Identification of charged particles produced in Au+Au collisions based on energy loss and passing time information

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1. Introduction

Experiments with heavy ions have demonstrated the formation of a new state of matter which demonstrates properties of quasi ideal fluid and is called the Quark Gluon Plasma. The main goal of these experiments is to form and characterize a state of unconfined quarks and gluons in local thermal equilibrium in the heavy ion collisions to investigate the properties of the hadronic matter and recreate the QGP. It is believed those conditions were present during the first nanoseconds after the Big Bang. Moreover, this conditions can be present inside the cores of neutron stars at modern time.

The matter consists of tiniest blocks – quarks which are bind together by gluons. Under normal conditions this blocks are confined by the strong force into regular particles baryons and mesons. But experiments at high energies have demonstrated that after some point this confinement is not working anymore and quarks can travel for distances longer than the typical size of a baryon. That means a phase transition to the new state of matter. To investigate precisely this new form of matter several experimental programs are performed and planed at accelerator centers like RHIC, LHC, NICA and FAIR.

Analysis of particle spectra for different particle species is used to extract thermodynamical properties of the QGP system. System produced in the collision can be described using methods of statistical physics assuming this system performs as the Grand Canonical ensemble. This allow to extract such parameters as temperature of the system and it's baryon chemical potential.

2. Experiment description

STAR stands for Solenoidal Tracker At RHIC and is aimed for studying strongly interacting matter at extreme conditions produced at heavy nuclei collisions at high energies. It is in operation since 1999 and provide experimental data on different species of nuclei collisions at variety of energies from 3 to 200 GeV. STAR is a complex detector consisting of many sub-detectors which provide precise tracking and particle identification. Main sub-detectors for PID are Time Projection Chamber and Time-of-Flight system. Identification in TPC is performed by particle energy loss in the TPC volume and TOF provides identification based on the time which particle takes to travel between start and stop parts of TOF.

3. Tasks

During the project student will perform the following tasks:

a. Install ROOT framework with STAR packages
b. Learn to work with experimental DST data
c. Perform particle identification using TPC and TOF information
d. Obtain particle momentum spectra for identified particles

4. Requirements

Basic knowledge of C++/ROOT

English knowledge B2 or higher

5. Recommended literature

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Nucl.Instrum.Meth. A558 419, 2006

Nucl.Instrum.Meth. A614 28, 2010

6. Number of students

Project is designed for 1 -2 students.