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Development of a Gamma Ray Spectroscopy Capability at LANSCE

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Abstract

This is the final report of a one-year, Laboratory Directed Research and Development (LDRD) project at the Los Alamos National Laboratory (LANL). The goal of this project was to explore an upgrade to the GEANIE high-resolution gamma-ray spectrometer at the Los Alamos Neutron Science Center (LANSCE) to help build additional experimental capabilities. The improvements identified have significantly added to the capabilities of GEANIE and made the facility more attractive for studies supporting our core national security mission as well as for use by outside collaborators. These benefits apply to both basic and applied studies.

Background and Research Objectives

GEANIE is a large, high-resolution gamma-ray detector array sited at the Weapons Neutron Research (WNR) facility at the Los Alamos Neutron Science Center (LANSCE). The use of such an array at a high-energy neutron-spallation source provides a unique facility. This project was designed to explore enhancement of the research capabilities of GEANIE at WNR to help create new capability. A side benefit was to attract outside users and collaborators, especially from the academic community. In consultation with university colleagues, we established what would be needed to upgrade the detector and data acquisition electronics for greater throughput and experimental effectiveness.

Importance to LANL's Science and Technology Base and National R&D Needs

GEANIE at WNR is an important component of two of LANL's tactical goals, the Neutron Laboratory and Science-Based Stockpile Stewardship. This unique facility is an important resource for both applied and basic research at LANL. High-profile experiments for stockpile stewardship are currently in progress. Any improvements achieved in this project would be of direct and immediate benefit to our core mission. Further, establishing a strong user program for nuclear science at LANSCE is important for attracting and retaining talented scientists. National research is enhanced by providing research capabilities and opportunities found nowhere else.

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Scientific Approach and Accomplishments

The goals of this project were to look at what upgrades the detector and data acquisition electronics would be required for greater throughput and user effectiveness. We determined that attention to the following areas would be most beneficial:

(1) Upgrade the computer system in a way that would allow multi-user access and state-of-the-art analysis tasks.

(2) Increase the number of detectors in the array and improve the electronics in a way that would allow greater data capture rates and improved system resolution.

(3) Add neutron detectors to the array to broaden usefulness of the experimental capabilities.

For the first goal we simply added 1 GB of memory to our analysis computer, increased the disk space and upgraded the tape drives and printer. All of these changes proved valuable by providing sufficient resources for experimenters to process their data more rapidly and efficiently, and to present it more professionally.

For the second goal, we looked at improvements to the detectors and their electronics. We found that the electronics modifications, combined with new mounts to allow addition of more detectors to the array, significantly increased the data capture rate and improved the energy resolution of the system. These enhancements are very important for maximizing productivity and the quality of the data obtained. New fast amplifiers were also incorporated into the electronics and found to improve the timing resolution of the system. Mounts for six additional detectors were designed and fabricated. The additional detectors and new electronics will be used in upcoming experiments.

The third goal was furthered by the design and fabrication of a new target holder as well as by addition of neutron detectors made available to us by university and local collaborators. The target holder required an innovative design that allowed for efficient use of both neutron and other detectors close to the targets without affecting the germanium detectors in the array. The previous target holder did not allow detector mounting below the array and was less than ideal in stability and ease of adjustment. Current plans are to install and operate neutron detectors as part of a study of spontaneous fission of ^{252}Cf. The neutron detectors can be used for background reduction by triggering on fission neutrons, or with time-of-flight information to gain insight into the detailed nature of the fission process through correlation with specific fragments.

The improvements detailed above have significantly added to the capabilities of GEANIE at WNR and made the facility more attractive for studies supporting our core national security mission as well as for use by outside collaborators. These benefits apply to both basic and applied studies. An international workshop with 37 attendees was held in

June 1997 to discuss research with GEANIE. Over 17 presentations on GEANIE have been given at national and international conferences. Individual discussions are ongoing to inform potential internal and external users of the opportunities available at LANSCE. A meeting with the DOE Office of High Energy and Nuclear Physics is scheduled for November 1997 to discuss plans for basic physics with GEANIE.

Publications

1. Becker J.A. and Nelson, R.O., "New Opportunities in Nuclear Science with GEANIE at LANSCE/WNR", *Nuclear Physics News* **7**, 11-14 (1997).

2. Nelson, R.O., Becker, J.A., Archer, D.A., Bernstein, L.A., Johns, G.D., Wilburn, W.S., Younes, W., Drake, D.M., Rundberg, R.S., Wender, S.A., Hauschild, K., Yates, S.W., and Garrett, P.E., "GEANIE at WNR/LANSCE: a New Instrument for Nuclear Science," Proceedings of the International Conference on Nuclear Data for Science and Technology, May 19-24, 1997, Trieste, Italy, to be published.

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