The DAQ system of the Dual-Readout Calorimeter for future e^+e^- colliders and its operation in 2022 August test-beam experiment at CERN

Department of physics, Yonsei University

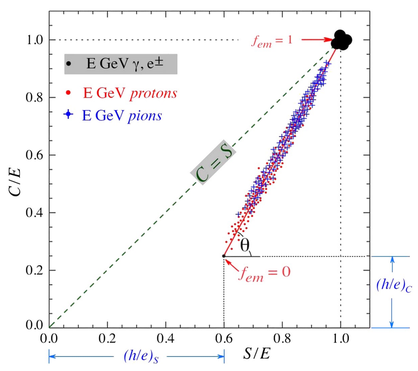
Haeun Jang (Supervisor : Hwidong Yoo)

Introduction

Dual-Readout calorimeter(DRC), which **detects both EM & hadronic particles**, is included in IDEA detector conceptual design report(CDR). The prototype of DRC was produced over a period of times. To test the performance of it, we had the **test beam at CERN.** And it needed to construct our own data acquisition(DAQ) system for it. In this talk, we will present our DAQ system of Dual-Readout calorimeter and how we operated it in this test beam.

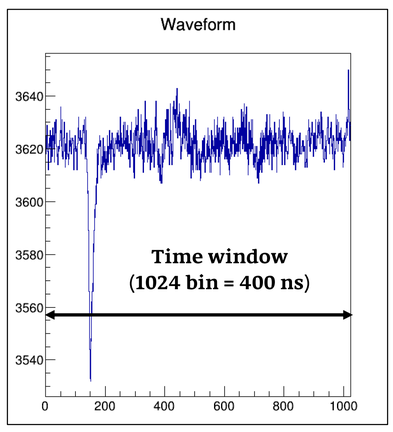
Dual-Readout Calorimeter

- **Non-gaussian EM fluctuations** make it difficult to measure energy of hadron shower.
- **Dual-Readout Calorimeter can measure** *f_EM* for using two types of fibers with different h/e responses.



Requirements for Test Beam

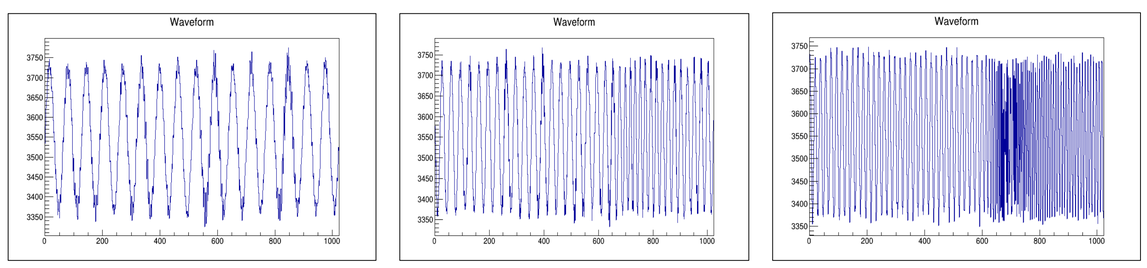
- The significant goal of DAQ system for Test Beam is making all signals (from ancillary detectors and our module) be in **400 ns time window gate.**
- Our DAQ system should cover at least **437 channels.** (detectors + module)



DAQ System Design

Time Window

- **Down Sampling option**
  - 5 GHz : 200 ns
  - 2.5 GHz : 400 ns
  - 1.25 GHz : 800 ns
  - 0.625 GHz : 1600 ns
  - 0.3125 GHz : 3200 ns
- Sampling rate are not fixed in 0.625 and 0.3125 GHz.
- We prepared 200, 400, 800 ns time window, and used 400 ns for Test Beam.



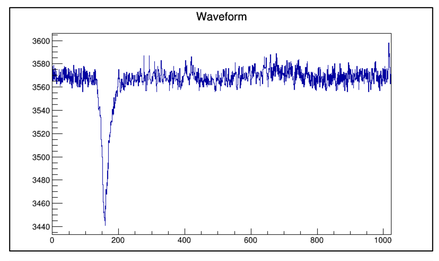
1.25 GHz | 0.625 GHz | 0.3125 GHz

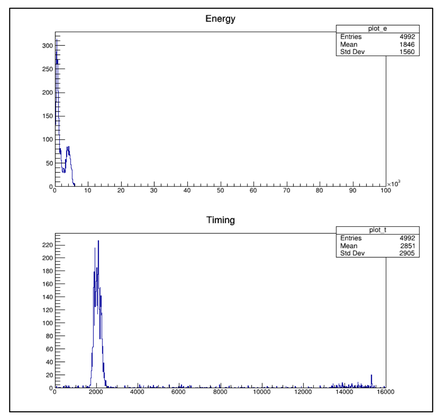
Trigger type

- **Pedestal trigger**
  - Using when getting pedestal. Designate time interval to get it.
- **Self trigger**
  - Set threshold, and when a size of signal is over that, TCB board forces DAQ boards to open the time window to get signal.
- **External trigger**
  - Making external digital signal, then put in TCB board.

Data mode

- **Waveform mode**
  - Save waveform data
  - Data size : 64 kB
  - Heavy and slow, but detail.
- **Fast mode**
  - Save integral and timing information.
  - Data size : 256 Byte
  - Light and fast.
- **We take data using both mode.**





Fast Mode Data

- **Energy calculation (Integrated ADC)**
  - From Fig A, Energy can be taken by difference of pulse and pedestal.
- **Threshold (timing) calculation**
  - From Fig B, Calculate threshold using peak value and constant fraction.

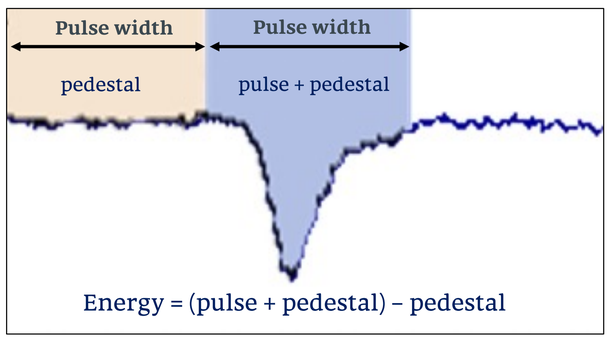


Fig A. Energy

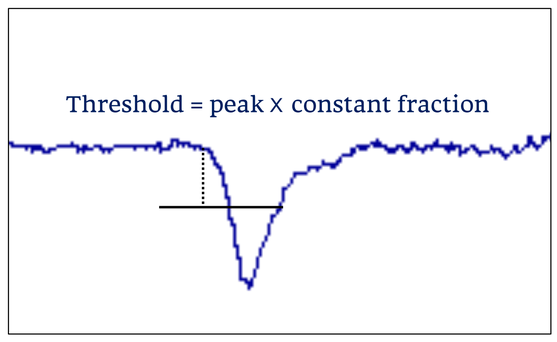


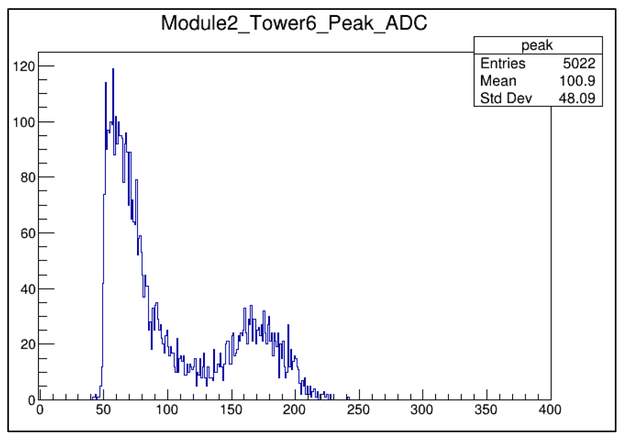
Fig B. Threshold (timing)

DAQ Operation

1. Set every hardware equipment including ancillary detectors and module.
2. Turn on DAQ & TCB board.
3. Operate them on DAQ PC.
   - We set simple shell script on linux environment to operate it.
   - Shifters can easily set DAQ system just through typing config file name.

```
bash-3.2# ./run_all.sh
/Users/drc_daq/scratch/notice
run number is 337!!
Enter the set up config file : setup
setup
test
Info: open_device: opening device Vendor ID = 0x547, Pr
Info: open_device: super speed device opened (bus = 2,
mid 1 is found at ch1
mid 2 is found at ch2
DRAM is aligned, delay = 17, bitslip = 0
DRS PLL lock status = 15
DRAM is aligned, delay = 18, bitslip = 0
DRS PLL lock status = 15
Run number = 337
setting complete!
Enter the nevt : 10
1 2
processing 1 / 1 : mid num is 1
processing 2 / 1 : mid num is 2
ready!!
```

Data taking process



Monitoring the plot

Summary

- We experienced the **Test Beam at CERN** to verify the performance of Dual-Readout Calorimeter.
- In this process, it was important to **construct Data Acquisition(DAQ) system.**
- Finally, We got **4.7M waveform** and **23M fast mode** events for **84 hours.**