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Verification of Monte-Carlo Transport Codes FLUKA, MARS and SHIELD

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Present study is a continuation of the project "Verification of Monte-Carlo transport codes" which is running at GSI as a part of activation studies of FAIR relevant materials. It includes two parts: verification of stopping modules of FLUKA, MARS and SHIELD-A (with ATIMA stopping module) and verification of their isotope production modules. The first part is based on the measurements of energy deposition function of uranium ions in copper and stainless steel. The irradiation was done at 500 MeV/u and 950 MeV/u, the experiment was held in GSI in September 2004 – May 2005. The second part was based on gamma-activation studies of aluminum target irradiated with argon beam of 500 MeV/u in August 2009. Experimental depth profiling of the activation of the target is compared with the simulations.

Summary

The comparison of experimentally achieved energy deposition function and the results of simulations show that FLUKA overestimates the range of uranium ions by 5% for 500 MeV/u and 10% for 950 MeV/u uranium beam. The ranges calculated by MARS and SHIELD-A give discrepancies below 5%, depending on the energy of the incident ion, which coincides with the measured ranges within the accuracy of the measurement. Comparing the experimental and simulated depth profiles of the activated isotopes one could see that in case of Na-22 the codes show similar behaviour of the activation, though the discrepancies in the number of activated particles per incident ion per unit of depth are still observed, which could be explained by differences in cross sections. For this case FLUKA shows better agreement with the experiment, than MARS and SHIELD-A. In case of Be-7 the results of simulations differ in behaviour with the experimentally achieved ones, which could be explained by physical models implied in the codes.

Primary author: CHETVERTKOVA, Vera (Goethe University, Frankfurt am Main; GSI, Darmstadt)

Co-authors: MUSTAFIN, Edil (GSI, Darmstadt); STRASIK, Ivan (GSI, Darmstadt); LATYSHEVA, Ludmila (INR RAS, Moscow, Russia); SOBOLEVSKIY, Nikolai (INR RAS, Moscow, Russia)

Presenter: CHETVERTKOVA, Vera (Goethe University, Frankfurt am Main; GSI, Darmstadt)

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