MONTE CARLO VERIFICATION AND MODELING OF LEAD-BISMUTH SPALLATION TARGETS

Daniel Lowe
University of Nevada Las Vegas
Department of Mechanical Engineering
4505 Maryland Parkway
Las Vegas, NV 89154
(702) 895-1331, (702) 895-4403
Email: lowe@cmest.unlv.edu

A series of experiments were conducted at LANSCE in the support of the transmutation of spent nuclear waste. These experiments were in support of lead-bismuth neutron spallation targets which were the focus of the experiments. The initial experiment was conducted in December 2001 on a 20 cm diameter Pb/Bi spallation target. Since this was the first experiment to be done, the effects of experimental variable were yet to be determined. MCNPX analyses were conducted to validate that the code could adequately predict the performance of lead/bismuth as a neutron spallation source. In effect, it provided the information that allowed the experimenters to focus on the variables that caused the most problems. Asymmetric neutron flux was heavily researched in order to provide a more accurate understanding on the key factors that influenced the asymmetric readings found in the December experiment. A second experiment was conducted in July of 2002 with the new target being 40 cm in diameter with the same elemental composition as its predecessor. The information obtained from the December run lead to the addition of ~20 more foil packets. This allowed us to have a more accurate rendition of beam location from the foil pack readings. Furthermore, 3-D CAD drawings and detailed room environment variables were obtained in the latter of the two experiments for benchmarking purposes.

To prepare for the experiment performed in July 2002, further investigation was needed as to what caused the asymmetrical fluxes that were found in the foil pack analysis. Qualitatively, this was done by observing the beam spot located on the front face of the target (December 2001). A phosphorus plate with evenly spaced increments was placed on the front face that allowed an approximation to be made as to how far off the beam was form the center of the target. Quantitative analyses were done using MCNPX. A multitude of runs were conducted with different beam offsets. The flux results could then be quantified to show how much a certain range of offset would contribute to the asymmetric properties. With these results, it was found that even a small amount of deviation from center would cause significant asymmetric fluxes in the target. To account for this in the latter experiment, more attention was paid to aligning the target and positioning the beam in the center of the target. This was accomplished by using a combination of lasers, radio-chromic film, levels, and the phosphorus plates. The new alignment procedures with the aid of MCNPX allowed the experimenters to accurately predict where the maximum neutron flux would be generated, allowing the foil samples to be irradiated at the highest possible levels.