Upconversion WG

- New subgroup of DetChar

- Tasked with identifying and reducing non-linear noise coupling

- Began meeting in May 2006

- Meets 1:30 PST every second Monday immediately following the commissioning telecon
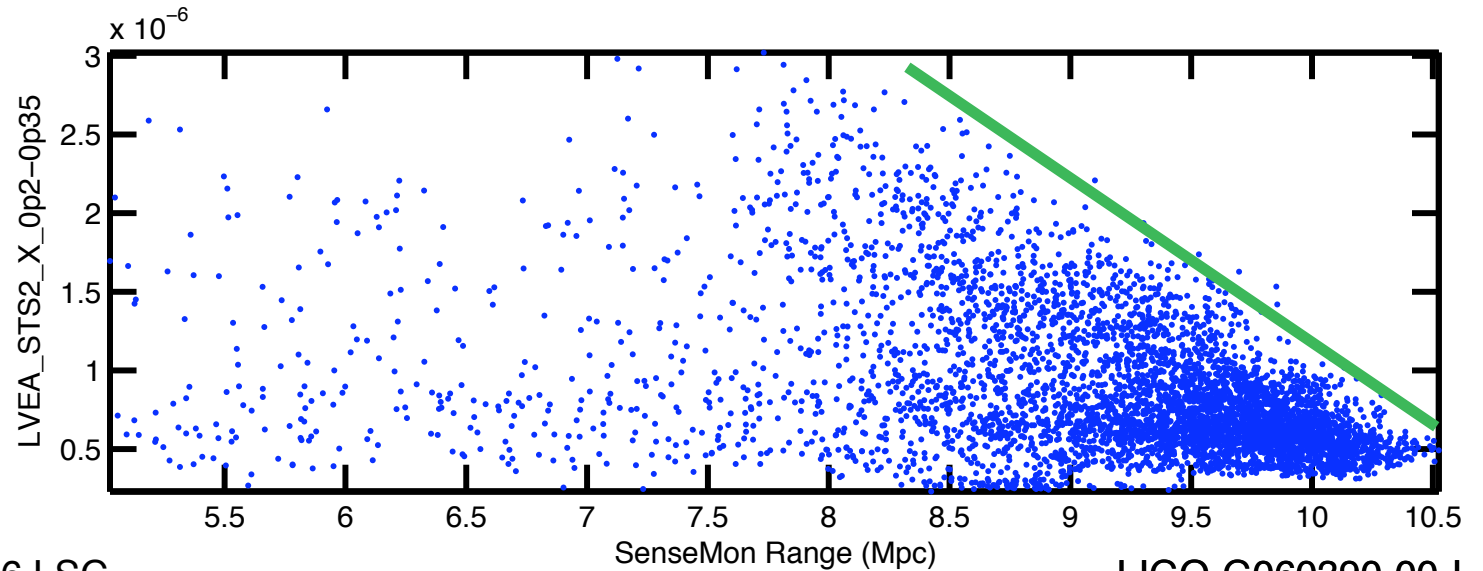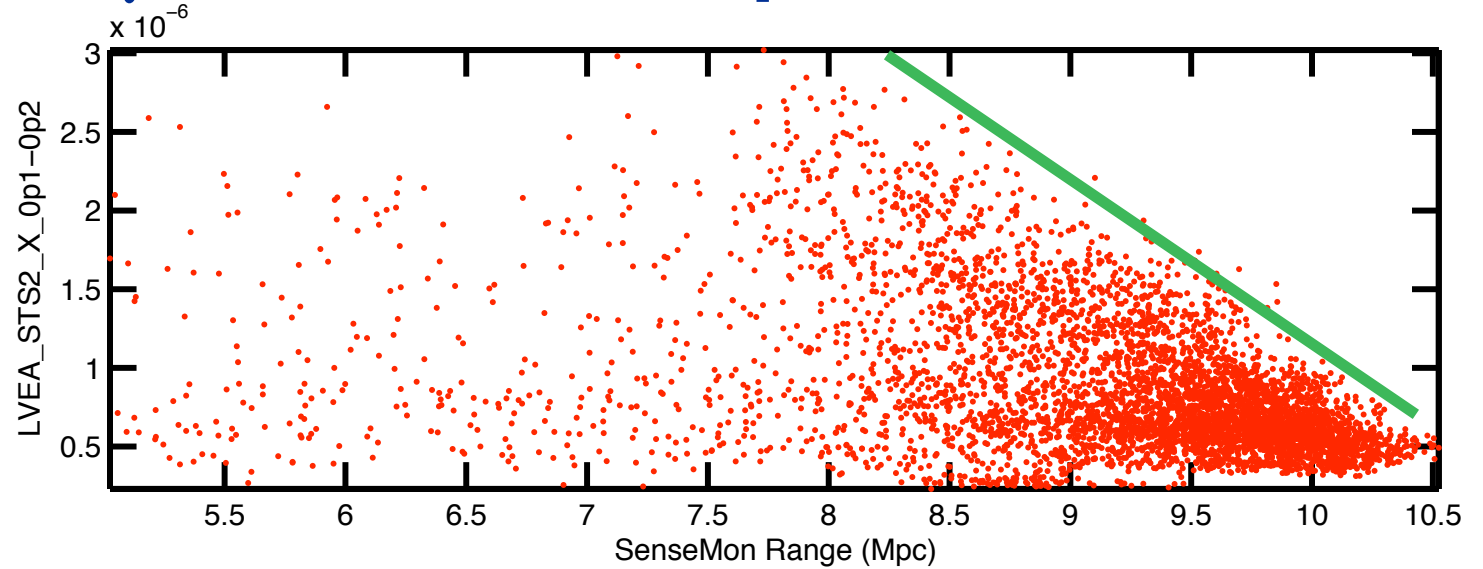
- Lots of overlap with other groups

μSeismic upconversion

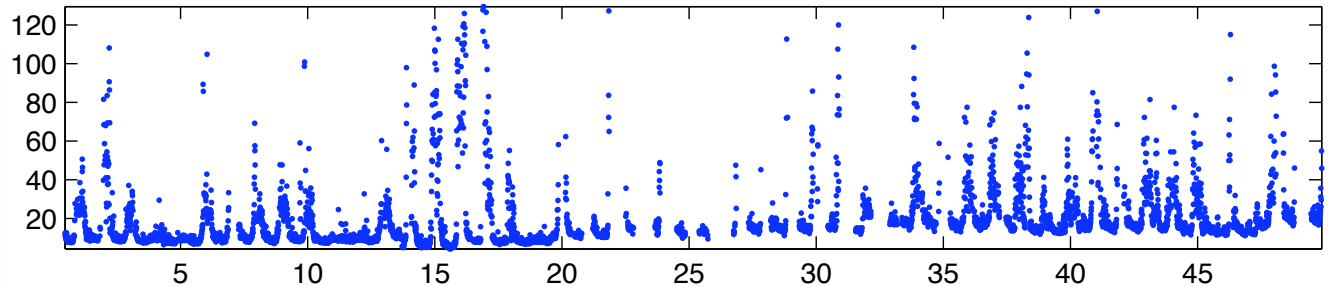**LIGO**

60 days
10 min.
trend

by
Brian O.

Jan. 24
LLO iLog

LIGO-G060390-00-I

μSeismic upconversion
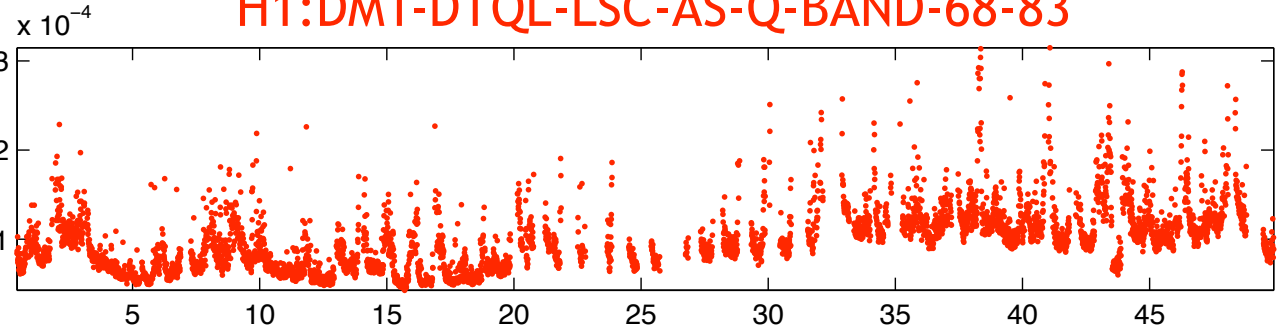

H0:DMT-BRMS-PEM-EX-SEISX-1-3 Hz

H0:DMT-BRMS-PEM-EX-SEISX-3-10 Hz
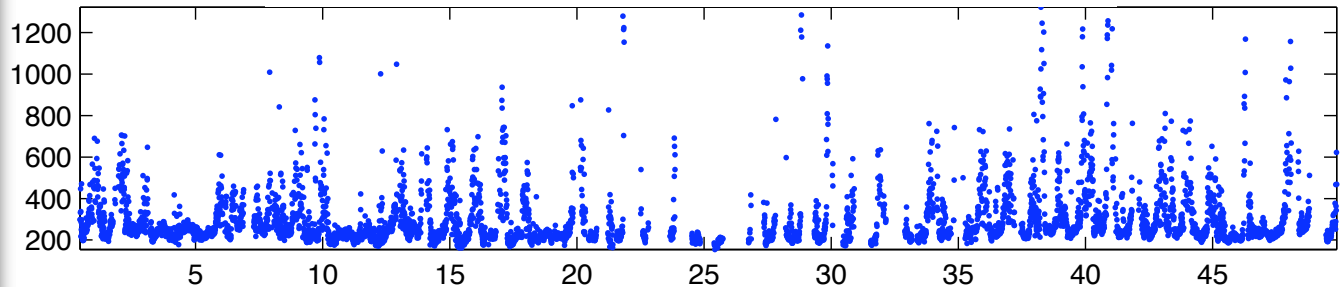
H1:DMT-DTQL-LSC-AS-Q-BAND-68-83

Time [Days]

50 days

10 min trend

Similar for H2 & L1

LHO iLog May 2

LIGO-G060390-00-I

2-d coherence

72–80 Hz DARM power

Time [hrs]

Cts^2/Hz x 10^{11}

X end
Seismic

Mean subtracted signal [dB]

Frequency [Hz]

4   SJW August 2006 LSC

LIGO-G060390-00-I
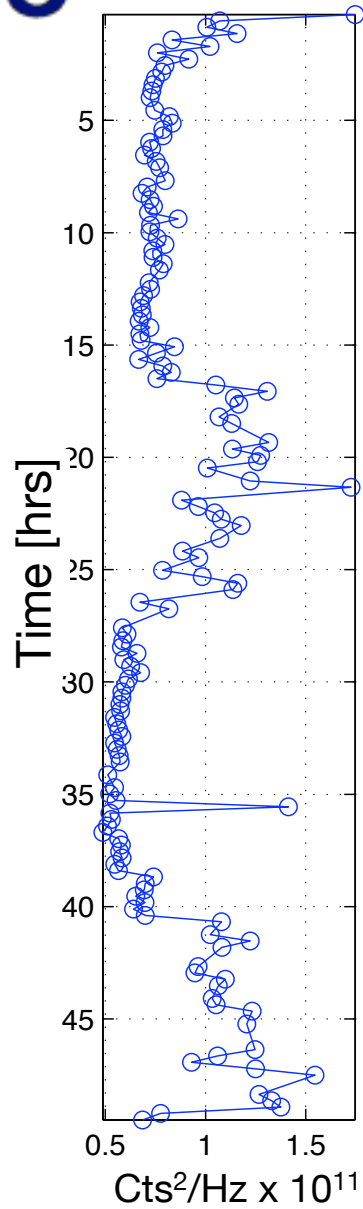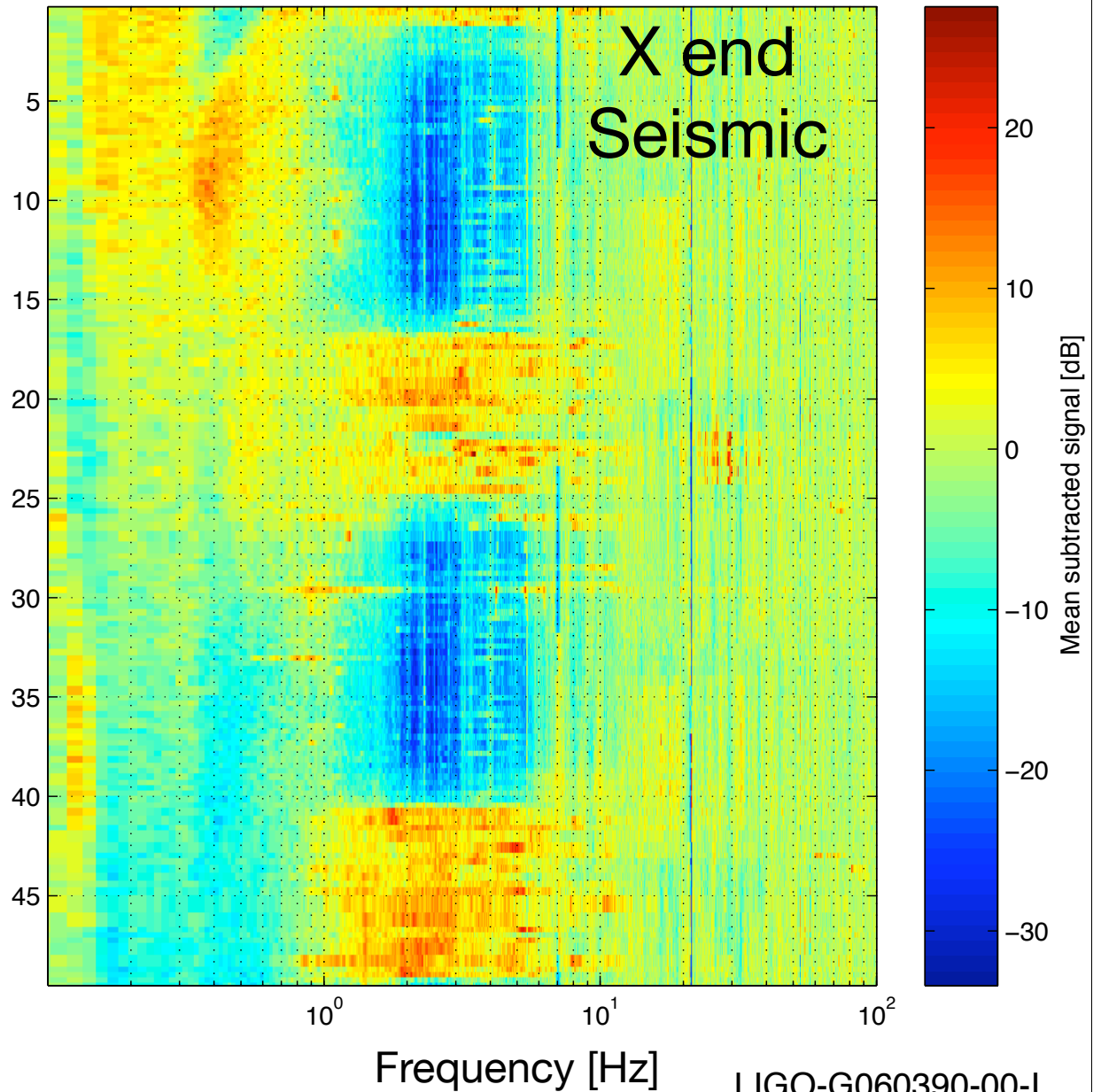
seismic Good vs. Bad

LIGO

- **64 Avgs, 0.5 Hz BW**
- **N~ $F^{-7/2}$**
- **40-120 Hz**

Legend:
- 6:15 pm Aug. 9 –– 13.9 Mpc
- 12:45 pm Aug. 9 –– 12.7 Mpc
- Noise Excess

Y-axis: DARM_ERR [m/rtHz]
X-axis: Frequency [Hz]

LIGO-G060390-00-I
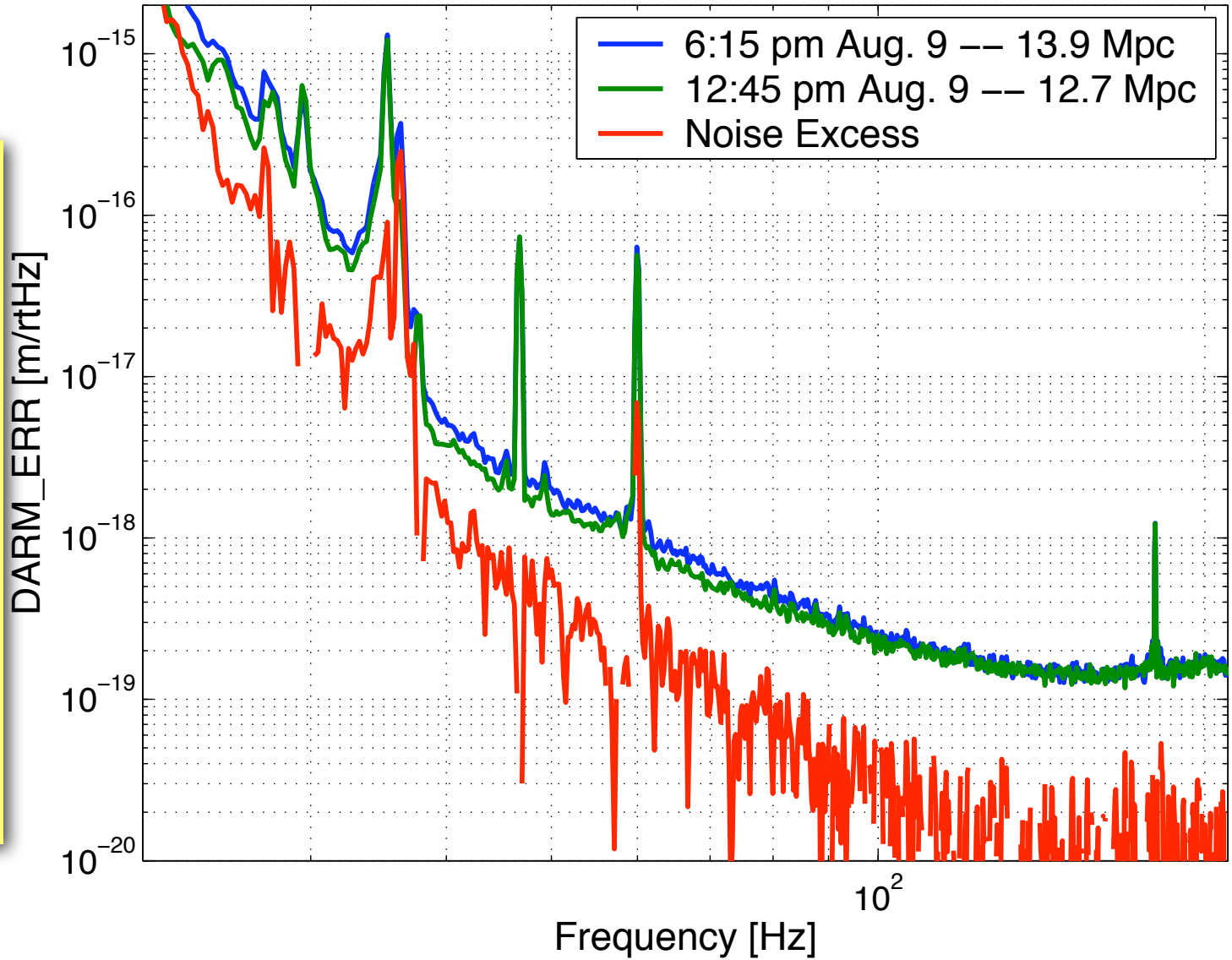
Mechanisms

Many have been proposed, few have been definitively ruled out
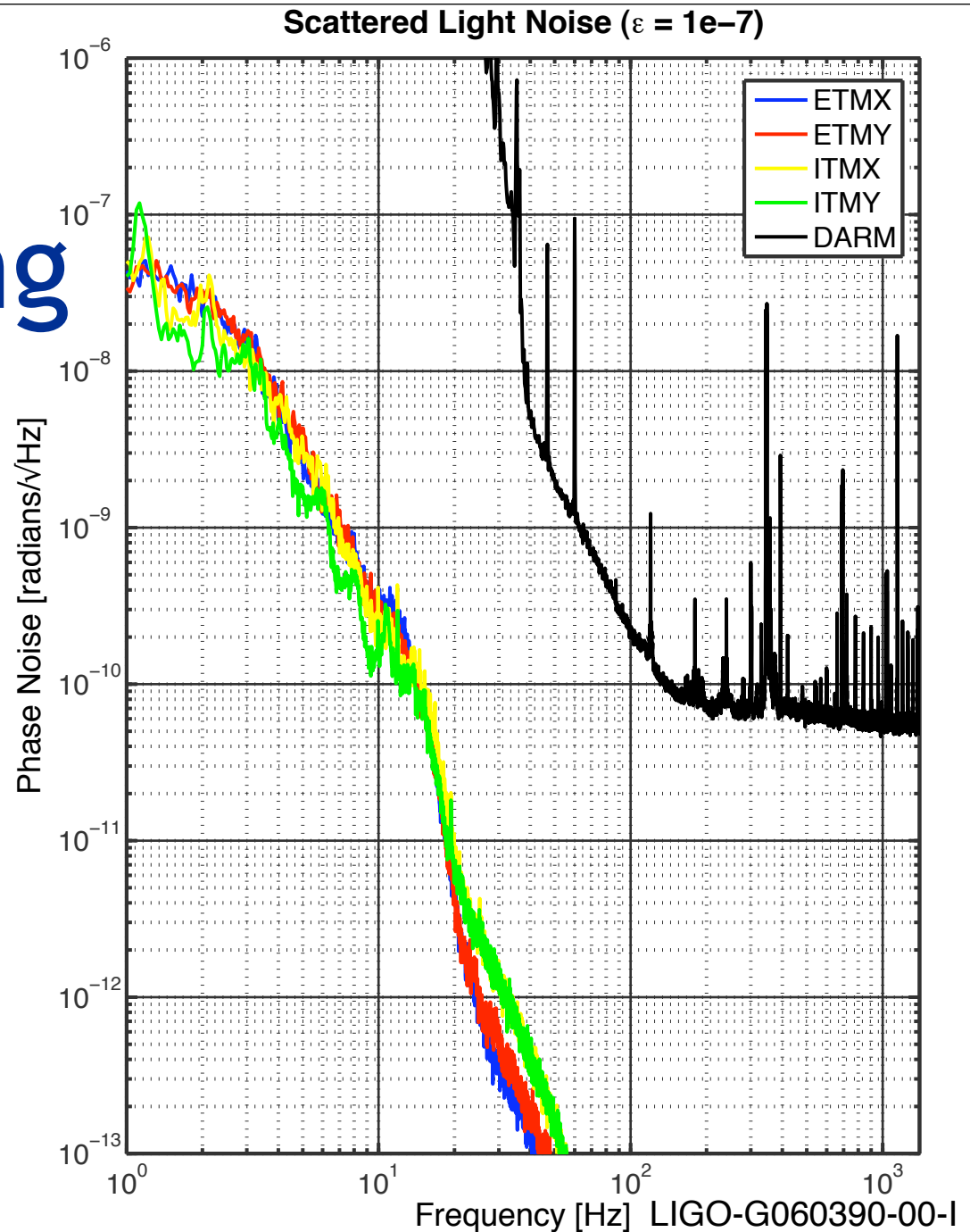
- Barkhausen noise

- Charge motion

- Optical scattering

- Stick-slip suspension noise (eg. clamp)

- "Other" actuation noise

- Electronics noise

Optical Scattering

- Use OSEM signals to determine optic-LOS cage motion

- Huge, efficient scatterers

- Orders of magnitude too low

- Many small scatterers?

Scattered Light Noise (ε = 1e−7)

Legend: ETMX, ETMY, ITMX, ITMY, DARM

Phase Noise [radians/√Hz] vs Frequency [Hz] LIGO-G060390-00-I

Seismic upconversion for 1.2 Hz floor shaking: April PEM injections

RMS in high f band as a function of RMS in low f band

- RMSS at LHO
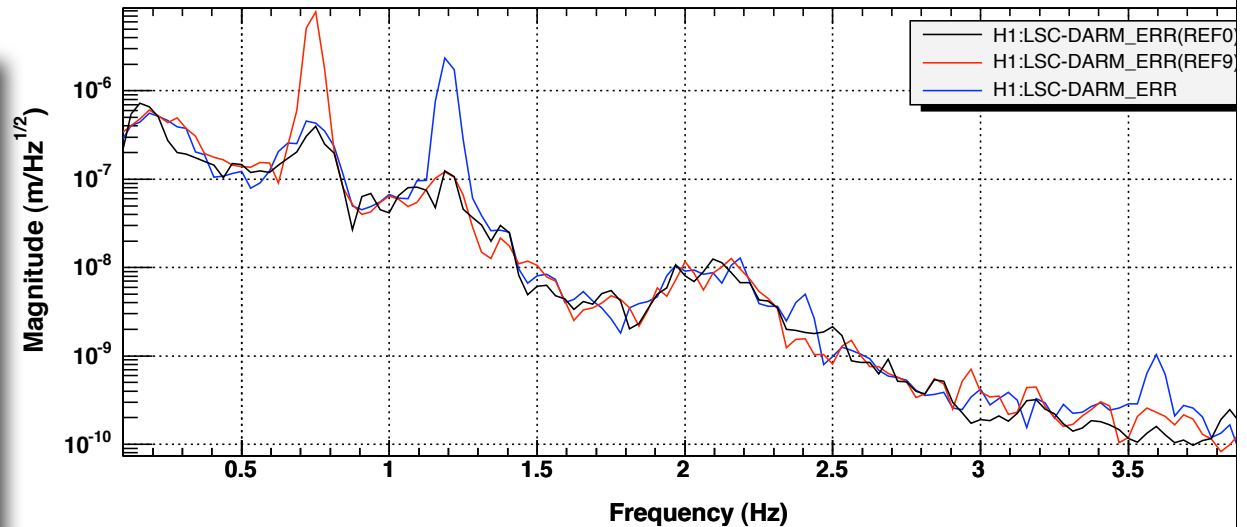
- H1 & H2 see same U.C.

H* DARM RMS in 65–115 Hz [m x 10⁻¹⁸]

H* DARM RMS in 0.3-4 Hz [m x 10⁻⁸]

Legend:
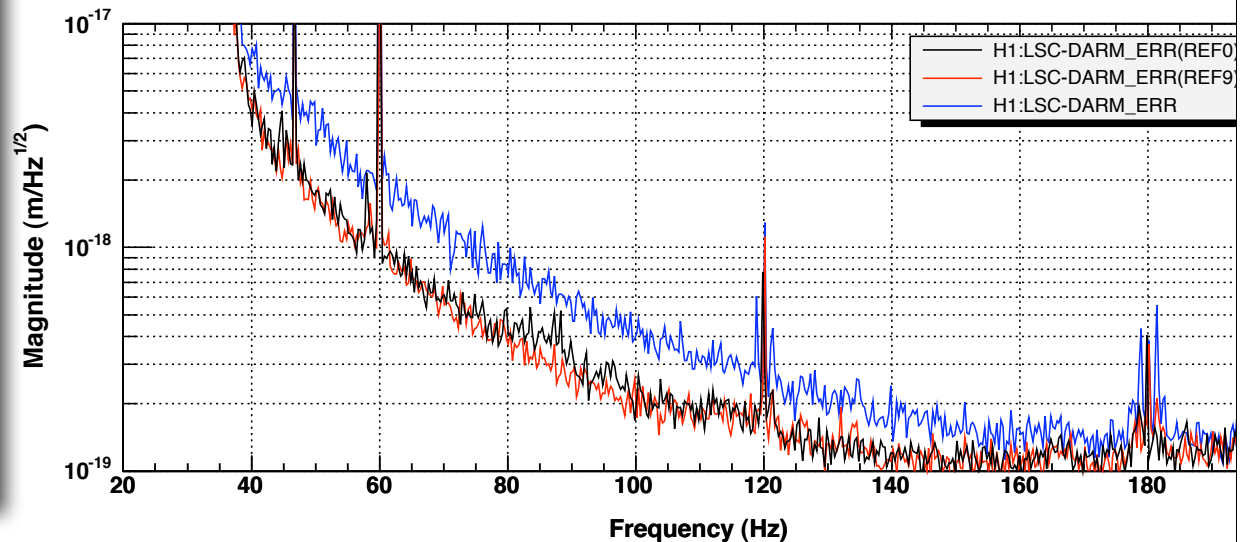○ EX
△ EY
○ MX
△ MY

LIGO-G060390-00-I
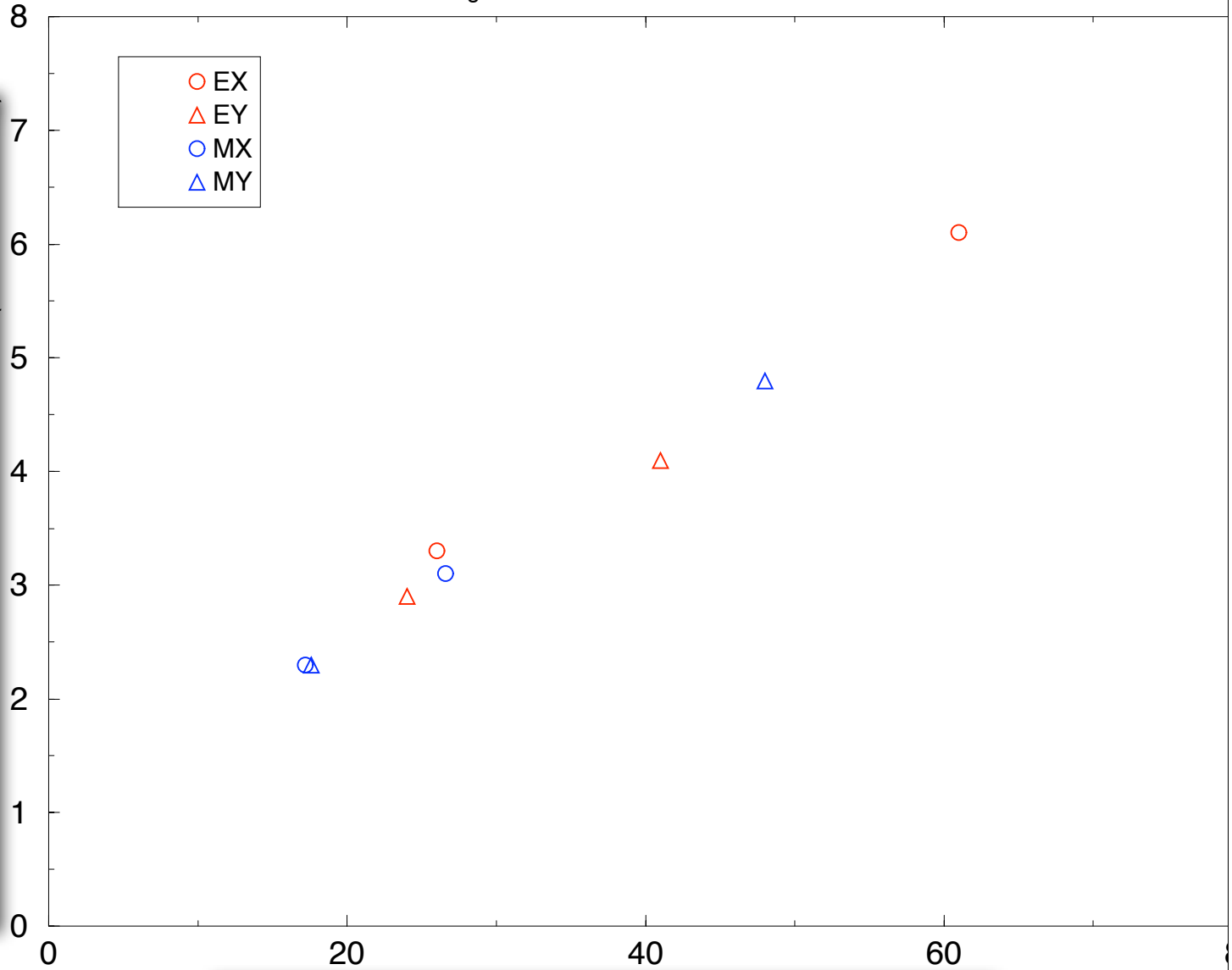
not Optic Motion

Mid-Y ground injections: Black: none, Red: 0.75 Hz, Blue: 1.2 Hz

- 2/20/06 LHO elog

- ground injection

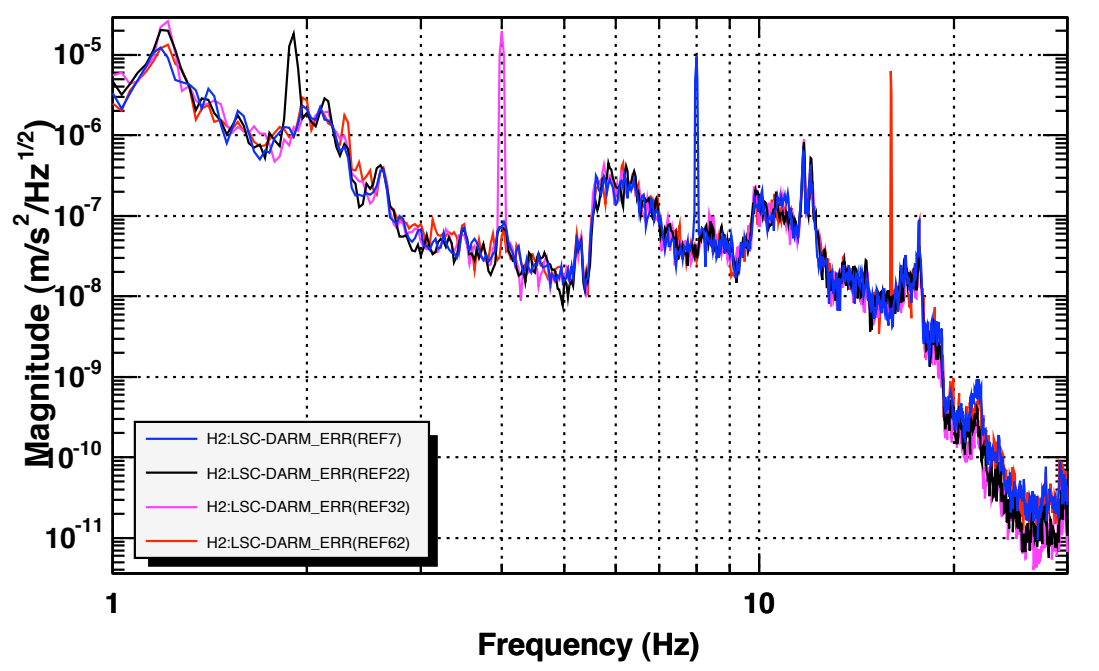- + no ETM damping -> 10x MC_F increase w/ no UC

- increase of DARM RMS != UC
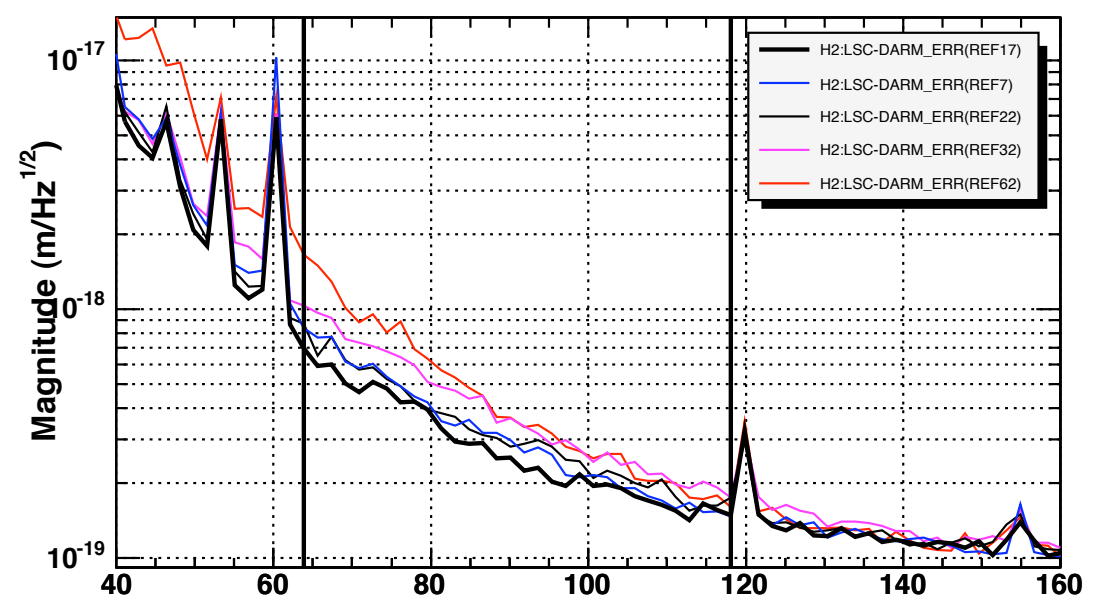
Same color scheme

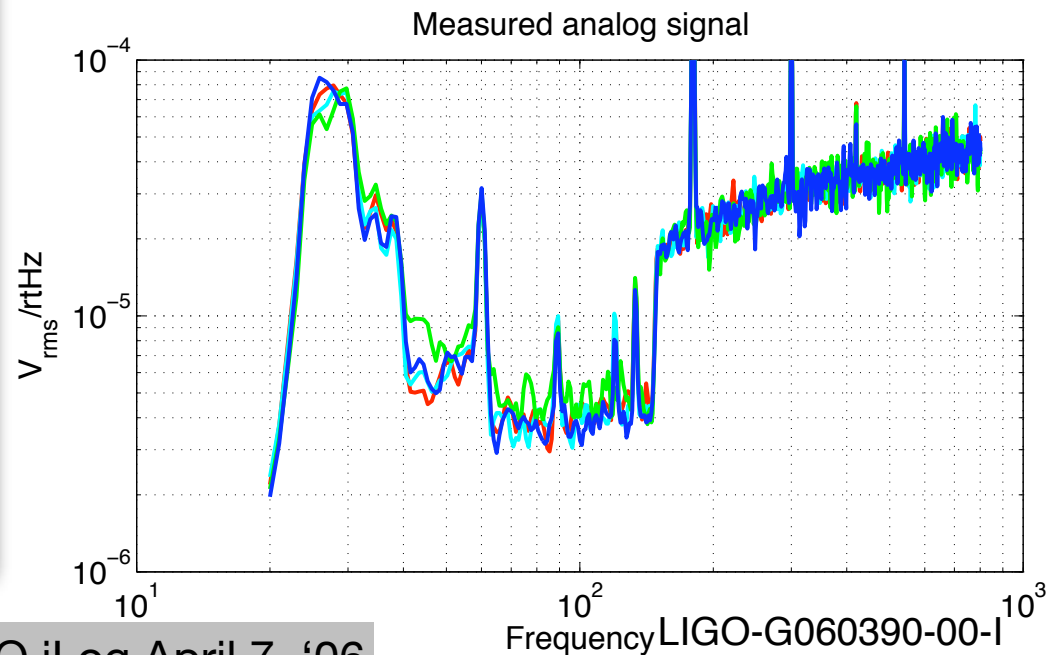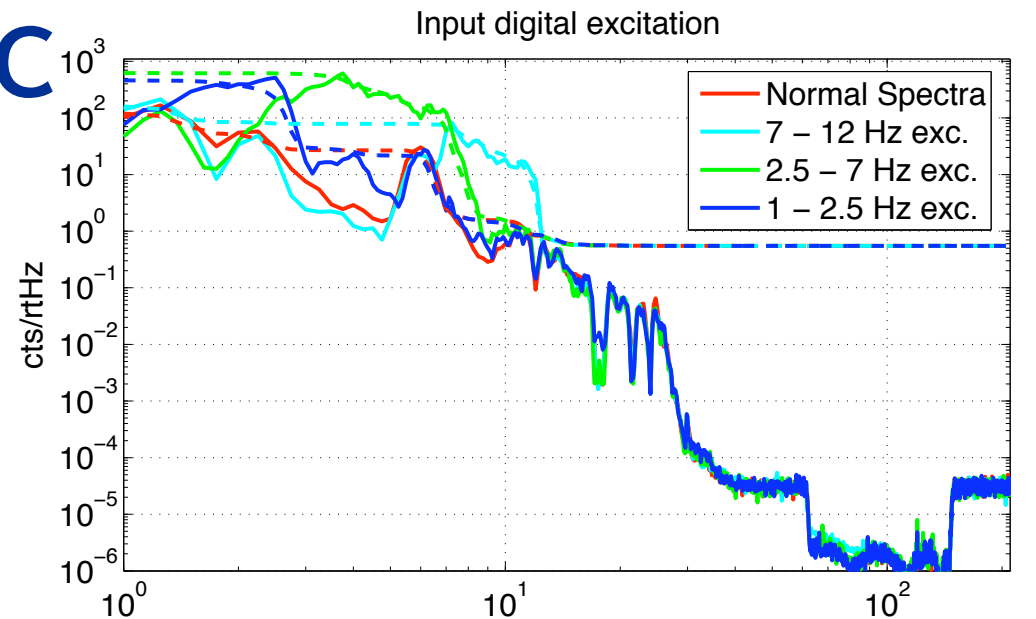*T0=03/12/2005 23:00:55   *Avg=1/Bin=10   *BW=0.0

LIGO-G060390-00-F

Frequency dependence

- RMSS injection to LSC-ETMX_EXC

- Approx. match upconversion
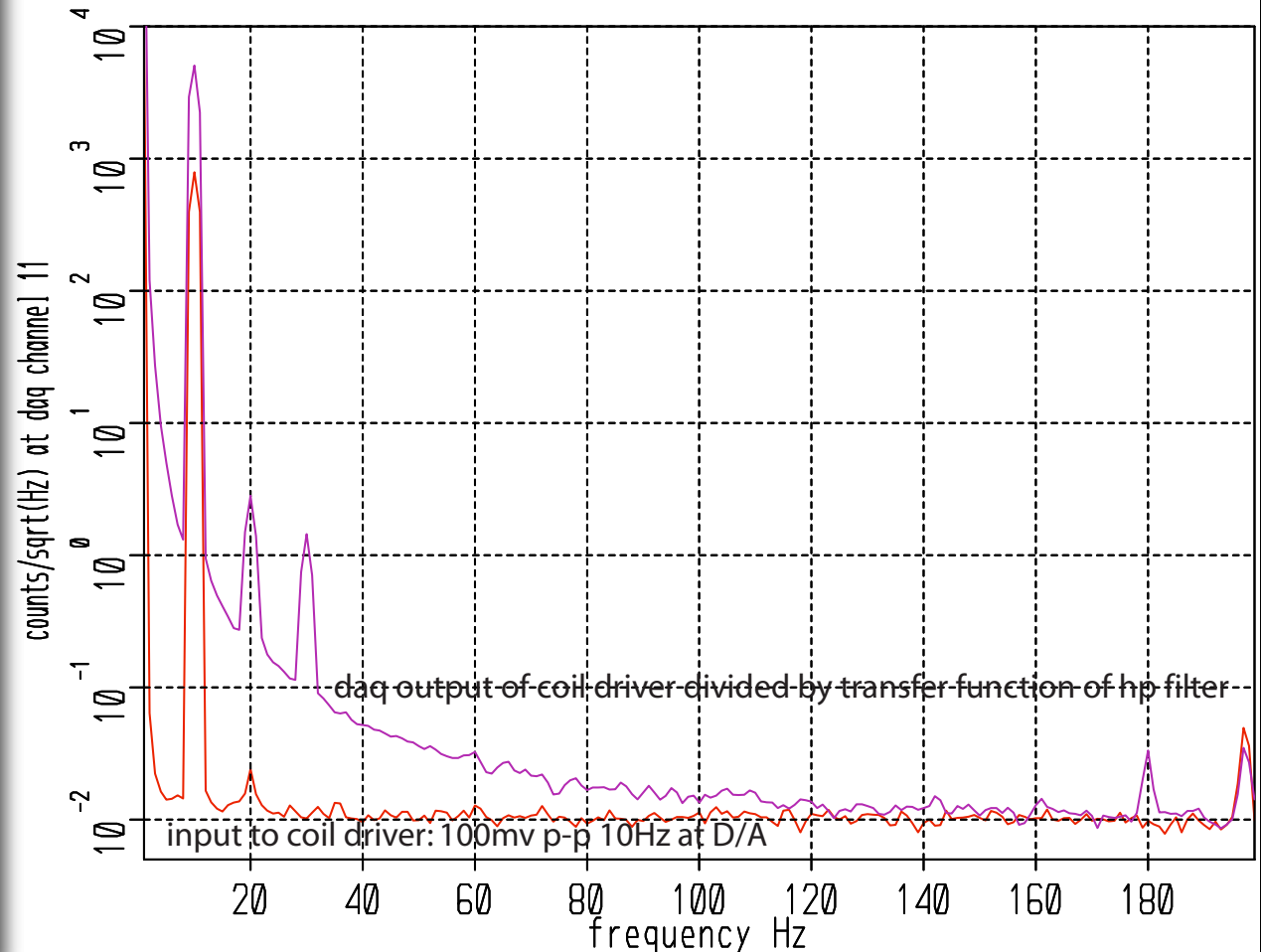
- Seems linear in acceleration

Electronic UC

- Drive output w/ simulated signal

- Notch drive in bucket

- Measure analog coil driver output *in situ*

- Largest exc. @ 2.5 - 7 Hz (may) show UC

Input digital excitation

- Normal Spectra
- 7 – 12 Hz exc.
- 2.5 – 7 Hz exc.
- 1 – 2.5 Hz exc.

Measured analog signal

SJW in LHO iLog April 7, '06

LIGO-G060390-00-I

Direct injection

- *In situ* single tone tests @ 10Hz

- Observed both distortion and broad band noise

- Not seen in the electronics shop

- Further testing in progress

Input to coil driver and output corrected for hp filter

counts/sqrt(Hz) at daq channel 11

daq output of coil driver divided by transfer function of hp filter

input to coil driver: 100mv p-p 10Hz at D/A

frequency Hz

Rai in LLO iLog July 26, '06

LIGO-G060390-00-I

LLO seismic reprised

LIGO

- Before/
  After ITMY
  change

- Unequiv.
  seismic

- Increase in
  correlation

- Two corr
  slopes after

LIGO-G060390-00-I
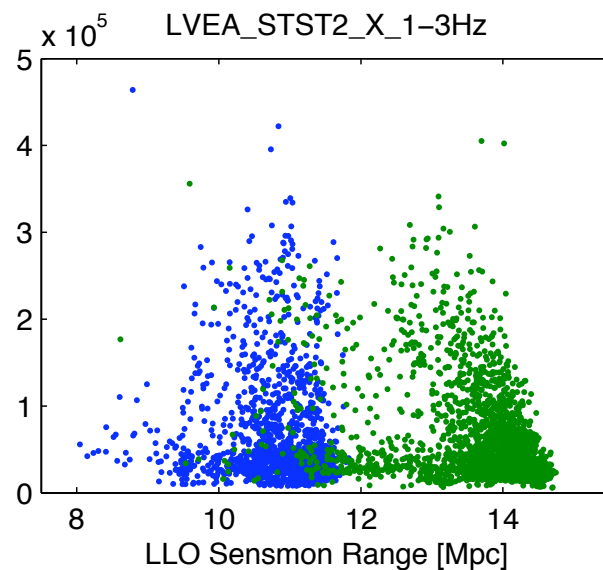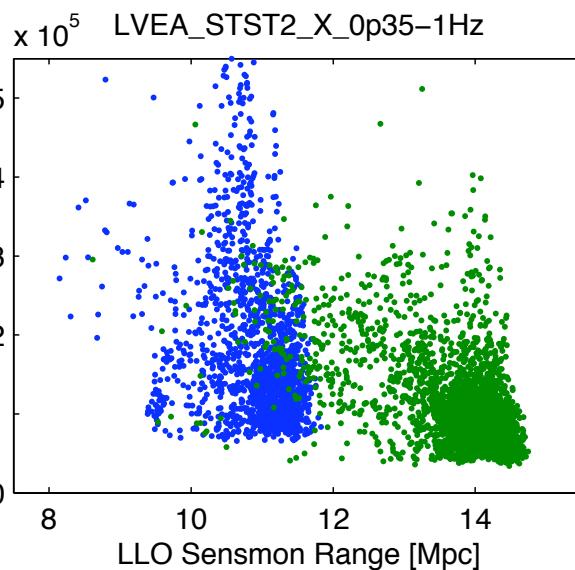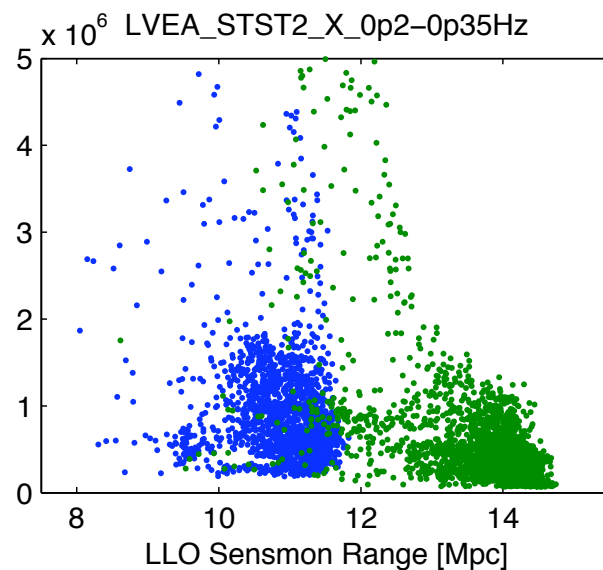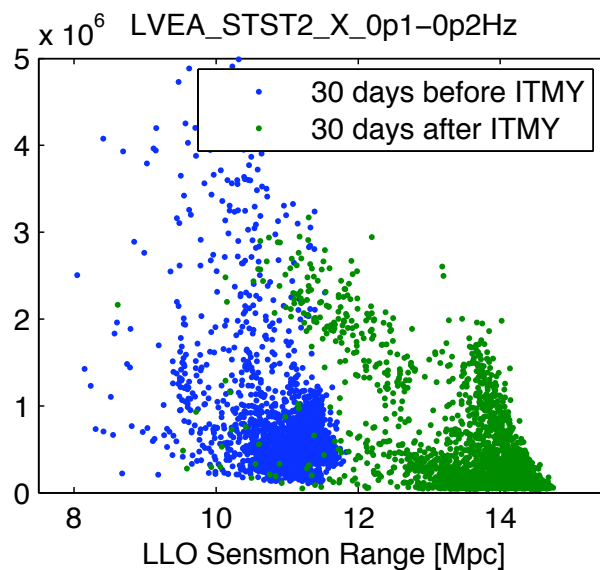
State of the Upconversion

LIGO

- Violin-mode Q measurements consistent w/ low wire loss and low thermal noise *but not all wires tested and clamp stick/slip may be an issue in the future*

- Optic motion alone insufficient to increase noise from free swinging CARM measurement

- Optical scattering probably not the dominant up-conversion mechanism

- Low F up-conversion caused by actuation force unrelated to suspension stack

- Actuation chain electronics are the probable cause for Low F up-conversion - "easily" fixable

- Retraction of the earth quake stops from LLO ITMY greatly reduced "baseline" noise - could be applied to all IFOs

- HVAC up-conversion noise effect still unexplained