Photonuclear reactions in FLUKA: cross sections and interaction models

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Photonuclear reactions were implemented in the FLUKA general-purpose multi-particle transport code about ten years ago, opening the way to a more accurate design, fully based on Monte Carlo, of electron accelerator shielding. Since then, photonuclear reactions have been introduced also in other codes: but the strategy chosen for the FLUKA implementation, aimed at covering all nuclei over the whole energy range, probably remains still unique.

The FLUKA scheme is based on four physical models corresponding to different energy ranges but partially overlapping to ensure continuity. All models are smoothly integrated in the FLUKA hadronic event generator (Generalized Intranuclear Cascade, Preequilibrium and Evaporation).

In the lowest energy range, Giant Resonance total cross sections have been derived from experimental data or from existing evaluations for 190 nuclides; for all other nuclei, excitation functions are obtained from parametrizations or by interpolation. Many partial cross sections, not used explicitely in FLUKA, have also been evaluated in order to ensure consistency of the total cross sections entered into the database.

The FLUKA capability to simulate nuclear reactions due to both real and virtual photons has been successfully used in recent years to calculate not only electron accelerator shielding, but also activation of soil and accelerator structures, detector background and muon production by high-energy cosmic gamma rays.

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