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The DMAPS Upgrade of the Belle II Vertex Detector

The Super-KEKB collider will undergo a major upgrade to reach the target luminosity of 6 10ˆ35 cm-2 s-1. A long shutdown is foreseen around year 2027, which provides the opportunity to revisit significant parts of the Belle II experiment and adapt them to the expected change of the experimental conditions. In particular, a new pixelated vertex detector (VTX) is being designed to fit the upgraded interaction region. This new silicon tracker aims to be both more robust against the expected higher level of machine background and more performant in terms of precision and standalone track finding efficiency.
The VTX design presented here features an envelope close to the present one, spanning from radii of 14 mm to 135 mm. The baseline layout consists of two identical layers composing the inner part (iVTX) and three outer layers (oVTX), all arranged in a barrel-shaped geometry, with minimal material budget.
It is equipped with a dedicated DMAPS CMOS sensor named OBELIX. The latter is an approximately 2 cm x 3 cm large die designed in the TJ-180 nm technology, derived from the MONOPIX-2 sensor originally developed for the ATLAS experiment. It is expected be submitted to foundry by late 2023.
The two iVTX layers have a sensitive length of about 12 cm and are based on an "all-silicon ladder"concept. A 4-sensor wide module is cut from the processed wafer and submitted to two post-processing operations: 1.) a large size signal redistribution layer (RDL) to interconnect on top the sensors along the ladder; 2.) a selective backside 50-µm thinning.
A demonstrator, based on dummy silicon wafers, is going to be realized with a monolithic self-supporting structure to assess the concept of an all-silicon ladder.
To target a material budget of 0.1 % X0/layer, the cooling of the iVTX relies on forced convection of air, expected to be applicable given the low power density of the sensors and the limited area of the inner ladders. First simulations supporting the viability of this solution will be presented.
As for the oVTX, the target material budget is ranging from 0.3 % X0 for layer 3 up to 0.8 % X0 for the 70 cm-long ladder of the fifth (i.e. external) layer. An evolved design of the ladder concept used in the ALICE-ITS is adopted, with a light mechanical structure, supporting a liquid-cooled plate. The sensors are glued on top of this plate, with traditional Aluminum flex circuits used to distribute power/controls and for data transfer. The mechanical structure of the most challenging outer prototype ladder consists of a truss structure, obtained by assembling 3 water-jet cut layers. The mechanical and thermal characterization of the prototypes will be presented.

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