Enhanced LIGO Status

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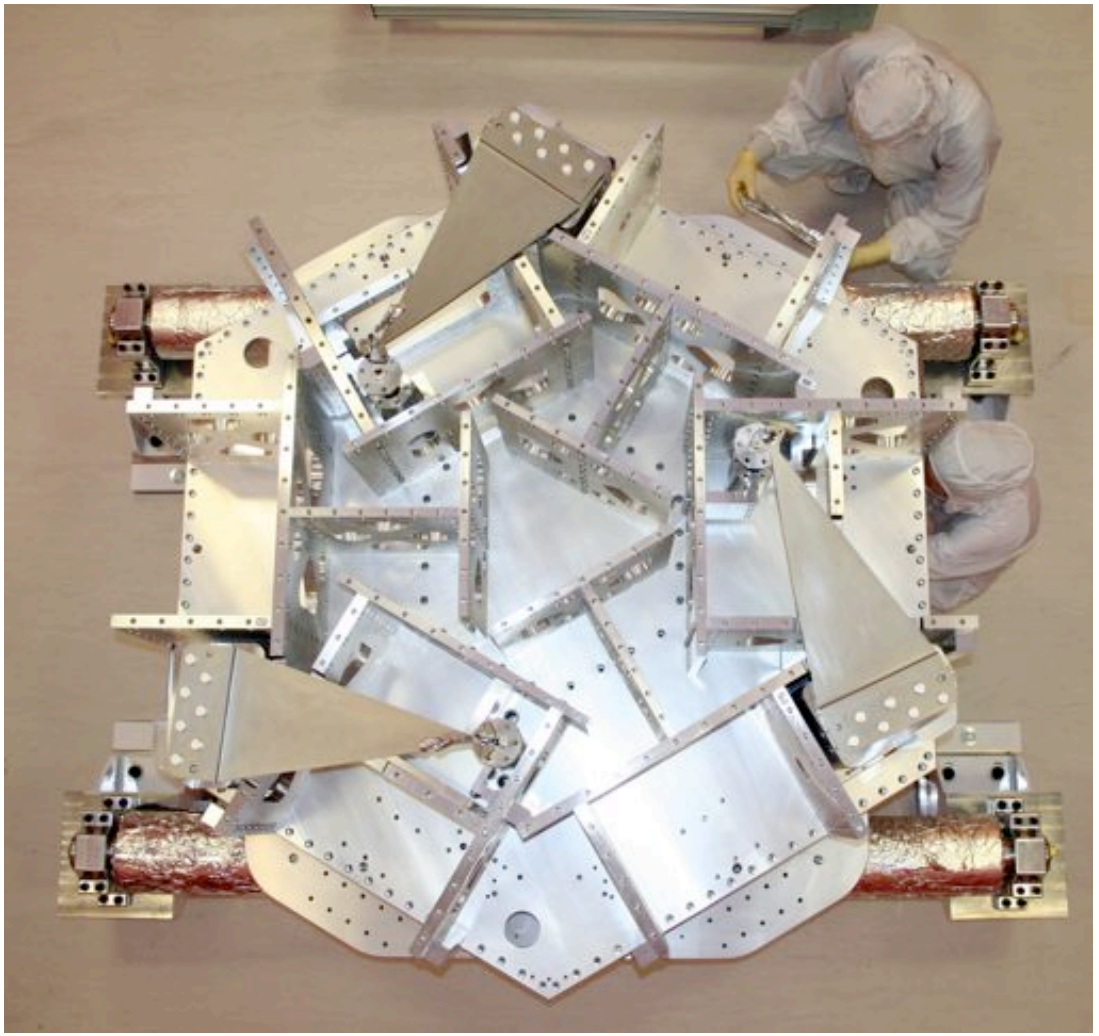
LIGO Hanford Observatory

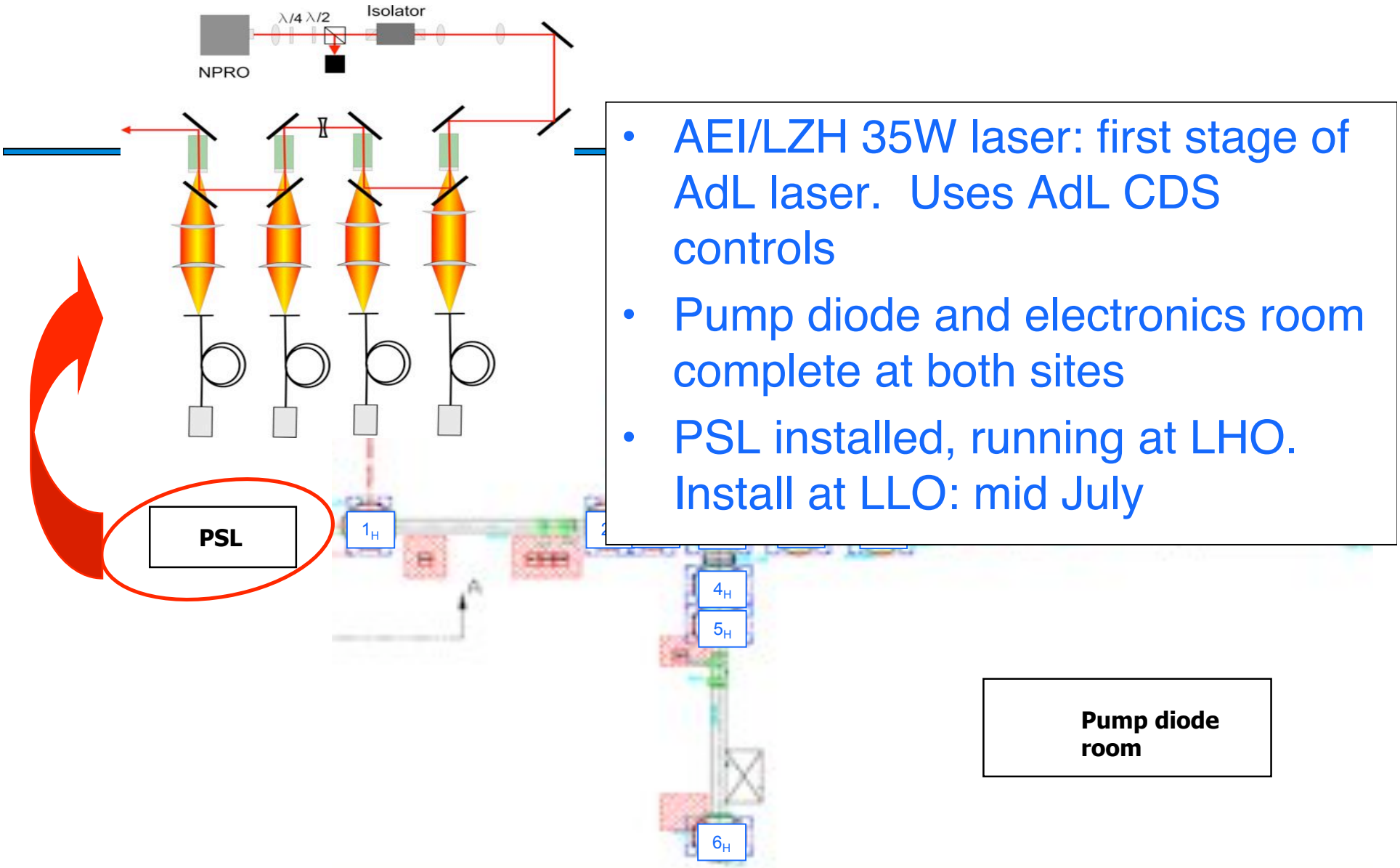
PAC24
Jun 23, 2008
LHO



LIGO-G080387-00-D

Status

- Enhanced LIGO
  - » Factor of ~2 improvement in reach of the two 4km instruments (nearly order-of-magnitude improvement in rate)
  - » All upgrades make use of Advanced LIGO technology: vet and learn
  - » Enhanced LIGO is well underway - the majority of installation is complete. Currently locking both instruments. At least one significant vent and one minor vent remain at each site.
  - » Aggressive schedule; ~few months behind our original markers



- AEI/LZH 35W laser: first stage of AdL laser. Uses AdL CDS controls
- Pump diode and electronics room complete at both sites
- PSL installed, running at LHO. Install at LLO: mid July

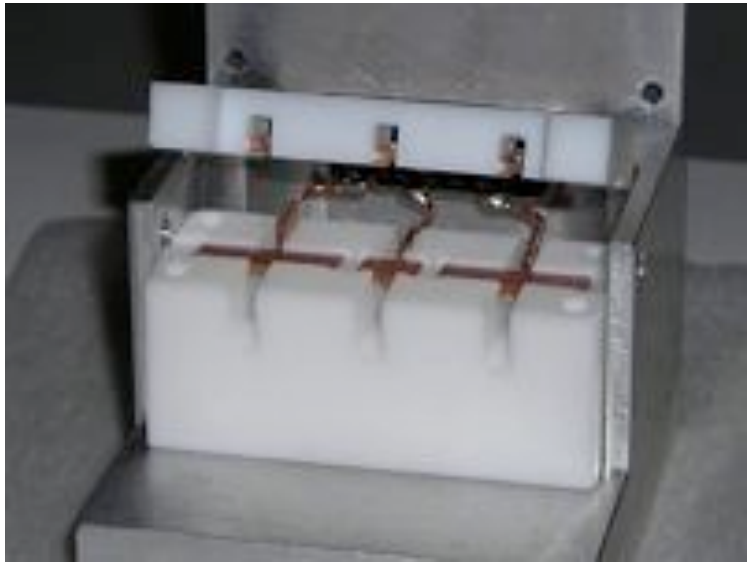
PSL

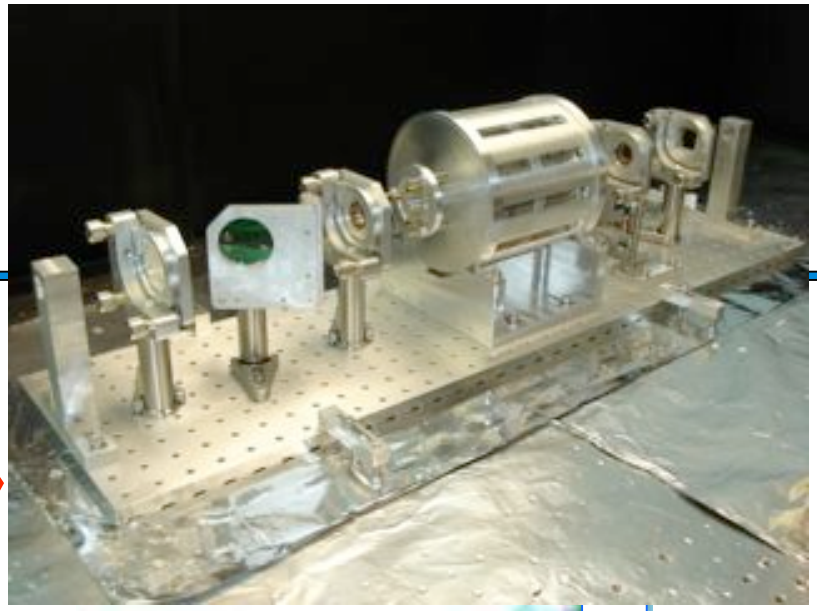
- 35W PSL installation completed smoothly at LHO
- Pump-diodes operating in new (AdL) external laser diode room
- All PSL servos (FSS, ISS, PMC) have operated at eLIGO levels
- IO high power working nominally
- Mode-matching into suspended mode-cleaner complete, with 97% visibility

more PSL

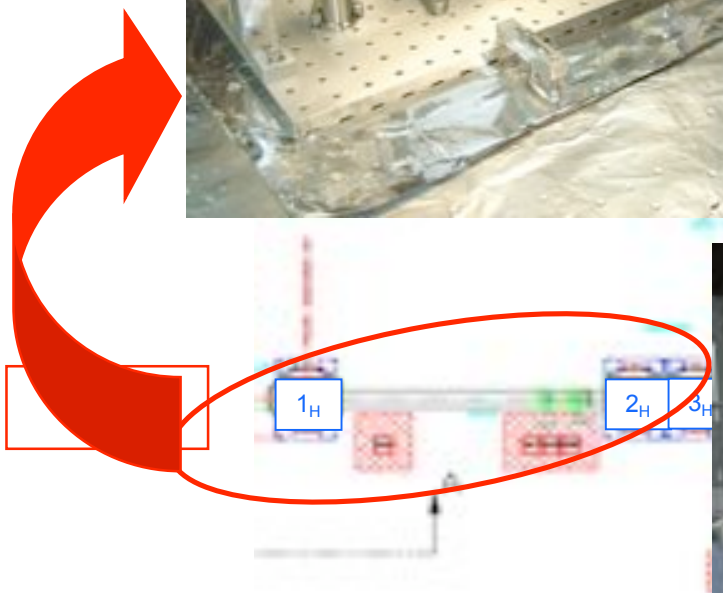
LHO diode room

- Electro-optic modulator
  - » 30-50X less thermal lensing than iLIGO units
  - » 3 frequencies in single unit



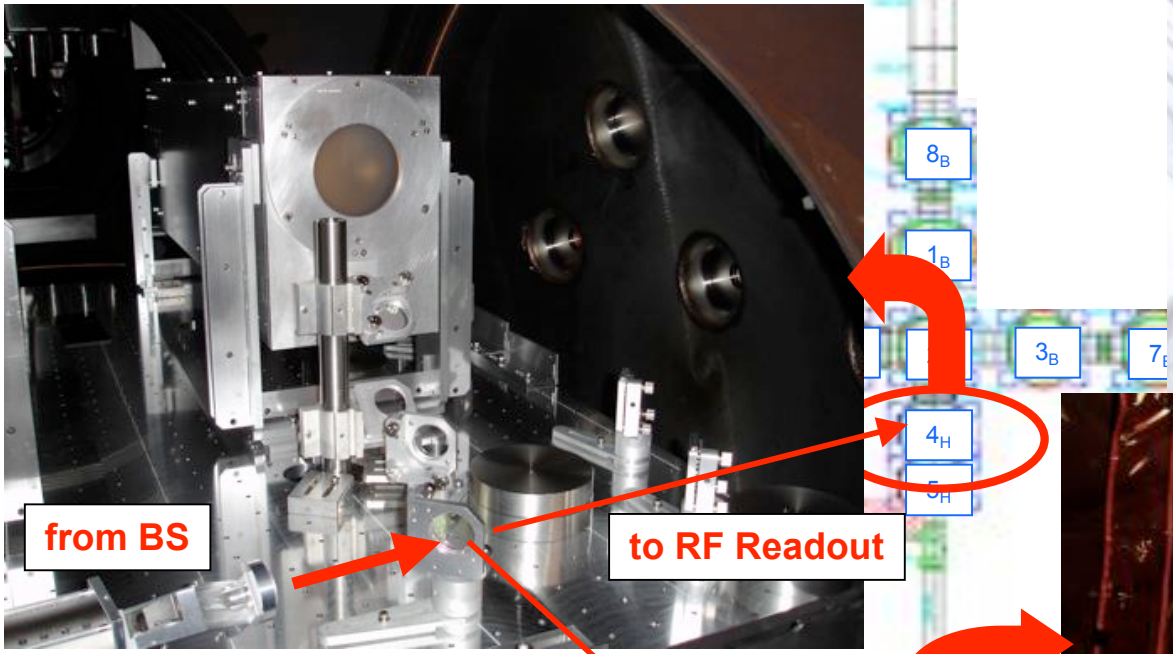


- Faraday isolator
  - » Two TGG rotators interleaved with quartz
  - » Polarization and thermal compensation



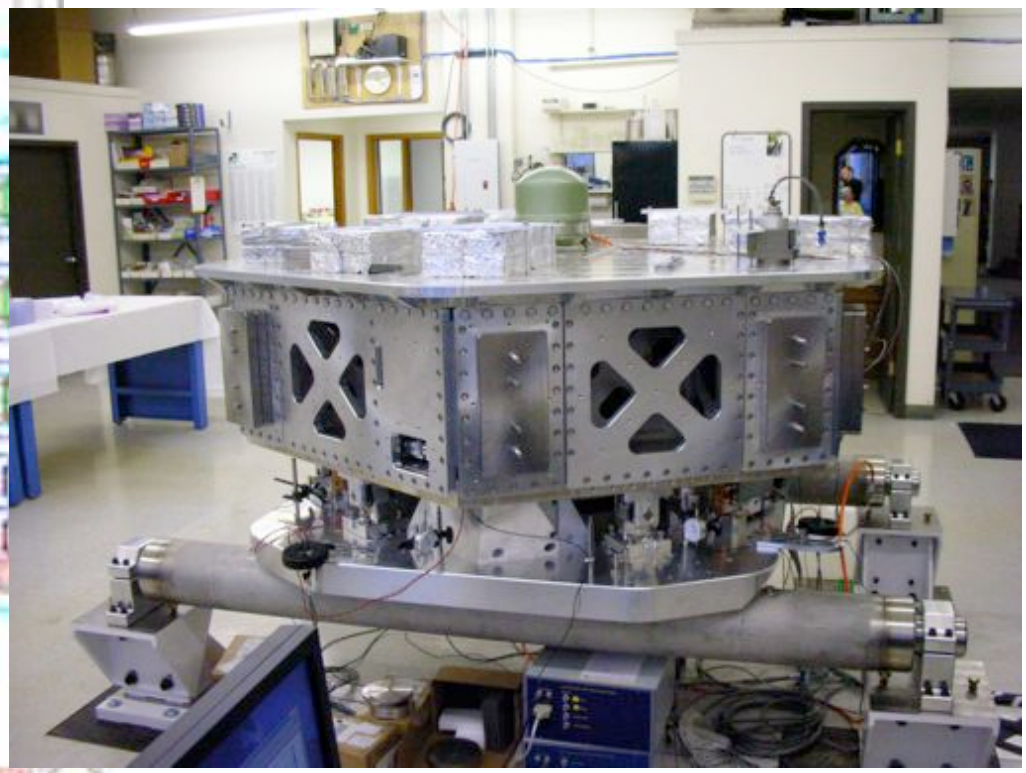
Septum and HAM4

HAM4 mods at LLO



Active seismic (SEI) isolation

- Two active seismic isolation systems on 4k interferometer outputs
- Six onboard GS-13 seismometers and six position sensors measure velocity and position
- Feedback to six coil actuators
- First unit built and tested at High Precision Devices, Inc
- Next unit assembled, installed and locked down at LLO
- First unit rebuilt (clean) at LHO, installed, currently under commissioning



Testing at HPD, Boulder last November

N.B. ISI = “internal seismic isolation” (in case I say it).

Installation into HAM6

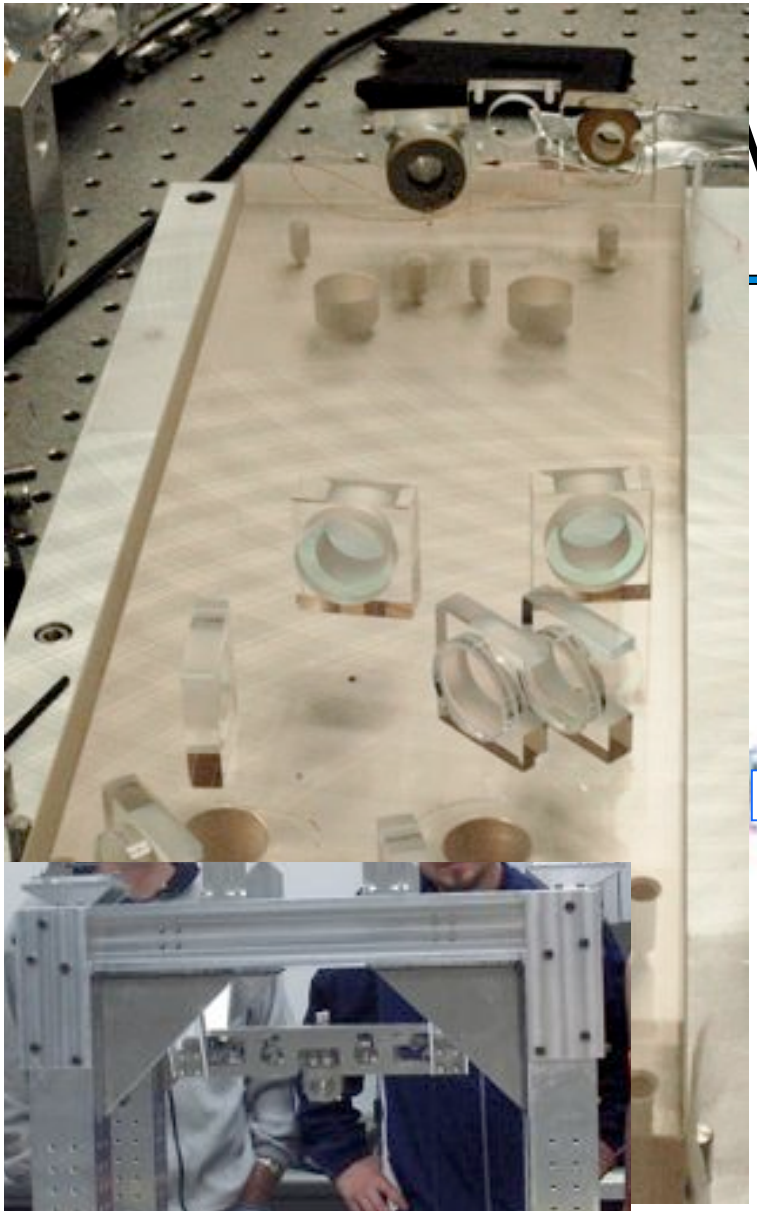
AVI at LLO elog, Fri Mar 7, 2008

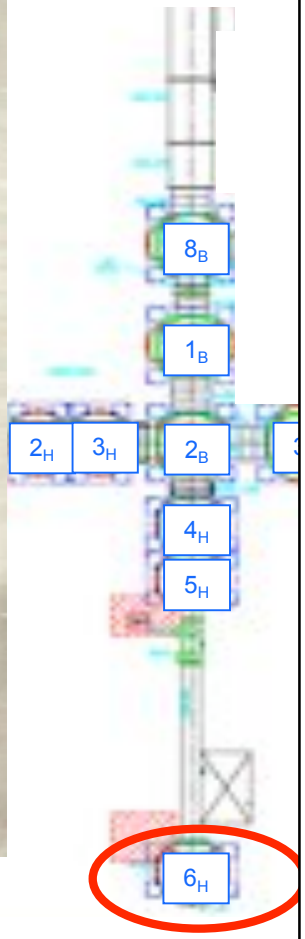
Installation into HAM6

SEI status

- LLO
  - » Table floating in vacuum, with payload
  - » Passive (pendulum) isolation only
- LHO
  - » All damping loops closed and running
  - » All control loops for six degrees-of-freedom designed and implemented - with unity gain frequencies of about 25Hz, but missing some low frequency performance
  - » Work on low-frequency sensor correction underway

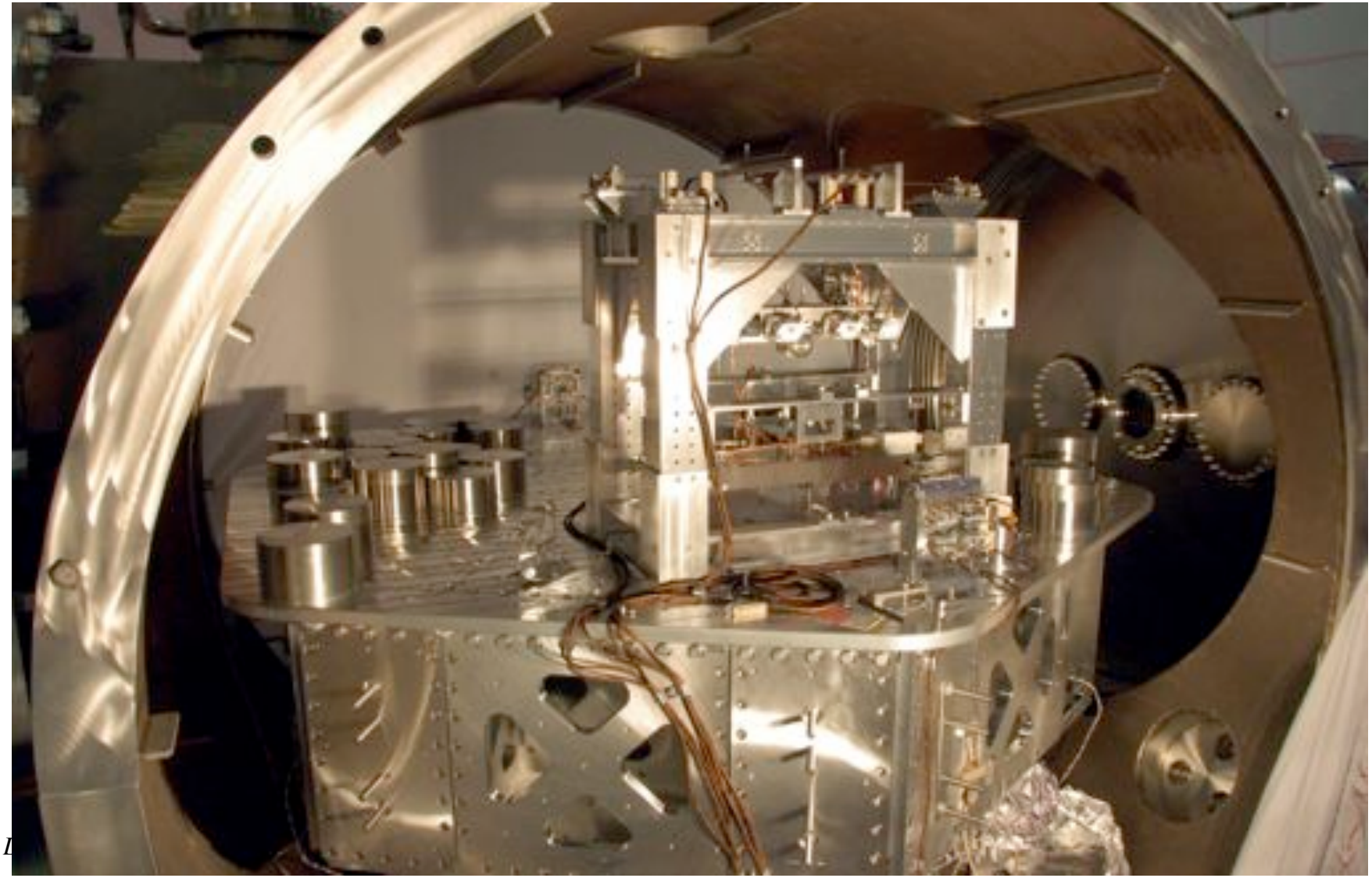
MC, DC readout

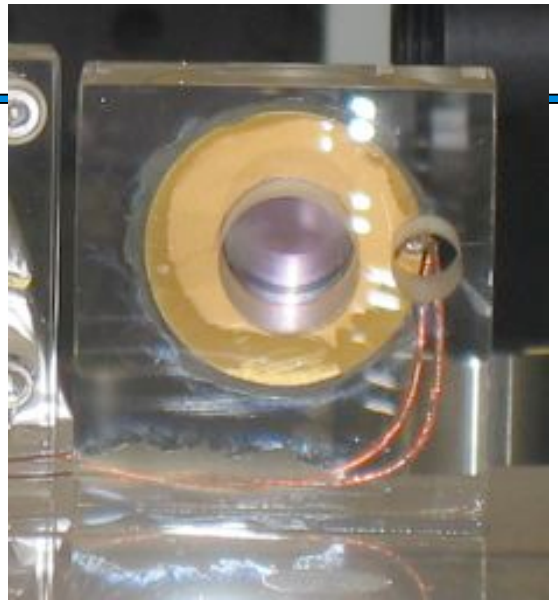


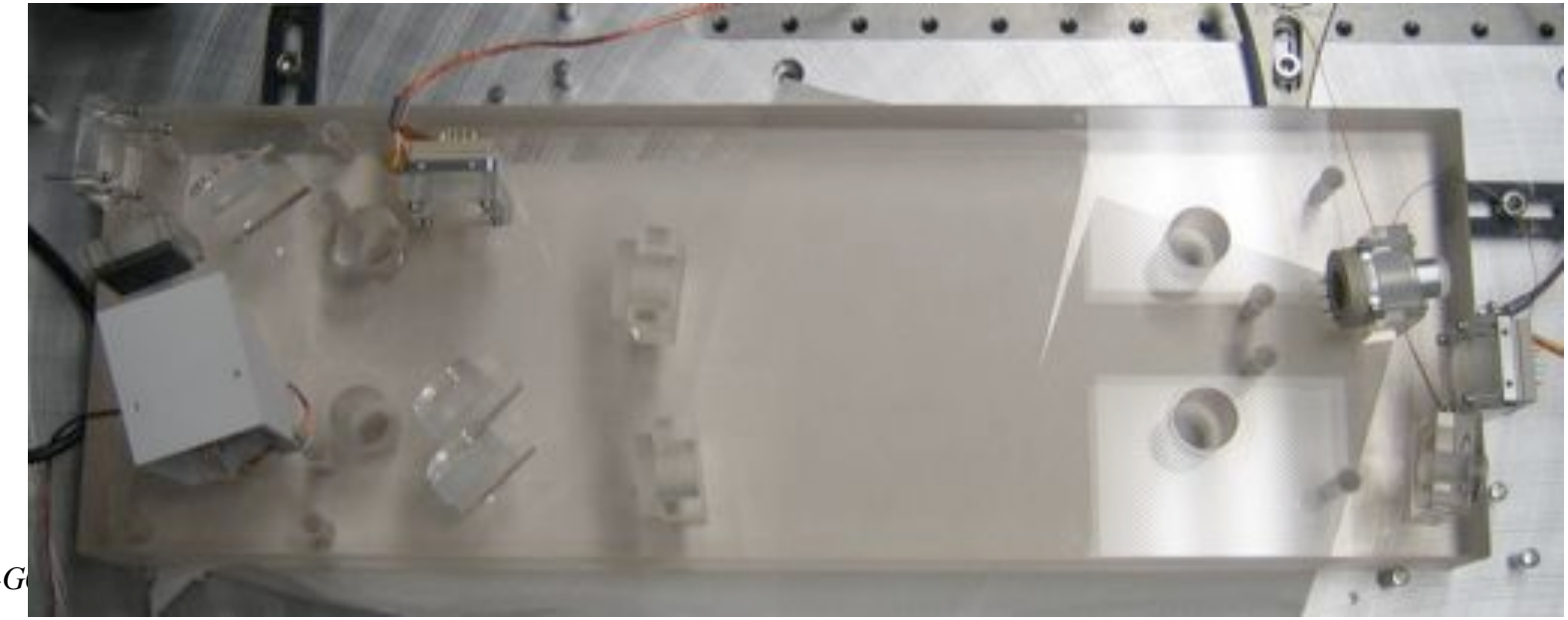


- Output Mode-Cleaner (OMC)
  - » RF detection limited by photodiode saturations
  - » OMC rejects junk light and higher order modes
  - » Critical for AdvLIGO
  - » First OMC assembled and tested, installed at LLO
  - » Resonated TEM00 mode
  - » *Locked full interferometer with DC readout!*
- OMC suspension
  - » Double suspension provides passive isolation > few Hz
  - » First unit built at CIT, suspended OMC board: assembled at LLO
  - » *Fabrication of 2nd unit pacing next vent at LHO*

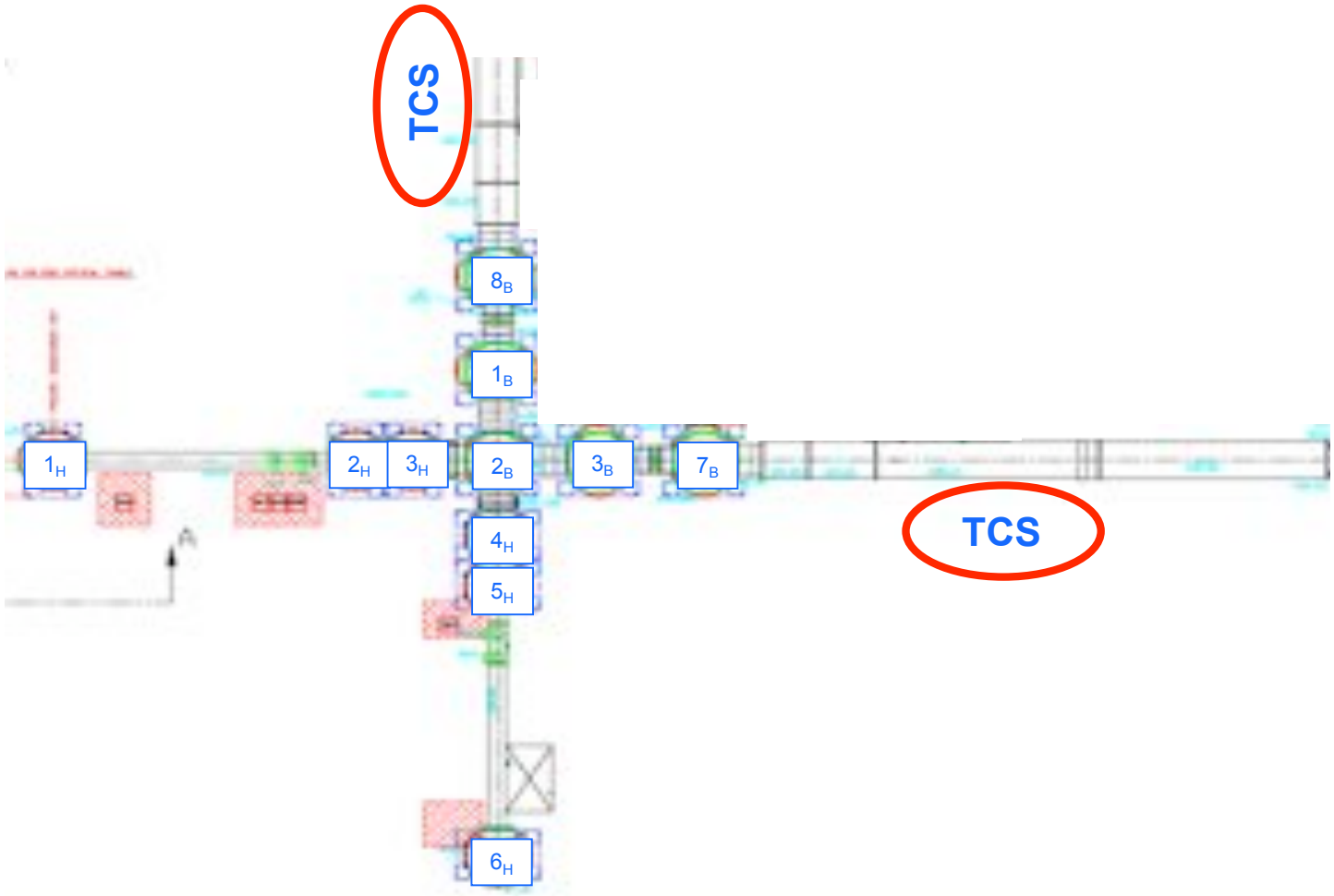
OMC with SUS



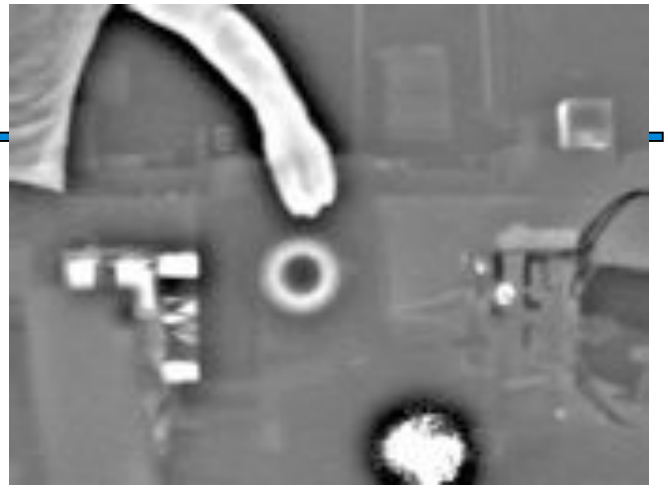




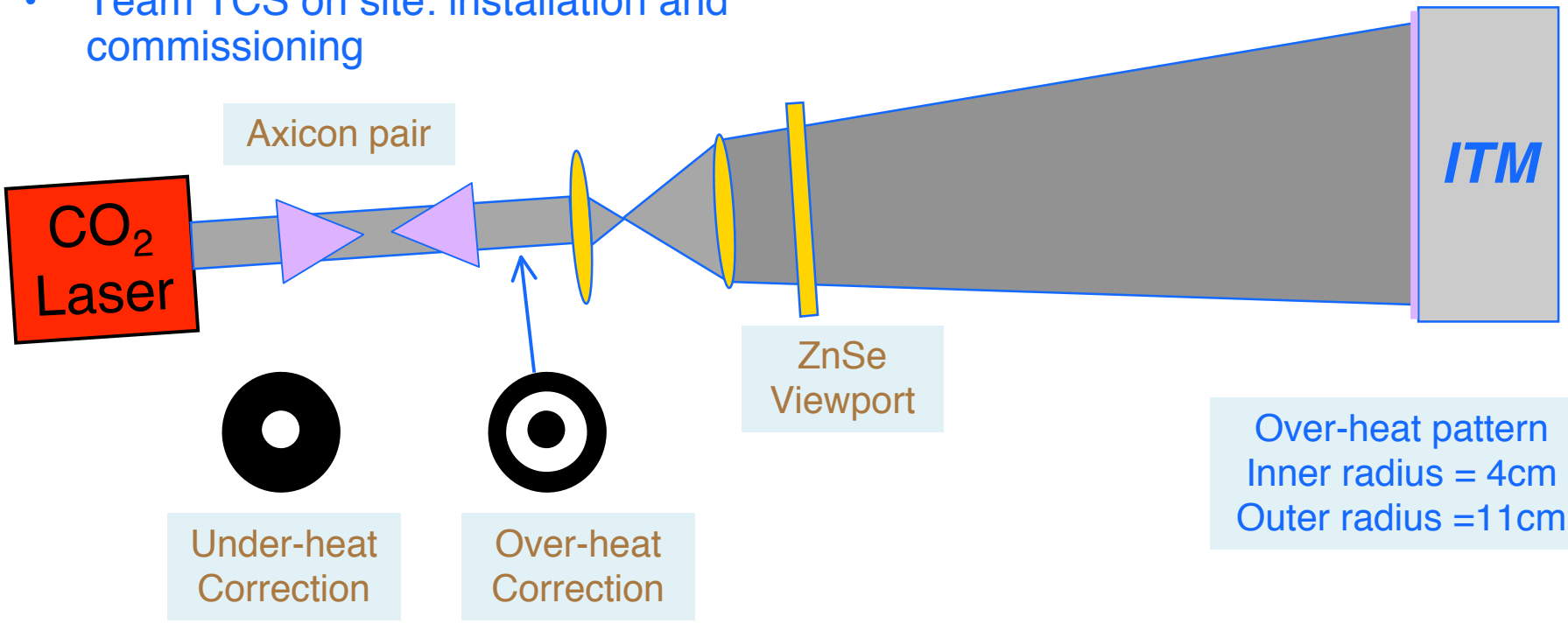
Thermal compensation system (TCS)



TCS

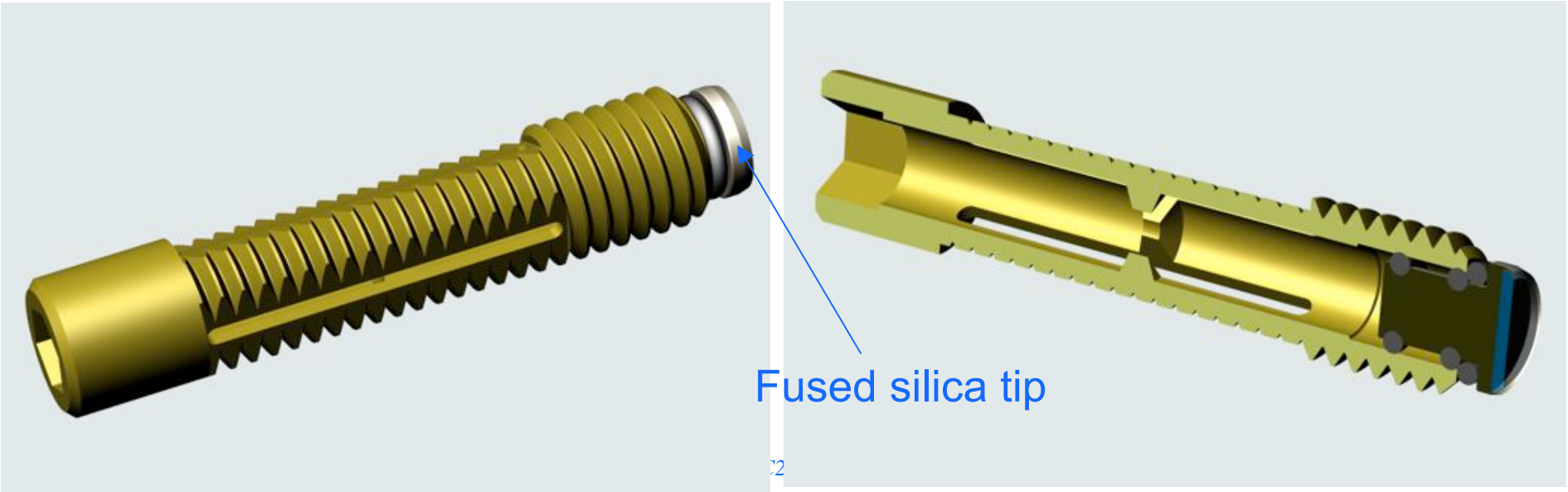


- Require several W of CO2 power to compensate for heating by NdYAG beam at 30 W input power
- Use axicons to make a donut out of Gaussian beam
- Team TCS on site: installation and commissioning

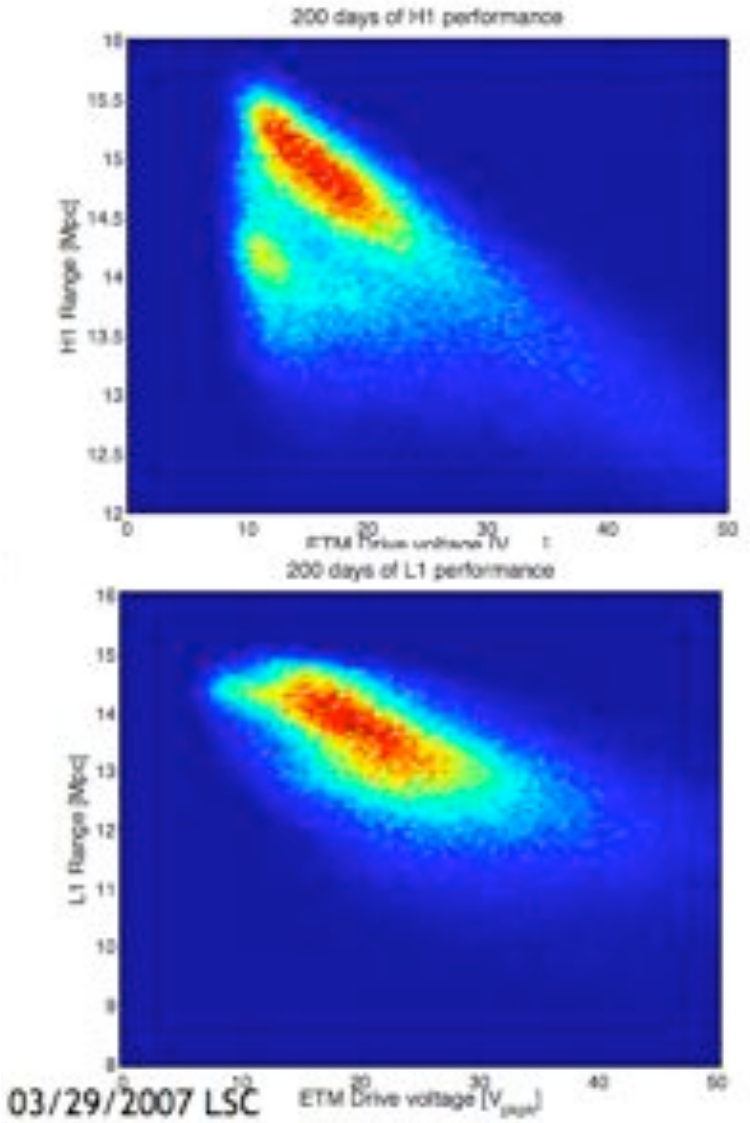


Other

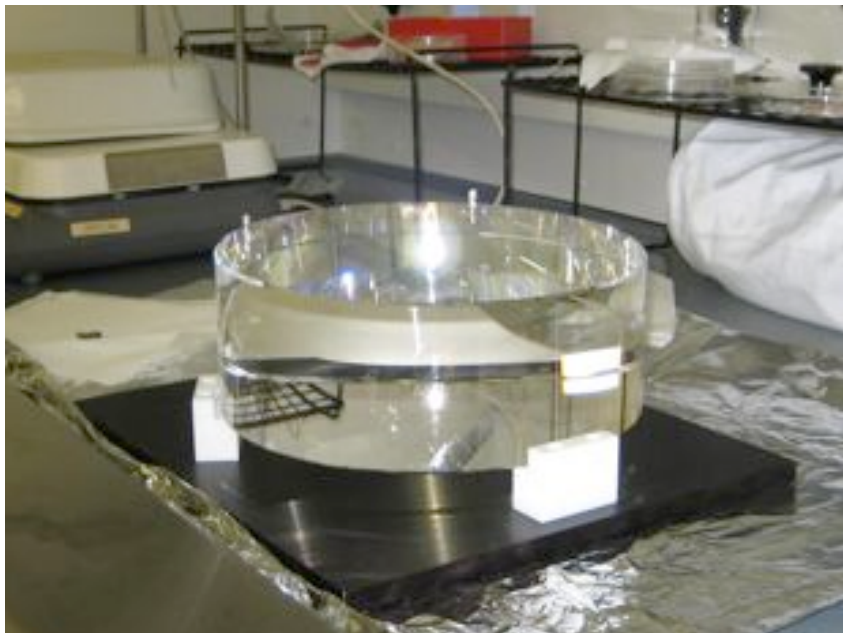
- Additional tasks such as
  - » earthquake stop retrofit. Potential to reduce charging noise, as observed in L1 during S5. All test masses.
  - » Mode cleaner drag wiping, baffle (scatter site) removal, etc



Other: magnet swap

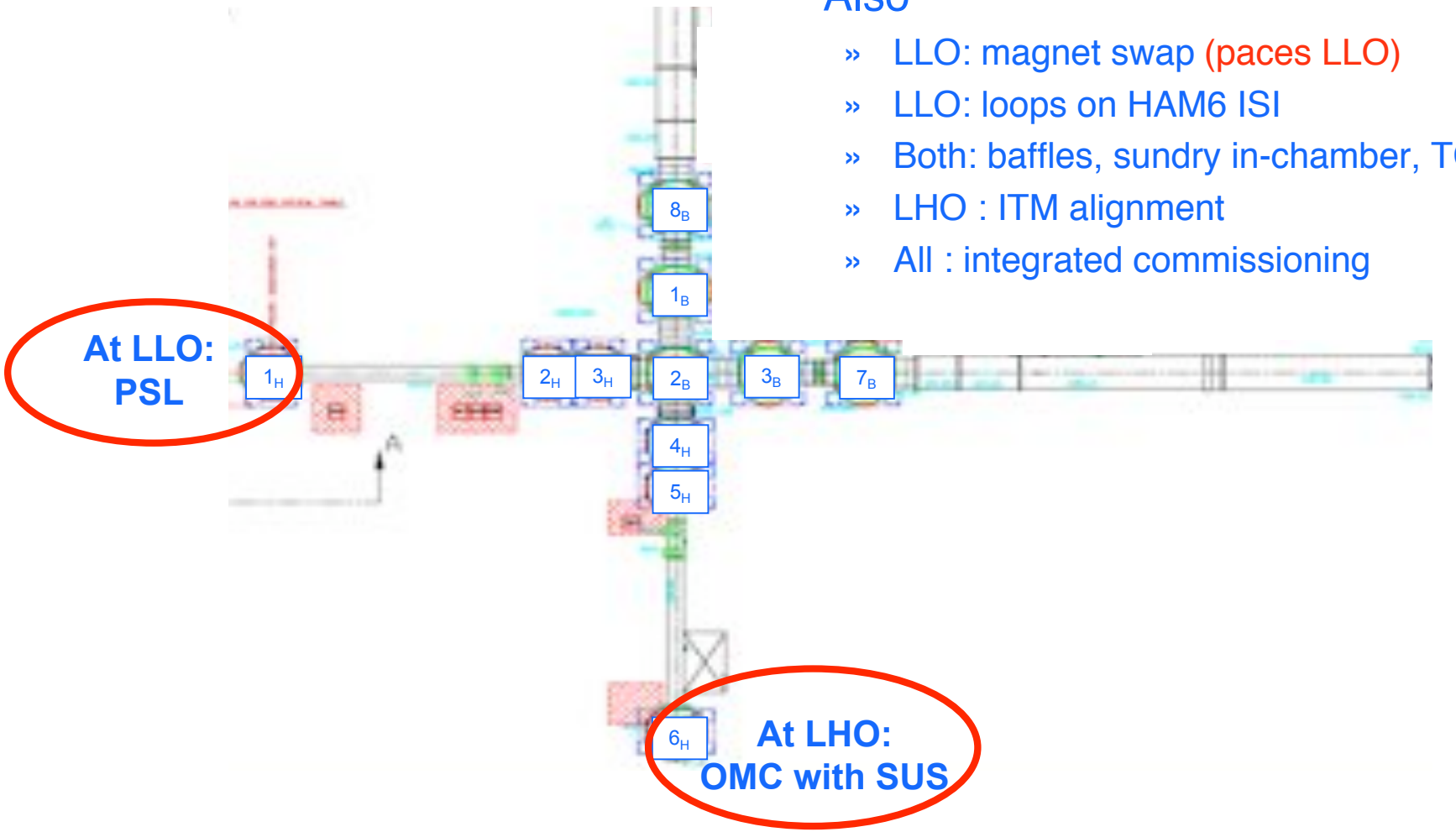


- Low-frequency upconversion observed, understood to be Barkhausen noise
- Swap NdFeB magnets for SmCo on end-test masses
- Complete at LHO; July swap for LLO



What's left to do?

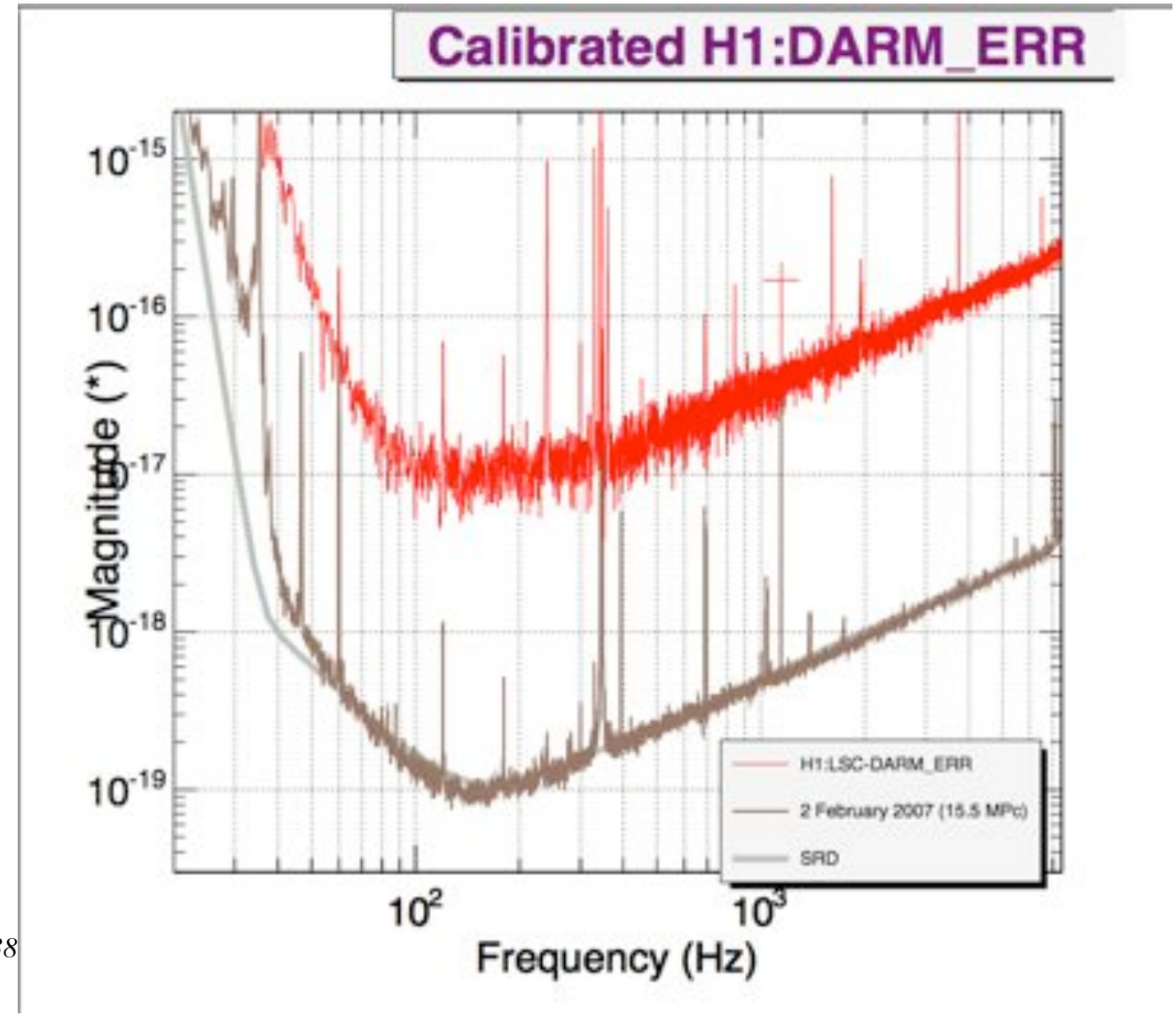
- Also
  - » LLO: magnet swap (paces LLO)
  - » LLO: loops on HAM6 ISI
  - » Both: baffles, sundry in-chamber, TCS
  - » LHO : ITM alignment
  - » All : integrated commissioning



LHO highlights

- LHO running at high power
  - » 35W on PSL table, currently only up to 7W into mode cleaner
  - » Interferometer relocked with new laser, new input chain, new alignment, using RF (only - no DC readout yet)
  - » Adding TCS this week - will pave the way for high-power tests
- HAM6 ISI nearly commissioned
  - » Have not made noise performance evaluation yet, but expect to meet or exceed AdL spec
- July vent
  - » Baffle installation
  - » ITM realignment/debiasing
- OMC being assembled on site this week
- Expect OMC SUS late July - land OMC on HAM table early August

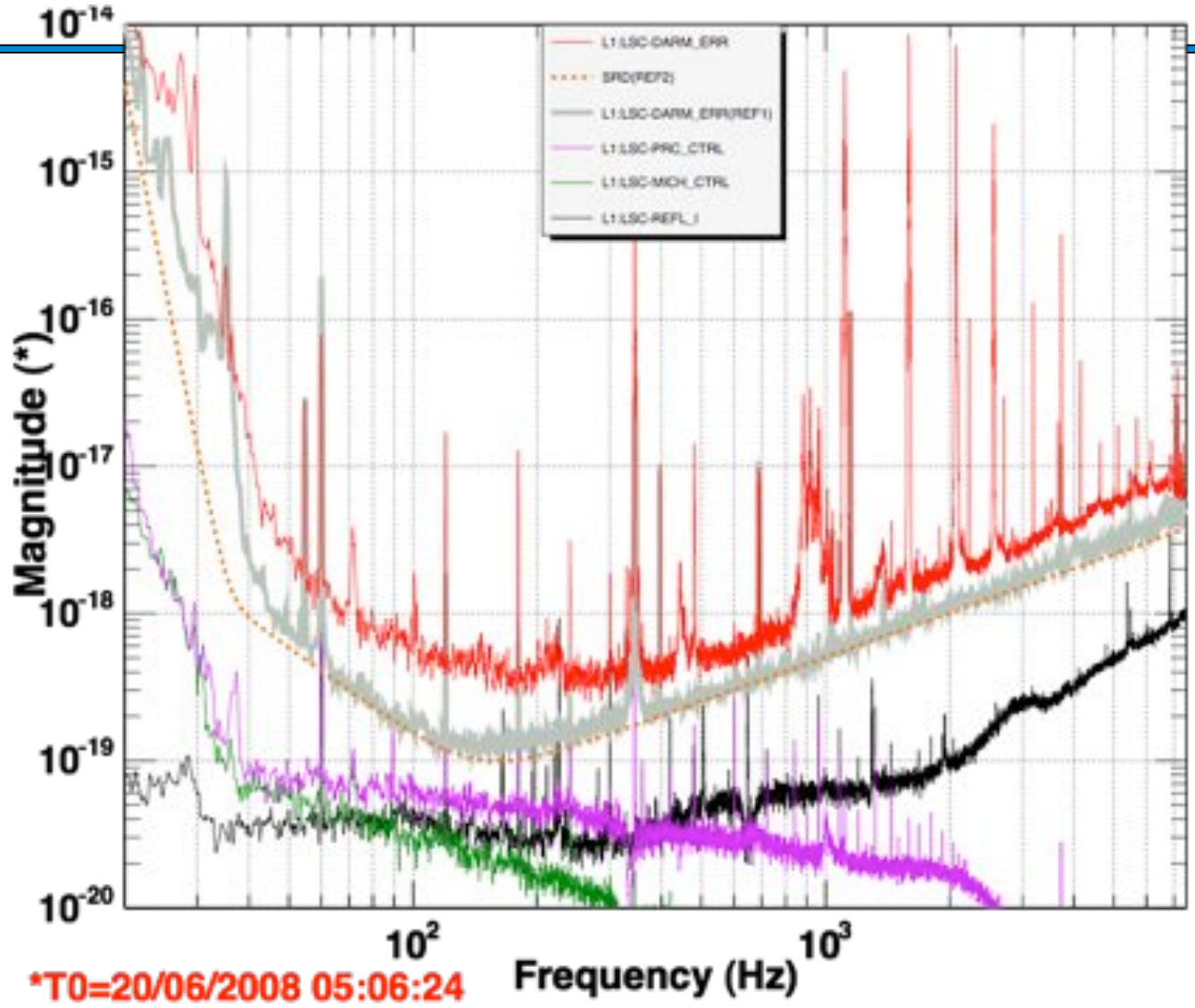
Beginning to measure noise at LHO



LLO highlights

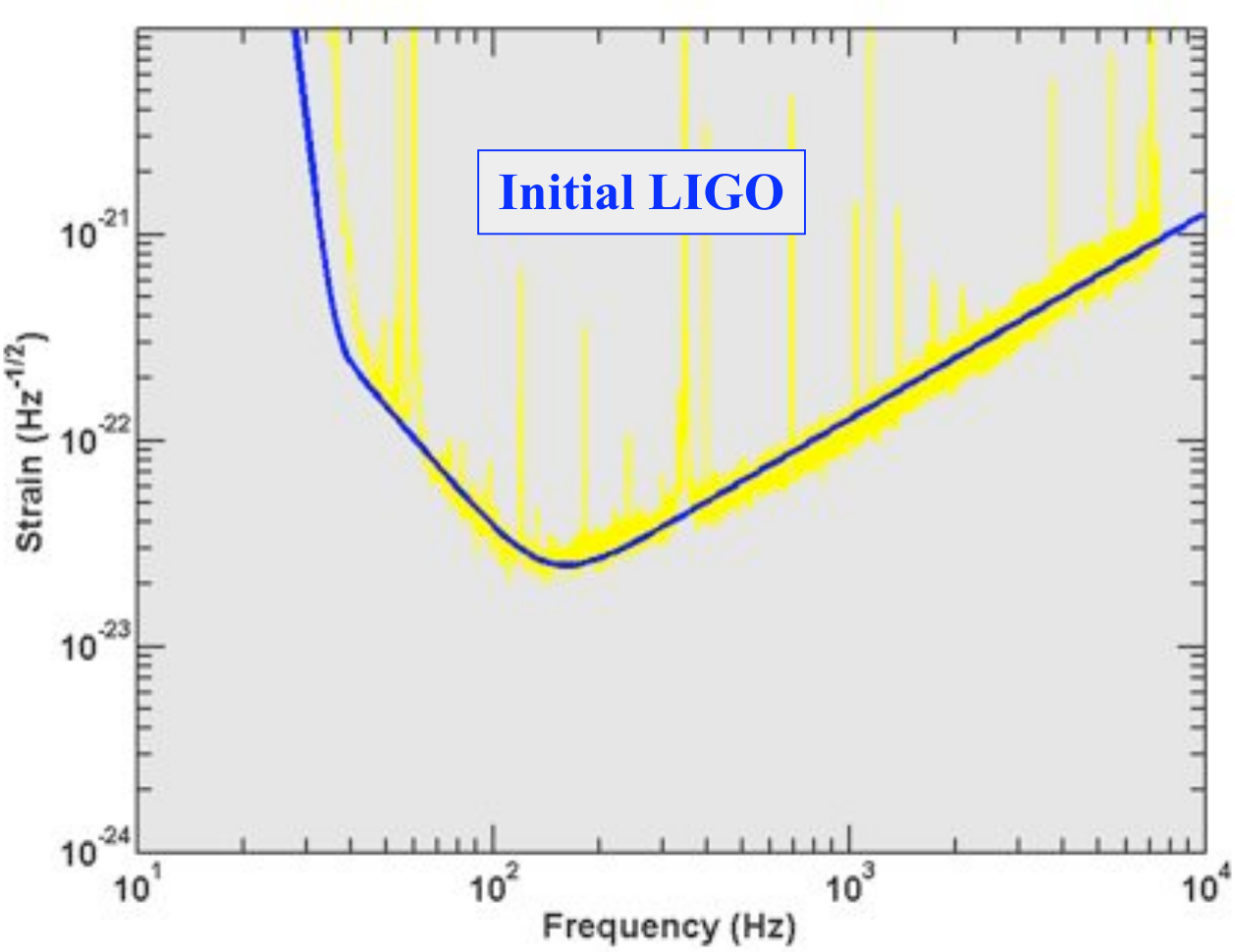
- LLO locking with DC readout
  - » OMC is fully operational in vacuum (transmission ~90%, mode matching ~ 90%)
  - » Measured noise couplings to DARM in full lock: laser intensity and oscillator phase. So far no surprises or show stoppers
  - » PRC correction signal is down by a few hundreds indicating that coupling is also lower
  - DC DARM noise is mostly shot noise limited above 1 kHz .
  - OMC length and angular control loop noise investigations underway (contributing above 200Hz?)
- July vent
  - » Baffles
  - » ETM magnet swap

4Mpc at LLO


L1:LSC-DARM_ERR
SRD(REF2)
L1:LSC-DARM_ERR(REF1)
L1:LSC-PRC_CTRL
L1:LSC-MICH_CTRL
L1:LSC-REFL_I
Magnitude (*)
Frequency (Hz)
*T0=20/06/2008 05:06:24

Summary

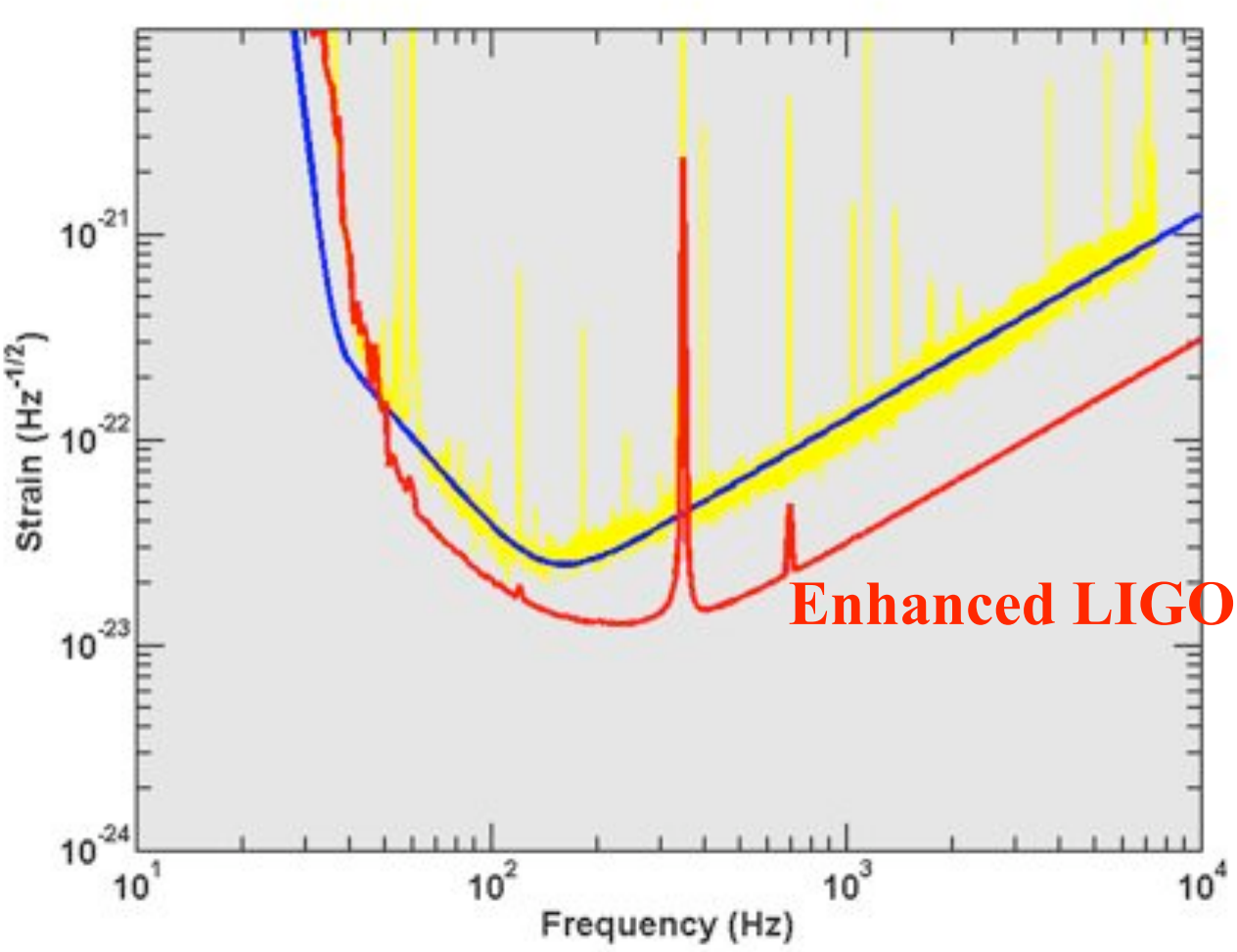
Primary
Enhanced
LIGO installs
complete…



Summary

Primary Enhanced LIGO installs complete…

commissioning is underway,

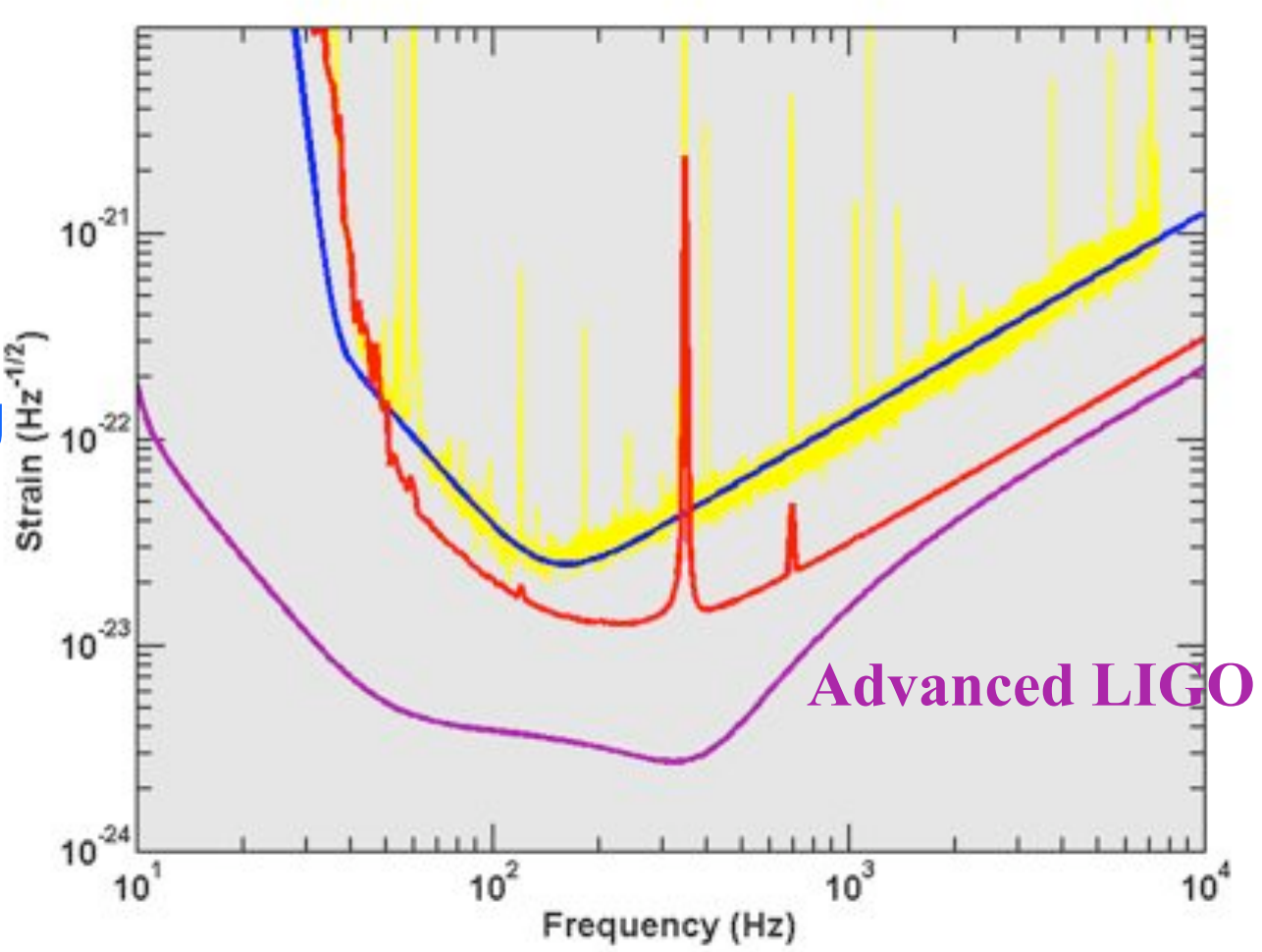


Summary

Primary Enhanced LIGO installs complete…

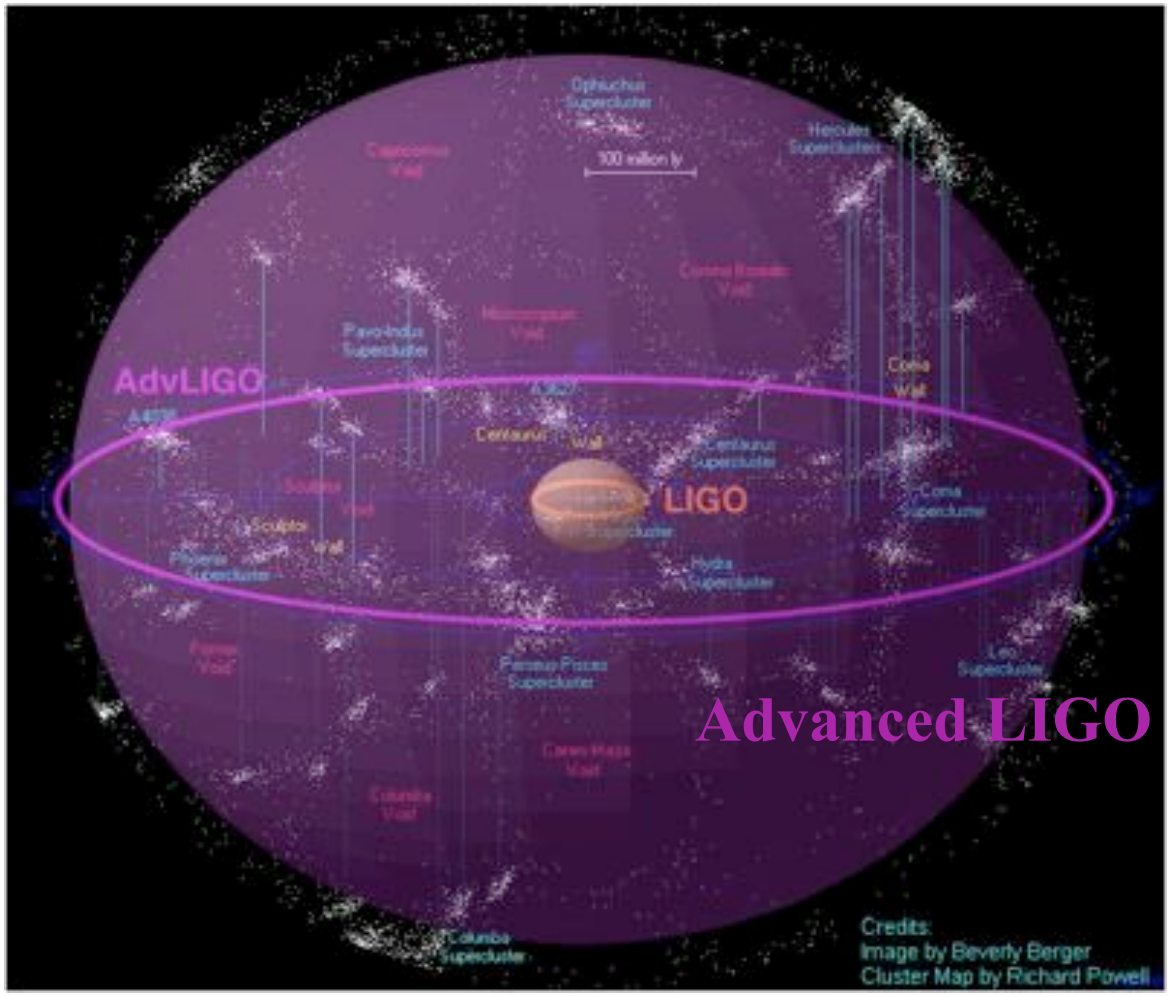
commissioning is underway,

a natural step towards Advanced LIGO



Summary

Detection, and transition to full-fledged GW astronomy are not far off



Noise and the enhanced detector