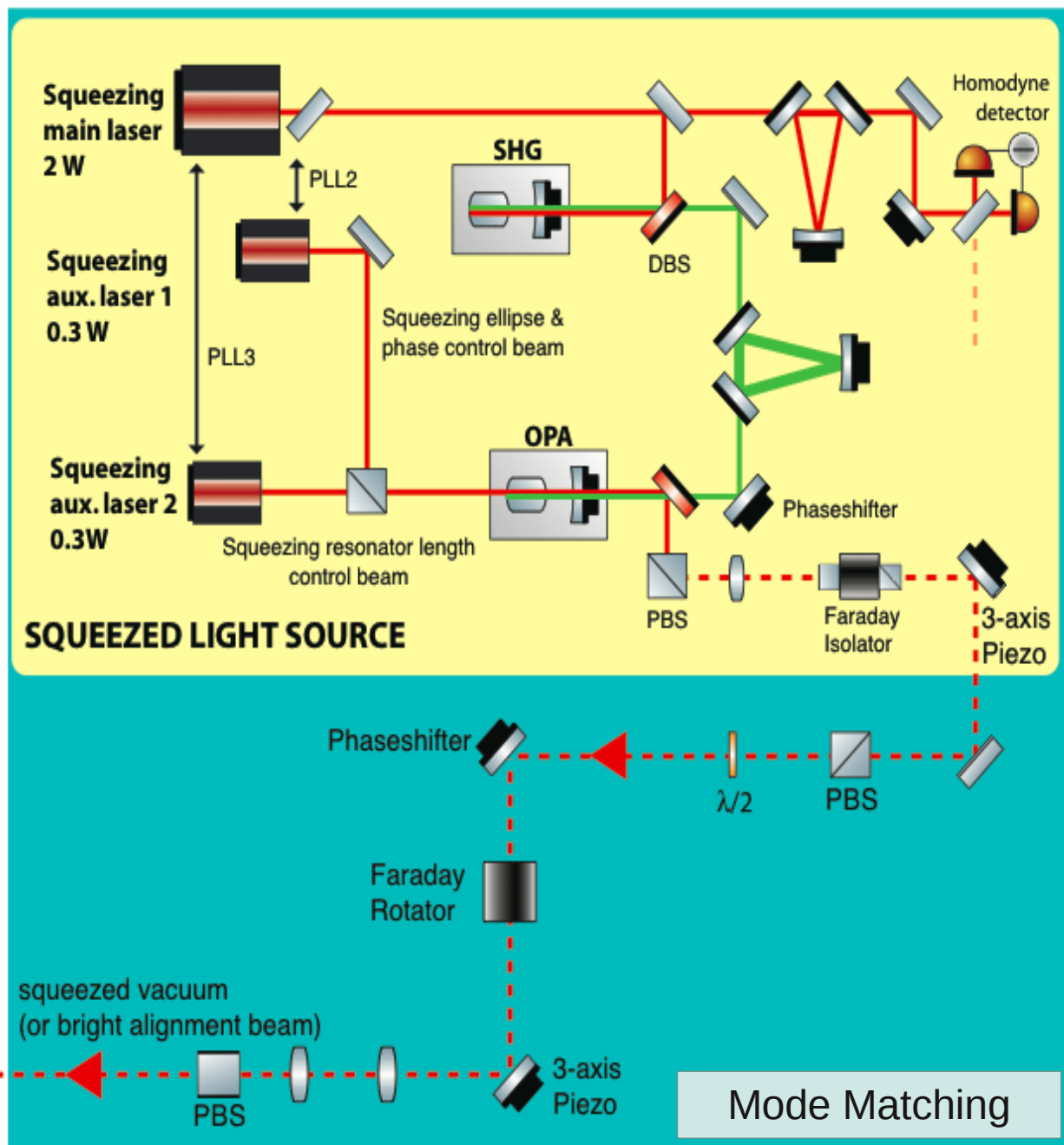
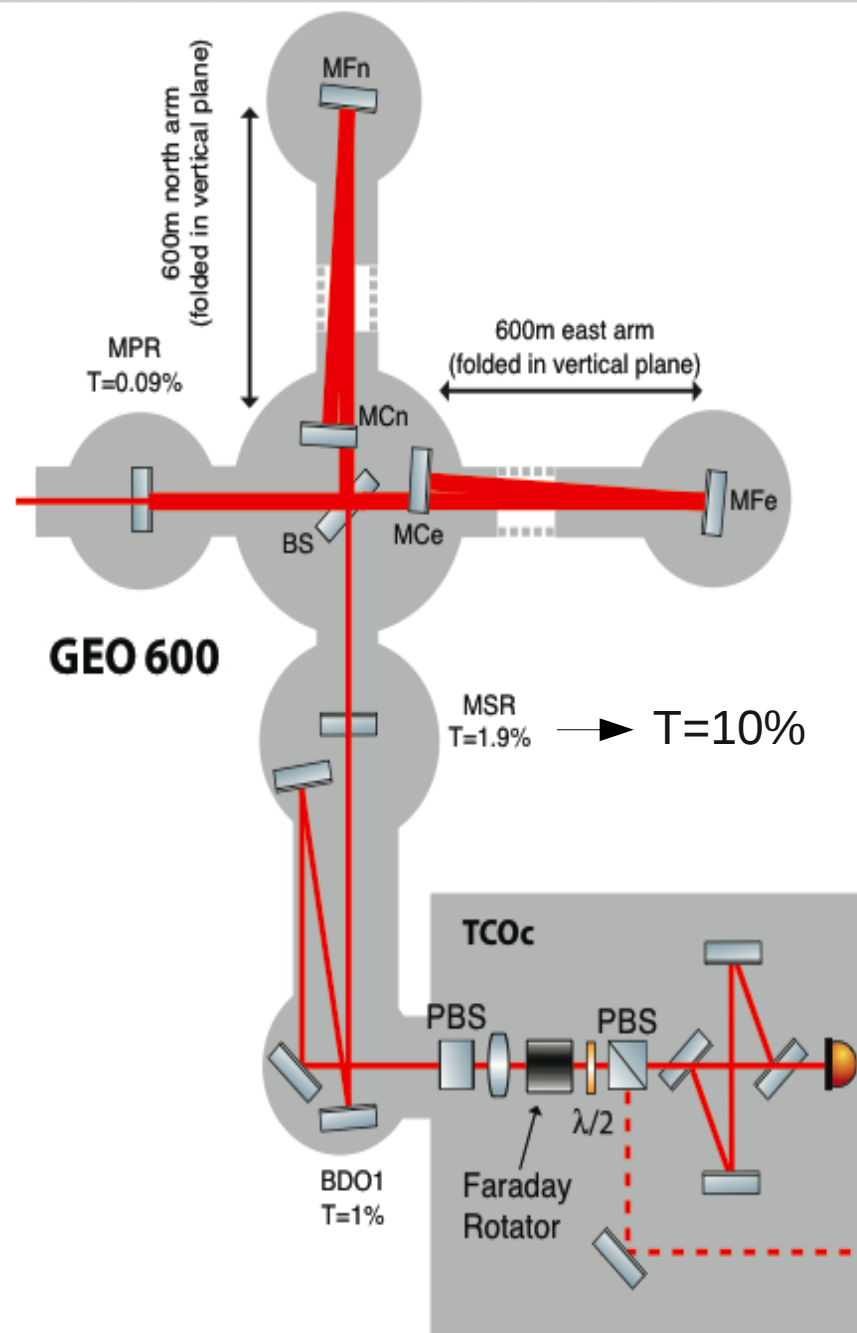


Squeezing GEO600

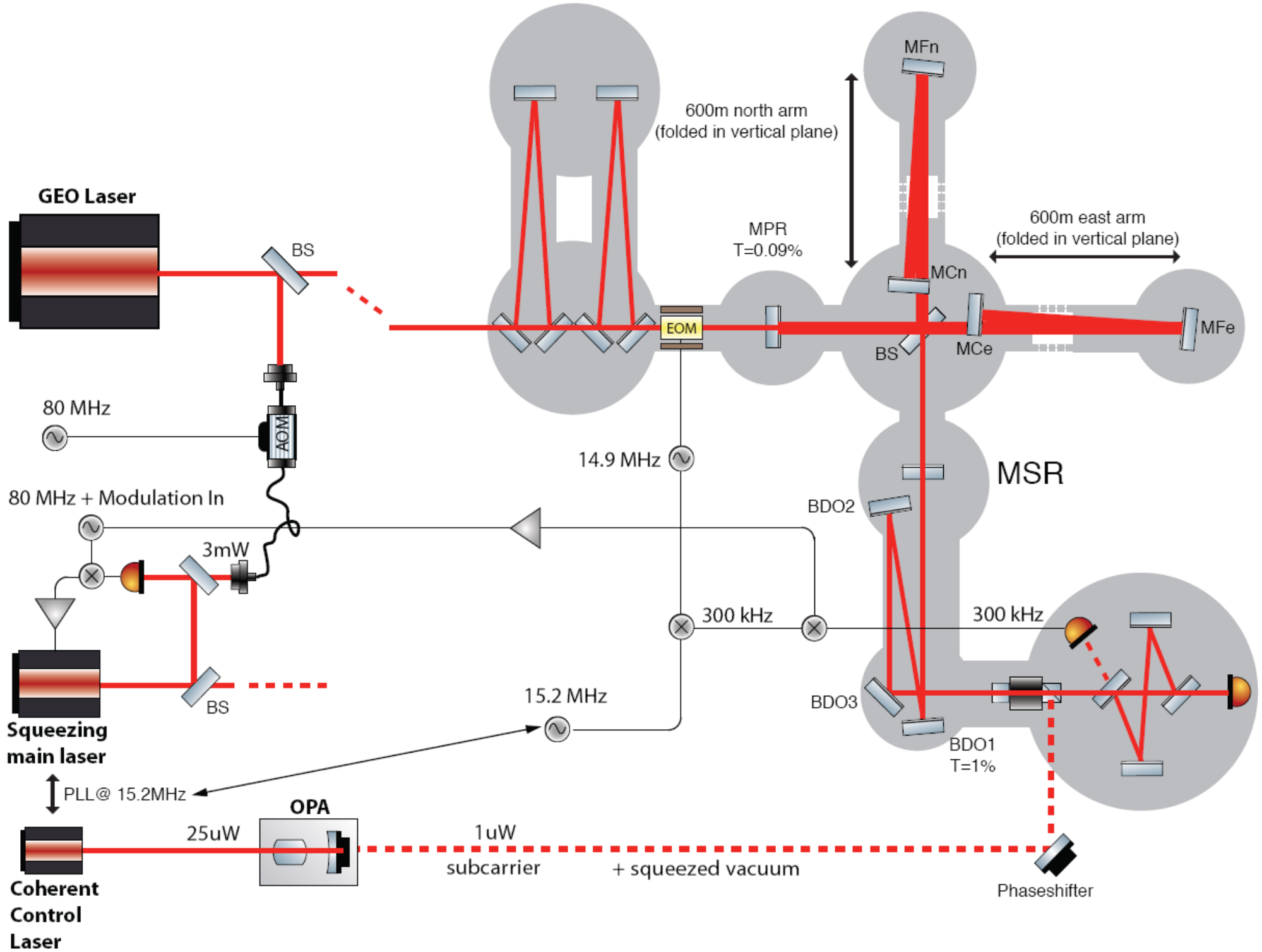


H.Grote, AEI
GWADW
Hawaii, May 2012
H.Vahlbruch, K.Dooley, ...

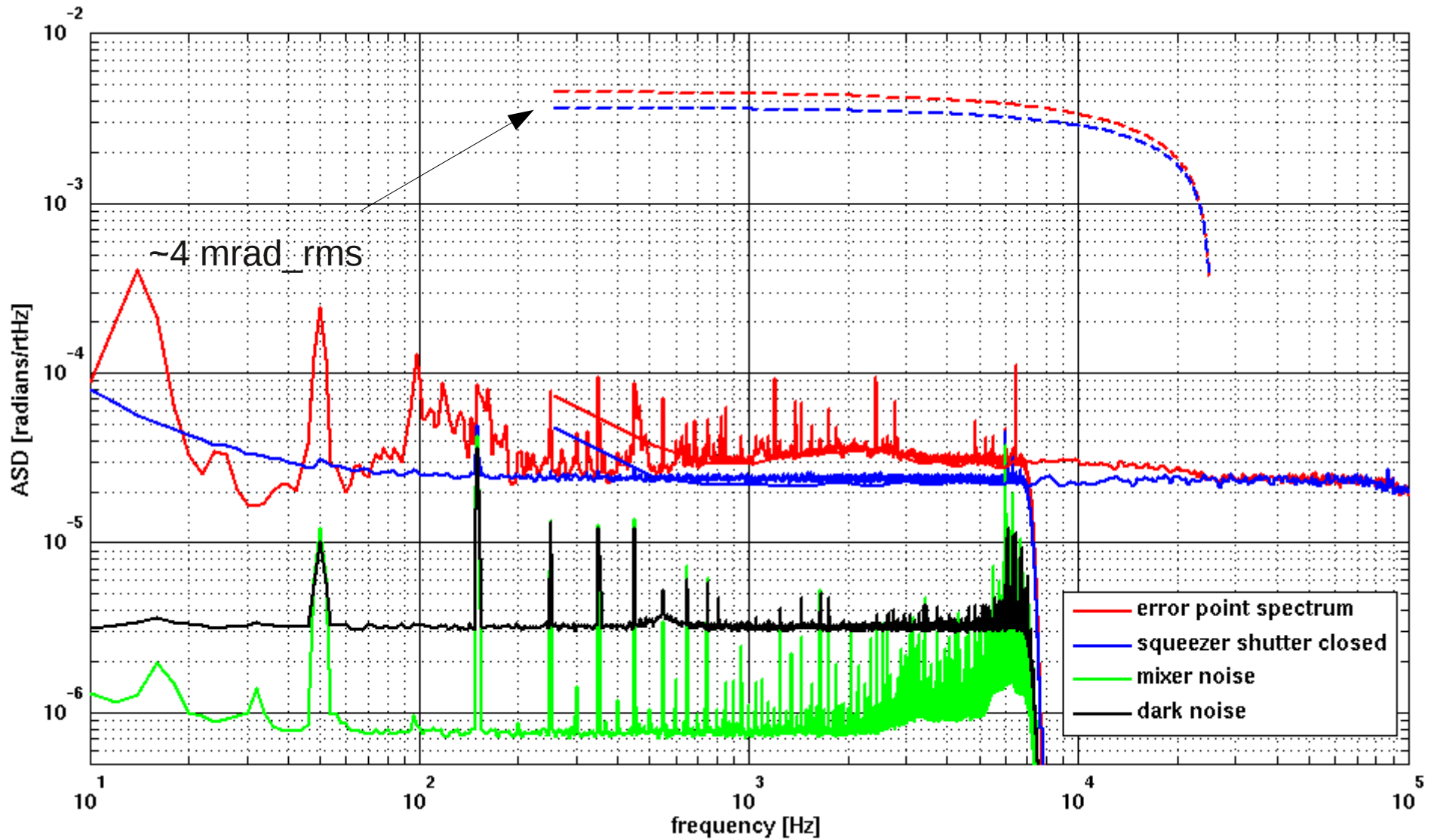


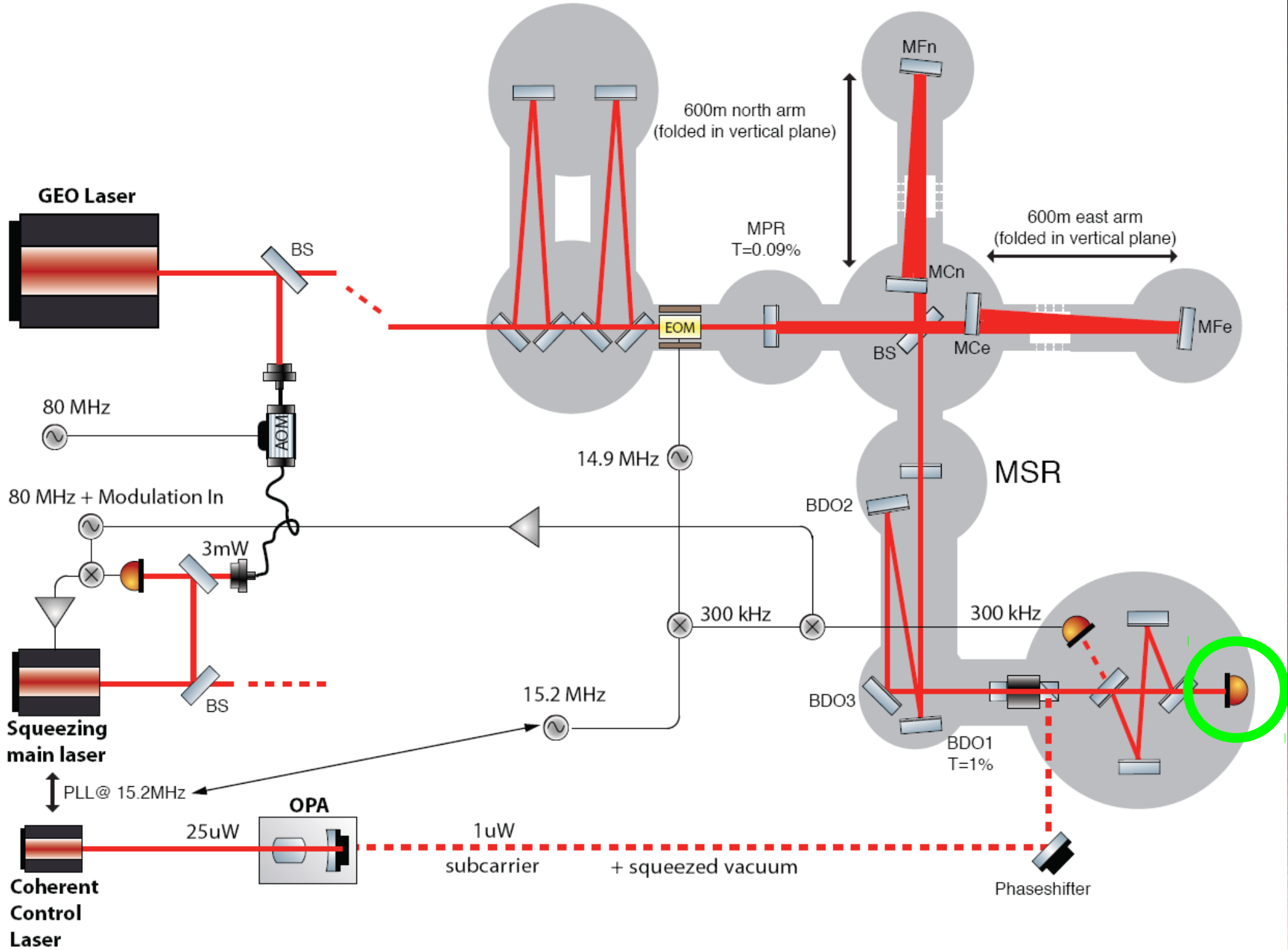
Squeezing Phase Lock

- Start with SQZ master to IFO main laser (fiber/PLL)
- Error signal in refl. of IFO (Coherent Control signal)
different ports / possibilities
- Feedback to SQZ master frequency (DC-2kHz)
- Low-freq. Error signal ($<0.01\text{Hz}$) from noise dither



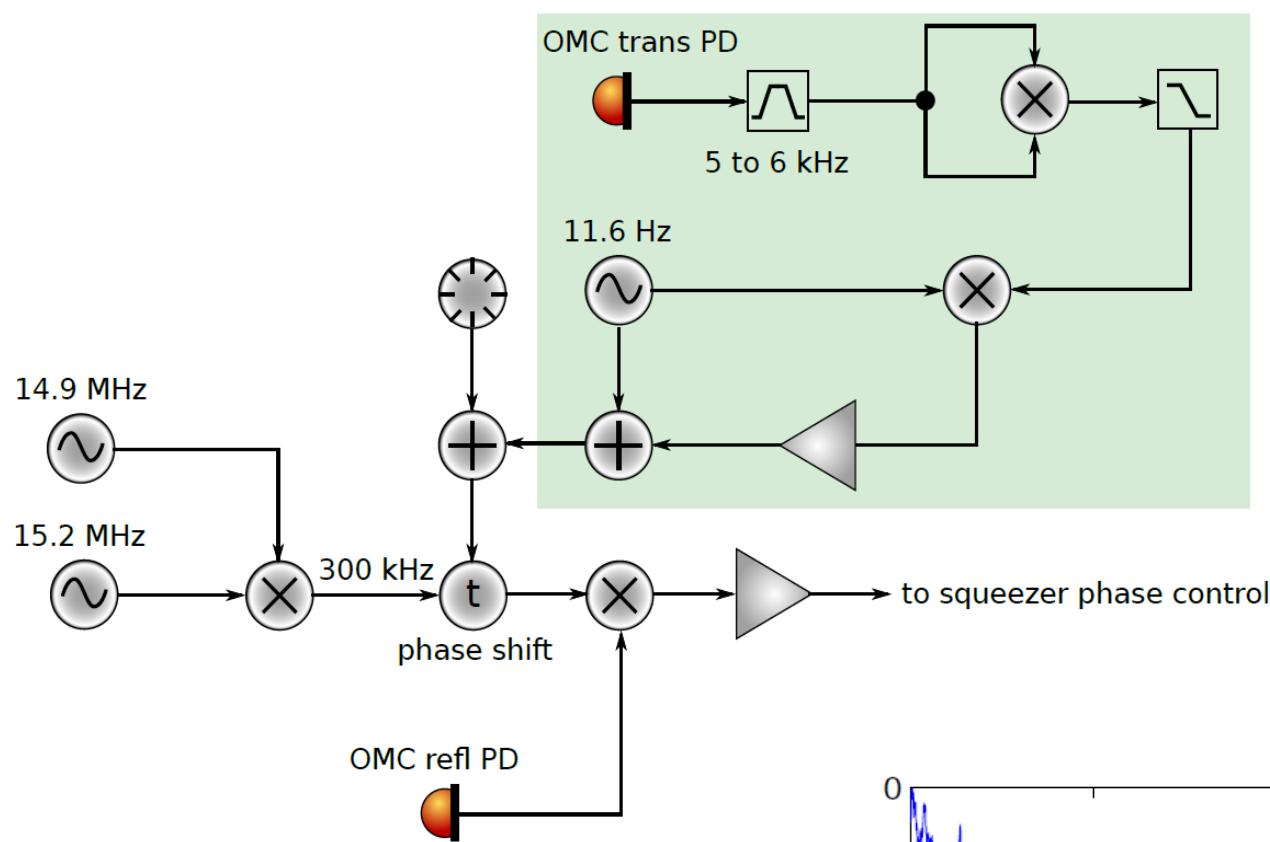
SQZ phase lock error point (in-loop)



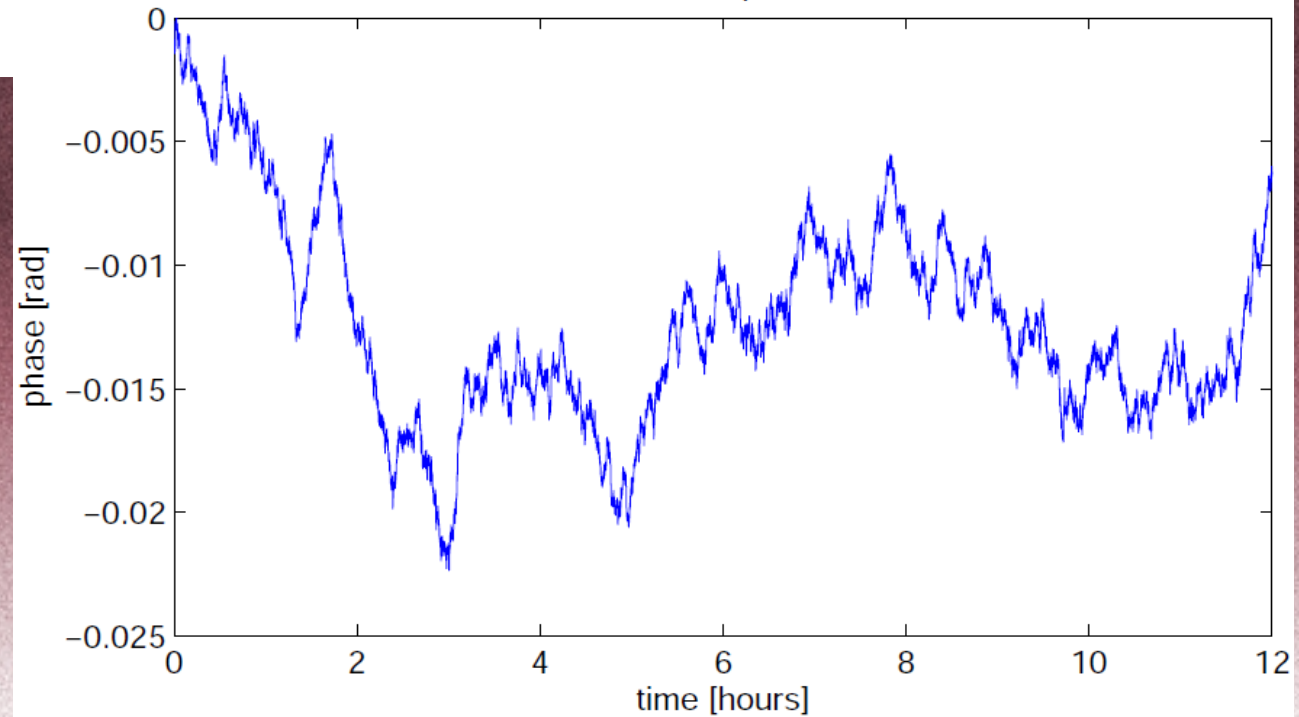


Noise dither for low-freq. Correction.

$BW \leq 10\text{mHz}$



Noiselock loop feedback



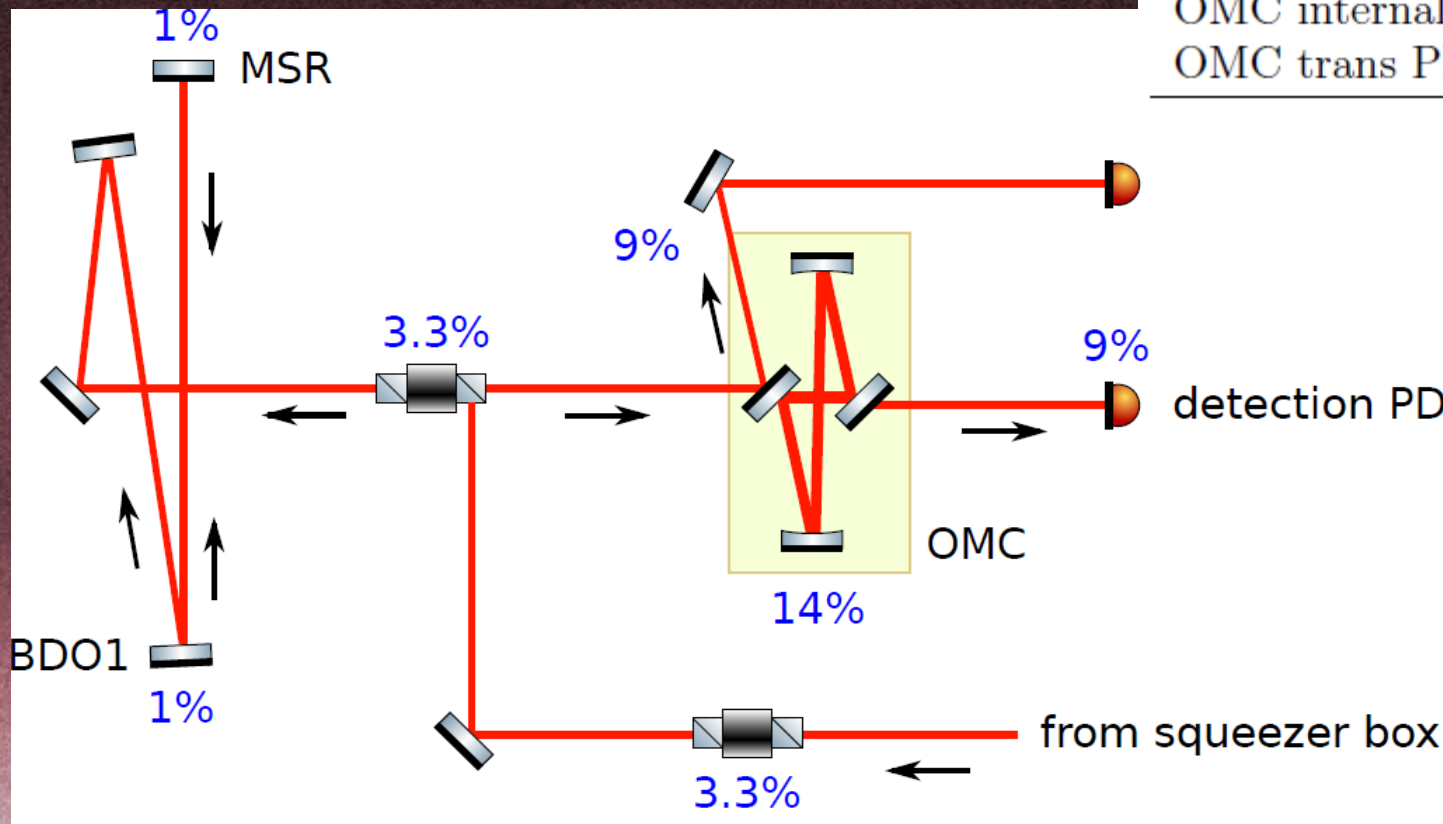
What Limits The Observed Squeezing?

- Optical loss: **detection efficiency ~ 0.63**
- Phase-noise (LF+RF): **$\sim 4+8\text{mrad}$ known**
- Alignment (TBD)
- Detection Noises: **$0.1-0.4\text{dB}$ degradation
(@ 3dB expected)**

Observed squeezing almost matches estimated squeezing,
...well, sometimes!

Optical Loss

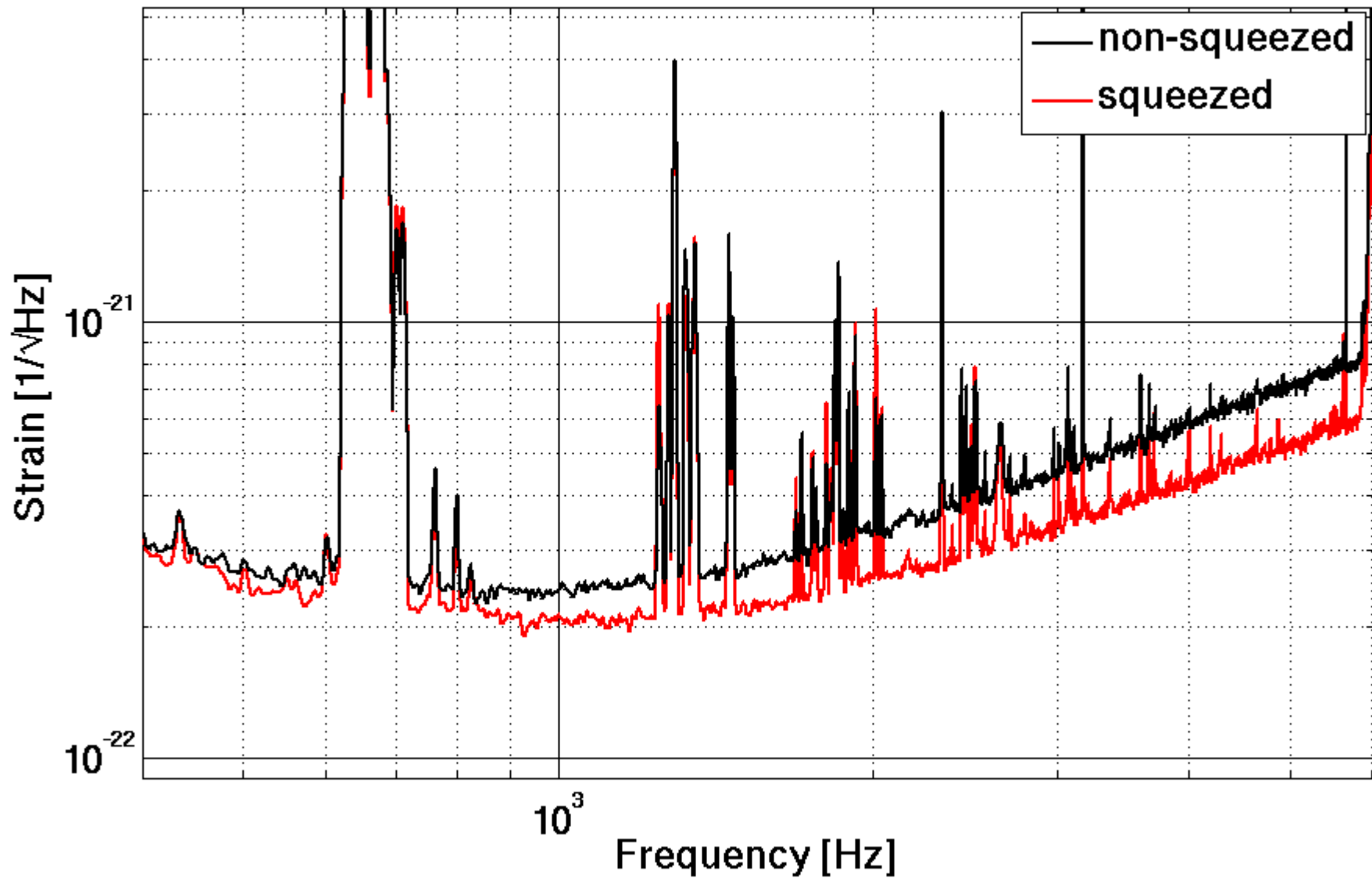
component	power loss
squeezer path Faraday	3.3%
output port Faraday	$3.3\% \times 2$
BDO1 transmission	$1\% \times 2$
SR cavity (when locked)	1%
OMC mode-matching loss	6%
squeezer mode-matching loss	2%
OMC AR coating loss	1%
OMC internal losses	14%
OMC trans PD detection loss	9%



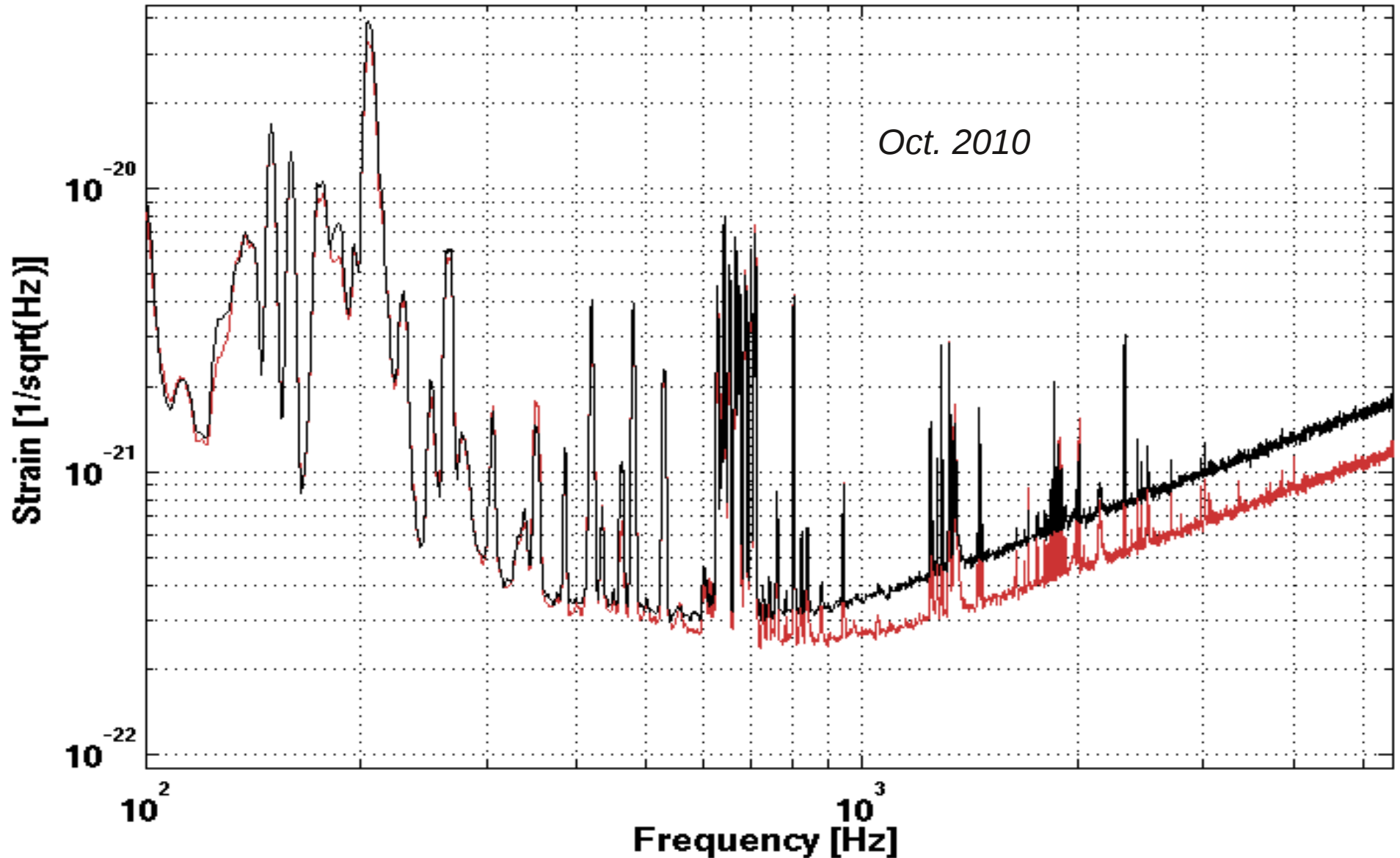
Detection Efficiency:
0.626

(Faraday Rotators: 0.65% loss)

Recent: $\sim 2.8\text{dB}$

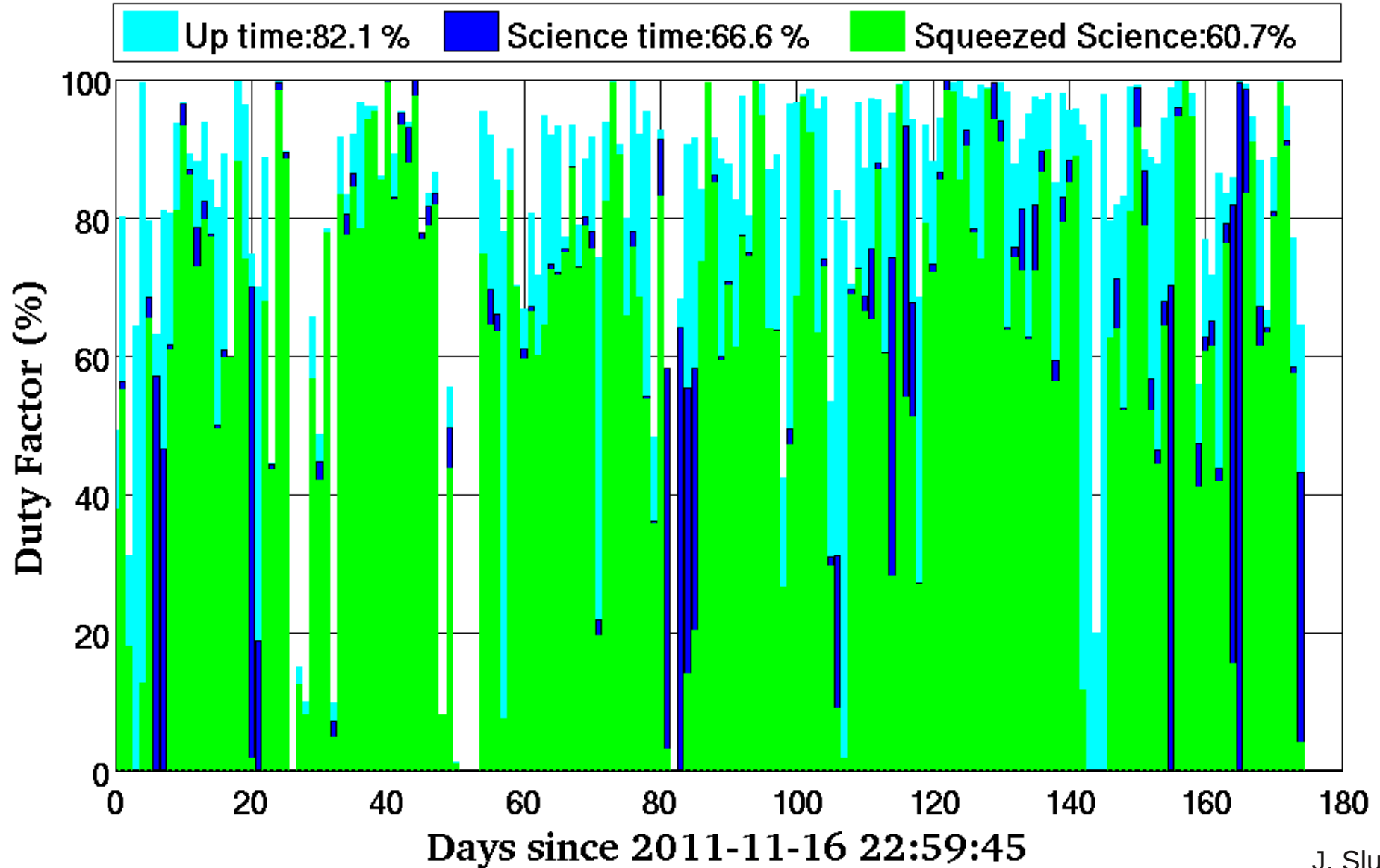


With 2%-MSR: up to 3.5dB



High-QE PD had degraded to 97% QE by end 2011

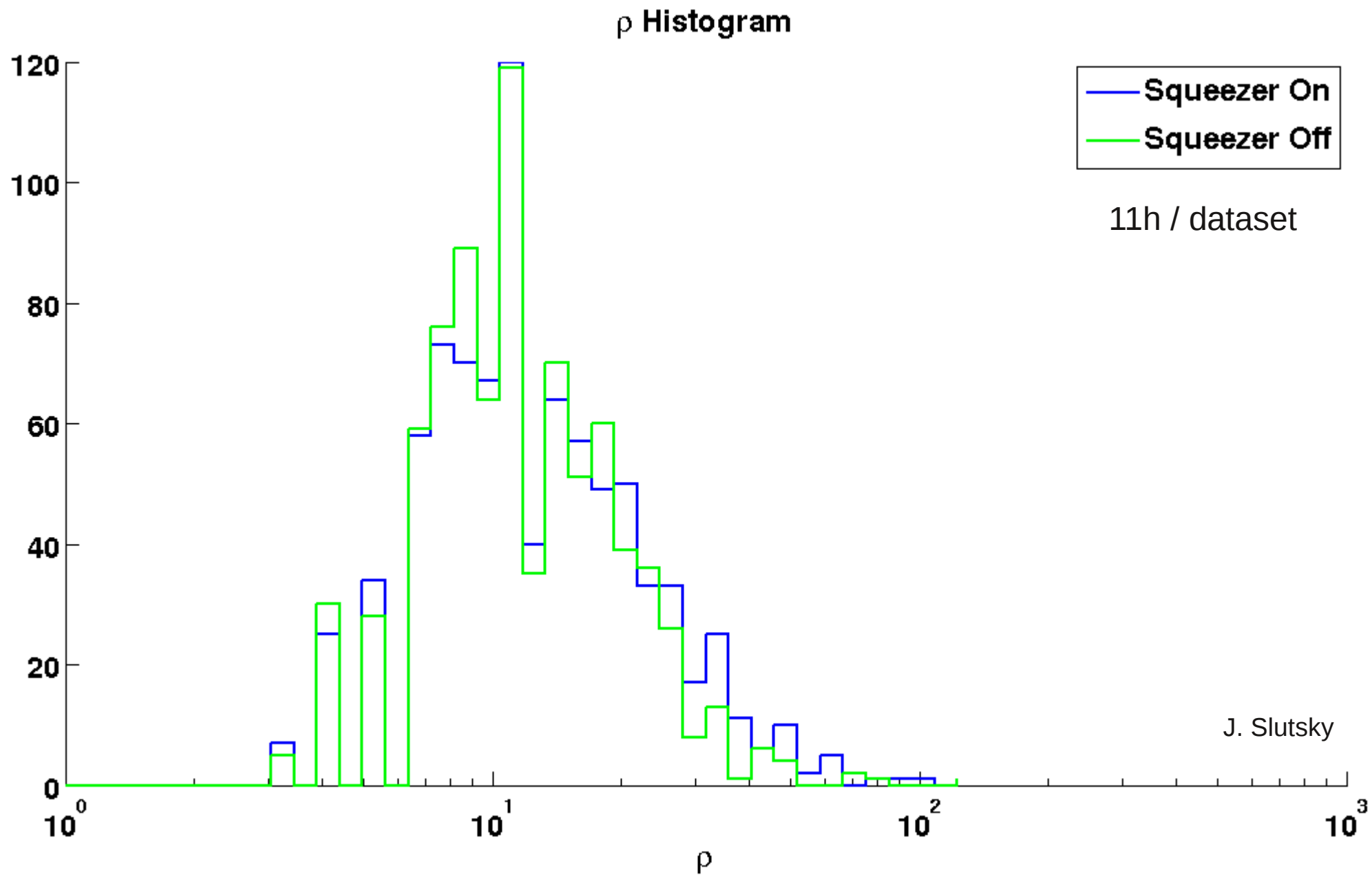
½ Year of 'Continuous' Squeezing



J. Slutsky

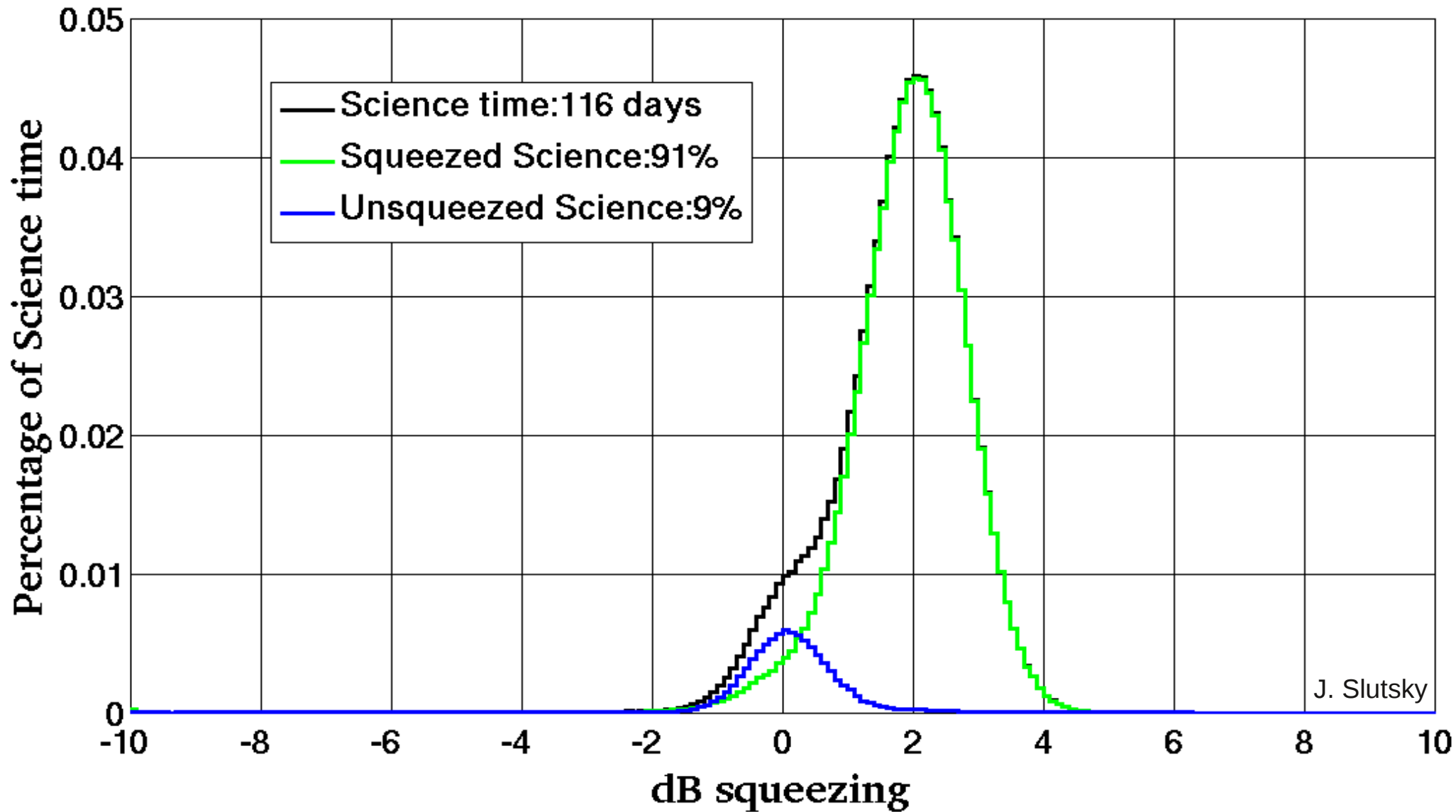
91% of science time is with squeezing applied

No Excess Glitches from Squeezing



1/2-Year Performance

Histogram of squeezing GEO600 (4400-4600Hz)



J. Slutsky

Future (GEO)

- Need Automatic Alignment (started)
- Need OPA temp set-point control
- Lower OMC loss (->2%), high-QE PD (->1%)
- Better MM (remote-control lens in vacuum)
- Understand and Remove excess noise
- Lower det. Noise (main IFO)
- ->6dB look realistic, perhaps little more...

Future (Adv. Detectors +)

→ from 6 to 9 dB

- Again: low-loss OMC
- High QE PD's
- Remote MM (IFO to OMC, SQZ to IFO)
(may be part of loop)
- Realize low-loss Isolators (PBS's!)
Test Glasgow-design PBSs in GEO
- Phase noise and alignment noise budget

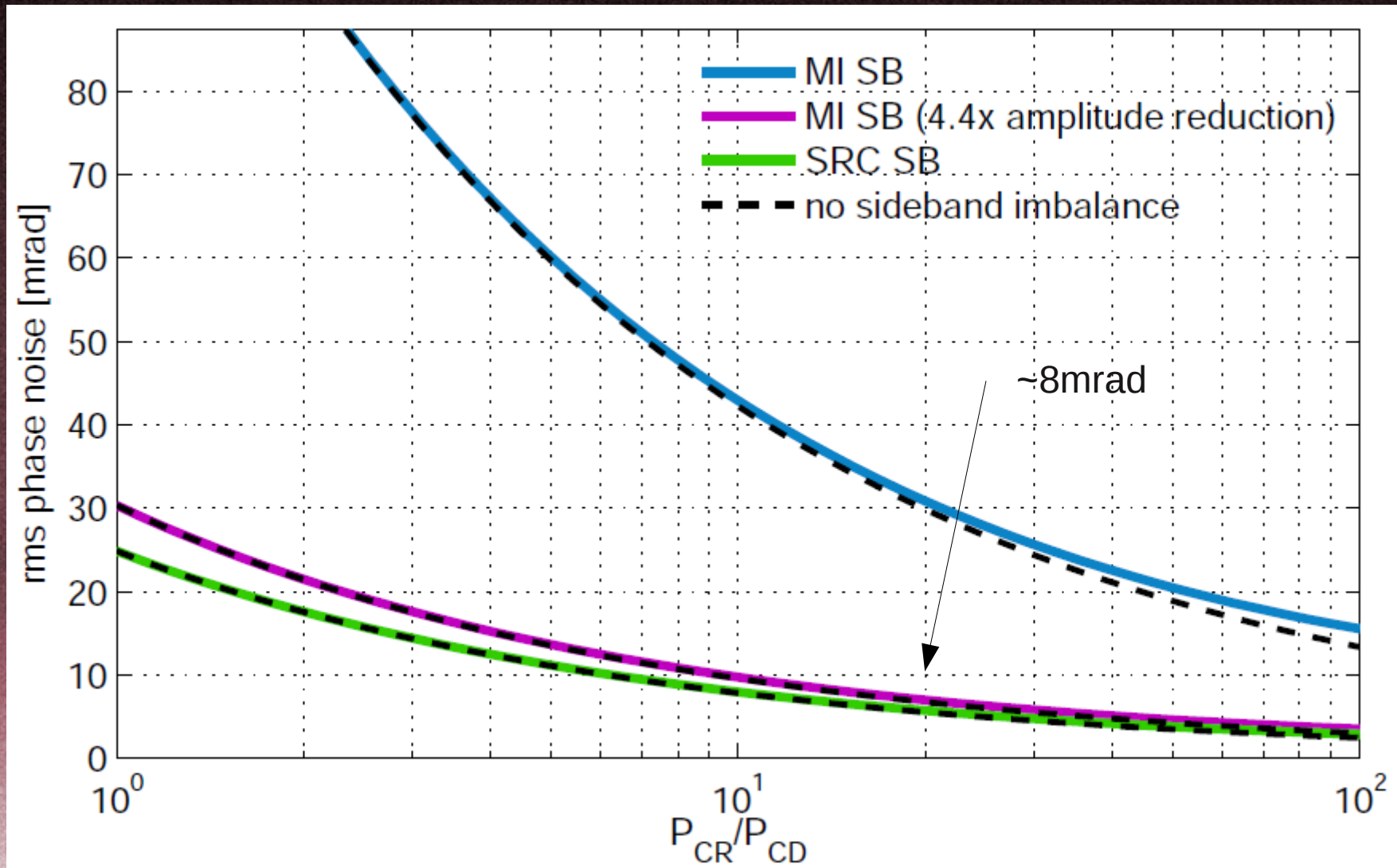
More is different



- Is it?
- 2dB 1/2year, 3.5dB max
- Want 6+dB

P.W.Anderson, Science, Vol.177, Nr.4047, 1972

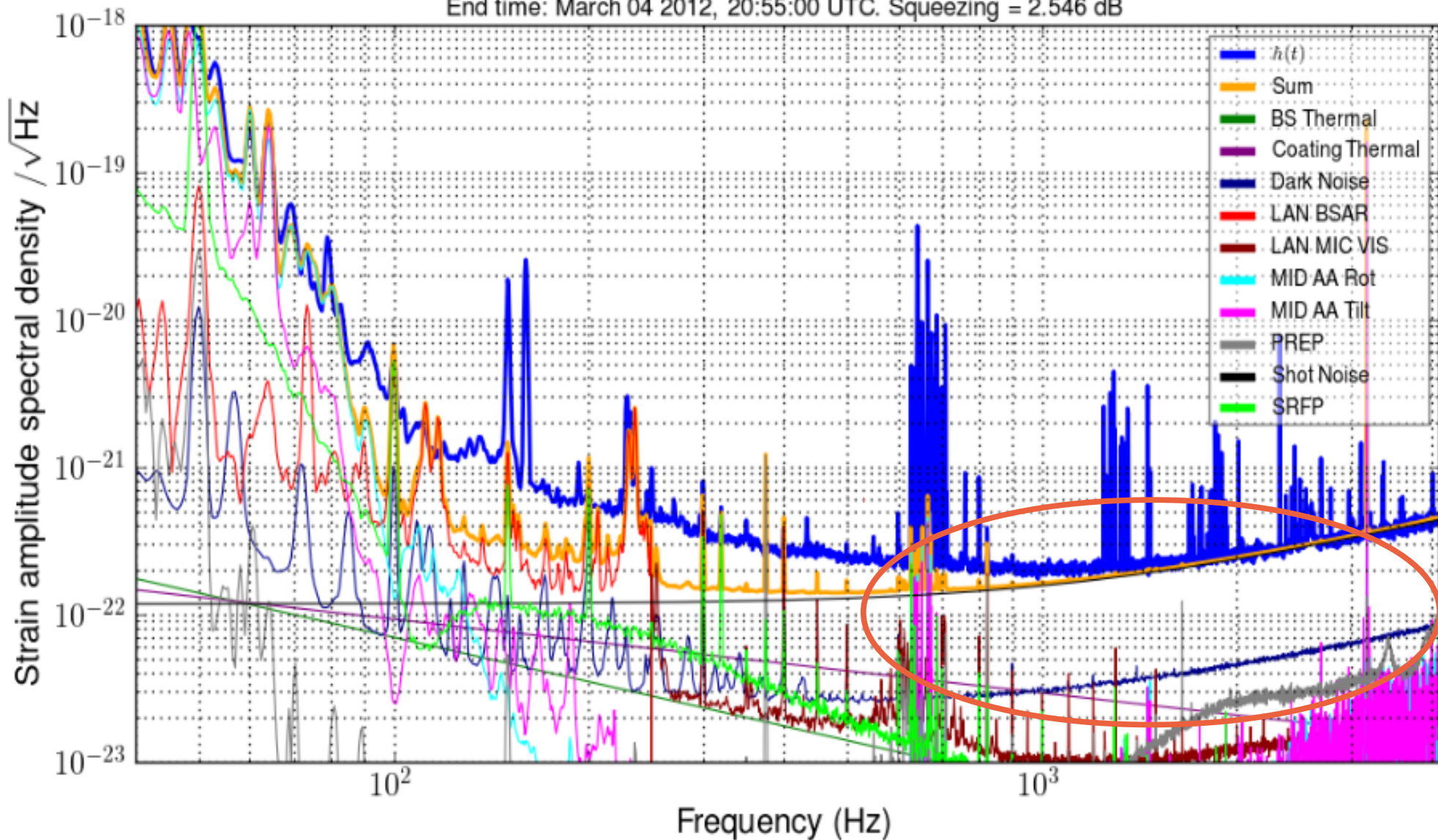
RF Phase Noise from IFO Mod. Sidebands



Detection Noise

GEO Noise Budget

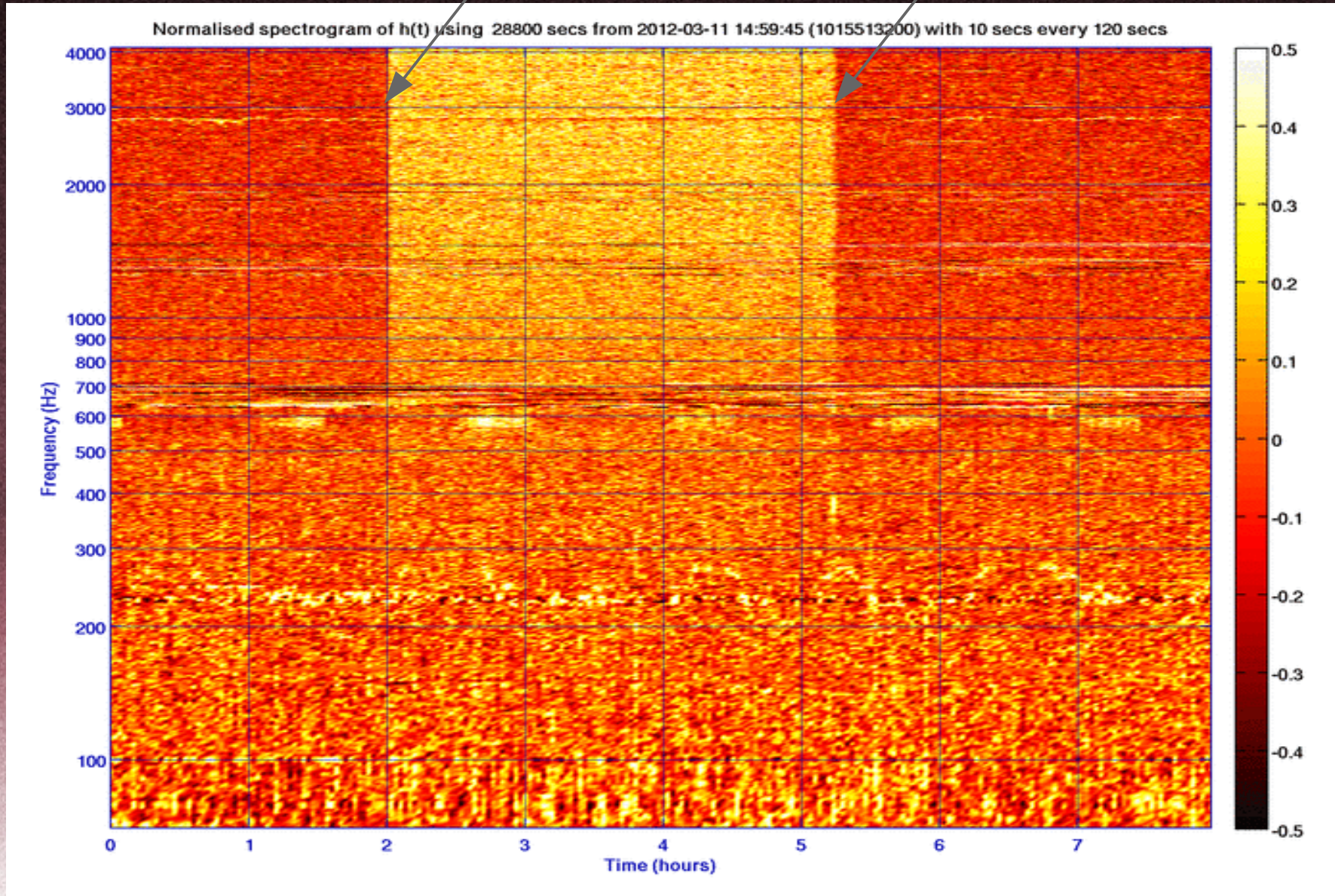
End time: March 04 2012, 20:55:00 UTC. Squeezing = 2.546 dB



Stationary Squeezing !

Squeezing switched off,

...and on again



LASER PREPARATION STAGE

