

Title: aLIGO Installation Acceptance Document for LBSC5

This document covers the technical content for acceptance review of a subset of the Advanced LIGO (aLIGO) installation. See document [M1300468](#) for an overview of the aLIGO acceptance process. Acceptance by Systems Engineering is to be indicated in the metadata for this document in the LIGO Document Control Center (DCC).

1 Installation Instance/Subset Definition

Insert a brief description of the subset of the aLIGO equipment which is covered under this installation acceptance document. Complete the entries in the following table. If elements of the table are not applicable, enter "not applicable".

This installation covers the BSC chamber LBSC4 and all of the equipment within and attached plus associated electronics racks.

Interferometer [<i>L1 or H1</i>]:	L1
Building(s)/Room(s) : [<i>e.g. corner/LVEA</i>]	LVEA
Vacuum Chamber(s) :	LBSC5 (Y ARM)
Electronics Rack Designation(s) :	L1-VDC-YC1, L1-VDC-YC2, L1-SEI-YC1, L1-SUS-YC1, L1-SUS-YC2, L1-SUS-YR1, L1-ISC-YC1, L1-ISC-YR1, L1-TCS-YC1 Note that the Capacitive Position Sensor readout boxes which sit on the cable trays do not have an official designation.
Optics Table(s)/Enclosure(s) Designation(s) , and other equipment/assemblies related to this installation:	ETMY Cryo-Pump Baffle , Optical Lever and Photon Calibrator , ISCTEY Table , STS-2 Ground Seismometer.

2 Procedures

If there are any caveats or explanatory notes regarding the procedure documentation cited in the table below, then add these notes to the table entries.

Baseline or initial Installation Procedure(s) : <i>[enter linked DCC document #(s); found under E1200023]</i>	We used https://dcc.ligo.org/E1200344-v4 for our install procedure. Redlined versions are attached to this document in the DCC>
As-Built/Installed Procedure(s) , either: a) Enter hyperlinked DCC number for revised or red-lined baseline install procedure, and/or b) Enter hyperlinked DCC number for separate document with installation notes on deviations, changes in procedure, changes in tooling, etc., and/or	No as-built notes were recorded in document E1200269. However some as-built notes ("red lines") were recorded in the file name BSC5INSTALL.pdf which is filed as an "other file" with E1200344-v4 , the BSC Cartridge installation procedure.



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<p>c) Enter a list of hyperlinked electronic log entries detailing the experience in applying the baseline installation procedure</p>	<p>This test lift which included a cartridge weight measurement occurred 20 Feb 2014 and was recorded in LLO alog #11051</p> <p>The installation took place on 21 Feb 2014 and was recorded in LLO alog #11061</p>
<p>Baseline or initial Alignment Procedure(s): <i>[enter linked DCC document #(s); found under E1100734]</i></p>	<p>E1200957-v4 is the initial procedure.</p>
<p>As-Built/Aligned Procedure(s), either:</p> <p>a) Enter hyperlinked DCC number for revised or red-lined baseline alignment procedure, and/or</p> <p>b) Enter hyperlinked DCC number for separate document with alignment notes on deviations, changes in procedure, changes in tooling, etc., and/or</p> <p>c) Enter a list of hyperlinked electronic log entries detailing the experience in applying the baseline alignment procedure</p>	<p>E1200956-v5 is the as-built alignment procedure, with embedded notes.</p> <p>The LBSC5 cartridge alignment was recorded in LLO alog #10390</p> <p>The CMBY installation was recorded in LLO alog #8220 B&K Hammering in LLO alog #8194.</p> <p>The in-chamber ETMY alignment was recorded in LLO alog #11533.</p> <p>TMSy alignment was recorded in LLO alog #10882 With a final alignment check in LLO alog #11769.</p> <p>The ETMy ACB installation is recorded in LLO alog #11572. The alignment was not recorded in the LLO alog except for a comment in the aforementioned entry that it is within tolerance.</p> <p>OptLev install and alignment in LLO alog entries #11717 and #11844</p>

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Enter hyperlinked DCC document number(s) for each drawing in the table below. If elements of the table are not applicable, enter "not applicable". All chamber-level, assembly drawings can be found listed at [E1200562](#) and found linked under [D0901491](#).

Applicable Building/Room Top-Level Drawing(s):	D0901464 aLIGO Systems Layout LLO Y-End Station
Top-Level Chamber Assembly Drawing(s):	D0900506 aLIGO Systems, LBSC5-L1 Top Level Chamber Assembly
Electronics Rack Drawing(s):	All drawings for the racks can be found by navigating through G1001032 .
ETM Optical Lever Drawing(s):	G1000702 Floor Occupancy, Optical Levers, LLO Y-End Station.
Cryopump Manifold Baffle Dwg(s):	D1003228 Manifold_Cryo_Baffle_Assembly, ETMY
PCAL Video CAM Periscope	D1200174 : aLIGO, PCAL-VIDEO CAM, PERISCOPE
Photon Calibrator Transmission Pier Assembly	D1000676 : aLIGO AOS Photon Calibrator Transmission Pier Assembly
ISCTEY	ISC Table containing ALS optics etc. The drawing is D1100607 , an annotated version will be attached as a related file.

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4 Serial Number Records

Serial numbers are used to track a subset of the parts, particularly active elements (see [M1000051](#)) and electronics (with S-numbered documents; see [T0900520](#)). Enter the hyperlinked DCC document number(s), and name(s) for the highest level assembly(ies) covered by this installation acceptance document in the table below. Also enter the hyperlink to the ICS entry for the instance of this assembly in the Inventory Control System (ICS). If elements of the table are not applicable, enter "not applicable". If elements of the table are not available/missing, then enter "not available".

Assembly DCC D-Number	Assembly Name	ICS entry
D0900471	aLIGO Systems, LBSC4-L1 Top Level Chamber Assembly	https://ics-redux.ligo-la.caltech.edu/JIRA/browse/ASSY-D0900471-NA
D1000513	HEPI	N/A (assembly and install done in 2004, before ICS)

5 Testing

All post-installation, stand-alone, in situ, checkout/testing (phases 2 and 3 per [M1000211](#)) must be completed, be successful and be documented:

- phase 2: pre-installed, post-storage, test results for the assembly (testable item)
- phase 3: stand-alone, in situ test results for the assembly (testable item)

Note that integrated testing (phase 4 testing per [M1000211](#)) is covered under the system acceptance review, not this installation acceptance review. In the table below, enter hyperlinked DCC document number(s) for all of the relevant testing for the major subassemblies/subsystems covered within this installation instance/subset. If elements of the table are not applicable, enter "not applicable". If elements of the table are not available/missing, then enter "not available".

Subsystem	Testable Item	DCC document numbers	
		Phase 2	Phase 3
SEI	BSC-ISI	LIGO-E1100859	
SEI	HEPI	N/A	E1300931
SUS	BSC3 Suspension (under <i>Test Results</i>)	E1400131	E1400131
AOS/SLC/Viewports	Leak and pressure testing.	E1200445 Leak and pressure testing was completed, refer to above link. All viewports were tagged at time of inspection and testing.	Visual inspection in-situ not completed, refer to bug list.



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AOS/OpLev	OpLev Impulse Hammer Modal Testing at CIT.	T1100152	Not Completed.
AOS/CMB	Impulse Hammer Modal Testing		8194
AOS/TCS/RHy	Collection, refer to links.	N/R	T1300495 and G1400018 Install Recorded in LLO aLOG #9388
TMSy	Transfer Functions B&K Hammer Test	Phase 3a in #11798 Phase 3a in #11489	Phase 3b in #11798
AOS/ACB	Photodiode continuity testing. In-situ operation.	E1300376 Not envisioned at start. Diodes used for alignment of beam thus confirmed working.	
AOS/ACB	Impulse Hammer Modal Testing	One instance of testing completed, refer to LHO e-log entry 8656 .	
ESD	ESD install/testing for the quads	(E1300848)	#12193 for LBSC5

6 Installation Completeness

If/as applicable, provide a hyperlink reference to a list of remaining tasks to be completed before the installation is finished (i.e. a 'punch' list).

Installation tasks remaining to be completed:	All items are installed.
ICS Assembly Record needs to be updated	There are some issues with ICS which are affecting this task. Some TCS and SLC records have been added but do not appear. Still need to add viewports, Oplev periscope and perhaps misc. other items to the ICS records.

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If/as applicable, provide a hyperlinked list of integration issues and Engineering Change Requests (ECRs) encountered during installation and which are relevant to the installation subset/instance covered by this acceptance document. See [M1300323](#) for a description of the Integration Issue and ECR Tracker.

Tracker # [hyperlinked]	Title/description
#823 closed	LBSC5 (ETMY) Issue Tracker
#3 closed	Unintentional ground connection at GS-13 pods
#26 closed	LLO End Station Rack layout missing ISC rack
#27 closed	Improve robustness of electrical connections for TCS UHV Temperature Sensing
#30 closed	Change Locating Dimensions of Pcal Transmitter and Oplev/Pcal Receiver Installations in all End VEAs
#31 closed	ECR: Modifications to Photon Calibrator Periscope Structures
#34 closed	ECR: Add PEM, timing chassis to end-station TCS Remote racks
#35 closed	ECR: Add Beckhoff, Dolphin equipment to end-station DAQ racks
#44 closed	Removal of ETM HWS secondary beam
#49 closed	Changes to TMS post LLO initial build
#55 closed	Modifications to Photon Calibrator Periscope Structures (duplicate of #31)
#61 closed	ECR - Pcal Periscope Mirror Alignment Pin
#63 closed	ECR: Dog Clamps for SLC suspended baffles
#67 closed	ECR – Manifold/Cryopump Baffle Suspension Flexure has inadequate strength
#78 closed	SUS Electronics Missing/Incomplete/Out-of-date Drawings
#80	Possibility of damage to ESD pattern on ERMs and CPs due to arcing
#81	add vacuum hardware to TM chambers for future instruments without venting
#92 closed	ports misidentified on End 2 EtherCAT chassis
#97	Add direct wire connection between RT and EtherCAT systems
#101 closed	Pinhole transmission in ETM08 and ETM09
#105 closed	Remake Manifold Cryopump Turnbuckle Handle

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#111 closed	Modify Manifold Cryopump Copper Plate (D1100821) to add grooves for o-ring bumper stops.
#115	TOP driver for Quad suspension: DC current range mismatch
#118 closed	ECR: HEPI medm screen update
#182 closed	ECR: BSC-ISI and HEPI MEDM (Duplicate of #500)
#183 closed	Change the CPS biases from the local basis to the calibrated cartesian basis (Duplicate of #205)
#186 closed	ECR: Topology Changes to SUS models as a result of ISC Informed Interaction
#191 closed	Droopy Quad top mass blades
#205 closed	ECR: Add Cartesian bias monitoring and offsets to the ISI models
#207 closed	ECR: Model and screens update to allow sensor correction to the ISI using Ground seismometers (STS-2)
#215 closed	Purchase additional F1 Mirrors (D1102335) from higher quality vendor. Strip, resurface and recoat mirrors in-house or ship back to vendor. LLO TMSx was already assembled and did not receive new mirrors (BO'R)
#236	Addition by welding of Pcal Receiver Mounting Blocks to six Oplev/Pcal Receiver Pylon Weldments.
#253 closed	ECR – minor rework/modifications to the Manifold Cryopump Baffle Assembly
#261 closed	Issues arising from LLO TMSx primary optic being too thin
#283	CPS Circuit Modification to eliminate a high frequency oscillation
#327	Odd High-frequency behavior from all SUS Top2Top Transfer Functions
#355 closed	ECR: Modify HAM-ISI and BSC-ISI simulink control filters to monitor gain for ODC
#359 closed	Modifications to TMS tablecloth and cable routing during TMSx build at both LLO and LHO
#375 closed	ECR: Migrate the ISI Checker Script functions to the frontend code
#385 closed	ECR: create science frame channels for the SEI models
#445 closed	ECR: Update the SAFE level for the BSC and HEPI model watchdog
#459 closed	Add XTerm window pop-up for BSC-ISI and HAM-ISI transition command buttons (Duplicate of #650)

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#482	ECR: ODC changes in SUS, SEI, HPI and PSL
#487 closed	ECR: Remove ISI IPC links which come from SUS offload
#489 closed	Duplicate cable number in end station wiring diagram
#500 closed	ECR: HEPI MEDM Update
#524 closed	27 out of 30 Silicon Photodiodes have suffered bond wire failure
#530 closed	ECR: update to the HEPI master model and related MEDM screens
#551 closed	ECR: HEPI script update
#556	TCS End Station EtherCAT chassis design modifications
#557	Lack of Baffle Photo-diode Readback
#562 closed	Readbacks for arm cavity baffle photodiodes (Duplicate of #557)
#589	Alignment drift of the ALS return beam in the end station
#614 closed	ETM HR coating for green out of spec
#629	CPS Racks Grounding Schemes
#630	CPS cross talk
#650	ECR: ISI model update - Jan 2014
#652 closed	Acquisition of green arm transmitted power
#662	Use of GE FANUC RFM cards on end-station SEI, SUS front-ends
#664	5V regulator failing on Timing Comparators
#668	DC Switch Breaker Box Install in Pier Pod and TCS ISS Power cords.
#696	Adding auto-alignment for ALS
#713	AA/AI placement in End Station Remote rack
#716	Add a relay switch for ALS laser noise eater
#721	ECR: Replace the custom cartesian-bias-ramping code with cdsFiltCtrl2 parts
#722	ECR: Adding Independent ASC IPC Paths for Dither Alignment to Most SUS
#724 closed	Updating documentation on ITM and ETM coating specifications
#746	ECR: store suspension mis/alignment values separately in EPICS database
#751	Op Lev Cover for lead bricks
#759 closed	Add BLRMS for OpLevs on suspensions



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#761	In Situ, Visual Inspections of All Viewport Windows
#762	Increase drive range for the ETM UIM actuators
#776 closed	Syncing the CPS Timing to the GPS (Duplicate of #630)
#777	Low signal strength for green PFDs
#788	mechanical problems with the Optical Levers (OptLev) at both sites
#822	LBSC4 (ETMX) Issue Tracker