# Magnetic and Mechanical FEA of SiD

IRENG07

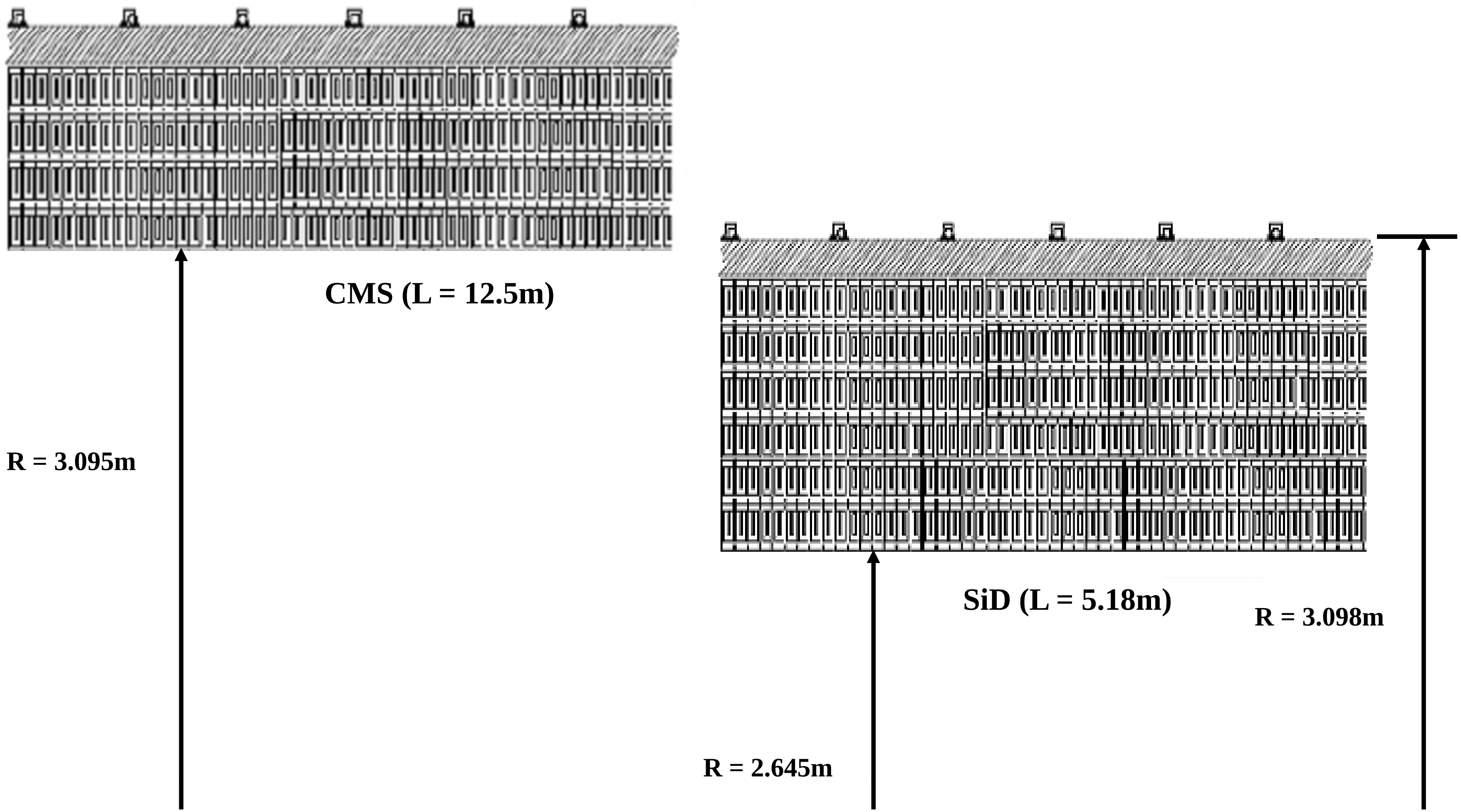
Bob Wands

September 18, 2007

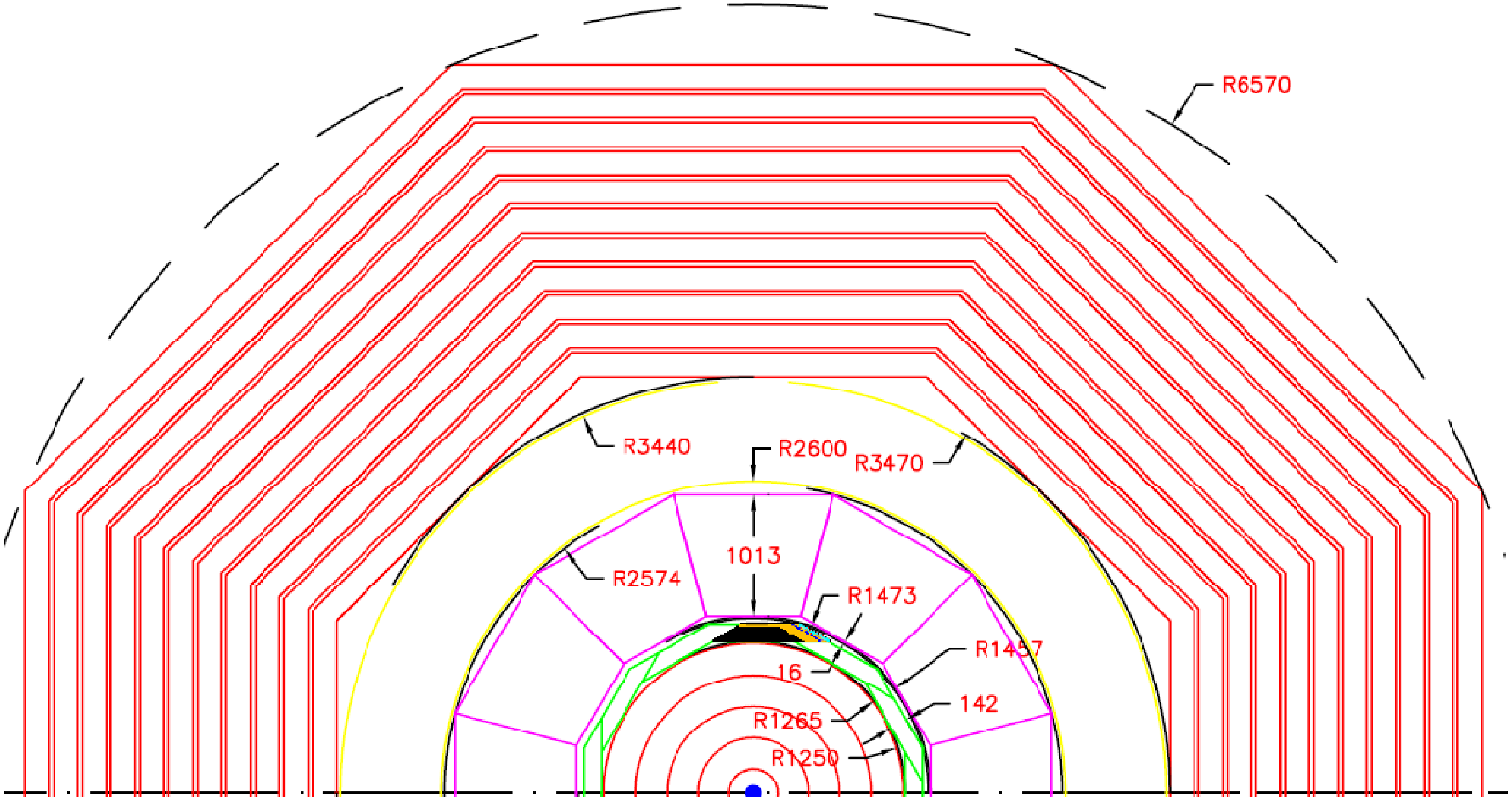
# Brief Review of Solenoid Design

- **Design is based on a scaling of the successful CMS solenoid**
- **Six layers of CMS conductor are used vs. four layers for CMS**
- **Operating current is 17500 amps vs. 19500 amps for CMS**
- **Central Field is 5 T vs. 4 T for CMS**
- **Stored energy is 1.4 GJ vs. 2.7 GJ for CMS**

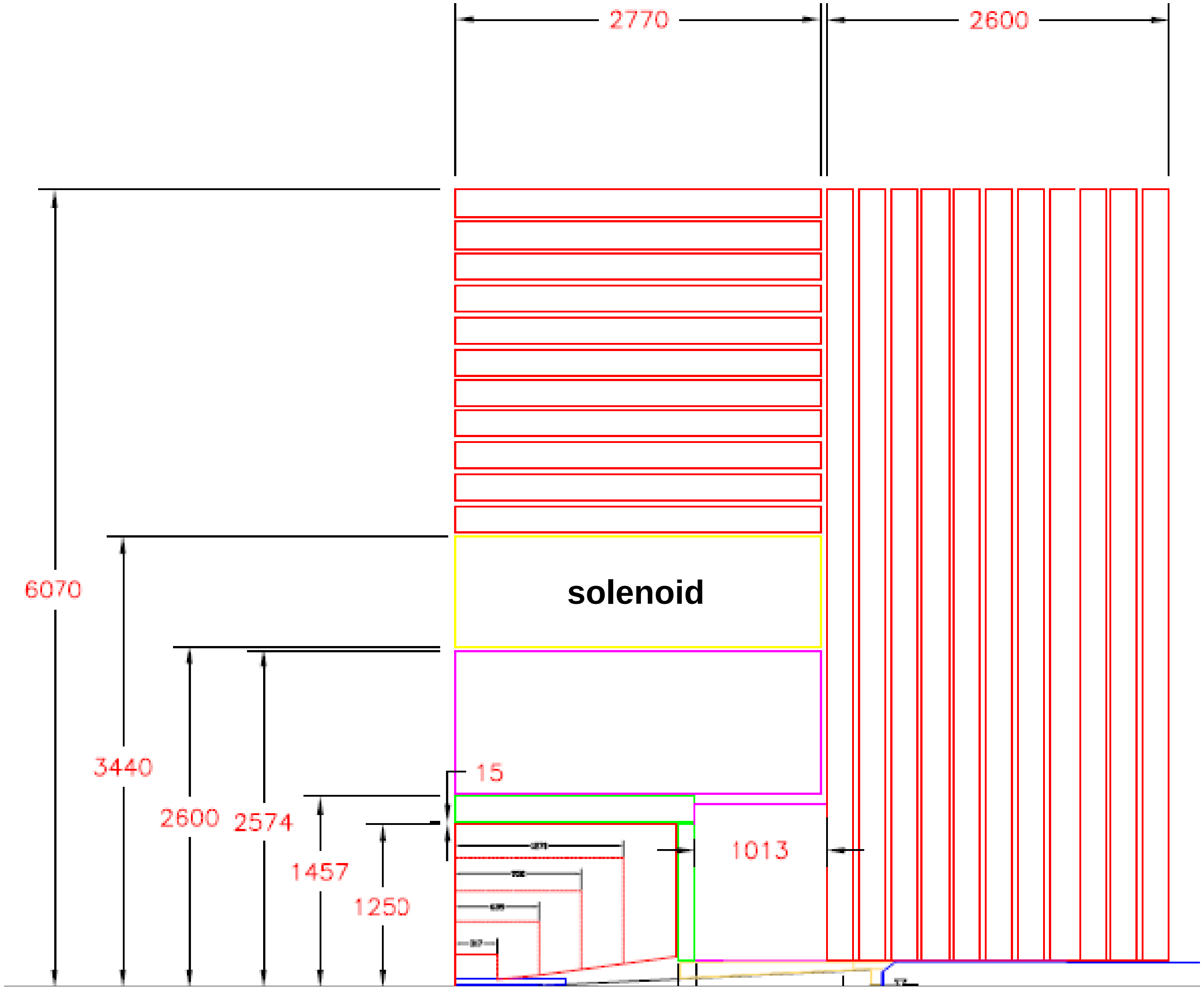
# Comparison of Coils – SiD and CMS



# SiD Geometry – End View



# SiD Geometry – Side View

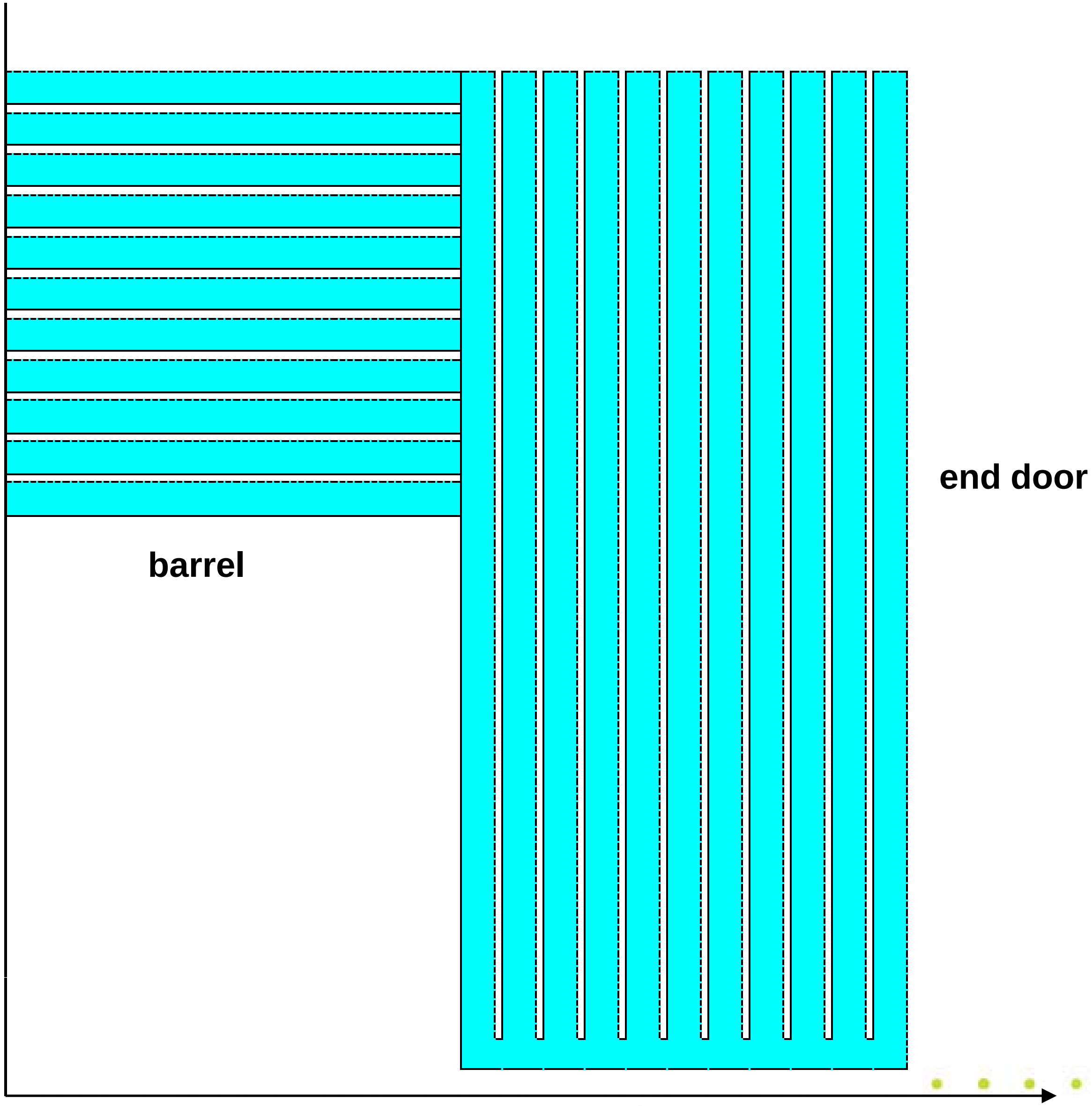


# Iron Configuration – Effect on Fringe Fields

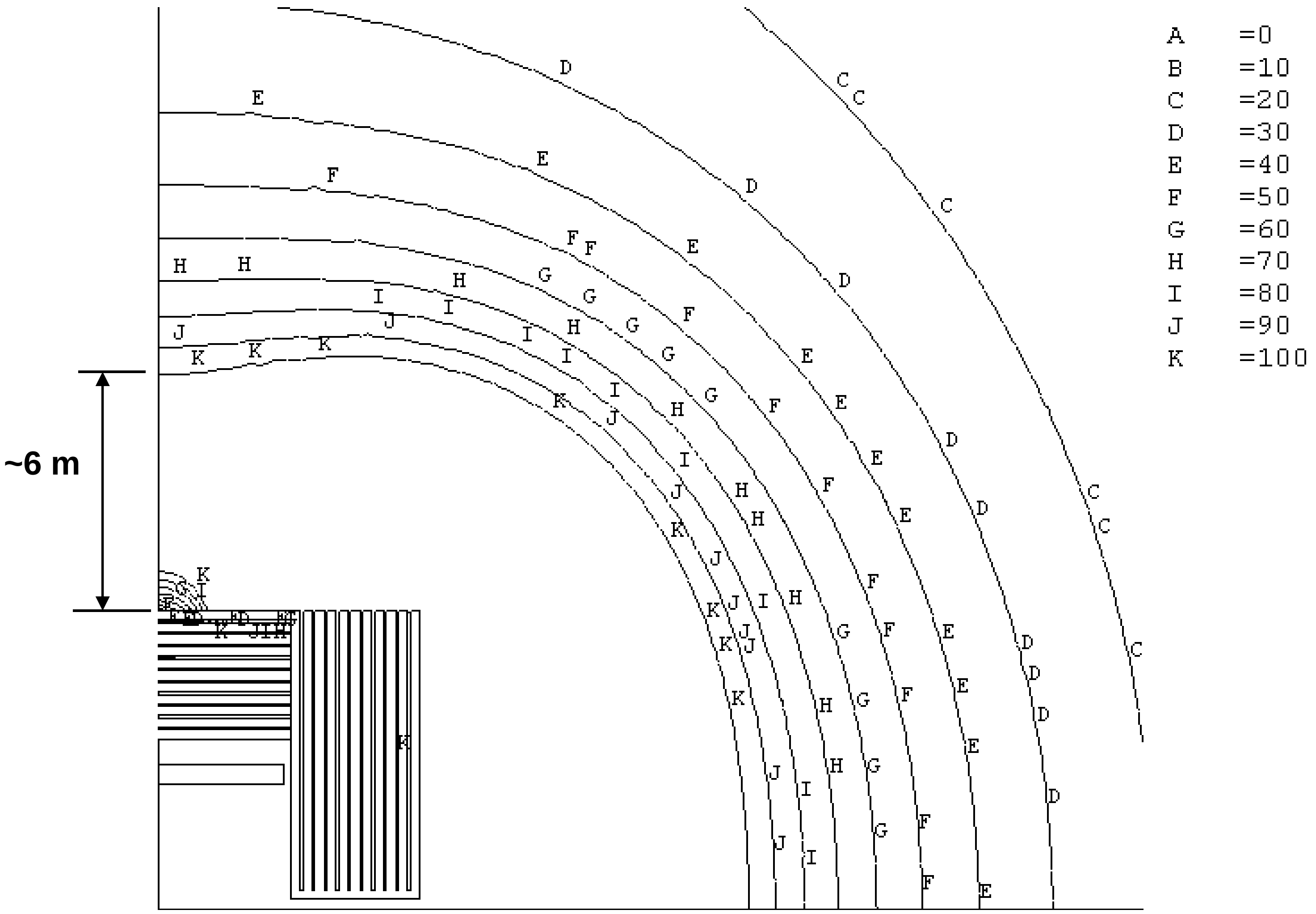
- The basic configuration is 11 iron plates, 20 cm thick, in both the barrel and end door regions
- Gaps between plates are 4 cm
- Variations on this geometry were examined in two dimensions to determine the features that most affected fringe fields outside the barrel

- *Fringe field requirements have yet to be specified. Could be as low as 5 g close to the magnet, or >100 g.*
- *The 2-d axisymmetric models did not include the PacMan shielding iron, or the anti-solenoids*
- *For all but one configuration (the "practical design") no consideration was given as to how to actually build the iron*

# The Simplest Configuration
## (1/4 shown)

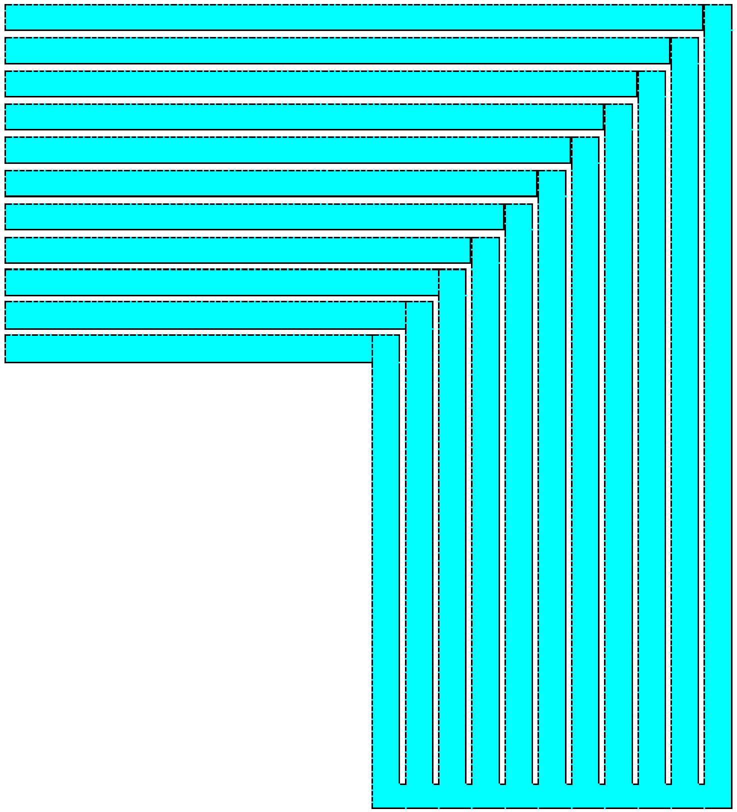


# Fringe Field - Simplest Configuration

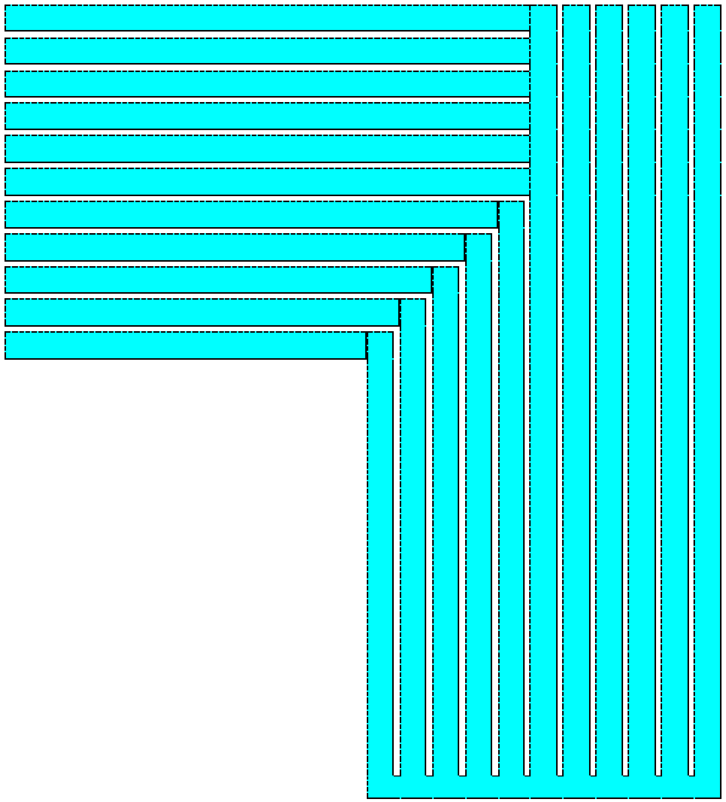


# Two Tapered Configurations

**Fully Tapered**



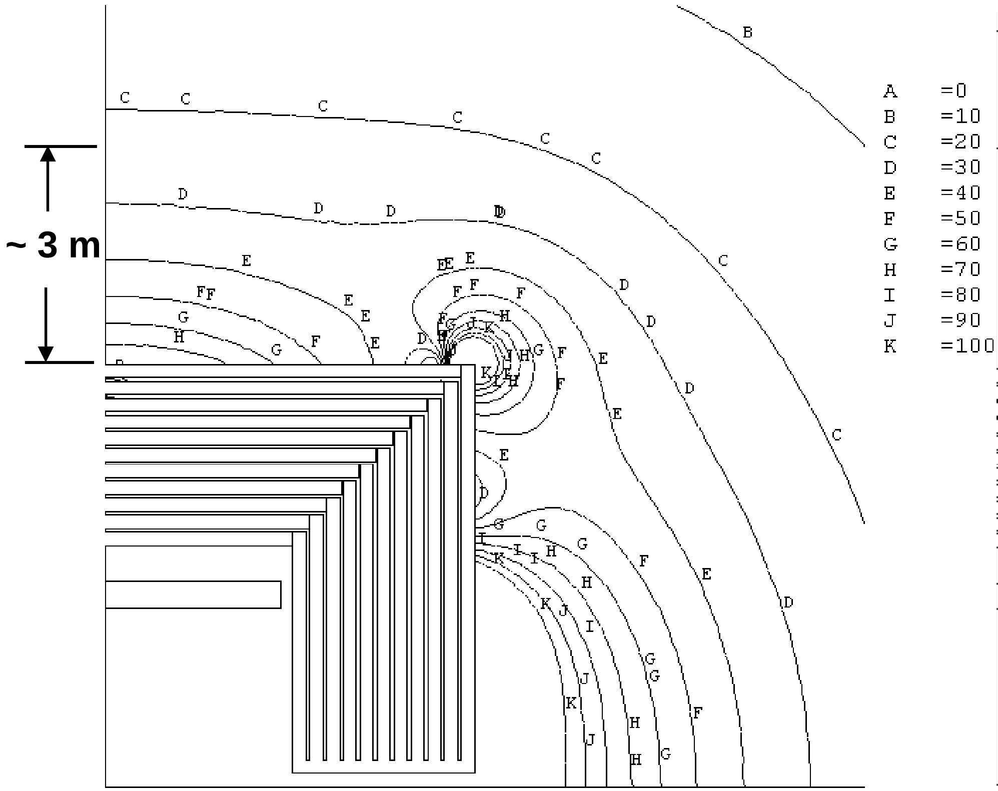
**Partially Tapered**

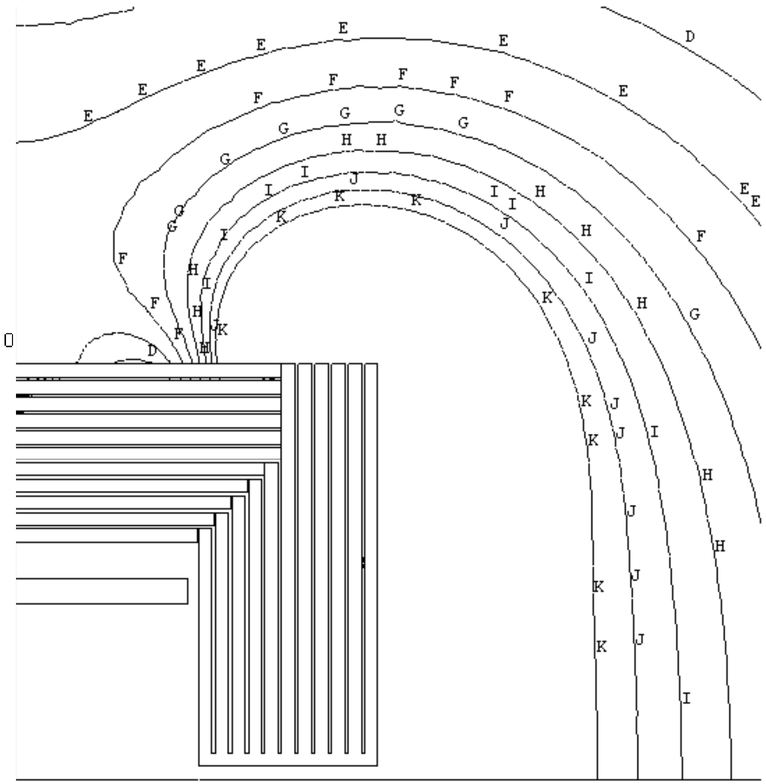


# Fringe Field - Two Tapered Configurations

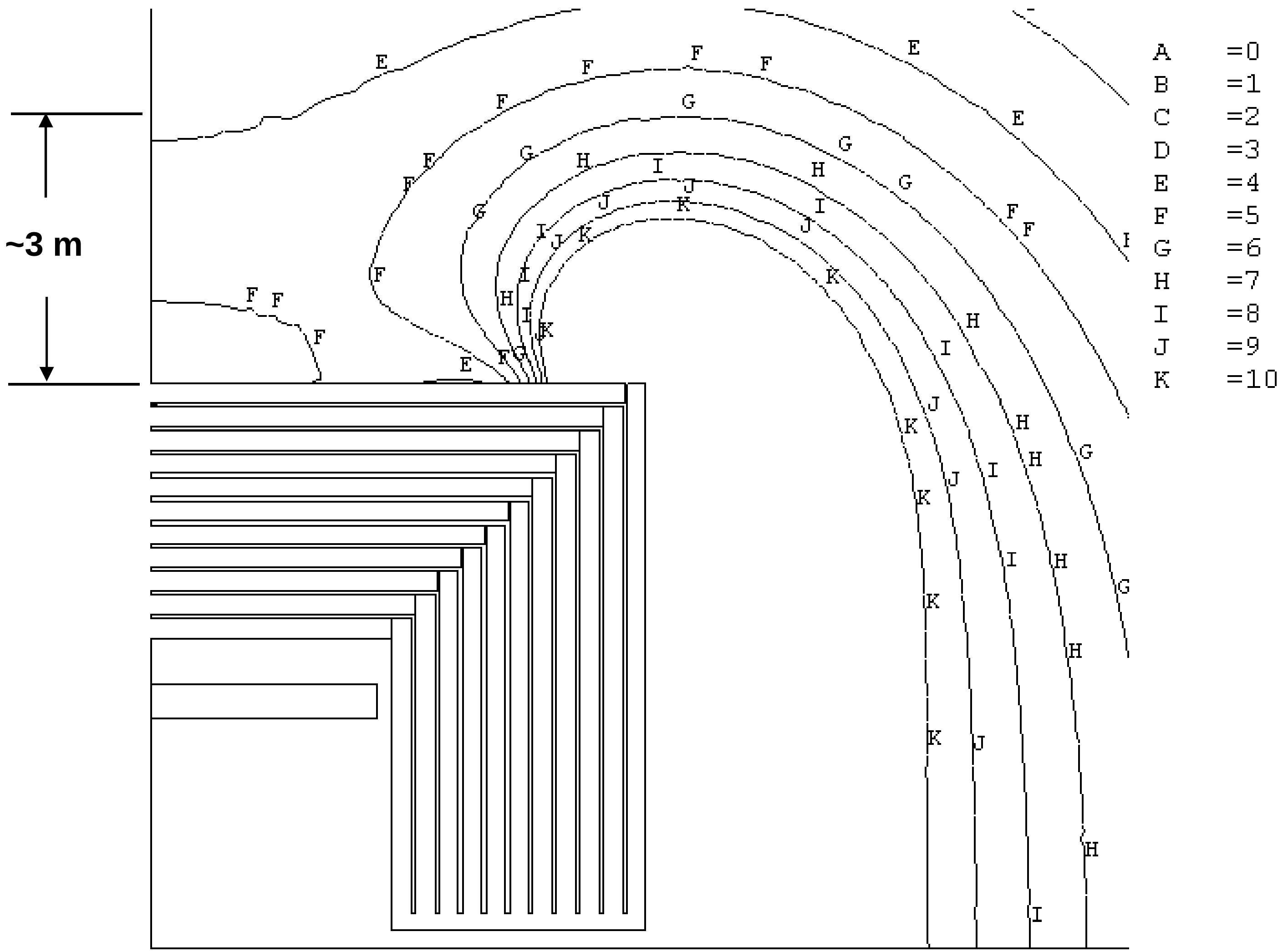
**Fully Tapered**

**Partially Tapered**



# Fully-Tapered Configuration, 22 cm Plates

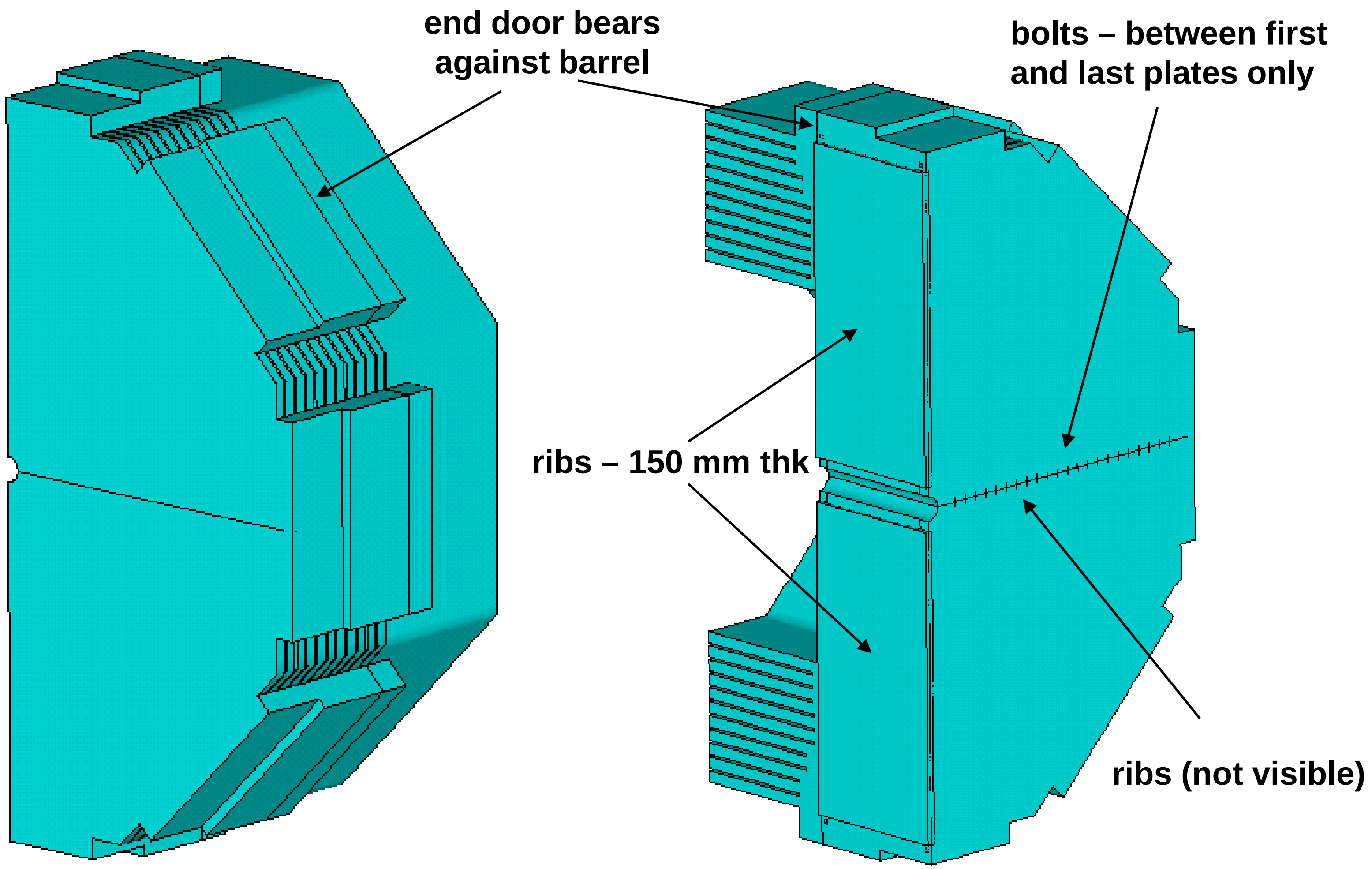



**(note change of scale)**

# Requirements for a Practical Iron Design

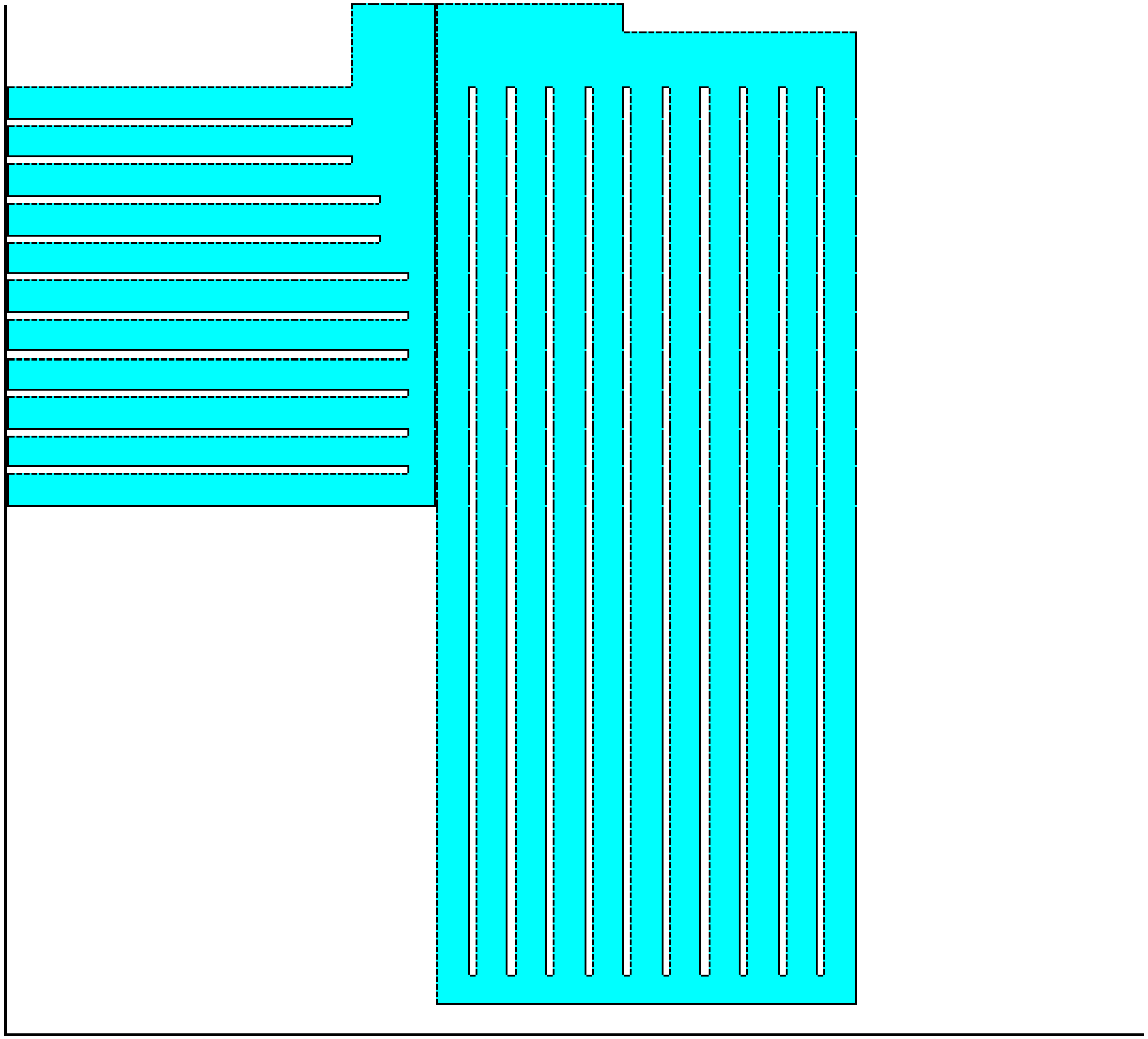
- End doors must resist axial magnetic force of ~14000 tonnes
- Dead weight of the iron alone is in excess of 8000 tonnes
- Crane and space considerations require segmenting of barrel and end door
- Design must allow for adequate detector coverage while maintaining small deflections
- Fringe fields must be within specifications

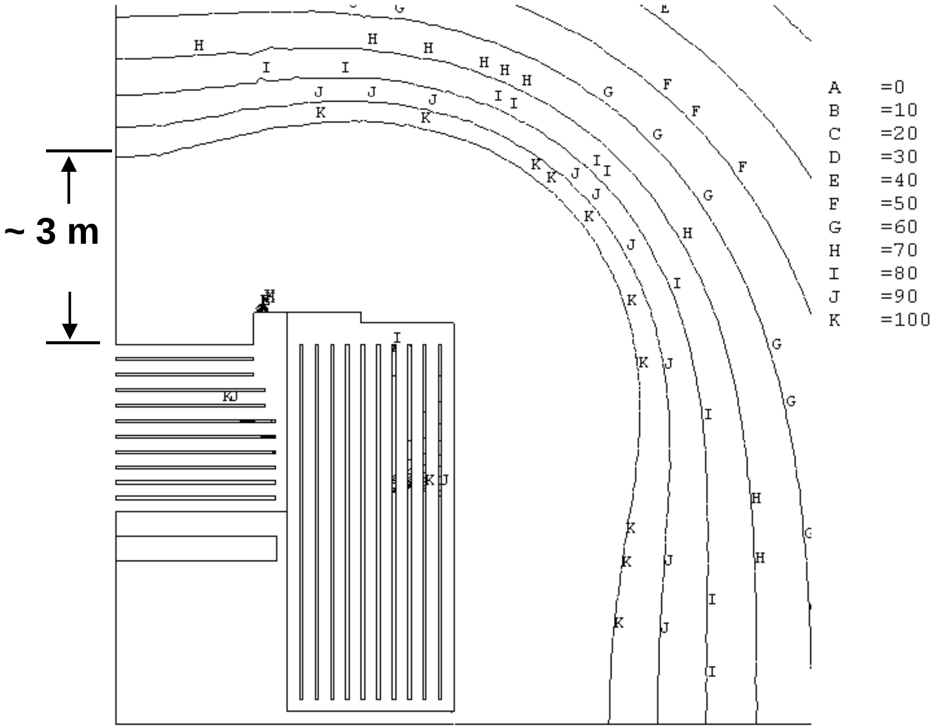
# A Practical Iron Design (H.J. Krebs)



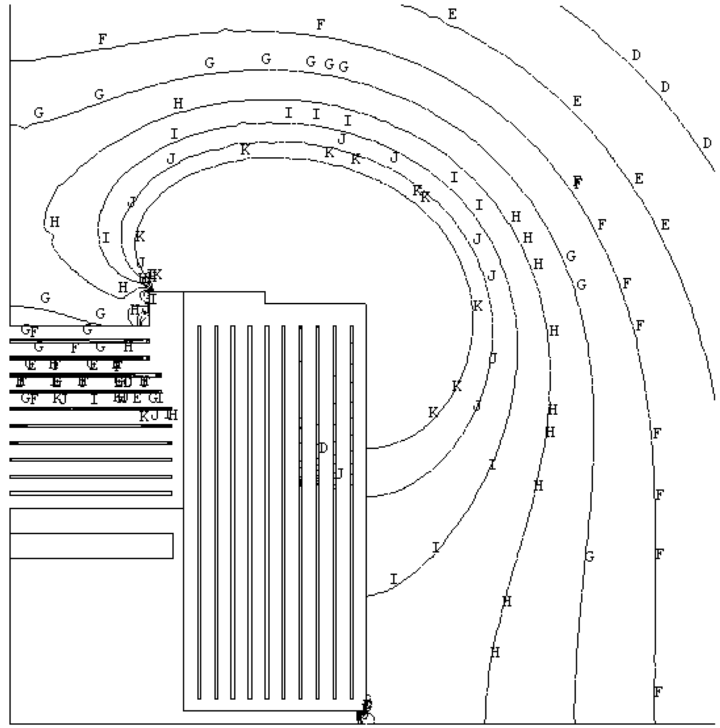

**total weight (barrel + both end doors) = 8300 tonnes**

# A Practical Iron Design – Magnetic Model



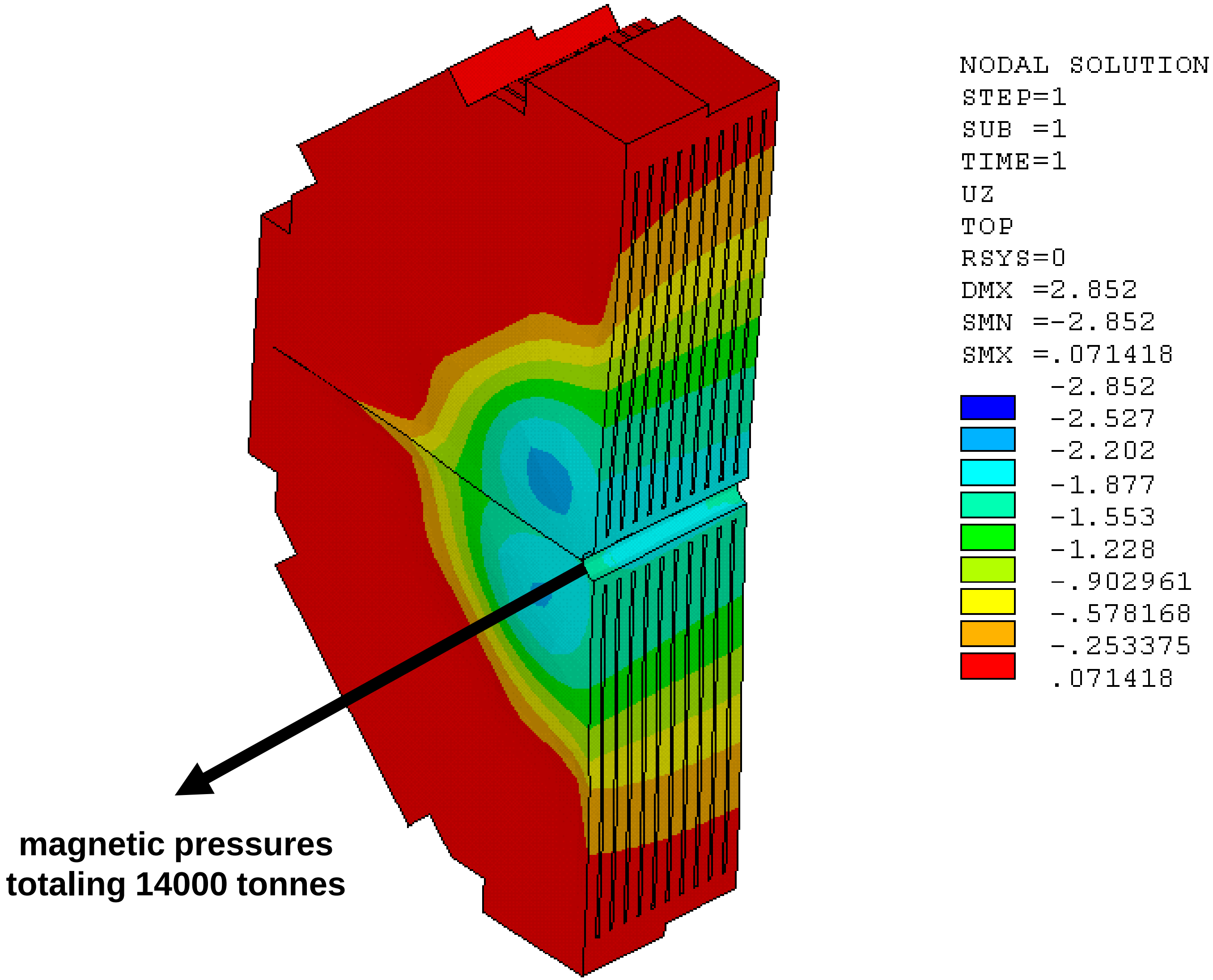



**20 cm plates**

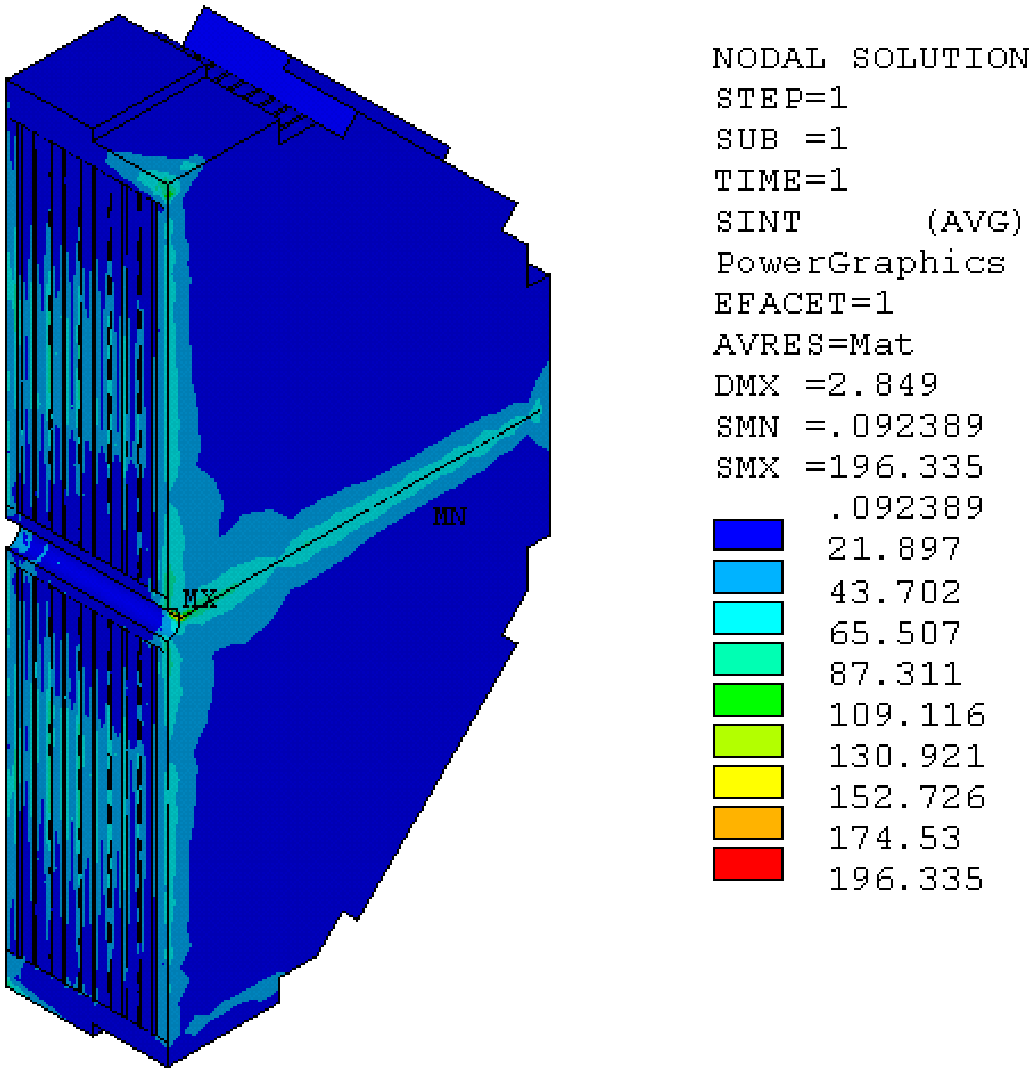


**22 cm plates**

# Axial Deflections of End Door - mm



# Stresses in End Door - MPa



# Conclusions

- **Only full tapering with 22 cm plates produces 5 gauss fringe fields near the barrel, but support of end door is problematic**
- **Practical iron designs will almost certainly be untapered to some extent for ease of assembly and support**
- **If very low fringe fields (~5 g) are required, then thicker iron plates may be called for, increasing weight and cost**
- **The practical design considered here is *extremely* robust, and could probably be optimized to increase space available for detectors**