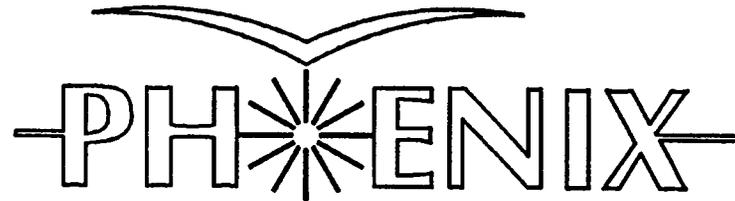


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# **RHIC/PHENIX Detector**



## **Central Magnet Transporter System Final Design Review**

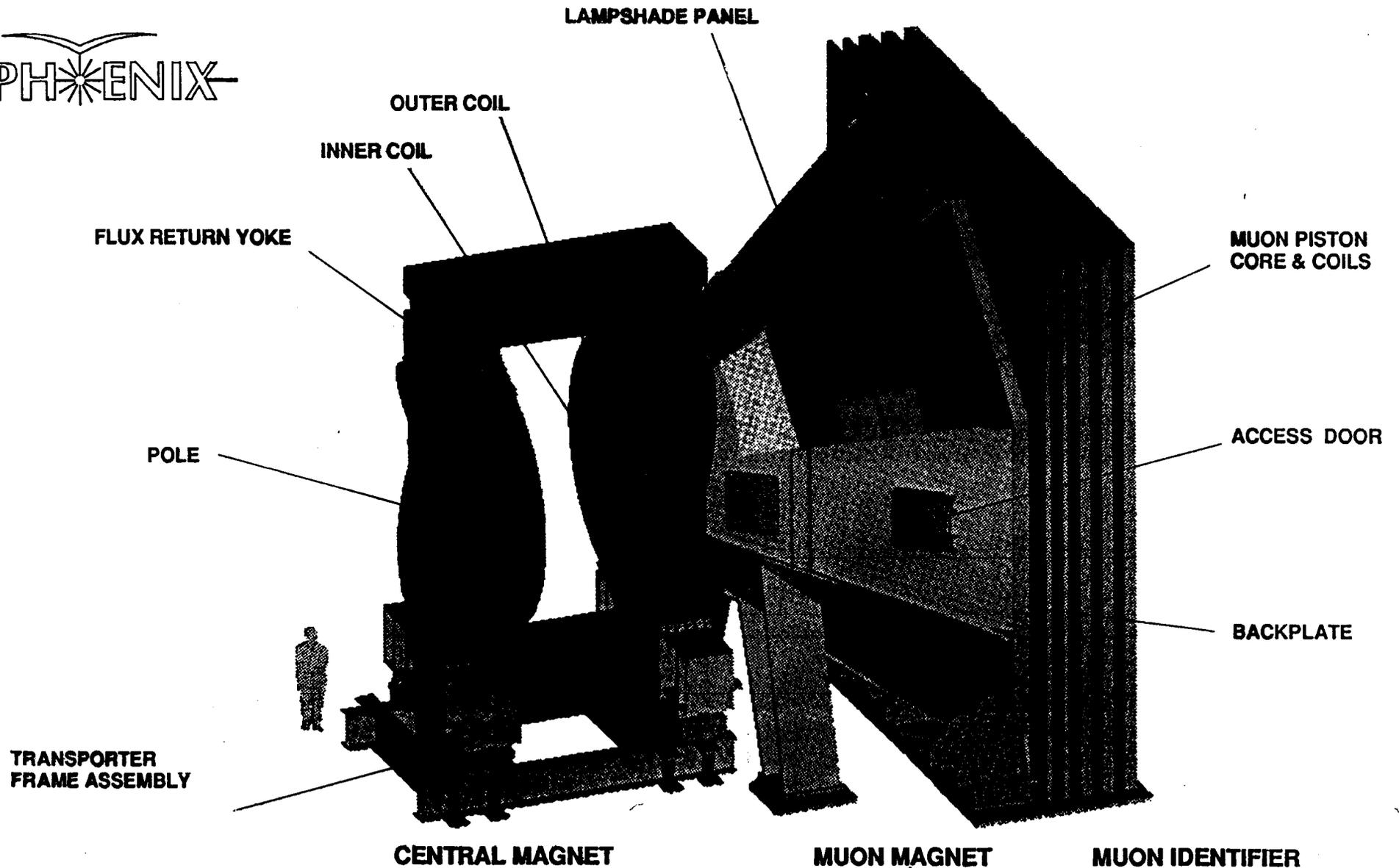
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Joel Bowers  
Larry Mullins



Lawrence Livermore National Laboratory  
April 5, 1994

# PHENIX Magnet Subsystem



# **Agenda**

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- **Introduction**
- **Purpose of this review**
- **System definition**
- **Design description**
- **Engineering priorities**
- **Acquisition Plan**
- **Summary**



## **Purpose of this review**

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- **Verify form and function of Phenix CM transporter**
- **Obtain commitment on final design**
- **Obtain approval to complete detailed design package**
- **Obtain approval proceed with procurement**
- **Resolve interface issues with detector carriage transport**

# **System definition**

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- **The transporter system provides mobility and seismic restraint to the PHENIX Central Magnet and detector carriages.**
  
- **Major Equipment**
  - Tracks
  - Roller/suspension assemblies
  - Lifting and transporting hydraulic systems
  - Seismic restraint system

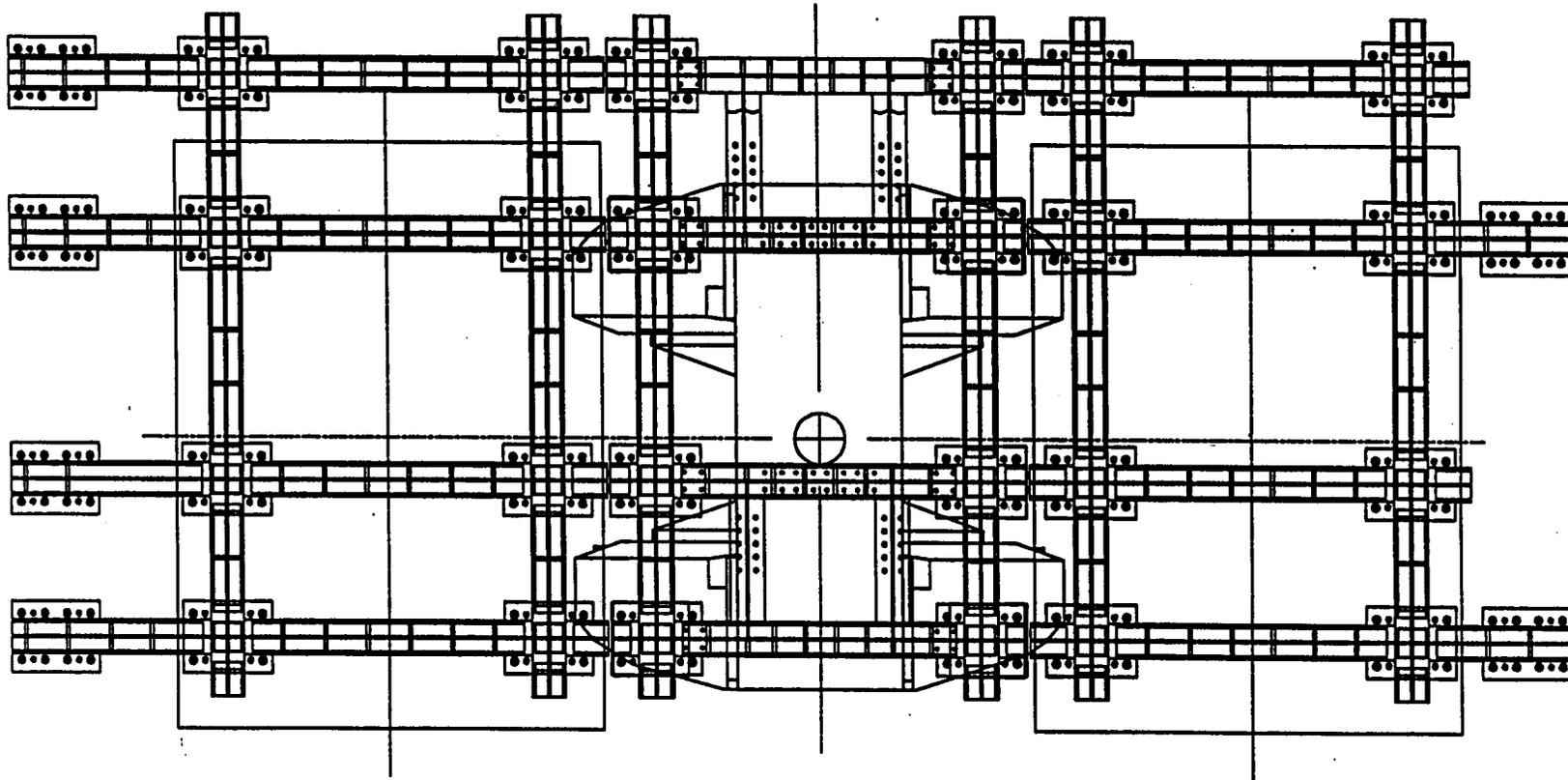
# **Functions performed**

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- **Translate CM along beam line 1.5m to access muon station 1**
- **Guide CM accurately during transport**
- **Support weight of CM**
- **Prevent uncontrolled motion during a seismic event**
- **Provide seismic restraint at  $Z=0$  and  $Z=1.5\text{m}$**
- **Lift CM to rotate rollers 90 degrees**
- **Provide a compatible track system for the PHENIX detector carriages**

# Central magnet: installed position

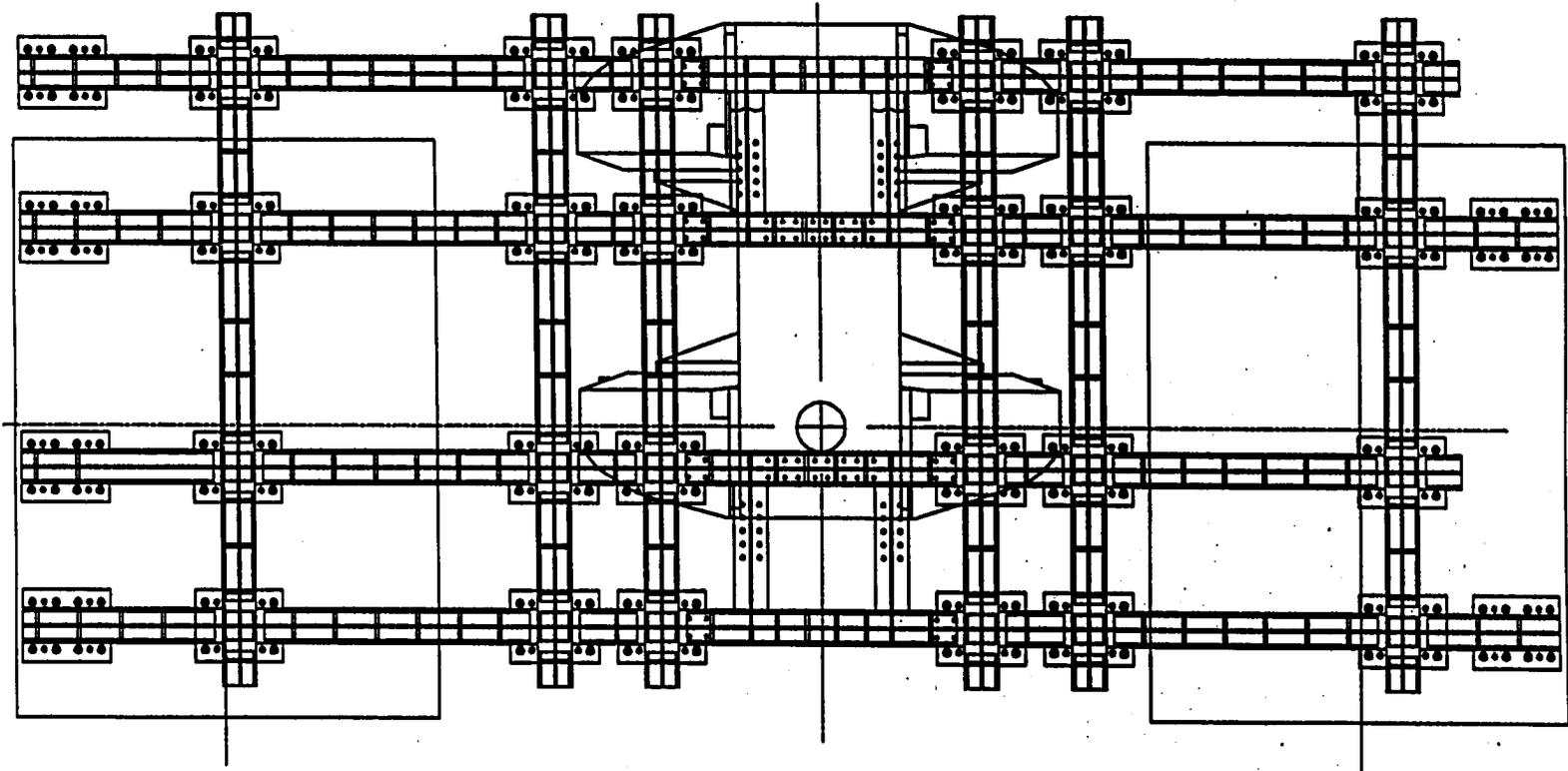


DETECTOR 1

CENTRAL MAGNET

DETECTOR 2

# Central magnet: maintenance position



DETECTOR 1

CENTRAL MAGNET

DETECTOR 2

## **Design requirements**

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- **1.5m travel accuracy must be repeatable to 2mm (0.080")**
- **Guide CM accurately during transport**
- **Support CM assembly weight of 600 tons**
- **Seismic requirements for BNL 0.15g horizontal, 0.08g vertical (UCRL 15910)**
- **Minimum factor of safety for seismic events = 1 on yield strength**
- **Minimum lift stroke of 0.5"**
- **Maximum structure width of 4 meters to avoid detector carriages**

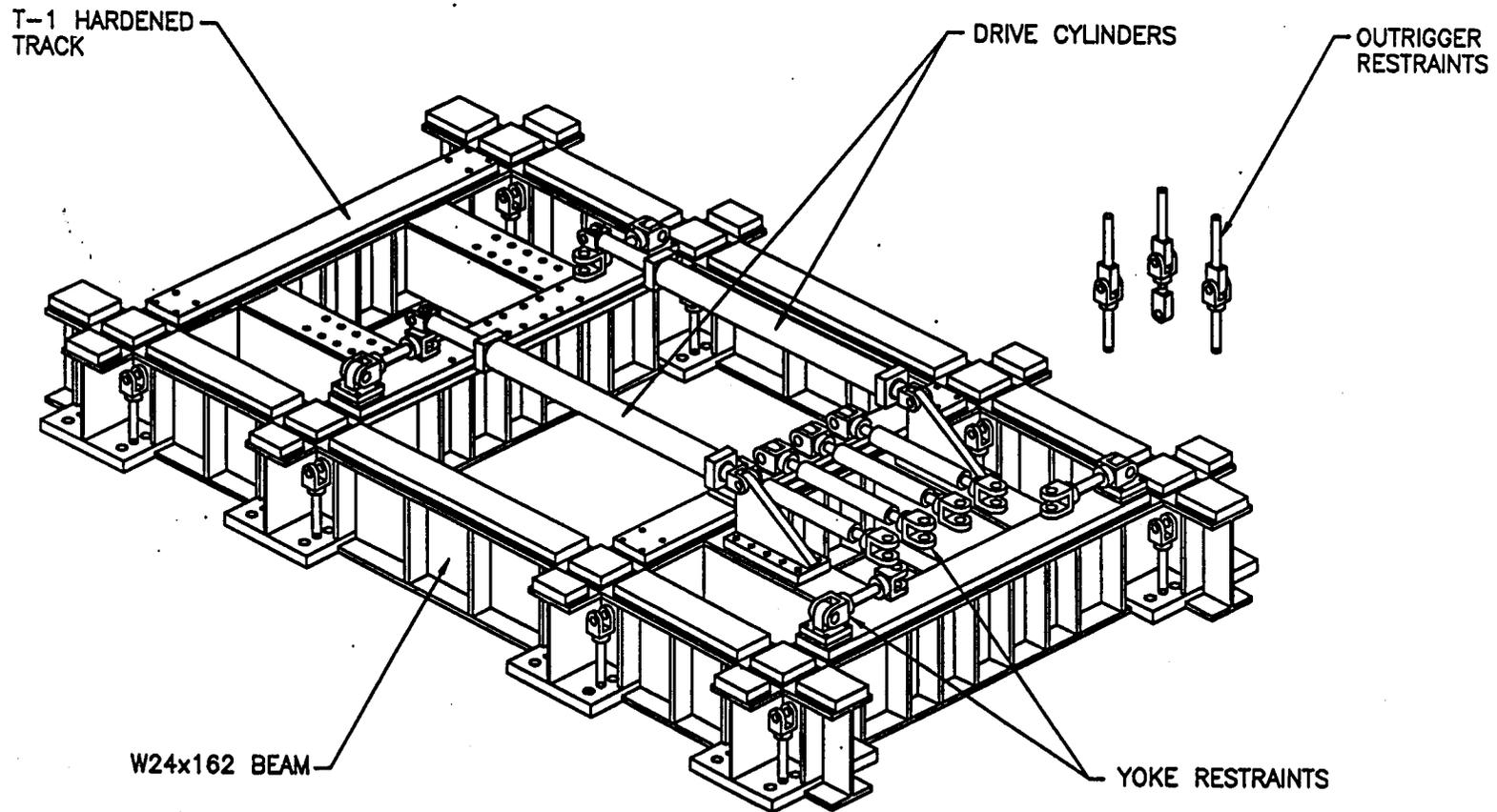
# **Assumptions**

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- **Hydraulic system designed for twice the design load**
- **Hilman roller friction factor = 0.05**
- **Experimental hall concrete strength >2500 psi**
- **Piping and cables are all above track level**
- **BNL detector carriage uses similar seismic tie down scheme to LLNL design**
- **BNL responsible for detector restraints**
- **LLNL responsible for detector tracks**
- **BNL responsible for portable tracks**

# Design description



# **Track weldment**

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- **Weight: 20 tons**
- **24" deep wide flange beams**
- **T-1 hardened plate provides bearing surface**
  - **track is welded to beam assy, then machined**
- **Weldment mounts to the floor on 64 grouted threaded rods**
- **Track is compatible with detector carriage tracks**



# **Track weldment installation**

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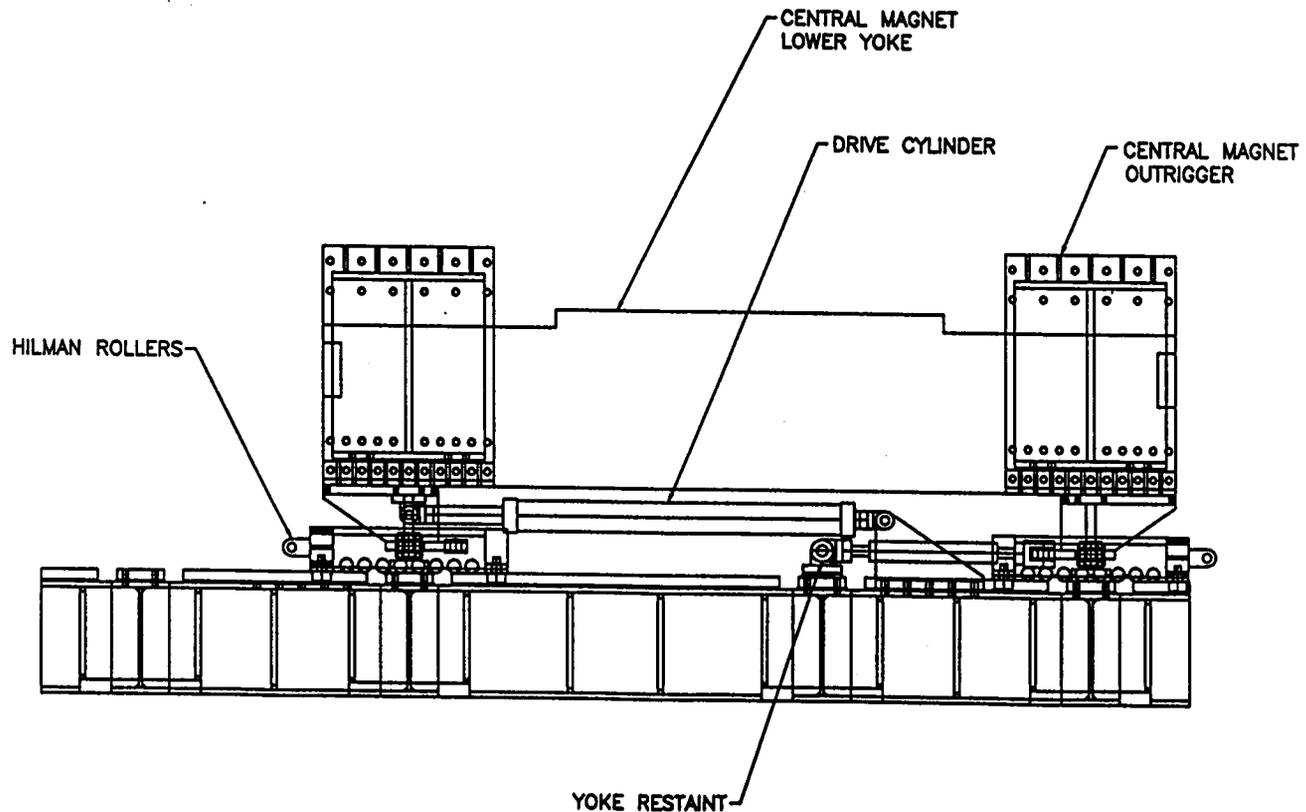
- **Locate drill template on hall floor using surveyors**
- **Core drill anchor holes in floor through the template**
- **Position weldment roughly over holes**
- **Crib weldment up 24" on wood blocks**
- **Double nut anchor studs to the weldment**
- **Lower weldment to nominal position, survey to 1/8"**
- **Inject grout into each stud mounting hole**
- **Loosen studs, position mounting frame to 1/16"**

# Drive system

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- Twin 7" bore hydraulic cylinders, 1.5 meter stroke
- Control system provides accurate positioning
- Mounted beneath magnet yoke for protection



# **Transport of Central Magnet Assy. on tracks**



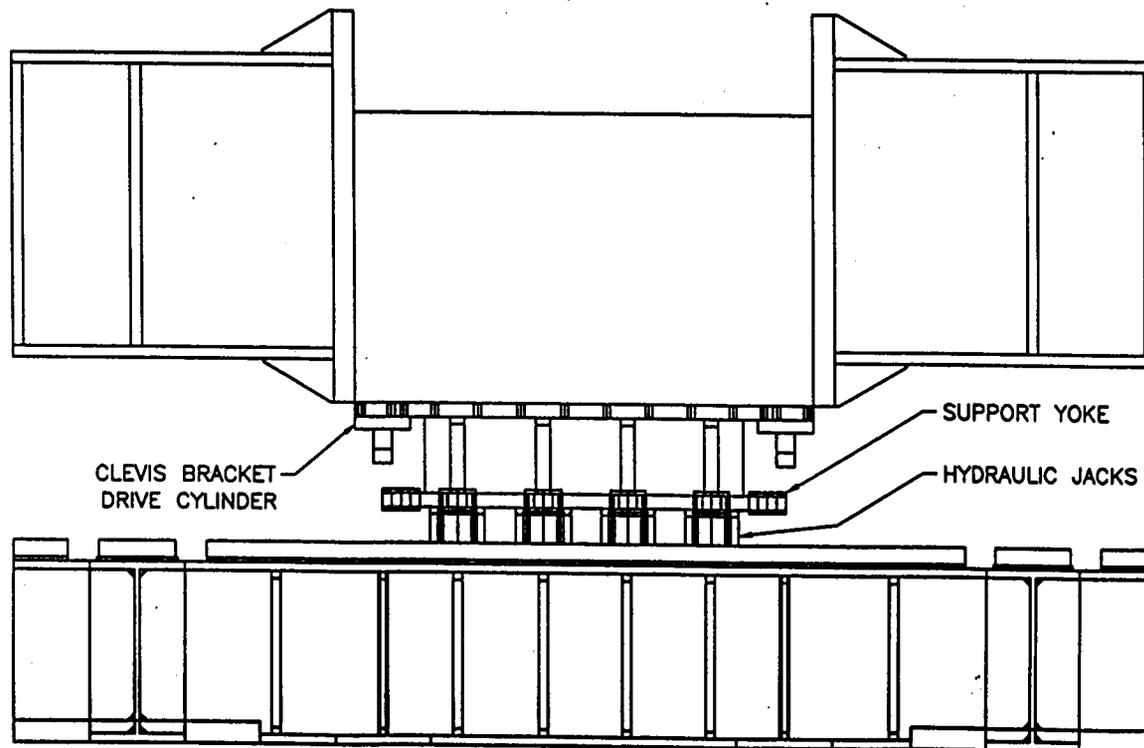
- **Total force to move 600 ton assembly = 60,000 lbs @ a .05 friction factor**
- **Two push-pull hydraulic cylinders ( one per track ) are used, each cylinder capable of a push or pull => 30,000 lbs**
- **Cylinder size: 3000 psi, 7" bore, 4" rod, 60" stroke, 9" stop tube (51" effective stroke )**
  - **Max. pull @ 3000 psi = 77,750 lbs**
  - **Push @ 2000 psi ( Max. allowed ) = 76970 lbs**
- **Rod end clevis attached to Hilman Roller bracket**
- **Cylinder end clevis attached to track bracket**
  - **Track bracket to be relocated after every 4' of travel**
- **Representative pump: Enerpac PER 8418, 230v, 3Φ, 12.5hp, 4.4 gpm ( time to go 4' = about 4 minutes )**

# Jacking system

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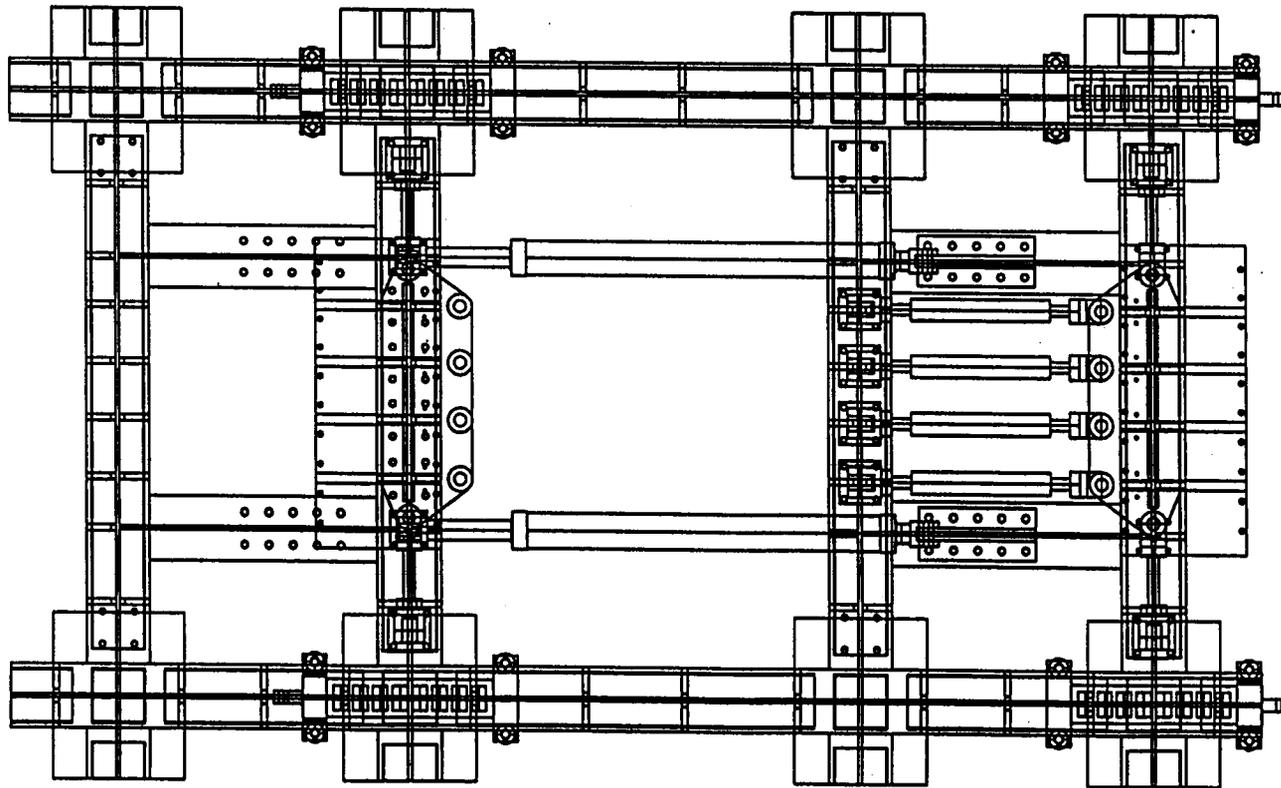
- 8 x 150 ton pancake jacks
- 0.5" stroke, allows rollers to be turned 90 degrees
- Interfaces with yoke support weldment



# Restraint system



- **Separate restraints for horizontal shear and overturning moment**
- **Bar stock with cylinder clevis brackets attached**

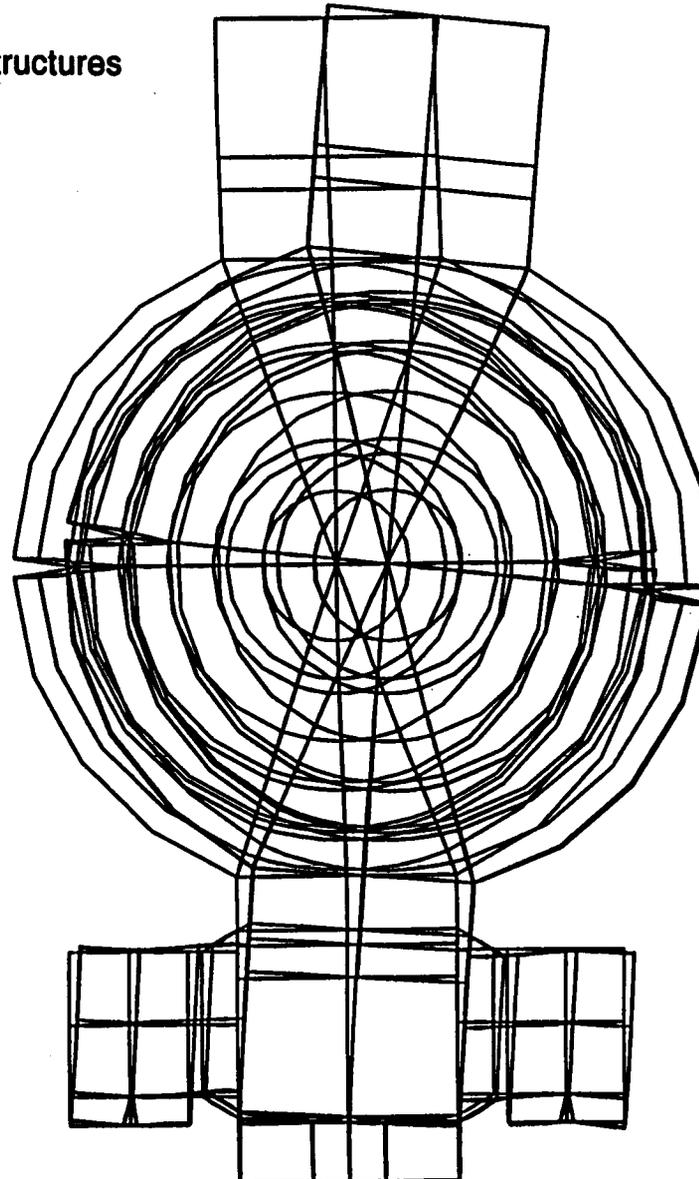


# Central Magnet finite element analysis

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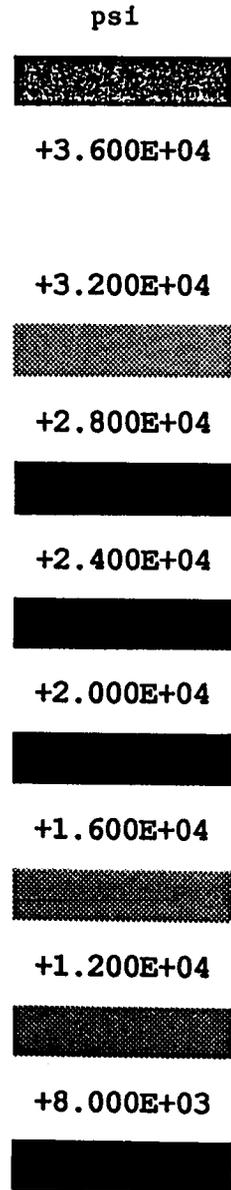
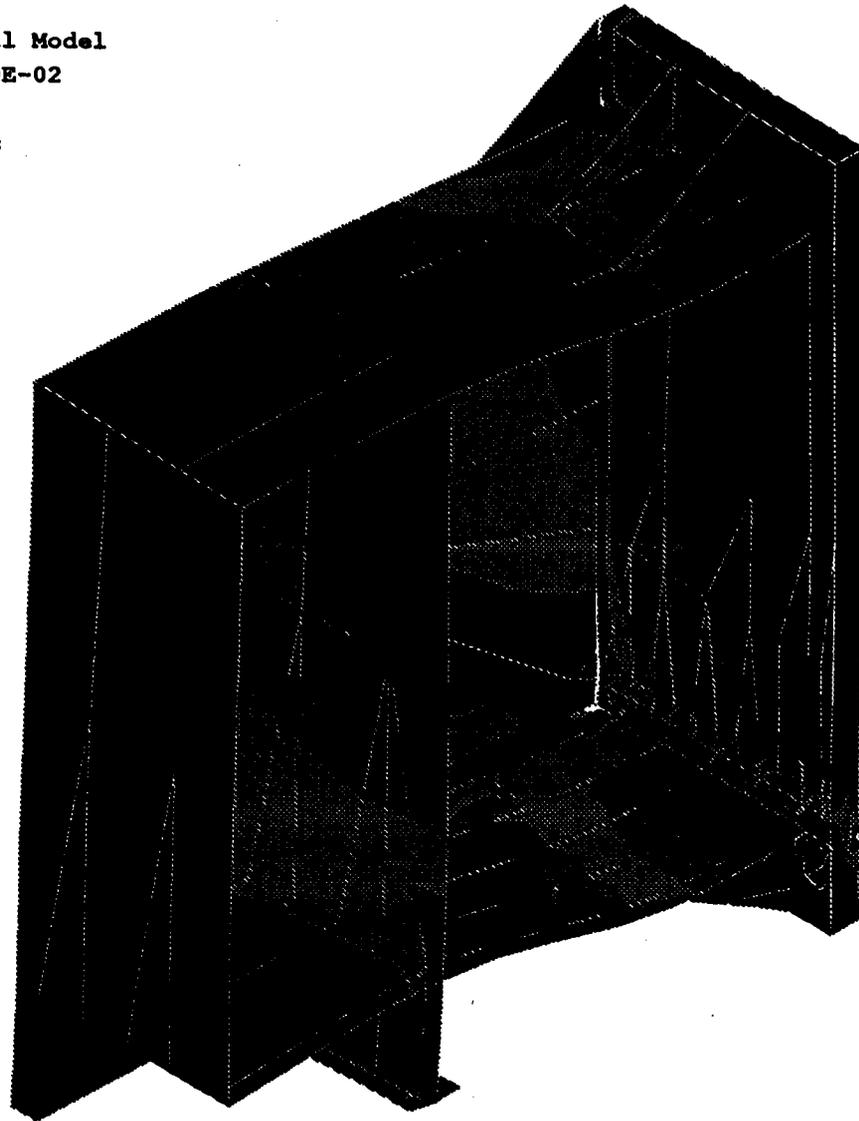
Analyses by Marcus Libkind  
Software: Rasna/ Mechanics/Applied Structures



JMB-32  
4/29/93

"model\_os1\_1" - ds\_cm3\_model\_os1 - model

Stress Von Mises  
Max +2.4060E+05  
Min +9.1678E+01  
Deformed Original Model  
Max Disp +6.2539E-02  
Scale 8.8745E+01  
Load: wt\_seismic



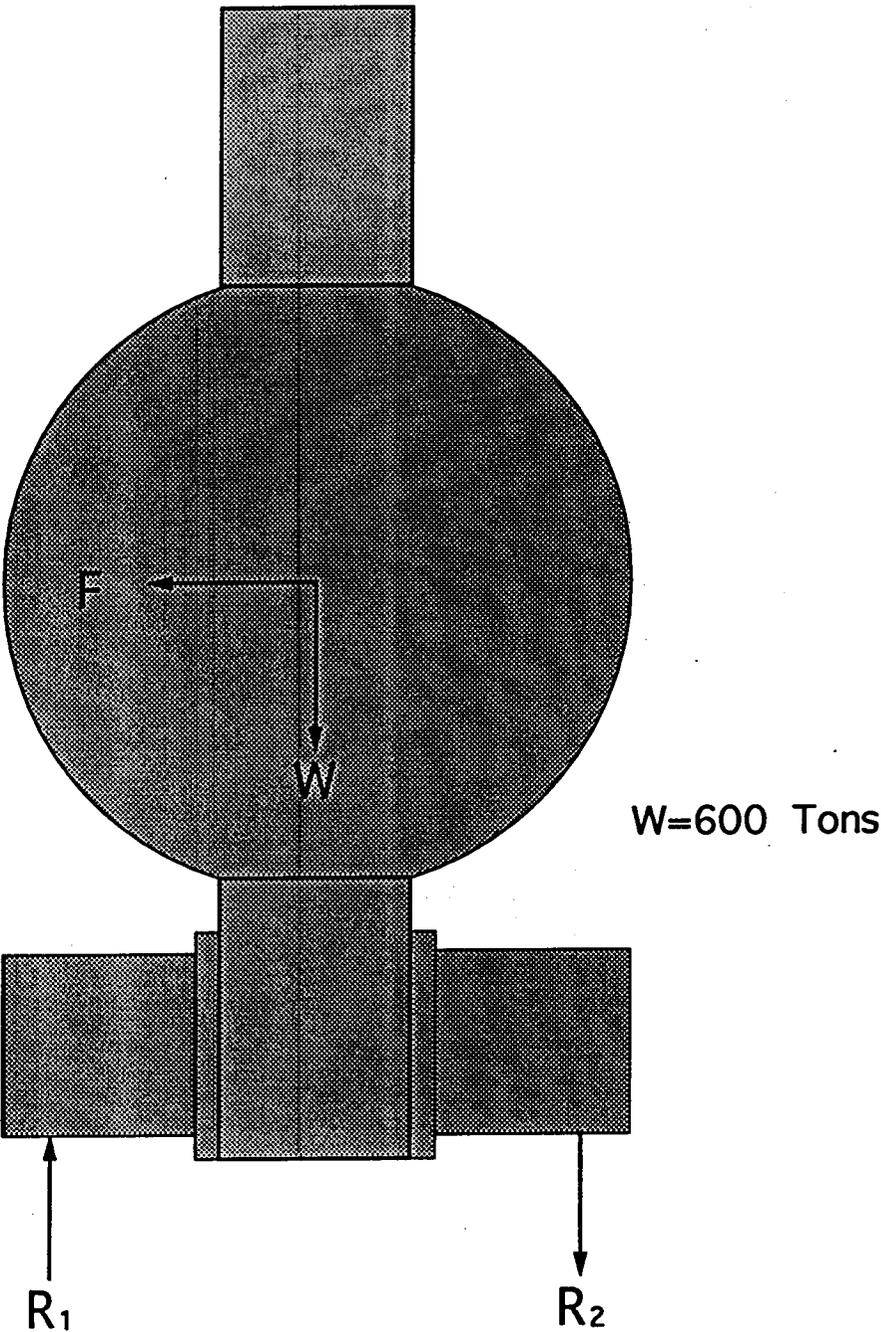
"stress\_vm" - ds\_rigla\_stress1 - stress1

# **Earthquake loads: Central Magnet Assembly**



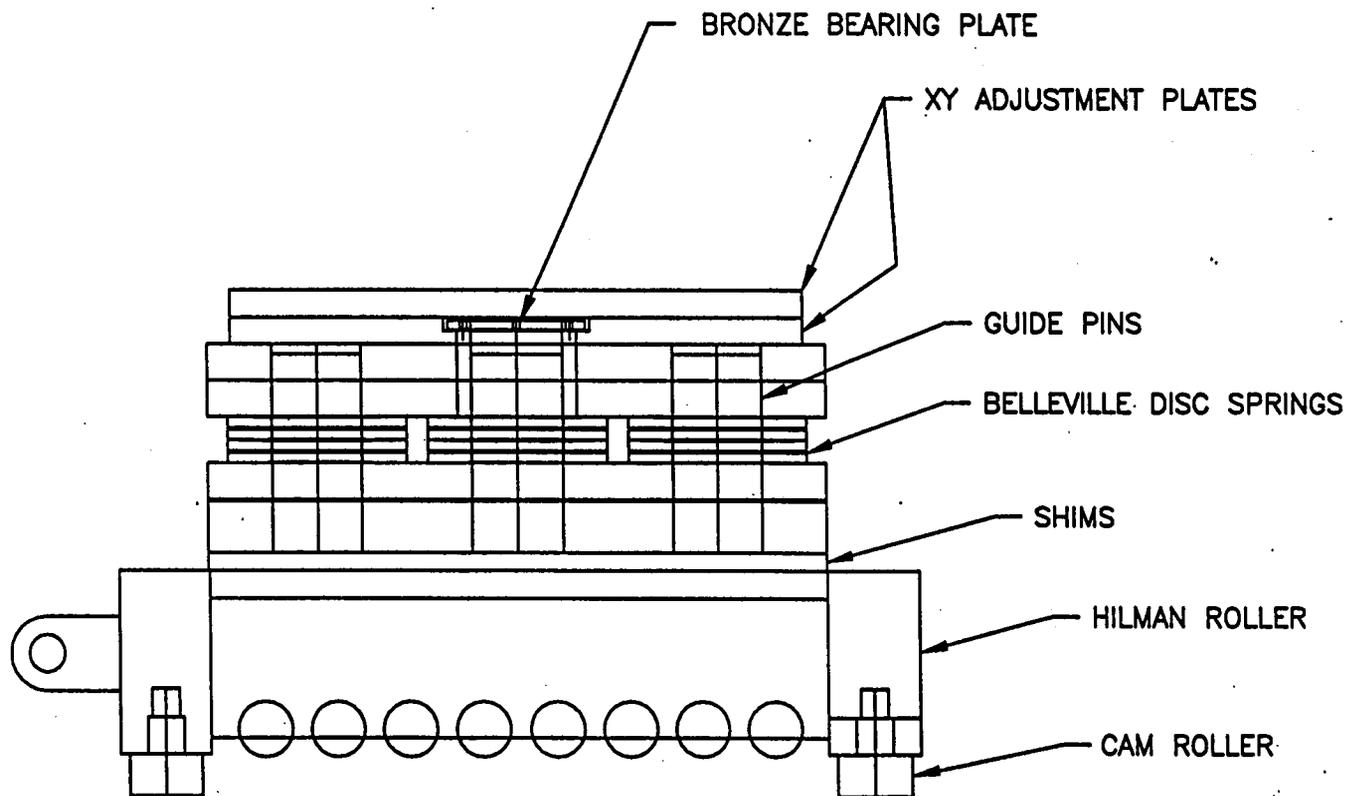
- **Design total weight = 600 tons**
- **Loads are reacted by the outriggers**
- **Maximum vertical acceleration = .1g ( no amplification )**
- **Maximum horizontal acceleration = .52g ( amplification of 3.21)**
- **Maximum upward force on an outrigger = 407 tons**
  - **Factor of safety of outrigger in bending = 3.2 (yield, A36 steel)**
  - **Factor of safety of outrigger bolts = 5.0 (Ult. M36, 8.8 bolts)**
- **Maximum downward force on an outrigger = 107 tons**
  - **factor of safety of tie rods = 2.8 (yield, 1.5"-6, 4140 rods)**

# Phenix Central Magnet Assembly



<u>MODE</u>	<u>DIRECTION</u>	<u>LOAD PER OUTRIGGER (MAX)</u>
Weight	Up	150 TONS, R1, R2
Wt. + E.Q.	Up	407 TONS, R1
E.Q.	Down	107 TONS, R2

# Suspension system cross section

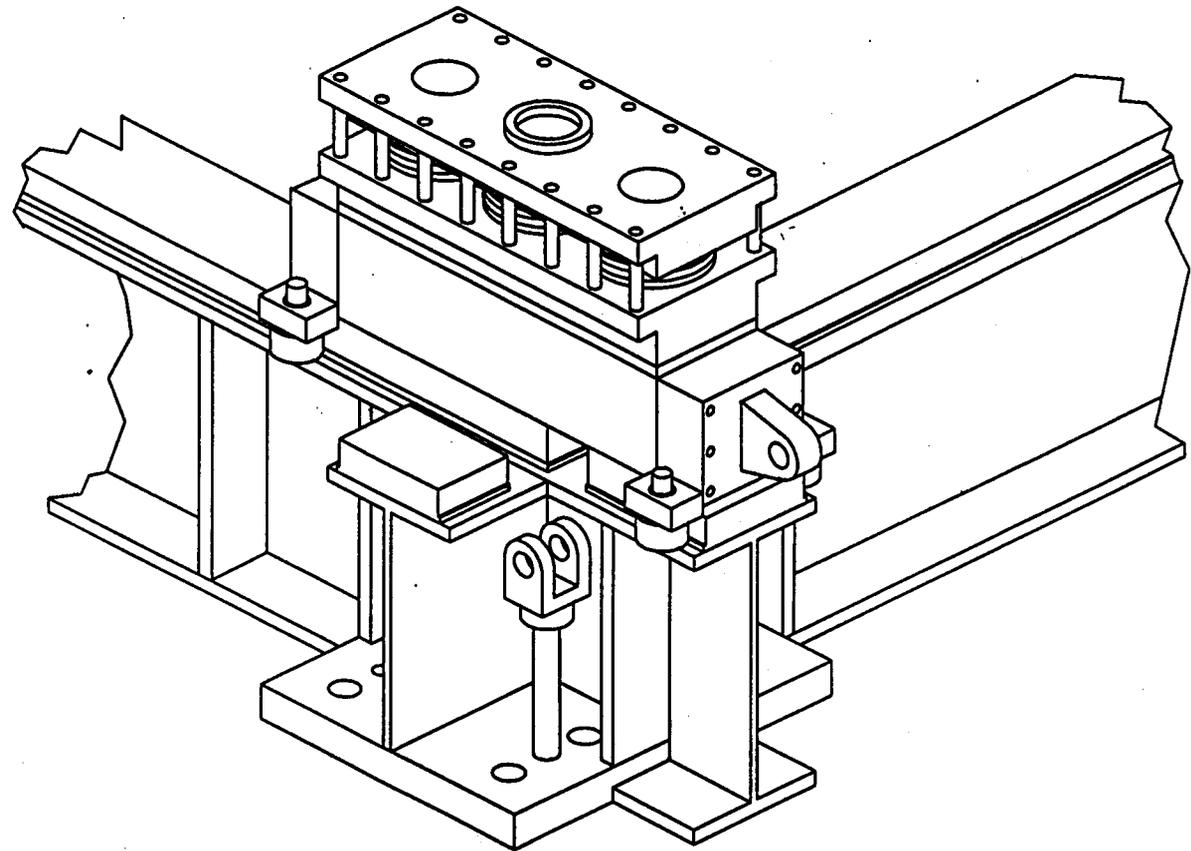


# Guided rollers

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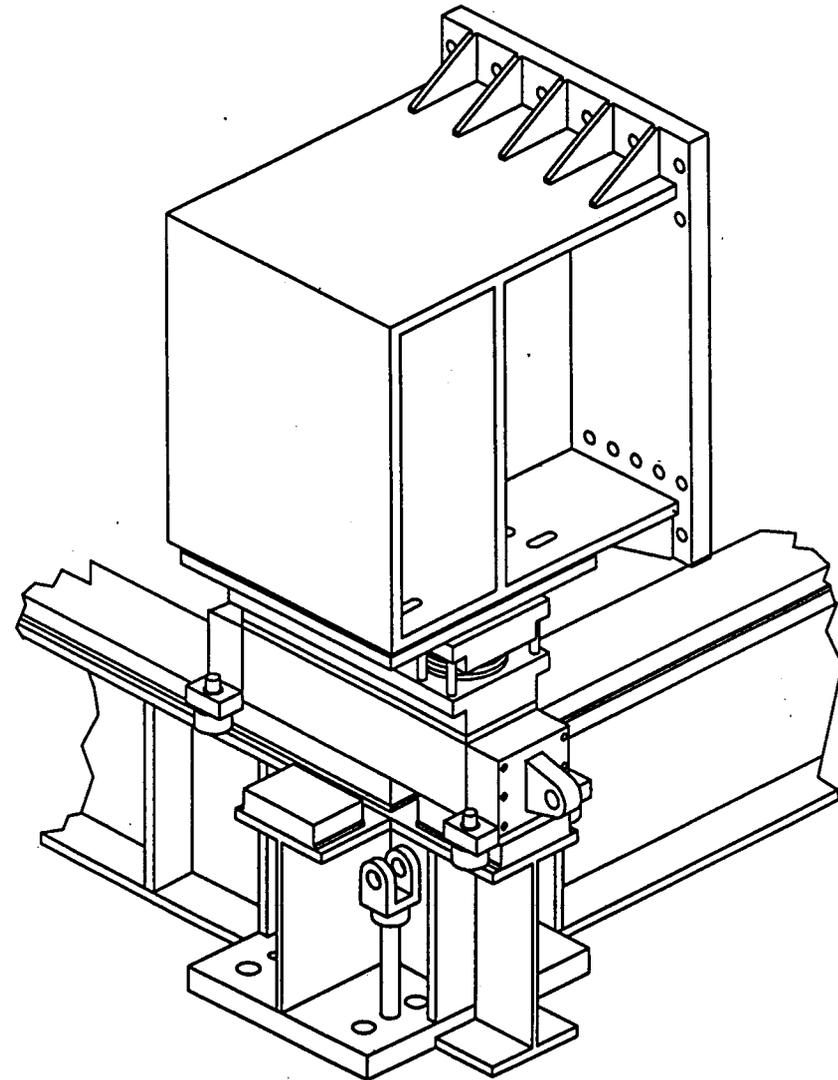
- **300 ton Hilman rollers carry load**
- **4" eccentric cam rollers provide linear guidance on T-1 track**
- **Rollers connected to outrigger through a suspension system**
- **To rotate 90 degrees, lift CM assembly and turn rollers manually**



# Suspension system



- **Accommodates variations in track flatness**
- **Assures that all four outriggers share load**
- **Can be modified to have no compliance**



# **Acquisition plan**

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- **Track weldments will be procured to a detail drawing package from a domestic vendor**
- **Jacks are off the shelf items**
- **Drive cylinders and control system will be procured to a specification, jointly authored by BNL and LLNL**
- **Hilman rollers are catalog items built to order**
- **Belleville washers are catalog items built to order**
- **Miscellaneous parts fabricated to detail drawings**

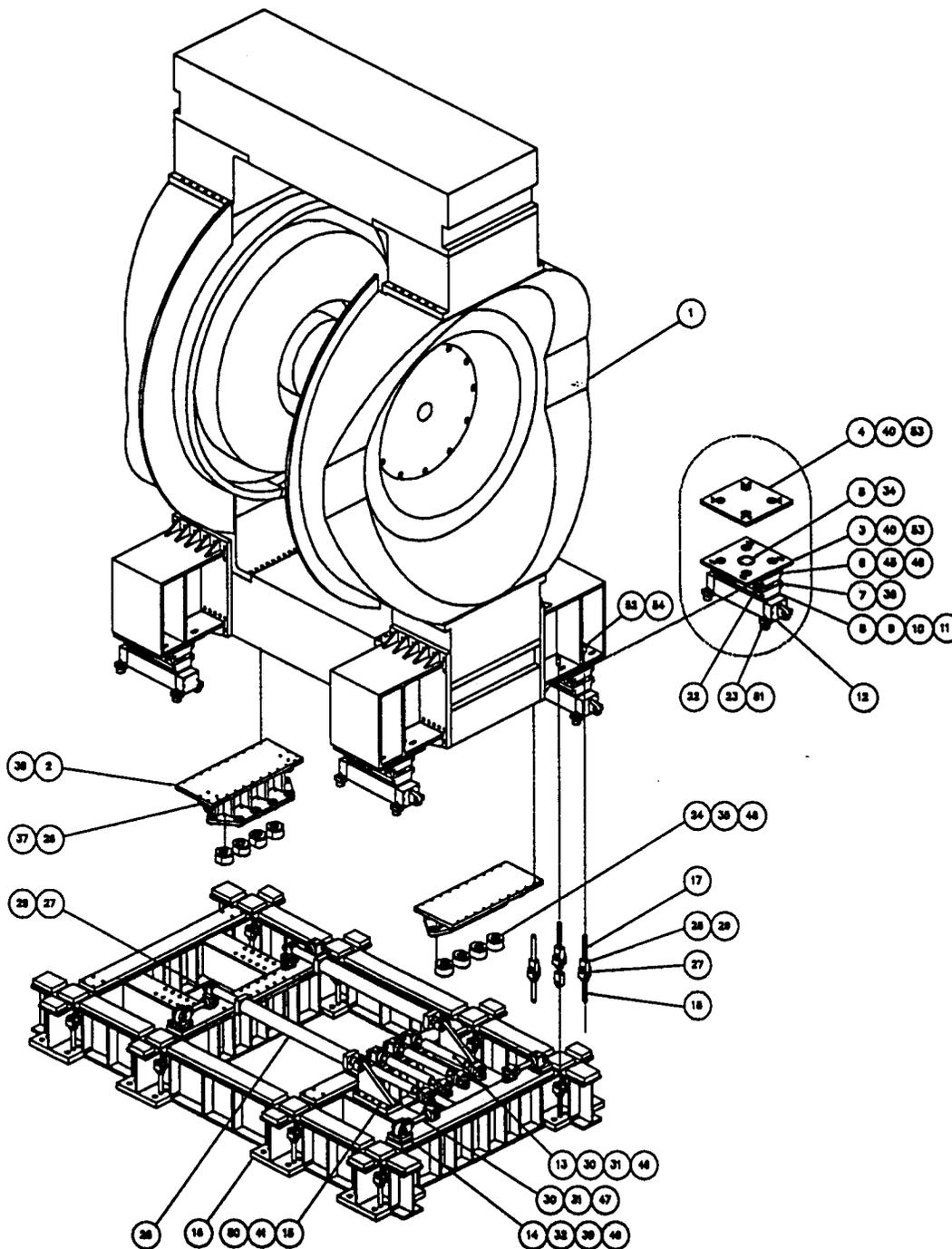
# **Summary**

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- **Transport system has been designed to be simple**
- **Seismic issues have been addressed**
- **Transport system details are in final checking**
- **Pending resolution of BNL interfaces, system design is complete.**

SI METRIC



NO	QTY	PART / U/LR ORL NO	DESCRIPTION / MATERIAL	SPCS	REF
10			WASHER FLAT 2" NOM. STEEL		84
32			WASHER FLAT M30		83
10			NUT HEX 3-4.8UNF STEEL		82
16			NUT HEX 1.8-18UNF STEEL		81
20			NUT HEX BLACKM384		80
88			NUT HEX BLACKM343		48
18			NUT HEX BLACKM120.78		48
4			ROD THREADED 2.38-12" X 12" STL 4140		47
8			ROD THREADED 2.38-12" X 12" STL 4140		48
84			ROD THREADED BLACKM243 280		48
					44
					43
					42
20			SOCHD.CAP SCREW BLACKM384 120		41
32			SOCHD.CAP SCREW BLACKM384 80		40
32			SOCHD.CAP SCREW BLACKM343 120		38
40			SOCHD.CAP SCREW BLACKM343 120		38
8			SOCHD.CAP SCREW BLACKM343 80		37
48			SOCHD.CAP SCREW BLACKM120.78 280		36
18			SOCHD.CAP SCREW BLACKM120.78 180		35
18			HECHD.CAP SCREW BLACKM120.78 38		34
					33
8			EYE BRACKET 10" BORE		32
18			PIVOT PIN 10" BORE		31
18			ROD CLEVIS 10" BORE		30
20			PIVOT PIN 7" BORE		29
18			ROD EYE 7" BORE		28
20			ROD CLEVIS 7" BORE		27
2			EYE BRACKET 7" BORE		26
2			2BR3000HY87888EC4-1/2 2 3000DA CYLINDER		25
8			R8L-1600 HYDRAULIC CYLINDER		24
18			CPE-4-28 CAM BEARING		23
94-100826			SPACER SPRING (3 REQ.) OPTIONAL		22
48			AM 28012716 DISC SPRING		21
					20
					19
18			94-100833 TAB-02		18
18			94-100833 TAB-01		17
1			94-100833 FRAME TRANSPORT		16
2			94-100831 SUPPORT CYLINDER		15
8			94-100830 SPACER EYE BRACKET		14
4			94-100828 RESTRAINT ROD		13
4			94-100828 ROLLER ASSEMBLY		12
4			94-100827 TAB-04		11
4			94-100827 TAB-03		10
4			94-100827 TAB-02		9
4			94-100827 TAB-01		8
4			94-100828 SPRING BRACKET LOWER		7
4			94-100824 SPRING BRACKET UPPER		6
4			94-100823 THRUST BEARING		5
4			94-100822 PLATE ADJUSTMENT TOP #2		4
4			94-100821 PLATE ADJUSTMENT TOP #1		3
2			94-100820 SUPPORT YOKE		2
1			93-104183 CENTRAL MAGNET ASSEMBLY		1

NO REQ

FILE NAME: 4100340

DATE: \_\_\_\_\_

DESIGNED BY: \_\_\_\_\_

DATE: \_\_\_\_\_

LABORING LABORATORY

RESEARCH DIVISION

MEMORANDUM FOR THE DIRECTOR

DATE: \_\_\_\_\_

FILE NO: 94-100834-00

DATE: \_\_\_\_\_

BY: \_\_\_\_\_

REVISIONS:

NO. 1

DATE: \_\_\_\_\_

BY: \_\_\_\_\_

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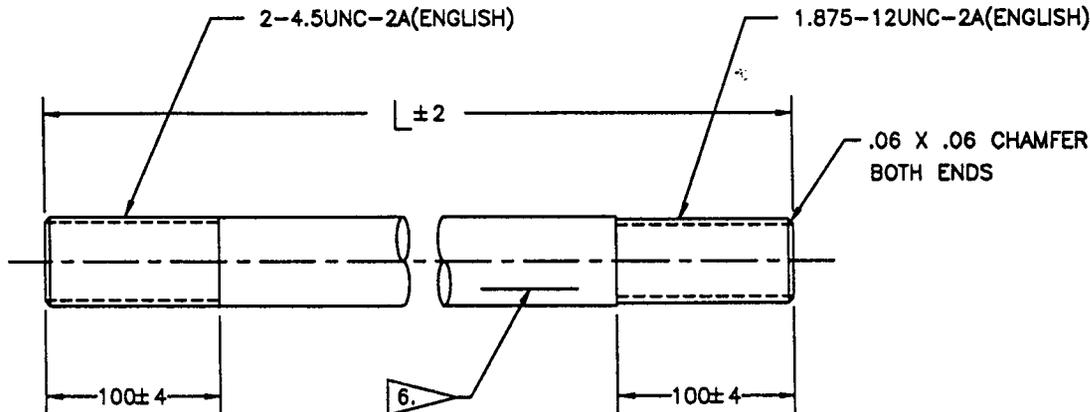
THIRD ANGLE PROJECTION



**NOTES**

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1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1985.
4.  $\sqrt{3.2}$  ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6. SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
7. AFTER FINAL INSPECTION AND MACHINING, PLATE SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1710, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.



TAB NO.	L
01	913mm (34")
02	457mm (18")

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	CHK			FILE NAME: 41009330.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
	APVD			THIS DOCUMENT IS THE PROPERTY OF		SUBASSY	
	CLASSIFIED BY:			THE UNIVERSITY OF CALIFORNIA		CENTRAL MAGNET FRAME	
	TITLE		DATE	LAWRENCE LIVERMORE NATIONAL LAB.		DETAIL	
				REPRODUCTION PROHIBITED WITHOUT		ROD MAGNET HOLDDOWN	
				PERMISSION OF THE MECHANICAL		DRAWING NO	
				ENGINEERING DEPARTMENT.		AAA 94-100933-00	
LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA				SHOWN ON AAA		ADDT NO 8883-25	
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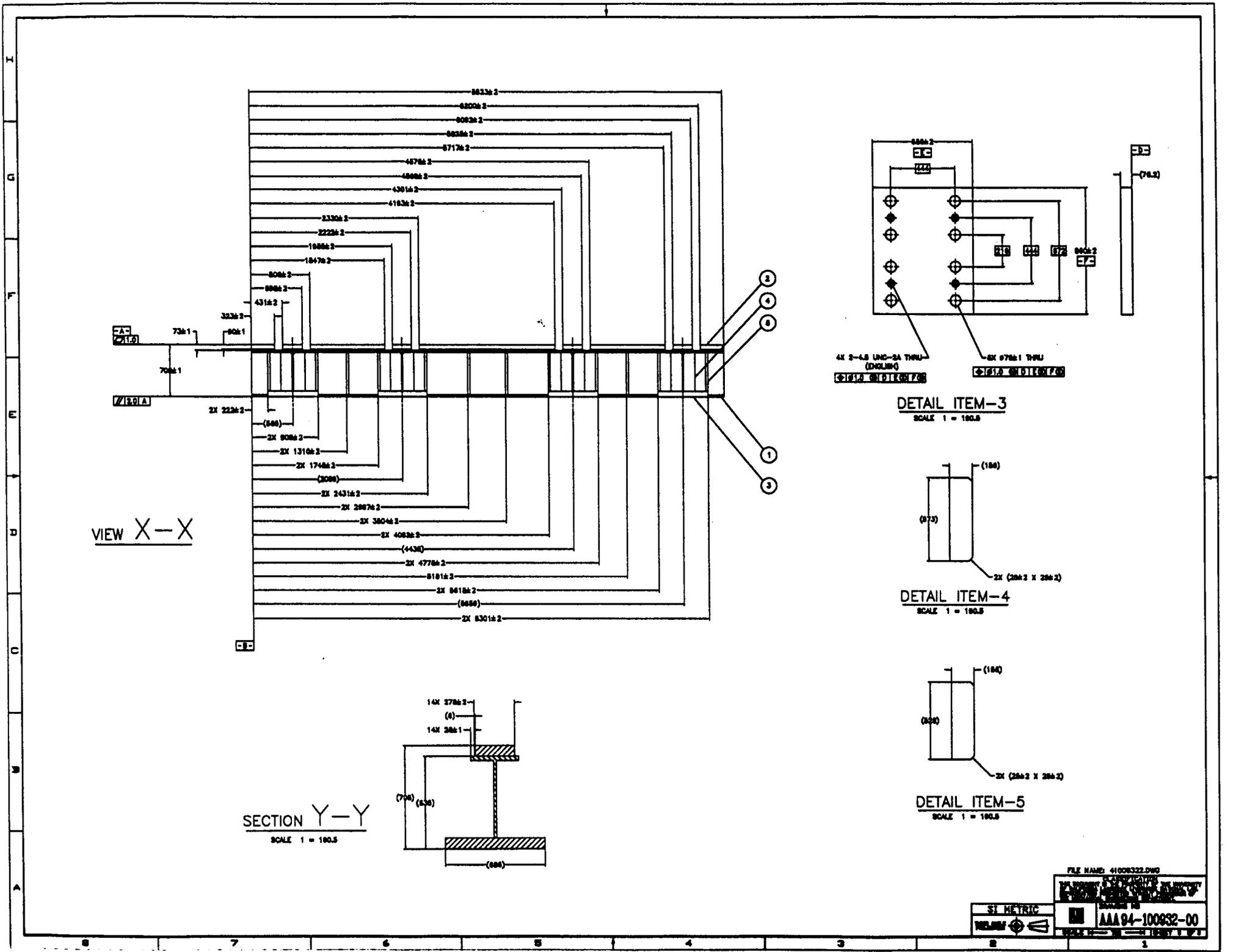
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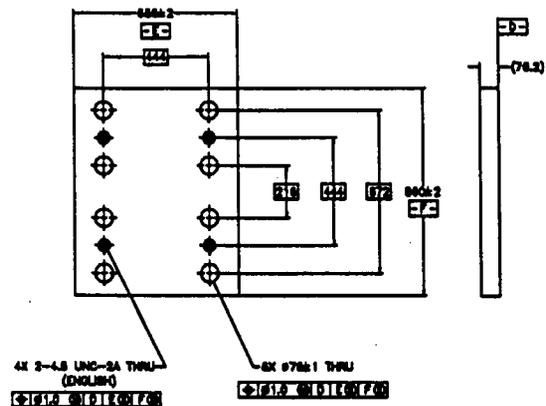
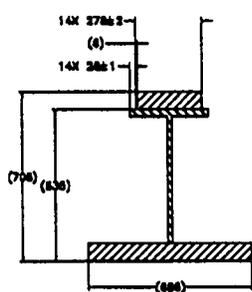
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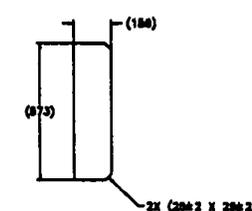


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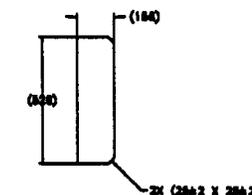
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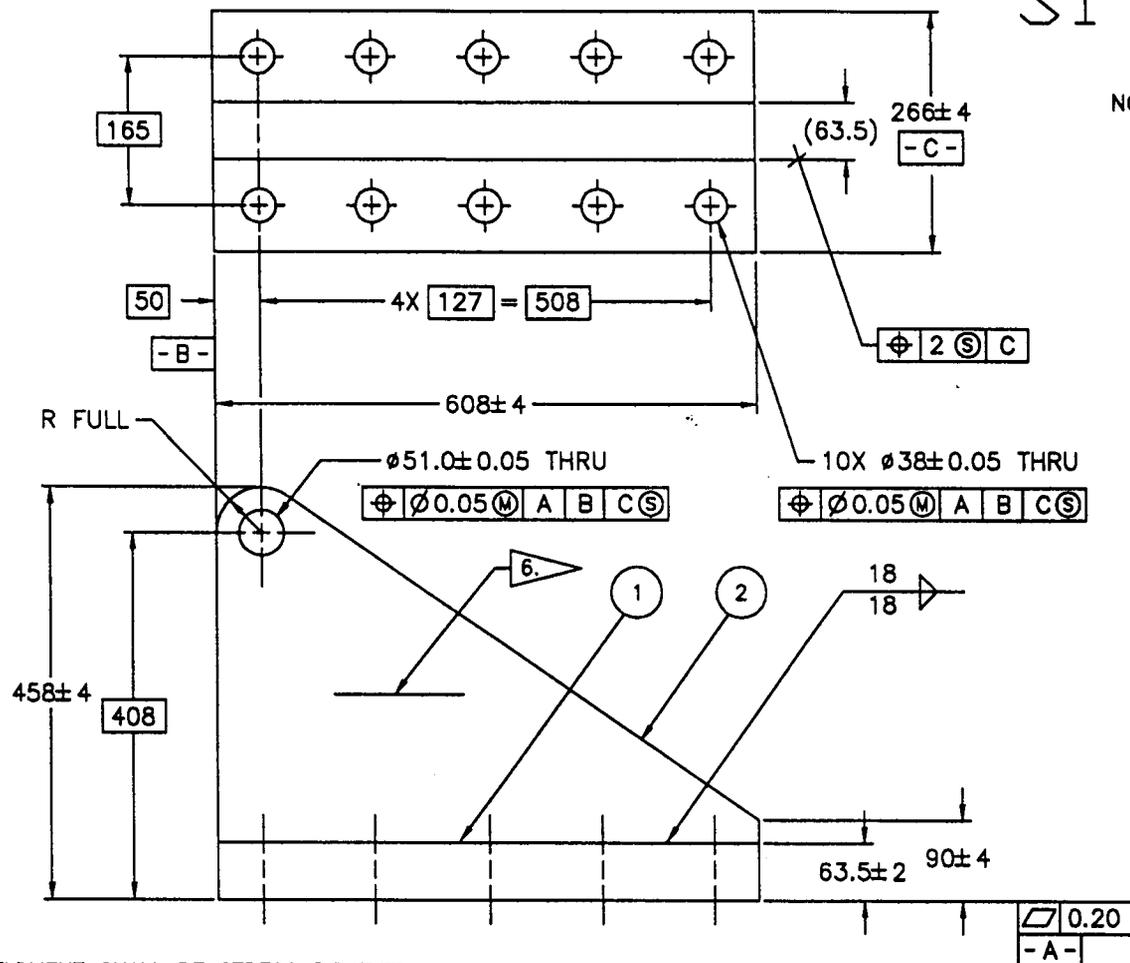
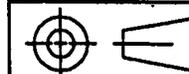
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SI METRIC

AAA 04-100832-00

# SI METRIC

THIRD ANGLE PROJECTION



**NOTES**

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1. ALL DIMENSIONS ARE IN MILLIMETERS.
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3. SURFACE TEXTURE PER ANSI B46.1-1985.
4.  $3.2 \sqrt{\text{ }}$  ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6.  $\nabla$  SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
7. WELDERS WORKING ON THIS PART OR ANY SUBCOMPONENTS SHALL BE QUALIFIED IN ACCORDANCE WITH AWS D1.1.
8. WELD PROCEDURES AND INSPECTIONS SHALL BE PERFORMED IN ACCORDANCE WITH AWS D1.1 STRUCTURAL WELDING CODE - STEEL.
9. WELD FILLER ROD SHALL BE CERTIFIED WITH RESPECT TO CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES.
10. MAGNETIC PARTICLE TEST IN ACCORDANCE WITH AWS D1.1, AND WITNESSED BY A CERTIFIED WELD INSPECTOR. RECORD OF INSPECTION FOR EACH WELD SHALL BE INCLUDED IN QUALITY ASSURANCE DOCUMENTATION.

11. WELDMENT SHALL BE STRESS RELIEVED AFTER ALL WELDING AND BEFORE FINAL MACHINING.

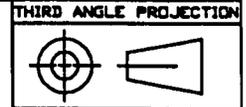
12. AFTER FINAL WELD INSPECTION AND MACHINING, WELDMENT SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1710, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.

1	PLATE 63.5 THK.	STEEL ASTM A36	2	
1	PLATE 63.5 THK.	STEEL ASTM A36	1	
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	CHK		<b>SUBASSY</b> CENTRAL MAGNET FRAME	
	APVD		<b>DETAIL</b> CYLINDER, SUPPORT	
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	DATE			SHEET 1 OF 1

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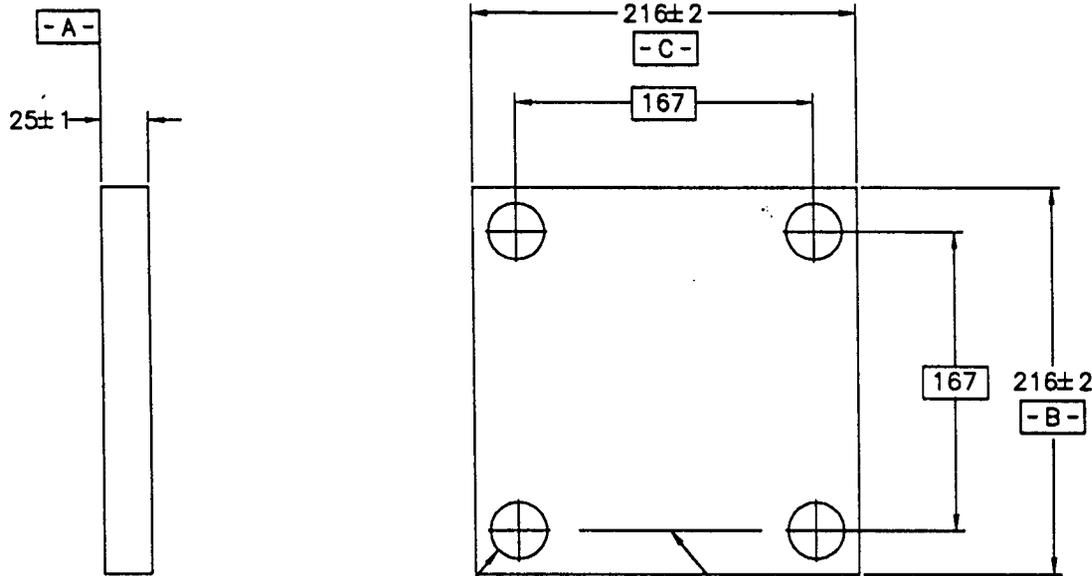
# SI METRIC



### NOTES

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$\varnothing \varnothing 0.05 \text{ (M)}$  A B  $\text{C}$   $\text{C}$

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		APVD				DETAIL SPACER EYE BRACKET	
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LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA							

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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4

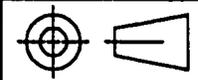
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2

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# SI METRIC

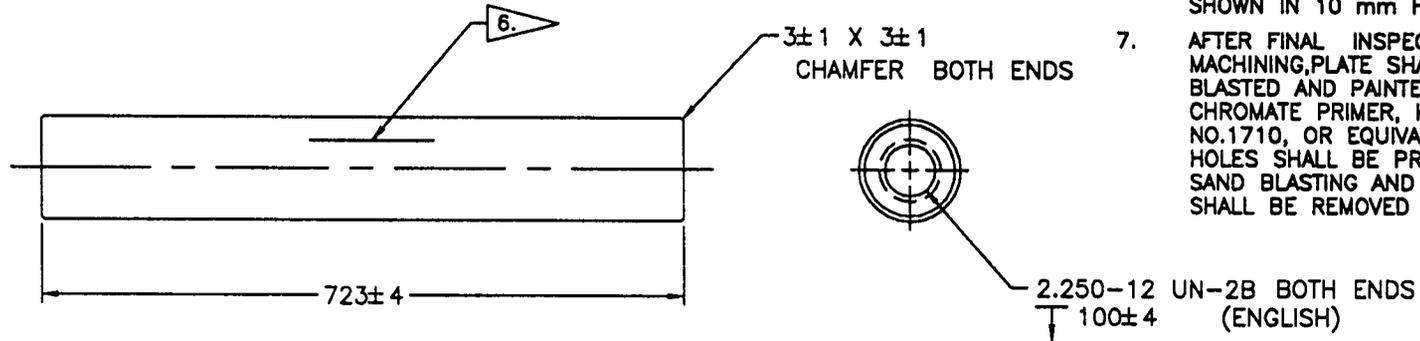
THIRD ANGLE PROJECTION



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	DWN	L. MULLINS	1-84	CLASSIFICATION		MAJOR UNIT	
	CHK			FILE NAME: 41009290.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
	APVD			THIS DOCUMENT IS THE PROPERTY OF		SUBASSY	
	CLASSIFIED BY:			THE UNIVERSITY OF CALIFORNIA		CENTRAL MAGNET FRAME	
	TITLE		DATE	LAWRENCE LIVERMORE NATIONAL LAB.		DETAIL	
				REPRODUCTION PROHIBITED WITHOUT		RESTRAINT ROD	
LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA				SHOWN ON AAA		DRAWING NO	
				8863-25		AAA 94-100929-00	
				SCALE		SHEET 1 OF 1	

LTR | DWN | CHK | APVD | DATE | ZONE | CHANGE

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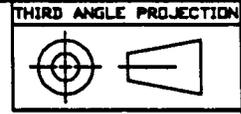
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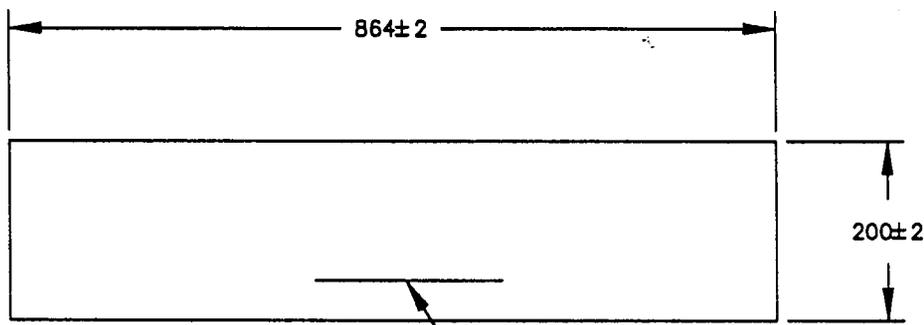
# SI METRIC



**NOTES**

UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1985.
4.  $\sqrt{3.2}$  ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6. SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
7. AFTER FINAL INSPECTION AND MACHINING, PLATE SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1710, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.



TAB NO.	MATERIAL THK.
01	18mm (.75)
02	6mm (.25)
03	3mm (.1196)
04	1.5mm (.0598)

		PLATE (SEE TAB)		STEEL AISI 1008 OR EQUIV.			
NO REQD	PART / LLNL STK NO		DESCRIPTION / MATERIAL			SPEC NO	ITEM
	DWN L. MULLINS	1-94	CLASSIFICATION FILE NAME: 41009270.DWG  THIS DOCUMENT IS THE PROPERTY OF THE UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE NATIONAL LAB. REPRODUCTION PROHIBITED WITHOUT PERMISSION OF THE MECHANICAL ENGINEERING DEPARTMENT.			MAJOR UNIT RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
	CHK					SUBASSY CENTRAL MAGNET FRAME	
	APVD					DETAIL SPACER	
	CLASSIFIED BY:					SHOWN ON AAA DRAWING NO AAA 94-100927-00	
	TITLE	DATE	ADMT NO 8863-25			SCALE $\longleftarrow 203.2 \longrightarrow$ SHEET 1 OF 1	
LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA							

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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D  
C  
B  
A

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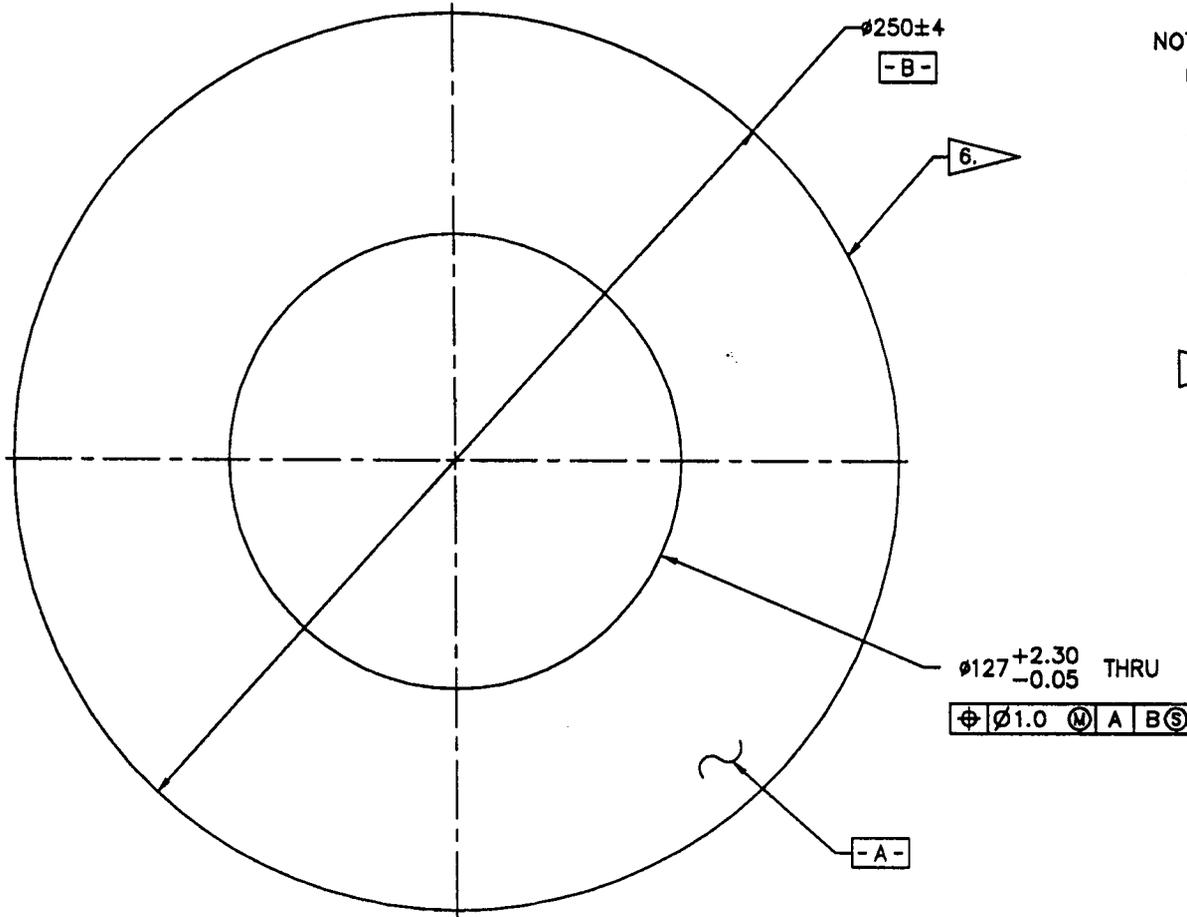
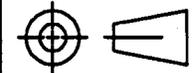
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# SI METRIC

THIRD ANGLE PROJECTION



**NOTES**

UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1985.
4.  $\sqrt{3.2}$  ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6. SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
7. AFTER FINAL INSPECTION AND MACHINING, PLATE SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1710, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.

		PLATE 65mm THK.		STEEL AISI 1008 OR EQUIV.			
NO REQD		PART / LLNL STK NO		DESCRIPTION / MATERIAL		SPEC NO	
		DWN L. MULLINS 1-94		CLASSIFICATION		MAJOR UNIT	
		CHK		FILE NAME: 41009260.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
		APVD		THIS DOCUMENT IS THE PROPERTY OF		SUBASSY	
		CLASSIFIED BY:		THE UNIVERSITY OF CALIFORNIA		CENTRAL MAGNET FRAME	
		TITLE		LAWRENCE LIVERMORE NATIONAL LAB.		DETAIL	
		DATE		REPRODUCTION PROHIBITED WITHOUT		SPACER SPRING	
		LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA		PERMISSION OF THE MECHANICAL ENGINEERING DEPARTMENT.		DRAWING NO	
						AAA 94-100926-00	
						SCALE	
						50:8	
						SHEET 1 OF 1	

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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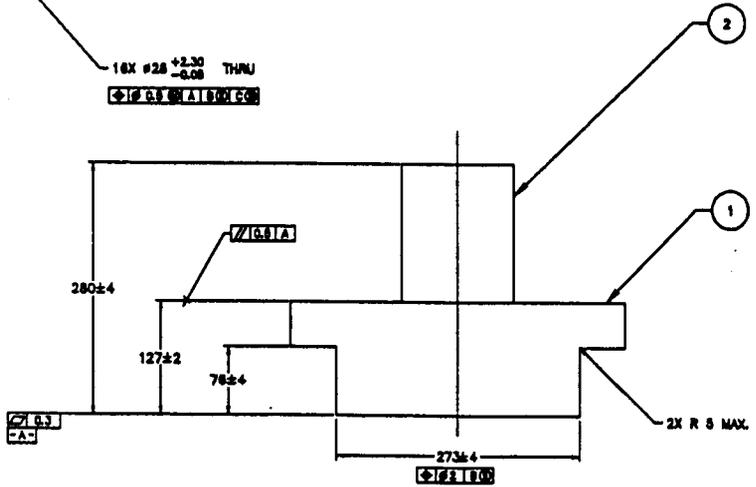
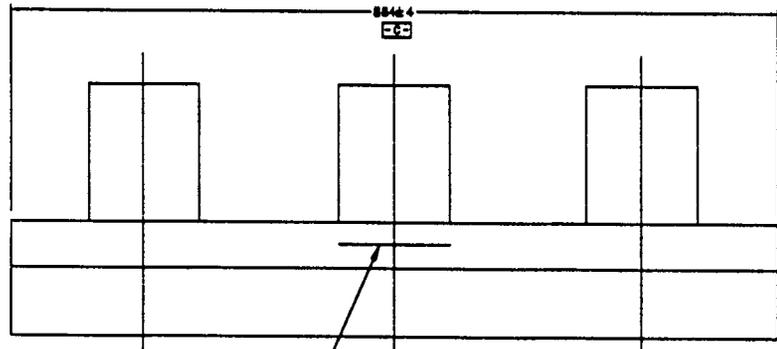
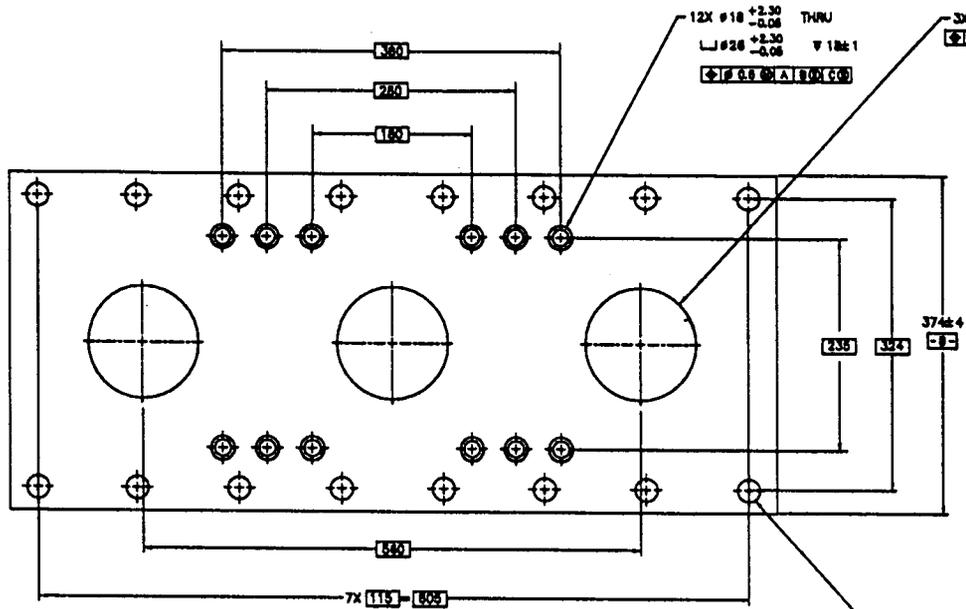
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- NOTES  
UNLESS OTHERWISE SPECIFIED:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
  3. SURFACE TEXTURE PER ANSI B46.1-1988.
  4.  $\sqrt{R}$  ALL MACHINED SURFACES.
  5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
  6.  $\nabla$  SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
  7. AFTER FINAL INSPECTION AND MACHINING, PLATE SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1716, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.

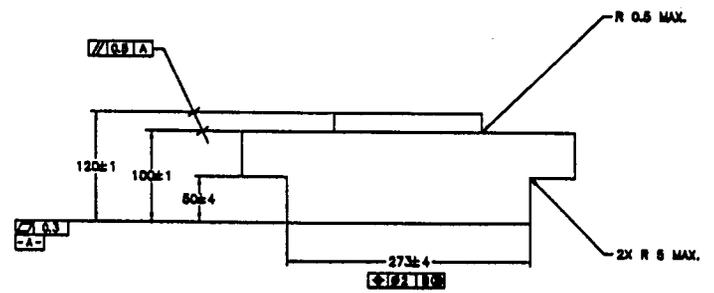
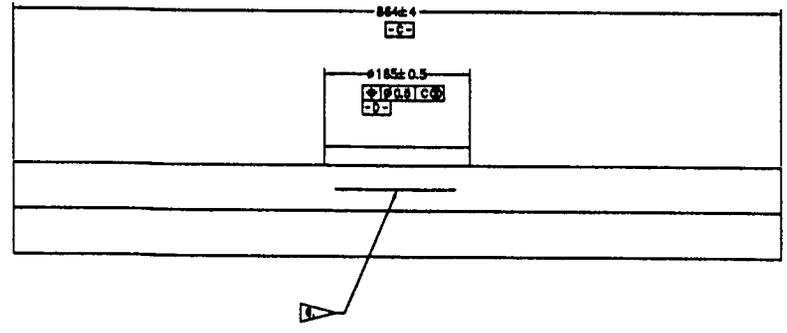
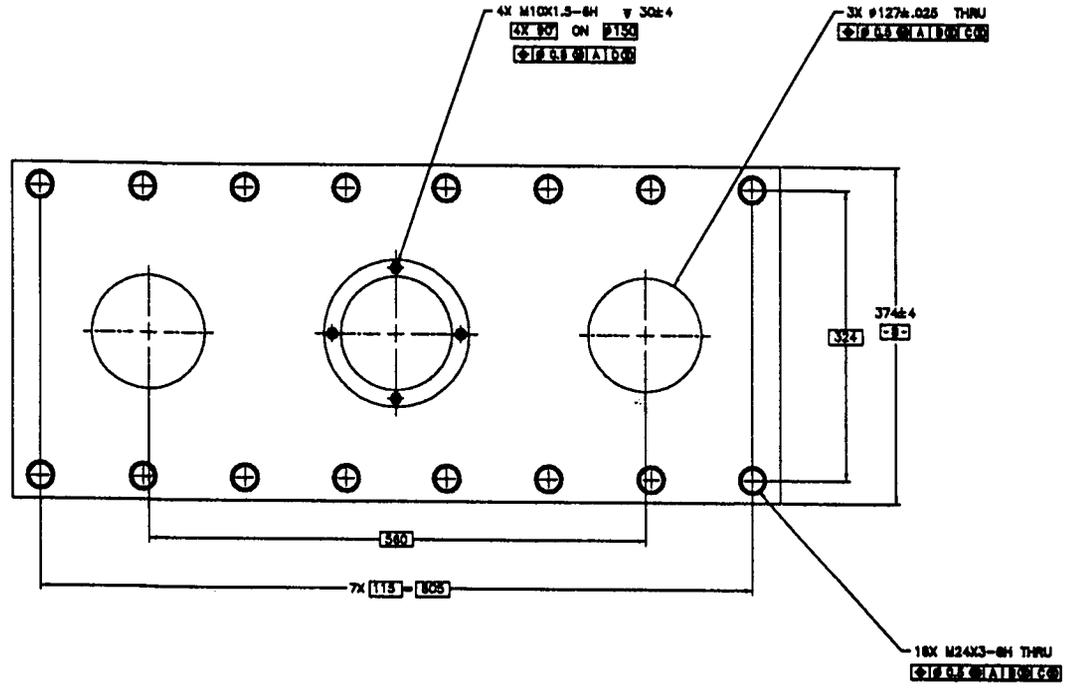


3	BAR RD.(#125)	CR23 304	2
1	PLATE	STEEL, A36 1008 OR EQUIV.	1
NO. REV.	PART / U/L. OR. NO.	DESCRIPTION / MATERIAL	QTY. NO.
	DATE	DATE	
DATE: _____ DRAWN: _____ CHECKED: _____ APPROVED: _____ TITLE: _____		FILE NAME: 41008360.DWG NO. INVENTORY IS THE PROPERTY OF THE UNIVERSITY OF CALIFORNIA LABORATORY: LANSFORD LABORATORY UNIVERSITY OF CALIFORNIA DIVISION OF THE UNIVERSITY OF CALIFORNIA RADIATION LABORATORY	PROJECT: RELATIVISTIC HEAVY ION COLLIDER (RHIC) PART: CENTRAL MAGNET FRAME SUBPART: SPRING BRACKET LOWER DRAWING NO: AAA 94-100925-00

SI METRIC



- NOTES  
UNLESS OTHERWISE SPECIFIED:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M-1982.
  3. SURFACE TEXTURE PER ANSI B46.1-1988.
  4.  $\nabla$  ALL MACHINED SURFACES.
  5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
  6.  $\nabla$  SCREWS OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
  7. AFTER FINAL INSPECTION AND MACHINING, PART SHALL BE SAND BLASTED AND PAINTED WITH A ZINC CHROMATE PRIMER, KELLY-MOORE NO.1716, OR EQUIVALENT. ALL TAPPED HOLES SHALL BE PROTECTED DURING SAND BLASTING AND PAINTING. ALL SAND SHALL BE REMOVED BEFORE PAINTING.

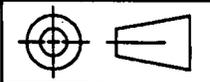


NO	PART / LHM ORK NO	DESCRIPTION / MATERIAL	SPCS NO	TRM
	DATE LABELLED	CLASSIFICATION		
	CHK	FILE NAME: 400RS46LWS		
	APP'D	THIS DRAWING IS THE PROPERTY OF THE UNIVERSITY OF CALIFORNIA, LAWRENCE LIVERMORE NATIONAL LAB.		
	TRM	REPRODUCTION PROHIBITED WITHOUT PERMISSION OF THE MEMORIAL ENGINEERING DEPARTMENT.		
		STEEL, A8E 1008 OR EQUIV.		
		RELATIVISTIC HEAVY ION COLLIDER (RHIC)		
		CENTRAL MAGNET FRAME		
		SPRING BRACKET UPPER		
		REVISION NO		
		AAA 94-100924-00		

100 1000 500 2000 3000 4000 5000 6000 7000 8000 9000 10000

# SI METRIC

THIRD ANGLE PROJECTION



**NOTES**

UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1985.
4.  $\sqrt{3.2}$  ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6. SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.

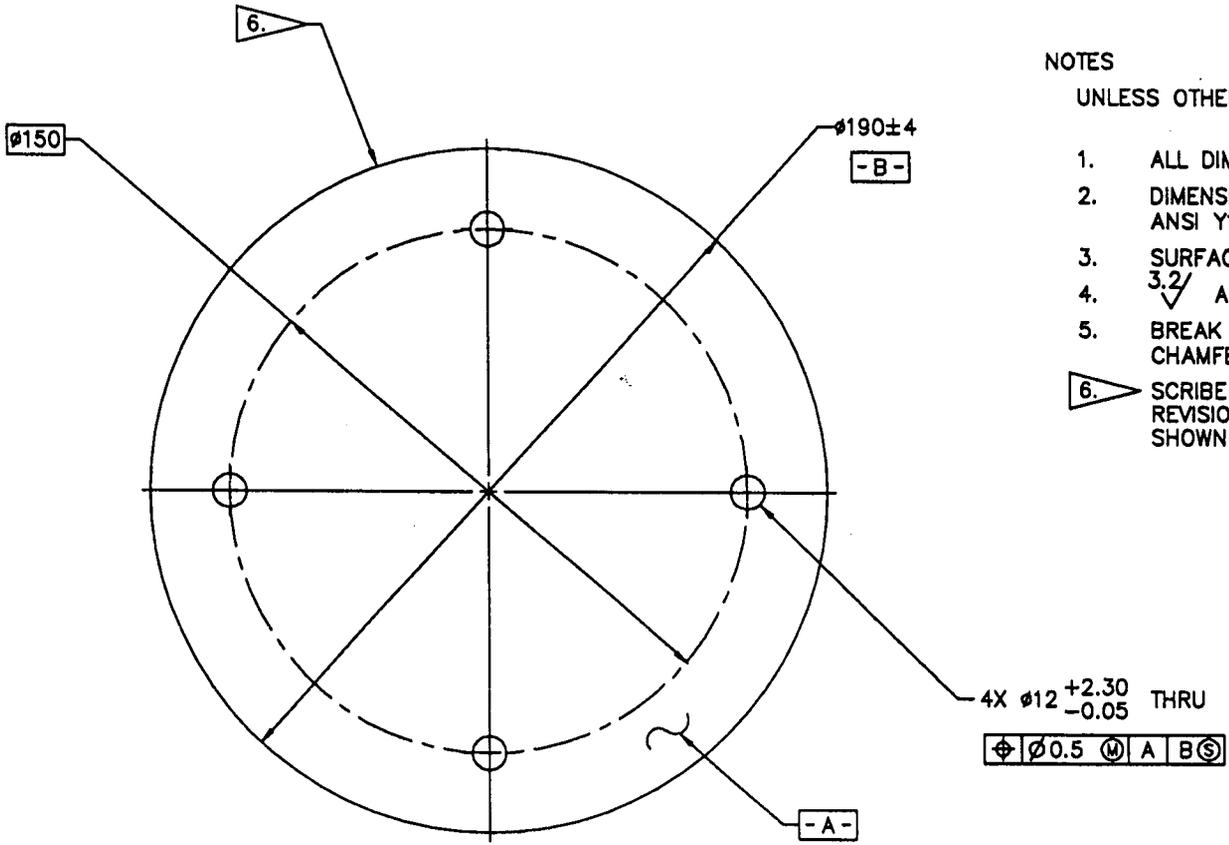


		PLATE 12.7mm THK.		BOST-BRONZ		BOSTON GEAR	
NO REQD	PART / LLNL STK NO		DESCRIPTION / MATERIAL			SPEC NO	ITEM
	DWN	L. MULLINS	1-84	CLASSIFICATION		MAJOR UNIT	
	CHK			FILE NAME: 41009230.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
	APVD			THIS DOCUMENT IS THE PROPERTY OF		SUBASSY	
	CLASSIFIED BY:			THE UNIVERSITY OF CALIFORNIA		CENTRAL MAGNET FRAME	
	TITLE		DATE	LAWRENCE LIVERMORE NATIONAL LAB.		DETAIL	
				REPRODUCTION PROHIBITED WITHOUT		THRUST BEARING	
				PERMISSION OF THE MECHANICAL		SHOWN ON AAA	DRAWING NO
				ENGINEERING DEPARTMENT.		8863-25	AAA 94-100923-00
LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA				SCALE		50.8	SHEET 1 OF 1

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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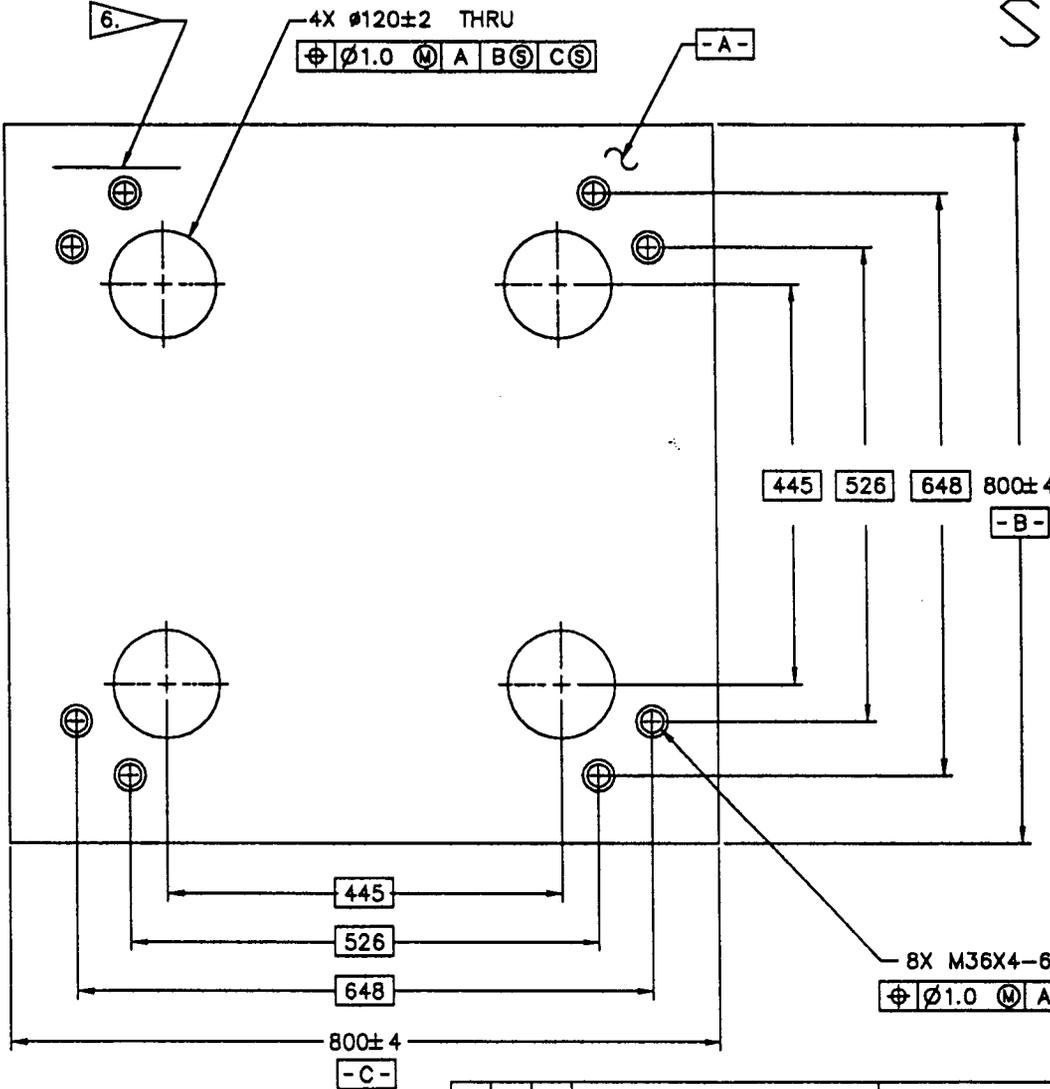
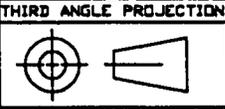
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# SI METRIC



- NOTES  
UNLESS OTHERWISE SPECIFIED:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
  3. SURFACE TEXTURE PER ANSI B46.1-1985.
  4.  $\sqrt{3.2}$  ALL MACHINED SURFACES.
  5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
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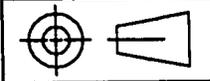
LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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NO REQD		PART / LLNL STK NO		DESCRIPTION / MATERIAL		SPEC NO	ITEM
		DWN L MULLINS	1-84	PLATE 38.1mm THK. STEEL AISI 1008 OR EQUIV.			
		CHK		CLASSIFICATION		MAJOR UNIT	
		APVD		FILE NAME: 41009220.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
		CLASSIFIED BY:		THIS DOCUMENT IS THE PROPERTY OF THE UNIVERSITY OF CALIFORNIA		SUBASSY	
		TITLE	DATE	LAWRENCE LIVERMORE NATIONAL LAB.		CENTRAL MAGNET FRAME	
				REPRODUCTION PROHIBITED WITHOUT PERMISSION OF THE MECHANICAL ENGINEERING DEPARTMENT.		DETAIL	
						PLATE ADJUSTMENT TOP #2	
						SHOWN ON AAA	DRAWING NO
						ASST NO 8863-25	AAA 94-100922-00
						SCALE	SHEET 1 OF 1

LAWRENCE LIVERMORE NATIONAL LABORATORY  
MECHANICAL ENGINEERING DEPT  
UNIVERSITY OF CALIFORNIA

THIRD ANGLE PROJECTION

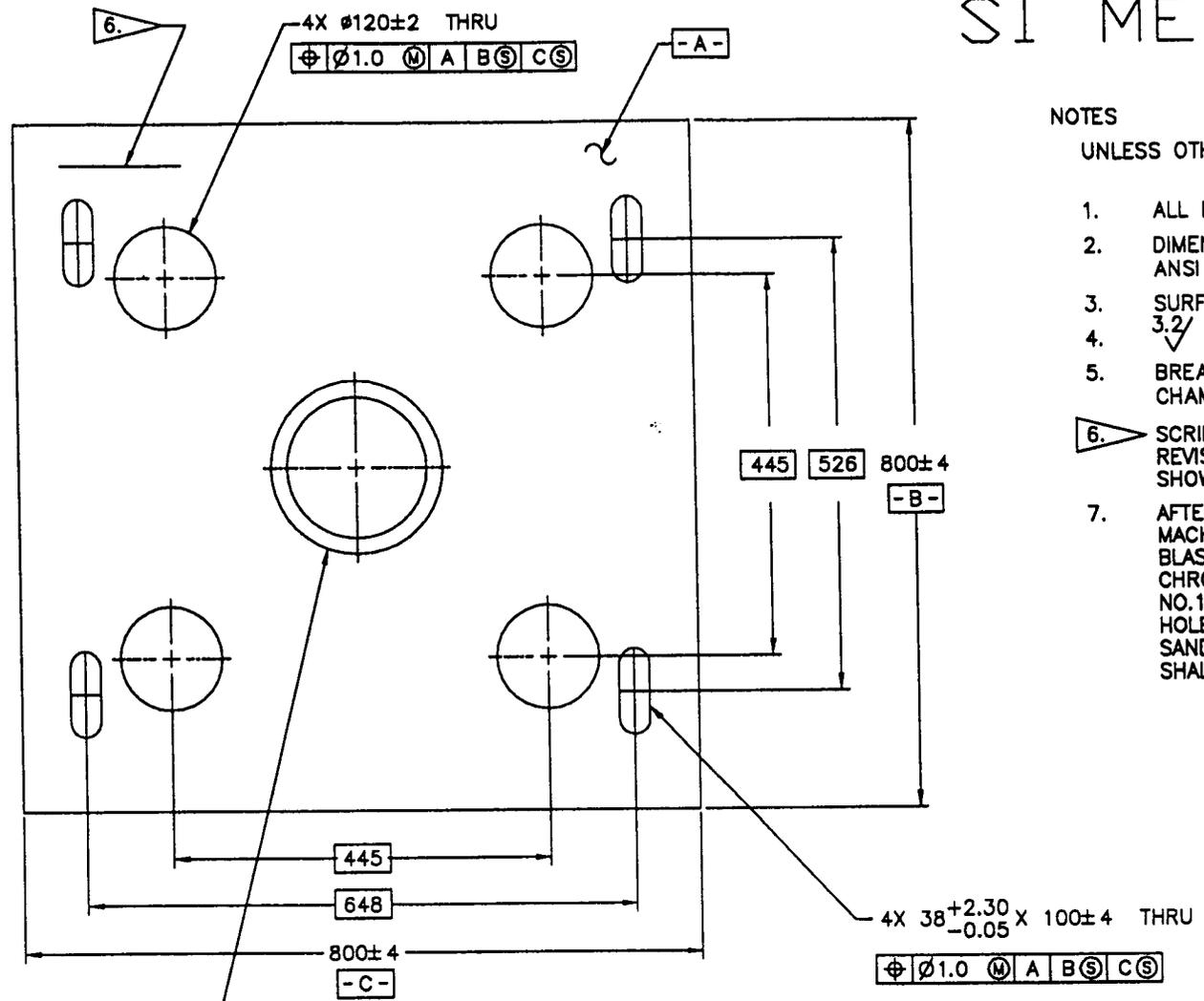
SI METRIC



NOTES

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1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1985.
4. 3.2/ ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R 0.5 MAX OR CHAMFER.
6. SCRIBE OR STAMP DRAWING NUMBER AND REVISION LEVEL APPROXIMATELY WHERE SHOWN IN 10 mm HIGH CHARACTERS.
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$\phi 127 \pm .025$  THRU  
 $\phi 200 \pm 2 \sqrt{20 \pm 0.5}$   
 $\phi \phi 1.0 \text{ (M) A B (S) C (S)}$

NO REQD		PART / LLNL STK NO		PLATE 38.1mm THK. STEEL AISI 1008 OR EQUIV.		SPEC NO	ITEM
DWN L. MULLINS		1-94		CLASSIFICATION		MAJOR UNIT	
CHK				FILE NAME: 41009210.DWG		RELATIVISTIC HEAVY ION COLLIDER (RHIC)	
APVD				THIS DOCUMENT IS THE PROPERTY OF		SUBASSY	
CLASSIFIED BY:				THE UNIVERSITY OF CALIFORNIA		CENTRAL MAGNET FRAME	
TITLE		DATE		LAWRENCE LIVERMORE NATIONAL LAB.		DETAIL	
				REPRODUCTION PROHIBITED WITHOUT		PLATE ADJUSTMENT TOP #1	
				PERMISSION OF THE MECHANICAL		DRAWING NO	
				ENGINEERING DEPARTMENT.		AAA 94-100921-00	
				LAWRENCE LIVERMORE NATIONAL LABORATORY MECHANICAL ENGINEERING DEPT UNIVERSITY OF CALIFORNIA		ADDT NO 8863-25	
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LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE
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