S3/S4 Calibration

A cast of thousands… including

Peter Fritschel, Gabriela González, Corey Gray, Mike Landry, Greg Mendell, Brian O'Reilly, William Quintero , Rick Savage Xavier Siemens, Myungkee Sung, Patrick Sutton, Rai Weiss…

LIGO-G050185-00-Z

S3 Calibration

- S3 Final calibration V3: released Jan 28 2005.
- First version to use “demodulated” lines for alpha, beta estimates (X. Siemen’s code).
- Also, first science run to use “dynamic beta”.
- Somewhat reviewed (?)
- Document, paper with details and errors in preparation.
- Measurement errors in alpha, beta <0.5%, DC calibration ~few-10%, reference functions ~few %, 5^{o}
- new flag CALIB_LINE_V03 (supersedes all the old flags, except no EXC).

S4 calibration

- Two gw channels, with different (but related!) calibrations:
  - DERR(t)=β(t) ASQ(t); $C_{DERR}(f)=k_0 C_{ASQ}(f)$
  - AS_Q, with $h(f)=R_{ASQ}(f,t)$ ASQ(f) and

    $R_{ASQ}(f,t)=(1+\alpha(t)\beta(t)G(f))/(\alpha(t)C_{ASQ}(f))$
  - DARM_ERR (“darma”), with $h(f)=R_{DERR}(f,t)$ DARM_ERR(f) and

    $R_{DERR}(f,t)=(1+\alpha(t)\beta(t)G(f))/(\alpha(t)\beta(t)C_{DERR}(f))$

S4 online calibration

- Released ~ a week before S4 (a first!)
- Not reviewed yet (errors?)
- Online coefficients (OLOOP_GAIN, CAV_FACTOR) from SenseMon
- Problems: Dropouts
- Recommend: use DARM_ERR with $\alpha(t)*\beta(t)=1$.

S4 to-do list

- A few more measurements (electronics, cavity poles,…)
- DC vs AC calibration, sign of calibration
- Revised model and reference functions
- Coefficients from demodulated lines (M. Sung) -- ~a week after S4
- Error estimates
- DQ flags (dropouts, large fluctuations, large errors…)
- H1 Photon calibrator: validation

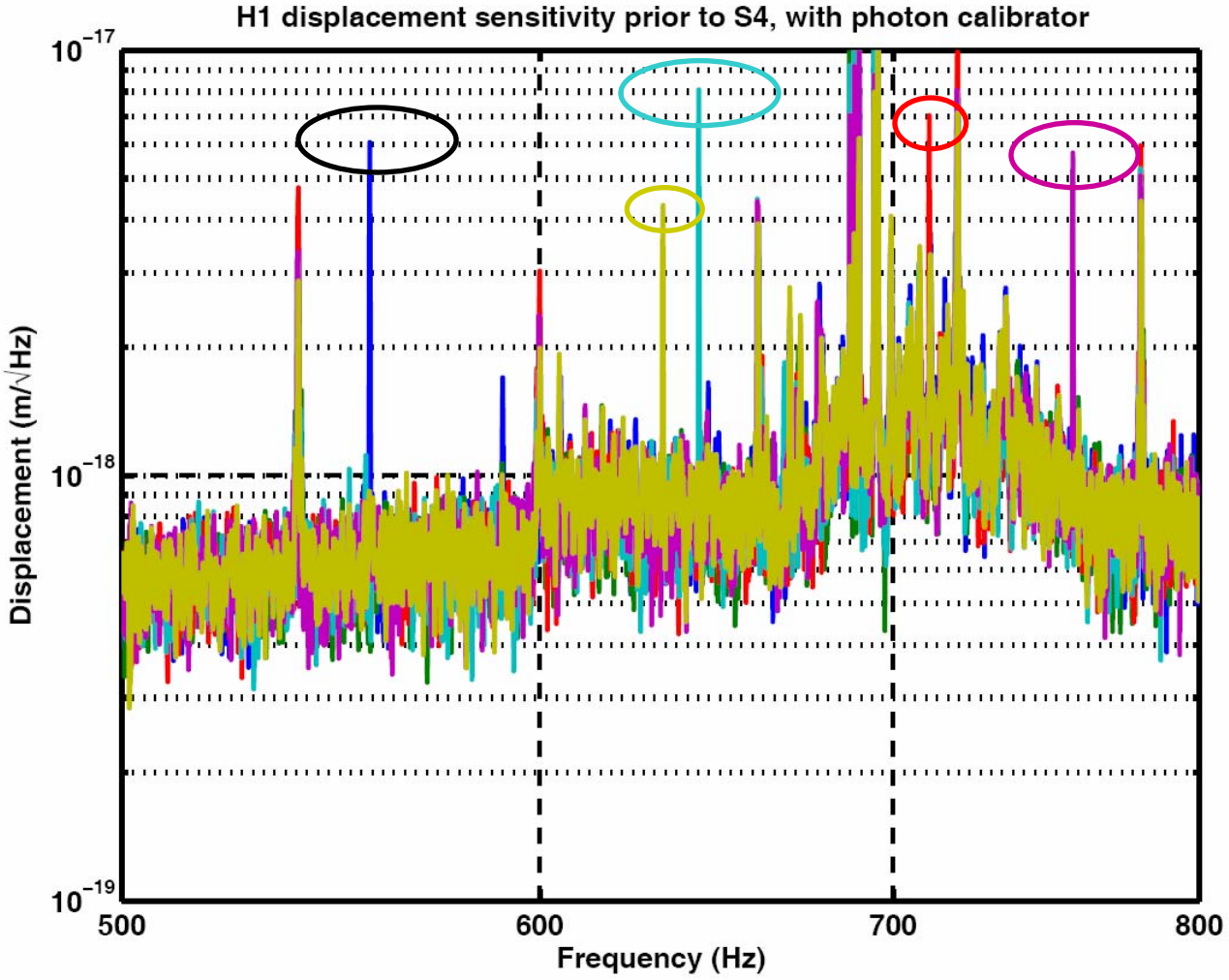
S4 photon calibrator

- **previously installed and tested – laser troubles with rotating polarization**
- **recently reinstalled at LHO (Corey Gray) on new LLO-designed shelves (Oddvar Spjeld)**

Expectations: photon calibration would be precise but not necessarily accurate (~20%?). Official calibration method more accurate (approaching 5%), but question of precision remains (do we have poorly understood systematics?)

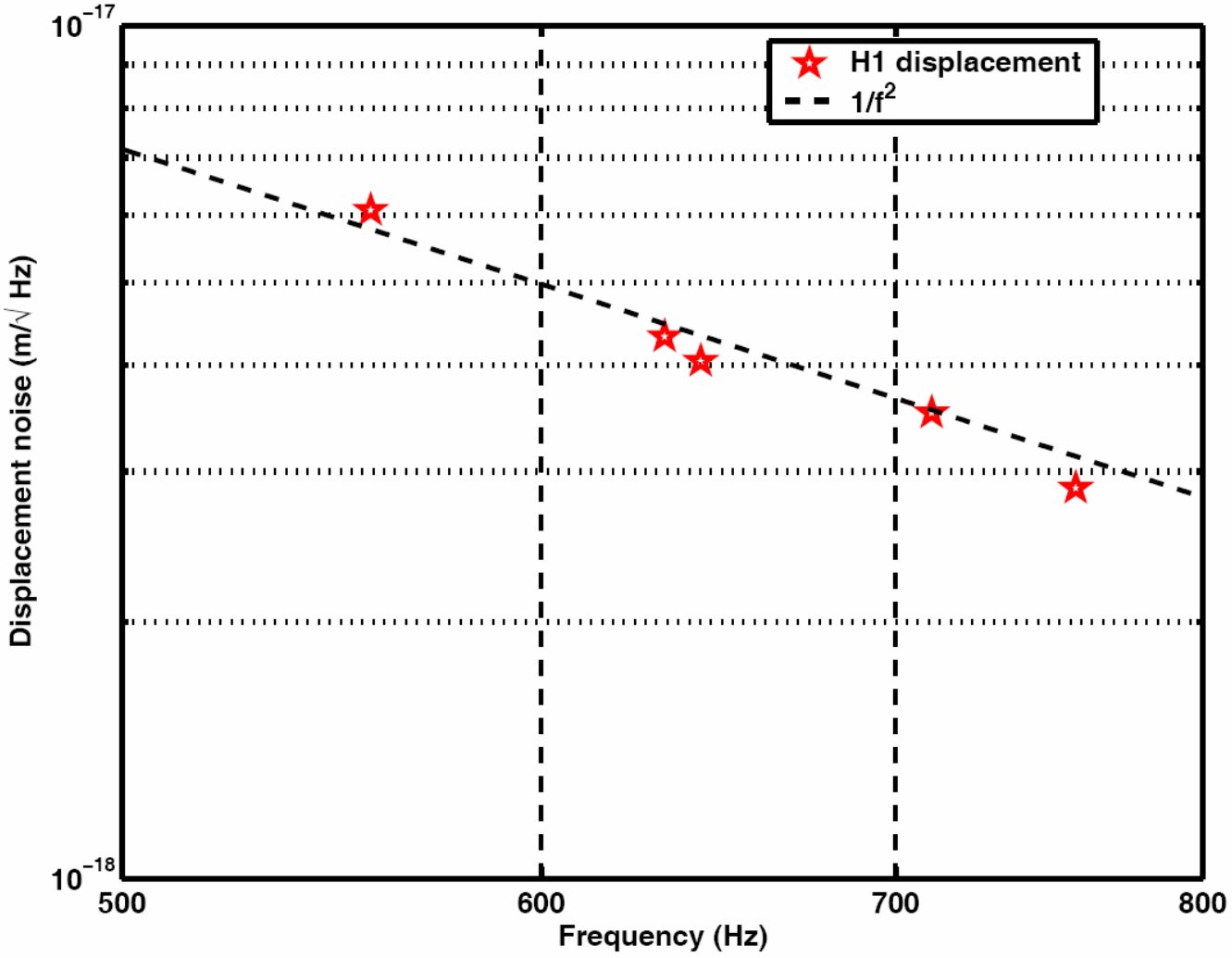
photon calibrator injected lines

- **Single test in EX made at LHO ~9h prior to S4**
- **5 calibration lines briefly injected**
- **Calibration for these five curves: standard, official method**



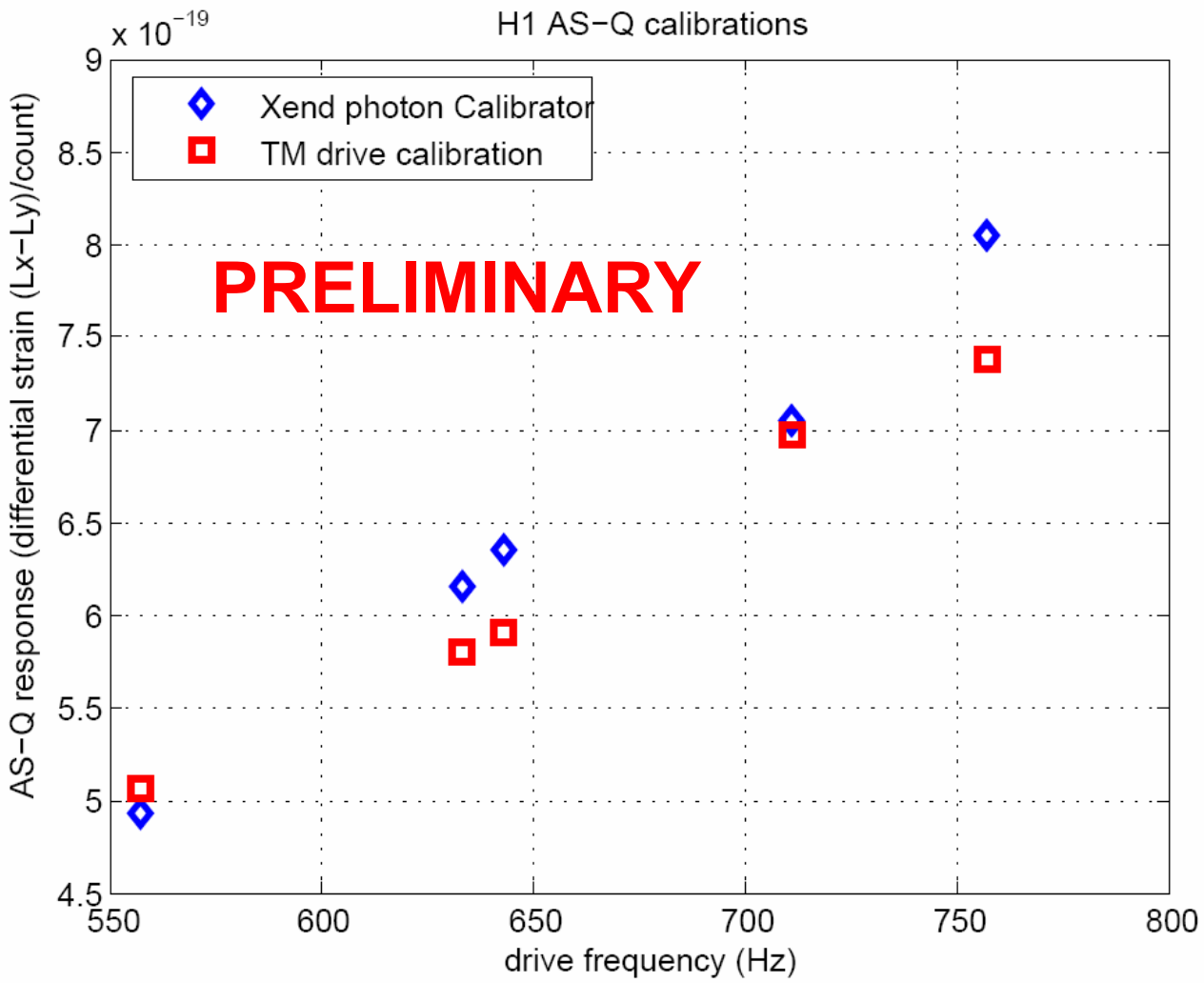
response to photon calibrator

- **Displacement equivalent noise of photon calibrator calibration peaks (scaled by size of excitation)**
- **Calibration here is obtained via official method**
- **Peak displacement due to photon calibrator falls like $1/f^2$**

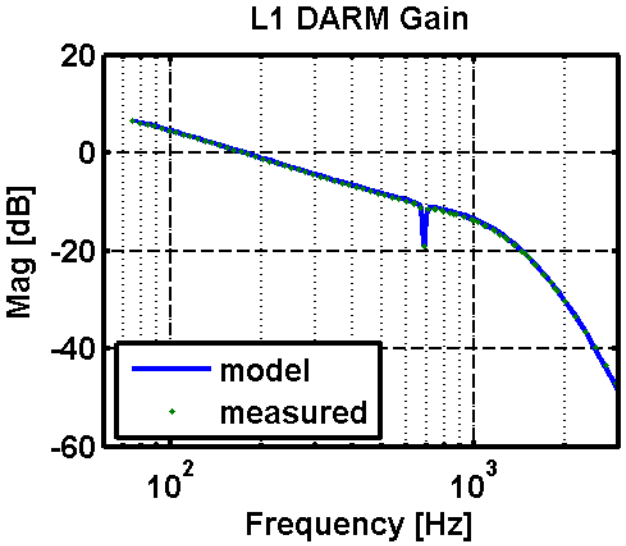


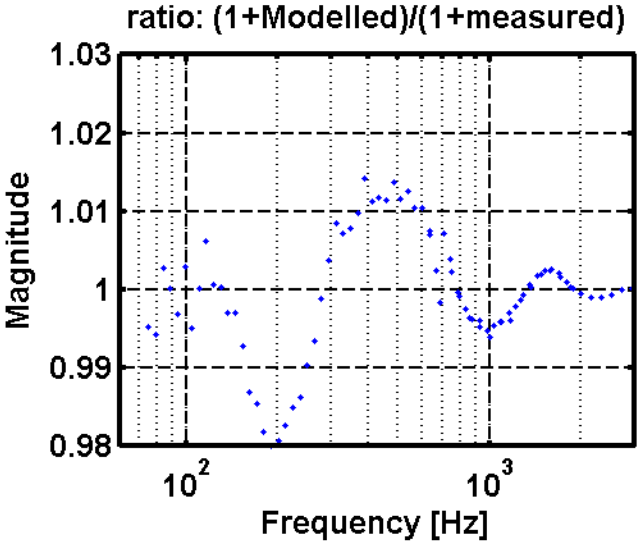
Comparison: official calibration vs photon calibrator

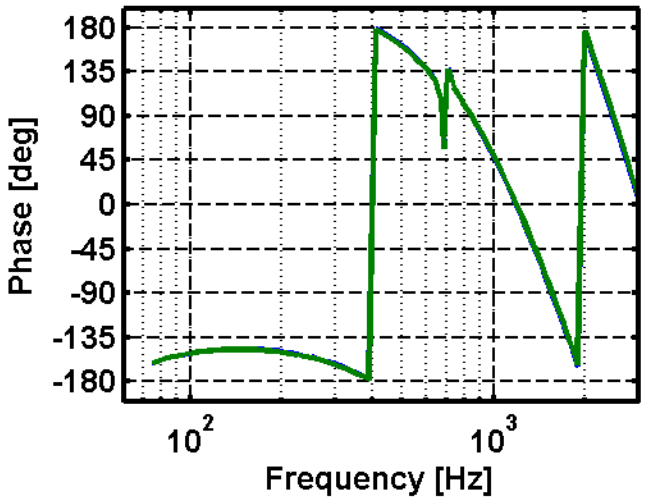
- **Magnitude of response functions in strain/rtHz is shown for two different calibrations**
- **red blocks: 'official'**
- **blue diamonds: photon calibrator**
- **Good agreement (one to nine percent)**

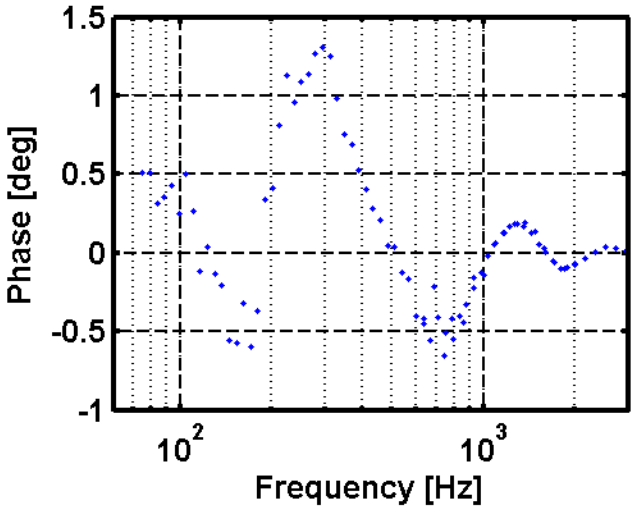


Matlab models: L1



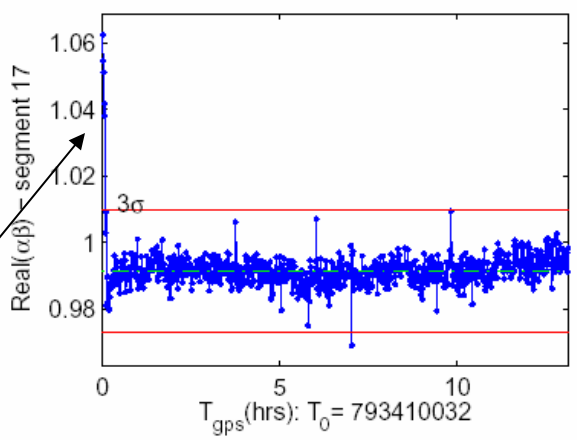


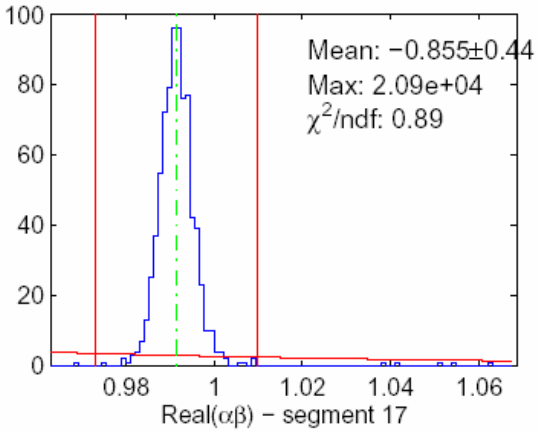


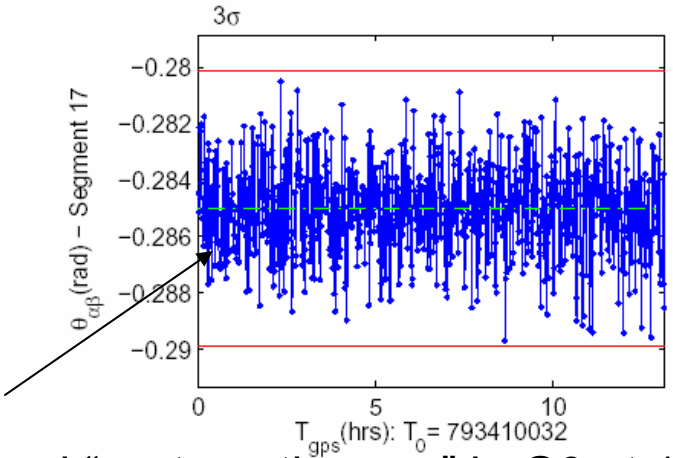


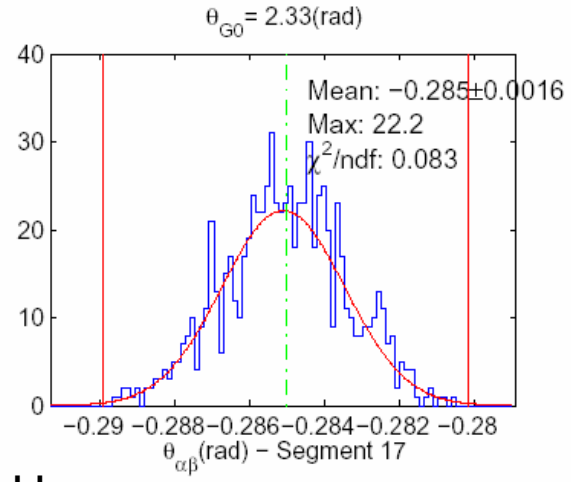
H1, Seg 17, 60 sec

Warm-up









~-0.3 rad “systematic error” in G0 at 1144 Hz,

~0.2% “statistical error” in αβ estimate

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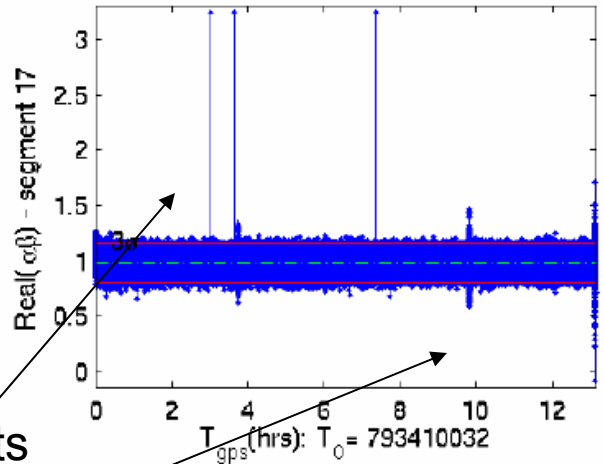
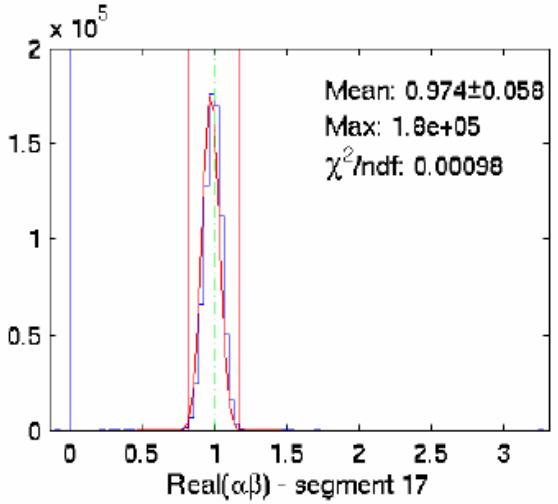
http://ligo.phys.lsu.edu/sung/Factors/S4/index.html

H1, Seg 17, 16 Hz



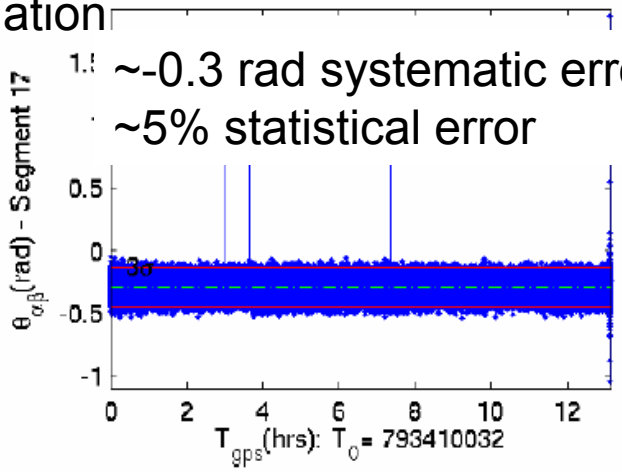


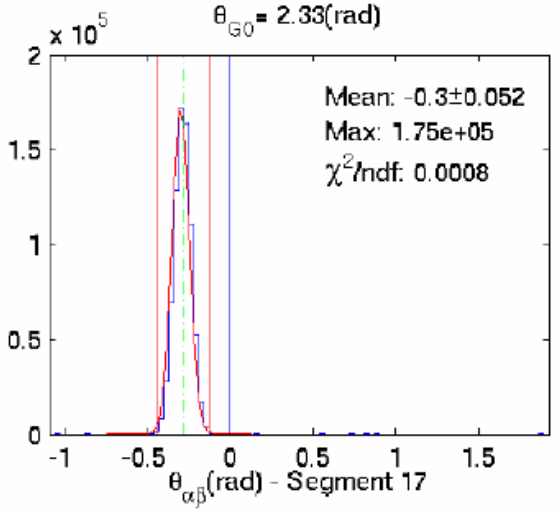
Noise bursts

Gain fluctuation

~-0.3 rad systematic error

~5% statistical error





Calibration dropouts

- For first 3 weeks in S4:
  - L1: 83 instances, 283 sec flagged
  - H1: 56 instances, 168 sec flagged
  - H2: 120 instances, 360 sec (0.02%)