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CMOS MAPS upgrade for the Belle II Vertex Detector

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The success of the Belle II experiment in Japan relies on the very high instantaneous luminosity, close to 6x10^35 cm^-2 s^-1, expected from the SuperKEKB collider. The corresponding beam conditions generate large rates of background particles and creates stringent constraints on the vertex detector, adding to the physics requirements.
Current prospects for the occupancy rates in the present vertex detector (VXD) at full luminosity fall close to the acceptable limits and bear large uncertainties.
In this context, the Belle II collaboration is considering the possibility to install an upgraded VXD system around 2026 to provide a sufficient safety factor with respect to the expected background rate and possibly enhance tracking and vertexing performance.

Our international consortium has started the design of a fully pixelated VXD, dubbed VTX, based on a depleted CMOS Monolithic Active Pixel Sensor prototype developed for LHC-type conditions and recent light detection layer concepts.

The striking technical features of the VTX proposal are the usage of the same sensor over the few layers of the system and the decrease of the overall material budget below 2 % of radiation length. The new dedicated OBELIX sensor is under development, starting from the existing TJ-MONOPIX-2 sensor. The time-stamping precision below 100 ns will allow all VTX layers to take part in the track finding strategy contrary to the current situation. The first detection layers are designed according a self-supported all-silicon concept, where 4 contiguous sensors are diced out of a wafer, thinned and interconnected with post-processed redistribution layers. Beyond a radius of 3 cm, detection layers follow a more conventional approach with a carbon fiber support structure and long but light flex cables interconnecting sensors.

This talk will review the context, technical details and development status of the proposed VTX as well as discussing performance expectations from simulations.

Collaboration

The Belle II VTX collaboration

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