DC Readout for GEO HF: what we (need to) know

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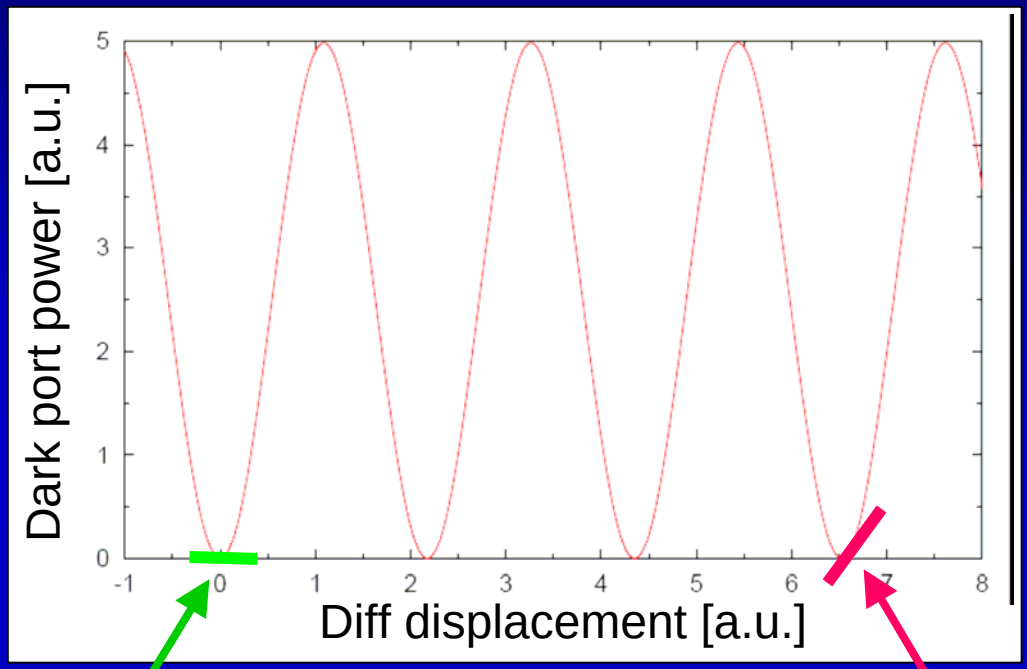
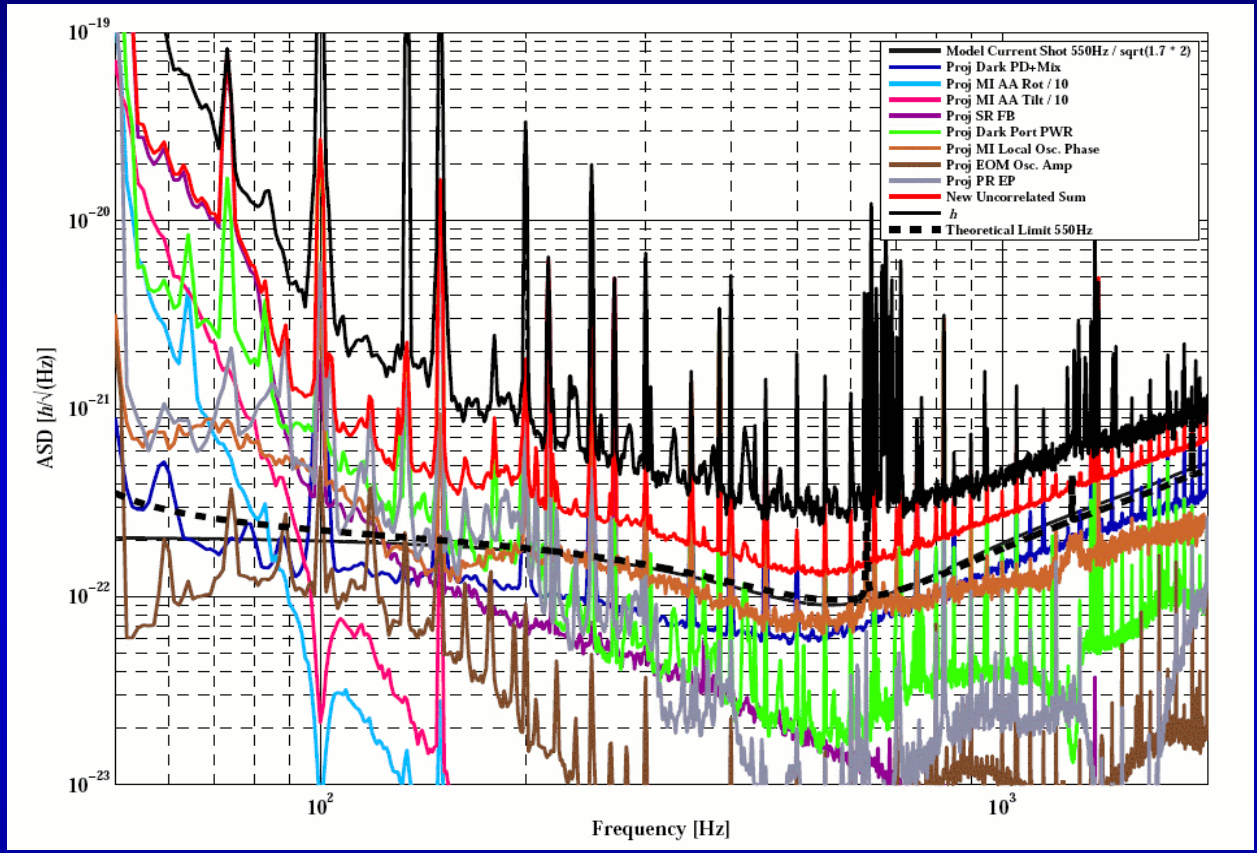
Heterodyne vs DC-readout



Heterodyne (currently used in GEO)
Operating at dark fringe
LO: MI-sideband (15 MHz)

DC-readout
Operating slightly off dark fringe
LO: carrier

Motivation: win at high frequencies



Limits at high frequencies:

- shot noise
- darknoise of main photodiode (+mixer)
- oscillator phase noise

Reducing shot noise

Approaches to reduce shot noise (@ high frequencies):

- increase circulating light power
- change tuning to higher frequency
- using squeezed light

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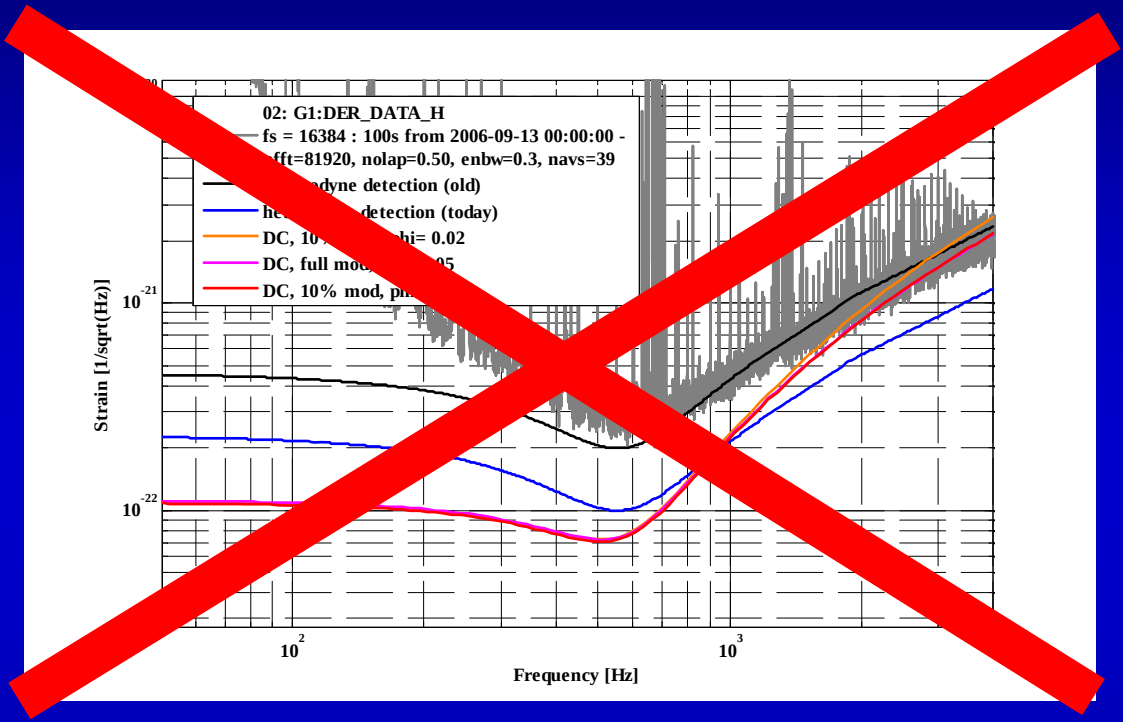
- DC_readout

Shot noise improvement from DC_readout

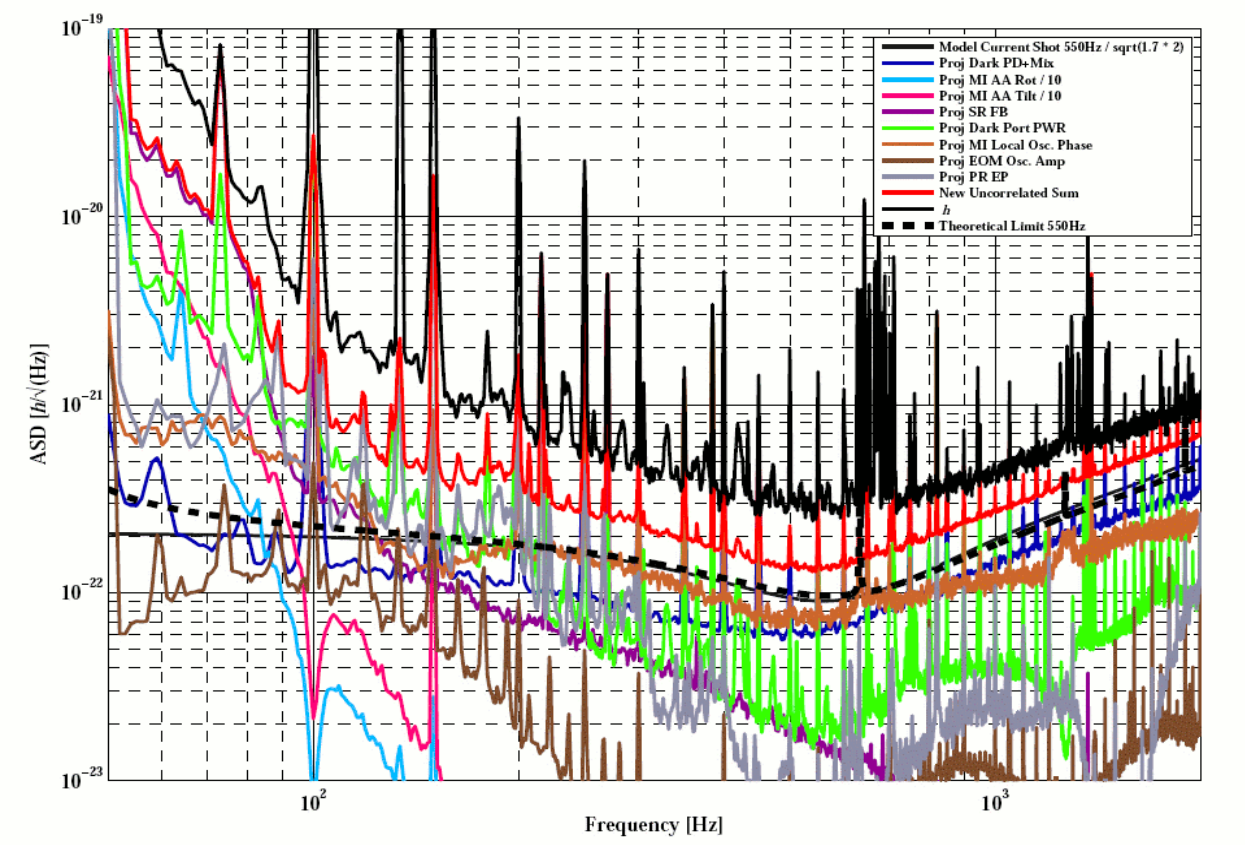


Simulations correct for DC_readout, but at the moment we are not able to predict the shotnoise for GEO600 with heterodyne readout.

However **at the shot noise meeting all participents** *(M. Bastarrika, S.Chelkowski, K. Danzmann, A. Freise, J. Harms, M. Hewitson, S. Hild, J. Hough, H. Lück, S. Rowan, R. Schilling, A. Thüring, B. Willke.)*

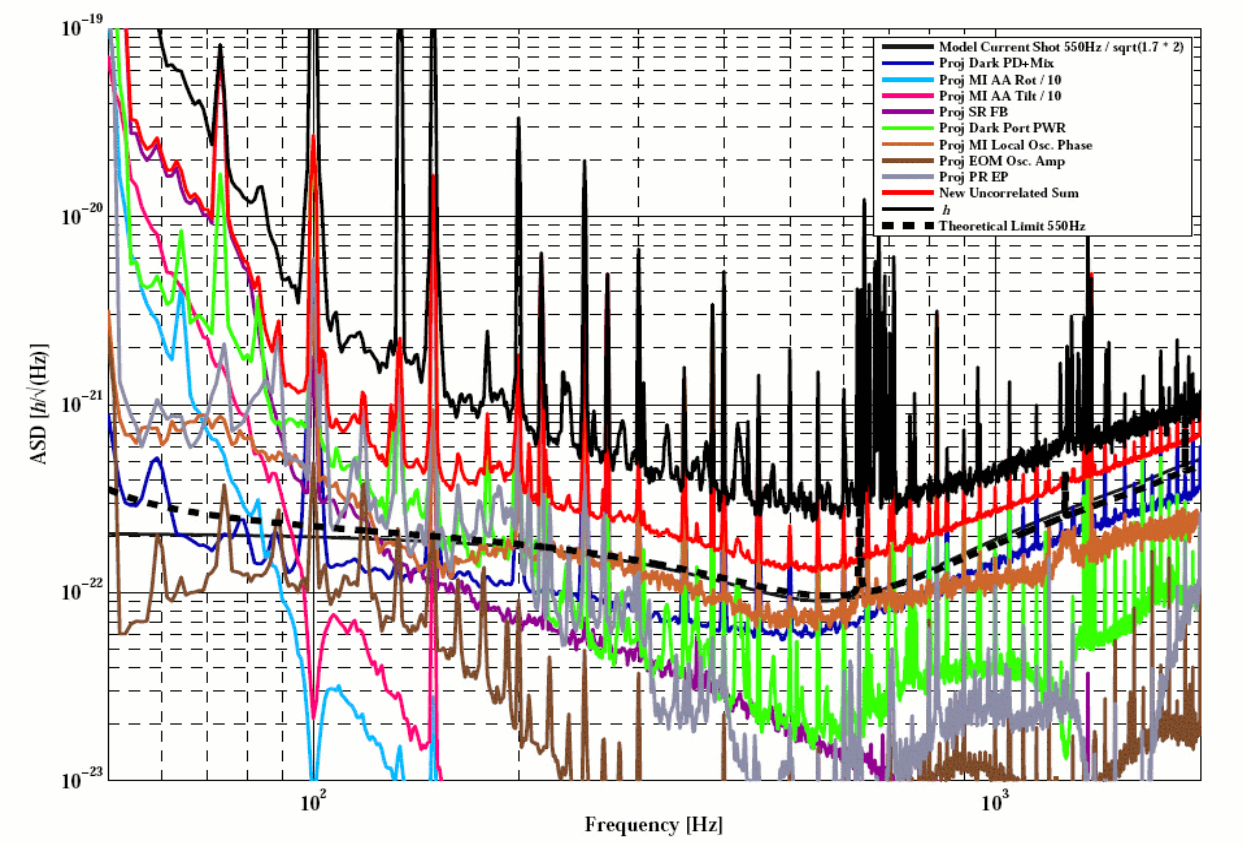
agreed that DC_readout gives X times better shotnoise.

Dark noise



Should gain quite a bit with DC_readout.

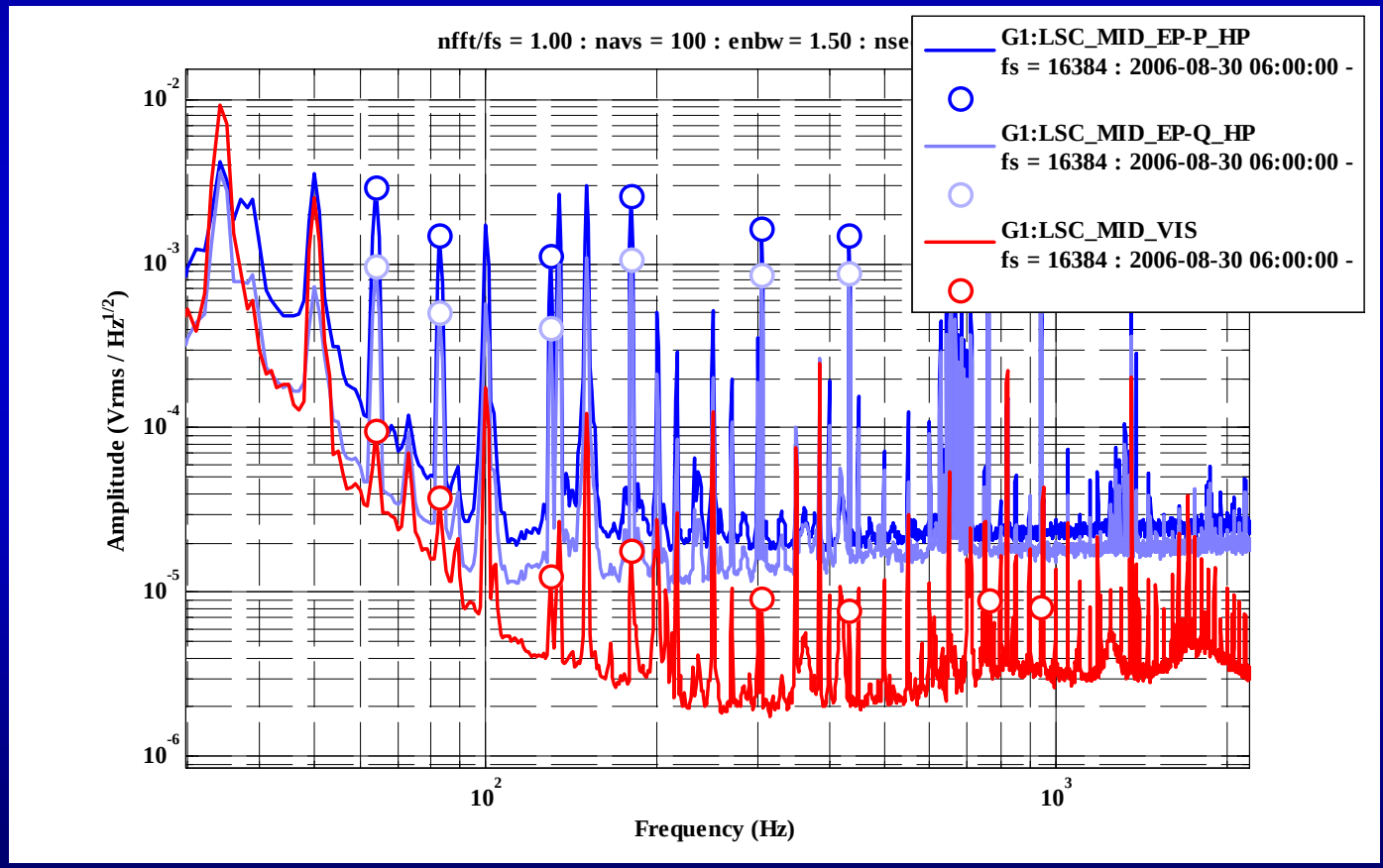
Oscillator phase noise



Will be gone when going to DC_readout !! ☺

First step towards DC-readout (1)

We see already the MI differential calibration lines in the DC power at the dark port (10 times less sensitive than the GW channel)



First step towards DC-readout (2)

1st IDEA (Hartmut)
demonstration gain sensitivity at high frequency (few kHz):

- **Leave the detector control mainly as it is at the moment (still use Schnupp modulation and use error signals derived from RF).** (MI_long + MI_AA from MI_quad_PD)

- **Introduce an offset from dark fringe.**

- **Add a output mode cleaner in air in the HPD path (aiming for reducing the MI sidebands by a factor of 10).**

- **That will give poor sensitivity at low frequencies, but there is a chance to confirm the gain in sensitivity at high frequencies.**

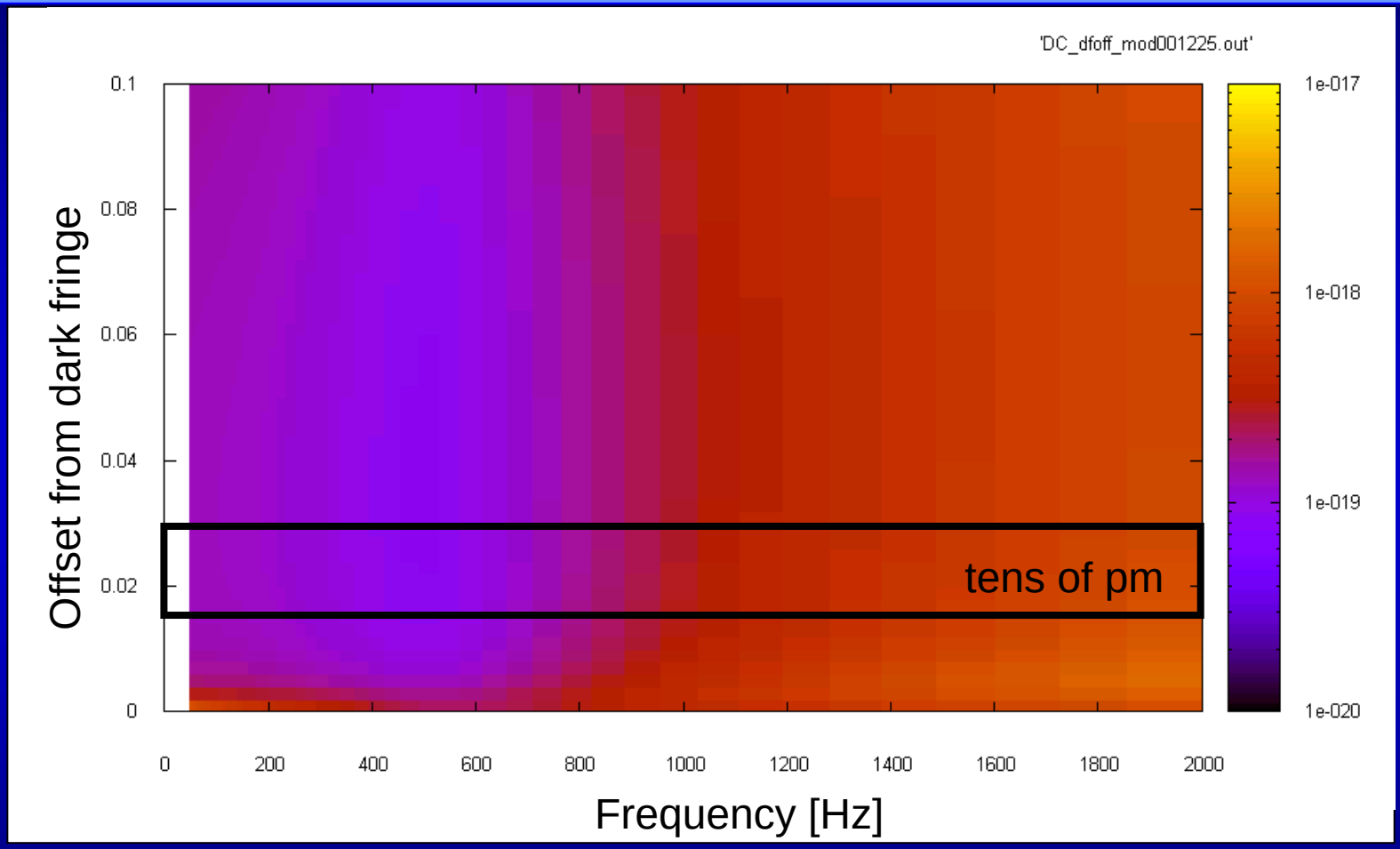
Simulations required !

We need to simulate:

- Determine the optimal dark fringe.
- Do we still get reasonable error signals for the Michelson (RF) at the required dark fringe offset.
- What are the requirements for the output mode cleaner
- How to noise transferfunctions change
(for instance frequency and laser amplitude noise)

Problem:
At the moment we see some disprecany between results from simulations and measured values.
If we want to recieve reliable result from simulations we have to invest time and manpower to measure several parameters!!

Determine the offset needed *(prelimanary)*



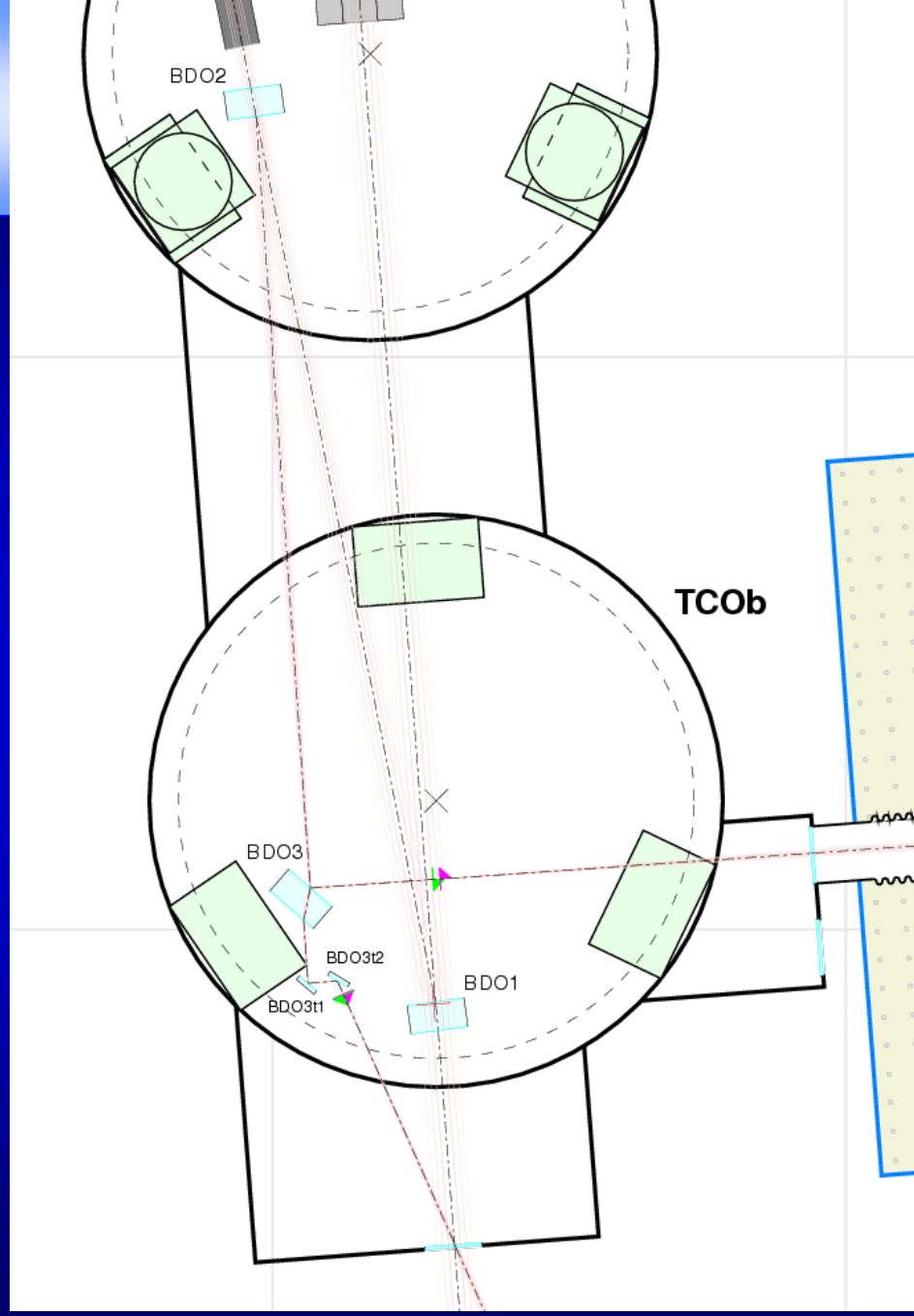
The optimal offset from the dark fringe strongly depends on the actual light field contributions at the dark fringe.

=> Need to get this piece of information. Measurements required !!

The far future

If we really want to do it right we propably have to:

- Suspend the OMC and put it into vacuum.
- To redesign the BDO2 suspension and shift it.
- Think about from where we can derive several control signals (MI_AA).
- Think how to reduce technical noise at low frequencies.
- …. (long list)



E n d

Acquisition of Dual Recycling