12th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors (HSTD12) at Hiroshima, Japan

Contribution ID: **341** Type: **POSTER**

Novel architecture for the analog front-end of Medipix4

Saturday 14 December 2019 14:56 (1 minute)

Medipix4 is the latest member of the Medipix family of pixel detector readout chips aimed at high rate spectroscopic X-ray imaging. Unlike its predecessors it will be possible to tile the chip on all 4 sides permitting seamless large area coverage. This presentation focuses on the development of a new architecture for the front-end of Medipix4 capable of event-by-event data processing allowing photon energy reconstruction with charge sharing correction at an increased rate compared with Medipix3. The architecture is particularly well adapted to high-Z detector materials allowing accurate energy binning of incoming hits at a fine pixel pitch.
In order to fulfil the demanding requirements from future users of Medipix4, a novel front-end architecture has been implemented to improve the energy dynamic range, the count-rate capability, and the energy resolution. As the chip can be tiled on 4 sides it is necessary to have a readout pixel pitch which is slightly smaller in one dimension than the sensor pixel pitch. The fan-in required from sensor to readout imposes further constraints on the front-end. Moreover, the architecture is tuned to contact a sensor with either 70 μm or 140 μm pitch
The analog front-end is implemented using a commercial 130 nm deep sub-micron technology process, and the functionality is verified by simulation. Each 70 μm pixel contains a charge sensitive amplifier with a baseline holder to compensate DC leakage currents coming from the sensor, two shapers for implementing the charge sharing correction mode (CSM), followed by discriminators with locally programmable threshold. The linear range of the front-end is extended to 150 keV using a sensor CdTe, implying a 40% enhancement with respect to Medipix3. A feedback circuit in the shaper with a reference current allows a faster return to the baseline, resulting in an expected count rate of 17 Mphotons/mm2.s at 10% hit loss for a pixel pitch of 140 μm, and not affected by charge sharing effect, showing a gain of factor 5 with respect to its predecessor.

Submission declaration

Original and unpublished

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Session Classification: POSTER

Track Classification: Pixel sensors for imaging