Charged particle multiplicity measurement using sPHENIX-INTT in Au + Au collision at $\sqrt{s_{NN}} = 200$ GeV

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The sPHENIX experiment at the Relativistic Heavy Ion Collider (RHIC) is a collision experiment started from 2023. The primary objective of the sPHENIX experiment is to investigate the properties of quark-gluon plasma. The intermediate tracker (INTT) of sPHENIX is a silicon strip detector, consisting of inner and outer barrels approximately 7 cm from the beam axis, respectively. The very first commissioning of the INTT detector was conducted using Au + Au collision at $\sqrt{s_{NN}} = 200$ GeV keeping the magnetic field off of the sPHENIX magnet. The performance of the INTT can be verified by comparing the observed multiplicity of charged particles in INTT against existing measurements in past RHIC experiments of the same reaction.

Past RHIC experiments have measured the multiplicity of charged particles as a function of rapidity for a given centrality of collision. The multiplicity can be evaluated by following two methods: (i) hit cluster counting in the each INTT layer and (ii) tracklets counting by connecting the hit clusters in each layer and the collision vertex. In the analysis, the cluster counting method was employed. Ideally, the multiplicity should be counted based on reconstructed tracklets; however, but this requires validation of the tracking algorithm, which is under development. The main difficulty of the cluster counting method is the estimation of background hits.

As the first step of the analysis, a rough envelope comparison was performed without complex background subtraction. The measured and expected total number of charged particles across the INTT acceptance for the inner and outer barrels are compared in Table 1. The measured number of charged particles is estimated by the hit cluster counting, whereas the expected is taken from a Ref. 1). The centrality of 0–5% is grouped based on the cluster multiplicity of the INTT, as shown in Fig. 1. The results shows that the measured multiplicities are larger than the expected values by more than a factor of two. The measured multiplicity distributions depicted in Fig. 1 is compared with Monte-Carlo (MC) simulation results. A HIJING model,[2)] which was tuned for Au + Au collisions at $\sqrt{s_{NN}} = 200$ GeV was embedded as an event generator in GEANT simulations. The geometries of INTT barrels were implemented in the simulation. The event z-vertex was limited to the range of $-20 <$ z_vtx < -16 cm because the collision z-vertex was off centered by approximately -20 cm when these data were taken.

Table 1. The measured and expected total number of charged particles across the INTT acceptance for inner and outer barrels.

	Expected	*Measured*
Inner	1600±100	3700±400
Outer	1400±100	3400±600

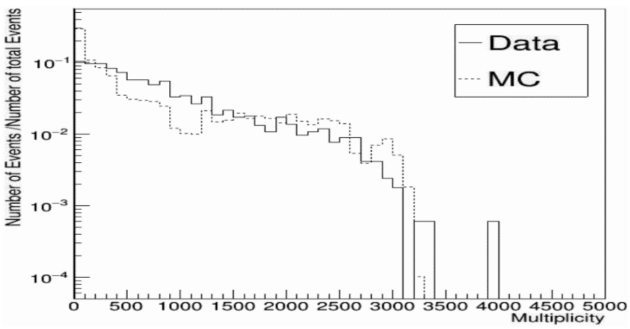

Fig. 1. Comparison of the cluster multiplicity distributions of the INTT inner barrel (solid line) and result of the MC simulations (dashed line).

The measured data and MC results shown in Fig. 1 are evidently. The distortion in MC distribution at a multiplicity of 1000, suggests presence of MC artifacts requiring further validation. The average multiplicities estimated from both measurements and MC simula-

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tions are summarized in Table 2. The measured average multiplicities are typically 10–20% higher than MC simulation average multiplicities indicating that the background removal from the data is incomplete. The background needs to be carefully studied MC model as the next step.

Table 2. The average multiplicity of the INTT from the measurements and MC simulation results shown of Fig. 1.

	MC	*Measured*
Inner	718±8	790±20
Outer	652±8	750+20

References
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