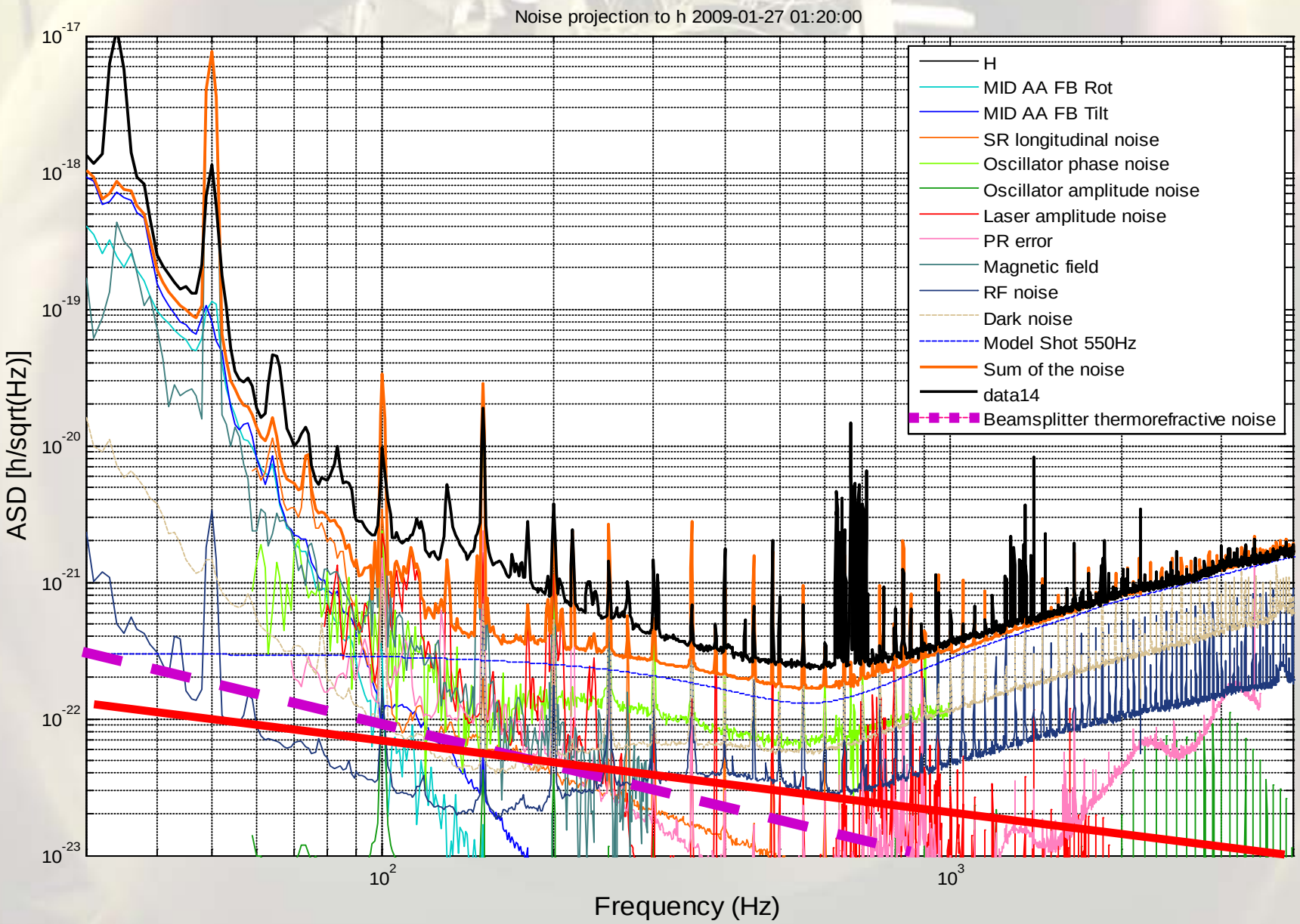
The Transition to GEO HF

Harald Lück
for the LSC

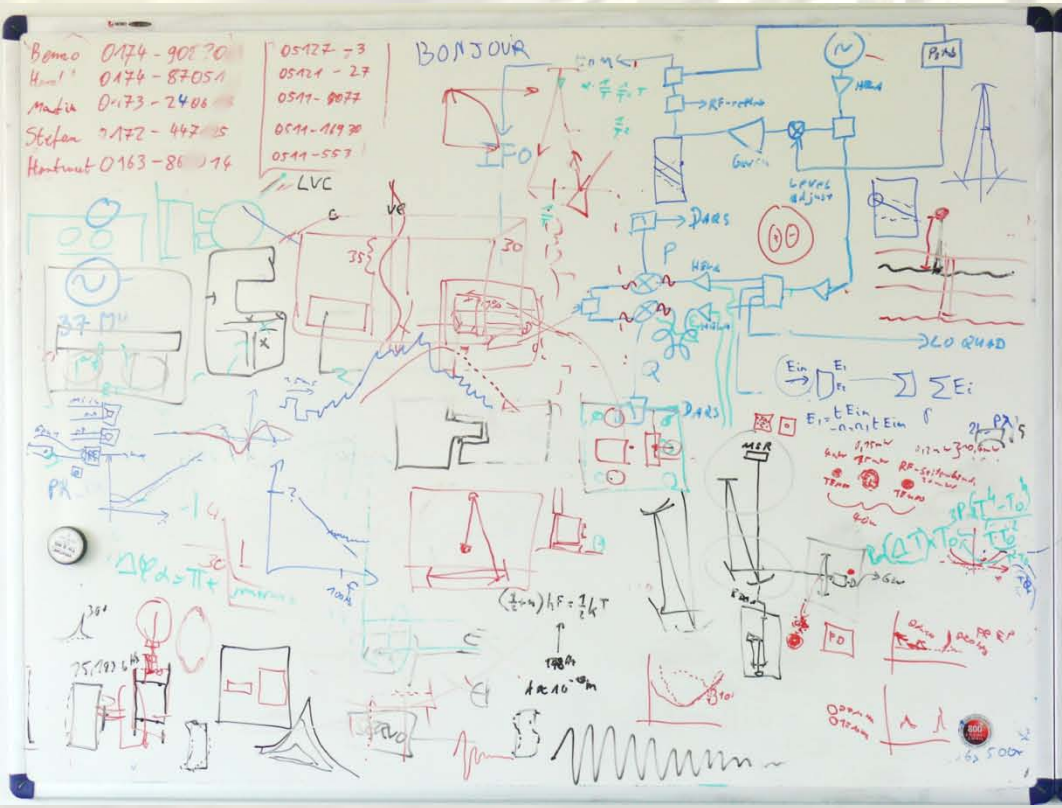
8. Amaldi Conference
New York, 23. June 2009
LIGO-G0900523

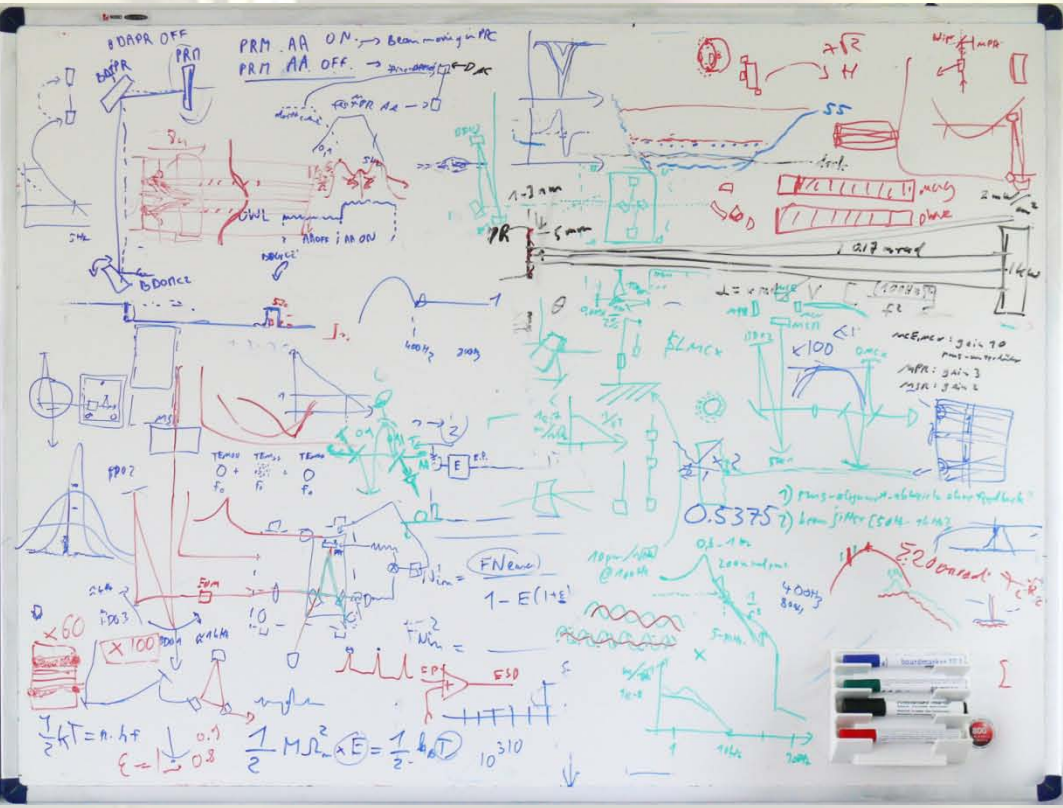
The limits


Noise projection to h 2009-01-27 01:20:00
ASD [h/sqrt(Hz)]
Frequency (Hz)
H
MID AA FB Rot
MID AA FB Tilt
SR longitudinal noise
Oscillator phase noise
Oscillator amplitude noise
Laser amplitude noise
PR error
Magnetic field
RF noise
Dark noise
Model Shot 550Hz
Sum of the noise
data14
Beamsplitter thermorefractive noise

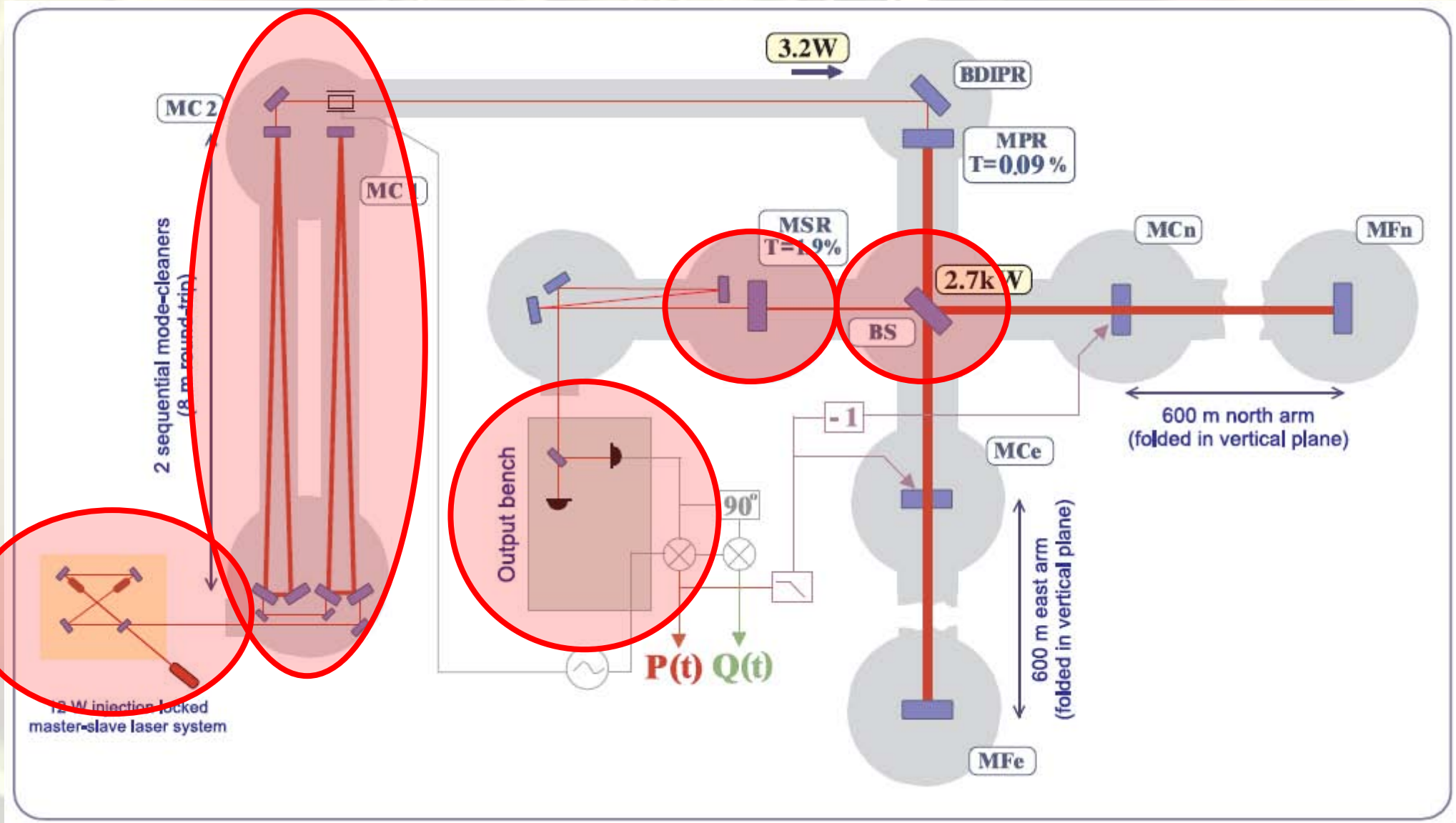
The Master Plan

Experimenter‘s Notation





The GEO600 Interferometer



Upgrade Plan A

2009

- DC readout
- Squeezing
- Tuned SR
- OMC
- Adv. Ligo CDS system for SQZ, OMC, GEOcontrols

2010

- Increase Power (8x, Laser 5x, 1.5x IMC throughput, Shadow-sensors)
- Thermal Compensation
- Increase SR Bandwidth

Upgrade Plan B

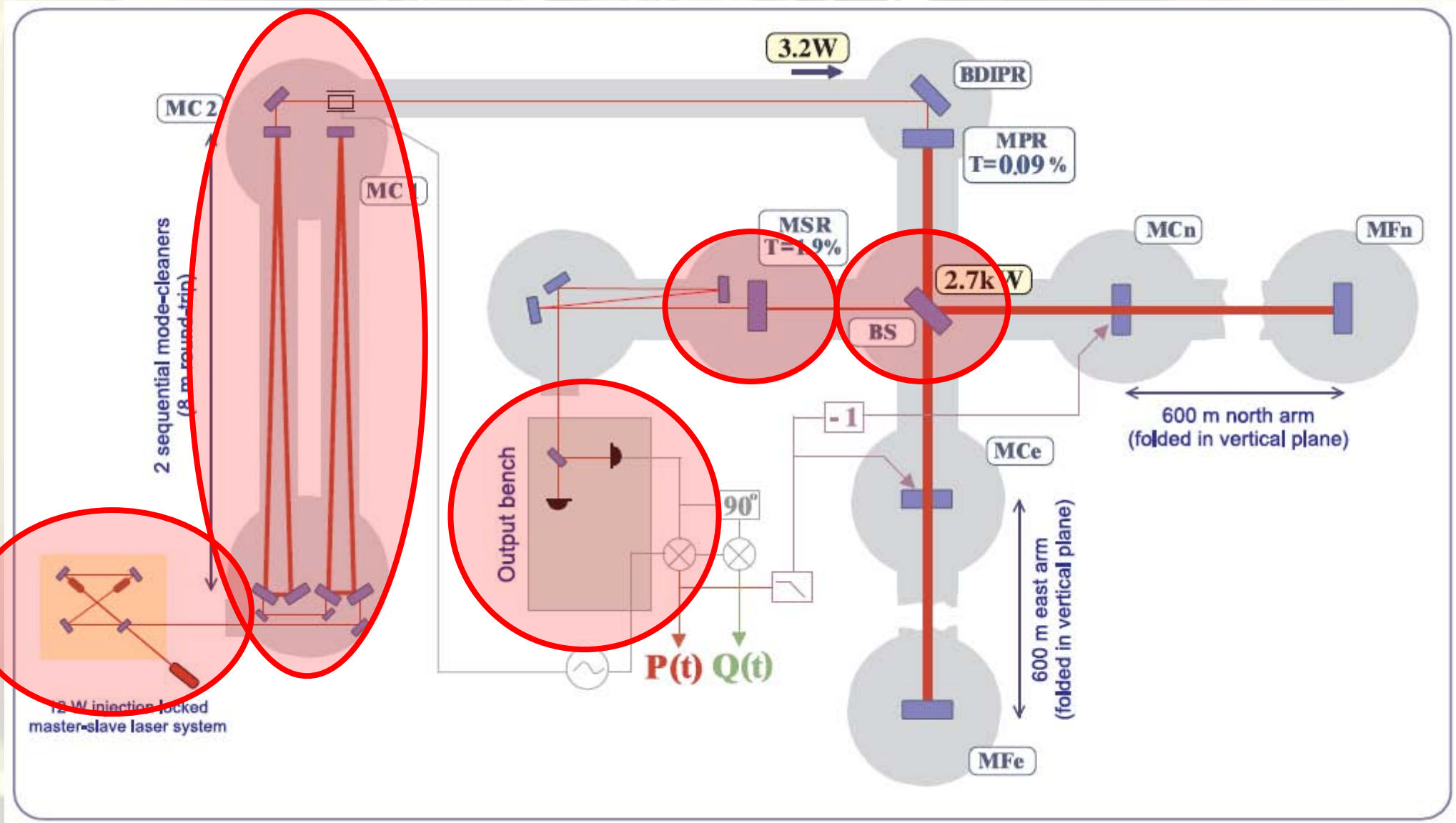
2009

- DC readout
- Squeezing
- Tuned SR
- OMC
- Adv. Ligo CDS system for SQZ, OMC, GEOcontrols

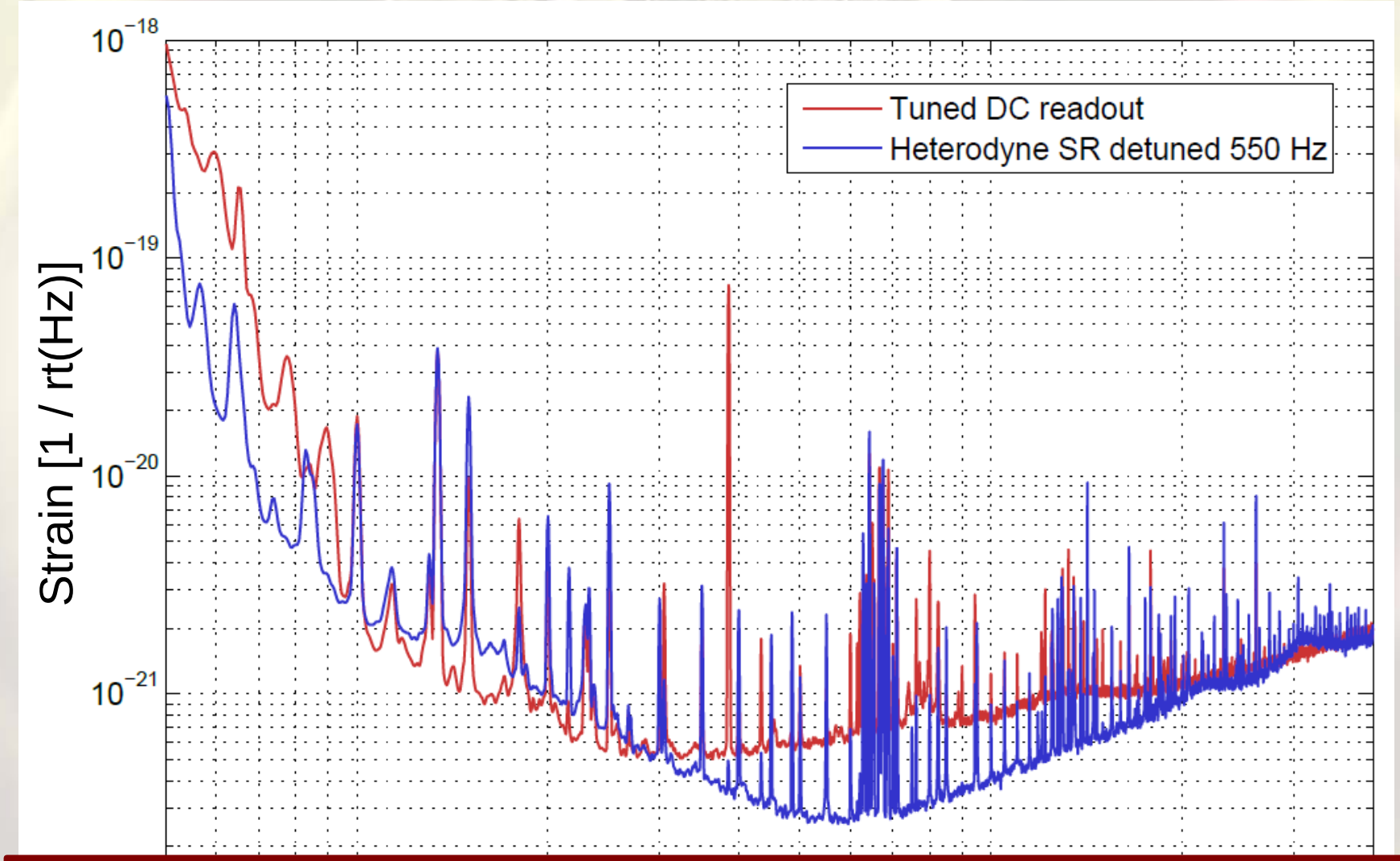
2010

- **Increase SR Bandwidth**
- Increase Power (8x, Laser 5x, 1.5x IMC throughput, Shadow-sensors)
- Thermal Compensation

The GEO600 Interferometer

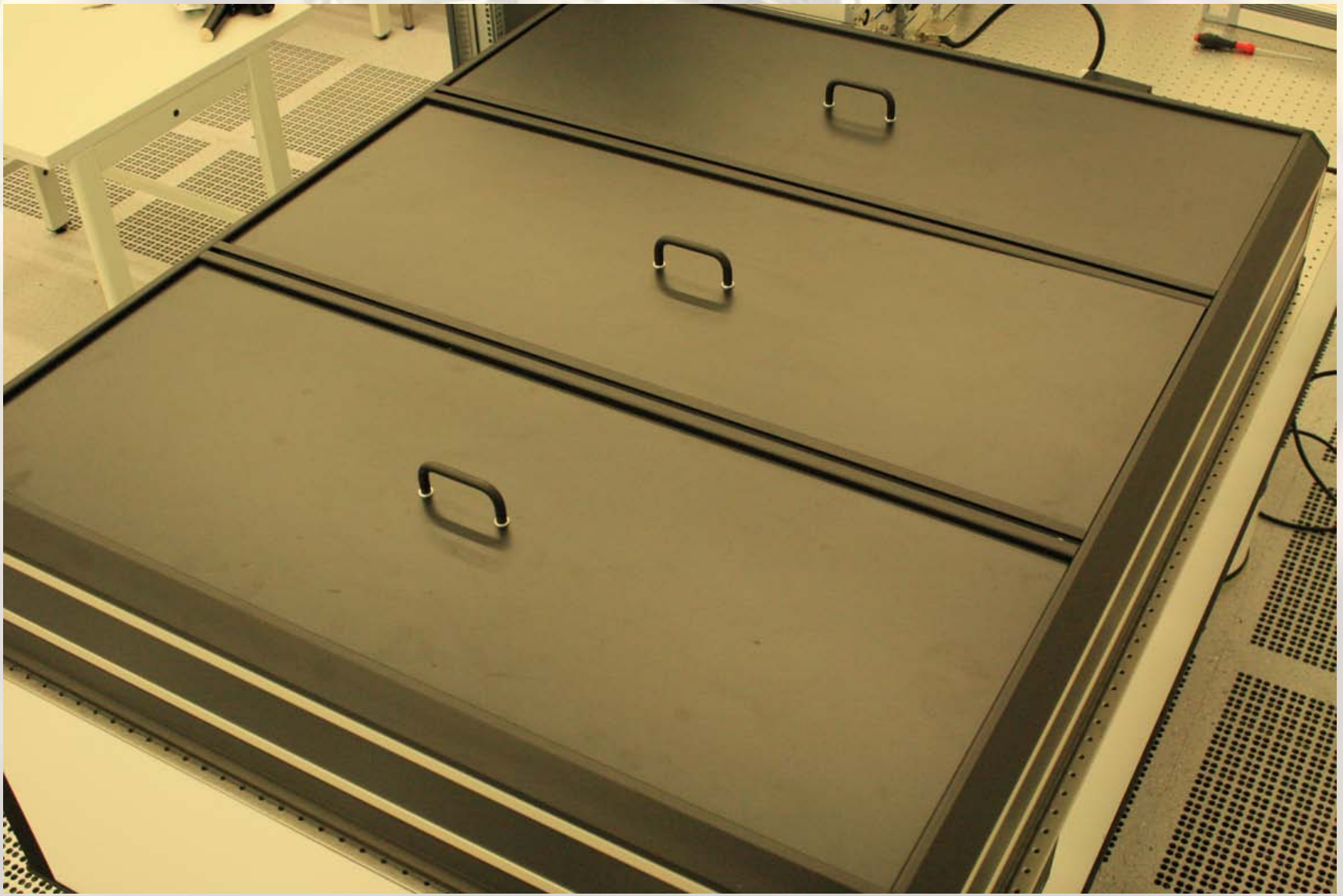


Recent DC-Readout vs. Heterodyne

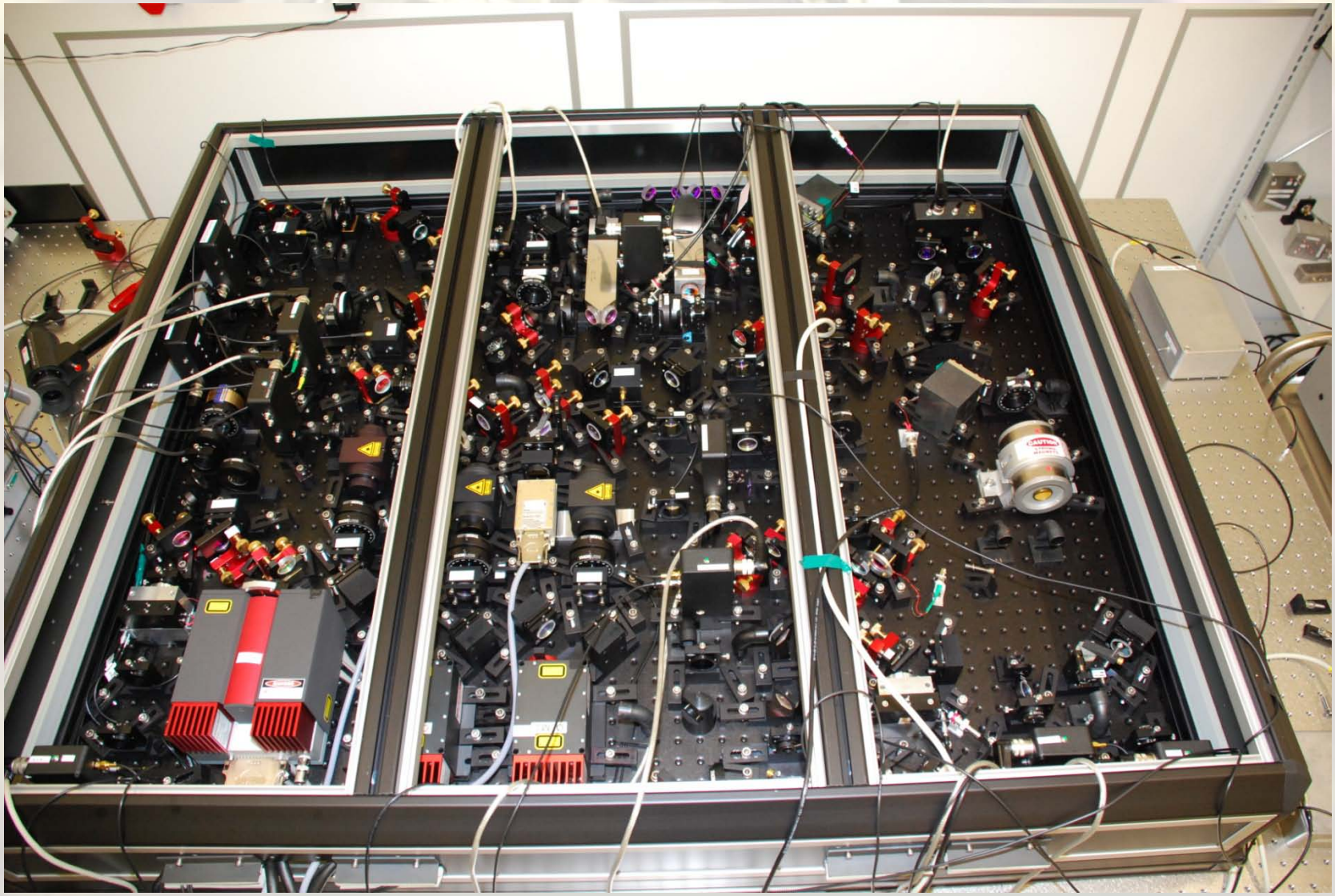


Poster available:
Jerome Degallaix: ***Commissioning of the tuned DC readout at GEO600***

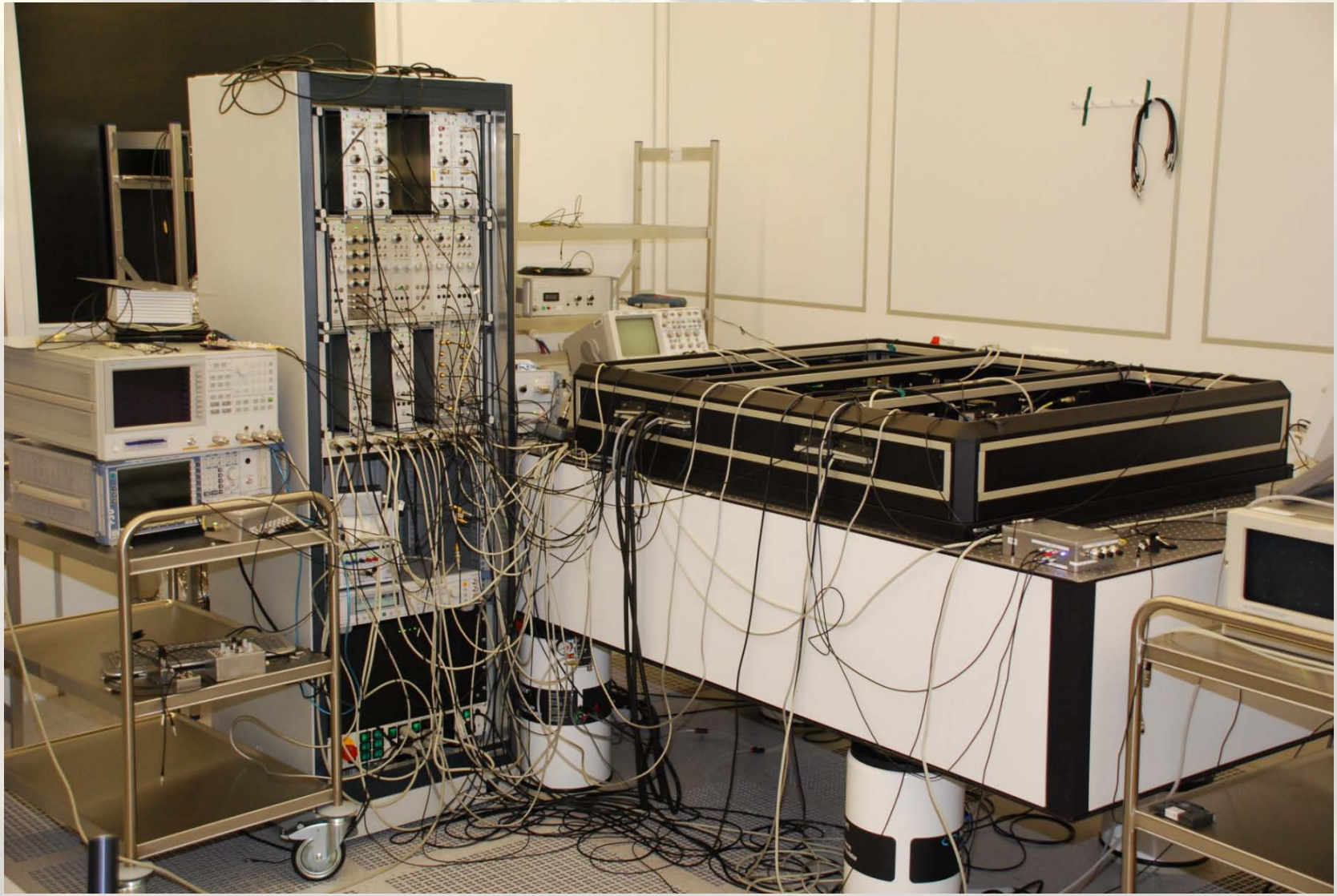
The Squeezing Black Box



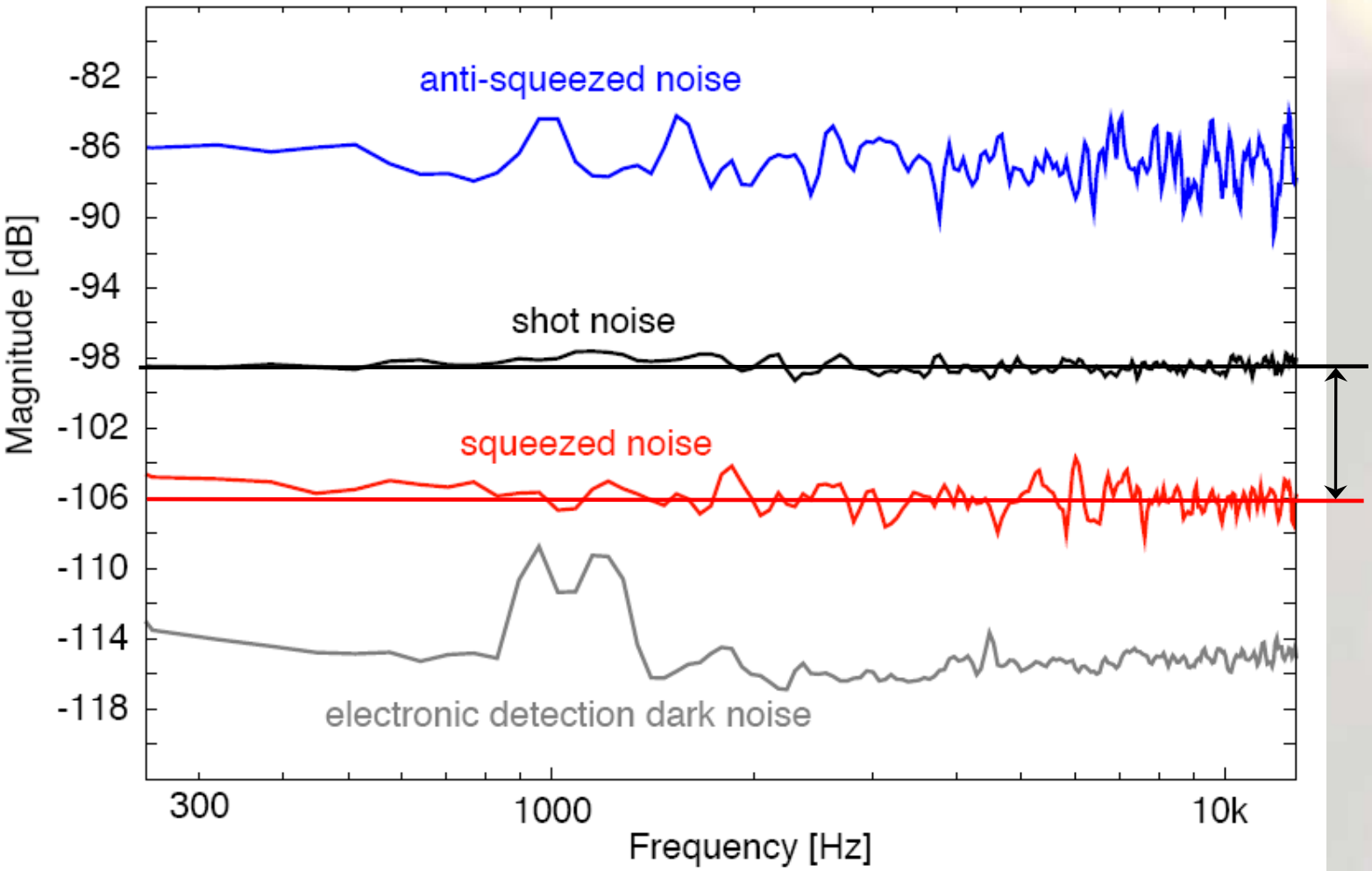
... inside



+ Control Electronics



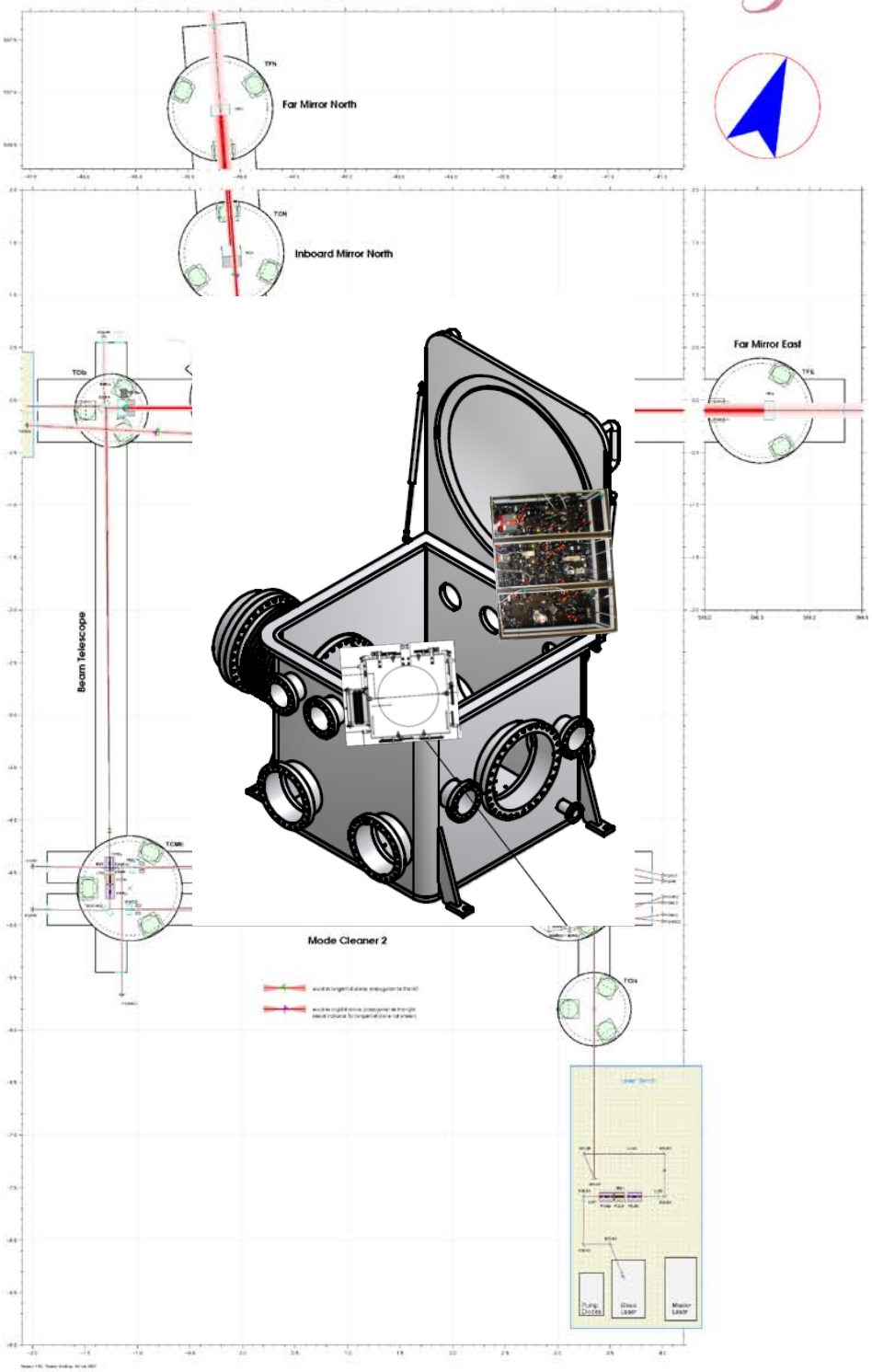
Initial Performance



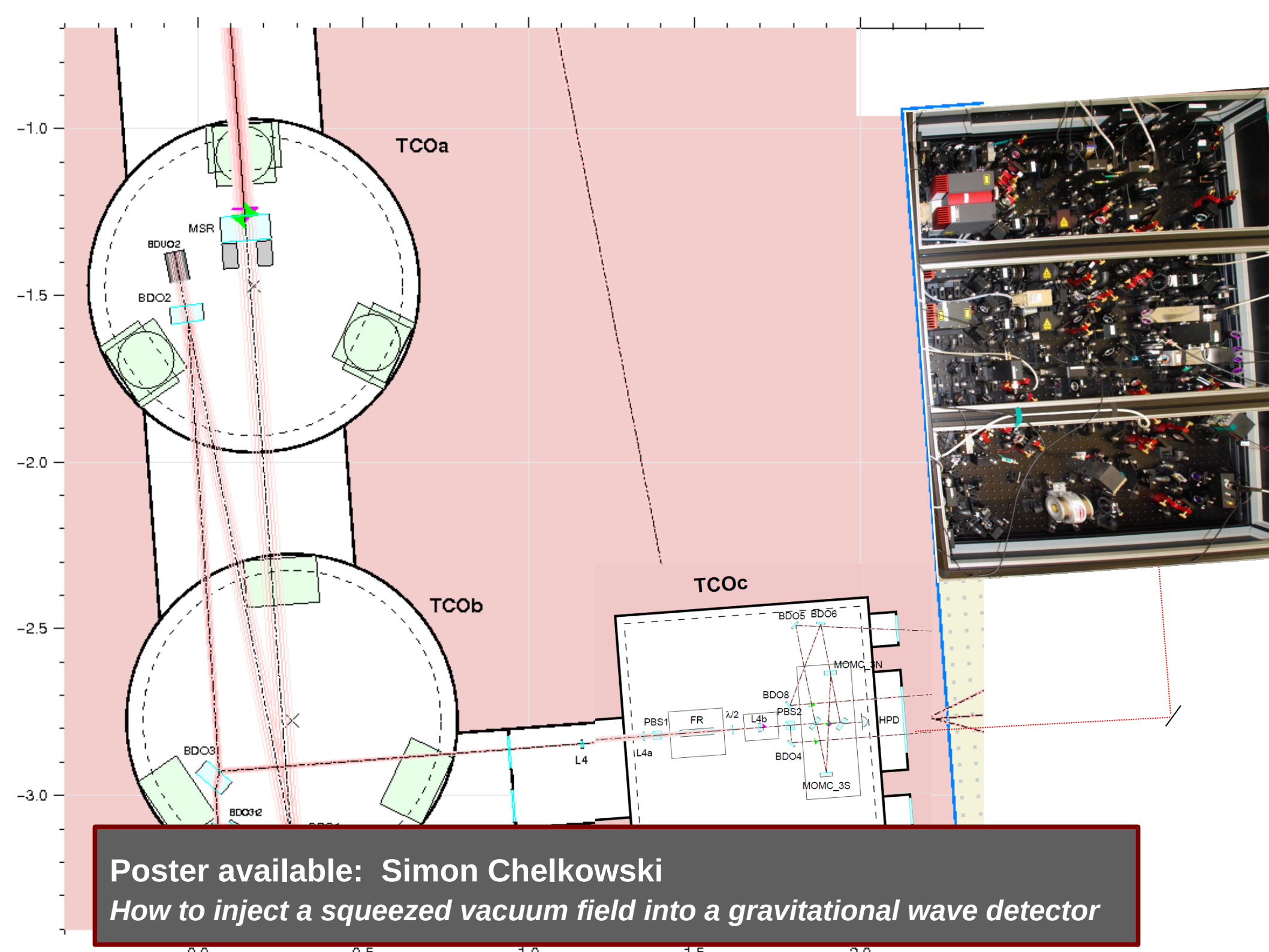
Henning Vahlbruch (Fri, 11:20):
Squeezed light for Gravitational Wave Astronomy

Extending the central building

GEO 600 optical layout



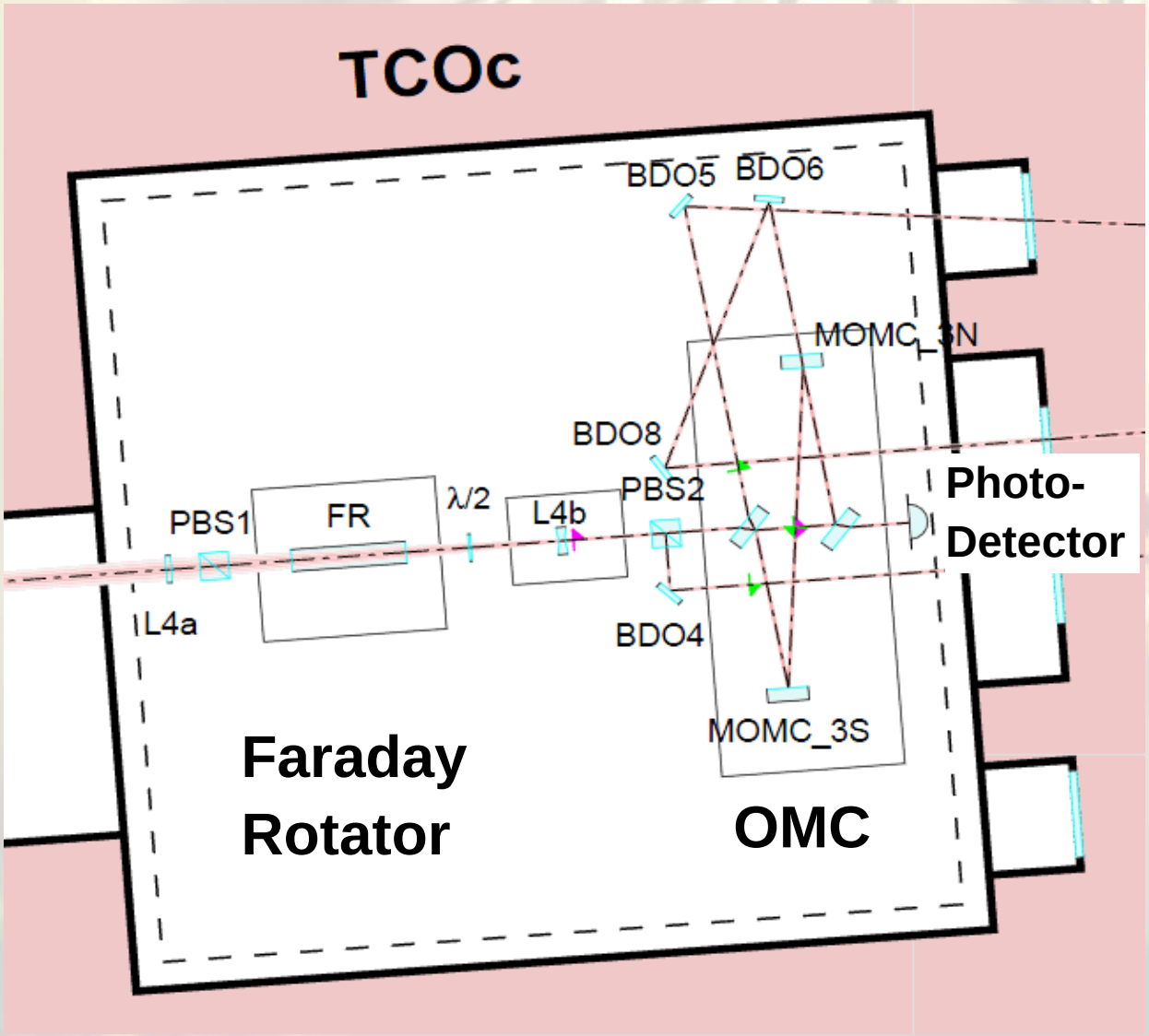
Detection Bench Changes



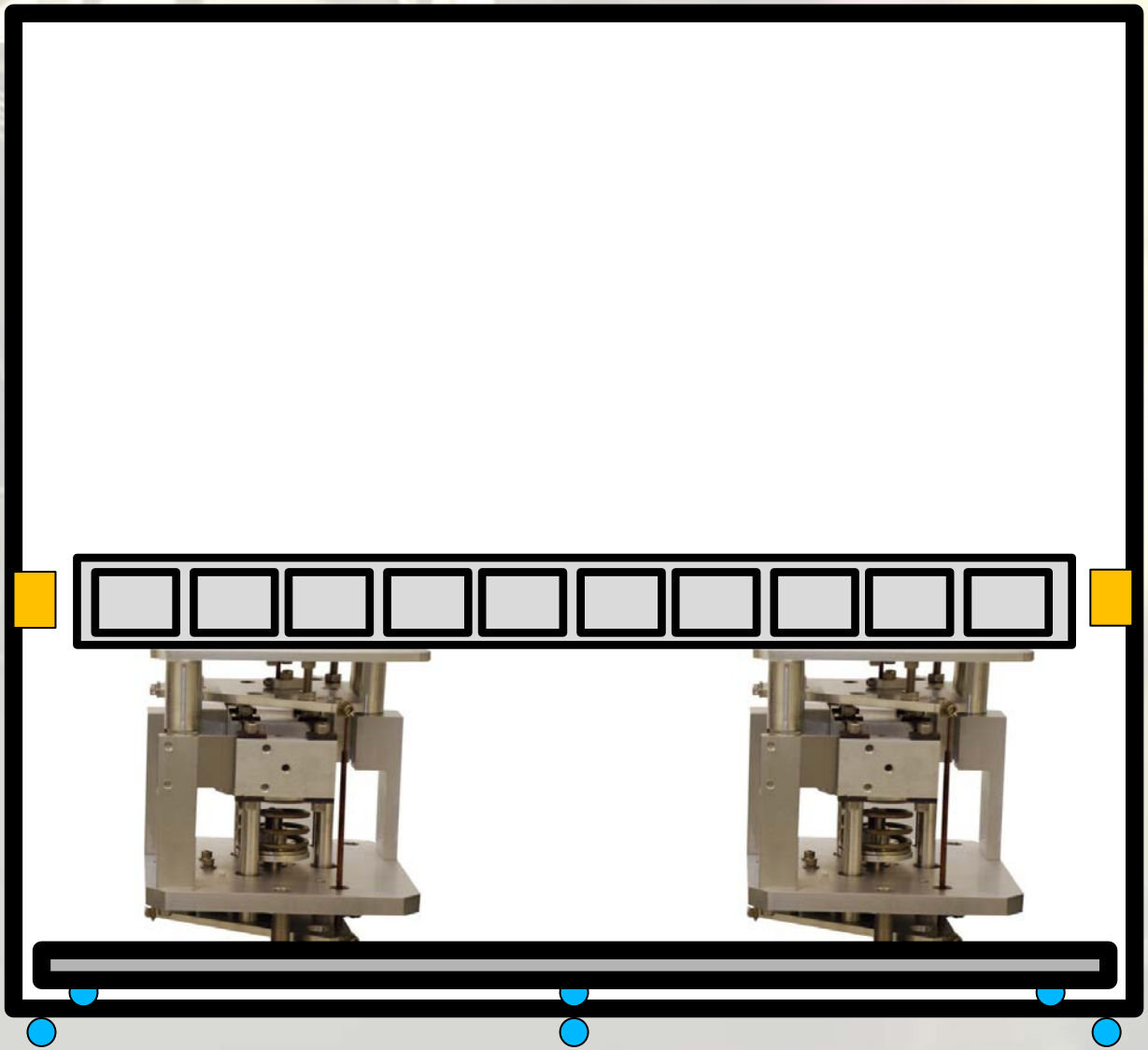
Poster available: Simon Chelkowski

How to inject a squeezed vacuum field into a gravitational wave detector

New Vacuum Chamber



Vibration Isolation Inside TCOc

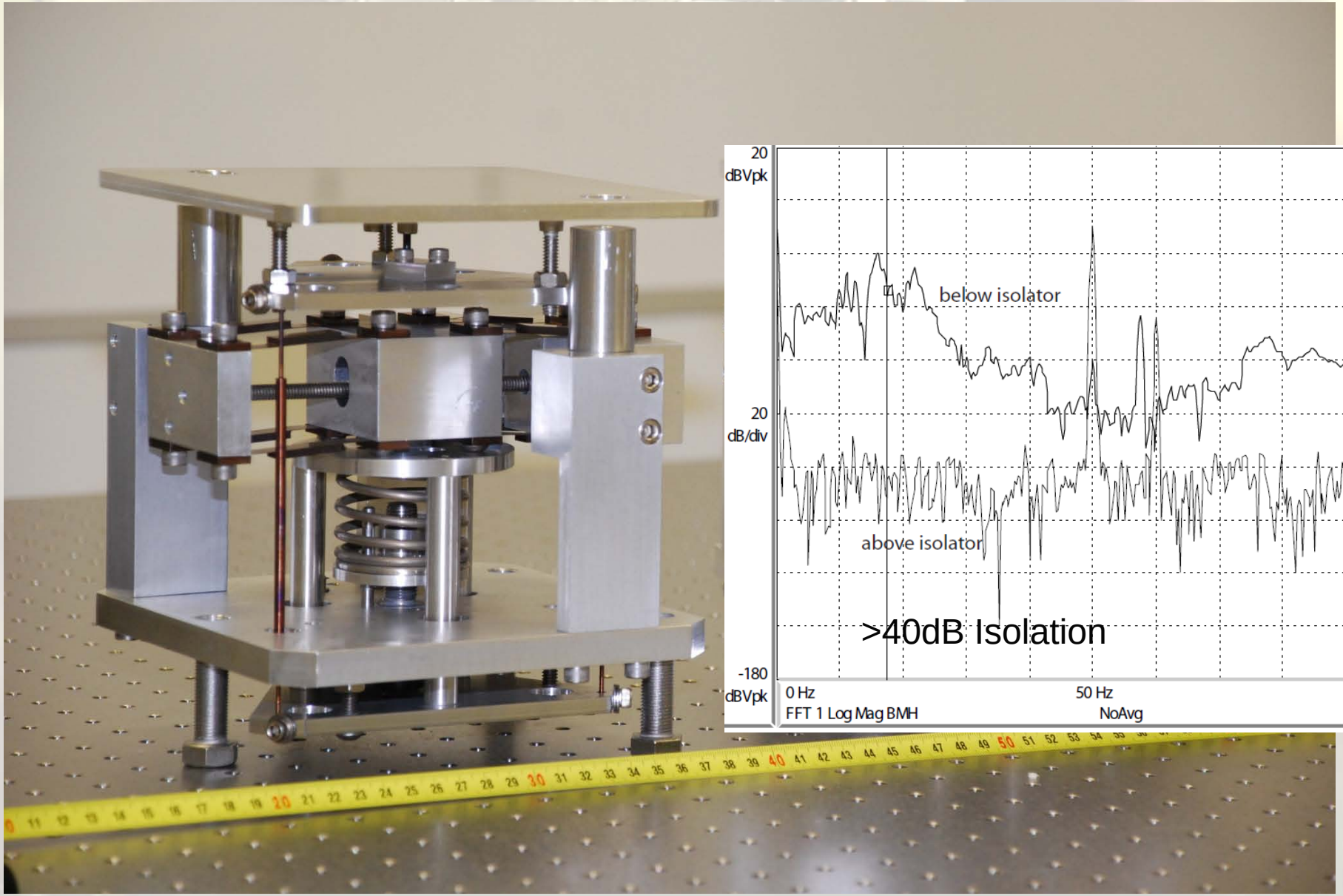


Minus-K Isolators

Stainless Steel plate ~80kg

Viton

3D Seismic Isolators: ‚Minus-K‘



Inside TCOc

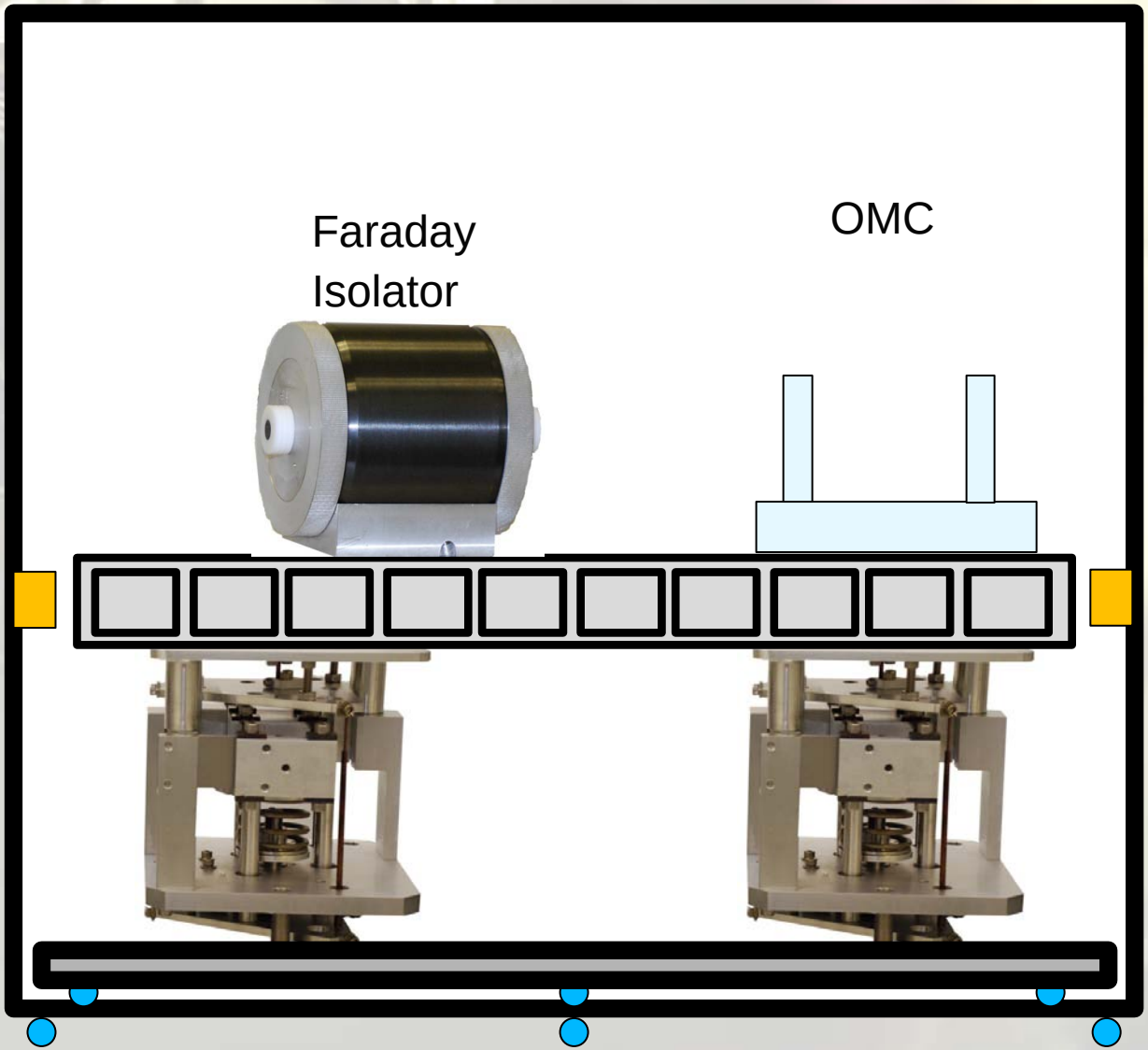
Payload + breadboard ~ 36kg

Payload

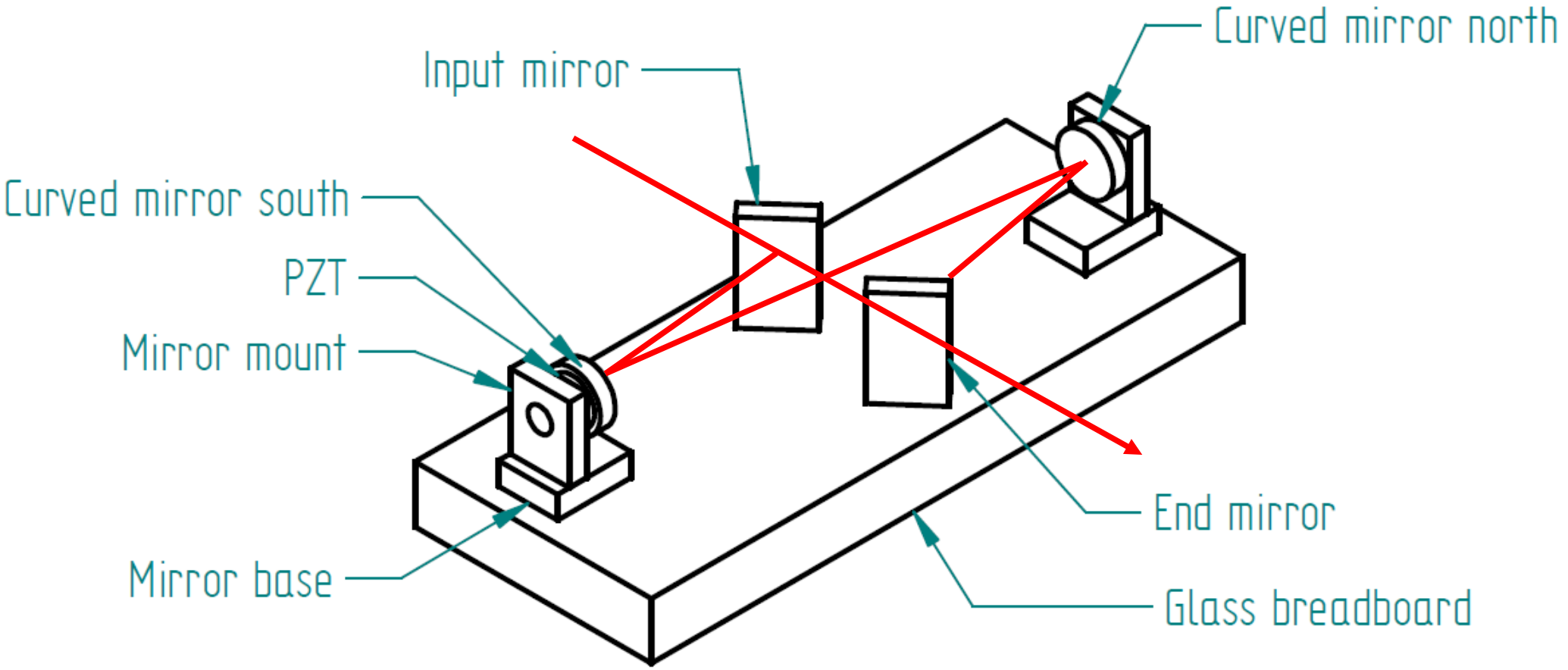
Aluminium breadboard +
Eddy current damping

Minus-K Isolators

Stainless Steel plate
Viton

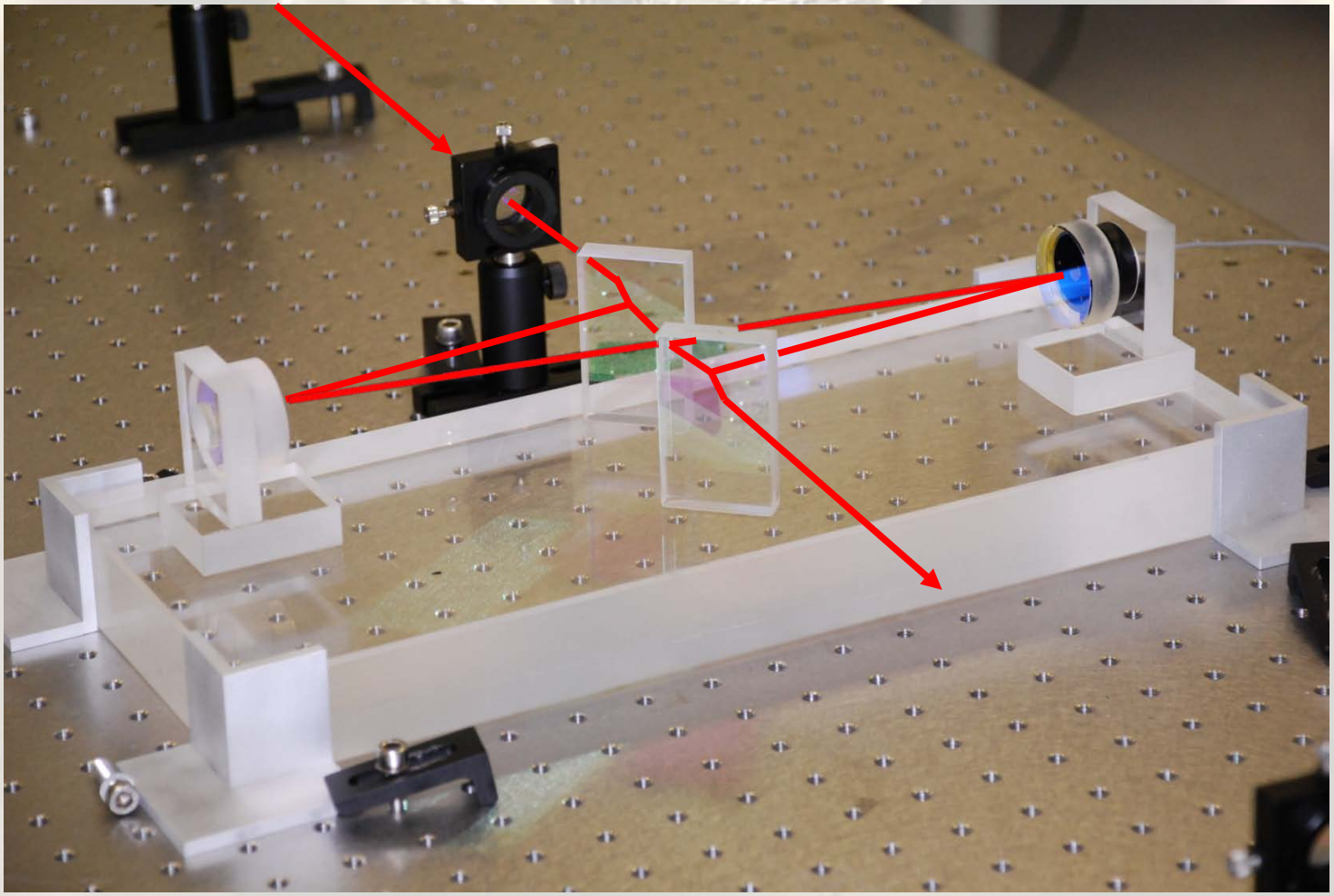


GEO - OMC



- Finesse 150
- Rejection of HOM and RF SBs power > 100

GEO - OMC



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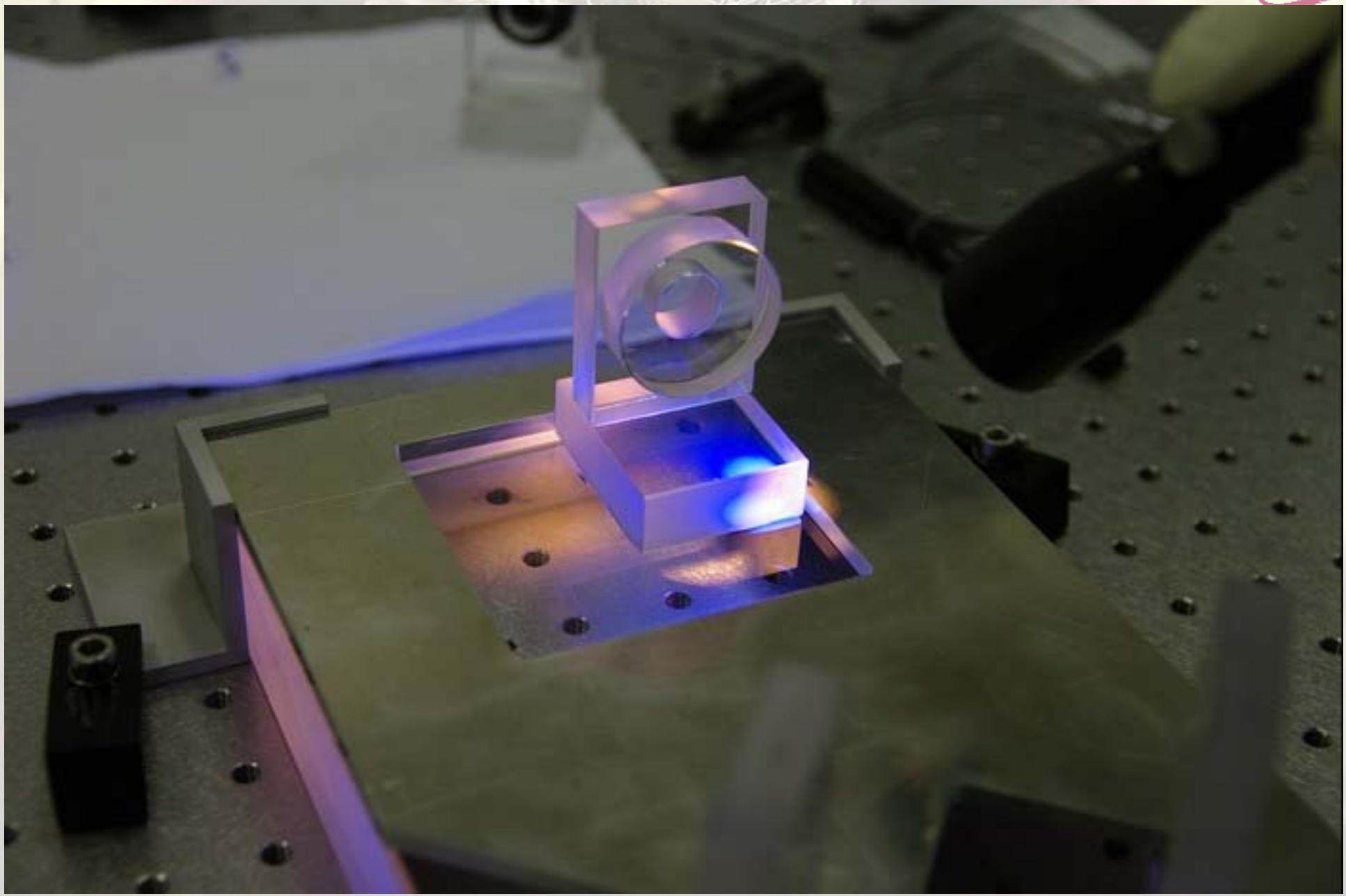
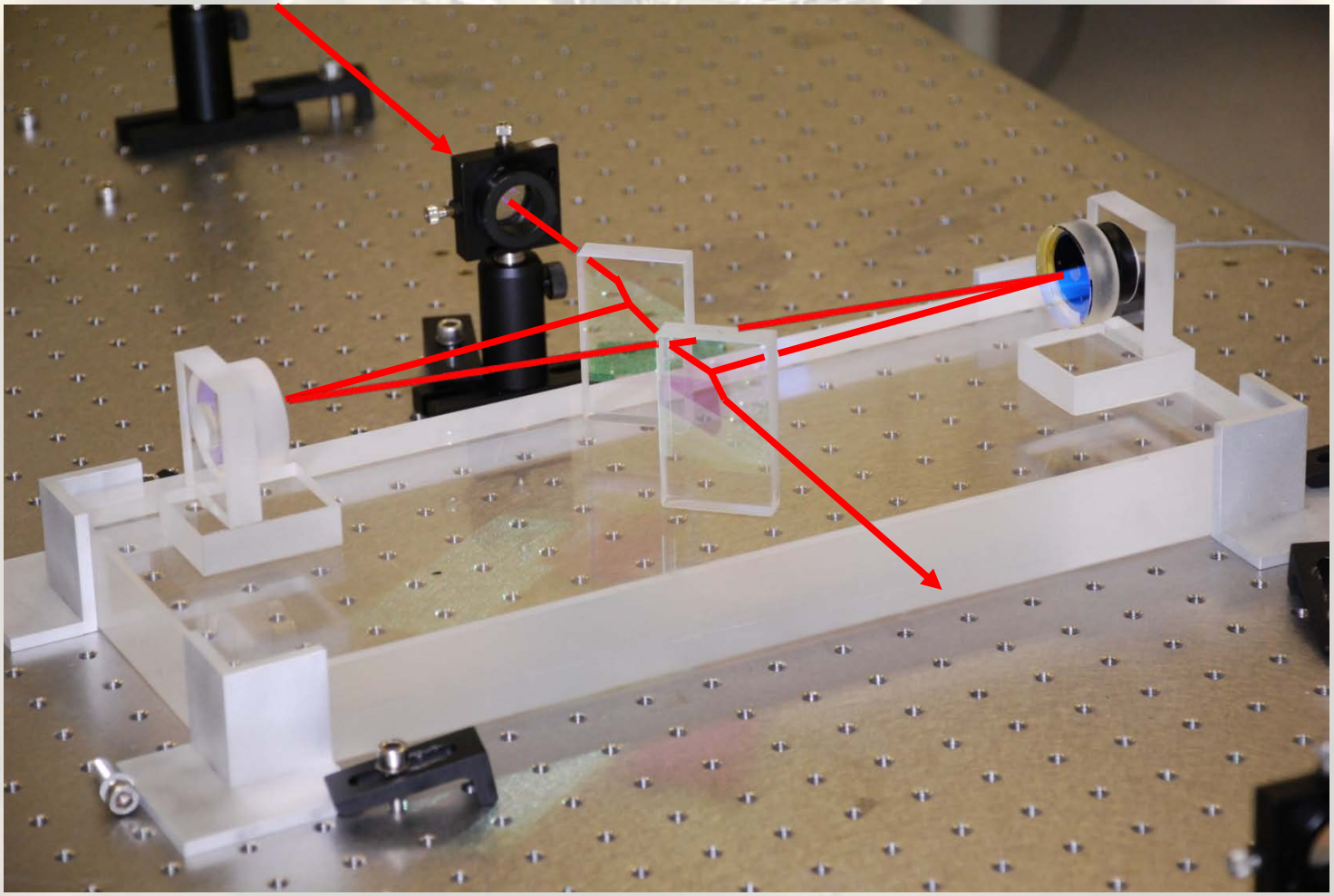


GEO - OMC



Poster available:
Mirko Prijatelj: ***Control and Automatic Alignment of the Output Mode Cleaner of GEO***
Jerome Degallaix: ***Commissioning of the tuned DC readout at GEO600***

Power increase

Decrease MC Finesse

- T= 0.1% -> T=0.8%

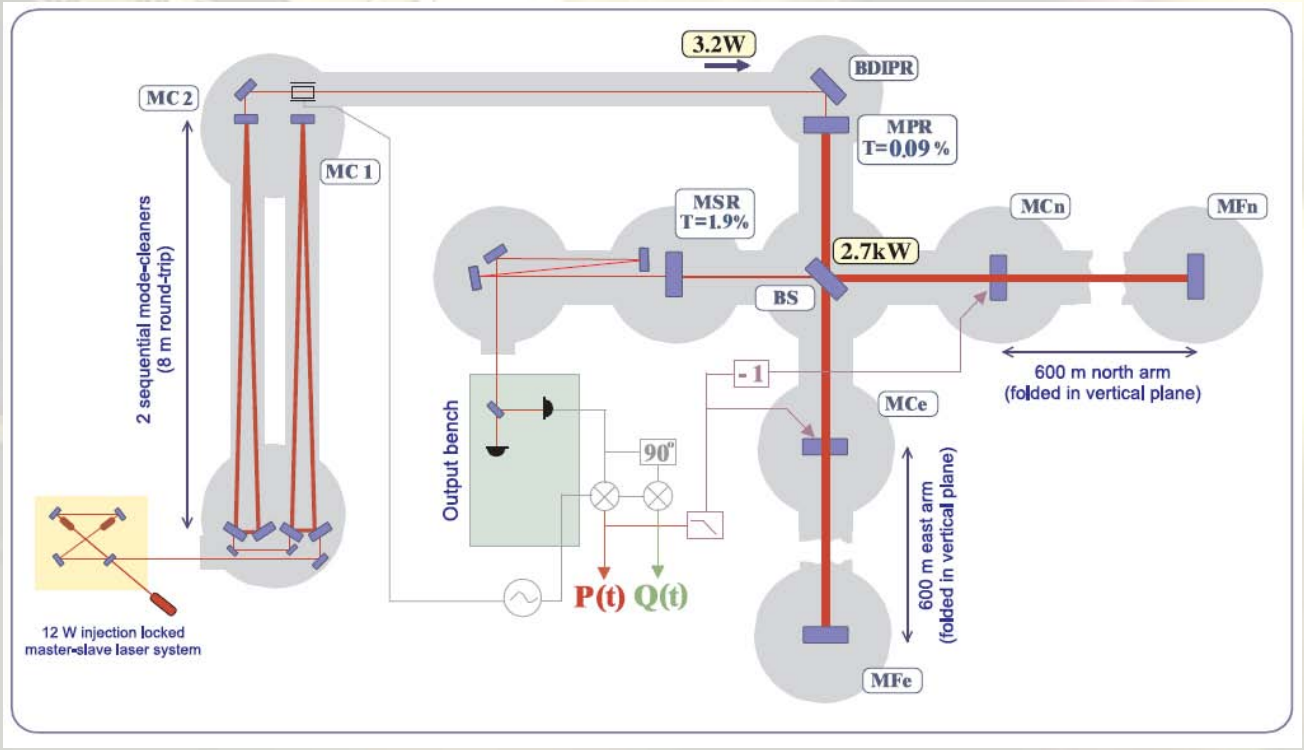
Increase Laser Power

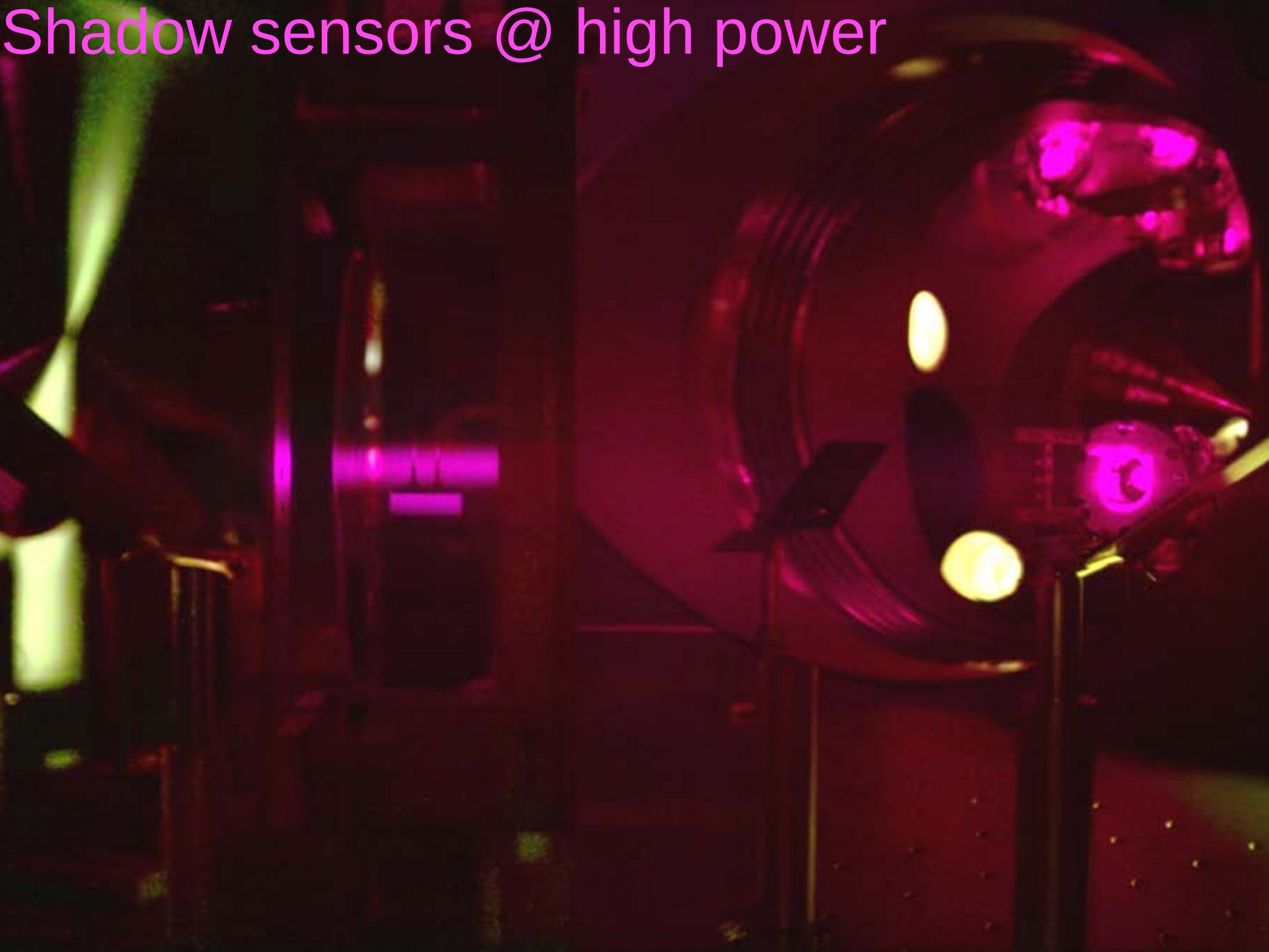
- P=6W -> P=35W

Increase Power into PRC by factor ~10

Shadow Sensor Read-out

DC -> AC

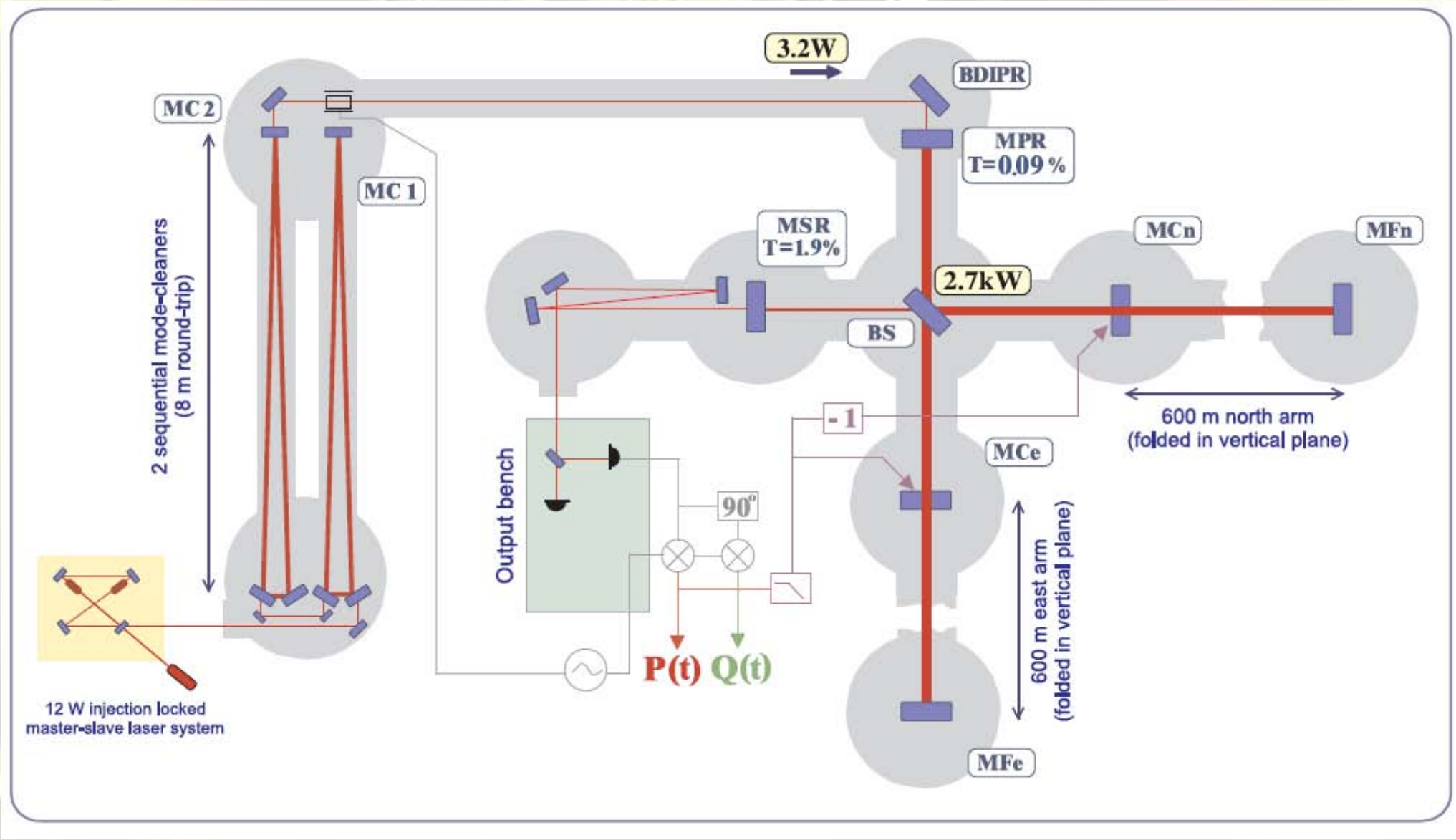


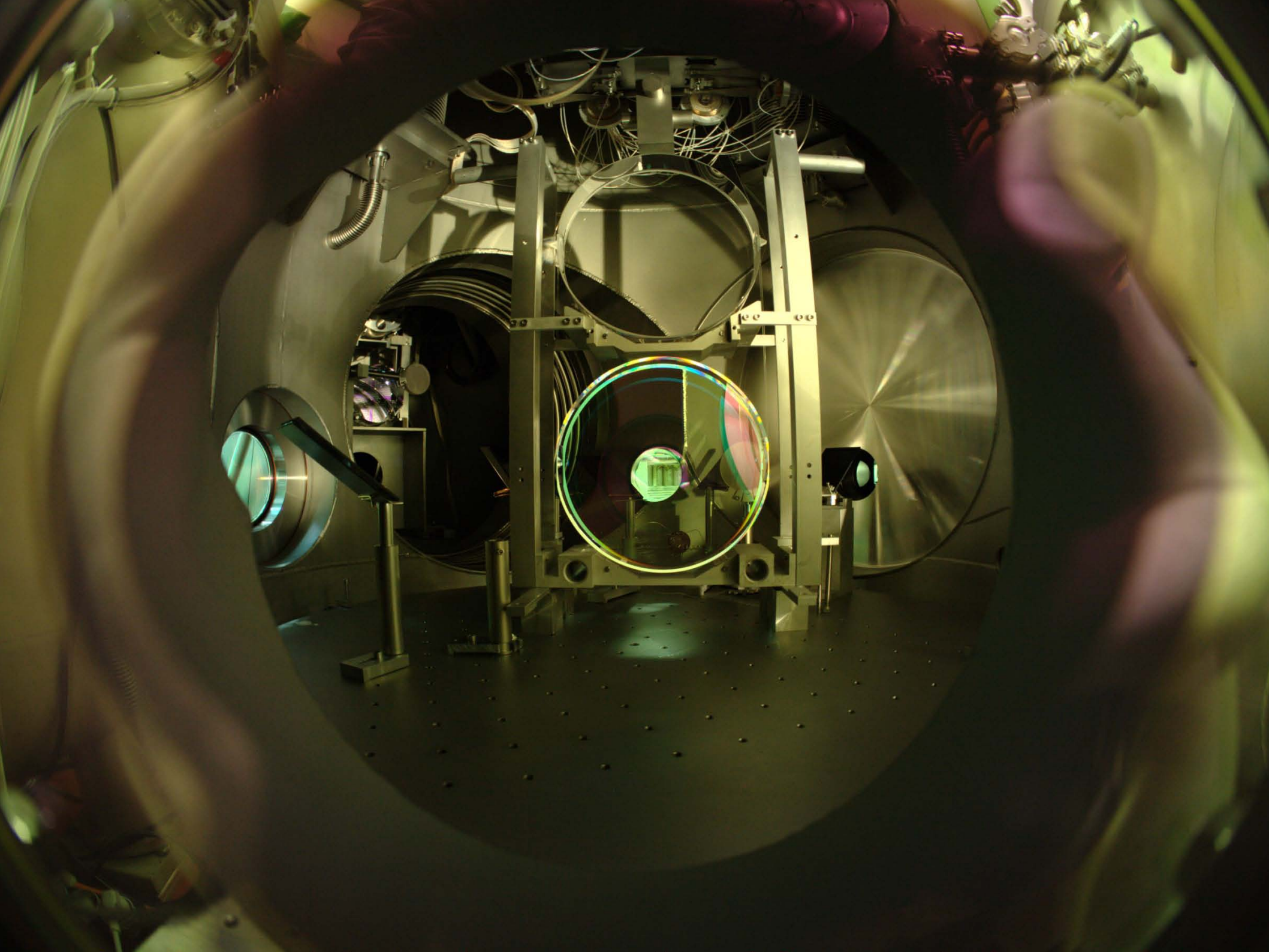

Shadow sensors @ high power

GEO Shadow Sensors

change to AC operation

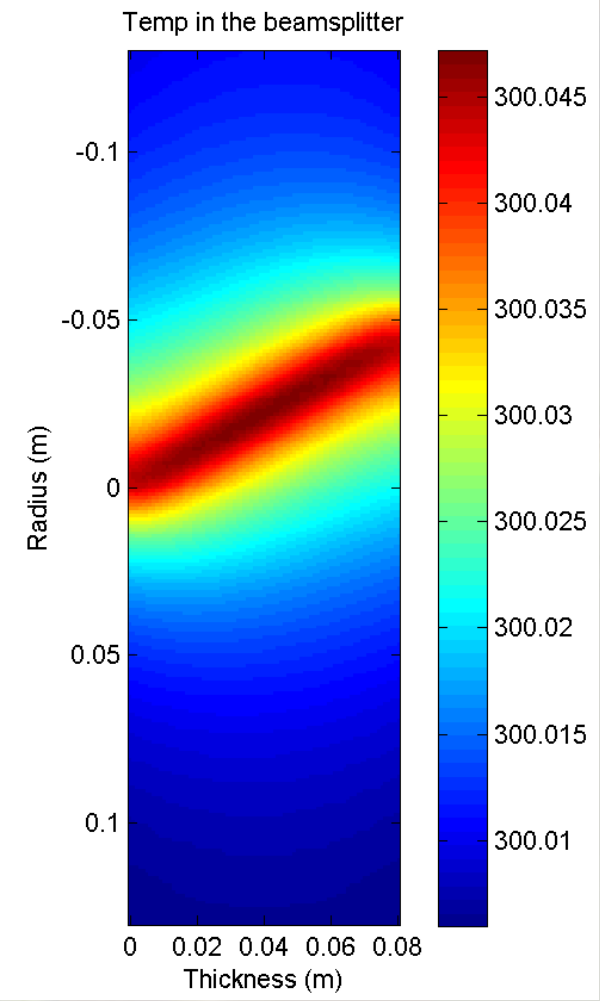
Thermal compensation





Thermal compensation

The Problem:



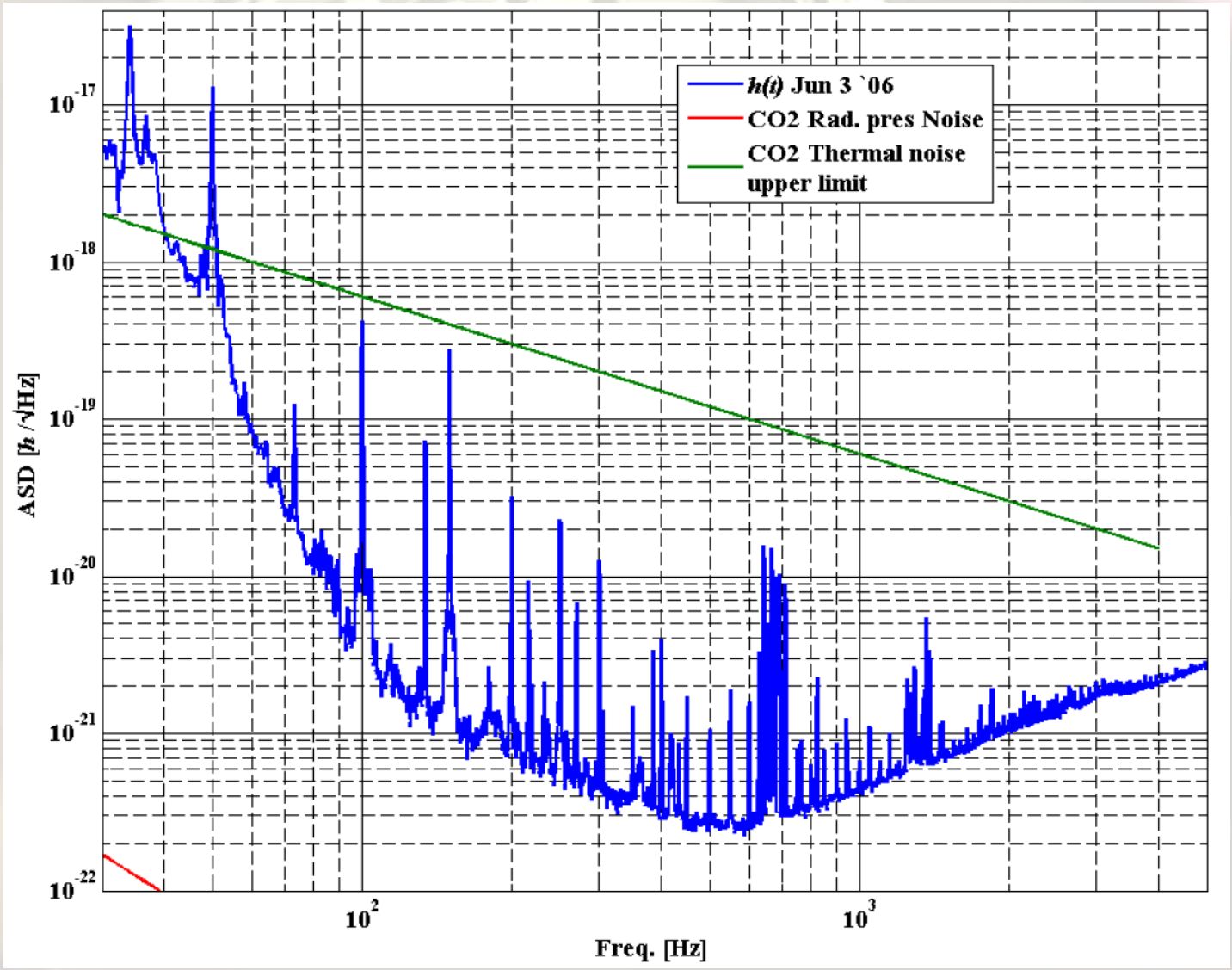
The Solution:

Heating the BS surface

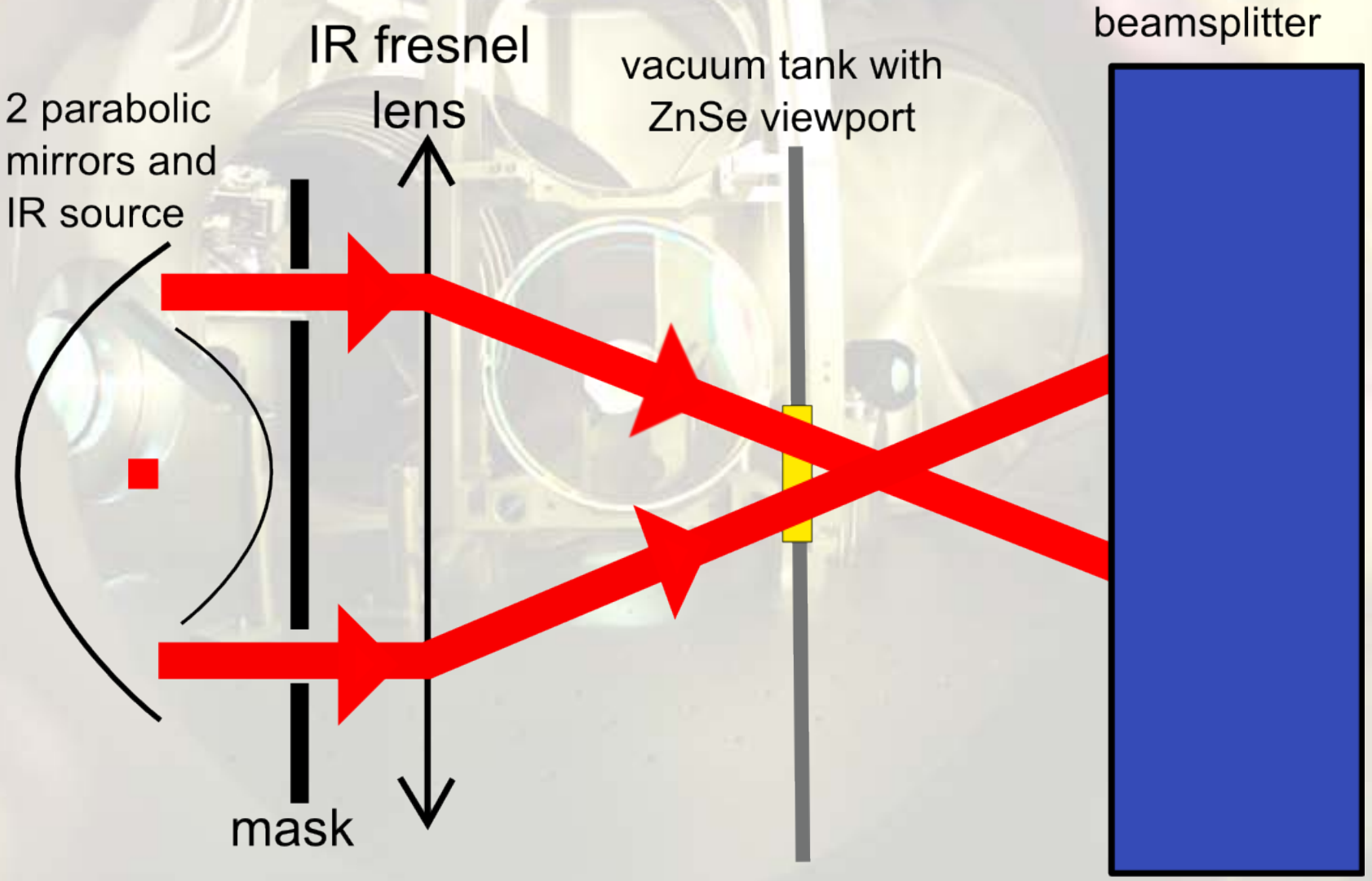
Need about 10 W of heating power for full 25W of Laser power

CO_2 Laser Intensity Noise

CO_2 RIN = 10^{-5} assumed, RIN required $< 10^{-8}$

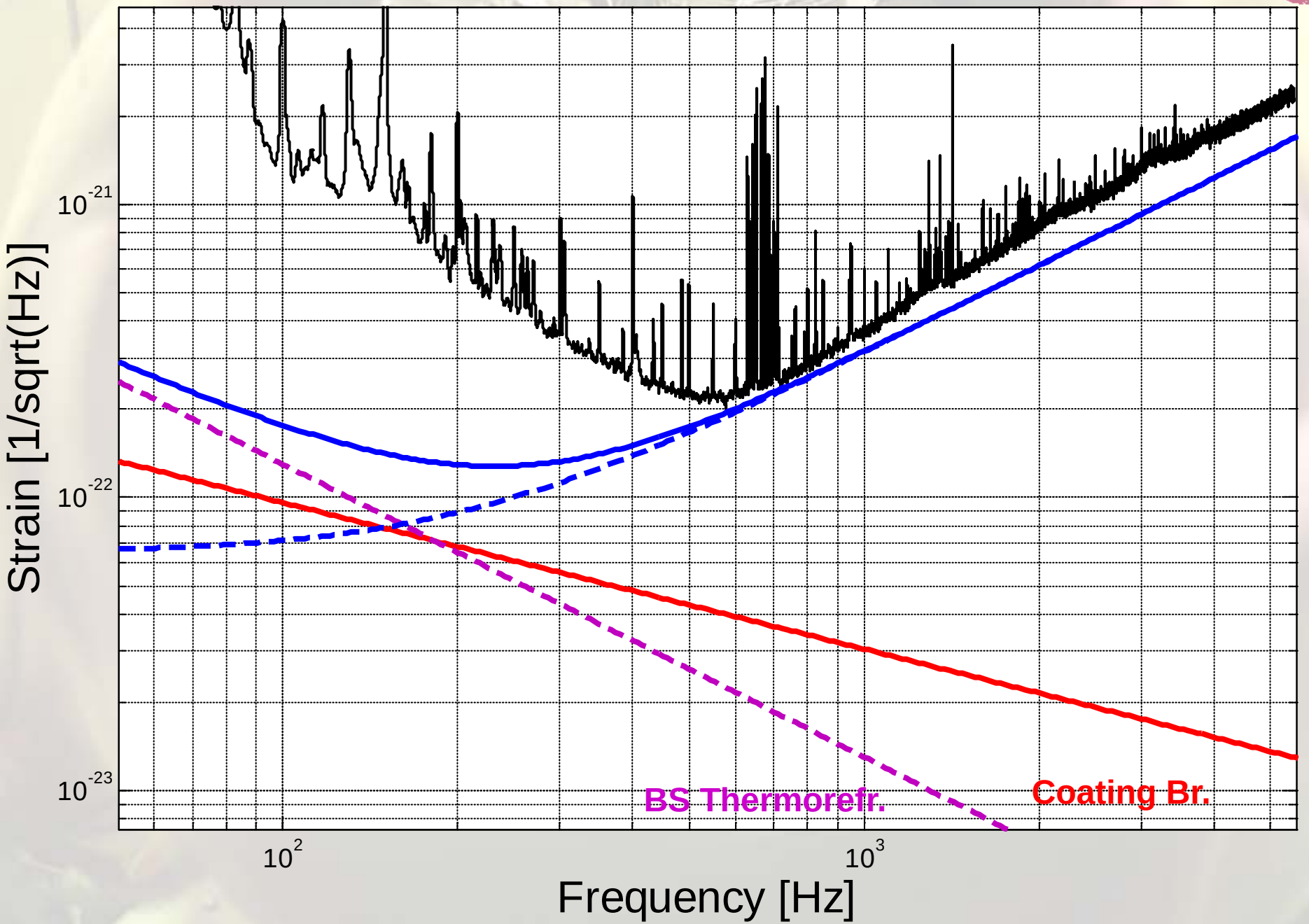


Thermal compensation



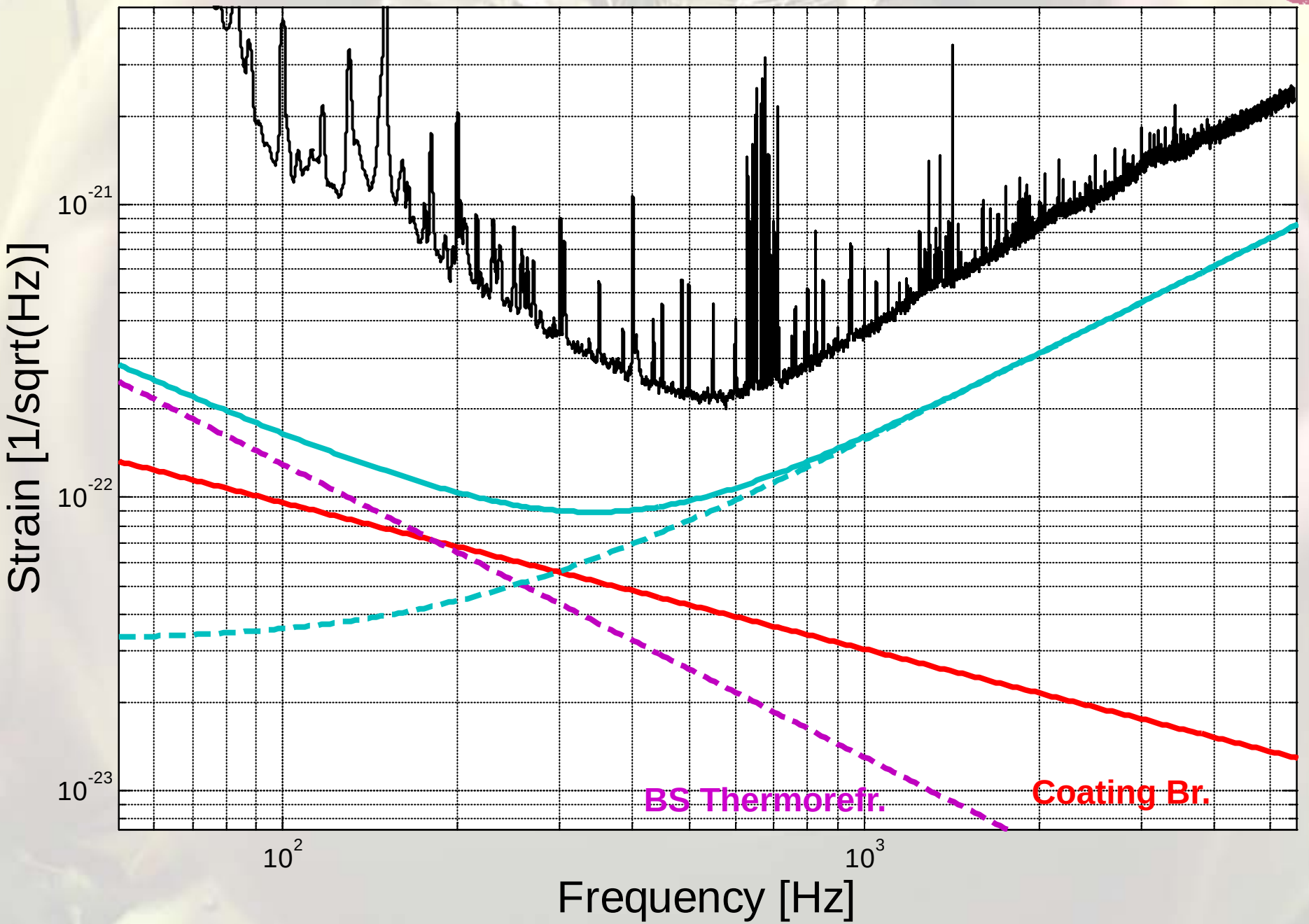
GEO-HF Sensitivities

DC readout, Tuned SR



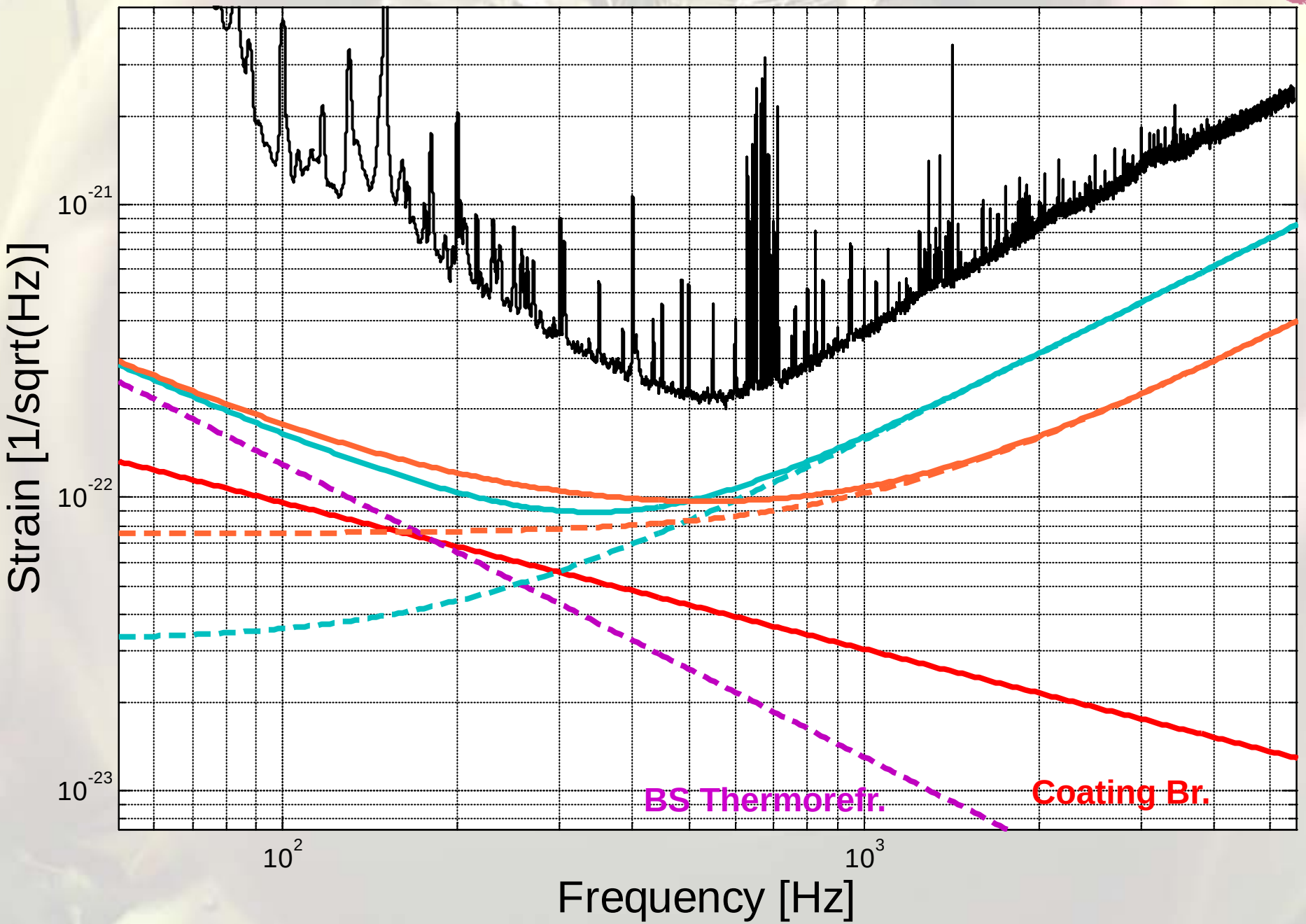
GEO-HF Sensitivities

DC readout, Tuned SR, 6dB Squeezing



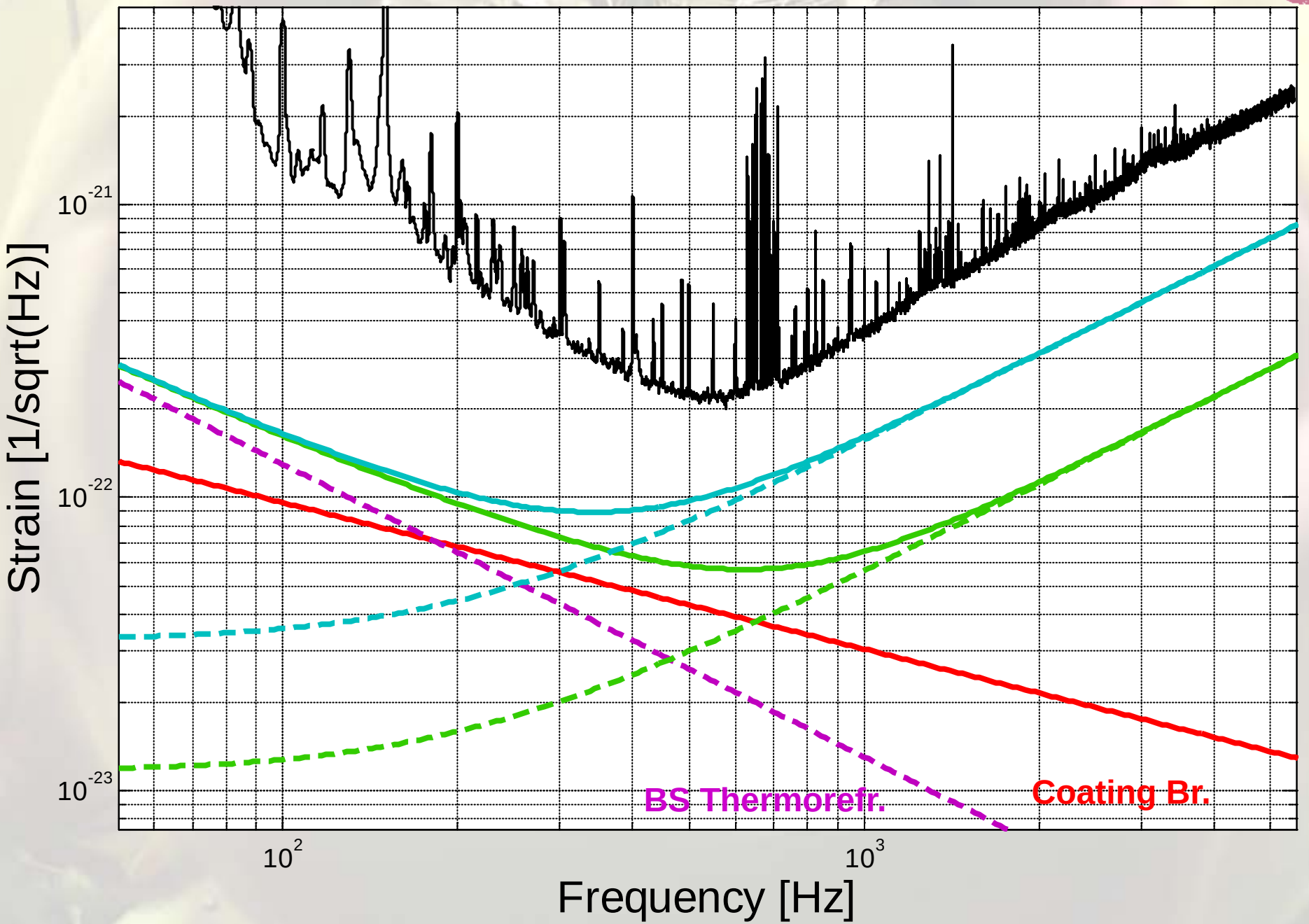
GEO-HF Sensitivities

DC readout, Tuned SR, 6dB Squeezing, MSR 10%,3.2W input



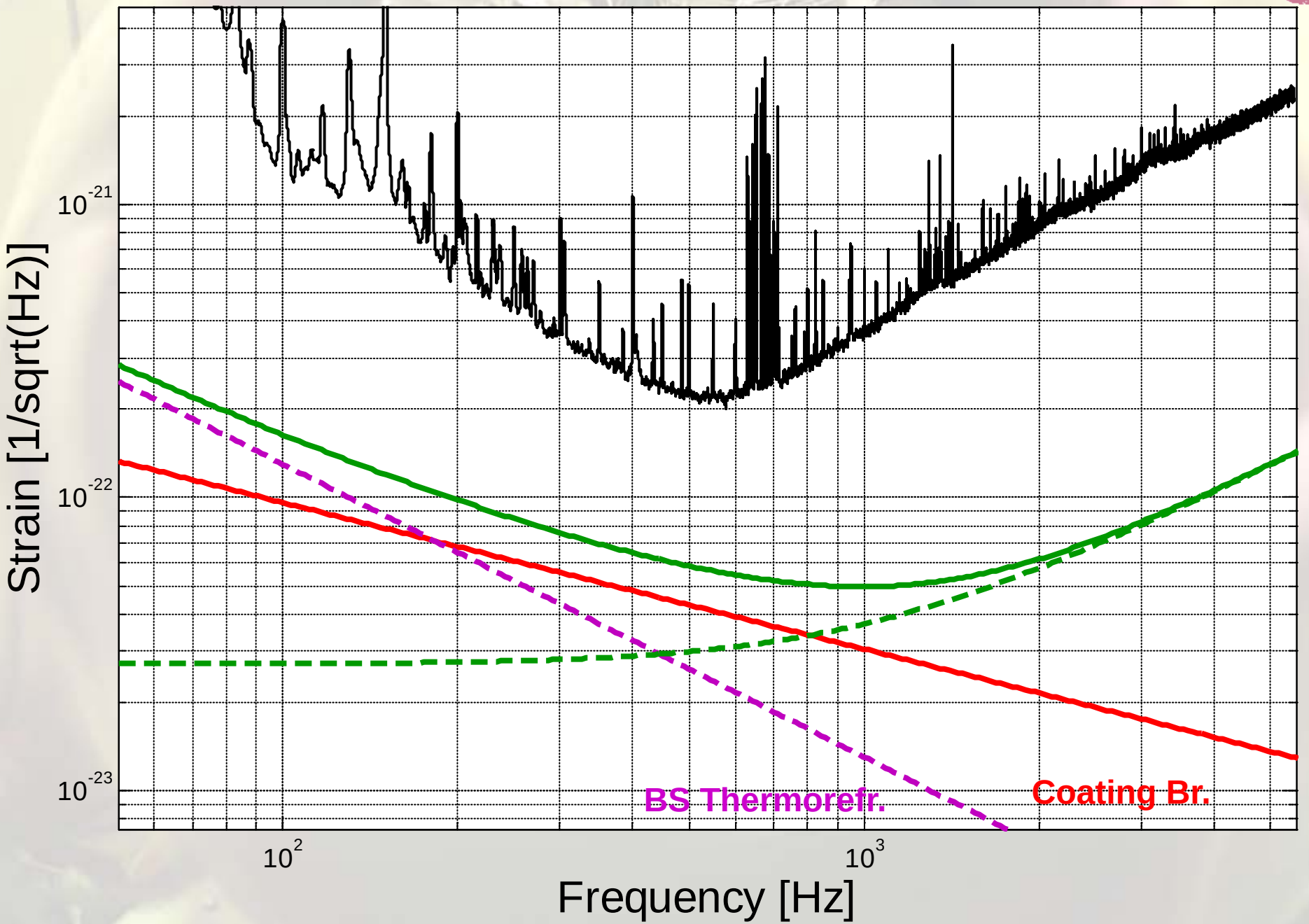
GEO-HF Sensitivities

DC readout, Tuned SR, 6dB Squeezing, 2% MSR, 25W input



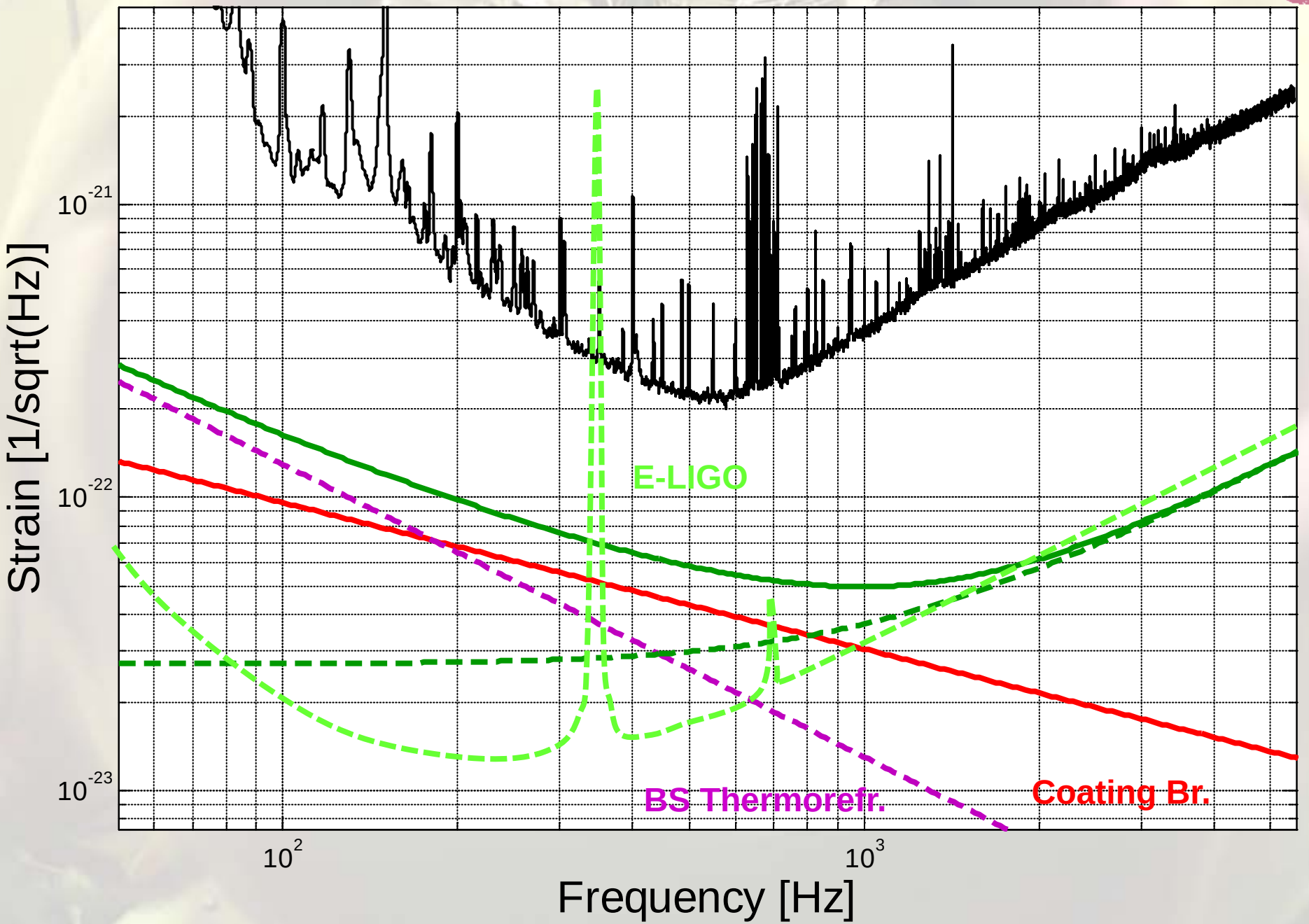
GEO-HF Sensitivities

DC readout, Tuned SR, 6dB Squeezing, MSR 10%, 25W input

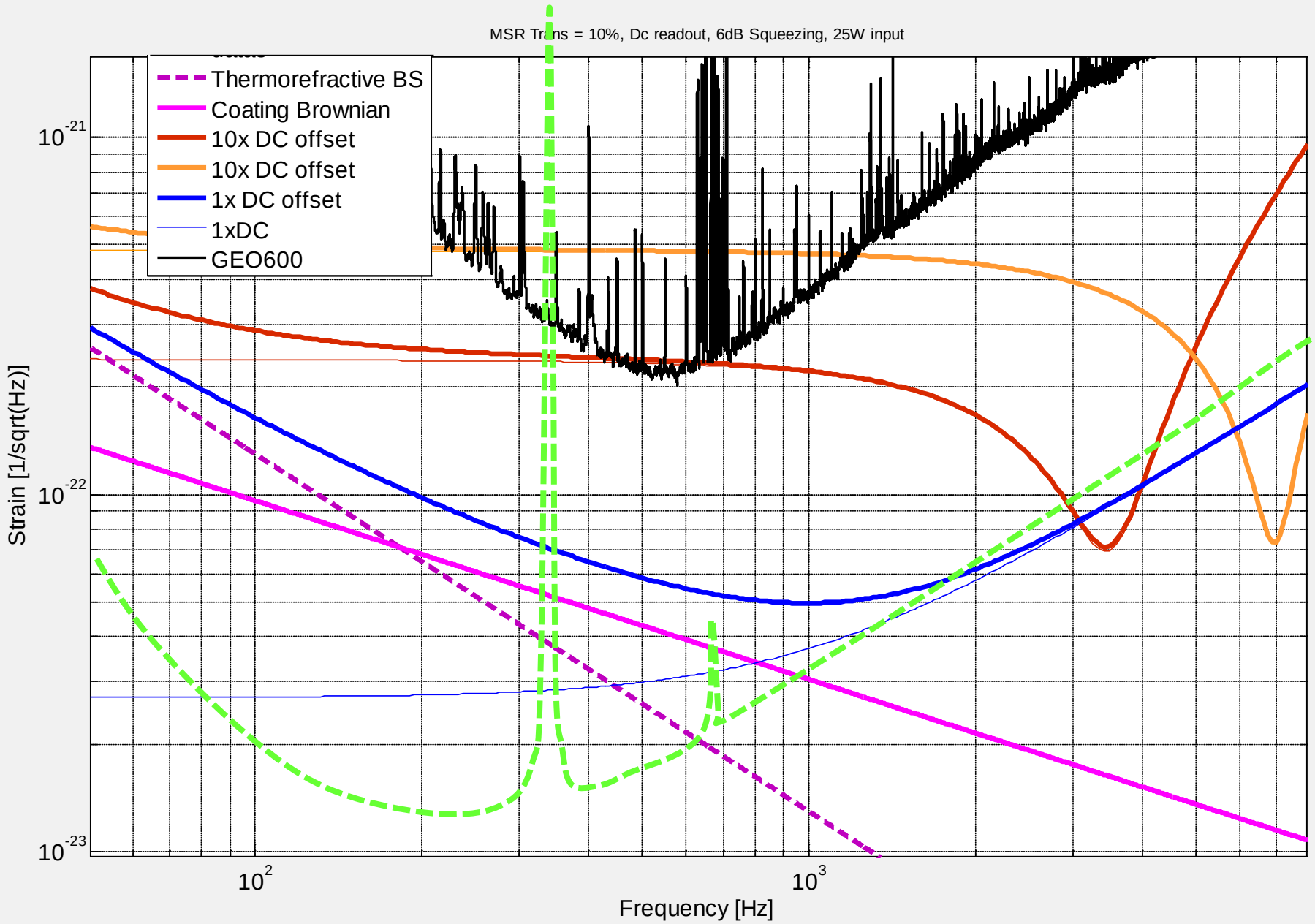


GEO-HF Sensitivities

DC readout, Tuned SR, 6dB Squeezing, MSR 10%, 25W input



Various detunings + Squeezing

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