PRIN - A Facility for neutron production using Accelerator

E. Vardaci, L. Campajola, P.K. Rath, G. Larana, Md Assaduzzaman,
B. De. Canditiis and F. Di Capua
Department of Physics, University of Naples "Federico II" and INFN, I-80125 Napoli, Italy
· * *email:* rath@na.infn.it

Introduction

The study of neutrons are demanding subject. The demand for reliable nuclear data [1], in particular for neutron cross section from 5 to 14 MeV, is still open and has now been enhanced by the need of precise fast neutron data for fusion reactor development. More over there is a need for calibrated neutron (n) detectors to be used for reliable cross section measurements. In addition the use of neutron for imaging is an emerging field which needs more efficient neutron detectors. Accelerators play an important role for the production of mono-energetic neutrons. In most cases the D(d, n)^{3}He reaction has been used for the source of mono-energetic neutrons. Keeping all the things on mind we developed a beam line for n production using two body D(d, n)^{3}He reaction. In the present report we have presented the test result using the CAEN Digitizer for data acquisition and use of newly developed algorithms for n-γ discrimination. This is a continuation of our previous report [2]. The detail of the algorithms will be presented.

Experimental Hall & test result

A dedicated beam line has been developed for the production of the mono-energetic neutrons using the 3.3MV Tandem Accelerator (TTT-3) at Department of Physics, University of Naples Federico II. The tank holds the high voltage terminal and the Stripper foil has been shown in Fig.1. The neutron production has been done by using the two body reaction D(d,n)^{3}He. A detail of the beam line development has been reported in[2]. The produced neutrons have been detected by an Organic scintillator (BC-501A) and the associated particle (^{3}He) has been detected by the SSB detector. We have used the tagging of neutron by associated particle detection method (APT) [3].

Fig.1 Tandem accelerator (TTT-3) at University of Naples Federico II. It I horizontally installed having maximum terminal voltage is 3.3MV.

The neutron has been detected by using the Scintillator as mentioned. VME based data acquisition system has been used to record the data. As the detector is sensitive to both neutron and γ, the traditional Pulse shape discrimination method (PSD) has been used to separate the neutron and the γ events. We have used the CAEN-V1720 Digitizer a 12 bit 250 MS/s sampler. The use of Digitizer reduces not only the use of more electronic module but also give a digitized output of the waveform, which can be transformed immediately using suitable algorithms and any information can be extracted easily. There are more advantages of the use of Digitizer compare to the traditional analog electronic chain. The data acquisition and the used V1720 Digitizer have been shown in Fig.2. The transformation of the Digitizer signal has been done by our newly developed algorithms.
Each output pulse of the scintillator is composed of a leading and a trailing edge. The leading edge could not be exploited for discrimination purposes. On the other hand, the trailing edge of the neutron signal takes longer to decay than that of the γ signal. The trailing edge has been used in

the algorithm for the n-γ discrimination. The slow, fast component and their ratio have been used for the extraction of the n & γ events. Once the data has been recorded all the other processing has done by newly developed algorithms.

Fig.2 [a] The data acquisition system and the connected Fiber optics with the High voltage Power supply.[b] The used eight channel CAEN V1720 Digitizer.

The neutron detector has been tested by using the γ source (^{152}Eu). The algorithm performs the the PSD of the Digitizer data also able to analyze the Time of Flight (TOF) data at the same time for better separation between the neutron and the γ ray detected by the detector. As the n are tagged by the ^{3}He the TOF measurement is easier. A test result using newly developed PSD algorithm and TOF algorithm has been shown in Fig.3. From the Fig.3a one can see that by PSD method a clear separation has been shown between the neutron and the γ events. Similarly Fig.3b shows the analyzed TOF spectra. All the analysis has been done by using the ROOT data analysis software.

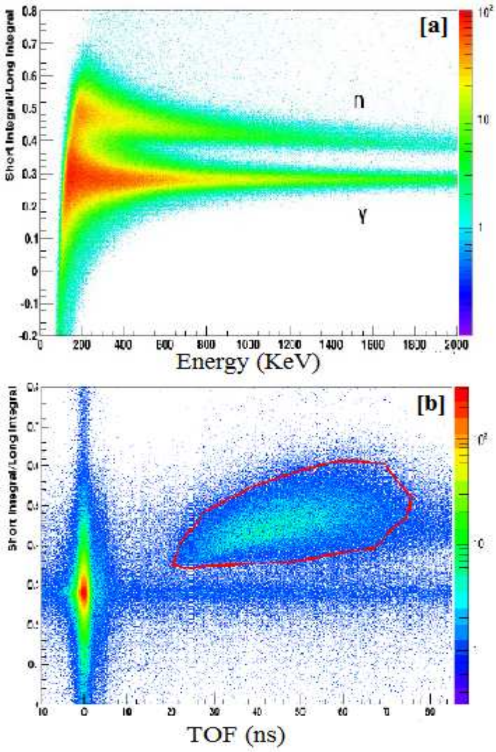

Fig.3 [a] Use of the PSD algorithm to distinguish between the n and the γ. [b] TOF analysis by the same algorithm. The events under the red marks are the n events which are very well separated from the γ events.

Summary and Future Plan

We have installed a separate dedicated line (PRIN) for the generation of mono-energetic neutron and also developed a dedicated data acquisition system including special algorithms for the n-γ separation. As the n are tagged very precisely it will be use for the dark matter experiment and also this will open new opportunities for the imaging.

Acknowledgment

One of the authors (P.K.Rath) acknowledges the financial support of University of Naples Federico II, INFN Naples to carry out these investigations.

References

[1] NIM. in Physics A**269** (1988) 623-633.
[2] DAE, Symp. on Nucl. Phys. **60** (2015) 938.
[3] Nuclear Physics A **l92** (1972) 609-624 .