Subthreshold J/ψ production in Au+Au collisions at SIS-100 studied with a start version of the CBM muon detector

A. Kiseleva[1]*, C. Höhne*[2]*, E. Kryshen*[3]*, A. Lebedev*[4,5]*, M. Ryzhinskiy*[3]*, and P. Senger*[5]

[1]Goethe University, Frankfurt, Germany; [2]Justus Liebig University, Giessen, Germany; [3]PNPI, Gatchina, Russia; [4]JINR-LIT, Dubna, Russia; [5]GSI, Darmstadt, Germany

The CBM experiment at FAIR will measure the leptonic decay of vector mesons both in the di-electron and the di-muon channel. A particular challenge is the identification of the soft muons from ρ, ω, and ϕ mesons produced in nucleus-nucleus collisions at beam energies between 15 and 45 AGeV. To perform these measurements an instrumented hadron absorber system has been designed which comprises 6 iron plates of variable thickness (see first column in table 1) and 18 gaseous tracking chambers located in triplets behind each iron slab [1]. The detector layers are segmented into read-out pads with a minimum size of 0.28×0.28 cm^2, and a maximum size of 4.48×4.48 cm^2, corresponding to a total of 560000 channels.

The identification of energetic muons from charmonium decays is less demanding. We developed a start version of the CBM muon detection system which can be used for the measurement of J/ψ mesons already at SIS100 beam energies. As a first step, we have simulated the reconstruction of J/ψ mesons in 25 GeV $p + Au$ collisions at using the LIT global tracking package for full track reconstruction [2]. It turned out that a setup consisting of 2 iron absorber layers (thickness 20 cm and 205 cm) and 2 detector stations with 3 detector layers each would be sufficient to identify J/ψ mesons with an efficiency of 13% and a signal-to-background ratio of above 100 [3].

In a second step we have investigated the possibility to identify J/ψ mesons in nucleus-nucleus collisions at SIS100 energies. We have used the UrQMD event generator to calculate the background for Au+Au collisions at 10 A GeV, and calculated the corresponding J/ψ multiplicity with the HSD code. Please note, that the threshold energy to produce J/ψ mesons in p+p collisions is 11.3 GeV. The muon detector start version which was optimized for proton-nucleus collisions turned out to be insufficient because of many track mismatches resulting in a large combinatorial background (see last column in Table 1). In order to improve the track reconstruction we have inserted one more detector triplet after an iron absorber of 70 cm thickness while keeping the overall absorber thickness constant (225 cm). The result is very promising: J/ψ mesons can be identified with an efficiency of 3.3 % and a signal-to-background ratio of 0.6 (see second column in Table 1).

These simulations demonstrate that a start version of the muon detection system for charmonium measurements can be built with 3 detector stations as illustrated in figure 1: a highly granulated detector triplet consisting of Gas-Elektron-Multipliers (GEM) behind the first hadron absorber (20 cm iron), a second detector triplet optionally based on Micromegas technology behind the second absorber (70 cm iron), and a large-area low-granularity detector triplet behind the last absorber (135 cm iron). The last triplet consists either of straw-tube detectors, or the first TRD station will be used. The different detector options are under investigation.

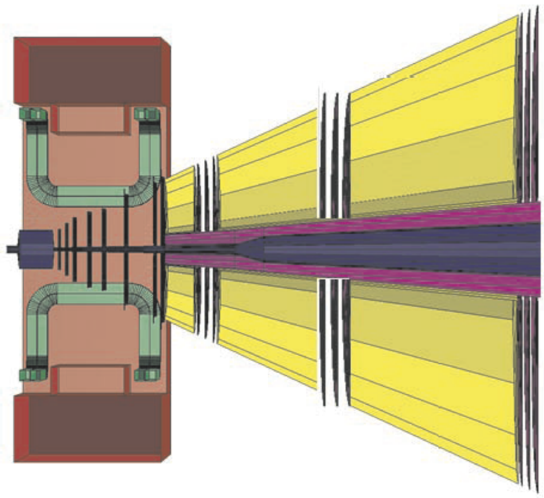

Figure 1: Start version of the CBM muon detection system for J/ψ meson measurements in nucleus-nucleus collisions at SIS-100 beam energies

Table 1: Efficiency and signal-to-background (S/B) ratio for J/ψ mesons from central Au+Au collisions at 10A GeV for three different absorber/detector combinations

detectors	18	9	6
Fe (cm)	3x20+30+35+100	20+70+135	20+205
$\varepsilon(J/\psi)$	7%	3.3%	1.3%
S/B	0.5	0.6	0.08

References

[1] A. Kiseleva *et al.*, *CBM Progress Report 2008*, Darmstadt 2009, p. 27

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[3] A. Kiseleva *et al.*, *CBM Progress Report 2009*, Darmstadt 2010, p. 27