Simulation of photon-nuclear interaction in production of medical isotopes and transmutation of nuclear waste

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Abstract:

The photon-nuclear interactions are usually excluded from nuclear simulations since theirs contributions are negligible. However when energy of photons increases above 10 MeV they can excite nuclei and for appropriate energy all nuclei exhibit an isovector giant dipole resonance (GDR). GDR decays by emitting neutrons and therefore new isotope is formed. This GDR (gamma,n) reaction has tremendous application since it allows production of short-live nuclear medical isotope from the existing in nature stable isotope. On the other hand it is possible to transmute long-live isotopes in nuclear waste to the isotopes that decays faster and therefore become non-radioactive.

In this presentation FLUKA code, Monte Carlo simulations are presented for planned experiments on GDR application. The suitability of various isotopes for production of medical or industrial application isotopes is examined. The gamma ray beam irradiation of long-live isotopes like 135Cs and 129I, which are present in a nuclear waste, are simulated. The transmutation efficiency is studied for various hypothetical experimental settings.

The results are very promising as the amount of desirable isotopes that are produced during simulation are of the orders of magnitude higher than the other isotopes. . We conclude that simulations confirm that gamma ray beams have potential application for production of some medical isotopes and transmutation of nuclear waste to shorten theirs live-time. However because of low intensity of the currently available gamma beams further developments are needed to make this technique applicable for production of medical isotopes. The required intensities for a full transmutation of nuclear-wastes will be probably not available in the near future.