Silicon tracker for sPHENIX

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sPHENIX is a proposal[1)] to be built in the experimental hall after the PHENIX experiment is decommissioned in 2016 at the Relativistic Heavy Ion Collider (RHIC). The experiment is scheduled during 2022 - 2024 in oder to address on fundamental unanswered questions about the nature of the strongly coupled Quark-Gluon Plasma (QGP), discovered experimentally at RHIC to be a perfect fluid. These questions include how and why the QGP behaves as a perfect fluid in the vicinity of strongest coupling, near the temperature at which the phase transition takes place, whether there are quasiparticles that play an important role in the dynamics of the QGP, and how the strongly coupled QGP evolves to become a weakly coupled system at asymptotically high temperature. These questions can only be fully addressed with a detector which can measure jet production and jet properties at RHIC energies, at temperatures near the phase transition where the coupling is strongest and by comparing these measurements to higher temperature QGP measurements at the Large Hadron Collider. Taken together, these data will provide valuable insight into the thermodynamics of Quantum Chromodynamics (QCD), the theory which governs the interactions of the quarks, the building blocks of nuclei.

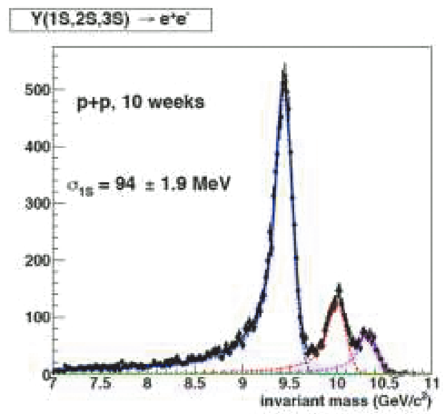

Fig. 1. Simulated invariant mass of three Υ states assuming the designed momentum resolution of the silicon tracker.

sPHENIX design is thus optimized to measure jets, jet correlations and upsilons to determine the temperature dependence of transport coefficients and the color screening length in the QGP. It will do this with high rate, large acceptance, hadronic and electromagnetic calorimetry and precision tracking. It will have mass resolution sufficient to distinguish separately the three states of the Υ family.

The measurement of the Υ family places the most stringent requirement on momentum resolution at lower momentum. The large mass of the Upsilon means that one can primarily focus on electrons with momenta of $\sim 4-10$ GeV/c. The $\Upsilon(3S)$ has about 3% higher mass than the $\Upsilon(2S)$ state and to distinguish them clearly one needs invariant mass resolution of ~100 MeV, or $\sim 1\%$ as demonstrated in Fig. 1. This translates into a momentum resolution for the daughter $e^{\pm}$ of $\sim 1.2\%$ in the range $4-10$ GeV/c.

In order to meet the requirement to distinguish the three Υ states, the silicon strip tracker is under development. The silicon strip tracker covers the acceptance $|\eta| < 1$ and has full azimuthal coverage, $\Delta\phi = 2\pi$. It consists of 3 stations (from inner to outer, called S0, S1 and S2) as illustrated in Figure 2. In each of the S0 and S1 stations, sensor modules are mounted on the front and back of a single support and cooling structure to form two closely spaced tracking layers. To achieve hermeticity, alternate support and cooling structures are staggered in radius and offset in azimuthal angle so that the alternating sensor modules overlap in azimuth. The S2 station contains a single tracking layer, again with alternate support and cooling structures staggered in radius and offset in azimuth to achieve hermeticity of the active area. The R&D status is discussed in elsehwere[2),3)].

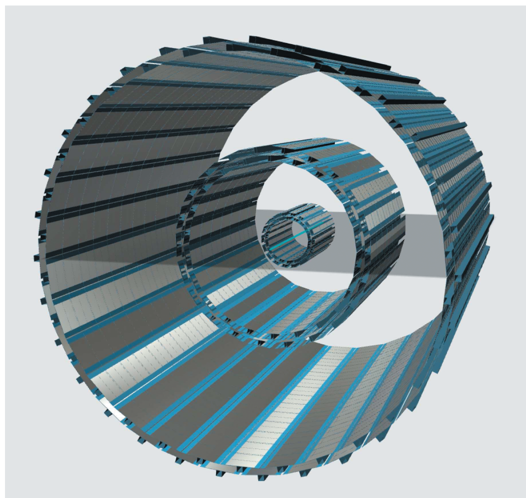

Fig. 2. The silicon tracker for sPHENIX.

References

1) sPHENIX pre-Conceptual Dsign Report (2015) .
2) Y. Akiba (et. al) in this report.
3) G. Mitsuka (et. al) in this report.

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