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Method for nuclear fragment identification in FOOT experiment.

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Hadrontherapy is a therapy that treats tumors by irradiating cancer cells with proton or heavy ion beams. The main advantage of this technique is that charged particles can release most of their energy in the end-path region (Bragg Peak), limiting the damage to healthy tissues near the tumor.
The effects of charged particle electromagnetic interaction with biological tissue are well-known; however, other effects due to nuclear fragmentation are still partially unknown. INFN financed the FOOT experiment in 2017 to cover this lack of data evaluating the production cross-section of nuclear fragments produced in the interaction beam-human body. Thus, this work proposes to identify fragments produced in the fragmentation process, estimating the charge Z and mass number A. Analyzed data were obtained from MC simulation, done with FLUKA code, of an interaction between a ¹⁶O beam @ 200 MeV/u and a C_2H_4 target. Precisely, the data analysis was focused on the eight most-produced fragments, which are ¹H, ⁴He, ⁷Li, ⁹Be, ¹¹B, ¹²C, ¹⁴N, and ¹⁶O.
Atomic number Z estimation had been obtained through the Bethe-Bloch formula, using two fast scintillators. The mass number A had been obtained through 3 correlated methods, each based on the relativistic definition of four-momentum. In both cases, the final resolutions had been evaluated to be sufficiently precise for future cross-section measurements. Then, to find the best precision possible for mass number A, a systematic study on TOF resolution had been performed. The results had shown that by improving the TOF resolution, it's possible to improve the percentage resolution on A, yielding a 5% resolution for ¹H and 3% for the heaviest fragment. These improvements in mass number A reconstruction precision are fundamental for an optimal isotope separation of the produced fragments. The obtained results had shown that the FOOT experiment can perform an unambiguous identification of the selected fragments.

Title

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