BRAHMS RUN-6 Beam Use Proposal

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Abstract

The BRAHMS collaboration is requesting a 2-3 week pp run at 62.4 GeV to complete and augment the heavy ion program of AuAu and Cu-Cu at this same energy. These data are crucial for deducing the nuclear modification factors R_{AA} and R_{cp}) in Au-Au and Cu-Cu collisions at 62.4 GeV and quantifying the suppression for mesons at intermediate p_{T}at both mid-rapidity and at large rapidity.. At the same time we propose to make measurement of $\mathrm{A_N}$of π^- and π^+ in tranversely polarized pp collisions at large $\mathrm{x_F}$ (≈ 0.5). A measurement of $\mathrm{A_N}$ at this energy will bridge the measurements of this quantity from FNAL to full RHIC energy.

1 pp reference spectra at 62.4 GeV

The BRAHMS physics program in the first 5 RHIC runs has mapped out global features of particle production in rapidity and p_{T} for Au-Au at 130, and 200 GeV, in d-Au at 200 GeV, Cu-Cu at 200 and 62.4 GeV , and pp at 200 GeV. The evidence gathered from the first 4 runs has been evaluated and presented in the BRAHMS whitepaper[1]. Nuclear modification factors for all heavy ion systems have been studied in a wide range of rapidity ($\eta = 1 - 3.5$) at an intermediate p_{T} range up to 4 GeV/c. These data are used to understand the rapidity dependence of jet quenching and gluon saturation, and thus a tool to disentangle the physical processes involved. The result that the suppression in AA systems is large and nearly constant with rapidity for both $h^{\pm}$ as well as for identified $\pi's$ is certainly surprising, and indicates that the color dense medium is extended in rapidity. The precise interpretation albeit is complicated due to the effects of a decreasing $dN/d\eta$, a change in the underlying reference pp spectrum, and possible entrance channels effects from gluon saturation in AA.

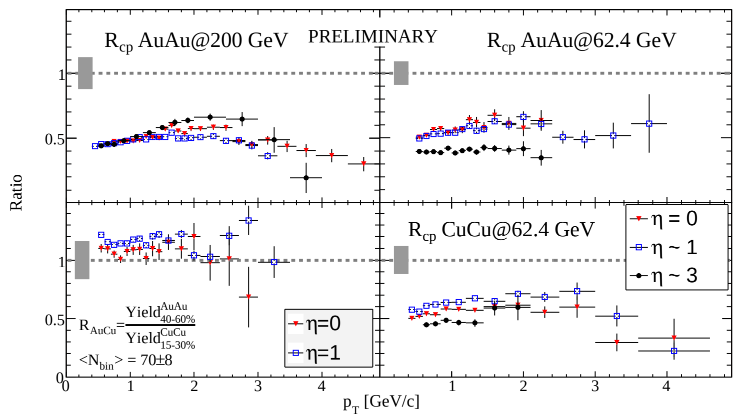

Figure 1: Nuclear modification factor R_{CP} for charged hadrons at pseudorapidities $\eta = 1.0, \mathrm{and} 3.$. Statistical errors are shown with error bars. Each panel shows a given collisions system, namely Au-Au and 200 GeV, Au-Au at 62.4 GeV and Cu-Cu at 62.4 GeV.

A recent analysis[2] of Au-Au and Cu-Cu data at 62.4 GeV has revealed a similar trend as at the full RHIC energy. The data shown in Fig.1 summarizes the BRAHMS result on R_{CP} at this energy for charged hadrons. The R_{CP} was used, even though this quantity does not reflect the suppression as well as R_{AA}due to the presence of common effects in central and peripheral collsions. These data shows that for all collisions systems, and at the lower energy of 62.4 GeV a significant suppression is observed at intermediat p_T at large rapidities. In order to obtain the R_{AA} from the data collected in both the Au-Au and Cu-Cu data from run 4 and run 5, repecctively it is imperative to obtain spectra for $h^{\pm}$ at $\eta = 2.5$ and 3 (8 and 4 degrees). The existing data at lower ISR energies are very sparse at forward rapidities[**?**]. It has further more been demonstrated[**?**] that pQCD does not provide an adaquate description at forward rapidities. Thus experimental data is a must. A distinct difference between pions and baryons (protons) have also been observed at all rapidities, with the baryons not being suppressed. Thefore sufficient statistics is needed to measure both pions and protons at these rapidities.

Even at mid-rapidity where data from several ISR experiments exists for charged and neutral pions the status of reference data is quite uncertain as described in [3]. Additionally, the major data set from BRAHMS Au-Au and

Cu-Cu data set is at $\eta = 1$ where additional transformations from mid-rapdity is needed. Henceforth direct measurements of the hadrons spectra at η=1 in pp at 62.4 GeV with the BRAHMs spectrometers would very much enhance the understanding of the nuclear suppression at 62 GeV, an important step between SPS and maximum RHIC energies.

2 Transversely Polarized pp at 62.4 GeV

Measurements of transverse spin asymmetries in pp collisions at forward angles may reveal information on the internal spinstructure of the proton, in particular on the orbital angular momenta of the quarks. Large asymmetries has been reported for charged pion production at $\sqrt{s_{NN}} = 19$ GeV [4], and for π^0 at 200 GeV[6]. The BRAHMS data from the previous RHIC run aquiered a small sample of data at $0.15 < x_F < 0.35$ for $\pi^{\pm}$ transverse asymmetry. The measured raw asymmetries corrected for the beam polarization is shown in Fig. 3 for π^- and π^+ . The π^+ asymmetries are positive while the π^- are negative i.e. the same sign dependence as seen in the E704 data at lower energy.

The just completed run-5 resulted in a much large sample and allows an extension of the measurements to higher x_F and p_T with better both systematic and statistical uncertainties.

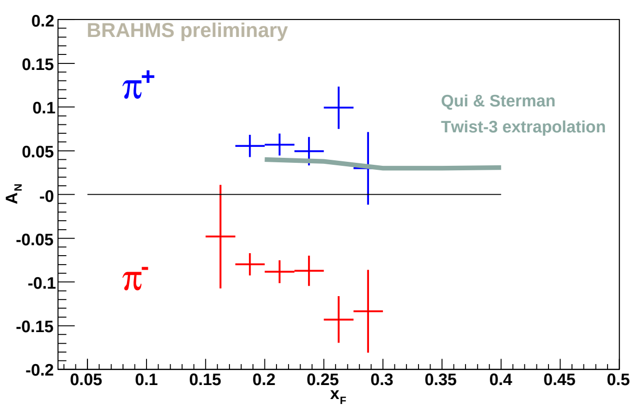

Figure 2: Analyzing power $\mathrm{A_N}$ for π^+ and π^- .

The data at full energy only cover up to a moderate $\mathrm{x_F}$ of 0.3-0.35, but in a range of p_{T}value where pQCD may be appropriate. At the lower beam energy the BRAHMS forward spectrometer spans the complete kinematic range of $\mathrm{x_F}$, but to make a measurement in a reasonable short time the $\mathrm{x_F}$ range up to 0.5 can be measured. Based on the extrapolations from lower and higher energies a fairly large asymmetry is expected possibly around $20 - 30\%$ so the statistics needed is also moderate.

3 Request

In this section we outline what the requirements to delivered beam is to achieve the physics outlined above. The C-A department have given the information that an average luminosity of $2*10^30 \mathrm{cm}^2\mathrm{s}^1$ can be achieved at 62.4 GeV with 3 collision points at $\beta^* = 3.5$. This corresponds to a mean luminosity of 0.7 pb^{-1} per week. For the $\mathrm{A_N}$measurements the beam has to be polarized transversely. Since the measuements are for the forward spectrometer strictly speaking only the blue beam has to be polarized. It is assumed that a polarization of better than 50% can beachieved

The key measurements to be made includes for the forward spectrometer.

- 4 Degrees 3 field settings 2 Polarities.
- 8Degrees 1 field settings 2 Polarities.
- 2.3 degrees 1 Field setting 2 polarities.
- simultaneous with these measurments at 45 degrees ($\eta = 1$

The aim is to get comparable statistics as for the Cu-Cu and Au-Au data at the same settings. In Figs.3 and 3 is shown examples of the yields that can be obtained in a nominal 24 hours period with the standard asumptions of machine and experiment up-time and effeciency.

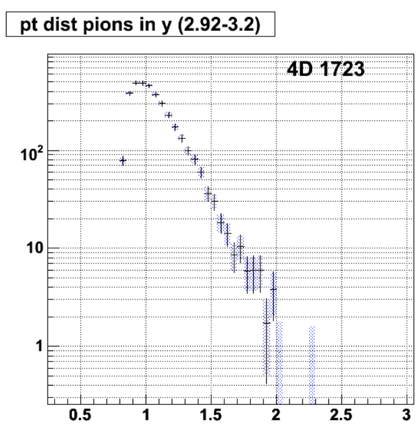

Figure 3: Estimate Collected Yield for π^- per 24 hours for π^- at 4 degree at half field.

The measurement plan with contingency and initial setup time translate into 16 days of physics beamtime or an equivalent delivered luminosoty of 1.6 pb^{-1}.

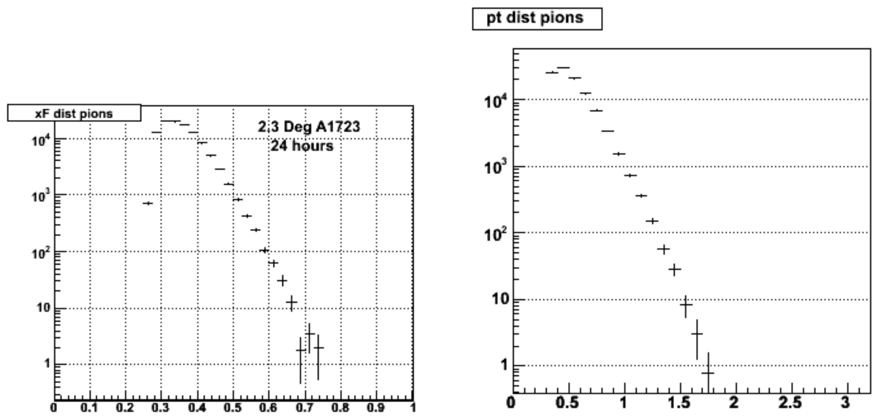

Figure 4: Estimate Collected Yield for π^- per 24 hours for Analyzing power for measurements of $\mathrm{A_N}$ vs. $\mathrm{x_F}$ (left panel) and p_T(right panel).

4 Acknowledgements

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