THE STATUS OF GEO 600

Ken Strain
for the GEO team
G070506-00-Z

Based on a prior talk by
Hartmut Grote
(G070414-02-I)

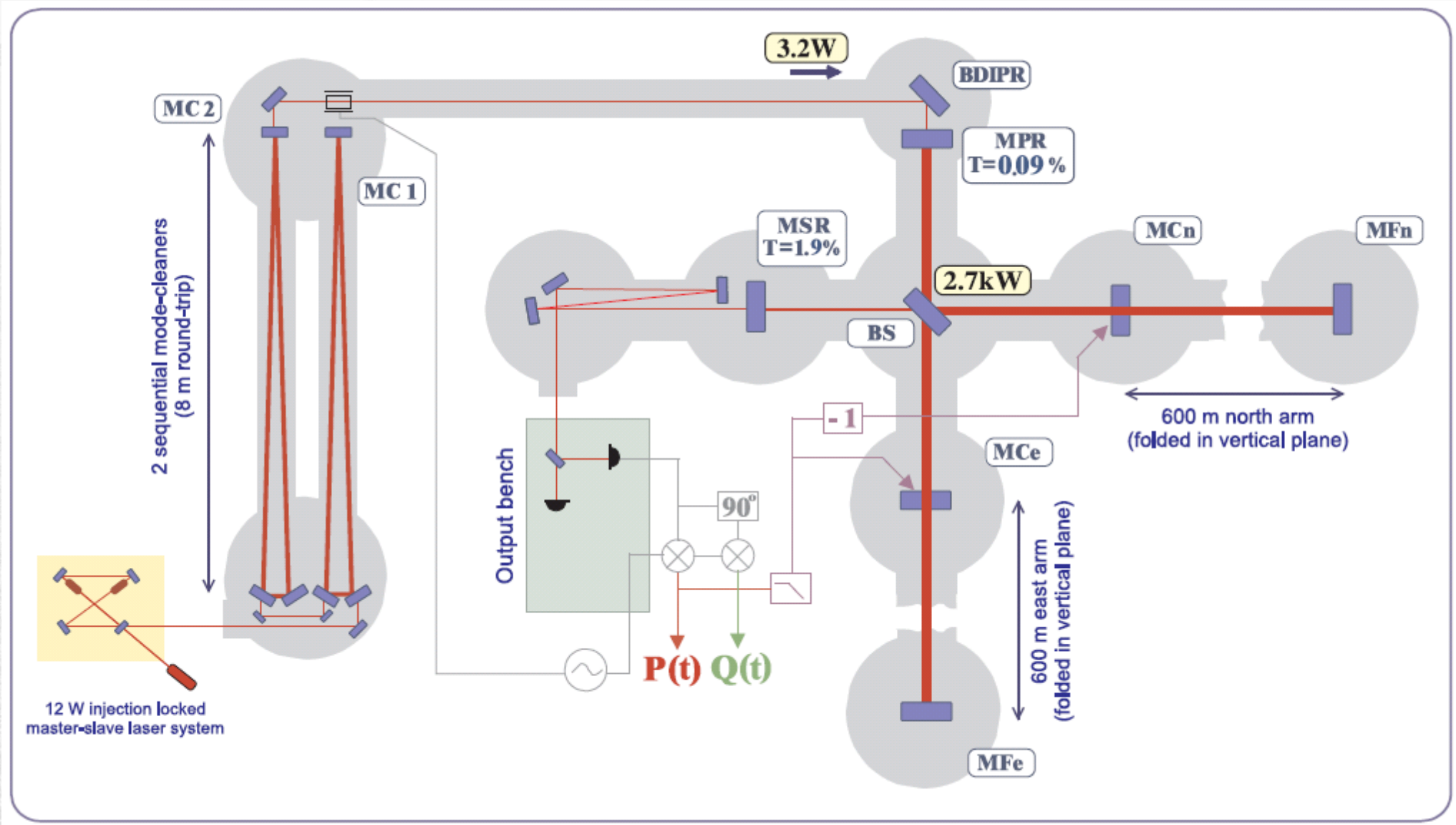
Leibniz Universität Hannover

CARDIFF UNIVERSITY

LSC

UIB Universitat de les Illes Balears

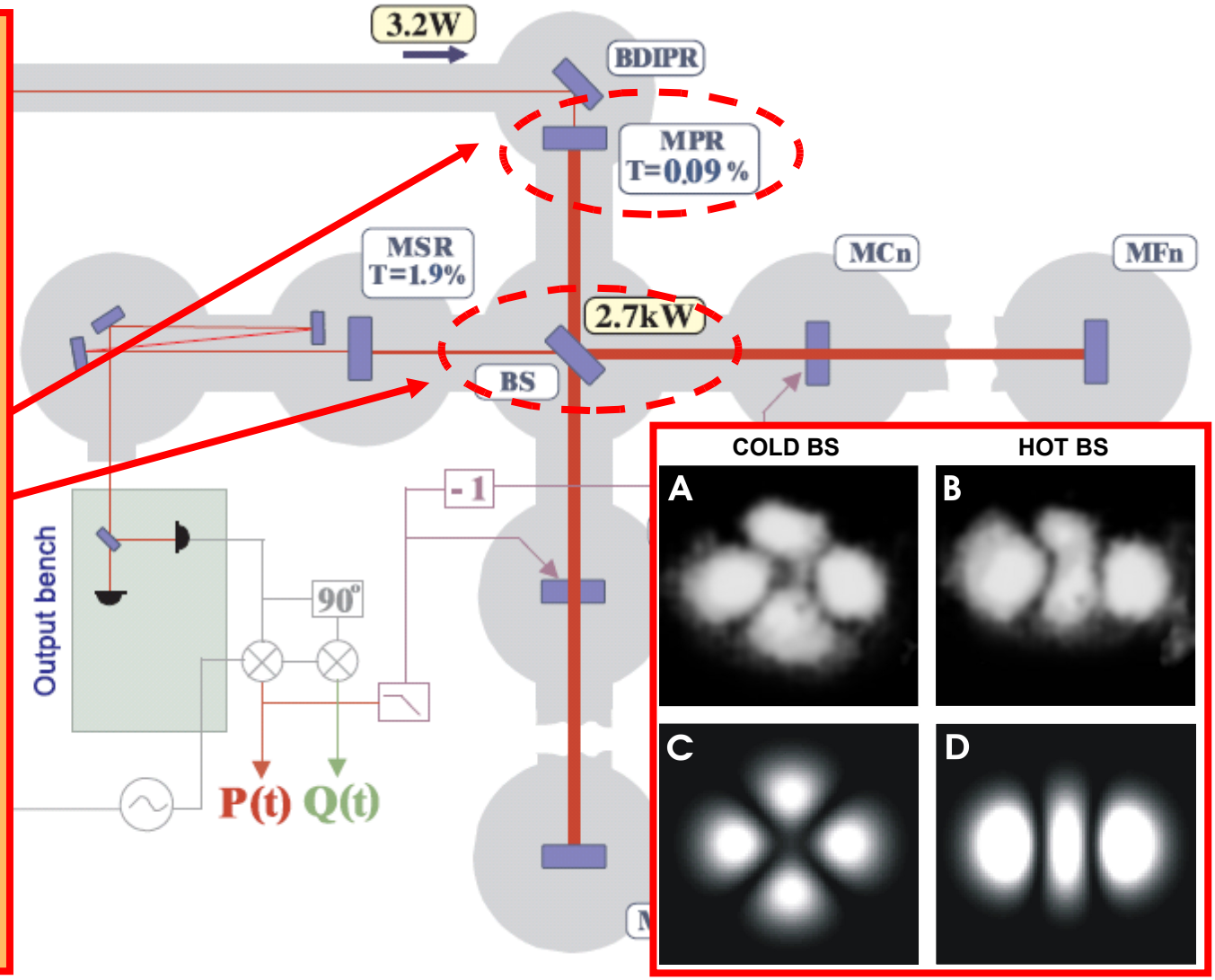
The GEO600 Interferometer



The GEO600 Interferometer

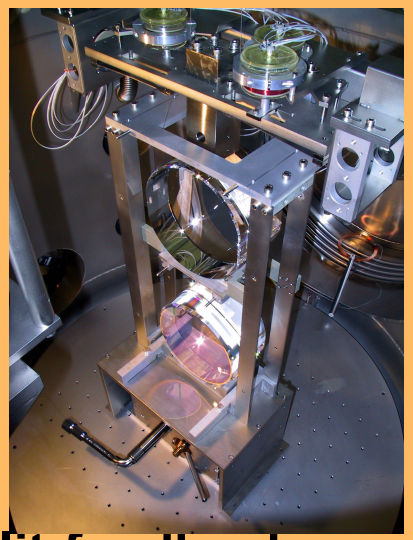
No arm cavities, but folded arms:

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

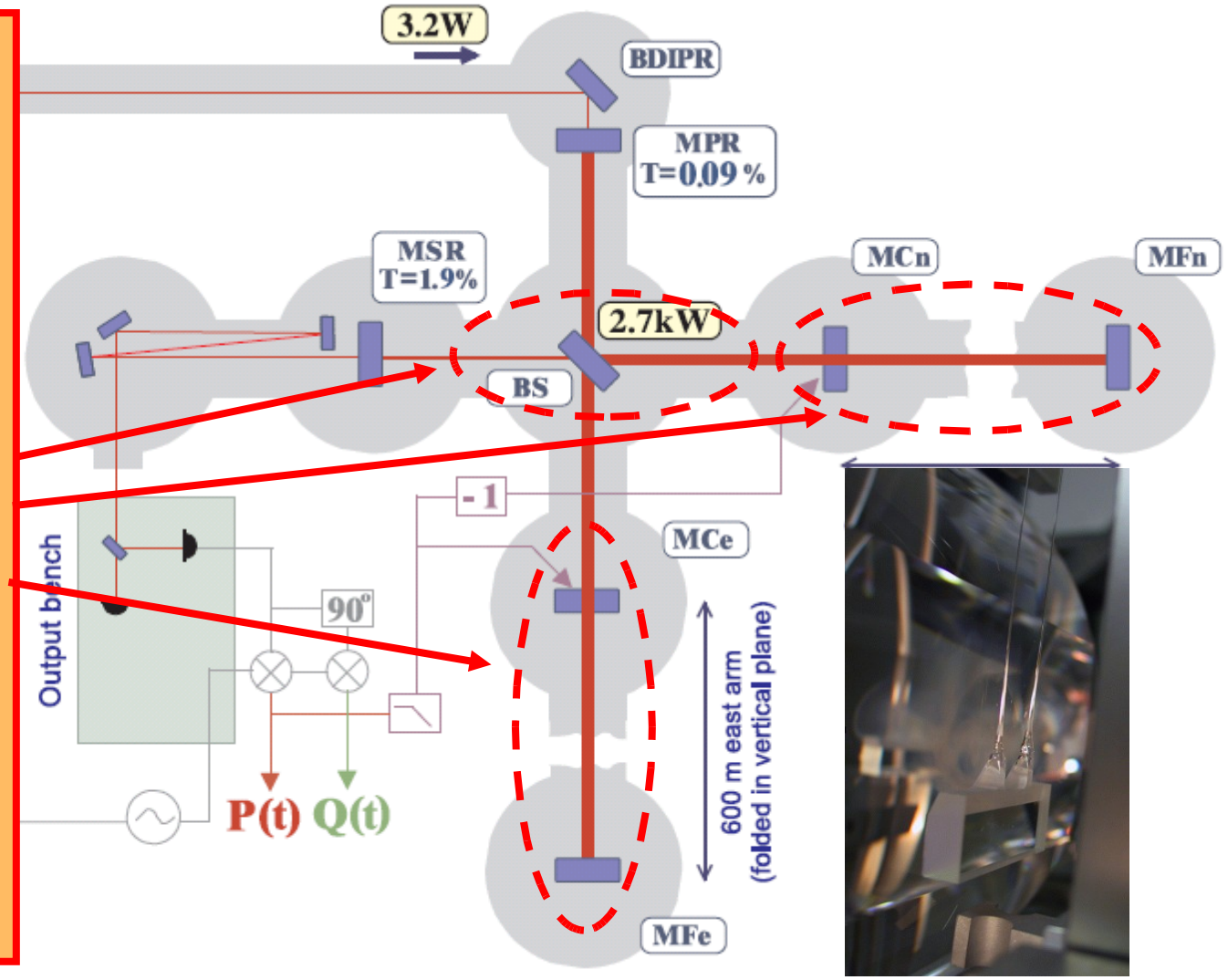


The GEO600 Interferometer

Triple suspensions:



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

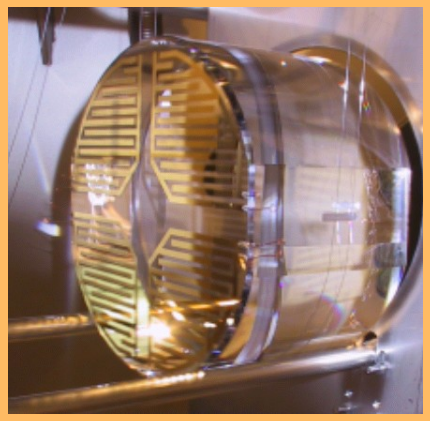


Monolithic stages: ~100 fibre years on running IFO with ~5 partial ventings

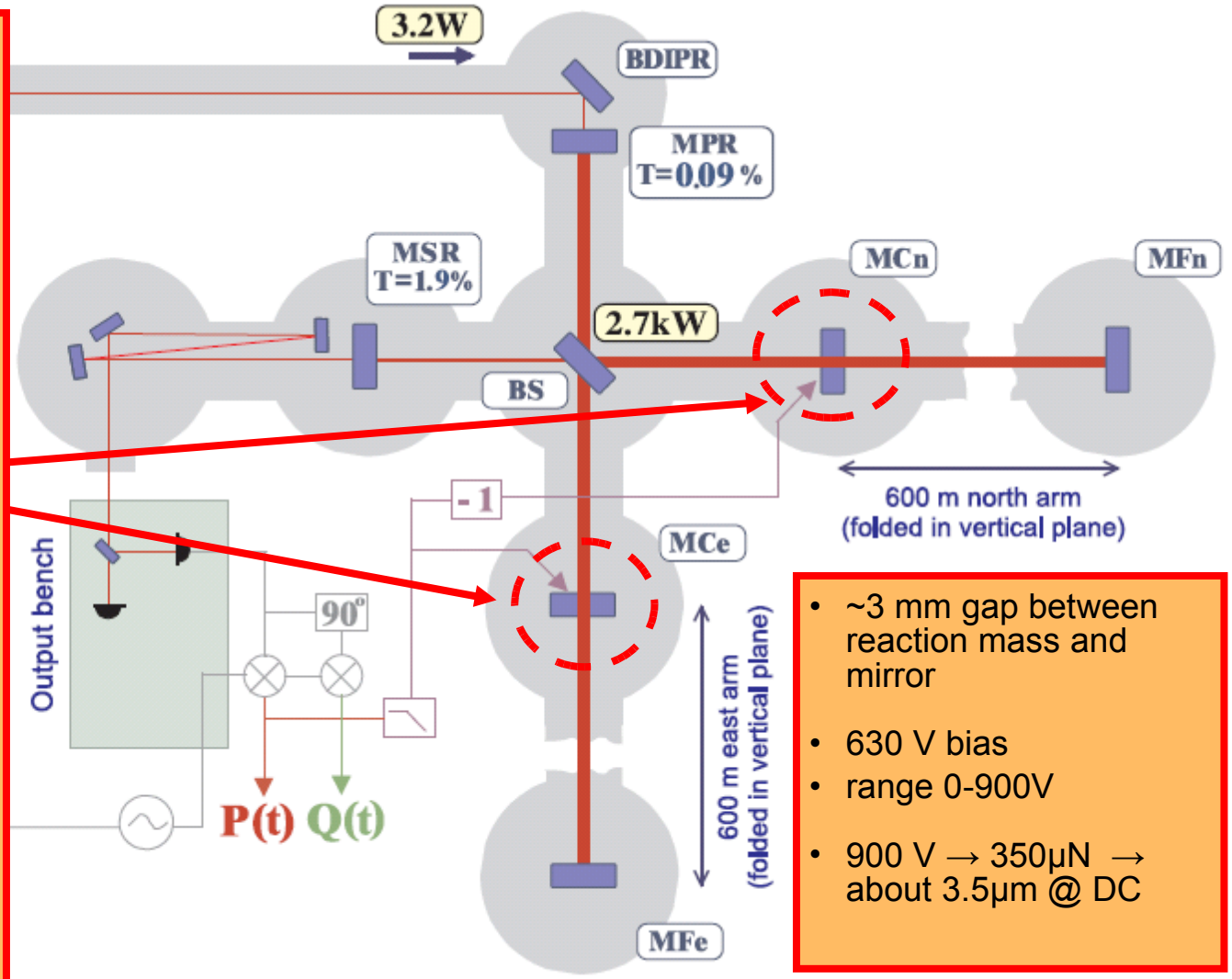
The GEO600 Interferometer

Electro-Static Drives:

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



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

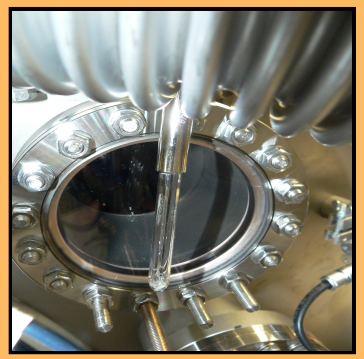


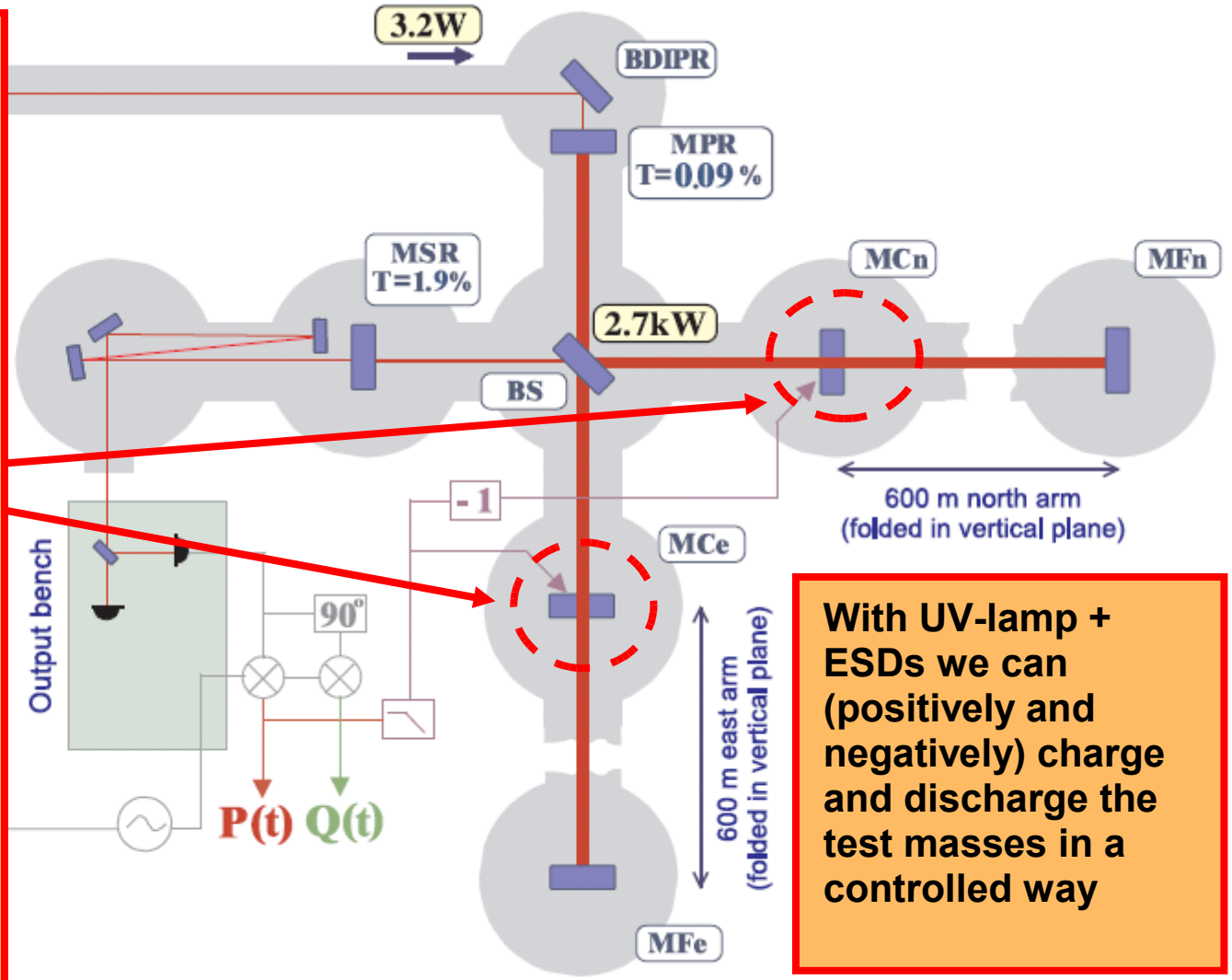
- ~3 mm gap between reaction mass and mirror
- 630 V bias
- range 0-900V
- 900 V → 350µN → about 3.5µm @ DC

The GEO600 Interferometer

Charges on test masses

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



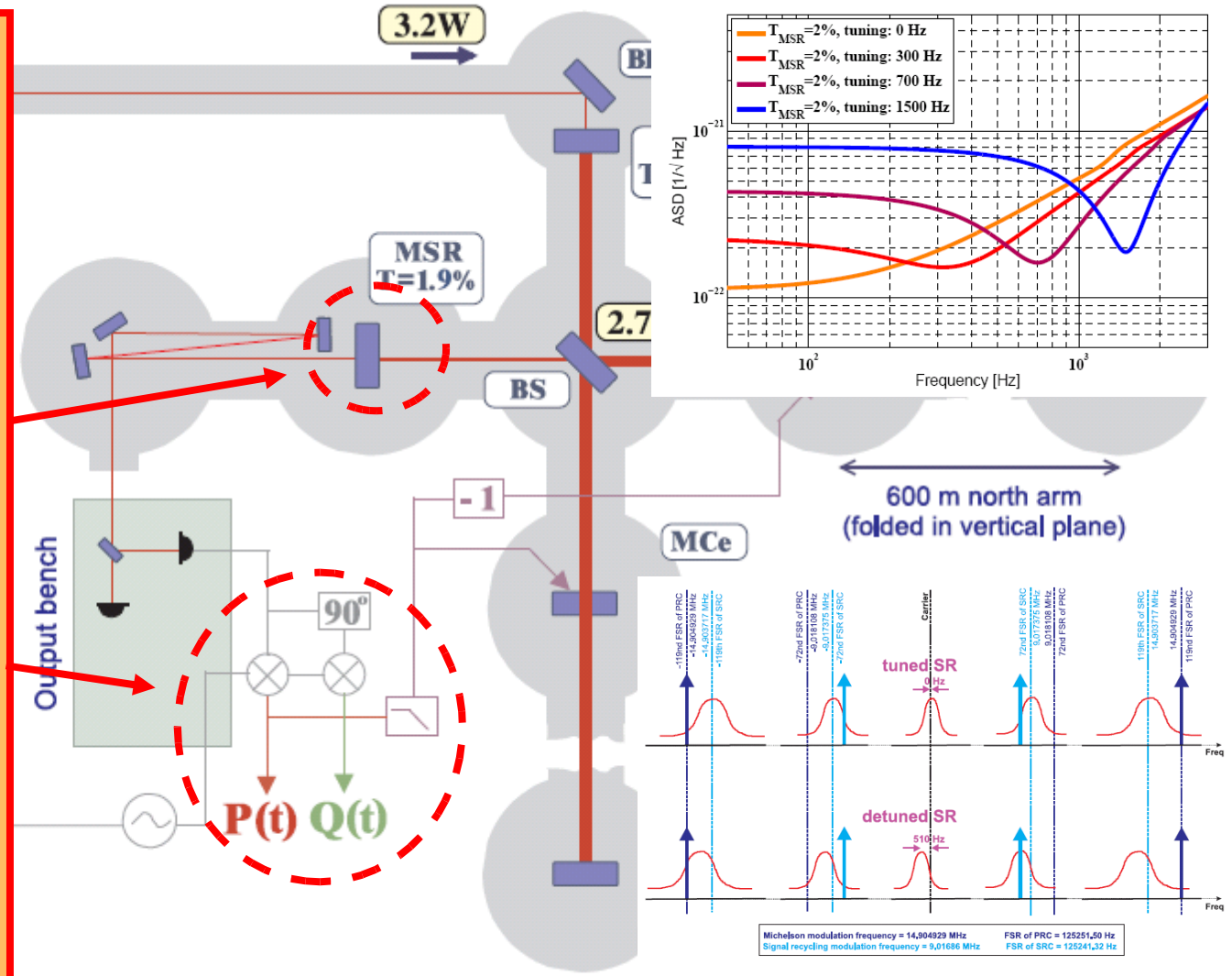


With UV-lamp + ESDs we can (positively and negatively) charge and discharge the test masses in a controlled way

The GEO600 Interferometer

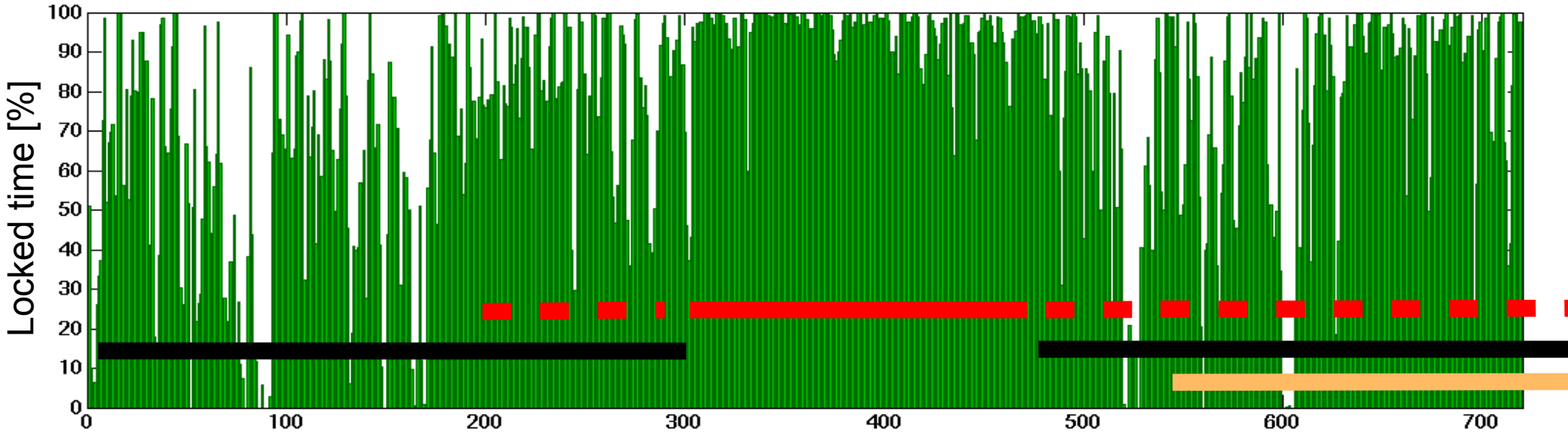
Signal-Recycling:

- **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

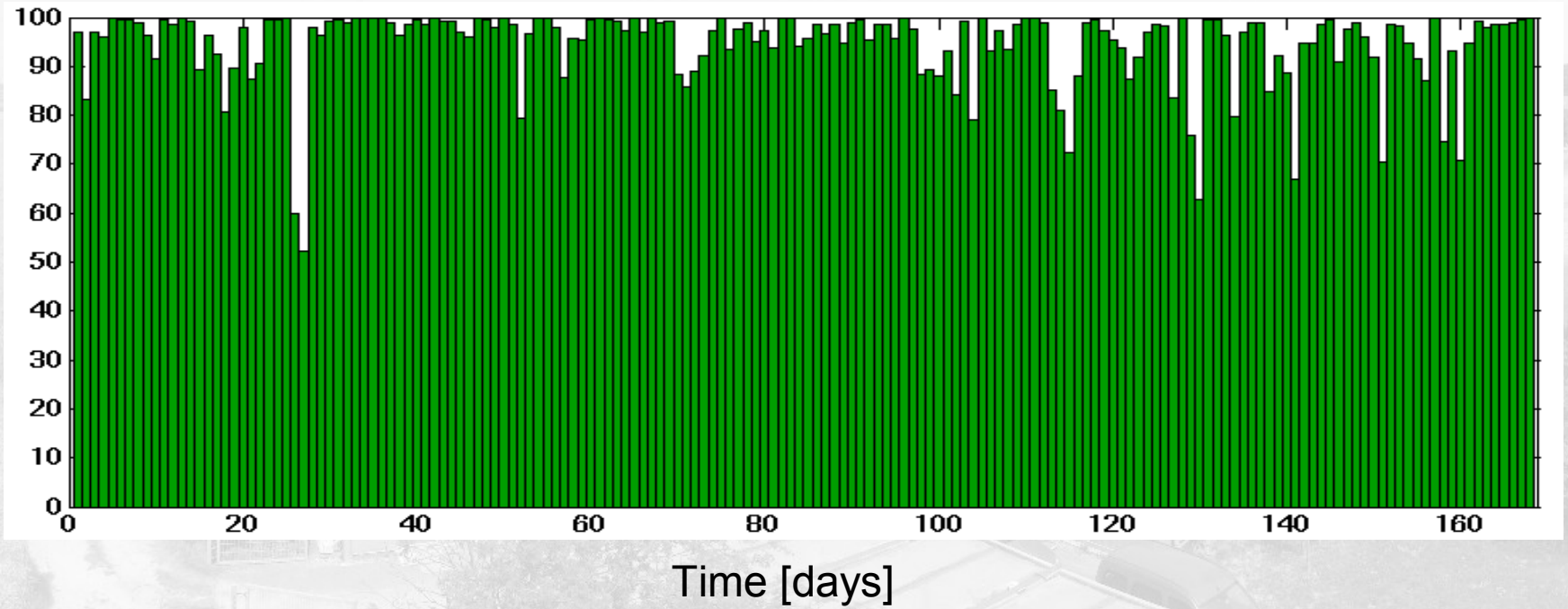
Infrastructure work

~190 days science time [57%]

~152 days science time [91%]

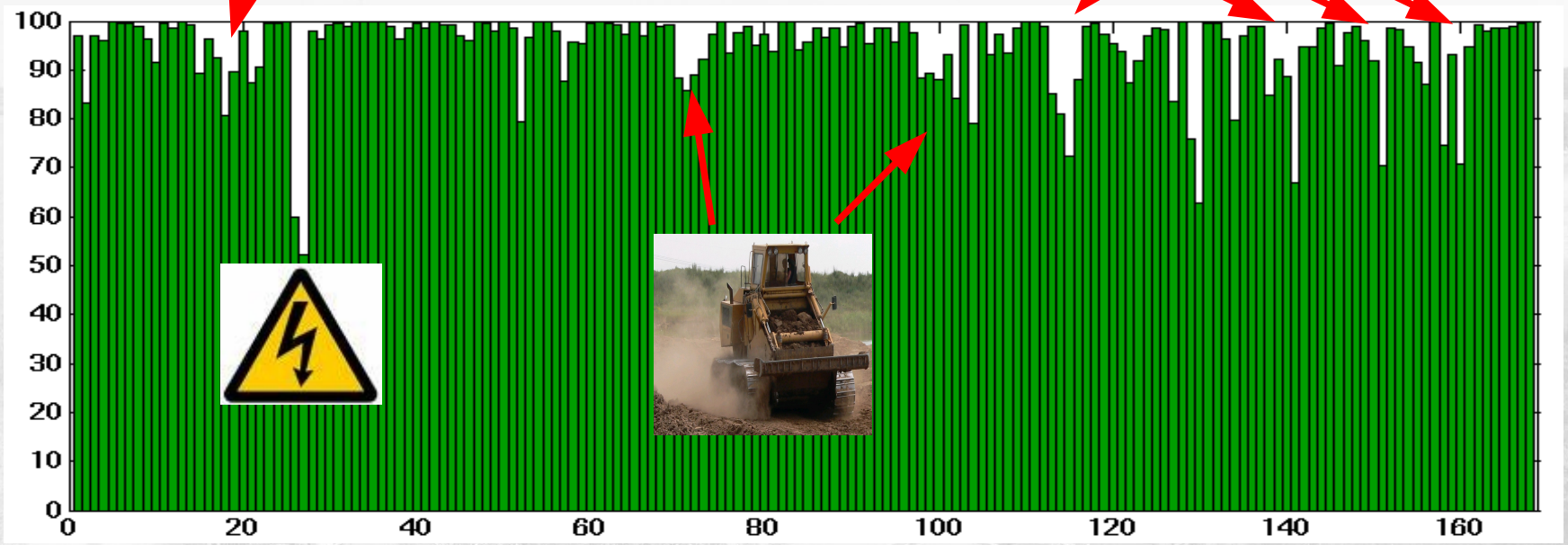
~342 days

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



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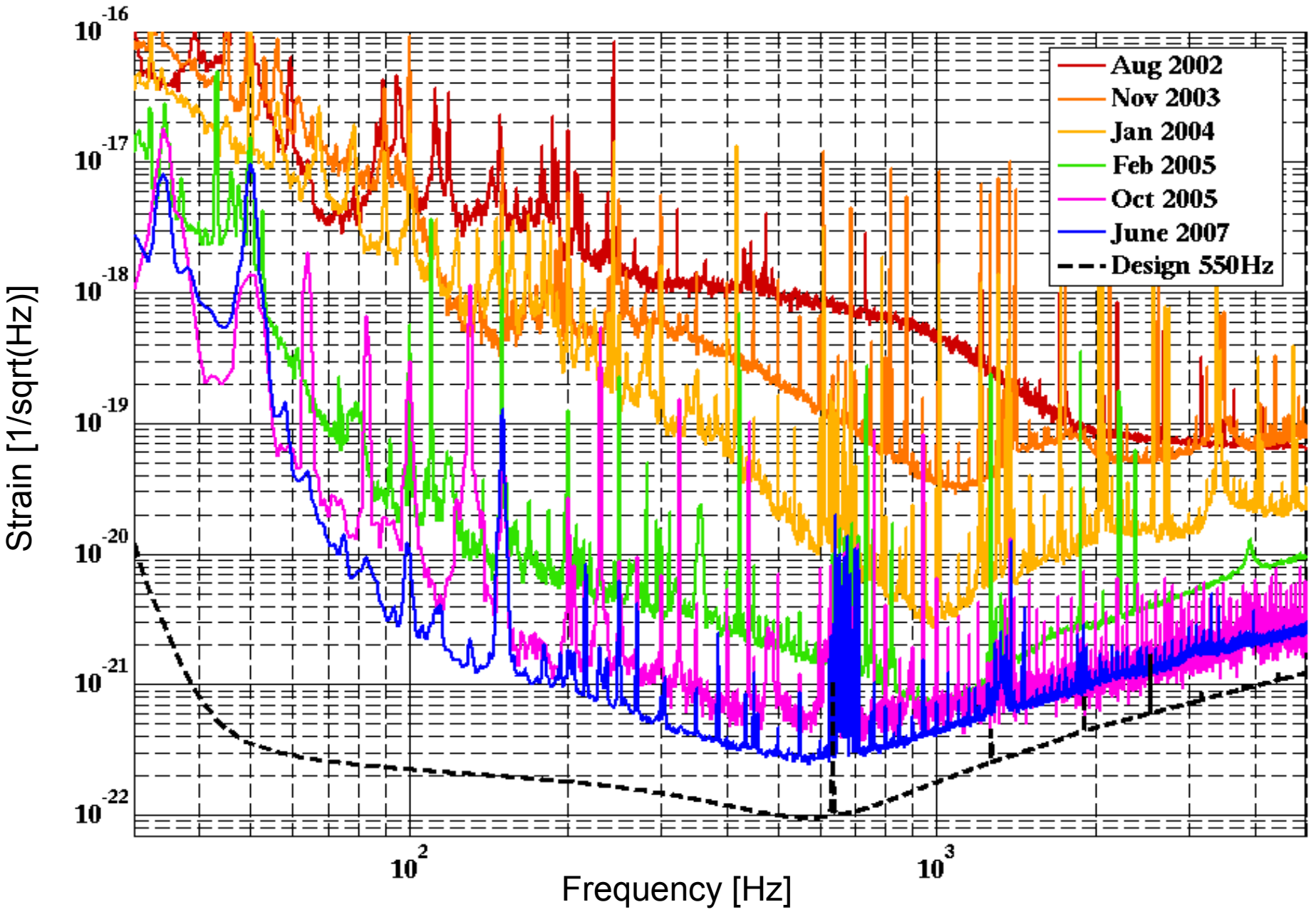
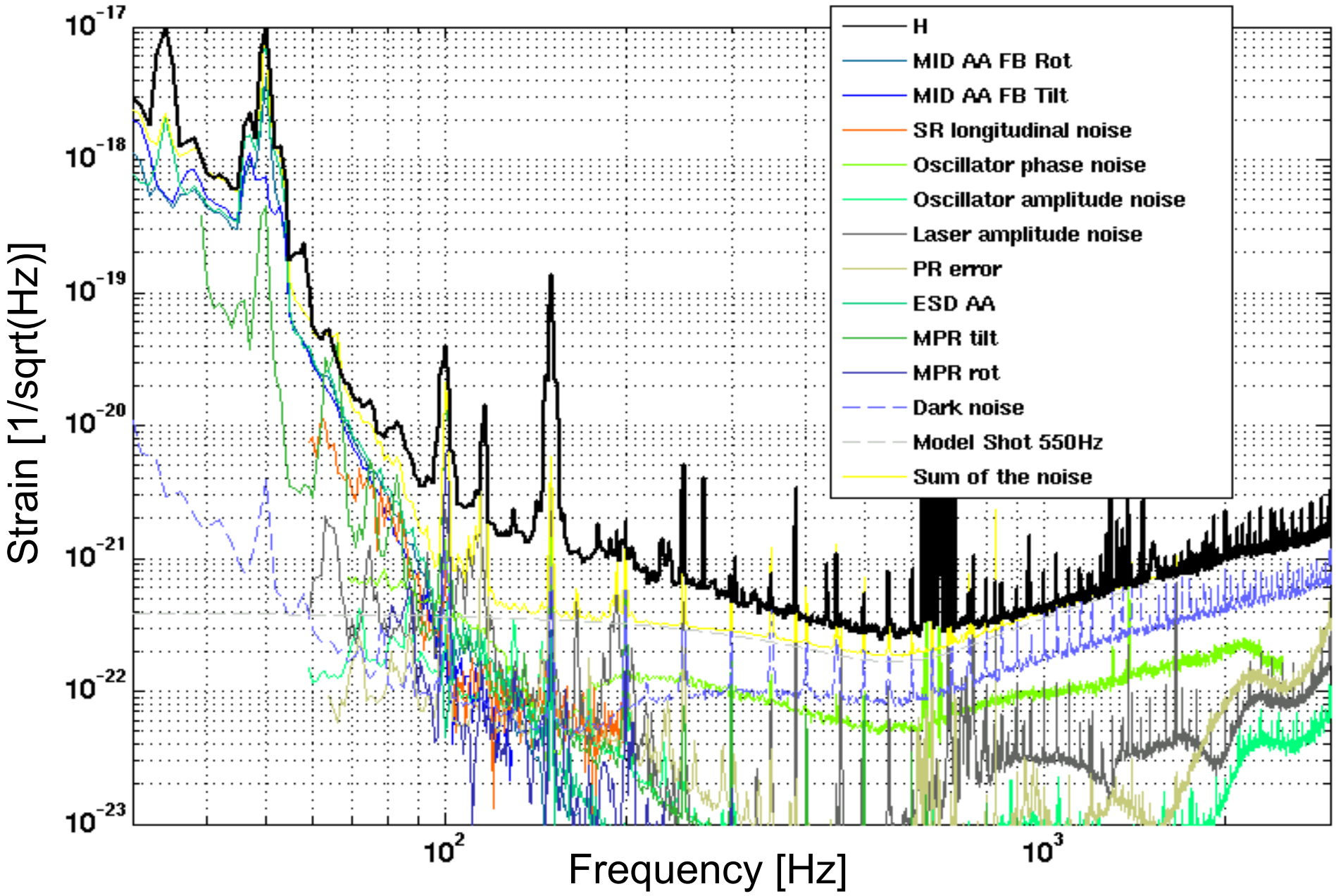
GEO Sensitivities



Noise Projections



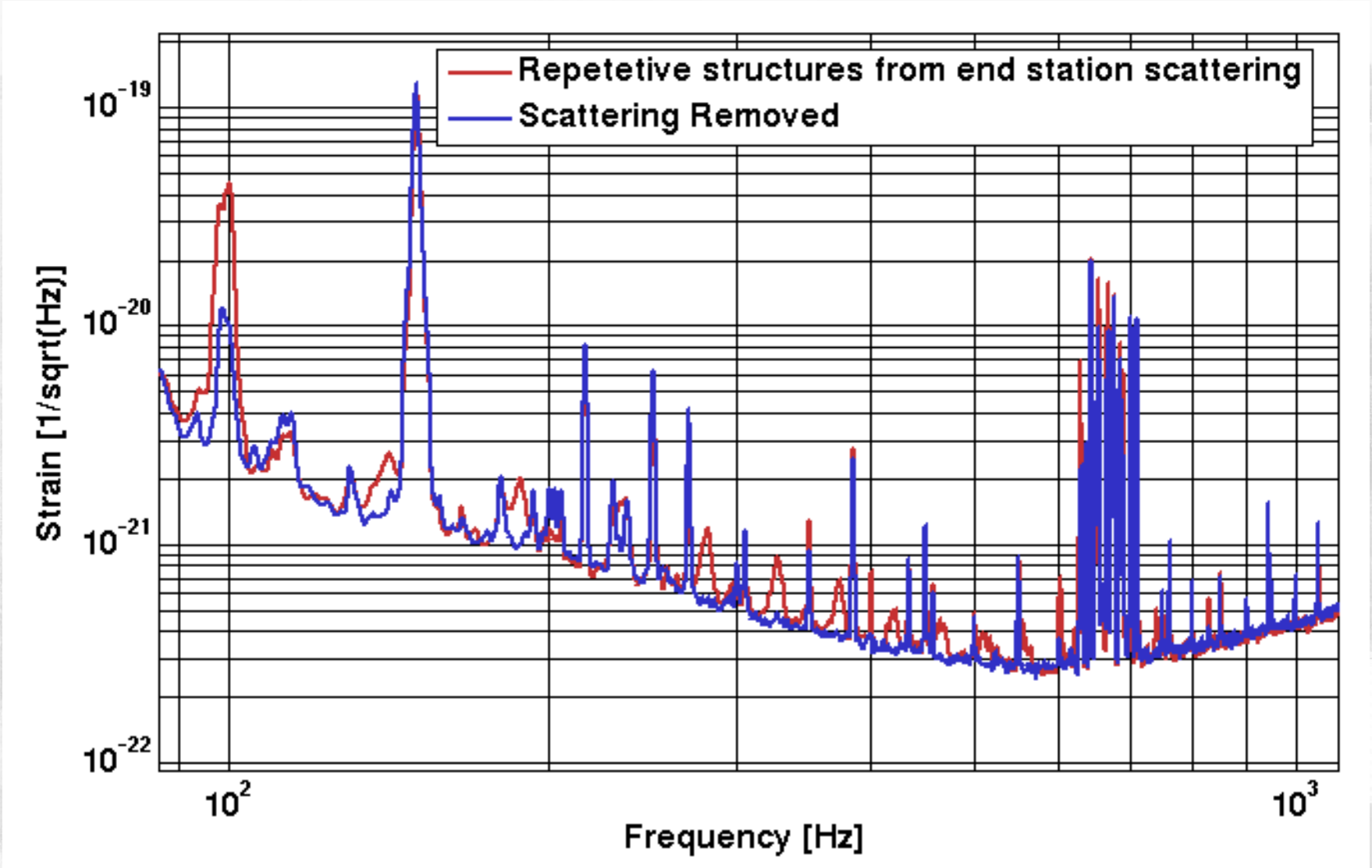
Main Noise Reduction Topics

- Low-frequency (< ~200Hz):
  - Signal recycling feedback
  - Michelson auto-alignment feedback
- Mid & high frequency (> ~200Hz):
  - Detection noise (dynamic range of photodetector)
  - RF Modulation: phase noise and glitches
  - Acoustics / scattered light

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

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

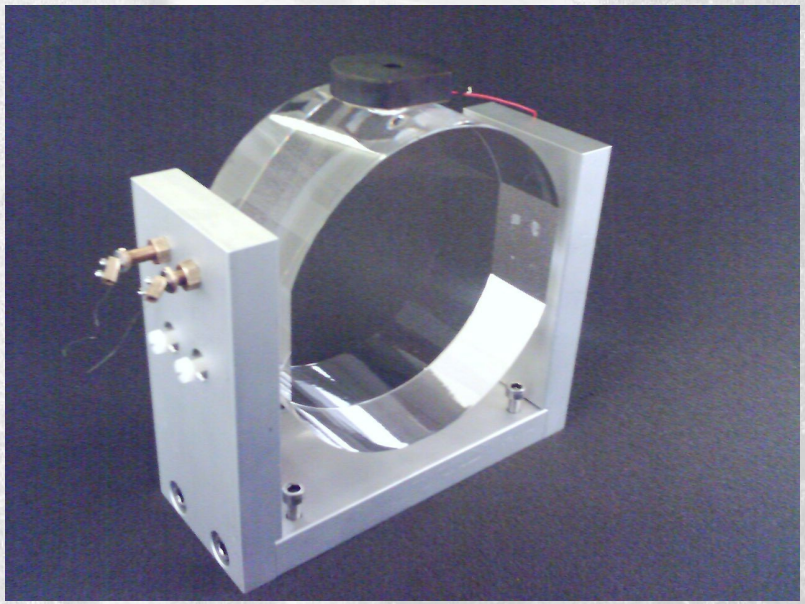
Scattered Light Reduction



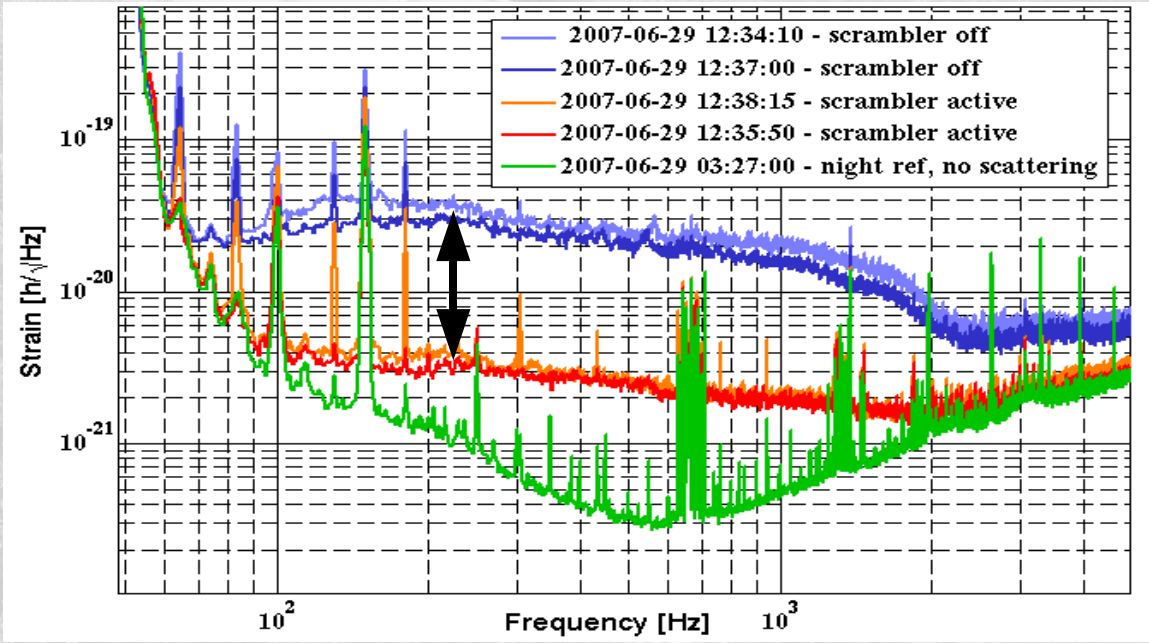
Acousto-Optic Phase Shifter...

...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

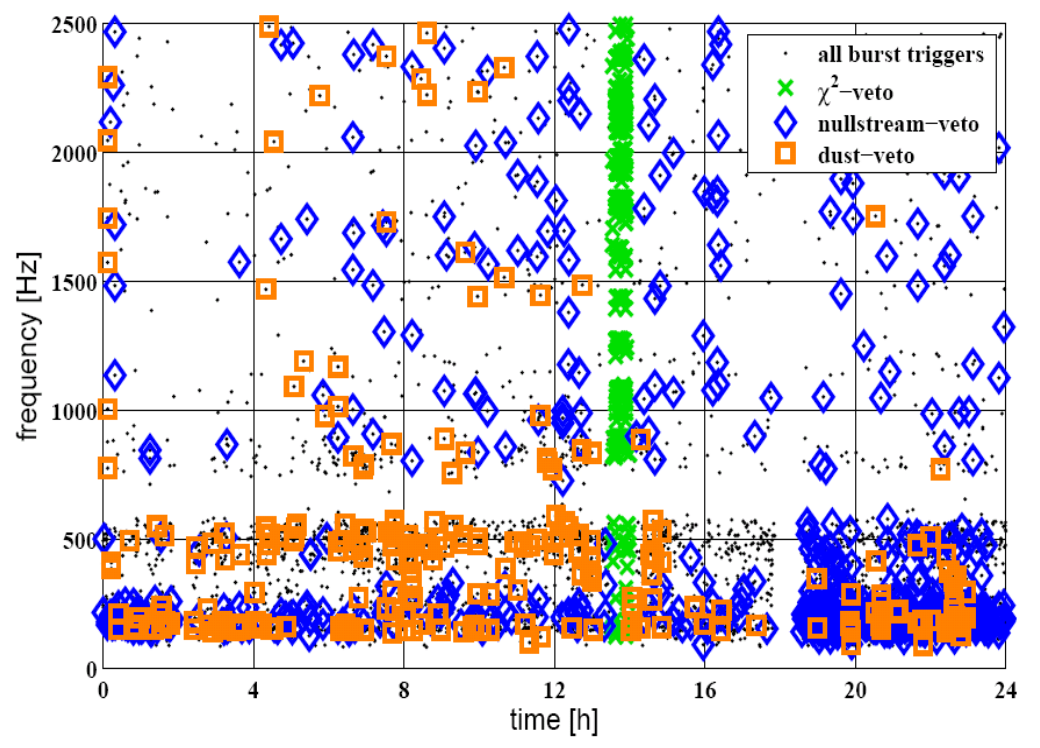


Infrastructure Work

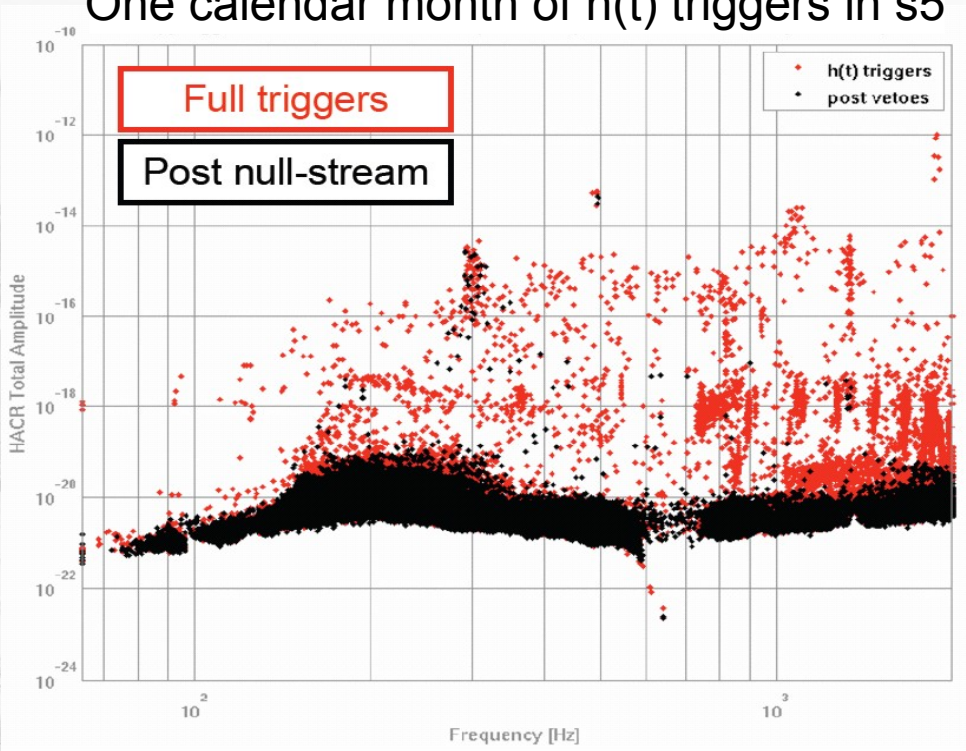
- New HV feedthroughs for electrostatic drives (old ones developed corrosion and tracking)
- Cleanroom: particle reduction by additional HEPA filters in main airconditioning stream
- Debugging of mains power routing done.
  Work ongoing on balancing of currents
- All intended to reduce the glitch rate and increase up time

We are ready for a long data run

Glitches and Vetoes



One calendar month of h(t) triggers in s5



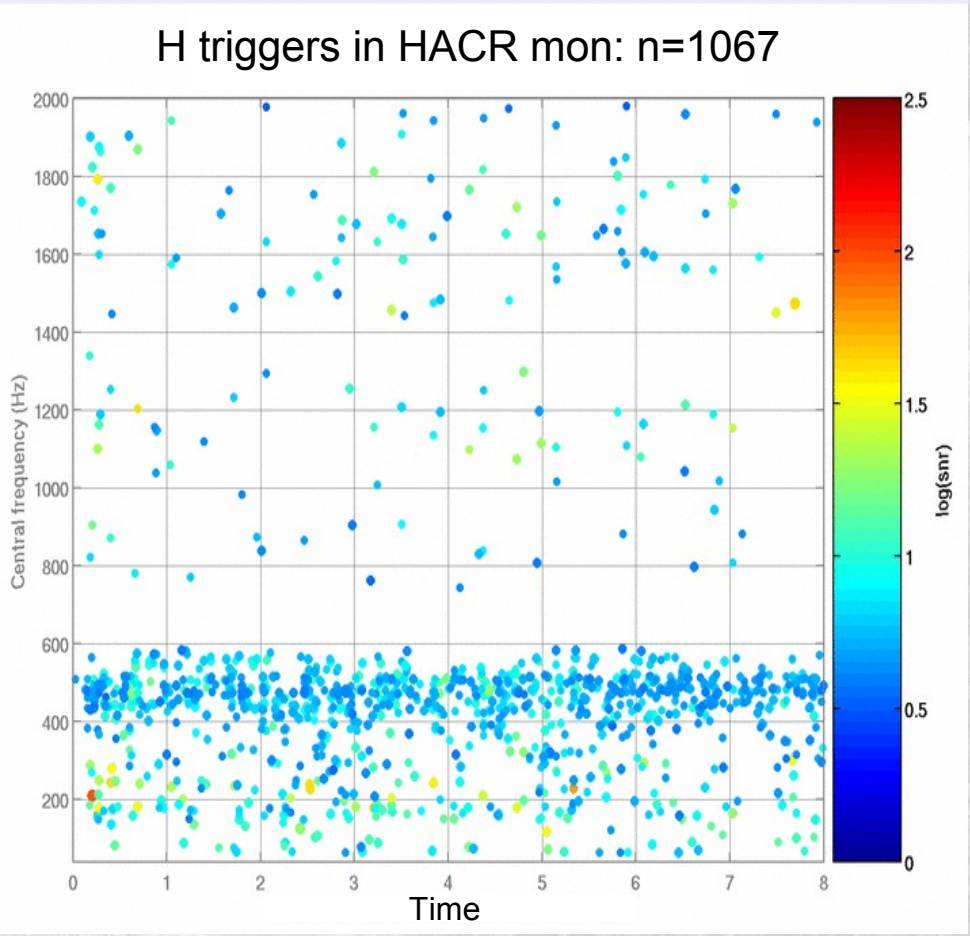
- Nullstream veto
- Noise projection vetos

Chi² veto

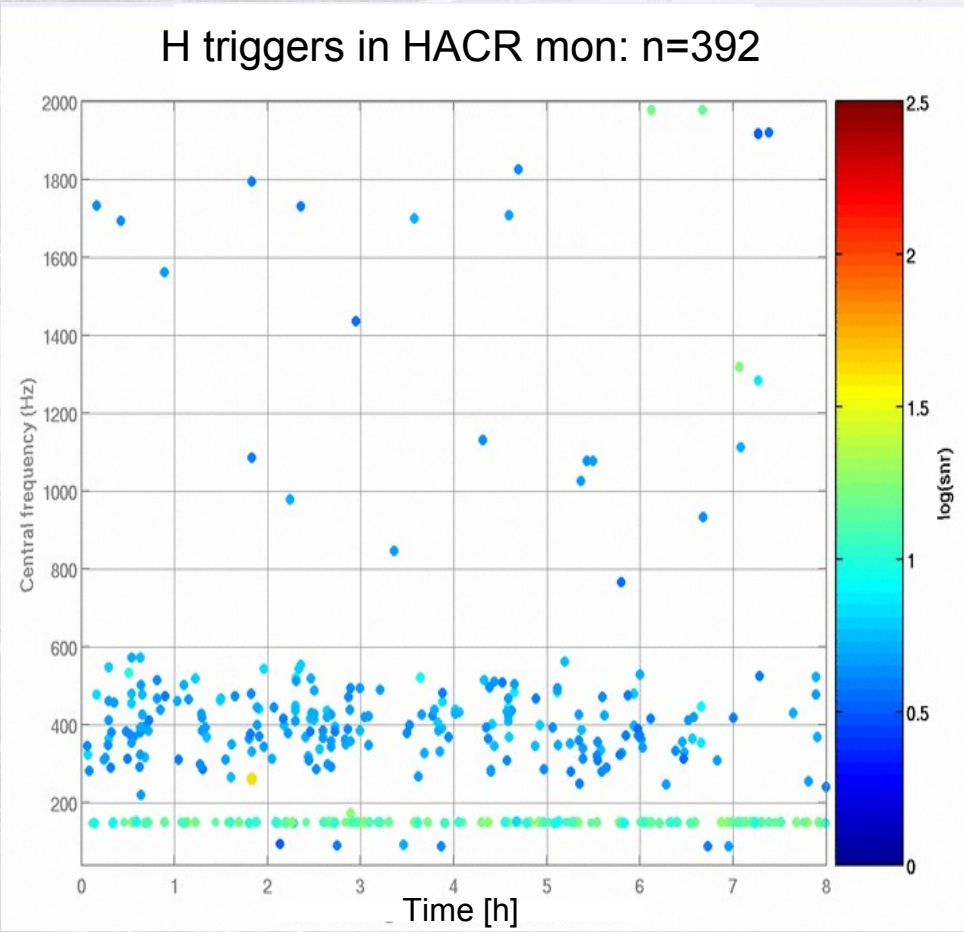
Statistical vetos

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.



Typical s5 in 2006



End of June 2007

DC readout - exploration

- 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 gain optical filter for LO !
  - Output mode-cleaner: Alignment to power coupling, scattering

DC-Readout without OMC

IDEA:

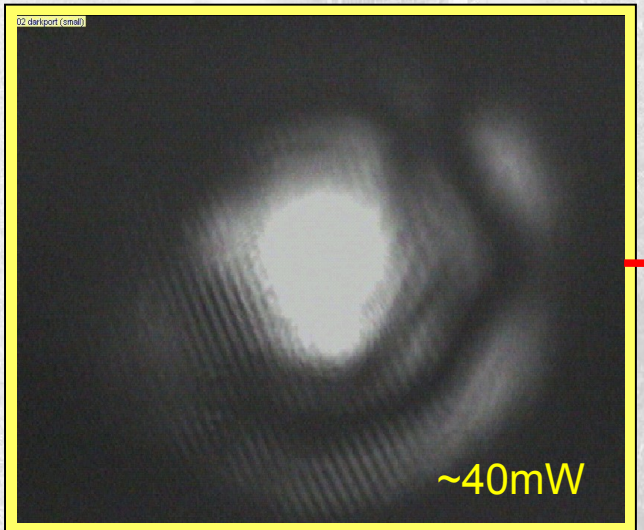
Turning down the RF-modulation *(factor 10 is possible in lock)*

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

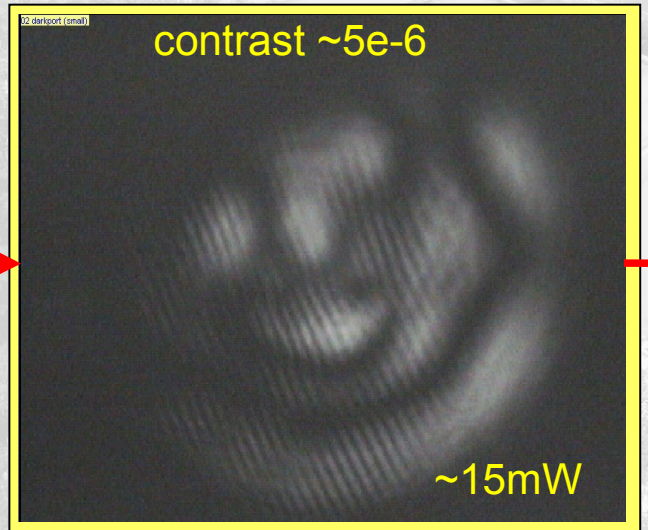
Dark port then dominated by carrier light

EXPERIMENT in GEO600:

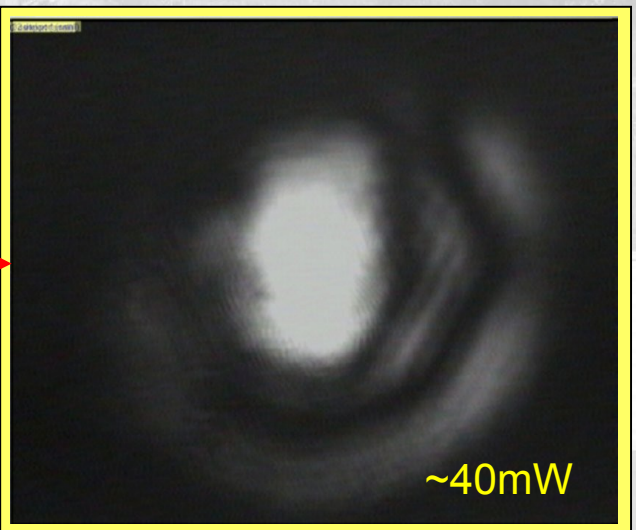
Lock to dark port power



Nominal heterodyne



Heterodyne with only 10% modulation



Offset to dark fringe (~ 50pm)

Results from first Experiments with DC-readout

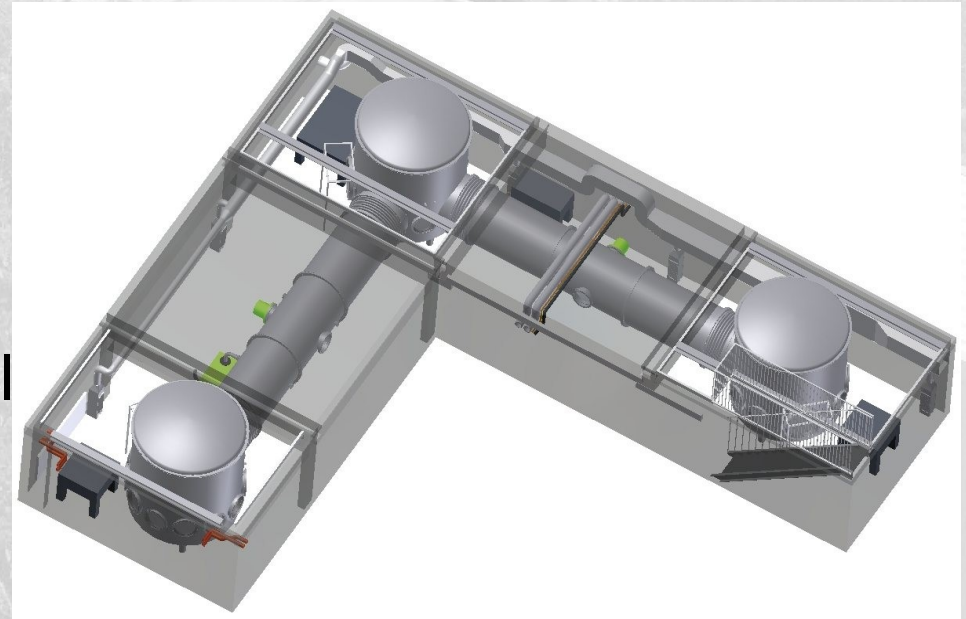
It works !

- Slightly better (10-20%) sensitivity than heterodyne at high frequencies (> ~2kHz)
- Not much worse sensitivity at mid frequencies
- Power noise coupling is not terrible !
  - the intracavity power noise was not known above ~200Hz, as the sensor was shot noise limited

But there is still excess noise,
and even additional excess noise,
so no science benefit yet

GEO-HF and the AEI Prototype

- GEO-HF is the frame for sequential upgrades of the GEO600 detector
- Topics: high-power, squeezing, DC readout, additional/new digital controls, new mirrors to lower thermal noise (when available), ...
- A new prototype is being built at AEI-Hannover serving as a platform for different types of experiments, including testing of GEO-HF upgrades
- vacuum system designed
- 3m ID tanks
- isolation tables conceptual



Summary

- We have ~1 year of s5 science data
- Noise and glitch reduction, infrastructure work, detector characterization work etc. done and ongoing
- Still pushing on mid-band 'mystery' noise