

New Pixel Detector Concept 'DuTiP' for Belle II Upgrade and the ILC with an SOI Technology

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Belle II experiment was successfully started. The first data for physics with full Belle II detector were taken in 2019 and 50ab^{-1} data will be accumulated by 2027. A discussion of an upgrade plan for Belle II and SuperKEKB is started. The instantaneous luminosity by the upgraded SuperKEKB is 5 times larger than current design luminosity for SuperKEKB ($8 \times 10^{35} \text{cm}^{-2}\text{s}^{-1}$) and the upgraded Belle II will collect data sample of 250ab^{-1} . In such high luminosity environment, current DEPFET pixel detector is hard to operate due to too high occupancy since the readout scheme of DEPFET is rolling shutter mode with a $20\mu\text{s}$ frame.

We have invented a new pixel detector concept 'DuTiP' (Dual Timer Pixel) which is a binary pixel detector with a trigger signal based global shutter readout scheme. A binary hit information is stored in a down counting timer inside a pixel whose initial value is set as trigger latency plus 1 clock (around $5\mu\text{s}$). If the trigger signal is received when the timer is 1 (0 or 2), the hit information is readout as current (previous or next) timing. To take into account for multiple hits during trigger latency, two timers are equipped in a pixel. The clock speed is important parameter for the occupancy and data size. We tentatively decided the clock speed as 15.9MHz (62.9ns). The requirement of spacial resolution at Belle II is around $10\mu\text{m}$ for both z and r-phi directions, thus $35\mu\text{m}$ pixel size is selected. This pixel detector can be also used for layer 7 and 8 of ILC vertex detector which requires single bunch (554ns) time stamping capability and moderate spatial resolution of $10\mu\text{m}$ in r-phi direction.

We report the concept of 'DuTiP' and the status of development of the pixel detector with an SOI technology for Belle II upgrade.

Submission declaration

Original and unpublished

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