NOVA Double Dipole Magnet

(Conceptual Design)

V. Kashikhin, May 18, 2007

Variant I. Magnet without ferromagnetic shield

Magnet parameters:

Distance between beams	158.8 mm
Integrated strength	0.56954 T-m
Air gap	50.8 mm
Good field area width	101.6 mm
Permanent magnets	SmCo5 (Br=0.8655T, Hc=-662kA/m)
Center field	0.278 T
Effective length	2.049 m
Magnet dimensions	
Width	220 mm
Height	90 mm

Permanent magnet volume 9.8x10^6 mm3 (600 cu. Inches)

Permanent magnet cost/dipole at 30$/cu. inch) 18 k$

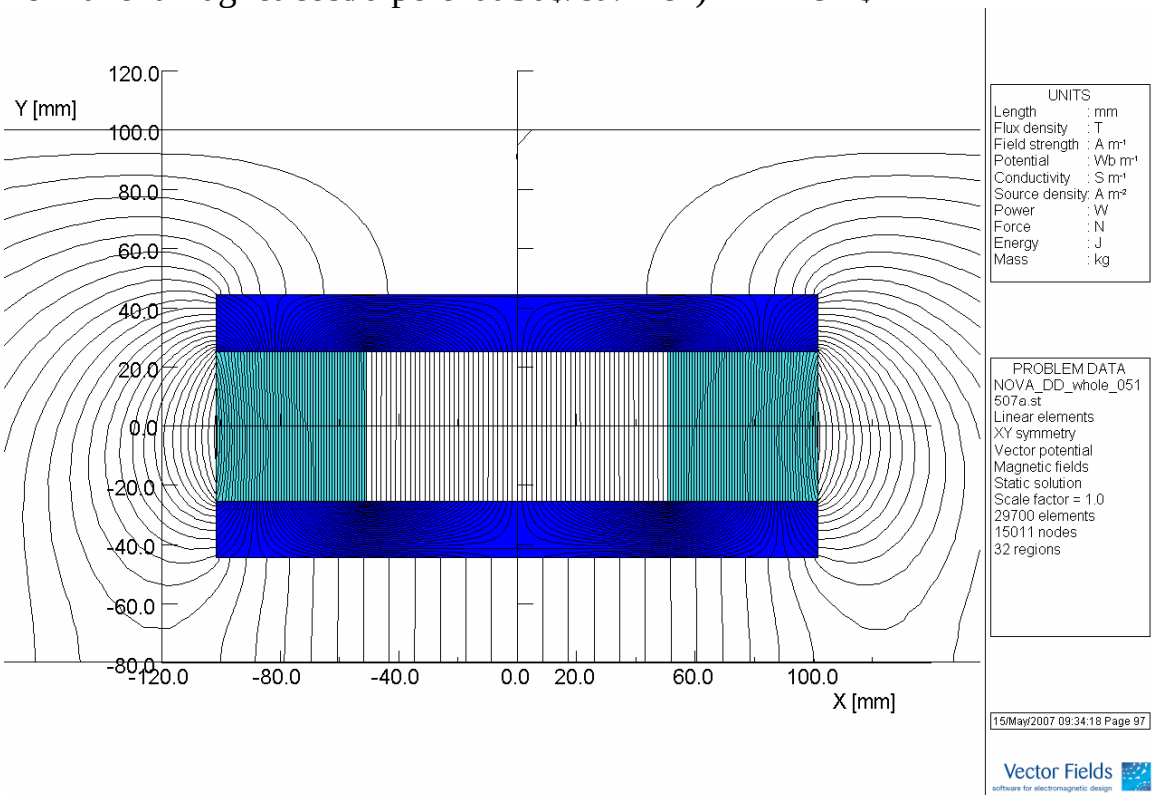

Fig. 1. Magnet cross-section and flux lines.

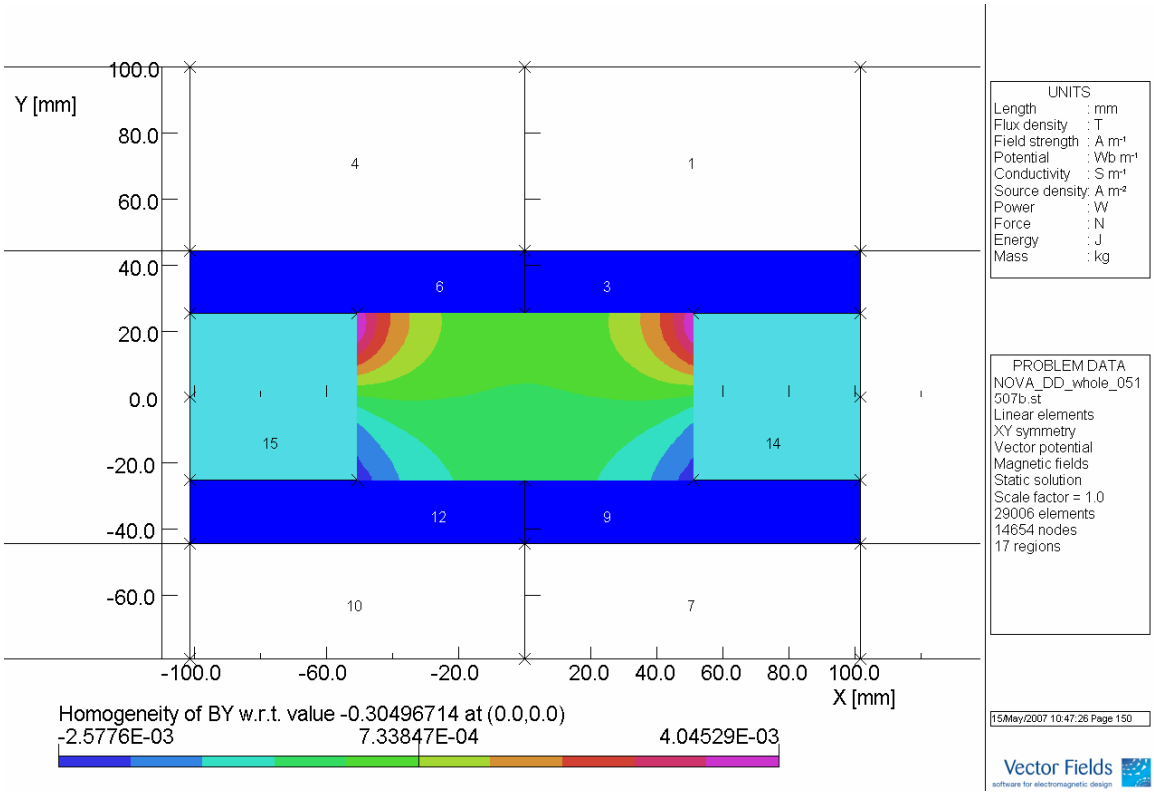

Fig. 2. Field homogeneity.

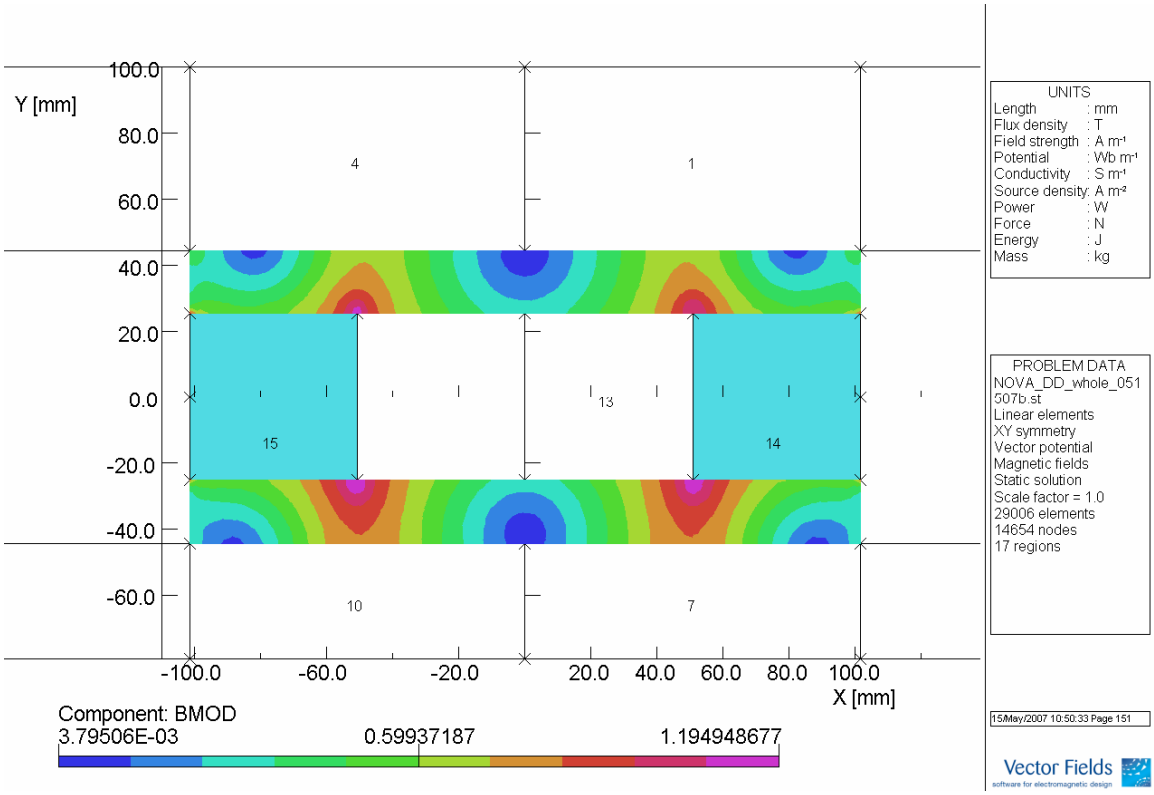

Fig. 3. Iron yoke flux density.

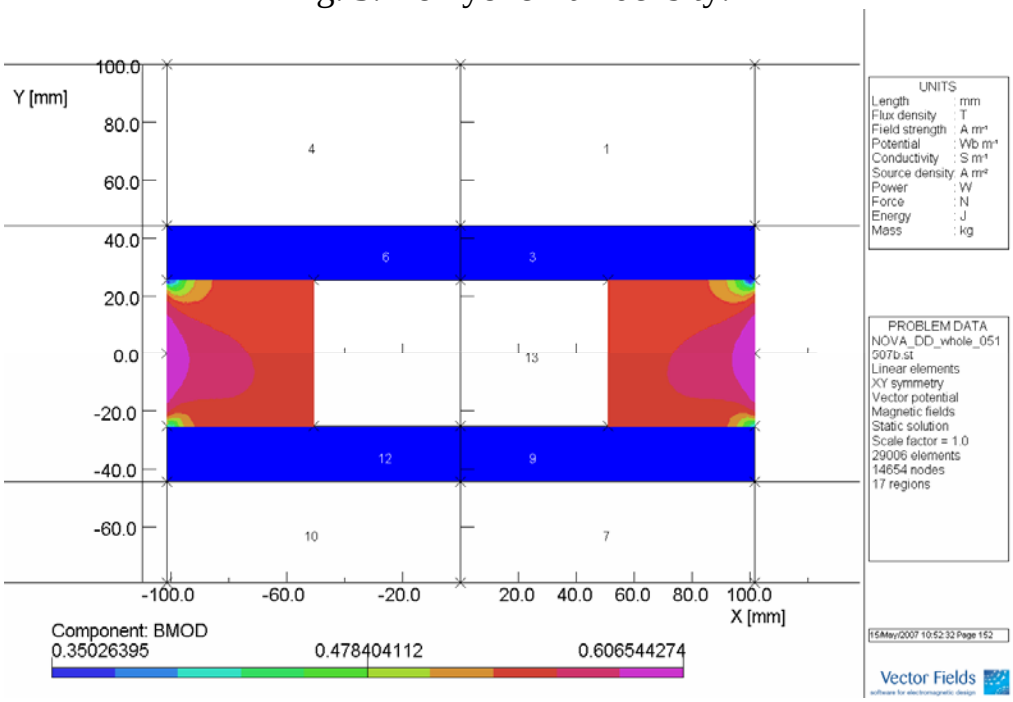

Fig. 4. Permanent magnet flux density.

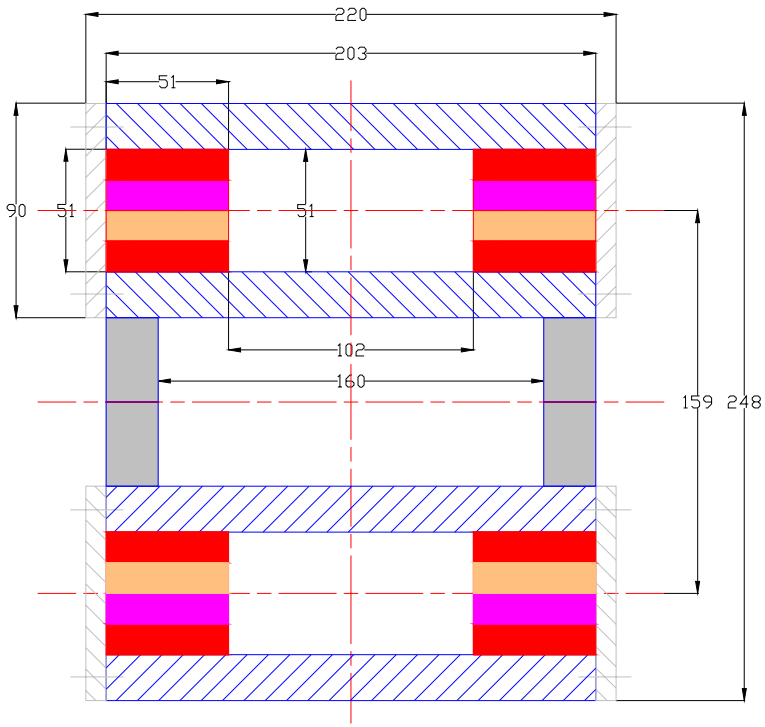

Fig. 5. Double magnet cross-section.

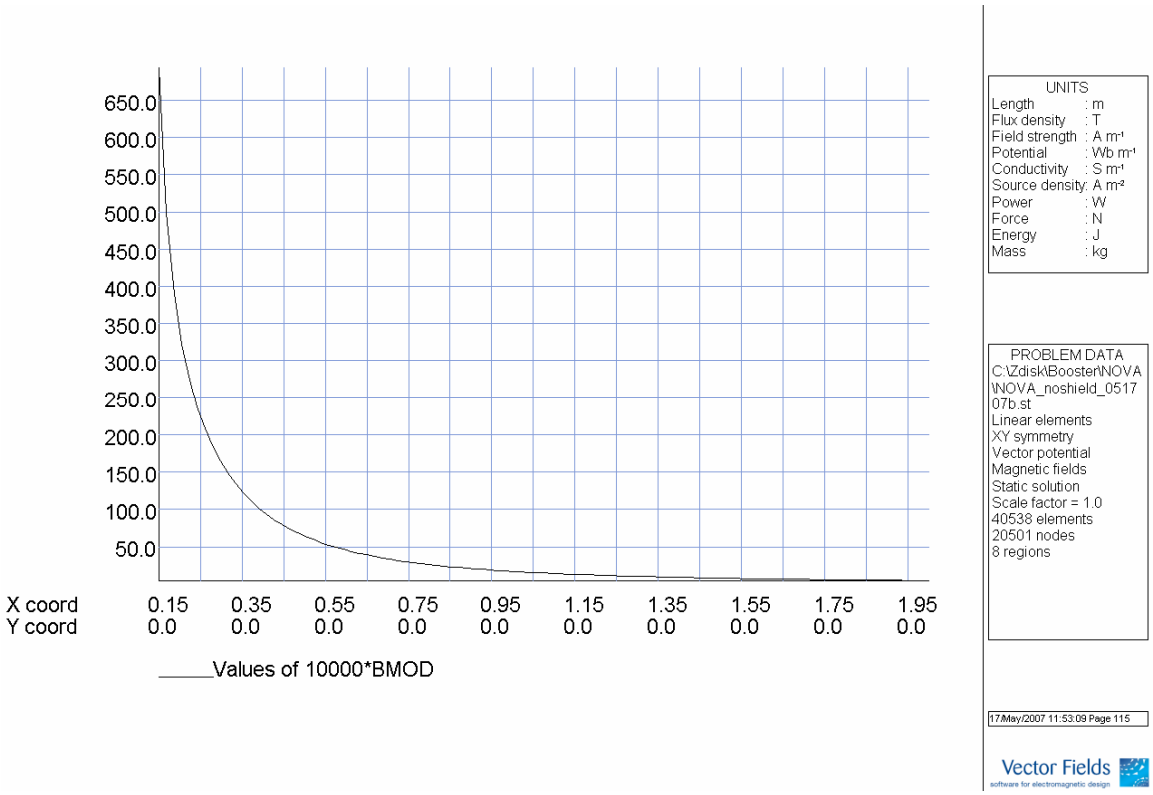

Fig. 6. Magnet fringing field in median plane (Gauss). 800 Gauss is a level of “bullet” effect.

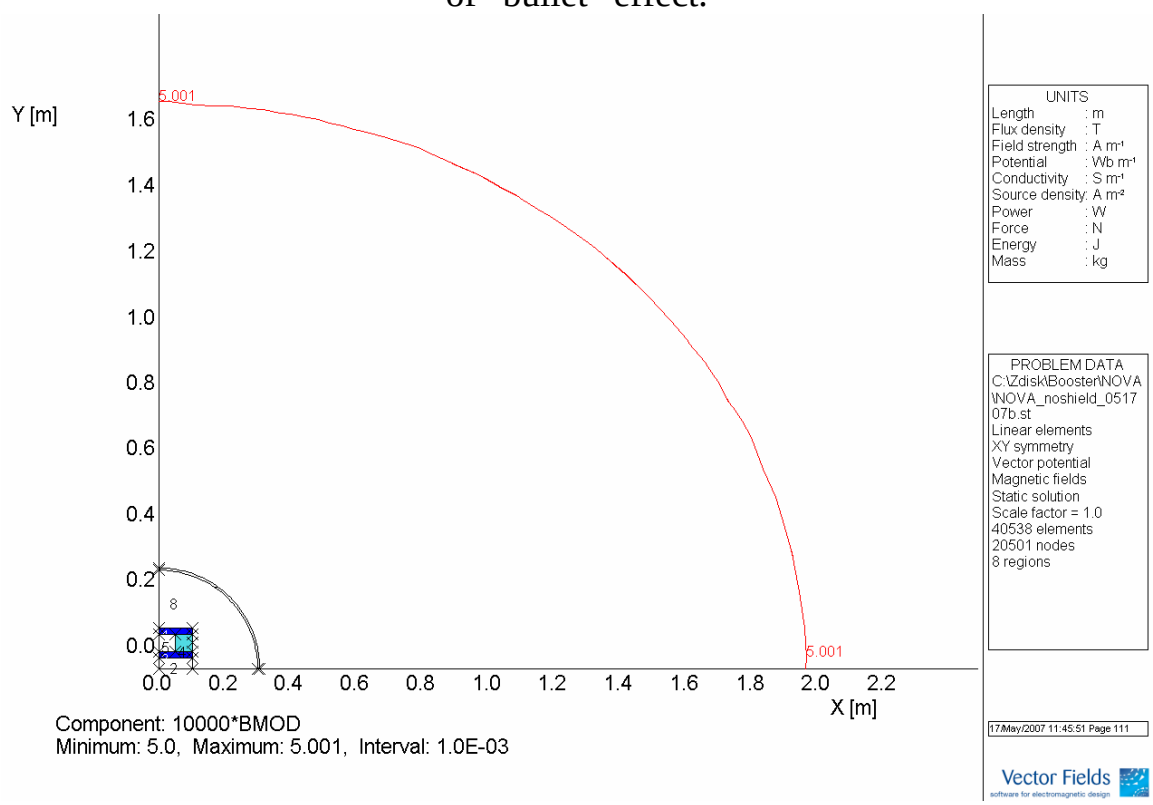

Fig. 7. Five Gauss field line (red) for space safety limitation.

Variant II. Magnet with ferromagnetic shield

Magnet parameters:

Distance between beams	158.8 mm
Integrated strength	0.56954 T-m
Air gap	50.8 mm
Good field area width	101.6 mm
Permanent magnets	SmCo5 (Br=0.8655T, Hc=-662kA/m)
Center field	0.25 T
Effective length	2.28 m

Permanent magnet volume 9.8x10^6 mm3 (600 cu. Inches)
Permanent magnet cost/dipole at 30$/cu. inch) 18 k$
Ferromagnetic shield ID 600 mm, OD 620 mm

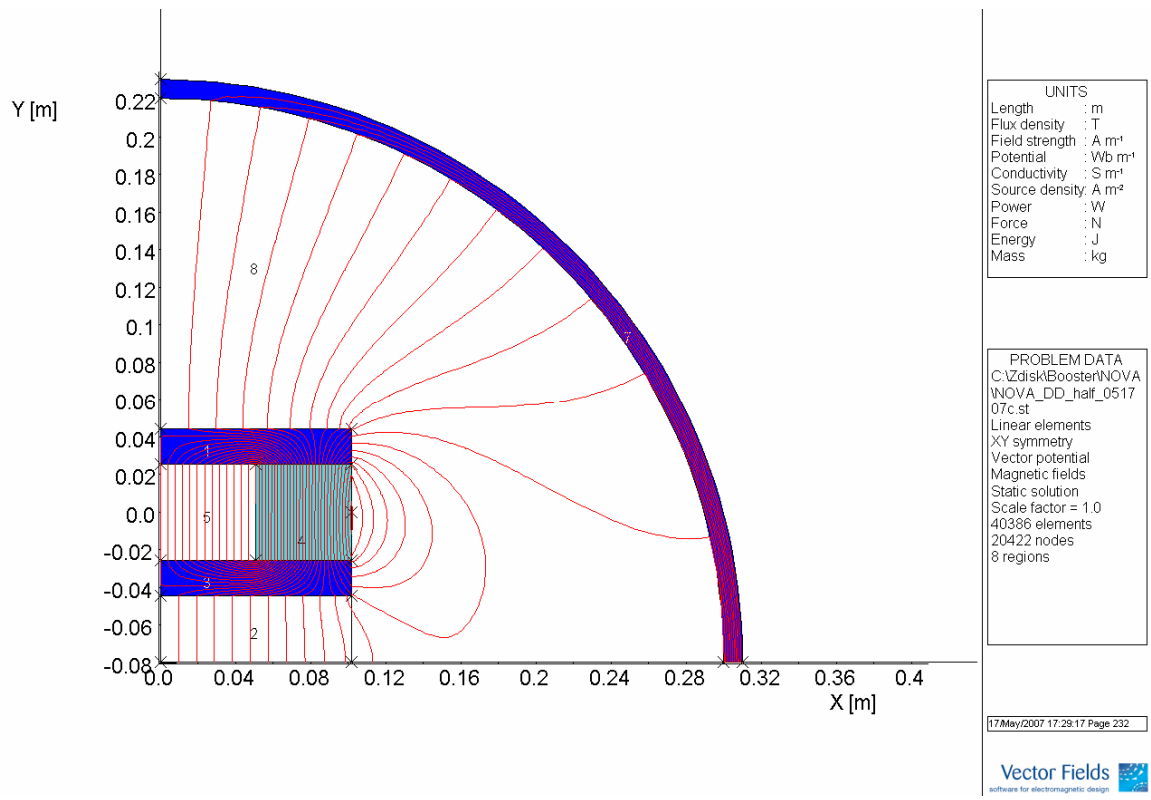

Fig. 8. Quarter of magnet cross-section and flux lines.

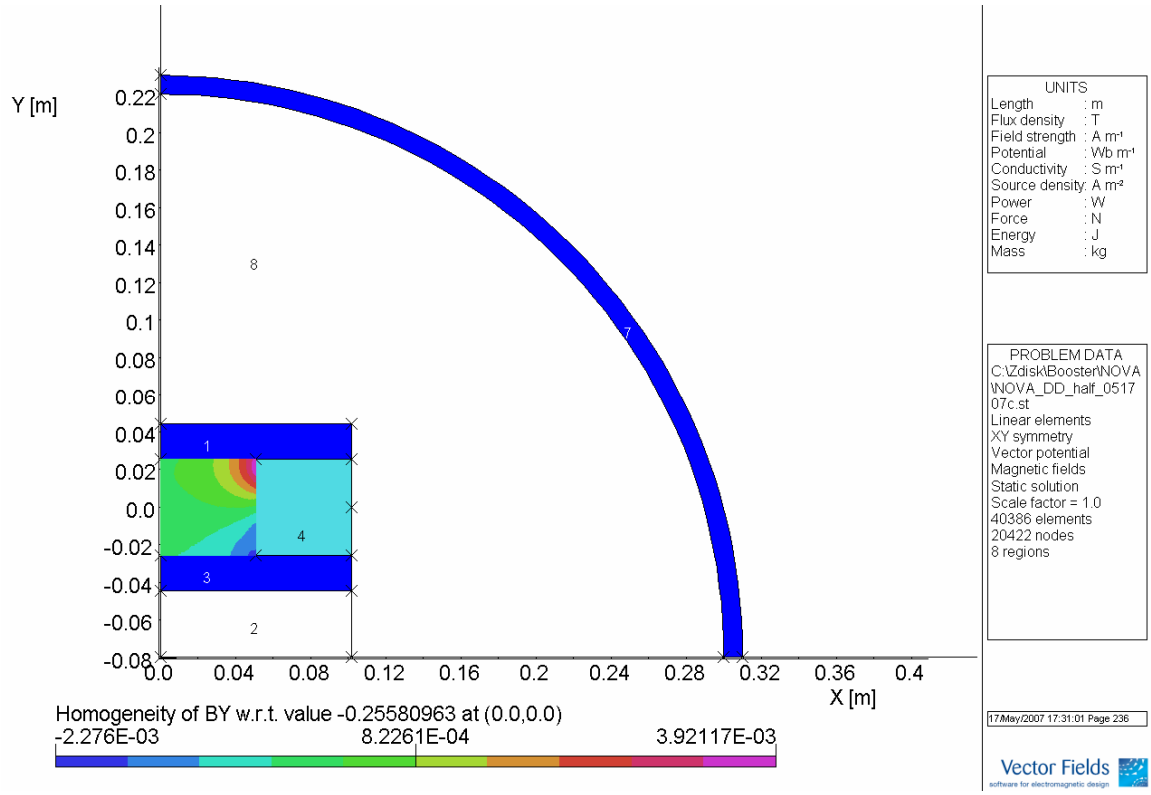

Fig. 9. Field homogeneity in the magnet air gap.

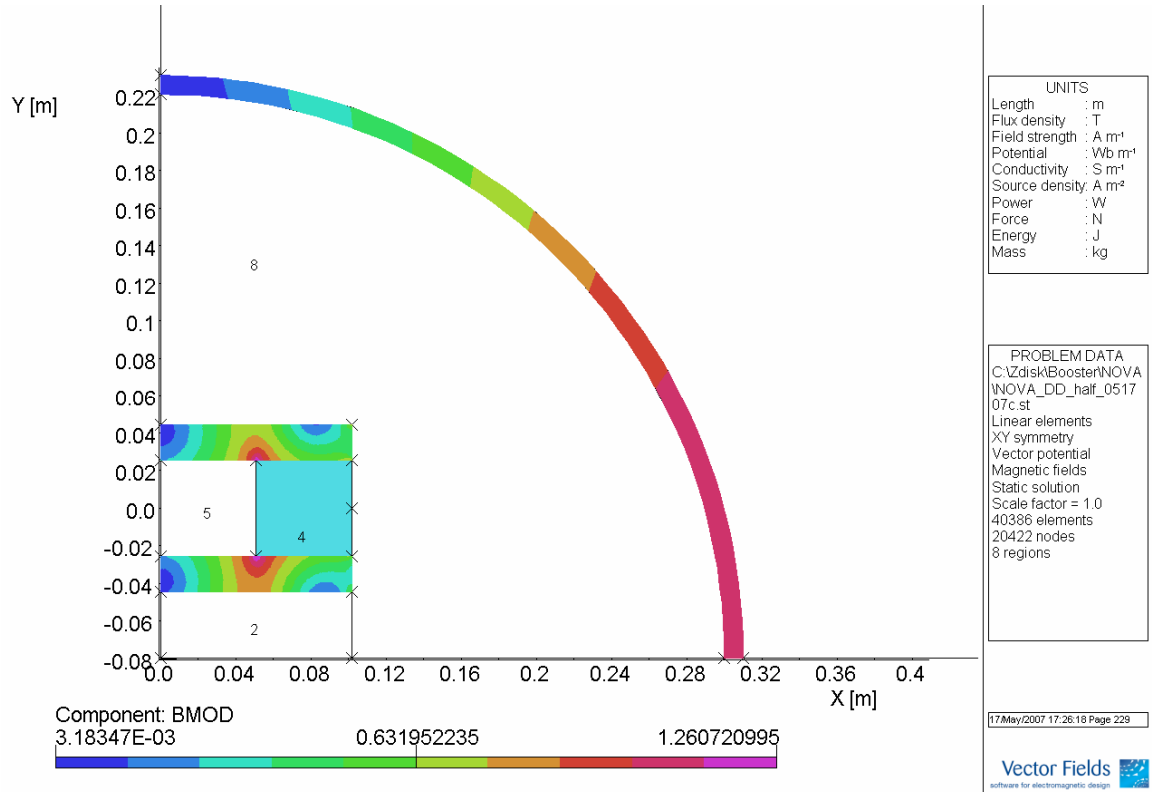

Fig. 10. Flux density in the iron yoke and magnetic shield.

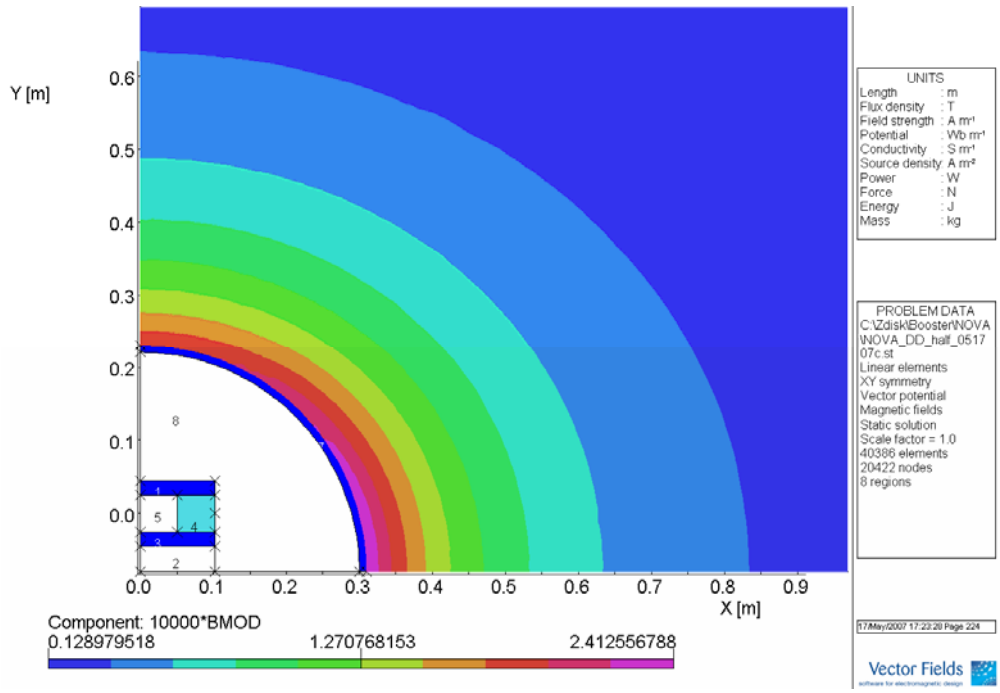

Fig. 11. Magnet fringing field less than 2.5 Gauss.

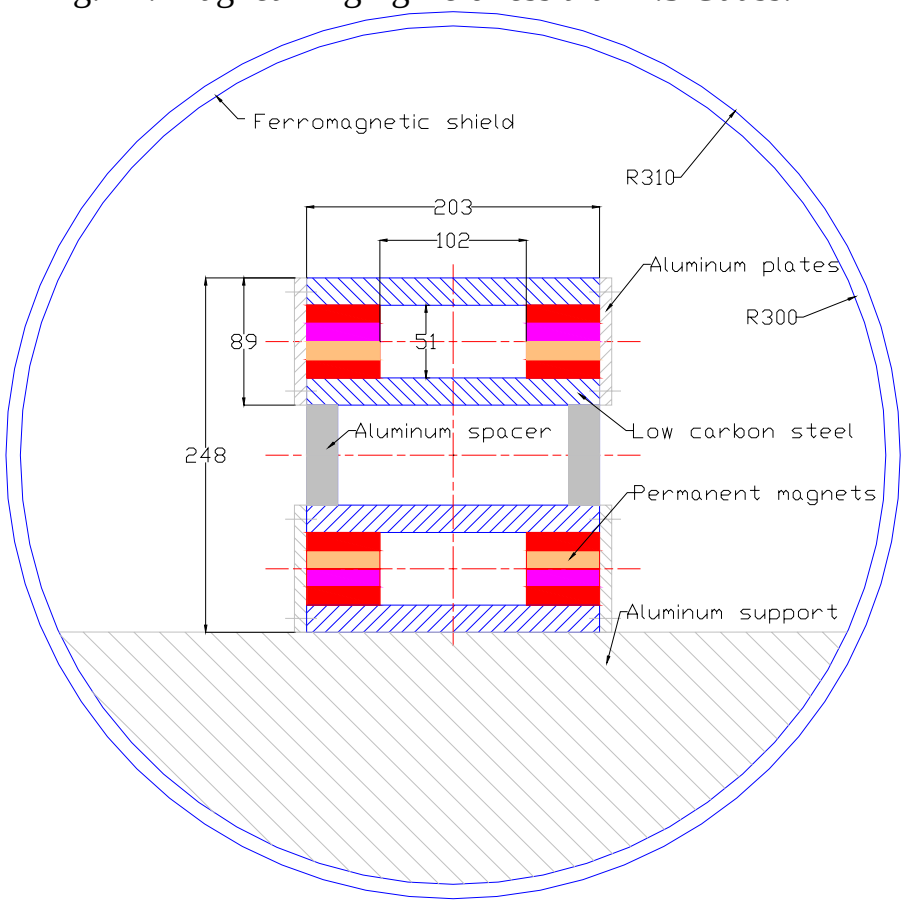

Fig. 12. Magnet cross-section.

Summary

Advantages of proposed design:

- Smaller magnet dimensions; instead 241mm x 343mm x 2630mm for Ferrite variant it has 220mm x 90mm x 1900mm;
- Yoke consists of only two flat plates of low carbon steel;
- SmCo5 has a better -0.043%/C than Ferrite -0.2%/C thermal stability and do not need thermo-compensators;
- Easy control field quality for window-frame magnet;
- Simple magnet assembly
- Permanent magnet bricks supplied magnetized and do not need magnetization equipment recovery, labor for magnetization, etc.
- SmCo5 has high radiation resistance
- NdFeB permanent magnets with higher strength but lower thermal stability also could be used.
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The magnet without ferromagnetic shield has the fringing field 5 Gauss at 2 m distance from the magnet center. The ferromagnetic tube effectively shields this field up to 2.5 Gauss on the outer surface of this tube. As a shield could be used standard gas/oil pipe with close dimensions.

So, it seems, all these advantages overcompensate an extra cost of buying permanent magnets.

The next step could be a magnet geometry optimization and 3D magnetic design with proper end field shimming.