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A new approach to calorimetry in space based experiments for high-energy cosmic rays

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Unambiguous measurements of the energy spectra and of the composition of cosmic rays up to the knee region, around 1 PeV, could provide important clues on their origin, acceleration mechanism, propagation, and composition. A space experiment dedicated to measurements in this energy region has to achieve a balance between the requirements of lightness and compactness, with that of a large acceptance to cope with the low particle rates.
CaloCube is a four-years R&D project, approved and financed by INFN in 2014 aiming to optimize the design of a space-borne calorimeter. The large acceptance needed is obtained by maximizing the number of entrance windows, while thanks to its homogeneity and high segmentation this new detector allows achieving an excellent energy resolution and an enhanced separation power between hadrons and electrons.
In order to optimize detector performances with respect to the total mass of the apparatus, comparative studies on different scintillating materials, different sizes of crystals and different spacings among them have been performed making use of MonteCarlo simulations. In parallel to simulations studies, several prototypes instrumented with CsI(Tl) cubic crystals have been constructed and tested with particle beams. An overview of the results obtained so far will be presented and the perspectives for future space experiments will be discussed.
In addition, we will present the TIC (Tracker-In-Calorimeter) project, the natural development of CaloCube, financed by the INFN for 2018. The basic idea is to study the feasibility of including several silicon layers at different depths in the calorimeter in order to reconstruct the particle direction. Respect to the traditional approach of using a tracker with a passive material in front of the calorimeter, the TIC solution can save a significant amount of mass budget in a space satellite experiment, that can be therefore exploited to improve the acceptance and the resolution of the calorimeter. The studies realized so far making use of MonteCarlo simulations will be presented.

Summary

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