CENTRALITY DETERMINATION IN HEAVY-ION COLLISIONS WITH CBM*

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The size and evolution of the medium created in a heavy-ion collision depends on collision geometry. Experimentally, collisions are characterized by the measured particles multiplicities around midrapidity or energy measured in the forward rapidity region, which is sensitive to the spectator fragments. The performance for collision centrality determination in CBM using the multiplicity of produced particles measured with the silicon tracking system (STS) and the projectile spectator detector (PSD), which is sensitive to spectator fragments, is presented.

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The CBM performance for the centrality determination is studied for Au+Au collisions with beam energy of 10 AGeV simulated with DCM-QGSM and UrQMD event generators (see Ref. [18–28] and [29–30] in [1]). The simulated CBM setup includes the beam pipe, CBM magnet, STS detector [2] with an acceptance in polar angle $2.5^\circ < \Theta < 25^\circ$, and the PSD [1] located 8 meters from the target. The PSD geometry has 44 modules elongated in x direction with 6 cm hole in the center which covers the range in x (y) direction of $0.21^\circ < \Theta < 5.7^\circ$ (4.3°).

The total number of reconstructed tracks with at least 3 hits in 8 STS stations was used to calculate the multiplicity of produced particles. The modules of the PSD, which is sensitive mostly to spectator fragments (outer modules are also sensitive to produced particles), were grouped into PSD1, PSD2 and PSD3 subevents as shown in Fig. 1.

Event-by-event centrality is determined with the following procedure: (1) The STS multiplicity (M_{STS}) and energy deposition in PSD subgroup (E_{PSD}) are scaled by their maximal value ($M_{\mathrm{STS}^{\max}}$ and $E_{\mathrm{PSD}^{\max}}$); (2) The correlation between multiplicity and/or energy of the PSD subgroups (Fig. 1, middle) is parameterised as follows (Fig. 1, right): (2a) initial fit of profile

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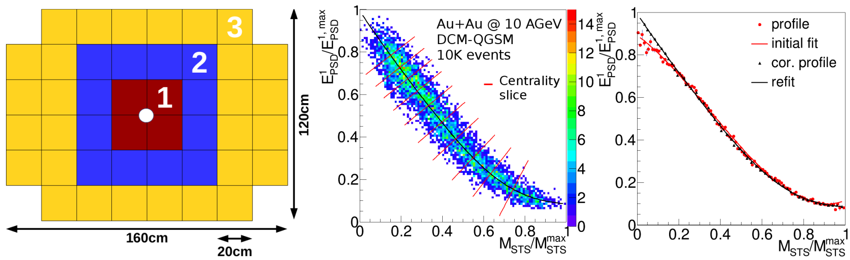

Fig. 1. (Color online) Left: Transverse to the beam layout of the PSD modules. Middle and right: Illustration of the centrality determination procedure.

(gray/red circles) of the correlation using a polynomial function (gray/red line); (2b) recalculate profile (black triangles) according to the fit slope and refit the correlation (black line); (3) Following the procedure described in [3], determine the total cross section and the "anchor" point (a value below which determination is not reliable) based on a fit with a Glauber model based function (Fig. 2, left); (4) Slice the correlation perpendicular to the fit (Fig. 1, middle) or individual distributions of the multiplicity or PSD energy (not shown) in percentiles of the total number of events. For each centrality class, the mean value of the impact parameter and its corresponding standard deviation is calculated from simulated input. Figure 2, right shows centrality dependence of the impact parameter resolution for different centrality estimators and two different models.

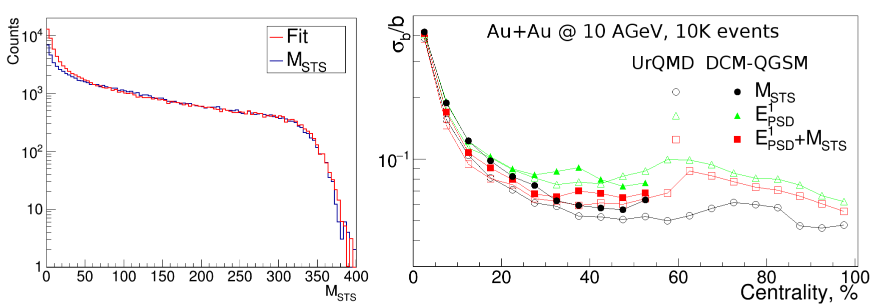

Fig. 2. Left: MC-Glauber model fit to the multiplicity distribution for STS. Right: The impact parameter resolution with different centrality estimators.

In summary, the impact parameter resolution obtained with the PSD centrality estimation is comparable to that of the STS. Using the STS and PSD together slightly improves the resolution in central (0–30%) collisions.

REFERENCES

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[3] ALICE Collaboration, *Phys. Rev. C* **88**, 044909 (2013).