Development of Future Facilities

Pion Spectrometer

The QDDM spectrograph is limited in its usefulness for pion experiments by its small momentum bite (3%), small solid angle (3 msr), and long flight path (6.1 m). H. Enge of Deuteron Inc. was comissioned to design a spectrograph of modest energy resolution which would overcome these limitations for pion experiments. The design is now complete and a bid specification package is now being prepared. Figure 13 shows a schematic representation of the pion spectrograph which consists of two quadrupole magnets, and a split dipole magnet.

The spectrograph will require measurement of both position and angle of entrance. This can be carried out using two of the laboratory's existing helical cathode proportional counters. The basic properties of the spectrograph are given in Table 5. Of major significance to the pion experiments will be the factor of 10 increase in solid angle compared to the QDDM, factor of 20 increase in momentum range, and factor of 3 decrease in path length.

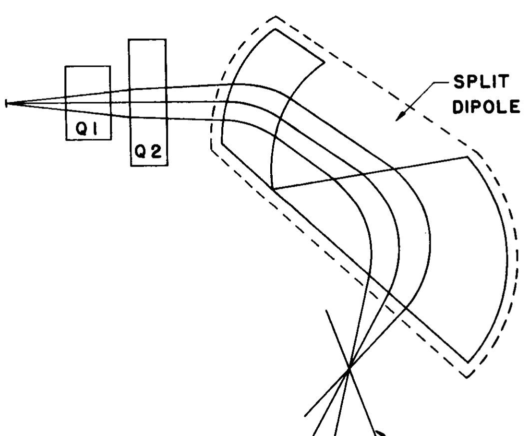


Figure 13. Schematic representation of the pion spectrometer.

Table 5. Pertinent parameters of the pion spectrometer

1.	Orbit radius	46.8 cm max 28.8 cm min
2.	Angular range	25° to 135° continuously 0° to 10° fixed setting
3.	Angular acceptance	± 100 mrd horizontal ± 100 mrd vertical
4.	Solid angle	35 msr low momentum to 16 msr high momentum
5.	Magnet gap	5.76 cm
6.	Magnetic field strength	1.0 to 16.0 kG
7.	Momentum range (pmax/pmin)	1.625
8.	Maximum pion energy (at 16 kG)	125 MeV
9.	Focal plane angle	40°
10.	Dispersion along focal surface (cm/% mom)	1.1
11.	Resolution ($\Delta E/E$) @ full solid angle	.2%
12.	Horizontal magnification	0.3
13.	Horizontal angular magnification	3.2
14.	Vertical angular magnification	0.3 to 0.4
15.	Vertical image at full solid angle	4.0 cm max

Beam Swinger for Neutron Time-of-Flight Experiments

A beam swinger facility for neutron time-of-flight experiments is under construction†. The scheme utilizes three magnets as shown in Figure 14. The first magnet bends the beam away from its original path and into a second magnet which focuses the beam onto the target. The angle of incidence on the target depends on how far the beam was deflected by the first magnet, so the combined effect of the two magnets is to provide a variable angle of incidence. The third magnet sweeps the charged beam particles away from the flight path and into a beam dump.

The magnets provide a 26° swing for 200 MeV protons. Semipermanent flight stations will be set up to allow coverage of forward angles from 0 - 60° with long flight paths. The swinger itself allows coverage of angles all the way back to 180° except for a 15° region around 135° which is shadowed by the magnet yoke. Figure 15 shows the planned layout.

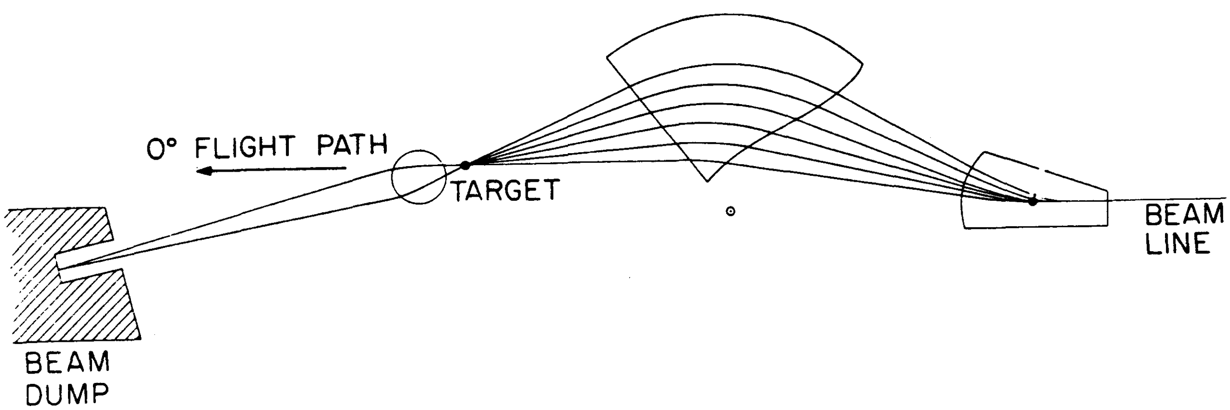
The use of fixed flight paths with a swinging beam gets around some difficult problems peculiar to neutron experiments. It allows one to retain a fixed geometry of collimators and shields as one changes the angle of observation, so the background and inscattering do not change with angle. Also the threshold, and hence the efficiency, of a neutron detector usually changes if the detector is moved, so a fixed detector avoids many problems of calibrating and stabilizing parameters that affect efficiency.

The first two magnets, originally built for similar use in Oak Ridge, have been moved to IUCF. The beam dump magnet is being built from an old magnet yoke available at IUCF. The target chamber is designed and construction will commence soon.

We expect the time resolution of the overall system to be about 500 ps. The corresponding energy resolution as a function of neutron energy is shown in Figure 16. This facility will provide unique capabilities for the study of (p,n) reactions substantially better in resolution and ease of operation than any other time-of-flight facility in this energy range.

The research uses include studies of giant spin-flip (related to M1) resonances, searches for high angular momentum particle-hole states, and

Figure 14. The three magnet beam swinger system. The six representative beam paths show how the angle of incidence of beam on the target is varied. The beam dump magnet can be energized in either polarity to bend the beam to the right or left as required for the angle of incidence being used.



measurements to determine the isovector terms in the optical model potential.

† Collaborators in this effort are C.D. Goodman, Oak Ridge National Laboratory; M.B. Greenfield, and C.A. Goulding, Florida A & M University; J. Rapaport and D. Bainum, Ohio University, and C.C. Foster, IUCF.

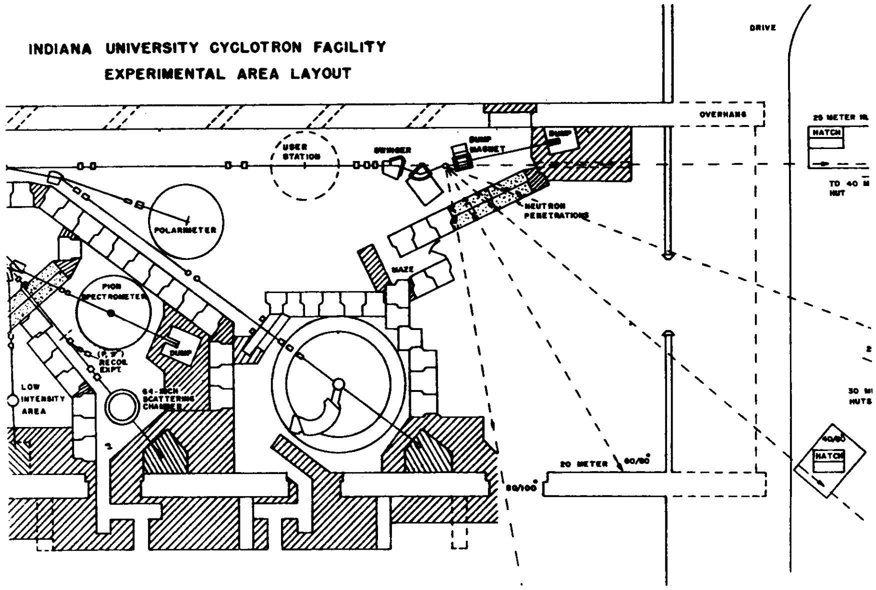


Figure 15. Floor plan for the beam swinger system. The long flight path stations will be outside the existing building.

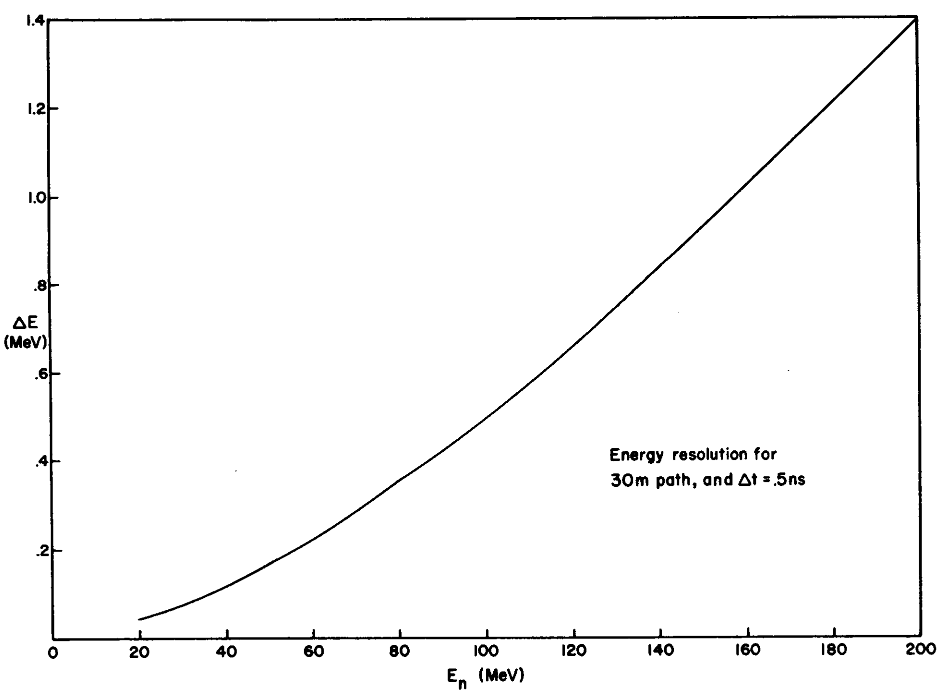


Figure 16. Energy resolution as a function of neutron energy for time resolution of 500 ps and a 30 m flight path.