MUCH layout optimization for SIS-100

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The experimental programme of CBM includes the measurement of charmonia and low-mass vector mesons via their decay into the di-muon channel. The simulation studies done so far have already established the feasibility of such measurements, and an optimized layout of the muon detection system was found for operation at SIS-300. The aim of the present work is to search for an optimized MUCH layout for SIS-100 collision energies. As it is likely that there will be a gap between the start of operation of SIS-100 and SIS-300, we plan to have a start version of MUCH with less number of stations compared to SIS-300, in order to take advantage of emerging technologies for the full version of the detector.

The present version of the muon detection system, implemented in the cbmroot repository (DEC09) and optimized for SIS-300 collisions, is termed as standard (S) geometry. It includes 6 iron absorbers and 18 detector layers (3 behind each absorber). The total absorber length in the current design amounts to 225 cm of iron, the last absorber being 100 cm thick. This geometry is used for both charmonium and low mass vector mesons (lmvm). For the latter, hits before the last absorber are relevant. We explored the possibility to perform muon simulations with two additional geometries, namely reduced geometry (R) and intermediate geometry (I). In both cases the total effective absorber thickness for lmvm as well as for charmonia is kept the same as in the standard geometry. The reduced geometry thus consists of 3 hadron absorbers (30+95+100 cm) and 9 gas detector layers located in triplets behind each absorber. The intermediate geometry consists of 4 hadron absorbers (30+30+65+100cm) and 12 detector layers located in triplets behind each absorber.

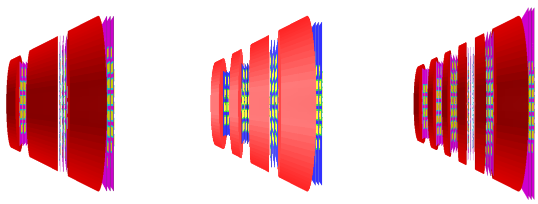

Figure 1: Schematic view of the three MUCH geometries: reduced(R) (left), intermediate(I) (middle) and standard(S) (right) as implemented in cbmroot

We simulated central Au+Au collisions for the beam energies $E_L = 8A, 25A$ and $35A$GeV. As signal we considered the ω meson, which was generated and decayed by the PLUTO generator and embedded into background events generated with URQMD. The particles were transported through the detector setup using GEANT3. Ideal tracking [1] was used for track finding and momentum reconstruction in STS. The littrack software [2] was used for track finding in the muon system. A track was required to be reconstructed both in STS and in the Muon Chamber (MuCh) for being classified as a muon track. We segmented the detector planes into pads of varying size from 4×4 mm^2 to 3.2×3.2 cm^2 for track reconstruction. The reconstruction efficiency and the signal-to-background ratio were calculated in a $\pm2\sigma$ window around the signal peak and are presented in Tables 1 and 2, respectively.

Table 1: Reconstruction efficiency $\epsilon(\%)$ for ω in central Au+Au collisions at $8A$, $25A$ and $35A$ GeV for different geometries

E_L [A GeV]	ϵ [%]		
	R	I	S
8	0.94	0.91	0.86
25	1.77	1.72	1.48
35	1.85	1.83	1.82

Table 2: Signal-to-background ratio S/B for ω in central Au+Au collisions at $8A$, $25A$ and $35A$ GeV for different geometries

E_L [A GeV]	S/B		
	R	I	S
8	0.05	0.088	1.41
25	0.00098	0.003	0.49
35	0.00059	0.00162	0.34

It is evident from the tables that different geometries with same absorber thickness but varying number of detector layers give comparable values for the reconstruction efficiency. The S/B ratio, however, is drastically different for the different geometries. Reduction in the number of stations results in a huge reduction of the S/B ratio for ω mesons, even at the lowest energy. Thus our studies indicate that as far as the measurement of low-mass vector mesons is concerned, there is practically no cheaper version of the muon detection system other than the standard geometry, which effectively comprises 15 layers for lmvm detection.

References

[1] I. Kisel, Nucl. Instr. Meth. Phys. Res. **A 566** (2006) 85

[2] A. Lebedev *et al.*, *CBM Progress Report 2008*, Darmstadt 2009, p. 81