Upgrades to the Neutron Ball

R.P. Schmitt, G.J. Derrig, J. Shumbera,
D. Utley, R. Wada, K. Hagel, J.B.Natowitz

The project to reconfigure the Neutron Ball has been completed. The completed assembly is shown in Figure1 with the photomultiplier tubes attached and with a 480 mm i.d. by 533 mm long target chamber suspended in the annular space of the scintillator filled wedges. When the NIMROD detector is completed this summer it will be installed in place of the target chamber.

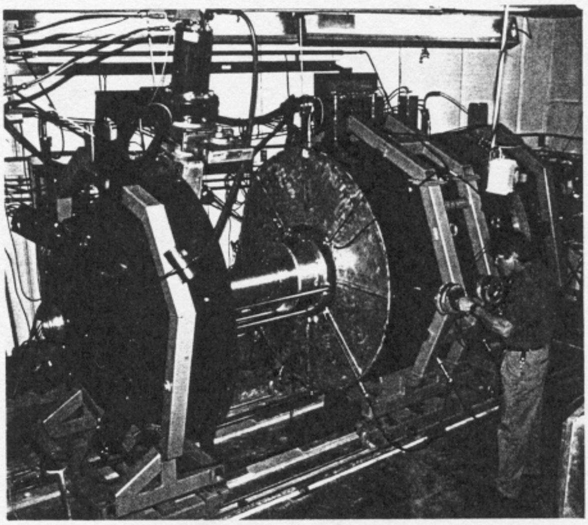


Figure 1. The neutron ball

A great deal of time was spent this past year preparing the scintillator liquid for use in the ball. The Gd salts as provided by the vendor were very wet upon arrival and required time consuming drying and grinding procedures including dry nitrogen purging and vacuum pumping and oven heating and pulverizing before it was possible to dissolve the salts in the pseudocumene. The salts were dissolved into individual 55 gal. drums of heated pseudocumene before being filtered through 10 micron filters while being pumped into the 600 gal. capacity blending tank. To insure uniformity of the solution the final mixture was circulated through the chambers for several days. ICP analysis of the final mixture showed a minimum 0.229% Gd concentration compared to a minimum 0.133% Gd concentration that was used in the Neutron Ball over the past several years. As reported in last years *Progress in Research* the total volume of scintillator in the detector is now approximately 2400 liters, comparable to the ORION detector at GANIL [1].

Calibration of the reconfigured Neutron Ball using a Cf source showed the necessity of using 3 photomultiplier tubes in each of the wedges that form the middle section of the Neutron Ball. The chambers were built with 3 ports for photomultiplier tubes but initially only 2 tubes were installed on each chamber. The Cf source testing showed that with these 2 tubes the efficiency of the light gathering was approximately 70% but the addition of a third tube raised the efficiency to over 80%.

Figure 1 shows the multiplicity distribution we obtained with a ^{252}Cf source. The multiplicity was obtained in two ways. One was to count the number of neutrons in a 100μs gate which was generated by the fission fragment from the ^{252}Cf source. This is shown as the solid histogram in figure 1. The second method shown as the dotted histogram in figure 1 uses a multi-stop TDC which is started with the timing signal from the fission fragment. It is seen that both methods produce very similar multiplicity distributions.

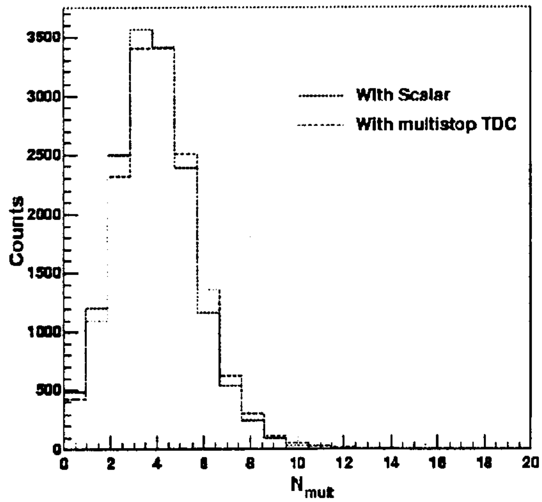


Figure 2 Cf Neutron multiplicity distribution

Using the multi-stop TDC can give information on the capture time distribution of the neutrons. We show in figure 2 the capture time distributions obtained for the various neutrons. The cutoff observed results from the TDC being set on a range of 112μs (the maximum).

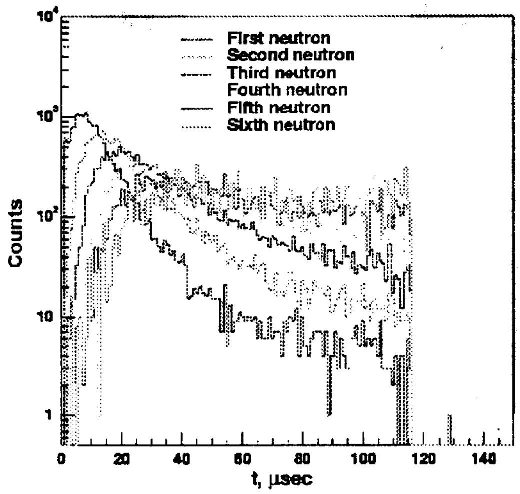
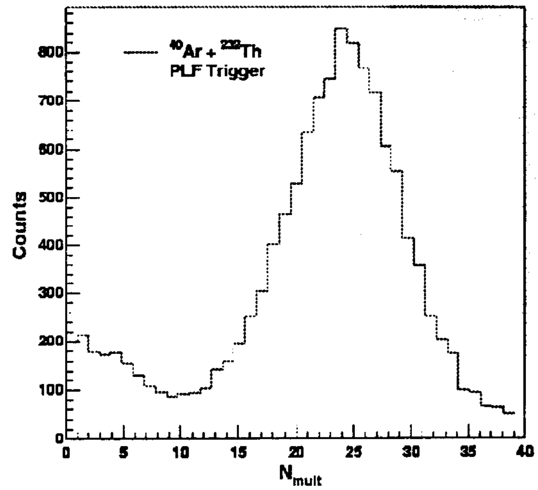


Figure 3 Capture time distribution

The concentration of Gd can be estimated using the shape of the capture time distribution. Preliminary estimates indicate a higher concentration than that used in the previous neutron ball, but that analysis is ongoing.

We performed a test to see how the neutron ball would perform in a beam environment. We picked the ^{40}Ar + ^{232}Th system to compare to earlier work we have done.[2] In order to be sure of what we were observing, we triggered on PLF's at about 20°. Figure 4 shows the neutron multiplicity distribution of the ^{40}Ar + ^{232}Th system.



We note a peak for central collisions near 25 which is in good agreement with our earlier measurement[2].

References

1. J. Galin *et. al.*, New Nuclear Physics with Advanced Techniques, Eds. F. Beck, S. Kossionides, and C. A. Kalifas (World Scientific, Singapore, 1992) p. 131.
2. D. Utley *et. al.*, Phys. Rev. **49** (1994) R1737.