FY2001 Activities

A. SUMMARY

Scientific effort at the laboratory was broadly based in four areas: (1) the continuation of the research program in nuclear and accelerator physics with the Cooler, (2) the preparation of the endcap calorimeter for the STAR detector at RHIC along with participation in the present heavy ion and polarized proton experimental programs there, (3) the continuation of efforts in weak interaction and nuclear physics using cold neutrons, and (4) the development of a new detector for neutrinos at Fermilab. The accomplishments in each area are summarized here and reviewed in detail in various parts of the Findings and Contributions sections of this Annual Report.

This report covers the second full year of experimental activities using the electron-cooled storage ring (Cooler) with beams injected solely from the Cooler Injector Synchrotron (CIS). Beams were delivered to 4 experiments, in some cases for multiple running times, and 2 development projects. As before, the schedule consisted of a balance between production running and access to the ring for experimental changes and equipment installation. There were longer access periods during this fiscal year set aside for the development of the polarized deuteron beam and the installation of equipment for the charge symmetry experiment in the Cooler T-region. Smaller projects included changing the configuration of the Cooler A- and T-regions for ongoing experiments, and the installation of silicon strip detectors in the G-region.

Two major experiments were completed, the measurement of the spin correlation parameters in d+p elastic scattering, and the measurement of the n+p back angle cross section using tagged neutrons. The first of these was part of a larger quest for information about three-body forces using the three-nucleon system. The elastic scattering channel shows deviations between Faddeev calculations based on high quality two-body force input and measurements for the cross section and analyzing powers near the middle of the angular range where the cross section is at its smallest. Using the polarized deuteron target in the PINTEX setup, a large set of spin correlations parameters were added to the data base at proton energies of 135 and 200 MeV. Most of the angular range was covered, given the limitations of the PINTEX detector system. For some angles, the front scintillator was made thicker to enhance the separation of proton and deuteron tracks through the detectors.

The second experiment used the previously commissioned neutron tagger to provide a well-understood flux of neutrons onto a CD_2 target. Runs with a carbon target were interspersed to provide a way to subtract the quasi-elastic background. Most of August and September were devoted to getting an adequate data set for this experiment, despite difficulties with the operation of the RF amplifiers for the RFQ and DTL pre-accelerator systems.

Additional running was made for projects in accelerator physics. The polarized proton beam was used to study snake resonances and to optimize the use of an RF dipole for flipping the spin of a stored proton beam. CIS by itself was used for the study of space

charge effects in a system that is analogous to that planned for the Spallation Neutron Source at Oak Ridge. Beam time was made available to the Nuclear Chemistry group to investigate the feasibility of an experiment to measure the intermediate mass fragments from proton collisions on a gold target. The silicon strip detectors in the LASSA array proved to be too thick to give an adequate separation of charge and mass for very low energy fragments, and it was decided not to continue work on this project. Two commissioning runs were made for the experiment to search for the isospin-forbidden dd $\rightarrow \alpha\pi^0$ reaction, one to demonstrate the measurement of deuteron vector and tensor polarization in the Cooler ring, and another to commission the magnetic channel using the pd $\rightarrow {}^3\mathrm{He}\pi^0$ reaction.

For the STAR collaboration, most of the effort went into bringing the production line for the calorimeter into full operation. As part of that effort, a second trip was made to the Stanford Linear Accelerator Center to test the prototype calorimeter. With cosmic ray calibration information available, the performance of the prototype in most respects lived up to the expectations from simulations. At IUCF, production lines were established for scintillator sheets and lead radiators. At the same time, Argonne National Laboratory undertook the production of the shower maximum detectors. Tests of the shower maximum prototype indicated that discrimination against π^0 decay will be adequate for the spin program proposed for RHIC with the STAR detector.

Effort also went into the software that will be needed to understand proton-proton collisions at RHIC. Much of this effort was directed toward the development of algorithms to eliminate pile-up tracks from the TPC data that are expected to appear at the highest luminosities.

Once the runs at SLAC were completed, the prototype detector was moved to RHIC where, along with three arrays of Pb-glass, it was positioned at one end of the STAR intersection where it can observed inclusive π^0 events at large x_F and small p_T. It is hoped that this process will allow an online measurement of the transverse spin components of the polarized beam at the STAR detector. Electronics and a readout system were included with this prototype. Successful operation will lead to the development of a system to look at π^0 events at both ends of STAR.

Collaborators from IUCF were also involved with the running of the STAR heavy ion program once beam operations got underway during the summer. Much of this service was in skilled positions as shift leaders or software experts. Work also began on the recalibration of the proton polarimeter used at the end of the Brookhaven linac.

In physics experiments with cold neutrons, the measurement of the neutron lifetime was completed at NIST. Protons from neutron decay were caught in a Penning trap and counted. The goal of the experiment is a value of the neutron lifetime with an error of 0.1%. This should provide new constraints on the unitarity of the CKM matrix.

Work continued on experiments aimed at the study of parity violation with particular emphasis on the measurement of pionic coupling parameters for the weak interaction. The two experiments expected to be most useful will be the observation of the parity-forbidden longitudinal analyzing power in the radiative capture pn $\rightarrow$ dγ reaction and the observation of neutron spin rotation as the neutrons pass through a liquid helium target. IUCF is contributing the LH_2 cryostat for the radiative capture experiment as well as

the construction of the CsI array to observe the γ-rays. For the second experiment, the laboratory has undertaken the construction of the superfluid ^{4}He target chamber.

In related efforts, IUCF has been developing the use of polarized ^{3}He to make polarized cold neutrons. One application is the measurement of the decay parameters of the neutron. An accurate result, like the lifetime, is related to the unitarity of the CKM matrix. In other efforts, IUCF is working on the measurement of the scattering length for low-energy neutrons on several light nuclei.

The effort of the laboratory in the area of neutrino physics is proceeding with the construction of the miniBooNE detector at Fermilab. The cyclotron beam at IUCF has been used to test the scintillation properties of the oil that is to be used to fill the detector. Meanwhile, the miniBooNE detector is being constructed. Occupancy of the building took place this year and many of the detector components, such as PMTs and data acquisition electronics, have been installed.

There were no meetings of the Program Advisory Committee during this fiscal year. Several reviews were held for the STAR program. These were aimed mainly at the verifying that the design of system components was sound, checking the management plan, reviewing that safety requirements were met, and planning for the installation of detector components at RHIC. Members of the IUCF staff were also involved with a review of the Department of Physics at Indiana conducted by the Dean of the College of Arts and Sciences.

Two larger reviews of the IUCF program were held. One was a site visit from the NSF related to the new three-year proposal for funding the scientific program. The other was called by Indiana University as part of its regular assessment of the relationship between the laboratory and the university. The programs for these two events are given below.

B. COMPLETED EXPERIMENTS

Exp. No.	Spokesperson(s) *Title*
CE-71	Todd Peterson and Steven E. Vigdor, Indiana University *Absolute measurement of the np backscattering cross section using tagged neutrons in the Cooler*
CE-80	Barbara von Przewoski, IUCF *Probing the spin dependence of the three nucleon force by measuring spin correlation coefficients in pd scattering at backward angles*
CE-81	L. Beaulieu, Indiana University *Cluster emission from hot, dilute nuclear matter*

C. EXPERIMENTS RECEIVING BEAM TIME

CE-63	S.Y. Lee, Indiana University *Nonlinear resonances and bunched beam manipulation experiments at the IUCF Cooler ring*

CE-69/83	Alan D. Krisch, University of Michigan *Spin manipulation of polarized protons and deuterons*
CE-78/82	Andrew D. Bacher and Edward J. Stephenson, Indiana University *A search for the charge symmetry breaking reaction* $dd \rightarrow \alpha\pi^0$

D. NSF SITE VISIT

As part of the evaluation of the three-year proposal to the NSF for support of the program in experimental nuclear physics, a site visit team came to IUCF December 18 and 19, 2000 to hear presentations and hold discussions. The team consisted of Sidney Coon (NSF), Nicolas Hadley (University of Maryland), Barry Holstein (University of Massachusetts), Bradley Keister (NSF), Alan Nathan (chair, University of Illinois), and Werner Tornow (Duke University).

Monday, December 18

Steve Vigdor	Proposal overview
Scott Wissink	Pion coupling
Ed Stephenson	Charge symmetry breaking experiment
Les Bland	STAR spin physics
Steve Vigdor	STAR endcap calorimeter project
Will Jacobs	STAR calorimeter management, e-p collider
Rex Tayloe	Neutrino Oscillations
Mike Snow	Slow neutrons and the SNS
Andy Bacher	Education and outreach
John Cameron/Will Jacobs	Budget and schedule

E. IUCF VISITING COMMITTEE

The IUCF Visiting Committee was called by the George Walker, Vice President for Research and Dean of the University Graduate School, to evaluate the relationship between IUCF and the university. It met January 11 through 13, 2001 to hear presentations. The members of the committee were Lawrence Cardman (TJNAF), Paul DeLuca (University of Wisconsin), Jay Flanz (Massachusetts General Hospital), Gerald Garvey (LANL), Arlene Lennox (Fermilab), Jay Loeffler (Massachusetts General Hospital), David McGinnis (Fermilab), and Tony Thomas (chair, University of Adelaide).

Thursday, January 11

Vice-Pres. G. Walker	Charge to the committee
John Cameron	Lab overview
Hans Meyer	PINTEX
Scott Wissink	T-region experiments
Mike Snow	Slow neutrons

Rex Tayloe	Neutrinos
Romualdo deSouza	Nuclear chemistry
Mike Snow/John Cameron	SNS Initiatives and oppertunities
Will Jacobs	STAR physics
Jim Sowinski	STAR endcap construction
Ed Stephenson	STAR polarimetry and calibration
Tim Londergan, et al.	Theory
S.Y. Lee, Gail Hanson, and Peter Schwandt	Accelerator Physics

Friday, January 12

Alan Thornton	MPRI - The medical plan
John Cameron	Construction/operations overview
Dennis Freisel	Hardware construction
John Collins	Schedule and controls
Susan Klein	Clinical requirements and research
Chuck Foster	Radiation effects research program
Andy Bacher	Education initiatives