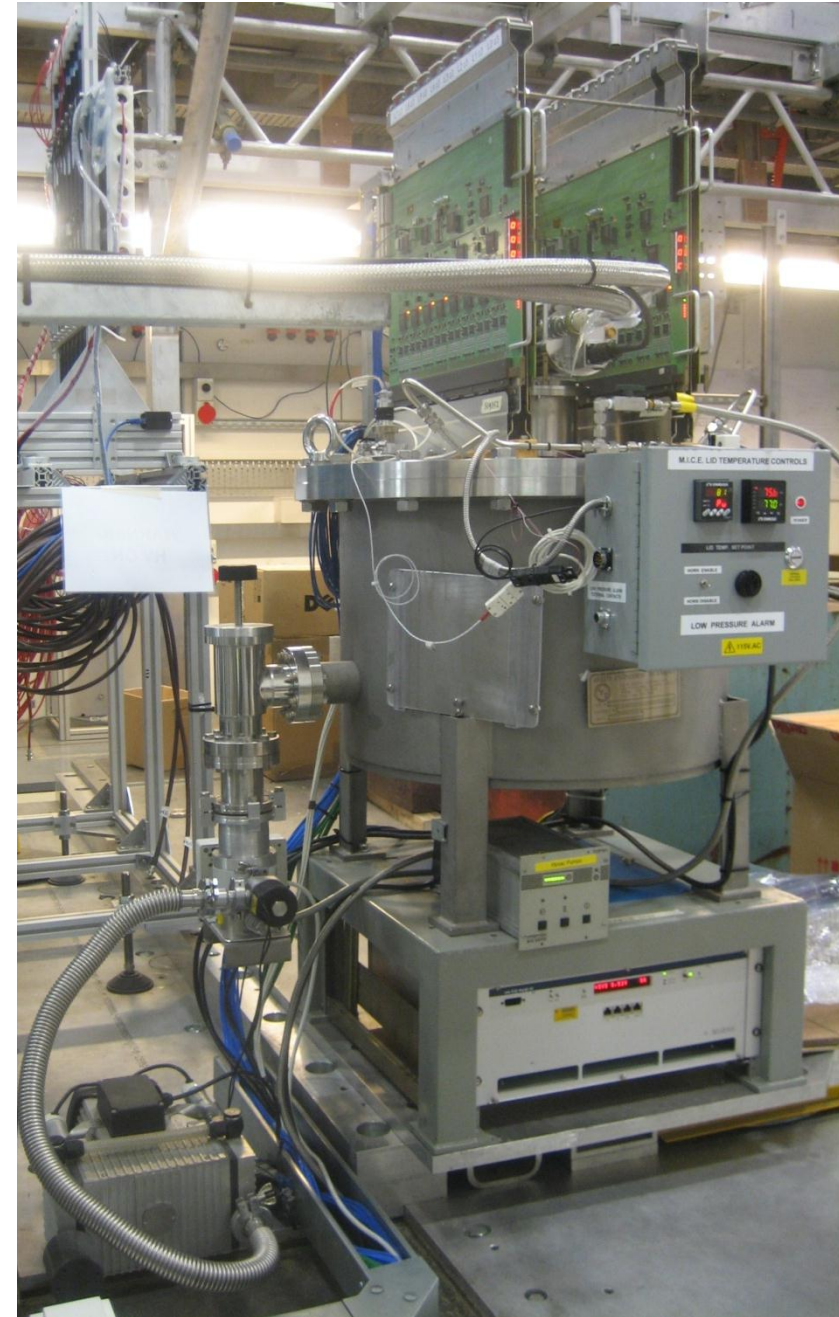
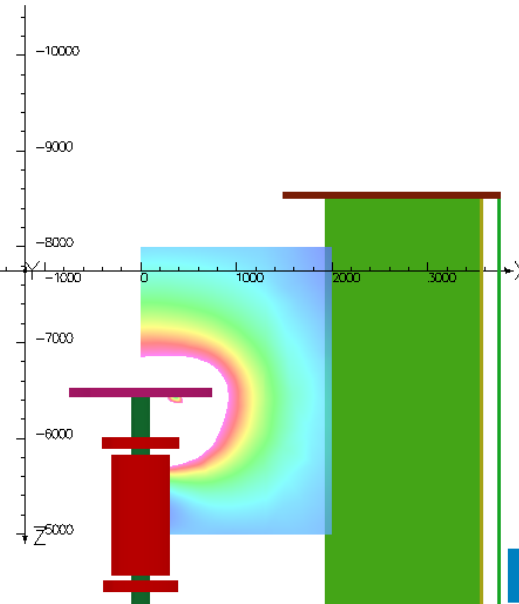
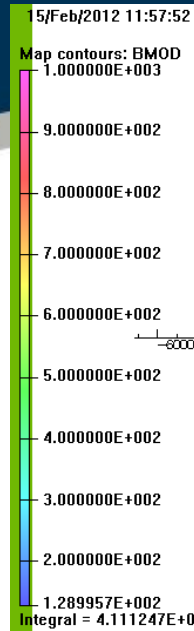


Magnetic Shielding for Tracker components

Craig Macwaters – STFC
MICE CM33 Glasgow



Field at Cold head level



UNITS

Length	mm
Magn Flux Density	gauss
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

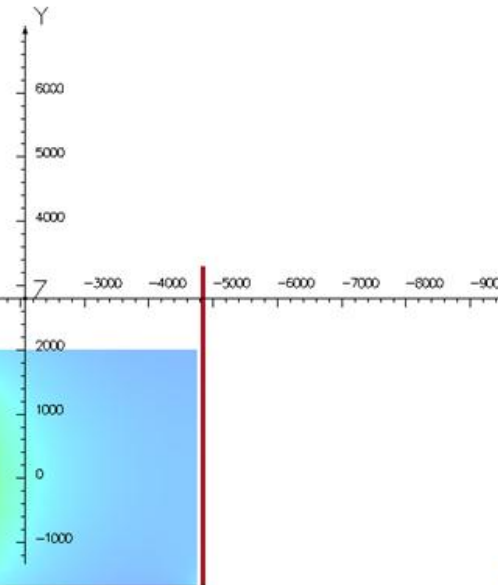
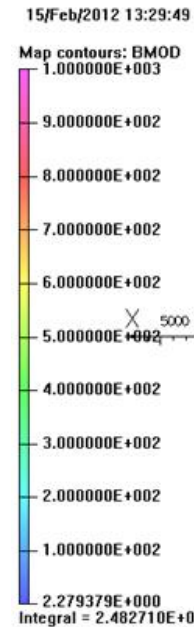
MODEL DATA
model_xt25c6s240b42.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
3341264 elements
2319728 nodes
18 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

FIELD EVALUATIONS
Cartesian CARTESIAN 200x200 Cartesian
(nodal)
x=0.0 to y=-534.0 z=-8000.0
2000.0 to -5000.0

Opera

Cross section view



UNITS

Length	mm
Magn Flux Density	gauss
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA
model_xt25c6s240b42.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
3341264 elements
2319728 nodes
18 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

FIELD EVALUATIONS
Cartesian CARTESIAN 200x200 Cartesian
(nodal)
x=4000.0 to y=-1684.0 z=-6150.0
-4750.0 to 2000.0

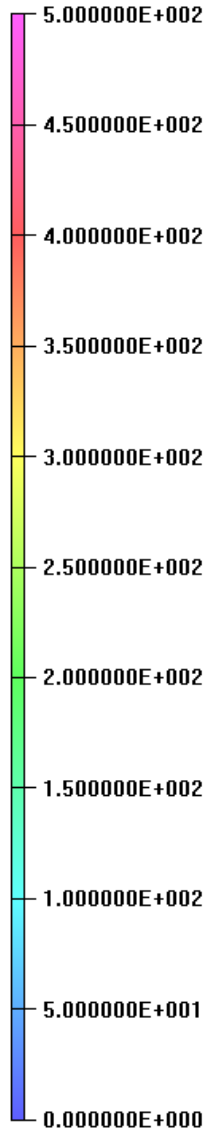
Opera

Weiner AFE PSU

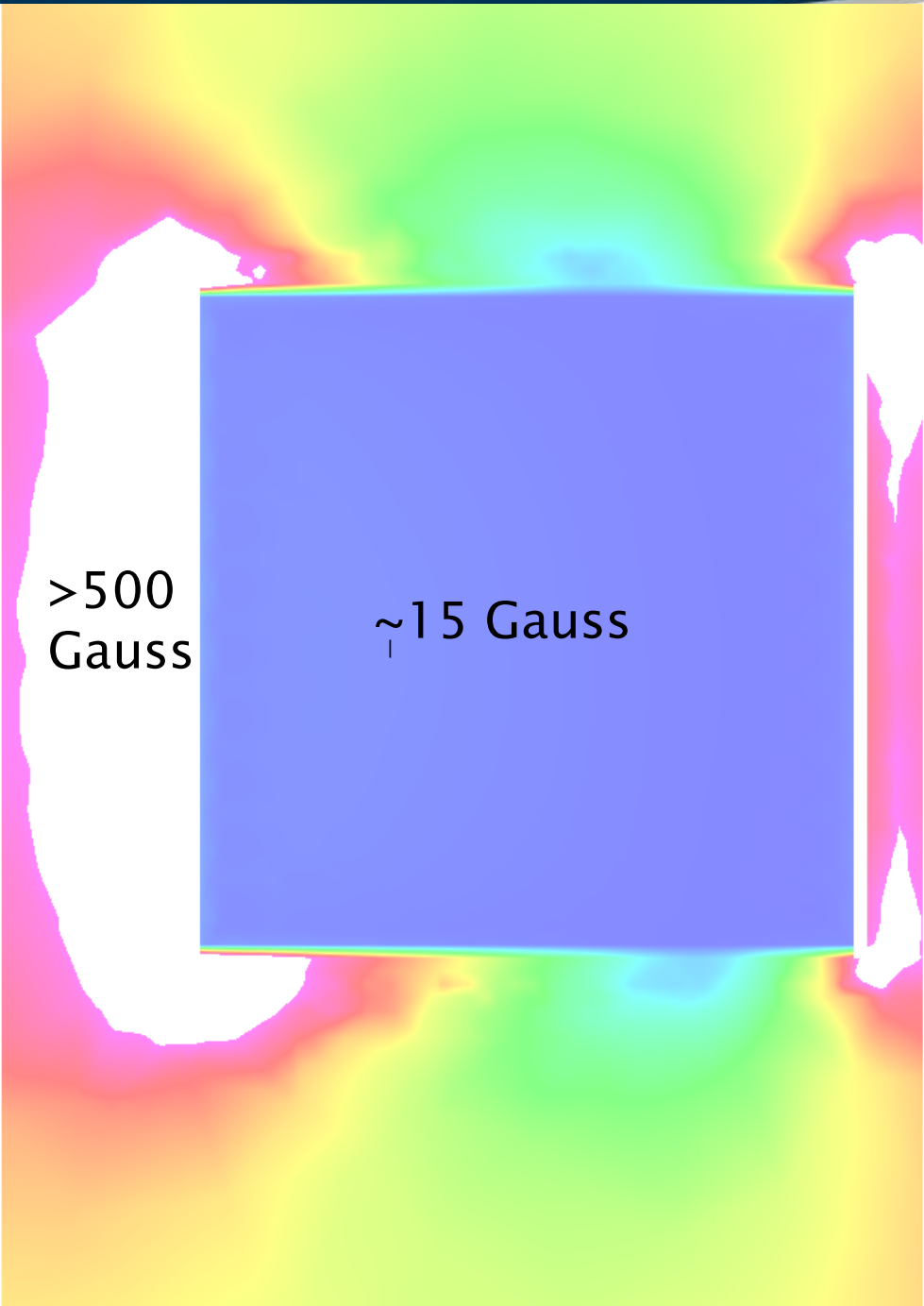
- Weiner limit 250Gauss, calculated field in air ~300Gauss
- Cannot go remote – FNAL found noise
- Done initial modelling
- Found 5mm steel/1mm mu-metal
- Only 1st pass. Need services
- Forces 1000N x, -400N y, 700N z
- Fit shield within stand or make all new integrated solution. Need more modelling
- Require mechanical design input and testing in typical field



Map contours: BMOD



Integral = 4.267001E+008



UNITS

Length	mm
Magn Flux Density	gauss
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA

modelxx_1mmmetal and 5mmsteel.op3
TOSCA Magnetostatic
Linear materials
Simulation No 1 of 1
1644768 elements
740707 nodes
18 conductors
Nodally interpolated fields
Activated in global coordinates

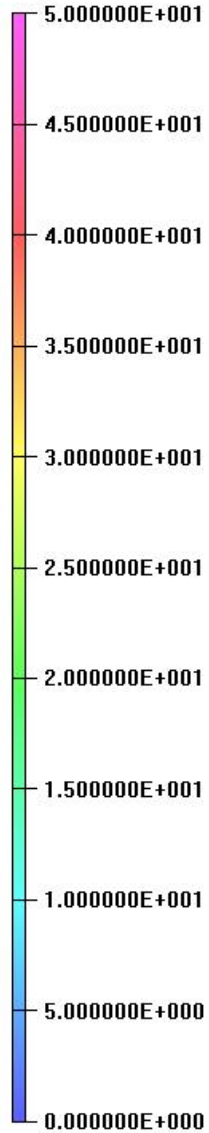
Field Point Local Coordinates

Local = Global

FIELD EVALUATIONS

Cartesian CARTESIAN 200x200 Cartesian
(nodal)
x=1500.0 to y=-1500.0 z=-5000.0
800.0 to -7000.0

Map contours: BMOD



Integral = 4.267001E+008



UNITS

Length	mm
Magn Flux Density	gauss
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA

modelxx_1immumetal and 5mmsteel.op3
 TOSCA Magnetostatic
 Linear materials
 Simulation No 1 of 1
 1644768 elements
 740707 nodes
 18 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates

Local = Global

FIELD EVALUATIONS

Cartesian CARTESIAN 200x200 Cartesian
 (nodal)
 x=1500.0 to y=-1500.0 z=-5000.0
 800.0 to -7000.0

Cryostat cold heads

- Sumitomo SRDK-415D cryocooler
- Sumitomo : Max 350G due to motor loading
- Mike Green confirms similar for Cryomech
- We have 700G in air in this region
- Field will cause increased piston wear and require more regular servicing
- Will need local shielding covering cold head and motor
- Mike G thinks shielding might be difficult to do without increasing the heat loads



Lid Heater Box

- Presently steel box with relays and 24V PSU inside
- Area is ~ 300 Gauss in air
- Relays sensitive to ~ 20 Gauss
- Requested modelling
- Looking into moving or shielding
- If moved still might need shielding and extended heater element and thermocouples



Cryostat turbo pumps

- New Leybold SL80 CF63 turbos
- Limit 50G radially. In area ~ 400 Gauss in air
- Requested modelling
- DL vac group responsible
- Looking at ideas like nEXT400 shield
- Chris P. talking to Leybold about non ferrous bearings and shaft
- Therm/Rel testing
- Shut off valve - Pnu



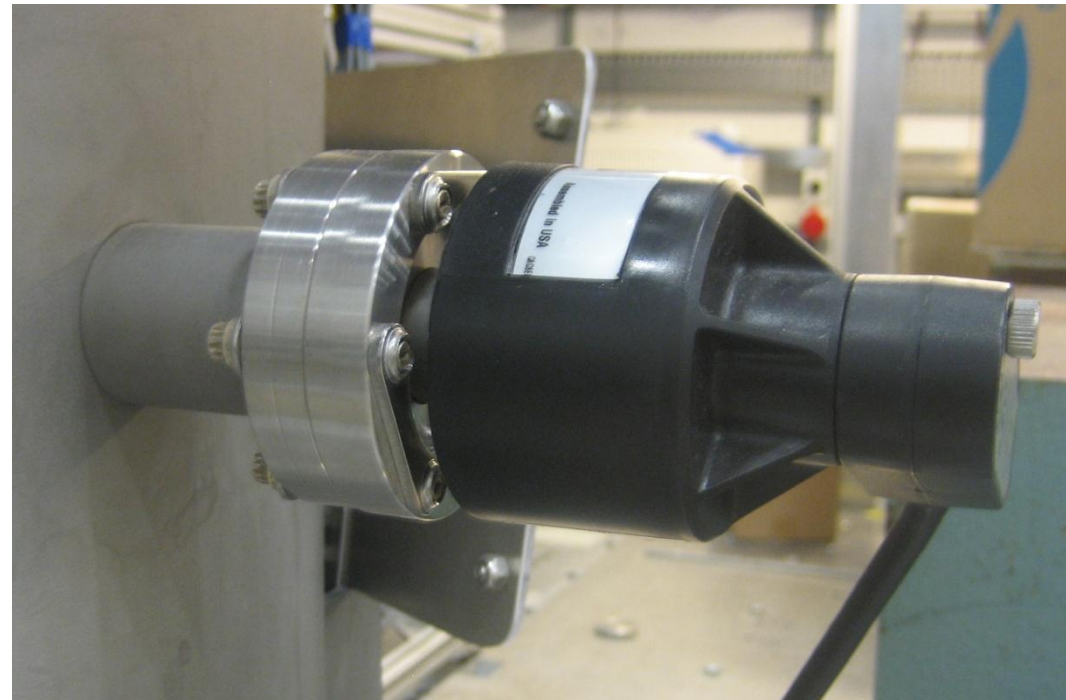
Turbo controller

- Leybold TD400 turbo controller
- Operating limit 150 Gauss
- Next to turbo so 400G in air
- Easiest to move away in a rack
- Put with associated AC/DC PSU
- Official 5M cable limit
- Got 8M but with no guarantee
- About to start some pump tests
- If can't accommodate or operate from distance then shield box



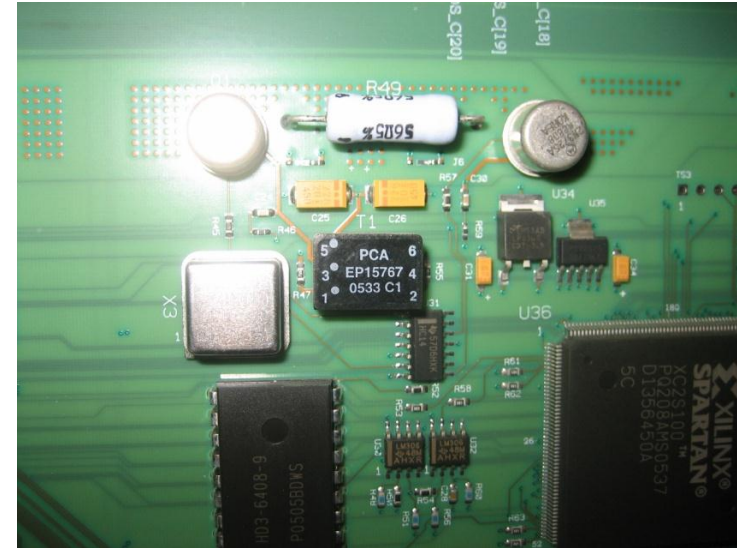
Cold cathode vac gauge

- MKS I-Mag vacuum gauge used on cryo insulating vac
- 3 different models tested by Ben Shepherd at DL
- 2 out of 3 effected
- Field in air ~ 400 Gauss
- Will get Ben to test this
- Concern that shield will effect performance
- Consider changing
- Inverted magnetron vs traditional penning type



AFE PCB transformer

- Pulse transformer using ferrite toroid
- Paul R. thinks good to 800 Gauss
- In an area showing 500-1000 Gauss
- Requested modelling
- Most likely requires a mu-metal can
- Will need some “neat” mounting on PCB and cover/lid on reverse



Other tracker items

Prototype
compressor
shield

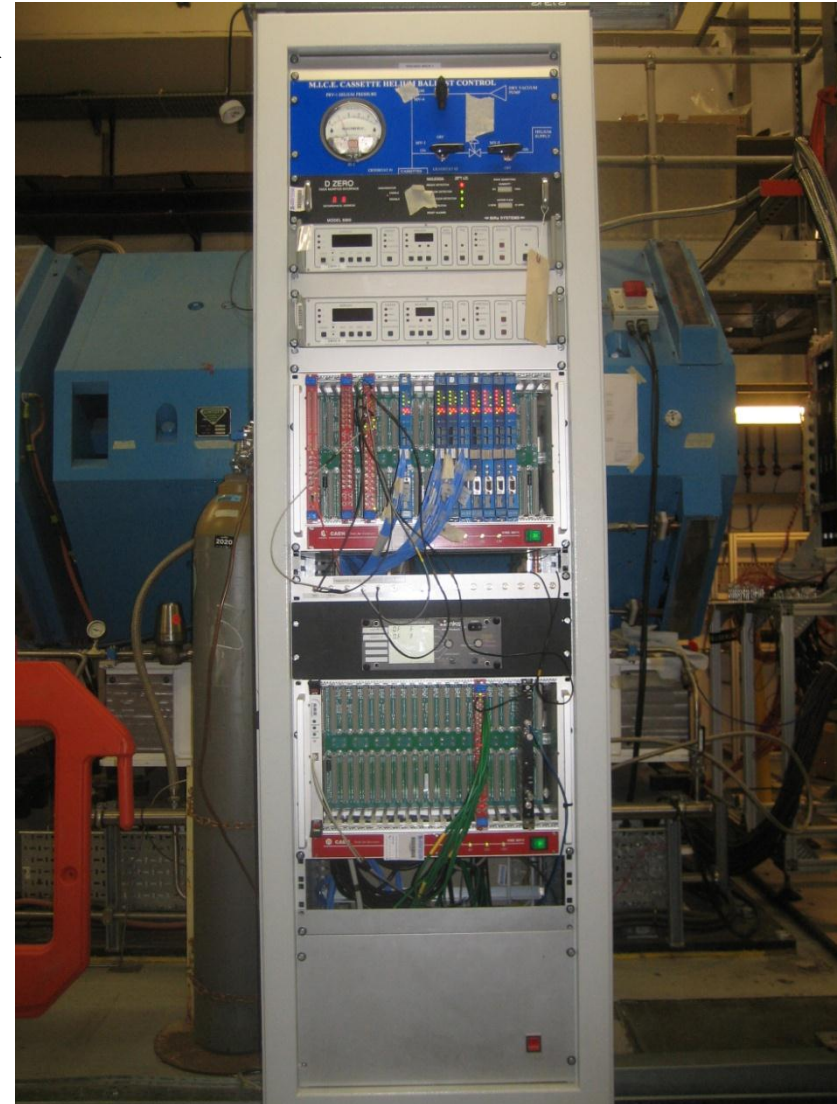


Control racks →

Where will
these items
go?

Likely not to
have access
inside the
shield box.

Limited cable
lengths. 12M
VLSB. 30M
for He lines

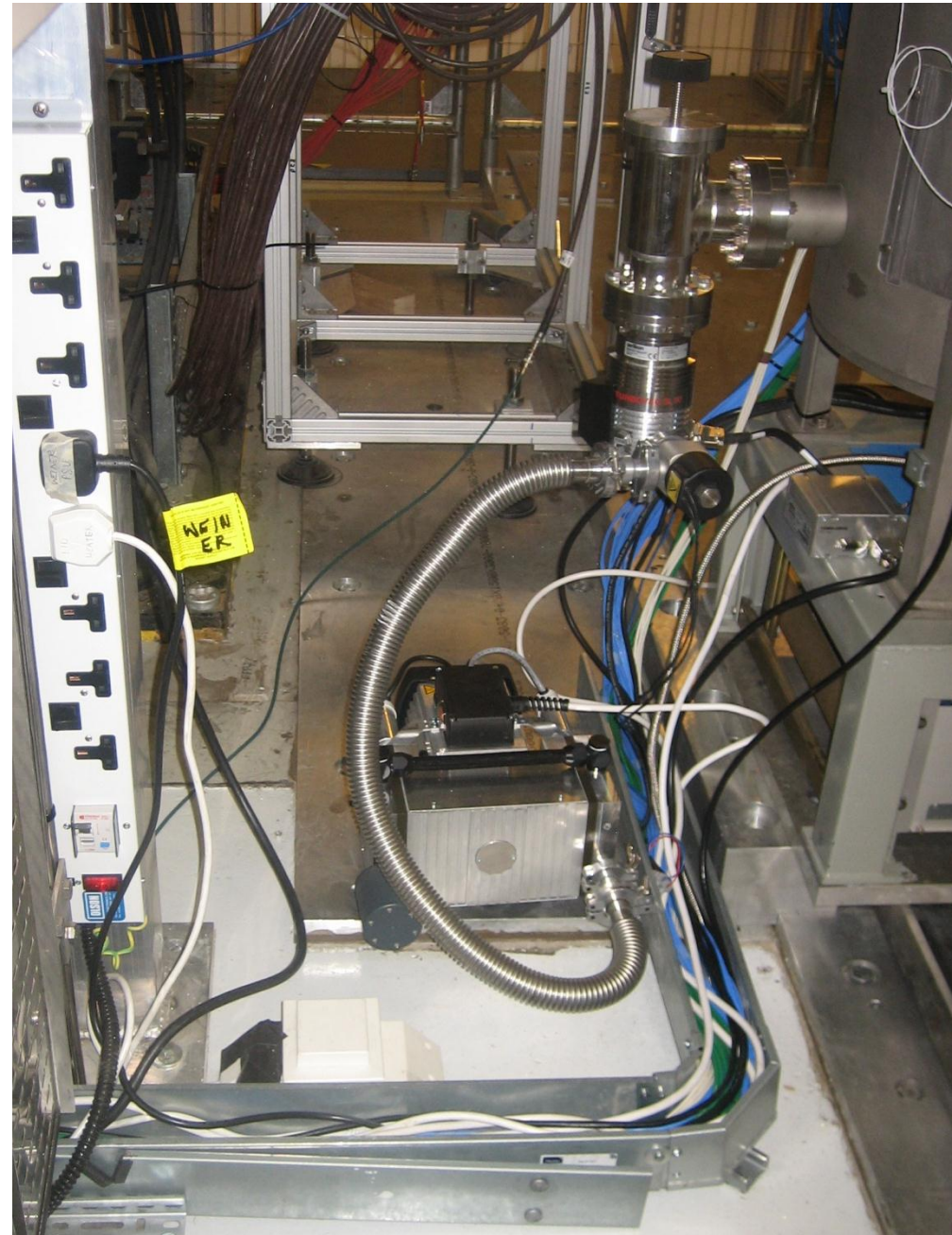


More tracker items

- Backing pumps. Likely to change to “Global” pump system
- Fall back, local pumps are diaphragm based. Probably ok.
- Vesda smoke detector. Trip relays inside. Shield box?
- UKUS transformer for lid heater box. Design out?
- In total we have 12 tracker items we need to take action on
- Even if we move the compressors and racks, still got 10

1xCryostats services

- Turbo control cable (5 or 8M max)
- 24V for turbo controller
- Backing pump mains
- Weiner interlocked mains
- Auto shut-off vac 24V
- Lid heater contacts
- 8 x green RG58 time & trig cables
- 4 x VLSB (Rubinov 12M max?)
- Blue RG58 1553 cable
- 5 x White Oxford temp sensors (max?)
- Weiner permanent mains
- Lid heater mains 110V ac
- MKS CCG gauge (max?)
- RG58 Weiner PSU enable
- Gas flexi for He cassettes
- 2 x 30mm braided hoses (30M max)
- 1 x 10mm power for cold head



We can do this but...

- We need **more modelling** time and effort. Vicky has a huge queue of work. I only have one solution roughed out so far yet I would like another 5 items modelled.
- We would really benefit in having some **more experience** in the team. None of us have been through a major magnetic shielding design cycle before. We have to get this right first time, we do not have time to waste by learning from our mistakes.
- This is going to need a lot **more budget** than has so far been allocated
- Unless we get a significant increase in resources **the shielding will not be finished by October** when we are scheduled to install the first tracker
- We will need a considerable amount of **engineering effort to design shields** to integrate with existing services and equipment.
- We will need a **test facility** and a considerable amount of **test effort** to ensure the items are adequately shielded and will operate in the intended field. We cannot just install them and cross our fingers and hope for the best.
- We have to appreciate that shielding these items will mean that **“live” debugging becomes very difficult** with boxed off racks and equipment
- Understand that the model (and the items within it) produces results that are not utterly accurate. We have to approximate ferrous masses, item sensitivities, materials etc

Operation of MICE Vacuum Gauges in a Magnetic Field

Ben Shepherd, 27 April 2012

Introduction

Several of the vacuum gauges to be used on MICE will be operating in a relatively high-field region. Fields of up to 40mT are possible. The ion gauges to be used are of the inverted magnetron type, which relies in part on a field produced by an axially-magnetised annular permanent magnet to confine the ions on their way to the collector anode. An external magnetic field may disrupt the path of the ions to the point where they do not hit the anode, and the pressure reading is reduced. It is therefore desirable to verify the operation of these gauges in an environment where they are subject to a magnetic field.

Experimental Setup

A pumping cart in the MICE hall was set up with several different makes of ion gauge, some using different operating principles. The gauges used were:

Edwards WRG-5

Leybold PTR-225

Leybold PTR-90

A small permanent magnet block was held close to the gauges to generate a magnetic field. The block was a spare from the SRS HU56 undulator. It is made from NdFeB, and has dimensions of 40x40x10mm and a remanence of about 1.3T. The field generated by the block, in the absence of any other field sources, was measured using a Metrolab THM-1176 Hall probe to be 0.34T in contact, dropping off in an inverse-square fashion with increasing distance (Figure 1).

Figure 1. Variation of field with distance from the PM block.

Results

The reading from the Edwards WRG-5 gauge was observed to change when the PM block was around 30cm away, i.e. producing a field of approximately 0.5mT. The reading is reduced slightly, from 3.0×10^{-5} to 2.6×10^{-5} . The reading further reduces as the block is brought closer to the gauge. On contact, the reading evidently 'bottoms out' at its minimum value of around 10^{-9} . A separation of at least 2cm is required to keep the reading from changing by more than a decade. This corresponds to a field of about 70mT.

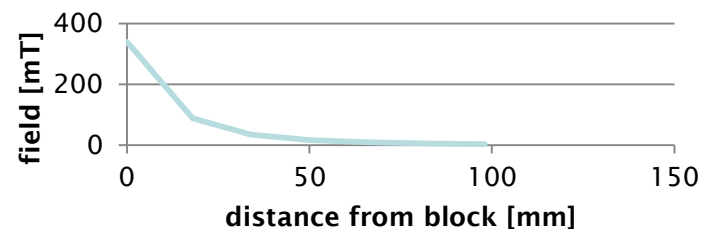
The magnetic field had almost no effect on the Leybold PTR-225 gauge. On contact, the reading only changed by a small amount, from 7×10^{-6} to 1×10^{-5} (i.e. in the opposite direction to the Edwards gauge). No discernible pressure difference was observed as the PM was brought up to the gauge.

For the Leybold PTR-90 gauge, there was no effect until the block was 5cm away (20mT), at which point the pressure reading steadily decreased, and reached a minimum of 10^{-9} on contact.

The Edwards gauge and the Leybold PTR-90 are combination gauges; in the high-pressure regime, the magnetic field had no effect whatsoever. Similarly, the field had no effect on a capacitance gauge.

Conclusion

The obvious winner here is the Leybold PTR-225 gauge. The reading only changed by a small amount with the probe in contact with the magnet. When the gauge was immersed in fields at a level comparable to those it will experience on MICE, there was no change in the pressure readings.





Ferrite Bsat 3000-4000G

MuMetal 0.6T

Steel 1.5T

Power Inverter

