



LAWRENCE  
LIVERMORE  
NATIONAL  
LABORATORY

LLNL-TR-471524

# Towards Reliable Cross Sections for National Security Applications

J. E. Escher, F. S. Dietrich, G. P. A. Nobre, I. J.  
Thompson

February 25, 2011

## **Disclaimer**

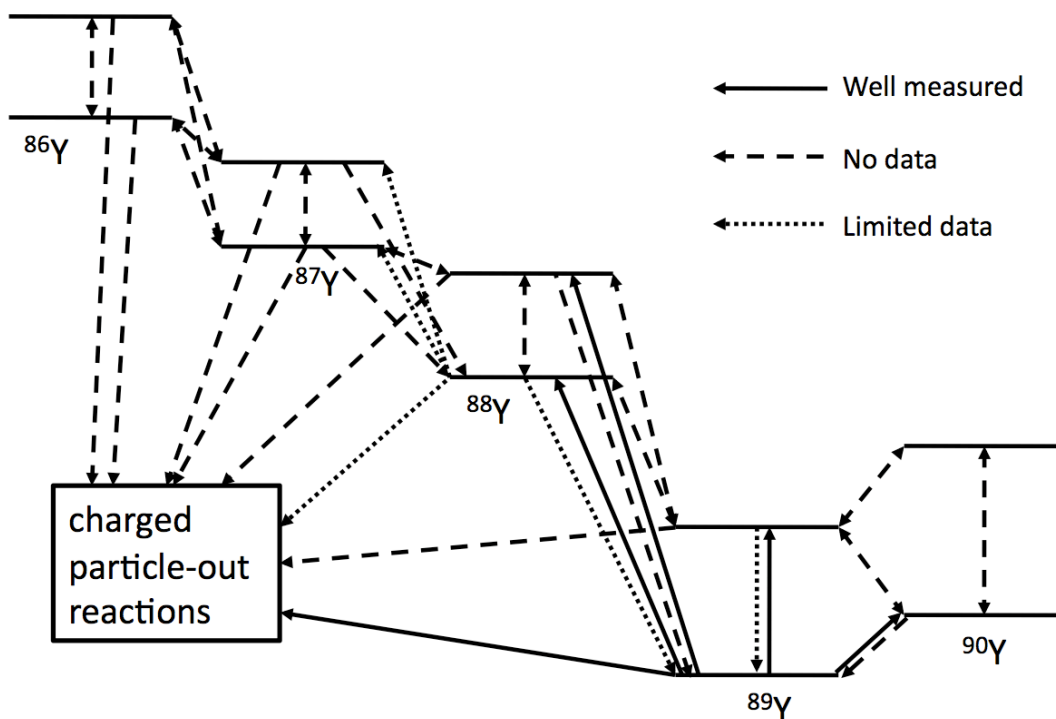
---

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

SciDAC-II / UNEDF / Reaction Highlights  
Towards reliable cross sections for national security applications\*  
J. E. Escher, F. S. Dietrich, G. P. A. Nobre, I. J. Thompson, LLNL

Stockpile stewardship requires the description of weapons performance without resorting to underground nuclear testing. In the earlier tests, selected isotopes were used as detectors, and recovered after irradiation. Aspects of nuclear device performance were inferred by comparing the measured isotopic ratios to those predicted from simulations. The reaction flows that produce the final isotopic distributions proceed through regions of the nuclear chart that include unstable nuclei. Presently, improved nuclear data input is required to reanalyze prior tests and to certify the stockpile's reliability and safety. Many important cross sections are unknown, as is shown in the example of the Yttrium reaction network (Figure 1). The relevant reactions include  $(n,2n)$ ,  $(n,n')$ ,  $(n,\gamma)$ ,  $(n,p)$  and other charged-particle emitting reactions. The cross sections have to be calculated or inferred from indirect measurements. In both cases, reliable optical models that are valid a few nucleons away from stability are needed. The UNEDF Nuclear Reaction activities address this need by combining nuclear-structure input from UNEDF structure calculations with modern reaction theory and large-scale computational capabilities to develop microscopic nucleon-nucleus optical potentials that can be extrapolated to unstable nuclei. In addition, the reaction calculation tools and optical models developed in this context are proving valuable for planning and interpreting indirect (surrogate) measurements of the required cross sections.



\*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344 and under SciDAC contract DE-FC02-07ER41457.