Contribution ID: **46** Type: **Poster and book of abstract**

FPGA-Based RoCEv2-RDMA Readout Electronics for the CTAO-LST Advanced Camera

The Advanced Camera (AdvCam) for the Cherenkov Telescope Array Observatory's Large-Sized Telescope (CTAO-LST) requires an efficient, high-throughput data acquisition system capable of handling the increased sensitivity and resolution of Silicon Photo Multipliers (SiPMs). To address this challenge, we present an FPGA-based Remote Direct Memory Access (RDMA) implementation leveraging the RoCEv2 protocol for direct data transfer to event-building servers without the need for additional backend electronics.

The core of this approach is a lightweight RoCEv2 engine developed in Bluespec SystemVerilog, ensuring reliable, low-latency, and high-bandwidth communication. Bluespec's high-level abstraction enables concise, maintainable hardware descriptions, while its compiler produces pure Verilog, allowing seamless targeting of any FPGA family and even ASIC implementations. The RoCEv2 core, designed for minimal footprint, operates efficiently within the constrained resources of small FPGAs while maintaining full compatibility with commercial RDMA-enabled network interfaces. The reliability of RoCE ensures lossless data transmission, making it ideal for large-scale physics experiments.

Although the RoCEv2 core has been implemented for a 10 Gbps Ethernet communication system, initial tests were conducted at 100 Gbps, demonstrating its scalability and adaptability to future high-speed networks. Performance validation include throughput measurements targeting an RDMA-enabled NIC, achieving near-line rate performance of 9.7 Gbps. Additional evaluations confirm robust operation under realistic conditions, highlighting the system's efficiency and reliability.

By merging front-end and back-end processing into a single FPGA platform, this implementation streamlines data acquisition, significantly reducing hardware requirements and power consumption. The combination of Bluespec's portability, RoCE's efficiency, and the elimination of backend electronics offers a scalable and cost-effective solution for AdvCam's data acquisition needs, setting the stage for future high-energy astrophysical discoveries.

Primary author: MARINI, Filippo (Istituto Nazionale di Fisica Nucleare)

Presenter: MARINI, Filippo (Istituto Nazionale di Fisica Nucleare)