Detector DAQ and trigger systems requirements

1. Introduction

1.1. Definitions

1.1.1. Front End Electronics (FEE):

The Front End Electronics converts the analog signals into digital signals and stores the latter in memory buffer.

1.1.2. Trigger System

The Central Trigger System has to deal with the different triggers defined in the DAQ Terminology Note [ref], including the triggers for the Target and the RF system.

The DAQ Trigger System receives signals form the MICE target, RF, DAQ and Control Systems, processes them through hardware logic and produces the signal which triggers the readout of data from the FEE buffers.

The Particle Trigger System, receives a selected subset of analog data from the detectors, discriminates it, processes it through hardware logic and issues a signal used to trigger the digitization of analog signals inside the FEE.

1.1.3. Detector DAQ System (or DAQ System)

The Detector DAQ System, upon trigger from the Trigger System, reads data from the FEE's memory buffers, packs together data corresponding to the same DAQ Events and writes it to permanent, remote, data storage (RDS). The DAQ system can perform some checks on data consistency at the architectural level (e.g. all the FEE units receive the same triggers) but it doesn't check the data content itself.

The Detector DAQ system can also handle data from the MICE Control and monitoring system.

The DAQ System also performs the necessary initialization of the FEE units.

1.1.4. Online Data Stream

The Online Data Stream is the data handled by the Detector DAQ System, in between the FEE buffer memory and the Remote Data Storage.

1.1.5. Online Monitoring System

The Online Monitoring System accesses the Online Data Stream, decodes it to a certain level and displays it in a format that allows the person in charge to check the data quality (e.g. histograms).

1.1.6. Online Reconstruction System

The Online Reconstruction System accesses the Online Data Stream, decodes it, puts together data corresponding to the same Particle Event (Particle Event Building), reconstructs tracks from hits, matches the tracks in the different detectors and computes different variables associate to the event (e.g. the amplitudes).

1.1.7. MICE Control and Monitoring (or Slow Control) System (MCM)

The MCM System allows setting and monitoring of the parameters of the MICE experiment, including beam settings, cooling channel settings, target status, RF status, absorber status, detector high voltages, etc. It archives the measured values and constantly checks it with respect to their respective allowed ranges.

1.2. General Statements

Trigger and DAQ Systems are essential, long-lived projects, needing long-term stable operation and maintainability in close connection with Detectors' FEE and Online Monitoring System, Reconstruction System and MCM Systems

The DAQ system is meant to be used by a large community of people, many of them not expert in DAQ matters. Therefore it requires reliable state management and reporting, as well as ease of operation.

2. DAQ System Requirements

1.3. General

The DAQ System should be based on PC running Linux as operating System.

The DAQ System should be able to read data from FEE through VME bus.

1.4. Performance

The DAQ system should allow acquiring data for up to 600 Particle Triggers in a 1 ms spill repeating at 1 Hz.

Should it be any spare time between spills, the DAQ system should allow sub-detectors to take calibration data in between spills.

The DAQ system should be able to deal with event size up to 60 MB (up to 10 MB per sub-event)

The DAQ system should have a local disk buffer capacity exceeding 3 days of permanent data taking.

1.5. Partitioning

The DAQ system should be able to build events with data collected from up to 6 independent VME buses.

The DAQ system should allow a simple selection of the data sources that should be included in the event building process, on a run by run basis, without requiring any kind of code modification of compilation.

The DAQ system should allow the run to be stopped automatically if the number of incomplete events exceeds a limit set by the user.

The DAQ System should allow a simple selection of the active FEE equipments, on a run by run basis, without requiring any kind of code modification of compilation.

The DAQ system should check that all the active equipments receive the same number of particle triggers per spill and the run should be stopped with error if it's not the case.

1.6. Interface with Trigger System

The DAQ system should send a signal to the trigger system when it's not ready to accept a trigger.

The Online Data Stream should contain the DAQ trigger type (Physics or Calibration or other) for each DAQ event in a directly accessible way.

The DAQ System should allow the selection of the Particle Trigger Condition by software.

The Online Data Stream should contain the information on the selected Particle Trigger Condition in a directly accessible way.

The Online Data Stream should contain the information on the Particle Trigger Condition actually met for each individual particle Event.

1.7. Interface with MCM

The DAQ System should be able to access data from the MCM System and to include a subset of it in the Online Data Stream in such a way that it is possible to (un-)validate a spill taken when some parameters of the subset are outside ranges defined after offline analysis.

The DAQ System should be able to report its status to the MCM System.

The DAQ System should be able to accept requests to stop the run from the MCM System.

1.8. Interface with Online Monitoring

The DAQ system should allow Online Monitoring even when the data is not saved on disk.

3. Trigger System Requirements

1.9. Central Trigger

The Central Trigger System should be designed is such a way that the overlap between the time when the target is in the beam, the time when the RF is locked and the time when the DAQ system is accepting particle triggers is between 850 and 1000 microseconds.

The Trigger system should allow taking data when the RF is turned on, when it's turned off and a programmable combination of the two.

The DAQ system should be able to run when the target system is not operational.

The DAQ system should be able to run when the RF system is not operational.

The DAQ system should be able to run when any one of the MICE sub-detectors is not operational.

The DAQ Trigger system should not send a DAQ trigger when the DAQ system is not ready to process it.

The target should be able to be activated when the DAQ system is not running.

Particle Triggers

In MICE, there is no Particle Trigger at a higher level than level 0.

The timing of the particle trigger should be given by the start of burst.

In case there is more than one particle per burst, there should be only one Particle Trigger issued.

Any sub-detector should be able to inhibit the production of the Particle Trigger if it is not ready to accept it.

The DAQ dead time after a Particle Trigger should not exceed one burst after the one that generated it.

The user should be allowed to select by software, at the start of run, one of the following Particle trigger conditions
- Periodic with a software adjustable frequency between 1 and 200 kHz
- Burst
- TOF0
- TOF0 AND TOF1
- TOF0 AND TOF1 AND TOF2
- TOF 0 AND TOF1 OR downscaled Burst. The downscale factor can be fixed by hardware. The condition(s) met when the trigger was generated should be accessible in a single data word in the event data.
- TOF 0 AND TOF1 AND TOF2 OR downscaled Burst. The downscale factor can be fixed by hardware. The condition(s) met when the trigger was generated should be accessible in a single data word in the event data.
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