

Technical Progress: Third Interferometer aka 3IFO

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NSF Review 16-18 June 2015 @ LLO



- ❑ Organization and Management
 - Physical location
 - Documentation

- ❑ Monitoring
 - Eyes on
 - Probes and sensors

- ❑ Safeguarding and Securing
 - Physical control
 - Administrative control



Organization of 3IFO: Storage Venues

- Venues arranged according to general storage condition requirements
 - LIGO-E1300001: [Long Term Storage Plan for the Components of the Third Advanced LIGO Interferometer](#)
 - Temperature range: 72F +/- 3.5F
 - Maintained through building HVAC
 - Humidity range: 20-70% relative humidity (RH)
 - Cleanliness: Either “clean” or “dirty” space
 - “Clean”-required for storage of in-vacuum (Class A or Class B) items
 - “Dirty”-acceptable for the storage of “in-air” and “in-the crate” items
- Assignment of 3IFO Storage venue is further refined using each sub-system’s specific humidity control requirements
 - For example:
 - LIGO-T1200527: [Suspension \(SUS\) Long Term Storage for the 3rd aLIGO Interferometer](#)

Organization of 3IFO: Storage Venues Spaces and Storage Conditions

□ “Clean” Storage Spaces

- » Laser-Vacuum Equipment Area (LVEA)
 - Items stored in
 - Custom containers under dry nitrogen purge
 - Bins/Walled pallets
 - » With desiccant (WD)
 - » Without desiccant (WOD)
 - Air
- » Vacuum Prep Warehouse (VPW)
 - Items stored in
 - Bins/Walled pallets
 - | Without desiccant
 - “Dry Boxes”

□ “Dirty” Storage Spaces

- » H2 Electronics Building
 - Items stored in plastics bags with desiccant
- » Mechanical Room
 - Items stored in air
- » Mid-Station
 - Items stored in
 - Bins/Crates/Walled Pallets
 - » With desiccant (WD)
 - » Without desiccant (WOD)
 - Air

LVEA: Custom Containers with Dry Nitrogen Purge Internal Seismic Isolation Units



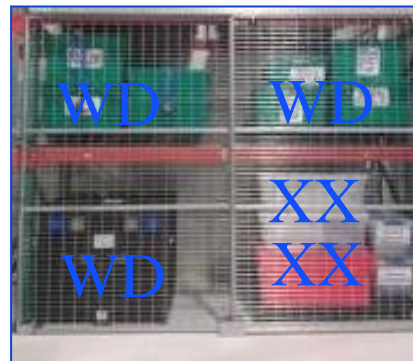
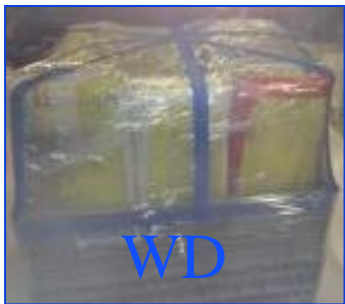
LVEA: Custom Containers with Dry Nitrogen Purge Core Optic and Baffle Suspensions

3IFO SUS SUS Cross Check and Custody-19 March 2015



LVEA: In-Air or Bins/Walled Pallets With (WD) or Without (WOD) Desiccant

❑ Stray Light Control (SLC) aka Baffles



❑ SUS Install and cabling kits

❑ Installation (INS) Tooling

» Stored "In-Air"



» Thermal Compensation System (TCS)



VPW: In Bins/Walled Pallets Without (WOD) Desiccant or in Dry Boxes



- ❑ Interferometer Sensing and Control (ISC)



- ❑ Various subsystems
 - » Dry boxes for humidity control and security

- ❑ Commercial viewports
- Custom viewport glass
- Testing fixtures

H2 Electronics Building Sealed Plastic Bags with Desiccant



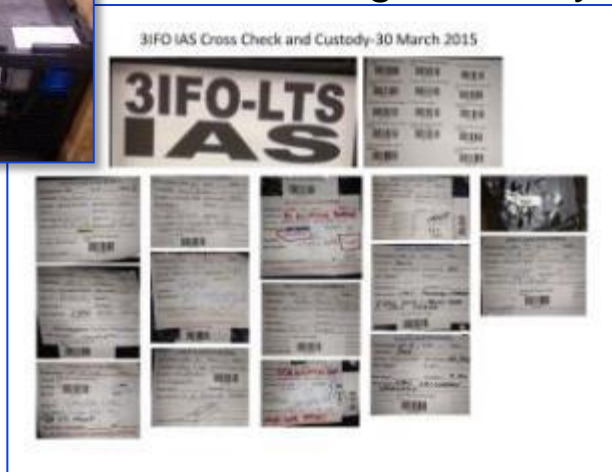
- Various subsystems
 - » SEI-Eight (8) racks
 - » SUS-Ten (10) racks
 - » ISC-Thirteen (13) racks

□ SEI HEPI Actuators and Pump Carts



Mid-Station X: In-Air or Bins/Crates/Walled Pallets With (WD) or Without (WOD) Desiccant

Initial Alignment System



Optical Levers



Photon Calibration



Seismic Isolation (SEI)



Mid-Station Y: In-Air or Bins/Crates/Walled Pallets With (WD) or Without (WOD) Desiccant

❑ Electronics Cables



❑ ISC and TCS Optical Tables



❑ Input Optics (IO) Hardware



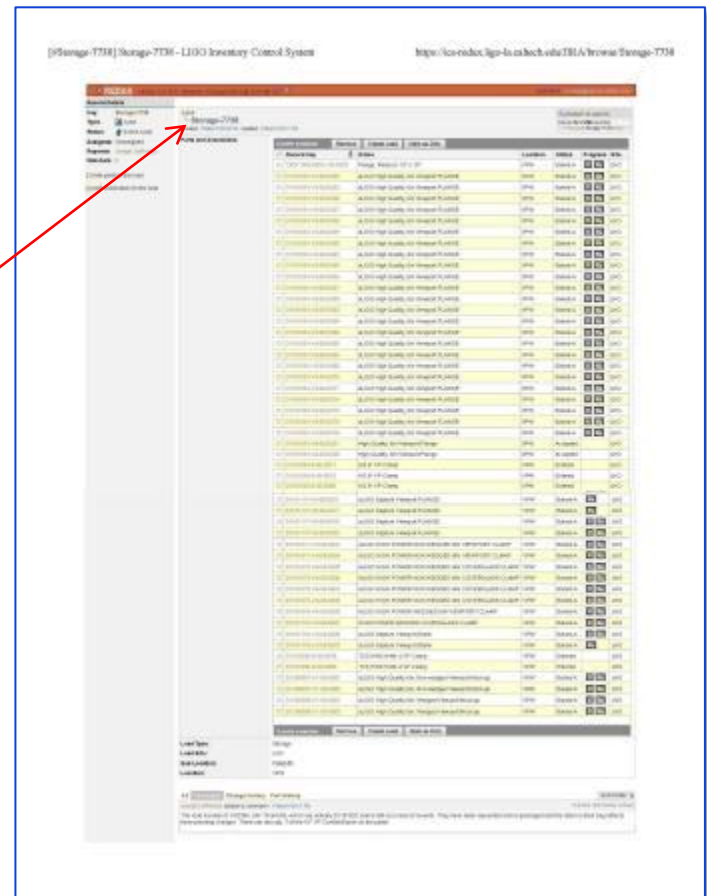
❑ Pre-Stabilized Laser (PSL)



❑ Viewport Hardware



- ❑ aLIGO Inventory Control System (ICS)
 - » Provides the history of in-vacuum parts/assemblies
 - » Storage Loads
 - Packing lists for kits

The screenshot shows the aLIGO Inventory Control System (ICS) interface for Storage-7738. The browser address bar displays `http://ice.index.ligo-la.caltech.edu/TLA/browse/Storage-7738`. The page title is "[Storage-7738] Storage-7738 - LIGO Inventory Control System".

The interface includes a navigation menu on the left with options like Home, List, Add, Edit, and Delete. The main content area displays a detailed table of inventory items. The table columns include:

- Barcode
- Item
- Location
- Status
- Quantity
- Unit
- Created
- Modified
- Deleted

The table contains multiple rows of data, with each row representing an inventory item and its associated details. A red arrow points from the text "Packing lists for kits" in the previous list to this table.

Organization and Management of 3IFO: Documentation continued

- Long-Term Storage (LTS) Asset Management System (LAM)
 - » Check-out/check-in capability

Assets by Asset Type Report 3IFO-LIGO Test Bed Observatory

Asset Type: IAS

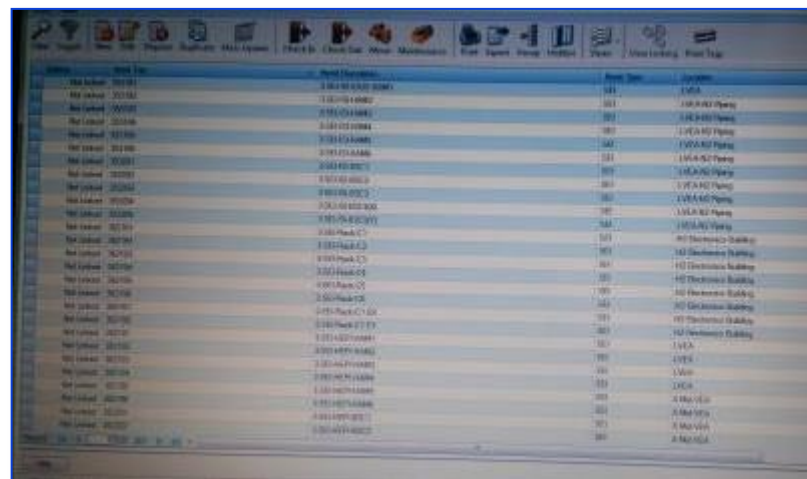
Asset Tag	Description	Serial No.	Additional Info	Vendor	Purchase Date	Purchase Cost
211104	3-IAS-CTM ACB Alignment Target					\$8.00
211102	3-IAS-ACB Target Counterweight					\$8.00
211111	3-IAS-TM ACB Alignment Target					\$8.00
211121	3-IAS-603 Corner Cube Mount					\$8.00
211125	3-IAS-PR3/SRS Corner Cube Mount					\$8.00
211125	3-IAS-603 Corner Cube and Mount					\$8.00
211131	3-IAS-HAM Cornering Actuator (x/y)					\$8.00
211141	3-IAS-903 Elliptical Baffle Target					\$8.00
211142	3-IAS-HLTS Target					\$8.00
211145	3-IAS-TM Elliptical Baffle Cross-Hair Th					\$8.00
211144	3-IAS-PR3/SRS Target (Vertical)					\$8.00
211145	3-IAS-TMS Primary Target					\$8.00
211146	3-IAS-TMS Secondary Target (x/y)					\$8.00
211131	3-IAS-PR3/SRS Inra Posn. (Vertical)					\$8.00
211148	3-IAS-HAM Support Table Actuator					\$8.00

Asset Type: INS/FMP Tooling

Asset Tag	Description	Serial No.	Additional Info	Vendor	Purchase Date	Purchase Cost
302104	3-INS-BSC Ripper Arm					\$8.00
302111	3-INS-HAM Intra Arm					\$8.00
302121	3-INS-Egg Arm					\$8.00
302204	3-INS-BSC Vertical L/R					\$8.00
302205	3-INS-HAM Elevator					\$8.00
302211	3-INS-Gema L/R					\$8.00
302211	3-INS-HAM L/R					\$8.00
302211	3-INS-Solestar L/R					\$8.00
302304	3-INS-S-Axis Table					\$8.00
302311	3-INS-Lift Cart for S-Axis Table					\$8.00
302411	3-INS-Trap Stand (Mechanical)01					\$8.00
302412	3-INS-Trap Stand (Mechanical)02					\$8.00
302413	3-INS-Trap Stand (Mechanical)03					\$8.00
302414	3-INS-Trap Stand (Mechanical)04					\$8.00

Asset Type: IC

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- » Barcodes for inspections and audits

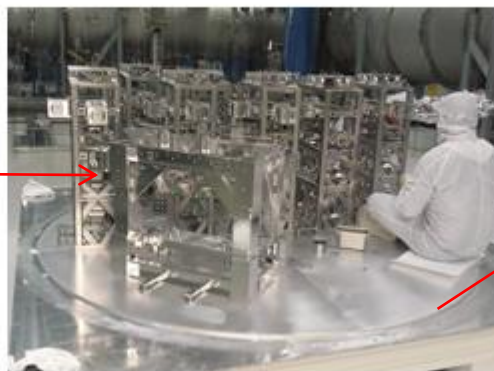
- » BOM/Packing List for Out-Bound Shipment

Monitoring of 3IFO: Eyes On

- Weekly visits by LTS Manager: usually on maintenance day
 - » Visits to major storage areas: brief general checklist
 - Are all expected bins and pallets in place?
 - Is there any evidence of tampering?
 - » Special conditions =Special questions
 - | LVEA
 - » Qualitative check on nitrogen purge
 - » Containers cool?
 - » Does it sound like gas is flowing?
 - | VPW
 - » Dry boxes present and locked?
- Check out system for borrowing mid-station key
 - » No un-fettered access

Monitoring of 3IFO: Probes and Sensors Nitrogen Purge

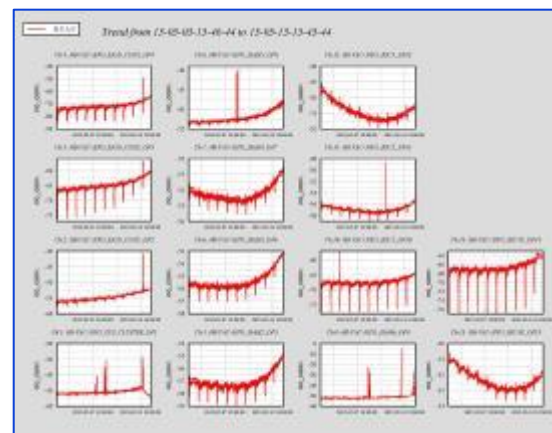
- Large assemblies transferred from temporary to LTS containers



- Containers have attached probes. Probe information is monitored in the control room on the Facility Management screens.



3IFO STORAGE DEWPOINT SENSORS		
	TdF (deg C)	H2O PPM
Sun Cluster	-56	21
H2O Con #1	-56	20
H2O Con #2	-57	15
H2O Con #3	-57	8
H2O 2	-57	27
H2O 3	-57	34
H2O 4	-57	36
H2O 5	-57	45
H2O 6	-57	52
BSC 1	-57	7
BSC 2	-54	25
BSC 3	-48	43
BSC 4(X)	-51	26
BSC 5(Y)	-42	8



Monitoring of 3IFO: Probes and Sensors

Relative Humidity

- ❑ A number of LTS items require humidity control
 - Crystals
 - Tip tilts
- ❑ Traditional solution: Desiccant cabinets
 - Require desiccant replacement
- ❑ Technology of choice: Dry boxes
 - Four (4) dehumidifying motors per unit
 - Housed in the Clean and Bake facility (VPW) so that motor noise does not impact interferometer performance
 - Logging sensor within the unit



- ❑ Very stable performance so far
 - 0% relative humidity (RH) most of the time
 - Spikes in RH when door has been opened
 - Return to 0% RH within half an hour

Safeguarding and Securing 3IFO: Physical and Administrative Controls



- ❑ Physical controls
 - Limited access
 - Special locks on mid-stations
 - Gatekeepers
 - Locked pallet rack
 - Key card access (Summer 2015)
 - Locked/Sealed containers
 - Tamper evident containers

- ❑ Administrative control
 - Established procedure for removing items from storage
 - Specifies loan terms
 - Requires System Engineer and LTS Manager approval

Safeguarding and Securing 3IFO: Administrative Control-Request Form



DCC E-Number: [Type here]

Document Title:

Third IFO Component Request: Click here to enter text.

Read the procedure below before completing this form.

Requester	
Requester's Name:	Click here to enter text.
Request Date:	Click here to enter a date.

Component Requested	
Source:	Choose an item.
Part Number (D-number if LIGO)	Click here to enter text.
Component Name or Description	Click here to enter text.
Quantity	Choose an item.
Next Level Major Assembly:	Click here to enter text.
Subsystem:	Choose an item.

Requested Loan Terms	
Requested Loan Start Date:	Click here to enter a date.
Proposed Return (or replacement) Date:	Click here to enter a date.
Loan Type:	Choose an item.
<ul style="list-style-type: none"> IF updating component, THEN ECR E-number: 	Click here to enter text.
<ul style="list-style-type: none"> IF Spare, THEN which IFO (where): 	Click here to enter text.
<ul style="list-style-type: none"> IF testing/evaluating, THEN why and where? 	Click here to enter text.
Risks and wear anticipated:	Click here to enter text.
UHV clean & bake required after loan?	Click here to enter text.
Inspection/test actions required upon return or replacement?	Click here to enter text.
Additional comments or references:	Click here to enter text.
Approx. Replacement Cost:	Click here to enter text.
Approx. Lead Time to Replace:	Click here to enter text.



DCC E-Number: [Type here]

Disposition of Request (section to be completed by Systems Engineering)	
Systems Engineering Disposition:	Choose an item.
Caveats, Request for More Information, or reason for rejection:	Click here to enter text.
SE Personnel Name:	Click here to enter text.

Loaned Item Details (section to be completed by Long Term Storage (LTS) Manager)	
Serial Number (SN): (if relevant/known)	Click here to enter text.
S-number: (if relevant/known)	Click here to enter text.
LAM number:	Click here to enter text.
Additional comments:	Click here to enter text.
LTS Personnel Name:	Click here to enter text.

Return/Completion (section to be completed by Long Term Storage (LTS) Manager)	
All loaned items returned?	Click here to enter text.
Appropriately inspected and/or tested?	Click here to enter text.
Additional comments:	Click here to enter text.
LTS Personnel Name:	Click here to enter text.

Procedure:

- The requester/borrower reserves an E-number from the DCC, completes the form above, uploads the completed form, and requests the System Engineer to review via the DCC electronic approval.
- The System Engineer considers and disposes the request:
 - consults with the LTS Manager and/or requests clarification from the requester, as needed.
 - If deemed warranted (e.g. high risk, high replacement cost, etc.), the System Engineer may request TRB and/or OMT review and approval.
- If rejected, the System Engineer explains the reason for rejection above and marks the request "rejected" in the "notes and changes" metadata field in the DCC, and informs the requester.
- If approved, the System Eng:
 - indicates any caveats above & marks the request "approved" or "approved with caveats" in the "notes and changes" metadata field in the DCC, and informs the requester and the LTS mgr.
 - adds the approved loan to the Third IFO Request Log, [E1500228](#), and updates the total loan value
 - informs the LIGO Business Mgr. of the implicit escrow amount if/when the total loan value exceeds \$50K
- The LTS Manager informs the borrower of any modifications to the request. The form must be updated to be the final, accurate record of agreement.
- The LTS manager puts a reminder in the calendar to follow-up with the borrower before the agreed end/return date.
- The LTS Manager enquires of status on that date, and either prepares for return or informs the System Engineer of difficulties/request for change of date, etc.
- The LTS Manager maintains civil pressure on situation and uses the System Engineer to resolve difficulties.
- The LTS Manager coordinates return processing as appropriate (e.g., arranges shipping/receiving, inspection, lines up clean and bakes, etc.)
- The LTS Manager annotates the final (return) section of the form indicating satisfactory return to LTS (as this is the only acceptable completion)



Safeguarding and Securing 3IFO: Administrative Control-3IFO Loan Log

Third IFO Component Loan Log							
E1500229							
5/19/2015 today's date				\$177,813.00 total implicit escrow total			
Request	status	start	end	loan value	returned?	escrow value	comments
E1500227	approved	4/27/2015	7/1/2015	\$2,000.00	no	\$7,813.00	4/28/2015 quote from Physik instrumente: qty 1 S-330.4SD Piezo Tip/Tilt Platform, 5mrad (10 mrad Optical), Closed-Loop, Sub-D Delivery is ~ 4 weeks ARO
E1500231	approved	4/27/2015	9/1/2015	\$170,000.00	no	\$170,000.00	
						\$0.00	
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