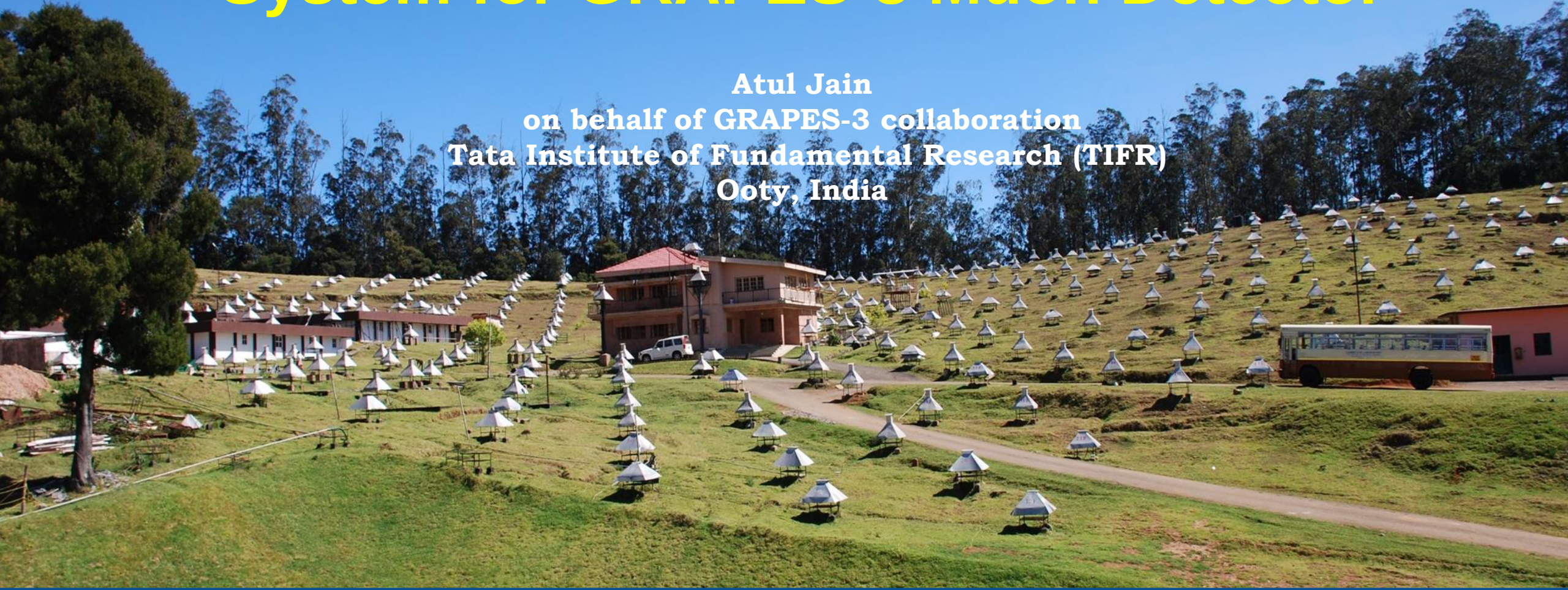


An Advanced Triggerless Data Acquisition System for GRAPES-3 Muon Detector

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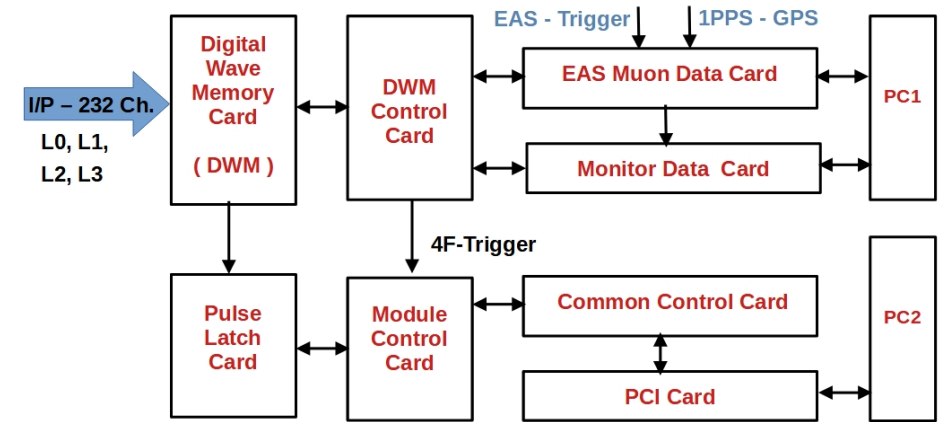
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PoS (ICRC2021) 257

Existing DAQ

- ❖ 2 decades old
- ❖ Large dead time, obsolete interface techniques, coarser data recording in packets of 10sec
- ❖ Limiting the scope of new science



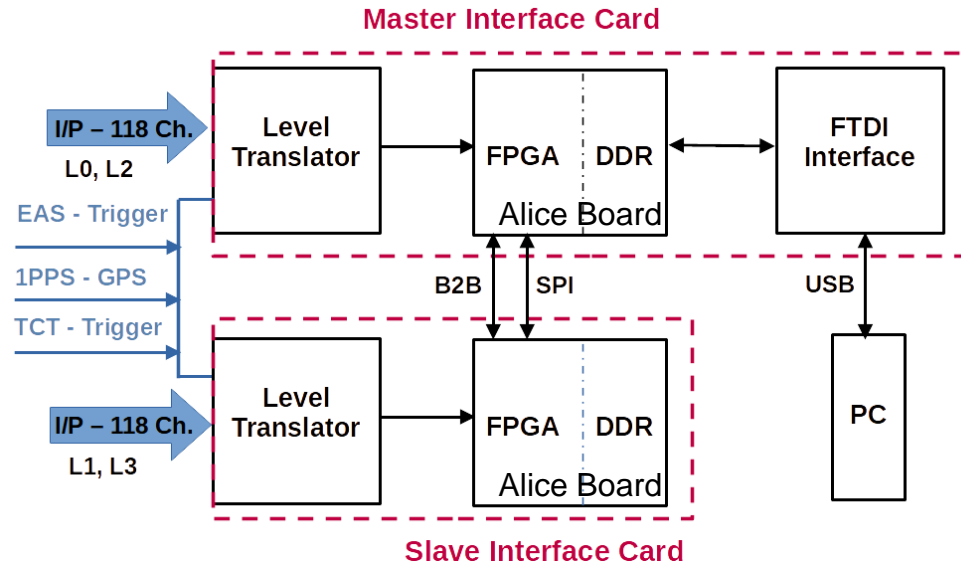
Block diagram, existing DAQ for a muon module

Triggerless Muon Data Acquisition system (TM-DAQ)

Field-programmable gate array (FPGA) based TM-DAQ would enhance the present capabilities and open a new window on several physics fronts such as

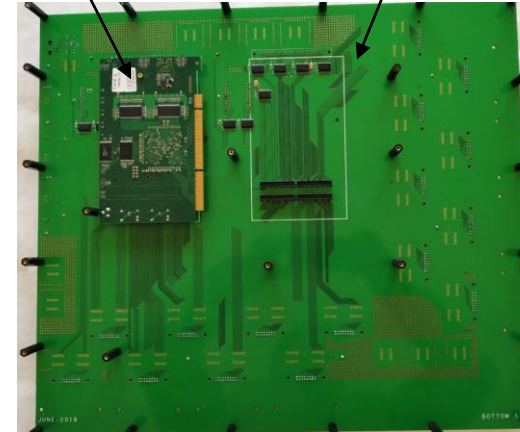
- ✓ Precise measurement of the muon flux for thunderstorm studies
- ✓ Search for exotic particles characterized by its early or delayed arrival
- ✓ Study of large angle EAS using the muon component

Hardware for Triggerless Muon DAQ System (TM-DAQ)



Block diagram, TM-DAQ for a muon module

Alice Board Interface Card



ALICE board mounted on Interface card

ALICE Board

- The board is a High-Level-Trigger (HLT) Read-Out Receiver Card (H-RORC) used for ALICE detector at LHC Point 2, CERN Geneva during Run I phase

Interface Card

- I/O Interface between ALICE board and GRAPES-3 system in terms of level translator, matching connectors and PC interface.
- A set of board configured as Master and Slave to process data from all 236 PRC's of a module

Salient Features

- Negligible dead time (~0.001% compared to 15-20% for the legacy DAQ system)
- Continuous measurement of pulse width and precision arrival time with a resolution of 10 ns
- Excellent time matching between various cards thus allowing to apply any offline trigger condition

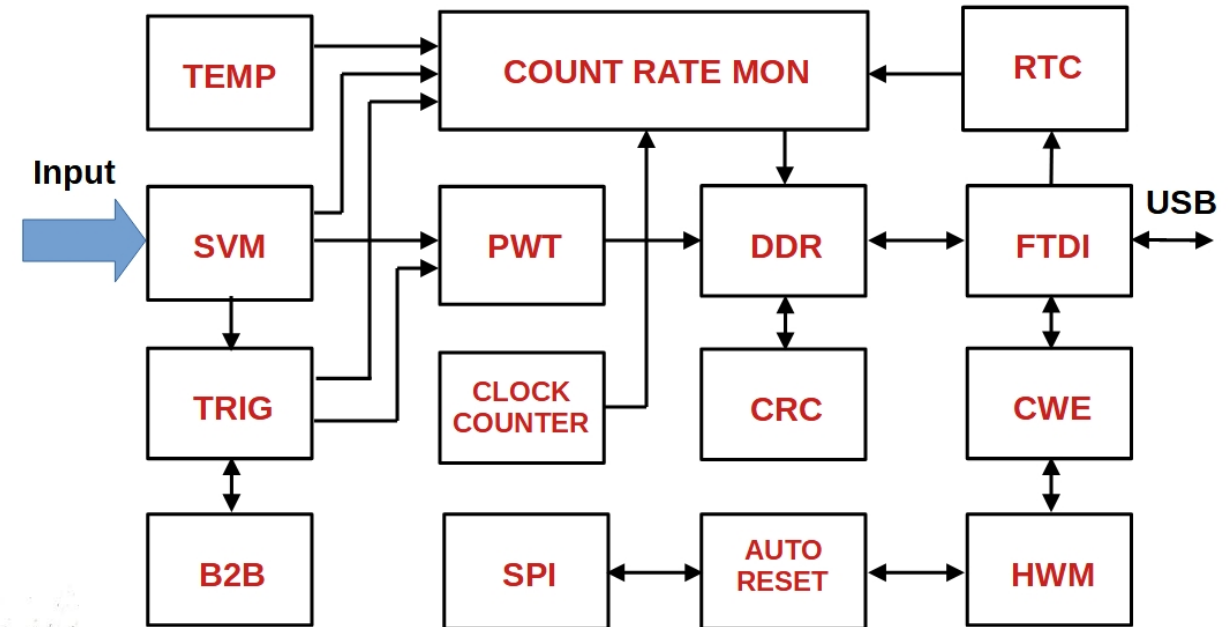
Firmware for Triggerless Muon DAQ System (TM-DAQ)

Salient Features

- State Machine based design approach
- Robust
- Continuous monitoring and recording of all Hardware parameters (HWM)
- Online Debugging
- Smart Auto Reset feature for both device and PC

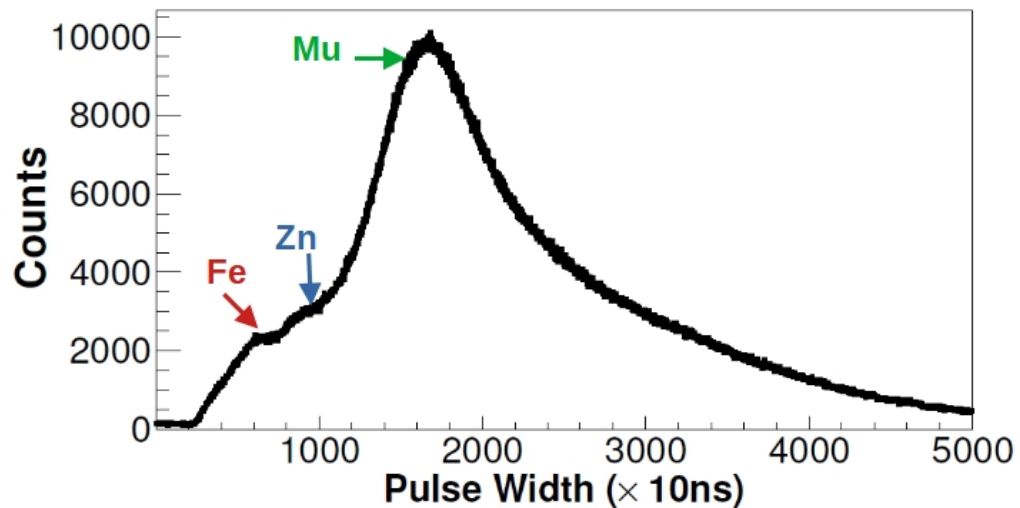
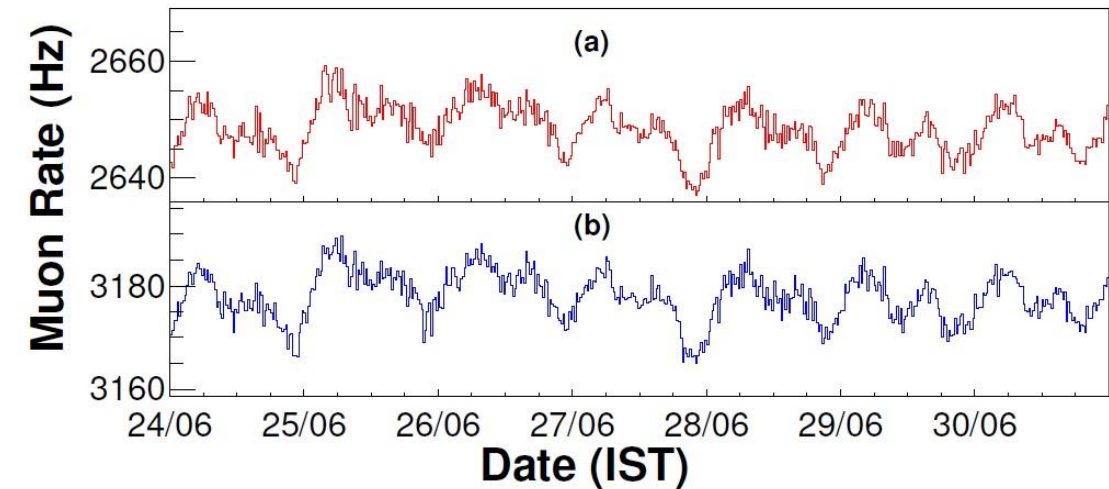
TM-DAQ Installation

- ✓ TM-DAQ installed in parallel to existing system
- ✓ 4 muon modules
- ✓ 928 PRCs



Block diagram representing firmware embedded in FPGA for TM-DAQ

Observations



- The measured flux from the TM-DAQ (b) is larger by $\sim 20\%$ as compare to the existing DAQ (a) which is a significant improvement
- Precise measurement of the muon flux would enhance thunderstorm studies
- In existing DAQ the pulse width spectrum (PWS) of each PRC was performed in a multiplex mode thus allowing to monitor the performance of the PRC only for duty cycle of 1.5% however, TM-DAQ allows continuous PWS for each PRC
- Using offline software trigger algorithm it has demonstrated to reconstruct the muons as large as 85° Details are presented in poster by B. Hariharan et al. [PoS (ICRC2021) 379]
- Precise measurement of muon flux would enhance thunderstorm studies
- Overall the TM-DAQ by its features and performance would open new frontiers in the field of physics.

Thanks