FCAL energy calibration

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for the GlueX Collaboration

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FCAL-LED description

Setup

- Four acrylic panels each covering the upstream end of one quadrant
- Each panel is illuminated by forty LEDs, ten violet, ten blue, and twenty green
- Different colors are used to study the wavelength dependence of the transmission
- Transmission of blue is sensitive to radiation damage which causes brownish color of lead glass
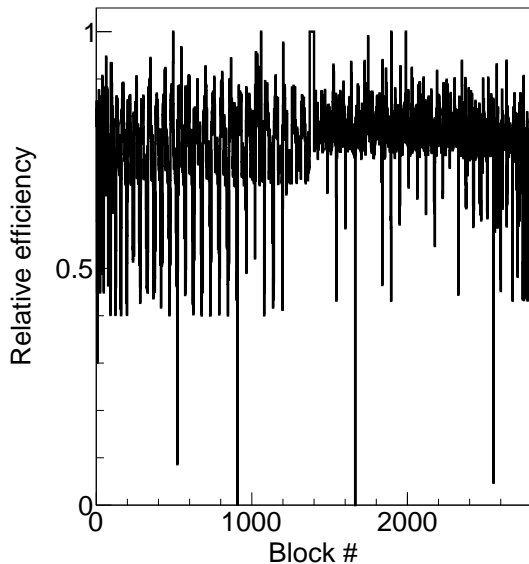
Usage, during production, FCAL LEDs are cycled through 6 configurations, each 10 minutes long and tied to the wall clock

- Violet 12 V (00 to 09 minutes)
- Blue 10 V (10 to 19 minutes)
- Green 29 V (20 to 29 minutes)
- Violet 22 V (30 to 39 minutes)
- Blue 15 V (40 to 49 minutes)
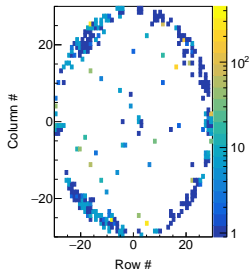- No pulsing (50 to 59 minutes)
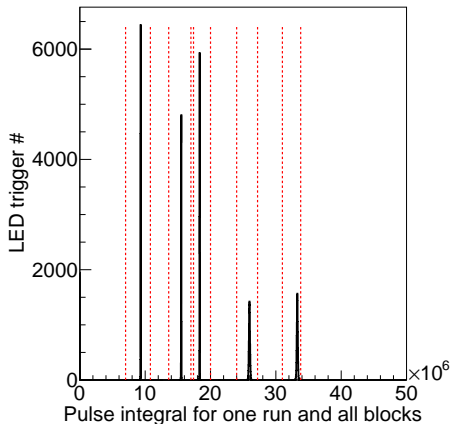
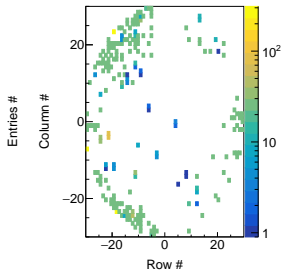# Block quality criteria

Check for each run individualy, threshold at 0.2
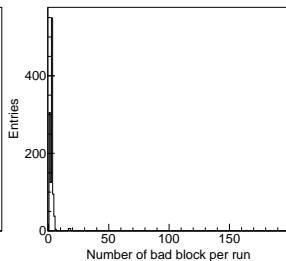
Block quality mapping
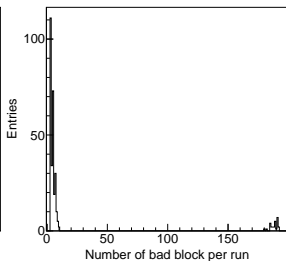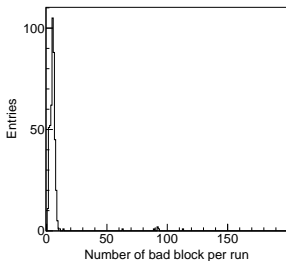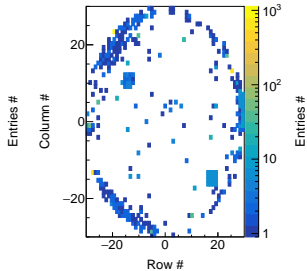
FCAL-LED skims analysis results:

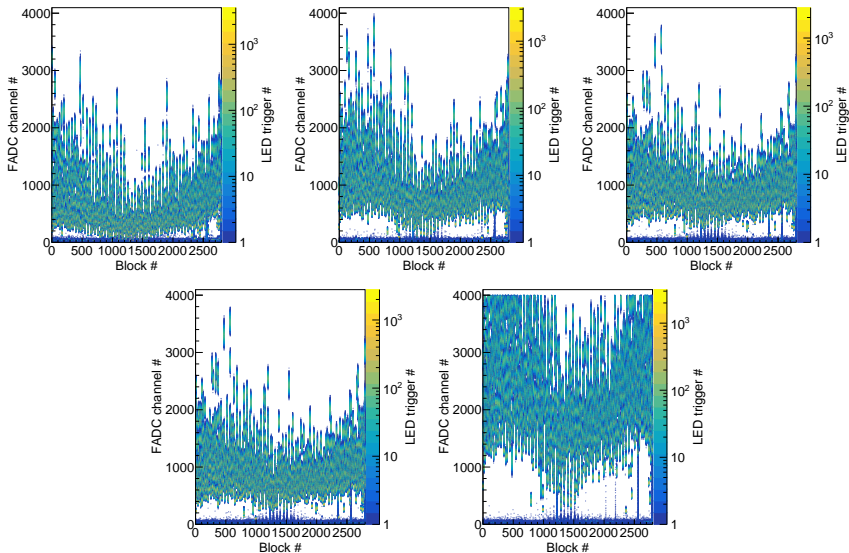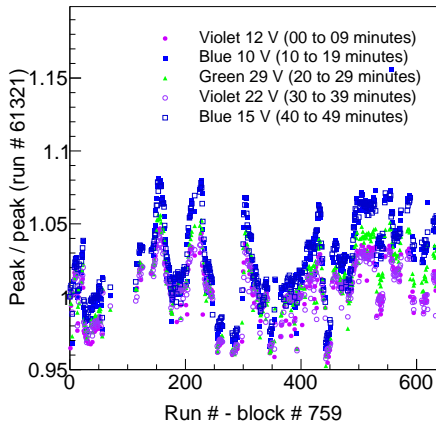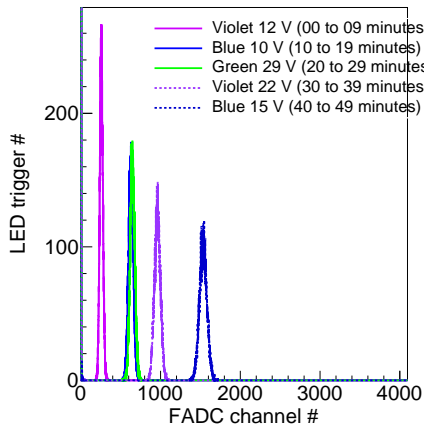● 2019-01 (448 skims)   ● 2021-08 (310 skims)   ● 2022-08 (1131 skims)

LED signal

Non-uniform, specific LED light/bias voltage for each ring

Gain stability

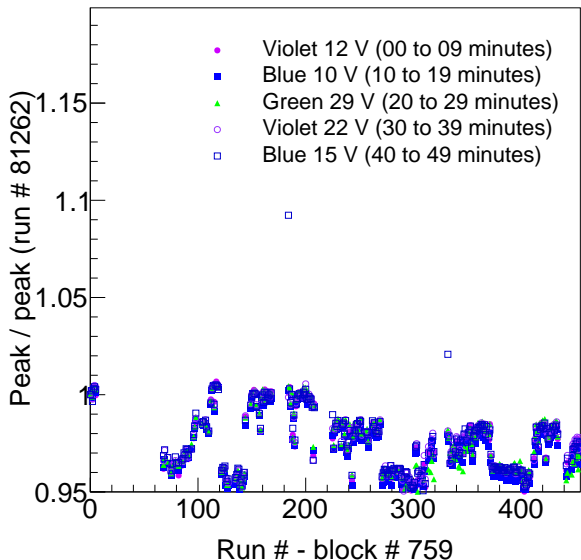Each cycle for each block is fitted

- Software gain, $G^i = G^0 \times \frac{p^i}{p^0}$
  - ▶ G^0, software gain determined by a "π^0 gain matching" for a reference run
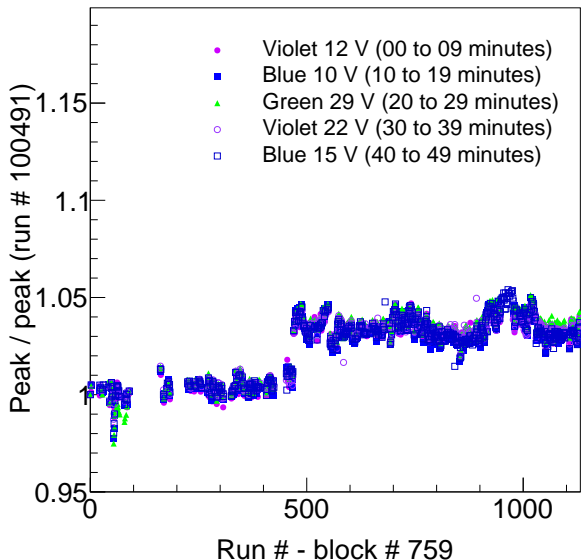 - ▶ p^0, fitted FADC peak distribution

Gain stability

Same block but different run period: 2021-08 (PrimEx-eta phase 2)

Gain stability

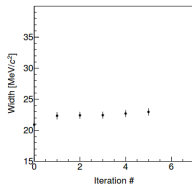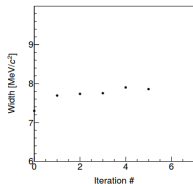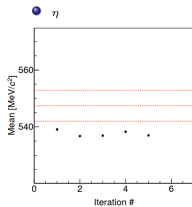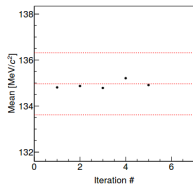Same block but different run period: 2022-05 (CPP)

Test results

On period41 of RunPeriod-2019-01 (PrimEx-eta phase 1)

- Reference run corresponds to 1st run of period41 (61833), 1% precision
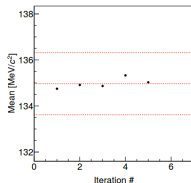- First run after the reference run (61834)

- Iteration 0 to 3, "π^0 gain matching"
- Iteration 4, LED cycle 1 corrections, resolution is worsing by 3%
- Iteration 5, LED cycle 5 corrections, resolution is worsing by 2%

Test results

On period41 of RunPeriod-2019-01 (PrimEx-eta phase 1)

- Last run of period41 (61846)
- 24hours difference between 61833 and 61846

- π^0

- η

- Iteration 0 to 3, "π^0 gain matching"
- Iteration 4, LED cycle 1 corrections, resolution is worsing by 3%
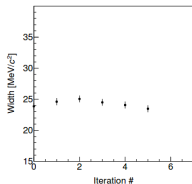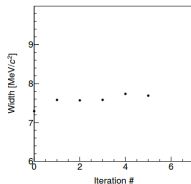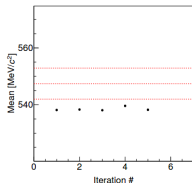- Iteration 5, LED cycle 5 corrections, resolution is worsing by 2%

Conclusion

FCAL-LED usable to determine:

- Gain stability and number of calibration periods needed
- Gain correction
  - ▶ Method 1: based on a reference run
  - ▶ Method 2: normalized all amplitudes, then do a "π^0 gain matching"