Booster Notching Absorber Design

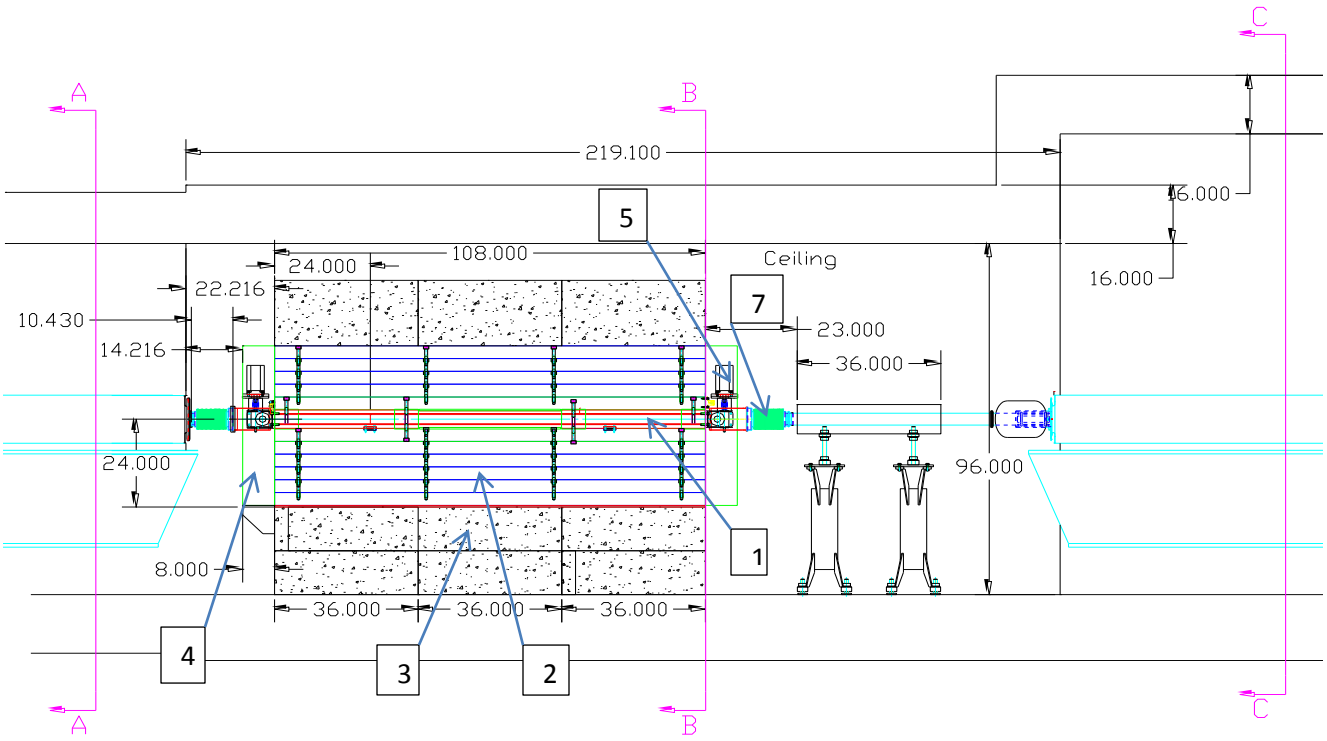
Vladimir Sidorov

01/11/2012

The conceptual design of the Booster Notching Absorber is based on **Primary beam loss calculations at notching** prepared by Sasha Drozhdin and **Energy deposition simulations with MARS** prepared by Igor Tropin. The New Booster Notching Absorber will be located in Long 13 of the Booster Ring.

Fig.1 Booster Ring Long 13.

1.**Booster Notching Absorber Components.**



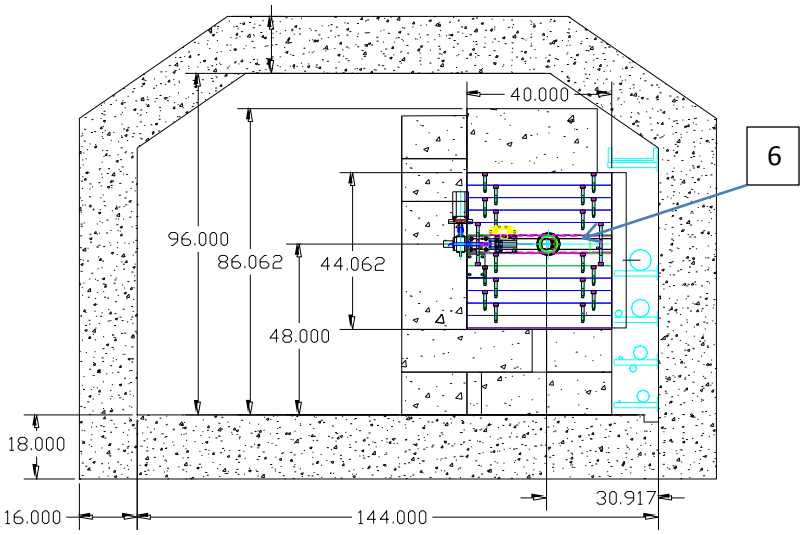


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Fig.2 Booster Notching Absorber.

The vacuum liner (item 1) is surrounded with steel absorber blocks (item 2) and concrete (item 3). The polyethylene masks (item 4) are mounted around the vacuum liner in the upstream and downstream ends of the absorber. The driving system (item 5) provides 1.00" movement of the moving block (item 6) in the horizontal direction. Two bellows (item7) are connected the vacuum liner to the Booster beam pipe.

2. Vacuum Liner Design.

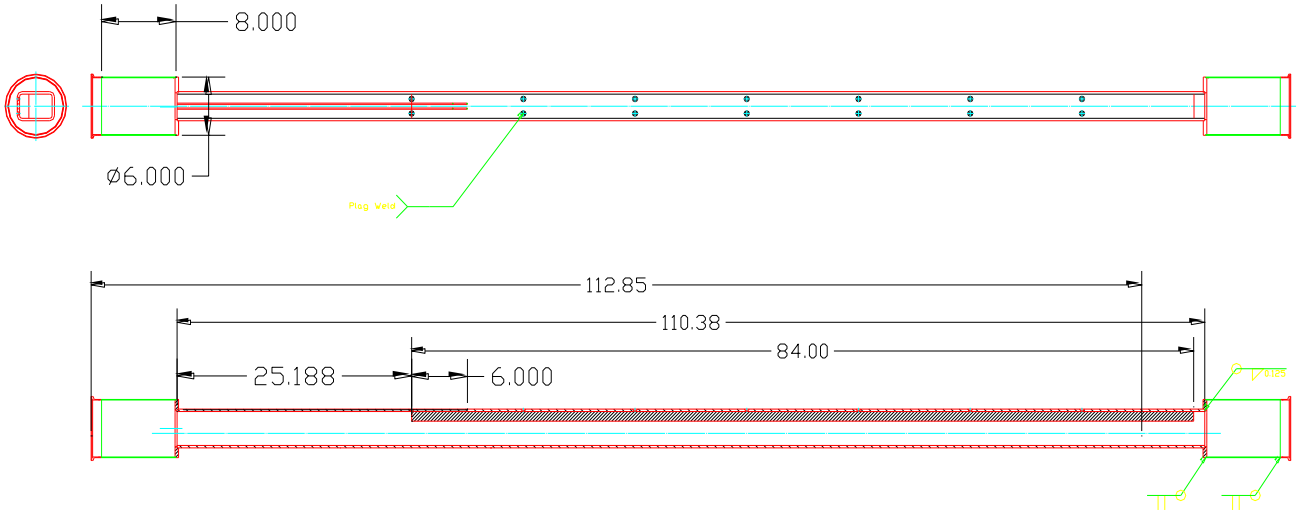


Fig.3 Vacuum Liner.

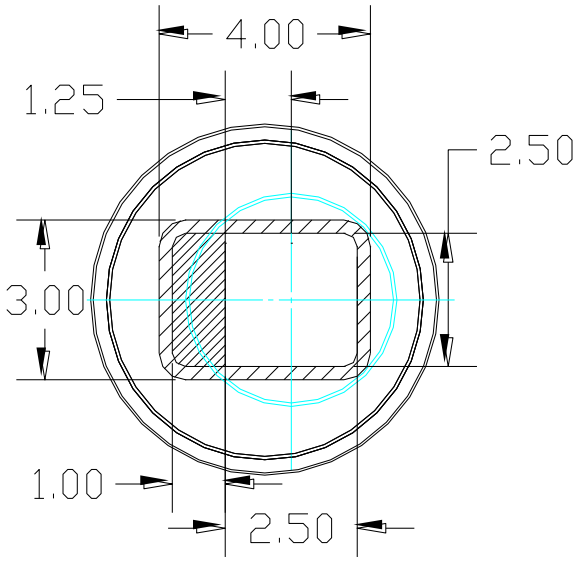


Fig.4 Vacuum Liner neutral position.

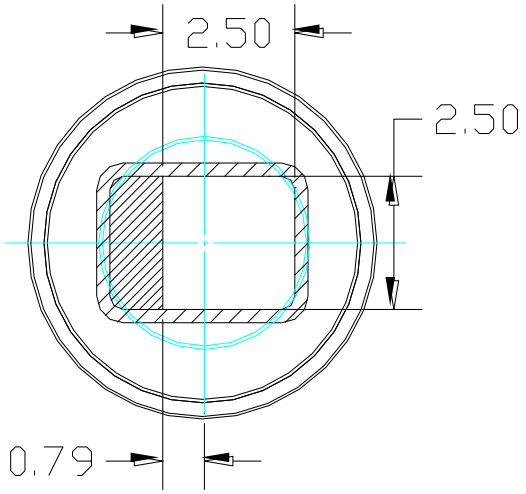


Fig.5 Vacuum Liner working position.

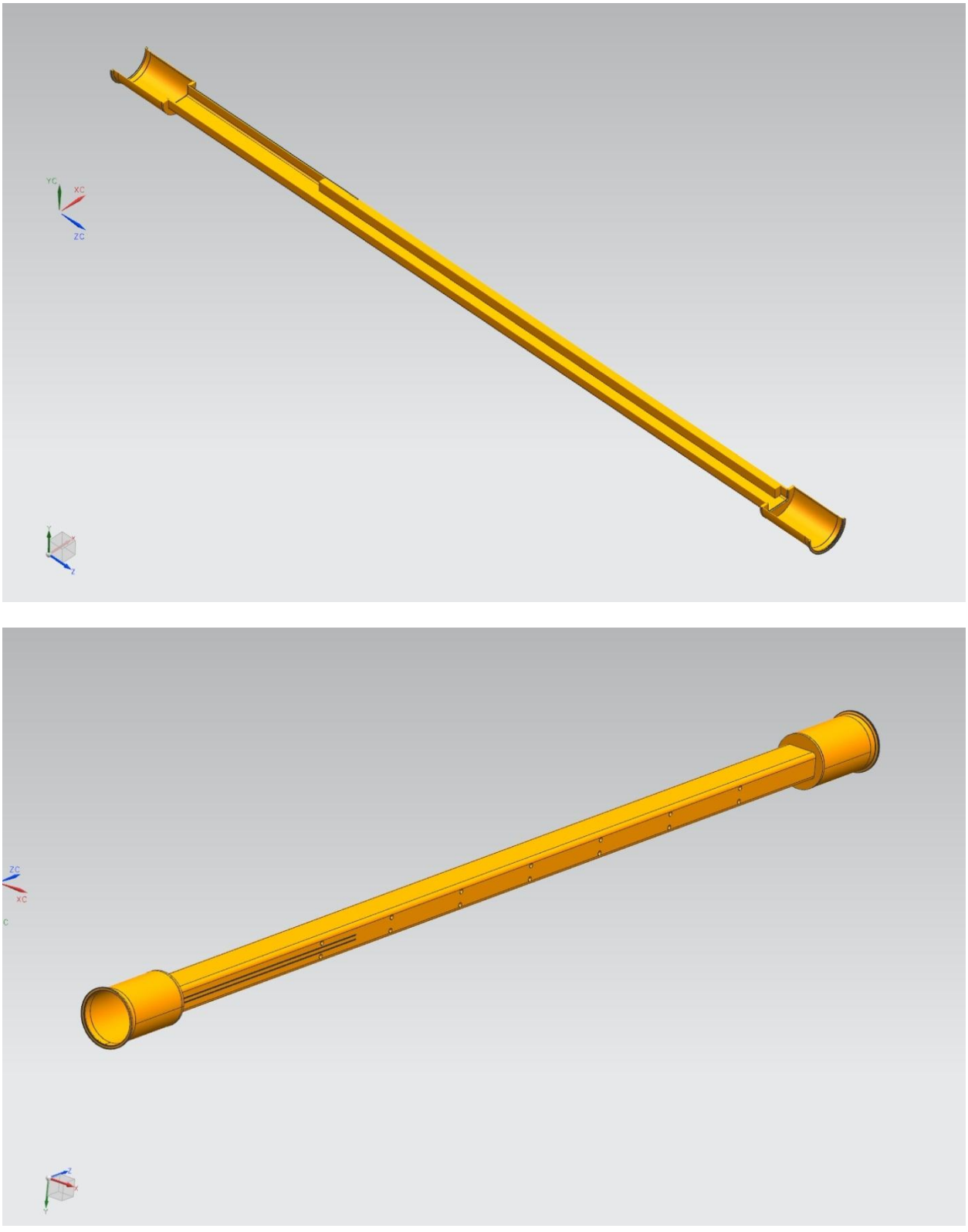


Fig.6 Vacuum liner 3d pictures.

3. Absorber Assembly.

3. 1 Moving Block.

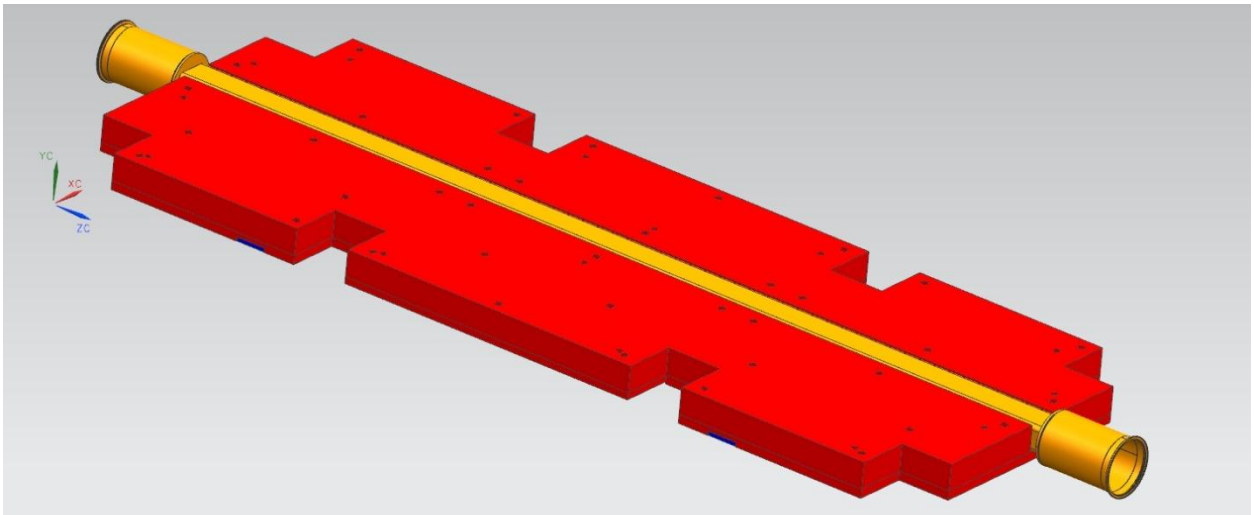


Fig.7 Vacuum Liner inserted into the shielding.

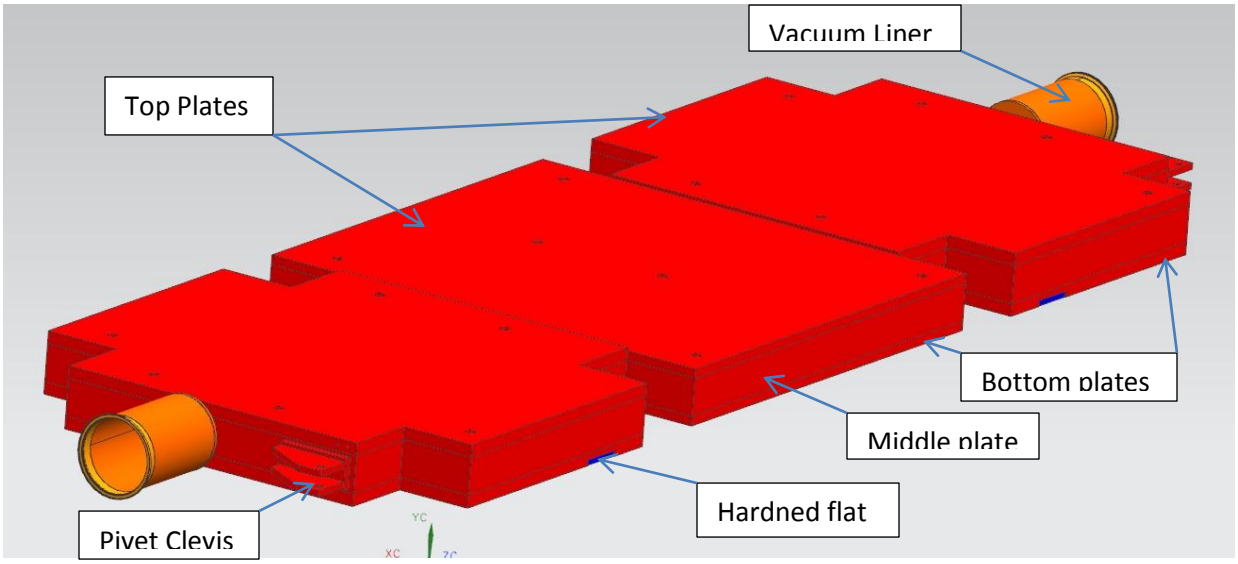


Fig.8 Moving block assembly.

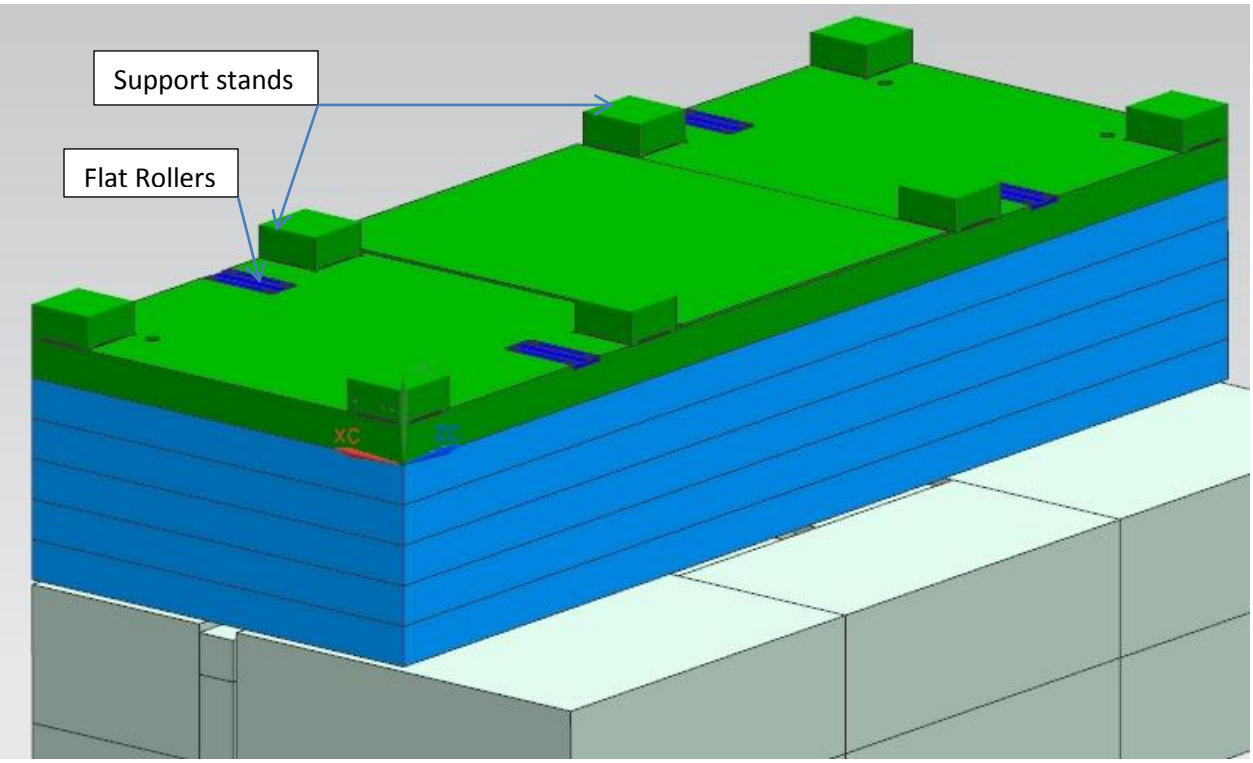


Fig.9 Base plates with flat rollers and top shielding support stands.

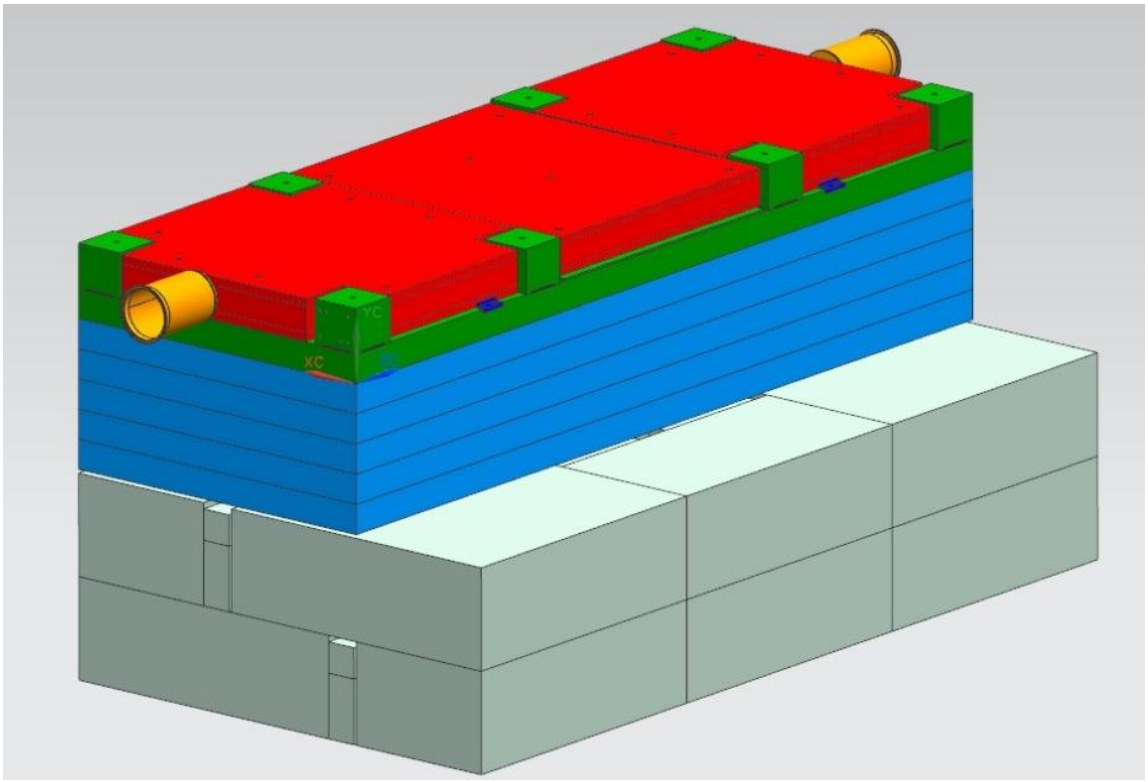


Fig.10 Moving Block placed on the base plate flat rollers.

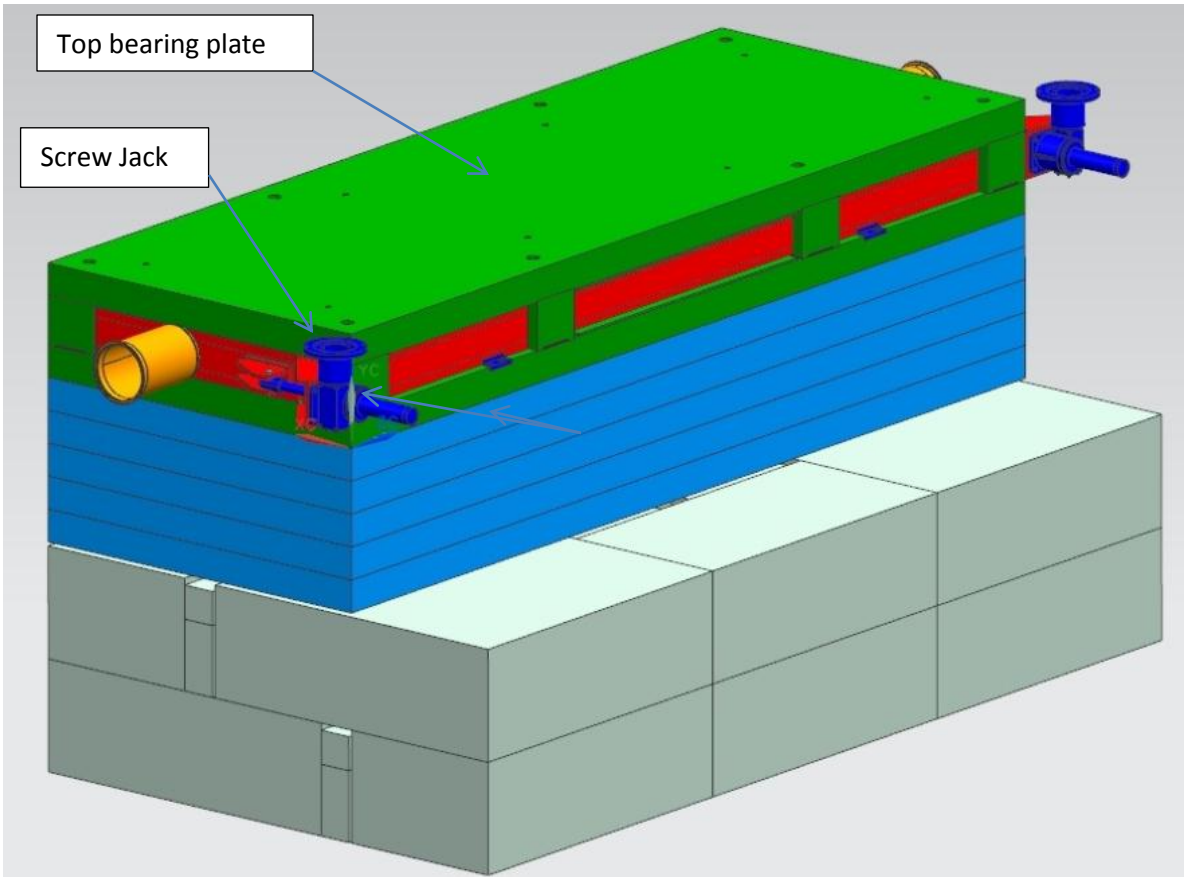


Fig.11 Moving block assembly.

Two screw jacks 2.5 ton capacity are bolted to the two aisle side support stands.

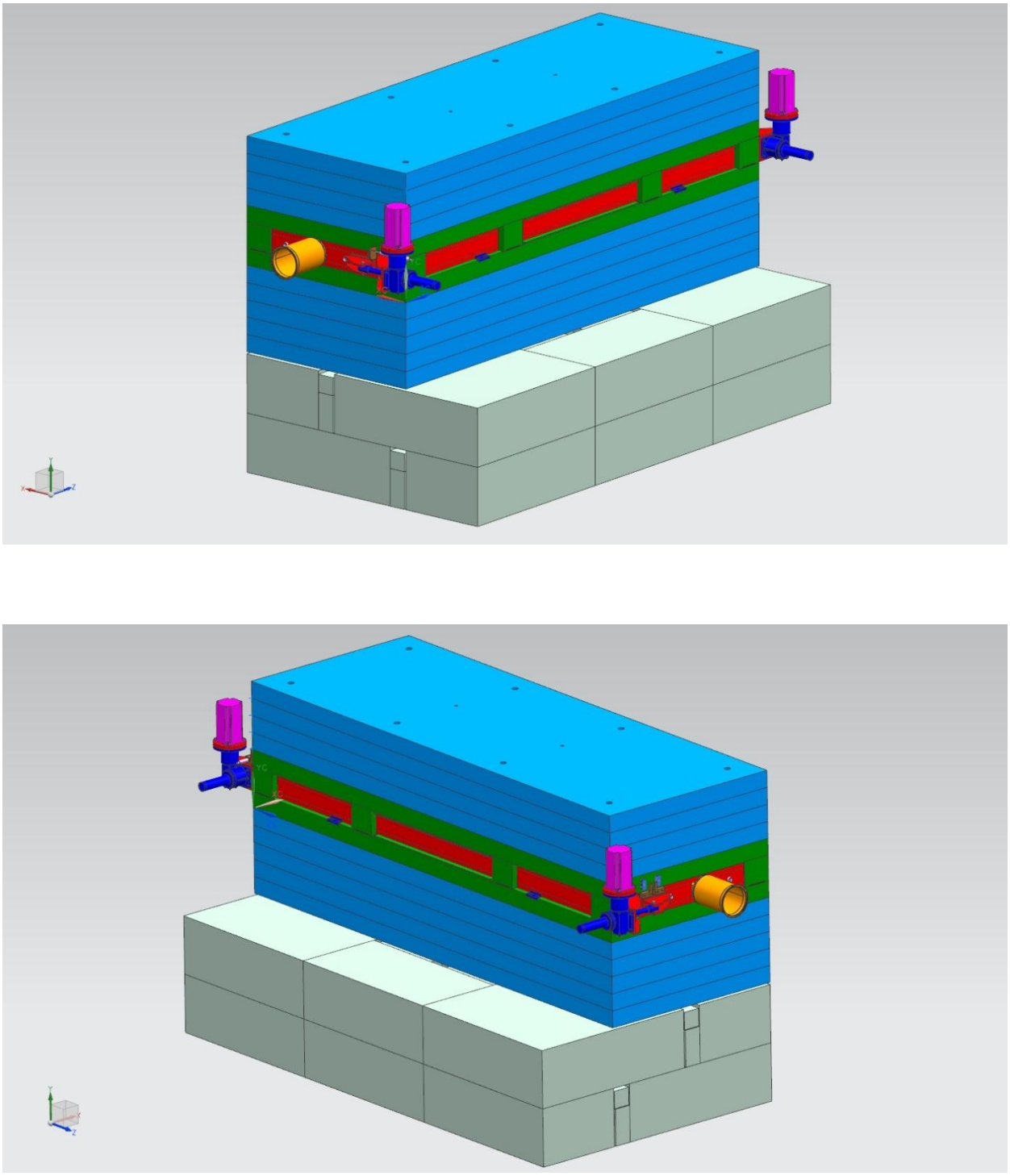


Fig.12 Top steel plates installation.

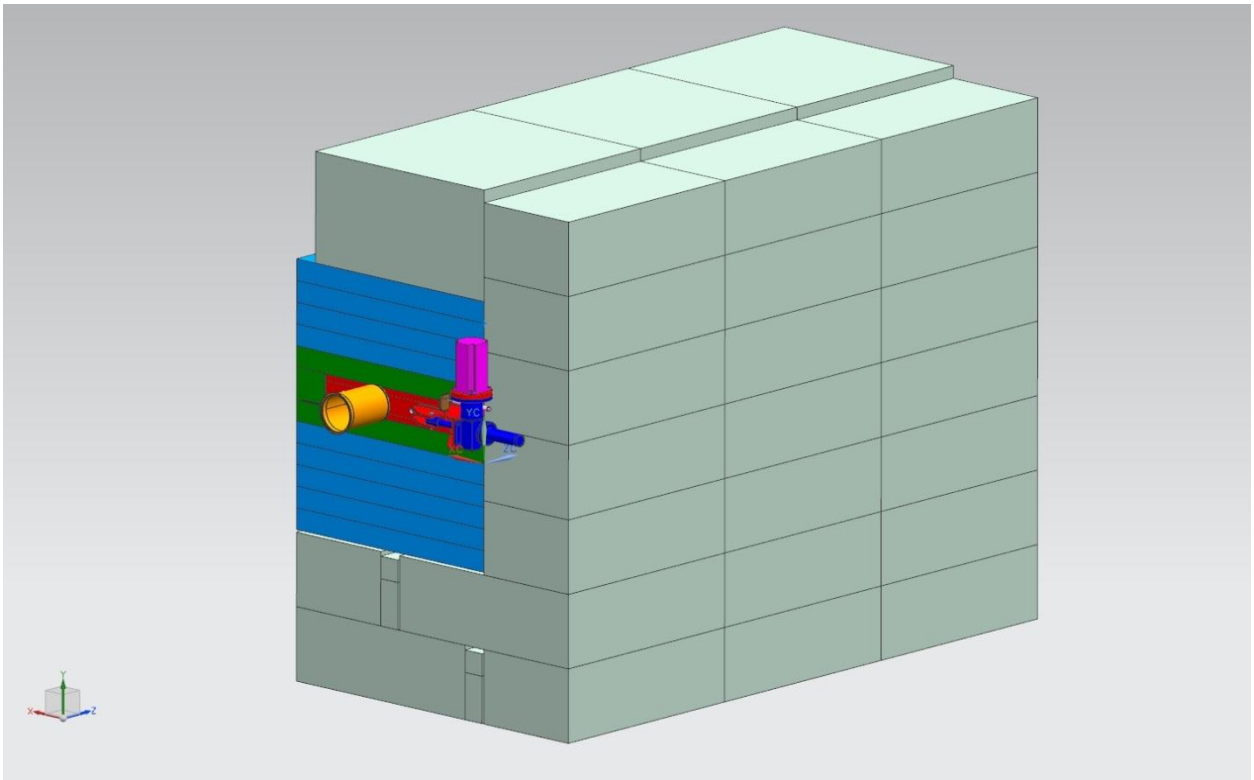


Fig.13 Concrete blocks installation.

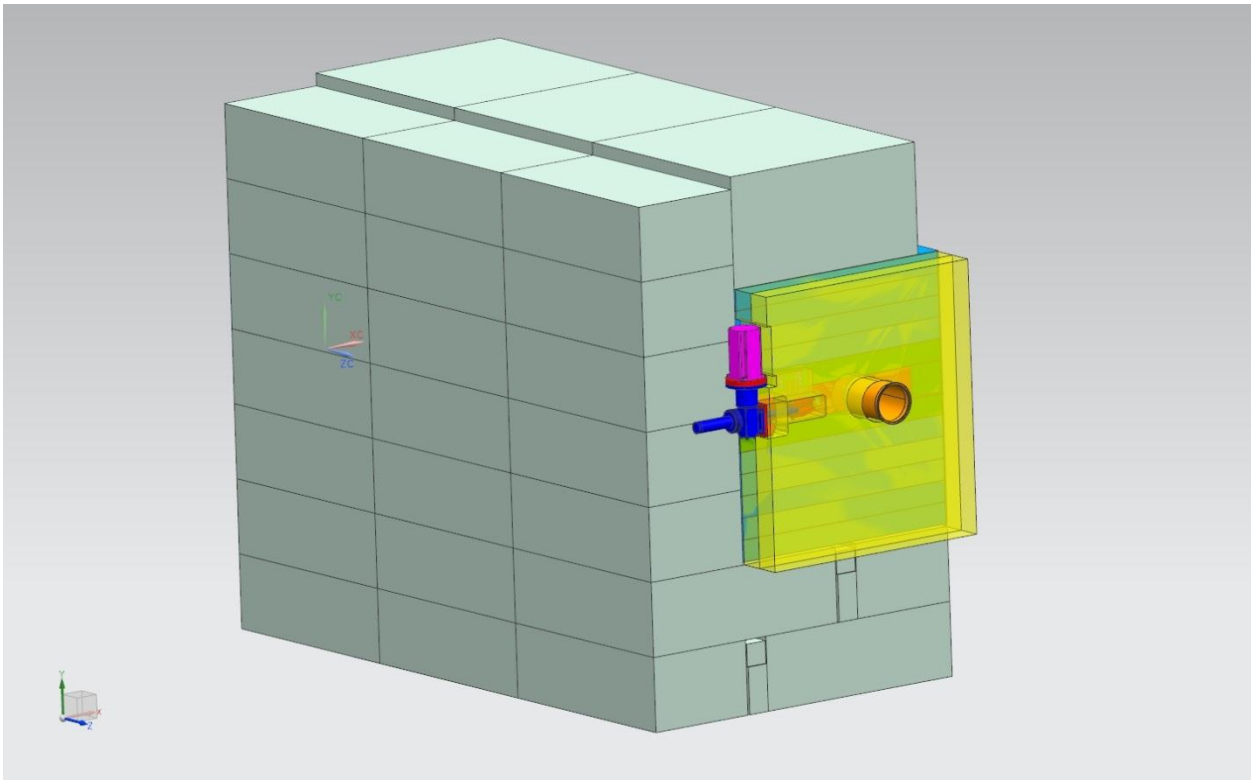
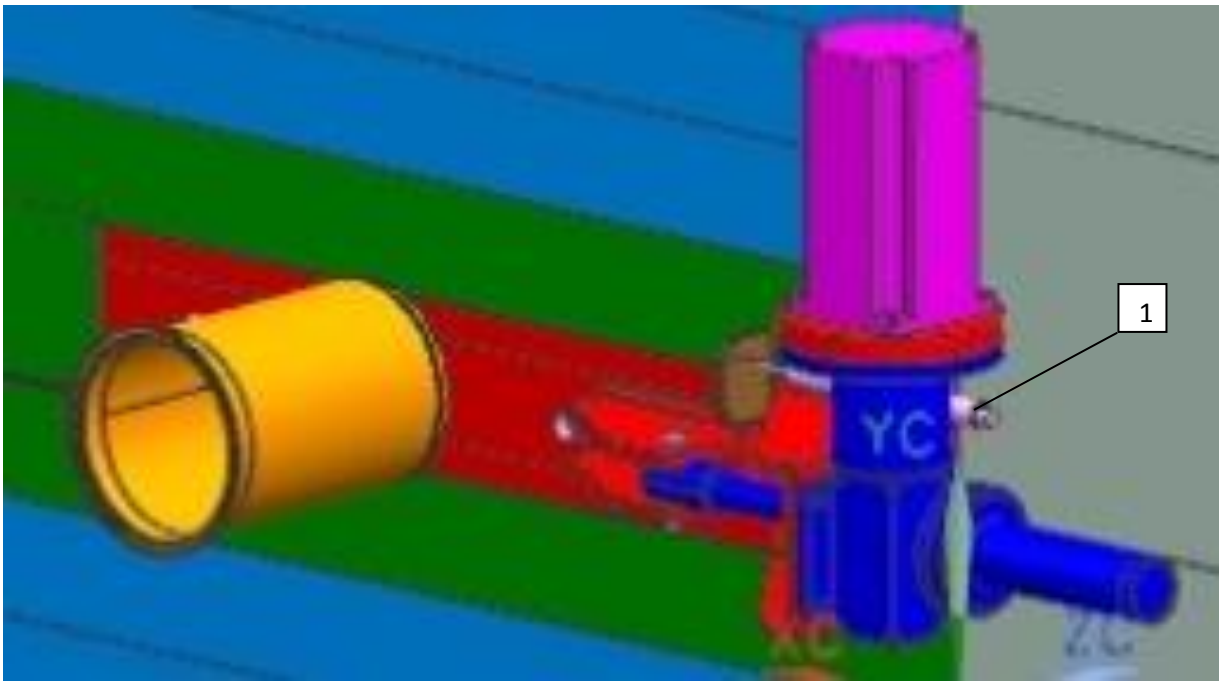
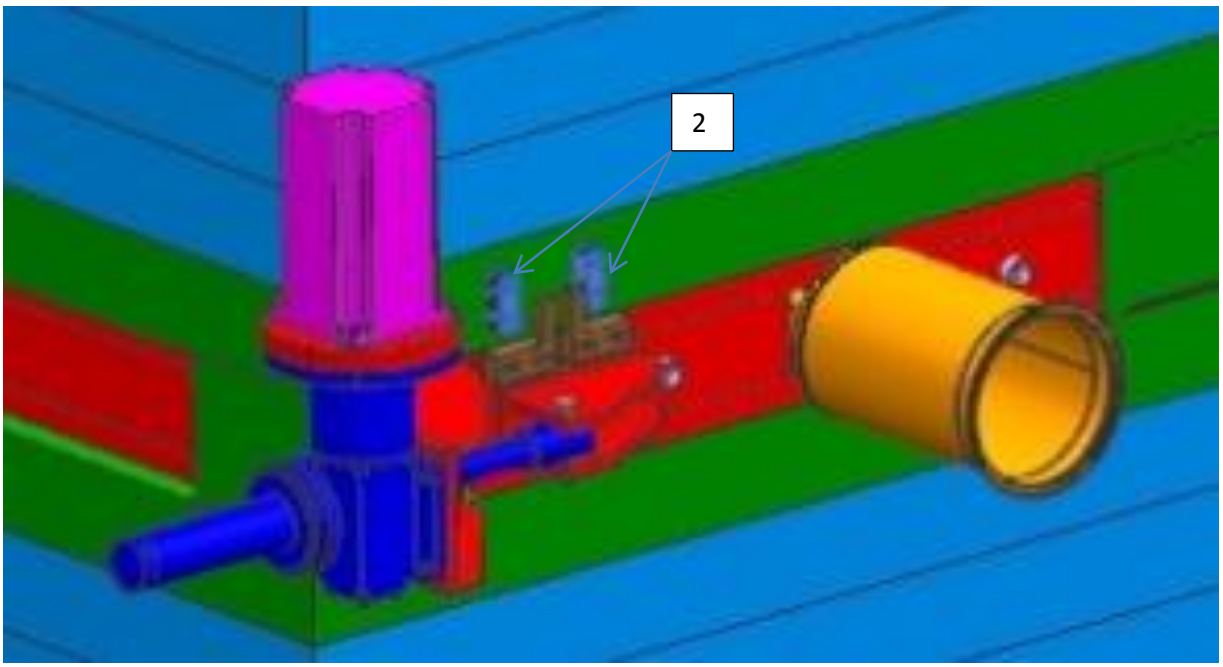


Fig.14 Polyethylene Mask Installation

4. Control System.

The horizontal LVDT (item1) control the position of the moving block during operation and connected to the ACNET. Limit switches and (item 2), keep the moving block in limits (1.0” horizontally) and protect motors from the overdrive. Two thermocouples are inserted into the vacuum liner. One of them is connected to the ACNET.





5. Motion System .

Two Action Jack 2.5-MSJ-series screw actuators, 24 : 1 ratio, are used to push-pull 6,200 pounds of the moving part of the absorber. Required push-pull force is: 6,200x 0.8= 4,960 lb. Where: 0.8 – coefficient of static friction between rollers and absorber steel block in case of sliding.

2.5-MSJ SPECIFICATIONS

GEAR RATIO	CAPACITY (lbs.)	LIFTING SCREW (in.)			TURNS OF WORM FOR 1" TRAVEL	MAX INPUT TORQUE (in.-lb.)	MAX ALLOWABLE INPUT (HP)	MAX WORM SPEED AT RATED LOAD (RPM)	
		DIAMETER	LEAD	ROOT DIA.				NON-KEYED	KEYED
24:1	5000	1	0.25	0.698	96	53	0.5	594	516

MAX LOAD AT 1750 RPM (lbs.)		TORQUE TO RAISE 1 LB. (in.-lbs.)		TARE DRAG TORQUE (in.-lbs.)	STARTING TORQUE (in.-lb.)	WEIGHT (Approx. in lbs.)			PDF PAGE
NON-KEYED	KEYED	NON-KEYED	KEYED			"0" TRAVEL	PER INCH OF TRAVEL	GREASE	
1699	1476	0.0106	0.0122	5	0.0212	17	0.45	0.5	323

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1. Determine Unit Running Torque: (T1) (lb-in)

T_1=0.0122x4960/2 = 30.25

0.0122 – Torque to raise 1 lb (from chart)

2. Find Unit Power:

HP = (T_1 x RPM) / 63025 = 30.25 x 300 / 63025 = 0.15

3. Determine Unit Starting Torque: (Ts)

Ts=2T_1 = 30.25 x2= 60.5

4. Motor selected:

1. Anaheim Automation Stepper Motor NEMA 42 , Y Series, 42Y312S, Motor speed- 5 RPS, Torque – 1200 oz-in.

2. Anaheim Automation Stepper Motor NEMA 42 K Series, 42K322S-CB8, Motor speed- 5 RPS, Torque – 4000 oz-in.

5. Motor running torque: (lb-in)

1200/ 16 = 75 >30.25

6. Motor Power: (HP)

75 x 300 / 63025 = 0.357 >0.15

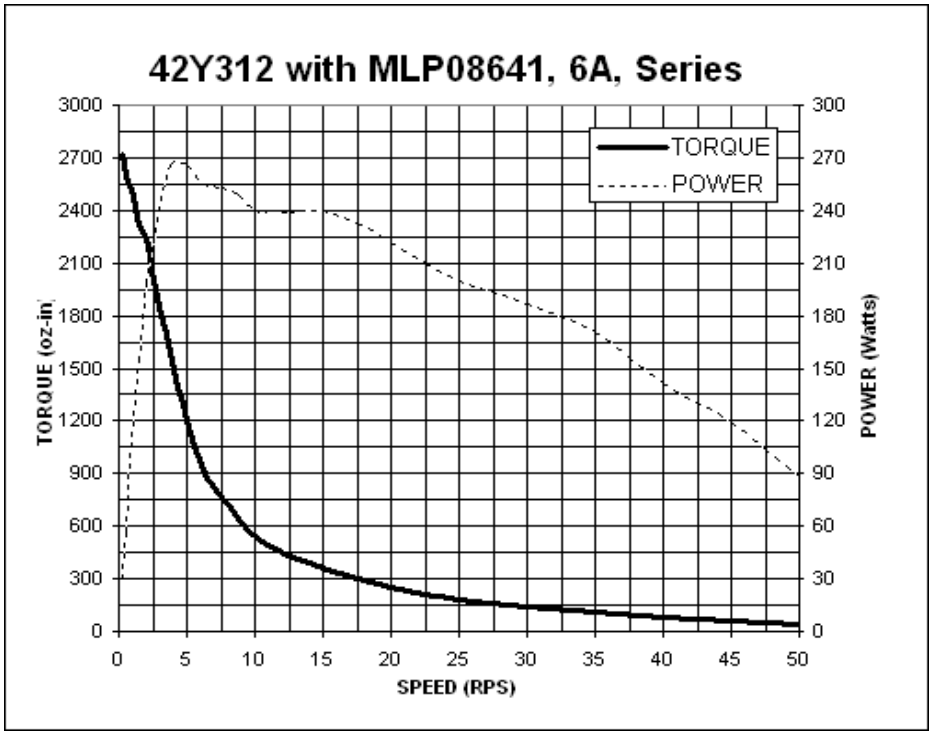
7. Motor starting torque: (lb-in)

2720 / 16 = 170 > 60.5

8. Time to move 1”

Travel time –0.32 min=20sec., Travel speed 3.125 in / min

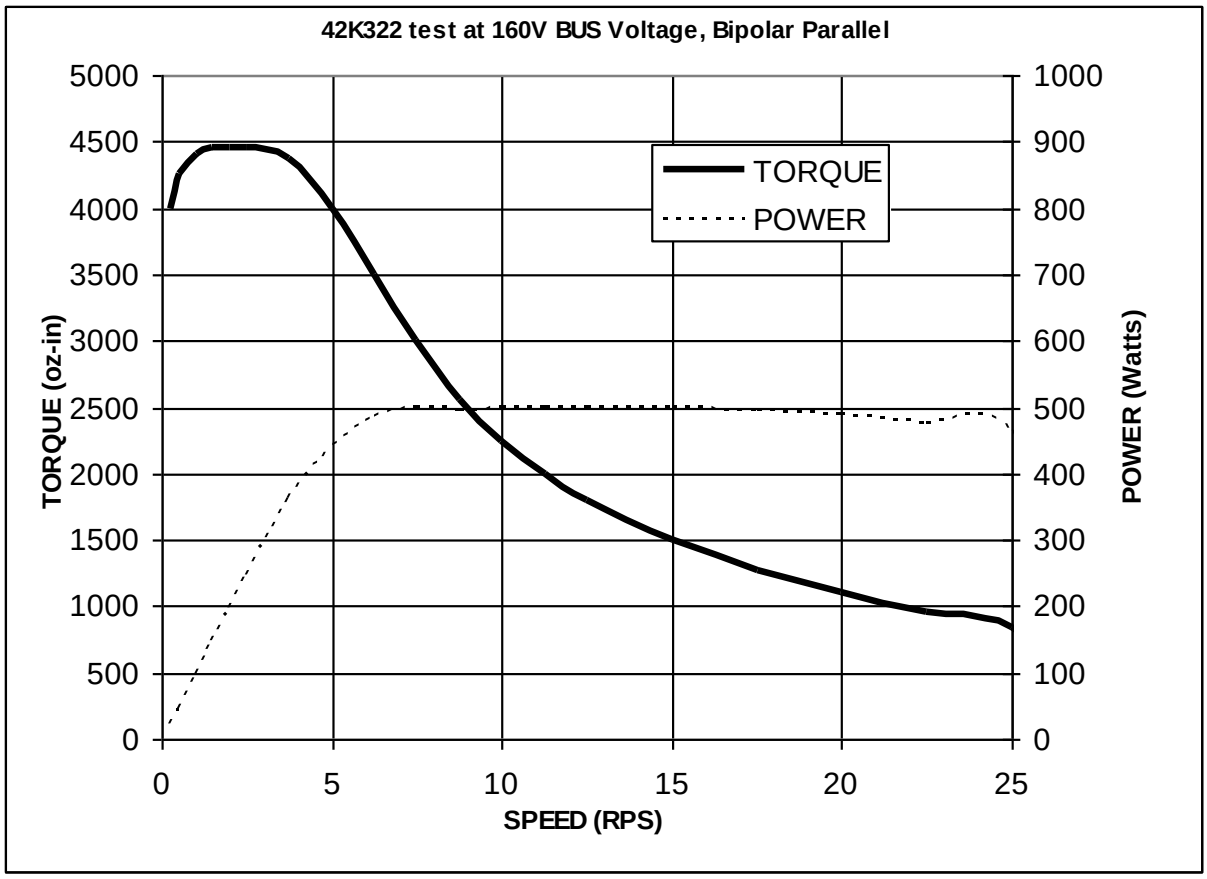
Calculated Torque Chart for Stepper Motor 42Y312.



PPS	**RPS**	**TORQUE**	**POWER**
100	0.25	2720	30.1648
200	0.5	2600	57.668
400	1	2520	111.7872
600	1.5	2320	154.3728
800	2	2240	198.7328
1000	2.5	2000	221.8
1500	3.75	1600	266.16
2000	5	1200	266.16
2500	6.25	920	255.07
3000	7.5	760	252.852
3500	8.75	640	248.416
4000	10	540	239.544
4500	11.25	480	239.544
5000	12.5	430	238.435
6000	15	360	239.544

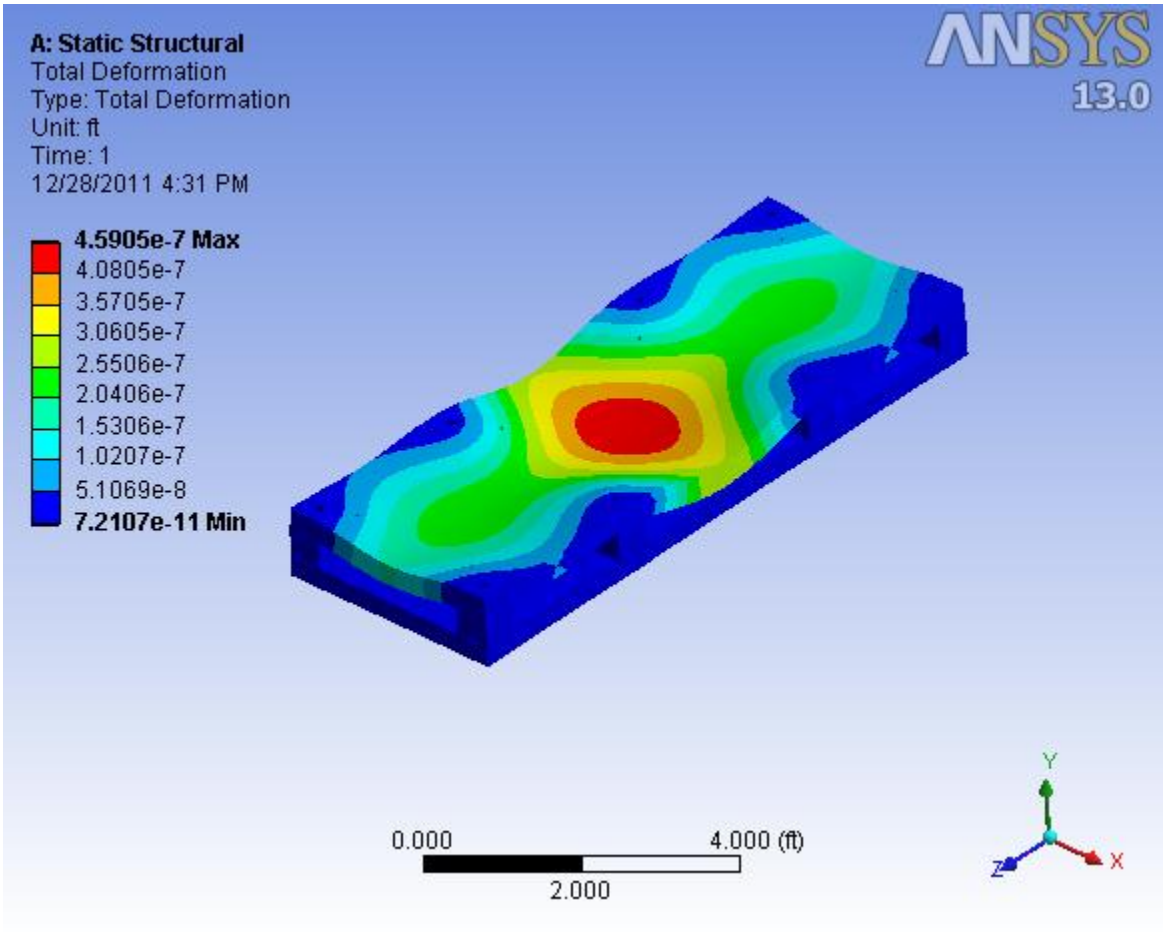
Calculated Torque Chart for Stepper Motor 42K312.

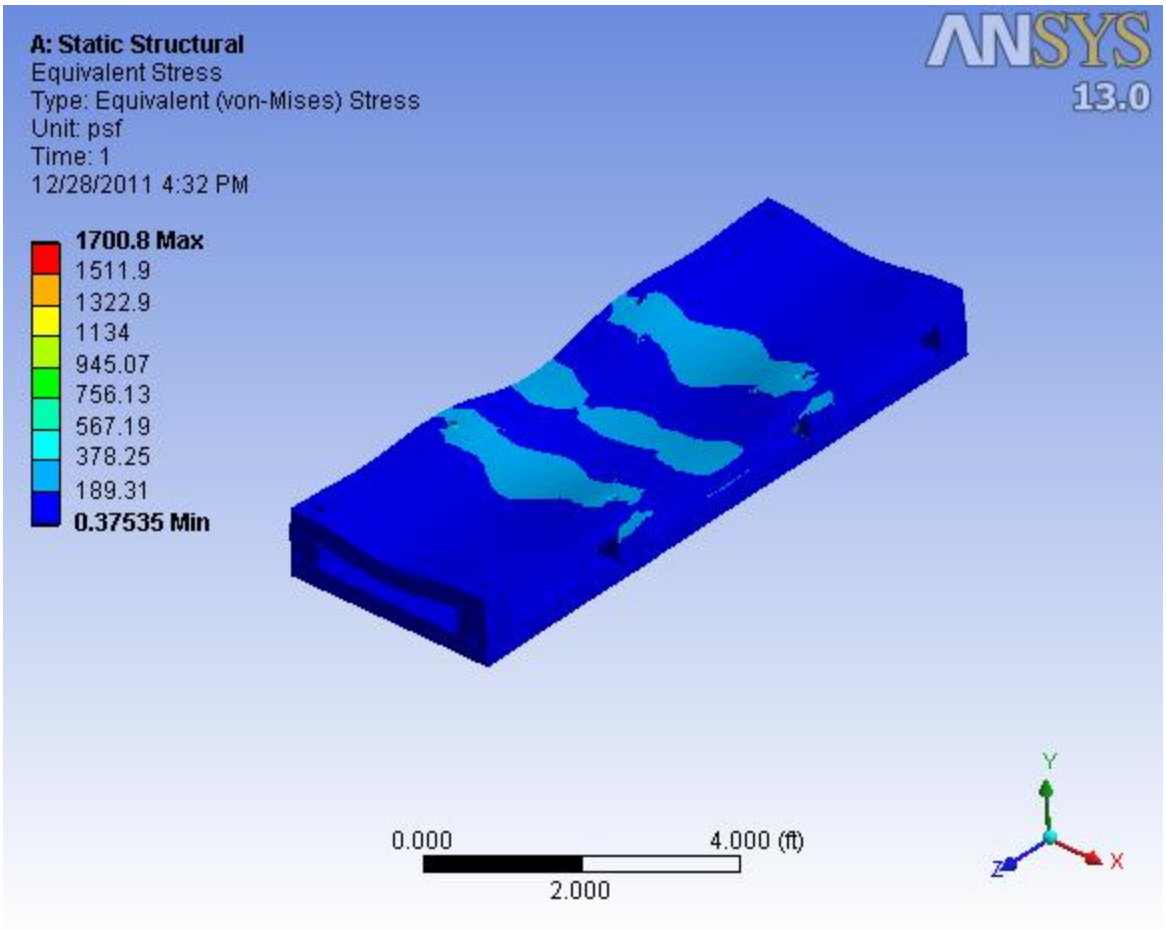
SPEED		TORQUE	POWER
PPS	RPS		
400	0.25	4000	22.18
800	0.5	4250	47.1325
1600	1	4400	97.592
2400	1.5	4450	148.0515
3200	2	4450	197.402
4000	2.5	4450	246.7525
6000	3.75	4375	363.890625
8000	5	4000	443.6
10000	6.25	3500	485.1875
12000	7.5	3000	499.05
14000	8.75	2550	494.89125
16000	10	2250	499.05
18000	11.25	2000	499.05
20000	12.5	1800	499.05
24000	15	1500	499.05
28000	17.5	1275	494.89125
32000	20	1100	487.96
36000	22.5	950	474.0975
40000	25	840	465.78
48000	30	0	0
56000	35	0	0


42K322 test at 160V BUS Voltage, Bipolar Parallel
TORQUE
POWER
TORQUE (oz-in)
POWER (Watts)
SPEED (RPS)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25

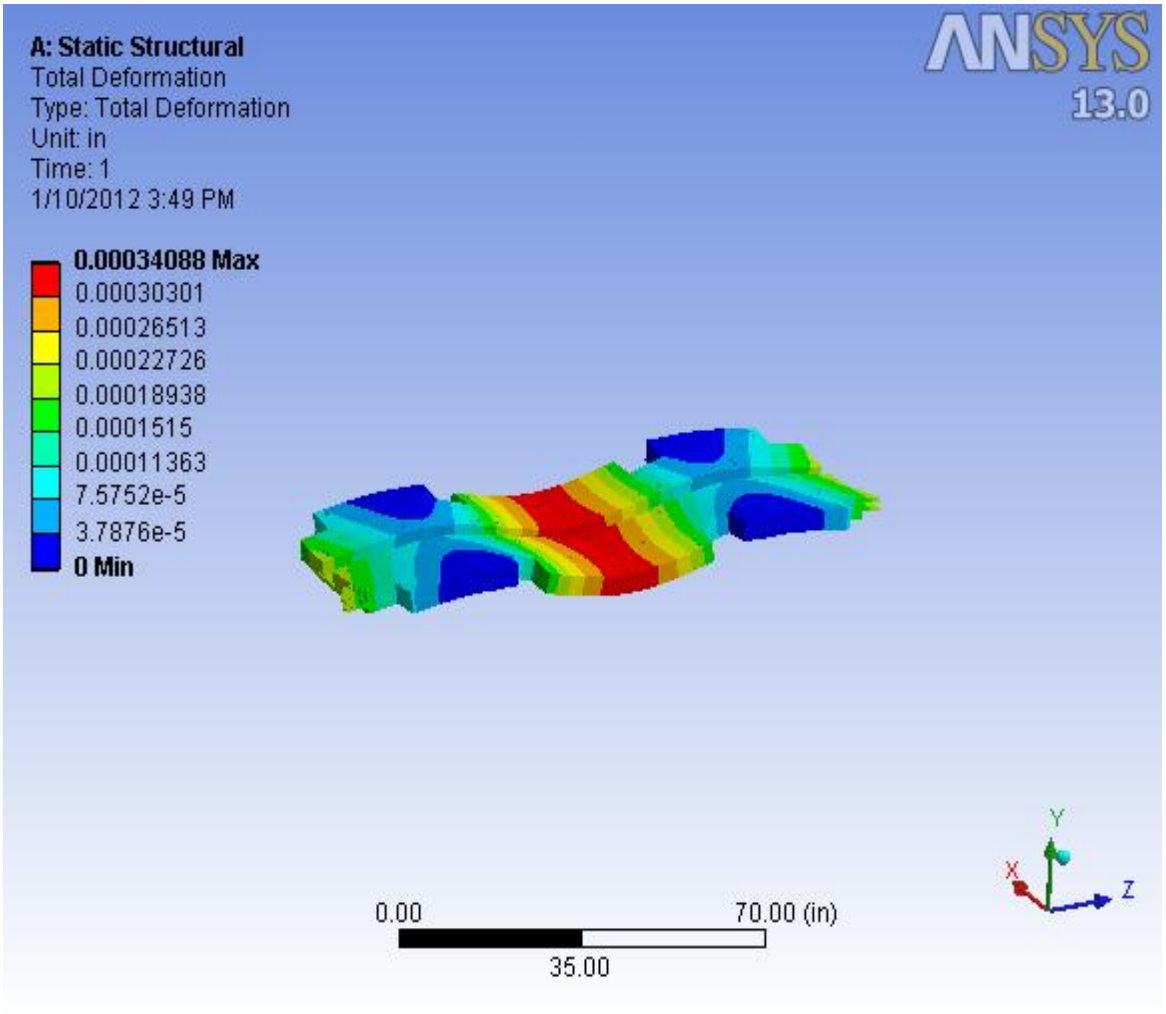
6. Moving Block FEA Calculations.

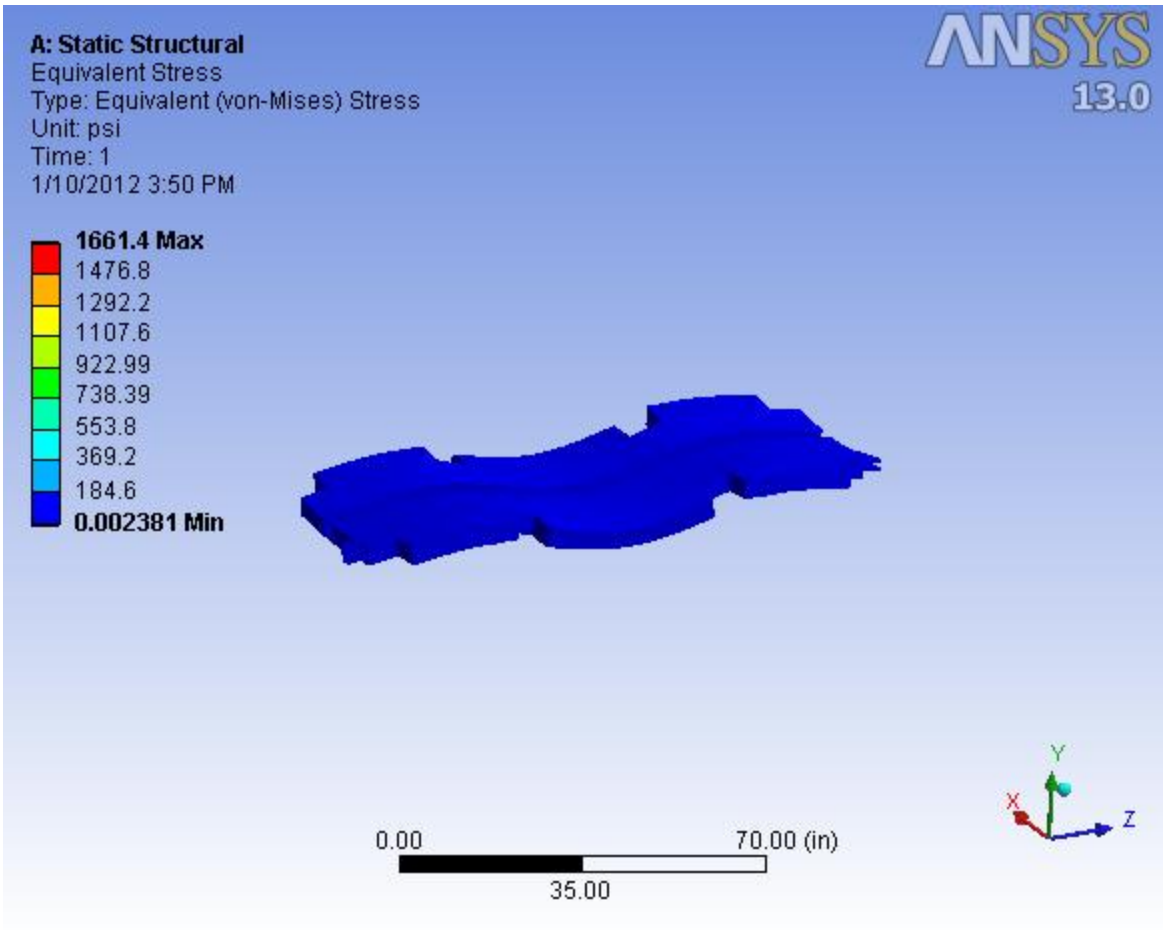
6.1 Moving block base FEA Calculations.




A: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: psf
Time: 1
12/28/2011 4:32 PM
1700.8 Max
1511.9
1322.9
1134
945.07
756.13
567.19
378.25
189.31
0.37535 Min
ANSYS
13.0
0.000
4.000 (ft)
2.000
Y
Z
X

6.2 Moving block parts FEA Calculations.




A: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: psi
Time: 1
1/10/2012 3:50 PM
1661.4 Max
1476.8
1292.2
1107.6
922.99
738.39
553.8
369.2
184.6
0.002381 Min
ANSYS
13.0
0.00
70.00 (in)
35.00
Y
X
Z

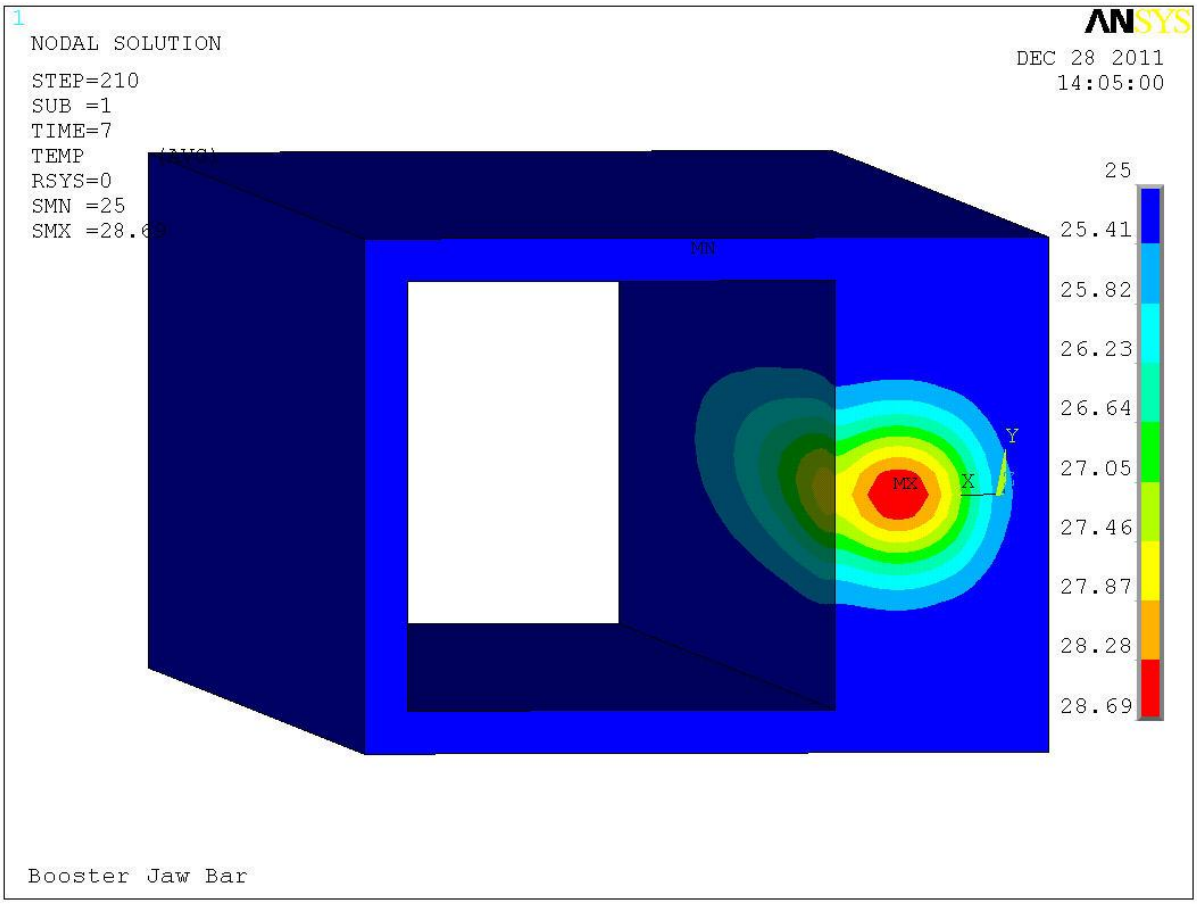
7. Thermal Analysis

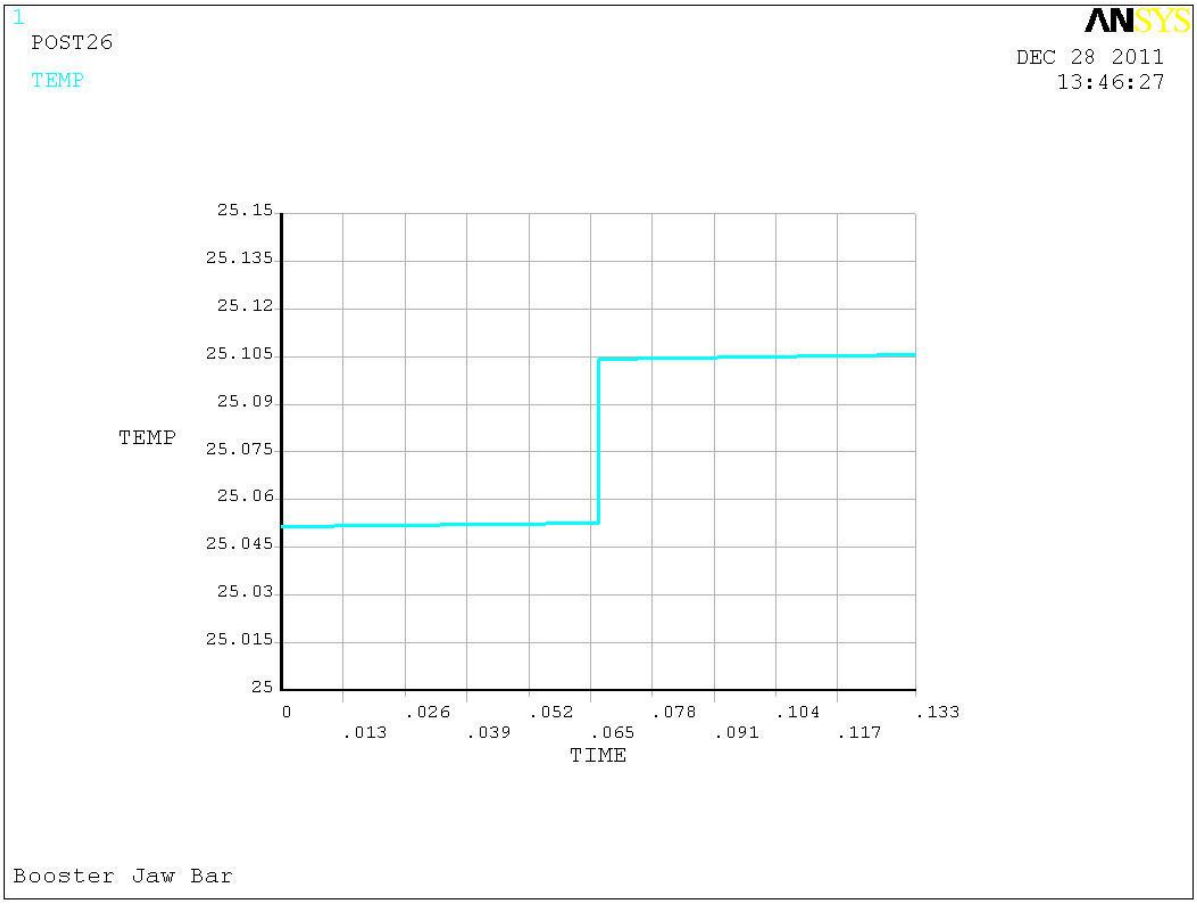
The Absorber Liner jaw will be heated by energy deposition of the lost beam.

Proton per puls: $5x10^{12}$, 15Hz , 700 MEV.

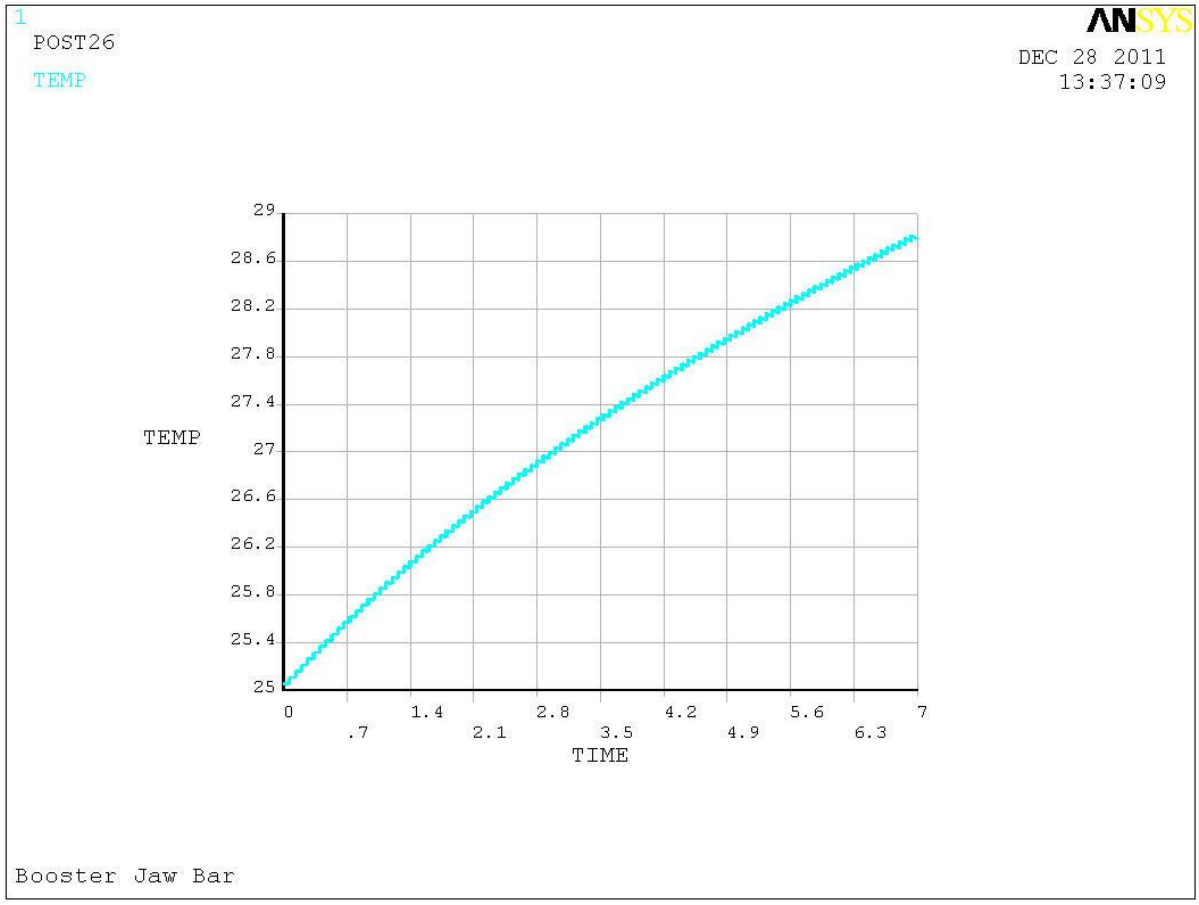
Conductive heat transfer only.

Model 1: Piece of tube with jaw inside two feet long is heated by beam.

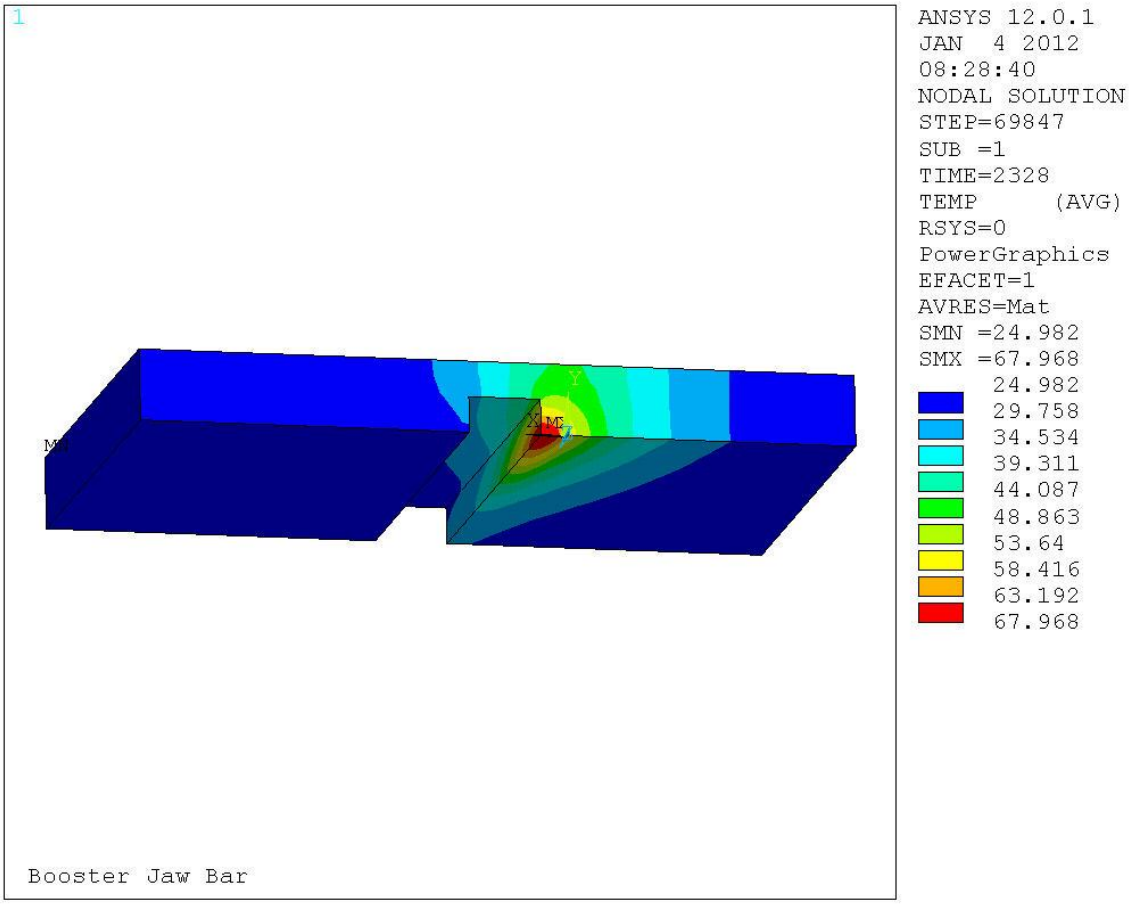


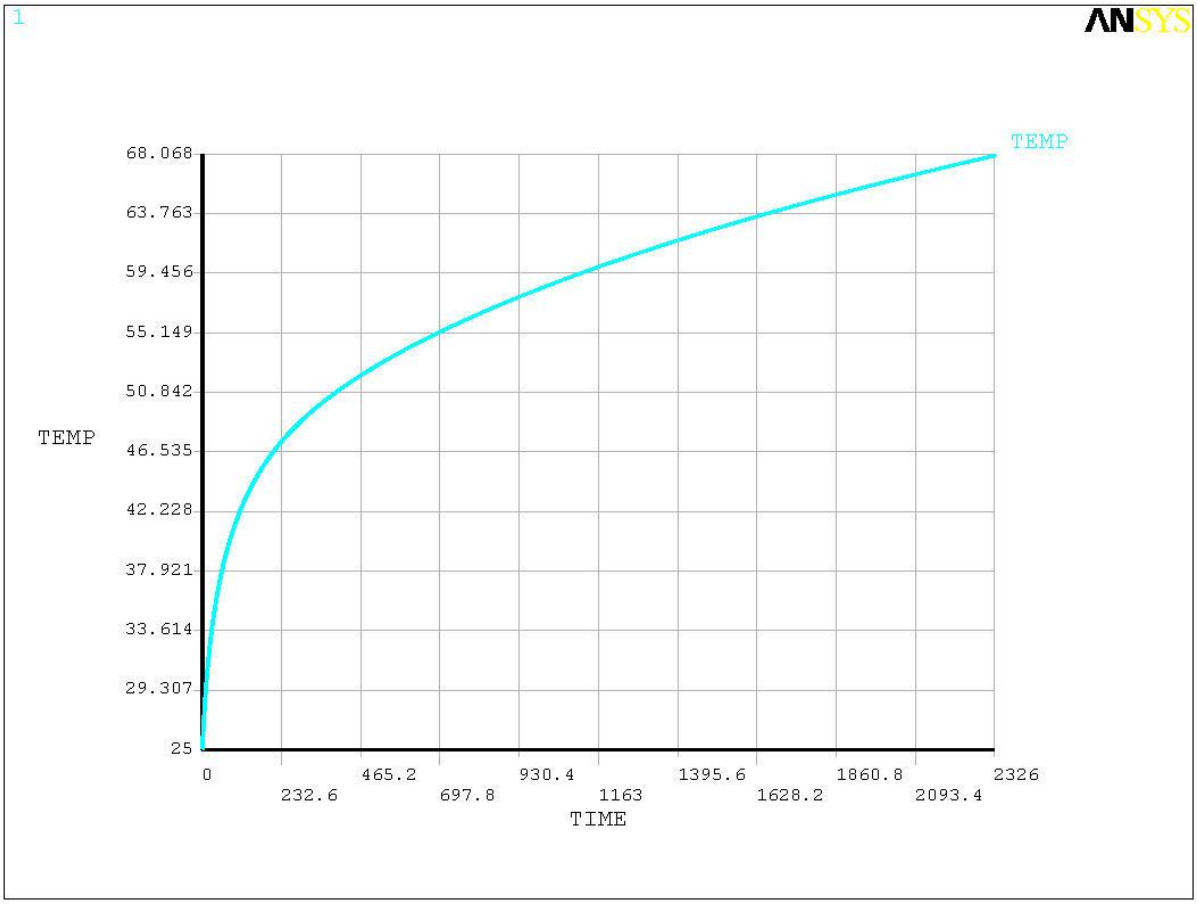


Instant temperature- rise per puls is 0.6^{o}C.


1
POST26
TEMP
ANSYS
DEC 28 2011
13:37:09
TEMP
29
28.6
28.2
27.8
27.4
27
26.6
26.2
25.8
25.4
25
0
.7
1.4
2.1
2.8
3.5
4.2
4.9
5.6
6.3
7
TIME
Booster Jaw Bar

Model2: piece of moving block with vacuum liner, jaw and shielding around is heated by beam.

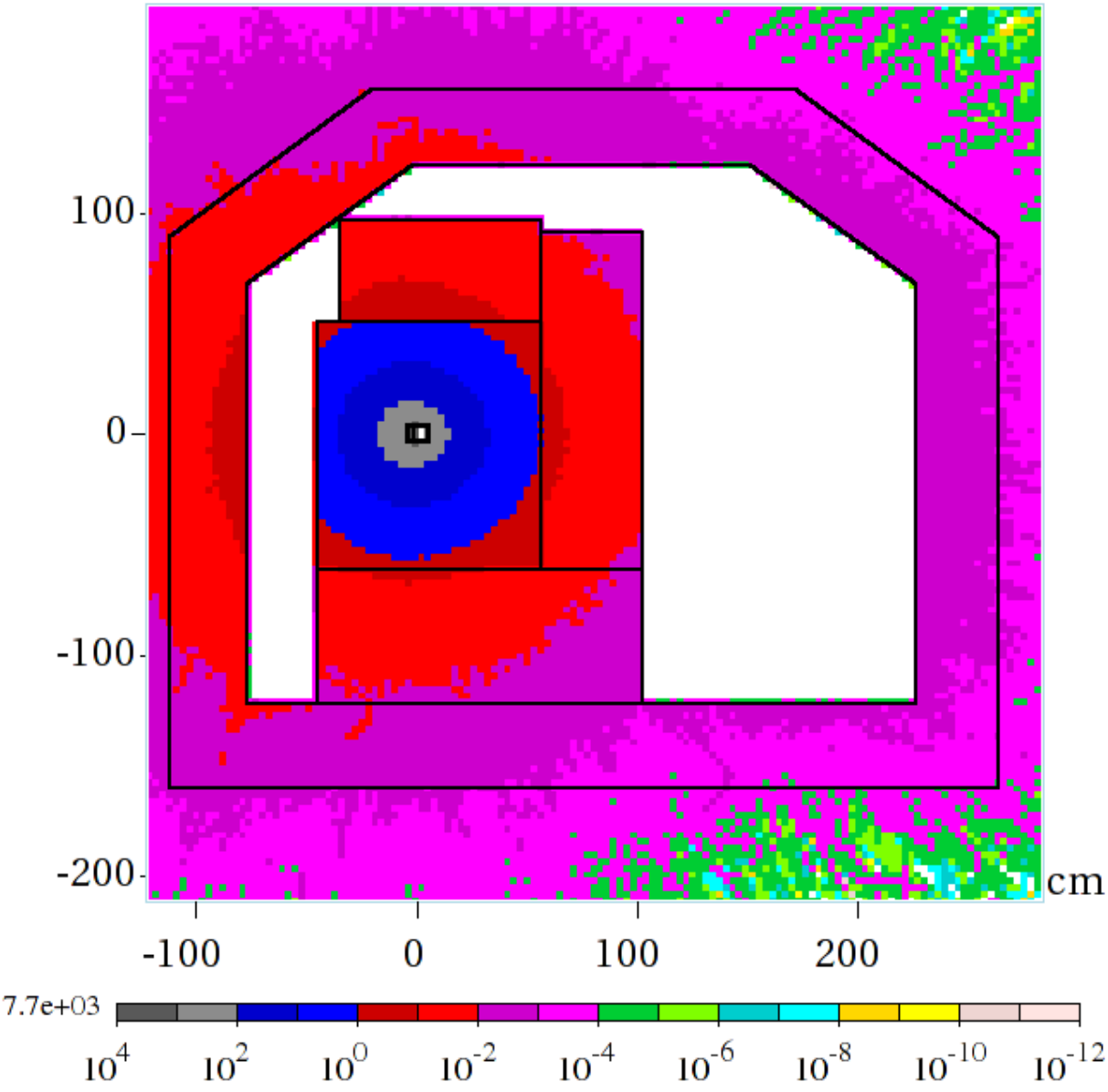



1
ANSYS
TEMP
68.068
63.763
59.456
55.149
50.842
46.535
42.228
37.921
33.614
29.307
25
TEMP
0
232.6
465.2
697.8
930.4
1163
1395.6
1628.2
1860.8
2093.4
2326
TIME

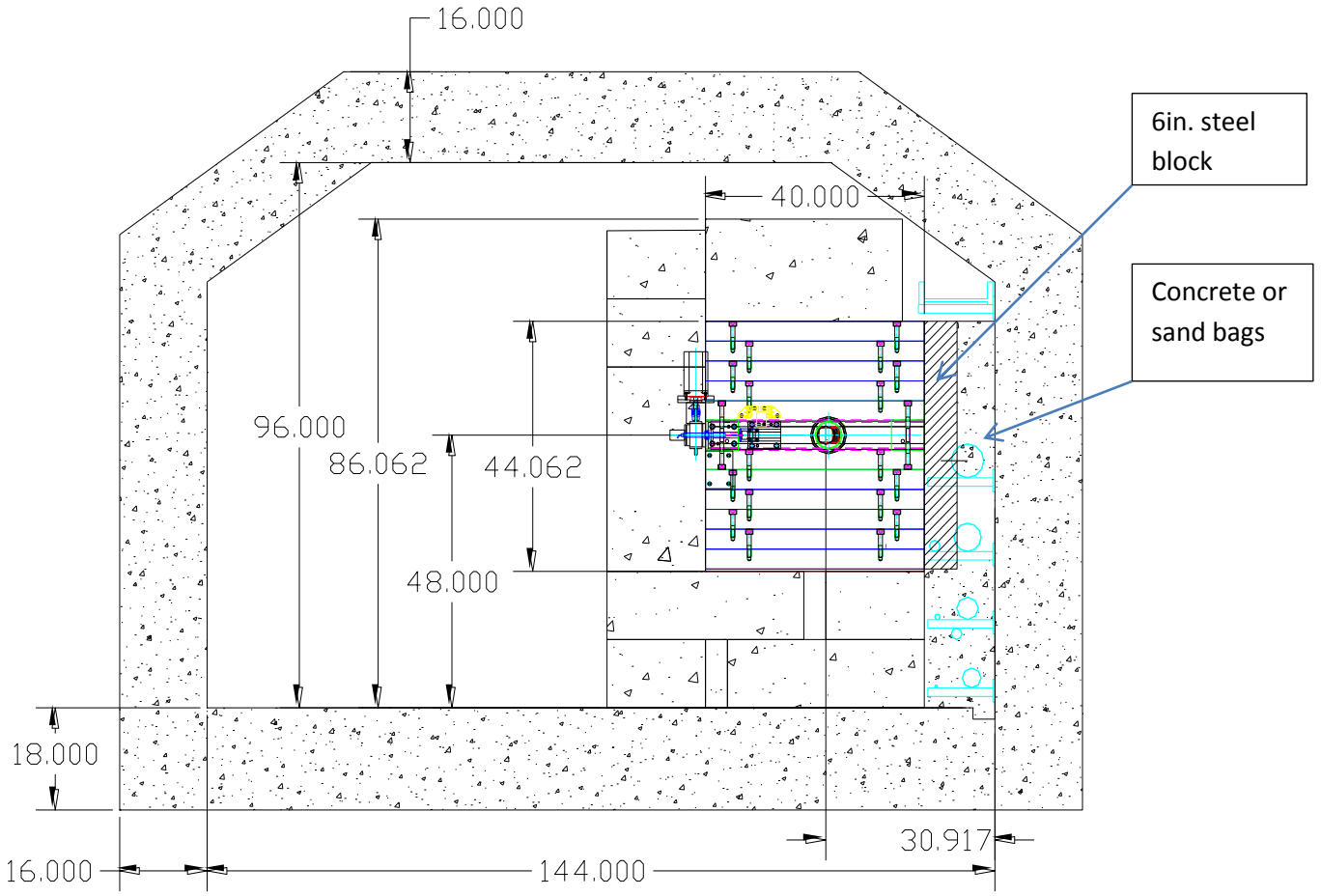
8. Additional shielding.

According MARS calculations the star density behind the tunnel concrete wall in case of the 13” gap between the absorber and tunnel wall is about 8000.

Required limits of the star density are 4000.



Energy deposition MARS Calculations



Additional shielding installation.

Star Density is 3000.