High Optical Power Test Facility

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Overview

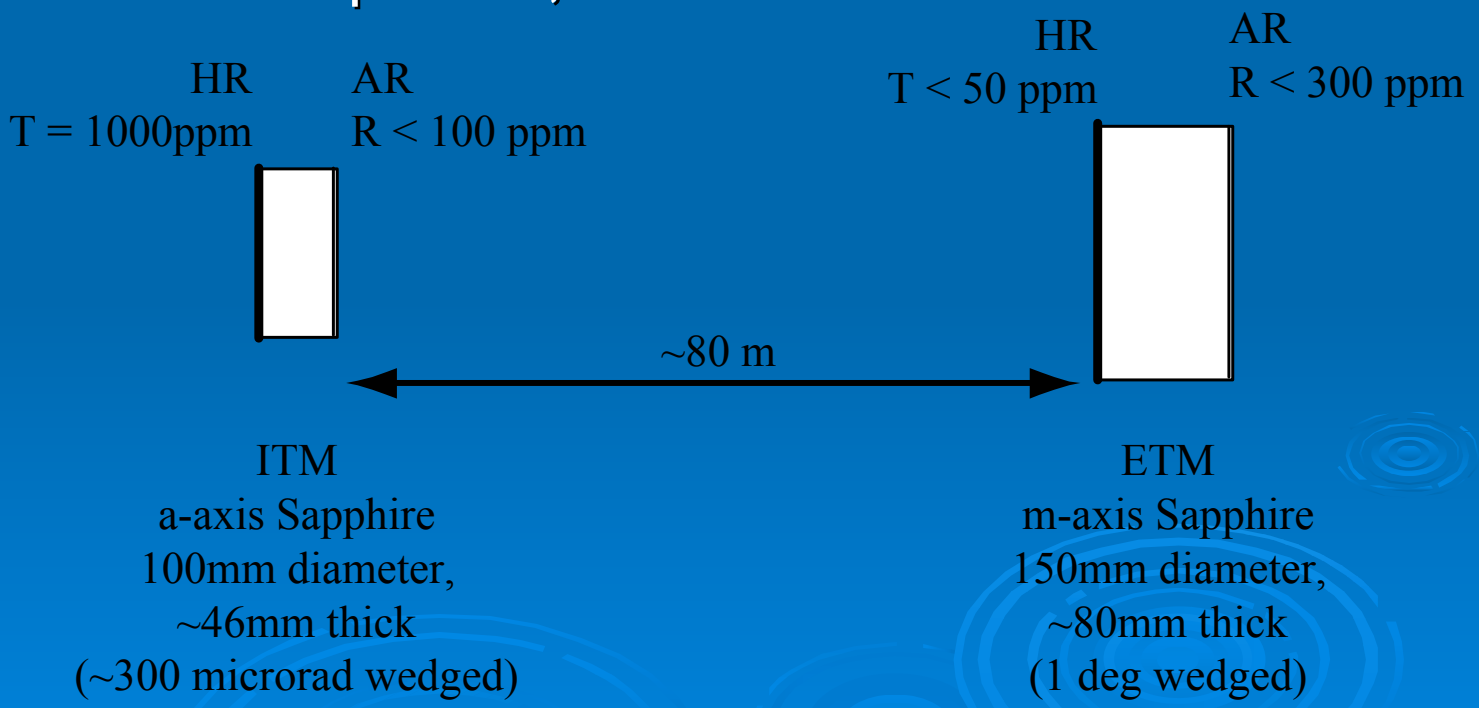
- The High Power Tests
  - Test 1 - Absorption in the ITM substrate.
  - Thermal effects.
  - Laser power coupling into the cavity - mode-matching.
  - Test 2 and Test 3.
- The Experiment - Stage 1-1
  - Initial Suspended Cavity.
  - The NPRO laser set up.
  - The input-table.

The High Power Tests

- Investigating high power cavity operations, stability and dynamics at A/LIGO circulating powers (~1MW).
- Investigate the 'cold' lock up to full operating power.
- **Test 1**: Placing the ITM substrate inside the high power Fabry-Perot cavity. Investigating optical ITM-absorption of the sapphire.
- **Test 2**: Investigate the optical distortion dominated by HR coatings of the ITM and ETM. This is a pre-cursor to Test 3.
- **Test 3**: Assemble a power-recycled F-P cavity, investigate and compensate the thermal lensing in the substrates and other high power dynamics.

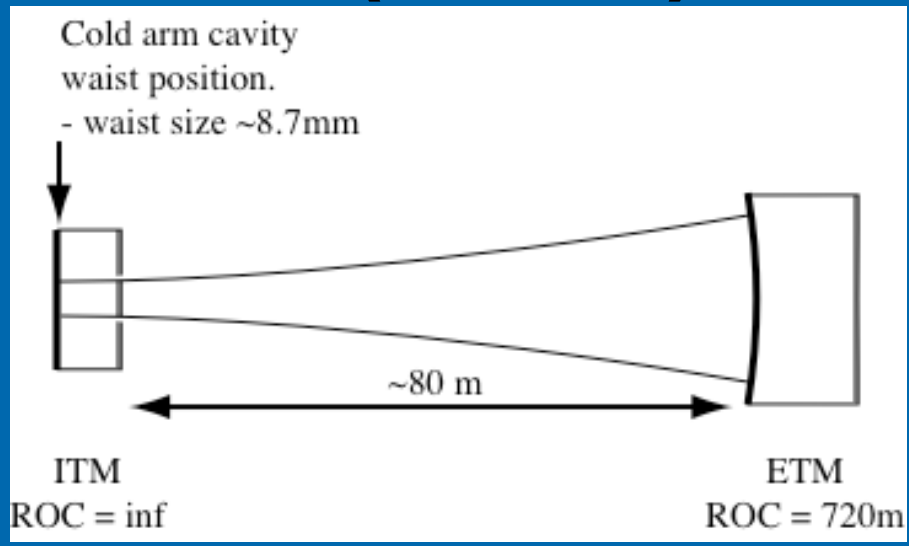
High Power Test 1

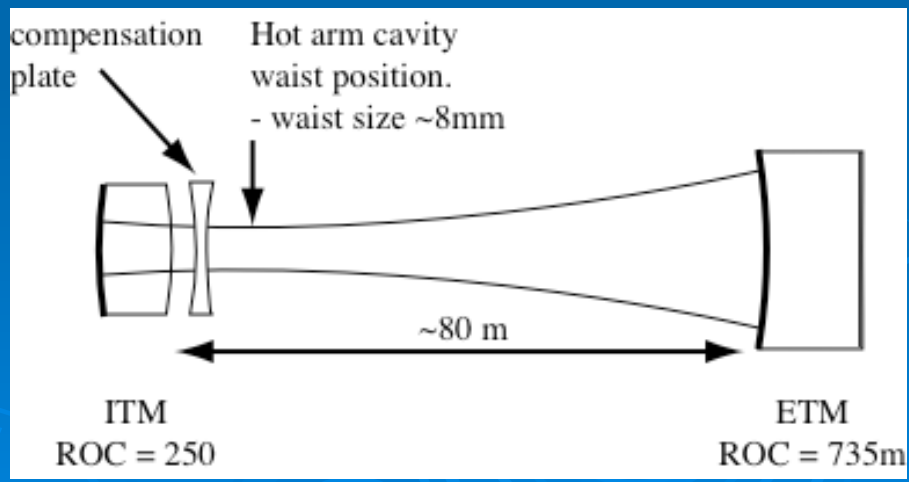
- Placement of the ITM substrate inside the cavity
- ITM substrate of Sapphire (50 ppm/cm absorption)
- Cavity waist (cold): ~8.6 mm
- TEM_{00} power built-up ~770, Finesse ~2029



High Power Test 1 (cont.)

- ITM parameters
  - Circulating power with 7W input: ~5 kW circulating
  - Cavity waist (hot): ~8 mm
  - Thermal lensing induced ROC of ITM: ~230m
  - Waist position with thermal lensing will be moved away from he ITM towards the ETM.
  - Use of a thermal compensation plate to compensate the thermal lensing in the ITM.





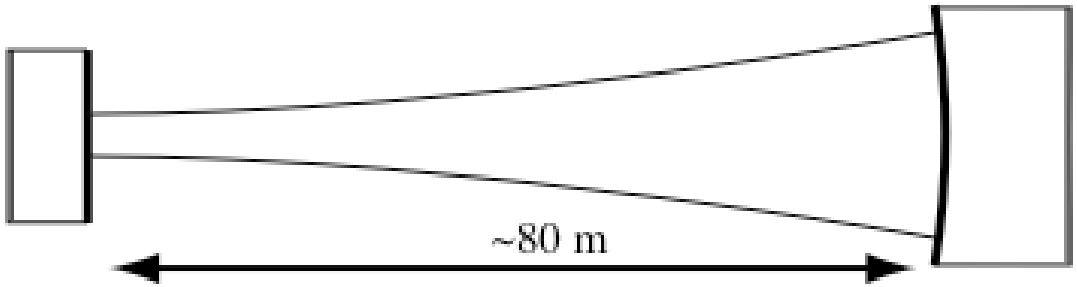
High Power Test 1 (cont.)

- Due to the thermal lensing, there will be a reduction in the power coupling into the cavity. An other method to compensate the thermal lensing can be done by changing the mode-matching.

1. Cold mode-matching into cavity-> 12% loss
2. Adjusting the focal length of one of the mode-matching mirrors -> 2.5% loss
3. Set up the mode-matching so it will deliver a ‘hot’ cavity waist -> prior lock there is 6% power loss.

High Power Test 2 and 3

Test 2: ITM substrate outside the arm cavity.

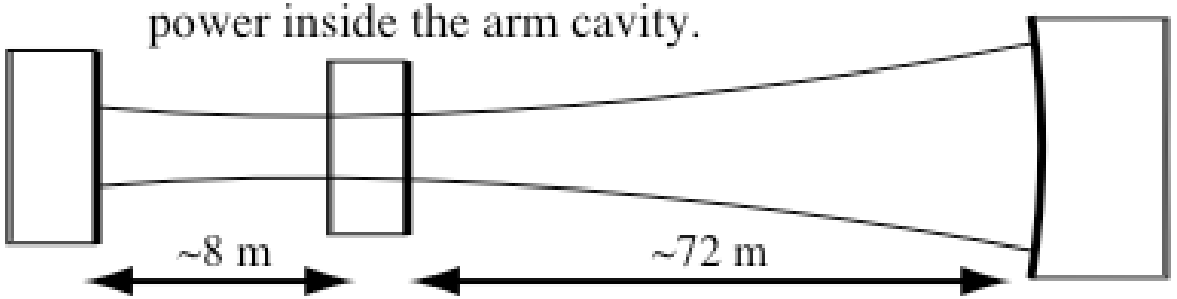


ITM
ROC = inf

ETM
ROC = 720m

Pin = 50W
Gain = 1900
Circ. Power = 95kW

Test 3: Using a Power Recycling Mirror to increase the power inside the arm cavity.



PRM
ROC = 5.8km

ITM
ROC = 4km

ETM
ROC = 720m

Pin = 50W

Circ. Prc ~4kW

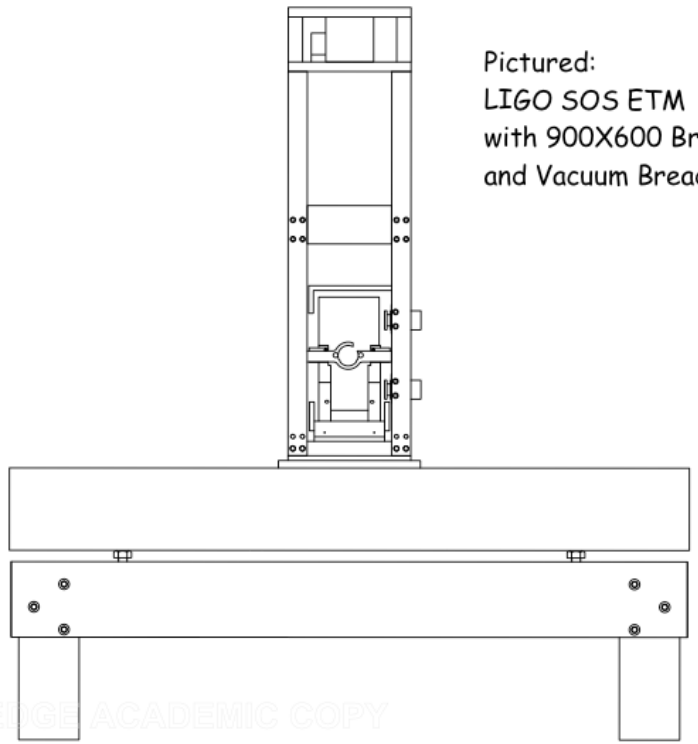
Circ. Arm ~ 1MW

The Experiment - Stage 1-1

- The vacuum system
  - 24/7 pump operation (since 14/01), ~5e-7 mbar, with 8e-10 mbar total partial hydrocarbon pressure.
- The Dummy suspended cavity
  - BK7 optics has been installed, and currently fringes are visible.
  - Optimize the local SOS damping.
- The laser set up
  - 500mW NPRO to initialize the suspended cavity

Initial Suspended Cavity

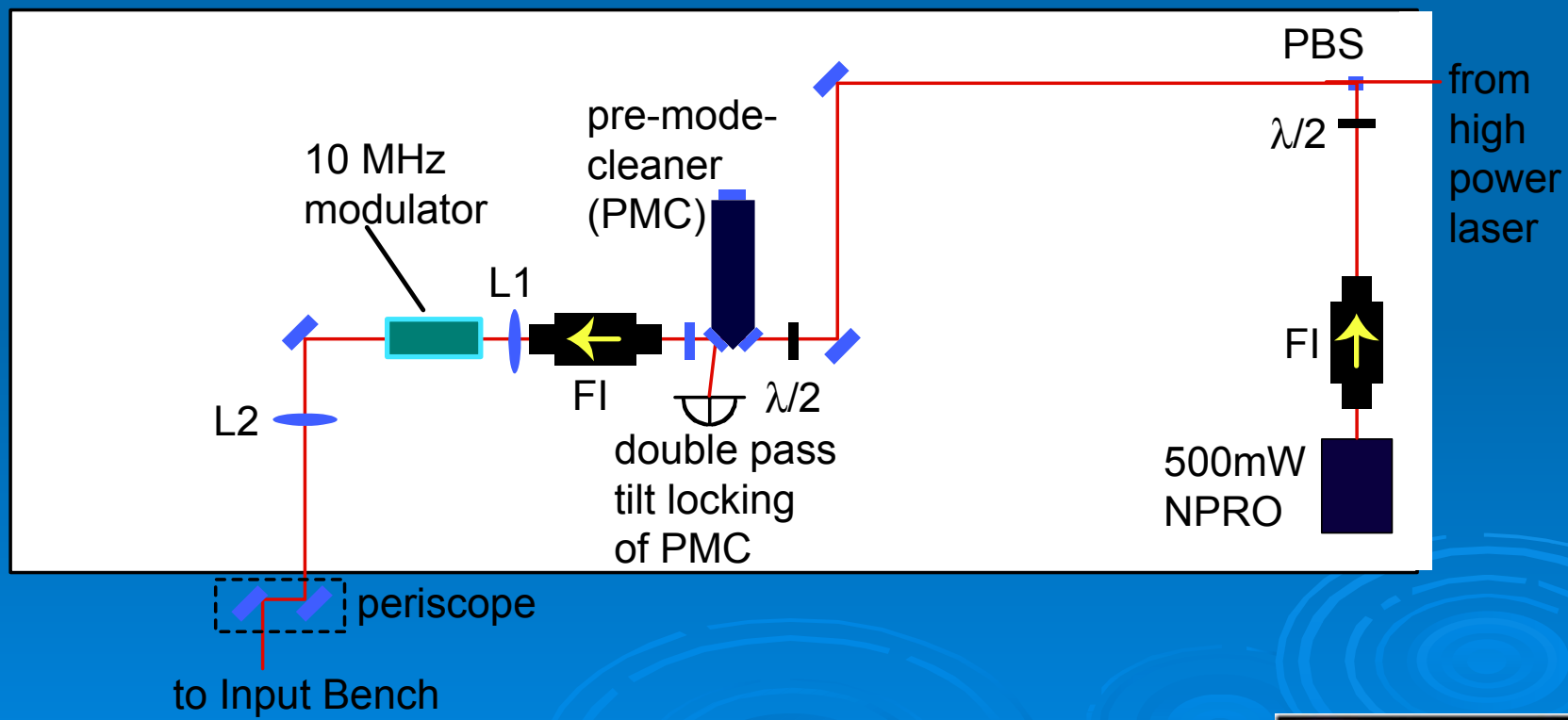
- Using BK7 optics to initial try to lock the suspended cavity.
- LIGO SOS, placed on top of a 900mm x 600mm breadboard.
- Replacement of the BK7 optics with the Sapphire optics, when the system is running reliably.



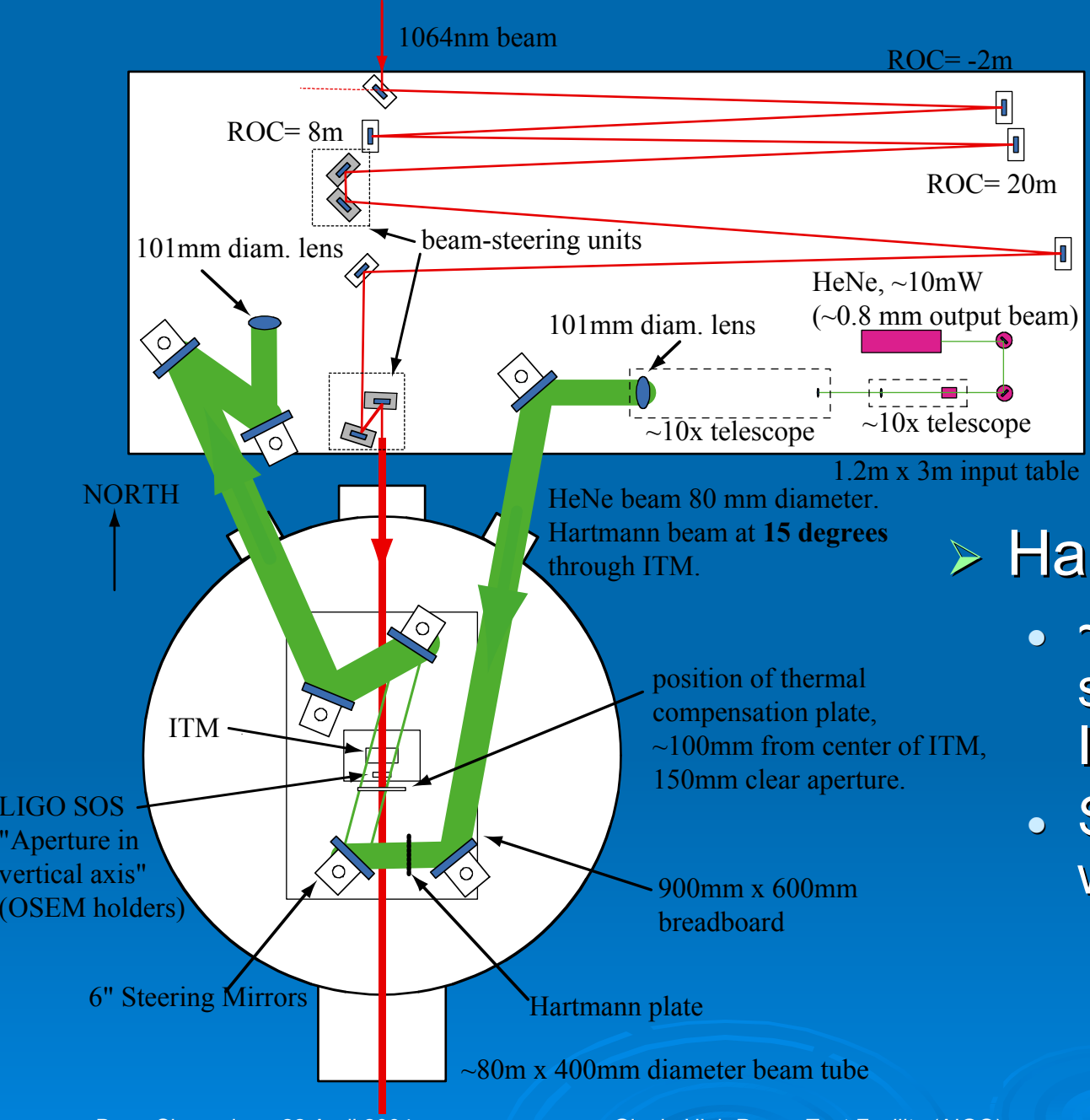
Drawing: Tim Slade

Laser Room

- Preliminary cavity alignment with 500mW NPRO



Input Bench



- Hartmann Sensor
  - ~80mm diameter sensor beam through ITM
  - Sensor beam at 15º with cavity optical axis

Global Control

length control