ACTS-based track reconstruction for the forward detector in the MPD experiment at NICA

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The main goals of the Multi-Purpose Detector (MPD) at Nuclotron-based Ion Collider Facility (NICA, Dubna, Russia) are the investigation of the phase diagram of QCD matter at high baryon densities and search for transition of nuclear matter into a deconfined state of quarks and gluons, known as the Quark-Gluon Plasma (QGP). The MPD will be constructed in two stages, with the first stage including the time projection chamber (TPC), the time-of-flight (TOF) detector, the electromagnetic calorimeter (ECAL) covering the pseudorapidity range $|\eta| < 1.2$, and supplemented with fast beam-beam counters and zero degree calorimeters at forward rapidities. At the second stage of the experiment the inner tracking system and the forward tracking detector are foreseen to be installed.

The installation of the forward tracking detector in MPD would extend kinematic range to higher rapidities, which is critical for the studies of various observables that can be used to probe the properties of the produced matter: the rapidity dependence of meson and baryon yields, the anisotropic flow and global polarization a forward rapidities and others.

The proposed forward tracker setup consists of five tracking stations on each side from the interaction point, covering pseudorapidity range $1.5 < |\eta| < 2.1$. The tracker will be installed in the existing solenoidal magnetic field with $B_z = 0.5$ T, imposing a challenge for the track reconstruction, since the momentum resolution is driven by the radial distance available for the track curvature measurements that is strongly reduced at high pseudorapidities.

The performance of the forward detector concept has been studied using the tracking algorithms based on the ACTS package. It provides a set of experiment-independent tools and algorithms, including the Kalman filter for track parameter fitting, seeding tools and combinatorial Kalman filter for track finding, as well as vertex reconstruction algorithms.

The momentum resolution for pions and protons reconstructed only using information from the forward tracker ranges from 3% to 10% depending on transverse momentum and pseudorapidity and found to be in agreement with analytical calculations.

Track finding efficiency in high-multiplicity environment foreseen in heavy ion collisions was tested using Au-Au events at $\sqrt{s_{\mathrm{NN}}} = 11$ GeV from the UrQMD event generator injected into the forward tracker model integrated into the standard MPD reconstruction framework, MpdRoot. Efficiency of the ACTS-based track reconstruction reaches 90-95% for both pions and protons at transverse momenta $p_{\mathrm{T}} > 0.3$ GeV/c.

In this report, we will discuss the expected performance of the forward tracker in more detail. In addition, the possibilities for improvements, including utilization of the TPC information, will be discussed.