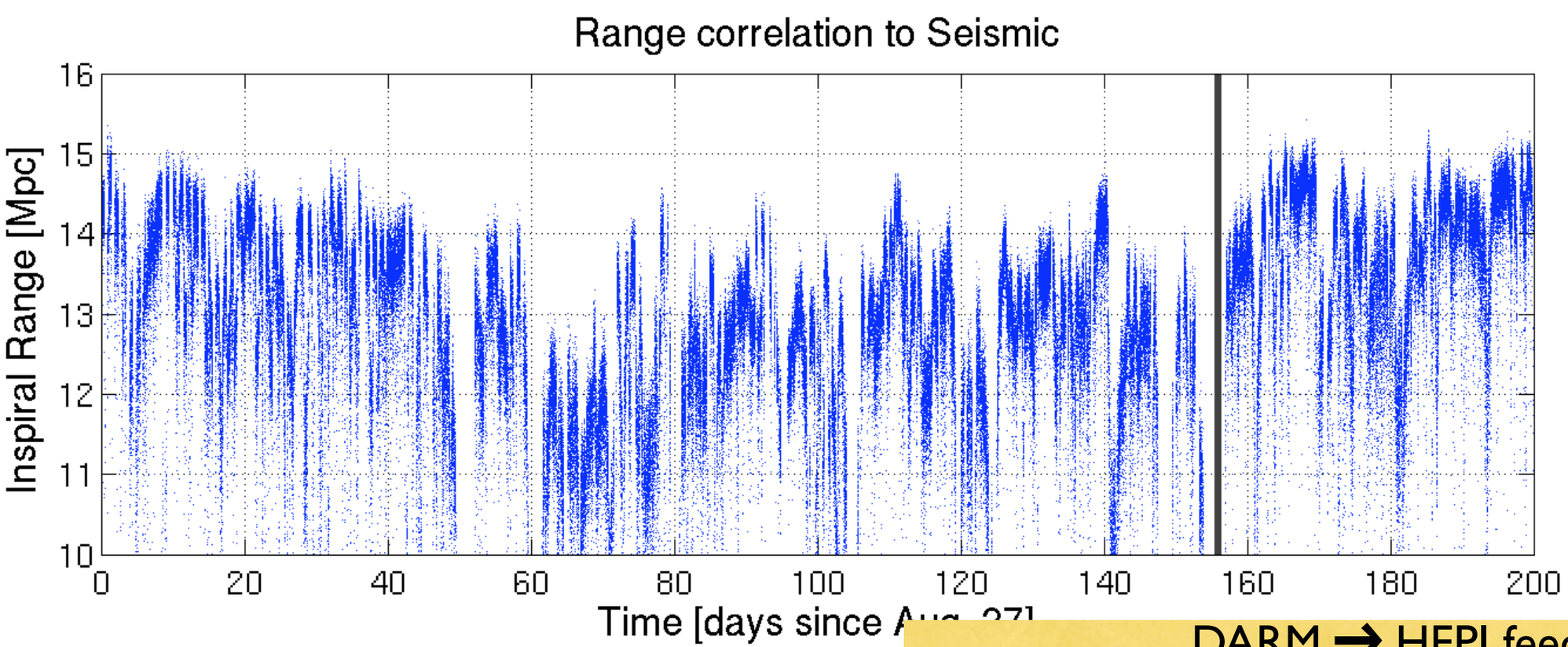
Upconversion 2007

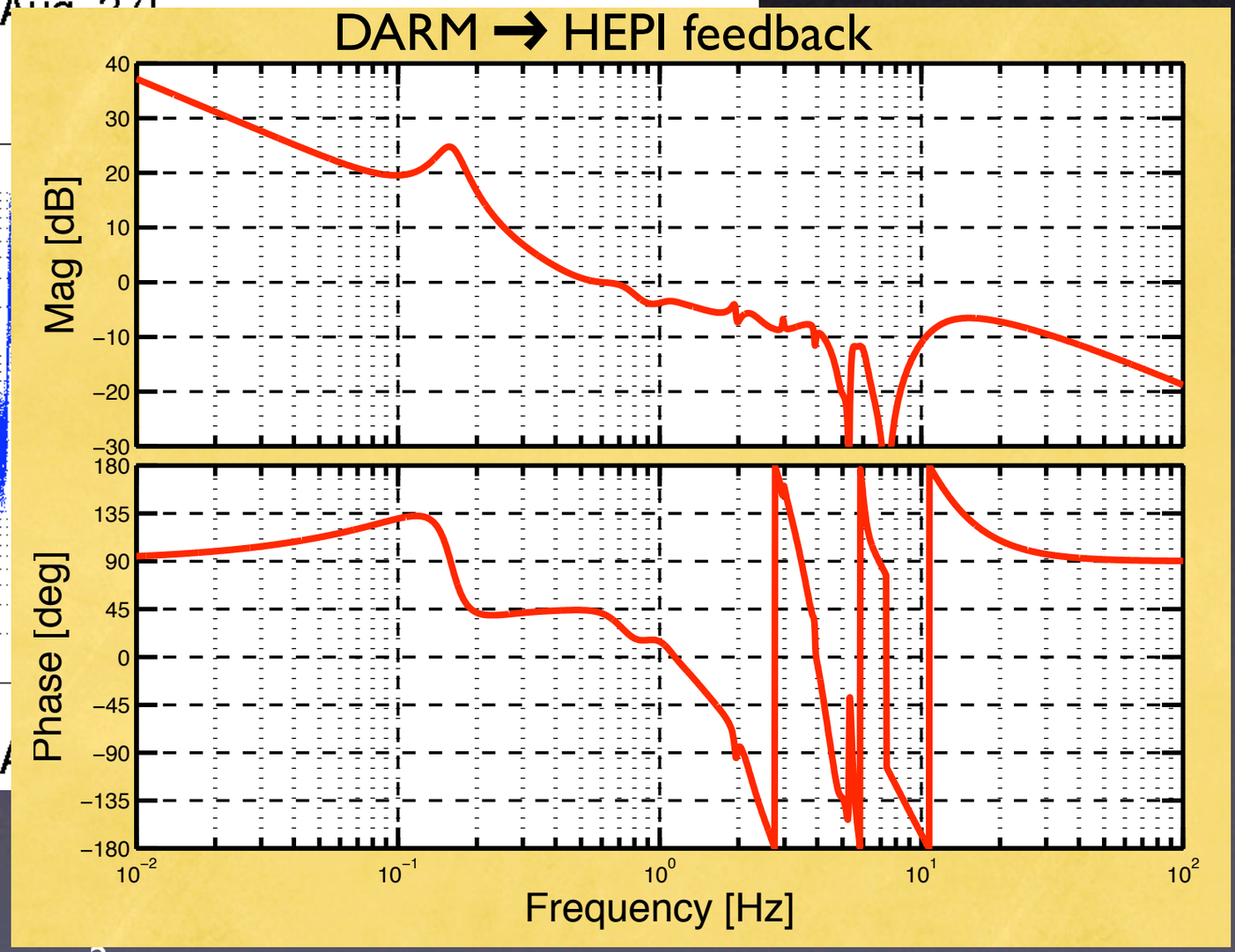
Sam Waldman

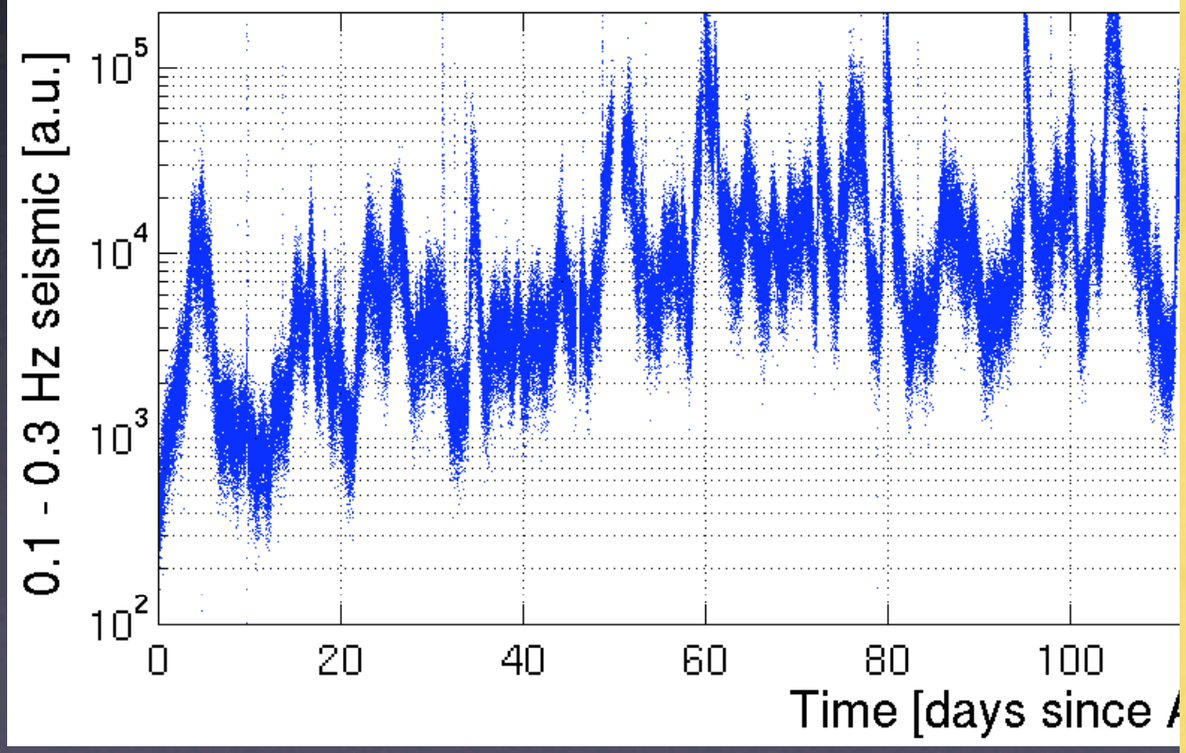
March LSC Meeting

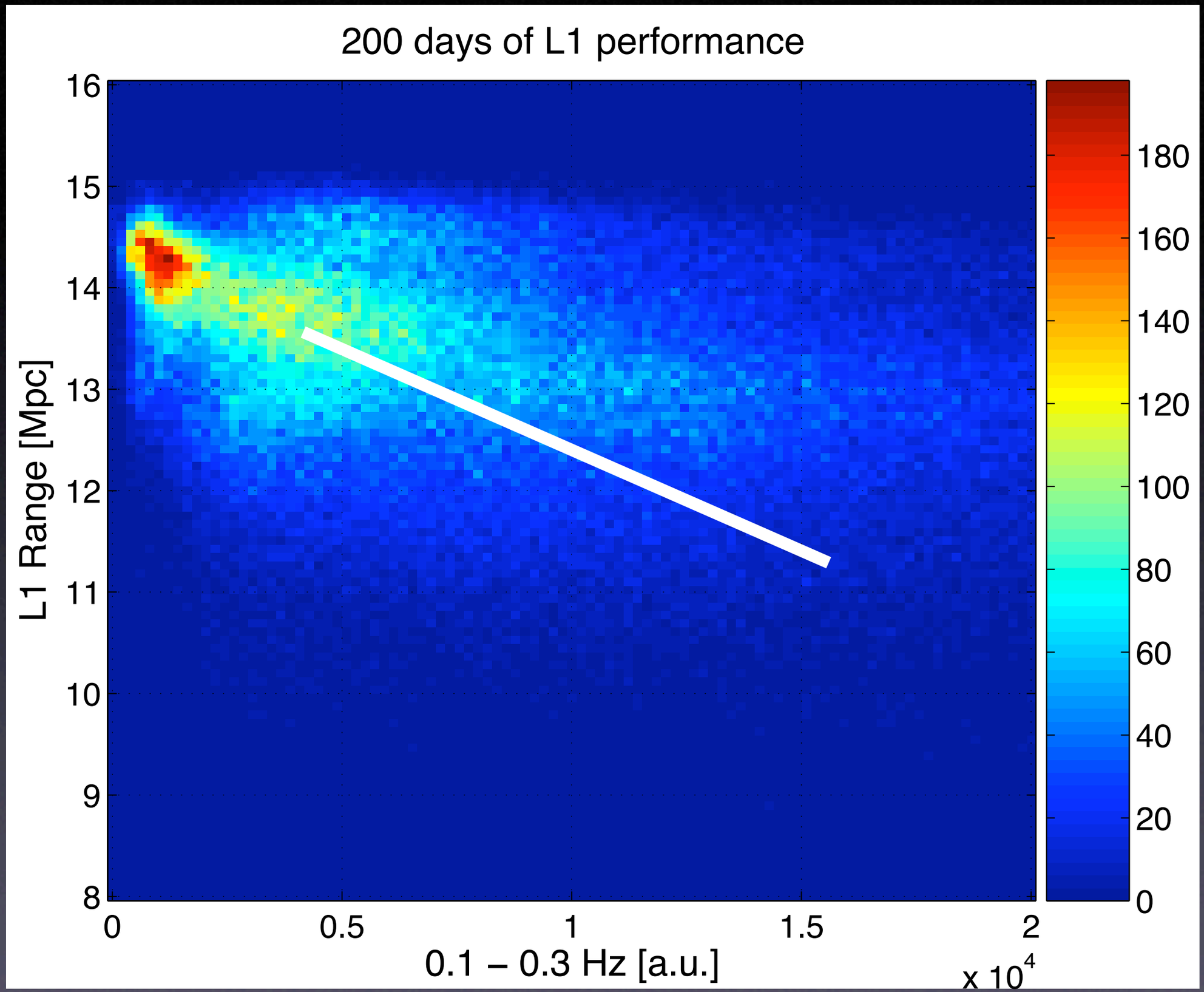
Baton Rouge, LA

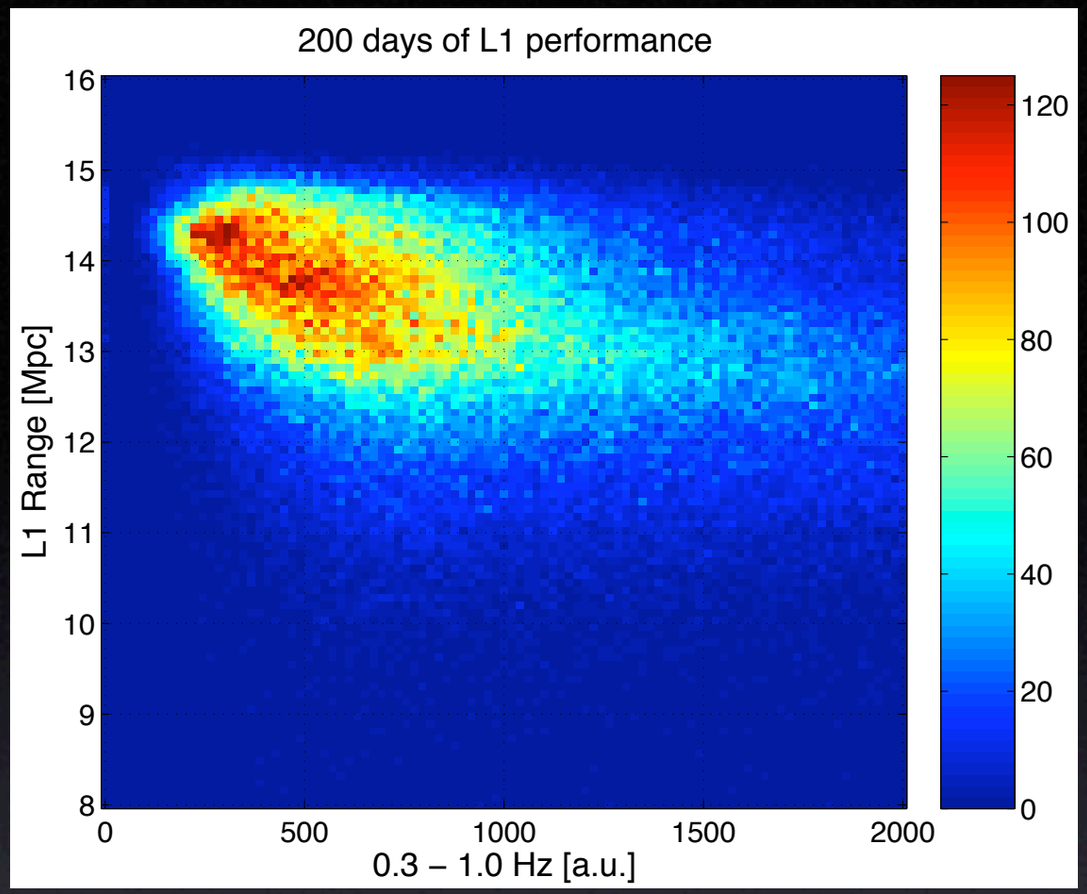
G070068

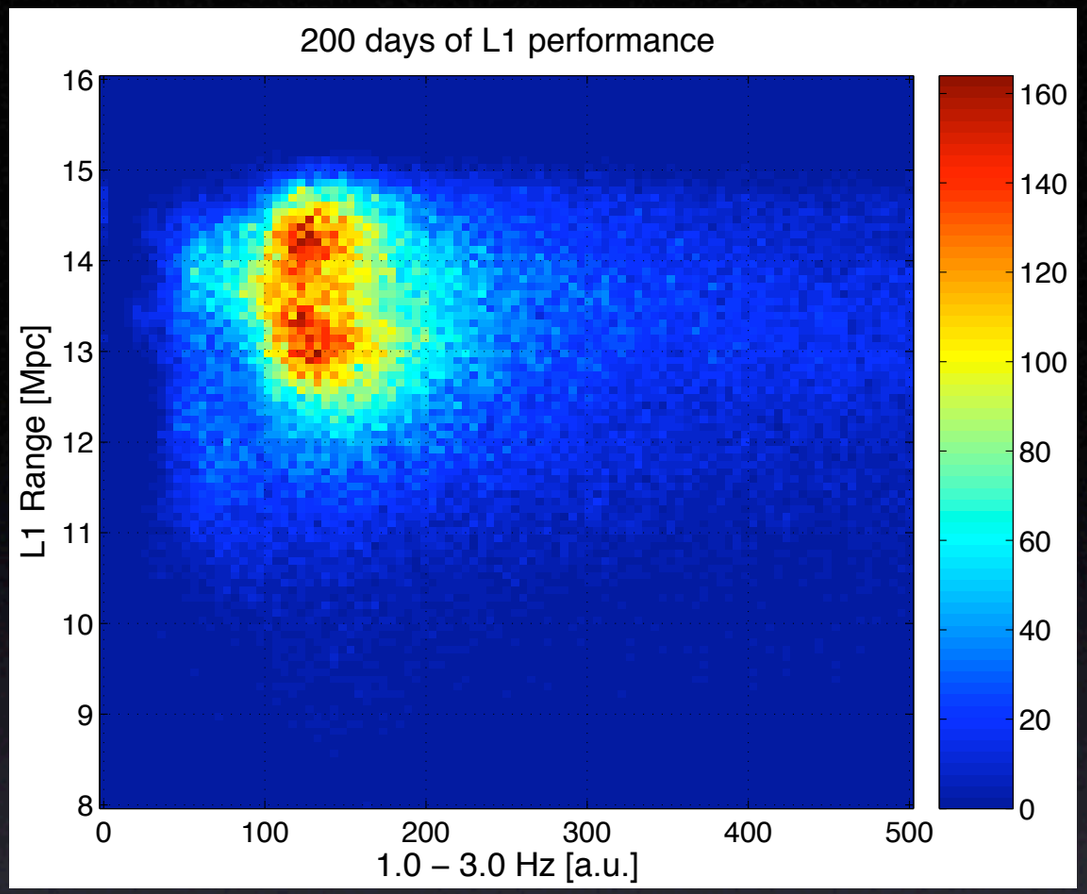

Range correlation to Seismic
Inspiral Range [Mpc]
16
15
14
13
12
11
10
0
20
40
60
80
100
120
140
160
180
200
Time [days since A

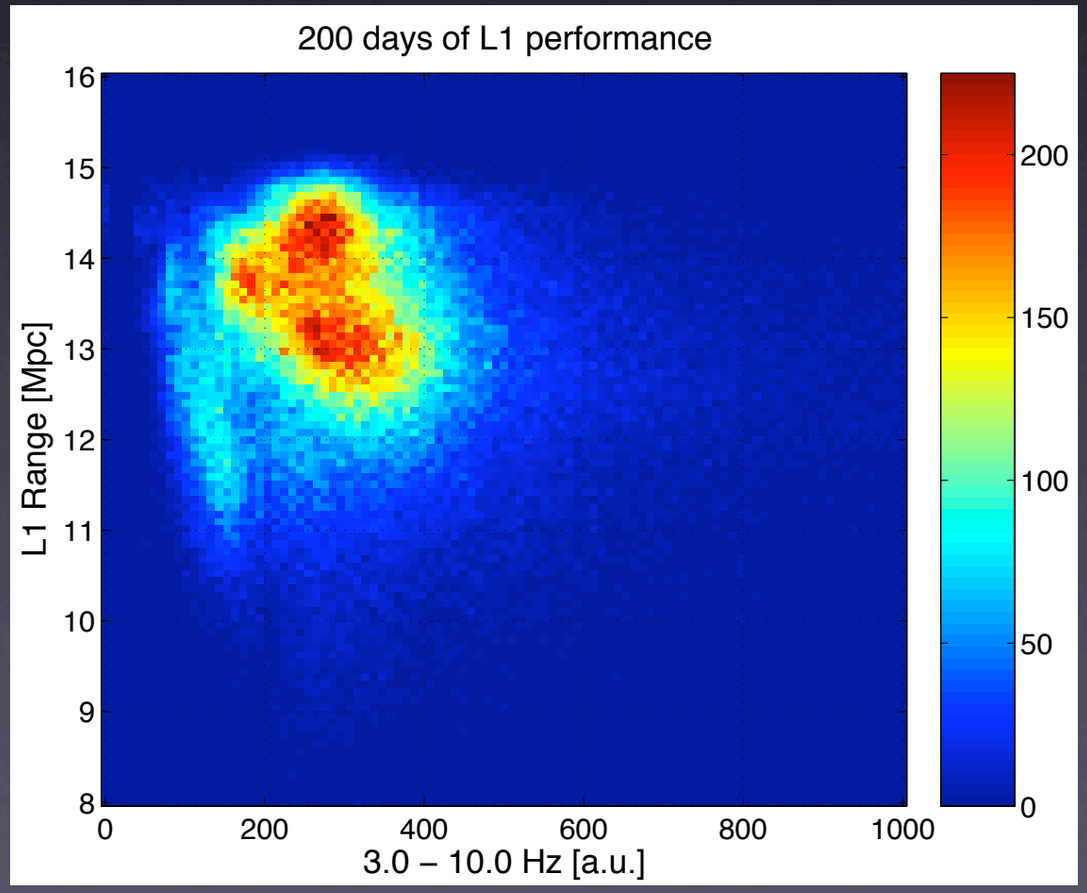

DARM ➜ HEPI feedback
Mag [dB]
40
30
20
10
0
−10
−20
−30
Phase [deg]
180
135
90
45
0
−45
−90
−135
−180
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency [Hz]

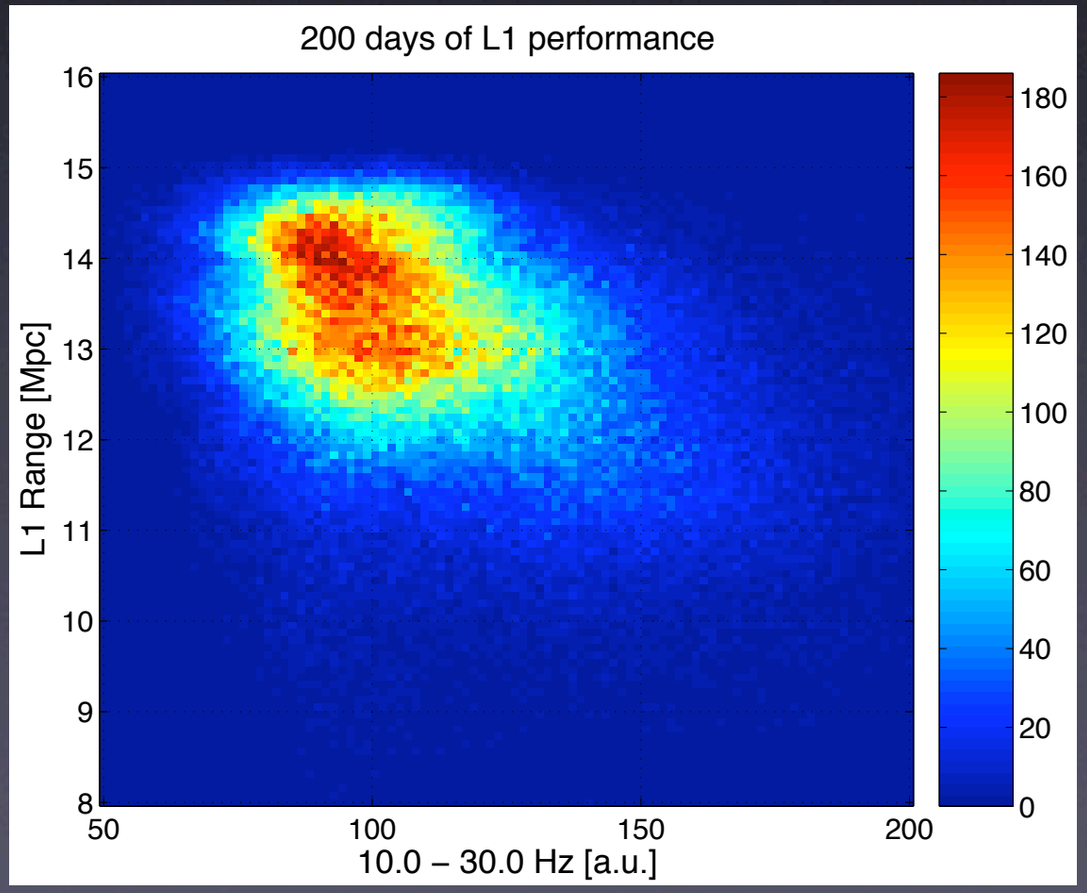

0.1 - 0.3 Hz seismic [a.u.]
10^{5}
10^{4}
10^{3}
10^{2}
0
20
40
60
80
100
Time [days since A

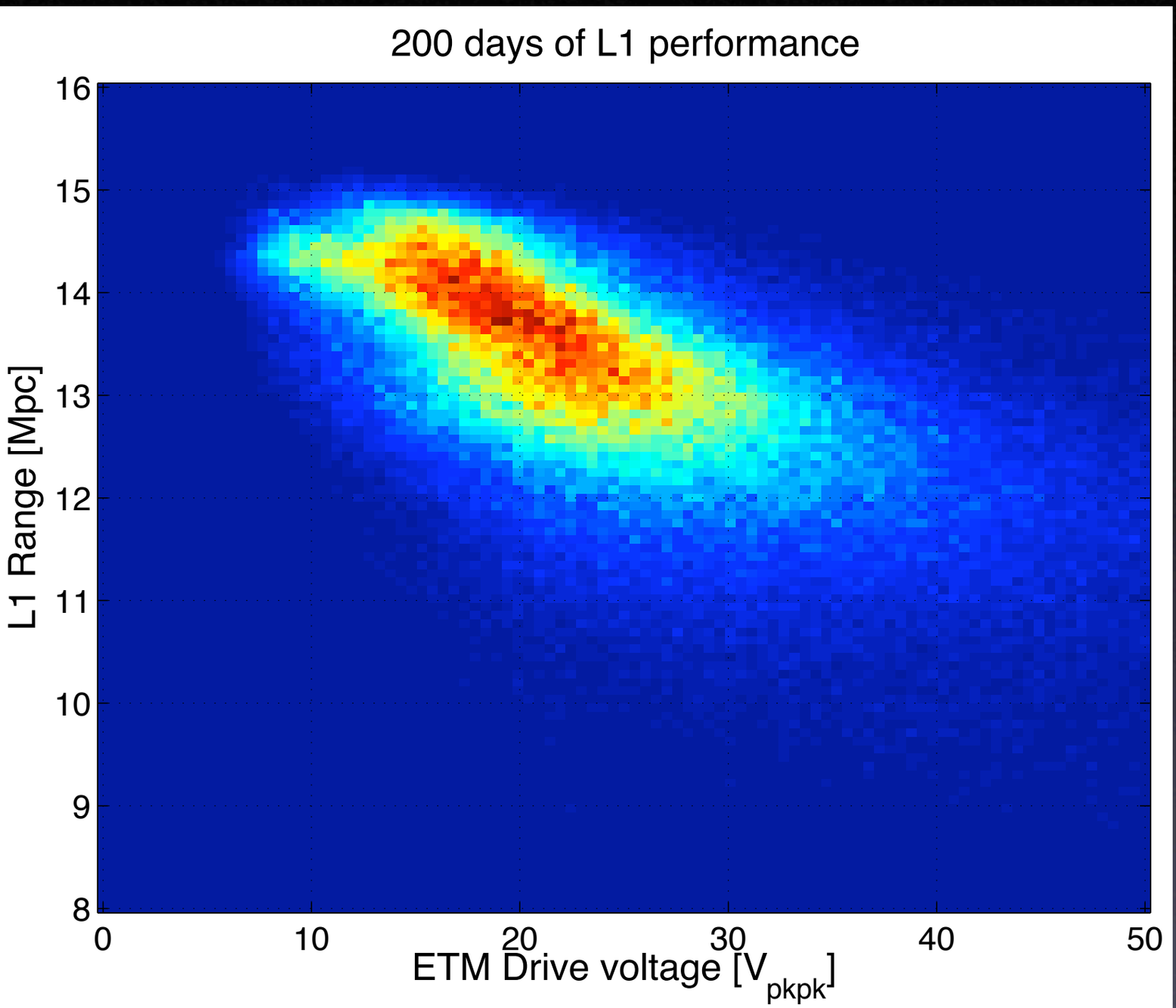

200 days of L1 performance
L1 Range [Mpc]
16
15
14
13
12
11
10
9
8
0
0.5
1
1.5
2
0.1 – 0.3 Hz [a.u.]
x 10^4
180
160
140
120
100
80
60
40
20
0


200 days of L1 performance
L1 Range [Mpc]
0.3 – 1.0 Hz [a.u.]

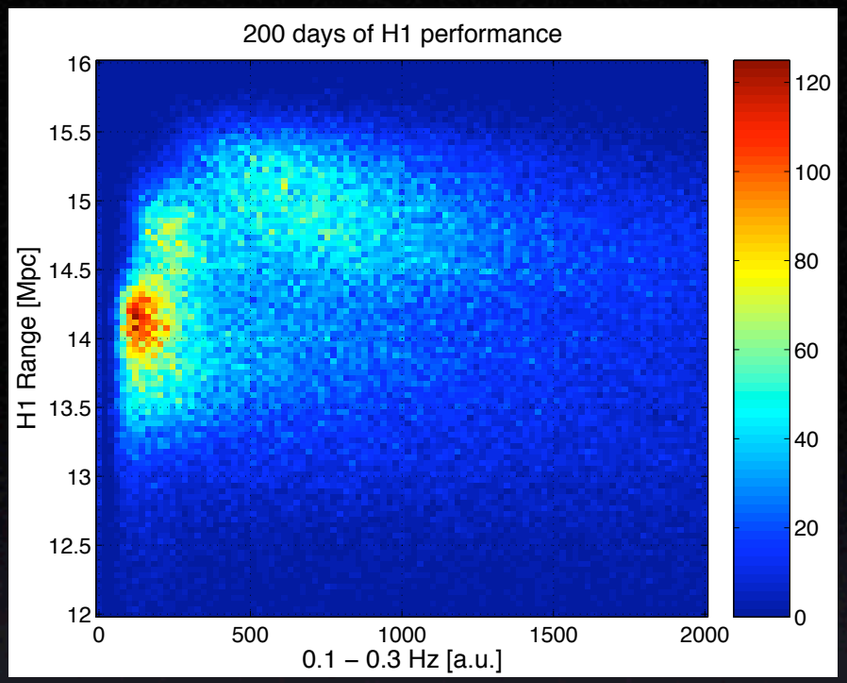

200 days of L1 performance
L1 Range [Mpc]
1.0 – 3.0 Hz [a.u.]

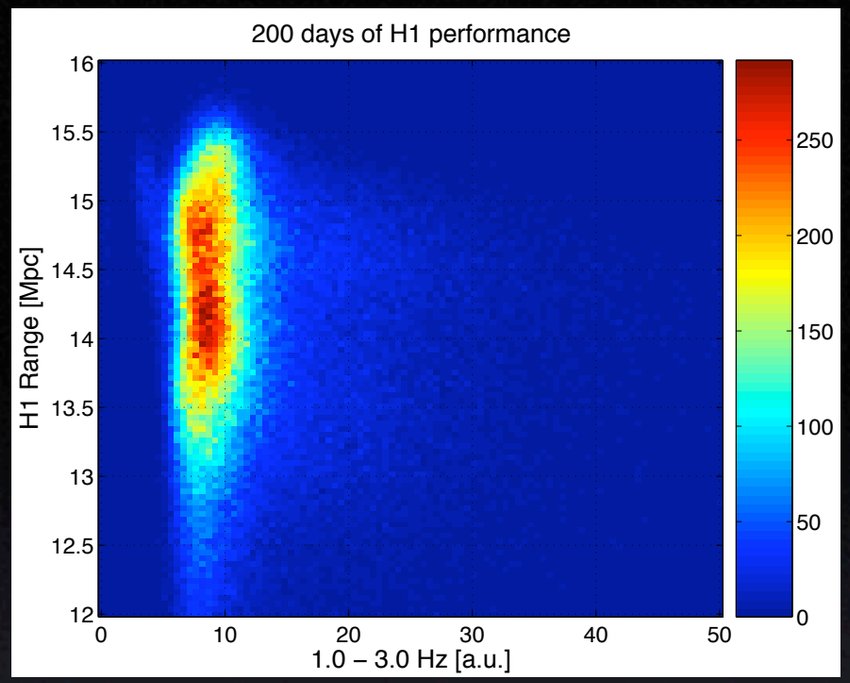

200 days of L1 performance
L1 Range [Mpc]
3.0 – 10.0 Hz [a.u.]


200 days of L1 performance
L1 Range [Mpc]
10.0 – 30.0 Hz [a.u.]

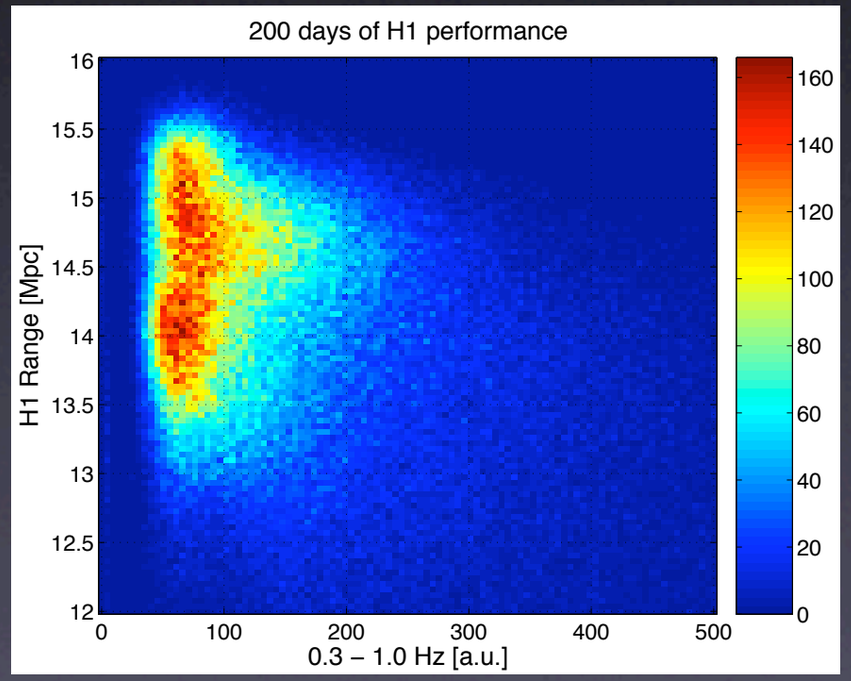


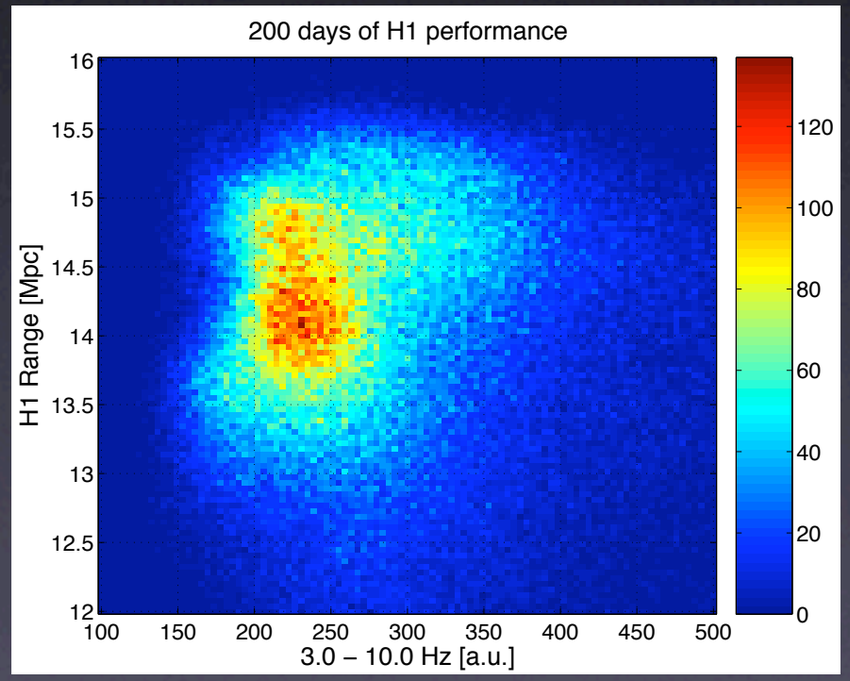
- Strong coil current correlation, better than seismic
- Physical machine signal
- Correlation ≠ Causation
- Other correlations?

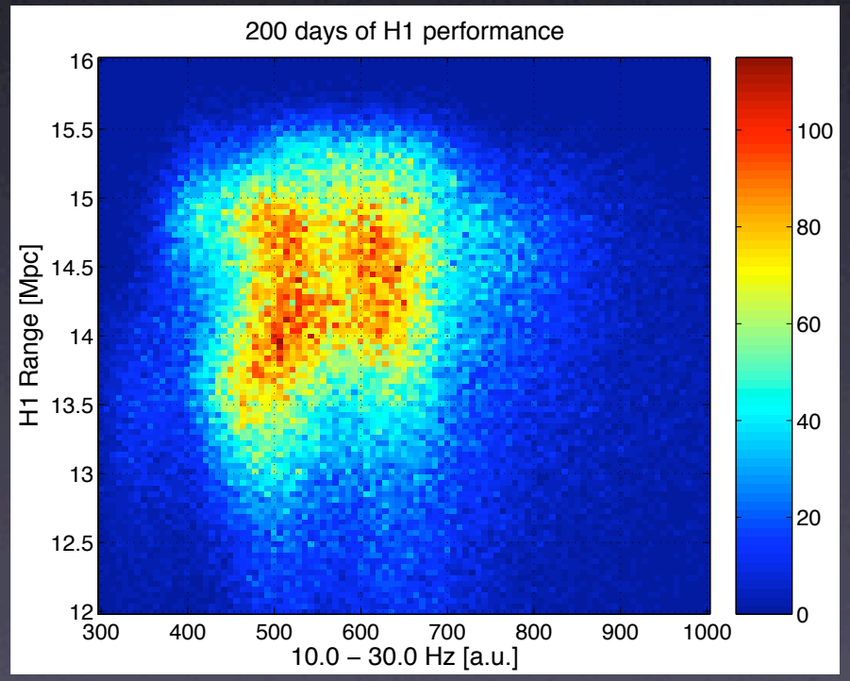


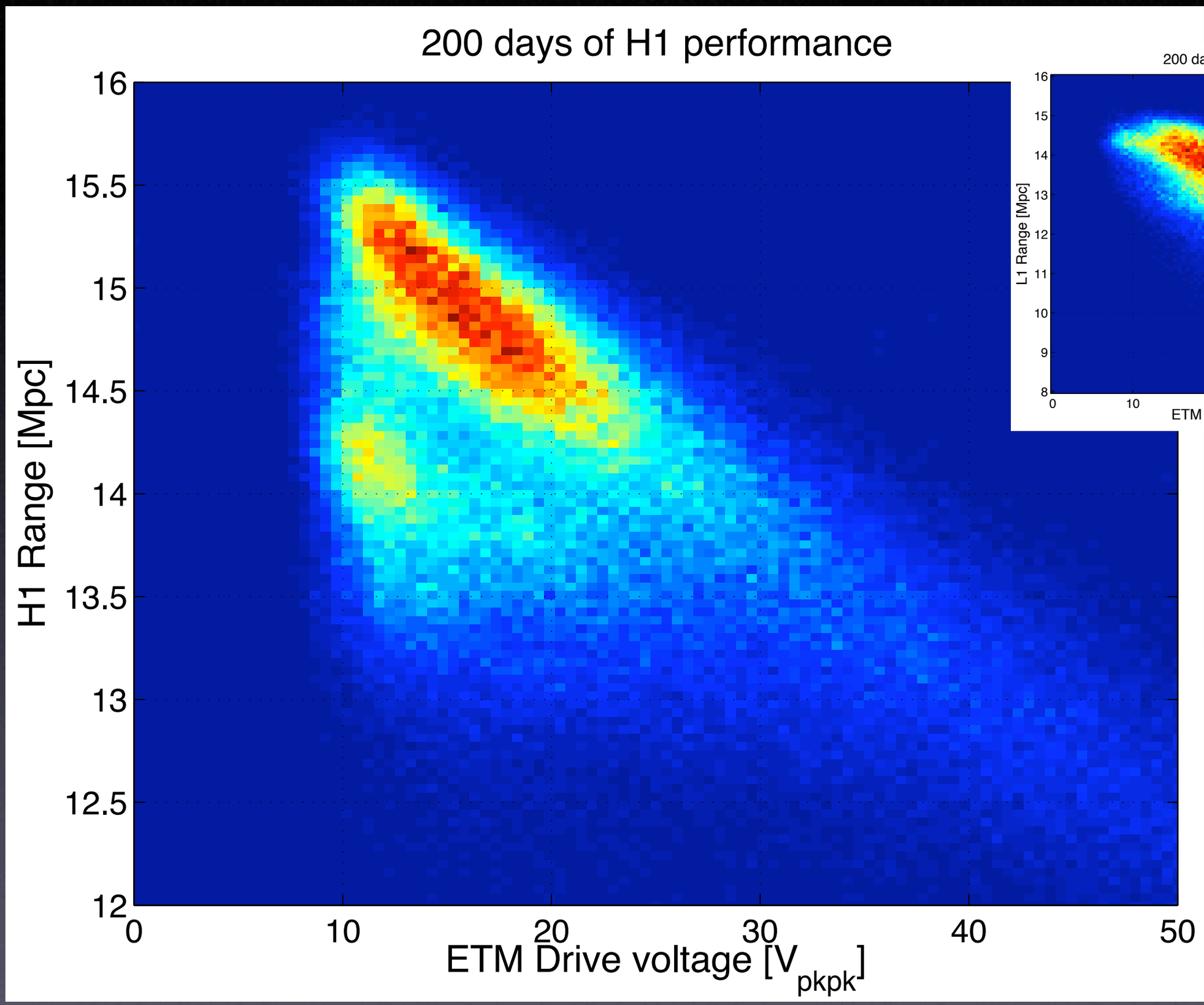


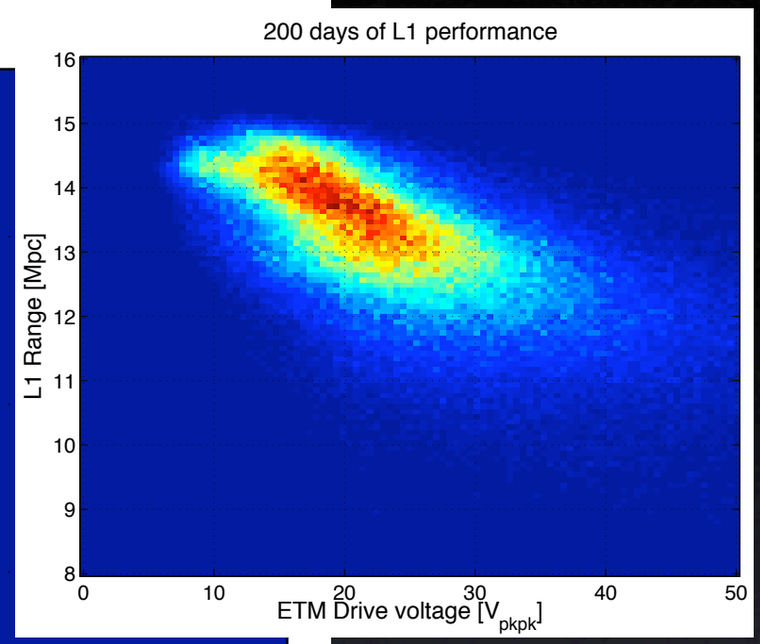
H1 seismic correlation





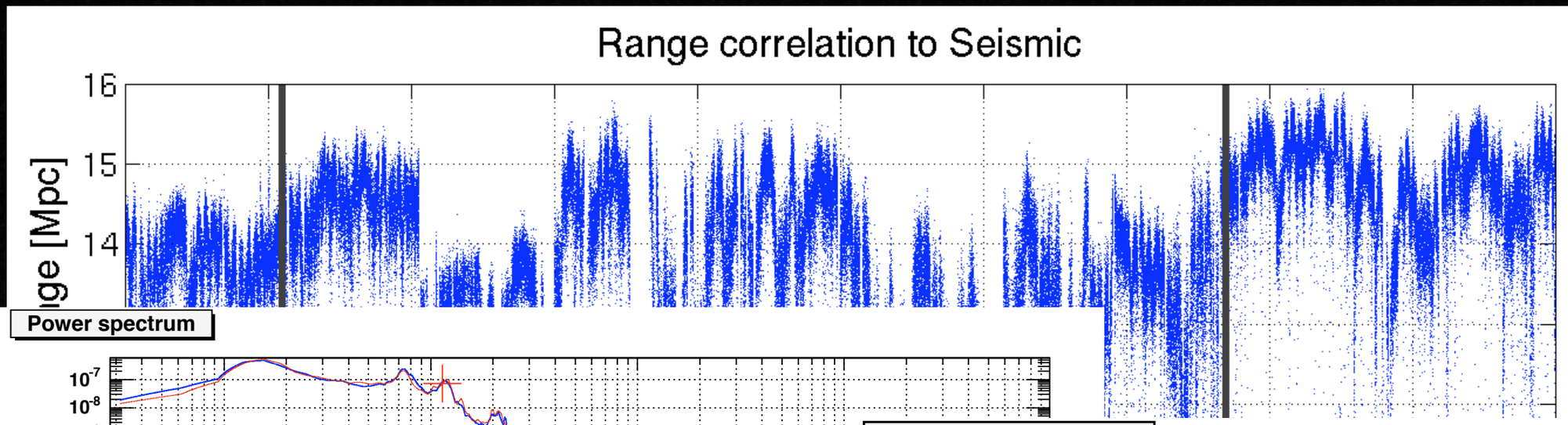


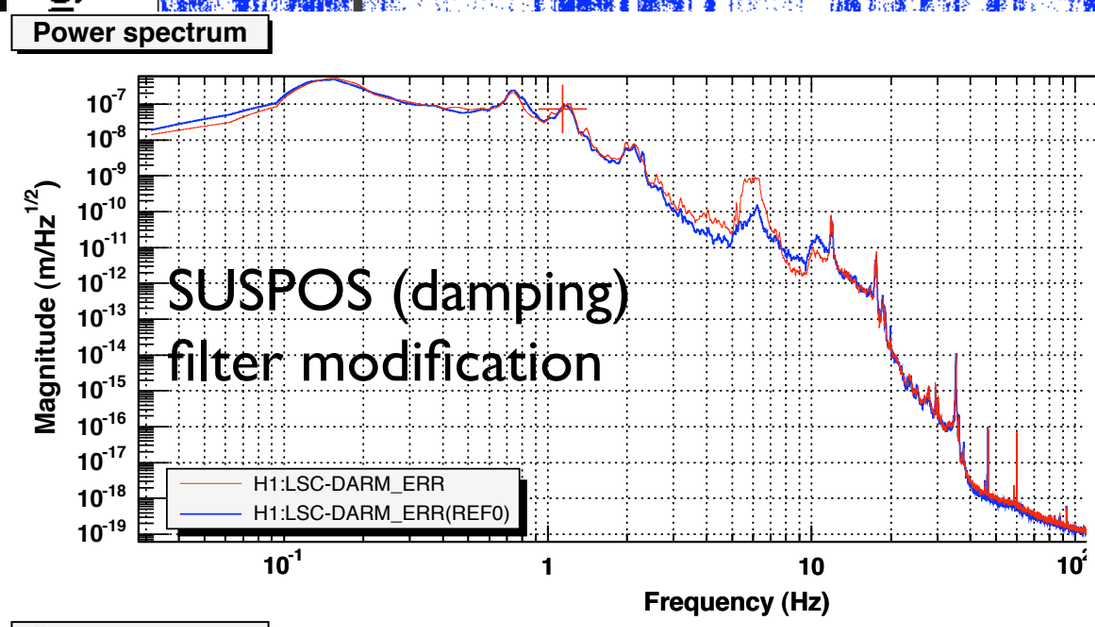


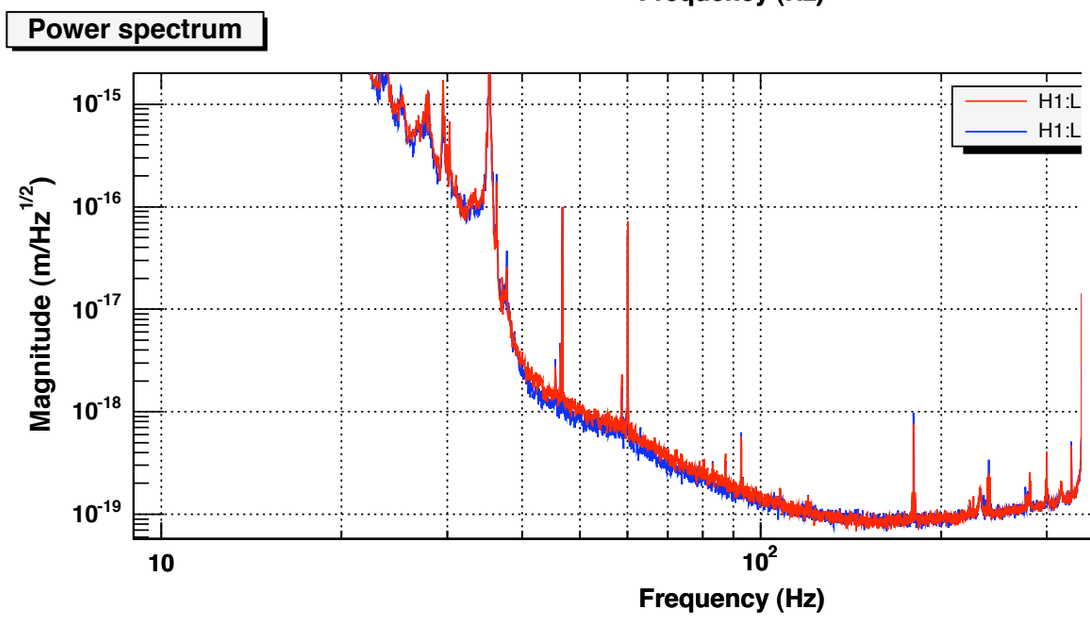


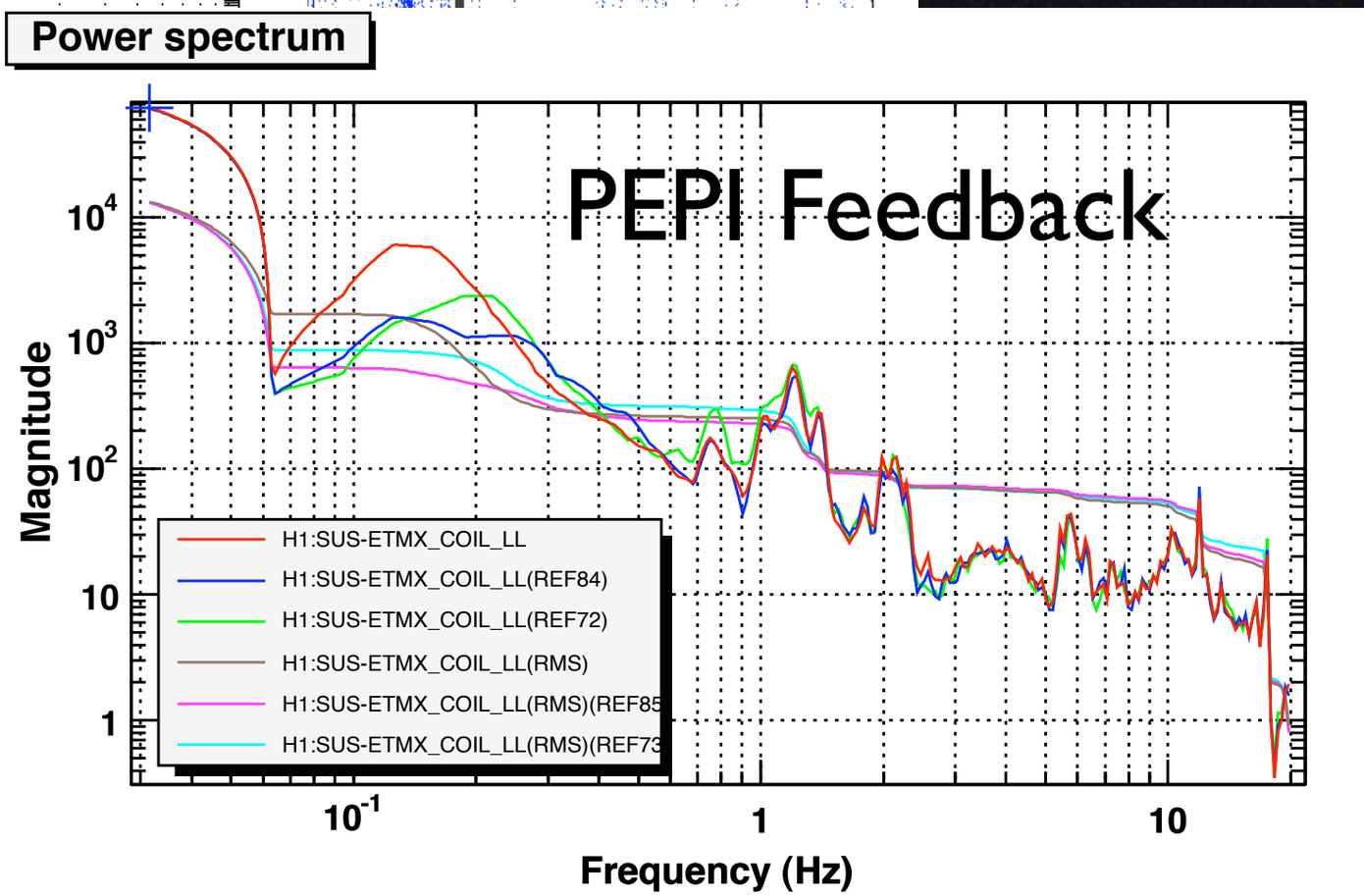
H1 Coil correlation very, very tight

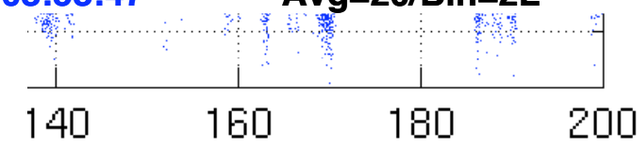
NB: axis range differs!





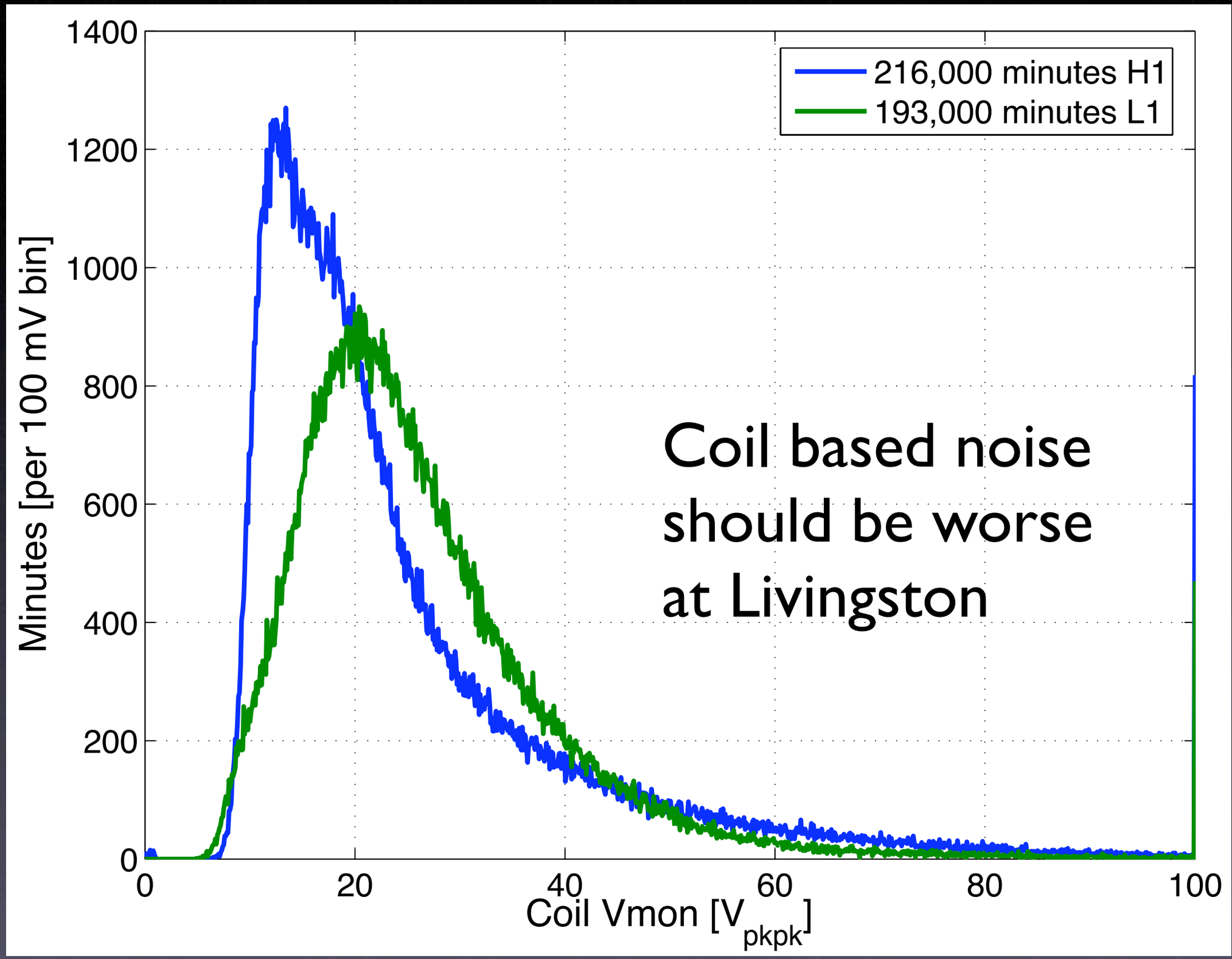




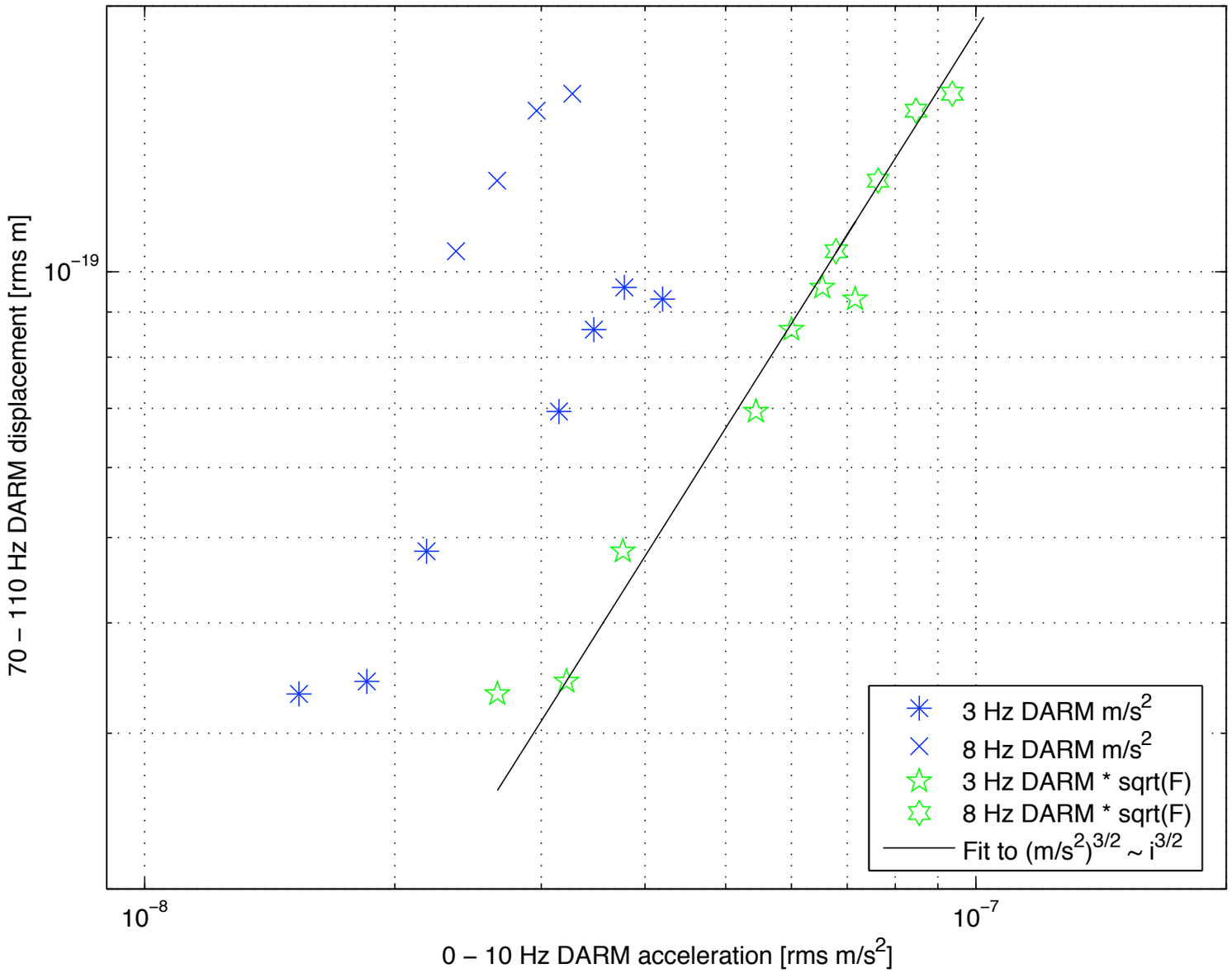


Time [days since Aug. 27]

Excess f^{-4}

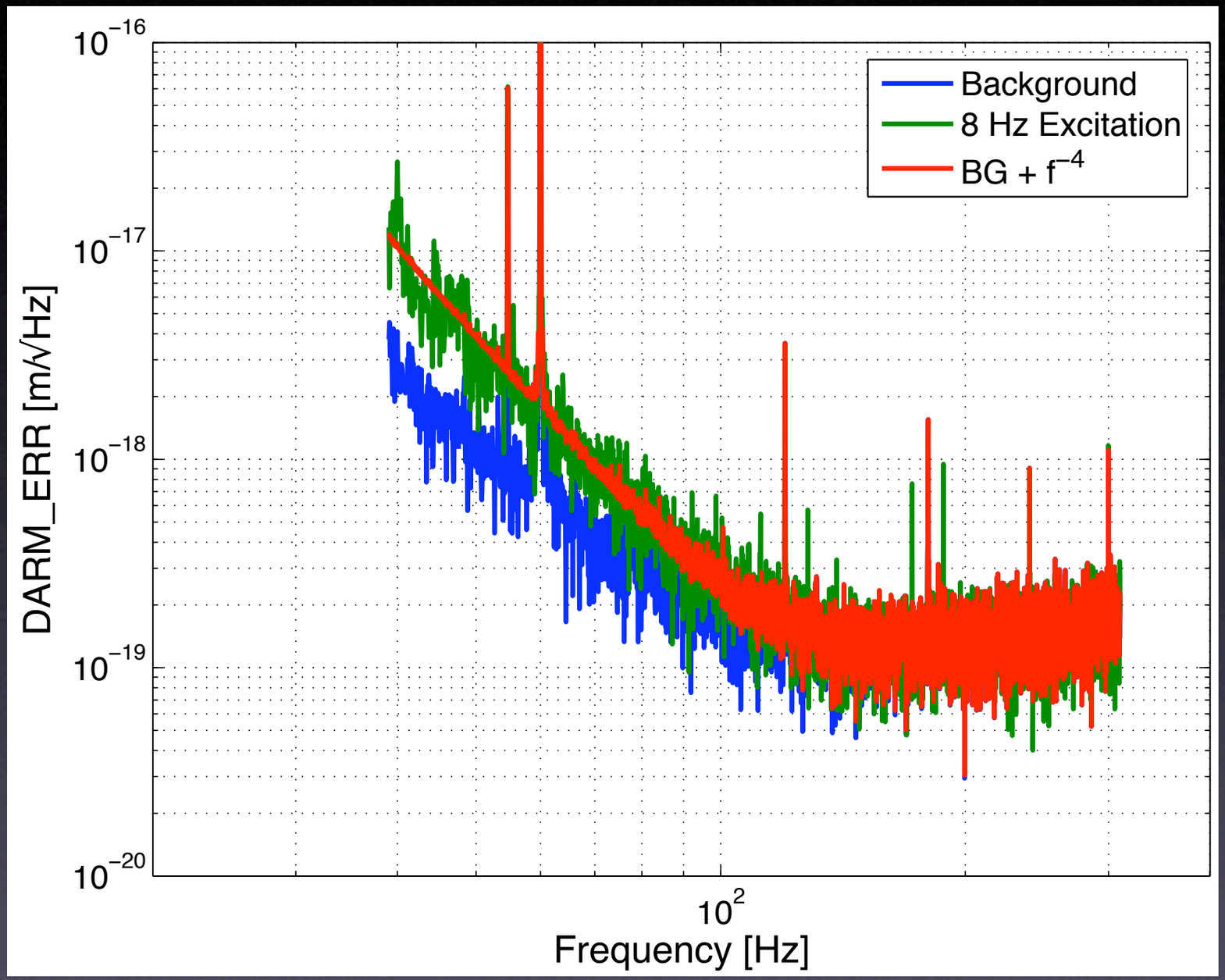

216,000 minutes H1
193,000 minutes L1
Coil based noise
should be worse
at Livingston
Minutes [per 100 mV bin]
Coil Vmon [V pkpk]
0
200
400
600
800
1000
1200
1400
0
20
40
60
80
100

UC injections



- This series from LLO in August
- narrowband POS excitation into L1:SUS-ETMX_LSC_EXC
- ~ $f^{1/2}$, $I^{3/2}$

~f^{-4} Noise



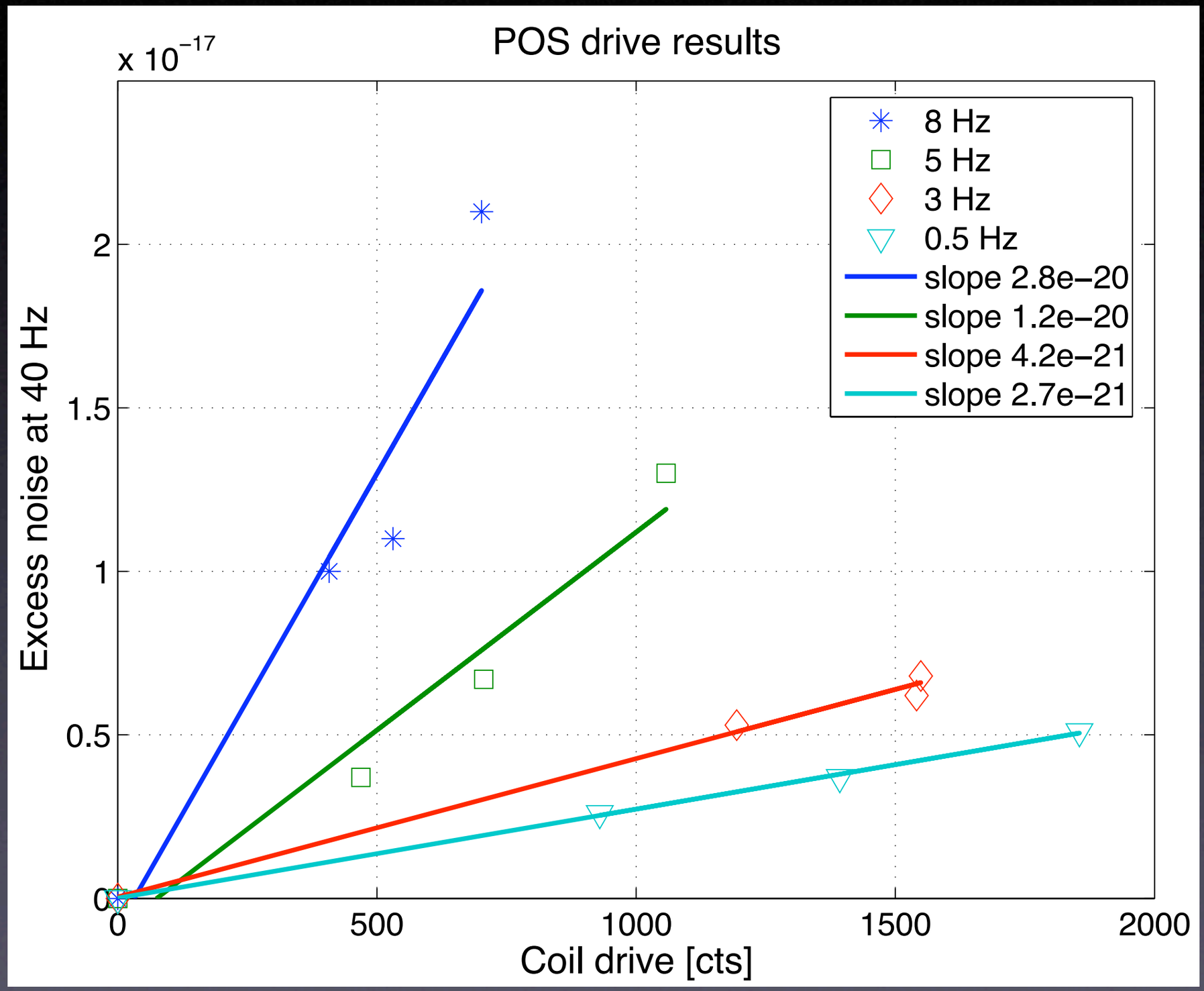
Fit to:

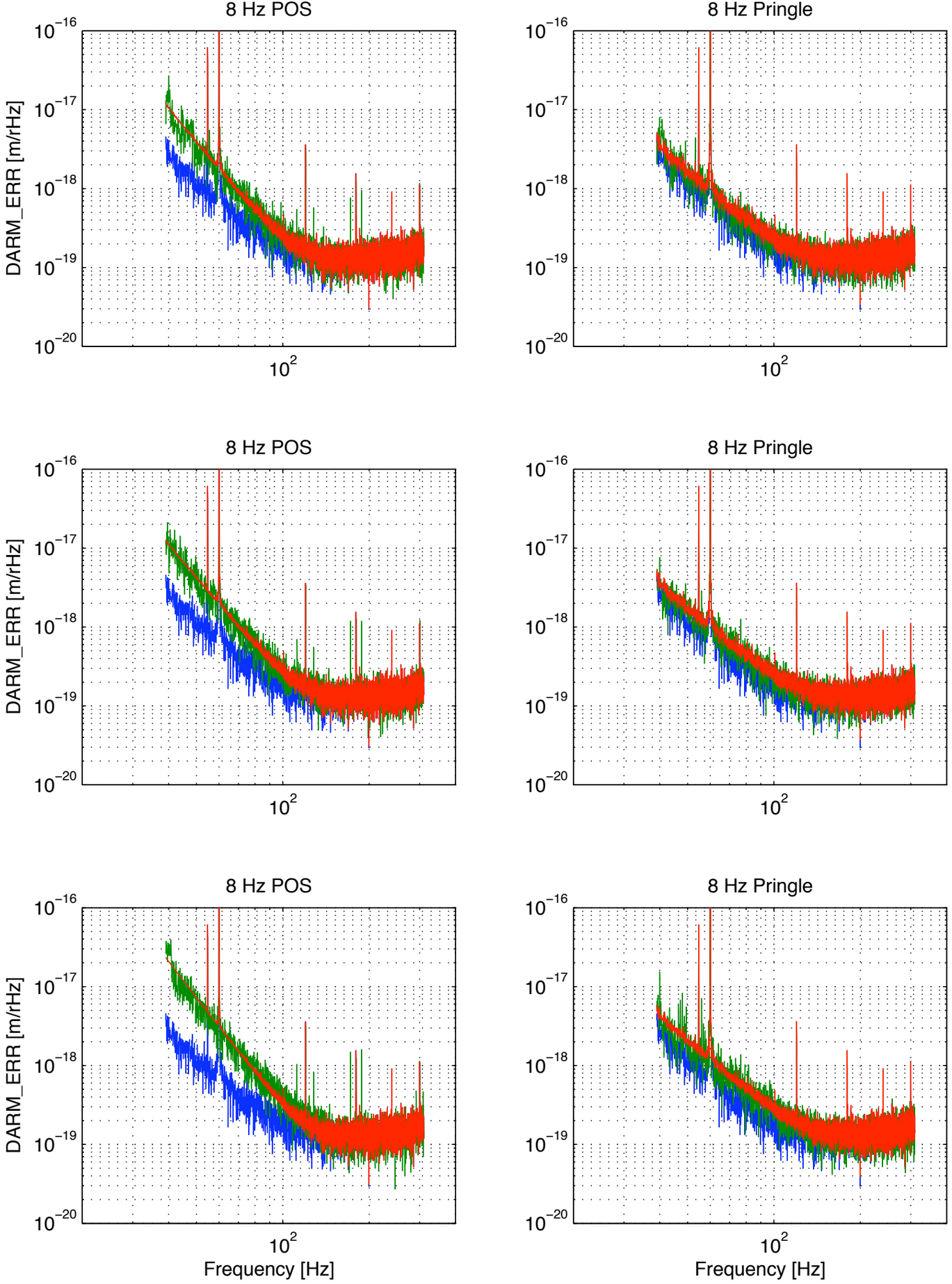
$$y = \sqrt{y_{BG}^2 + (a \times x^{-n})^2}$$

power law varies from 3 to 4 for pos

Data from Feb. 07

- Non-trivial frequency dependence
- Need more data
- Not yet predictive





Pringle

- Initial test in Aug. showed Pringle = Pos
- Follow up in Feb. w/ improved method ≠
- Follow up to the Follow up this week

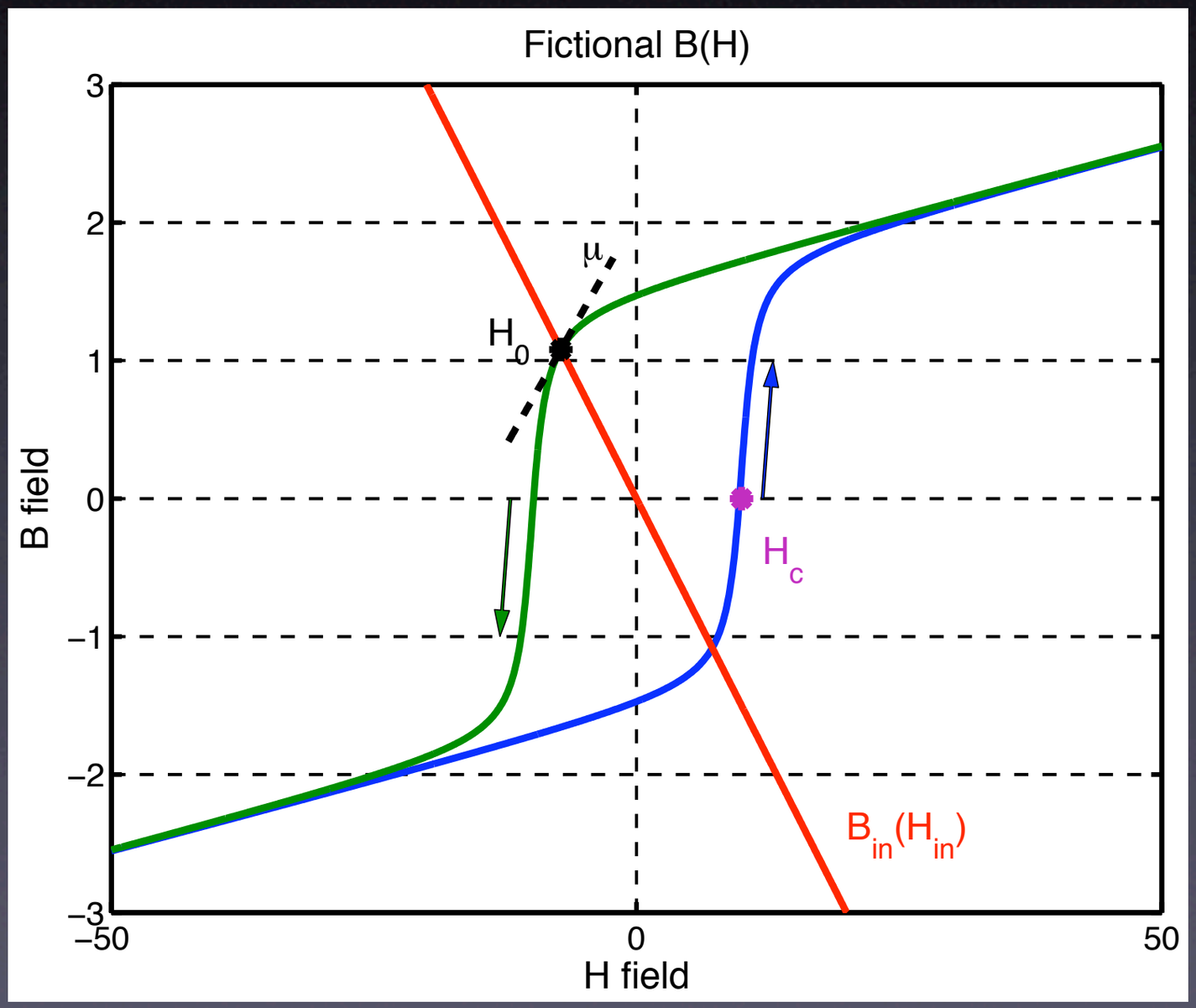
Time dependence

- Stay for Jordan's talk

Jackson Magnetostatics

$$H = \frac{1}{\mu_0} B - M$$

$$\nabla \times H = 0$$
$$\nabla \cdot B = 0$$



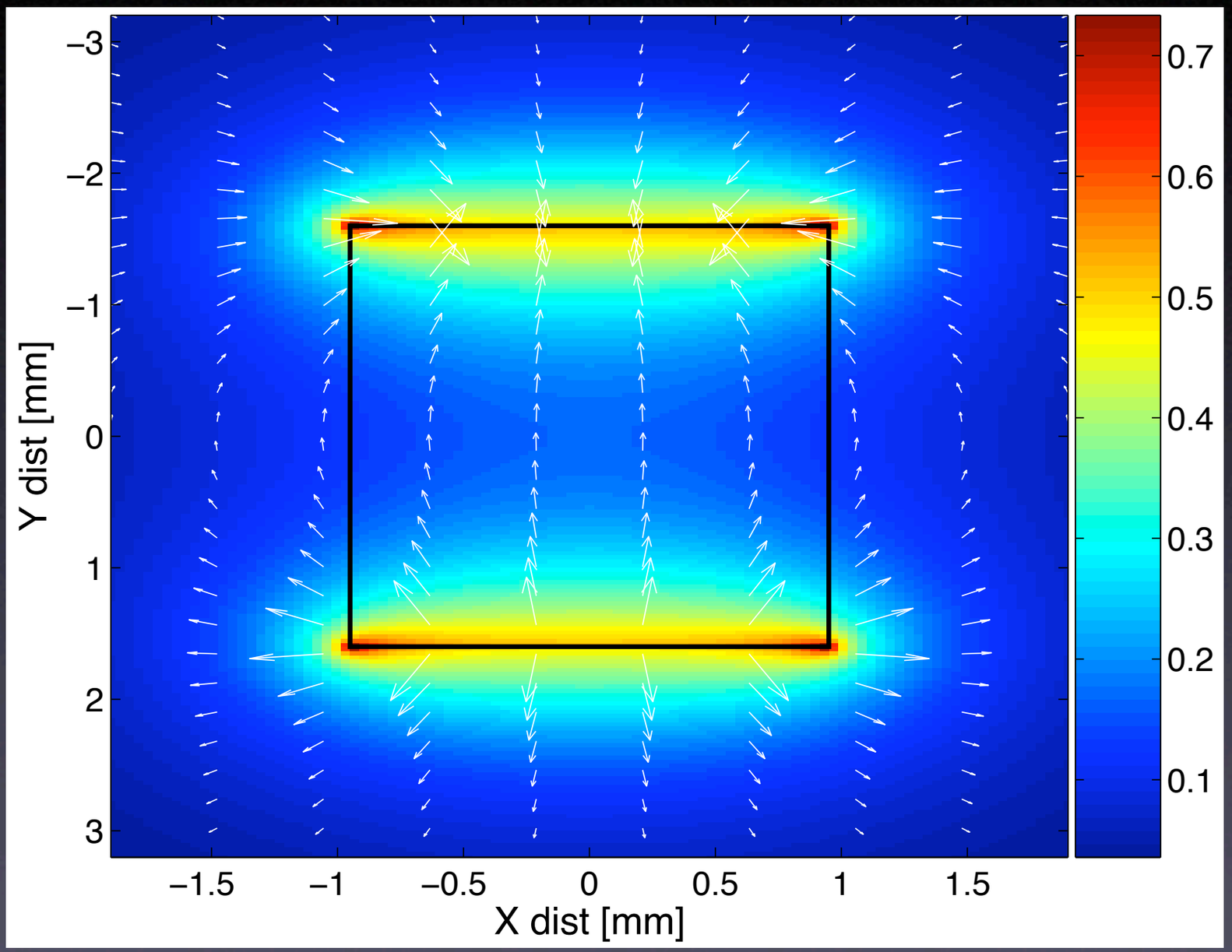
H = magnetic field

B = induction field

M = magnetic moment

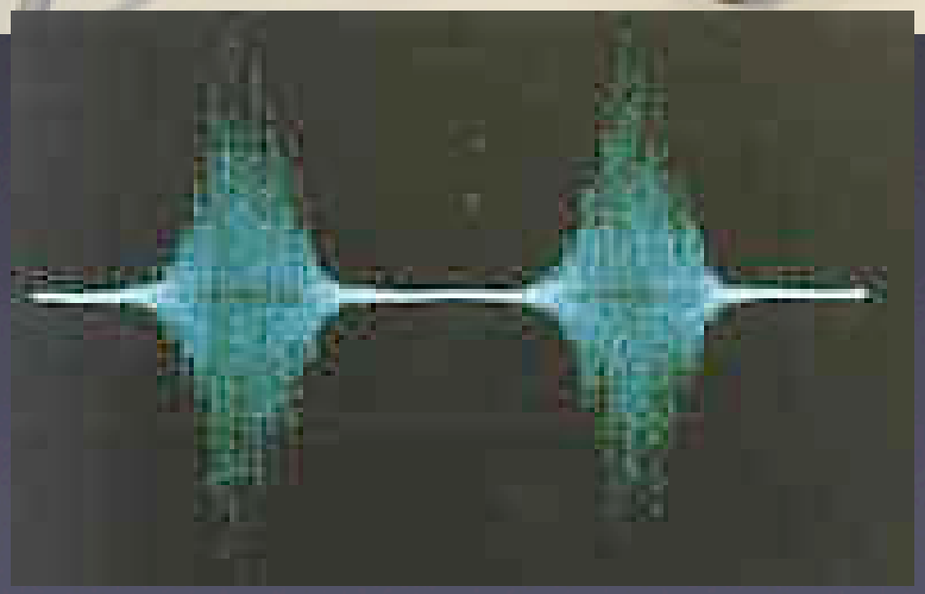
Hard ferromagnet relaxes to an H_0 depending on geometry

Edge-effects

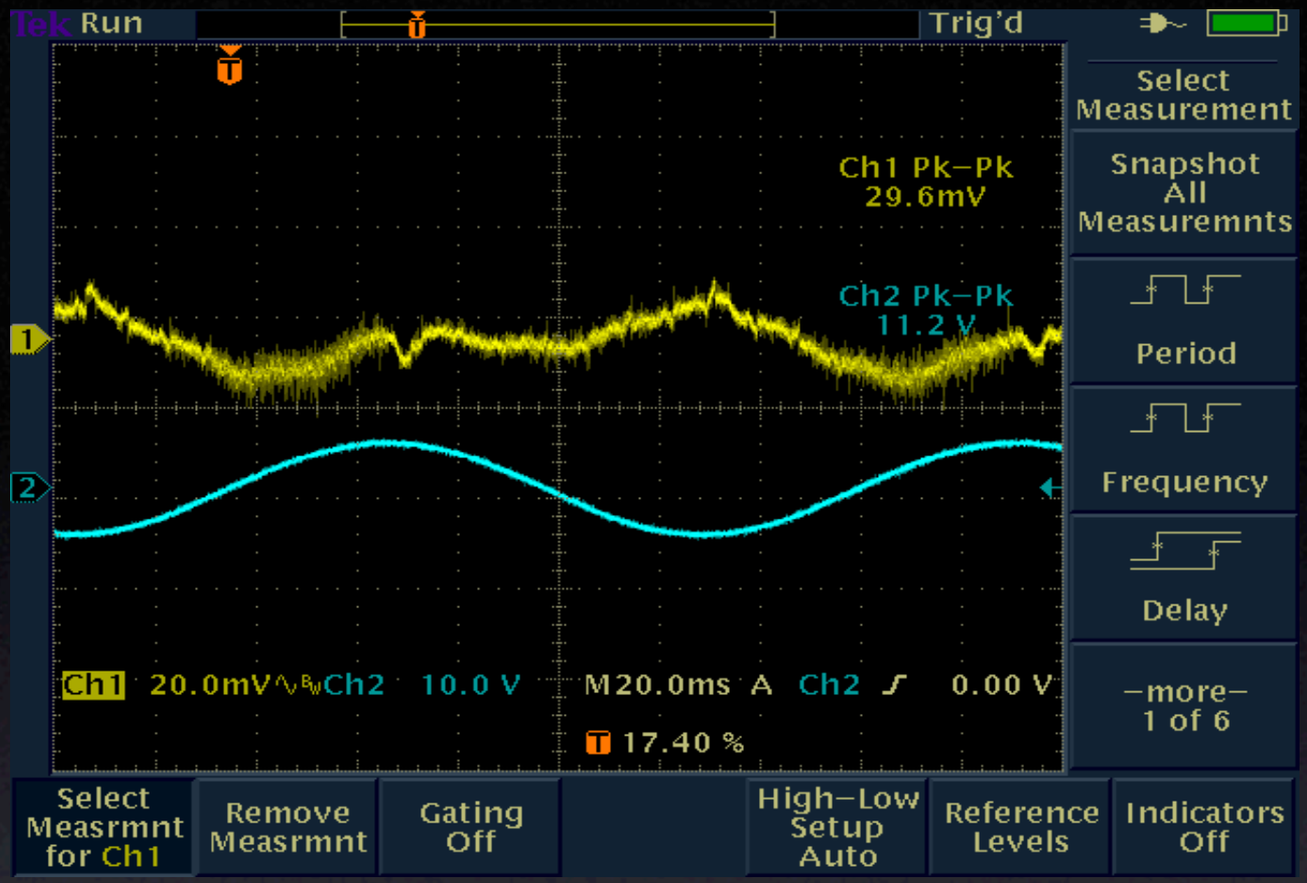


- Solved for rectilinear geometry (Engel-Herbert & Hesjedal)
- Magnetic field (and stress) peaks in corners
- All test mass magnets similar size, material, field

Money in Noise



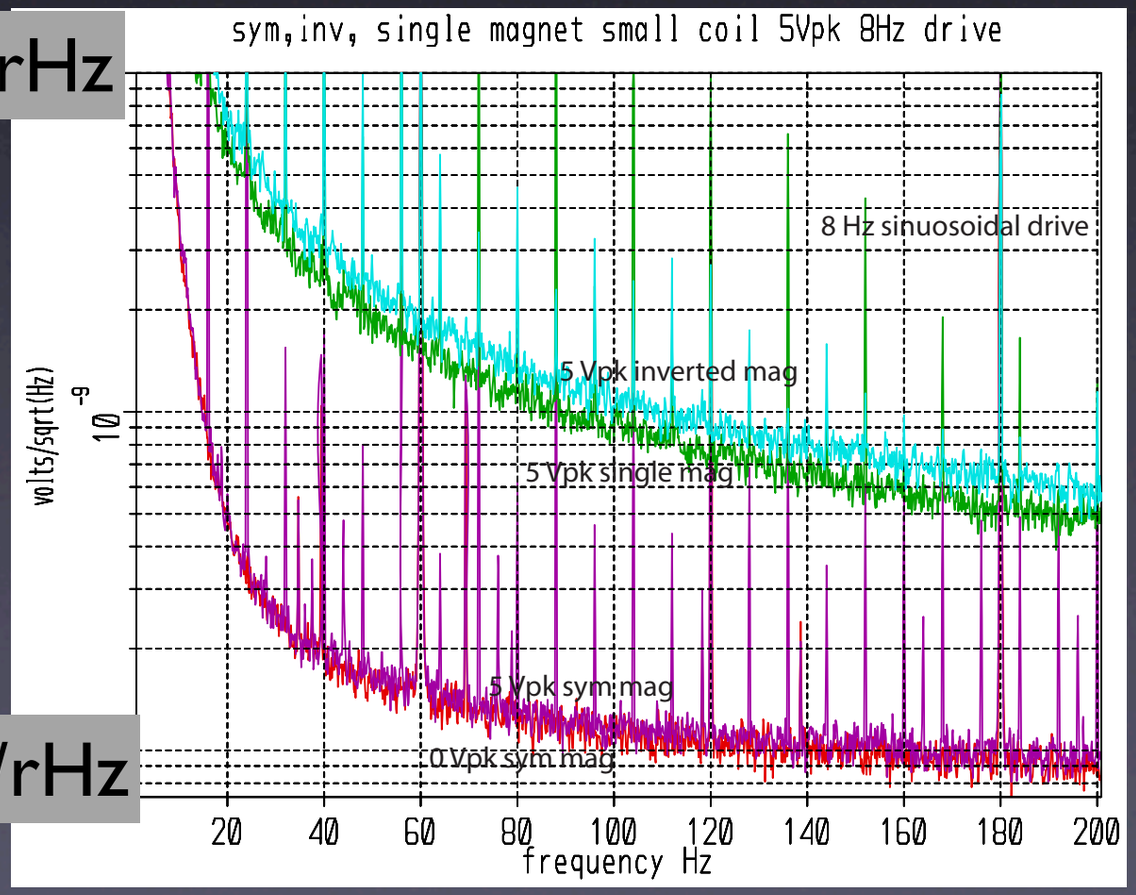
- Barkhausen noise (domain wall rotation) stress-dependent
- Power law distributions of H_C and magnetic viscosity
- (American Stress Tech)



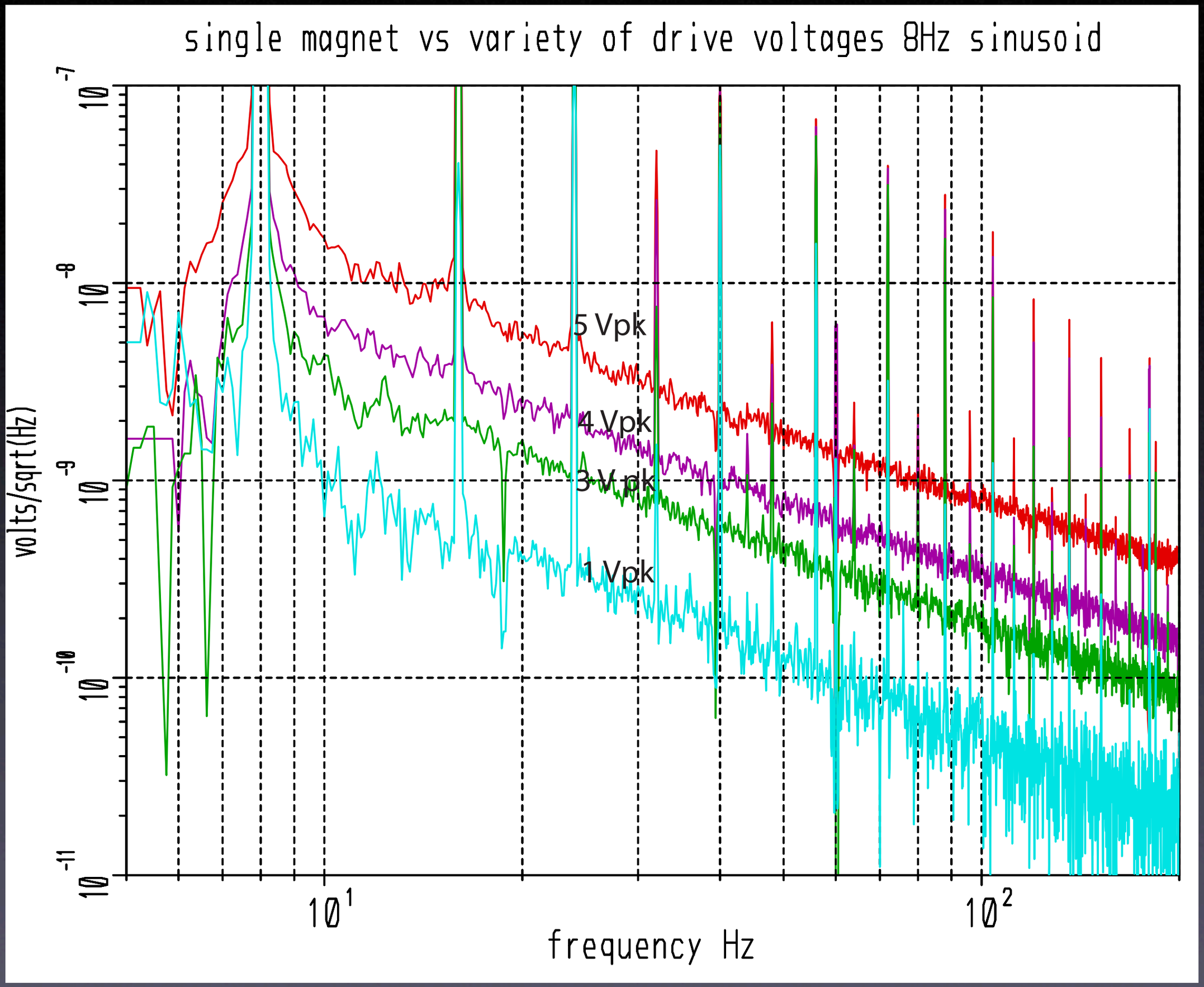
Bench Tests

- Rai Weiss @ LLO over the last ~8 months
- Visible in time, frequency, multiple apparati
- Magnet alignment matters
- Qualitatively supported by the literature

10^{-8} nV/rHz



10^{-10} nV/rHz


single magnet vs variety of drive voltages 8Hz sinusoid
volts/sqrt(Hz)
10^-7
10^-8
10^-9
10^-10
10^-11
5 Vpk
4 Vpk
3 Vpk
1 Vpk
10^1
10^2
frequency Hz

Mitigation Smoking Guns

- Feedforward & Feedback to pre-isolator
- Chamfer the existing magnets
- High-μ "Hats"
- Replace NdFeB with SmCo
- High frequency bias - "domain shaking"

BN isn't the only Noise

Many have been proposed, few have been definitively ruled out

- Barkhausen noise
- Charge motion
- ~~Optical scattering~~
- Stick-slip suspension noise (eg. clamp)
- "Other" actuation noise
- ~~Electronics noise~~