



LHAM3

AUTHOR(S)	DATE	Document Change Notice, Release or Approval
Dennis Coyne, Eric James	4 June 2012	see LIGO DCC record Status

Instructions on the use of this document:

- 1) Use, and complete, this document on a cleanroom compatible computer while the work is proceeding. This procedure, and all of the applicable documents, must be available at all times during the procedure.
- 2) Use this procedure as a check list for preparation and during the installation; As each step is completed, enter the name of the person completing the work (or approving or checking the step), as well as the date and any comments or notes. In particular, note any discrepancies or deviations and augment with any missing definition. **ALL NOTES MUST BE RECORDED IN THE COMPLETED VERSION OF THIS DOCUMENT (NOT IN OTHER NOTEBOOKS OR FILES).** If the additional notes are too cumbersome to include within the body of this completed procedure, then electronically attach them to the completed procedure.
- 3) Once completed, file the document in the LIGO Document Control Center (DCC) as the next highest version of the procedure and add a note that this is a completed/finished procedure.
- 4) File any significant notes or data from the completed procedure in the electronic logbook (such as any deviations); as a minimum note in the electronic logbook that the installation was completed in accordance with this procedure (cite document number and revision).

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1 SCOPE

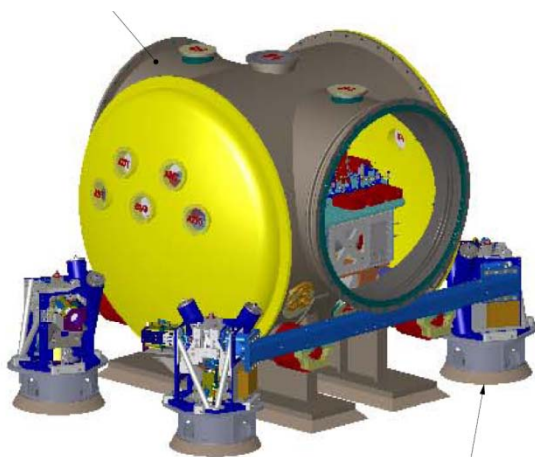
The scope of this procedure is installation of in-chamber components and assemblies in the LHAM3 chamber (see Figure 1), which are defined in the following documents:

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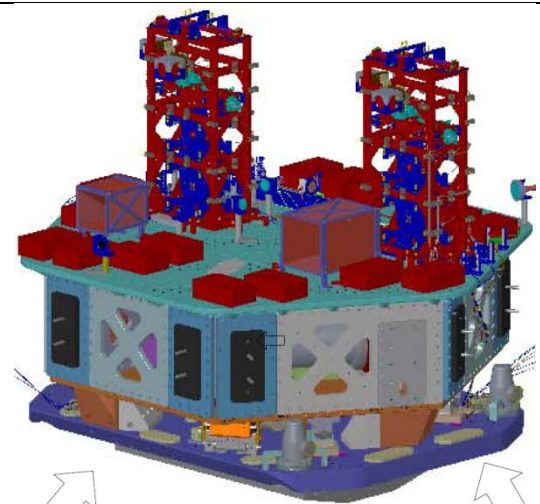
LHAM3:

- LIGO-D0900520: [AdvLIGO Systems, HAM3-L1 Top Level Chamber Assembly](#)
- LIGO-E1100818: [HAM3-L Top Level Chamber Assembly BOM](#)
- LIGO-E1100742: [AdvLIGO Detailed Mass Properties-CG Report HAM Tables \(LLO\)](#)
- LIGO-D0900521: [AdvLIGO VE HAM3-L1, Vacuum Equipment Assembly](#)
- LIGO-D0900523: [AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS \(PR2, MC2\)](#)
- LIGO-D0900522: [AdvLIGO SEI HAM3-L1, XYZ Local CS for ISO Table](#)
- LIGO-D0900524: [AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS \(PR2\) Sub-Assy](#)
- LIGO-D0900526: [AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS \(MC2\) Sub-Assy](#)
- LIGO-D1101393: [AdvLIGO SUS HAM3-L1, XYZ Local CS for MC2 and PR2 Scraper Baffles](#)
- LIGO-D1101118: [AdvLIGO HAM3-L1 ISI Table, Balance Masses Assembly](#)
- LIGO-D1002235: [AdvLIGO SEI HAM3-L1, XYZ Local CS for IO Optic Mount Components](#)
- LIGO-D1002234: [AdvLIGO SEI HAM3-L1, XYZ Local CS for ISC Components](#)
- LIGO-D1101463: [CABLE HARNESS ROUTING CONFIGURATION, HAM 3](#)
- LIGO-D1101394: [AdvLIGO SEI HAM3-L1, XYZ Local CS for OptLev DLC Components](#)
- LIGO-D1101296: [ALIGO, AOS, HAM Chamber, Optical Table, Hole Tabulation](#)
- LIGO-D1002886: [Flange Layout - L1 Horizontal Access Module 3 \(HAM 3\)](#)
- LIGO-D1101249: [ALIGO IO L1 HAM3 INSTALLATION PLATE LAYOUT](#)
- LIGO-F1100030: [aLIGO Systems HAM2/3 Related Documents](#)
- LIGO-D1101775: [ALIGO, ELECTRICAL FEEDTHROUGH TYPES, TYPICAL SUBFLANGES, AND PORT CONFIGURATIONS](#)
- LIGO-D1101296: [ALIGO, AOS, HAM Chamber, Optical Table, Hole Tabulation](#)
- LIGO-D1101309: [aLIGO, SUS, OPTIC TABLE .25-20 HAM2-L1 / HAM3-L1 FIDUCIAL KIT](#)

All of these documents are provided as “related document” links in the Document Control Center (DCC) entry for the top level chamber assembly drawing [D0900520](#).



a) LHAM3 with vacuum equipment, HEPI



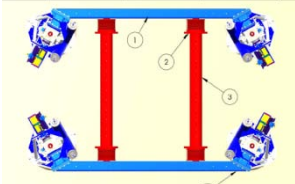
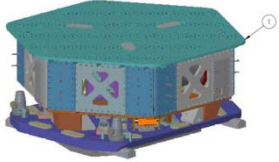
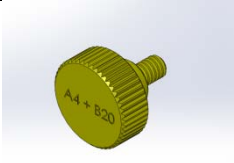
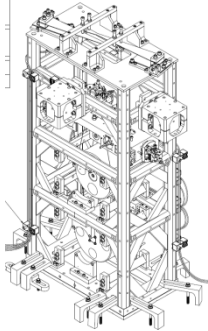
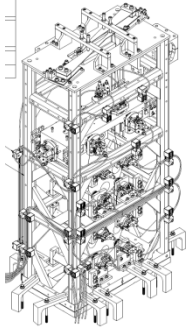
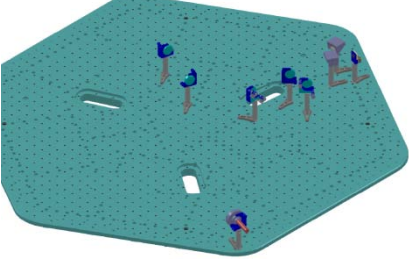
b) LHAM3 without vacuum equipment, HEPI, & ISI support frame

Figure 1 LHAM2 and LHAM3 Installation



LHAM3

This installation includes the following principal, sub-system major assemblies:

Subsys.	Assy Dwg	Sub-Assembly Name	Image
INS	D1000514	HEPI HAM Chamber Level Assembly <i>N.B.: WHAM2 and WHAM3 use the same HEPI assembly.</i>	
SEI	D0900522	LHAM3-ISO Table assembly Including: HAM ISI Table D0900124	
SYS	D1101309	Optic Table 1/4-20 LHAM2/LHAM3 Fiducial Kit	
SUS	D0900524	LHAM3, HSTS suspension assembly (PR2) (LHAM3 only) including: HSTS Assembly (D020700) SUS Structure Spacer (D1100176) Vibration Absorbers (D1002424) Optics Cap (D1101143)	
SUS	D0900526	LHAM3, HSTS suspension assembly (MC2) (LHAM3 only) including: HSTS Assembly (D020700) SUS Structure Spacer (D1100175) Vibration Absorbers (D1002424) Optics Cap (D1101143)	
IO	D1002235	Optic Mount Components (LHAM3 only) Includes the following 6 sub assemblies: <ol style="list-style-type: none">1. D1002085 Rigid Optic Mount LH Assy.2. D1002075 Rigid Optic Mount RH Assy. (2 each)3. D1002088 Actuated Optic Mount RH Assy. (2 each)4. D1100789 (3.235) aLIGO In-Vac QPD Assy.	



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
ALIGO INSTALLATION PROCEDURE

E1200025 -v5-
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Subsys.	Assy Dwg	Sub-Assembly Name	Image
IO	D1101393	LHAM3 MC2 & PR2 Scraper Baffles Assembly Includes: IO MC2 Scraper Baffle Assembly (D1000327) IO PR2 Scraper Baffle Assembly (D1000328)	
AOS/ OptLev	D1101394	DLC Assembly LHAM3 Including: DLC assembly (D1101392).	
SYS	D1101118	LHAM3 ISI Table Balance Masses	
SEI/SYS	D1101775 D1101463	Electrical Feedthrough Types Cable Routing, HAM3	
AOS/SLC	T1100292	Viewport Source List	

LHAM3

Subsys.	Assy Dwg	Sub-Assembly Name			Image	
IFO	CHAMBER	VIEWPORT	FUNCTION	DESCRIPTION	VIEWPORT P/N	SOURCE
L1	HAM3	VPA1F3	ILLUMINATION		5.4 DIA VP800/450009	iLIGO
L1	HAM3	VPA1F4	DIAGNOSTIC	MC2-TRANS	6.0 in-AR1064/532_nonwedge	CUSTOM
L1	HAM3	VPA1F5	VIDEO	MC2	5.4 DIA VP800/450009	CATALOG
L1	HAM3	VPA2F3	VIDEO	PR2	5.4 DIA VP800/450009	CATALOG
Rack and cable tray layout		D1003141	Not yet issued. In the interim refer to H1 layout in D1002704 .			

2 Required Equipment List

Each of the procedures referenced within this overall procedure call out required equipment and parts/assemblies. Below is listed only those parts or assemblies not covered in the subsidiary procedures.

- LIGO-D1101674: [aLIGO, SUS, BSC/HAM INSTALLATION TOOLING](#)
 - for transporting HXTS and OMC structures (sheets 4, 5 & 6)
 - Genie lift adapter plate, D110515

Note: At LLO they used the old iLIGO lift table as the installation team found it easier.
- LIGO-D1101854: [aLIGO, HAM INSTALLATION ARM USAGE](#)
 - LIGO-D1001994: [aLIGO, HAM INSTALLATION ARM, ASSEMBLY, FLANGE MOUNT](#)
 - LIGO-D1002052: [aLIGO, ASSEMBLY, HAM ARM](#)
 - LIGO-D1001664: [HAM STRUCTURE LIFT ASSEMBLY, aLIGO, SUS](#)
 - LIGO-D1101674: [aLIGO, SUS, BSC/HAM INSTALLATION TOOLING](#)
 - see sheet 11 of D1101674
- LIGO-E1100831: [HAM Installation Arm User Guide](#)
- LIGO-D1001664: [HAM STRUCTURE LIFT ASSEMBLY, aLIGO, SUS](#)
 - HAM vertical lift, D1001667 (sheet 11)- 1 lift at each site (lifting arms, extenders being returned to CIT for rework). 1 spare at CIT

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date:

comments (optional):



LHAM3

3 Prerequisites

- Vent the vertex vacuum volume and set the purge gas flowing per procedure [M1000360](#). Follow the Lockout-Tagout procedure [M990190](#).

4 ISI Installation for LHAM3

4.1 Prepare the Chamber for ISI Installation

- The oxide layer removed from the interior of the HAM shells, and the HAM chamber certified as “clean”.
- Install HEPI per [E040011](#) and [E1100094](#).
- Install the cable tray ([D1003141](#)) around the LHAM3 chamber.
- Install HAM Chamber Cleanrooms around the LHAM3 chamber and clean the chamber exterior and the region around the chamber.
- Install the dial indicators on the HAM support tube ends.
- Remove the LHAM3 Chamber Doors per procedure [M1000362](#).
- Install the electrical feed-throughs listed in [D1002886](#) into LHAM3 per procedure [M990173](#).
Note: The electrical feed-throughs can be installed later in the sequence.
- Install the field cabling from the electrical feed-throughs to the electronics racks. Field-route cables as necessary.
Note: The field cabling can be installed later, but must be done after the cable trays are in place, yet before the ISI is installed. For LLO, the field cabling was required for chamber-side testing but it was not necessary to connect it to the chamber prior to ISI installation.
- Install the viewports listed in [T1100292](#) LHAM3, per procedures [E1100484](#) and [M990173](#)
Note: The viewports can be installed later in the sequence.
- Ensure that the support tubes are level (to within 0.4 mrad) with a precision bubble level and HEPI static adjustment (per procedure [E040011](#)).
Note: At LLO the tables were leveled to better than this using surveying equipment. In addition the IAS group asked that the tables be aligned to 100 micro-radians in angle and 1.0 mm in position (X&Y).

- completed, approved or checked by:
date:

Version numbers of all subsidiary documents followed:

comments (optional, e.g. deviations, exceptions, problems, “punch-list”):

**LHAM3****4.2 Install the LHAM3 ISI Assembly**

- Install the ISI assembly into their vacuum chambers per [E080012](#).

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date:

comments (optional):

4.3 Perform final HAM-ISI testing/characterization prior to payload integration

- Perform the phase II testing associated with HAM-ISI installation prior to attaching payload to the optics table, per appropriate sections of [E1100994](#)

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date:

comments (optional):

5 PAYLOAD INSTALLATION IN THE LHAM3 CHAMBER

The LHAM3 assembly is depicted in Figure 3. The major optics assemblies integrated into the LHAM3 assembly are the Power Recycling Mirror 2 (PR2) suspension assembly ([D0900526](#)), and the Mode Cleaner Mirror 2 (MC2) suspension assembly ([D0900524](#)).

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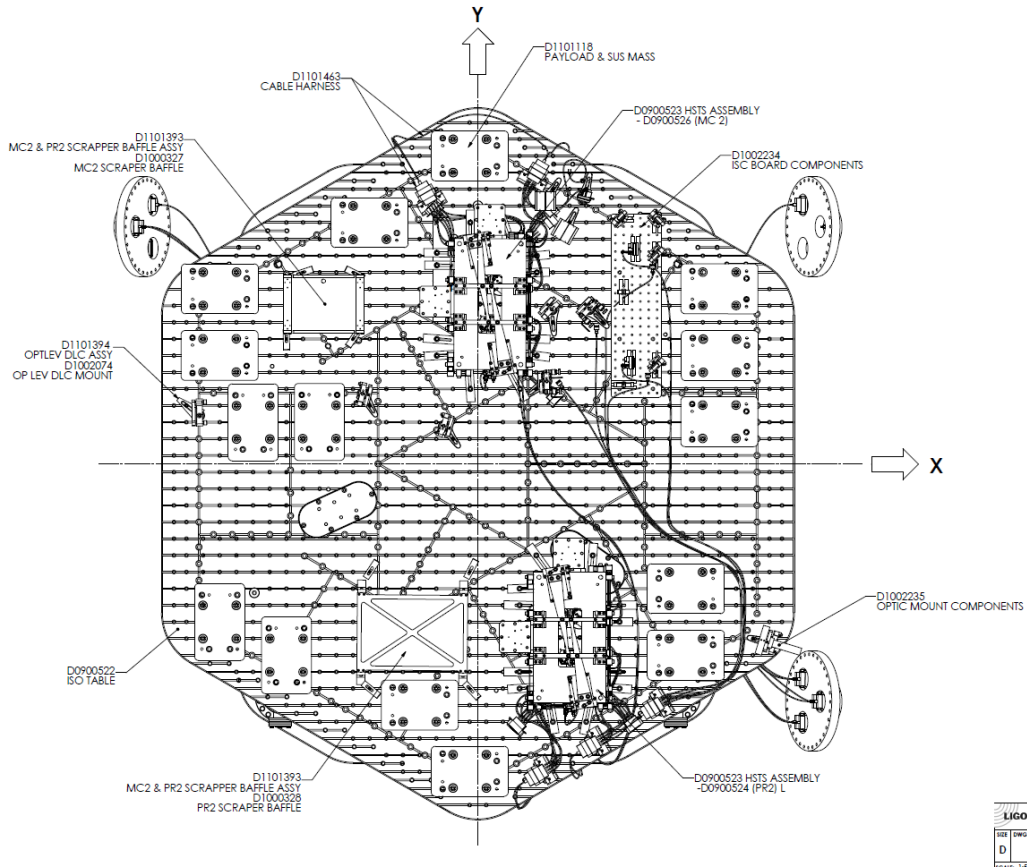


Figure 2 LHAM3 ISI Assembly ([D0900520](#))

5.1 Applicable Documents

Listed below are all of the applicable and referenced documents for this installation procedure. This list gives the latest revisions of the documents; within the installation steps, only the document number (and not the revision) is quoted.

Only documents actually required to perform the installation should be included in this list and not background or reference material. It is essential that all of the procedures and all of the drawings listed below are available with this procedure during the installation/integration work.

Document No.	Document Title
General Documents	
E0900047-v12	LIGO Contamination Control Plan
Install/Align Procedures	
T1000097	Input Optics Plan
E1100783	Initial Alignment Procedure: LHAM2 and LHAM3

**LHAM3**

T1100091	Mechanical static pitch adjustment in HSTS
Test Procedures	
E1100994	aLIGO HAM-ISI Testing Procedure, Phase II : Integration process
Safety	
E1100094	aLIGO HAM-HEPI switch/install hazard analysis
Drawings	
LIGO-D0900520:	AdvLIGO Systems, HAM3-L1 Top Level Chamber Assembly
LIGO-D0900523:	AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS (PR2, MC2)
LIGO-D0900522:	AdvLIGO SEI HAM3-L1, XYZ Local CS for ISO Table
LIGO-D0900524:	AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS (PR2) Sub-Assy
LIGO-D0900526:	AdvLIGO SUS HAM3-L1, XYZ Local CS for HSTS (MC2) Sub-Assy
LIGO-D1101393:	AdvLIGO SUS HAM3-L1, XYZ Local CS for MC2 and PR2 Scraper Baffles
LIGO-D1101118:	AdvLIGO HAM3-L1 ISI Table, Balance Masses Assembly
LIGO-D1002235:	AdvLIGO SEI HAM3-L1, XYZ Local CS for IO Optic Mount Components
LIGO-D1002234:	AdvLIGO SEI HAM3-L1, XYZ Local CS for ISC Components
LIGO-D1101463:	CABLE HARNESS ROUTING CONFIGURATION, HAM 3
LIGO-D1002886:	Flange Layout - L1 Horizontal Access Module 3 (HAM 3)
LIGO-D1101249:	ALIGO IO L1 HAM3 INSTALLATION PLATE LAYOUT
LIGO-D1101775:	ALIGO, ELECTRICAL FEEDTHROUGH TYPES, TYPICAL SUBFLANGES, AND PORT CONFIGURATIONS
LIGO-F1100030:	aLIGO Systems HAM2/3 Related Documents
LIGO-G1000125:	Advanced LIGO BSC and HAM ISI Conventions
LIGO-D1101296:	ALIGO, AOS, HAM Chamber, Optical Table, Hole Tabulation

5.2 Weigh the full suspension payloads

- Weigh the full MC2 HSTS suspension, record below
- Weigh the full PR2 HSTS suspension, record below
- Systems to confirm, or revise, the mass balancing plan ([E1100742](#), “AdvLIGO Detailed Mass Properties-CG Report HAM Tables (LLO)”) and drawing of the balance mass locations:

[D1101118](#), AdvLIGO HAM3-L1 ISI Table, Balance Masses Assembly

Payload	Mass (Kg)	Comments/caveats
MC2 HSTS Suspension		
PR2 HSTS Suspension		

LHAM3

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date:

comments (optional):

5.3 Install the Fiducials

- Install the LHAM2/3 Fiducial Kit (D1101309) into their designated hole locations using [D1101296](#) as a guide.

5.4 Installed the main suspension payloads

- Install the HSTS suspension assembly for PR2 per [D0900524](#) and [E0900334](#)
- Install the HSTS suspension assembly for MC2 per [D0900526](#) and [E0900334](#).
- As the HSTS and HLTS suspensions are installed, add the vibration absorbers per:

PR2: [D0900524](#)

MC2: [D0900526](#)

See [D1002424](#) for assembly/installation instructions.

- N.B.: For the first instance of the addition of a major assembly to the optics table, the table will be re-balanced, floated and SEI will take transfer function measurements in order to help identify (at a later time after post-processing) any troublesome modes. These major assemblies are the two HSTS. *Note that this is for the first installation instance on any optics table. For example if an HSTS (say MC2) is added to LHAM2 and SEI takes transfer function measurements, then no further transfer functions are required when other HSTS suspension are added to the LHAM3 optics table.*
- Adjust the HSTS pitch per [T1100091](#).

5.5 Install the IO components, Optical Lever mirror and balance mass

- The detailed steps for the installation of the most of the payload elements on the optics tables of LHAM3 are defined in [T1000097](#), *Input Optics Installation Plan* This plan covers the IO components. Additional payload elements to be installed are listed below.
- For the optical lever mirror assemblies on each optics table, see: [D1101394](#), AdvLIGO SEI HAM3-L1, XYZ Local CS for OptLev DLC Components
- Payload & Suspended Mass Assembly, and [D1101118](#): AdvLIGO HAM3-L1 ISI Table, Balance Masses Assembly.
- Rebalance the Table per ISI procedure **REF#?**

**LHAM3**

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date:

comments (optional):

5.6 Align the Optics

- Align the optical elements on the cartridge in accordance with [E1100783](#): Initial Alignment Procedure - LHAM2 and LHAM3.

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date:

comments (optional):

5.7 Final operations

- Remove all optic covers.
- Remove locking pins from vibration absorbers.
- Remove First Contact™ from optics.
- Unlock all suspensions.

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date:

comments (optional):

5.8 Clean the Optics

- Inspect the optical surfaces. If cleaning is required, then complete the following steps:
- Lock down the HAM-ISI stages per [E1101037](#)
- Lock down ITMy per [T1100406](#)
- Lock down the FMy per [T1100489](#)
- Clean the optics if needed. First Contact™ cleaning (per procedure [E1000079](#)) is the preferred method.

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date:

Version numbers of all subsidiary documents followed:



LHAM3

comments (optional, e.g. deviations, problems):

6 Testing

Conduct final checkout and inspection per [T1000097](#).

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date:

Version numbers of all subsidiary documents followed:

comments (optional, e.g. deviations, problems):