Status of GEO 600

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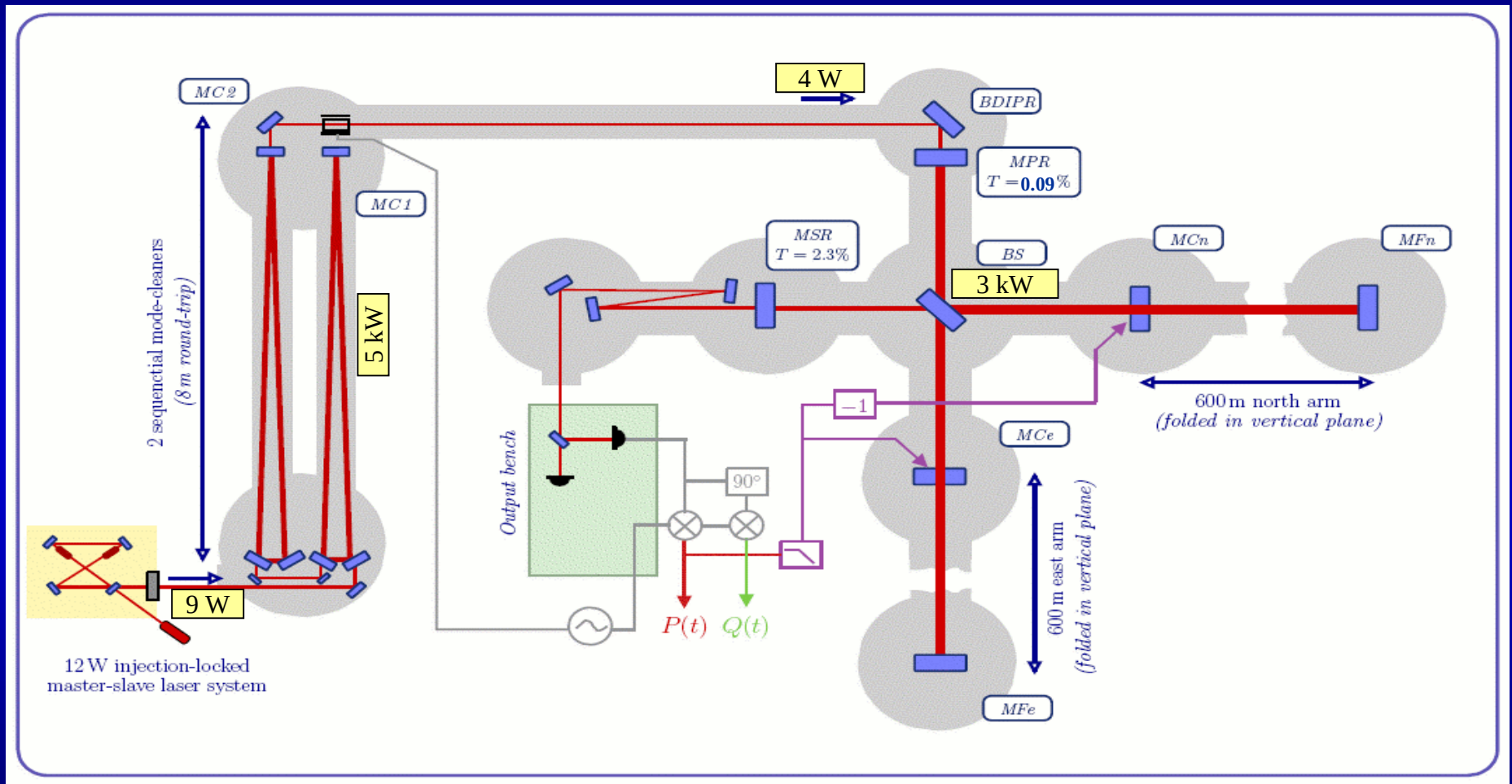
for the GEO-team

Overview

- Some examples from commissioning work
  - increasing circulating power
  - radiation pressure compensation
  - reduction of feedback noise
- Calibration
- Data quality
- Detector characterization, stationarity
- Sensitivity progress

GEO 600 layout



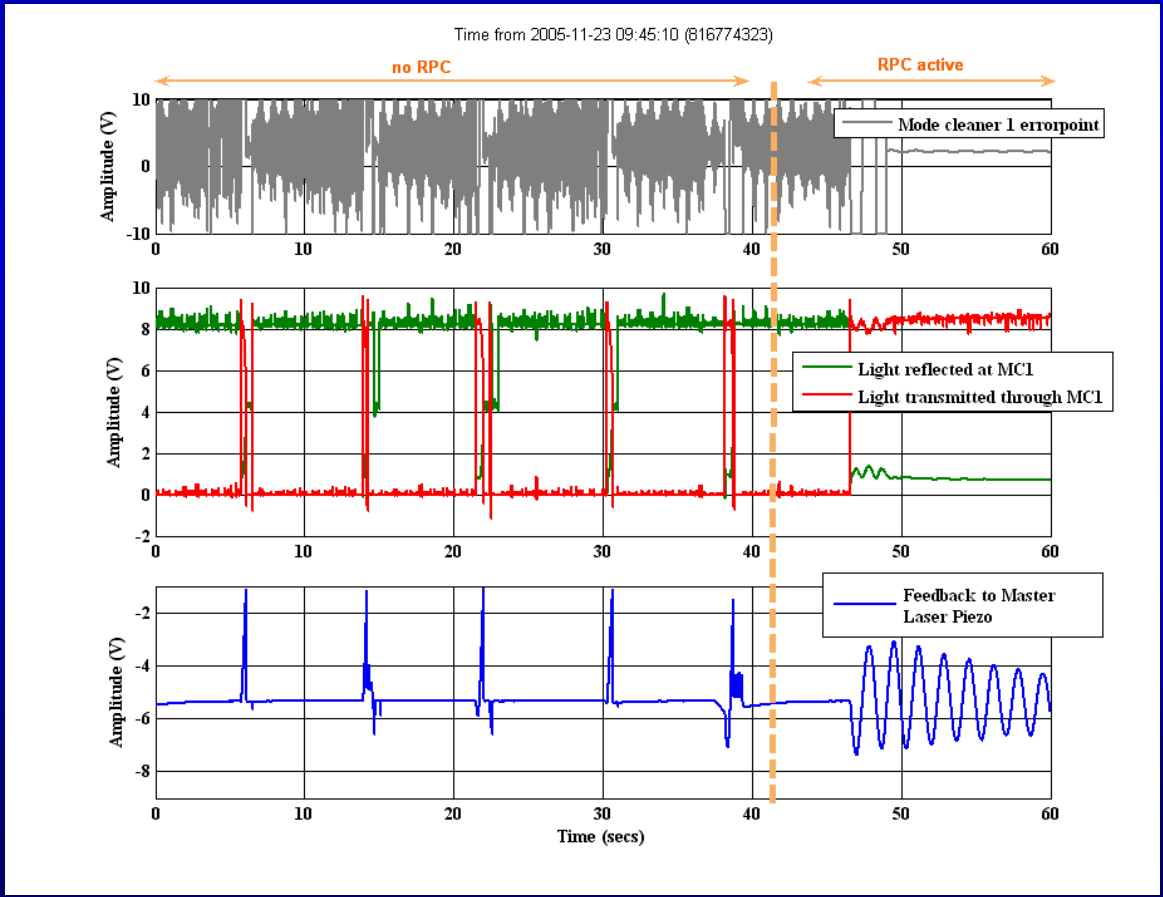
- Increased to full input power
- Still not the full power build-up IFO due to unexplained power losses

Radiation pressure compensation

High power inside the modecleaners in combination with low weight suspended mirrors causes strong radiation pressure effects

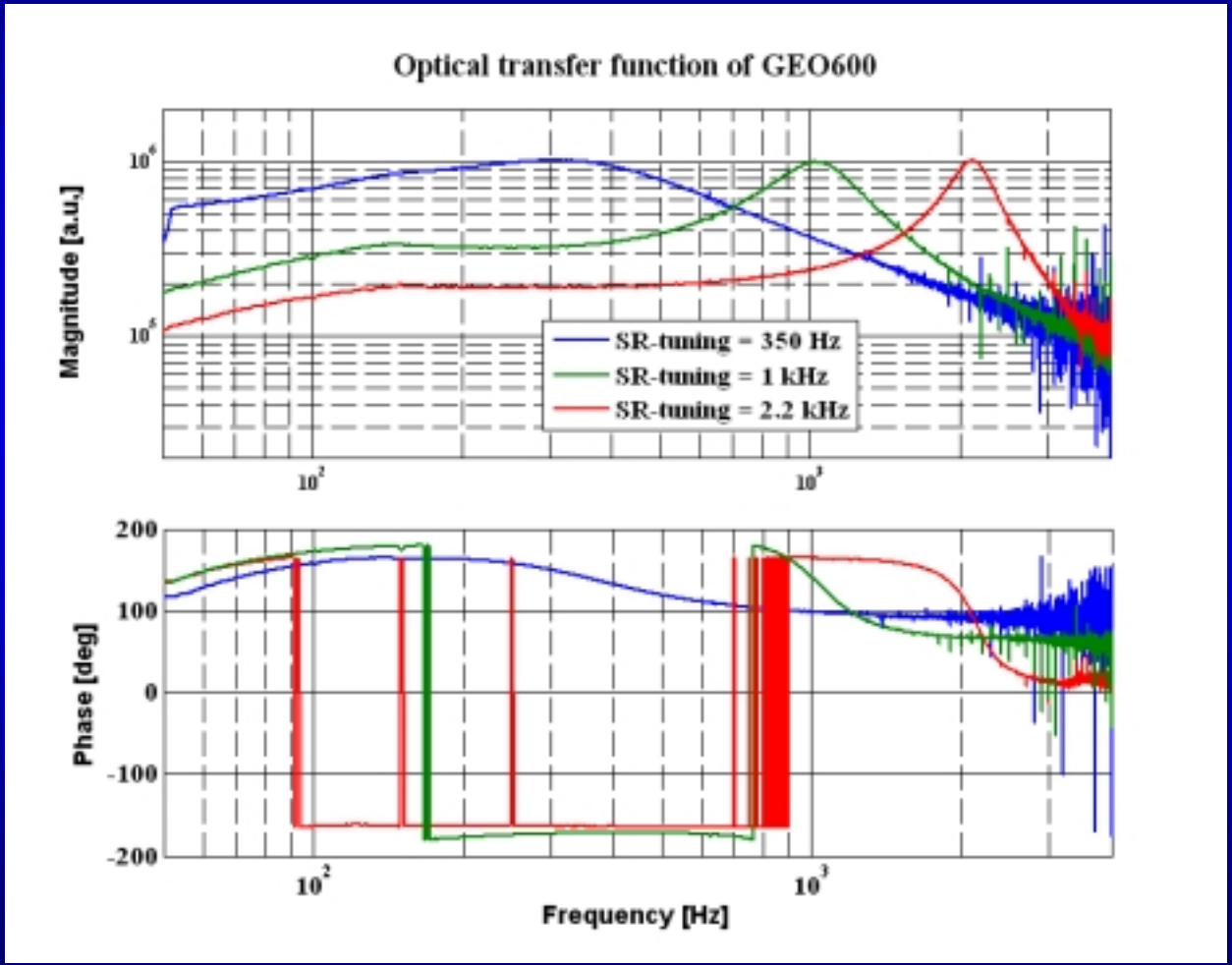
Right after lock acquisition mirrors are pushed by RP
⇒ Saturation of the actuator (Laser PZT)

Solution: Apply a bias force to the mirrors for acquisition and reduce this force in lock corresponding to the power build-up.



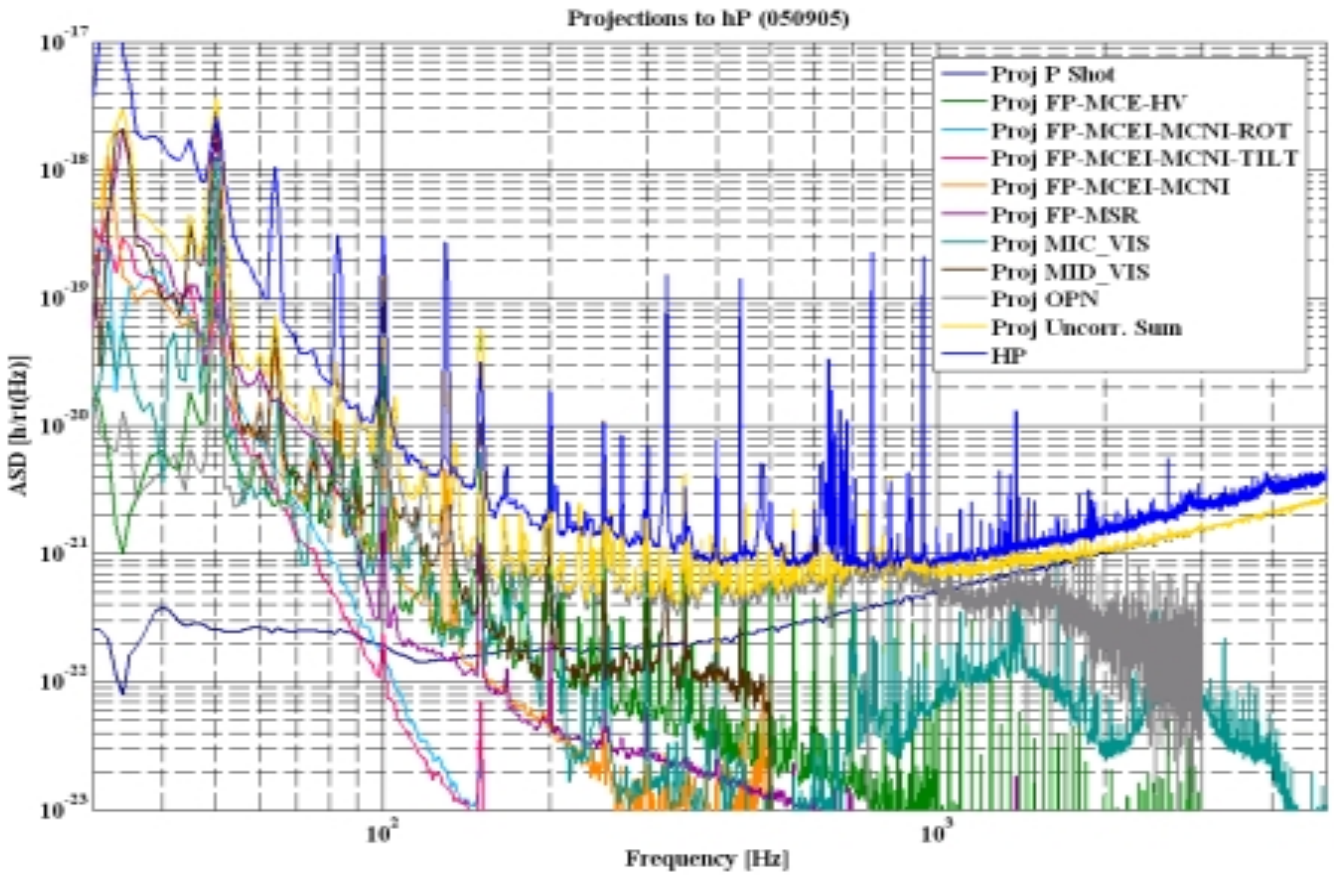
Optical transfer function

Signal Recycling provides an adjustable optical response



Lock acquistion at 2.5 kHz, **OPERATION NOW at 350 Hz.**

Noise projections / instrumental vetoes



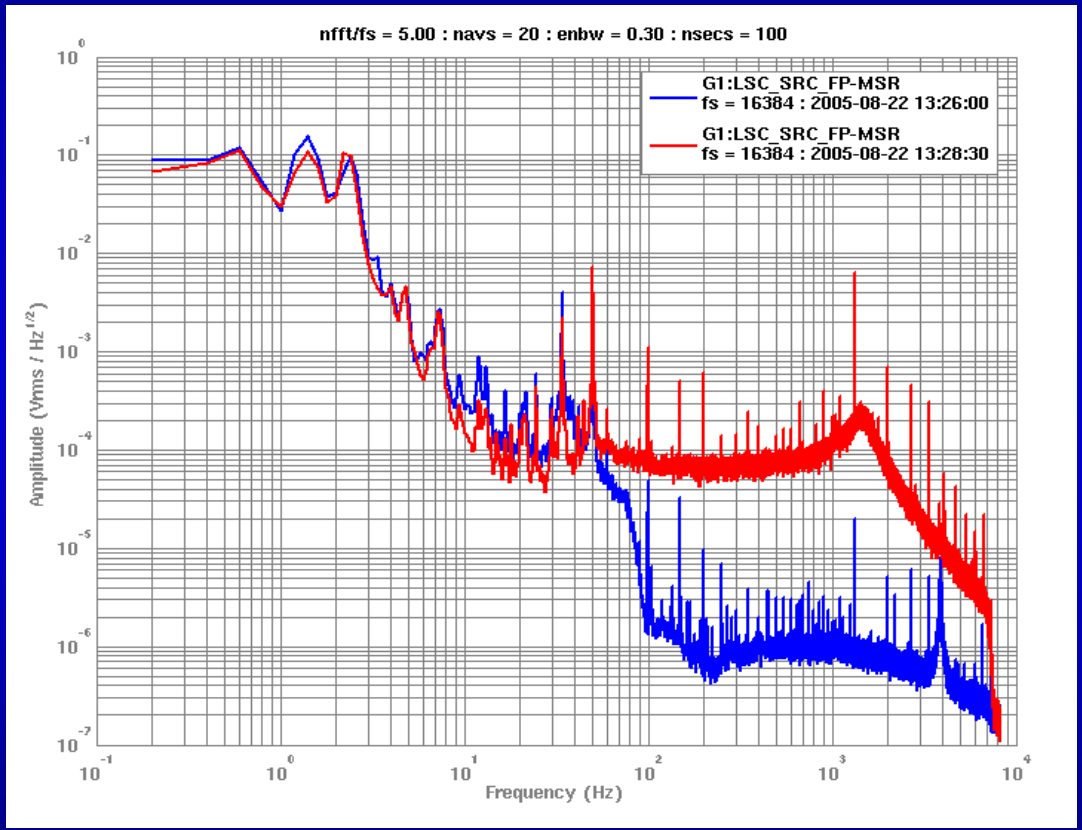
- Useful tool for commissioning
- Can be used for instrumental vetoes

Noise hunting example 1: Reduction of feedback noise in SR-loop

FB noise in Signal Recycling loop:

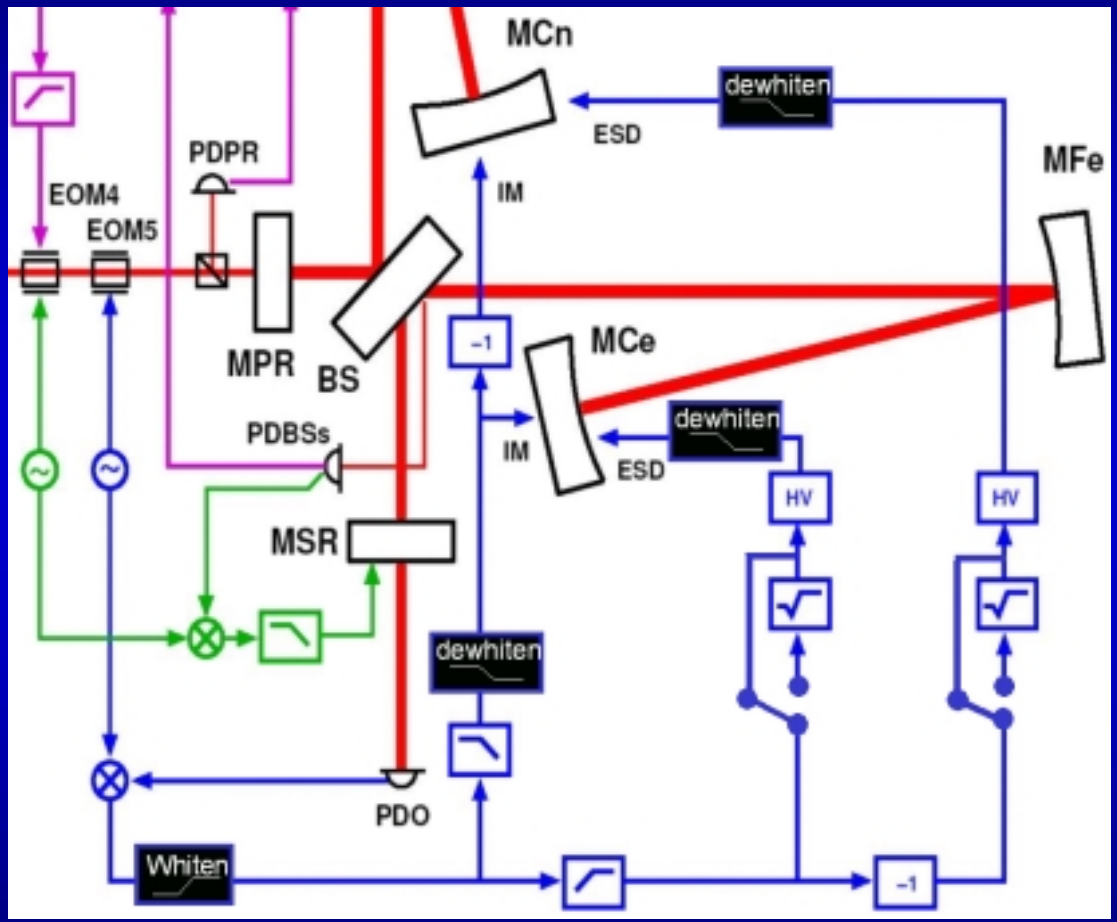
Shot noise from camera causes FB noise in detection band

Solution: Using a digital loop with strong filtering above unity gain.



Improved sensitivity below 500 Hz

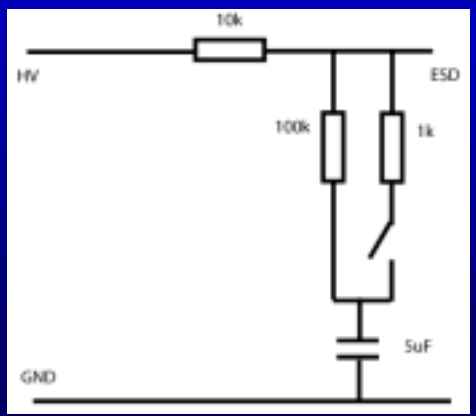
Noise hunting example 2: Reduction of feedback noise in MI-loop



Noise mainly caused in HVA for ESD

Due to dynamic range constraints use whitening-dewhitenig

Passive dewhitening done in HV path (0-1kV)

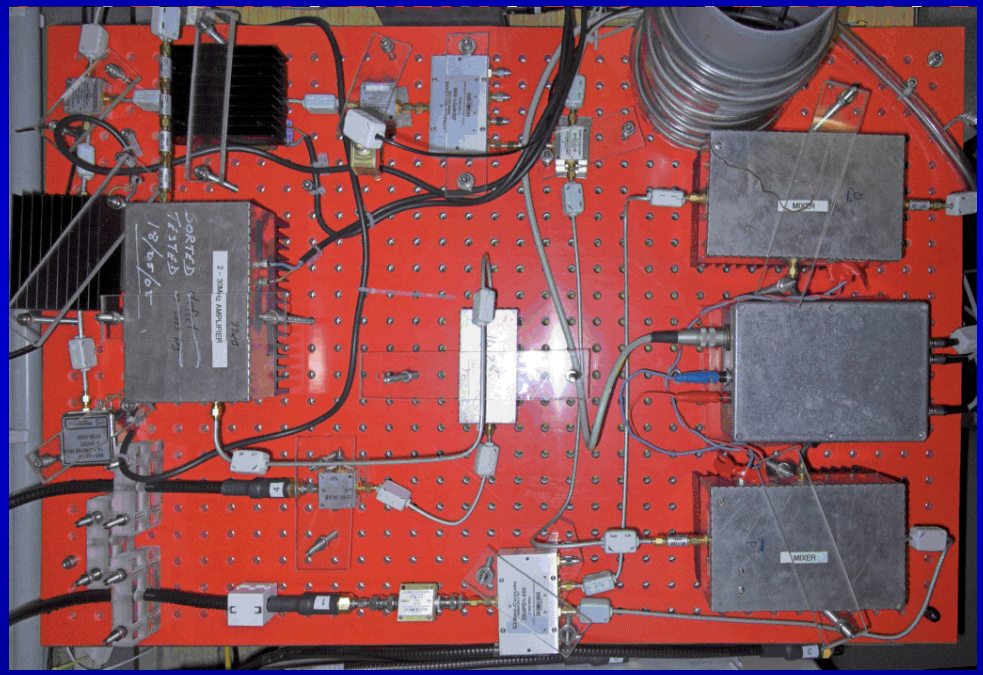


Improved sensitivity from 50 to 600 Hz

Noise hunting example 3: Attacking Phase noise

- Indication that Phase noise is nearly limiting

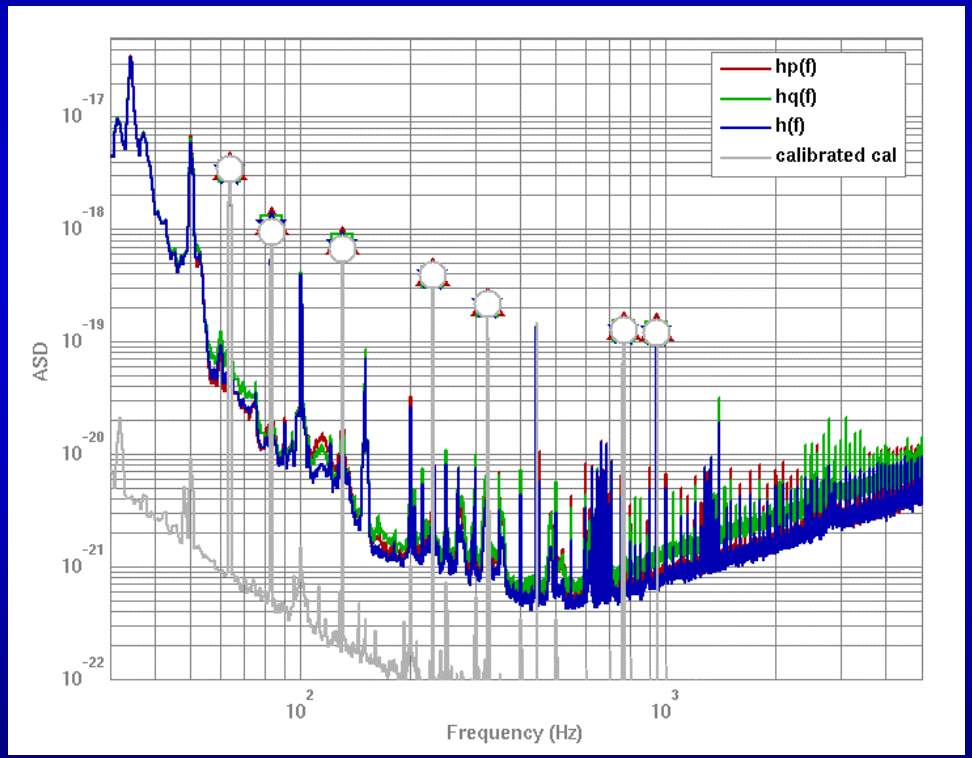
- Implementation of a new RF-setup for Michelson modulation (higher signal levels, higher quality components)



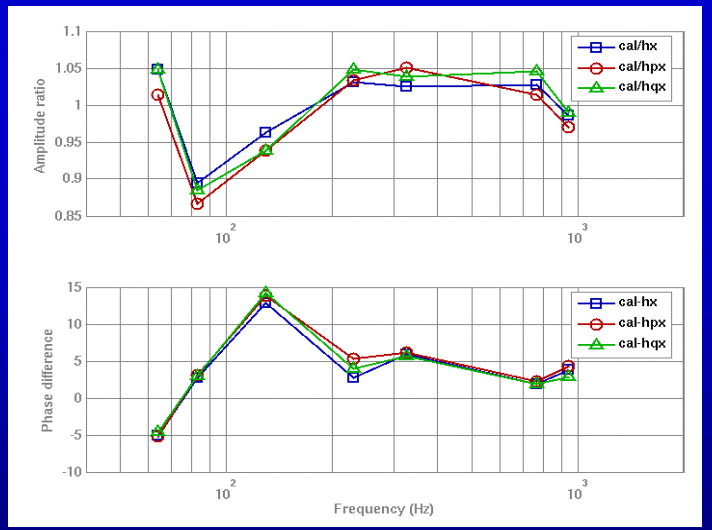
Increased robustness of the detector, but no sensitivity improvement.

Calibration of GEO600

- 2 main outputs (each containing GW signal)
- both calibrated to strain using time-domain method
- making an optimal combination



$$h_P(t) = h(t) + N_P(t)$$
$$h_Q(t) = h(t) + N_Q(t)$$



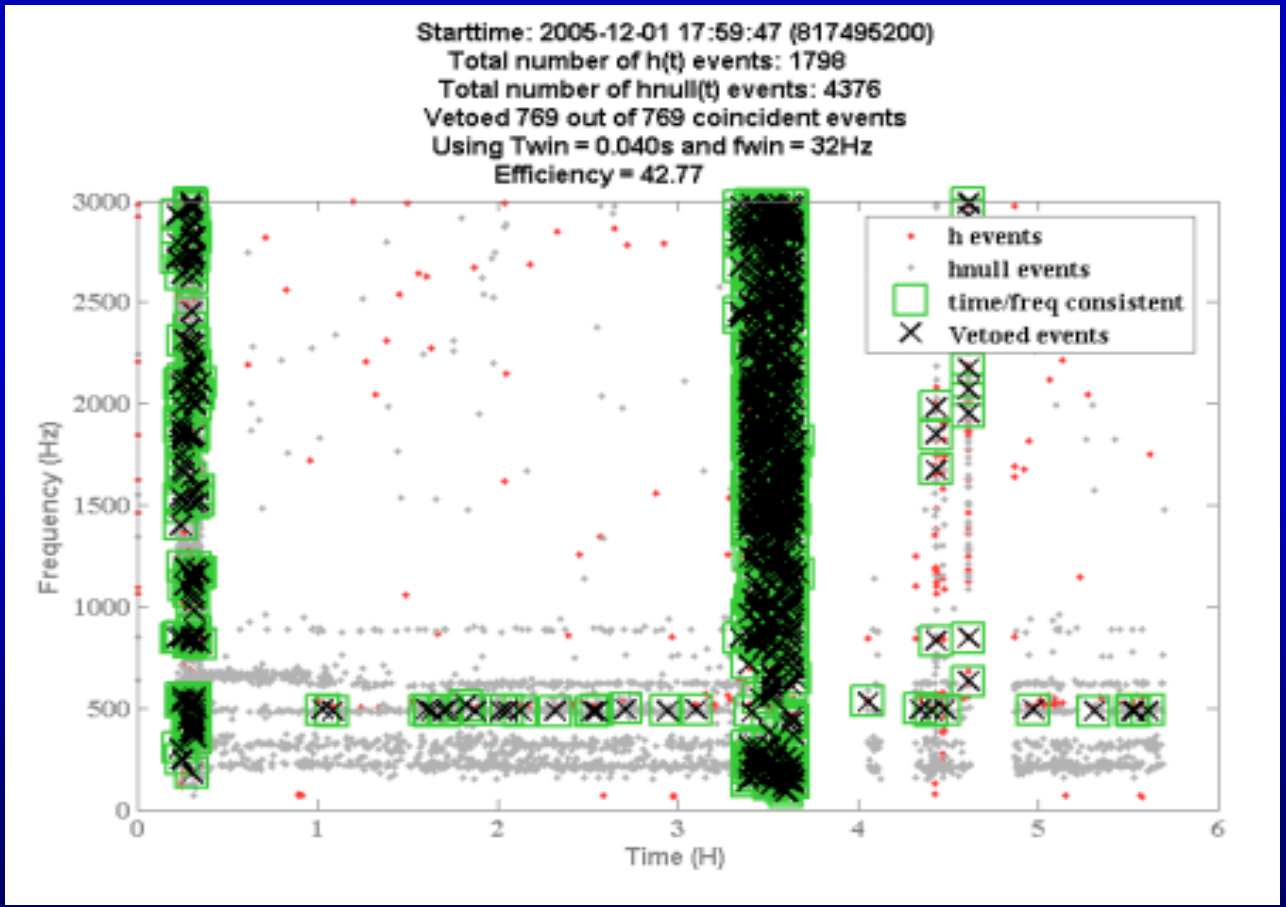
$$\chi^2 = \sum_f \frac{(d_f - m_f)^2}{\sigma_f^2}$$

Calibration quality can be judged by chi^2 value (data quality flag)

Null-Stream Veto

$$h_{\mathrm{P}}(t) = h(t) + N_{\mathrm{P}}(t)$$
$$h_{\mathrm{Q}}(t) = h(t) + N_{\mathrm{Q}}(t)$$

$$h_{\mathrm{null}}(t) = h_{\mathrm{P}}(t) - h_{\mathrm{Q}}(t),$$

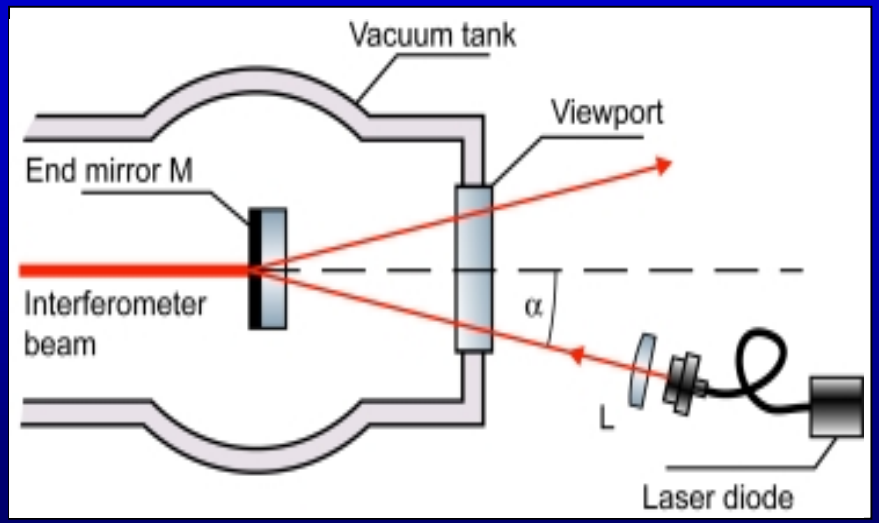


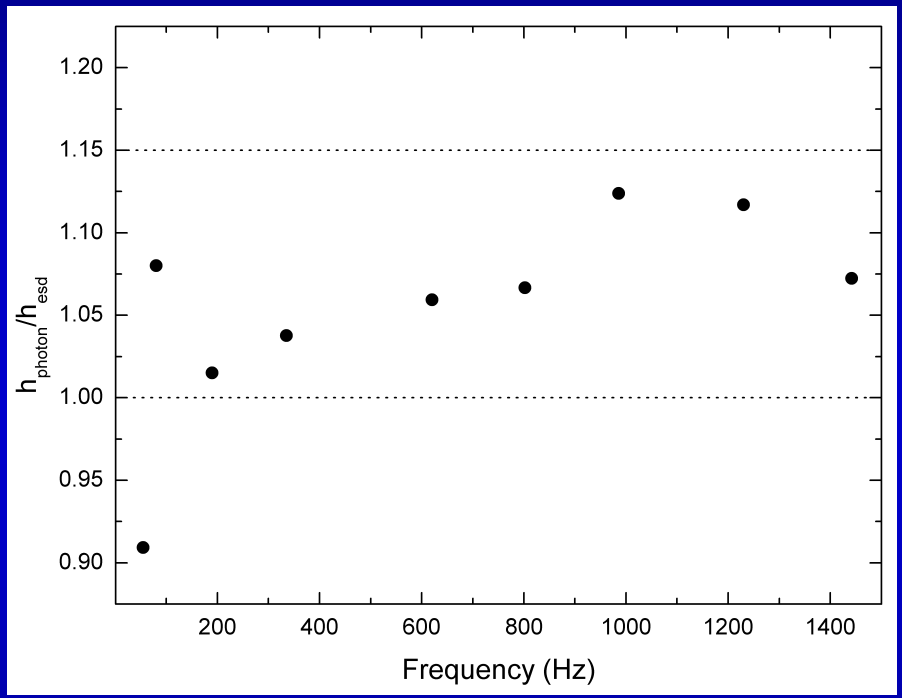
Photon pressure calibrator

Independent check of calibration using:

$$F = 2\frac{P}{c}$$

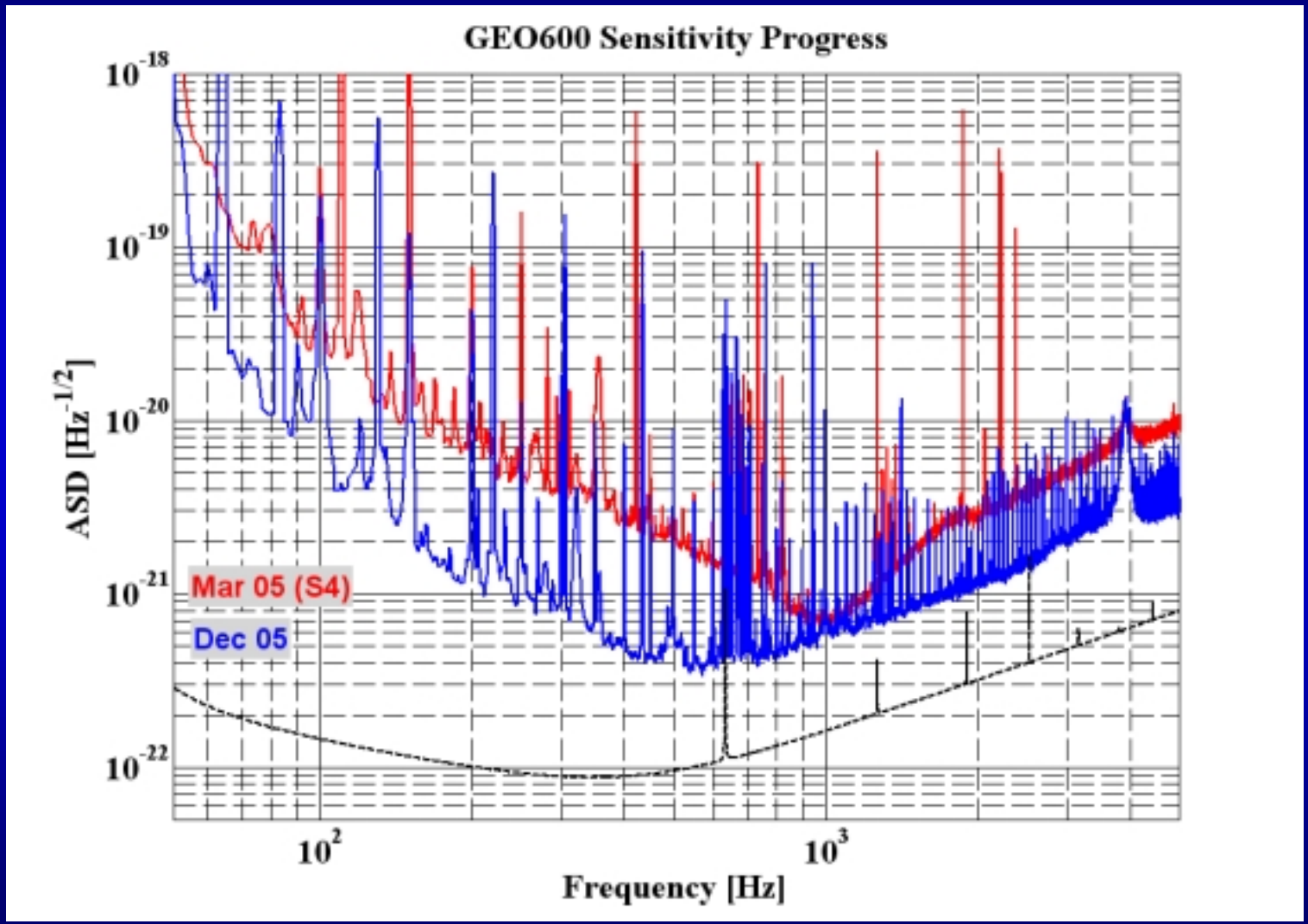
Wavelength: 1035 nm
Max. power: 1.4 W





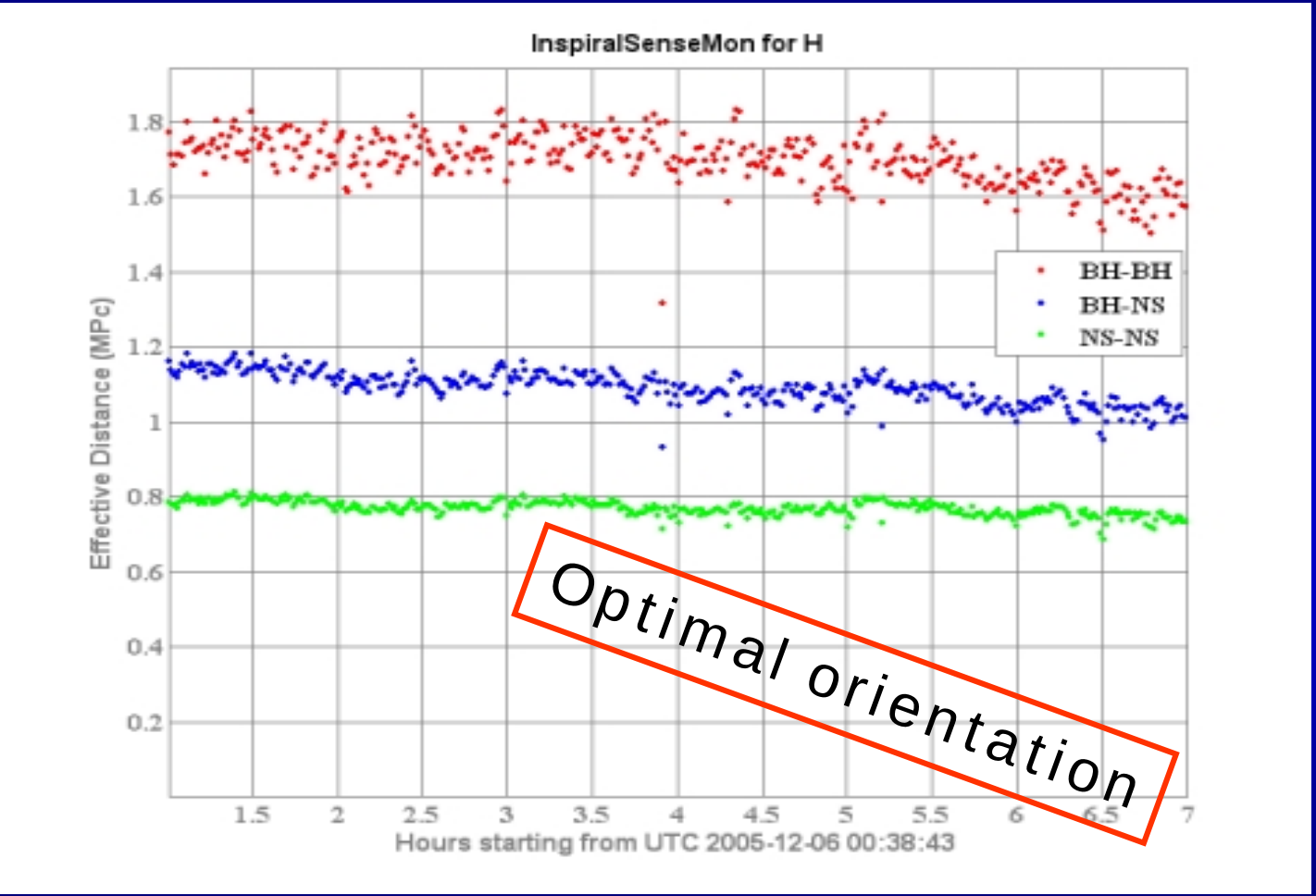
Good agreement with ESD.

Sensitivity improvement of GEO



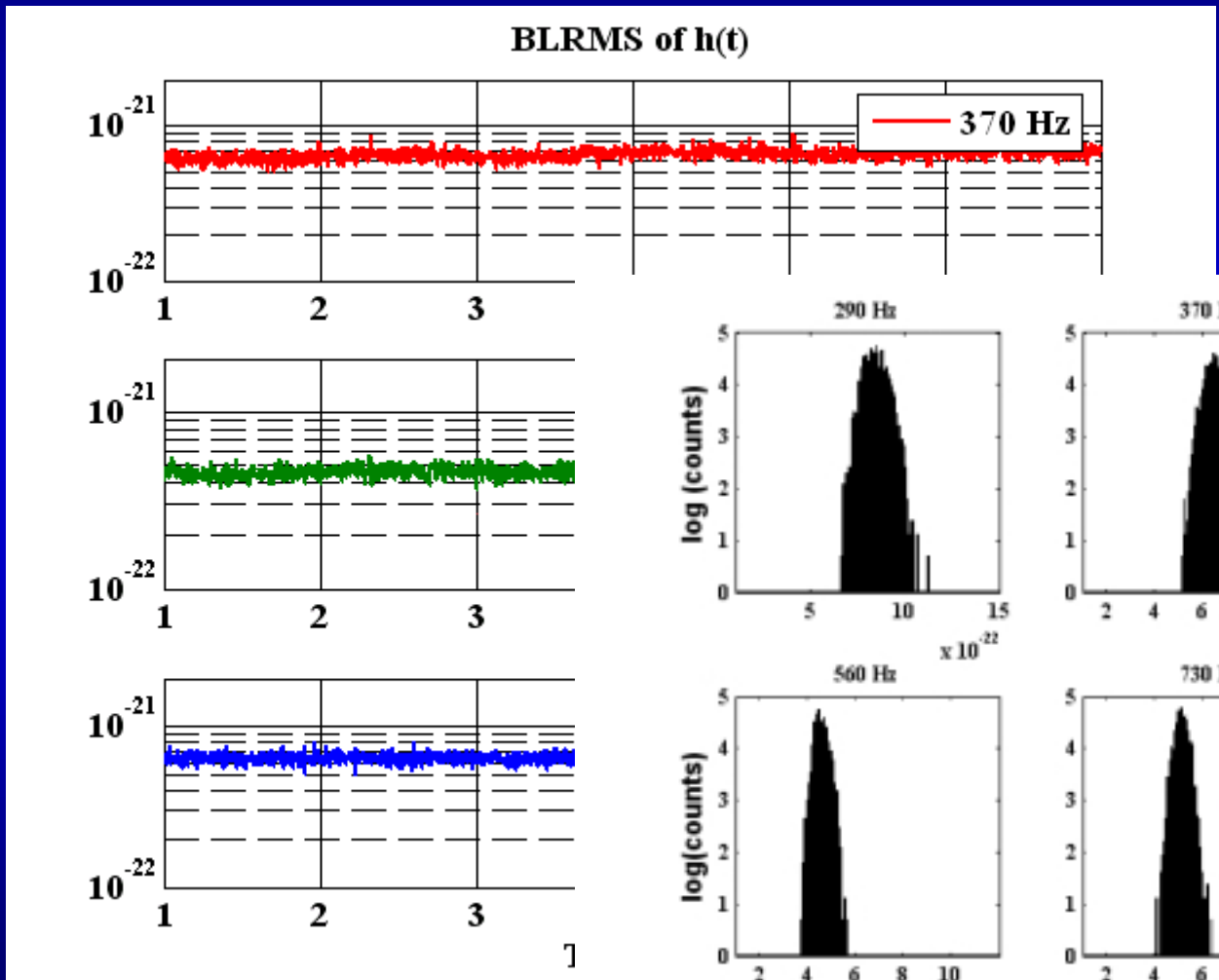
Peak sensitivity = 4e-22 @ 550 Hz

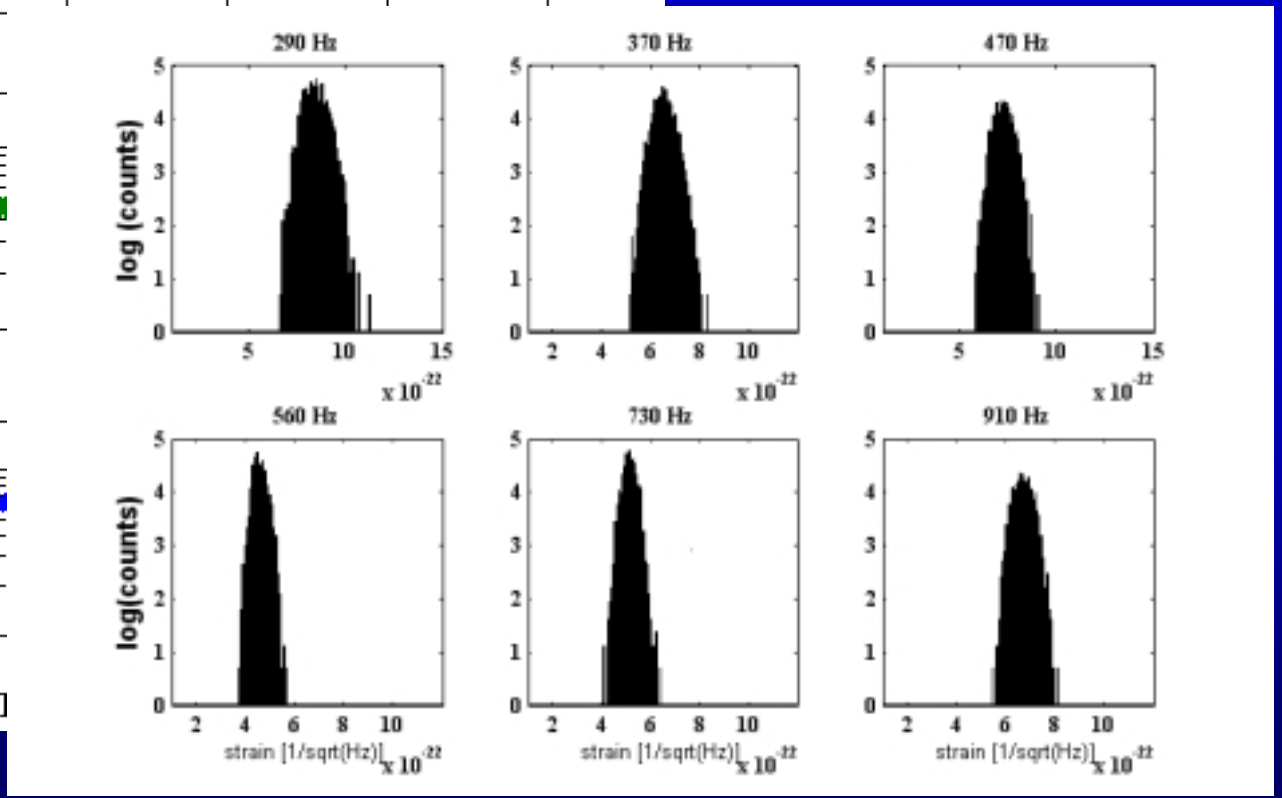
Inspiral range



Detector characterization information available on daily basis:
www.geo600.uni-hannover.de/georeports/

Noise stationarity / BLRMS of h(t)





Future plans

- No hardware changes foreseen
- Continue intense noise hunting
- Overnight and weekend runs

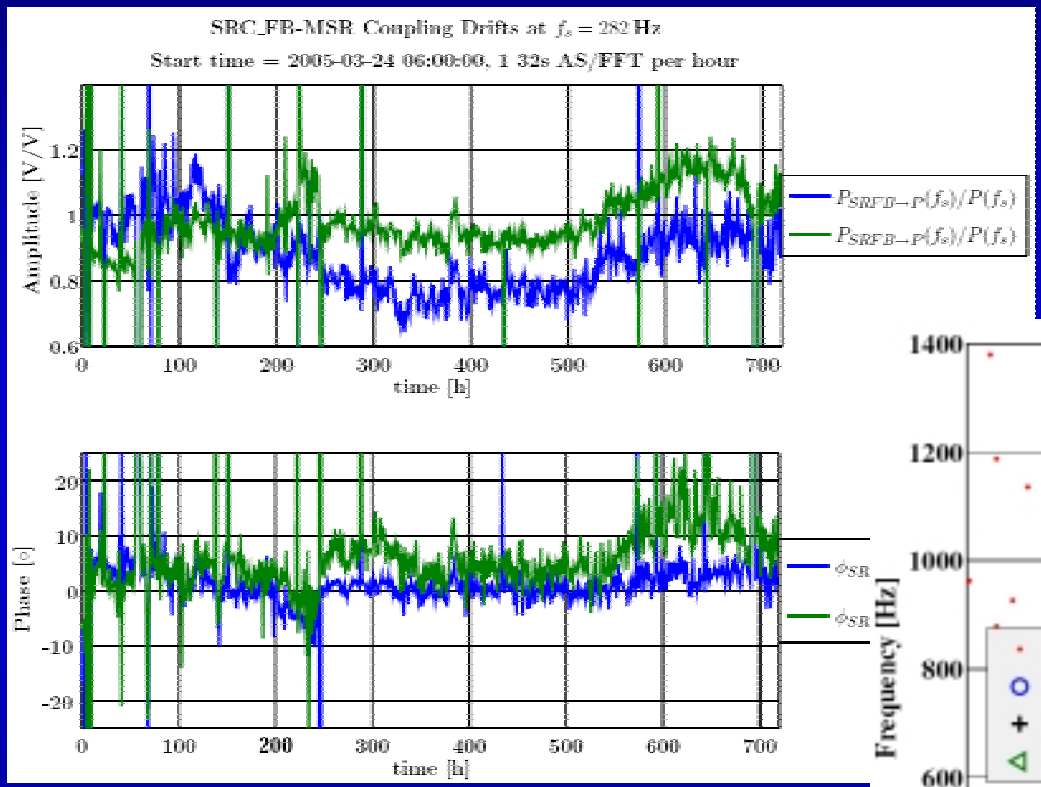
  Best guess: start around Christmas

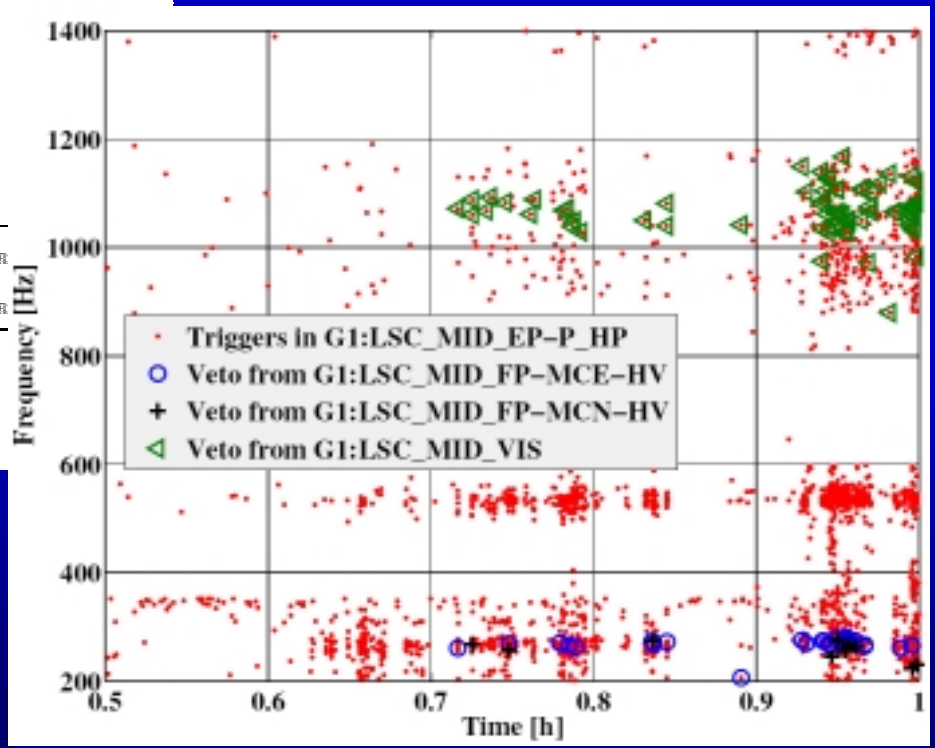
  Provide a well-calibrated detector output
- Join S5

  When additional improvements will take too long or are too risky to implement

End

Instrumental vetos

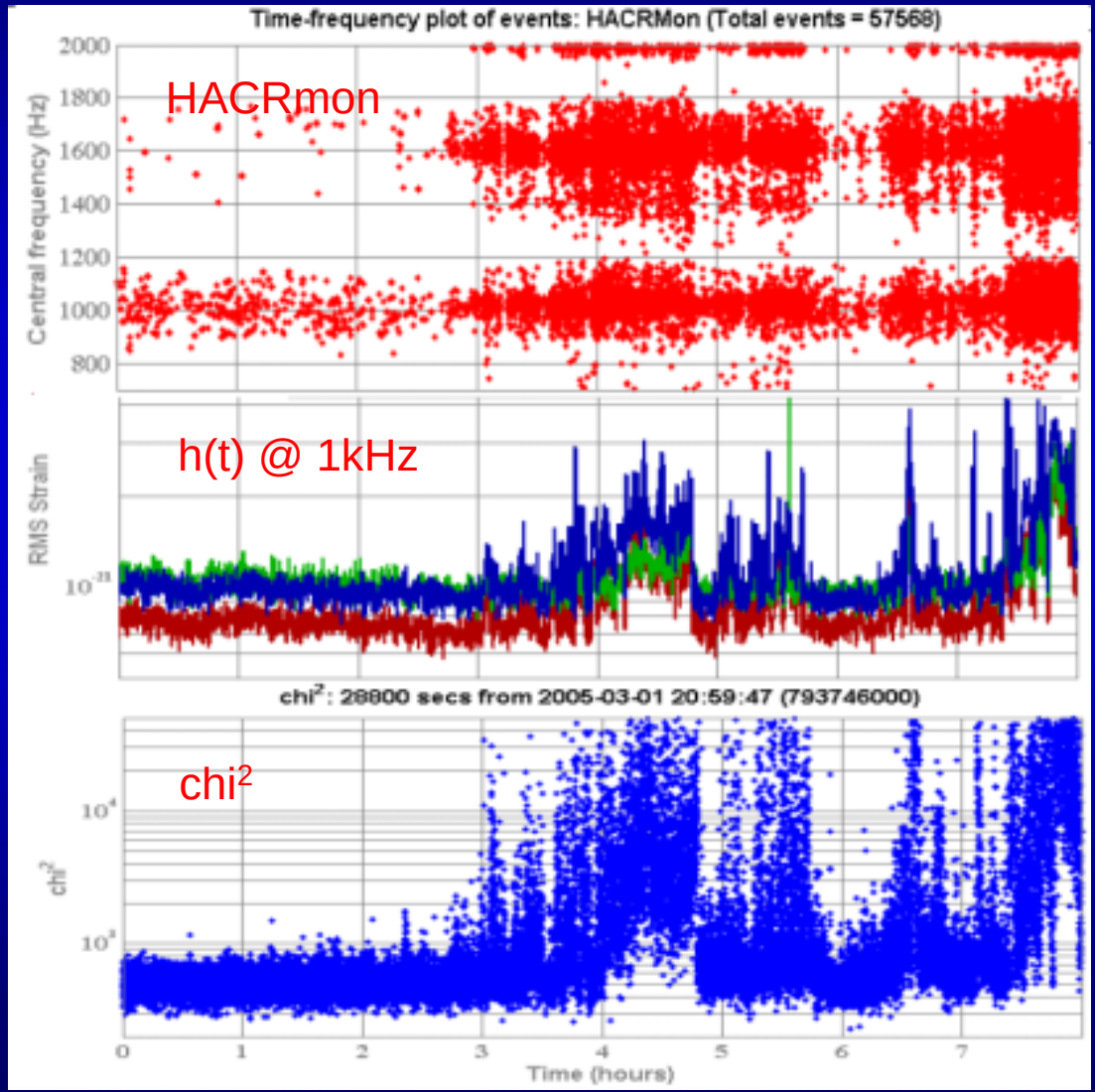




CHI^2 data quality flag

Example: MU3-Glitches

(Problem was fixed during S4)



S4 duty cycle (chi^2 cutoff dependent)