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CaloCube: a innovative homogeneous calorimeter for the next-generation space experiments

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The direct measurement of cosmic-ray spectrum, up to the knee region, is one of the instrumental challenge for next-generation space experiments. The main issue for these measurements is a steeply falling spectrum with increasing energy, so the physics performance of the space calorimeters are primarily determined by their geometrical acceptance and energy resolution. CaloCube is a three-years R&D project, approved and financed by INFN in 2014, aiming to optimize the design of a space-borne calorimeter. The peculiarity of the design of CaloCube is its capability of detecting particles coming from any direction, and not only those on its upper surface. To ensure that the quality of the measurement does not depend on the arrival direction of the particles, the calorimeter will be designed as homogeneous and isotropic as possible. In addition, to achieve a high discrimination power for hadrons and nuclei with respect to electrons, the sensitive elements of the calorimeter need to have a fine 3-D sampling capability. In order to optimize the detector performances with respect to the total mass of the apparatus, which is the most important constraint for a space launch, a comparative study of different scintillating materials have been performed using detailed Monte Carlo simulation based on the FLUKA package. Different geometries, besides the cubic one, and the possibility to implement dual-readout techniques have been also investigated. In parallel to simulation studies, a prototype consisting in 14 layers of 3 × 3 CsI(Tl) crystals per layer has been assembled and tested with particle beams. An overview of the obtained results during the first two year of the project will be presented and the future of the detector will be discussed too.

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