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Neutron Multiplicity Measurements for the AFCI Program Final Quarterly Progress Report January-March 2006

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UNLV Transmutation Research Project, Task 06
Principle Investigator: Denis Beller, Ph.D.

Purpose and Problem Statement

The U.S. Advanced Fuel Cycle Initiative (AFCI) is a program to develop economic and environmental methods to reduce the impact of waste from commercial nuclear fuel cycles. One concept for near-complete destruction of waste isotopes from used nuclear fuel is accelerator-driven transmutation. High-power accelerators would be used to produce high-energy charged particles, which then collide with heavy metal targets to create a cascade of neutrons. These neutrons then cause a nuclear chain reaction in subcritical systems. Fission neutrons then transmute fissile waste isotopes as well as other problematic isotopes such as technetium-99 and iodine-129. To design these systems, complex reactor physics computer codes and highly detailed data libraries are used to compute the reactivity of systems, reaction rates, destruction rates, and nuclear-induced damage rates to materials. This project was developed to test a Russian-built Neutron Multiplicity Detector System (NMDS) for measuring neutrons generated in a central target by a variety of accelerators. To assist in experiment design and evaluation, we use the most advanced high-energy radiation transport code, MCNPX, to model experiments. Experimental results are compared to computational predictions and discrepancies are investigated. Initial plans were to conduct experiments using a 70-MeV proton cyclotron at the Crocker Nuclear Laboratory at the University of California at Davis and/or a 20 to 40 MeV electron linac (linear accelerator) at the Idaho Accelerator Center (IAC) at Idaho State University (ISU). Finally, we planned to use the 800-MeV proton linac at the Los Alamos Neutron Science Center at Los Alamos National Laboratory and to compare the performance of the NMDS .

Personnel

Principle Investigator: Dr. Denis Beller (UNLV Mechanical Engineering)

Students: Ms. Shruti Patil, a graduate student, worked on her M.S. thesis to upgrade the NMDS for future use as a non-proliferation detection system. Ms. Patil is majoring in computer engineering at UNLV. She upgraded the capabilities of the NMDS to increase data acquisition speed, to record more information for each detected neutron, and to improve data analysis software. Mr. Brice Howard, an undergraduate student (Mechanical Engineering), was using MCNPX to model detector performance. Mr. Timothy Beller, an undergraduate student (M.E.) working on another TRP task with considerable experience with the NMDS, also consulted with Mr. Howard and with Ms. Patil on the project. Pavan Kumar Attur, a graduate student in the Electrical and Computer Engineering Department, was hired in December to assume the responsibilities of managing the NMDS.

UNLV Graduate Student Thesis Advisor: Prof. Venkatesan Muthukmar, Electrical and Computer Engineering, UNLV, is Ms. Patil's and Mr. Attur's thesis advisor.

National Laboratory Collaborators: Dr. Eric Pitcher (AFCI Experiments, LANSCE-12, Los Alamos National Laboratory); Dr. Stephen Wender (LANSCE-3 Group Leader, Los Alamos National Laboratory); and Dr. Michael Todosow (Brookhaven National Laboratory).

DOE Collaborator: Dr. Thomas Ward (UNLV Russian Collaboration Science Adviser, TechSource, Inc.)

Issues:

Budget: The budget was expended.

Management: The project was terminated without completing accelerator testing as the system could not perform at the counting rates required for existing high-energy accelerators operating at any reasonable current. The NMDS will now be used in a new project to assay separations processing streams for Materials Protection, Accounting, and Control (TRP Task 30).

Summary Report for January-March 2006

Task 6 was terminated in December and remaining funds were used in January to cover the cost of an MCNPX course for several UNLV students. Work using the NMDS will henceforth be reported in Task 30.