Prototype DEPFET active pixel sensors designed for the vertex detector at the Belle-II experiment at KEK, Japan, and for experiments at a future linear collider have been produced on thin silicon-on-insulator (SOI) material. The DEPFET (DEpleted P-channel FET) is a field effect transistor with an additional implantation beneath the transistor channel integrated on a fully depleted substrate. The inherent property of combined signal detection and signal amplification of the DEPFET allows the production of very thin sensors with an excellent signal-to-noise ratio for minimum ionizing particles. Combining a highly specialized MOS process which includes two poly-silicon and three metal layers on a fully depleted bulk with MEMS technology makes it possible to build thin wafer-scale (150 mm wafers) DEPFET active pixel sensors on a self-supporting all-silicon module.

The DEPFET is the basis element of the DEPFET active pixel sensors for future e+/e- collider experiments. Due to charge sharing between several pixels, the hit resolution is better than expected from the actual pixel size alone. The observed signal to noise ratio is ~40 and confirms the prediction from detailed simulations. The DEPFET pixels are read out by a series of specially designed ASIC chips. The ASICs (SwitcherB and DCDB) switch on the matrix row by row and digitize the drain currents. Laser scans and radioactive source measurements have been performed to investigate its resolution. Tests at CERN and DESY measure the decay vertices of the B-mesons recorded by the Belle II experiment. Due to the PXD, the expected vertex resolution will improve by roughly a factor of two compared to Belle, as shown in the figure below.

In the PXD, the DEPFET pixels are read out by a series of specially designed ASIC chips. The ASICs (SwitcherB and DCDB) switch on the matrix row by row and digitize the drain currents. The DEPFET pixels are arranged in arrays of 768 x 250 pixels called half-ladders. The sensitive area is about 5 cm by 1.25 cm. The excellent signal to noise ratio allows for very thin detectors, reducing multiple scattering for low momentum particles. A thinning technology, based on direct wafer bonding and deep anisotropic etching, is used to produce self-supporting sensors with a sensitive layer of only 75 µm thickness. By thinning only the sensitive area an integrated support frame is created which allows safe handling and serves as substrate for the auxiliary control and read-out ASICs. As shown in the above figure two half-ladders are joined together to a full ladder by gluing ceramic inserts into small grooves etched in the support frame.