LIGO Laboratory / LIGO Scientific Collaboration

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Output Faraday Isolator Assembly and Alignment Procedure

Mike Smith

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LIGO Scientific Collaboration

This is an internal working note
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California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – NW22-295
185 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

http://www.ligo.caltech.edu/

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CHANGE LOG

Date, version	Summary of Changes
V3 2/1/13	• Added Change Log • Changed to 4 magnets and added magnet orientation • Revised counter weights • Revised Earthquake Rods and Transport Locking Shim
V4 4/9/13	• Added SH Test Procedure
V5 5/24/13	• Added part number for earthquake stop post • 3.6.2 Setting Gap Between Blade Guard Assembly and Spring Blade • Added Split Clamp Clamp D1300321 to secure SUS wire to Blade Tip
V6 8/26/13	• Added balance weight locations for heavy optical table D0900015-v5

1 Introduction

This document details the assembly and alignment of the AOS Faraday Isolator (OFI) Assembly, D0900136. The OFI is one element of the Stray Light Control (SLC) subsystem.

The OFI will be assembled and aligned in a Class A environment that meets the following Clean room standards:

For a clean assembly all LIGO standards should be followed, as presented in the latest version of the **LIGO Contamination Control Plan (E0900047).** Clean room garb including UHV gloves should be worn when working with parts.

All tools that come in contact with assembly should be cleaned to class B standards.

Assembly will be done under a portable clean room. Any time a part of the assembly is not covered by the portable clean room or is not being actively worked on it should be covered with appropriate clean covers, e.g. C3 polyester or equivalent.

Alignment will be done on an optical bench inside a CLASS 100 enclosure.

All parts that will be included in the final assembly must be cleaned to LIGO standards, Class A. The list of parts to be Class A-cleaned includes screws, washers, inserts, and assorted other hardware. All tooling and other parts that are not included in the final assembly, but that contact Class A parts during assembly must be cleaned to LIGO standards, Class B.

This procedure must be read before beginning the assembly and alignment of the OFI.

2 OFI Assembly

2.1 Overview of the D0900136 OFI Assembly

The OFI is comprised of the following sub-assemblies, as shown in Figure 1.

D0900048 DAMPER HOLDER ASSEMBLY

D0900623 FARADAY ISOLATOR TABLE ASSY

D0900586 UPPER WIRE ASSY

D0900170 EARTHQUAKE CROSSBAR ASSY

D1002256 EARTHQUAKE CROSSBAR_IN ASSY

D0900579 BLADE GUARD ASSY

D0900655 STRUCTURAL WELDMENT ASSY, OMC

Note: Use torque values specified in T1100066 Torque Values, unless a different value is indicated on the sub-assembly drawing.

Table 1: Bill of Materials, D0900136 Faraday Isolator Assembly

18	D0900048	DAMPER HOLDER ASSEMBLY	--	1		0
17	D0900623	FARADAY ISOLATOR TABLE ASSY	--	1		0
16	1185-4EN500	#1/4-20 X .500 HELICOIL (Emhart P/N 1185-4EN500)	Nitronic 60	4		0
15	93235A248	SHCS, .25-20 x 1.13 LG. 1808 SSTL, Vented		4		0
14	-	WASHER, FLAT, #8 (NAS 620-C8 OR EQUIVALENT)	300 SSTL	4		0
13	D0900566	UP BLADE CLAMP TOP	6061-T6 Al	2		0
12	D0900586	UPPER WIRE ASSEMBLY	N/A	2		0
11	92200A199	8-32 x 1, SHCS 300SSTL		12		0
10	D0901514	BLADE CLAMP PLATFORM	6061-T6 Al	2		0
9	92200A194	SCREW, SHC, 8-32 x 1/2, MS16995-26, MC #92200A194	300 SSTL	16		0
8	92200A535	SCREW, SHC, 1/4-20 x 3/8, MS16995-47, MC #92200A535	300 SSTL	2		0
7	92200A542	Screw, Socket Head Cap, 1/4-20 UNC-2A x 1.00 lg.	300 SSTL	8		0
6	92200A540	SCREW, SHC, 1/4-20 x 3/4, MS16995-50, MC #92200A540	300 SSTL	8		0
5	D0900170	EARTHQUAKE CROSSBAR ASSY	--	1		0
4	D1002256	EARTHQUAKE CROSSBAR_IN ASSY	--	1		0
3	D0902845	REFLECTION BAFFLE	A424 TYPE I, 18GA, SSTL	1		0
2	D0900579	BLADE GUARD ASSY	--	2		0
1	D0900655	STRUCTURAL WELDMENT ASSY, OMC	N/A	1		0
ITEM NO.	**PART NUMBER**	**DESCRIPTION**	**MATERIAL**	**Default /REQ**	**SPARE**	**TOTAL**
PARTS LIST						

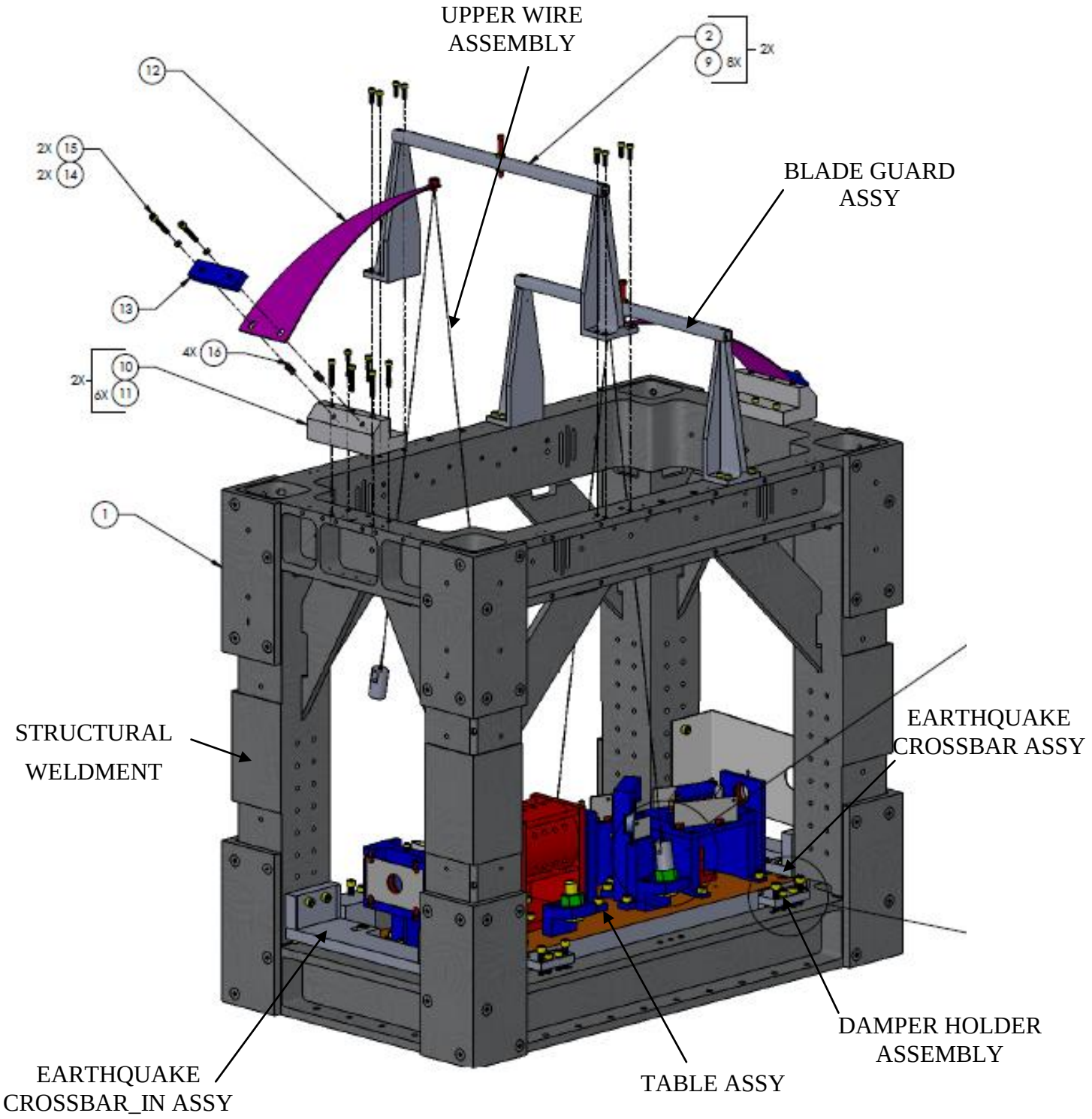
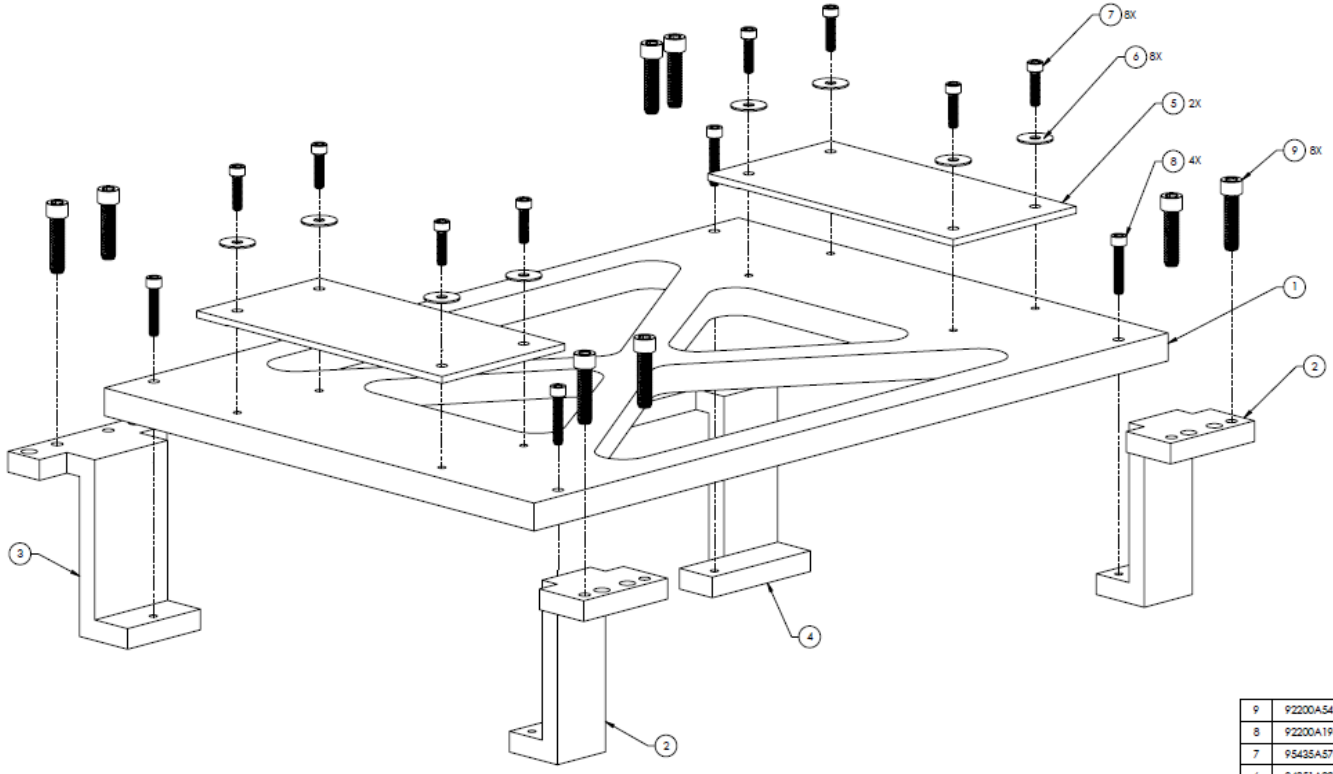


Figure 1: Output Faraday Isolator Assembly

2.2 D0900048 Faraday Isolator Damper Holder Assembly



ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	Default/REQ	SPARE	TOTAL
		PARTS LIST				
9	92200A542	Screw, Socket Head Cap, 1/4-20 UNC-2A x 1.00 lg.	300 SSTL	8		0
8	92200A198	SCREW, SCH, 8-32X 7/8, MS18995-29, MC #92200A198	300 SSTL	4		0
7	95435A575	SHCS, 8-32 x .63, Titanium	TITANIUM	8		0
6	94051A209	Washer, Flat, #8, Titanium	TITANIUM	8		0
5	D0900027	COPPER PLATE	COPPER	2		0
4	D1200186	DAMPER PLATE MOUNTING BACK (LOWERED) BRACKET	6061-T6 Al	1		0
3	D1200185	DAMPER PLATE MOUNTING BACK BRACKET	6061-T6 Al	1		0
2	D1200184	DAMPER PLATE MOUNTING FRONT BRACKET	6061-T6 Al	2		0
1	D0900026	DAMPER MOUNTING PLATE	6061-T6 Al	1		0

2.3 D0900614 PRISM MOUNT ASSY_LH

Table 2: Bill of Materials, D0900614 Prism Mount Assy LH

ITEM NO	REQ.	SPARE	TOT.	PART NUMBER	REVISION	DESCRIPTION	MATERIAL
1	1	0	1	D0900616	V2	PRISM MOUNT BASE LH	6061-T6
2	2	0	2	D1001862	V4	PRISM BASE SUPPORT	6061-T6
3	1	0	1	D1001870	V2	FIXED STOP LH	6061-T6
4	2	0	2	D0900617	V1	OPTICAL PRISM	BK7 GLASS
5	1	0	1	D1001863	V1	OPTICAL PRISM SPACER	304 SSTL
6	1	0	1	D1001871	V2	SPRING BLOCK LH	6061-T6
7	1	0	1	D1001861	V2	U-SPRING	304 SSTL
8	2	0	2	D0900619	V1	CLIP	304 SSTL
9	2	0	2	D1001864	V1	PRISM BEAM DUMP	A424 TYPE I 18GA, SSTL
10	1	0	1	D0900618	V1	OPTICAL PRISM TOP PLATE	6061-T6
11	4	0	4	D1100027	V1	CLIP	304 SSTL
12	2	0	2	9713K53		DISC SPRING SS BELLEVILLE, 1/8" OD, .009 THICK	304 SSTL
13	2	1	3	92200A108		SHCS, 4-40 X 3/8" LG., (MS16995-10) McMASTER-CARR	18-8 SSTL
14	2	1	3	92185A112		SHCS, 4-40 X 3/4" LG., SILVER	300 SSTL
15	6	1	7	92200A076		SHCS, 2-56 X 3/16" LG., (MS16995-1) McMASTER-CARR	300 SSTL
16	4	1	5	92200a146		SHCS, 6-32 X 3/8" LG., (MS16995-17) McMASTER-CARR	300 SSTL
17	1	1	2	92949A076		BUTTON HD SHCS, 2-56 X 3/16" LG.	18-8 SSTL

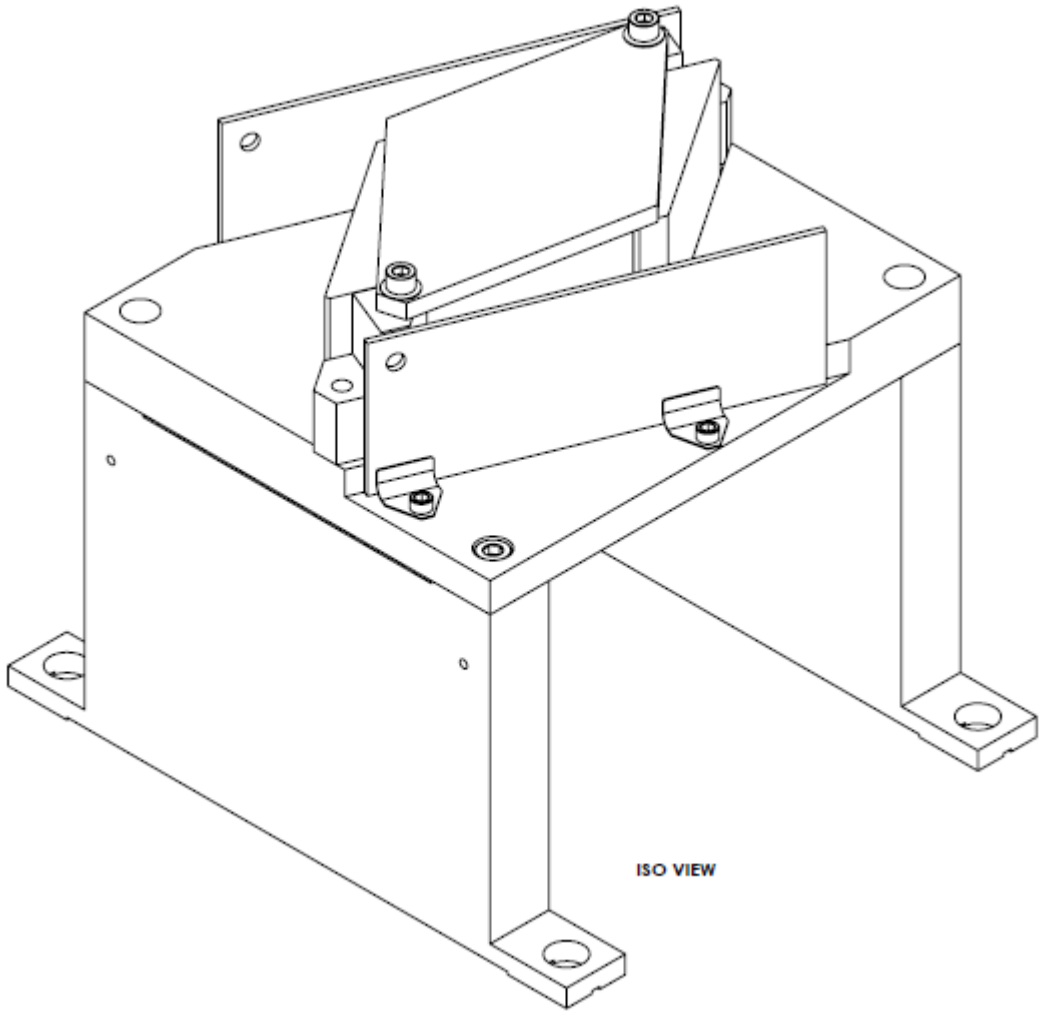
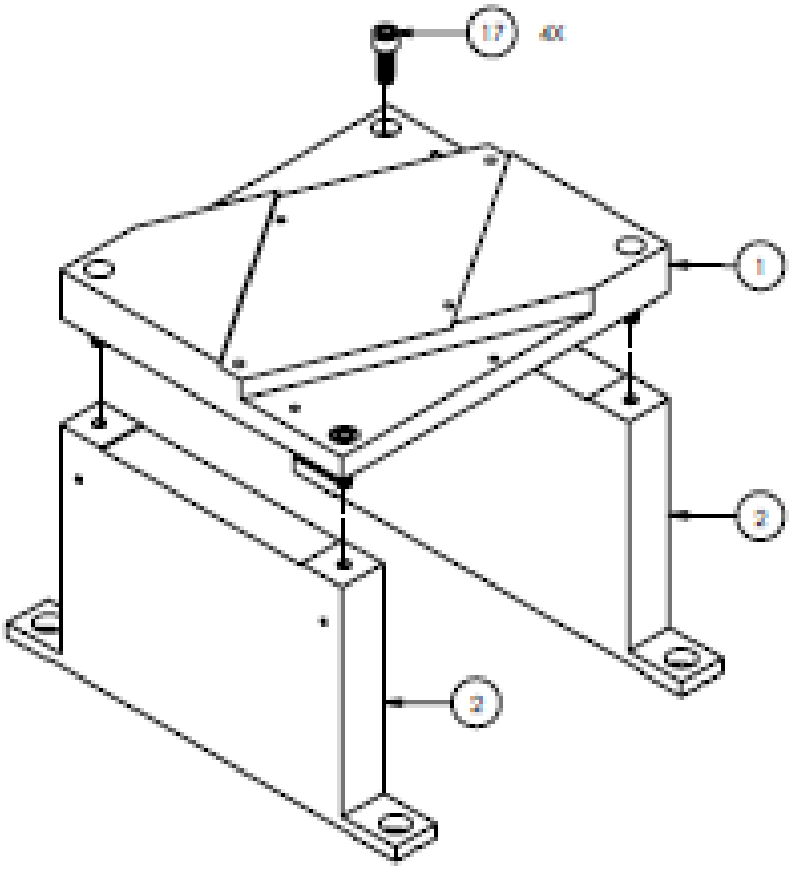


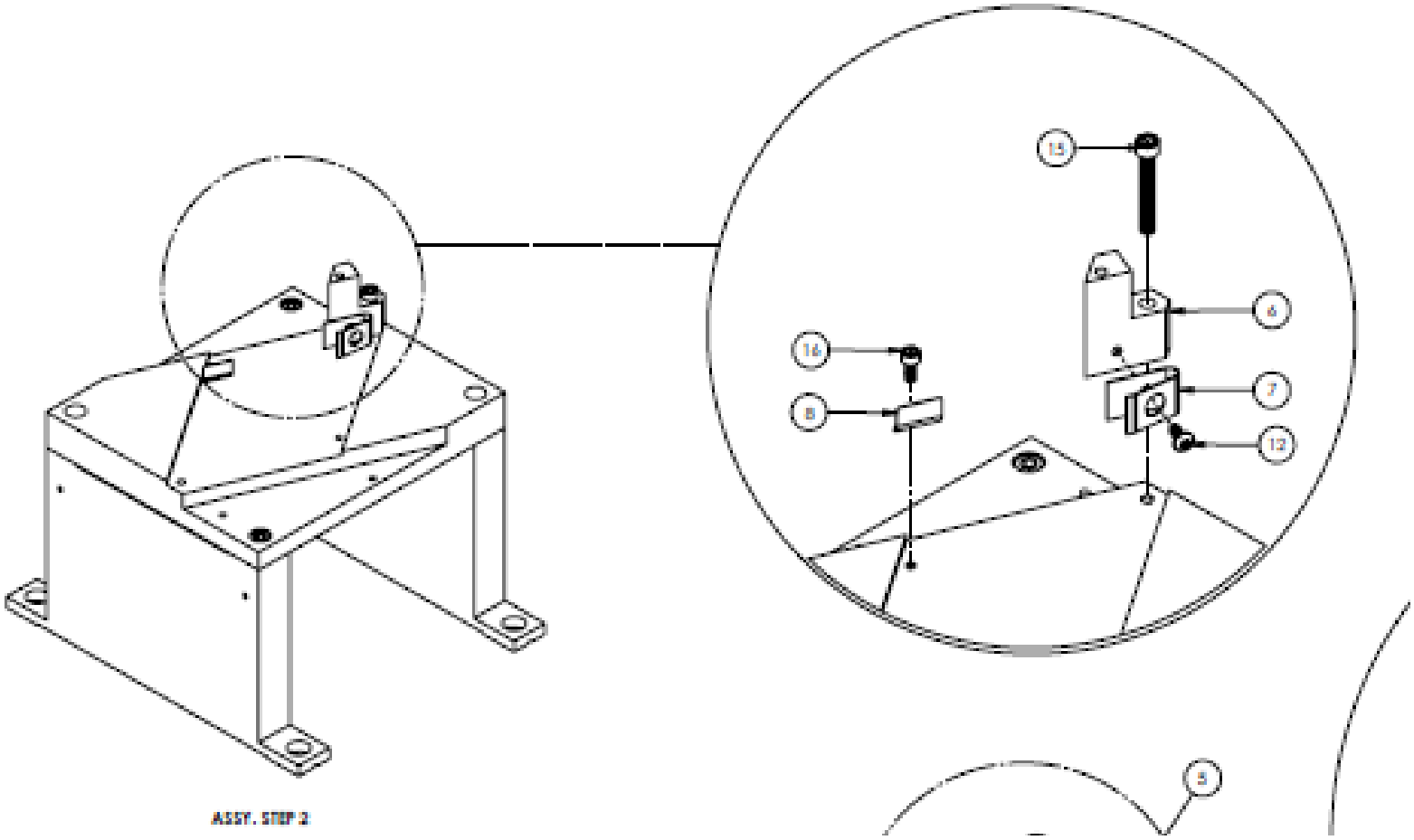
Figure 2: Prism Mount Assy_LH

2.3.1 **Step 1**

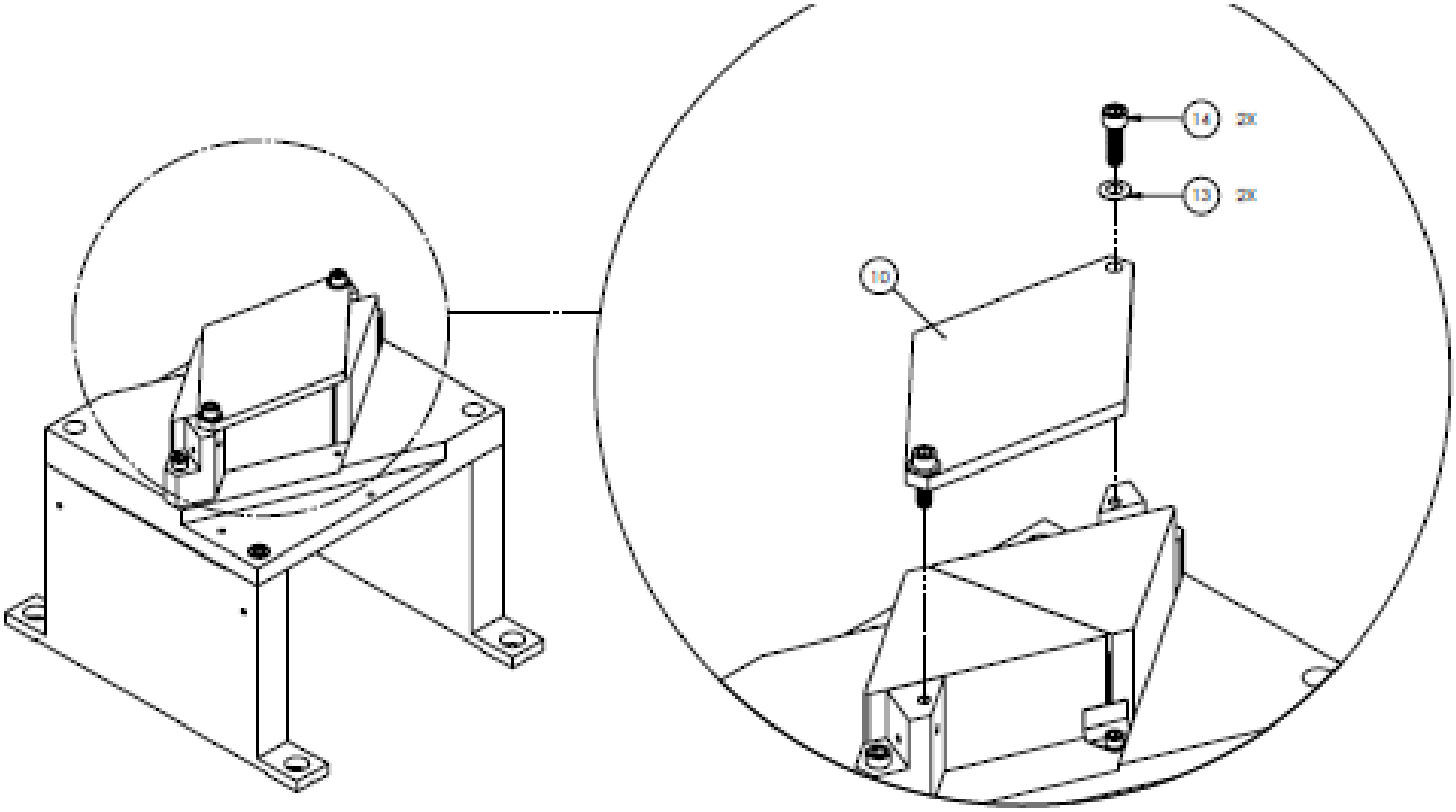


ASSY. STEP 1

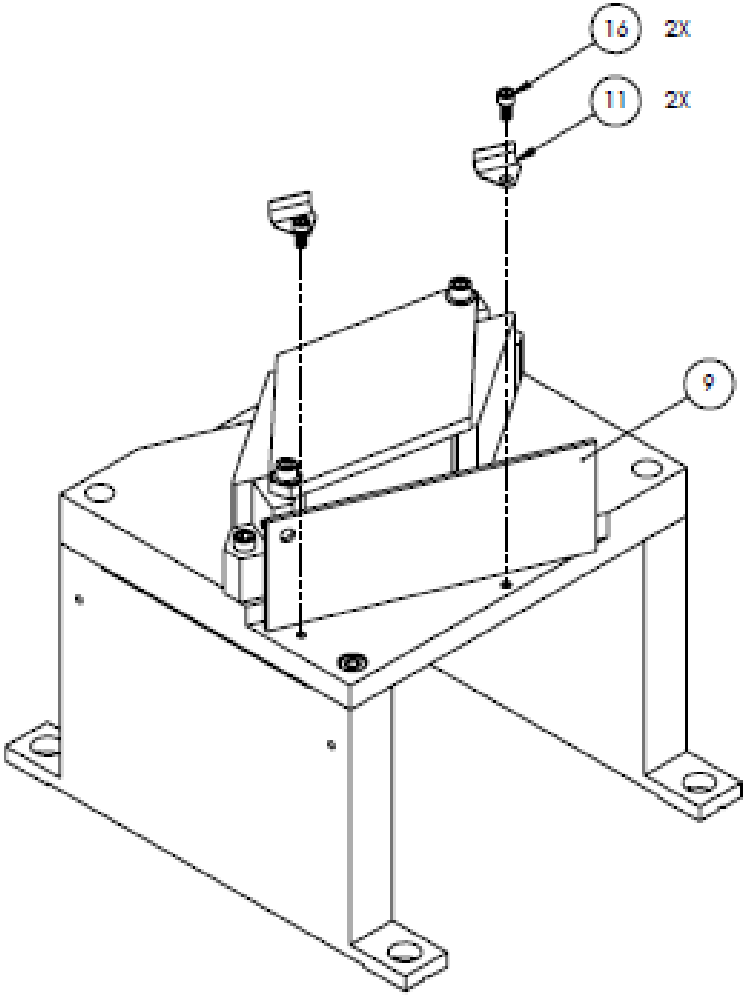
2.3.2 **Step 2**



2.3.3 **Step 4**

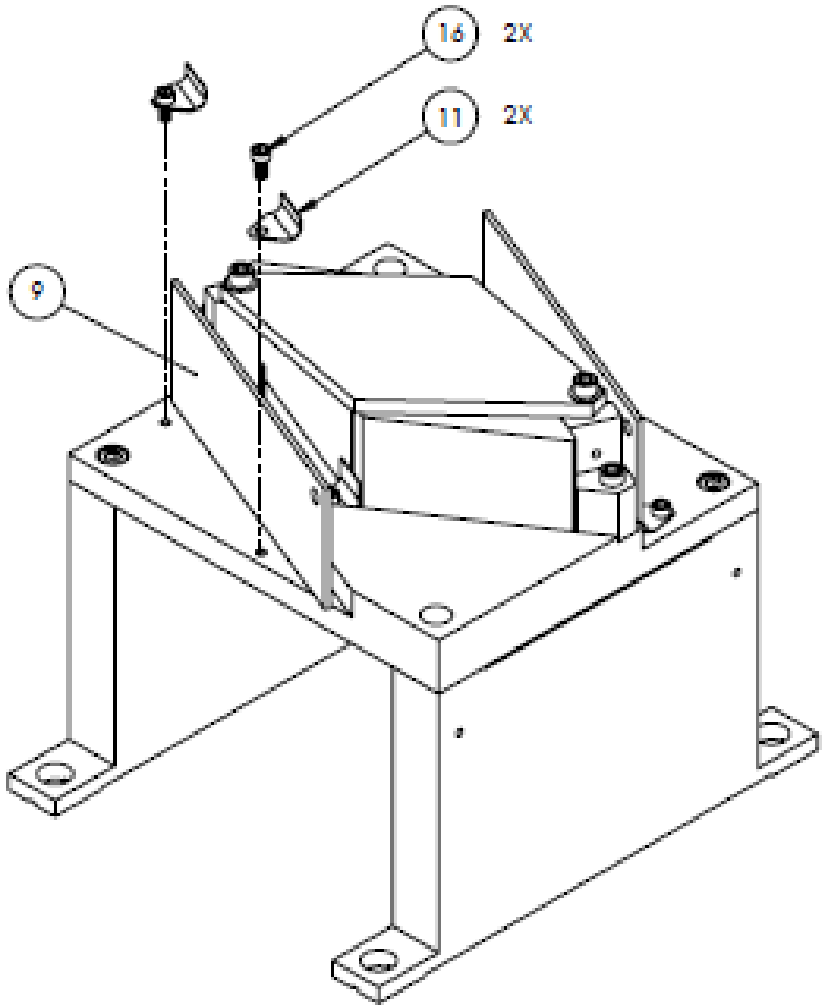


2.3.4 **Step 5**



ASSY. STEP 5

2.3.5 **Step 6**



ASSY. STEP 6

2.4 D0900615 PRISM MOUNT ASSY_RH

Table 3: Bill of Materials, D0900615 Prism Mount Assy RH

ITEM NO	REQ.	SPARE	TOT.	PART NUMBER	REVISION	DESCRIPTION	MATERIAL
1	1	0	1	D0900620	V3	PRISM MOUNT BASE RH	6061-T6
2	1	0	1	D1001859	V2	FIXED STOP RH	6061-T6
3	2	0	2	D0900617	V1	OPTICAL PRISM	CALCITE
4	1	0	1	D1001863	V1	OPTICAL PRISM SPACER	304 SSTL
5	2	0	2	D1001862	V4	PRISM BASE SUPPORT	6061-T6
6	1	0	1	D1001860	V2	SPRING BLOCK RH	6061-T6
7	1	0	1	D1001861	V2	U-SPRING	304 SSTL
8	1	0	1	D0900618	V1	OPTICAL PRISM TOP PLATE	6061-T6
9	2	0	2	D0900619	V1	CLIP	304 SSTL
10	6	1	7	92200A076		SHCS, 2-56 X 3/16" LG., (MS161995-1) McMASTER-CARR	300 SSTL
11	2	1	3	92185A112		SHCS, 4-40 X 3/4" LG., SILVER	300 SSTL
12	2	1	3	92200A108		SHCS, 4-40 X 3/8" LG., (MS16995-10) McMASTER-CARR	300 SSTL
13	2	0	2	9713K53		DISC SPRING SS BELLEVILLE, 1/8" OD, .009 THICK	304 SSTL
14	4	1	5	92200A146		SHCS, 6-32 X 3/8" LG., (MS16995-17) McMASTER-CARR	300 SSTL
15	1	0	1	92949A076		BUTTON HD, SHCS, 2-25 X 3/16" LG.	18-8 SSTL
16	2	0	2	D1100247	V1	OUTPUT FARADAY ISOLATOR BAFFLE	18 GA A424 TYPE I
17	2	0	2	D1100258	V1	OUTPUT FARADAY ISOLATOR BAFFLE (OPPOSITE)	18 GA A424 TYPE I STEEL

The assembly of the Right Hand Prism Mount follows the same steps detailed in section D0900614 PRISM MOUNT ASSY_LH, with the addition of the “W” baffles, detailed in the following steps.

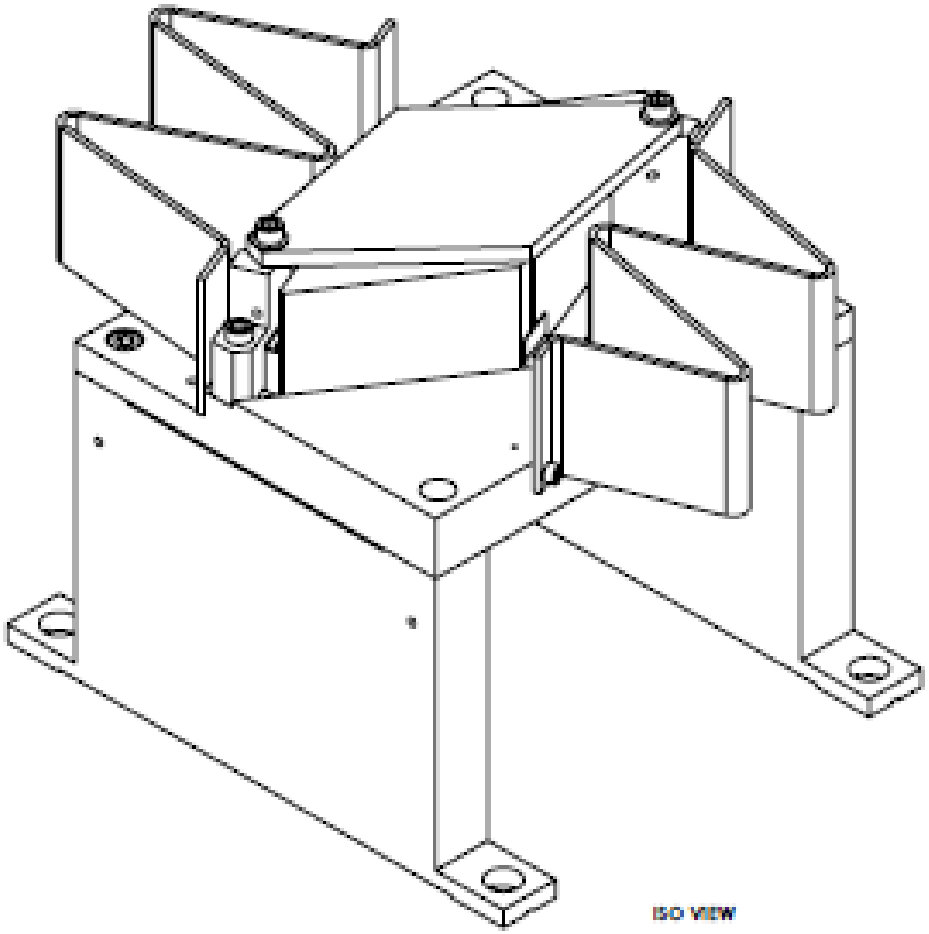
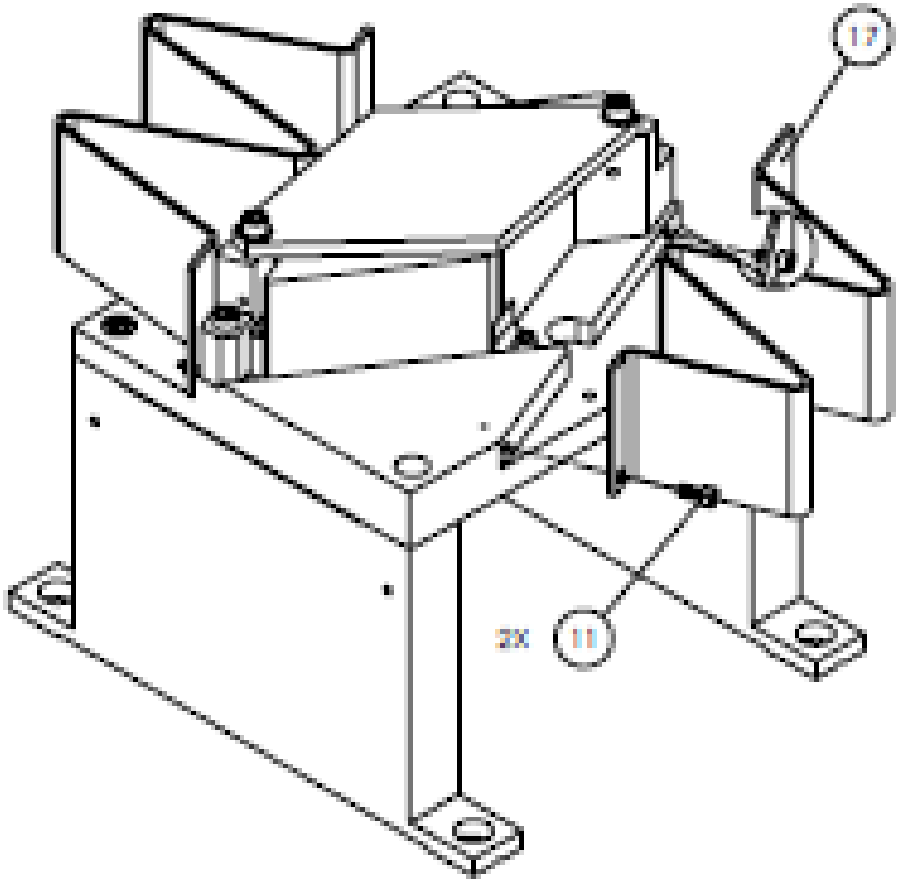


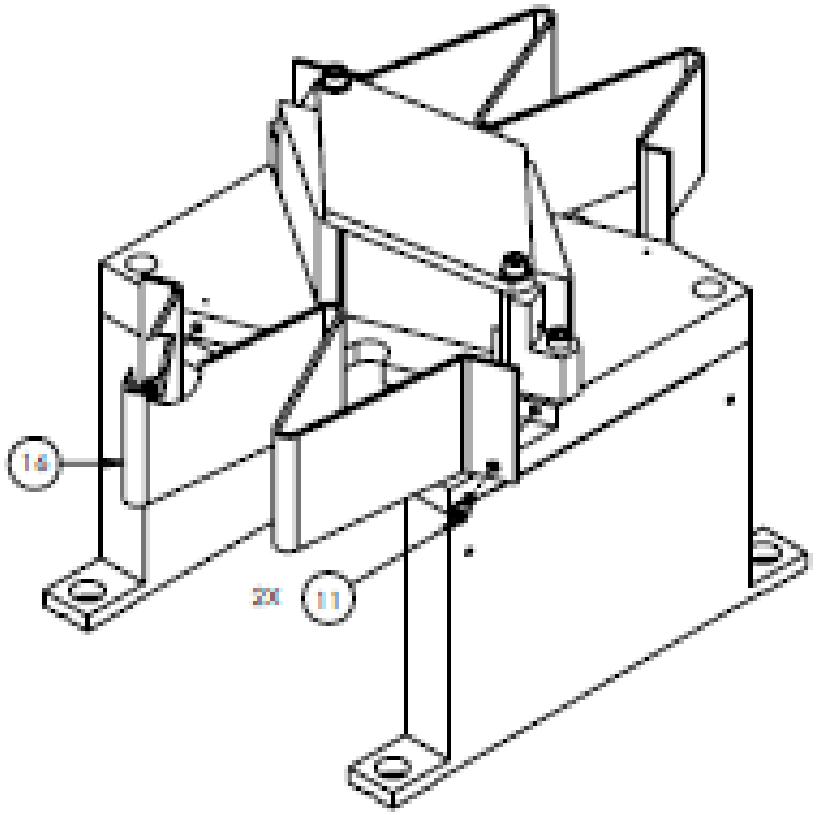
Figure 3: Prism Mount Assy_RH

2.4.1 **Step 5**



ASSY. STEP 5

2.4.2 **Step 6**



ASSY. STEP 6

2.5 D1002364 Faraday Isolator Beam Dump Assy

Table 4: Bill of Materials, D1002364 Faraday Isolator Beam Dump Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
4	D1100027	CLIP	304 SSTL	2		2
3	92200A076	Head Cap Screw 300 Series SS, 2-56 Thrd, 3/16" Length, MS 16995-1	300 SSTL	2		2
2	D1002363	FARADAY ISOLATOR BEAM DUMP	18 GA A424 TYPE I STEEL	1		1
1	D1002362	FARADAY ISOLATOR BEAM DUMP MOUNT	6061-T6 Al	1		1

PARTS LIST

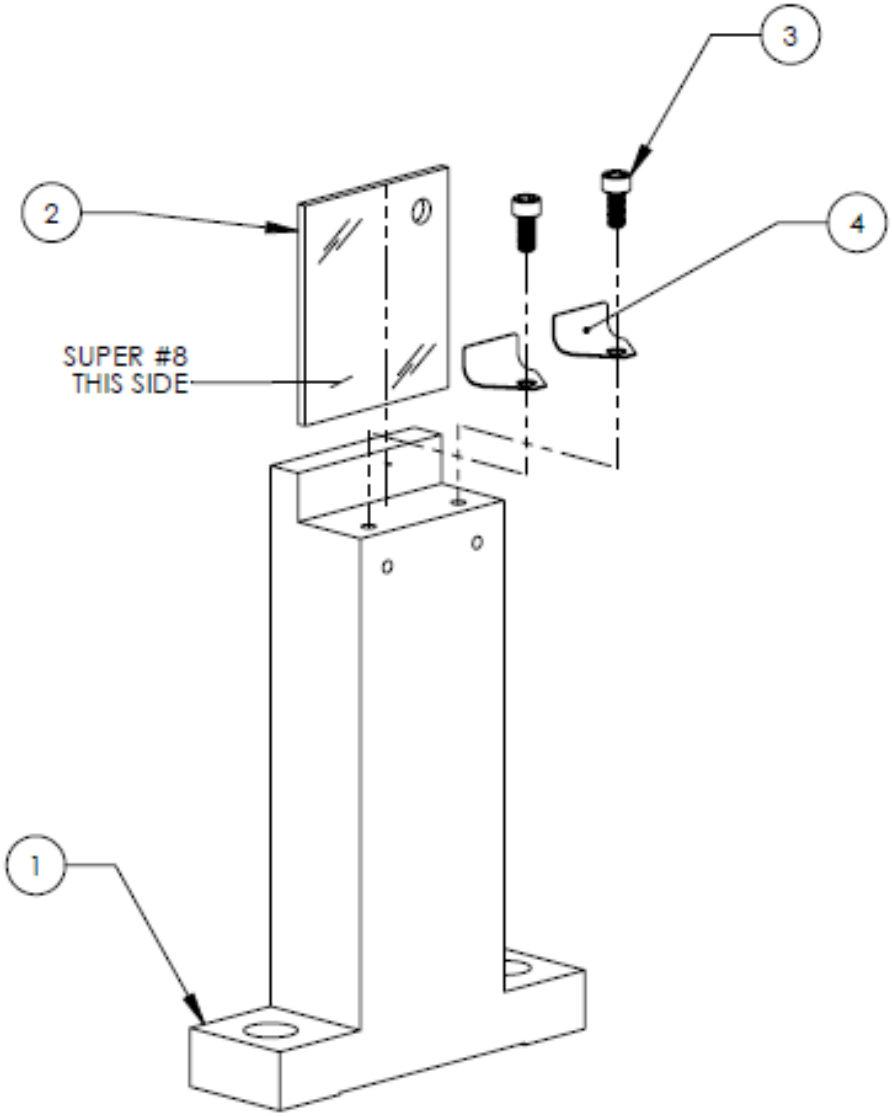


Figure 4: 3.5 D1002364 Faraday Isolator Beam Dump Assy

2.6 D0900353 Half Wave Plate Holder Assy

Table 5: Bill of Materials, D0900353 Half Wave Plate Holder Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY
1	D1100029	ALIGO AOS HALF WAVE QUAARATZ ASSY	N/A	1
2	C-808-N	SCREW, SHC, 8-32 x 1/2, MS16995-26	300 SSTL	1
3	D0900352	HALF WAVE PLATE HOLDER	6061-T6 Al	1

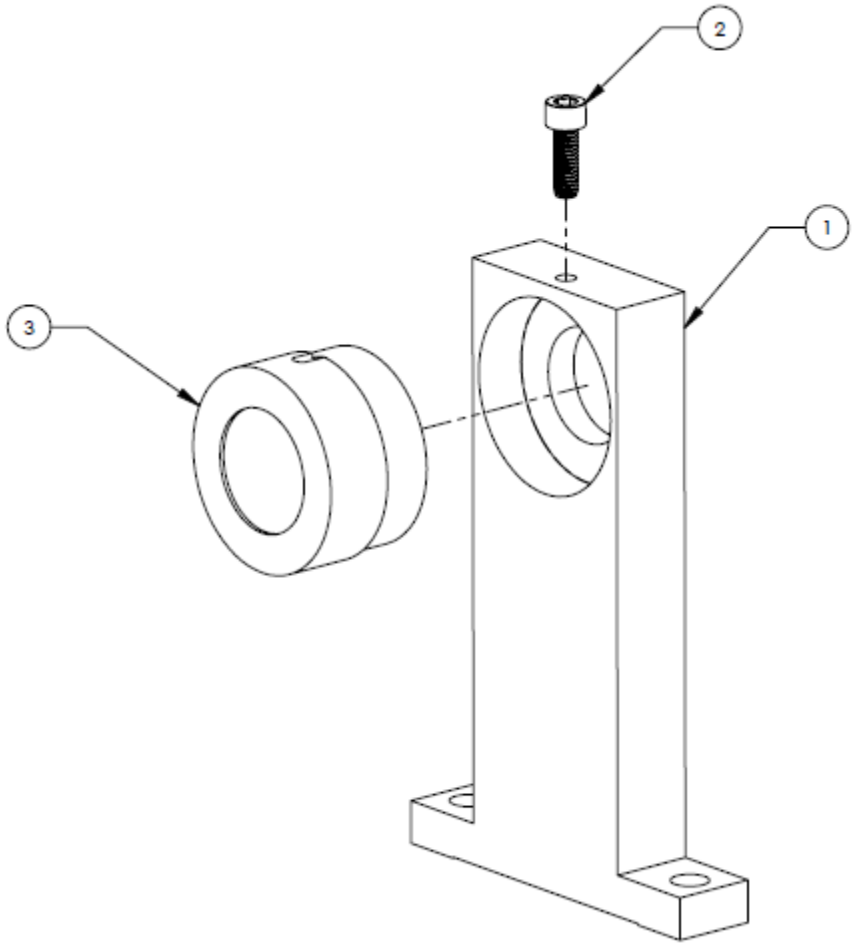


Figure 5: Half Wave Plate Holder Assy

2.7 D0900440 TFP Polarizer Plate Assy

Table 6: Bill of Materials, D0900440 TFP Polarizer Plate Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ
PARTS LIST				
5	WF-04	WASHER, FLAT, #4 (NAS 620-C4L OR EQUIVALENT)	300 SSTL	3
4	92200A108	Head Cap Screw 300 Series SS, 4-40 Thrd, 3/8" Length, MS 16995-10	18-8 SSTL	3
3	D1001919	BEAM DUMP MOUNTING CLAMP	304 SSTL	3
2	D1201320	ALIGO, OFI, THIN FILM POLARIZER	FUSED SILICA	1
1	D0900439	TFP POLARIZER PLATE	6061-T6 Al	1

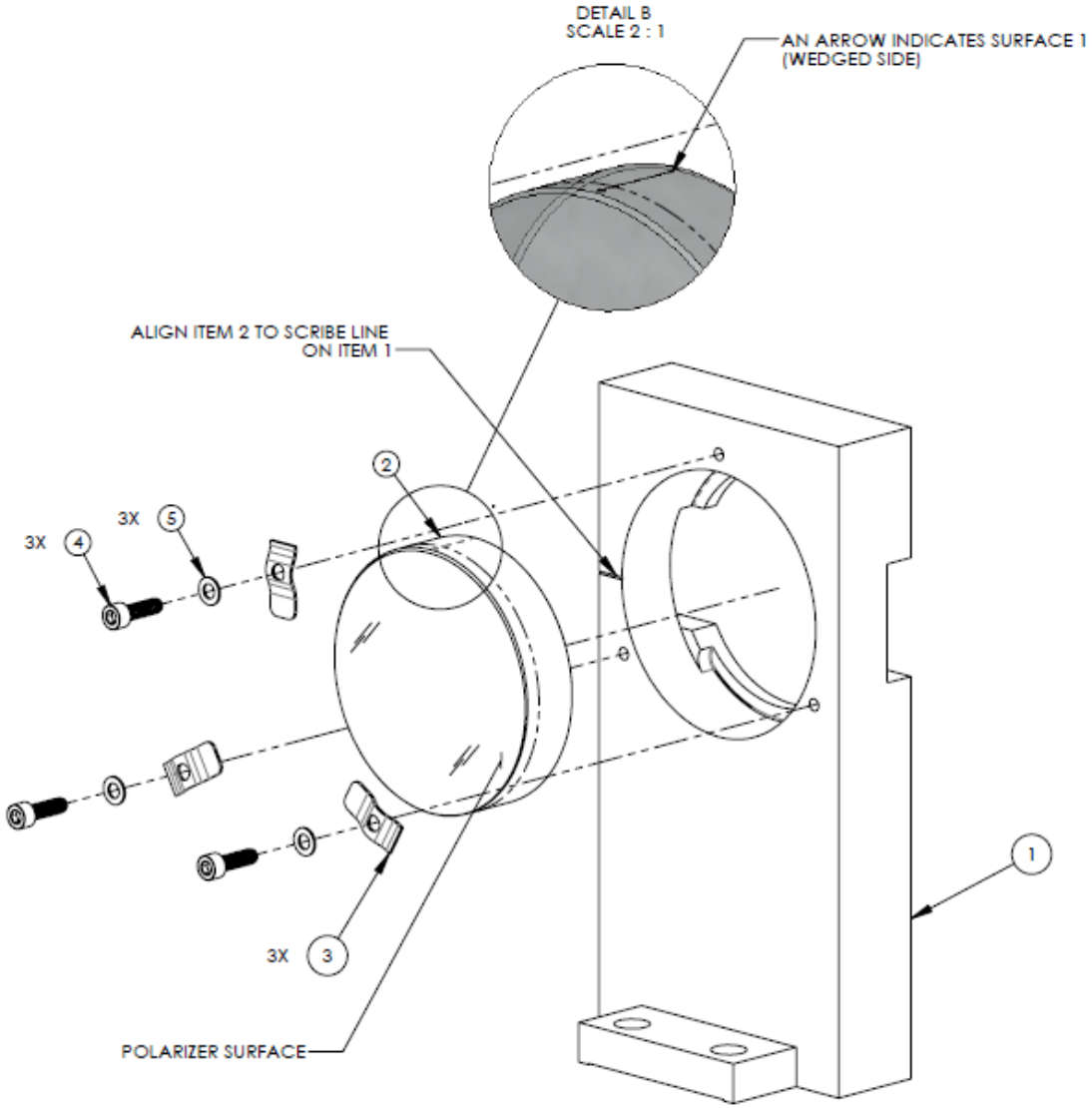


Figure 6: 2.7 D0900440 TFP Polarizer Plate Assy

2.8 D1001958 Wire Support Block Assy

Table 7: Bill of Materials, D1001958 Wire Support Block Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	TOTAL
3	D1201445	OFI_LOCKED NUT, 1/2-20, MODIFIED	Ag-PLATED 18-8 SSTL	1	1
2	C-5020-N	SOCKET HEAD CAP SCREW, 1/2"-20 THRD, 1-1/4" L	300 SSTL	1	1
1	D1001960	WIRE SUPPORT BLOCK	6061-T6 Al	1	1

PARTS LIST

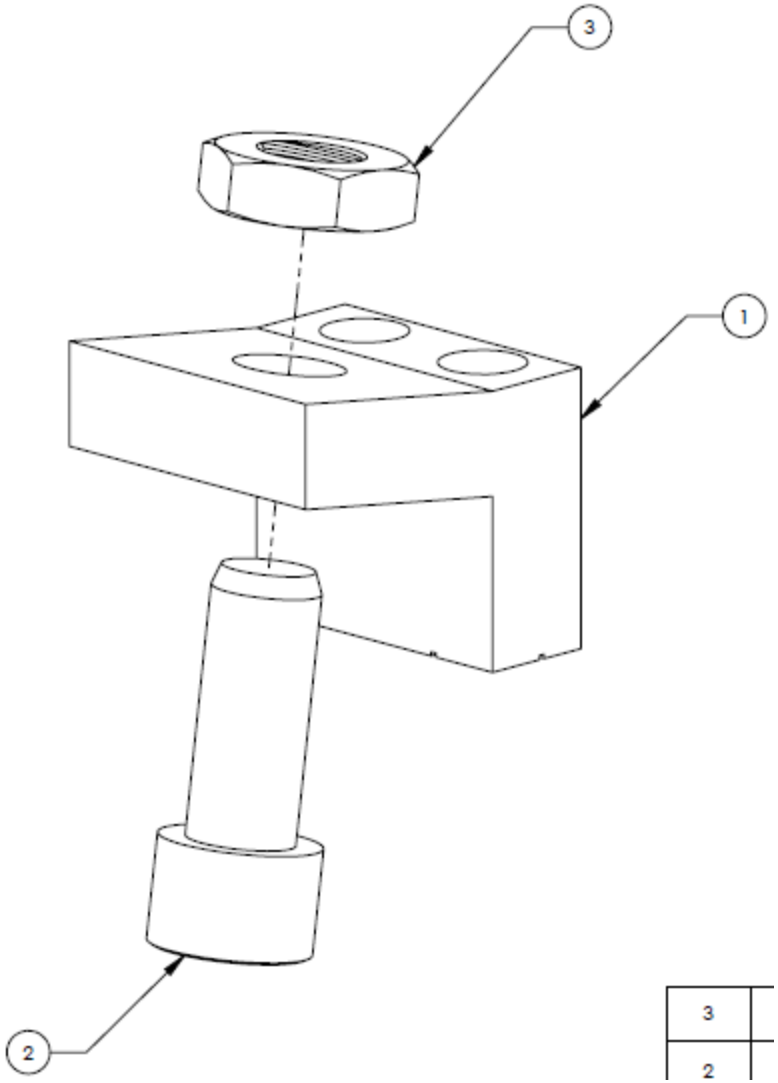
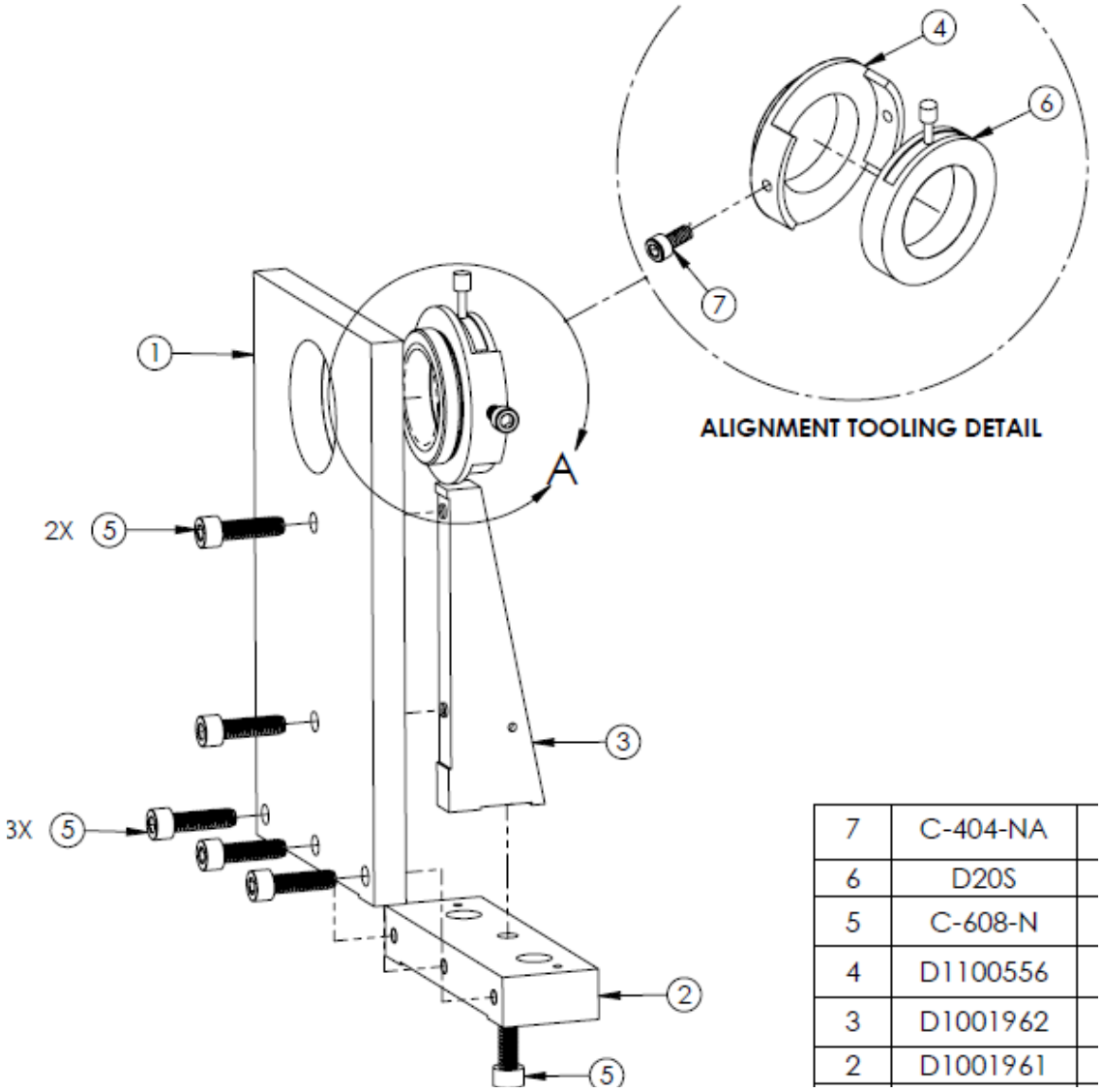


Figure 7: 3.8 D1001958 Wire Support Block Assy

2.9 D1001963 Output Alignment Fixture Assy

Table 8: Bill of Materials, D1001963 Output Alignment Fixture Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
		PARTS LIST		
7	C-404-NA	#4-40 X 0.250", 18-8 SSTL, SILVER PLATED	Ag-PLATED 300 SSTL	1
6	D20S	DIAPHRAGM D20S OFI	-	1
5	C-608-N	SHCS, 6-32 x .50, 300 SSTL, MS16995-18	300 SSTL	6
4	D1100556	IRIS DIAPHRAGM MOUNT	304, 316 OR 302 SSTL	1
3	D1001962	OUTPUT ALIGNMENT FIXTURE SUPPORT	6061-T6 Al	1
2	D1001961	OUTPUT ALIGNMENT FIXTURE BASE	6061-T6 Al	1
1	D1001959	RETICLE HOLDER	6061-T6 Al	1



7	C-404-NA	
6	D20S	
5	C-608-N	
4	D1100556	
3	D1001962	
2	D1001961	

Figure 8: Output Alignment Fixture Assy

2.10 D1200197 Wedged Prism Holder Assy

Table 9: Bill of Materials, D1200197 Wedged Prism Holder Assy

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ
6	92200A106	Head Cap Screw 300 Series SS, 4-40 Thrd, 1/4" Length, MS 16995-9	18-8 SSTL	4
5	C-814	SHCS, Vented, 8-32 X .875 LG.	18-8 SSTL	1
4	D0900359	WEDGED PRISM ASSY	N/A	1
3	D1001919	BEAM DUMP MOUNTING CLAMP	304 SSTL	4
2	D1001920	INPUT BAFFLE BEAM DUMP	18 GA A424 TYPE I STEEL	1
1	D1200198	WEDGED PRISM HOLDER STAND	6061-T6 Al	1

PARTS LIST

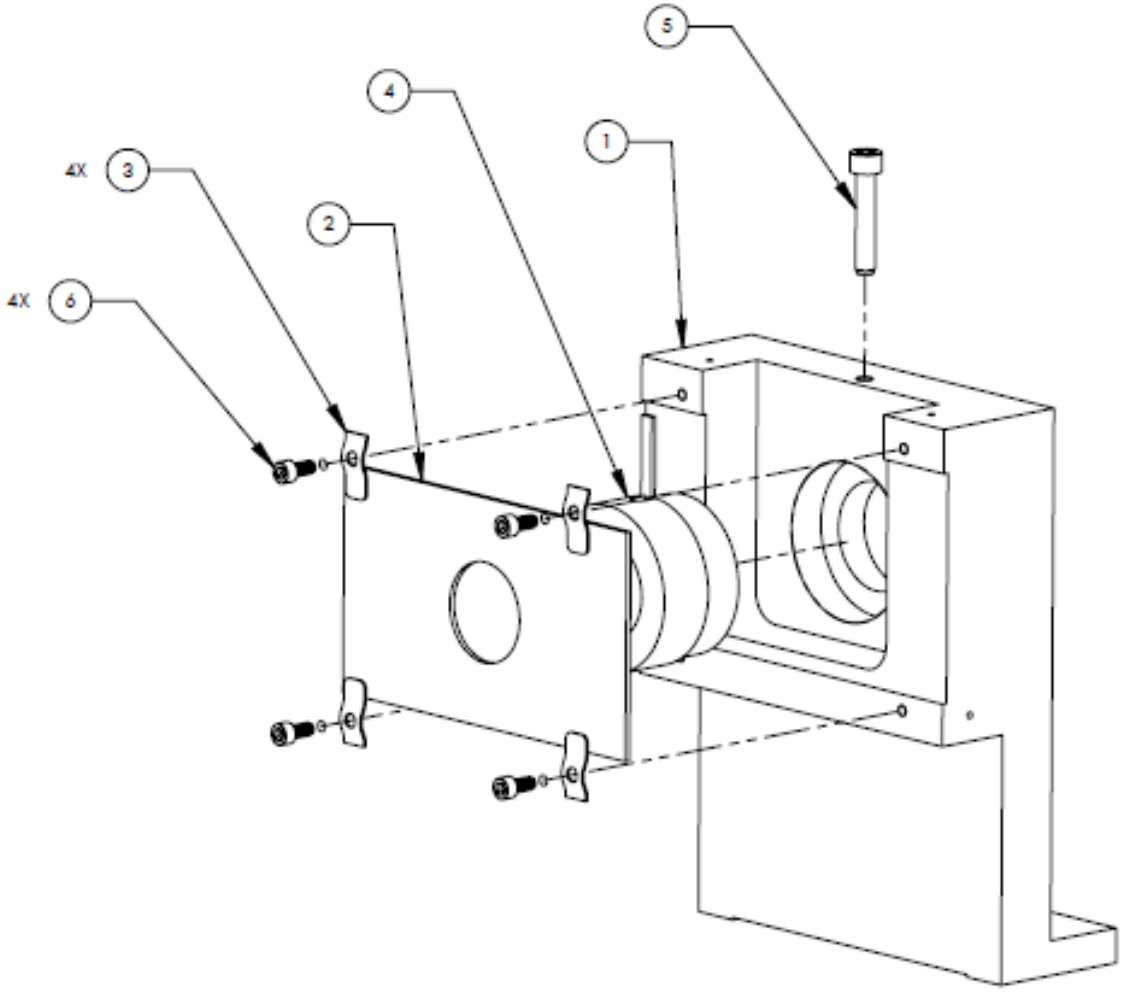
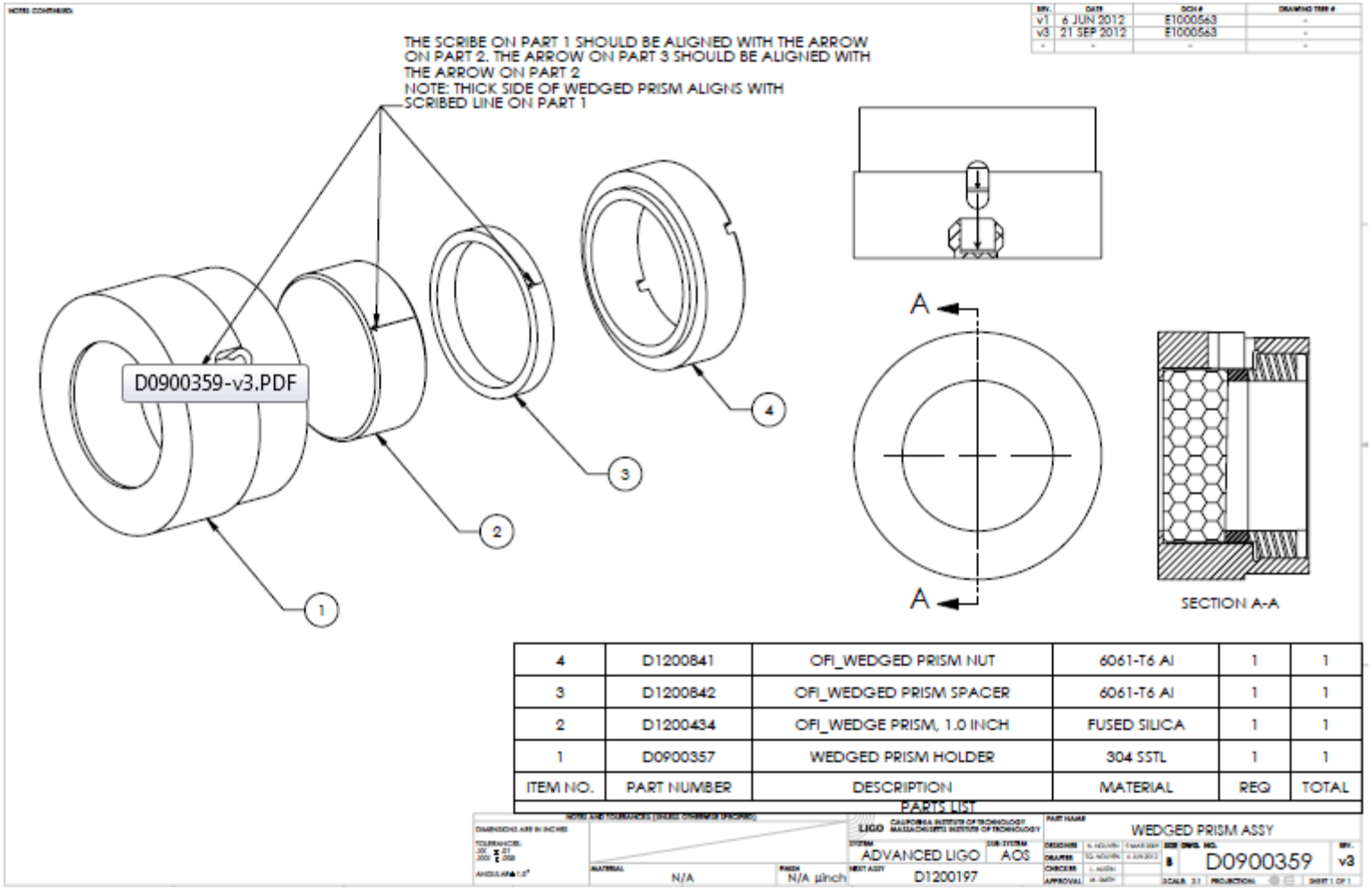


Figure 9: 3.10 D1200197 Wedged Prism Holder Assy

2.10.1 **D0900359 Wedged Prism Assy**

Note: The thick side of the Wedged Prism must be aligned with the scribed line on Part 1. When the wedged prism is installed on the optics table, the thick side of the wedged prism must be on top.



REV.	DATE	ECN #	DRAWING TREE #
v1	6 JUN 2012	E1000563	"
v3	21 SEP 2012	E1000563	"
"	"	"	"

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	TOTAL
4	D1200841	OFI_WEDGED PRISM NUT	6061-T6 Al	1	1
3	D1200842	OFI_WEDGED PRISM SPACER	6061-T6 Al	1	1
2	D1200434	OFI_WEDGE PRISM, 1.0 INCH	FUSED SILICA	1	1
1	D0900357	WEDGED PRISM HOLDER	304 SSTL	1	1

PARTS LIST

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PART NAME: WEDGED PRISM ASSY
SYSTEM: ADVANCED LIGO
SUB-SYSTEM: AOS
NEXT ASSY: D1200197
MATERIAL: N/A
FINISH: N/A µinch
SIZE: B
DWG. NO.: D0900359
REV: v3
SCALE: 2:1
PROJECTION:
SHEET 1 OF 1

2.11 Faraday Isolator Table Assy

Table 10: Bill of Materials, D0900623 Faraday Isolator Table Assy

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
24	D1200197	WEDGED PRISM HOLDER ASSY	1
23	C-816-NA UC COMPONENTS OR EQ.	8-32 x 1, SHCS, 18-8 SSTL	4
22	91475A029 McMASTER-CARR OR EQ.	Washer, Lock, .25 x .49 OD, 300 SSTL	2
21	90945A760 McMASTER-CARR OR EQ.	1/4 FLAT WASHER, .260 ID x .47 OD X .02 THK	2
20	D1002542	TABLE BALANCE WEIGHT, .75#	4
19	D0901764	TABLE BALANCE WEIGHT	2
18	D1002540	Output Faraday Isolator Dummy Weight (rotate)	1
17	D1002533	Output Faraday Isolator Dummy Weight	1
16	95435A568 McMASTER-CARR OR EQ.	SCREW, SHC, 8-32 X .50 LG. (TITANIUM)	12
15	C-2012 UC COMPONENTS OR EQ.	SCREW, SHC, 1/4-20 X .75 LG.	4
14	92200A540 McMASTER-CARR OR EQ.	SCREW, SHC, 1/4-20 X .75 LG.	4
13	92200A542 McMASTER-CARR OR EQ.	Screw, Soc Hd Cap, 1/4-20 UNC-2A X 1.00 L	16
12	92200A541 McMASTER-CARR OR EQ.	Screw, Socket Head Cap, 1/4-20 UNC-2A x .88 LG.	13
11	N35P500500HT	BLUNTING MAGNETICS-NEODYMIUM .50 DIA X .50L	16
10	D1002364	FARADAY ISOLATOR BEAM DUMP ASSY	2
9	D0900614	PRISM MOUNT ASSY_LH	1
8	D1001963	OUTPUT ALIGNMENT FIXTURE ASSY	1
7	D0900778	MAGNET ATTACHMENT PLATE	2
6	D0900440	TFP POLARIZER PLATE ASSY	1
5	D0900353	HALF WAVE PLATE HOLDER ASSY	1
4	D0900615	PRISM MOUNT ASSY_RH	1
3	D0900464	ROTATOR 20mm 1064nm-VAC COMPATIBLE	1
2	D1001958	WIRE SUPPORT BLOCK ASSY	4
1	D0900015	FARADAY ISOLATOR TABLE	1

PARTS LIST

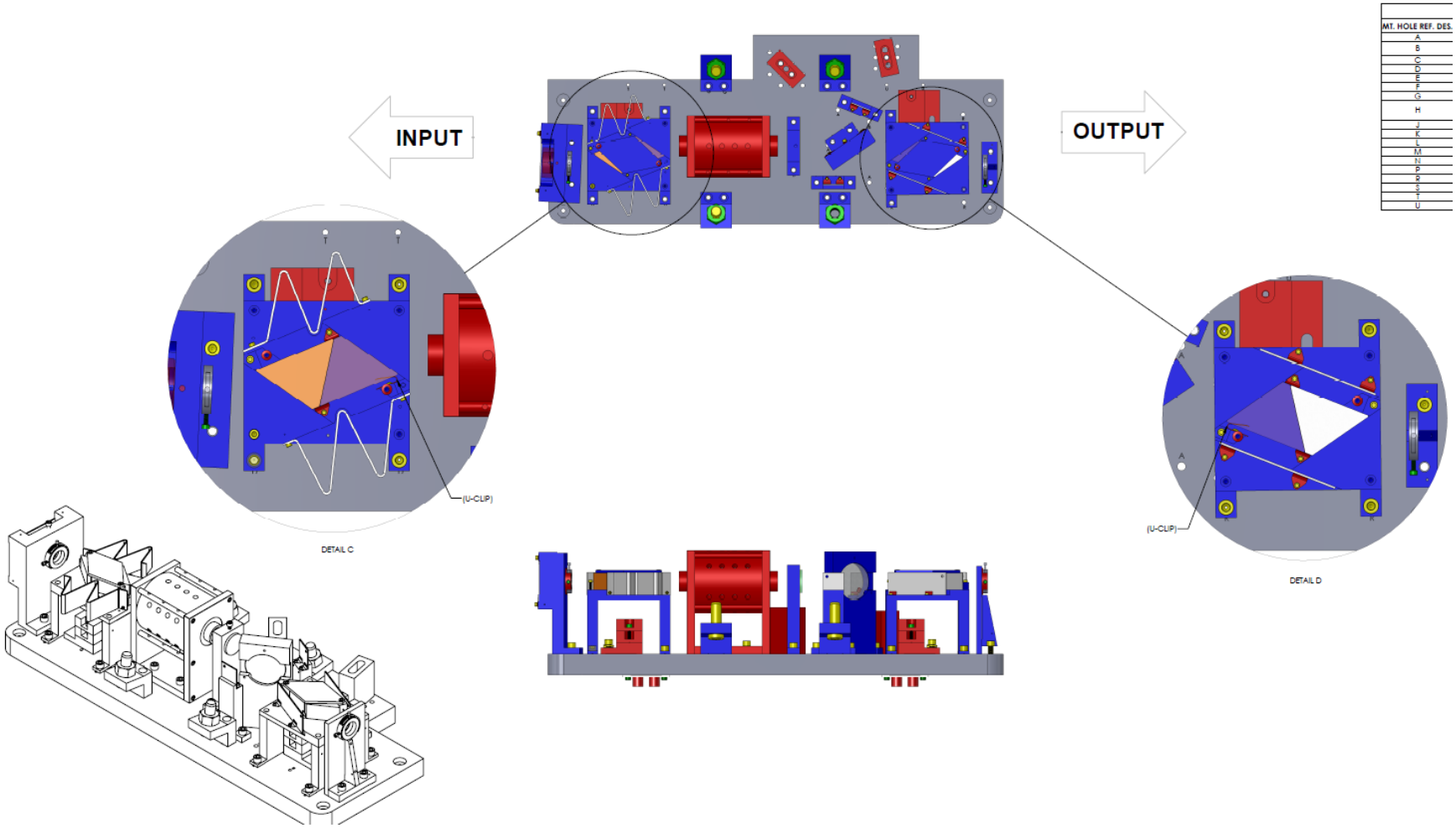
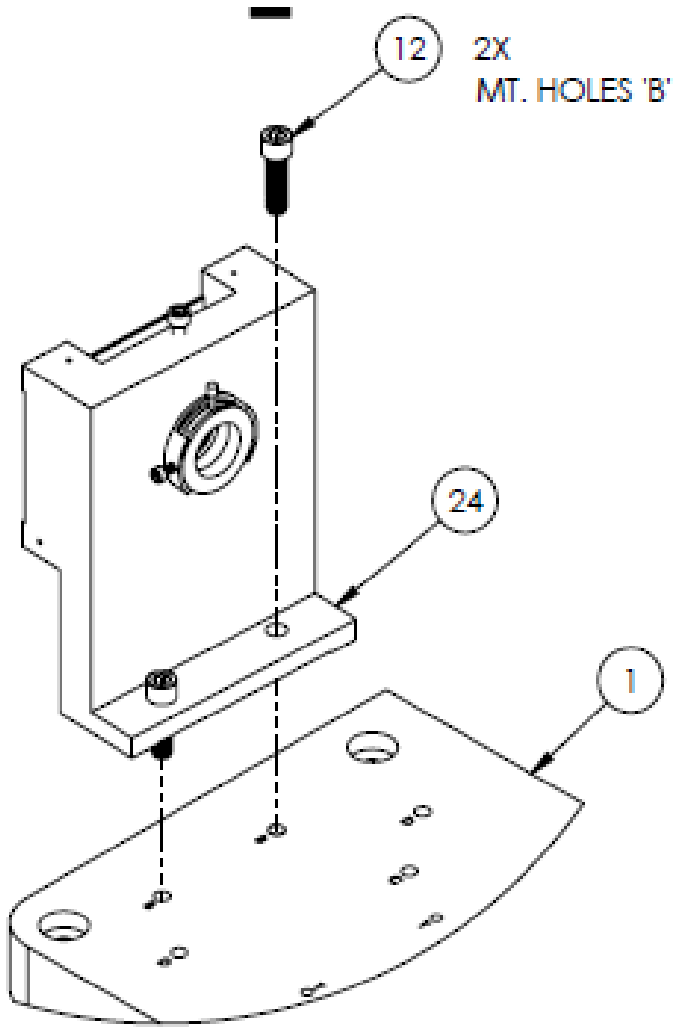


Figure 10: Assembly of Faraday Isolator Table

2.11.1 **Step 1**

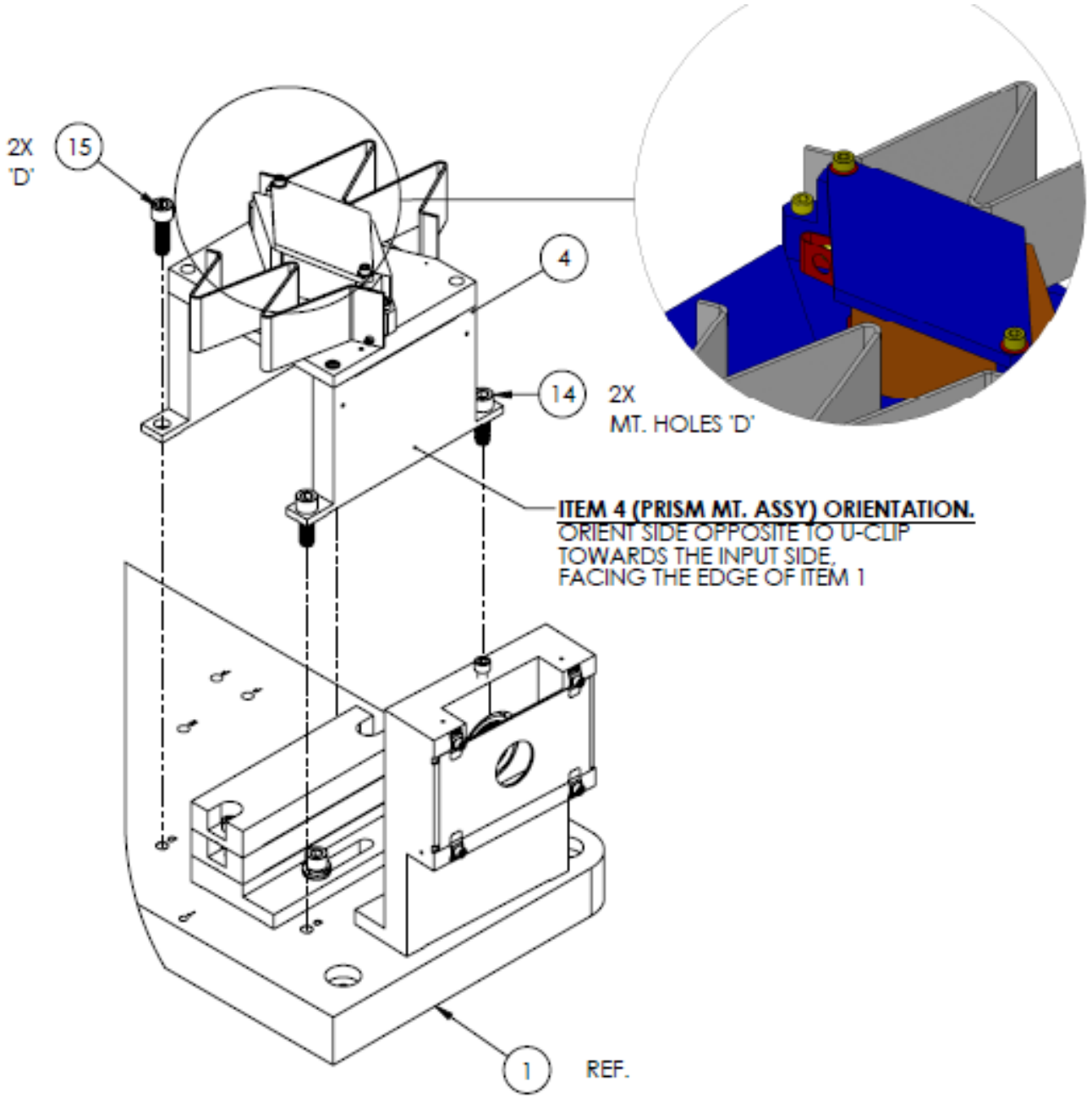


ASSY. STEP 1
ISO VIEW - FRONT RIGHT
(WEDGE PRISM HOLDER ASSY. MT.)

2.11.2 **Step 2**

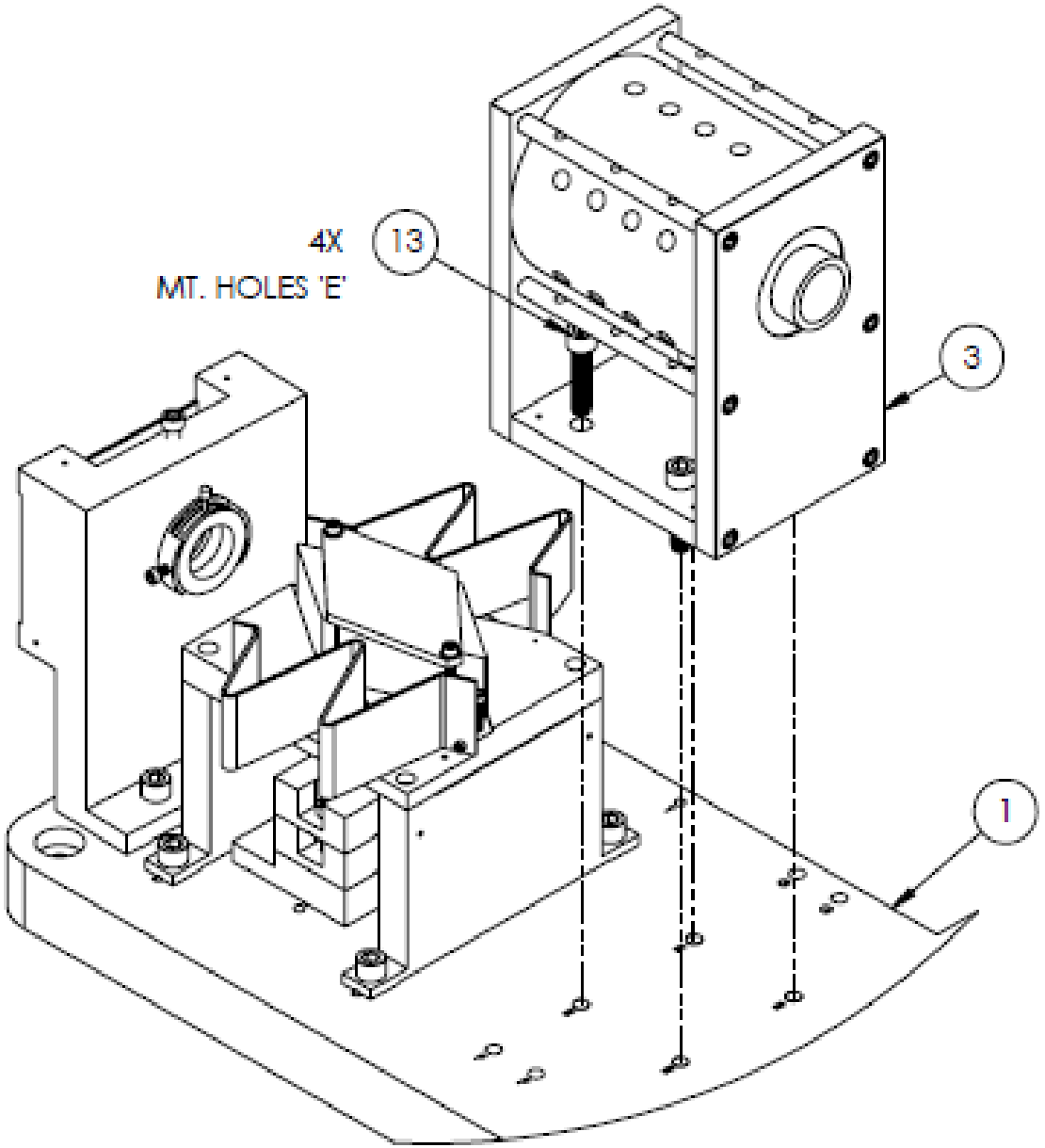
Front Balance Weight Installation: see 3.6.1 Adjust Balance Weights.

2.11.3 **Step 3**



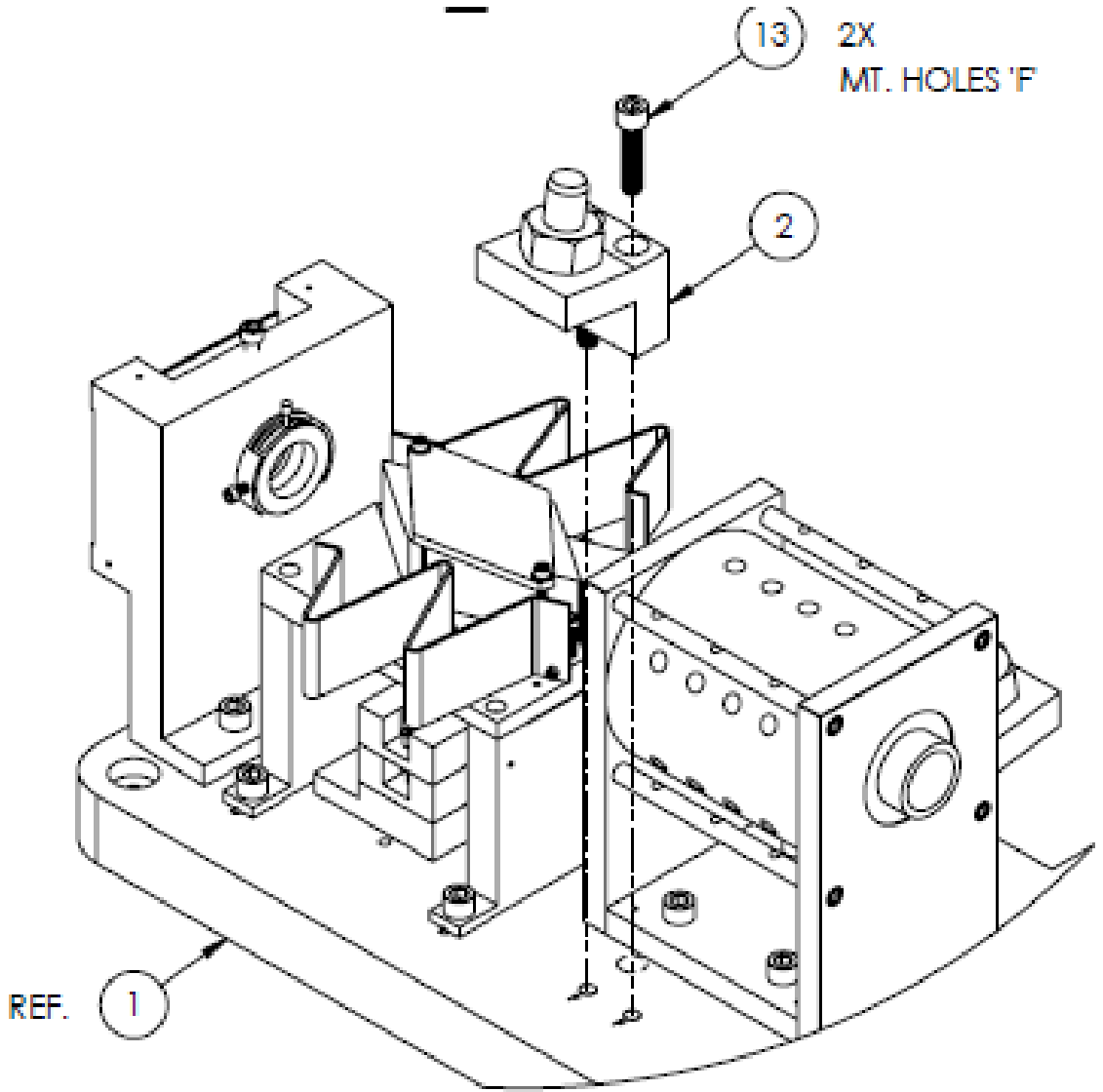
ASSY. STEP 3
ISO VIEW - REAR LEFT
(FI PRISM MT. ASSY-RH)

2.11.4 **Step 4**



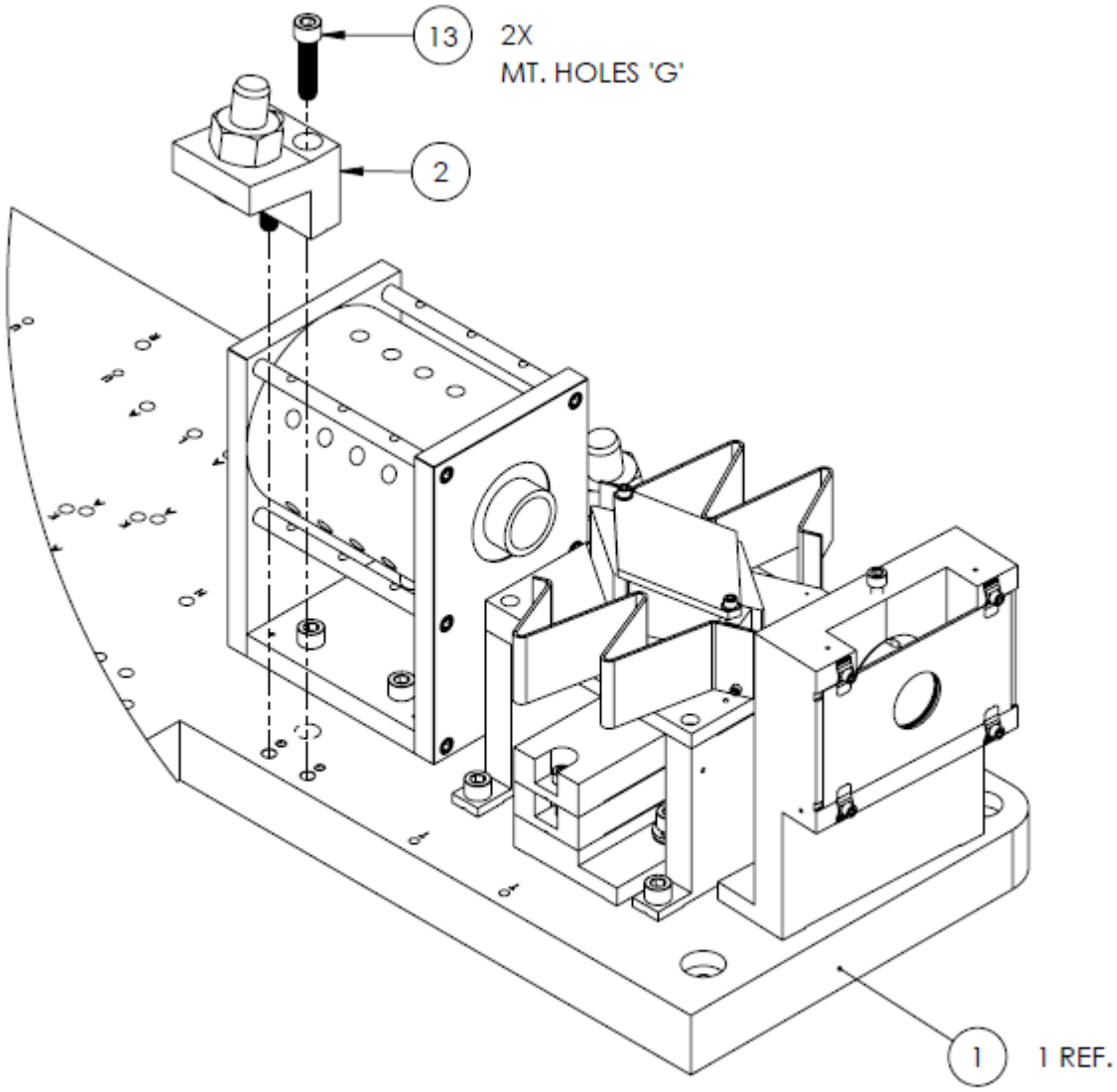
ASSY. STEP 4
ISO VIEW - FRONT RIGHT
(ROTATOR MT.)

2.11.5 **Step 5**



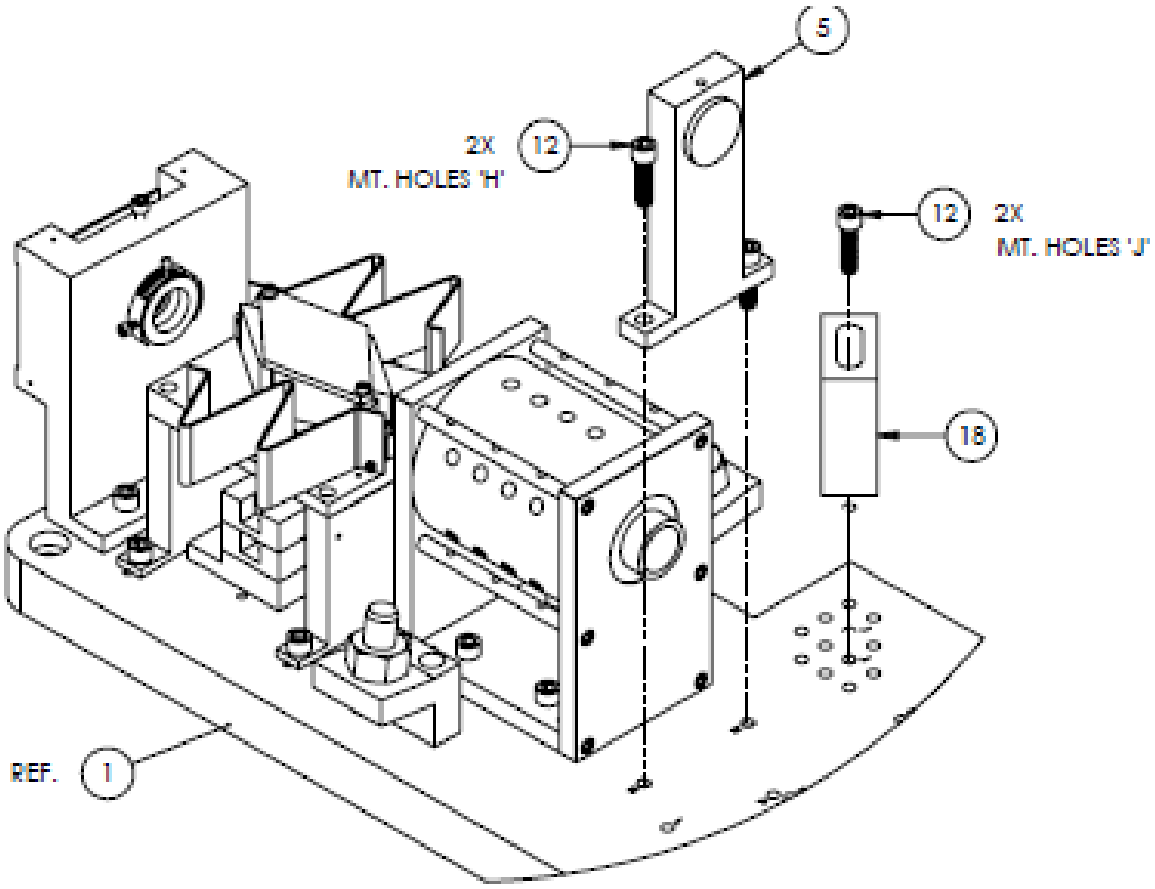
ASSY. STEP 5
ISO VIEW - FRONT RIGHT
(WIRE SUPPORT BLOCK MT.)

2.11.6 **Step 6**



ASSY. STEP 6
ISO VIEW - REAR LEFT
(WIRE SUPPORT BLOCK MT.)

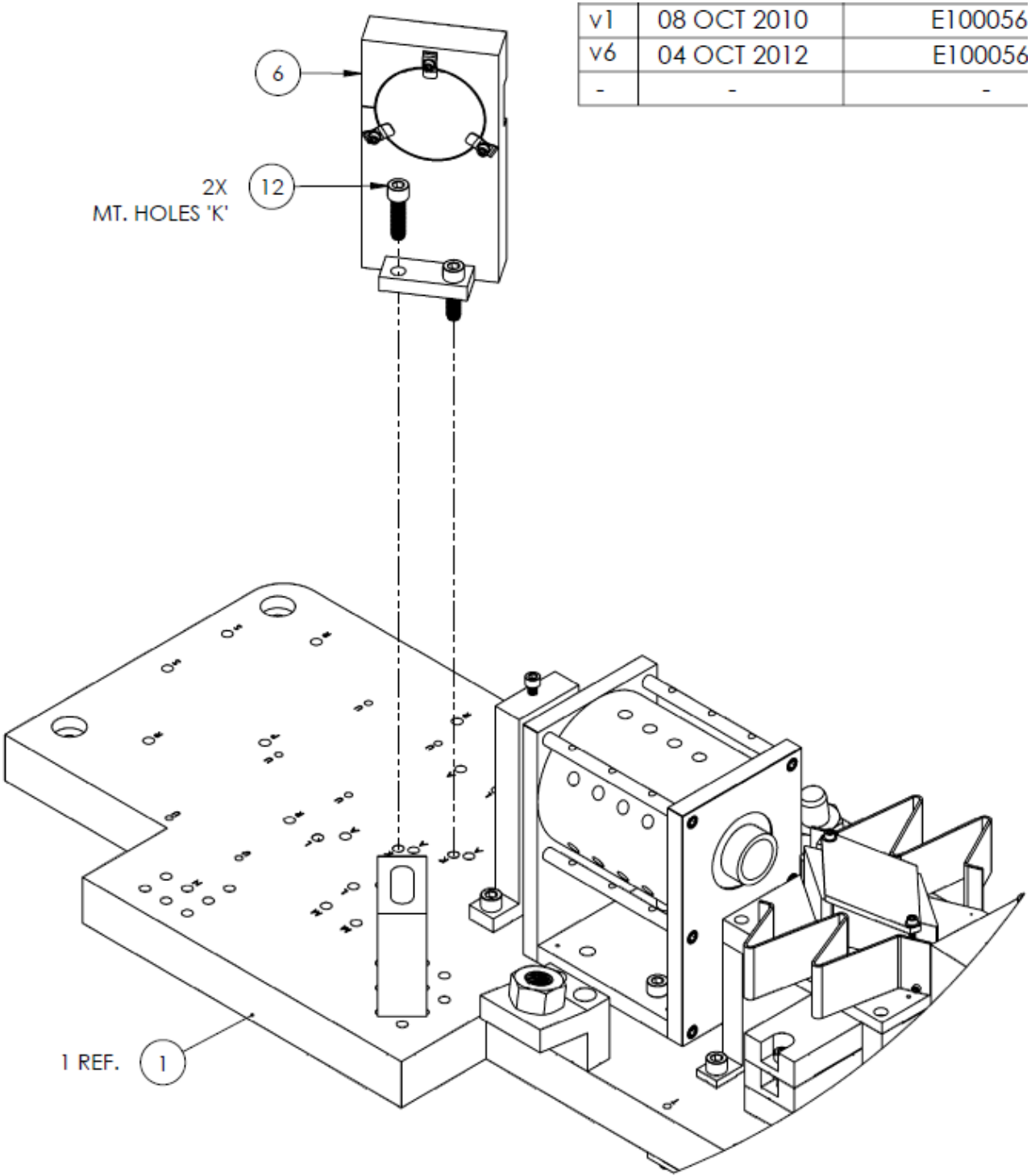
2.11.7 **Step 7**



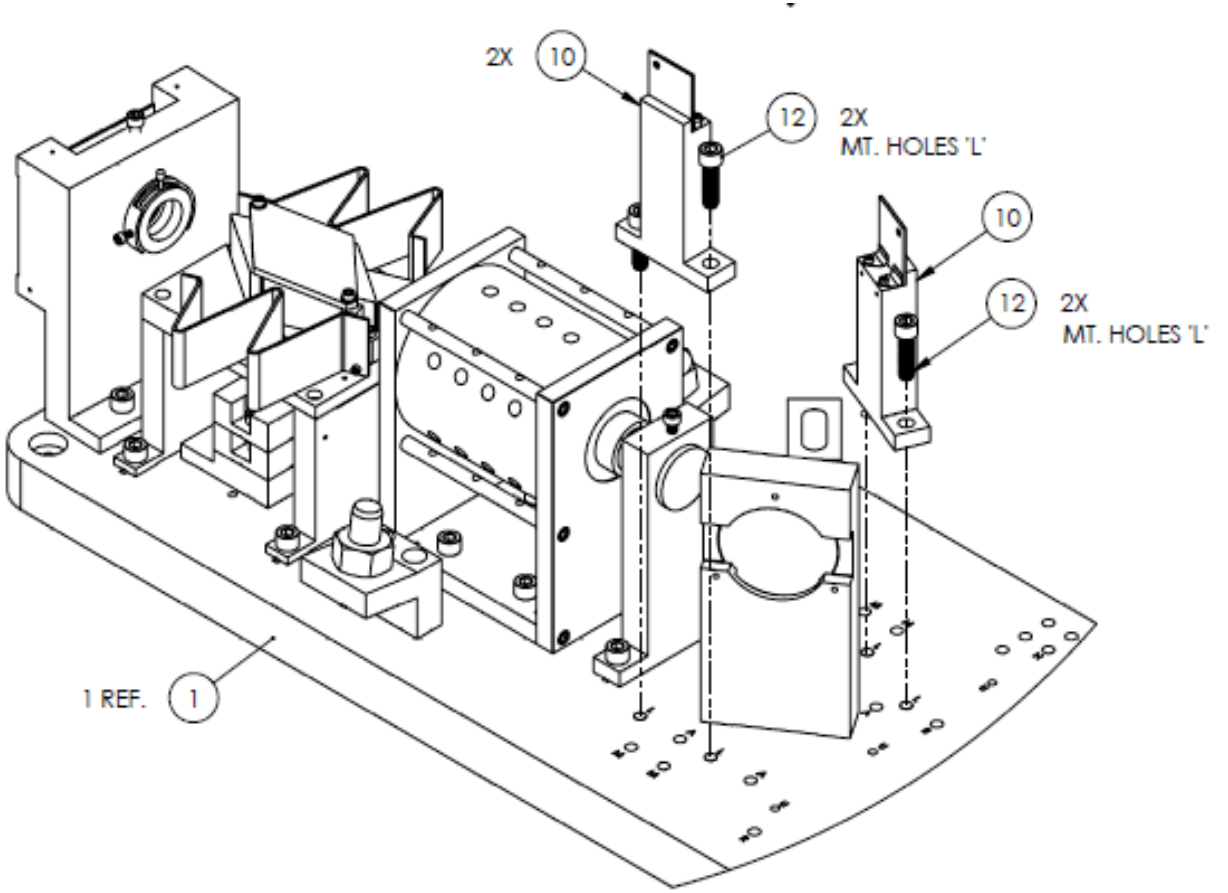
ASSY. STEP 7
ISO VIEW - FRONT RIGHT
(HALF WAVE PLATE HOLDER ASSY. MT.)

2.11.8 **Step 8**

v1	08 OCT 2010	E100056
v6	04 OCT 2012	E100056
-	-	-



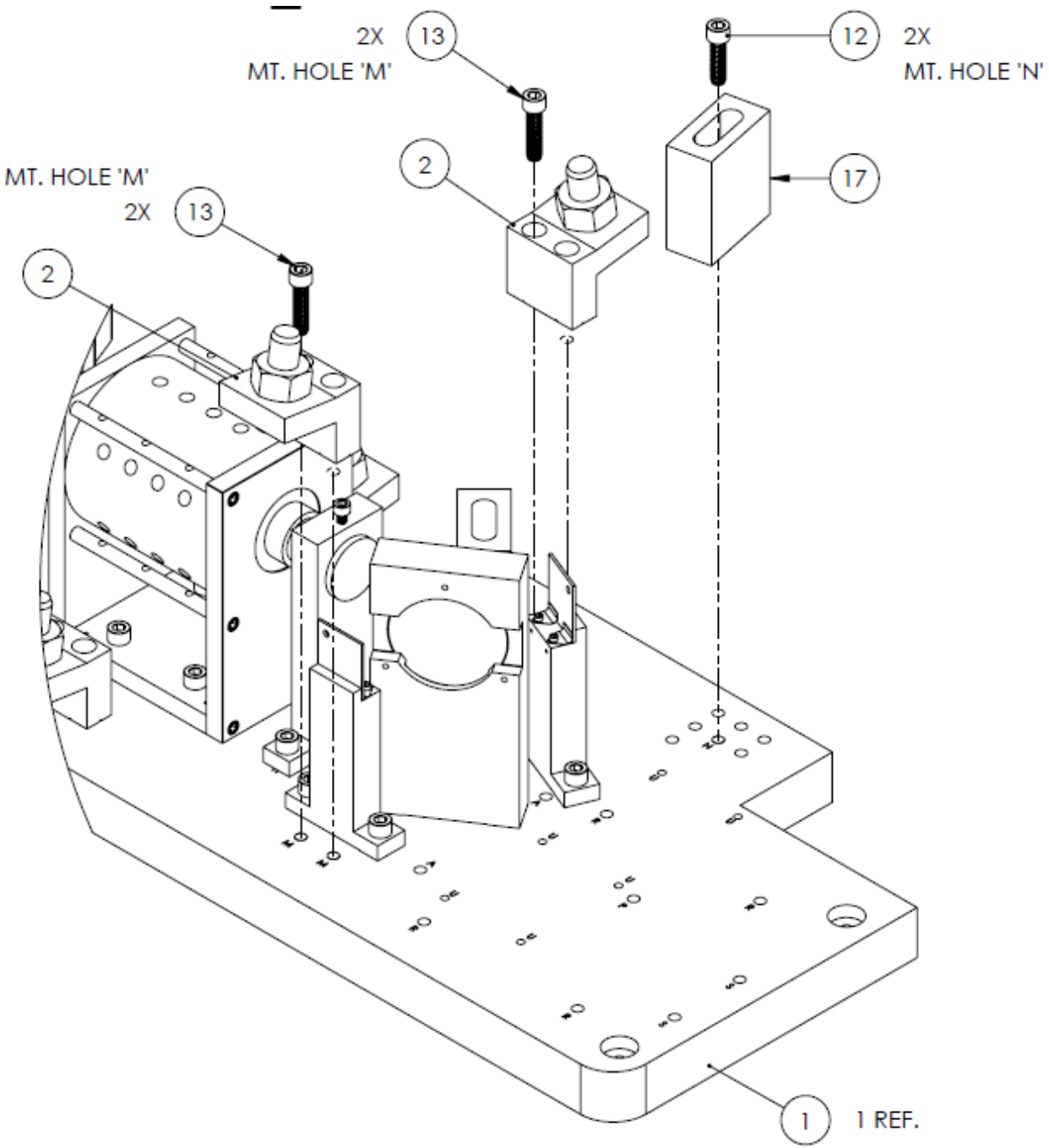
2.11.9 **Step 9**



ASSY. STEP 9
ISO VIEW - FRONT RIGHT
(FI BEAM DUM ASSY. MT.)

24	D1200197

2.11.10 **Step 10**

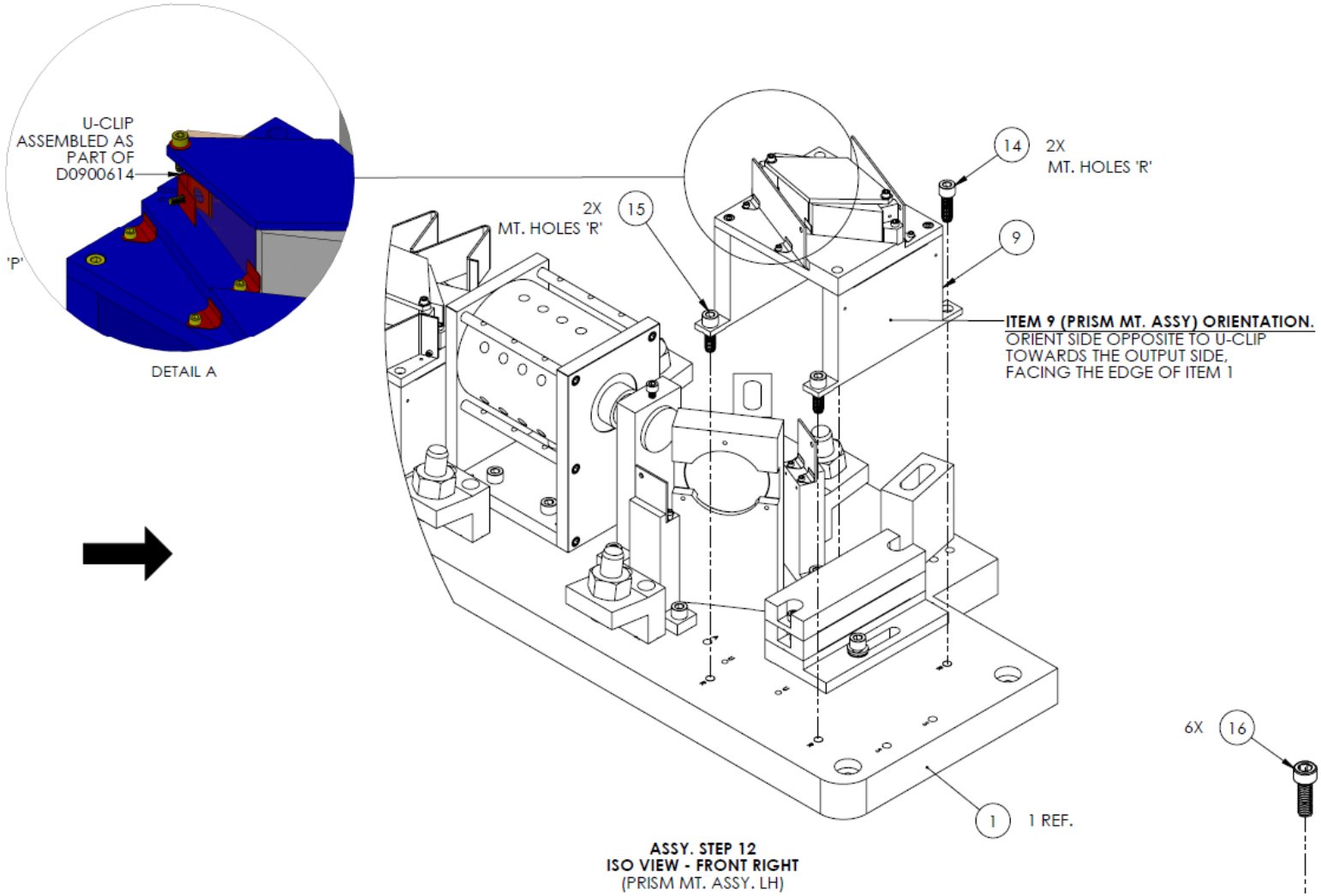


ASSY. STEP 10
ISO VIEW - FRONT RIGHT
(WIRE SUPPORT BLOCKS + DUMMY WEIGHT MT.)

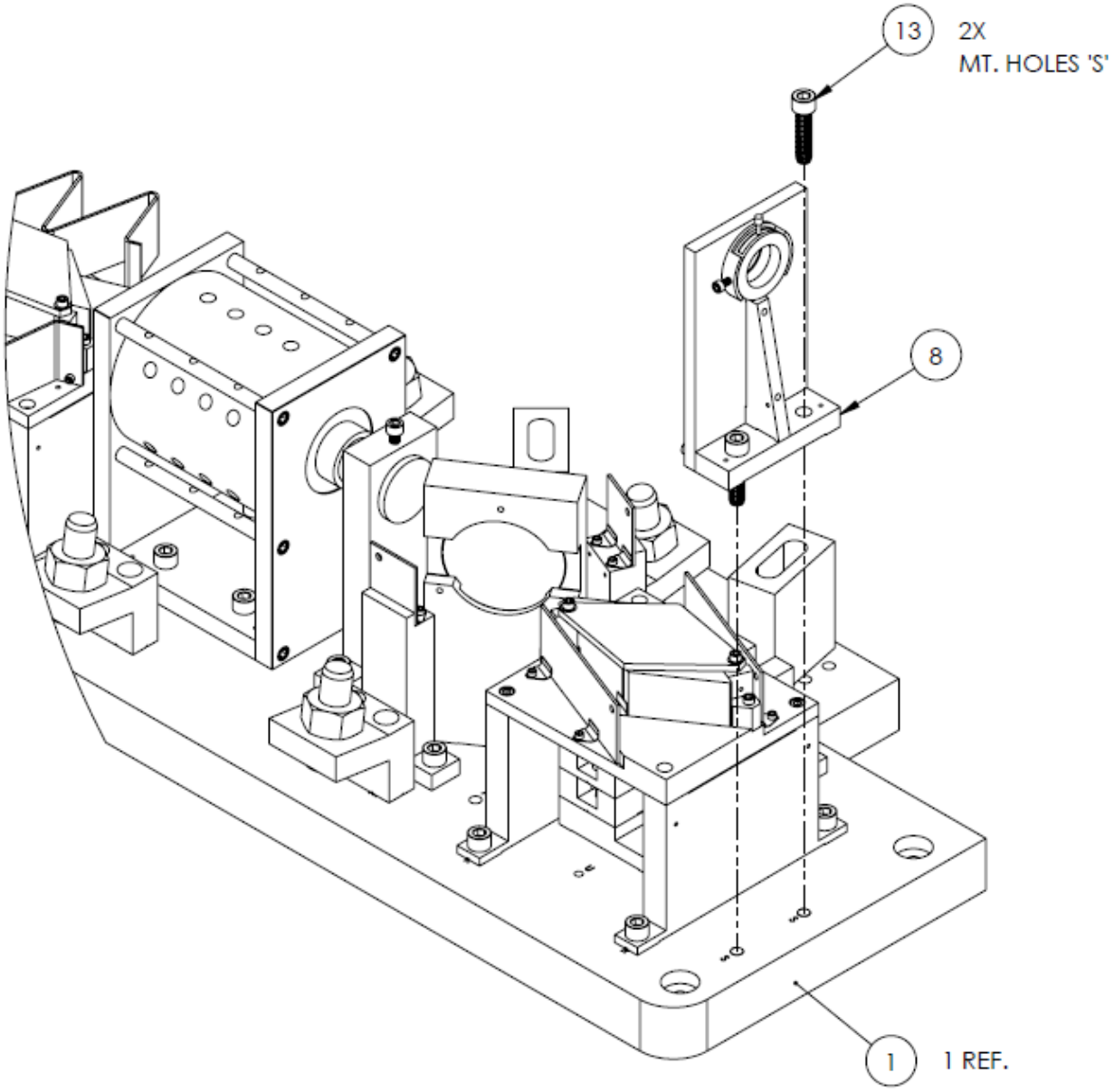
2.11.11 **Step 11**

Rear Balance Weight Installation: see 3.6.1 Adjust Balance Weights.

2.11.12 **Step 12**



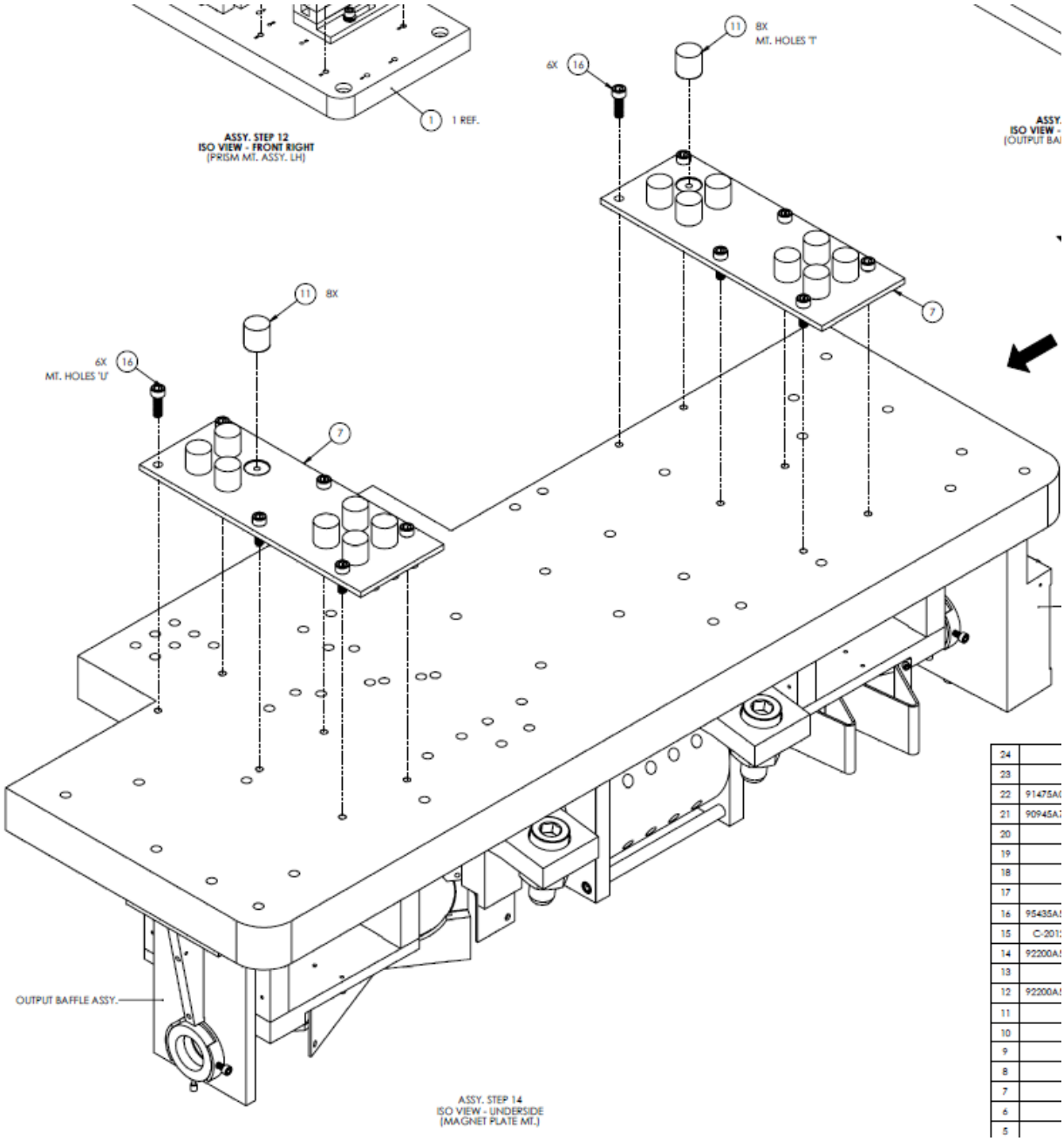
2.11.13 **Step 13**



ASSY. STEP 13
ISO VIEW - FRONT RIGHT
(OUTPUT BAFFLE ASSY. MT.)

2.11.14 **Step 14**

Place 2 magnets on each Magnetic Attachment Plate in pairs with opposite polarity, at the locations shown in Figure 11.



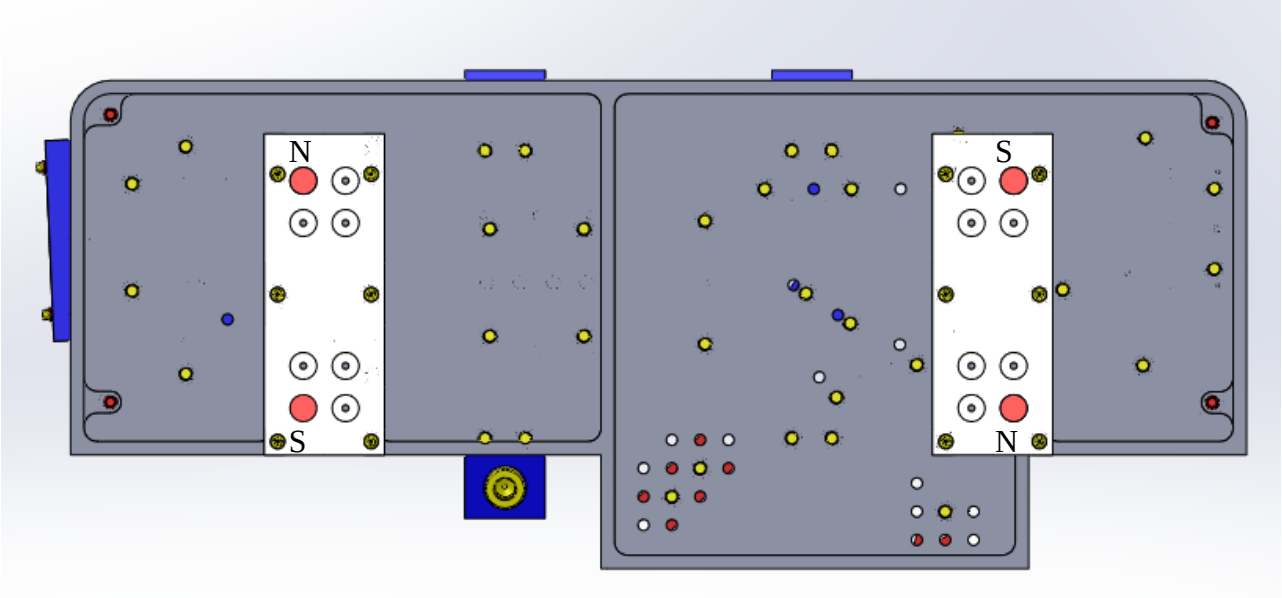


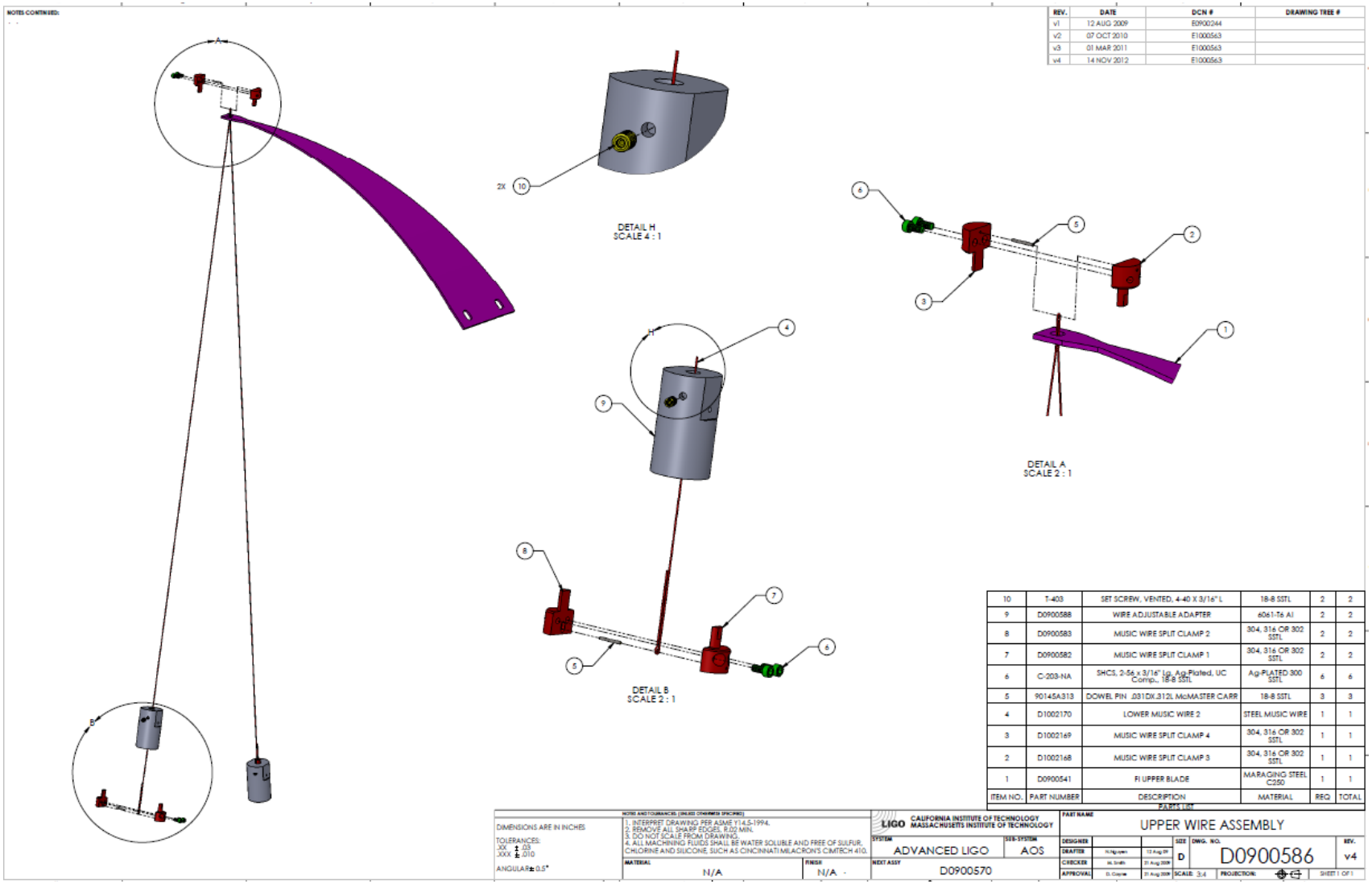
Figure 11: Magnet Locations, with Opposite Pole Orientations

2.12 D0900586 Faraday Isolator Upper Wire Assembly

Table 11: Bill of Materials, D0900586 Faraday Isolator Upper Wire Assembly

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	TOTAL
10	T-403	SET SCREW, VENTED, 4-40 X 3/16" L	18-8 SSTL	2	2
9	D0900588	WIRE ADJUSTABLE ADAPTER	6061-T6 Al	2	2
8	D0900583	MUSIC WIRE SPLIT CLAMP 2	304, 316 OR 302 SSTL	2	2
7	D0900582	MUSIC WIRE SPLIT CLAMP 1	304, 316 OR 302 SSTL	2	2
6	C-203-NA	SHCS, 2-56 x 3/16" Lg, Ag-Plated, UC Comp., 18-8 SSTL	Ag-PLATED 300 SSTL	6	6
5	90145A313	DOWEL PIN .031DX.312L McMASTER CARR	18-8 SSTL	3	3
4	D1002170	LOWER MUSIC WIRE 2	STEEL MUSIC WIRE	1	1
3	D1002169	MUSIC WIRE SPLIT CLAMP 4	304, 316 OR 302 SSTL	1	1
2	D1002168	MUSIC WIRE SPLIT CLAMP 3	304, 316 OR 302 SSTL	1	1
1	D0900541	FI UPPER BLADE	MARAGING STEEL C250	1	1

PARTS LIST


NOTES CONTINUED:
REV. | DATE | DCN # | DRAWING TREE #
v1 | 12 AUG 2009 | E0900244
v2 | 07 OCT 2010 | E1000563
v3 | 01 MAR 2011 | E1000563
v4 | 14 NOV 2012 | E1000563
DETAIL H
SCALE 4 : 1
DETAIL A
SCALE 2 : 1
DETAIL B
SCALE 2 : 1
10 | T-403 | SET SCREW, VENTED, 4-40 X 3/16" L | 18-8 SSTL | 2 | 2
9 | D0900588 | WIRE ADJUSTABLE ADAPTER | 6061-T6 Al | 2 | 2
8 | D0900583 | MUSIC WIRE SPLIT CLAMP 2 | 304, 316 OR 302 SSTL | 2 | 2
7 | D0900582 | MUSIC WIRE SPLIT CLAMP 1 | 304, 316 OR 302 SSTL | 2 | 2
6 | C-203-NA | SHCS, 2-56 x 3/16" Lg, Ag-Plated, UC Comp., 18-8 SSTL | Ag-PLATED 300 SSTL | 6 | 6
5 | 9014SA313 | DOWEL PIN .031DX.312L McMASTER CARR | 18-8 SSTL | 3 | 3
4 | D1002170 | LOWER MUSIC WIRE 2 | STEEL MUSIC WIRE | 1 | 1
3 | D1002169 | MUSIC WIRE SPLIT CLAMP 4 | 304, 316 OR 302 SSTL | 1 | 1
2 | D1002168 | MUSIC WIRE SPLIT CLAMP 3 | 304, 316 OR 302 SSTL | 1 | 1
1 | D0900541 | FI UPPER BLADE | MARAGING STEEL C250 | 1 | 1
ITEM NO. | PART NUMBER | DESCRIPTION | MATERIAL | REQ | TOTAL
PARTS LIST
DIMENSIONS ARE IN INCHES
TOLERANCES:
.XX ± .03
.XXX ± .010
ANGULAR ± 0.5°
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 SHALL BE WATER SOLUBLE AND FREE OF SULFUR, CHLORINE AND SILICONE, SUCH AS CINCINNATI MILACRON'S CIMTECH 410.
MATERIAL: N/A
FINISH: N/A
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY
SYSTEM: ADVANCED LIGO
SUB-SYSTEM: AOS
NEXT ASSY: D0900570
PART NAME: UPPER WIRE ASSEMBLY
DESIGNER
DRAFTER
CHECKER
APPROVAL
SIZE: D
DWG. NO.: D0900586
REV.: v4
SCALE: 3:4
PROJECTION:
SHEET 1 OF 1

2.12.1 **OFI Wire Length**

2.12.1.1 Attaching the upper wire clamp

Select a piece of wire that is approximately 5 in longer than twice the length of the D1201506 OFI Wire Length Fixture, shown in Figure 12.

Press the Pin 5 into the D1002168 Music Wire Split Clamp 3, as shown in Figure 14: **NOTE: the upper wire clamp pair, Clamp 3 and Clamp 4 must be used only for the upper end.** Loop the wire at the midpoint once over Pin 5, and clamp the upper loop by attaching the other half of the wire clamp, D1002168 Music Wire Split Clamp 4, using the two SHCS, 2-56 x 3/16 long: tighten the screws iteratively to maintain a uniform gap between the clamping halves. The two halves of the wire should extend uniformly beyond the small ends of the assembled split wire clamp.

2.12.1.2 Making the Bottom Loop

Place the upper split wire clamp into the recess on the right edge of the OFI Wire Length Fixture and hold it in place. Grab one of the extending wire lengths with a pair of pliers and pull it across the top of the OFI Wire Length Fixture toward the opposite end. While maintaining tension on the wire, loop it half way around the small pin protruding from the surface at the left end of the OFI Wire Length Fixture. Place the D1201508 OFI Wire Loop Tool over the wire, mating it with the protruding pin, as shown in Figure 12. Rotate the wire loop tool clockwise 1 1/8 turn, while maintaining tension of the wire; the wire end should be pointing approximately toward the right end of the wire length fixture. Remove the wire loop tool, and lift the looped end from the pin. Cut the end of the wire to a length approximately ½ in beyond the formed double loop.

Repeat the above steps to form a loop on the other length of wire from the upper clamp.

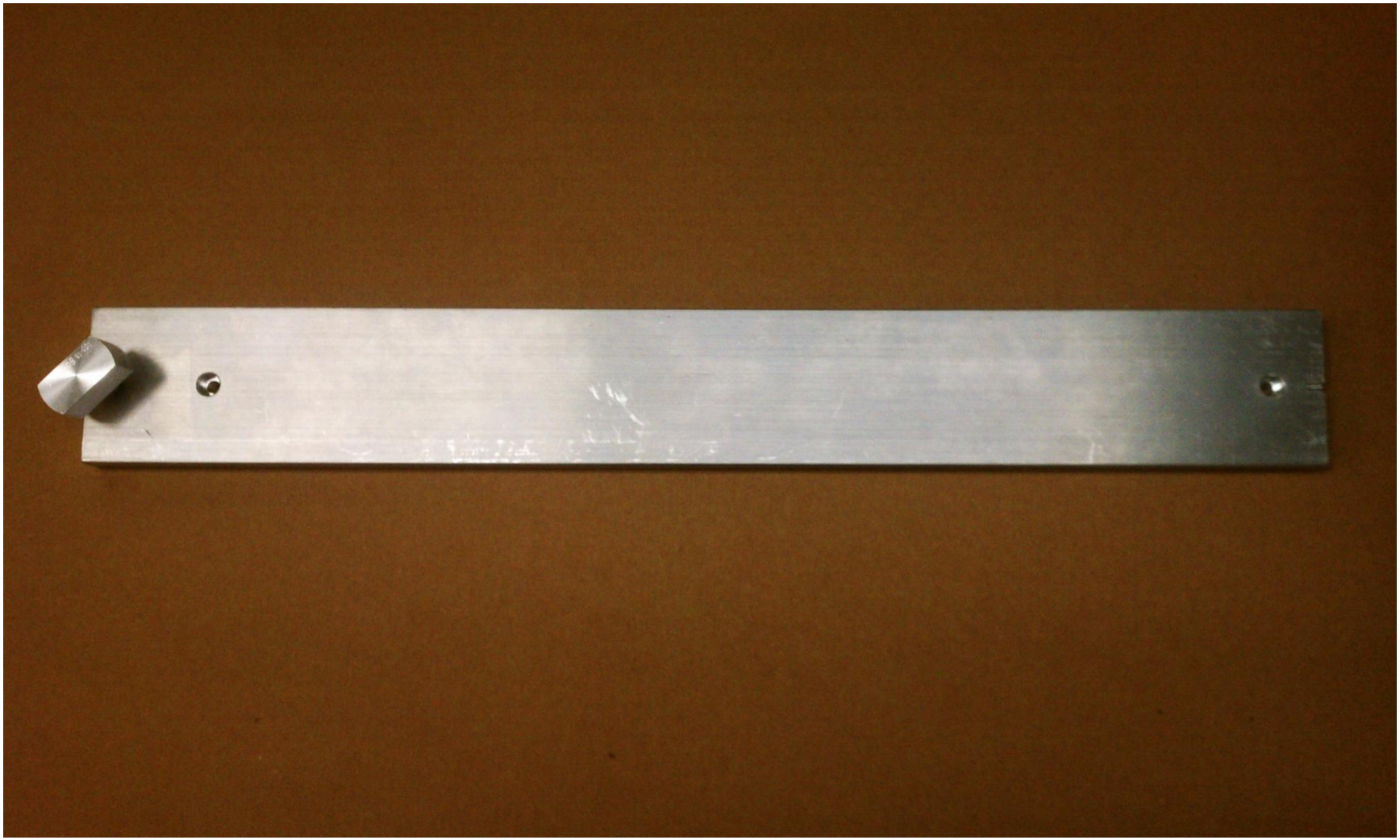


Figure 12: OFI Wire Length Fixture with Wire Loop Tool

D1201508 OFI Wire Loop Tool ?

Figure 13: Right End of Wire Length Fixture with Recess for Inserting the Small End of the Upper Wire Clamp

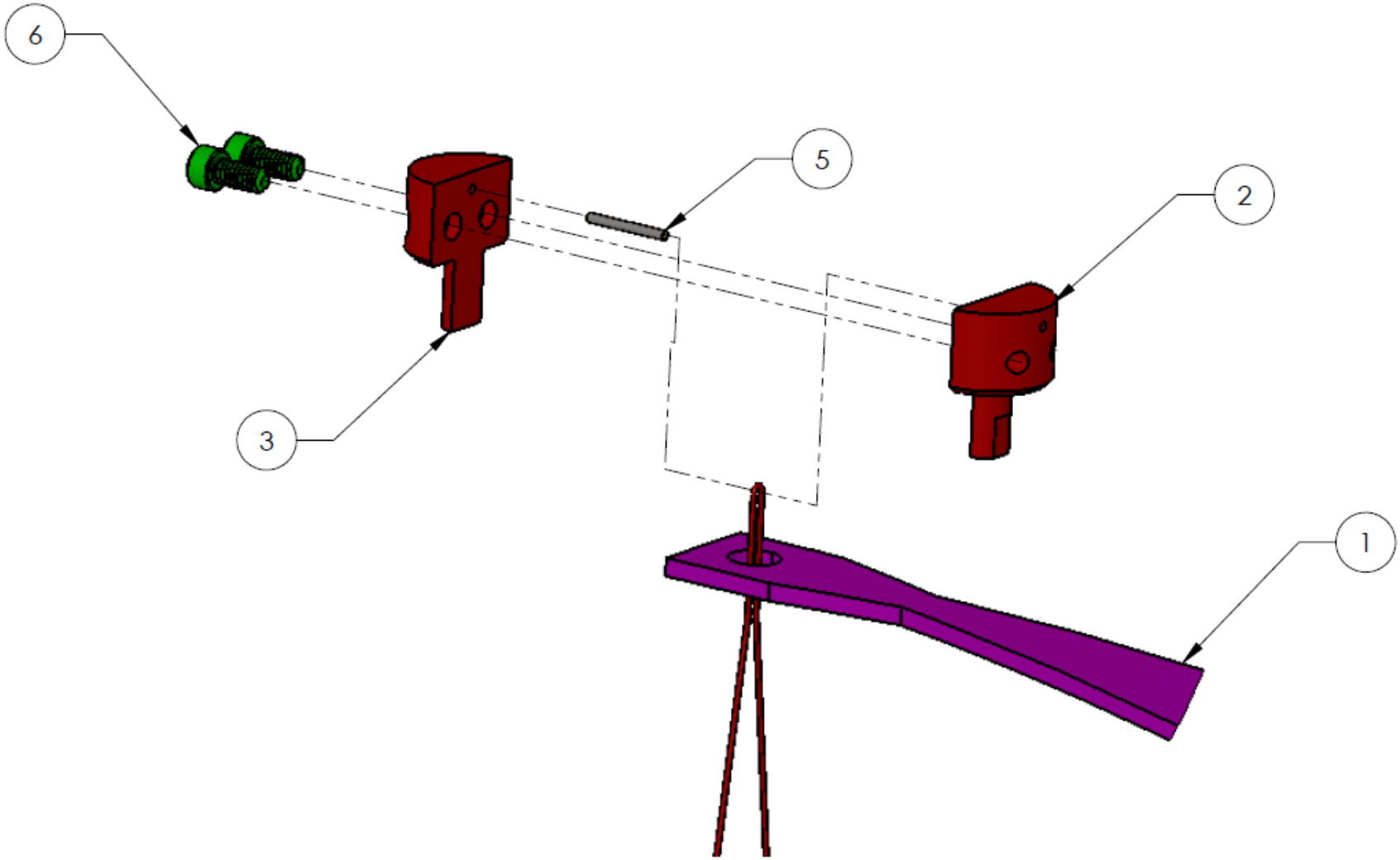


Figure 14: Upper Wire Loop Clamp Assembly

2.12.1.3 Attaching the Bottom Clamp

Thread the double looped end of the wire through the D0900588 Wire Adjustable Adapter, with the machined flat sides facing toward the upper wire clamp as shown in Figure 15.

Assemble both halves of the bottom Music Wire Split Clamp, D0900582 and D0900583, and loosely attach the 2-56 SHCS. Wet the D0900582 press fit hole for the pin 5 with clean alcohol and insert the pin through the clearance hole in D0900583 until it mates with the press fit hole. Hold the Split Clamp assembly with pliers and use a hammer to lightly tap the pin into D0900582 Music Wire Split Clamp 1; the pin must be tapped until it is flush with the outer surface of D0900583.

Separate the two halves of the Music Wire Split Clamp. Place the double loop at the end of the wire over the pin in Music Wire Split Clamp 1, making sure that the double loop is facing away from the clamp so that it will fit into the recess in D0900583.

NOTE: The lower wire clamp pair, Clamp 1 and Clamp 2 must be used only for the lower end--the pin is purposely offset from the center of the split clamp; the double wire loop must be oriented so that the continuous wire passes through the center of the clamp, and the cut end is offset;

Align the long music wire with the groove in the Split Clamp 1. Clamp the wire by attaching the other half of the wire clamp, D0900583 Music Wire Split Clamp 2, using the two SHCS, 2-56 x 3/16 long; tighten the screws iteratively to maintain a uniform gap between the clamping halves. The wire should extend from the center of the small end of the assembled split wire clamp.

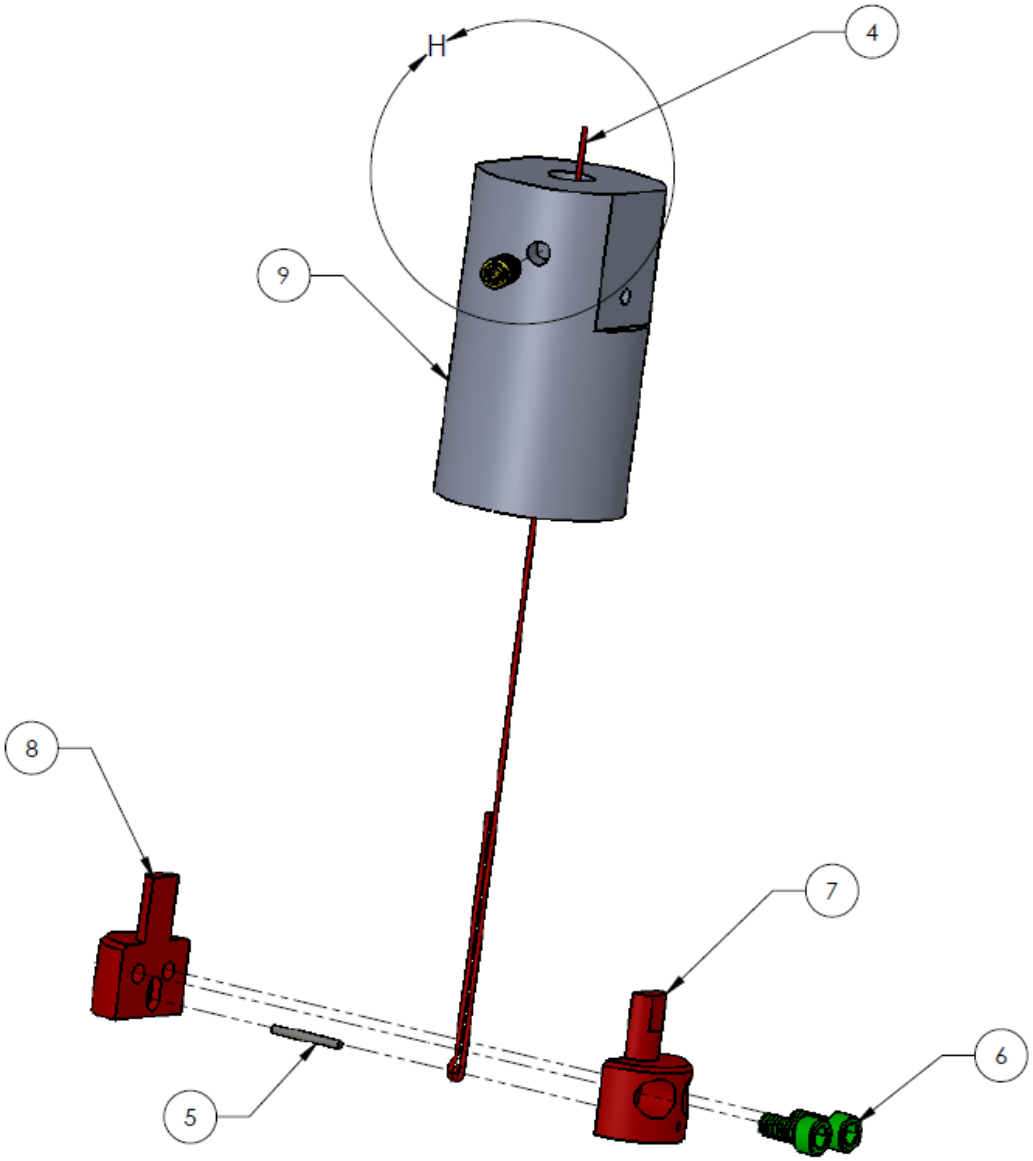
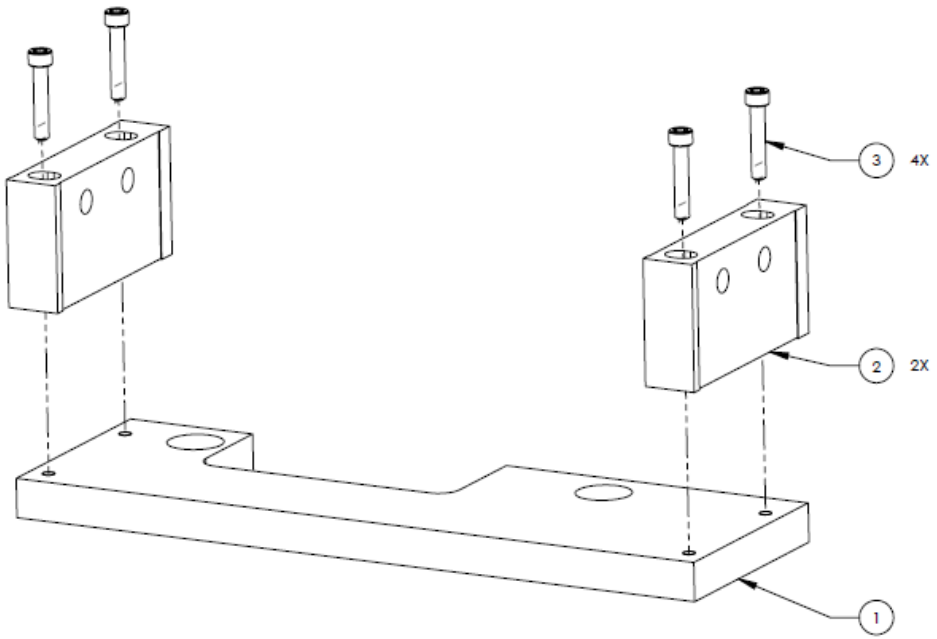
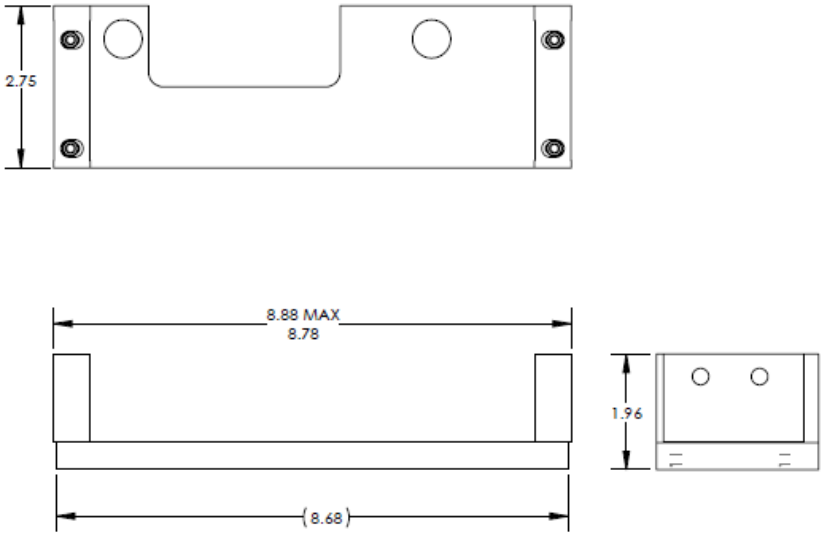


Figure 15: Bottom Wire Clamp Assembly

2.13 D0900170 Earthquake Crossbar Assy

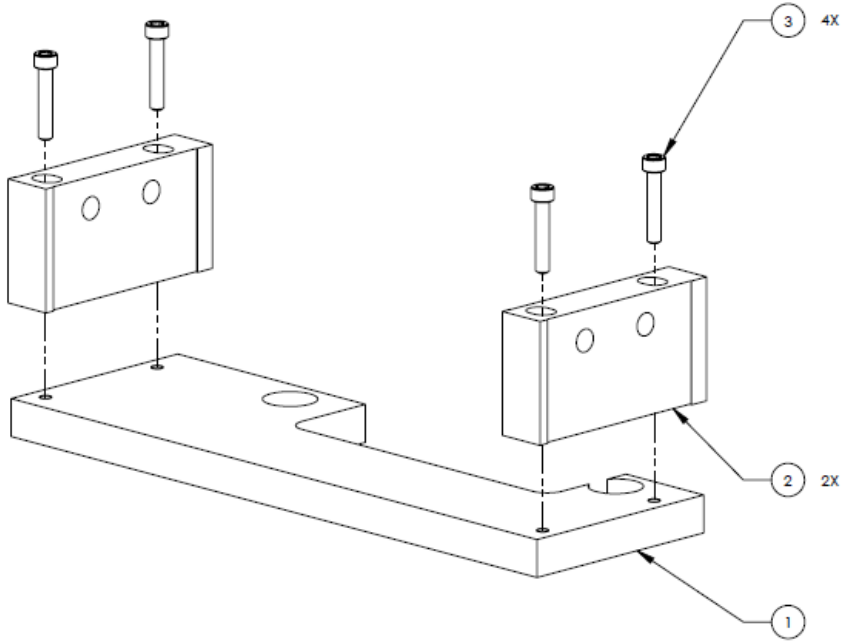


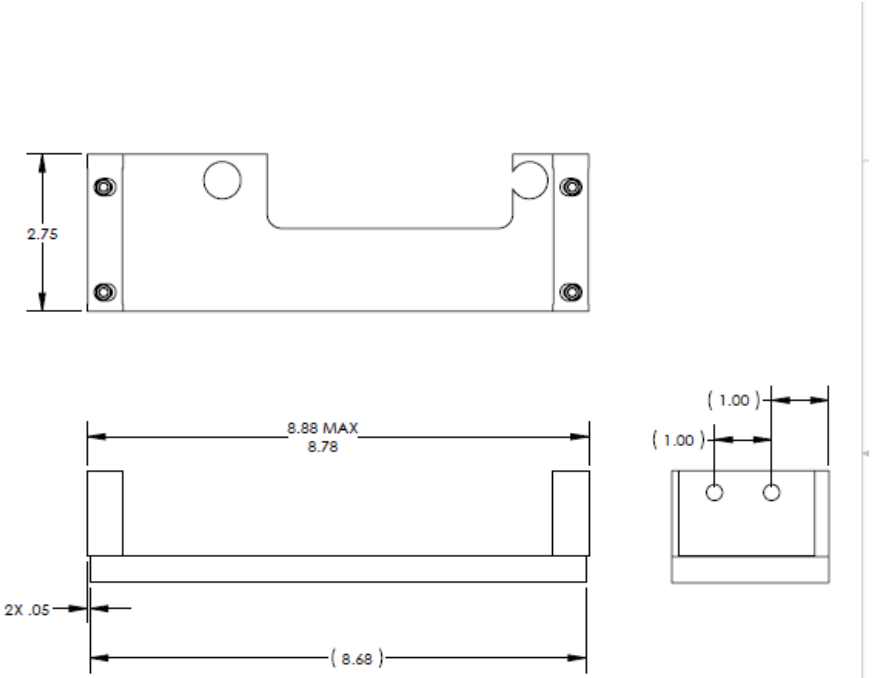


ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	TOTAL
3	C-814-N	C-814-N_SHCS 8-32 X .875 IN LONG, UC COMPONENTS	18-8 SSTL	4	4
2	D0900169	CROSSBAR SIDE	6061-T6 Al	2	2
1	D0900168	CROSSBAR PLATE	6061-T6 Al	1	1

PARTS LIST

2.14 D1002256 Earthquake Crossbar_In Assy

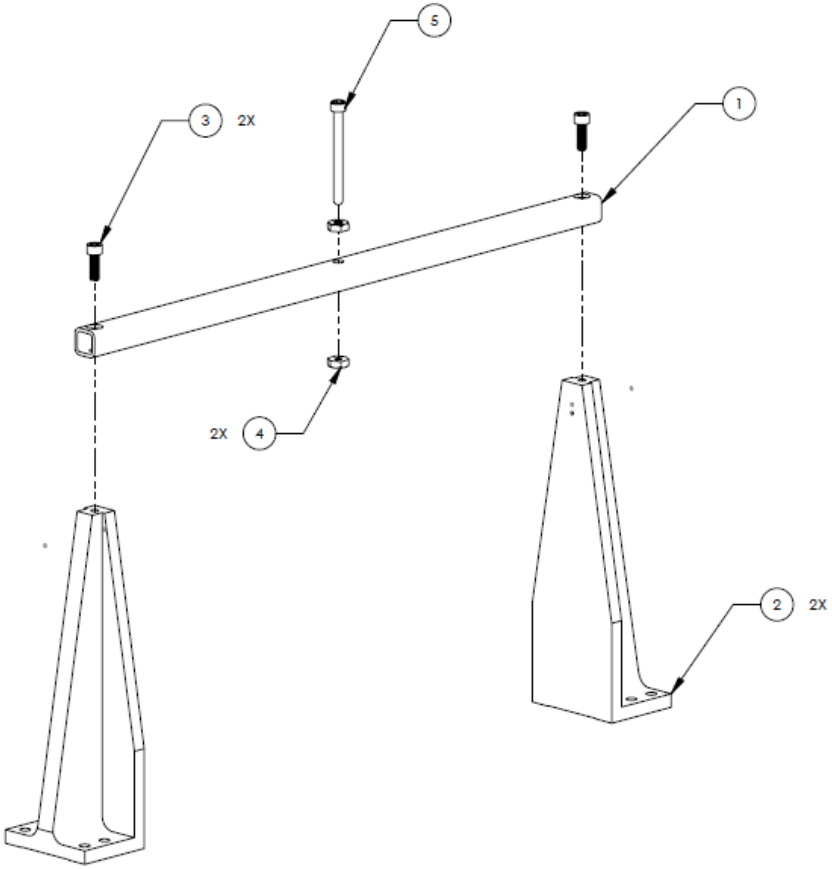




ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY	TOTAL
3	C-814-N	C-814-N_SHCS 8-32 X .875 IN LONG, UC COMPONENTS		4	0
2	D0900169	CROSSBAR SIDE	6061-T6 Al	2	0
1	D1002257	CROSSBAR PLATE_IN	6061-T6 Al	1	0

PARTS LIST

2.15 D0900579 Blade Guard Assy



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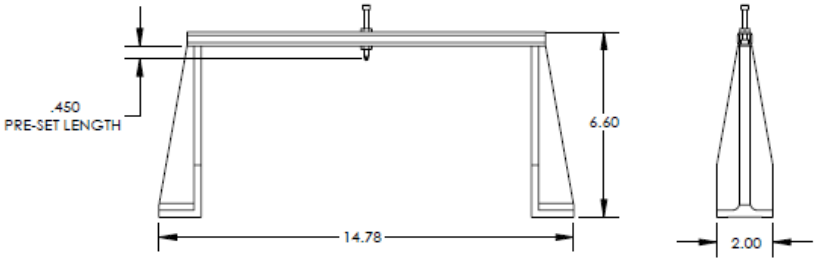
v3	01 MAR 2011	E1000563
v4	14 NOV 2012	E1000563



ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	TOTAL
5	D0900991	SCREW, SOCKET HEAD CAP, #8-32 UNC-3A X 1.75 LONG, FULLY THREADED, ROUNDED END	300 SSTL	1	1
4	N-832-A	HEX NUT 8-32, SILVER PLATED	Ag-PLATED 300 SSTL	2	2
3	C-808-N	SCREW, SHC, 8-32 x 1/2, MS16995-26,	300 SSTL	2	2
2	D0900578	BLADE GUARD RISER	6061-T6 Al	2	2
1	D0901271	BLADE GUARD CROSSPIECE	6061-T6 Al	1	1

PARTS LIST

2.16 D0900655 Structural Weldment Assy, OMC

Table 12: Bill of Material, D0900655 Structural Weldment Assy, OMC

REQ	SPARE	TOTAL	PART NUMBER	DESCRIPTION	MATERIAL	ITEM NO.
56	12	68	1185-2EN328	#8-32 X .328" HELICOIL ⟨8⟩	NITRONIC 60	4
64	14	78	90585A358	CHCS, 1/4-20 X 5/8" LONG (McMASTER-CARR)	316 SSTL	3
8	-	8	D0900309	CORNER BRACE, OMC STRUCTURAL WELDMENT	6061-T6 Al	2
1	-	1	D0900308	OMC STRUCTURAL WELDMENT	6061-T6 AL	1

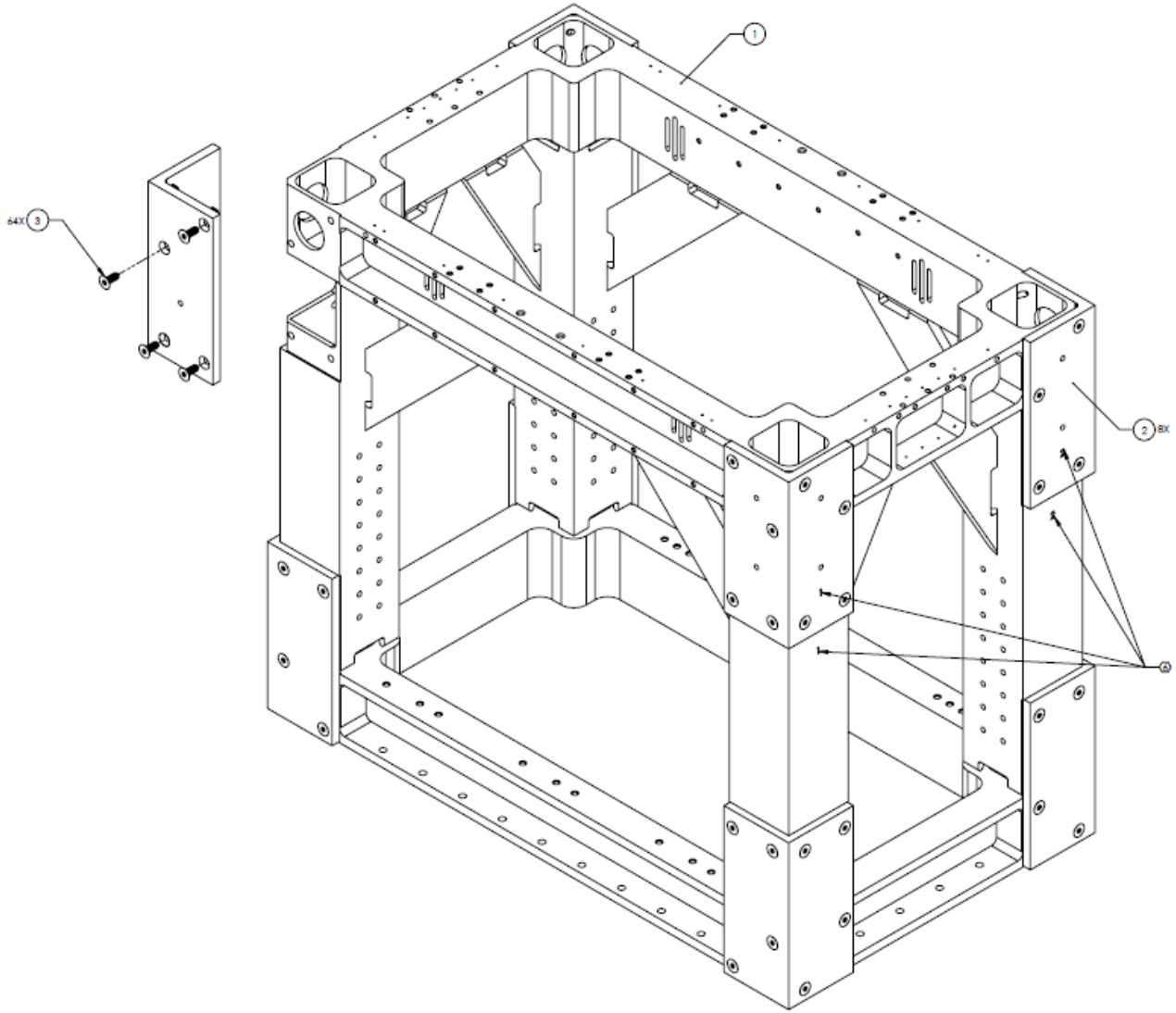


Figure 16: 2.16 D0900655 Structural Weldment Assy, OMC

3 OFI Balancing

3.1 Install Faraday Isolator Damper Holder Assembly

Mount the Damper Holder Assembly to the bottom cross beams, as shown in Figure 17. Set the nominal height of the top of the mounting bracket to 0.62 in, as shown in Figure 18.

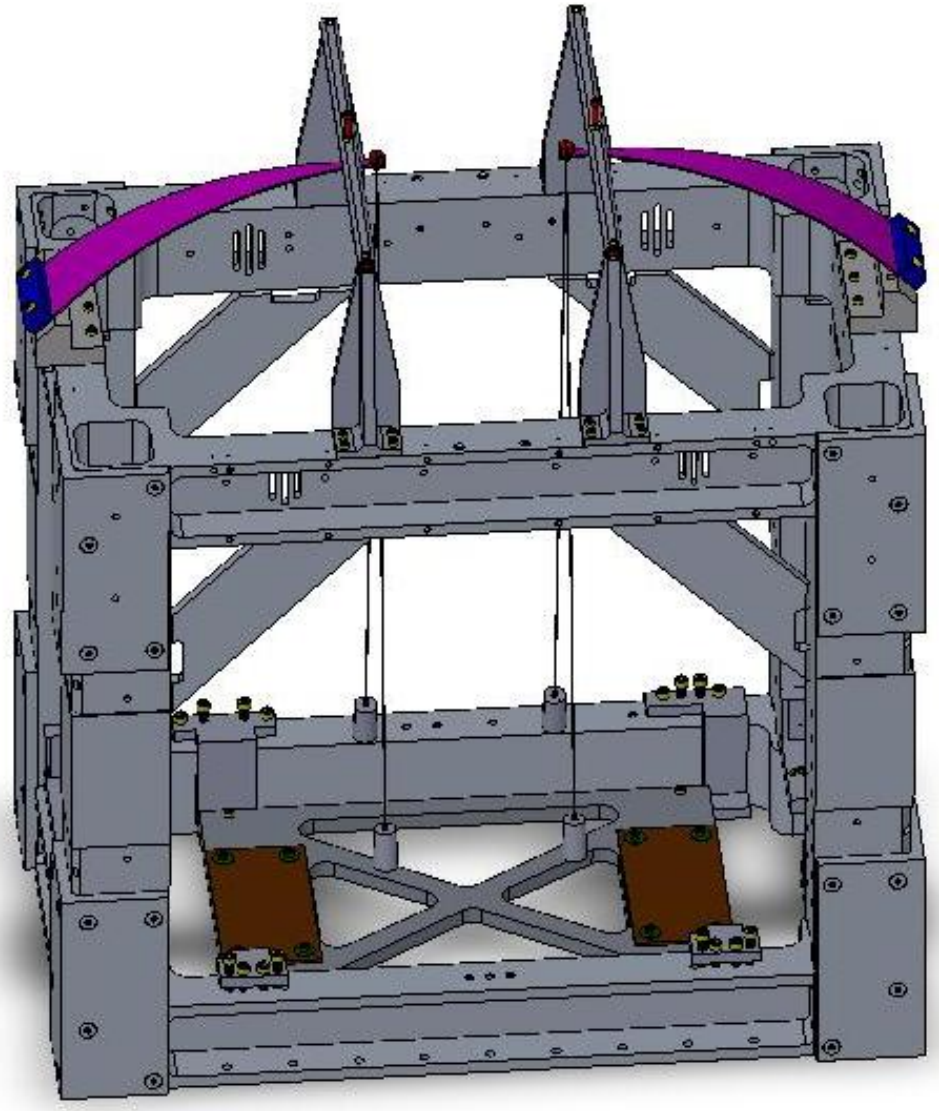


Figure 17: Mounting of the Damper Holder Assembly

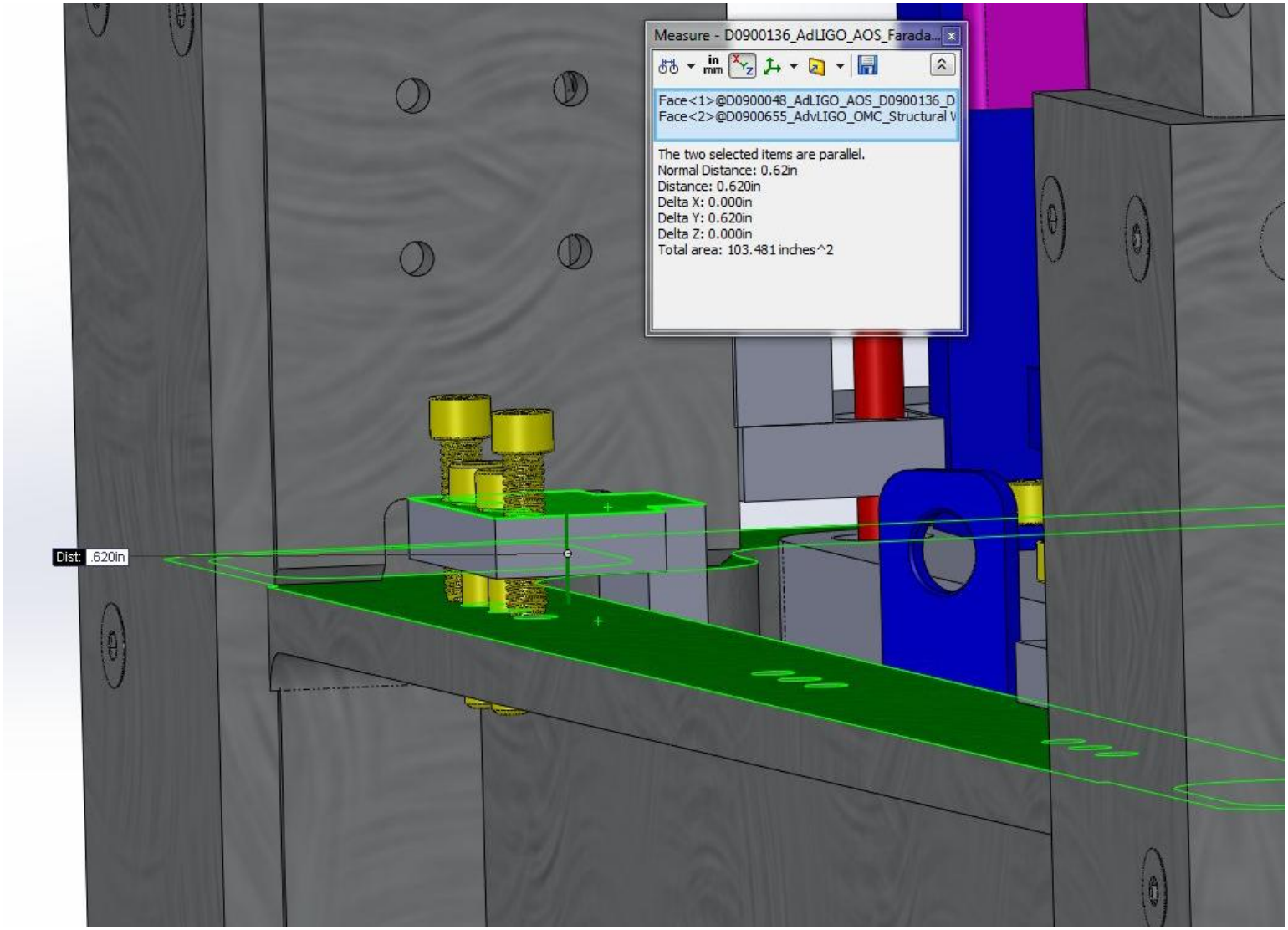


Figure 18: Nominal Height of Damper Holder Assy

3.2 Install Blade Springs

Mount the D0901514 BLADE CLAMP PLATFORM to the top end cross member of the structural Weldment, as shown in Figure 1: Output Faraday Isolator Assembly.

Clamp the D0900541 FI Upper Blade Spring with the D0900566 Up Blade Clamp Top.

Note: The blade pairs are listed in Table 13**; place the stiffest blade of the pair on the input side of the OFI.**

3.3 Install Blade Guard Assembly

Mount two Blade Guard Assemblies, D0900579 Blade Guard Assy, to the OMC structure top, as shown in Figure 1. Adjust the length of the 8-32 bolt to extend 0.45in below the lower side of Blade Guard Crosspiece, as shown in D0900579.

Loosen the D0900566 Up Blade Clamp Top slightly so that the tip of blade spring tip can be moved laterally to align with the 8-32 bolt; then, firmly re-clamp the blade spring.

3.4 Install Upper Wire Assembly

See 2.12 D0900586 Faraday Isolator Upper Wire Assembly.

3.4.1 Clamp Wire Clamp to Tip of Blade Spring

Clamp the Music Wire Split Clamp to the tip of the blade spring with the Split Clamp Clamp D1300321, as shown in

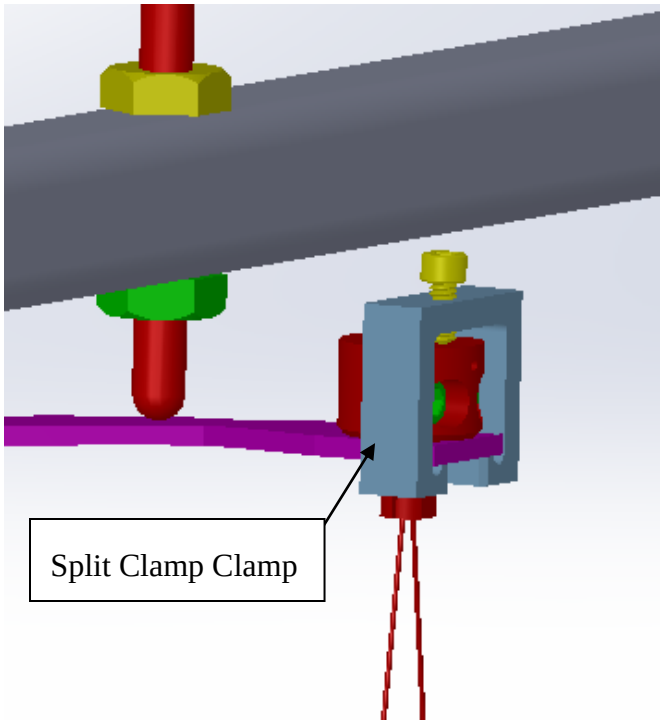


Figure 19: Split Clamp Clamp D1300321

3.5 Install Table Assy

See 2.11 Faraday Isolator Table Assy.

Attach the Wire Adjustable Adapter to the ¼-20 bolt, as shown in Figure 24. Screw the adapter onto the bolt with approximately 0.25 in gap between the adapter bottom and the nut; this gap will be adjusted during the subsequent table balancing step.

3.6 Balance Table

3.6.1 Adjust Balance Weights

Two sets of balance weights, CW1 and CW2, are used to balance the suspended OFI optical table; the weights and their positions are specific to a particular pair of as-built matched blade springs. The matched blade springs for the light optical table_D0900015-v4 are listed Table 13 below, together with the magnitude and mounting positions for the weights; the matched blade springs for the heavy optical table_D0900015-v5 are listed Table 14. The off-set mounting positions are described in the Figure 20 and Figure 21. Load each spring to its measured suspended weight by placing the specified balance weight at the correct position; this will also place the center of gravity of the optics table approximately at the midpoint between the suspension wires, as indicated by the intersection of the lines drawn between the four suspension wires in Figure 20 and Figure 21.

Table 13: Light Optical Table_D0900015-v4: Balance Weights and Positions

E1300043-v2 Blade pairs	S/N	Blade Balance Weight, kg	Blade Balance Weight, lbs	x-offset of CW1 from mounting bolt, in	CW1 (centered), lbs		CW1 assembly		y-offset of CW2 from mounting bolt, in	CW2 (offset), lbs		CW1 assembly	
						1#	0.5#	0.25#			3#	0.5#	0.25#
1, 1st article	11	6.50	14.33	-0.276	0.50	0	1	0	0.717	3.25	1	0	1
	7	6.50	14.33										
2, LLO	5	6.45	14.22	0.374	0.75	0	1	1	0.770	3.00	1	0	0
	9	6.45	14.22										
3, LHO	4	6.65	14.66	0.000	1	1	0	0	0.673	3.50	1	1	0
	1	6.60	14.55										
5, H2	2	6.55	14.44	0.000	0.75	0	1	1	0.717	3.25	1	0	1
	6	6.45	14.22										
6, spare	12	6.80	14.99	0.294	1.50	1	1	0	0.635	3.75	1	1	1

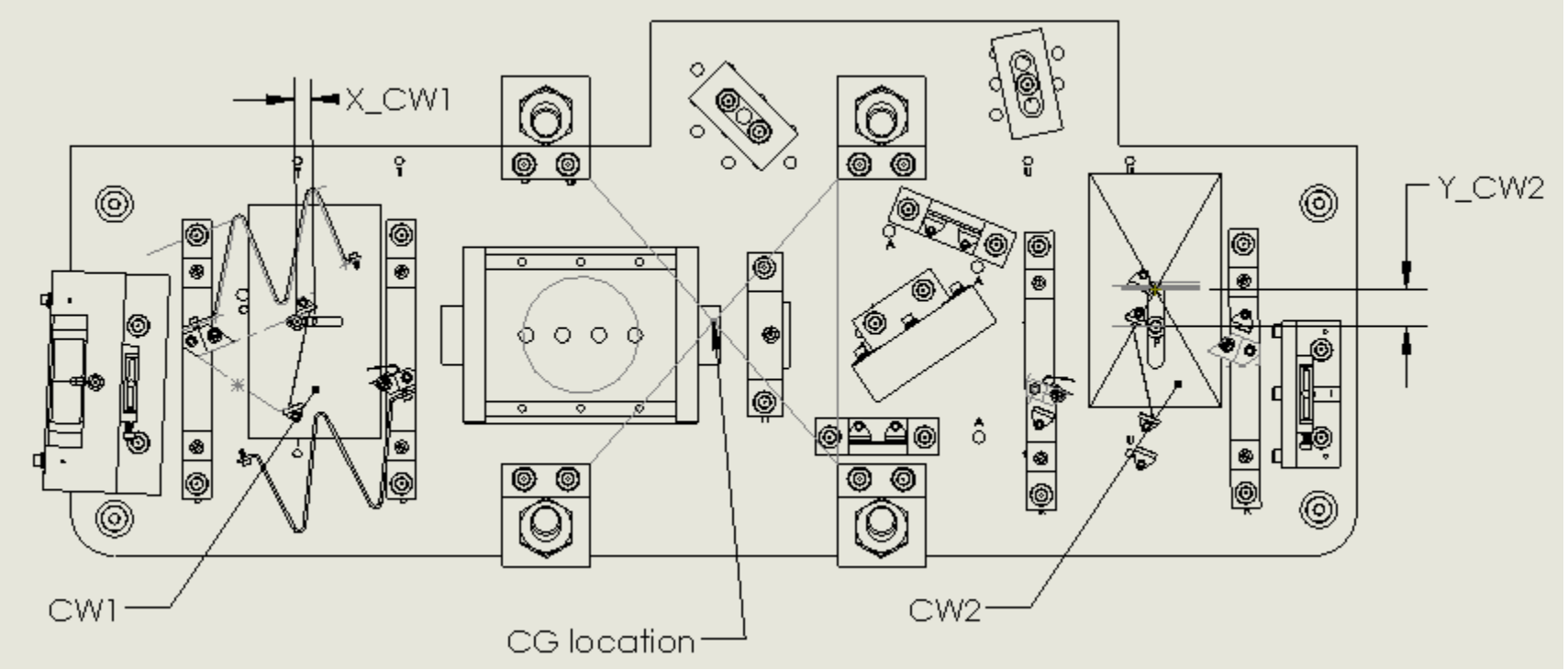


Figure 20: Light Optical Table_D0900015-v4: Off-set Positions for Balance Weights CW1 and CW2

Table 14: Heavy Optical Table_D0900015-v5: Balance Weights and Positions

Blade pairs	E1300043-v3 S/N	Location	Blade Balance Weight, kg	Blade Balance Weight, lbs	x-offset of CW1 from mounting bolt, in	CW1, lbs	CW1 weight assembly				y-offset of CW2 from mounting bolt, in	CW2, lbs	CW2 weight assembly			
							1#	0.5#	0.25#	0.13#			3#	1#	0.5#	0.25#
1	11	Input	9.22	20.33	0.218	1.63	1	1	0	1	-0.575	3.75	1	0	1	1
	12	Output	9.22	20.33												
2	13	Input	9.15	20.18	0.296	1.63	1	1	0	1	-0.575	3.75	1	0	1	1
	14	Output	9.17	20.22												
3	15	Input	9.17	20.22	-0.296	1.50	1	1	0	0	-0.480	3.75	1	0	1	1
	19	Output	9.19	20.26												
4	16	Input	9.07	20.00	-0.030	1.38	1	0	1	1	-0.413	3.50	1	0	1	0
	18	Output	8.99	19.82												
5	17	Input	9.20	20.29	0.046	1.75	1	1	1	0	-0.627	4.00	1	2	0	0
	20	Output	9.32	20.55												
total weights needed							5	4	2	3			5	2	4	3

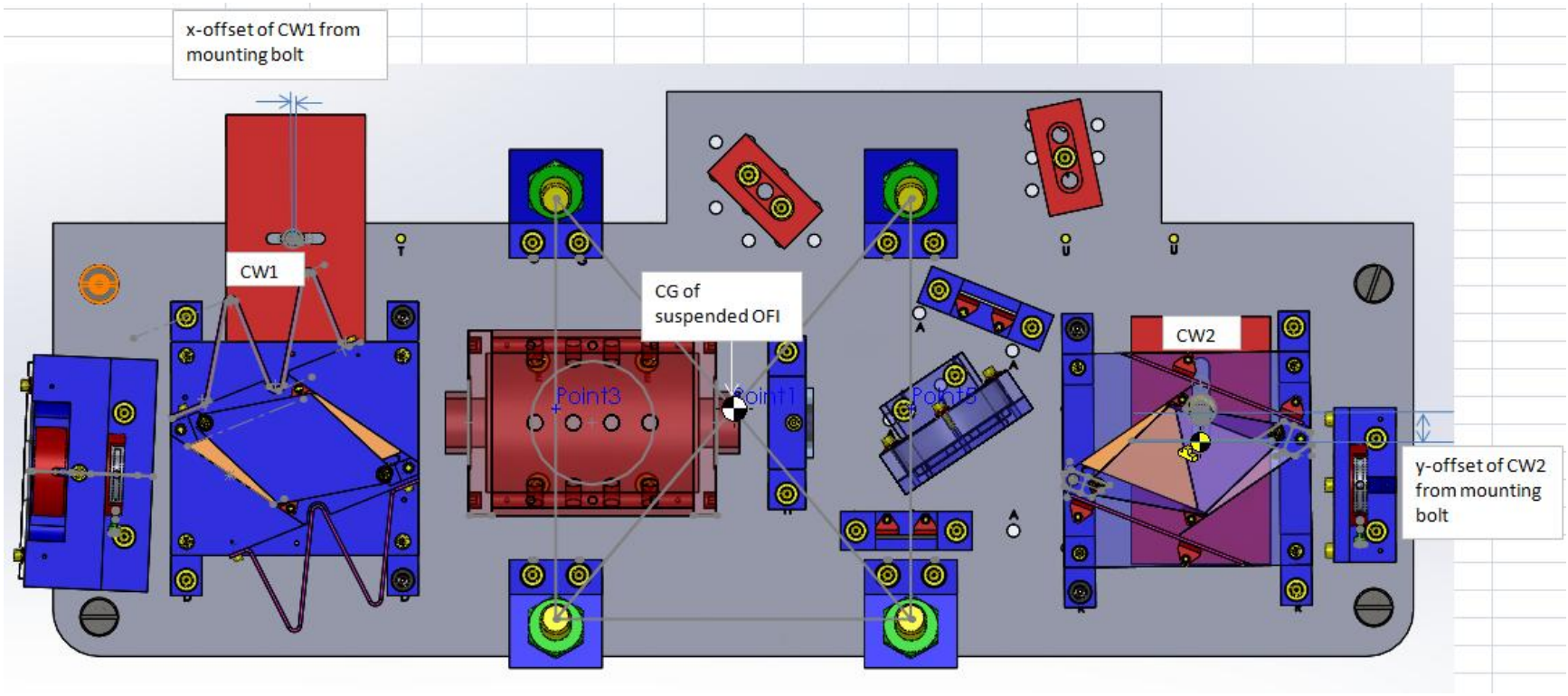
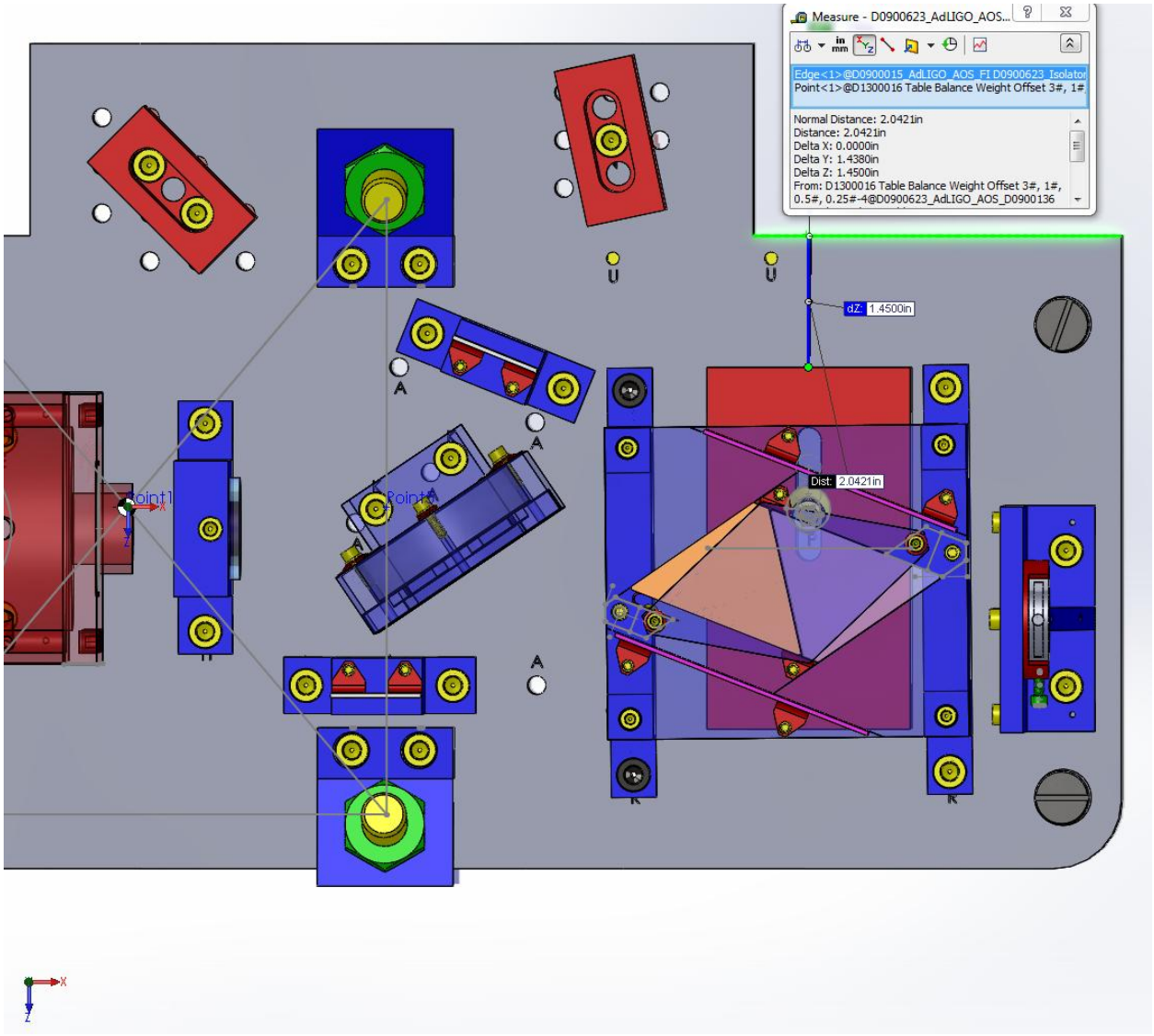
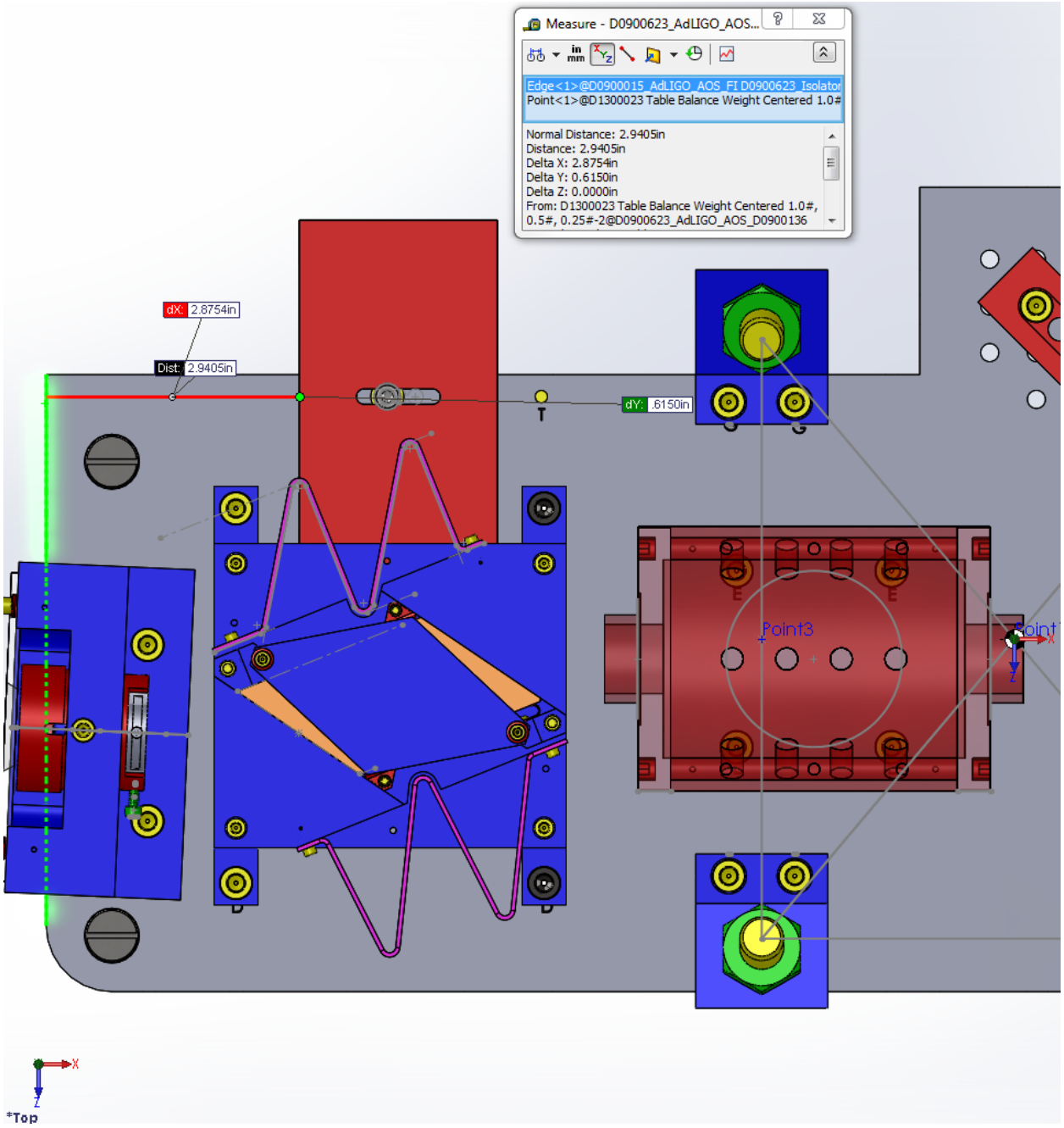


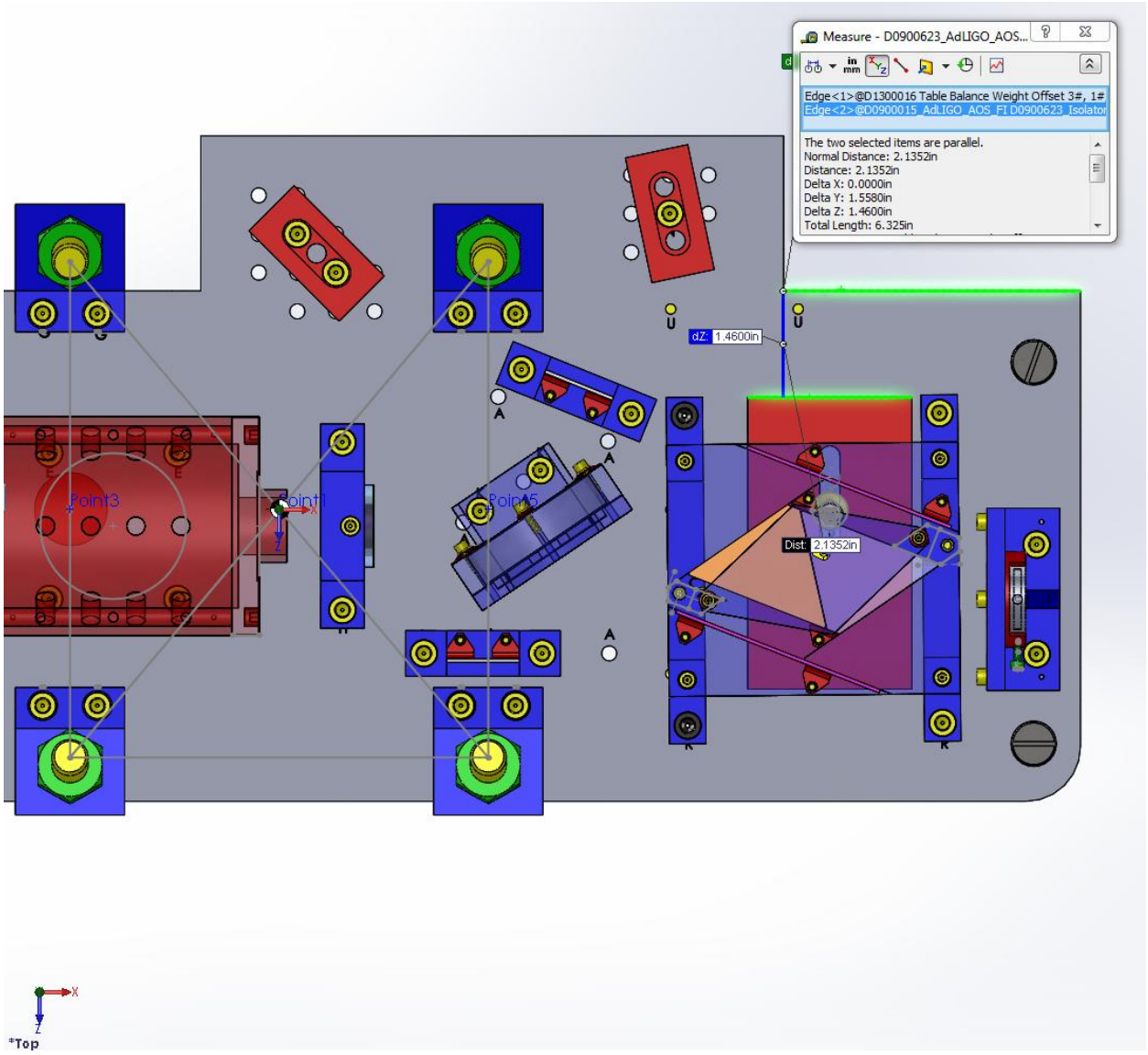
Figure 21: Heavy Optical Table_D0900015-v5: Off-set Positions for Balance Weights CW1 and CW2

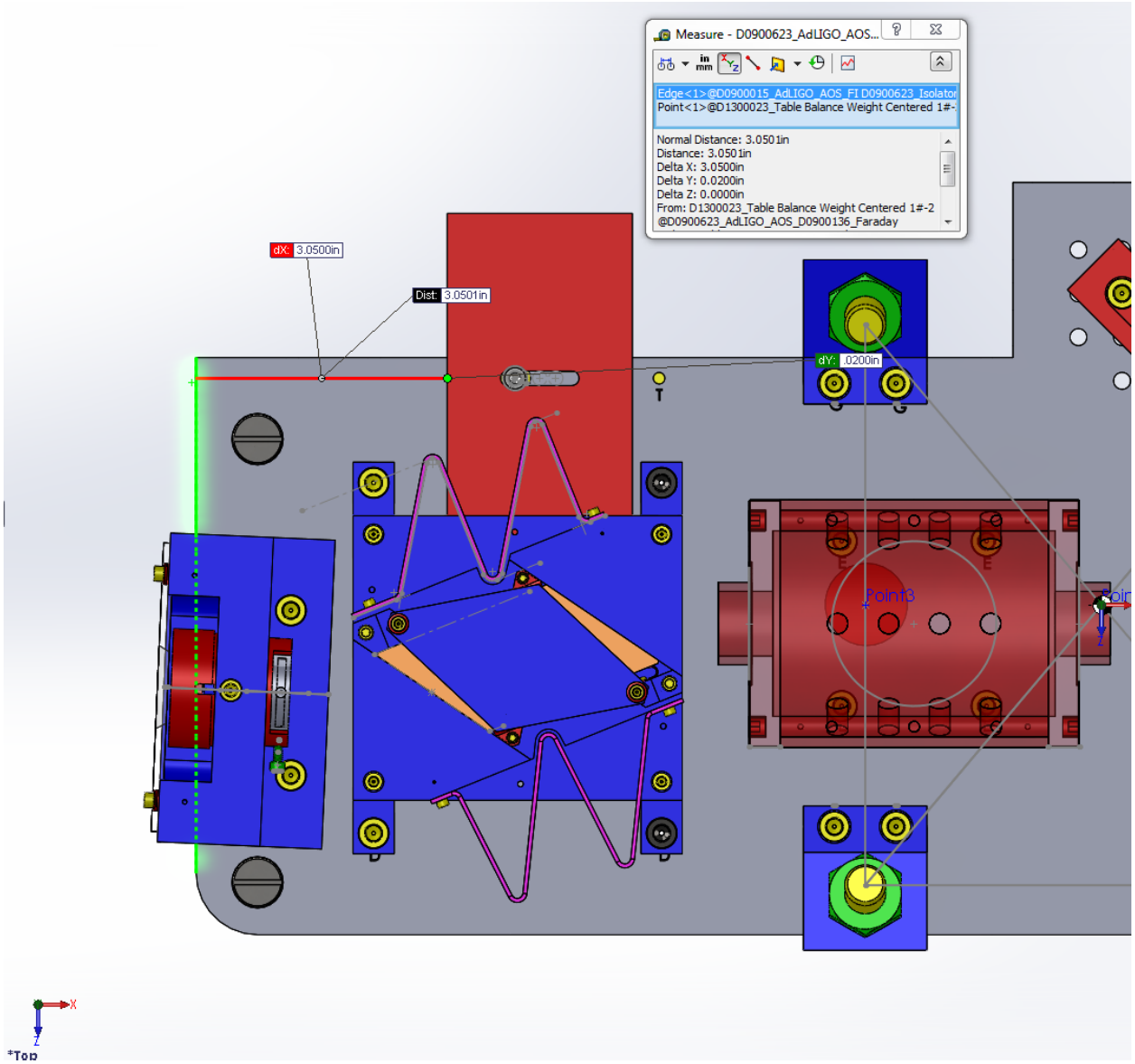
3.6.1.1 D0900015-v5 Weight Offset Locations—Pair 1



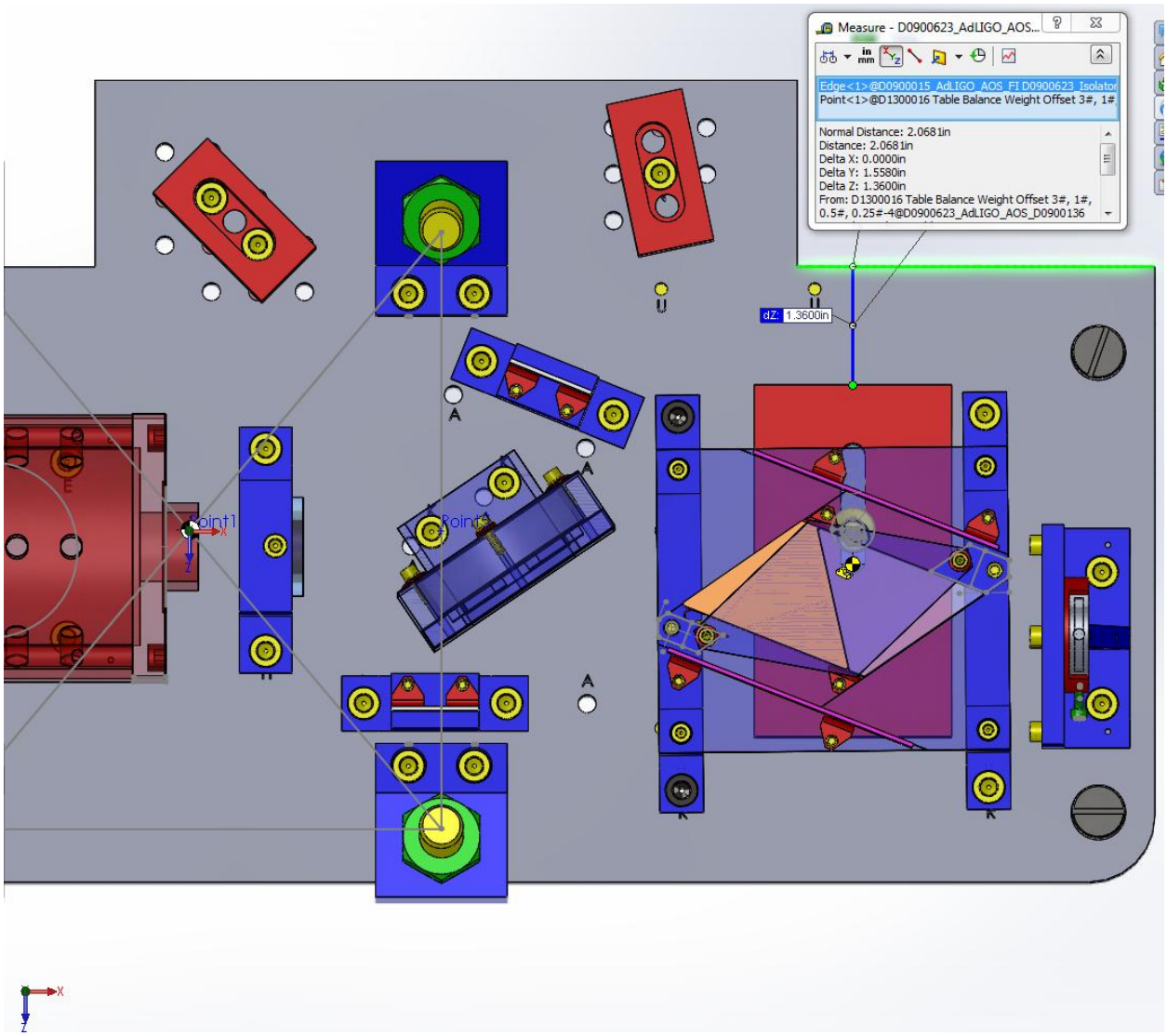

Measure - D0900623_AdLIGO_AOS...
Edge<1>@D0900015_AdLIGO_AOS_FI D0900623_Isolator
Point<1>@D1300023 Table Balance Weight Centered 1.0#
Normal Distance: 2.9405in
Distance: 2.9405in
Delta X: 2.8754in
Delta Y: 0.6150in
Delta Z: 0.0000in
From: D1300023 Table Balance Weight Centered 1.0#, 0.5#, 0.25#-2@D0900623_AdLIGO_AOS_D0900136
dX: 2.8754in
Dist: 2.9405in
dY: .6150in
Point3
*Top

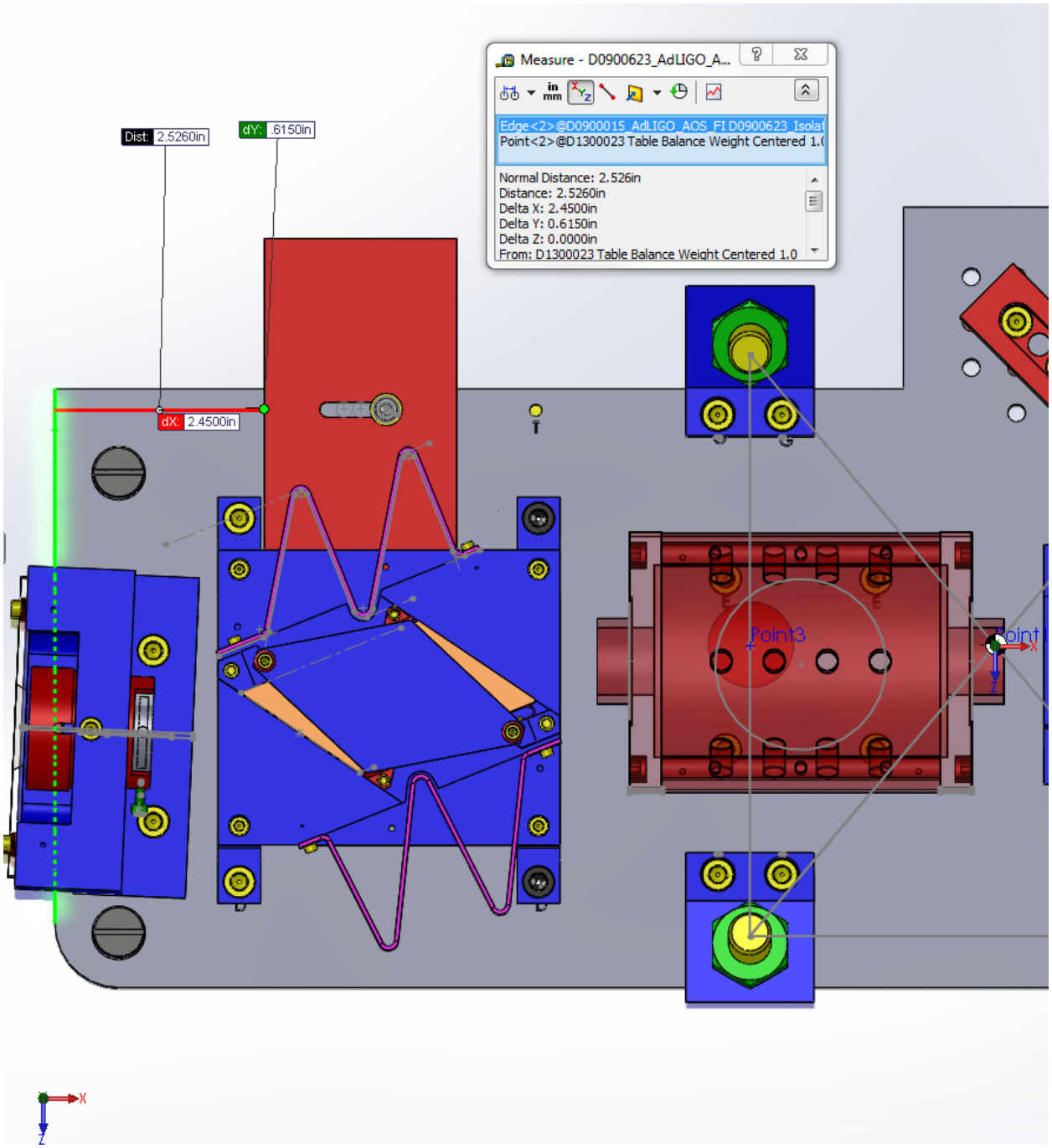
3.6.1.2 D0900015-v5 Weight Offset Locations—Pair 2



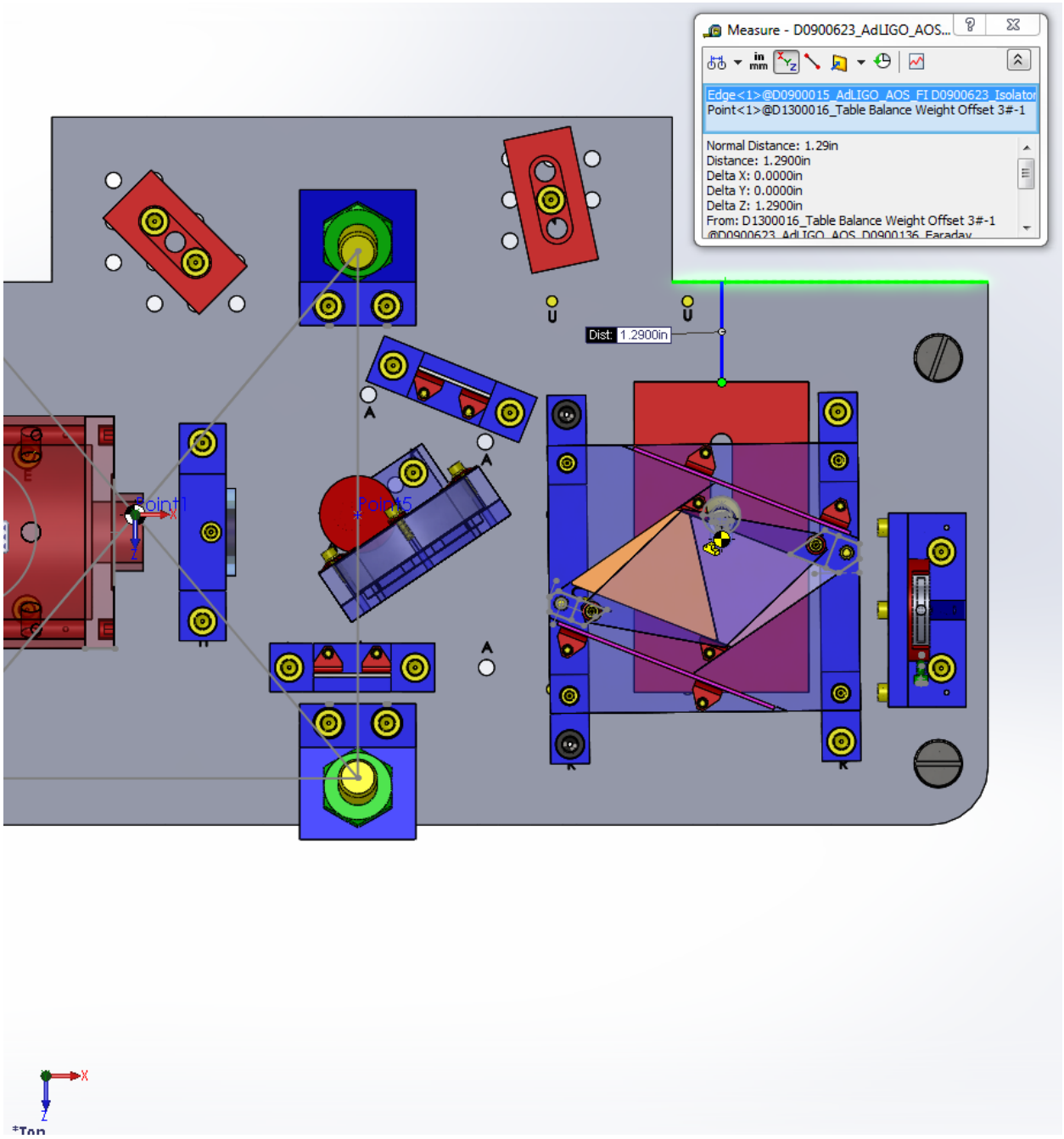

Measure - D0900623_AdLIGO_AOS...
Edge<1>@D0900015_AdLIGO_AOS_FI D0900623_Isolator
Point<1>@D1300023_Table Balance Weight Centered 1#-
Normal Distance: 3.0501in
Distance: 3.0501in
Delta X: 3.0500in
Delta Y: 0.0200in
Delta Z: 0.0000in
From: D1300023_Table Balance Weight Centered 1#-2
@D0900623_AdLIGO_AOS_D0900136_Faraday
dX: 3.0500in
Dist: 3.0501in
dY: .0200in
Point3
*Top

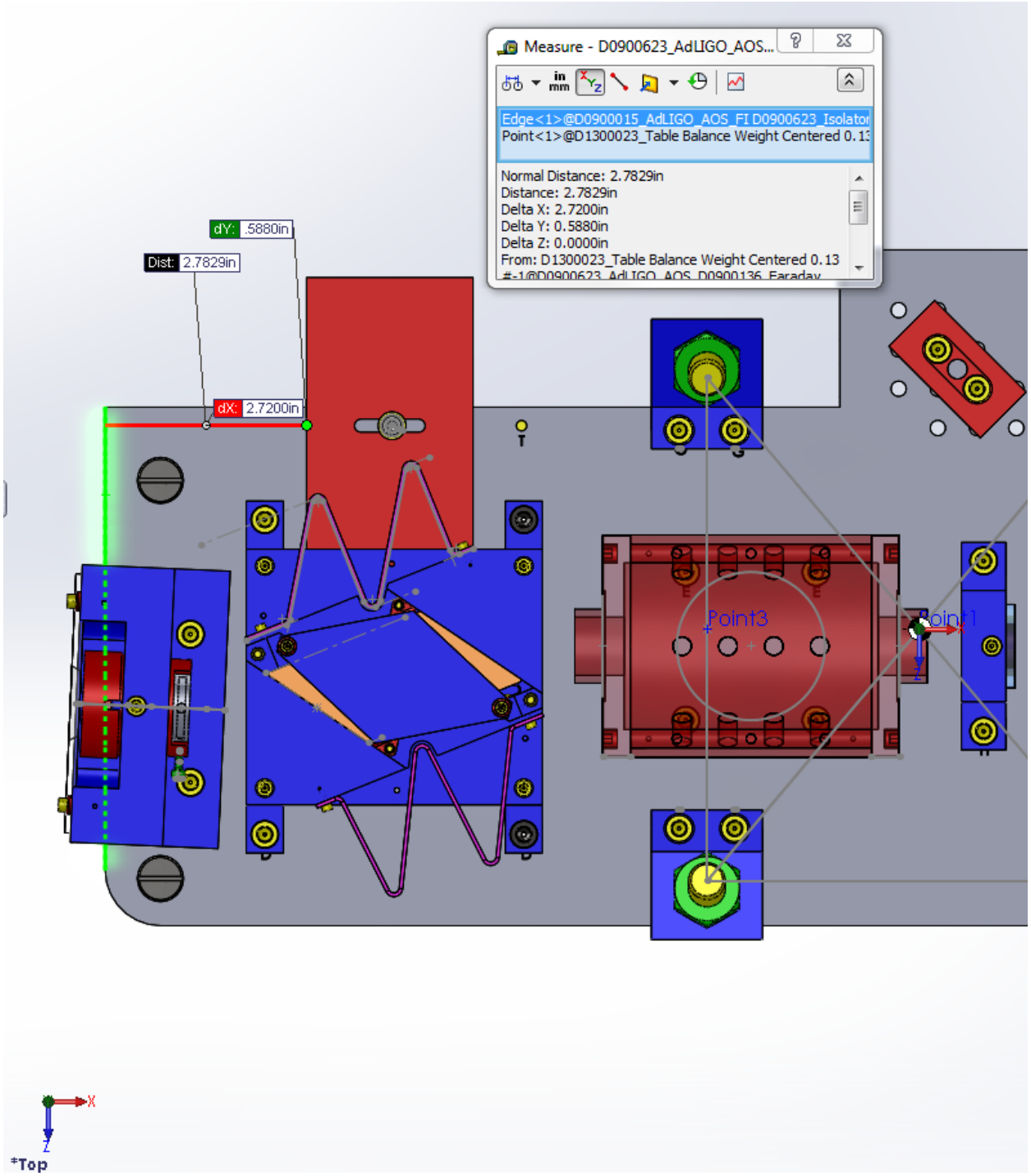
3.6.1.3 D0900015-v5 Weight Offset Locations—Pair 3



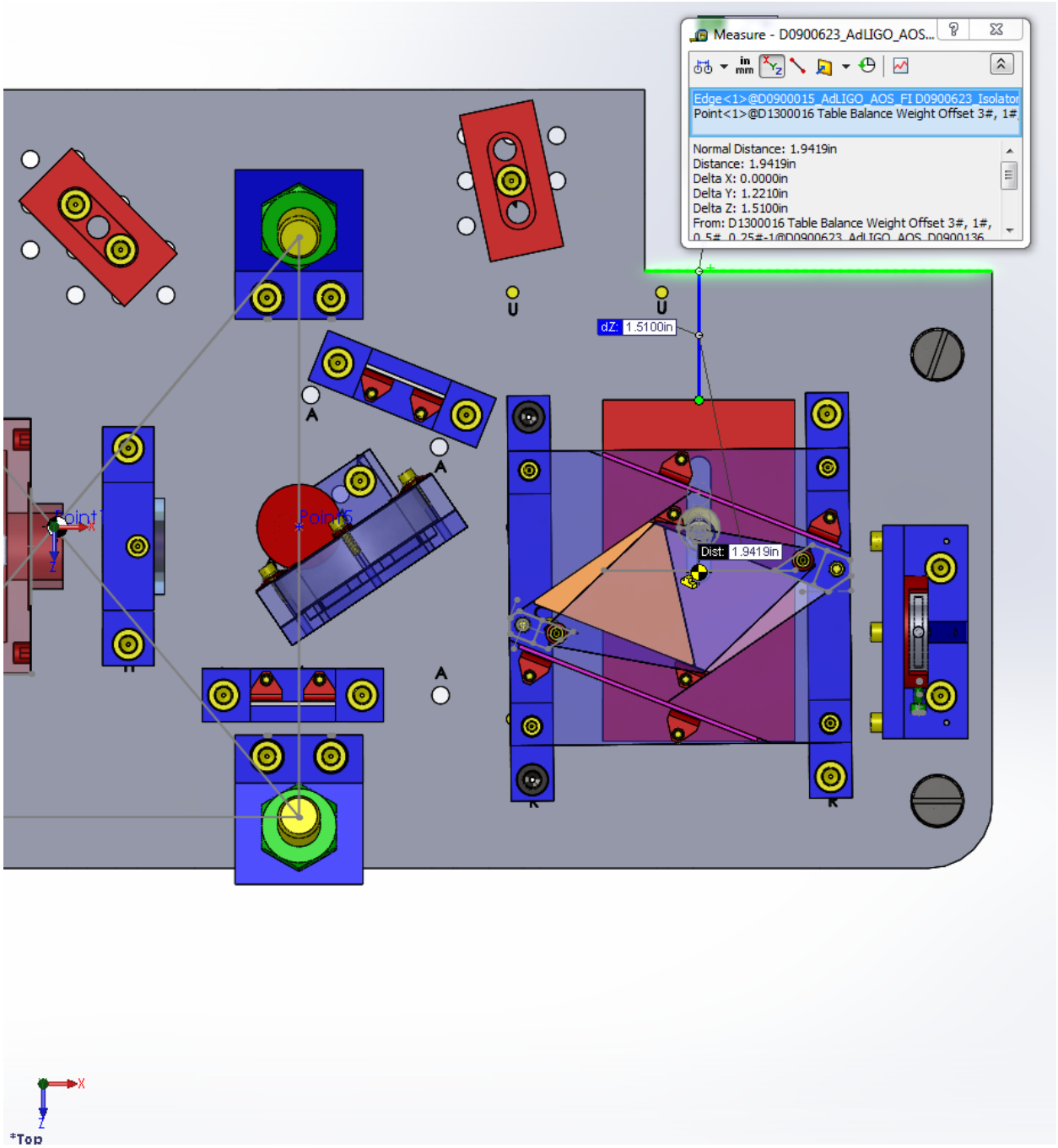

Measure - D0900623_AdLIGO_A...
Edge<2>@D0900015_AdLIGO_AOS_FI D0900623_Isolat
Point<2>@D1300023 Table Balance Weight Centered 1.(
Normal Distance: 2.526in
Distance: 2.5260in
Delta X: 2.4500in
Delta Y: 0.6150in
Delta Z: 0.0000in
From: D1300023 Table Balance Weight Centered 1.0
Dist: 2.5260in
dY: .6150in
dX: 2.4500in
Point3

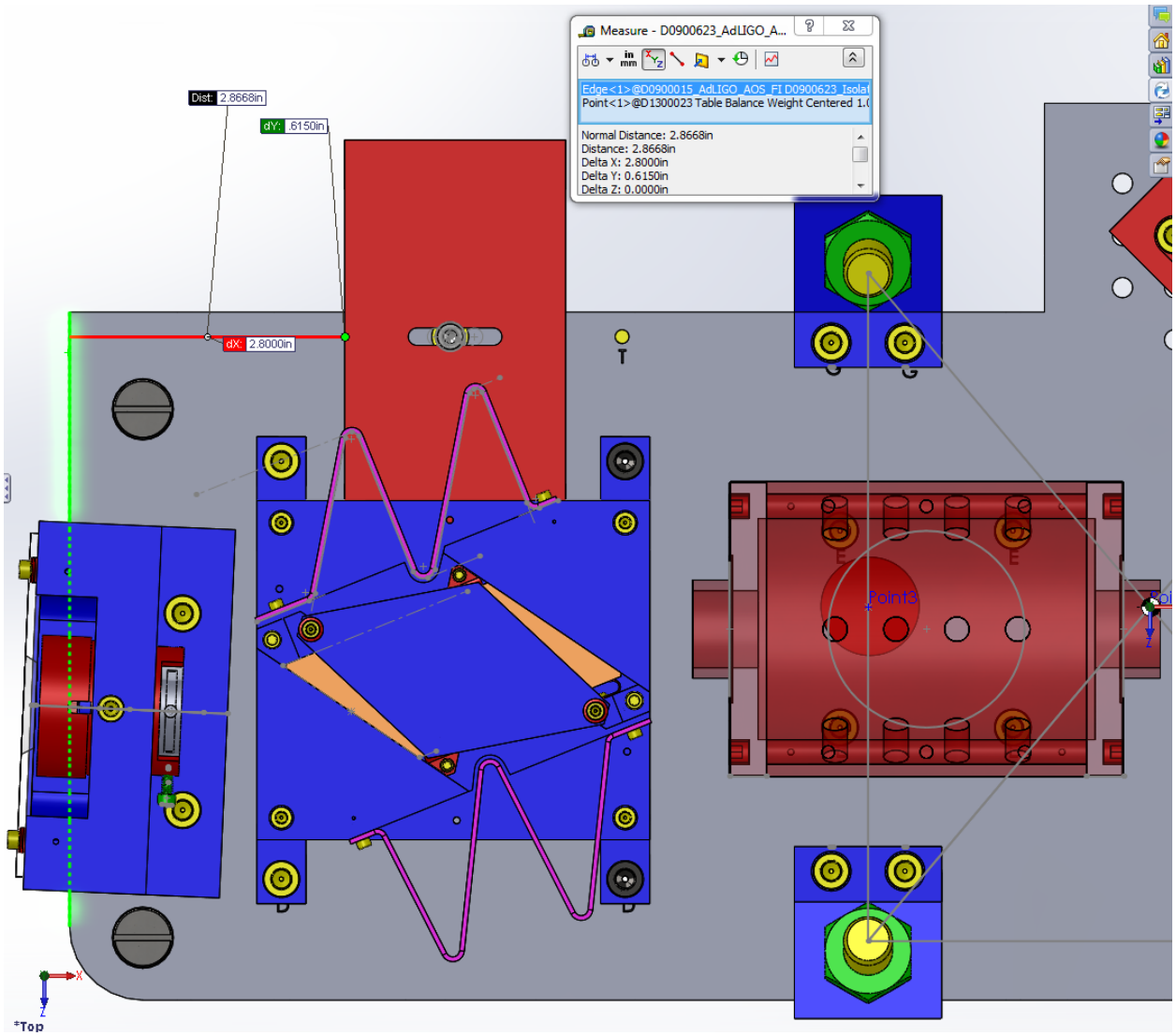
3.6.1.4 D0900015-v5 Weight Offset Locations—Pair 4




Measure - D0900623_AdLIGO_AOS...
Edge<1>@D0900015_AdLIGO_AOS_FI D0900623_Isolator
Point<1>@D1300023_Table Balance Weight Centered 0.13
Normal Distance: 2.7829in
Distance: 2.7829in
Delta X: 2.7200in
Delta Y: 0.5880in
Delta Z: 0.0000in
From: D1300023_Table Balance Weight Centered 0.13
dY: .5880in
Dist: 2.7829in
dX: 2.7200in
Point3
Point1
*Top

3.6.1.5 D0900015-v5 Weight Offset Locations—Pair 5




Measure - D0900623_AdLIGO_A...
Edge<1>@D0900015_AdLIGO_AOS_FI D0900623_Isolat
Point<1>@D1300023 Table Balance Weight Centered 1.(
Normal Distance: 2.8668in
Distance: 2.8668in
Delta X: 2.8000in
Delta Y: 0.6150in
Delta Z: 0.0000in
Dist: 2.8668in
dY: .6150in
dX: 2.8000in
Point3
*Top

3.6.2 Setting Gap Between Blade Guard Assembly and Spring Blade

After the balance weights are added, retract the 8-32 screws in the Blade Guard Assembly until the spring blade tip is approximately 0.25in and is free to move vertically without any constraints. Lock the nuts to secure the 8-32 screws.

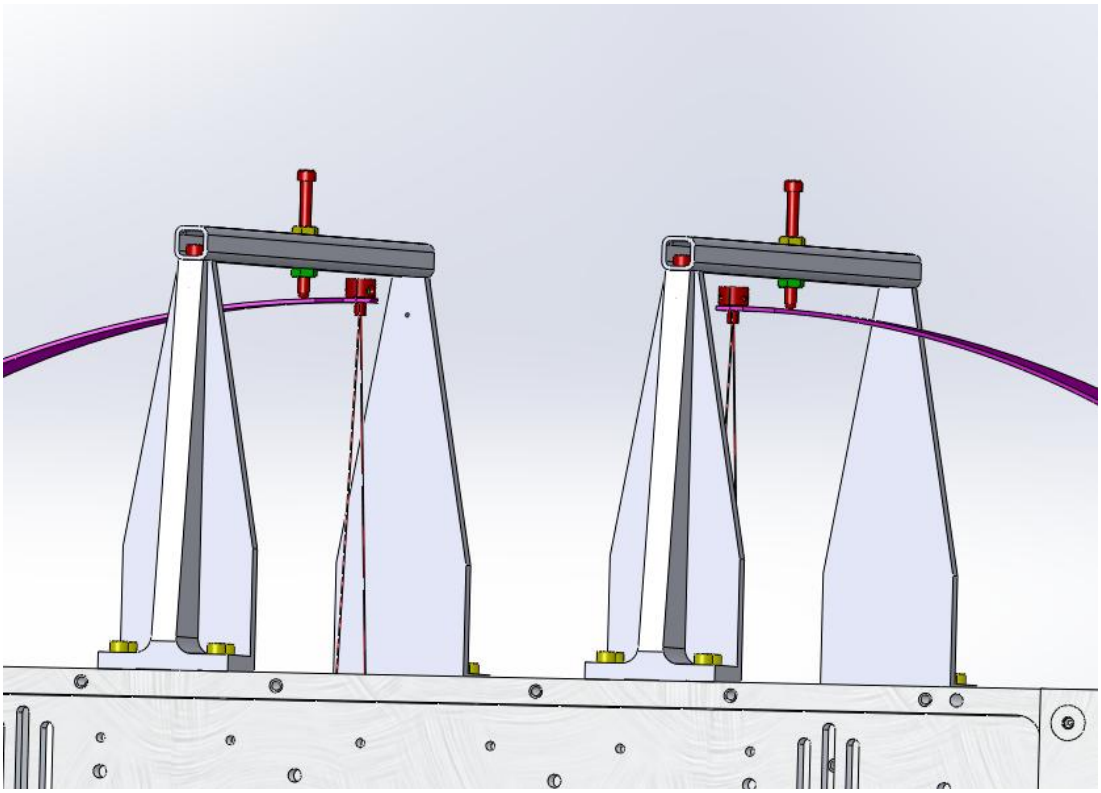


Figure 22: Retract Spring Restraints 0.25in so that Blades Move Freely in Vertical Direction

3.6.3 Adjust Wire Lengths

1. Place the guitar tuner against the base of the blade spring, as shown in Figure 23, so that it will pick up the sound of the suspension wire when strummed.

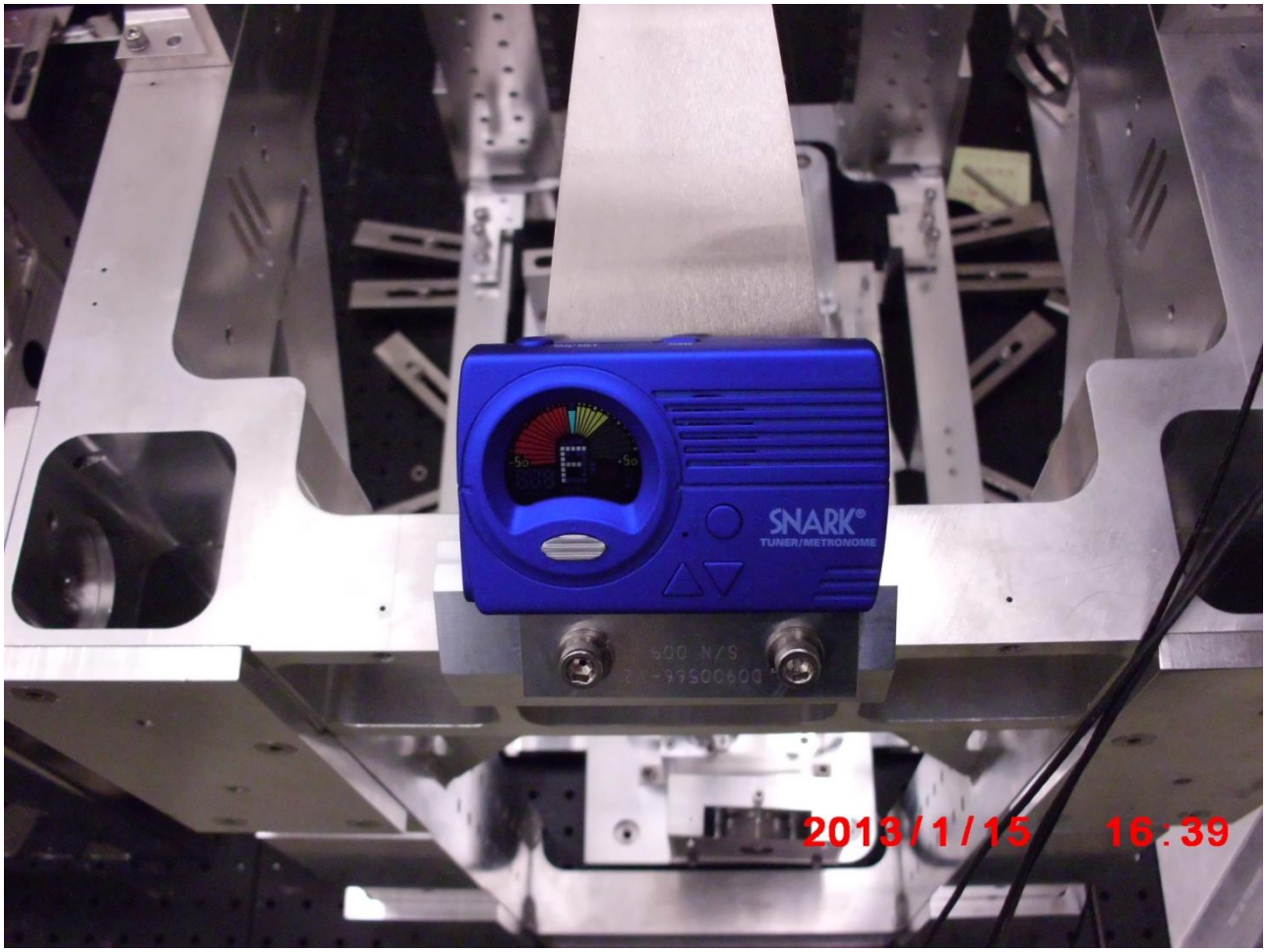


Figure 23: Guitar Tuner Placed at Base of Blade Spring

2. Strum the wire as you would a guitar string and watch the frequency on the guitar tuner. Tension the wire by turning the Wire Adjustable Adapter while holding the Music Wire Split Clamp with a pair of pliers so that the Music Wire Split Clamp does not rotate within the Wire Adjustable Adapter, until the desired frequency is displayed on the guitar tuner. The objective is to match the frequencies of the pair of wires connected to the same blade spring. In general, the wire pairs from the front and back blade springs will have different frequencies because the blade springs may have different stiffness.

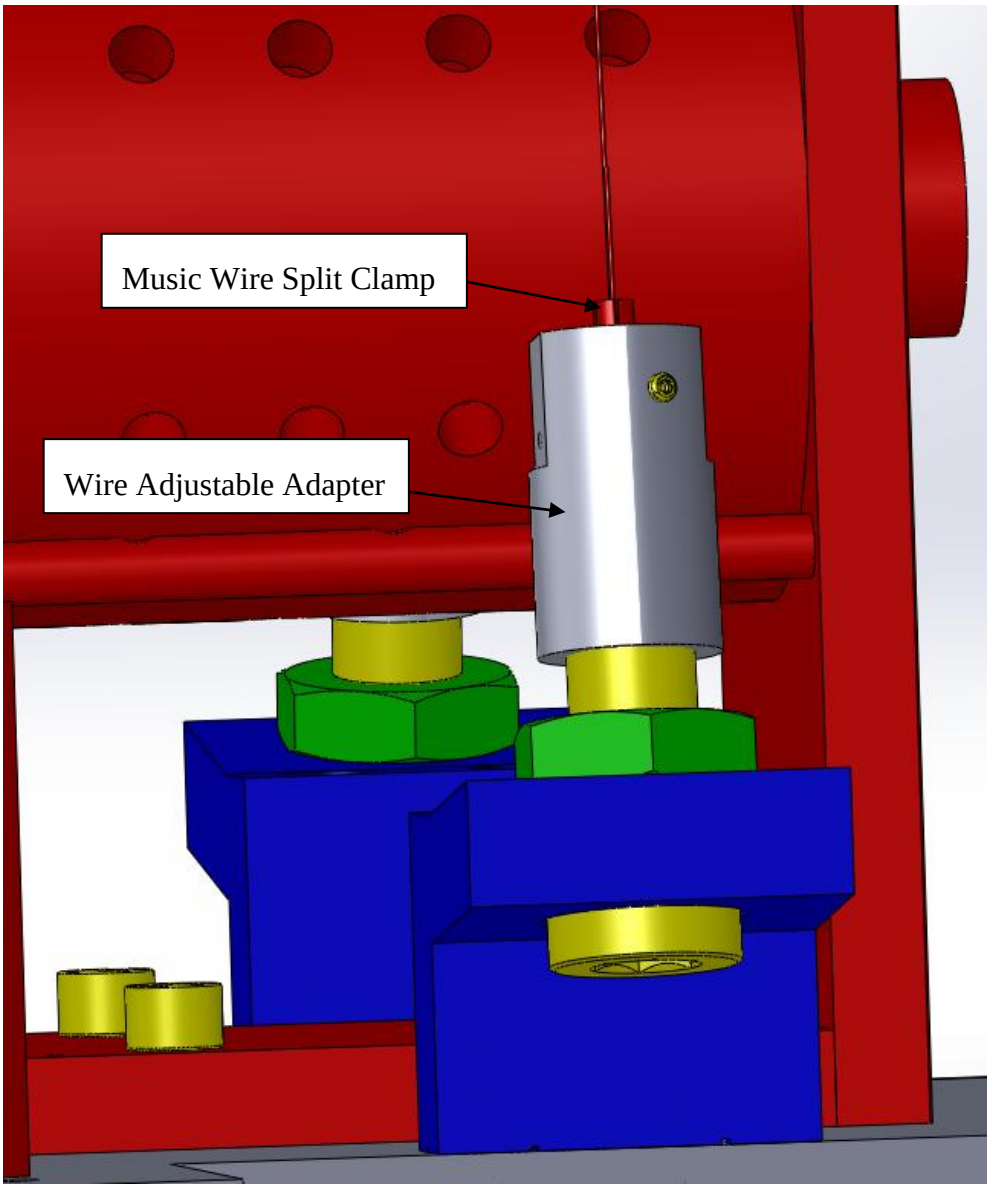


Figure 24: Wire Tension Adjustment

3. Place the Table Height Gauge (Figure 25) on the OMC Structure Base to set the nominal height of the suspended optical table 0.105 in above the base, as shown in Figure 26.

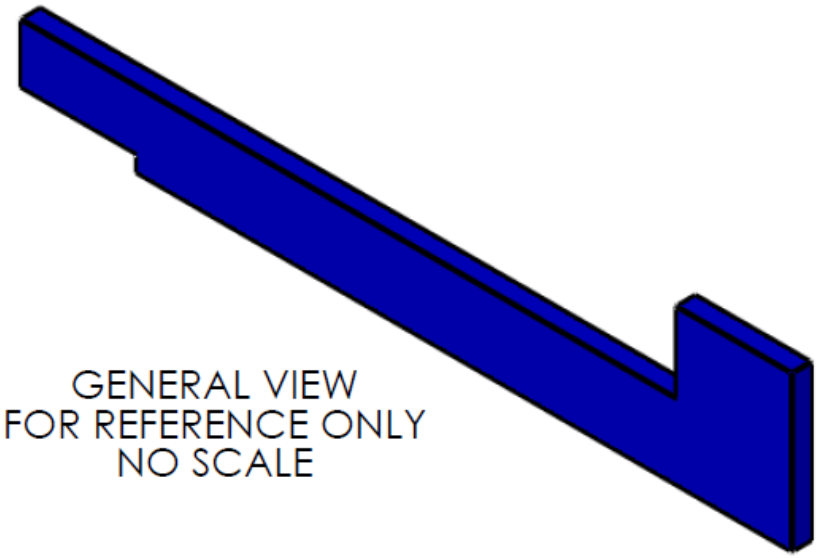


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Figure 25: Table Height Gauge, D1201449

This may result in the wire tuning changing. To reach a compromise between equal wire tension and equal table height on both sides, the balance weight CW2 may need to be shifted laterally to a position different from that listed in Table 13.

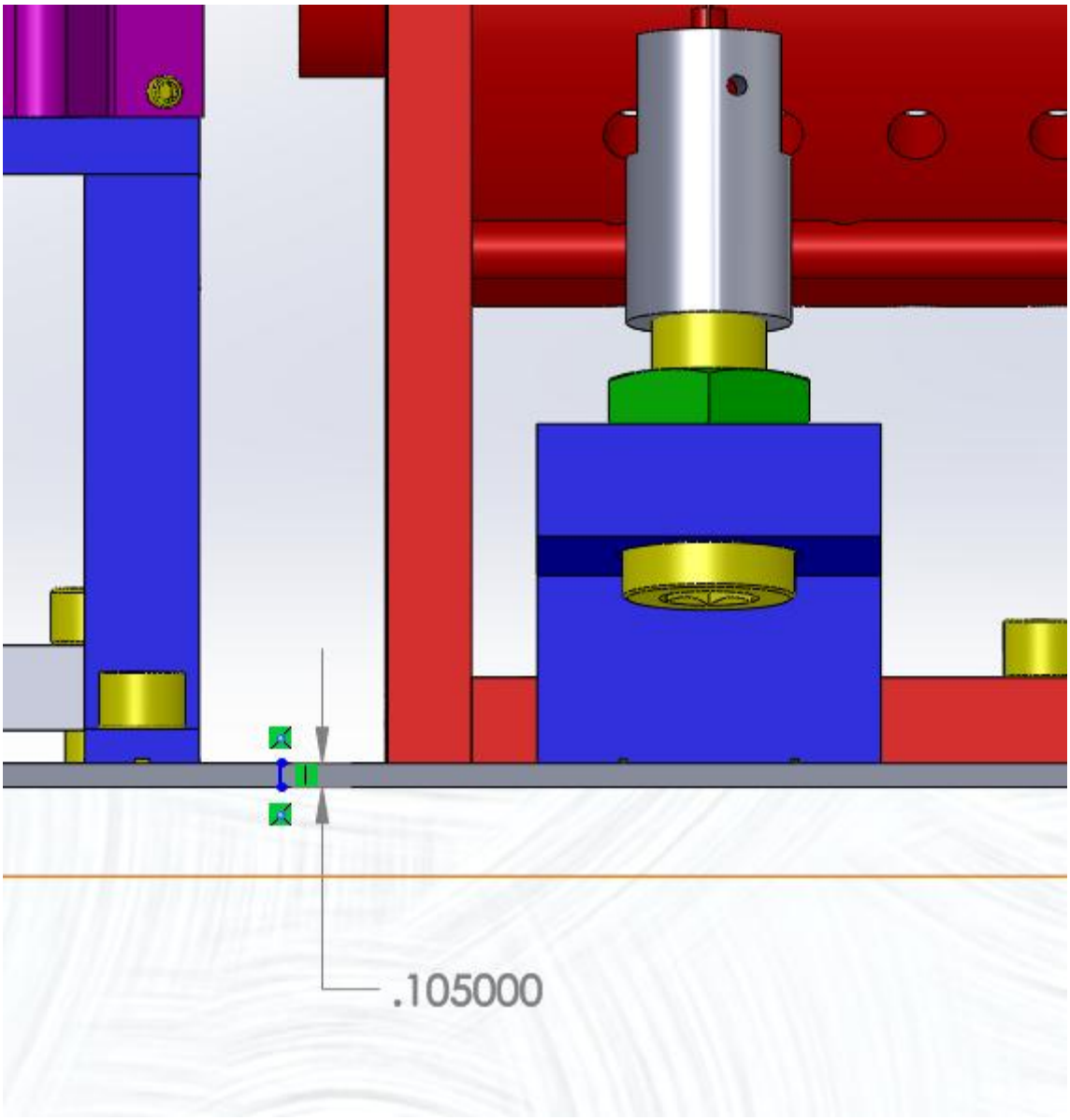

Figure 26: Nominal Height of Optics Table above the Structure Base

4. Verify that the Damper Holder Assy bracket is 0.515 in above the Optics Table by placing the Table Height Gauge (Figure 25) on the Damper Holder Assy bracket and using the other end of the height gauge.

3.7 Install Earthquake Crossbar Assy

Attach the Output Faraday Isolator Earthquake Stop Post D1300136 to the four corners of the optics table, as shown in Figure 27.

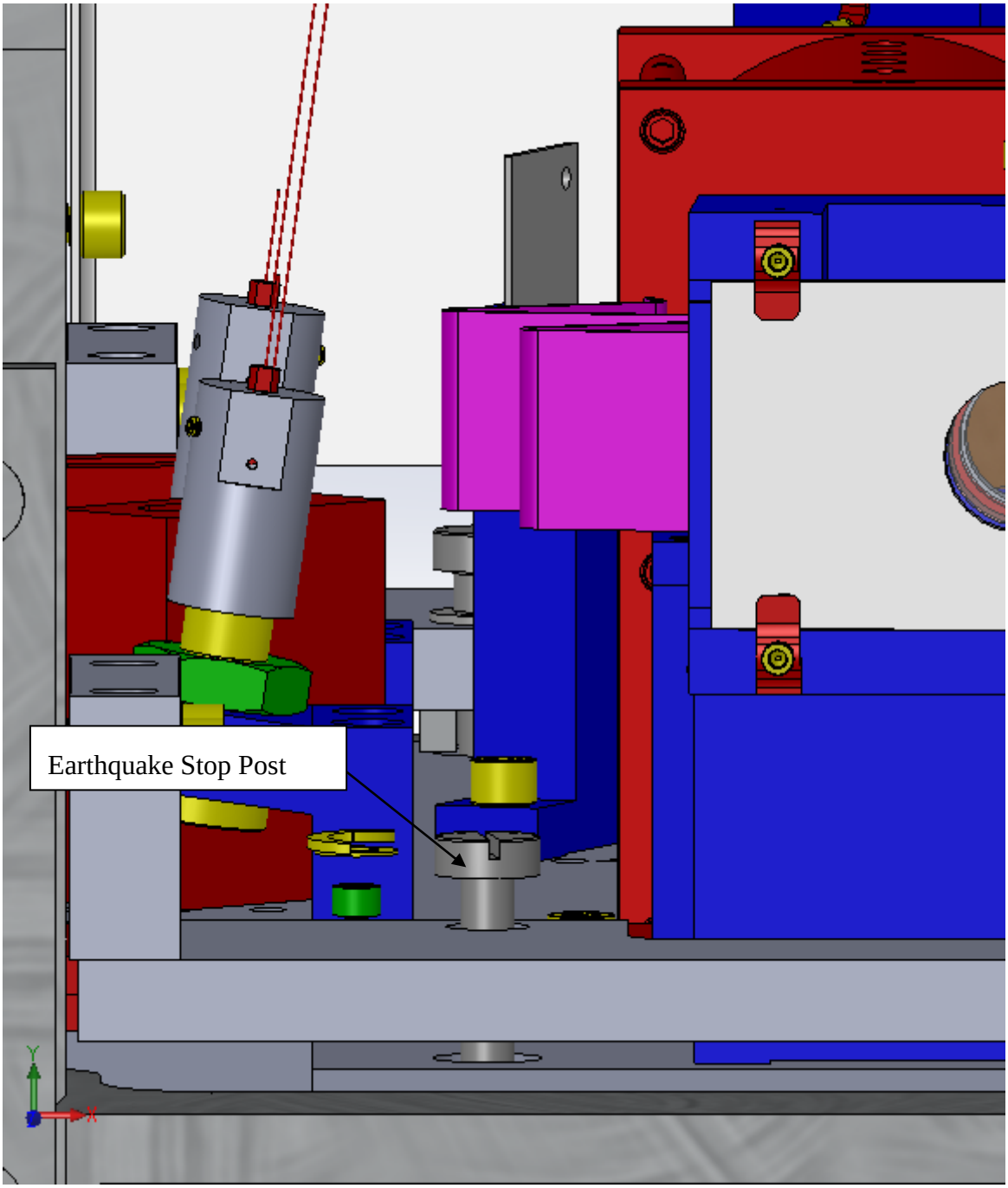

Figure 27: Earthquake Stop Posts Attached to Four Corners of the Optics Plate

Assemble the Earthquake Crossbar input and output assemblies loosely--see D0900170 Earthquake Crossbar Assy and D1002256 Earthquake Crossbar_In Assy--and attach the crossbar sides to the

structural Weldment at the input and output ends of the weldment, as shown in Figure 1 and **Error! eference source not found.**. Move the crossbar plate within the slotted mounting holes to align the earthquake stop clearance holes with the earthquake stop rods; then firmly bolt the crossbar plate to the crossbar sides.

4 OFI Optical Alignment

4.1 OFI Preliminary Optical Alignment

The preliminary optical alignment of the Output Faraday Isolator will take place on an optical bench in a class A environment.

4.1.1 Equipment List

1) 250 mW YAG Laser (NPRO), 1064nm wavelength
2) 1064 nm Photodetector on adjustable height, movable stand; sensitivity 0.25 W to 0.25 E-4 W
3) HR steering mirror on adjustable height stand with tip-tilt mount
4) 50% beam splitter on adjustable height stand with tip-tilt mount
5) HR retro mirror on adjustable height stand with tip-tilt mount

4.1.2 Alignment Setup

1. Clamp the OFI structural frame to the middle of an optical table
2. Mount the input laser, the input laser aperture, the steering mirror, and the beam splitter approximately 171.4 mm above the surface of the optical table in accordance with the optical layout shown in Figure 28. The height of the OFI optical centerline will be 167.8 mm above the table top, and the input laser beam will tilt down toward the input aperture, before being turned horizontal by the OFI wedge prism. The retro-mirror should be approximately 168 mm above the table.
3. Adjust the height of the input laser, and position and tilt the steering mirror until the laser beam passes through both the input aperture and the output aperture of the OFI.
4. Adjust the tilt of the retro-mirror so that the retro-reflected laser beam passes back through the OFI and through the input laser aperture—during this step, rotate the half-wave plate to maximize the retro-reflected power; then displace the beam slightly until the retro-reflected beam is blocked by the input laser aperture.

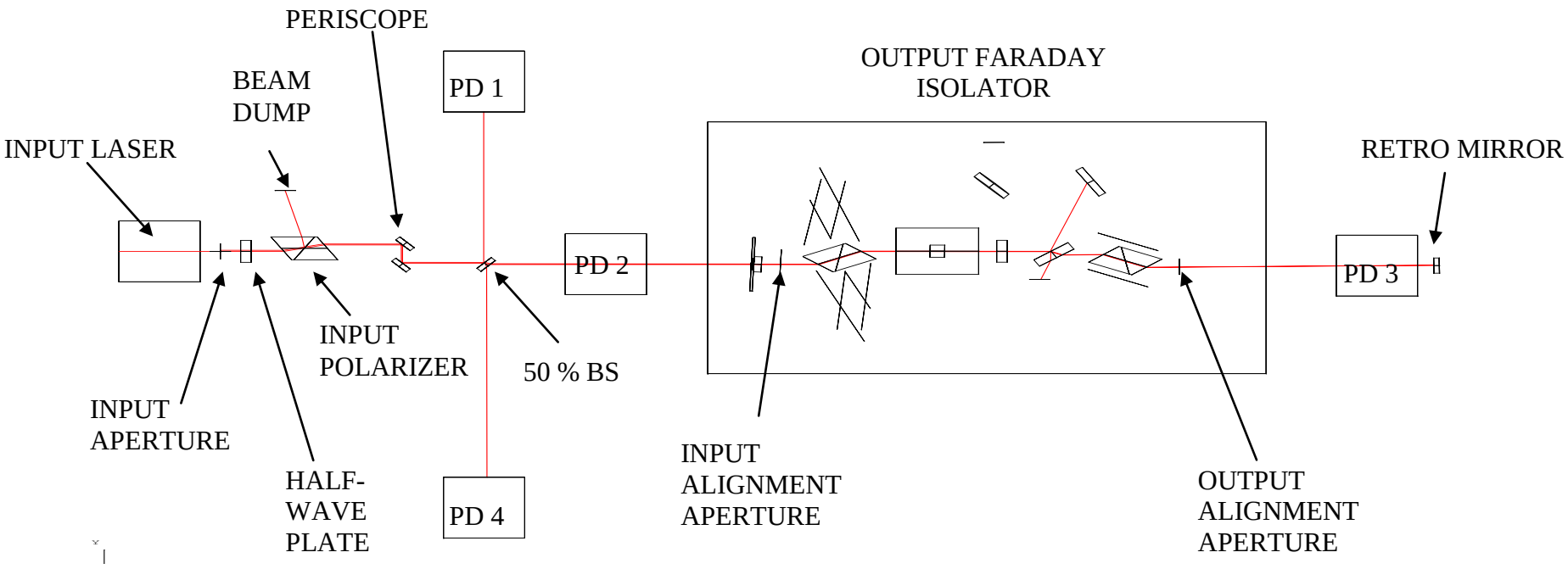

Figure 28: Optical Layout for OFI Alignment

4.1.3 Optical Alignment Procedure

1) Set the power of the laser to approximately 250 mW. Calibrate the transmissivity and reflectivity of the beam splitter by placing the photodetector alternately at position PD1 and PD2 and measure the power levels. The power at PD2 will be the reference power for calculating the Transmissivity and the power extinction ratio of the OFI.
2) Place the photodetector at position PD4 and rotate the half-wave plate to minimize the power at PD4; measure the power.
3) Place the photodetector at position PD3 and measure the power.
4) Calculate the OFI Transmissivity as the ratio of PD3 to PD2; calculate the OFI power extinction ratio as the ratio of PD4 to PD2.

4.1.3.1 Test Data

Measured Parameter	**Value**
OFI S/N	1
Location	LLO
Polarization Prism	iLIGO
Faraday Rotator	iLIGO
Optical Alignment	
input power at BS, W	5.56E-02
PD1, W	2.60E-02
PD2, W	2.93E-02
PD3, W	2.86E-02
PD4, W	6.70E-06
BS Reflectivity	4.68E-01
BS Transmissivity	5.27E-01
BS total	9.95E-01
OFI Transmissivity	9.76E-01
OFI Extinction Ratio	5.01E-04

4.2 OFI Shack-Hartmann Wavefront Test

The OFI Shack-Hartmann Wavefront Test will take place on an optical bench in a class A environment.

4.2.1 Equipment List

1) WFS300-14AR--00-OFI1 Shack-Hartmann WFS
2) S1FC635--00-OFI1 Fabry-Perot Benchtop Laser Source
3) P1-630A-FC-5--00-OFI1 Single Mode Fiber Patch Cable
4) LW-3-2037-C--00-OFI1 Large Wedged Windows
5) KM200--00-OFI1 Kinematic Mount

6) F810FC-635--00-OFI1 FC/PC Collimation Package
7) AOSSLCOFI4--00-OFI1 3" Mirror Mount
8) AOSSLCOFI2--00-OFI1 XY Stage Assembly
9) AOSSLCOFI1--00-OFI1 5 Axis Mirror Mount Assembly

4.2.2 **Alignment Setup**

Set up the SH test apparatus according to the optical schematic shown in Figure 29. Align the SH beam to pass freely through the entrance and exit apertures of the OFI.

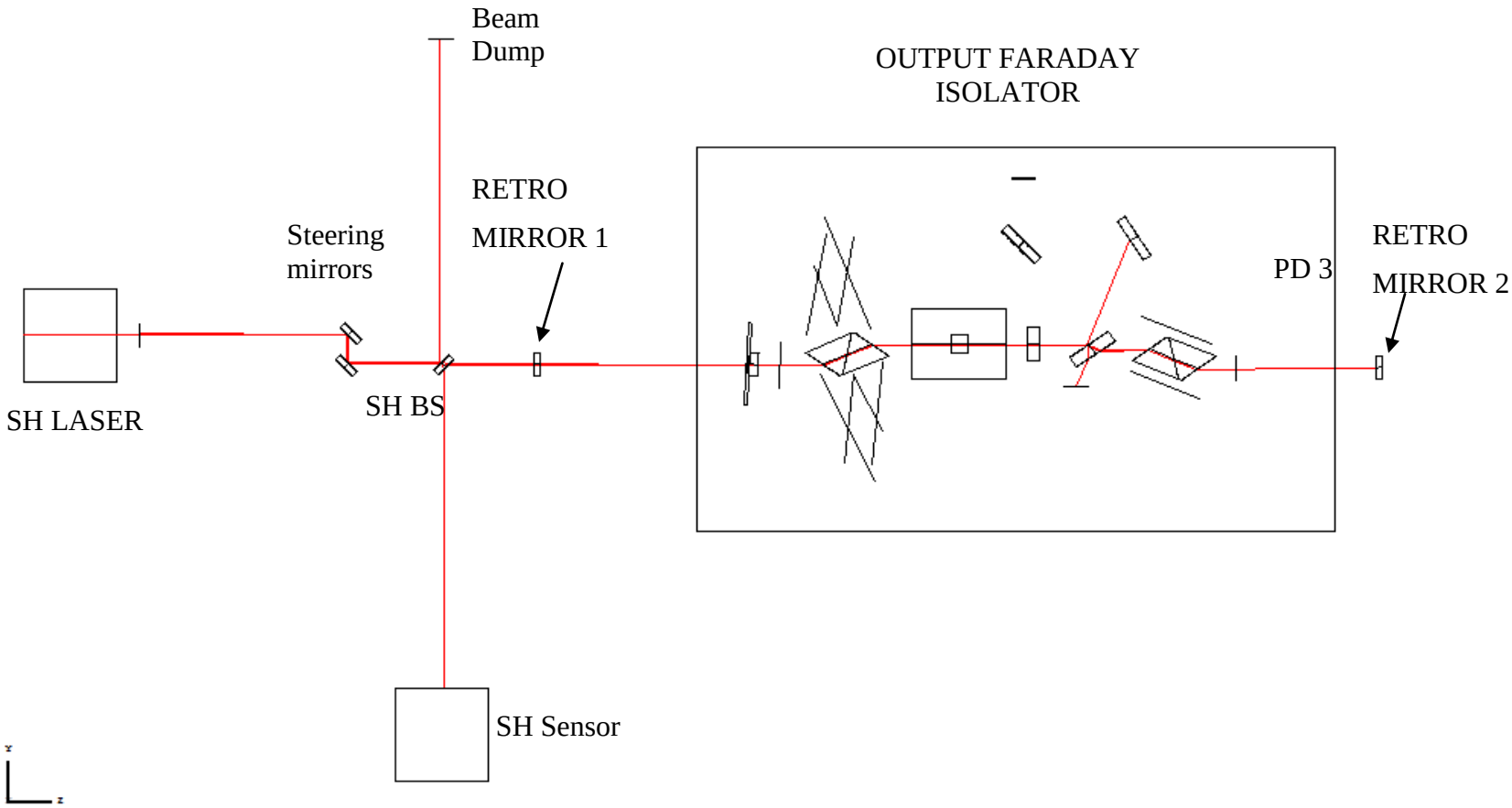

Figure 29: Optical Layout for SH Test

4.2.2.1 Reference Beam Alignment

Place the lambda/10 3” mirror in front of the OFI entrance aperture and steer the mirror so that the reflected beam is centered on the SH sensor.

Iteratively align the retro-reflected beam and the SH sensor by adjusting the steering mirror, the lateral position of the SH sensor, and the tilt of the SH sensor to center the beam on the SH sensor and to reduce the wavefront tilt by minimizing the Zernike Z2 and Z3 tilt coefficients.

The beam centroid should be approximately centered on the SH sensor, as shown in Figure 30.

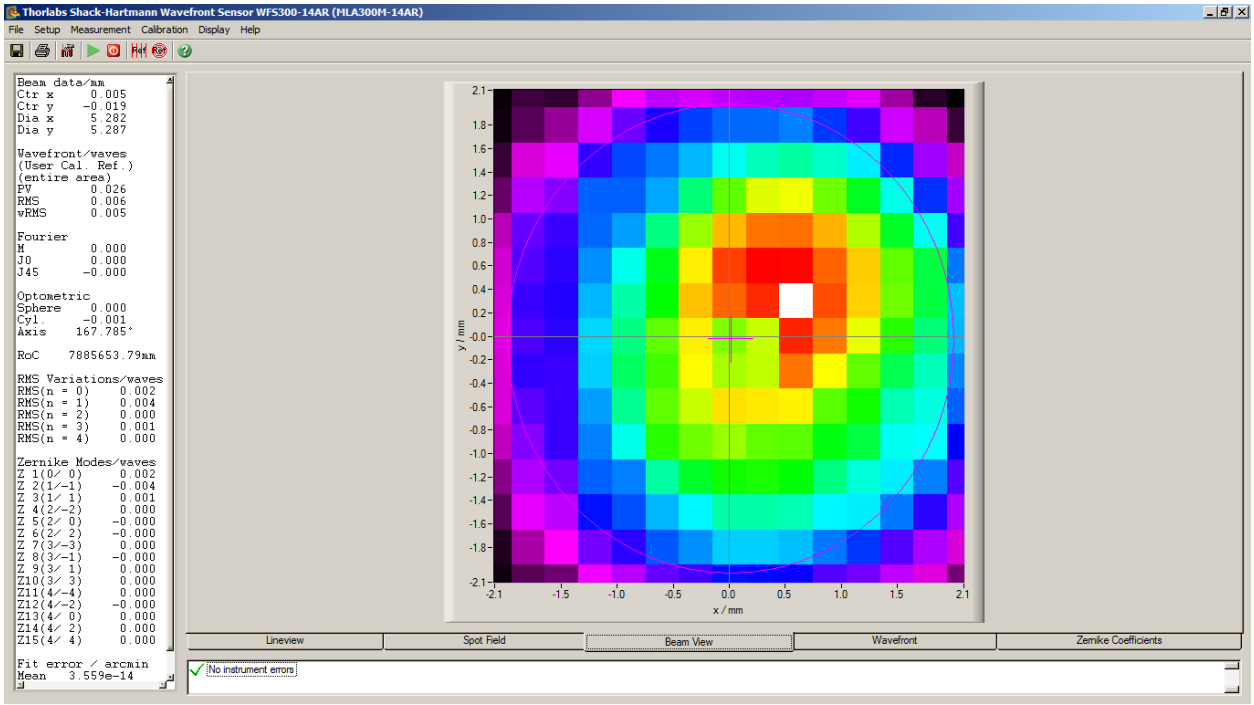

Figure 30: Contour of the Input Beam on Shack-Hartmann Sensor

The power measured by the central array of the SH lens sensor matrix is shown in Figure 31.

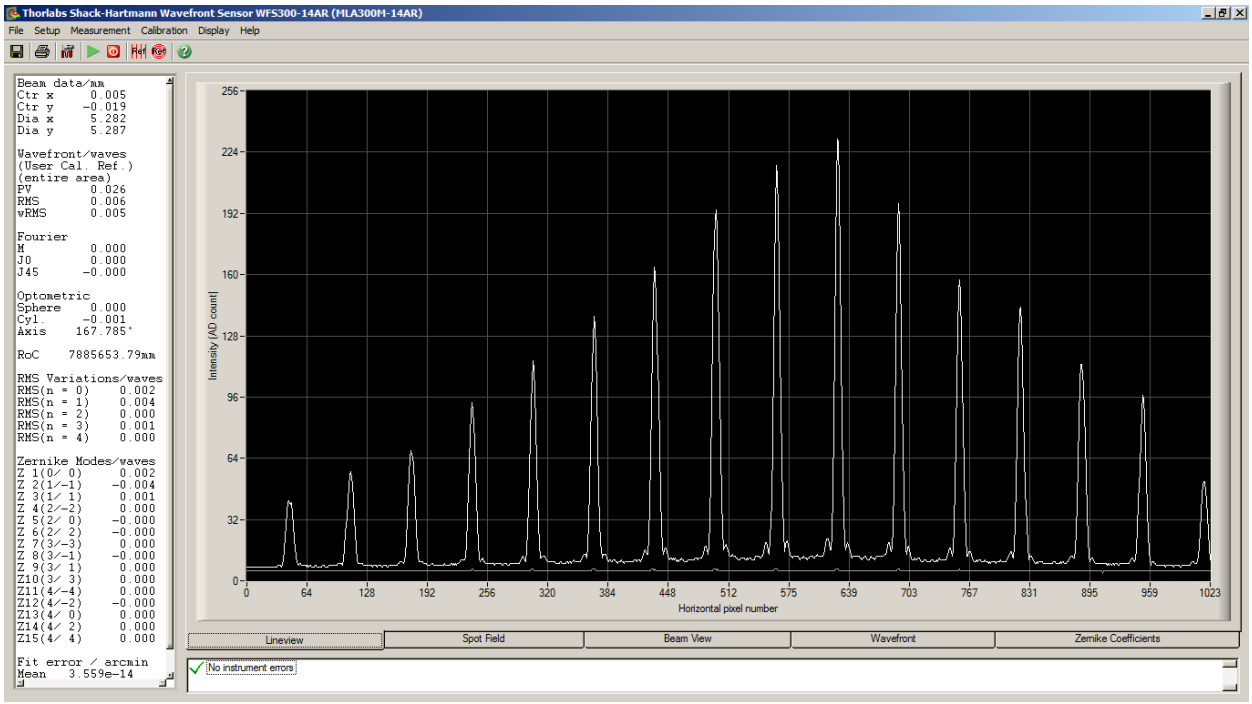

Figure 31: Reference Power Read by the Shack-Hartman Lens Array

4.2.2.2 Reference Beam Wavefront

The reconstructed wavefront of the reference beam is shown in Figure 32.

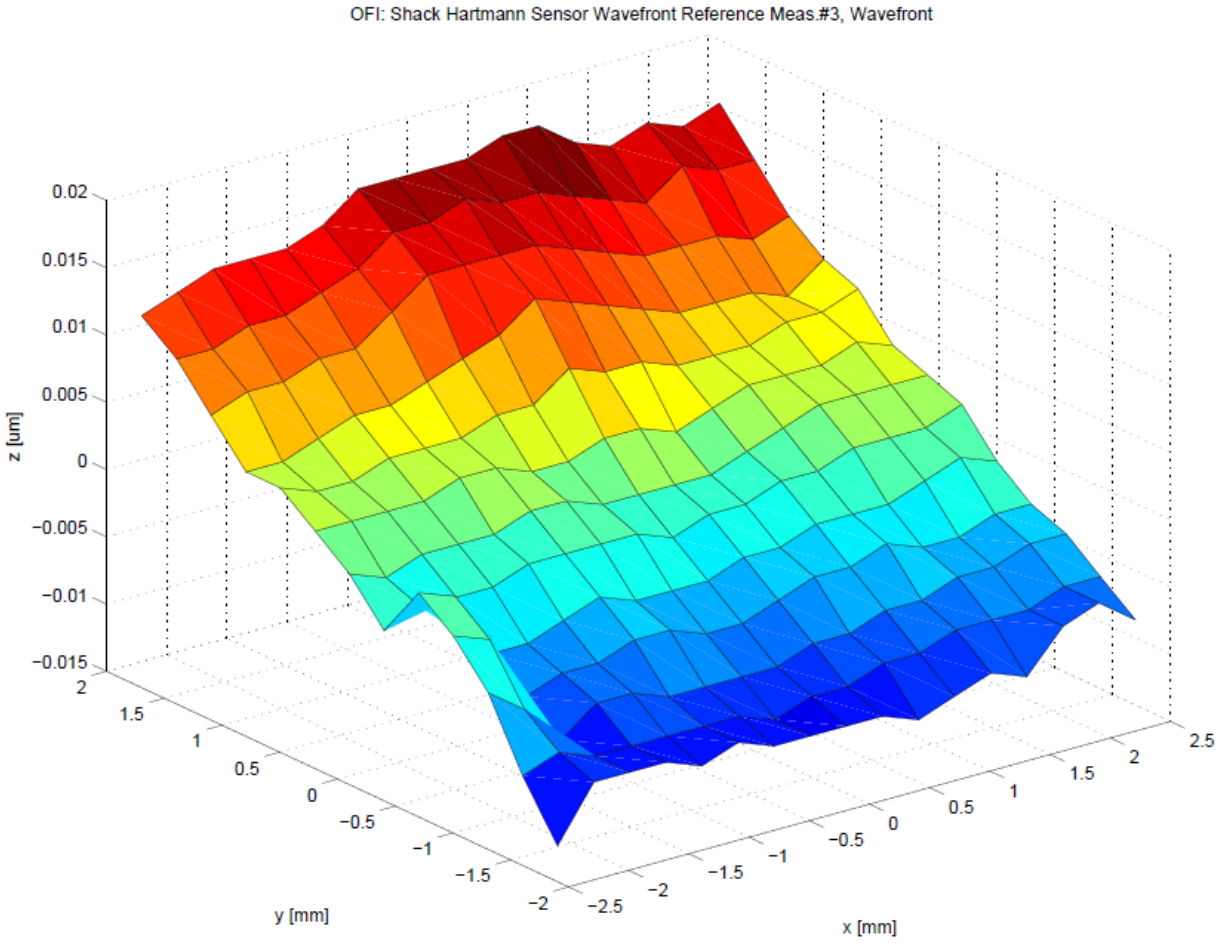

Figure 32: Reference Wavefront

The Zernike coefficients for reconstructing the reference wavefront will be saved in a software file and be used subsequently to subtract the reference wavefront from the double pass wavefront through the OFI.

4.2.3 Double Pass OFI Test Procedure

Place the lambda/10 3” mirror beyond the exit aperture OFI entrance aperture and steer the mirror so that the reflected beam passes back through the OFI and is centered on the SH detector.

Iteratively align the retro-reflected beam and the SH sensor by adjusting the steering mirror, the lateral position of the SH sensor, and the tilt of the SH sensor to center the beam on the SH sensor and to reduce the wavefront tilt by minimizing the Zernike Z2 and Z3 tilt coefficients—as was done in section 4.2.2.

Remove the tilt Zernike coefficients by means of the SH software commands. A typical double-pass wavefront through the OFI with tilt removed is shown in Figure 33.

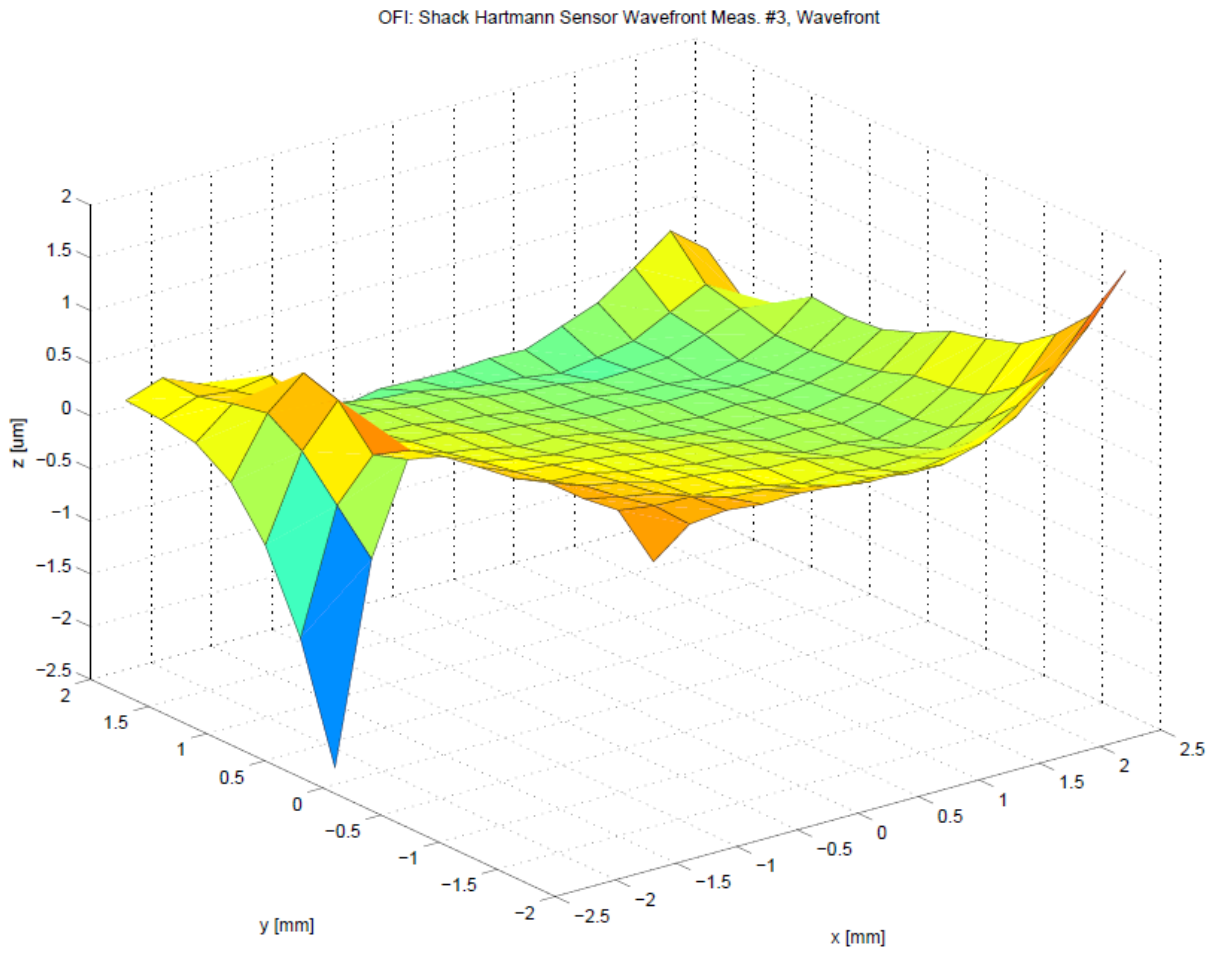

Figure 33: Typical OFI Double-pass Wavefront with Tilt Removed

4.2.4 Double Pass OFI Test Results

Typical OFI double pass test results are shown in Figure 34. The Zernike coefficients are listed in the figure. Zernike Coefficients 01, 02, 03, and 05, in units of micron, describe the piston, Y-tilt, X-tilt, and defocus respectively; these coefficients do not affect the wavefront aberration and will be ignored.

The astigmatism coefficients 04 and 06 are the most significant because they are responsible for direct coupling loss into the OMC. The higher order coefficients describe coma and other irregularities, which may also cause coupling loss due to generation of higher order Gaussian modes in the OMC cavity.

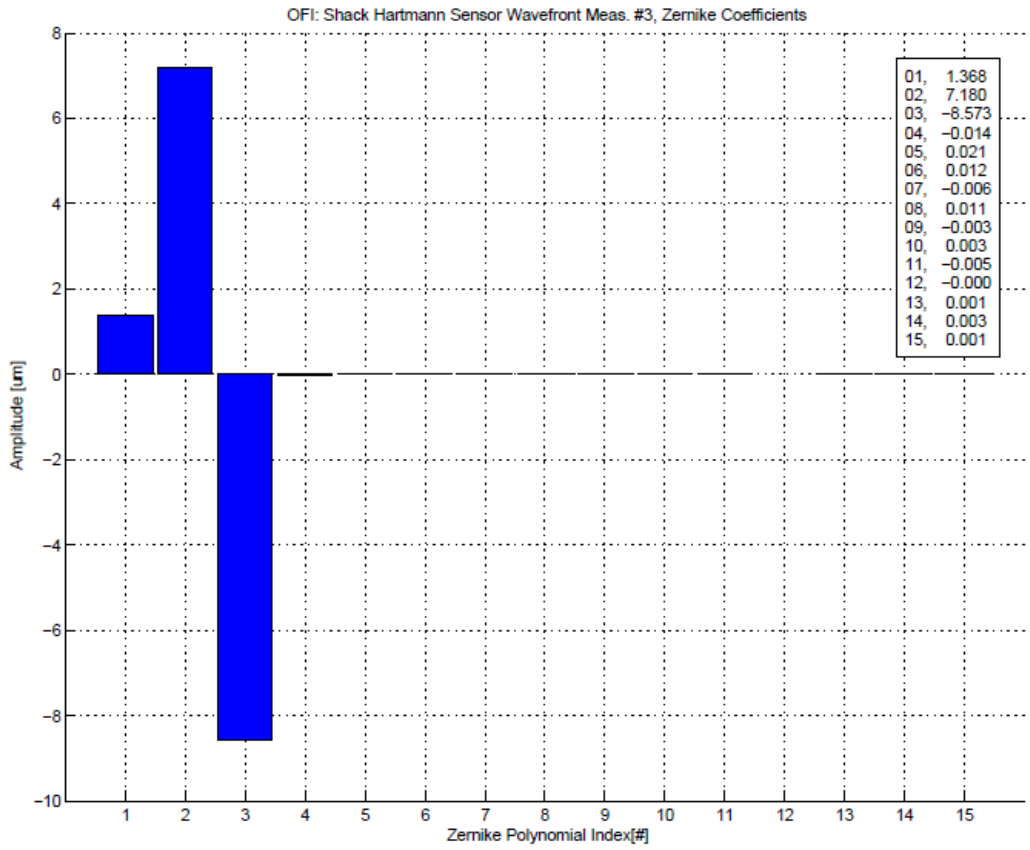

Figure 34: Typical OFI Double-pass Zernike Test Results