Anisotropic flow and reaction plane reconstruction with the CBM experiment*

V. Mikhaylov[†1,2], *M. Golubeva*[3], *A. Kugler*[1], *V. Kushpil*[1], *S. Seddiki*[4], *I. Selyuzhenkov*[4], *and P. Tlusty*[1]

[1]NPI of ASCR, Řež, Czech Republic; [2]CTU, Prague, Czech Republic; [3]INR RAS, Troitsk, Russia; [4]GSI, Darmstadt, Germany

The projectile Spectator Detector (PSD) of the CBM experiment is designed to register forward spectator nucleons and fragments emitted in nucleus-nucleus collisions at very low polar angles. It will be used to determine the orientation of the collision reaction plane. The accuracy of the reaction plane determination with the PSD depends on the multiplicity and energy distributions of spectators and the magnitude of their directed flow, v_1.

The PSD performance is studied with simulated Au+Au collisions in the beam energy range 2-30 AGeV, which corresponds to that of future accelerator rings SIS100/SIS300 at FAIR. To identify the most suitable heavy-ion event generator for the performance study, the simulated directed flow with UrQMD [1], DCM-QGSM [2], LA-QGSM [2], and HSD [3] heavy-ion event generators is compared with experimental data from E895 [4] and STAR [5] Collaborations. Figure 1 shows this comparison in terms of the slope of proton directed flow at midrapidity, $F_y(v_1) = dv_1/dy$. Protons are used for the directed flow comparison because they are the most abundant particles in this kinematic region. The magnitude of the directed flow generated with different collision generators varies significantly, while DCM-QGSM seems to be the most consistent model in describing the data over the whole energy range. The possibility of collision fragment generation in the spectator region and the qualitative agreement with the experimental data for directed flow justifies the use of DCM-QGSM for the PSD performance study.

The CBM detector response is simulated with the GEANT4 Monte-Carlo package for three different configurations: (1) "PSD-accept." when simulated azimuthal distributions of the particles within geometrical acceptance of the PSD [$0.215° < \theta < 5.0°$ for $E_{beam} = 2 - 8$ AGeV and $0.115° < \theta < 2.7°$ for $E_{beam} = 30$ AGeV] were used without simulating the actual PSD response; (2) "PSD-geom.,B=0" when PSD response is simulated without CBM magnetic field (this allows to study the bias due to finite PSD segmentation); (3) "PSD-geom.,B>0" - same as configuration (2) but with magnetic field on.

Reaction plane resolution, quantified in terms of correction factor used in the directed flow measurement, is shown in Fig. 2. Resolution simulated with the DCM-QGSM generator is similar to that of the E877 experiment [6]. The transverse segmentation of the PSD seems to have a small effect. While the CBM magnetic field introduces a significant bias, the reaction plane resolution is still high even in presence of the magnetic field.

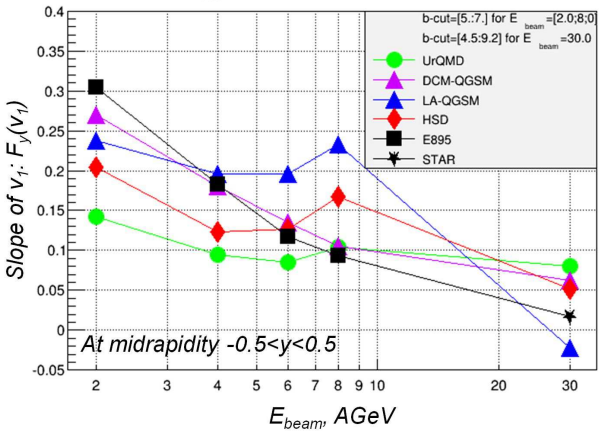

Figure 1: The slope of proton directed flow at midrapidity simulated with different collision generators is compared with E895 [4] and STAR [5] experimental data.

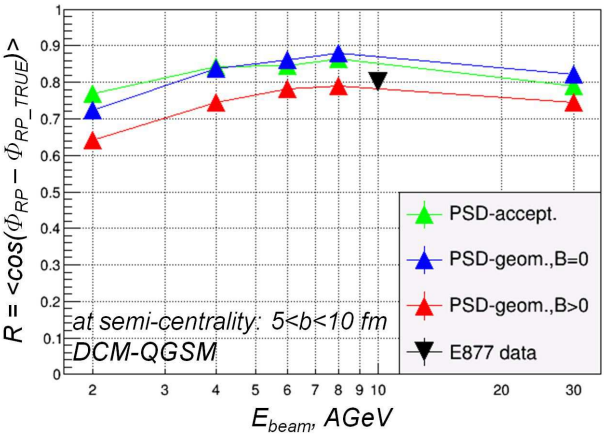

Figure 2: Reaction plane resolution correction factor for v_1. Results are from DCM-QGSM model and E877 [6] data.

References

[1] The UrQMD model, urqmd.org.

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[3] The HSD model, fias.uni-frankfurt.de/ brat/HSD/index1.html

[4] H. Liu et al. (E895), Phys. Rev. Lett. 84 (2000), p. 5488.

[5] L. Adamczyk et al. (STAR), Phys. Rev. Lett. 112 (2014).

[6] 7. J. Barrette, et al. (E877), Phys. Rev. C55 (1997), p. 1420.

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† mikhaylov@ujf.cas.cz