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A picosecond sampling system for continuous sampling of ultra-short pulses generated by THz-detectors

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This poster presents the 2nd version of the Karlsruhe Pulse Taking Ultra-fast Readout Electronics (KAPTURE-2) for continuous sampling of ultra-short pulses generated by terahertz (THz) detectors. KAPTURE-2 is able to sample each pulse with 4 to 8 sampling points with a resolution of down to 1 ps and accepts flexible pulse repetition rates in a range from 0.2 to 3.6 GHz. Low noise combined with wide dynamic range and bandwidth enables the sampling of signals generated by various GHz- and THz-detectors. To manage the high raw data rate of about 120 Gb/s, KAPTURE-2 is connected to a heterogeneous FPGA-/GPU-based readout system. FPGA and GPU are connected by a new Direct Memory Access (DMA) concept, called ”GPUDirect”. The readout card is equipped with a Xilinx Virtex-7 FPGA and is connected to the GPU by a PCIe Gen 3 x16 data link, capable of a net throughput of up to 13 GB/s. In a traditional DMA architecture, data is first transferred to the main system memory and afterwards moved to the GPUs for processing. Here, the main memory is involved in several read/write operations, depending on the specific implementation. The total throughput and latency of the system is therefore limited by the memory bandwidth.
Using the ”GPUDirect”communication, the DMA engine has a direct access to the GPU memory. Therefore latency and hardware requirements of the system are extremely reduced. The GPU real-time architecture is used for pulse reconstruction based on the 4 to 8 sampling points. It results in the peak amplitude of each pulse and the time between two consecutive pulses/buckets with a picosecond time resolution. With KAPTURE-2 it is possible to study THz behavior with an unprecedented temporal resolution and to resolve bunch-to-bunch interactions.

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