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FPGA based high speed DAQ systems for high-energy physics experiments: potential challenges

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Nuclear and particle physics experiments at high energies, often referred to as High Energy Physics (HEP) experiments, study the constituents of matter and their fundamental interactions. By colliding proton on proton or heavy-ions, such as, Au on Au or Pb on Pb at relativistic energies; one creates conditions that are prevalent within a microsecond after the birth of our universe. These collisions produce large number of highly energetic particles which are to be recorded by the experiments. This poses great challenges for particle detectors, readout electronics, and data acquisition (DAQ) systems including data storage. In addition, the radiation levels in the proximity of the detectors have also been growing, which demands for radiation tolerant devices. Traditional nuclear physics experiments employ detectors with several tens to few hundred of readout channels using standard electronics and conventional DAQ systems, which handles low data rate (few megabyte per second) and less resilient for data errors against multi-bit upset in radiation zones.
In contrast, the present day HEP experiments, for example at the Large Hadron Collider (LHC) at CERN, FAIR at GSI Darmstadt; operate detectors up to billions of electronics channels, which produce data at the rate of few terabyte (TB) per second. This requires a highly efficient system to cope with the increase in data volume by acquiring data at a high rate and recovery from data error against the multi-bit upsets in radiation environments.

We will present an overview of the new FPGA based high speed DAQ system which is capable of high data rate communication. We will summarize the technical challenges for the development such a DAQ system, points of uncertainties and their probable solutions. The applicability is not limited to particle physics only. It also fits well for industry applications like medical imaging, muon tomography and future HEP experiments.

What is your experiment?

ALICE at CERN, CBM at GSI

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