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TEMPUS, a Timepix4-Based Detector for Photon Science

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DESY in Hamburg, operates one of the brightest storage ring (SR) light sources in the world: PETRA III. The upcoming upgrade of the facility to a 4th generation SR, the PETRA IV project, will increase the brilliance by orders of magnitude and put pressure on existing instrumentation, including detectors. In order to take full advantage of the elevated flux, DESY has engaged in the development of fast and efficient x-ray detectors. A new readout chip has been recently produced by the Medipix4 collaboration: Timepix4, which combines photon-counting full-frame readout mode and event-driven time-stamping mode, with greatly enhanced performance over both Medipix3 and Timepix3. The single chip TEMPUS (Timepix4-based Edgeless Multi-Purpose Sensor) detector is being developed as a replacement to LAMBDA.

When running at full speed, the 16 gigabit wireline transmitter (GWT) responsible for sending the data out of the chip, will reach a total bandwidth of over 80 Gbps. Dealing with this large amount of data is one of the main challenges ahead. The chip was also designed to take full advantage of the through silicon via (TSV) technology and therefore we will be able to fully remove the wirebond connections on the sides, decreasing the dead areas when placing several chips together, which is also planned for future iterations of the prototype.

With 512 x 448 pixels, 55 μm pixel size, the chip offers a larger pixel area than its predecessors, 10 times higher count rate in the photon-counting mode and up to 40 kHz frame rate, as well as 200ps time resolution in the event-driven mode. All the tests discussed here were done using this latter mode. In this mode, a relatively high time resolution can be achieved. Also, under moderate incoming flux, a large reduction in the data volume is possible. Two experiments took place at PETRA III and ESRF. We were able to capture the electron bunch structure of both facilities. Also, when using a 300 μm p-on-n Si sensor fully biased, time resolutions as low as few ns were achieved. The combination of high time resolution and fast readout bandwidth will be crucial for many applications at 4th generation SR and also FELs.

I plan to submit also conference proceedings

Yes

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