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A highly granular, digital electromagnetic calorimeter prototype

In light of the upgrade program of the ALICE detector a calorimeter at forward rapidities (FoCal) is being considered. This detector would measure photons, electrons, positrons and jets for rapidities $\eta > 3$, offering a wealth of physics possibilities. Its main focus will be on measurements related to the structure of nucleons and nuclei at very low Bjorken-x and possible effects of gluon saturation. The FoCal electromagnetic calorimeter must be able to discriminate between decay photons and direct photons at very high energy, which requires extremely high granularity.

A dedicated R&D program is ongoing to develop the technology needed for such a high-granularity device. Within this program we have constructed a unique prototype of a digital electromagnetic calorimeter based on CMOS monolithic active pixel sensors (MAPS). This prototype has demonstrated the unique capabilities of such highly granular digital calorimeters, providing unique shower profile measurements and good linearity and energy resolution. The prototype calorimeter was based on the MIMOSA chip, which, with its rolling shutter readout, is not fast enough for application in a full detector at LHC.

As a next step, the ALPIDE chip, developed for the ALICE Inner Tracker Upgrade, is being investigated for performance with high occupancy. The ALPIDE chip has a size of 30 x 15 mm^2 with a pixel matrix of 1024 x 512, and a pixel size of 29.24 x 26.88 μm^2. The readout is hit driven, where each double column of pixels is read out via a priority encoder, at a maximum readout speed of 1.2 Gb/s.

A new small calorimeter prototype based on this chip, called mTower, has been designed and is under construction at the moment. It will consist of 24 layers, each of 2 ALPIDE chips and 3 mm of tungsten absorber. The sensitive area will thus be 3 x 3 cm^2. This prototype allows to test the performance of the ALPIDE in a digital calorimeter application and as such will provide input into the final FoCal design parameters. It allows the testing of the electronics, cabling and readout. In a test beam at SPS a few of these single calorimeter layers with ALPIDE chips were tested in August 2018. Currently, a small stack of several layers is tested for performance, with charge injection (occupancy tests) and cosmic muons. A test beam for the full mTower is planned for early 2020.

This contribution will present both results from the first prototype, as well as demonstrate the performance of the ALPIDE in a calorimeter in first measurements with this new prototype under development.

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