Jefferson Lab
Proposal Cover Sheet (Generic)

Experimental Hall: A
Days Requested for Approval: _____

Submission Date: 5/94
Other: PAC 8

☐ **New Proposal Title:**
☒ **Update Experiment Number:** 89-033
☐ **Letter-of-Intent Title:**
(Choose one)

Proposal Physics Goals
Indicate any experiments that have physics goals similar to those in your proposal.

Approved, Conditionally Approved, and/or Deferred Experiment(s) or proposals:

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By: _____

Update of Experiment 89-033

MEASUREMENT OF RECOIL POLARIZATION IN THE $^{16}O(e,e'p)$ REACTION WITH 4 GEV ELECTRONS

Spokespersons
C.C. CHANG, C. GLASHAUSSER (Contact Person), S. NANDA, and J. W. VAN ORDEN

Participants
THE HALL A COLLABORATION

This experiment is the gateway to spin physics in nuclei with A>4 at CEBAF. It is based upon a new observational tool in electron scattering, the focal plane polarimeter (FPP) that has proved so successful at hadron machines. It was approved in the first round of proposals and has retained its physics interest in the intervening years. In that time, a focal plane polarimeter has been built for Bates and is just about ready to take its first data (on deuterium). A similar polarimeter is under construction at Mainz. Members of the present collaboration are leaders of both these projects (Lourie at Bates and Gilman at Mainz) and many others are participants. It seems clear that spin physics, with focal plane polarimetry in particular, is about to become an important part of electron physics. This experiment, a first exploration of the terrain at higher momentum transfers than are possible at the lower energy machines, should contribute significantly to this interesting new direction.

ACTIVITIES OF THE COLLABORATION

This experiment was included in the first round of Hall A Collaboration experiments, and so the experimental collaboration is synonymous with the Hall A Collaboration. Many members of the collaboration thus support this experiment primarily through their MOU activities with Hall A. Since Rutgers is the lead institution in this experiment, and one of the leaders of the FPP effort since its inception, I will concentrate here on the FPP development which is critical for this experiment. In addition, the Italian group (Garibaldi et al) are working on the waterfall target necessary for this experiment and two others. The Rutgers group and the William & Mary group have designed and are presently constructing the

FPP at the two universities. R. Gilman and C. Perdrisat are the Principal Investigators for the NSF proposals submitted by Rutgers and by William & Mary, respectively. The proposals were fully funded (about $500,000) and represent, to our knowledge, the only NSF commitment to funding capital equipment at CEBAF. Rutgers is responsible for the rear chambers and the carbon analyzer (about 2/3 of the total cost) and William & Mary is responsible for the front chambers of the polarimeter. Funding began in the fall of 1992 and will be completed in the spring of 1995. The chambers for the FPP are straw chambers, chosen for their simplicity and low cost, good field configuration, and mechanical stability. Small prototypes have been built and tested in actual experiments, the most recent being a 1m long chamber for pion detection at LAMPF. The first actual chamber for CEBAF has now been built and is presently being strung. It is expected that the FPP will be installed in the focal plane of the hadron spectrometer in Hall A in the summer of 1995, at the same time as the rest of the focal plane detectors. In addition to the groups at the two institutions, Paul Rutt, a University of Georgia postdoc, is playing a leading role in building the polarimeter at Rutgers. This effort should mean that tests of the focal plane polarimeter should be possible with the earliest beams in Hall A, and that the experimental program based upon the FPP can begin soon thereafter.

Readout electronics for the FPP is partly being purchased and partly being designed and built at Rutgers. The design for most of these units has been fixed. Their cost is considerably less than would have been possible with commercial vendors.

Ed Brash, a Rutgers postdoc, is now permanently on site at CEBAF to work on data acquisition hardware and software for both the FPP and the Hall in general. The FPP software will be done in collaboration with Gerfried Kumbartzki, a Rutgers staff member based at Rutgers.

PHYSICS MOTIVATION

A basic goal of medium energy nuclear physics is the understanding of possible modifications of nucleon properties inside the many-body nuclear medium. Particularly as we move to higher energies and higher momentum transfers, it is expected that new phenomena may be observed that will be difficult to interpret without new kinds of data. Even in the traditional lower energy regime, there are

a number of unexplained puzzles mentioned in the proposal which may indicate interesting new physics. But different kinds of data are needed in order to solve these puzzles. Focal plane polarimetry affords a rich set of new observational possibilities, and, at the same time, permits measurements of many observables with small systematic errors. This is because many measurements involve ratios rather than absolute values, and many can be carried out without changing angles and beam energies.

These virtues of the FPP are applicable in a number of experiments approved for Hall A with very light targets, and the same experimental collaboration, viz, the entire Hall A Collaboration, is supporting them as well. What is almost unique about Exp. 89-033 is that it will explore a target heavier than ^4He. We thus look on this experiment as an introduction to electron scattering studies of "heavy" nuclei, nuclei in all their complexity, at CEBAF. Given the history of nuclear physics, the study of heavy nuclei needs no apologia for an audience of nuclear physicists. We have observed many interesting phenomena in the truly many-body environment, and we have been able to interpret them in appropriate, not necessarily reductionist, ways. Now the outside (physics) world has caught on to this, and the study of complexity has become suddenly fashionable. It would be truly ironic if we nuclear physicists chose this moment to neglect our heritage and concentrate entirely on few body systems. The fact that this experiment and the several other experiments with "heavy" nuclear targets have been approved with alacrity suggests that this is not a real danger at CEBAF, but it is useful to keep in mind that it is important to get started early on this kind of program.

The specific goals of Exp. 89-033 remain as proposed in 1989. We want to measure the three possible polarization states of 500 MeV protons knocked out of the nucleus from known configurations in ^{16}O, and compare the results with the best theoretical predictions. A number of predictions have been made by Van Orden, some of which were shown in the proposal or at the defense. These show the expected sensitivity of the polarizations to interactions of the proton with its environment on the way out of the nucleus. For example, with unpolarized electron beams, the recoil nucleon polarization, predicted to be large, results only from its final state interactions. Understanding of these effects would thus be a natural prelude to the study of color transparency. The relativistic calculations of Van Orden are often significantly different from the non-relativistic ones, but it should be stressed that, even where these effects seem to be unimportant, at low recoil

momentum P_R, for example, both relativistic and non-relativistic predictions could be simply wrong. There are no data!