

Upgrade of the Belle II vertex detector with depleted monolithic CMOS active pixel sensors



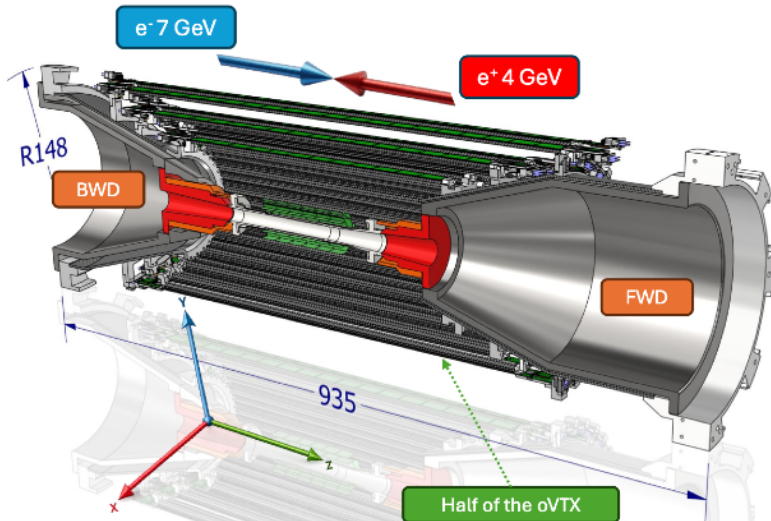
Adrian Bevan on behalf of the Belle II VTX collaboration

(IGFAE Santiago, University of Bergamo, University of Bonn, University of Dortmund, University of Göttingen, Jilin University, KIT, Karlsruhe, IPMU Kashiwa, QMUL, CPPM Marseille, IJCLab Orsay, RAL, INFN & University of Pavia, INFN & University of Pisa, IFCA (CSIC-UC) Santander, IPHC Strasbourg, University of Tokyo, KEK, IFIC (CSIC-UV) Valencia, MBI Vienna)

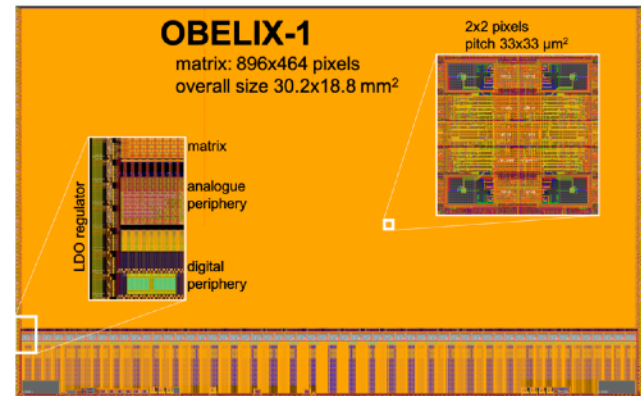
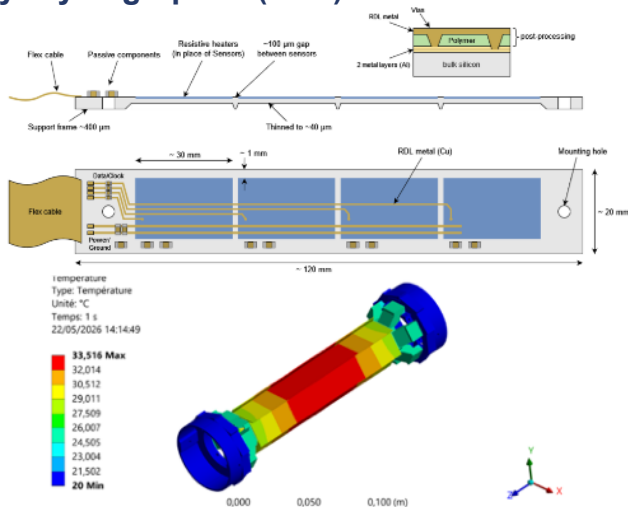
Belle II is the worlds highest luminosity e^+e^- collider. Designed to accumulate 50ab^{-1} of data at, or near the $\Upsilon(4S)$ resonance to search for physics beyond the Standard Model, and do precision tests of particle physics.

Aim to upgrade the silicon vertex detector, replacing the double sided silicon micro strip and DEPFET detector systems with an inner and outer vertex tracker (iVTX and oVTX) based on a 180nm CMOS MAPS sensor: OBELIX-1 [1, 2].

To realise this upgrade the detector has to fit in a smaller volume than the existing detector, creating a challenging design problem.



iVTX: 2 layers of 4 reticles sized ladders close to the beam pipe: spatially constrained, low mass solution. The baseline solution is a passively cooled system using thermoplyrotic graphite (TPG) to extract heat.

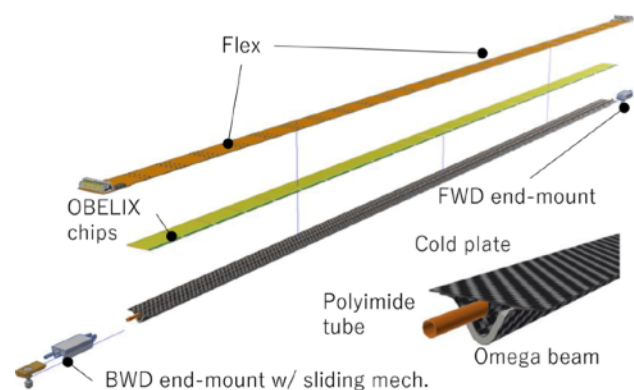


Pitch	33 μm
Signal ToT	7 bits
Time stamping	50 to 100 ns
Fine time * stamping	~ 5 ns for hit rate < 10 MHz/cm ²
Trigger handling	30 kHz with 10 μs delay
Trigger * output	~ 10 ns resolution with low granularity
Power (with hit rate)	200 to 300 mW/cm ² (1 to 120 MHz/cm ²)
Bandwidth	1 output 320 MHz

* Optional features

OBELIX-1 chips will be used for the oVTX and iVTX structures. Four chips are combined to make an iVTX ladder. Individual chips are assembled on Omega beams for the oVTX.

oVTX: 3 layers of long Omega beam structures providing support for the CMOS sensors and readout flex.



The project is refining details of the design. We expect OBELIX-1 prototype chips to be delivered in the autumn of this year, and are aiming to produce demonstrator ladders for the VTX and a Technical Design Report in 2027.

References:

- [1] H. Aihara et al., "The Belle II Detector Upgrades Framework Conceptual Design Report", arXiv: 2406.19421.
- [2] For a recent update on the project please see Y Onuki et al. arXiv:2607.00741 (submitted to JINST)