a large parity violating transmission asymmetry, then a search for time reversal violation will be seriously considered.

The Indiana group is responsible for constructing the xenon target. The target will consist of 1 kg of liquid xenon of natural isotopic abundance immersed in a magnetic field for maintaining the neutron polarization. Target design is finished, and tests of the target will begin in the summer of 1995. The experiment is projected to run at LANCSE in fall 1995.

1. *Time Reversal Invariance and Parity Violation in Neutron Reactions,* ed. C.R. Gould, J.D. Bowman, and Y.P. Popov (World Scientific, New York, 1994).
2. Y. Masuda, T. Adachi, A. Masaike, K. Morimoto, Nucl. Phys. **A504**, 267 (1989).
3. O.P. Sushkov and V.V. Flambaum, JETP Letters **32**, 352 (1980); V.E. Bunakov and V.P. Gudkov, Z. Phys. A **303**, 285 (1971) and Nucl. Phys. **A401**, 93 (1983).
4. T.E. Chupp, *et al.*, Phys. Rev. C **36**, 2244 (1987).
5. R.S. Timsit, *et al.*, Can. J. Phys. **49**, 508 (1971).
6. K. F. Smith, *et al.*, Phys. Lett. **B234**, 191 (1990); I.S. Altarev, *et al.*, Phys. Lett. **B267**, 242 (1992).
7. M. Gatzke, *et al.*, Phys. Rev. Lett. **70**, 690 (1993).

A STUDY OF SINGLE–PARTICLE PARITY–NONCONSERVING NUCLEAR MATRIX ELEMENTS

B. Cain, R.D. Hartman, C. Keith, J.E. Knott, A. Komives, M. Leuschner, W.M. Snow, and J.J. Szymanski
Indiana University Cyclotron Facility, Bloomington, Indiana 47408

J.D. Bowman
Los Alamos National Laboratory, Los Alamos, New Mexico 87545

A. Andalkar, I.C. Girit, and M. Petrov
Princeton University, Princeton, New Jersey 08540

There has been long-term interest in measuring the amplitudes for weak nucleon-nucleon interactions within nuclei. In particular, the dominant weak amplitudes are the isovector and isoscalar weak amplitudes, which correspond in a meson-exchange model to pion and rho exchange, respectively. The isovector amplitude is conventionally termed f_π and the isoscalar amplitude h^0_ρ. Limits on f_π and h^0_ρ are found from decays of light nuclei, p-α scattering and, more recently, from low-energy neutron-nucleus scattering. Fig. 1 is a plot of present limits on f_π and h^0_ρ. A long-term goal of the measurements described here is to restrict the possible values of f_π and h^0_ρ by putting limits on parity non-conserving

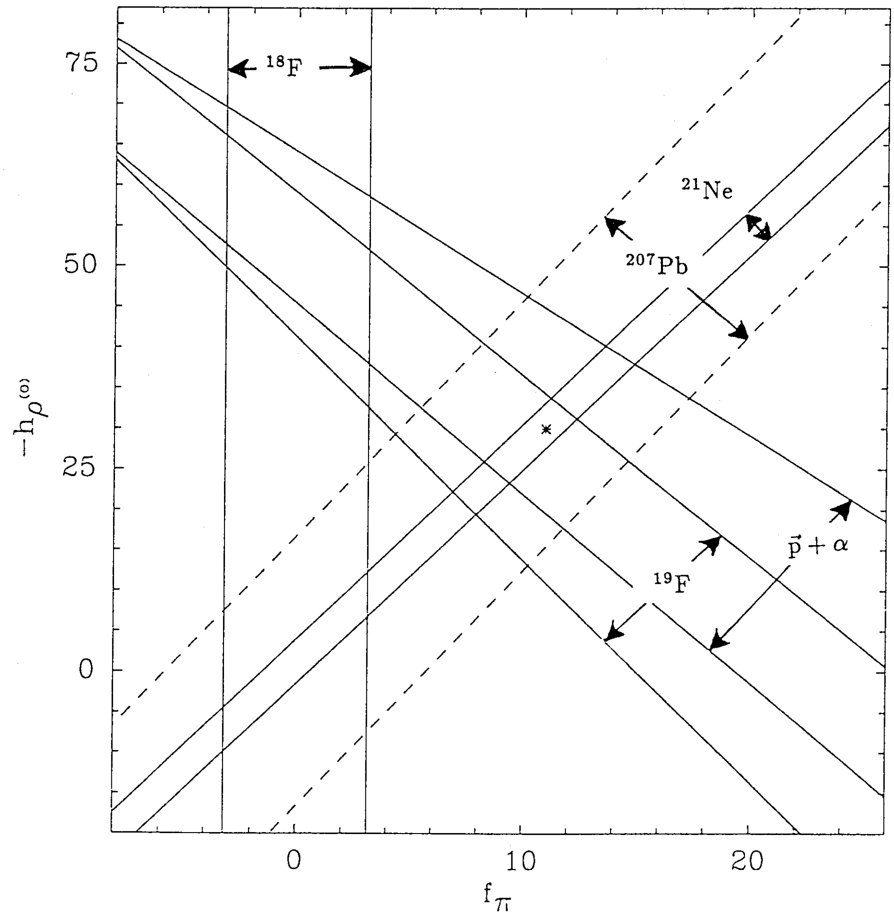

Figure 1. Plotted are the ranges in h_ρ^0 (isoscalar) – f_π (isovector) space allowed by various nuclear parity violation experiments. The ^{207}Pb limit would be obtained in an experiment that measures the weak matrix element to be 0 ± 1 eV.

(PNC) observables in ^{207}Pb decay. The limits obtained from a possible measurement in ^{207}Pb are included in Fig. 1.

Additional motivation for measurements of PNC observables in ^{207}Pb comes from a recent paper by Dmitiev, *et al.*[1] They make the connection between measurements done on atomic PNC and nuclear PNC. This is the first case where nuclear and atomic PNC measurements have been done on the same isotope. The theoretical interpretations of the two PNC phenomena are different and provide a valuable cross check.

An IUCF-LANL-Princeton collaboration has been formed to measure the weak mixing between single-particle states in ^{207}Pb (Refs. 2, 3). ^{207}Pb was selected because the states particpating in the weak mixing are good single-particle states, and the experimental observable is interpreted in terms of weak mixing matrix elements with relative ease. The energy-level scheme and other particulars have been given in a previous annual report and are also reported in Szymanski, *et al.*[4] The experiment was originally motivated by measurements at the Los Alamos Neutron Scattering Center by the TRIPLE collaboration that showed non-statistical behavior in neutron-nucleus parity studies.[5,6] More recent data

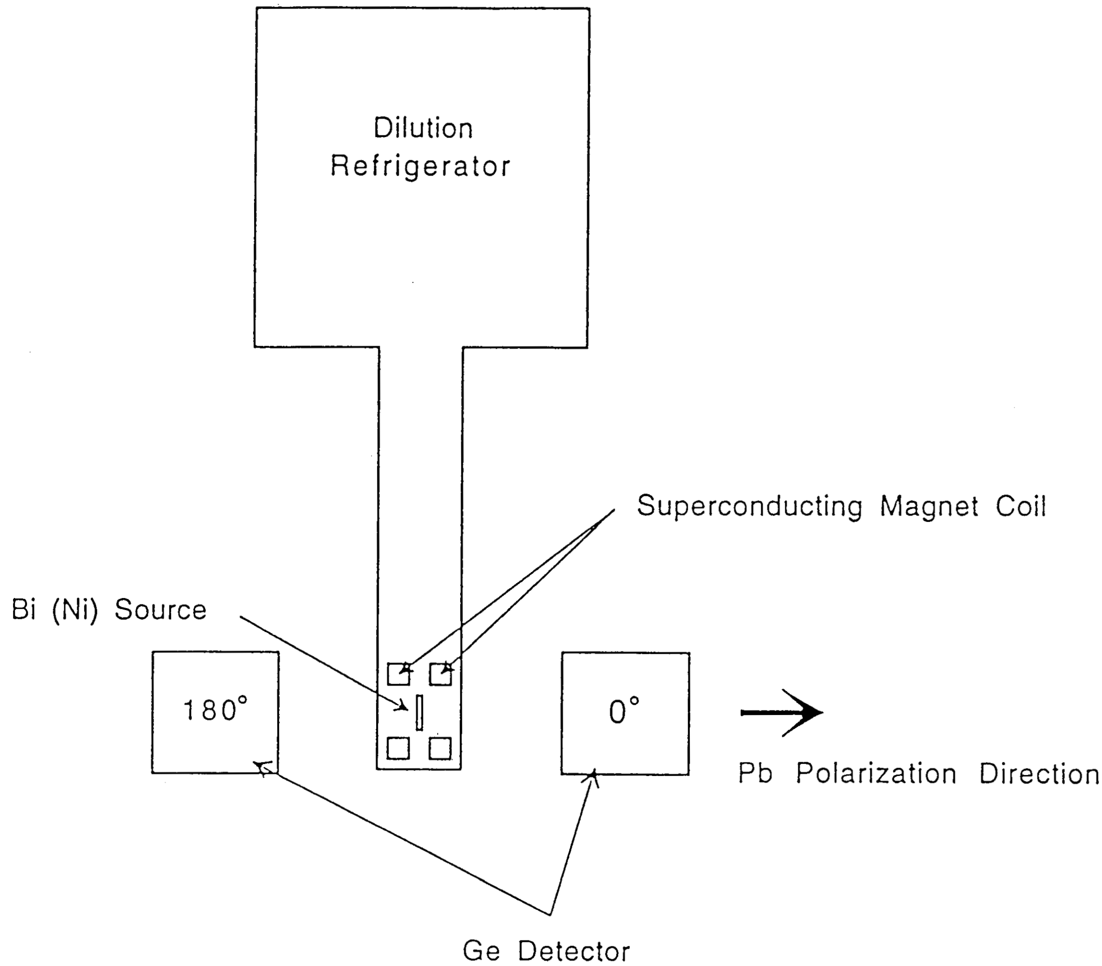

Figure 2. Experimental setup for the forward-backward asymmetry measurement.

from the TRIPLE collaboration no longer imply the non-statistical behavior.[7] The limit we have obtained agrees with the new TRIPLE data.

The weak mixing of single-particle states is measured by detecting either a circular polarization or a forward-backward asymmetry of the 1.063-MeV gamma ray emitted from the decay of ^{207}Bi down through states of ^{207}Pb. The circular polarization of the gamma rays is measured for unpolarized ^{207}Pb and the forward-backward asymmetry requires polarized ^{207}Pb nuclei. Either PNC effect is proportional to the single-particle weak matrix element and is a consequence of transitions between parity-mixed states of ^{207}Pb.

The experimental setup for the circular polarization experiment consists of a ^{207}Bi source, gamma polarimeter, intrinsic CsI gamma detectors and a fast data-acquisition system. The setup details were described in a previous annual report, and will not be repeated here. The setup for the forward-backward asymmetry measurement is considerably different and is shown in Fig. 2. The major components of this setup are a dilution refrigerator, a source consisting of ^{207}Bi diffused into a Ni lattice, and two intrinsic Ge detectors. A holding field is set up inside the dilution refrigerator by a superconducting coil; the direction of this field is flipped by 180° every 10 min during data taking. The ^{207}Bi nuclei are polarized by the large internal field of the Ni lattice and by the low (7-10 mK) temperature of the dilution refrigerator. The measurements described below were done on the Princeton University dilution refrigerator.

The progress made during the last year on each experiment follows.

As indicated in the previous annual report, the supplier of the ^{207}Bi source was only able to provide 0.8 mCi of activity within the volume allowed in our old polarimeter design. An activity of 4 mCi is needed to do the circular polarization experiment. Thus, a redesign of the polarimeter was done. The new polarimeter has been fabricated and will soon be wound and tested.

During 1994 we had two runs on the dilution refrigerator in January and May. The January run was short (approximately 4 days of data) and the source was not highly polarized (13% versus 52% for another source). The May run was longer; however the Ge detectors developed stability problems. Subsequent analysis showed that the statistical weight of the May data is less than that of the January data.

The asymmetries are extracted by dividing the data into individual sets that are two, four or eight runs long. Each run contains 10 minutes of data taken with a single source polarization. The asymmetry is calculated for each run set, and the distribution of asymmetries is plotted. Such an asymmetry distribution is plotted in Fig. 3 for the 1063-keV line. The centroid and error on the centroid are measured by fitting the asymmetry distribution to a gaussian function.

Results for the January run are summarized in Fig. 4, where three groups of asymmetries are shown, corresponding to three energy regions (near the 570, 1063 and 1770-keV lines). Within each of the three groups, asymmetries are, from left to right as plotted in the figure:

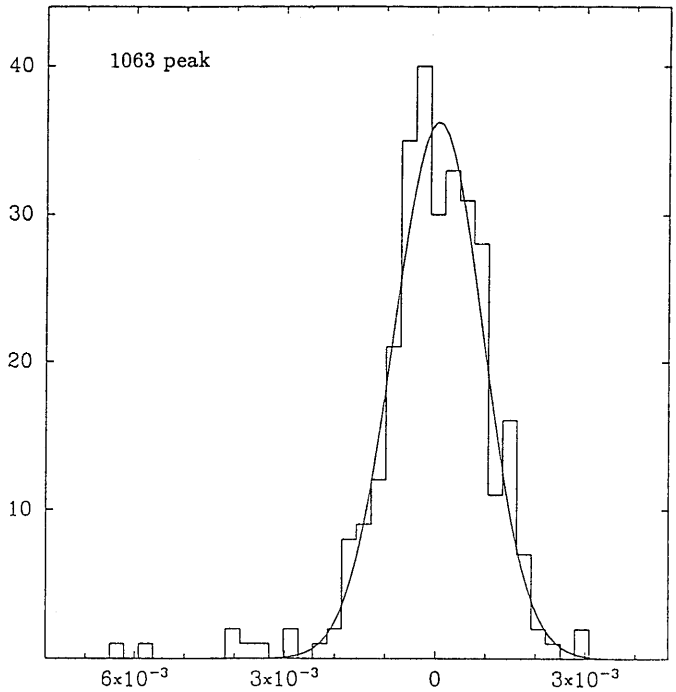

Figure 3. A distribution of asymmetries for the 1063-keV line. The data are divided into two-run sets and the asymmetry is measured for each two-run set.

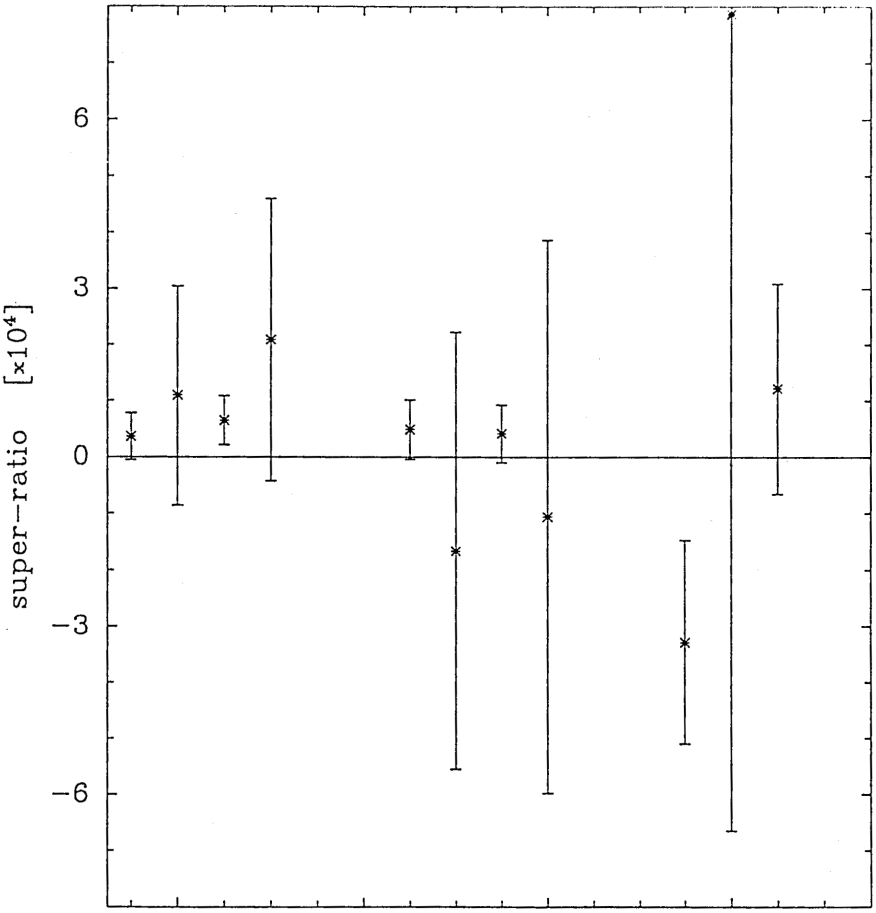

Figure 4. Three groups of asymmetries are plotted, one group for each of the 570, 1064 and 1770-keV peaks. The first asymmetry in each group is derived from a gaussian fit to the energy spectrum, the second is derived from the number of counts within a gate to the left of each peak, the third is from a gate spanning each peak, and the fourth is from a gate to the right of each peak.

1. The asymmetry as measured by determing the number of counts in each peak with a gaussian fit.
2. The background asymmetry, determined within a gate to the left of the peak.
3. The peak asymmetry, determined within a gate set around the peak.
4. The background asymmetry, determined within a gate to the right of the peak.

All the asymmetries shown in Fig. 4 are zero within statistics. Thus, no PNC effects are observed either for the 1.063-MeV gamma ray line or for the other prominent lines at 560 keV and 1770 keV. The 560 and 1770-keV lines are expected to have a much smaller PNC asymmetry than the 1063-keV line and are used as measures of false asymmetries produced by systematic errors. These lines show no asymmetry, indicating systematic errors are smaller than the statistical errors. The present sensitivity of the data is $\sim$ 23 eV.

Several improvement can be made to the forward-backward asymmetry measurement. There are no more runs scheduled at present on the Princeton dilution refrigerator. We are investigating using another facility to improve further the sensitivity of this measurement. The polarization in the January, 1994 run was only 13%, and work is continuing to improve the polarization. In particular, new sources have been fabricated and measurements using an X-ray fluoresence spectrometer and an electron microscope have been made to determine the crystal properties of the sources. A 52% polarized source with 8 μCi activity (we have had a source with 52% polarization and 2 μCi activity) will give sensitivities in the range of 1-2 eV in 1 month of running.

1. V.F. Dmitriev, I.B. Khriplovish and V.B. Telitsin, a comment to the paper in reference 4; to appear in the August, 1995 issue of Phys. Rev. C.
2. J.J. Szymanski, B. Cain, J.E. Knott, A. Komives, M. Leuschner, J.D. Bowman, and D. Jamriska, in Proc. of the *Int. Conf. on Particles and Nuclei,* Perugia, Italy, June 1993.
3. M. Leuschner, J.J. Szymanski, B. Cain, J.E. Knott, A. Komives, J.D. Bowman, I.C. Girit, M. Petrov, and A. Andalkar, in Proc. of the *5th Conf. on the Intersections of Particle and Nuclear Physics,* St. Petersburg, Florida, June 1994 and in the Proc. of *SPIN '94,* Bloomington, Indiana, September, 1994.
4. J.J. Szymanski, J.D. Bowman, M. Leuschner, B.A. Brown, and I.C. Girit, Phys. Rev. C **49**, 3297 (1994).
5. J.D. Bowman, *et al.*, Phys. Rev. Lett. **65**, 1192 (1990); X. Zhu, *et al.*, Phys. Rev. C **46**, 768 (1992).
6. C.M. Frankle, *et al.*, Phys. Rev. Lett. **67**, 564 (1991); C.M. Frankle, *et al.*, Phys. Rev. C **46**, 778 (1992).
7. Y.F. Yen, *et al.*, in the Proc. of the *Eighth International Symposium on Polarization Phenomena in Nuclear Physics*, Bloomington, Indiana, September, 1994; J. D. Bowman, *et al.*, in Proc. of the *5th Conf. on the Intersections of Particle and Nuclear Physics,* St. Petersburg, Florida, June 1994; and G.E. Mitchell, NSAC/DNP Town Meeting, Berkeley, CA, February 5, 1995. All talks listed in this reference were given on behalf of the TRIPLE collaboration.