Forward Jet asymmetry measurements in fsPHENIX

R.Seidl[*1] and A.Vossen[*2]

The current PHENIX detector's small acceptance has substantially limited the possibilities to study the spin structure of the nucleon in more detail. With the inception of a new, large acceptance jet and charmonium detector for heavy ion physics, sPHENIX[1)], some incremental improvements are possible in the sPHENIX acceptance (-1< η < 1) but almost all interesting observables for spin and cold nuclear matter physics require forward coverage. The main reasons are that at forward rapidities both higher and lower Bjorken x can be probed than previously accessible. The lower x region is interesting for the study of the gluon spin where even a moderate polarization can substantially impact the total contribution to the proton spin. The higher x region is important as it relates to the valence region and above for transverse spin effects.

The so-called fsPHENIX project (for forward sPHENIX)[2)] proposed to augment the sPHENIX acceptance at the least by a forward hadronic calorimeter and GEM tracking planes in the rapidity region of 1.3 to 4. This minimal solution is relatively cost-effective and would allow the measurement of jets as well as charged hadrons within jets in these forward rapidities. With other detector additions or refurbishing, fsPHENIX can also become a zero-day detector for an electron-ion collider if realized at Brookhaven.

One of the main transvsere spin measurements is the access to the tensor charge, which is an important test quantity in lattice calculations. This chiral-odd object has so far been mostly accessed via the Collins fragmentation function[5)] which has been extracted in e^+e^- annihilation[6)]. Transversity is only known at moderately low x (0.05 to 0.3) accessible in semi-inclusive deep inelastic scattering (SIDIS). Recently STAR has managed to access a similar x region in transvsersely polarized proton-proton collisions at central rapidity via hadron in jet azimuthal asymmetries. Performing these measurements in forward rapidities, one can extend the measurement to x regions so far not accessed and at a high scale.

We have performed MC studies using either the currently extracted parameterizations[3)] or use the Soffer bound[4)]. Since no data exsits at the higher x we are interested in at forward rapidities these two expected asymmetry curves realistically reflect the amound of uncertainty at present. In addition, we have performed a realistic study of the experimentally achievable uncertainties taking into account jet axis smearing, beam remnant backgrounds as well as underlying event contributions assuming a rather moderate integrated luminosity of 268 fb $^{-1}$ at a collision energy of 500 GeV. In Fig. 1 the statistical uncertainties on the expected negative hadron measurements are not visible and with expected asymmetries as large as 10% the d quark transversity can be constrained. With increasing rapidity as well as jet transvsere momentum one can reach the high x values needed to eventually perform the integral and obtain the tensor charges. The lower x regions in turn can be used to experimentally confirm that factorization holds if compared to SIDIS. Last, when the backward going beam is transversly polarized instead of the forward going beam with a similar measurement the potential linear polarization of gluons in the nucleon can be probed for the first time. More details on these as well as other key measurements at RHIC can be obtained from the recently completed new RHIC spinplan[7)].

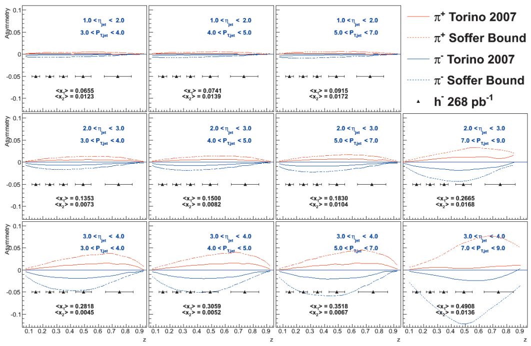

Fig. 1. Expected h$^-$ Collins asymmetry uncertainties (black points) compared to positive (red) and negative (blue) pion asymmetires based on the Torino extraction[3)](full lines) or the Soffer bound[4)] (dashed lines) as a function of fractional hadron energy z for various bins in jet rapidity and momentum. The average kinematics are also shown.

References
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*1 RIKEN Nishina Center
*2 Indiana University