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Energy response function and calibration of the FOOT calorimeter.

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The FOOT experiment aims at measuring the differential cross sections for the production of secondary fragments in interactions between light ions (C, O) and hydrogen-enriched targets, with beam energies of up to 400 MeV/u, a topic relevant for the optimization of particle therapy treatments, which can only be addressed in inverse kinematics [1]. By extending the energy range up to 800 MeV/u, the experiment will also collect valuable data for understanding fragmentation processes relevant for the design of spacecraft shielding [2].

The experiment, whose construction is almost completed, aims at identifying heavy fragments by measuring their momentum, kinetic energy, and time of flight with high resolution: 5%, 2% and <100 ps respectively. The kinetic energy will be measured with a calorimeter detector made of 320 BGO crystals coupled to SiPM photodetectors, covering a dynamic range from tens of MeVs to about 10 GeV.

Data takings, aiming at measuring the response function for different ions and at optimizing crystal intercalibration, have been conducted at HIT (Heidelberg, Germany), and at CNAO (Pavia, Italy), using 12 modules of 3x3 crystals each. The energy response between 50 and 430 MeV/u is consistent with a modified Birks function for all the ions, although the parameters depend on Z. The parameters dependency on Z has been measured, allowing to reconstruct the fragment energy. The integrated system resolution is, as expected, well below 2% over the 100-300 MeV/u range.

1. *Battistoni G, Toppi M, Patera V and The FOOT Collaboration (2021) Measuring the Impact of Nuclear Interaction in Particle Therapy and in Radio Protection in Space: the FOOT Experiment. Front. Phys. 8:568242. doi: 10.3389/fphy.2020.568242*
2. *M. Durante and F. Cucinotta, "Physical basis of radiation protection in space travel," Rev. Mod. Phys., vol. 83, no. 4, p. 1245, 2011.*

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