

13th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors (HSTD13), Vancouver, Canada

Contribution ID: 50

Type: Oral

The DMAPS Upgrade of the Belle II Vertex Detector

Friday 8 December 2023 09:20 (20 minutes)

The Super-KEKB collider is set to undergo a major upgrade to achieve a target luminosity of $6 * 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$. A long shutdown is foreseen around year 2027, which provides the opportunity to revisit parts of the Belle II experiment.

A new pixelated vertex detector (VTX) is being developed to match the upgraded interaction region. This silicon tracker aims to be more robust against the expected higher machine background and improve precision and standalone track finding efficiency.

The proposed VTX design comprises of five layers in a barrel-shaped configuration with minimal material budget.

The innermost layers are based on an "all-silicon ladder" concept with air cooling, targeting a material budget below 0.2% X₀/layer.

For the three outer layers, liquid cooling and carbon-fiber support structures based on on ALICE-ITS2 with a material budget ranging from 0.3% X₀ for later 3 up to 0.8% X₀ for layer 5 will be used.

All the ladders feature the OBELIX depleted-MAPS CMOS sensor, with an active area of approximately 2 cm × 3 cm, designed in the Tower 180 nm technology.

The pixel-matrix, derived from the TJ-Monopix2 sensor developed for the ATLAS experiment, has a 33 μm pitch and an integration time of less than 100 ns.

The power-dissipation is less than 200 mW/cm^2 at an average hit-rate of 60 MHz/cm^2 . A digital trigger logic is designed to meet Belle II requirements, targeting a 30 kHz average trigger-rate with a 10 μs trigger delay and a maximum hit-rate of 120 MHz/cm^2 . The initial version of the sensor is expected to be designed and submitted for foundry production by late 2023.

The presentation will encompass various aspects of the project, including tests of the TJ-Monopix2 to validate pixel-matrix performance, a detailed focus on the OBELIX features and design status as well as prototype fabrication and testing of the mechanical concepts.

Submission declaration

Original and unpublished

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Session Classification: Day 5 - Session 1

Track Classification: Pixel sensors for tracking