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Major items from field affected component list

MICE Magnetic shielding review

C.Macwaters 23/9/13

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Overview of MICE Hall Model

- Tracker Cryostats, LH2 kit, Quad PSU, Linde controls

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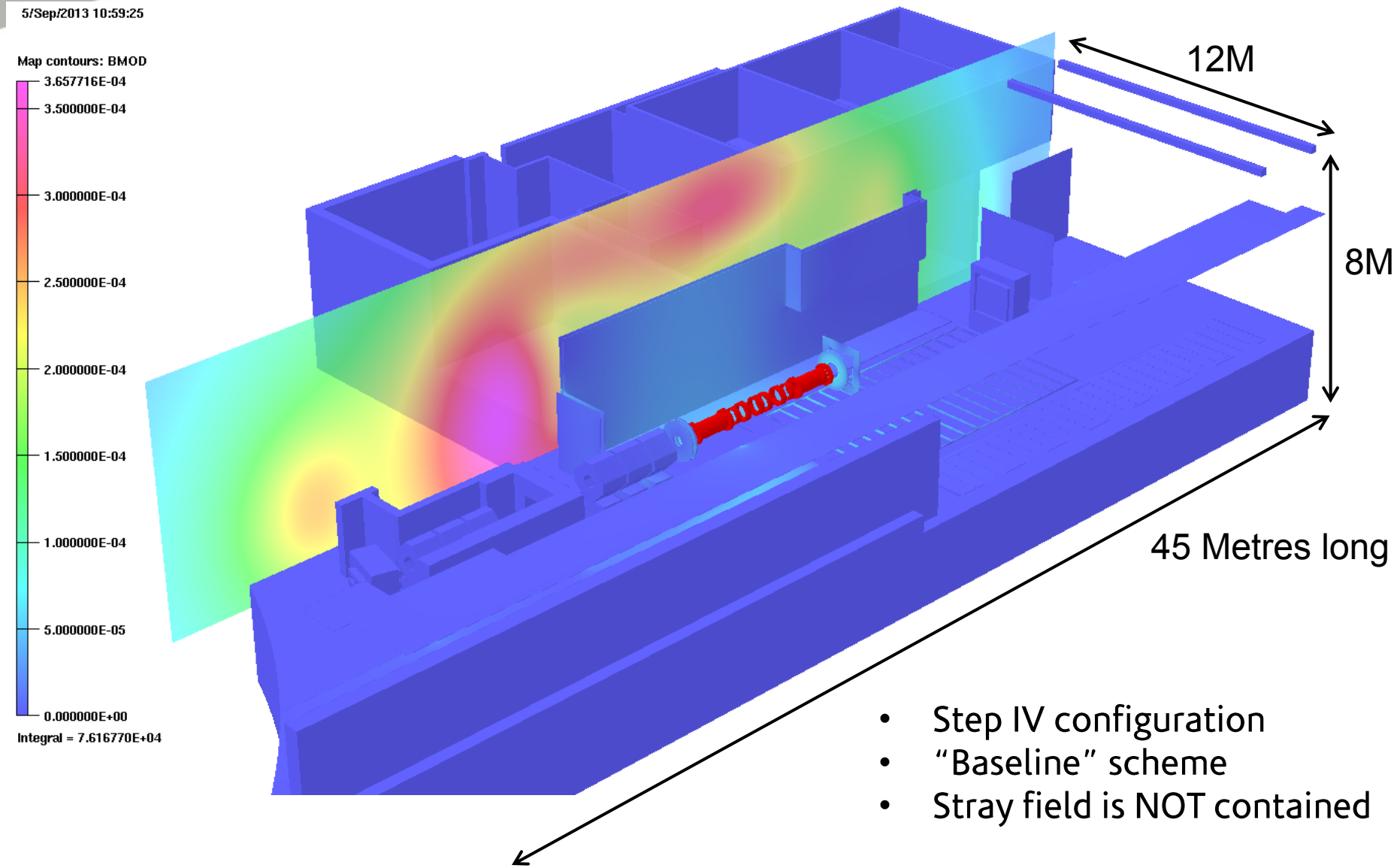
Overview of MICE Hall Model



- Step IV configuration
- "Baseline" scheme
- Stray field is NOT contained

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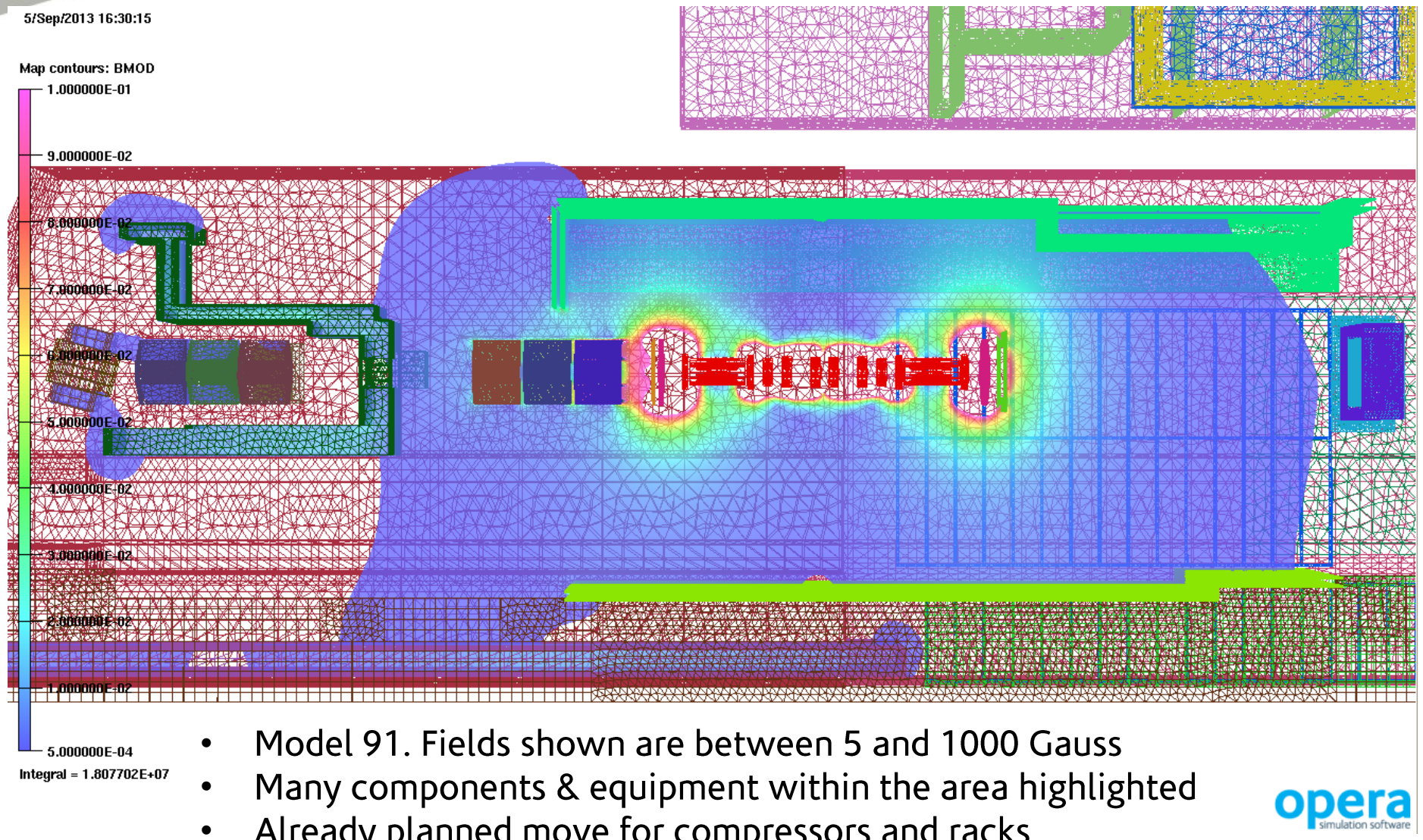
Overview of MICE Hall Model



- Model 91. Fields shown are between 5 and 1000 Gauss
- Many components & equipment within the area highlighted
- Already planned move for compressors and racks

opera simulation software

Survey & Model analysis

- Over 4000MSq full of equipment
- Compiled list of over 130 potentially sensitive items
- Typically included electronics & controls, sensors, power supply, pumps etc.
- Recorded XYZ position in hall

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- Specific co-ordinates for small items
- Cartesian patches for larger items and spaces

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- Evaluated on basis of item field sensitivity and operational risk
- Some items have manufacturers data, some can only assume generic values
- Testing of separate items mostly difficult and costly
- More importance on safety items. Fire, smoke, PPS etc
- Generally 10 Gauss threshold for further investigation and field mitigation

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Highlights from sensitive items list

Object	Location	System	Field in air (G) 240MeV/c Sol	Comment/Action
PPS Trench Magnetic Switch	Trench	PPS	9	Evaluated without consideration of ferrous framework mounted
Fluorescent Lighting	Throughout	Infrastructure	10	Taken at roof height
Smoke Detectors	Throughout	Fire Protection	10	On Ceiling
Filtration System	Trench	Water	10	Just above the air receiver. Sensitive?
Crowcon Gas analyser	North Wall	Infrastructure	10	Move/Shield
Linde Blue Chiller	South East Corner	Decay Solenoid	10	Pump, fan, PLC
Linde Controls cabinet	South East Corner	Decay Solenoid	10	PLC, PSU, Relays etc
D10 Board and Isolator	Trench	General Power	15	Removal of board. Water System fed from board will be relocated
208v Transformer	Trench	General Power	15	Relocation 208V Transformer from Trench to RR2
Cranes	Throughout	Infrastructure	16	Will not operated while magnets on
Web Cam	South Wall Ground	Webcams	20	Move/Shield
PH Moving Beam Stop	Beamline	Infrastructure	20	Motor, Isolator & Controls. Check sensitivity
Fire Bell	Trench	Fire Protection	20	Varying field. 10-20G
Grundfos Pumps & controls	Trench	Water	20	Varying field. Inverters and Control JB maybe sensitive. Moving
Air Con Units East	North Wall	Air Conditioning	20	Without ferrous mass modelled. Field gradient 5-20G
MQ9 PSU RACK	Cooling Channel	General Power	27	Proposed Relocation next to MQ8 PSU Rack
Linde Cold Box	South East Corner	Decay Solenoid	30	Non electrical - Pneumatic system. Non sensitive
Distribution Board D14	South Wall Mezz	General Power	40	Change for Redspot Fuse board. Varying region
N.Mezz Ext. Dist. board	North Wall Mezz	General Power	47	Change for Redspot Fuse board
LH2 Gas Panel	South Mezz	LH2	200	Varying field 80-200G
Tracker Cryostats x4	Beamline	Beamline	700	Varying field 250-700G

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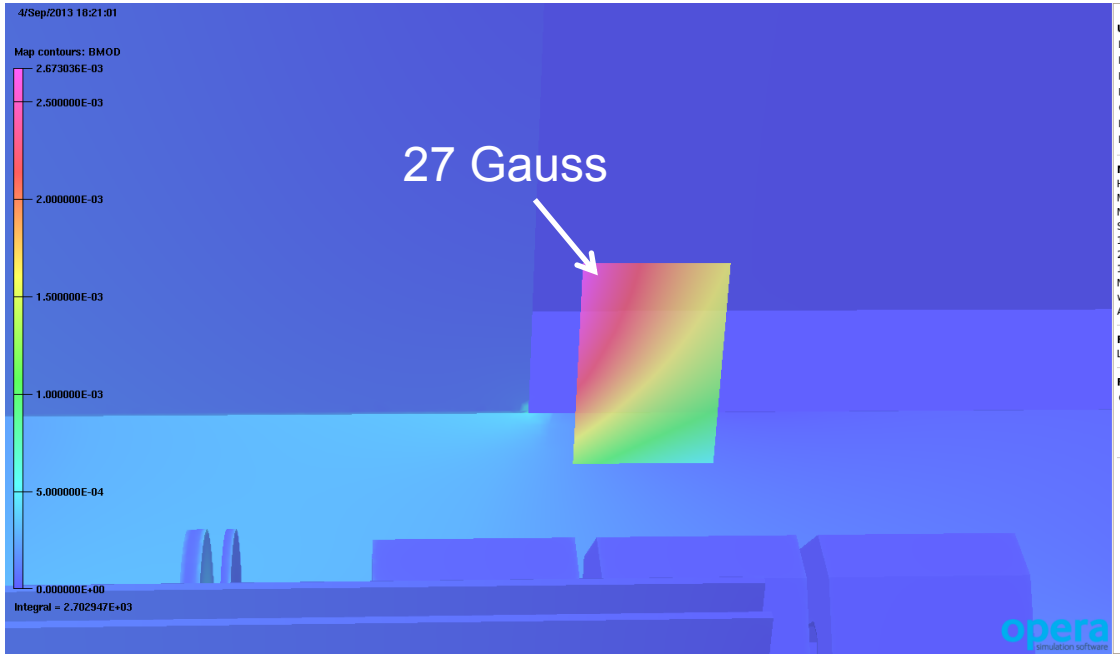
Q9 PSU

- Beamline level about 4M away
- Front panel electronics, dials & fans
- Would ideally be relocated – limited space
- New longer cable runs



UNITS

Length	mm
Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Current Density	A/mm²
Power	W
Force	N

MODEL DATA

Hall_Test_91.op3
Magnetostatic (TOSCA)
Nonlinear materials
Simulation No 1 of 1
15907802 elements
27271399 nodes
12 conductors
Nodally interpolated fields
with coil fields by integration
Activated in global coordinates

Field Point Local Coordinates

Local = Global

FIELD EVALUATIONS

Cartesian	CARTESIAN (nodal/inte)	200x200	Cartesian
	x=-4175.0	y=-1650.0 to 0.0	z=-8830.0 to -9830.0

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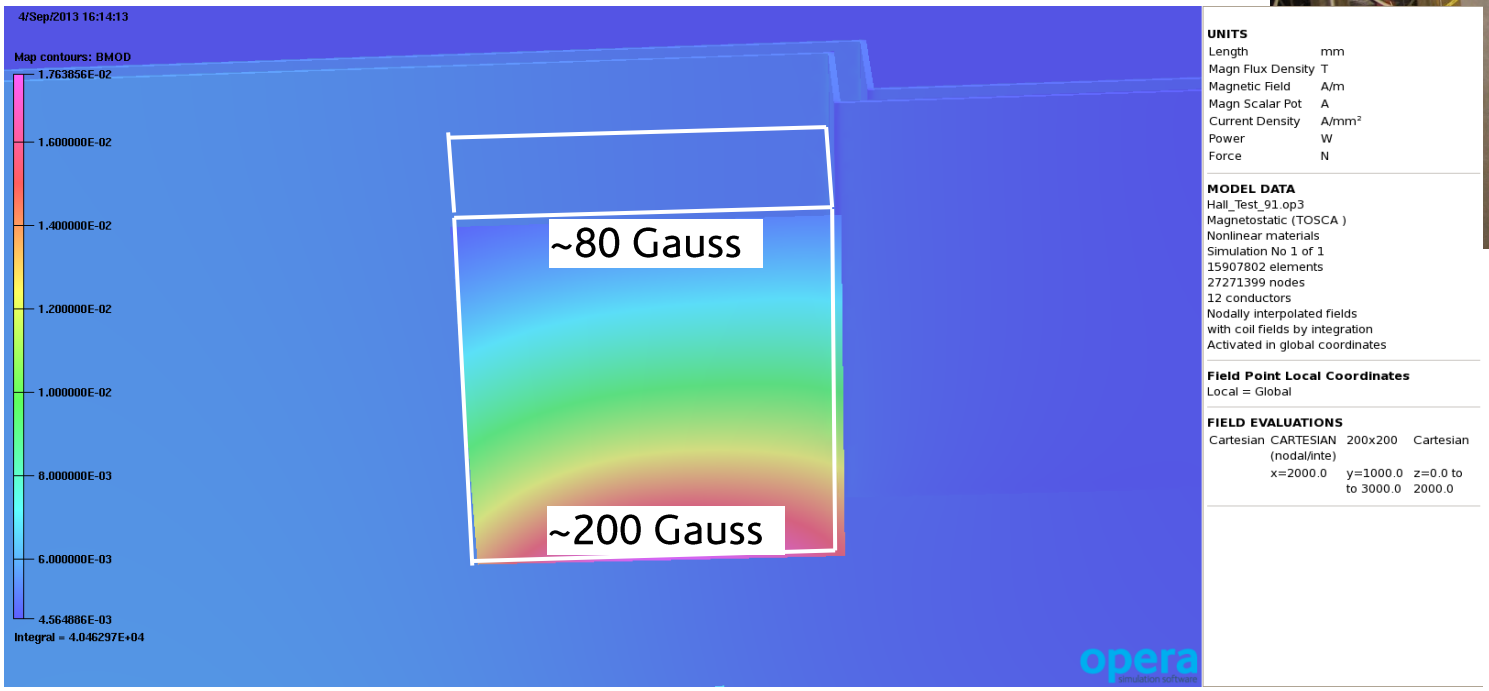
LH2 Gas Panel

- South mezz floor just above Spectrometer Sol
- Electro-mag valves & Hall effect indicators
- Rearrange routing & non sensitive alternatives
- Will require safety re-assessment
- LH2 turbo & gauges in higher field near AFC



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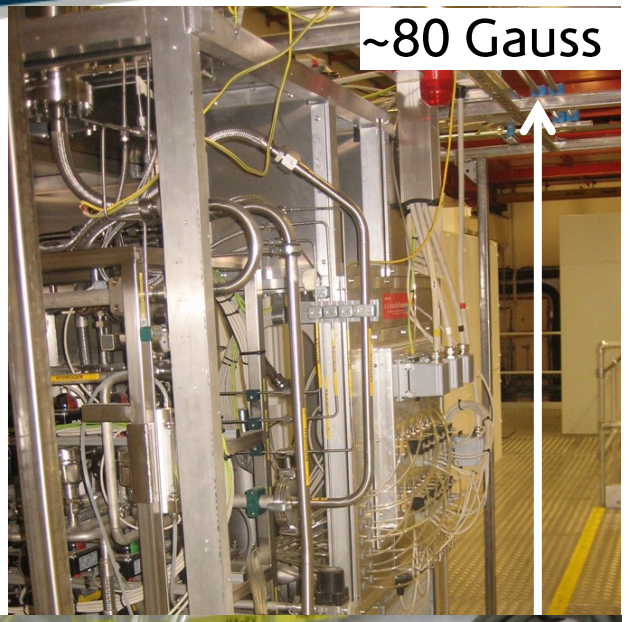
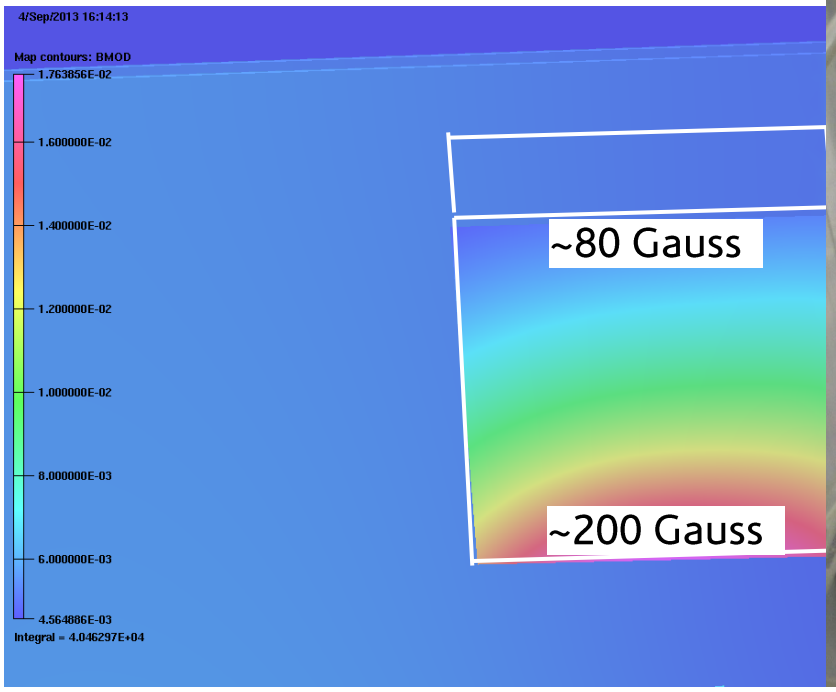
LH2 Gas Panel

- Large gas panel sited on south mezz floor
- Just above beamline & close proximity to downstream Spectrometer Solenoid
- Electro-mag valves, Turbo pump, Vac gauges
- Rearrange, alternatives & shiel





Safety concerns?

In 10 to 20 Gauss field

- Smoke detectors
- O2 Gas analyser
- Fire Bells
- PPS magnetic switches

- Likely to function correctly in these fields but as these are part of safety systems would require suitable testing to confirm this.

Other concerns

In 10 to 20+ Gauss field

- Power distribution boards
- Air Conditioning unit
- Water pumps

- These infrastructure components can be moved or alternatives used

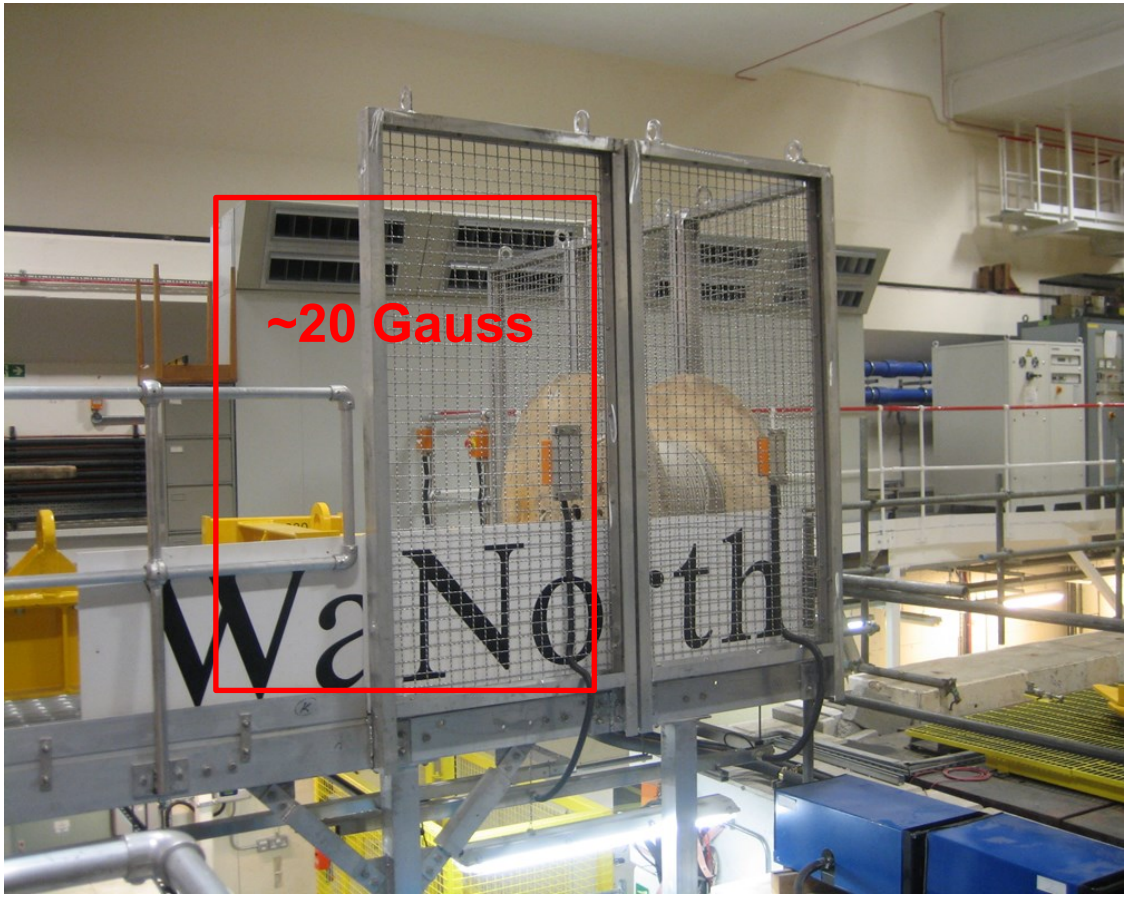
Other concerns

In 10 to 20+ Gauss field

- Power distribution boards
- Air Conditioning unit
- Water pumps

- Appreciated some large objects, like this AC unit, assessed without ferrous mass represented in model.

- Also some equipment in high field gradient area. Positioning crucial!



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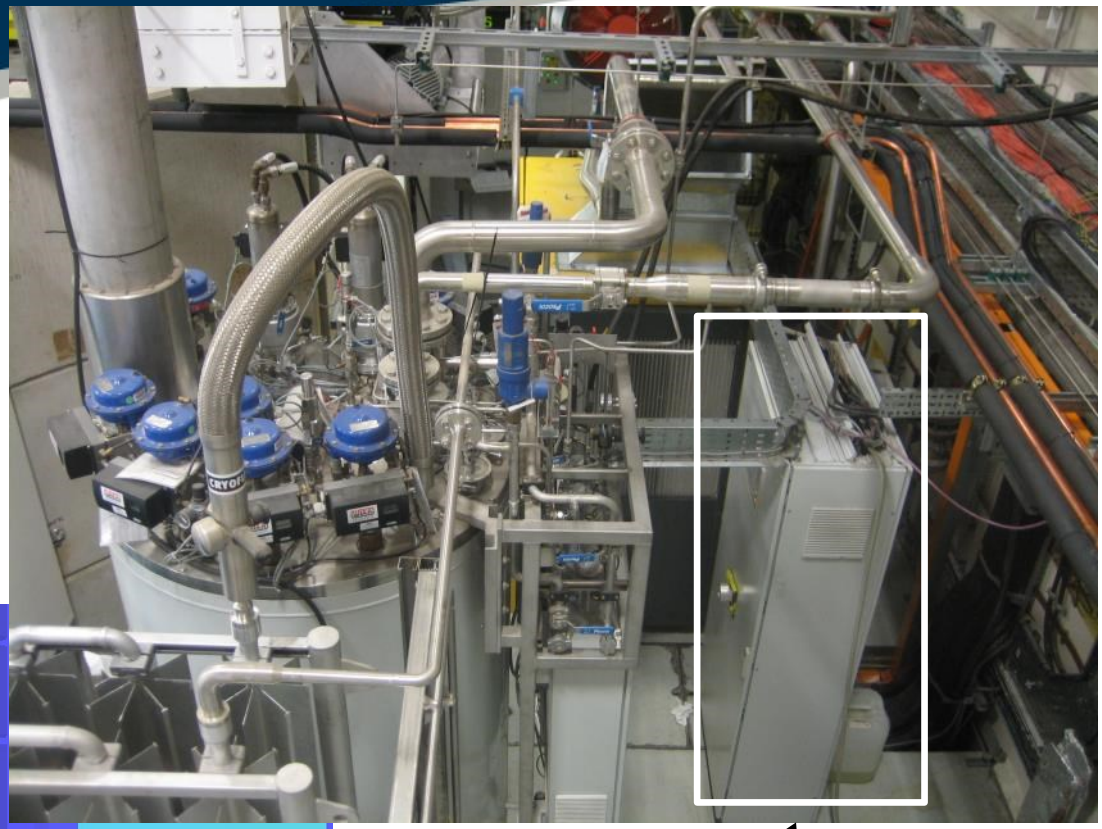
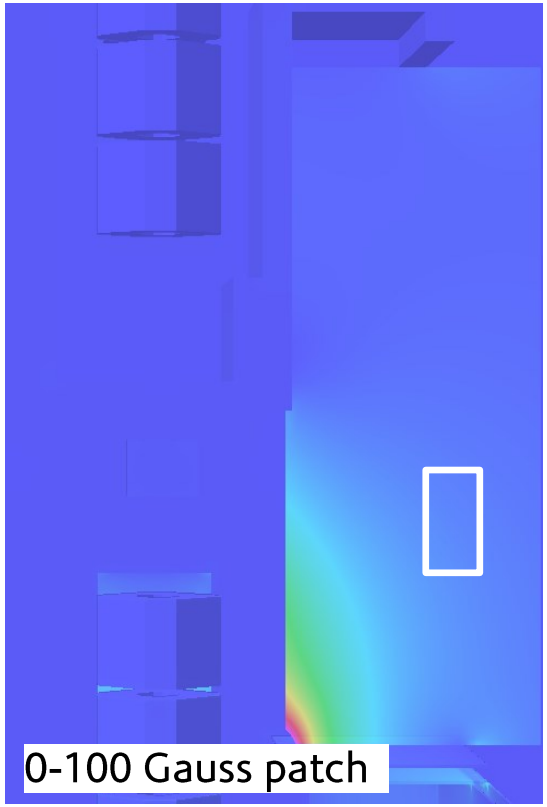
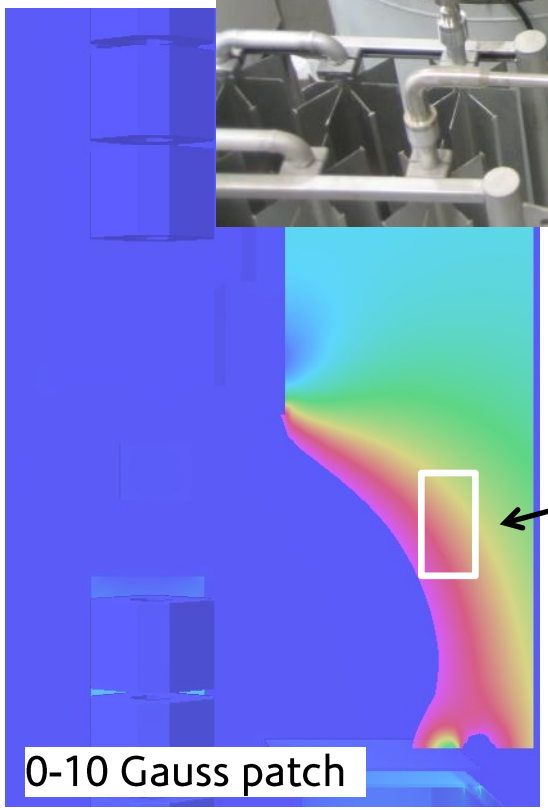
Linde Controls







Linde Control panel
Field up to 10G
Limit 25G (PLC)

Varying field. Model accuracy and placement could lead to an issue.

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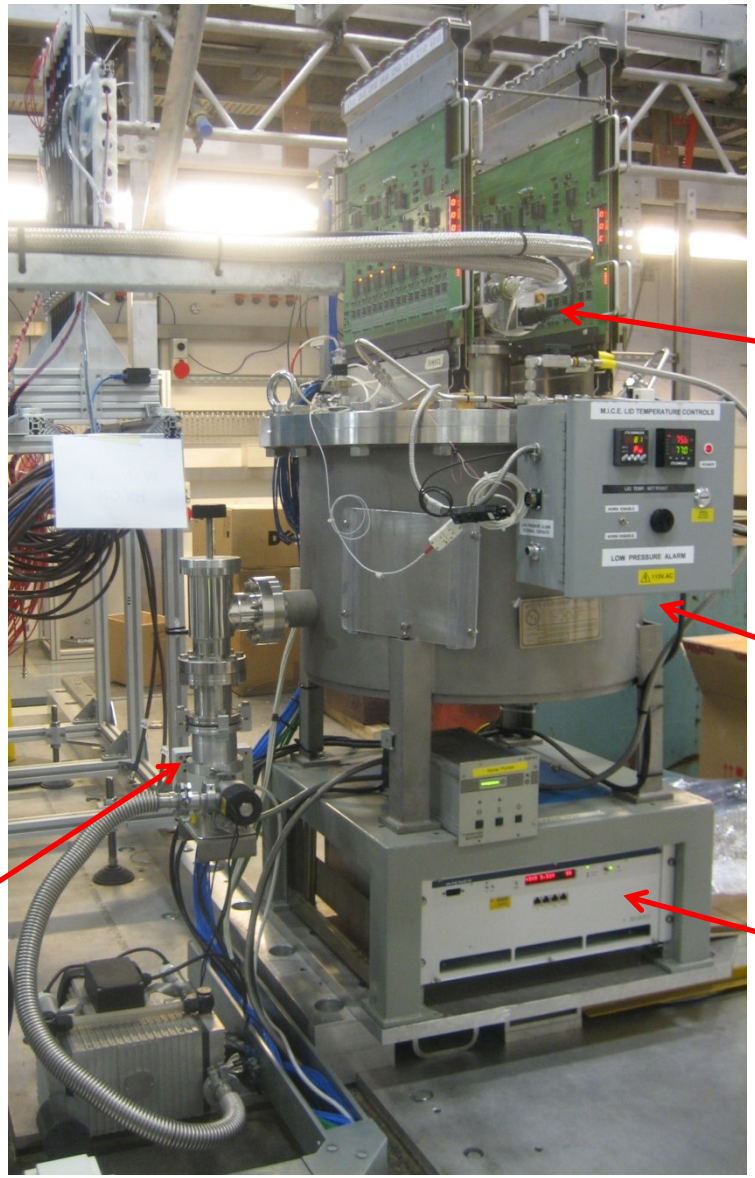
Sci-Fi Tracker cryostats

- 4x Cryostats
- Approx 1M x 1.5M
- High field <150mT
- Next to beamline to maintain efficiency of fibre waveguides
- Access for maintenance



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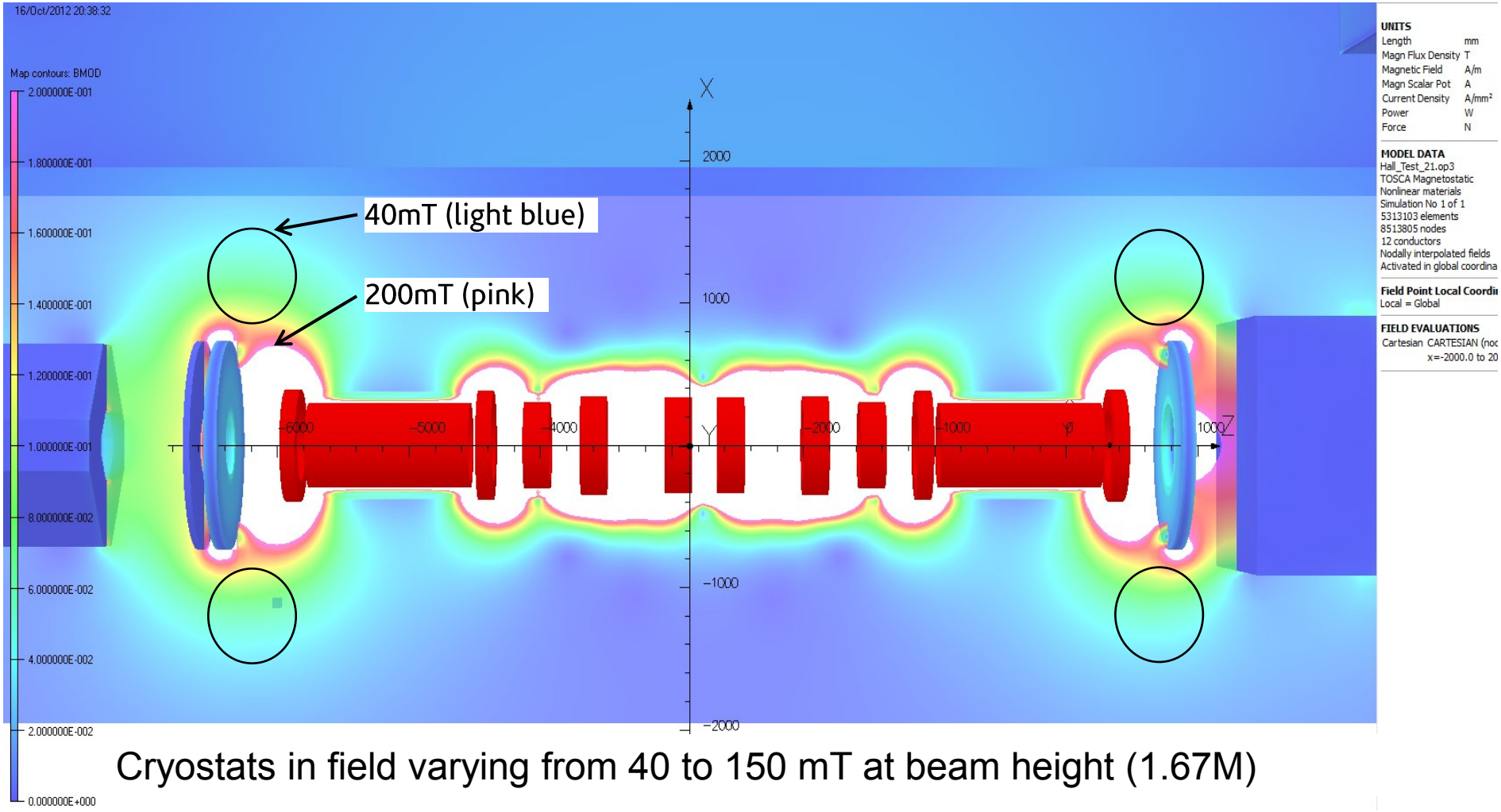
Cryostat positions – plan view

StepIV 240MeV/c solenoid mode. Field in AIR at beam height



Cryostats in field varying from 40 to 150 mT at beam height (1.67M)

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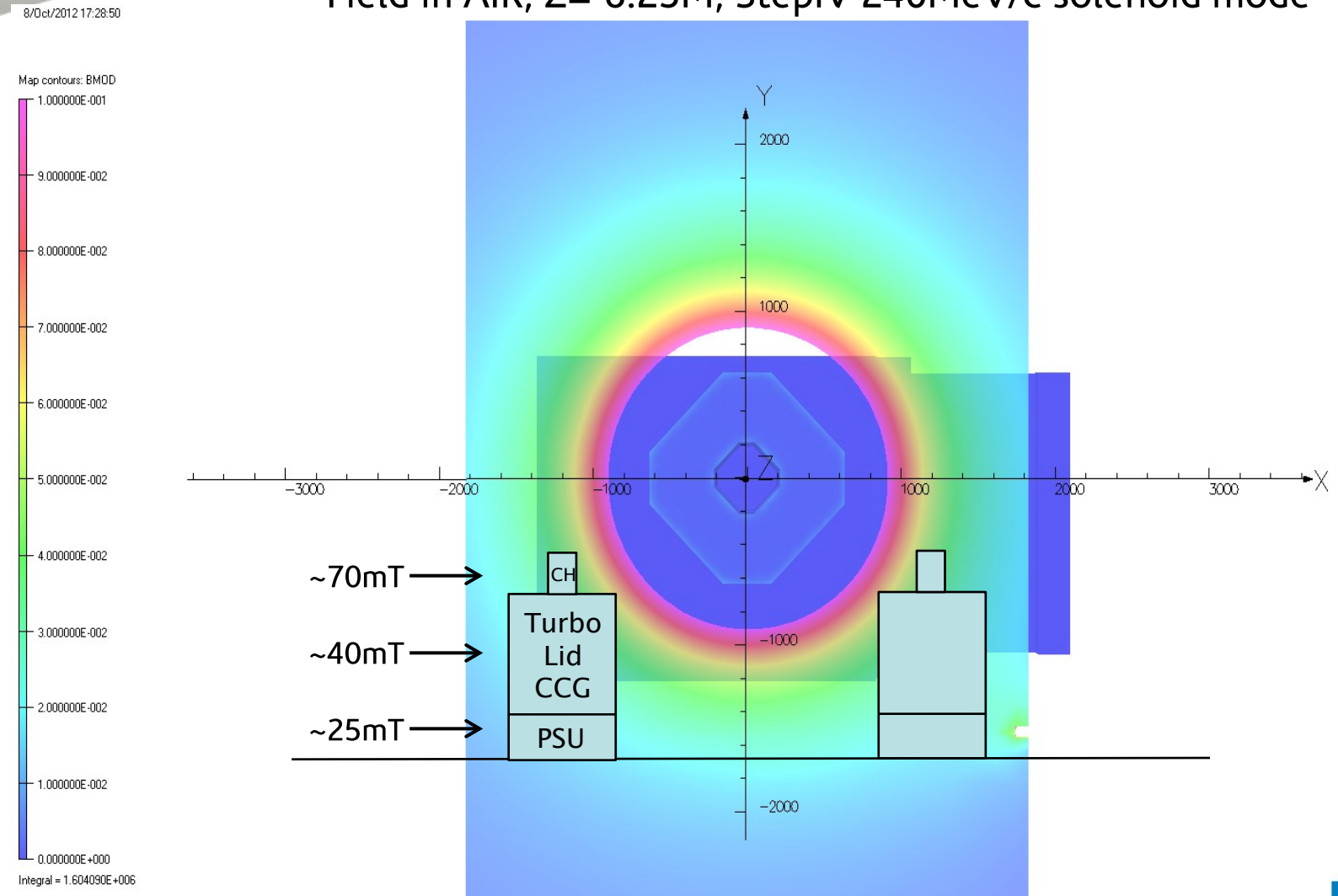
Cross sectional view

Field in AIR, Z=-6.25M, StepIV 240MeV/c solenoid mode



(Looking up to Q9)

Opera

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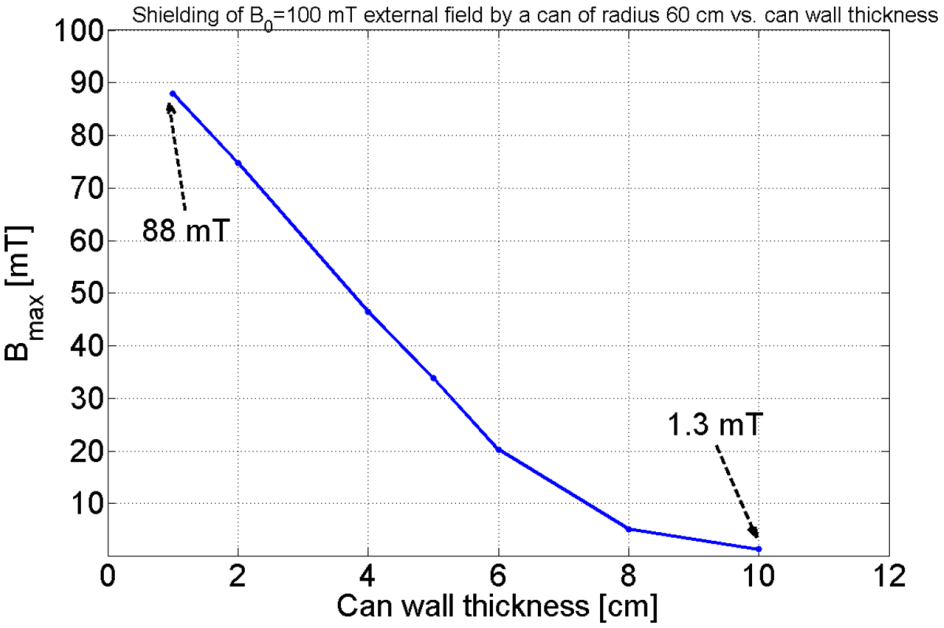
Big Shielding can

- ←Model is only half can!
- All Opera modelling and analysis for cryostat shields by K.Marinov at DL
- KM concluded require can >7cm thick
- Mass approx 7 Tonnes
- Position 0.7M further away in X
- Fibre waveguides unlikely to reach



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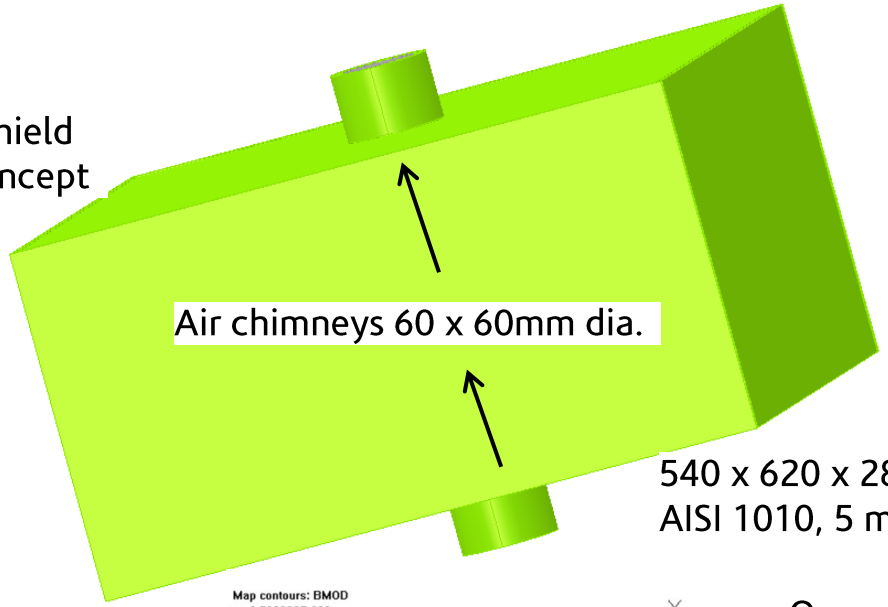
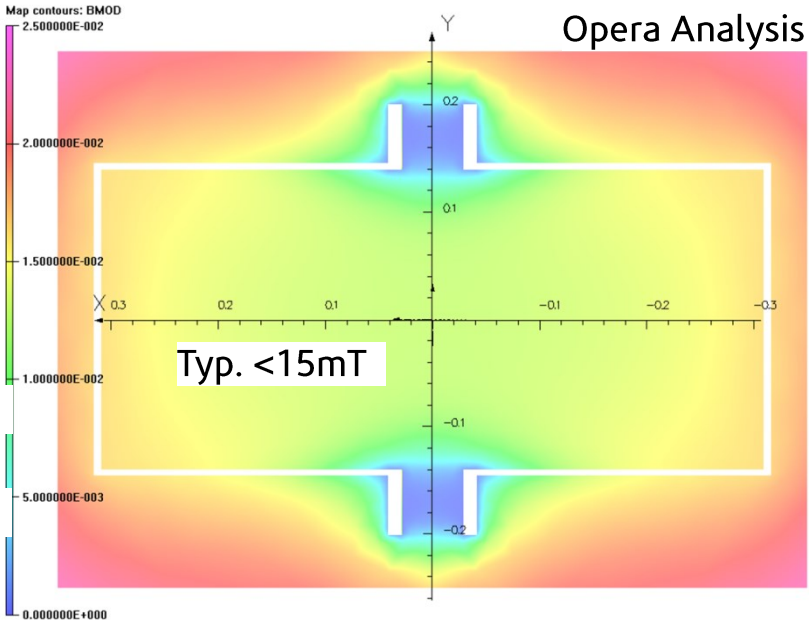
Shielding Power Supply

AFE PSU under cryostat

Shield concept



Opera Analysis



- Air chimneys allow bottom-to-top air convection
- Possibility of fans or using compressed air
- Also acts as route for cabling etc.
- All 3 orientations field <20mT which within limits
- Power dissipation would need to be quantified
- Would need careful thought with designing opening & closing features so not to effect performance
- Shield box & chimneys would increase location height
- High field tolerant PSU available but £70K for 4

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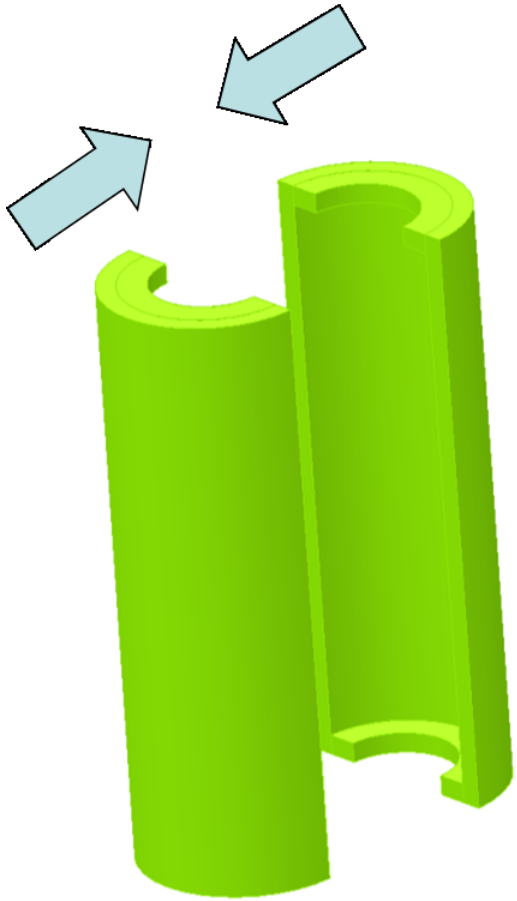
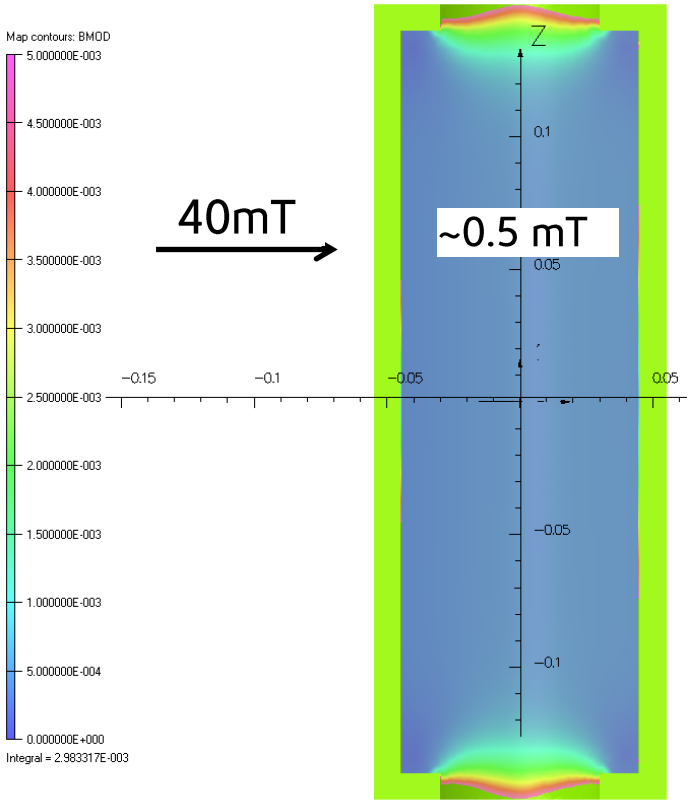
Shielding Turbo pump





- Pump can tolerate 5mT. Solution is a 10 mm thick AISI 1010 capped cylinder, 300X110 mm.
- 3 orientations checked, analysis shows internal field <5 mT in all.
- Further development - allow backing line connection. Cooling requirement air/water tricky?
- Inverted magnetron vac. gauge could be shielded with a similar single can. Re-calibration?

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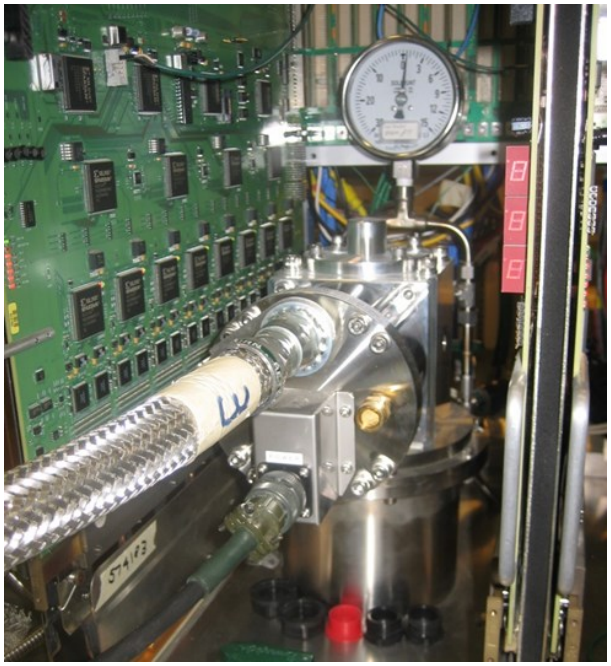
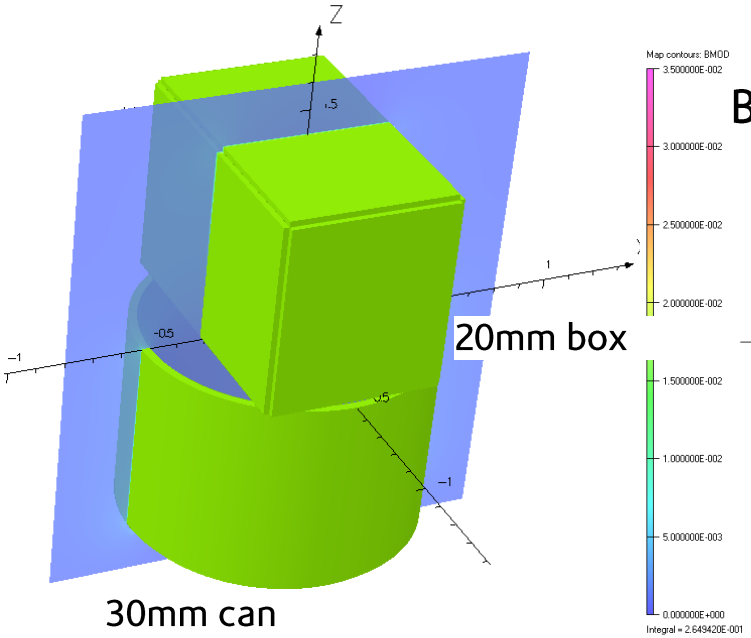
Shielding Tracker Cryocooler

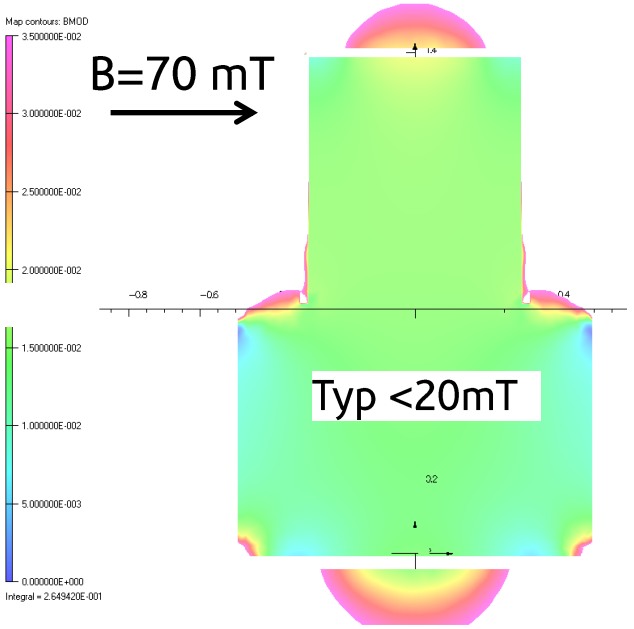
Cryocooler



Shield concept (AISI 1010)



Opera Analysis



- The field in the shielded volume is well below the target 35 mT
- Apertures required to allow electrical and gas services
- Design would need optimising though presently mass 0.5T + 0.3T!
- Question on need to shield internal parts
- Would severely limit ease and ability to service and work with cryostats

Comments

- Local shielding of items within the hall could work but there is a risk that a critical item could be missed or not shielded to a level where it will operate satisfactorily.
- This issue is hard to resolve fully because of the wide spread stray field, the varying nature and proximity of equipment and without benchmarking, the unknown accuracy of the model.
- The local shielding of the tracker cryostats would be complicated, costly and very restrictive in use.
- The relocation of items and infrastructure to lower field areas around the hall may prove difficult to achieve due to an already lack of space
- The replacement or sourcing of alternative non-field sensitive components could be costly
- There is a lack of experience within MICE for what would be required for the engineering and test of magnetic shields