



LIGO-I Installation

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Installation Highlights

- The 2km interferometer Mode Cleaner (MC) was aligned and locked
- 2km Interferometer recycling cavity is aligned
- The 2km long arm cavity test will start late Nov
- The IO assembly for the Livingston 4km interferometer is underway; installation will commence in Dec



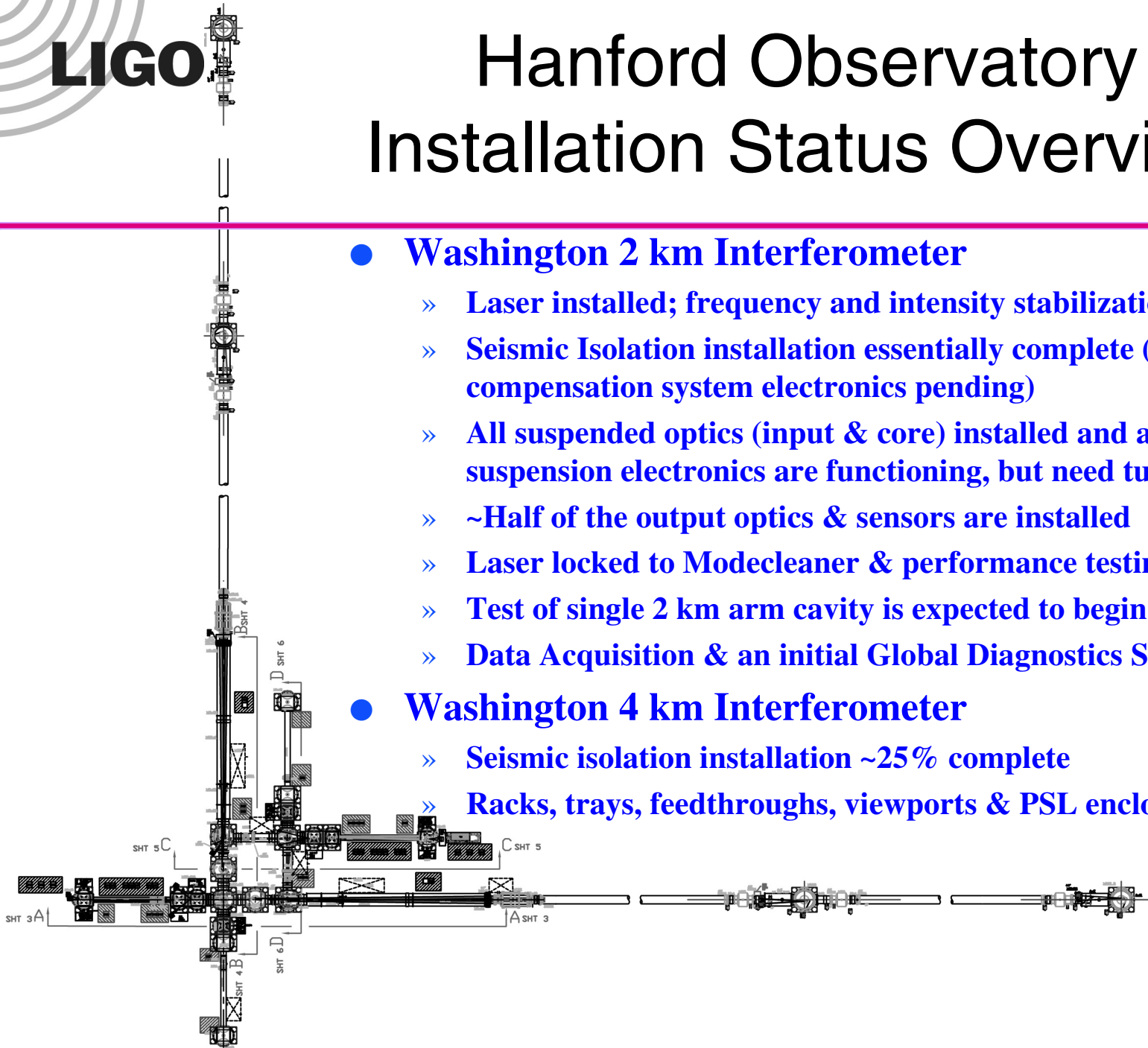
Hanford Observatory Installation Status Overview

- **Washington 2 km Interferometer**

- » Laser installed; frequency and intensity stabilization operational
- » Seismic Isolation installation essentially complete (tidal motion compensation system electronics pending)
- » All suspended optics (input & core) installed and aligned; suspension electronics are functioning, but need tuning
- » ~Half of the output optics & sensors are installed
- » Laser locked to Modecleaner & performance testing in progress
- » Test of single 2 km arm cavity is expected to begin 11/29
- » Data Acquisition & an initial Global Diagnostics System installed

- **Washington 4 km Interferometer**

- » Seismic isolation installation ~25% complete
- » Racks, trays, feedthroughs, viewports & PSL enclosure in place

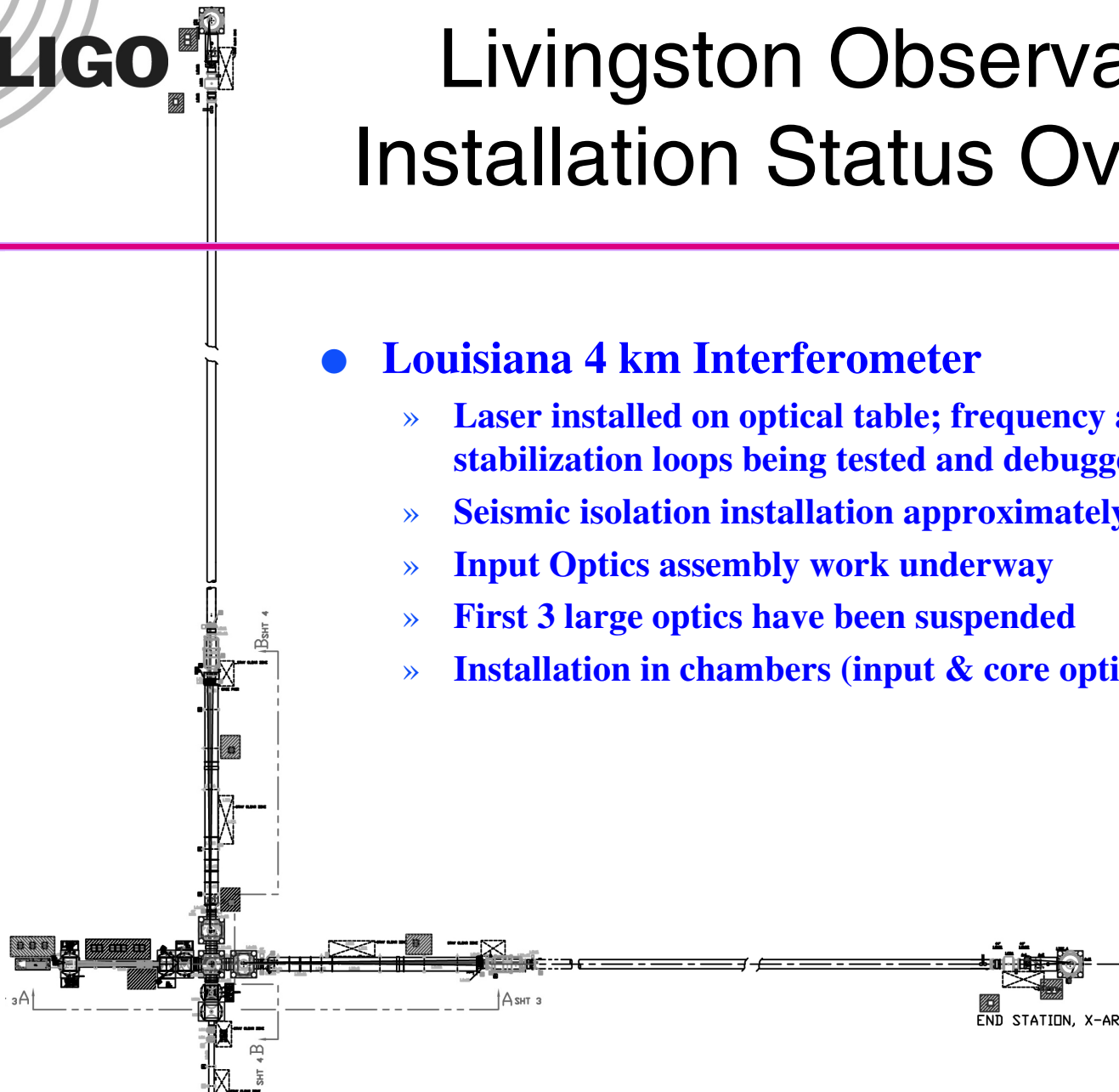




Livingston Observatory Installation Status Overview

- **Louisiana 4 km Interferometer**

- » Laser installed on optical table; frequency and intensity stabilization loops being tested and debugged
- » Seismic isolation installation approximately 80% complete
- » Input Optics assembly work underway
- » First 3 large optics have been suspended
- » Installation in chambers (input & core optics) to start 12/13



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LIGO-I Installation

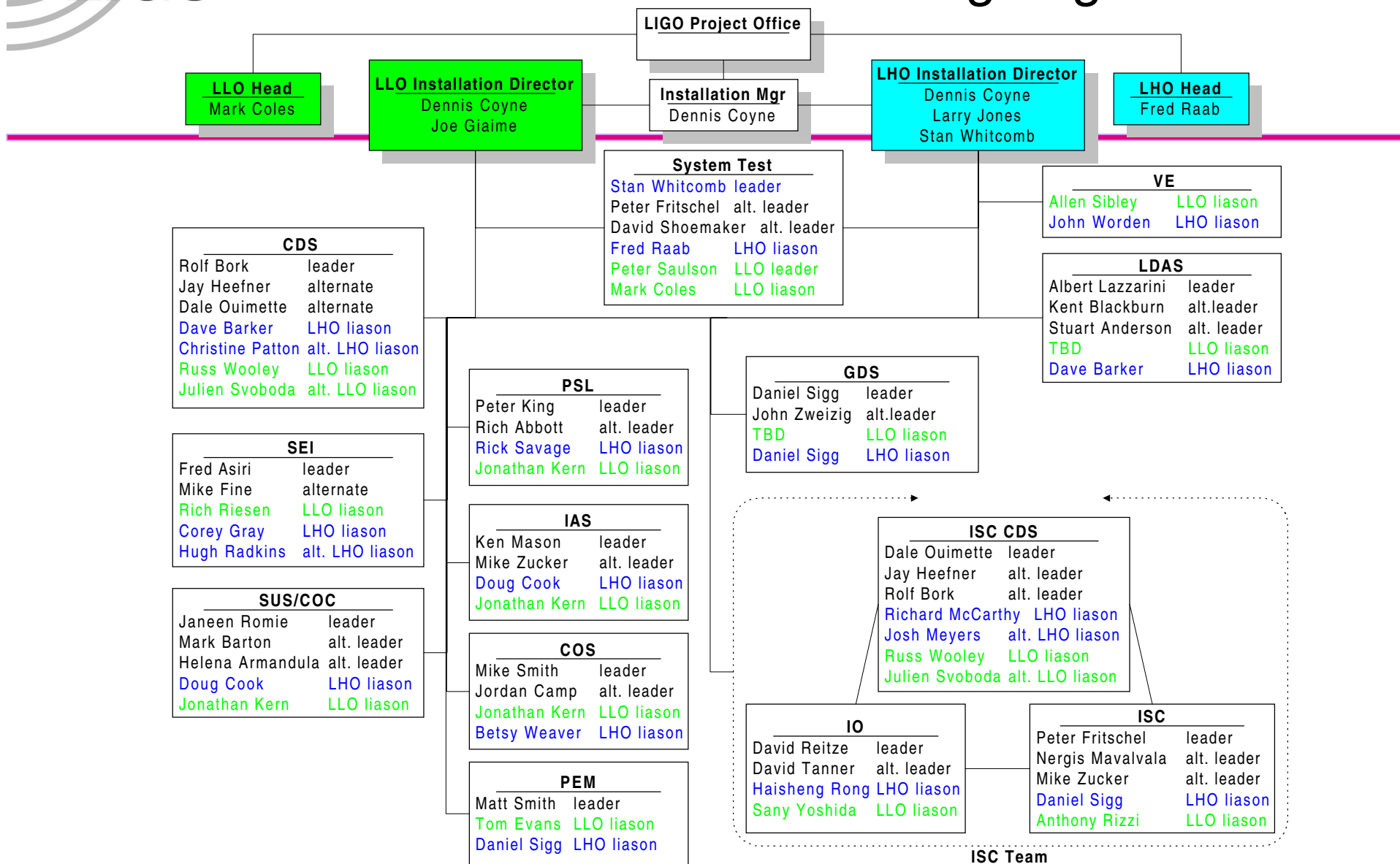


Installation Plan

- Basic Strategy:
 - » Simultaneous installation at both observatories (optimum staff utilization)
 - » Time phased installation of subsystems (leveling load on experts)
 - » Significant participation & support from observatory staff (training)
 - » Early as possible installation of all in-vacuum components (fab/assy/install. risk reduction)
 - » Early as possible system integration & commissioning (early warning)
 - » Hanford 2km Mission: Problem finding/solving ('pathfinder')
 - » Livingston 4km Mission: Robust implementation & characterization
- Organization:
 - » Centralized, flat organization
 - » staff from LIGO Lab (CIT, MIT, UFL, LHO, LLO)
 - » Focused on subsystems for installation:
 - subsystem leaders from the universities
 - Observatory liaisons
 - » Separate installation & commissioning leadership



Installation & Commissioning Organization



Seismic Isolation Systems

- Outstanding progress:
 - » production and delivery of components meeting or exceeding installation schedule needs (and almost entirely complete)
 - » Early quality problems have mostly disappeared; There have been a few problems with the quality of metal seal knife edges but we have been able to perform the required rework
 - » The Hytec contract work has been completed; The BSC first article is in rework
 - » The coarse actuation system for the BSC seismic isolation systems has been installed and tested successfully in the LVEA at both Observatories
- Hanford 2km seismic isolation system installation has been completed, with the exception of the tidal compensation (fine actuation) system
- Livingston seismic isolation systems are 85% complete
 - » Remaining: the X-end station BSC and flourel component replacement in 2 corner station BSC stacks
 - » BSC seismic systems at Livingston went as quickly as any installation at Hanford indicating that the transfer of experience was successful.
- Hanford 4km seismic isolation installation is ~25% complete



**HAM Door Removal
(Hanford 4km)**



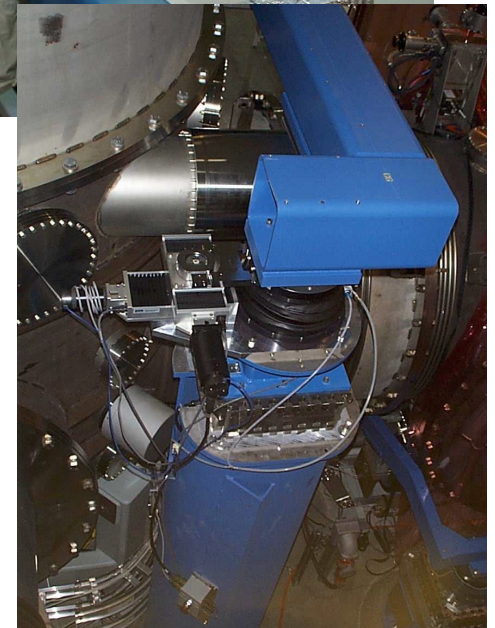
Seismic Isolation Systems

Support Tube Installation
(Hanford WBSC7)



Stack Installation
(Hanford X-Mid)

Coarse Actuation
System

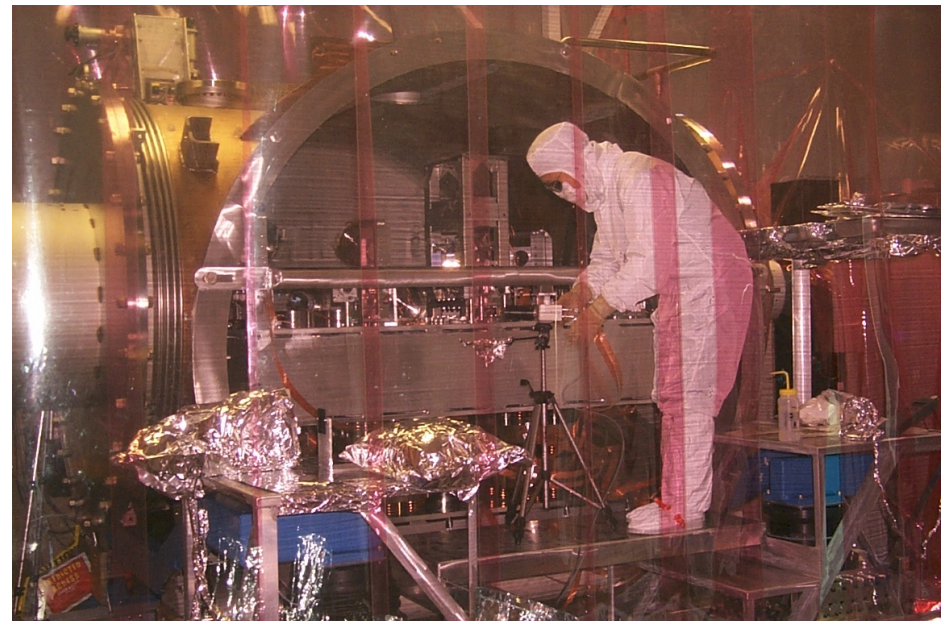


Input Optics (IO)

- The 2km Input Optics (IO) subsystem installation has been completed
 - » The Mode Cleaner routinely holds length servo-control lock for days
 - » Mode cleaner parameters are close to design specs, including the length, cavity linewidth and visibility
 - » Further characterization is underway (incl.. small optics suspension diagonalization, & PSL frequency noise measurement)
- Livingston IO small optics suspension assembly is underway; installation start 12/13



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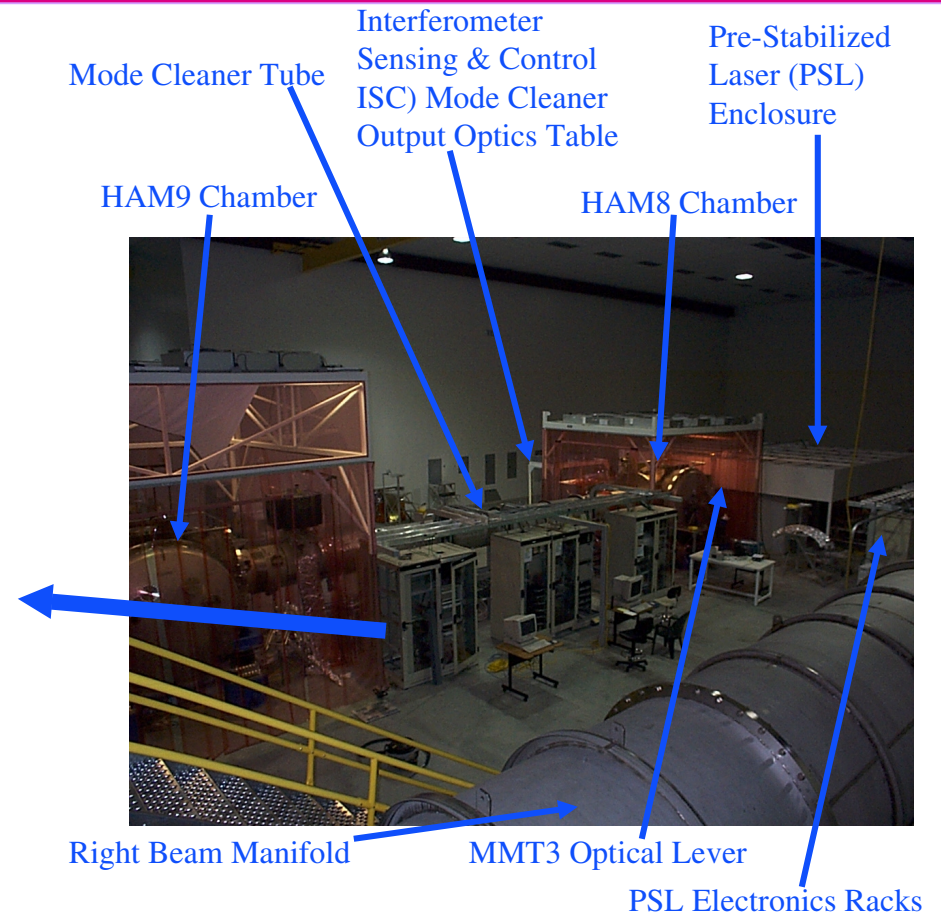


Input Optics (IO)



Control System Racks
(2km Interferometer)

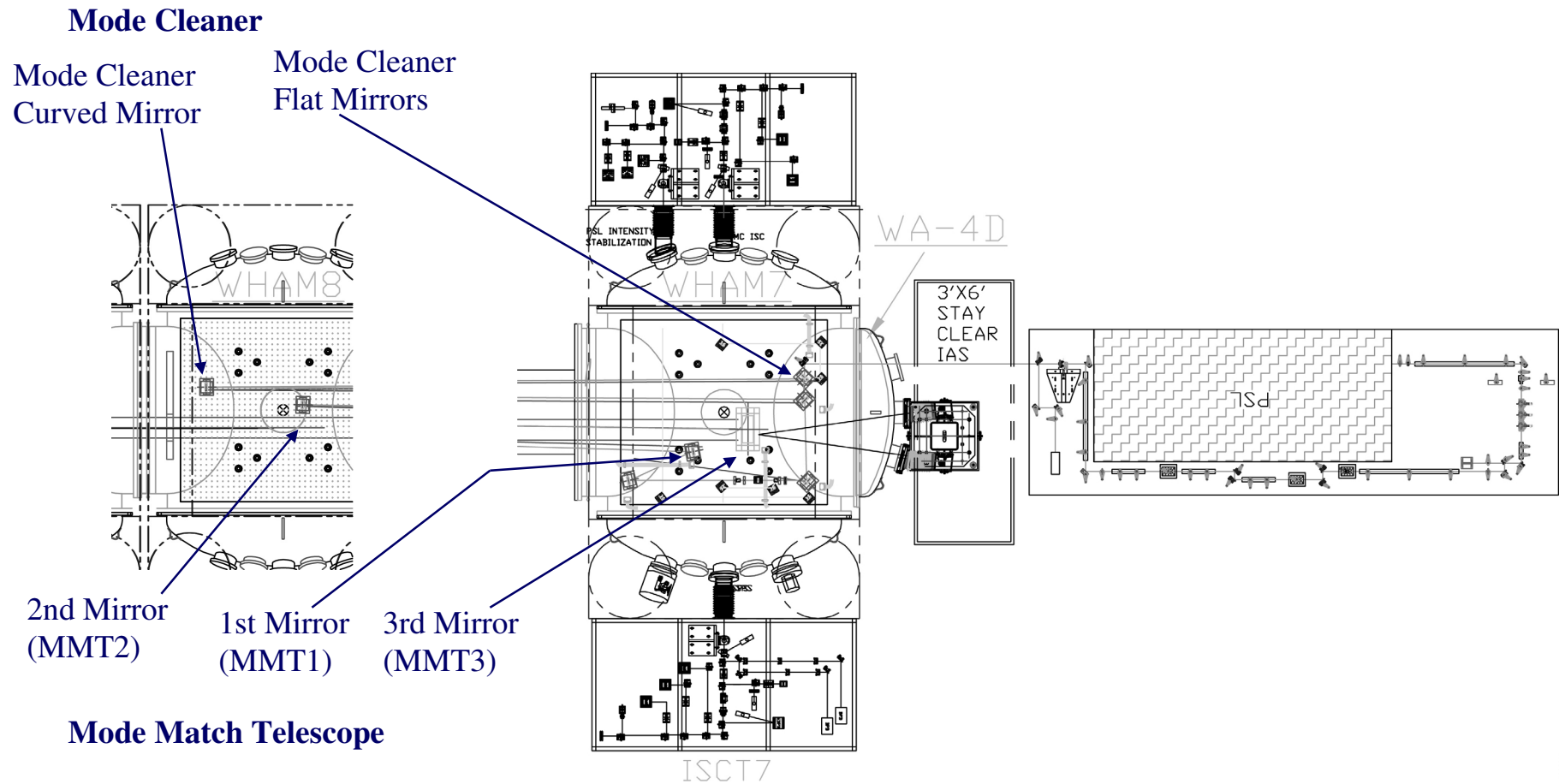
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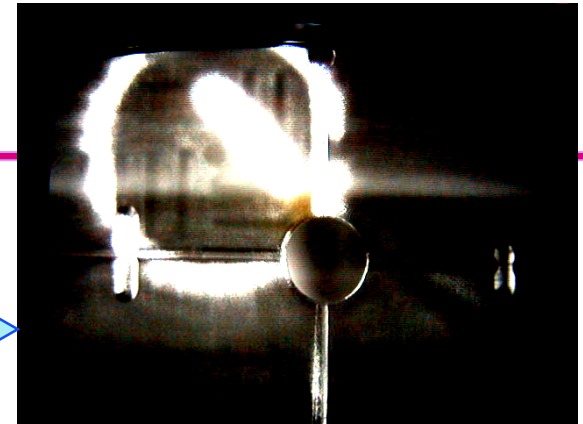
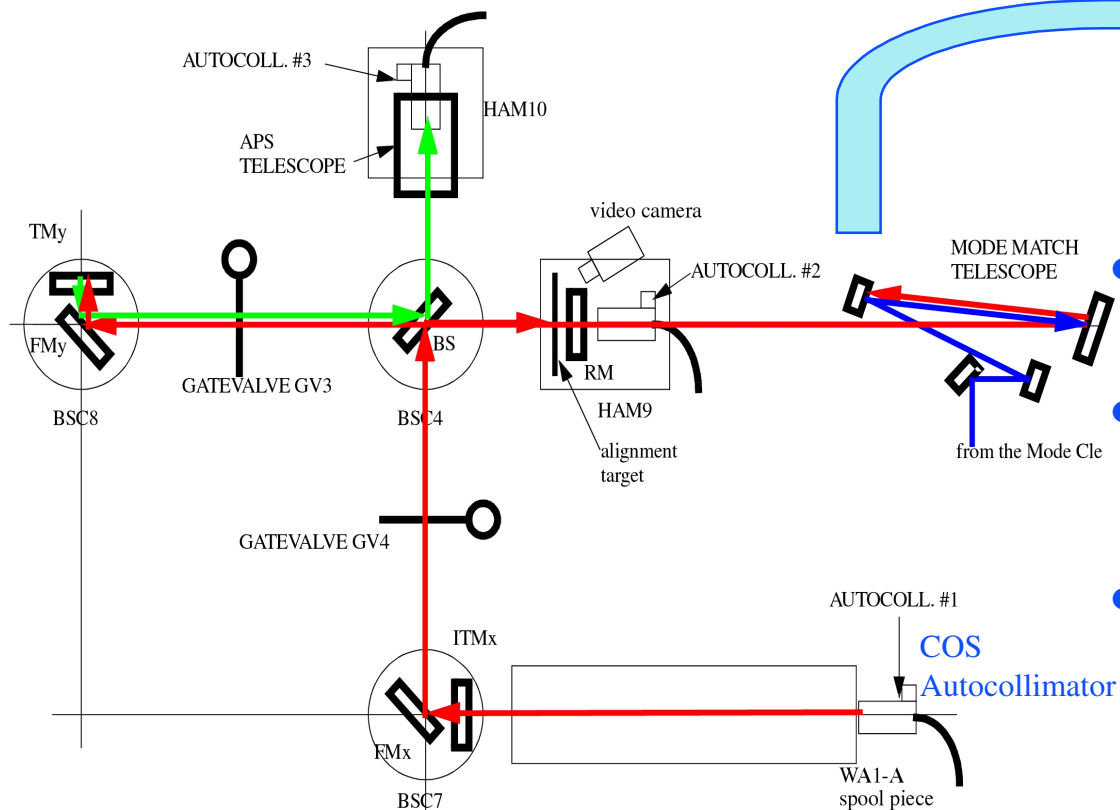
Input Optics Section
(2km Interferometer)₁₀

LIGO-I Installation

Input Optics (IO) Layout



Recycling Cavity Alignment

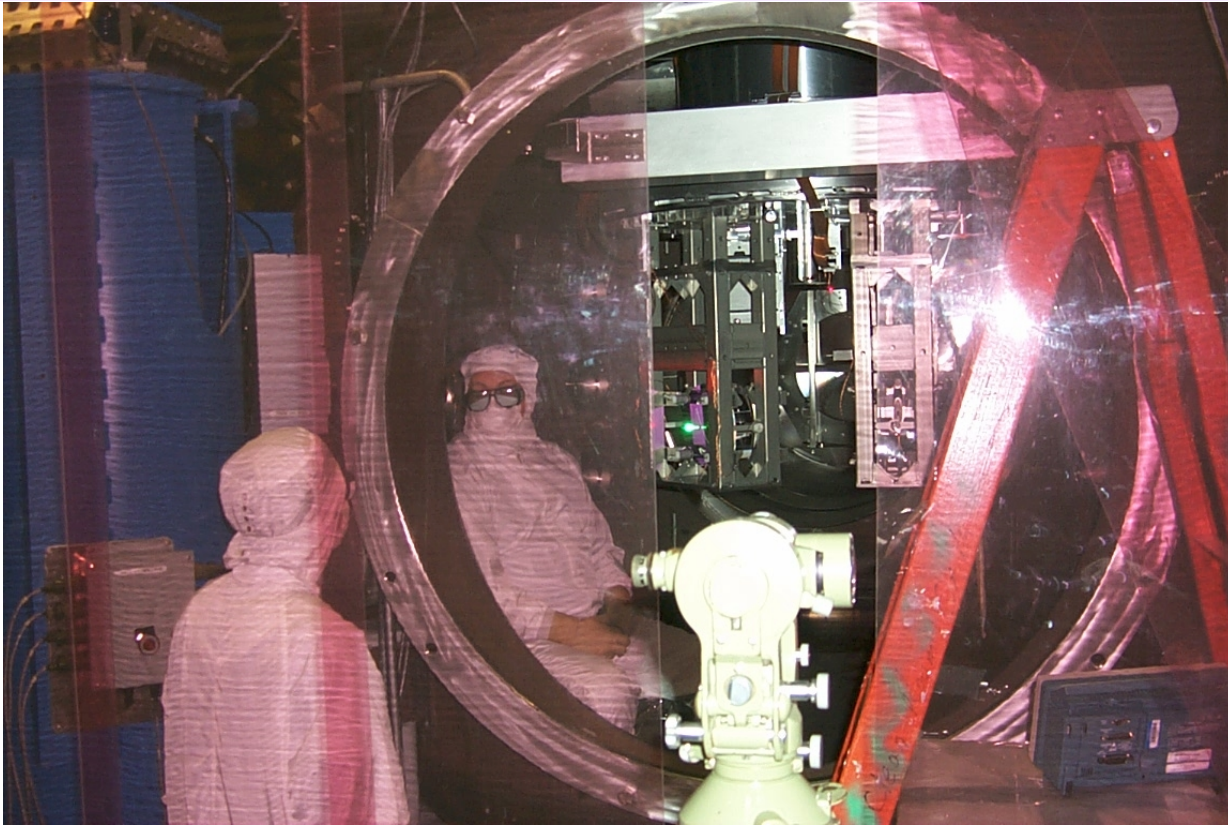


Projected reticule pattern & PSL beam on target in front of MMT2

- Absolute positioning & alignment reference from laser autocollimator co-boresighted to a theodolite
- co-alignment of the recycling cavity optics accomplished with an alignment telescope used alternately as an autocollimator & projector (940nm)
- alignment of the mode match telescope to the recycling cavity was accomplished by aligning the PSL beam to the projected reticule pattern & then by retroreflection from the RM



Recycling Cavity Alignment

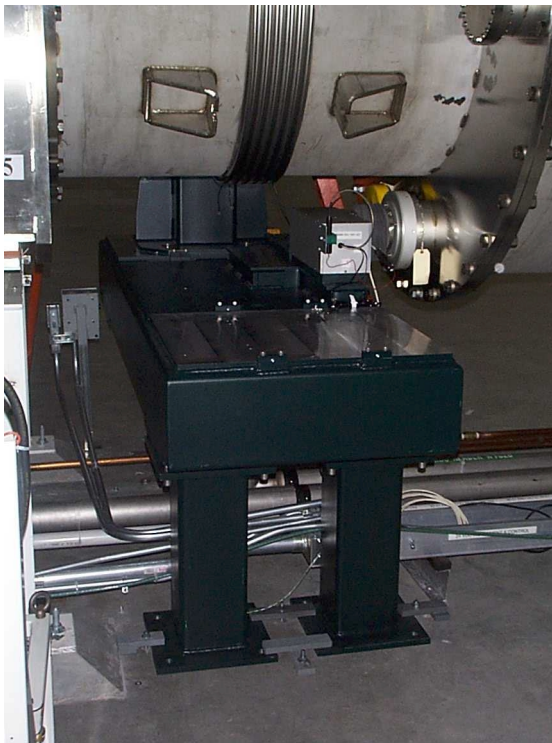


Adjusting the Fold Mirror (FMx) Alignment



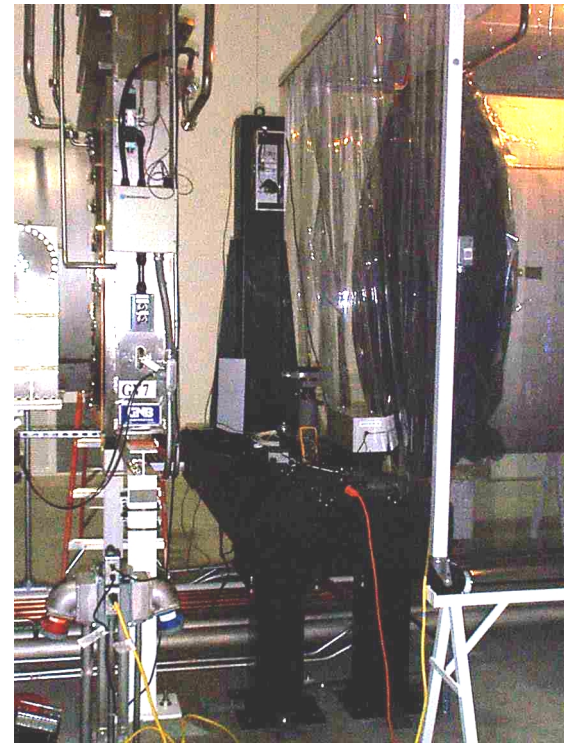
Initial Alignment System: Optical Levers

- Optical levers have been installed, aligned & are operational for all core optics in the 2km interferometer



Input Test Mass (ITMx) Optical Lever

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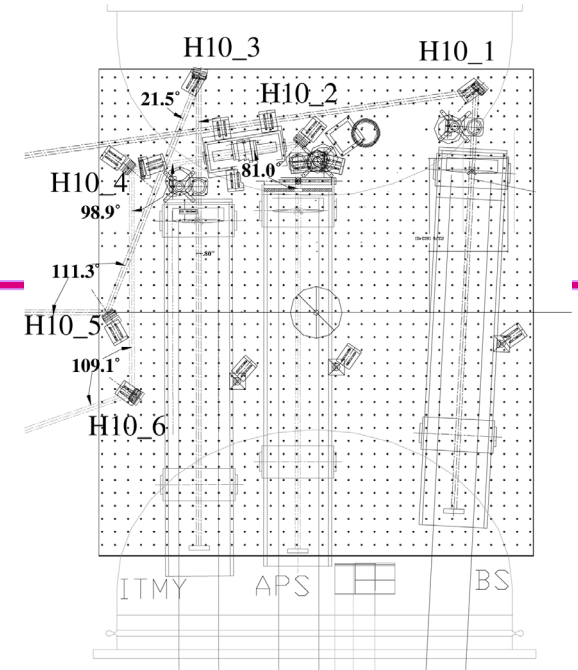


Transmit & Receive modules visible with
spool piece removed for ITMx alignment



Core Optics Support

- Fabrication nearly complete
- Installed for the 2km:
 - » Beam Dumps (most)
 - » Recycling cavity baffles, IO baffle & cryopump baffle
 - » Pick-Off Mirrors
 - » Antisymmetric Port Pick-Off Telescope
 - » Both End Test Mass Transmission Telescopes
- Pending installation for the 2km:
 - » arm cavity baffles
 - » 3 pick-off telescopes
 - » high wavefront quality viewports



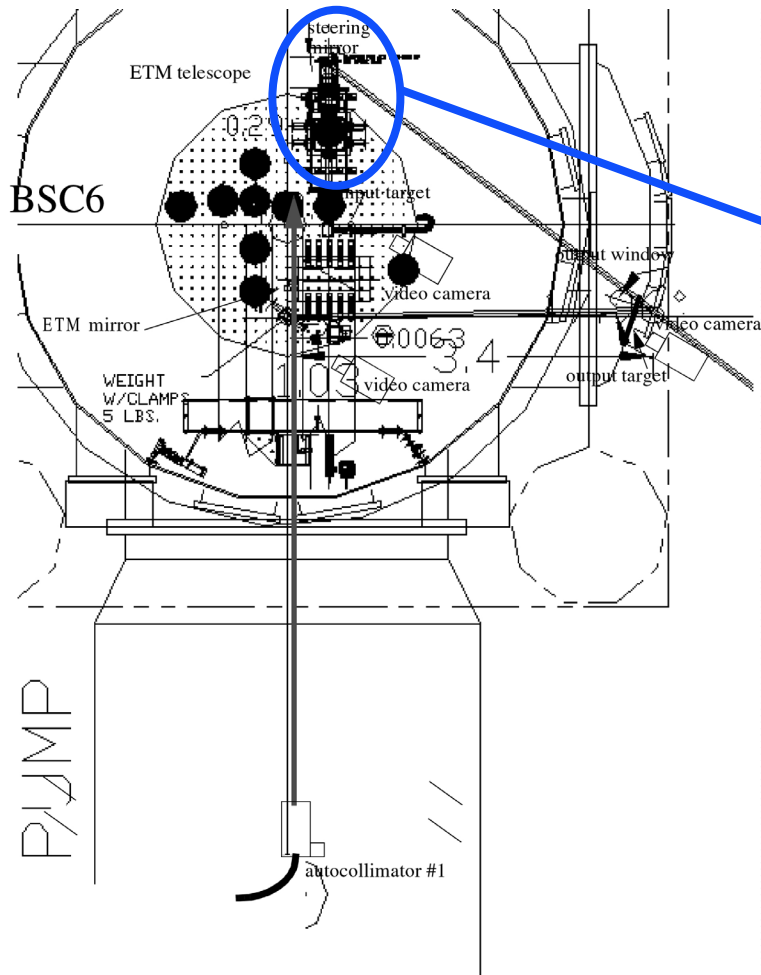
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LIGO-I Installation



Core Optics Support: End Test Mass Transmission Telescope





Milestones for Summer 2000

- **Washington 2 km Interferometer**
 - » All suspended optics installed, aligned and operational
 - » **Laser/Modecleaner testing complete**
 - » **Single arm cavity test completed**
 - » Full interferometer control system nearing completion
- **Louisiana 4 km Interferometer**
 - » Laser installed, frequency and intensity stabilization operational
 - » Seismic isolation installation complete
 - » Most suspended optics installed, aligned, damped
 - » Laser locked to Modecleaner and performance testing in progress
- **Washington 4 km Interferometer**
 - » Seismic isolation installation complete
 - » Laser installed, stabilization servos underway
 - » Some suspended optics installed, aligned, damped



Milestones for Summer 2001

- **Washington 2 km Interferometer**
 - » **Full interferometer locked, extended lock durations possible**
 - » **Performance characterization in progress; sensitivity ~10 -20**
- **Louisiana 4 km Interferometer**
 - » **All suspended optics installed, aligned, controlled**
 - » **Laser/Modecleaner testing complete**
 - » **Full interferometer locked for brief periods of time; investigations to extend lock duration ongoing**
- **Washington 4 km Interferometer**
 - » **Laser installed, frequency and intensity stabilization operational**
 - » **All suspended optics installed, aligned, controlled**
 - » **Laser locked to Modecleaner and performance tuning in progress**

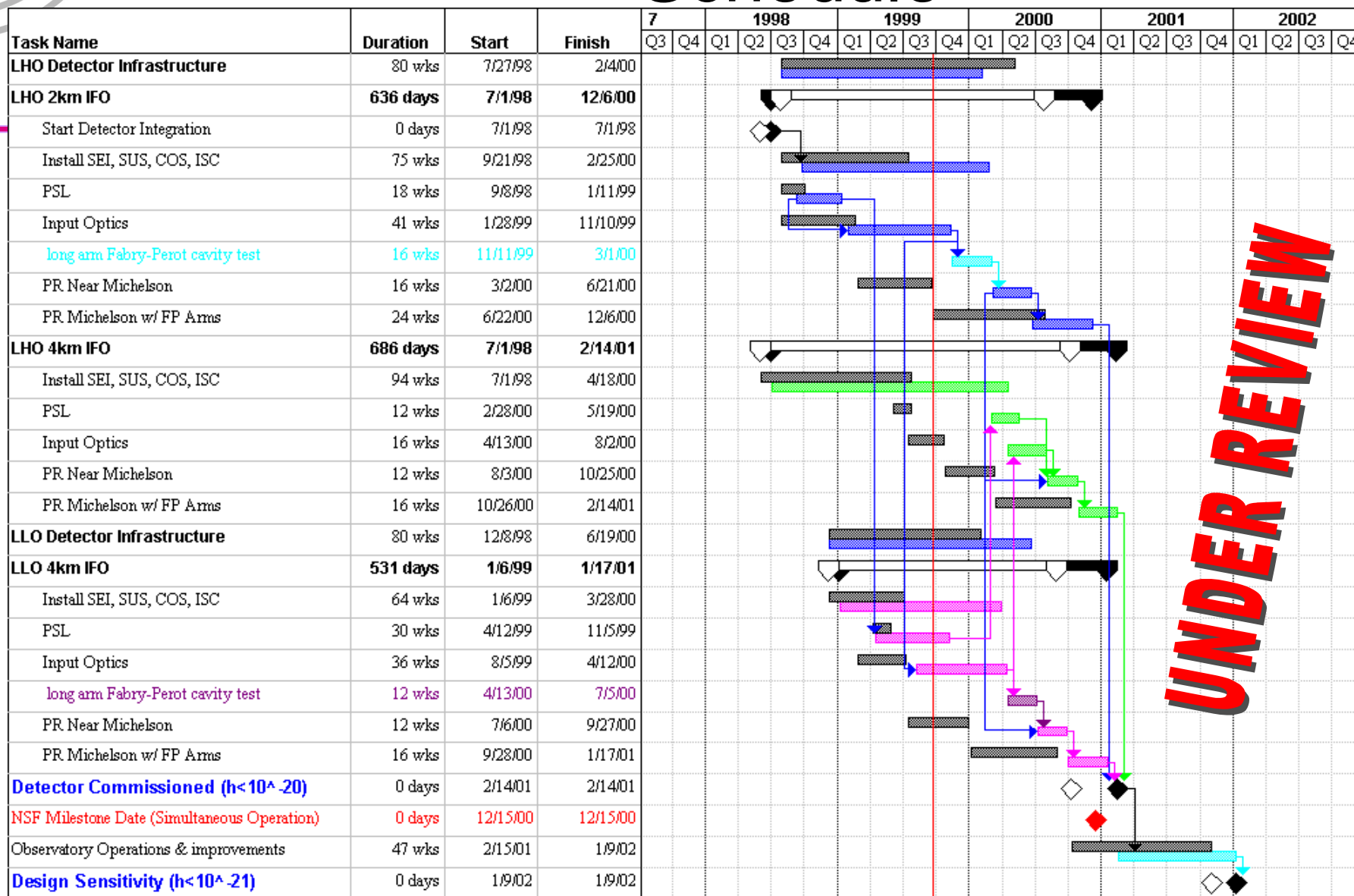


Progress Against Schedule?

- Process control problems for the magnet/standoff assembly adhesion to the optics (1st & 2nd quarters of '99) and have been solved
- Suspension handling & fixture problems (required reprocessing several suspension assemblies); Reworked fixtures and revised procedures have solved these problems.
- Flourel components lost from the Oklahoma tornado in May
- Delays due to additional bake & replacement of the flourel components in the seismic stacks (to reduce water outgassing rate)
- Schedule under review
 - » looking at load leveling of CDS installation/commissioning tasks
 - » redefine plan to allow for lessons learned & electronics modifications to be incorporated into subsequent interferometers



Schedule





Problems/Issues

- Scattered light sensitivity of the suspension occultation sensor
 - » Alternate design in-process with inherently less sensitivity
 - » Retrofit modulated design (control/readout electronics) in-process
- PSL pre-modecleaner sensitivity to barometric pressure (insufficient range?)
 - » under investigation
- Configuration Control
 - » draft plan for Detector configuration control under review; release imminent
- Capability in plan & schedule to incorporate lessons learned from servo-control electronics & system testing
 - » plan & schedule under review