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NEUTRON SPECTROSCOPY BY DOUBLE SCATTER AND ASSOCIATED PARTICLE TECHNIQUES

I. Dioszegi[1], P. Vanier[1] and L. Forman[2]

[1]Brookhaven National Laboratory, Upton, New York 11973
[2]Ion Focus Technology, Miller Place, New York 11764

Nonproliferation and National Security Department
Detector Development and Testing Division

Brookhaven National Laboratory
P.O. Box 5000
Upton, NY 11973-5000
www.bnl.gov

DISCLAIMER

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ABSTRACT

Multiple detectors can provide [1,2] both directional and spectroscopic information. Neutron spectra may be obtained by neutron double scatter (DSNS), or the spontaneous fission associated particle (AP) technique. Spontaneous fission results in the creation of fission fragments and the release of gamma rays and neutrons. As these occur at the same instant, they are correlated in time. Thus gamma ray detection can start a timing sequence relative to a neutron detector where the time difference is dominated by neutron time-of-flight. In this paper we describe these techniques and compare experimental results with Monte Carlo calculations.

SUMMARY

Possible geometries for DSNS and associated particle AP spectroscopy are shown below. The time of flight (TOF) scale is the time difference between the two plastic scintillators signals, where a 136 ns delay is being added to the path of the "stop" detector.

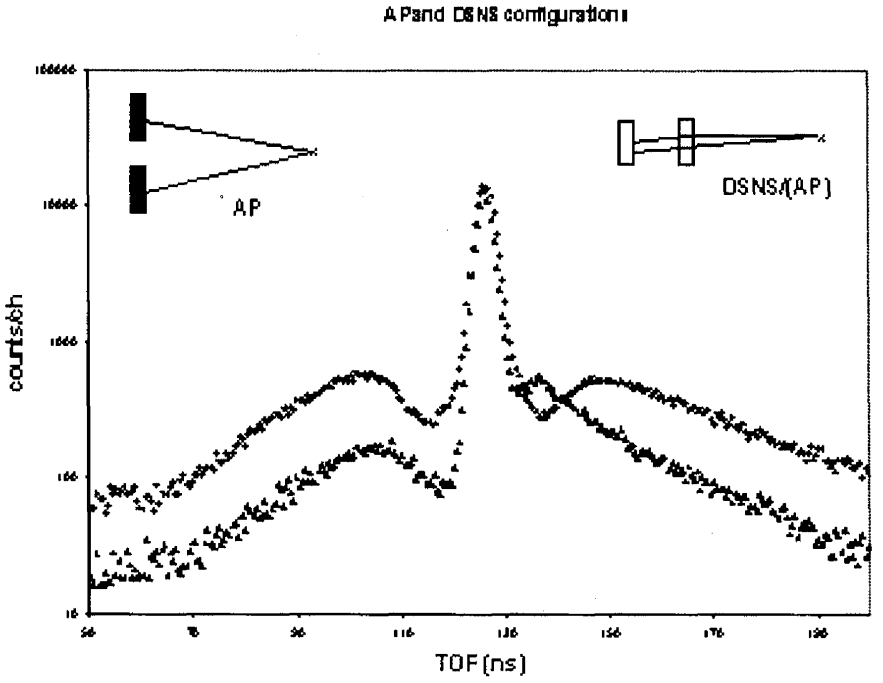

Fig. 1. DSNS (black) and AP (blue) spectra measured by two scintillators

In the consecutive DSNS geometry a double scatter occurs first in the front (start) and then in the rear detector (delayed stop). There is also the contribution of AP events where the gamma ray detected in the back detector first, then followed by a slower neutron event in the front detector. The AP geometry shown is parallel where a gamma ray or neutron can be measured in either detector and the spectral response is symmetric.

In an earlier set of experiments, we used a fast gamma-ray detector, BaF_2, and an organic scintillator for an AP neutron detector. The two detectors were on opposite sides of the source with the BaF_2 close, and the organic scintillator 1 meter away.

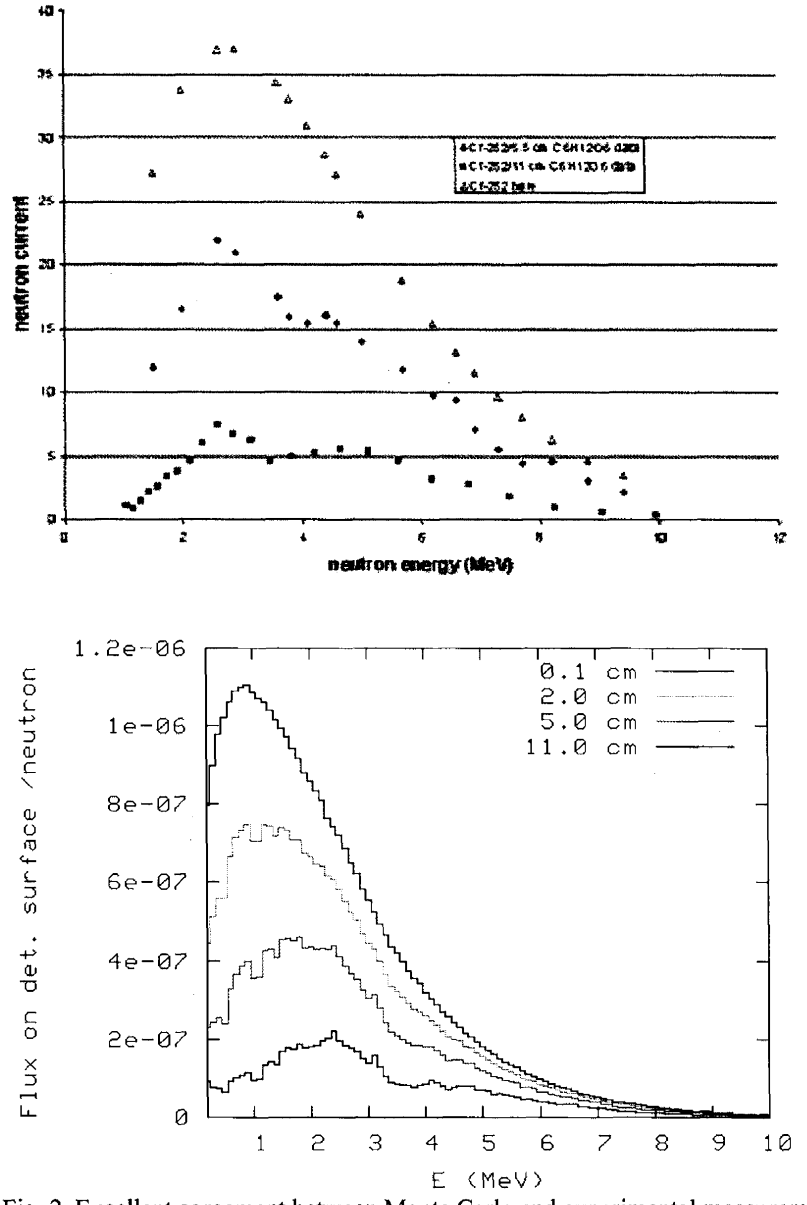

Fig. 2. Excellent agreement between Monte Carlo and experimental measurement of Cf-252 neutrons through sugar.

Recently, we have built a parallel AP spectrometer. We will describe this instrument and its performance. We were able to show by statistical analysis that it is possible to determine the thickness of low Z materials through which the fission neutrons are transmitted.

References:

1. Fast neutron source detection at long distances using double scatter spectrometry, L. Forman, P. E. Vanier, Brookhaven National Lab.; K. Welsh, *Proceedings of SPIE* Vol. #5198, August 2003.
2. Demonstration of a directional fast neutron detector , P. E. Vanier, L. Forman, Nuclear Science Symposium Conference Record, 2005 IEEE