ALLEGRO performance during E7

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- Bar has a double-resonant response to the gravitational field, in fourier domain, (to a few percent), of

$$X(\omega) \cong \frac{1}{\omega_0}\left(\sqrt{\frac{m_1}{m_2}}\sin\theta_M \cos\theta_M\right)\left(\frac{-1}{\left(\omega_+^2-\omega^2\right)+i\frac{\omega_+}{Q_+}\omega}+\frac{+1}{\left(\omega_-^2-\omega^2\right)+i\frac{\omega_-}{Q_-}\omega}\right)\frac{1}{2}l_e\omega^2 H(\omega)$$

$H(\omega)$ = strain tensor component aligned to bar

$X(\omega)$ = sensor output (displacement)

$$\frac{m_1}{m_2} = \frac{\text{resonator mass}}{\text{bar mass}} = \frac{0.64}{1148} = \left(\frac{1}{42}\right)^2$$

$$l_e = \text{effective length} = \frac{4}{\pi^2}(3.0\ \text{m})$$

θ_M = mode mixing angle = 31°

ω_+ upper mode freq 2π 919.5 Hz

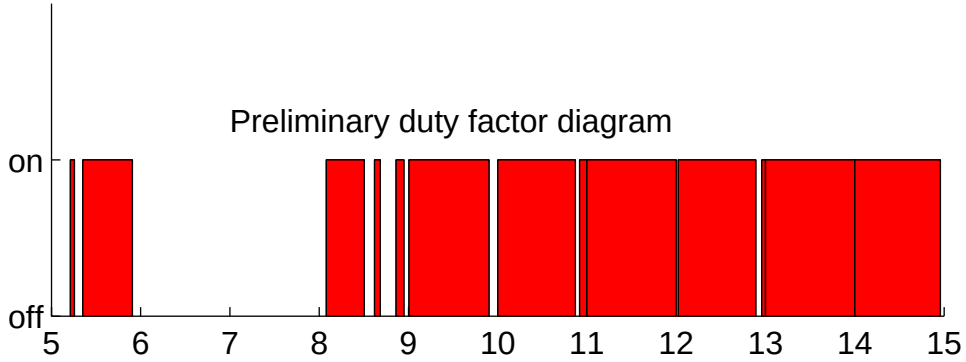
ω_- = lower mode freq = 2π 895.1 Hz

ω_0 average freq 2π 907.3 Hz

$$\frac{Q_+}{Q_-} = \frac{\text{coupled plus quality factor}}{\text{coupled minus quality factor}} = \frac{\sim 10^6}{\sim 10^6}$$

Data collected in 3 Orientations

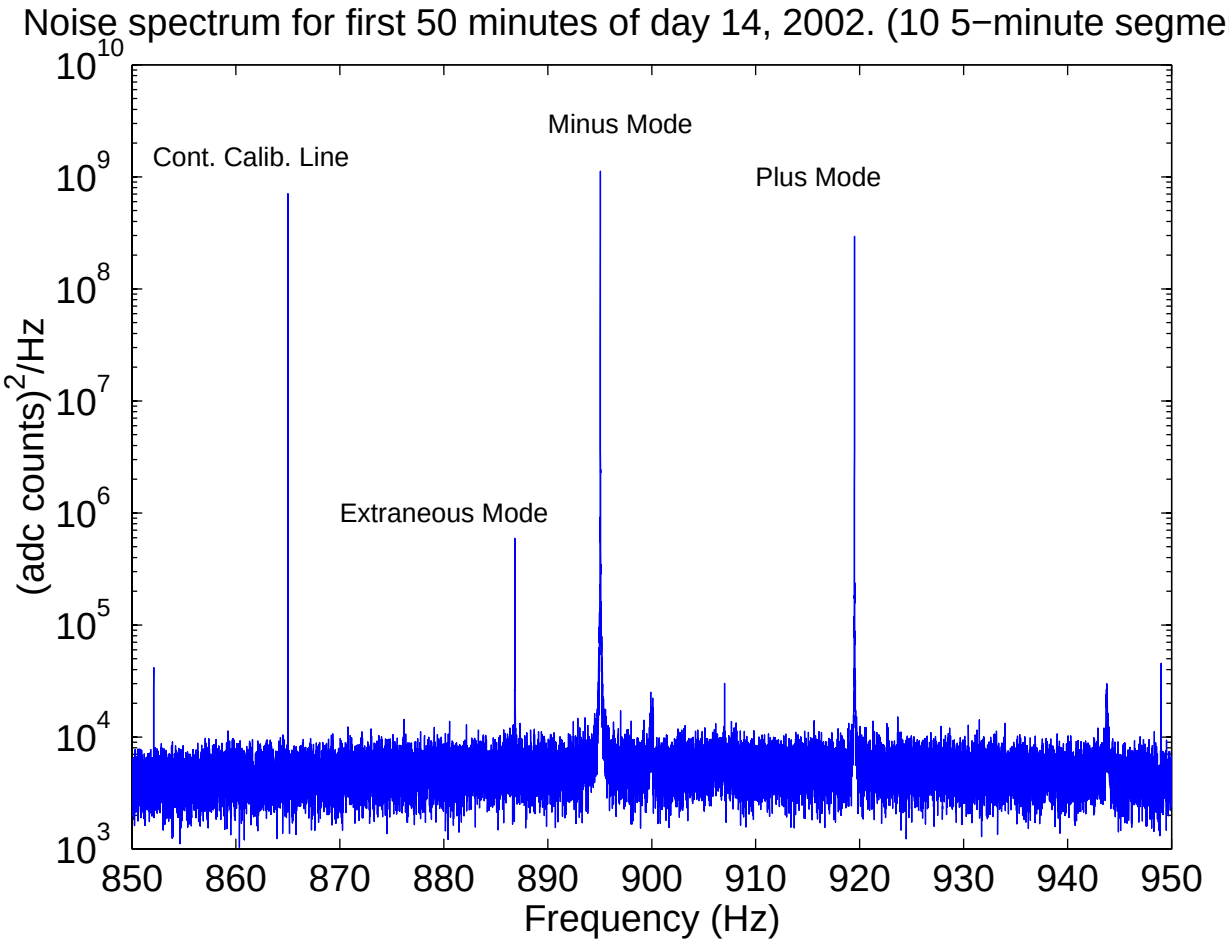
- Good data started with first alignment (~ IGEC alignment)
  - 48^0 W of N from UT008/01:21 to UT010/20:53
- Aligned to LLO Yarm – call this positive correlation
  - 18^0 W of N from UT010/23:27 to UT012/20:50
- Nearly null alignment to LLO – nearly 45^0 off the LLO Yarm
  - ~68^0 W of N from UT012/23:30 to UT014/22:13 (after E7)
  - (discovered uncertainty in last orientation. Will remeasure.)
- (missing data aligned to LLO Xarm – or negative correlation)



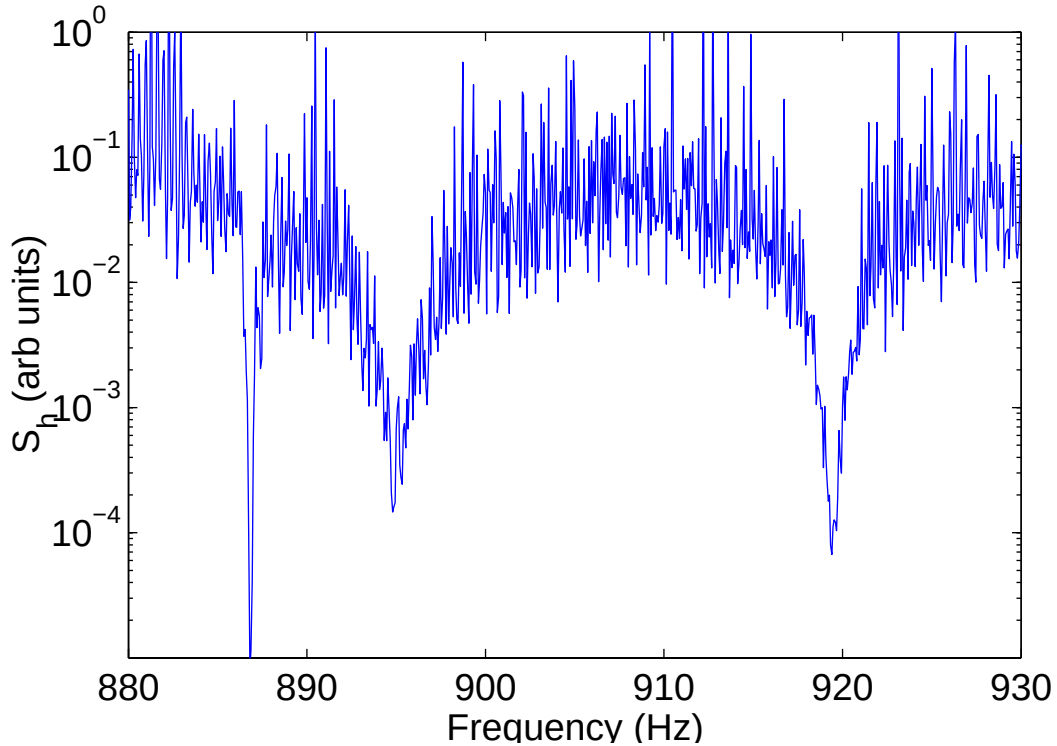
Performance

- White noise at output was nominal (SQUID fine)
- Coupling, from sensor input (displacement) to sensor output, was about 60% of nominal (increased the white noise, referred to input)
- Force noise appeared to be nominal, but most analysis ahead.
- Non-Gaussian noise was quite low in a typical segment. Can see some BIG burst events (from the construction activity?) No vetos applied yet.
- Have done the first pass burst filter, see time history on next graphs.
- NO DAMAGE FROM COLD ROTATION! FAST RECOVERY!

Typical Displacement Noise Spectrum



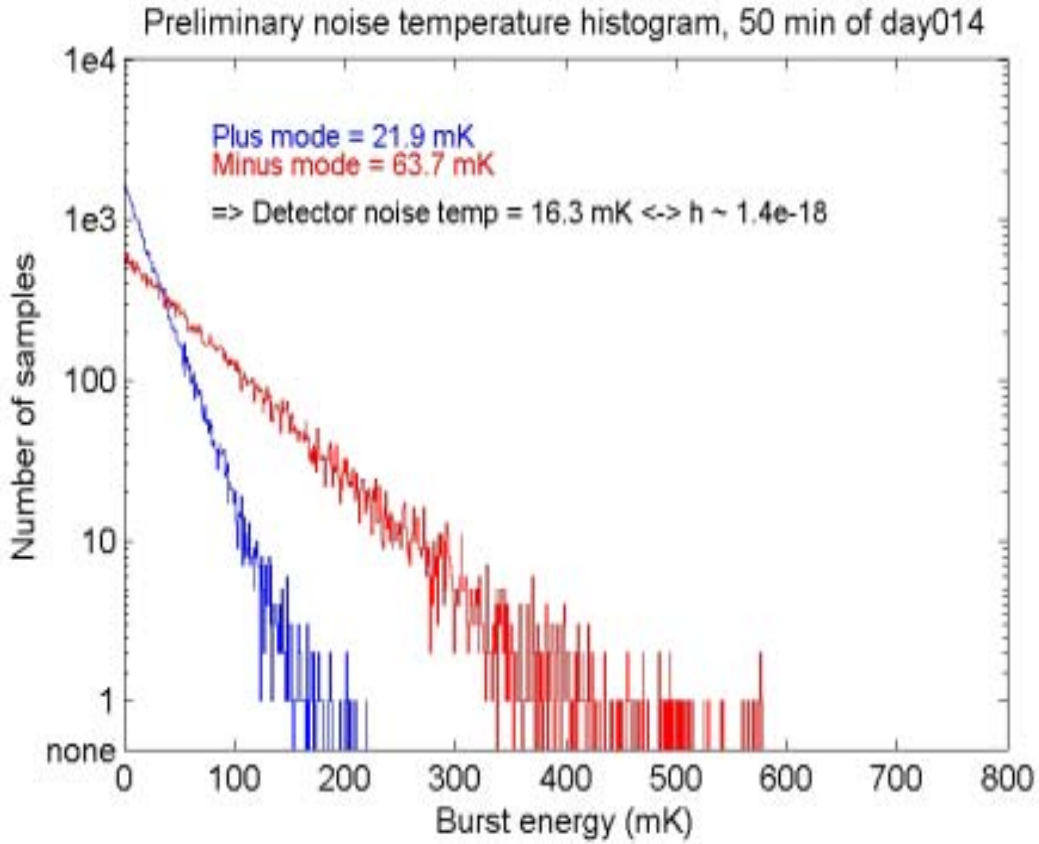
First Attempts at Strain Noise Spectrum



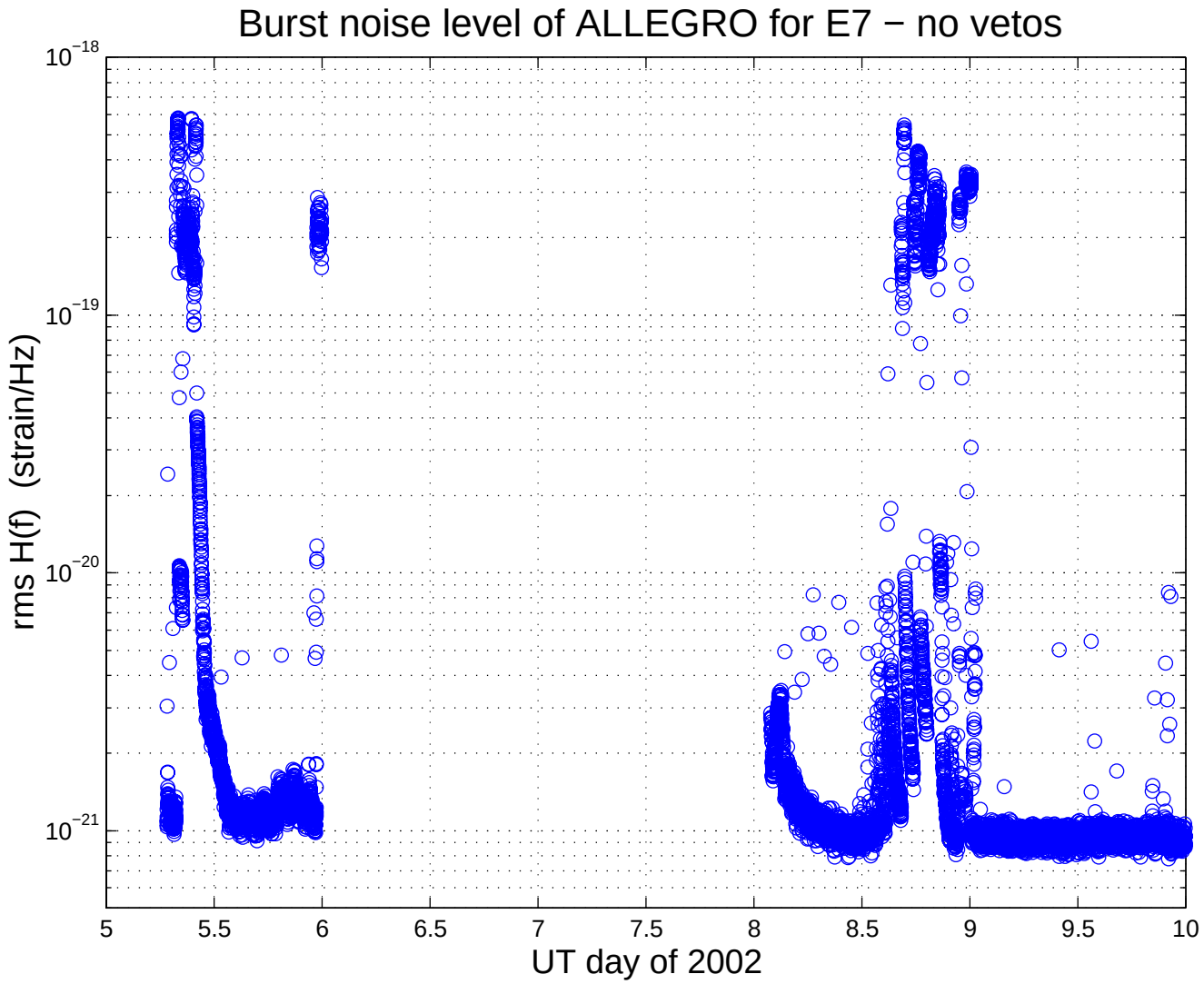
Analysis for Bursts

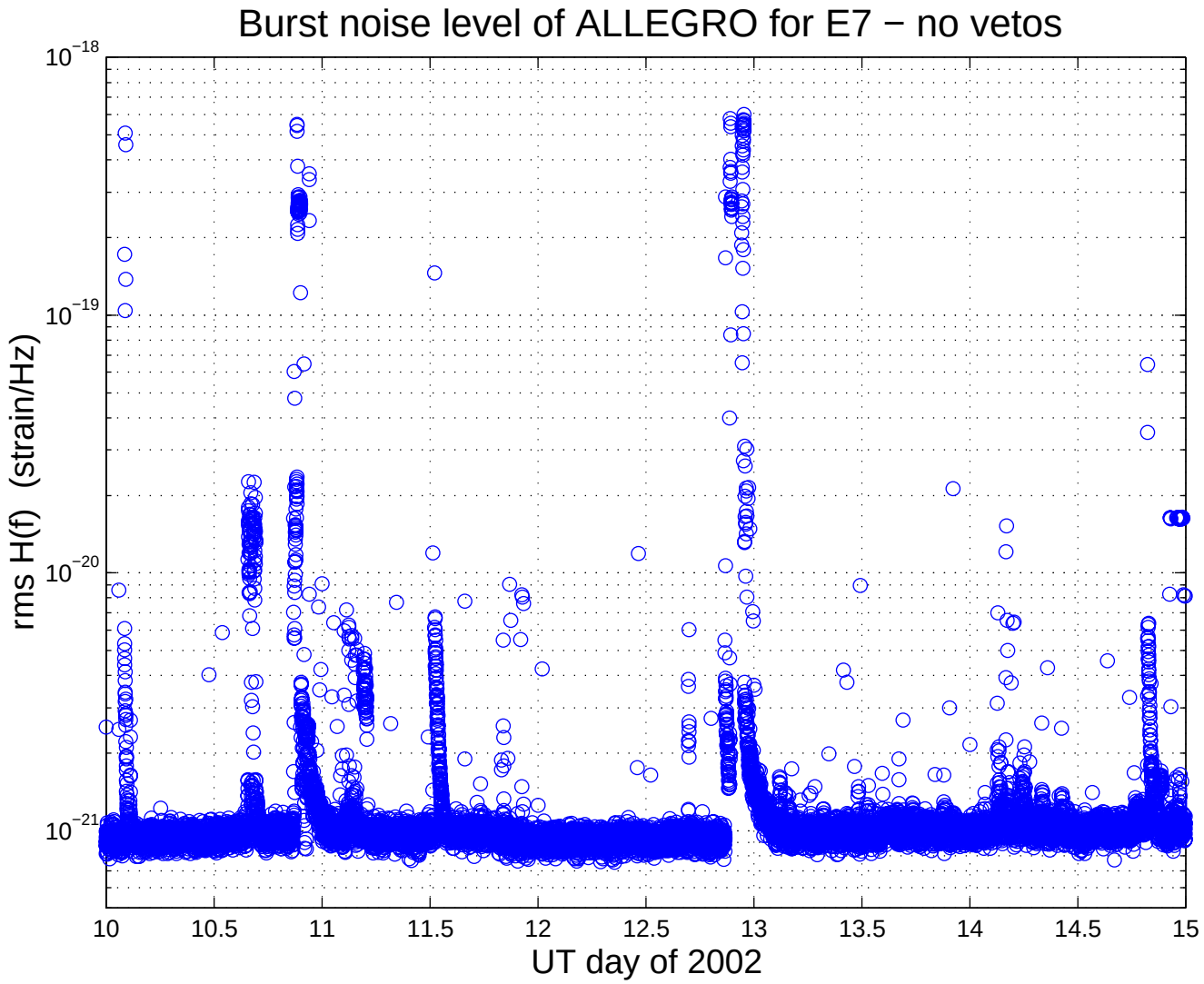
- Have applied our “separate mode” filter, looking for sudden excitation of each mode, then averaging the result.
- This filter constructed by the following algorithm:
  - Demodulate data around each mode separately to form a complex time series (decimated).
  - Measure discrete time autocorrelation to construct autocorrelation matrix **C**
  - Measure discrete time signal response to signal to get **s**, the signal vector
  - Form all FIR filter $\mathbf{s^T C^{-1}}$ for each mode and apply.
  - Square and sum two sequences. Normalize.
- Output is the best estimate of the fourier amplitude of the burst strain, $H(\omega_a)$ at the bar frequency $\omega_{a,}$ that accounts for the data surrounding that sample.
- Noise “temperature” shown as rms value of $H(\omega_a)$. No vetos yet.

Burst Result Histogram: no candidates



- Essentially no events outside the Gaussian distribution, indicating all ‘big’ events are consistent with statistical fluctuation of the stationary noise.


Burst noise level of ALLEGRO for E7 − no vetos
rms H(f) (strain/Hz)
10^{-18}
10^{-19}
10^{-20}
10^{-21}
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
UT day of 2002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10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
UT day of 2002

To Do

- Finish calibration and make clean S_h curve [2nd attempt failed].
- Construct burst filter for these conditions. [DONE]
- Run it over all the data – [DONE]
- Still TO DO
  - Implement previous veto strategy
    - Examine PEM channels for those (few?) events outside the gaussian distribution, and look for unmistakable local causes.
  - Set threshold and generate event list.

Stochastic Analysis

- Data conversion to frames underway by Ed Daw at LSU
- Windup for analysis at the MDC.
  - Siong Heng and Ed Daw from LSU
  - Martin McHugh from Loyola
  - John Whelan from Brownsville
- Correlation to LLO to be done with LDAS software