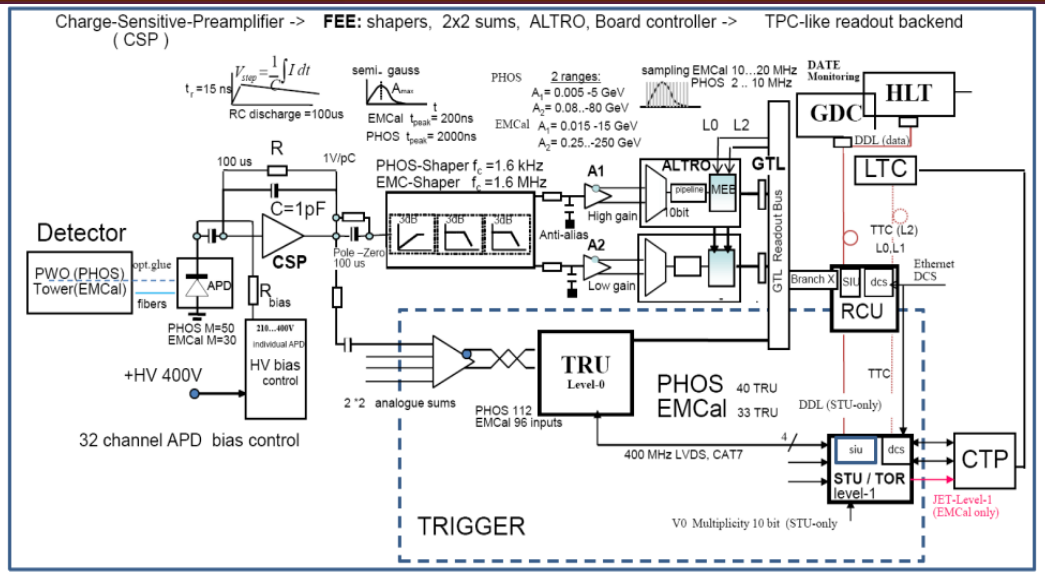
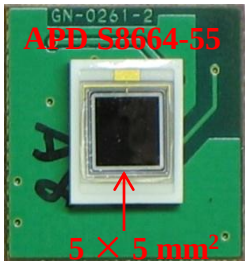
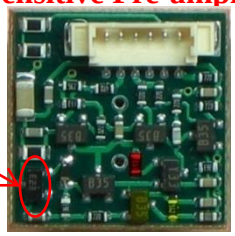
Front-end Electronics overview



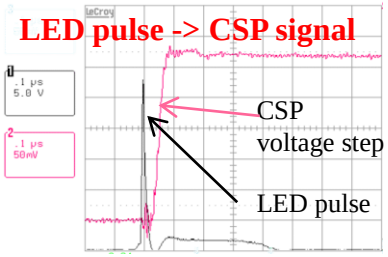


Charge Sensitive Pre-amplifier (CSP)

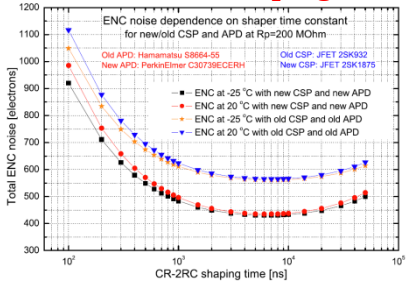
JFET 2SK932

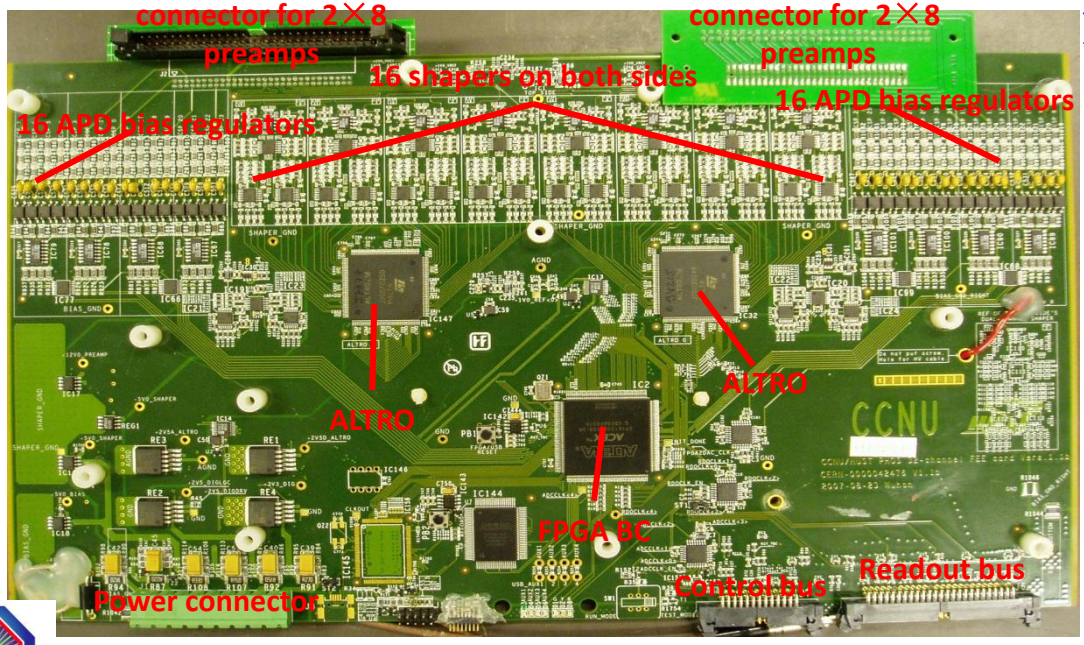


LED pulse -> CSP signal



ENC noise Vs. shaping time



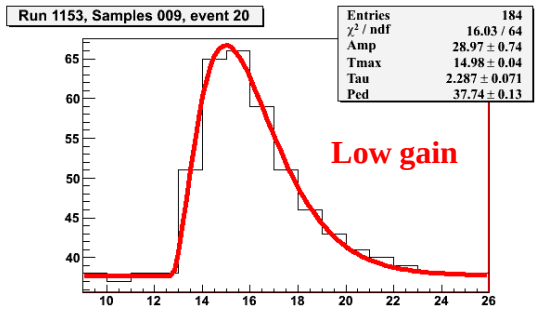


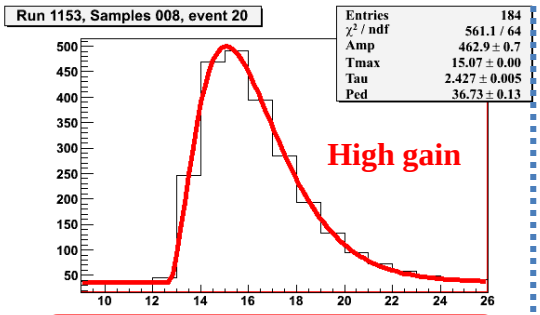
FEE cards hardware properties:

- 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





2nd order Gamma2 fit:

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

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

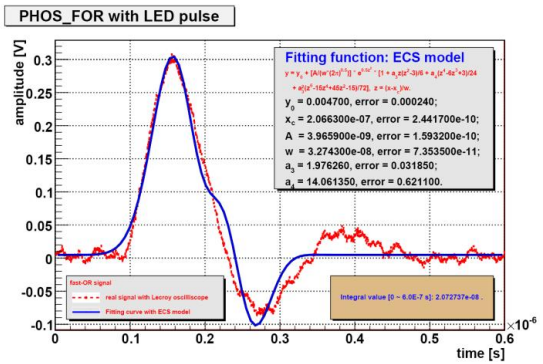
PHOS: energy ranges 0.005 GeV~5 GeV / 0.08 GeV~80 GeV for APD gain M=50

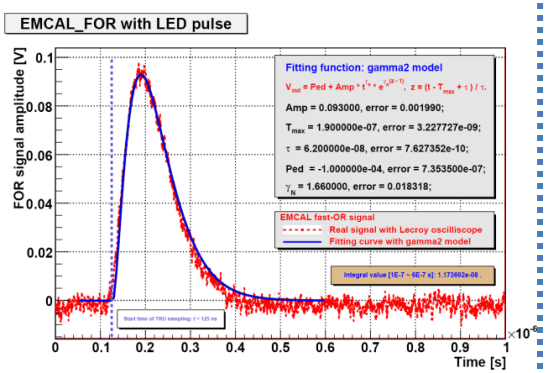
EMCal: energy ranges 0.015 GeV~15 GeV / 0.25 GeV~250 GeV for APD gain M=30

MIP ~ 215 MeV at room temperature at noise level of 30 MeV for PHOS.

Signal to Noise Ratio at room temperature ~ 7

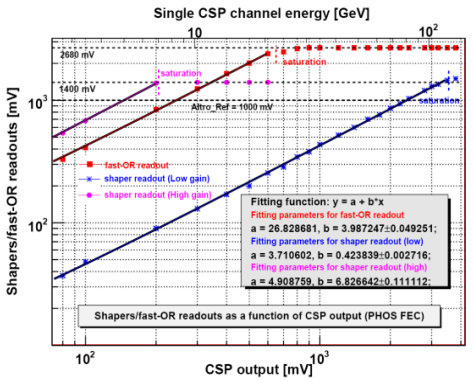
fast OR differential signal for TRU





fast OR: analogue 2×2 CSP signal of τ=100 ns

Shapers/fast-OR readout linearity

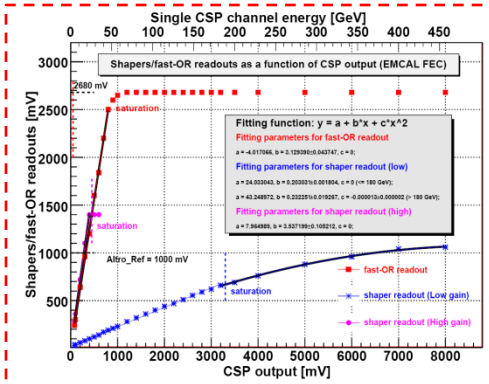


· Linear range:
· fast OR saturation @2.5V:
· LG value ~ 260mV
· CSP value = 0.609 V
· Saturation Energy ~ 21 GeV

· Non linear range:
· fast OR @ 2.68V
· LG value ~ 380 mV
· CSP value = 0.890 V
· Saturation Energy ~ 30 GeV

· 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



· Linear range:
· fast OR saturation @2.5V:
· LG value ~ 180 mV
· CSP value = 0.792 V
· Saturation Energy ~ 45 GeV

·Non linear range:
· fast OR @ 2.68V
· LG value ~ 250 mV
· CSP value = 1.091 V
· Saturation Energy ~ 63 GeV

· 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

EMCal