deep germanium detectors was used to stop up to 115 MeV protons. This was the first attempt to use one of the new phosphorous-backed, transmission-mounted germanium detectors as a ΔE detector in our laboratory. A typical spectrum for the scattering of 115 MeV protons from ^{28}Si at a 34° lab angle is in Figure 11. Preamplifier gains were reduced to eliminate the saturation problem previously mentioned. The observed spectral resolution of 180 keV was very near the minimum expected experimental resolution of 150 keV.

The versatility as well as the difficulties of using these detectors have been demonstrated during the past year. Work is continuing to improve and simplify their use in this laboratory. The problem of reliability will be partially solved by having a larger number of these detectors on hand, so that the failure of any one detector will not prevent an

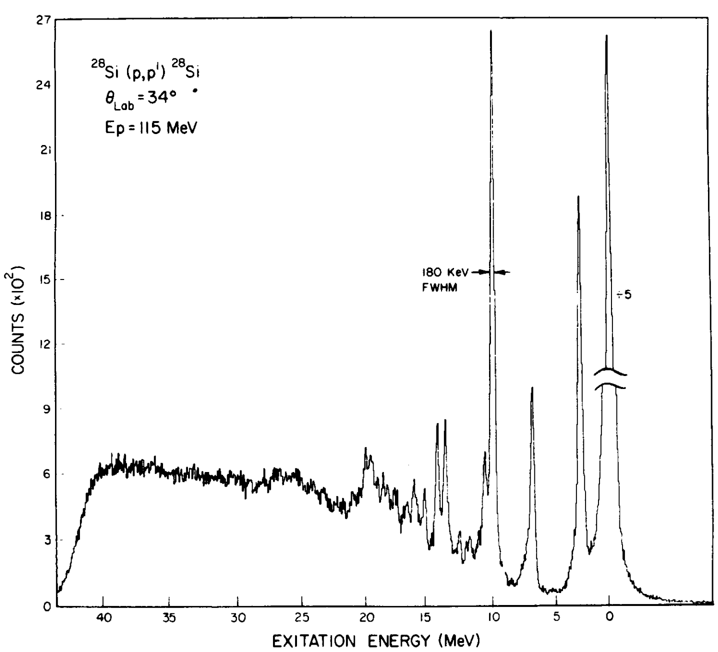


Figure 11. Excitation spectrum for inelastic proton scattering from ^{28}Si at 115 MeV measured with the intrinsic-Ge detector system (180 keV FWHM resolution).

experiment from continuing. Our present stock consists of two 15 mm and two 10 mm thick detectors. We expect during 1979 to increase that number to four 15 mm, four 10 mm, two 5 mm and two 1 mm thick detectors. These detectors will be available to any user of the facility, although prior notification of their intended use is recommended.

1) G. M. Crawley et al., this report, p.71

2) P.P. Singh et al., this report, p.39

Future Facilities

Beam Swinger Facility

Work on the beam swinger facility[1] for neutron time-of-flight measurements has progressed to the stage in which all three magnets are in position at the northwest end of the high-bay area (Fig. 12) and mechanical installation of beam line components is being completed. Remaining to be done to complete installation with one hut on the 0° to 26° line at 30 to 70 meters is completion of the beam dump, fabrication and installation of the Faraday cup, installation of beam line controls, extension of the radiation interlock system, and installation of power and signal cables to the hut stations. This work is expected to be finished in mid-February 1979, with beam tests and first data runs on the facility to be carried out in late February. In preparation for use of the swinger system, the floating wire technique was used to determine proper operating conditions for the entrance (magnet 1) and swinger (magnet 2) magnets. These conditions can be parametrized in terms of the radii of curvature, ρ_1 and ρ_2, of the two magnets as function of the scattering angle θ. Thus, to set the system for a given angle for particles of a given $B\rho$

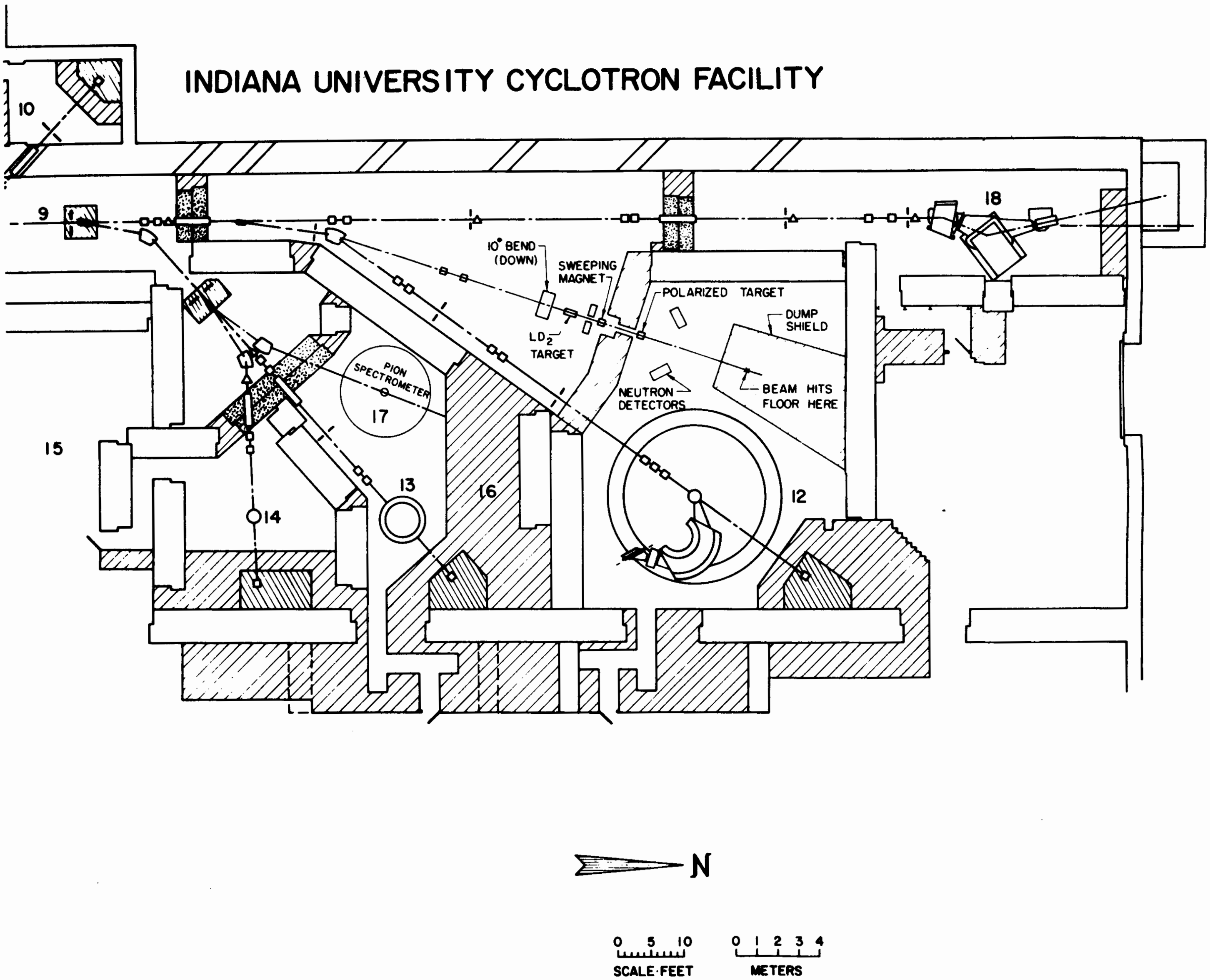


Figure 12. Layout of the experimental area at IUCF showing location of new facilities: beam-swinger system for n TOF (18), pion spectrograph (17) and proposed polarized neutron production and scattering facility to the west of the QDDM spectrograph (12).

(momentum), one determines ρ_1 and ρ_2 from the curves shown in Figure 13, B_1 and B_2 from $B\rho$ and I_1 and I_2 from B-I curves for each magnet which have also been measured.

Expansion of the facility to include detector stations on the 24° - 50°, 48° - 74° flight paths is planned for 1979 after experience has been obtained on the 0° to 26° flight path.

1) IUCF Techn. and Scient. Report 1976, p. 26; ibid. 1977, p. 24.

QQSP Pion Spectrograph

The large solid angle, large momentum bite spectrograph for pion studies described in detail in last year's report[1] is currently being fabricated by Alpha Scientific, Inc. of Hayward, CA. A contract for the design and construction of a rotating support system for the spectrograph and its associated detectors has also been awarded to Alpha Scientific.

A target chamber for the spectrograph has been designed and a contract for its construction has

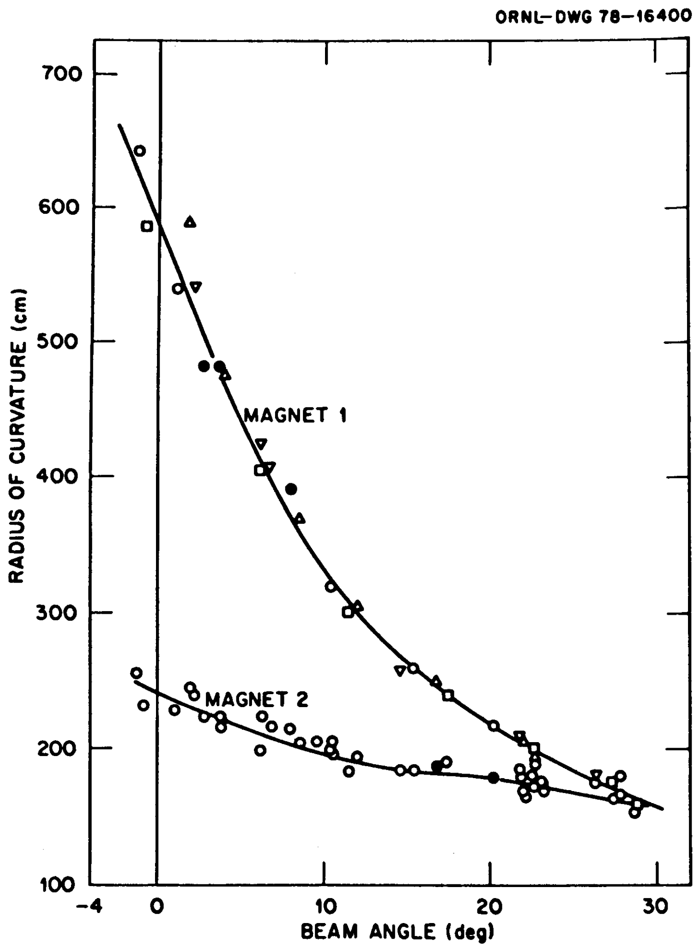


Figure 13. Radius of curvature of proton trajectories in the beam-swinger magnets as function of angle of incidence on target (measured with the floating wire technique).

been awarded to Precision Metalcraft, Inc. of Manhattan, Kansas. The chamber is basically a scaled-down version of the one presently in use with the QDDM spectrograph. It uses a sliding seal and can be rotated to cover three different angular ranges of measurements. The present schedule calls for the completion of all construction by mid-June, 1979, with installation of the system starting as soon as the equipment has been delivered. Installation of the mechanical systems is expected to be completed by summer when initial operational test, final field mapping, α-particle ray tracing, etc. will commence.

In parallel with the QQSP tests, checkout of the focal plane wire chambers designed for this system will proceed on the QDDM spectrograph.

1) IUCF Techn. and Scient. Report, 1977, p. 23.

Polarized Neutron Beam Line

One of the experimental facilities to be implemented at IUCF after the QQSP installation is a high-intensity polarized neutron beam for neutron energies between 100 MeV and 200 MeV. In this beam line the primary proton beam, polarized in the vertical direction, is deflected down by 10°, passes through a 20 cm long liquid deuterium target (where the neutrons are produced) and is refocussed by a large-aperture quadrupole doublet into a beam dump below floor level located about 12 m downstream of the target. The neutron beam is extracted horizontally from the production target, cleaned of charged particles by a "sweeping" magnet and passed through a neutron collimator. The design characteristics of this channel are primarily given by the requirements of exp. #80 ("Search for Charge-Symmetry Violation in n-p Scattering," this report, p. 15), but an attempt is being made to keep the design versatile for future nucleon-nucleon experiments. The schematic layout of this facility is illustrated in Fig. 3 on p. 17 of this report; its location in the experimental area of the lab is shown in Fig. 12. In Fig. 15 the relative spin orientations and magnitudes of polarization components are shown. Here BM is the bending magnet producing the 10° downward bend of the protons, LD_2 is the liquid deuterium target, and SM represents the sweeping magnet. The $\vec{p}+d\rightarrow\vec{n}+p+p$ charge-exchange reaction at 10° was chosen for $\vec{n}$ production

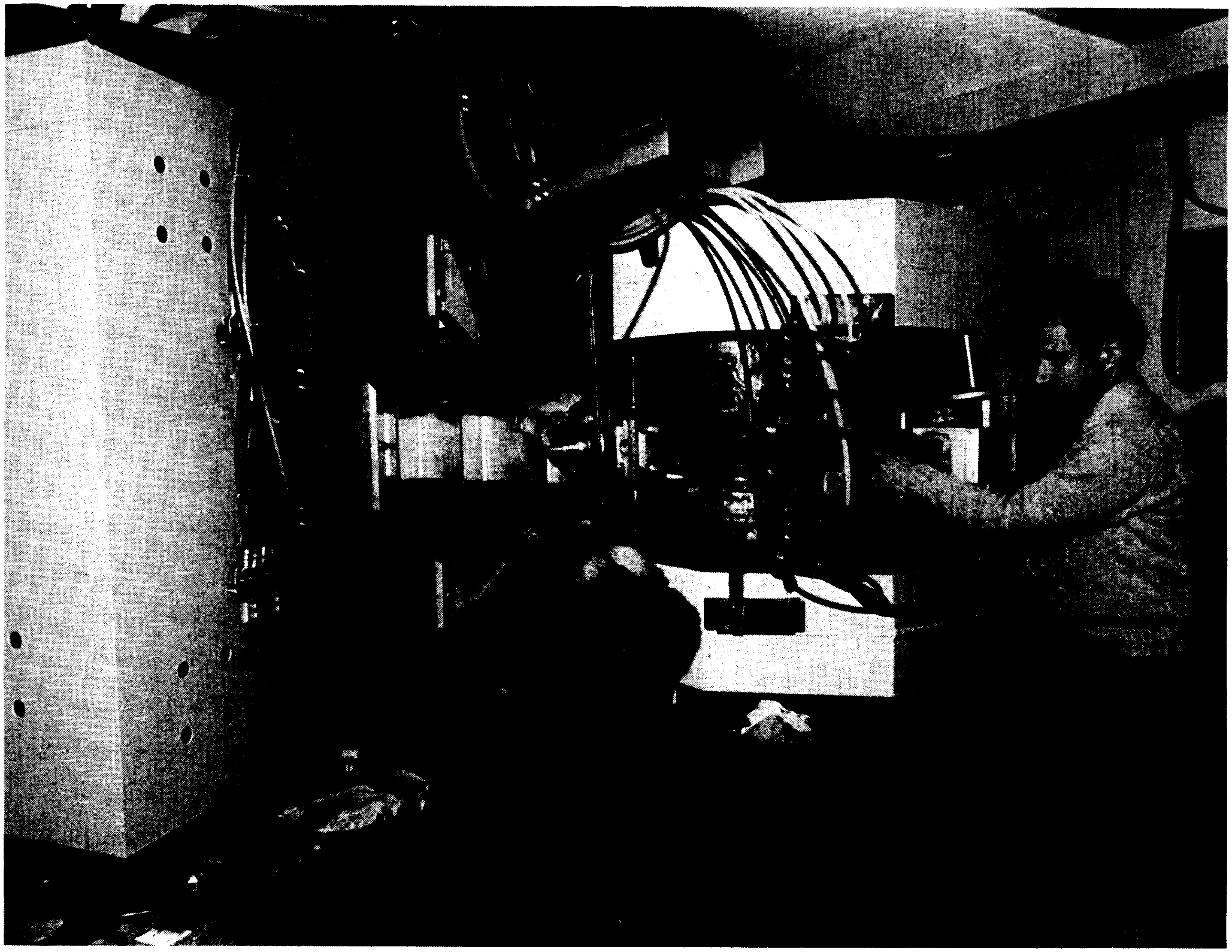
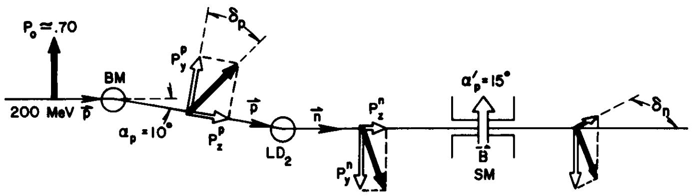


Figure 14. Beam-swinger magnet assembly. Second swinger magnet on right, neutron production target in between, and C. Goodman (ORNL) pointing out neutron exit slot.

because of the large value of the polarization transfer coefficient $R_t \sim -0.85$ between 100 and 200 MeV (Ref. 1.) and the relatively high concentration of produced neutrons in a narrow peak of the spectrum. The expected flux of high energy neutrons 4 meters from the production target is 5×10^4 n/cm^2-sec for an incident polarized proton intensity of 50 nA; the expected neutron polarization P_n is about $P_n \sim 0.55$.

Currently, all optical elements in the proton beam are being designed, including the charged particle sweeping magnet. The closed-circuit helium refrigerator for the cryotarget has been ordered. The design of the associated hardware such as the neutron collimator, the proton beam dump and the 0.2 liter target cell to hold the liquid deuterium will be carried out early in 1979. Assembly of the beam line can start in the autumn of 1979 and the first tests of the neutron beam can be expected early in 1980.

1) C. Amsler et al., Nucl. Instr. Meth. 157, 203 (1978).



$\delta_p = 1.793\,\gamma\alpha_p = 22°$ $\qquad$ $\delta_n = -1.913\,\gamma\alpha'_p = -35°$

$$\begin{cases} P_y^p = P_0 \cos\delta_p = .927\,P_0 \\ P_z^p = P_0 \sin\delta_p = .375\,P_0 \end{cases}$$

$$\begin{cases} P_y^n = P_y^p R_t + P_z^p A_t = -.80\,P_0 \simeq -.55 \text{ for } R_t \simeq -.85,\ A_t \simeq .1 \\ P_z^n = P_y^p R'_t + P_z^p A'_t = +.08\,P_0 \simeq .055 \text{ for } R'_t \simeq .05,\ A'_t \simeq -.1 \end{cases}$$

$$P_z^n \text{ rotated by } \delta_n \Longrightarrow \begin{array}{l} P_x^n = -.04_5\,P_0 \simeq .03 \\ P_z^n = .07\,P_0 \simeq .05 \end{array}$$

Figure 15. Polarization vectors (dark arrows) and longitudinal or transverse components (light arrows) for polarized neutron production set-up, showing spin orientations of $\vec{p}$ beam before production target (LD_2) and of $\vec{n}$ beam after target and sweeping magnet (SM).

High-Energy Proton Polarimeter

In experiments using a polarized proton beam, it is preferable to monitor the beam polarization continuously during the experiment by means of a polarimeter downstream from the target. Such a device should be sensitive to the polarization of protons between 100 MeV and 200 MeV. Additional requirements include a large efficiency and easy use of the instrument. Exploratory measurements have led to the design of such a high-energy polarimeter for protons.

Downstream from the target the proton beam traverses a gaseous ^{4}He target. The analyzing power of p+α scattering peaks at A ∿ 0.8 for T_p=150 MeV and θ=75° (Ref. 1.), where θ is the lab angle of the recoiling α-particles. The latter are collected with a pair of large solid angle detectors, situated symmetrically to the left and the right of the beam. Only events from a narrow range of scattering angles are accepted by using a system of plane-parallel vanes between the luminous volume of gas and the detector. The beam polarization is obtained as usual from the left and the right count rate. The instrument is presently under construction.

1) A.M. Cormack, J.N. Palmieri, N.F. Ramsey, and R. Wilson, Phys. Rev. 115, 599 (1959).