

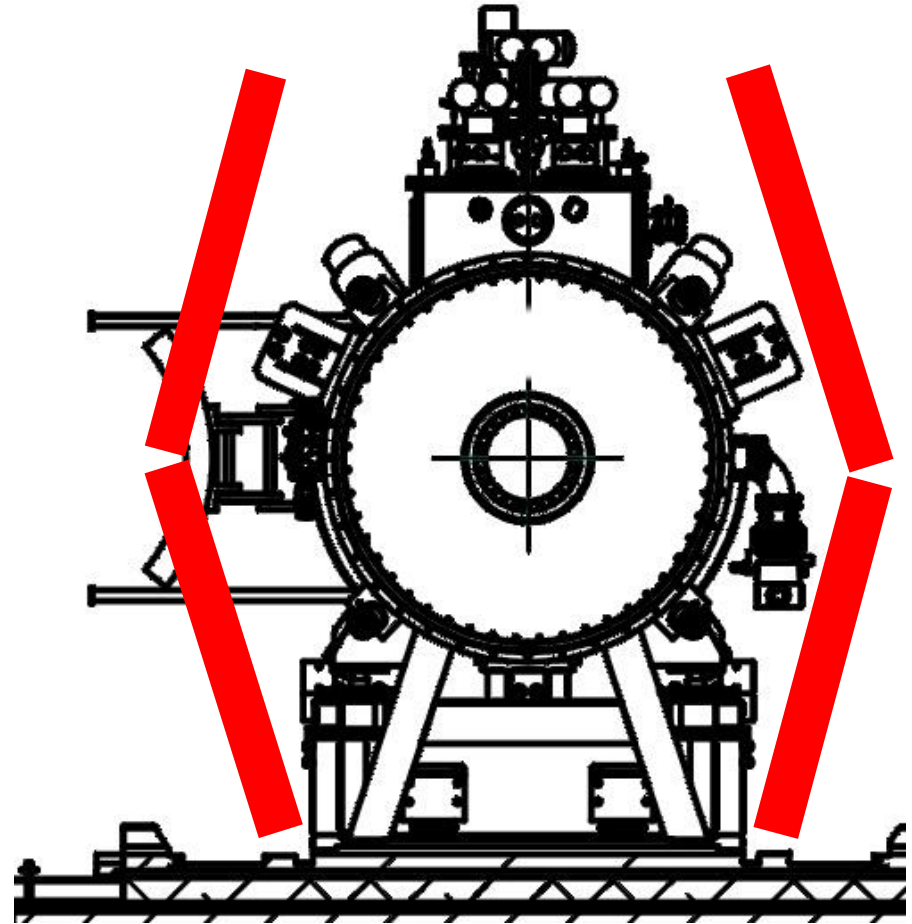
# Partial Return Yoke for MICE

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Advanced Accelerator Group

- Introduction and Concept
- Engineering
- Performance
- Ongoing work
  - PRY 'Light'
  - Field at Cryocooler Heads
  - Risk Mitigation

# Partial Return Yoke

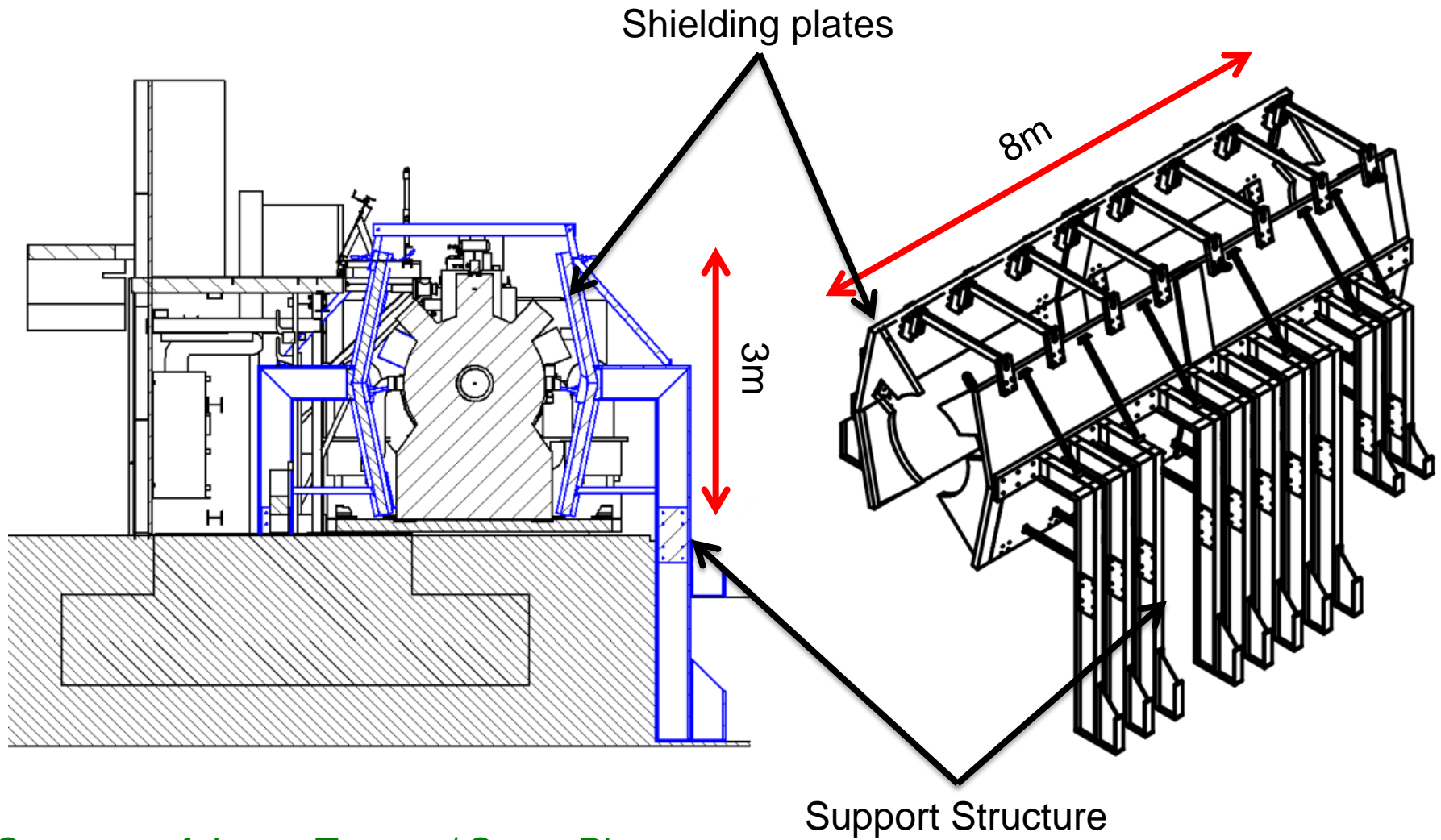
- MICE hall: solenoids cause large stray field
- Aim of PRY:  
Reduce stray field in hall to tolerable level
- Shielding plates
  - wall thickness  $>10$  cm
  - weight: 35t
- Performance
  - Reduces stray field outside of shield to 5-10 Gauss



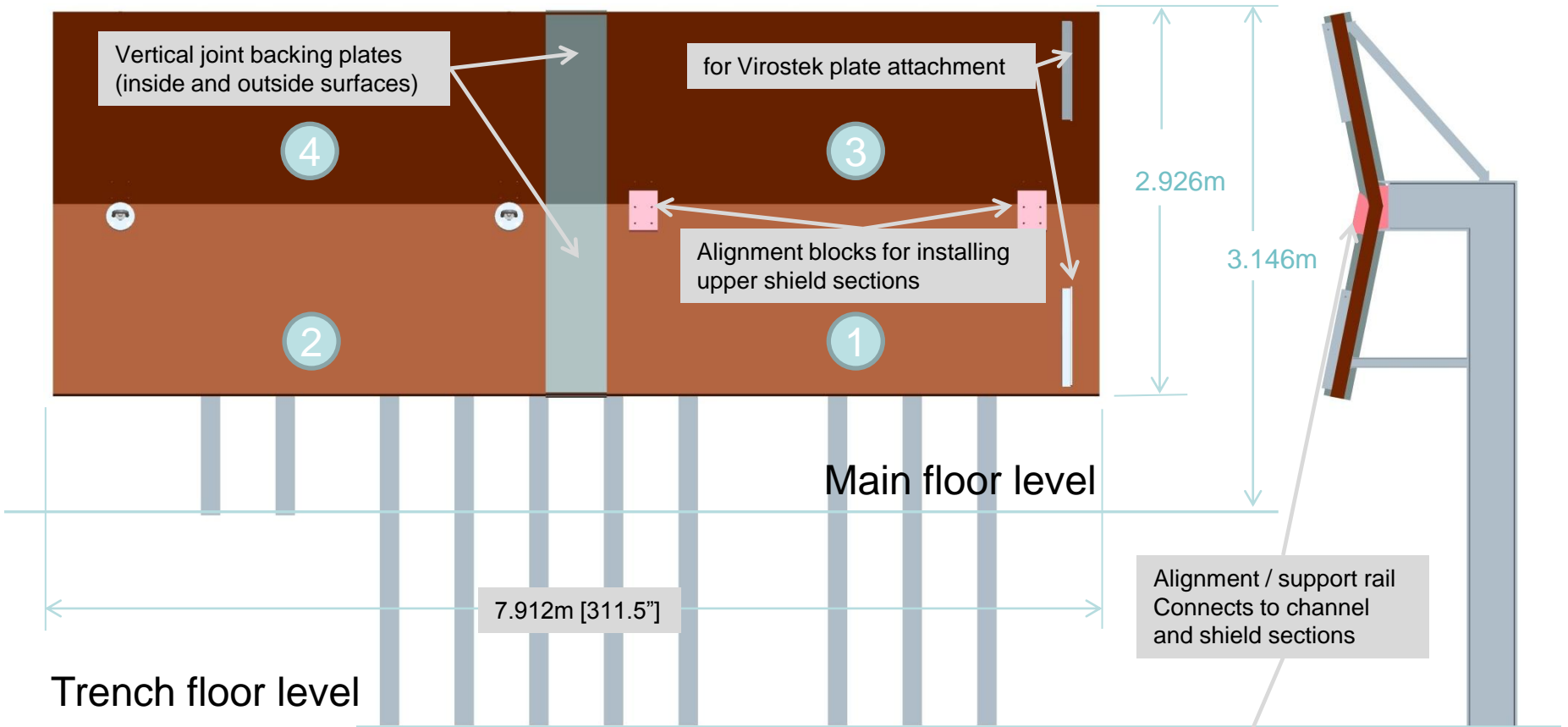
(Note: not to scale)

H Witte. Step IV & VI: Local Flux Return.  
MICE CM 34, October 2012.

# Partial Return Yoke



Courtesy of Jason Tarrant / Steve Plate

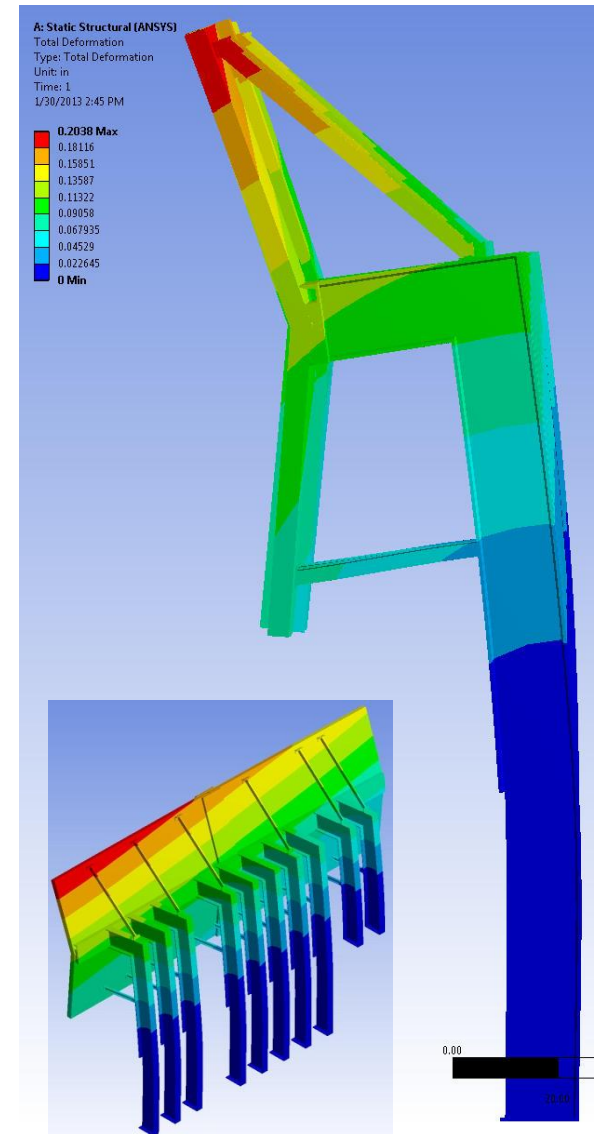


All connections to the four shield sections are bolted.  
Structural framework assumed to be a welded sub-assy.

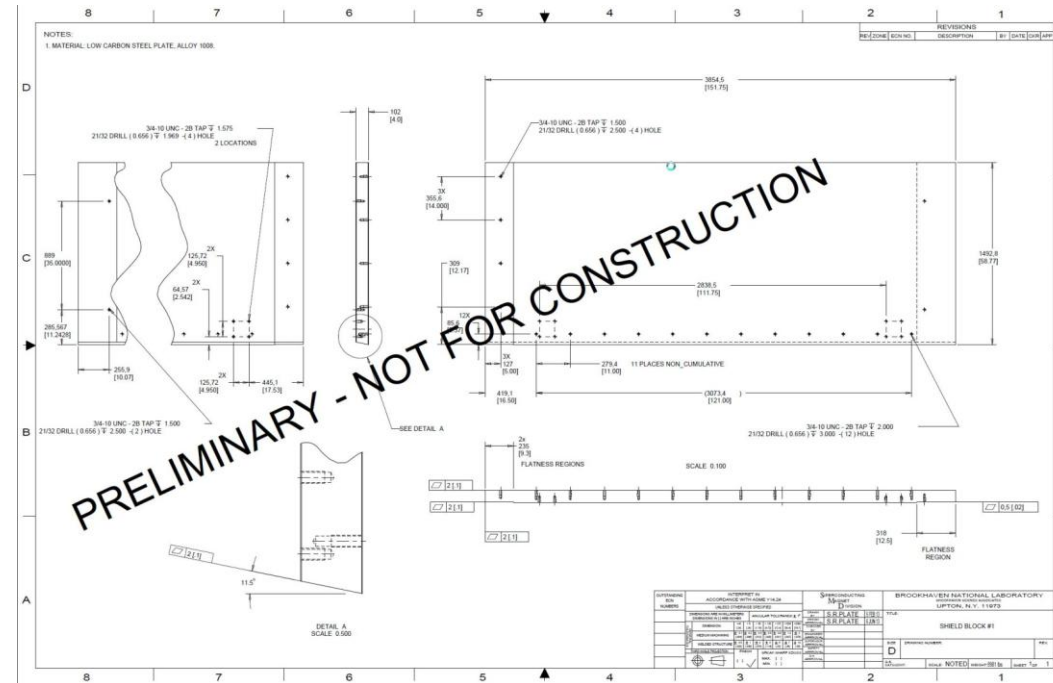
Weight: **53.4 tons total** (33.6t shielding, rest support)

# Forces Step IV

- Coils
  - Changes by a few percent
- Partial Return Yoke
  - 32 kN (horizontal)
  - Support structure designed for this load



- Detailed drawings
- Steel source investigation
- Schedule / Quotes
- Interferences
  - Meeting Steve Plate / Jason Tarrant / Andy Nichols



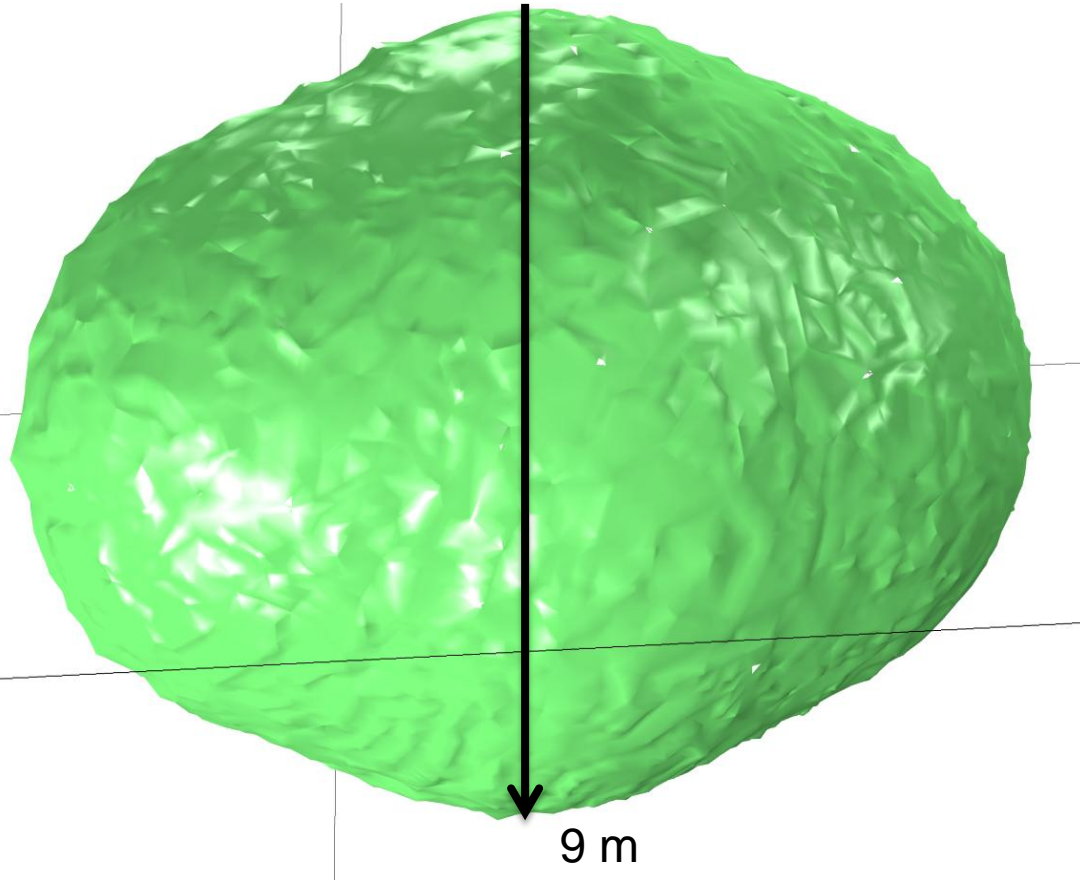
Courtesy of S. Plate

# Performance

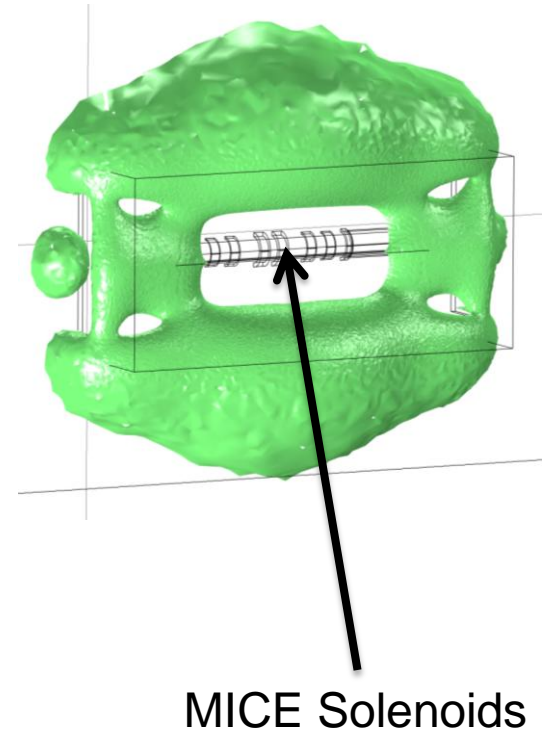


# Iso-Surface 0.5 mT

No Shield



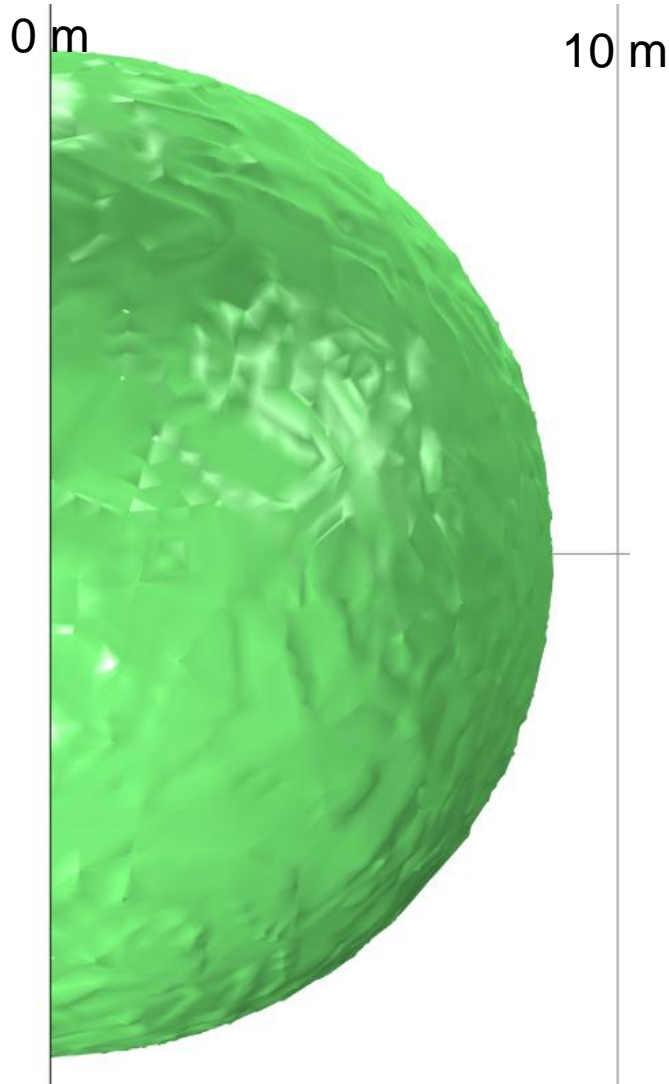
12 cm Shield



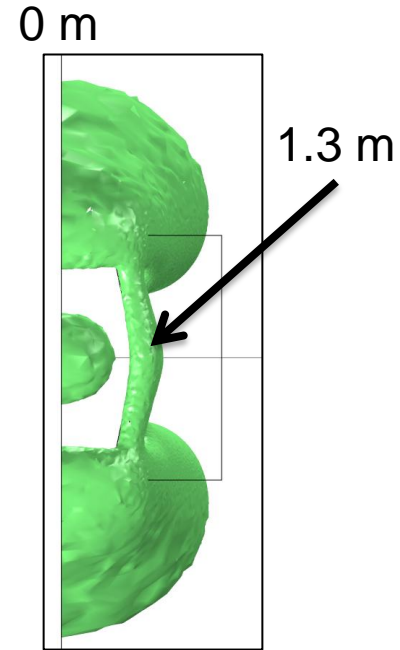
Step IV  
200 MeV Flip

# Frontal View – 240 MeV Solenoid

All 5 Gauss

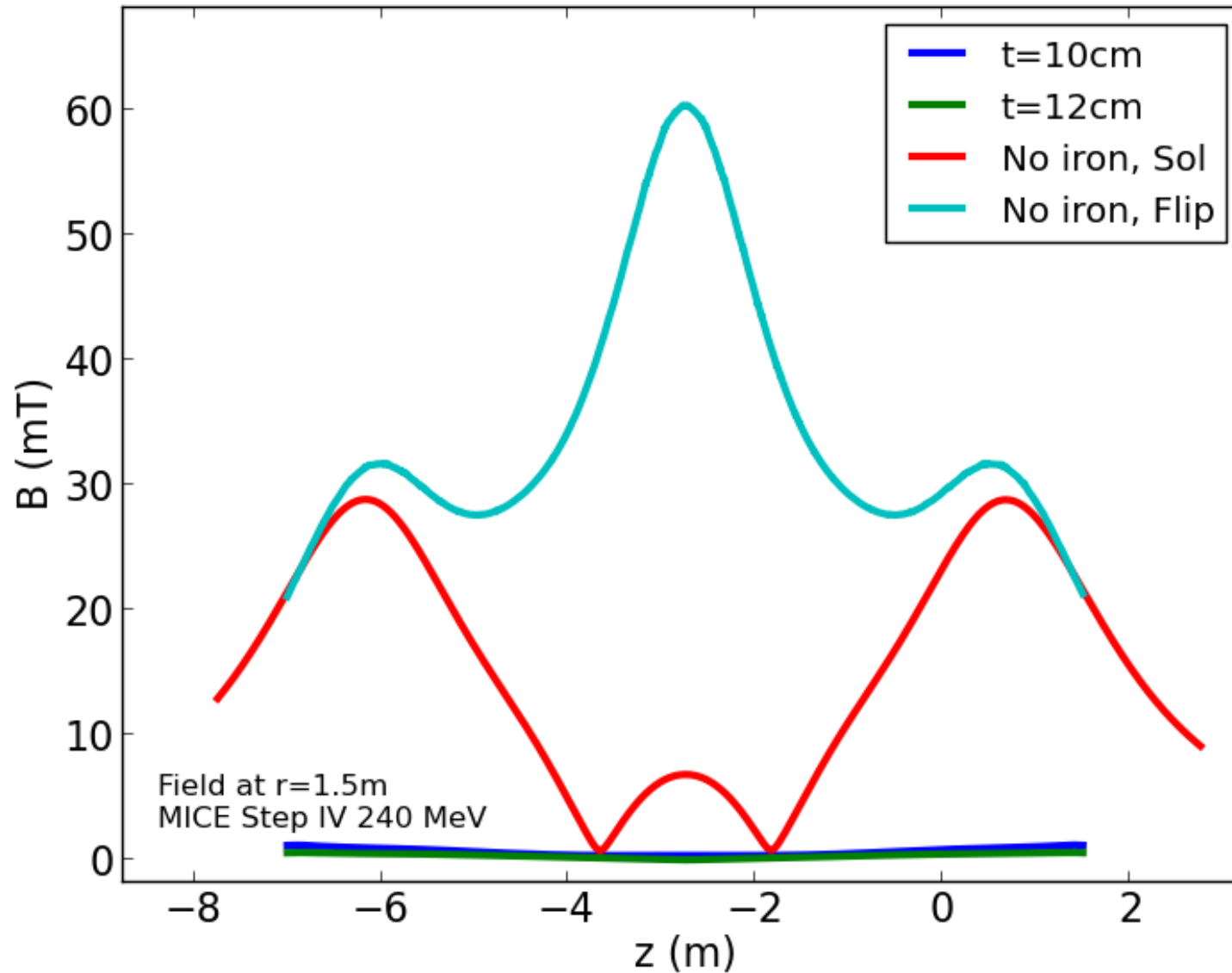


No Shield

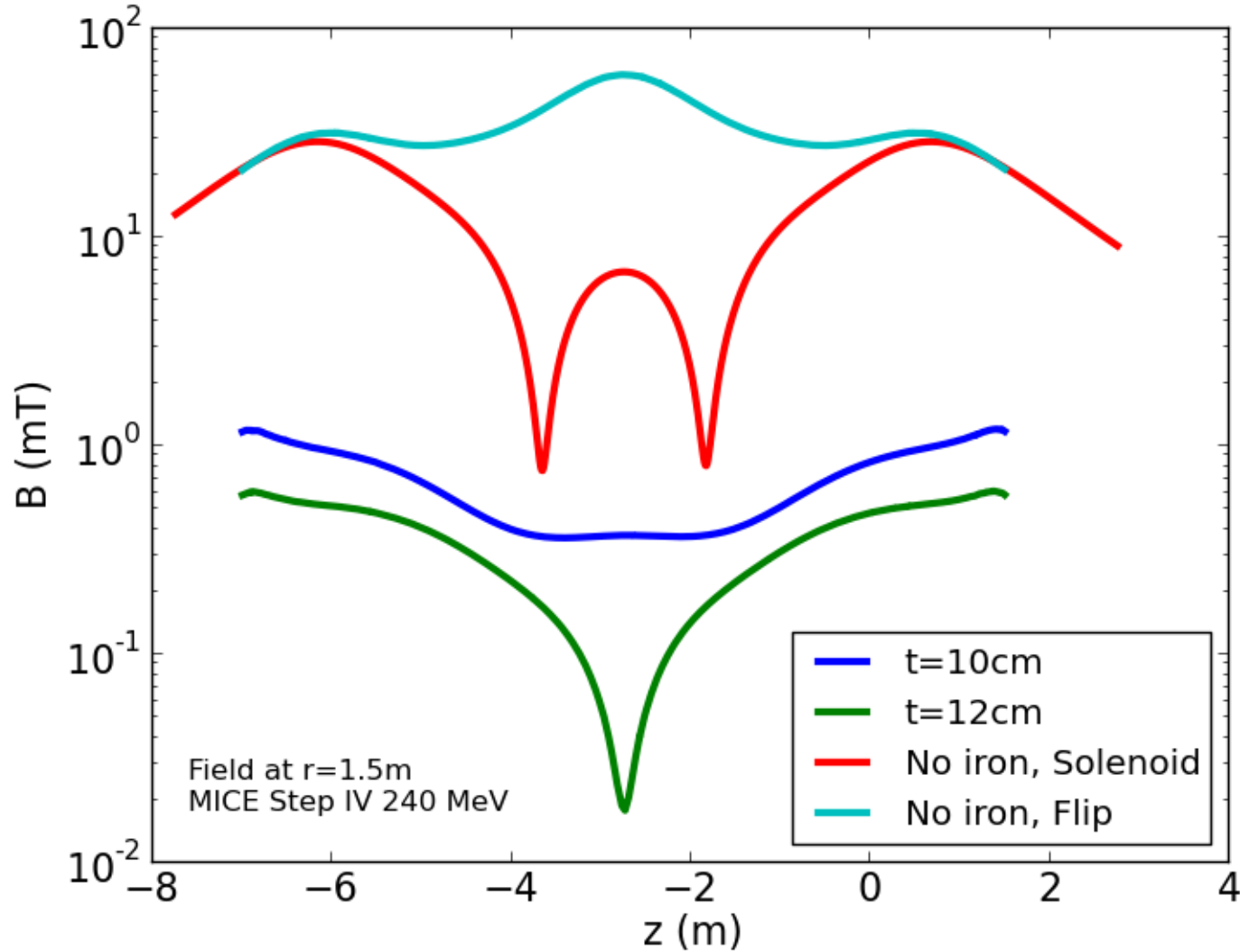


12 cm Shield

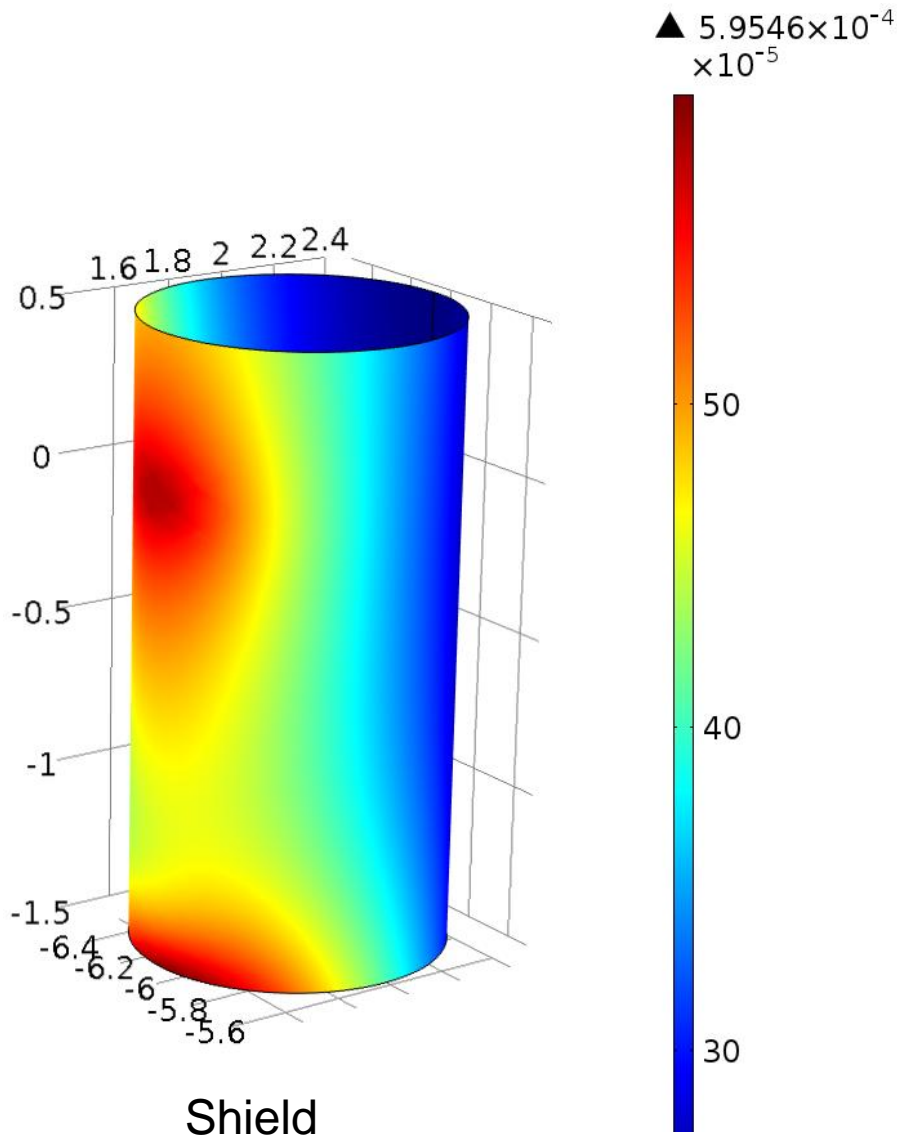
# 240 MeV Solenoid/Flip mode



# 240 MeV Solenoid/Flip



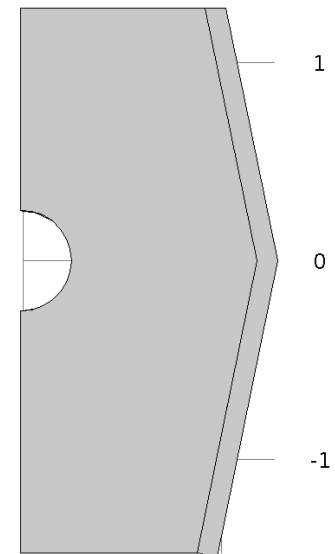
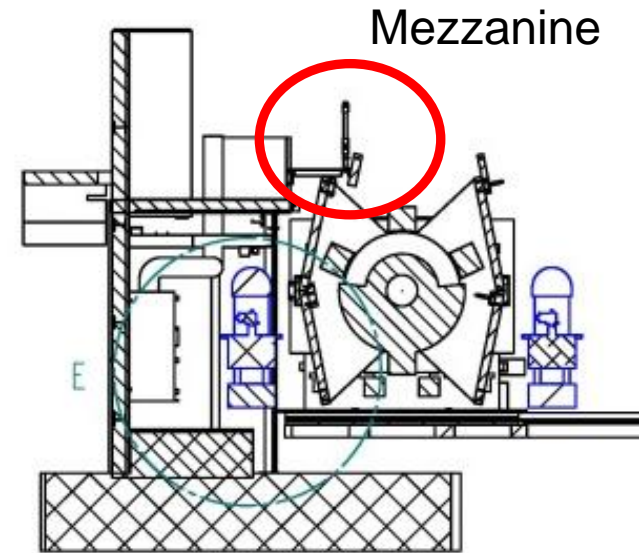
# Field Tracker Cryostat



- Tracker readout position:
  - Longitudinally same height as E2
  - Diameter 1 m
  - Just next to shield
- Fields
  - No iron: 36.4 mT
  - Shield: 0.6 mT
  - **Difference: factor 60**
  - 240 MeV Solenoid (12 cm shield)
  - Falls off quickly

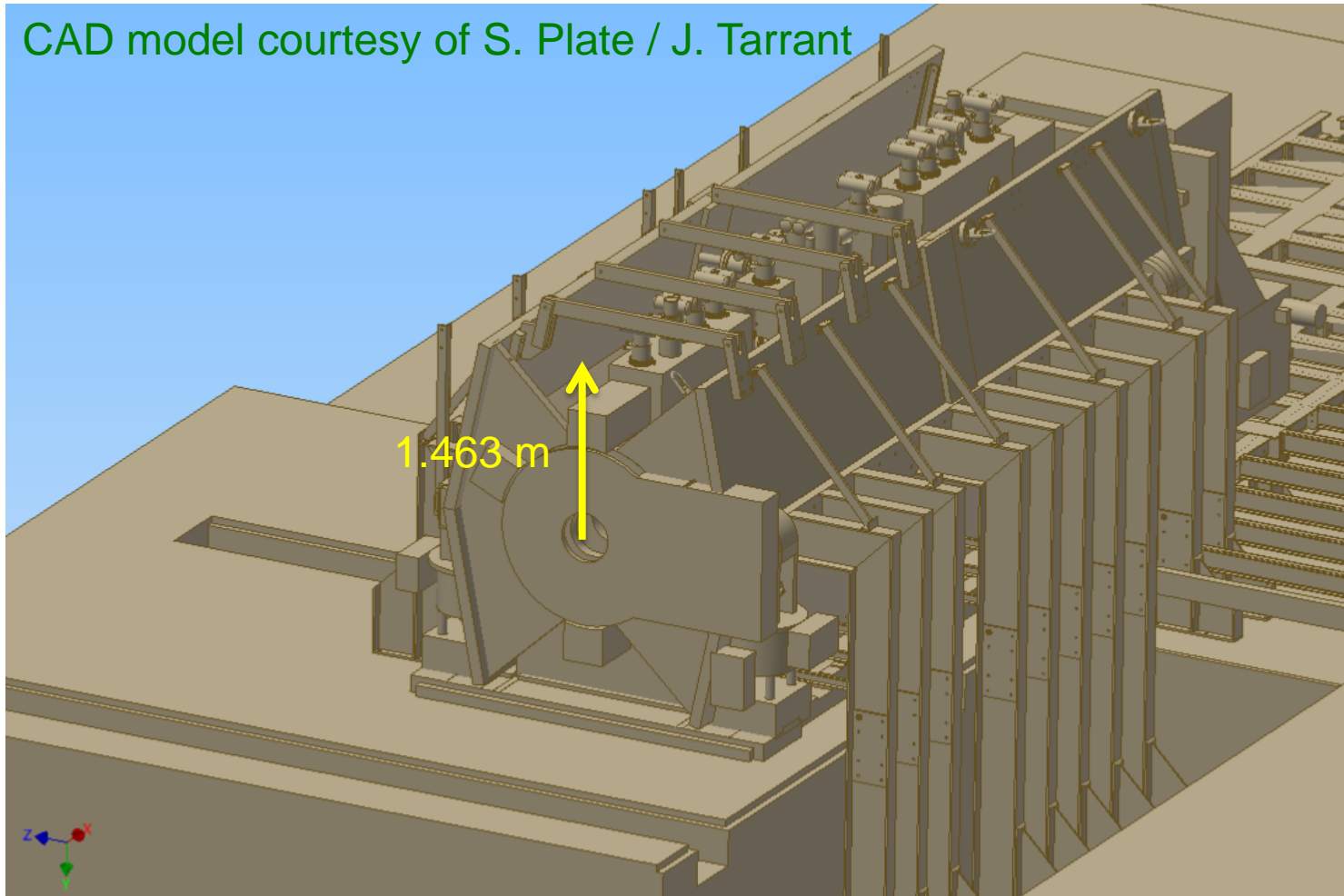
# MICE – PRY Light

- Review: investigate ‘light’ option
  - No/little modification to MICE hall
  - Two parts: Step IV and Step V+VI (not considered)
- Step IV: mezzanine
  - Currently needs to be raised by 200 mm
- PRY
  - Reduce shield by 200 mm on one side
- First simulations encouraging



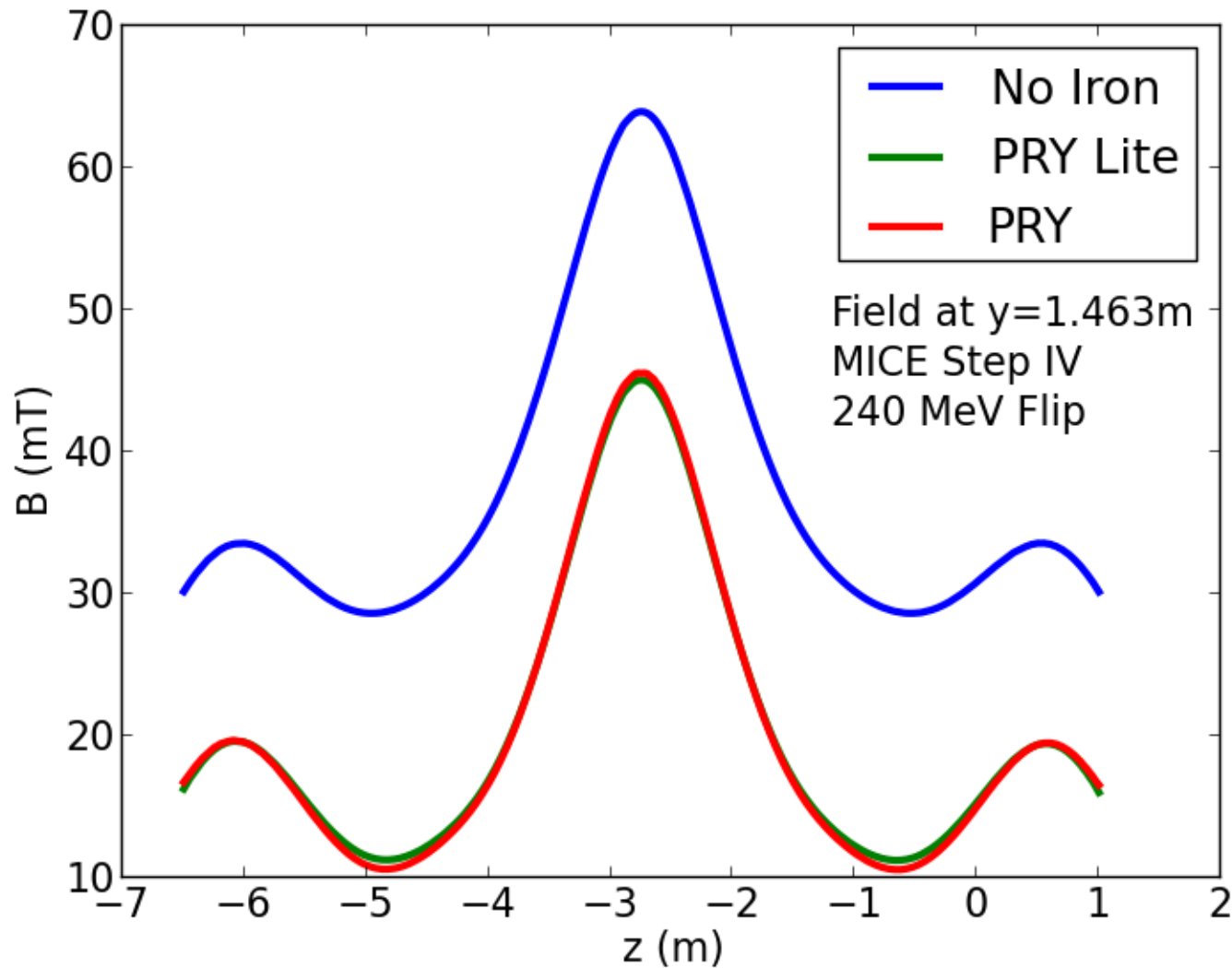
# Cryocooler Heads

CAD model courtesy of S. Plate / J. Tarrant



- Concern: PRY may increase field at cryocooler heads

# Field Cryocooler Head

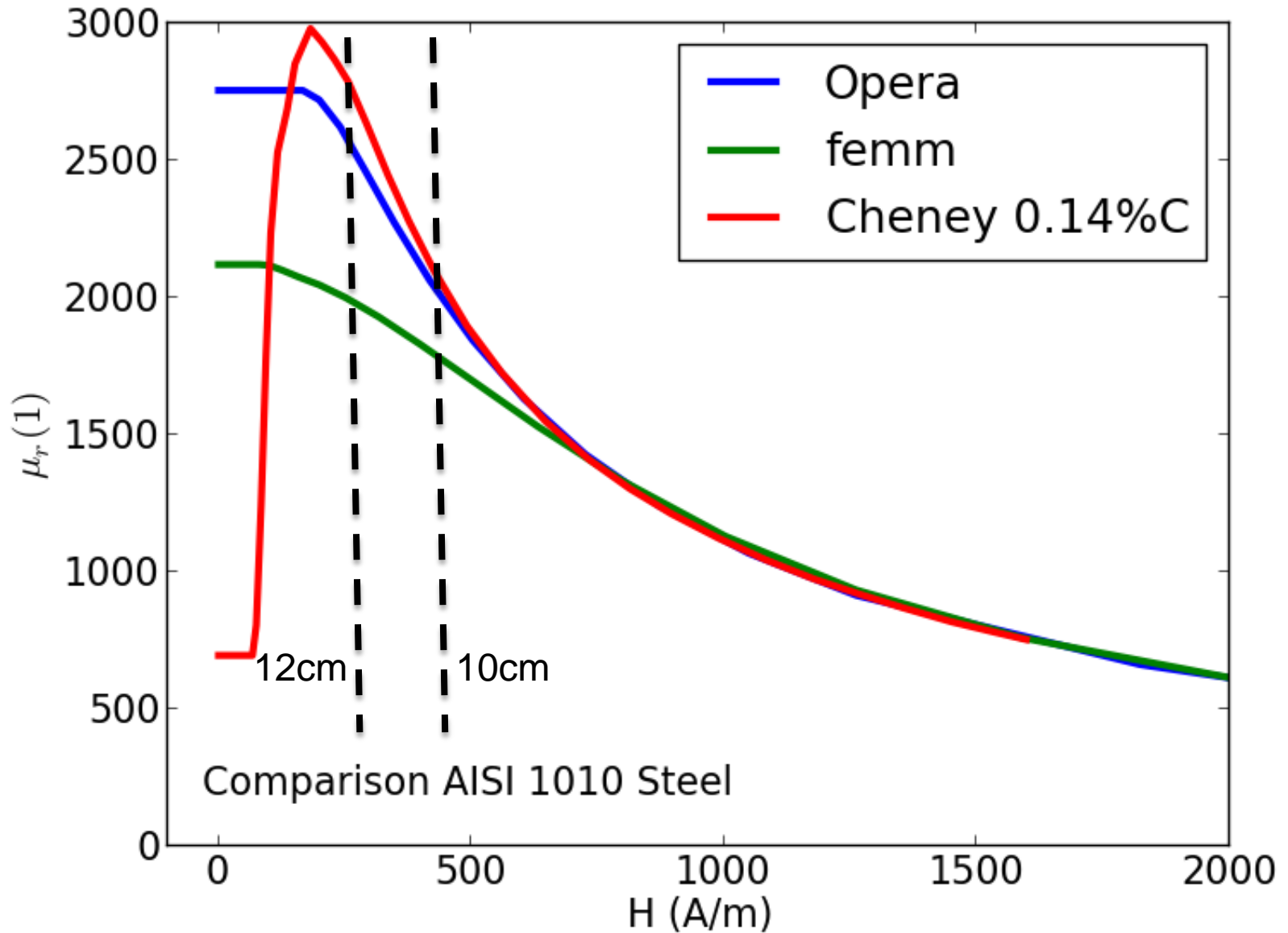


**PRY reduces field by 30%**

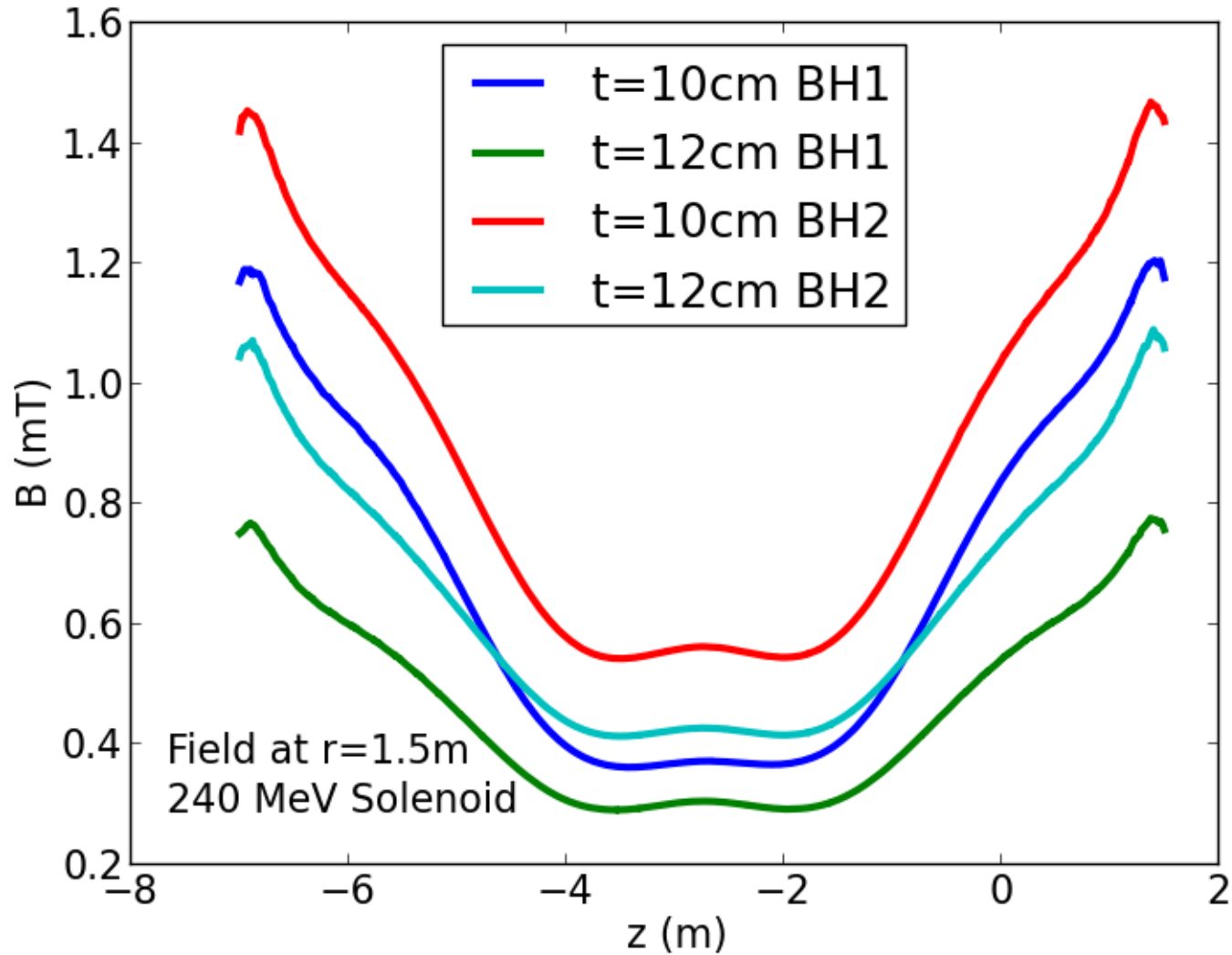


- Material Properties
  - Magnetization curve AISI 1010
- Mitigation strategies
  - Margin (increase shield thickness 10→12 cm)
  - Different material

# AISI 1010: $\mu_r$



# Sensitivity Study



- Shielding concept for MICE
  - Reduces stray fields to safe level (factor 50+)
- Engineering
  - Progressing as planned
  - Interferences and detailed drawings
  - Steel source investigation
- Performance / Risk mitigation
  - Shield thickness 10→12 cm