PRECISION CALIBRATION OF THE STAR TPC

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The STAR Experiment's Time Projection Chamber (TPC) was designed to efficiently reconstruct charged particle tracks in the high multiplicity environment of the original RHIC specifications with the spatial precision to topologically identify weak decays of strange hadrons. The evolving physics program of the experiment has driven the calibration requirements to exceed those design goals to handle higher luminosities and accurately reconstruct track positions with even finer precision for optimal cooperation with silicon detectors. We discuss the challenges involved in the calibration of the TPC and the efforts which have successfully realized these goals.

Summary

When the STAR TPC and solenoidal magnet systems were designed, it was understood that distortions in and misalignment between the electric and magnetic fields would cause distortions in track reconstruction. Software tools to calibrate and correct these distortions were developed to allow the TPC to achieve its design performance. In time, additional distortions grew from operating RHIC at beyond-design luminosities (particularly through ionization of the TPC gas), and deterioration of the components. We have sufficiently identified and resolved these issues such that the TPC has exceeded its original performance requirements, allowing it to deliver on its physics promise.

Concurrently, those requirements have become more stringent as the program has evolved. Most significantly, the use of precise silicon hit detectors in conjunction with the TPC has necessitated finer position resolution of tracks projected from the TPC and reduction of possible position biases to realize the benefit of those detectors. The success of such calibration is opening the door to exploration of heavy quark decays from heavy ion collisions, well beyond the scope of the original experimental goals.

As RHIC (RHIC II) continues to attain luminosity increases, and the component hardware continues to age, it is clear that the role of precision calibration of the TPC will remain paramount for STAR. We hope that our experiences and accomplishments will prove useful to the design, operation, and calibration of other time projection chamber experiments.