A Project/Dissertation Review-1 Report on

Data Acquisition in Particle Physics Experiments

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Abstract

Big Data technology is playing a very important role in education, but as we know big data has many advantages and also has some disadvantages. Education resources in colleges and universities, building a complete educational big data analysis platform Thus, the college and universities have to satisfy mally conditions, as providing broad sets of different type tasks. including group discussions, oral speeches, essays with more than qe possible correct opinion developing complex skills of their students, collecting information about courses, student's activities and progress, alumni skills and online also provide online education. Big Date and not the only for develop quality of education. Many colleges and small universities provide private educational programs for small groups. Moreover, they of filthier students more direct conversations with lecturers. This educational strategy definitely has its own advantages.

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CHAPTER-1
Introduction

This chapter presents an overview of technological aspects related to data acquisition (DAQ) systems for particle physics experiments. Being a general topic as data acquisition can be, particle physics experiments pose some challenges which deserve a special description and for which special solutions may be adopted.

Generally speaking, most of the particle physics experiments incur in the use of different types of sensors which information has to be gathered and processed to extract the biggest semantic contents about the process being analyzed. This fact implies the need for, not only a hardware coordination (timing, data width, speeds, etc.) between different sub-acquisition systems for the different types of sensors, but also an information processing strategy to gain more significance from the analysis of the data from the whole system that the one got from a single type of sensor. Also, from the point of view of hardware resources, each type of sensor is replicated several times (even millions) to achieve some spatial coverage. This fact directly drives to the extensive use of integrated devices when needed to improve cost and space utilization.

This chapter, thus, will cover the specific technologies used in the different stages in which a general DAQ system in particle physics experiments can be divided.

The rest of the chapter is organized following the natural flow of data from the sensor to the final processing. First, we will describe the most general abstraction of DAQ systems pointing out the general architecture used in particle physics experiment. Second, different common types of transducers used will be described with their main characteristics. A review of the different hardware architectures for the front-end system will follow. Then, we will get into several common data transmission paradigms including modern standard buses and optical fibers. Finally, a review of present hardware processing solutions will be done.

Data Acquisition Requirements

- Move the data: Detector --> Storage
- Configure and control Front-end electronics, trigger processing
- Monitor data flow
- Monitor detectors/hardware
- Inform operator of problems
- Experiments can run for days/weeks/months

CHAPTER-2
Literature Survey

- **The Anatomy of a DAQ System**

- Triggering (selecting events of interest)
- Readout (digitizing detector signals)
- Event formatting (standardize what we're saving)
- Event building (placing fragments collectively)
- Event storage (keep information for evaluation)
- Run Control (configure-start-stop experiments)
- Monitoring (get records approximately device status)
- Slow Controls (what's the opposite hardware doing?)

Triggering

- The information acquisition device wishes to understand while an interplay "Event" has passed off in the detector
- Some detectors are quicker than others
- Signals from rapid detectors are mixed to make a choice on while an event has passed off. This is referred to as a trigger
- Detectors should keep event information for the time had to generate and distribute cause. This time is referred to as trigger latency

Readout

- Data takes the shape of electrical signals
  - Convert Analog è Digital
  - Times -Time to Digital Converter, TDC

  - Voltages - Analog to Digital converter, ADC
  - Counts - scalars
- There are plenty of alerts unfold over a huge detector
  - Modular readout duplicated many times
  - Plug-in modules require something to plug into so they are able to all be accessed collectively --> *Buses*

In many cutting-edge structures A/D converters are inside the front-end electronics

Event Formatting

- The **information** comes from **one-of-a-kind** detectors.
  - Need to pick out the detector è Add channel number, module number …
  - Need to pick out which event these data come from è Add event identifier
  - Need to make evaluation easier è Sort information
- There is lots of information
  - Format have to be compact
- Analysis can take years
  - Format need to be *self documenting*

Event Building

- The detectors are unfolded over a bodily volume.
- Bits and pieces of events arrive at one-of-a-kind times from one-of-a-kind places
- All the elements of the event need to be collected together and packaged with different records wished through the evaluation
- The *Event builder* is a completely rapid collating gadget

Data Storage

Where to store event data?

- Physics experiments generate a variety of information.

– At CMS ~ TB/day

- The quickest approach is to Disk!!
- The most cost effective approach is tape

- Need to begin and prevent the DAQ
- Place to enter parameters which alternate from run to run
- Automatic monitor of the health of the DAQ system
- Something exceptional for the operator to examine

Monitoring/Analysis

- Need to monitor the data quality as it's read
- Monitoring have to not introduce dead-time
- Interface among code written through Physicists and code written through DAQ professionals

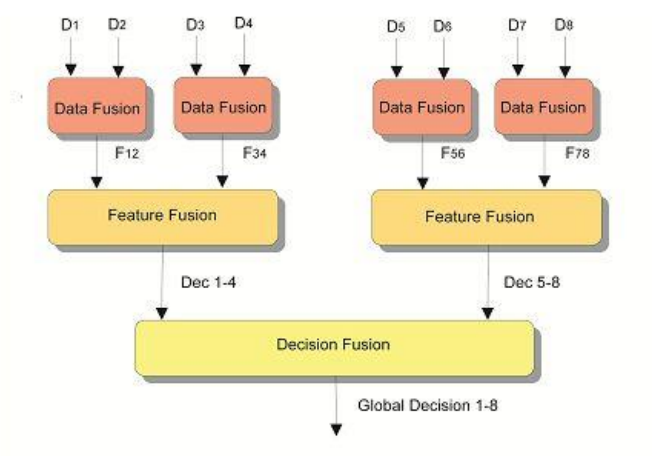
Complications

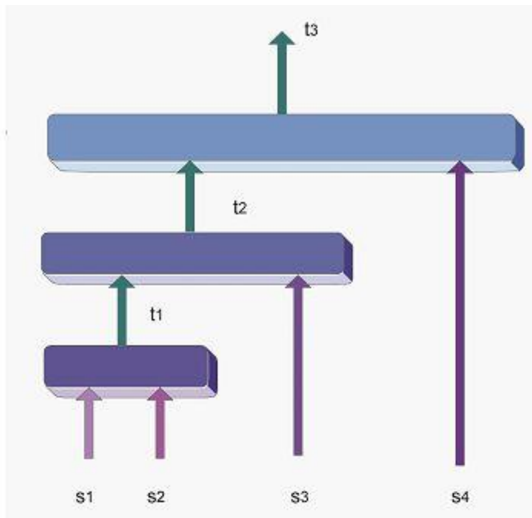
You have to store/send data with additional information to check data integrity, trigger distribution and data read correctness:

- Trigger number
  - Initialized at run start and incremented at each trigger
- Time of event
  - A counter is used to keep trace of trigger arrival time

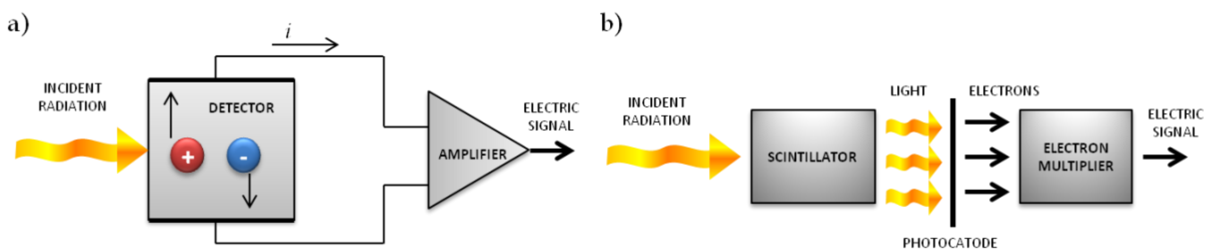
- Timestamp is the value of this counter store along with data
- A global synchronization signal is needed to initialize time counter (in CMS BCN0)

Trigger number + timestamp need to suit for all information





a)hierarchical sensor integration
b)multisensor integration



a) direct mode
b) indirect mode

REFERENCES

- https://www.intechopen.com/chapters/38453
- https://www.semanticscholar.org/paper/Data-Acquisition-in-Particle-Physics-Experiments-Gonz%C3%A1lez-Barrientos/bcf5df5718ab7825668ec9adb8d95b816e7c57c7
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