Nuclear Explosion Monitoring Research and Engineering (NEMR&E) Program
Quarterly Report - BAA06-36; DE-FC52-06NA27322

Research Title: A Multi-Layer Phoswich Radioxenon Detection System
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Reporting Period: 04/01/08 – 06/30/08

Technical Progress:

Description of Activities Conducted this Reporting Period:

Characterization of Phoswich Detector. Laboratory radioactive sources were used to characterize the phoswich detector. The CaF_2 scintillator has a low light-yield and slow decay time, thus produces very small signals due to low-energy gamma rays or X-rays. Therefore, detection of 30 keV X-rays (from the xenon radioisotopes) using this layer and discriminating its very small signals from electronic noise was a challenging task. Several solutions were considered and experimentally evaluated. We found that the best solution would be extending the fast triangular filter from 10 taps to 30 taps. This will extend the peaking time of this filter from 25 nsec to 75 nsec. The digital filter is implemented in FPGA on our DPP2.0 and is used to trigger the detection system. Functionality of the new filter in capturing and discriminating 30 keV X-rays was confirmed by using a ^{133}Ba gamma-ray source.

GUI Development. Development of the DPP GUI software has continued with the addition of two new panels to display histograms of beta/gamma and beta/x-ray coincidence events. This includes coincidence events from a single channel, as well as two-channel, coincidence event. A pileup rejection algorithm has been implemented in the FPGA code, and controls to adjust its sensitivity have been added to the GUI. Work has begun on a new prototype system to develop a USB host interface between the PC and the FPGA to end reliance on Opal Kelly prototyping boards; the hardware for this system has been completely assembled, and the PC-side software is currently in development.

Progress/Deliverables Required by this Reporting Period per Contract:

> The proposed schedule shows that, by the end of the 9th quarter, the experimental measurements with radioxenon would be ending (Phase 1, Task d), a 3D histogram interpretation using neural networks would be underway (Phase 1, Task e), work would continue on the generation of an algorithm to construct real-time 3D histograms of output (Phase 2, Task e), characterization of the XEPHWICH response would be completed (Phase 3, Task e), and experimental measurements with the DPP2 would commence (Phase 3, Task f).

Reason for Differences in Cooperative Agreement Statement of Objectives/Deliverables and Actual Progress/Deliverables, Corrective Actions:

We have limited measurements with radioxenons; the OSU TRIGA is down for refueling and our apparatus seems to need a redesign (with smaller void space). The algorithm for 3D histograms is being developed and neural network implementation is developing, as well. We have constructed neural networks for the recognition of beta spectra and these networks will be applied to the 3D output histograms. One half of the the XEPHWICH is characterized and we expect to place the order for the full XEPHWICH detector this quarter. We are evaporating thin layers on aluminum onto the BC400 scintillator in the OSU electrical engineering laboratory. This aluminum layer will act to eliminate light cross-talk between the two halves of the XEPHWICH, as well as to provide a memory-effect barrier from the surface of both halves.