

Facility Modifications & Preparation (FMP)

Requirements and Design Breakout Presentation
NSF Review of Advanced LIGO Project

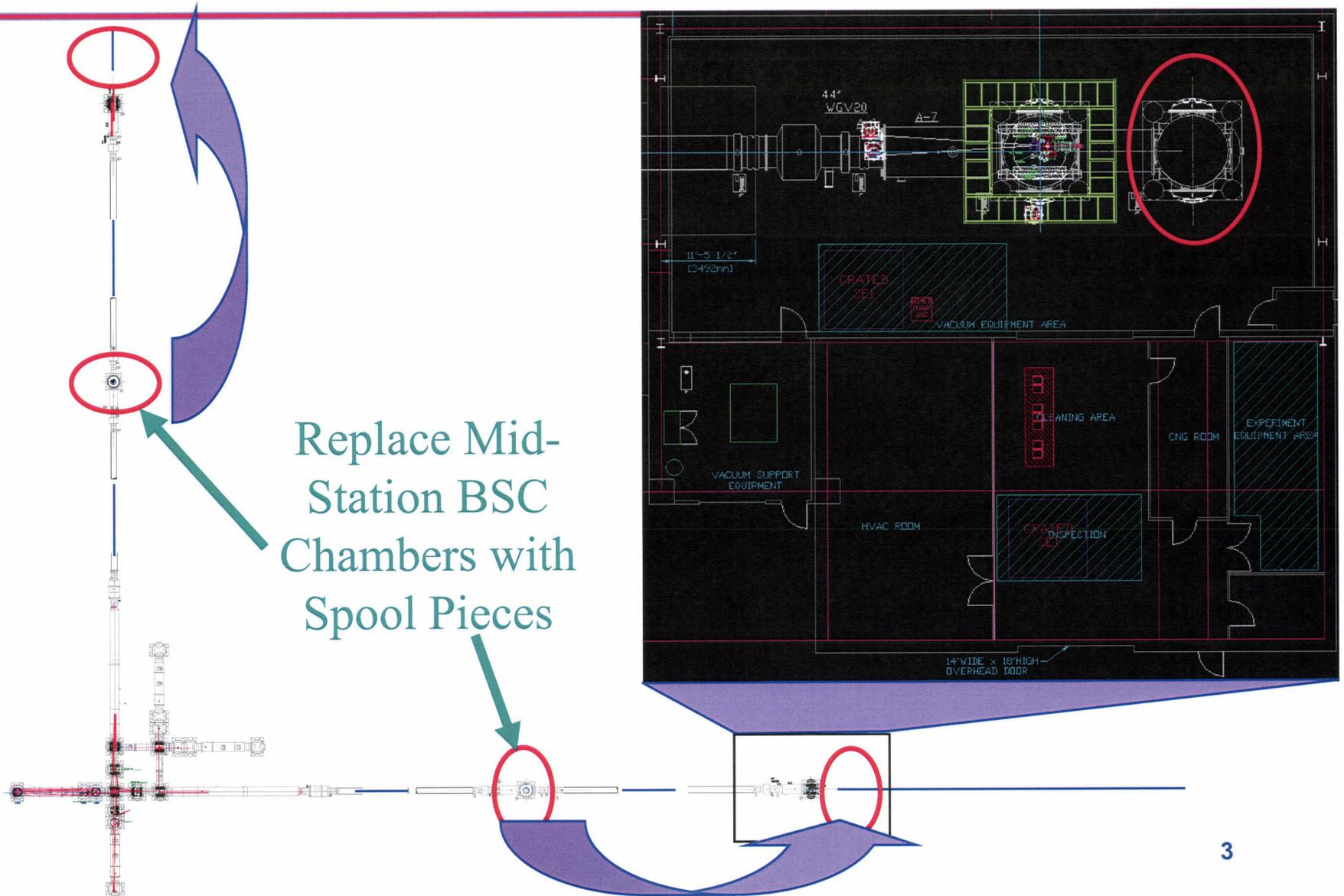
Dennis Coyne, Caltech
John Worden, LHO

May 31, 2006

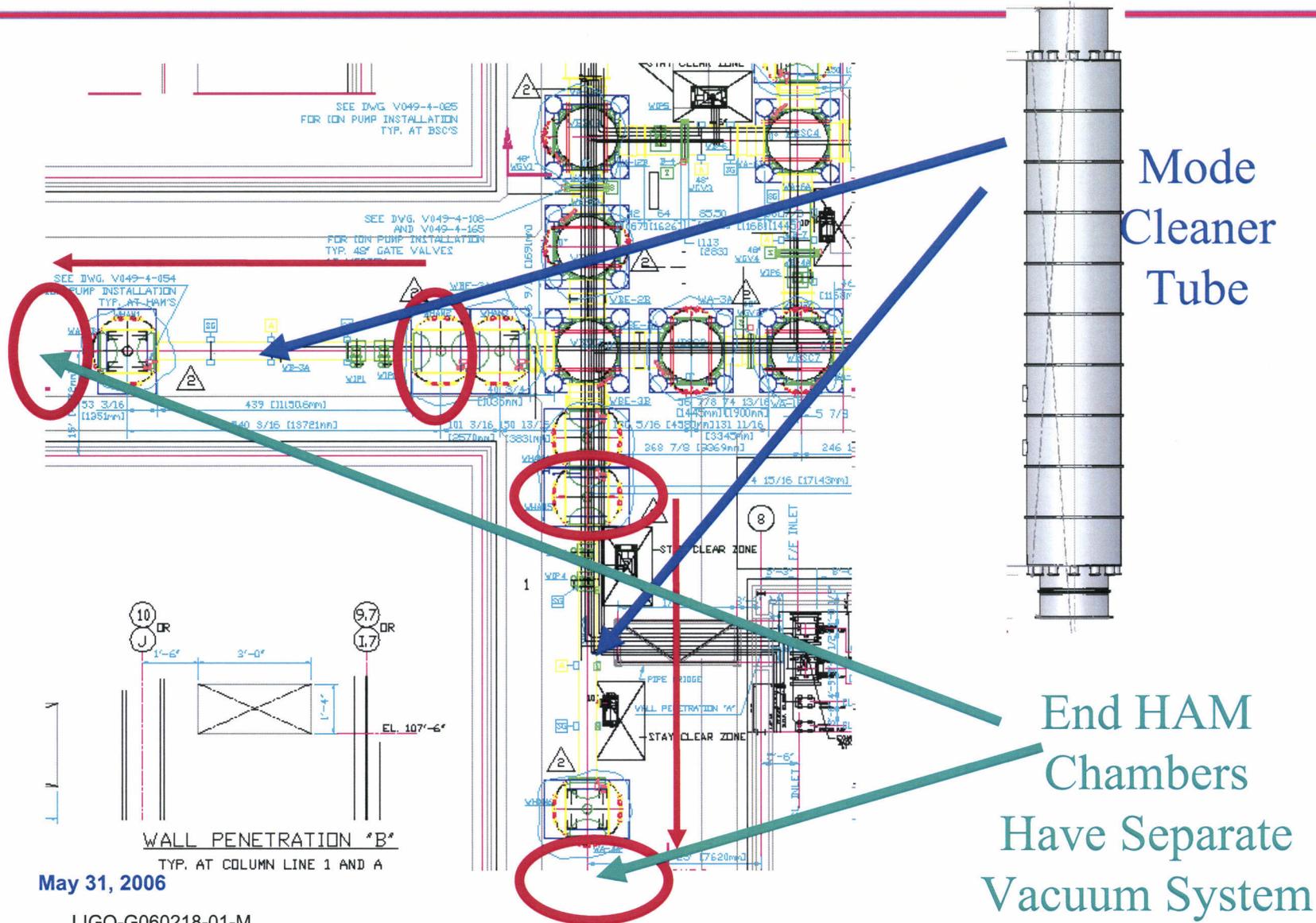
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- **Design & Build Vacuum System Modifications \$2.80M, WBS .4**
 - » Convert 2 km at Hanford Observatory to 4 km
 - » Move HAM Chambers for Input Optics (IO) and Interferometer Sensing & Control (ISC) use
 - » Does not include installation (INS WBS scope)
- **Prepare the facilities (buildings, laboratories): \$3.98M, WBS .2.1, .3, .5**
 - » Clean/modify spaces for use as clean assembly areas
 - » Refurbish large, portable, soft-walled, clean rooms
 - » Procure additional large, portable, soft-walled, clean rooms
 - » Procure additional vacuum bake ovens
 - » Prepare clean & conditioned spaces for storage
 - » Does not include assembly (subsystem WBS scope)
- **Prepare for assembly and installation tasks: \$1.62M, WBS .1, .2.2, .2.3, .2.4**
 - » Purchase additional material handling equipment, installation fixtures, optics lab supplies, clean room supplies, etc.
 - » Purchase supplies for wrapping, palletizing, storing assembled components
 - » Stage completed assemblies
 - » Plan the installation task (INS WBS only executes plan)
 - » Does not include installation (INS WBS scope) or system/subsystem test/acceptance (PM/systems WBS scope)

Mid-Station BSC Chamber relocated to End-Station



ISC Read-out Tables in Vacuum & Larger Input & Output Mode Cleaner Tubes

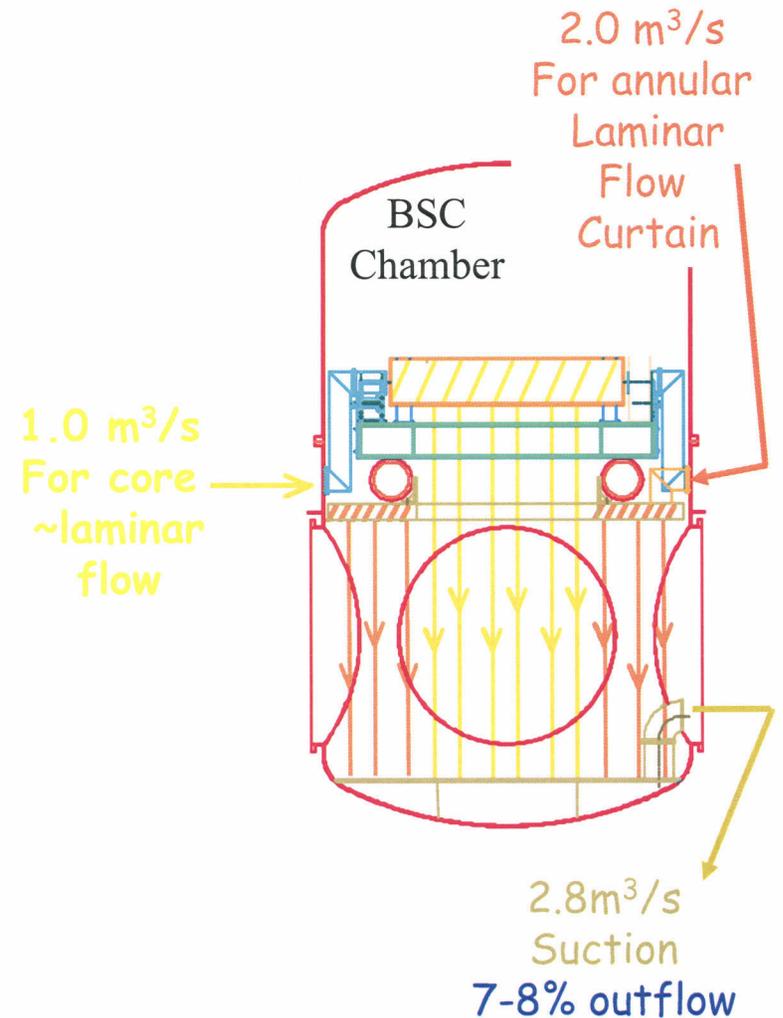


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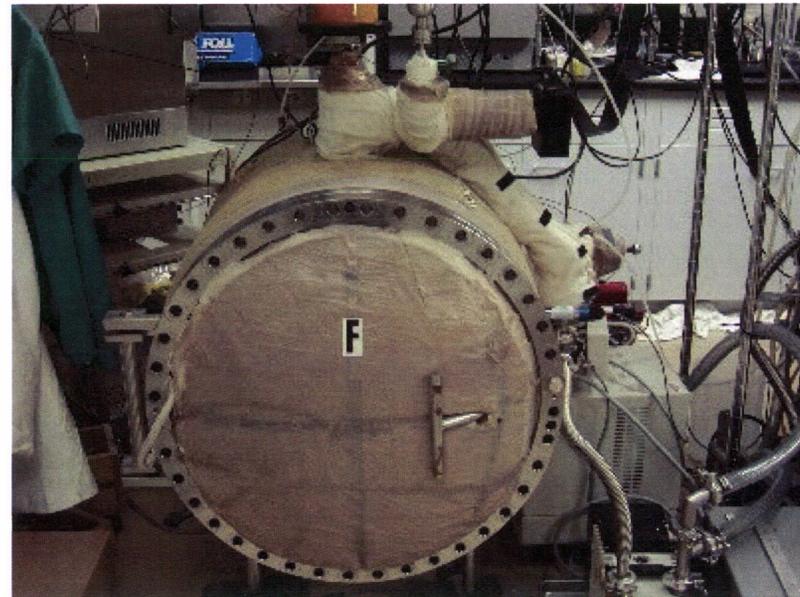
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End HAM
Chambers
Have Separate
Vacuum System ⁴

- **Particulate Cleanliness Requirements are more stringent than for initial LIGO**
 - » **Particulate cleaning: Ionized, particulate free airflow over benches are planned**
 - » **Basic Paradigm: The optical surfaces are only exposed when absolutely necessary**
 - » **LIGO Lab spaces plus Class 100, soft-walled clean rooms erected within are adequate**
 - » **Plan to add laminar air shower into the Test Mass (BSC) Chambers**



- **Low-Volatile Residue (out-gassing) Cleanliness Requirements are the same as for initial LIGO**
 - » Same clean and bake (air or vacuum) procedures/protocols as used for Initial LIGO
 - » Added Vacuum Bake Oven Capacity needed to support assembly schedule



Vacuum Bake Oven
at Caltech

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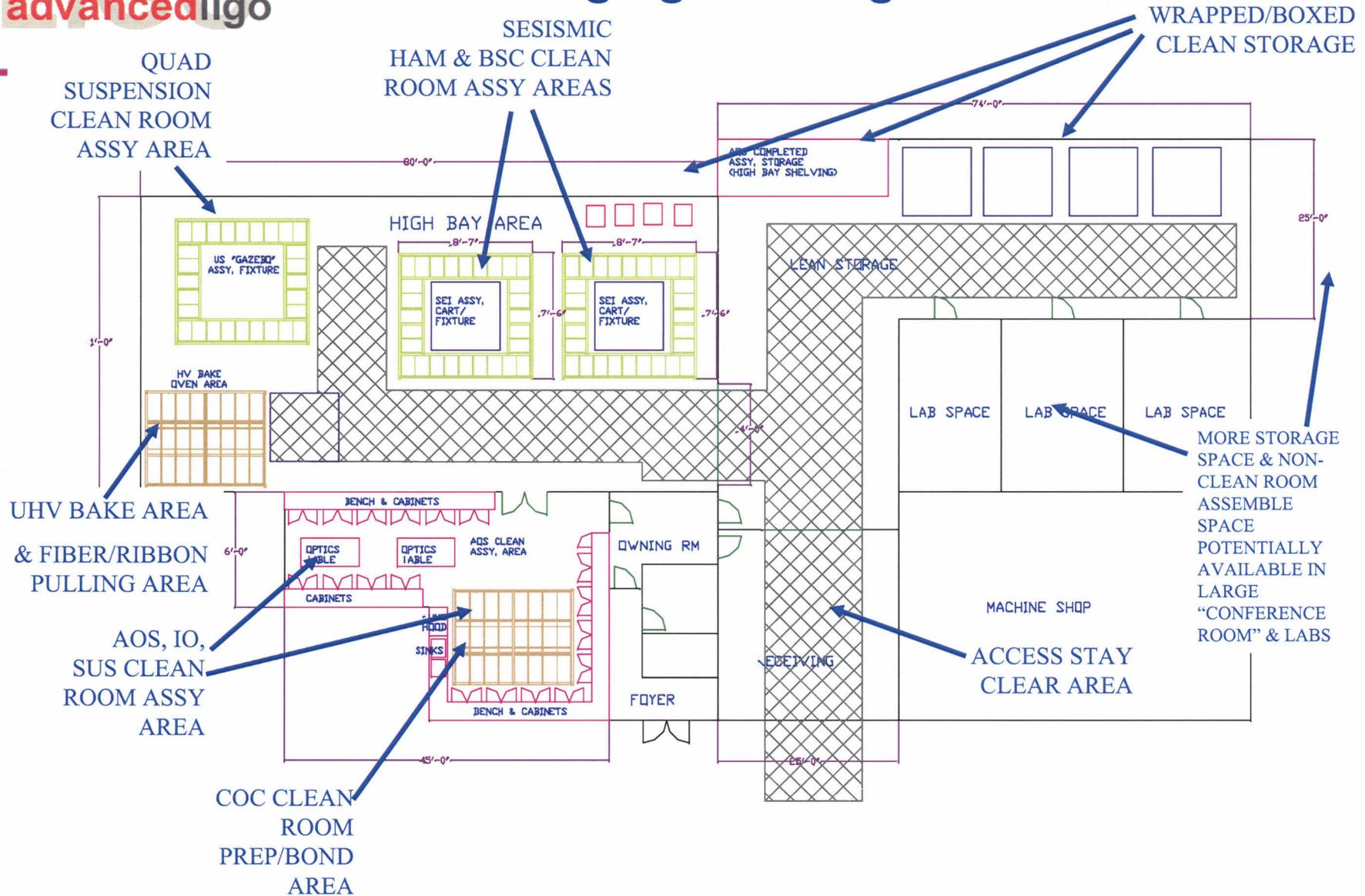
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- **Limited space and limited availability of observatory staff during science runs for assembly**
- **Perform assembly tasks which do not need to be done at the observatory at CIT, MIT, UFL, ... or the other observatory**
 - » **Rather limited space available at CIT, MIT – especially clean room space (but not insignificant)**
 - » **Possible tasks to be performed off-site:**
 - HEPI pier assembly
 - Electronics module stuffing, testing
 - Electronics rack, crate assembly
 - Optical lever modules
 - AOS telescope assembly
- **Out-Sourced Assembly**
 - » **Cleaning & Assembly of the Internal Seismic Isolation (ISI) system may be out-sourced to Fabricator**
 - » **Virtually all board-level Electronics Assembly is out-sourced – exploring out-sourcing of box-level assembly & board/unit test**

- **Have defined a possible assembly scenario & identified subsystem assembly space needs**
- **Hanford**
 - » **Convert staging building high bay into clean space**
 - » **Staging Building supports staging & assembly for:**
 - Internal Seismic Isolation (ISI) for HAM Chamber
 - Internal Seismic Isolation (ISI) for BSC Chamber
 - Suspension Quadruple Pendulum
 - Suspension Triple Pendulum
 - » **Lab Support Building:**
 - Fused Silica Ribbon/Fiber Pulling (for SUSpensions)
 - Vacuum Baking
 - Ear Bonding to Core Optics Components (COC)
 - » **Operations Support Building:**
 - Laser Lab
 - Input Optics Assembly
 - Thermal Compensation System Assembly
 - Auxiliary Optics Subsystem Assembly
 - Vacuum Baking
 - » **Mechanical Room (Vertex Building)**

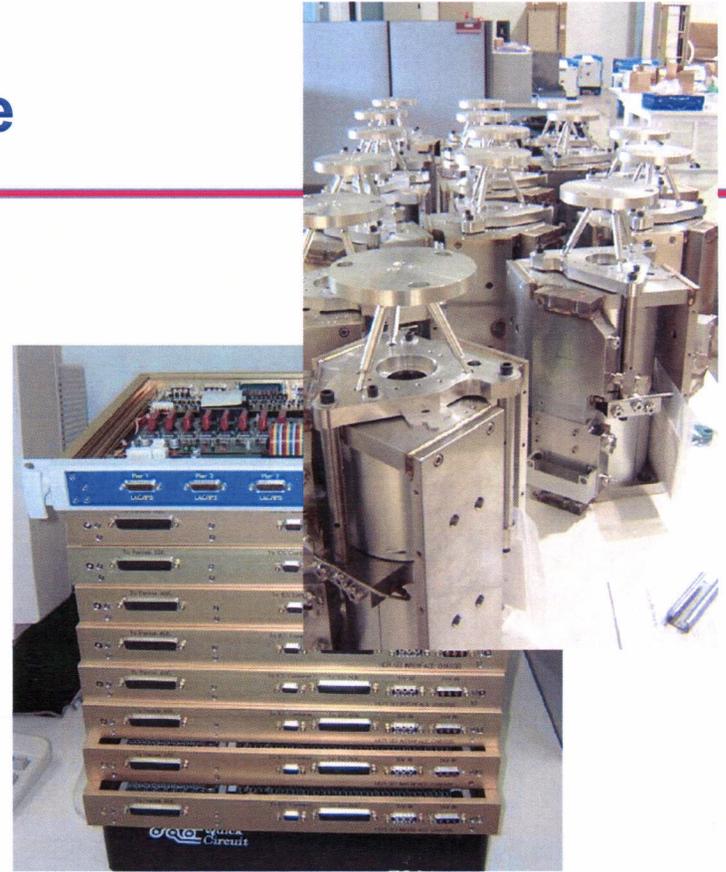
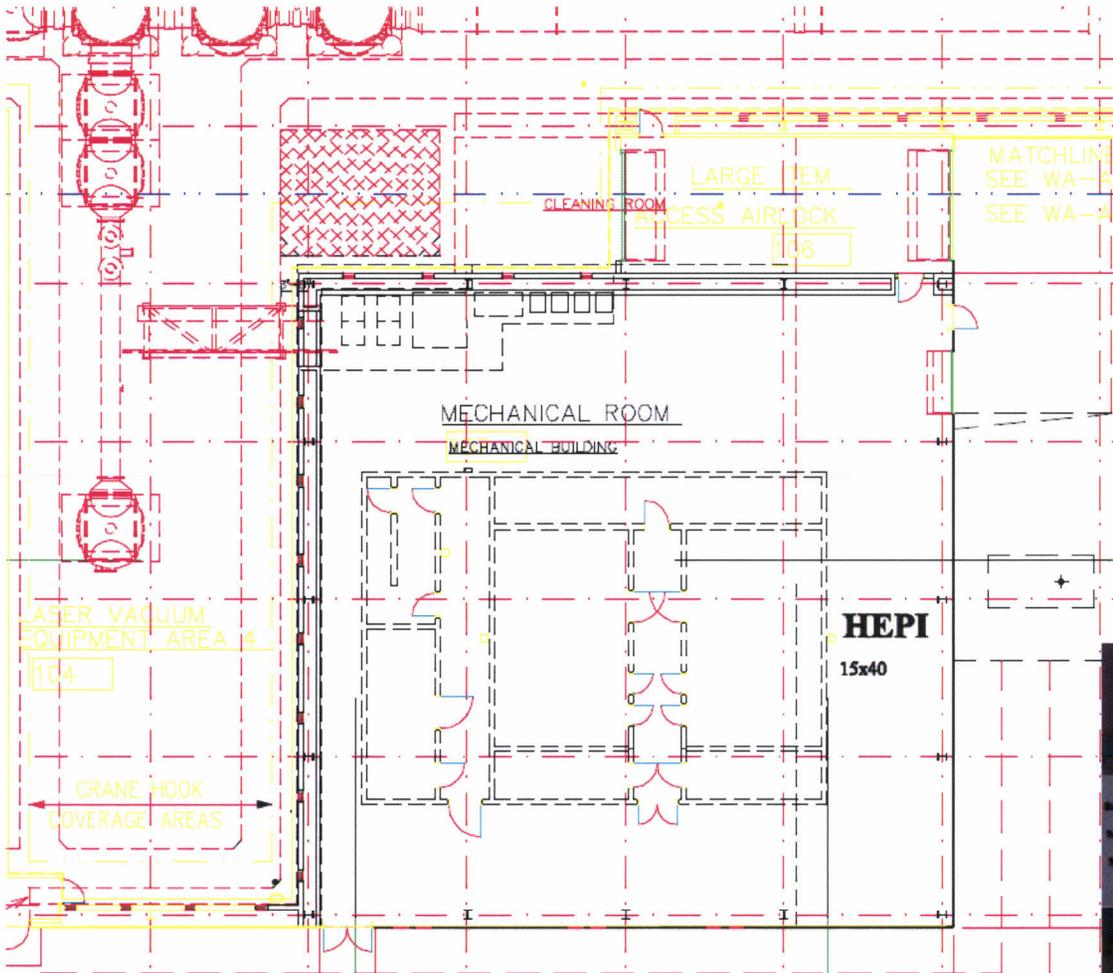
- **Livingston**
 - » **Convert staging building high bay into clean space**
 - » **Staging Building supports staging & assembly for:**
 - Internal Seismic Isolation (ISI) for HAM Chamber
 - Internal Seismic Isolation (ISI) for BSC Chamber
 - Suspension Quadruple Pendulum
 - Suspension Triple Pendulum
 - Fused Silica Ribbon/Fiber Pulling (for SUSpensions)
 - Vacuum Baking
 - Ear Bonding to Core Optics Components (COC)
 - » **Operations Support Building:**
 - Laser Lab
 - Input Optics Assembly
 - Thermal Compensation System Assembly
 - Auxiliary Optics Subsystem Assembly
 - Vacuum Baking
- **If required for large assembly part storage, we'll rent space in town to buffer deliveries (have contingency to cover costs)**

LLO Staging Building



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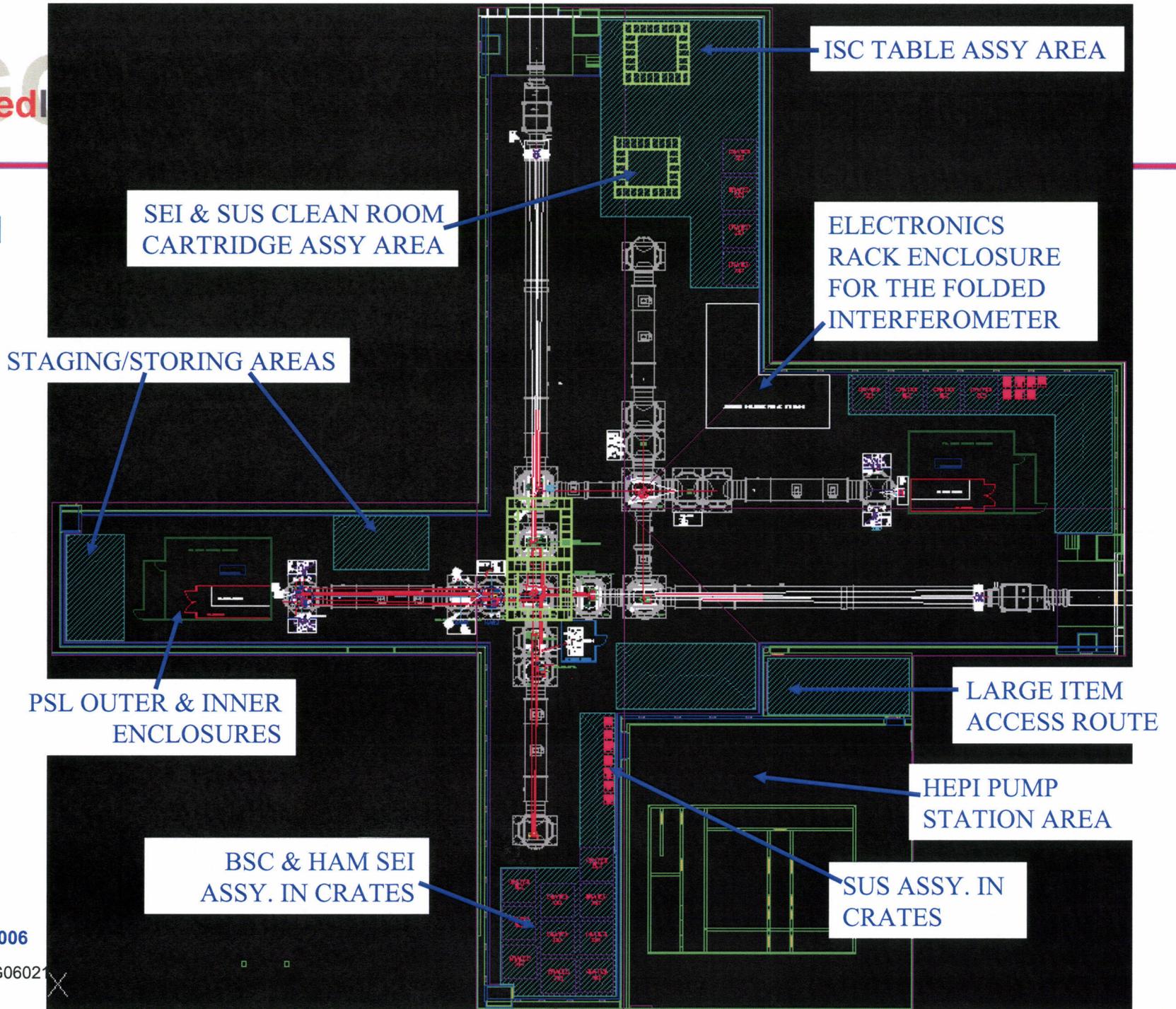


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- **Subsystem post-assembly, long-term, storage and installation staging areas are in the Laser/Vacuum Equipment Area (LVEA)**
 - » Adequate for LLO
 - » At LHO, also need to erect clean space inside existing warehouse
 - » Access is through the large item access route (or the main corner station receiving/cleaning areas)
- **Access during Science Runs is restricted to brief periods**
 - » Only a few hours per month is needed to transport finished assemblies into the Laser/Vacuum Equipment Area (LVEA)
 - » Sufficient temporary storage is available in the staging building in the interim periods

Hanford
LVEA



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LIGO-G0602

- **Subsystem assembly space & facility requirements**
 - » Initial estimates received
 - » need to definitize & update as prototypes are built – leads to written Assembly Plan with coordination of common space use
- **Vacuum Modifications**
 - » Review & refine conceptual design once optical layout has passed Preliminary Design Review (ADL Systems)
- **Cleanliness Requirements**
 - » Particulate cleanliness requirements need to be firmed up, especially with regard to in-situ environment
 - » Driven by low optic scattering requirements – on-going studies by COC subsystem
 - » Concept for improved air flow/cleanliness in the chambers to be designed

- **Maintaining Particulate Cleanliness**
- **Handling the Simultaneous Assembly Tasks and Space Needs will be Challenging**
- **Utilizing Available Space for Storage will also be challenging**