# MICE CM32

## 8th February 2012

# Magnet Group Report

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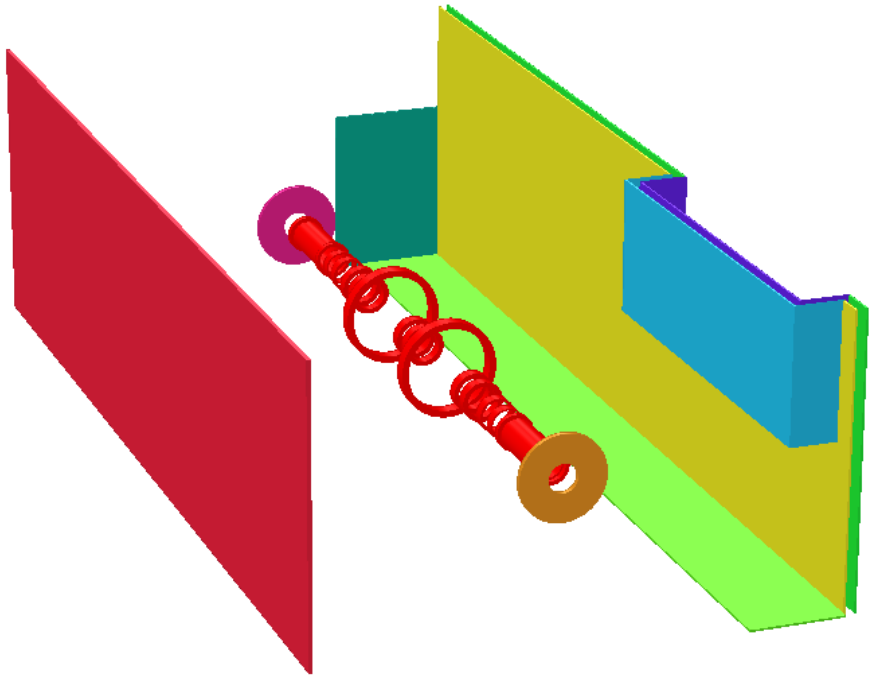
# Phase VI, Solenoid mode, 240MeV/c
# VF Opera Magnetic Shielding Wall Model

4/Feb/2011 14:38:21

MICE system and shiel



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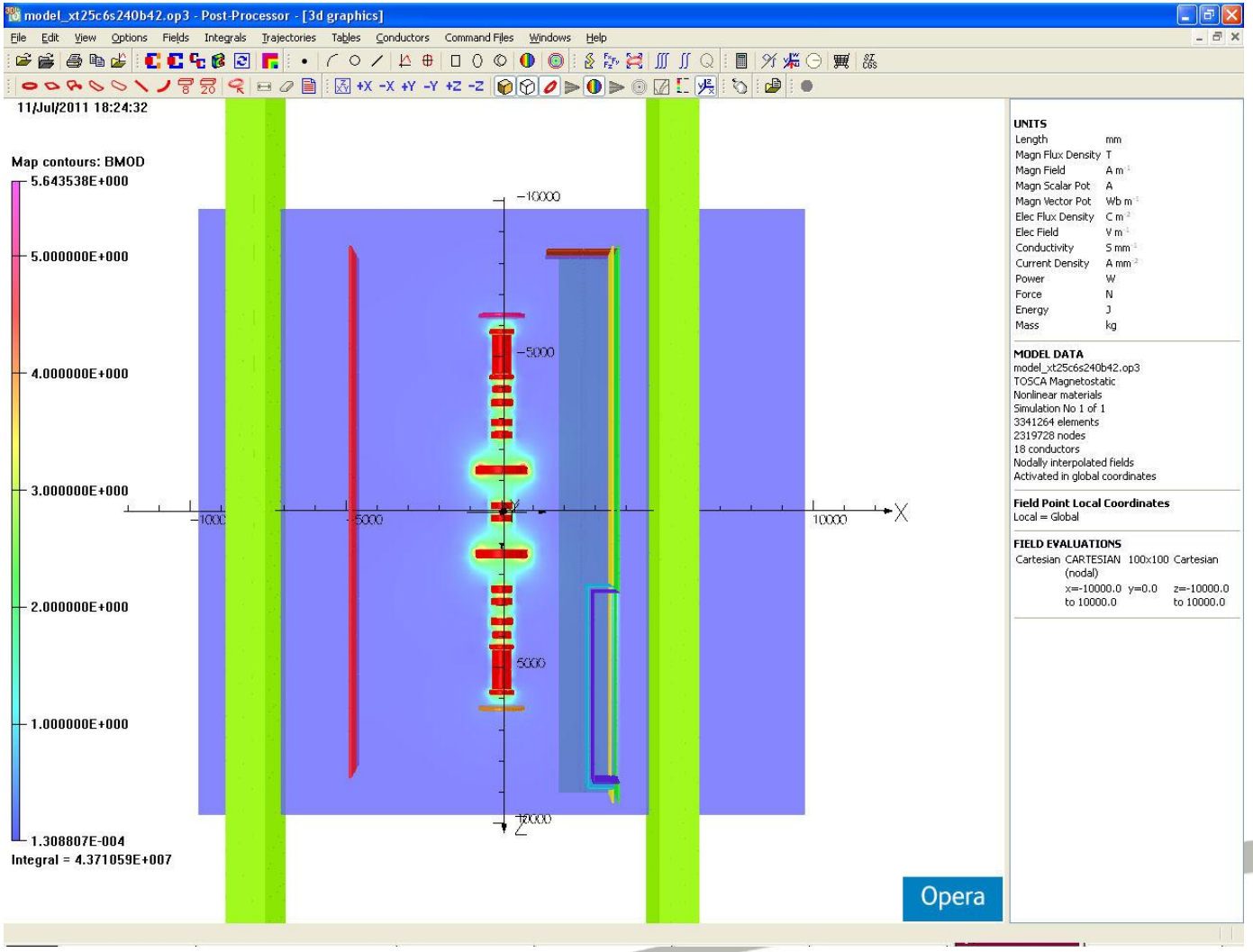
# Phase VI, Solenoid mode, 240MeV/c Beta 42 Zone map of field in ZX plane through beam axis (Y=1684mm) (viewed from above) – complete map




Bmod = 5.6T max

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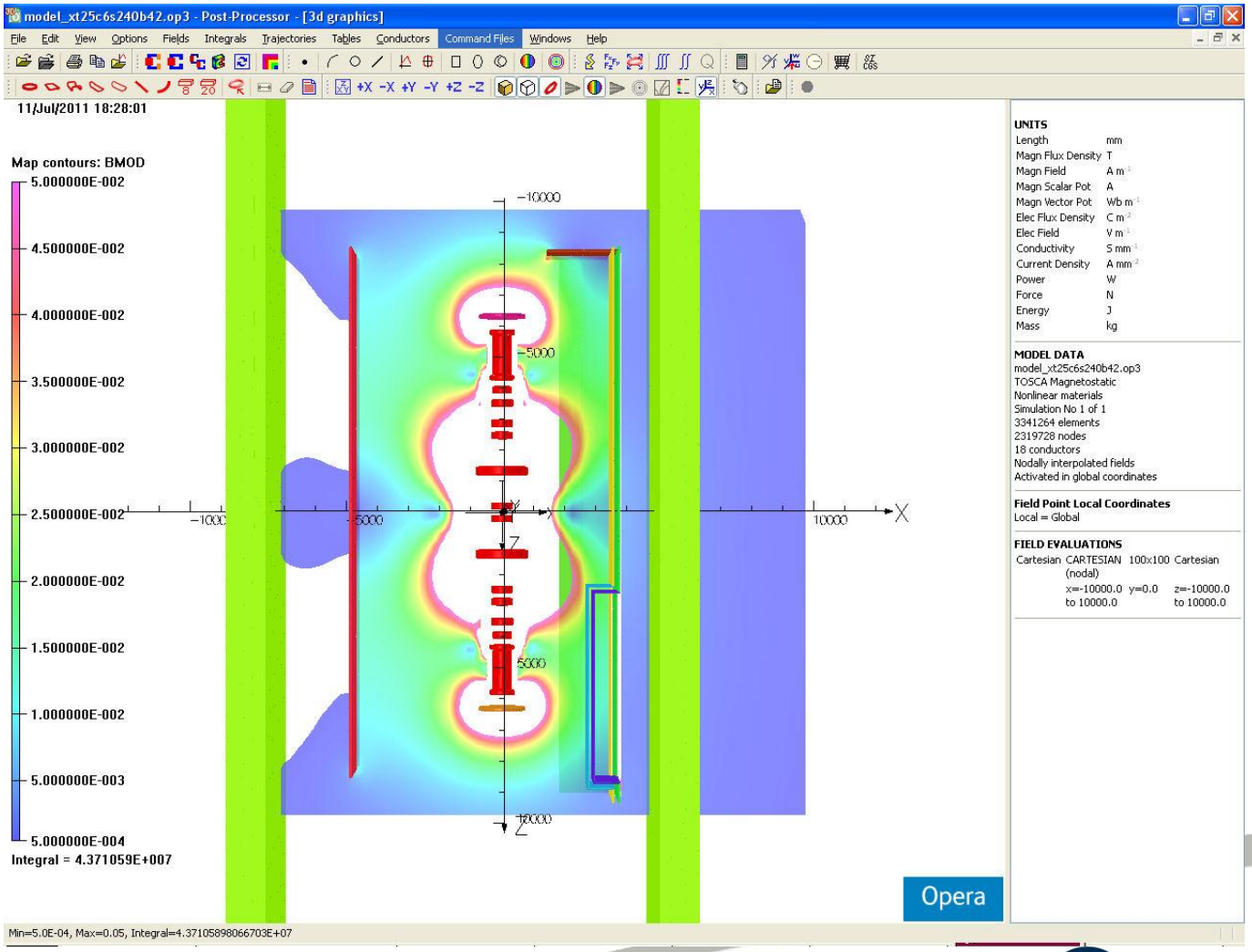
# Phase VI, Solenoid mode, 240MeV/c Beta 42 Zone map of field in ZX plane through beam axis (Y=1684mm) (viewed from above) – 5 to 500 Gauss only




NB: Field within Shielding Wall is mostly > 50 Gauss

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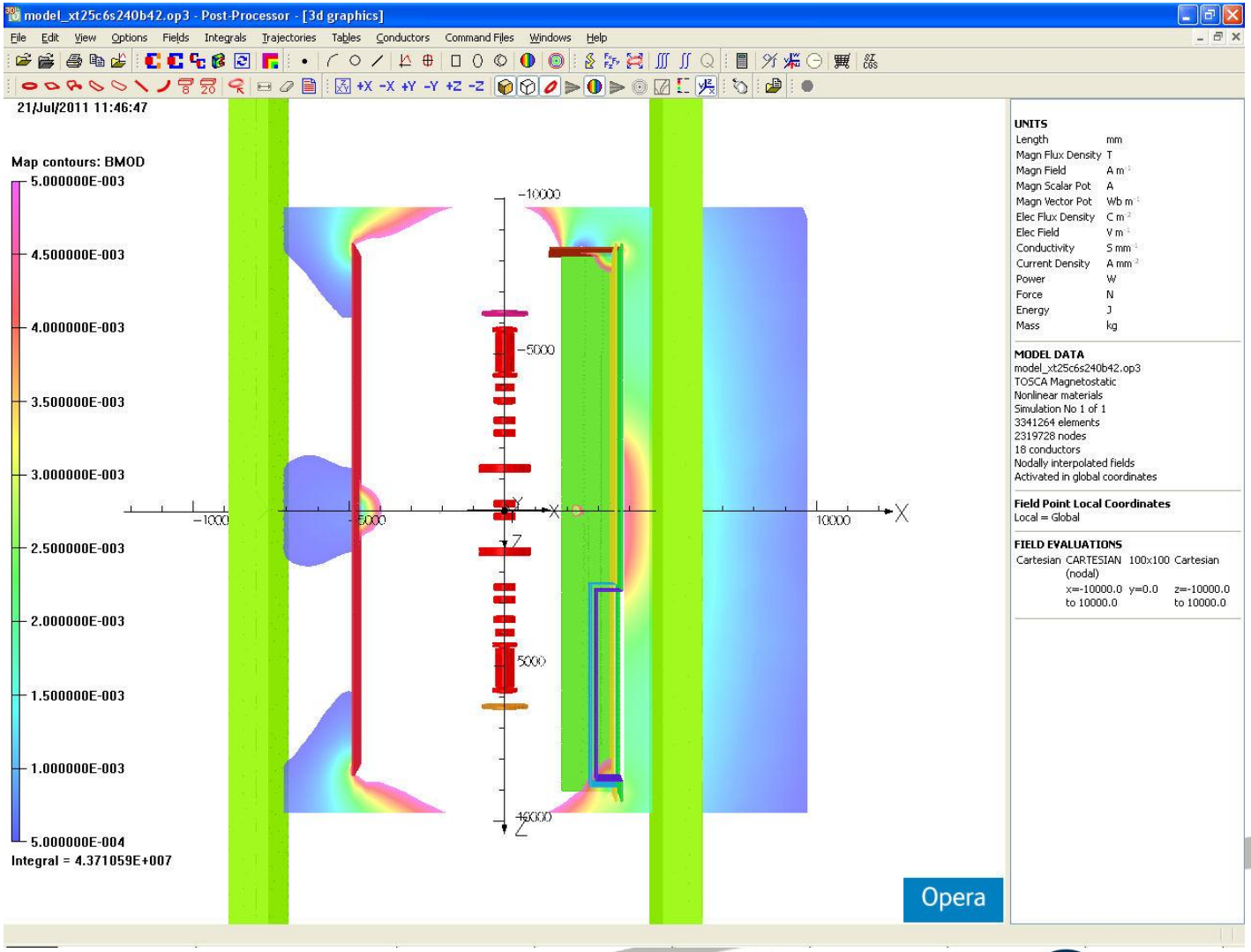
# Phase VI, Solenoid mode, 240MeV/c Beta 42 Zone map of field in ZX plane through beam axis (Y=1684mm) (viewed from above) – 5 to 50 Gauss only




NB: Field behind Sth Shielding Wall is still 25-50 Gauss
Note how far the fringe field extends West & East

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# Effect of Stray Magnetic Field from Cooling Channel Magnets on MICE Infrastructure

- **MICE infrastructure components affected by stray magnetic field**
  - All components within the magnetic shielding walls (and slightly beyond) (see field plots) will be subject to very high magnetic fields
    - **There is no place where the field will be less than 50 Gauss**
    - **Most of the region will experience fields in excess of 500 Gauss**
  - The stray field will affect numerous infrastructure components, particularly:
    - Turbo-pumps (fields > 5 Gauss) (due to eddy-current heating)
    - Rotary or scroll pumps, and motors generally
    - Transformers, relays, circuit-breakers (MCBs and RCDs)
    - Electro-magnetic valves, and proximity detectors (which use Hall effect)
    - Cryo-cooler heads and their compressors
    - Computer hard-disks, and other magnetic media
    - Vacuum gauges
  - It has been confirmed that **sensitive components can be individually protected** with single-layer Mumetal screens, **but at a cost** (eg - each of the 31cryo-cooler compressors will need a protective screen costing ~£1500 => £47k)
    - These screens can be designed and produced within 7 weeks for any items that are overlooked
  - **It is important to keep sensitive components as far from the stray fields as practical, to reduce the risk of malfunction and the consequential cost of remedial protective screening**

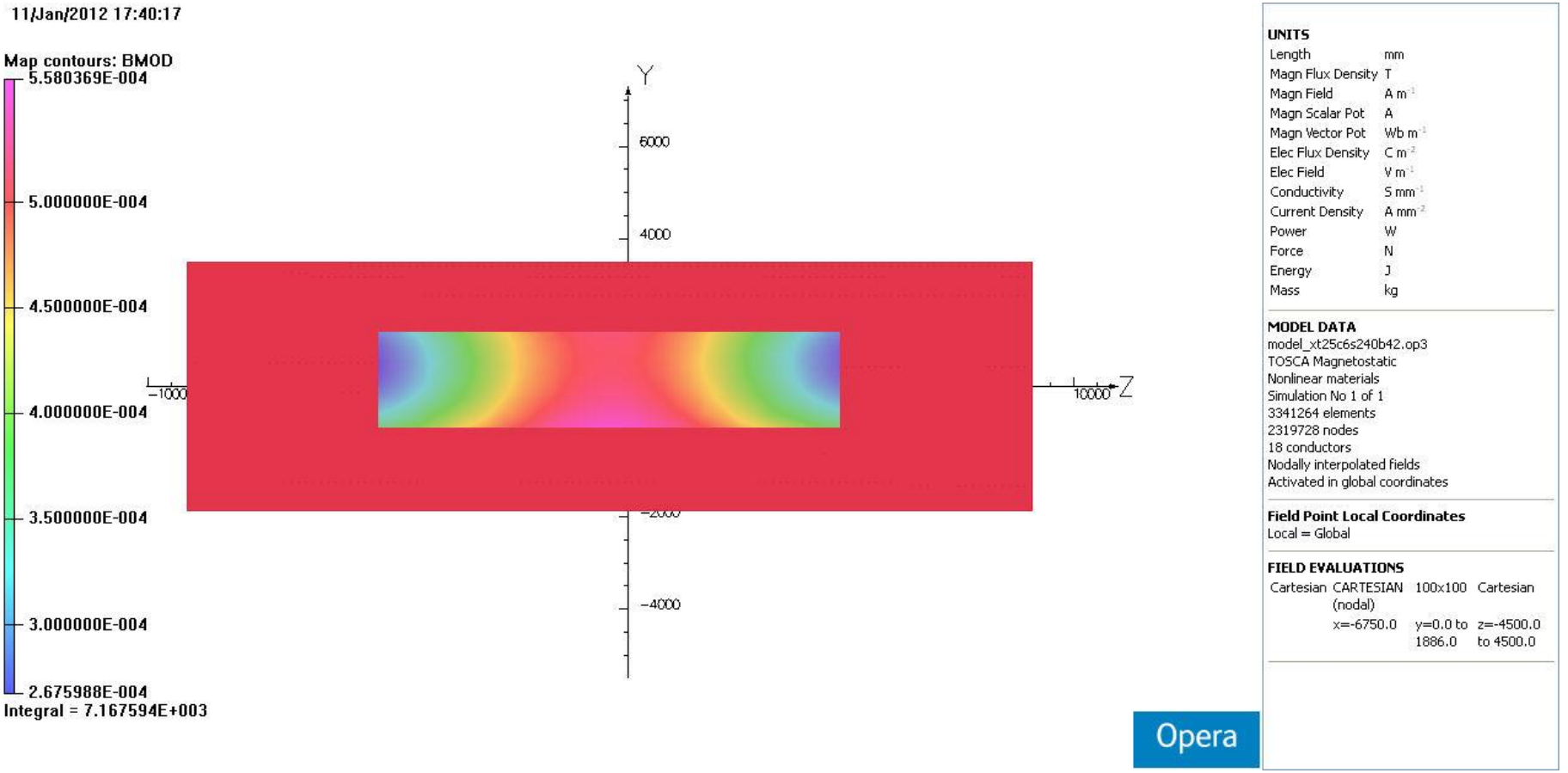
# Conclusions from previous report to CM31

- The MICE magnetic shielding walls are effective in shielding the ISIS and MICE Control Rooms from stray magnetic field in all MICE Steps and cases, except for the most energetic cases within Steps 5 and 6.
- MICE is in the process of seeking approval from ISIS and RAL SHE Group to operate the MICE Cooling Channel magnets in these conditions with restricted access to areas such as the ISIS & MICE Control Rooms by means of signs warning of stray magnetic fields
  - But there is no guarantee that ISIS and RAL SHE Group will agree to this request
- It is envisaged that the strength and extent of the stray magnetic fields predicted by the analysis will be checked by taking magnetic field measurements in key areas during running of the MICE operations, as confirmation.
- Numerous MICE infrastructure components could potentially be seriously affected by the stray magnetic fields, but there are ways to protect them, if they cannot be relocated, by means of Mumetal screening – but at a significant cost

# Magnet Group tasks since CM31

- Identification of magnetically-sensitive components within the Cooling Channel volume
  - Eg: Tracker Cryostat turbo-pumps; cryo-cooler compressors; relocated air-conditioning unit; RF pre-amplifiers; electro-magnetic valves, valve-actuator proximity detectors, and vacuum gauges on H2 system; Control & Monitoring racks
  - **It is essential that system owners check their systems thoroughly for magnetically-sensitive components, avoiding/replacing them where possible, and bringing all remaining sensitive components to the attention of the Magnet Group before installation in the MICE Hall**
- Use of the TRD Magnetic-Shielding model to predict magnetic field and potential shielding requirements in specific areas
  - NB: This can only be done if there is no ferrous content to object(s) being considered
- Adaption of the TRD model to predict the effect of inserting significant ferrous objects into the Cooling Channel volume (including Mu-metal shielding), to predict:
  - Resultant local distortion of magnetic field
  - Resultant forces on inserted objects, and thereby on Cooling Channel magnets
- Recalculation of the internal forces with the AFC module, due to an accidental departure from the TRD specification by Tesla during winding of the coils, resulting in:
  - Increased number of wound turns (84 layers instead of 76), leading to:
    - Change in coil geometry
    - Reduction in operating current from 250A to 225A
      - Which has led to a benefit in relaxing the power-supply specification
    - Changes in internal forces from 3.5 to ~4 MN
      - This is close to the margins, so is undergoing close scrutiny

# RF Power Amp
## Step 6 – Solenoid Mode 240 MeV/c B42




Bmod = 6 Gauss max

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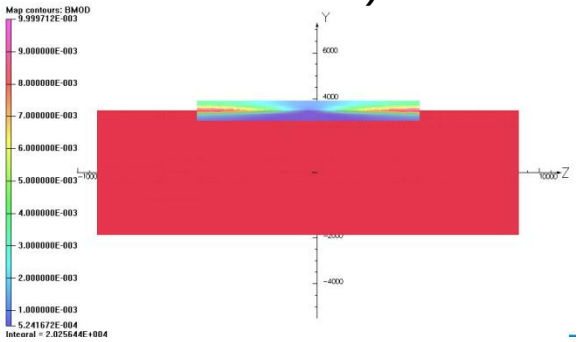
# **RF Pre Amp** – next to S/Wall

(Solenoid Mode 240 MeV/c B42)

**Step 6**

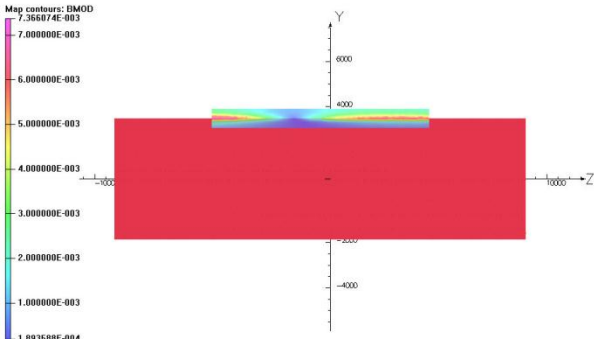



Bmod = **100 Gauss max**

**⇒28 G if moved 200mm away**

**⇒17 G if moved 500mm away**

**Step 5**

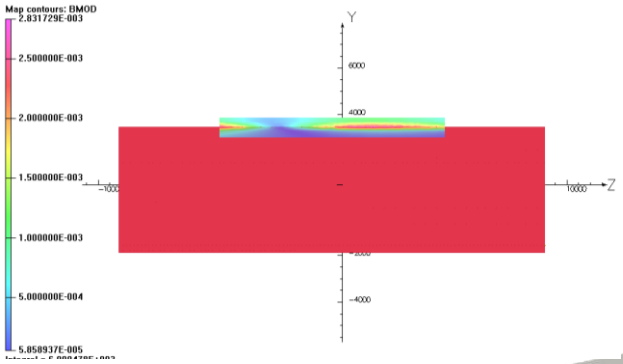



Bmod = **74 Gauss max**

**⇒20 G if moved 200mm away**

**⇒13 G if moved 500mm away**

**Step 4**




Bmod = 28 Gauss max

*Model needs to be refined for accuracy in the vicinity of the Nth Shielding Wall, as the actual wall differs from original design in several respects*

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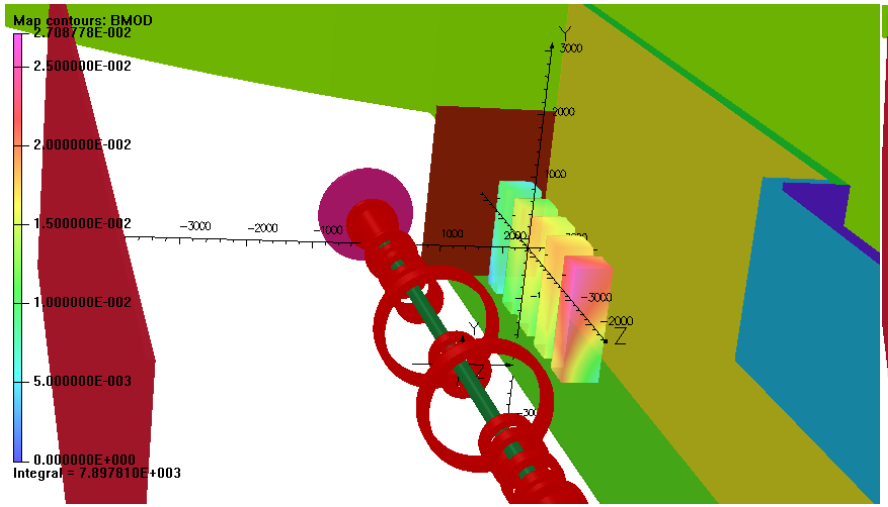
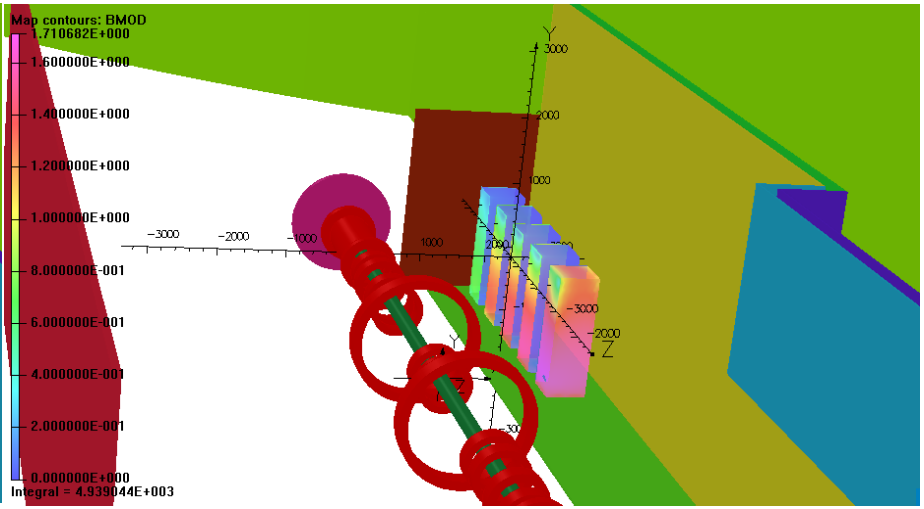
# Cryocooler Compressor Analysis




Predicted fields
without ferrous content




Predicted fields
with ferrous content

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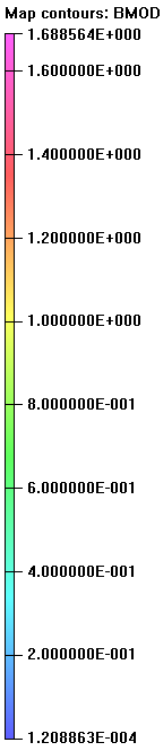
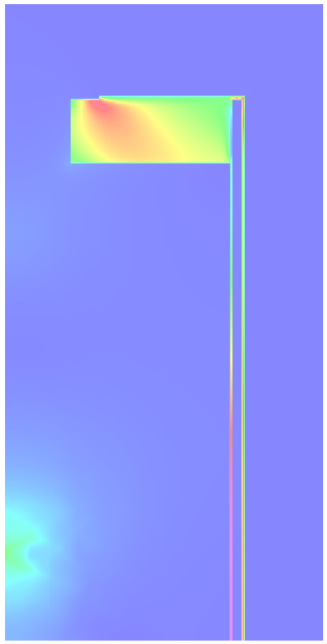
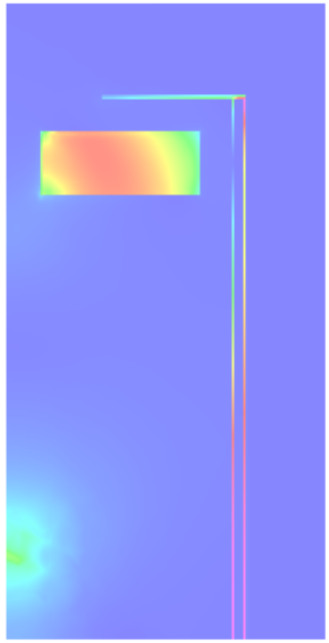
# Air Conditioning Unit Analysis



A/C unit next to Shielding Wall



A/C unit moved away from to Shielding Wall

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