


GEO 600 detector status report (S4)

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for the GEO 600 team

LSC Meeting

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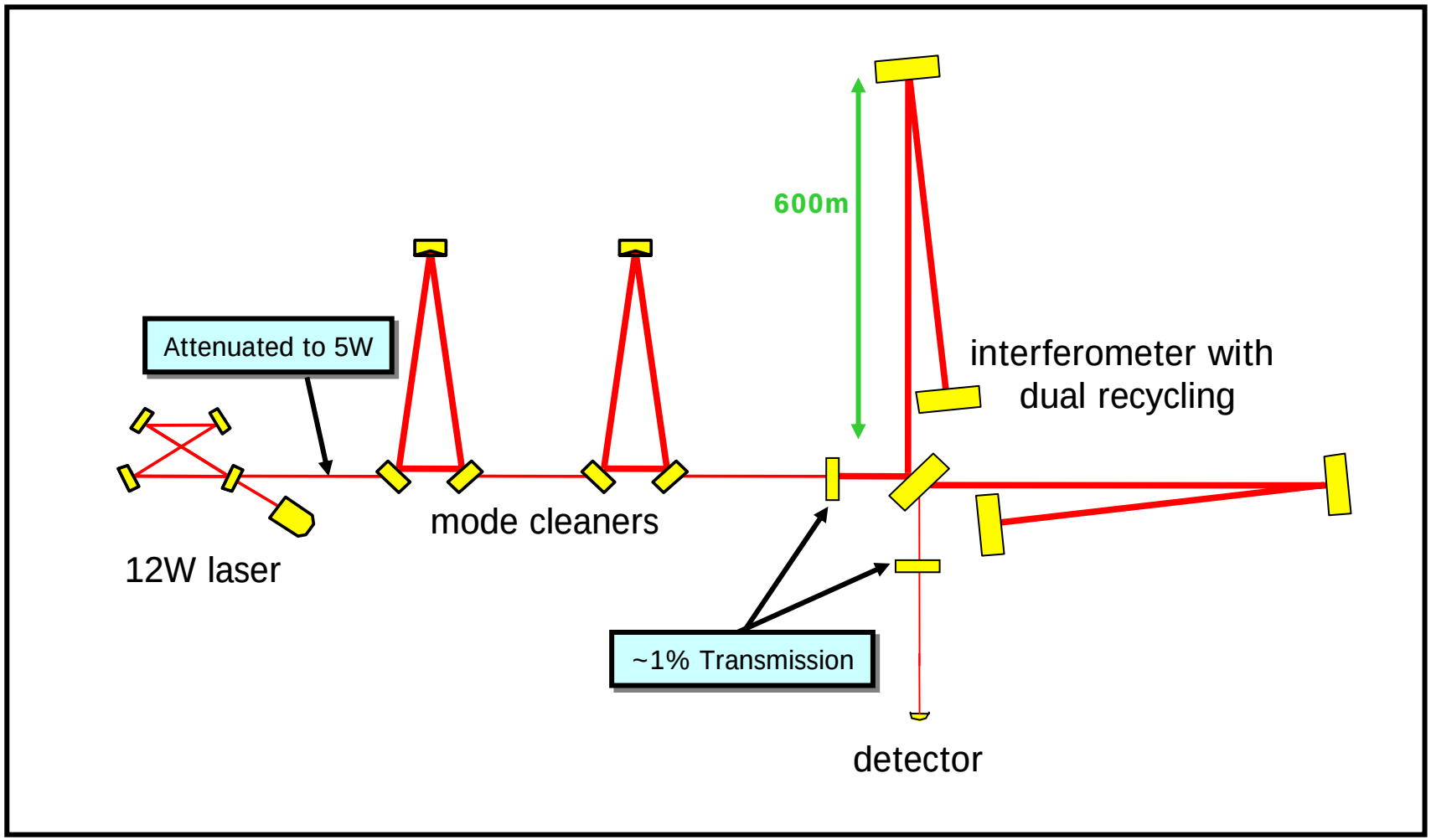
GEO600 optical layout (S4)



Site (S4)

- Container-city grows

Progress (post S3 to preS4)

- Improvements to *michelson* and *signal recycling* loops
  - less noise at low frequency through gain redistribution etc.
  - general reduction of RFI by improved signal handling

- Substantial reduction of collimated-backscatter from several optics
  - most importantly those handling the “arm pick-off” beam used to obtain SR control signals (components repositioned or removed)
  - now normally no scattering problem

- Modest increase in injected and circulating power (using almost half of the power from the 12W laser now)
  - 1 kHz performance limited by mixture of shot and dark noise

Progress (S3 to S4)

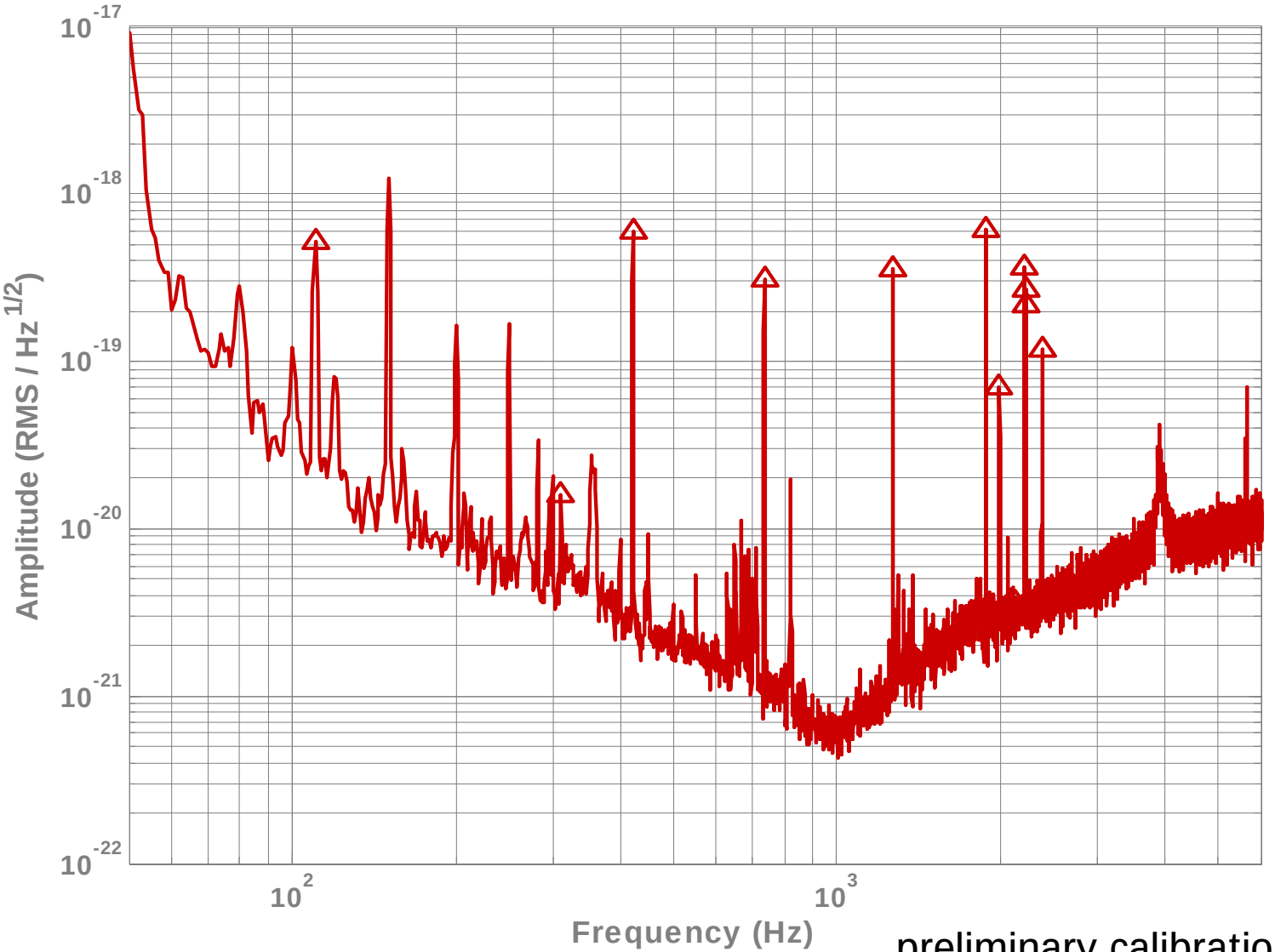
- Noise projection work
  - all major linear contributions now tracked (control noise, amplitude noise, oscillator phase noise ...)
  - some of the couplings tracked continuously to allow investigation of potential vetos

- Calibration
  - full on-line calibration of the two instrumental output quadratures (“HP”, “HQ”)
    - remember detuned SR gives nearly SSB at response peak so nearly equal signal in P,Q. “HP” has more information <1 KHz, HQ > 1kHz
  - combination of HP and HQ signals to get h(t)
  - optimal signal recovery, some SNR increase

Progress (S3 to S4)

- Computer / data exchange infrastructure
  - additional supervisory control computers
  - general upgrade of supervisory control computers to increase reliability, now very few problems
  - extension of on-site storage and various minor enhancements and upgrades of data handling computer infrastructure
  - rapid generation and publication of calibrated frames
  - many on-line monitors provided
  - summary reports generated

Sensitivity – Pre S4 example



line:

150 Hz

200 Hz

250 Hz

pump

820 Hz

32 violin modes +harmonics

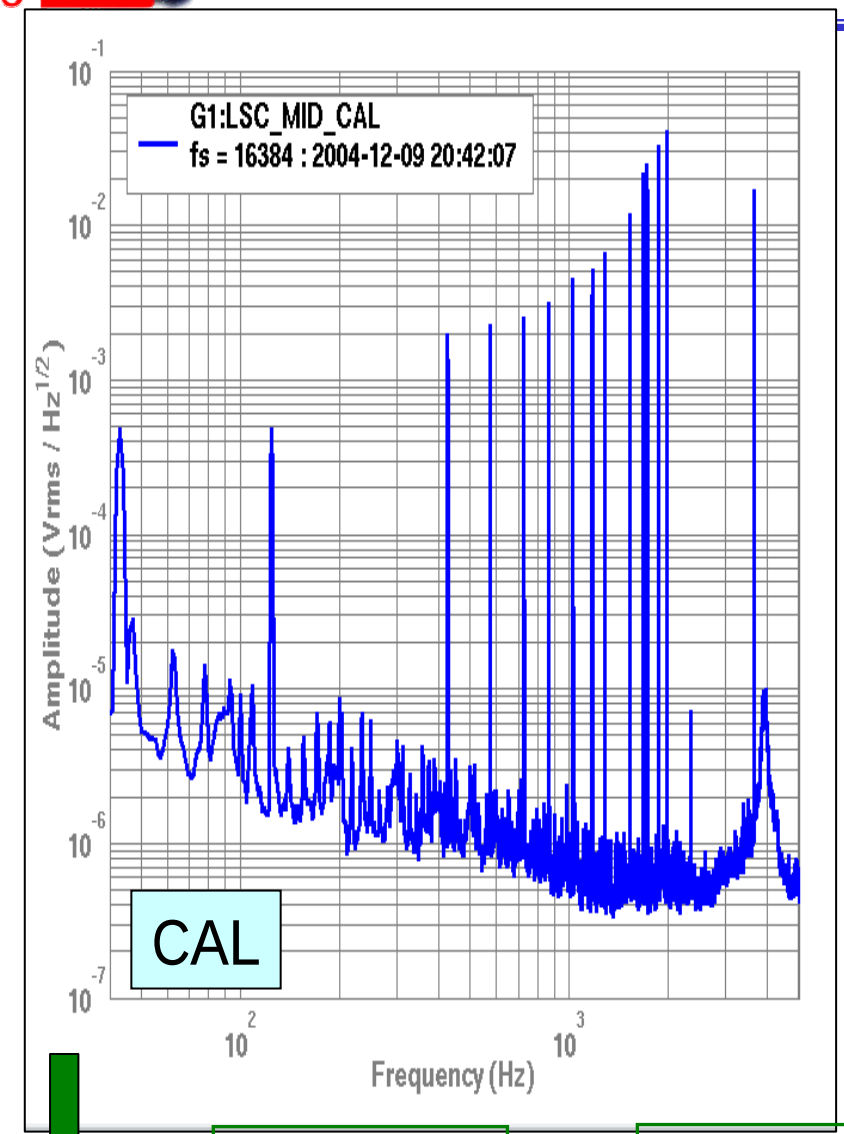
4kHz RFI peak

preliminary calibration

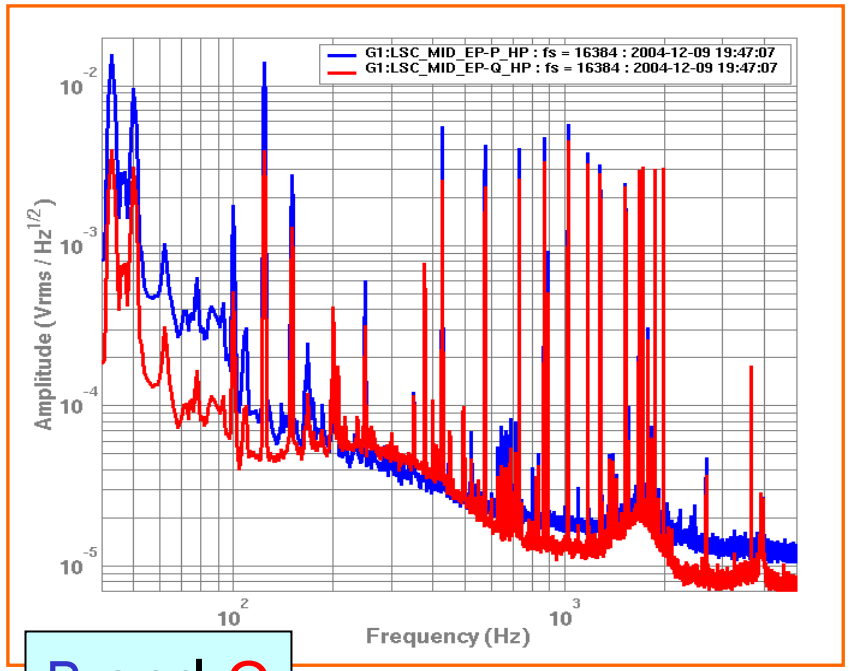
Continuous calibration

- continuous injection of calibration lines
- fitting of parameters (optical gain) to measured line amplitudes
- sophisticated control model used to aid good fit
- inverse filters calculated and applied to error point signals to produce HP and HQ
- random error due to parameter miss-estimation is kept small
- main uncertainty is systematic (overall gain) due to difficulty of establishing electrostatic drive response
- long term plan to use separate calibration “actuator”
- on-line calibration and good reliability allowed unattended frequent overnight runs

On-line optical TF measurements



CAL

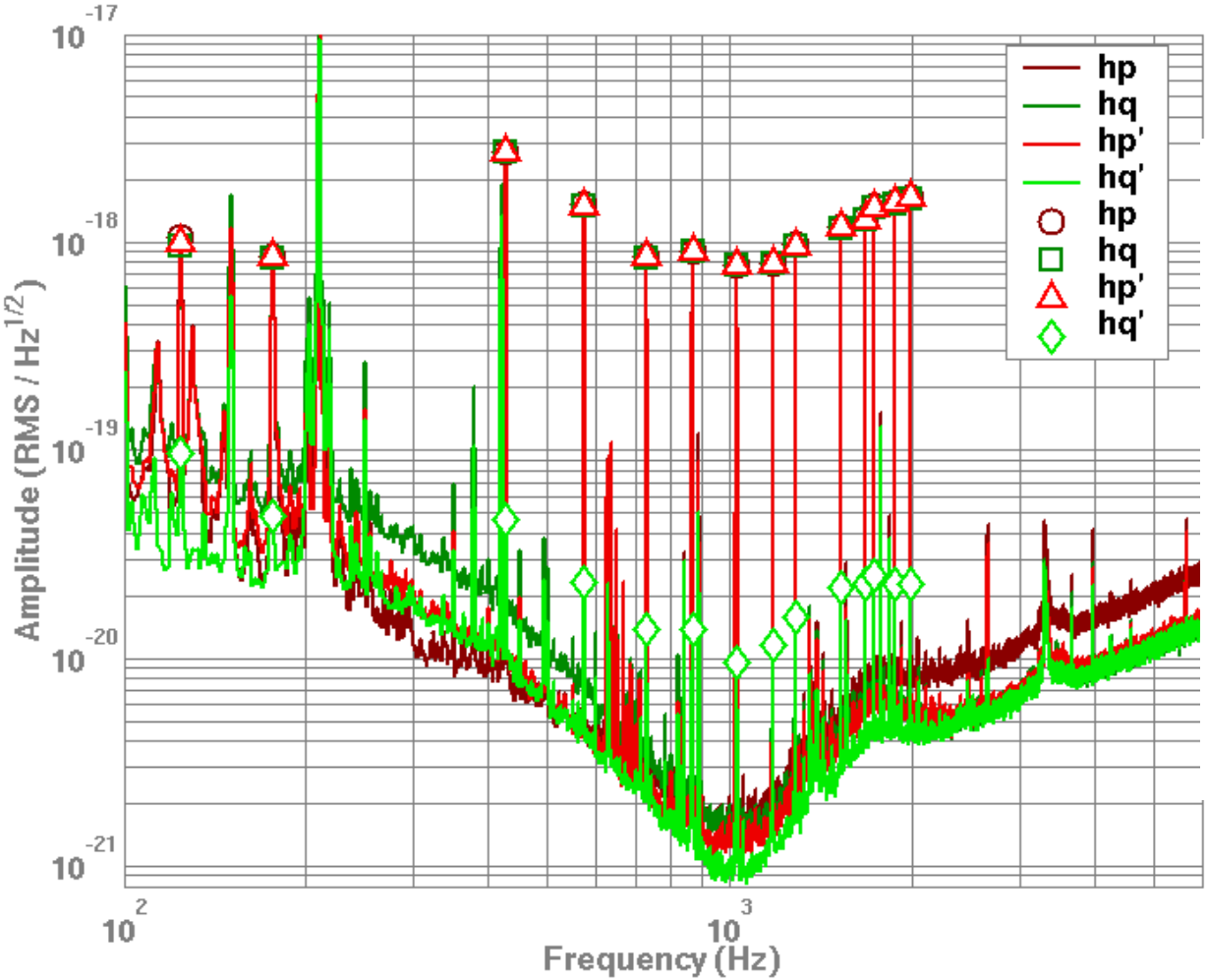


P and Q

actuator

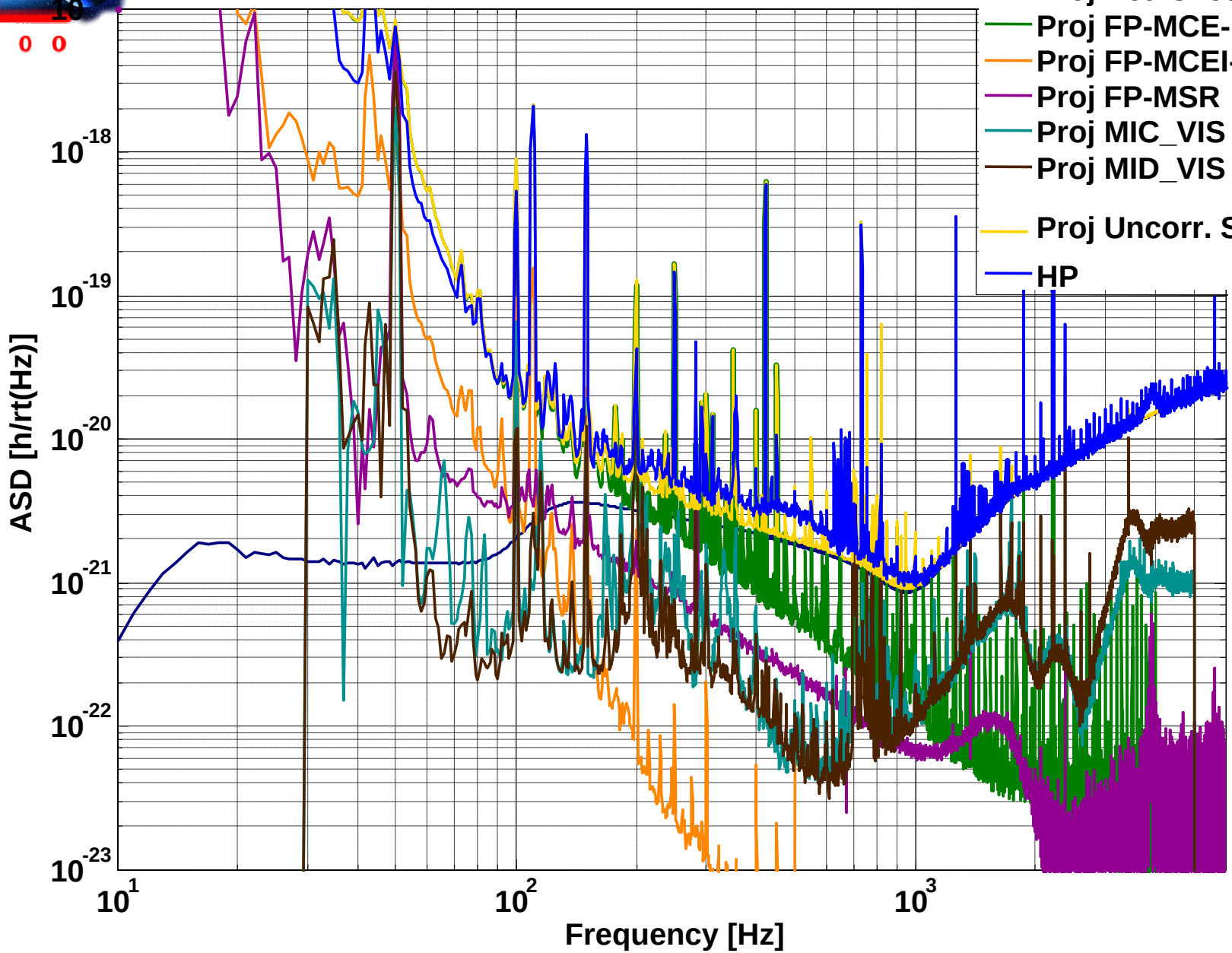
optical

Combining HP and HQ - example result



- Resulting HQ' contains almost no signal compared to HP' -> h(t)
- Noise cancels in some frequency regions, is uncorrelated in others

Noise Projections - example



S4

- Pre S4: one fault developed <24 hours before S4 - fixed just in time
- Early S4: intermittent fault in suspended EO modulator
  - reduced data quality for some times (part of some nights) about 10 bad periods of a few hours
  - problem identified and fixed
  - may (dis)qualify affected data where appropriate
- duty cycle
  - many long lock stretches (up to $>10^5$s)
  - over 35 100% 8-hour shifts so far
  - only 2 shifts < 90%
- two shifts (16hr /day) with experts on call (automated SMS calling 24/7)

Some next steps

- Post S4 checks and calibrations
  - actuator calibration
  - checking vetos arising from noise projection work
- Review of S4 after ~1 month
- Exchange of T~1% MPR for one with T~1000 ppm
  - some changes to the control systems
  - will make acquisition more complex
  - increased thermal effect in BS may increase contrast defect, but we have modulation index capability to spare
    - currently contrast defect is ~10^{-6}
    - probably do not require OMC
- Noise reduction and tuning to lower frequency to improve overlap with L1/H1/H2