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Towards ultra-high granularity calorimetry

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We are developing a new type of electromagnetic calorimeter based on a SiW sampling design using silicon pixel sensors with digital readout. A binary readout is possible due to the pixel size of $\approx 30 \times 30\,\mu\mathrm{m}^2$. At the same time, this unprecedented granularity allows us to measure electromagnetic shower properties with extreme detail. This kind of detector will have superior two-shower separation capabilities, and it should have unique properties beneficial for particle flow algorithms. The R&D is performed in the context of the Forward Calorimeter upgrade proposal within the ALICE experiment; it is equally applicable to other future collider projects such as EIC, ILC, CLIC or FCC.

Based on experience with the first full prototype of such a calorimeter, which demonstrated a proof of principle [1], we have constructed an advanced second prototype, EPICAL-2, which makes use of the Alpide MAPS sensor developed for the ALICE ITS upgrade. The prototype consists of alternating W absorber and Si sensor layers, with a total thickness of ~20 radiation lengths, an area of $30\mathrm{mm} \times 30\mathrm{mm}$, and ~25 million pixels. This prototype has been successfully tested with cosmic muons and with electron beams at the DESY test beam facility.
We will report on first results regarding alignment and calibration with muons and on the calorimetric response to electrons. The prototype shows good energy resolution and linearity, comparable with those of a SiW calorimeter with analog readout. MC simulations within the Allpix2 framework [2] have been performed and show agreement with the experimental results. We will also show first results of shower-shape studies with unprecedented spatial precision.
In addition, we will discuss the further R&D path for other applications in particle and nuclear physics.

[1] JINST13 (2018) P01014.
[2] NIM A901 (2018) 164–172.

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