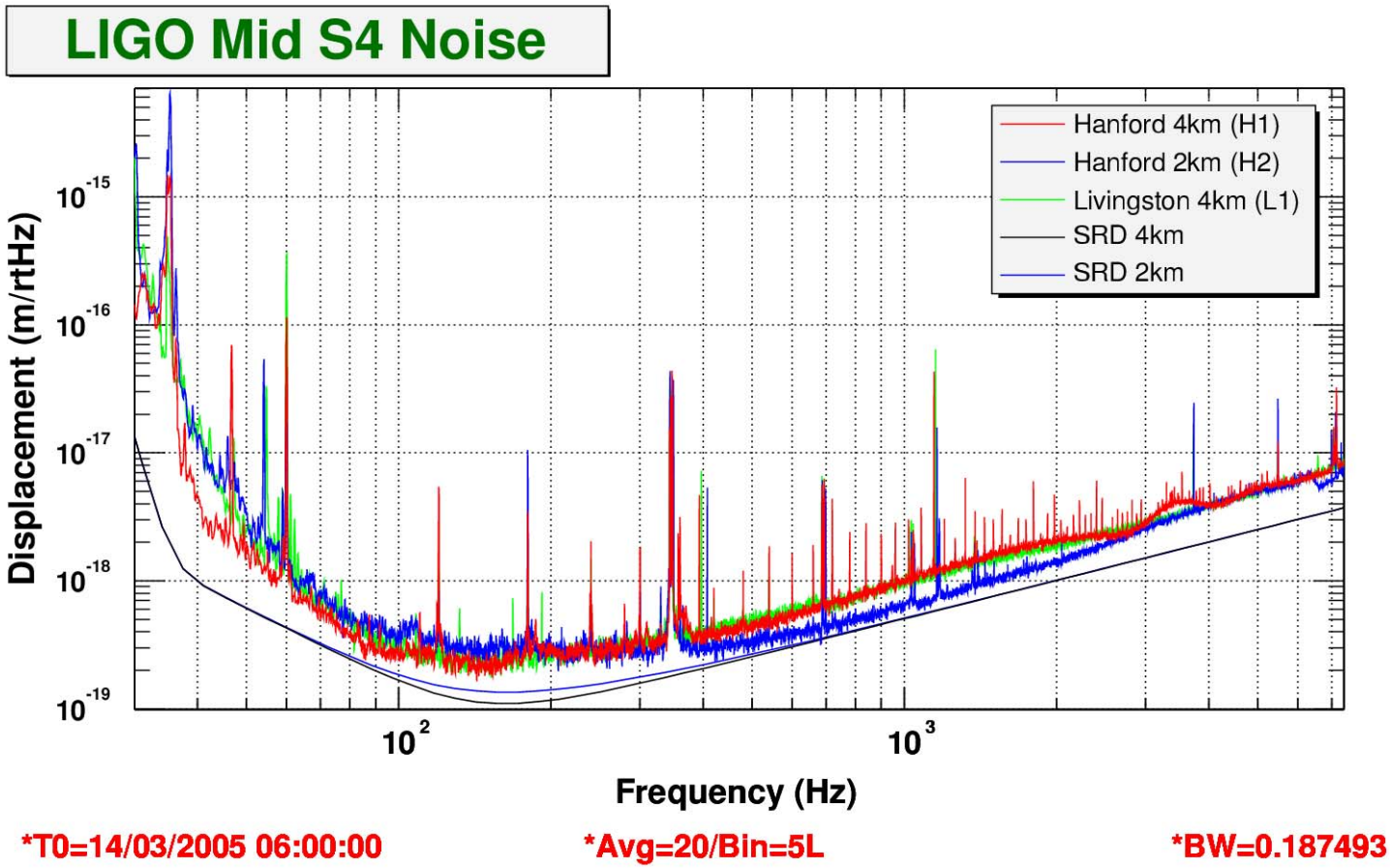
LIGO

Commissioning Progress and Plans Hanford Observatory

LSC Meeting, March 21, 2005

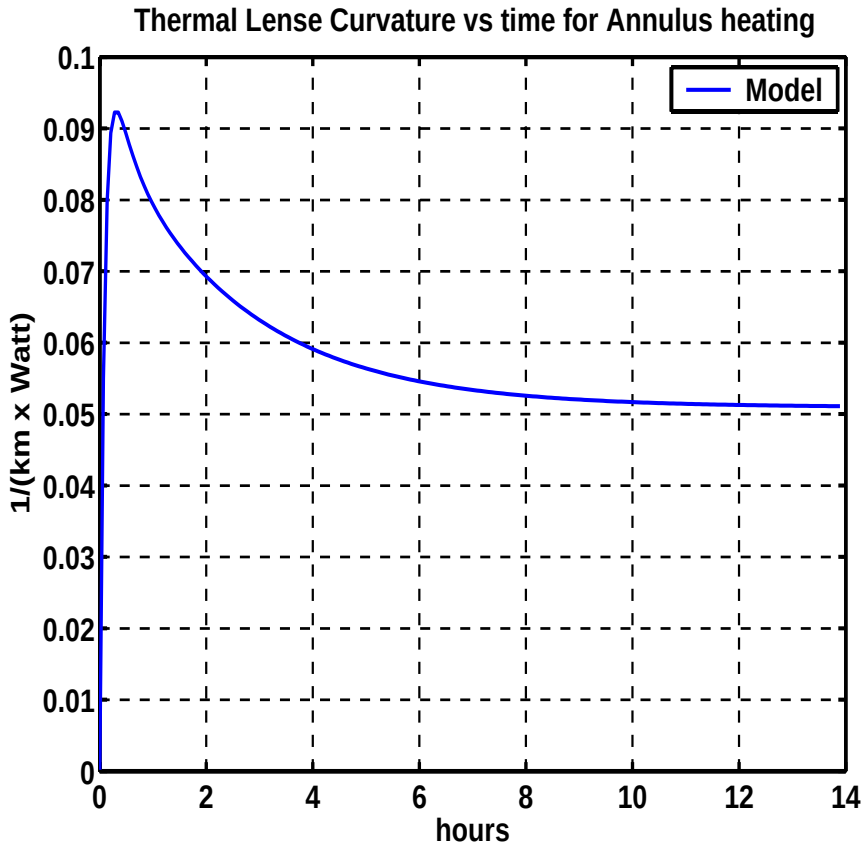
Stefan Ballmer

“Typical” noise midway through S4



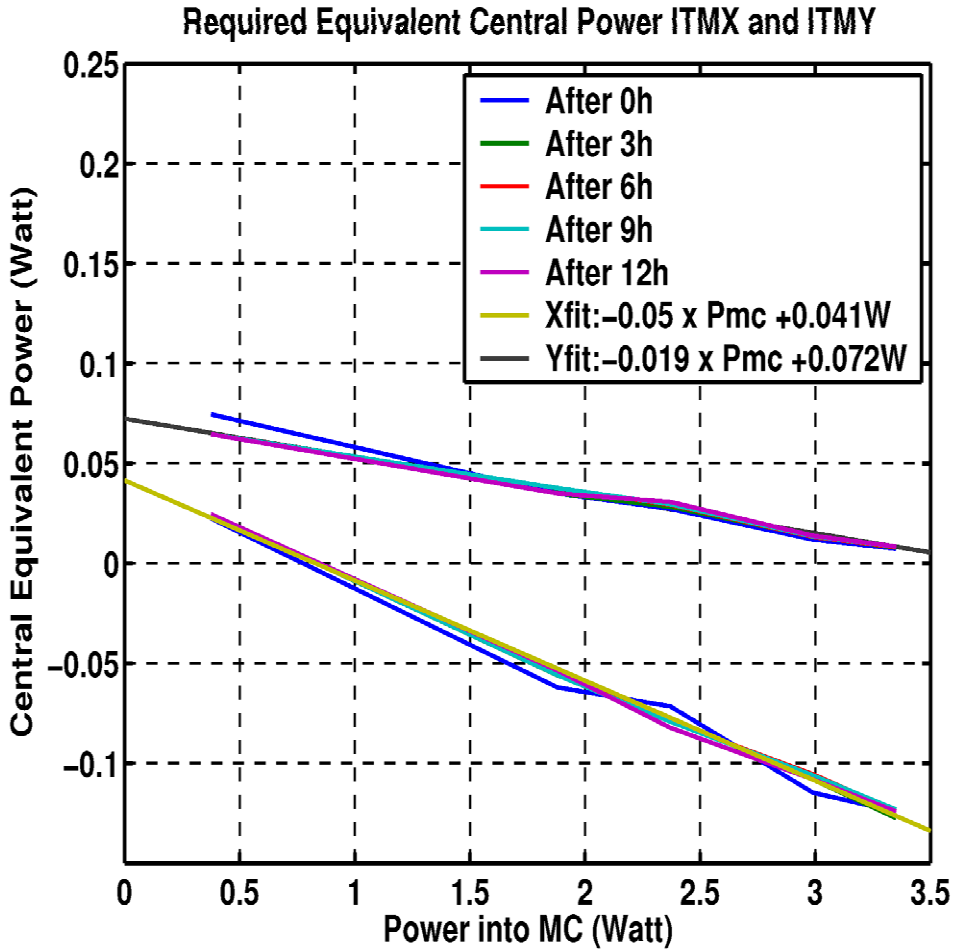
H1
Increasing the laser power

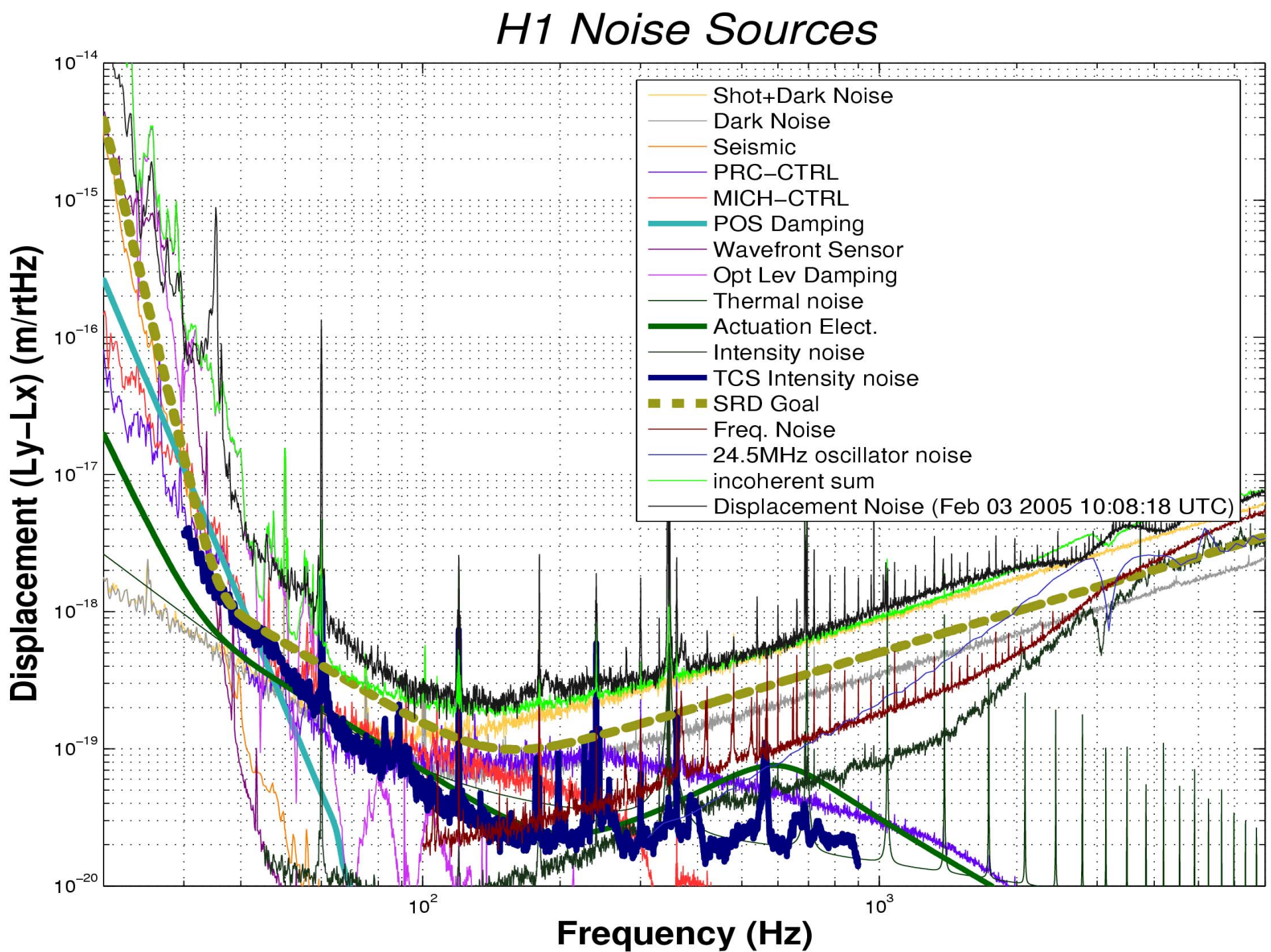
- With TCS Annulus heating we achieved optimal recycling gain
  - H1 Inspiral Range up to 8.5Mpc (back in Aug 2004, 4 Watt into MC)
- But:
  - Not stable over time because effective lens changed slowly ($T_{1/e}$=4h)
- Solution:
  - Implemented servo using Bull's eye detector on POB path and AS_I signal
  - This kept the recycling gain at maximum
  - But not enough TCS actuation range for long time operation a 4 Watt.
    - H1 at 3 Watt into the MC for S4



H1
Thermal lensing

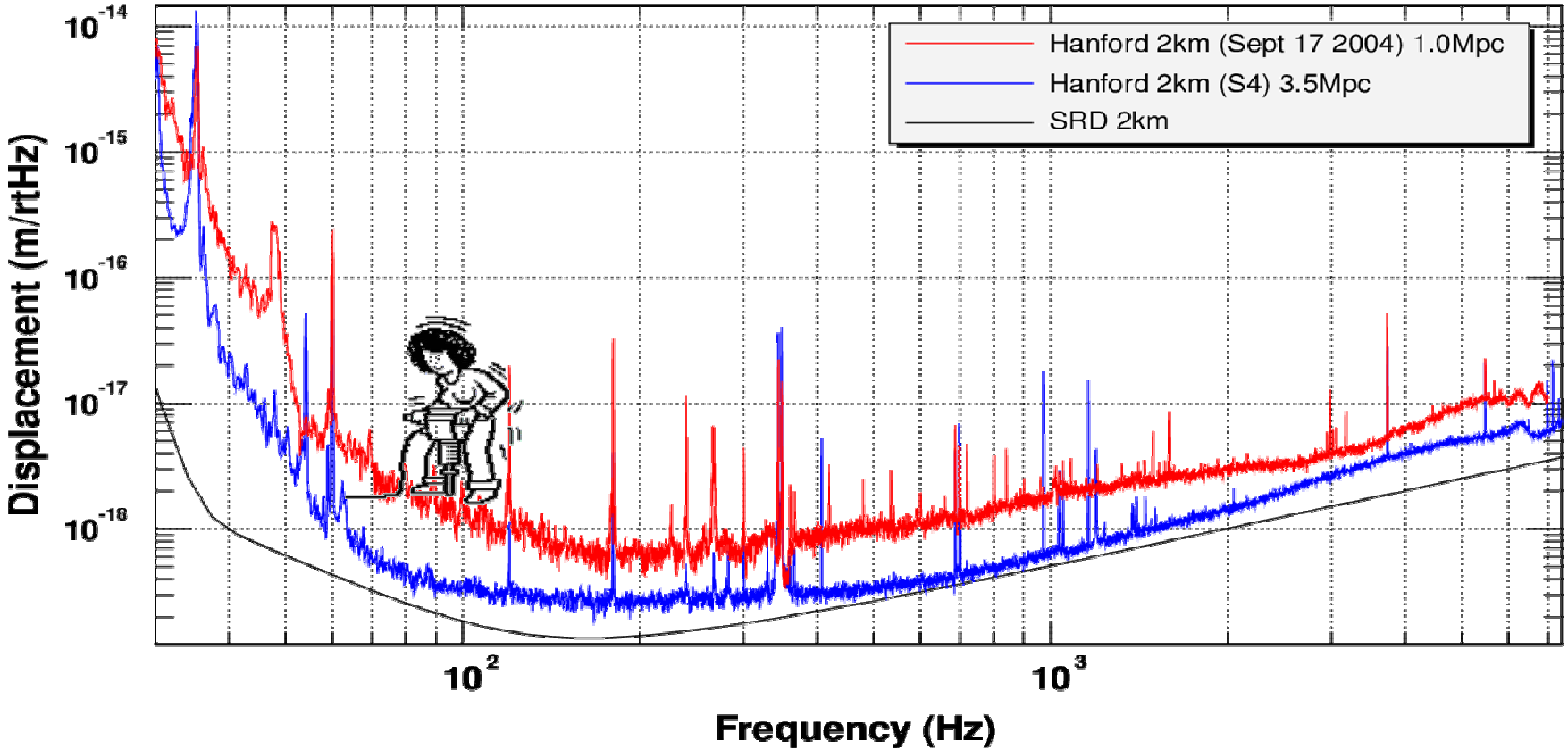
- Indirect measurement of absorbed power in H1:
  - Run H1 at different power levels
  - Let TCS Servo compensate
- Result:
  - DC offset due to beam splitter curvature
  - ~3 mWatt / Watt expected for ~1ppm coating absorption
  - 50 mWatt / Watt for ITMX
  - 19 mWatt / Watt for ITMY
- But which optics are bad?




H1 Noise Sources
Shot+Dark Noise
Dark Noise
Seismic
PRC−CTRL
MICH−CTRL
POS Damping
Wavefront Sensor
Opt Lev Damping
Thermal noise
Actuation Elect.
Intensity noise
TCS Intensity noise
SRD Goal
Freq. Noise
24.5MHz oscillator noise
incoherent sum
Displacement Noise (Feb 03 2005 10:08:18 UTC)
Displacement (Ly−Lx) (m/rtHz)
Frequency (Hz)
10^−14
10^−15
10^−16
10^−17
10^−18
10^−19
10^−20
10^2
10^3

H2:
Sensitivity progress

Hanford 2km Progress



*Bin=5L

H1 and H2: Accomplished since last August

- New actuation electronics (DAC / Dewhitening / Coil Driver)
- New Table Top FSS (800 kHz bandwidth)
- Installed new MC / CM board (100kHz / 45kHz bandwidth)
- WFS head simplified (more RF gain / no oscillation)
- 1-FSR (37kHz) and 100kHz channel readout implemented
- IOT EO shutter replaced with fast shutter
- Equi=Tech balanced power installed (all End's, Mid's and DC power supplies in LVEA)
- New TCS Chillers
- Some front-end code changes:
  - gain ramping (nice!)
  - LSC to ETM SUS timing improved
  - …
- Photon calibrator: Tested on EX

H1:
Accomplished since last August

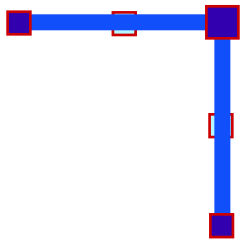
- New ISS installed (100kHz bandwidth)
- Micro-seismic feed-back system installed
- Mitigation of TCS intensity noise
- Auxiliary loops running on POX + POY (more power)
- Non-Resonant sideband REFL detector running (no improvement)
- 2nd generation OMC testing (Keita) (still beam jitter noise limited)

H2:
Accomplished since last August

- All 4 AS photodiodes + electronics installed
- A whole series of small electronics modifications copied from H1.
- Auxiliary loop bandwidth increase
- TCS system installed (but H2 already was close to max recycling gain)
- Moderate power increase (1.4 Watts into the MC)

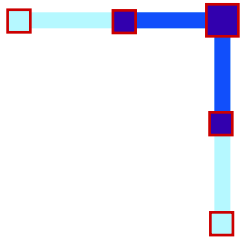
- But sometimes the biggest sensitivity improvement steps come from eliminating goof-ups…

Main Task After S4
Hanford 4 km (H1)



- Continue with excessive absorption study
  - Is it 1 bad optic or multiple optics?
  - Which optics?
  - What is bad (surface absorption / bulk absorption)?
  - Methods:
    - FLIR camera imaging of heating optics (expect ~1°C / Watt absorbed)
    - Spot size vs. heating for various interferometer ports
    - Witness sample and spare optics characterization
- 2 possible approaches:
  - Replace one / multiple bad optics
  - Increase TCS actuation range (more power / TCS for BS)
- Aim for decision in 3rd week of April

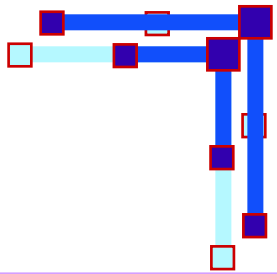
Main Task After S4
Hanford 2 km (H2)



- Power increase
  - Follow up on pre-S4 attempts
  - Refurbish Lightwave laser (currently at 4.5 Watt max)
  - AS_I range problem

- Finish catching up to H1 / L1
  - Install new ISS
  - Install 29MHz Crystal Oscillator (ordered, expected in April)
  - New low noise RF distribution system

Other Task After S4 all interferometers



- Assess environmental sensitivity (mainly seismic and acoustic)
  - Low-loss optics for ISC tables
  - Additional enclosures?
  - Floating ISCT tables?
- 60 Hz mitigation (We can't ignore it any longer…)
- More AS port photo detectors / more AS_I correction range
- Lock resonant / non-resonant sideband oscillators / RF distribution
- OMC tests on L1 and H2
- New timing system
- Remote Optical lever / transmission QPD centering
- PMC replacements
- Install all Photon Calibrators