



2024 TB - CAEN Readout

September 29, 2026

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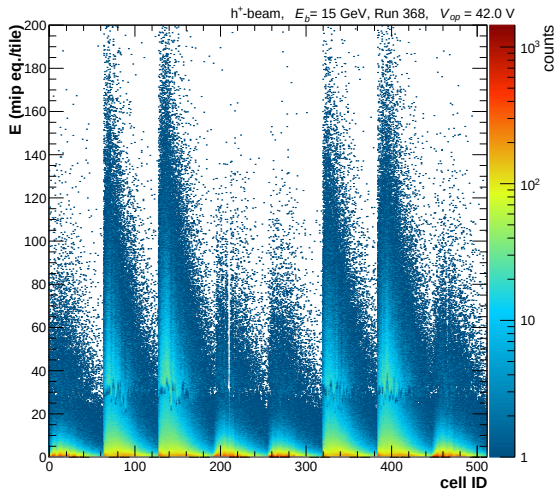


2024 TB - CAEN Readout Investigations LG-HG correlation Recap: Where we stopped in June!



Tackling the LG-HG calib problem! (1)

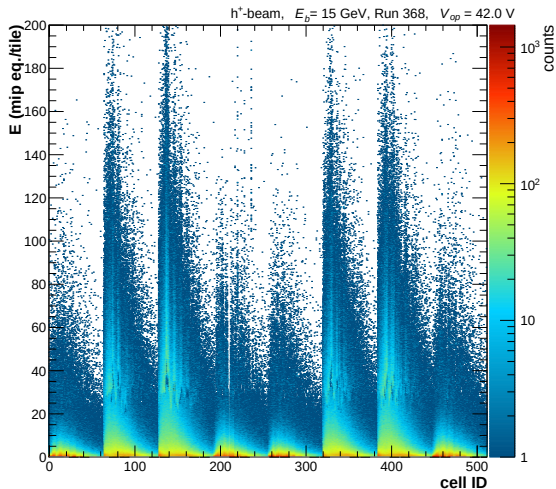
original distribution



- Original 15GeV proton distribution for all cells
- Found a bug in the $Max_{LG,mip,calc}$ calculation (neglected offset in correlation function)
- Using cross correlation between LG-HG of the highest π^- energy for correction $\rightarrow$ patched calib object
- Remaining small discontinuity $\rightarrow$ shift in pedestal?

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w/ bug fix for $Max_{LG,mip,calc}$

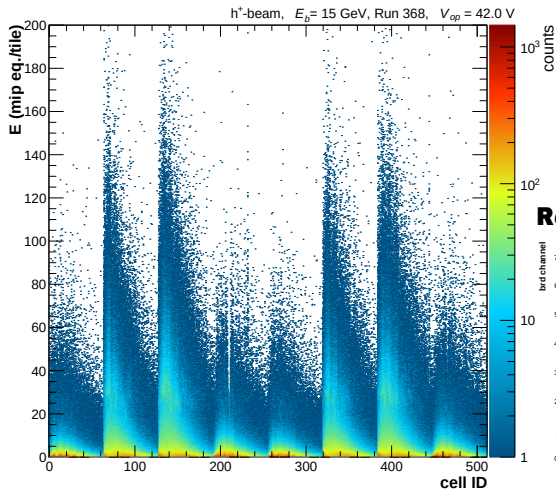


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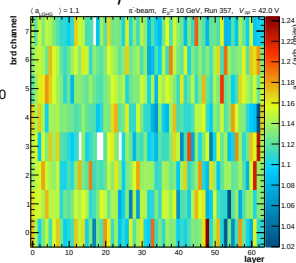
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& a_{LG-HG,π^-}

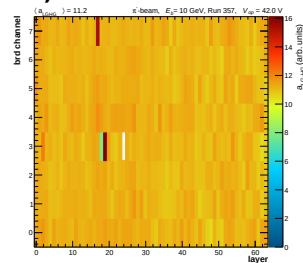
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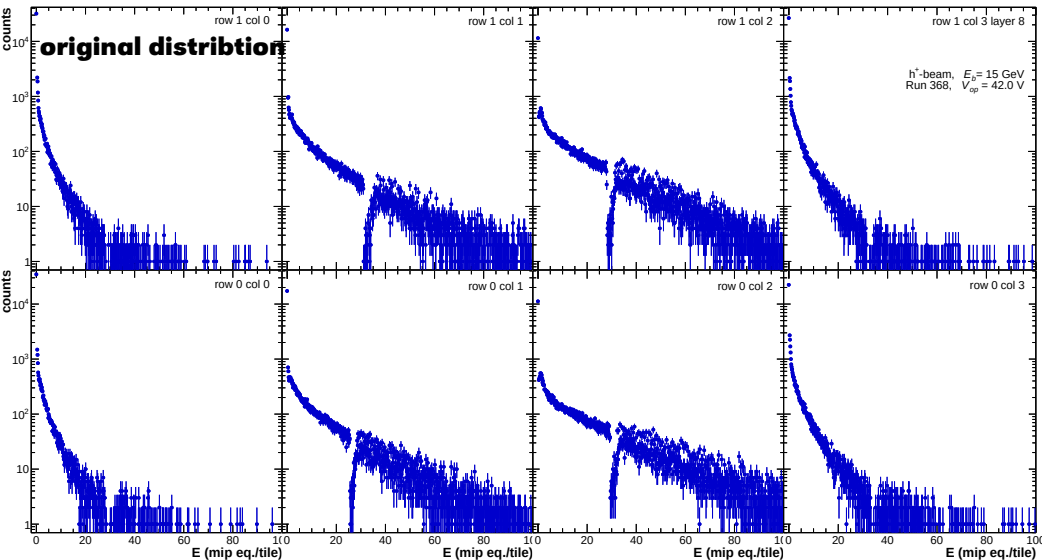
Ratio to μ values



π^- , 10 GeV values

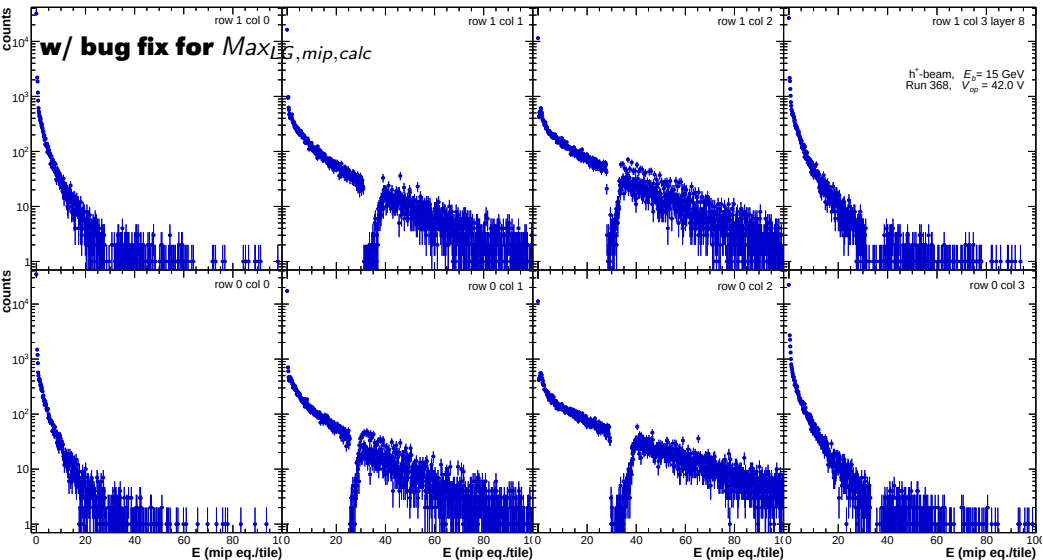


Tackling the LG-HG calib problem! (2)



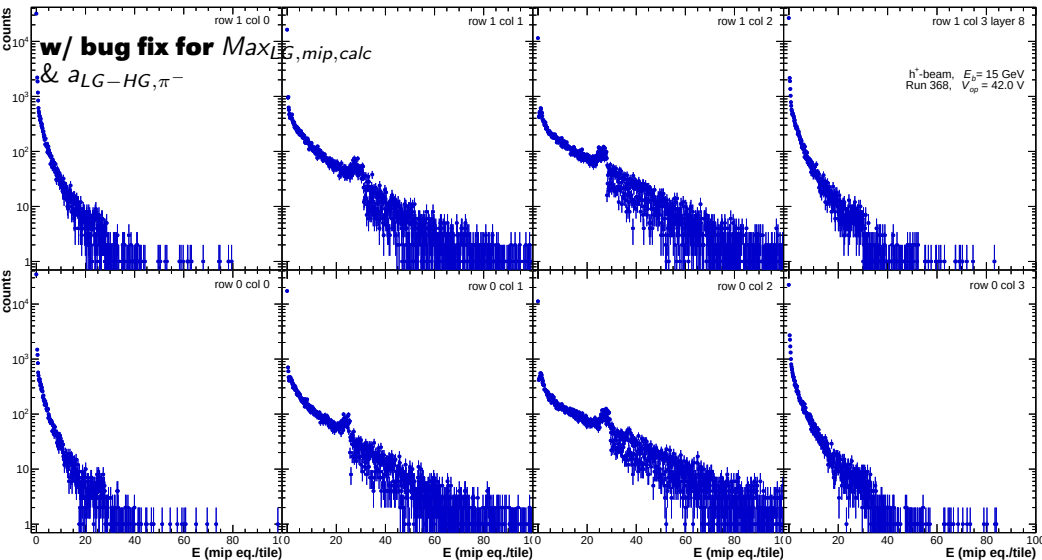
- Remaining small discontinuity → shift in pedestal?
- Same behaviour for all electron/hadron runs
- Event cuts?

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2024 TB - CAEN Readout Investigations LG-HG correlation How to calibrate e^- & $h^\pm$ data?



- a) Saturation of signal leads to too long decay time
 - ▶ LG-HG broken as consequence
 - ▶ Next event(s) data corrupted
 - ▶ This we can test!
- b) Ground shifts due to too high charge in RO-module
 - ▶ Could only test in lab with laser/led pulser.
- c) Cross talk expresses itself differently in HG & LG due to long delay in (independent amplifiers & shapers - same circuit diagrams)
 - ▶ Could only test in lab with laser/led pulser.

Focussing on one cell

Run 275, proton, $E = 15$ GeV

all events

cut-off HG ≈ 0

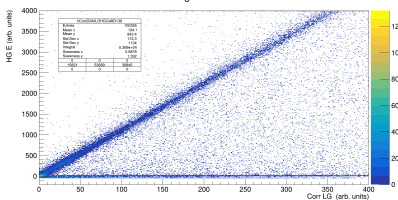
- Investigated HG & LG saturation events for single cells

- LG saturates very very seldom
- Hoped off-diagonal elements would be concentrated in events after saturated (throw them out)
- Very similar fractions

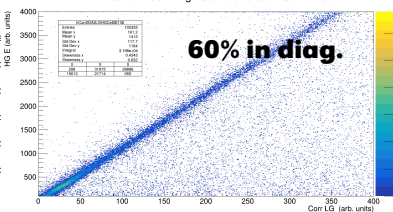
- Looked at single cell event by event $\rightarrow$ LG/HG ratio takes very long to recover to original (if at all)

- Worse effect for higher gain runs ($V_{op} = 45$ V)
- After saturation $nx10\mu s$ to recover (particles hitting SiPM in between makes situation worse)
 - HG likely unusable in higher gain runs $V_{op} > 42$ V

2D ADC Low Gain/High Gain correlation CellID 136

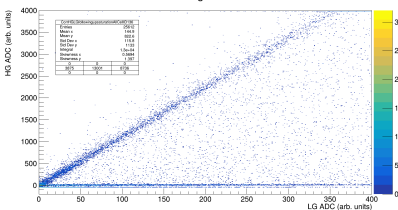


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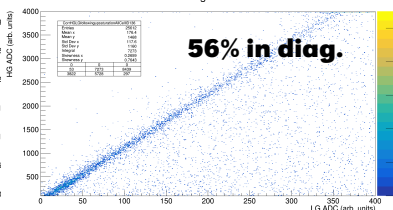


events after HG saturated

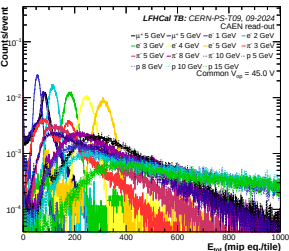
Corr HG vs LG following saturated HG CellID 136



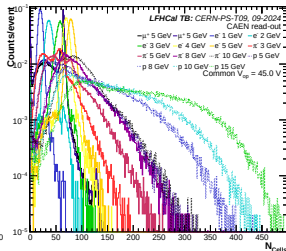
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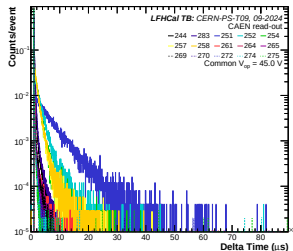
Mitigation strategy: a) Cut-out events ($V_{op} = 45 \text{ V}$)



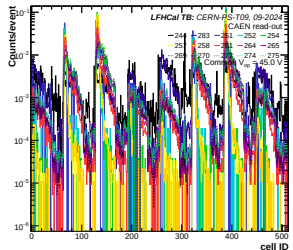
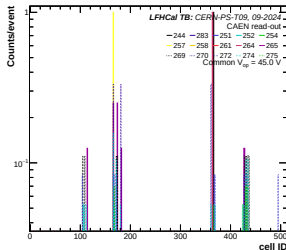
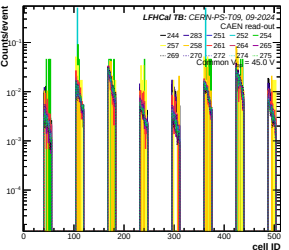
saturated HG



saturated LG



off diag > 30%



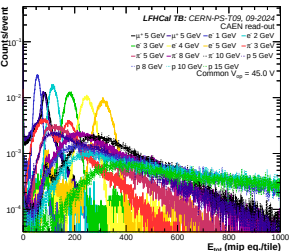
- LG saturation even for $> 1 \text{ cell} < 0.05\%$ events even in h^+ 15 GeV
- HG saturation for at least 1 cell 1% in μ , 36% in h^+ 15 GeV
- LG/HG corr outside $\pm 30\%$ of original ratio might be too tight close to pedestal

→ too many events flagged (≤ 2) cells also in μ runs (up to 10%)

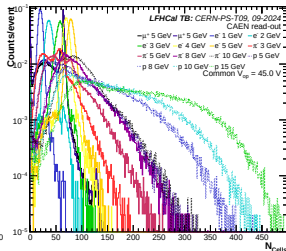
- ▶ e^- 0.7 (1 GeV) → 75% (5 GeV)
- ▶ $h^\pm$ 24 (3 GeV) → 95% (15 GeV)

⇒ Cutting not really an option

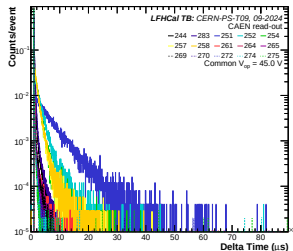
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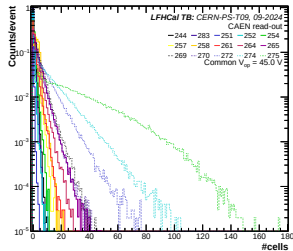
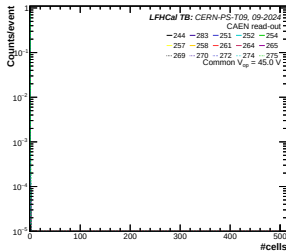
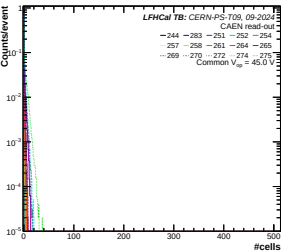
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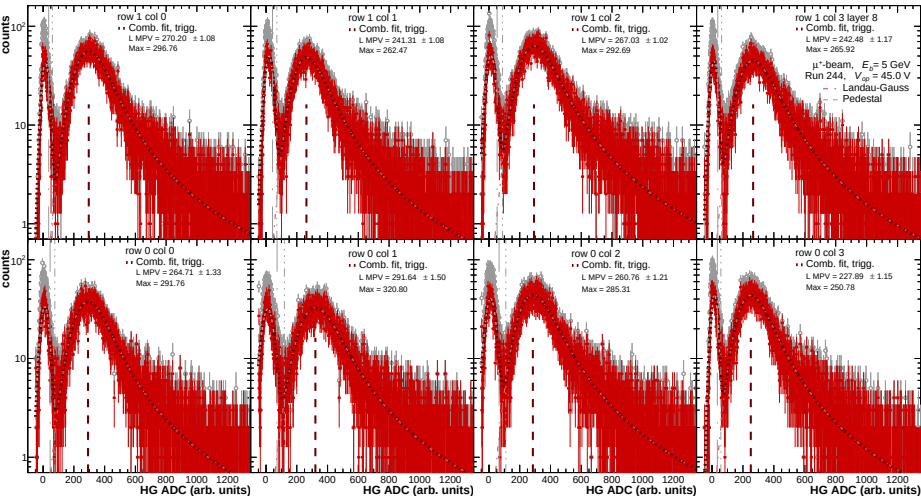
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Mitigation strategy: b) Use LG only for 'physics' events ePIC

How can we trust the LG is right?

- Could we calibrate with LG mips?
 - ▶ Lets see!
- Can we 'just' use the lower V_{op} runs?
 - ▶ Lets see!
- Compare local mip trigger from hadron events vs mip trigger from muon run
 - ▶ TBD
- Compare Emip tot(or per layer)/ event with calibration based on LG signal only vs HG and LG combined (current option) with strong cut on correlation and LG-HG from either mips or hadron run at 10GeV
 - ▶ TBD

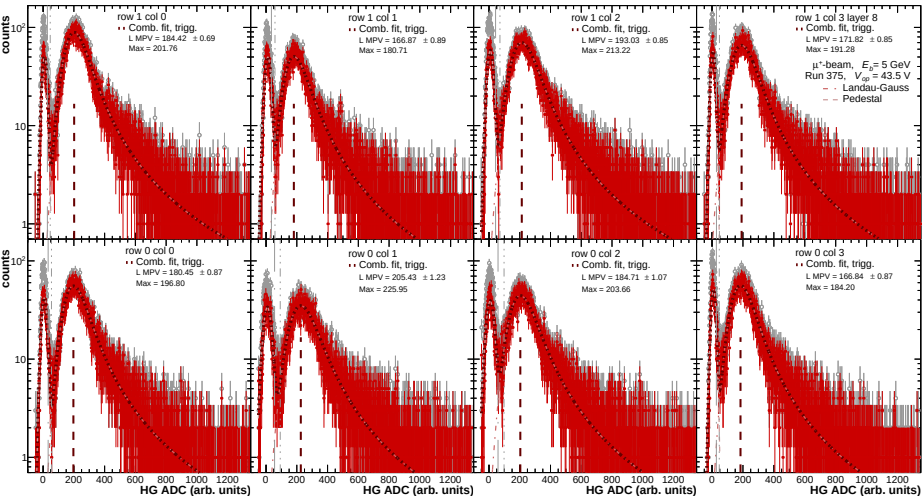
Improving HG fitting



- Fitting standalone
Landau-Gauss possible until $V_{op} \approx 42$ V
- Below very sensitive to merging with pedestal
⇒ Had to restrict fitting range significantly
- Now convoluted with Gauss for pedestal using starting parameters from pure pedestal run (2 - Gaussian width not yet combined to one param)
- Less fit range restrictions, more stable fitting
- Might need more iterations for $< V_{op}$

$V_{op} = 45$ V, Set A_1

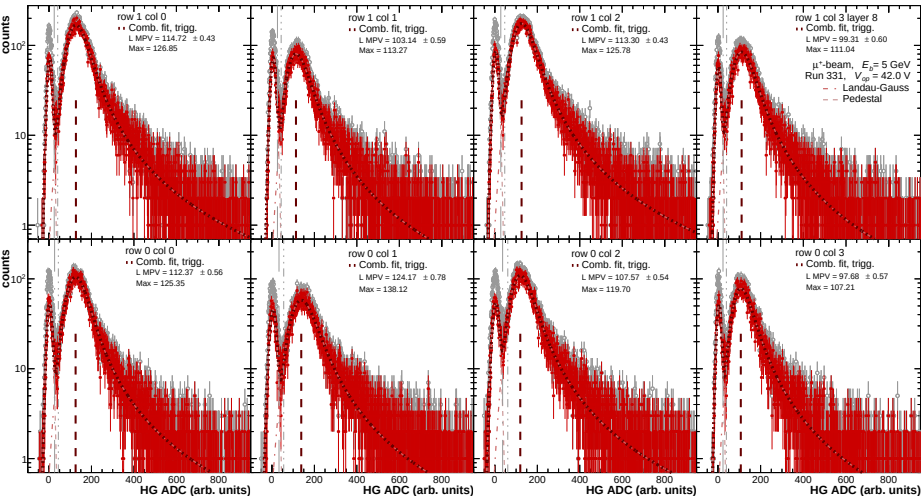
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$V_{op} = 43.5$ V, Set C_1

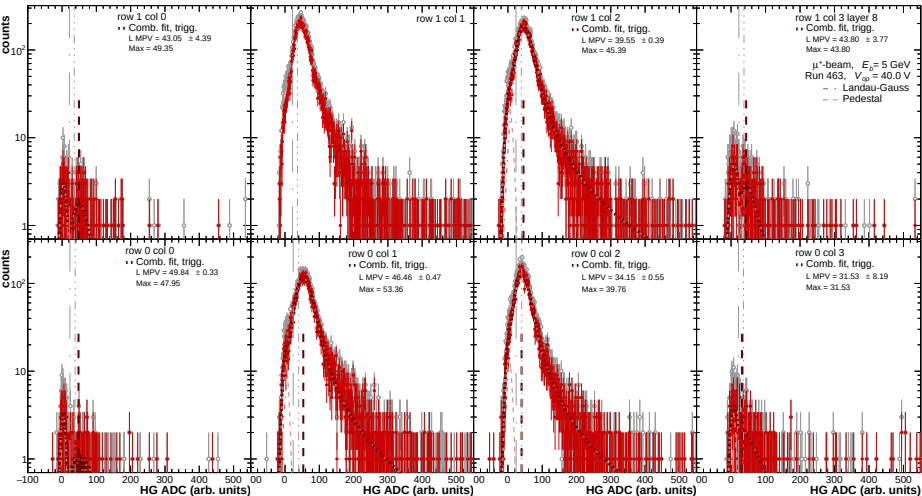
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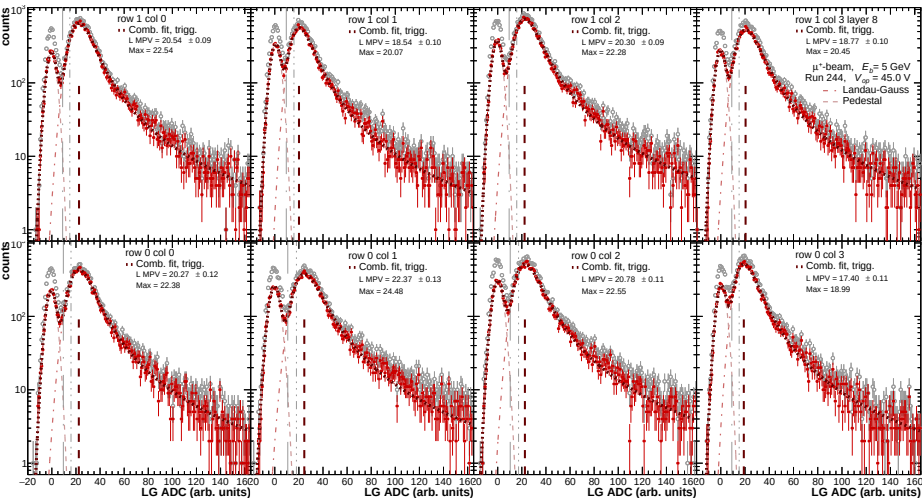
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$V_{op} = 40$ V, Set E (comb)

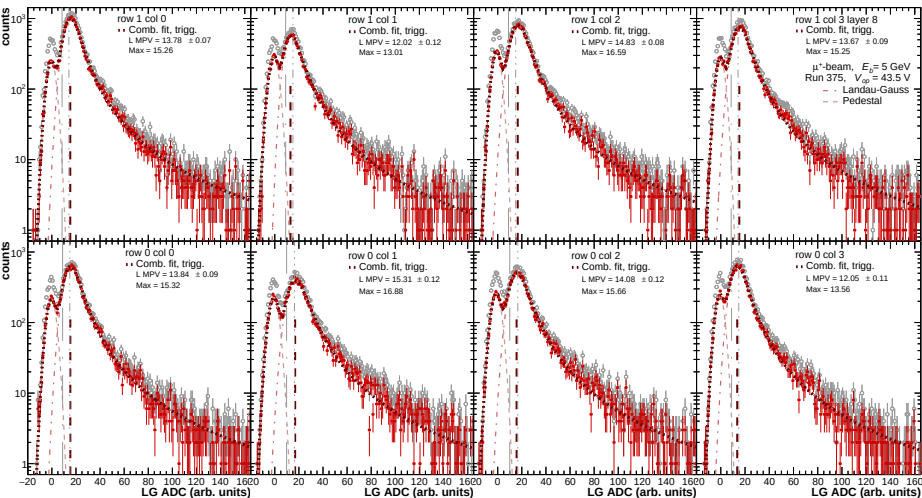
Improving LG fitting



- Fitting standalone Landau-Gauss possible until $V_{op} \approx 44$ V
- Below very sensitive to merging with pedestal
 $\Rightarrow$ Severe restrictions on fit range necessary & still lots of failures
- Now convoluted with Gauss for pedestal using starting parameters from pure pedestal run (2 - Gaussian width not yet combined to one param)
- Less fit range restrictions, more stable fitting
- Works down to $V_{op} \approx 41$ V
- Below fully merged & no chance

$V_{op} = 45$ V, Set A_1

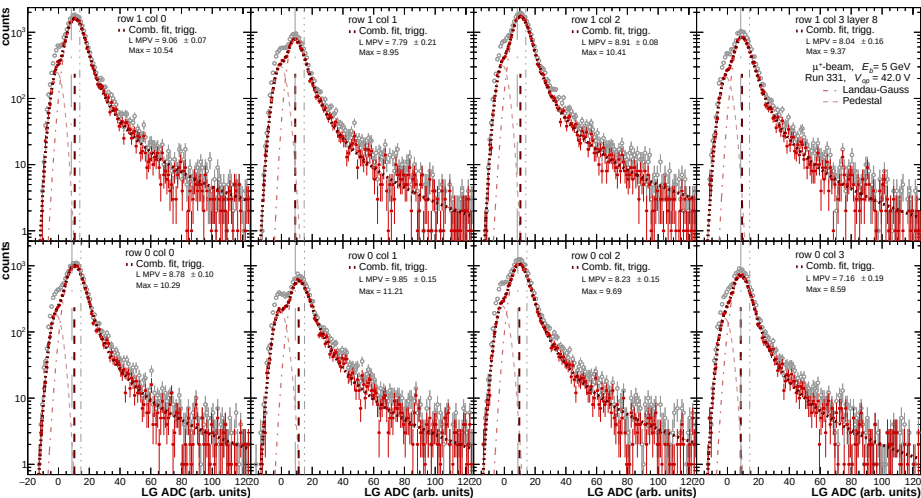
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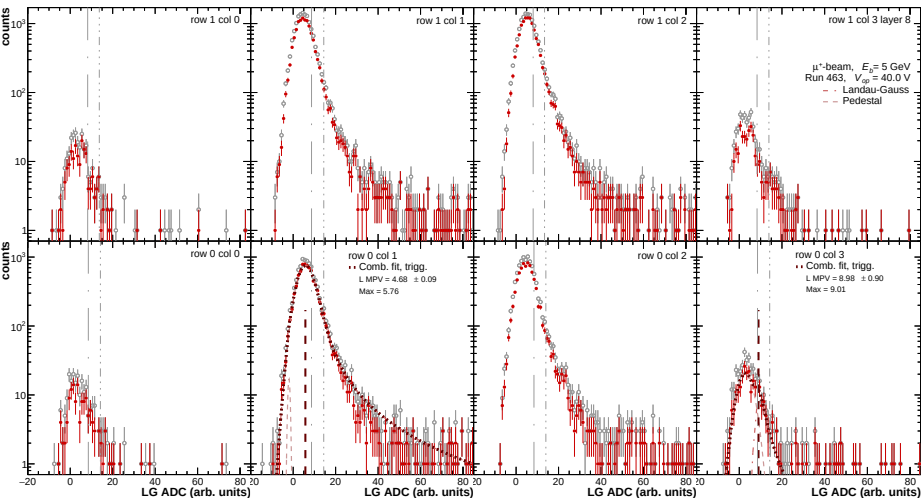
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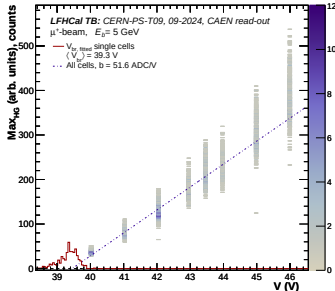
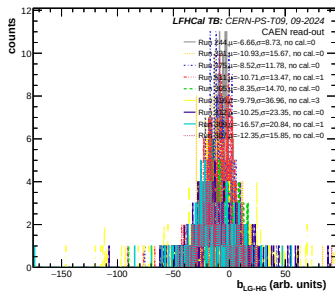
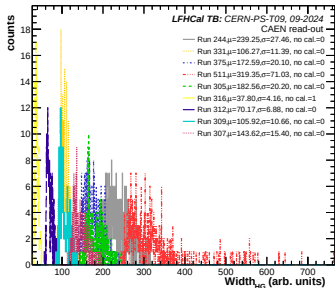
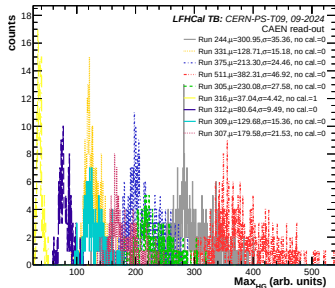
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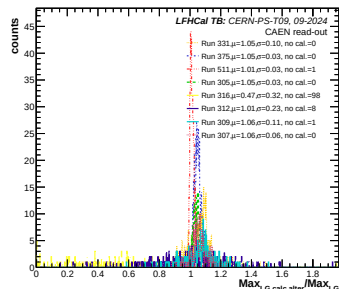
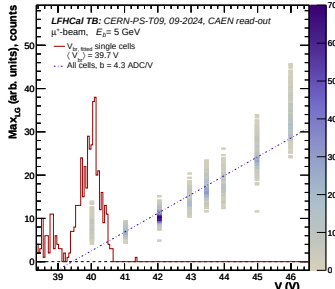
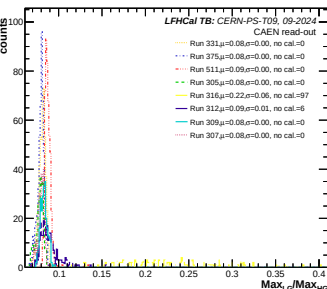
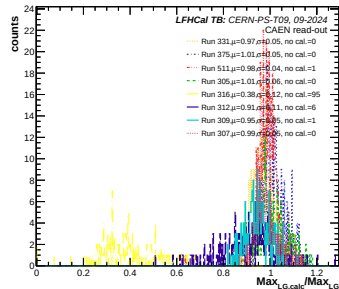
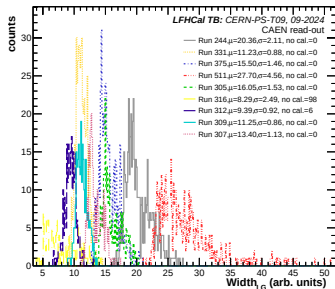
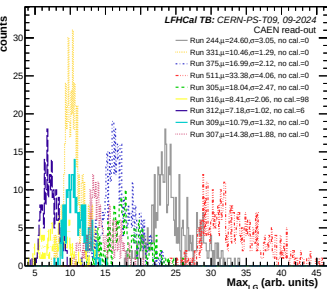
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First Look at HV scan + Sets - HG



First Look at HV scan + Sets - LG



Can we use the LG?

- Yes, we can use the LG calib.
- For low V_{op} we have to use the HG and convert it to LG equivalent
 - a) $Max_{LG,calc} = Max_{HG} / b_{LG-HG}$
 - b) $Max_{LG,calc,alter} = (Max_{HG} - a_{LG-HG}) / b_{LG-HG}$
- For those where low gain fits worked cross checked $Max_{LG,calc} / Max_{LG}$ & $Max_{LG,calc,alter} / Max_{LG}$ (right column prev slide), similar agreement offset (a_{LG-HG}) comparatively small for higher V_{op}
- Might be in slightly non linear part still