Part I

Introduction

Chapter 1

SVT Documentation Overview

Last Updated: 15 June 1995

Discuss document here.

Chapter 2

SVT Physics

Last Updated: 15 June 1995

The primary physics goal of the RHIC project is to collide heavy nuclei with sufficient energy to produce a transition from hot, dense, hadronic matter to a color de-confined, chirally symmetric plasma of quarks and gluons (QGP). STAR will focus mainly on the investigation of soft processes resulting in hadron production at central rapidities and transverse momenta below 2 GeV/c but, in addition, will study hard QCD processes such as the production of jets, mini-jets and hard photons. STAR will also investigate nucleon structure functions and effects of quark and gluon shadowing through proton-proton and proton-nucleus interactions. The intent of the experimental program is to measure many observables, some of which are obtained on an event-by-event basis, and study their dependence on the size of the colliding system, the collision impact parameter and total energy.

The time evolution of nucleus-nucleus collisions is thought to involve an initial parton scattering, pre-equilibrium stage, an intermediate thermalization stage in which the QGP might be formed, and a final expansion and hadronization stage. Observables can be associated with each stage which convey different information about the collision dynamics. For example, hard parton scatterings in the initial pre-equilibrium stage result in high $p_{\perp}$ particles, jets, high energy γs, and charmed mesons. Conditions during the intermediate thermalization stage (*i.e.,* hot hadronic gas or QGP) affect the production of mini-jets, strangeness, anti-baryons, isospin anomalies and energy/entropy fluctuations. Multi-strange baryon and ϕ meson production are strongly dependent on strangeness density during this stage and are therefore sensitive indicators of possible chiral symmetry restoration in the QGP. Global properties such as size and temperature during the final hadronization stage can be determined by the $p_{\perp}$ spectra and by $\pi\pi$ and KK HBT interferometry.

The baseline configuration of the STAR detector consists of a large room temperature solenoidal magnet, a time projection chamber (TPC) for charged particle tracking, and trigger counters (vertex position detectors, central trigger barrel). Charged particle momenta will be measured with the TPC at mid-rapidity ($|\eta| \leq 2$) with full azimuthal coverage and a transverse momentum, $p_\perp$, threshold of about 150 MeV/c. Particle identification through measurement of ionization density (dE/dx) will be accomplished for particles emitted with $|\eta| \leq 2$ and $150 \leq p_\perp \leq 600$ MeV/c. With the TPC alone, STAR is limited to the study of hadron production with $p_\perp$ above 150 MeV/c and has a modest efficiency and accuracy for the study of short lived particles decaying before they reach the inner layer of the TPC. Multi-strange baryons and anti-baryons cannot be studied with the STAR baseline detector.

A high resolution vertex tracker for STAR would allow for the measurement of several of the observables mentioned above as well as lead to an enhanced performance of the overall system over what would be achieved with the TPC alone. Because of recent advances in technology, such a vertex tracker can be made using large, high resolution silicon drift detectors. The Silicon Vertex Detector (SVT) is such a detector that has been designed for STAR.

Unique capabilities of the SVT include the detection of multi-strange baryons (Ξ^- and Ω^-) and measurement of low $p_\perp$ ($40 \leq p_\perp \leq 200$ MeV/c) spectra. Measurements of rare particles such as the D mesons and strange composite objects, which are impossible to observe with the TPC alone, might become accessible with the SVT.

The SVT will give substantial improvement in momentum resolution for high $p_\perp$ particles, in reconstruction efficiency for short lived neutral particles such as K_s^0, ϕ, Λ, and $\overline{\Lambda}$, and two-track resolution for HBT studies.

In addition, the SVT will enhance track reconstruction and particle identification for soft charged particles such as $\pi^\pm$, $K^\pm$, p, $\overline{p}$, d and $\overline{d}$, will enable better determination of the primary vertex, and will help distinguish particles resulting from secondary decays.

It is unlikely that conclusive evidence of QGP formation at RHIC can be based on a single observable or signature; instead the simultaneous observation of many signatures is required. It is expected that only a consistent analysis of many signals coming from all stages of the collision may lead to an unambiguous identification of the phase transition. STAR complemented with a high resolution vertex detector would be a powerful instrument for studying this possible transition to a new state of matter.

A detailed physics discussion concerning the above topics can be fround in the proposal entitled **Proposal for a Silicon Vertex Tracker (SVT) as an upgrade for the STAR experiment at RHIC**, by Rolf Beuttenmuller, et al.