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Reactor Physics Studies for the APCI RACE Project: Reactor-Accelerator Coupling Experiments Project: Quarterly Progress Report April-June 2005

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Reactor Physics Studies for the AFCI RACE Project (Reactor-Accelerator Coupling Experiments Project)

Quarterly Progress Report April-June 2005

UNLV Transmutation Research Project Task 27
Principle Investigator: Denis Beller, Ph.D.

Purpose and Problem Statement

In the RACE Project of the U.S. Advanced Fuel Cycle Initiative (AFCI), a series of accelerator-driven subcritical systems (ADSS) experiments is being conducted at the Idaho State University's Idaho Accelerator Center (ISU-IAC), at will be conducted at the University of Texas (UT) at Austin, and at the Texas A&M University. In these experiments we will use electron accelerators to induce bremsstrahlung photon-neutron reactions in heavy-metal targets; this source of about 10^{12} to 10^{13} n/s will then initiate fission reactions in the subcritical systems. These systems will include a compact, transportable assembly at ISU and TRIGA reactors at UT-Austin and Texas A&M. These experiments will provide a variety of cores, fuel types and enrichments, and target/reactor configurations for many separate accelerator coupling studies. The UNLV portion of this project will be a three-year, three-phase project employing a principal investigator (as well as the UNLV TRP RACE Project Director), a graduate student, and an undergraduate student to support computational and experimental research at the ISU and the Texas universities, to integrate the UNLV Transmutation Research Project with this accelerator-driven transmutation research, and to further develop UNLV's computational infrastructure for reactor physics research.

Personnel

Principle Investigator: Research Prof. Denis Beller, Department of Mechanical Engineering, UNLV.

Students: Mr. Evgeny Stankovskiy, graduate student, Department of Mechanical Engineering, came to UNLV from the Institute of Nuclear Power Engineering in Obninsk, Russia, to pursue a doctorate. He will design, conduct, and analyze an accelerator-driven subcritical experiment at UT-Austin or Texas A&M University. Mr. Timothy Beller, undergraduate student, Department of Mechanical Engineering, performed MCNPX calculations in support of experiments at the Idaho Accelerator Center.

UNLV Graduate Student Thesis Advisor: Prof. Robert Boehm, Department of Mechanical Engineering, UNLV.

National Laboratory Collaborators: Dr. George Imel, Argonne National Laboratory (director of experiments in the MUSE and TRADE programs in Europe)

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

Summary Report April-June 2005

During this quarter we concentrated on coordinating an expansion of RACE into an international project, focusing on high-power experiments using Texas TRIGA reactors with thermal feedback, which will impact the level of subcriticality, start-up and shut-down ADS reactor operations, and measurements of subcriticality. This will prove to be an extremely challenging expansion of the RACE Project. Graduate student Evgeny Stankovskiy began investigating design codes for modeling thermal feedback in reactors. We contacted INL to obtain a license for one reactor thermal-hydraulic analysis code, RELAP, which may be modified to calculate TRIGA reactor transients. We also initiated discussions with members of EUROTRANS (EUROpean Research Programme for the TRANSmutation of High Level Nuclear Waste in an ADS) at FZK (Germany) and ENEA (Italy) on thermal-hydraulic analyses of source-driven TRIGA reactors (e.g. the ENEA TRIGA at Cassachia).

In his role as national RACE Project Director, the PI visited Idaho State University (ISU) and participated in an international meeting in Brussels to begin integrating the EUROTRANS ECATS (Experimental activities on the Coupling of an Accelerator, a spallation Target and a Sub-critical blanket) project with the RACE Project.

Undergraduate student Mr. Timothy Beller began preparations to use a thermal code, FLUENT, to analyze the thermal performance of high-power targets for future Texas RACE. He began participating with a FLUENT working group at UNLV. He is computing deposition of accelerator beam power, which will be used as the heat source in the FLUENT calculations, by simulating the target with MCNPX, a Los Alamos neutron transport code. Mr. Beller also began modeling the use of the UNLV Neutron Multiplicity Measurements System to measure time-dependent neutron production in the Idaho State University full-core RACE

The PI and both students participated in the Third Annual Idaho Workshop on Accelerator-Driven Subcritical System (ADSS) Experiments which was held at Idaho State University on June 1 & 2. Other participants included faculty and students from ISU, UT-Austin, Texas A&M, and the U of Michigan, advisors from the U.S. DOE, ANL, and LANL, and collaborating scientists and engineers from CEA, ENEA, and FZK. The PI and students also participated in an organizing meeting at ISU between the RACE Project and the ECATS Project (Experimental activities on the Coupling of an Accelerator, a spallation Target and a Sub-critical blanket, Domain 2 of EUROTRANS). A RACE-ECATS work package was discussed and a statement of cooperation was signed.



UNLV students Evgeny Stankovskiy (far left) and Timothy Beller (kneeling far right) with other participants in the RACE and ECATS projects after the joint RACE-ECATS .

Progress

Our project is two months behind schedule due to a delay in shipment of an accelerator from ISU to UT-Austin. It is now scheduled for shipment in July with ADSS experiments to begin the end of July or the first week of August. The UNLV RACE experiment is scheduled for mid-August.

Publications and Presentations

"AFCI Reactor-Accelerator Coupling Experiments (RACE) Project," D. Beller and F. Harmon, presented by D. Beller to the 2nd Meeting on DM2 ECATS Feasibility Study, Brussels, Belgium, April 20-21, 2005.

"Dynamic Analysis of Space-Time Effects in the ISU RACE Configuration," V. V. Kulik, J. C. Lee, and D. E. Beller, full-length paper submitted to *Nuclear Instruments and Methods-A* for the Proceedings of the International Conference on Accelerator Applications 2005 (AccApp05), Venice, Italy, August 29-September 1, 2005.

"The U.S. AFCI Reactor-Accelerator Coupling Experiments (RACE) Project," D. Beller, F. Harmon, T. Ward, and F. Goldner, abstract for invited plenary presentation submitted to the International Conference on Accelerator Applications 2005 (AccApp05), Venice, Italy, August 29-September 1, 2005.

"Phase IV of the RACE Project: European Collaborations," D. Beller and J. Knebel, summary submitted to the ANS for oral presentation at the 2005 Winter Meeting of the American Nuclear Society, Nov. 13-17, 2005.

"Accelerator Driven Subcritical System Experiments at The University of Texas," D. S. O'Kelly, D. Beller, and W. S. Charlton, summary submitted to the ANS for oral presentation at the 2005 Winter Meeting of the American Nuclear Society, Nov. 13-17, 2005.