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The OBELIX sensor for the Belle II VTX Upgrade

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OBELIX is a depleted monolithic active pixel sensor developed for the Belle II experiment at the SuperKEKB e^+e^- asymmetric energy collider designed to cope with high particle fluence. The proposed upgrade of the Belle II Vertex Detector (VTX) will use OBELIX sensor on all its 5 layers. The sensor is based on the TJ-Monopix2 design, fabricated in a radiation hard CMOS 180 nm process.

While its pixel matrix is inherited from TJ-Monopix2, the OBELIX periphery is designed from scratch: A 2-stage pixel memory matches Belle II trigger requirements, handling events with hit rates up to 120 MHz/cm² at a 10 μ s latency without buffer overflow. This logic also handles hit rate spikes of 600 MHz/cm² and 0.5 μ s duration with less than 0.5% data loss. This tolerance to spikes is necessary to maintain efficiency at the continuous injection scheme of the SuperKEKB collider. In addition, OBELIX includes LDO regulators for supply voltages intending to simplify the chip integration into the detector system.

To improve track reconstruction performance, an additional high precision timing module is included in the periphery of OBELIX. Based on TJ-Monopix2 test results, a time resolution of less than 3 ns is expected. This feature is, however, currently limited to low hit rates and will only be enabled for the outer 3 layers of the VTX.

A new feature for the vertex detector introduced by OBELIX is the possibility to contribute to the trigger. The chip can provide coarse hit information at low latency to the trigger system in order to build decisions based on VTX tracks. The current implementation is intended as a proof of concept. A transmission time of 200 ns is reached by reducing the matrix granularity to only 8 macropixels.

This contribution will focus on the features of the first OBELIX submission ('OBELIX-1') chip currently under development. Details on the design and its implementation, as well as results of various performance simulations calibrated with real data from TJ-Monopix2 measurements will be presented.

Author: SCHWANDA, Christoph (Austrian Academy of Sciences (AT))

Presenter: SCHWANDA, Christoph (Austrian Academy of Sciences (AT))

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