DESCRIPTION OF BENCHMARK CALCULATIONS

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ALICE-91+BROSA

The coupling of the nuclear reaction code ALICE-91 with a temperature-dependent version of the Brosa model enables the prediction of fission fragment mass yields as well as fission product mass yields for all nuclear reactions in the intermediate energy range, i.e. between roughly 10 and 200 MeV.

The lower energy limit is inherent to the use of the Bohr-Wheeler approach in determining the fission probability in ALICE-91. This classical assumption forbids tunnelling through the fission barrier for nuclides with excitation energies below the barrier. The calculated fission cross-section at these energies is assumed to be zero, and therefore the low-energy contributions to the fission fragment mass yields are discarded. At incident energies below 10 MeV, this process leads to erroneous predictions, while the low-energy contributions may safely be neglected at higher energies.

An upper energy limit of 200 MeV stems from the extension of the Brosa model with temperature. The temperature dependence of the liquid-drop model used in the calculation of the potential energy surface is valid up to temperatures of 2-3 MeV, which corresponds to an excitation energy of approximately 250 MeV.

Detailed descriptions of the ALICE-91 code and of the revised MM-RNRM coupling with ALICE-91 can be found in Section 4 of the main technical report. Results from the benchmark calculations are obtained with barriers supplied by the rotating liquid-drop model. The saddle-point to ground-state level density parameter ratio is chosen in such a way that the best possible description of the mass yield curve is achieved.

TALYS+BROSA

Part of the benchmark exercise includes low-energy fission reactions that can not be treated within the approach presented above. Therefore, we have also coupled the Brosa model with a newly developed nuclear reaction code (TALYS). A suite of sophisticated nuclear reaction models has been implemented into a single code system named TALY, which includes direct, pre-equilibrium, fission and statistical models. All open channels are predicted for reactions involving neutrons, photons, protons, deuterons, tritons, ^{3}He-, α-particles, and fission for target nuclides of mass 12 and heavier. The most important improvement with respect to the ALICE-91-code for benchmark purposes lies in the use of the Hauser-Feshbach approach together with Hill-Wheeler fission competition. This approach incorporates tunnelling through the fission barrier, and therefore enables the description of fission at low energies.

The combination of TALYS with Brosa can in principle be used to predict fission fragment mass yields and fission product mass yields between zero and 200 MeV. However, TALYS does not work with a a_f/a_n-ratio that can be fitted for each reaction to reproduce the mass yield curve and, thus effectively accounts for the disappearance of collective effects in the level density. Instead collective effects are described explicitly. This vanishing process is still under development in the code. Hence, only results up to incident energies of 60 MeV are presented here. All the computations have been performed with fission barriers provided by the finite-range rotating model of Sierk.