



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

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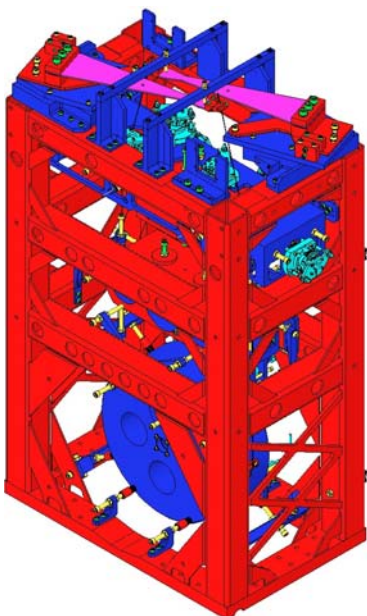


Fig 1: HLTS

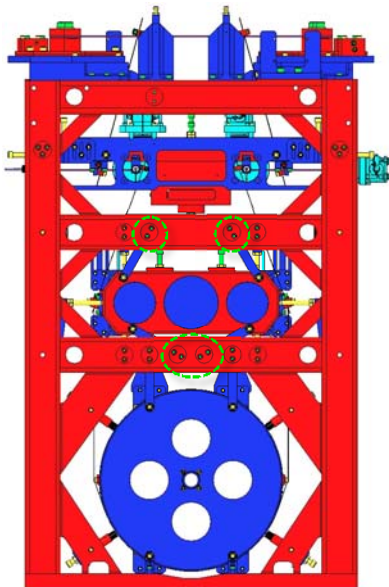


Fig 2: Front

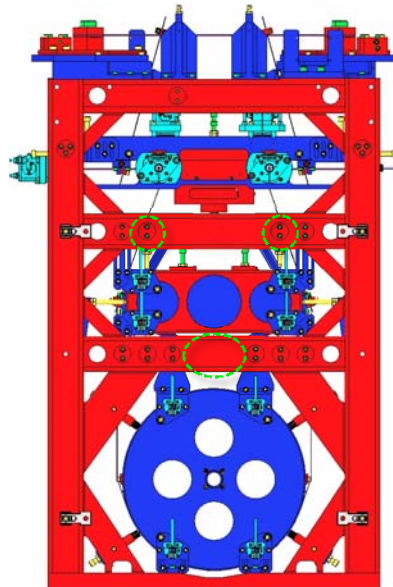


Fig 3: Rear

Note: Front vs. Rear of Weldment is identified by 3 hole patterns.

## 1 Safety

Read and understand the HLTS Assembly and Installation Hazard Analysis ([E1000043](#)). For specific safety information on wire handling, see Section 8.

## 2 Objective and Scope

The objection of this document is to outline and describe the steps necessary for the assembly of the HLTS. The following tasks are within the scope of this document:

- Assembly of subassemblies (masses, wires, earthquake stops), including the use of jigs and fixtures shown in [D080718](#) (HLTS Overall Assembly and Assembly Fixtures)
- Installation of subassemblies into the suspension structure
- Balancing of the suspension
- Gluing magnets on the metal masses and optic
- Installation and alignment of OSEMs
- Creep baking of the maraging steel blades
- Installation of the optic into the suspension
- Transportation of the suspension using a storage container

The following tasks are outside the scope of this document:

- Testing and commissioning of the suspension – see Ideal Order/Contents of aLIGO Triple Suspension Testing/Commissioning ([G1200070](#))
- Gluing primary and secondary prisms to the optic – see Prism Gluing for Input Optics ([E1200211](#))
- Installation of the suspension into the chamber – see the HLTS Installation Document ([E1000045](#))



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### 3 Documents

D070308	HLTS Top Blade Guard Assembly
D070319	HLTS Bridge EQ Stops
D070326	HLTS Rotational Adjuster
D070334	HLTS Intermediate Mass Assembly
D070335	HLTS Upper Mass Assembly
D070337	HLTS Bottom Mass Assembly
D070340	HLTS Upper Wire Assembly
D070393	HLTS Intermediate Wire Assembly
D070436	HLTS Lower Loop Wire Assembly
D070442	HLTS Overall Assembly
D070447	HLTS Assembly Drawings
D080677	HLTS Coil Holder Assembly
D080718	HLTS Assembly Fixtures
D080726	HLTS EQ Stop, Long Mount
D080727	HLTS EQ Stop, Long Bracket
D0900626	HLTS Mounting Pad Assembly
D1001695	Magnet and Flag Assembly, BOSEM
D1002821	HLTS EQ Stop Assembly, Bottom Mass, Lower
D1102071	HLTS EQ Stop, Bridge, Upper
E080208	HLTS Assembly Instructions (this document)
E0900047	Contamination Control Plan
E1000043	<b>HLTS Assembly and Installation Hazard Analysis</b>
E1000045	HLTS Installation Procedure
E1100109	Suspensions Controls Arrangement
E960022	LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures
E990196	Magnet/Standoff Assembly Preparation
E1100472	HLTS Assembly and Installation Documentation
G1100147	HLTS Introduction
M0900034	RODA - Use of Magnets in Suspensions
T000053	Advanced LIGO Universal Suspension Subsystem Design Requirements
T010007	Cavity Optics Suspension Subsystem Design Requirements
T010103	aLIGO Suspension System Conceptual Design
T1000012	HLTS Final Design Document
T1000089	HLTS Test Plan
T1100066	General Torque Recommendations for Socket Head Cap Screws
T1100003	Building Suspensions Subassemblies in ICS



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## 4 Documenting the Assembly Process

### 4.1 Documents

[T1100003](#) Building Suspensions Subassemblies in ICS.

### 4.2 Procedure

- See the above document.
- Data for each Final Assembly will be stored in ICS; using a Process Traveler is optional:

Item	Assembly 1	Assembly 1	Serial Number	Position	Variant	Weight
	Part Name	Part Number				
Each Mass	X	X	X	X		X
Each Blade	X	X	X	X		
Each Blade Clamp	X	X	X	X	X	
Each OSEM	X	X	X	X		
Each Optic	X	X	X			X

*Note regarding Subassembly weights: Each Subassembly must have 3 distinct weights recorded:*

- Estimated Weight** Calculated by SolidWorks;
- Actual Weight** Measured by a lab scale after built to the nominal mass;
- Balanced Weight** Totaled after Suspension is balanced (i.e. Actual Weight  $\pm$  Add-On Weights).  
When Addable weights are used, note their **location** on the Mass.



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## 5 Contamination Control

### 5.1 Documents

[E0900047](#) LIGO Contamination Control Plan

[E960022](#) LIGO Clean and Bake Methods and Procedures

### 5.2 General Practices

All assembly procedures must be performed in a Class 100 clean room environment while wearing:

- Hood
- Face Mask
- Coverall
- Overshoe Boots
- LIGO-approved UHV Gloves
- **Safety Glasses** (when working around wires and/or blades under load)
- **Glove Liners** (when pulling Wire Assemblies)

All work surfaces used for Class A or B components should be wiped down at the beginning of each work day, first with Acetone, then with Isopropanol. All HSTS parts are Class A hardware and, once cleaned and baked, should not come into contact with anything but Class A or B hardware. Review the LIGO Contamination Control Plan ([E0900047](#)) for details.

### 5.3 Clean and Bake of Components

All parts and hardware must be cleaned and bake to Class A or B as described in [E960022](#). Any part that comes into contact with anything other than an equivalent to a Class A or B part must be recleaned and rebaked.



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## 6 Hardware and Fasteners

### 6.1 Applications of Screw Types

The table below lists the most common types of screws used in the assembly of the HLTS, along with their applications. These types and applications apply to socket head cap screws (SHCS), flat head cap screws (FHCS), and set screws.

**Table 1: Common Types of Screws**

Screw Type	Description	Applications
Stainless Steel (SSTL)	Most common type of screw	<ul style="list-style-type: none"> <li>Threaded holes in aluminum parts</li> <li>Helicoils, in any material</li> </ul>
Stainless Steel, Vented	Stainless steel screw with a hole drilled through the shank of the screw	<ul style="list-style-type: none"> <li>Threaded holes in aluminum parts where the trapped volume in the hole must be vented</li> <li>Helicoils, in any material, where the trapped volume in the hole must be vented</li> </ul>
Silver-Plated (Ag-Plated) Stainless Steel	Stainless steel screw plated with a thin layer of silver	<ul style="list-style-type: none"> <li>Threaded holes ONLY in stainless steel parts</li> </ul>
Silver-Plated Stainless Steel, Vented	Stainless steel screw plated with a thin layer of silver with a hole drilled through the shank of the screw	<ul style="list-style-type: none"> <li>Threaded holes ONLY in stainless steel parts where the trapped volume in the hole must be vented</li> </ul>

### 6.2 Silver-Plated Stainless Steel Screws

As listed in the table above, all Silver-Plated screws are made of stainless steel SSTL, so they may be labeled simply as “Ag-Plated”, not “Ag-Plated SSTL” in this document.

### 6.3 Torque Values

All Socket Head Cap Screws (SHCS) are required to be tightened to the proper torque value using a torque wrench. The proper torque values (unless otherwise specified in this document) come from [T1100066](#) on the DCC and are listed in the table below. In future sections, the given torque values will be rounded to the nearest in-lb.

Torque values for Flat Head Cap Screws (FHCS) will be given in sections where the screws are used. In general, set screws are tightened by hand, not with a torque wrench.

**Table 2: Torque Values for SHCS**

Supplier	Generic	Holo-Krome	UC Components		
Type	Unplated	Unplated	Unplated, Vented	Ag-Plated	Ag-Plated, Vented
<b>SHCS Size</b>	<b>Torque (in-lb)</b>				
#2-56	2.5	4	2.9	4	2.9
#4-40	5.2	6	6.7	6	6.7
#8-32	19.8	30	25.2	30	25.2
1/4-20	75.2	100	85.8	100	85.8
5/16-18	132	184	N/A	184	N/A

In this table, all values are for coarse-threaded (UNC) SHCS, as shown by the listed thread pitch. Torque values for fine-threaded (UNF) or specially-threaded (UNS) SHCS will be given in sections where they are used. The Supplier of a SHCS can be determined in this manner: all Ag-Plated SHCS and vented SHCS are supplied by UC Components; Holo-Krome SHCS are indicated by an “H-K” marking on the head; all



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other SHCS should be considered to be generic, unless UC Components is positively known to be the supplier.

#### 6.4 Tightening Screw Patterns

To ensure proper alignment of components and to ensure even clamping pressure, it is important to tighten the final few threads of screws in a pattern evenly. That is, after all screws have been tightened initially by hand, each screw should be turned no more than ¼ turn (either by hand or with a torque wrench) before continuing to the next screw. Continue to tighten each screw ¼ turn in sequence until all screws are properly torqued.

#### 6.5 Helicoils

Helicoils (also known as threaded inserts) are used in threaded holes in aluminum or SSTL parts for a number of reasons:

- Additional strength
- Additional durability (for example, where a screw is frequently tightened and loosened for adjustment or repeated assembly/disassembly)
- To avoid the use of **Ag-Plated** hardware in a SSTL part
- To lock a screw in place (screw-lock helicoils only)

All helicoils used in this assembly are to be made of Nitronic 60. As with any other type of hardware, helicoils are cleaned and baked to Class A and installed using clean tools in a Class 100 clean room. After installation but before removing the tang, all helicoils should be checked by inserting a SHCS of sufficient length.

#### 6.6 Washers

The majority of washers used in assembly are flat washers made from stainless steel. In specific locations where parts slide against one another, Nitronic 60 flat washers ([D1100785](#), various types) may be used; these locations will be called out in the assembly procedure.

In the HLTS, most of the washers are vented for an additional measure of vacuum compatibility. Vented flat washers must be installed with the vented side facing away from the head of the SHCS. For SHCS in slots, the vent in the washer should be perpendicular to the direction of the slot, if possible.



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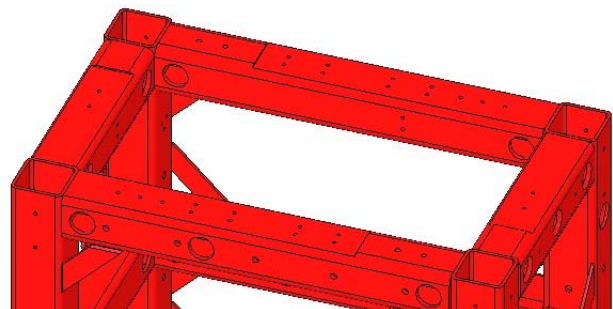
## HAM Large Triple Suspension (HLTS)

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## 7 Overview of Assembly Process

### 7.1 General Sequence of Assembly

1. Prepare HLTS Structure ([D070537](#))
2. Assemble subassemblies, in any order:
  - a. Top Blade Guard Assemblies (2X [D070308](#))
  - b. Earthquake Stop Assemblies (8X [D080726](#) and 8X [D080727](#) and 2X [D080728](#) and 4X [D1102071](#) and 2X [D1002821](#))
  - c. Coil Holder Mounting Brackets (4X [D1002133](#))
  - d. AOSEM Alignment Assemblies (2X [D0902024](#) and 2X [D0901551](#) and 2X [D0901552](#) and 2X [D0901553](#))
  - e. Rotational Adjusters (2X [D070326](#))
  - f. Upper Mass Assembly (1X [D070335](#))
  - g. Intermediate Mass Assembly (1X [D070334](#))
  - h. Metal Bottom Mass Assembly (1X [D070337](#))
3. Attach Top Blade Guard Assemblies to Structure
4. Attach Rotational Adjusters to Structure and flatten Upper Blades
5. Attach Earthquake Stop Assemblies to Structural Weldment
6. Install Intermediate and Metal Lower Mass Assemblies
7. Assemble Intermediate Wire Assemblies (4X [D070393](#)) and attach to Upper Mass Assembly
8. Assemble Upper Wire Assemblies (2X [D070340](#)) and attach to Upper Mass Assembly
9. Place Coil Holder/Tablecloth ([D070449](#)) over Upper Mass Assembly and lock the two together
10. Attach Upper Mass/Coil Holder Assembly ([D1001754](#)) to Structure
11. Connect Upper Wire Assemblies to Upper Blades
12. Connect Intermediate Wire Assemblies to Intermediate Mass Assembly
13. Assemble Lower Loop Wire Assembly ([D070436](#))
14. Attach Lower Loop Wire Assembly to Intermediate Mass Assembly
15. Suspend all masses
16. Initial balancing
17. Remove all masses and Rotational Adjusters
18. In parallel:
  - a. Creep baking of Upper Blades (in Rotational Adjusters) and Lower Blades (in Upper Mass Assembly)
  - b. Magnet gluing for Intermediate Mass and Metal Bottom Mass Assemblies
19. Reinstall Rotational Adjusters, Wires and Masses.
20. Rebalancing.
21. Install AOSEM Alignment Brackets.
22. Install BOSEMs on Coil Holder/Tablecloth.
23. Metal-Build Testing
24. Transport HLTS to chamberside using a storage container.
25. Metal-Build Testing, Part 2
26. Replace Metal Bottom Mass with Glass Optic
27. Rebalancing
28. Glass-Build Testing
29. Install HSTS into chamber
30. In-Chamber Testing







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## 8 Handling Suspension Wire

The Wire used for all Suspensions is a hard temper carbon steel, delivered on large spools. When unwound for cleaning, cutting and preparation for clamp-wire-clamp assembly, care must be taken such that the wire's strong potential energy (making it act like a coiled spring) does not cause injury.

1. **Safety Glasses**, provided in all Clean Room garbing areas, must be worn during all wire work.
2. **Glove Liners** must be worn under the latex clean-room gloves as a protective layer and extra barrier. The [E0900047](#) Contamination Control Plan, p. 13, provides further information on Glove Liners.
3. For **easier holding**, bend a small section (~3") of the end of the Wire. The bent section can be hooked around your thumb and held by your index finger. Un-spool the proper length of Wire – including extra for handling – and control the area of the Wire that will be cut. Add a 2<sup>nd</sup> bend at the newly cut end for easier handling.
4. Change your gloves and wipe each Wire at least 3 times each, and until no residue appears on each Wipe, using:
  - a. A Cleaning Wipe with **Methanol**;
  - b. A Cleaning Wipe with **Acetone**;
  - c. A Cleaning Wipe with **Isopropanol**;

changing Wipes until the wire is completely clean. Clean the Wire while it is coiled; do not stretch the wire until it is taut for cleaning. It can be laid down on a clean surface during this process. Clean one section at a time.

5. Transfer the Wire to the **Assembly Jig**. Use the Jig clamps to hold the Wire in place, and then cut off and discard the bent Wire ends.



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## 9 Preparing the Weldment

### 1.1 Materials

Qty	U	ID	Description
8	Ea	1185-2EN492	Helicoil 8-32 x 3.0D
8	Ea	D980184	LOS Clamps
8	Ea	NA	Socket Head Cap Screw 1/4-20 x 1.5" AgPlated

### 9.1 Procedure

6. Identify the **Front vs Rear** of the Weldment. The front has 4 pairs of adjacent, large-diameter through-holes.

7. Install at the base of the Weldment:

- 8 1185-2EN492 Helicoils  
8-32 x 3.0D

Install these **BEFORE** securing the Weldment to the Optical Table!

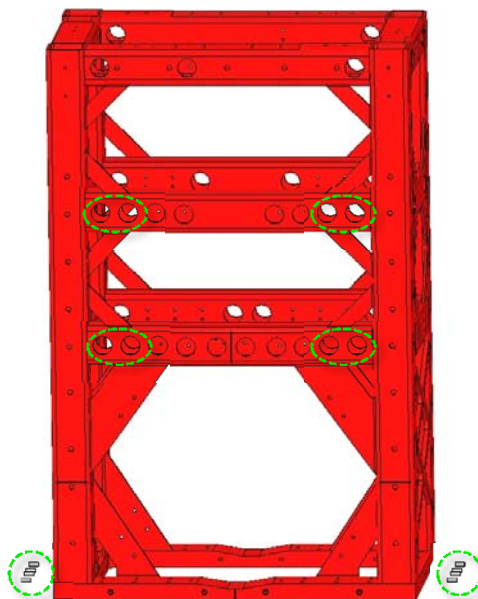


Fig 4: Helicoils in Weldment

8. Secure the D070442 Structural Weldment to the Optical Table with:

- 8 D980184 LOS Clamps, 2 per corner
- 8 Socket Head Cap Screws  
1/4-20 x 1.5" AgPlated

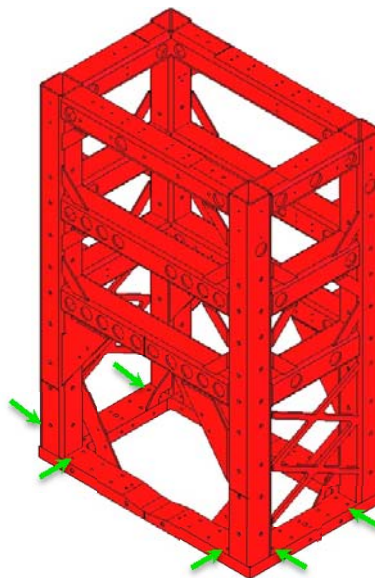


Fig 5: Securing the Weldment



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## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 10 Installing the Mounting Pads

### 10.1 Documents

[D0900626](#) HLTS Mounting Pad Assembly

### 10.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D070442</a>	HLTS Structural Weldment
8	Ea	<a href="#">D980184</a>	LOS Clamps
2	Ea	<a href="#">D070374</a>	HLTS Mounting Pad
8	Ea	NA	Helicoil 8-32 x 0.246"
4	Ea	1185-2EN246	Helicoil 8-32 2B x 2.0D
2	Ea	<a href="#">D0900628</a>	HLTS Mounting Pad Side Bracket
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" SSTL
14	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" <b>AgPlated</b>
18	Ea	NA	Flat Washer #8 SSTL

### 10.3 Procedure

9. Assemble to each of the 2 [D070374](#) Mounting Pads:

#### Top of the Pad

- 4 Helicoil 8-32 x 0.246 or longer

#### Side of the Pad

- 2 1185-2EN246 Helicoils 8-32 2B x 2.0D

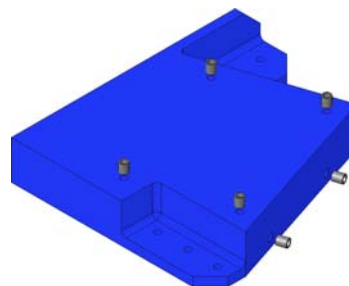


Fig 6: Helicoils in 1 of 2 Mounting Pads

10. Create 2 [D0900626](#) Mounting Pad Assemblies:

- 2 [D070374](#) Mounting Pad Body
- 2 [D0900628](#) Mounting Pad Side Bracket
- 4 Socket Head Cap Screw 8-32 x 0.5" SSTL
- 4 Flat Washer #8 SSTL  
Torque to **20 in-lb**

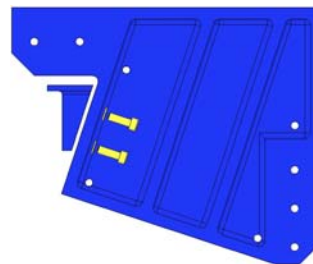


Fig 7: Mounting Pad Assembly

11. Assemble the Mounting Pad Assembly to the Structural Weldment using:

- 14 Socket Head Cap Screw 8-32 x 0.5" **AgPlated**
- 14 Flat Washer #8 SSTL  
Torque to **30 in-lb**

The **Serial Number** for each Pad is stamped on a specific **Weldment corner**. **Ensure each Pad is mounted on the correct Weldment location.**

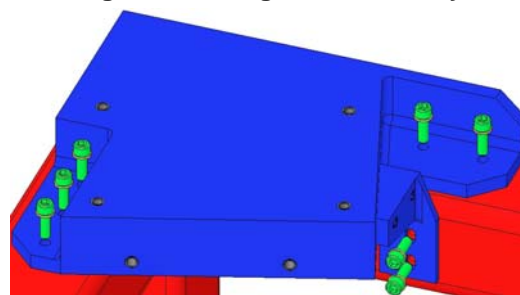


Fig 8: Mounting Pad on Weldment



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Assembly Instructions

## 11 Assembling Top Blade Guards

### 11.1 Documents

[D070308](#) HLTS Top Blade Guard Assembly

### 11.2 Materials

Qty	U	ID	Description
4	Ea	<a href="#">D070309</a>	Top Blade Guard Riser
2	Ea	<a href="#">D070310</a>	Top Blade Guard Bar
8	Ea	NA	Socket Head Cap Screw $\frac{1}{4}$ -20 x 1.0" SSTL
8	Ea	NA	Flat Washer, $\frac{1}{4}$ " Vented SSTL
4	Ea	<a href="#">D0900999</a>	Socket Head Cap Screw $\frac{1}{4}$ -20 x 2.0" SSTL Round-Tip
4	Ea	NA	Hex Nut $\frac{1}{4}$ -20 AgPlated

### 11.3 Procedure

1. Assemble 2 [D070308](#) Top Blade Guard Assemblies, each with:
  - 2 [D070309](#) Top Blade Guard Riser
  - 1 [D070310](#) Top Blade Guard Bar
  - 4 Socket Head Cap Screws  $\frac{1}{4}$ -20 x 1.0" SSTL
  - 4 Flat Washers,  $\frac{1}{4}$ -20 Vented SSTL
  - 2 [D0900999](#) Socket Head Cap Screw  $\frac{1}{4}$ -20 x 2.0" SSTL Round-Tip
  - 2 Hex Nut  $\frac{1}{4}$ -20 AgPlated

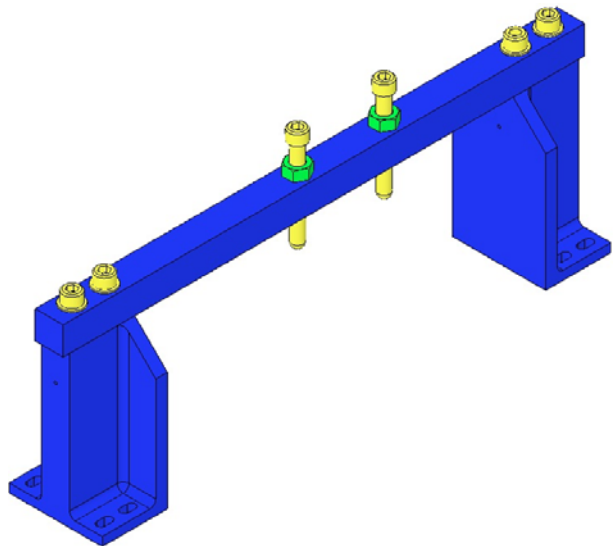


Fig 9: Top Blade Guard Assembly



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### Assembly Instructions

## 12 Assembling EQ Stops For Intermediate and Bottom Masses

### 12.1 Documents

D070447	HLTS Overall Assembly
D080726	HLTS EQ Stop, Long Mount
D080727	HLTS EQ Stop, Long Bracket
D1002821	HLTS EQ Stop Assembly, Bottom Mass, Lower
D1102071	HLTS EQ Stop, Bridge, Upper
D070319	HLTS Bridge EQ Stops

### 12.2 Materials

Qty	U	ID	Description
10	Ea	D070460	Long EQ Stop Mount
8	Ea	D070322	Long EQ Stop Bracket
4	Ea	D1002823	EQ Stop Bracket Back, Bottom Mass, Lower
4	Ea	NA	Socket Head Cap Screws 8-32 x 1.0" SSTL
4	Ea	NA	Flat Washer #8 <b>Vented</b> SSTL
4	Ea	D070321	EQ Stop Bridge Crossbar
8	Ea	D1102072	Bridge EQ Stop Mount, Upper
28	Ea	D080725	EQ Stop for Metal or Glass
28	Ea	NA	Hex Nut ¼-20 <b>AgPlated</b>
8	Ea	NA	Socket Head Cap Screw ¼-20 x 0.75" SSTL
8	Ea	D1100785	Flat Washer, ¼", Nitronic 60

### 12.3 Procedure

1. Assemble 10 D080726 Long Mount EQ Stops, each using:

- 1 D070460 Long EQ Stop Mount
- 1 D080725 EQ Stop for Metal or Glass
- 1 Hex Nut ¼-20 **AgPlated**

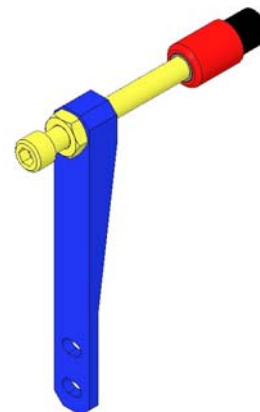
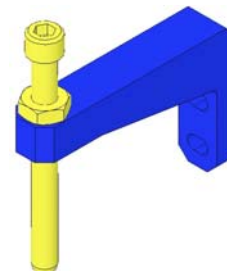


Fig 10: D080726 Long Mount EQ Stop

2. Assemble 8 D080727 Long Bracket EQ Stops, each using:

- 1 D070322 Long EQ Stop Bracket
- 1 D080725 EQ Stop for Metal or Glass
- 1 Hex Nut ¼-20 **AgPlated**





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# SPECIFICATION

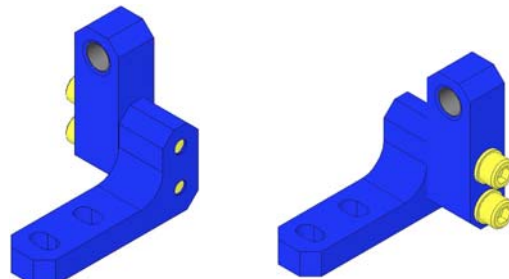
## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

3. Assemble 2 **D1002822** EQ Stop **Bracket Assemblies**, 1 LH and 1 RH version, each using:

- 1 **D1002823** EQ Stop Bracket, Back
- 1 **D1002824** EQ Stop Bracket, Side
- 2 Socket Head Cap Screw 8-32 x 1.00" SSTL
- 2 Flat Washer #8 SSTL **Vented**

**Fig 11: D080727 Long Bracket EQ Stop**

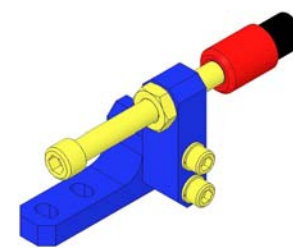
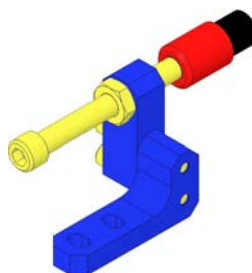


**Fig 12: D1002822 Left**

**Fig 13: D1002822 Right**

4. Assemble 2 **D1002821** EQ **Stop Assemblies**, 1 LH and 1 RH version, each using:

- 1 **D1002822** EQ Stop Bracket (see above)
- 1 **D080725** EQ Stop for Metal or Glass
- 1 Hex Nut ¼-20 **AgPlated**



**Fig 14: D1002821 Left**

**Fig 15: D1002821 Right**

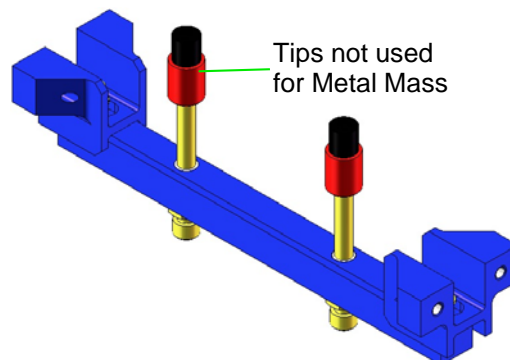
5. Assemble 4 **D1102071** Bridge EQ Stops in 2 configurations.

**Initial Build:**

- Upper RH diagram: 2 **above Metal**;
- Lower RH diagram: 2 **beneath Metal**.

**Optic Installation:**

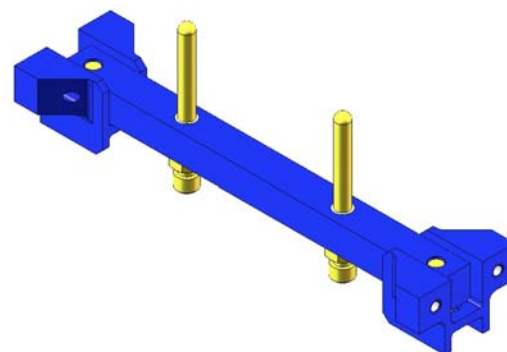
- Reconfigure existing assembly (lower RH diagram) as upper RH diagram.



**Fig 16: Above Metal / Optic & beneath Optic**

Assemble all 4 with:

- 1 **D070321** Crossbar
- 2 **D1102072** Mount
- 2 Socket Head Cap Screw ¼-20 x 0.75" SSTL
- 2 **D1100785** Flat Washer, ¼" Nitronic 60
- 2 **D080725** EQ Stop for Metal or Glass  
**The tips (shown red & black) are not used for the Metal Mass**
- 2 Hex Nut ¼-20 **AgPlated**  
**Hand-tighten all fasteners at this point**



**Fig 17: Use beneath the Metal Mass**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

### 13 Assembling Coil Holder Brackets

### 14 Assembling AOSEM Brackets

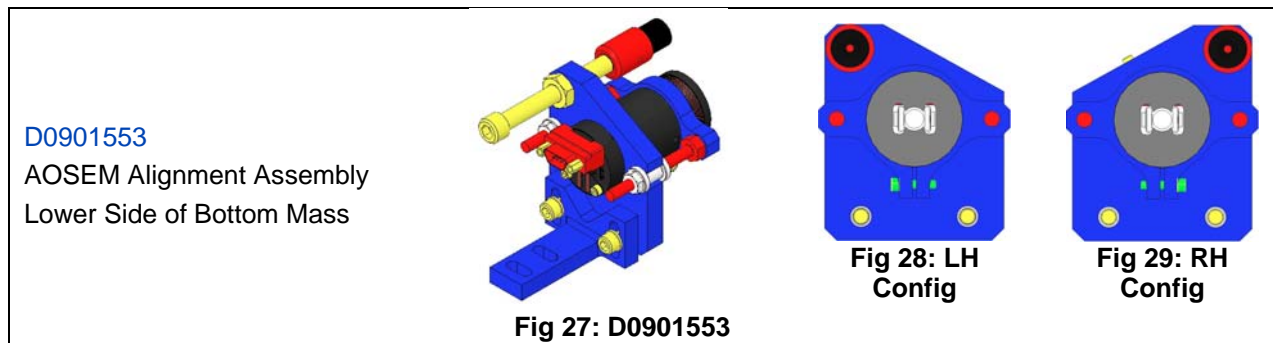
1 of each configuration is required. The difference between LH / RH is simply the orientation of the Mounting and / or Alignment Brackets.

<p>D090204 AOSEM Alignment Assembly Upper Side of Intermediate Mass</p>	<p>Fig 18: D090204</p>	<p>Mounting Bracket Alignment Bracket</p> <p>Fig 19: LH Config</p>	<p>Fig 20: RH Config</p>
<p>D0901551 AOSEM Alignment Assembly Lower Side of Intermediate Mass</p>	<p>Fig 21: D0901551</p>	<p>Fig 22: LH Config</p>	<p>Fig 23: RH Config</p>
<p>D0901552 AOSEM Alignment Assembly Upper Side of Bottom Mass</p>	<p>Fig 24: D0901552</p>	<p>Fig 25: LH Config</p>	<p>Fig 26: RH Config</p>



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions



### 14.1 Documents

D070442 HLTS Overall Assembly

### 14.2 Materials

#### D0902024

Qty	U	ID	Description
1	Ea	D0902025	HLTS AOSEM Mounting Bracket, Upper Side of Intermediate Mass
1	Ea	D0901492	HLTS AOSEM Alignment Bracket, Intermediate Mass
1	Ea	D0901065	AOSEM Assembly
1	Ea	D1002858	AOSEM Adjustment Collar, Reverse Side
2	Ea	D1000659	Adjuster Shaft
2	Ea	D1002865	Adjustment Nut, Thick
2	Ea	NA	Socket Head Cap Screw, 8-32 x 0.625", SSTL
2	Ea	1185-2EN246	Helicoil, 8-32 x 0.246"
2	Ea	NA	Flat Washer, <b>Vented</b> , #8
1	Ea	NA	Socket Head Cap Screw, 2-56 x 0.375" SSTL
1	Ea	D030021	Socket Head Cap Screw, 1/4-20 x 2.5", <b>Round Tip</b> SSTL
1	Ea	1185-4EN250	Helicoil, 1/4-20 x 0.25"
1	Ea	NA	Hex Nut, 1/4-20 <b>AgPlated</b>

#### D0901551

Qty	U	ID	Description
1	Ea	D0901493	Lower AOSEM Mounting Bracket, Intermediate Mass
1	Ea	D0901492	HLTS AOSEM Alignment Bracket, Intermediate Mass
1	Ea	D0901065	AOSEM Assembly
1	Ea	D1002858	AOSEM Adjustment Collar, Reverse Side
2	Ea	D1000659	Adjuster Shaft
2	Ea	D1002865	Adjustment Nut, Thick
2	Ea	NA	Socket Head Cap Screw, 8-32 x 0.625", SSTL
2	Ea	1185-2EN246	Helicoil, 8-32 x 0.246"
2	Ea	NA	Flat Washer, <b>Vented</b> , #8
1	Ea	NA	Socket Head Cap Screw, 2-56 x 0.375" SSTL
1	Ea	D030021	Socket Head Cap Screw, 1/4-20 x 2.5", <b>Round Tip</b> SSTL
1	Ea	1185-4EN250	Helicoil, 1/4-20 x 0.25"
1	Ea	NA	Hex Nut, 1/4-20 <b>AgPlated</b>

#### D0901552

Qty	U	ID	Description
1	Ea	D0901550	AOSEM Mounting Bracket, Upper Position of Bottom Mass





# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

1	Ea	D0901549	AOSEM Alignment Bracket, Bottom Mass
1	Ea	D0901065	AOSEM Assembly
1	Ea	D1002858	AOSEM Adjustment Collar, Reverse Side
2	Ea	D1000659	Adjuster Shaft
2	Ea	D1002865	Adjustment Nut, Thick
1	Ea	D080725	EQ Stop for Metal or Glass
2	Ea	NA	Socket Head Cap Screw, 8-32 x 0.625", SSTL
2	Ea	1185-2EN246	Helicoil, 8-32 x 0.246"
2	Ea	NA	Flat Washer, <b>Vented</b> , #8
1	Ea	NA	Socket Head Cap Screw, 2-56 x 0.375" SSTL
1	Ea	1185-4EN250	Helicoil, 1/4-20 x 0.25"
1	Ea	NA	Hex Nut, 1/4-20 <b>AgPlated</b>

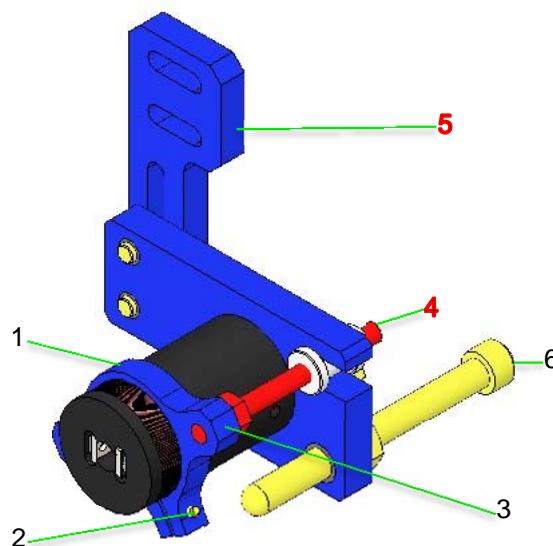
**D0901553**

Qty	U	ID	Description
1	Ea	D0900340	AOSEM Mounting Bracket, Lower Position of Bottom Mass
1	Ea	D0901549	AOSEM Alignment Bracket, Bottom Mass
1	Ea	D0901065	AOSEM Assembly
1	Ea	D1002858	AOSEM Adjustment Collar, Reverse Side
2	Ea	D1000659	Adjuster Shaft
2	Ea	D1002865	Adjustment Nut, Thick
1	Ea	D080725	EQ Stop for Metal or Glass
2	Ea	NA	Socket Head Cap Screw, 8-32 x 0.625", SSTL
2	Ea	1185-2EN246	Helicoil, 8-32 x 0.246"
2	Ea	NA	Flat Washer, <b>Vented</b> , #8
1	Ea	NA	Socket Head Cap Screw, 2-56 x 0.375" SSTL
1	Ea	1185-4EN250	Helicoil, 1/4-20 x 0.25"
1	Ea	NA	Hex Nut, 1/4-20 <b>AgPlated</b>

### 14.3 Procedure

Assembly procedure is similar for all 4 units, but varies by the **Mount Bracket** and **Alignment Bracket**.

1. Assemble Adjustment Collar to AOSEM
2. Assemble SHCS 2-56 to Collar
3. Assemble Adjuster Shafts to Collar
4. Assemble AOSEM w/Adjuster Shafts to Alignment Bracket, paying close attention to part number and orientation of Bracket
5. Assemble **Mount** to Alignment Bracket
6. Assemble EQ Stop to Alignment Bracket with a Hex Nut



**Fig 30: Assembly**



**SPECIFICATION**  
**HAM Large Triple Suspension (HLTS)**  
**Assembly Instructions**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

## 15 Assembling the Rotational Adjusters

### 15.1 Documents

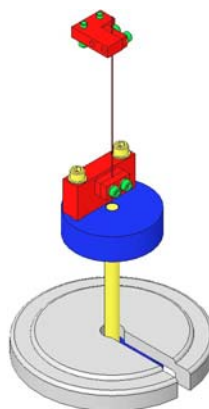
<a href="#">D070326</a>	HLTS Rotational Adjuster
<a href="#">E1000169</a>	Blade Characterization Spreadsheet
<a href="#">T0900559</a>	Blade Pairings Spreadsheet

### 15.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D080265</a>	HLTS Upper Blade Bake Fixture
1	Ea	<a href="#">D070327</a>	HLTS RA Base Plate
1	Ea	<a href="#">D070328</a>	HLTS RA Rotating Plate
3	Ea	NA	Socket Head Cap Screw ¼-20 x 0.625" SSTL
3	Ea	NA	Flat Washer ¼"
1	Ea	<a href="#">D070329</a>	HLTS RA Pull Plate
2	Ea	NA	Socket Head Cap Screw 8-32 x 1.0" <b>AgPlated</b>
1	Ea	<a href="#">D070330</a>	HLTS RA Push Plate
2	Ea	NA	Socket Head Cap Screw 8-32 x 1.25" <b>AgPlated</b>
1	Ea	NA	Socket Head Cap Screw 8-32 x 1.5" <b>Fully-Threaded SSTL</b>
1	Ea	NA	Flat Washer #8 <b>Vented SSTL</b>
1	Ea	NA	Socket Head Cap Screw 8-32 x 1.5" <b>Full-Thread Round-Tip SSTL</b>
3	Ea	NA	Socket Head Cap Screw 5/16-18 x 1.75" <b>AgPlated</b>
3	Ea	NA	Flat Washer 5/16" <b>Vented SSTL</b>
1	Ea	<a href="#">D0900665</a>	HLTS Upper Blade Library of Clamps
2	Ea	<a href="#">D020617</a>	Upper Blade
2	Ea	Various	Upper Blade Clamp Inside
2	Ea	<a href="#">D070331</a>	Upper Blade Clamp Shim, <b>1.0mm</b> <b>Consult with a Suspension Design Engineer to verify that 1.0 is appropriate; Shim height needed depends upon actual Weldment height.</b>
1	Ea	<a href="#">D020660</a>	Blade Pulldown Device
1	Ea	NA	Machinist's Square

### 15.3 Procedure

- Prepare a [D020660](#) Blade Pulldown Device with:
- 1 [D0901814](#) Upper Clamp, Inside
- 1 [D070341](#) Upper Clamp, Outside
- Socket Head Cap Screw  
8-32 x 0.5" **AgPlated**
- Flat Washer #8 **Vented**, SSTL
- 2' of 0.024" Wire.



**Fig 31: Blade Pulldown Device**

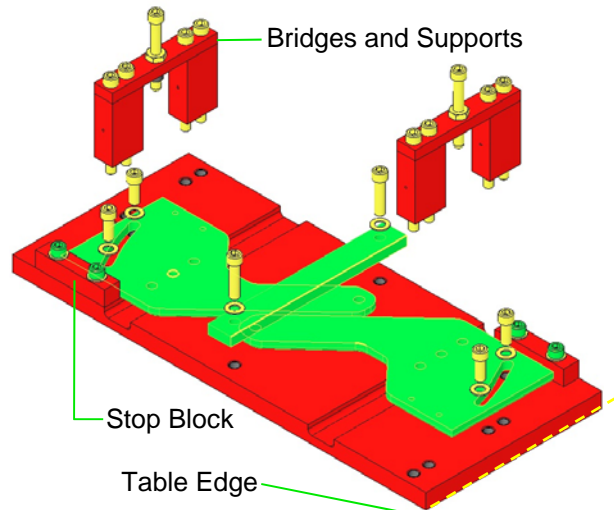


# SPECIFICATION

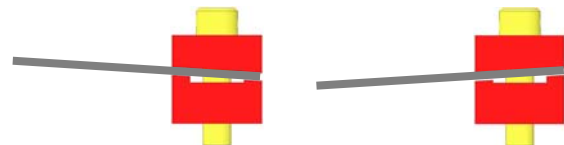
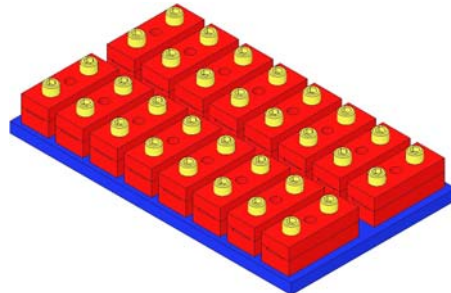
## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

12. Remove the Bridges and Side Supports from the [D080268](#) Upper Blade Bake Fixture Base Plate.
13. Mount the Base Plate to an Optics Table, leaving one end of the Plate extending beyond the Table Edge to accommodate the Blade Pulldown Device. Assemble 2 [D070328](#) Rotational Adjuster Rotating Plates to the Fixture Base Plate using:
  - 4 Socket Head Cap Screws  $\frac{1}{4}$ -20 x .625" SSTL
  - 4 Flat Washers  $\frac{1}{4}$ " Vented SSTLTighten the Screws firmly.  
**Square the edge of the Rotational Adjuster Rotating Plate against the Fixture Stop Block.**
14. Assemble the [D1003307](#) Hold Down Bar to the Fixture using:
  - 2 Socket Head Cap Screws  $\frac{1}{4}$ -20 x 1.00" SSTL
  - 2 Flat Washer  $\frac{1}{4}$ " Vented SSTLTighten the Screws firmly.

**Fig 32: Rotating Plates & Hold Down Bar**

15. Select a matching pair of Upper Blades and Clamps per the [E1000169](#) Blade Characterization Spreadsheet:
  - Blade launch angle is set by Blade Clamps. These range from 0-3.5 deg. in .5 deg. increments.
  - Select Clamps from the [D0900665](#) HLTS Upper Blade Library of Clamps
  - Select Clamps according to Blade Characterization data for stiffness and expected load.
  - Select Blades in pairs according to Blade Characterization data.
  - Align the Blade, Clamps and Shim using a Precision Square.
  - Record the Blade serial numbers and Blade clamp angles and orientations within ICS.

**Fig 33: Clamps Control Launch Angle****Fig 34: Upper Blade Library of Clamps**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

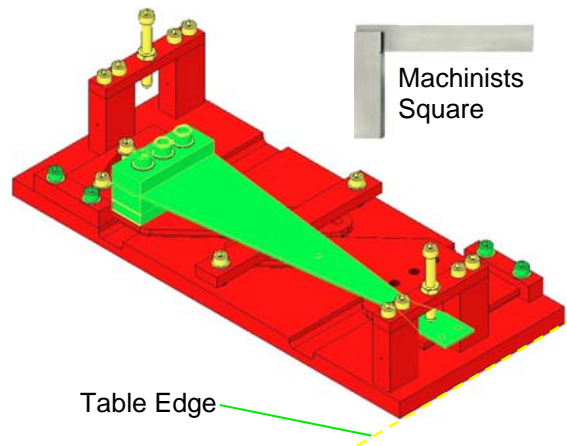
### Assembly Instructions

16. Assemble to the Rotational Adjuster Blade Rotating Plate furthest from the Table edge:

- 3 Socket Head Cap Screws  
5/16-18 x 1.75" **AgPlated**
- 3 Flat Washers 5/16" **Vented SSTL**
- **D09006XX** Upper Blade Clamp Outside
- **D020617** Upper Blade
- **D09006XX** Upper Blade Clamp Inside
- **D070331** Upper Blade Clamp Shim 1.0mm

**Consult with a Suspension Design Engineer to verify that 1.0mm is appropriate; Shim height needed depends upon actual Weldment height.**

**Using the Machinist's Square, Square the Blade, Clamps, and Shim to each other and to the Rotating Plate and hand-tighten the 3 Screws**



17. Hang the **18.252 kg** Pulldown Weight from the Blade Tip

18. Assemble to the Bake Fixture Base Plate:

- 2 **D1003306** Side Support
- 1 **D080267** Top Bridge
- 4 Socket Head Cap Screws  
1/4-20 x 2.5" **SSTL**  
Tighten the Screws firmly
- **D0900999** Socket Head Cap Screw  
1/4-20 x 2.0" **Round-Tip**
- Hex Nut 1/4-20 **AgPlated**

19. Turn down the Round Tip Screw until the weighted Blade tip is level with the Blade root.

**Be careful not to damage the nickel plating on the blade**

20. Leaving the Wire Clamp attached to the Blade, remove the rest of the Blade Pulldown Device.

21. Tighten the 5/16" Screws to **184 in-lb.**

22. Re-attach the Blade Pulldown Device to the Wire Clamp.

23. Turn back the Round Tip Screw and remove the Top Bridge and Side Supports.

24. Slowly lift and then remove the Blade Pulldown Device, allowing the Blade to curve fully upward.

25. Detach the Bake Fixture from the Optics Table, rotate it 180 deg., and remount it on the Optics Table, leaving one end of the Plate extending beyond the Table Edge to accommodate the Blade Pulldown Device.

26. Repeat steps 7-15 to assemble the second Upper Blade to the Bake Fixture.

27. Remove the Hold-down Bar.

28. Disassemble both Rotational Adjusters from the Upper Blade Bake Fixture.

**Fig 35: Blade & Clamps Assembled**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

29. Assemble the [D070328](#) Rotating Plate to the [D070327](#) HLTS Rotational Adjuster Base Plate using:

- 3 Socket Head Cap Screw  $\frac{1}{4}$  – 20 x 0.625" SSTL
- 3 Flat Washer  $\frac{1}{4}$ "  
Hand-tighten only, for now.

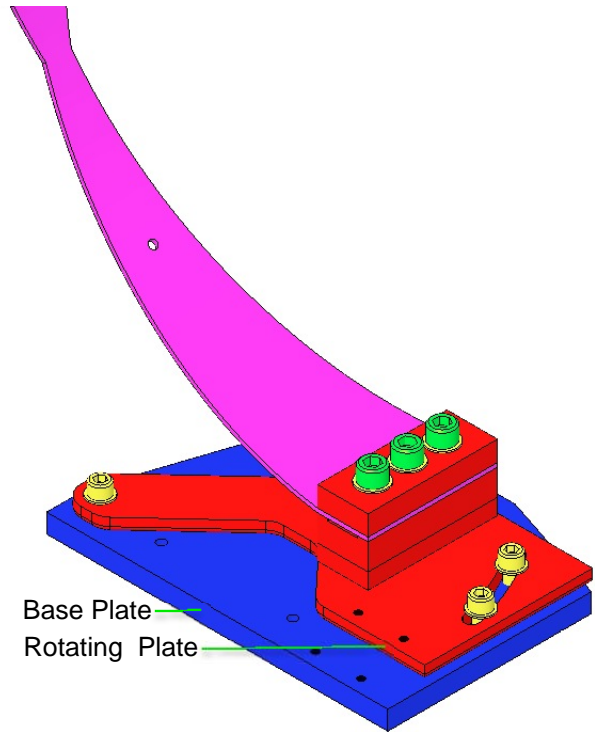


Fig 36: Attaching Base Plate

30. Assemble to the Base Plate:

- 1 [D070329](#) Pull Plate
- 2 Socket Head Cap Screws 8-32 x 1.0" **AgPlated**
- 1 [D070330](#) Push Plate
- 2 Socket Head Cap Screws 8-32 x 1.25" **AgPlated**
- 1 Socket Head Cap Screw 8-32 x 1.5" **Fully Threaded SSTL**
- 1 Flat Washer #8 **Vented SSTL**
- 1 Socket Head Cap Screw 8-32 x 1.5" **Fully Threaded, Round Tip SSTL**

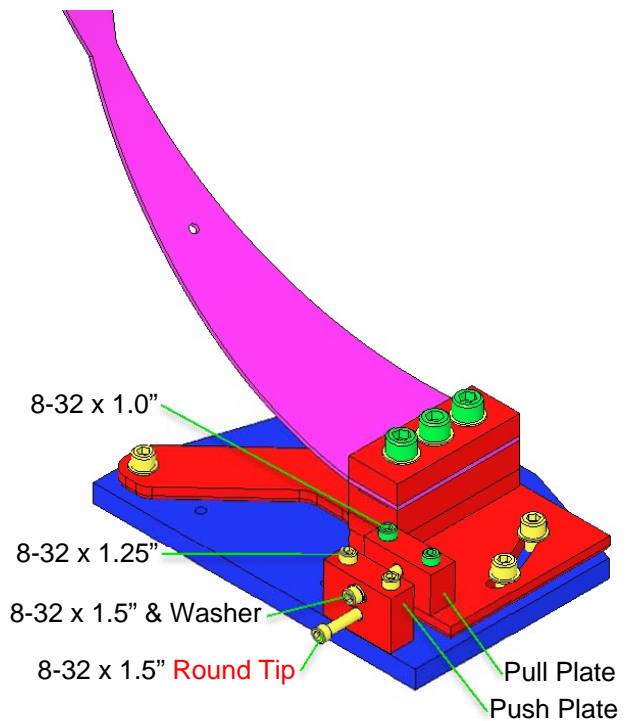


Fig 37: Assembling Push & Pull Plates



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

## 16 Assembling Upper Mass and Coil Holder (M1)

### 16.1 Documents

<a href="#">D070335</a>	Upper Mass Assembly
<a href="#">D080677</a>	Coil Holder Assembly

### 16.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D040259</a>	Upper Mass Jig
1	Ea	<a href="#">D020605</a>	<b>HLTS Upper Mass Main Section</b>
1	Ea	<a href="#">D020607</a>	<b>Upper Mass T-Piece</b>
8	Ea	NA	Socket Head Cap Screw ¼-20 x 1.25" <b>AgPlated</b> SSTL
1	Ea	<a href="#">D1001669</a>	Pitch Insert
1	Ea	NA	Socket Set Screw ½-20 x 3.5" <b>AgPlated</b>
2	Ea	NA	Socket Set Screw ¼-20 x 2.0" <b>Fully-Threaded</b> SSTL
2	Ea	<a href="#">D080221</a>	HLTS Lower Blade Guards
4	Ea	<a href="#">D030025</a>	Socket Head Cap Screws 8-32 x 1.0" SSTL <b>Fully-Threaded Round-Tip</b>
8	Ea	NA	Hex Nuts 8-32 <b>AgPlated</b>
4	Ea	NA	Socket Head Cap Screws 4-40 x 0.375" <b>AgPlated</b> SSTL
12	Ea	NA	Flat Washers #8 <b>Vented</b> SSTL
4	Ea	Various	HLTS Blade Clamp, Lower Blade, Inside
4	Ea	<a href="#">D020615</a>	Lower Blade
4	Ea	Various	HLTS Blade Clamp, Lower Blade, Outside
10	Ea	NA	Flat Washer ¼" SSTL
4	Ea	<a href="#">D020653</a>	Screwdrive Block
8	Ea	NA	Socket Head Cap Screw 8-32 x 1.0" <b>AgPlated</b>
4	Ea	NA	Socket Head Cap Screw ¼-20 x 1.125" <b>AgPlated</b>
1	Ea	<a href="#">D030139</a>	Roll Offset, Upper Mass T-Piece
2	Ea	NA	Socket Set Screw ¼-20 x 0.5" <b>AgPlated</b>
4	Ea	NA	Socket Head Cap Screw ¼-20 x 2.0" SSTL
4	Ea	NA	Hex Nut ¼-20 <b>AgPlated</b>
9	Ea	<a href="#">D1001699</a>	Magnet Holder, HLTS BOSEM
18	Ea	NA	Socket Head Cap Screw 4-40 x 0.625" <b>AgPlated</b>
9	Ea	<a href="#">D1001695</a>	Magnet / Flag Assembly
2	Ea	<a href="#">D070340</a>	<b>HLTS Upper Wire Assemblies</b>
4	Ea	<a href="#">D070393</a>	<b>HLTS Intermediate Wire Assemblies</b>
1	Ea	NA	Machinist's Square
			<b>Components Added Only for Weighing</b>
2	Ea	<a href="#">D020652</a>	Upper Mass C-Clamp
2	Ea	<a href="#">D020610</a>	Inside Upper Wire Lower Clamp
2	Ea	<a href="#">D020624</a>	Outside Upper Wire Lower Clamp
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" <b>AgPlated</b>
4	Ea	NA	Socket Head Cap Screw 8-32 x 1.125" SSTL
4	Ea	NA	Flat Washer #8 SSTL
1	Ea	<a href="#">D070449</a>	<b>HLTS Coil Holder</b>
8	Ea	NA	Socket Head Cap Screw 4-40 x 0.25" <b>AgPlated</b>
4	Ea	NA	Flat Washer #4, <b>Vented</b> , SSTL



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

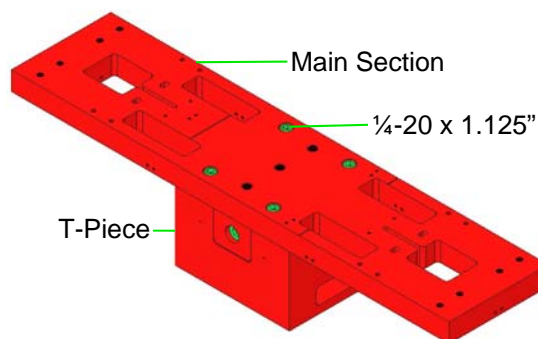
### Assembly Instructions

Qty	U	ID	Description
2	Ea	<a href="#">D020660</a>	<b>Lower Blade Pulldown Device</b> <ul style="list-style-type: none"><li>6.092 kg Hang Weight</li><li>Lower Blade Wire Clamp from Intermediate Wire Assembly</li><li>8 Socket Head Cap Screw 4-40 x 0.25" <b>AgPlated</b></li><li>Music wire .008" dia. minimum, about 18" long, clamped at one end, and with a small loop tied in the other.)</li></ul>

### 16.3 Procedure

31. Assemble to the [D020605](#) Upper Mass Main Section:

- [D020607](#) Upper Mass T-Piece
- 4 Socket Head Cap Screws  
1/4-20 x 1.125" **AgPlated**  
Torque to **100 in-lb**



32. Assemble to the [D1001669](#) Pitch Insert:

- 1 Socket Set Screw  
1/2-20 x 3.5" **AgPlated**

33. Assemble to the T-Piece:

- 1 [D1001669](#) Pitch Insert  
**Center the Insert within the T-Piece**
- 2 Socket Set Screws  
1/4-20 x 1.5" **AgPlated**

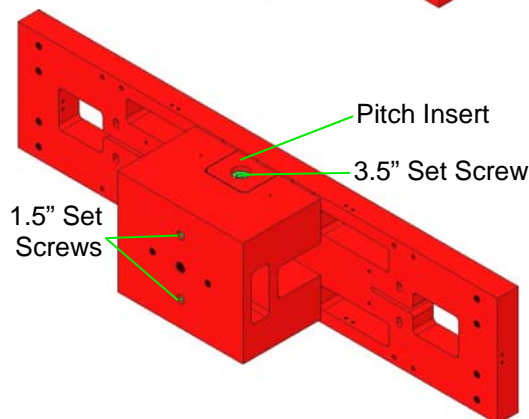


Fig 38: T-Piece Assembled to Main Section

34. Attach the [D040259](#) Upper Mass Jig to an Optics Table with a 1/4-20 Ag-Plated Bolt.

35. Thread the T-Piece onto the 1/4-20 stud at the top of the Jig.

The Jig will not be shown for the remainder of the assembly steps, but is necessary to secure the Upper Mass during the assembly process.

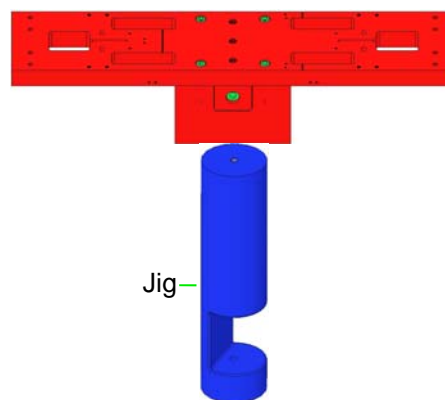


Fig 39: Upper Mass mounted on Jig





# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

Use safety glasses per E0900332.

Note: Blades are shown here as flattened, but are actually curved until weighted.

36. Per data in T0900559 Blade Pairings, retrieve:

- 4 **matched D020615** Lower Blades.
- 4 pair (Upper/Lower) of Lower Blade Clamps, each pair with a Clamp angle corresponding to the Matched Blades chosen above. The **D0900681** Library of Clamps lists all Blade Clamp angles and part numbers.
- Identify the placement of the blades as follows:
  - Blade with highest tip in +X, +Y corner
  - Blade with next to highest tip in -X, +Y corner
  - Blade with next to lowest tip in +X, -Y corner
  - Blade with lowest tip in -X, -Y corner

37. Attach the 2 Clamp/Wire Assemblies from the Lower Blade Pulldown Device to the tip of each Blade.

- 2 D0901815 Upper Clamp, Int. Wire, Inside
- 2 D0901813 Upper Clamp, Int. Wire, Outside
- 4 Socket Head Cap Screw 4-40 x .375" **AgPlated**
- 4 Flat Washer #4 **Vented SSTL**
- 4 Socket Head Cap Screw 4-40 x .25" **AgPlated**

38. Assemble each Lower Blade as shown:

- 2 Socket Head Cap Screws ¼-20 x 1.25" **AgPlated** SSTL
- 2 Flat Washer ¼ **Vented** SSTL
- 1 Lower Blade Clamp, **Lower**
- 1 **D020615** Lower Blade
- 1 Lower Blade Clamp, **Upper**

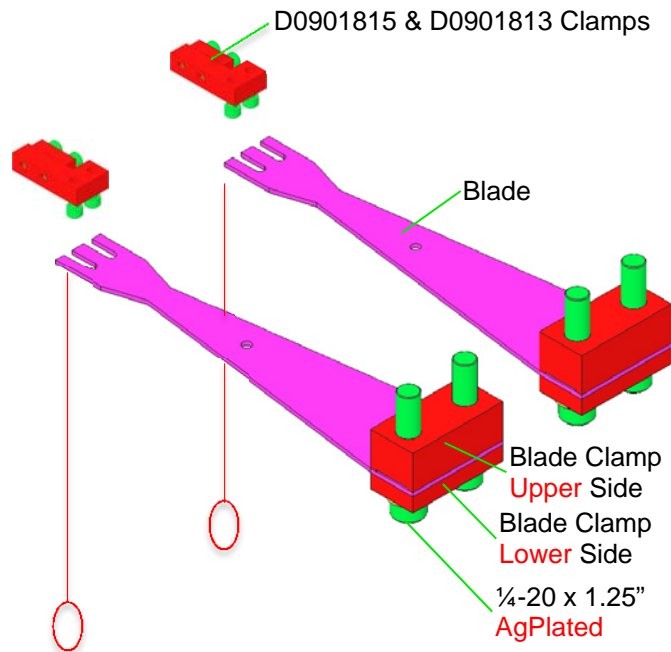


Fig 40: Weighting the Blades



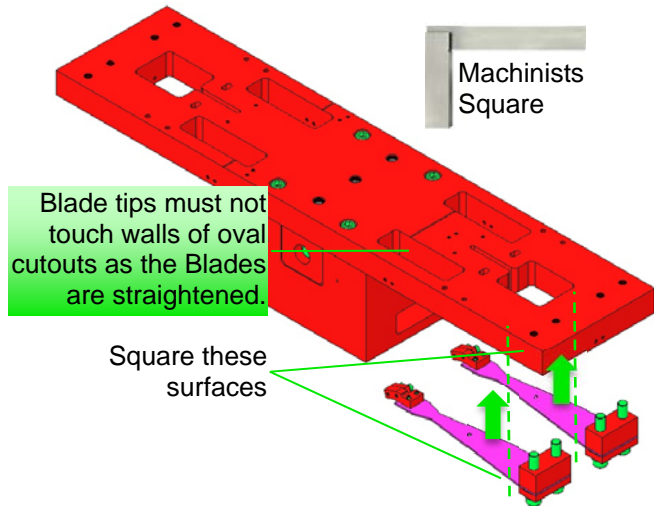
E080208	v15	D
Doc	Rev	Grp

# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

- 39. Attach the 2 Blade assemblies to the Upper Mass Main Section and snug the bolts finger-tight. Ensure the Blades are aligned such that the Blade tips can move through the oval cutouts without touching the cutout walls.
- 40. Use the Machinist's Square to ensure the Blades and Blade Clamps are square with the Main Section.

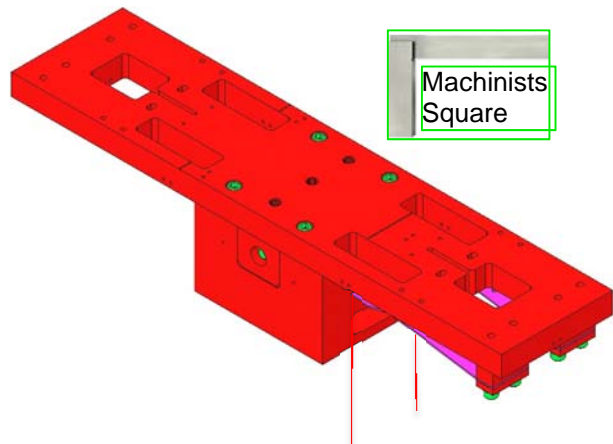


**Fig 41: Attaching the Blades**

- 41. Hang the 2 D020660 Pulldown Device Weights on the wire loops. The weight will pull the blade tip through the oval slot in the Upper Mass Main Section until the Blade is essentially flat.

Torque the 4 Screws to 100 in-lb.

**Be sure to Torque the Screws only after the Blades have been pulled down.**

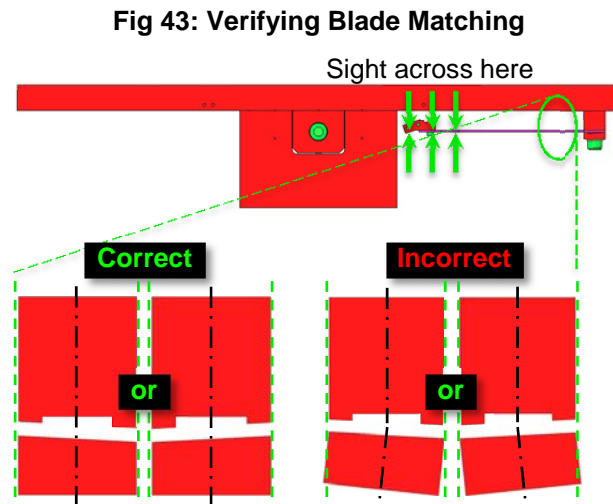


**Fig 42: Adding Weight to the Blades**

- 42. Visually verify that the profiles of pairs of Blades match  $\pm 0.5$  mm.

If the Blades are not of identical flatness within 1 mm, either the Blades or Blade Clamps must be replaced to achieve this flatness. Blade Clamps are available in angles from 0 – 3.5 deg.

When using Blade Clamp pairs other than 0 deg., CAREFULLY INSPECT CLAMP ORIENTATION to ensure the pairs are aligned so that the Clamp sidewalls are parallel (and therefore, the bolt holes are concentric).



**Fig 44: Upper & Lower Blade Clamp Alignment**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

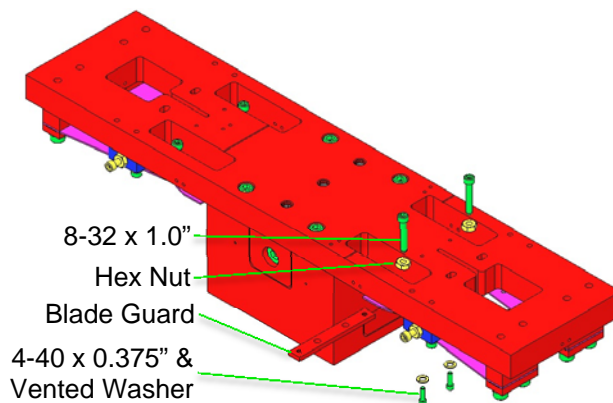
### Assembly Instructions

43. Assemble to 2 [D080221](#) Lower Blade Guards:

- 4 [D030025](#) Socket Head Cap Screws  
8-32 x 1.0" **Round Tip** SSTL
- 4 Hex Nuts 8-32 **AgPlated**

44. Attach the Blade Guards to the [D020605](#) Main Section using:

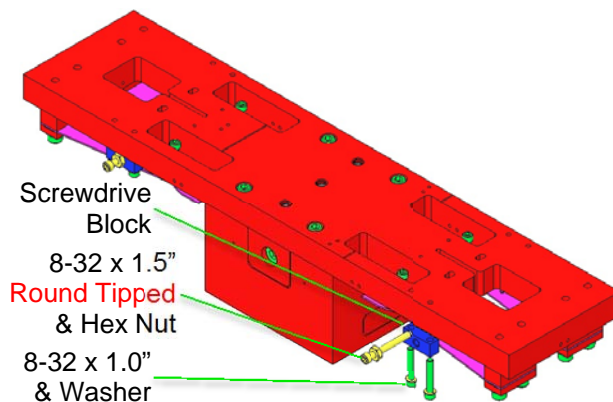
- 4 Socket Head Cap Screws  
4-40 x 0.375" **AgPlated**
- 4 Flat Washers #8 **Vented** SSTL



**Fig 45: Main Section with Blade Guards**

45. Assemble 4 sets of Screw Drives to the Upper Mass Main Section:

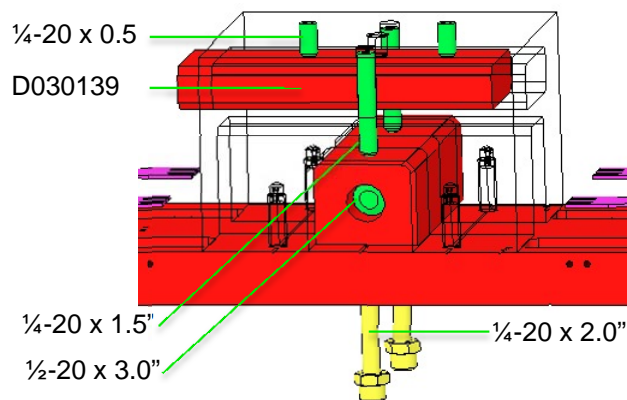
- 1 [D020653](#) Screwdrive Block
- 2 Socket Head Cap Screw  
8-32 x 1.00" **AgPlated**
- 2 Flat Washer #8 SSTL
- 1 Socket Head Cap Screw  
8-32 x 1.50" SSTL **Round Tipped**
- 1 Hex Nut 8-32 **AgPlated**  
Tighten Finger-Tight



**Fig 46: Screw Drives Installed**

46. Assemble to the T-Piece:

- [D030139](#) Roll Offset  
**Center the Offset within the T-Piece**
- 2 Socket Set Screw  
 $\frac{1}{4}$ -20 x 0.5" **AgPlated**
- [D1001669](#) Pitch Insert
- 1 Socket Set Screw  
 $\frac{1}{2}$ -20 x 3.0" **AgPlated**
- 2 Socket Set Screw  
 $\frac{1}{4}$ -20 x 1.5" **AgPlated**
- 2 Socket Head Cap Screw  
 $\frac{1}{4}$ -20 x 2.0" SSTL
- 2 Hex Nut  $\frac{1}{4}$ -20 **AgPlated**



**Fig 47: Roll Offset and Pitch Insert added**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

47. Assemble 9 assemblies to the Upper Mass Main Section, each with:

- 1 D1001699 Magnet Holder
- 2 Socket Head Cap Screws  
4-40 x 0.625" AgPlated  
Torque to 6 in-lb
- 1 D1001695 Magnet / Flag Assembly  
Leave off one of the end Magnet Flag assemblies until the Coil Holder has been assembled to the Upper Mass.

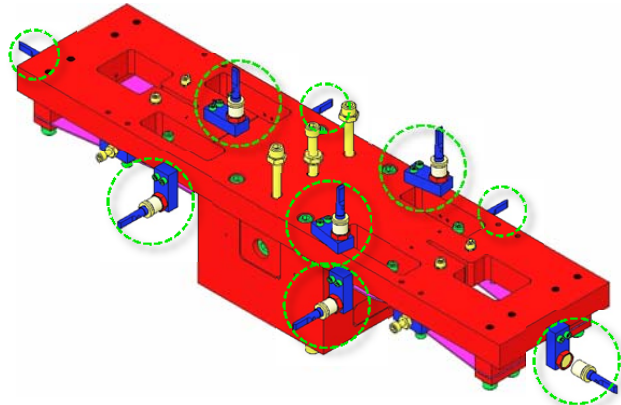


Fig 48: Magnet Assemblies added

48. Weigh the Upper Mass Assembly (including all 9 Magnet/Flag assemblies) along with these additional mass components:

#### 2 Upper Wire, Lower Clamp Assemblies

- 2 D020652 Upper Mass C-Clamps
- 2 D020610 Inside Upper Wire Lwr Clamp
- 2 D020624 Outside Upper Wire Lwr Clamp
- 4 Socket Head Cap Screw  
8-32 x 0.5" AgPlated
- 4 Flat Washer #8 Vented SSTL
- 4 Socket Head Cap Screw  
8-32 x 1.125" SSTL
- 4 Flat Washer #8 SSTL

#### 4 Int. Wire, Upper Clamp Assemblies

- 4 D070585 Upper Clamp, Inside
- 4 D070394 Upper Clamp, Outside
- 8 Socket Head Cap Screws  
4-40 x .375" AgPlated
- 8 Flat Washer #4 Vented
- 8 Socket Head Cap Screws  
4-40 x 0.25" AgPlated

#### Hardware for Additional Mass Disks

- 2 Socket Head Cap Screw  
¼-20 x 2.0" SSTL
- 2 ¼-20 Hex Nut AgPlated
- 2 Flat Washer ¼" SSTL
- Additional Mass Disks sufficient to bring the total mass to 12.087 kg. The additional mass should be divided equally between top disks and bottom disks.

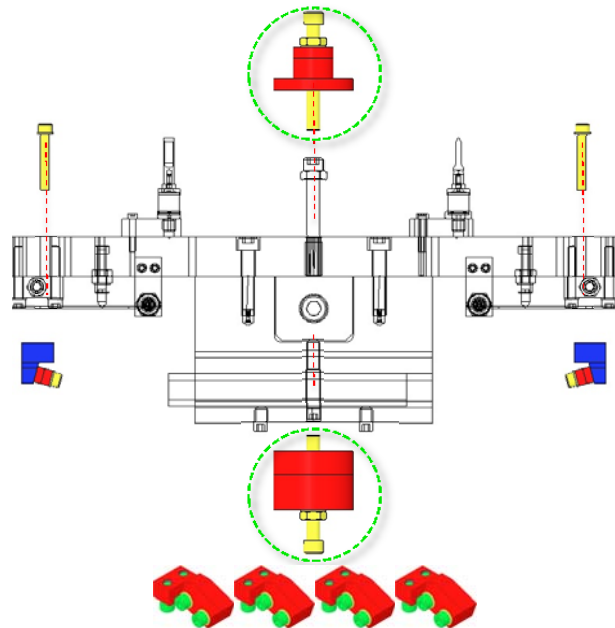


Fig 49: Weighing the Assembly

49. Record the actual mass, and the actual additional mass amount and locations, in ICS.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

50. Attach 2 Upper Wire Assemblies. Grasp the Upper Clamp end of each **D070340** Upper Wire Assembly and feed the Assemblies upwards through the outboard openings toward either end of the Upper Mass. Attach to the Upper Mass with:

- 4 Socket Head Cap Screws  
8-32 x 1.125" SSTL
- 4 **D1100785** Flat Washer #8 Nitronic 60

*If any Wire becomes bent during assembly, replace with another Wire Assembly.*

51. Attach 4 **D070393** Intermediate Wire Assemblies to the 4 Lower Blades, with:

- 8 Socket Head Cap Screw  
4-40 x 0.25" **AgPlated**  
Torque to **6 in-lb**

Fit the tab on the bottom of the Upper Clamp into a slot on the Lower Blade.

*If any Wire becomes bent during assembly, replace with another Wire Assembly.*

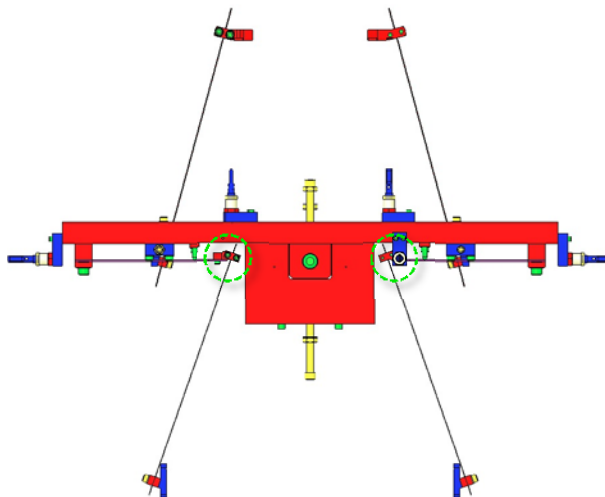


Fig 50: Intermediate Wire Assemblies added

52. Assemble 12 EQ Stops to the **D070449** Coil Holder:

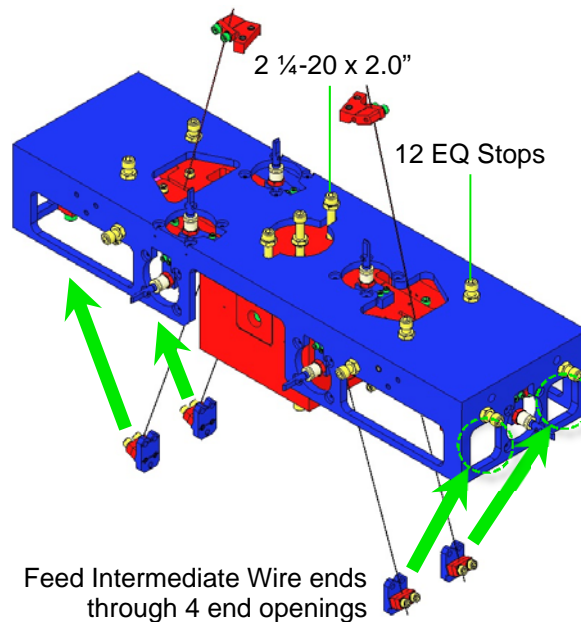
- 12 Socket Head Cap Screws  
 $\frac{1}{4}$ -20 x 1.0" **Fully-Threaded Round-Tip**  
SSTL
- Hex Nut  $\frac{1}{4}$ -20 **AgPlated**

53. Place the Coil Holder over the Upper Mass. Feed the Upper Wire Assemblies through the Coil Holder; feed the Intermediate Wires through the holes on the ends of the Coil Holder.

54. Assemble to the Upper Mass:

- 2 Socket Head Cap Screws
- $\frac{1}{4}$ -20 x 2.0" Fully-Threaded SSTL
- 4 Hex Nuts,  $\frac{1}{4}$ -20 **AgPlated**

Tighten the Hex Nuts to secure the Upper Mass to the Coil Holder.



Feed Intermediate Wire ends through 4 end openings

Fig 51: Coil Holder added



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 17 Assembling Magnets – Upper Mass

### 17.1 Documents

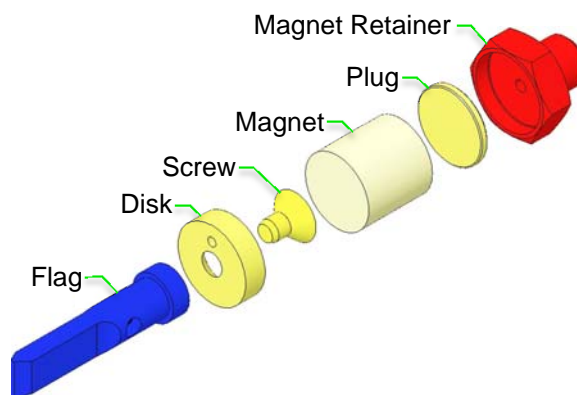
- [M0900034](#) RODA - Use of Magnets in Suspensions  
[D1001695](#) Magnet and Flag Assembly, BOSEM

### 17.2 Materials

Qty	U	ID	Description
9	Ea	<a href="#">D1100573</a>	BOSEM Flat Magnet Flag
9	Ea	<a href="#">D1100574</a>	BOSEM Flat Magnet Flag Disk
9	Ea	NA	Flat Head Socket Screw 4-40 x 0.1875" SSTL
9	Ea	DCNI 01888N	Sintered NdFeB Magnet, Ni Plated, 10mm x 5mm
9	Ea	<a href="#">D1001534</a>	BOSEM Magnetic Plug
9	Ea	<a href="#">D1001697</a>	HLTS BOSEM Magnet Retainer

### 17.3 Procedure – Assembly

- Assemble 9 [D1001695](#) BOSEM Magnet / Flag Assemblies, each with (shown left-to-right):
  - [D1100573](#) BOSEM Flat Magnet **Flag**
  - [D1100574](#) BOSEM Flat Magnet Flag **Disk**
  - Flat Head Socket Screw 4-40 x 0.1875" SSTL
  - Magnet** D394394N35UHP Sintered NdFeB Ni-Plated 10 mm x 10 mm
  - [D1001534](#) BOSEM Magnetic **Plug**
  - [D1001697](#) HLTS BOSEM Magnet Retainer



**Fig 52: HLTS BOSEM Magnet/Flag Assembly**

The Magnets attach the Flags to the Upper Mass. Since the Flags are aluminum and the Magnet Retainers are non-magnetic stainless steel, a magnetic 416 stainless steel Magnetic Plug is press-fit into each Flag and Magnet Retainer. The press-fitting operation must be done after all parts are cleaned and baked. The Press itself must be cleaned and/or wrapped in UHV foil.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

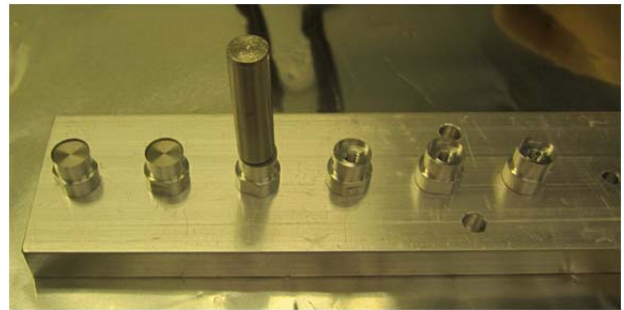
#### 17.4 Procedure – Plug Insertion

##### Procedure for assembling D1001534 Plug to Magnet Holder:

55. Heat Air Bake Oven to 70 c;
56. Attach Magnet Holders to Heating Fixture with:
  - Socket Head Cap Screw  
8-32 x 0.3125" SSTL  
**Screws must be Class A or B clean**
57. Place Heating Fixture in Oven for 10 min. minimum;
58. Remove Heating Fixture from Oven and inspect Magnet Holders for out-of-round condition, using tapered end of the Disk Insertion Tool to address any out-of-round conditions.
59. Place Disk on a Magnet Holder, Place non-tapered end of Disk Insertion Tool on Disk, and tap Insertion Tool until Disk is fully seated within Holder.
60. Return Heating Fixture to Oven for another 5 minutes, minimum.
61. Remove Heating Fixture from Oven, and repeat Step 5, above.
62. Remove Magnet Holders from Heating Fixture.



Fig 53: Heating Fixture with Holders



**Fig 54: Insertion Tool in position**

Note: Tapered end of Tool is up  
Note: Seated Disks on left 2 Holders



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

## 18 Assembling Intermediate Mass (M2)

### 18.1 Documents

D070334 HLTS Intermediate Mass Assembly

### 18.2 Materials

Qty	U	ID	Description
1	Ea	D070336	Main Section, Intermediate Mass
1	Ea	D080181	<b>Changer Assembly, Intermediate Mass</b>
1	Ea	D030155	Center Offset, Intermediate Mass
2	Ea	NA	Socket Head Cap Screw 8-32 x 0.75" SSTL
2	Ea	NA	Socket Head Cap Screw 8-32 x 0.75" AgPlated
X	Ea	D1001230	HLTS Additional Mass Disk 10g
X	Ea	D1001229	HLTS Additional Mass Disk 20g
X	Ea	D0901405	HLTS Additional Mass Disk 50g
X	Ea	D070333	HLTS Additional Mass Disk 100g
2	Ea	D030156	Side Offset, Intermediate Mass
4	Ea	NA	Socket Head Cap Screw ¼-20 x 1.5" Fully-Threaded SSTL
4	Ea	NA	Hex Nut ¼-20 AgPlated
4	Ea	NA	Flat Washer ¼ Vented SSTL
4	Ea	NA	Socket Head Set Screw ¼-20 x 0.50" AgPlated
2	Ea	NA	Socket Head Set Screw ¼-20 x 0.25" AgPlated
<b>Components for Weighing</b>			
4	Ea	D030149	Breakoff, Intermediate Wire
4	Ea	D070406	Lower Clamp, Intermediate Wire, Outside
4	Ea	D070405	Lower Clamp, Intermediate Wire, Inside
8	Ea	NA	Socket Head Cap Screw 8-32 x 0.625" SSTL
8	Ea	NA	Flat Washer #8 Vented SSTL
2	Ea	D030148	Lower Wire Breakoff
4	Ea	D070438	Upper Clamp, Lower Wire, Outside
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.5625" SSTL
4	Ea	NA	Flat Washer #8 Vented SSTL

### 18.3 Procedure

63. Assemble the D080181 Changer Assembly:

- D030155 Center Offset
- 300g nominal Upper Collar D080223
- 300g nominal Lower Collar D080232  
100g Collars shown
- Socket Head Cap Screw  
8-32 x 0.75" SSTL or AgPlated  
Use SSTL with Aluminum Collars  
Torque SSTL Screws to 20 in-lb  
Use AgPlated with SSTL Collars  
Torque AgPlated Screws to 30 in-lb

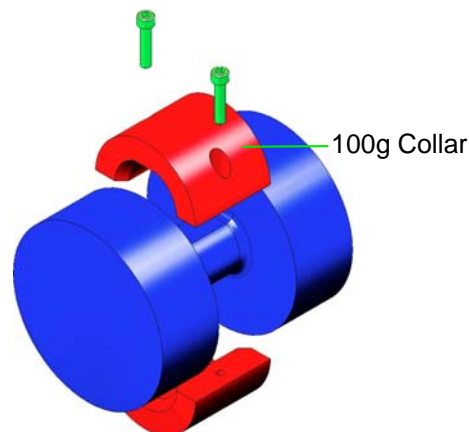


Fig 55: Changer Assembly





# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

64. Assemble 2 Side Offset assemblies, each with:

- 1 Side Offset [D030156](#)
- 2 Mass Disk [D070333](#) 100g **nominal**
- 2 Flat Washer ¼" **Vented** SSTL
- 2 Hex Nut ¼-20 **AgPlated**
- 2 Socket Head Cap Screw ¼-20 x 1.5" SSTL

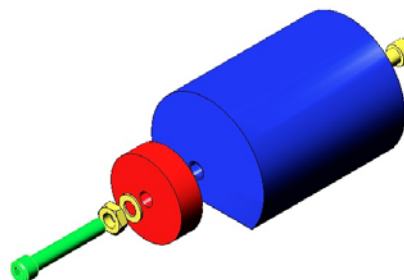


Fig 56: 1 of 2 Side Offset Assemblies

65. Slide the Changer Assembly and 2 Side Offsets into the [D070336](#) Main Section and secure with:

- 4 Socket Head Set Screw ¼-20 x 0.50" **AgPlated**
- 2 Socket Head Set Screw ¼-20 x 0.25" **AgPlated**

**Rotate Side Offsets so Mass Disks are toward the center, and Scribe Lines are aligned.**

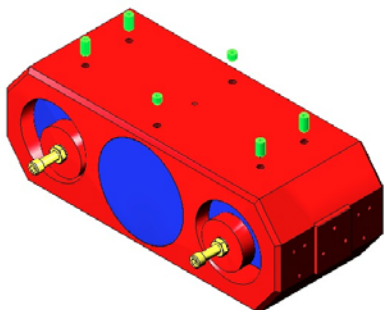


Fig 57: Changer and Offsets in Main Section

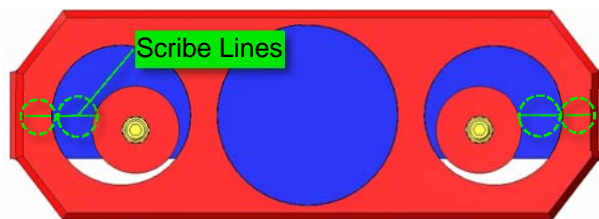


Fig 58: Completed Intermediate Mass Assembly

66. Weigh the completed Assembly along with:

- 4 [D030149](#) Breakoff, Intermediate Wire
- 4 [D070406](#) Lower Clamp, Intermediate Wire, Outside
- 4 [D070405](#) Lower Clamp, Intermediate Wire, Inside
- 8 Socket Head Cap Screw 8-32 x 0.625" SSTL
- 8 Flat Washer #8 **Vented** SSTL
- 12 Socket Head Cap Screw 8-32 x .625" SSTL **AgPlated**
- 2 [D030148](#) Lower Wire Breakoff
- 4 [D070438](#) Upper Clamp, Lower Wire, Outside
- 4 Socket Head Cap Screw 8-32 x 0.5625" SSTL
- 4 Flat Washer #8 **Vented** SSTL
- 6 Socket Head Cap Screw 8-32 x .625" SSTL **AgPlated**
- 4 [D0901927](#) Magnets
- 4 [D970075](#) Magnet Standoffs

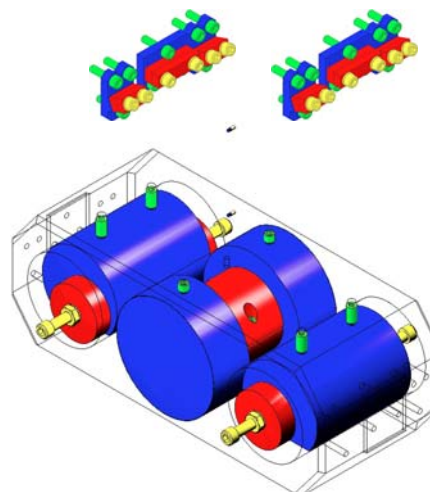


Fig 59: Items to Weigh

67. Swap Collars and Disks (red) to reach a total weight of **12.227 kg**. Record the total weight, noting changes in Disks or Collars. **Record the size and location of the added weights within ICS.**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 19 Assembling Bottom Mass and Optic (M3)

### 19.1 Documents

[D070337](#) HLTS Bottom Mass Assembly

### 19.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D070338</a>	Metal Bottom Mass
1	Ea	<a href="#">D0902658</a>	Optic Holder
1	Ea	<a href="#">D0902661</a>	Sapphire Prism Bonding Jig
4	Ea	<a href="#">D980184</a>	LOS Clamps, Long
2	Ea	<a href="#">D1100197</a>	Spacer
2	Ea	033-0280	Optosigma Mirrors
8	Ea	NA	Socket Head Cap Screw 4-40 x 0.5" <b>Vented</b> SSTL
2	Ea	<a href="#">D080124</a>	Prism Breakoff, Lower Wire, Lower Mass
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.75" SSTL
12	Ea	NA	Flat Washer #8 <b>Vented</b> SSTL
8	Ea	NA	Flat Washer #4 <b>Vented</b> SSTL
2	Ea	<a href="#">D0901286</a>	Secondary Metal Prism Breakoff
2		D070441	Sapphire Prism Breakoff

### 19.3 Procedure

68. Place the [D070338](#) Metal Bottom Mass, with the inscribed arrow on top of the Mass, pointing away from the glued-on Dumbbell Magnets, into the [D0902658](#) Optic Holder.

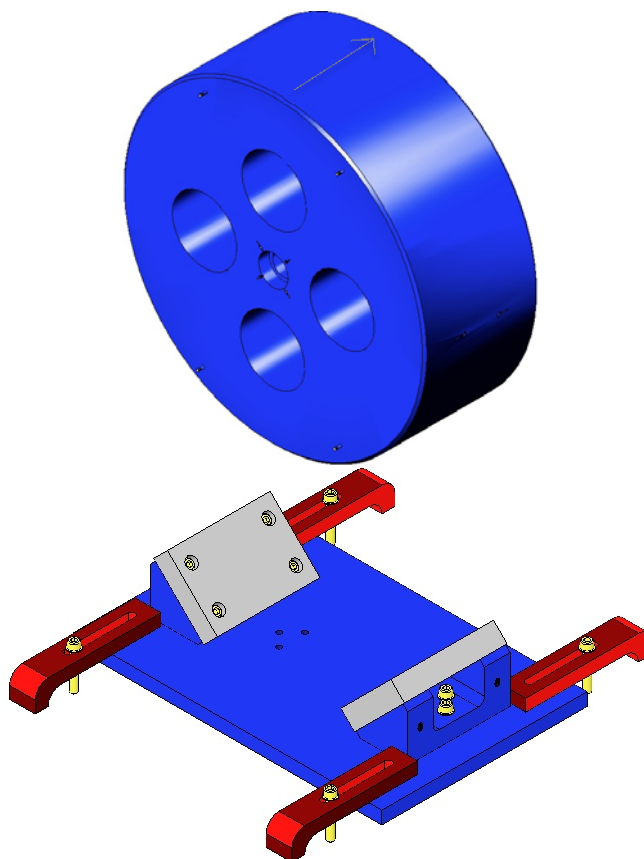


Fig 60: Optic Holder and Bottom Mass

# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

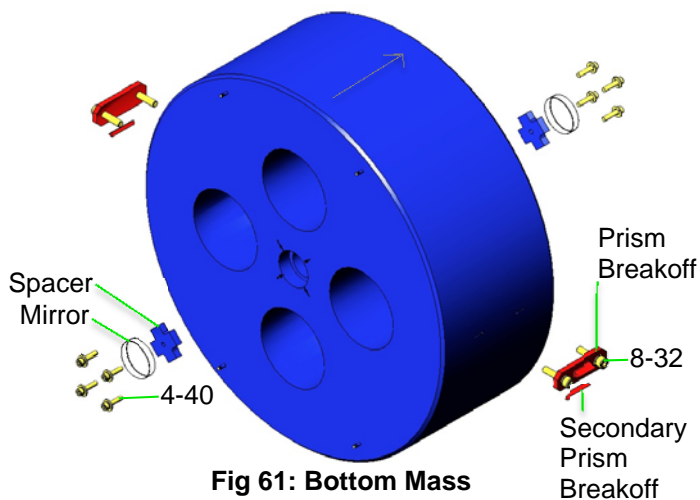
69. Assemble to the Bottom Mass:

- 2 D1100197 Spacers
- 2 033-0280 Optosigma Mirrors
- 8 Socket Head Cap Screws 4-40 x 0.5" Vented SSTL
- 8 Flat Washer # 4 Vented SSTL Torque to 7 in-lb
  
- 2 D080124 Prism Breakoffs
- 4 Socket Head Cap Screws 8-32 x 0.75 SSTL
- 4 Flat Washers #8 Vented SSTL Torque to 25 in-lb

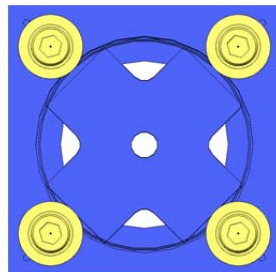
The Spacer wings must be aligned with the Screw locations.

Mirror Arrow must face outwards.

Be especially careful not to damage the glued magnet/dumbbell assemblies.

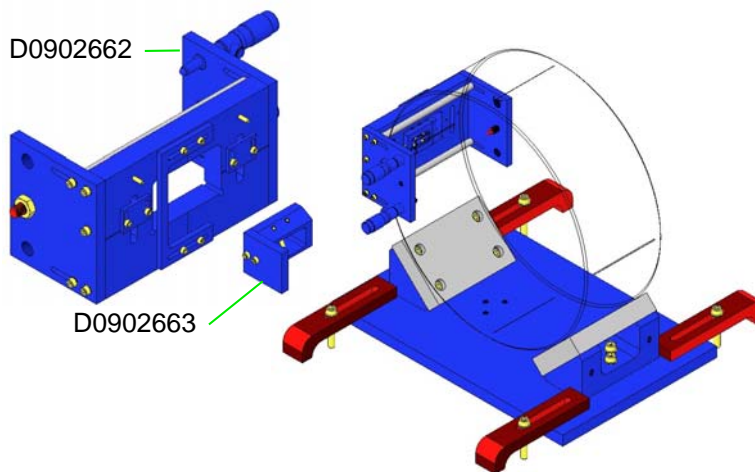


**Fig 61: Bottom Mass**



**Fig 62: Orientation of Spacer**

The fixture is used to attach the Sapphire Prism Breakoff (D070441) to the fused silica optics. The Sapphire Prism Placement Fixture is made up of the Optic Holder (D0902658) and the Sapphire Prism Bonding Jig (D0902661). The Sapphire Prism Bonding Jig itself is made up of the Sapphire Prism Bonding Fixture (D0902662) and the Sapphire Prism Holder Assembly (D0902663).



**Fig 63: Sapphire Prism Bonding Jig**

70. With the assembly process complete, weigh the Bottom Mass Assembly with the D0901286 Secondary Metal Prism Breakoffs; the combined weight should be 12.142 kg. Record this value in ICS. The Bottom Mass is not designed to be weight-adjusted; weight is added to or subtracted from the Intermediate Mass. So adjusting Bottom Mass weight is actually adjusting the combined weight of the Intermediate and Bottom Masses, a total of 12.227 + 12.142 kg = 24.369 kg.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

## 20 Installing Top Blade Guards

## 21 Installing Rotational Adjusters and Top Blade Guards

### 21.1 Documents

[D070442](#) HLTS Overall Assembly

### 21.2 Materials

Qty	U	ID	Description
2	Ea	<a href="#">D020660</a>	<b>Blade Pulldown Device</b>
2	Ea	<a href="#">D0901814</a>	Upper Clamp, Inside, <b>Class B Clean</b>
2	Ea	<a href="#">D070341</a>	Upper Clamp, Outside, <b>Class B Clean</b>
1	Roll	NA	Music Wire 0.024" dia.
1	Btl	NA	Methanol
1	Btl	NA	Acetone
1	Btl	NA	Isopropanol
1	Spl	NA	Steel Music Wire, 0.0106" dia.
1	Pkg	NA	Lint-Free Wipes
8	Ea	NA	Socket Head Cap Screw 8-32 x 0.50" <b>AgPlated</b>
4	Ea	NA	Flat Washer #8 <b>Vented</b> SSSL
2	Ea	<a href="#">D1102119</a>	Blade Pulldown Support
1	Roll	NA	UHV Aluminum Foil
2	Ea	<a href="#">D070308</a>	<b>HLTS Top Blade Guard Assembly</b>
16	Ea	NA	Socket Head Cap Screw 8-32 x 0.50" <b>AgPlated</b>
16	Ea	NA	Flat Washer #8 <b>Vented</b> SSSL
2	Ea	<a href="#">D070326</a>	<b>HLTS Rotational Adjuster</b>
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.75" SSSL <b>HoloKrome</b>
4	Ea	NA	Flat Washer #8 <b>Vented</b> SSSL

### 21.3 Procedure

71. Prepare 2 [D020660](#) Blade Pulldown Devices, each with:

- 1 [D0901814](#) Upper Clamp, Inside
- 1 [D070341](#) Upper Clamp, Outside
- 2 Socket Head Cap Screw 8-32 x 0.5" **AgPlated**
- 2 Flat Washer #8 **Vented**, SSSL
- 3' of 0.024" Wire.  
**Clean the Wire per Section 12.4.**

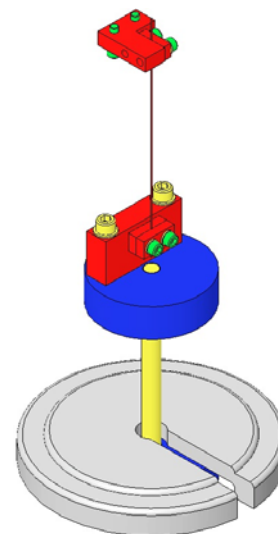


Fig 64: Blade Pulldown Device



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

72. Assemble the [D070308](#) Top Blade Guard Assembly to the [D070442](#) Structural Weldment using:

- 16 Socket Head Cap Screws  
8-32 x 0.5" **AgPlated**
- 16 Flat Washers #8 **Vented**, SSSL  
Torque to **30 in-lb**

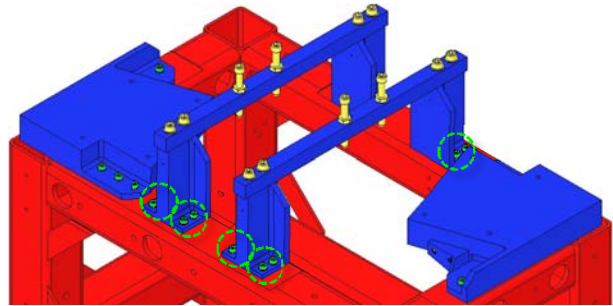


Fig 65: Top Blade Guards installed

73. Remove the [D070310](#) Bars.

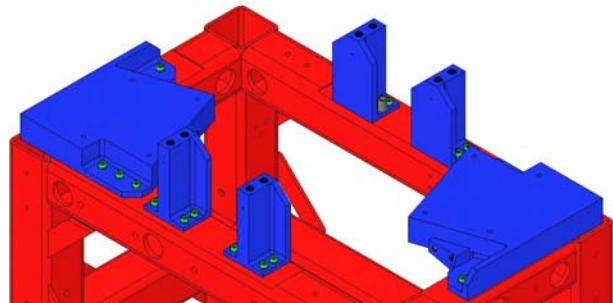


Fig 66: Bars removed

74. Install the 2 [D070326](#) Rotational Adjusters to the Mounting Pads, using for each:

- 4 Socket Head Cap Screws  
8-32 x 0.75" SSSL  
**Use HoloKrome Screws**
- 4 Flat Washer #8 **Vented**, SSSL  
Torque to **30 in-lb**

**Record the serial number and location of both Upper Blades in ICS in the RA assembly load.**

The Blades are shown here as flat, but are actually curved upward.

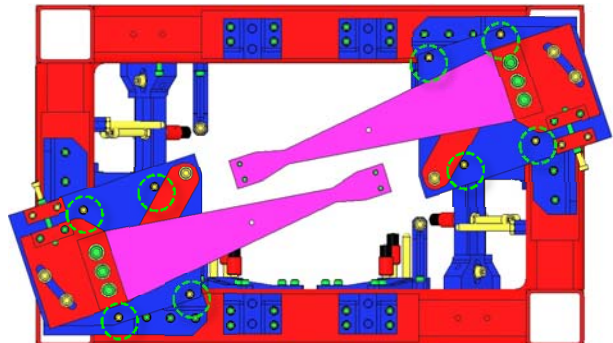


Fig 67: Rotational Adjusters Installed



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

**Wear proper safety glasses per E1000043.**

75. Attach the 2 [D1102119](#) Blade Pulldown Supports to the Weldment location shown; that is, in the center of the end Weldment cross member, with the Clevis extending outboard.
76. Cover each end of the Weldment Structure and surrounding Optical Table areas with UHV Aluminum Foil, to protect them from the dirty Pulldown Device.

**2 workers required:**

77. 1<sup>st</sup> person holds the Pulldown Weight.
78. 2<sup>nd</sup> person passes Wire Clamp of the Pulldown Device through the Weldment side opening, up toward the Upper Blade Tip, then attaches the Clamp to the Blade tip with:
  - 2 Socket Head Cap Screws  
8-32 x 0.50" **AgPlated**
79. 1<sup>st</sup> person gently drapes the wire over the Clevis, and slowly releases the Weight.
80. Repeat Steps 7-9 for the second Pulldown Device.

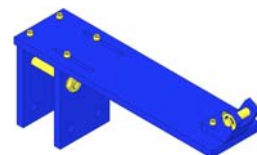
81. Re-Assemble the 2 [D070310](#) Top Blade Guard Bars to the Risers, using for each:

- 4 Socket Head Cap Screws  
¼-20 x 1.0" SSSL  
Torque to **75 in-lb**

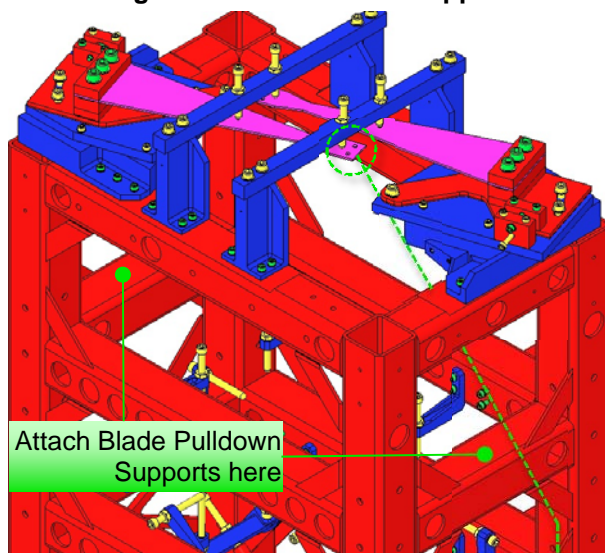
**Ensure the Bars are oriented with the EQ Stop Screws directly over the Blades.**

**The EQ Stop Screws should be adjusted so the Blades are flat. Once adjusted, the Screws should be secured with the Hex Nuts.**

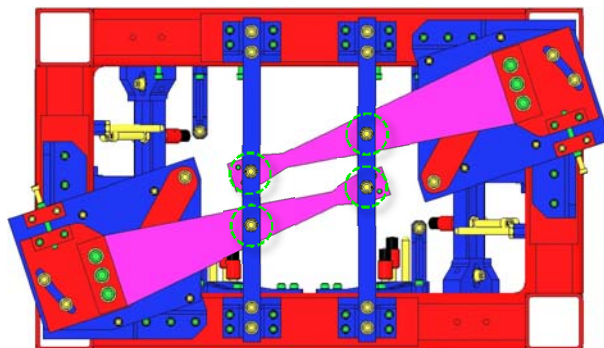
82. Carefully remove the 2 Blade Pulldown Devices.
83. Remove the 2 Blade Pulldown Supports.



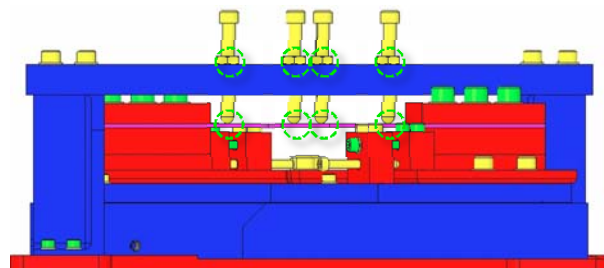
**Fig 68: Blade Pulldown Support**



**Fig 69: Location of Blade Pulldown Support**



**Fig 70: Top View: Screws centered over Blades**



**Fig 71: End View: Screws adjusted and secured**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 22 Installing EQ Stop Mounts and Brackets

### 1.2 Documents

[D070442](#) HLTS Overall Assembly

### 22.1 Materials

Qty	U	ID	Description
10	Ea	<a href="#">D080726</a>	HLTS EQ Stop, Long Mount
8	Ea	<a href="#">D080727</a>	HLTS EQ Stop, Long Bracket
2	Ea	<a href="#">D080728</a>	EQ Stop Assembly, Upper, Bottom Mass
4	Ea	<a href="#">D1002821</a>	EQ Stop Assembly, Bottom Mass, Lower
4	Ea	<a href="#">D1102071</a>	EQ Stop Assembly, Bridge, Upper
52	Ea	NA	Socket Head Cap Screws 8-32 x 0.5" <b>AgPlated</b>
52	Ea	NA	Flat Washers #8 SSTL
4	Ea	NA	Socket Head Cap Screws 8-32 x 0.5" <b>Vented AgPlated</b>
4	Ea	NA	Flat Washers #8 <b>Vented</b> SSTL



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 22.2 Procedure

84. Attach 2 D1002821 Short Brkt EQ Stops to the inside **front** of the Weldment, using:

- 4 Socket Head Cap Screw 8-32 x 0.5" **Vented, AgPlated**
- 4 Flat Washer #8 SSTL
- Torque to **30 in-lb**

85. Attach the following, using:

- 52 Socket Head Cap Screws 8-32 x 0.5" **AgPlated**
- 52 Flat Washers #8 SSTL
- Torque to **30 in-lb**
- 6 D080726 Long Mount EQ Stops to the inside **front** of the Weldment
- 2 D080726 Long Mount EQ Stops to the inside **rear** of the Weldment
- 4 D080727 Long Brkt EQ Stops to the inside **front** of the Weldment
- 4 D080727 Long Brkt EQ Stops to the inside **rear** of the Weldment
- 2 D080728 Bottom Mass Upper EQ Stops to the inside **front** of the Weldment (replacing the lowest 2X D080726 shown in Figure 75); NOTE: these assemblies are canted outboard by 5 degrees, as shown by the threaded holes in the Structure.
- 4 D1102071 Bridge EQ Stops to the Weldment.

86. At the Bridge EQ Stops, torque the 8 ¼-20 Screws (assembled earlier) that attach the Crossbars to the Bridge pieces, to **75 in-lb**.

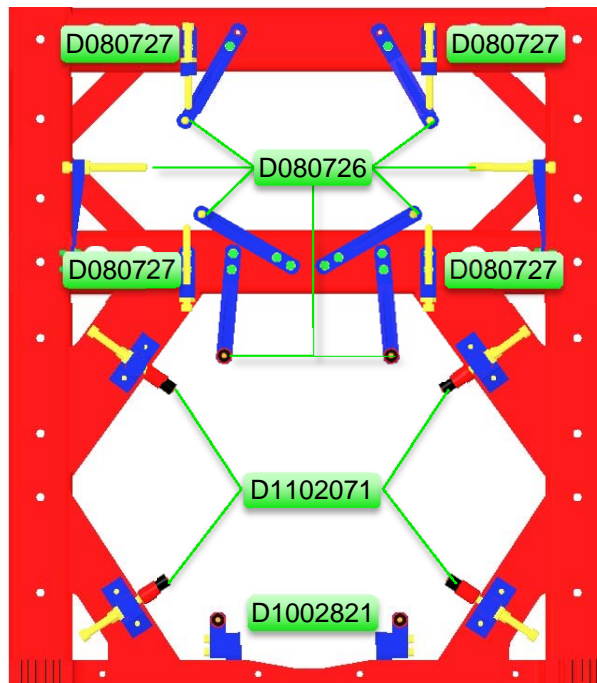


Fig 72: Facing Front from Inside of Weldment

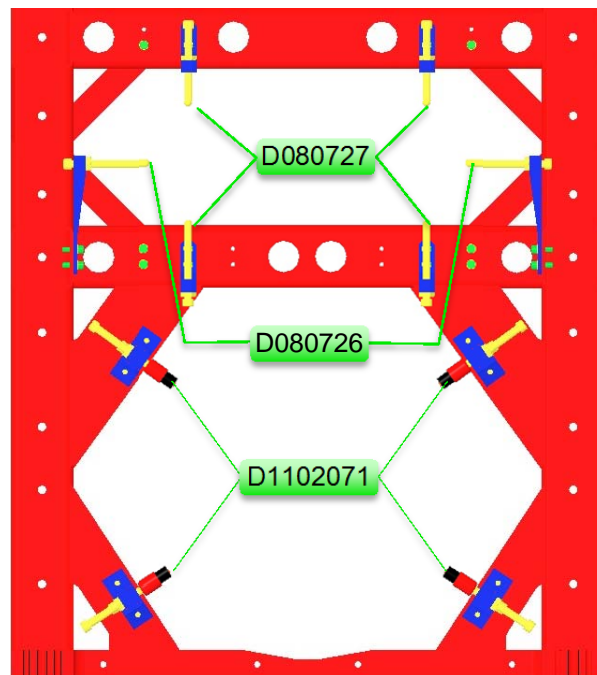


Fig 73: Facing Rear from Inside of Weldment





**SPECIFICATION**  
**HAM Large Triple Suspension (HLTS)**  
**Assembly Instructions**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 24 Assembling Intermediate Wires

### 24.1 Documents

[D070393](#) HLTS Intermediate Wire Assembly

### 24.2 Materials

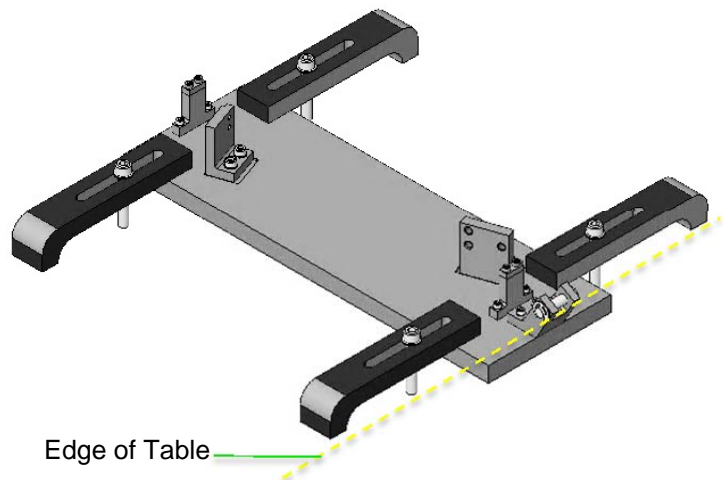
Qty	U	ID	Description
1	Ea	<a href="#">D0900630</a>	HLTS Intermediate Wire Jig
4	Ea	<a href="#">D980184</a>	LOS Clamps, Long
1	Ea	<a href="#">D070585</a>	Inside Upper Clamp
1	Ea	<a href="#">D070394</a>	Outside Intermediate Wire Upper Clamp
1	Ea	<a href="#">D030149</a>	Intermediate Wire Breakoff
1	Ea	<a href="#">D070405</a>	Inside Intermediate Wire Lower Clamp
1	Ea	<a href="#">D070406</a>	Outside Intermediate Wire Lower Clamp
2	Ea	NA	Socket Head Cap Screw 4-40 x 0.5" SSTL
3	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" SSTL
2	Ea	NA	Socket Head Cap Screw 4-40 x 0.375 <b>AgPlated</b>
2	Ea	NA	Flat Washer #4 <b>Vented</b> SSTL
2	Ea	NA	Socket Head Cap Screw 8-32 x 0.625" SSTL
2	Ea	NA	Flat Washer #8 <b>Vented</b> SSTL
2	Ea	1185-2EN164	Helicoil 8-32 x .164" Nitronic 60
2	Ea	1185-04EN224	Helicoil 4-40 x .224" Nitronic 60
1	Btl	NA	Methanol
1	Btl	NA	Acetone
1	Btl	NA	Isopropanol
1	Spl	NA	Steel Music Wire, 0.0134" dia.
1	Pkg	NA	Lint-Free Wipes
1	Ea	NA	Class B Wire Cutters
1	Ea	NA	Hang Weight, 1 Kg, or D020660 Blade Pulldown Device
4	Ea	NA	Large Test Weights, 10, 5, 2, 1 Kg
1	Ea	NA	Small Test Weight Set, 1 to 500 g

### 24.3 Procedure

4 Assemblies are required per HLTS.

**Use safety glasses per E0900332.**

87. Attach the [D0900630](#) Jig to an Optical Table using the 4 [D980184](#) LOS Clamps. The end of the Jig with the Clevis and Pin must hang over the edge of the Table enough to provide clearance for the hanging weight.



**Fig 74: Jig**



# SPECIFICATION

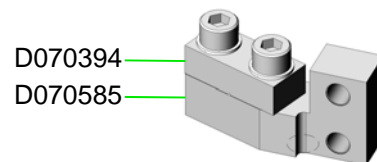
## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

88. Assemble all the Clamps you'll need; do not tighten the clamps.

Intermediate Wire Upper Clamp includes:

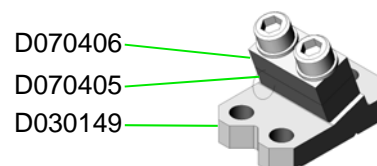
- 1 D070585 Intermediate Wire Upper Clamp, Inside
- 2 1185-04EN224 Helicoil 4-40 x .224"
- 1 D070394 Intermediate Wire Upper Clamp, Outside
- Socket Head Cap Screw  
2 4-40 x 0.375" AgPlated
- 2 Flat Washer #4 SSTL



**Fig 75: Upper Clamp**

Intermediate Wire Breakoff Assembly includes:

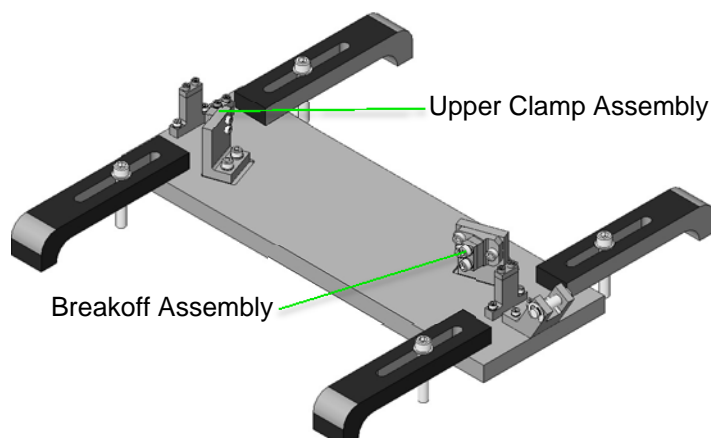
- 1 D030149 Intermediate Wire Breakoff
- 1 D070405 Intermediate Wire Lower Clamp, Inside
- 2 1185-2EN164 Helicoil 8-32 x .164"
- 1 D070406 Intermediate Wire Lower Clamp, Outside
- 2 Socket Head Cap Screw  
8-32 x 0.625" SSTL
- 2 Flat Washer #8 SSTL



**Fig 76: Breakoff**

89. Attach to the Jig:

- 1 Upper Clamp Assembly
- 2 Socket Head Cap Screw  
4-40 x 0.5" SSTL
- 1 Breakoff Assembly
- 3 Socket Head Cap Screw  
8-32 x 0.5" SSTL



**Fig 77: Clamps Attached to Jig**

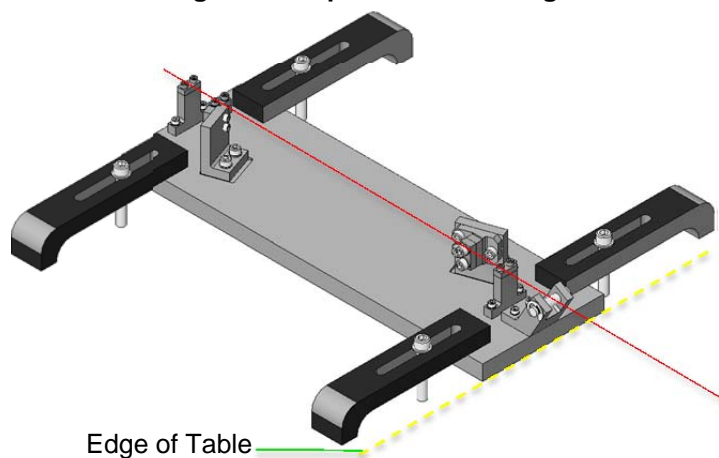
90. Cut 24" of 0.0134" diameter Steel Music Wire.

91. Clean the Wire per Section 12.4.

92. Feed the Wire through each set of 4 Clamps. Allow the extra Wire to hang over the edge of the Table.

93. Tighten the Screws on the Wire Start Clamp farthest from the Table edge.

**Ensure Wire is secured within the Clamp groove.**



**Fig 78: Wire Path**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

94. Tie a small loop in the end of the Wire hanging off the Table and hang the 1 kg Hang Weight or Pulldown Device from the loop. Add additional weights to the Hanger for a total of 6.092 kg. Then change gloves, since the weights are not clean.

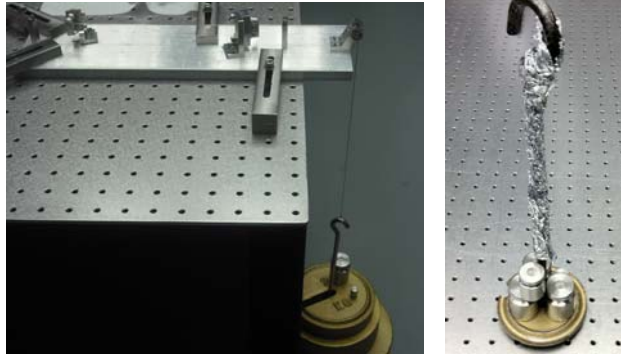


Fig 79: Hang Weight in use

95. Wait 5 minutes for the wire to come to equilibrium. Tighten the screws on each of the 3 remaining wire clamps in the order shown.

- 4-40 Screws: Torque to 6 in-lb
- 8-32 Screws: Torque to 30 in-lb

**During tightening:**

- Ensure Wire is secured within the grooves of each Clamp.
- Ensure Clamp halves are aligned with each other by using a Precision Square.

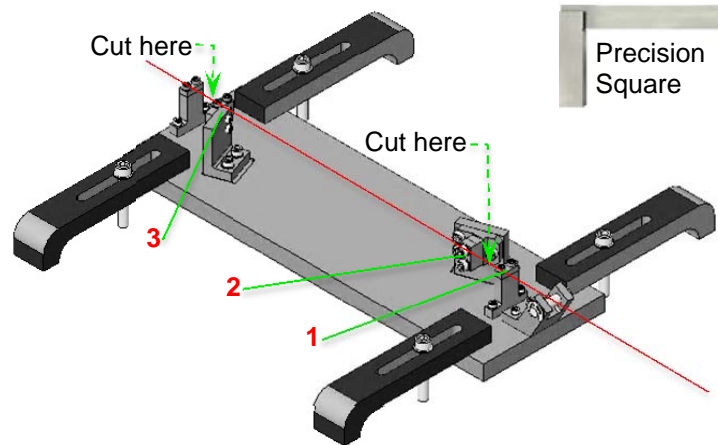


Fig 80: Cutting the Wires

96. Remove the Hang Weight and cut the Wire in the locations shown. Change gloves since the weights are not clean.
97. Loosen the Screws on the Wire Clamps on the jig and discard the leftover Wire.
98. Remove the screws holding the Intermediate Wire Assembly to the Intermediate Wire Jig. Bend back the ends of the wire to eliminate sharp points.
99. Measure the Wire length between Clamps to confirm that it is 203.60mm.



Fig 81: Completed Intermediate Wire Assembly



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 25 Assembling Upper Wires

### 25.1 Documents

[D070340](#) HLTS Upper Wire Assembly

### 25.2 Materials

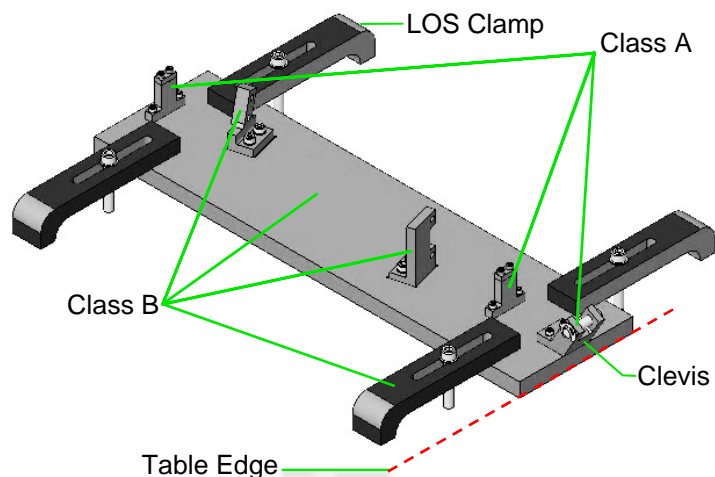
Qty	U	ID	Description
1	Ea	<a href="#">D0900594</a>	HLTS Upper Wire Assembly Jig
4	Ea	<a href="#">D980184</a>	LOS Clamps, Long
1	Ea	<a href="#">D020611</a>	Upper Clamp, Upper Wire, Inside
1	Ea	<a href="#">D020652</a>	C-Clamp, Upper Mass
1	Ea	<a href="#">D070341</a>	Upper Clamp, Upper Wire, Outside
1	Ea	<a href="#">D020610</a>	Upper Wire, Lower Clamp, Inside
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.625" SSTL
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" <b>AgPlated</b>
4	Ea	NA	Flat Washer #8 <b>Vented</b> SSTL
4	Ea	1185-2EN246	Helicoil 8-32 x .246"
1	Ea	NA	Hang Weight, 1 Kg, or D020660 Blade Pulldown Device
4	Ea	NA	Large Test Weights, 10, 5, 2, 1 Kg
1	Ea	NA	Small Test Weight Set, 1 to 500 g
1	Btl	NA	Methanol
1	Btl	NA	Acetone
1	Btl	NA	Isopropanol
			Steel Music Wire, 0.024" dia.
			Lint-Free Wipes
			Class B Wire Cutters

### 25.3 Procedure

2 Assemblies are required per HLTS.

**Use safety glasses per E0900332.**

1. Ensure the [D0900594](#) Assembly Jig has been cleaned Class B per [E960022](#).
2. Ensure Jig is fully assembled per the drawing.
3. Attach the [D0900594](#) Jig to an Optical Table using the 4 [D980184](#) LOS Clamps. The end of the Jig with the Clevis and Pin must hang over the edge of the Table enough to provide clearance for the hanging weight.



**Fig 82: Jig**



# SPECIFICATION

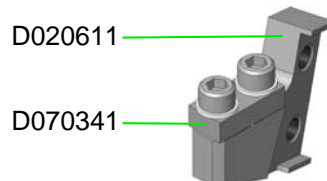
## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

4. Assemble all the Clamps you'll need; do not tighten the clamps.

Upper Wire Upper Clamp includes:

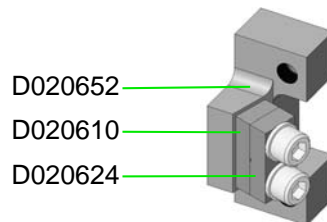
- 1 **D020611** Upper Wire Upper Clamp, Inside
- 2 1185-2EN246 Helicoils 8-32 x .246"
- 1 **D070341** Upper Wire Upper Clamp, Outside
- Socket Head Cap Screw  
2 8-32 x 0.5" **AgPlated**
- 2 Flat Washer #8 **Vented SSSL**



**Fig 83: Upper Clamp**

Upper Wire C-Clamp Assembly includes:

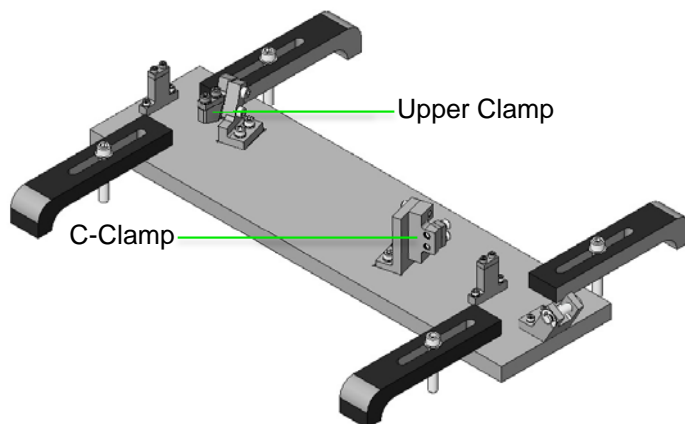
- 1 **D020652** Upper Mass C-Clamp
- 1 **D020610** Upper Wire Lower Clamp, Inside
- 2 1185-2EN246 Helicoil 8-32 x .246"
- 1 **D020624** Upper Wire Lower Clamp, Outside
- 2 Socket Head Cap Screws  
8-32 x 0.5625" SSSL
- 2 Flat Washer #8 **Vented SSSL**



**Fig 84: C-Clamp**

5. Attach to the Jig:

- 1 Upper Clamp Assembly
- 2 Socket Head Cap Screws  
8-32 x 0.625" SSSL
- 1 C-Clamp Assembly with
- 2 Socket Head Cap Screws  
8-32 x 0.625" SSSL



**Fig 85: Clamps on Jig**

6. Cut a 36" of 0.024" diameter Wire from the spool.

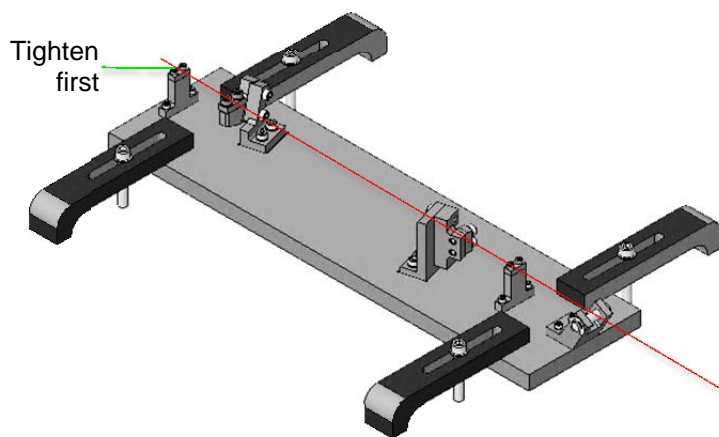
7. Clean the Wire per Section 12.4.

8. Feed the Wire through the Clevis and Clamps, as shown:

- Over Clevis Pin
- 1<sup>st</sup> Start Post;
- L-Clamp;
- C-Clamp;
- 2<sup>nd</sup> Start Post

9. Tighten the 2<sup>nd</sup> Start Post Clamp, after feeding through about 1/2" of wire.

**Ensure Wire is secured within the Clamp groove.**



**Fig 86: Wire Path**

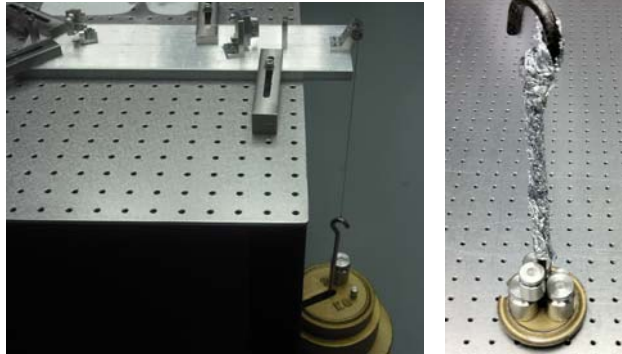


# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

10. Tie a small loop in the end of the wire hanging off the Table and hang the 1 kg Hang Weight. Add large and small weights for a total of 18.252 kg. Then change gloves, since the weights are not clean.

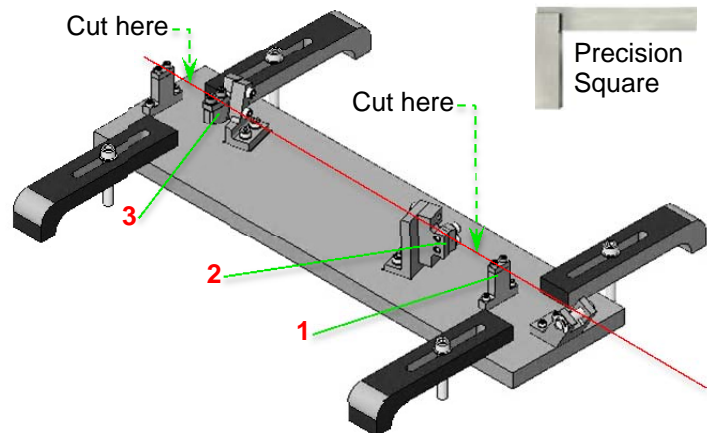
**Fig 87: Hang Weight in use**

11. Wait 5 minutes for the wire to come to equilibrium. Tighten the screws on each of the 3 remaining wire clamps in the order shown. Torque to 30 in-lb.

**During tightening:**

- Ensure Wire is secured within the grooves of each Clamp.
- Ensure Clamp halves are aligned with each other by using a Precision Square.

12. Remove the Hang Weight and cut the Wire in the locations shown. Change gloves since the weights are not clean.
13. Loosen the Screws on the Wire Clamps on the jig and discard the leftover Wire.
14. Remove the Screws holding the Upper Wire Assembly to the Upper Wire Jig. Bend back the ends of the wire to eliminate sharp points.
15. Measure the Wire length between Clamps to confirm that it is 202.50mm.

**Fig 88: Cutting the Wires****Fig 89: Upper Wire Assembly complete**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

## 26 Installing Upper Mass and Coil Holder

### 26.1 Documents

- [D070442](#) HLTS Overall Assembly  
[D1101493](#) HSTS / HLTS / OMCS OSEM Orientations

### 26.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D040259</a>	<b>Upper Mass Jig</b>
1	Ea	NA	<b>HLTS Upper Mass and Coil Holder Assembly from section 17, above</b>
12	Ea	NA	Socket Head Cap Screws 1/4-20 x 1.0" <b>Round-Tip</b> SSSL
14	Ea	NA	Hex Nut 1/4-20 <b>AgPlated</b>
5	Ea	Several	<b>HLTS Additional Mass Disks</b> (10g, 20g 50g 100g)
2	Ea	NA	Socket Head Cap Screw 1/4-20 x 2.0" SSSL
2	Ea	NA	Flat Washer 1/4" <b>Vented</b> SSSL
NA	Ea	<a href="#">D1002133</a>	<b>HLTS Coil Holder Bracket Assemblies</b>
4	Ea	<a href="#">D1002134</a>	Bracket Lateral Section
4	Ea	<a href="#">D1002135</a>	Bracket Longitudinal Section
8	Ea	NA	Socket Head Cap Screws 4-40 0.75" SSSL
8	Ea	NA	Flat Washer #4 <b>Vented</b> SSSL
12	Ea	NA	Socket Head Cap Screw 8-32 x 0.75" <b>AgPlated</b>
12	Ea	NA	Socket Head Cap Screw 8-32 x 0.625" SSSL
24	Ea	NA	Flat Washer #8 <b>Vented</b> SSSL

### 26.3 Procedure

The corner Brackets are shown here only for orientation and are not yet attached. Note the (2) Bracket Screws used for vertical adjustments.

100. Attach the [D040259](#) Jig to an Optics Table.
101. Remove but keep all Add-On hardware from the bottom of the Upper Mass T-Piece.
102. Attach the previously-assembled Upper Mass and Coil Holder (with 6 Wire assemblies) to the Jig. (Jig not shown here, but in section on Assembling Upper Mass).
103. Using the pair of 1/4-20 Screws at the top center, raise the Upper Mass completely into the Coil Holder, then tighten the Hex Nuts.
104. Remove the 4 side EQ Stop Screws and Hex Nuts.
105. Lock down the Upper Mass

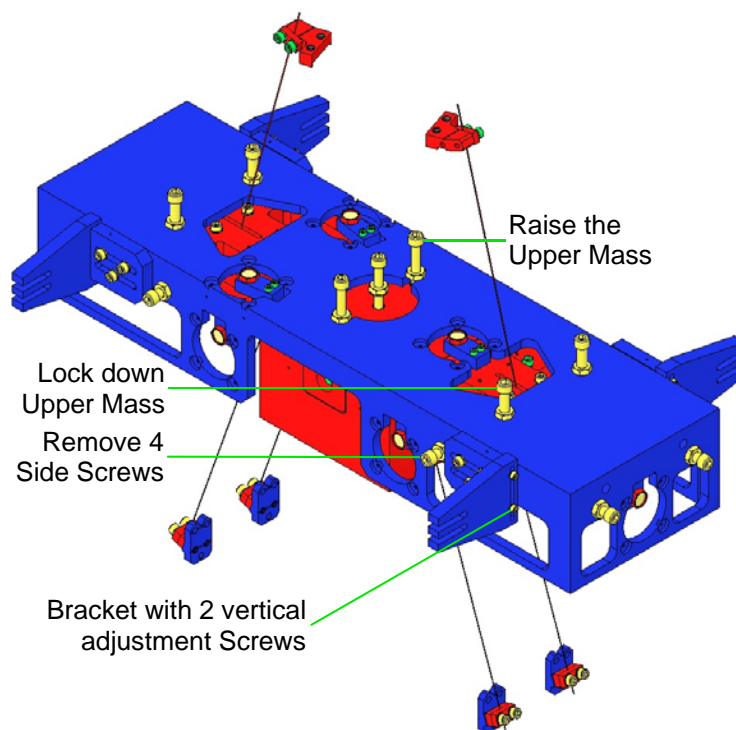


Fig 90: D1002133 Coil Holder Brackets (4)





# SPECIFICATION

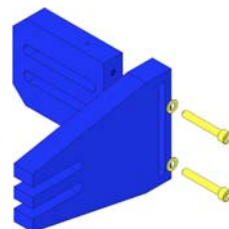
## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

with the remaining 8 EQ Stop Screws and Hex Nuts.

106. Assemble 4 **D1002133** HLTS Coil Holder Bracket Assemblies, each with:

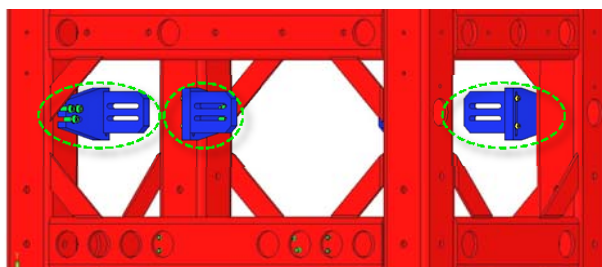
- 1 **D1002134** Lateral Section
- 1 **D1002135** Longitudinal Section
- 2 Socket Head Cap Screws 4-40 0.75" SSTL
- 2 Flat Washer #4 **Vented** SSTL
- Torque to **5 in-lb**



**Fig 91: Bracket Assembly**

107. Attach the 4 Brackets to the Weldment, using for each:

- 3 Socket Head Cap Screws 8-32 x 0.75" **AgPlated**
  - 3 Flat Washer #8 **Vented** SSTL
- Torque Screws after Coil Holder is installed and aligned.**



**Fig 92: Coil Holder Brackets Installed**

108. Insert the Upper Mass / Coil Holder Assembly through either narrow opening in the top section of the Weldment. **The pair of BOSEMS on top of the Assembly must be at the -Y side of the Suspension per D1101493 OSEM Orientations.**

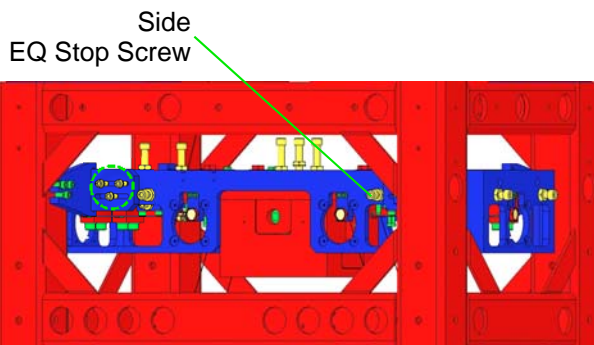
109. Assemble the Coil Holder to the 4 Brackets using at each Bracket:

- 3 Socket Head Cap Screws 8-32 x 0.625" SSTL
  - 3 Flat Washer #8 **Vented** SSTL
- Torque to 20 in-lb**

110. Back out each of the 4 lower Clamps of the Intermediate Wire Assemblies, back through the 4 end openings in the Coil Holder.

111. Re-assemble 4 EQ Stop Screws to the long sides of the Coil Holder, each using:

- 1 Socket Head Cap Screw ¼-20 x 1.0" **Round Tip** SSTL
- 1 Hex Nut ¼-20 **AgPlated**



**Fig 93: Upper Mass & Coil Holder Installed**



## SPECIFICATION

HAM Large Triple Suspension (HLTS)  
Assembly Instructions

112. Install the Additional Mass Disks on the top and bottom of the Upper Mass, as equally divided as possible; tighten the Hex Nuts to secure the Disks. Use:

- 2 Socket Head Cap Screw  
1/4-20 x 2.0" SSTL
- 2 1/4-20 Hex Nut **AgPlated**
- 2 Flat Washer 1/4" SSTL

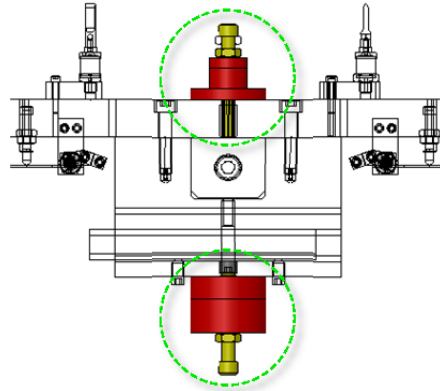


Fig 94: Additional Mass Disks Added



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 27 Installing the Intermediate Mass

### 27.1 Documents

[D070442](#) HLTS Overall Assembly

### 27.2 Materials

Qty	U	ID	Description
1	ea	<a href="#">D070334</a>	HLTS Intermediate Mass
1	Ea	<a href="#">D1102344</a>	HLTS Intermediate Mass Lifting Plate Assembly

### 27.3 Procedure

1. Raise the 4 bottom EQ Stops as far as possible.
2. Back off the 12 top, front and side EQ Stops

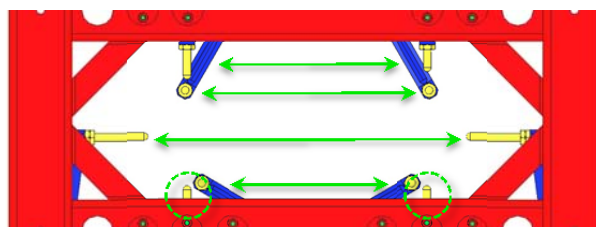


Fig 95: Rear View; EQ Stops prepared

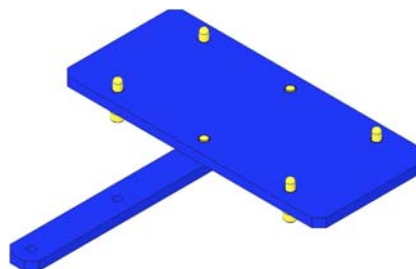


Fig 96: Lifting Plate

3. Using the [D1102344](#) Lifting Plate Assembly, insert the [D070334](#) Intermediate Mass assembly through the rear of the Weldment, ensuring the 4 Magnet assemblies are facing the rear. Center the assembly front-to-back and left-to-right on the bottom EQ Stops.

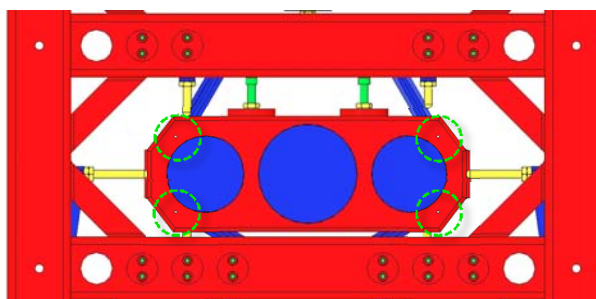
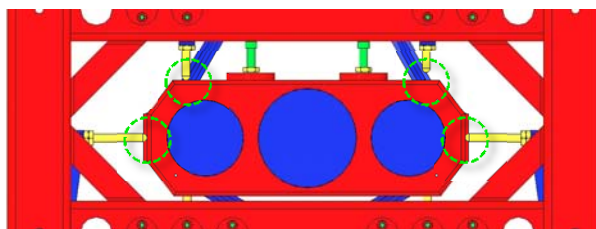


Fig 97: Rear View; Magnets facing rear

4. Lock down the Intermediate Mass assembly using the 8 top and side EQ Stops.





**SPECIFICATION**  
**HAM Large Triple Suspension (HLTS)**  
**Assembly Instructions**

**Fig 98: Rear View; Mass locked down**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 28 Assembling Lower Loop Wire

### 28.1 Documents

[D070436](#) HLTS Lower Loop Wire Assembly

### 28.2 Materials

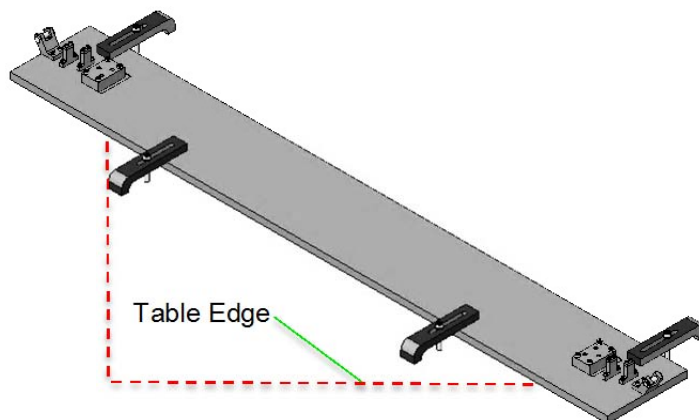
Qty	U	ID	Description
1	Ea	<a href="#">D0901419</a>	HLTS Lower Loop Wire Jig
4	Ea	<a href="#">D980184</a>	LOS Clamps, Long
2	Ea	<a href="#">D030148</a>	Lower Loop Wire Intermediate Mass Breakoffs
6	Ea	NA	Socket Head Cap Screw 8-32 x 0.5" SSTL
4	Ea	<a href="#">D070438</a>	Lower Loop Wire Clamps
4	Ea	NA	Socket Head Cap Screw 8-32 x 0.5625" SSTL
4	Ea	NA	Flat Washer #8 <b>Vented</b> SSTL
4	Ea	1185-2EN164	Helicoil 8-32 x .164"
1	Btl	NA	Methanol
1	Btl	NA	Acetone
1	Btl	NA	Isopropanol
1	Spl	NA	Steel Music Wire, 0.0106" dia.
1	Pkg	NA	Lint-Free Wipes
1	Ea	NA	Wire Cutters, cleaned Class B
1	Ea	NA	Hang Weight, 1 Kg, or D020660 Blade Pulldown Device
4	Ea	NA	Large Test Weights, 10, 5, 2, 1 Kg
1	Ea	NA	Small Test Weight Set, 1 to 500 g

### 28.3 Procedure

One Assembly is required per HLTS.

**Use safety glasses per E0900332.**

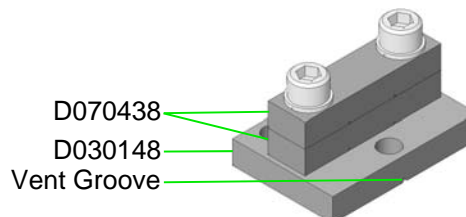
113. Attach the [D0901419](#) Lower Loop Wire Jig to an Optical Table using 4 [D980184](#) Long LOS Clamps arranged so both ends of the Jig hang over the edges of the Table.



**Fig 99: Jig**

114. Assemble loosely the Lower Loop Breakoffs, each using:

- 1 [D030148](#) Breakoff  
**Ensure the vent groove faces downward**
- 2 [D070438](#) Lower Loop Wire Clamp
- 2 Socket Head Cap Screw 8-32 x .5625" SSTL
- 2 Flat Washer #8 **Vented** SSTL



**Fig 100: Breakoff**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

115. Attach the [D030148](#) Lower Loop Wire Intermediate Mass Breakoffs, vent grooves facing down.

- 6 Socket Head Cap Screw  
8-32 x 0.5" SSTL

Tighten the screws.

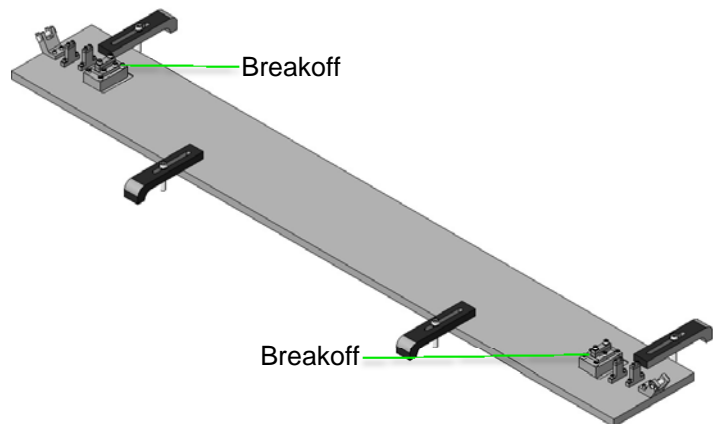


Fig 101: Attaching the Breakoffs

116. Cut one length of 0.0106" diameter Steel Music Wire.

117. Clean the Wire per Section 12.4.

118. Feed the Wire through a set of Wire Clamps in the order shown. Allow the long end of the wire to hang over the edge of the Table passing over the Wire Jig Pin Support.

119. Tighten Wire Start Clamp farthest from the corresponding Wire Jig Pin Support.

Ensure the wire is secured within the groove of the clamp.

120. Repeat Steps 4-7 for the second wire, but feed the Wire through the Clamp in the opposite direction.

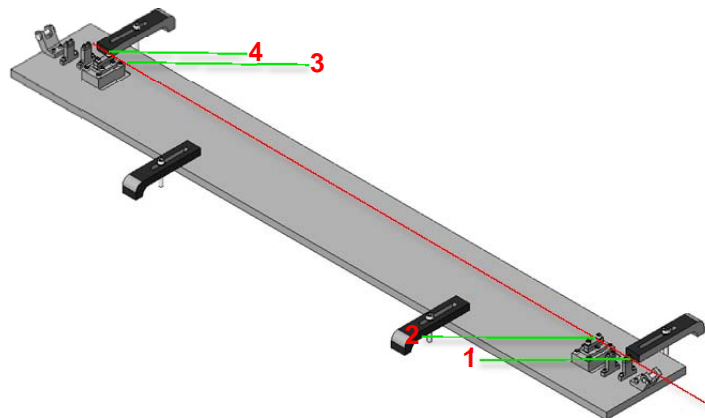


Fig 102: Loading the Wires

121. Tie a small loop in each Wire, at the end of the wire hanging off the Table. Hang a 1 kg Hang Weight from each loop. Add more weights to each hanger for a total of 6.071 kg per Wire. Then Change gloves since the weights are not clean.

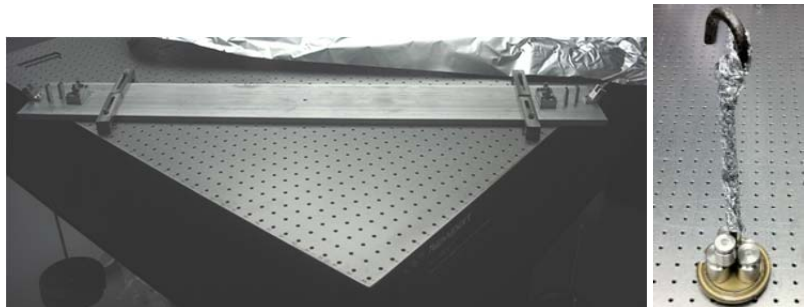


Fig 103: Hang Weight in position



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

122. Wait 5 minutes for the wires to come to equilibrium. Tighten the Screws on the Lower Loop Wire Clamps, then tighten the screws on the remaining Wire Start Clamps. Torque to 30 in-lb.

During tightening:

- Ensure Wire is secured within the grooves of each Clamp.
- Ensure Clamp halves are aligned with each other by using a Precision Square.

123. Cut the wires between the Lower Loop Wire Clamps and the Wire Start Clamps.

124. Remove the weights on both ends. Change gloves since the weights are not clean.

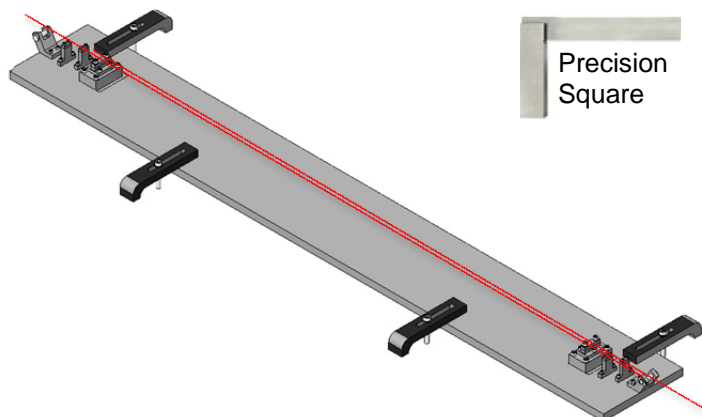


Fig 104: Tightening and Cutting the Wires

125. Loosen the screws on the Wire Start Clamps on the Jig and discard the leftover pieces of wire.

126. Remove the Screws holding the Lower Loop Wire Assembly to the Jig.

127. Bend back the ends of the wires to eliminate sharp points.

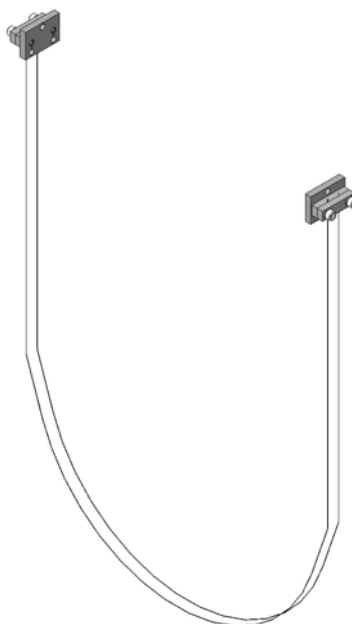


Fig 105: Lower Loop Wire complete Assembly



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 29 Installing Wire Assemblies

### 1.3 Documents

D070442 HLTS Overall Assembly

### 29.1 Materials

Qty	U	ID	Description
4	Ea	NA	Socket Head Cap Screws 8-32 x .50" AgPlated
18	Ea	NA	Socket Head Cap Screws 8-32 x .625" AgPlated

### 29.2 Procedure

Upper Wire Assemblies fully installed.

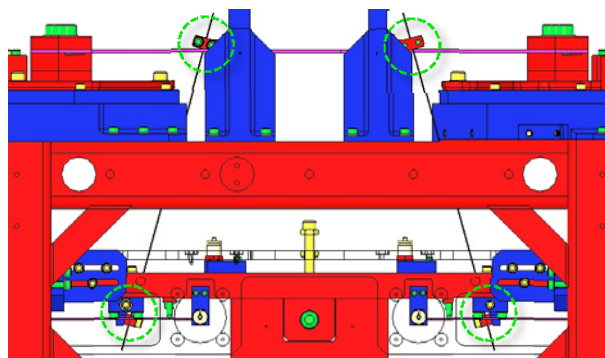


Fig 106: Upper Wire Assemblies installed

3. Raise the Upper Mass/Tablecloth Assembly on its brackets as high as possible and secure it in place.

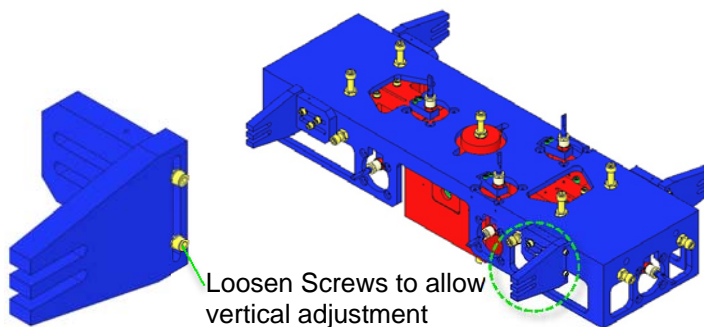


Fig 107: Raising Coil Holder on its Brackets

4. **Be careful not to kink or twist the wires.** Attach the 2 Upper Wire Upper Clamps to the 2 Upper Blades using:
  - 4 Socket Head Cap Screws 8-32 x 0.50" AgPlated  
Torque to 30 in-lb

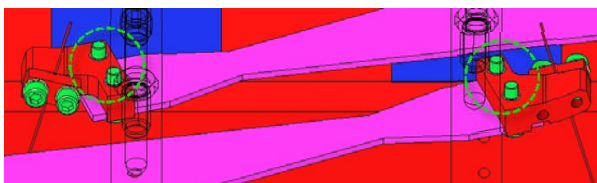


Fig 108: Upper Clamps attached to Upper Blades





# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

- Center the C-Clamps using the 4 Screwdrive System Screws, then tighten the Hex Nuts to lock the Screws.

Torque the eight 8-32 x 1.125" C-Clamp Screws to **30 in-lb**.

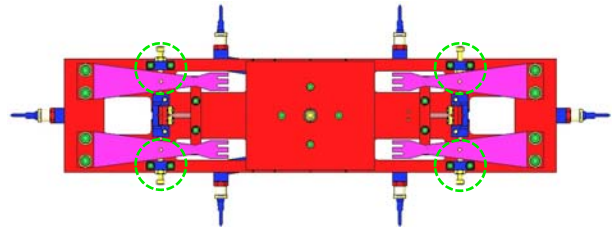


Fig 109: Centering C-Clamps with Screw Drives

- Adjust the height of the Upper Mass/Tablecloth Assembly on its brackets to remove slack in the Upper Wires.

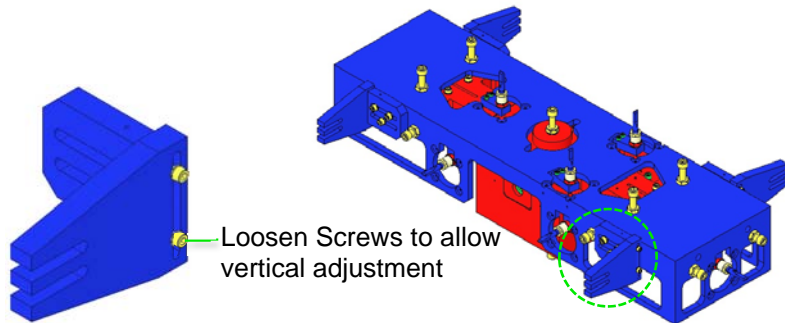


Fig 110: Lowering Coil Holder to eliminate slack in Wires

- Attach the 4 Intermediate Wire **Lower** Clamps to each end of the Intermediate Mass Assembly using:

- 12 Socket Head Cap Screws 8-32 x .625" **AgPlated**  
Torque to **30 in-lb**

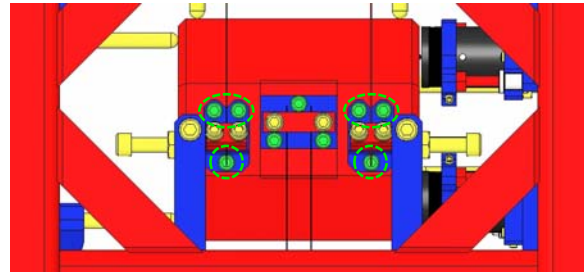


Fig 111: End of Intermediate Mass

- Remove the 2 Screws and Hex Nuts at the top center of the Upper Mass Assembly that are holding the Upper Mass Assembly against the Coil Holder. The Upper Mass Assembly should still be locked relative to the Coil Holder using the top and side earthquake stops.

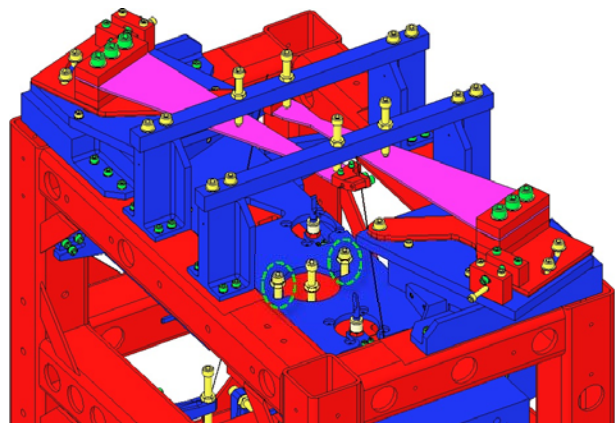


Fig 112: Screws to remove



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions

9. Adjust any or all of the 16 top, bottom and side intermediate EQ Stops to remove slack in the Intermediate Wires.

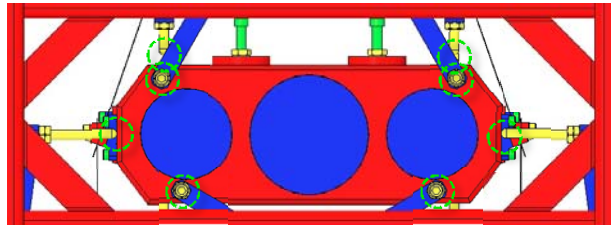


Fig 113: Front View, EQ Stops

10. Attach the Lower Loop Wire to the Intermediate Mass Assembly using:

- 6 Socket Head Cap Screws  
8-32 x .625" AgPlated  
Torque to 30 in-lb

Be careful not to kink, twist or tangle the wires.  
Use silver-plated SHCS.

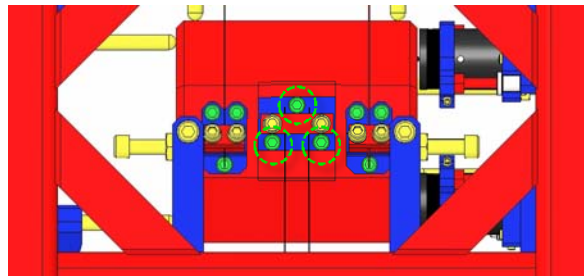


Fig 114: End View of Intermediate Mass



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 30 Installing Bottom Mass

### 1.4 Documents

D070442 HLTS Overall Assembly

### 1.5 Materials

Qty	U	ID	Description
2	Ea	D0901286	HLTS Secondary Metal Prism Breakoff

### 30.1 Procedure

128. Adjust the Lower Bridge EQ Stops (4 Screws) as far in as possible.
129. Back off the Upper Bridge EQ Stops (4 Screws) and Front EQ Stops (4 Screws).

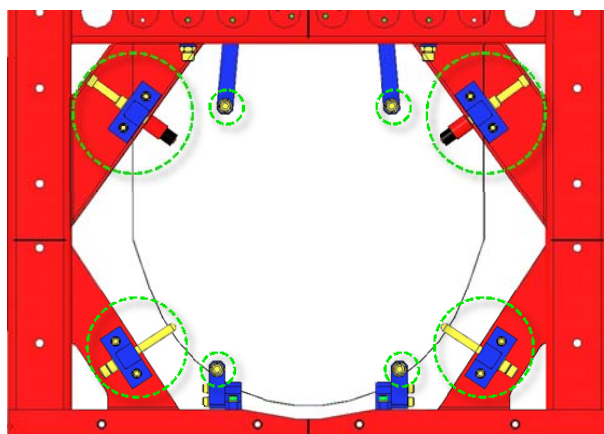


Fig 115: EQ Stops Adjusted

130. Install the Bottom Mass Assembly through the back of the HLTS Structure. Place the Bottom Mass Assembly above the Lower Wire Assembly, resting on the Lower Bridge EQ Stops, making sure that the 2 Wires are straight and fit in the 2 grooves of each Prism Breakoff.

**Be sure not to kink, twist or tangle the wires.**

131. Install the 2 D0901286 Secondary Metal Prism Breakoffs. Insert the breakoffs between the Bottom Mass Assembly and the Lower Loop Wire at the points where the breakoffs just touch the wires.

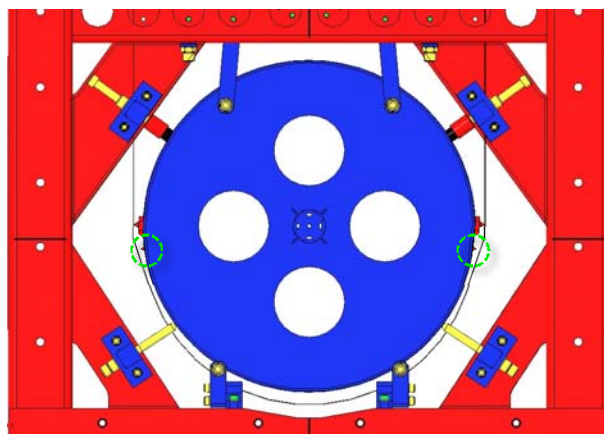


Fig 116: Lower Mass Placed on Bridge EQ Stops



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 31 Suspension and Alignment of Masses

Note: "Level" as referenced below, is defined as being within the visual indicators on the Bubble Levels used (Carpenter's Level for Optical Table, Single Bubble for Suspension Masses).

### 1.6 Materials

Qty	U	ID	Description
1	Ea	NA	Bubble Level
1	Ea	NA	Optical Level
1	Ea	NA	Lower Loop Wire Comb

### 31.1 Procedure

132. Unlock all Stops to allow the Suspension to hang freely:

#### Bottom Mass

- 4 Face EQ Stops
- 8 Bridge EQ Stops

#### Intermediate Mass

- 16 EQ Stops

#### Upper Mass

- 4 Lower Blade Stops
- 12 Coil Holder Stops

#### Upper Blades

- 4 Upper Blade Stops

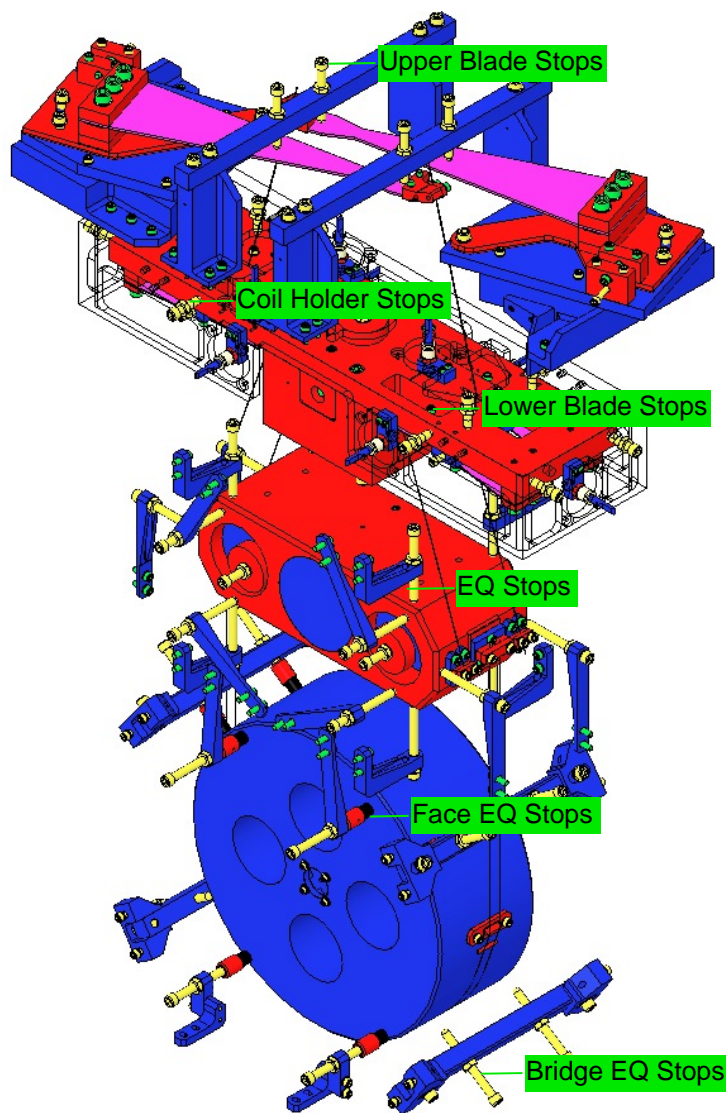


Fig 117: Unlock all Stops

**SPECIFICATION**

**HAM Large Triple Suspension (HLTS)  
Assembly Instructions**

**Lock the Intermediate Mass**

133. Lock the Intermediate Mass with the 16 EQ Stops such that the Mass is level. Use a Bubble Level, and then an Optical Level. The Mass height is unimportant at this point.

**Adjust Bottom Mass Roll**

134. Using the Lower Loop Wire Comb, ensure the Lower Wires are parallel and 10mm apart.

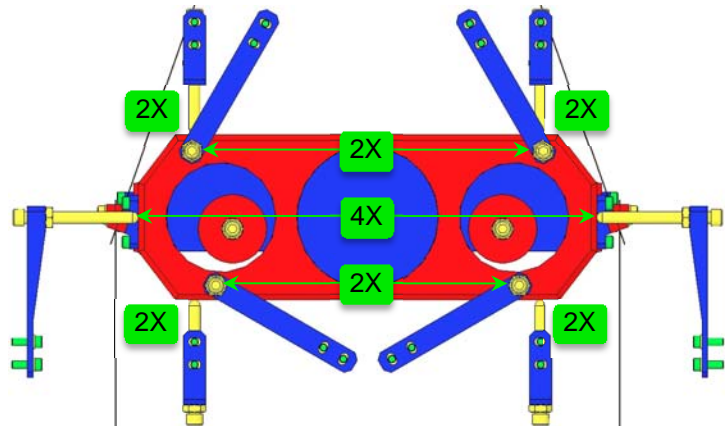
135. Measure and compare the heights of the bottom of the side bores, on the with side of the front of the Bottom Mass. Rotate the Mass until the heights are equal.

**Adjust Bottom Mass Pitch**

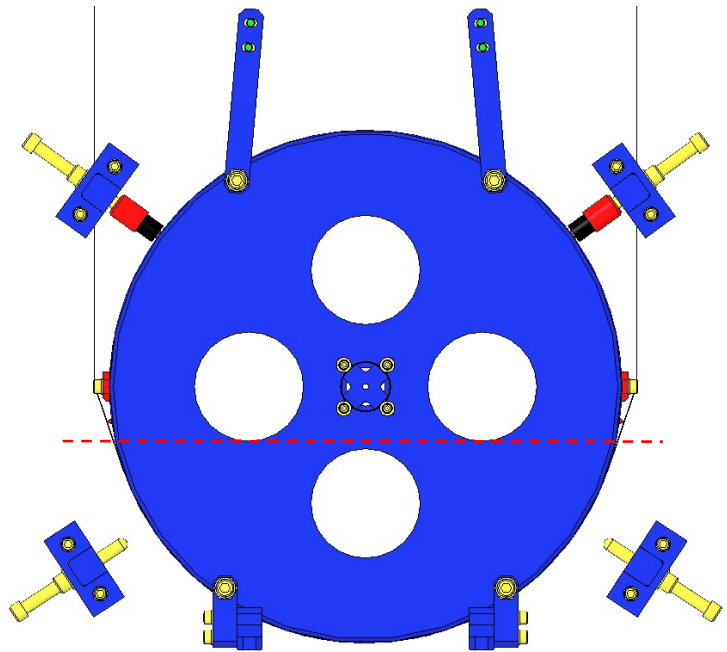
136. Measure and compare the heights of the bottom of the bores on the front and back of the Mass. If unequal, first repeat Step 3, above. Then verify that the Lower Wire Clamps are attached squarely to the Intermediate Mass. If the heights remain unequal, the lengths of the Lower Wires are unequal, and need to be replaced.

**Unlock the Intermediate Mass**

137. Once the Bottom Mass is level, unlock the Intermediate Mass.



**Fig 118: Intermediate Mass Leveling**



**Fig 119: Adjust Roll and Pitch**

# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

#### Adjust Yaw

138. Using a Ruler while adjusting the Corner Brackets, center the Coil Holder within the Weldment, in the X direction (front-to-back).

139. Adjust the Rotational Adjusters as needed to center the Magnet Holders at either end of the Upper Mass within the Coil Holder Openings.

To adjust the Rotational Adjusters, loosen the 3 screws attaching the RA to its base, then adjust the Push and Pull Screws, then tighten the 3 screws.

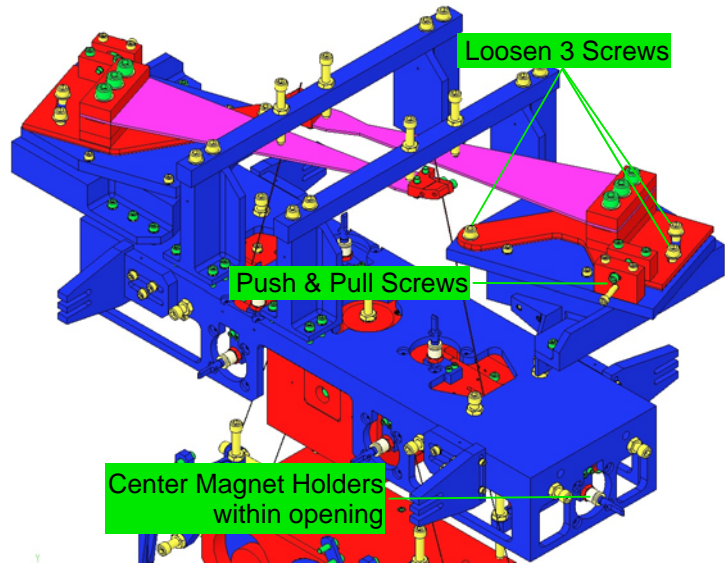


Fig 120: Adjusting Yaw

#### Adjust Upper Mass Pitch

140. Measure the heights of either the bottom of the T-Piece or the bottoms of the Screw Drive Blocks, front and back (+X & - X). To adjust Pitch, manipulate the Screw Drives to shift the location of the Upper Wire Lower Clamps.

Diagram shows Upper Mass without Coil Holder nor Blades, for visibility.

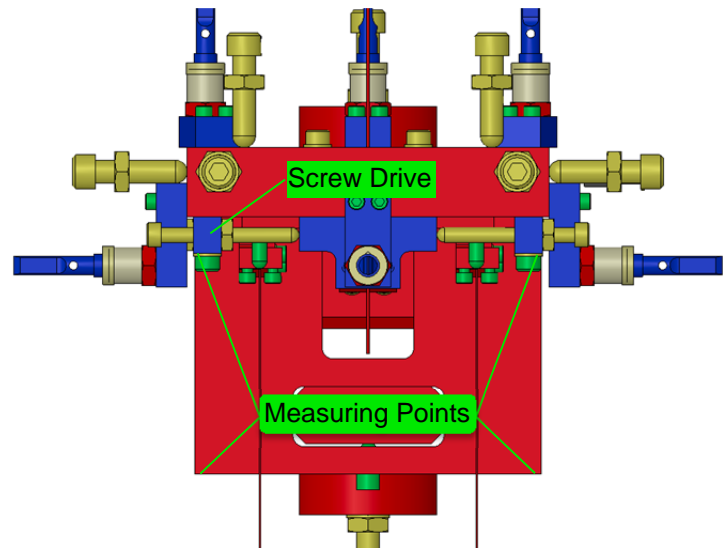


Fig 121: Upper Mass Pitch, End View

141. Measure heights in mm from the Optical Table surface of these points.

\*Not measurable with Optical Level

Upper Blade Wire Breakoffs (2)	NOT Blade tip	806.120
Coil Holder	Upper surface	658.587
Upper Mass – Screwdrive Blocks (4)	Bottom surface	613.181
Upper Mass – T-Piece	Bottom surface	552.228
Lower Blade Wire Breakoff (4)	NOT Blade tip	608.838
Intermediate Mass	Upper surface	461.620
Intermediate Mass	Lower surface	371.620
Bottom Mass Metal – Side Bores (2)	Bottom	130.243
Bottom Mass Metal or Optic	Centerline*	158.500
Bottom Mass Metal	Bottom	25.984

\* Not measurable using an Optical Level

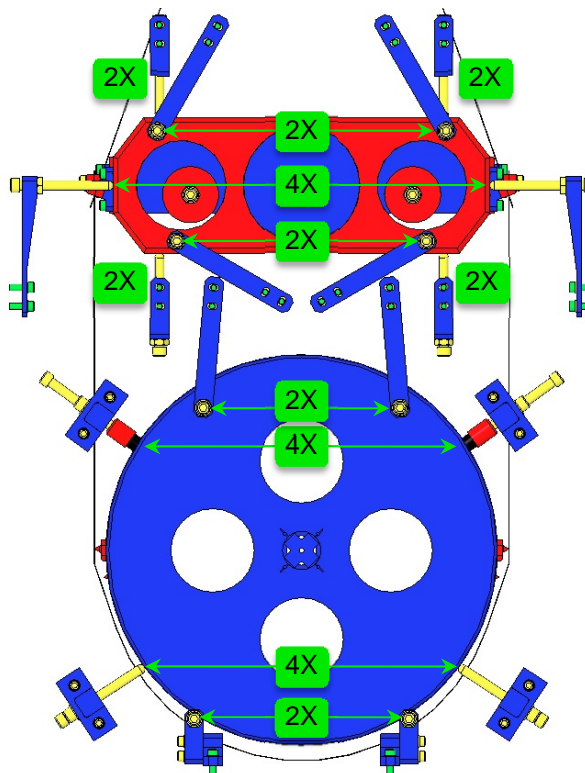
# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

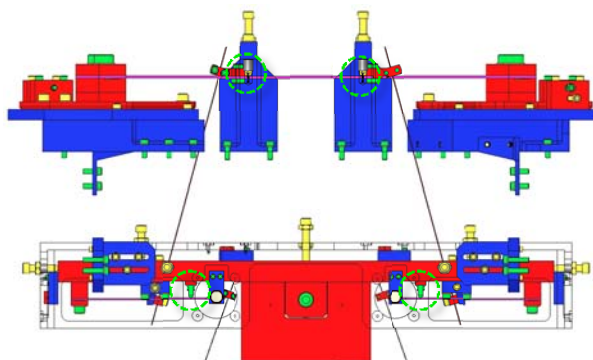
Perform the following on the **28** ¼-20 EQ Stop Screws shown at right:

142. Adjust each Screw so that it contacts the Mass, but applies no pressure.
143. Rotate each Screw  $\frac{3}{4}$  turn counterclockwise to leave a **1 mm gap** between the Screw Tip and the Mass.
144. Tighten the Hex Nuts at each of the Screws, to lock the Screws in position.



**Fig 122: 1 mm gap at EQ Stops**

145. Adjust the **4** Lower Blade Guard Screws so they contact the Lower Blades but apply no pressure.
146. Rotate the Screws **1 ¼ turns counterclockwise**, to leave a **1 mm gap** at the Lower Blades.
147. Repeat these 2 steps with the **2** Upper Blade Guard Screws, but with only a  $\frac{3}{4}$  turn counterclockwise.



**Fig 123: Blade Guard Screws**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 32 Assembling Magnets To Intermediate Mass

### 32.1 Documents

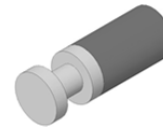
[E990196](#) Magnet / Standoff Assembly Preparation

### 32.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D0901461</a>	<b>HLTS Magnet Placement Fixture, Intermediate Mass</b>
4	Ea	<a href="#">D980184</a>	LOS Clamps
4	Ea	NA	Socket Head Cap Screw 1/4-20 x 1.5" <b>AgPlated</b>
4	Ea	<a href="#">D020661</a>	Magnet/Standoff Assemblies, 2 N and 2 S configurations
1	Ea	NA	Machinist Square, approx. 6" in length
1	Ea	TBD	Epoxy Gun Applicator, MasterBond
1	Ea	EP30-2	Epoxy, Double Barrel Cartridge with Mix Tube, MasterBond
1	Ea	NA	Tweezers
1	Btl	NA	Isopropanol
X	Ea	NA	Lint Free Wipes
X	Ea	TBD	Sewing Needle
X	Ea	TBD	Razor Blade
X	Roll	NA	UHV Aluminum Foil
1	Ea	NA	Heat Lamp, 120w Bulb

### 32.3 Procedure

148. Prepare 2 "N" and 2 "S" [D020661](#) Magnet/Standoff assemblies per [E990196](#) Preparation procedure.



**Fig 124: D020661 Magnet/Standoff Assembly**





# SPECIFICATION HAM Large Triple Suspension (HLTS) Assembly Instructions

### Place the Mass or Optic

149. Mount the Base Plate of the [D0901461](#) Magnet Placement Fixture on an Optics Table using the 4 [D980184](#) LOS Clamps.

150. Place the Intermediate Mass Assembly on the Base Plate with the back side facing up.

*The Intermediate Mass is symmetric; front/back is identified only after the Mass is balanced within the Weldment.*

151. Place the Positioning Standoff over the Mass. Using a Machinist's Square, carefully align the engraved markings on the [D0902452](#) Side Plates with those on the main Standoff Plate [D0902445](#) (see red dashed lines at right). The Sides and Standoff Plate together form the [D0902444](#) Positioning Standoff.

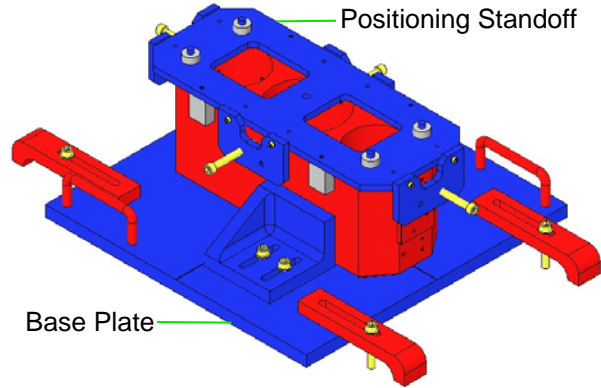


Fig 125: Magnet Placement Fixture

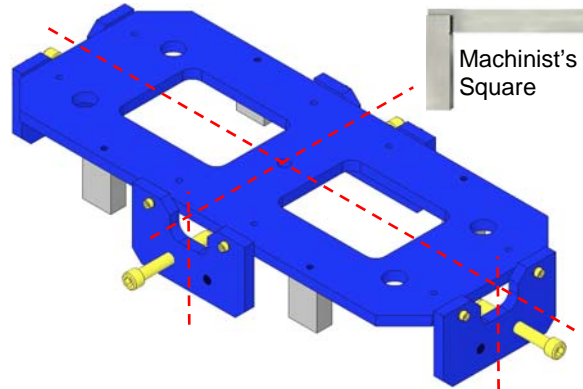


Fig 126: Aligning Side Plates with Main Plate

### Load Plungers

152. Wipe the counterbore end of each plunger with Isopropanol and a Wipe.

153. Using the Tweezers, load 4 Magnet/Standoff assemblies into the 4 Plungers, 2 North Magnets and 2 South Magnets. The Magnet end of each assembly rests within the Plunger counterbore.

*The Magnet/Standoffs are held to the Plungers magnetically.*

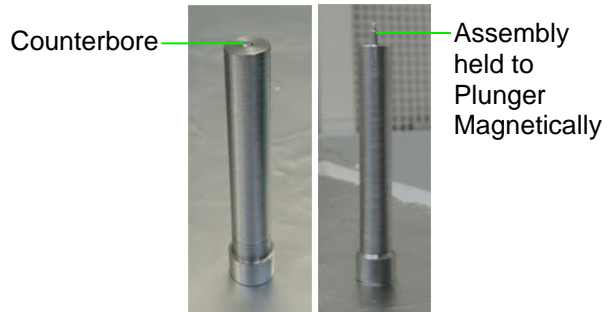


Fig 127: Plungers Empty and Loaded

154. Lay the loaded Plungers on the Optics Table around the Fixture per the Magnetic Polarity layout shown.

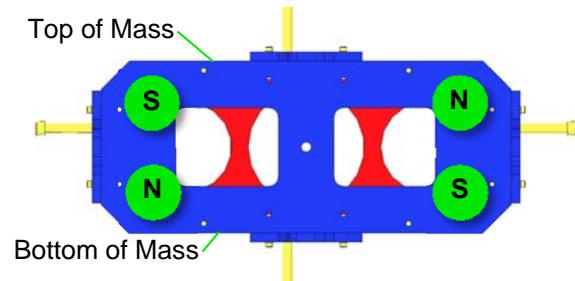


Fig 128: Magnet Polarity Layout



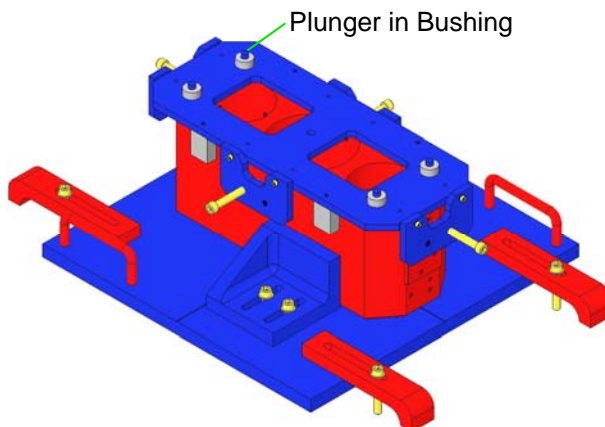
# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

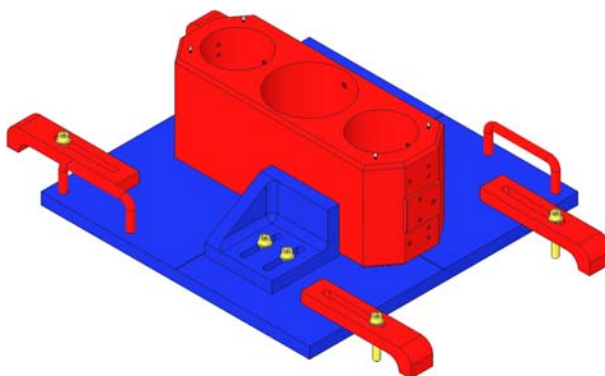
#### **Bond Magnets to Mass- See T1300322 for more information on EP30-2.**

155. Load the EP30-2 Cartridge with Mix Tube attached, into the Gun Applicator.
156. Pull the trigger on the Gun Applicator 1 full stroke, to purge the Mix Tube of under-mixed adhesive.
157. Dispense a “quarter-sized” pool of Adhesive onto a small piece of clean UHV aluminum foil.
158. Pick up a Plunger loaded with a Magnet/Standoff assembly and hold it vertically, with the Magnet/Standoff end facing up. Clean the Standoff with Isopropanol and a Wipe.
159. Dip the end of a Sewing Needle in the pool of Epoxy and withdraw it, leaving a tiny drop on the Needle tip. Apply approximately  $\frac{1}{2}$  mm of Epoxy to the center of the Standoff end.
160. Load the Plunger, Magnet/Standoff down, into the appropriate Bushing in the MPF. Slide the Plunger down within the Bushing until the Standoff contacts the Mass. Press down on the Plunger lightly with one finger for about 2 seconds, then release.
161. Repeat the previous steps to load all 4 Plungers into the Placement Fixture.
162. Allow the Epoxy to cure within the Fixture at room temperature for 12 - 16 hours.



**Fig 129: Loading Magnets into Fixture**

163. Carefully remove the 4 Plungers from the Magnet Placement Fixture, and remove the Positioning Standoff from the Mass.
164. Carefully move the fixture and mass into an air bake oven for a 34 deg C elevated bake for 6 hours. The ramp up and ramp down should be 1.5 deg C per minute or less. Measure the oven temp before and during use with a thermocouple.



**Fig 130: Air bake Cure**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 33 Assembling Magnets To Bottom Mass

### 33.1 Documents

[E990196](#) Magnet / Standoff Assembly Preparation

### 33.2 Materials

Qty	U	ID	Description
1	Ea	<a href="#">D0901460</a>	<b>HLTS Magnet Placement Fixture, Bottom Mass</b>
4	Ea	<a href="#">D980184</a>	LOS Clamps
4	Ea	NA	Socket Head Cap Screw 1/4-20 x 1.5" <b>AgPlated</b>
1	Ea	<a href="#">D070338</a>	HLTS Bottom Mass
1	Ea	Various	HLTS Optic
4	Ea	<a href="#">D0902432</a>	Magnet/Standoff Assemblies, 2 N and 2 S configurations
1	Ea	NA	Machinist Square, approx. 6" in length
1	Ea	NA	Depth Gage; either Vernier Calipers or Spring-Type Needle Gage
1	Ea	EP30-2	Epoxy, Double Barrel Cartridge with Mix Tube, MasterBond
1	Ea	TBD	Gun Applicator, MasterBond
1	Ea	NA	Tweezers
1	Btl	NA	Isopropanol
X	Ea	NA	Lint Free Wipes
X	Ea	TBD	Sewing Needle
X	Ea	TBD	Razor Blade
X	Roll	NA	UHV Aluminum Foil
1	Ea	NA	Heat Lamp, 120w Bulb

### 33.3 Procedure

- Glass Optics and Metal Masses will not be Air Baked.
- Glue Magnets before gluing Prisms (primary and secondary).
- Ensure the Main Section of the Mass has been cleaned and baked before attaching the Magnet/Dumbbell assemblies.
- Thoroughly Class B clean all parts of the Magnet Placement Fixture.

165. Prepare 2 "N" and 2 "S" [D0902432](#) Magnet/Standoff assemblies per [E990196](#) Preparation procedure.



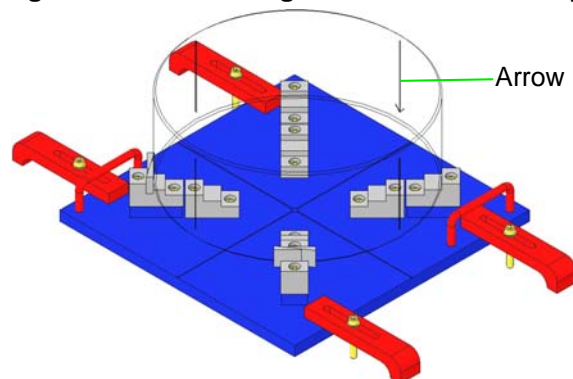
**Fig 131: D0902432 Magnet/Standoff Assembly**

#### Place the Mass or Optic

166. Mount the Base Plate of the [D0901460](#) HLTS Magnet Placement Fixture on an Optics Table using the 4 [D980184](#) LOS Clamps.

167. Place the Test Mass or Optic on the Base Plate.

**The Mass/Optic Arrow must be facing downwards.**



**Fig 132: Base Plate Mounted on Optics Table**



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

168. Place the Magnet Positioning Fixture (MPF) on top of the Mass / Optic.  
**For the Optic, ensure the PFA440HP-tipped Stops are installed on the Stop Screws**

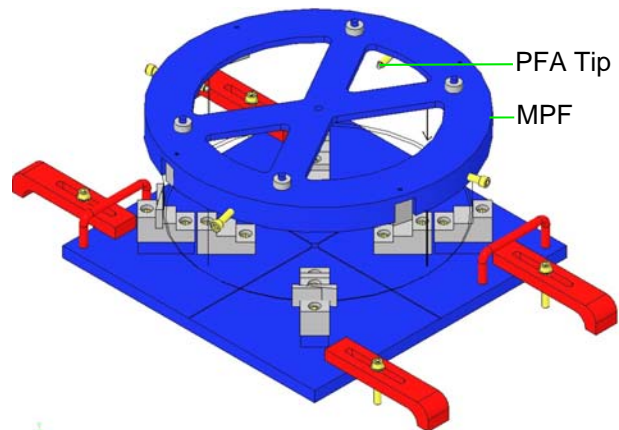


Fig 133: MPF in place

#### Align the MPF and Mass / Optic scribe lines:

For clarity, the Base Plate is not shown.

The MPF Scribe Lines are not visible in the drawings; they fall within 4 flat areas on the MPF perimeter, about 15° clockwise from each Screw.

169. **Center the MPF on the Mass / Optic** by obtaining equidistant readings between opposing pairs of MPF Scribe Lines and the Mass Optic perimeter, using a Depth Gage. **The MPF Screw tips must barely contact and not "clamp" the Mass/Optic.**
170. For a **Metal Mass**, rotate the Mass while using a Machinist Square to align the Mass and Fixture scribe lines. Align at 2 Lines 90° apart. For an **Optic**, sight across (through) the glass through 2 opposing scribe lines, then rotate the Optic while using a Machinist Square to align the MPF and Optic scribe lines.

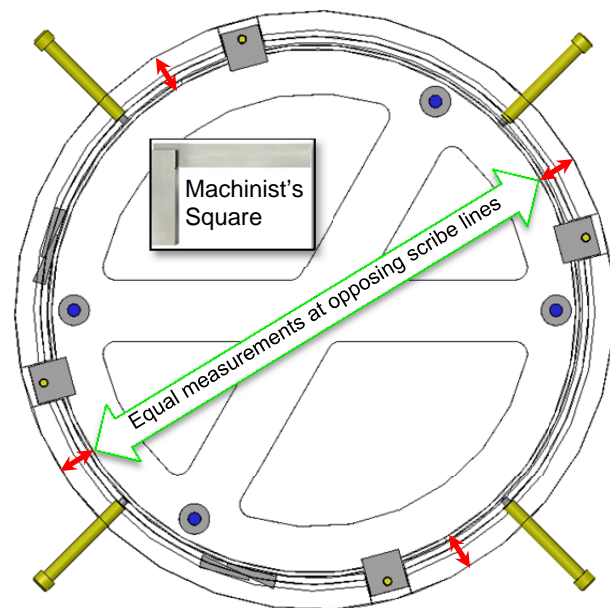


Fig 134: Centering the MPF on the Mass / Optic

#### Load Plungers

171. Wipe the counterbore end of each plunger with Isopropanol and a Wipe.
172. Using the Tweezers, load 4 Magnet/Standoff assemblies into the 4 Plungers, 2 North Magnets and 2 South Magnets. The Magnet end of each assembly rests within the Plunger counterbore.

**The Magnet/Standoffs are held to the Plungers magnetically.**

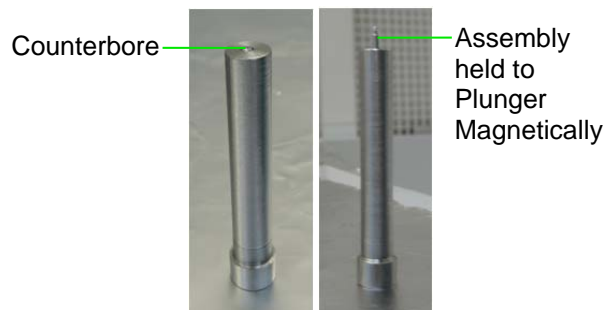


Fig 135: Plungers Empty and Loaded



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

173. Lay the loaded Plungers on the Optics Table around the Fixture per the Magnetic Polarity layout shown.

Note that the "X" pattern is rectangular and not square; this pattern defines the Magnet layout.

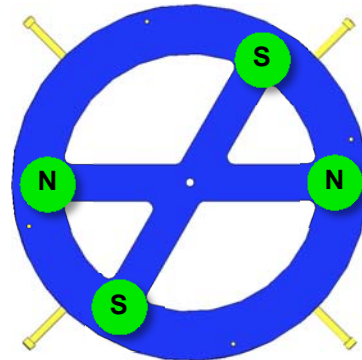


Fig 136: Magnet Polarity Layout

#### Bond Magnets to Mass/Optic - See T1300322 for more information on EP30-2.

174. Load the EP30-2 Cartridge with Mix Tube attached, into the Gun Applicator.
175. Pull the trigger on the Gun Applicator 1 full stroke, to purge the Mix Tube of under-mixed adhesive.
176. Dispense a "quarter-sized" pool of Adhesive onto a small piece of clean UHV aluminum foil.
177. Hold a Plunger loaded with a Magnet/Standoff assembly vertically, with the Magnet/Standoff end facing up. Clean the Standoff with Isopropanol and a Wipe.
178. Dip the end of a Sewing Needle in the pool of Epoxy and withdraw it, leaving a tiny drop on the Needle tip. Apply approximately 1/2 mm of Epoxy to the center of the Standoff end.

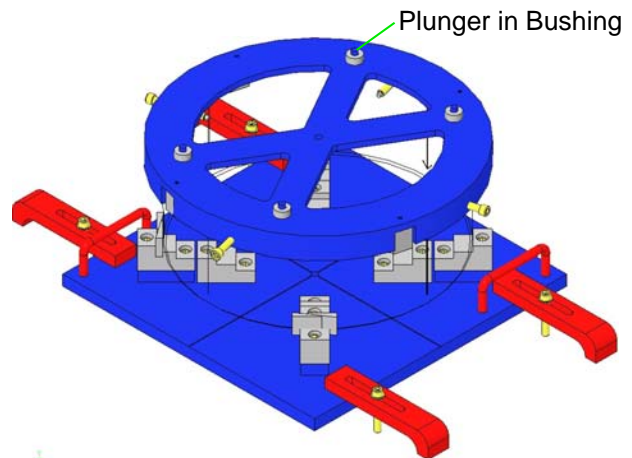


Fig 137: Loading Magnets into Fixture

179. Load the Plunger, Magnet/Standoff down, into the appropriate Bushing in the MPF. Slide the Plunger down within the Bushing until the Standoff contacts the Mass/Optic. Press down on the Plunger lightly with one finger for about 2 seconds, then release.
180. Repeat previous steps to load all 4 Plungers into the Placement Fixture.
181. Allow the Epoxy to cure within the Fixture at room temperature for 12 - 16 hours.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

182. Carefully remove the 4 Plungers from the MPF, and remove the MPF from the Mass/Optic.
183. Carefully move the fixture and mass into an air bake oven for a 34 deg C elevated bake for 6 hours. The ramp up and ramp down should be 1.5 deg C per minute or less. Measure the oven temp before and during use with a thermocouple.

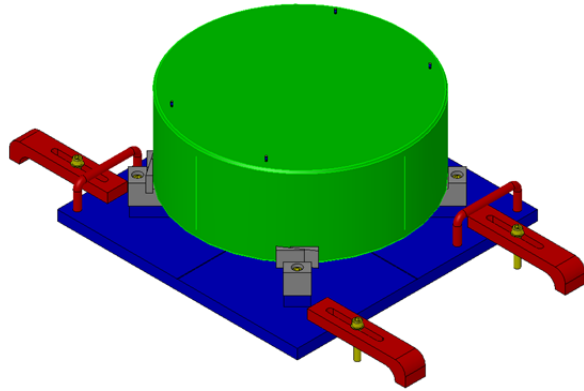


Fig 138: Air bake Cure

## 34 Installing AOSEM Brackets

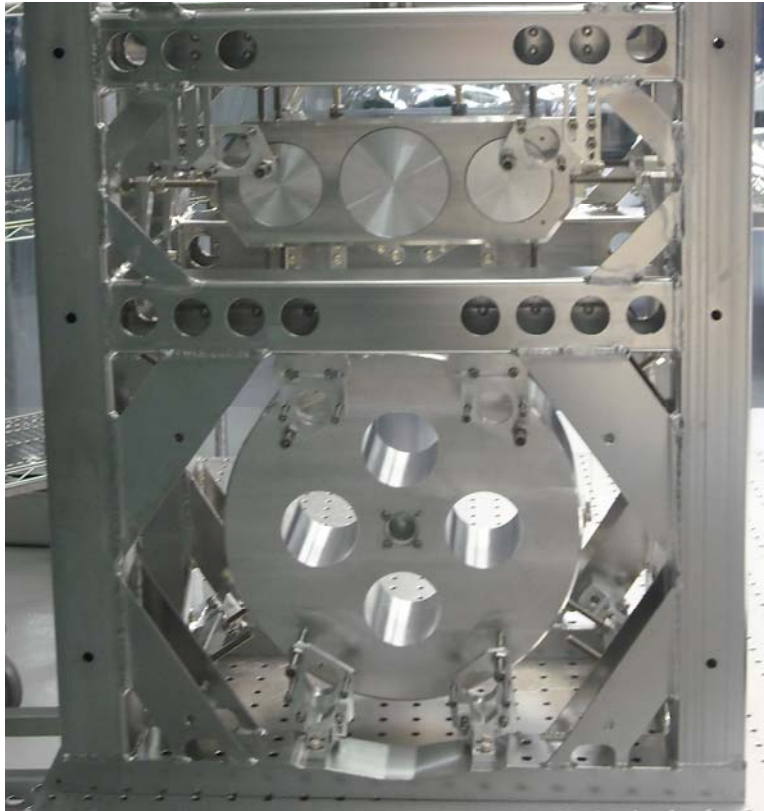
### 34.1 Procedure

1. Adjust the push and pull screws on each AOSEM bracket so that the front face of each AOSEM is as far back as possible. Back off the earthquake stop on each AOSEM bracket.
2. Attach the AOSEM brackets (as shown in Figure 37) to the HLTS Structure in this order: Bottom Mass Lower AOSEM Alignment Assembly (D0901551), Bottom Mass Upper AOSEM Alignment Assembly (D0901552), Intermediate Mass Lower AOSEM Alignment Assembly (D0901551), Intermediate Mass Upper AOSEM Alignment Assembly (D0902024). Record the serial number and position of each AOSEM on the HLTS Process Traveler.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS) Assembly Instructions



**Fig 139: AOSEM Bracket Arrangement**

3. Align each AOSEM vertically and laterally using the slots on the AOSEM brackets. Look through the barrel of the AOSEM and align the magnet/dumbbell assembly with the center axis of the AOSEM.
4. Adjust the earthquake stop on each bracket to a distance of approximately 0.75 mm (between  $\frac{1}{2}$  and  $\frac{3}{4}$  of a turn of the  $\frac{1}{4}$ -20 earthquake stop screw) from the corresponding mass. Tighten the hex nuts on the bracket to lock the earthquake stop in place.
5. After all AOSEM brackets are installed, connect the in-vacuum cabling and related cable connectors and clamps.



# SPECIFICATION

## HAM Large Triple Suspension (HLTS)

### Assembly Instructions

## 35 Installing the BOSEMs

### 1.7 Documents

D070442 HLTS Overall Assembly

### 1.8 Materials

Qty	U	ID	Description
6	Ea	D060218	<b>BOSEM Assembly</b>
24	Ea	NA	Socket Head Cap Screw 4-40 x 7/8" SSTL
24	Ea	NA	Flat Washer #4 SSTL

### 1.9 Procedure

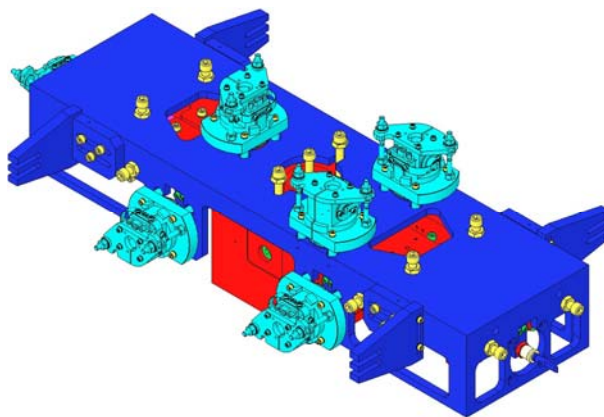
1. Install the 6 BOSEMs in the arrangement shown, using:

- 24 Socket Head Cap Screws 4-40 x 7/8" SSTL
- 24 Flat Washers #4 SSTL  
Torque to **5 in-lb**

It may be necessary to install the end BOSEM opposite from the end shown, due to space requirements inside the HAM chamber. Use a non-magnetic hex key to avoid attracting the hex key to the Magnet and Flag Assembly.

**Be careful not to bend the Magnet Flags.**

**Record the serial number and position of each BOSEM in ICS.**



**Fig 140: BOSEMs Installed**

2. After all 6 BOSEMs are attached, install the in-vacuum cabling and related cable connectors and clamps. Use silver-plated SHCS in threaded holes in the HLTS Structure.

## 36 Aligning OSEMs

### 36.1 Procedure

1. Connect the in-vacuum cabling for the AOSEMs and BOSEMs to the Triples Test Stand. Confirm that each cable is connected correctly.
2. Using the MEDM screens on the Triples Test Stand, read the open light voltage for each BOSEM. Adjust the BOSEM using the SHCS connecting it to the tablecloth for rough positioning. Use the PEEK hex nuts for fine adjustment. Position the BOSEM so that the Triples Test Stand indicates 50% of the open light value.
3. Using the MEDM screens on the Triples Test Stand, read the open light voltage for each AOSEM, starting with those for the Intermediate Mass. Use the push and pull screws on each bracket to adjust the position of each AOSEM. Position each AOSEM so that the Triples Test Stand indicates 50% of the open light value.