Subpixel resolution in CdTe Timepix3 pixel detectors

**Timepix3** (256 × 256 pixels with a pitch of 55 µm) is a hybrid-pixel-detector readout chip that implements a data-driven architecture and is capable of simultaneous time-of-arrival (ToA) and energy (ToT: time-over-threshold) measurements. The ToA information allows the unambiguous identification of pixel clusters belonging to the same X-ray interaction, which allows for full one-by-one detection of photons. The weighted mean of the pixel clusters can be used to measure the subpixel position of an X-ray interaction. An experiment was performed at the European Synchrotron Radiation Facility in Grenoble, France, using a 5 µm × 5 µm pencil beam to scan a CdTe-ADVAPIX-Timepix3 pixel (55 µm × 55 µm) at 8 × 8 matrix positions with a step size of 5 µm. The head-on scan was carried out at four monochromatic energies: 24, 35, 70 and 120 keV. The subpixel position of every single photon in the beam was constructed using the weighted average of the charge spread of single interactions. Then the subpixel position of the total beam was found by calculating the mean position of all photons. This was carried out for all points in the 8 × 8 matrix of beam positions within a single pixel. The optimum conditions for the subpixel measurements are presented with regards to the cluster sizes and beam subpixel position, and the improvement of this technique is evaluated (using the charge sharing of each individual photon to achieve subpixel resolution) versus alternative techniques which compare the intensity ratio between pixels. The best result is achieved at 120 keV, where a beam step of 4.4 µm ± 0.86 µm was measured.

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Corresponding author: Khalil, M.
Contributors: Khalil, M., Dreier, E. S., Kehres, J., Jakubek, J., Olsen, U. L.
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