

Development of highly compact digital pixels for the vertex detector of the future e+e- collider

For the advantages of reduced power dissipation, higher readout speed, and less insensitive sensor area, pixel-level discrimination becomes the necessary solution of the pixel sensors for the vertex detector in the future e+e- collider. However, the complexity of digital pixels always leads to an increased pixel dimension which is contrary for vertex detector to obtain a high spatial resolution.

In order to push the dimension limit of digital pixels while maintaining other key parameters such as power consumption and readout speed, a CMOS pixel sensor (CPS) prototype including two versions of highly compact digital pixel (pitch size = 22 μ m) has been designed in a 0.18 μ m CMOS Image Sensor Process. It contains 112 x 96 pixels, with a size of 2.9 x 3.3mm².

The sensing diode in each pixel is AC-coupled with following electronics and biased with positive high voltage about 10 V, which could fully depleted the thin epitaxial layer. Comparing with traditional biased diode (\approx hundreds mV), the equivalent capacitance of the sensing diode is 30% less for the same diode dimension based on the simulation, thus the effective signal value converted by the diode is 30% higher, also the Equivalent Noise Charge (ENC) contributed by the following electronics is proportional less.

Take advantages of the depleted CPS, two simple in-pixel digitization structures are proposed. The two structures are trade-offs between high precision and simplicity which guarantee a compact pixel dimension with certain signal over noise ratio. Both of them composed with an amplifying stage and a precise comparator. The main difference of the two versions is the amplifying stage is a differential amplifier or two stage single-end amplifiers. The prototype is operated in rolling-shutter mode, the processing speed is 100 ns/row and 80 ns/row respectively for the two versions. The design details for the trade-off consideration and operation principles will be presented.

Primary author: ZHOU YANG

Co-authors: Dr ZHU, Hongbo (IHEP); Prof. OUYANG, Qun (IHEP); Dr LU, Yunpeng (Institute of High Energy Physics, CAS)

Presenter: ZHOU YANG

Track Classification: Semiconductor detectors