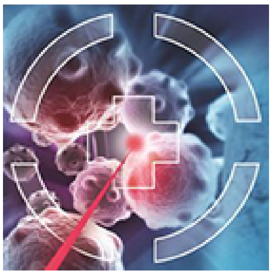

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Measurement of PET isotope production cross sections for protons and carbon ions for applications in particle therapy range verification

Range uncertainties are among the major problems in modern particle therapy 1. The measurement of the activation pattern induced by the beam with positron emission tomography (PET) is a promising technique for in-vivo range verification and is investigated at different facilities worldwide (e.g. CNAO in Italy) in different setups (in-beam, in-room, offline). The accuracy that can be achieved by the particle therapy PET technique relies heavily on the quality of the nuclear reaction models implemented in the radiation transport code used to calculate the reference activation pattern from the treatment plan (e.g. FLUKA [2, 3]).
To support the development and validation of such transport codes, an experimental setup to measure production cross sections for the isotopes 10C, 11C and 15O on target materials of interest (12C and 16O) was built of three BaF2-scintillators and a coincidence unit. It measures the time course of the decay of the β+-activity induced in the target by a proton or carbon ion beam pulse. The production cross sections for 10C, 11C and 15O are obtained by fitting the measured decay curve with a composite exponential decay function with the half-lives corresponding to the different isotopes.

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First experiments with protons and carbon ions were conducted at the Trento proton therapy center and at the Marburg Ion-Beam Therapy center (MIT). Cross sections on 12C were obtained by irradiation of graphite targets and cross sections on 16O were measured using beryllium oxide targets. Some of the measured cross sections are shown in Figure 2.

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The cross sections obtained in the experiments at MIT are in good agreement with literature data and complement them well. In order to validate the nuclear models embedded in the FLUKA code the corresponding cross sections were extracted and compared with the experimental data. Good agreement between experiment and FLUKA was found for incident protons while some refinement of the nuclear models of FLUKA is required for carbon projectiles. Preliminary improvements in FLUKA to better match the measured production cross sections have been presented in [5].

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