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The Belle II DEPFET Pixel Detector

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BELLE II is an experiment in KEK (Tsukuba, Japan) that will explore heavy flavour physics (B, charm and tau) from early 2018 with unprecedented precision. Charged particles are tracked by a two-layer DEPFET pixel device (PXD), a four-layer silicon strip detector (SVD) and the central drift chamber (CDC). The PXD will consist of two layers at radii of 14 mm and 22 mm with 8 and 12 modules respectively. The pixel sizes will vary, between $50\mu\text{m} \times (55 - 60)\mu\text{m}$ in the first layer and between $50\mu\text{m} \times (70 - 85)\mu\text{m}$ in the second layer, to optimize the charge sharing efficiency. These innermost layers have to cope with high background occupancy, high radiation and must have minimal material to reduce multiple scattering. These challenges are met using the DEPFET technology. Each pixel is a FET integrated on a fully depleted silicon bulk. The signal charge collected in the 'internal gate' modulates the FET current resulting in a first stage amplification and therefore very low noise. This allows very thin sensors ($75\mu\text{m}$) reducing the overall material budget of the detector ($0.21\% X_0$). Four fold multiplexing of the column parallel readout allows read out a full frame of the pixel matrix in only $20\mu\text{s}$ while keeping the power consumption low enough for air cooling. Only the active electronic outside the detector acceptance has to be cooled actively with a two phase CO₂ system. Furthermore the DEPFET technology offers the unique feature of an electronic shutter which allows the detector to operate efficiently in the continuous injection mode of superKEKB. All of these features, the sensor concept and the electronics involved, system tests and the construction status will be presented in detail.

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