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UCRL-TR-235935

Neutron Capture gamma ENDF libraries for modeling and identification of neutron sources

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October 29, 2007

Disclaimer

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

Technical Report Format

Project Title

Neutron Capture gamma ENDF libraries for modeling and identification of neutron sources

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Abstract

There are a number of inaccuracies and data omissions with respect to gammas from neutron capture in the ENDF libraries used as field reference information and by modeling codes used in JTOT. As the use of Active Neutron interrogation methods is expanded, these shortfalls become more acute. A new, more accurate and complete evaluated experimental database of gamma rays (over 35,000 lines for 262 isotopes up to U so far) from thermal neutron capture has recently become available from the IAEA. To my knowledge, none of this new data has been installed in ENDF libraries and disseminated. I propose to upgrade libraries of ^{184,186}W, ^{56}Fe, ^{204,206,207}Pb, ^{104}Pd, and ^{19}F. he 1st year. This will involve collaboration with Richard Firestone at LBL in evaluating the data and installing it in the libraries. I will test them with the transport code MCNP5.

Introduction

Identifying the materials present in unknown detector spectra using gamma ray spectroscopy is a fundamental tool of the JTOT/NEST program. The neutron capture line spectra also indicate the presence of a neutron source which is usually an actinide such as Plutonium. Additionally, the high energy gamma lines (8 to 10 MeV) are harder to shield and are not as obscured in detector spectra by background radiation.

Project

This project installed new neutron capture discrete gamma ray spectra into nuclear data libraries for ^{182,183,184,186}W, ^{56}Fe, ^{207}Pb, ^{19}F, and ^{104}Pd. It was decided to modify the original list by replacing the ^{204,206}Pb isotopes with ^{182,183}W as these cross sections were larger and appeared more useful for the program. This new absolutely calibrated and evaluated data was obtained from a recently released IAEA research project. Because the isotopes were medium to heavy, much of the gamma energy is in the form of an unresolved continuum that must be accounted for in the library but is not measured (only the line spectra and associated cross sections are measured). The unresolved continuum is modeled with a nuclear structure code called Dicebox. This code uses the discrete line spectra as input and matches this while simultaneously generating a continuum

to be used in the library. Getting this code running and reformatting the continuum into the library was a major part of this work. Now that it is complete other libraries can be constructed more quickly. A Hauser Feshbach code is required to predict the gamma spectra from higher energy neutrons as neutrons, alpha particles, etc will start be preferentially emitted at these higher energies. A Code to model this data for a number of neutron energies into ^{184}W is shown below right.

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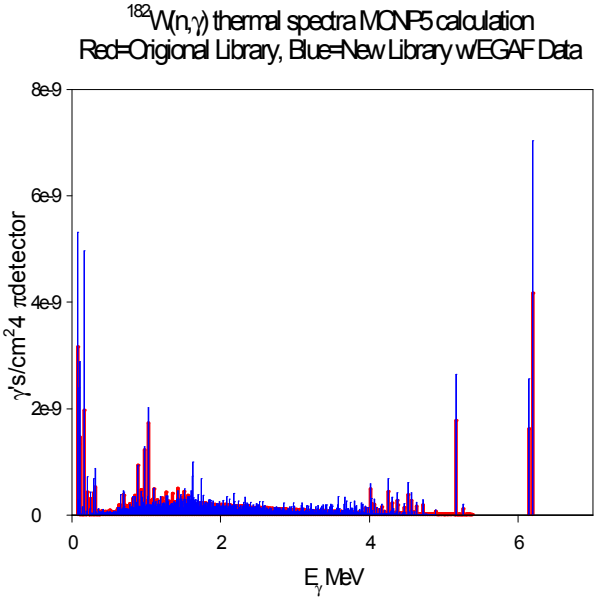

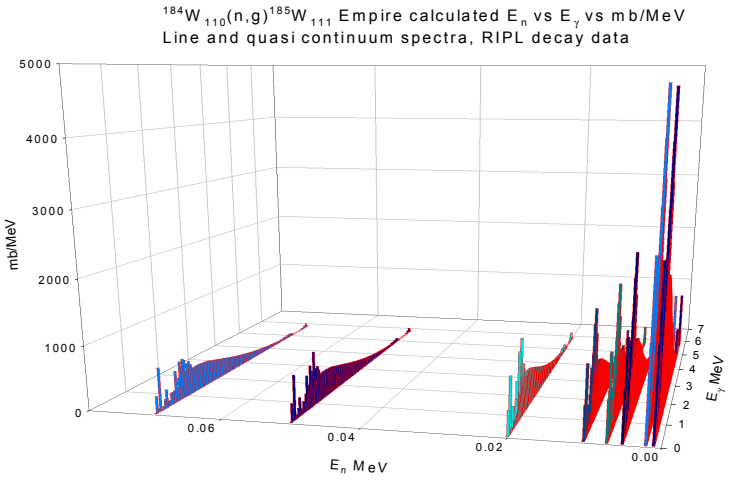

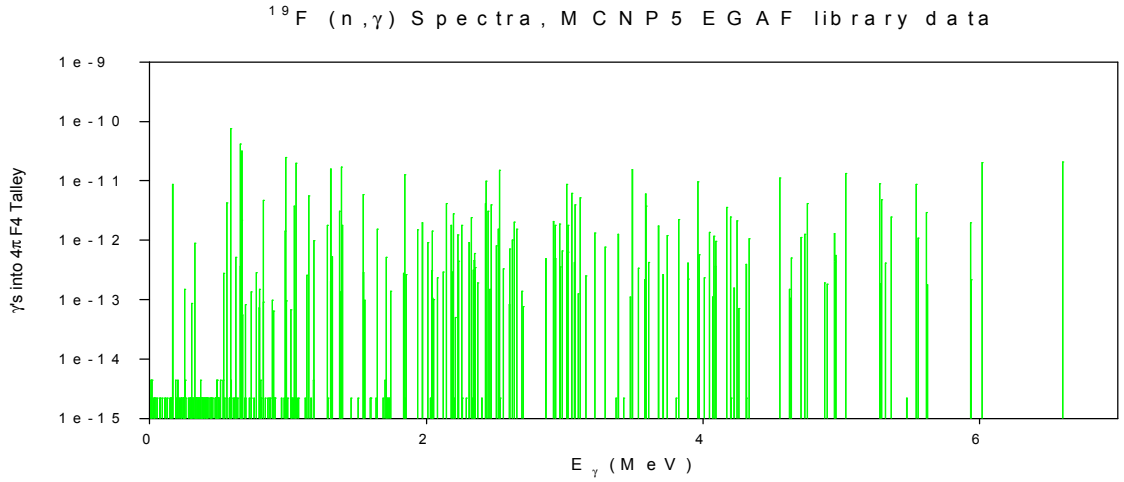

Results

Eight libraries were upgraded with the new data as was promised in the original request. 2 isotopes were switched for 2 others as being higher value to the program due to large cross section differences. All the libraries are in use in the JTOT program at LLNL now.

Programmatics

As this work has no funding for FY 08 through the TI process the rate of progress will be much slower. There were plans to automate this process in the future and to start upgrading the inelastic discrete gamma spectra also as an atlas of these lines is also available to get a complete set of gammas from neutrons of all energies.

Conclusion

Eight nuclear data libraries were upgraded with the new neutron capture data. This was what was originally promised in the funding request. The ability to model the unresolved continuum inherent in the heavy nuclei and required by the nuclear data libraries has been developed and implemented.

References