Development of the magnetic shielding box for the CBM RICH camera*

E. Ovcharenko[†1,2], *P. Akishin*[‡2], *C. Pauly*[3], *T. Mahmoud*[4], *Yu. Ryabov*[5,6], *C. Höhne*[4], *and V. Schetinin*[2,7]

[1]ITEP Moscow, Russia; [2]LIT JINR Dubna, Russia; [3]University Wuppertal, Germany; [4]Justus Liebig University Giessen, Germany; [5]PNPI, Gatchina, Russia; [6]SPbSPU, St.Petersburg, Russia; [7]BMSTU, Moscow, Russia

The design of the CBM dipole magnet revealed a stray field in the region of the RICH photon detector of about 50-100 mT, too high for the operation of MAPMTs. A design for a magnetic shielding box has been developed to reduce the stray field in the region of photon sensors to less than 1 mT.

The size of the shielding box has currently been fixed following these considerations: The active PMT area of one quarter is 19x13 MAPMTs [1]. Sticking to the 3x2 PMT module design [2] that makes 7x7 modules leaving the upper two rows and the outer row on the sides not equipped with PMTs. This space is necessary for cabling, cooling, etc. In addition some 5cm free space is added at the outer edges plus 3cm free space on the lower border.

Once the shielding box is designed, the RICH vessel has to be adopted to carry its weight. Also, the free space towards the magnet has to be considered. Furthermore, the design of the box has to keep the acceptance angle unaffected. In a first step, the box will simply be designed from steel which provides high magnetic permeability.

Later, it can be investigated whether layers of mu-metal might help to reduce the weight while offering the same shielding capability. The box presented in the figure 1 would weight around 850kg; further optimization is still ongoing.

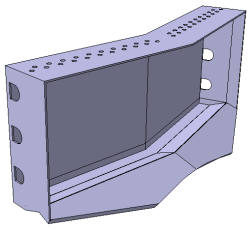

Figure 1: Latest design of the shielding box.

Finite element model simulations of magnetic field for several geometrical models have been performed showing that there is high influence of shield shape and configuration on the magnetic field distribution inside the shielding box. The thickness of the box is 1cm except bottom and back planes which have a thickness of 3cm. The crucial component of the shielding box showed to be the bottom side of the box. It has thus been extended longer and thicker into the RICH volume. This hanging part is 3.5cm thick.

The shielding box needs to have holes for high-voltage, low-voltage, signal cables and air flow for cooling the electronics. The cables will be taken out of the box to the sides. For cooling with air, the box needs to have holes at least on the top side. Holes in the bottom side are hardly possible because the magnetic field is the strongest here. For the lower box the cooling concept has thus to be studied thoroughly.

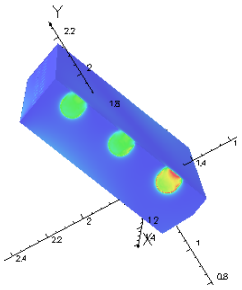

Figure 2: Distribution of the absolute value of magnetic field inside the shielding box in the area of holes.

In general holes break the continuity of the shell letting the field inside. Therefore they have been shifted closer to the back plate - to the area where the electronics is located. Figures 2 and 3 show the distribution of the absolute value of magnetic field inside the shielding box. The electronics can stand the stray field of the CBM dipole magnet, the only crucial point is the photocatode plane of the PMTs. The final mechanical design of the box will keep the back plate as a separate part in order to be able to unmount it for direct access to the camera. For convenient cable routing the holes for the cables will be open-ended to the backplane and closed by the latter.

Different geometric models of the shielding box have been created in the geometry subsystem of the OPERA package and then exported into a STEP file which has been used to perform space analysis in CATIA and later to create a ROOT-compatible geometry using the "CATIA-GDML geometry builder" [3].

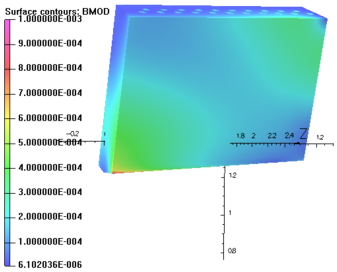

Figure 3: Distribution of the magnetic field inside the shielding box.

Detailed physics simulation of the RICH including the shielding box is planned to be performed in CbmRoot in the nearest future.

References

[1] T. Mahmoud et al, Optimization of the RICH geometry

[2] C. Pauly et al, CBM-RICH readout chain and data rates

[3] Development and application of CATIA-GDML geometry builder S Belogurov et al 2014 J. Phys.: Conf. Ser. 513 022003

* Work supported by HIC for FAIR

† eovchar@jinr.ru

‡ akishin@jinr.ru