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Tracker-In-Calorimeter (TIC) project: a calorimetric new solution for space experiments

A multi-messenger, space-based cosmic ray detector for gamma rays and charged particles poses several design challenges due to the different instrumental requirements for the two kinds of particles. The optimization of the detector, to have a good angular resolution needed for gamma rays, and a good geometric factor needed for charged particles is the main purpose of the Tracker-In-Calorimeter (TIC) project. In cosmic rays experiments, such as Fermi-LAT, the direction of the incident particle is reconstructed using an external tracker made of passive layers (like tungsten) and active position-sensitive layers (such as a silicon microstrip detector). In this case, the angle of the gamma rays is indirectly measured from the tracks of the electron-positron pair formed by conversion in passive layers. The main disadvantage of this configuration is that the acceptance is limited by the large level arm between silicon layers needed to have good track reconstruction performances. In addition, tungsten layers require an additional allocation of a fraction of the mass budget that could instead be used to increase the size of the calorimeter. Passive layers also induce fragmentation of nuclei, thus worsening charge reconstruction performances. All these drawbacks are solved by the TIC approach, where silicon detectors are moved inside a highly-segmented calorimeter, except for a couple of external layers dedicated mainly to charge and tracking reconstruction of charged particles. This solution exploits the scintillator layers to develop the shower and the silicon detectors to measure the lateral profile. In this case, the angle of the gamma rays is reconstructed indirectly from the lateral profile of the shower sampled at different depths in the calorimeter.

The effectiveness of this approach has been studied with Monte Carlo simulations and has been validated with test beam data of a detector prototype.

The results of these studies will be presented.

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