DRAFT

Preliminary Report of the FPD Review Committee

James Symons, Bill Christie, Spencer Klein, Larry Roberts, Raju Venugopalan, Zhangbu Xu

July 11, 2002

Introduction

The Committee has reviewed the proposal to install a forward π^0 detector in STAR. In this report, we address the three topics discussed in our charge: scientific merit, feasibility and integration into the larger detector. In the time available to us, we have not carried out a detailed technical review of the cost and schedule.

Scientific Merit

The physics issues discussed in the FPD proposal are the following: a) gluon distributions in heavy nuclei, b) novel high parton density effects, c) single spin asymmetries, and d) tests of QCD factorization. These are issues of fundamental importance in QCD. Measurements of gluon distributions and single spin asymmetries would be first measurements of ``benchmark" quantities in unexplored kinematic regimes. The measurements could in principle reveal novel phenomena in QCD at high parton densities and provide a stringent test of the factorization theorems that underly the framework of perturbative QCD (pQCD).

The gluon distribution in heavy nuclei is largely unknown, particularly at small x. The data that exists is in a very limited kinematic range making it difficult to interpret in the framework of pQCD. Nuclear gluon distributions besides being of considerable intrinsic interest are also extremely important in interpreting the results of a wide range of observables in heavy ion collisions.

It is not clear, however, that one can, from the set up envisaged in the FPD proposal, directly extract the nuclear gluon distribution at small x. The reason is as follows. The relevant expression quoted in the proposal is a convolution over parton densities over a range of x values. To specify the x value of the gluon distribution, one needs to measure both the jet corresponding to the π^0 (at rapidity η_1) and the away-side jet at rapidity η_2 (with η_1 and η_2 chosen to achieve the smallest x values). The expectation that the parton contribution from the smallest possible kinematic x value will dominate the convolution

holds only if the gluon distribution in nuclei rises very rapidly with decreasing x. Measuring the "spectator" jet may be difficult with the coverage of the FPDs alone. The FPD in combination with the EEMC may allow this but simulations of this process are not presented.

Despite these uncertainties in the extraction of parton densities, the measurement of forward π^0s would be very useful because one can presumably compute the multiplicity and distribution of π^0s in different models of small x physics. It is conceivable that this measurement alone could help discriminate between different models and thereby have significant ``discovery potential". The committee believes that the proponents are wise to focus on the inclusive measurement at this time, but it is also clear that further development will take place once the calorimeters are fully implemented in STAR.

Single spin asymmetries are now a hot topic in the QCD spin community. As pointed out by several authors, these asymmetries probe the nature of the light cone wave function and the importance of initial state versus final state effects in hard scattering. They thereby provide a test of QCD factorization theorems. An interesting idea discussed in the proposal is to test the π^0 asymmetry with that of other charged particle tracks at large rapidities, thereby testing the Collins explanation of the asymmetry as an asymmetry of the polarized quark's fragmentation.

Use of the detector as a transverse polarimeter

The natural polarization state of the RHIC ring is transverse. Longitudinal polarization will be achieved using spin rotator magnets in the STAR region. It is clearly very important (perhaps essential) that a local polarimeter be available to ensure that the direction of polarization is known in the intersection region. The single spin asymmetry discussed above would be ideal for this purpose if the large values measured at lower energies persist at RHIC energies. Data taken during the last run are still inconclusive, and measurement of this property is one of the most important goals of the coming run.

Feasibility

The proposed FPD system is designed to detect forward π^0 s in three environments: (a) polarized pp collisions, (b) deuterium side of dAu collisions, and (c) gold side of dAu collisions. 'Side' refers to the direction of the incident beam, so the deuterium side detects π^0s from the deuterium fragmentation. The group also proposes to instrument the detector with scalers, to measure the asymmetries in almost-real time, for use in tuning the spin rotator magnets around STAR.

For polarized proton collisions, the experience gained from this year's prototype FPD and the simulations presented give us high confidence that π^0 may be effectively extracted from the backgrounds. There do not appear to be major issues that would severely limit the systematic errors. The size and resolution of the calorimeter also appear to be adequate to the physics requirements. On the deuterium side of dAu collisions, the physics background for π^0 on the deuterium side can be naively estimated to be twice that in pp, and also should not be a major problem. The simulations presented (Fig. 9) bear this out; a comparison of Figs. 8 (pp data) and 9 (dAu simulations qualitatively confirm the factor of 2). On the gold side of dAu collisions, the backgrounds may be considerably higher than the other two cases. Simulations of this case were not presented, and we do not know what signal to noise ratio is achievable in this case.

In addition to the π^0 studies, it is proposed to use the FPD to tune the spin rotator magnets. This requires that a non-zero asymmetry be measurable using a FPD + scalar system. This is predicated on two assumptions: that the π^0 asymmetry be non-zero, and that the asymmetry be detectable using simple threshold cuts, without reconstructing π^0s. The former point depends on nature, and must be measured. The latter depends on the overall energy asymmetry, which will include contributions from π^0 as well as other particles, and possible spin dependent backgrounds, weighted by their acceptance in the FPD calorimeter. Understanding of this latter point will require detailed study, and experimental measurements.

Mechanical Integration:

The proposed FPD detector configuration will consist of four calorimeter modules on both the East and West tunnel extension platforms. These platforms also contain vacuum pumps and gate valves associated with the RHIC collider. While it appears that the FPD can fit on these platforms, a detailed layout has not been done. STAR will need to discuss this space allocation issue with the relevant collider people to receive approval for the use of this space. Another related issue that will need to be addressed is the access and space requirements of the RHIC vacuum group on these platforms during the annual beam pipe bakeout process.

A detailed breakdown and layout for the necessary utilities (AC power, cable trays, network connections, etc.) was not available for review. This information is necessary to give a concise estimate on the validity of the proposed schedule. A general comment is that a number of the STAR detector systems slated for installation during the Summer and Fall of 2002 have fallen behind their original schedules, and will be requiring technical resources in the fall, when a large fraction of the FPD installation work would likely take place if approved. This will certainly require a well-defined prioritization by the collaboration for these sub systems. As the collider requirements for technical resources are also likely to rise between now and the start of the run, allocation of resources is likely to be a problem.

There was concern expressed during the committee discussions regarding the feasibility of the proposed satellite operation of the DSM crates. However, further investigation has led to assurances by the trigger group that the proposed setup will work.

A brief review of the proposal by the STAR DAQ group leader and Chief mechanical Engineer led to comments that the proposed FPD schedule for electronics and mechanical design, fabrication, and installation was optimistic. Further detail on the FPD project plans would be necessary to refine these statements. As is the case for the technical resources to get the necessary FPD detector components and utilities installed. Prioritization will likely to be necessary for DAQ and trigger manpower resources needed for the FPD, and for other STAR sub systems, both new and old.

Summary

The proposed forward calorimeters will provide exciting new capabilities for STAR, allowing important new physics topics to be explored. The two measurements discussed in detail (transverse π^0 asymmetries in polarized pp collisions and forward π^0 ratios in dAu collisions) are unique to STAR. In addition, this system may be usable as a transverse polarimeter. Many experts believe that this is an essential capability for the spin program.

The detector is not large by STAR standards and is very cost-effective, thanks to the availability of existing lead glass modules, and the use of electronics developed for other STAR subsystems. The proponents are confident that it can be installed for the upcoming run. However, we note that there are problems common to ANY new detector, independent of its size, (grounding, DAQ, trigger, safety review, etc.) that will need to be addressed at a time when several other projects will be competing for resources. We also note that the detector will be using electronics, developed for other subsystems, that have not yet been fully debugged.

Because of the possibility for conflict between this and other subsystems, it will be important for STAR management to consider their relative priority and provide clear guidance. The schedule is aggressive, but the group is highly motivated and we believe that there is a fair chance that they can, in fact, succeed in installing the device.

We were asked to identify potential “Show stoppers”. Only two stand out: (1) The background on the Gold side in dAu collisions is certainly a concern that may limit the inclusive π^0 ratio measurement; (2) If there is no asymmetry in the π^0 cross section, then the device obviously cannot be used as a polarimeter. Of course, when the schedule is as tight as this, a single minor item may stop the show!

Finally, we believe that that it is very important to gather the data necessary to settle the question of whether this detector can function as a polarimeter for the spin program. It is unclear that the present data is adequate for this. In the event that it is not possible to install the full FPD as described in the proposal, we recommend that every effort be made to install a symmetric system on one side of STAR for the coming run, even if it has to be read out with conventional electronics.