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# Discrepancy Between Photon Calibration and Official Calibration

**Peter Kalmus**
**Columbia University**

**on behalf of the**
**Calibration Committee**

**Commissioning Meeting**
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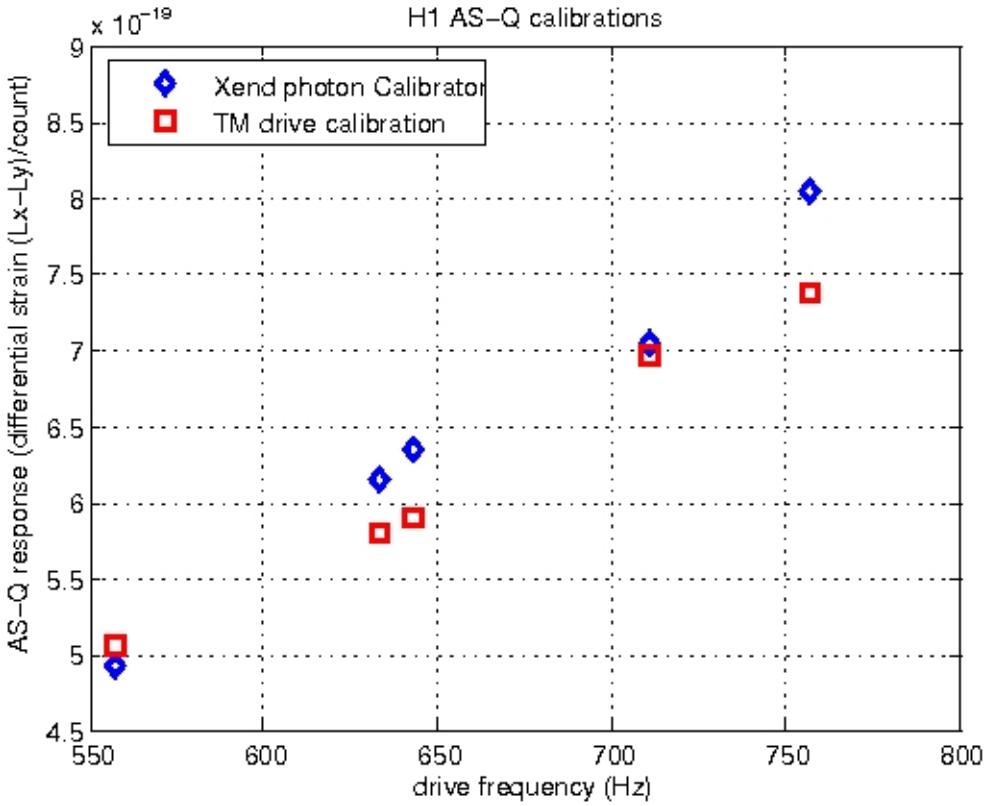
# Mike Landry and Rick Savage's First Look

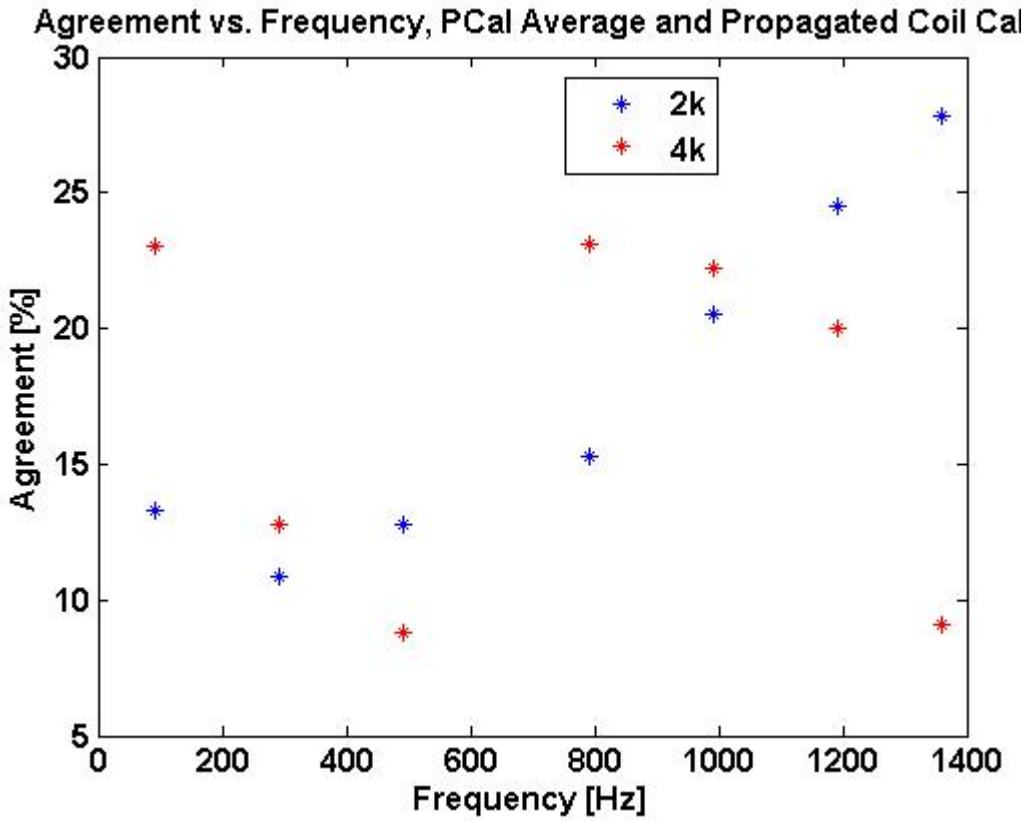
Biggest discrepancy is 7%.

We haven't done so well since.

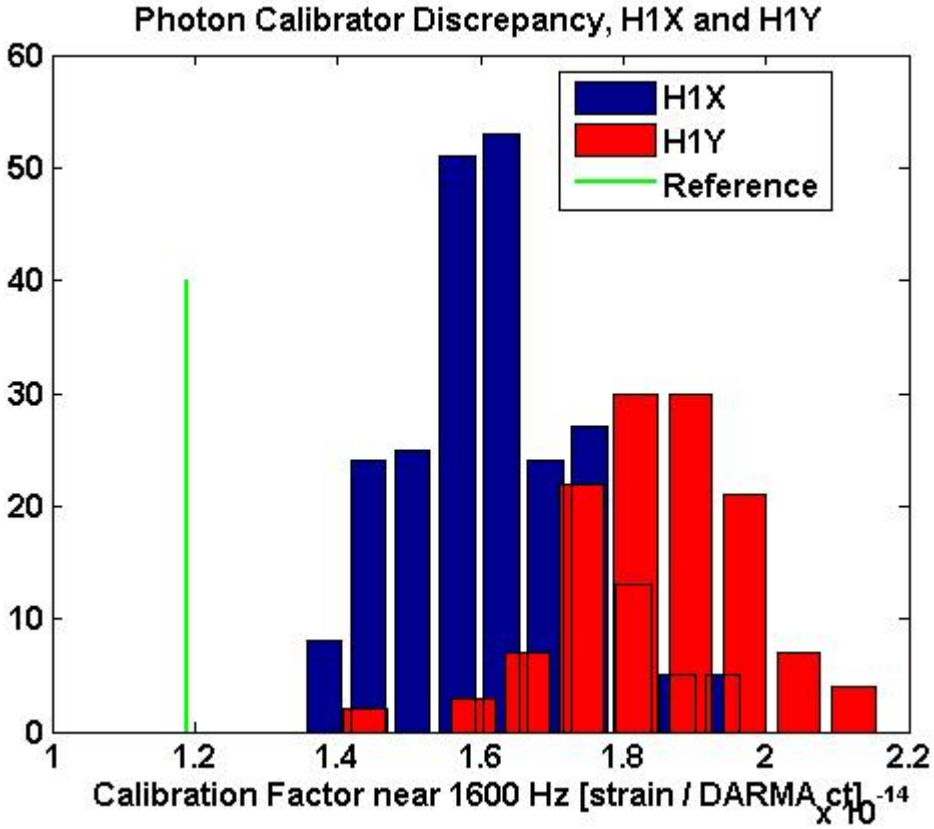


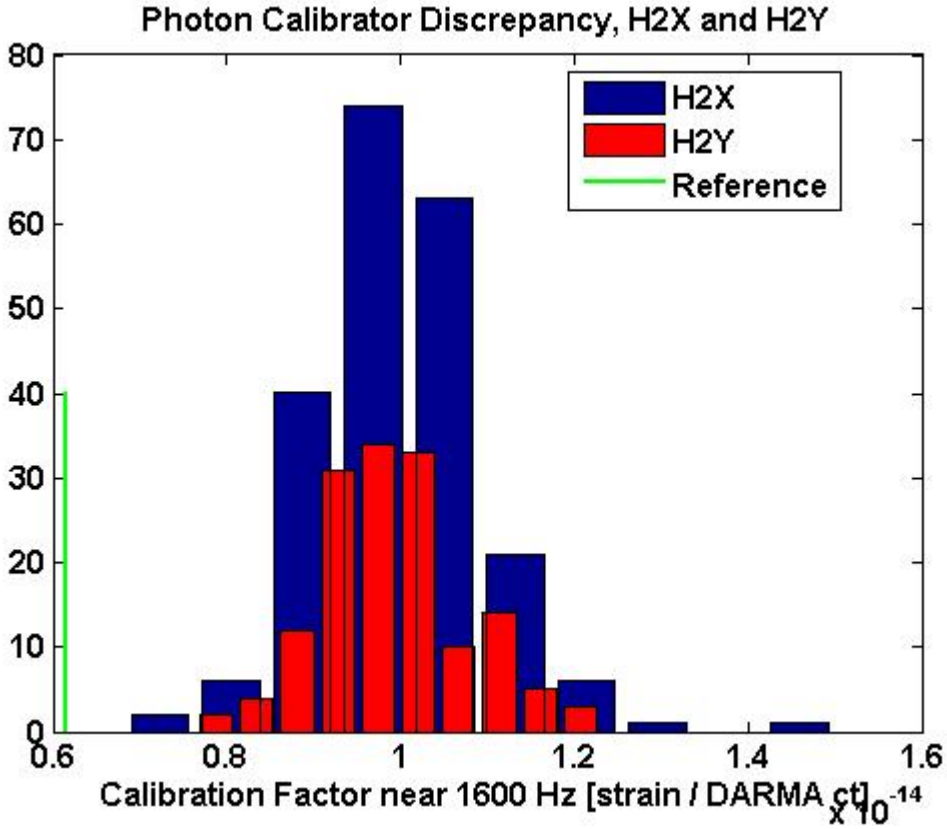
# August 2005

- 2k shows discrepancy may be increasing with frequency
- 4k propagation might not be valid
  - alpha and beta were not available at the time this was done – they were extrapolated



# LIGO Recent Measurements with DMT




1000 second integrations, measurements of peak only

H1X mean is 1.4x reference; H1Y is 1.6x reference

H2 means are both 1.6x reference

it's really ~15% worse than this: noise power has not been subtracted from DARM_ERR peak measurement; this will shift PCal higher

standard deviations between 7% and 10%

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# todo list

Get a DMT started at Livingston

Subtract power from noise in DMT

use nearest neighbor bins in DMT (tests in Matlab on sandbox data imply that this probably won't change things significantly)

Propagate DARM response function with FDCalibrate in DMT

Test hypothesis that discrepancy increases with frequency

- try adding a pcal line with H1X for one week at a lower frequency.
- 719.1 Hz should be clear of pulsars, violin modes, and pulsar injections
- 804.85 Hz  (1609.7 / 2) is clear as well
- probably OK to keep drive level the same....

# Brief Review of the Process

- Inject a line (on an ETM) with the photon cal laser / AOM
- Measure peak in DARM_ERR PSD
  - use 3 bins (peak + nearest neighbors)
  - subtract power from noise, estimated from nearby bins (or use fit)
  - take sqrt to get peak amplitude
- Measure peak in ETMX_CAL PSD
  - bin width and windowing function factors cancel
- Convert ETMX_CAL measurement to strain
  - readout cts -> Watts out of enclosure (at DC)
  - account for power lost due to reflection off of viewport
  - account for momentum lost due to transmission through optic
  - measure angle of incidence, mass of optic
  - systematic errors: off-centered beam in H1 (~3%); AOM to photodetector transfer function (~2%); power meter (up to 10%)

# Possible Culprits

Power meter systematic – readings possibly ~10% high

- would cause cal factor to be ~10% too high
- currently under investigation – meters have been sent to Scientech for comparison

We assume test mass displacement is given by:

$$x_{exc}(\omega) = \frac{2P\cos\vartheta}{Mc\omega^2}$$

- Heating effect would change $f^{-2}$ dependency, but this was checked
- Would expect this to be worse at lower frequencies

Transfer function ETMY_CAL/ ETMY_CAL_EXC attenuates by 2% from DC at 1600 Hz

- still a mystery
- would cause the cal factor to be lower, not higher

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# Other ideas

- Blunder
  - sqrt(2) somewhere? Not correcting for windowing function?
  - hmm.
- Not using the correct reference response function
- Photodetector calibrations may have drifted
- Harmonics
  - They account for less than 1% of power; also, they will “factor out” of the result
- Absorption in viewport
- Other means by which power is not getting to TM, or TM is not moving as much as we think.