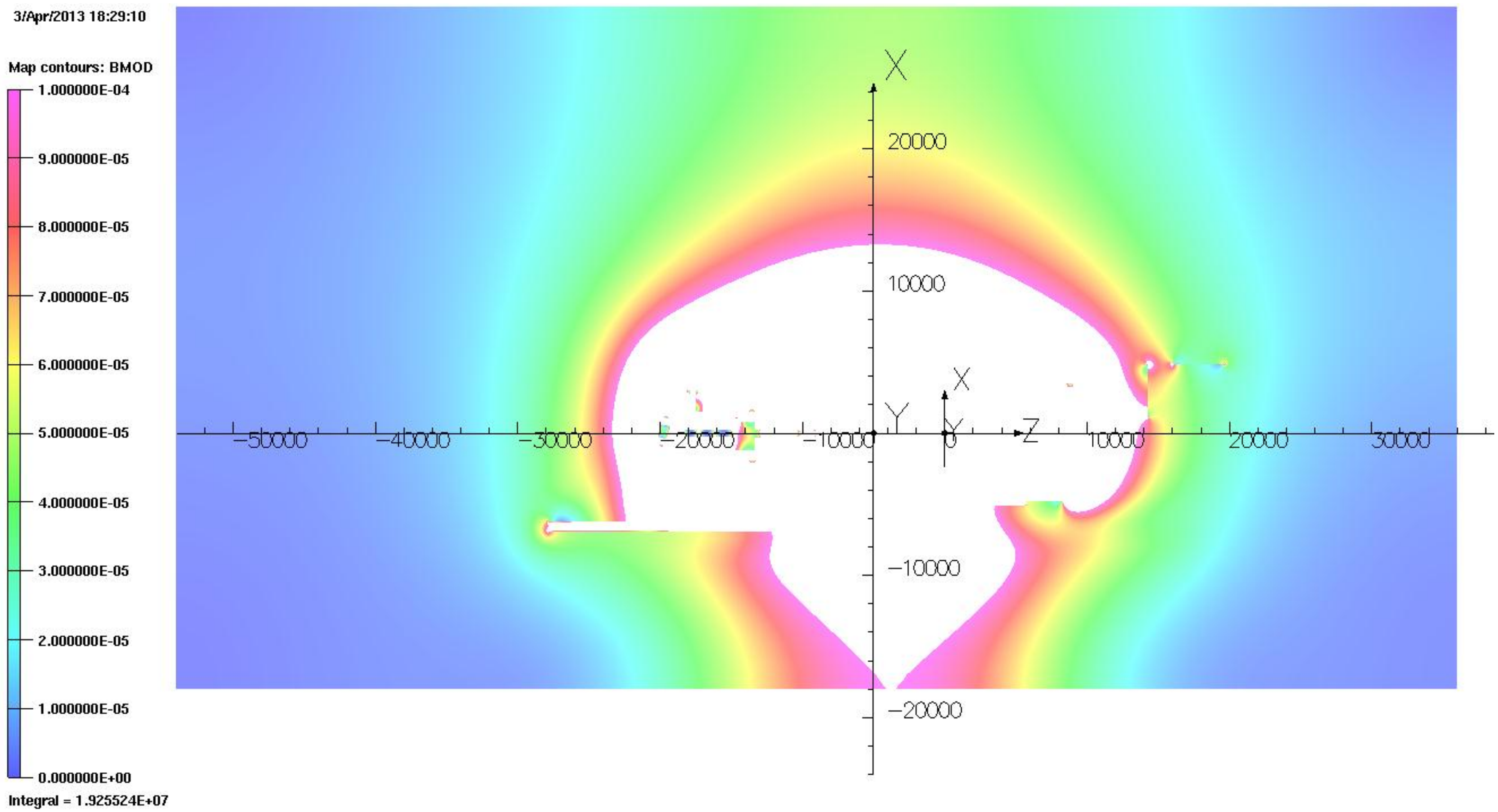
Magnetic Modelling 23/04/2013

Model Border Comparison

As I stated last week I had moved the model borders out to +/-60m in z and +/-40m in x,y as there was some indication that the borders weren’t far enough out.

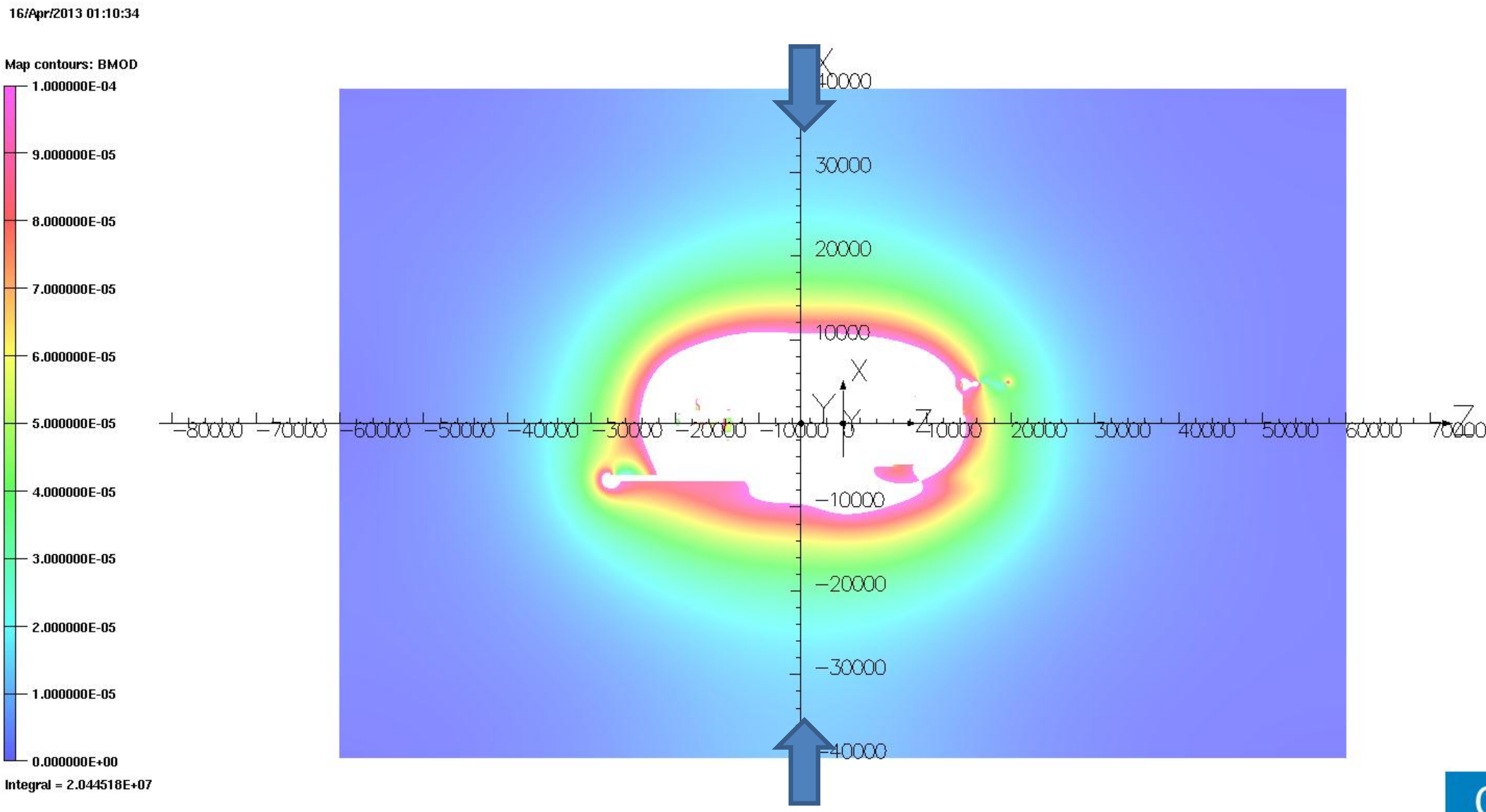
The following plots are shown as a comparison of before and after.

The scale is 0-100uT, (0-1 gauss), which whilst below our threshold of concern does serve to illustrate the changes. The changes are also observable on the 5 gauss scale.



Model 61 y=0

Bmod 240MeV/c Solenoid. Plot to model boundaries



Model 71 – Extended Model Boundaries y=0
Bmod 240MeV/c Solenoid. Plot to model boundaries

Still some slight evidence that the field is being pulled (see arrows) but probably of no consequence. At some point I may run with normal boundaries and run a comparison, I'm not expecting significant differences – but I need some way of comparing models –see later.

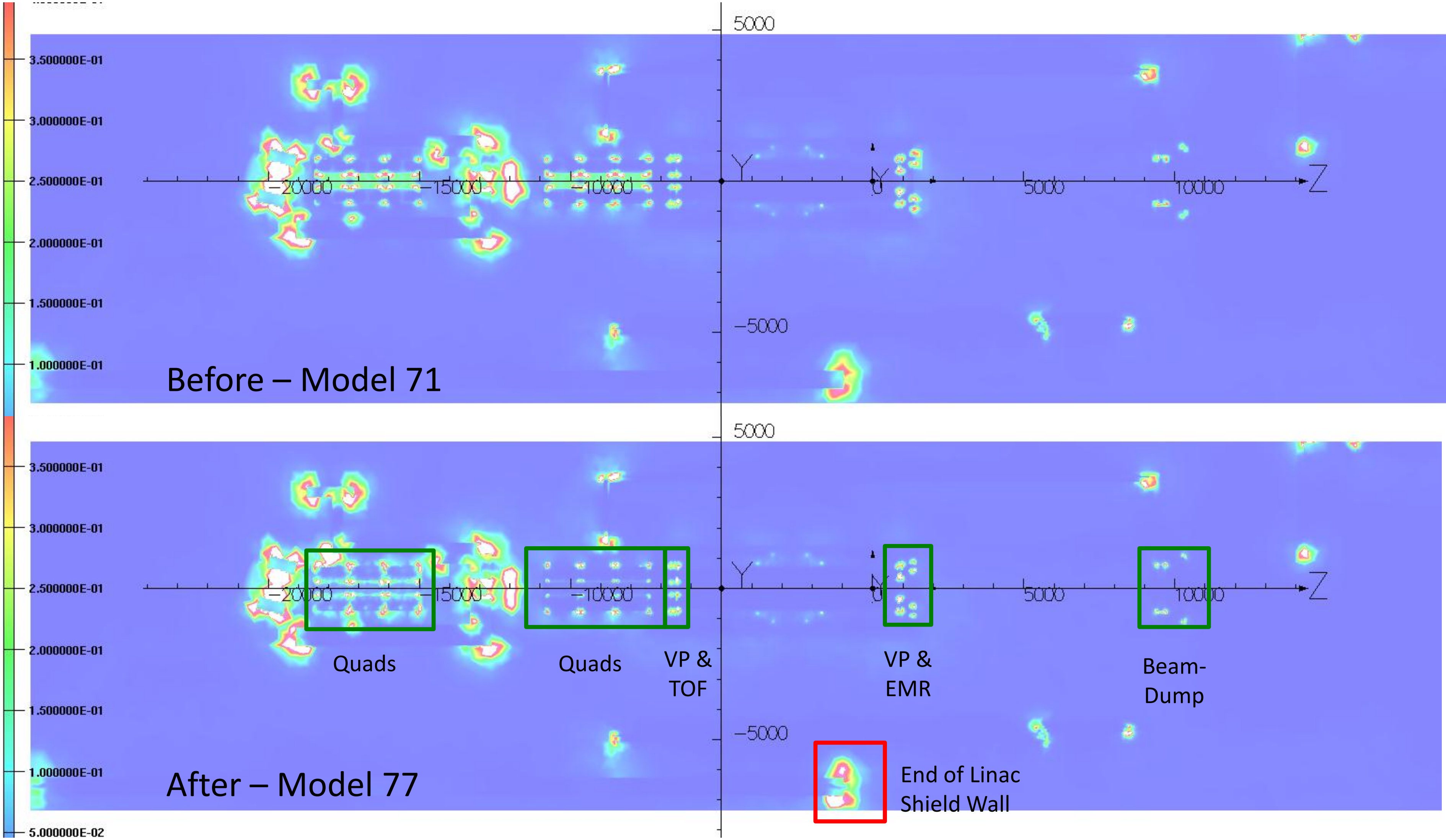
Mesh Improvements

Last week I said that I'd tried to improve the meshing in various components to reduce the ErrB/B error shown in the plots. See last weeks slides for explanation of what this means.

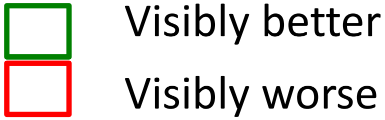
Has this worked?

The first set of plots shows the difference in ErrB/B for improvements in

Beam Dump
EMR
Virostek/TOF Plates
Quads
Linac Wall



Model 71 vs Model 77 . Scale = 0.5 (50%) y=0
Bmod 240MeV/c Solenoid. Plot to hall boundaries



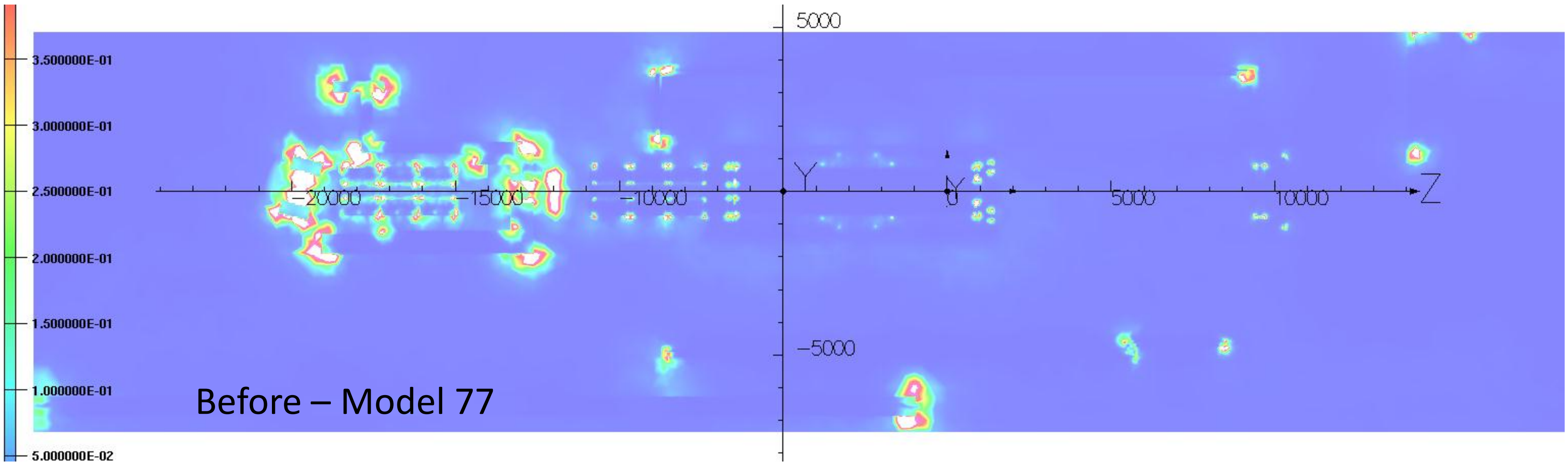
Mesh Improvements

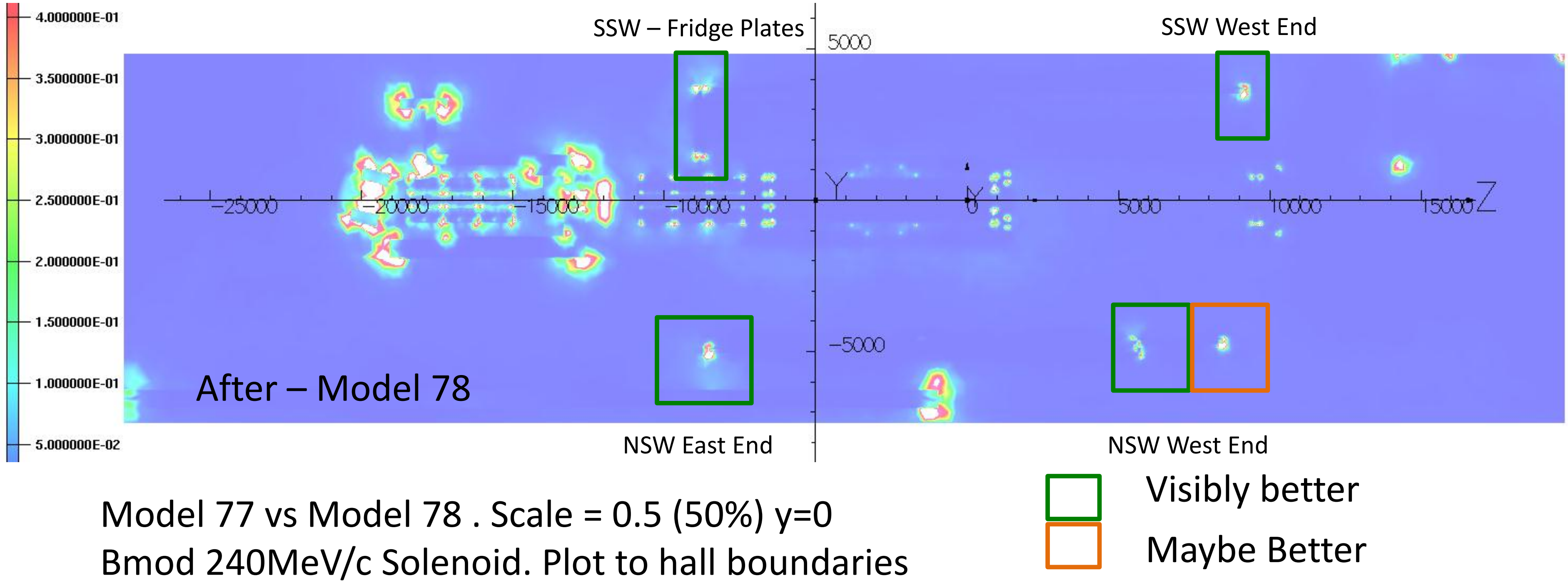
I have also made (improvements) to the NSW and SSW meshing. To get variable meshing I have had to switch from Hexahedral to Tetrahedral meshing, so there was some work to retain the layering in the steel plates.

The model with the 'improved' meshing for the NSW and SSW (model 78) finished running yesterday afternoon, and there is also another model with a second iteration of mesh improvements queued for solving – this is now running.

These refined models are taking longer to solve – model 78 was 112 hours, but this solve time needs to be put into perspective against the effect on the solve time of improving the meshing resolution by a factor of ~2-4 everywhere! Imho the observed increase in solve time is not surprising.

The other point is that I think the current set of hall models will be the last iteration until we have some feedback from VF so the longer solve time doesn't concern me too much at this point.





Model 77 vs Model 78 . Scale = 0.5 (50%) y=0
Bmod 240MeV/c Solenoid. Plot to hall boundaries

Mesh Improvements

Where to go from here….

I don’t want to spend forever refining a mesh unless it is of value. (i.e. I’m not making the ErrB/B graph blue in colour for the sake of it!). I also think that this process has been done in the wrong order which is definitely making life harder – the mesh refinement should have been done as individual components were added to the model.

I also want to be sure that the quad model is of value – most of the improvements that I’m currently chasing will be translated over to the quad model.

I need another tool to visualise the changes in the field Bmod between 2 consecutive models.

So far I’ve been producing the occasional line plot, but the location of these line plots is somewhat random (or a reasonable estimate of where it would be useful to look)– but it would be easy to miss something, so I think they are less than ideal for trying to establish what has happened globally to the model after a change has been made.

Model Comparison

To this end for the last couple of days my attention has been turned to understanding how to compare the output of one model to another. I have discovered that there is some in-built functionality to do this in the post-processor. There is an arithmetic function that allows you to compare values between models.I have wrote a .comi script that will compare the output (eg Bmod) from two models on a plane.

Justification:

1) Compare different boundary condition models quantitatively.

2) To have a consistent system for looking for mesh convergence in the models we have been running. Is tightening up the mesh (reducing ErrB/B) having a noticeable effect on the output of the model?

Also: (change of paradigm for the future?)

3) For new models I would start with Biot-Savart and then add components one at a time to see how they perturb the field. I would like a script that would quantitatively plot the differences in the field over a given a plane between models so you could see effect any changes to the model had made.

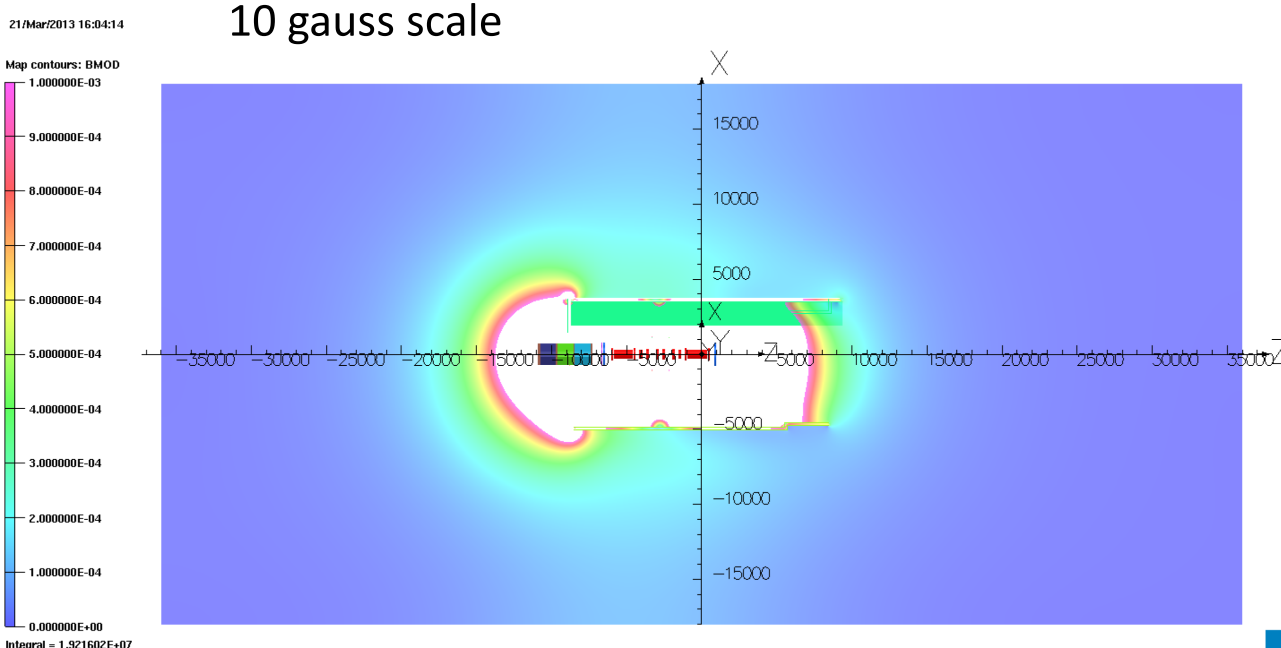
Model Comparison

First look. I'm still tweaking the code, currently it can only make comparisons on the 'y-plane' but here are some screenshots generated from taking the output of Quad Model 05 and subtracting the output of Quad Model 02 (Bmod)

Quad Model 05 was identical to Quad Model 02 except that the boundary condition was switched from Tangential to Normal. If the boundary is far enough out then the difference between the plots should be minimal.

On 26/3/2013 I showed some Bmod plots that illustrated that the differences between these 2 plots were significant enough to indicate that boundaries were too close, I can now show this directly.

10 gauss scale



UNITS

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

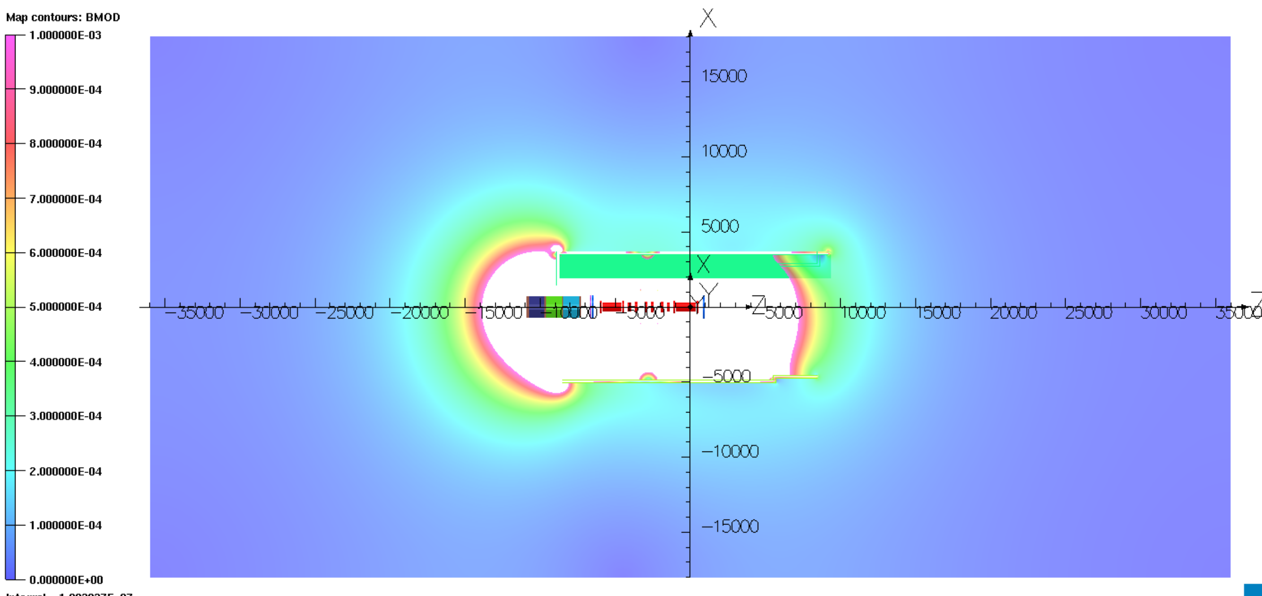
MODEL DATA
Quad_Sub_Model_02.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
9327364 elements
13052338 nodes
12 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

FIELD EVALUATIONS
Cartesian CARTESIAN (nodal) 2880x1440 Cartesian x=-18000.0 to 18000.0 y=0.0 z=-36000.0 to 36000.0

Quad Model 02 – Tangential Border

Opera



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

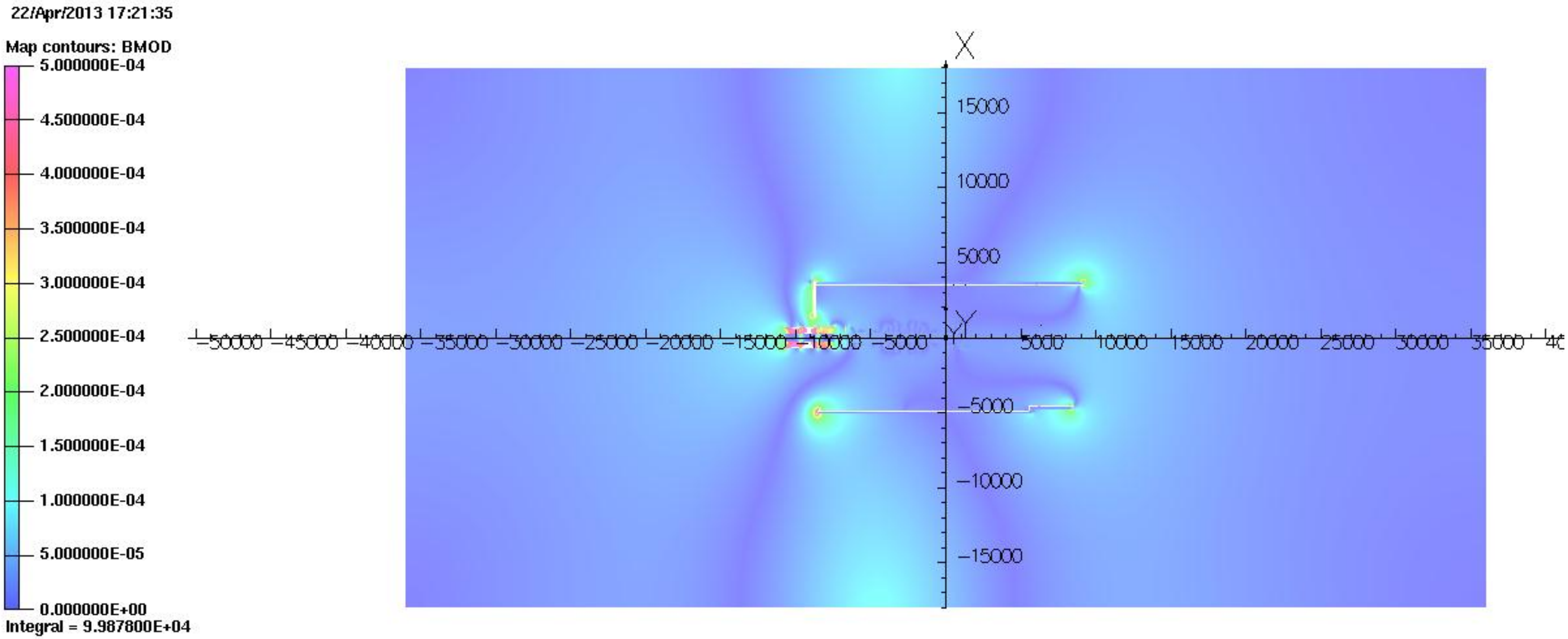
MODEL DATA
Quad_Sub_Model_05.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
9327364 elements
13052338 nodes
12 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

FIELD EVALUATIONS
Cartesian CARTESIAN (nodal) 1440x720 Cartesian x=-18000.0 to 18000.0 y=0.0 z=-36000.0 to 36000.0

Quad Model 05 – Normal Border

Opera



ABS{Quad Model 05(Bmod) – Quad Model 02(Bmod)}

Subtraction of Quad Model 02 from Quad Model 05 - plane y=0
5 gauss scale

I have yet to do the obvious test of subtracting a model from itself – I shall do this asap - the post processor is currently tied up.