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Implementation of a pattern recognition neural network for live reconstruction using AI processors

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For years, data rates generated by modern particle detectors and the corresponding readout electronics exceeded by far the limits of bandwidth and data storage space available in many experiments. Using fast triggers to discard uninteresting and irrelevant events is a solution used to this day. FPGAs, ASICs or even directly the readout chip are programmed or designed to apply a fixed set of rules based on low level parameters for an event pre-selection. However with detector technology progressing quickly and newly devised experiments demanding ever-increasing particle collision rates new ways for triggering have to be considered.

One of these is live track reconstruction for triggering meaning that high level information like particle momentum is exracted from the raw data and directly used for triggering. Up until now this approach was rarely possible due to a conflict between processing time and the required trigger latency. With the emergence of novel fast and highly parallelized processors, targeted mainly at AI inference, attempts to sufficiently accelerate tracking algorithms become viable. The Xilinx Versal AI Series Adaptive Compute Acceleration Platform (ACAP) is one such technology and combines traditional FPGA and CPU resources with dedicated AI cores and a network on chip for fast memory access. Despite being available for some years this technology is still largely unexplored for particle physics cases.

In this talk a Versal ACAP implementation of a neural network for pattern recognition for a dark photon experiment at the ELSA accelerator in Bonn, Germany will be shown as an example application and the expected performance will be discussed.

Primary authors: KAMINSKI, Jochen (University of Bonn (DE)); DESCH, Klaus (University of Bonn); LUPBERGER, Michael (University of Bonn); SCHWAEBIG, Patrick

Presenter: SCHWAEBIG, Patrick

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