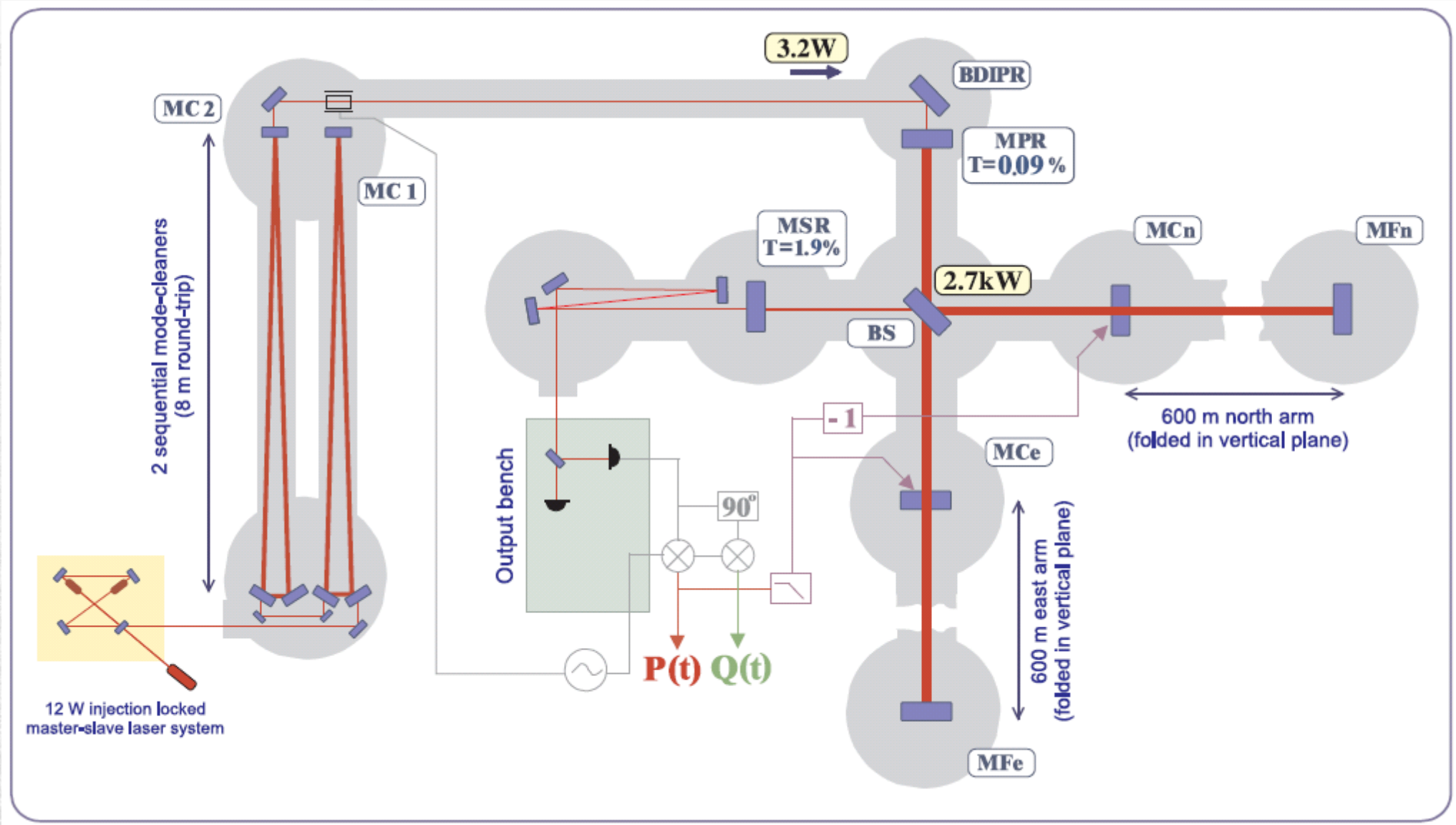
GEO 600
Status and Plans

Andreas Freise

HEP 2007
Manchester, 20 July. 2007

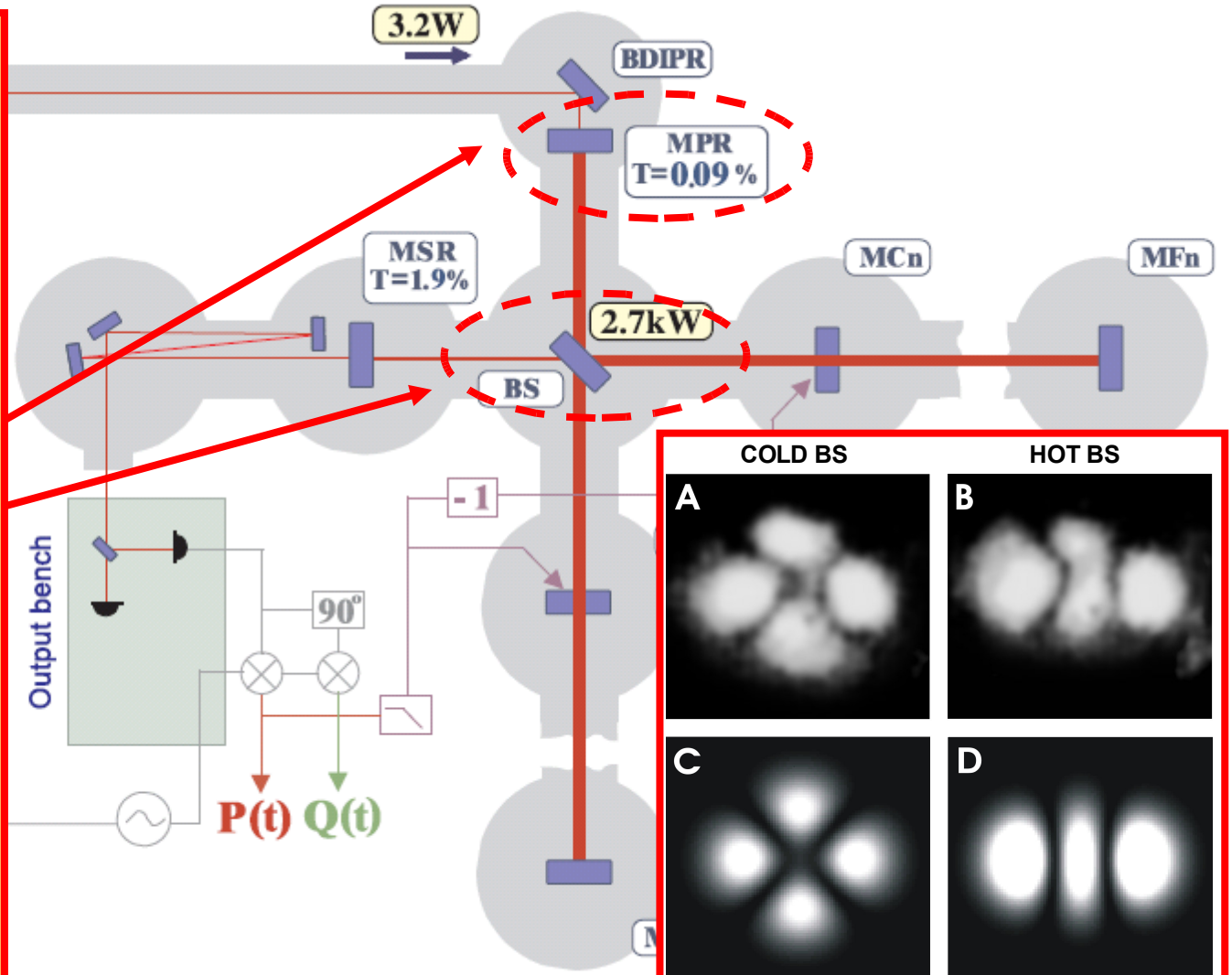
The GEO600 Interferometer



The GEO600 Interferometer

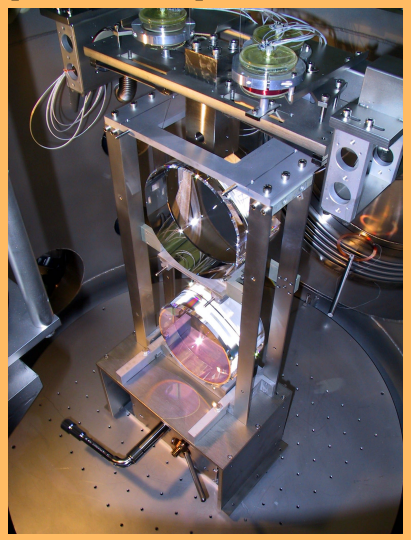
No arm cavities, but folded arms:

- **High PR factor (~1000)**
- **High power in BS substrate (~kW)**
- **Very low absorp-tion of BS substrate (< 0.25 ppm/cm)**

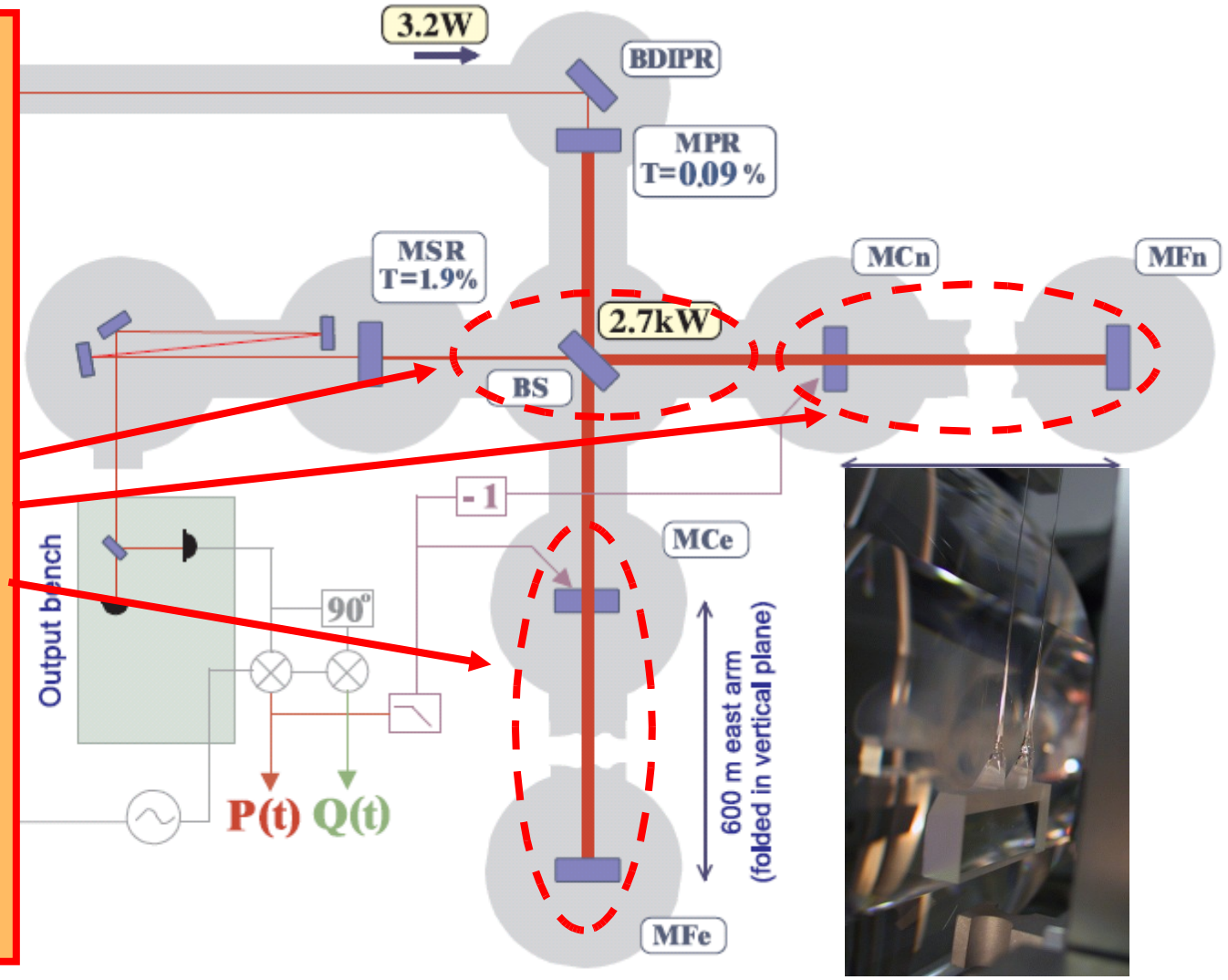


The GEO600 Interferometer

Triple suspensions:



Split-feedback (3-stage hierarchical control: longitudinal + alignment)

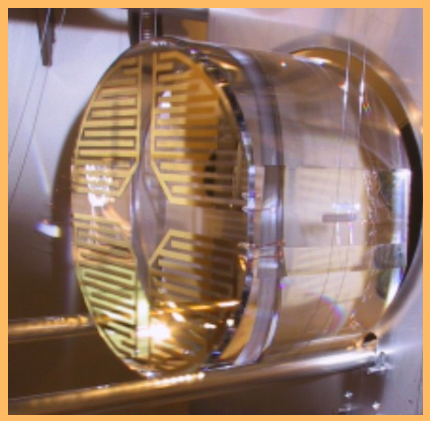


Monolithic stages: ~100 fibre years on running IFO with ~5 partial ventings

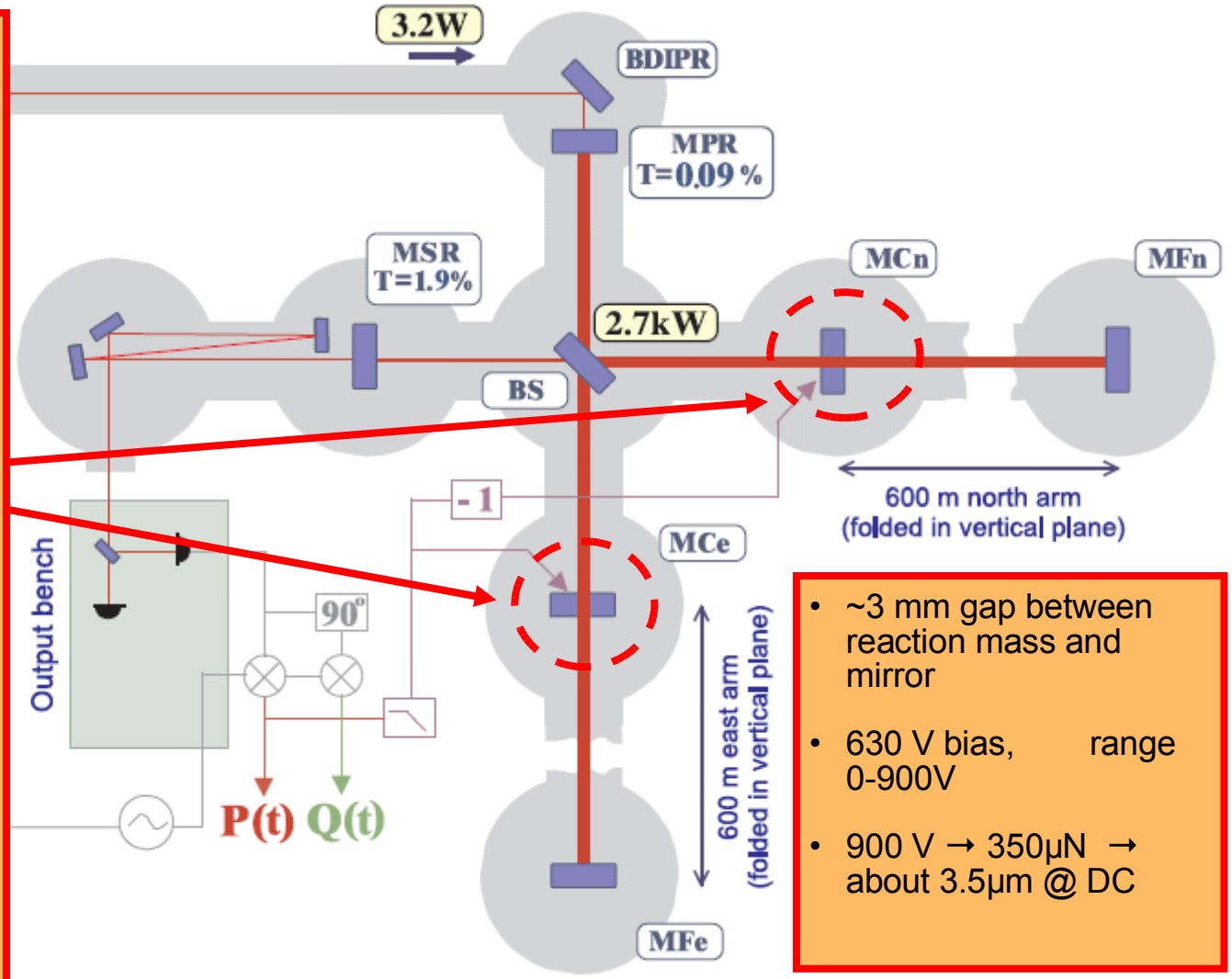
The GEO600 Interferometer

Electro-Static Drives:

- **Used for fast control of diff. arm length**



- **Also used for fast autoalignment (quadrants).**

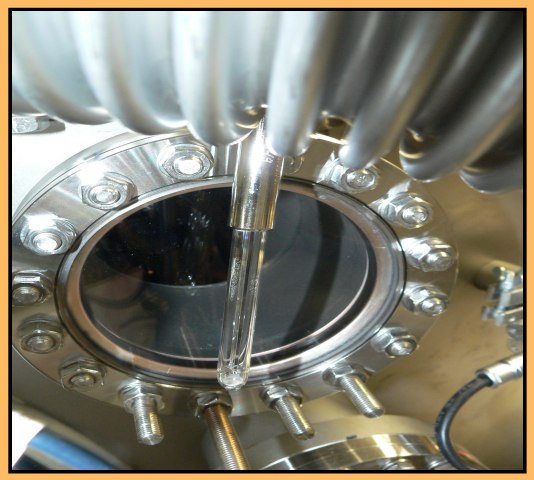


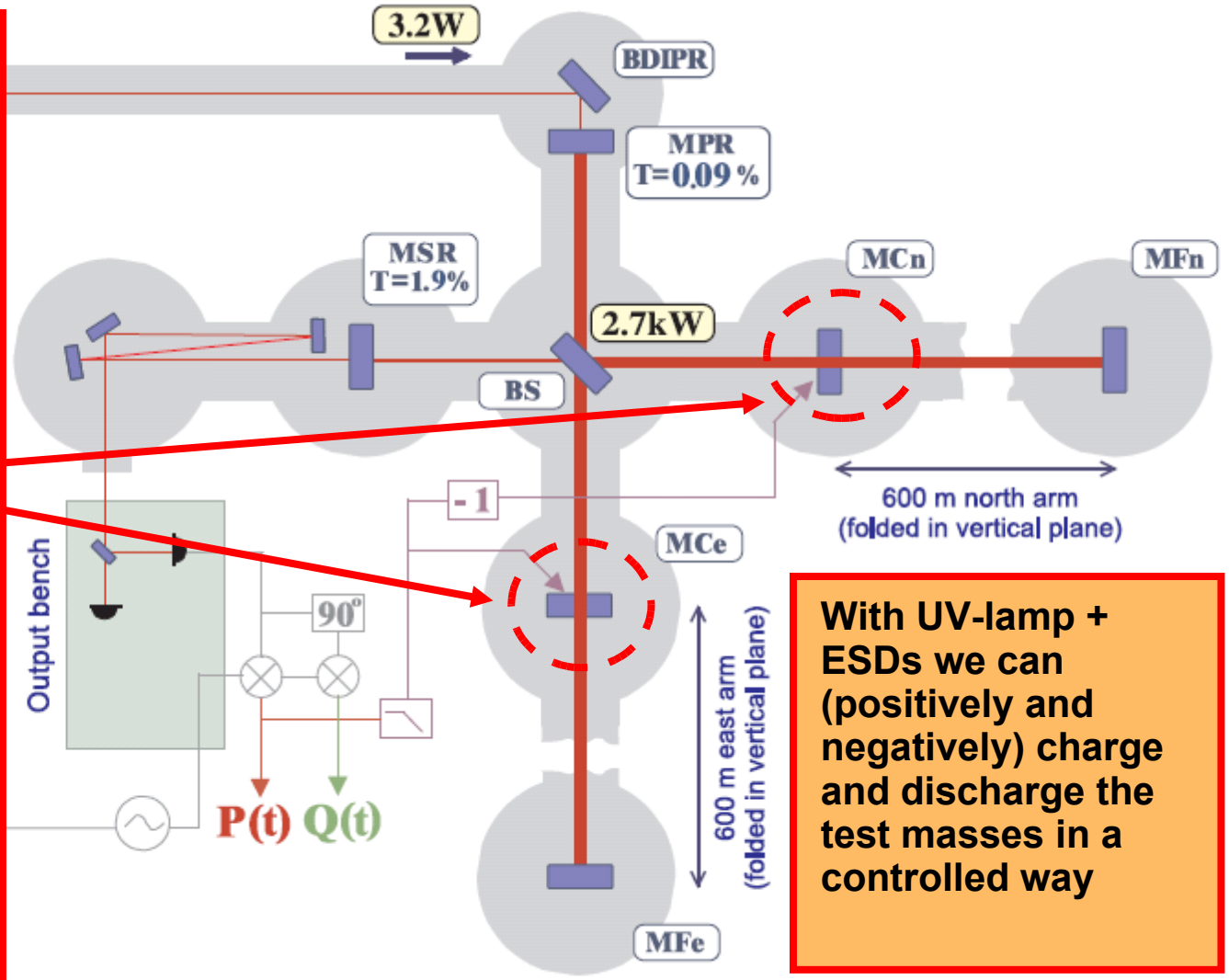
- ~3 mm gap between reaction mass and mirror
- 630 V bias, range 0-900V
- 900 V → 350μN → about 3.5μm @ DC

The GEO600 Interferometer

Charges on test masses

- **Measured positive charging of testmasses**
- **Discharged by using a UV-lamp (electrons are freed from ESD electrodes)**



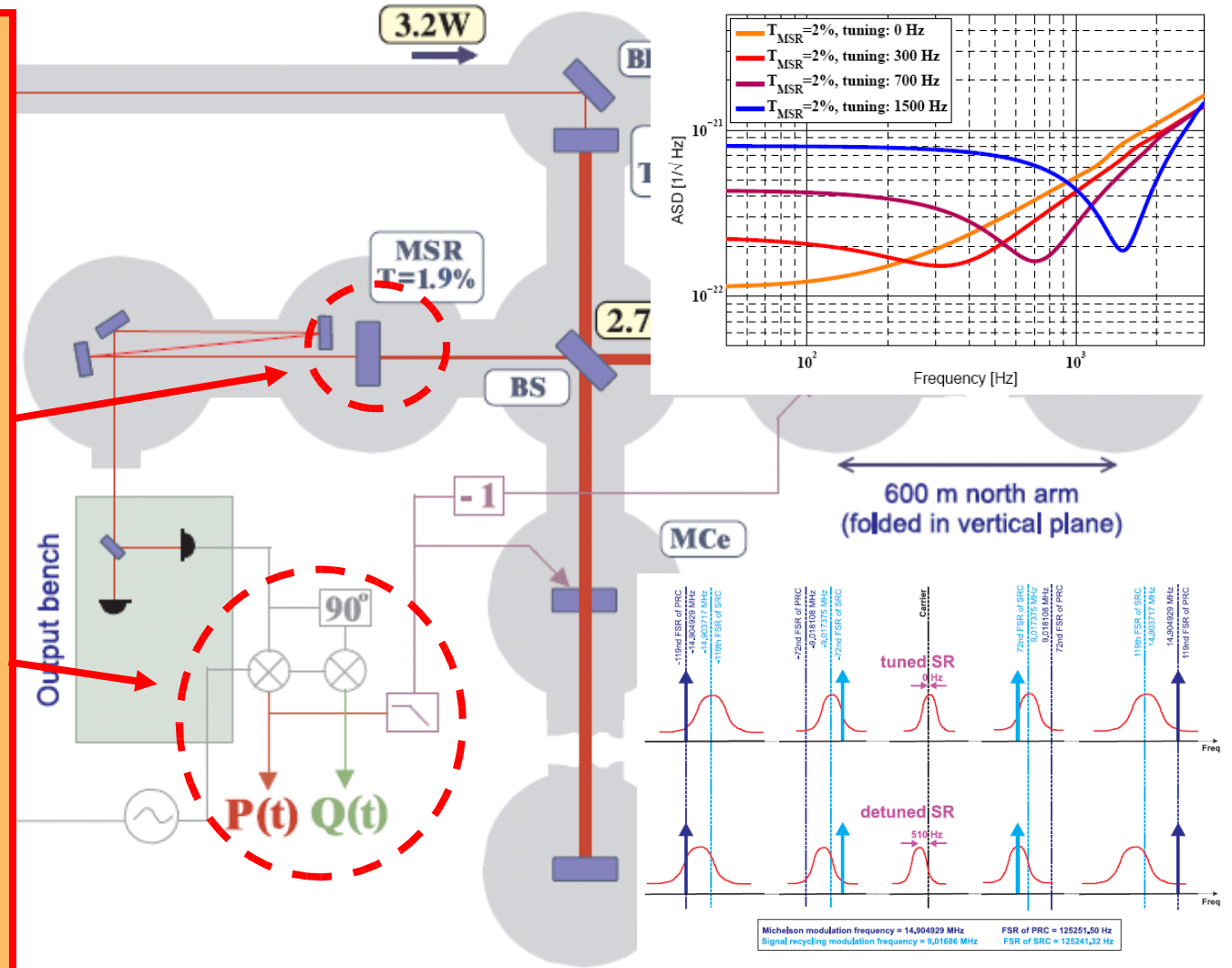


With UV-lamp + ESDs we can (positively and negatively) charge and discharge the test masses in a controlled way

The GEO600 Interferometer

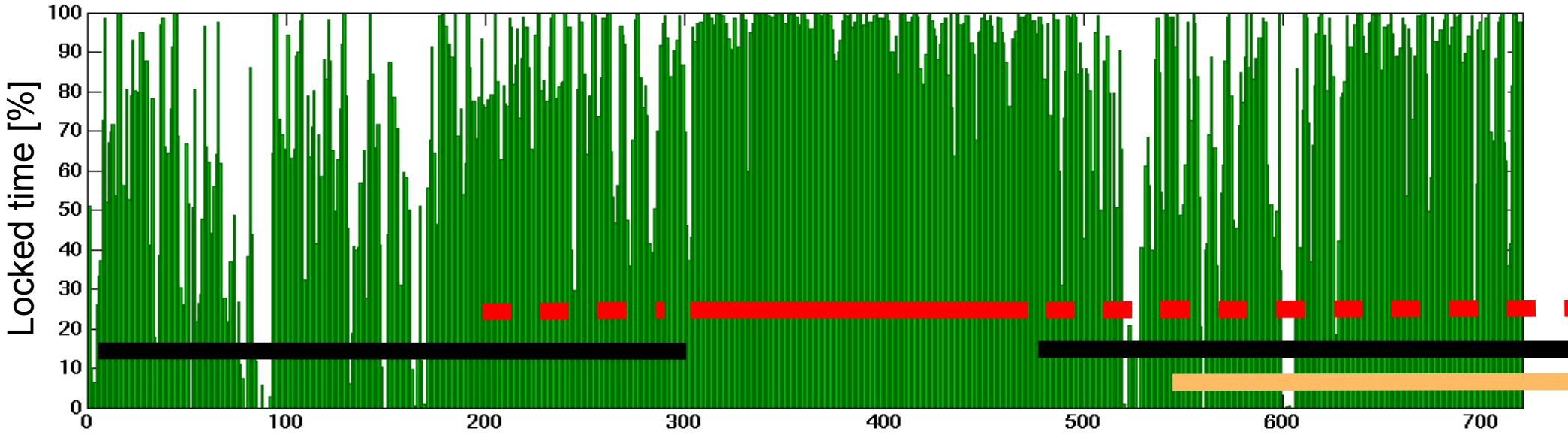
Signal-Recycling:

- **Shaping detector response**
- **Complex detector (resonance conditions with detuned SR)**
- **GW signal is spread over both quadratures *P* and *Q*.**



The Last Two Years

Locked state and main activities at the site



S5 N&W

S5 24/7

Noise hunting

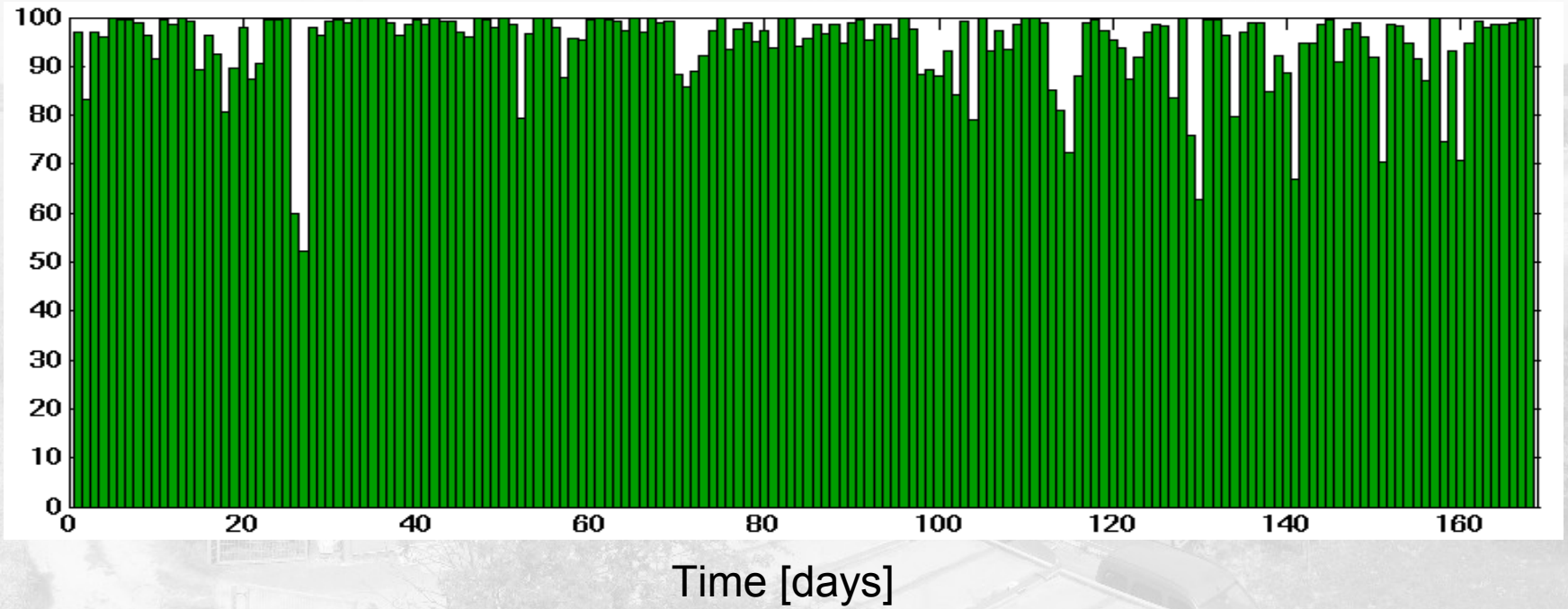
Infrastructure work

~190 days science time [57%]

~152 days science time [91%]

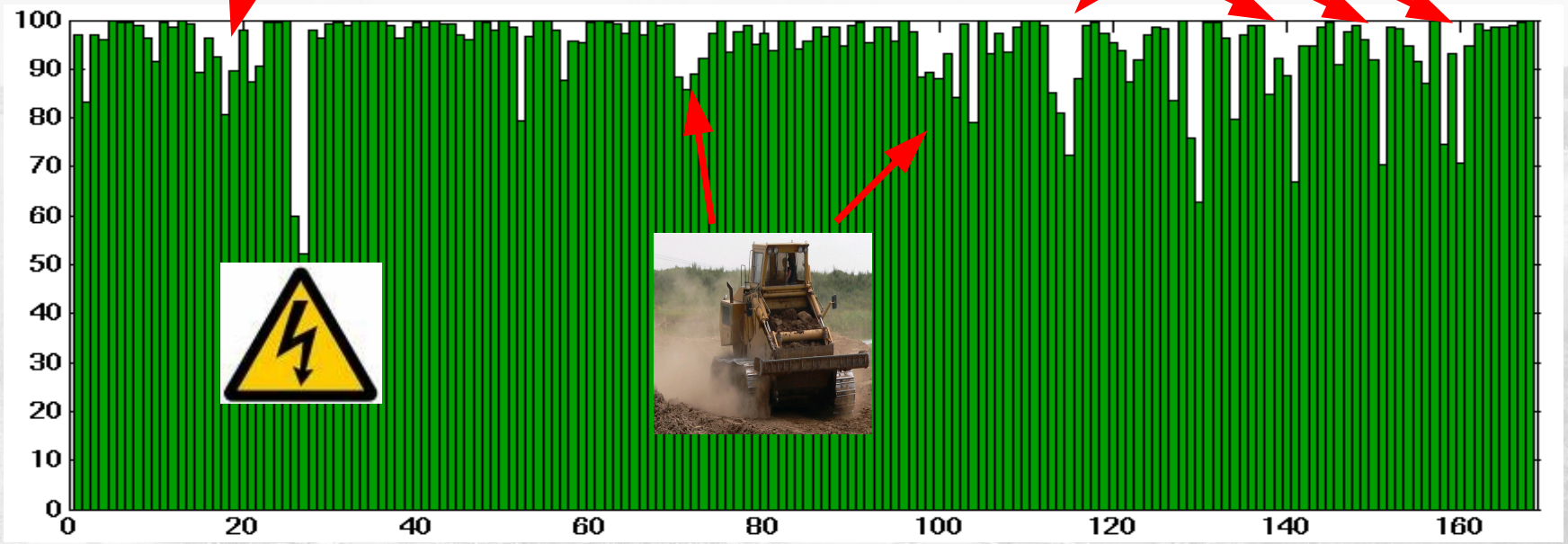
~342 days

S5: 24/7 Mode



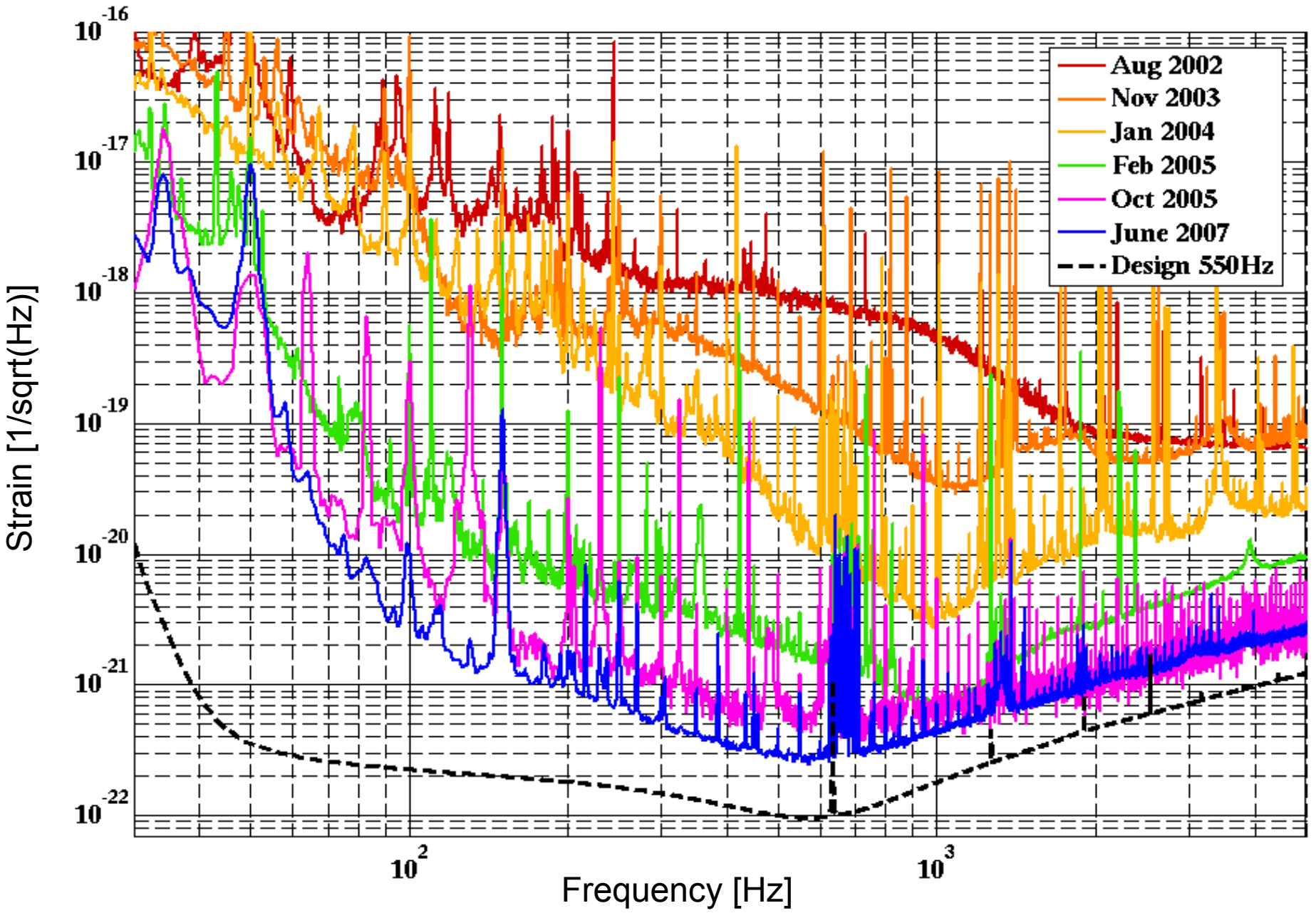
- 1. May - 15. October, 168 days
  - Instrumental duty cycle: 94.3%
  - Science time duty cycle: 91 %
- Longest lock: 102 hours

S5: 24/7 Mode

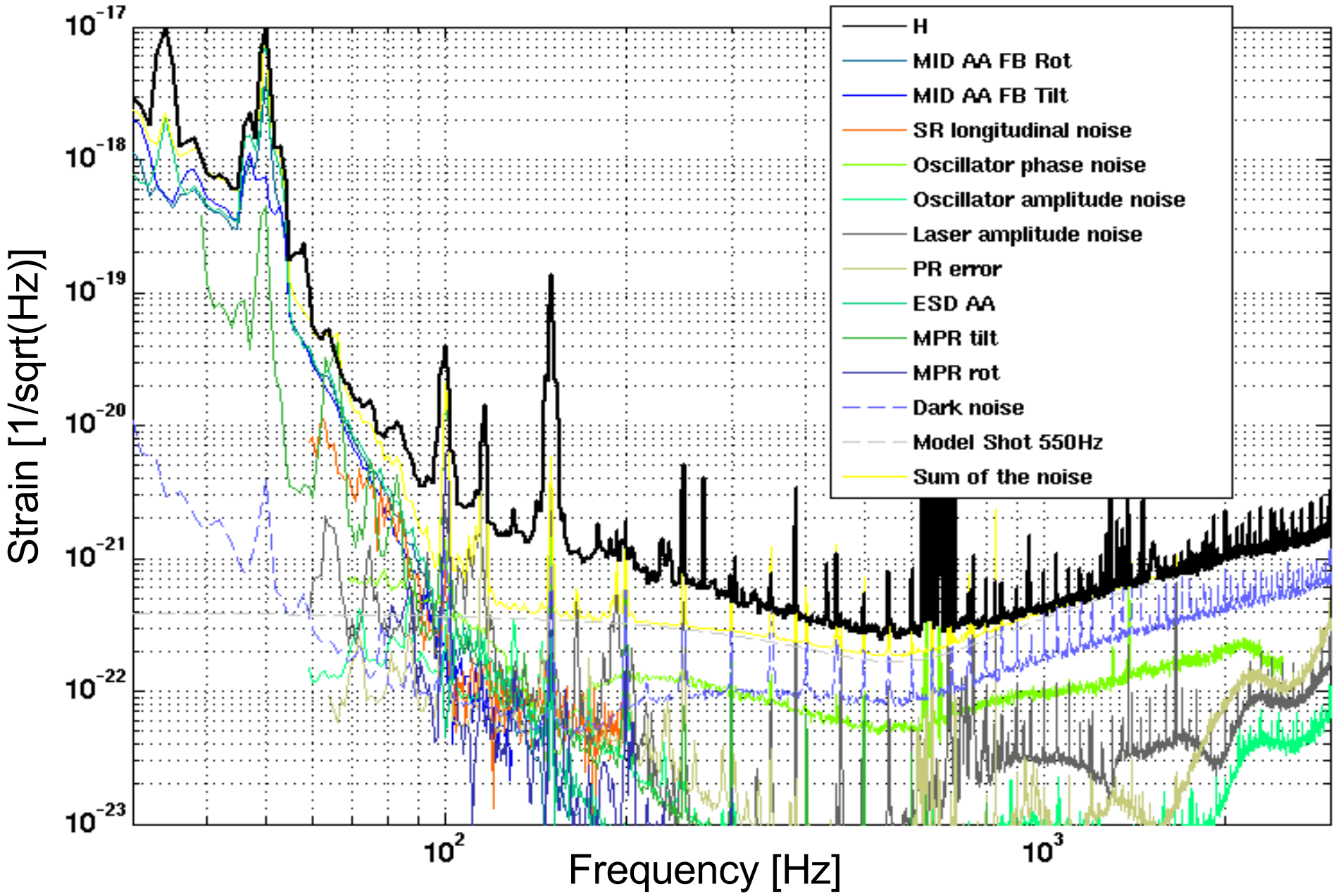


- 1. May - 15. October, 168 days
  - Instrumental duty cycle: 94.3%
  - Science time duty cycle: 91 %
- Longest lock: 102 hours

GEO Sensitivities



Noise Projections



Main Noise Reduction Topics

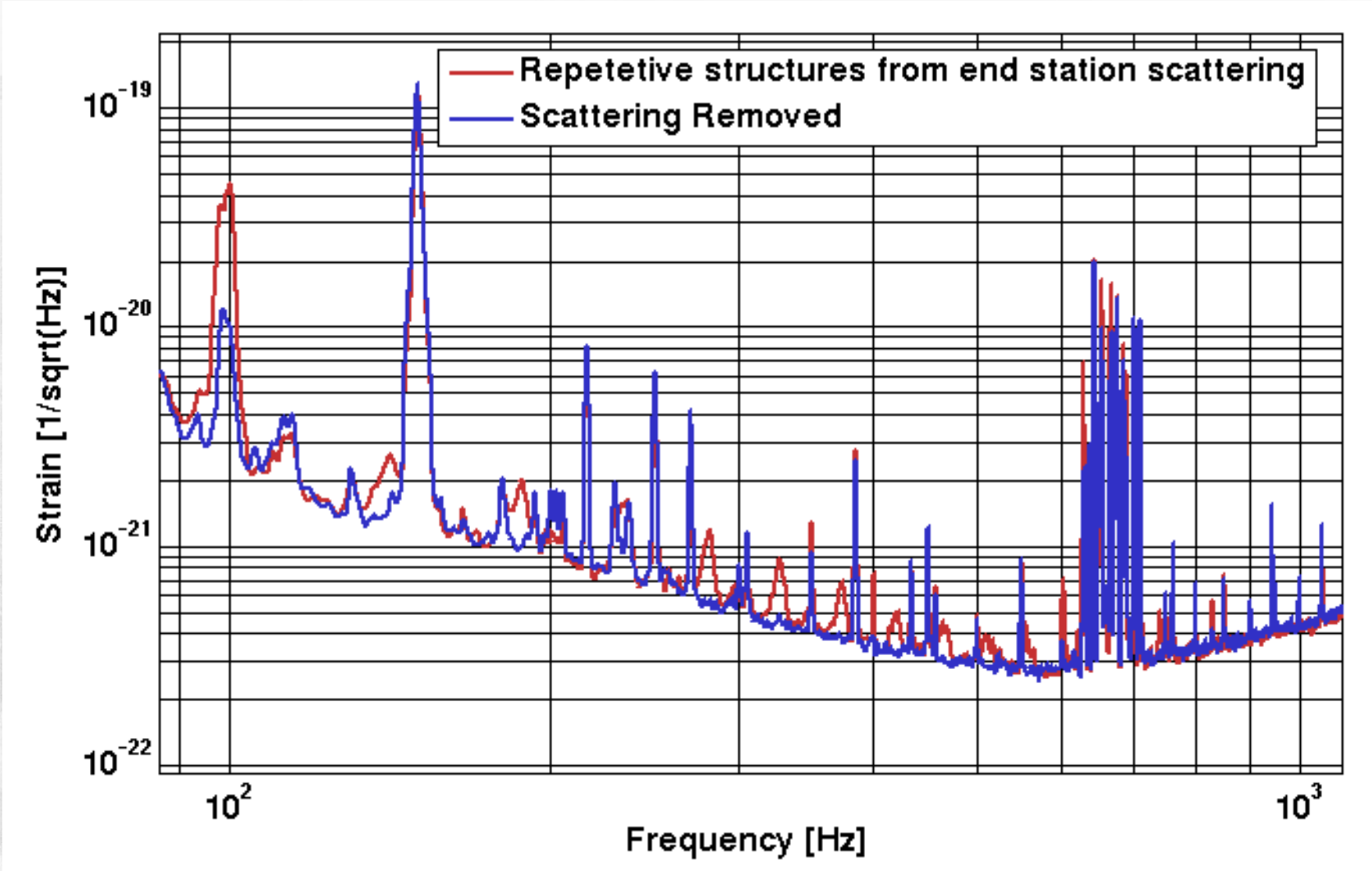
- Low-frequency (< ~200Hz):
  - Signal recycling feedback
  - Michelson auto-alignment feedback

Digital controls, ESD autoalignment, noise subtraction, ...

- Mid & high frequency (> ~200Hz):
  - Detection noise (dynamic range of photodetector)
  - RF Modulation: phase noise and glitches
  - Acoustics / scattered light

PD design, crystal oscillators, SMA connectors, RF power stabilization, acoustic schielding, larger optics, cleaner air, ...

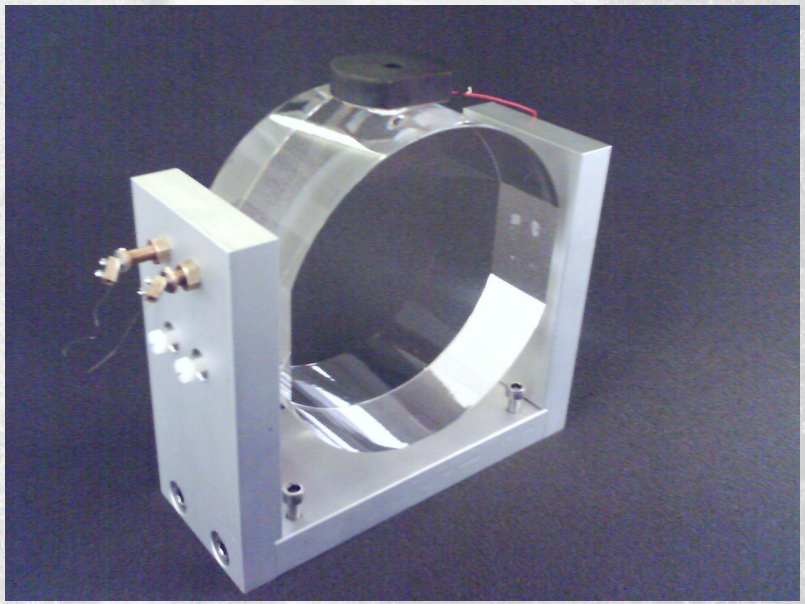
Scattered Light Reduction



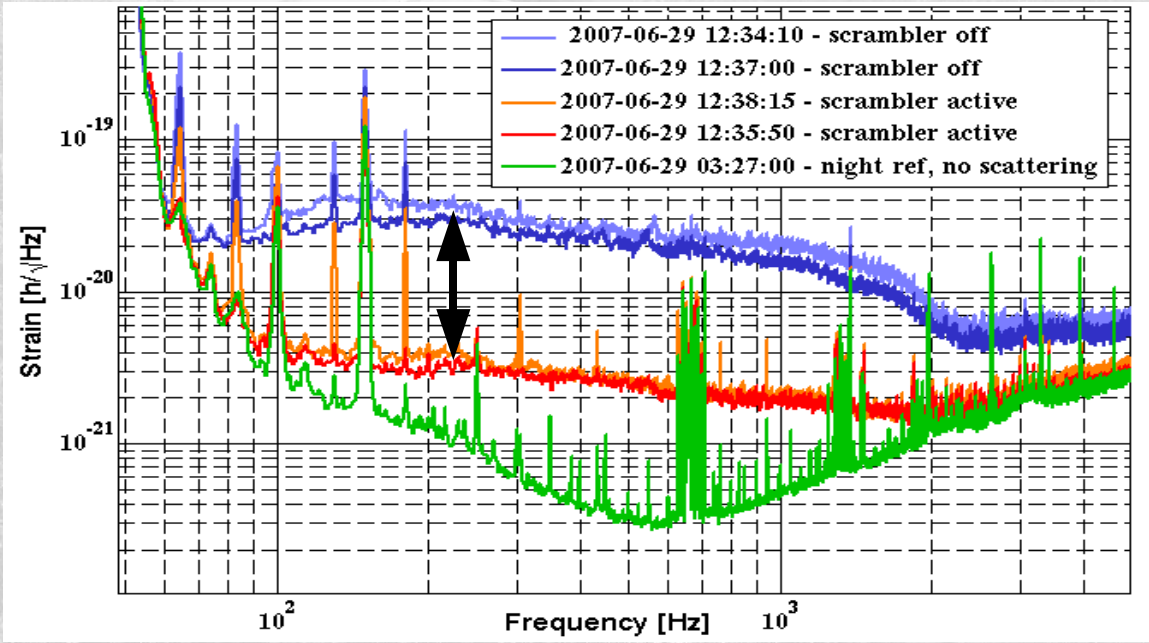
Acousto-Optic Phase Shifter...

...to suppress back-scattering from optics beyond

- Phase-modulate beam via excitation of substrate eigenmode
- Can handle large apertures and is polarization independent
- Place as first component on output beams in places where scattering cannot be avoided, e.g. photodiodes, telescopes



Scattering provoked and suppressed at end station

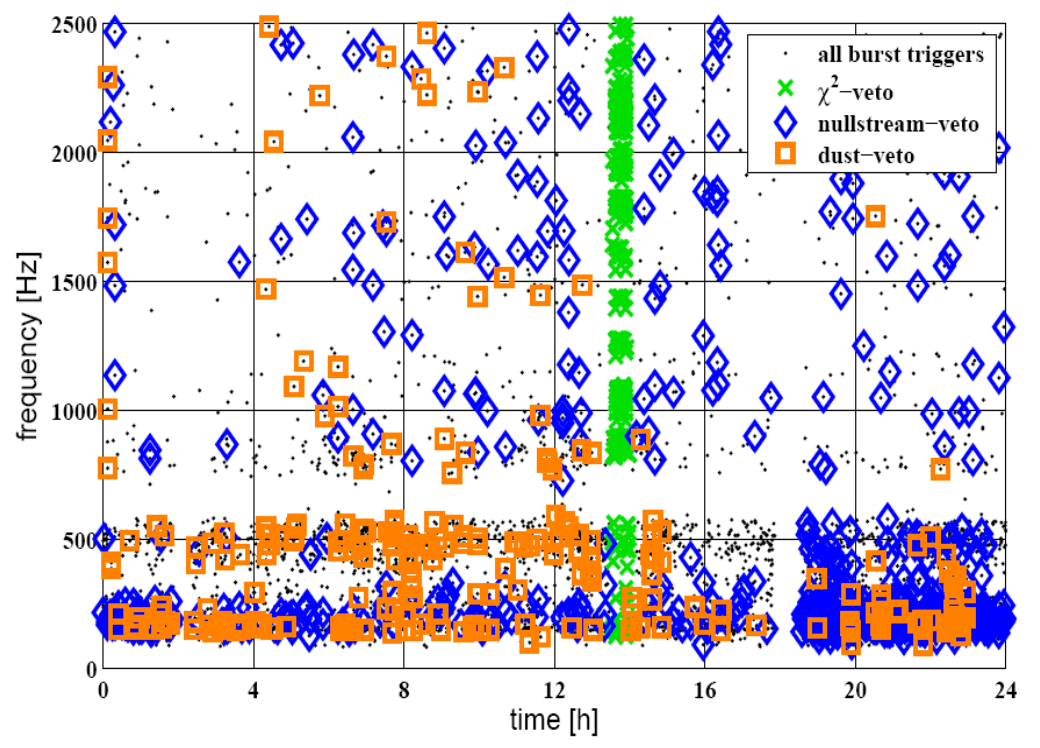


Infrastructure Work

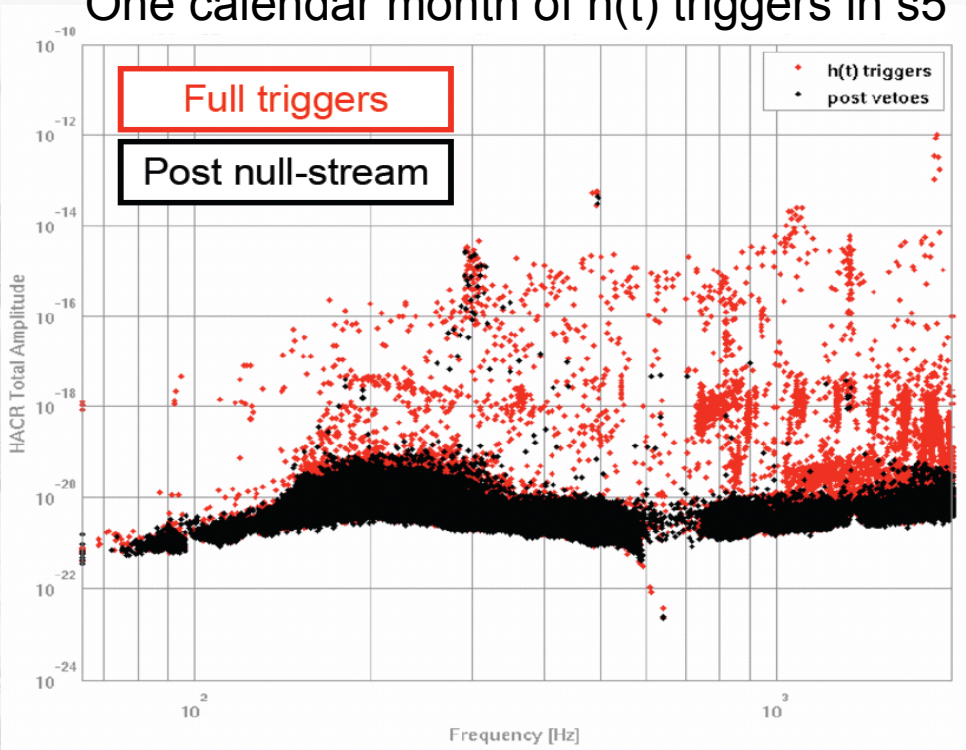
- New HV feedthroughs for electrostatic drives, improved ESD wiring
- Cleanroom: particle reduction by HEPA fiters in main airconditioning stream
- Debugging of mains power routing done.
  Work ongoing on balancing of currents

We are ready for a long data run

Glitches and Vetoes



One calendar month of h(t) triggers in s5



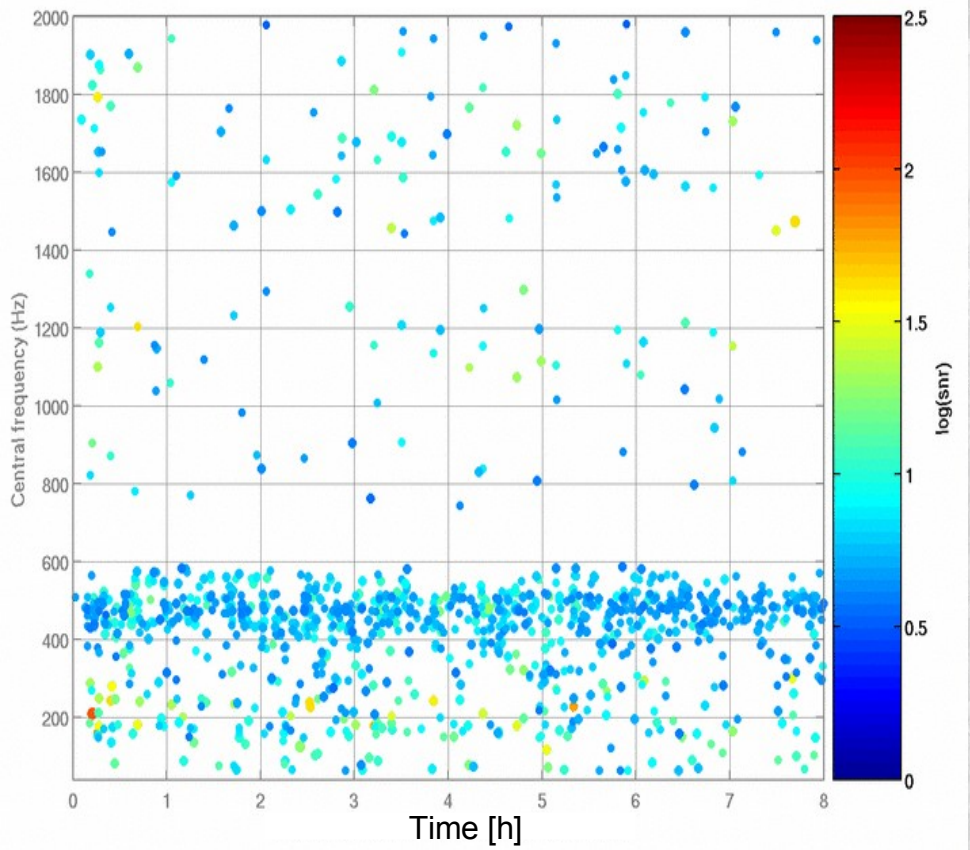
- Nullstream veto
- Noise projection vetos

- Chi^2 veto
- Statistical vetos

Reduction of Glitches

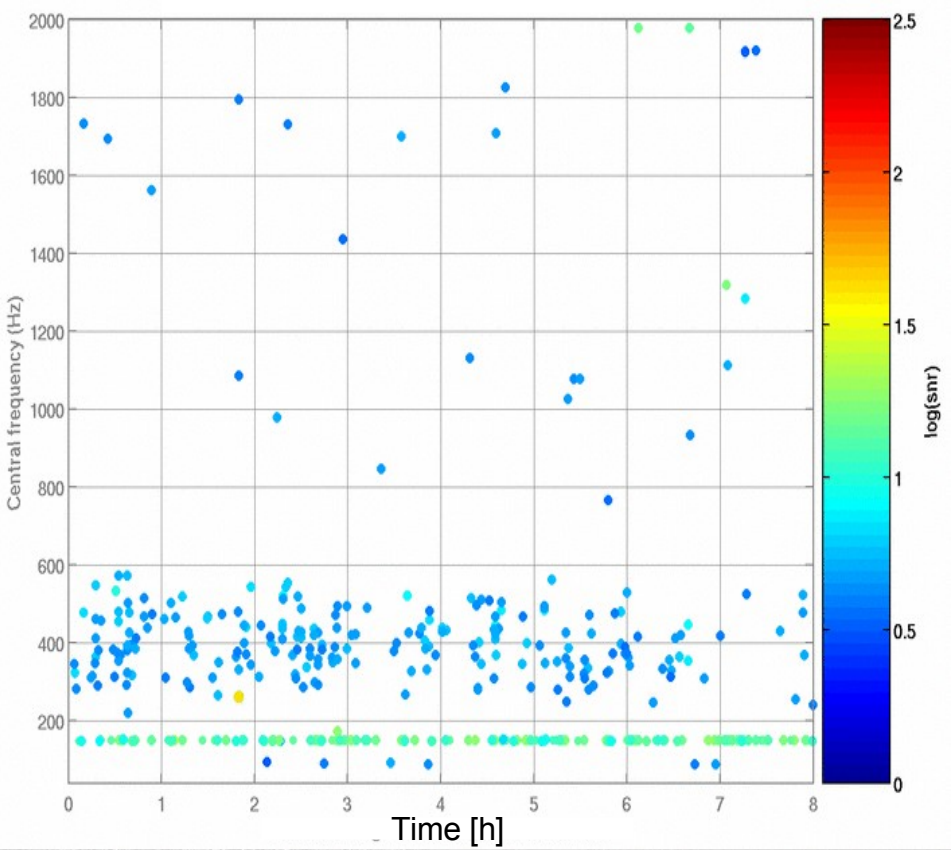
Comparizon of glitchiness of LIGO /GEO /VIRGO data with coherent waveburst showed GEO glitchiness around the average of all detectors (Sept. 2006). Since then we further reduced glitches.

H triggers in HACR mon: n=1067



Typical s5 in 2006

H triggers in HACR mon: n=392



End of June 2007

DC Detection: A New World

- From heterodyne (AC) to homodyne (DC) detection
- Anticipated advantages:
  - Reduced modulation noise coupling
    (in particular important for detuned signal recycling)
  - Better sensitivity (~20 to ~40 %)
- But pay attention to:
  - Larger power noise coupling: OK, but get optical filter for LO !
  - Output mode-cleaner: Alignment to power coupling, scattering

DC-Readout without OMC

IDEA:

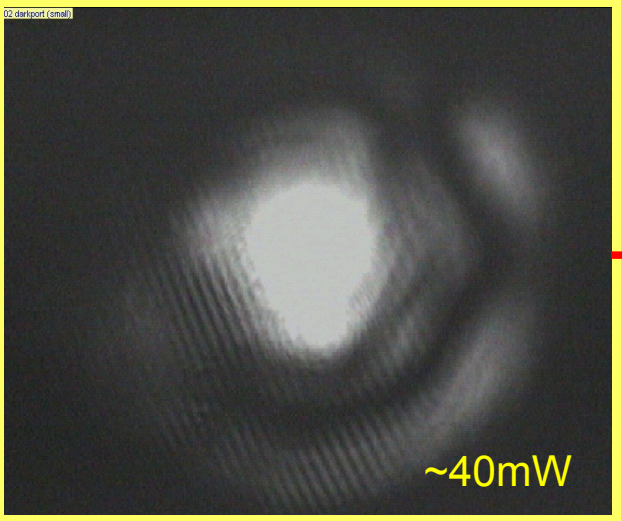
Turning down the RF-modulation *(factor 10 is possible)*

Using an offset from dark fringe *(of the order 50pm)*

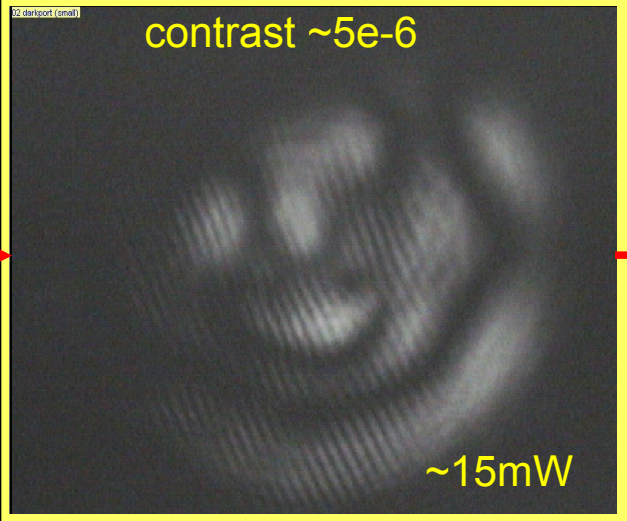
Dark port dominated by carrier light

EXPERIMENT in GEO600:

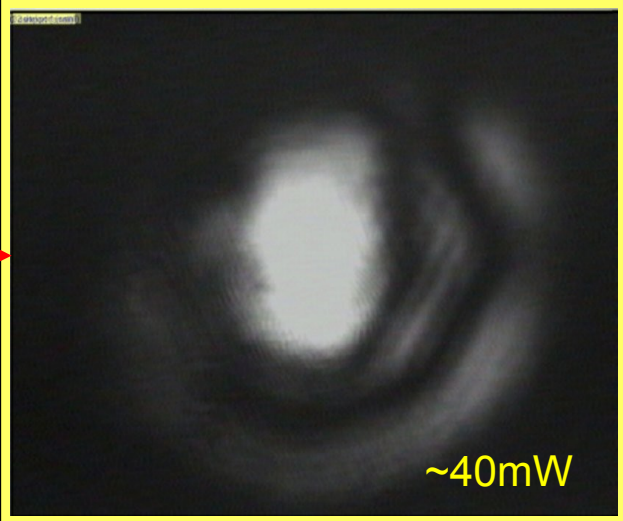
Locked to dark port power



Nominal heterodyne



Heterodyne with only 10% modulation



Offset to dark fringe (~ 50pm)

Results from first Experiments with DC-readout

It works !

- Slightly better (10-20%) sensitivity than heterodyne at high frequencies (> ~2kHz)
- Not much worse sensitivity at mid frequencies
- Power noise coupling is not terrible !


Astrowatch
220

Astrowatch

- The current plan is to start 24/7 run in October 2007
- Run until Enhanced IFOs start science run (LSC: S6, ~early 2009)
- 2009 and beyond:
  Sequential upgrades in the GEO-HF frame, minimizing downtime (and take science data when possible) during construction of advanced detectors

Summary

- We have ~1 year of S5 science data
- Noise and glitch reduction, infrastructure work, detector characterization work etc. done and ongoing
- Long observation from Oct. 2007 to the end of 2008...