High Optical Power Test Facility - Status

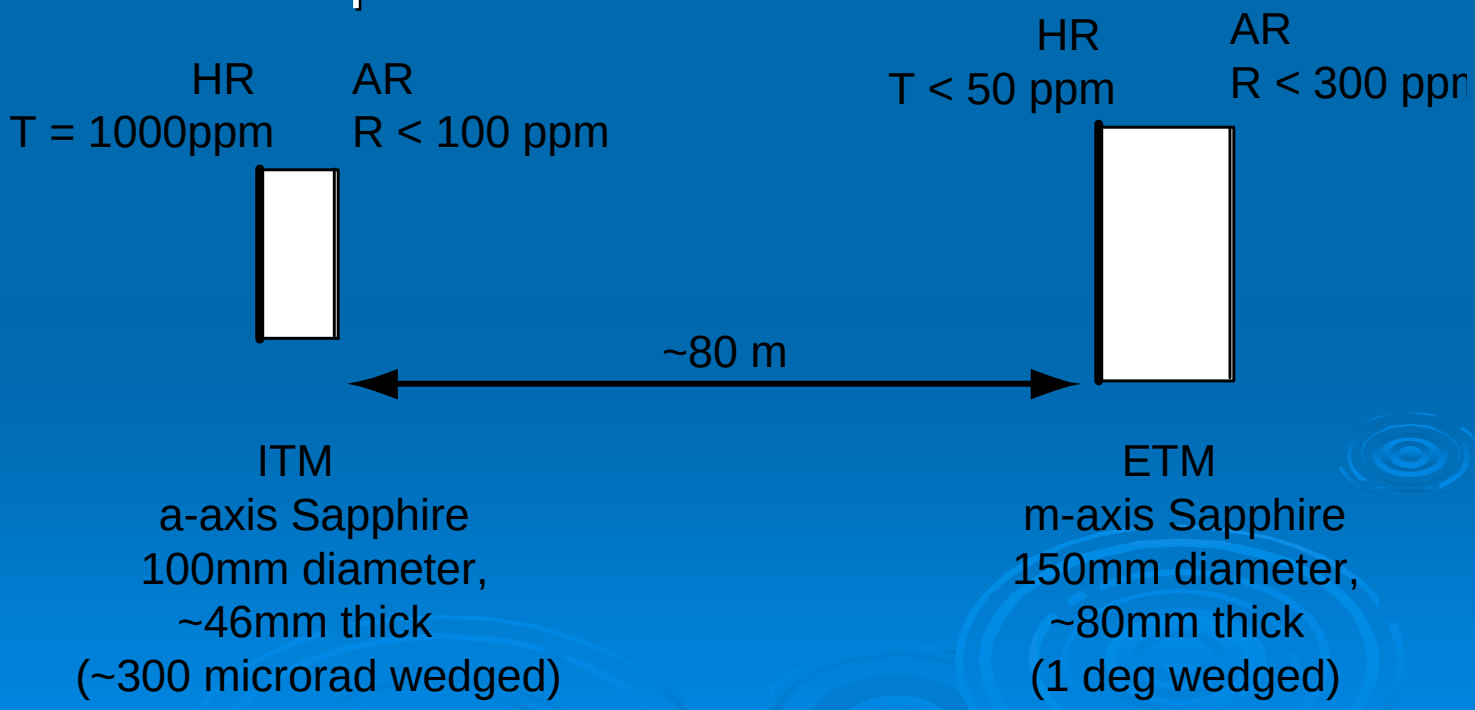
Bram Slagmolen

ACIGA-UWA

First lock, auto-alignment and 10W laser installation

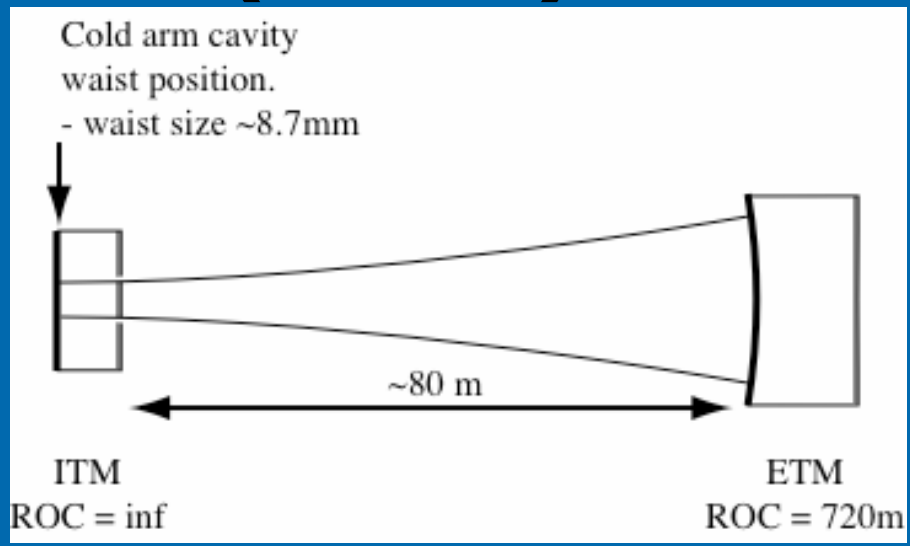
Gingin Test 1/3 (Gingin Strawmann)

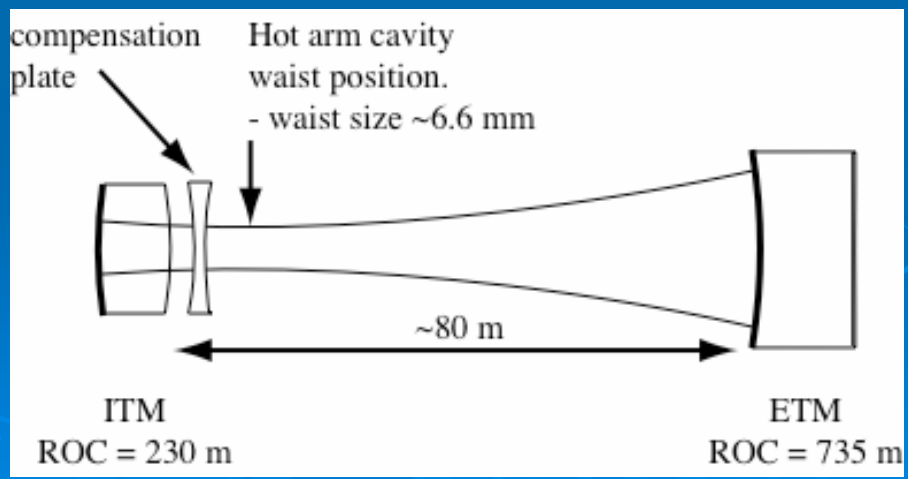
- Placement of the ITM substrate inside the cavity
- ITM substrate of Sapphire (50 ppm/cm absorption)
- Cavity waist (cold): ~8.6 mm
- TEM_{00} power built-up ~800



HOPTF Test 1 (cont.)

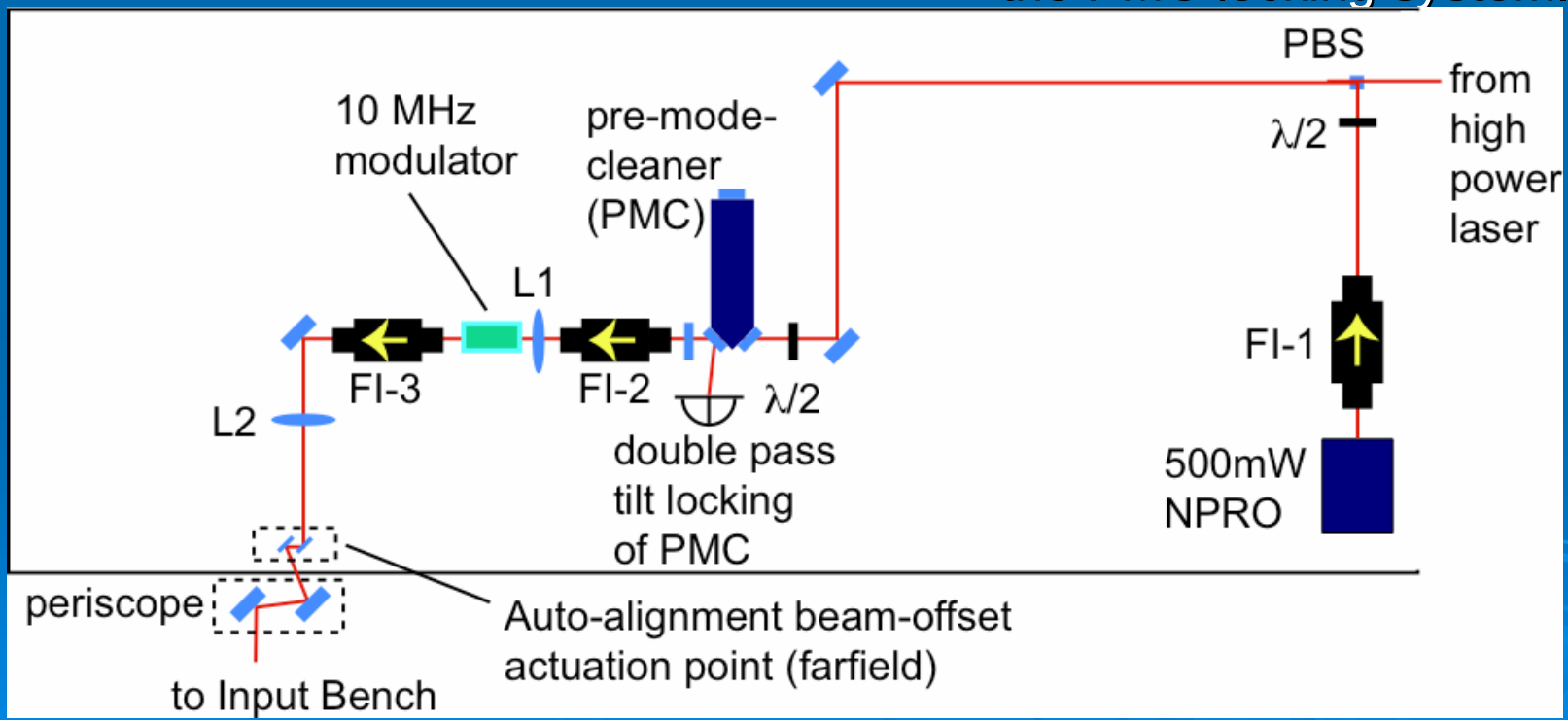
- ITM parameters
  - Circulating power with 7W input: ~5.5 kW.
  - Thermal lensing induced ROC of ITM: ~230m.
  - Cavity waist (hot): ~6.6 mm.
  - Waist position with thermal lensing will be moved away from the ITM towards the ETM.
  - Use of a Fused Silica thermal compensation plate to compensate the thermal lensing in the ITM.





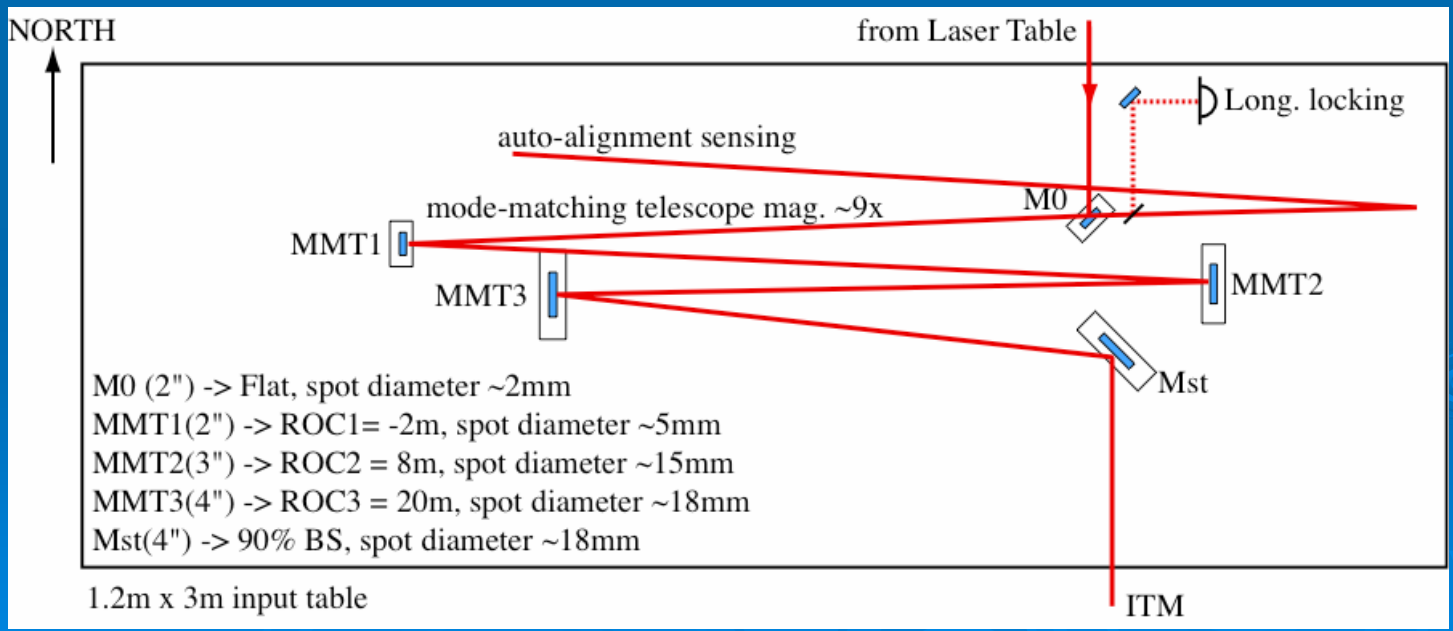
Laser Room

- Preliminary cavity alignment with 500mW NPRO laser.
- Faraday Isolator(FI-1, FI-2 and FI-3), T=91%.
- PMC locking bandwidth ~30kHz.
- PMC transmission (F=200), 85%.
- Additional faraday isolator (FI-3) preventing optical feedback into the PMC locking system.



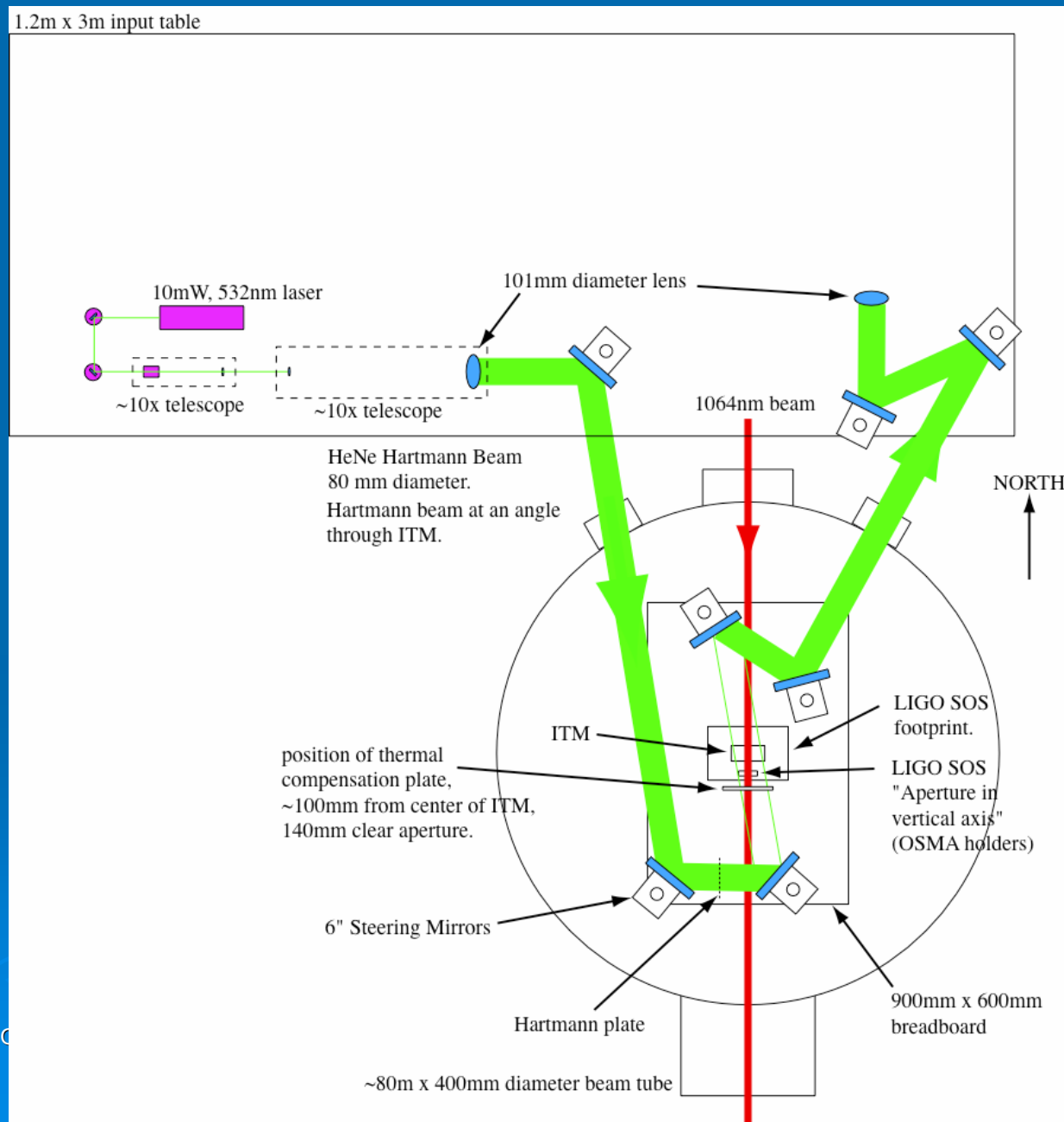
Input-Bench

- Input-Bench accommodates the suspended cavity mode-matching telescope, longitudinal sensing and auto-alignment sensing.
- Also the Hartmann Wave-front Sensor.



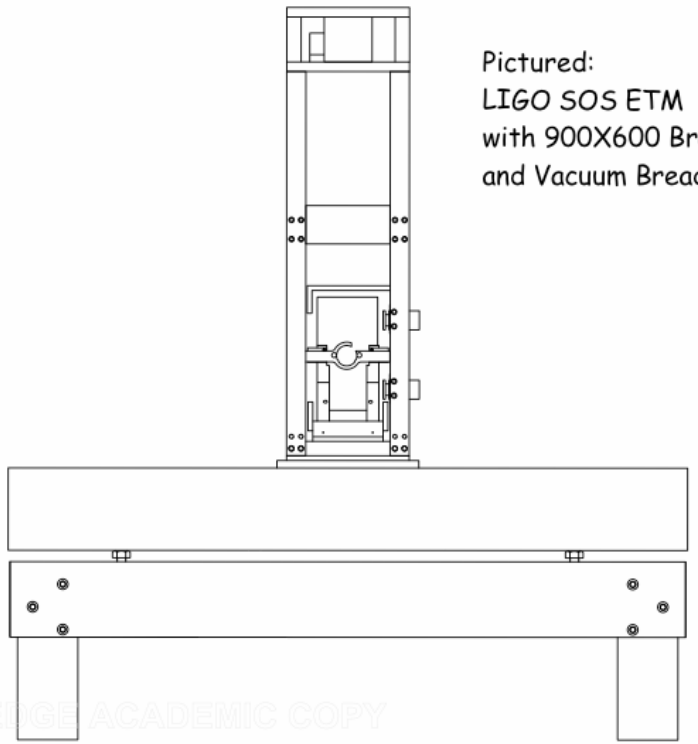
Input - Bench (2)

- Hartmann Sensor
  - ~80mm diameter sensor beam through ITM.
  - Sensor beam at ~10º with the optical axis of the cavity.



Initial Suspended Cavity

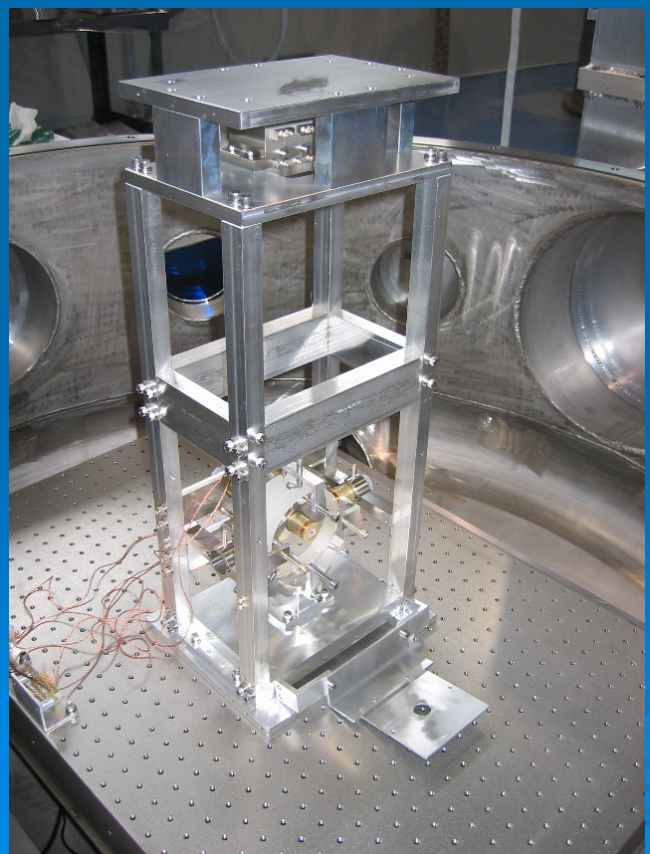
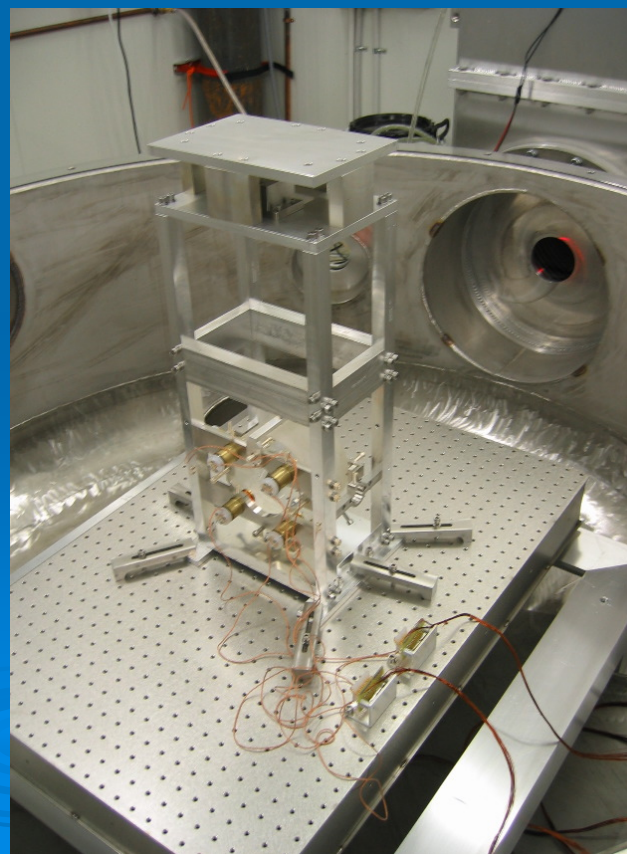
- Using BK7 optics initially to try to lock the suspended cavity.
- LIGO SOS, placed on top of a 900mm x 600mm breadboard.
- Breadboard supported by 4 bolts, with no further isolation.
- Replacement of the BK7 optics by the Sapphire optics, when the system is running reliably.



Drawing: Tim Slade

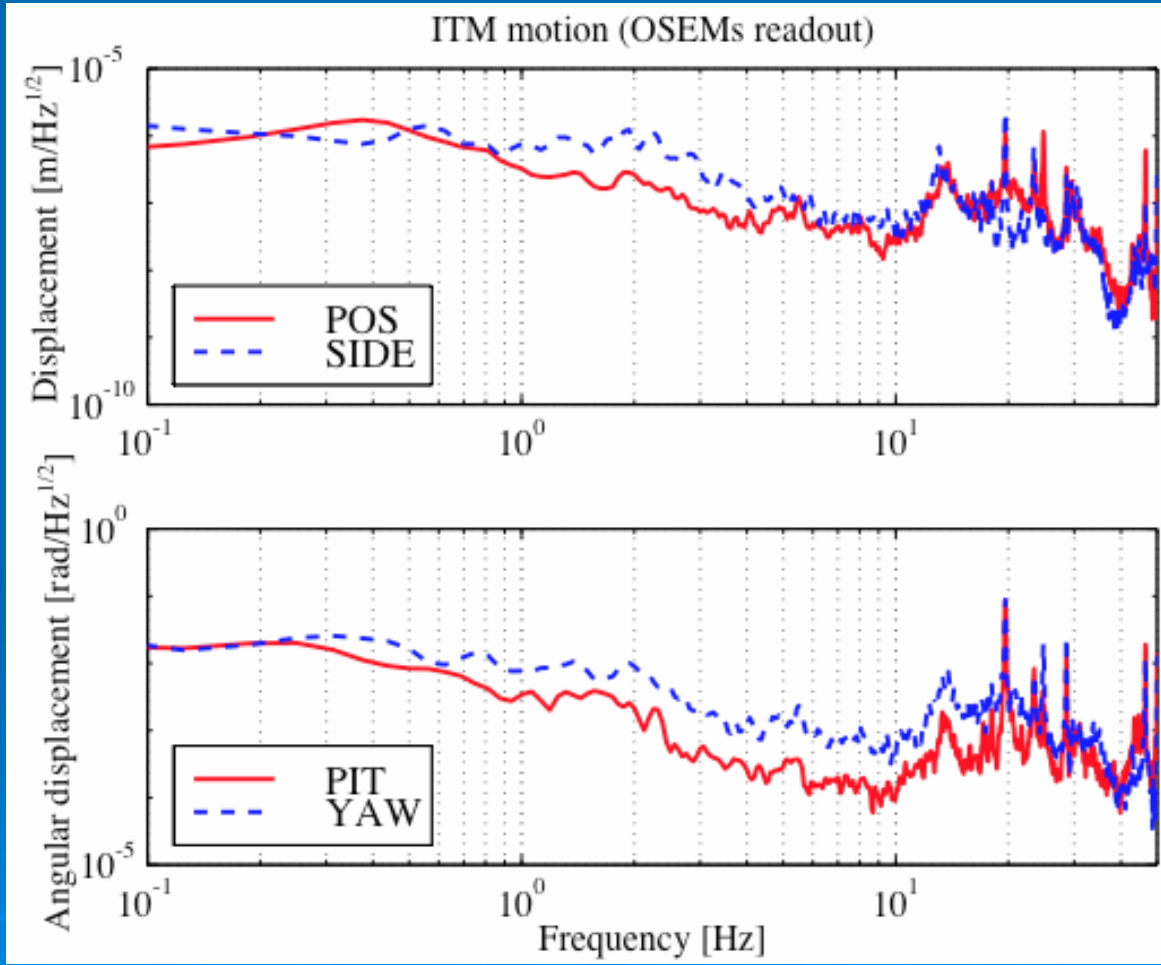
Installation of the ITM and ETM

- Mark Barton (Caltech) visited the AIGO lab, providing help in assembling and installation of the BK7 optics.
- David Ottaway (MIT) visited the lab help initiated cavity locking.

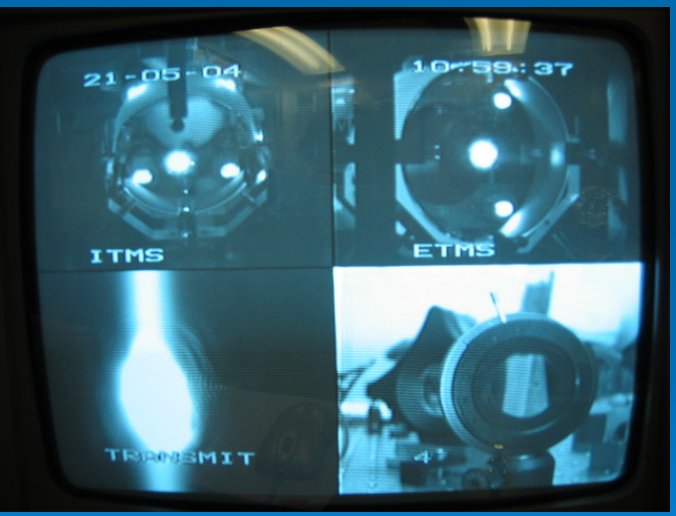
ITM residual motion

- Test masses have local damping.
- ITM SOS is placed on a breadboard, providing no advanced seismic isolation.
- Even so, the system can be locked.
- ITM residual motion, from the OSEMs.
  - LSC <1μm @1Hz.
  - ASC-P ~7.5mrad @1Hz.
  - ASC-Y ~3mrad @1Hz.

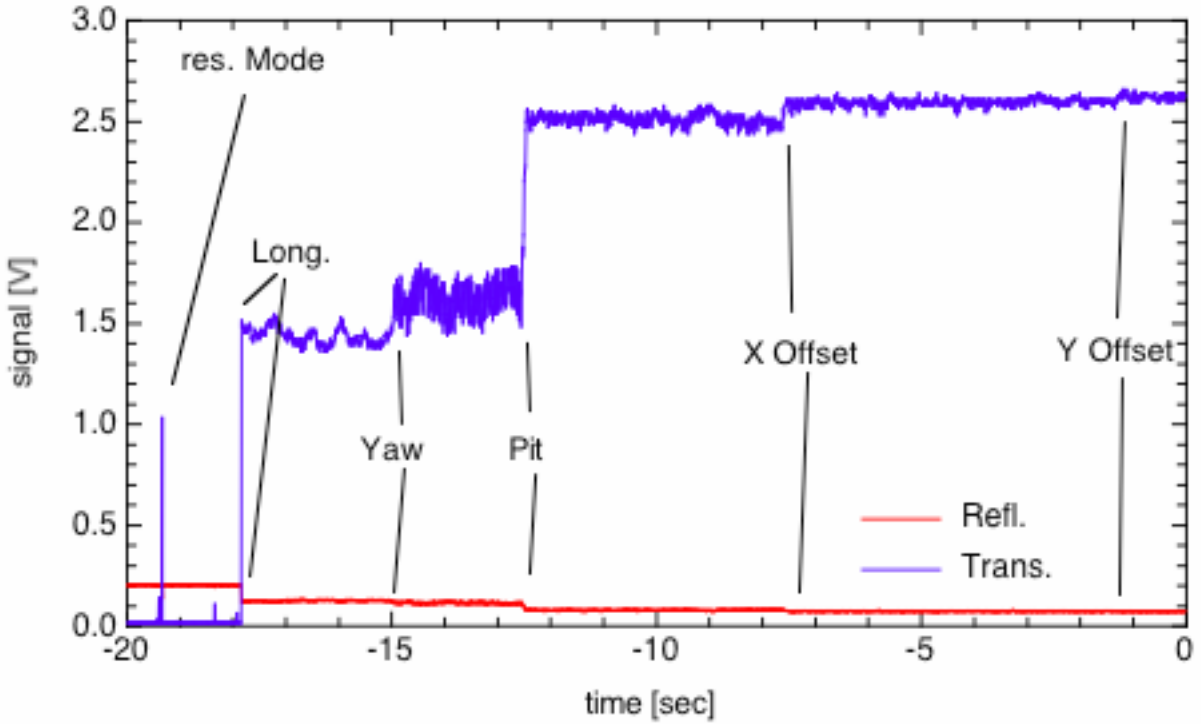


Cavity lock-up

- NPRO laser is locked longitudinal to the suspended cavity, with a bandwidth ~20kHz.
- Longitudinal lock is reliable and repeatable over long periods of time (~1h).

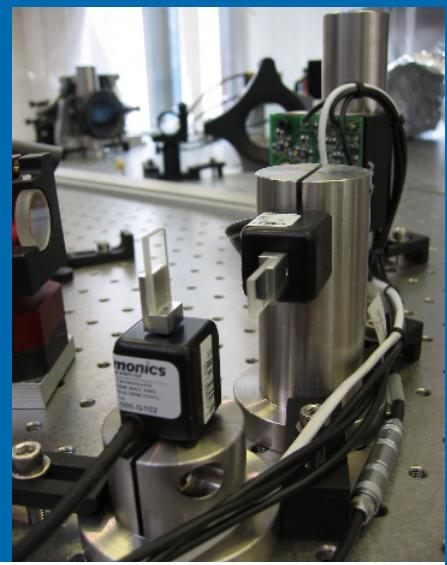


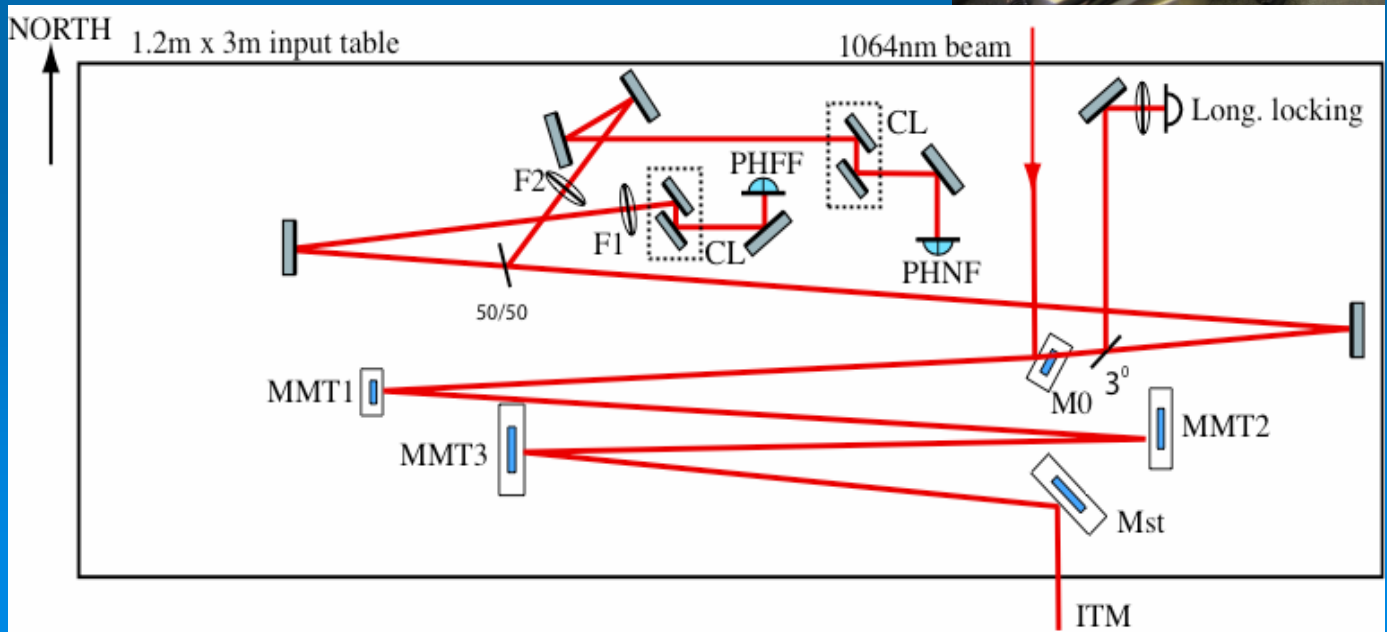
First long. Lock.



Auto-alignment installation

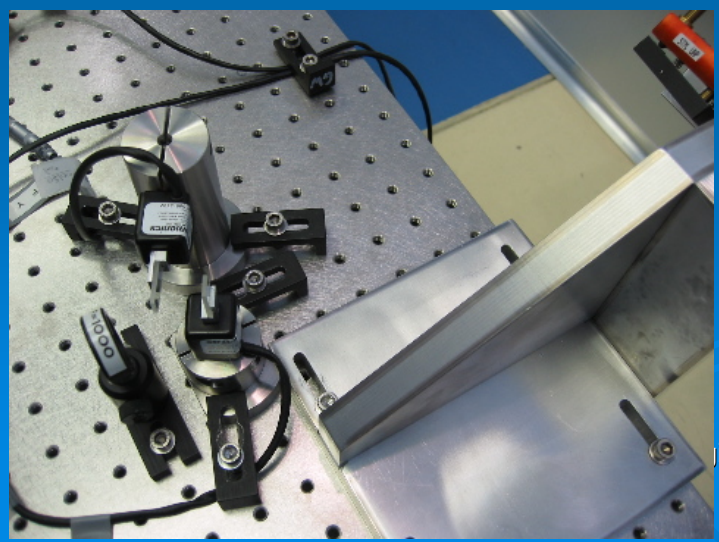
- Wave-front sensing is employed in the auto-alignment system.
- Galvanometers actuate for off-set in the far-field, while the ITM is actuated for tilt in the near-field.
- QPD centering loops have a unity gain bandwidth of 100Hz, with a suppression of 60dB @1Hz.

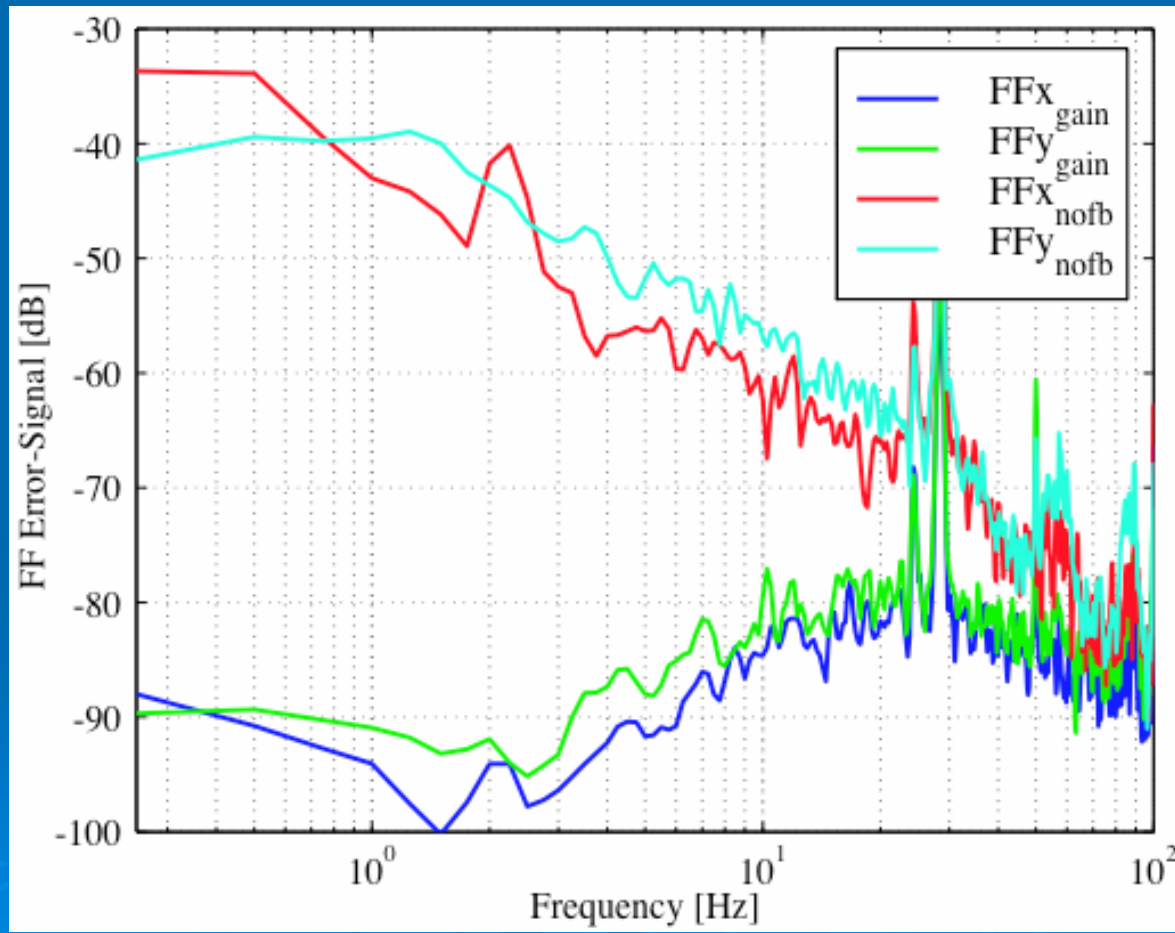




X/Y beam-offset (Far-Field)

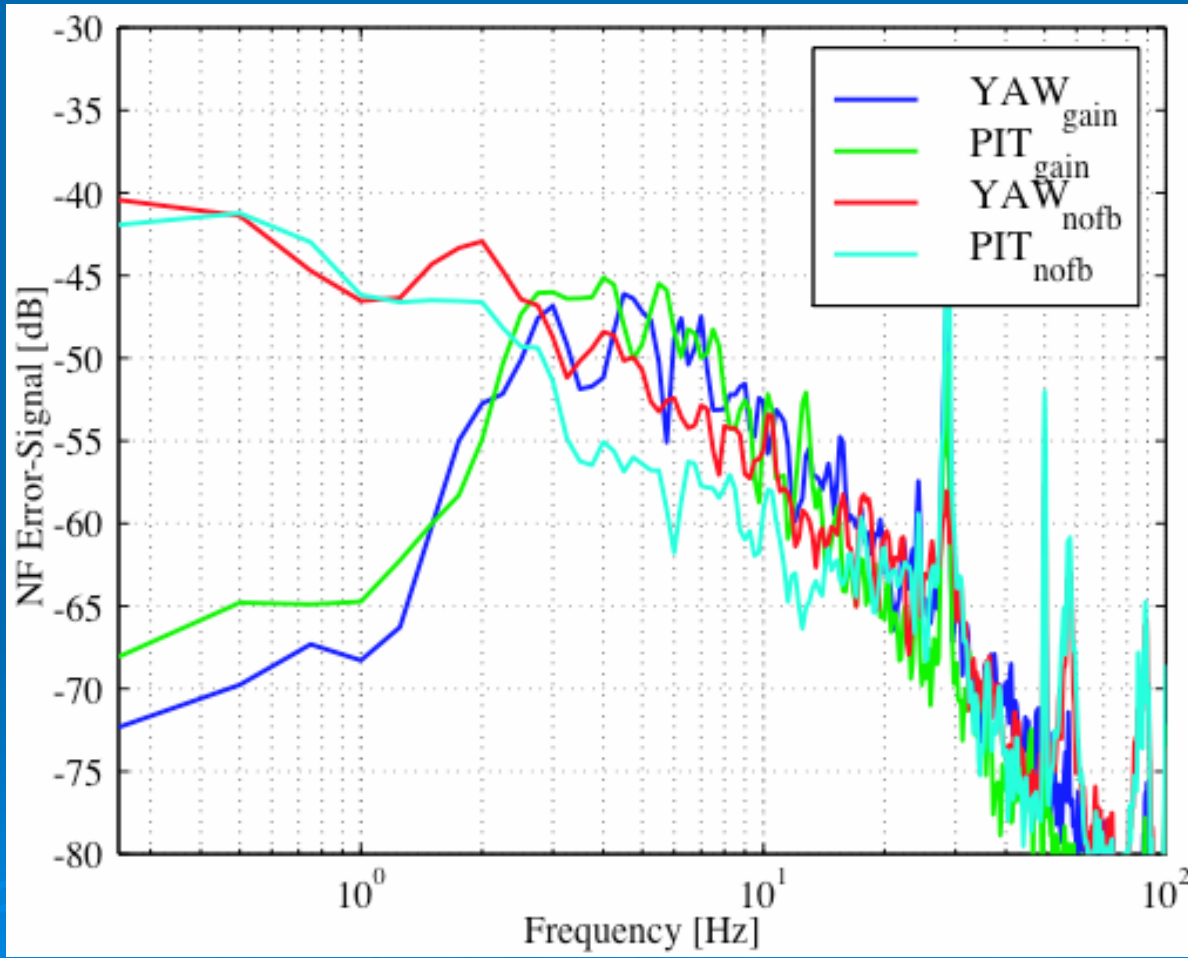
- 2 galvanometers with small mirrors steering the beam in X/Y onto the ITM.
- Far-Field unity gain bandwidth ~80Hz, with a suppression of ~50dB @1Hz.





Pitch & Yaw (Near-Field)

- Near-Field actuation is applied to the ITM pitch and yaw.
- Near-Field unity gain bandwidth ~3Hz, with a suppression of ~20dB @1Hz.
- Limited by SOS damping (using PIT/YAW Test input channels)



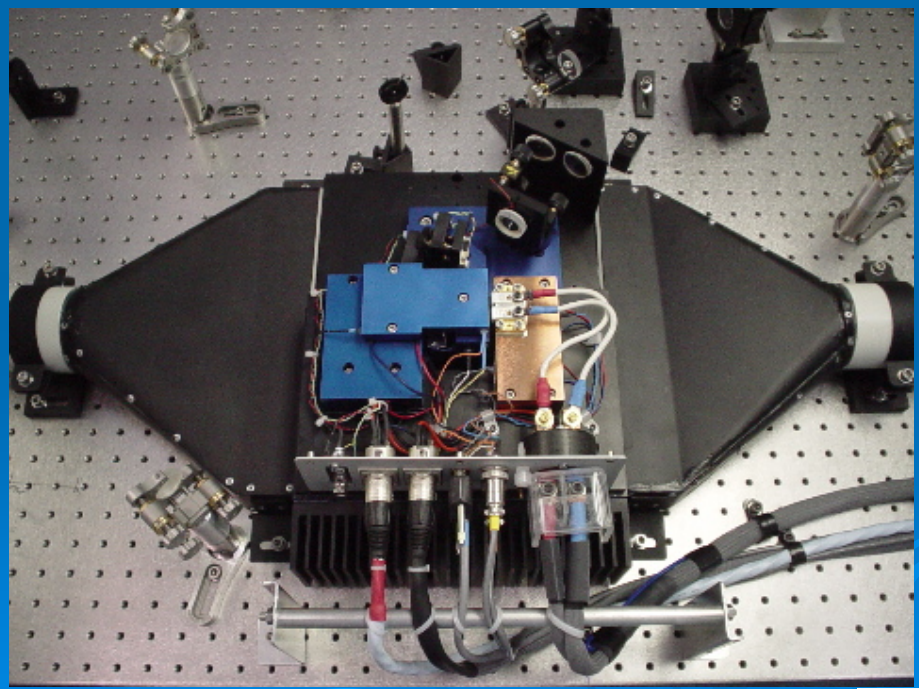
10W laser installation

- ACIGA group of the University of Adelaide have installed the 10W laser.

David Hosken installing the 10W laser.

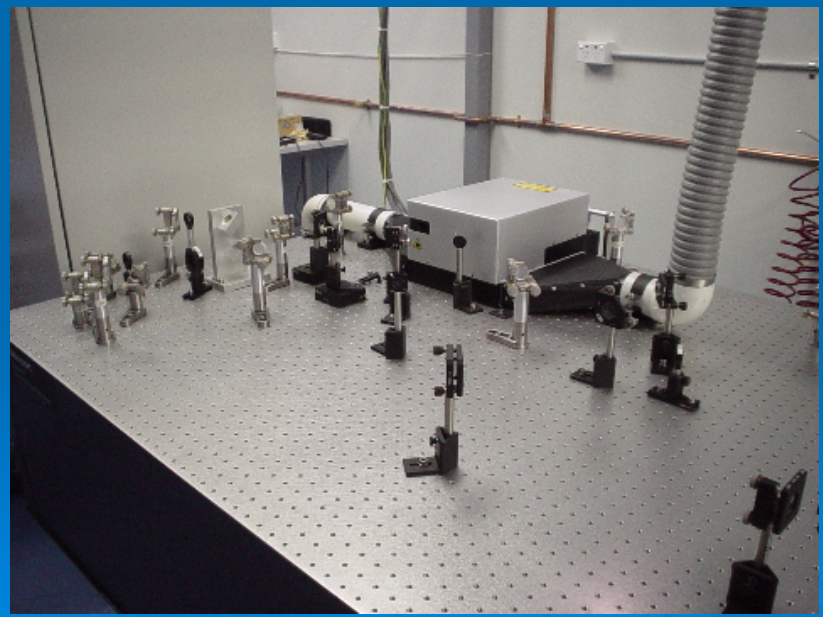
HOPTF 10W Laser
Progress to date

- 10W air-cooled slave laser installed at AIGO.
  - 10W CW output in traveling-wave configuration, $M^2_{x,y} < 1.1$
  - Passive injection-locking demonstrated.

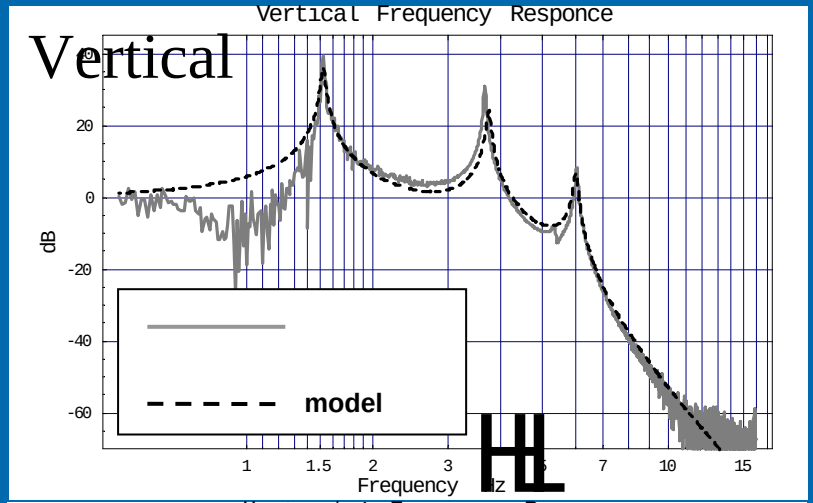


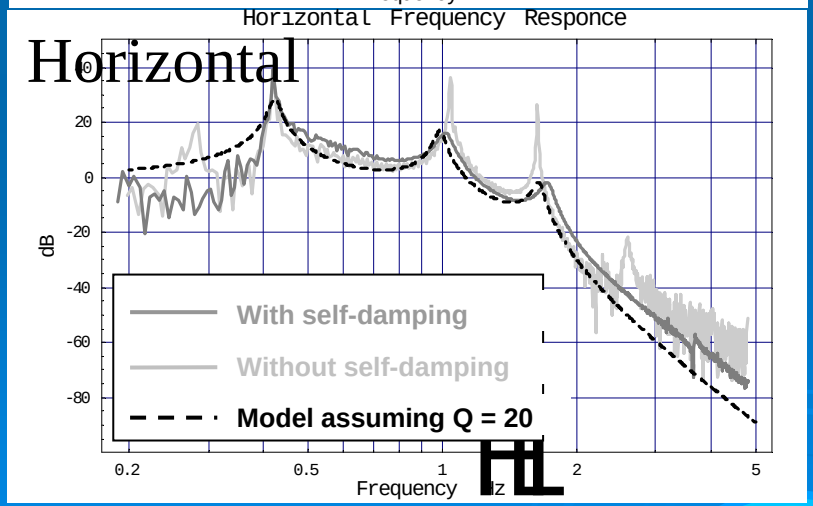
HOPTF 10W Laser
Future plans

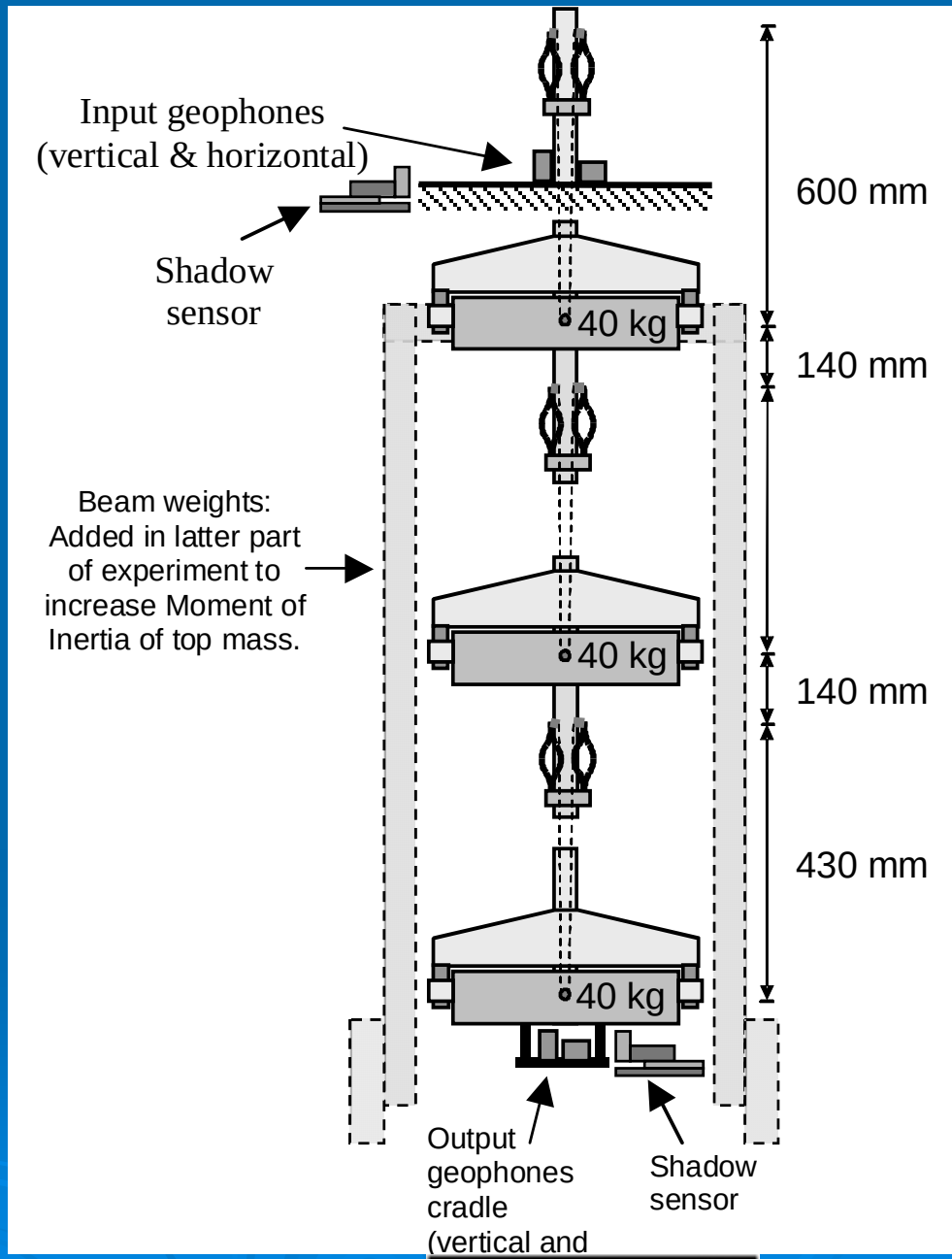
- During the LSC Meeting installation of the PDH servo control electronics.
- Complete 10W CW Injection-locked laser with active feedback control operational by early September.



3D Isolator


Vertical
Vertical Frequency Responce
dB
Frequency
model


Horizontal
Horizontal Frequency Responce
dB
Frequency
With self-damping
Without self-damping
Model assuming Q = 20


Input geophones
(vertical & horizontal)
Shadow
sensor
Beam weights:
Added in latter part
of experiment to
increase Moment of
Inertia of top mass.
40 kg
40 kg
40 kg
600 mm
140 mm
140 mm
430 mm
Output
geophones
cradle
(vertical and
Shadow
sensor

High Power Test Project Timeline

Bram Slagmolen - 12/08/2004

: changes/canceled
: scheduled jobs to commence