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The new two-layer Belle II PiXel Detector (PXD)

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The Belle~II experiment at the SuperKEKB super B-factory collects data from asymmetric-energy e^+e^- collisions at the $\Upsilon(4S)$ resonance since 2019.
Its goal is to collect a $B\bar{B}$ data set 50 times larger than that of the predecessor experiments Belle and Babar enabling new levels of accuracy in measurement of standard model processes and search for new physics at the luminosity/precision frontier.

A vertex resolution of O(10) μm is required for the precise discrimination of decay vertices and lifetime measurements of short-lived particles.
This is made possible by the Belle~II VerteX Detector (VXD). It consists of the ultra low-mass PiXel Detector (PXD) based on the DEpleted P-channel Field Effect Transistor (DEPFET) sensor technology surrounded by a double sided silicon strip detector (SVD).

The PXD features self supported all-silicon modules with 75 μm thin sensor areas bringing down the material budget to an average of $\sim 0.21\%\ X_0$ per layer inside the physics acceptance.
This constitutes the lowest mass tracking detector in a running high energy physics experiment to date.
It features ladders of up to 17 cm length with pixel sizes of 50×55 to 50×85~$\mu\mathrm{m}^2$.
Cooling of the low power matrix is provided by N_2 gas flow while the readout Application Specific Integrated Circuits (ASICs) are cooled by closed two-phase CO_2 loops.

During Run 1 (2019-2022), a single-layer of PXD was installed and delivered the expected performance. In 2023, during the first long shutdown (LS1) a new, fully populated two-layer PXD (PXD2) has been installed.
The production and pre-commissioning of PXD2 took several years and culminated in its installation into the Belle~II detector in summer 2023.
Since February 2024, Belle II has restarted data-taking of Run 2 and PXD2 performs within its specifications.

Due to its large thin ladder design, PXD is subject to small scale mechanical deformation caused by varying temperatures depending on its operation and beam conditions.
Ensuring mechanical stability of the system has been a significant effort during the commissioning of the detector and the monitoring of its condition is an ongoing task.
In order to avoid damage from severe sudden beam losses, as experienced when tuning SuperKEKB for higher luminosities, the PXD was switched off for part of the current run.

This presentation will highlight challenges from the construction and commissioning of PXD2 as well as its performance during the first months of Run 2.

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