Tagger Magnet Procurement Schedule

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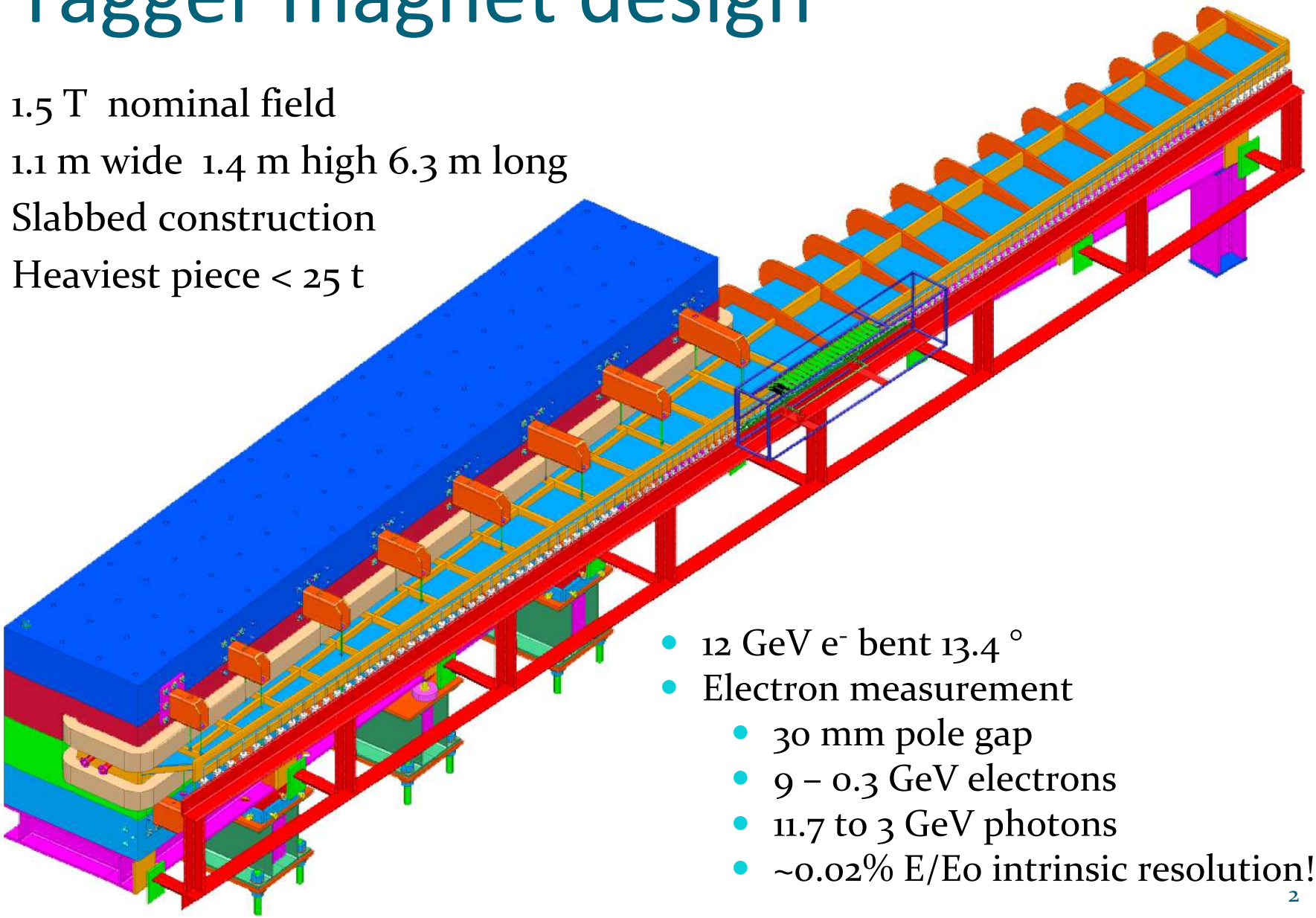
JLAB

Internal Review
May 2009

Tagger magnet design

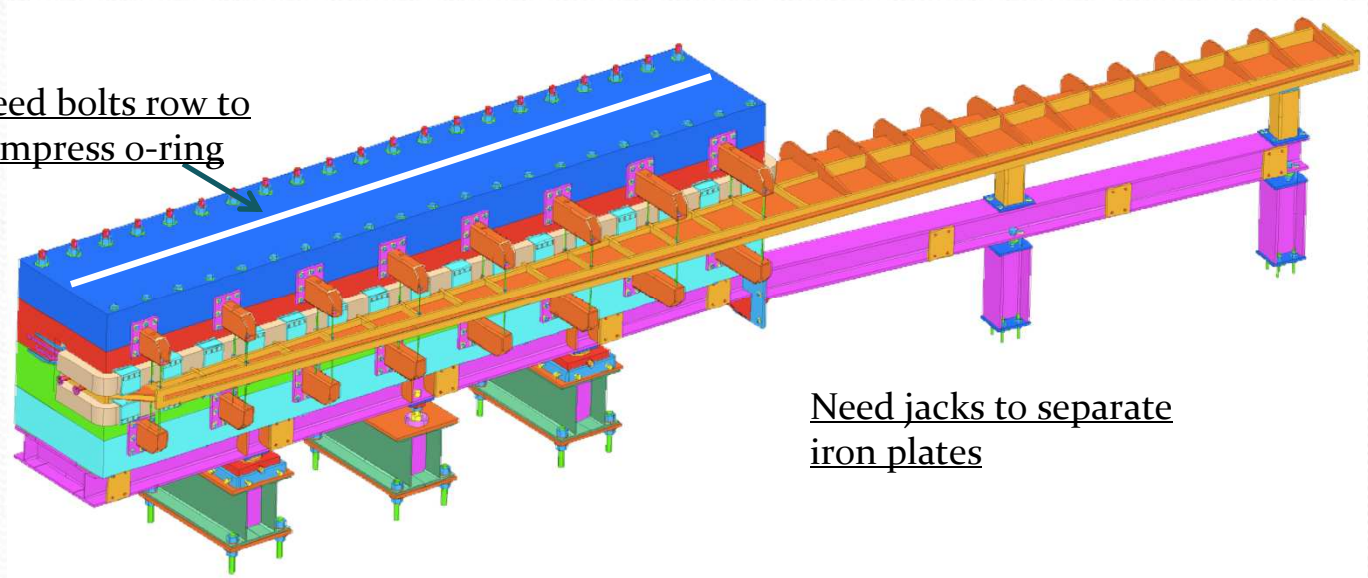
- 1.5 T nominal field
- 1.1 m wide 1.4 m high 6.3 m long
- Slabbed construction
- Heaviest piece < 25 t



- 12 GeV e^- bent 13.4 °
- Electron measurement
  - 30 mm pole gap
  - 9 – 0.3 GeV electrons
  - 11.7 to 3 GeV photons
  - ~0.02% E/Eo intrinsic resolution!

Design Status Summary

- Initial 3-D models exist but they are not final.
  - Changes still being made.
- No real assembly or detail drawings exist.
- Substantial FEM analysis has been done at Glasgow.
- Substantial FEM analysis is being done now @ JLAB.



Procurement possible Strategies

- Issue a design and build contract
  - Here the company will take our design proposals and then finish the design or start from scratch.
- Finish the design and then issue a set of build contracts.
  - Here we have to generate all documentation and shop drawings ourselves.

Design and build contract

- JLAB will define the specification and the statement of work for the Magnet and the vacuum chamber.
  - Will include a drawing set which represents a proposal for how the magnet could be built.
- Companies bid on the magnet with a proposal how it will be built.
  - They can change the design as long as meets our requirements.
- When the final design is finished it will be reviewed.
- Material procurement and manufacturing starts.

Build contract

- JLAB will design all the components of the magnet system.
  - Magnet Yoke
  - Magnet Coils
  - Stands
  - Vacuum chamber
- We need final drawings with tolerances.
- We need exact specifications for all materials, handling, and quality control.
- We need to produce all safety related analysis and documentation.

Pros and Cons

Design and Build

- Pros
  - Do not need to finish the design.
  - Can benefit from company's experience .
  - Company will generate the necessary documentation.
  - Company can test the magnet before delivery.
    - Know we will receive a working magnet!
- Cons
  - Must review the company's proposal.
  - Must pay for all design work at the company.

Straight Build

- Pros
  - Do not have to review the company's final design.
  - Cost of contracts may be less as the companies do not need to engineer.
- Cons
  - Cannot benefit from company's experience.
  - More work in procurement here due to multiple contracts.
  - Q&A is more important as only partial testing can be done before delivery.
  - First assembly and testing at JLAB.

Pros and Cons

	Design and Build	Build
Design Effort	We don't have to finish the design. Must review their design.	Must finish our design.
Cost	Must pay for all design work and testing at the company (+profit). Must integrate their documents into JLAB	Must pay to finish the design. Must produce full documentation set.
Risk	Can benefit from outside experience . Company accepts responsibility for mistakes. Additional optimization may save cost.	If we make a mistake it we will need to fix it. (How to evaluate risk?)
Q&A	Will test/map the magnet at the company.	We must assure Q&A.

Results from RFI issued 1 year ago

Companies claiming to be able to build

- Babcock Noell GmbH
- Bruker Biospin
- Everson Tesla
- General Atomics
- Milhous Company
- Precision Custom Components
- Sigmaphi

Rough Cost mentioned

- $950k
- $920k
- $500k

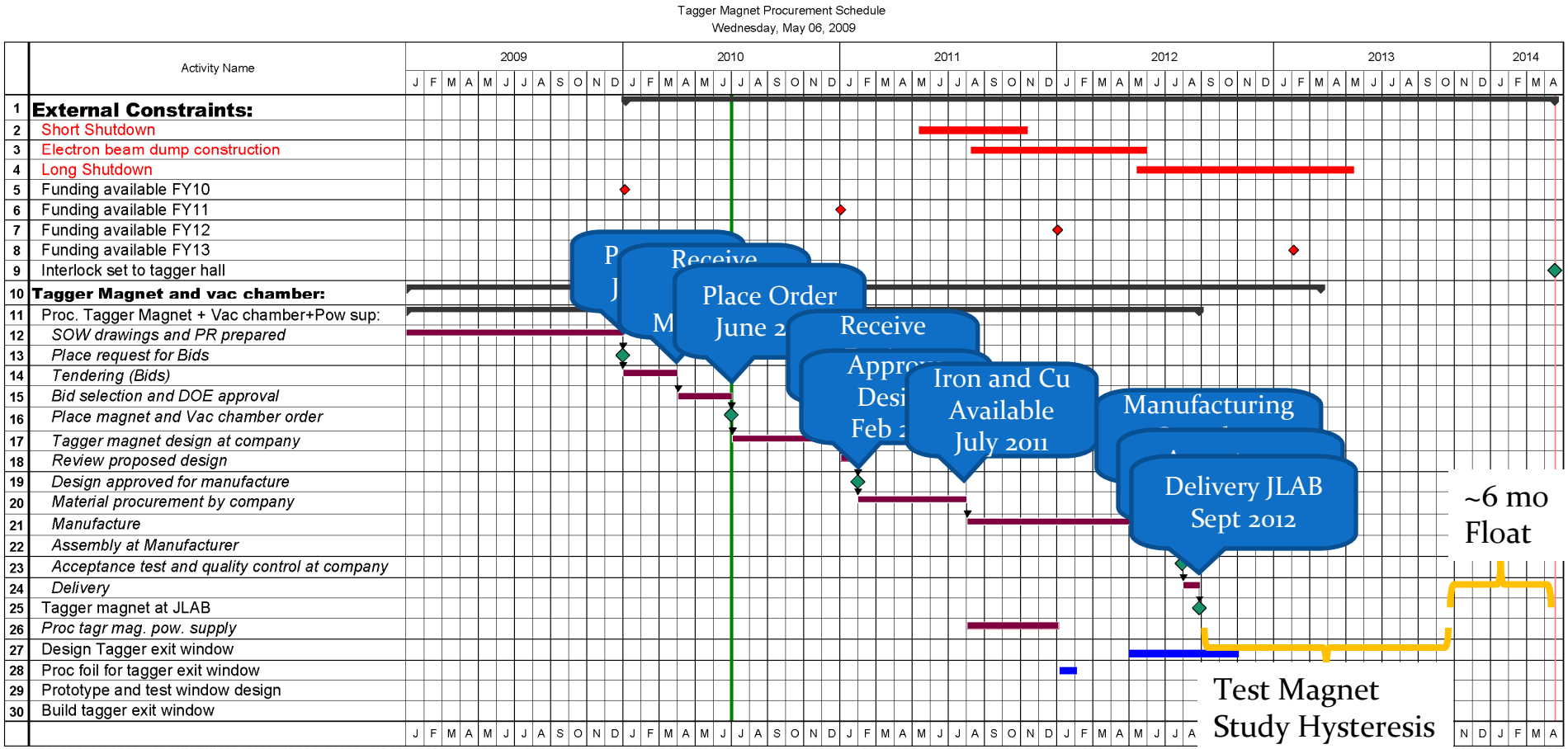
Note: The dollar-euro rate and steel prices have changed in the last year.

SigmaPhi

Tim met with the a rep. from SigmaPhi recently to discuss the magnet.

If it is a design and build they would start from scratch as they will be responsible. Plan for 2 years between issuing the contract and delivery. Cast ~$1.2M for the magnet only. They can map if we request.

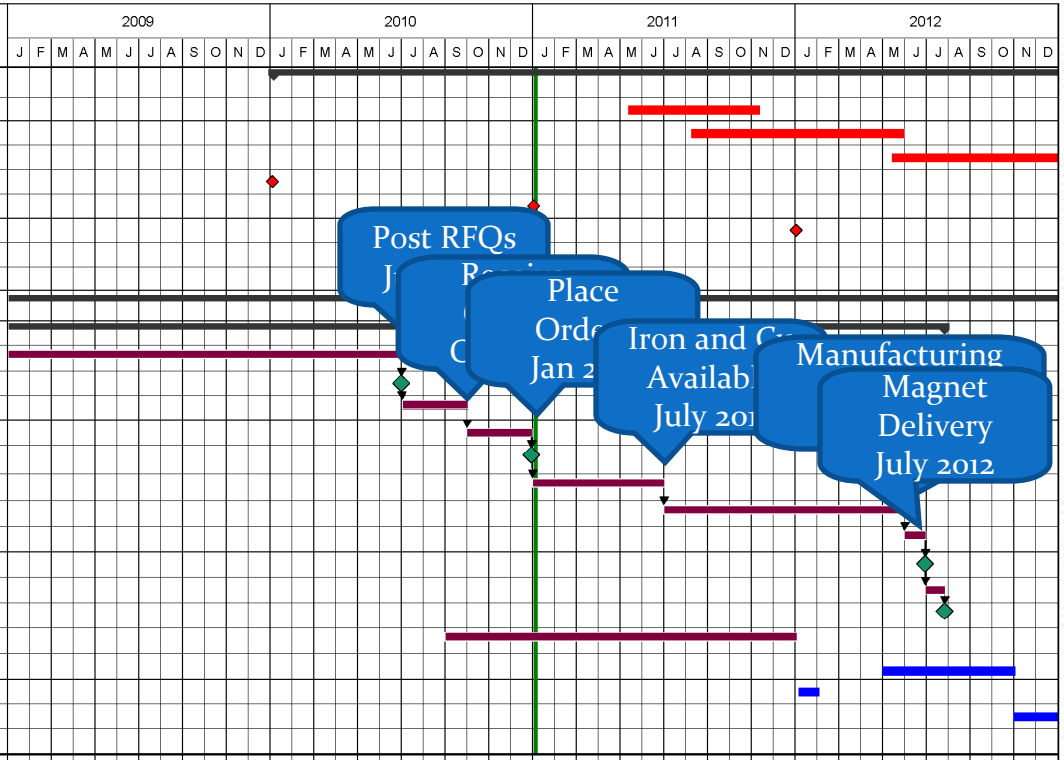
Design and Build contract timeline



Build Only Schedule

Tagger Magnet Procurement Schedule
Thursday, May 07, 2009

	Activity Name	Duration (Work Days)	Start Date	Finish Date	Predecessors
1	**External Constraints:**	**1,118.00**	**1/4/10**	**4/17/14**	
2	Short Shutdown	131.00	5/13/11	11/11/11	
3	Electron beam dump construction	211.00	8/10/11	5/30/12	
4	Long Shutdown	261.00	5/14/12	5/13/13	
5	Funding available FY10	0.00	1/4/10	1/4/10	
6	Funding available FY11	0.00	1/3/11	1/3/11	
7	Funding available FY12	0.00	1/2/12	1/2/12	
8	Funding available FY13	0.00	2/4/13	2/4/13	
9	Interlock set to tagger hall	0.00	4/17/14	4/17/14	
10	**Tagger Magnet and vac chamber:**	**1,194.00**	**8/22/08**	**3/20/13**	
11	Proc. Tagger Magnet + Vac chamber+Pow sup:	**1,025.00**	**8/22/08**	**7/26/12**	
12	*SOW drawings and PR prepared*	485.00	8/22/08	7/1/10	
13	*Place request for Bids*	0.00	7/1/10	7/1/10	12
14	*Tendering (Bids)*	65.00	7/2/10	9/30/10	13
15	*Bid selection and DOE approval*	65.00	10/1/10	12/30/10	14
16	*Place magnet and Vac chamber order*	0.00	12/30/10	12/30/10	15
17	*Material procurement by company*	130.00	12/31/10	6/30/11	16
18	*Manufacture*	240.00	7/1/11	5/31/12	17
19	*Delivery*	20.00	6/1/12	6/28/12	18
20	*Magnet at JLAB*	0.00	6/28/12	6/28/12	19
21	*Assembly at JLAB*	20.00	6/29/12	7/26/12	19
22	*Power test and quality control*	0.00	7/26/12	7/26/12	21
23	*Proc tagr mag. pow. supply*	350.00	8/31/10	1/2/12	
24	Design Tagger exit window	133.00	4/30/12	10/31/12	
25	Proc foil for tagger exit window	21.00	1/5/12	2/2/12	
26	Prototype and test window design	53.00	11/1/12	1/14/13	
27	Build tagger exit window	47.00	1/15/13	3/20/13	



Effort for Design and Build

Now to RFQ	5 mw Engineer	Finish SOW and PR.
	7 mw Designer	Finish drawing package for bid.
Review Bids	6 mw Engineer	3 mw answer questions from companies. 3×1 wk committee reviews bids .
Design phase support	3 mw engineer	Reviews at 1.5 mo and 6 mo. Check design and documents.
	2 mw designer	Support for design review.
Build phase	4 mw engineer	Site visits. Testing review.
Delivery	4 mw	Documentation and Safety integration.

Total : 22mw Eng. 9 mw Designer (~$85k)

Effort for a build only contract

Now to RFQ	14 mw Engineer	Finish FEA. Documentation. Safety analysis.
	32 mw Designer	Finalize design. Make all drawings. Get signed archived drawings.
Review Bids	6 mw Engineer	Review 4 different contracts.
Build phase	4 mw engineer	Site visits. Testing review.
Delivery	3 mw	Certificates Documentation and Safety review.

Total : 27 mw Eng. 32 mw Designer (~$148k)

Overview of what is in P3E for the tagger magnet →excluding installation←

Activity ID	Activity Name	Start	Finish	Bud. Labor Cost	Bud.Labor Cost	Bud. Mat. Cost	Bud. Total Cost
15511005	Drawings for Yoke Steel	01-Apr-10	20-Sep-10	43.0w	$41,676	$0	$41,676
15511010	Drawings for Coils	01-Apr-10	20-Aug-10	65.0w	$52,966	$0	$52,966
15511015	Drawings for Vac Chamb	01-Apr-10	20-Sep-10	65.0w	$52,966	$0	$52,966
15511025	Dsgn Stands for Mag	01-Apr-10	24-Jun-10	37.0w	$41,676	$0	$41,676
15511030	Dsgn Supprt for Vac Chamb	01-Apr-10	03-Sep-10	37.0w	$41,676	$0	$41,676
15511040	Write Pwr Supply Spec	23-Aug-10	27-Sep-10	11.0w	$6,938	$0	$6,938
15511045	EH&S Review of Dsgn	21-Sep-10	27-Sep-10	0.0w	$0	$0	$0
15511050	Proc Yoke Steel	05-Jan-11	26-Aug-11	2.0w	$1,334	$541,992	$543,326
15511060	Proc Vac Chamb	05-Jan-11	30-Mar-11	3.0w	$2,000	$70,948	$72,948
15511065	Proc Pwr Supply	05-Jan-11	31-Mar-11	0.0w	$0	$64,735	$64,735
15511105	Tag Mag Acceptance Test	02-Jul-12	02-Jul-12	0.0w	$0	$0	$0
15511110	Shipping to JLab	03-Jul-12	27-Aug-12	0.0w	$0	$34,074	$34,074
		Power Supply Subtotal		11.0w	$6,938	$64,735	$71,673
		Tagger Dipole Subtotal		252w	$234.3k	$647k	$881.3

Budgeted cost for installation

Activity ID	Activity Name	Start	Finish	Bud. Labor	Bud. Material	Bud. Total
1562045	Install Tagger Magnets & Chamber	28-Aug-12	30-Oct-12 04:00 PM	$26,035	$27,685	$53,720
1562050	Install Tagger Pwr Supply (Installtn)	27-Jun-12	24-Jul-12 04:00 PM	$17,612	$10,648	$28,261
1562055	Install LCW Connections (Installtn)	25-Jul-12	21-Aug-12 04:00 PM	$9,248	$2,130	$11,378
1562060	Survey & Align Magnets (Installtn)	31-Oct-12	13-Nov-12 04:00 PM	$16,090	$0	$37,392
1562061	Field Map Tagging Magnet	14-Nov-12	19-Feb-13 04:00 PM	$22,581	$0	$22,581
			Total	$91.5k	$20.4k	$112k

Summary: 2 technician man years of effort and $20k material

Remember this includes: Magnet Survey, Magnet Assembly, Power Supply Installation, Cables, Cable Trays, Water, Temperature Switches, Controls, Programming Controls, Testing the Magnet, Hysteresis Suppression Studies, Generation of the excitation table for CEBAF, Mapping the Magnet, A Mapping Machine if needed including software ….

Must decide on the best plan!

- Main Factors to consider:
  - Manpower availability
  - Risk
  - Cost

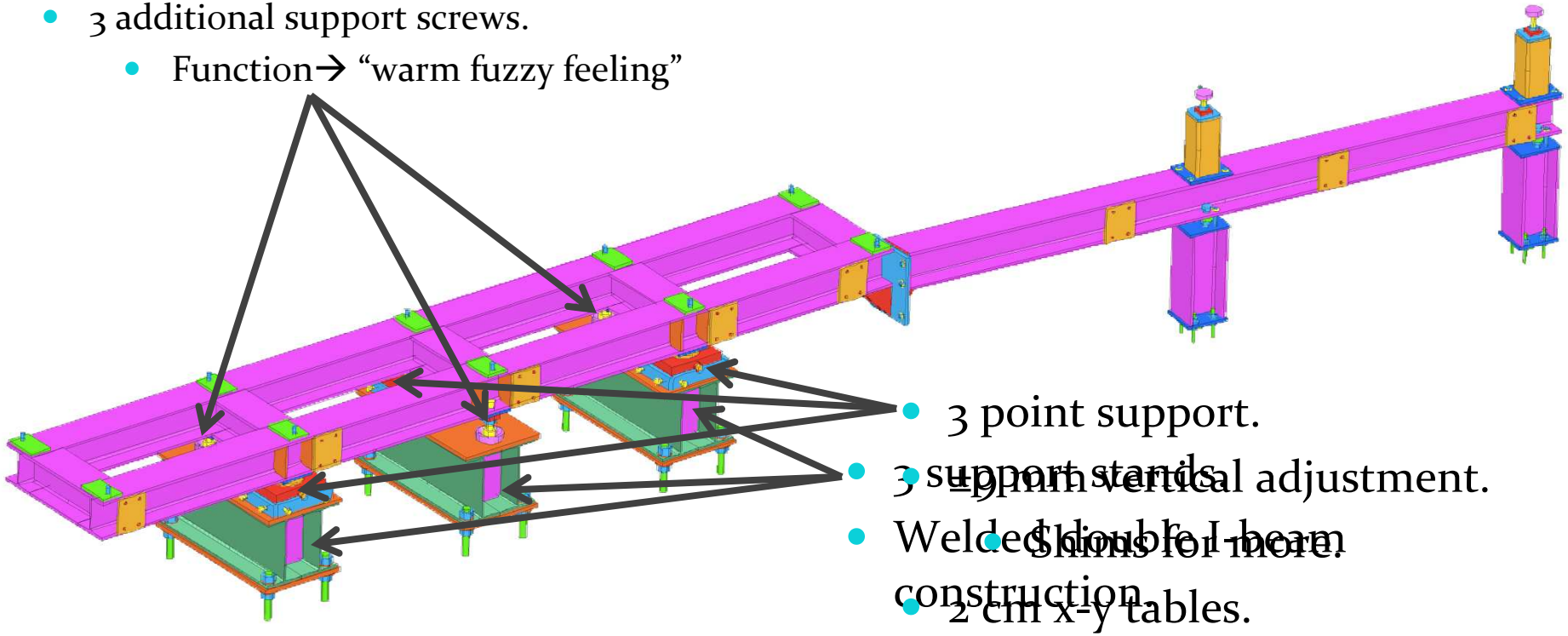
Backup

Manpower cost

- Mech Eng $63.81 per hr
  - 63.81*40*(52/44)= $3.0 k per mw
    - Fully burdened non-escalated effort
  - Mech Designer $43.84 per hour
  - $43.84 *40*(52/44)=$2.1 k per mw
    - Fully burdened non-escalated effort

Overview

- 3 additional support screws.
  - Function→ “warm fuzzy feeling”

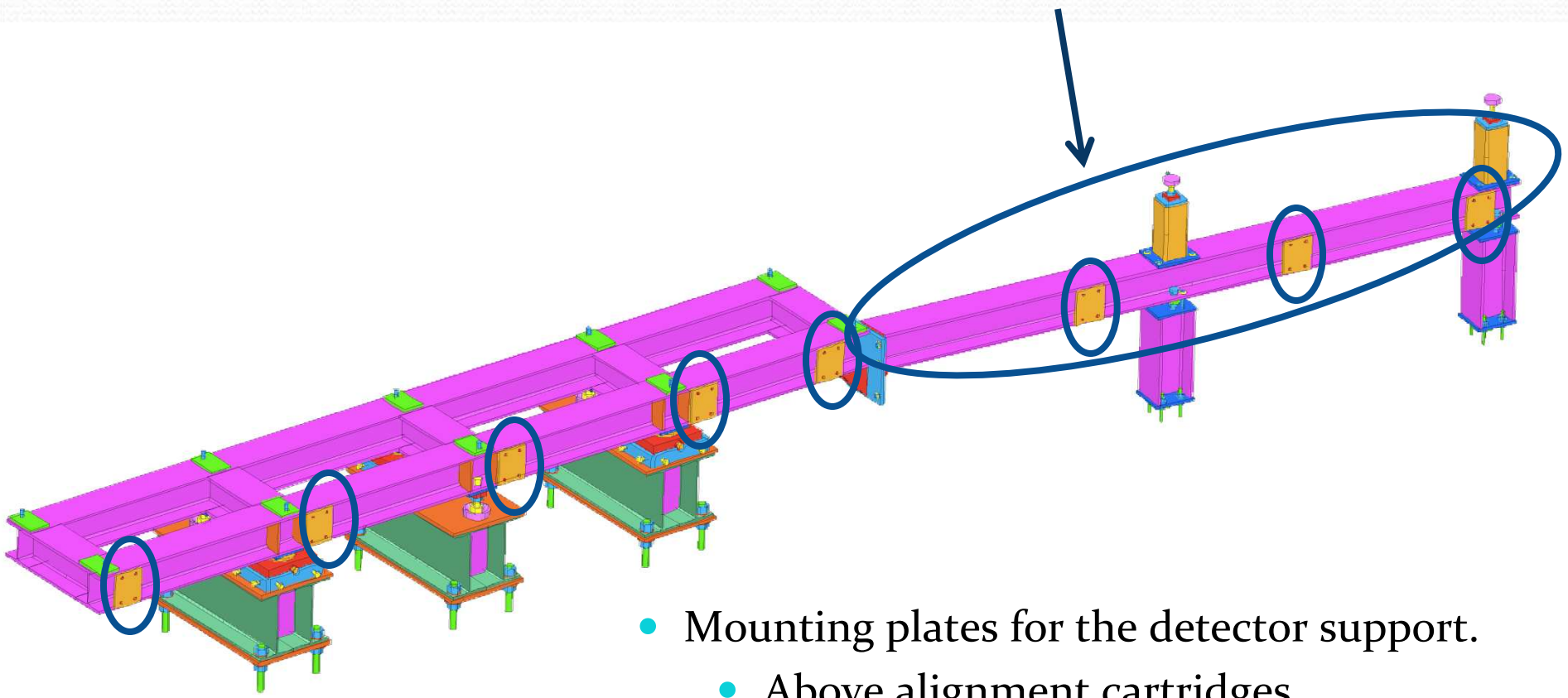


- 3 point support.
- 3 support stands.
- Welded double I-beam construction.
- 8ot load

- ±19mm vertical adjustment.
- Shims for more.
- 2 cm x-y tables.

Overview

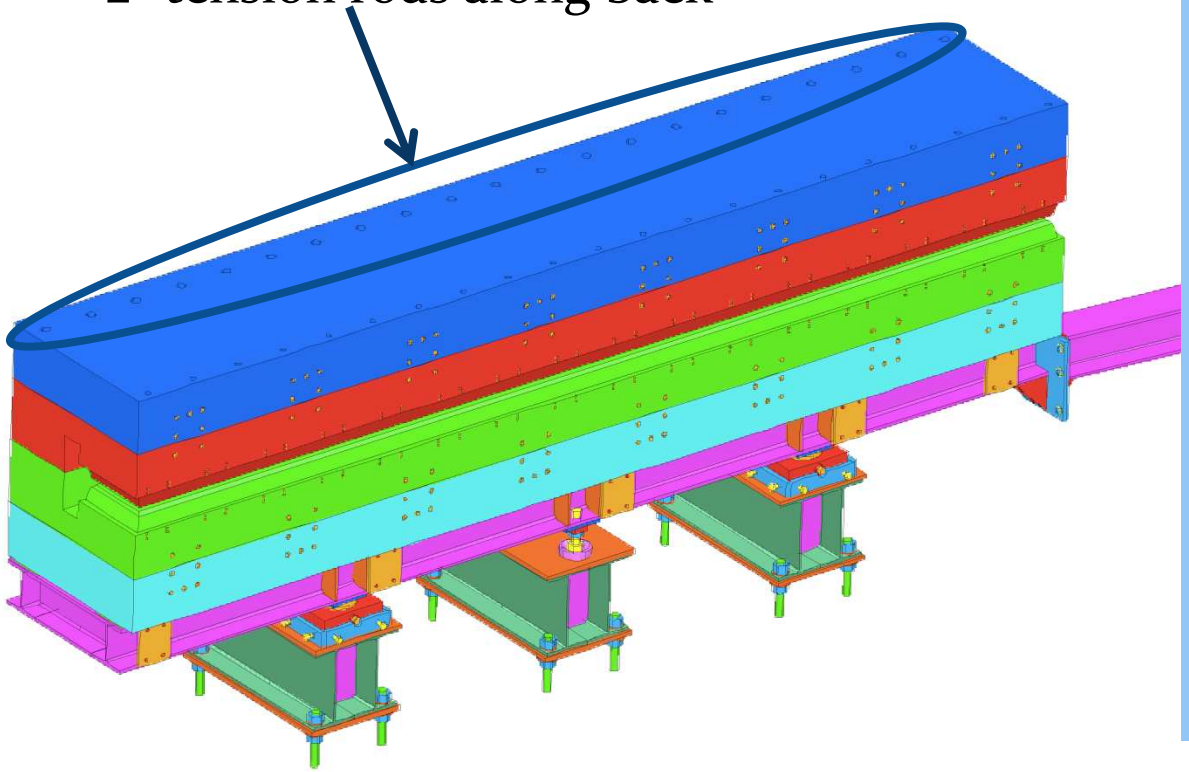
- Vacuum chamber support.



- Mounting plates for the detector support.
  - Above alignment cartridges.
  - Detectors move with magnet

Overview

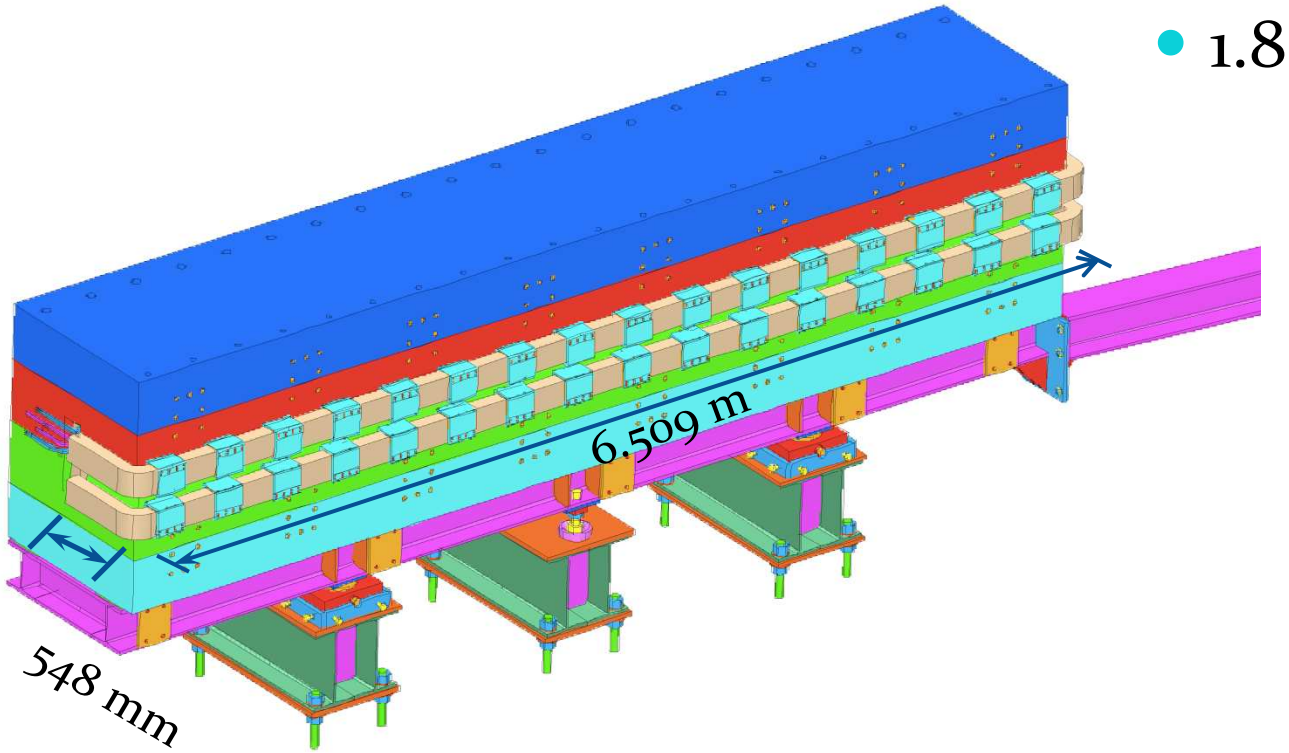
- 2” tension rods along back

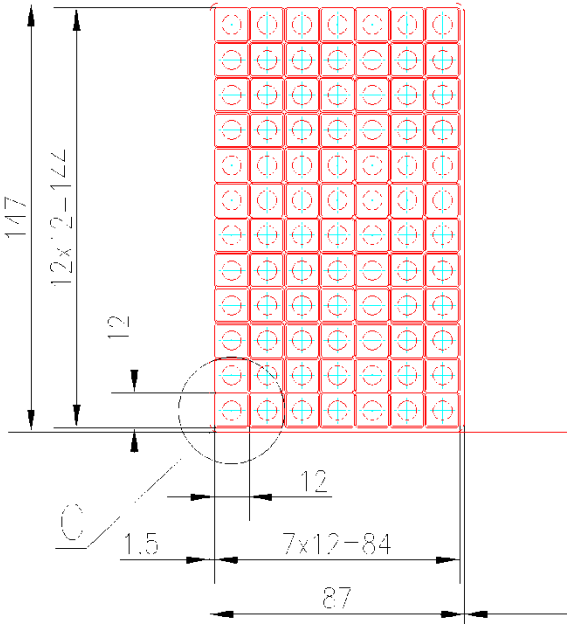


- Constructed of 4 iron plates.
  - Color TBD→Big enough for serious artwork.
- 470 mm wide pole.
- 2 surface pole contour.
- Effective field width ~470 mm.
- Magnetic force between poles @1.5 T ~ 240t.
- Magnetic deflection of poles ~0.1 mm.

Overview

- Magnet CoilsCoil
  - 12 by 7 cu matrix.
  - 11 mm sq cu
  - 7 mm water path
  - 1.5 T→ 220A 105V
  - 1.8 T→ 366A 200V

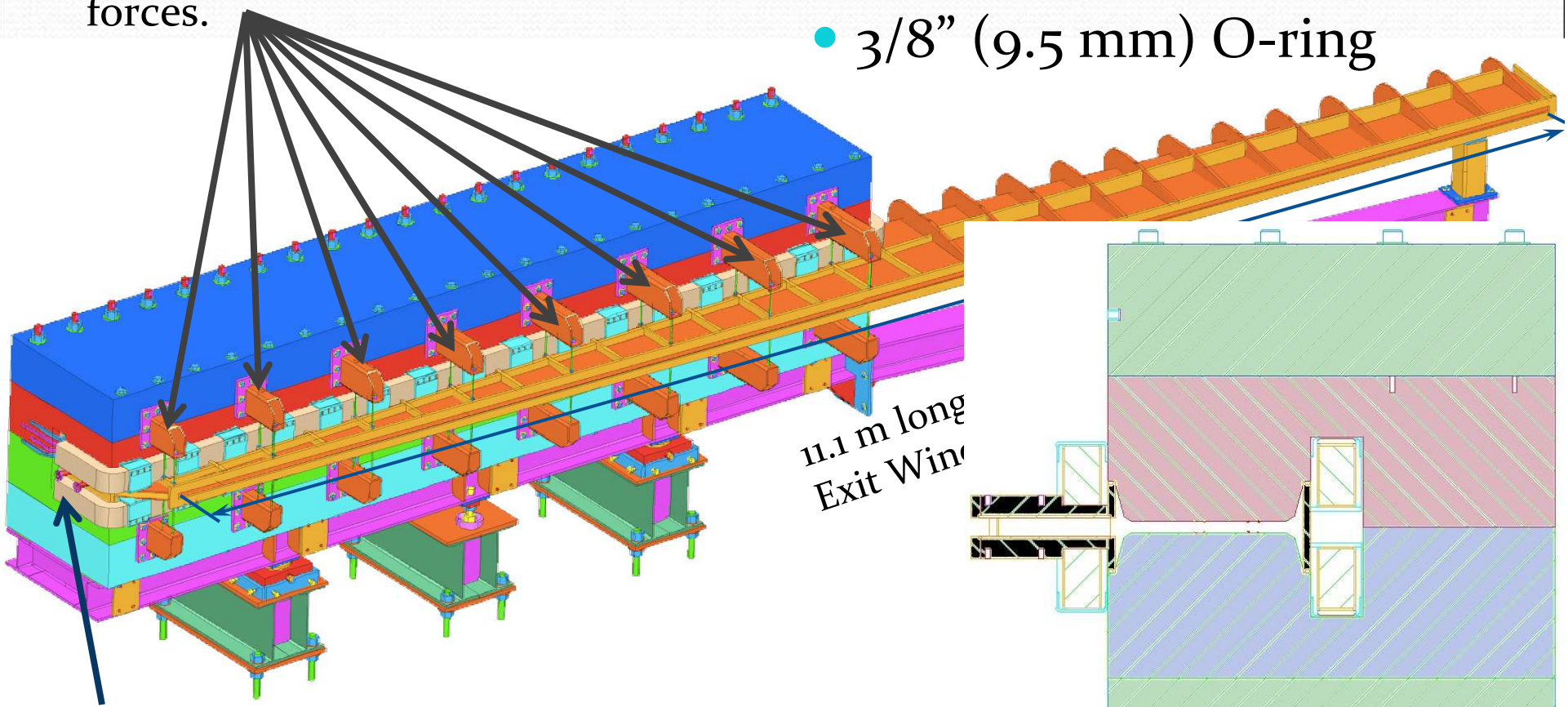




Overview

- 1” reinforcing ribs.
- ¼” Stn.Stl. Shell
  - Max 1 mm deflection
- 3/8” (9.5 mm) O-ring

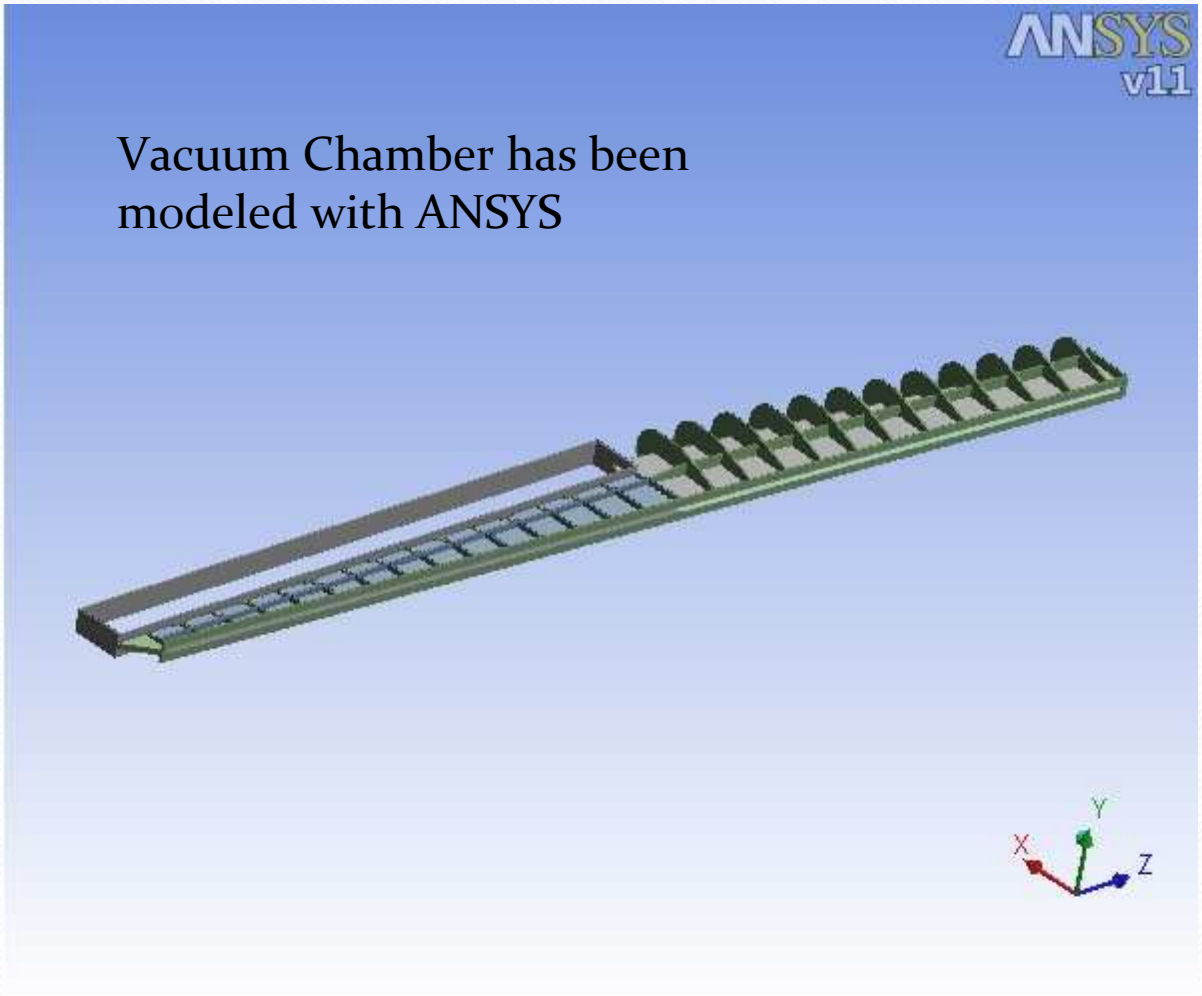
- Brackets to support vacuum forces.



- Two NMR probes for field stabilization and monitoring.

Status of FEA (Vacuum Chamber)

Vacuum Chamber has been modeled with ANSYS

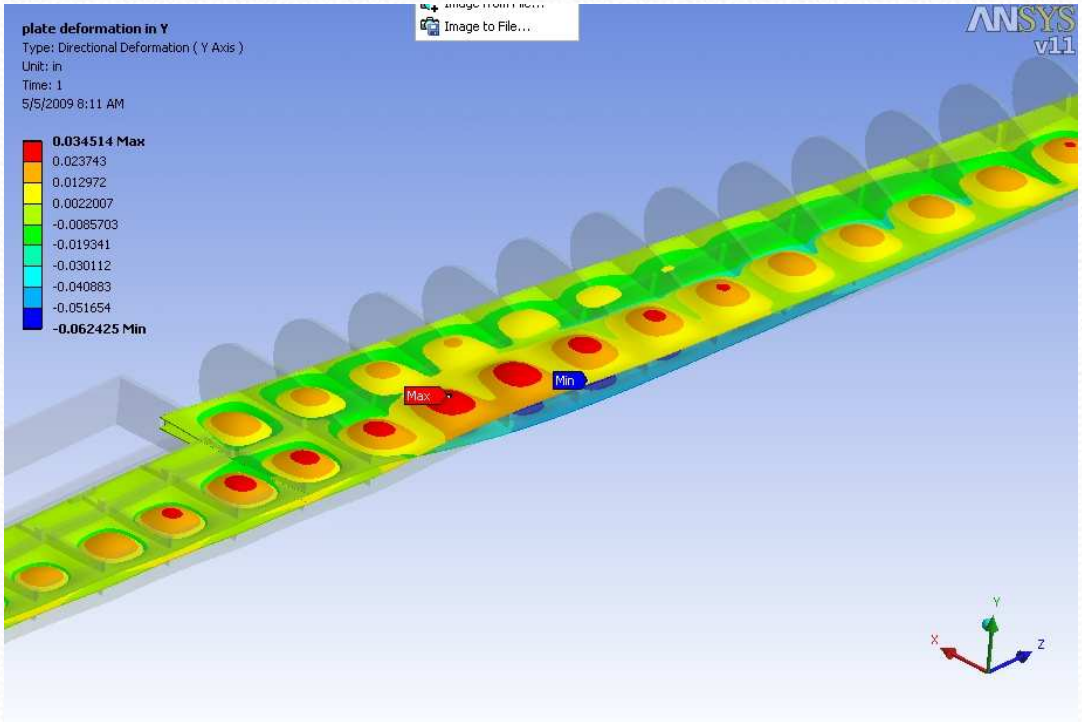


Status of FEA

Deformation of the stainless steel skin due to the vacuum forces has been modeled.

The distance between supports and the thickness of the skin are reasonable.

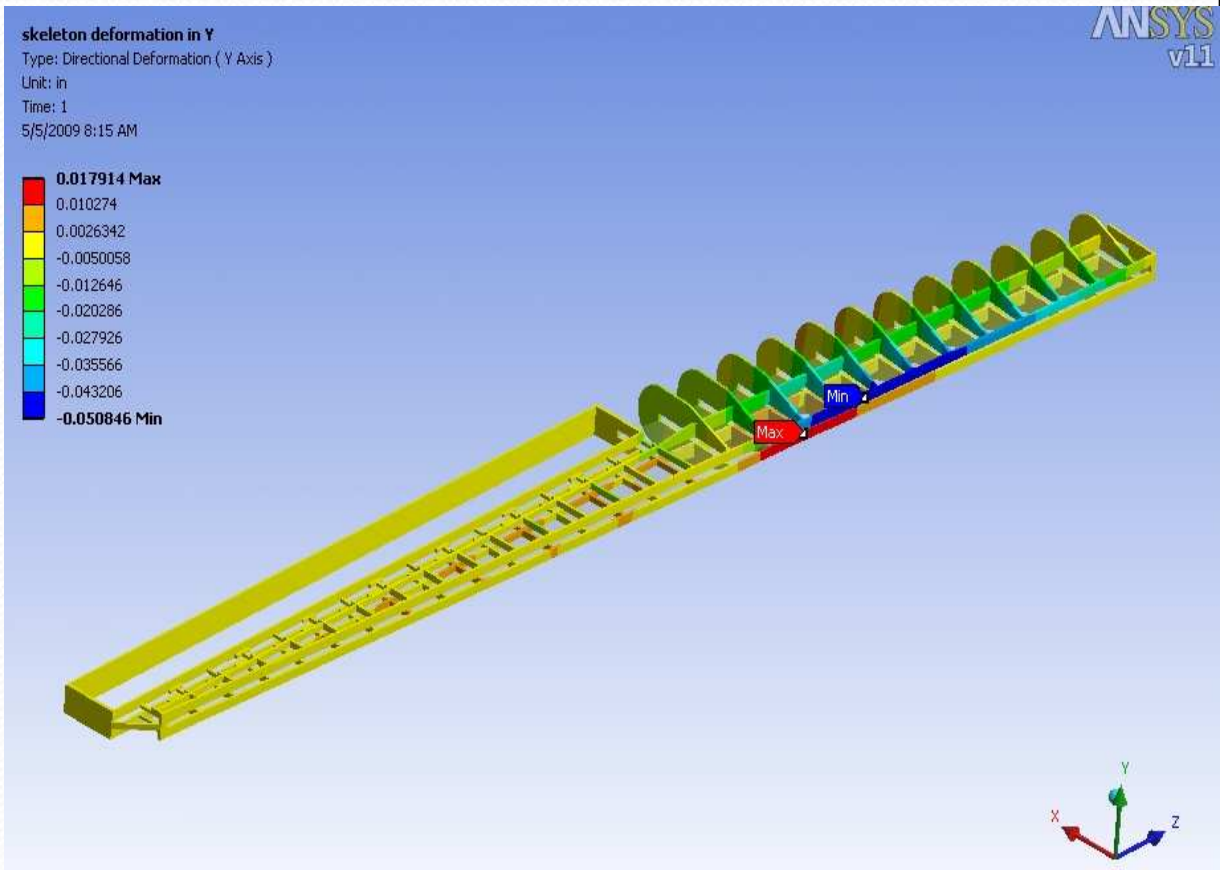
Here maximum deformation of skin is 0.035" (0.9 mm).



Status of FEA

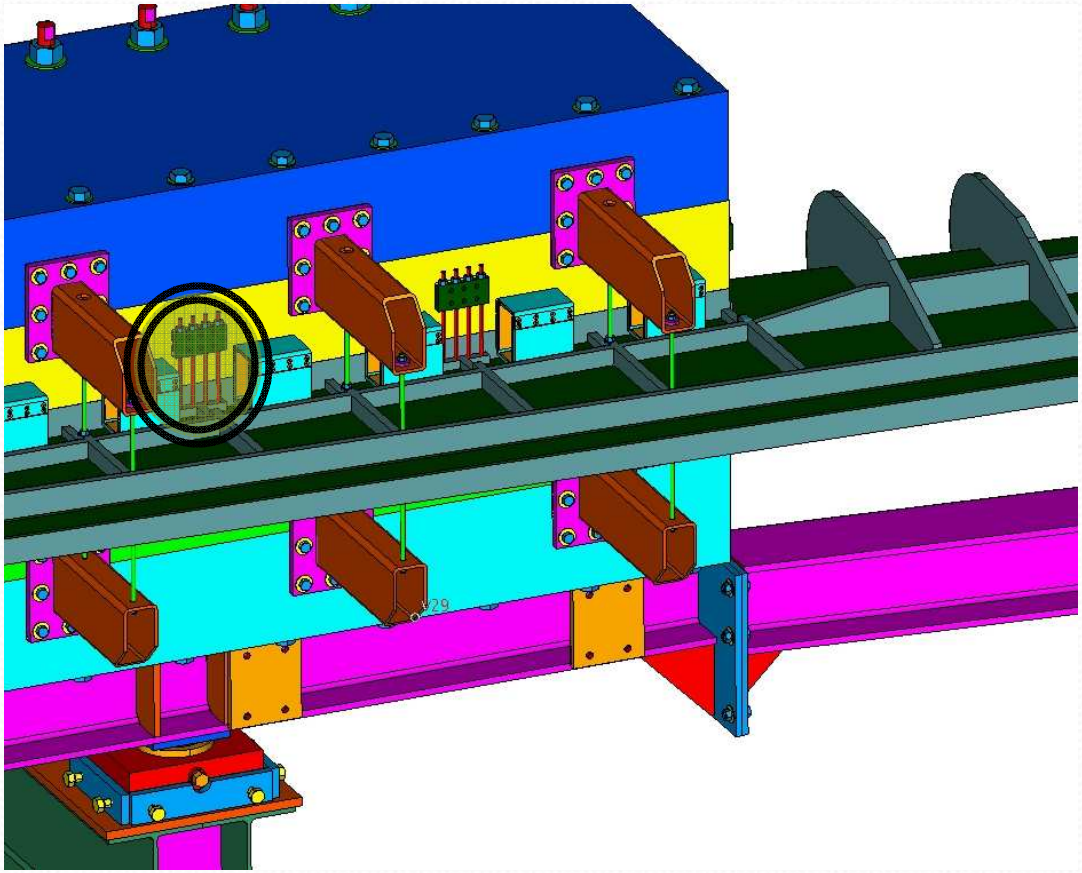
Deformation of the stainless steel window opening.

Here maximum deformation of flange which supports the window is 0.018" (0.5mm).



FEA results

Deflection along o-ring seal was a couple of millimeters. Decided to install support rods similar to the original Glasgow design.

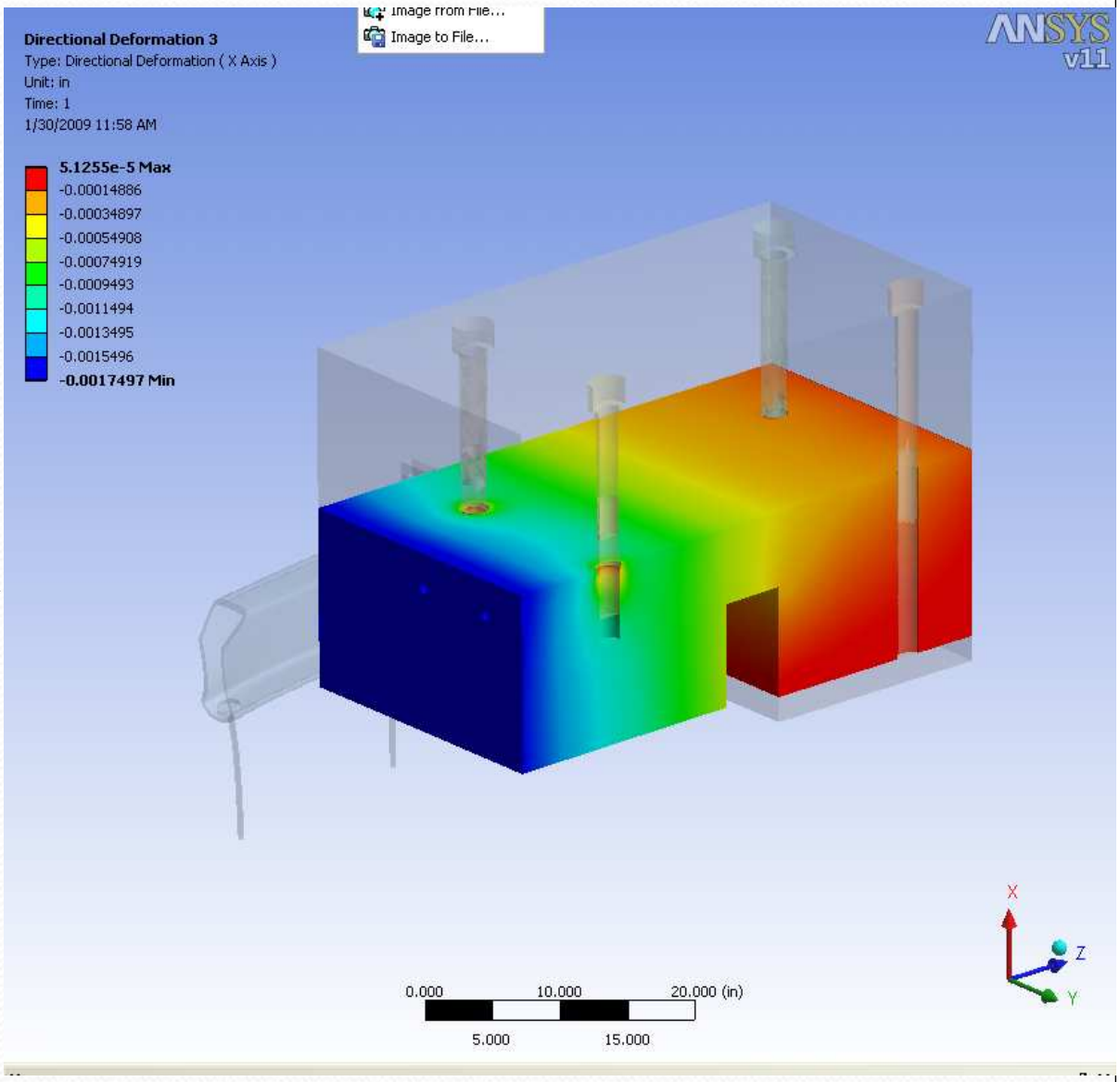


FEA Magnet Yoke

The total force on the poles was taken from Yang's earlier analysis.

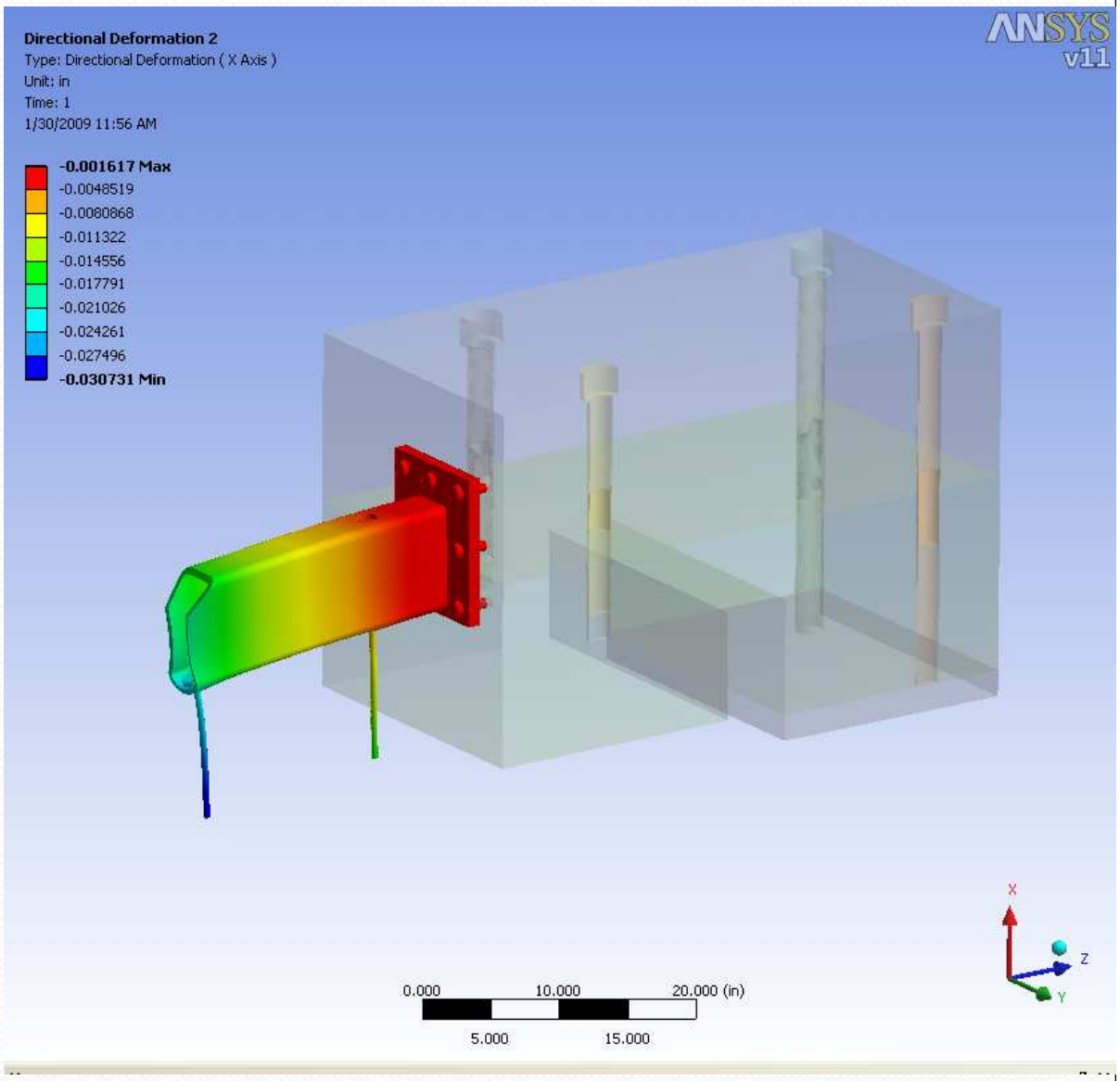
The total deflection of the pole due to magnetic and vacuum forces was computed to be 0.02" (0.05 mm)

The change in gap will be then ~0.1 mm. We should remember that the Mainz magnet had twice the deflection calculated but 0.2 mm would still be good.



FEA Chamber Support Bracket

The deflection of the support bracket was modeled and found to be reasonable.



FE Analysis

- Models are well advanced
- Final results could be available in about a month.
- Would need ~3 months to covert these to a set of documentation acceptable to JLAB as fulfillment of Safety and ES&H requirements.