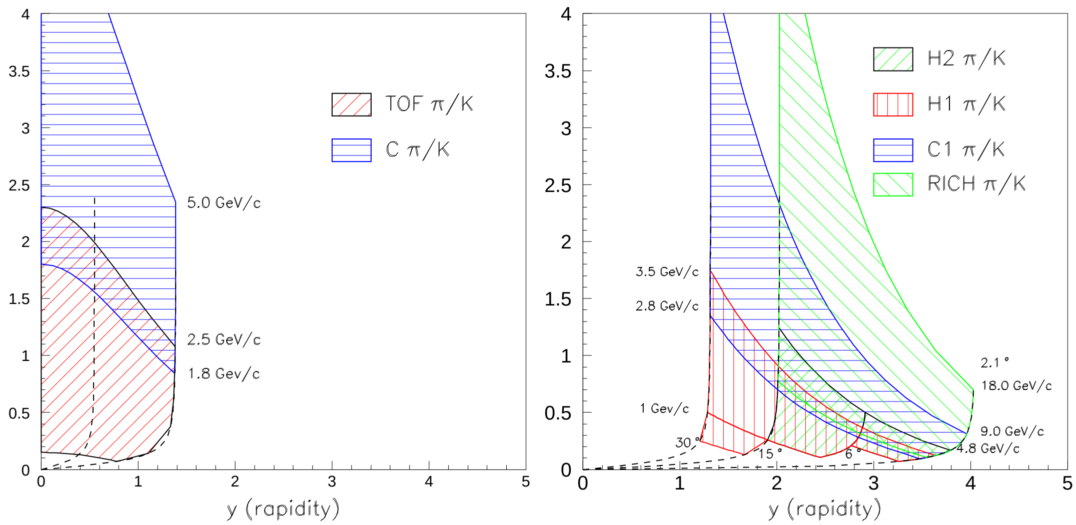

Figure 3. Acceptance for pions in the midrapidity (left frame) and forward arm (right frame). The different shaded areas indicates the detector which performs the PID.

4. Summary

The two spectrometers will be used with all beams and energies available at RHIC and will be ready when RHIC turns on.

The results from this experimant will address particular the proton and anti proton production both in the central and in the fragmentation region. It will also measure the semi-inclusive spectra of charged pions and kaons over a wide interval in rapidity and p_t.

The results are needed to study and understand the reaction mechnism at the RHIC energies and will have impact on our understanding of stopping, equilibration and thermalisation in heavy ion reactions. They will thus also provide a framework for the other measurements to be done at RHIC.

This is one of the “small” RHIC experiments and has a collaboration of 30 physicists from BNL, CRN-Strasbourg, the Chinese Institute of Atomic Energy in Beijing, New York University, Texas A. & M., and U.C. Berkeley Space Sciences Laboratory.

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distances ($\approx$ 20 cm) . The requirements for T1 are the most stringent since it has to deal with estimated particle densities up to the order of order 0.2 cm^{-2} . For T2 the estimated number can be up to 0.05 cm^{-2}. The tracking detectors T3–T5 will be conventional drift chambers with $\approx$ 14 planes pr detector. The positions of tracks are determined locally to better than 0.3 mm and their direction to better than 0.5 mrad.

The lower momentum part of the particle identification for the forward arm is based on two time-of-flight hodoscopes, H1 and H2. Each of the 60 staves (H1 $\approx$ 40, H2 $\approx$ 20) will be instrumented with a fast photomultiplier at both ends, giving a time resolution of $\sigma \leq 75$ ps. The H1 array at 9 m from the vertex will provide 4σ separation of π and K to 3 GeV/c and K/p to 5.2 GeV/c. The H2 array (after D4) will have π/K separation to 4.3 GeV/c and K/p to 7.2 Gev/c.

High momentum particles will be identified at two places in the forward spectrometer: namely after D2, covering the range of 2.5–6 GeV/c, and behind D4 with coverage from 4 to 25 GeV/c. The first region behind D2 will be instrumented by the use of a conventional semented Čerenkov tank, C1. A ring-imaging Čerenkov detector (RICH) wirh C_4F_{10} as the radiator gas will sit behind H2 to perform K/π separation up to $\approx$ 20 GeV/c and K/p separation much higher. This is accomplished by determining the ring radius with an accuracy of $\Delta R/R$ ~2%. A readout scheme using several large (10*10 cm) segmented photomultiplier tubes is being vigorously pursued for this detector.

3.2. Midrapidity Spectrometer

The midrapidity arm is a single dipole magnetic spectrometer of 8 msr solid angle designed to cover the angular region from 30° up to 90° and to measure and identify particles with momenta in the range of p ~0.2 GeV/c to 5 GeV/c. The magnet M0 will have a gap of ~10×35 cm^2 (h×w) at a distance of 140 cm from the nominal interaction point, with the width of the opening chosen so as to accept particles from a significant part of the interaction "diamond".

Since many particles detected behind the magnet arise from decays and secondaries it is necessary include tracking in front of the magnet. This purpose will be served by a time-projection chamber, TPC1, read out by approximately 1200 pads. A second time-projection chamber behind the magnet, TPC2, will have to deal with fewer particles than TPC1, but will be larger resulting in 1000 channels. More details can be found in ref.[5]

The time-of-flight detection will be done with an array of 250 plastic scintillators placed at 4 m. Each element will be 22 cm high and will use the same kind of tubes and electronics as used in the H1 and H2 hodoscopes in the forward arm. This will give π/K separation up to 2 GeV/c and K/p to about 3.5 GeV/c. A pressurized gas Čerenkov threshold detector with segmentation $\approx$15 will give π/K separation up to $\approx$6 GeV/c. This will be augmented with a suitable back counter to measure K conversions in the Čerenkov tank.

3.3. Global detectors

A charged-particle multiplicity counter with nominal pseudorapidity coverage $|\eta| \leq 3.6$ will provide a global trigger, determining the degree of centrality of the event. An array of beam-beam counters at 6 m backwards and forwards of the beam vertex will provide a start-time for the time-of-flight counters and will determine the vertex position to roughly 1 cm. The beam-beam counters will be phototubes with Čerenkov radiators in front.

particles: up to $p_t = 1.5$ GeV/c at all pseudorapdities and up to at least 2.5 GeV/c for $\eta < 3$. In addition, the centrality of the collisions is measured by a global multiplicity detector.

3. Description of Experimental Layout

The large range covered in rapidity and the dynamic range in momenta lead to a design which employs two moveable small solid- angle spectrometers.

Fig. 2 shows a schematic floor plan of the spectrometers, which are both freely rotating. The midrapidity arm covers angles $25° \leq \theta_{lab} \leq 90°$, while the forward arm coverage is in two parts: the full forward spectrometer covers $2.1° - 15°$ and the front section D1 through C2 swings loose to cover $15° - 30°$.

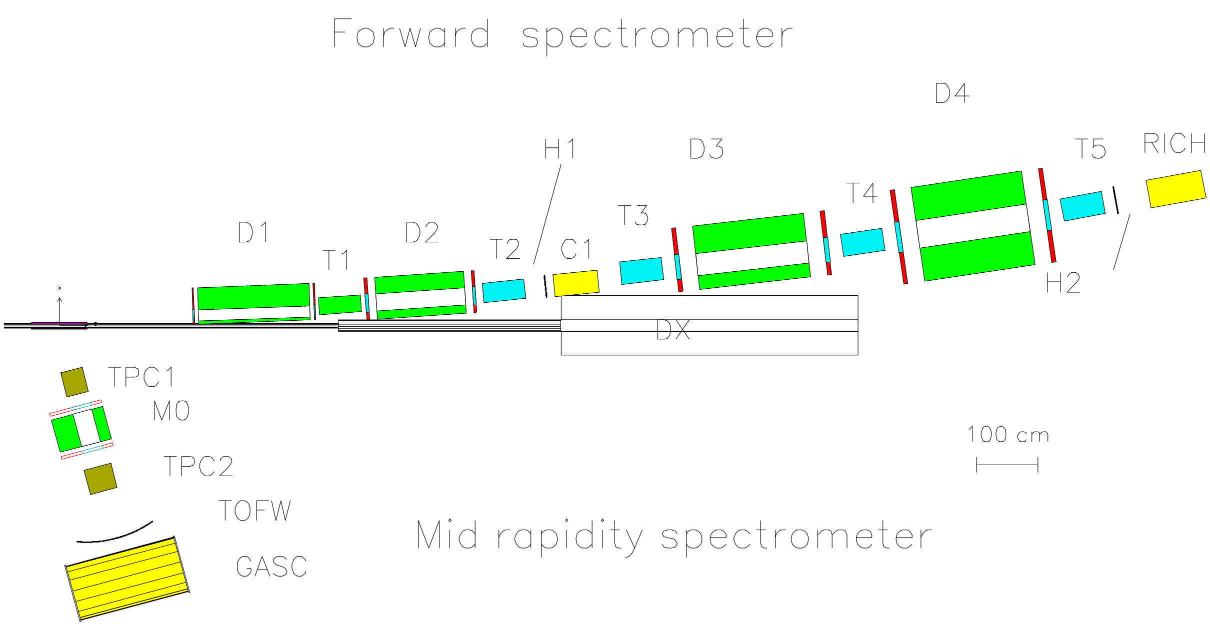

Figure 2. Layout of BRAHMS spectrometers. The names of individual components shown corresponds to the text where further detaiuls are given.

3.1. Forward Spectrometer

The forward spectrometer arm will contain four magnets (D1–D4) for sweeping and analyzing primary particles emerging from the reaction. In order to fit in the space by the beampipe at the most forward setting of 2.1°, D1 is of a septum design; in order to bend 25 GeV/c particles, it will have a field of up to 1.2 T. The other magnets, D2–D4 and M0 on the midrapidity arm, are of conventional design.

The forward arm tracking elements T1 and T2 each consist of a small time projection chamber (TPC), which provides good three dimensional track identification and rejection of background. The TPC's operate outside the magnetic field and have quite small drift

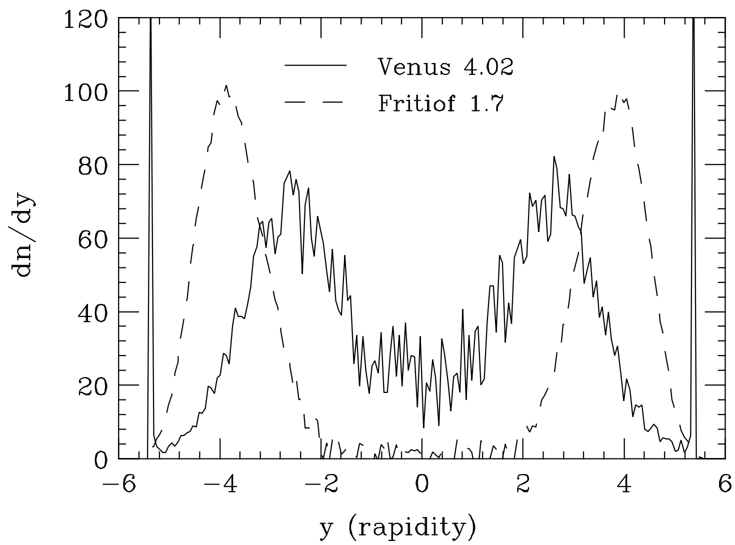

Figure 1. Calculated dn/dy for net baryon density in central Au+Au collisions.

and in part on scaling from p+p data. Plotted in Fig. 1 is the rapidity density for the net baryon number, namely the multiplicity of $p - \bar{p} + n - \bar{n}$ (after all unstable particles have decayed.) The FRITIOF 1.7 model,[1] predicts a flat, baryon poor region in midrapidity for central Au+Au collisions at RHIC, and peaks at $y = \pm 3.8$, shifted 1.6 units from the beam rapidity of ± 5.4. The prediction of the VENUS 4.02 code [2] for the same system is dramatically different from FRITIOF, showing no baryon free region, and smaller peaks at $y = \pm 2.6$. Thus the increased "stopping" inherent in VENUS has spread the colliding baryons over the whole rapidity region. Recent results[3] from the RQMD transport model, which also incorporates a string breaking scheme, support the VENUS result, namely that a baryon free, boost invariant region is not obtained at RHIC energies.

This discussion has shown the importance of actually measuring the rapidity dependence of the baryon yields, but equally strong arguments can be made for measuring baryon and meson p_t distributions over as wide a range of rapidity as possible. Furthermore, it is important to systematically study these distributions as a function of the mass of the projectiles as well as the violence (impact parameter) of the collision. Such information is critically needed to establish constraints on the theoretical models and for understanding the basic physical conditions for the quark gluon physics at RHIC.

2. Design Criteria

With these goals in mind, a magnetic Forward Angle Hadron Spectrometer and a Midrapidity Spectrometer to measure inclusive and semi–inclusive $p^{\pm}$, $\pi^{\pm}$, and $K^{\pm}$ spectra in the pseudorapidity interval $0 \leq \eta \leq 4$ ($2.1^{\circ} \leq \theta_{lab} \leq 90^{\circ}$) has been approved for the RHIC physics program[4]. In addition to the broad rapidity coverage, the spectrometers are also unique within the suite of RHIC detectors in their p_t coverage for well identified

The BRAHMS experiment at RHIC

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The physics Goals for the BRAHMS (Broad RAnge Hadron Magnetic Spectrometers) experiment at RHIC is presented. The proposed detector layout and means are discussed in some detail to show how the goals are achieved in this small experiment.

1. Physics Goals

It is generally conjectured that the quark–gluon plasma may be created in high energy nucleus–nucleus collisions under a broad range of conditions which are bounded in one direction by high baryon density and low temperature, and in the other by zero net baryon density and temperatures above the Hagedorn limit. The first situation, according to current wisdom, is appropriate to the stopping regime, up to $\sqrt{s}$ ≈10 GeV per pair of nucleons where stopping of the projectile results in high baryon and energy density. This regime is now being studied in the heavy ion fixed target experiments at the AGS and the CERN– SPS.

The creation of the baryon–poor, high–temperature plasma, on the other hand, depends on attaining collision energies far above the stopping regime. The colliding nuclei will then pass through one another and the baryon rich regions will be close to the original nuclei in rapidity. After the collision has occurred, a strong color field is created in the space between the nuclei which is anticipated to result in the creation of a quark gluon plasma with about an equal number of baryons and anti-baryons.

At the RHIC opportunities exist for experiments investigating both the baryon poor quark gluon plasma in the midrapidity region and the baryon rich plasma in the fragmentation regions of rapidity.

The most basic information available for understanding the phenomena that occur in heavy ion collisions comes from the momentum spectra and yields of the various emitted particles as a function of transverse momentum, p_t and rapidity, y. It is one of the goals of this experiment to measure these spectra in the kinematic regions in which they are most sensitive to model predictions. Particle yields, as a function of y, are important indicators of the densities obtained in the collisions and of the produced entropy. The spectral shapes and slopes and their y dependence reveal the reaction dynamics and the degree of thermalization attained. Enhancement of strangeness and/or antibaryons may signal the creation of the quark gluon plasma.

As an example of the importance of these measurements the expectations for the "baryon free" region for Au+Au central collisions at RHIC energies are compared for two different calculations, both of which are based in part on theoretical string models