

---

## RECENT DEVELOPMENT OF THE NUCLEAR REACTION MODEL CODE EMPIRE

Mike Herman<sup>1</sup>, Roberto Capote<sup>2</sup>, Pavel Oblozinsky<sup>1</sup>, Mihaela Sin<sup>3</sup>, Andrej Trkov<sup>4</sup>,  
Alberto Ventura<sup>5</sup>, Victor Zerkin<sup>4</sup>

<sup>1</sup> *Brookhaven National Laboratory*

<sup>2</sup> *University of Sevilla*

<sup>3</sup> *University of Bucharest*

<sup>4</sup> *International Atomic Energy Agency*

<sup>5</sup> *Ente Nazionale Energia ed Ambiente, Bologna*

---

EMPIRE-II is a system of codes intended as a general theoretical tool to be used in basic research and nuclear data evaluation for calculation of nuclear reactions in the broad range of incident energies and projectiles. It was design to contain state of art nuclear reaction modeling, being at the same time very easy to use. A full ENDF-6 formatted file and its graphical comparison with available experimental data can be obtained with just a few mouse clicks and key strokes.

Empire-II includes most of major nuclear reaction mechanisms, such as spherical optical model (SCAT2) and Coupled Channels (ECIS), Multi-step Direct (ORION + TRISTAN), NVWY Multi-step Compound, exciton model (DEGAS), Monte Carlo preequilibrium emission, and the full featured Hauser-Feshbach model with width fluctuation correction (HRTW). A comprehensive library of input parameters, based on RIPL-2, covers nuclear masses, optical model parameters, ground state deformations, discrete levels and decay schemes, level densities, fission barriers (BARFIT), moments of inertia (MOMFIT), and gamma-ray strength functions. The results can be converted into the ENDF-6 format using the accompanying code EMPEND. Relevant EXFOR entries are automatically retrieved during the calculations. By default, plots comparing experimental results with the calculated ones are produced using the extended PLOT4 code linked to the rest of the system through a series of preprocessing codes and bash-shell scripts. Interactive plotting is possible through the powerful ZVView package. Easy operation of the whole system is assured by the graphic user interface written in Tcl/Tk.

In the present contribution recent developments, extending functionality and applicability of the system will be discussed. These include: (i) new algorithm for disentangling emission spectra into exclusive components, (ii) treatment of the recoils spectra, (iii) state of the art handling of the fission channel, (iv) merging resonance region into the final evaluation, (v) extended formatting and plotting capabilities, and (vi) new user graphic interface.