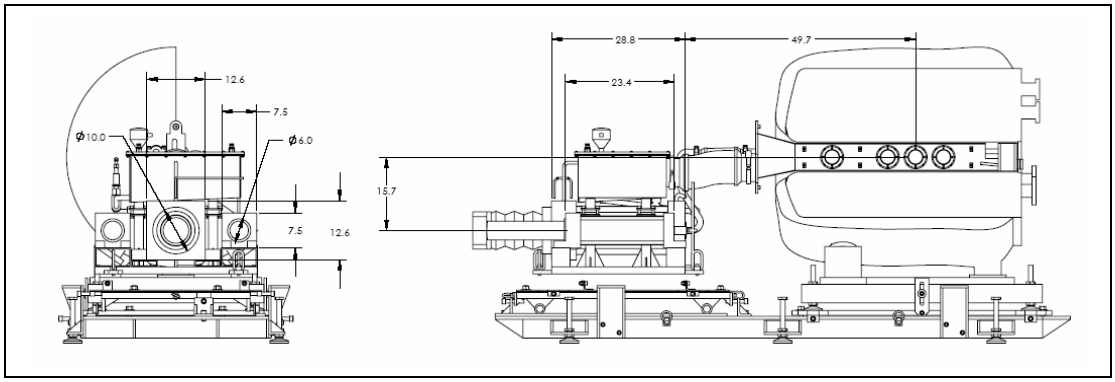
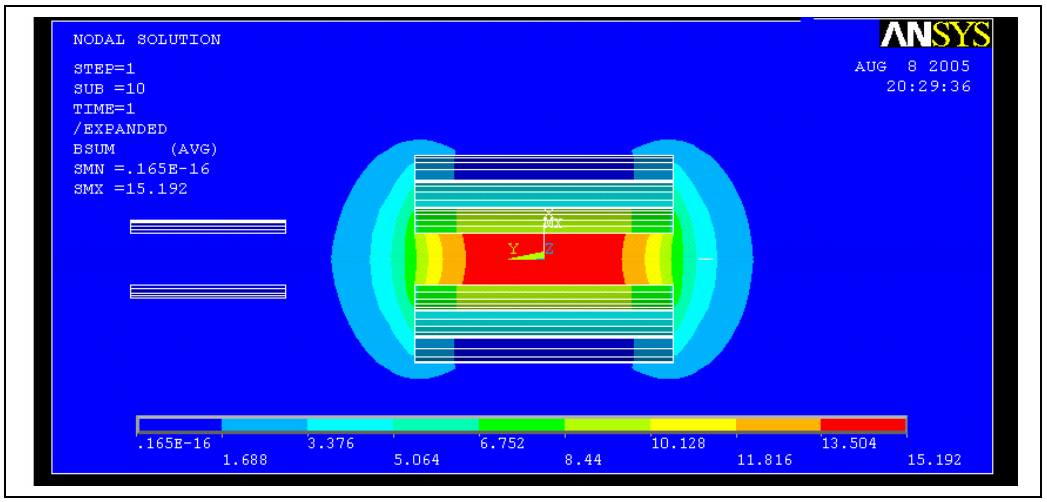
Memo to Van Graves
From: Peter Titus
Subject: Magnetic loads on Mercury Jet Components
Date: August 9 2005

An iron cylinder of .6 m length, an inner radius of .1 m and thickness of .05 m was used to model the inventory of magnetic material in the mercury jet system. The cylinder edge is .5 m from the end of the magnet or 1 m from the centerline of the magnet. The iron modeled, weighs 416 lbs. The magnetic force developed is 57438N or 12900lbs. This would probably be unacceptable for the magnet cold mass supports even if the cylinder could be adequately supported. Do they make aluminum cylinders?

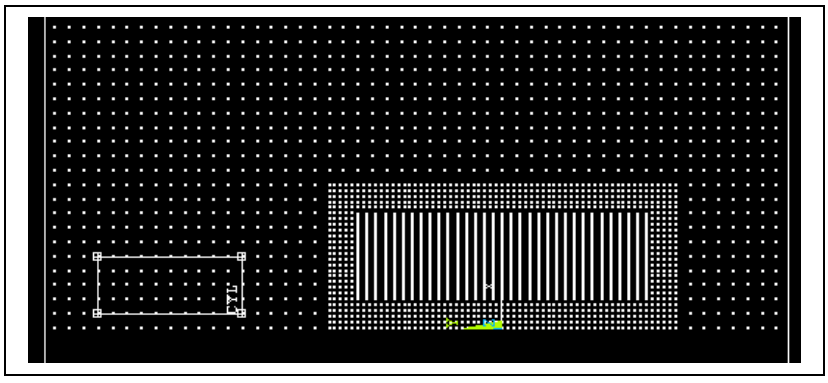


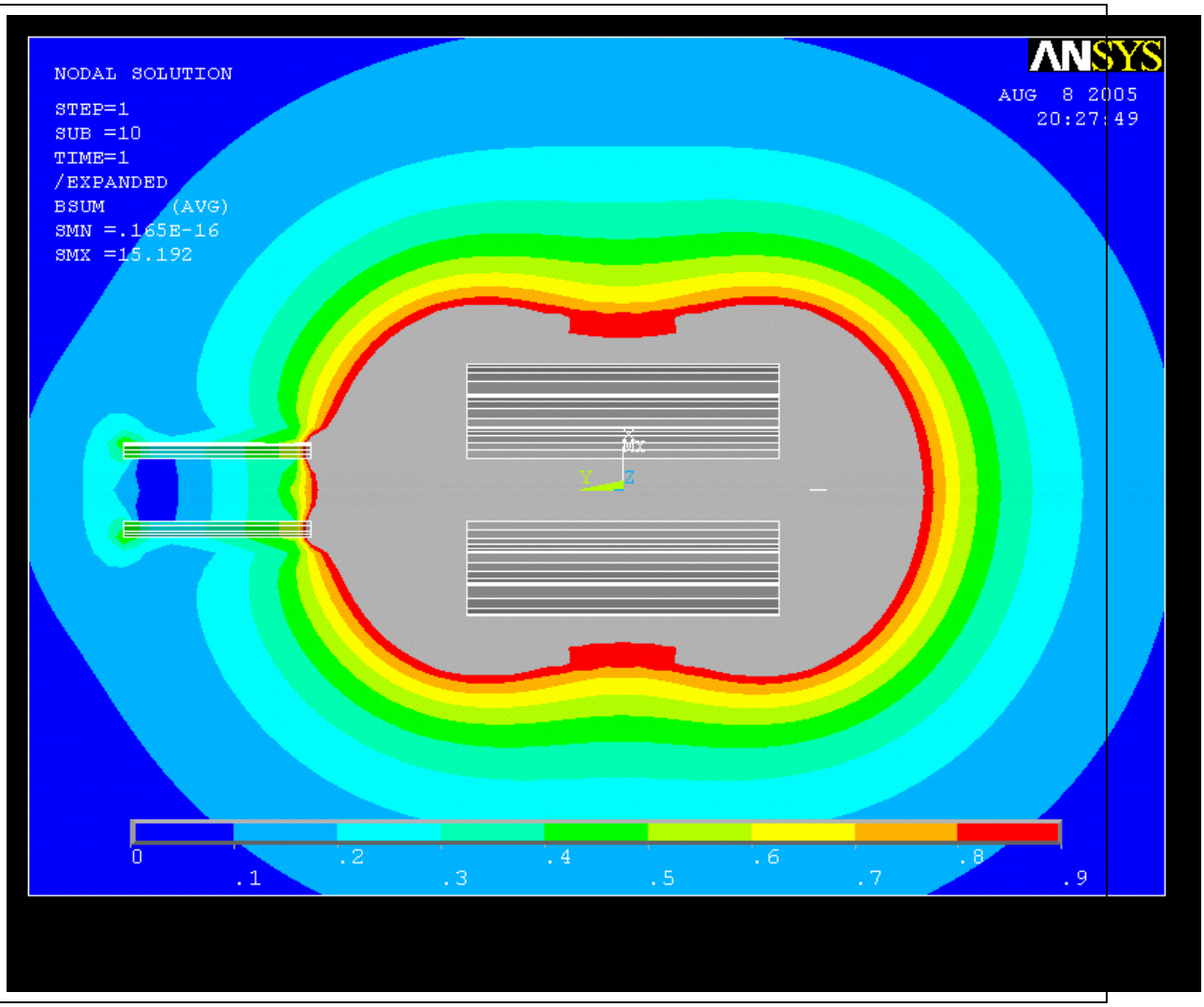


This sounds like a large force, but I am not surprised after experimenting with a small wrench in the bore of one of the coil segments at Everson.. It was being heated by running it with 250 amps DC, and the force was enough to take the wrench out of your hand if you weren't careful. At 15 T there are 3 segments with 7200 amps in them.

Load calculations require a non-linear magnetic solution and a path integral through the air surrounding the iron. This is done with an ANSYS macro, FOR2D.

The path is defined in the graphic user interface.





ANSYS output for the FOR2D Macro:

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 ___SUMMARY OF FORCE CALCULATIONS BY
MAXWELL STRESS TENSOR____

 Force in x-direction = 1138.51061 N/m.

 Force in y-direction = -57438.5828 N/m.
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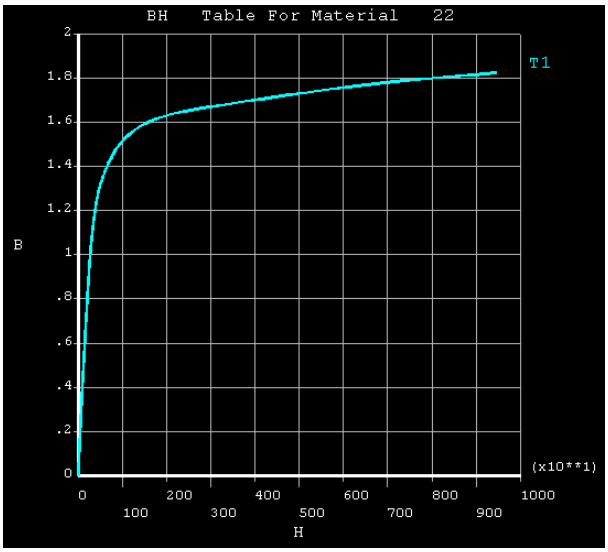
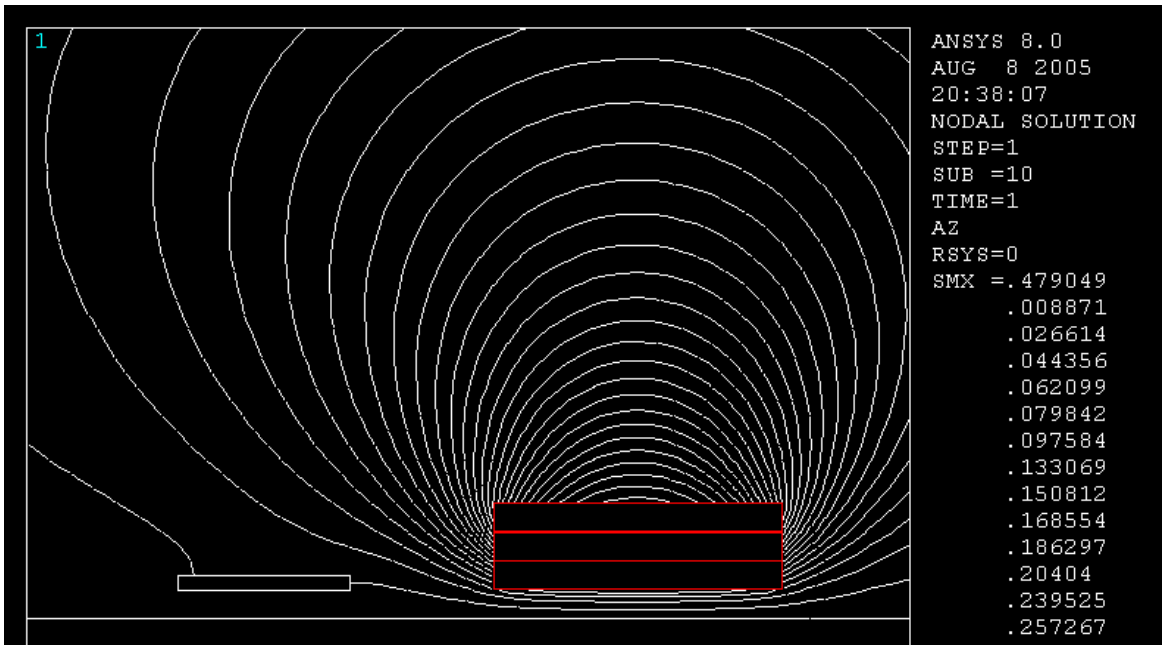
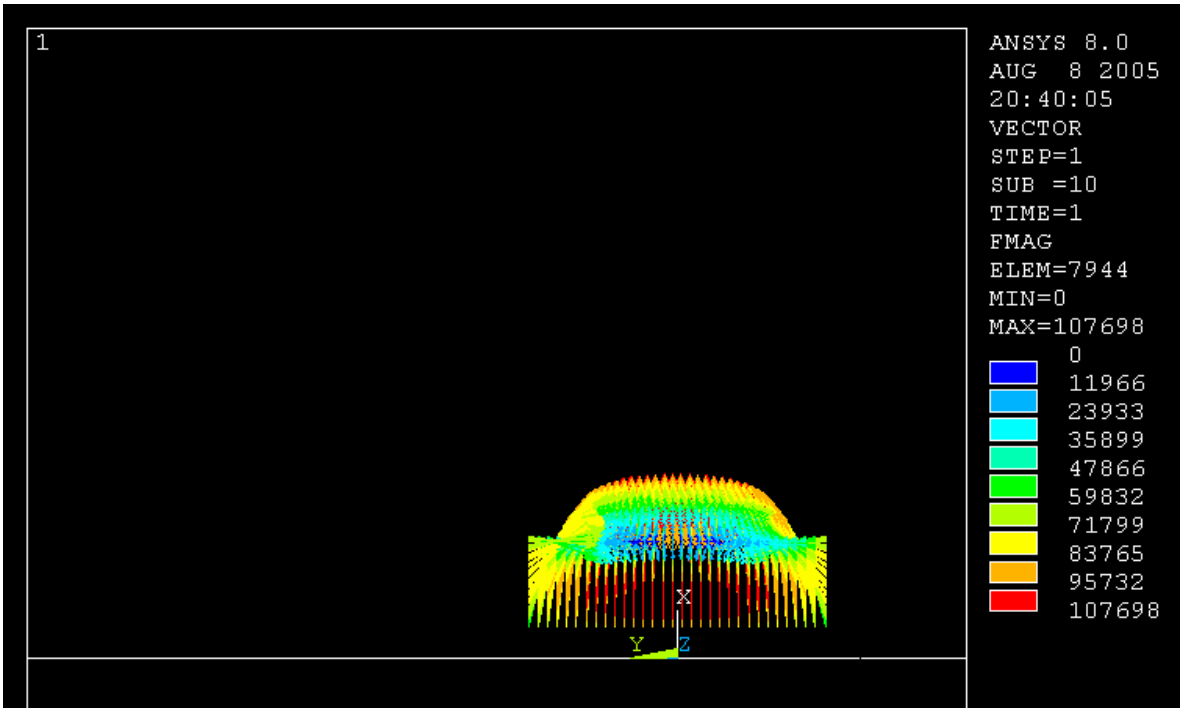
In this model, the x direction is radial and the y direction is axial The N/m unit is somewhat of a mystery because the macro should compute the force integrated over 2*pi and the units should be in N for an axisymmetric model, The N/m unit is probably an error in the macro. But the magnitude of the force would be similar if multiplied by the cylinder circumference.



Iron B-H curve used for the cylinder



Flux plot with the iron cylinder included



Coil Lorentz Forces. This should show some shift to the left to equilibrate the attractive load on the iron