**Implementation of Uncertainty Propagation in TRITON/KENO**
(to support the Global Nuclear Energy Partnership)

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| **UNLV Collaborators:** | Students:<br>Matthew Voegelle, GRA, MSNE beginning Jan 2008<br>TBD UgRA to be hired Jan 2008 |
| **GNEP Program Laboratory Collaborators:** | Dr. Mark D. DeHart (Project Technical Advisor)<br>Reactor Analysis Group, Oak Ridge National Laboratory<br>865-576-3468; dehartmd@ornl.gov<br><br>Dr. Michael Dunn, Nuclear Data Group Leader, Oak Ridge National Laboratory |
| **GNEP research Area:** | Fuel Cycle Systems Engineering |
| **Requested Funds:** | \$90,270; (\$95.7 k 2$^{nd}$ yr, \$101.4 k 3$^{rd}$ yr; 287.4 k total) |

Monte Carlo methods are beginning to be used for three-dimensional fuel depletion analyses to compute various quantities of interest, including isotopic compositions of used fuel.[1] The TRITON control module, available in the SCALE 5.1 code system, can perform three-dimensional (3-D) depletion calculations using either the KENO V.a or KENO-VI Monte Carlo transport codes, as well as the two-dimensional (2- D) NEWT discrete ordinates code.
For typical reactor systems, the neutron flux is not spatially uniform. For Monte Carlo simulations, this results in non-uniform statistical uncertainties in the computed reaction rates. For spatial regions where the flux is low, e.g., axial fuel ends, computed quantities, such as isotopic compositions, may have large statistical uncertainties. However, in currently available Monte Carlo depletion codes these statistical uncertainties are not calculated or reported to the user. Consequently, users have no indication of the fidelity of their results in such regions, which can be a significant impediment to the effective use of Monte Carlo methods for design and optimization studies of advanced fuel designs. Additionally, for applications such as criticality safety of used nuclear fuel, the lower depleted end regions tend to dominate the reactivity,[2] and hence must be accurately and/or conservatively represented.

To enhance and expand the proper/informed use of Monte Carlo methods for 3-D depletion analyses, in this project a graduate research assistant will develop and implement statistical uncertainty propagation in the TRITON/KENO sequence of SCALE. In particular, the work will focus on development and implementation of an approach to determine the uncertainty in isotopic predictions based on the compound effects of multiple calculations (depletion time steps) with stochastic uncertainties in the spatial fluxes in each time step. Subsequently an evaluation of the statistical uncertainties for an actual commercial used fuel sample will be performed to verify the implementation and develop a better understanding of the importance of statistical uncertainties in the prediction of isotopic compositions. This implementation of uncertainty propagation in the TRITON/KENO code sequence is beneficial to the GNEP program as its application is very broad. Better predictions of isotopic compositions are essential to optimize transmutation, recycling, and waste disposition.

**References**

1. Mark D. DeHart, Ian C. Gauld, and Kenya Suyama, "Three-Dimensional Depletion Analysis of the Axial End of a Takahama Fuel Rod," *International Conference on Reactor Physics, Nuclear Power: A Sustainable Resource*, Interlaken, Switzerland, September, 14-19, 2008.

2. DEHART, M.D., *Sensitivity and Parametric Evaluations of Significant Aspects of Burnup Credit for PWR Spent Fuel Packages*, ORNL/TM-12973, Lockheed Martin Energy Research Corp., Oak Ridge National Laboratory, May 1996.

**Personnel:**

**Dr. Charlotta Sanders** will be appointed as a Research Professor in the Mechanical Engineering Department at the University of Nevada, Las Vegas. She is currently employed by Bechtel-SAIC Corp., where she works on criticality and shielding analysis studies for the Yucca Mountain Project. She will serve as Principal Investigator for this project. In addition to her Yucca Mountain work, Dr. Sanders' experience includes nuclear engineering, reactor design, and other nuclear studies. She is well acquainted with computational reactor physics personnel working these issues at national laboratories.

**Prof. Denis Beller** is a Research Professor in the Mechanical Engineering Department at the University of Nevada, Las Vegas. He will serve as Co-Investigator for this project. Prof. Beller has a long career in nuclear engineering, reactor physics, systems analysis and radiation effects and currently supervises undergraduate, M.S., and Ph.D. students at UNLV.

**Dr. Michael Dunn** is the Nuclear Data (ND) Group Leader in the Nuclear Science & Technology Division (NSTD) at the Oak Ridge National Laboratory (ORNL). He oversees the development of cross-section processing and the ORNL cross-section measurement and evaluations for the U.S. Evaluated Nuclear Data File (ENDF/B) system. His expertise in the areas of nuclear criticality safety, radiation transport, and cross-section processing methods development will be invaluable for this project.

**Dr. Mark DeHart,** a nuclear engineer in the Reactor Analysis Group of the Nuclear Science and Technology Division of Oak Ridge National Laboratory, will be the laboratory technical advisor on this project. Areas of R&D include advanced reactor modeling. He is also an Adjunct Associate Professor at the University of Tennessee, Knoxville.