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Neutron Multiplicity Measurements for the AFCI Program Quarterly Progress Report September-December 2004

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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. In this project, we will use a Russian-built detector system to make measurements of neutrons generated in a central target by a variety of accelerators. We will also use the most advanced high-energy radiation transport code, MCNPX, to model the experiments. Experimental results will be compared to computational predictions and discrepancies will be 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 linac at the Los Alamos Neutron Science Center at Los Alamos National Laboratory.

Personnel

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

Students: Ms. Shruti Patil, a graduate student, began working on her M.S. thesis this quarter to plan and conduct an experiment with the NMDS at the Los Alamos Neutron Science Center (LANSCE) or at Brookhaven National Laboratory (BNL). Ms. Patil is majoring in computer engineering at UNLV. She will also upgrade the capabilities of the NMDS and improve data acquisition and analysis software. Mr. Timothy Beller, an undergraduate student (Mechanical Engineering), performed MCNPX calculations and consulted with Ms. Patil to operate and troubelshoot the NMDS. Tim was employed on TRP Task 27, RACE.

UNLV Graduate Student Thesis Advisor: Prof. Rama Venkat, Department Head, Electrical and Computer Engineering, UNLV.

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.)

Management Issues:

Personnel: A new undergraduate student will be hired for the spring semester.

Budget Issues: None

Summary Report

- Evaluation of NMDS experiments that were conducted at the Idaho State University Idaho Accelerator Center in July continued. In these experiments we used electron beams from a 30-MeV electron linac to create photoneutrons in the lead-block core of the NMDS. We then counted these neutrons with the NMDS detectors. The work was summarized in a report that was submitted to the Eighth Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation, 9-11 November 2004, Las Vegas, Nevada. This was an international OECD/NEA meeting. The poster was presented by students Shruti Patil and Timothy Beller, and the full paper was accepted for publication in the proceedings of the meeting. It is available on the NEA website.

  "The UNLV Neutron Multiplicity Detector System," T. Beller, D. Curtis, D. Beller, A. Rimsky-Korsakov, and T. Ward; to be published in the *Proceedings of the Eighth Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation*, 9-11 November 2004, Las Vegas, Nevada. <http://www.nea.fr/html/pt/iempt8/abstracts/Abstracts/Beller_NMDS_P&T.doc>
- The NMDS has experienced several failures since we brought it back to UNLV from the Idaho State University. Troubleshooting revealed that the electronic system had many loose components. This condition was probably caused by vibration during transportation from UNLV to ISU and back (one 8-detector sub-system failed at the ISU). This involved disassembling the system, packing it in its shipping crates, transporting it to ISU, reassembling it, and conducting a series of accelerator-driven experiments.
- Collaborators at the KRI continued to work with us to evaluate system problems and repair failed electronic components.
- In addition to background counts and performance checks, data were taken to compare daytime to nighttime background measurements, which were determined to be the same statistically. In addition, we ran a series of counts to look for increased cosmic radiation during the passing of a meteorite--again with negative results.
- Other work this semester has involved developing documentation of the system. This included translating many Russian schematics and preparation of a “user’s manual,” which was completed in December.
- Planning was initiated for conducting tests at LANL or BNL. However, both of those facilities provide very strong neutron sources, even when operating at minimum power and energy (“dark current”), whereas the NMDS was designed to count only very weak neutron sources. Thus, testing at those two laboratories will probably not be practical.