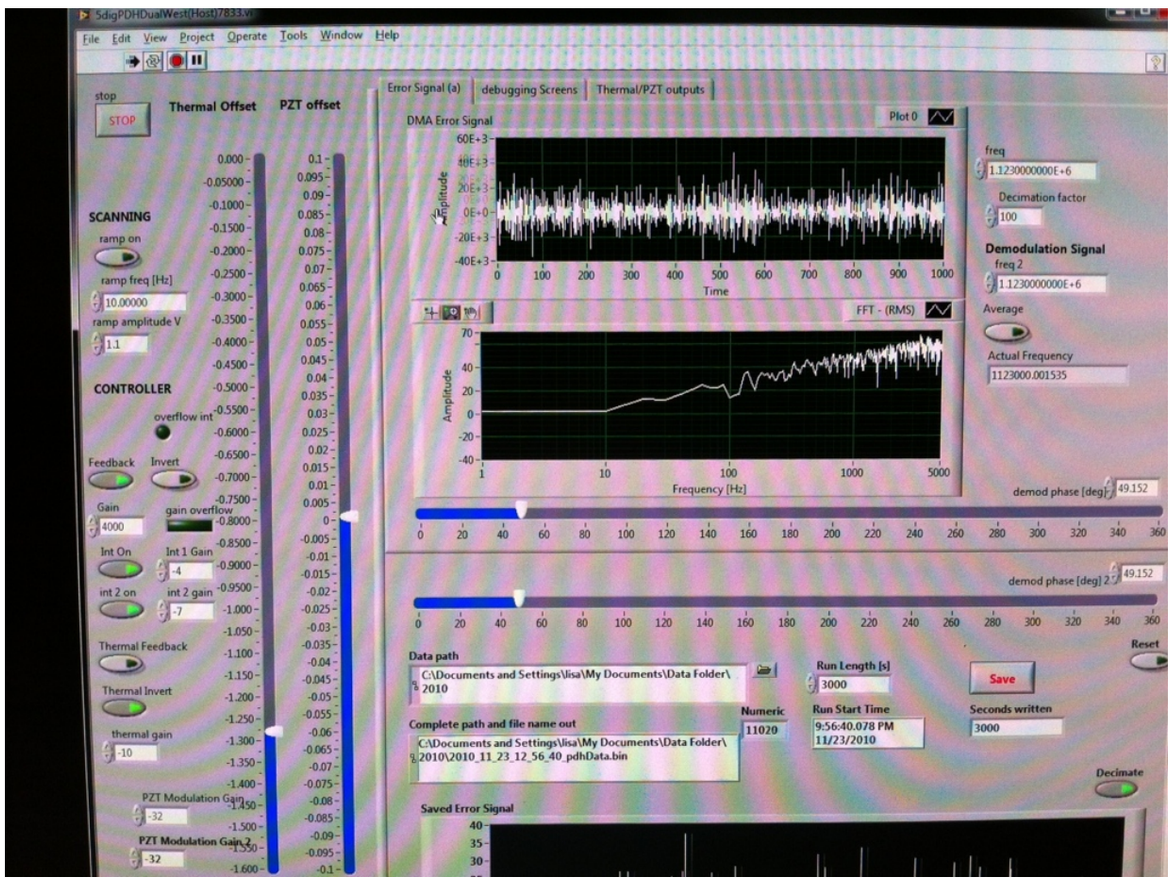


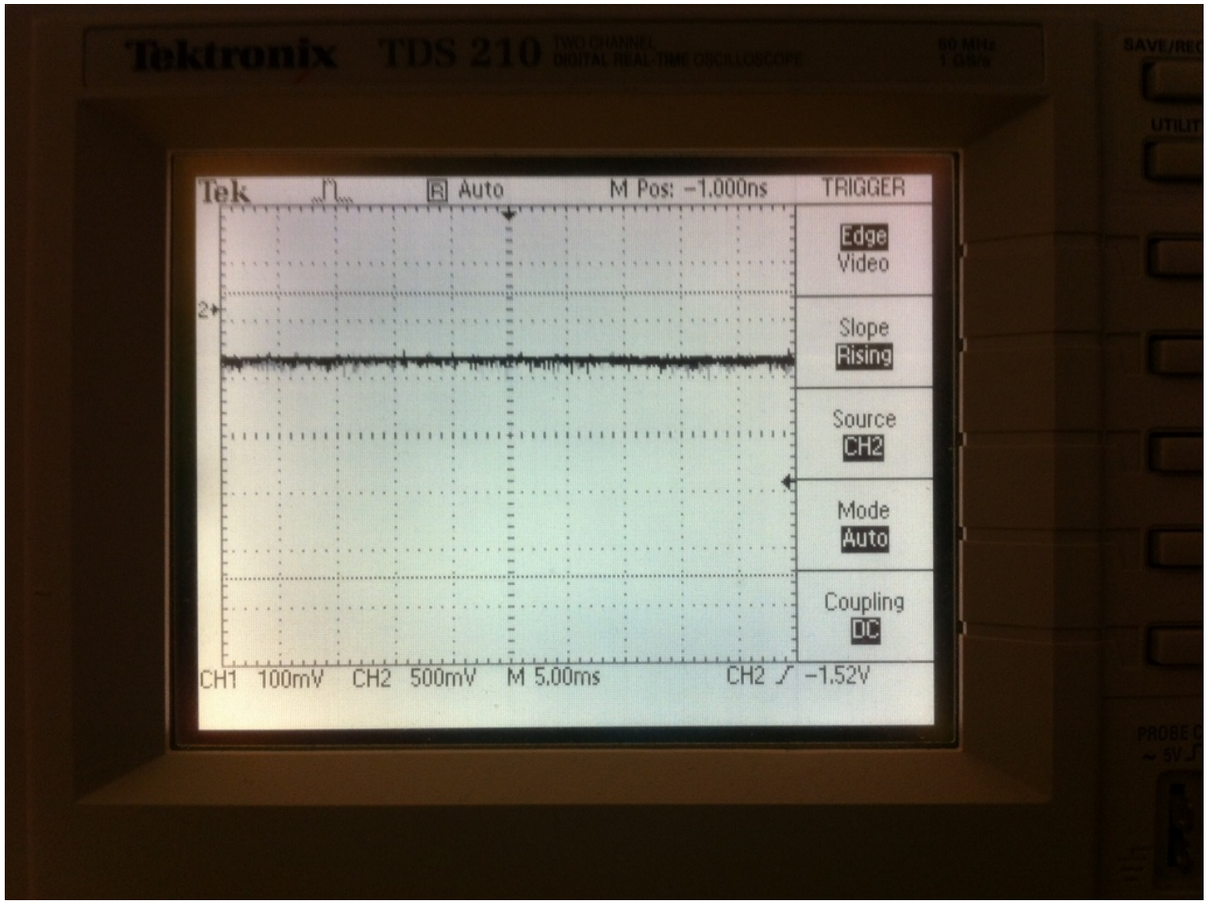
Tesat PDH Ball cavity

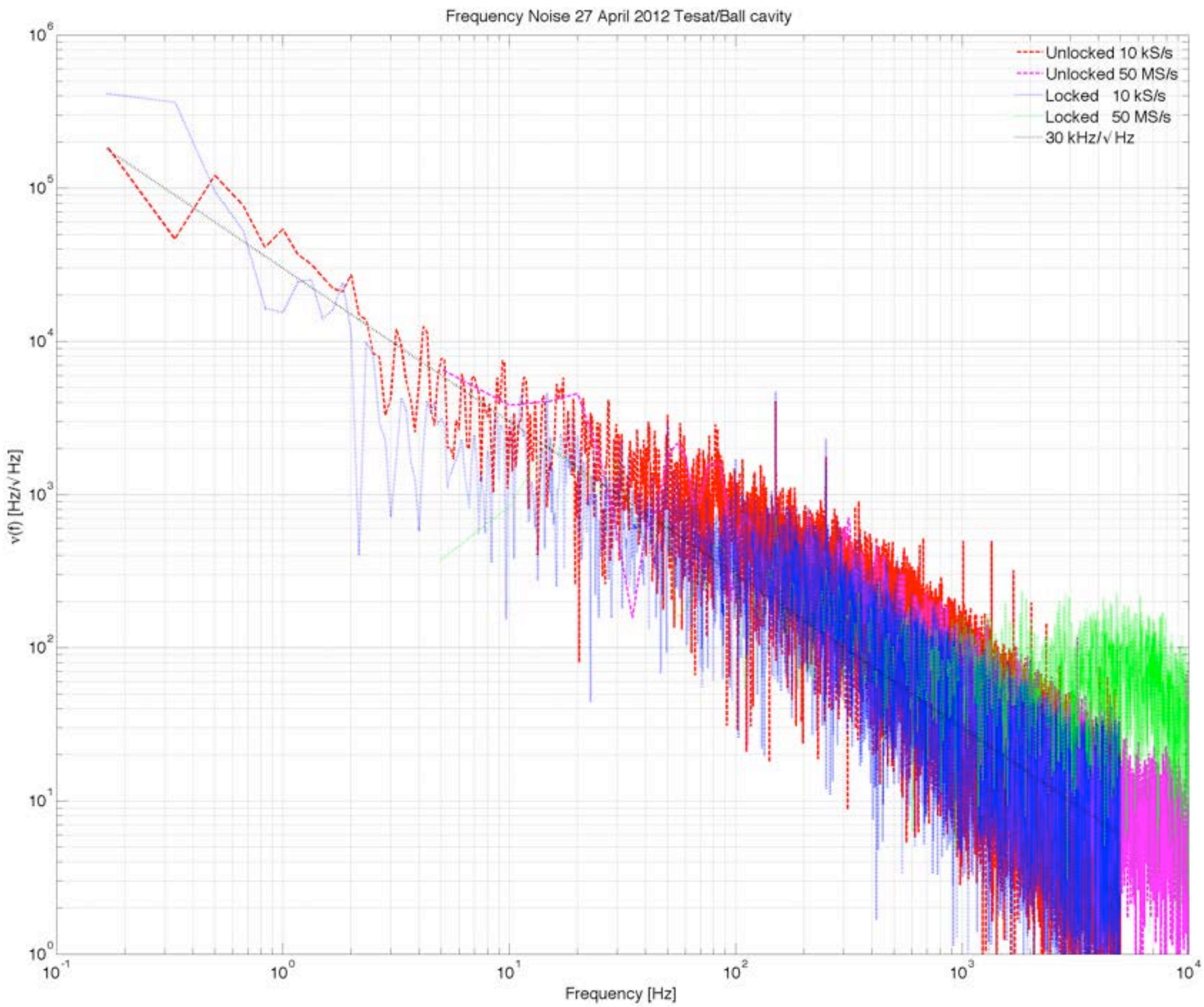




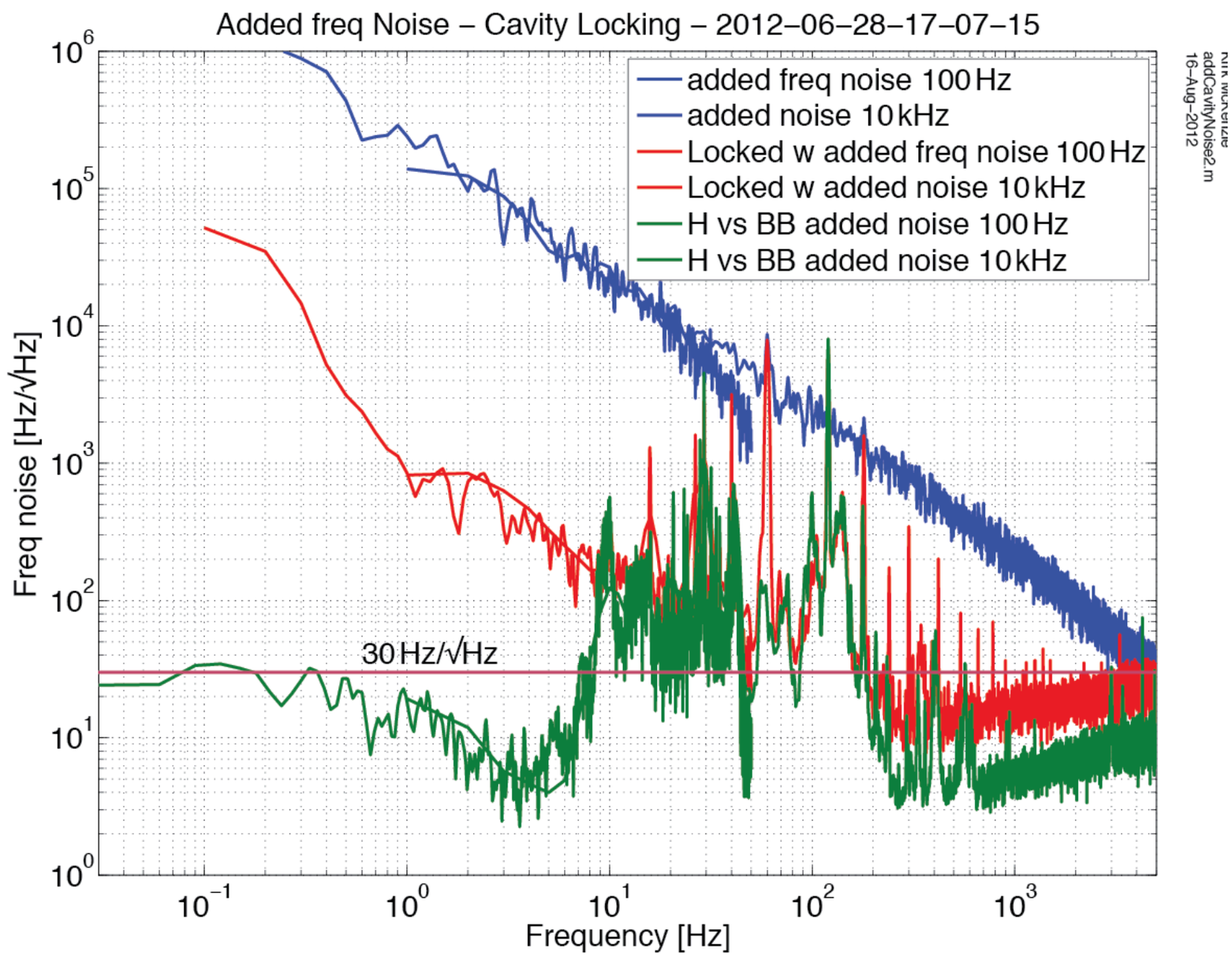
Tesat PDH locked to Ball cavity






Frequency Noise 27 April 2012 Tesat/Ball cavity
Unlocked 10 kS/s
Unlocked 50 MS/s
Locked 10 kS/s
Locked 50 MS/s
30 kHz/√Hz
ν(f) [Hz/√Hz]
Frequency [Hz]
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}

Cavity lock test with simulated noise



Summary

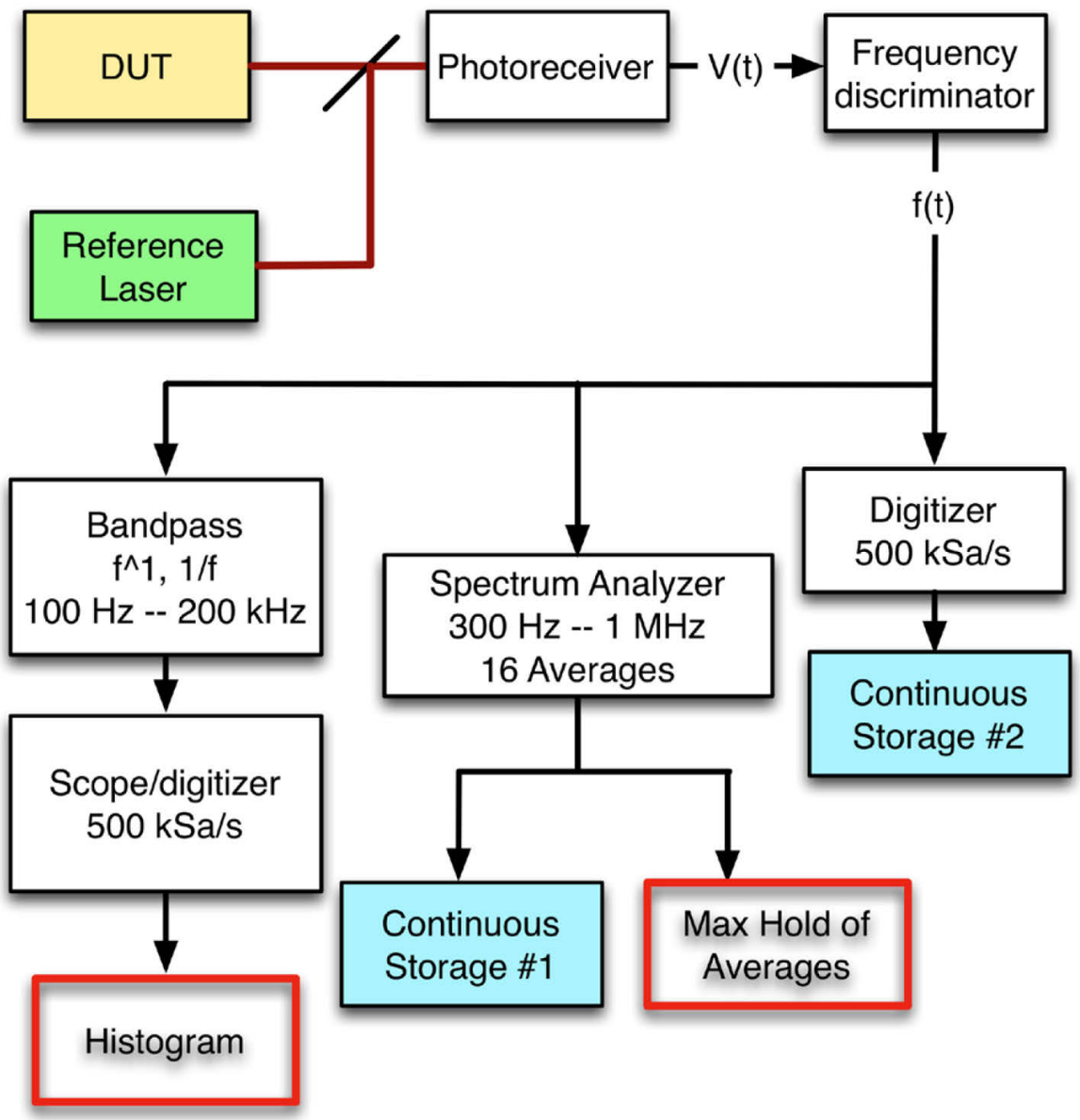
- Better performance than we expected
- Easy to phase lock, phasemeter works, PDH cavity works
- Have not found amplitude instabilities, or they have not been a problem
- We have had much help from people at AEI, esp.
- Felipe
- Michael
- Gerhard
- Karl-Heinz

Laser testing

- Heterodyne and homodyne techniques under development
- Emphasis on simple electronics, quick look pass/fail, large data volumes for detailed analysis
- Key element: frequency discriminator
- Time-domain and frequency domain requirements

Laser qualification testing

Heterodyne, quick look + off-line

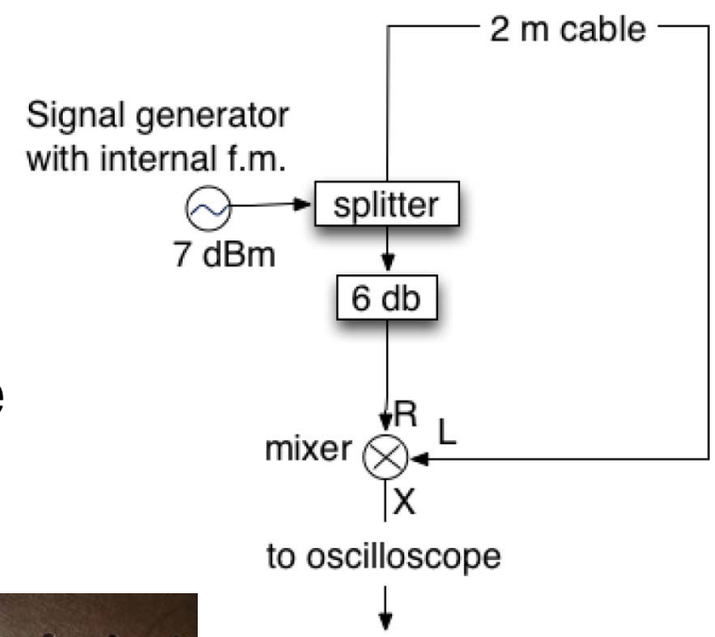


Laser testing

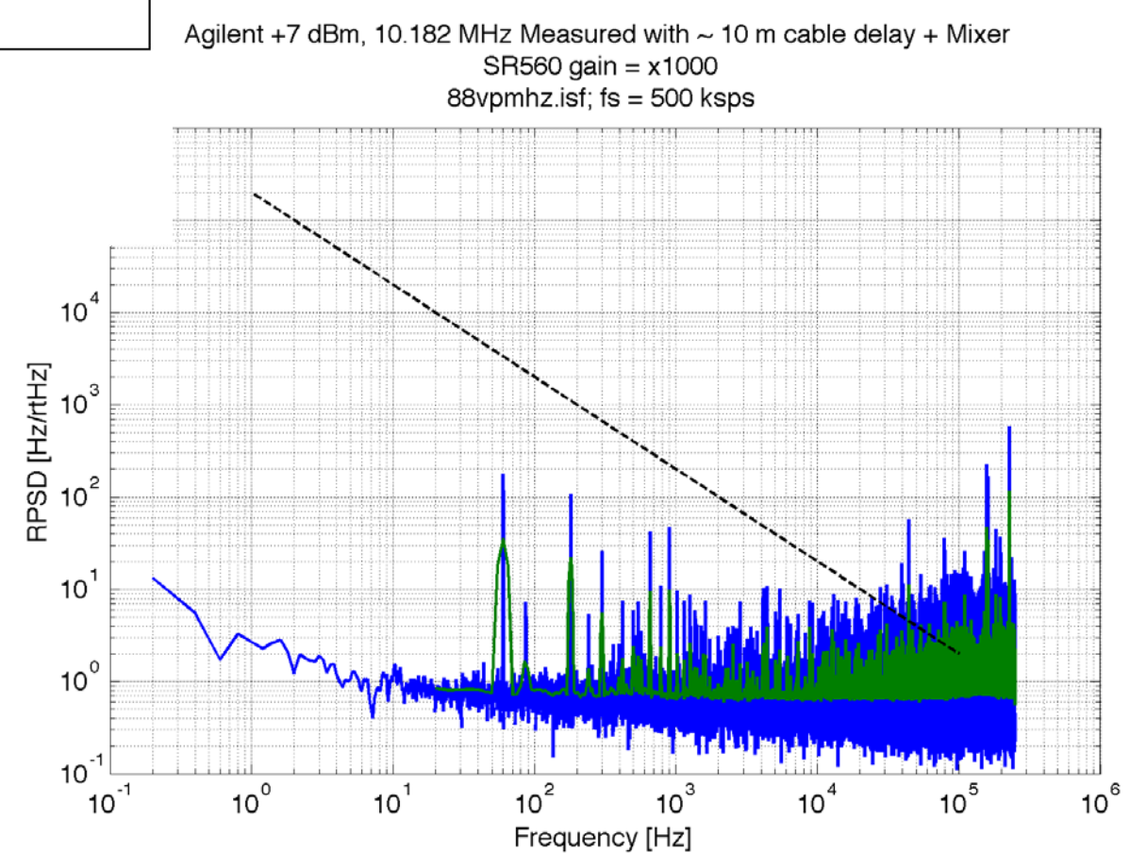
Heterodyne frequency discriminator

Frequency discriimnatortor,

Cable delay + mixe



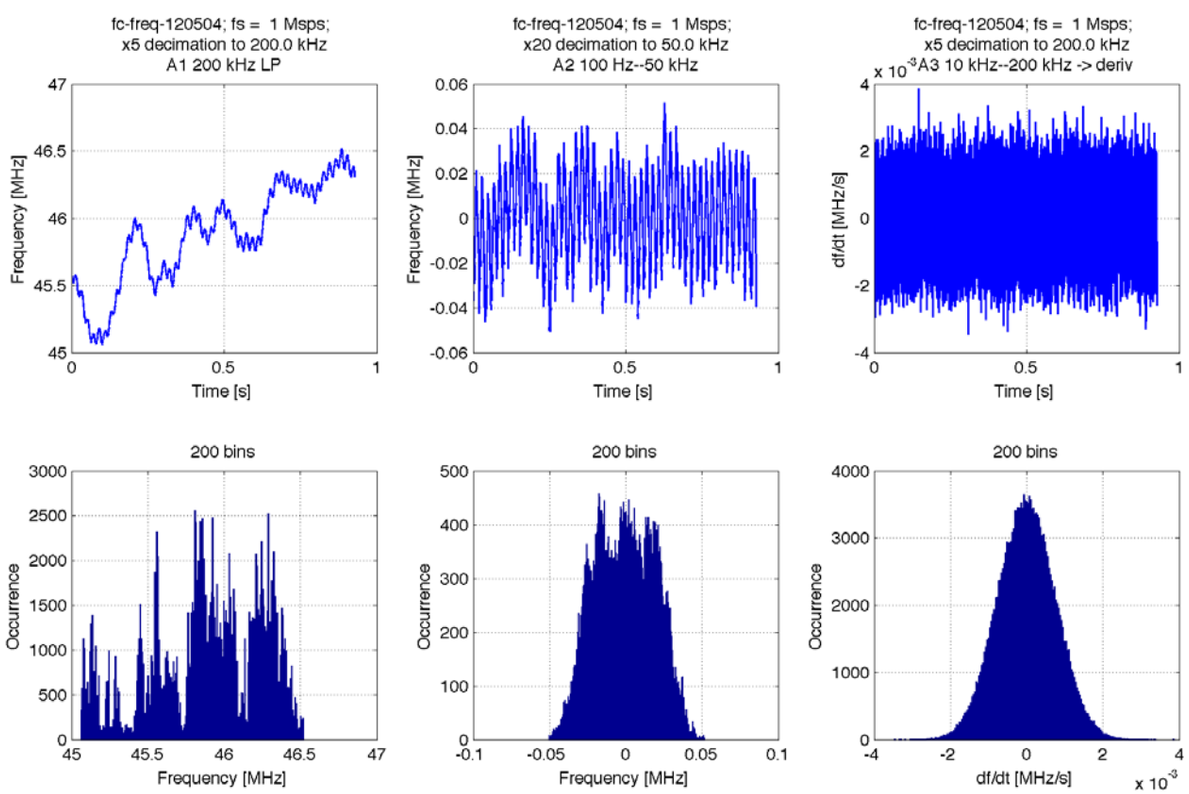
Noise floor

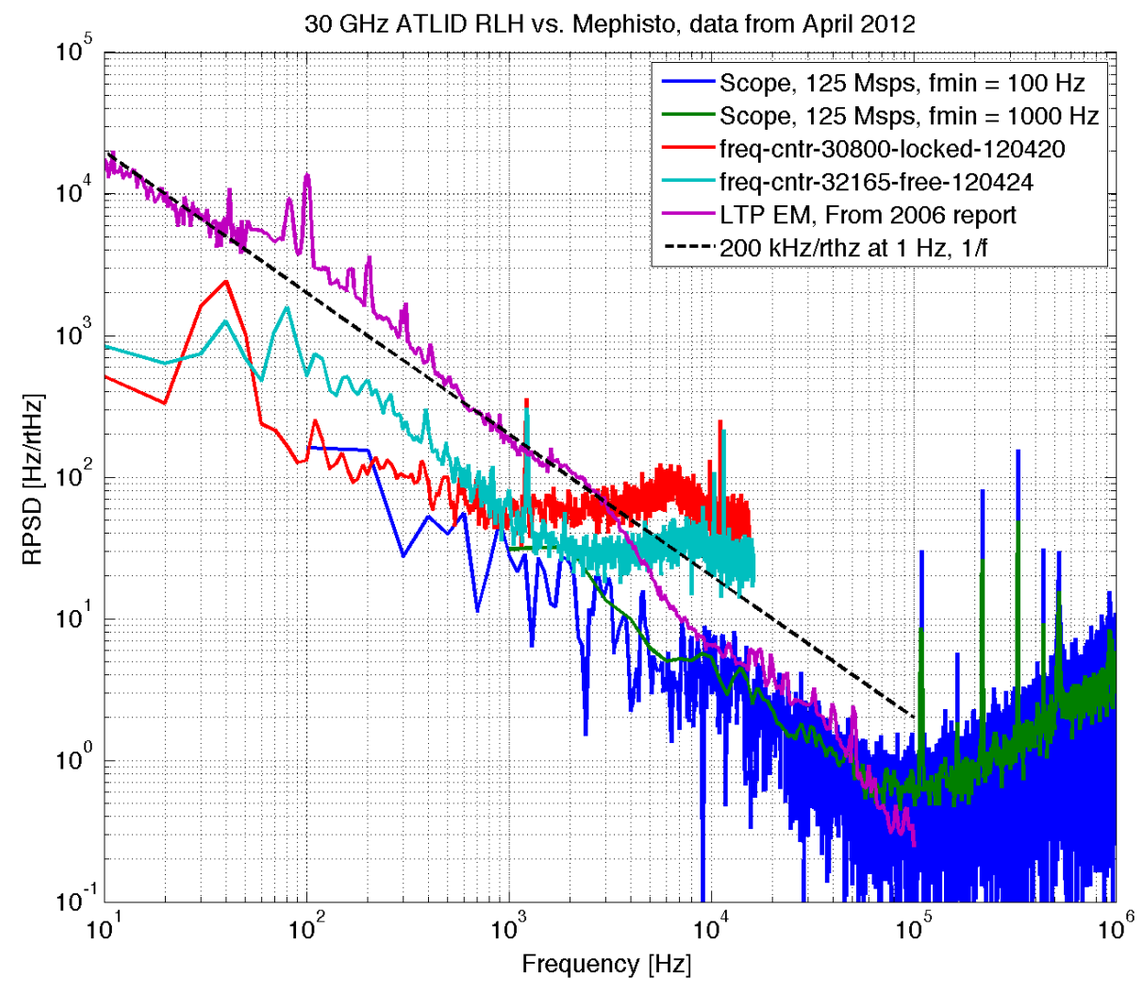


Laser testing

Tesat measurements
Frequency counter, amplitude storage

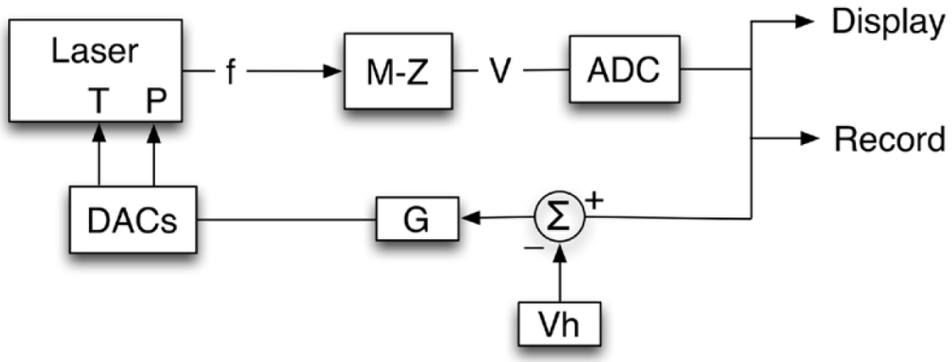
Time and frequency-domain performance



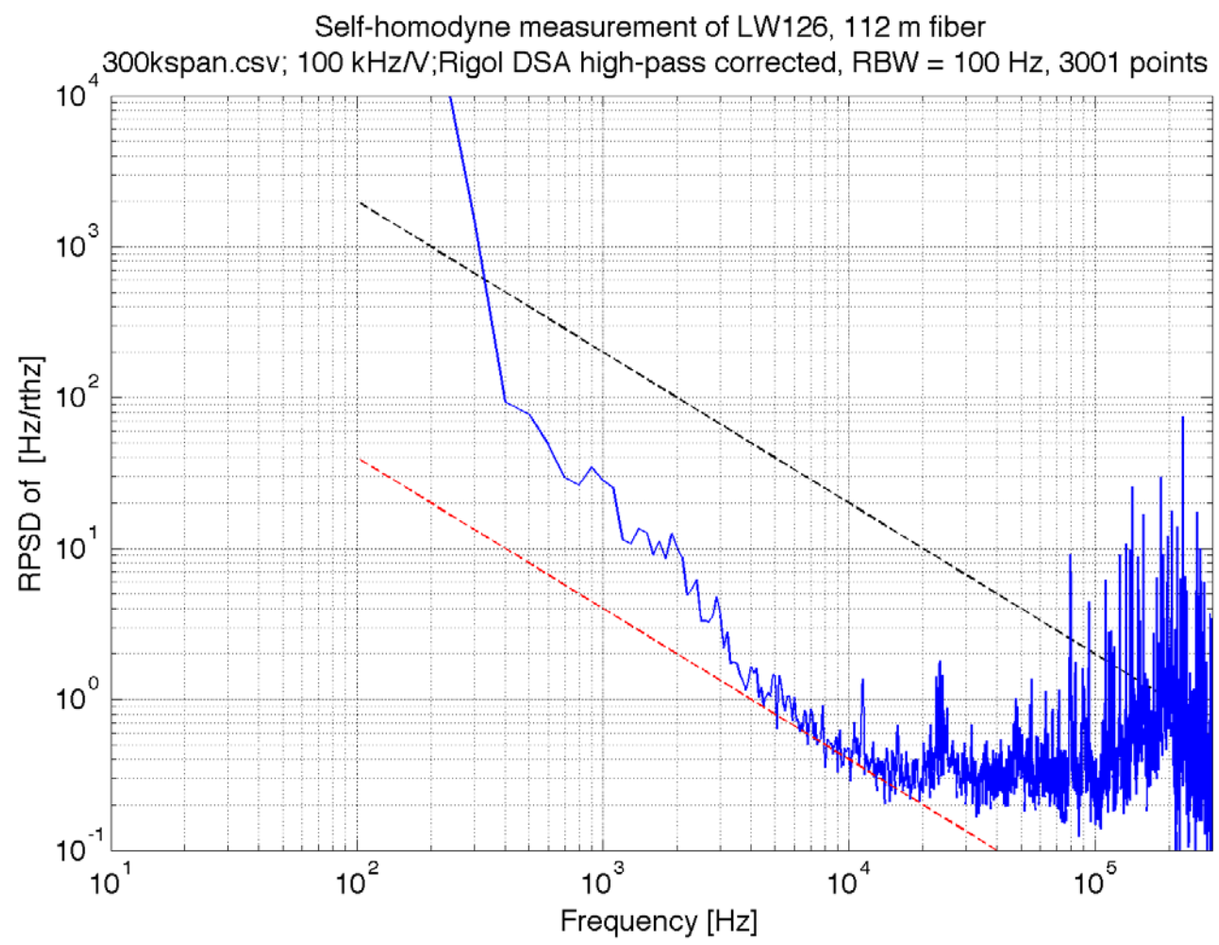


Laser testing

Homodyne fiber discriminator



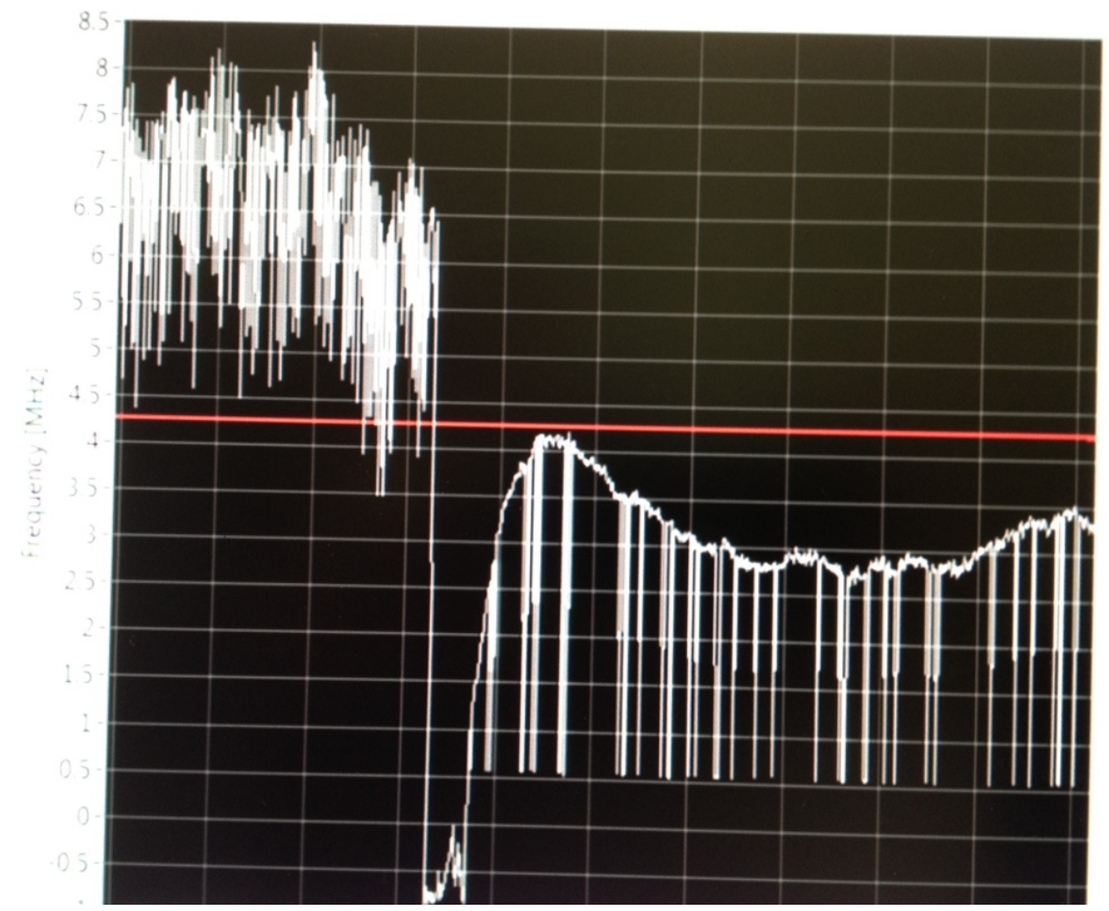
Fiber in air good above 1 kHz



Backup

DPLL noise

- saw this on first day
- never again
- until last day
- had to reboot PXI and computer
- LV glitch or laser warm up noise?



Tesat laser frequency noise - 2006

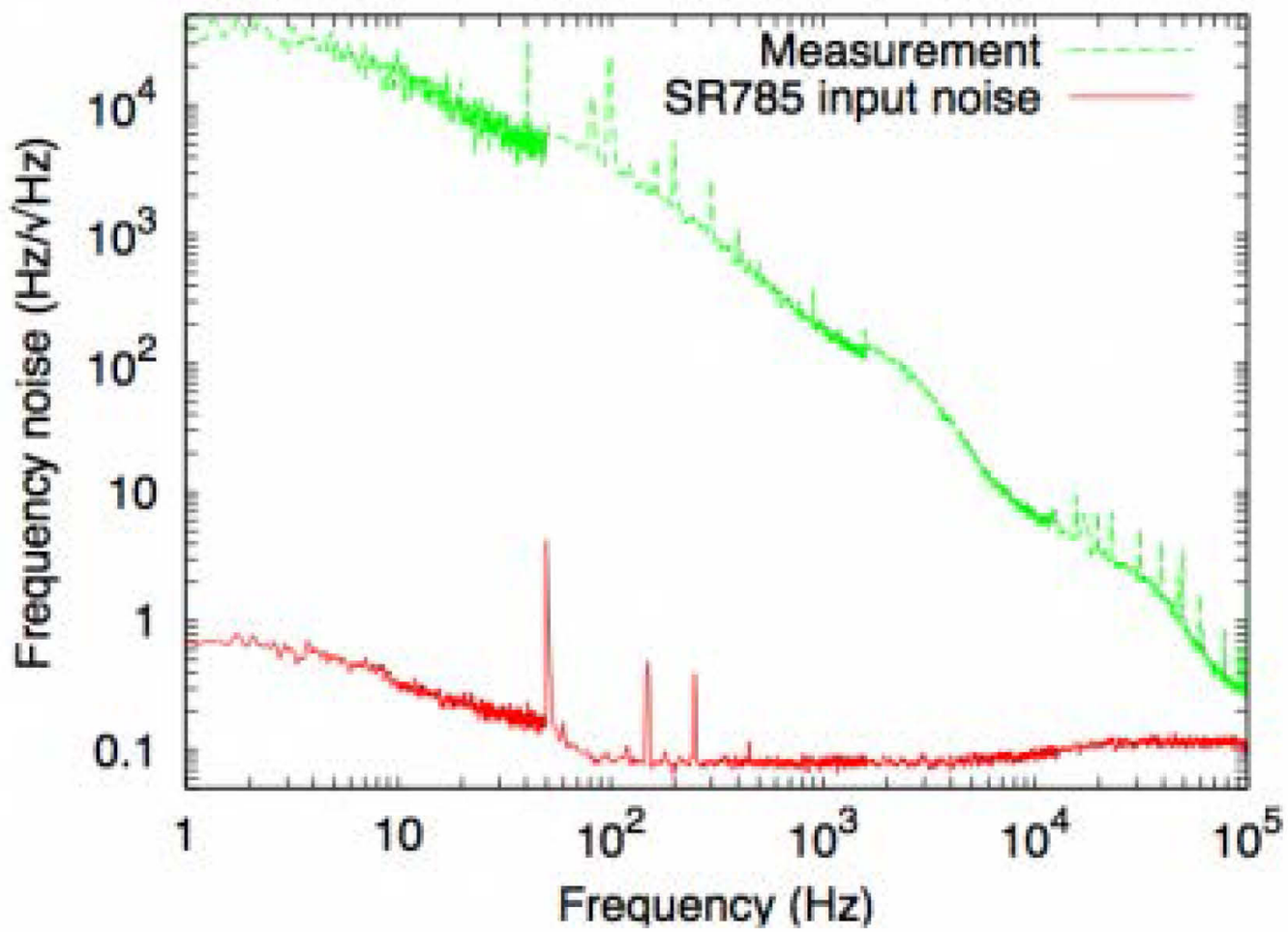


Figure 46: Frequency noise of the free-running LTP RLU EM at 25.0 °C reference point temperature. The baseplate temperature measured 21.7 °C.