

MEASUREMENT OF THE CROSS SECTIONS AND ANALYZING POWERS
FOR QUASIFREE $n(\bar{p}, \gamma)d$ IN DEUTERIUM AT 183 MeV

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The purpose of Experiment E349 is to investigate that portion of the phase space for the process $p + d \rightarrow p + d + \gamma$ that is associated with the quasifree radiative capture of the incident proton by the target neutron within the deuteron. This region of phase space is characterized by a very low kinetic energy for the residual proton from the target deuteron. One expects many of the observables to be similar to those found in the case of free capture, $p + n \rightarrow d + \gamma$. We plan to measure cross sections and analyzing powers for $d(\bar{p}, d\gamma)p$, and compare them directly to precise results obtained at the same energy for the free process $p + n \rightarrow d + \gamma$.^{1,2,3}

This was done, with much less precision, almost 25 years ago.^{4,5} The cross sections obtained in that study are in good agreement with those obtained recently for the free process,^{1,2} and the analyzing powers obtained are also in good agreement with those for the free process.^{2,3} Our experiment is designed to make a far more rigorous comparison between the free and quasifree processes.

The reaction $pd \rightarrow pd\gamma$ is one involving a three body-final state, which is kinematically described by nine parameters. However, conservation of energy and momentum provide four constraints. We therefore need to determine only five independent parameters to fully describe the three-body final state. In this experiment we choose to measure the angles of the gamma ray (θ_γ and ϕ_γ) and the deuteron (θ_d and ϕ_d), and the kinetic energy of the deuteron (T_d). We will measure these parameters with sufficient precision to allow a determination of the kinetic energy of the residual proton to better than 200 keV, for residual protons whose laboratory kinetic energy is less than 10 MeV.

The activities of the past year have focussed on designing, constructing, and obtaining the large amount of new equipment needed to perform this experiment. We will measure the deuteron angles using a large MWPC (Multi-Wire Proportional Chamber), and the gamma angles by using a converter plate followed by a MWPC. These chambers will be read out using the PCOS III system manufactured by LeCroy. We have presently obtained a CAMAC crate, a PCOS III crate controller (LRS 2738), a CAMAC interface (LRS 4299), and enough latch modules (LRS 2731A) and discriminator cards (LRS 2735PC) to instrument 320 wires. By January, 1993, we will have enough electronics to instrument the full experiment, consisting of 512 wires. We have also obtained two dual high voltage supplies for our chambers (Bertan 375N). All this equipment has been provided by the University of Kentucky group, and will be initially dedicated to this experiment.

Other equipment necessary for the operation of our chambers that has been constructed include a gas handling system, power supplies for the discriminator cards, and power and signal cables for the discriminator cards.

The design and machining of the pieces needed for the large chamber used to determine the recoil deuteron angles was also a task pursued by the University of Kentucky group. This chamber has both X- and Y-planes, each with 160 wires. The wire spacing is 3.97 mm, which provides an active region of $63.5 \times 63.5 \text{ cm}^2$. Because it is necessary to position the chamber as close to the beam as possible to detect the small-angle recoiling deuterons, a deep slot has been cut into one side of the chamber. This will permit the sense wires to be as close as 4.7 cm to the beam, and still allow a clearance of 2 cm between the beam and the frame. Final assembly of the pieces of the chamber, including the wire wrapping, will be made by the Wire Chamber Group at IUCF during the summer of 1992. The machining and assembly of the small chamber needed for the photon detector will take place during the summer and fall of 1992.

The equipment and materials needed for the construction of the plastic scintillator array used to detect the recoil deuteron have also been obtained. This includes twenty fast two-inch phototubes, each with a transistorized base capable of operating at high rates. The array consists of a ΔE plane, an E plane, and a Veto plane. The ΔE plane has eight elements, each 5 mm thick \times 5 cm wide \times 64 cm high. The E plane also has eight elements, each 7.6 cm thick \times 5 cm wide \times 80 cm high. The Veto plane has 3 elements, each 5 mm thick. By placing the tube for each ΔE element opposite the tube for its associated E element, we will be able to determine the vertical coordinate of a hit to within 5 cm. This, and the 5 cm horizontal segmentation of the scintillator array, will provide us with some capability for working with multi-hit events. The machining and assembly of these elements will take place during the summer and fall of 1992.

We plan to begin in-beam tests in the fall of 1992. Pending successful completion of these tests, we plan on making production runs in the spring and summer of 1993.

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