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The FOOT (Fragmentation of Target) experiment: A nuclear fragmentation measurement for particles-therapy and space radio-protection

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Particle-therapy adopts ion beams for the treatment of deep-seated solid tumors. Due to the characteristic energy deposition of charged particles, a small amount of dose is released to the healthy tissue in the beam entrance region, while the maximum of the dose is released the tumor. Nuclear interactions between the beam and the patient tissues induce nuclear fragmentations that must be taken into account. The FOOT experiment, a new project funded by INFN (Istituto Nazionale di Fisica Nucleare), was designed to study these processes. Its aim is to measure the fragments differential cross section as a function of the energy, charge and mass with 5% uncertainty, using ion beams (He, C, O) of energy ranging from 200 to 700 MeV/n. The measurements at energies greater than 400 MeV/n are dedicated to study space radio-protection. The target fragmentation cross section will be measured in inverse kinematic, using a polyethylene (C_2H_4) target. The cross section over H ions is obtained by subtracting the C cross section measured using a graphite target. The apparatus (schematically shown in Fig. 1) is composed of a start counter providing the trigger. A drift chamber reconstructs the direction and the impinging point of the ion on the target. A silicon pixel detector track the fragments after the target. ΔE-TOF detector measures the energy released in a thin plastic scintillator and the stop of the TOF system. A calorimeter of BGO crystals measures the kinetic energy of the fragments. In addition, an emulsion spectrometer will characterize the production of low Z fragments. The experiment is designed as a 'table-top' experiment with a 10° angular acceptance in a length of less than 1,5 meters. The first data taking is foreseen in 2019 at GSI. The detector, the performances adn the physical program of the experiment will be presented.

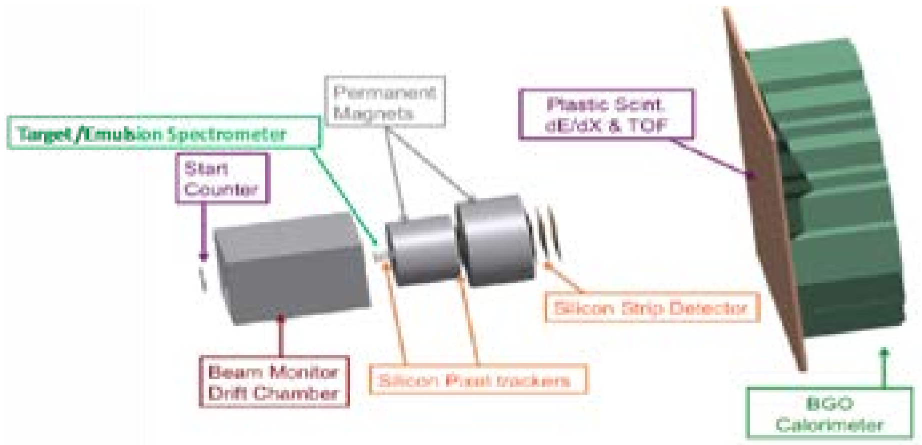

Figure 1: Schematic view of the FOOT detector.

Recent Publications

1. A Alexandrov et al., (2017) Measurement of 12C ions beam fragmentation at large angle with an Emulsion Cloud Chamber. JINST 11:P08013.
2. A. Alexandrov, A. Buonaura, L. Consiglio, N. D'Ambrosio, G. De Lellis, A. Di Crescenzo, G. Galati, V. Gentile, A. Lauria, M.C. Montesi, V. Tioukov, M. Vladymyrov, E. Voevodina, (2017) The Continuous Motion Technique for a New Generation of Scanning Systems. SCIENTIFIC REPORTS 7: P07310.

3. N. Agafonova et al. (OPERA Coll.) (2018) Final results of the OPERA experiment on $\nu\tau$ appearance in the CNGS neutrino beam. Phys. Rev. Lett. 120:211801.
4. N. Agafonova et al. (OPERA Coll.) (2018) Discovery potential for directional Dark Matter detection with nuclear emulsions. Eur. Phys. J. C, 78: 578.
5. M. Marrocchi et al. (FOOT Coll.) (2018) Development and characterization of a ΔE-TOF detector prototype for the FOOT experiment. NIM-A. DOI: 10.1016/j.nima.2018.09.086.

Biography

Adele Lauria completed her studies in Medical Physics in 2003 at University of Naples. Since 2011, she worked in the field of the nuclear emulsion detectors, adopted in particle physics experiments for the neutrino oscillation studies. Later, she applied this experience in the Medical Physics research, where the nuclear emulsions were adopted to study the target fragmentation in the hadron therapy.

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