

Task 12

Radiation Transport Modeling of Beam-Target Experiments

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BACKGROUND

The ability to accurately model the performance of an accelerator-target system and assess its performance is vital to the development of accelerator-driven transmutation systems. Los Alamos National Laboratories developed the MCNPX code suite, a Monte Carlo radiation transport code, for this purpose. This code is widely used by national programs and most international programs developing accelerator-driven systems to model the behavior of the accelerator-target system. These models are then used to assist in designing experiments, evaluating system designs, and other applications necessary to support the development of this technology.

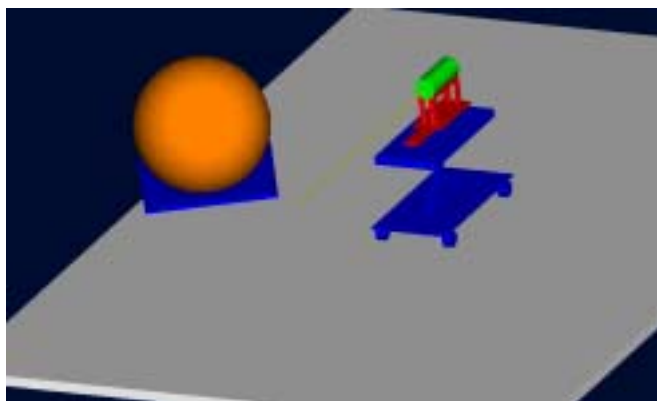
Through these modeling efforts, however, researchers have found that the uncertainties in the nuclear data within the reference libraries, and those introduced by assumptions within the computational methods used by MCNPX, lead to significant uncertainties in the predicted performance. These propagated uncertainties are even more significant at high energies. To address these uncertainties in the nuclear database, researchers are currently conducting experiments at national laboratory facilities (such as the LANSCE facility at LANL) to generate the data needed to benchmark the MCNPX models that predict neutron production and leakage rates from targets. Student researchers at UNLV are a part of this research effort, serving the effort by developing the models of the experimental systems and analyzing the data from the experiments.

RESEARCH OBJECTIVES AND METHODS

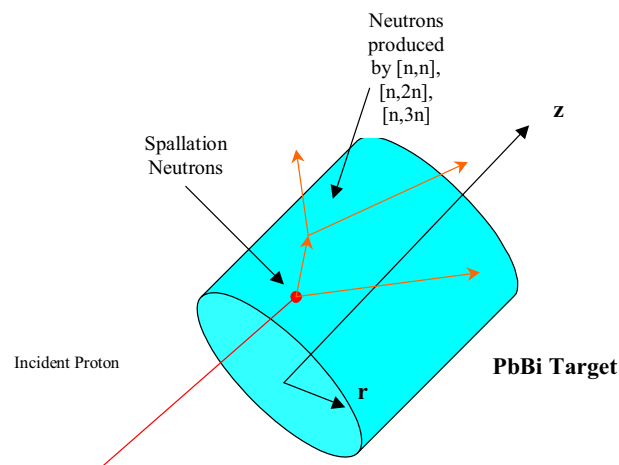
In the first year of the UNLV effort, researchers planned to develop the models of the experimental systems to predict the neutron flux and leakage from the experimental targets using the MCNPX code suite in order to help determine these missing parameters. To support these models, the researchers project, or estimate, values for the unknown parameters describing various events and phenomena occurring within the beam-target experiment. The results of these simulations will then be compared against the observed neutron leakage rates and energies. The estimates for the unknown parameters are then revised to correlate with the observed values (these parameters cannot be measured directly, and must be determined by inference). The resulting models will then be validated and benchmarked against data from future experiments. These models, even before being validated, have also been instrumental in designing the experiments themselves.

RESEARCH ACCOMPLISHMENTS

In the first year, the UNLV research team completed the modeling and analysis of experiments conducted to assess neutron leakage, sodium activation, actinide fission, and neutron multiplicity. Through participation in the MCNPX workshop at UNLV, the research team received the training in using the code that allowed the students to participate directly in the modeling and analysis of the experimental campaigns conducted at LANSCE. The first collaborative experimental campaign was the neutron leakage test experiments on LANSCE. Preliminary results from the experiment are in good agreement with the model projections for the neutron energy spectra. Refinements of the model to improve the agreement are currently underway.



Schematic of the Experiment at LANSCE, December 2002.



Leakage of High Energy Neutrons from a Spallation Target.

FUTURE WORK AND GOALS

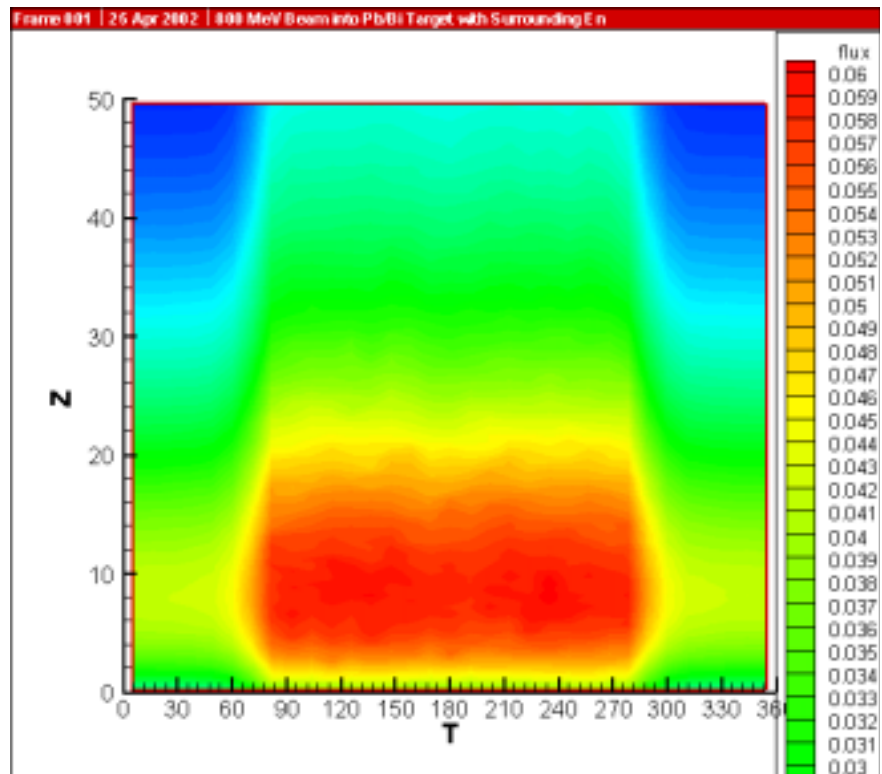
The simulation of experiments at LANSCE will continue, modeling both already completed experiments (to benchmark the codes) and to assist the planning and analysis of future experiments. For example, the research team has been added to the experiments led by Dr. Pitcher (LANL) to analyze the activation induced by neutrons passing throughout the sets of foils attached to the spallation target. Work will also continue in support of the neutron spallation experiments.

The UNLV team also plans to develop a benchmark program for the neutron leakage tests and other tests related to transmuter development. This program will parallel the international benchmark experiments and modeling conducted by the OECD nuclear energy agency and cooperating laboratories. As part of this effort, a comprehensive, three dimensional CAD image of the LANSCE experimental set-up will be developed to ensure accurate geometric data for MCNPX modeling.

HIGHLIGHTS

- Based on the success to date in supporting the LANL/LANSCE experiments, UNLV has been asked to collaborate on experiments at the Idaho Accelerator Center (IAC). Suresh Sadenini, a graduate student in the UNLV Mechanical Engineering department accompanied Prof. William Culbreth (UNLV-ME) to visit the IAC to plan for an experimental campaign for the summer 2002. IAC staff invited Mr. Sadenini to assist with the experiment, provide simulations, and analyze data.
- Students presented their research at the American Nuclear Society Conference in Reno, November 2001.
- Mr. Daniel Lowe, student in the UNLV Mechanical Engineering Department, has been invited to spend six weeks at LANSCE to conduct MCNPX simulations and assist with the planned neutron spallation tests. His work contributed to the preparation of a benchmark program for these tests.

Neutrons per Square Centimeter per Incident 800 MeV Proton on a Lead Bismuth Target



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