Modelling Update
06/08/2013

I was really hoping to have something concrete to say on the substation model but I think these models are cursed.

I had completed a set of models but Kiril convinced me that the models were inaccurate due to a lack of elements across the width of the substation wall.

I rebuilt the models in a way that addresses this but due to a number of computer crashes I have not yet got a complete set of results. I'm also having the dreaded meshing issue problem when I try to introduce holes into the substation walls. Consequently I will hold off presenting anything on the substation until next time rather than give half the story…

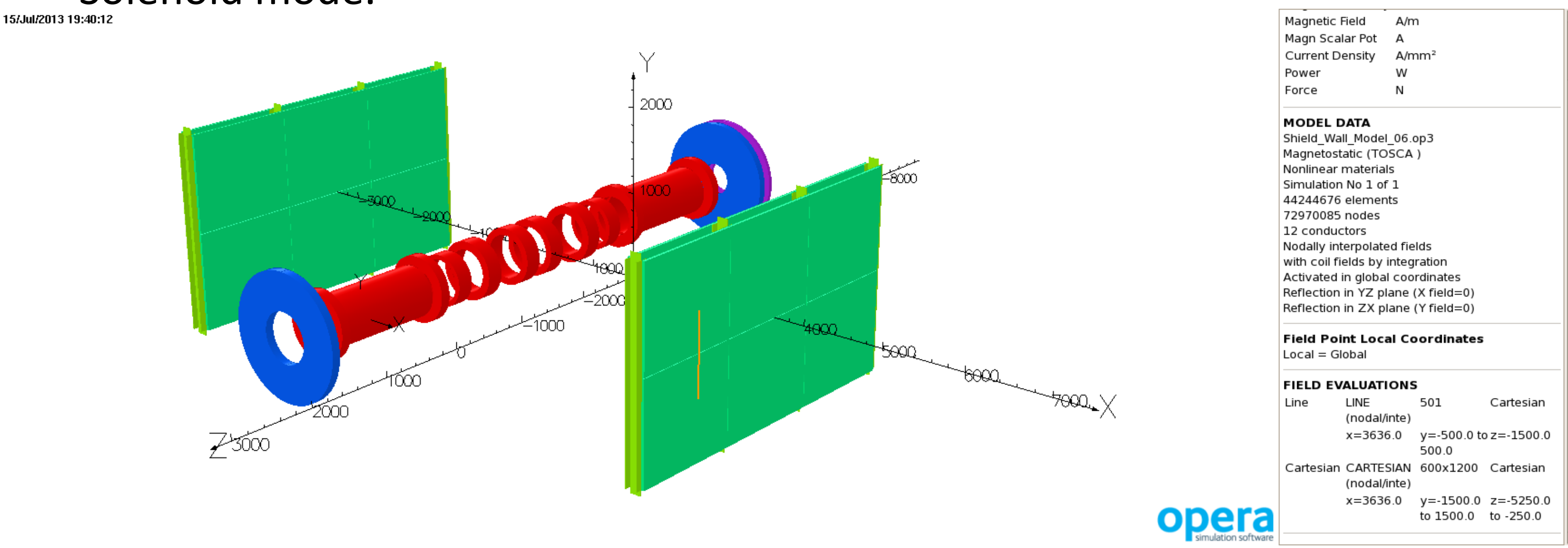
So for this week I'm going to revisit the shield wall because I think there are some more interesting results from this…

Now the last presentation was sent out in my absence and the slides follow on from this.

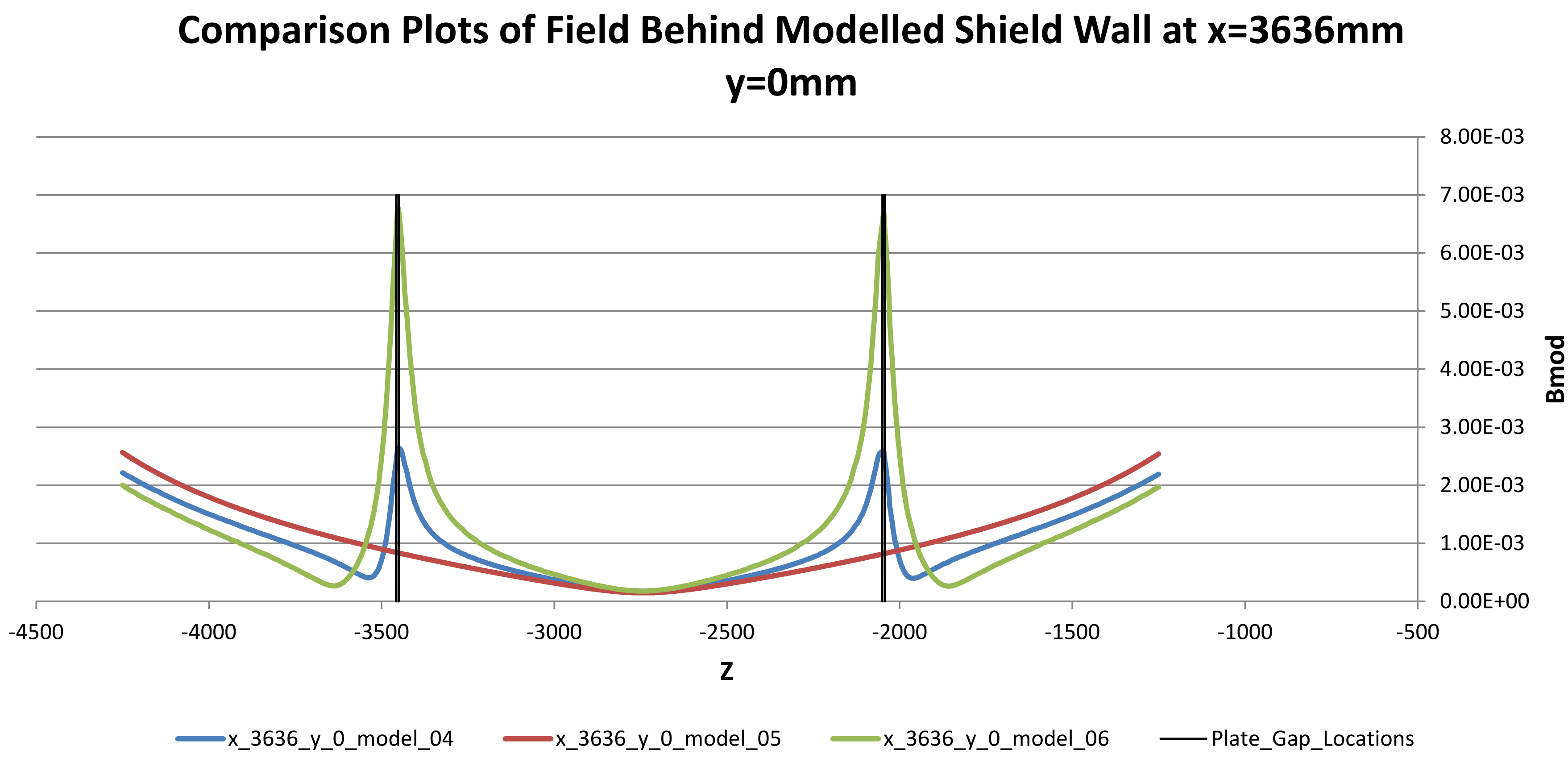
Brief reminder.

A short section of shield wall was modelled in isolation that included the gaps between the shield wall plates. The section was short because the meshing resolution meant that the model was large and I couldn't physically build a larger model without running out of computer memory.

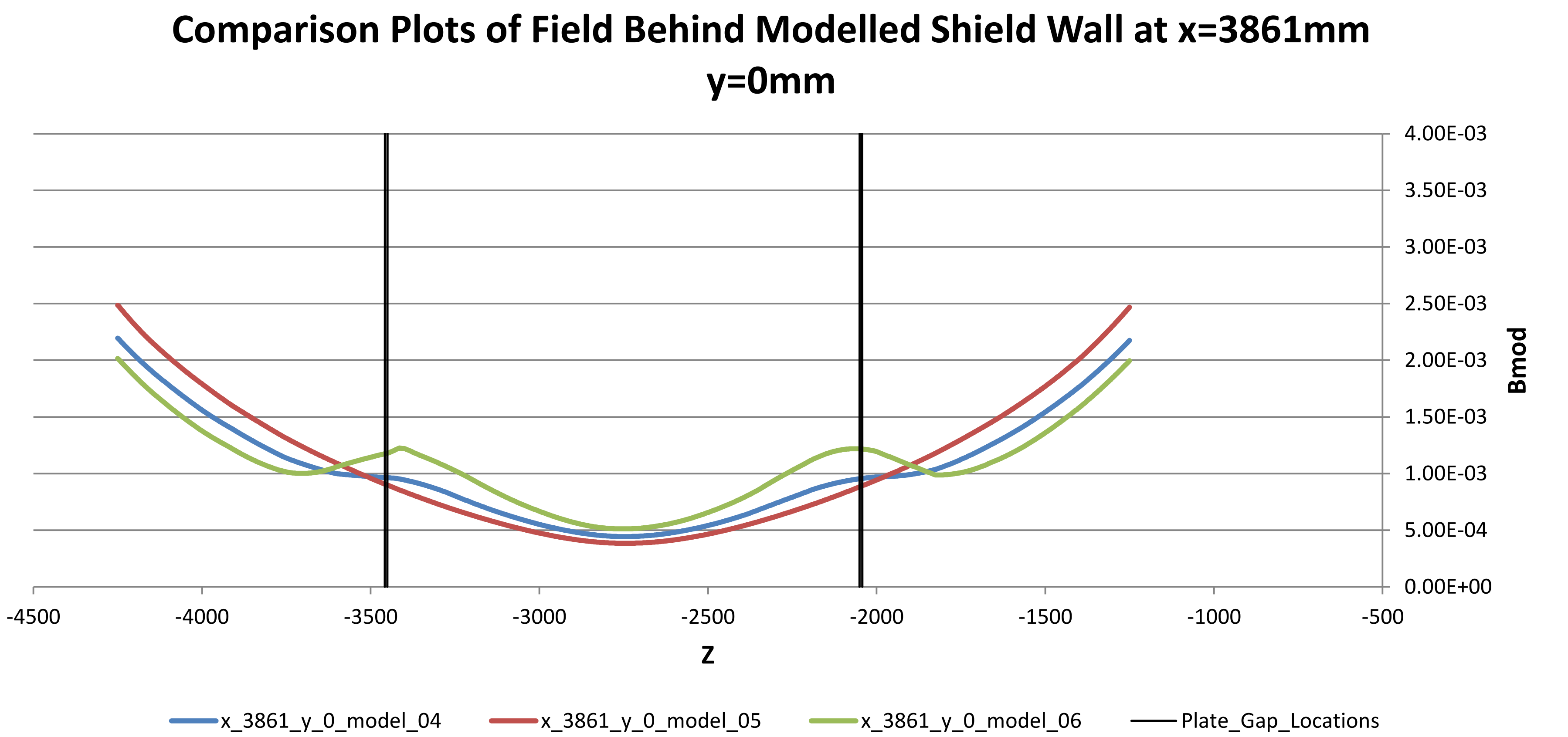
The distance to the plates was supposed to be the same as the distance to the SSW but I got this wrong by about 100mm (3% error). Step IV magnets Solenoid mode.



This plot lies about 1” behind the shield wall and is line that runs in the z direction



Brown line is baseline (continuous shield)
One would like to hope that reality lies between the blue (best case – plates touching the I beams)
and the green line (worst case? – 1.5mm gap between plates and I beams)



This plot lies about 10” behind the shield wall and is line that runs in the z direction

A number of points:

All of the plots in the last shield wall presentation were produced by nodal interpolation rather than integral.

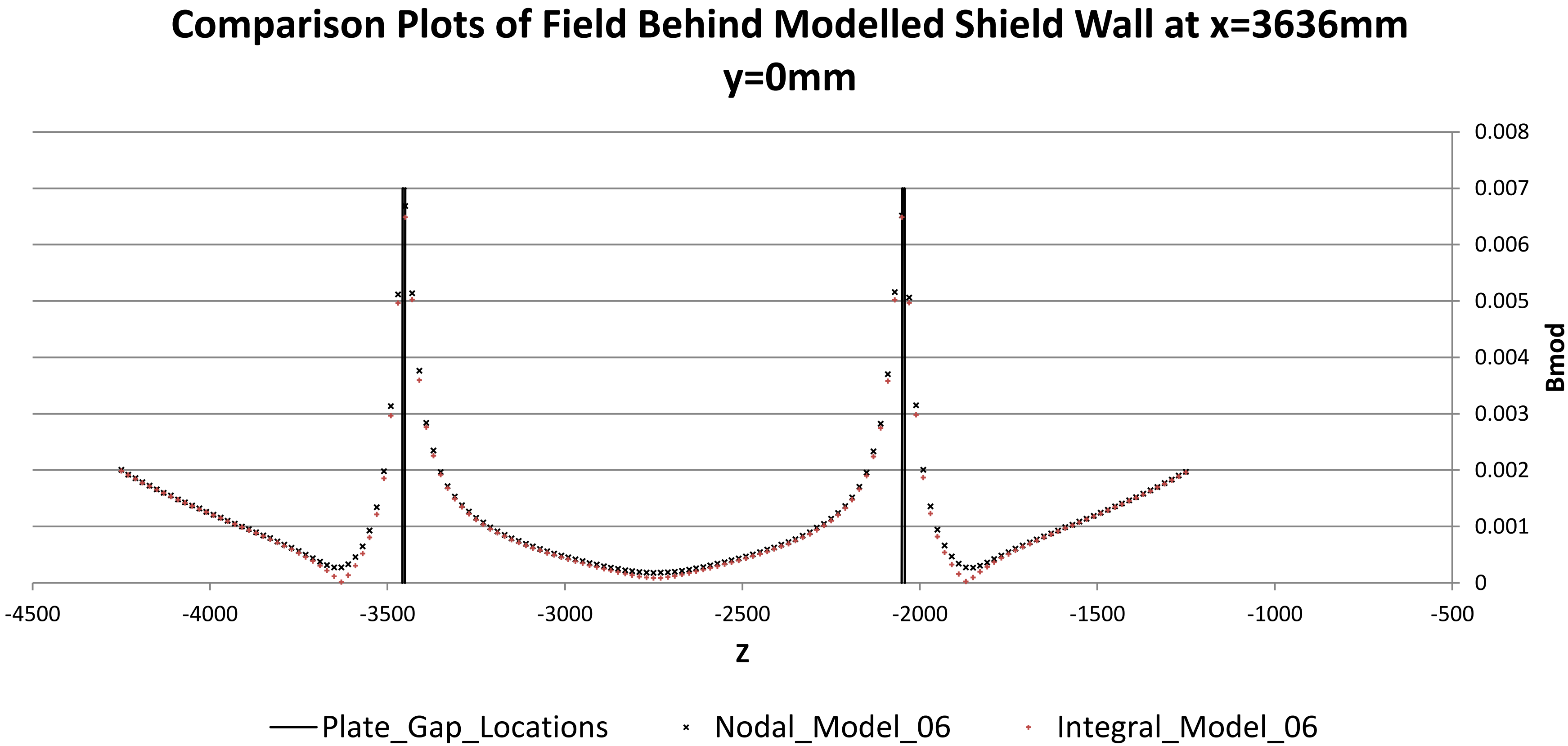
Normally integral is preferred but in these cases I think there might not be much in it.

Integral plots are generally preferred except:

1) When there is large cancellation between iron and magnet fields
2) When the line is very close to a magnetised piece of material (within ~2 elements).

In all our shield wall models we are up against point 1) in any case. In the shield wall models the meshing resolution is high enough that the nodal plots appears to give good results that are comparable with the integral results. Integral results show much less leakage across gap – In this case I'm not sure which results to believe…

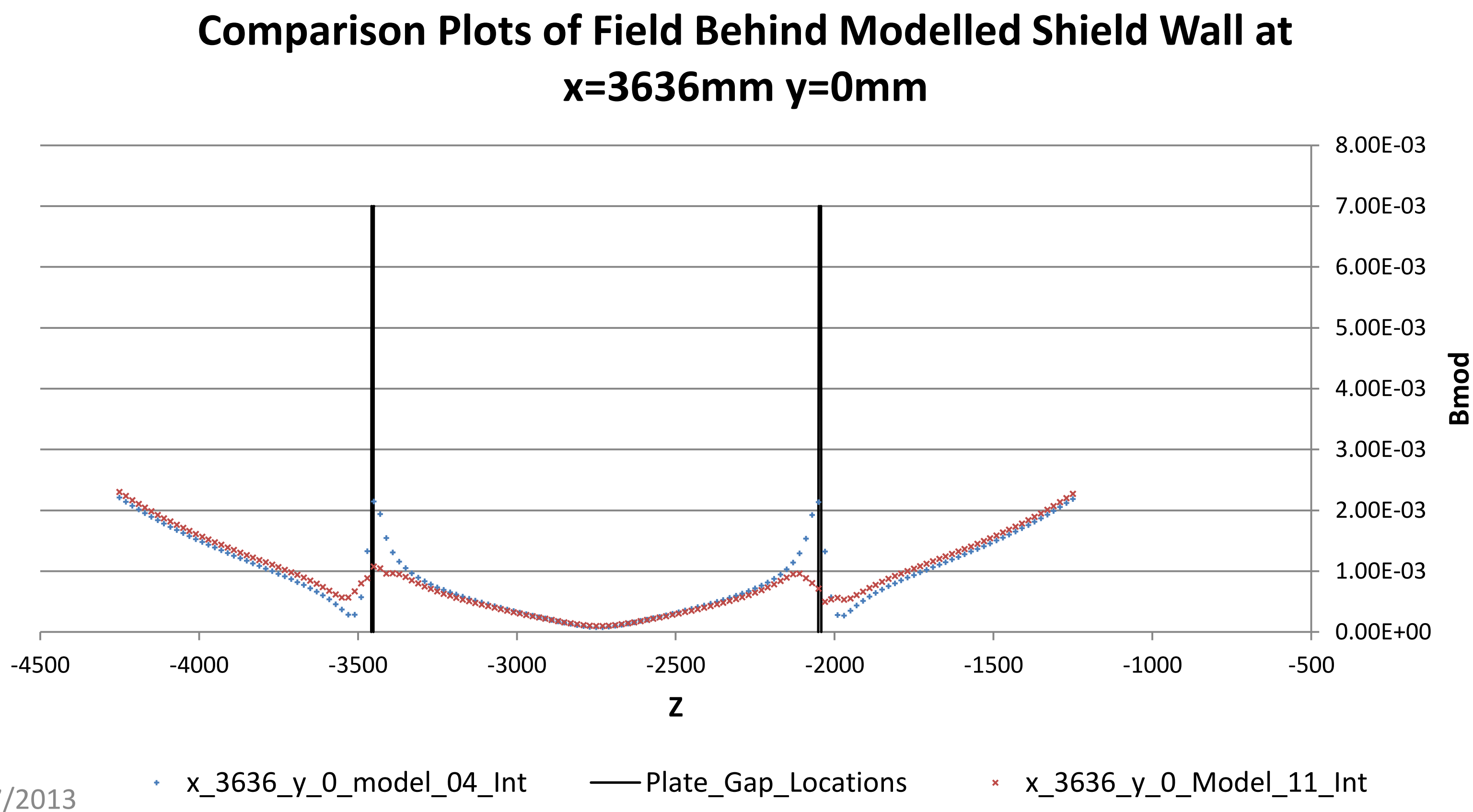
In the hall model the meshing resolution is much poorer and the point 2) above has a very noticeable effect… (Actually I believe this outweighs the poorer meshing resolution with nodal plots which I'll show later.)



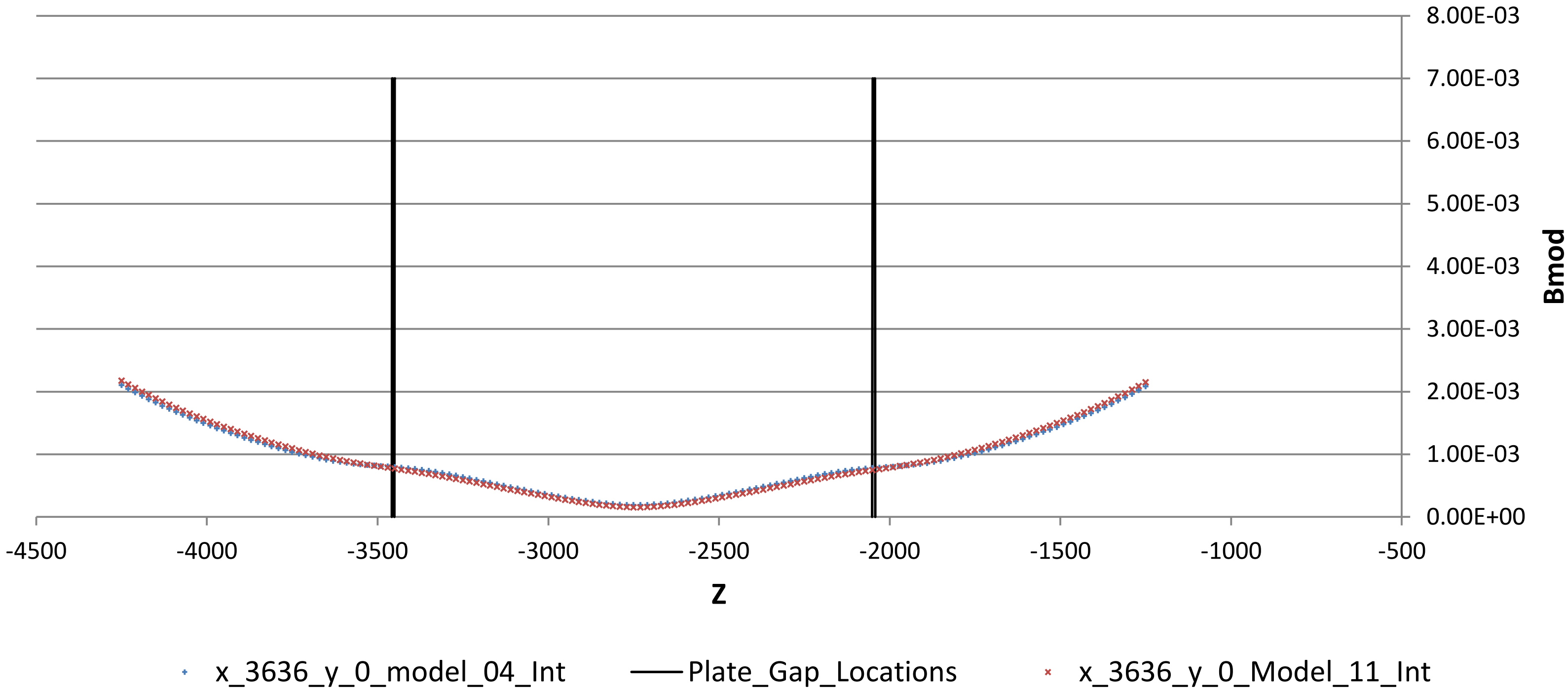
The nodal vs integral results compare quite well for the shield wall models primarily due to the high meshing resolution of the shield wall model. This is for model 6 with the 1.5mm gap between the plates and the I beam (largest field between plate gaps)

The second point was that I ran some of these models again but used linear elements instead of quadratic elements. The reports from VF suggested the quadratic was probably overkill in most scenarios and using linear elements produces smaller models.

This means that if the linear results are comparable to the quadratic results then I can build a model with more plates that would more closely represent the shield wall that we have in the MICE hall.



Comparison Plots of Field Behind Modelled Shield Wall at x=3861mm y=0mm

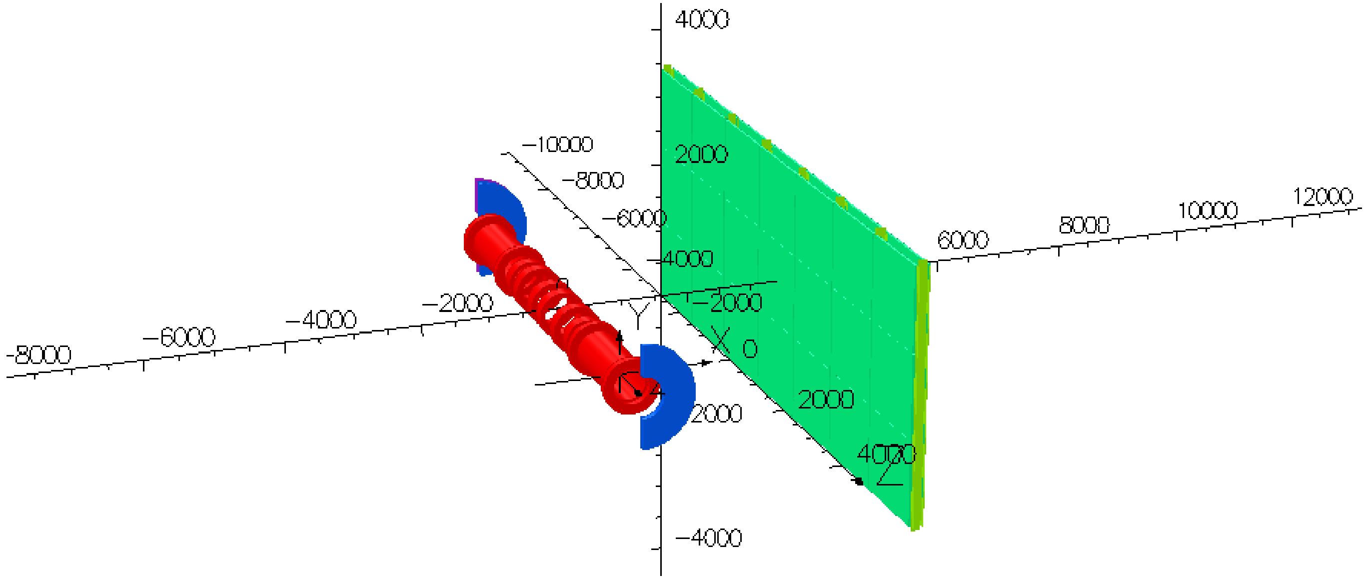


These plots are just for model 4 vs model 11 (quadratic vs linear elements) Good agreement further away from the shield but there's a slight discrepancy over the plate gap close to the shield wall in the first plot.

Probably not too surprising as the quadratic model would better capture the rapidly changing field in this region – but still passable agreement.

Also note that these are integral plots and as already pointed out the integral plots might not do so well so close up to the shield wall. I haven't redone this with nodal for comparison but something to bear in mind.

As the agreement was 'reasonable' I ran a shield model with more panels but all linear elements. This allowed a much larger shield wall to be built.

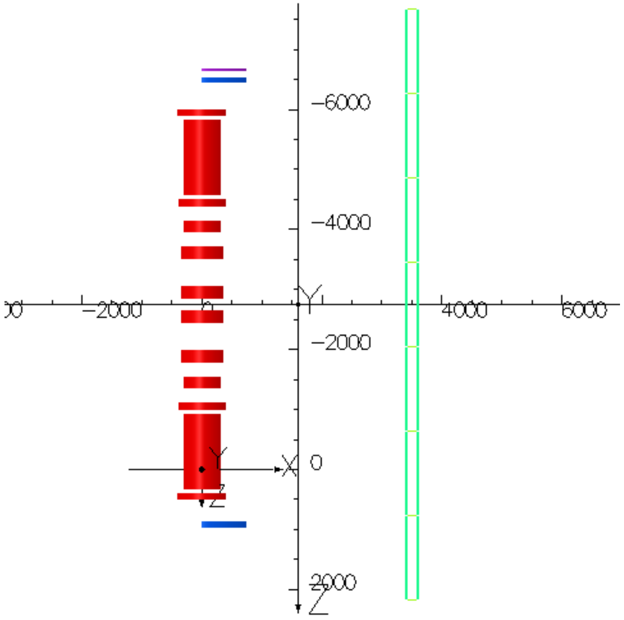


Shield Wall is 7 x 3 panels. 7mm gap between panels
Panels are stood off from I beams by 1mm.

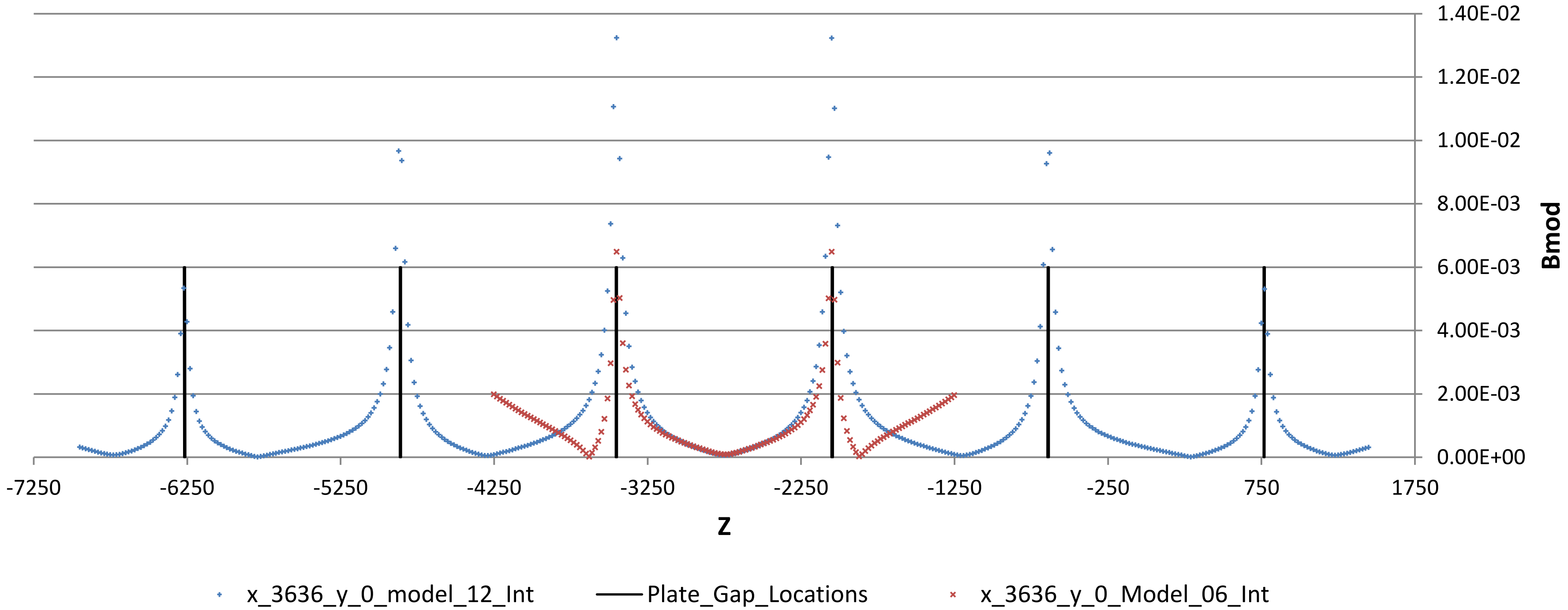
Note this only shows 50% of model - there is an implied symmetric shield on the other side of the model.

Length of this shield: 9842 mm
Length of NSW: 17019 mm

Height of this shield 3764 mm
Height of NSW ~5m

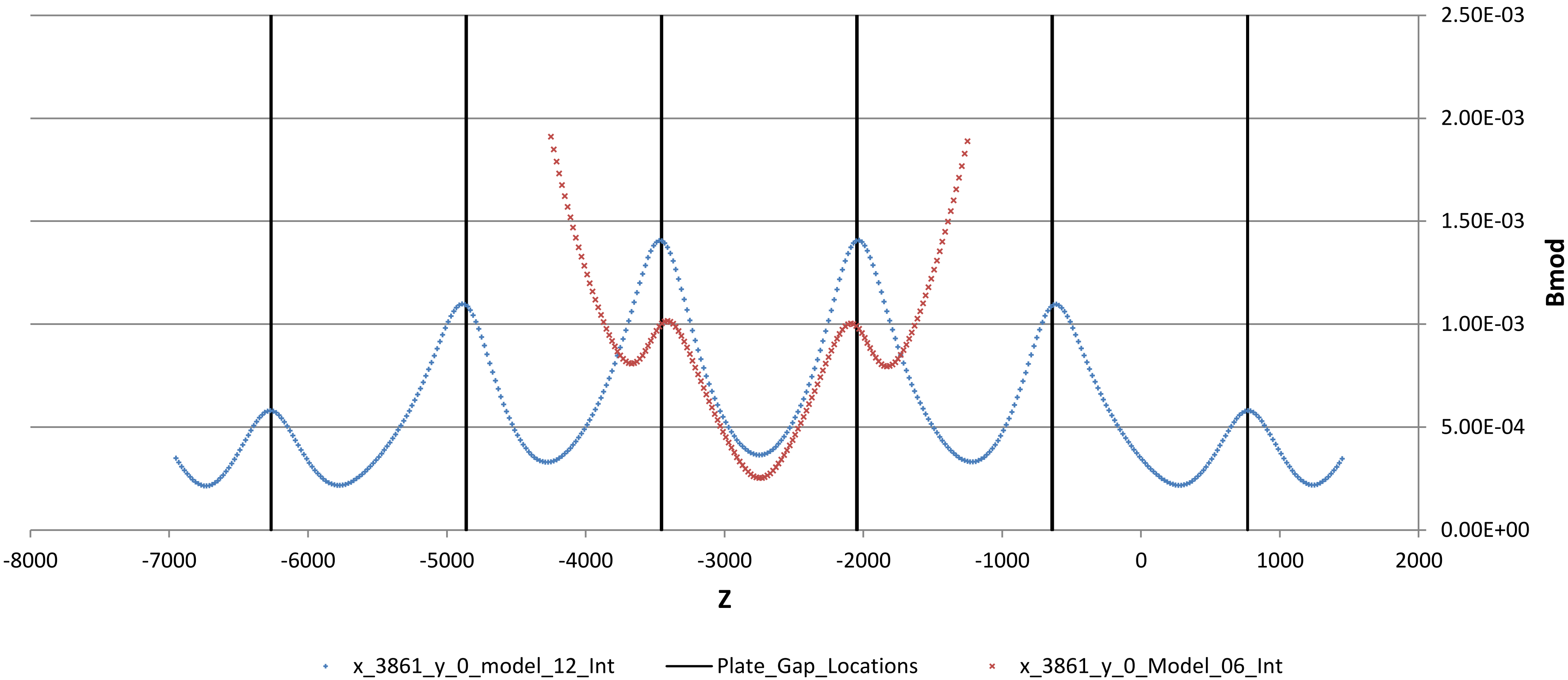


Comparison Plots of Field Behind Modelled Shield Wall at x=3636mm y=0mm



These are integral line plots.
Model 06 is for the 2 x 3 plates and is with the plates in contact with the I beams.
Model 12 is for the 7 x 3 plates and there is a 1mm gap between the plates and the I beams hence the larger field at the gaps. (The flux will find it harder to find a path through the I beam)

Comparison Plots of Field Behind Modelled Shield Wall at x=3861mm y=0mm



These are integral line plots. 3861mm represents approximately 10” behind the shield wall
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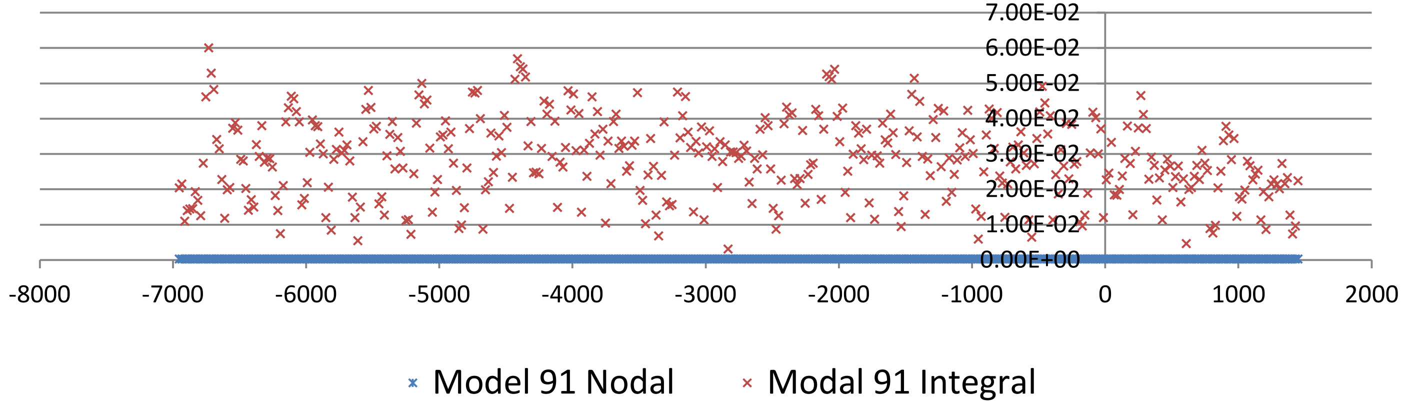
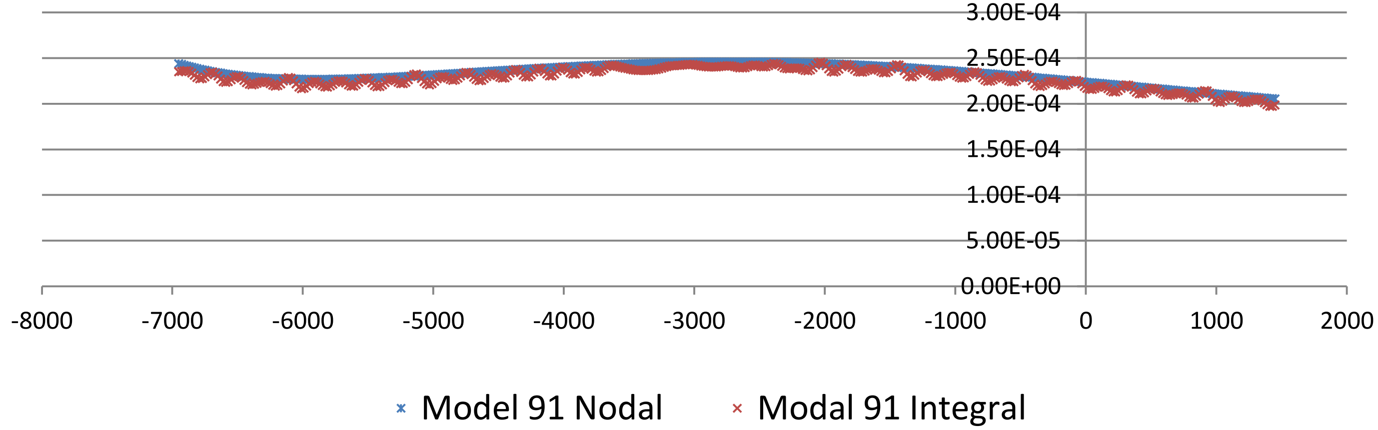
Model 12 is for the 7 x 3 plates and there is a 1mm gap between the plates and the I beams hence the larger field at the gaps. (The flux will find it harder to find a path through the I beam)

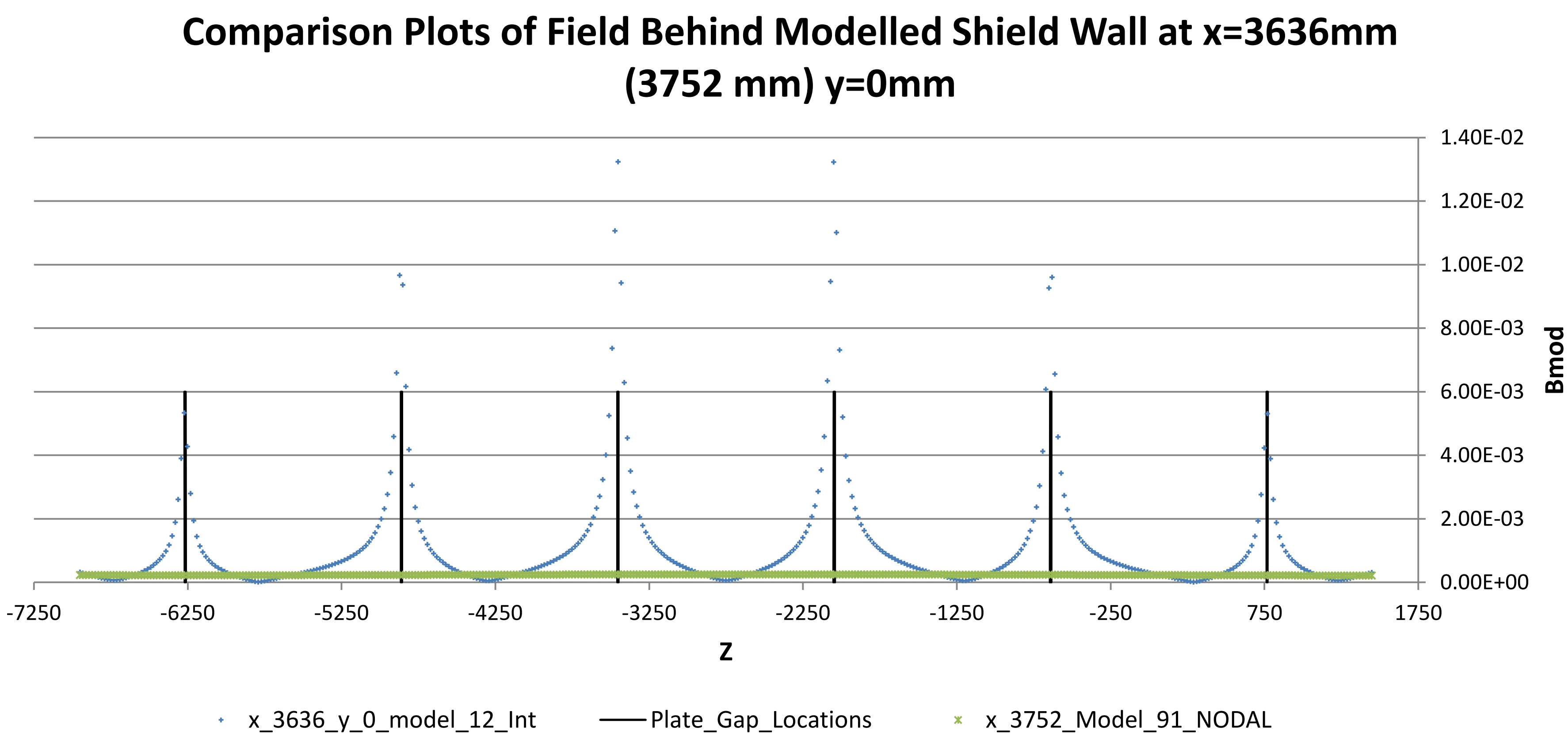
Comparison of Nodal vs Integral Plot at x=3752, y=0 from Model 91 (Just behind SSW)



When taking data from behind SSW in hall model 91 the Nodal result looks much more believable…

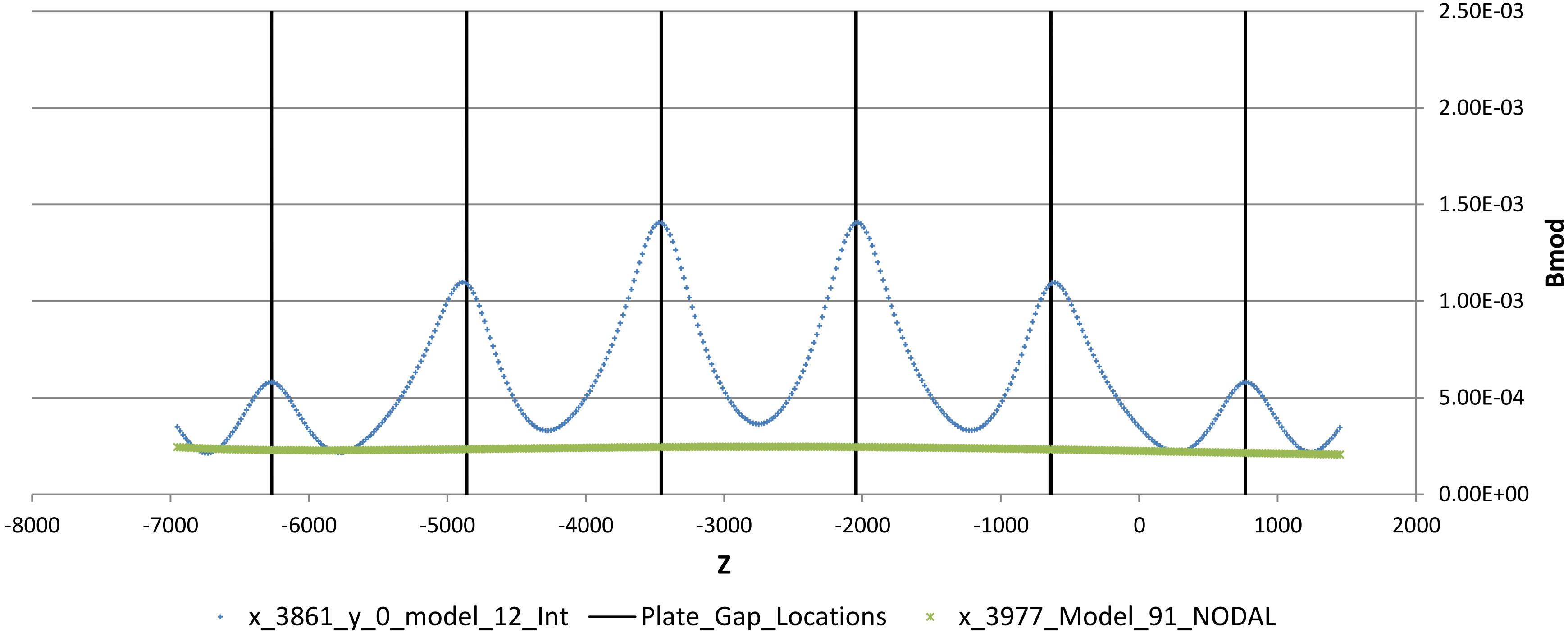
Comparison of Nodal vs Integral Plot at x=3977, y=0 from Model 91 (Just behind SSW)





This is the same plot as from the earlier slide but I've added the nodal result from model 91 from behind the SSW. Not directly comparable as geometry is different for the SSW and SSW is slightly (116mm) further away from magnets but perhaps this gives a qualitative comparative indication of the effect of the gaps?

Comparison Plots of Field Behind Modelled Shield Wall at x=3861 mm (3977 mm) y=0mm



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Conclusions

I could spend quite a bit more time trawling through these models, pulling out data to plot. It is my feeling that these models are complex and without any real measurements to baseline them against I'm concerned about extrapolating too much from them; I think it could be dangerous to draw too much from this.

However it is clear that the models are indicating that the plate gaps are having an effect upon the magnitude of the field that is observed behind the shield wall and there is some indication that the effect is not insignificant close to the plate gap.

These models also indicate that we have another unknown which is difficult to precisely quantify without having access to measurements. The models are complex and several simplifications/assumptions have been made of which are difficult to judge accurately and to which the model is likely to be sensitive. (I'm thinking of effective gap between plates and I beam).

Are we concerned about this result?

If anyone else wishes me to have a look at any other aspect of these models then I welcome suggestions…