Uncertainties in LIGO data calibration

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Workshop on Interplay between Numerical Relativity and Data Analysis

Kavli Institute for Theoretical Physics

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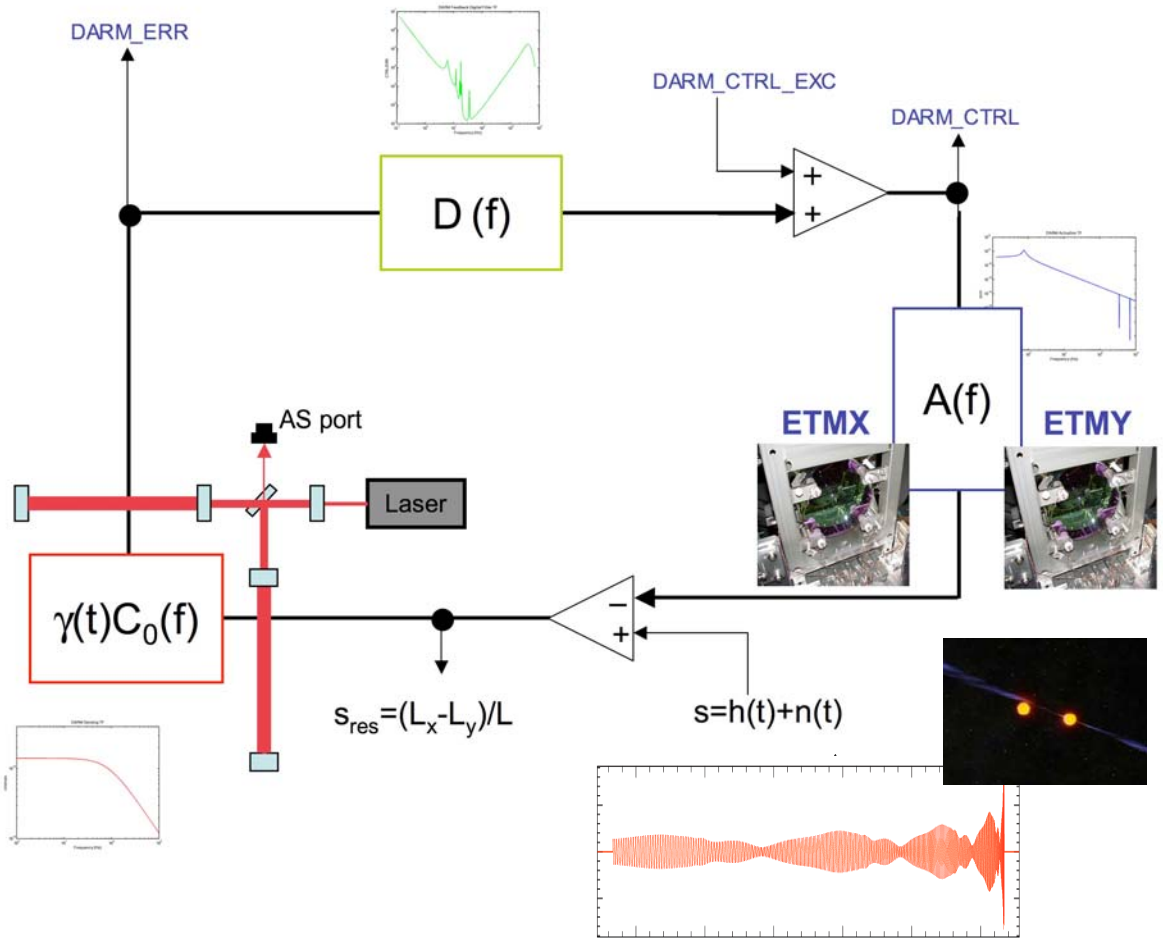
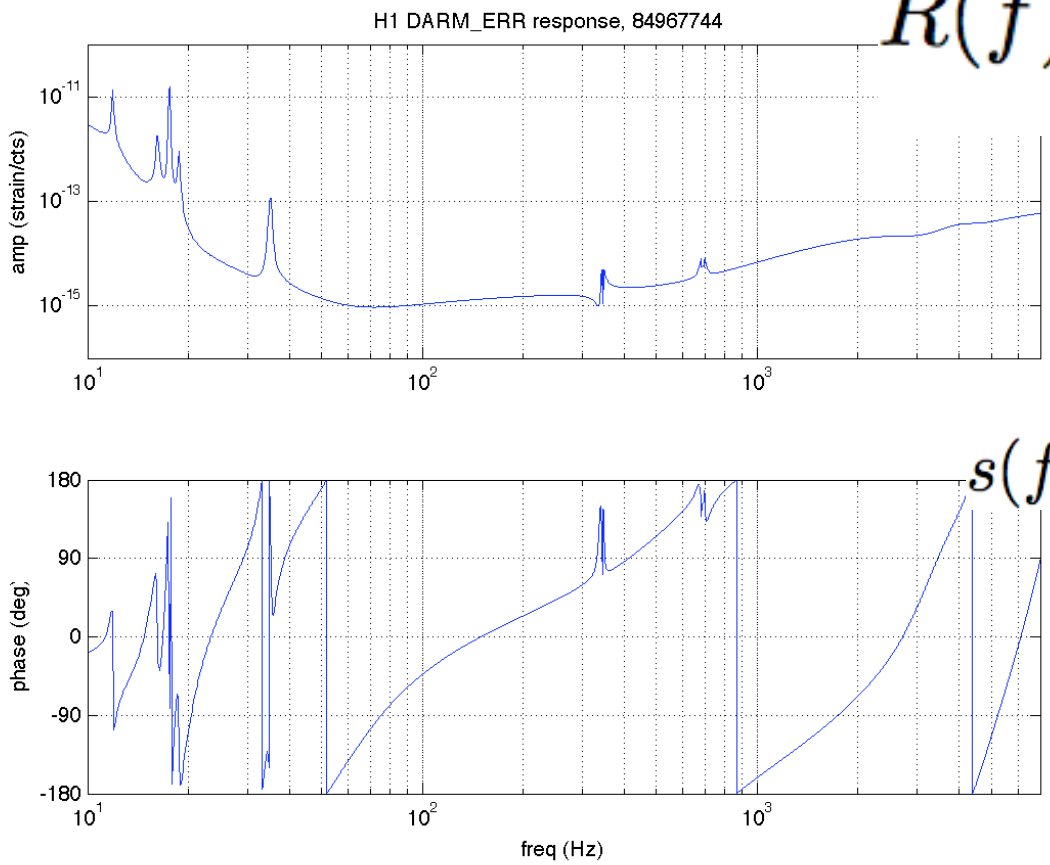
The “DARM loop”



The “DARM response”

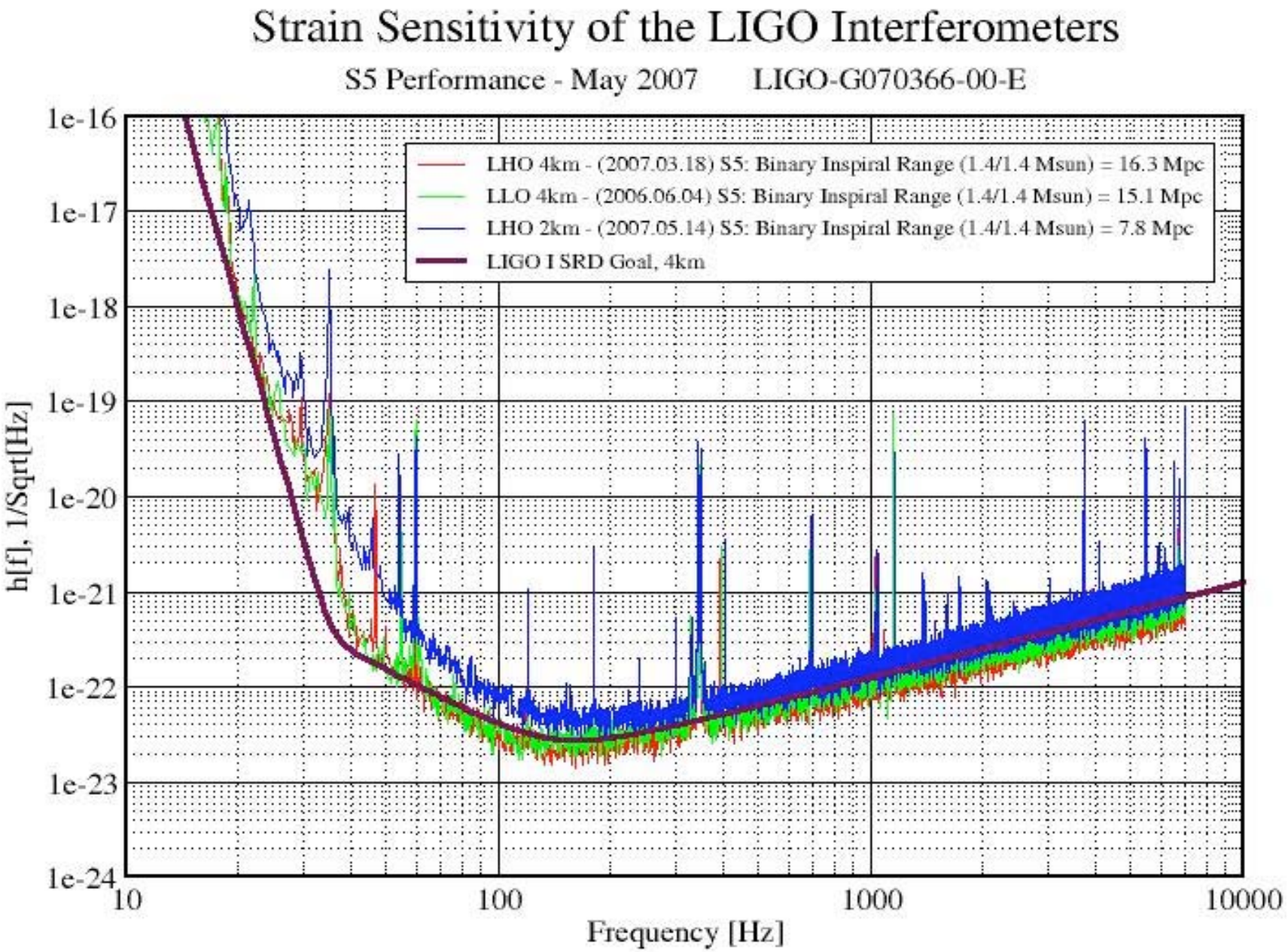


$$R(f) = \frac{1 + \gamma(t) G_0(f)}{\gamma(t) C_0(f)}$$

(from model) (from ifo)

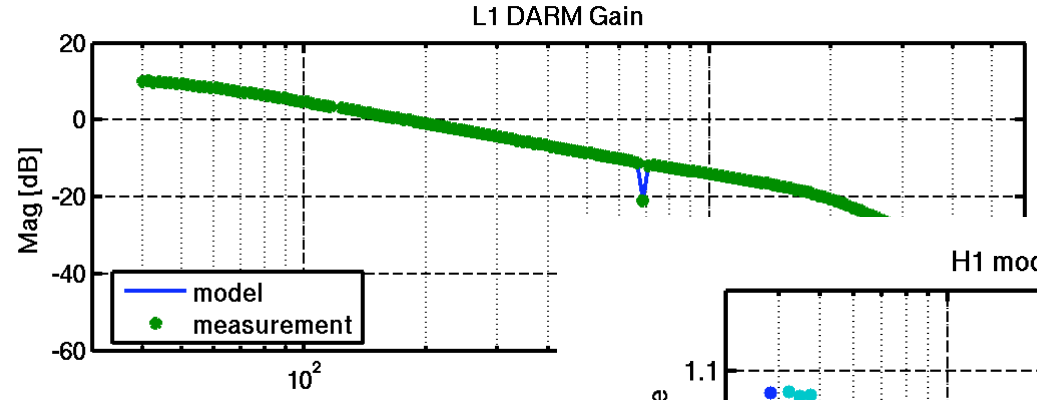
$$s(f) = R(f)\mathrm{DARM\_ERR}(f)$$

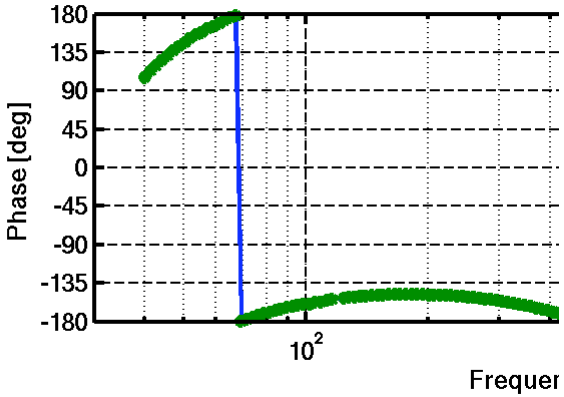
$$h(t) = \int R(t-\tau) DARM(\tau) d\tau$$


Strain Sensitivity of the LIGO Interferometers
S5 Performance - May 2007
LIGO-G070366-00-E
LHO 4km - (2007.03.18) S5: Binary Inspiral Range (1.4/1.4 Msun) = 16.3 Mpc
LLO 4km - (2006.06.04) S5: Binary Inspiral Range (1.4/1.4 Msun) = 15.1 Mpc
LHO 2km - (2007.05.14) S5: Binary Inspiral Range (1.4/1.4 Msun) = 7.8 Mpc
LIGO I SRD Goal, 4km
h[f], 1/Sqrt[Hz]
1e-16
1e-17
1e-18
1e-19
1e-20
1e-21
1e-22
1e-23
1e-24
10
100
1000
10000
Frequency [Hz]

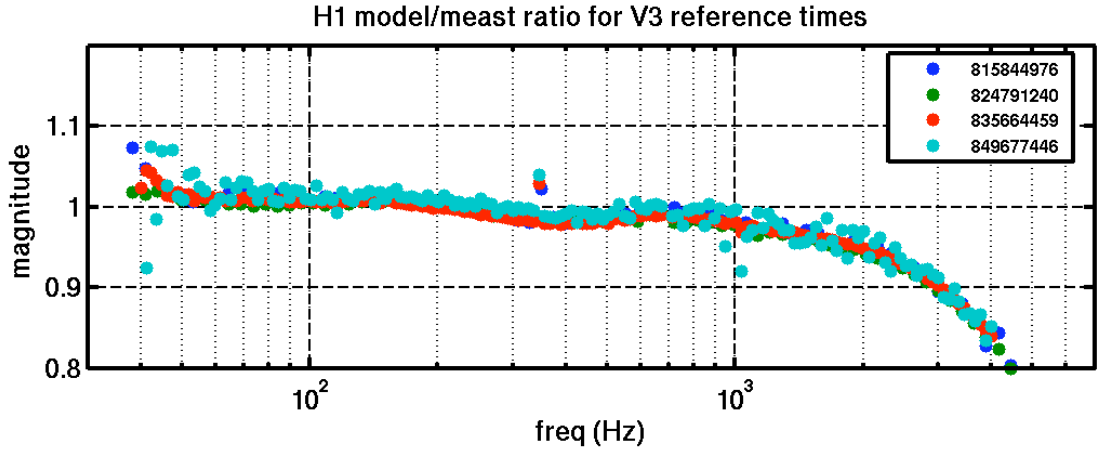

LIGO Celebrates Successful S5
Displacement Sensitivity of the LIGO Interferometers
Frequency [Hz]
WE DiD iT !

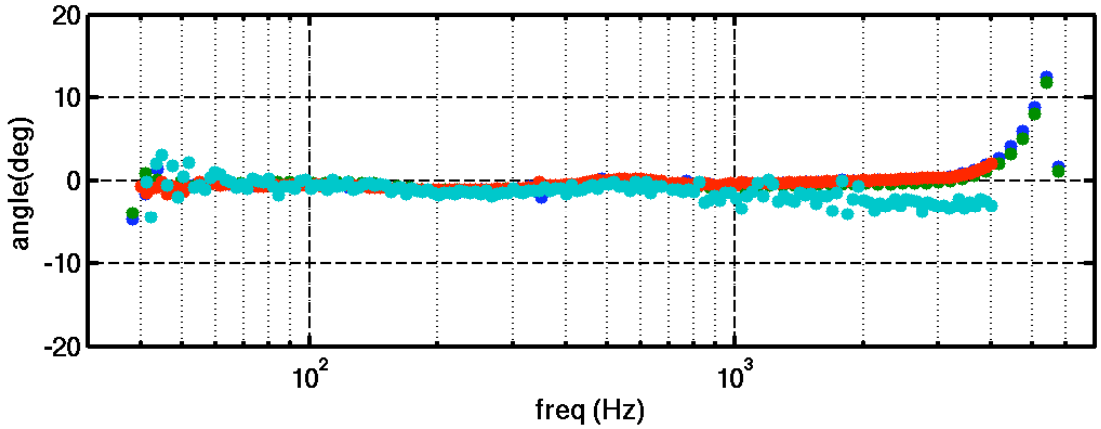
G_0 Model vs measurement: an error estimate





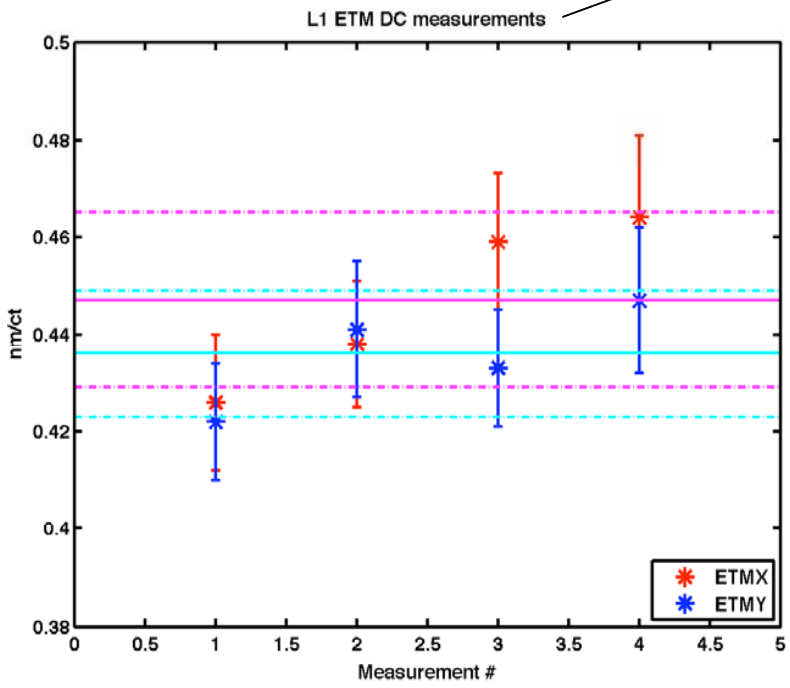
$$R(f) = \frac{1 + \gamma(t) G_0(f)}{\gamma(t) C_0(f)}$$

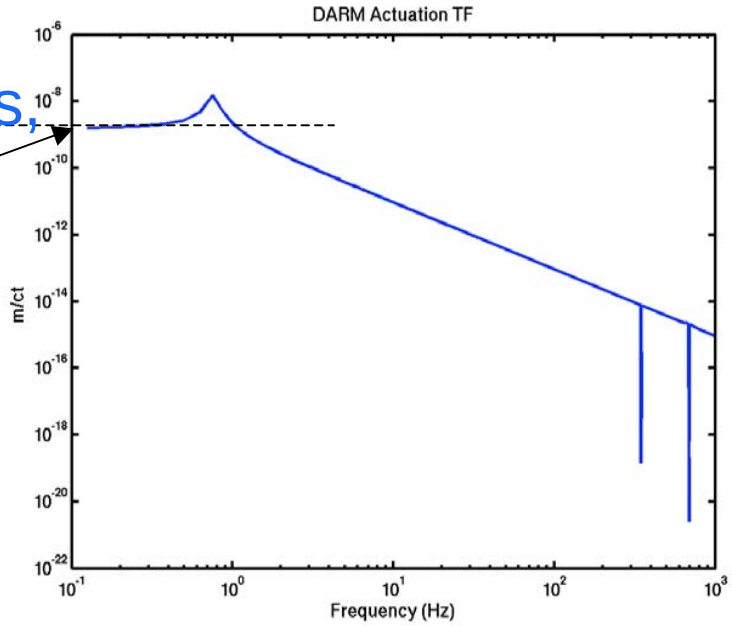




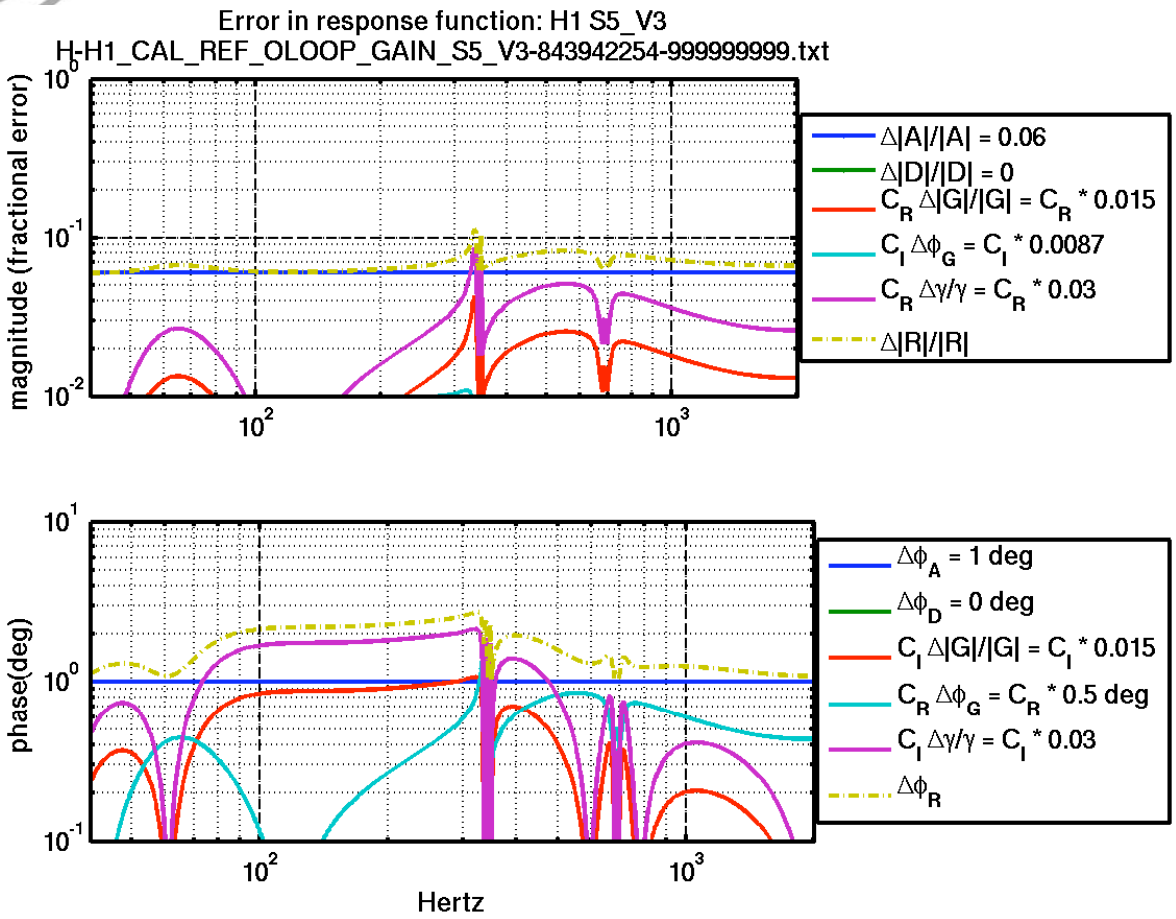
Overall scale factor ("DC calibration")

Average several measurements, taken during the run:





Error Budget



$$R(f) = \frac{1 + \gamma(t) G_0(f)}{\gamma(t) C_0(f)}$$

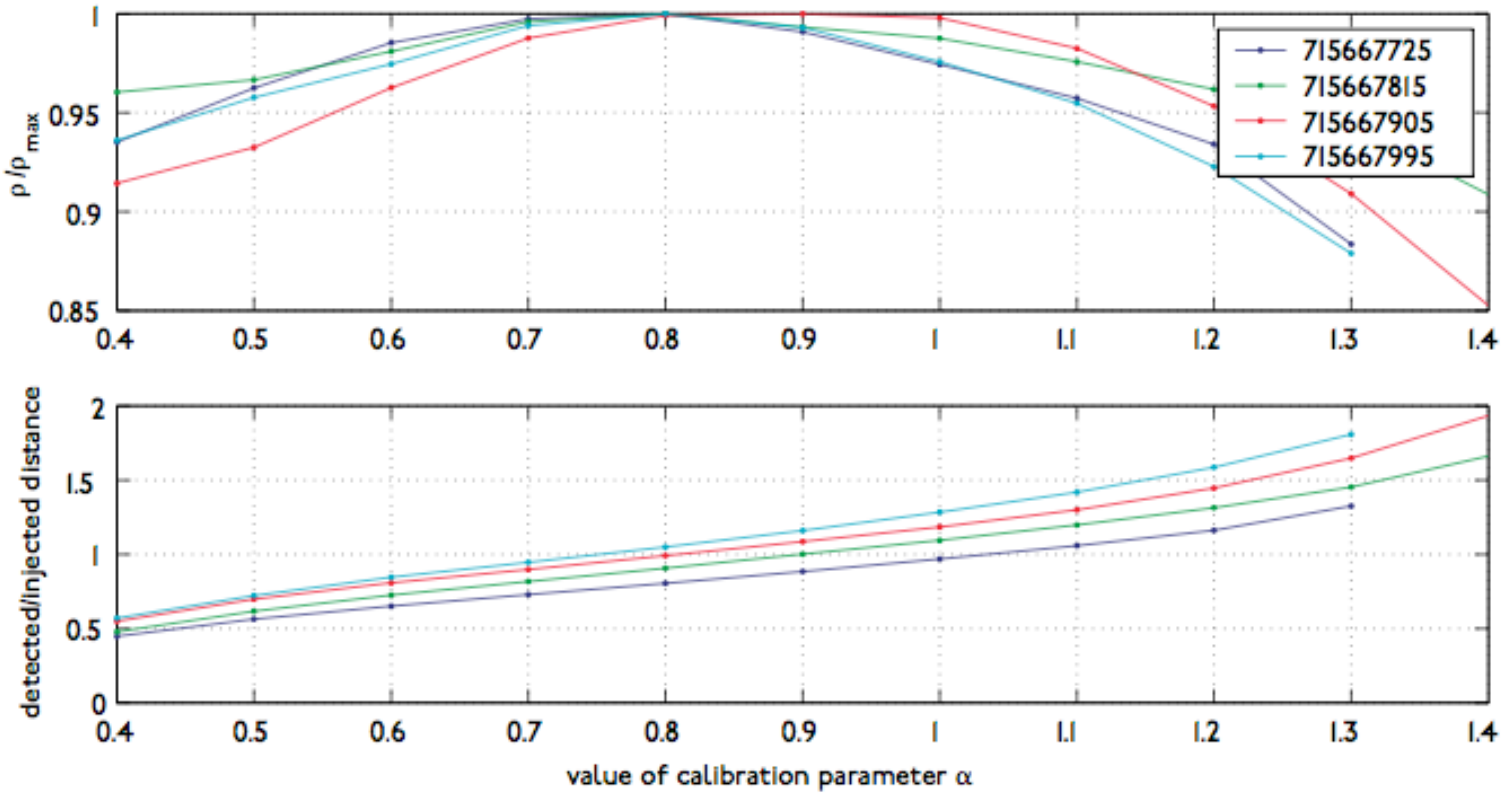
$$C_0(f) = \frac{G_0(f)}{A(f) D(f)}$$

(1deg = 18mrad)

(plus systematic errors)

Rule of thumb: 10%, few degrees

Can we detect with errors present?



Yes, if we are careful enough with vetoes.
Can we measure parameters? Discussion topic!