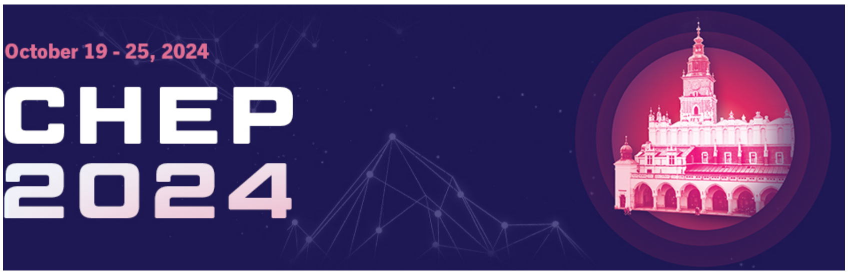

Contribution ID: **496**

Type: **Talk**

FPGA-RICH: A low-latency, high-throughput online particle identification system for the NA62 experiment

Thursday 24 October 2024 14:42 (18 minutes)

This work presents FPGA-RICH, an FPGA-based online partial particle identification system for the NA62 experiment utilizing AI techniques. Integrated between the readout of the Ring Imaging Cherenkov detector (RICH) and the low-level trigger processor (L0TP+) , FPGA-RICH implements a fast pipeline to process in real-time the RICH raw hit data stream, producing trigger-primitives containing elaborate physics information, such as the number of charged particles in a physics event, that the L0TP+ can use to improve trigger decision efficiency.
The system is deployed on a single FPGA device and uses both classical online processing methods and a compact Neural Network algorithm to achieve efficient event classification while managing NA62's challenging throughput requirements ($\approx$ 10 MHz). The streaming pipeline guarantees low latency (~ 1 μs), comparable to the other NA62 sub-detectors that send trigger-primitives to the L0TP+, allowing seamless integration in the existing TDAQ setup as a new detector running in parallel with the RICH.
The system development leverages High Level Synthesis (HLS) programming language and the open-source *hls4ml* software-hardware codesign workflow for fast, flexible and relatively simple reprogramming, debugging and feature enhancements.
Currently integrated in parasitic mode in the experiment TDAQ, we will present and discuss our experience with the system's design and deployment along with the results obtained during the 2024 data taking.
The work highlights the strength and maturity of modern computing solutions, programming paradigms and machine learning algorithms even within the challenging context of modern HEP experiments'online data acquisition and analysis.

Author: PERTICAROLI, Pierpaolo (INFN, Roma I (IT))

Co-authors: LONARDO, Alessandro (INFN, Roma I (IT)); BIAGIONI, Andrea (INFN); CHIARINI, Carlotta (Sapienza Universita e INFN, Roma I (IT)); ROSSI, Cristian (Sapienza Universita e INFN, Roma I (IT)); LO CICERO, Francesca (INFN, Roma I (IT)); Dr SIMULA, Francesco (Istituto Nazionale di Fisica Nucleare - sezione di Roma 1); PONTISSO, Luca (INFN, Roma I (IT)); TURISINI, Matteo (Sapienza Universita e INFN, Roma I (IT)); RAGGI, Mauro (CERN and Sapienza); MARTINELLI, Michele (INFN); FREZZA, Ottorino (INFN, Roma I (IT)); CRETARO, Paolo (INFN - National Institute for Nuclear Physics); VICINI, Piero (INFN Rome Section); AMMENDOLA, Roberto (INFN e Universita Roma Tor Vergata (IT)); PIANDANI, Roberto (Univ. Autonoma de San Luis Potosi); CIARDIELLO, Andrea

Presenter: PERTICAROLI, Pierpaolo (INFN, Roma I (IT))

Session Classification: Parallel (Track 2)

Track Classification: Track 2 - Online and real-time computing