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CMOS Monolithic Sensor for Calorimetry and Outer Tracking at Future Colliders

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The DECAL sensor, a depleted monolithic active pixel sensor (DMAPS), was developed for digital calorimetry, where the number of pixels above threshold are counted to estimate the shower energy. The pixel size must be sufficiently small to avoid hit saturation (where in the core of dense showers multiple particles hit the same pixel). The DECAL and DECAL FD sensors have been fabricated in the TowerJazz 180 nm standard and "modified" imaging process (see below), respectively. They each feature a single cell with 64 x 64 matrix of 55 um pitch pixels read out every 25ns. Within in each pixel are 4 collection electrodes, trimming logic, shaper, comparator, and discriminator with digital output. The pixel configuration logic provides a five-bit calibration DAC and a mask flag.

The DECAL can be reconfigured as a strip sensor (reading out the column address of hits) for pre-shower and tracking applications. A detector with 55 um pitch crossed strips at the start of the calorimeter should enhance bremsstrahlung recovery for electrons and aid discrimination of high energy pi_0s from gammas. Results on the latter for such a detector are presented from simulation. Combining columns from neighbouring cells and assuming a final wafer-scale design with stitching, would provide a single CMOS sensor which could be configured in different layers to serve as either outer tracker, pre-shower or pad calorimeter.

This talk will present characterization results on the DECAL and DECAL FD prototypes, where the latter (modified process) has been fabricated with an additional continuous low doped n-type layer, using a low dose high energy implant. This moves the diode boundary to the interface of this layer with the p-type epitaxial layer, allowing full depletion of the device with charge collection by drift rather than diffusion. This greatly speeds up charge collection, even from corners of the pixel far from the electrodes, which also significantly improves the radiation hardness, even to the levels required for barrel ECAL regions of FCC-hh. Along with the DECAL results, initial results on DECAL FD, such as threshold scans and analogue pixel measurements will be presented

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