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# DIGITAL DATA ACQUISITION SYSTEM FOR TIME OF FLIGHT NEUTRON BEAM MEASUREMENTS

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## INTRODUCTION

A system for neutron scattering measurements is under development at the RPI LINAC [1]. The system is design to provide additional differential scattering data to improve upon the currently available cross section data. The system is designed to work in the energy range of 0.2-20 MeV using an array of 5”x3” liquid scintillation (EJ-301) neutron detectors. Use of an all digital data acquisition system in obtaining and storing neutron time-of-flight data allows pulse shape analysis [2] to discriminate neutrons from gamma rays with a dead time that is limited to the response time of the detector (~100 nsec).

## DESCRIPTION OF THE ACTUAL WORK

In addition to the detectors, the experimental system includes a computer controlled high voltage power supply, four digital data acquisition boards (AP-240), and a Windows XP workstation. The detector array is placed 31 meters away where time-of-flight measurements can be used effectively. A 5 ns neutron pulse for these measurements is produced by a photoneutron target [1].

To check the capabilities of the system, initial testing was done using a single detector placed in the neutron beam. Additional tests using a pulser verified a maximum data collection rate of 16,000 pulses/sec for each of the eight detectors.

In this experimental system, the software takes the place of traditionally analog components such as amplifiers, filters, integrators, discriminator, etc. In a digital data acquisition system, this functionality is replaced by algorithms within data analysis programs. Most of the development effort was dedicated to writing a suite of programs for data acquisition and analysis. All programs are Windows based coded in C++ with an intuitive user interface. The data acquisition software uses

National Instruments Measurement Studio [3], and the data analysis software uses ROOT [4] for analysis and plotting functionality.

Use of intelligent data transfer techniques between the digitizing hardware and the computer minimizes the transfer and storage requirements by passing only the data around a detector pulse. The system was designed to be capable of digitizing 120 points at a 1.0 nsec interval around a pulse at an overall rate (from the entire array) of 128,000 pulses/sec, but is capable of almost twice that rate if the data acquisition program is the only task running.

## RESULTS

Figure 1 shows a typical result from a neutron beam time of flight measurement; where both gammas and neutrons are present during the experiment but figure 2 shows how clearly using pulse analysis one can distinguish between the two.

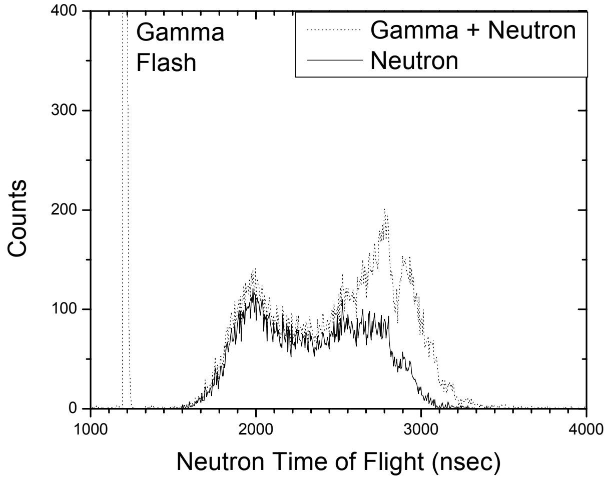


Fig. 1 - Neutron time of flight plot showing gamma ray discrimination by pulse shape analysis.

This distinction between gammas and neutrons is achieved by measuring the fall time of a pulse. Figure 2 shows a scatter plot of this fall time vs. the pulse amplitude where neutrons typically have a longer fall time. A neutron time of flight spectrum is produced by using a polygon shaped discrimination technique which eliminates the gamma contamination. (also seen in figure 1, black)

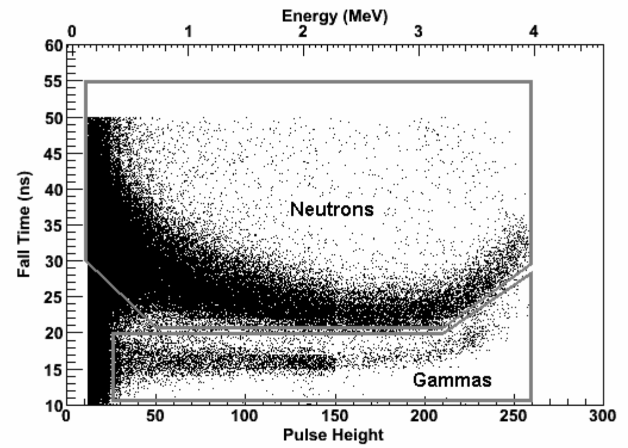


Fig. 2 - Fall Time versus pulse height shows the separation between gamma rays and neutrons with the energy scale (top axis) shown for gammas. A 2.2 MeV gamma from hydrogen capture can be clearly seen by the change in the point density of the gamma events region.

Since the entire experiment is digitized at the output of the detectors, the results of the experiment can be later scrutinized in a number of different ways. Furthermore, computer algorithms offer more freedom and flexibility than analog circuits which offers the experimenter the opportunity to produce superior results than could otherwise be achieved.

**REFERENCES**

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