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Improvement of event-building for data-driven hybrid pixel detector data

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Hybrid pixel detectors like Timepix3 and Timepix4 detect individual pixels hit by particles. For further analysis, individual hits from such sensors need to be grouped into spatially and temporally coinciding groups called clusters. While state-of-the-art Timepix3 detectors generate up to 80 Mio hits per second, the next generation, Timepix4, will provide data rates of up to 640 Mio hits (data bandwidth of up to 164 Gbps), which is far beyond the current capabilities of the real-time clustering algorithms, processing at roughly 3 MHits/s. We explore the options for accelerating the clustering process, focusing on its real-time application. We developed a tool that utilizes multicore CPUs to speed up the clustering. Despite the interdependence of different data subsets, we achieve a speed-up scaling with the number of used cores. Further, we exploited options to reduce the computational demands of the clustering by determining radiation field parameters from raw (unclustered) data features and self-initiating further clustering if these data show signs of interesting events. This further accelerates the clustering while also reducing storage space requirements. The proposed methods were validated and benchmarked using real-world and simulated datasets.

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