Contribution ID: **133**

Type: **Oral**

Commissioning and operation of CGEM-IT readout chain

Tuesday 7 October 2025 16:00 (16 minutes)

A full readout chain based on TIGER, a triggerless ASIC, and on GEMROCs, ARRIA-V FPGA-based readout modules, has been deployed for the BESIII CGEM-IT detector, along with ancillary modules to connect with the pre-existing DAQ.
The full system was installed in the experimental hall at the end of 2024 and it is now being commissioned with the detector with cosmics and beam collision. A dedicated DAQ based on the GUFI interface has been developed waiting for the finalization of originally planned optical links readout.
The presentation will discuss the system and the experience working with it in the BESIII experiment.

Summary (500 words)

A dedicated full readout chain has been developed for the CGEM-IT of the BESIII spectrometer. It consists of a dedicated ASIC, called TIGER, and readout module based on the ARRIA-V FPGA, called GEMROC. The systems shall read the 10000 strips of the detector with a trigger rate up to 4 kHz and be integrated easily with the existing infrastructure of the BESIII experiment. Dedicated ancillary fanout modules collect the fast signals and distribute them to the GEMROCs on the two ends of the spectrometer. In the future, optical links will be used to collect and save the data into the BESIII data stream.
TIGER is a 64 channel mixed-signal triggeless ASIC capable of readout charge and time simultaneously. 160 TIGERs hosted by 80 front end boards, directly connected to either end of the anode, read out the signals. The GEMROCs are readout modules that allow for powering, configuring, and reading the data from up to 4 FEB per module. 22 GEMROCs are used to fully readout the system. The data can be sent to the PC via UDP protocol and to VME modules via optical links.
A python-based dedicated user interface, called GUFI, has been developed to control the GEMROCs and manage the data acquisition. Moreover, it allows checking FEB status, miscabling, communication errors, performing noise assessment and threshold settings, via a routine using the FPGA internal counters and TIGER triggerless structure.
After the installation, a series of different grounding configurations have been tested to study the noise level and to find the optimal solutions. Excluding the channels connected to one particular view, the noise level is of the order of 1-3 fC.
Due to delays in the finalization of the optical link and in order to allow the start of the experiment's data taking, a new server running an updated version of GUFI has been deployed. This standalone system communicates with the BESIII DAQ via the TCP/IP protocol, enabling synchronized start and stop of the acquisition, error monitoring, and ensuring full "expert" control over threshold settings, noise assessment, and data transmission integrity. Additionally, the GUFI software has been extended with a dedicated acquisition and disk writing module. This highly parallelized component spawns processes that receive data from UDP packets and enqueue them into buffers, which are then emptied by dedicated writing processes. This architecture is designed to optimize the use of the machine's hardware resources. The system has undergone extensive testing over the past months at different trigger rates to ensure full synchronization between the two systems. The adoption of this software-based solution demonstrates the ability to shift part of the acquisition workload from firmware to software, particularly leveraging Python. This approach significantly reduces development and testing time while improving system scalability and ease of updates.

The beam commissioning, starting in May, will reveal the full capabilities of the system, allowing for testing its limits in operations. The presentation will also focus on the lessons learned during this period.

Author: MEZZADRI, Giulio (Universita e INFN, Ferrara (IT))

Co-authors: CIBINETTO, Gianluigi (INFN Ferrara); GRECO, Michela (INFN - National Institute for Nuclear Physics); GRECO, Michela (INFN-UniTO)

Presenters: GRECO, Michela (INFN - National Institute for Nuclear Physics); GRECO, Michela (INFN-UniTO)

Session Classification: Systems

Track Classification: System Design, Description and Operation