Contribution ID: **139** Type: **Poster**

Particam: A fully digital sensor for sub micron resolution

Tuesday 1 October 2024 17:40 (20 minutes)

Silicon particle detectors struggle to follow the miniaturisation of available commercial processes, partially due to the relatively large transistors required for the optimal performance of the analogue frontend. Particam instead uses a digital only approach which is focused on digital storage cells switching due to transient radiation. With a pixel being little more than a memory cell it can be designed with close to minimum feature size with very few transistors allowing pixel pitches of a few microns.
Results of initial proof-of-principle MPWs as well as plans for the next steps in the project are presented.

Summary (500 words)

While commercial CMOS processes allow smaller and smaller feature sizes, designs for analogue frontends of pixel sensors for particle physics applications are typically designed in much larger nodes. On contribution inhibiting the miniaturisation is the large size of the transistors required for analogue circuits. Thus, granularity of pixel sensors has not significantly improved over the past decade.
Particam seeks to improve the pixel segmentation by an order of magnitude by taking a radical approach: Instead of having a typical amplifier + digitiser circuit, Particam pixels are implemented as simple memory like cells which are sensitive to single event transients (SETs). Instead of hardening the memory to the influence of ionising radiation, the pixel is optimised such that it content is flipped by the induced charge.
In particam1, the first demonstrator implemented in a 65nm process, 4 different arrays are implemented. The standard array consists of 256x256 pixels with 2.5 um pitch with a standard SRAM circuit. The custom array has the same dimensions but the memory cell circuit is adapted to have a much lower charge required for a bit flip. Pixels of the aggressive array consist of only 4 transistor and have a pitch of 2um. The exploratory array aims to exploit latch-up like events by creating parasitic bipolar transistors from different wells. Its pixels have a pitch of 6.5um.
Test pixels are stimulated with external signals to measure the critical charge required to toggle the different types of pixels, demonstrating the functionality of the circuits.
Samples of Particam1 have been coated with a neutron converter to test the capability as high resolution neutron detector.
Due to the lack of deep junctions and significant depletion voltage, charge collection and efficiency to particles leave much to be desired. A second prototype aimed at studying the charge collection of such small pixels has been submitted and is expected in June. Very small nodes (<30nm) are currently considered for further R&D.
While the Particam approach is most likely not suited for high rates, the improved granularity is relevant for high precision applications which could also be outside of particle physics. Particam should be presented at TWEPP to inform the community of the potential spatial resolution this concept offers such that use cases can be identified and dedicated developments can be initiated.

Author: HAMMERICH, Jan (University of Liverpool (GB))

Co-authors: CASSE, Gianluigi (University of Liverpool (GB)); Mr PARMESAN, Luca (Fondazione Bruno Kessler); Mr GOTTARDI, Massimo (Fondazione Bruno Kessler); MASSARI, Nicola (Fondazione Bruno Kessler)

Presenter: HAMMERICH, Jan (University of Liverpool (GB))

Session Classification: Tuesday posters session

Track Classification: ASIC