The PRY in the Hall model

P J Smith
29/10/2013

The PRY has been an established feature of the Step IV Hall Model for some time, however the Hall models that contain the PRY have not been used very much, as clearly Holger's models are more up to date, more PRY focussed, and have been benchmarked on separate codes. Therefore for the purposes of looking at how the PRY performs they are clearly much better models.

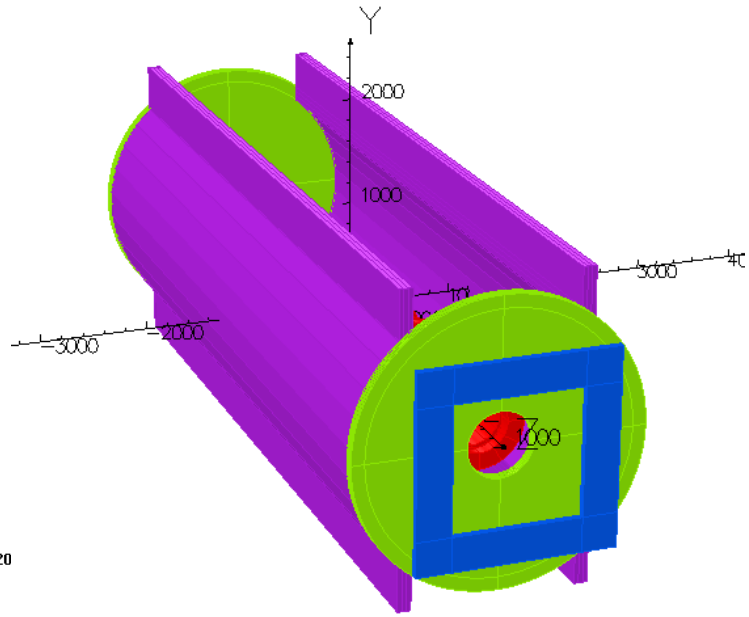
Models 92 and Models 95 are the '90 series' Step IV models that incorporate the PRY. We ignore model 95 as it contains the Flip mode file that we now know is incorrect.

Built from 12cm AISI1010 steel, the version of the PRY in the Hall model looks like an early model of the PRY, the PRY includes the extended Virostek plates and the vertical flanges.

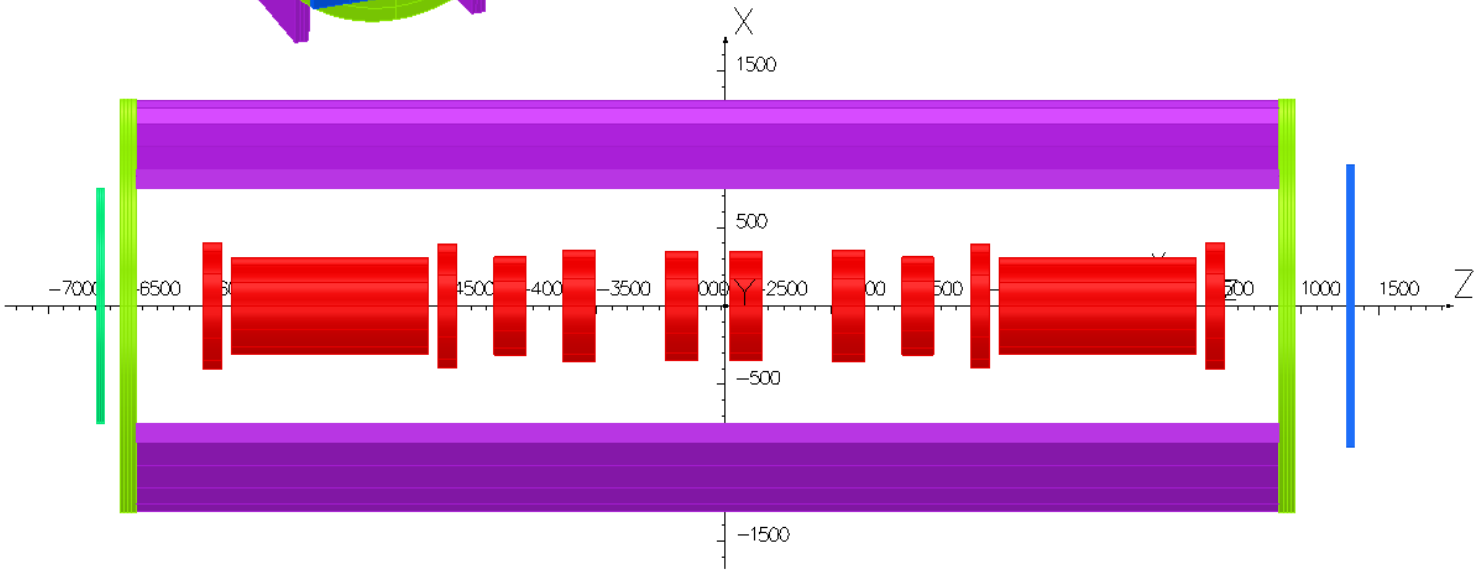
From my point of view there are a couple of reasons for including the PRY in the hall model.

1) Do my results concur with Holger's results – agreement here would be a good benchmark indicator for the Hall model.

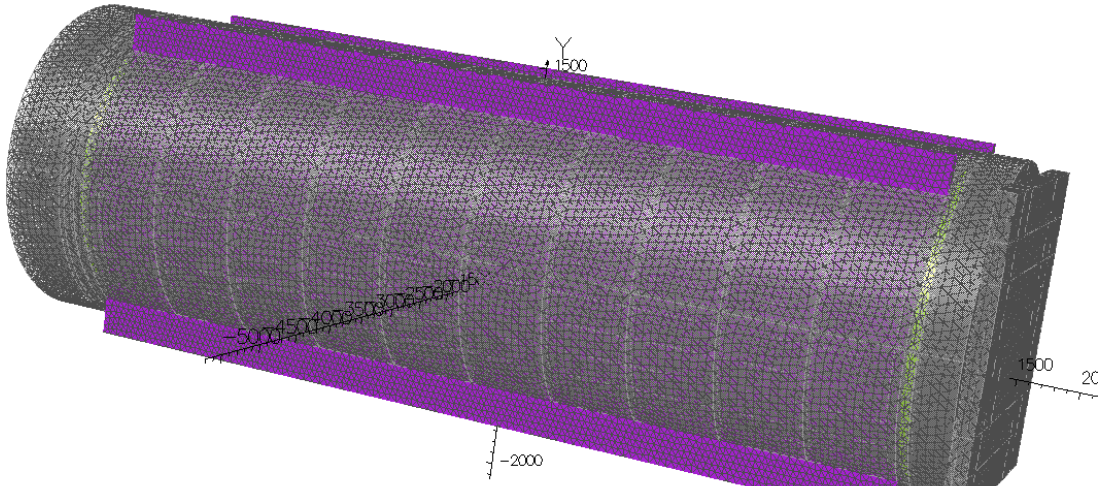
2) If we can obtain reasonable agreement, what external fields are predicted on/in items external to the PRY that are present in the Hall model?



- All AISI1010 steel.
- Virostek Plates are 100 mm thick (Green).
- Shield Walls are 120 mm thick (Purple).
- Outer Radius 1320 mm.
- Cutout Width (Top & Bottom) 1500 mm.
- Flange Height ~500 mm.
- EMR steel is blue.
- TOF plate steel is turquoise.



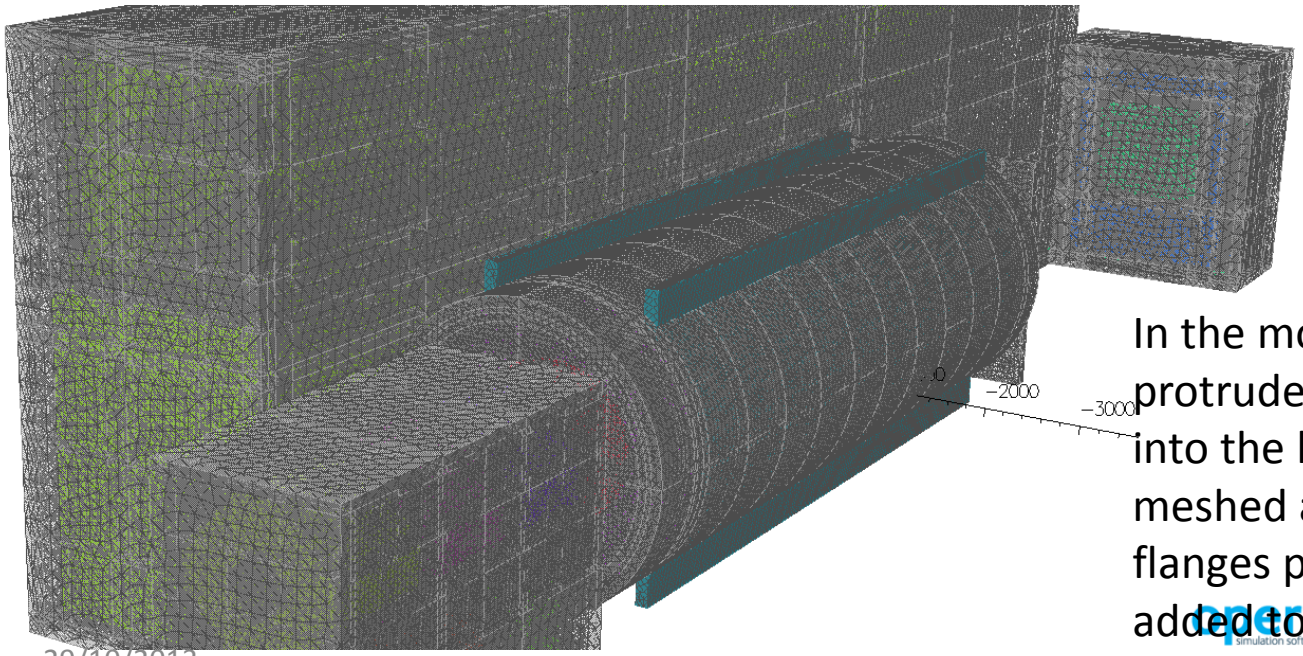
opera simulation software



Meshing of local objects.

There are a number of conflicts between air-blocks that have been resolved in code.

Note outer mesh on PRY air as shown here is ~2x better than that in 90 series models. These screenshots were generated recently using code that generates higher resolution mesh.

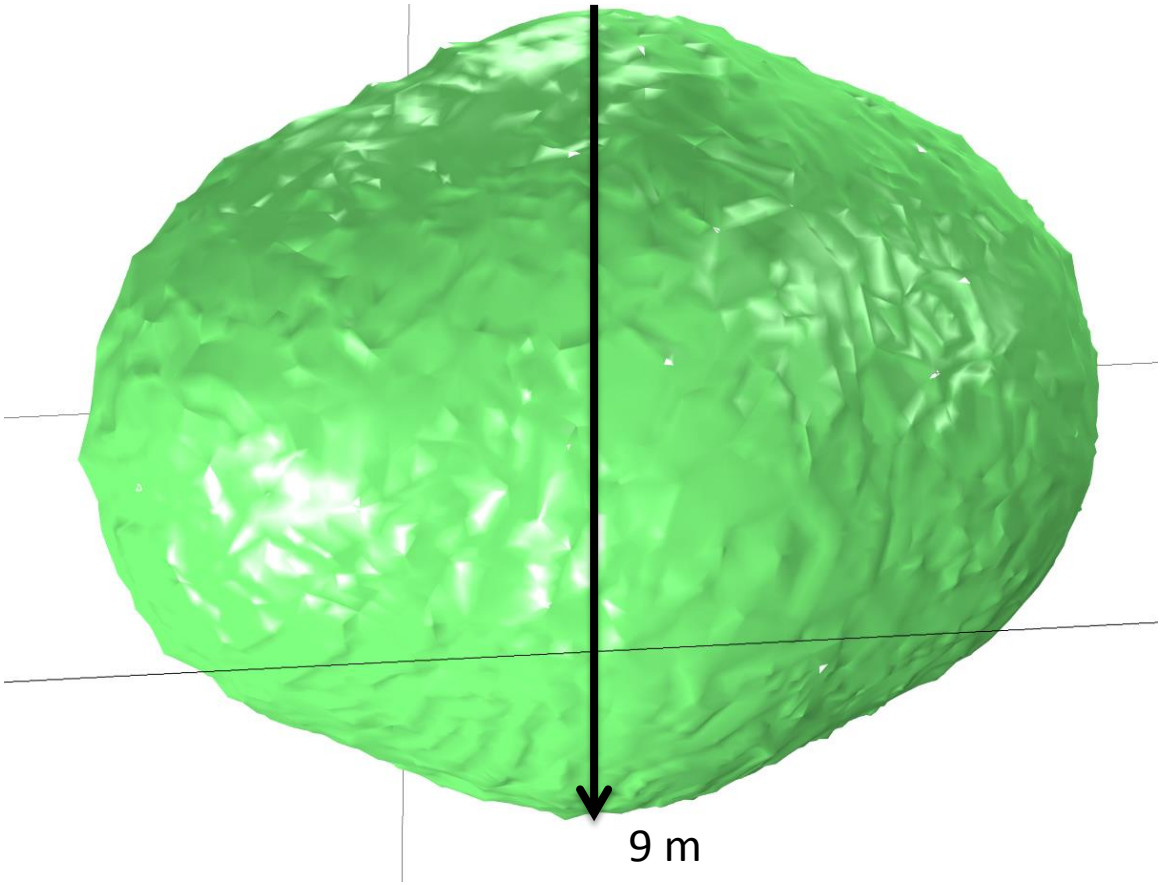


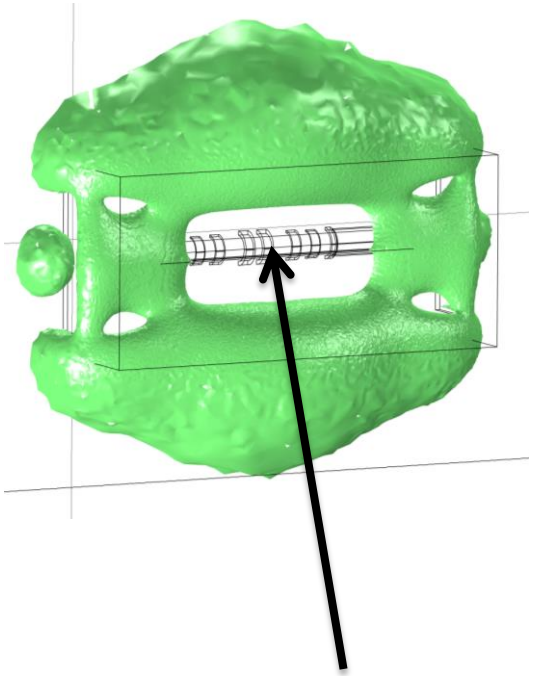
In the model 90 series the flanges, protrude through the 'local' air into the hall air, the hall air is meshed at a lower resolution. The flanges protrude as they were added to the PRY later

Iso-Surface 0.5 mT

No Shield

12 cm Shield

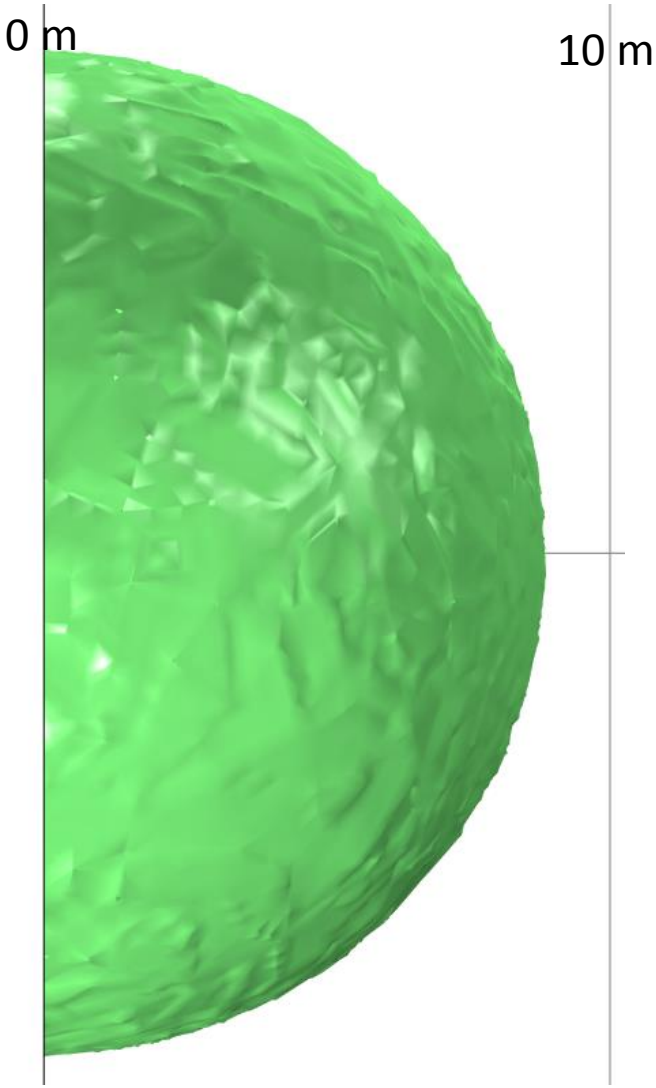




Step IV
200 MeV Flip

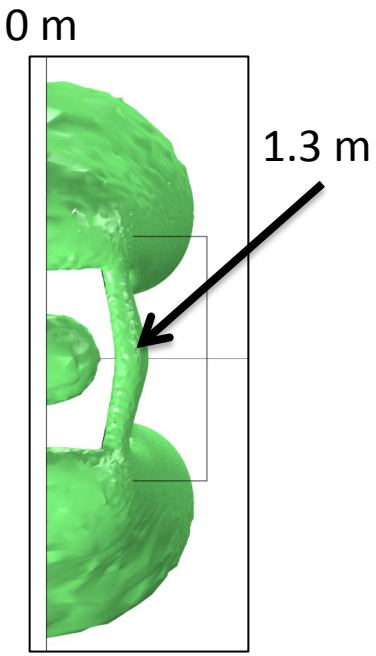
Slides copied from Holger's review presentation.

Frontal View – 240 MeV Solenoid



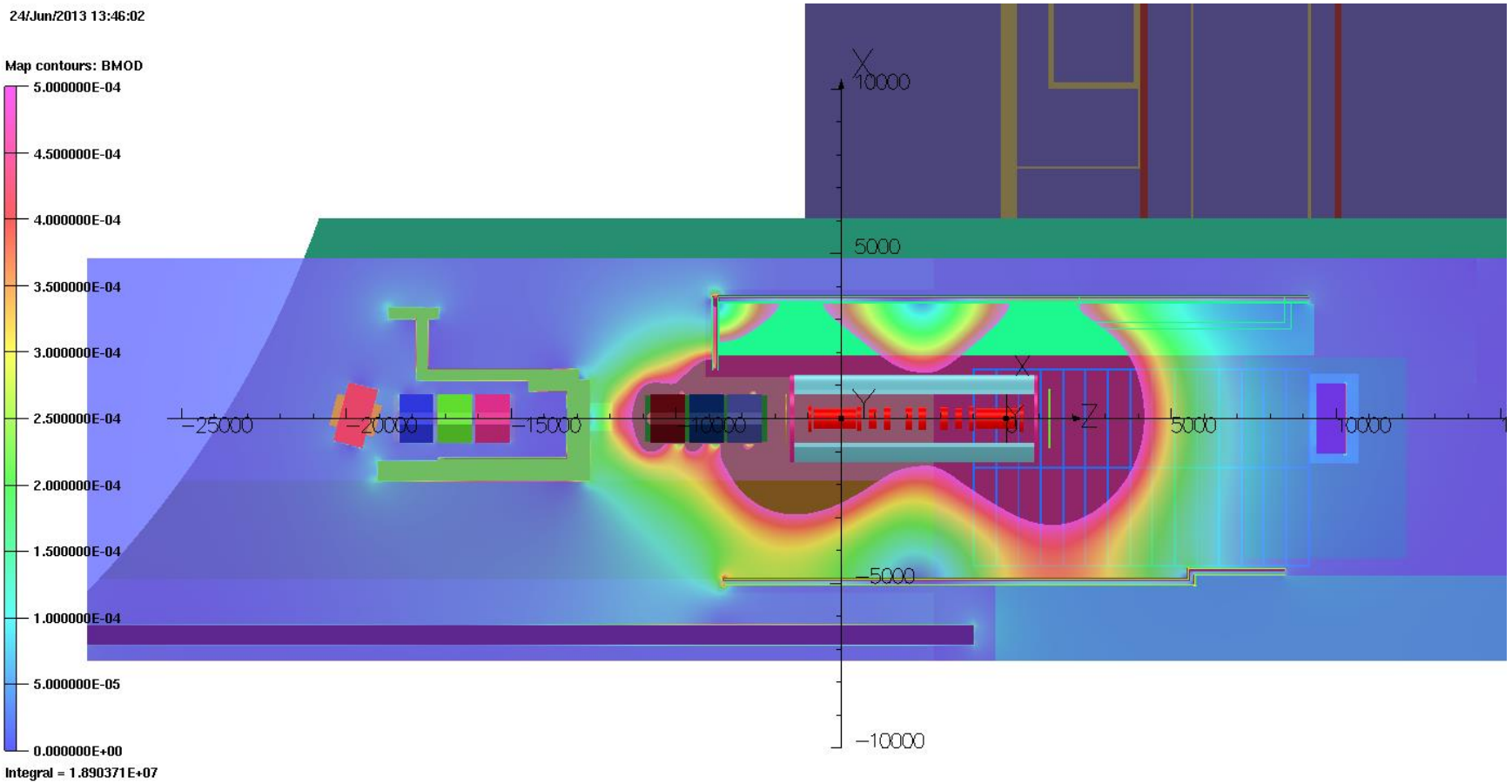
No Shield

All 5 Gauss

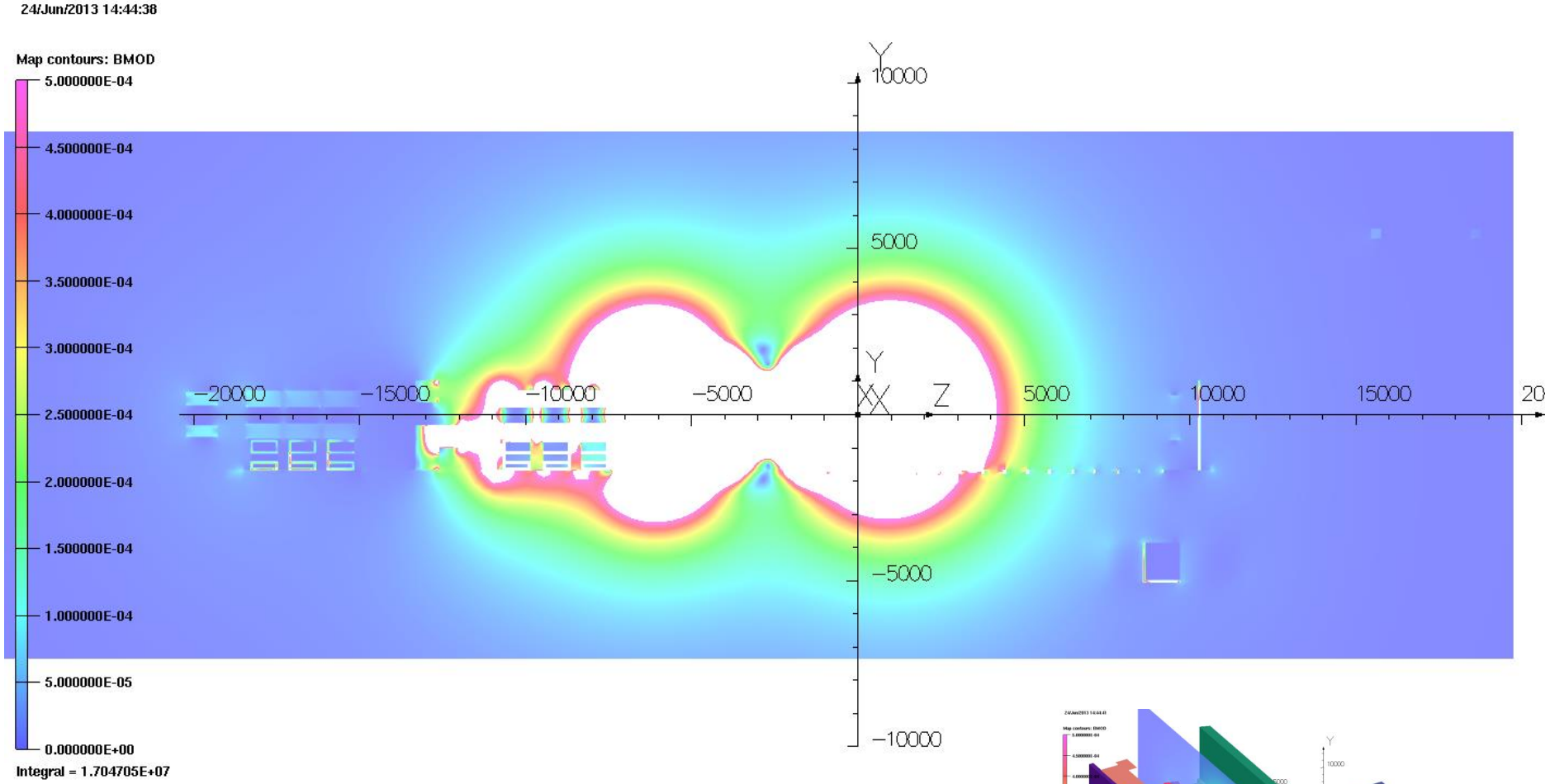


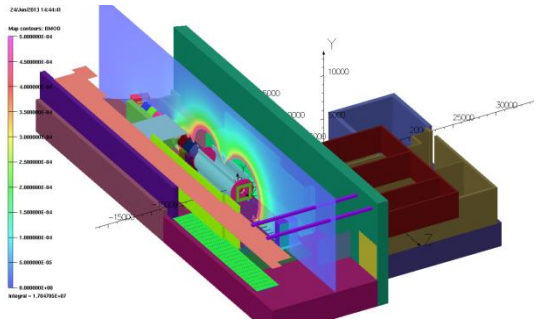
12 cm Shield

Slides copied from Holger's review presentation.



Model 92 – 240 MeV/c Solenoid Mode – 5 gauss scale.





Model 92 – 240 MeV/c Solenoid Mode – 5 gauss scale.

As indicated on the previous slides there are some visible differences between the output of the Hall model and Holger's PRY model – the 5 gauss line appears to be located further out in the Hall model. There also appears to be much more 'bloom' in the field at the end of the cooling channel. I would like to understand why the Hall model does not agree with Holger's model.

It was suggested that my results were different due to insufficient mesh resolution. To test this we can change the mesh and see if the results change.

Halving the meshing resolution in the hall model is probably not possible – I suspect I will get volume meshing errors.

However doubling the meshing resolution is doable– but this would result in a long solve time if all the model features were incorporated - > Double mesh -> ~x8 solve time.

Doubling the resolution in particular volumes is much more achievable.

It is also worth running a model with the external steel turned to air to see if this is having an influence on the model output.

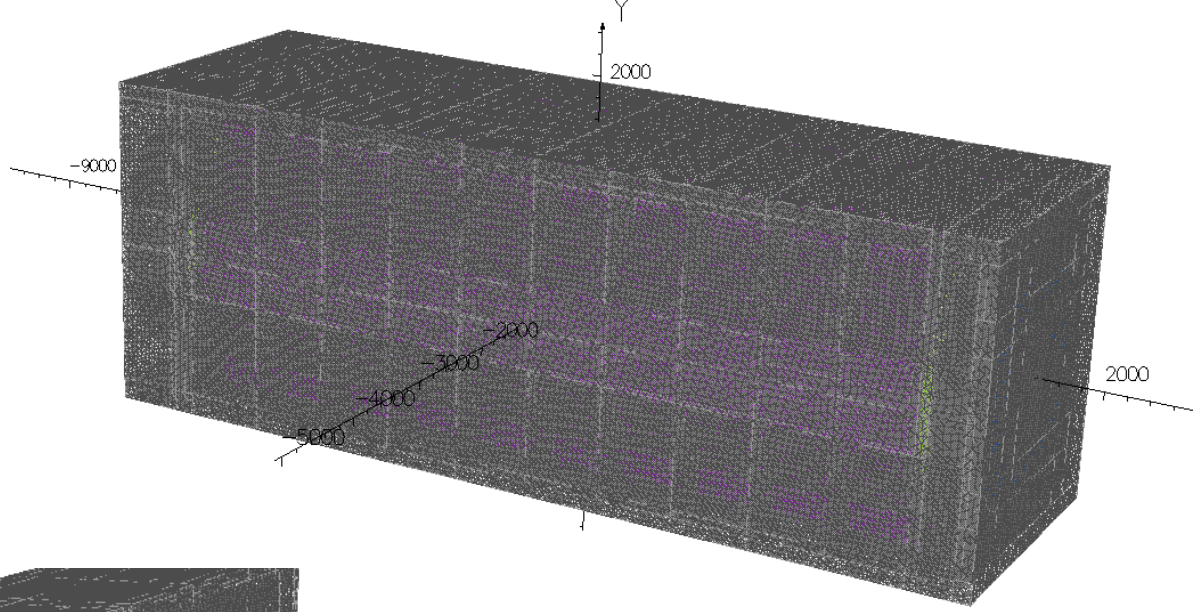
Firstly the mesh resolution in the air around the PRY was increased - In fact there was a number of improvements to the meshing resolution throughout most of the volume of the model.

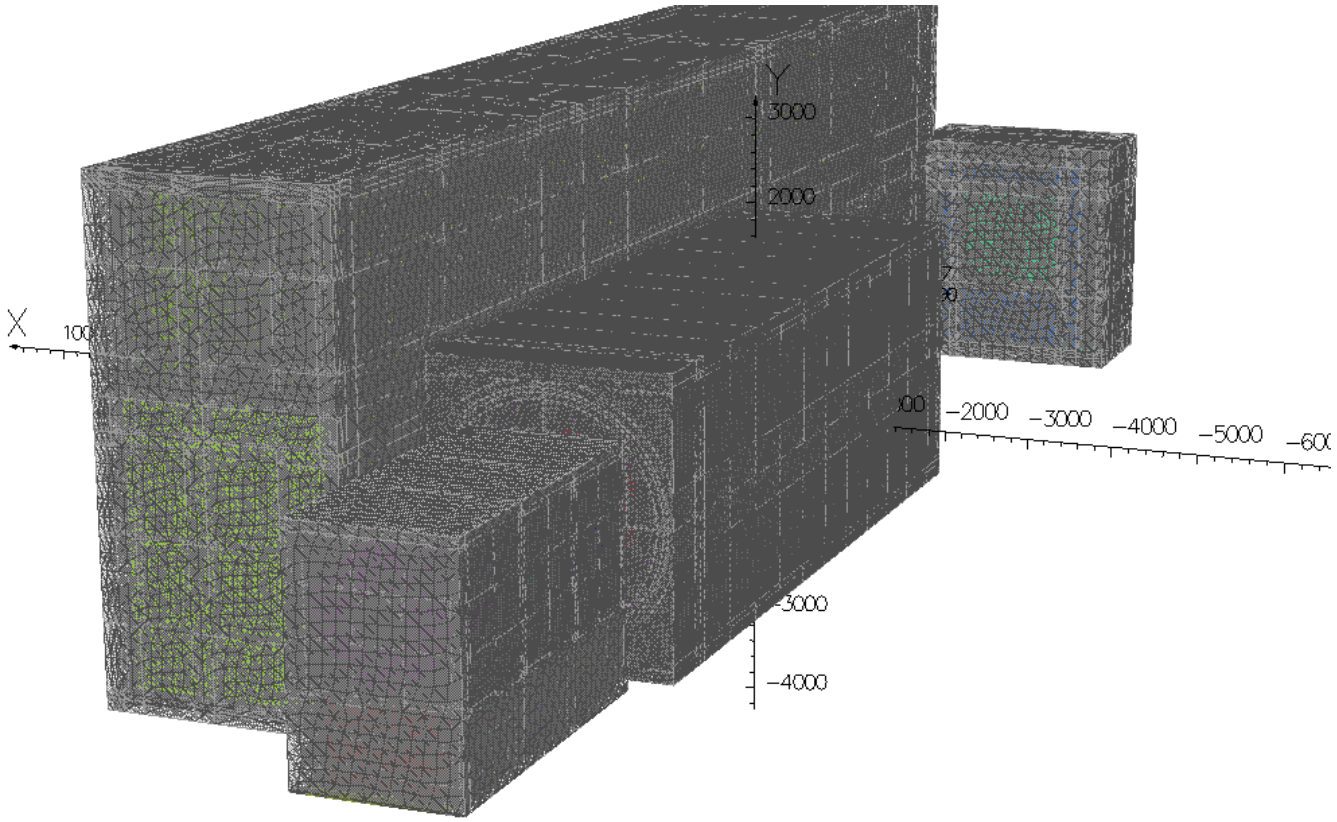
Second the meshing volume around the PRY was extended to enclose the flanges – this also extends the volume of high res mesh.

Big increase in solve time of these models generally >100 hours

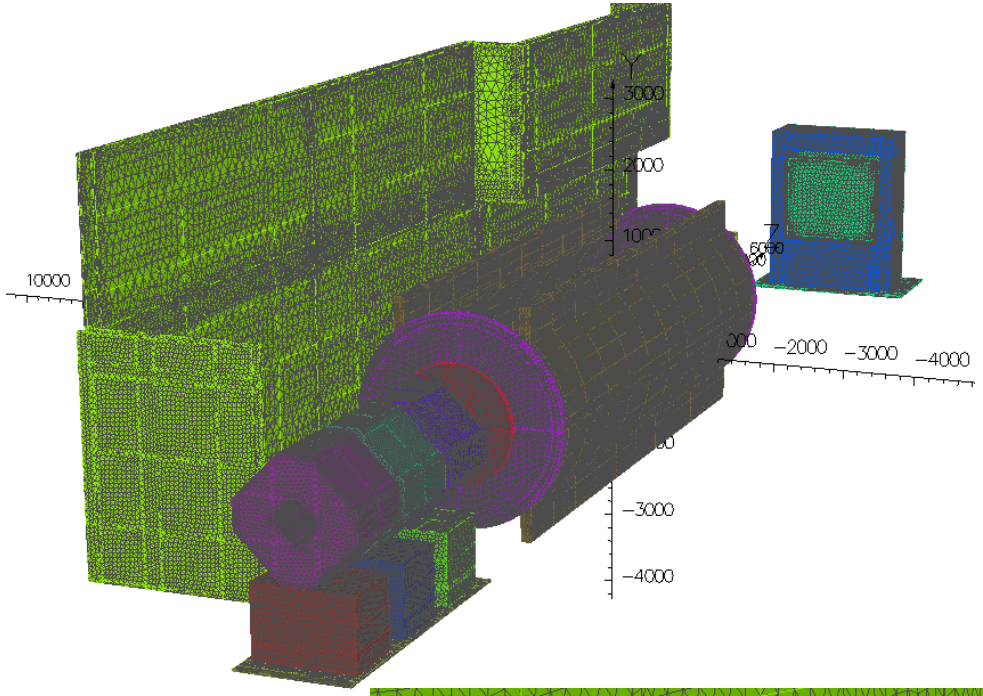
	Model 92	Model 121
#Cellar_ElementSize	500	250
#D2_AirOuterElementSize	500	250
#East_Wall_ElementSize	500	250
#Floor_ElementSize	500	250
#Hall_AirElementSize	500	250
#NMF_Air_ElementSize	500	250
#North_Wall_ElementSize	500	250
#Roof_ElementSize	500	250
#S4SHIELD_AirElementSize	200	100
#S4SHIELD_ElementSize	200	75
#South_Wall_ElementSize	500	250
#Wall_ElementSize	500	250
#West_Wall_ElementSize	500	250

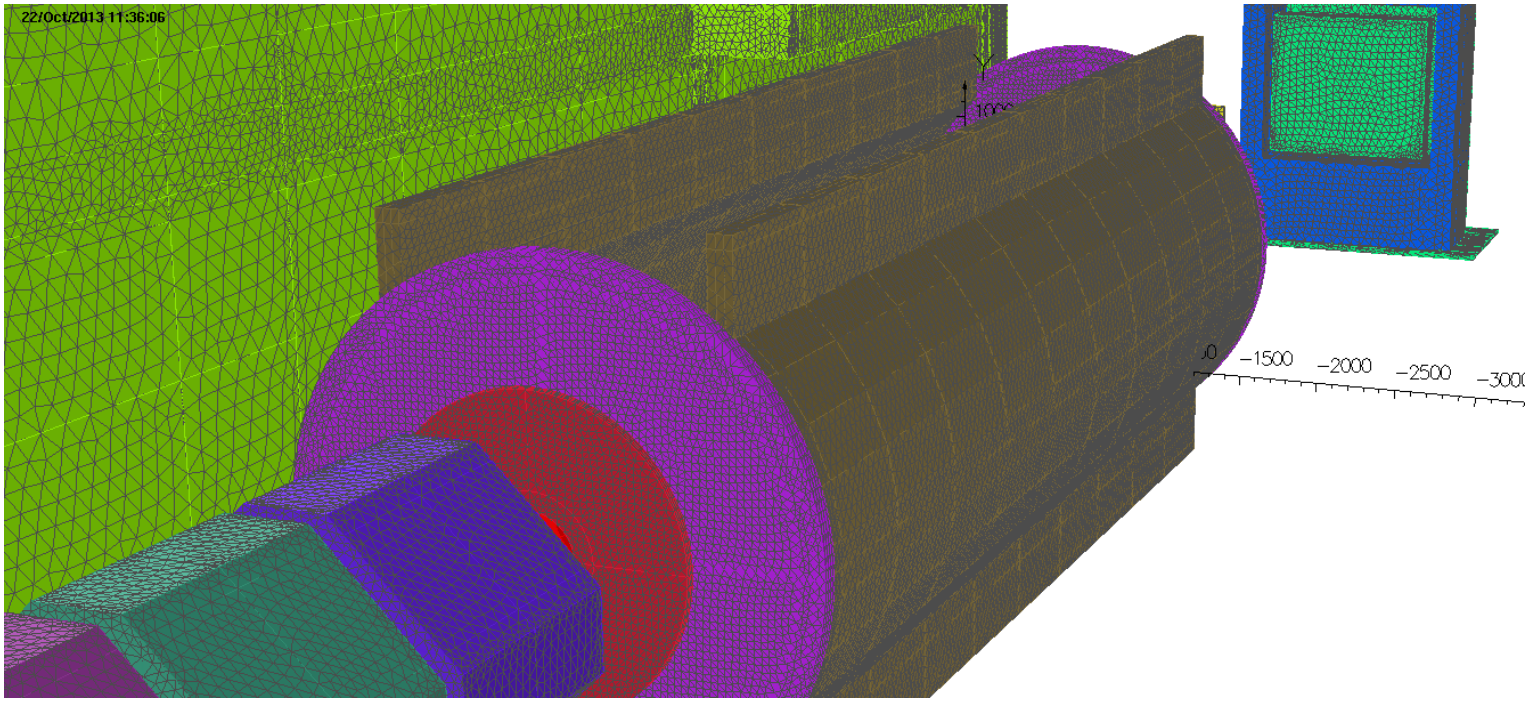
The object mesh was extended to incorporate the flanges from the PRY.

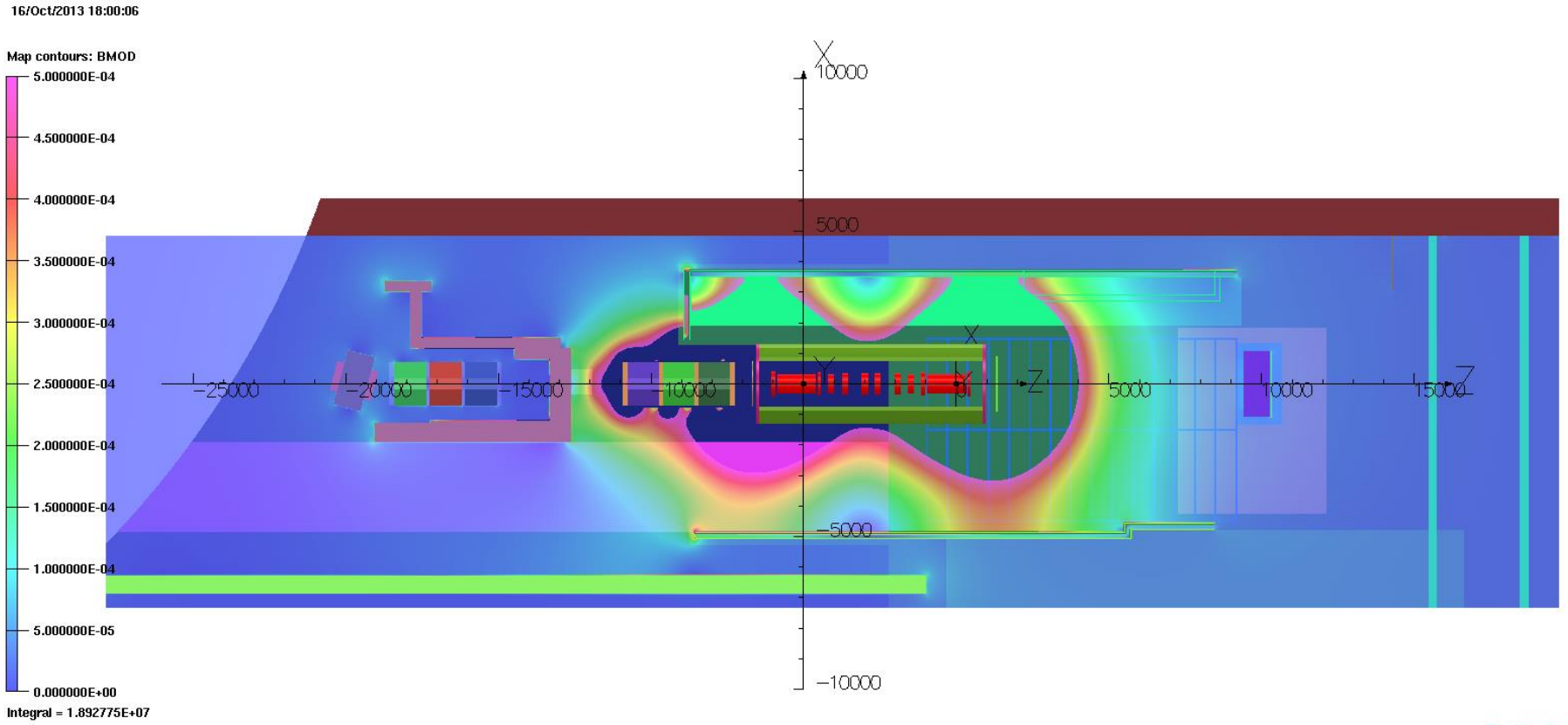




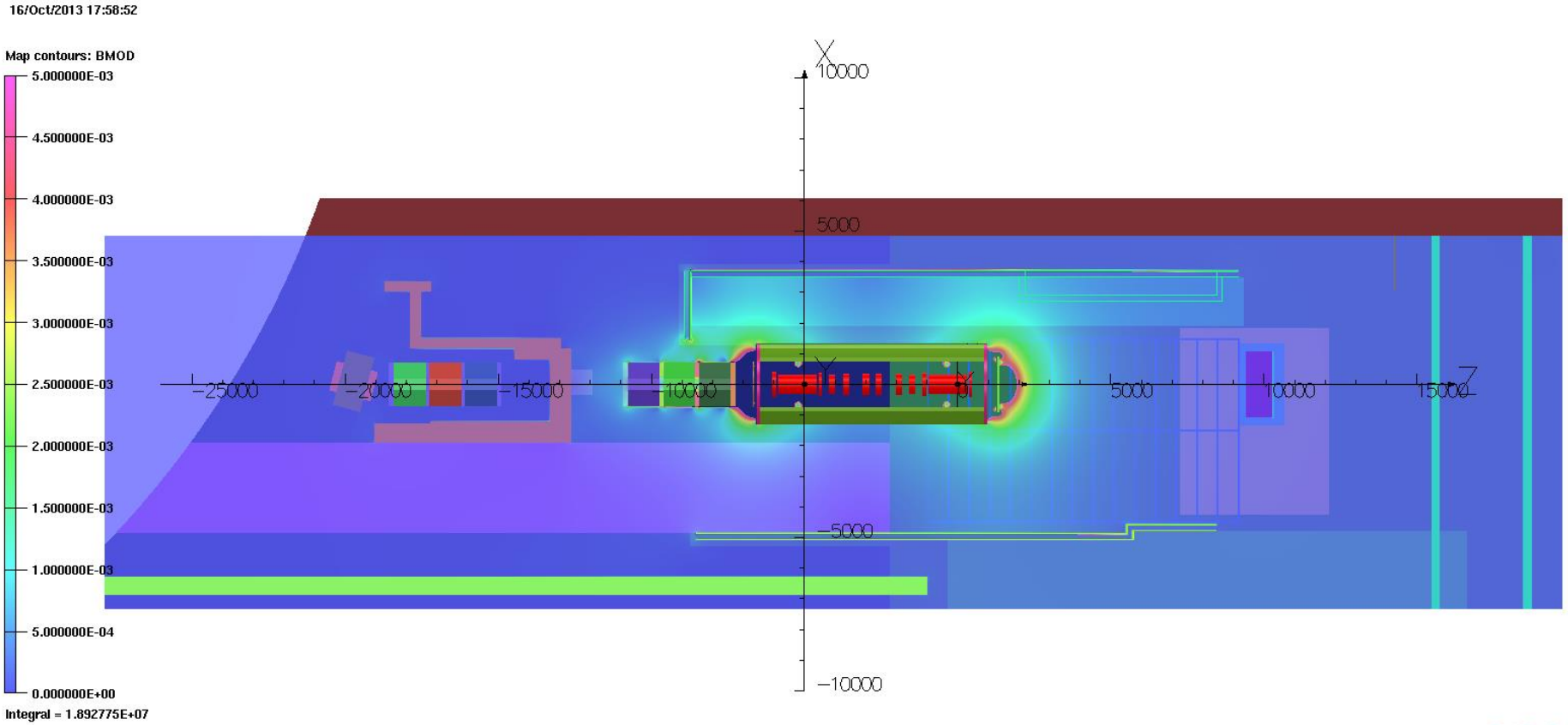
The mesh on the objects.



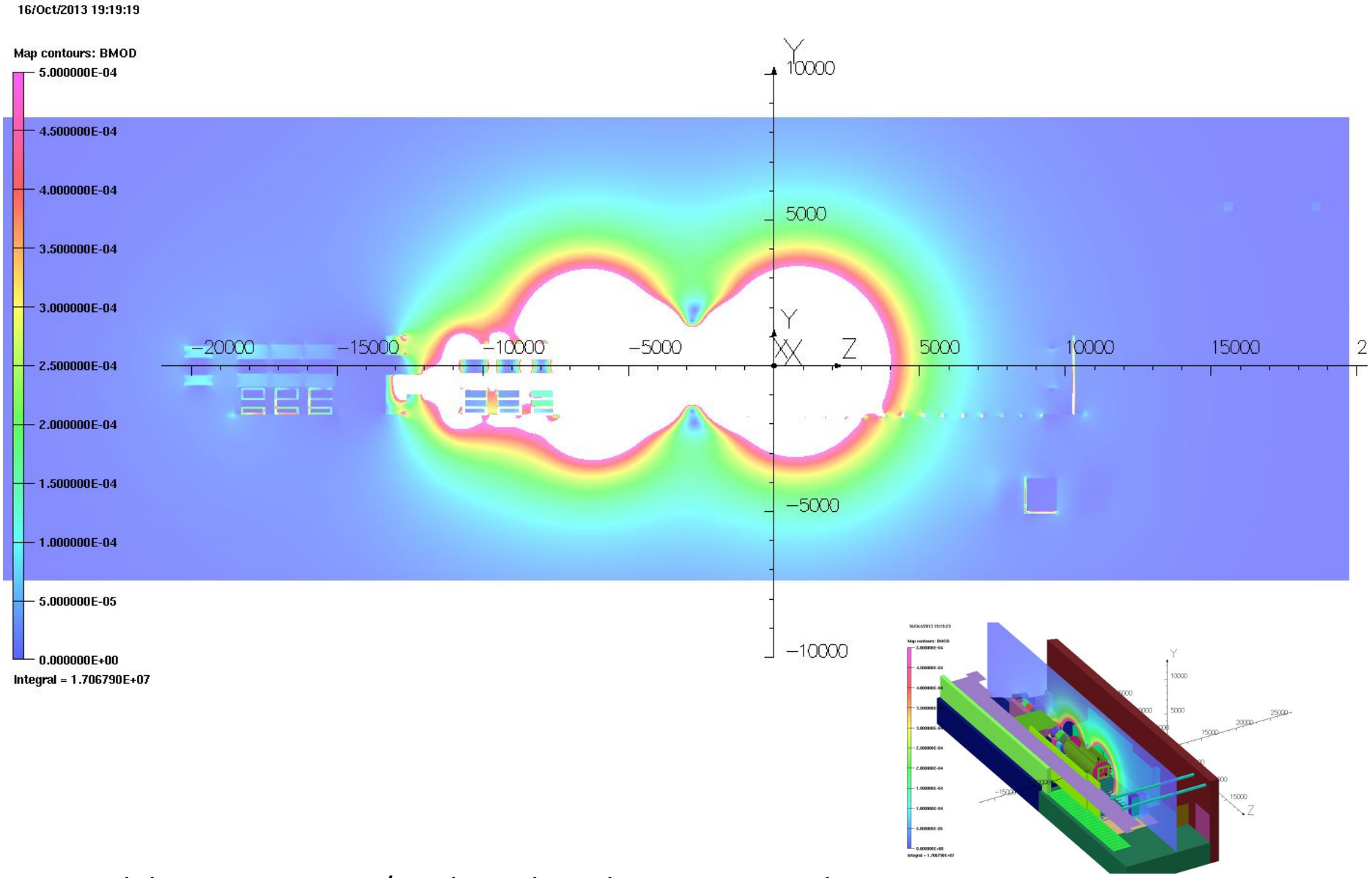




Model 121 – 240 MeV/c Solenoid Mode – 5 gauss scale.

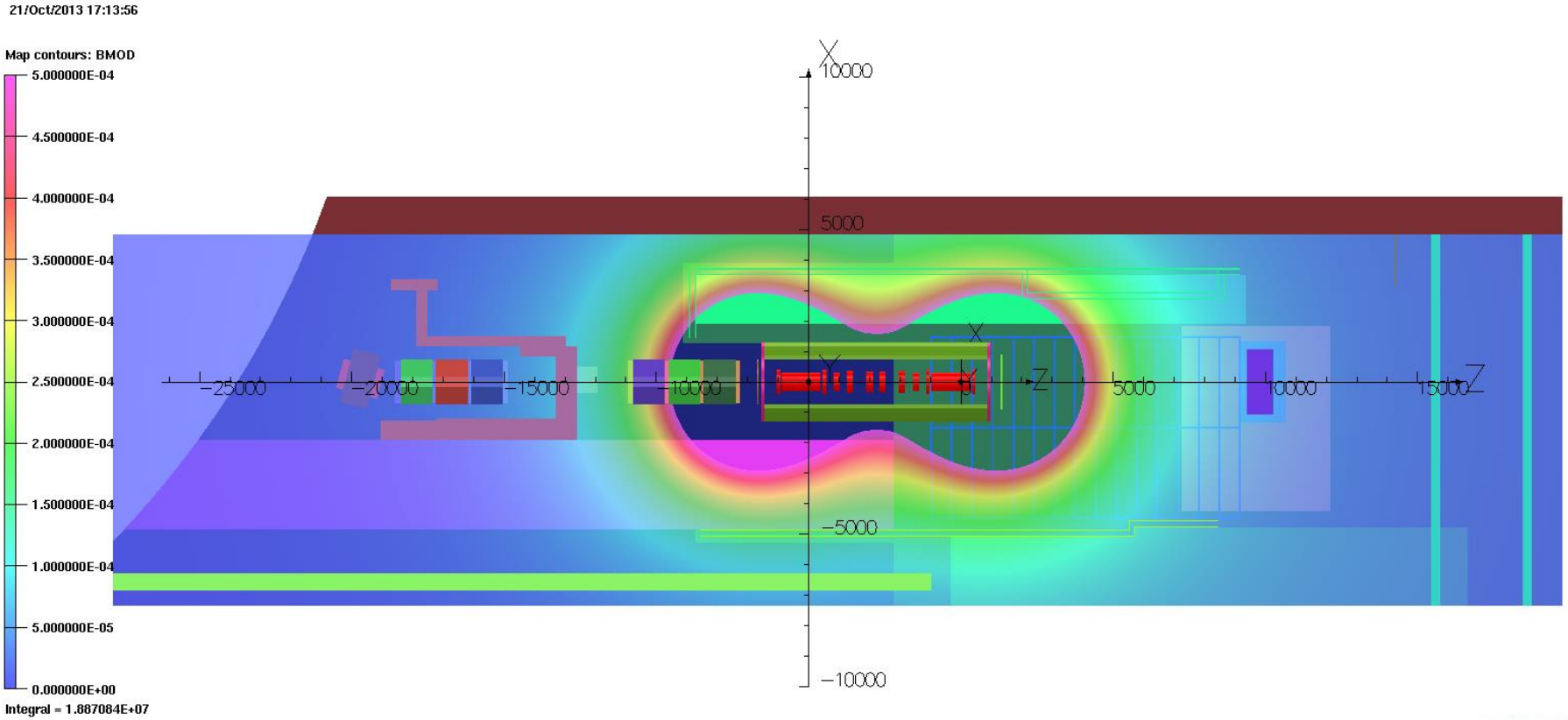


Model 121 – 240 MeV/c Solenoid Mode – 50 gauss scale.

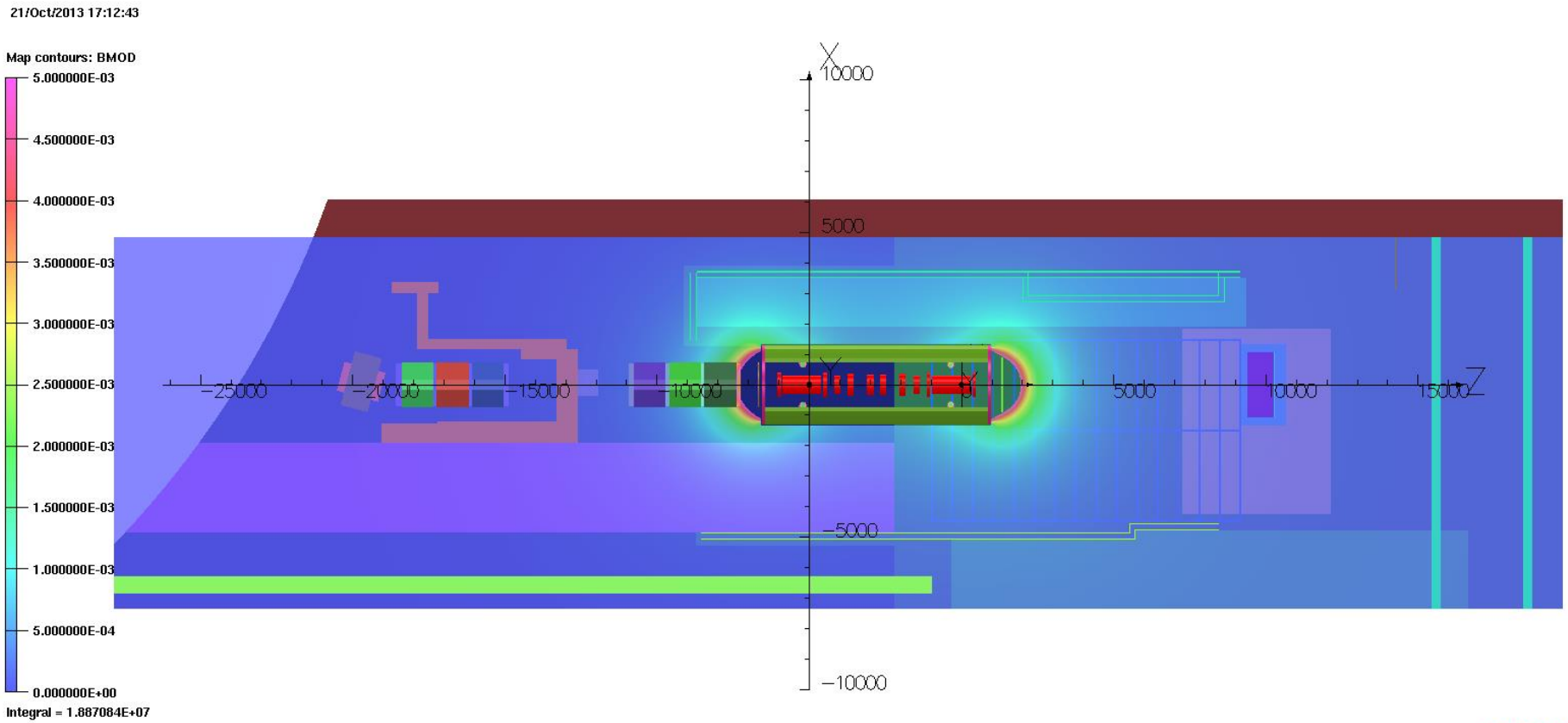


Model 121 – 240 MeV/c Solenoid Mode – 5 gauss scale.

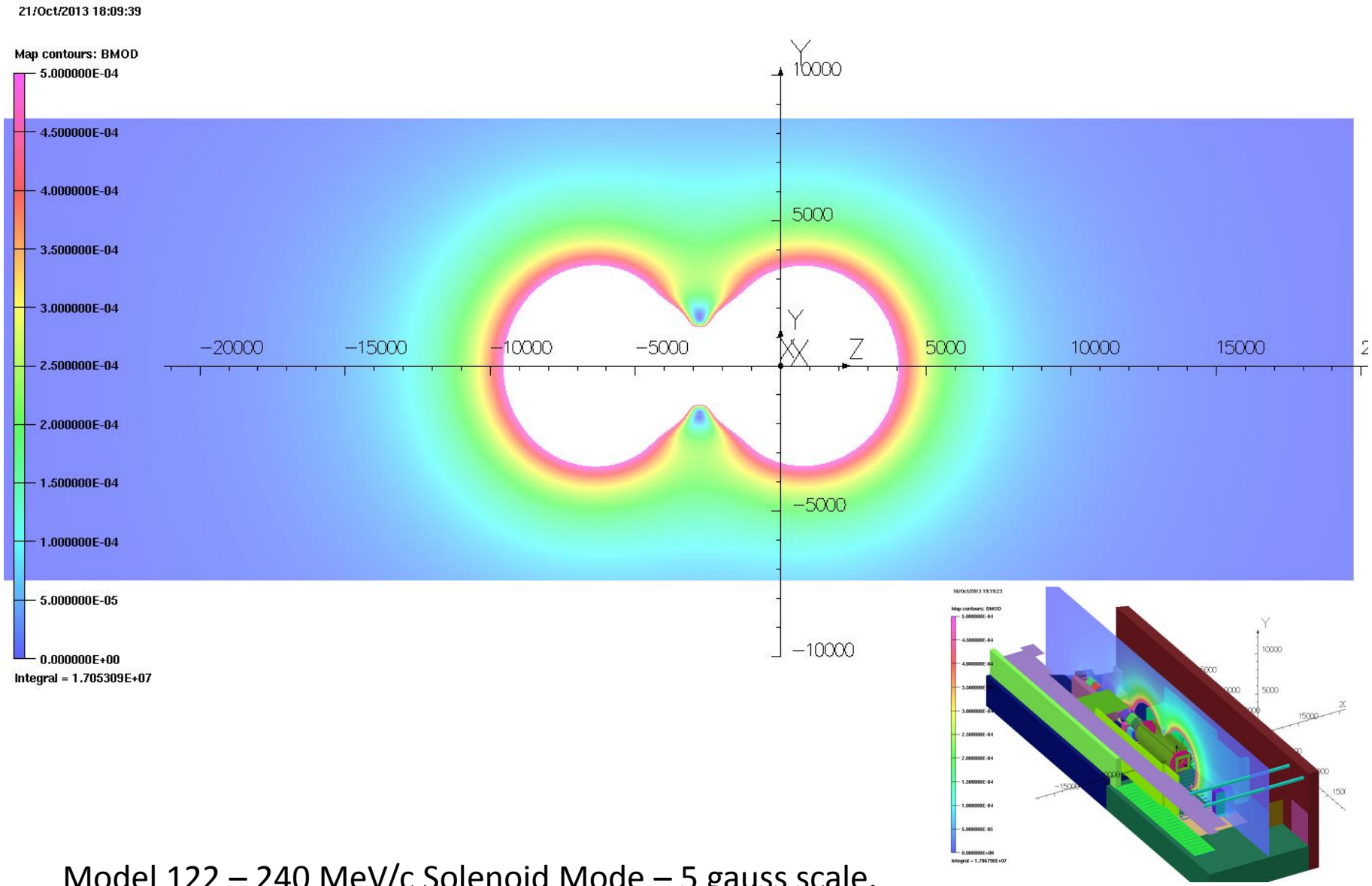
Clearly changing the meshing resolution hasn't changed much, so I also run a model (model 122) where all the structures had their BH curves set to 'Air' except for the PRY and Virostek Plates:



Model 122 – 240 MeV/c Solenoid Mode – 5 gauss scale.



Model 122 – 240 MeV/c Solenoid Mode – 50 gauss scale.

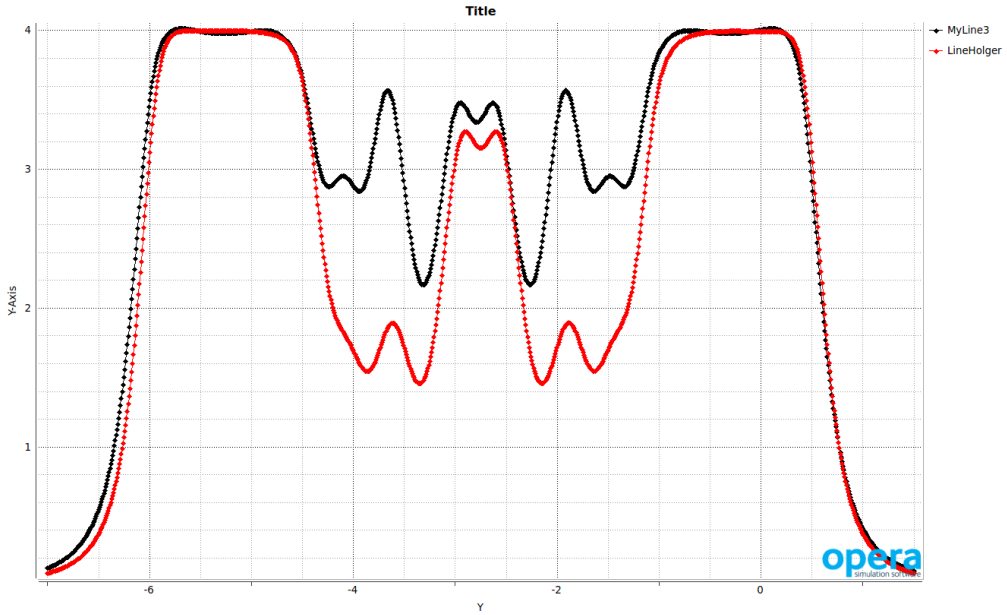


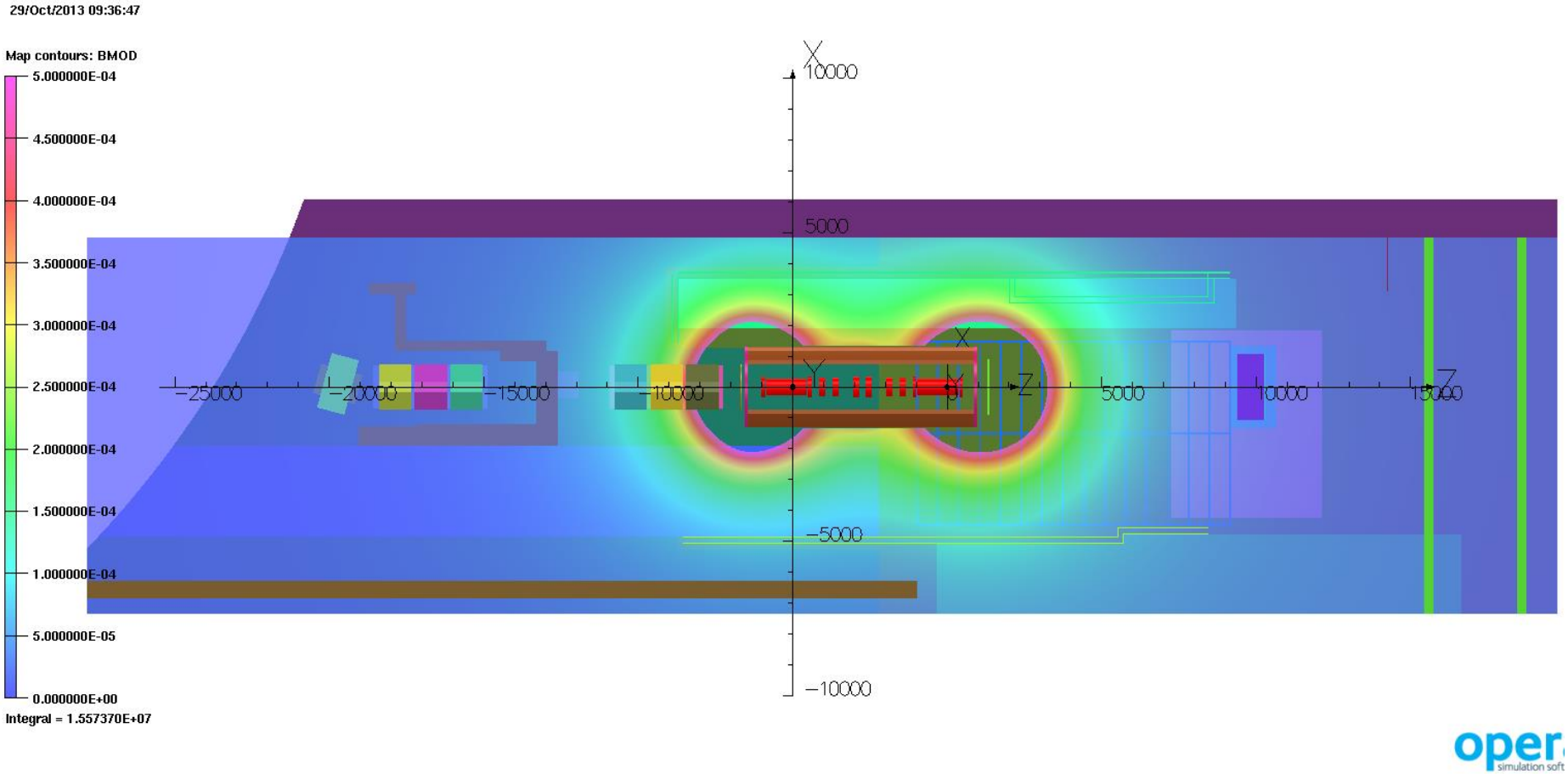
Model 122 – 240 MeV/c Solenoid Mode – 5 gauss scale.

I spoke to Holger about these results, and given that I was convinced that it wasn't a meshing resolution issue we decided to compare magnet files.

To cut a long story short I have been using the TRD magnet files whilst Holger has been using the 'as-built' magnet files. It is clear that this difference has an effect upon the field external to the PRY as predicted from the models.

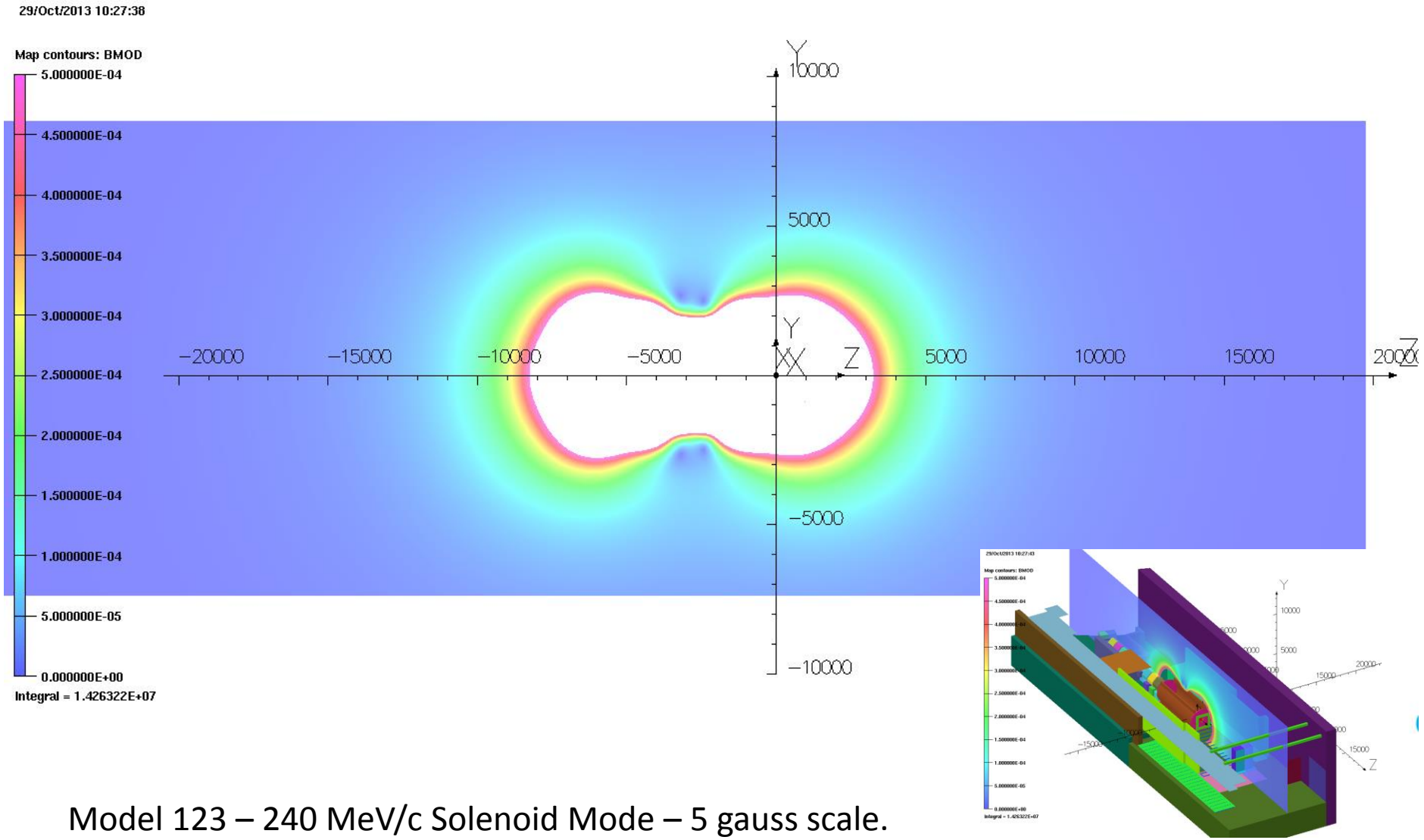
Holger has run his models with my magnet files (his models are quick) and I'm in the process of running my Hall model with his magnet files so that I have a comparison.





Model 123 – 240 MeV/c Solenoid Mode – 5 gauss scale.

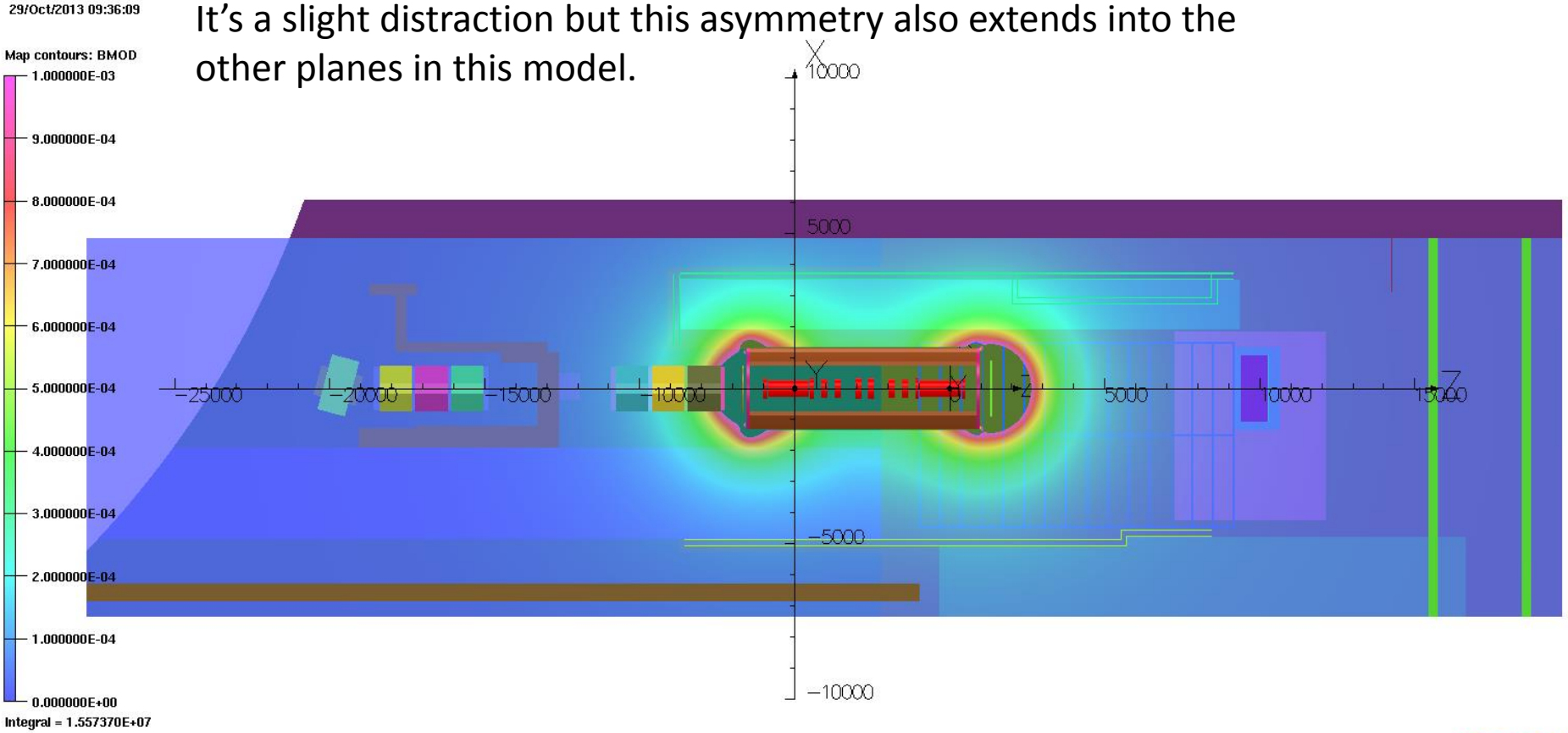
As Built magnet file (from Holger) and all components except the shield and VP are set to air.



Model 123 – 240 MeV/c Solenoid Mode – 5 gauss scale.

I believe the asymmetry is because the magnets are not sitting centrally between VP – Note not visible in model 122 where magnets are symmetric between plates. (slide 19)

It’s a slight distraction but this asymmetry also extends into the other planes in this model.



Model 123 – 240 MeV/c Solenoid Mode – 10 gauss scale.

So, there appears to be an asymmetry between the LHS and RHS of the plot, I strongly suspect that this is due to the 40mm offset between the centre of the magnets and the centre of the Virostek Plates.

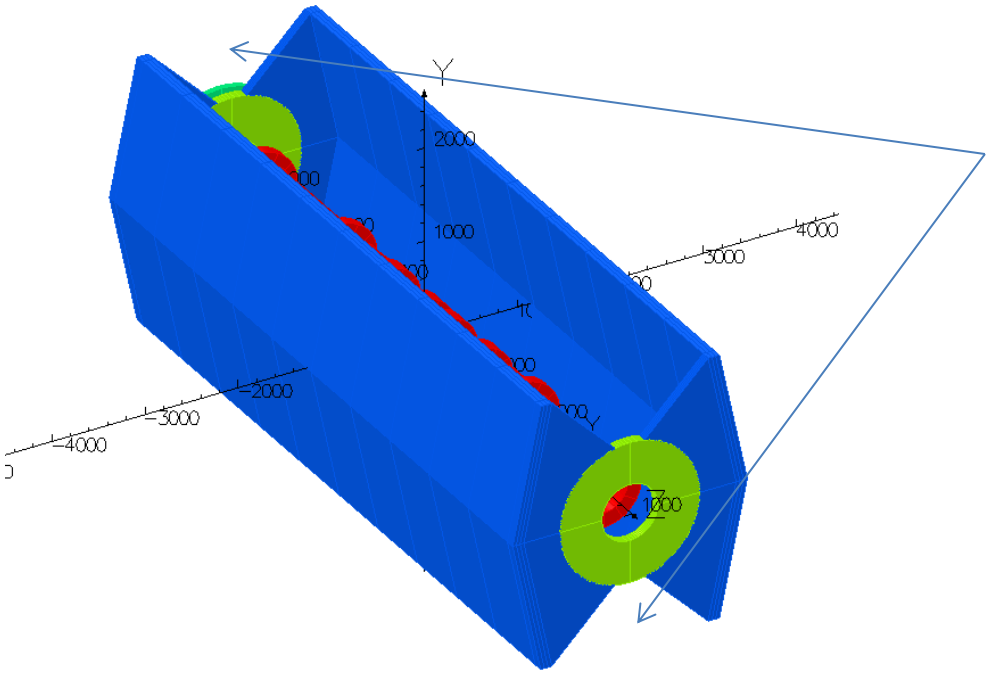
Conclusions

It has taken quite a lot of modelling time but I think we have partially closed in on some of the discrepancy between the Hall model and Holger's models.

I still think that I need to understand why I see more field at the ends of the cooling channel than Holger does but I understand Holger may have some insight into this.

I want to run a simplified PRY model on it's own and tie this in to the Hall model (i.e. they should agree). This shouldn't be too difficult to set up and will give a faster turnaround on these PRY models.

I have also updated the geometry of the PRY for the hall model, as this was something else I had wanted to try before we discovered the discrepancy between the magnet files. In future any PRY Hall models will include this updated geometry.



The geometry is consistent with current drawings.

The triangular cut-outs above and below the Virostek Plates can be left solid (switch in code)

The new PRY model meshes in the hall model without issue.

Other News

- In fact given that I have now moved all the magnets to centre them between the VP and that I have the step V files and the 200Mev/c magnet files nearly all of the models need re-running. I also want to run some models with different shield wall configurations with the PRY in-situ. This is going to take a long time… (However I'm going to reduce the meshing resolution again as I think the recent increase was unnecessary.)

- To help me do this I have purchased a second computer. The current models are consuming most of the memory up in my current machine and preventing me from using my second licence. My plan is to split the functionality of OPERA up so that I have a machine to develop on and a machine to solve on. The solver machine should be able to solve two models simultaneously in the 64GB if it is not running the modeller and post-processor at the same time.