Free-running data acquisition system for the AMBER experiment

Martin Zemko[1,3], *Vladimir* Frolov[5], *Stefan* Huber[6], *Vladimir* Jary[3], *Igor* Konorov[6], *Antonin* Kveton[2], *Dmytro* Levit[6], *Josef* Novy[3], *Dominik* Steffen[6], *Benjamin Moritz* Veit[1,4], and *Miroslav* Virius[3]

[1]CERN, Geneva, Switzerland
[2]Charles University in Prague, Czech Republic
[3]Czech Technical University in Prague, Czech Republic
[4]Johannes Gutenberg University Mainz, Germany
[5]Joint Institute for Nuclear Research in Dubna, Russia
[6]Technical University of Munich, Germany

Abstract. Triggered data acquisition systems provide only limited possibilities of triggering methods. In our paper, we propose a novel approach that completely removes the hardware trigger and its logic. It introduces an innovative free-running mode instead, which provides unprecedented possibilities to physics experiments. We would like to present such system, which is being developed for the AMBER experiment at CERN. It is based on an intelligent data acquisition framework including FPGA modules and advanced software processing. The system provides a triggerless mode that allows more time for data filtering and implementation of more complex algorithms. Moreover, it utilises a custom data protocol optimized for needs of the free-running system. The filtering procedure takes place in a server farm playing the role of the high-level trigger. For this purpose, we introduce a high-performance filtering framework providing optimized algorithms and load balancing to cope with excessive data rates. Furthermore, this paper also describes the filter pipeline as well as the simulation chain that is being used for production of artificial data, for testing, and validation.

1 Introduction

The majority of physics experiments use trigger systems to initiate the data collection process and reduce the amount of data coming from the detectors. These systems usually meet the needs of experiments, but there are some use cases that cannot be covered by them. Specifically, we can point out experiments containing various detectors with diametrically different response times. Slower detectors are not able to process the same trigger signal as faster ones. This results in a huge conflict in the data acquisition system. As an example, the detector apparatus of the AMBER experiment will include a hydrogen time projection chamber (TPC) as an active target that has very long drift times. Due to this requirement, it is not possible to use a triggered data taking approach, and the need for a triggerless system has emerged.