Final report Training Program

Mu2e Project

T-tracker detector

T-tracker Panel analysis

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Contents

1 Tracker

The Tracker consists of 20 "stations" supported by a rigid frame. Each station consists of two planes, and each plane consists of six panels. Groups of straws are assembled into the panels, 2 layers in each panel. The tracker design includes a self supporting structure, as shown in Figure 1. Three longitudinal staves and three stiffening rings make up the support frame of the Tracker detector. The bottom two staves each have large grooves used to accept electrical cables, fibers, and cooling lines. This structure maintains the structural integrity and provides the internal position accuracy of the straws.
The overall size of the Tracker without the external support structure is 1620 mm outside diameter and 3087 mm long. Including the support structure, it is 1680 mm outside diameter and 3270 mm long. An exception to the 1680 mm outside diameter is the region just below the geometric center, where the bottom staves extend radially to a 1700 mm outside diameter.

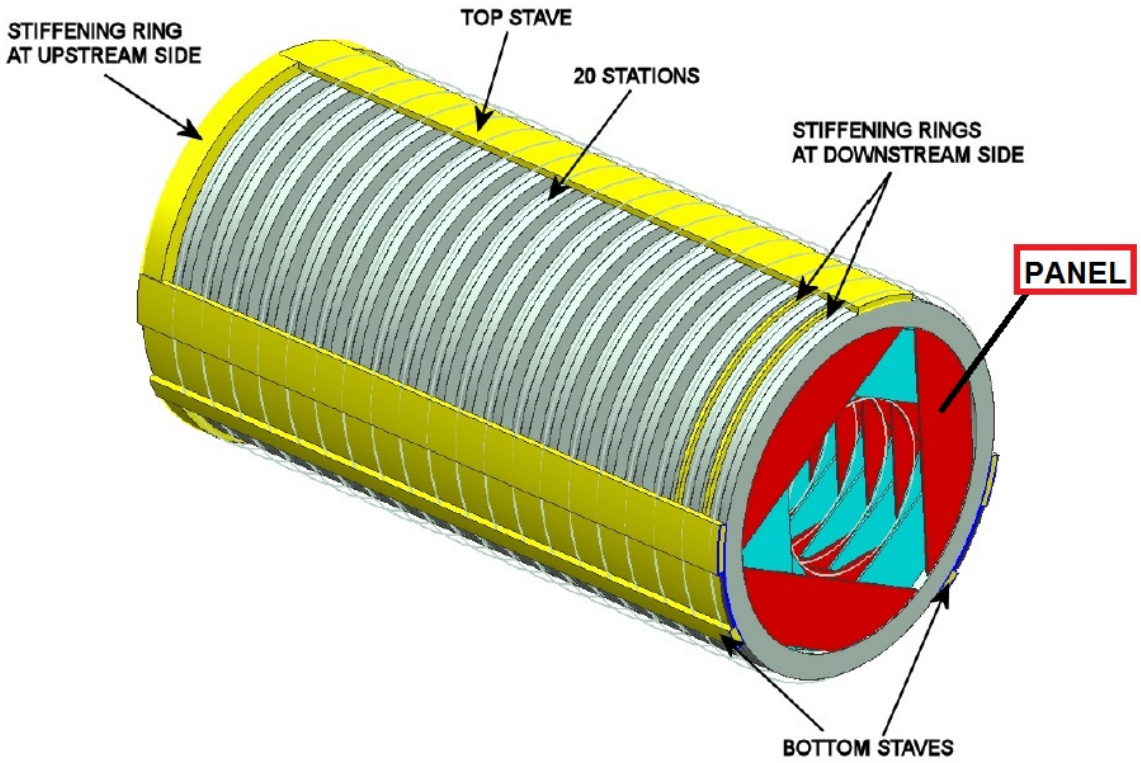

Figure 1: Tracker

2 Panel

Panels are mechanical parts that are needed for includeing electronic components. We are developing panels layout to optimize space for electronic devices and manufacturing costs with the goal to keep constant the tracker efficiency . The purpose of this document is to show the new layout of Panel, and the analysis related to the panel installation activities.

2.1 Changes in Ring Manifold 2.5

In this section will be analyzed the new geometry of panel component, show in the Figure 2.1.

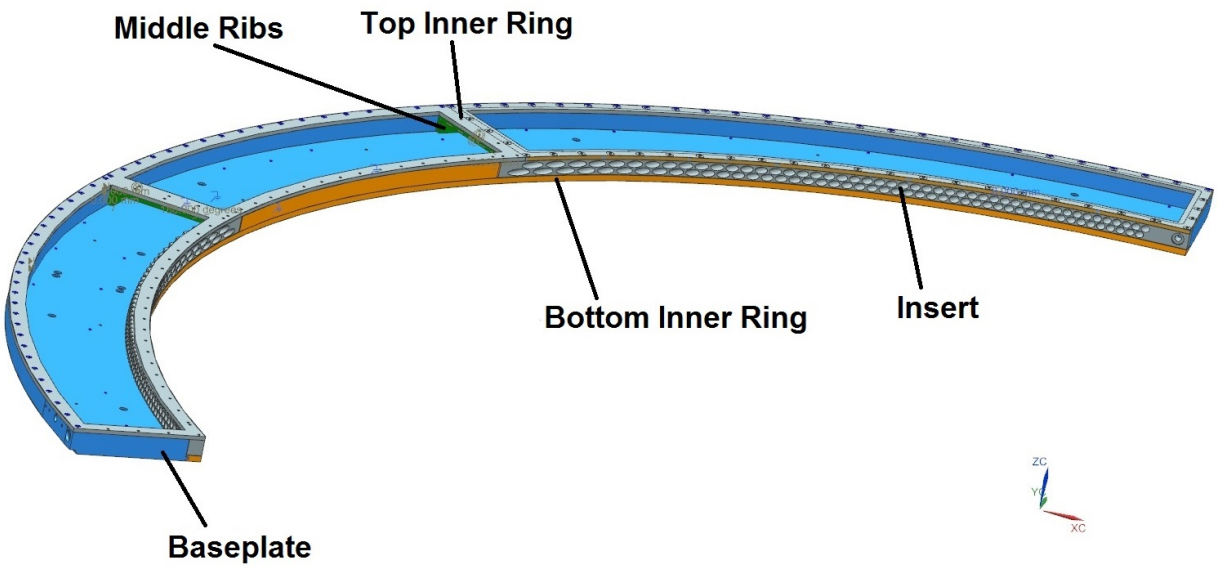

Figure 2: Ring Manifold 2.5

2.1.1 Baseplate

Baseplate is the component due to accomodate electronic devices (e.g. motherboard etc.).
In this configuration, according with electronic team, we have had to chage the location of electronic mounting holes.
Moreover the total height of this part has been reduced in order to save longitudinal space along tracker, with a significative reduction of the tracker weight.
Particular attention has been paid during this step because the minimum space for electronic devices had to be guaranteed.
Another conceptual change has been to manufacture baseplate in an unique part with external ribs, and as it will be shown in the next pages, we have verified that the increase of stiffness was not a problem about installation.

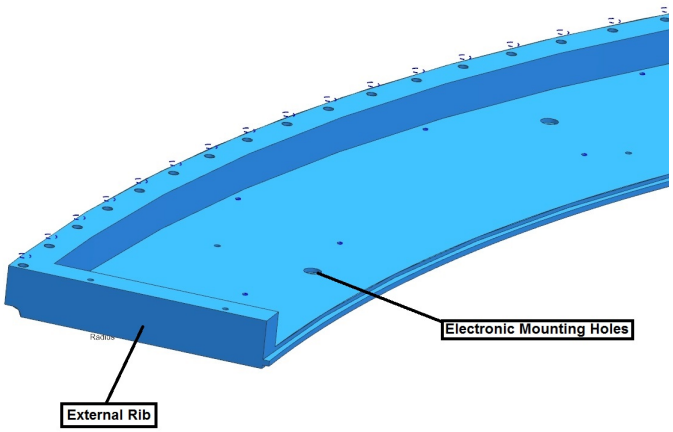

Figure 3: Layout of baseplate

2.1.2 Top Inner Ring

In order to reduce manufacturing cost, according with machine shop has been decided to produce Top Inner Ring in Alluminum, instead stainless steel. Moreover with respect to the previous version it has manufacture in an unique part.
Those changes have been applied respecting all interfaces and the drawing of this part has been sent to machine shops. We have already received an answer and the total cost of this part is about 800 USD. For this reason this part has been approved.

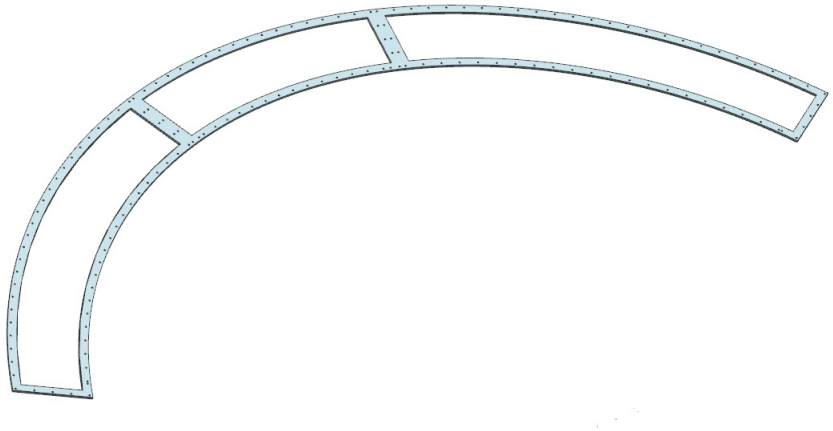

Figure 4: View of Top Inner Ring for Ring Manifold 2.5

2.1.3 Middle Ribs

To permit this configuration, of course middle ribs height has been reduced too. The result is that panel internal space has been reduced, as shown in the figure 5. As I explained it before, the maximum value of reduction has been imposed by electronic devices and the available space is into the red rectangular.
7.76mm height is sufficient to install electronic devices.

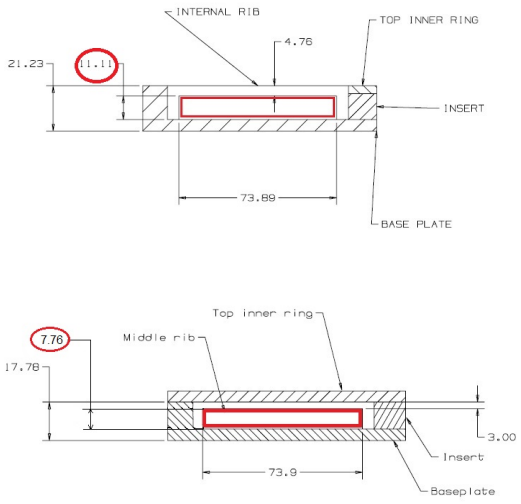

Figure 5: Panel cross section with quotes 2.0 vs 2.5

3 Baseplate FEM analysis

Baseplate is the most critical component as concerns installation of Ring Manifold 2.5.
Our goal is to evaluate how baseplate stiffness changes from 2.0 to 2.5 configuration, in order to understand if the new layout is acceptable regarding installation process. To do this, manufacturing defects have been simulated by a FEM analysis that will be described in the following paragraphs.

3.1 Model

I've created simplified model of baseplate with the following criteria (Figure 6):

- Holes and geometrical details have been excluded;
- For simmetry reasons, I've studied only the half part of baseplate.

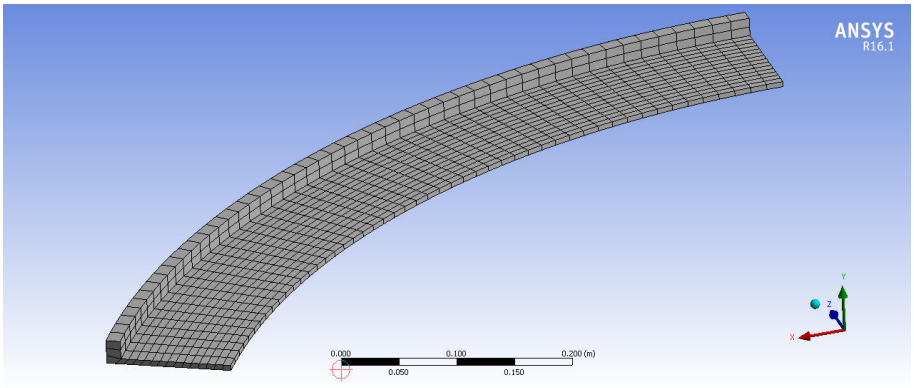

Figure 6: Simplified model for baseplate 2.0 with 16mm size mesh

3.2 Mesh

Each simulation that will be described has been done with three different mesh size: 16mm, 8mm, 4mm.
The convergence value related to the result, is evaluated with 4mm size mesh.

4 Baseplate stiffness analysis before installation

I've investigated on the behaviour of baseplate in a free state condition, evaluating the force reaction that the operator should apply in order to compensate flatness errors. I've applied a *Fixed Support* condition on the plane of simmetry, because for simmetry reason displacements and rotation are not allowed.
I've applied *3mm* displacement in a critical point as load condition, to simulate flatness errors due to manufacturing defects and residual stress after manufacturing process. see figure 8.

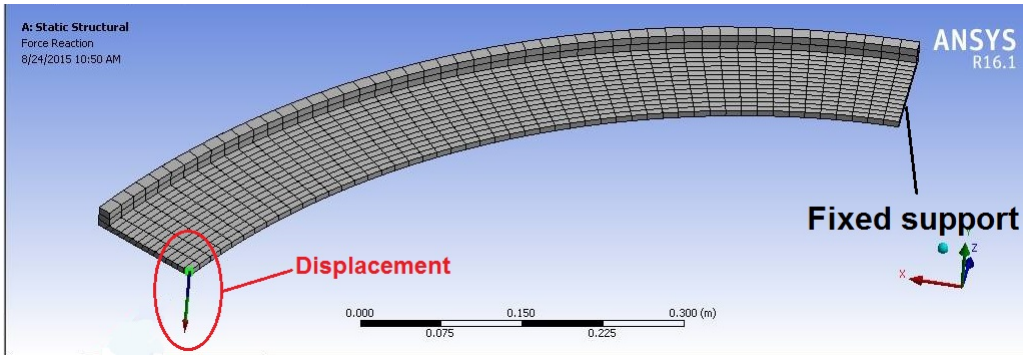

Figure 7: Constrain and load condition

4.1 Results

Values of forces reaction found are shown in the table 1.

Mesh size [mm]	16	8	4
Force reaction for Baseplate 2.0v [N]	15.48	15.34	15.29
Force reaction for Baseplate 2.5v [N]	15.54	15.49	15.48

Table 1: Results of FEM analysis on varying Mesh size

So in a free state condition, the new layout of this component is not absolutly a problem as regards the flatness handle correction by an operator.

5 Baseplate stiffness analysis during installation

In order to evaluate the baseplate stiness during installation, a FEM Analysis has been done with the following criteria:

- Constrain: Fixed support on the middle face. On the plane of simmetry displacements and rotation are not allowed;
- Constrain: No displacement along outer lower edge.

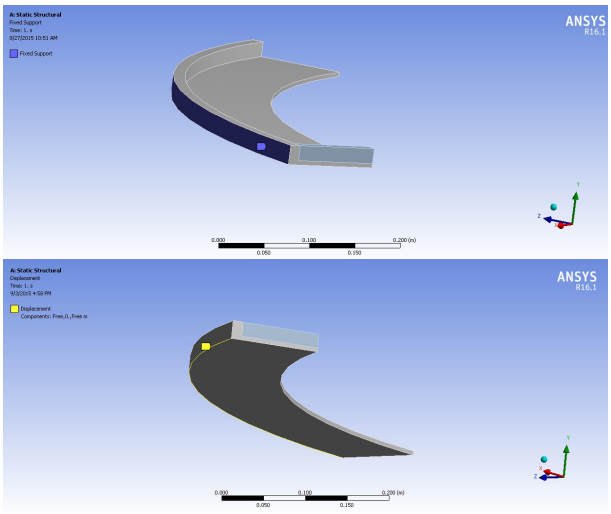

Figure 8: Constrain conditions

Load condition has been imposed in order to simulate manufacturing defects and residual stress considering boundary conditions due to other components which interfaces with baseplate. Considering also mechanical tolerances, *1mm* displacement has been imposed in the vertex shown in figure 9.

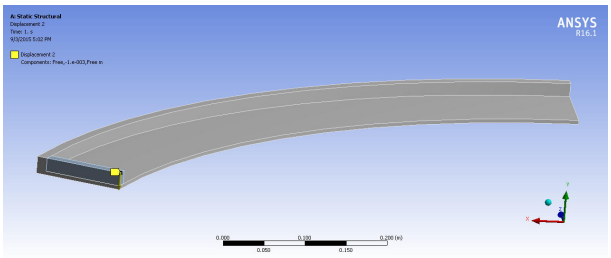

Figure 9: Load conditions

5.1 Results

The results of this simulation are reported in the table 5.1. A map of Y displacements

Mesh size [mm]	16	8	4
Force reaction for Baseplate 2.0v [N]	53.95	53.54	53.38
Force reaction for Baseplate 2.5v [N]	69.37	69.15	69.03

is shown in the figure 10

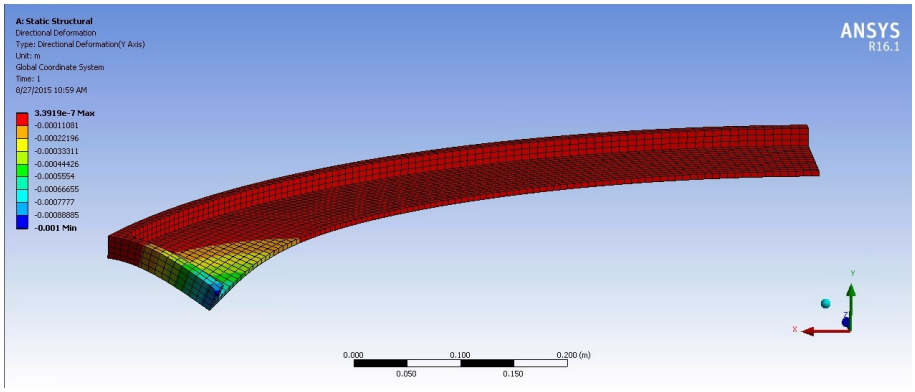

Figure 10: Map of displacements

5.2 Conclusion

As shown in the analysis, the difference between baseplate 2.0 and baseplate 2.5 version is not significative as far as the installation is concerned. Comparing the force reactions found, they have the same order of magnitude and the value of them is acceptable for the purpose required.

6 Goals achieved

The new Ring Manifold 2.5 layout suggested has been approved, so all components have been drawn in order to estimate manufacturing costs.
Drawings are reported in Appendix.

7 Table of drawings

F10046000	Assembly Ring Manifold 2.5
F10044993	Bottom Inner Ring
F10045419	Side cover
F10045438	Middle cover
F10045536	Internal rib
F10045539	Baseplate
F10046166	Frame

Table 2: Caption for the table.

In attachement are reported the non-commercial components drawings of Ring Manifold 2.5.

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CATEGORY1: PROJECT1: MUDETracker

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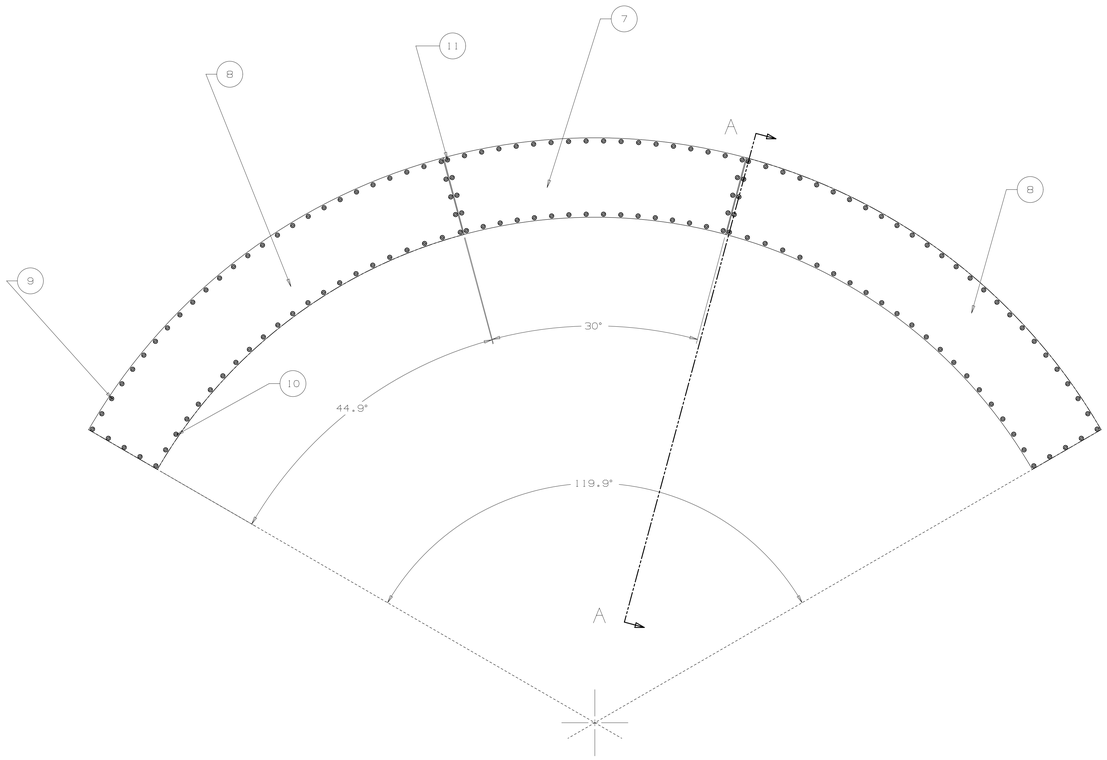
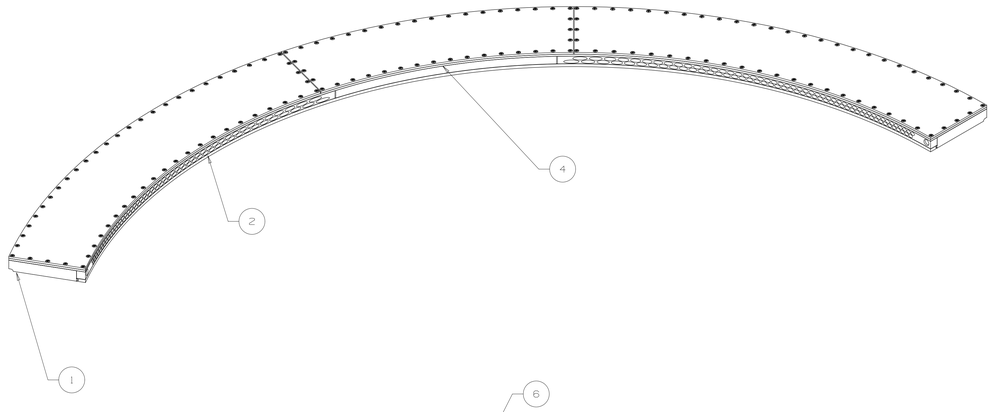
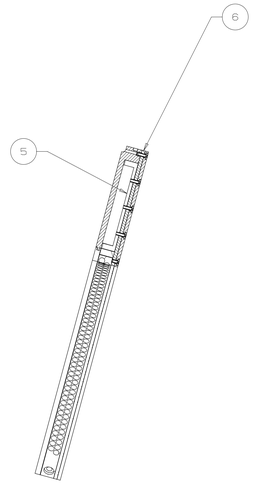
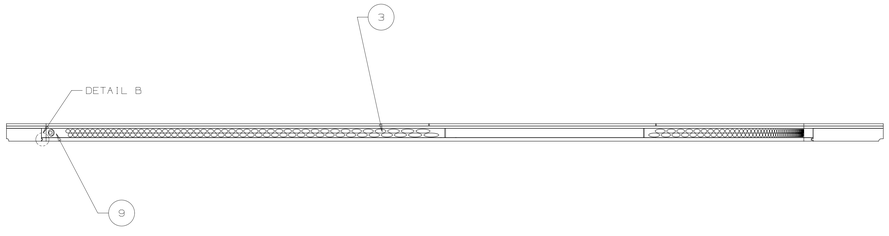
			APPROVED

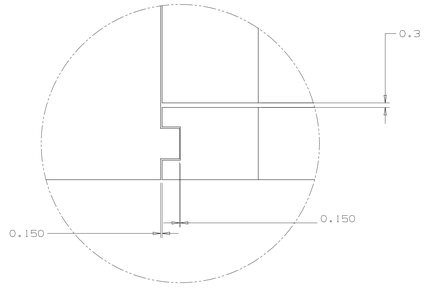






SECTION A-A





DETAIL B
SCALE 7:1

ITEM	PART NUMBER	DESCRIPTION	QTY
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10	FC0053414	McMaster-Carr, 90910A714 Low Probile Torx Hd, 4-40 1/4" ; cover to inner rib (4x3), baseplate to outer ring (9)	54
9	FC0053413	McMaster-Carr, 98164A714 Low Probile Torx Hd, 4-40 5/16" ; cover to outer ring (26+18+26) & external rib (2x3)	90
8	F10045419	SIDE COVER	2
7	F10040930	MIDDLE COVER	1
6	F10046166	FRAME	1
5	F10046000	INTERNAL RIBS	2
4	F10044993	MIDDLE PART	1
3	F10045001	INSERT	2
2	F10044993	BOTTOM INNER RING	1
1	F10045539	BASEPLATE	1

UNLESS OTHERWISE SPECIFIED

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USED ON			
MATERIAL	-		
GROUP:		CAGE CODE: 0U5R6	

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UNITED STATES DEPARTMENT OF ENERGY

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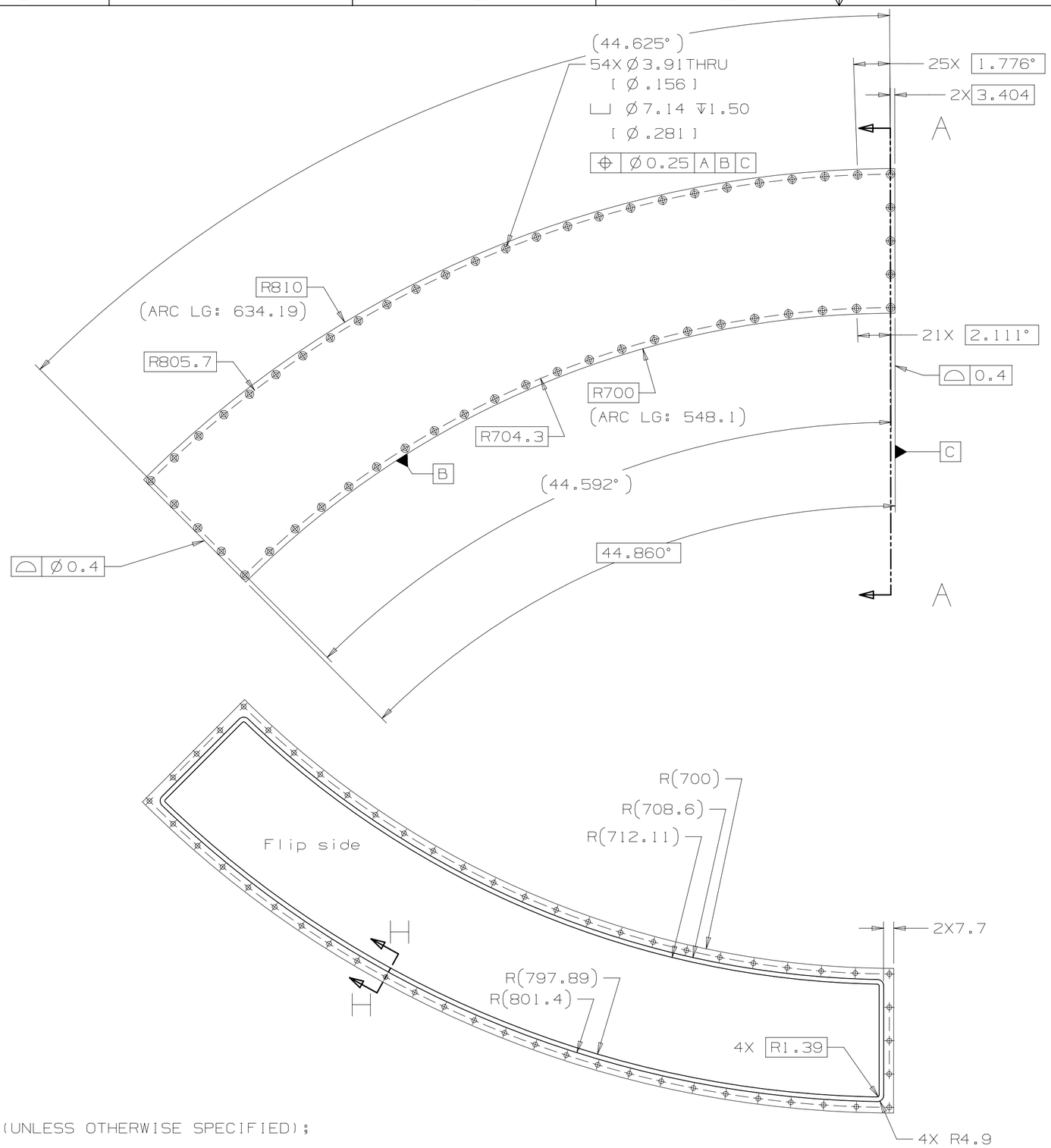

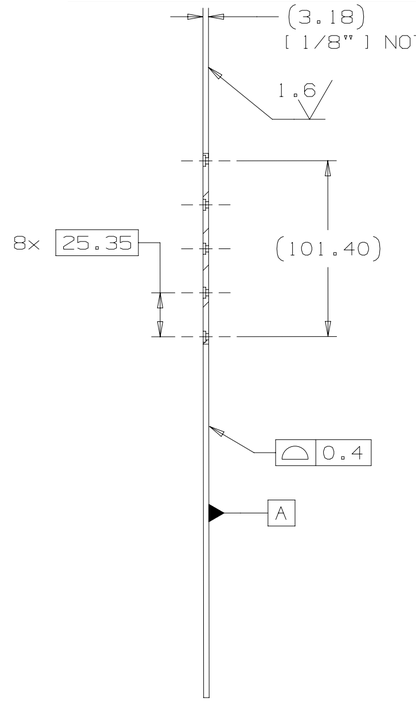

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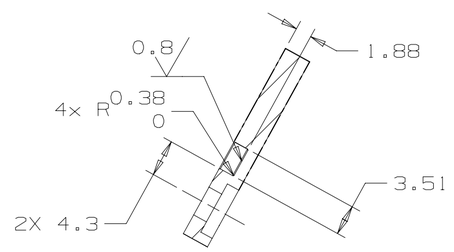

SECTION H-H

Issued for Quotation

NOTES (UNLESS OTHERWISE SPECIFIED);

1. PART MUST BE FREE OF DIRT, GREASE, OIL AND CHIPS.
2. PART MUST BE FREE OF ALL SHARP EDGES, CORNERS AND BURRS.
3. ALL FILLETS TO BE 0.36mm UNLESS OTHERWISE SPECIFIED.
4. DIMENSIONS IN BRACKETS [X.XX], ARE IN INCHES.
5. DIMENSIONING AND TOLERANCES MUST MEET THE CRITERIA IN THE LIGHT CLAMP CONDITION.

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UNITED STATE DEPARTMENT OF ENERGY

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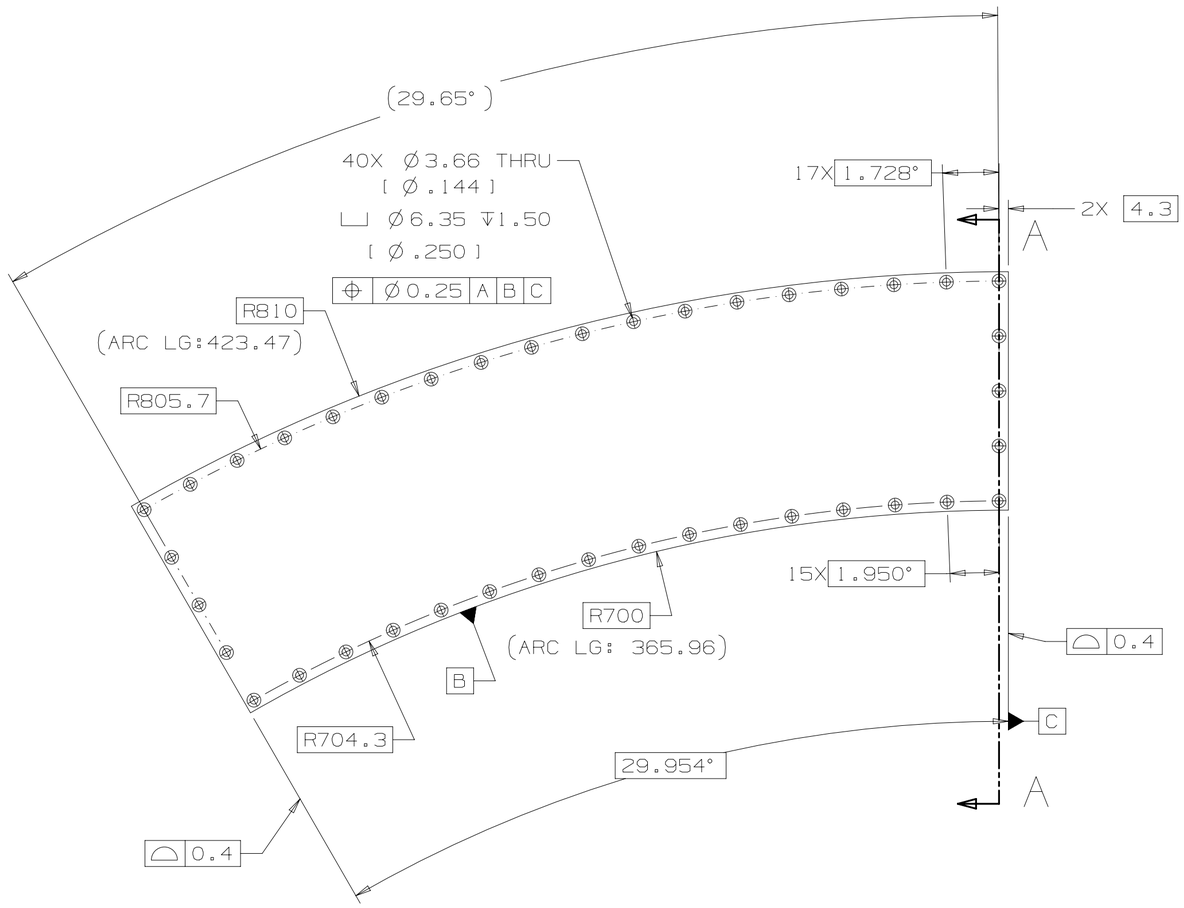

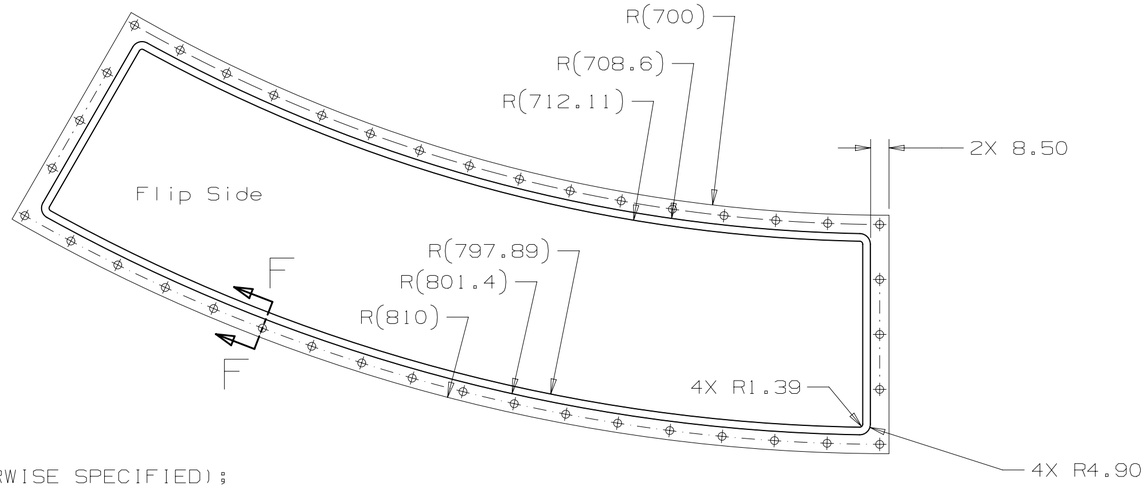

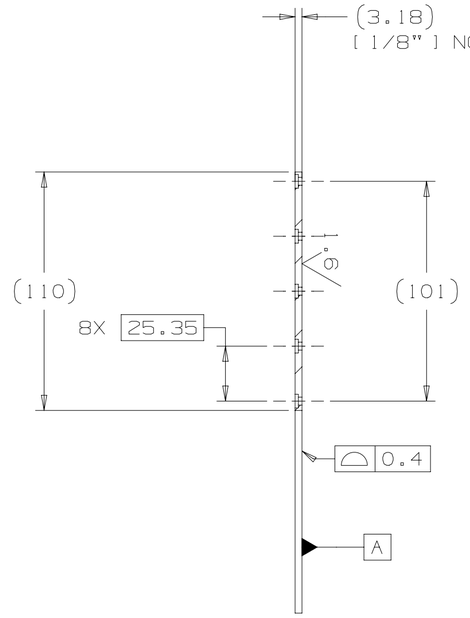

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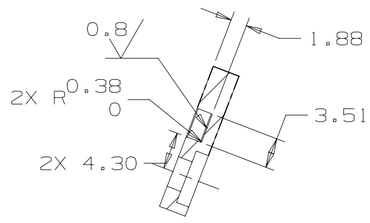

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NOTES (UNLESS OTHERWISE SPECIFIED);

1. PART MUST BE FREE OF DIRT, GREASE, OIL AND CHIPS.
2. PART MUST BE FREE OF ALL SHARP EDGES, CORNERS AND BURRS.
3. ALL FILLETS TO BE 0.36mm UNLESS OTHERWISE SPECIFIED.
4. DIMENSIONS IN BRACKETS [X.XX] ARE IN INCHES.
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FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

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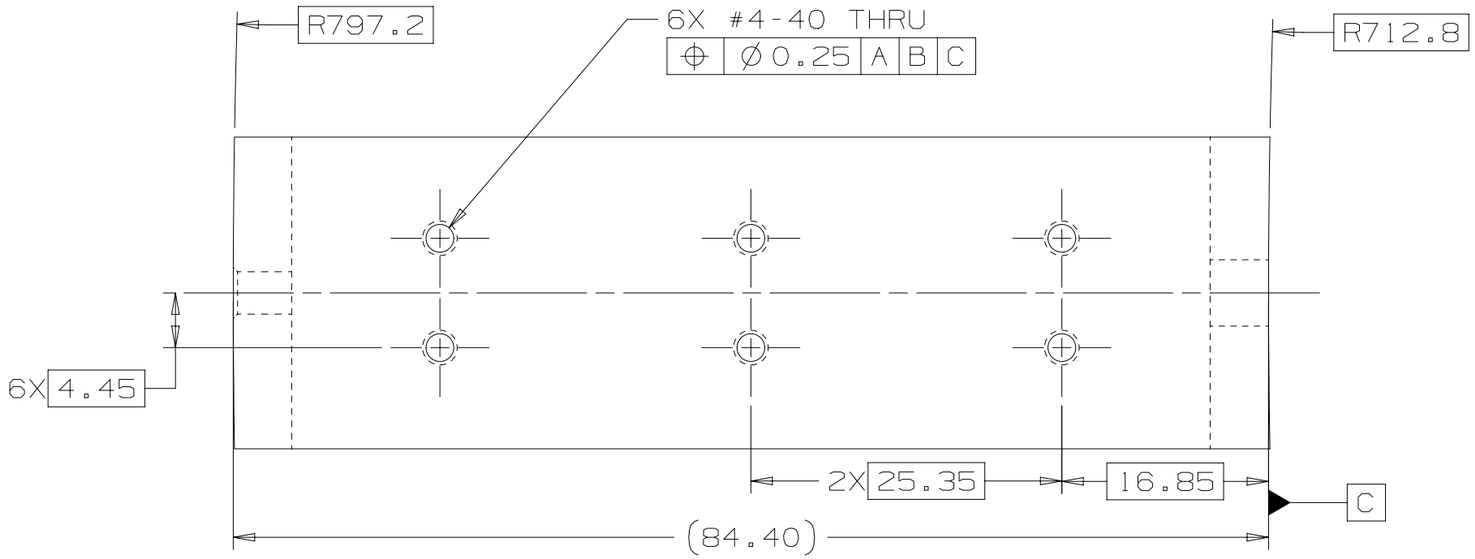

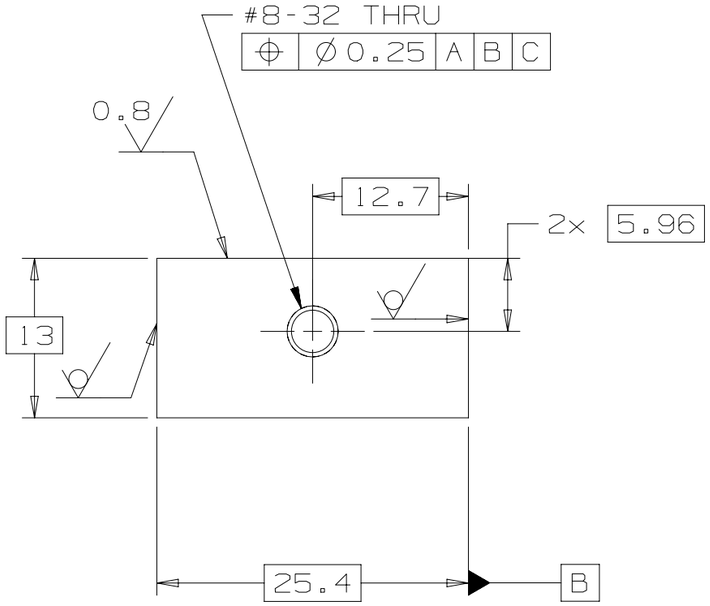

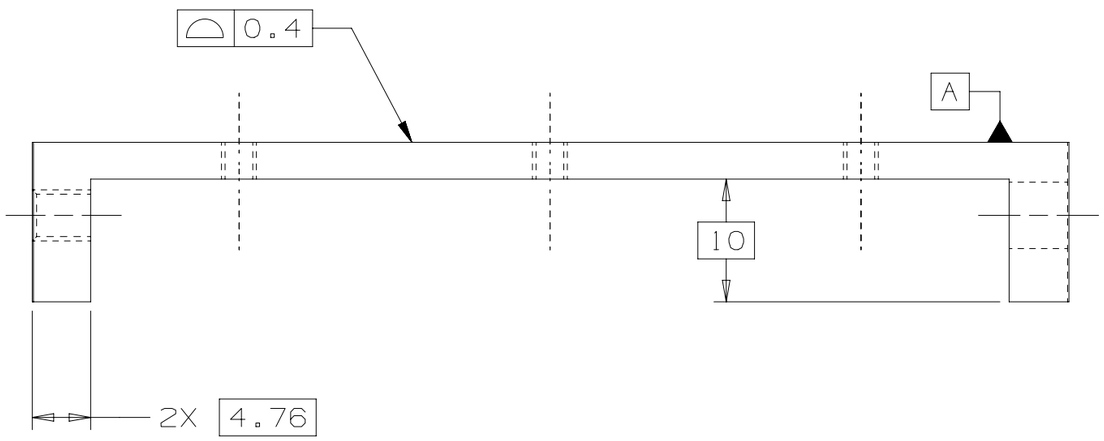

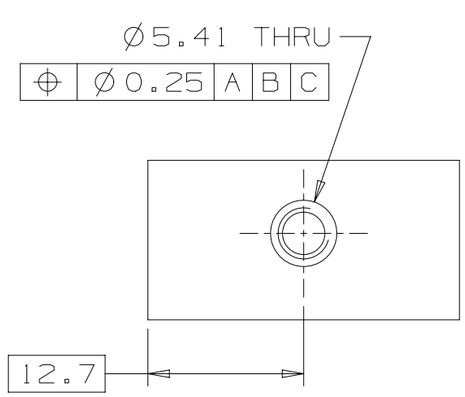

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2. PART TO BE FREE OF ALL SHARP EDGES, CORNERS AND BURRS.

UNLESS OTHERWISE SPECIFIED				
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APPROVED		DATE	

USED ON: F10046000

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FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

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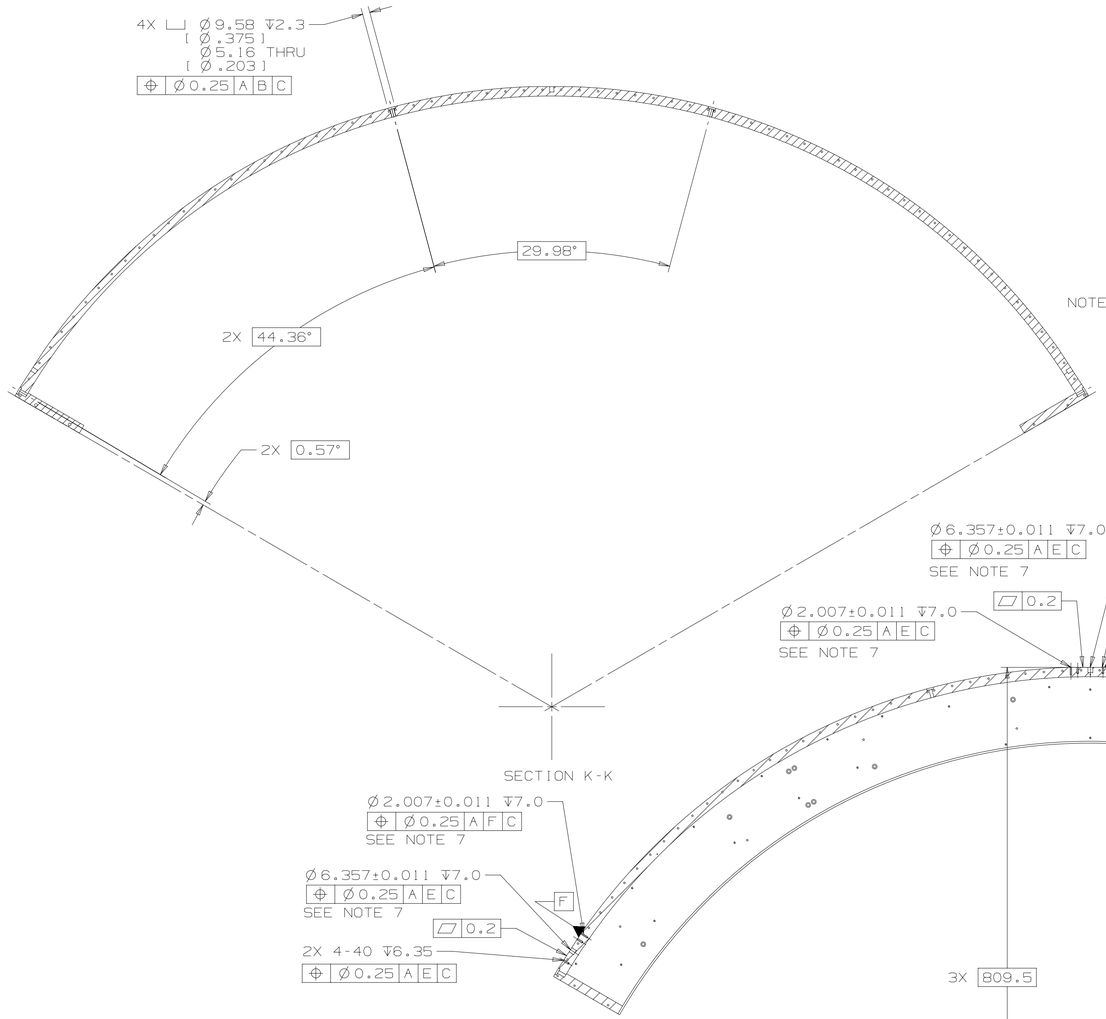

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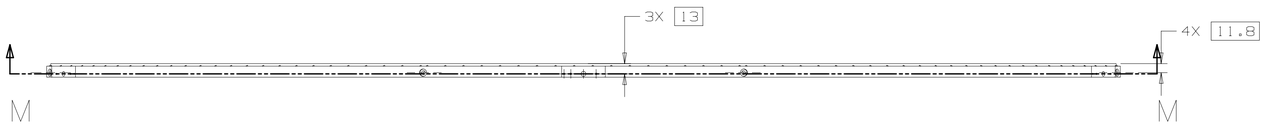
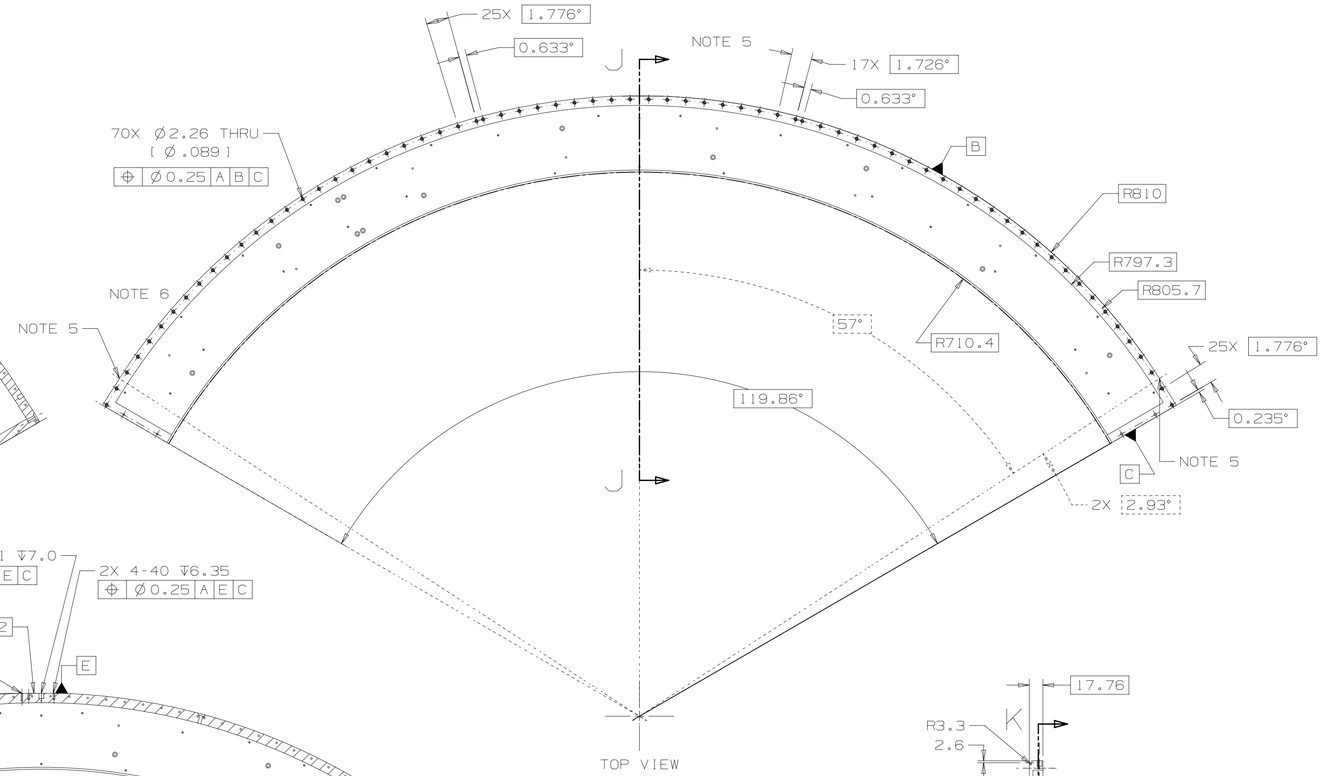
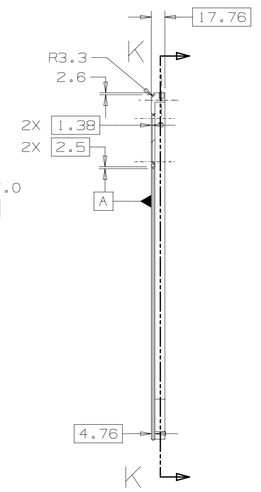




TOP VIEW

SECTION M-M



SECTION J-J

Issued for Quotation

NOTES (UNLESS OTHERWISE SPECIFIED):

1. PART MUST BE FREE OF DIRT, GREASE, OIL, AND CHIPS.
2. PART MUST BE FREE OF ALL SHARP EDGES, CORNERS AND BURRS.
3. ALL FILLETS TO BE 0.36mm UNLESS OTHERWISE SPECIFIED.
4. DIMENSIONS IN BRACKETS ARE IN INCHES.
5. THESE SURFACE MUST BE FLAT TO ALLOW THE INSTALLATION OF NEST AND/OR OTHER SURVEY TOOLS.
6. TAPPED HOLES MUST BE IN ACCORDANCE WITH HELICAL INSERT MCMASTER #91732A702 OR EQV.
7. DRILL HOLES FOR LIGHT INTERFERENCE FIT USING AS REFERENCE Ø.25" X 1" DOWEL PIN MCMASTER #90145A542 OR EQV.

UNLESS OTHERWISE SPECIFIED				
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DRAWING UNITS: MM

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APPROVED		DATE	
USED ON			
MATERIAL	MIC 6 PRECISION GROUND		

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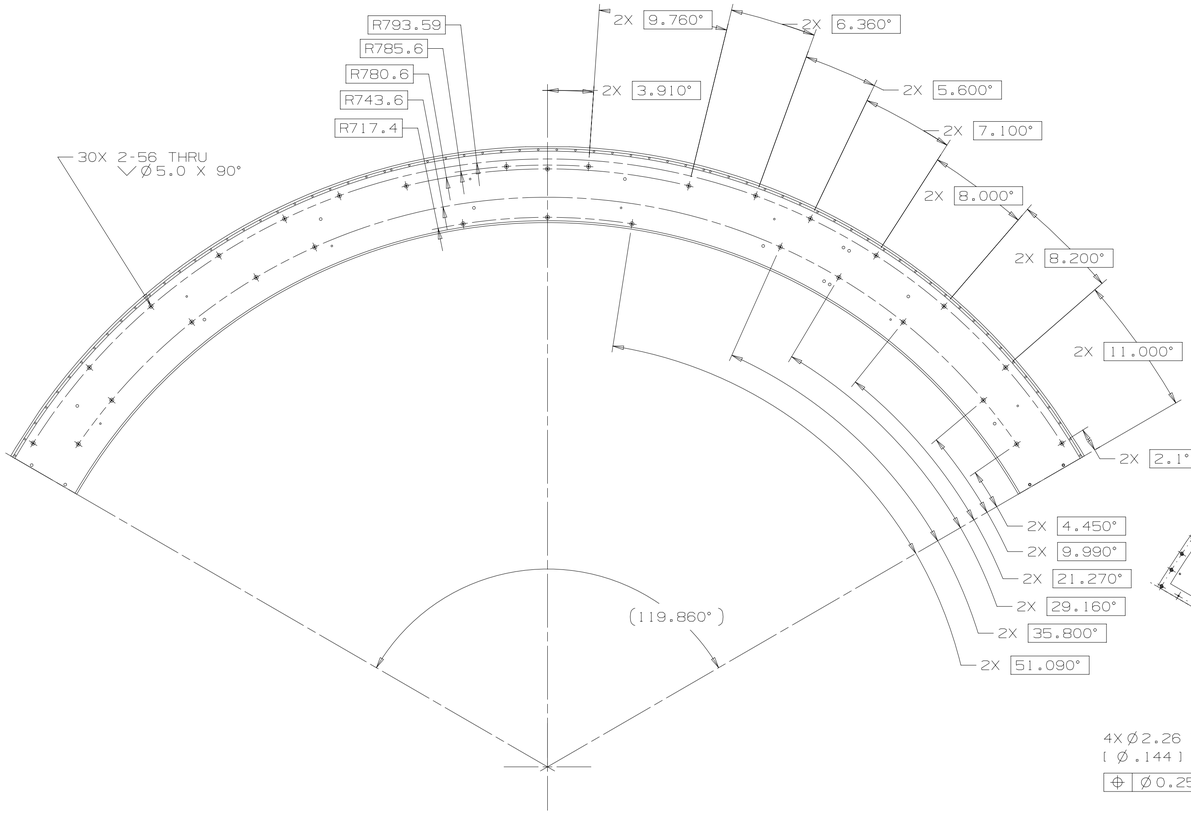
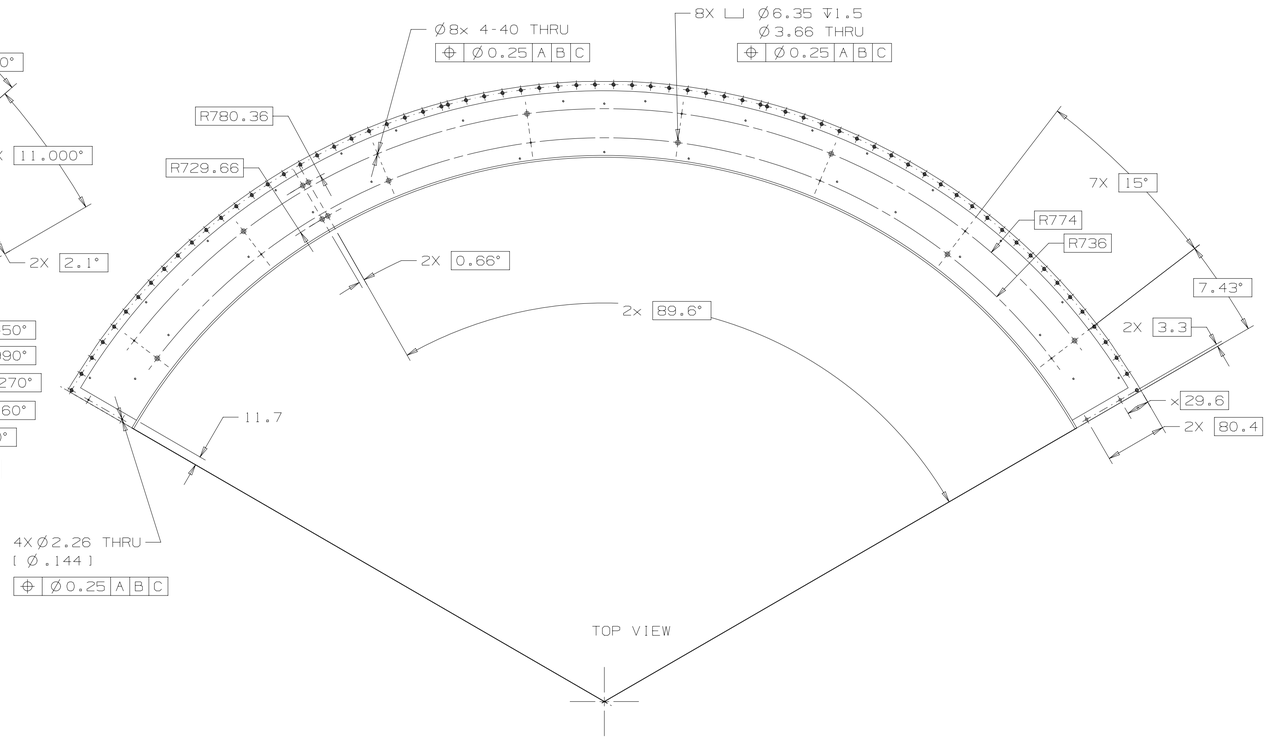
			DRAWN
			APPROVED



BOTTOM VIEW
(ELECTRONIC MOUNTING HOLES)



TOP VIEW

Issued for Quotation

UNLESS OTHERWISE SPECIFIED				
±X	±X.X	±X.XX	±X/X	±X°
2	0.2	0.10	N/A	1°

BREAK ALL SHARP EDGES 0.38 MAX.
DO NOT SCALE DRAWING
DIMENSIONS BASED ON ASME Y14.5M-2009
MAX. ALL MACH SURFACES 3.2
DRAWING UNITS: MM

DRAWN	G.DUCCI	DATE	15-Sep-2015
CHECKED		DATE	
APPROVED		DATE	
USED ON			
MATERIAL	PRECISION GROUND 5/8" STOCK		

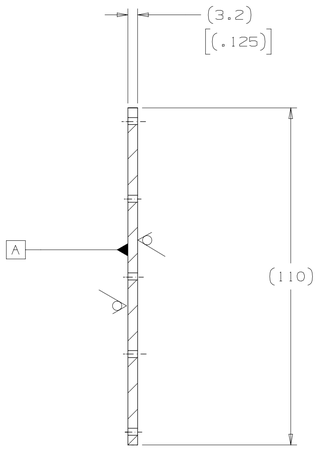
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NAME: T-TRACKER BASE PLATE

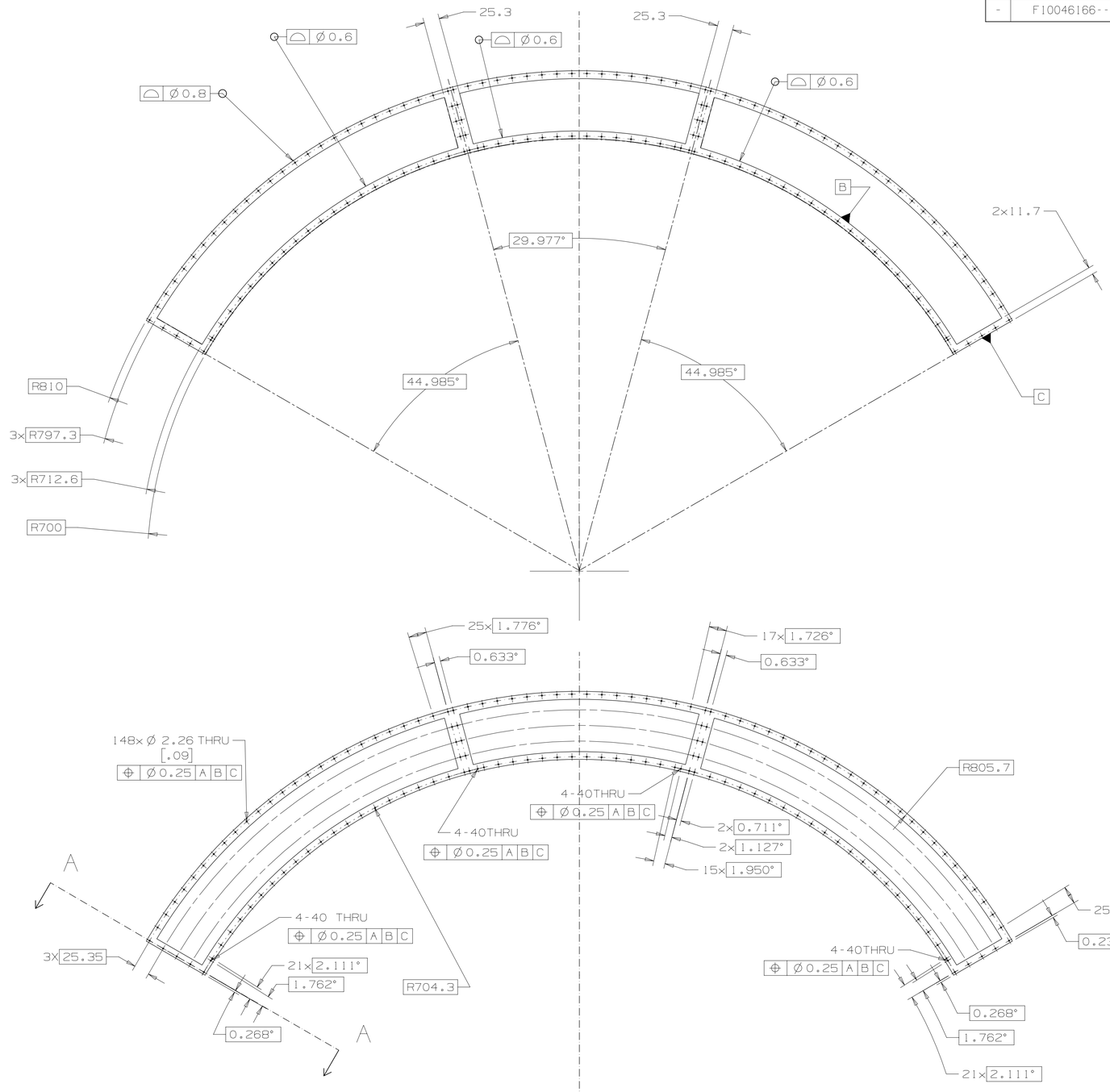
SCALE	SIZE	DRAWING NUMBER	SHEET	REV
1:4	A1		2 OF 2	

DESCRIPTION: Enter Description ...
CATEGORY: PROJECT: MU2ETracker

REV	REVISION CONTROL DOCUMENT	DATES	SIGNATURES	
-	F10046166---RCD	18-Aug-2015	DRAWN	G.DUCCI
			APPROVED	



SECTION A-A



Issued for Quotation

NOTES (UNLESS OTHERWISE SPECIFIED):

1. PART MUST BE FREE OF DIRT, GREASE, OIL, AND CHIPS.
2. PART MUST BE FREE OF ALL SHARP EDGES, CORNERS AND BURRS.
3. ALL FILLETS TO BE 0.36mm UNLESS OTHERWISE SPECIFIED.
4. DIMENSIONS IN BRACKETS ARE IN INCHES.
5. ALL DIMENSIONING AND TOLERANCING MUST MEET THE CRITERIA ON THE LIGHT CLAMP CONDITIONS.

TAPPED HOLES DETAILS

UNLESS OTHERWISE SPECIFIED				
±X	±X.X	±X.XX	±X/X	±X°
2	0.3	0.12	N/A	1°

BREAK ALL SHARP EDGES 0.5 MAX.
DO NOT SCALE DRAWING
DIMENSIONS BASED ON ASME Y14.5-2009
MAX. ALL MACH SURFACES 3.2
DRAWING UNITS: MM

DRAWN	G.DUCCI	DATE	18-Aug-2015
CHECKED	G.GALLO	DATE	21-Aug-2015
APPROVED		DATE	
USED ON			
MATERIAL	ALUMINUM 7075-T6 1/8" STOCK SIZE		
GROUP:		CAGE CODE: 0U5R6	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NAME: FRAME RING MANIFOLD

SCALE	SIZE	DRAWING NUMBER	SHEET	REV
1:4	A1	F10046166	1 OF 1	-