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High granularity digital Si-W electromagnetic calorimeter for forward direct photon measurements at LHC

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It is widely expected that the non-linear growth of parton densities at low x predicted from linear QCD evolution will lead to gluon saturation. As a decisive probe of gluon saturation, the measurement of forward (3.5 < y < 5) direct photons in a new region of low x (10-5 - 10-6) in proton-nucleus collisions at the LHC is proposed. An extremely high-granularity electromagnetic calorimeter is proposed as a detector upgrade to the ALICE experiment. This Forward Calorimeter (FoCal) is required to discriminate direct photons from decay photons with very small opening angles from neutral pions.
To facilitate the design of the upgrade and to perform generic R&D necessary for such a novel calorimeter, a compact digital Si-W sampling electromagnetic calorimeter prototype, using Monolithic Active Pixel Sensors (MAPS) with a granularity of 30×30 μm2 and a total length of 28 X0 has been built and tested with beams. The prototype features ˜39 million pixels and an extremely small Molière radius ˜11mm.

We will present the design principle of the proposed FoCal detector, and the realisation of the prototype. Test beam results will be discussed, which show good energy linearity and resolution. These results show the successful proof of principle of particle counting calorimetry technology. This technology has an excellent position resolution for electromagnetic showers (< 30μm) and should allow the separation of two photon showers down to distances of a few mm. In addition, it should provide unprecedented capabilities for applications of particle flow algorithms in future calorimeters.

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