

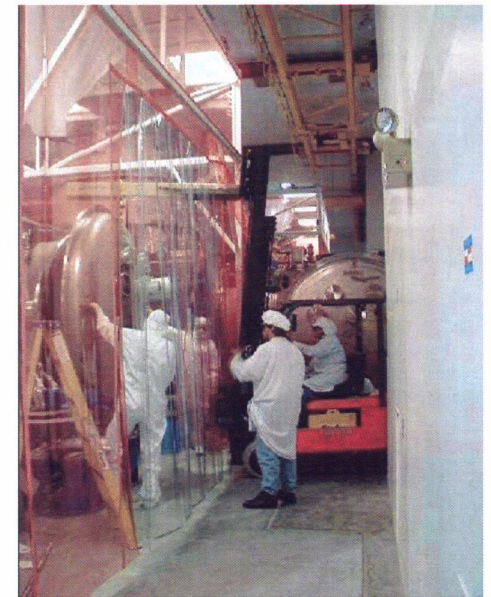
## Installation (INS)

### Requirements and Design Breakout Presentation NSF Review of Advanced LIGO Project

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**INS is the project phase between subsystem assembly & project completion**

**Includes:**

- **Removal**
  - » Removal of existing detector equipment
  - » Disposition or storage of equipment
  - » Particulate clean up of vacuum chambers
- **Installation**
  - » Installation of Vacuum Equipment
  - » Installation of all Detector Equipment
    - External to vacuum system
    - Internal to vacuum system
- **Testing**
  - » In-situ Unit/subsystem Testing
  - » Integrated System-Level Testing

**Does not include:**

- Installation Planning (FMP scope)
- Installation Staging (FMP scope)
- Assembly (subsystem scope)
- Unit Acceptance testing (subsystem scope)
- Installation Fixtures (subsystem & FMP scope)
- Commissioning (beyond project scope) – Commissioning starts on a subsystem-by-subsystem basis in parallel with continued installation/integration
- Data & Computing System (DCS) installation & test



- Start with Livingston (L1) to minimize impact of initial problem discovery
- LIGO Staff employed principally
  - » Skilled in UHV, subsystem install, interferometer testing, etc.
- LIGO manages all INS activities
  - » No subcontracted effort
  - » Skilled trade labor all directed by LIGO staff
- Prior to INS start:
  - » All production/fabrication and assembly are completed per interferometer (reduce labor distraction and delays from late deliveries)
  - » Integrated Testing & Training at LASTI Lab (@MIT) & 40m Lab (@Caltech)
    - Significant participation & support from observatory staff (training)
    - Pre-Stabilized Laser + Input Optics + Data Acquisition/Networking (PSL+IO+DAQ)
    - Seismic Isolation System + Suspension Assemblies + partial Interferometer Sensing & Control + Data Acquisition/Networking (SEI+SUS+~ISC+~DAQ)

# INS Procedure Development & Training at the MIT LASTI Facility

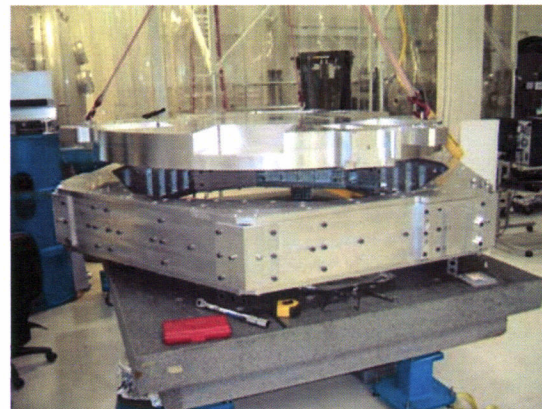
- **Large Full-Scale Prototype Assemblies are Installed & Tested in the LASTI Facility Chambers**



Mode Cleaner, Triple Suspension  
Installation in a HAM Chamber at LASTI



Quadruple Suspension Installation  
on Temporary Optics Table at LASTI



Internal Seismic Isolation (ISI) Assembly at LASTI  
(to be installed in BSC Chamber in 2006)

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- After INS Start:
  - » Simultaneous installation at both observatories (optimum staff utilization)
  - » Time phased installation of subsystems (leveling load on experts)
    - Sufficient to transfer/re-direct expertise to support 2<sup>nd</sup> observatory installation
    - Some time to rework or work-around in response to problems
  - » Installation & Integrated Testing are parallel activities
    - emphasis on early discovery of problems at integrated systems level
    - emphasis on installation of in-vacuum components ASAP

- **Installation Readiness Review to be held prior to switching off an Operating Observatory**
- **Litmus Test for Readiness:**
  - » **Re-affirm readiness with LSC & LIGO Lab**
  - » **All Installation Procedures Approved**
    - **Note that many procedures developed for Initial LIGO are common to AdL**
  - » **Critical Installation Activities & Tooling have been Tested (LASTI testbed)**
  - » **Sufficient assembly, check-out and delivery of subsystem components completed, so that installation will not be supply chain limited**