SiD Muon Yoke Structure
- Deformation Studies -

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Question:

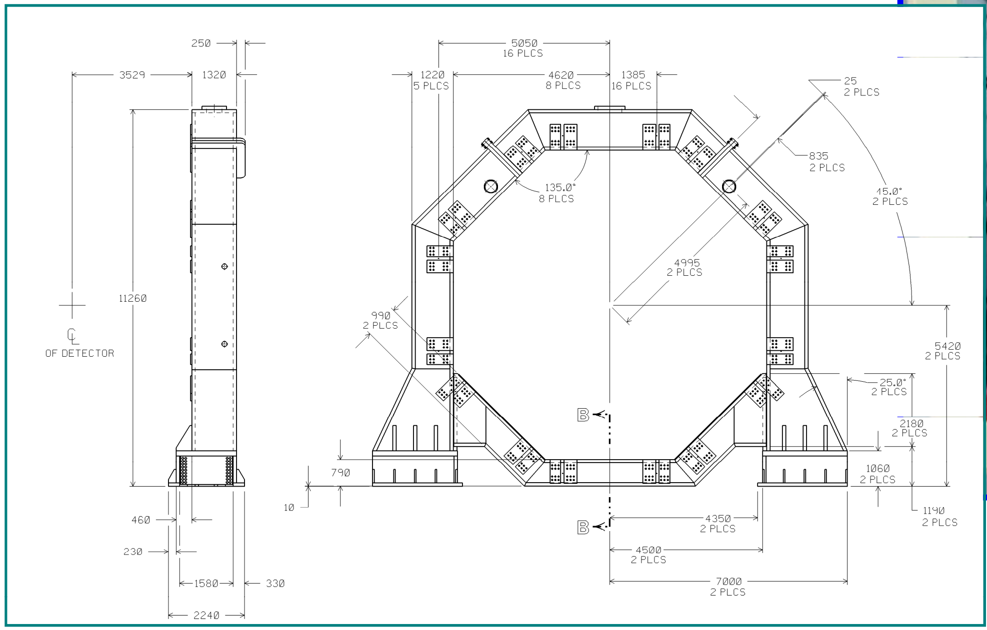
If we move the detector without a platform by lifting with air casters at the corner legs, how much does the central barrel region deform?

Approach:

Create a 3D model design concept of the SiD muon yoke structure similar to that of SLD. Using ANSYS, model the structure and subject it to various asymmetric lifting scenarios.

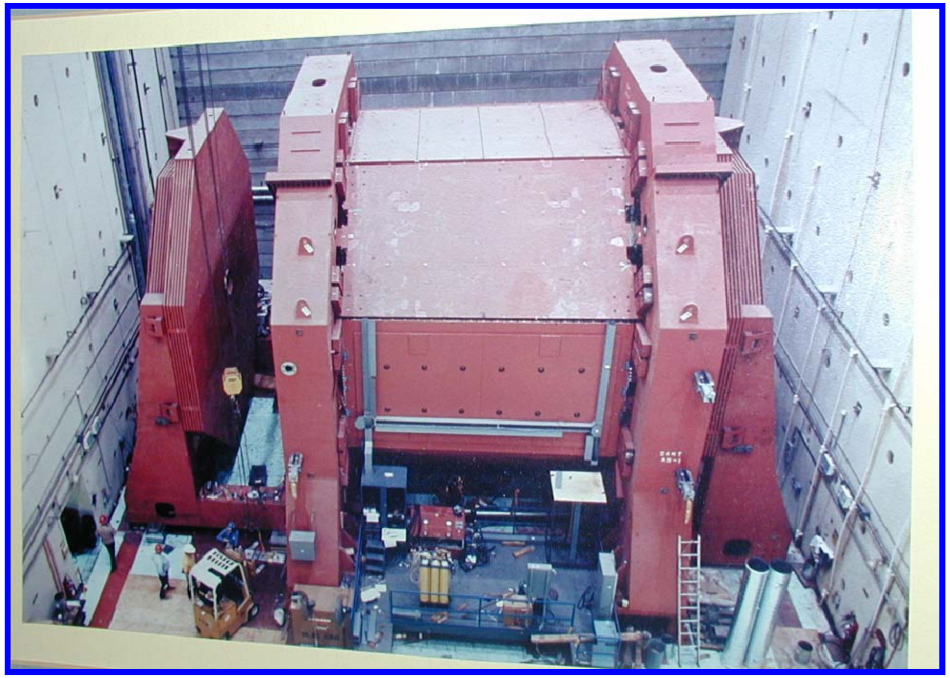
SLD Support Arches

Arch Details:
Hollow structure.
Welded and bolted construction.
A36 plate steel, 4-6” thick.



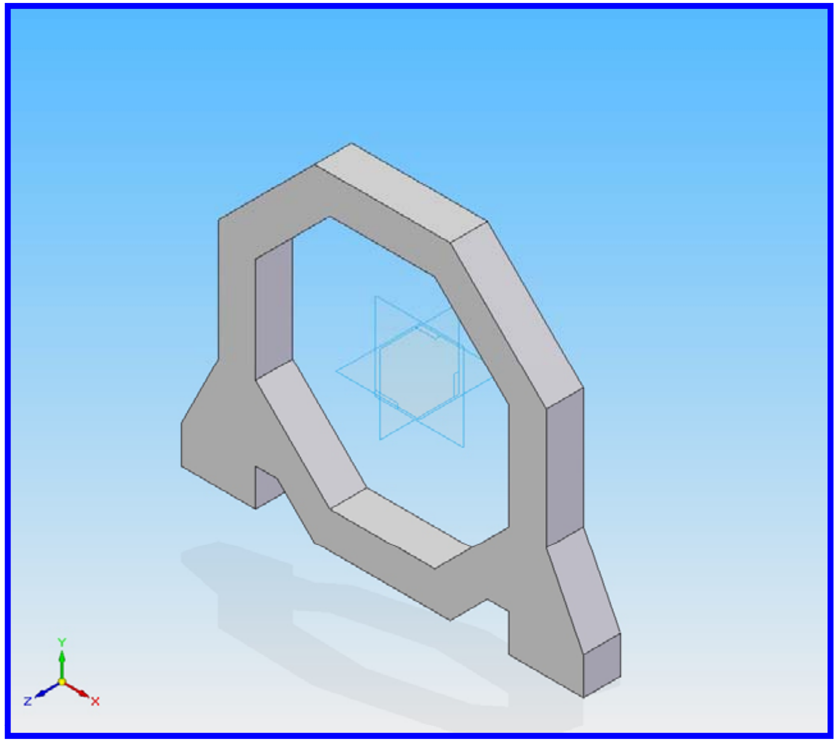
SLD Central Barrel

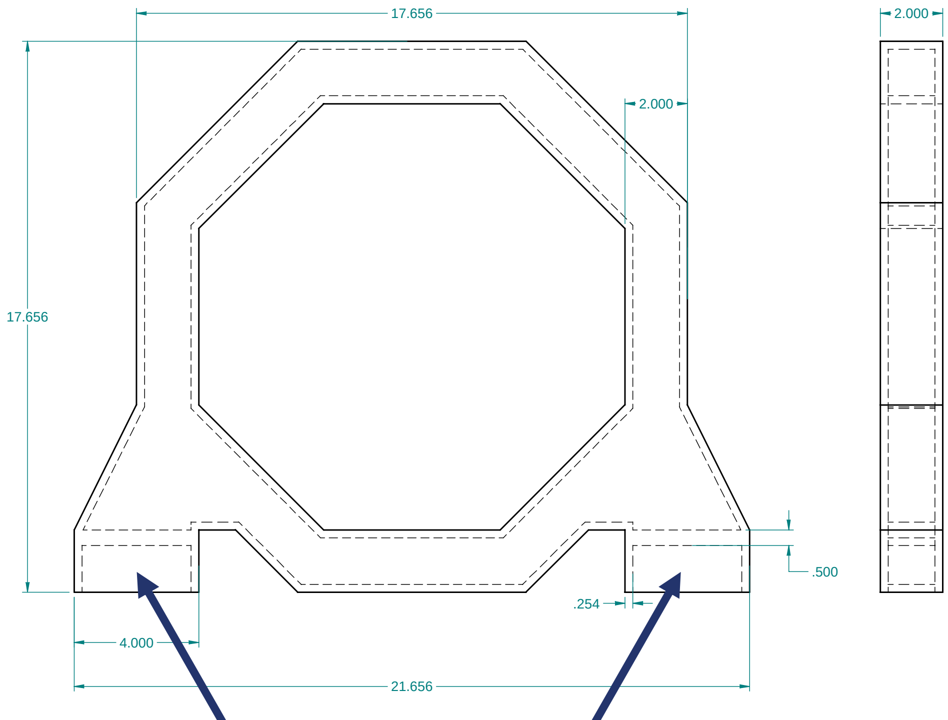
Central Barrel:
Steel plates bolted and welded to support arches in octagonal geometry.



SiD Simple Arch Concept

Arch Details:
Hollow structure.
Welded 10” A36 plate steel.
Weight ~1K tons.

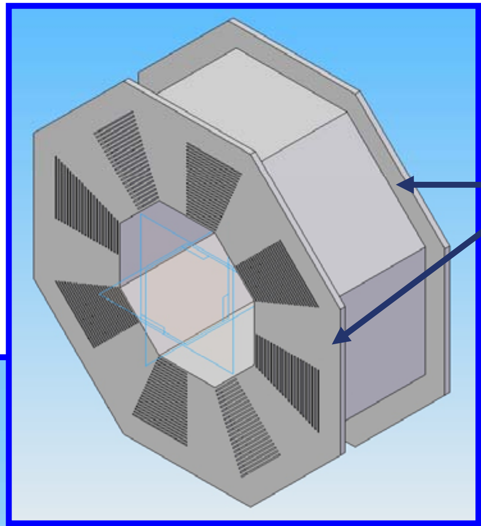


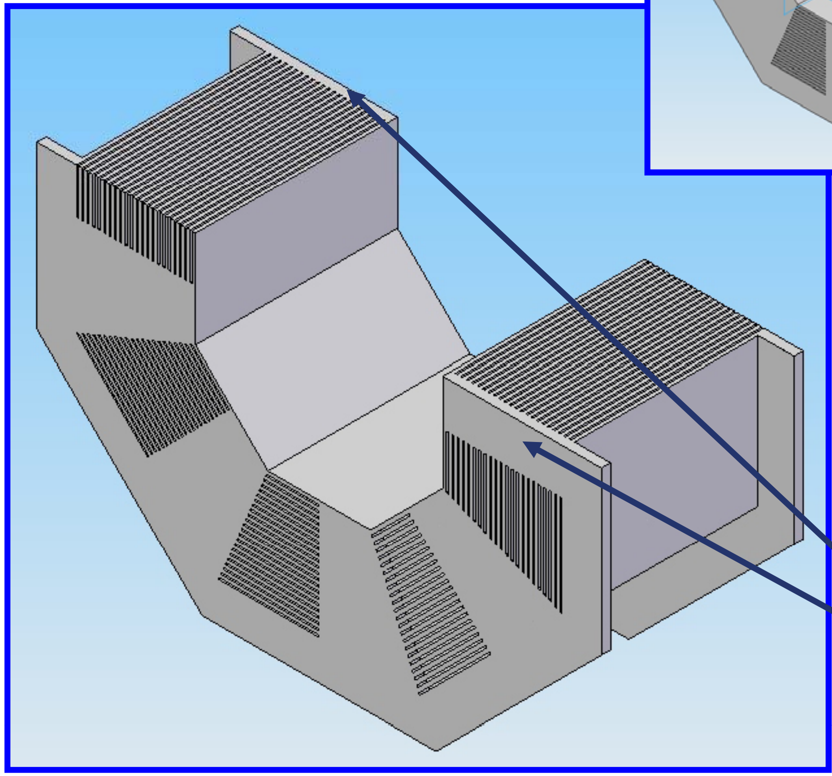


Recess for air casters

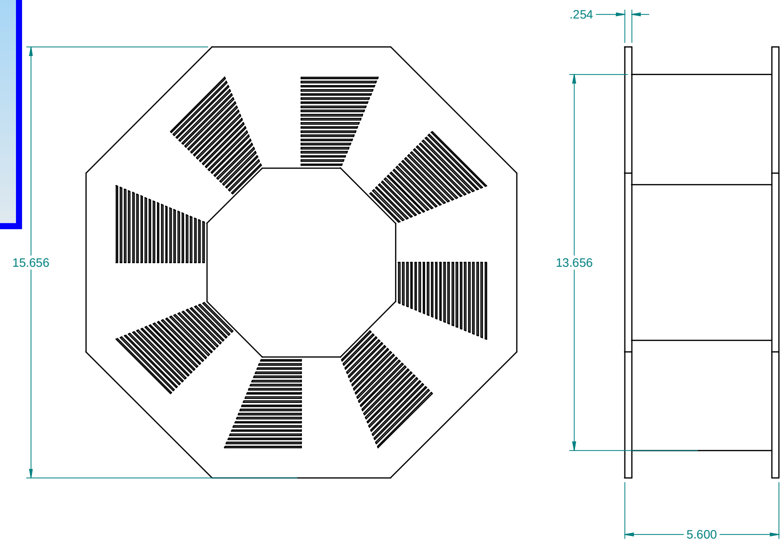
SiD Central Barrel Concept

Central Barrel Details:
23 layers 10cm steel plate.
5 cm gaps between.
Octagonal geometry.
Weight ~4K tons.





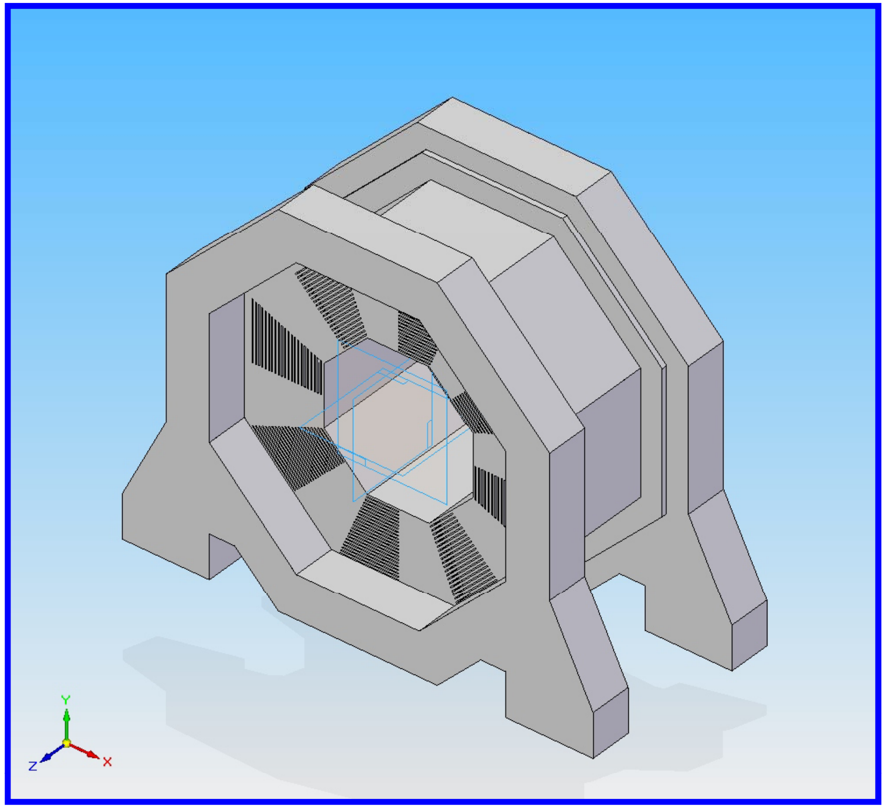
Barrel Flanges: 10” thick steel plate. Connect central barrel to arches.

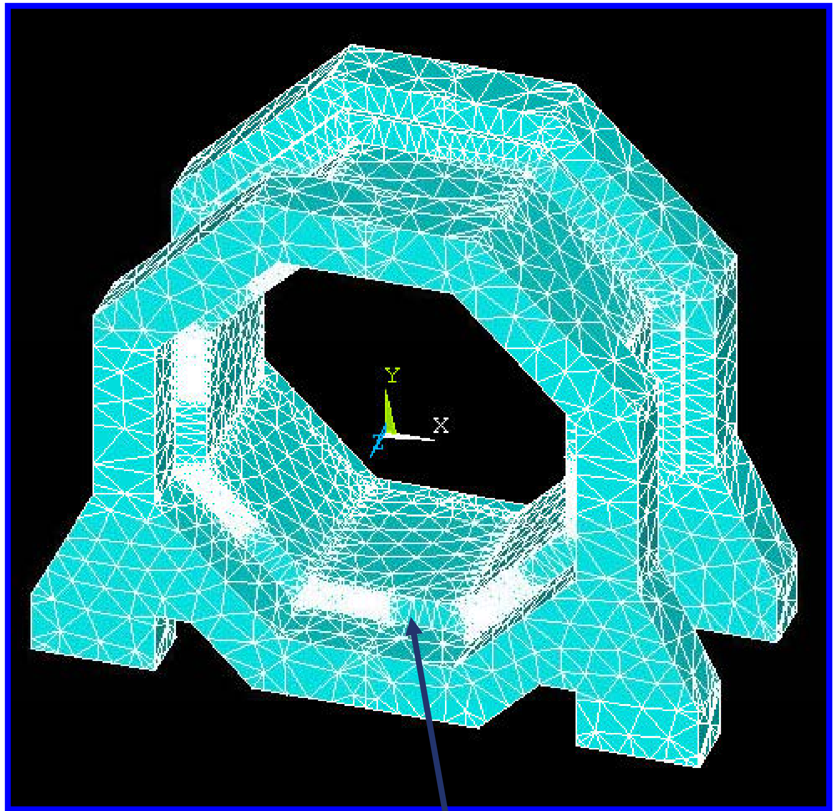


Gusset Plates: 10” thick steel plate cap ends. Connects plates together and to barrel flange. Alternating pattern to allow insertion of muon detectors.

SiD Central Barrel FEA Model

Complete 3D solid model results in FEA mesh which exceeds memory limits. Reduced model to arches, barrel shell and ~1m of central barrel plates.

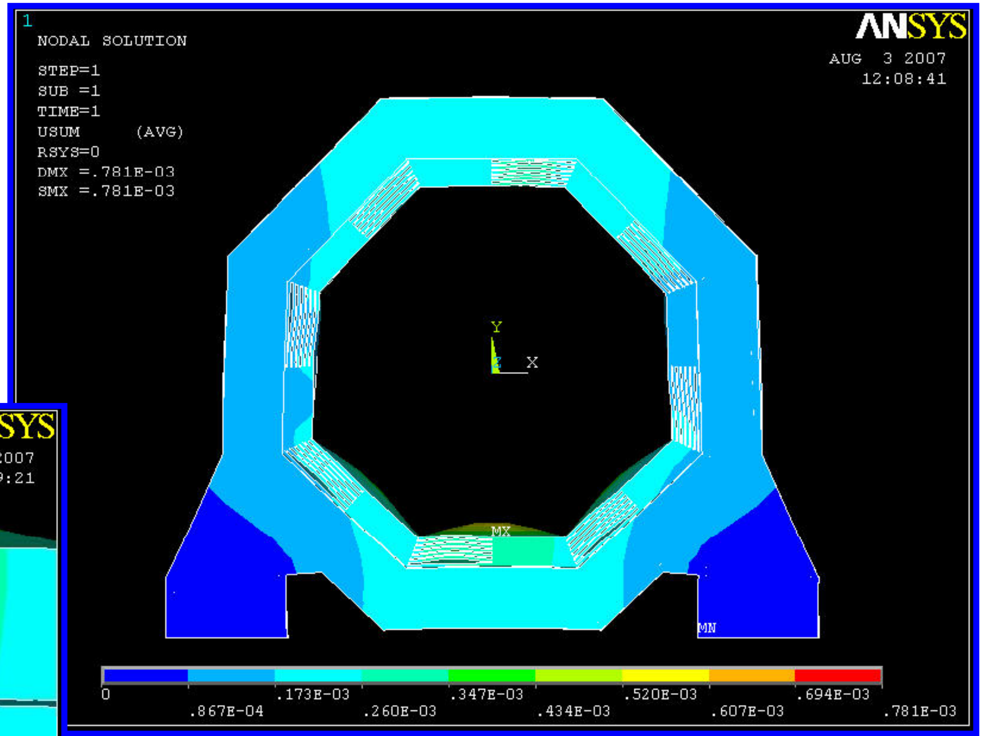


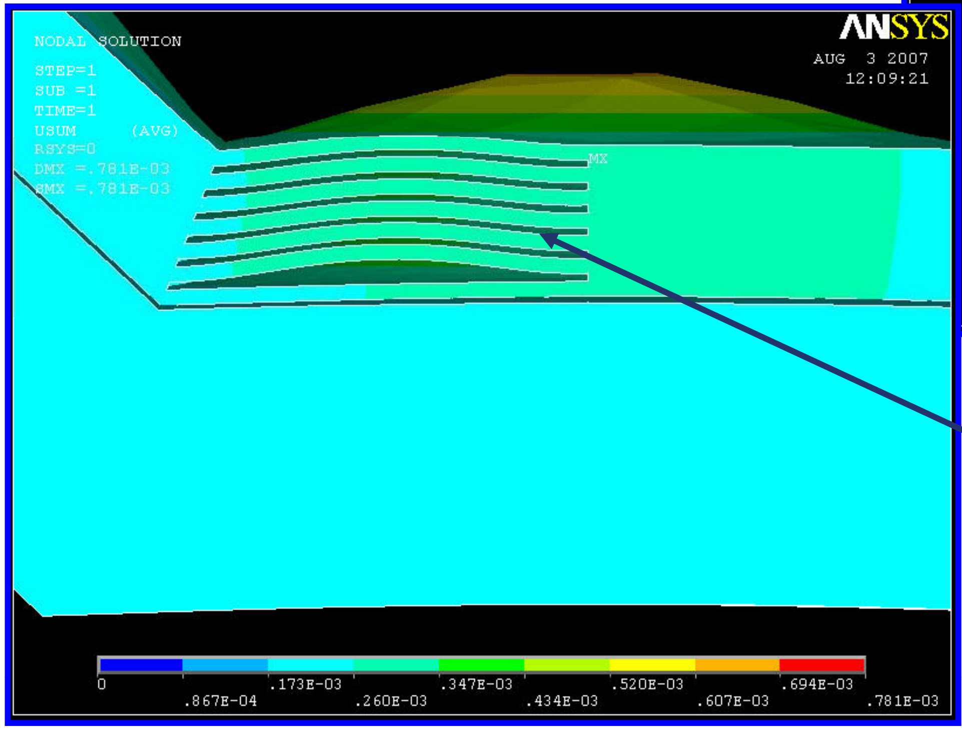


Reduced central barrel weight is ~1.6K tons.

Even Lifting @ 4 Corners

ANSYS Results:
Deformation due to gravity and even lifting at all corners.
Displacement vector sum, units are in meters.



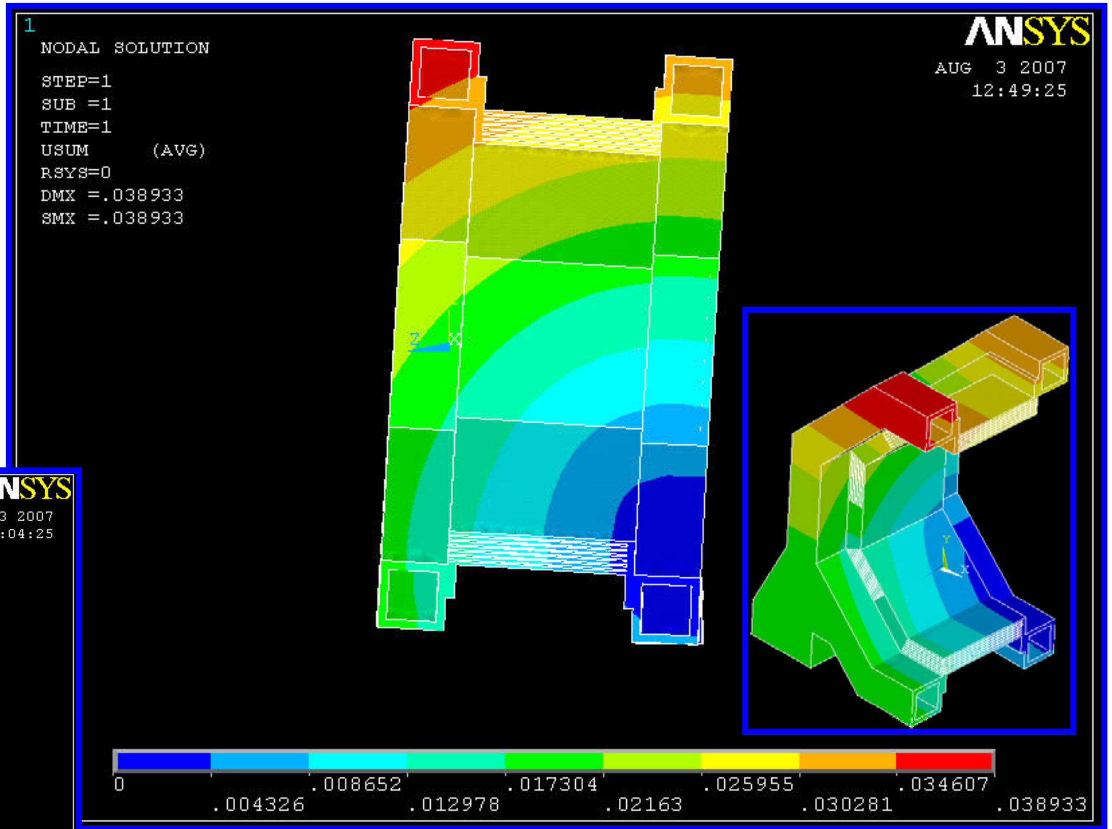


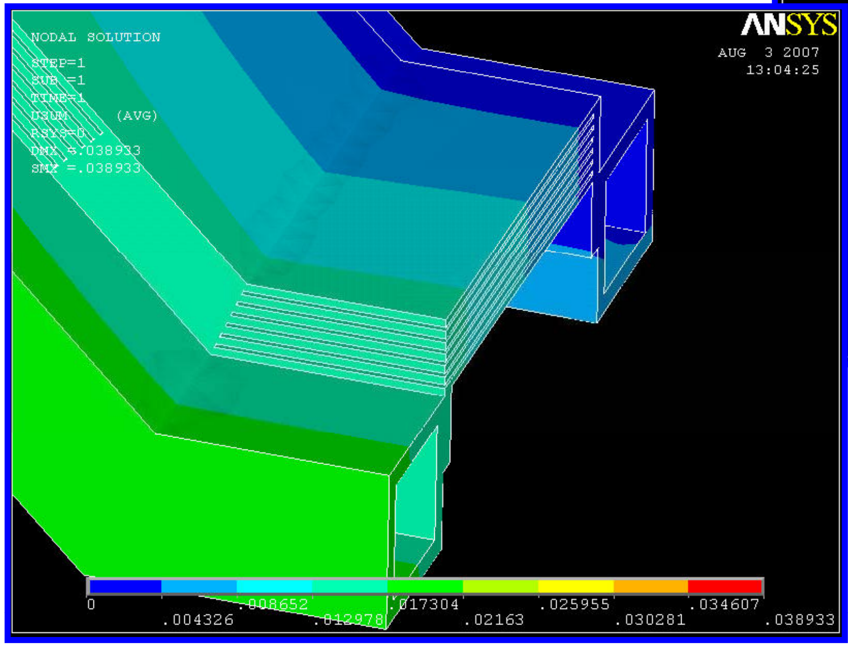
Displacement of plates is ~1mm. Compared to the flatness of the plates when fabricated, this is small.

Scaling exaggerated to show deformation.

Lifting @ Front Corners

Rear corners are anchored. Deformation due to lifting at front corners and gravity. Displacement vector sum, units are in meters.



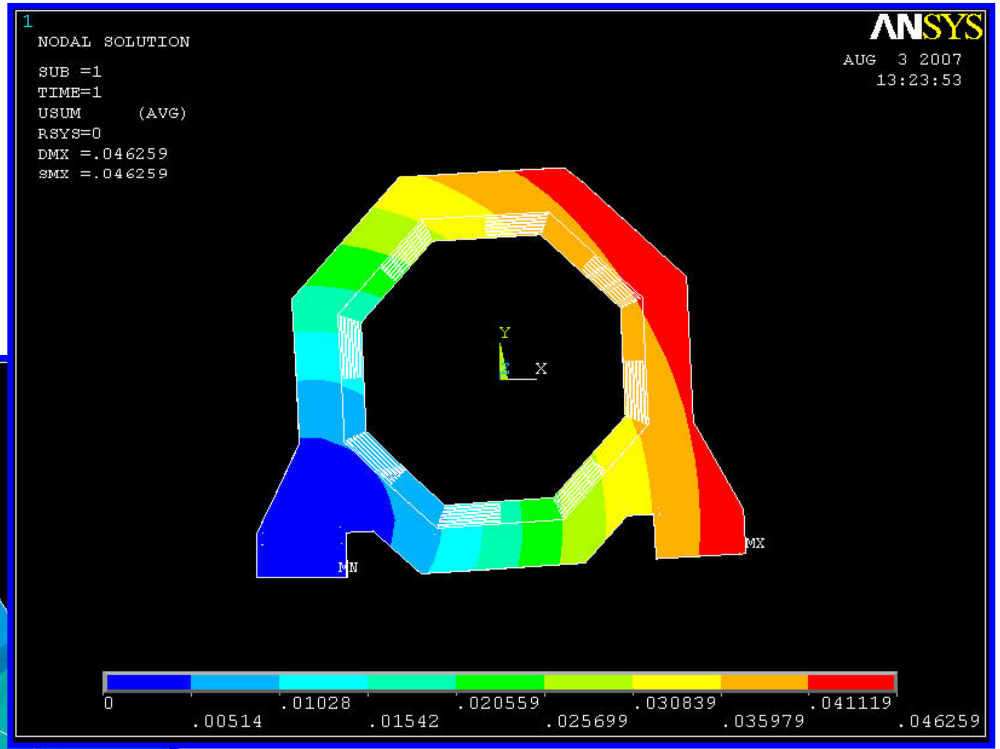


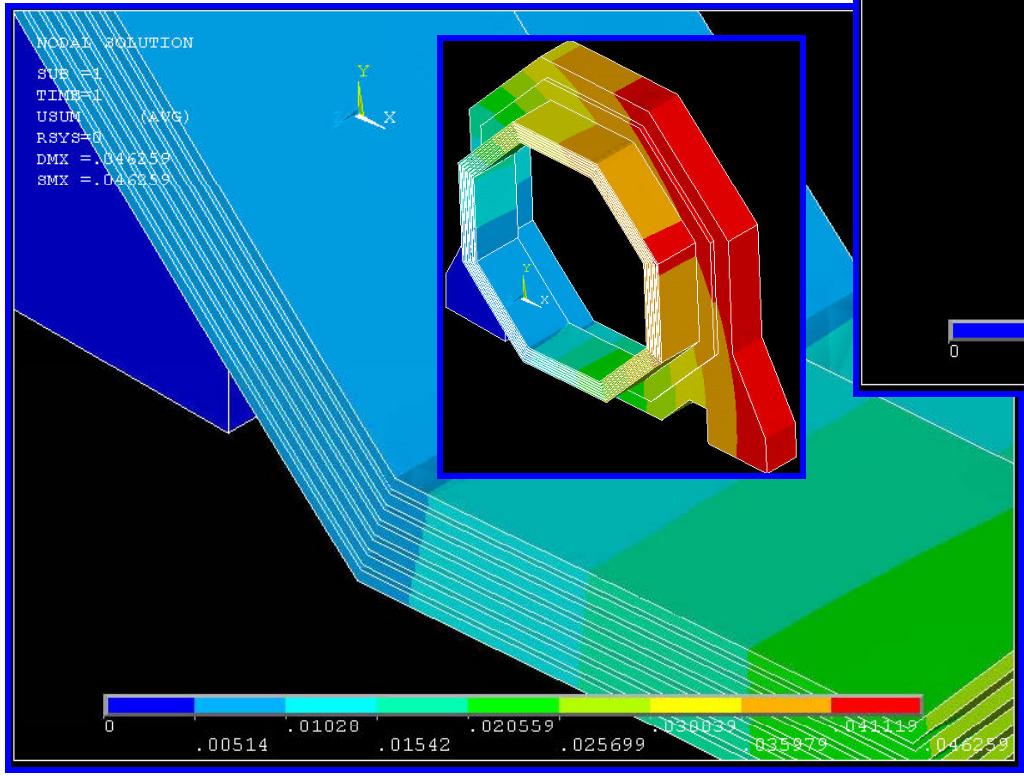
Vector sum displacements seem large (cm), But this is due to the rotation of the detector about the rear legs. The relative displacements of the barrel plates remain small (~1mm).

Scaling exaggerated to show deformation.

Lifting @ Right Corners

Left corners are anchored. Deformation due to lifting at right corners and gravity. Displacement vector sum, units are in meters.





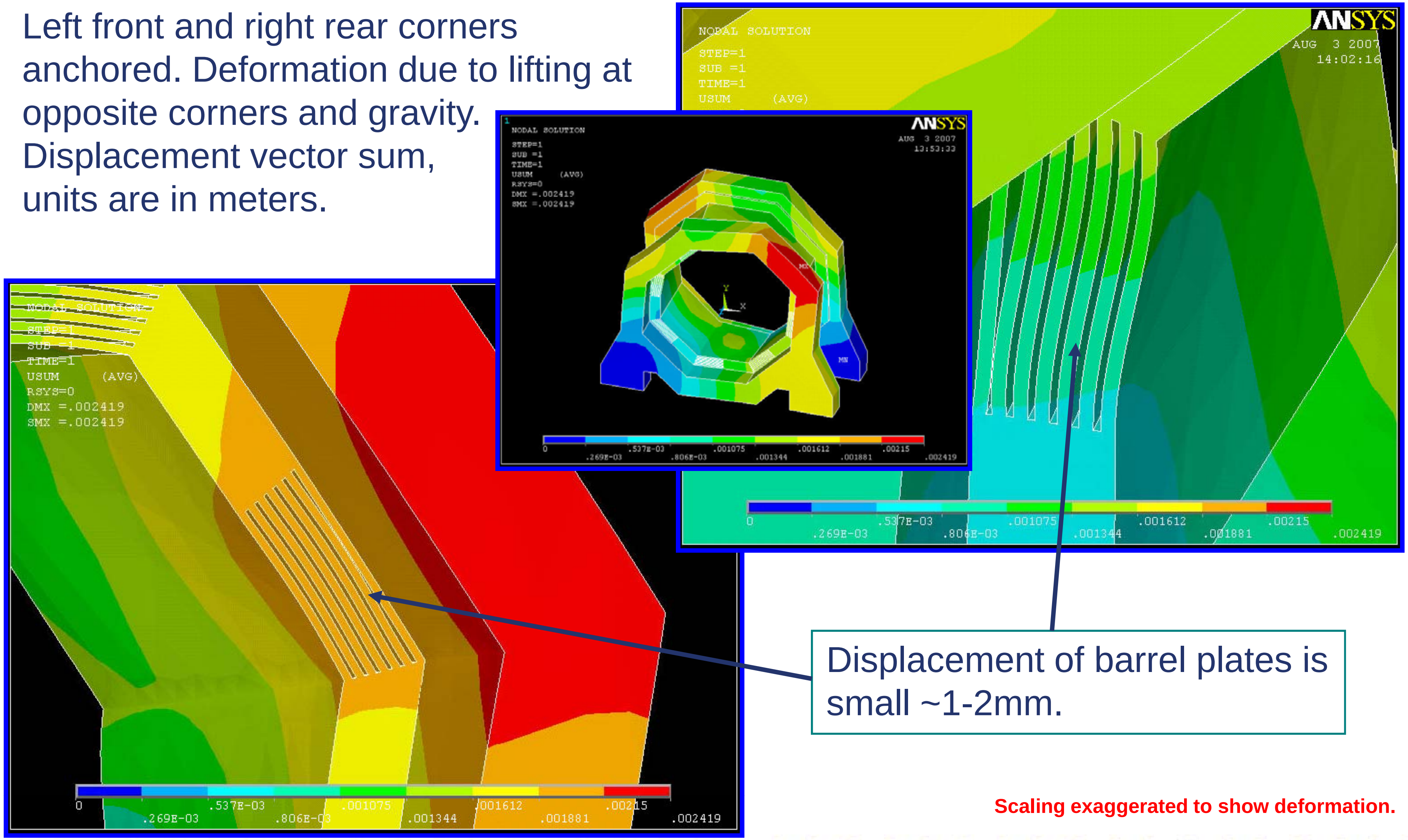
Vector sum displacements seem large (cm), but this is due to the rotation of the detector about the left legs. The relative displacements of the barrel plates remain small (~1mm).

Scaling exaggerated to show deformation.

Lifting @ Opposite Corners

International Linear Collider
at Stanford Linear Accelerator Center

Left front and right rear corners anchored. Deformation due to lifting at opposite corners and gravity. Displacement vector sum, units are in meters.



Displacement of barrel plates is small ~1-2mm.

Scaling exaggerated to show deformation.

For Discussion…

A real detector structure will not be as rigid and may exhibit larger deformations of the central barrel plates. What is an acceptable amount of deformation, 1-2 mm? How well must the alignment with the solenoid, calorimeter, tracker, and vertex detector be maintained during a swap?

The asymmetric lifting scenarios depicted are worst case “disasters” which might occur. Could an MPS system be engineered to prevent such extreme scenarios?

The detector end caps were not modeled at this time. Will they add stiffness to the detector assembly or increase deformation? How will they be attached and moved with the detector?

The design concept does not provide easy access for detector modules. The central barrel will have more segments for access to detector modules. For surface assembly the central barrel and arches must be subdivided to be compatible with the shaft and crane capacities. Will this decrease the stiffness of the detector assembly?