MAGiC shielding calculation overall status

Consorcio ESS-BILBAO

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Intro

Aims & scope

In this presentation, we review the overall status of the MAGiC beamline shielding calculation, detailing the milestones reached, and also discussing the problems that we may later find when validating this work. Due to a number of events in the last few weeks, progress has not been discussed much. We aim to provide a comprehensive update.

Antecedents

In the acceptance of the work by ESS-Bilbao, a number of separate task were defined. We will check the current progress againts said tasks, and look for feedback on the methods used.

Geometry

Beamline geometry

As noticed in previous presentation and meetings, we have used Blinggen to automatically take the information from the McStas instr file and create an MCNP input. Because the instr file used has limited information about guide segments, further editing was neccesary. **Regardless of how confident we feel on the methodology, we can not find a reference to the instr file or the related McStas calculations. This is a significant risk at the moment. Further communication with the MAGiC opticals team is needed.**

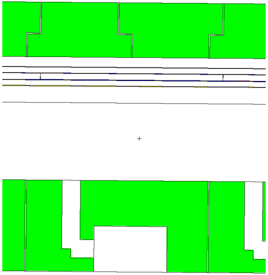
Shielding geometry

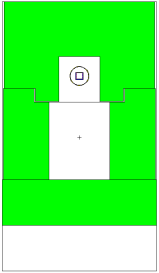
A piecewise MCAM to MCNP conversion has been used, with separate submodels for D02 and E02 halls, and then integrated with the beamline. This is possible thanks to the transformation cards and housing interface set up by Blinggen. This way, we can have detailed geometry, including gaps. Because this part of the geometry is based in CAD model, we should have no trouble with referencing it.

Geometry

Polarizer

A special bit of the shielding geometry is the polarizer. In order to have a first approximation to the model, we have taken the chopper bunker pit of BEER, and adapted it to its size. The reason is that both elements are aimed at stopping large amounts of gammas generated inside, so at least from a shielding point of view there can be similarities. This also leaves plenty of space for other elements inside, as we have no information on how, for instance, the magnetic field is kept.





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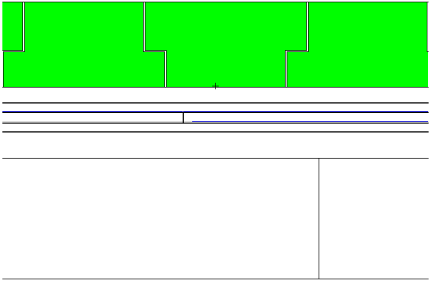

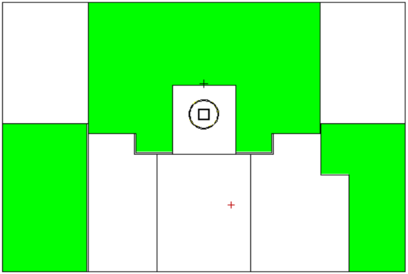

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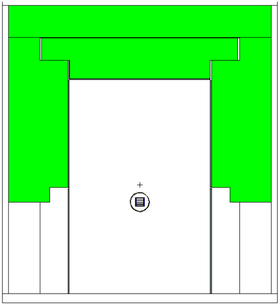

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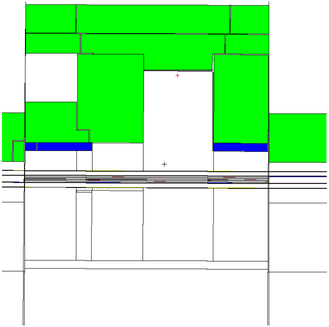


Source term

Term division

The source was intended to be divided into thermal/cold (dominated by optics) and fast (where reflection is irrelevant). However, on further learning about the instrument, it turns out we need to further divide the first part into thermal (straight from the moderator) and cold (coming through the polarizing bender). Those are calculated in the same way, just changing the *cold* parameter in the McStas run.

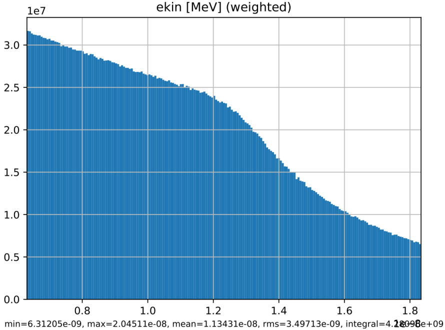
From our understanding, all shielding calculations must be done adding those two source terms.

Thermal and cold parts

Back in the discussions, we had the idea of getting the thermal source calculated by the optical team. Due to the unfolding of events and some help from F. Jimenez, we ended up getting enough proficiency with McStas to set the monitor ourselves, so we did not need external help for that task. Notice that the source is calculated at the end of the polarizing bender (X 6.9m), rather than at 2m like in other instruments.

MCPL stats for cold and thermal sources

Using pymcpltool, we can get some statistics and plots of the source which are quite helpful for documenting. Some of them are plotted below, full pdf available (probably a good idea to attach to report). **We still have the problem of not being able to reference the model**



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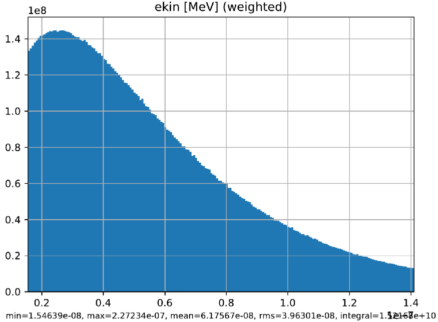

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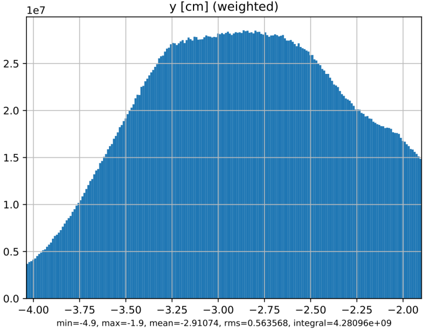

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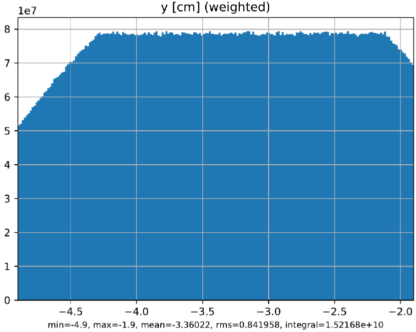

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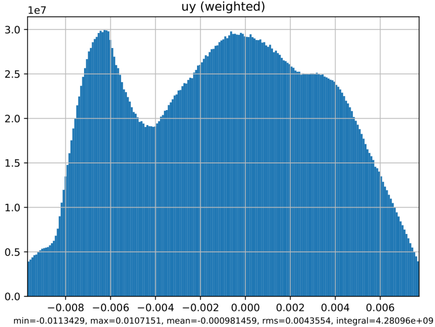

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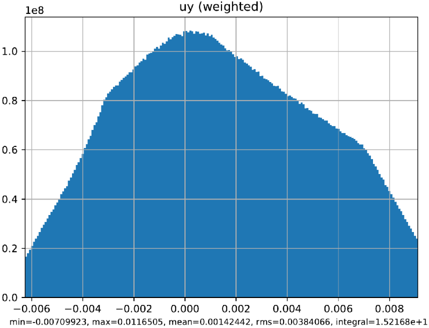

Fast source

Business as usual BUT...

The methodology for obtaining the fast source is well documented (ESS-1500654). However, the latest updates in the model (ESS-3138893, pending approval) feature, among other things, a significant target and reflector update. This leaves us at a tricky choice:

- Use the previous, approved model, which is approved and referenced (we could discuss wether it is documented, though!). However, we would need to prove that the updates in the target wheel are not relevant.
- Use the new model, and hope that it will be approved in a reasonable timeframe.

For now, we have taken the second option. Again, notice that we are calculating this source at X=6.9m. We have also refined the angular bins to 0.5 degrees, since 1 seemed too coarse at this point.

Polarizer methodology

Validation with McStas calculation

The development and validation of the polarizer methodology has been ongoing for some time now, so in this presentation we will only provide the latest update.
In order to set up a problem comparable to McStas, we changed the material of the blades and coating to boron, thus essentially taking out scattering. Density was then adjusted so that the mean free path of neutrons match that used in McStas. Using different temperatures for the material, we can easily discriminate where the gammas are generated, while not altering the actual behavour. This results in capture rates that are within 10% of those calculated by McStas. **We still have the recurrent issue of not being able to reference the model, although in this case, since it is a methodology description, a description of the polarizer component suffices**

Thermal	Up	Down	Total Thermal		Cold	Up	Down	Total Cold	**Grand Total**
	6,60E+09	6,60E+09				3,48E+09	3,45E+08		
5010.00c	9,53E-02	5,11E-01				4,19E-02	1,90E-01		
B (Substrate)	6,29E+08	3,37E+09	4,00E+09			1,46E+08	6,56E+07	2,12E+08	**4,21E+09**
5010.80c	4,50E-03	8,72E-02				6,73E-03	1,61E-01		
Pseudo Si	2,97E+07	5,75E+08	6,05E+08			2,34E+07	5,56E+07	7,90E+07	**6,84E+08**
5010.81c	8,53E-03	4,74E-02				3,75E-03	9,13E-02		
Pseudo Fe	5,63E+07	3,13E+08	3,69E+08			1,30E+07	3,15E+07	4,45E+07	**4,13E+08**
Total abpsortion	7,15E+08	4,26E+09	4,98E+09			1,82E+08	1,53E+08	3,35E+08	**5,31E+09**

Cursory calculations

Some initial work focused in the later part of the guide

We have managed to start some quick calculations using the thermal source, and looking at photon dose rate integrated over the surface. So far, the results point out that the shielding in the polarizer (which more or less equals 10cm of Steel+70cm of concrete) is just about enough to pass the surface dose criterium, but may fail the volume dose one. The final EL01 guide has issues in the final meters, and reinforcement may be neccesary. Furthermore, we fully expect the design to fail the volumetric dose criteria just after the polarizer. All of this is consistent with previous calculations.

	7,60E+09	7,60E+09	3,90E+09	3,85E+08							
	Thermal		Cold		Thermal			Cold		GRAND TOTAL	
	Up	Down	Up	Down	Up	Down		Up	Down		
Tally 2	1,72E-11	2,19E-11	2,27E-11	3,31E-11	0,1306	0,1664	0,0000	0,0885	0,0127	**0,3983**	El1 Top
	2,06E-12	4,67E-13	1,81E-12	1,18E-12	0,0157	0,0035	0,0000	0,0071	0,0005	**0,0267**	
	5,37E-13				0,0041	0,0000	0,0000	0,0000	0,0000	**0,0041**	
	6,45E-13				0,0049	0,0000	0,0000	0,0000	0,0000	**0,0049**	
	9,25E-13				0,0070	0,0000	0,0000	0,0000	0,0000	**0,0070**	
	1,87E-12				0,0142	0,0000	0,0000	0,0000	0,0000	**0,0142**	
	6,50E-12	1,09E-12	3,02E-12	9,40E-13	0,0494	0,0083	0,0000	0,0118	0,0004	**0,0698**	
	9,03E-12	1,65E-12	4,74E-12	1,74E-12	0,0686	0,0125	0,0000	0,0185	0,0007	**0,1003**	
Tally12	1,46E-11	1,64E-11	1,90E-11	2,34E-11	0,1110	0,1246	0,0000	0,0741	0,0090	**0,3187**	El1 Lateral
	1,83E-12	3,93E-13	1,39E-12	9,33E-13	0,0139	0,0030	0,0000	0,0054	0,0004	**0,0227**	
	4,49E-13				0,0034	0,0000	0,0000	0,0000	0,0000	**0,0034**	
	5,87E-13				0,0045	0,0000	0,0000	0,0000	0,0000	**0,0045**	
	8,52E-13				0,0065	0,0000	0,0000	0,0000	0,0000	**0,0065**	
	1,53E-12				0,0116	0,0000	0,0000	0,0000	0,0000	**0,0116**	
	5,50E-12	9,74E-13	2,51E-12	8,77E-13	0,0418	0,0074	0,0000	0,0098	0,0003	**0,0593**	
	1,88E-11	3,36E-12	9,78E-12	3,71E-12	0,1429	0,0074	0,0000	0,0381	0,0014	**0,1898**	
Tally 22	4,70E-11	6,05E-11	5,76E-11	7,31E-11	0,3572	0,4598	0,0000	0,2246	0,0281	**1,0698**	All result suspect due tc
	4,54E-12	1,06E-12	3,48E-12	2,18E-12	0,0345	0,0081	0,0000	0,0136	0,0008	**0,0570**	
	1,20E-12				0,0091	0,0000	0,0000	0,0000	0,0000	**0,0091**	
	1,74E-12				0,0132	0,0000	0,0000	0,0000	0,0000	**0,0132**	
	2,00E-12				0,0152	0,0000	0,0000	0,0000	0,0000	**0,0152**	
	4,86E-12				0,0369	0,0000	0,0000	0,0000	0,0000	**0,0369**	
	1,24E-11	2,22E-12	6,10E-12	1,97E-12	0,0942	0,0169	0,0000	0,0238	0,0008	**0,1357**	
	5,27E-11	9,98E-12	2,67E-11	1,01E-11	0,4005	0,0758	0,0000	0,1041	0,0039	**0,5844**	
Tally 102	1,35E-12	8,22E-12	3,19E-13	1,43E-11	0,0103	0,0625	0,0000	0,0012	0,0055	**0,0795**	Polarizer Top
Tally 112	5,51E-12	3,35E-11	1,36E-12	5,67E-11	0,0419	0,2546	0,0000	0,0053	0,0218	**0,3236**	Polarizer Lateral
Tally 122	5,45E-12	3,34E-11	1,35E-12	5,70E-11	0,0414	0,2538	0,0000	0,0053	0,0219	**0,3225**	Polarizer Lateral

Conclusions

All set for calculations?

- Geometry has been set up in a very robust manner, this time featuring gaps and more details, so extra analysis won't be needed.
- Source terms are calculated, although it is possible we need to re-run the fast source, depending on the decission regarding models.
- Methodology to deal with the polarizer has been developed and checked.
- Due to the nature of the problem, we will need to run 5 sources, adding to the computational cost. Fortunately, the latest upgrade in DMSC has given us plenty of power.
- All of the above will not do us any good if we can not correctly document the information used to build all this. Even if we are very glad with it, we need to convince the reviewers!