

LIGO Laboratory / LIGO Scientific Collaboration

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Advanced LIGO

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**TRANSMON-SUS ASSEMBLY &
INSTALLATION PROCEDURE**

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1 Introduction

1.1 Purpose and Scope

This document describes the assembly and installation procedure for the TransMonSus (TMS). Open DCC for Latest Drawing Versions and Notes

1.2 References

- LIGO-E1100841: TMS Transportation-Installation Restraint Procedure
- LIGO-E1000097: ETM TransMon Telescope SUS Installation Plan
- LIGO-E1100651: TMS Top Mass Assembly Procedure
- LIGO-D1100908: aLIGO TMS TELE-OPT TABLE TOOL ASSY-GENIE FORK CONNECTION
- LIGO-D1101307: TOOLING LAYOUT-aLIGO TMS Telescope Cartridge lift Safety Supports
- LIGO-D1100807: aLIGO TMS TELE-OPT TABLE INSTALL, FRAME-PLATE ASSY
- LIGO-D1101096: aLIGO TMS OPT TABLE-TELE- SUPPORT BRIDGE CONNECTION
- LIGO-D1101095: aLIGO TMS TELESCOPE-SUPPORT BRIDGE CONNECTION
- LIGO-D1101097: aLIGO TMS TELE-OPT TABLE-BALANCE BRIDGE interface
- LIGO-E1200049: aLIGO Transmission Monitor Suspension Installation Plan
- LIGO-E1200453: Fine Initial Alignment Procedure of the Transmission Monitor Telescope
- LIGO-T1100600: Requirement For Adjustment Procedure Of Advanced LIGO Transmission Monitor Telescope
- LIGO-T1100603: TMS Telescope Alignment Procedure
- LIGO-G1101254: TMSY Telescope focal tuning results.
- LIGO-T1100604: TMS Change Suggestions after First Build
- LIGO-D1101096: aLIGO TMS OPT TABLE-TELE- SUPPORT BRIDGE CONNECTION
- LIGO-E1200793: aLIGO TMS System Drawing Assembly Tree
- LIGO-D1002097: aLIGO_TMS_TEST_MASS_ASEM

2 Preparation

Advanced LIGO has implemented a new Inventory Control System (ICS) which is designed to record all aLIGO hardware as it moves through receiving, inspection, clean, bake, storage, shipment, and assembly processes. The ICS is meant to replace the shipping type paper traveler used in iLIGO. While the ICS is still in final development as of this writing, the hope is that the engineering teams will be able to utilize ICS to record many aspects of the lifetime of a part from its initial receipt through the clean and bake

processes previously documented in the iLIGO traveler. The sites have dedicated staff to help with managing the data related to the processing of parts in ICS. Engineering staff should become familiar with the ICS such that they can utilize it for their own record keeping and data management. If the ICS fails to facilitate data that you need to record, process travelers (PT) can be placed on the DCC. In either case, make sure to record all serial numbers and data in the ICS or the DCC during the following steps.

2.1 Receiving/inventory

2.1.1 Receiving/inventory of metal parts

Upon receipt of shipments of SUS parts, the following steps should be performed:

Basic inspection by the receiver prior to unpacking the shipment (crate damage, etc). Packing slips should be sent (hardcopy or emailed) to Jennie Murdock at LHO. Person performing this step should notify site subassembly lead of the shipment arrival.

Inventory Control and inspection performed by ICS person and site subsystem lead as parts are unpacked. Drawing numbers, serial numbers, and quantities will be imported into the ICS database via spreadsheet templates (F0900052). This is a good time for QA/QC and engineering inspections. The following processes can now be recorded in ICS by grouping the parts into Loads.

Parts get separated into cleaning loads based on their level of cleanliness, and moved to the appropriate cleaning station.

Parts get separated into clean and bake loads based on their material – see E960022. Sorting should be reflected in the Load records in ICS, where instructions to technicians can be added for any special handling or material considerations.

Parts will be processed as per E960022.

Parts will be stored in clean storage areas until assembly.

2.2 Cleaning/Baking

Process all parts except for the Test Masses as Class A per E960022. Test Mass D1002097 is to be processed as Class B, since it is used as tooling and will be removed. All Parts should be processed as Class A or B prior to Helicoil installation.

2.3 HeliCoils

Install all the HeliCoils in all the parts and make sure they are free running and not cross threaded, remove the tangs. Perform HeliCoil inspections as per the instructions listed on the Advanced LIGO HeliCoil Wiki page for installation and inspection.

3 D0901880: aLIGO AOS Transmission Monitor System Assembly Overview

3.1 TMS Principal Assemblies

The Transmission Monitor Suspension (TMS) is an in-vacuum component that is located behind the ETM (End Test Mass) and is mounted to the internal seismic isolation (ISI) optics platform inside the BSC, as shown in **Figure 1**. The TMS Telescope reduces the size of the interferometer (IFO) beam transmitted through the ETM. The reduced TMS beam is used for monitoring the alignment of the IFO beam in the arms. The TMS is also used for injection of the green laser beam used in the Arm Length Stabilization (ALS) scheme. Finally, the TMS also accommodates probe beams for the Hartmann sensor that monitors the curvature of the ETM HR surface.

The TMS consists of three principal assemblies: 1) suspension frame and top mass with springs and controls, 2) ISC TMS Optical Assembly, and 3) TMS Telescope.

NOTE: SEE SECTION 9.0 FOR BEAM DISTANCE FROM CARTRIDGE TABLE

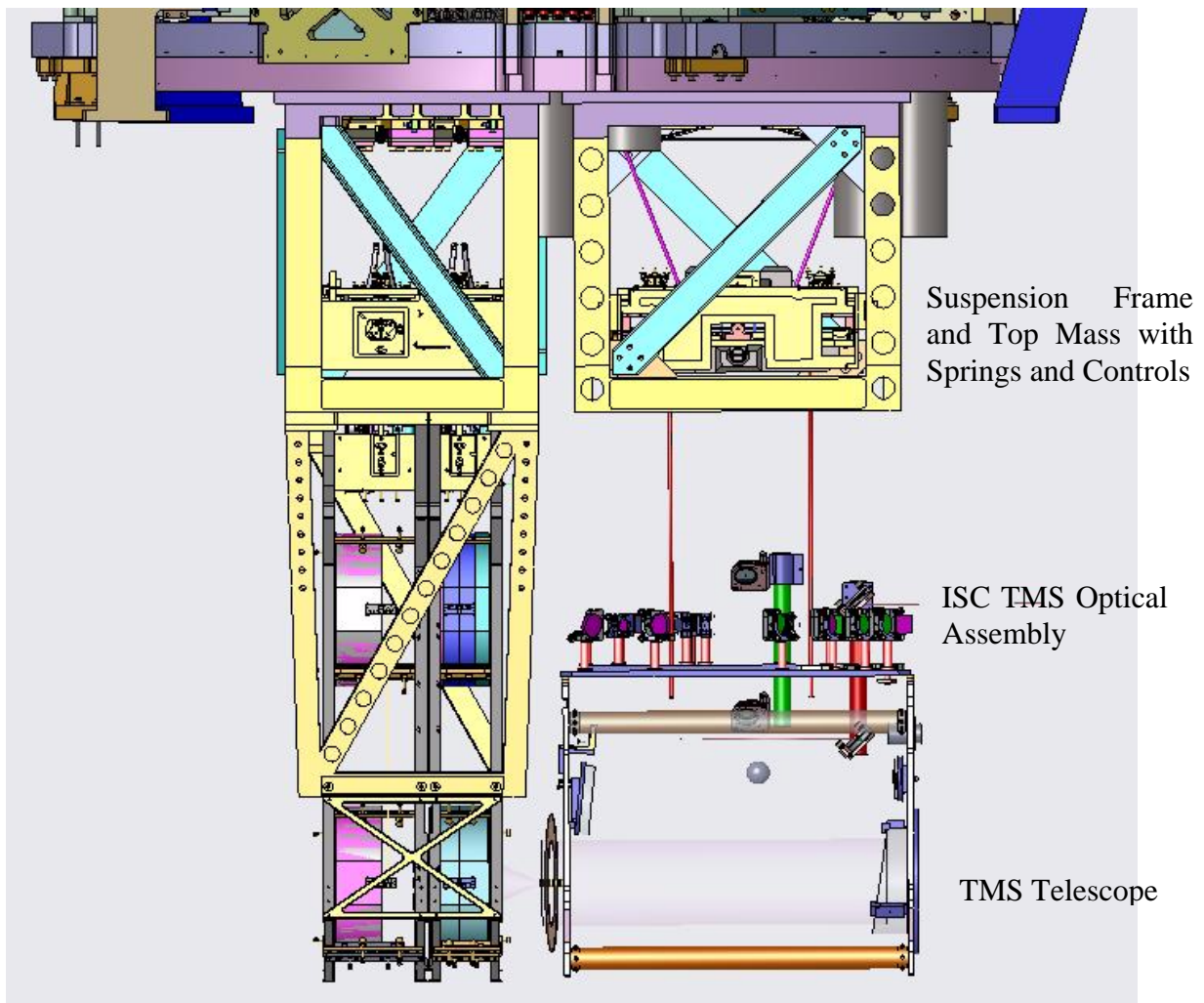


Figure 1: TMS shown behind the ETM quad

3.2 TMS Accessory Assemblies

In addition to the principal assemblies, the following accessory assemblies are also part of the TMS.

D1100827: ALIGO VERTICAL SAFETY WIRE ASSEMBLY

D1101130: ALIGO TMS TELESCOPE SAFETY SUPPORT BEAM ASSY

D1001891: ALIGO TMS VERTICAL SEISMIC SAFETY STOP ASSEMBLY

D1101163: ALIGO TMS TELESCOPE SUS WIRE ASSEMBLY

Note: In Cartridge assembly D1300448 TMS Cartridge Swing Stop Tool is used to prevent TMS and ETM from Bumping.

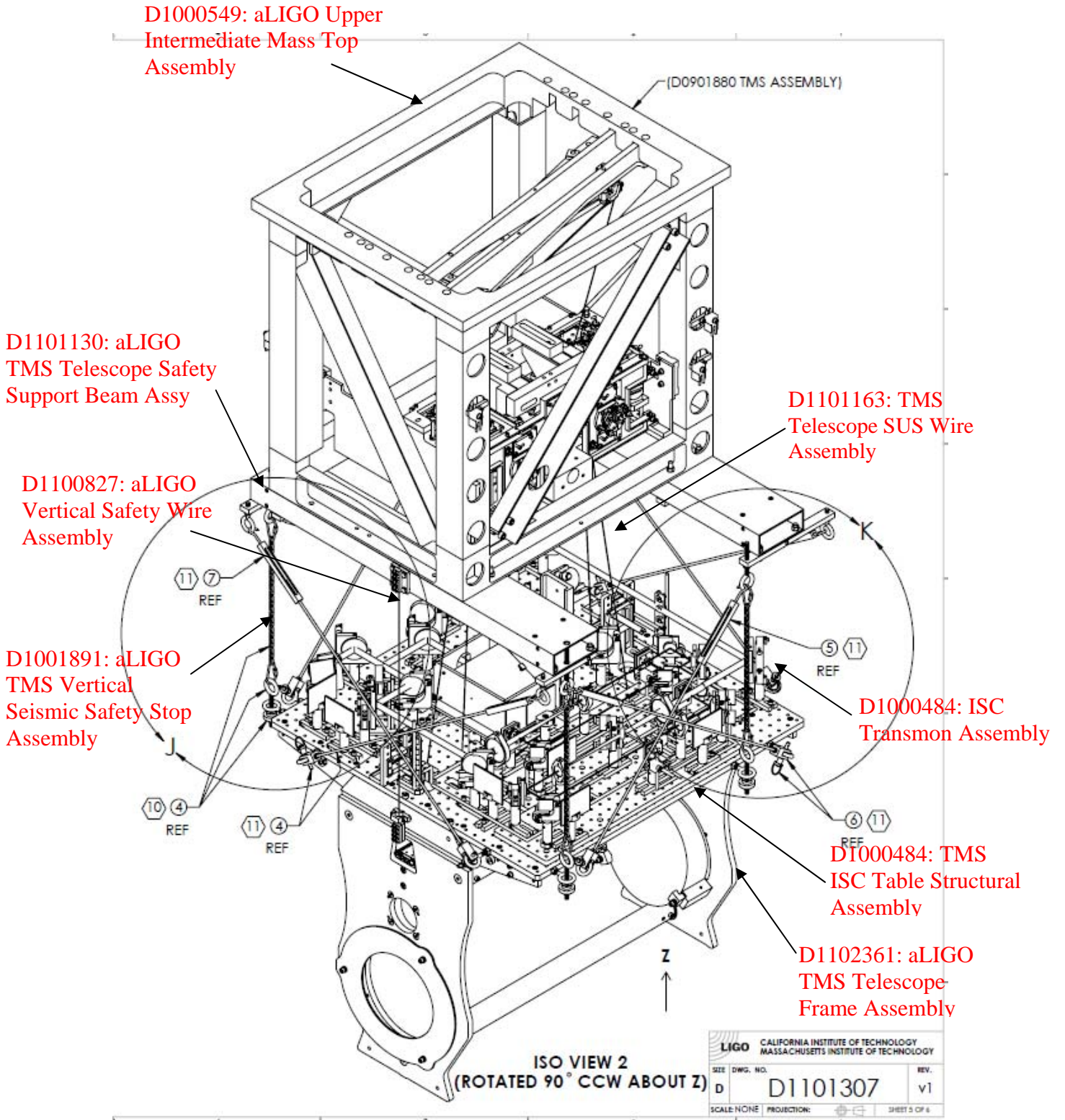


Figure 2: TMS Principal and Accessory Assemblies

3.3 Subassembly Part Number Assignment

Each subassembly will be assigned a unique serial number based on the parent number which can be used for referencing data taken on that subassembly. For example, if 3 UPPER INTERMEDIATE MASS TOP Assemblies are assembled from drawing number D1000549, the units should be assigned serial numbers like:

D1000549-001

D1000549-002

D1000549-003, and so on.

As individual parts are added to the subassembly, record their serial numbers as part of that subassembly. The overall subassembly number (i.e. D1000549-001) can now be used in the ICS to track further operations performed on that subassembly. These subassemblies will eventually become associated with their parent D0901880: aLIGO AOS Transmission Monitor System Assembly, which will have its own serial number, such as D0901880-001 (aka TMS 001). Label the bag with the newly designated subassembly and serial number after wrapping and bagging.

3.4 Weighing Subassemblies

When weighing subassemblies, use the high precision scale dedicated for the SUS assemblies.

4 D1101064: aLIGO TMS FIRST ARTICLE & PRODUCTION INSTALLATION AND ASSEMBLY TOOLING


Table 1: D1101064: aLIGO TMS FIRST ARTICLE & PRODUCTION INSTALLATION AND ASSEMBLY TOOLING

29	D1200565		aLIGO TMS tele input end mirror tool	N/A	1		1
28	D1002097		aLIGO_TMS_TEST_MASS_ASEM	-	1		1
27	92200A542 (McM-Cam) or equiv per M616995-52		SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 1 LONG	300 SSSL	4	2	6
26	D1101757	v1	aLIGO TMS UPPER SUS WIRE ADJUSTER	6061-T6 Al	4	-	4
25	D1101575	v1	aLIGO ALLEN WRENCH, FOR TMS VERT.-HOR. SCREW	Alloy Steel	1	-	1
24	D1100989	v1	NICKEL-COPPER ALLOY 400 .312-18 HEX NUT, MODIFIED	NICKEL-COPPER ALLOY 400	6	4	10
23	96861A700 (McM-Cam) or equiv		VENTED FLAT WASHER .328 ID, .562 OD, .032 TH	18-8 SSSL	6	4	10
22	33045T72 (McM-Cam) or equiv		EYEBOLT, NON-SHOULDERED, 780# 5/16-18 X 1.88" THREAD	304 SSSL	6	-	6
21	D1101506	v1	aLIGO TMS TELE SAFETY SUPPORT TURNBUCKLE ASSY, SIDE SHORT	N/A	2	-	2
20	D1101559	v1	aLIGO TMS TELE SAFETY SUPPORT TURNBUCKLE ASSY, SIDE LONG	N/A	2	-	2
19	D1101565	v1	aLIGO TMS TELE SAFETY SUPPORT TURNBUCKLE ASSY, FRONT	N/A	4	-	4
18	D1001891	v1	aLIGO TMS VERTICLES SEMIC SAFETY STOP ASSEMBLY	N/A	4	1	5
17	D1101361	v1	TMS TOOLING TELESCOPE I-P ALIGNMENT MIRROR ASSEMBLY	N/A	1	1	2
16	D1101487	v1	TMS TOOLING TELESCOPE O-P ALIGNMENT MIRROR ASSEMBLY	N/A	1	1	2
15	D1100728	v1	TMS TELESCOPE DUMMY SECONDARY MIRROR	6061-T6 Al	1	1	2
14	D1100729	v1	TMS TELESCOPE MIRROR GAUGE ROD (NOT USED)	6061-T6 Al	1	1	2
13	D1100933	v1	TMS TELESCOPE BENCH SUPPORT ASSEMBLY	N/A	4	1	5
12	92778A071 (McM-Cam) or equiv		SCREW, SOCKET SET, OVAL POINT, #6-32 UNC X 0.25 LONG	300 SSSL	2	2	4
11	D-271 (Davidson Optronics)		AUTOCOLLIMATOR	N/A	2	-	2
10	D1100531	v1	aLIGO TMS OPTICAL TABLE SUPPORT BRIDGE ASSY	N/A	1	-	1
9	D1100649	v1	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE ASSY	N/A	1	-	1
8	D1100841	v1	aLIGO TMS TELE-OPT TABLE INSTALL TOOL ASSY	N/A	1	-	1
7	D1100886	v1	MODIFIED GENIE LIFT FORKS	N/A	1	-	1
6	D1100613	v1	aLIGO TMS TELESCOPE ASSEMBLY ALIGNMENT STABILIZATION TOOL	N/A	1	-	1
5	D1101510	v1	aLIGO TMS TELE ALIGNMENT 6in MIRROR MOUNT ASSY	N/A	1	-	1
4	D1100460	v1	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE ASSY	N/A	1	-	1
3	D1101486	v1	aLIGO TMS EARTHQUAKE STOP TOOLING GAUGE	6061-T6 Al	1	-	1
2	D1001781	v2	aLIGO TMS SEMIC SAFETY STOP STRUCTURE	N/A	1	-	1
1	D0900419	v1	Adv LIGO SUS BS C6-H2, XYZ Local Csm for ETMTel Assy	N/A	1	-	1
ITEM NO.	PART NUMBER	REV	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL

PARTS LIST				PART NAME			
 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY				aLIGO TMS FIRST ARTICLE INSTALLATION AND TOOLING			
DESIGNED	DATE	BY	SCALE	DESIGNED	DATE	BY	SCALE
ADVANCED LIGO		ACS		D			
CHECKED	DATE	BY	SCALE	CHECKED	DATE	BY	SCALE
MATERIAL: N/A FINISH: N/A TOLERANCES: N/A				D1101064 v5 SCALE: 40:1 PROJECTION:			

4.1 D1101361: TMS TOOLING TELESCOPE I-P ALIGNMENT MIRROR ASSEMBLY

7	9	92200A198		McMASTER, SOCKET HEAD CAP SCREW, #8-32 X .88 LG, NAS 1352C-08-14	300 SSSL	3	2	5
7	8	90135A455		McMASTER, SHIM WASHER, .171 ID X .241 OD X .030 THK, SSSL	18-8 SSSL	3	3	6
	7	D1101362	v1	TMS TOOLING FIXTURE CLAMP	6061-T6 Al	3	-	3
7	6	92200A541		McMASTER, SOCKET HEAD CAP SCREW, .25-20 UNC X .88 LG, NAS 1352C-4-14	300 SSSL	3	2	5
7	5	MS 15795-854		WASHER, 1/4, FLAT, .296 ID X .438 OD X .032 THK, SSSL	300 SSSL	3	3	6
7	4	9263K696 (McM-Carr) or equiv		O-RING, 2.5MM WIDTH, 7MM I.D. APPROVED VITON ELASTOMER, SHORE A 70-75	FLURO-ELASTOMER	3	3	6
	3	D1100418	v1	αLIGO TMS TOOLING TELESCOPE MIRROR CLAMP, 2 IN.	DIE CAST ALUMINUM	1	-	1
	2	D1101109	v1	TMS TELESCOPE INPUT BEAM ALIGNMENT MIRROR	TRANSPARENT GLASS	1	-	1
	1	D1101342	v1	αLIGO TMS TOOLING PRIMARY MIRROR PLATE	DIE CAST ALUMINUM	1	-	1
	ITEM NO.	PART NUMBER	REV	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				PARTS LIST				
DIMENSIONS ARE IN INCHES		1. INTERPRET DRAWING PER ASME Y14.5-1994 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.		LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME TMS TOOLING TELESCOPE I-P ALIGNMENT MIRROR ASSEMBLY		REV. v1
TOLERANCES: XX ± .01 XXX ± .005		MATERIAL N/A		SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER K. MALAND 12 JUL 2011	SIZE DWG. NO. B D1101361	
ANGULAR ± 1.0°		FINISH N/A μinch		NEXT ASSY TMS TOOLING		DRAFTER C. CONLEY 05 AUG 2011	SCALE NONE PROJECTION: 	
						CHECKER SEE DCN	SHEET 1 OF 4	
						APPROVAL SEE DCN		

4.2 D1101487: TMS TOOLING TELESCOPE O-P ALIGNMENT MIRROR ASSEMBLY

NOTES CONTINUED:
 5. BAG AND TAG ASSEMBLY WITH DRAWING NUMBER, REVISION, AND SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. EXAMPLE (TAG): DXXXXXX-VY, S/N 001
 6. APPROXIMATE WEIGHT = .26 LB [.12 KG].

REV.	DATE	DCN #	RCM #
v1	25 JUL 2011	E1100351	E1100695-v1
v2	4-17-13	to follow	E1100695-v2

ITEM NO.	PART NUMBER	REV	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
6	N-832-A (U-C COMPONENTS) or equiv		HEX NUT, #8-32	Ag-PLATED 300 SSSL	3	3	6
5	92196A203 (McM-Carr) or equiv		SCREW, SOCKET HEAD CAP, #8-32 UNC-2A X 1.5 LONG	300 SSSL	3	2	5
4	98019A326 (McM-Carr) or equiv PER MS15795-841		FLAT WASHER .198 I.D., .438 O.D., .049 THICK	300 SSSL	6	3	9
3	AS568A-106		O-RING, 3/32" WIDTH, 3/16" I.D. APPROVED VITON ELASTOMER, SHORE A 70-75	FLUORO-ELASTOMER	3	3	6
2	D1100897	v1	ALIGO TMS TOOLING TELESCOPE MIRROR CLAMP, 56 MM	6061-T6 Al	1	-	1
1	D1100949	v1	TMS TELESCOPE TOOLING MIRROR, 56 MM	FUSED SILICA	1	-	1

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)		PARTS LIST		PART NAME		
DIMENSIONS ARE IN INCHES TOLERANCES: XX .4 (I) XXX .2 (S) ANGULAR: 1.0°		1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005" DIA. FOR MACHINED PARTS, ROUND ALL EDGES APPROXIMATELY EQUAL TO SHARP METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUTES MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SILICON, SODIUM, AND CHLORINE.		LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		TMS TOOLING TELESCOPE O-P ALIGNMENT MIRROR ASSEMBLY
MATERIAL N/A FINISH N/A μinch		SYSTEM ADVANCED LIGO NEXT ASSY D1101361	SUB-SYSTEM AOS	DESIGNER I. MALAND (22 JUL 2011) DRAFTER C. CONLEY (28 JUL 2011) CHECKER SEE DCN APPROVAL SEE DCN	SCALE: NONE PROJECTION: SHEET 1 OF 3	

4.3 D1100933: aLIGO TMS TELESCOPE on BENCH SUPPORT ASSEMBLY (2 Req'd)

NOTES CONTINUED:

5. BAG OR WRAP AND TAG ASSEMBLIES SEPARATELY WITH DRAWING NUMBER, REVISION, SERIAL NUMBER, AND QUANTITY. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. EXAMPLE (TAG): DXXXXXX-VY, S/N 001, QTY:1

6. APPROXIMATE WEIGHT = 1.11 LB [.50 KG].

REV.	DATE	DCN #	DRAWING TREE #
v1	05 AUG 2011	E1100351	E1100701-v1
-	-	-	-
-	-	-	-

ITEM NO	PART NUMBER	REV	DESCRIPTION	MATERIAL	QTY	SPARE	TOTAL
5	92200A542 (McM-Carr) or equiv		SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 1 LONG	300 SSSL	2	1	3
4	D1100712	v1	TMS EARTHQUAKE STOP SCREW	300 SSSL	2	1	3
3	D1101269	v1	NICKEL-COPPER ALLOY 400 .250-20 HEX NUT, MODIFIED	NICKEL-COPPER ALLOY 400	2	2	4
2	94861A600 (McM-Carr) or equiv		VENTED FLAT WASHER .255 ID, .468 OD, .032 TH	18-8 SSSL	4	2	6
1	D1100106	v1	aLIGO ETM TELESCOPE BRIDGE SUPPORT TEE PLATE, BACK	6061-T6 Al	1	-	1

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				BOM		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°				1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, R.02 MIN. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY LIGO SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS NEXT ASSY: TMS TOOLING	
MATERIAL: N/A FINISH: N/A μinch				TMS TELESCOPE BENCH SUPPORT ASSEMBLY		DESIGNER: K. AKASAND 20 JAN 2011 DRAFTER: M. MILLER 05 AUG 2011 CHECKER: SEE DCN APPROVAL: SEE DCN	
				SIZE: B DWG. NO.: D1100933		REV.: v1 SCALE: NONE PROJECTION: SHEET 1 OF 1	

4.5 D1100649: aLIGO TMS TELESCOPE + OPTICAL TABLE, BALANCE BRIDGE ASSEMBLY

NOTES CONTINUED:

① SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR TYPE IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWING ON THE NEXT USE WITH A THREE-DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND INCREASE CONSECUTIVELY. USE MINIMUM 0.17 HIGH CHARACTERS. UNLESS THE SIZE OF THE PART INDICATES SMALLER CHARACTERS. A VIBRATORY TOOL MAY BE USED. EXAMPLE: DXXXXXX-Y, TYPE-XZ, S/N XXX

6. APPROXIMATE WEIGHT = 18.02 LBS.

REV.	DATE	DCN #	DRAWING TREE #
v1	10 JUN 2011	E1100355-v1	-
v2	8-10-12	to follow	-
-	-	-	-

16	92196A544	[mc master carr 1/4-20 x 1.25 long SHCS	18-8 SSSL	4	2	10
15	D1200098	aLIGO TMS OPTICAL TABLE BALANCE BOLT STEP SPACER	6061-T6 Al	1		0
14	D1102252	aLIGO TMS TELE-OPT TABLE BALANCE BOLT	18-8 SSSL	1		0
13	D1102250	aLIGO TMS OPTICAL TABLE BALANCE BOLT SPACER	6061-T6 Al	1		0
12	98126A849	(McMASTER-CARR), WASHER, 1" ID X 1.5 OD x .12 T	18-8 SSSL	4	2	6
11	92384A053	(McM-Carr), QUICK RELEASE PIN, .312 DIA X 1.25 USABLE LGTH, SSSL	SSSL	1		0
10	6111K55	McMASTER, SWIVEL LEVELING MOUNT, .50-13 X 3.125 LG, 1.875 DIA BASE, 2.00 STUD	NICKEL PLATED STEEL	4		0
9	96861A600	(McMASTER-CARR).25 VENTED WASHER, .255 ID X .468 OD X .031 THK	18-8 SSSL	32	8	40
8	C-2012-N	SOCKET HEAD CAP SCREW, 1/4-20 X .75 LG	18-8 SSSL	28	8	8
7	D1100671	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE TIE PLATE	6061-T6 Al	2		0
6	D1100653	aLIGO TMS OPTICAL TABLE SUSPENSION BRIDGE PIN	NICKEL-COPPER	1		0
5	D1100654	aLIGO TMS OPTICAL TABLE SUSPENSION BRIDGE PIN SUPP BAR	303 ROD	1		0
4	D1100655	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE PIN GUIDE BAR	6061-T6 Al	1		0
3	D1100652	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE GUSSET	6061-T6 Al	4		0
2	D1100651	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE TOP BAR	6061-T6 Al	2		0
1	D1100650	aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE LEGS	6061-T6 Al	4		0
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	1/REQ	SPARE	TOTAL

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES. .005-.015 FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHARP METAL PARTS.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING EDGES MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SODIUM, AND CHLORINE.

TOLERANCES:
 XX .002
 XXX .005

ANGULAR ±10°

MATERIAL N/A **RINSE** N/A **μinch**

PARTS LIST

SYSTEM: **ADVANCED LIGO** SUB-SYSTEM: **AOS**

NEXT ASSY: **TOOLING**

PART NAME: aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE ASSY

DESIGNER: J. TERESAAS 12 APR 2011 **SIZE** DWG. NO. **D1100649** REV. **v2**

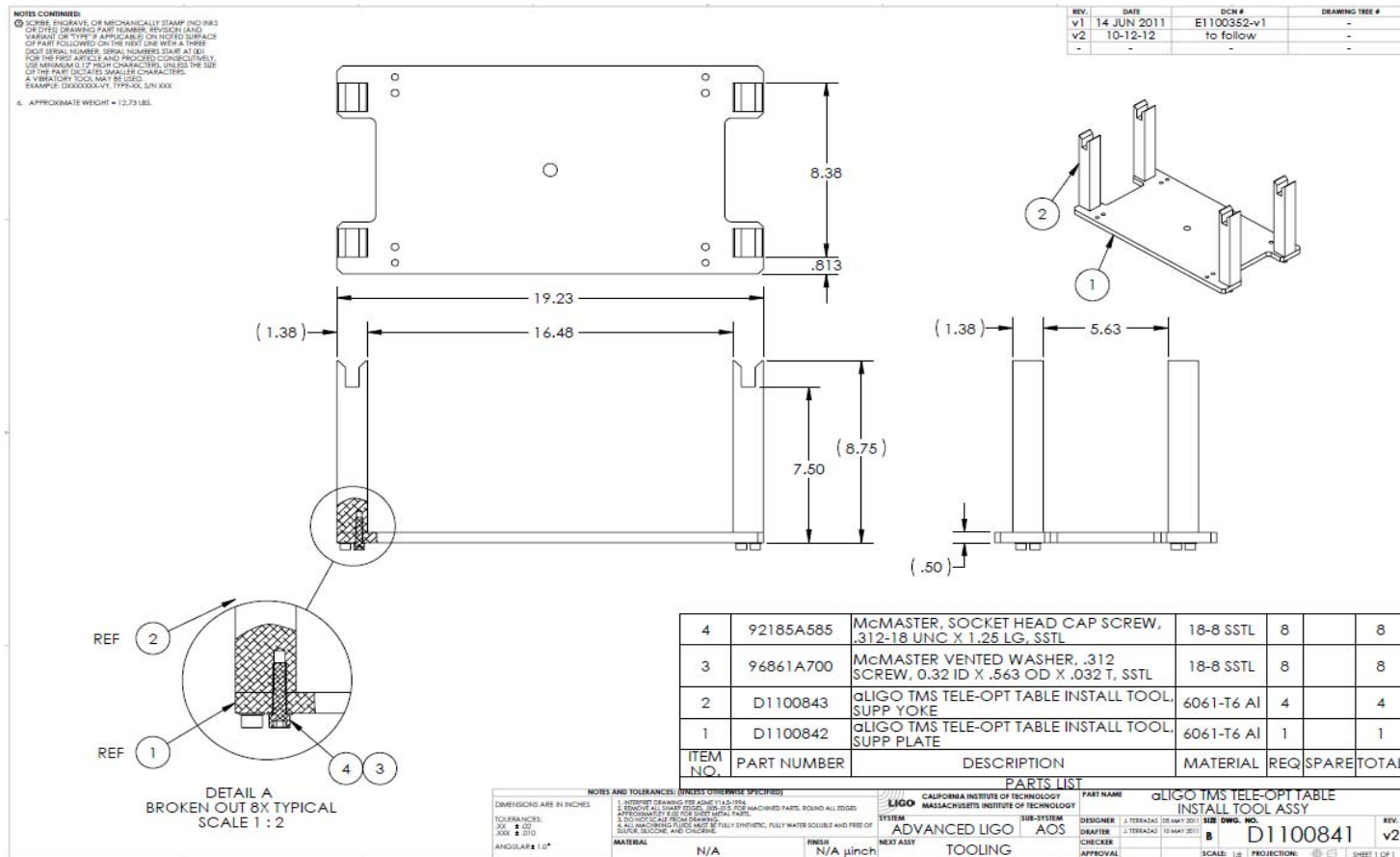
DRAFTER: J. TERESAAS 17 APR 2011 **B**

CHECKER: **SCALE** 1:8 **PROJECTION** **SHEET** 1 OF 2

4.6 D1100841: aLIGO TMS TELE W/OPT TABLE, INSTALL TOOL ASSEMBLY

See: D1100908 For application w/ Genie Lift

Note: Use D1200355 optional Height Spacers + longer screws, under #2, for added Working Room between underside of Tele -Table and Plate #1



4.7 D1100613: aLIGO TMS TELESCOPE ASSEMBLY ALIGNMENT STABILIZATION TOOL

NOTES CONTINUED:
 (C) SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO INK) OR LINES DRAWING PART NUMBER, REVISION (AND VARIANT OR TYPE IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.17" HIGH CHARACTERS. UNLESS THE SIZE OF THE PART INDICATES SMALLER CHARACTERS. A VIBRATORY TOOL MAY BE USED.
 EXAMPLE: DXXXXXXXV1, TYP-XX, S/N XXX

REV.	DATE	DCN #	DRAWING TREE #
v1	6/17/2011	E1100352	-
v2	07-18-12	TO FOLLOW	-
-	-	-	-

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.	SPARE	TOTAL
10	92198A567	HEX HEAD CAP SCREW, .25-20 X 6.50 LG, ASME B18.2.1	4		
9	92778A999	McMASTER-CARR .25-28 X 1.50 LG. S.H.S.S., OVAL POINT	12	0	12
8	N-2528-A	U-C COMP. NUT, HEX .25-28- SILVER PLATED, 18-8 SSSL	12	4	16
7	92198A575	[McM-Carr], .25-20 X 9.0 LG. HEX HEAD CAP SCREW	4	0	4
6	WFB-25	U-C COMP. FLAT WASHER, VENTED .255 ID, .46 OD, .03 THK	28	10	46
5	92196A539	SOCKET HEAD CAP SCREW, 1/4-20 X .625 LG, SSSL	8	4	12
4	D1100403-02	TMS TOOLING TELESCOPE ALIGNMENT SUPPORT NUTPLATE	4	0	4
3	D1100402	TMS TOOLING TELESCOPE ALIGNMENT SUPPORT SPACER	2	0	2
2	D1100414	TMS TOOLING TELESCOPE ALIGNMENT SUPPORT BRACKET	4	0	4
1	D1100400	TMS TOOLING TELESCOPE ALIGNMENT SUPPORT BAR	4	0	4

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES. .001" - .015"
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.

TOLERANCES:
 XXX ± .01
 XXX ± .005
 ANGULAR ± 1.0°

DIMENSIONS ARE IN INCHES

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	PART NAME aLIGO TMS TELESCOPE ASSEMBLY ALIGNMENT STABILIZATION TOOL	DESIGNER L. WALKER 3/20/2011	REV.
SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DRAWER M. WALKER 5/24/2011	REV. v2
NEXT ASSY TOOLING	SCALE 1:8	PROJECTION 1st	SHEET 1 OF 2

4.8 D1101510: aLIGO TMS TELE ALIGNMENT 6in MIRROR MOUNT ASSY

NOTES CONTINUED:

① SCRIBE, ENGRAVE, LASER MARK OR MECHANICALLY STAMP (NO DIMS OR INGS) A UNIQUE THREE DIGIT SERIAL NUMBER & REVISION NUMBER ON EACH PART. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. BAG AND TAG PARTS WITH THEIR DRAWING PART NUMBER, REVISION, VARIANTE OR TYPE (IF APPLICABLE) AND QUANTITY. IF PARTS ARE TOO SMALL TO SCRIBE BAGGING AND TAGGING ALONE IS SUFFICIENT. EXAMPLE (PART: 001-V1) EXAMPLE (TAG): D000000-V1, TYPE:00, QTY: 100

6. APPROXIMATE WEIGHT = X.XXXX LB.

REV.	DATE	DCN #	BOM #
v1	27 JUL 2011	E1100351	E1100750-v1
-	-	-	-
-	-	-	-

EXPLODED

ASSEMBLED

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
4	UCC WFV-25	Flat Washer, Vented .255 ID, .46 OD, .032 THK	18-8 SSSL	3	2	5
3	92185A537	McMASTER, SOCKET HEAD CAP SCREW, .25-20 X .50 LG, SSSL	316 SSSL	3	2	5
2	112-4450	6in GIMBALED MIRROR MOUNT (OPTOSIGMA)	ALUMINUM	1	0	1
1	D1101447	aLIGO TMS TELE ALIGNMENT MIRROR MOUNT, 6"	6061-T6 Al	1	0	1

NOTES AND TOLERANCES (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES; .005-DIS FOR MACHINED PARTS; ROUND ALL EDGES APPROXIMATELY #20 ACP SHEET METAL PARTS.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUTES MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF BURRS, BLOBS, AND CHIPS.

DIMENSIONS ARE IN INCHES

TOLERANCES:
 XX ± .02
 XXX ± .010
 ANGULAR ± 1.0°

MATERIAL: N/A **FINISH:** N/A µinch

PARIS LIST		PART NAME: aLIGO TMS TELE ALIGNMENT 6in MIRROR MOUNT ASSY	
SYSTEM: ADVANCED LIGO	SUB-SYSTEM: AOS	DESIGNER: J. TERRAZAS	DATE: 26 JUL 2011
NEXT ASSY: D1003120 TOOLING	CHECKER:	DRAWN: J. TERRAZAS	DATE: 27 JUL 2011
		SHEET NO. B D1101510	
		SCALE: 1:1 PROJECTION: 1st ANGLE SHEET 1 OF 2	

4.9 D1100460: aLIGO TMS TELESCOPE ALIGNMENT, SUPPORT BRIDGE ASSEMBLY

NOTES CONTINUED:
 ① SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR TYPE IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE BY A THREE-DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART INDICATES SMALLER CHARACTERS. A VIBRATORY TOOL MAY BE USED.
 EXAMPLE: DXXXXXX-V1, TYPE-XX, S/N XXX

approx 37 lbs

REV.	DATE	DCN #	DRAWING TREE #
v-1	04/13/2011	E1100352-v1	
v2	10-11-12	TO FOLLOW	

DETAIL B
SCALE 3 : 8

11	92196A552	(McMASTER-CARR),.25-20 2.5 L. S.H.C.S	18-8 SSSL	4		0
10	98126A849	(McMASTER-CARR), WASHER, 1" ID X 1.5 OD X .12 T	18-8 SSSL	4		0
9	6111K188	McMASTER, SWIVEL LEVELING MOUNT, .50-20 X 3.125 LG, 1.875 DIA BASE, 2.00 STUD	NICKEL PLATED STEEL	4		0
8	96861A600	(McMASTER-CARR),.25 VENTED WASHER,) .255 ID X .468 OD X .031 THK	18-8 SSSL	20		0
7	C-2012-N	SOCKET HEAD CAP SCREW, 1/4-20 X .75 LG	18-8 SSSL	20		0
6	92196A546	(McM-Carr) .25-20-1.5"L. S.H.C.S.	18-8 SSSL	4		0
5	D1100465	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE GUSSET	6061-T6 Al	4		0
4	D1100464	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE SIDE BRACE	6061-T6 Al	6		0
3	D1100552	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE TOP BAR, ENTRY	6061-T6 Al	1		0
2	D1100463	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE TOP BAR, PRIMARY	6061-T6 Al	1		0
1	D1100462	aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE LEGS	6061-T6 Al	4		0
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	ASSY FULL/REQ	SPARE	TOTAL

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
 .XXX ± .01
 .XXX ± .005
 ANGULAR ± 1.0°

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES, R1.0 MIN.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SEUCONE, AND CHLORINE.

MATERIAL: N/A
 FINISH: N/A μinch

PARTS LIST

SYSTEM: ADVANCED LIGO
 SUB-SYSTEM: AOS
 NEXT ASSY:

PART NAME: aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE ASSY

DESIGNER: J. TERBAZAS | 10/08/2011
 DRAFTER: J. TERBAZAS | 5/19/2011
 CHECKER:
 APPROVAL:

SCALE: 1:12 PROJECTION: 1st ANGLE SHEET 1 OF 2

4.10 D1100886: MODIFIED GENIE LIFT FORKS

See: D1100908 For application w/ Genie Lift

NOTES CONTINUED

REV.	DATE	DCN #	DRAWING TREE #
v1	11 MAY 2011		

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY	UNIT
8	OUTER EXTENSION TUBE	OUTER EXTENSION TUBE	#06176 Al	2	2
7	INNER EXTENSION TUBE	INNER EXTENSION TUBE	#06176 Al	2	2
6	SPRING PLUNGER	5/8-11 W/KNURLED KNOB SPRING PLUNGER	316 SST OR 302 SST	2	2
5	GENIE FORK	GENIE FORK	Alloy Steel	2	2
4	9480A320	HEX NUT, .205-16 X .563 WD X .328 HT, 316 SST	316 SST	2	2
3	92210A624	3/8-16 X 1 PHCS SCREW	18-8 SST	2	2
2	9058BA990	10-32 X 5/8 FLY SPOCKET HEAD CAP SCREW	316 SST	2	2
1	GENIE FORK SUPPORT	GENIE FORK SUPPORT	Alloy Steel	1	1

DIMENSIONS ARE IN INCHES		TOLERANCES:		ANGULAR ± 0.5°	
.XX	± .01	.XXX	± .005		

MATERIAL		FINISH		HEAT TREAT	
N/A		N/A	µinch		

DESIGNER		DRAWN		CHECKED		APPROVED	
E. NICOLAND	1 JAN 2011	E. NICOLAND	31 JAN 2011				

SYSTEM		MATERIAL		SIZE		DWG. NO.		REV.	
ADVANCED LIGO	SUS			D		D1100886		v1	

SCALE: 1:1 PROJECTION:

SHEET 1 OF 2

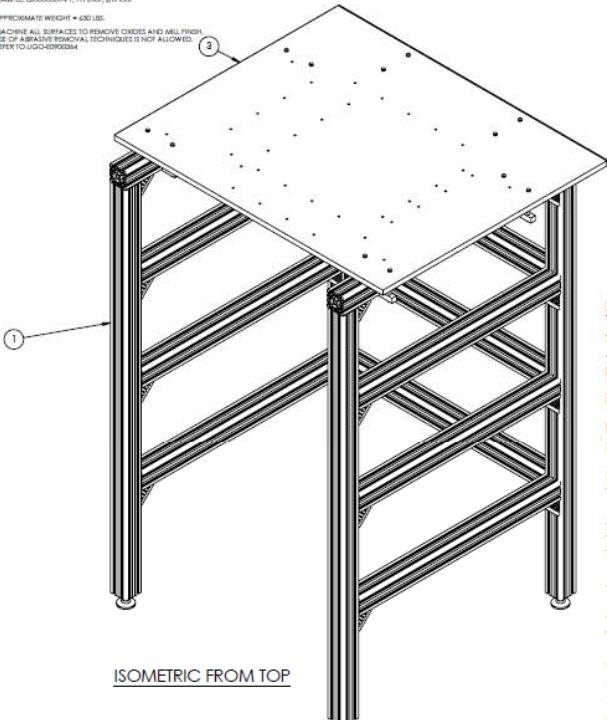
4.11 D1100807: aLIGO TMS Setup Table Bosch-Frame Assembly

NOTES CONTINUED:

3. SCORE, ENGRAVE, OR MECHANICALLY STAMP (INDUPLY OF DYES, DRAWING PART NUMBER, REVISION, AND VALUE OF TOLERANCE IF APPLICABLE) ON NOTED SURFACES OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 00 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 1/16" HIGH CHARACTERS. USE THE SIZE OF THE PART INDICATED SMALLER CHARACTERS. A VISIBLITY TOOL MAY BE USED. EXAMPLE: DXXXXXXXXXX-Y1-TYPE-XX, L/N XXX

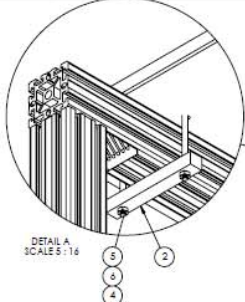
4. APPROXIMATE WEIGHT = 630 LBS.

5. MACHINE ALL SURFACES TO REMOVE CHIPS AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-ED900044



ISOMETRIC FROM TOP

DETAIL A
SCALE 5:16



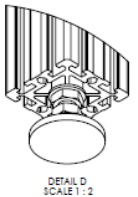
TMS Bosch Frame
Frame mass ~330 lbs. Table Top mass ~300 lbs. Total ~630 lbs
See Sheet 2 & 3 for Dimensions

Prep
There must be access in the room for this plate and the genie lift to be alongside the BOSCH frame to then do the lift. Also since this is a "semi dirty" procedure ensure there are no parts or sub-assemblies etc out on the tables.

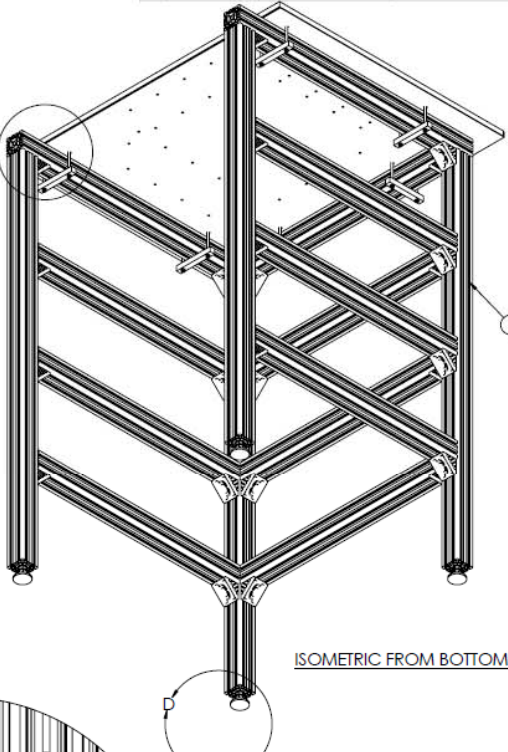
Procedure

1. Adjust feet prior to starting to ensure all 4 legs are equal in height. This should be done prior to cross braces being put in place or table top is installed.
2. One Genie lift (one with adjustable legs), forks reversed (i.e. vertical bars of the forks pointing down).
3. All people in the room lift the plate together by hand and put the plate down on the forks. We might have used C-clamps to fix the plate to the forks but I'm not sure.
4. Lift.
5. Move Genie so the plate goes between Bosch frame and the ceiling. Remove C-clamps if you used them.
6. Maneuver Genie to for finer adjustment.
7. Lower.
8. Move Genie out of the way.
9. Joy. Dance if necessary.
10. If a height adjustment is done after plate is in place then Care should
11. Bubble level should be used to check plate surface.

Adjustable Foot Typ



DETAIL D
SCALE 1:2



ISOMETRIC FROM BOTTOM

REV.	DATE	DCN #	DRAWING TREE #
v1	09 JULY 2011	E1100522-v1	-
v2	-	-	-
v3	11-8-12	to follow	-

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
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REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
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3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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REV.	DATE	DCN #	DRAWING TREE #
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5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
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2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

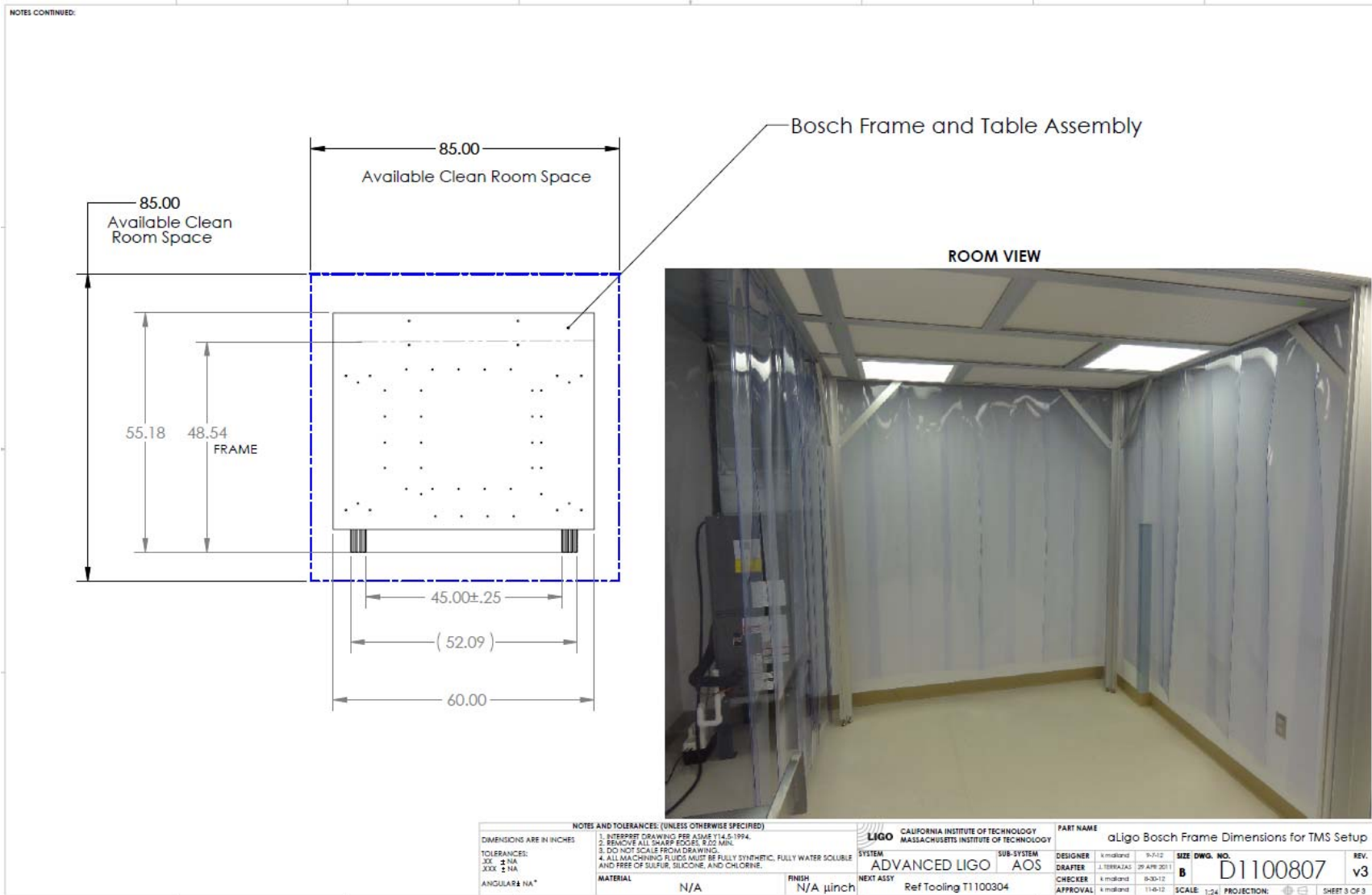
REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
4	14/08/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
3	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
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REV.	DATE	DCN #	DRAWING TREE #
6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
5	12/19/14	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	12
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6	14/08/14	LC COMPONENTS/M-361-A, HEX NET, 375-16 UNC	12
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REV.	DATE	DCN #	DRAWING TREE #
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2	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24
1	01/10/12	GENIE, HEX HEAD CAP SCREW, 375-16 X 4.00	24

REV.	DATE	DCN #	DRAWING TREE #
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4.12 Other Tools

Ian's list

- Test stand:** Mechanical Test Stand mounted with Solid Stack Assembly
- Manual fork truck:** Similar to Caltech Genie
- Bench:** May be an optics bench but this is not mandatory
- Tools:** All the appropriate hand tools and measuring devices
- Masses:** These will be necessary to load blades flat.
- Lower structure assembly tooling:**
- Wire jig:**

Brett's list

$\frac{9}{32}$ inch nut driver or wrench for axial OSEM positioning.

$\frac{7}{16}$ inch nut driver or wrench for lateral OSEM positioning.

$\frac{9}{64}$, $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{5}{16}$ inch allen wrenches.

A flat head screw driver for turning the top mass pitch adjusters.

Torque wrench for the blade clamp bolts capable of 400 in-lb (33 ft-lbs, 45 Nm).

Slip or block gauges for measuring 5 mm, 9.6 mm, and 15 mm gaps.

Dentist Mirror.

Flashlight or small lamp.

Structure pushers for rotating the structure on the optical table (see Figure 14).

5 axis table for safety while rotating the structure.

Lower structure tooling for use with the 5 axis table.

Safety goggles for working around the wires.

An optical alignment tool with 10 μ Rad accuracy, such as an autocollimator.

A small, light, reliable level to place on suspended masses (optional).

5 Assembly Procedure for TMS

5.1 Assembly Procedure for TOP MASS ASSEMBLY

The D1000549 Upper Intermediate Mass Top Assembly consists of:

- 1) D1200453 aLIGO TMS Upper Structure Weldment
- 2) D060324 SUS, Quad N-Ptype Top Stage, Blade Cartridge
- 3) D1101526 aLIGO TMS Mass Balanced Assembly
- 4) D060310 Advanced LIGO, SUS, QUAD N-PType Tablecloth
- 5) D1101166 TMS Upper Suspension Wire Assembly

In addition, it comprises the Control System Hardware for controlling the TMS Telescope Assembly.

Refer to E1100651

5.1.1 D1200453 aLIGO TMS Upper Structure Weldment

The aLIGO TMS Upper Structure Weldment is shown in **Figure 3**.

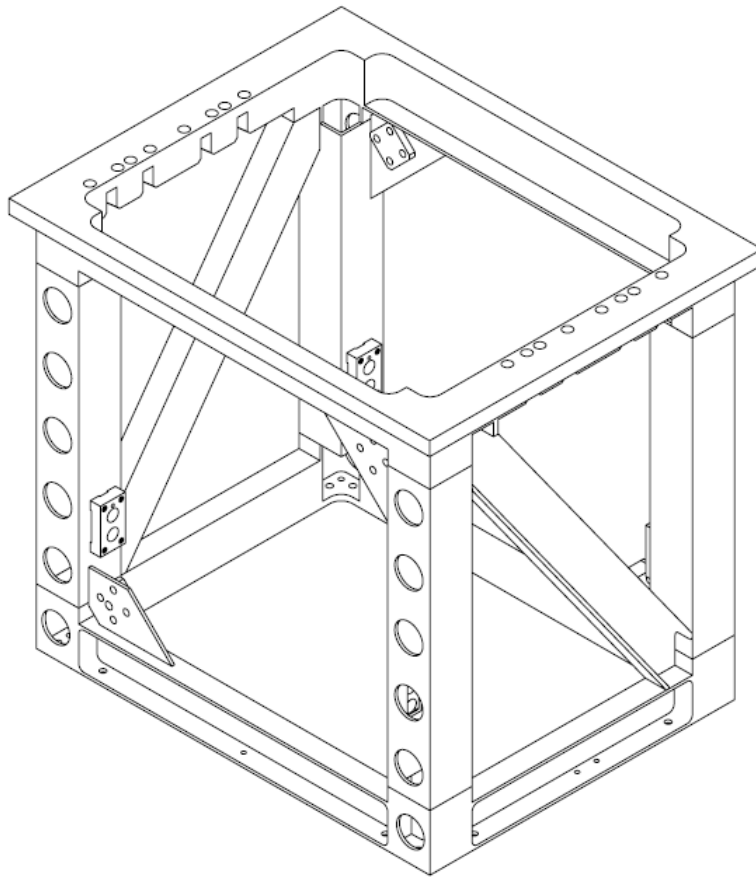


Figure 3: TMS Upper Structure Weldment

5.1.2 D060324 SUS, Quad N-Ptype Top Stage, Blade Cartridge

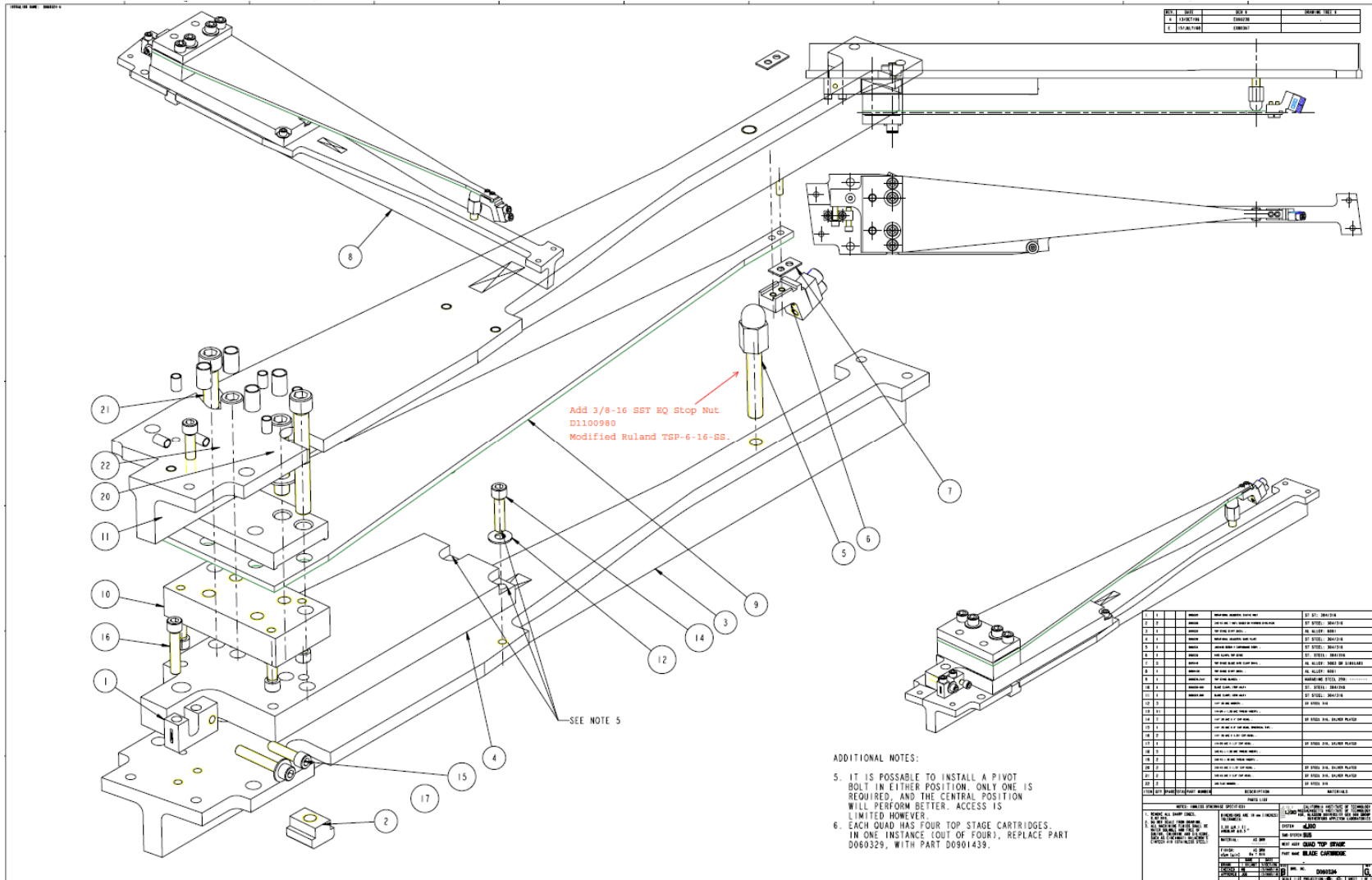


Figure 4: Quad N-Ptype Top Stage, Blade Cartridge Assembly

5.1.2.1 Pre-loading of Top Mass Suspension Blades

The pre-load (blade straightening) of the Top Mass Suspension Blade is applied by using the Straightening Tooling Assy - Quad Top Stage Blade Tooling D060370, as shown in **Figure 5** and **Figure 6**. The top blade springs are each pre-loaded with approximately 140 lbs.

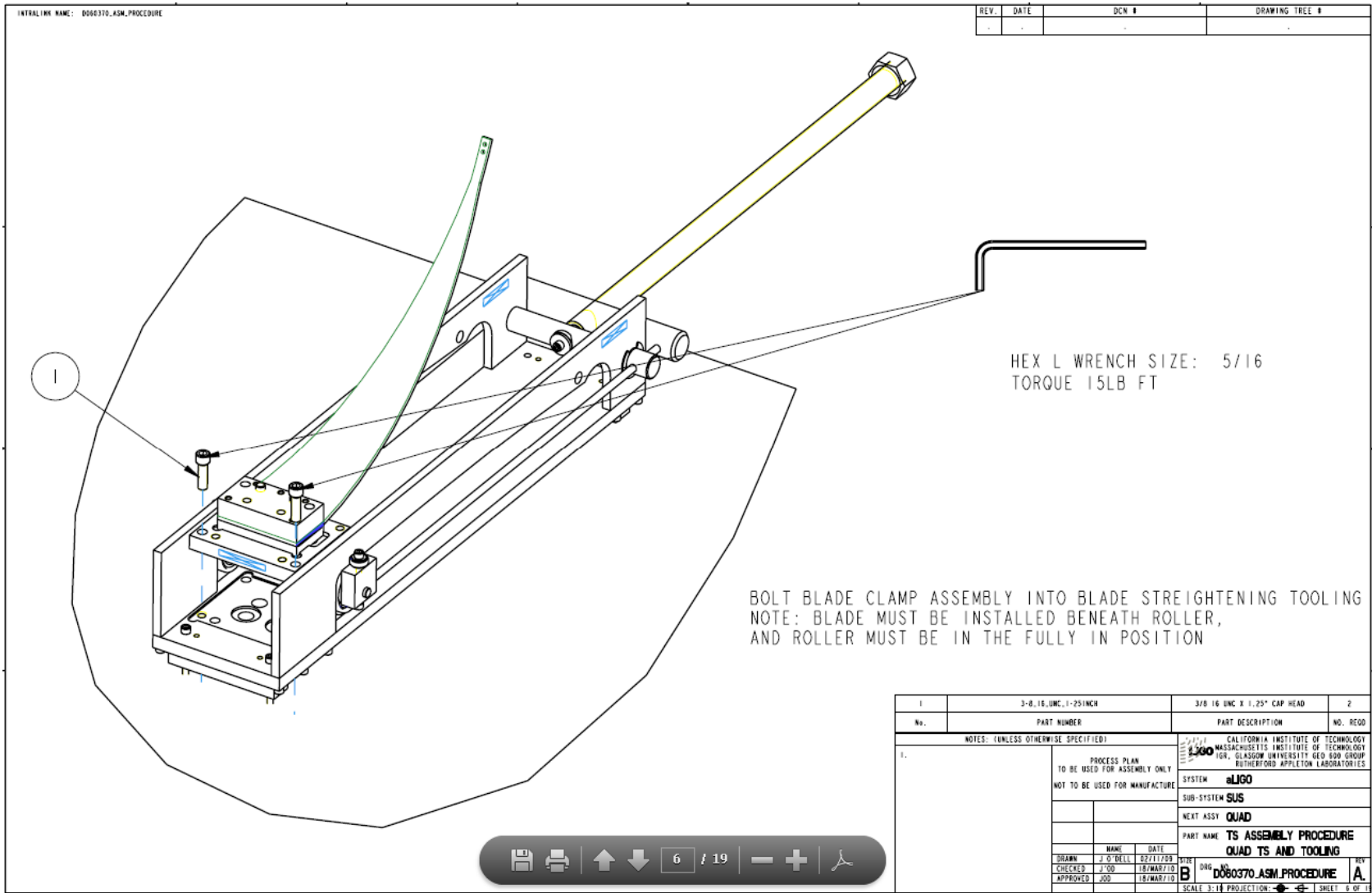


Figure 5: Insertion of Blade in Straightening Fixture

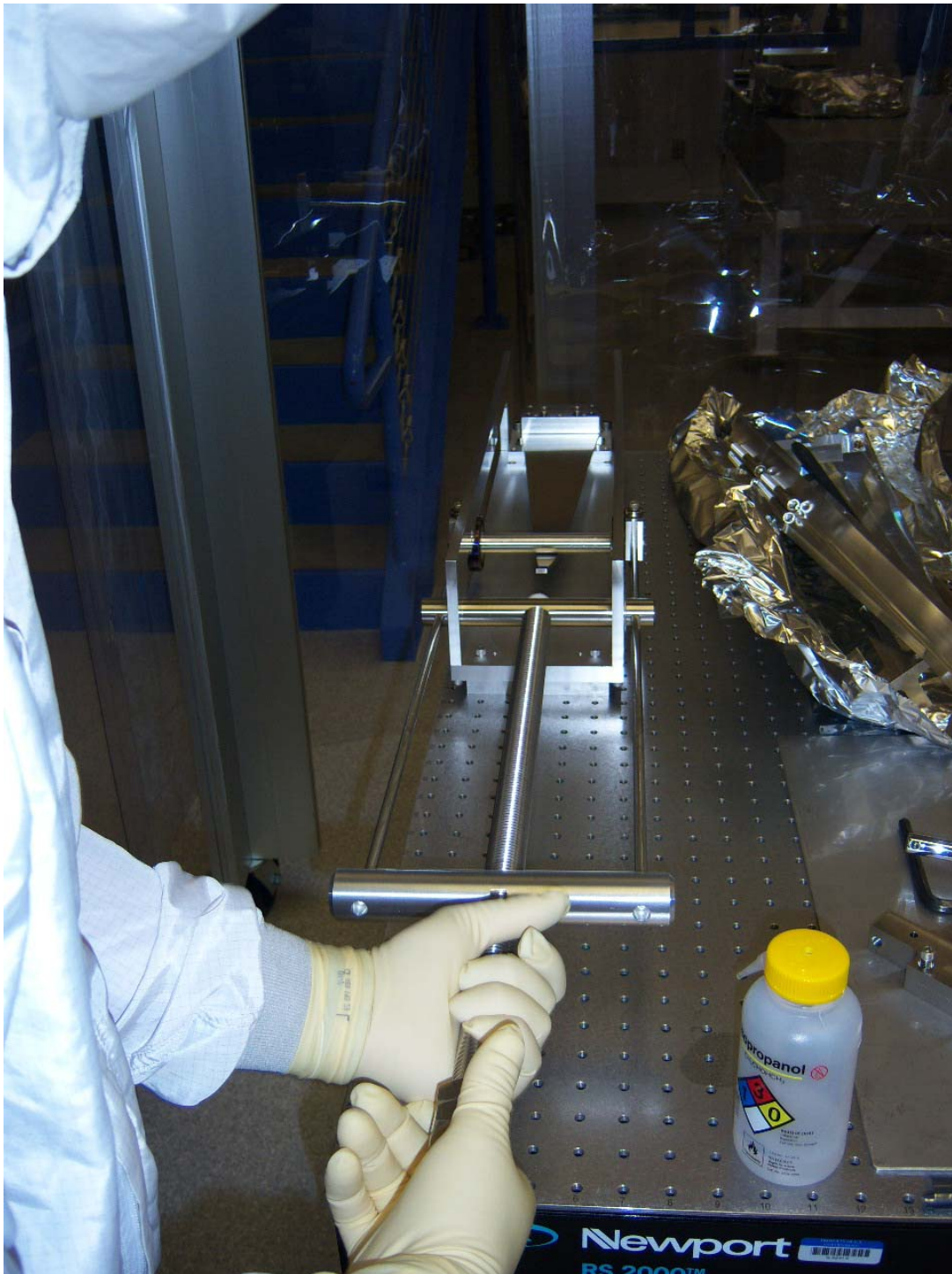


Figure 6: Straightening of Blade Spring

After straightening the blade, it is inserted into the cartridge holding assembly. The completed blade cartridge assembly is shown in **Figure 7**.

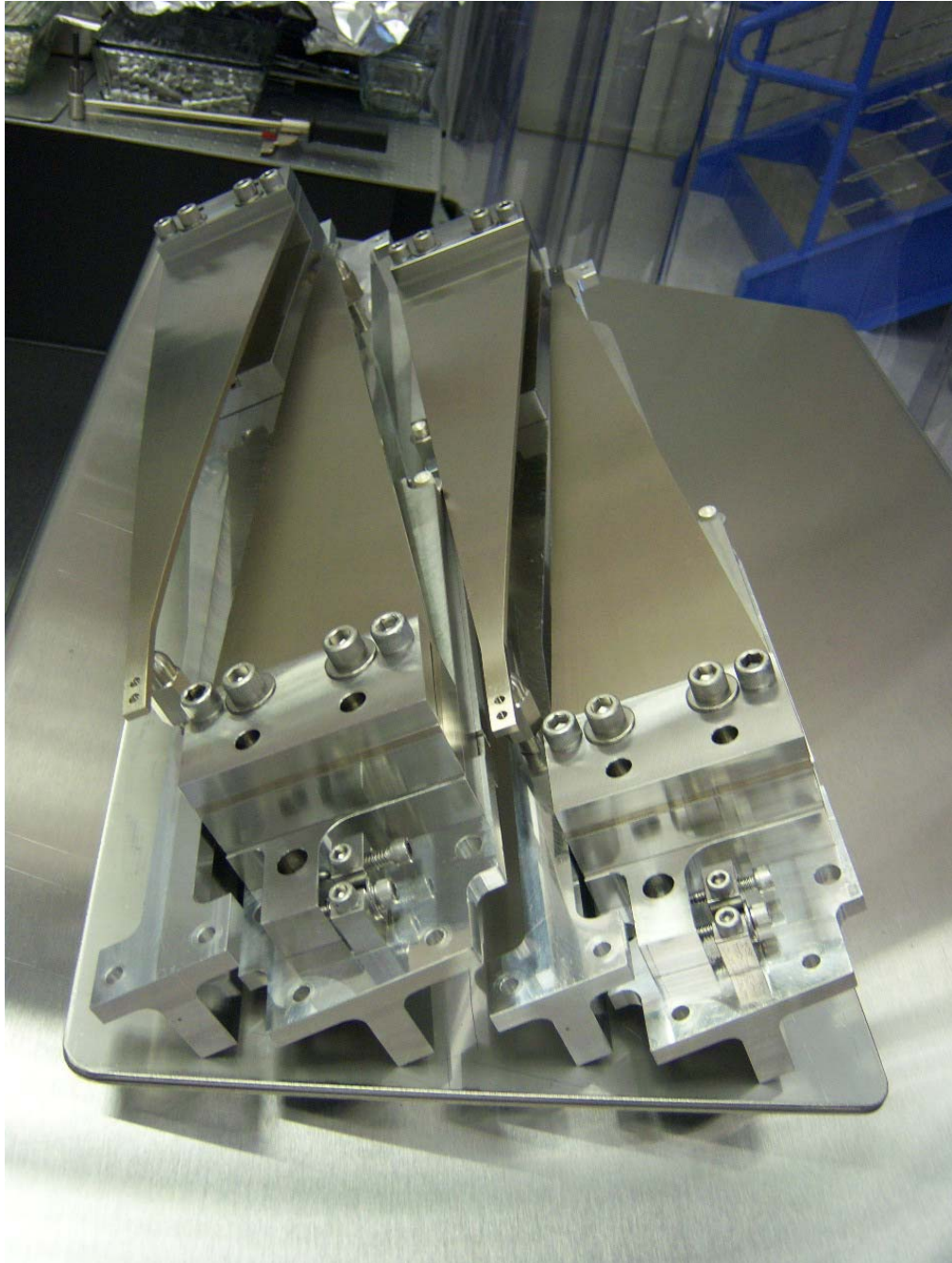


Figure 7: Completed Blade Cartridge Assembly

5.1.3 D1101526 aLIGO TMS Mass Balanced Assembly. Note: this is the Production Assembly (all but the WBSC6)

Top Mass Assembly Drawings in Order:

1. D1100525
2. D1200527
3. D1200526

The assembly procedure is described in D060370 Picture Book.

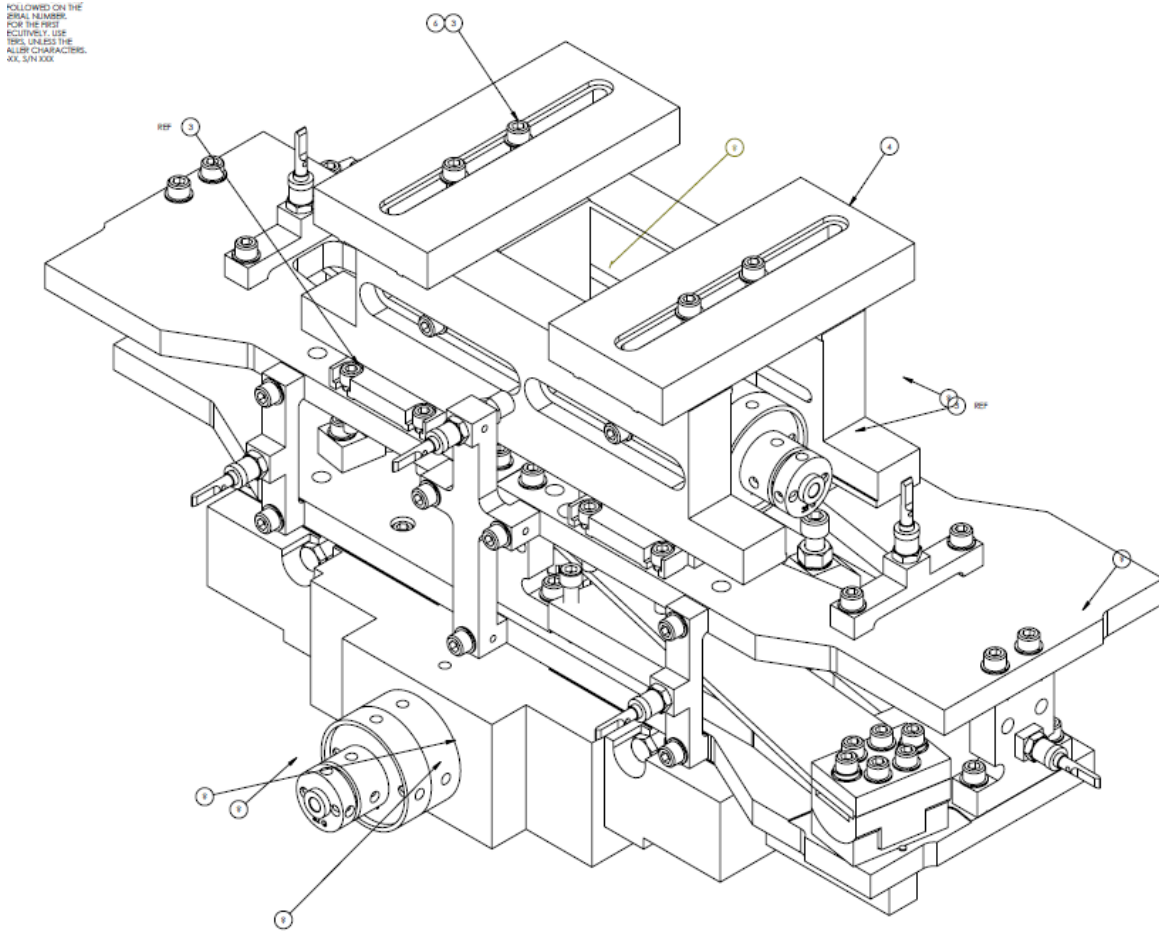
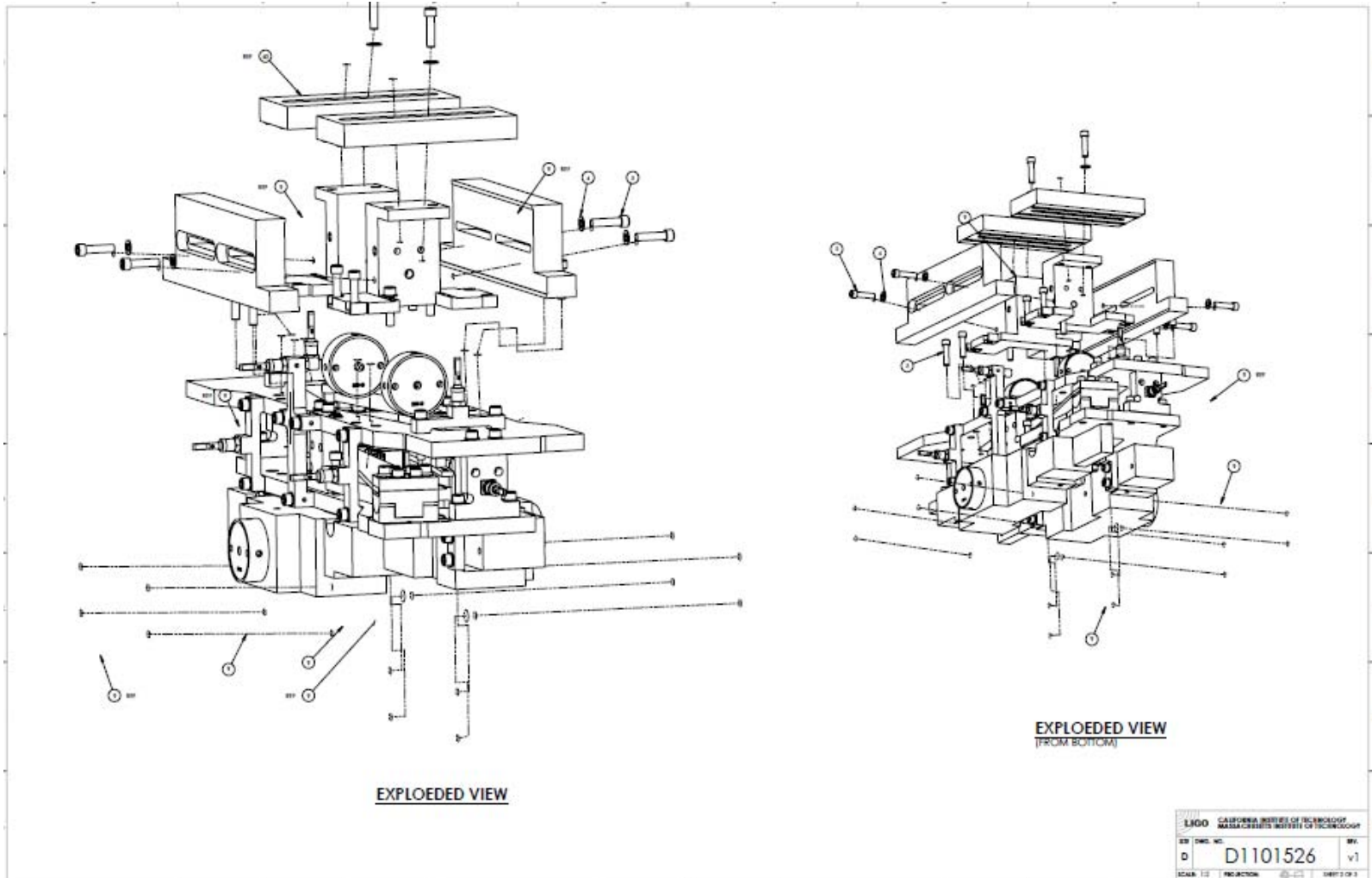
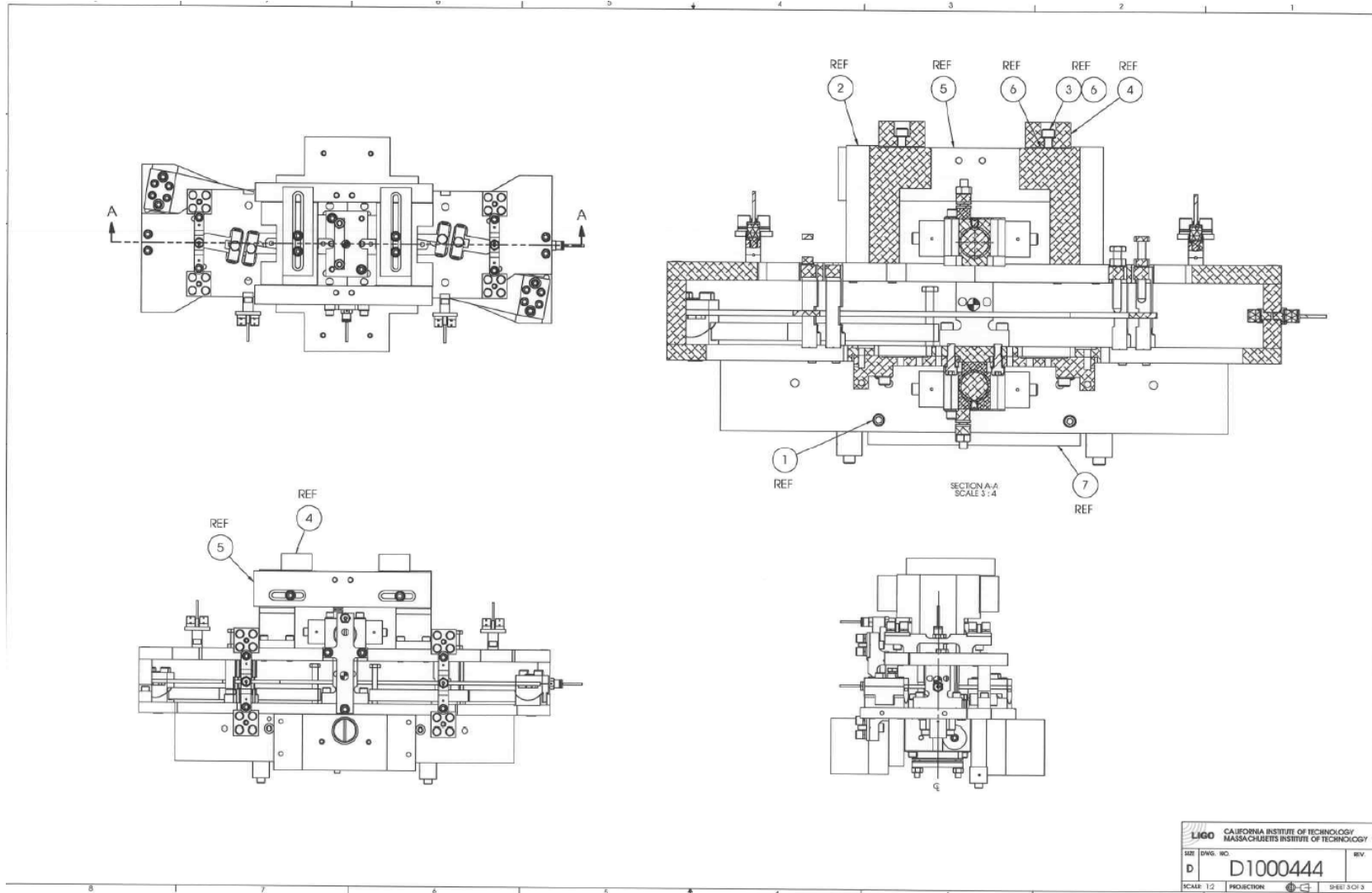


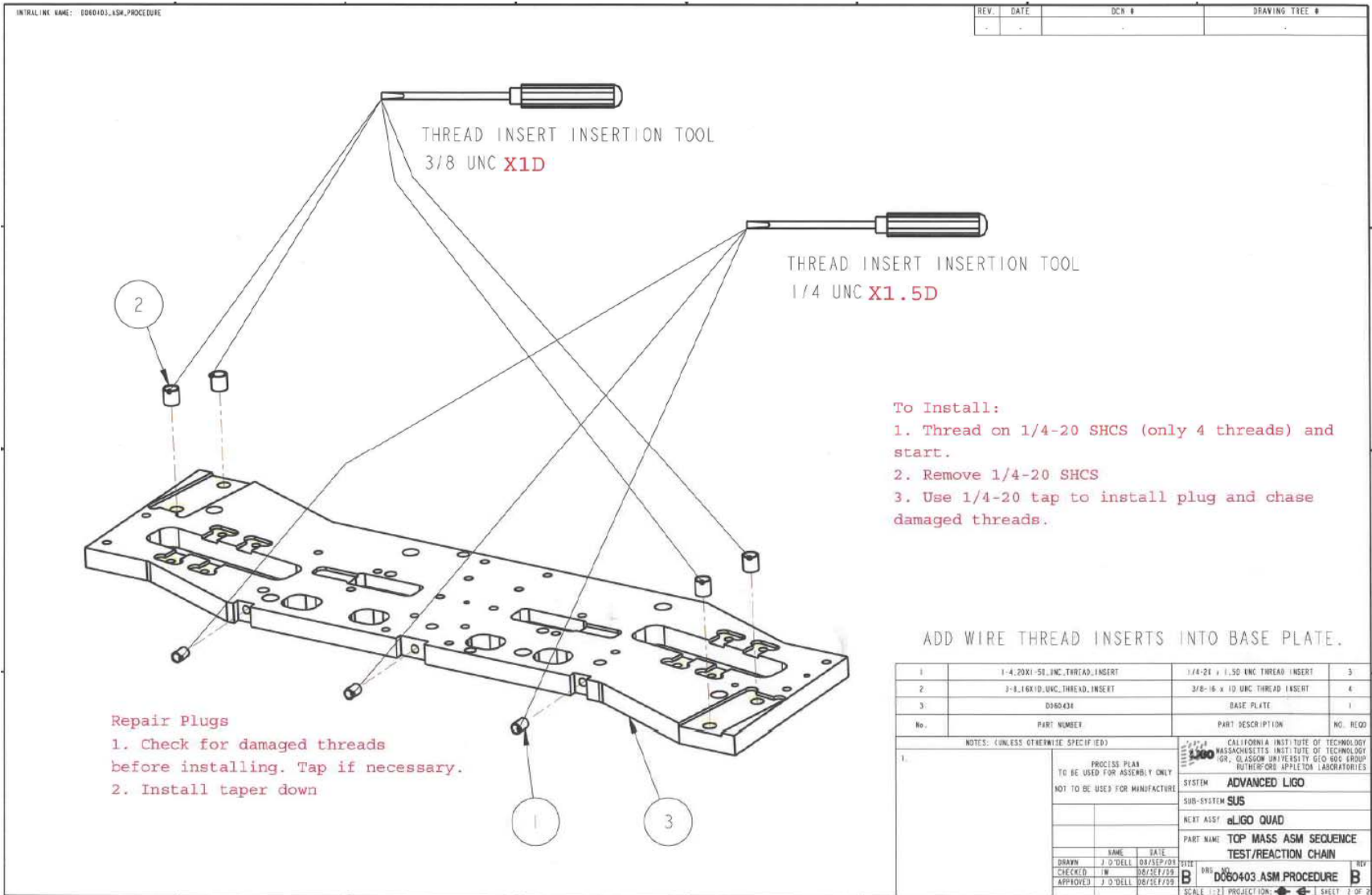
Figure 8: aLIGO TMS Mass Balanced Assembly

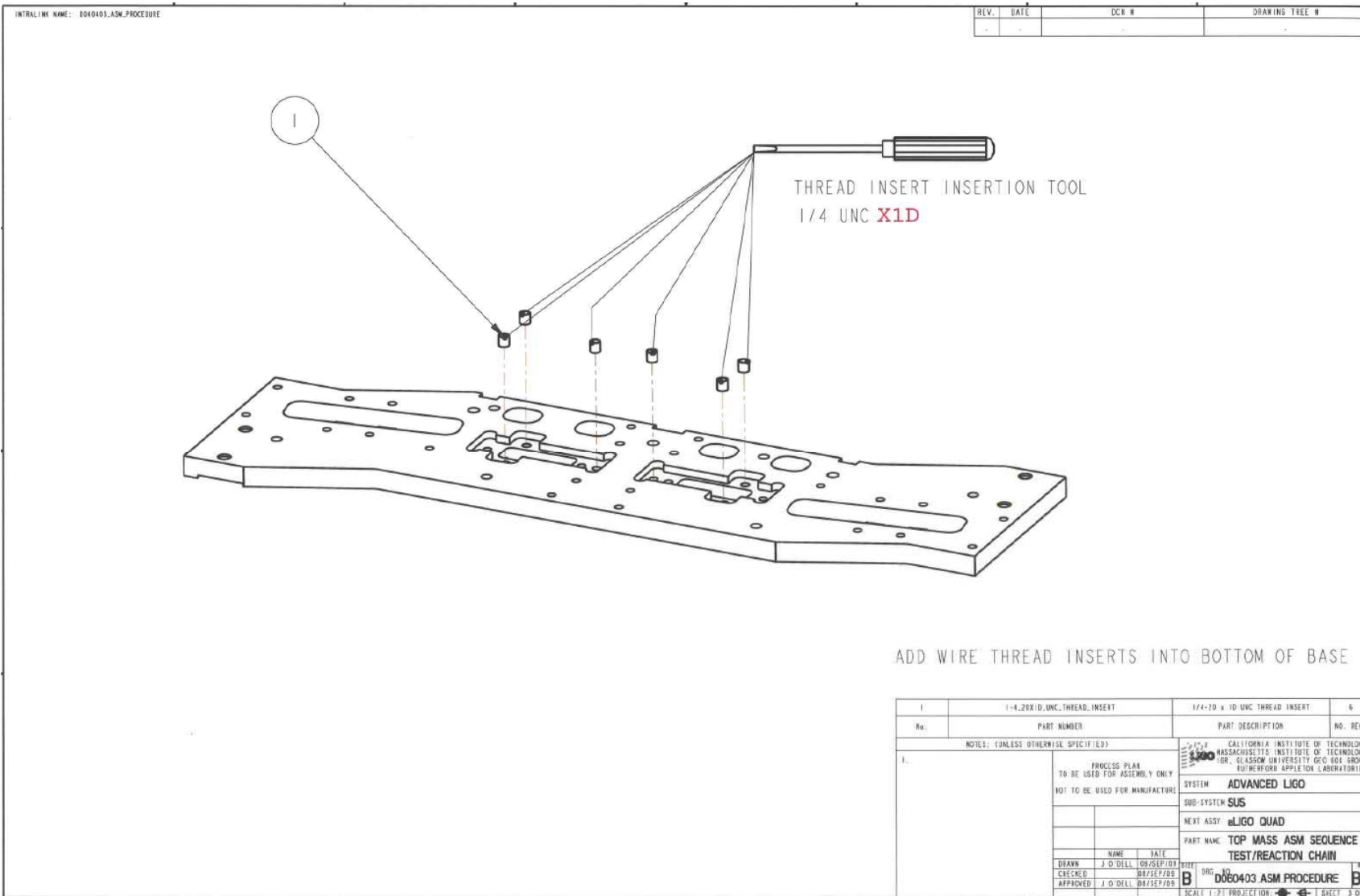


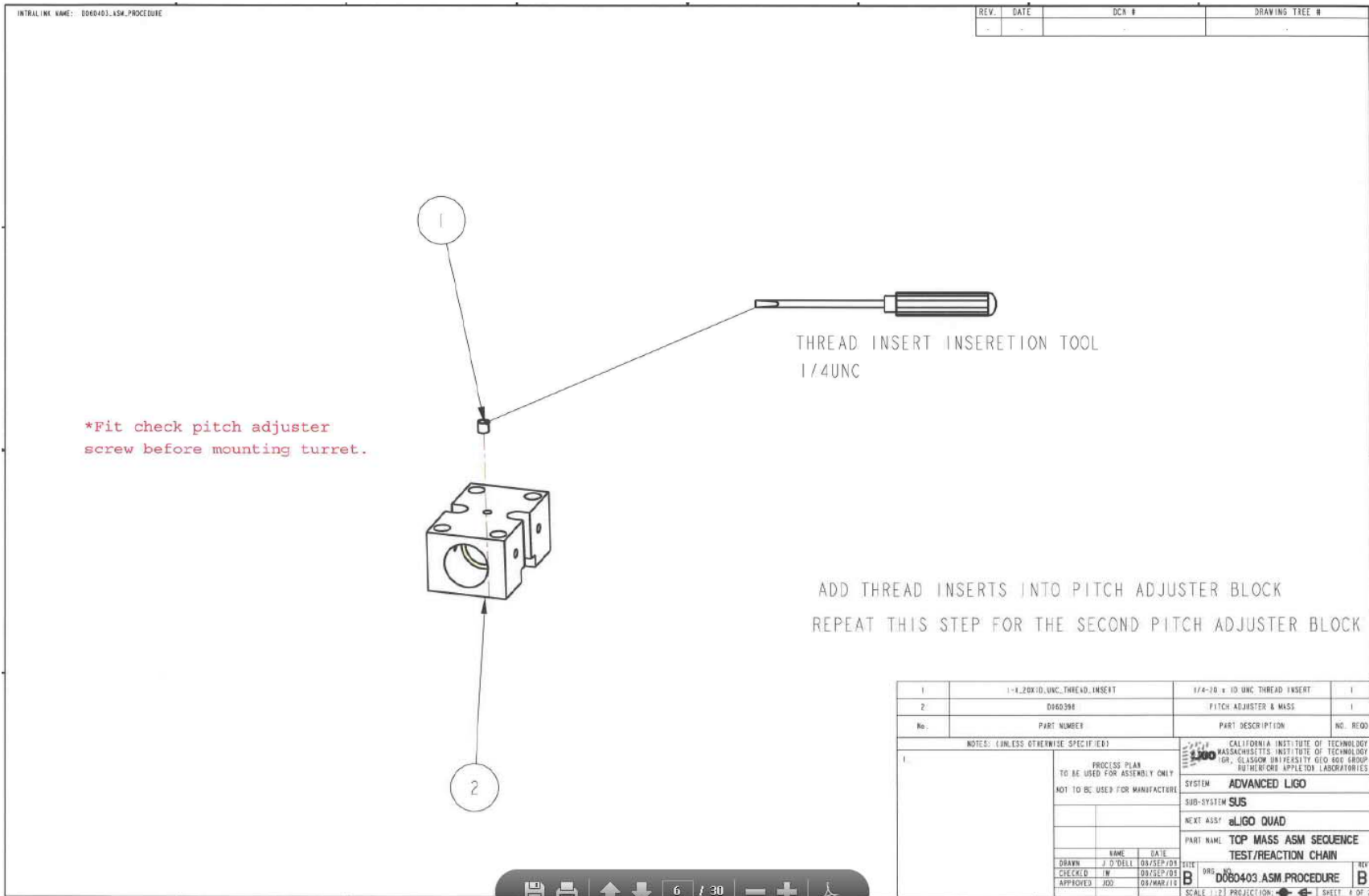
NOTE: THIS ASSEMBLY (D1000444) IS FIRST ARTICLE (WBSC6)

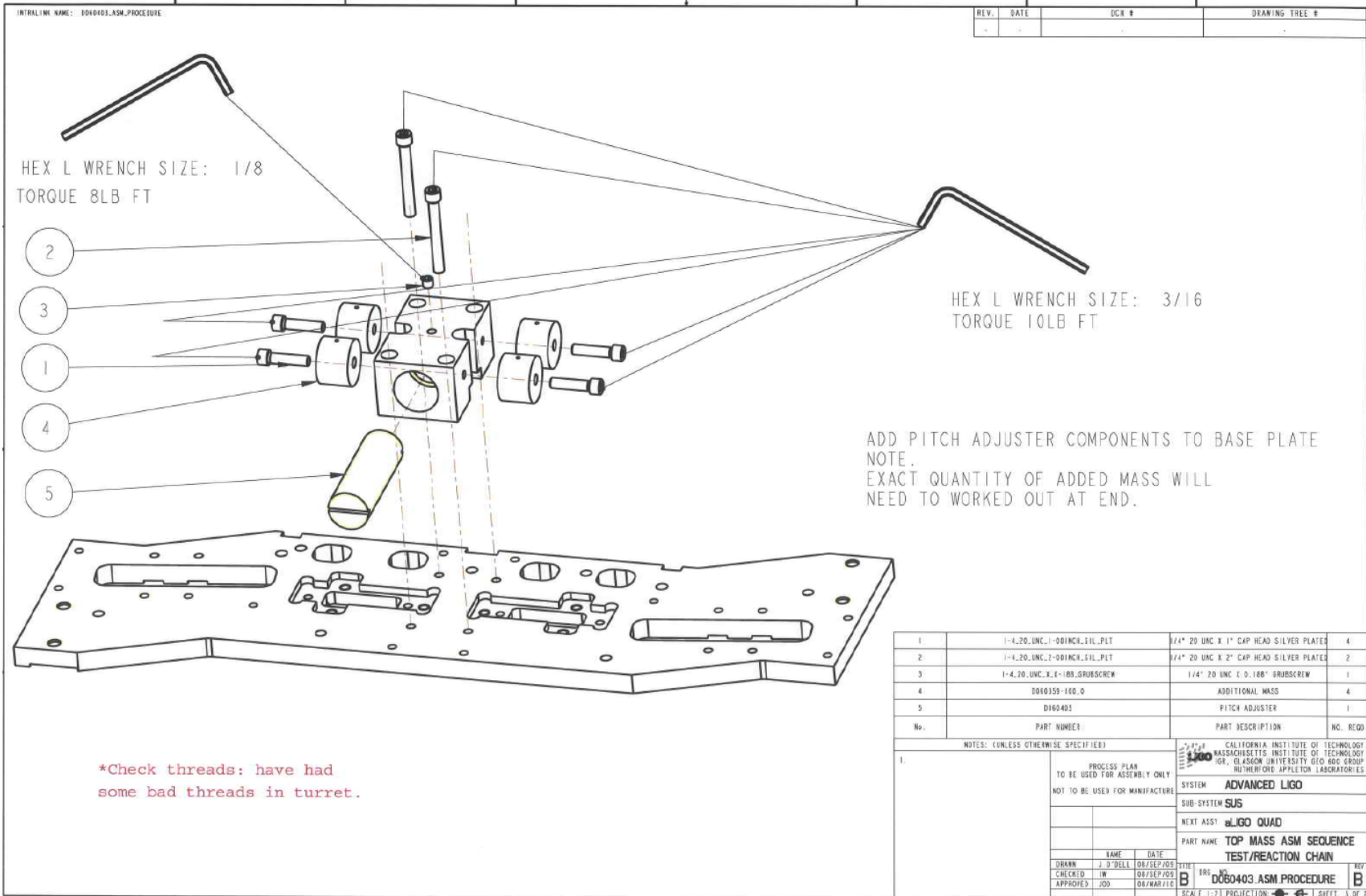


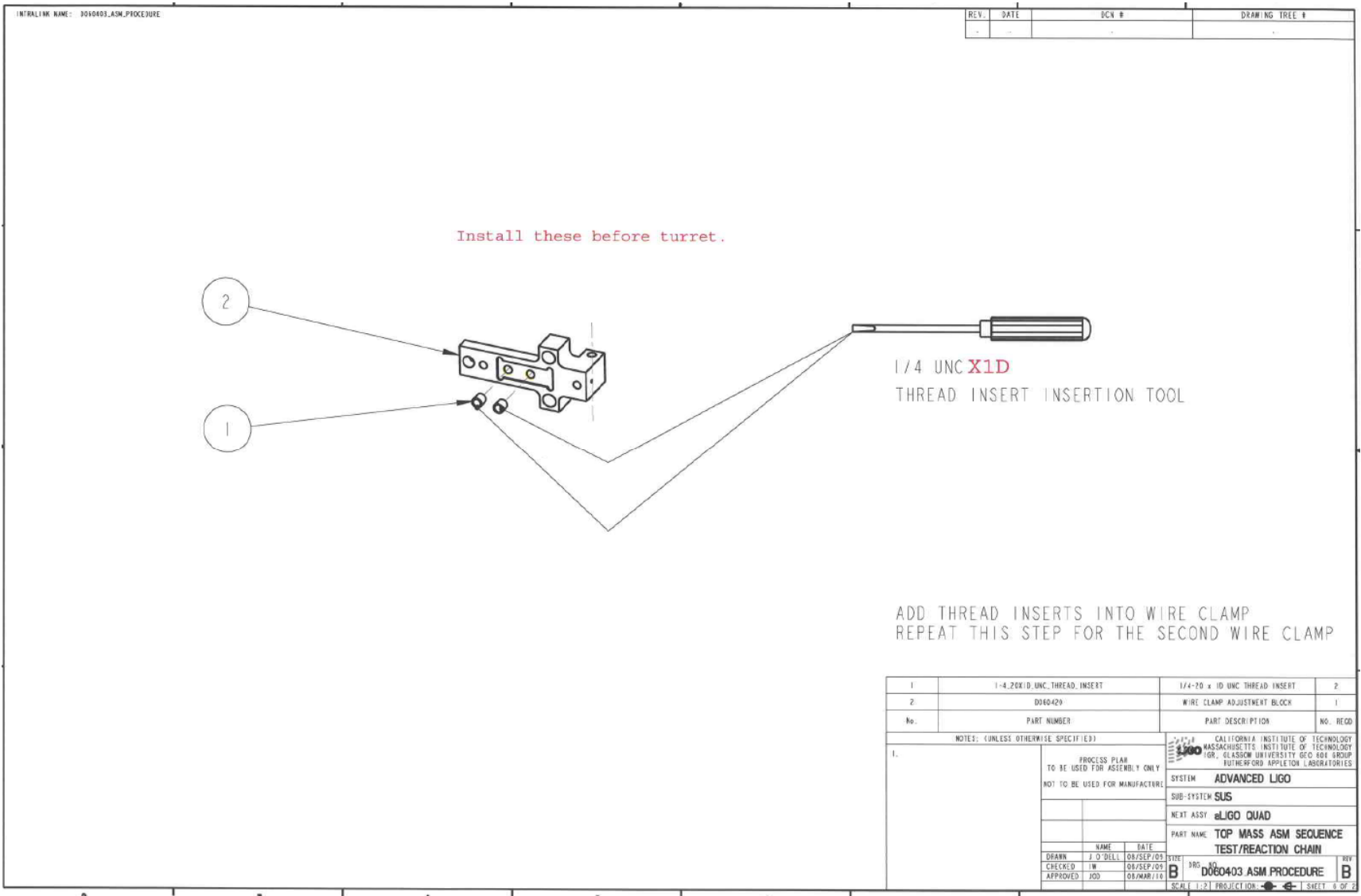
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE: DWG. NO.	REV.
D	D1000444
SCALE: 1:2	PROJECTION: SHEET 3 OF 3





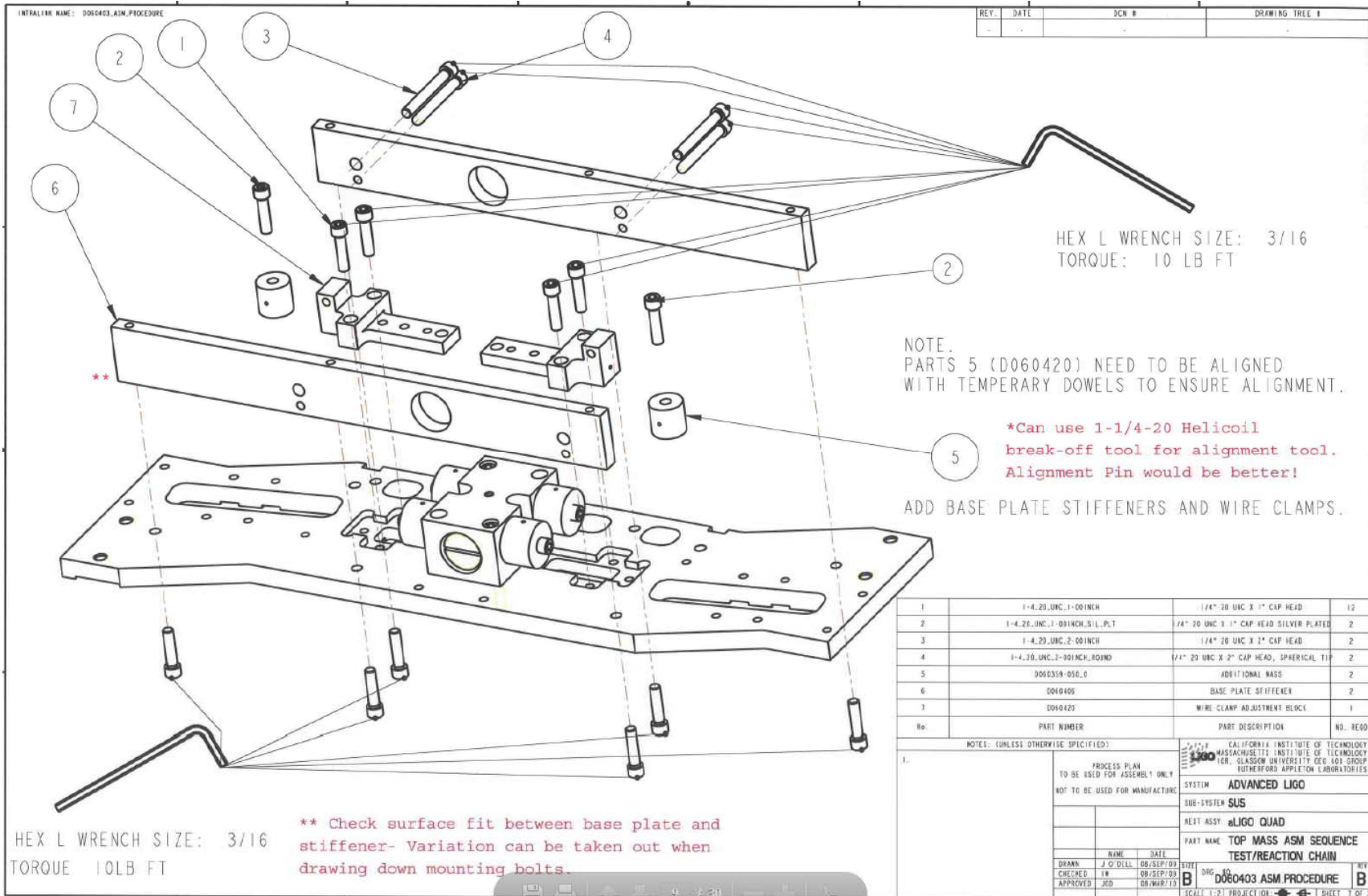


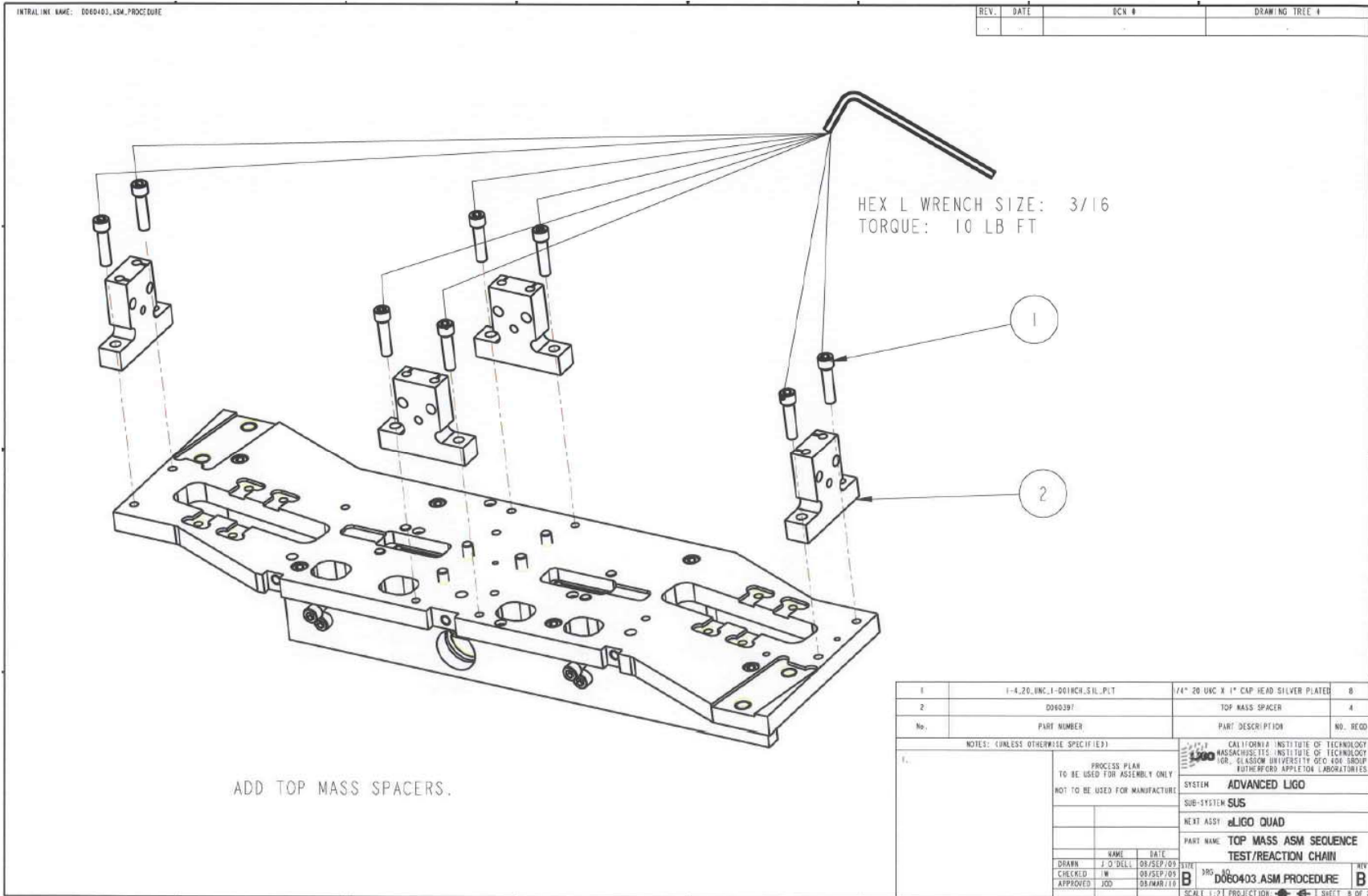




REV.	DATE	DCN #	DRAWING TREE #
-	-	-	-

1	1/4-20X1D UNC THREAD INSERT	1/4-20 x 1D UNC THREAD INSERT	2
2	D060429	WIRE CLAMP ADJUSTMENT BLOCK	1
No.	PART NUMBER	PART DESCRIPTION	NO. REQD
NOTES: (UNLESS OTHERWISE SPECIFIED)			
1.	PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		
		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY FOR GLASSBORO UNIVERSITY GEO. HILL GROUP FUTUREPROOF APPLICATION LABORATORIES	
		SYSTEM ADVANCED LIGO	
		SUB-SYSTEM SUS	
		NEXT ASSY eLIGO QUAD	
		PART NAME TOP MASS ASM SEQUENCE TEST/REACTION CHAIN	
DRWN	J. D. BELL	08/SEP/05	REV
CHECKED	JW	08/SEP/05	DRG. NO.
APPROVED	JOD	09/MAR/16	B
SCALE 1:1:21 PROJECTION:			REV B





REV.	DATE	DCN #	DRAWING TREE #

1	1-4.20.UNC.1-501RCH.SIL.PLT	1/4" 20 UNC X 1" CAP HEAD SILVER PLATED	8
2	0060301	TOP MASS SPACER	4
No.	PART NUMBER	PART DESCRIPTION	NO. REQD
NOTES: (UNLESS OTHERWISE SPECIFIED)			
PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IOR: GLASGOW UNIVERSITY GEO. ION. GROUP FUTURE/ERO APPLETON LABORATORIES SYSTEM ADVANCED LIGO SUB-SYSTEM SUS NEXT ASSY LIGO QUAD PART NAME TOP MASS ASM SEQUENCE TEST/REACTION CHAIN	
DIARR	J. O. DELL	09/SEP/09	REV
CHECKED	JW	08/SEP/09	DRG. NO. 0060403 ASM PROCEDURE
APPROVED	JOD	08/MAR/10	REV B
SCALE 1:1.2 PROJECTION: SHEET 8 OF 7			

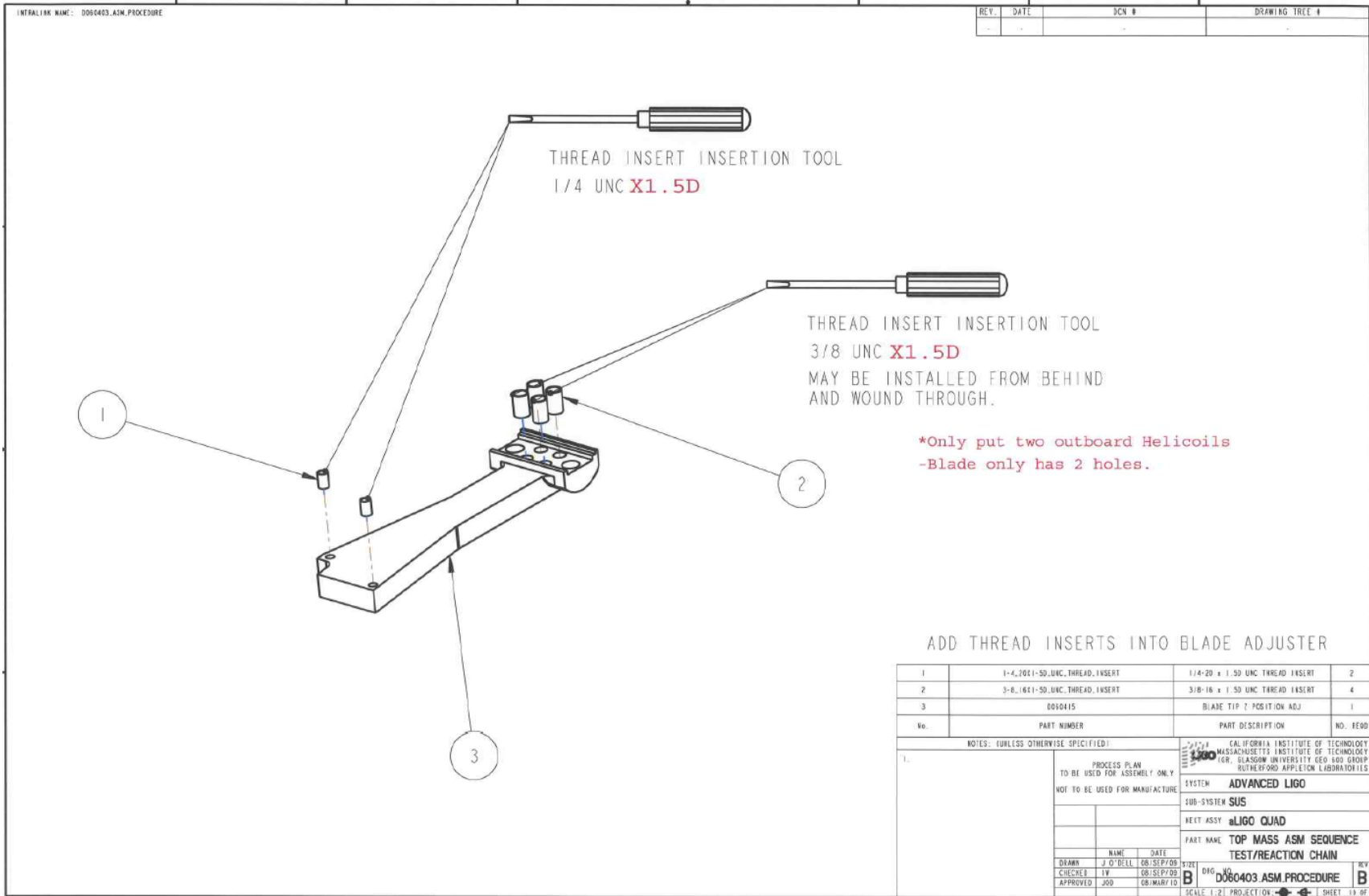
INTRALINK NAME: D060403.ASM.PROCEDURE

REV.	DATE	DCN #	DRAWING TREE #

MAY NEED TO BE TAPPED IN WITH RUBBER Mallet.

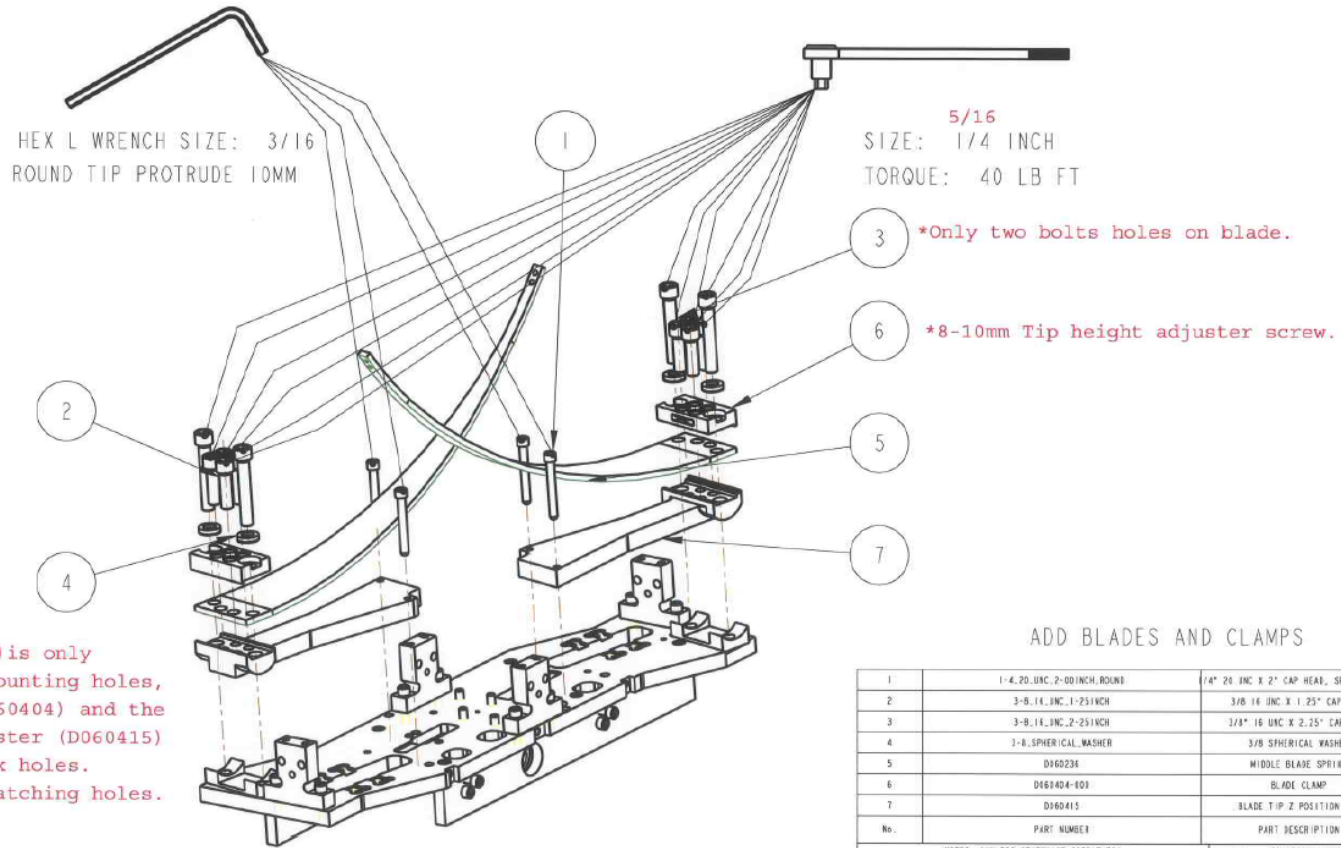
ADD BLADE TIP Z POSITION ADJUSTER

1	D060414	BLADE TIP Z POSITION ADJ	2
No.	PART NUMBER	PART DESCRIPTION	NO. REQD
NOTES: UNLESS OTHERWISE SPECIFIED:			
1.	PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		
		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY FOR GLASGOW UNIVERSITY GEO 400 GROUP BUTHERFORD APPLIED LABORATORIES	
		SYSTEM ADVANCED LIGO	
		SUB-SYSTEM SUS	
		NEXT ASSY aLIGO QUAD	
		PART NAME TOP MASS ASM SEQUENCE TEST/REACTION CHAIN	
DRWN	J O'DELL	09/SEP/03	STRT
CHECKED	JW	09/SEP/04	REV
APPROVED	JCO	05/MAR/11	B
		ORG. NO. D060403.ASM.PROCEDURE	REV. B
SCALE: 1:1 PT PROJECTION			



INTRALINK NAME: 3010403_ASM_PROCEDURE

REV.	DATE	DCN #	DRAWING TREE #



*The Blade (D060236) is only drilled with four mounting holes, while the Clamp (D060404) and the Tip Z position adjuster (D060415) are drilled with six holes. Only use the four matching holes.

ADD BLADES AND CLAMPS

No.	PART NUMBER	PART DESCRIPTION	NO. REQD
1	1-4.20.UNC.2-00INCH.ROUND	1/4" 20 UNC X 2" CAP HEAD, SPHERICAL TIP	4
2	3-8.14.UNC.1-251NCH	3/8 14 UNC X 1.25" CAP HEAD	8
3	3-8.14.UNC.2-251NCH	3/8" 14 UNC X 2.25" CAP HEAD	4
4	3-8.SPHERICAL WASHER	3/8 SPHERICAL WASHER	4
5	D060234	MIDDLE BLADE SPRING	2
6	D060404-100	BLADE CLAMP	2
7	D060415	BLADE TIP Z POSITION ADJ	1

NOTE.
ALL 3/8 BOLTS MUST BE TORQUED UP TO THE REQUIRED TO THE REQUIRED TORQUE.
A TORQUE WRENCH IS NEEDED FOR THIS.

NOTES: (UNLESS OTHERWISE SPECIFIED)

PROCESS PLAN
TO BE USED FOR ASSEMBLY ONLY
NOT TO BE USED FOR MANUFACTURE

CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
OR. GLASSBORO UNIVERSITY GIG GROUP
RUTHERFORD APPLETON LABORATORIES

SYSTEM **ADVANCED LIGO**

SUB-SYSTEM **SUS**

NEXT ASSY **ALIGO QUAD**

PART NAME **TOP MASS ASM SEQUENCE TEST/REACTION CHAIN**

DRWN: J.D. DILL 08/SEP/05
CHKD: W. 08/SEP/05
APPR: JOD 08/MAR/10

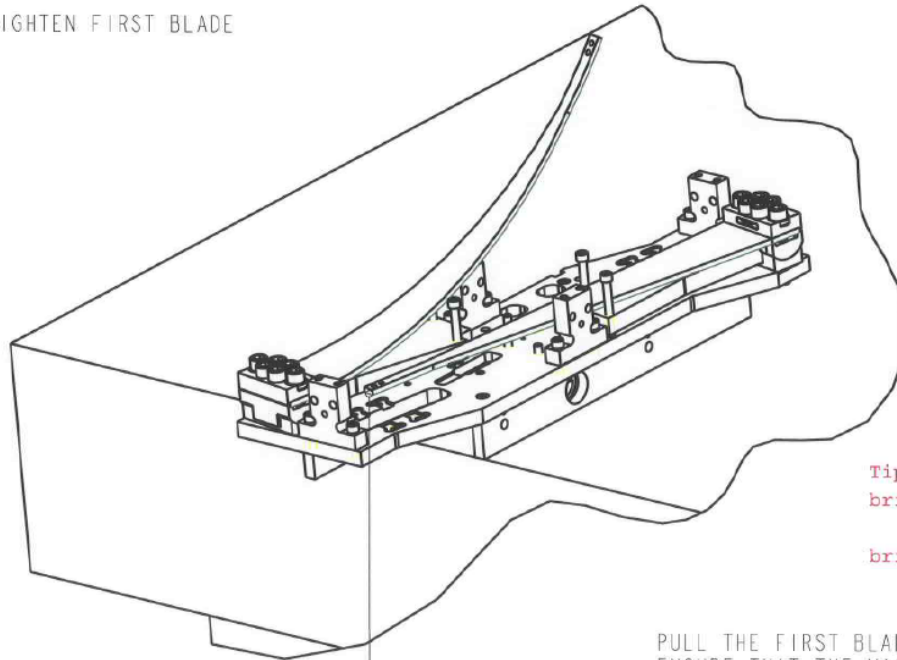
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SCALE: 3:1 PROJECTION:

INTRALINK NAME: D060403_ASM_PROCEDURE

REV.	DATE	DCN #	DRAWING TREE #

STRAIGHTEN FIRST BLADE



*Build hold down flat bar with hole for 1/4-20 bolt.

Tip = 9.6mm from top cut in stop bridge for blade.
5mm side to side blade to stop bridge.

PULL THE FIRST BLADE FLAT BY HANGING MASS FROM THE TIP
ENSURE THAT THE MASS IS SECURELY CLAMPED TO A ROBUST TABLE DURING THIS PROCEDURE

*Put wire clamp tooling in outboard hole to clear stop bridge.

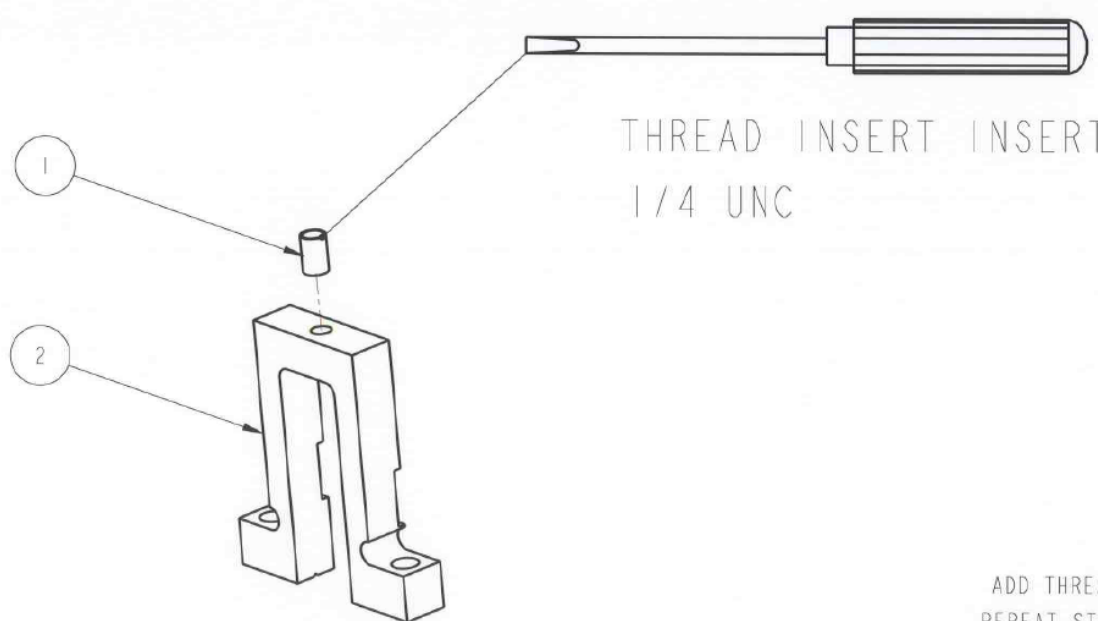


MASS: 50 KG
50650g

NOTES: (UNLESS OTHERWISE SPECIFIED)		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY FOR CLASSION UNIVERSITY GROUP FUTHERFORD APPLETON LABORATORIES	
1. PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		SYSTEM	ADVANCED LIGO
		SUB-SYSTEM	SUS
		NEXT ASSY	@LIGO QUAD
		PART NAME	TOP MASS ASM SEQUENCE TEST/REACTION CHAIN
BRANN	J O'DELL	DATE	09/SEP/03
CHECKED	EW	DATE	09/SEP/03
APPROVED	JCO	DATE	09/MAR/10
		DWG NO	D060403_ASM_PROCEDURE
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
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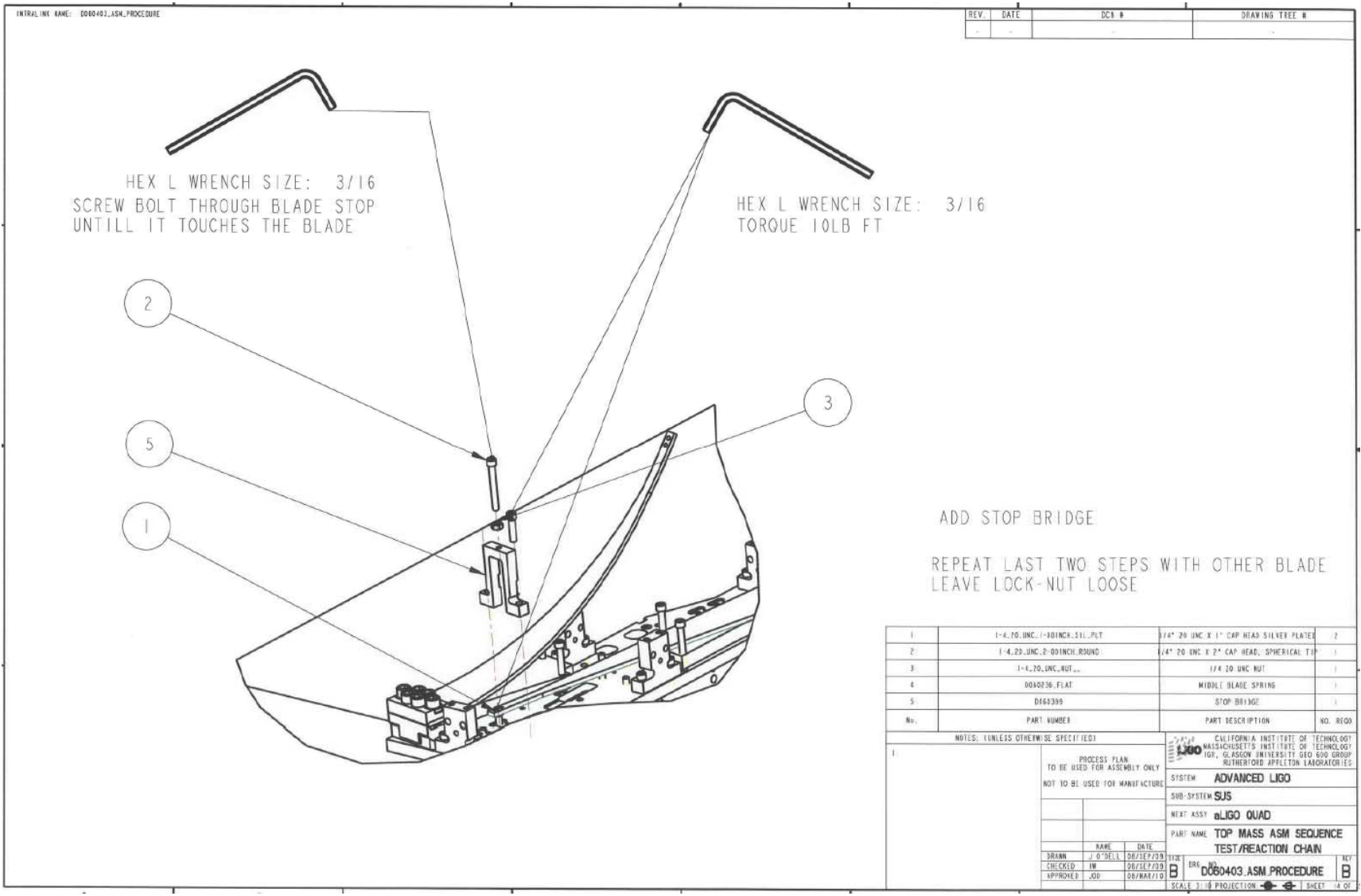
REV.	DATE	DCN #	DRAWING TREE #



THREAD INSERT INSERTION TOOL
1/4 UNC

ADD THREAD INSERT INTO STOP BRIDGE
REPEAT STEP FOR ALL BRIDGES (4 OFF)

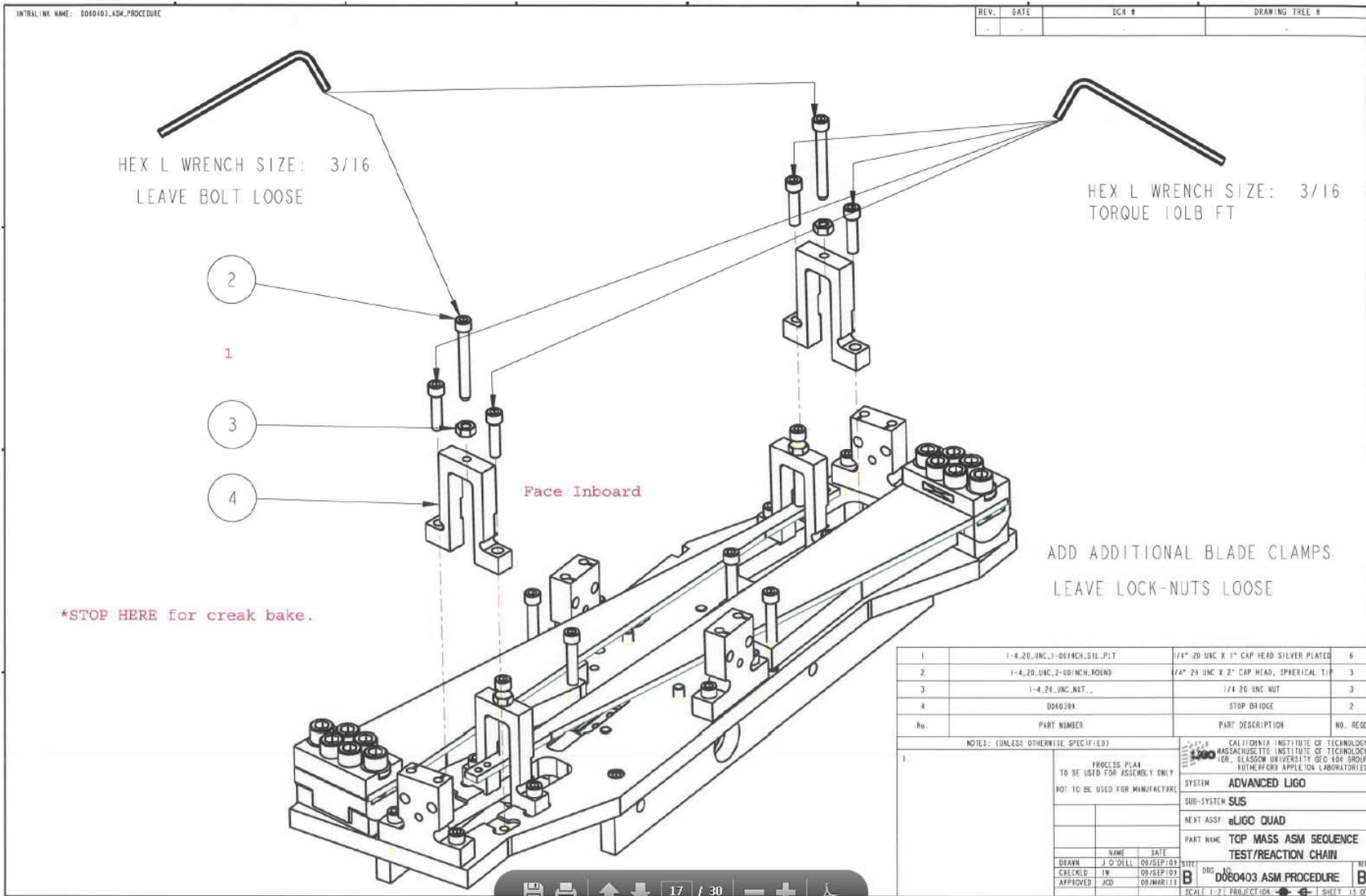
1	1-4, 20X1-50, UNC, THREAD INSERT	1/4-20 x 1.50 UNC THREAD INSERT	1
2	D060303	STOP BRIDGE	1
No.	PART NUMBER	PART DESCRIPTION	NO. REQD
NOTES: (UNLESS OTHERWISE SPECIFIED)			
1.	PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY LIGO		CALIFORNIA INSTITUTE OF TECHNOLOGY LIGO MASSACHUSETTS INSTITUTE OF TECHNOLOGY LIGO, GLASGOW UNIVERSITY GEO 604 GROUP RUTHERFORD APPLETON LABORATORIES	
SYSTEM		ADVANCED LIGO	
SUB-SYSTEM		SUS	
NEXT ASSY		eLIGO QUAD	
PART NAME		TOP MASS ASM SEQUENCE	
TEST/REACTION CHAIN		TEST/REACTION CHAIN	
DRAWN	NAME	DATE	REV
CHECKED	M	08/SEP/04	B
APPROVED	JDD	09/MAR/11	B
SCALE 1:1		PROJECTION	SHEET 13 OF

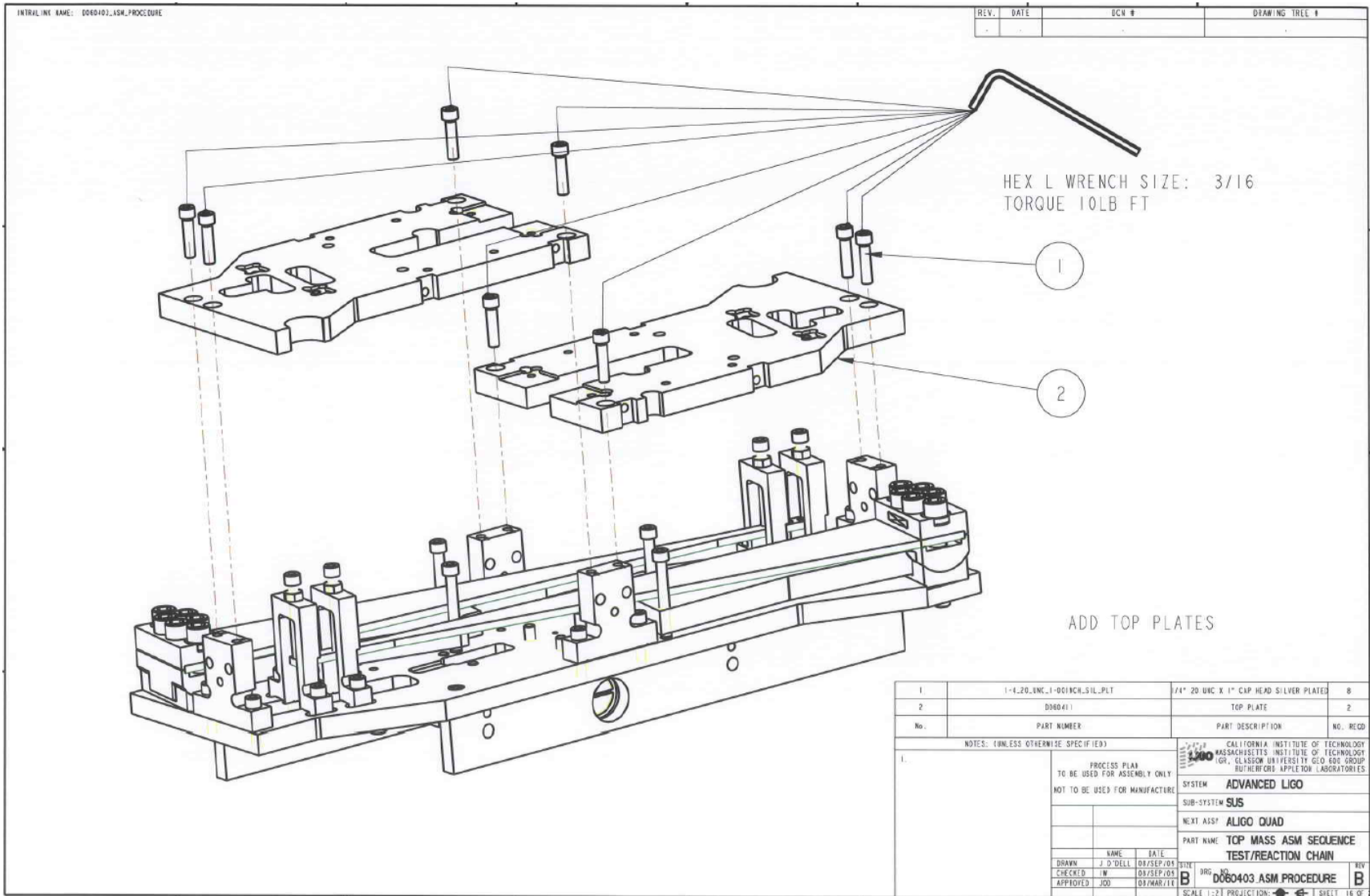


REV.	DATE	DCN #	DRAWING TREE #

ADD STOP BRIDGE
 REPEAT LAST TWO STEPS WITH OTHER BLADE
 LEAVE LOCK-NUT LOOSE

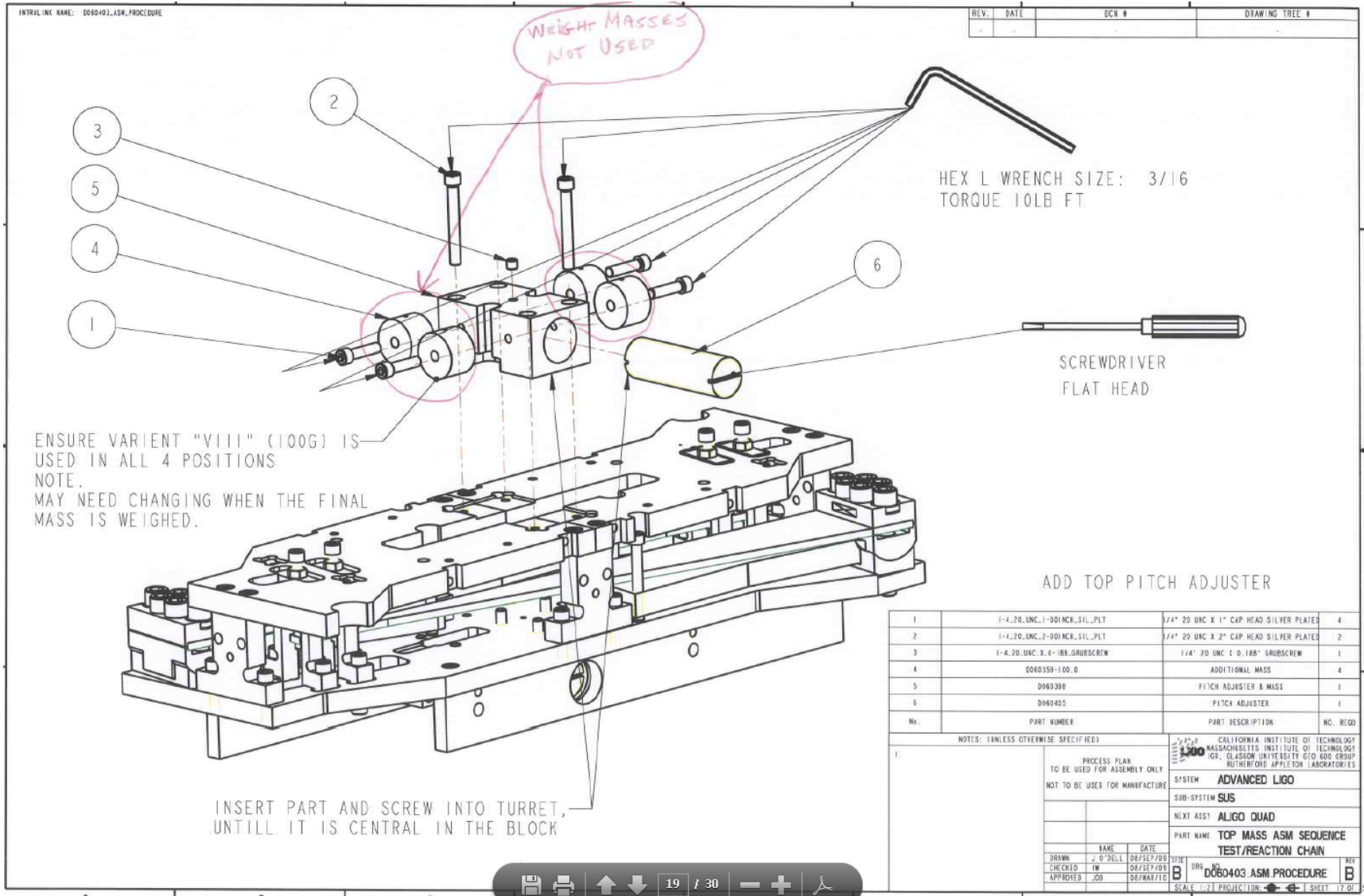
1.	1-4.70.UNC.1-30INCH.SIL.PLT	3/4" 20 UNC X 1" CAP HEAD SILVER PLATE	2
2.	1-4.29.UNC.2-00INCH.ROUND	1/4" 20 UNC X 2" CAP HEAD, SPHERICAL TIP	1
3.	1-4.70.UNC.NUT...	1/4" 20 UNC NUT	1
4.	004036.FLAT	MIDDLE BLADE SPRING	1
5.	0166399	STOP BRIDGE	1
No.	PART NUMBER	PART DESCRIPTION	NO. REQD
NOTES: UNLESS OTHERWISE SPECIFIED:			
PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY FOR: GLASSON UNIVERSITY GEO GROUP RUTHERFORD APPLETON LABORATORIES	
		SYSTEM: ADVANCED LIGO	
		SUB-SYSTEM: SJS	
		NEXT ASSY: BLIGO QUAD	
		PART NAME: TOP MASS ASM SEQUENCE TEST/REACTION CHAIN	
DRWN	J. O'BELL	DATE	08/SEP/09
CHECK'D	JW	DATE	08/SEP/09
APPROVED	JOD	DATE	08/NOV/10
		REV. NO.	0060403.ASM.PROCEDURE
		SCALE	3:18 PROJECTION: SHEET 4 OF 4

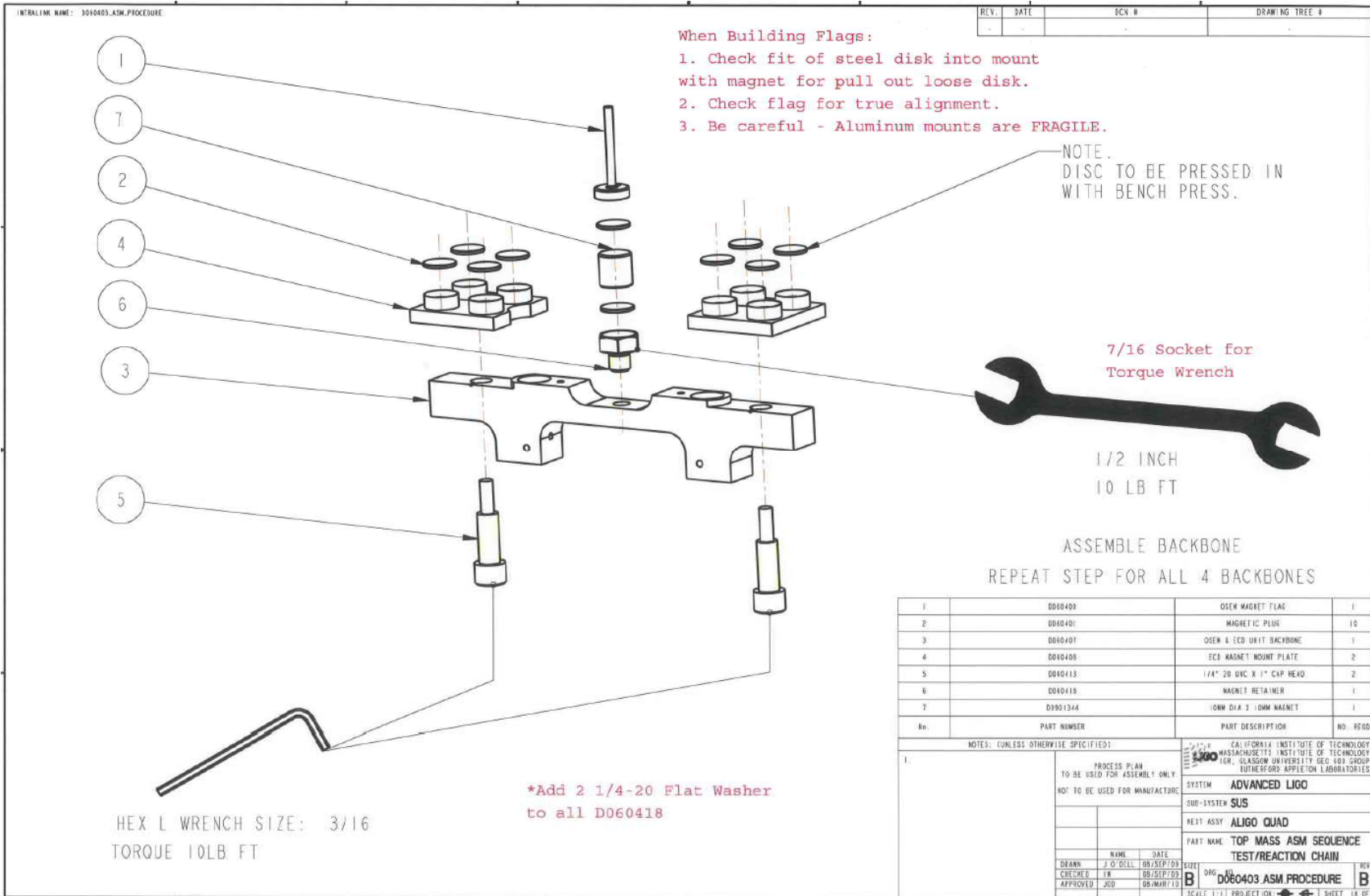


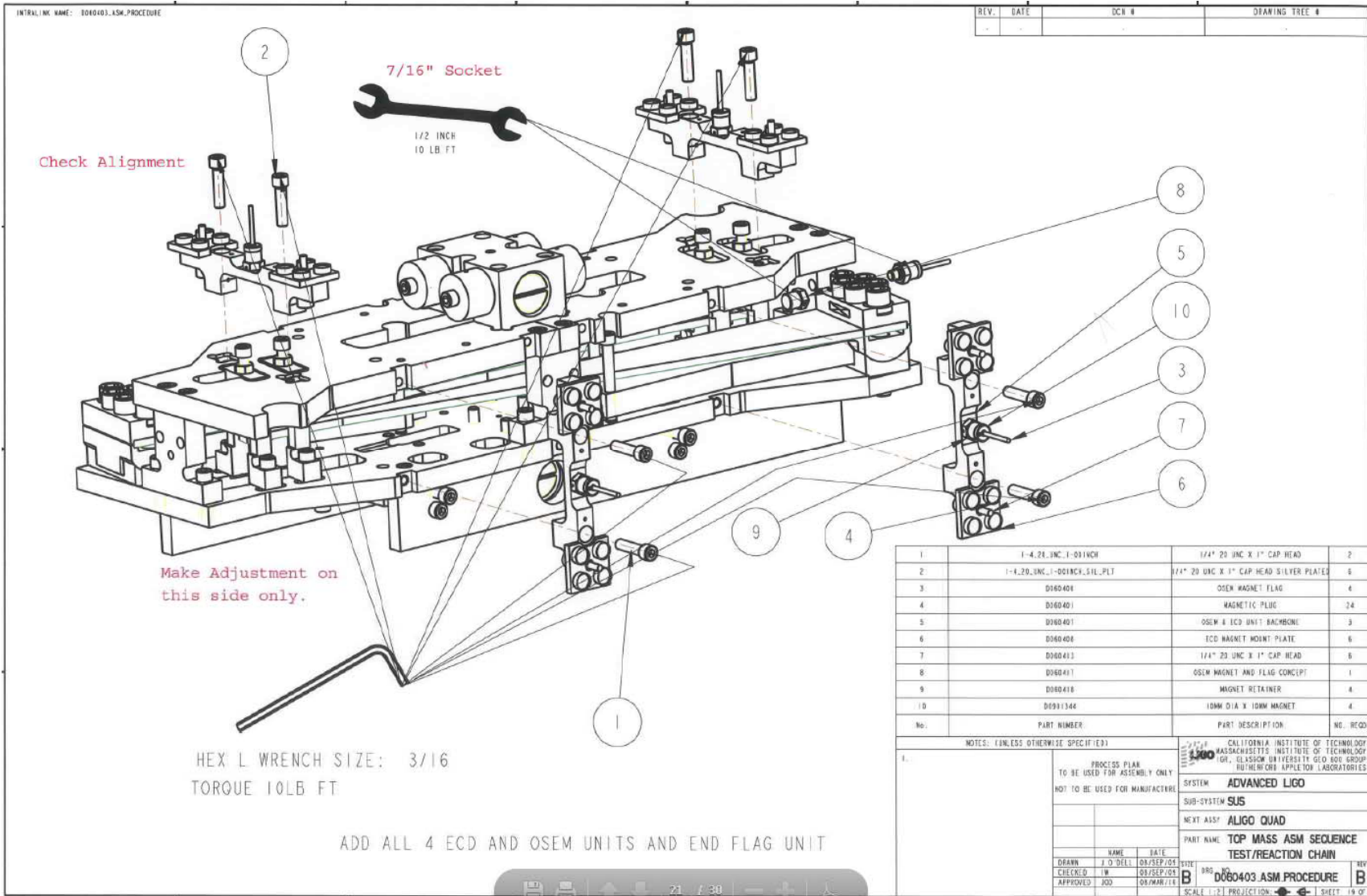


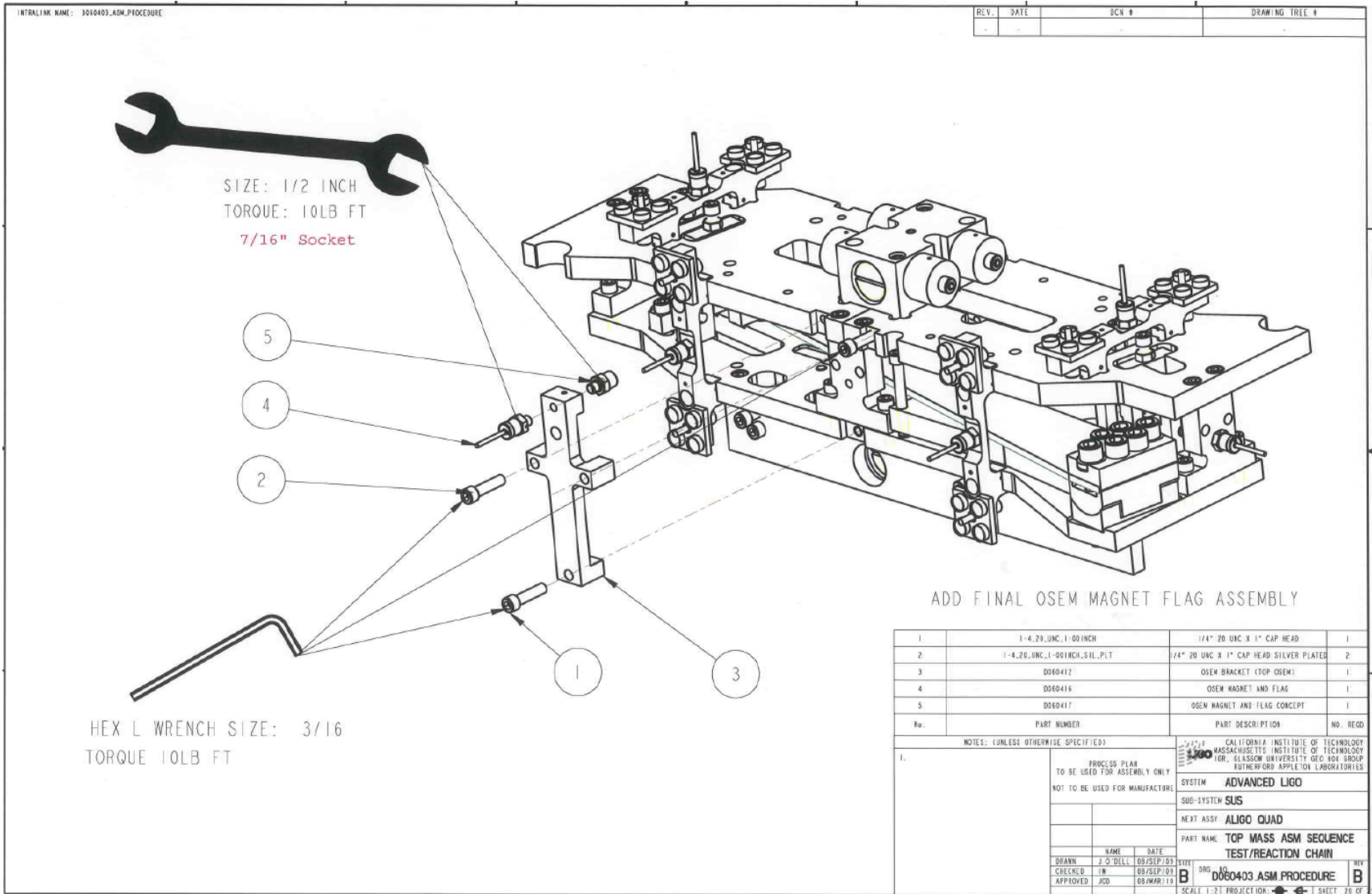
REV.	DATE	DCN #	DRAWING TREE #
1			
2			

1	1-4.20.UNC-1-00INCH-SIL-PLT	3/4" 20 UNC X 1" CAP HEAD SILVER PLATED	8
2	D060411	TOP PLATE	2
No.	PART NUMBER	PART DESCRIPTION	NO. RECD
NOTES: (UNLESS OTHERWISE SPECIFIED)			
PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY NOT TO BE USED FOR MANUFACTURE		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY OR. GLASSBORO UNIVERSITY GLO. ISE. GROUP BUTHERTON APPLETON LABORATORIES	
		SYSTEM ADVANCED LIGO	
		SUB-SYSTEM SUS	
		NEXT ASSY ALIGO QUAD	
		PART NAME TOP MASS ASM SEQUENCE TEST/REACTION CHAIN	
	NAME	DATE	REV.
DRAWN	J. D'ELLE	03/SEP/01	B
CHECKED	JW	03/SEP/01	B
APPROVED	JOO	03/MAR/01	B
		ORG. NO.	REV.
		D060403 ASM PROCEDURE	B
SCALE: 1:2 PROJECTION: 1 SHEET 16 OF			









INTRALINK NAME: 0060403_ASM_PROCEDURE

REV	DATE	DCN #	DRAWING TREE #

HEX L WRENCH SIZE: 3/16
TORQUE 10LB FT

ADD ADDITIONAL MASS / SUPPORT MEMBER

1	1-4.20_INCL1-0618CH_SIL_PLT	1/8" 20 UNC X 1" CAP HEAD SILVER PLATED	6
2	0060359-030.0	ADDITIONAL MASS	2
3	0060421	MASS AND SUPPORT MEMBER	2
No.	PART NUMBER	PART DESCRIPTION	NO. REQD

NOTES: (UNLESS OTHERWISE SPECIFIED)

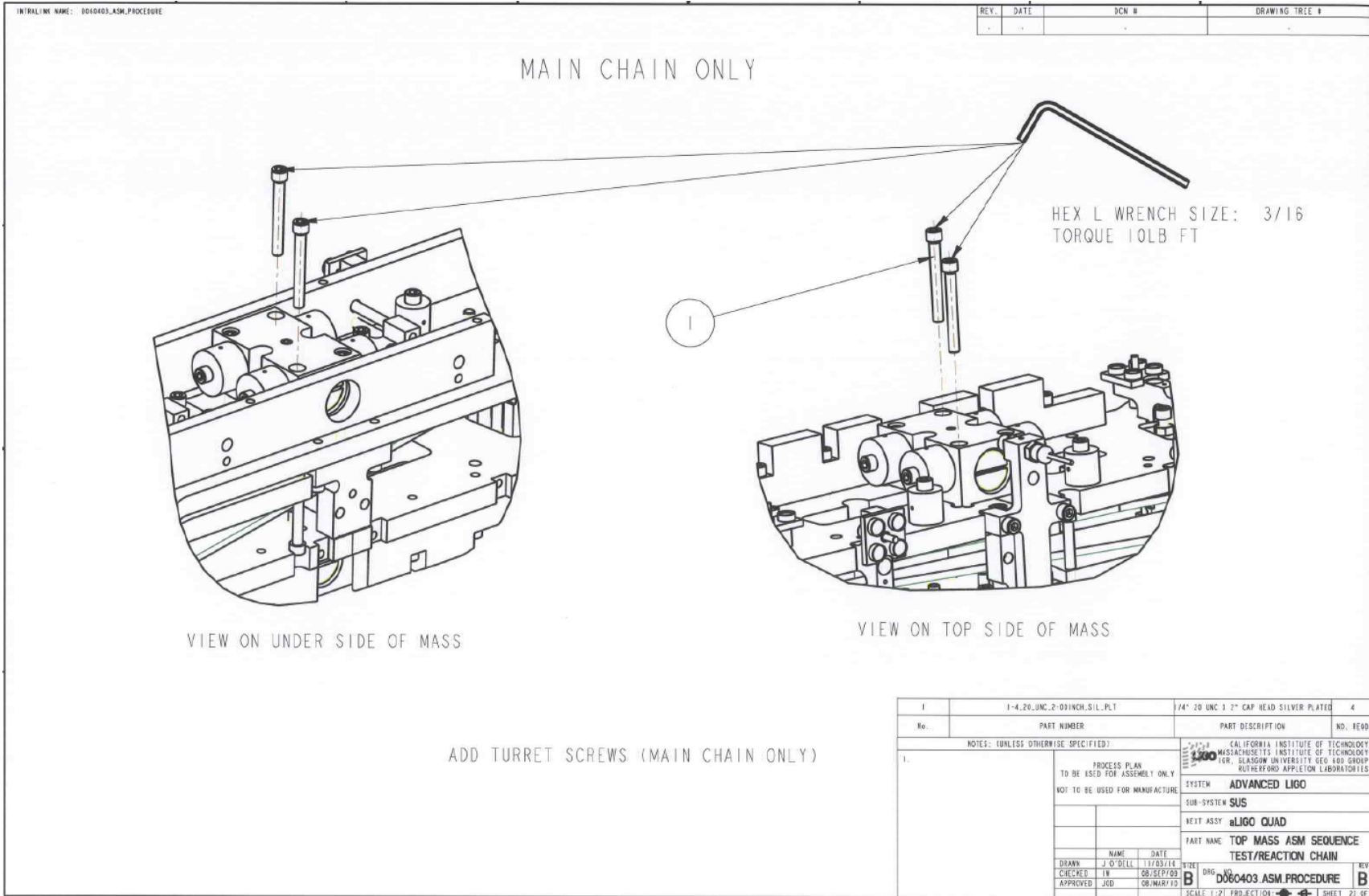
1. PROCESS PLAN TO BE USED FOR ASSEMBLY ONLY
NOT TO BE USED FOR MANUFACTURE

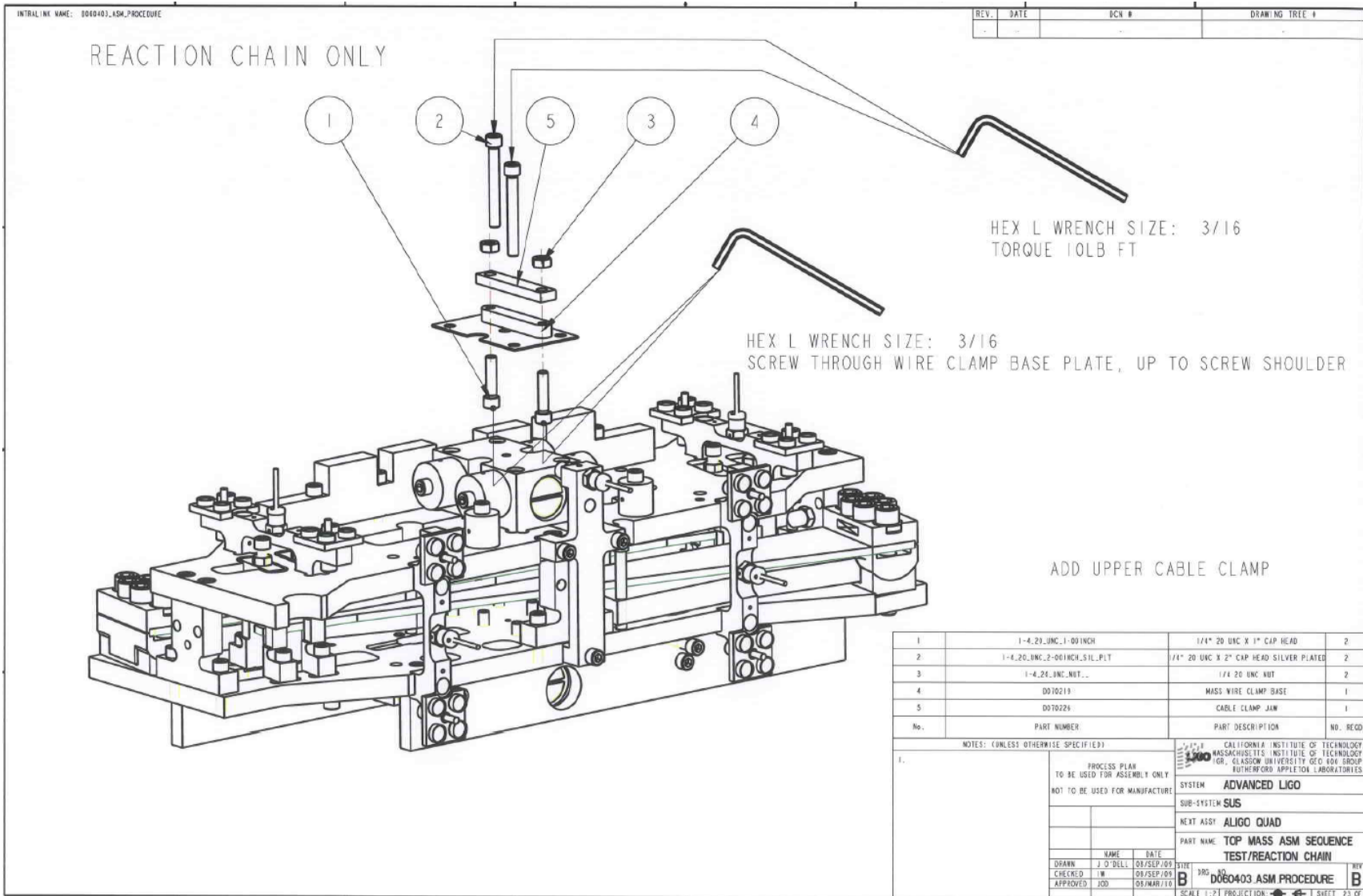
2. CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
FER. GLASGOW UNIVERSITY GEO 400 GROUP
FUTHERBURY APPLETON LABORATORIES

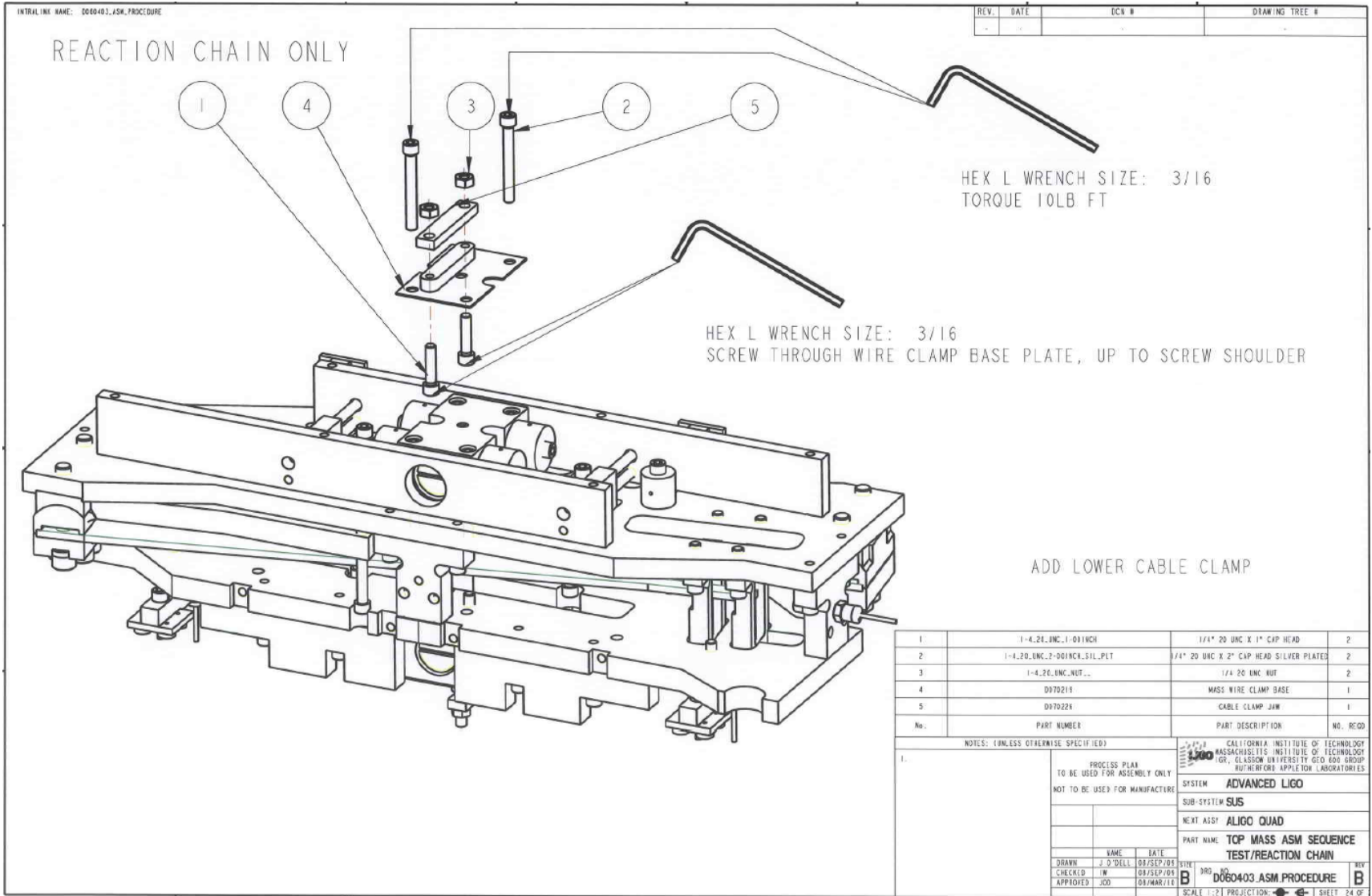
SYSTEM: ADVANCED LIGO
SUB-SYSTEM: SUS
NEXT ASSY: ALIGO QUAD
PART NAME: TOP MASS ASM SEQUENCE
TEST/REACTION CHAIN

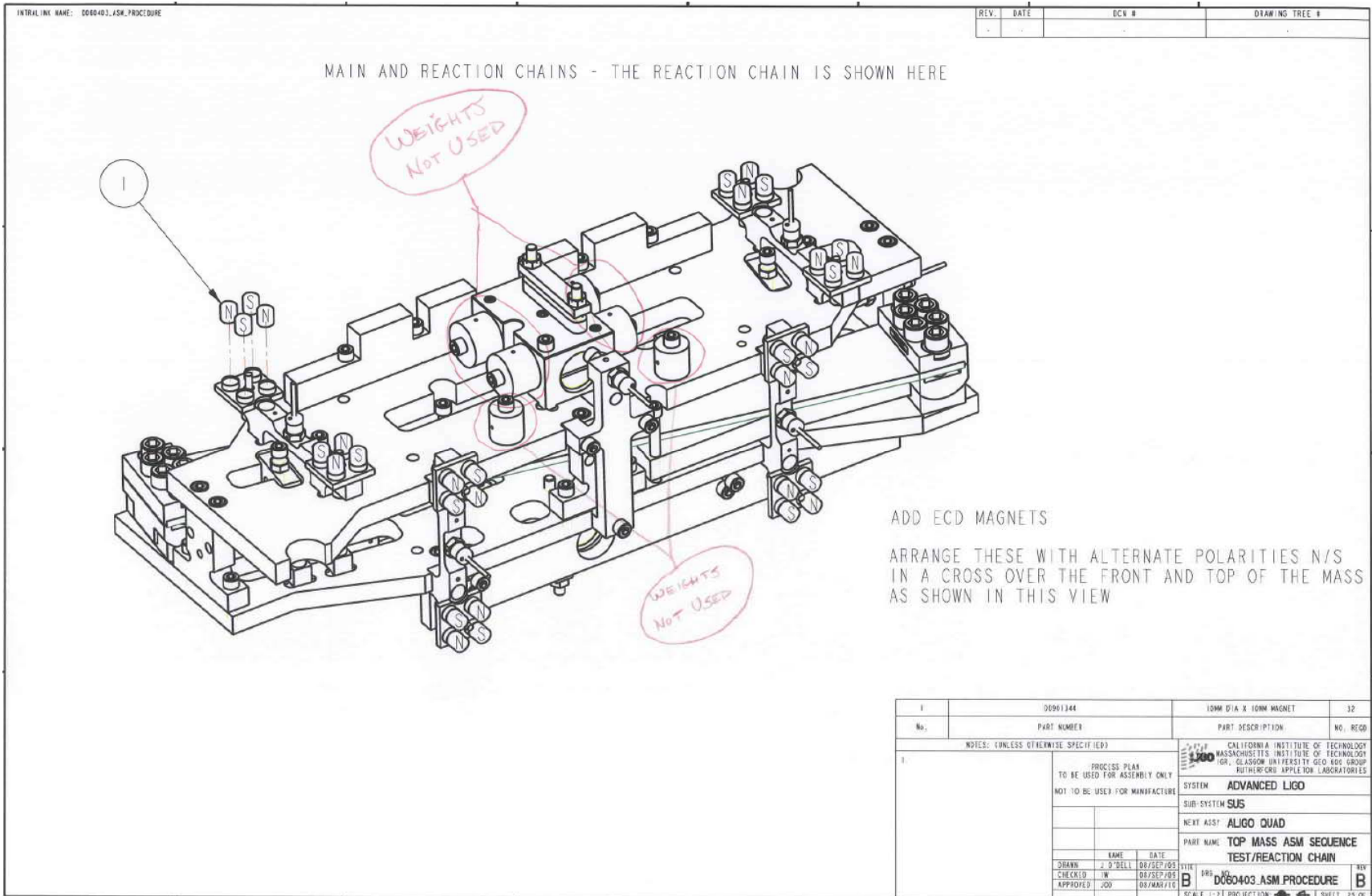
DESIGN	J O'NEILL	09/SEP/03	BY	
CHECKED	JW	09/SEP/03	BY	
APPROVED	JCO	09/MAR/13	BY	

SCALE: 1:21 PROJECTION: SHEET 21 OF



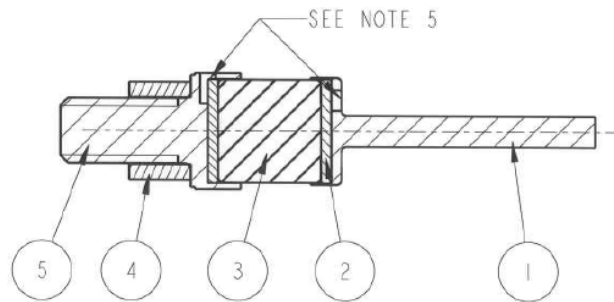
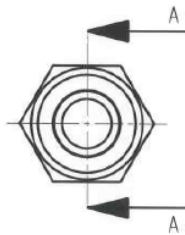




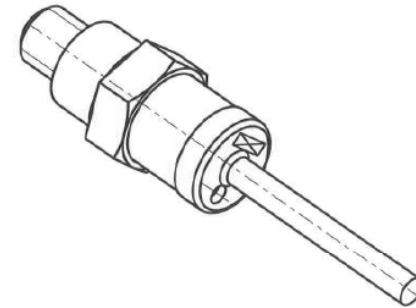


INTRALINK NAME: 0060416

REV	DATE	BY	APP'D	DRAWING TITLE
A	19/OCT/06			E060246
B	17/DEC/07			E060246-B
H	15/JULY/08			E060368



SECTION A-A



3-D VIEW

ADDITIONAL NOTES:

5. STEEL PLUGS ARE PRESS FITTED IN TO ALU AND SS PARTS
6. SUPPLY ALL ASSEMBLIES IN PART FORM

ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS
1	1			0060400	OSEM MAGNET FLAG; (MAGNETIC DESIGN)	ALUMINIUM: 5082
2	2			0060401	MAGNETIC PLUG; .	STAINLESS STEEL: 416
3	1			00901344	10MM DIA X 10MM MAGNET; .	AS PAR SPEC: -----
4	1			01003126	FLAG SPACER; QUAD TOP MASS	AL ALLOY: 6061/5083
5	1			01003127	MAGNET RETAINER; (MODIFIED 1/4-20 HEX HEAD SCREW)	STAINLESS STEEL: 304/316

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL SHARP EDGES, R 0.2 MIN.
2. DO NOT SCALE FROM DRAWING.
3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINATI WILCOX'S C/MTECH 416 (STAINLESS STEEL)
4. SCRIBE, ENGRAVE OR STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE 97 HIGH CHARACTERS. EXAMPLE: 0620188-001 A VIBRATORY TOOL MAY BE USED.

DIMENSIONS ARE IN mm (INCHES)
TOLERANCES:
 ± .13 ± .00 =
 ANGULAR ± =

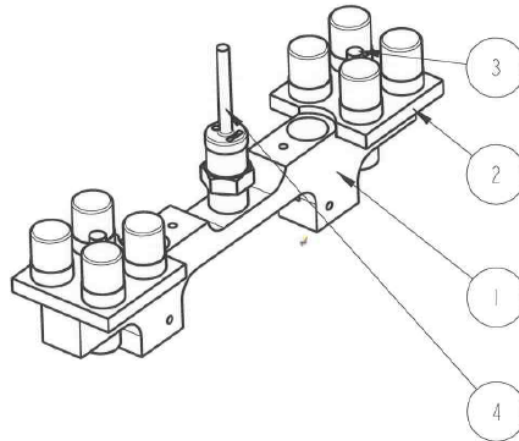
MATERIAL: AS DRAWING
 FINISH: AS DRN
 Ra =

DRWN	FILED	DATE
		30/03/11
CHECKED	NO	15/MAR/12
APPROVED	JD	

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY 77 MASSACHUSETTS AVENUE, CAMBRIDGE, MA 02139-0001 617.253.5924	
SYSTEM	ADVANCED LIGO
SUB-SYSTEM	SUS
NEXT ASSY	QUAD TOP MASS
PART NAME	OSEM MAGNET AND FLAG
DRG. NO.	0060416
REV	K
SHEET	1 OF 1

INTRALINK NAME: D060409

REV.	DATE	DCR #	DRAWING TREE #
A	19/OCT/06	E009248	-
B	17/DEC/07	E060748-B	-
B	15/JULY/08	E009368	-



ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS
1	1			D06640T	OSEM & ECD UNIT BACKBONE; OSEM & ECD UNIT	AL ALLOY: 5083
2	2			D06641G	OSEM MAGNET ASSEMBLY; ..	SEE ITEMS LIST:
3	2			D06641G	1/4" 20 UNC X 1" CAP HEAD; OSEM & ECD UNIT	ST. STEEL: 304/316
4	1			D06641E	OSEM MAGNET AND FLAG; ..	AS DRAWING:
PARTS LIST						

NOTES: (UNLESS OTHERWISE SPECIFIED)
 1. REMOVE ALL SHARP EDGES, R. 0.2 MIN.
 2. DO NOT SCALE FROM DRAWING.
 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICON, SUCH AS CIRCINAT[®] HALOGEN'S C/MTECH 410 (STAINLESS STEEL).
 4. SERIE, ENGRAVE ON STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 301 FOR THE FIRST PART AND PROCEED CONSECUTIVELY USE 3" HIGH CHARACTERS. EXAMPLE: D06018B- 031 A VIBRATORY TOOL MAY BE USED.

DIMENSIONS ARE IN mm (INCHES) TOLERANCES
 X.X1 ± .mm
 ANGULAR ± °

MATERIAL: AS DRW
 AS DRAWN

FINISH:

√Lm (Lm) Ra = AS DRAWN

DRWN	NAME	DATE
J D'ELLE		27/MAR/05
CHECKED	NAME	DATE
JB		15/MAR/11
APPROVED	NAME	DATE
JO		15/MAR/11

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 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
 IGR, GLISSON UNIVERSITY GEO 800 GROUP
 RUTHERFORD APPLETON LABORATORIES

SYSTEM **aLIGO**

SUB-SYSTEM **SUS**



NEXT ASSY: **TOP MASS QUAD**

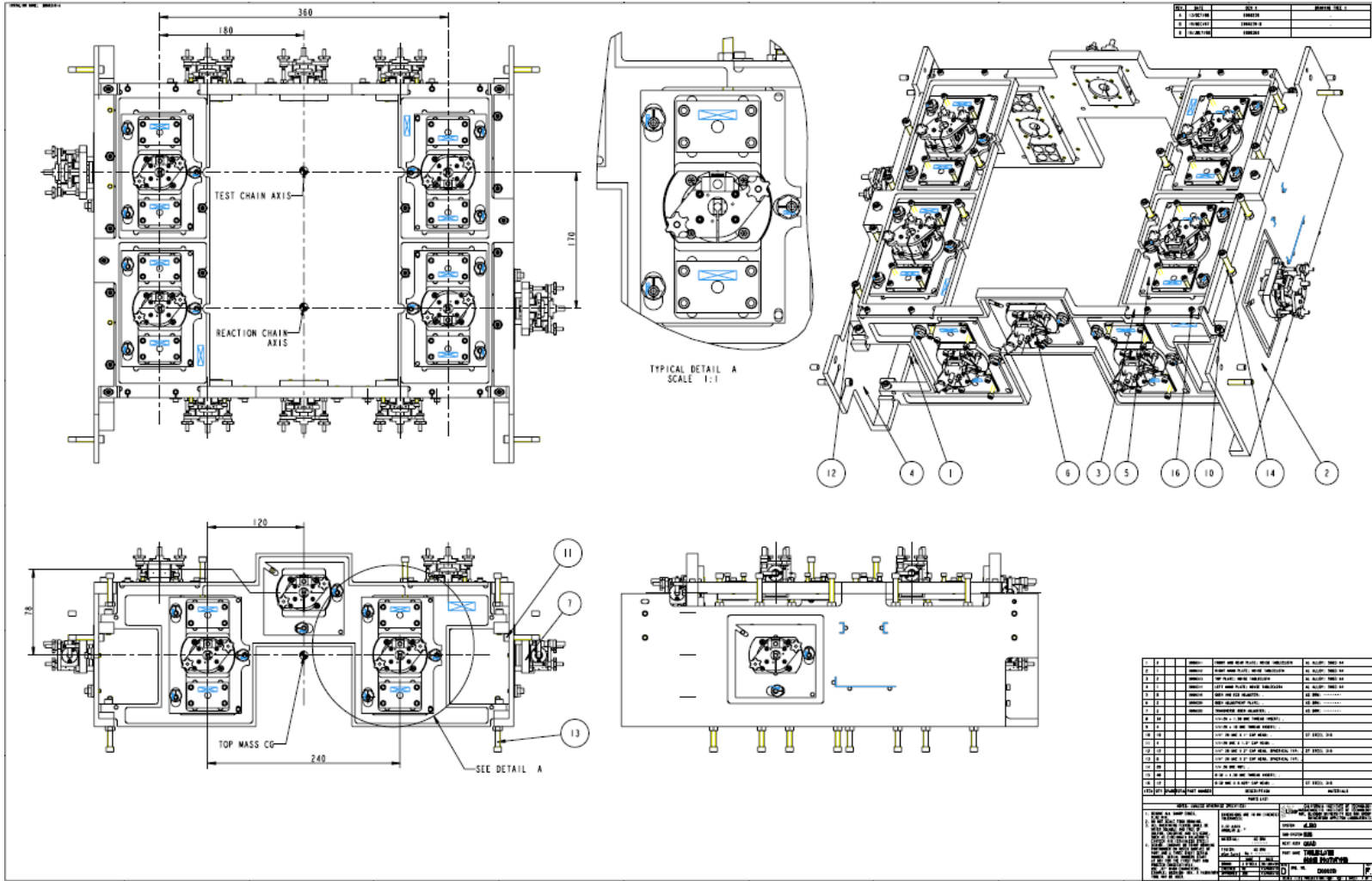
PART NAME: **OSEM ECD UNIT**

DRG. NO. **D060409**

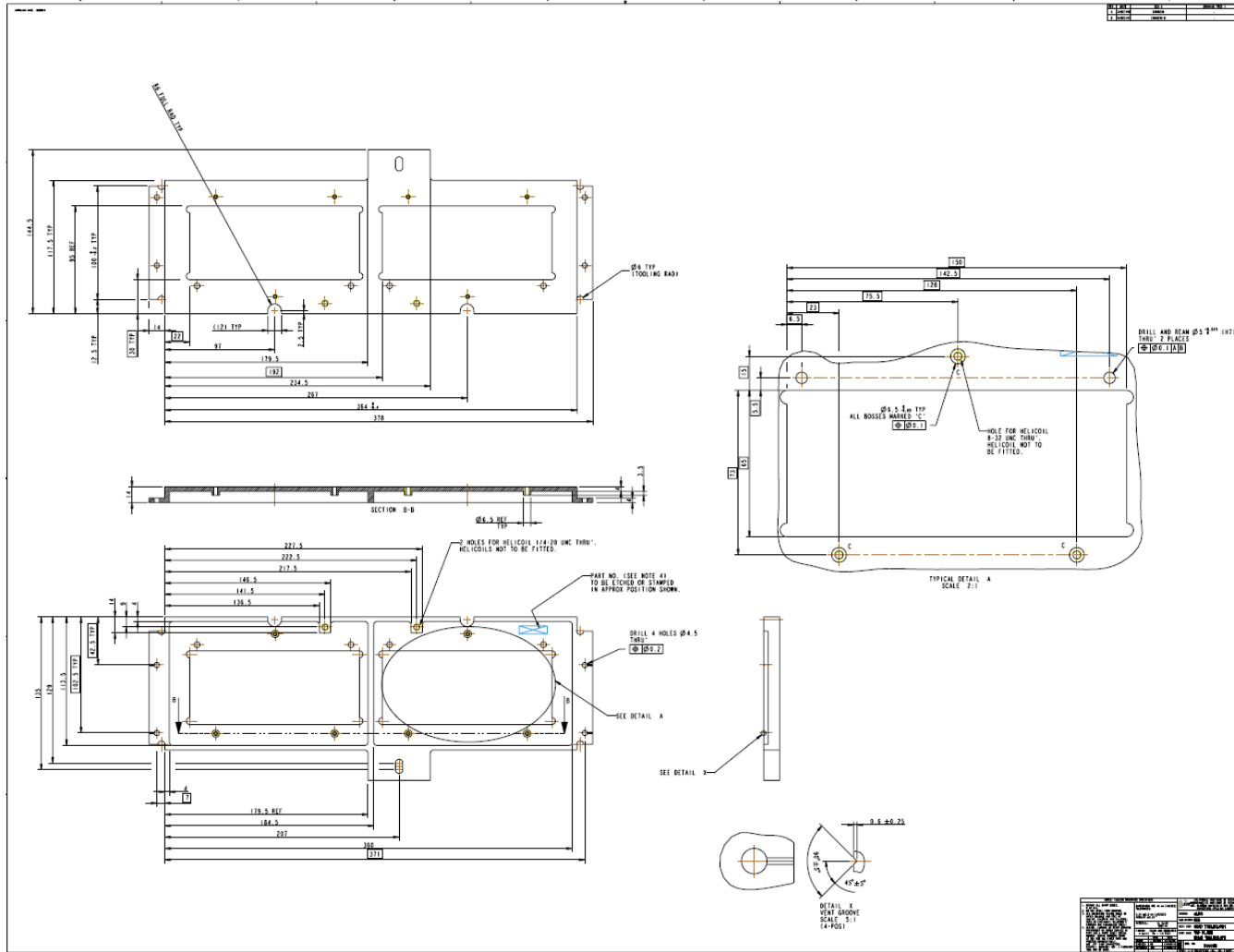
SCALE: 1:1 PROJECTION: SHEET 1 OF 1

5.1.4 D060310 ADVANCED LIGO, SUS, QUAD N-PTYPE TABLECLOTH

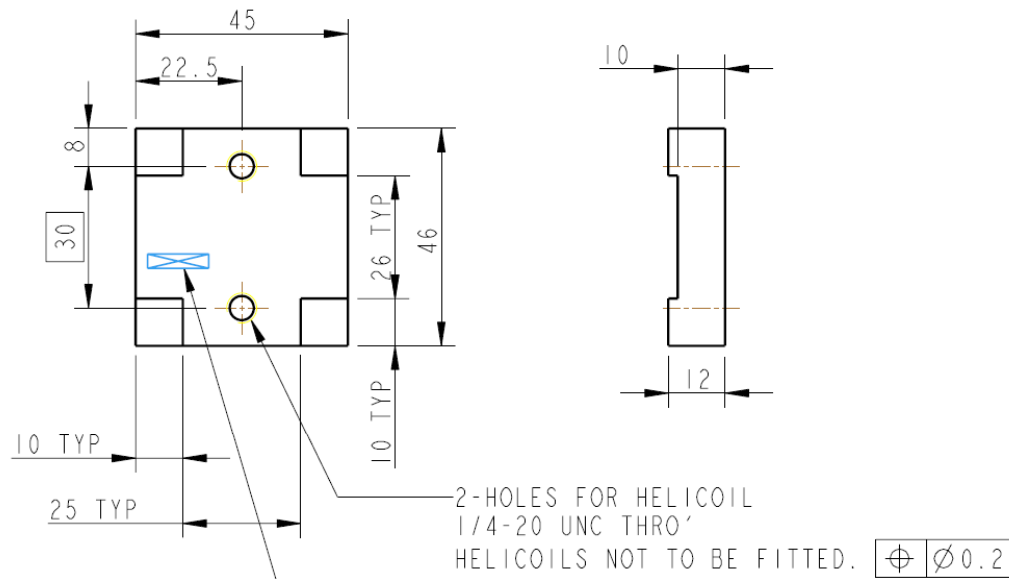
1	2			D060311	FRONT AND REAR PLATE; NOISE TABLECLOTH	AL ALLOY: 5083 H4		
2	1			D060312	RIGHT HAND PLATE; NOISE TABLECLOTH	AL ALLOY: 5083 H4		
3	2			D060313	TOP PLATE; NOISE TABLECLOTH	AL ALLOY: 5083 H4		
4	1			D060314	LEFT HAND PLATE; NOISE TABLECLOTH	AL ALLOY: 5083 H4		
5	8			D060316	OSEM AND ECD ADJUSTER; .	AS DRW: -----		
6	2			D060320	OSEM ADJUSTMENT PLATE; .	AS DRW: -----		
7	2			D060322	TRANSVERSE OSEM ADJUSTER; .	AS DRW: -----		
8	34				1/4-20 x 1.5D UNC THREAD INSERT; .			
9	4				1/4-20 x 1D UNC THREAD INSERT; .			
10	10				1/4" 20 UNC X 1" CAP HEAD; .	ST STEEL 316		
11	4				1/4-20 UNC X 1.5" CAP HEAD; .			
12	12				1/4" 20 UNC X 2" CAP HEAD, SPHERICAL TIP; .	ST STEEL 316		
13	8				1/4" 20 UNC X 2" CAP HEAD, SPHERICAL TIP; .			
14	20				1/4 20 UNC NUT; .			
15	40				8-32 x 1.5D UNC THREAD INSERT; .			
16	12				8-32 UNC X 0.625" CAP HEAD; .	ST STEEL 316		
ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS		
PARTS LIST								
NOTES: (UNLESS OTHERWISE SPECIFIED)								
<p>1. REMOVE ALL SHARP EDGES, R.02 MIN.</p> <p>2. DO NOT SCALE FROM DRAWING.</p> <p>3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410 (STAINLESS STEEL)</p> <p>4. SCRIBE, ENGRAVE OR STAMP DRAWING PARTNUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE .07" HIGH CHARACTERS. EXAMPLE: D020188-001. A VIBRATORY TOOL MAY BE USED.</p>				DIMENSIONS ARE IN MM [INCHES]		 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP RUTHERFORD APPLETON LABORATORIES		
				TOLERANCES:			SYSTEM aLIGO	
				X.XX ±N/A			SUB-SYSTEM SUS	
				ANGULAR ± °			NEXT ASSY QUAD	
				MATERIAL: AS DRW			PART NAME TABLECLOTH	
-----		(NOISE PROTOTYPE)						
FINISH: AS DRW		SIZE DRG. NO. D060310 REV F.						
√μm [μin] Ra = -----								
NAME DATE								
DRAWN J O'DELL 30/JUN/09								
CHECKED MB 15/MAR/10		SCALE 1:2 PROJECTION:  SHEET 1 OF 1						
APPROVED JOD 15/MAR/10								



5.1.4.2 D060313 Quad N-Ptype Tablecloth, Top Plate, Noise Tablecloth



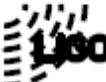

5.1.4.4 D060315 Quad N-Ptype Tablecloth, Tablecloth Pinch Plate, Upper Structure



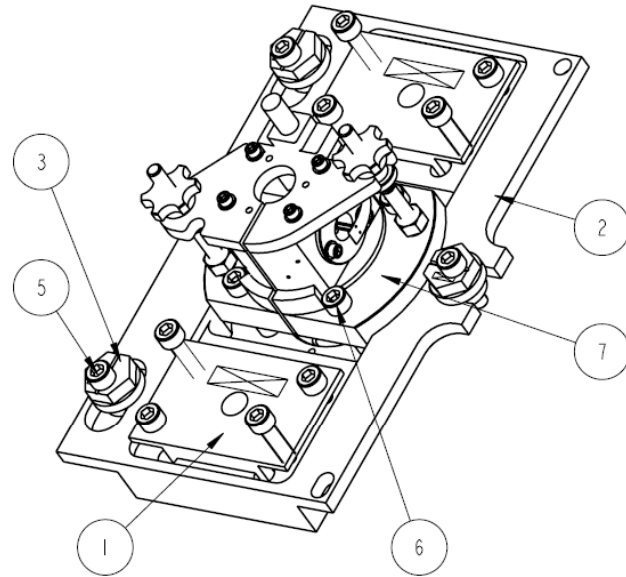
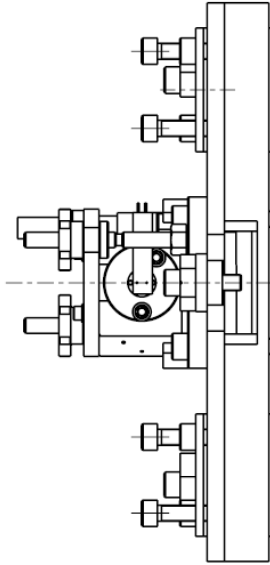
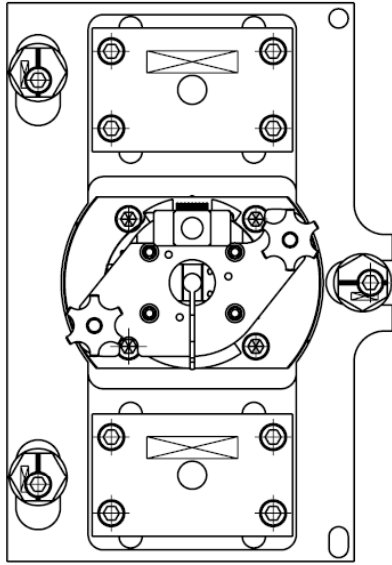
PART NO. (SEE NOTE 4)
TO BE ETCHED OR STAMPED
IN APPROX POSITION SHOWN.

NOTES: (UNLESS OTHERWISE SPECIFIED)			CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP RUTHERFORD APPLINGTON LABORATORIES	
1. REMOVE ALL SHARP EDGES, R .02 MIN. 2. DO NOT SCALE FROM DRAWING. 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMATECH 410 (STAINLESS STEEL) 4. SCRIBE, ENGRAVE OR STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE .07" HIGH CHARACTERS. EXAMPLE: D060315-001. A VIBRATORY TOOL MAY BE USED.	DIMENSIONS ARE IN mm (INCHES) TOLERANCES: X.XX ±0.2 mm ANGULAR ±0.25 °		SYSTEM aLIGO	
	MATERIAL: AL ALLOY 5083 T4		SUB-SYSTEM SUS	
	FINISH: SEE NOTE 3 √μm (μin) Ra = 1.6		NEXT ASSY QUAD TABLECLOTH	
	DRAWN I WILMUT 26/JUN/06 CHECKED MB 15/MAR/10 APPROVED JOD 15/MAR/10		PART NAME TABLECLOTH PINCH PLATE UPPER STRUCTURE	
SIZE A		DRG. NO. D060315		REV C.
SCALE 1:1 PROJECTION: SHEET 1 OF 1				

5.1.4.5 D060316 Quad N-Ptype Tablecloth, OSEM and ECD Adjuster, Noise Tablecloth

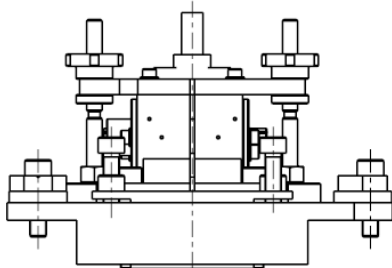
1	2			D060317	ECD STATIC BLOCK; .	OFHC COPPER: -----													
2	1			D060318	OSEM AND ECD MOUNTING BRACKET; (LOCAL CONTROLS)	AL ALLOY: 5083 H4													
3	3			D060336	2MM CAM; OSEM ADJUSTER	PH BRONZE: -----													
4	4				8-32 x 1.5D UNC THREAD INSERT; .														
5	11				8-32 UNC X 0.625" CAP HEAD; .	ST STEEL 316													
6	4				8-32 UNC X 0.875" CAP HEAD; .	ST STEEL 316													
7	1				BIRMINGHAM OSEM; .	OSEM SUPPLIED BY BIRMINGHAM													
ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS													
PARTS LIST																			
NOTES: (UNLESS OTHERWISE SPECIFIED)																			
<p>1. REMOVE ALL SHARP EDGES, R.02 MIN. 2. DO NOT SCALE FROM DRAWING. 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410 (STAINLESS STEEL) 4. SCRIBE, ENGRAVE OR STAMP DRAWING PARTNUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE .07" HIGH CHARACTERS. EXAMPLE: D020188- 001. A VIBRATORY TOOL MAY BE USED.</p>				DIMENSIONS ARE IN mm [INCHES] TOLERANCES: $X.XX \pm n-a$ mm ANGULAR $\pm n-a$ °		 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP RUTHERFORD APPLETON LABORATORIES													
				MATERIAL: AS DRW -----			SYSTEM aLIGO												
				FINISH: AS DRW $\sqrt{\mu m}$ [μin] Ra = -----			SUB-SYSTEM SUS												
				<table border="1"> <thead> <tr> <th></th> <th>NAME</th> <th>DATE</th> </tr> </thead> <tbody> <tr> <td>DRAWN</td> <td>I WILMUT</td> <td>18/MAY/06</td> </tr> <tr> <td>CHECKED</td> <td>MB</td> <td>15/MAR/10</td> </tr> <tr> <td>APPROVED</td> <td>JOD</td> <td>15/MAR/10</td> </tr> </tbody> </table>				NAME	DATE	DRAWN	I WILMUT	18/MAY/06	CHECKED	MB	15/MAR/10	APPROVED	JOD	15/MAR/10	NEXT ASSY QUAD TABLECLOTH
					NAME		DATE												
DRAWN	I WILMUT	18/MAY/06																	
CHECKED	MB	15/MAR/10																	
APPROVED	JOD	15/MAR/10																	
		PART NAME OSEM AND ECD ADJUSTER																	
					SIZE B DRG. NO. D060316	REV E.													
					SCALE 1:1	PROJECTION:  SHEET 1 OF 1													

INTERNAL NAME: D060316



ADDITIONAL NOTES:

- 5. OSEM IS SUPPLIED BY BIRMINGHAM UNIVERSITY AND SHOULD NOT BE ASSEMBLED PRIOR TO INSTALATION



REV.	DATE	DCN #	DRAWING TREE #
A	13/OCT/06	E060239	
B	19/DEC/07	E060239-B	
D	16/JULY/08	E060369	

ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS
1	2			D060317	ECD STATIC BLOCK	OFHC COPPER
2	1			D060318	OSEM AND ECD MOUNTING BRACKET (LOCAL CONTROL)	AL ALLOY: 5083 H4
3	3			D060336	JMW CAM: OSEM ADJUSTER	PH BRONZE
4	4				B-32 x 1.50 UNC THREAD INSERT	
5	11				B-32 UNC X 0.825" CAP HEAD	ST STEEL 316
6	4				B-32 UNC X 0.875" CAP HEAD	ST STEEL 316
7	1				BIRMINGHAM OSEM	OSEM SUPPLIED BY BIRMINGHAM

NOTES: (UNLESS OTHERWISE SPECIFIED)

- REMOVE ALL SHARP EDGES, R. 0.2 MIN.
- DO NOT SCALE FROM DRAWING.
- ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICON, SUCH AS CIMCOX (MILL) WILCOX'S CIMTECH 410 (STAINLESS STEEL).
- SCRIBE: ENGRAVE OR STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE '07' HIGH CHARACTERS. EXAMPLE: 0020100-001. A VIBRATORY TOOL MAY BE USED.

DIMENSIONS ARE IN mm (INCHES) TOLERANCES:

3 XX ±0.00 mm ANGULAR ±0.0°

MATERIAL: AS DRW

FINISH: AS DRW

NAME: DATE:

DRAWN: J. WILMOT 18/MAY/06

CHECKED: MB 15/MAR/10

APPROVED: JOD 15/MAR/10

SCALE: 1:1 PROJECTION: SHEET 1 OF 1

CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
 IGR, GLASGOW UNIVERSITY GEO 600 GROUP
 DUTHERDORF APPLETON LABORATORIES

SYSTEM: LIGO



SUB-SYSTEM: SUS

NEXT ASSY: QUAD TABLECLOTH

PART NAME: OSEM AND ECD ADJUSTER

DRG. NO.: D060316

5.1.4.6 D060320 Quad N-Ptype Tablecloth, Right Hand Plate, Noise Tablecloth

1	1			D060321	POSITION ADJUSTER FOR; FRONT PITCH OSEM	AL ALLOY: 5083 H4														
2	2			D060336	2MM CAM; OSEM ADJUSTER	PH BRONZE: - - - - -														
3	2				8-32 UNC X 0.625" CAP HEAD; .	ST STEEL 316														
4	4				8-32 UNC X 0.875" CAP HEAD; .															
5	1				BIRMINGHAM OSEM; .															
ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS														
PARTS LIST																				
NOTES: (UNLESS OTHERWISE SPECIFIED)																				
<p>1. REMOVE ALL SHARP EDGES, R.02 MIN. 2. DO NOT SCALE FROM DRAWING. 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410 (STAINLESS STEEL) 4. SCRIBE, ENGRAVE OR STAMP DRAWING PARTNUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE .07" HIGH CHARACTERS. EXAMPLE: D020188- 001. A VIBRATORY TOOL MAY BE USED.</p>				DIMENSIONS ARE IN mm [INCHES] TOLERANCES: X.XX ±N/A mm ANGULAR ±N/A °			 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP RUTHERFORD APPLETON LABORATORIES													
				MATERIAL: AS DRW - - - - -				SYSTEM aLIGO												
				FINISH: CLEAN AND DEGREASED √μm [μin] Ra = N/A				SUB-SYSTEM SUS												
				<table border="1"> <thead> <tr> <th></th> <th>NAME</th> <th>DATE</th> </tr> </thead> <tbody> <tr> <td>DRAWN</td> <td>I WILMUT</td> <td>18/MAY/06</td> </tr> <tr> <td>CHECKED</td> <td>MB</td> <td>15/MAR/10</td> </tr> <tr> <td>APPROVED</td> <td>JOD</td> <td>15/MAR/10</td> </tr> </tbody> </table>					NAME	DATE	DRAWN	I WILMUT	18/MAY/06	CHECKED	MB	15/MAR/10	APPROVED	JOD	15/MAR/10	NEXT ASSY QUAD TABLECLOTH
					NAME	DATE														
DRAWN	I WILMUT	18/MAY/06																		
CHECKED	MB	15/MAR/10																		
APPROVED	JOD	15/MAR/10																		
			PART NAME OSEM ADJUSTMENT PLATE																	
		SIZE B	DRG. NO. D060320		REV E.															
		SCALE 1:1	PROJECTION: 	SHEET 1 OF 1																

INTERNAL NAME: 0060320

REV.	DATE	DCN #	DRAWING TREE #
A	13/OCT/06	E060239	
B	19/DEC/07	E060239-B	
D	16/JULY/08	E080369	

ITEM	QTY	SPARE/TOTAL	PART NUMBER	DESCRIPTION	MATERIALS
1			0060320	POSITION ADJUSTER FOR: FRONT PITCH OSEM	AL ALLOY: 5083 H4
2			0060320	ZMW CAM; OSEM ADJUSTER	PH BRONZE:
3				8-32 UNC X 0.825" CAP HEAD: .	ST STEEL 316
4				8-32 UNC X 0.815" CAP HEAD: .	
5				BIRMINGHAM OSEM: .	

NOTES: (UNLESS OTHERWISE SPECIFIED)

- REMOVE ALL SHARP EDGES.
- DO NOT SCALE FROM DRAWING.
- ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SODIUM, CHROME AND SILICONE, SUCH AS CINCINNATI MILACRON'S CINCITECH 410 (STAINLESS STEEL).
- SCRIBE, ENGRAVE OR STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE 0* FOR HIGH CHARACTERS. EXAMPLE: 0020188-001, A VIBRATORY TOOL MAY BE USED.

DIMENSIONS ARE IN mm (INCHES) TOLERANCES:
 X.XX ±0.01A mm
 ANGULAR ±0.1°

MATERIAL: AS DAW
 FINISH: CLEAN AND DEGREASED
 (50um Lgrs) Ra = N/A



DRWN	CHKD	DATE	BYN

SCALE: 1:1 PROJECTION: SHEET 1 OF 1

CALIFORNIA INSTITUTE OF TECHNOLOGY
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 ROTHERFORD APPLETON LABORATORIES

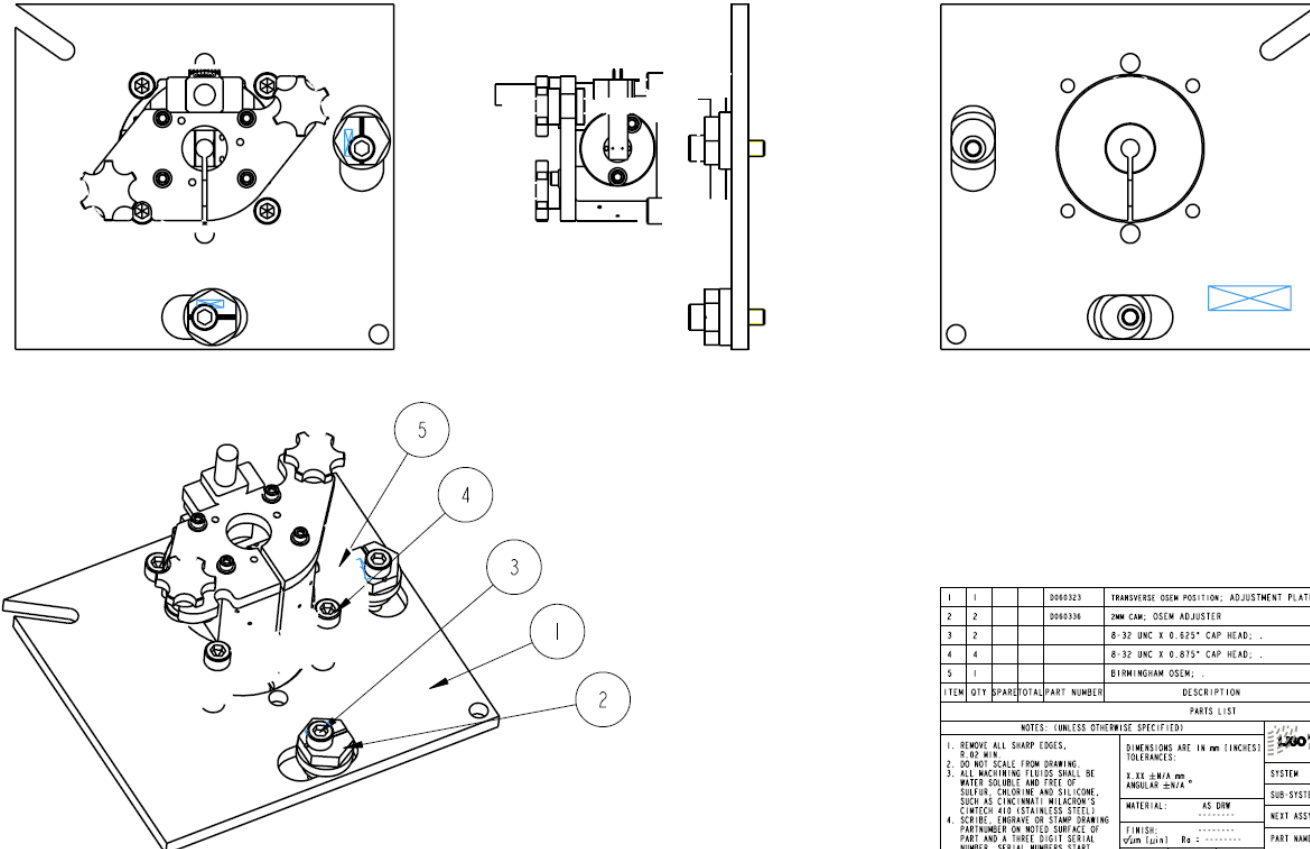
SYSTEM: **LIGO**
 SUB-SYSTEM: **SUS**
 NEXT ASSY: **QUAD TABLECLOTH**
 PART NAME: **OSEM ADJUSTMENT PLATE**
 DRG. NO.: **D060320**
 REV: **E**

5.1.4.7 D060322 Quad N-Ptype Tablecloth, Right Hand Plate, Noise Tablecloth

1	1			D060323	TRANSVERSE OSEM POSITION; ADJUSTMENT PLATE	AL ALLOY: 5083 H4							
2	2			D060336	2MM CAM; OSEM ADJUSTER	PH BRONZE: -----							
3	2				8-32 UNC X 0.625" CAP HEAD; .	ST STEEL 316							
4	4				8-32 UNC X 0.875" CAP HEAD; .	ST STEEL 316							
5	1				BIRMINGHAM OSEM; .								
ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS							
PARTS LIST													
NOTES: (UNLESS OTHERWISE SPECIFIED)					 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP RUTHERFORD APPLETON LABORATORIES								
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					DIMENSIONS ARE IN mm [INCHES] TOLERANCES: X.XX ±N/A mm ANGULAR ±N/A °								
					MATERIAL: AS DRW -----								
					FINISH: ----- √μm [μin] Ra = -----								
					<table border="1"> <thead> <tr> <th></th> <th>NAME</th> <th>DATE</th> </tr> </thead> <tbody> <tr> <td>DRAWN</td> <td>I WILMUT</td> <td>19/MAY/06</td> </tr> <tr> <td>CHECKED</td> <td>MB</td> <td>15/MAR/10</td> </tr> <tr> <td>APPROVED</td> <td>JOD</td> <td>15/MAR/10</td> </tr> </tbody> </table>			NAME	DATE	DRAWN	I WILMUT	19/MAY/06	CHECKED
	NAME	DATE											
DRAWN	I WILMUT	19/MAY/06											
CHECKED	MB	15/MAR/10											
APPROVED	JOD	15/MAR/10											
					SYSTEM aLIGO								
					SUB-SYSTEM SUS								
					NEXT ASSY QUAD TABLECLOTH								
					PART NAME TRANSVERSE OSEM ADJUSTER								
					SIZE B	DRG. NO. D060322							
					SCALE 1:1	PROJECTION: 							
					SHEET 1 OF 1	REV E.							

INTERNAL LINK NAME: D060322

REV.	DATE	DCN #	DRAWING TREE #
A	13/OCT/06	E000239	.
B	19/DEC/07	E000239-B	.
D	16/JULY/08	E000369	.




ITEM	QTY	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIALS
1	1			D060323	TRANSVERSE OSEM POSITION: ADJUSTMENT PLATE	AL ALLOY: 5083 H4
2	2			D060334	PMW CAM: OSEM ADJUSTER	PH BRONZE:
3	2				8-32 UNC X 0.625" CAP HEAD: .	ST STEEL 316
4	4				8-32 UNC X 0.875" CAP HEAD: .	ST STEEL 316
5	1				BIRMINGHAM OSEM: .	


NOTES: (UNLESS OTHERWISE SPECIFIED)

- REMOVE ALL SHARP EDGES.
- R.02 MIN.
- DO NOT SCALE FROM DRAWING.
- ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CINTEC-H 410 (STAINLESS STEEL).
- SCRIBE, ENGRAVE OR STAMP DRAWING PART NUMBER ON NOTED SURFACE OF PART AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST PART AND PROCEED CONSECUTIVELY. USE 37° HIGH CHARACTERS. EXAMPLE: 0001000-001. A VIBRATORY TOOL MAY BE USED.

DIMENSIONS ARE IN mm (INCHES) TOLERANCES:
 X .XX ±0.04 mm ANGULAR ±0.174°
 MATERIAL: AS DIM
 FINISH:

SCALE: 1:1 PROJECTION: 

DATE	BY	CHKD	APP'D	REV
19/MAY/06				
12/MAR/07				
15/MAR/08				

CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
 FOR: GLASGOW UNIVERSITY GEO GROUP
 RUTHERFORD APPLIION LABORATORIES
 SYSTEM: **LIGO**
 SUB-SYSTEM: **SUS**
 NEXT ASSY: **QUAD TABLECLOTH**
 PART NAME: **TRANSVERSE OSEM ADJUSTER**
 BRG. NO: **D060322**
 SCALE: 1:1 PROJECTION:  SHEET 1 OF 1

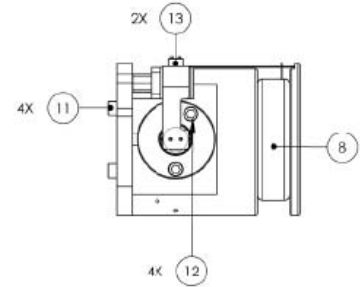
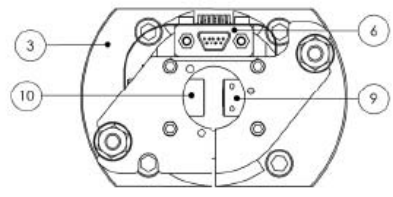
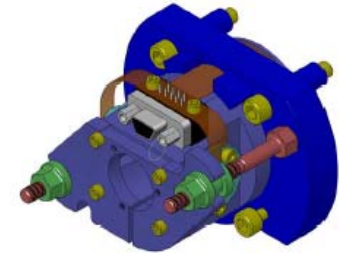
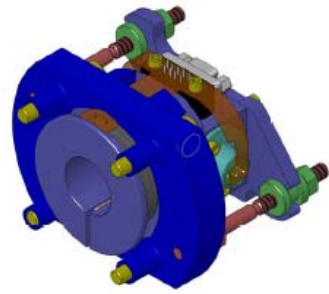
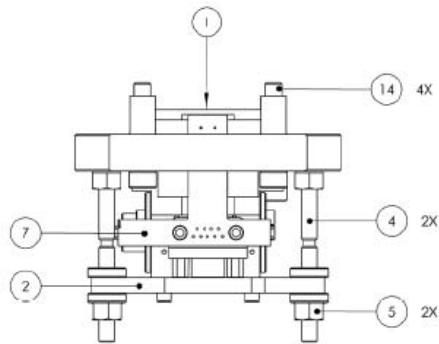
5.1.4.8 D060218 BOSEM Assembly

14	95966A339 McMASTER-CARR	SCREW, SHC, 8-32 X .38 LG., CAPTIVE	4	-	4
13	-	SCREW, SOCKET HEAD CAP, #2-56 UNC-2A X 0.5 LONG	2	2	4
12	-	SCREW, SOCKET HEAD CAP, #2-56 UNC-2A X 0.25 LONG	4	4	8
11	-	SCREW, SOCKET HEAD CAP, #2-56 UNC-2A X 0.3125 LONG	4	4	8
10	D060216	IRLED Assembly	1	1	2
9	D060217	PD Assembly	1	1	2
8		Coil Winding (MWS 32QML)	1	1	2
7	D050435	Flexi-Circuit	1	1	2
6	GlenAir	Connector (GlenAir)	1	1	2
5	D060110	Adjuster Nut	2	2	4
4	D060109	Adjuster Shaft	2	2	4
3	D060108	ALIGO, SUS, QUAD, BOSEM ASSY., COILFORMER CLAMP	1	1	2
2	D060107	Coilformer Backplate	1	1	2
1	D060106	Coilformer	1	1	2
ITEM NO.	PART NUMBER	DESCRIPTION	REQ	SPARE	TOTAL

PARTS LIST

 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME ALIGO, SUS, BOSEM ASSEMBLY			
SYSTEM ADVANCED LIGO	SUB-SYSTEM SUS	DESIGNER S. BROOKES	DATE 26 JUN 2006	SIZE DWG. NO. B	REV. v2
NEXT ASSY MULTIPLE		CHECKER S. ASTON	DATE 2 OCT 2006	DWG. NO. D060218	
		APPROVAL A. VECCHIO	DATE 31 OCT 2006	SCALE: 1:1	PROJECTION:  SHEET 1 OF 1

REV.	DATE	DCN #	DRAWING TREE #
C	12 DEC 2007	E060262	E060243
v2	20 JAN 2012	E1200066-x0	-
-	-	-	-





ITEM NO.	PART NUMBER	DESCRIPTION	REQ	SPARE	TOTAL
14	95966A339 McMASTER-CARR	SCREW, SHC, 8-32 X .38 LG., CAPTIVE	4	-	4
13	-	SCREW, SOCKET HEAD CAP, #2-56 UNC-2A X 0.5 LONG	2	2	4
12	-	SCREW, SOCKET HEAD CAP, #1-56 UNC-2A X 0.25 LONG	4	4	8
11	-	SCREW, SOCKET HEAD CAP, #2-56 UNC-2A X 0.3125 LONG	4	4	8
10	D060216	IRLED Assembly	1	1	2
9	D060217	PD Assembly	1	1	2
8	-	Coil Winding (MWS 32GML)	1	1	2
7	D050435	Flexi-Circuit	1	1	2
6	GlenAir	Connector (GlenAir)	1	1	2
5	D060110	AdjusterNut	2	2	4
4	D060109	Adjuster Shaft	2	2	4
3	D060108	ALIGO, SUS, QUAD, BOSEM ASY., COILFORMER CLAMP	1	1	2
2	D060107	Coilformer Backplate	1	1	2
1	D060106	Coilformer	1	1	2

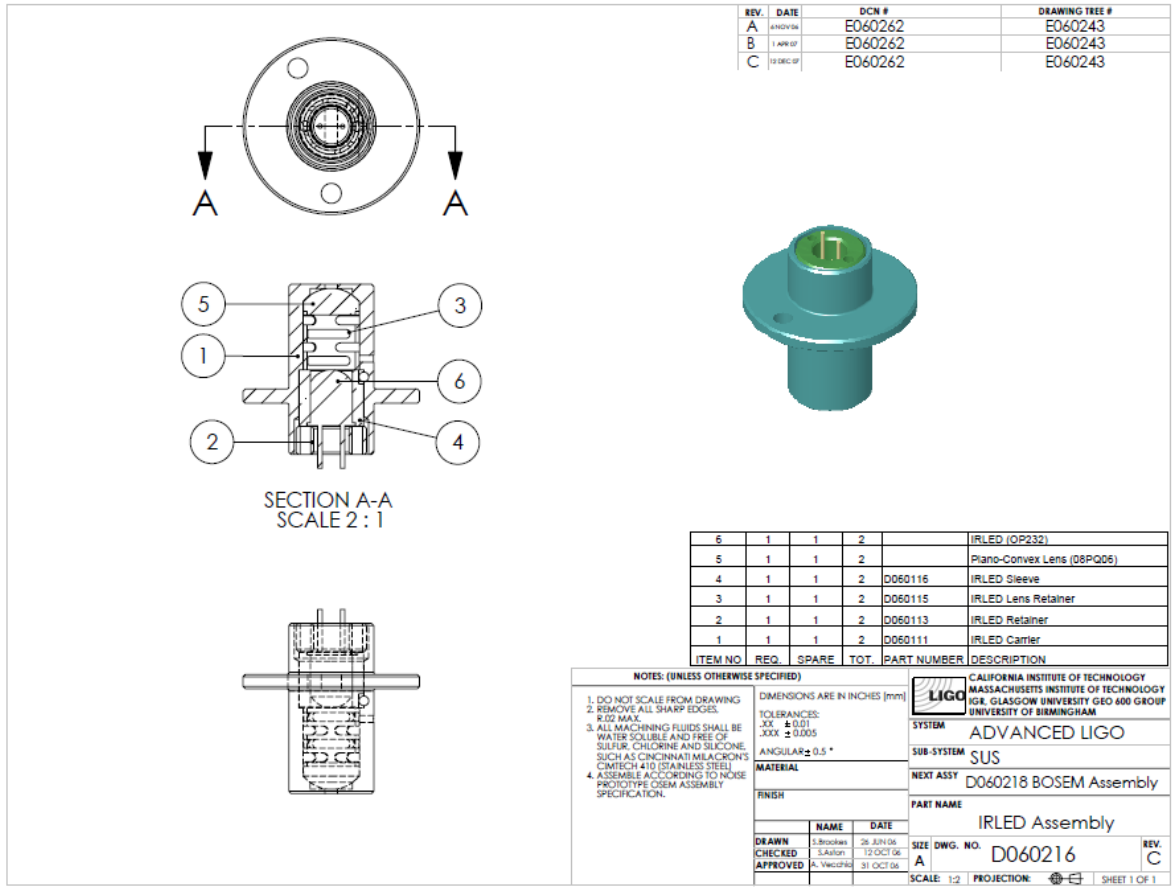
NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

MATERIAL		N/A	FINISH		N/A pinch	NEXT ASSY		MULTIPLE	PART NAME		ALIGO, SUS, BOSEM ASSEMBLY	DESIGNER	SIRCOBES	18 JUN 2004	SIZE	DWG. NO.	D060218	REV.	v2										
SYSTEM		ADVANCED LIGO	SUB-SYSTEM		SUS	DESIGNER		SIRCOBES	18 JUN 2004	SIZE	B	DRAWN		SARON	2 OCT 2004	CHECKER		SARON	2 OCT 2004	APPROVAL		AVECCHIO	11 OCT 2004	SCALE:	1:1	PROJECTION:	1st	SHEET	1 OF 1

5.1.4.8.1 D060216 IRLED Assembly



6	1	1	2		IRLED (OP232)
5	1	1	2		Plano-Convex Lens (08PQ06)
4	1	1	2	D060116	IRLED Sleeve
3	1	1	2	D060115	IRLED Lens Retainer
2	1	1	2	D060113	IRLED Retainer
1	1	1	2	D060111	IRLED Carrier
ITEM NO	REQ.	SPARE	TOT.	PART NUMBER	DESCRIPTION

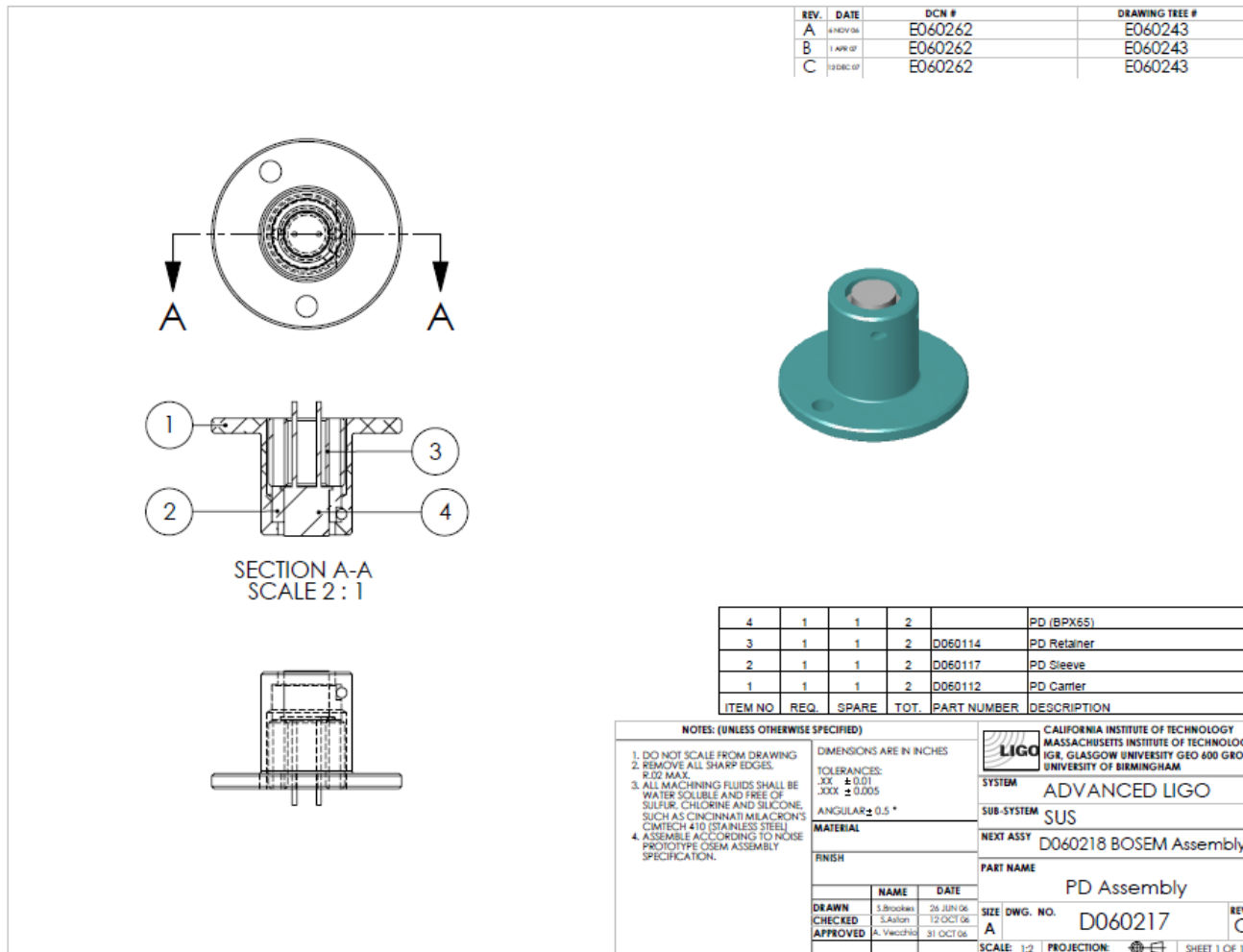
NOTES: (UNLESS OTHERWISE SPECIFIED)					CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP UNIVERSITY OF BIRMINGHAM	
1. DO NOT SCALE FROM DRAWING 2. REMOVE ALL SHARP EDGES, R.02 MAX. 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410 (STAINLESS STEEL) 4. ASSEMBLE ACCORDING TO NOISE PROTOTYPE OSEM ASSEMBLY SPECIFICATION.	DIMENSIONS ARE IN INCHES [mm]		TOLERANCES:		SYSTEM	
			.XX ± 0.01		ADVANCED LIGO	
			.XXX ± 0.005		SUB-SYSTEM	
	ANGULAR ± 0.5 °		MATERIAL		SUS	
	FINISH		NEXT ASSY		D060218 BOSEM Assembly	
		PART NAME		IRLED Assembly		
	NAME	DATE	SIZE	DWG. NO.	REV.	
DRAWN	S.Brookes	26 JUN 06	A	D060216	C	
CHECKED	S.Aston	12 OCT 06				
APPROVED	A. Vecchio	31 OCT 06				
SCALE: 1:2			PROJECTION: 		SHEET 1 OF 1	



5.1.4.8.2 D060217 PD Assembly

4	1	1	2		PD (BPX65)
3	1	1	2	D060114	PD Retainer
2	1	1	2	D060117	PD Sleeve
1	1	1	2	D060112	PD Carrier
ITEM NO	REQ.	SPARE	TOT.	PART NUMBER	DESCRIPTION

NOTES: (UNLESS OTHERWISE SPECIFIED)			 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY IGR, GLASGOW UNIVERSITY GEO 600 GROUP UNIVERSITY OF BIRMINGHAM		
1. DO NOT SCALE FROM DRAWING 2. REMOVE ALL SHARP EDGES, R.02 MAX. 3. ALL MACHINING FLUIDS SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410 (STAINLESS STEEL) 4. ASSEMBLE ACCORDING TO NOISE PROTOTYPE OSEM ASSEMBLY SPECIFICATION.	DIMENSIONS ARE IN INCHES		SYSTEM ADVANCED LIGO		
	TOLERANCES:		SUB-SYSTEM SUS		
	.XX ± 0.01		NEXT ASSY D060218 BOSEM Assembly		
	.XXX ± 0.005		PART NAME PD Assembly		
ANGULAR ± 0.5 °		DRAWN S.Brookes 26 JUN 06 CHECKED S.Aston 12 OCT 06 APPROVED A. Vecchio 31 OCT 06			
MATERIAL		SIZE A DWG. NO. D060217 REV. C			
FINISH		SCALE: 1:2 PROJECTION:  SHEET 1 OF 1			



5.1.5 D1101166 TMS Upper Suspension Wire Assembly

1. Safety glasses must be worn during all wire work. Safety glasses are provided in the garbing areas and in all clean rooms.
2. Glove liners should be worn under latex clean-room gloves, as a protective layer and an extra barrier. For information on glove liners, see the Contamination Control Plan, [E0900047](#), page 13.
3. Take the end of the wire and bend a small section, say 3” or so, for easier holding. The bent wire section can be hooked around your thumb, and held by your index finger.
4. Un-spool the proper length of wire, including extra for handling, and control the area of the wire that needs to be cut. Add a bend at the other end, if handling it that way is easier for you.
5. Clean the end with the first bend. Change your gloves and grab the cleaned, bent end around your thumb.
6. Prepare the cleaning wipes with methanol. Wipe wire clean with methanol 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 a section at a time.

Transfer the wire to the wire jig. Use the wire jig clamps to hold down the wire. Cut the bent ends off and remove, after the wire is secured, according to the wire assembly procedure, [T1000674-v2](#).

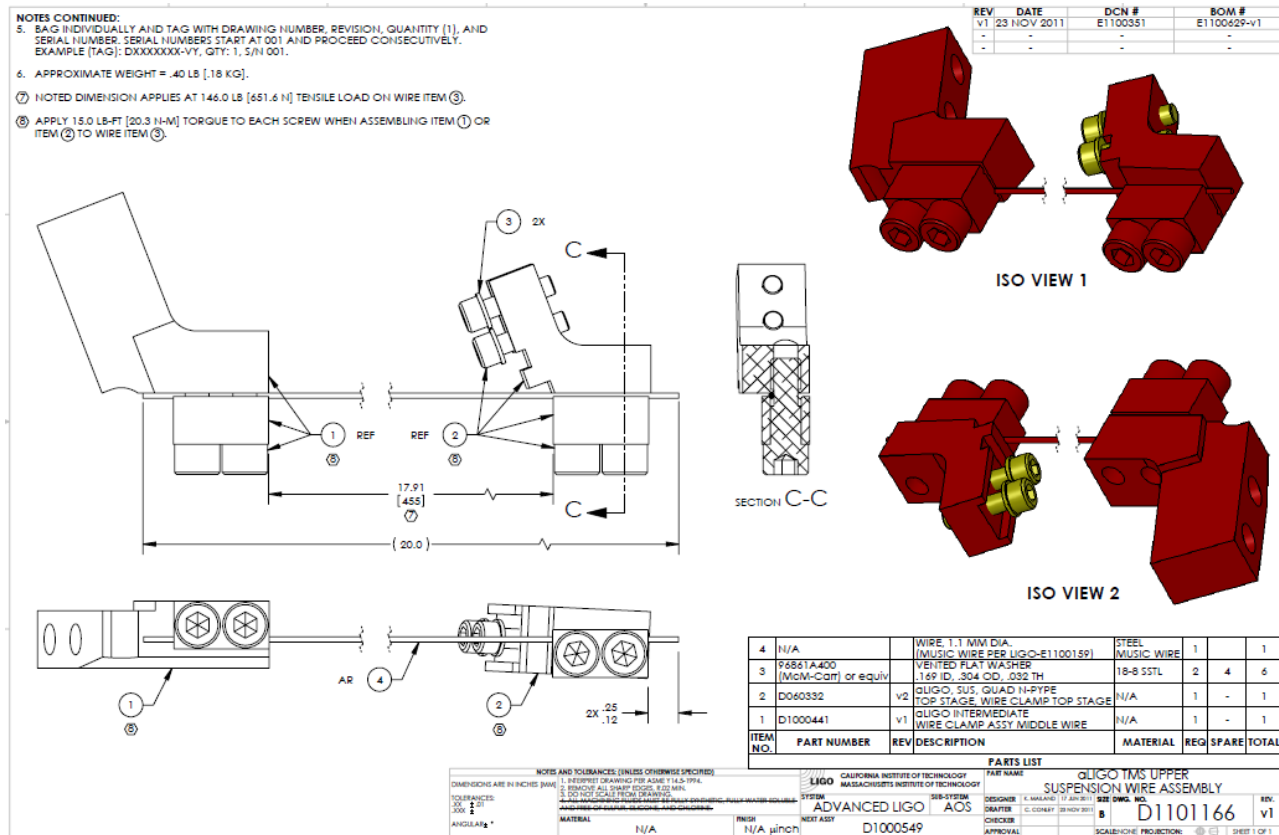


Figure 9: TMS Upper Suspension Wire Assembly

5.1.5.1 T1200388 TMS Wire Jig Assembly

The TMS Upper Suspension Wire will be stretched under load and set to the correct length by using a modified version of the D060517 Quad Wire Jig Assembly shown in **Figure 10**.

The modified version of the TMS wire jig assembly is shown in **Figure 11**, **Figure 12**, and **Figure 13**.

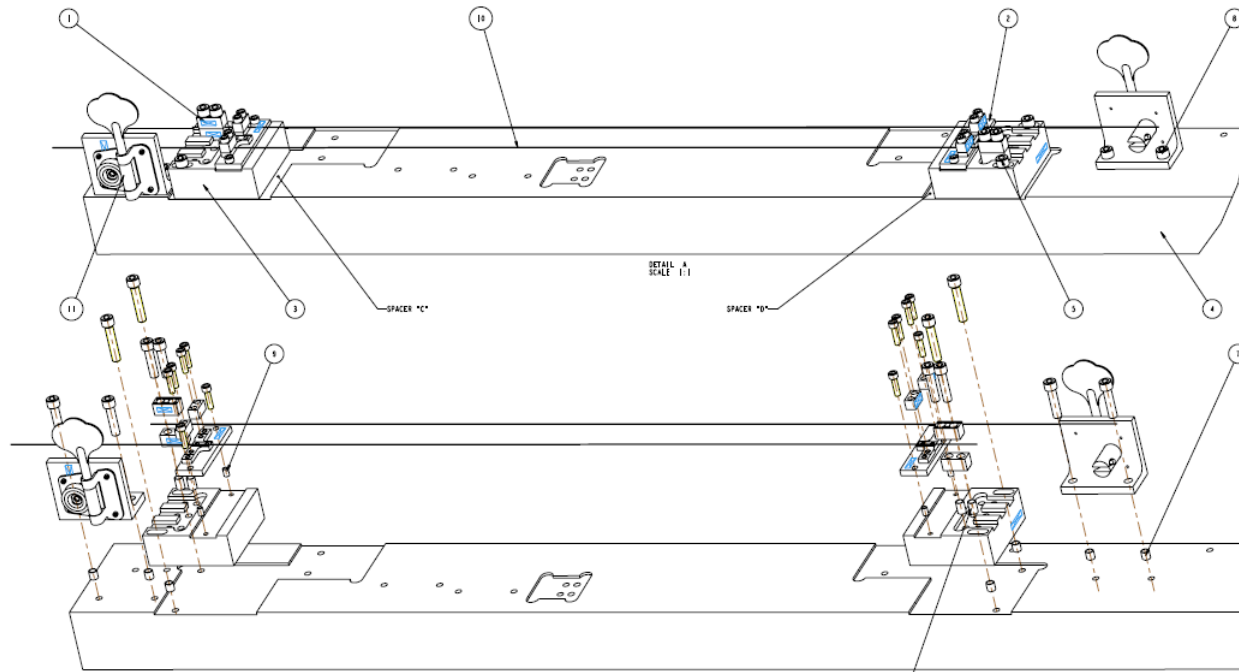


Figure 10: Quad Wire Jig Assembly



Figure 11: Modified TMS Wire Jig Assembly

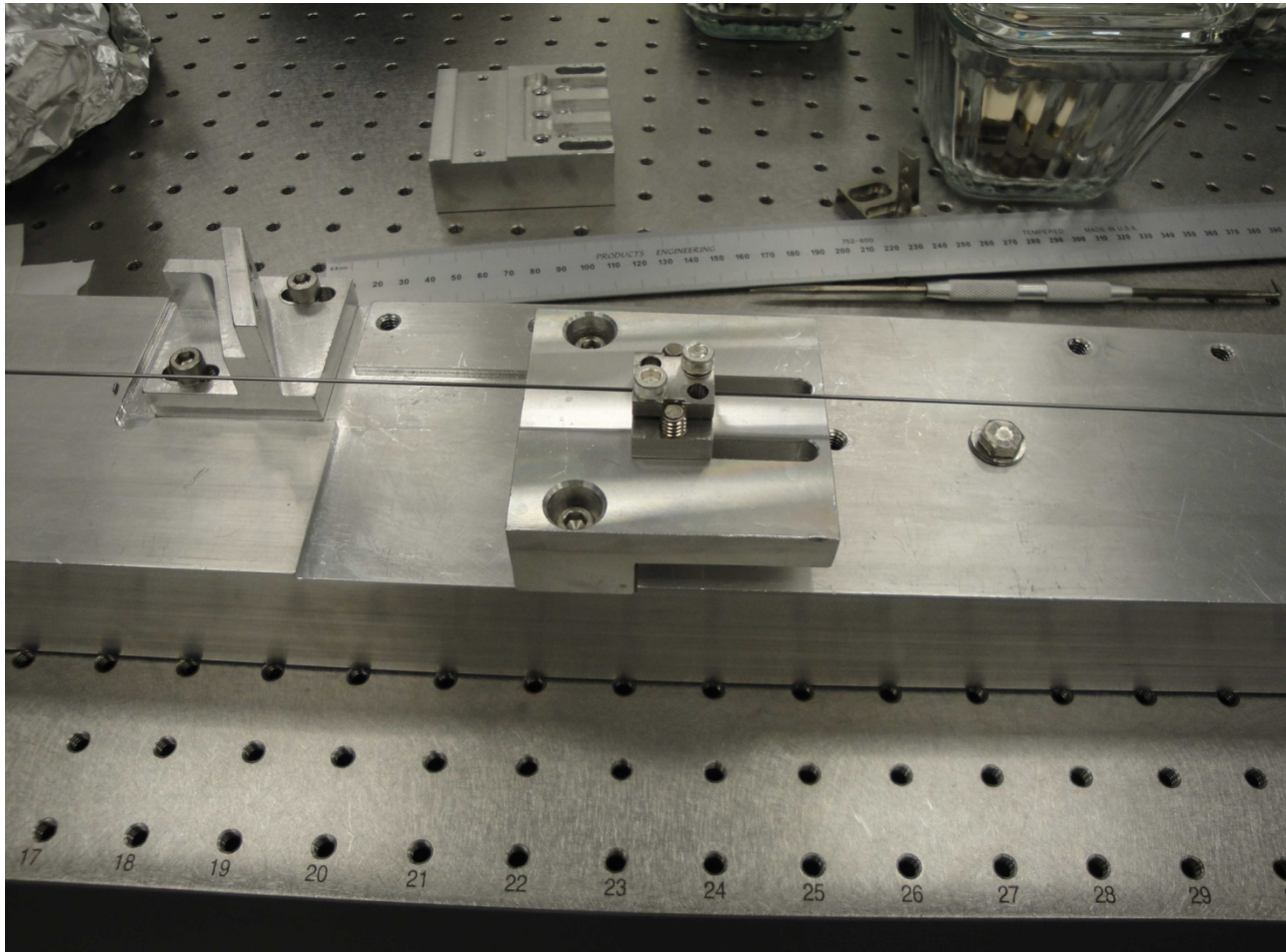


Figure 12: Modified TMS Wire Jig Assembly, Clamping Detail

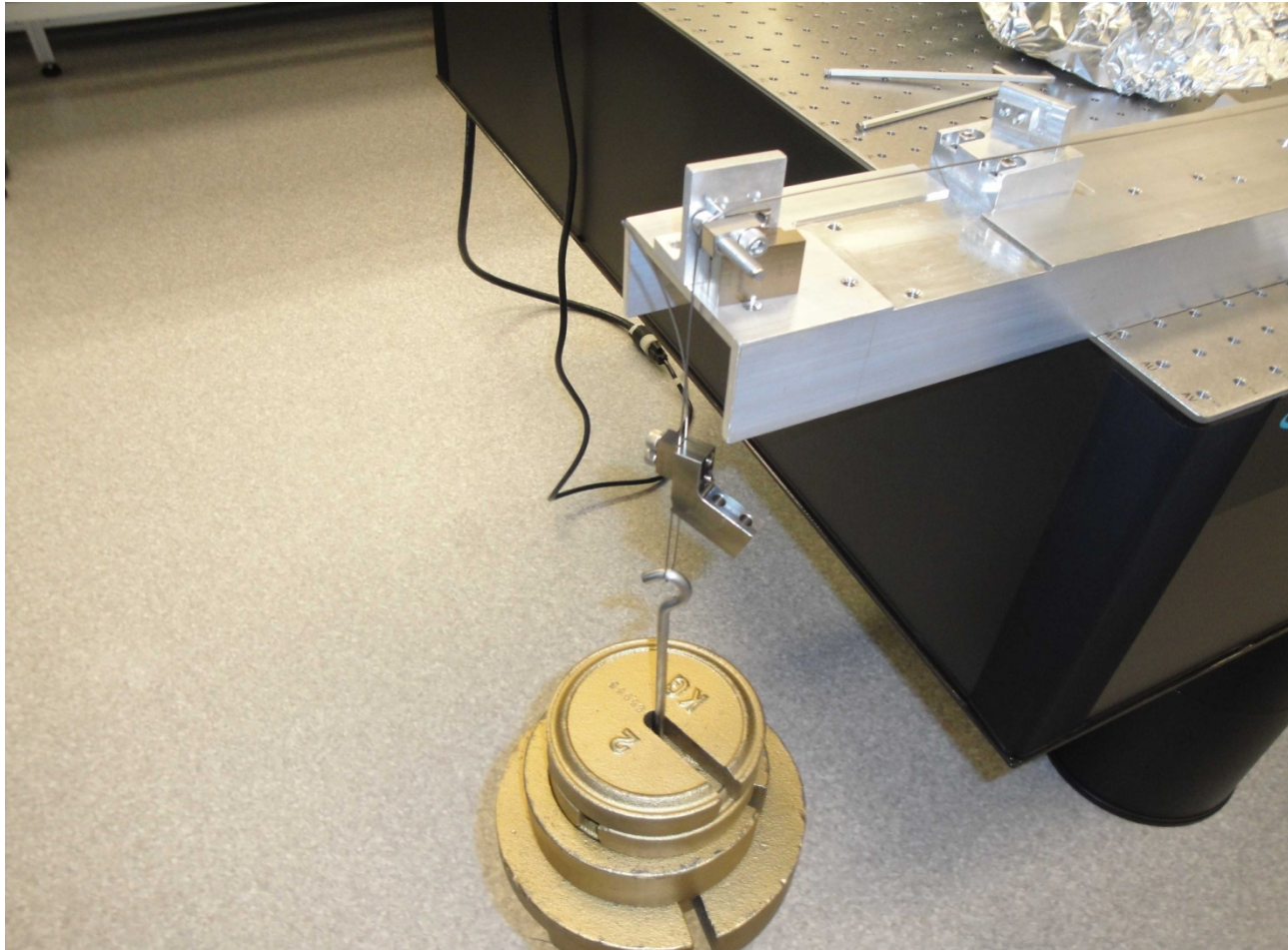
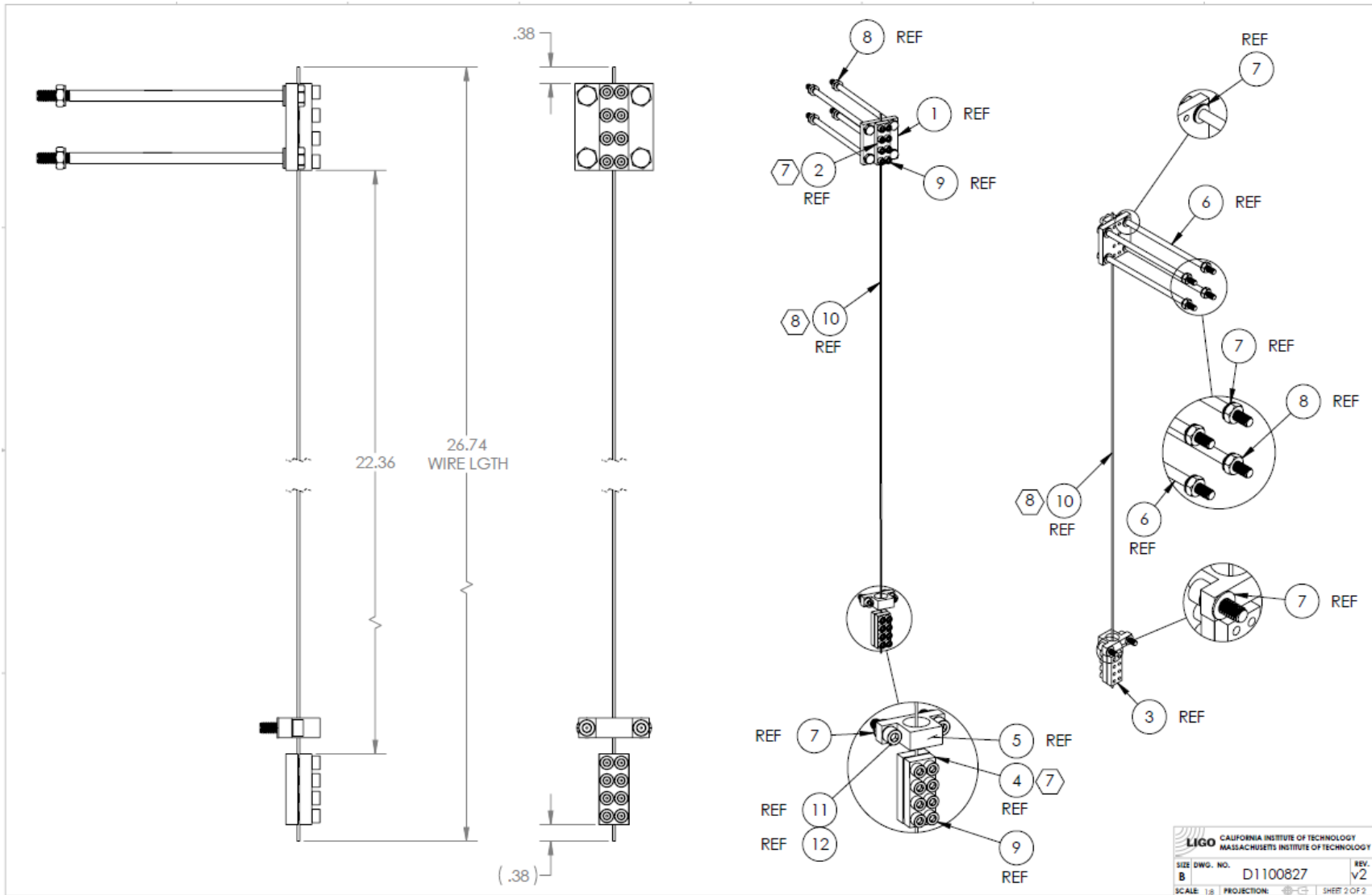


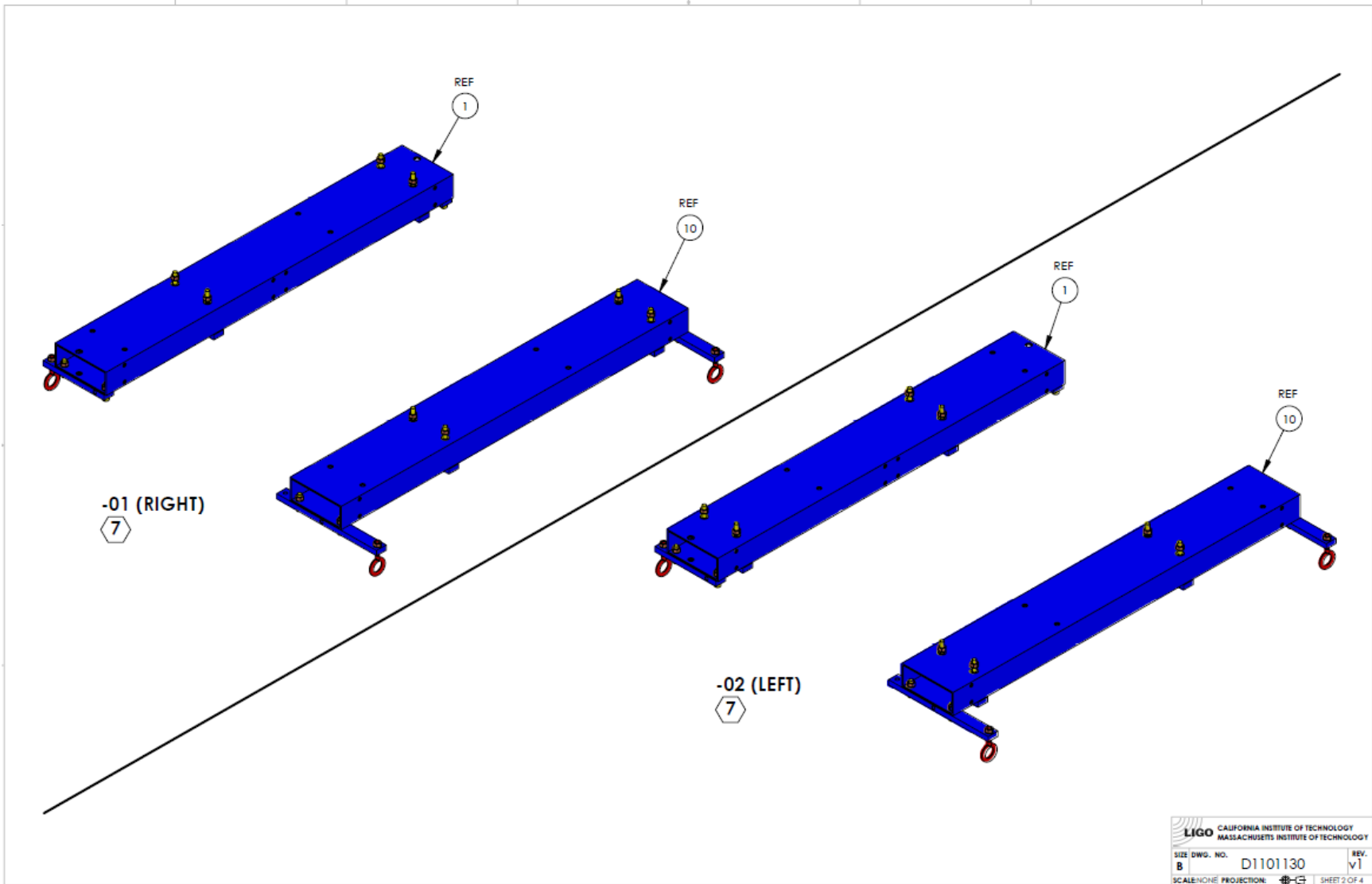
Figure 13: Modified TMS Wire Jig Assembly, with Loading Weight

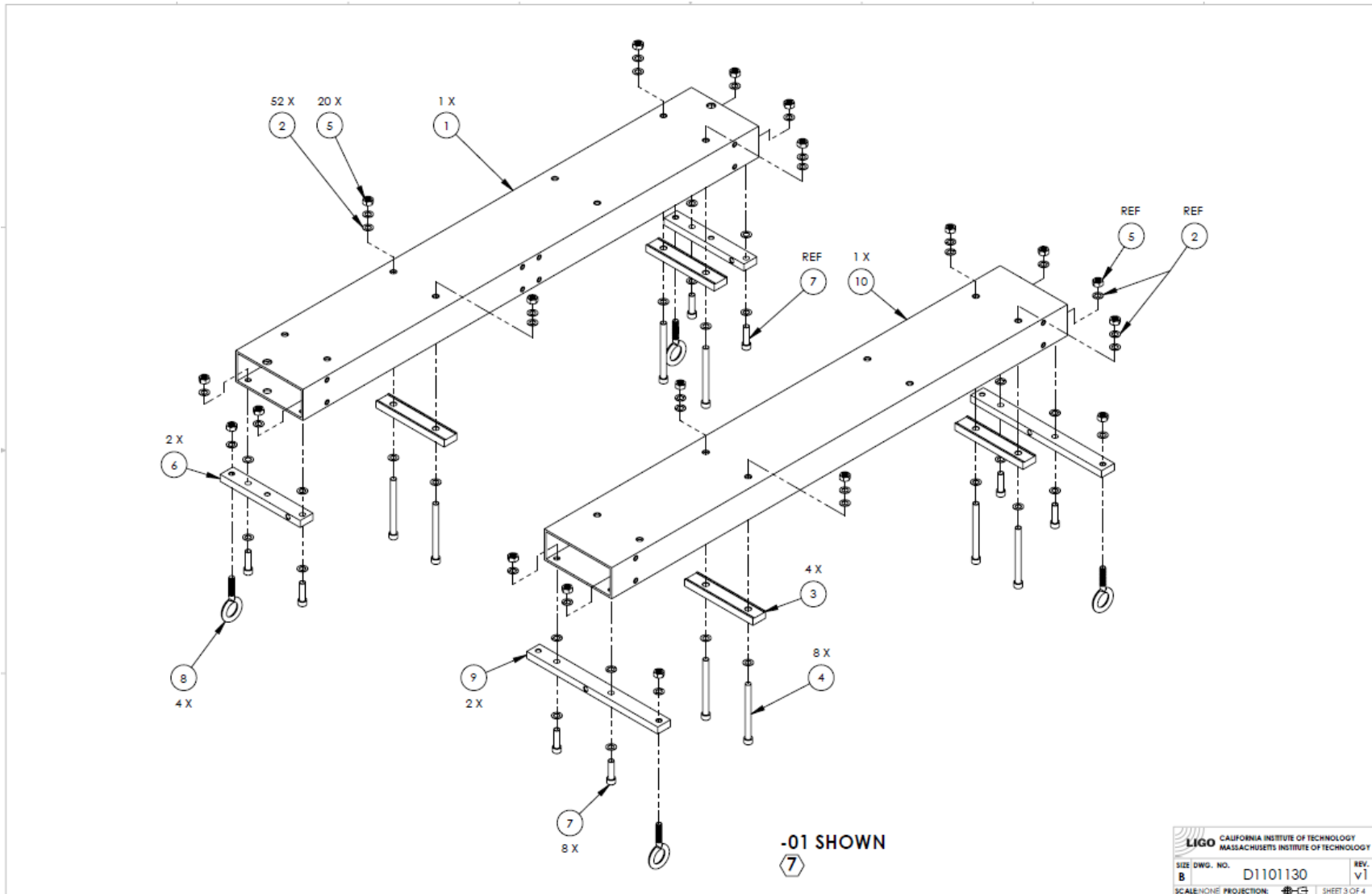


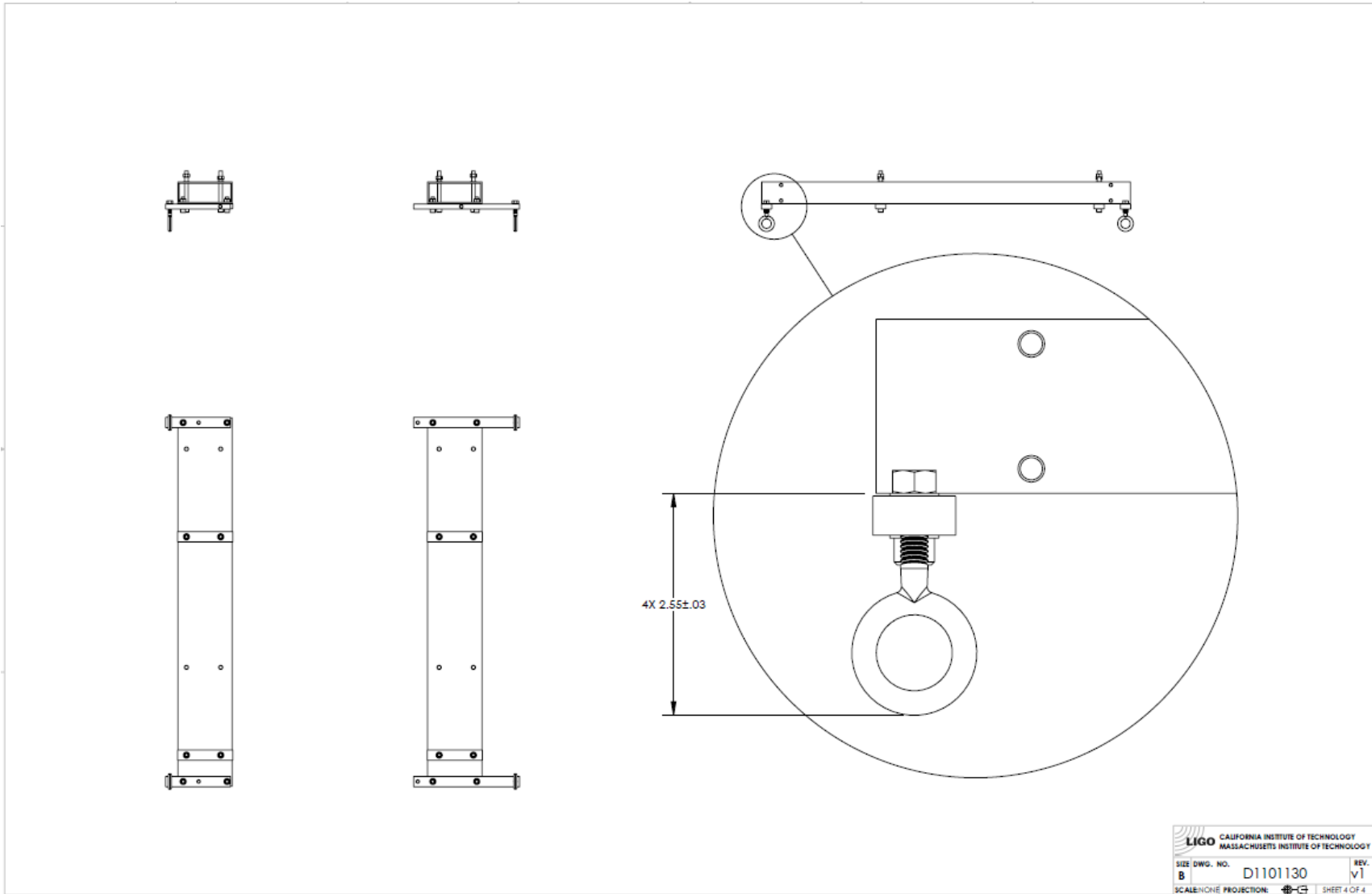
5.3 D1101130: aLIGO TMS TELESCOPE SAFETY SUPPORT BEAM ASSY



10	D1100264-02	v2	TMS TELESCOPE SAFETY SUPPORT BEAM, REAR	6061-T6 Al	1	-	1
9	D1100281	v1	TMS SAFETY CHAIN MOUNT, REAR	6061-T6 Al	2	-	2
8	33045T72 (McM-Carr) or equiv		EYEBOLT, NON-SHOULDERED, 780# 5/16-18 X 1.88" THREAD	304 SSSL	4	2	6
7	92196A584 (McM-Carr) or equiv		SCREW, SOCKET HEAD CAP, 5/16-18 UNC-2A X 1.125 LONG	18-8 SSSL	8	2	10
6	D1100280	v1	TMS SAFETY CHAIN MOUNT, FRONT	6061-T6 Al	2	-	2
5	D1100989	v1	NICKEL-COPPER ALLOY 400 .312-18 HEX NUT, MODIFIED	NICKEL-COPPER ALLOY 400	20	6	26
4	92196A597 (McM-Carr) or equiv		SCREW, SOCKET HEAD CAP, 5/16-18 UNC-2A X 3.5 LONG	18-8 SSSL	8	2	10
3	D1100271	v1	TMS VERTICAL SAFETY STOP STRUCTURAL MOUNT	6061-T6 Al	4	-	4
2	96861A700 (McM-Carr) or equiv		VENTED FLAT WASHER .328 ID, .562 OD, .082 TH	18-8 SSSL	52	16	68
1	D1100264-01	v2	TMS TELESCOPE SAFETY SUPPORT BEAM, FRONT	6061-T6 Al	1	-	1
ITEM NO.	PART NUMBER	REV	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL

NOTES AND TOLERANCES (UNLESS OTHERWISE SPECIFIED)				LIGO		PART NAME	
DIMENSIONS ARE IN INCHES 1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, R.20 MIN. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUES MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.				CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		aLIGO TMS TELESCOPE SAFETY SUPPORT BEAM ASSEMBLY	
TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°				SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER E. MARANO 10 FEB 2009	REV. v1
MATERIAL N/A FINISH N/A μinch				NEXT ASSY D0901880	DRAFTER AL. MUELLER 04 OCT 2011	SEE DWG. NO. B D1101130	
				APPROVAL SP. DCH	CHECKER SP. DCH	SCALE/DWG. PROJECTION:	SHEET 1 OF 4







 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		
SIZE	DWG. NO.	REV.
B	D1101130	v1
SCALE: NONE		PROJECTION: 
SHEET 4 OF 4		

5.4 D1001891: aLIGO TMS VERTICAL SEISMIC SAFETY STOP ASSEMBLY

This assembly is used only during alignment and servicing of the ETM.

NOTES CONTINUED:

- BAG AND TAG ASSEMBLIES INDIVIDUALLY WITH THEIR DRAWING NUMBER, REVISION, AND SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. EXAMPLE (TAG): DXXXXXX-VV, S/N 001
- APPROXIMATE WEIGHT = .52 LB [.23 KG].

ITEM NO.	PART NUMBER	REV	DESCRIPTION	QTY	SPARE	TOTAL
8	94773A772 (McM-Carr) or equiv		SHIM WASHER .314 ID, .438 OD, .060 TH	1	1	2
7	Kit9426 Ball Bearing (VXB)		BALL BEARING, RADIAL METRIC, FULL COMPLIMENT 300# STATIC, 148# DYNAMIC, 9 X 14 X 3	1	-	1
6	D1003329	v1	aLIGO TMS SAFETY EXCHANGE CLAMP	1	-	1
5	96861A700 (McM-Carr) or equiv		VENTED FLAT WASHER .328 ID, .562 OD, .032 TH	1	-	1
4	D1100989	v1	NICKEL-COPPER ALLOY 400 .312-18 HEX NUT, MODIFIED	2	1	3
3	D1100986	v1	TMS TELESCOPE CHAIN, 12 IN.	1	-	1
2	3712T31 (McM-Carr) or equiv		THREADED CONNECTOR 285# CAPACITY	2	1	3
1	8891T56 (McM-Carr) or equiv		EYEBOLT, NON-SHOULDERED, 900# 5/16-18 X 3" THREAD	2	1	3

BOM	
ITEM NO.	REV DESCRIPTION
8	94773A772 (McM-Carr) or equiv
7	Kit9426 Ball Bearing (VXB)
6	D1003329
5	96861A700 (McM-Carr) or equiv
4	D1100989
3	D1100986
2	3712T31 (McM-Carr) or equiv
1	8891T56 (McM-Carr) or equiv

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. FINISH ALL SHARP EDGES R.02 MIN.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUDES MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.

TOLERANCES:
 XX .01
 XXX .005
 ANGULAR ± 1.0°

MATERIAL: N/A
FINISH: N/A μinch
NEXT ASSY: TMS TOOLING

SYSTEM: ADVANCED LIGO
SUB-SYSTEM: AOS

PART NAME: aLIGO TMS VERTICE SEISMIC SAFETY STOP ASSEMBLY
DESIGNER: E. MALAND
DRAFTER: M. MELLER
CHECKER: SEE DCH
APPROVAL: SEE DCH

DATE: 05 FEB 2011
DATE: 05 AUG 2011

SCALE/DWG. NO.: B D1001891
PROJECTION: 1st ANGLE
SHEET: 1 OF 1

5.5 D1101163: aLIGO TMS Telescope SUS Wire Assembly

The assembly procedure is the same as described in D1101166 TMS Upper Suspension Wire Assembly—see section 5.1.5.

NOTES CONTINUED:

5. SAG INDIVIDUALLY AND TAG WITH DRAWING NUMBER, REVISION, QUANTITY (1), AND SERIAL NUMBER. SERIAL NUMBERS START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE (TAG): DXXXXXX-VY, QTY: 1, S/N 001.
6. APPROXIMATE WEIGHT = .36 LB [1.6 KG].
7. NOTED DIMENSION APPLIES AT 44.4 LB [197.7 N] TENSILE LOAD FOR EACH WIRE.
8. APPLY 15.0 LB-FT [20.3 N-M] TORQUE TO EACH SCREW WHEN ASSEMBLING ITEM 1 TO ITEM 2.
9. APPLY 10.0 LB-FT [13.6 N-M] TORQUE TO EACH SCREW WHEN ASSEMBLING ITEMS 3 TO ITEM 2.

ITEM NO.	PART NUMBER	REV	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
4	Y0851A400 (McM-Carr) or equiv		VERTICAL FLAT WASHER .169 ID, .304 OD, .032 TH	18-8 SSTL	2	-	2
3	D1101162	v1	aLIGO TMS TELESCOPE SUS CLAMP ASSEMBLY	N/A	2	-	2
2			WIRE, 1.1 MM DIA. (MUSIC WIRE PER LIGO-E1100189)	STEEL MUSIC WIRE	1	-	1
1	D060422	v2	aLIGO, SUS, QUAD N-PTYPE W/ MASS. W/ MASS WIRE CLAMP	N/A	1	-	1

PARTS LIST

ADVANCED LIGO SYSTEM AOS
 DOP01880

D1101163 v1

SCALE: NONE PROJECTION: 3D SHEET 1 OF 1

5.6 D1000484: ISC Transmon Assembly

The ISC group is responsible for the ISC Transmon Assembly D1000484, which is placed on top of the TMS ISC Table Structural Assembly D1102291, as shown in .

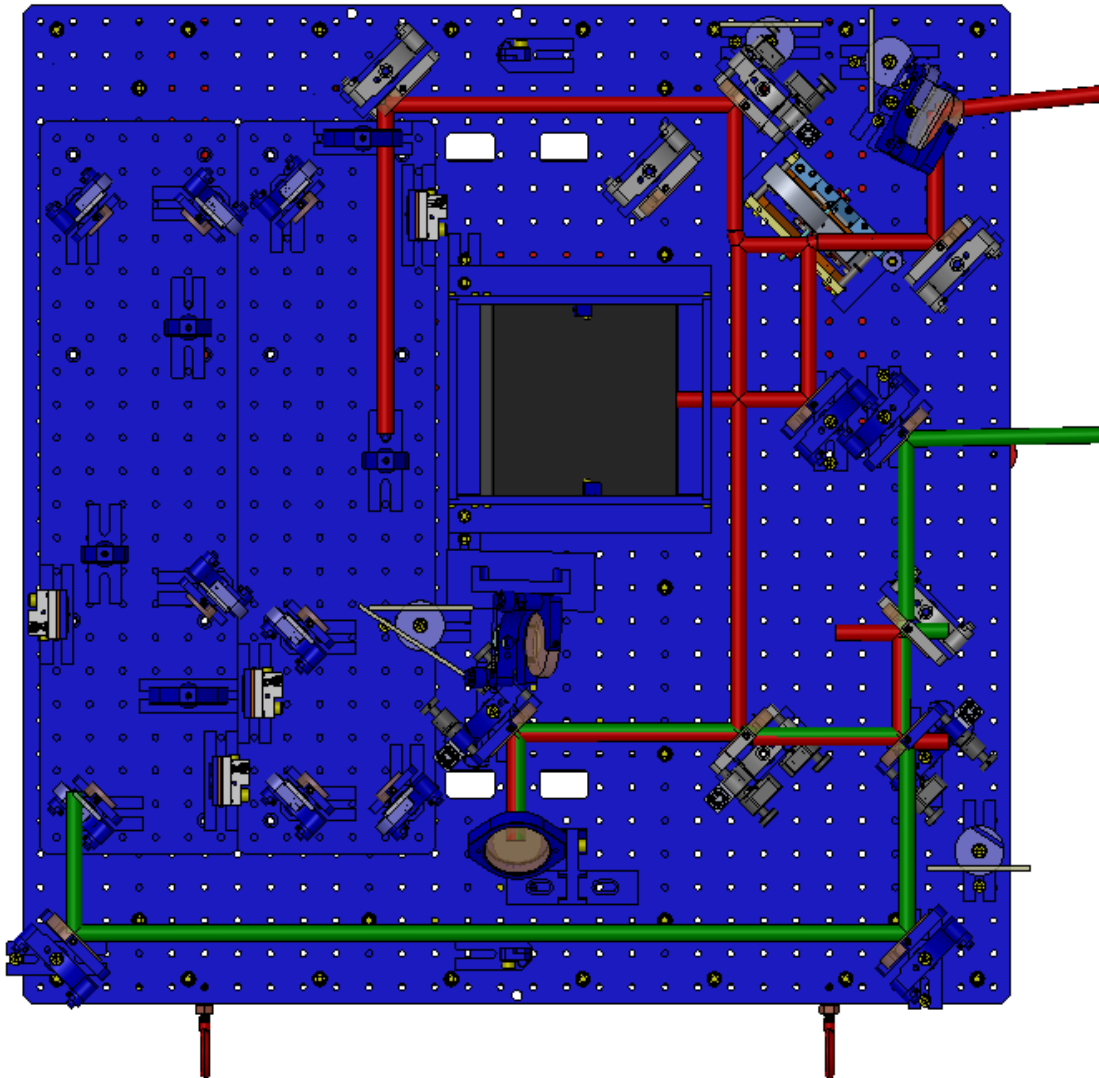


Table 2: ISC Transmon Assembly

5.7 D1102291: aLIGO TMS ISC Table Structural Assembly

38	D1002504 TMS, SISKIYOU MOUNT BRACKET, LOWER OUTBOARD	1
37	D1001435 TMS, SISKIYOU MOUNT BRACKET, LOWER INBOARD	1
36	D1100904_aLigo_TMS_Periscope_Mount_Clamp	6
35	D1200471 200 GM TABLE MASS	1
34	D1100358 TABLE MASS ATTACHMENT SCR	7
33	D1200470 500GM TABLE MASS	6
32	COPPER NICKEL NUT 5/16-18 (McMaster) # 90810A030	2
31	D1001161 MOD. EYE BOLT AT E.Q. ROD	2
30	One Piece Clamp 1/4 Bore s. s. 94211300 (McM-Carr)	2
29	D1003162 PITCH MASS ADJUSTER ROD	2
28	D1002757 PITCH SLIDE GUIDE BRKT.	2
27	D1002699 PITCH MASS	2
26	D1002758 PITCH MASS GUIDE	2
25	BU-2406-NA [U-C Components]10-24x.37 Button Socket Hd. Scr Silver Plated	2
24	D1002769 ROLL SLIDE GUIDE BRACKET	1
23	60705K46 SPLIT CLAMP (McM-Carr) 5/8-18 threaded Stainless Stl.	2
22	D1201364 - REF. #8492A167 [McM-Carr]Nickel Plated - Electroless	2
21	D1002768 THD. STOCK CUT TO LG.	1
20	1/4-20 x .37 Silver Tip Set Scr 99934A760 (McM-Carr)	1
19	1/4-20 x 1" long SHCS SILVER PLATED UC-Components # C-2016-NA	4
18	1/4-20 X .75 LONG SHCS SILVER PLATED UC-Components # C-2012-NA	6
17	D1002759 ROLL MASS LOCK	1
16	D1002698 ROLL SLIDE MASS	1
15	1/4-20 x .75 Silver Plated SHCS, C-2012-NA	4
14	D1002755 ROLL SLIDE ROD	2
13	D1001109 END PLATE BACK	1
12	D1002696 END PLATE FRONT	1
11	D1001164 SMALL GUSSET	2
10	D1200310 SPREADER BAR	2
9	#10 VENT FL WSHR U-C Components WFV-10 Washer, Vented Flat	2
8	.312 VENT FL WSHR U-C Components WFV-31 Washer, Vented Flat	12
7	.250 VENT FL WSHR U-C Components WFV-25 Washer, Vented Flat	98
6	S.STL 0.25-20 UNC-2A x 0.5 LG, U-C Components C-2008-N Screw, Socket Head Cap	12
5	S.STL 0.25-20 UNC-2A x 0.75 LG, U-C Components C-2012-N Screw, Socket Head Cap	14
4	S.STL 0.31-18 UNC-2A x 0.875 LG, U-C Components C-1814-N Screw, Socket Head Cap	8
3	S.STL 0.25-20 UNC-2A x 0.625 LG, U-C Components C-2010-N Screw, Socket Head Cap	46
2	D1001163 TABLE GUSSET PLATE	2
1	D1102293 TABLE ASSEMBLY	1
ITEM NO.	PART NUMBER	QTY.
BOM Table		

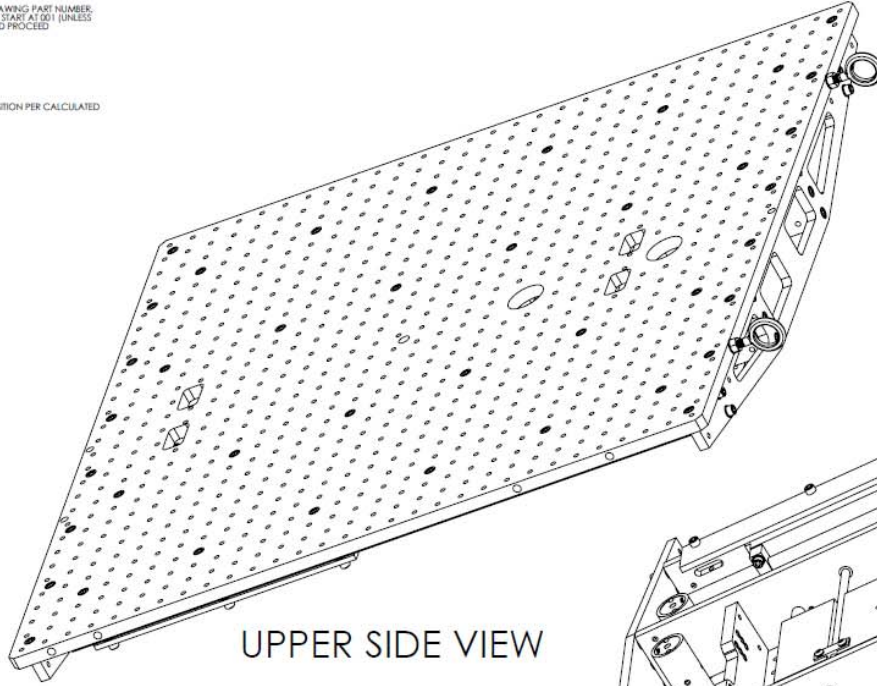
REV.	DATE
v3	11-13-12

Add -
C-404-NA, qty = 4
C-406-NA, qty = 2

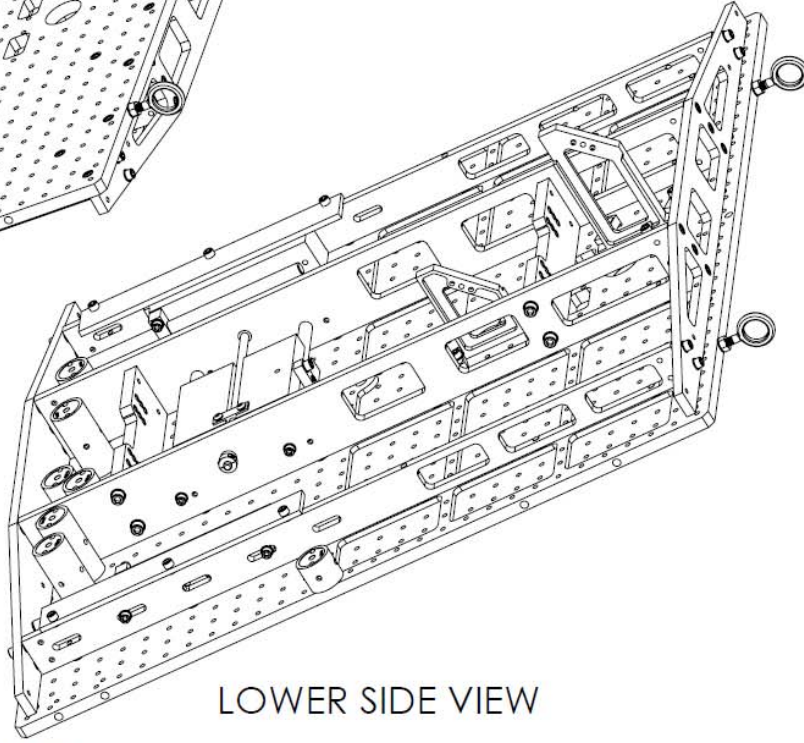
- NOTES CONTINUED:**
5. BAG AND TAG PARTS SEPARATELY WITH THEIR DRAWING PART NUMBER, REVISION, AND SERIAL NUMBER. SERIAL NUMBERS START AT 001 (UNLESS OTHERWISE SPECIFIED) FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY.
EXAMPLE:
D1000000-v1
S/N-001
 6. MASS: APPROX 84 LBS.
 7. CYLINDER MASSES ARE SHOWN IN SUGGESTED POSITION PER CALCULATED MASS PROPERTIES OF TELESCOPE ASSEMBLY.

REV.	DATE	DCN #	BOM #
v1	06 APR 2012	E1101152	E1101161-v1
v2	11-6-12	to follow	-
v3	11-13-2012	to follow	-

UPDATE TO CURRENT VERSION



UPPER SIDE VIEW



LOWER SIDE VIEW

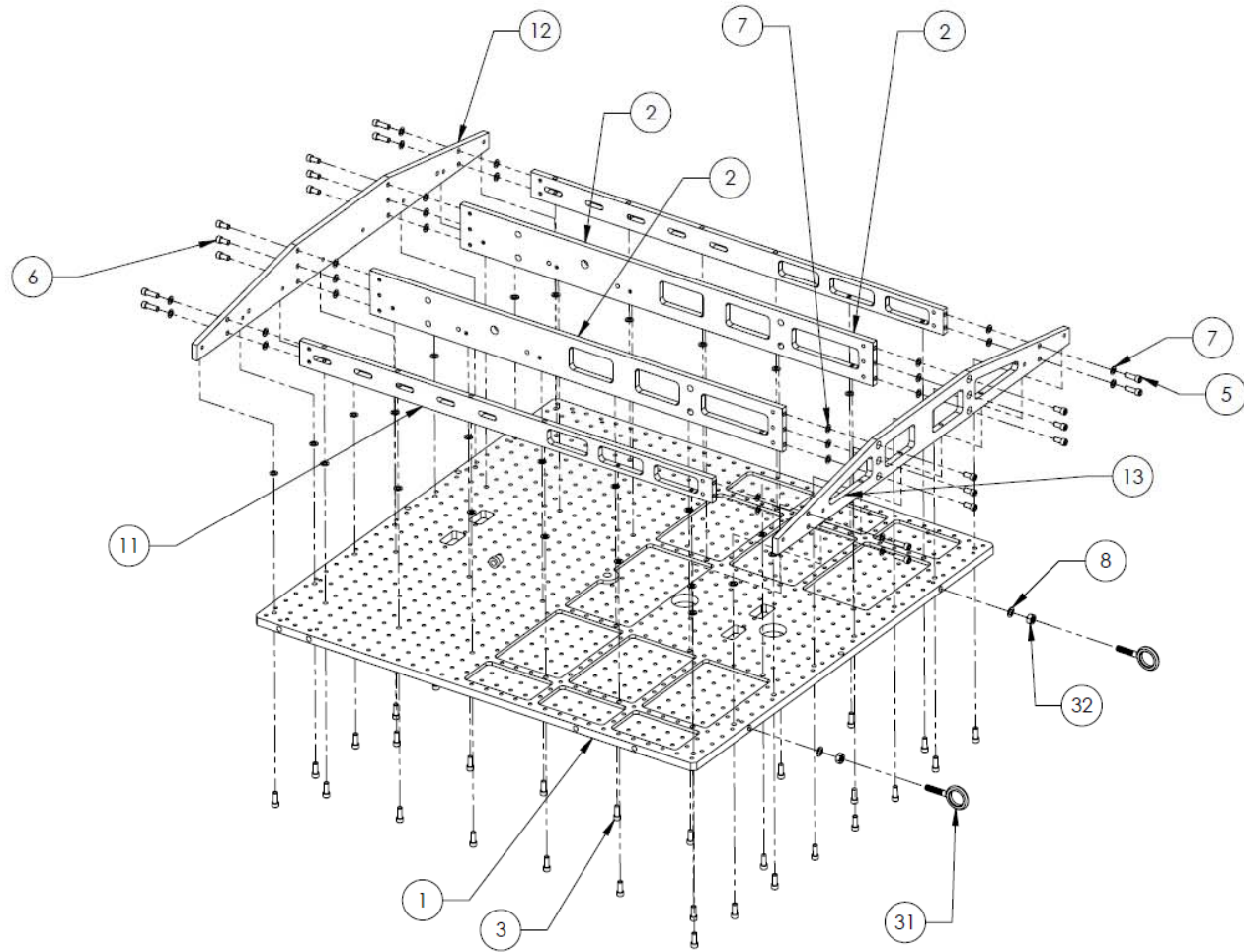
DIMENSIONS ARE IN INCHES		TOLERANCES: XX .4 (.) .XXX ± .005 ANGULAR ± 1.0°		NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED) 1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, R.02 MIN. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.		LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME LIGO TMS ISC TABLE STRUCTURAL ASSEMBLY	
MATERIAL N/A		FINISH N/A		SYSTEM ADVANCED LIGO		SUB-SYSTEM AOS		DESIGNER E. MARELAND (08 DEC 2011)	
NEXT ASSY D1000484		DRAWN BY C. COOPER (08 APR 2012)		CHECKER SEE DCH		APPROVAL SEE DCH		SIZE DWG. NO. B D1102291	
								SCALE NONE PROJECTION: SHEET 1 OF 7	

Table 3: BOM TMS ISC Table Structural Assembly

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Default/REQ
1	D1102293	aLIGO ETM OPTICAL TABLE	6061-T6 Al	1
2	D1001163	aLIGO OPTICS TABLE GUSSET PLATE, LARGE	6061-T6 Al	2
3	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 0.625 LONG	300 SSSL	46
4	-	SCREW, SOCKET HEAD CAP, 5/16-18 UNC-2A X 0.875 LONG	300 SSSL	8
5	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 0.75 LONG	300 SSSL	14
6	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 0.5 LONG	300 SSSL	12
7	.250 VENT FL WSHR	.255 ID, .468 OD, .032 TH	18-8 SSSL	98
8	.312 VENT FL WSHR	.328 ID, .562 OD, .032 TH	18-8 SSSL	12
9	#10 VENT FL WSHR	.195 ID, .354 OD, .032 TH	18-8 SSSL	2
10	D1200310	aLIGO OPTICS TABLE SPEADER BRIDGE	6061-T6 Al	2
11	D1001164	aLIGO OPTICS TABLE GUSSET PLATE, SMALL	6061-T6 Al	2
12	D1002696	aLIGO ETM TELESCOPE BRIDGE SUPPORT TEE PLATE, FRONT	6061-T6 Al	1
13	D1001109	aLIGO ETM TELESCOPE BRIDGE SUPPORT TEE PLATE, BACK	6061-T6 Al	1
14	D1002755	aLIGO TMS TELESCOPE ROLL SLIDE ROD	304 SSSL	2
15	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 0.75 LONG, VENTED	Ag- PLATED 300 SSSL	4
16	D1002698	aLIGO TMS TELESCOPE ROLL SLIDE MASS	304 SSSL	1

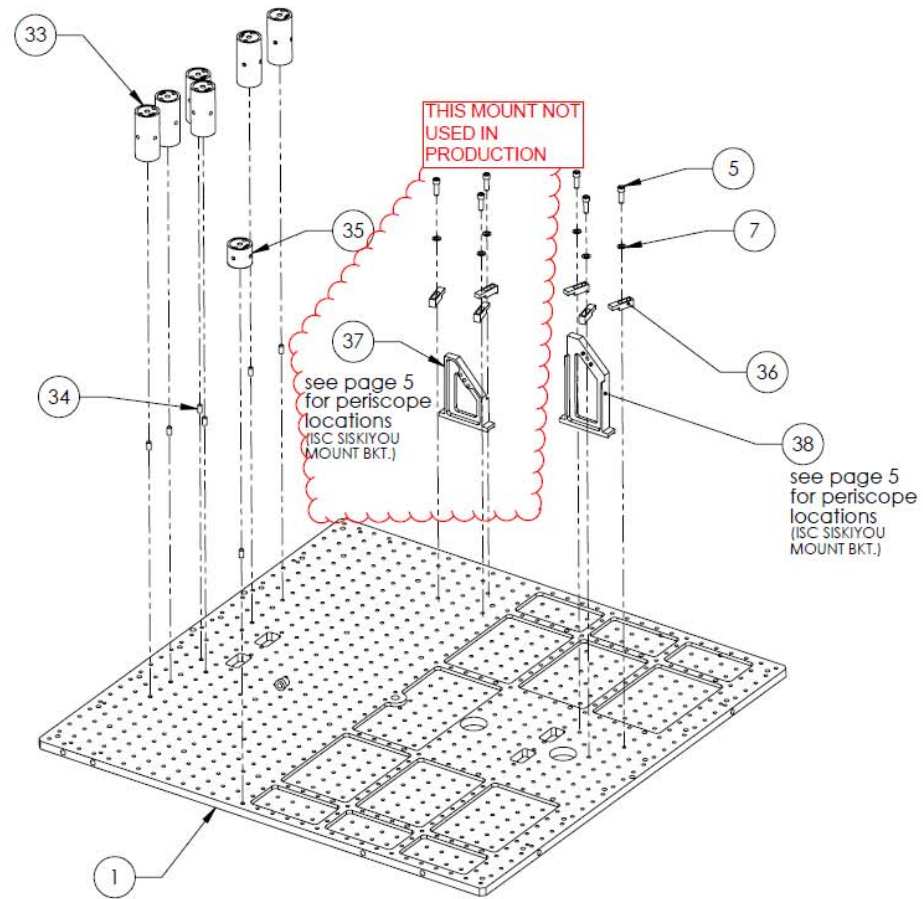
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Default/REQ
17	D1002759	aLIGO TMS TELESCOPE ROLL LOCK	6061-T6 Al	1
18	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 0.75 LONG	Ag-PLATED 300 SSSL	6
19	-	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A X 1 LONG	Ag-PLATED 300 SSSL	4
20	99934A760 (McM-Carr) or equiv	SKT SET SCRW, 1/4-20 X 3/8 L, SILVER TIP	18-8 SSSL	1
21	D1002768	aLIGO TMS TELESCOPE ROLL MASS ADJ. ROD	316 SSSL	1
22	8492A167 (McM-Carr) or equiv	DRILL BUSHING, PRESS FIT 5/16" ID, 1/2" OD, 3/8" LENGTH	Alloy Steel	1
23	60705K46 (McM-Carr) or equiv	THREADED COLLAR, CLAMP ON 5/16"-18 UNC, 11/16" OD, 9/32" WIDTH	300 SSSL	2
24	D1002769	aLIGO TMS TELESCOPE ROLL SLIDE BKT.	6061-T6 Al	1
25	BU-2406-NA (U-C Components) or equiv	BUTTON HEAD SOCKET SCREW 10-24 X 3/8	Ag-PLATED 300 SSSL	2
26	D1002758	aLIGO TMS TELESCOPE PITCH GUIDE	304 SSSL	2
27	D1002699	aLIGO PITCH SLIDE MASS	304 SSSL	2
28	D1002757	aLIGO TMS TELESCOPE PITCH SLIDE BKT.	6061-T6 Al	2
29	D1003162	aLIGO TMS TELESCOPE PITCH MASS ADJ. ROD	316 SSSL	2
30	9421T300 (McM-Carr) or equiv	1/4" ID SHAFT COLLAR	316 SSSL	2
31	D1001161	aLIGO OPTICS TABLE TOP MODIFIED EYEBOLT	304 SSSL	2

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Default/REQ
32	D1100989	NICKEL-COPPER ALLOY 400 .312-18 HEX NUT, MODIFIED	NICKEL-COPPER ALLOY 400	2
33	D1200470	aLIGO TMS OPTICS TABLE CYLINDER MASS	304 SSSL	6
34	D1100358	TMS TELESCOPE MASS ATTACHMENT SCREW	TITANIUM	7
35	D1200471	aLIGO TMS OPTICS TABLE SMALL CYLINDER MASS	304 SSSL	1
36	D1100904	aLigo_TMS_Periscope_Mount_Clamp	6061-T6	6
37	D1001435	TMS, SISKIYOU MOUNT BRACKET, LOWER INBOARD	6061-T6 Al	1
38	D1002504	TMS, SISKIYOU MOUNT BRACKET, LOWER OUTBOARD	6061-T6 Al	1



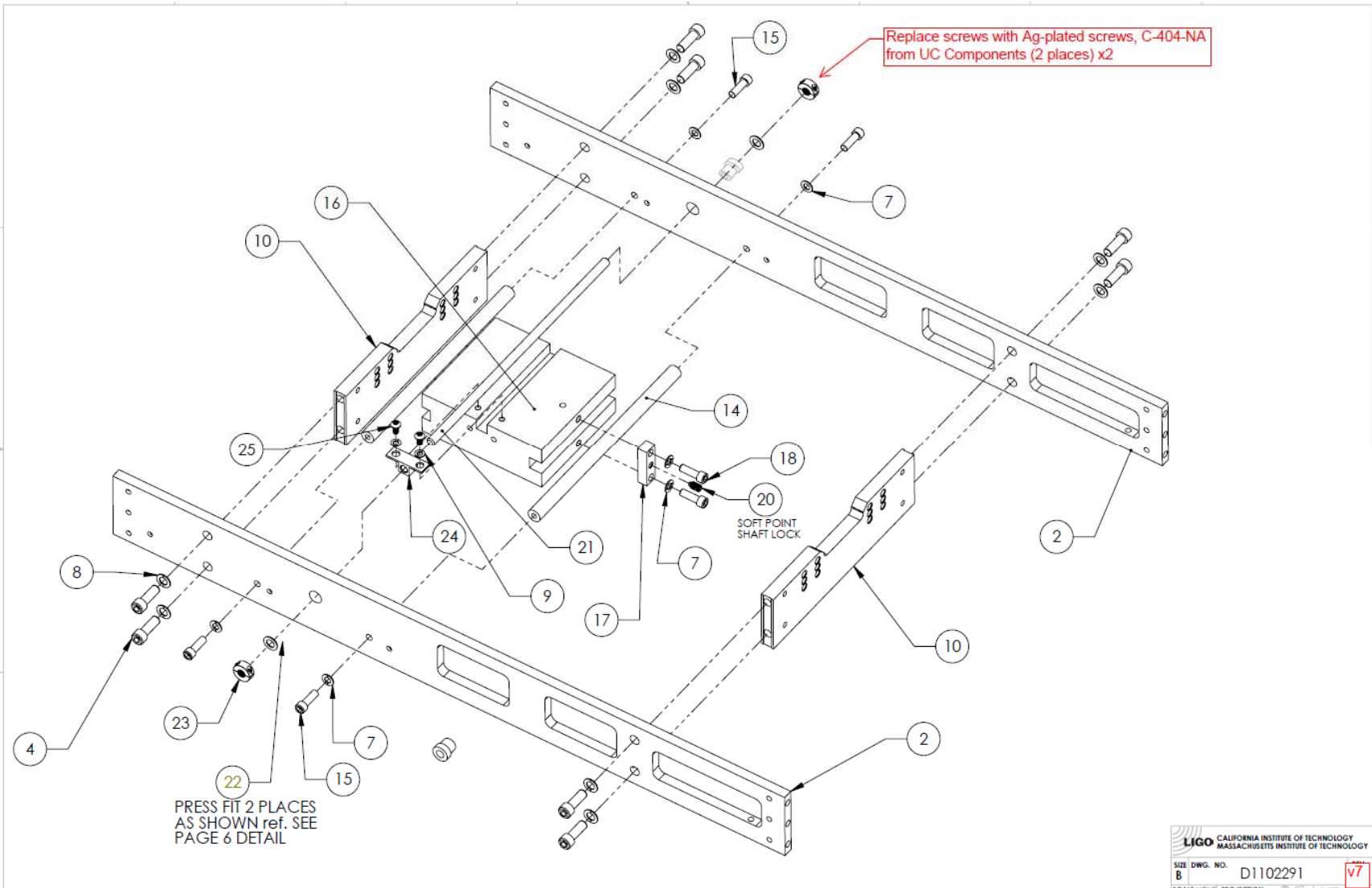
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

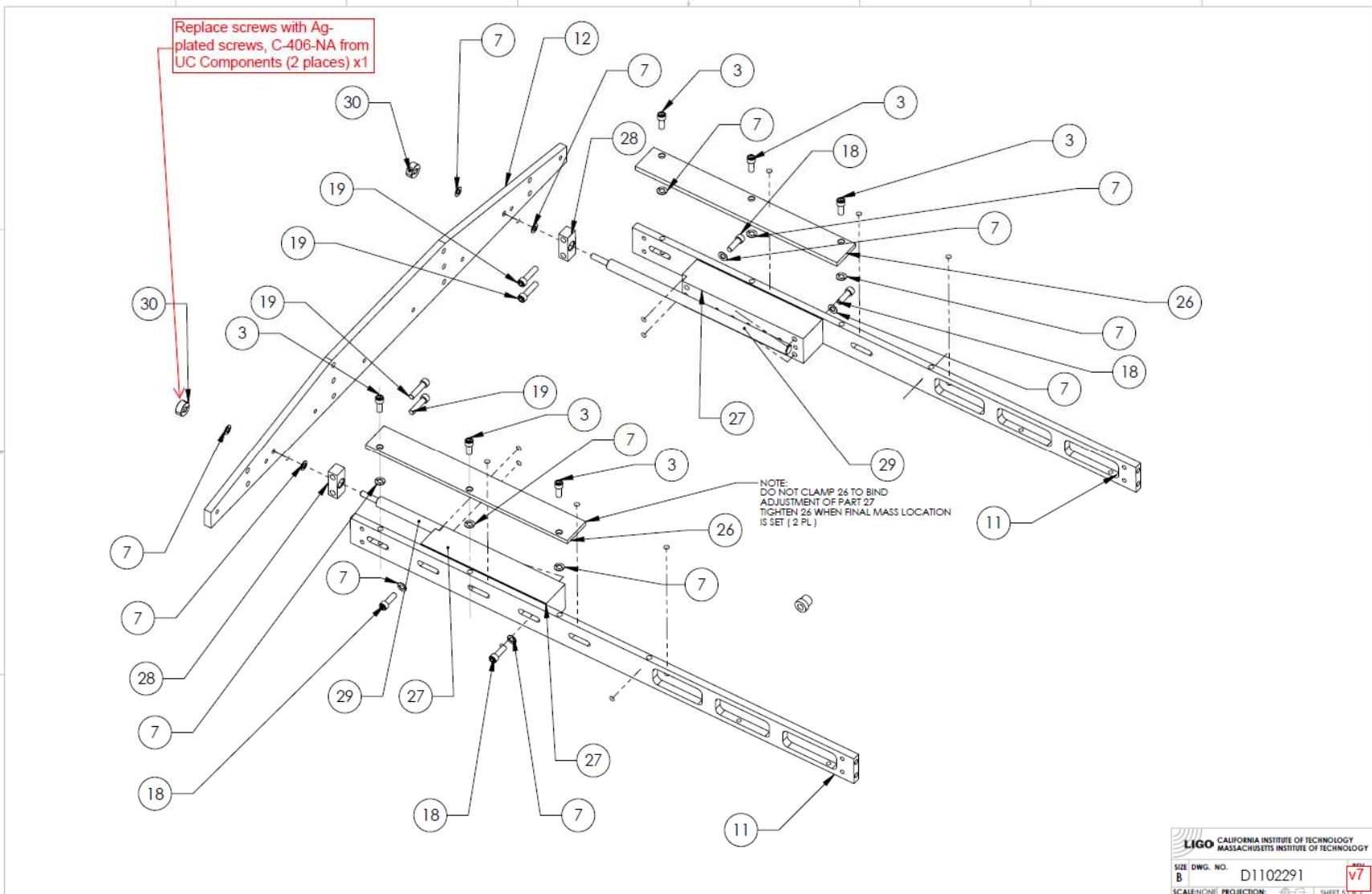
SIZE	DWG. NO.	v7	
B	D1102291		
SCALE: NONE		PROJECTION:	SHEET 2 OF 7



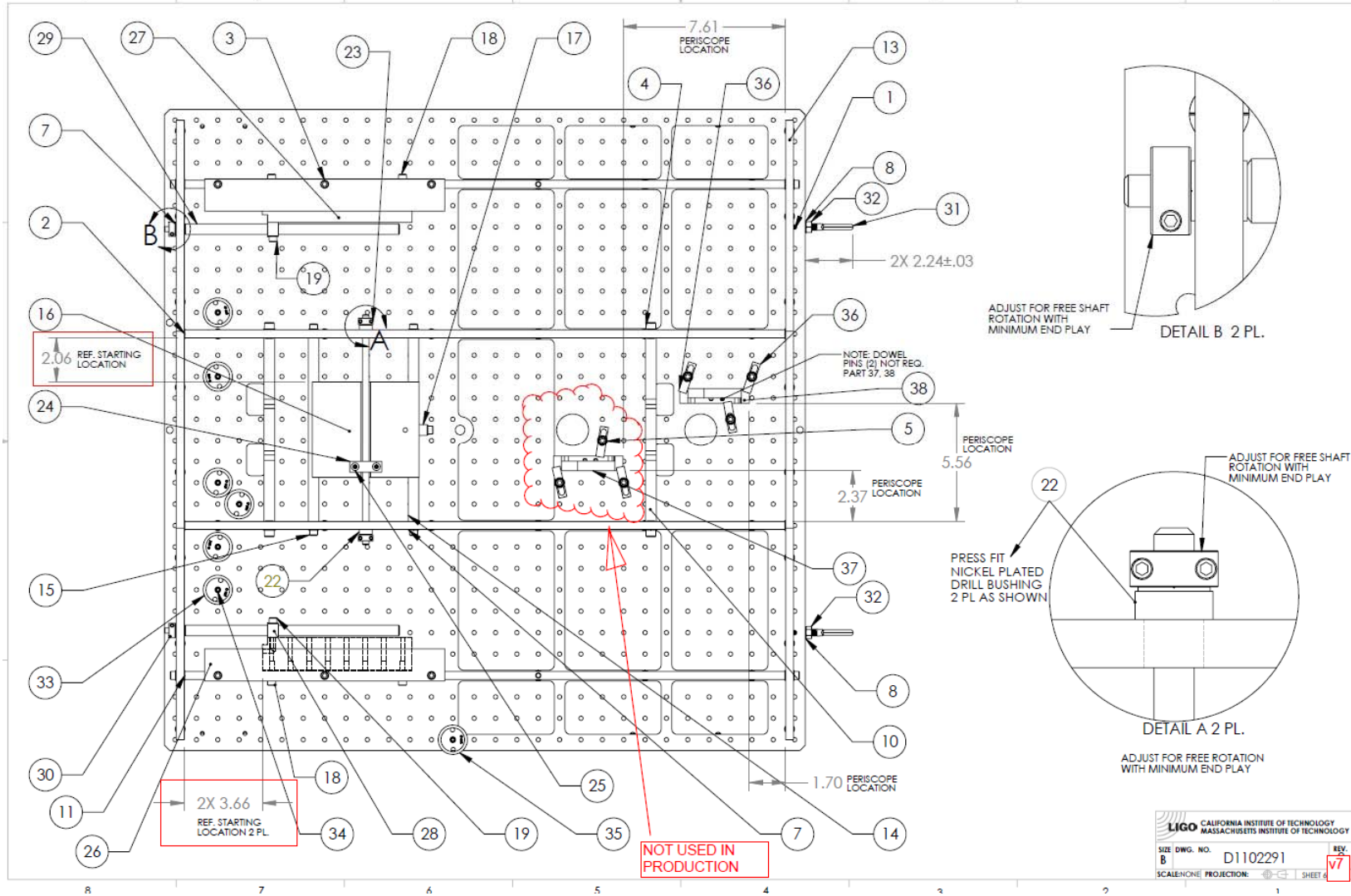
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
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SIZE: DWG. NO. D1102291 v7





NOTE: SEE SECTION 11. FOR ROLL AND PITCH ADJUSTER PROCEDURE



LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
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SIZE DWG. NO.	D1102291	REV.	v7
B			
SCALE	PROJECTION	SHEET	4

5.8 D1102361: aLIGO TMS Telescope Frame Assembly

5.8.1 Parts List for TMS Telescope Frame Assembly

5.8.2 T1300639-v1 TMS Primary Mirror Installation Procedure

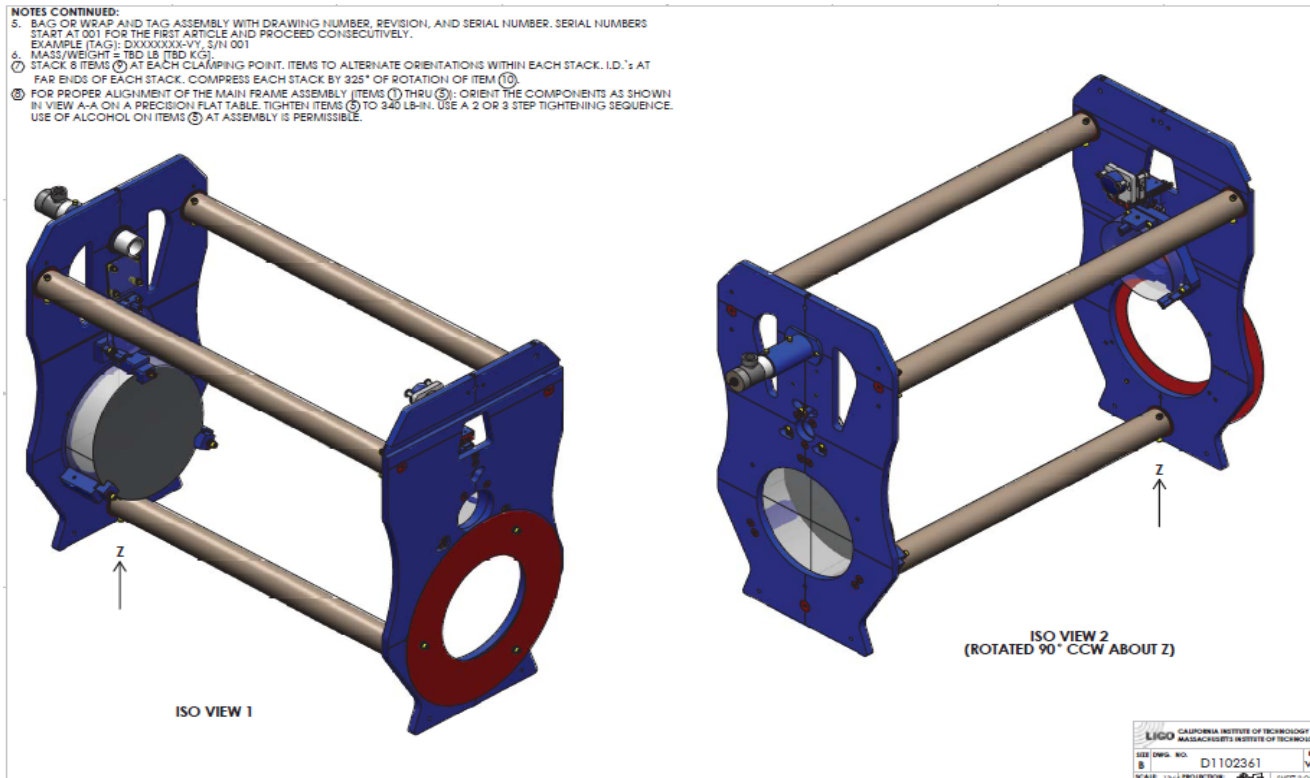


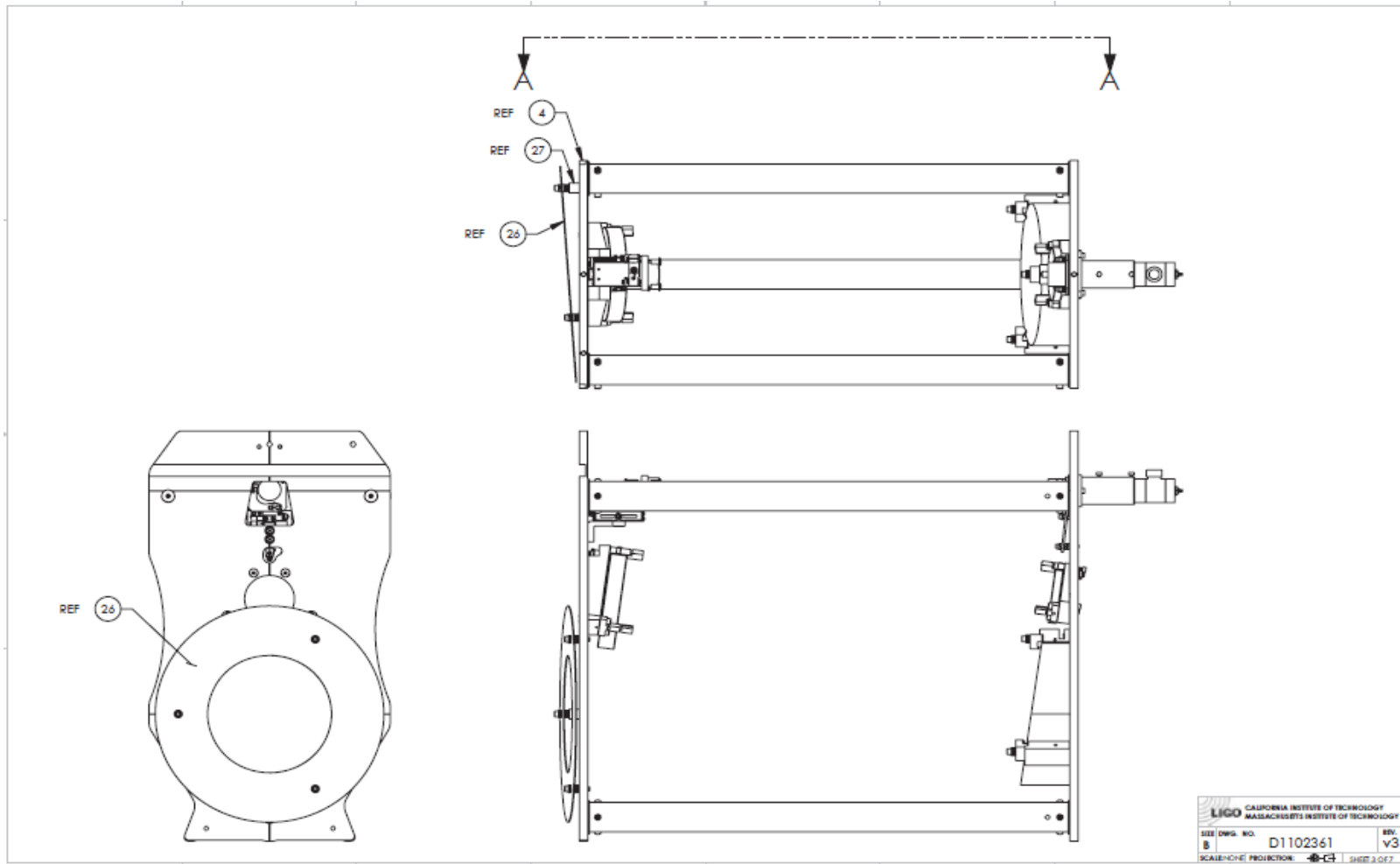
Table 4: Bill of Material, D1102361: aLIGO TMS Telescope Frame Assembly

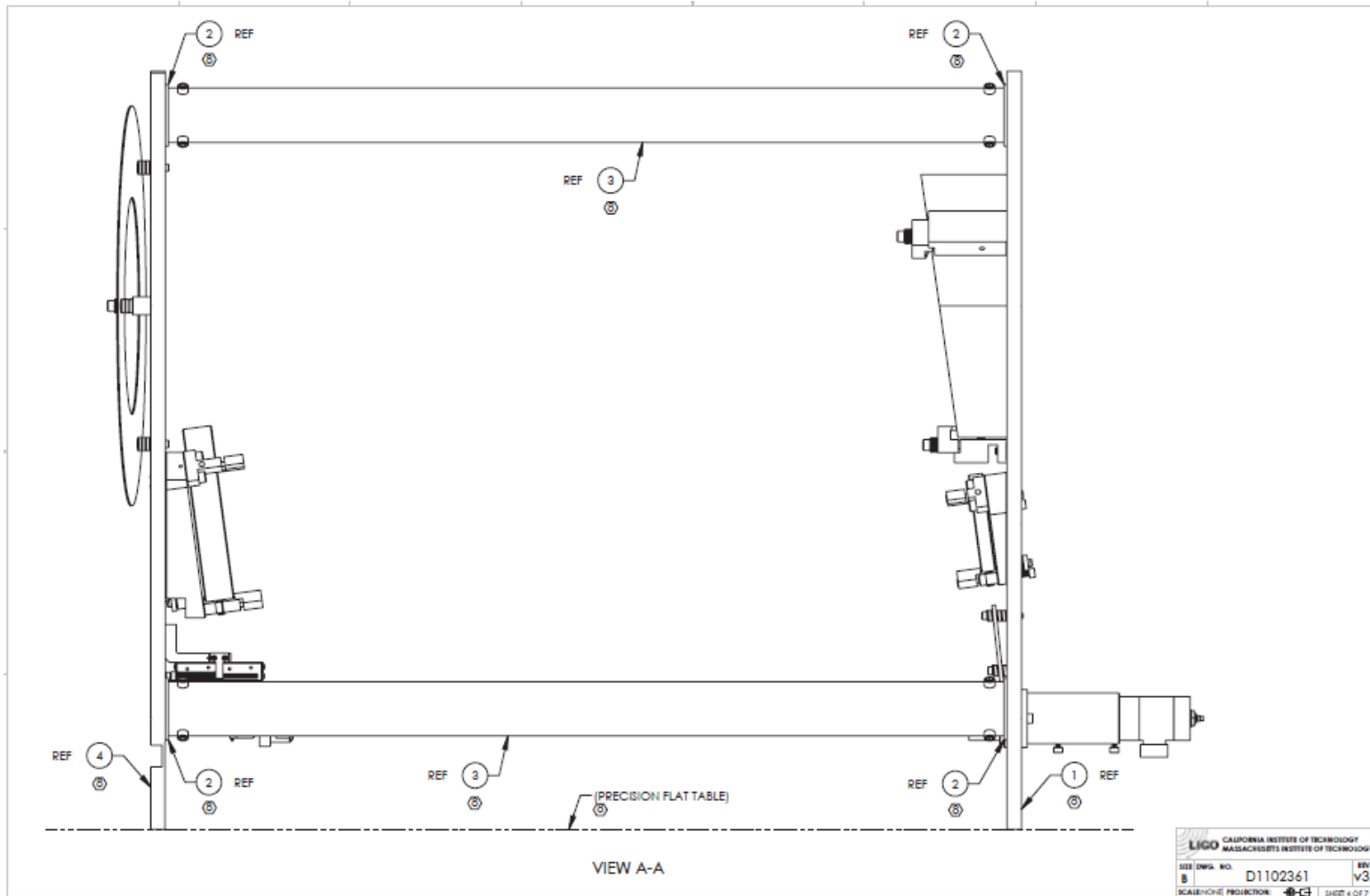
ASSEMBLY - 1	QTY	ASSEMBLY - 2	QTY	ASSEMBLY - 3	QTY	PART NUMBER	QTY	DESCRIPTION
D1102361	1	D1000243	3		1	C-2006	6	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 0.375 LONG, VENTED
D1102361	1	D1000243	3		1	D1000072	1	ADLIGO ETM TELE TUBE
D1102361	1	D1000243	3		1	D1000242	2	aLIGO ETM TELE TUBE THD INSERT
D1102361	1	D1102365	1	D1200246	1	BU-404	7	BUTTON HEAD SOCKET SCREW 4-40 x .25, vented
D1102361	1	D1102365	1	D1200246	1	D1200247	1	aLIGO TMS FOCUS Carriage
D1102361	1	D1102365	1	D1200246	1	D1200248	1	aLIGO TMS FOCUS SLIDE
D1102361	1	D1102365	1	D1201077	1	92778A121	1	18-8 SS Oval Point Socket Set Screw 10-32 Thread, 1/2" Length
D1102361	1	D1102365	1	D1201077	1	D0901565	1	ADLIGO_ETM_TELE_SECONDARY
D1102361	1	D1102365	1	D1201077	1	D1100114	3	TMS Telescope Secondary Mirror Clamp
D1102361	1	D1102365	1	D1201077	1	D1200826	1	aLIGO secondary mount plate
D1102361	1	D1102365	1	D1201077	1	D1201076	1	aLigo secondary mirror mount tip-tilt sub assem.
D1102361	1	D1102365	1	D1201077	1	D1201078	1	ball for the secondary mount screw
D1102361	1	D1102365	1		1	94125K577	5	COMPRESSION SPRING, 7.1 MM OD, 0.8 MM WD, 15.5 MM L, 2.52 N/MM
D1102361	1	D1102365	1		1	9716K36	2	DISC SPRING .174" ID x .322" OD x .0050" THICK 1.50 Lb @ .034" DEFLECTION
D1102361	1	D1102365	1		1	98017A625	4	#8 FLAT WASHER, .17 ID x .38 OD x .032 THK, NAS 1149-CN832R
D1102361	1	D1102365	1		1	99040A416	3	SHIM WASHER .188 ID, .250 OD, .016 TH
D1102361	1	D1102365	1		1	BU-402-N	3	BUTTON HEAD SOCKET SCREW 4-40 x .13
D1102361	1	D1102365	1		1	C-2006-N	1	SCREW, SOCKET HEAD CAP, #1/4-20 x .38 LG
D1102361	1	D1102365	1		1	C-2406-N	2	SCREW, SOCKET HEAD CAP, #10-24 x .38 LG
D1102361	1	D1102365	1		1	C-406-N	2	SCREW, SOCKET HEAD CAP, #4-40 x 0.38 LONG
D1102361	1	D1102365	1		1	C-408	3	SCREW, SOCKET HEAD CAP, #4-40 x .50 LONG, VENTED
D1102361	1	D1102365	1		1	C-804-N	2	SCREW, SOCKET HEAD CAP, #8-32 x .25 LONG
D1102361	1	D1102365	1		1	D1001813	1	aLIGO TMS THREAT MT. SEC. FOCUS
D1102361	1	D1102365	1		1	D1001834	1	aLIGO TMS HOLDER SEC. FOCUS
D1102361	1	D1102365	1		1	D1001973	1	aLIGO TMS FOCUS SCREW

ASSEMBLY - 1	QTY	ASSEMBLY - 2	QTY	ASSEMBLY - 3	QTY	PART NUMBER	QTY	DESCRIPTION
D1102361	1	D1102365	1		1	D1200321	1	aLIGO, AOS, TMS TELESCOPE, SECONDARY MIRROR, MT. BRACKET
D1102361	1	D1102365	1		1	D1200579	1	aLIGO TMS FOCUS SLIDE LOCK
D1102361	1	D1102365	3		1	WFV-04	2	WASHER, VENTED, NO. 4
D1102361	1	D1102365	1		1	WFV-08	2	#8 FLAT WASHER, .169 ID x .304 OD x .032 THK, VENTED
D1102361	1	D1200243	1		1	70466S	3	COMPRESSION SPRING .210 O.D., .018 W.D., .63 L, 3.4#/IN
D1102361	1	D1200243	1		1	94035A999	3	PRECISION SKT SHLDR SCRW, 5/32 OD, 5/8 L, #6-32 x 3/16 THD
D1102361	1	D1200243	1		1	94355A614	1	SKT SET SCRW, FLAT PT, 1/4-28 x 1/2
D1102361	1	D1200243	1		1	9529K44	2	440C SS BALL 7/32" DIAMETER, GRADE 24
D1102361	1	D1200243	1		1	99934A330	1	SKT SET SCRW, 6-32 x 1/8 L, SILVER TIP
D1102361	1	D1200243	1		1	C-2014-N	6	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 0.875 LONG
D1102361	1	D1200243	1		1	C-2416-N	3	SCREW, SOCKET HEAD CAP, 10-24 x 1.0 LONG
D1102361	1	D1200243	1		1	D1002458	2	aLIGO AOS F2 MIRROR SIDE CLAMP LOWER
D1102361	1	D1200243	1		1	D1002459	1	aLIGO AOS F2 MIRROR SIDE CLAMP UPPER
D1102361	1	D1200243	1		1	D1002465	3	aLIGO AOS TRANSMON F2 MIRROR CLAMP
D1102361	1	D1200243	1		1	D1102334	1	aLIGO TMS TELESCOPE SECOND FOLD MIRROR
D1102361	1	D1200243	1		1	D1200249	1	aLIGO TMS F2 MIRROR BASE
D1102361	1	D1200243	1		1	-	3	SISKIYOU 1" LEFT HAND MIRROR MOUNT
D1102361	1	D1200243	1		1	WFV-25	6	VENTED FLAT WASHER .255 ID, .468 OD, .032 TH
D1102361	1	D1200244	1		1	94035A999	3	PRECISION SKT SHLDR SCRW, 5/32 OD, 5/8 L, #6-32 x 3/16 THD
D1102361	1	D1200244	1		1	94355A614	1	SKT SET SCREW, FLAT PT, 1/4-28 x 1/2
D1102361	1	D1200244	1		1	9435K420	3	COMPRESSION SPRING .240 OD, .032 WD, .63 L, 23.32#/IN
D1102361	1	D1200244	1		1	9529K44	2	440C SS BALL 7/32" DIAMETER, GRADE 24
D1102361	1	D1200244	1		1	99934A330	1	SKT SET SCRW, 6-32 x 1/8 L, SILVER TIP
D1102361	1	D1200244	1		1	C-2014-N	6	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 0.875 LONG
D1102361	1	D1200244	1		1	C-2416-N	3	SCREW, SOCKET HEAD CAP, 10-24 x 1.0 LONG
D1102361	1	D1200244	1		1	D1001136	3	aLIGO F1 MIRROR CLAMP
D1102361	1	D1200244	1		1	D1002336	2	aLIGO ETM F1 MIRROR SIDE CLAMP LOWER

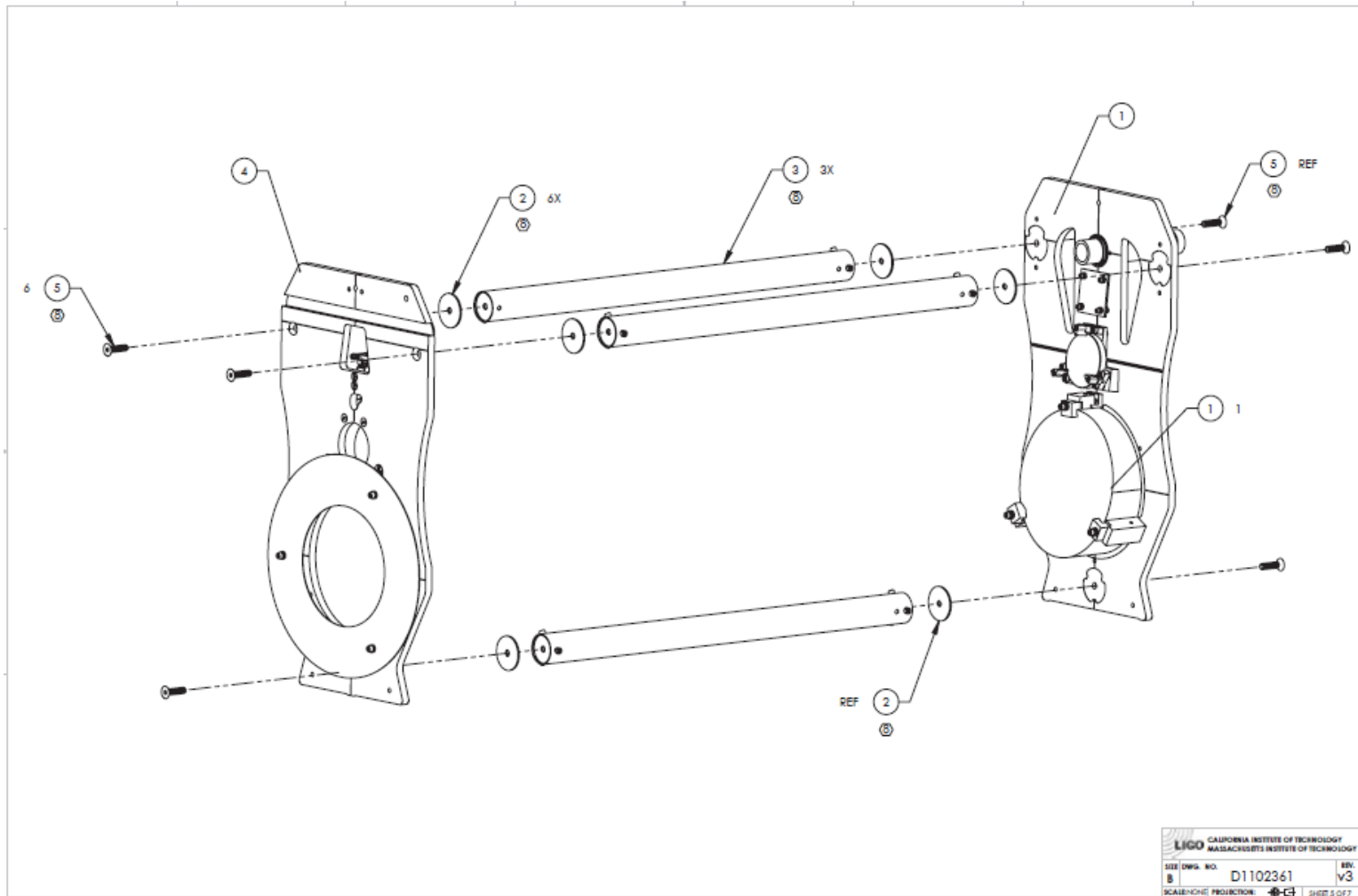
ASSEMBLY - 1	QTY	ASSEMBLY - 2	QTY	ASSEMBLY - 3	QTY	PART NUMBER	QTY	DESCRIPTION
D1102361	1	D1200244	1		1	D1002337	1	aLIGO ETM F1 MIRROR SIDE CLAMP UPPER
D1102361	1	D1200244	1		1	D1102335	1	aLIGO TMS TELESCOPE FIRST FOLD MIRROR
D1102361	1	D1200244	1		1	D1200245	1	aLIGO TMS F1 MIRROR BASE
D1102361	1	D1200244	1		1	-	3	SISKIYOU 1" LEFT HAND MIRROR MOUNT
D1102361	1	D1200244	1		1	WFV-25	6	VENTED FLAT WASHER .255 ID, .468 OD, .032 TH
D1102361	1		1		1	90585A628	6	FLAT HEAD SOCKET SCREW, 3/8-16 x 1-1/2
D1102361	1		1		1	92510A780	1	SPACER ALUMINUM, .252 ID, 5/8 OD, 5/8 L
D1102361	1		1		1	9263K696	12	O-RING, 2.5MM WIDTH, 7MM ID APPROVED VITON ELASTOMER, SHORE A 70-75
D1102361	1		1		1	94355A614	1	SKT SET SCRW, FLAT PT, 1/4-28 x 1/2
D1102361	1		1		1	94518A418	2	FLAT HEAD SOCKET SCREW, 10-24 x 3/4
D1102361	1		1		1	9713K61	24	DISC SPRING .255" ID, .500" OD, .018" THICK 47Lb @ .008" DEFLECTION
D1102361	1		1		1	99934A330	1	SKT SET SCREW, 6-32 x 1/8 L, SILVER TIP
D1102361	1		1		1	99934A330	2	SKT SET SCREW, 6-32 x 1/8 L, SILVER TIP
D1102361	1		1		1	AS568A-106	10	O-RING, 3/32" WIDTH, 3/16" ID, APPROVED VITON ELASTOMER, SHORE A 70-75
D1102361	1		1		1	C -816-N	2	SCREW, SOCKET HEAD CAP, #8-32 UNC-2A x 1 long
D1102361	1		1		1	C -820-N	2	SCREW, SOCKET HEAD CAP, #8-32 UNC-2A x 1.25 long
D1102361	1		1		1	C-2020-N	2	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 1.25 long
D1102361	1		1		1	C-2024-N	3	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 1.5 long
D1102361	1		1		1	C-2028-N	1	SCREW, SOCKET HEAD CAP, 1/4-20 UNC-2A x 1.75 long
D1102361	1		1		1	C-2412-N	2	SCREW, SOCKET HEAD CAP, 10-24 x .75 LONG
D1102361	1		1		1	D0902829	1	aLIGO, AOS, TMS, ALIGNMENT TELESCOPE, MT. ADAPTER
D1102361	1		1		1	D1000075	1	aLIGO PRIMARY PARABOLIC MIRROR
D1102361	1		1		1	D1001108	6	aLIGO ETM TELESCOPE TUBE LARGE WASHER
D1102361	1		1		1	D1001241	1	aLIGO ETM TELESCOPE BEAM DUMP GLASS
D1102361	1		1		1	D1002728	2	aLIGO TMS PRIMARY MIRROR SIDE CLAMP LOWER
D1102361	1		1		1	D1002731	1	aLIGO TMS PRIMARY MIRROR SIDE CLAMP UPPER
D1102361	1		1		1	D1002732	3	aLIGO TMS PRIMARY MIRROR CLAMP

ASSEMBLY - 1	QTY	ASSEMBLY - 2	QTY	ASSEMBLY - 3	QTY	PART NUMBER	QTY	DESCRIPTION
D1102361	1		1		1	D1101688	1	aLIGO TMS TELE ENTRY END PLATE
D1102361	1		1		1	D1101727	1	aLIGO TMS TELE PRIMARY 3 TUBE END PLATE
D1102361	1		1		1	D1102297	1	aLIGO TRANSMON TELESCOPE SSSL PLATE
D1102361	1		1		1	D1200527	1	aLIGO, AOS, TMS, ALIGNMENT TELESCOPE, CENTERING SLEEVE
D1102361	1		1		1	D-271	1	AUTOCOLLIMATOR
D1102361	1		1		1	FA-2014-N	13	FLAT HEAD SOCKET SCREW, 1/4-20 x 7/8
D1102361	1		1		1	WF-08	16	WASHER, FLAT, NO. 8
D1102361	1		1		1	WF-25	28	.255 ID, .468 OD, .032 TH

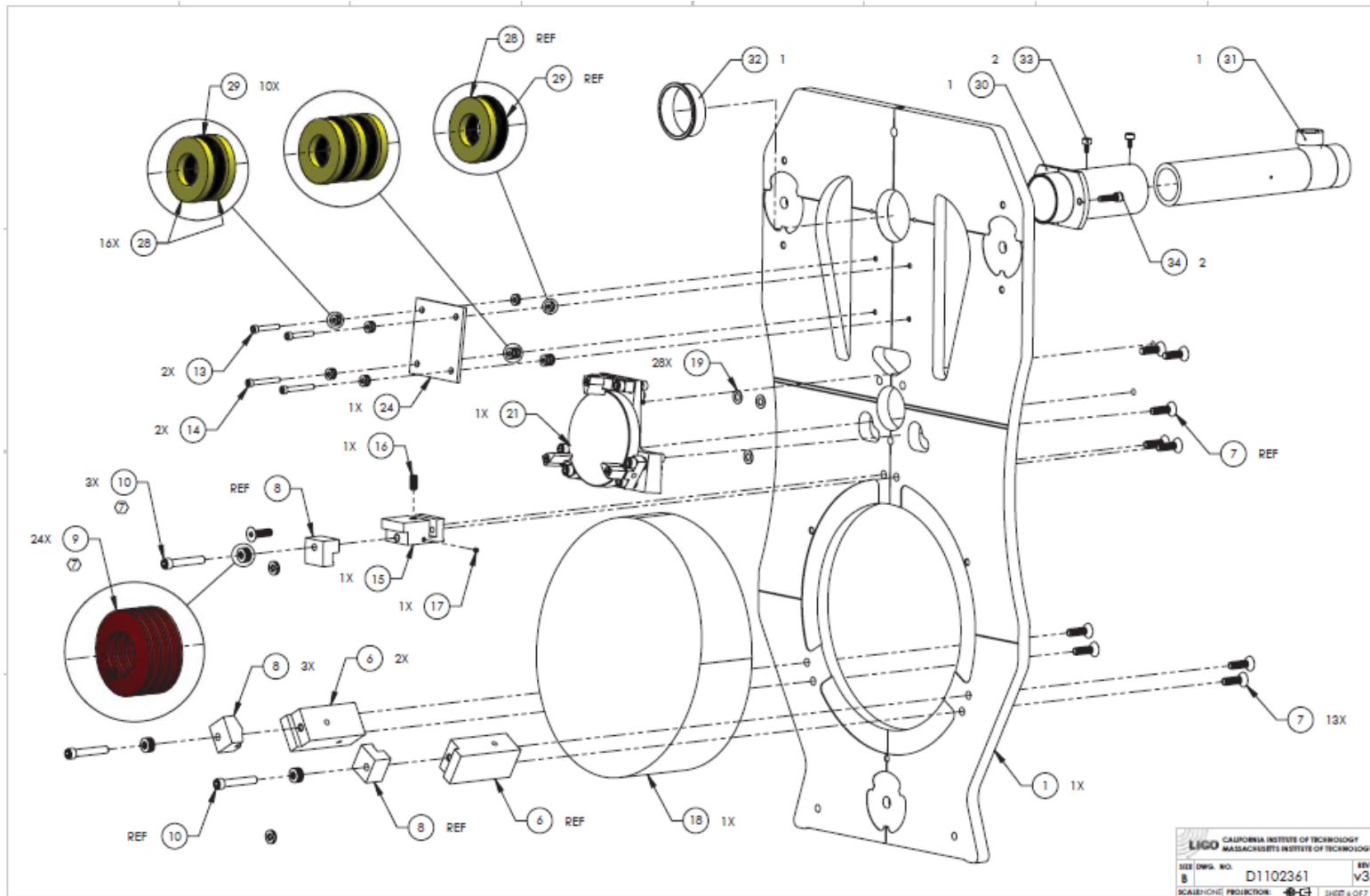


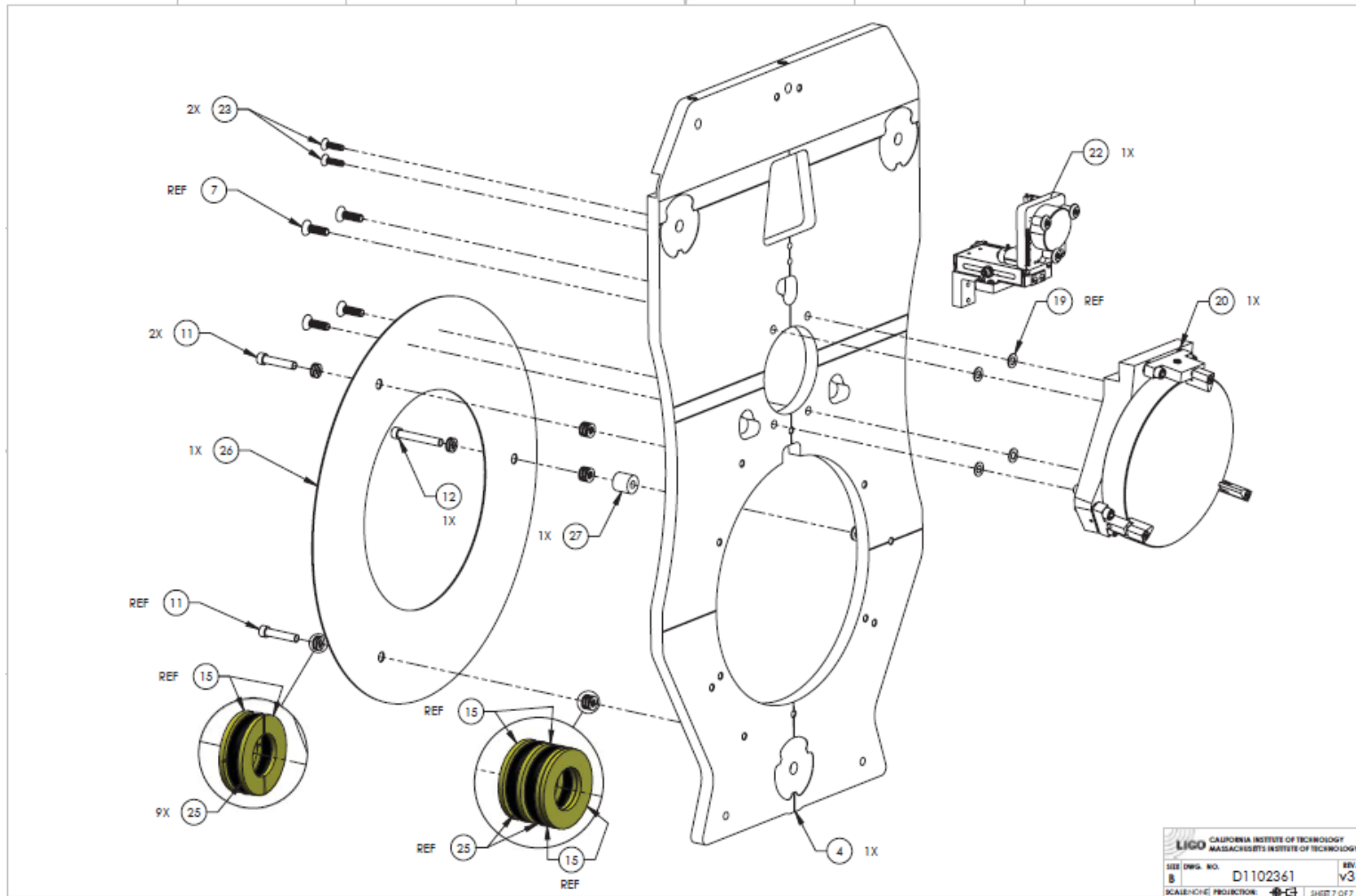


VIEW D1102361 SHEET 4 OF 7, THE STARTING ASSEMBLY ORIENTATION OF THE TELESCOPE.
 NOTE: END PLATES ARE INVERTED ON A FLAT SURFACE TO ALIGN WHAT WILL BECOME THE TOP SURFACES PARALLEL

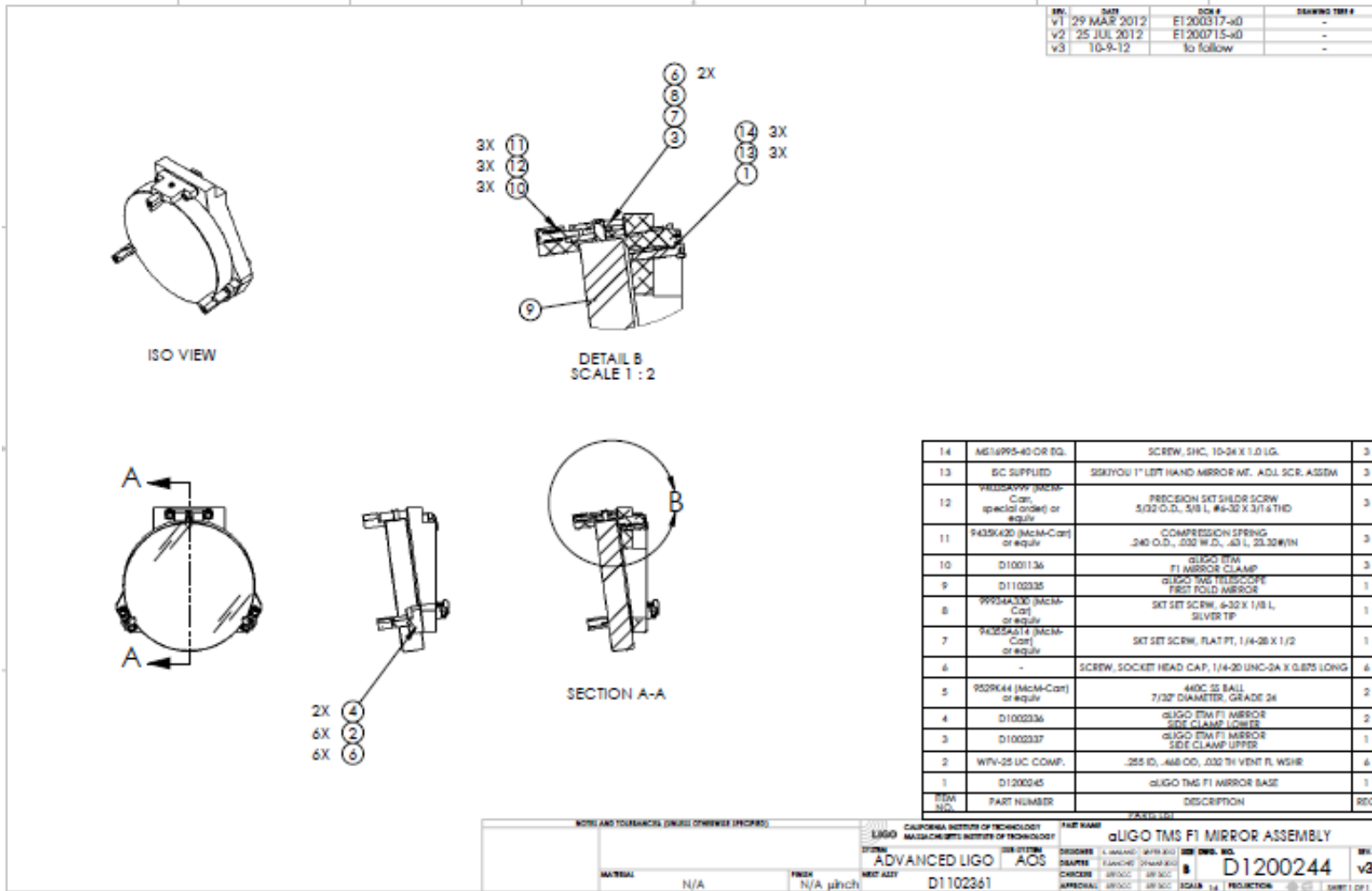


LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE (DWG. NO.)	REV.
B D1102361	v3
SCALE/CHPT PROJECTION:	SHEET 5 OF 7





5.8.4 Assembly of D1200244: aLIGO TMS F1 Mirror Assembly



5.8.5.1 Assembly of D1201077-aLigo Secondary Mirror Mount Tip-tilt Sub-assembly

NOTES CONTINUED:

5. SCREWS, ENGRAVE, OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT, IF APPLICABLE), ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 1/16" HIGH CHARACTERS. UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. A VIBRATORY TOOL MAY BE USED.
EXAMPLE: D0000000-V1, TYPES-XL, S/N XXX

6. APPROXIMATE WEIGHT = 3.00X LB.

7. MACHINE ALL SURFACES TO REMOVE DIVES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED.

8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0000364.

9. ALL MELCOL HOLES TO BE PREPARED ACCORDING TO EMHART MELCOL PRODUCT CATALOG, PL-300A, REV 4

10. ALL MELCOL INSERTS TO BE INSTALLED BY LIGO PERSONNEL AFTER DELIVERY OF FINISHED PARTS. USE NITRONIC 60 THREADED INSERTS.

11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NOT WELD REPAIRS OR PLUGS UNLESS APPROVED IN ADVANCE IN WRITING BY LIGO. REFER TO LIGO-E0000364.

12. NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. IN GENERAL, WELD REPAIRS AND PRESS FIT INSERT REPAIRS ARE NEVER ACCEPTABLE. IF THE MATERIAL SHOULD BE MADE WITH VIRGIN MATERIAL, SPECIAL CIRCUMSTANCES CAN BE REVIEWED IF/WHEN BROUGHT TO THE ATTENTION OF LIGO CONTRACTING OFFICE REPRESENTATIVE (COOR) THROUGH A MATERIAL REVIEW BOARD (MRB) PROCESS. REFER TO LIGO-E0000364.

Note:

- part 3 screw (3)
- part 3 spring (3)
- part 6 mcmaster oval end screw (in house CIT)
- part 1 unknown

ITEM NO.	PART NUMBER	QTY.
6	92778A121	1
5	D1201076 aLigo secondary mirror mount tip-tilt sub assem..	1
4	D0901565	1
3	D1100114	3
2	D1200826-v1 aLIGO secondary mount plate	1
1	D1201078 ball for the secondary mount screw	1

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
XXX & .010
XXX & .010
ANGULAR ± 1.0°

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES, R1/16 MIN.
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.

MATERIAL: N/A

FINISH: N/A μinch

NEXT ASSY: D12002365

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SYSTEM: ADVANCED LIGO
SUB-SYSTEM: AOS

PART NAME: aLigo sec. mirror mt. tip-tilt sub assem with Ligo mt pL&LDASM

DESIGNER: k.moland 8-28-12
DRAWER: k.moland 8-28-12
CHECKER:
APPROVAL:

SIZE: B
DWG. NO.: D1201077
SCALE: 1:1
PROJECTION: 1st
SHEET 1 OF 1

REV. v1

5.8.5.2 Assembly of End Telescope Plates and Spacer Tubes

One person holds the bottoms of the End Plate assembly, with invar support tubes between loosely attached between them, against the table top, while a second person tightens the flat-head cap screws and fastens the tubes to the end plates with a torque value of **240 in-lbs** using three iterations.(**Alcohol on screws and heads to Torque**)

Next, the TMS Telescope Bench Support Assembly D1100933 is attached to the bottoms of each End Plate.

Note: VIEW D1102361 SHEET 4 OF 7, THE STARTING ASSEMBLY ORIENTATION OF THE TELESCOPE.

Note: END PLATES ARE INVERTED ON A FLAT SURFACE TO ALIGN AT START, WHAT WILL BECOME THE TOP SURFACES PARALLEL

5.8.5.3 Assembly of FM2

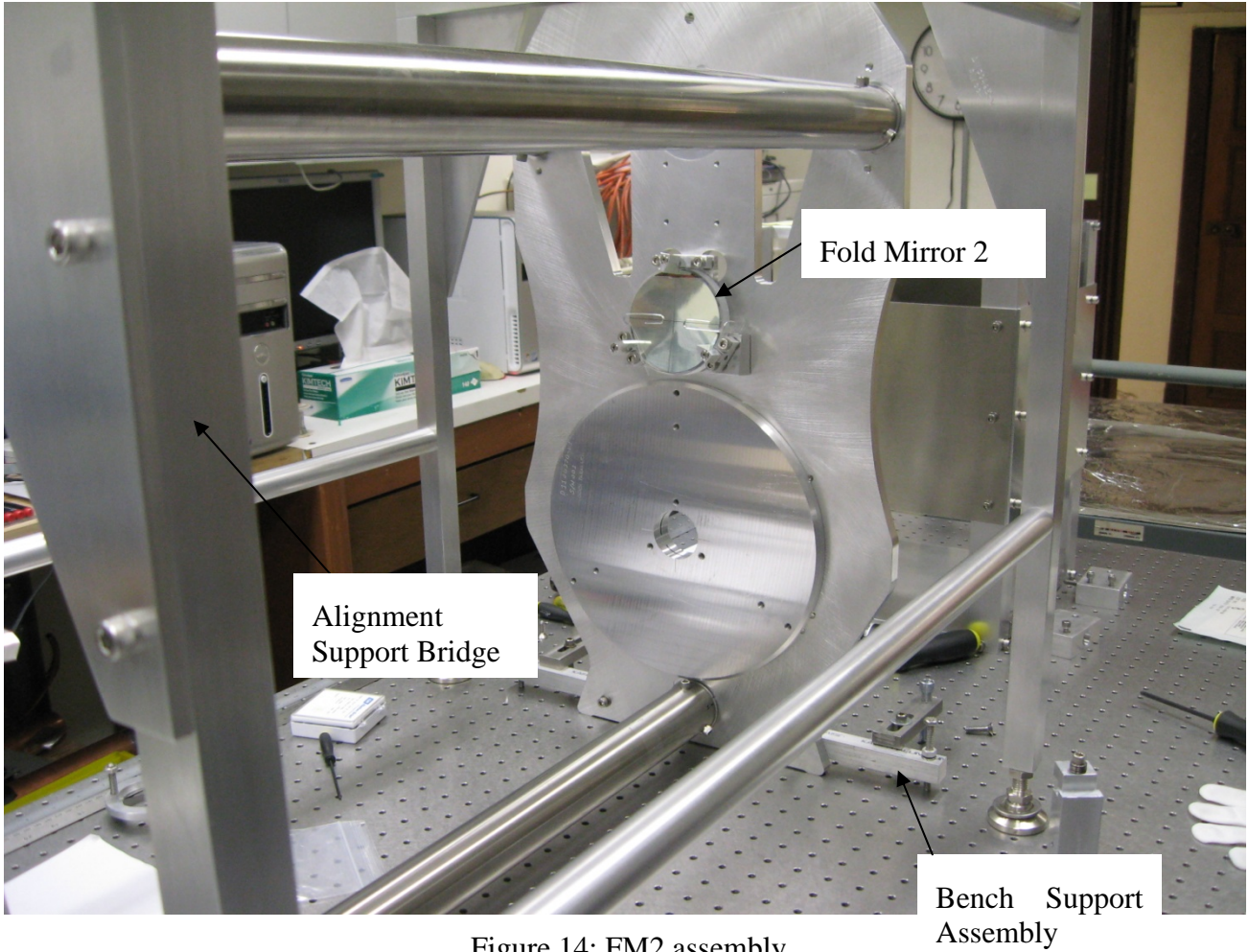


Figure 14: FM2 assembly

5.8.5.4 Assembly of Primary Mirror

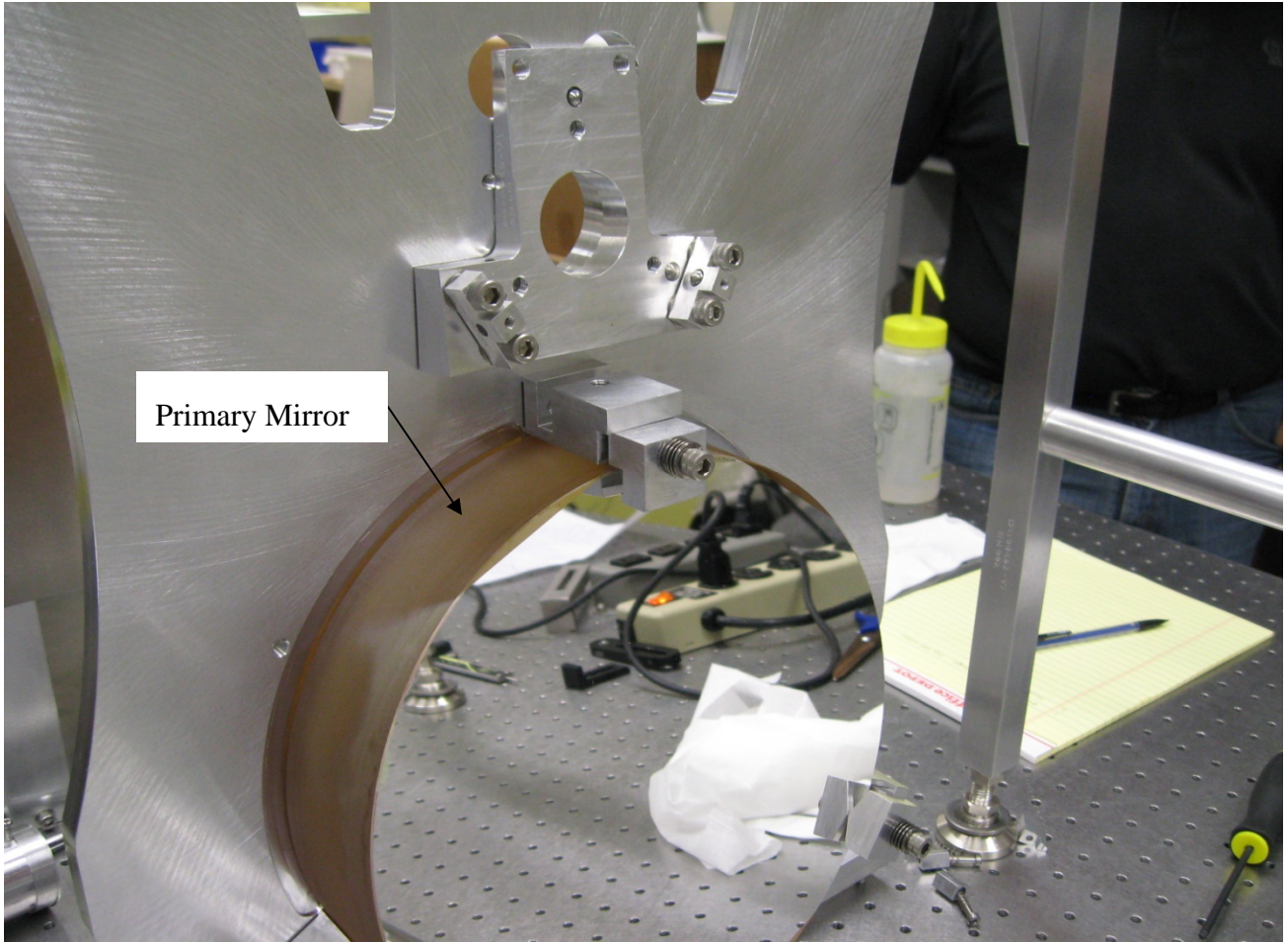


Figure 15: Primary Mirror Assembly

5.8.5.5 Assembly of FM2 and Secondary Mirror

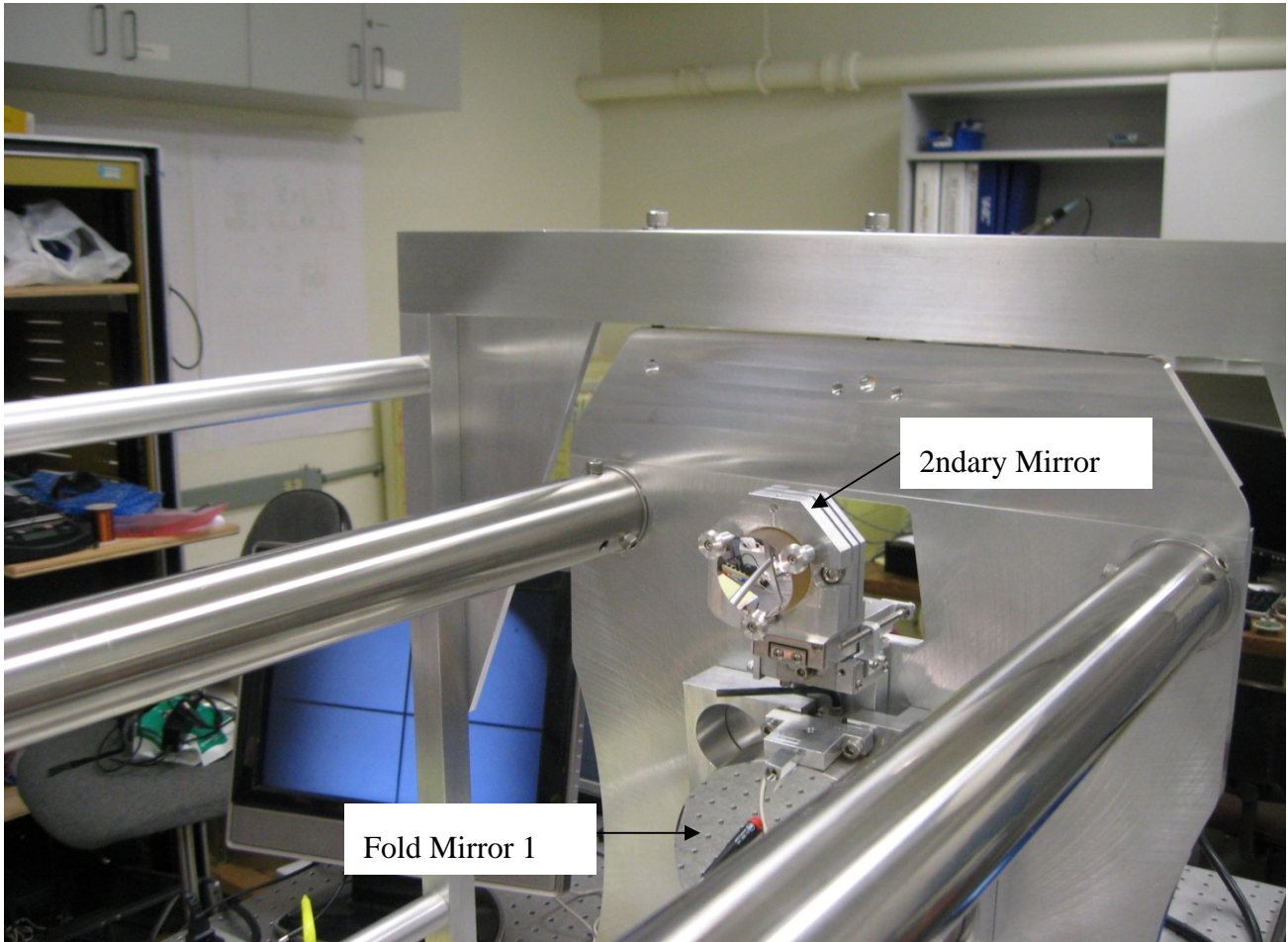


Figure 16: FM1 and Secondary Mirror Assembly

5.8.6 Initial Alignment of TMS Telescope

The assembled TMS Telescope, which weighs approximately 58 lb, will be attached to the TMS Tele Alignment Support Bridge Assy D1100460, and then lifted 1/8 in above the table by turning the support screws on the Bridge Assy for initial alignment, as shown in **Figure 17**.

Remove the D1100933 stabilization bars during the optical alignment procedure.

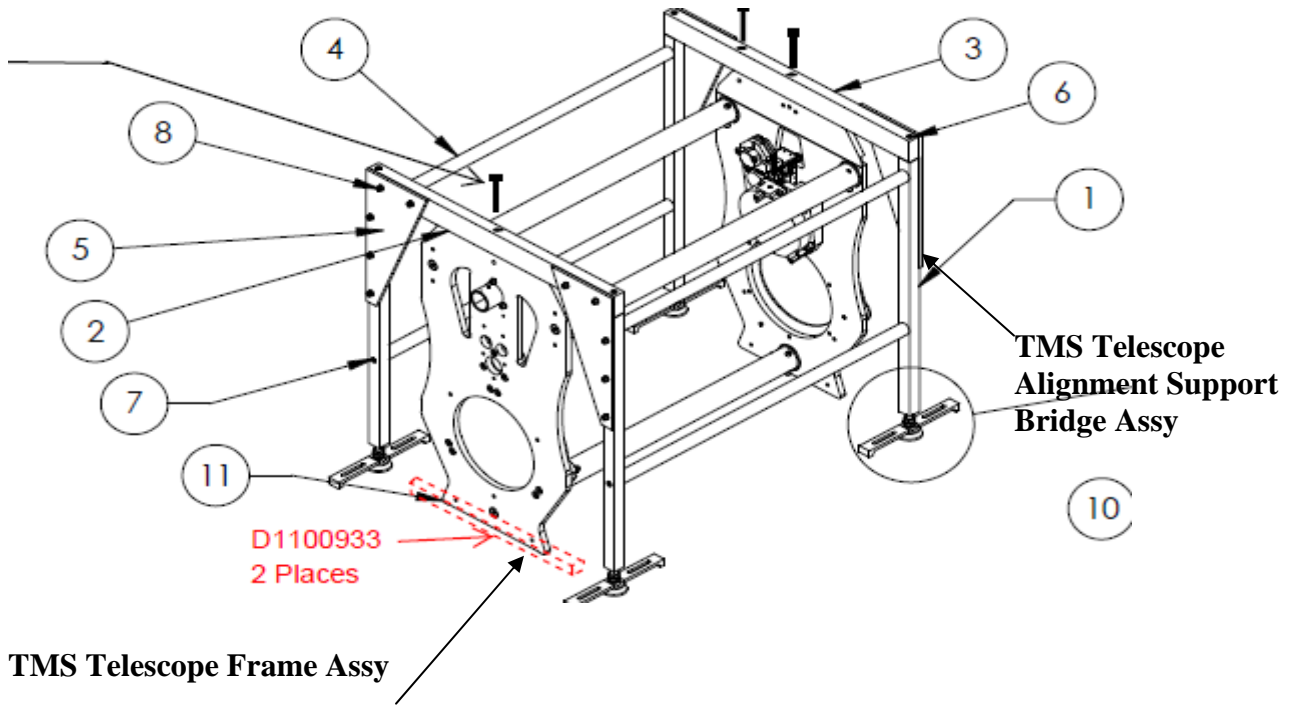


Figure 17: TMS Telescope Mounted to TMS Tele Alignment Support Bridge Assy D1100460 for Initial Alignment

VIEW D1102361 SHEET 4 OF 7, THE STARTING ASSEMBLY ORIENTATION OF THE TELESCOPE.
NOTE: END PLATES ARE INVERTED ON A FLAT SURFACE TO ALIGN WHAT WILL BECOME THE TOP SURFACES PARALLEL

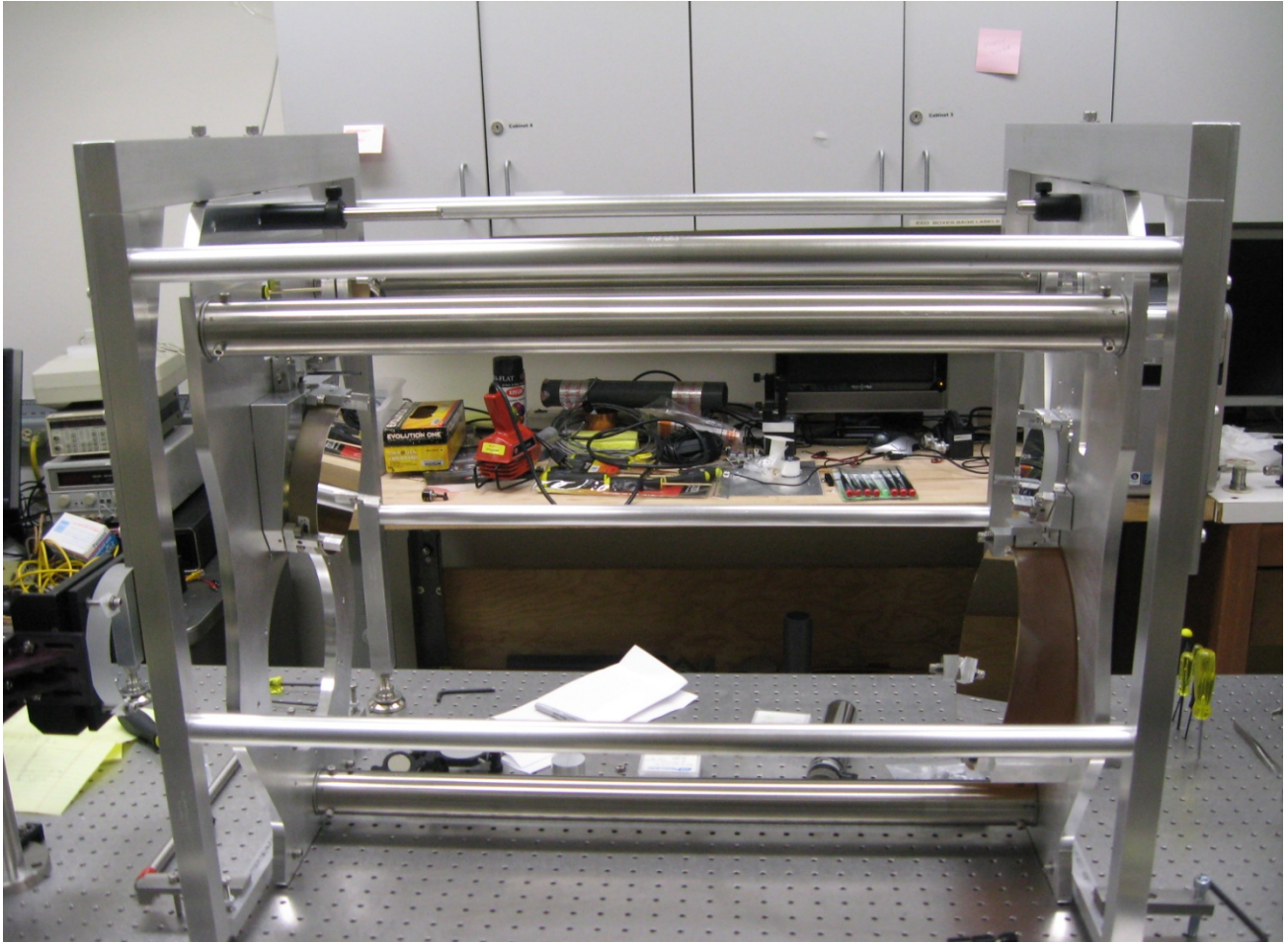
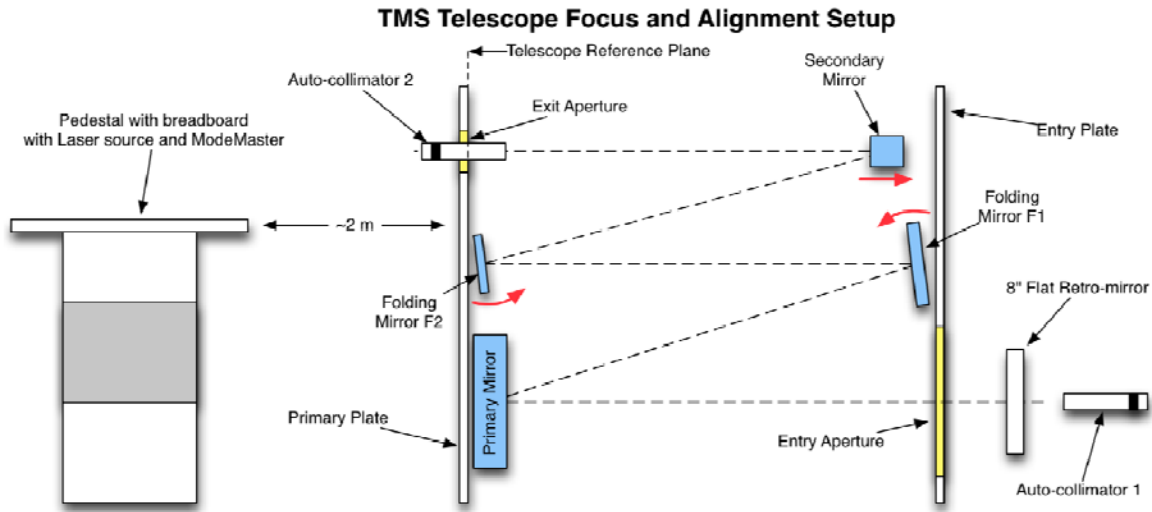


Figure 18: Completed TMS Telescope Assembly, Hanging from Alignment Support Bridge for Initial Alignment

5.8.7 T1100603: TMS Telescope Alignment Procedure

The TMS Telescope alignment procedure is described in T1100603: TMS Telescope Alignment Procedure.



5.8.8 Mounting the ISC Table Assembly to the TMS Telescope

After the optical alignment of the TMS Telescope on the Support Bridge, re-attach the D1100933 stabilization bars. Turn the support screws on the TMS Tele Alignment Support Bridge and lower the TMS Telescope to rest on the assembly table.

Remove the TMS Tele Alignment Support Bridge Assy to storage, as it will no longer be needed during the subsequent procedures.

Four people will lift the ISC Table Assembly and place it on top of the TMS Telescope. The ISC Table will then be attached to the TMS Telescope using the attachment hardware, as shown in

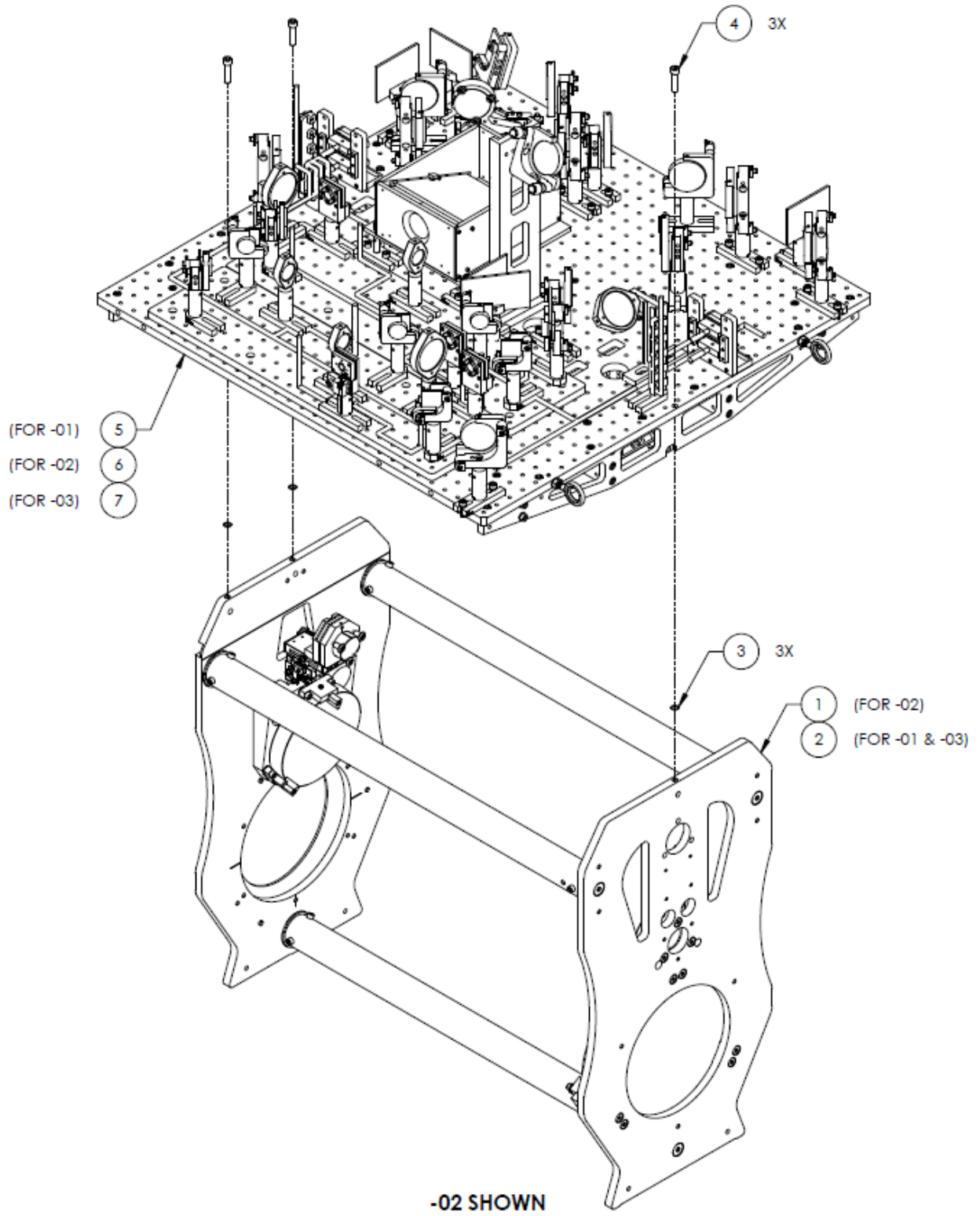


Figure 19: ISC Table Assembly being mounted to Top of the TMS Telescope

5.8.9 Balancing the TMS Telescope Frame Assembly /ISC Table Assembly

5.8.9.1 Assemble the TMS Tele-opt Table Balance Bridge Assembly, D1100649

The assembled aLIGO TMS Tele-Opt Table Balance Bridge Assembly is shown in **Figure 20**

Note: Use this Balance Bridge with the assembled Telescope and ISC table to Balance it, prior to using the support bridge D1100531 for Telescope to ISC table alignment.

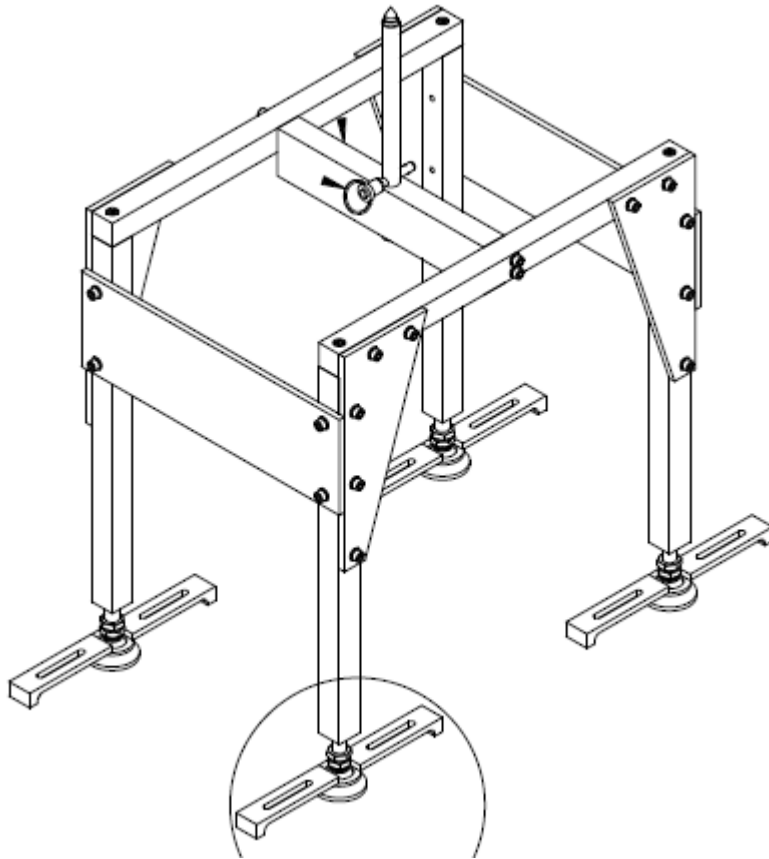


Figure 20: TMS Tele-opt Table Balance Bridge Connection-Interface

5.8.9.2 Prepare the Pin-in-Socket Balance Point

Insert the TMS Tele-Opt Table Balance Bolt into the ISC Table Extension, as shown in **Figure 21**.

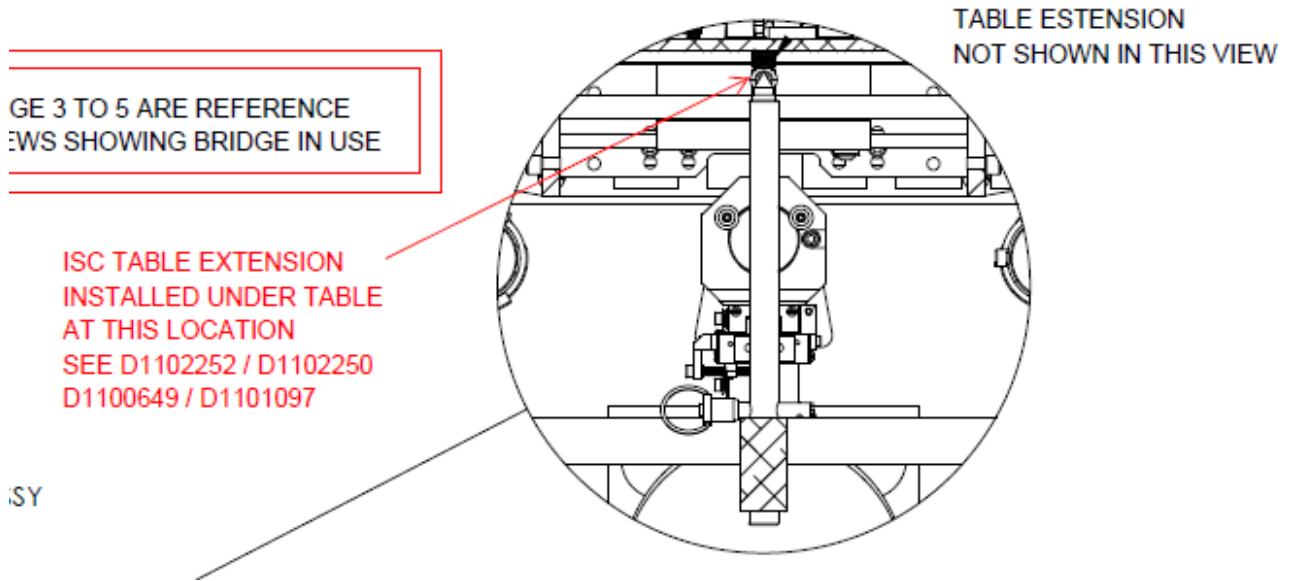


Figure 21: Balance Bolt Inserted into ISC Table Extension

Set the height of the pointed pivot screw to the nominal value, so that the pin and the socket will contact when the Balance Bridge is placed below the ISC Optics Table.

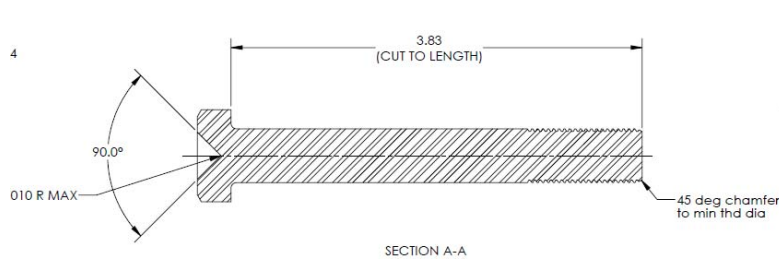


Figure 22: TMS Tele-Opt Table Balance Bolt

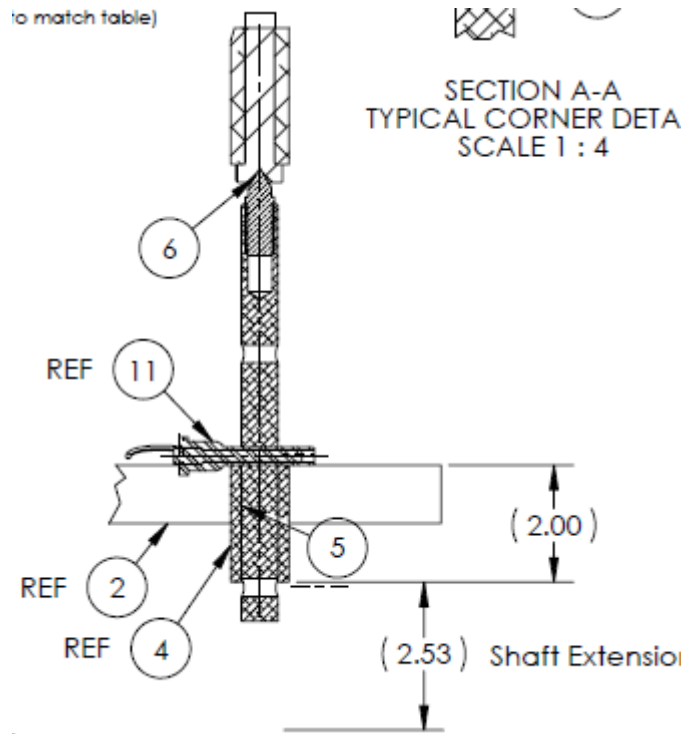


Figure 23: Detail of Balance Pin and Socket Positions

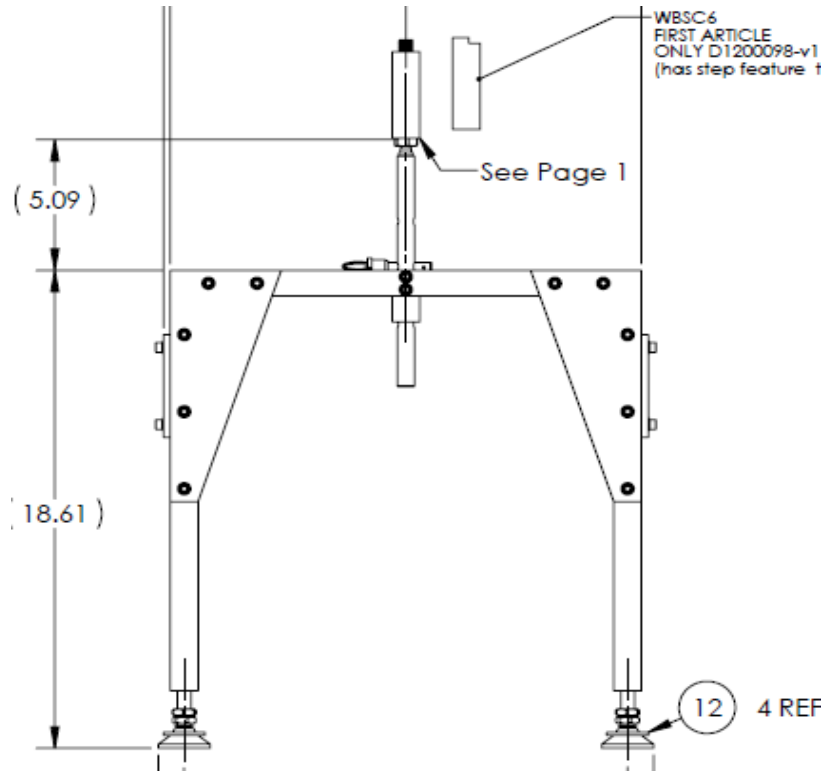


Figure 24: Detail of Pivot Pin Mating with Pivot Socket

5.8.9.3 Support the ISC Table / TMS Telescope Assembly with the Balance Bridge

Place the Balance Bridge on the assembly table underneath the ISC Table, by straddling the lower invar tube of the Telescope, as shown in **Figure 25**. Position the Balance Bridge so that the Pivot Pin on the Bridge and the Socket Bolt on the ISC Table are aligned.

Raise the leveling pad feet of the Balance Bridge iteratively, until the Telescope is lifted approximately $\frac{1}{4}$ in above the assembly table. Clamp the feet against the assembly table with dog clamps.

Remove the stabilizing bars on the bottoms of the Telescope End Plates.

5.8.9.4 Balance the ISC Table / TMS Telescope Assembly, See Table Assembly for Nominal Position of Trim Masses. First Article 80kg., Production 82kg.

Move the adjustable balance weights on the underside of the ISC Table until the ISC Table is balanced in a horizontal plane. Note the nominal location of the trim masses per D1102291

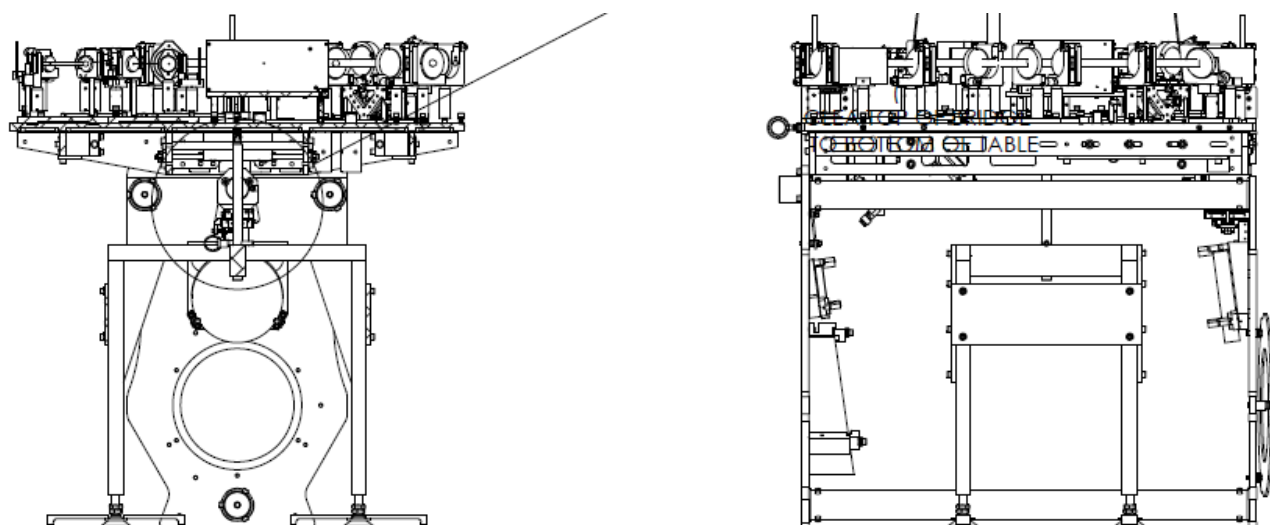


Figure 25: Balance Bridge supporting the ISC Table/ TMS Telescope Assembly

5.8.10 Suspending the TMS Telescope Frame Assembly/ISC Table Assembly from the TMS Optical Table Support Bridge Assy D1100531

The Optical Alignment between the ISC Table and the TMS Telescope will be accomplished while the TMS Telescope Frame Assembly/ISC Table Assembly is suspended. To do this, the TMS Telescope Frame Assembly/ISC Table Assembly will be suspended with straps from the TMS Optical Table Support Bridge Assy to simulate the suspension wires.

Place the TMS Optical Table Support Bridge Assy D1100531 on the work table to straddle the combined TMS Telescope Frame Assembly /ISC Table Assembly structure, as shown in the figures below. Table clamps, shown in **Figure 26**, are fastened to immobilize the suspended Telescope Assembly. Note: Telescope /Optical table is a complete as installed in Chamber

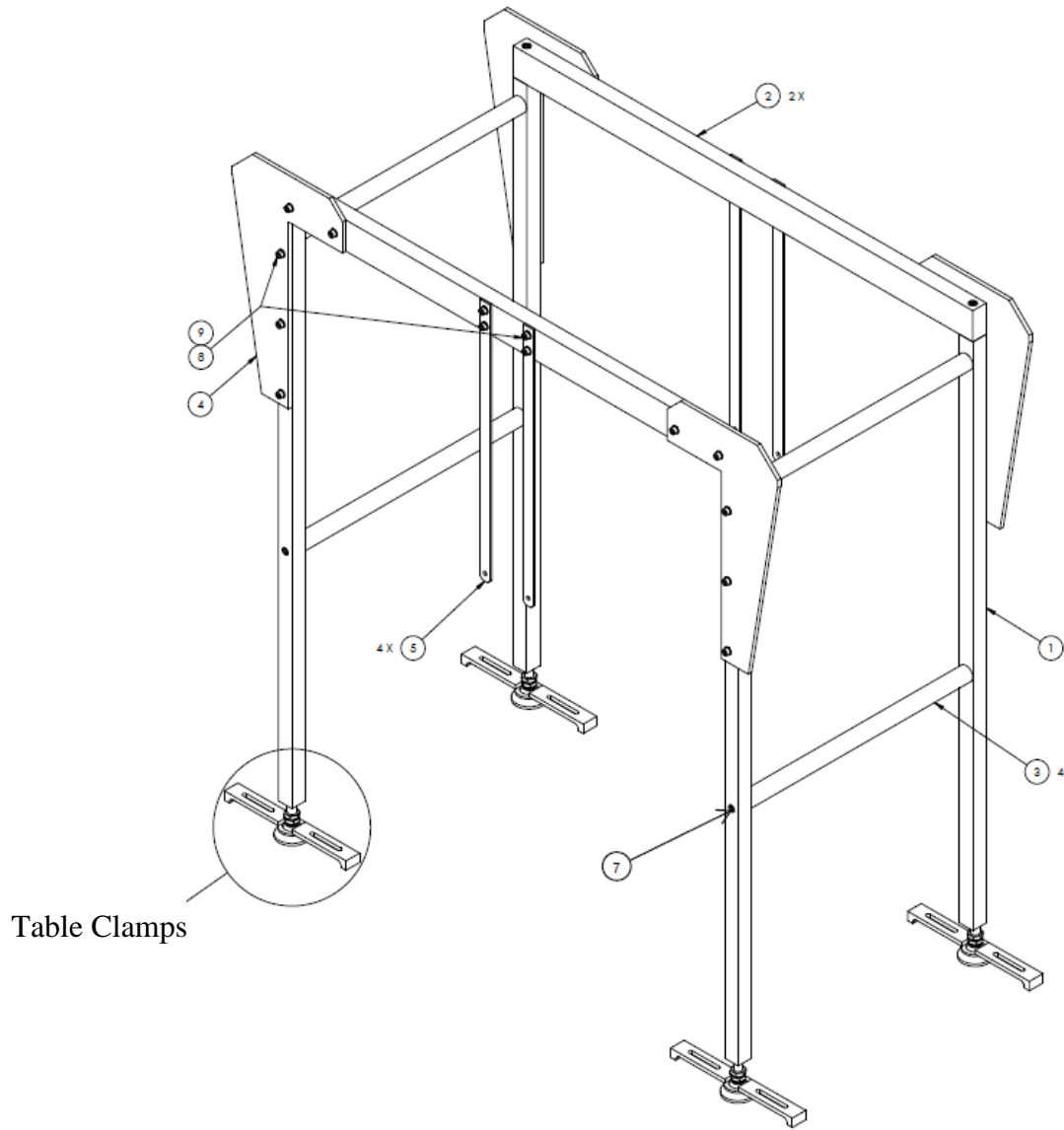


Figure 26: TMS Optical Table Support Bridge Assy D1100531

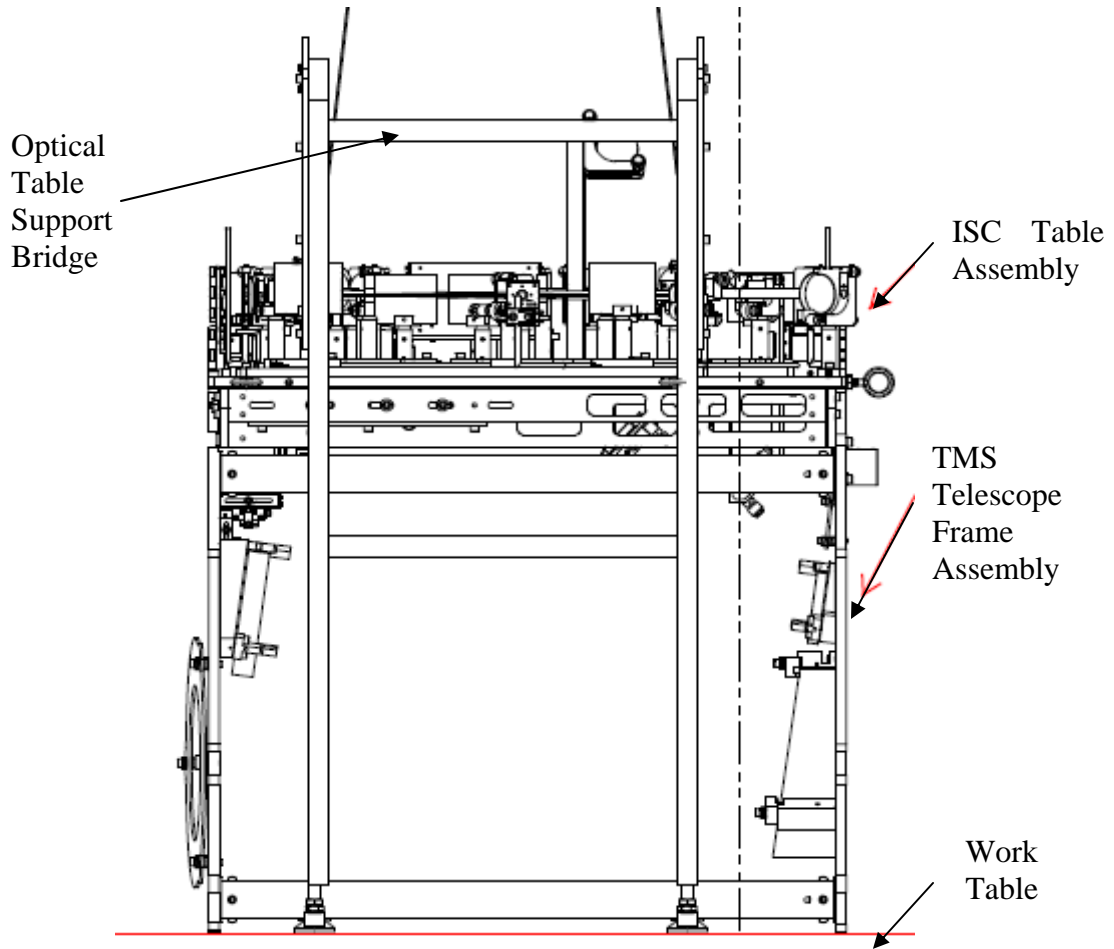


Figure 27: TMS Optical Table Support Bridge Assy Straddling the Combined TMS Telescope/ISC Table Assembly Structure

Attach the suspension straps to the mounting holes of the ISC Table Assembly structure and adjust the leveling pad feet equally, in increments, to raise the Telescope assembly approximately 1/8 in above the assembly table, as shown below.

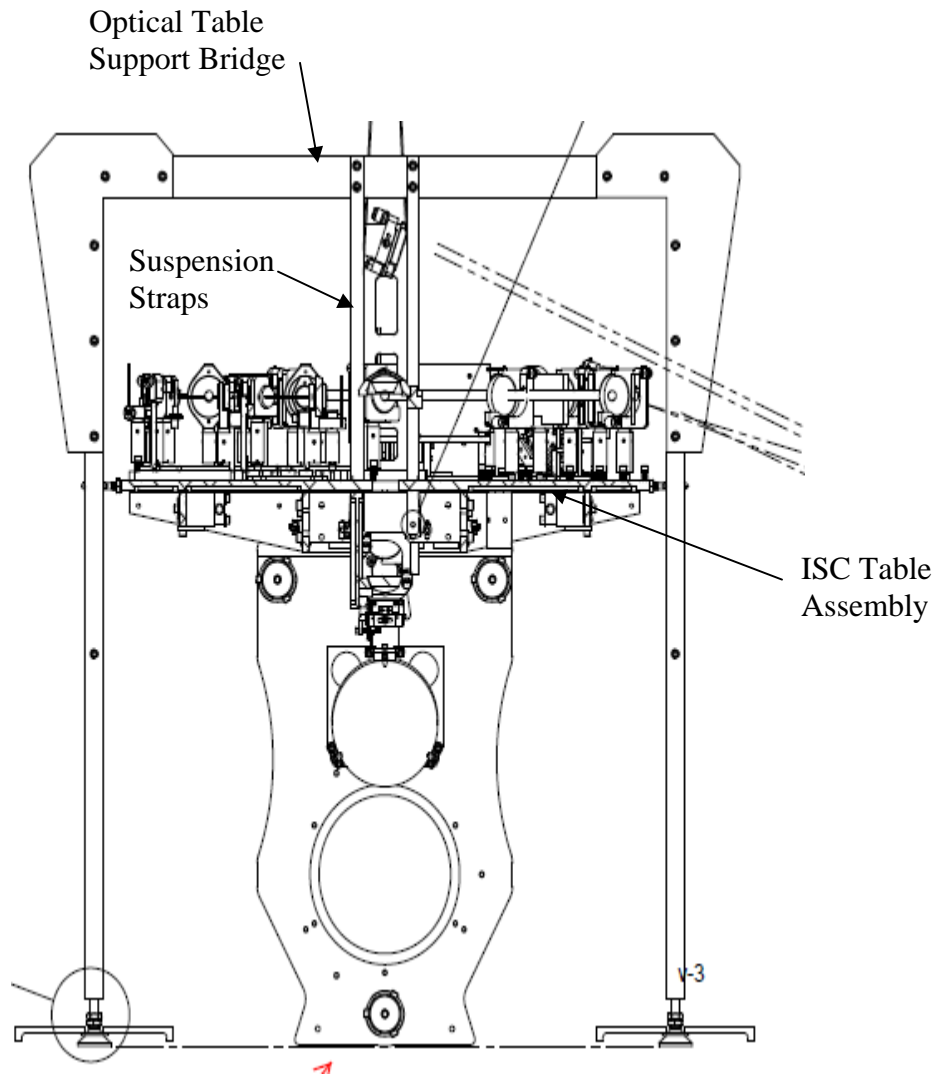


Figure 28: TMS Telescope/ISC Table Assembly Suspended by Straps to the ISC Table Assembly structure

5.8.11 Mounting the AOS ETM Telescope Upper Suspension Frame and Top Mass to the Tele-opt Table (Bosch Frame)

Level the Tele-opt Table Frame Plate D1100807 on the Bosch Frame by adjusting the leveling pad feet, as shown in **Figure 29**.

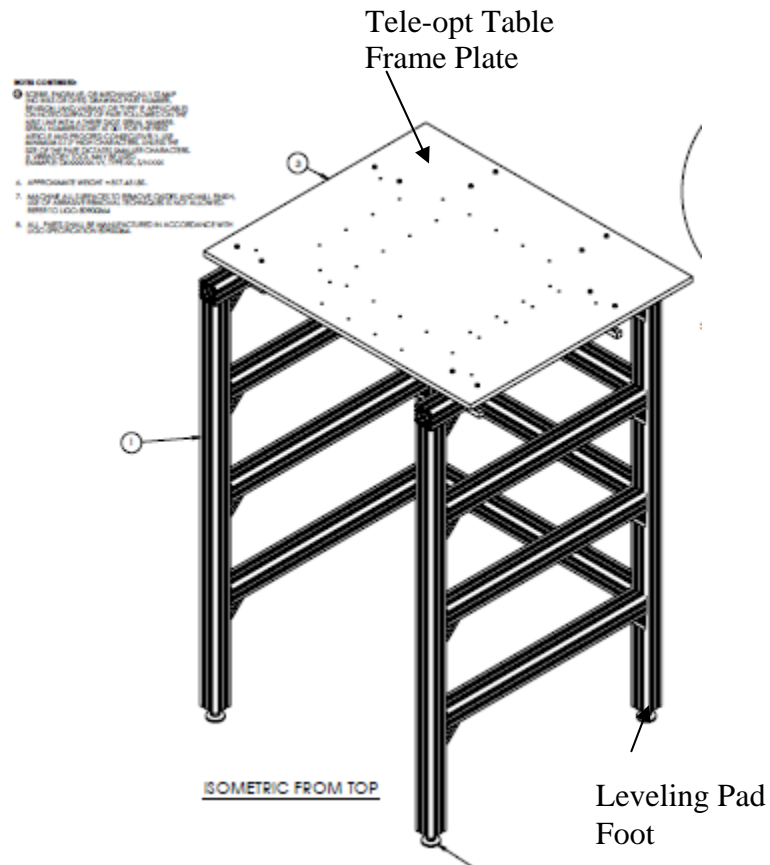


Figure 29: TMS Tele-opt Table on Bosch Frame

A Genie lift, with special lifting forks attached (see **Figure 30**) and with the legs splayed appropriately to avoid tipping over of the load, will lift the Upper Suspension Frame and Top Mass (see **Figure 31**) up to the underside of the Tele-opt Table Frame Plate D1100807 on the Bosch Frame, as shown in **Figure 32**.

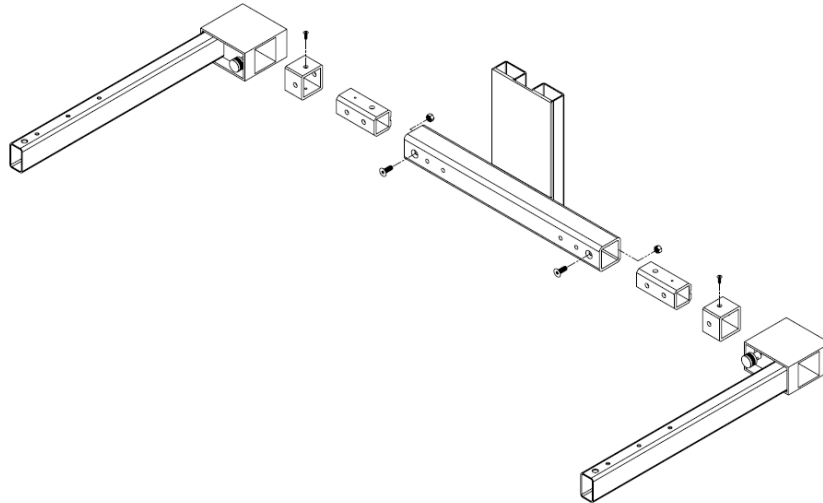


Figure 30: Modified Genie Lift Forks, D1100886

The combined Upper Suspension Frame and Top Mass weight is 273 lbs (124kg).

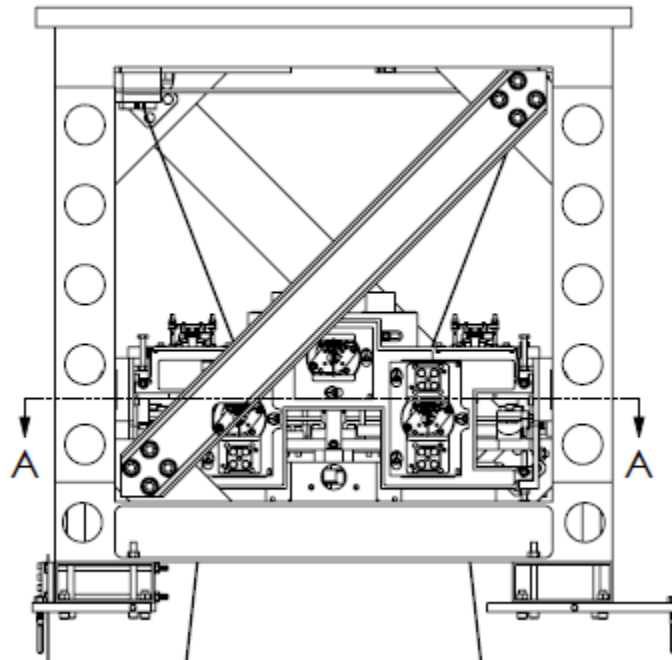


Figure 31: Upper Suspension Frame and Top Mass

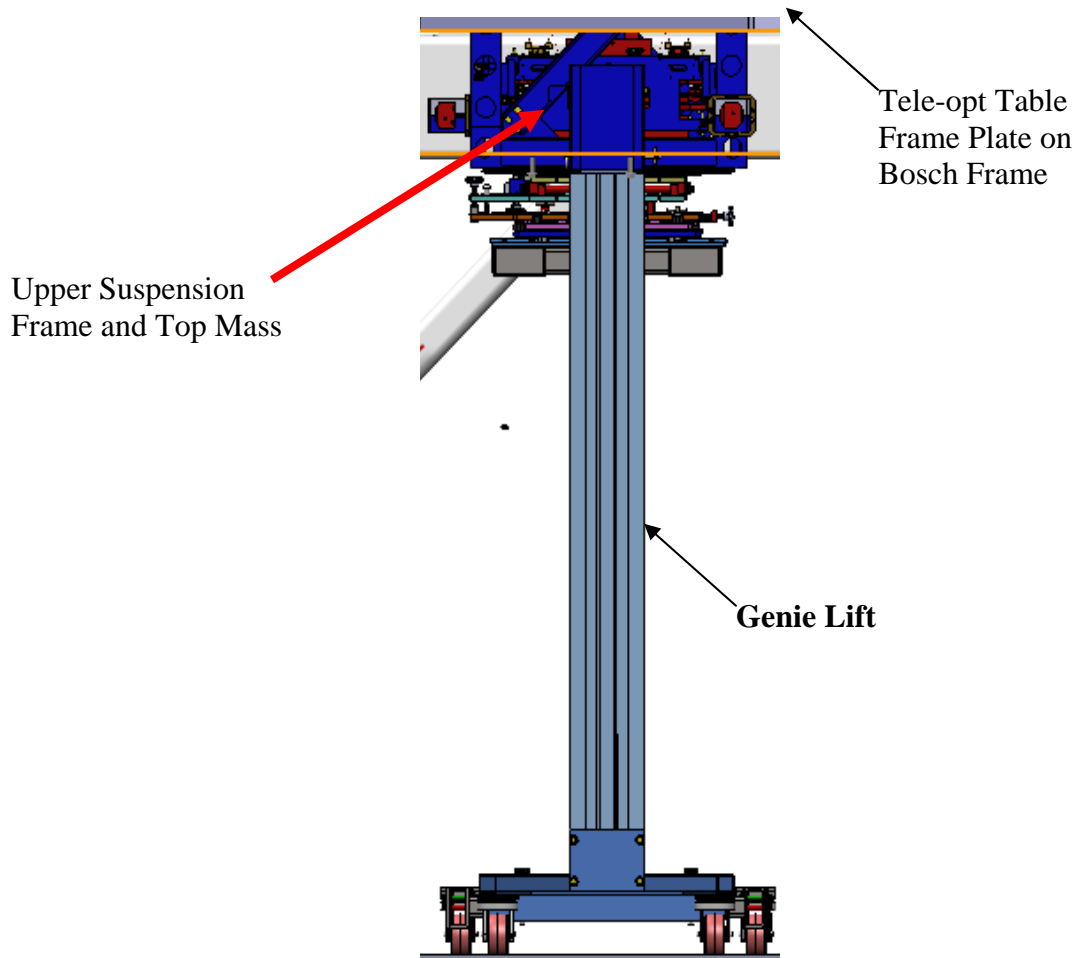


Figure 32: Genie Lift supporting Upper Suspension Frame and Top Mass

5.8.12 TMS Test Mass Assembly, D1002097

A Test Mass will be used as a payload for the preliminary adjustment of the Top Mass control system.

5.8.12.1 Assembly of the Test Mass

The assembled TMS Test Mass is shown in **Figure 33**. Weighs: 80 kg First Article, 82kg Production. The various attached weights can be repositioned to change the location of COM. The suspension wires from the Upper Mass attach to the D1002240 aLIGO TMS Tele Wire Clamp Base, as shown in Detail A.

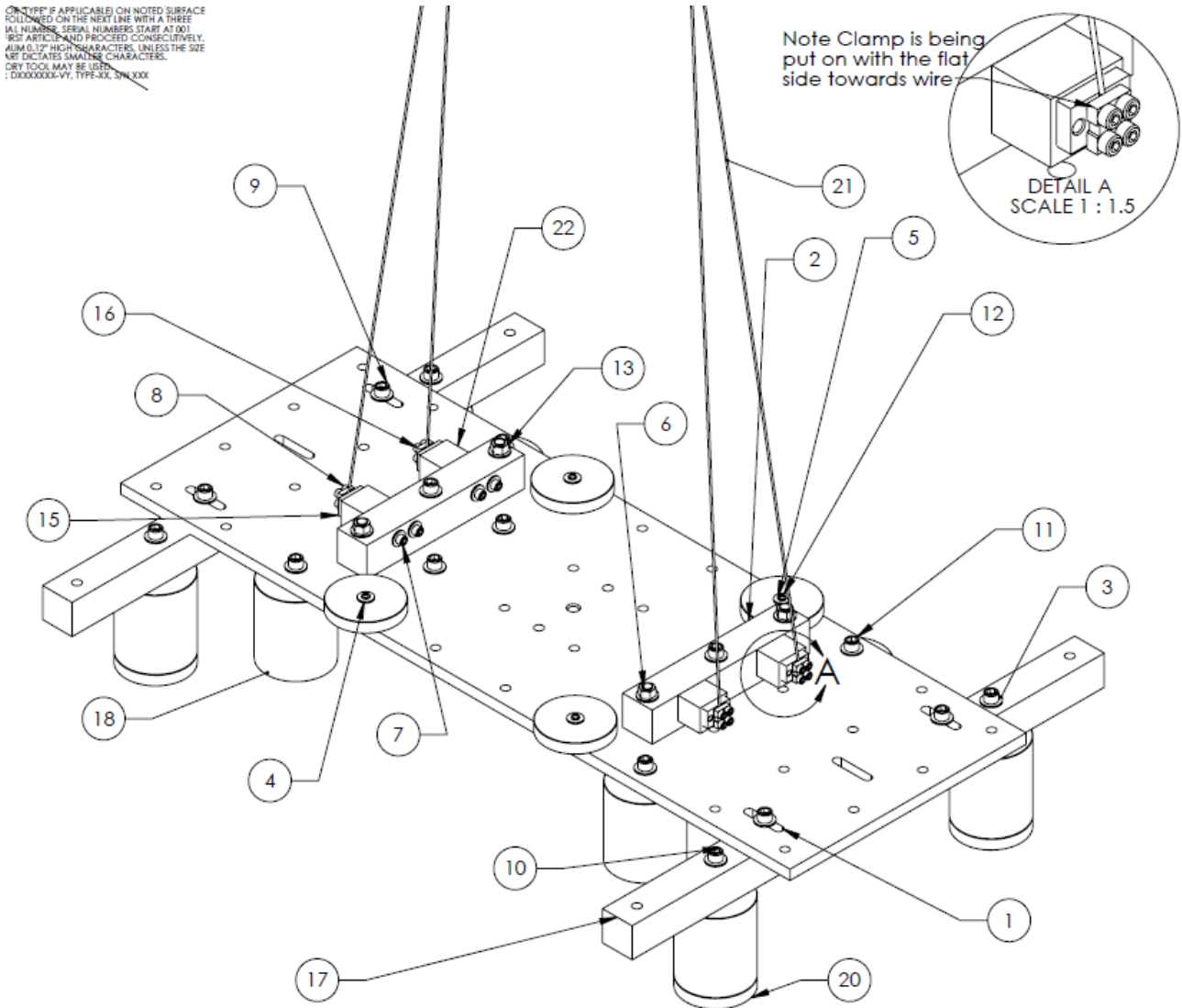


Figure 33: TMS Test Mass Assembly

5.8.12.2 Balancing the Test Mass

The Test Mass will be lifted by four people, while a fifth person places the D1201330 aLIGO TMS Test Mass Balance Ball and spacer under the Test Mass Plate to mate with the locating hole, as shown in **Figure 34**.

The movable balance weights will be positioned so that the Test Mass is balanced in a level horizontal plane.

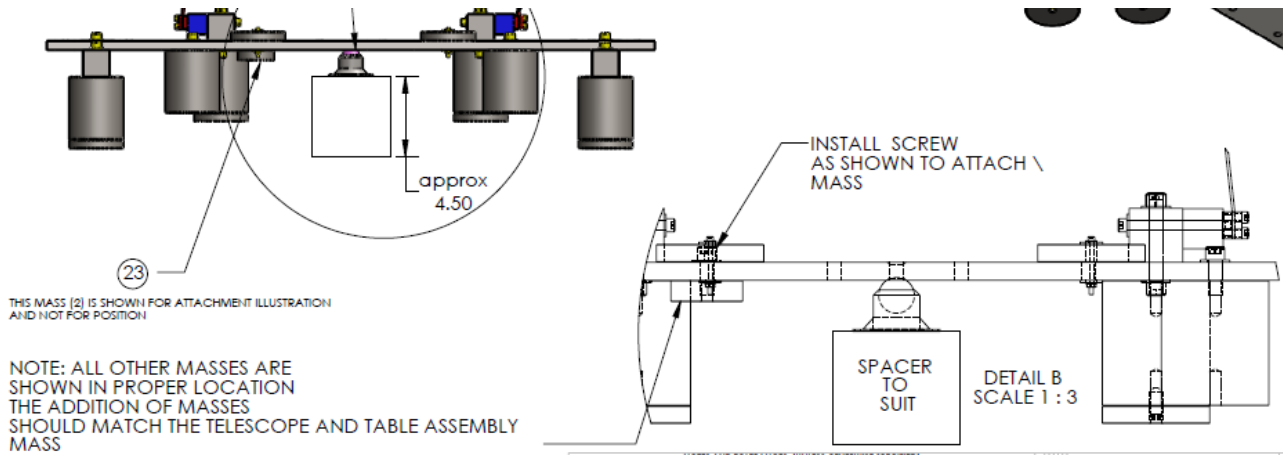


Figure 34: Placement of Balance Ball beneath the Test Mass

5.8.12.3 Installing the Test Mass: 80kg First Article (WBSC6) Production 82kg

The Genie lift adjustable forks will be positioned beneath the Test Mass, and the Test Mass will be transported under the Bosch Frame and lifted to a height that enables the hanging suspension wires from the mounted Top Mass to be connected to the Test Mass. The suspension wires will then be secured to the ISC Table mounting locations, as shown in the figures below.

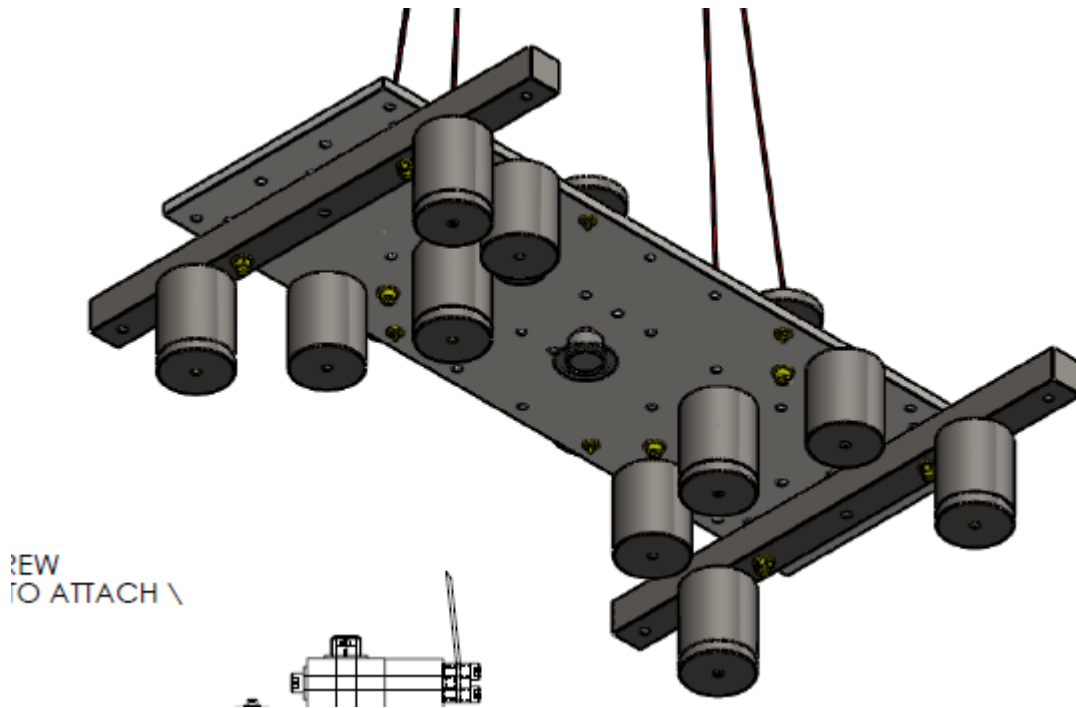


Figure 35: Test Mass Suspended from Top Mass

5.8.12.4 Adjust the TMS Control System with Suspended Test Mass

5.8.12.5 Removing the Test Mass

After the Top Mass OSEM Controls have been adjusted, the suspension wires will be disconnected from the Test Mass, and it will be lowered using the Genie lift, as described in section 5.8.12.3, and transported to a storage area.

5.8.13 Mounting the TMS Telescope Frame Assembly/ISC Table Assembly to the Top Mass

A modified Genie lift, with adjustable forks and with the D1100841 TMS Tele-opt Table Install Tool attached, is shown in **Figure 36** and **Figure 37**. See: D1100908 For application w/ Genie Lift.

Note: Use D1200355 Height Spacers, under #2, to for additional Working Room between Underside of Table and Tool Plate #1

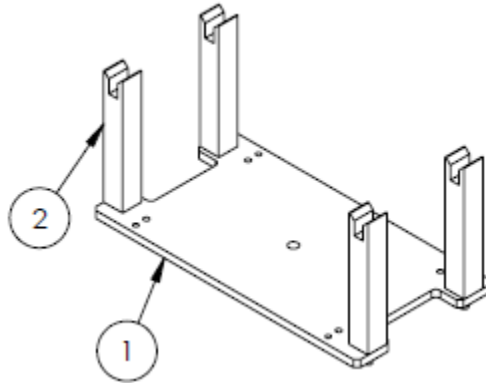


Figure 36: TMS Tele-opt Table Install Tool Assy

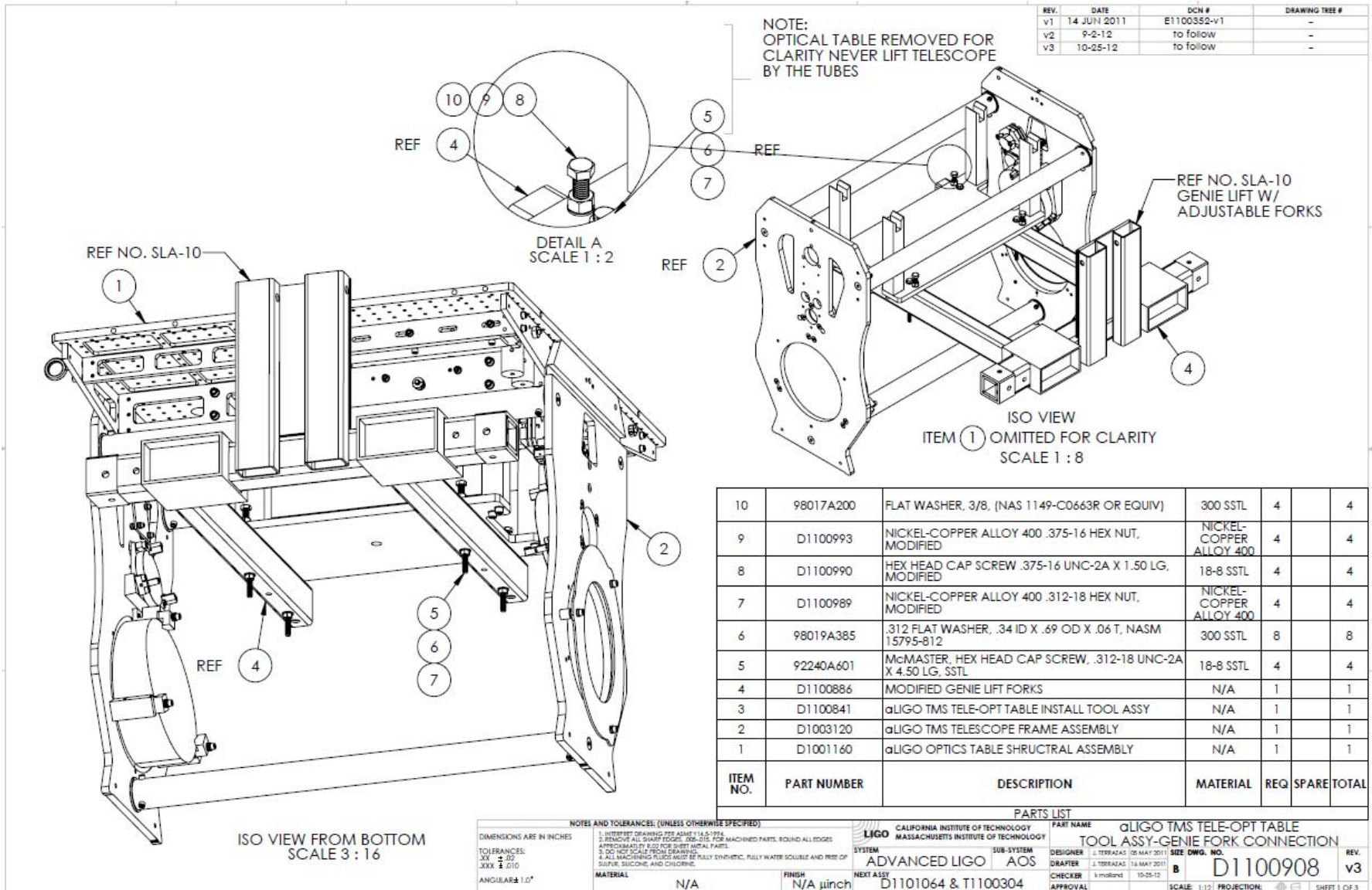


Figure 37: TMS Tele-opt Table Tool Assy-Genie Fork Connection

Lift the TMS Telescope/ISC Table Assembly from the assembly table using the Genie lift and transport it to the Bosch Frame (just as was done to transport and lift the Test Mass). Lift it to the level of the suspension wires hanging from the Top Mass, and connect the Top Mass suspension wires to the TMS Telescope/ISC Table--in the middle hole of the attachment bracket) and suspend it, as shown in **Figure 38**.

Final adjustment of the TMS control system will be done while the TMS Assembly is mounted to the Bosch Frame.

NOTE: SEE SECTION 9.0 FOR BEAM DISTANCE FROM CARTRIDGE TABLE

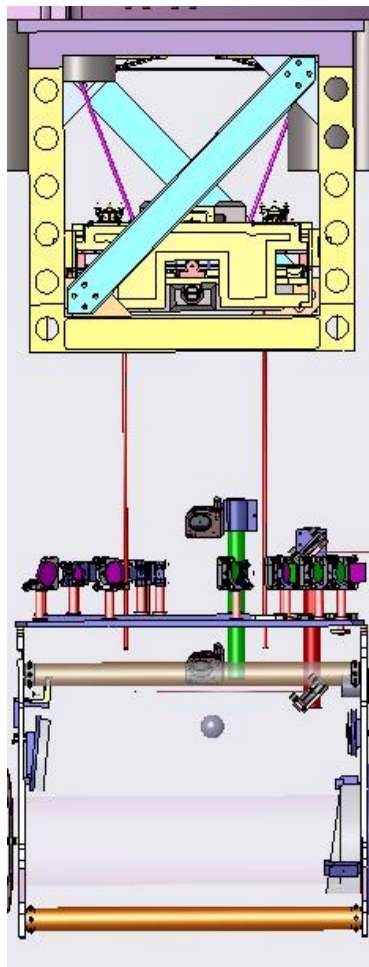


Figure 38: TMS Assembly attached to Tele-opt Table Frame Plate on Bosch Frame

5.8.14 Adjustment of TMS Control System will Suspended TMS Telescope/ISC Table Assembly

6 TMS Installation Procedure

6.1 Transporting and Mounting the TMS System to the ISI Cartridge

The TMS System will be transported and installed on the ISI Cartridge in two steps: 1) First install the Top Mass, and 2) suspend the TMS Telescope/ISC Table Assembly from the Top Mass. This procedure requires reversing the procedure described in section 5.8.13 to detach the suspended TMS Telescope/ISC Table Assembly from the Upper Suspension Frame and Top Mass in the Bosch Frame.

Whenever the ISC Table Assembly is moved or transported, the Protective Covers (D1102411, D1102349, D1102329, D1102328) shown in **Figure 39** should be in place. Ref D1102327 assem.

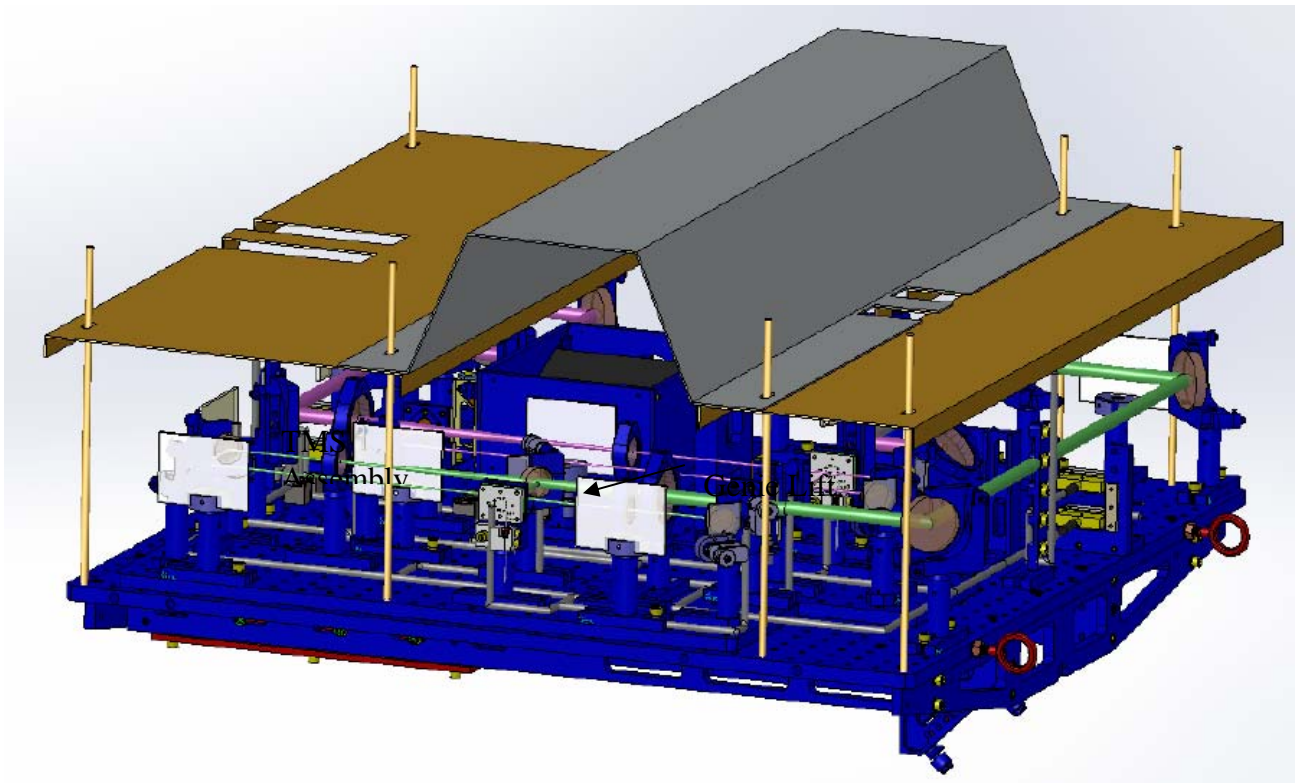


Figure 39: Transmon ISC Protective Cover

6.1.1 Remove TMS Telescope/ISC Table Assembly from the Upper Suspension Frame and Top Mass

1. Release the tension on the suspension wire by raising the Genie lift against the Safety Support Assembly, shown in Figure 2, until the blade springs rest against their stops.
2. Unscrew the 1/4-20 SHCS which hold the wire clamp onto the short cross bar (two per wire clamp). Although not difficult, they are awkward to reach, especially at the side of the secondary mirror!! Have one person underneath the Tele working on the screws, while a second person keeps the suspension wire under tension from above. Because the suspension wire is quite thick you can control the orientation of the wire clamp. This will greatly help the person underneath unscrewing the SHCS. Note: someone with small hands has an advantage.
2. Attach the TMS Telescope Bench Support Assembly D1100933 to the bottoms of each End Plate.
3. Once all wires are removed, the Genie will be rolled away, and the TMS Telescope/ISC Table Assembly will be placed temporarily on a work table.

6.1.2 Prepare Upper Suspension Frame and Top Mass

1. Reposition the four electrical cables such that they do not cross underneath the Upper Suspension Frame and Top Mass.
2. Install the 5-axis SUS platform onto the Genie forks. The total nominal weight of the cube + cage + 5-axis SUS platform is approximately 275 lbs. Rotate the platform such that it can rotate by at least 180 degrees in both directions (CW and CCW), along the vertical axis once the Upper Suspension Frame and Top Mass is mounted on the platform.
3. Bring the Genie underneath the Upper Suspension Frame and Top Mass, which is still hanging from the Bosch frame. One point to check is the location of the Upper Suspension Frame and Top Mass on the 5-axis platform. You want to locate the 'front' of the Upper Suspension Frame and Top Mass as close to the edge of the platform as possible, as this will aid during the mounting on the ISI platform next to the ETM, which is fully assembled. The clearance between the TMS and the ETM is approximately 4 inch.
4. Mount the Upper Suspension Frame and Top Mass to the platform and unclamp the cube from the Bosch frame.
5. Lower the Upper Suspension Frame and Top Mass to knee height and cover with the clean-room cover.
6. The Upper Suspension Frame and Top Mass is now ready for transport to the ISI.

6.1.3 Attach Upper Suspension Frame and Top Mass to Cartridge

The Suspension Frame will be placed on the ISI Optical Table at the local coordinates specified in D0900419 AdvLIGO SUS BSC6-H2, XYZ Local CS for TMS ETM Tel Assy. Refer to E1101131 BSC6 H2, Test Stand, Quad, TMs, Tooling Clearances, aLIGO

Protective covers for the ETM must be in place.

Note: D1300448 TMS Cartridge Swing Stop Tool is used to prevent TMS and ETM from Bumping

Use the Genie lift to transport and lift the Upper Suspension Frame and Top Mass up to the ISI table on the Cartridge placed on top of the Test Stand, as shown in **Figure 40**. This portion of the TMS Assembly weighs 273 lbs (124kg). Place the Frame against the preset location stops on the ISI Optical Table, as described in D1101260.

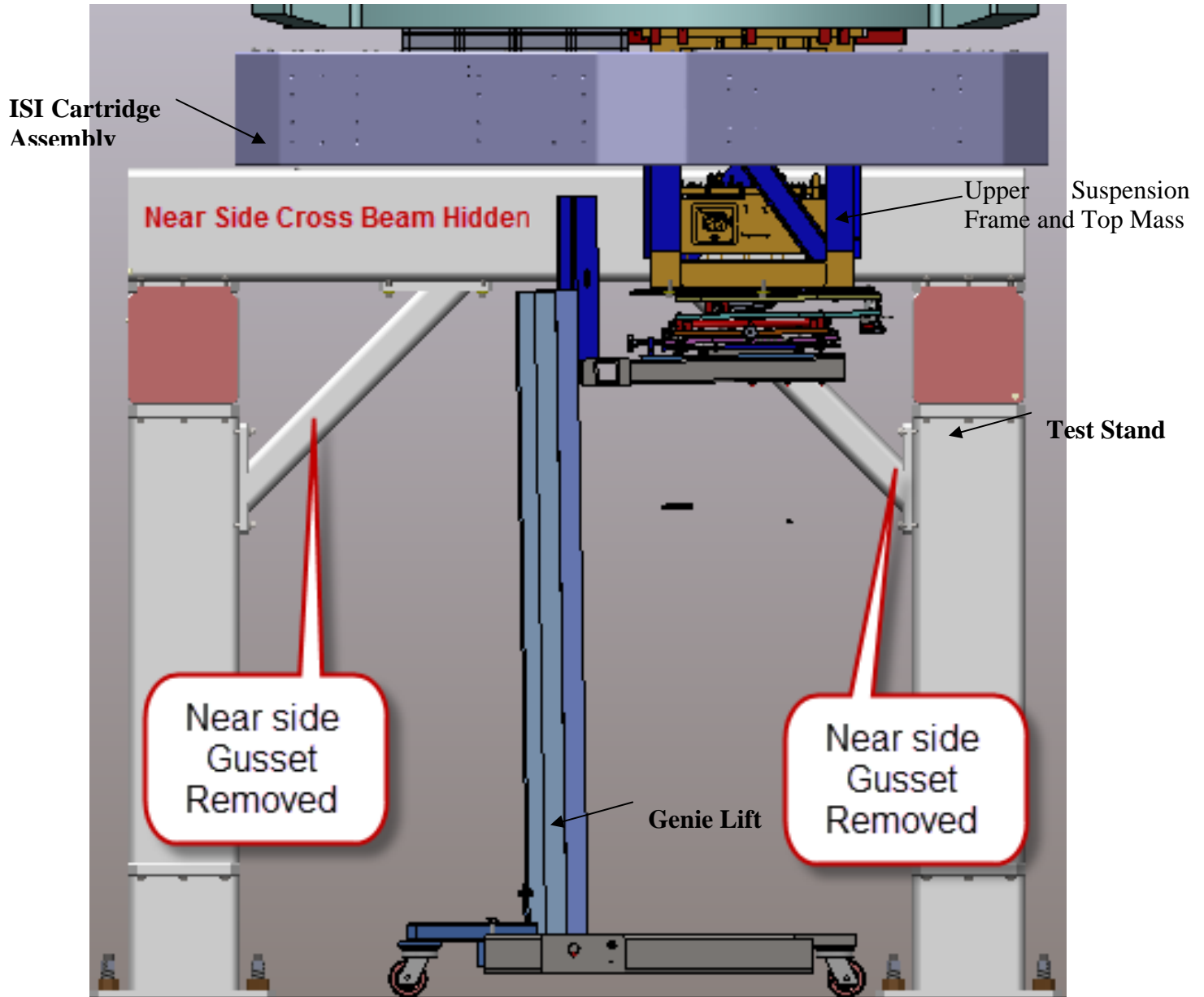


Figure 40: Upper Frame and Top Mass Attached to Cartridge Assembly

6.1.4 Attach TMS Telescope/ISC Table Assembly to the Top Mass Suspension Wires

The Transmon ISC Protective cover should be in place.

Use the Genie lift to transport and lift the TMS Telescope/ISC Table Assembly up to the suspension wires hanging from the Top Mass, and attach to the suspension wires following the procedure described in section 5.8.13. This portion of the TMS Assembly weighs 176 lbs (80 kg).

6.2 Final Installation inside BSC

6.2.1 Preparing the TMS System for Cartridge Flight into the BSC

After alignment of the TMS Assembly and before transporting or installing the TMS Assembly to the Cartridge, install the Transmon ISC Protective cover.

The Transportation-Installation Restraints must also be in place to protect the TMS from damage by securing its suspended components per the Transportation-Installation Restraint Procedure, E1100841. Refer to the restraint tooling assemblies D1001891, D1101506, D1101559, D1101565 and related hardware to the TMS Assembly, with reference to Tooling Layout D1101307 and Assembly Drawing D1000549.

D1300248 Swing Stop Tool is used to Prevent the TMS and ETM from Bumping, NOTE: see p. 160

OPTICAL TABLE REF. D1102291

TMS TELESCOPE REF. D1102361

TABLE NUMBERS AND QUANTITIES NOT CHECKED 4-30-13

24	D1300278	a Ligo Swing Stop Cross Bar Plug	2
23	D1300277	a Ligo swing stop base parts	1
24	D1102291		1
23	D1102361		1
22	a Ligo Swing Stop Cross Bar mc master		1
21	Mc Master 4698T102		4
20	a Ligo horizontal Swing Stop Rod		1
19	Mc Master 642 6K24		4
18	Mc Master 642 6K28		2
17	Mc Master 7219 6A557		8
16	D980275	a Ligo Swing Stop Mass_SEL_TABLE_BA LAH CE_WEIGHTS	8
15	Mc Master 78017A200		14
14	Mc Master 7219 6A 622		14
13	leveling pad foot swing stop mc mast 6111K38		4
12	Mc Master 24025T51		4
11	Mc Master 78017A215		4
10	Mc Master 78017A209		4
9	Mc Master 71845A225		4
8	Mc Master 71847A520		4
7	a Ligo Swing Stop Alum Vertical Post Foot mc master 4698T146		2
6	a Ligo Swing Stop Foot Bracket at 45 deg a lrm mc master 4698T79		2
5	Mc Master 4698T172		4
4	a Ligo Swing Stop 45 Deg Bracket		2
3	a Ligo Swing Stop 1.25 round-R2 mc master		2
2	D1300290	a Ligo Swing Stop Vertical Post 1.25 dia	2
1	a Ligo Swing Stop 45 deg 1.25 foot round mc master		2

WHEN THIS ASSEMBLY IS USED THE FRONT SAFETY WIRE D1100827 MUST ALSO BE IN PLACE

NOTES AND TOLERANCES (UNLESS OTHERWISE SPECIFIED):
 1. UNLESS OTHERWISE SPECIFIED TO 0.004"
 2. FINISH: ALL SURFACES: 320Ra
 3. DIMENSIONS ARE IN INCHES
 4. DIMENSIONS ARE IN MILLIMETERS
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 22. DIMENSIONS ARE IN MILLIMETERS
 23. DIMENSIONS ARE IN MILLIMETERS
 24. DIMENSIONS ARE IN MILLIMETERS
 MATERIAL: N/A
 FINISH: N/A punch

ADVANCED LIGO AOS
 DESIGNED: 11/2012
 DRAWN: 11/2012
 CHECKED: 11/2012
 APPROVAL: 11/2012

aLigo TMS Swing Stop
 SEE DIAG. NO. D1300248
 SCALE: 1/8" PROJECTION: 30° SHIP LOG

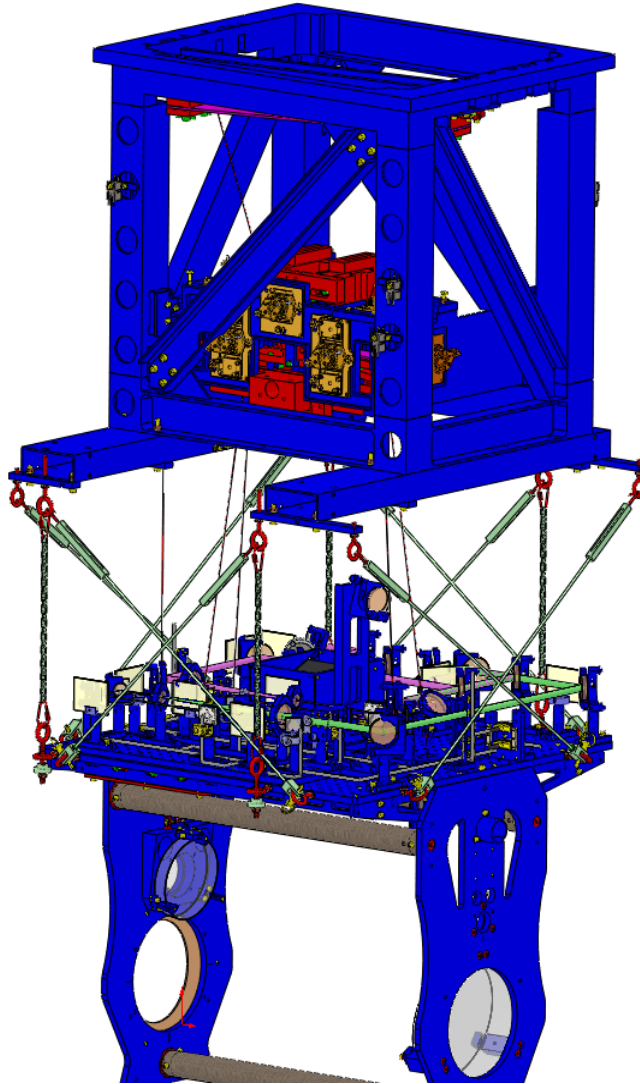


Figure 41: Restraint Tooling Layout (D1101307), when
Transporting the Cartridge

6.2.1.1 TMS Transportation-Installation Restraint Procedure, E1100841

6.2.1.1.1 Adjust & Install Eye-Bolts

Adjust the 2 Eye-Bolts of the TMS Assembly according to Tooling Layout D1101307, view D-D. Install the additional tooling eye-bolts, nuts & washers according to Tooling Layout D1101307 (Parts List items 1, 2, & 3).

6.2.1.1.2 Install Vertical Safety Chains

Install the 4 Vertical Safety Chains D1001891 according to Tooling Layout D1101307. Tighten the nuts on the eye-bolts to raise the TMS Telescope/ISC Table Assembly until the Top Mass blade springs rest against their stops and the suspension wires become slack.

6.2.1.1.3 Lift Telescope

Lift the suspended Telescope .35" to .5" according to Tooling Layout D1101307, using the 4 Vertical Safety Chains.

6.2.1.1.4 Install Turnbuckles

Install Turnbuckle assemblies D1101506 (2), D1101559 (2), & D1101565 (4), adjusting them snugly according to Tooling Layout D1101307 to secure the suspended Telescope.

6.2.1.1.5 Secure Upper Mass

Secure the upper mass using the Earthquake Stop Screws and jam nuts of the TMS Assembly (see Assembly Drawing D1000549, Parts List items 21 & 22). Adjust the lower 4 Earthquake Stop Screws to touch the bottom of the Upper Mass. Adjust the upper 4 Earthquake Stop Screws to clamp down on the top of the Upper Mass to fully restrain it. Tighten all 8 jam nuts.

6.2.2 Cartridge Flight into the BSC

Fly the Cartridge with the TMS into the BSC.



Figure 42: TMS Assembly being Installed in BSC

6.2.3 TMS Seismic Safety Stop Structure Attachment to TMS

Assemble the TMS Seismic Safety Stop Structure D1001781, as shown in **Figure 43**.

After the TMS is placed inside the BSC, attach the TMS Seismic Safety Stop Structure D1001781

To the Chamber wall brackets as shown in **Figure 45**, **Figure 44**, and **Figure 45**.

The Seismic Safety Stop Structure supports a rod that extends thru the eye-bolts of the TMS Telescope Safety Support Beam Assembly located at the end edge of the optical table; it will restrain the TMS from violent motion. In normal operation, the rod passes clearly through the inside diameter of the eye-bolts without making contact with the suspended TMS assembly; this arrangement limits travel motion but will not interfere with the normal operation of the suspended TMS.

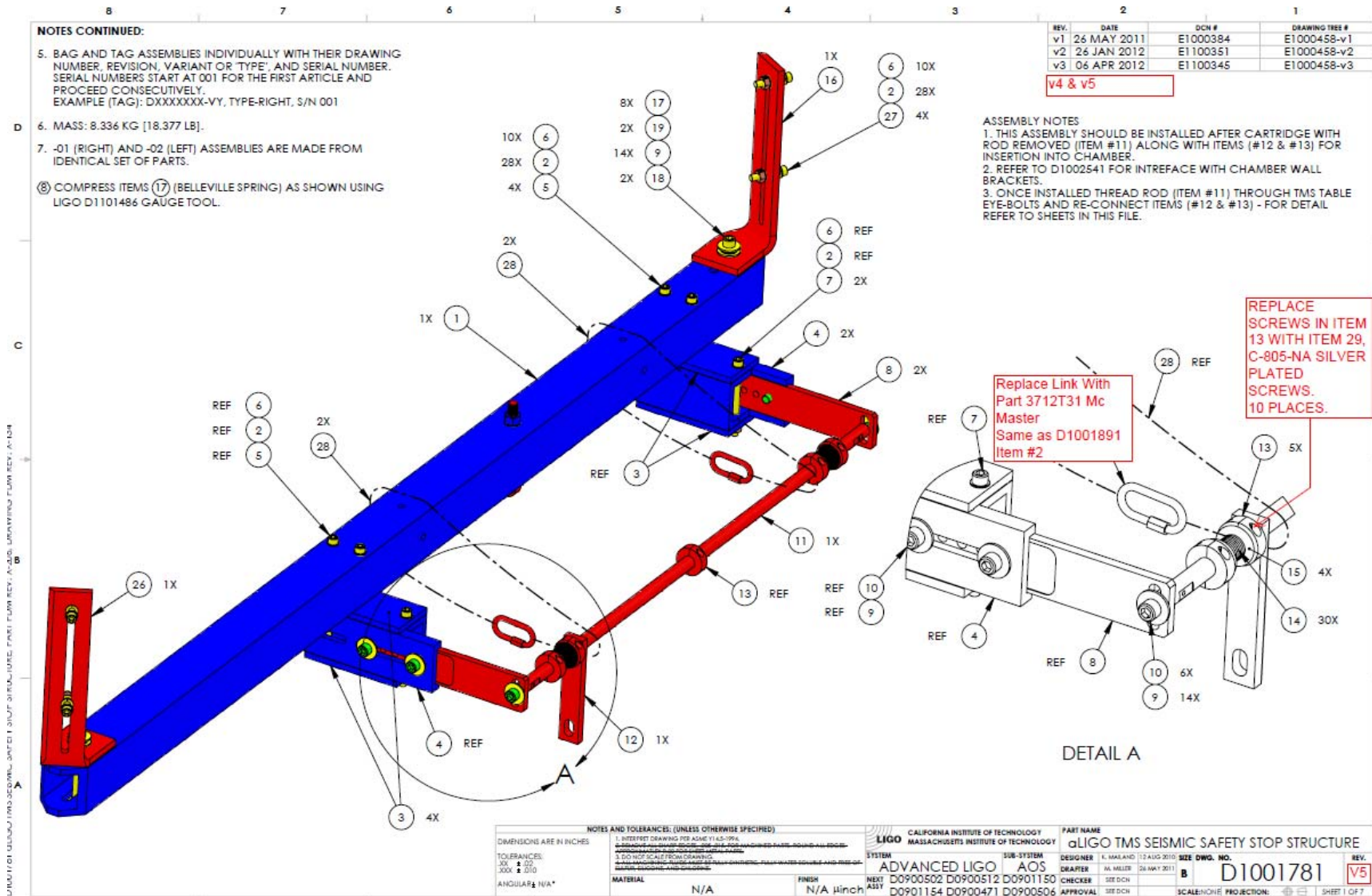


Figure 43: TMS Seismic Safety Stop Structure (D1001781)

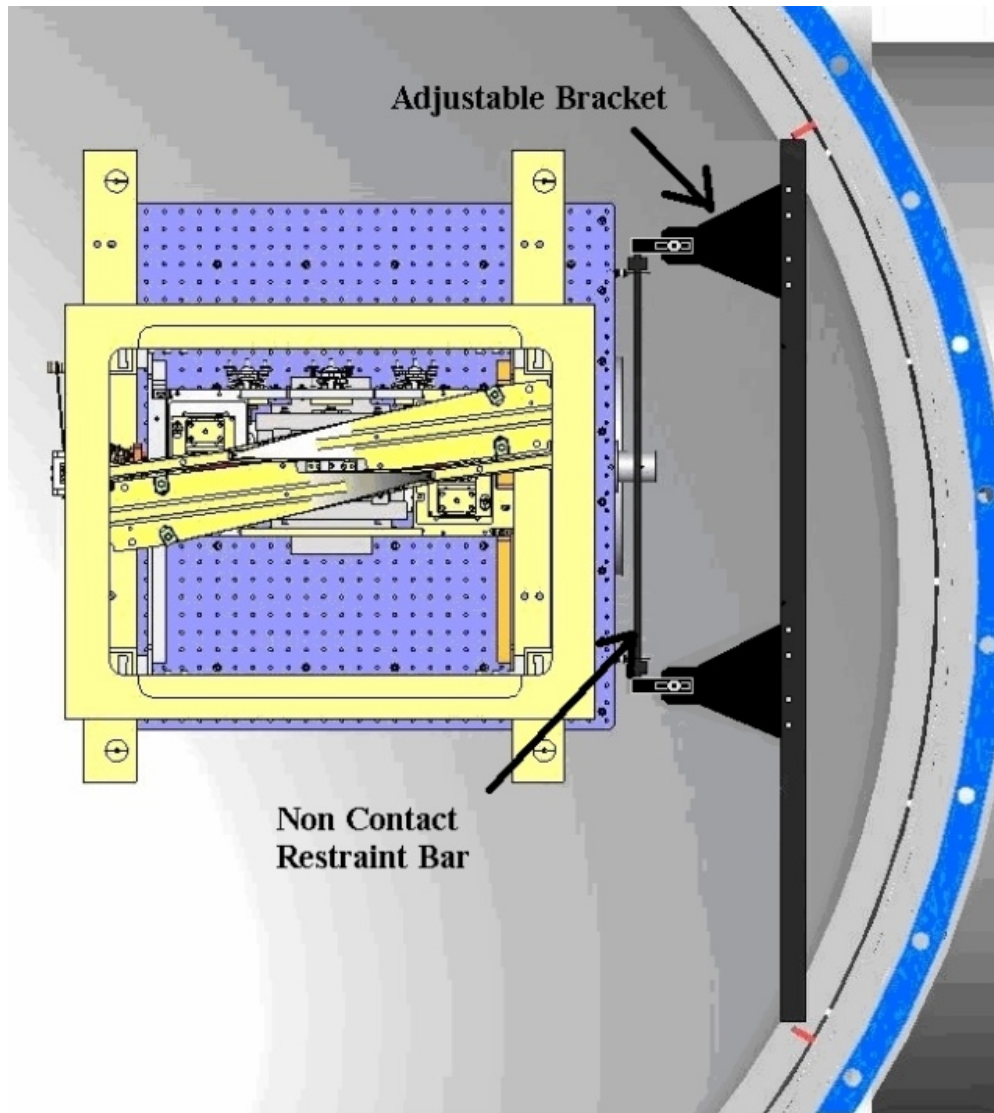


Figure 44 Earthquake Restraint

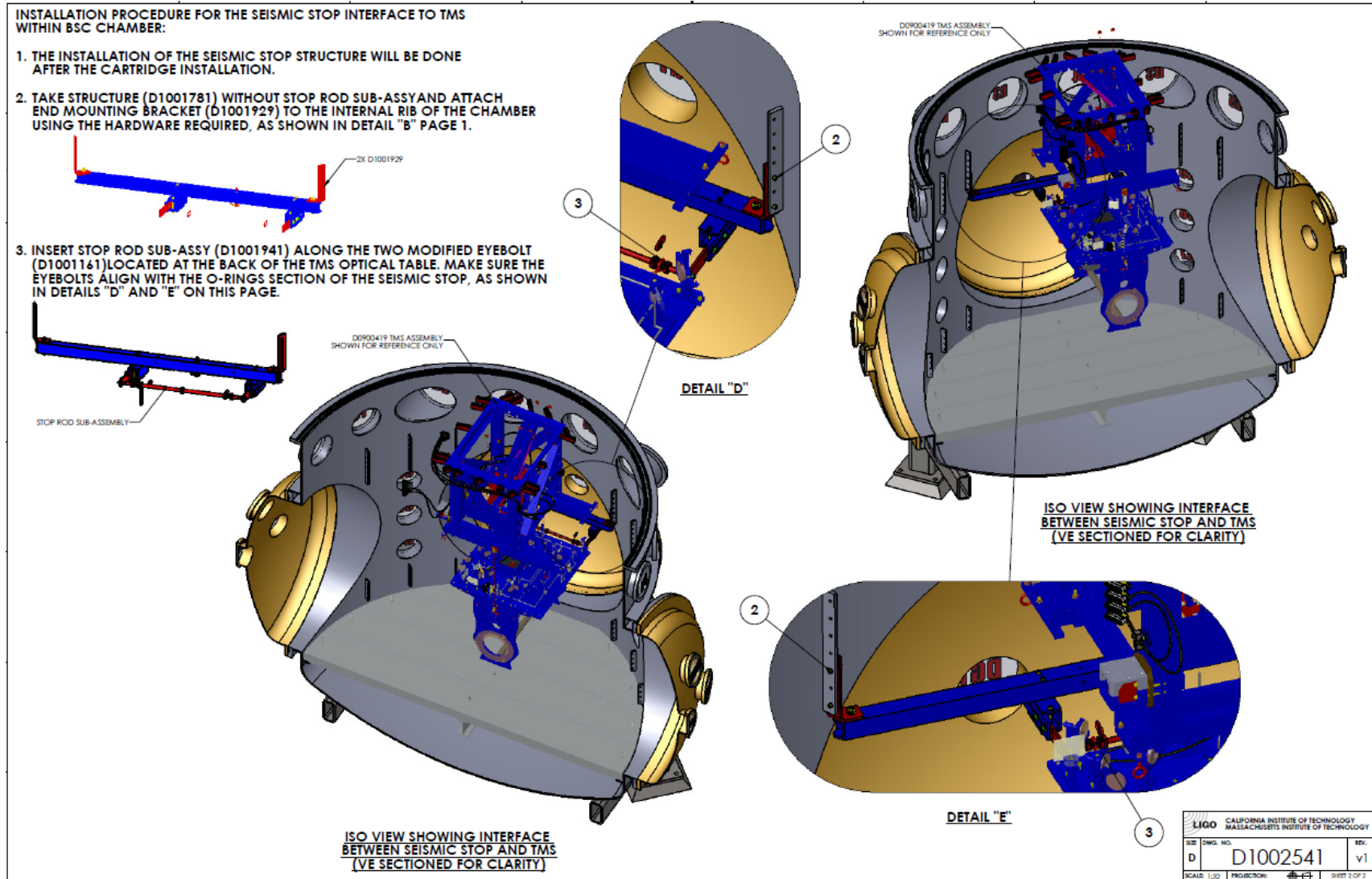


Figure 45: Seismic Stop Installation Procedure

6.3 Pull Back Procedure for Maintenance of ETM

The TMS Telescope/ISC Table Assembly will be supported by the Vertical Safety Chains and pulled back during maintenance of the ETM Quad assembly, as shown in **Figure 46**, and held in place by the Seismic Safety Stop. The procedure is described below.

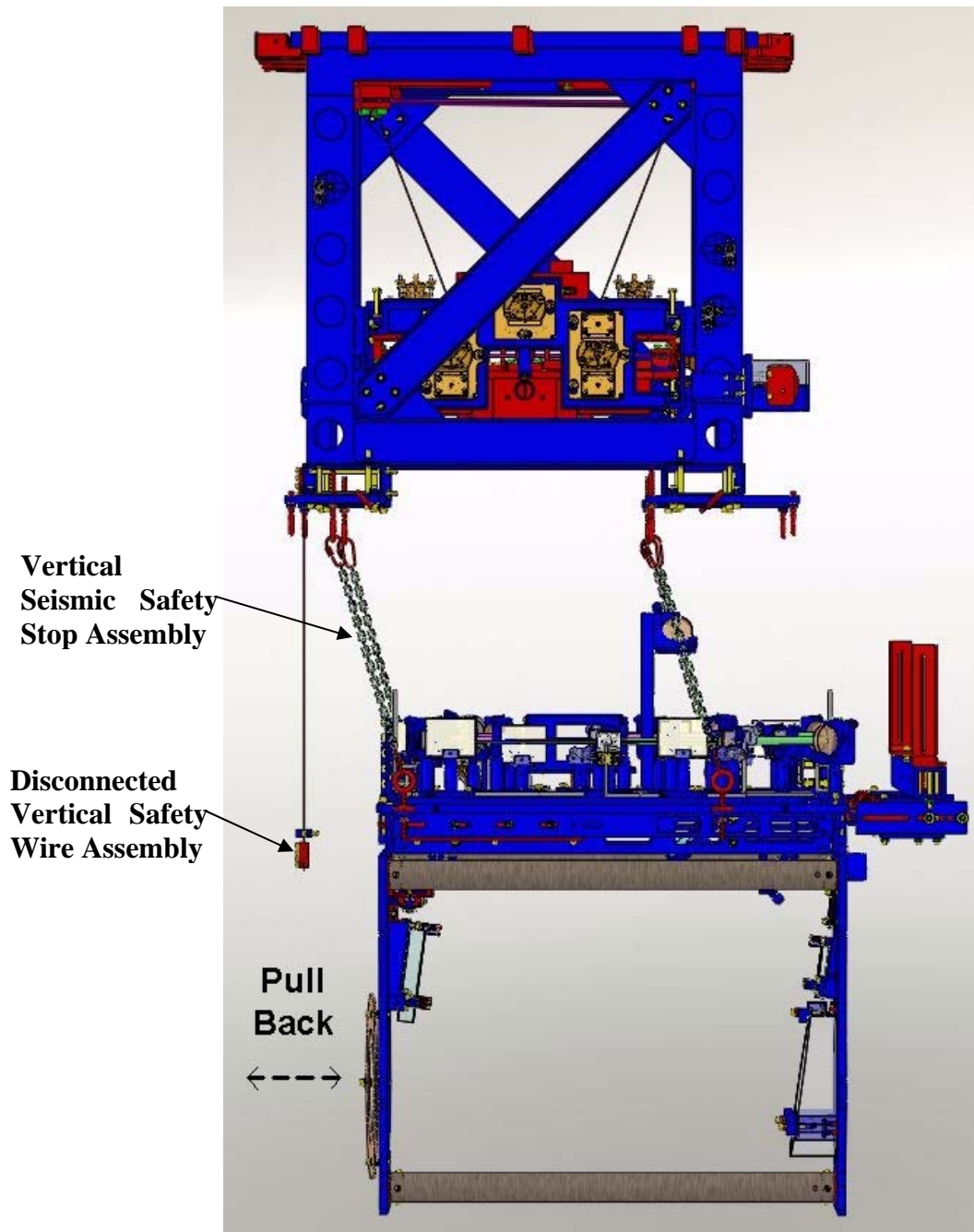


Figure 46: TMS Telescope Pulled Back to Service the ETM, Elevation View

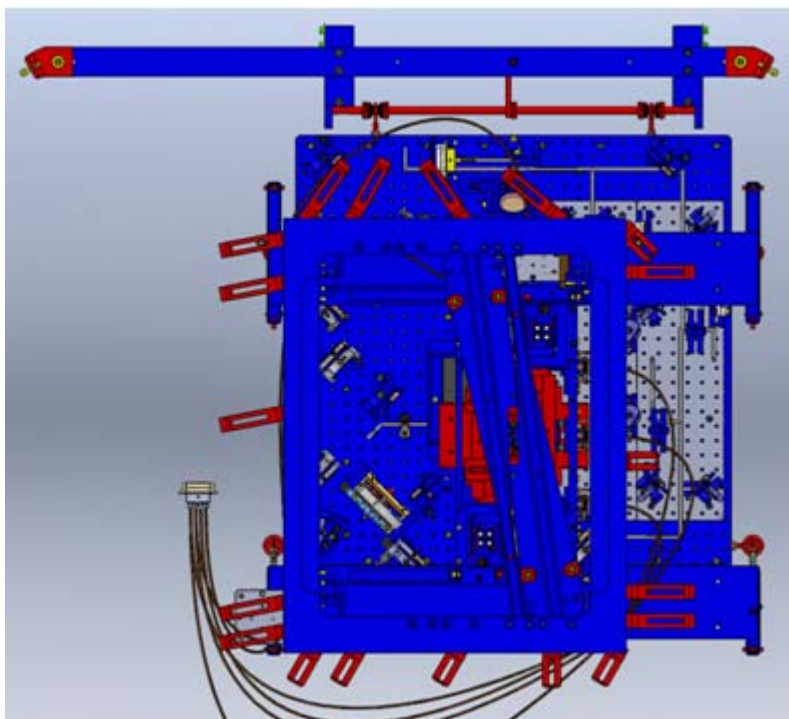


Figure 47: TMS Telescope Pulled Back to Service the ETM, Top View

6.3.1 Disconnect the Vertical Safety Wire Assembly

Remove the screws that connect the Vertical Safety Wire Assembly to the Telescope Frame. Be careful not to drop the captured washer between the bracket and the Telescope Frame, and the captured washer underneath the screw head. Keep the hardware for subsequent re-attachment after the pull back procedure is undone.

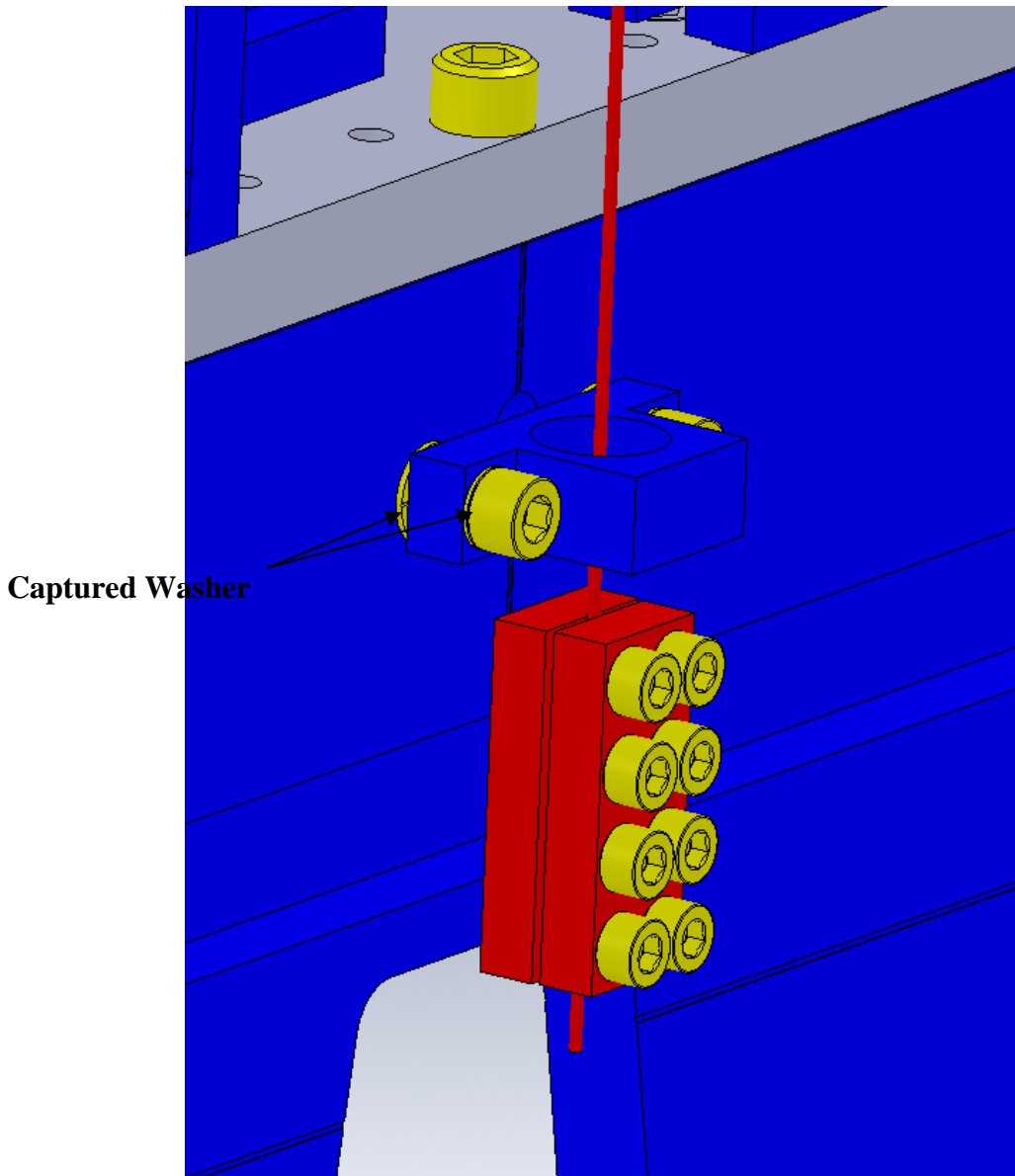


Figure 48: Vertical Safety Wire Assembly Connected to the TMS Telescope Frame

6.3.2 Disengage Earthquake Restraint from the TMS

6.3.2.1 Attach the Seismic Safety Stop Chain

The Seismic Safety Stop Chains are hanging permanently on the Seismic Safety Stop Structure inside the BSC. Unhook the threaded mechanical link and wrap the chain around the TMS Stop Rod, as shown in **Figure 49**.

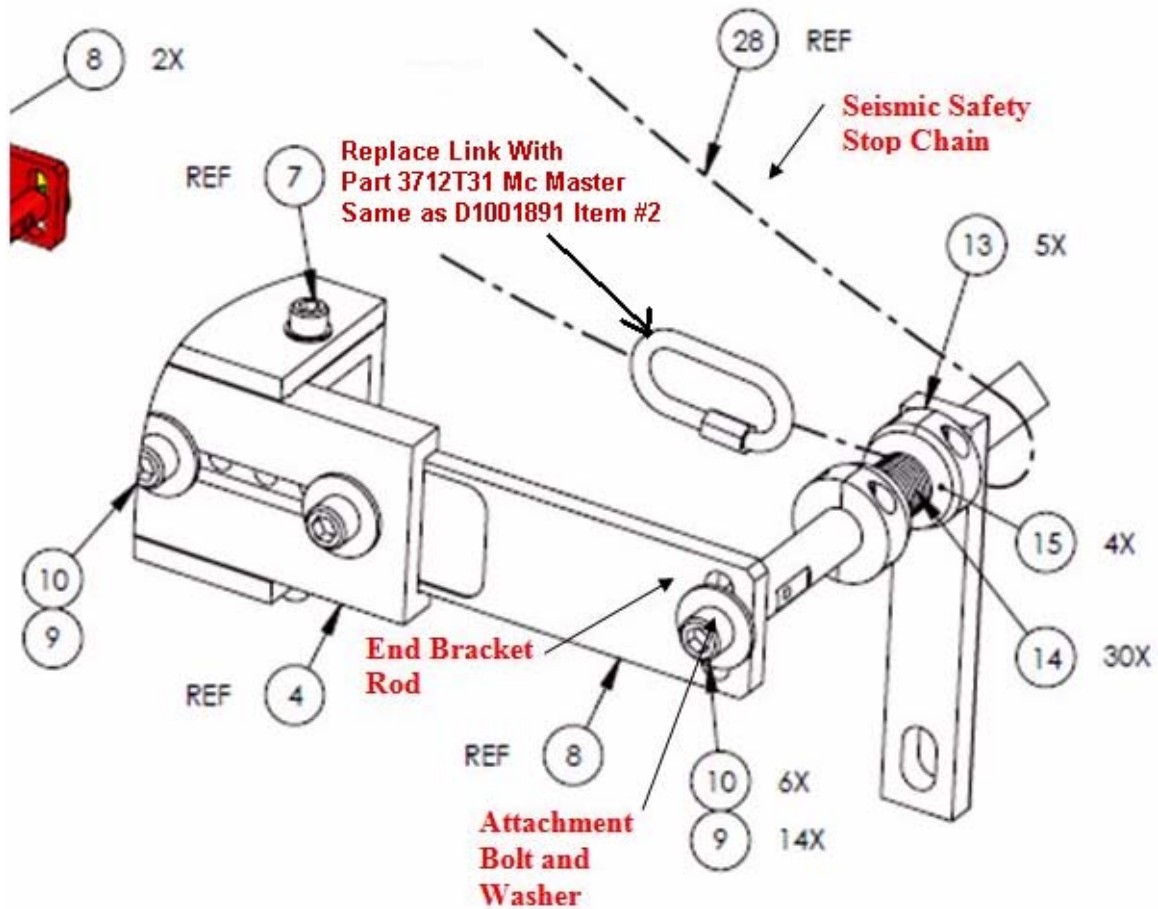


Figure 49: Seismic Safety Stop Chain attached to TMS Stop Rod

6.3.2.2 Free the TMS Stop Rod

Unscrew the attachment bolt that fastens the TMS Stop Rod to the TMS End Bracket Rod. Be careful not to drop the captured washer. Keep the hardware for subsequent re-attachment after the pull back procedure is undone.

6.3.3 Attach Vertical Safety Chains and Pull Back

Install the Vertical Safety Chains as described in section 6.2.1.1.2.

Slide the TMS Horizontal Restrain Link to the center of the TMS Stop Rod against the Two Piece Collar, as shown in **Figure 50**.

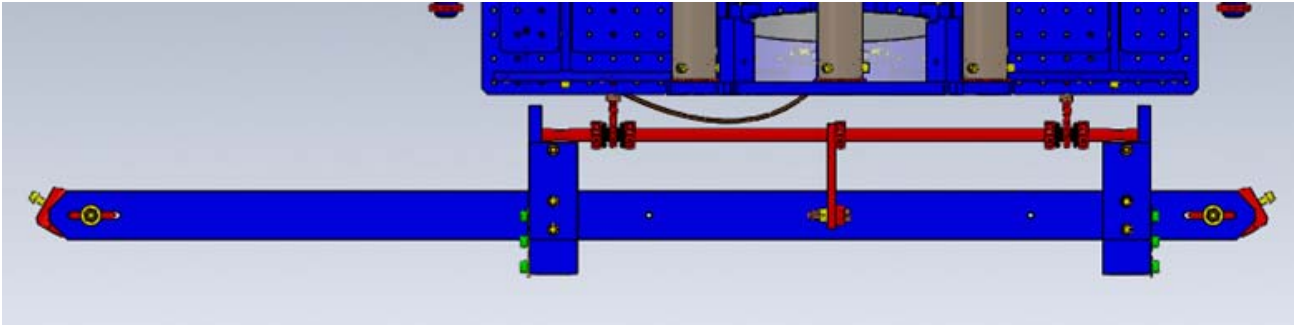


Figure 50: Positioning of Horizontal Restrain Link on TMS Stop Rod, as Seen from Below

Two people will grab the TMS Stop Rod and pull the ISC Optical Table/ Telescope Assembly toward the Earthquake Stop Cross Bar. A third person will apply the bolt and nut from underneath to attach the Restrain Link to the Rod End, as shown in **Figure 51**.

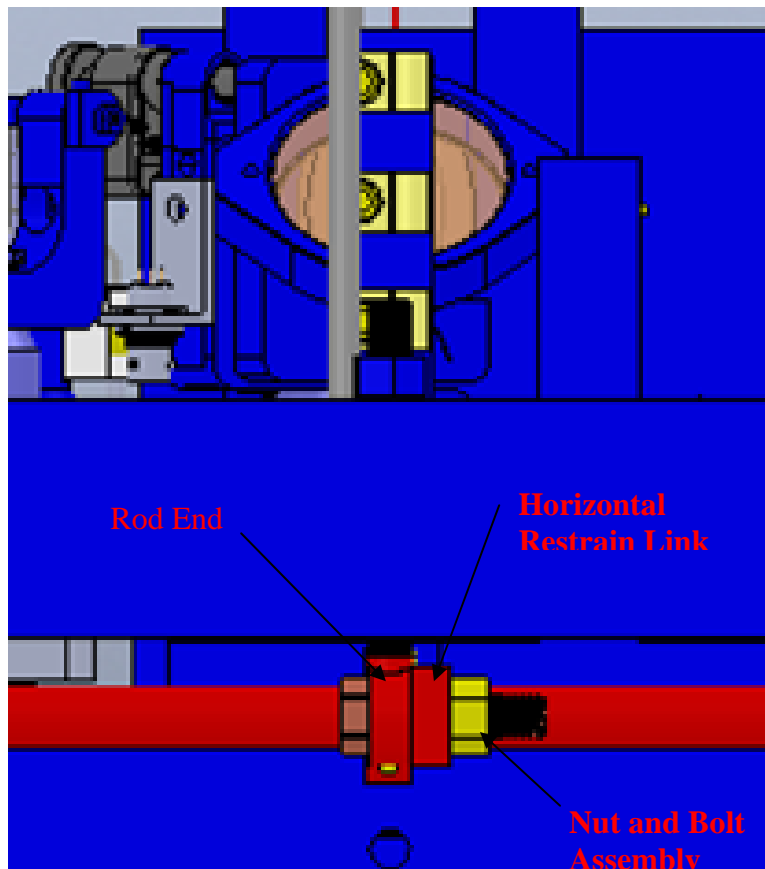


Figure 51: Detail of Horizontal Restrain Link attachment to Earthquake Stop Cross Bar, View from Back of TMS Assembly

7 Appendix A: Useful Balancing and Alignment Data

**The Telescope and Optical Table Assembly First Article
Assembly: Total mass 80 kg**

**The Telescope and Optical Table Assembly Production
Assembly: Total mass 82 kg**

1. TMS system is Weighed and Massed Properly Using the Telescope and Table Drawing D1002460 to roughly locate added Cylinder Masses. (this has been changed due to new mass properites)
2. The Cylinder Masses are positioned for Balance per the Balance Bridge (page 129) and instruction text, note the trim pitch and roll mass locations per instructions.
3. The assembly is lowered to the table and then attached to the D1100531 Bridge to align the Telescope to the ISC table per outlined procedures.

Appendix C: Related Documents

T1300639 Primary Mirror Installation Procedure
D060310 Advanced LIGO, SUS, QUAD N-PType Tablecloth
D060324 SUS, Quad N-Ptype Top Stage, Blade Cartridge
D060370 Picture Book
D0900419 AdvLIGO SUS BSC6-H2, XYZ Local CS for TMS ETM Tel Assy
D1000484: ISC Transmon Assembly
D1000549 Upper Intermediate Mass Top Assembly
D1001781 TMS Seismic Safety Stop Structure
D1001891: aLIGO TMS VERTICAL SEISMIC SAFETY STOP ASSEMBLY
D1002097 aLIGO_TMS_TEST_MASS_ASEM
D1002097 TMS Test Mass Assembly
D1100460: aLIGO TMS TELE ALIGNMENT SUPPORT BRIDGE ASSY
D1100531: aLIGO TMS OPTICAL TABLE SUPPORT BRIDGE
D1100613: aLIGO TMS TELESCOPE ASSEMBLY ALIGNMENT STABILIZATION TOOL
D1100649: aLIGO TMS TELE-OPT TABLE BALANCE BRIDGE ASSY
D1100807: aLIGO TMS Setup Table Bosch-Frame Assembly
D1100827: VERTICAL SAFETY WIRE ASSEMBLY
D1100841: aLIGO TMS TELE-OPT TABLE INSTALL TOOL ASSY
D1100886: MODIFIED GENIE LIFT FORKS
D1100933: aLIGO TMS TELESCOPE BENCH SUPPORT ASSEMBLY
D1101064: aLIGO TMS FIRST ARTICLE INSTALLATION AND TOOLING
D1101130: aLIGO TMS TELESCOPE SAFETY SUPPORT BEAM ASSY
D1101163: aLIGO TMS Telescope SUS Wire Assembly
D1101166 TMS Upper Suspension Wire Assembly
D1101307 aLIGO TMS Telescope Safety Support Assemblies
D1101361: TMS TOOLING TELESCOPE I-P ALIGNMENT MIRROR ASSEMBLY
D1101487: TMS TOOLING TELESCOPE O-P ALIGNMENT MIRROR ASSEMBLY
D1101510: aLIGO TMS TELE ALIGNMENT 6in MIRROR MOUNT ASSY
D1101526 aLIGO TMS Mass Balanced Assembly
D1102291: aLIGO TMS ISC Table Structural Assembly
D1102361: aLIGO TMS Telescope Frame Assembly
D1200453 aLIGO TMS Upper Structure Weldment
E0900047 Contamination Control Plan
E1000006 Advanced LIGO Quad Suspension Metal-Build Assembly Procedure
E1100841 Transportation-Installation Restraint Procedure (integrated into this doc.)
E1101131 BSC6 H2, Test Stand, Quad, TMs, Tooling Clearances, aLIGO
E1200049 aLIGO Transmission Monitor Suspension Installation Plan
F0900052 Advanced LIGO Inventory Database Part Import
T1000674-v2 TMS wire assembly procedure
T1100304 TMS ASSEMBLY and ALIGNMENT DOCUMENTATION
T1100603: TMS Telescope Alignment Procedure
T1200388 TMS Wire Jig Assembly
D1101624 Install Tooling (reference for other sub-systems)

8 TMS Swing Stop Tool Used on Cartridge Installation w/ETM

D1300248 TMS Swing Stop Tool (Used to Prevent the TMS and ETM from Bumping)

See Page 146

used when TMS and ETM are mounted on the Cartridge. Note counter weight disc's are fixed from sliding off with long cap screws, nuts are not required.

This Drawing needs minor Update as of 6-18-13

NOTES CONTINUED:

WHEN THIS ASSEMBLY IS USED THE FRONT SAFETY WIRE D1100827 MUST ALSO BE IN PLACE

OPTICAL TABLE REF. D1102291

TMS TELESCOPE REF. D1102361

TABLE NUMBERS AND QUANTITIES NOT CHECKED 4-30-13

ITEM NO.	PART NUMBER	QTY.
26	D1300278 aLigo Swing Stop Cross Bar Plug	2
25	D1300277 aLigo swing stop base parts	1
24	D1102291	1
23	D1102361	1
22	aLigo Swing Stop Cross Bar mc master	1
21	Mc Master 4698T102	4
20	aLigo horizontal Swing Stop Rod	1
19	Mc Master 6426K24	4
18	Mc Master 9219 6A 557	2
17	D1300275 aLigo Swing Stop Mass_SEL_TABLE_BALANCE_WEIGHTS	8
16	Mc Master 98017A200	14
15	Mc Master 9219 6A 622	14
13	leveling pad foot swing stop mc mast 6111K58	4
12	Mc Master 2402551	4
11	Mc Master 98017A215	4
10	Mc Master 98017A209	4
9	Mc Master 91845A225	4
8	Mc Master 91847A320	4
7	aLigo Swing Stop Alum Vertical Post Foot mc master 4698T146	2
6	aLigo Swing Stop Foot Bracket at 45 deg alum mc master 4698T77	2
5	Mc Master 4698T172	4
4	aLigo Swing Stop 45 Deg Bracket	2
3	aLigo Swing Stop 1.25 round-R2 mc master	2
2	D1300270 aLigo Swing Stop Vertical Post 1.25 dia	2
1	aLigo Swing Stop 45 deg 1.25 foot round mc master	3

NOTES AND TOLERANCES (UNLESS OTHERWISE SPECIFIED):

DIMENSIONS ARE IN INCHES
 SURFACE FINISH: 320 - 1.00
 SURF. 1.00
 ANGULAR 1/10"

1. DIMENSIONS ARE APPROXIMATE TO 0.004"
 2. DIMENSIONS ARE APPROXIMATE TO 0.004"
 3. DIMENSIONS ARE APPROXIMATE TO 0.004"
 4. DIMENSIONS ARE APPROXIMATE TO 0.004"
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 24. DIMENSIONS ARE APPROXIMATE TO 0.004"
 25. DIMENSIONS ARE APPROXIMATE TO 0.004"
 26. DIMENSIONS ARE APPROXIMATE TO 0.004"

ADVANCED LIGO ALOS

DESIGNED BY: [Name]
 DRAWN BY: [Name]
 CHECKED BY: [Name]
 APPROVAL: [Signature]

SCALE: 1:1 PROJECTION: 1ST ANGLE

DATE: 4-26-12

REV: v1

DRAWING NO.: D1300248

REV: v1

9 TMS BEAM CENTER LINE DISTANCE FROM CARTRIDGE TABLE

9-10-13 K Mailand

Distance of TMS Telescope Input Beam from Cartridge Table

Reference Dimension - V3

Distance from Cartridge Table surface to Beam Center Line is: $68.58'' \pm .28''$ (1742mm) ± 7 mm
 This can be measured from the Horizontal scribed line on the end plate, (Fig. 2) Ref. line crosses the center on End Plate beam hole.

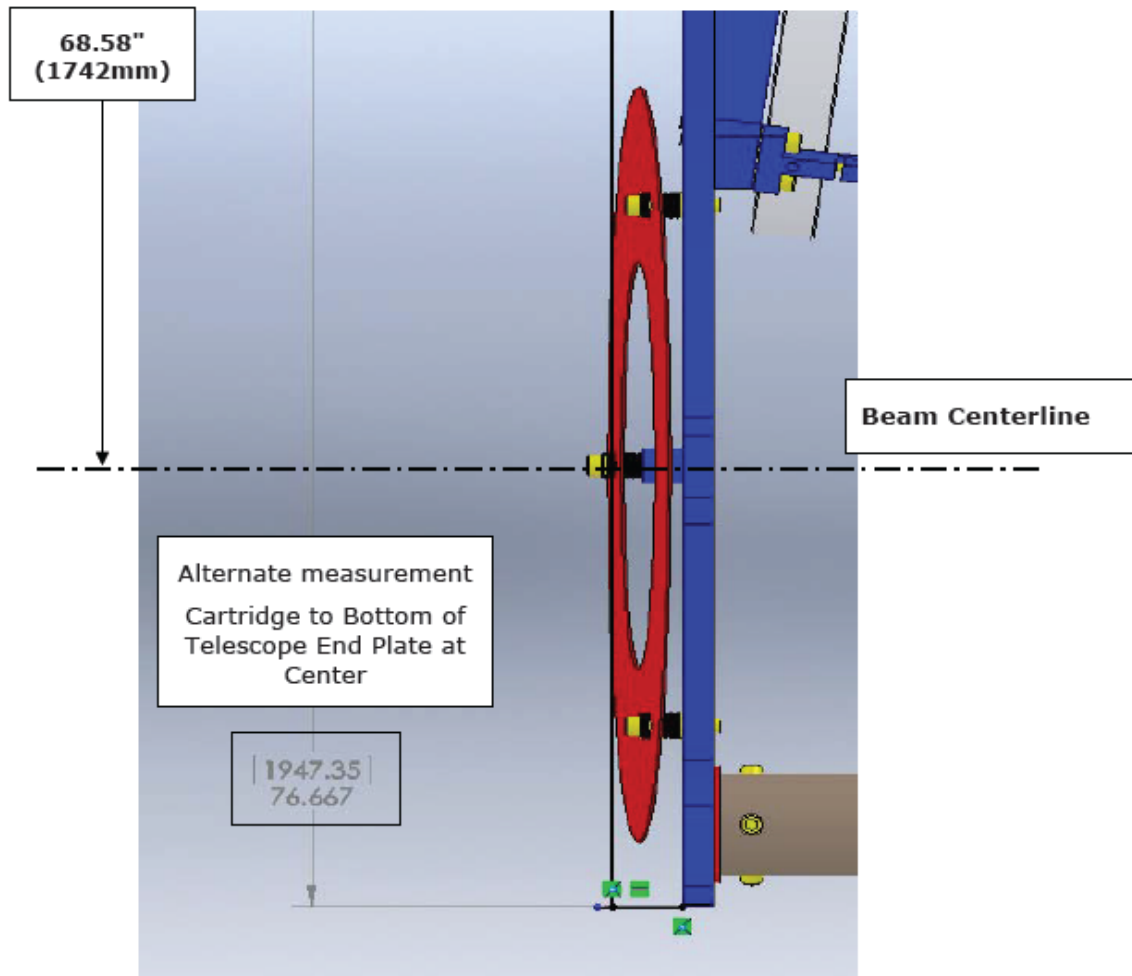


Fig 1.

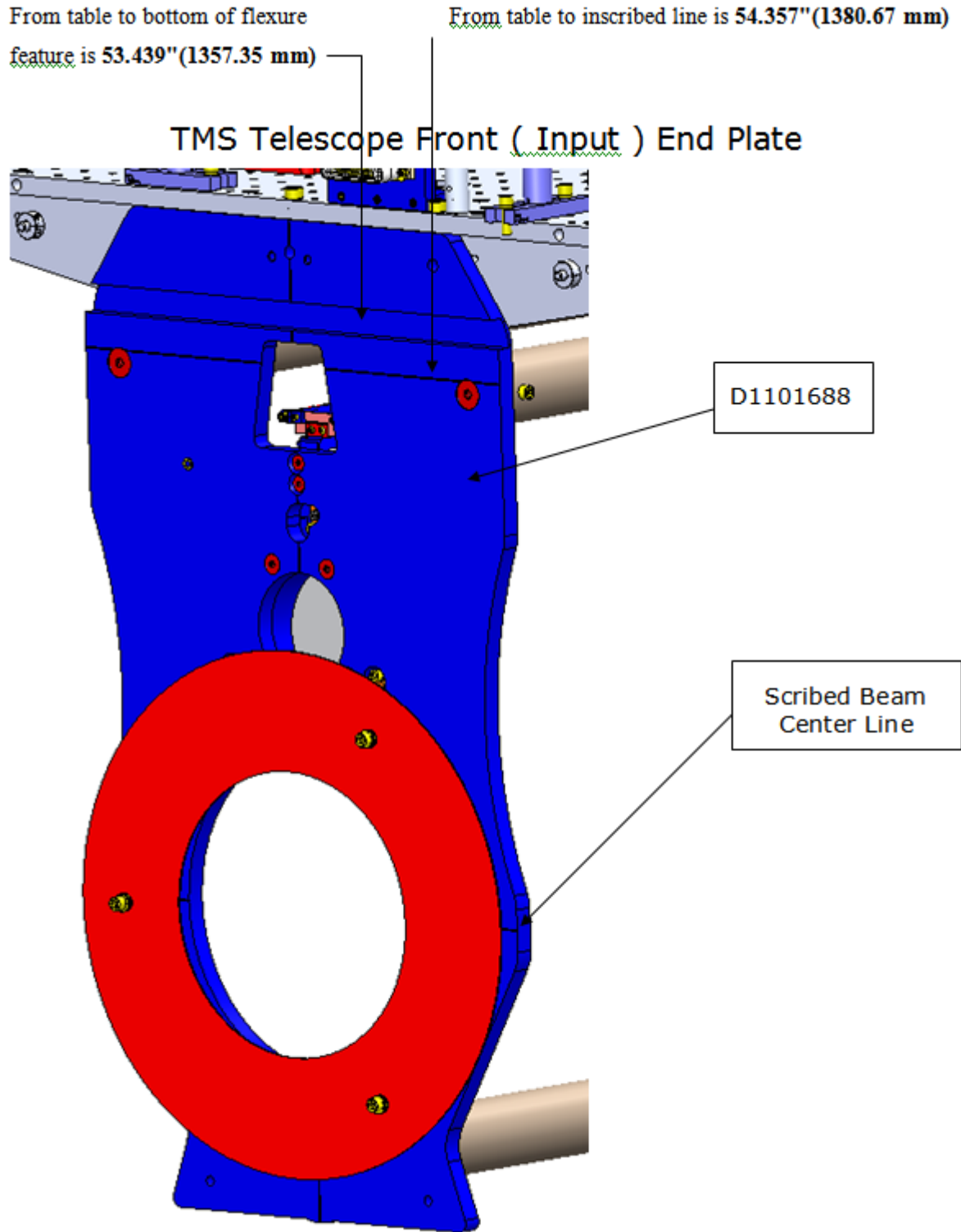


Fig 2.

10 TMS TOOLING USED DURING VARIOUS STAGES OF INSTALL ON BOSCH FRAME AND CARTRIDGE

Genie Transfer tool D1100908 and Optional D1200355 spacers. Ref. section 4.6 /4.10

TOOLING USED DURING VARIOUS STAGES on INSTALL	DCC Numbers	Notes: Refer to E1201012 overall TMS installation procedure.	Additional Notes
BOSCH FRAME			
ON BOSCH FRAME (Suspended)		OUT - SWING STOP TOOL, - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 OUT - Stabilization tooling, - DCC D1100613 IN - CHAINS, DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 OUT -ISC Cover, DCC D1102327	Chains - chains and eye disks should not contact telescope during functional tests. , see D1101307
ON BOSCH FRAME (Working on telescope or Away i.e. overnight / weekend)		OUT - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE - DCC D1100827 IN - Stabilization tooling, - DCC D1100613 IN - CHAINS. - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 IN - ISC Cover,DCC D1102327, (WHEN NEEDED)	
TEST STAND 'Cartridge'			
ON TEST STAND 'Cartridge' (working on telescope)		IN - SWING STOP TOOL, - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 IN - Stabilization tooling, DCC D1100613 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 OUT - ISC Cover, - DCC D1102327	
ON TEST STAND (working on BOSEM adjustment / blade adjustment)		IN - SWING STOP TOOL, - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 IN - Stabilization tooling, - DCC D1100613 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 IN - ISC Cover,DCC D1102327- Used to protect optics when e.g. working BOSEMS - then removed	

<p>ON TEST STAND 'Cartridge' (suspended - testing BOSEMS or transfer function)</p>		<p>IN - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE - DCC D1100827 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 OUT - Stabilization tooling, - DCC D1100613 OUT - ISC Cover, DCC D1102327</p>	
<p>ON TEST STAND 'Cartridge' (Away i.e. overnight / weekend)</p>		<p>IN - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 OUT - Stabilization tooling (Item #6 in D1101064) OUT - ISC Cover, DCC D1102327</p>	
<p>FLIGHT</p>			
<p>FLIGHT</p>		<p>OUT - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 IN - CHAINS DCC D1001891 Per Installation Procedure IN - TURNBUCKLES, - DCC D1101307 OUT - Stabilization tooling, - DCC D1100613 IN - ISC Cover, DCC D1102327</p>	<p>Chains - chain and eye disks should be adjusted to lift telescope, Per Installation Procedure</p>
<p>IN CHAMBER</p>			
<p>IN CHAMBER (work e.g. aligning)</p>		<p>OUT - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 IN - Stabilization tooling, - DCC D1100613 OUT - ISC Cover, DCC D1102327 (UNLESS NEEDED)</p>	

IN CHAMBER (doors closed)		IN - *NEW* Seismic Safety Stop D1001781 OUT - SWING STOP TOOL - DCC D1300248 IN - FRONT SAFETY WIRE, - DCC D1100827 OUT - CHAINS, - DCC D1001891 OUT - TURNBUCKLES, - DCC D1101307 OUT - Stabilization tooling, - DCC D1100613 OUT - ISC Cover, DCC D1102327	D1001781 is installed in the BSC, there is a description of the installation procedure for this in E1201012, 6.2.3, and noted on drawing, also use gage D1101486 To set clamping torque by Gauge gap.
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11 TMS ROLL AND PITCH ADJUSTER PROCEDURE

Using D1002460 page 2 and more importantly D1102291 pages 5 and 7 you will see (along with the text below) i) the starting positions of the pitch and roll devices ii) how to un-lock these devices iii) how to move them and iv) how to lock them (same as #2).

ROLL ADJUSTER

- i) Starting position of roll adjustment mass (page 5 of D1102291) - Ref dimension in zone B8.
- ii) and iv) Blow out in zone D3 shows un-lock and re-lock screws
- iii) Detail E shows the mechanism to adjust - use Allen key

PITCH ADJUSTER

- i) Starting position of roll adjustment mass (page 7 of D1102291) - Ref dimension in zone D3.
- ii) and iv) in zone A4 and A5 you will see fasteners in slots. These should be loosened prior to adjusting. They can also be moved to different slots as needed
- iii) Detail F shows the mechanism to adjust - use Allen key