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Centrality and Event Registration Efficiency Determination in Xe+CsI Collisions at BM@N

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Centrality determination is an essential step in the analysis of heavy-ion collisions and the comparison of experimental results with model calculations. At beam energies of a few GeV per nucleon, trigger selection and the primary-vertex reconstruction requirement preferentially suppress peripheral events. Accounting for these losses is necessary to define centrality classes relative to the total inelastic nucleus–nucleus cross section. This work presents centrality determination results for Xe+CsI collisions at a beam energy of 3.8A GeV using data from the first BM@N physics run. The analysis employs charged-particle multiplicity and two approaches: the Monte Carlo Glauber method and a modified direct reconstruction method based on Bayes' theorem. In the latter approach, the conditional multiplicity distribution at a fixed impact parameter is described by a gamma parametrization using fully reconstructed simulated events. The multiplicity dependence of the event registration and selection efficiency is reconstructed with both methods, while its impact-parameter dependence is also obtained with the direct reconstruction method. The sensitivity of the results to nuclear geometry parameters, the inelastic nucleon–nucleon cross section, and the choice of transport model is investigated. The Monte Carlo Glauber method yields an integrated efficiency of 72.72%, with deviations of −1.55 and +0.86 percentage points corresponding to the envelope of the variations considered. The mean and standard deviation of the direct reconstruction results obtained using DCM-QGSM-SMM, UrQMD-AMC, JAM2 MD2, and SMASH are (72.8 ± 1.0)%. These estimates characterize the model-related uncertainty components investigated. The shape of the multiplicity-dependent efficiency is validated by comparing experimental distributions recorded with the CCT2 and BT triggers. The two methods yield consistent results, with the largest model dependence observed in the peripheral region.

Primary author(s) : IDRISOV, Dim

Co-author(s) : DEMANOV, Alexander; GUBER, Fedor (INR); TARANENKO, Arkadiy (NRNU MEPhI)

Presenter(s) : IDRISOV, Dim

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