Proposal for an ADS-related computational benchmark

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Abstract

Accelerator Driven Systems (ADS) are innovative technological applications identified as potential candidates to perform the transmutation of high-level nuclear waste produced in the nuclear reactors. ADS are multi-disciplinary in the essence of the technical and scientific issues involved and address several cross-cutting issues in Nuclear Engineering and Technology and in Nuclear Science and Materials Science.

ADS involve high-intensity (beam currents in the few mA or even up to a few tens of mA) and intermediate-energy (beam particle energies in the few hundreds of MeV) proton beams impinging on a target of lead-bismuth or pure lead. Neutron fluxes of the order of 10^{15} neutrons / cm2 / s are generated by spallation of the incident protons in the heavy target. Such neutrons are used to induce, through capture and fission reactions, the transmutation of actinides (Neptunium, Plutonium, Americium and Curium) surrounding the target. These radionuclides are characterized by a high radiotoxicity and long decay times and are produced in the nuclear reactors used for the generation of electronuclear energy.

Due to intensity and energy characteristics of the beam and the high density of the target, the simulation of the accelerator-target system is very challenging. Quantities of interest for the design of ADS systems are the neutron fluxes, the energy deposition and power density in the target and surrounding structures, the spallation products generated in the target, the activation of the surrounding structural materials, the radiation damage (dpa) of the target and surrounding materials, helium production, etc..

These issues can be addressed by several Monte Carlo programs (FLUKA, MCNPX, MARS, etc.) representative of the state-of-the-art in computational Radiation Physics. However, computations carried out in previous studies were largely based in MCNPX results and no comparison between such results and the predictions of other codes was performed.

This proposal, submitted to the SATIF group, aims at assessing the relevance of an intercomparison between different codes in the computational topics previously mentioned and to identify a set of issues of interest for the ADS community that could be addressed computationally using the expertise of the SATIF Group members.