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Challenges for next generation of vertex detectors for collider experiments

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New studies of extremely hot and strongly interacting matter, formed in the collision of relativistic nuclei, are proposed at the currently running Relativistic Heavy- Ion Collider (RHIC) and the Large Hadron Collider (LHC), while the colliders like FAIR (Facility for Antiproton and Ion Research) and NICA (Nuclotron-based Ion Collider fAcility) are being constructed to bring a deeper insight into the dynamics of multiparticle production in the high baryon density region of the QCD phase diagram. These new physics programs are pushing the limits of the existing experimental research thus imposing strict requirements on the characteristics of the new detectors proposed for future applications. So-called vertex detectors are among the most demanding devices of cutting-edge research, facing extremely contradictive requirements. Among them are the closest distance to the beams collision point, minimum amount of low-Z matter along particle tracks and high thermo-mechanical stability of precisely located sensors, fine granularity and capability to work at high counting rates. In the first part of this report, we present the major challenges existing for measurements of low-momentum charm and beauty hadrons and low-mass di-electrons formed in heavy-ion collisions at the LHC. A brief overview of the existing technology of secondary vertices identification, used in the current experiments at the LHC and RHIC, will be also provided. We will discuss in the second part of the report the existing critical items and the technological challenges to be met (the necessity of application of high-granularity sensors, the extremely minimal material budget and the high precision layout, thermo-mechanical stability and the efficient cooling). Finally, we will present the results of feasibility studies of practical solutions proposed at Saint-Petersburg State University that could be considered for the next generation of the vertex detectors including the on-going developments for the experiments at NICA collider. The authors acknowledge Saint-Petersburg State University for a research project 95413904

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