The GEO600 detector:

Status and Plans

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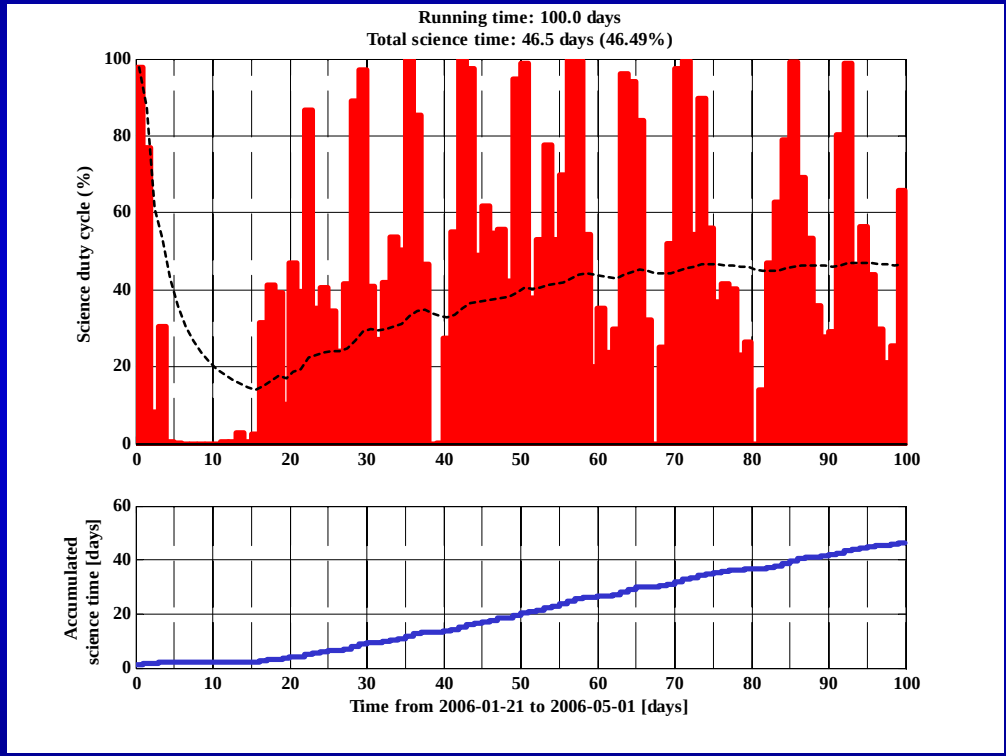
GEO600 in S5

Most of 2006 GEO600 participated in S5.

O&WE-mode 1:

20th January – 1st May

Science time = 46.5%



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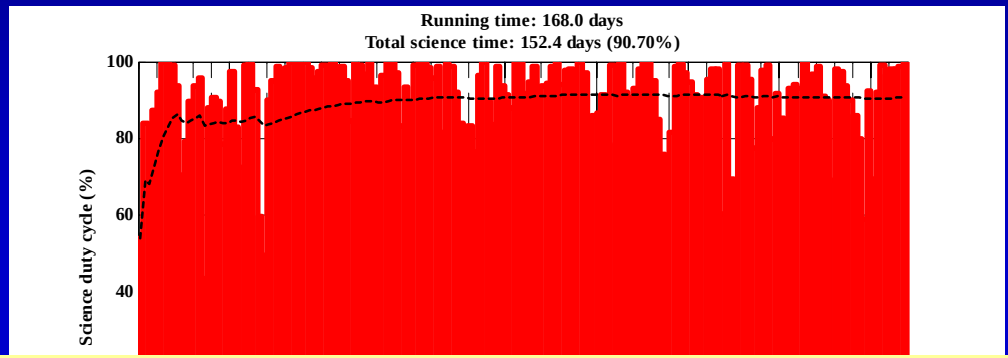

Strategic Decision @ October GEO-meeting:

- **Input:** LSC data analysis groups, LSC operations committee, Benefit/Risk-analysis from commissioning team.
- **Result:** O&WE-mode period 2
  - Gain understanding of the detector
  - Improving GEO600
  - Maintenance work required to prepare GEO for a long science run in 2008

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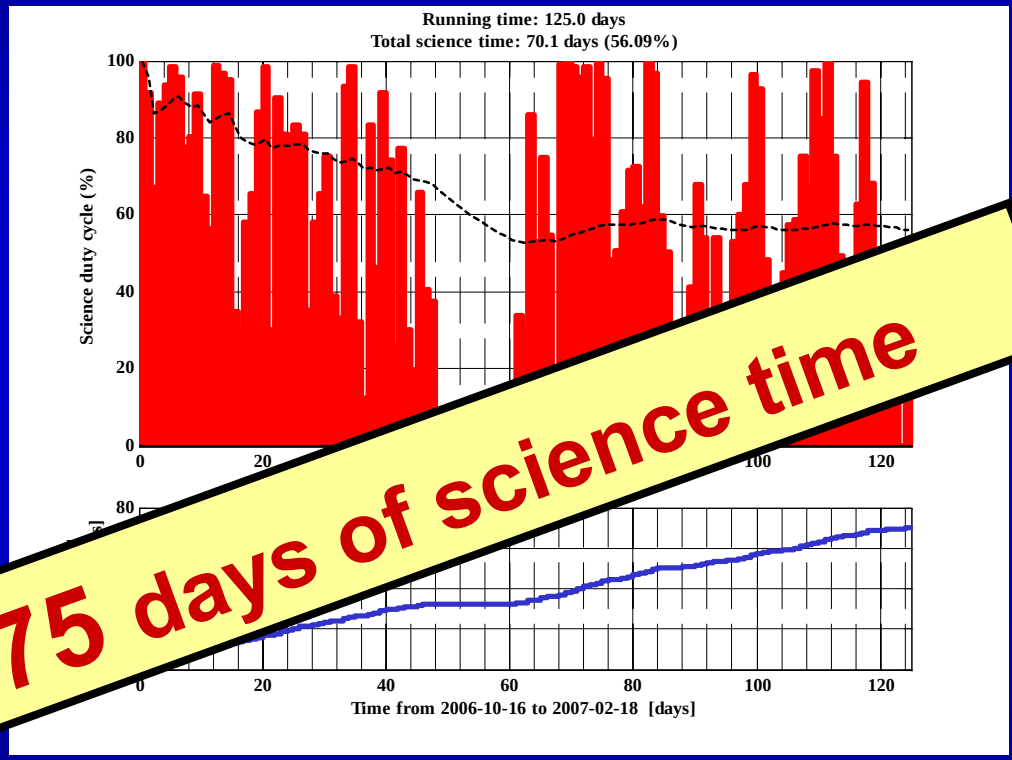
O&WE-mode 2:

16th Oct

Sci .1%



Overall about 275 days of science time

Coming up
(Slide taken from previous ILIAS meeting)

- **Opening vacuum system**
  - Reposition beam dump(s) and install translation stage(s)
  - Repair ESDs
    - Fix wiring and install new HV feedthroughs
- **Improvement of air-conditioning system**
  - HEPA filters in clean room **[done]**
- **Continue work on power increase**
- **Continue commissioning of MID ESD AA**

Overview of this talk

- **Opening vacuum system**
  - Reposition beam dump(s) and install translation stage(s)
  - Repair ESDs
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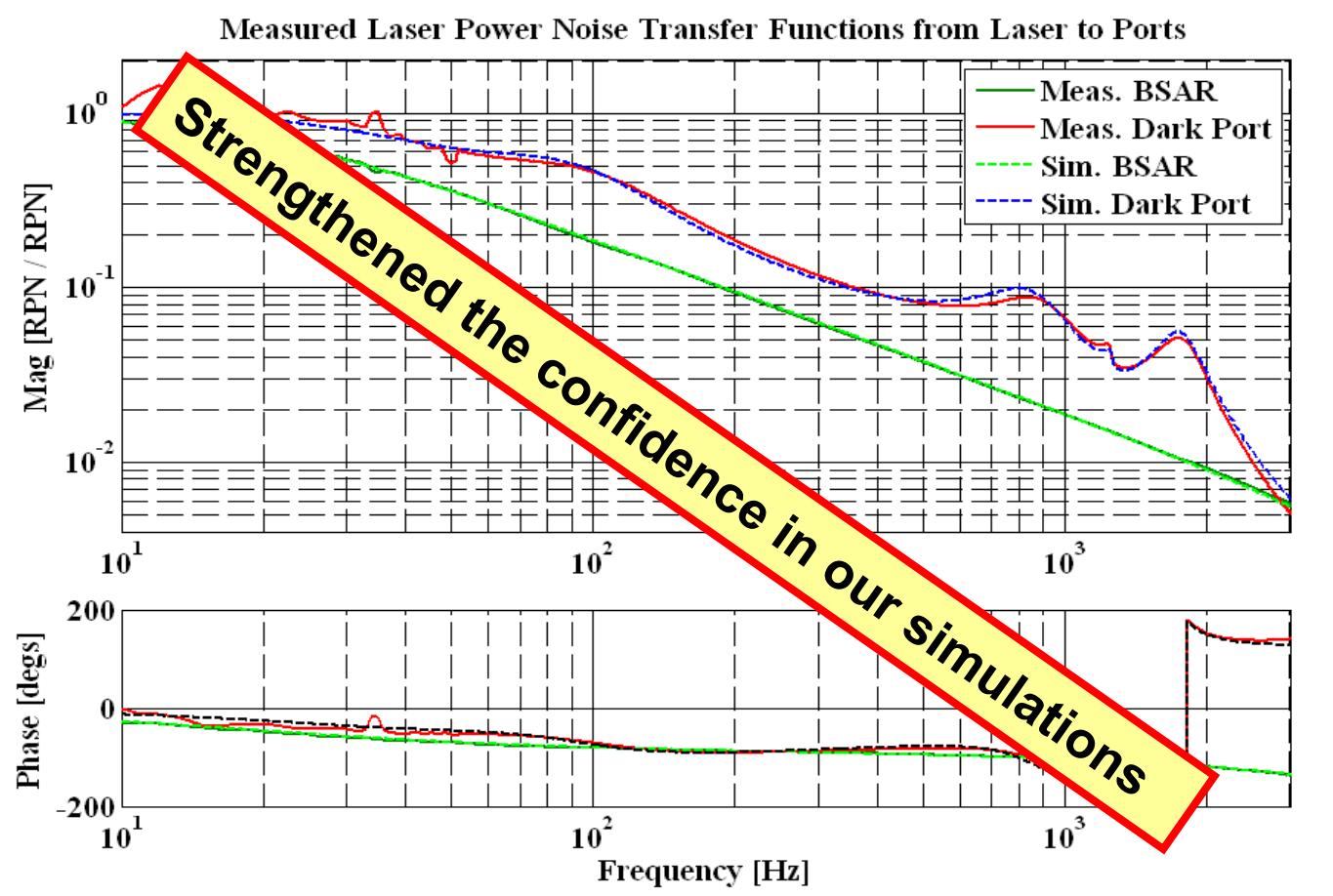
- **Improvement of air-conditioning system**
  - HEPA filters in clean room **[done]**
- ~~**Continue work on power increase**~~
- **Continue commissioning of MID ESD AA**

Unforseen:

- ***Discharging the test masses***
- ***DC readout without OMC***

Improved understanding of the detector: Laser power noise coupling

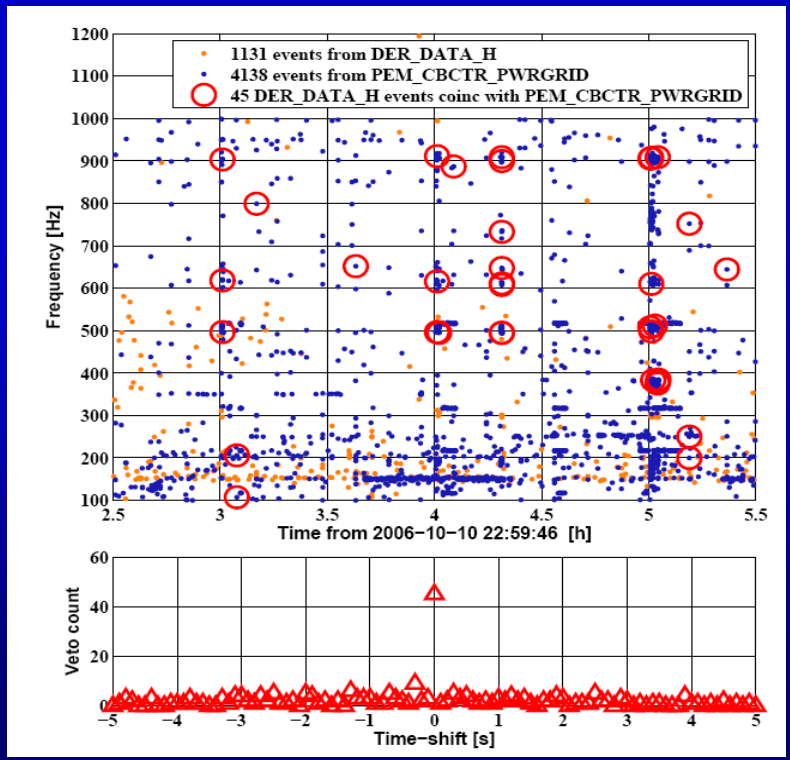
Laser power noise TFs using FINESSE match our measurements.

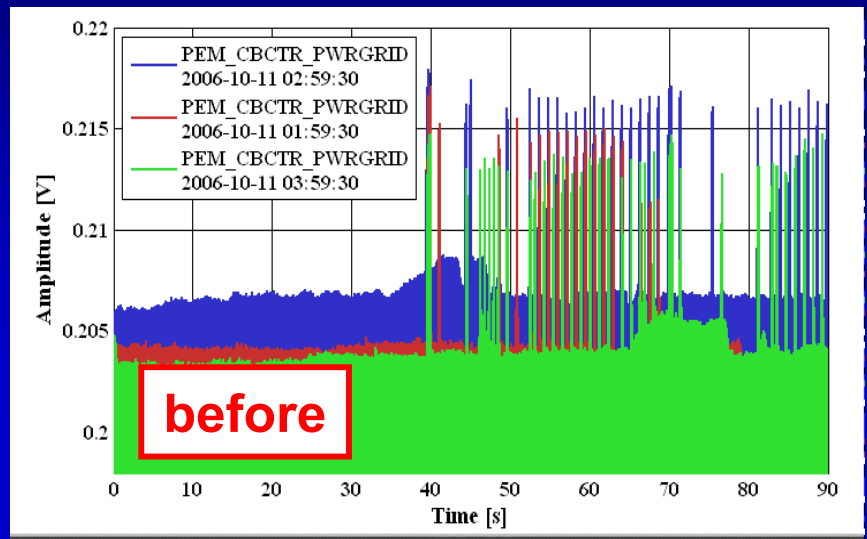


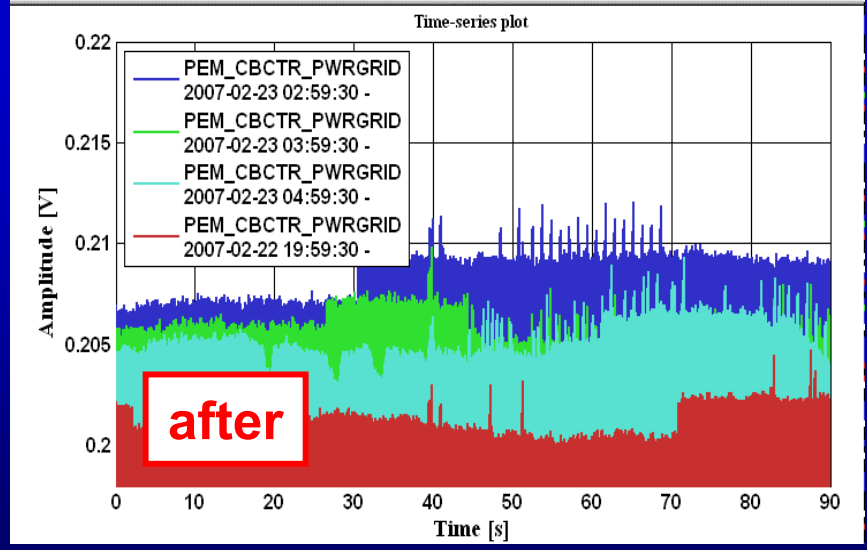
"Laser power noise coupling in GEO600" , JR Smith, A Freise, H Grote, M Hewitson, S Hild, H Lück, KA Strain, B Willke, in preparation

Installation of mains filter

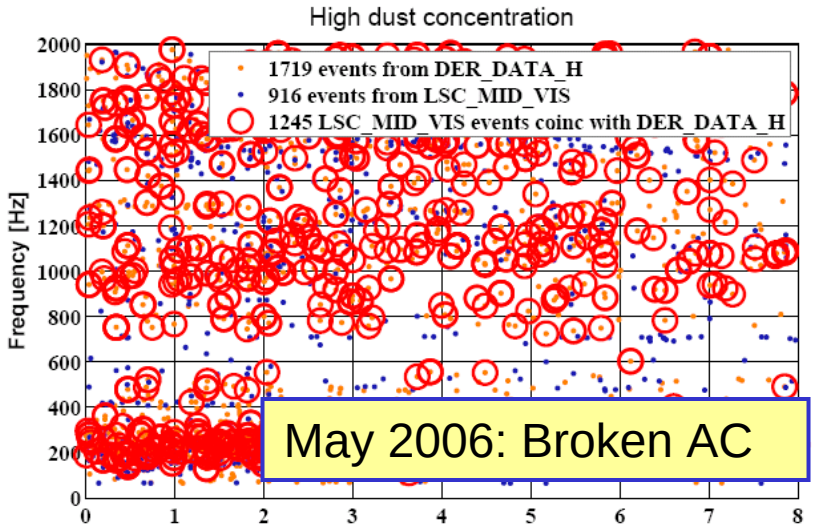
- Found many glitches in GW signal at hour boundary (10 sec after)
- Coincident events in mains monitors
- Control signals created by power companies.
- Solution: Installation of mains filter.



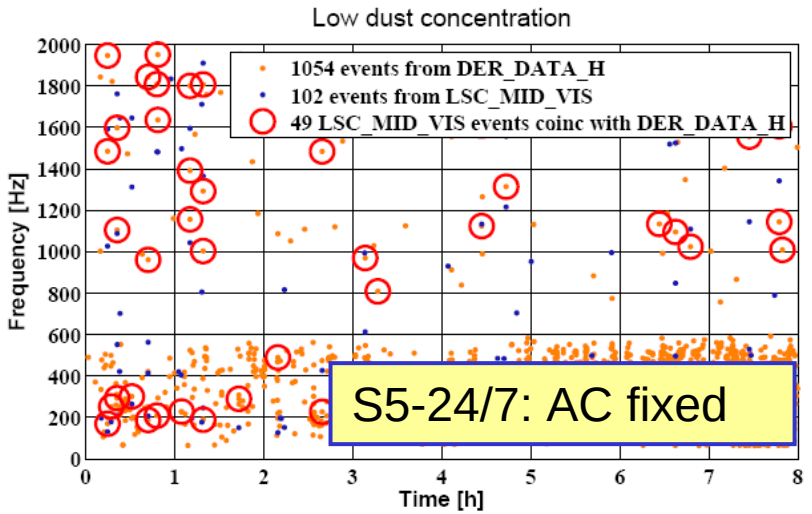




Reduction of particle concentration in the cleanroom



May 2006: Broken AC

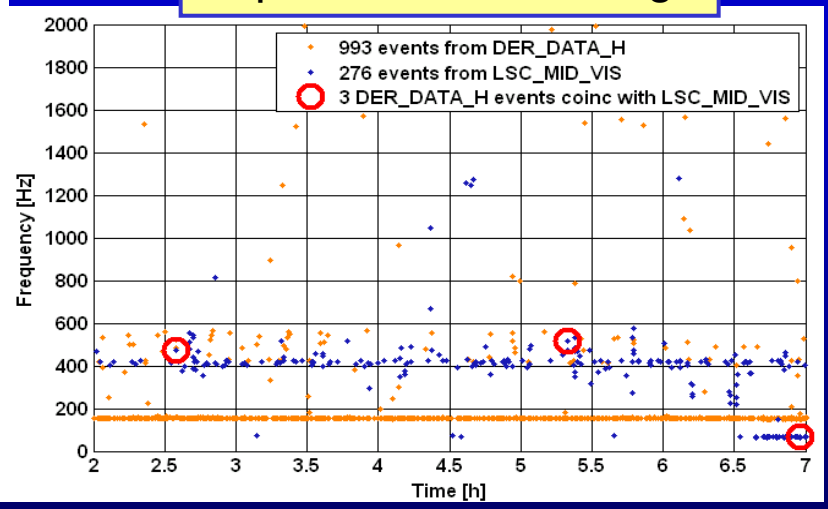


S5-24/7: AC fixed

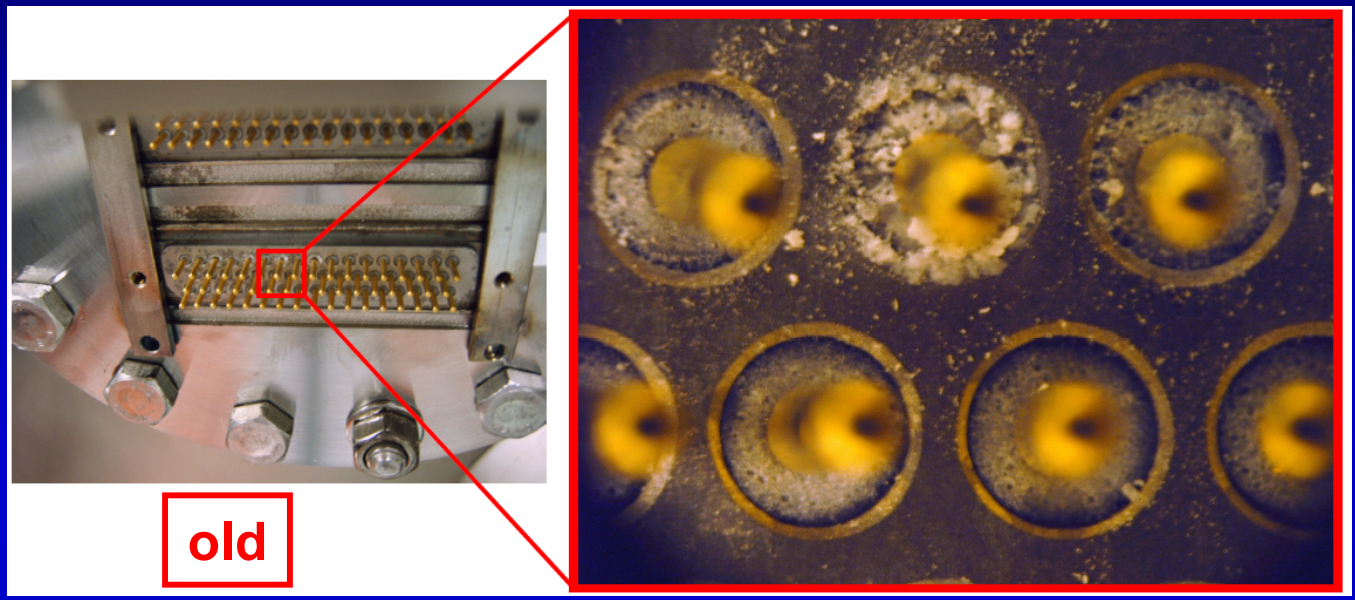
Glitches caused by dust falling through the laser beam in front of main photo diode.

(veto available for dust glitches)

January 2007:
Improved dust filtering



Exchanged HV-feedthroughs

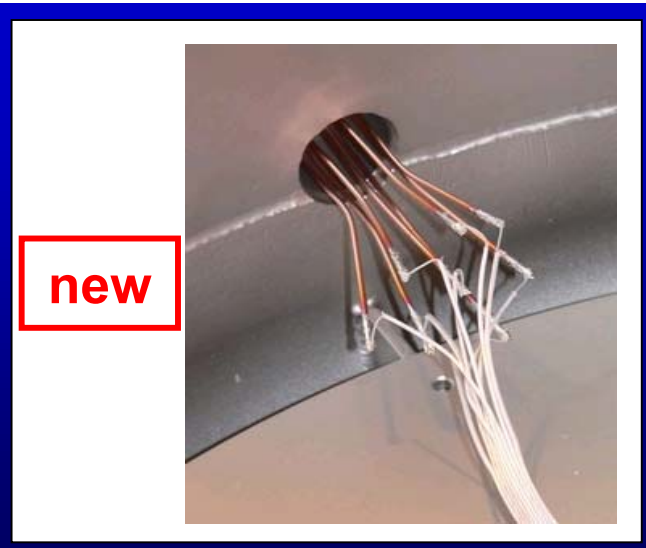


Installation in March 2001

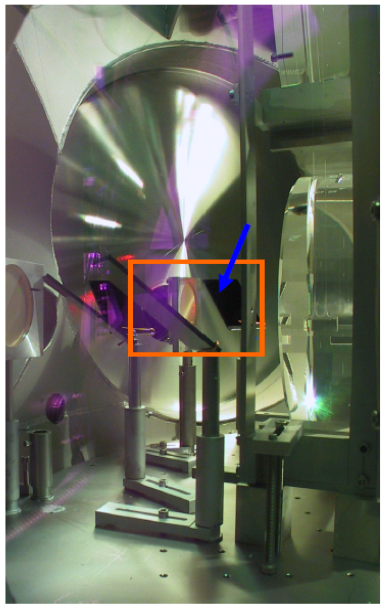
Failed due to corrosion in August 2004

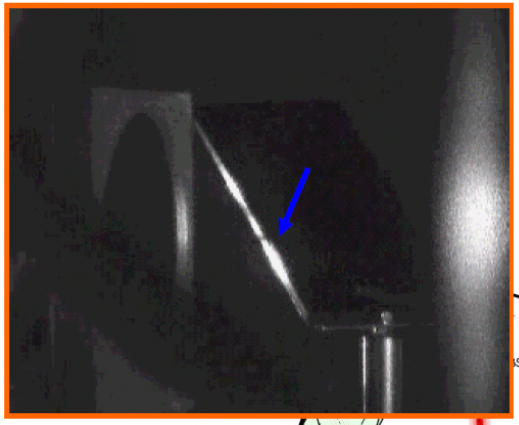
Since then using the spares !!

Replaced in Febuary 2007

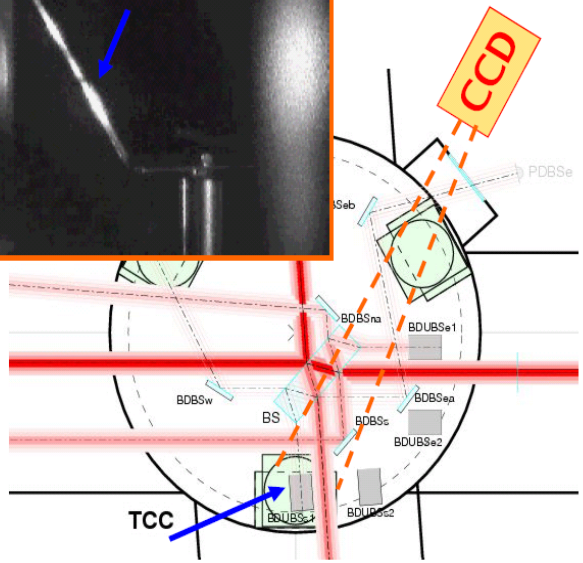


Fixed beam clipping inside Signal-Recycling cavitiy





old



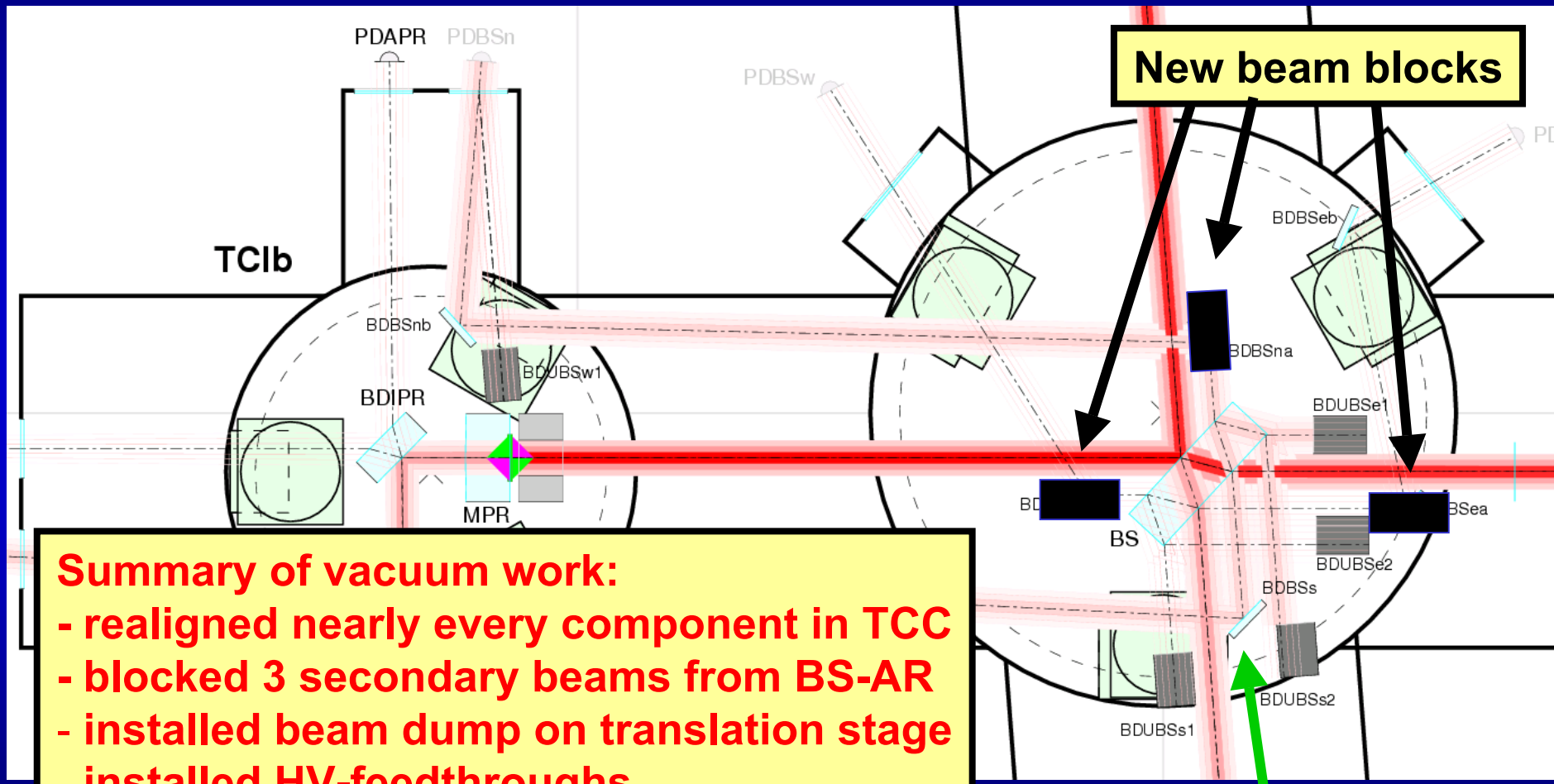
Suspect the beam dump to clip the beam (blue arrows)

new

Solution: Beam dump on translation stage

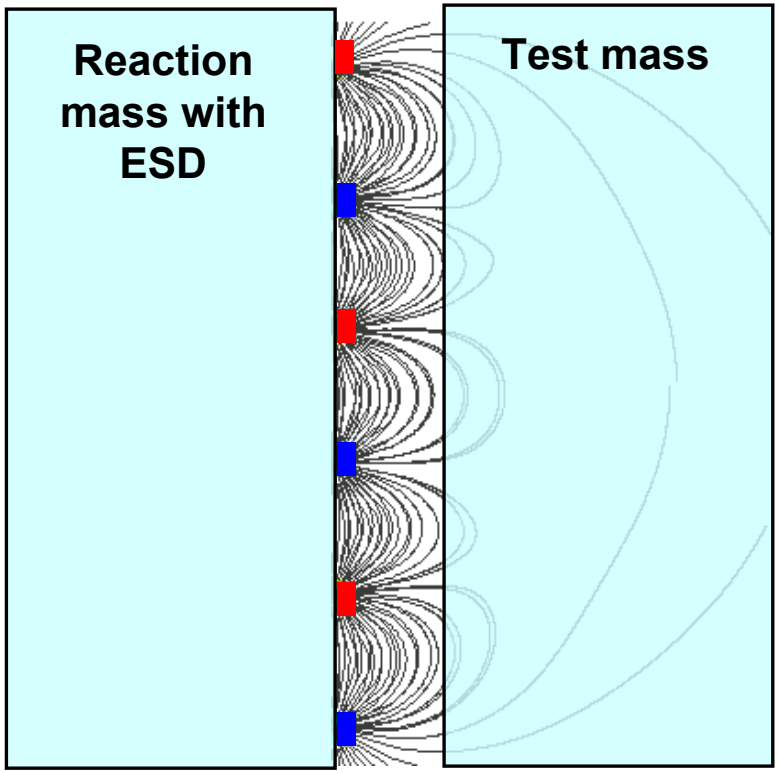
- Piezo actuator
- Range of 28 mm
- Load: up to few 100g

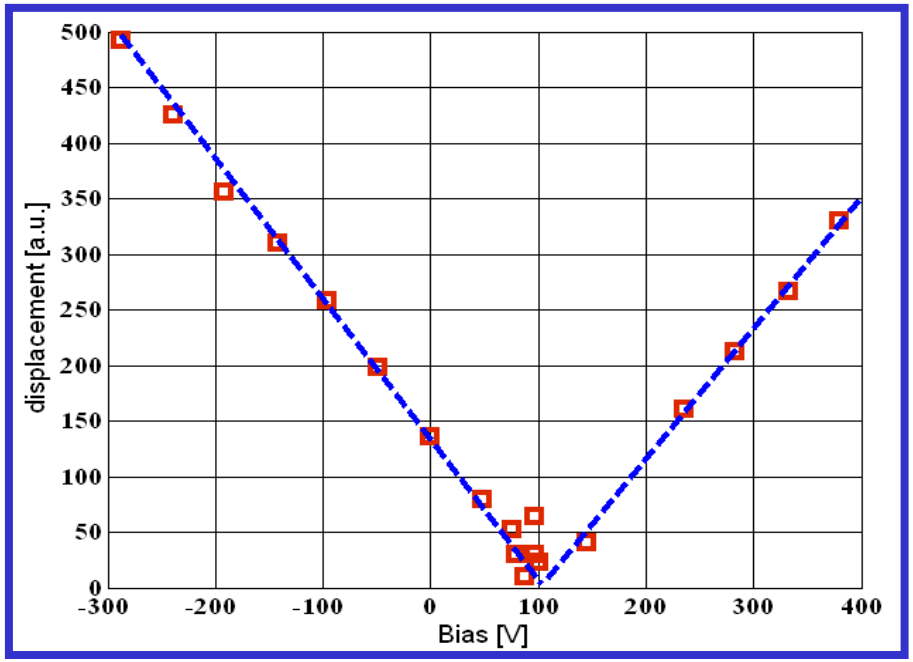
Repositioning of beam dumps



Summary of vacuum work:
- realigned nearly every component in TCC
- blocked 3 secondary beams from BS-AR
- installed beam dump on translation stage
- installed HV-feedthroughs
- installed fused silica viewports

Charges on test masses after vacuum work





$$F = U^2 \varepsilon_0 \varepsilon_r d^{3/2} A = (U_{bias} + U_{signal})^2 \cdot const$$
$$= F_{Offset} + U_{bias} \cdot U_{signal} \cdot const + U^2_{signal} \cdot const$$

After the vacuum work we found the test masses to be charged (+100V/+30V)

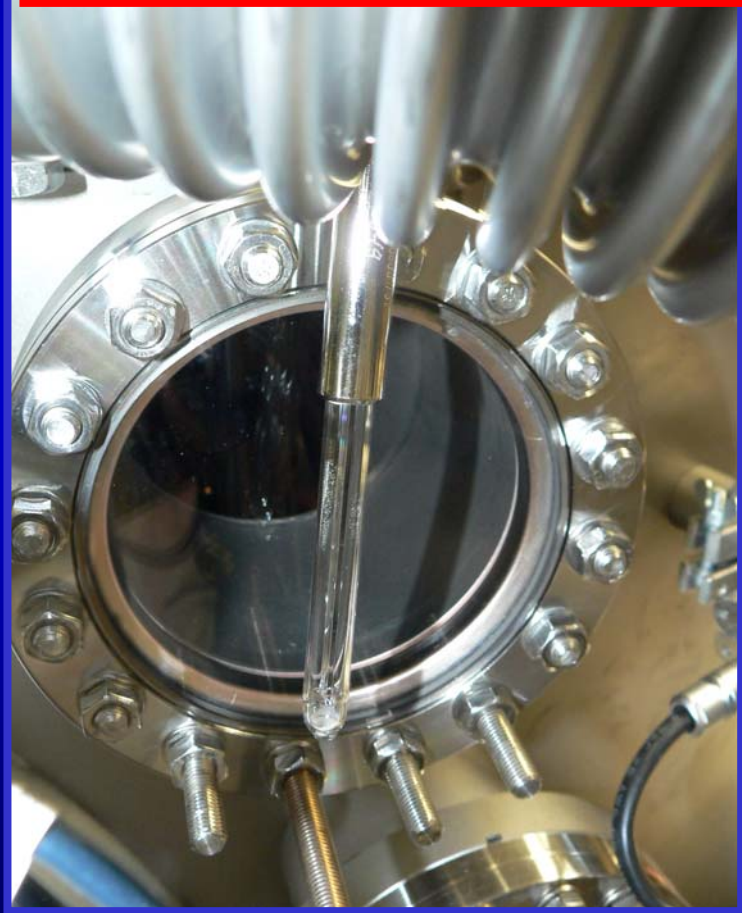
Uncharching test mass by UV light

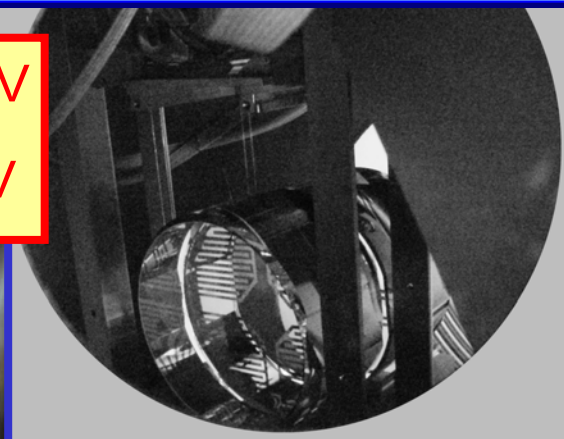
S. Rowan et al, CQG. 14 1537–1541 (1997):

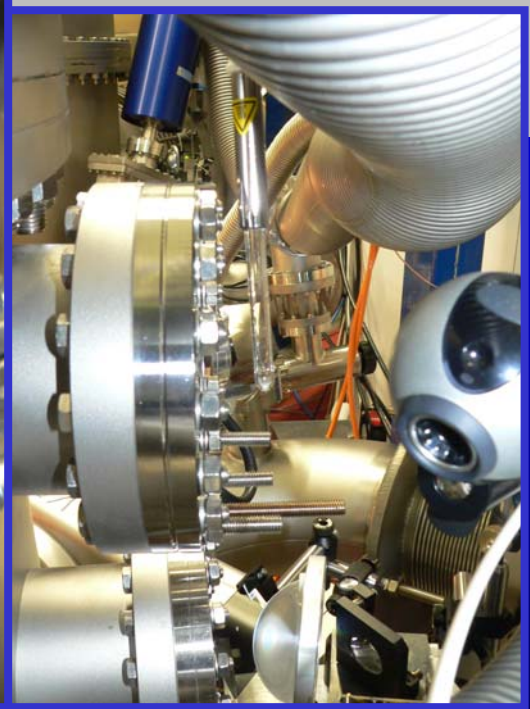
Discharging by use of UV light to free electrons.

Mecury lamp: 258nm => 4.8eV

Work function of gold = 4.8eV







In our case:

- UV transmitted through test mass
- electrons are freed of the ESD electrodes
- electrons compen-sate positive charge on test mass

History of UV attacks

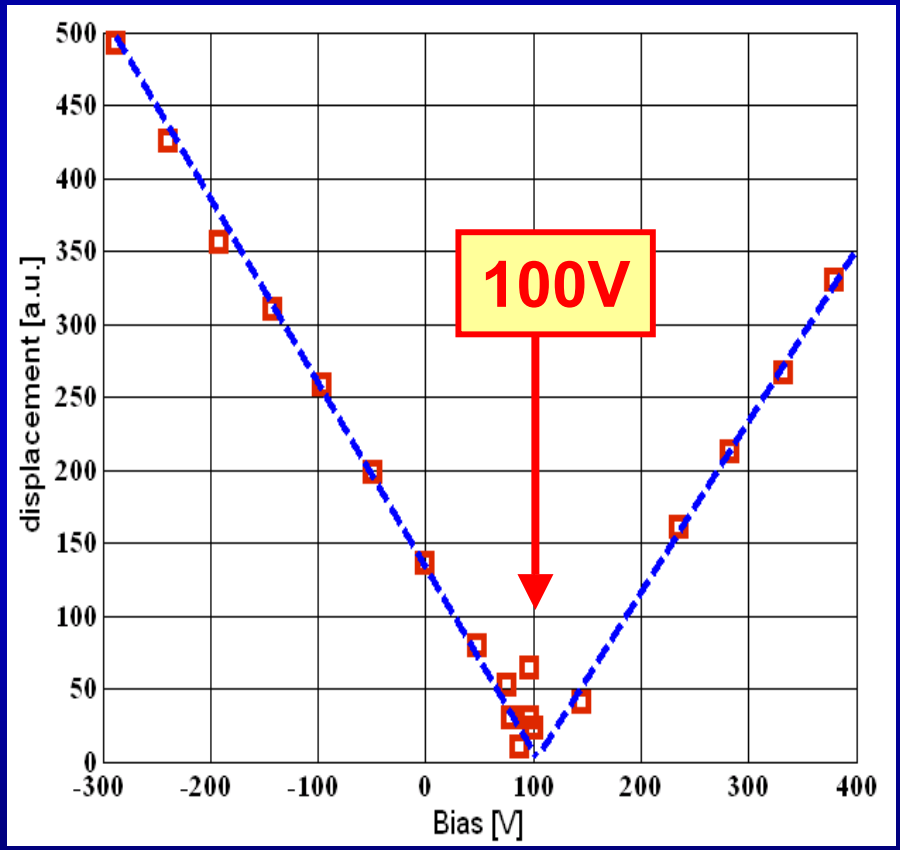
- After pumping down: east = 90V, north = 30V
- 1st UV attack:
  - IFO locked with north ESD
  - no voltage applied to east ESD
  - 2 hours of UV (illuminating only east ESD)
- After 1st UV attack: east = 30V, north = 90 V
- 2nd UV attack:
  - IFO unlocked
  - HVA off
  - Illuminating 1 night (Illuminating only east ESD)
- After 2nd UV attack: east = -70V, north = 17V
- 3rd UV attack:
  - IFO locked with north ESD
  - +200V applied to east ESD
  - Illuminating 100 seconds (Illuminating only east ESD)
- After 3rd UV attack: east = 15V, north = 17V

What we (might) have learned:

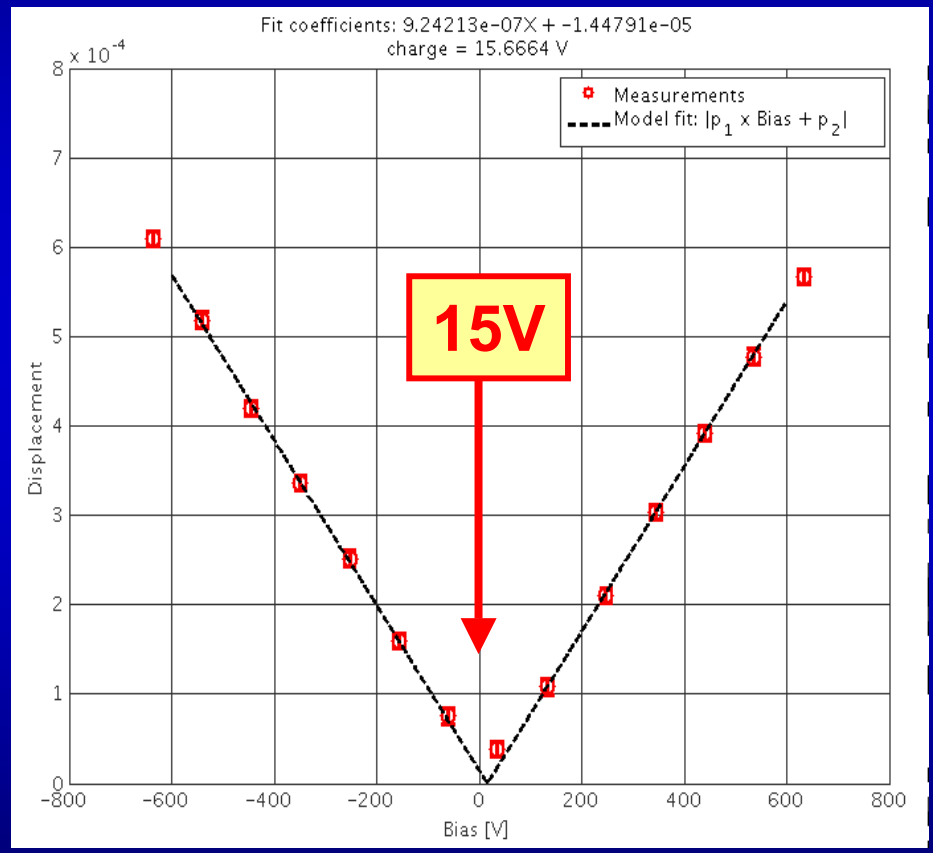
1. **Test masses got charged during evacuating the system. (?)**
2. **In absence of any electrical field, UV frees electrons from ESD and negatively charges testmasses.**
3. **If positive voltage is applied to ESD, UV frees electrons from testmasses. (???)**

Sucessfully discharged the test masses

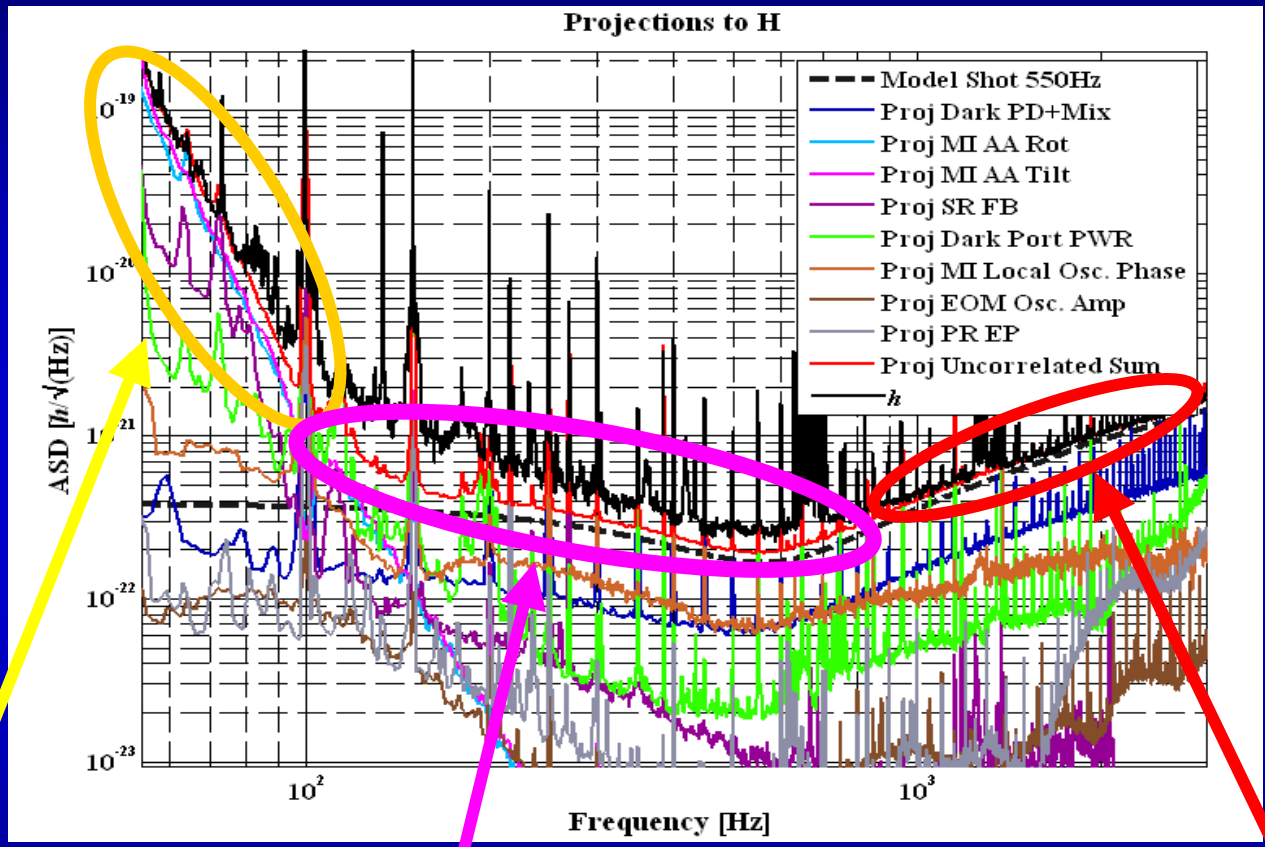
BEFORE



AFTER



Noise projections

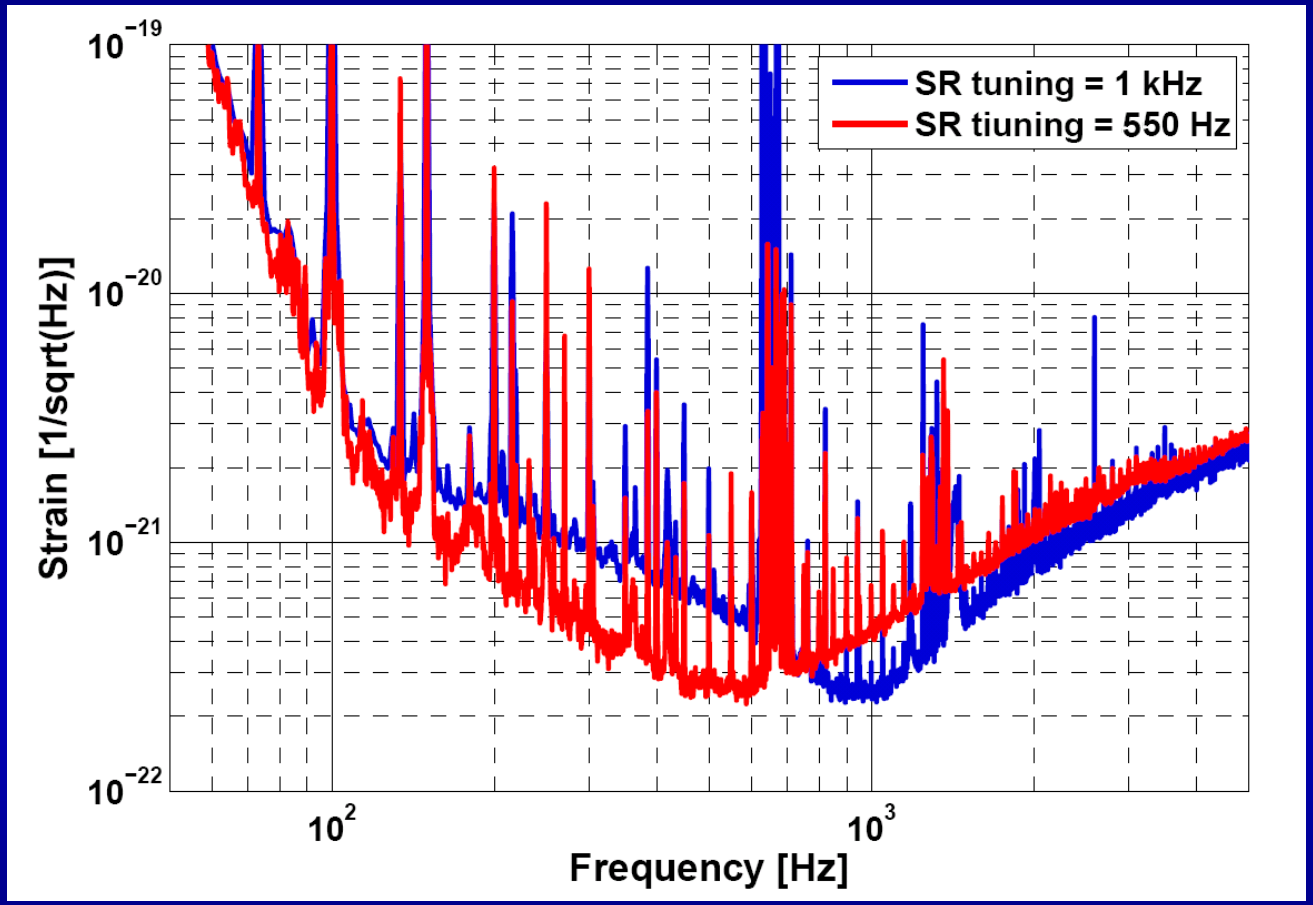


Feedback noise
⇒ ESD for fast AA

unexplained
⇒ Strong indication for scattering
⇒ larger viewports in the endstations

Shot noise
⇒Increase light power

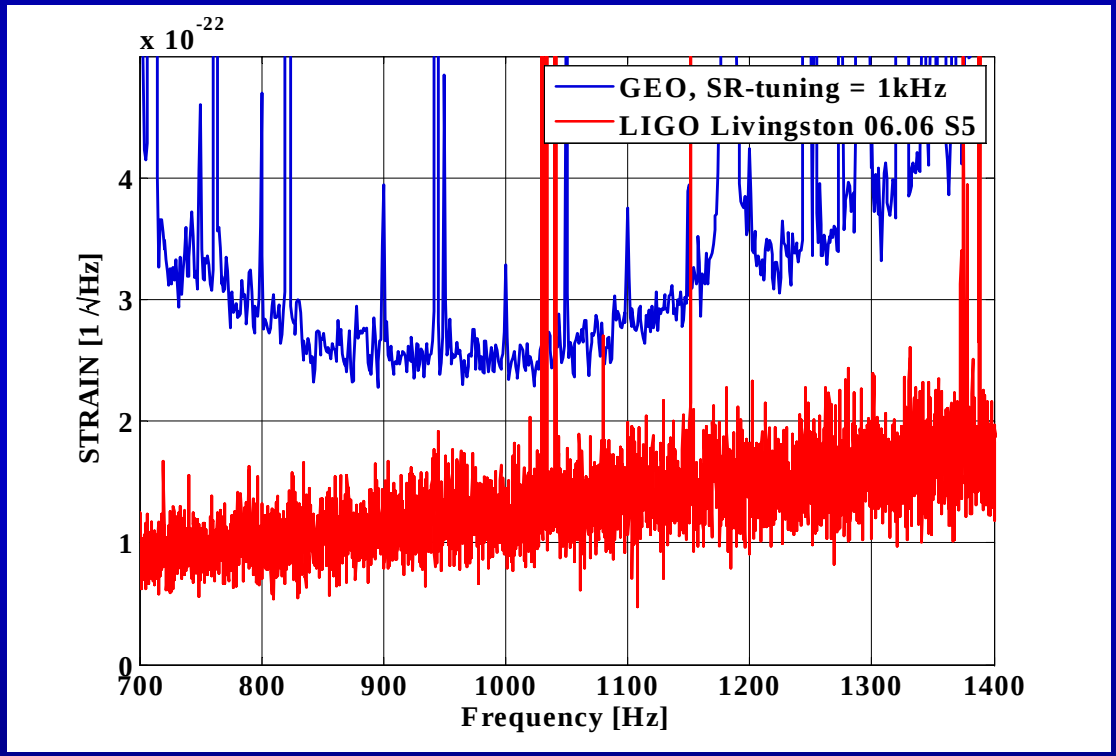
Different SR-tunings



Peak sensitivity better than 3e-22/sqrt(Hz) for both tunings.

SR tuning of 1kHz

Around 1kHz GEO**600** is about a factor **2** worse than the LIGO **4**km Instruments.



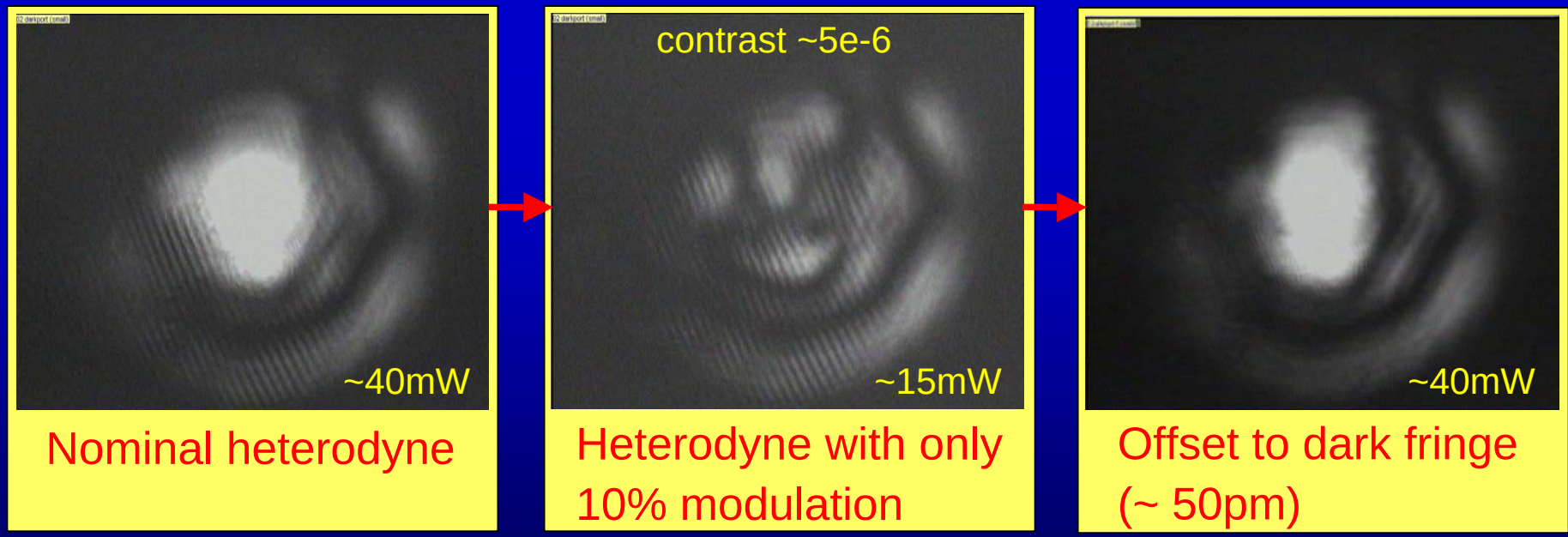
Consider to use this tuning in the near term in order to improve the science impact of GEO600.

DC-readout without OMC

IDEA:

- Turning down the RF-modulation *(factor 10 is possible)*
- Using an offset from dark fringe *(of the order of 50pm)*

$\Rightarrow$ Dark port dominated by carrier light



Nominal heterodyne

Heterodyne with only 10% modulation

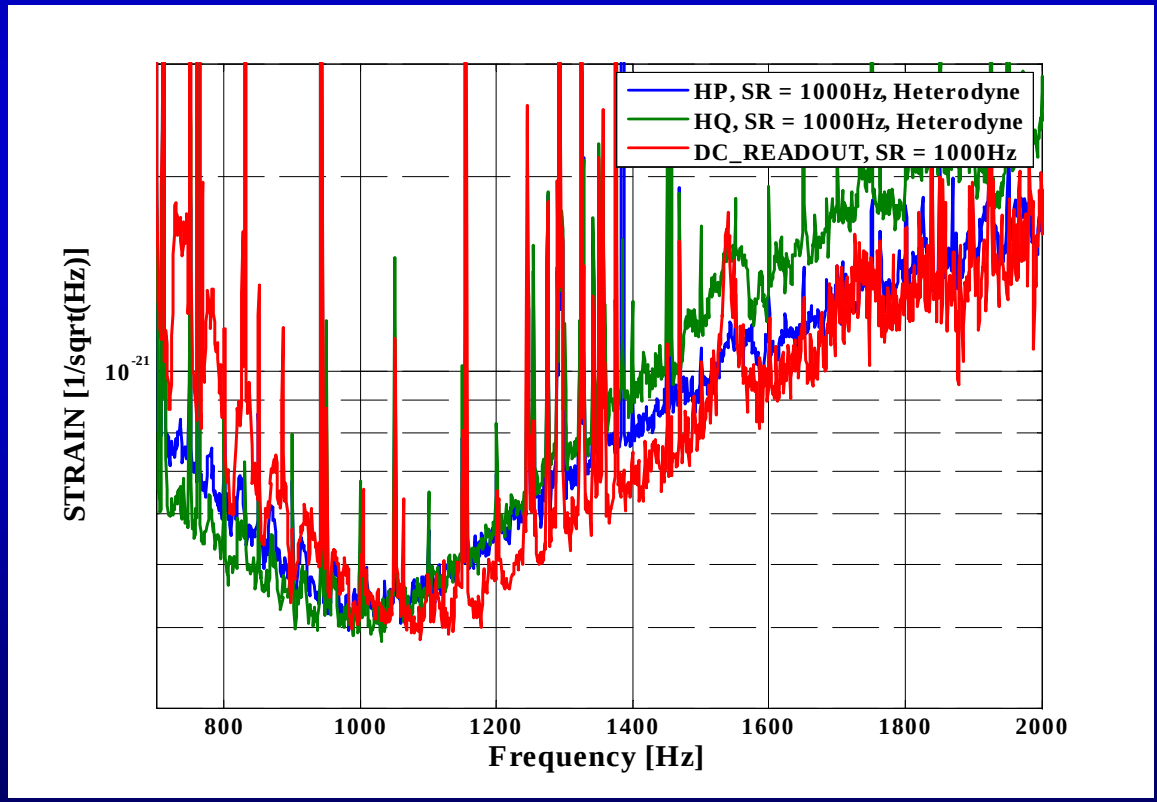
Offset to dark fringe (~ 50pm)

Results from first Experiments with DC-readout

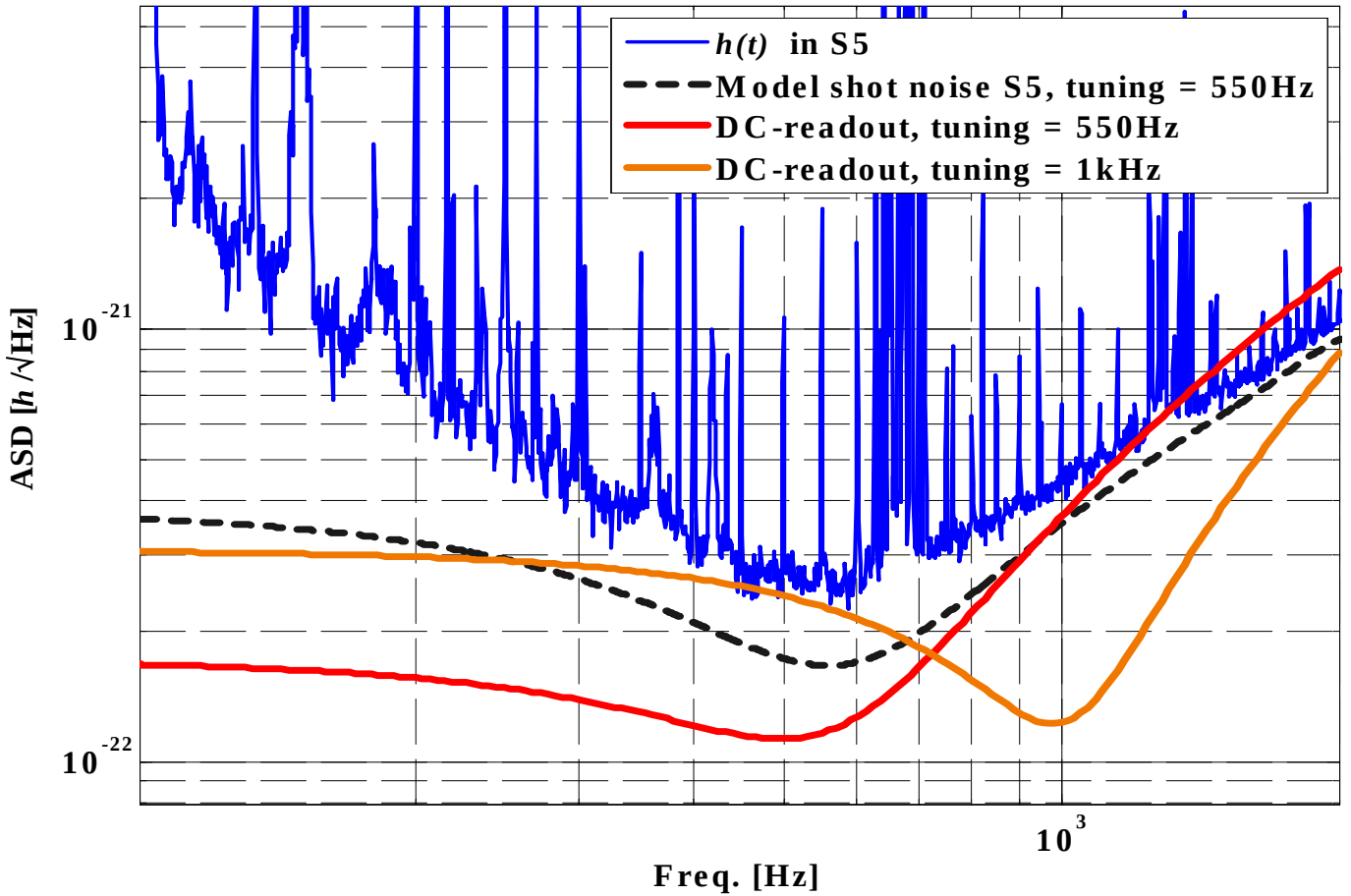
- Stable interferometer with reduced modulation and dark fringe offset:
  - Locking with heterodyne signal, readout with DC signal
  - Locking with DC (homodyne) signal, readout with DC signal

- Above 1kHz a sensitivity competitive to heterodyne readout is achieved

- So far no optimisation or noise hunting took place



What might be gained from DC-readout



Options and Plans for the near future

- **Improving sensitivity & detector stability:**
  - Implement ESD-Autoalignment
  - Reduce scattered light (larger viewports in endstations)
  - Increase circulating light power
  - Tuning flexibility
  - DC-readout scheme

- **Datataking in 2008 to cover the period when LIGO and Virgo are going to upgrade.**

E N D