Front-end Electronics overview

FEE cards hardware properties:

- 32 ch. dual gain shapers, 64 readout channels
- RMS noise: ~ 3.2 MeV
- 14 bit dyn. energy range
- 32 HV regulators, 10 bit for APD bias
- Fast OR (2 × 2 crystals) for trigger
- 10 bit ADCs (ALTRO) 10 MHz
- Board controller firmware in FPGA
- GTL readout and control bus
- DAQ readout and DCS via RCU
- 5.5 watt, 349 × 210 mm²
FEE readout characteristics

High/Low gain shaper readout

Run 1153, Samples 009, event 20

Low gain

Run 1153, Samples 008, event 20

High gain

2nd order Gamma2 fit:

\[ V_{\text{out}}(t) = \left( \frac{4Q\cdot A}{C_f} \right)^2 \cdot \left( \frac{t-t_0}{\tau} \right)^2 \cdot e^{-\frac{t-t_0}{\tau}} \]

- \( Q \) = input charge on APD
- \( C_f = 1 \) pF
- \( \tau = 1000 \) ns (PHOS) or 100 ns (EMCal)
- \( A = \) CSP gain

PHOS: energy ranges 0.005 GeV~5 GeV / 0.08 GeV~80 GeV for APD gain M=50
EMCal: energy ranges 0.015 GeV~15 GeV / 0.25 GeV~250 GeV for APD gain M=30
MIP ~ 215 MeV at room temperature at noise level of 30 MeV for PHOS.

Signal to Noise Ratio at room temperature ~ 7

fast OR differential signal for TRU

Shapers/fast-OR readout linearity

- fast OR saturation at 2.5 - 2.74V differential
- fast OR / LG = ratio 9.403
- CSP gain = 29.2 uV/MeV (for M=50)
- LG shaper gain = 0.427
- HG shaper gain = 6.85

PHOS

- fast OR saturation @ 2.5V:
  - LG value ~ 260mV
  - CSP value = 0.609 V
  - Saturation Energy ~ 21 GeV

EMCal

- fast OR saturation @ 2.68V:
  - LG value ~ 380 mV
  - CSP value = 0.890 V
  - Saturation Energy ~ 30 GeV

fast OR: analogue 2×2 CSP signal of \( \tau = 100 \) ns

- fast OR saturation at 2.5 - 2.74V differential
- fast OR / LG = ratio 13.784
- CSP gain = 17.5 uV/MeV (for M=30)
- LG shaper gain = 0.229
- HG shaper gain = 3.66

Y.P Wang, H. Muller, et al.: Front-end Electronics for the ALICE Calorimeters