The Physics of STAR at RHIC

J.L. Drachenberg, C.A. Gagliardi, T.W. Henry, Y. Li, S. Mioduszewski, M. Sarsour,
R.E. Tribble, and the STAR Collaboration

During the past year, we have been involved in several STAR physics efforts. A major goal of the STAR spin physics program is a determination of the contribution that gluons make to the proton spin. A long polarized proton run occurred during Run 5. STAR devoted nearly the entire p+p run to longitudinally polarized proton collisions, with a mix of triggers that was designed to maximize our acceptance for high-p_T jets. Since then, there has been a major effort within the STAR Spin PWG to extract the longitudinal double-spin asymmetry A_{LL} for inclusive jet production. Our group has focused on detailed studies of a broad range of systematic effects that may contribute and on developing ways to minimize their impact on A_{LL}.

The d+Au data from Run 3 allow one to explore modifications of the parton distributions that occur in finite nuclei. BRAHMS found that the negatively charged hadron yield at forward rapidity (η = 2.2 and 3.2) is suppressed in d+Au relative to p+p [1]. This result is consistent with expectations of gluon saturation models, but several other explanations have also been proposed. STAR has now measured inclusive π^0 cross sections in p+p and d+Au collisions at η = 4 [2]. Figure 1 shows the nuclear modification factor R_{dAu}, the ratio of the yield in d+Au per nucleon-nucleon pair vs. p+p. The observed suppression is much stronger than expected in conventional NLO pQCD calculations that include nuclear shadowing. STAR also performed an exploratory study of correlations between forward π^0 and mid-rapidity charged hadrons [2]. The back-to-back correlations observed in p+p collisions are characteristic of di-jet production and consistent with expectations from Pythia. The back-to-back correlation probability is considerably weaker in d+Au collisions. This may point to the production of "mono-jets", as expected in gluon saturation models. However, while these results are suggestive, the statistics and kinematic coverage are limited. A follow-up d+Au run with improved instrumentation in the forward region is needed to clarify this picture.

We also continue to study similarities and differences in mid-rapidity jet and di-jet production in p+p and d+Au collisions at RHIC energies. Good agreement is found between Pythia+GEANT and data for the longitudinal (z) and transverse (j_T) jet shapes [3]. A new procedure is under development to determine the intrinsic k_T in p+p collisions and the additional nuclear k_T in d+Au collisions.

The STAR Forward Meson Spectrometer (FMS) will be a new addition to the STAR electromagnetic calorimetry, providing complete coverage over the pseudorapidity region $2.5 < \eta < 4$, which is the deuteron forward direction when RHIC studies d+A collisions. When it is completed in 2007, STAR will have nearly complete EMC coverage over the range $-1 < \eta < +4$. The FMS will enable STAR to search for mono-jet production in d+Au collisions. It will also facilitate measurements of gluon polarization in the proton at low-x and detailed studies of the dynamics that underlie the significant single-spin asymmetries that have been seen in forward π^0 production at RHIC [4]. This past year members of the group participated in the construction and development of the physics program for the FPD++ detector. The FPD++ is an engineering prototype for the FMS. It is also designed to explore the

dynamics that underlie the sizable single-spin asymmetries by going beyond inclusive π^0 production to jet-like events and direct photons.

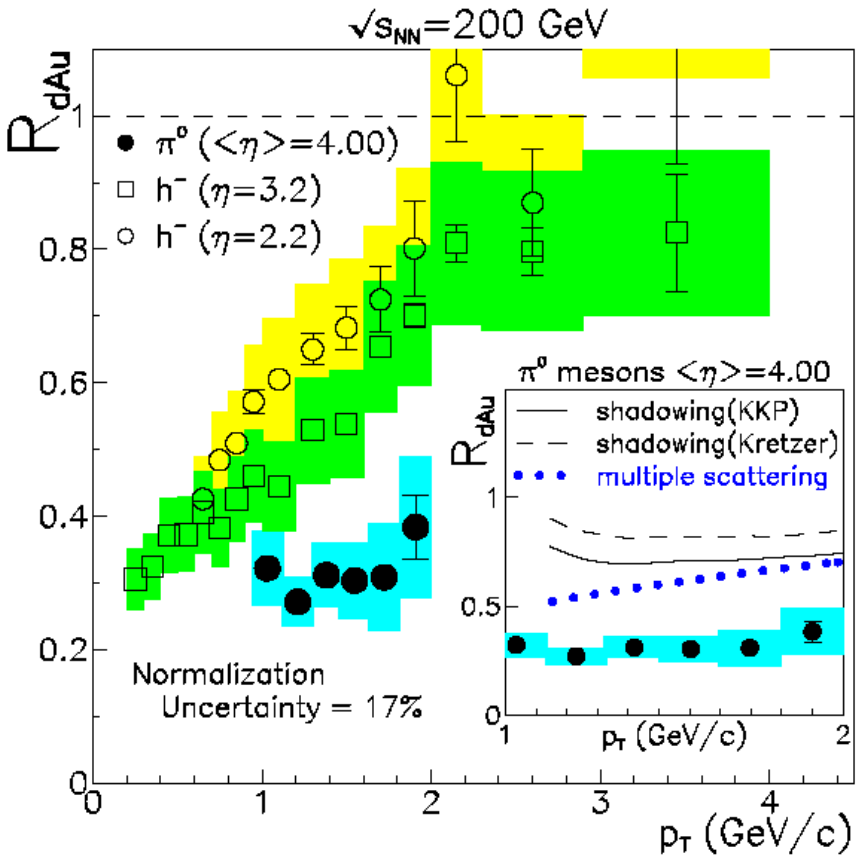

Figure 1. Nuclear modification factor for minimum-bias d+Au collisions vs. p_T. The solid circles are for π^0 mesons at η=4 from STAR, compared to previous measurements for h^- at smaller η from BRAHMS [1]. The inset shows the STAR data compared to several different calculations.

We also carry administrative responsibilities related to STAR and RHIC. Dr. Gagliardi was named Deputy Spokesperson of the STAR Collaboration effective September, 2005. He has also served as co-chair, with A. Frawley of Florida State, of the RHIC II White Paper writing committee, and as co-convener of the RHIC II Forward/p+A Working Group. Dr. Mioduszewski has served as co-convener of the RHIC II High-p_T Working Group. Drs. Mioduszewski and Tribble chaired STAR god-parent committees, and Drs. Gagliardi, Mioduszewski, and Tribble all served on STAR god-parent committees.

[1] I. Arsene *et al.* (BRAHMS Collaboration), Phys. Rev. Lett. **93**, 242303 (2004).

[2] J. Adams *et al.* (STAR Collaboration), Phys. Rev. Lett., submitted; nucl-ex/0602011.

[3] T. Henry, for the STAR Collaboration, Acta Phys. Hung., in press; nucl-ex/0511002.

[4] J. Adams *et al.* (STAR Collaboration), Phys. Rev. Lett. **92**, 171801 (2004).