

2026 SPS TB - HGCROC Readout

September 15, 2026

Friederike Bock



- 1 SPS 2026 Set E - 44V
 - Overview
 - Pedestals
 - TOA offset calibration
 - Muon Calibrations
- 2 Calibrations Summary
- 3 Additional material

2026 SPS TB - HGCROC Readout Full Set E - analysis status



Overview - Set E

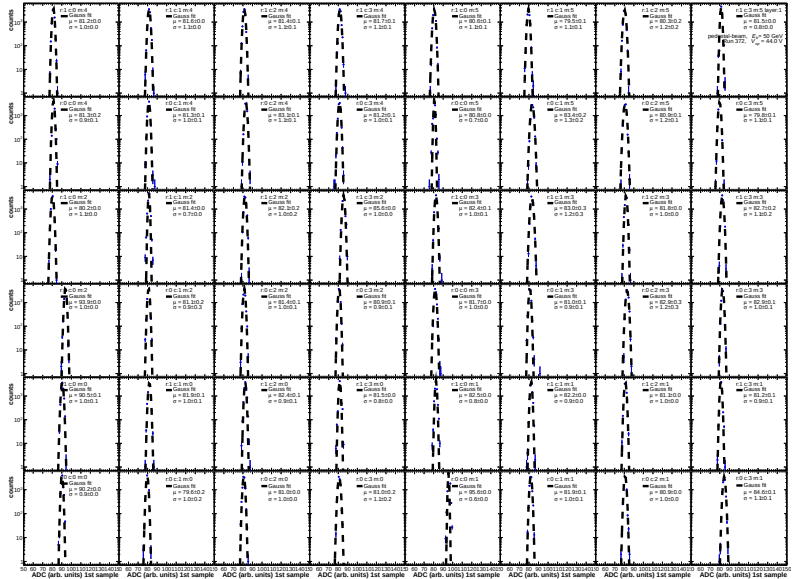
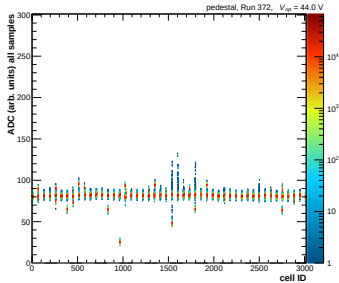
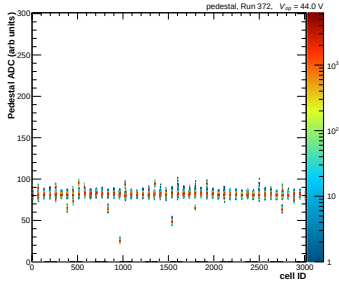
Full Set E

Summing Board V2, $V_{op} = 44$ V, gain settings: RF = 12, CF = 7, CC= 3, CFcomp=1
May 18, 17:05 - May 19, 2:36, additional May 19, 17:35 - May 19, 19:01

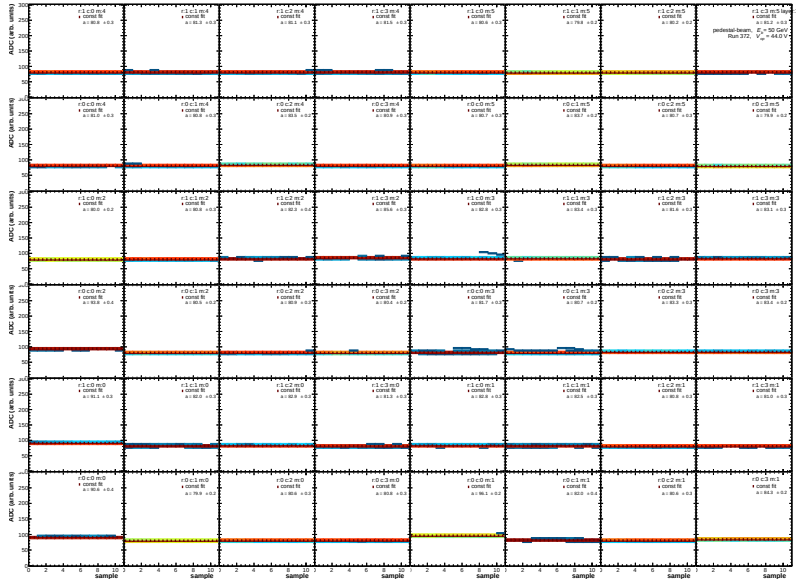
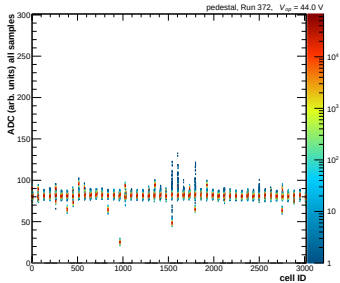
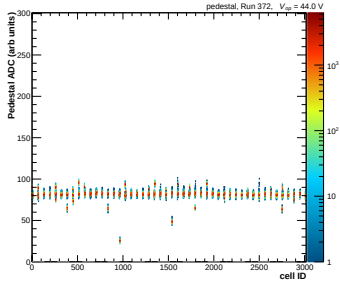
Calibration sets:																
μ table position	ped	(10,-5)	(10,5)	(-10, -5)	(-10,5)	(0,0)										
1 st	runs	372	375	376	377	378	374									
	tot events	10K	155K	161K	154K	154K	156K									
μ table position	ped	(10,-5)	(10,5)	(-10, -5)	(-10,5)	(0,0)										
2 nd	runs	420	422	423	425	424	421									
	tot events	10K	151K	158K	152K	164K	151K									
μ table position	ped	(10,-10)	(10,0)	(10,10)	(-10, -10)	(-10,0)	(-10,10)									
3 rd	runs	471	473	474	477	482	481	478								
	tot events	10K	152K	156K	151K	150K	156K	151K								
Electron set:																
E (GeV)	20	30	40	50	80	100										
e ⁻	runs	391	392	381	382	383	384									
	tot events	254K	256K	259K	255K	253K	254K									
e ⁺	runs	385	386	387	388	389	390									
	tot events	253K	256K	253K	258K	253K	252K									
Hadron set:																
E (GeV)	20	30	40	50	60	70	80	90	100	150	200	250	300	325	350	
h ⁻	runs	393	394	395	396	397	398	399	400	401	402	403	404			
	tot events	281K	259K	265K	256K	260K	258K	252K	263K	262K	254K	255K	256K			
h ⁺	runs	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419
	tot events	288K	255K	266K	263K	255K	253K	253K	259K	257K	259K	258K	258K	260K	251K	263K

- time:
 - 18.5.2026 17:05 - 19.5.2026 2:36 &
 - 19.5.2026 17:35 -19:01
- $V_{op} = 44$ V, $V_{br} = 38.3$ V
- Gain settings:
 - RF = 12, CF = 7, CC= 3, CFcomp=1
- e⁻ and h[±] with small scintillators
- μ with large scintillator triggers:
 - 5 positions Scan "_1"
 - 5 positions Scan "_2"
 - 6 positions Scan "_3"

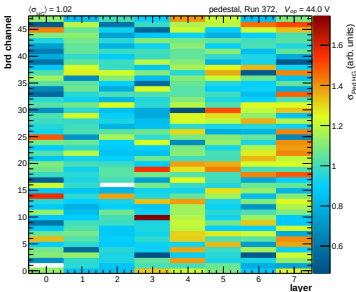
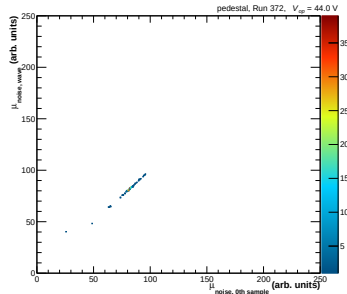
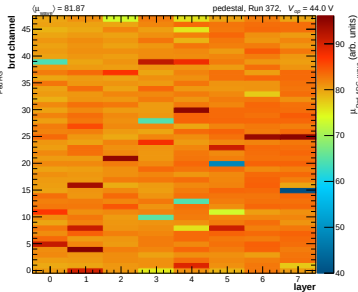
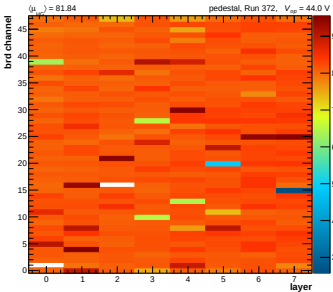
Muon calibration - Set 1: Pedestals



Muon calibration - Set 1: Pedestals

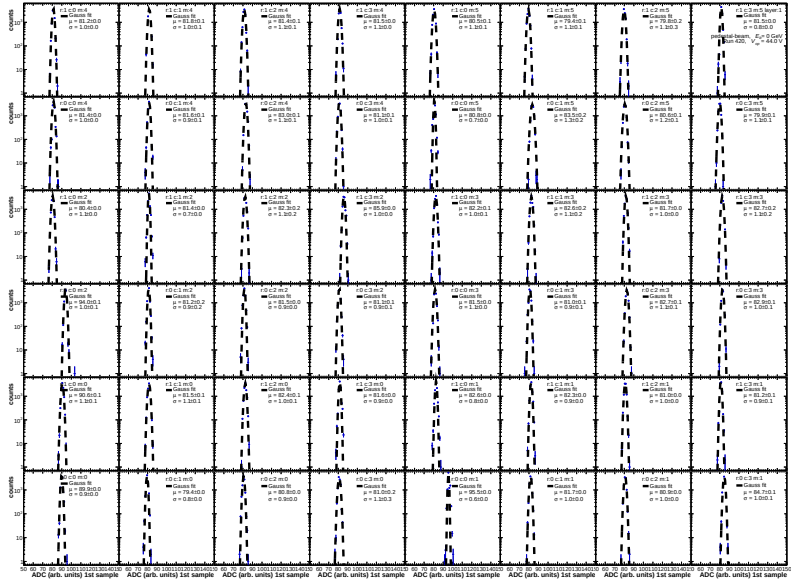
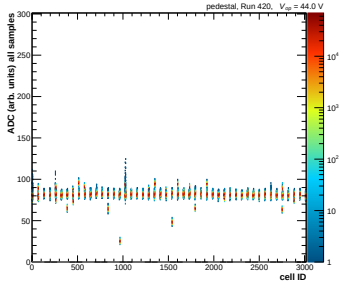
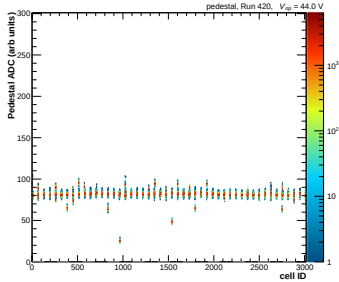


Muon calibration - Set 1: Pedestals

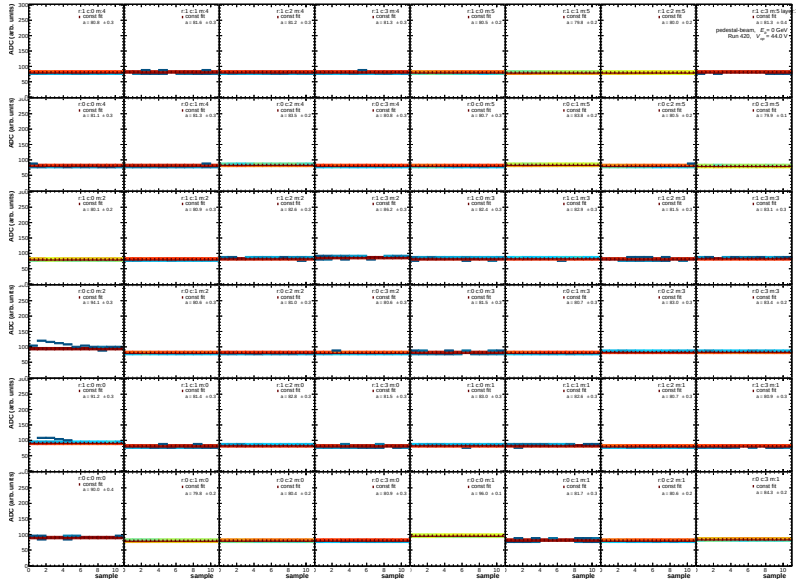
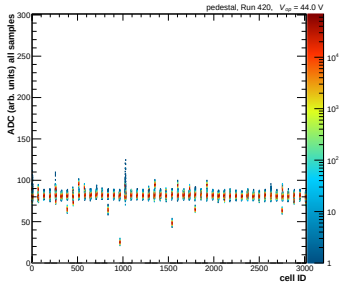
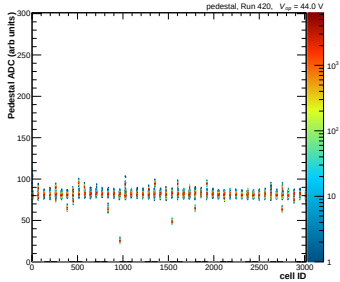


- Pedestal for all readout units set to 80 ADC
- Online calibration verified
- Fitting converges for most cells (4 missing)
- Good correlation between alternative fitting methods for pedestal

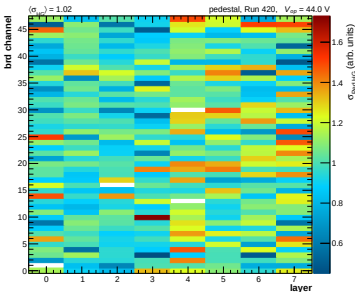
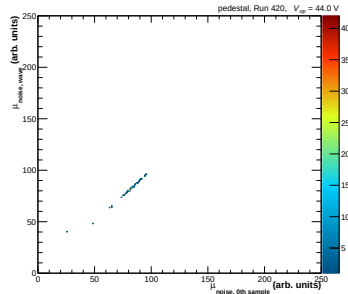
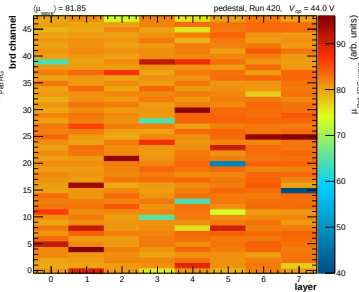
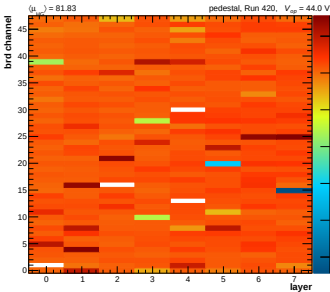
Muon calibration - Set 2: Pedestals



Muon calibration - Set 2: Pedestals

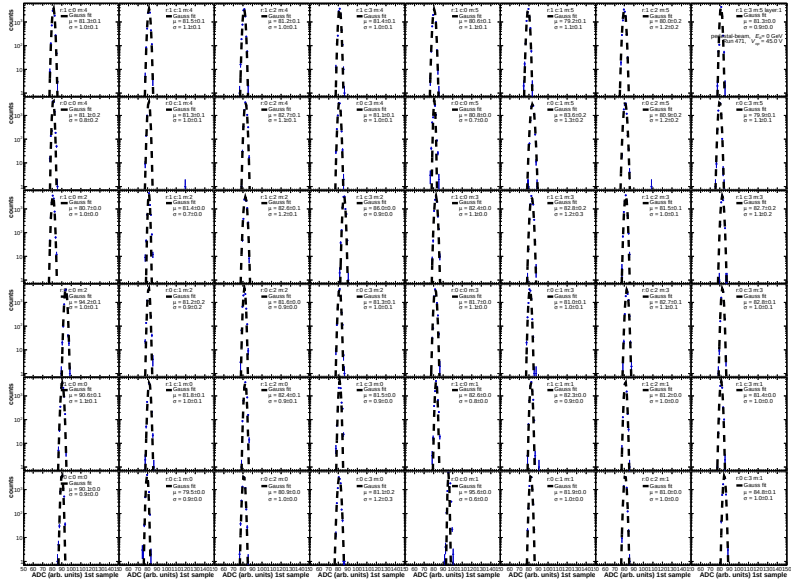
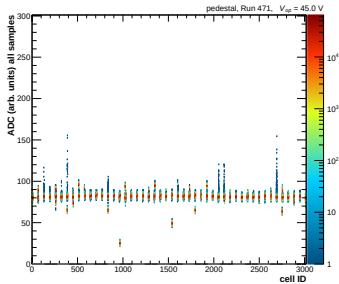
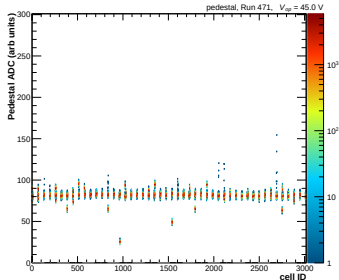


Muon calibration - Set 2: Pedestals

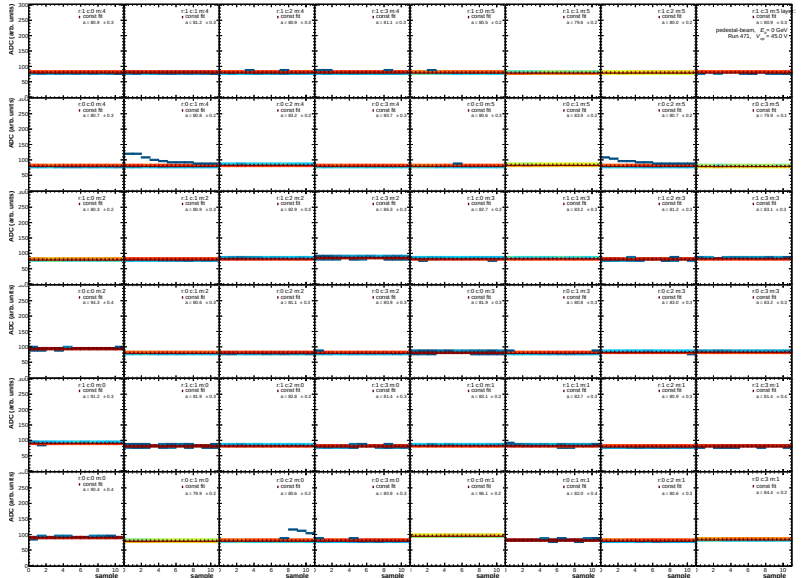
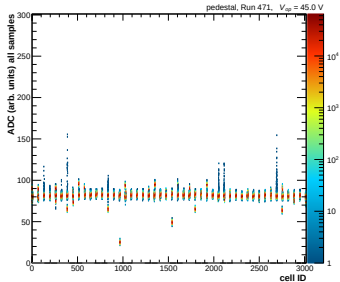
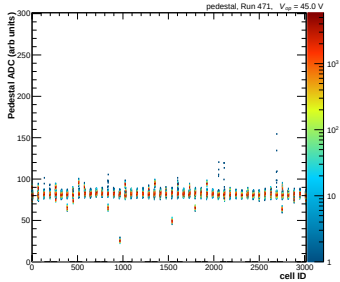


- Pedestal for all readout units set to 80 ADC
- Online calibration verified
- Fitting converges for most cells (3 missing)
- Good correlation between alternative fitting methods for pedestal

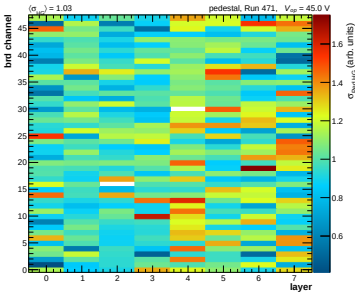
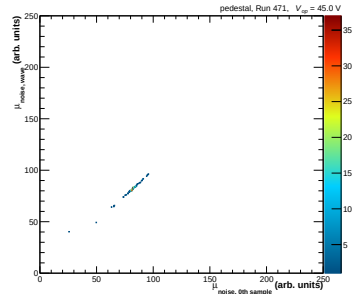
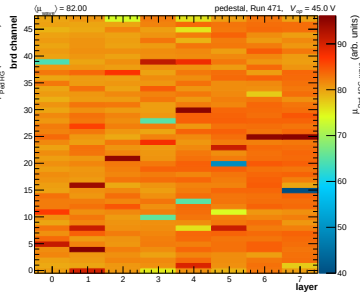
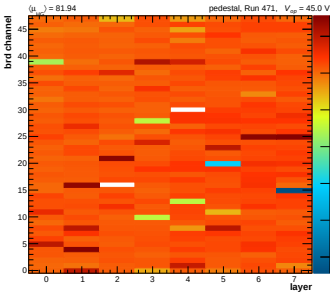
Muon calibration - Set 3: Pedestals



Muon calibration - Set 3: Pedestals

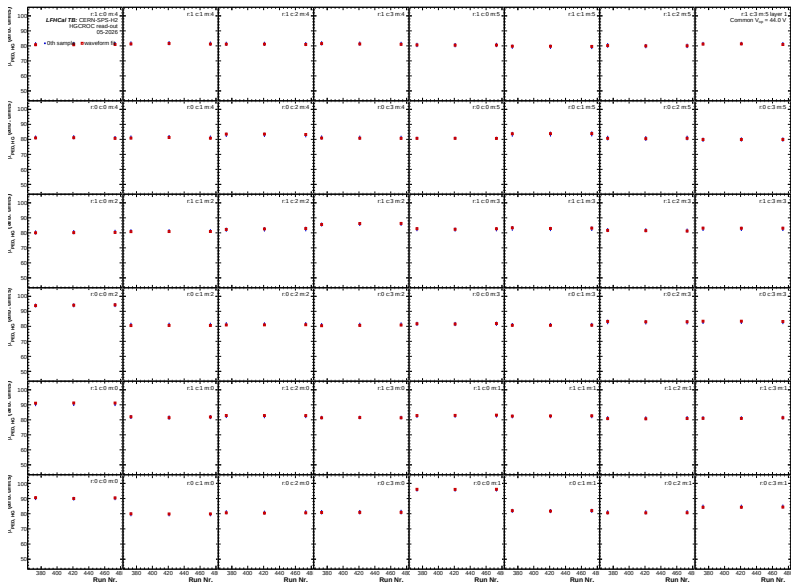
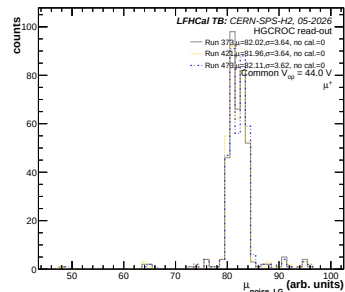
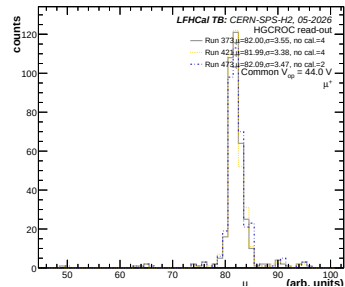


Muon calibration - Set 3: Pedestals

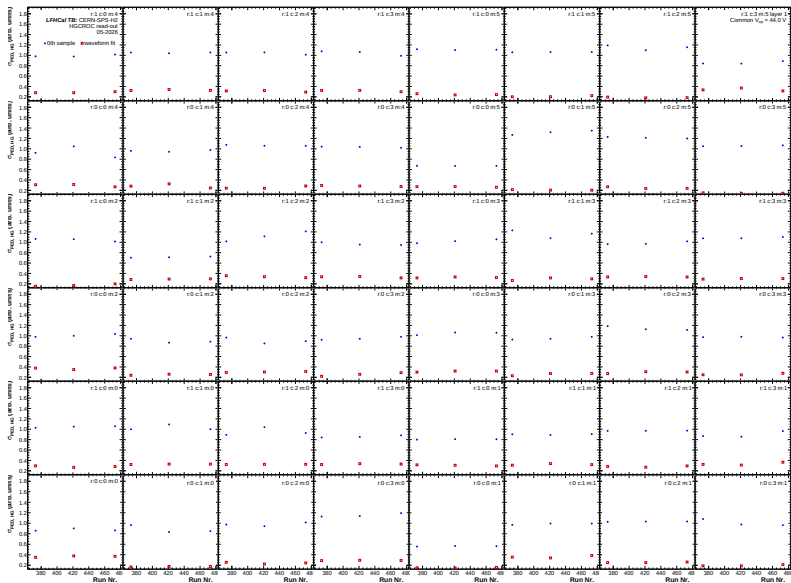
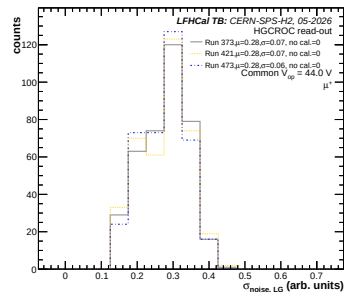
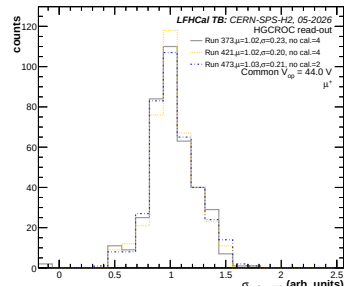


- Pedestal for all readout units set to 80 ADC
- Online calibration verified
- Fitting converges for most cells (2 missing)
- Good correlation between alternative fitting methods for pedestal

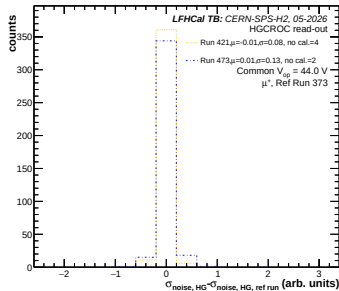
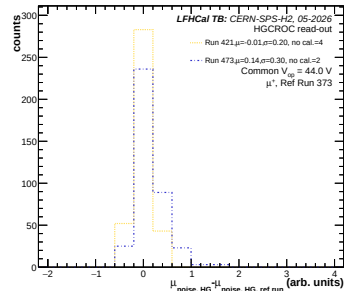
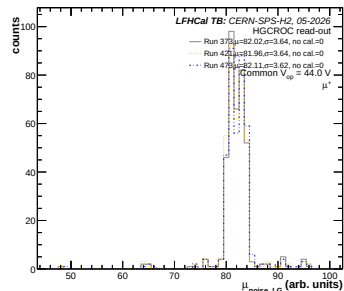
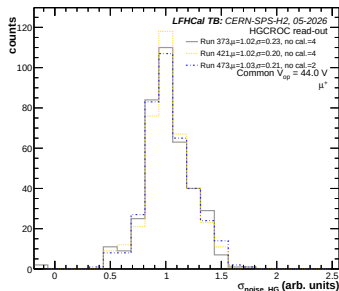
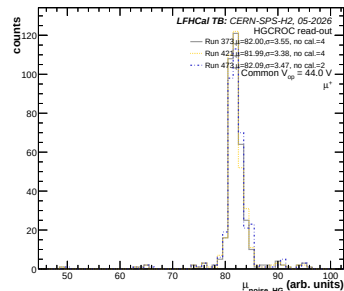
Muon calibration - Pedestal Comparison



Muon calibration - Pedestal Comparison

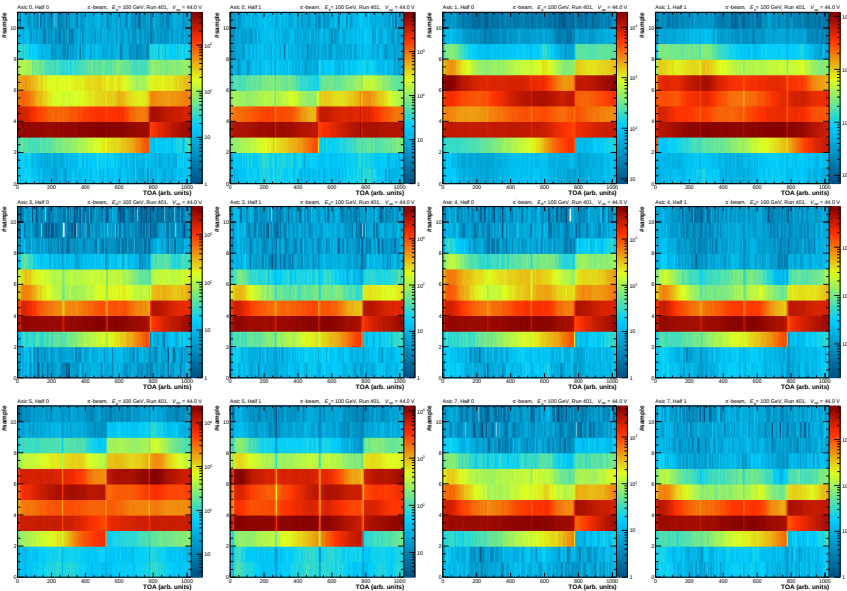


Muon calibration - Pedestal Comparison



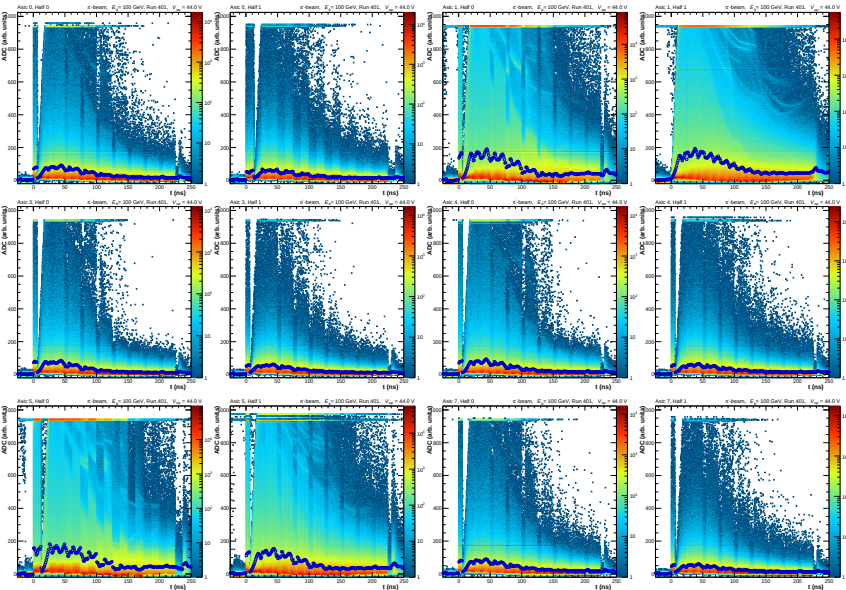
- Very similar pedestal position for all pedestal runs
- Width varies slightly between runs, but within fitting uncertainties
- Either run could be used for corrections

TOA offset calibration



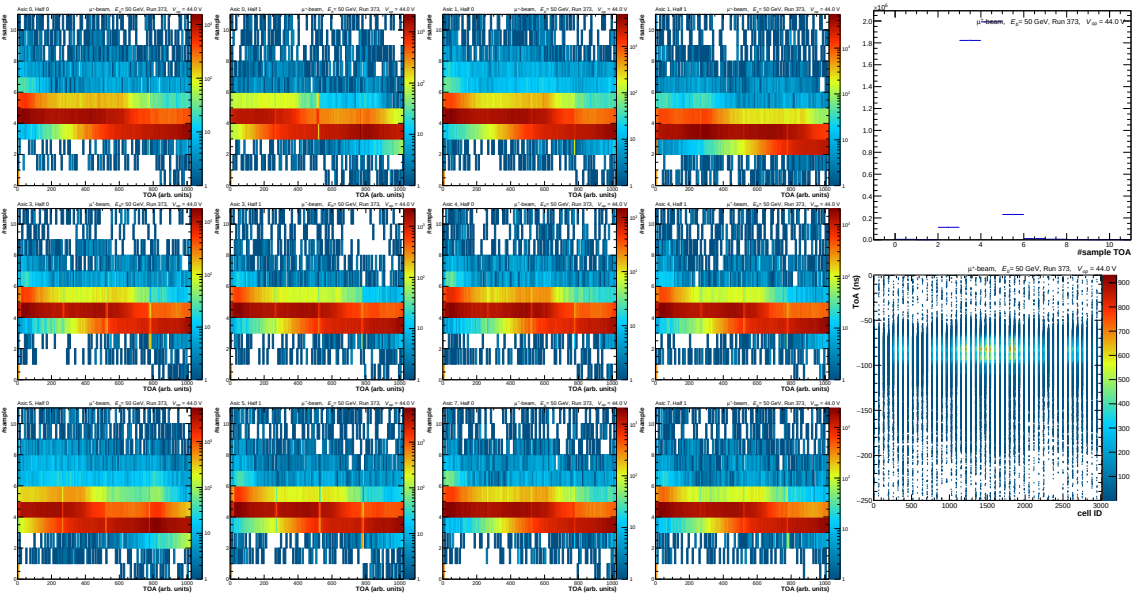
- Estimated using 100 GeV pion run (401)
- Based on ToA vs nSample plot
- Applied consistently to subsets 1-2
- [TOA calib offset file (1 & 2)]
- Using ToA offsets from run 452 (FullSet F) for 3rd subset
- [TOA calib offset file (3)]

TOA offset calibration

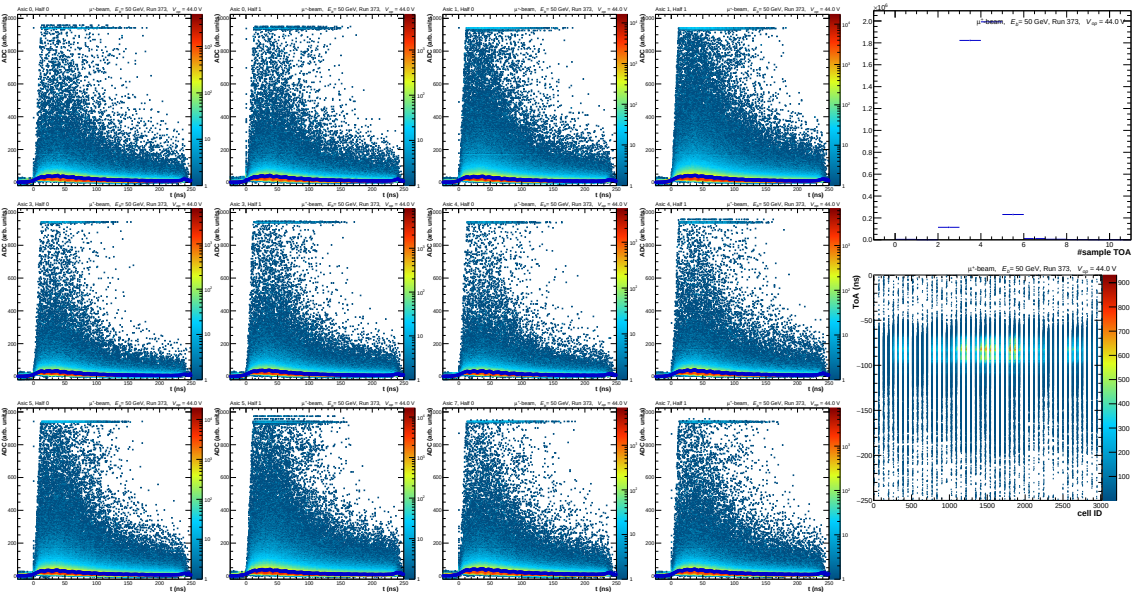


- Estimated using 100 GeV pion run (401)
- Based on ToA vs nSample plot
- Applied consistently to subsets 1-2
- [TOA calib offset file (1 & 2)]
- Using ToA offsets from run 452 (FullSet F) for 3rd subset
- [TOA calib offset file (3)]

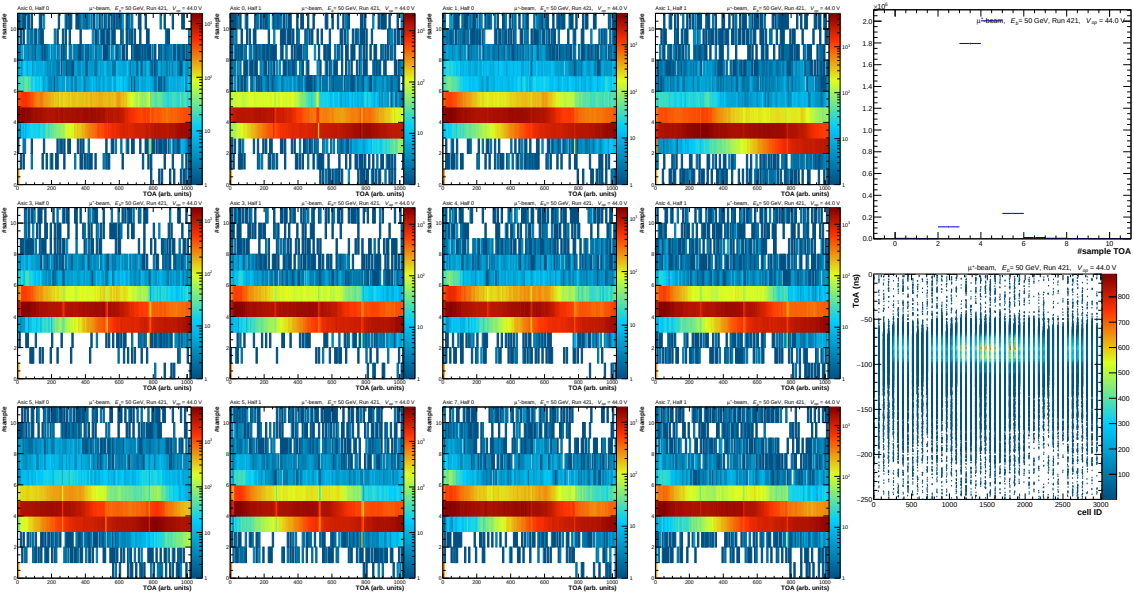
TOA offset calibration - Applied Set 1



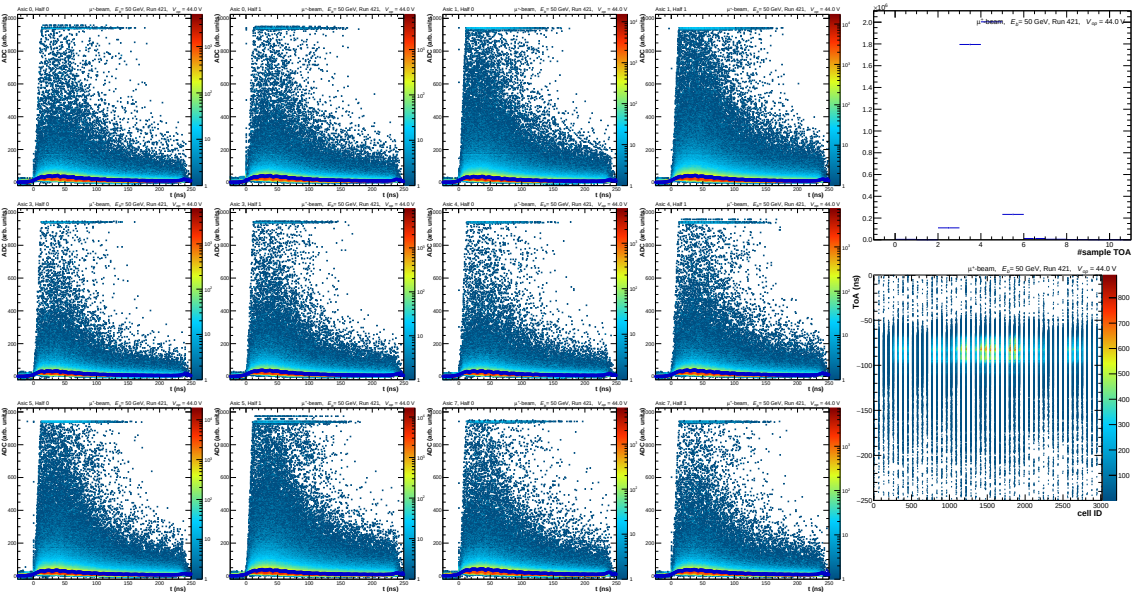
TOA offset calibration - Applied Set 1



TOA offset calibration - Applied Set 2

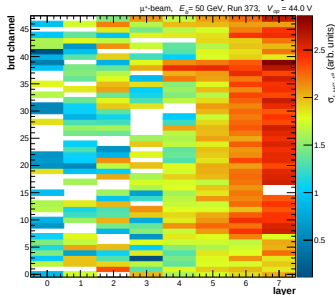
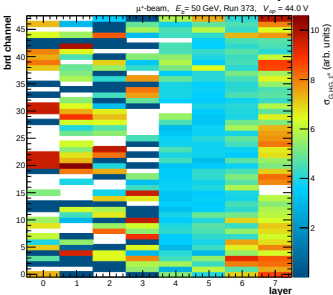
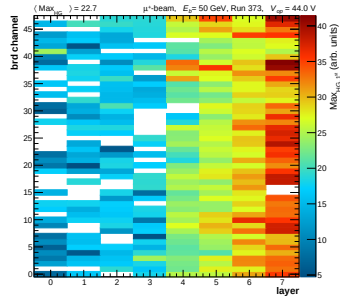
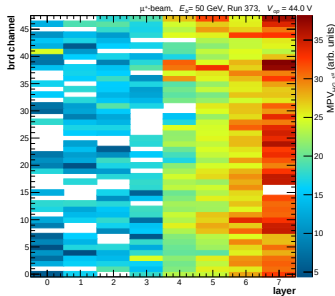
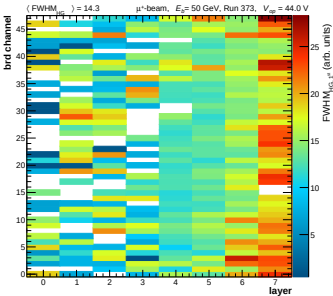


TOA offset calibration - Applied Set 2



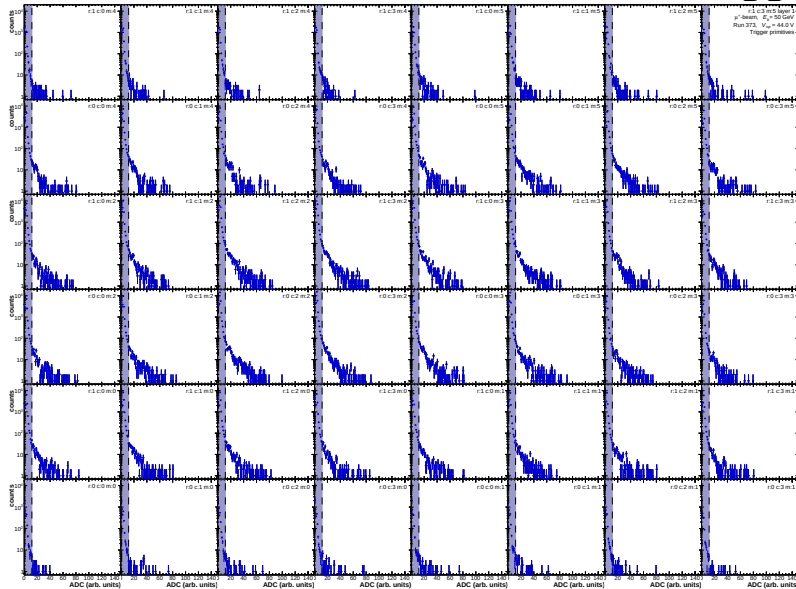


Muon calibration - Set 1: Muons - init (blue)

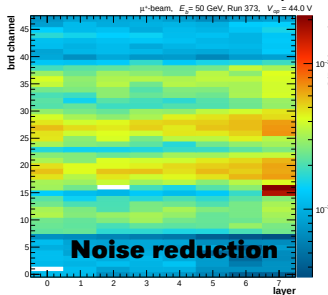
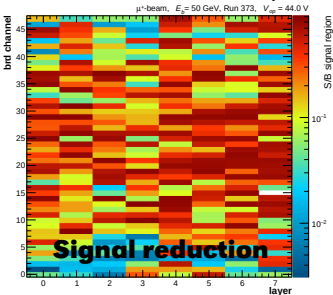
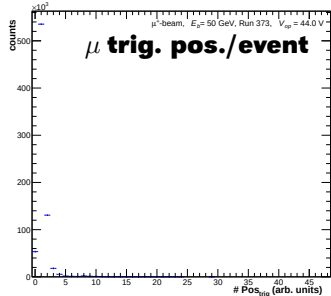
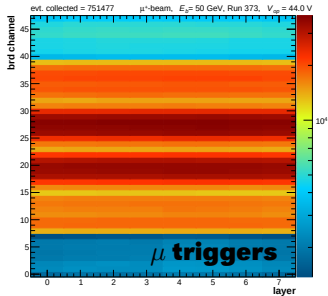
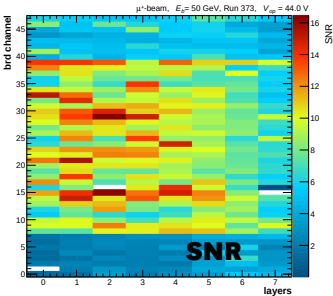


- Initial fit for 44 V & RF=12 with lots of non converging cells, most of front layers fail initial fit (too bad separation between pedestal & mip)
- $\langle \text{Max}_{\text{mip}} \rangle = 22.7$

Muon calibration - Set 1: Muons - Trigger

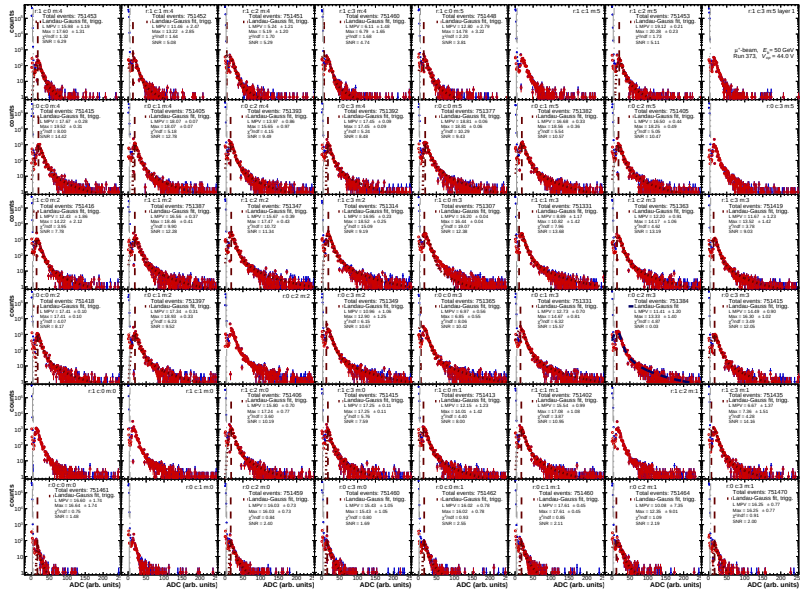


Muon calibration - Set 1: Muons - Trigger

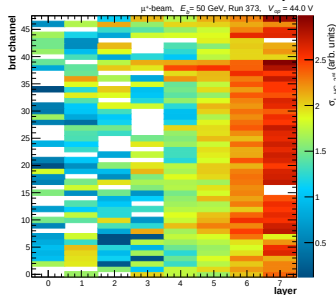
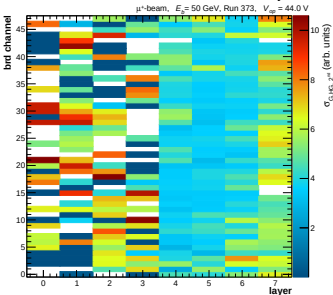
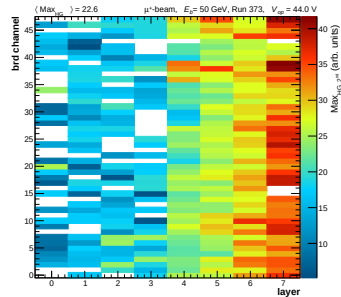
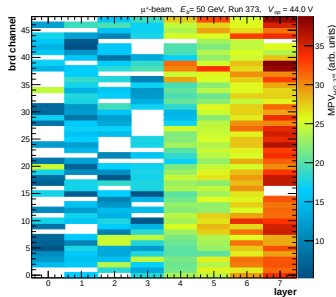
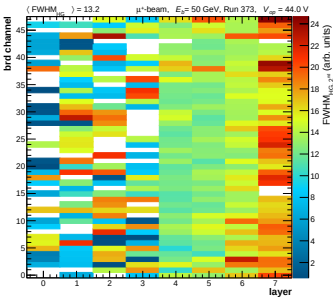


- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle < trigg_{prim} < 4\langle Max_{mip} \rangle$
- Same range used for skimming
- Significant reduction of noise peak (red vs. blue on next page)

Muon calibration - Set 1: Muons - 0th ite

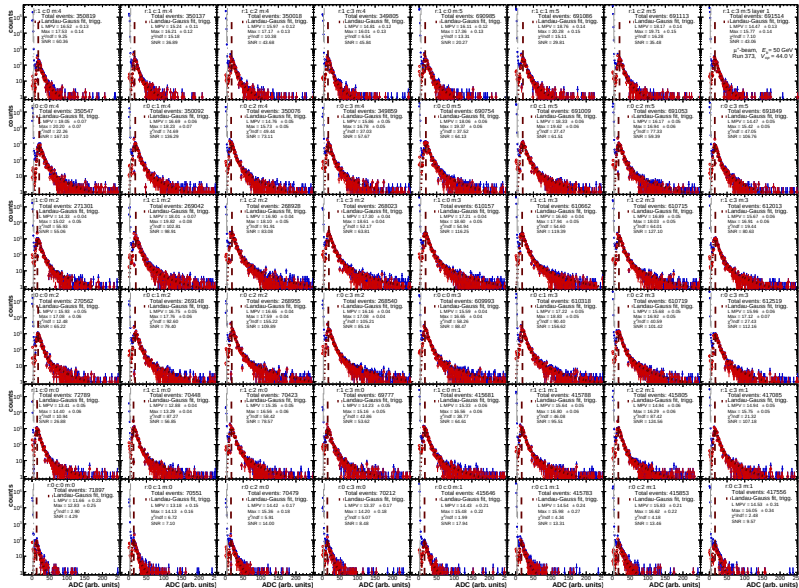


Muon calibration - Set 1: Muons - 0th ite

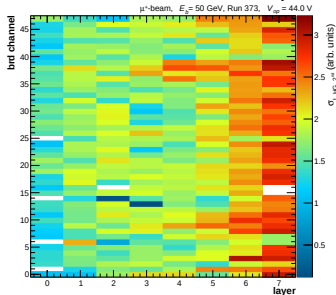
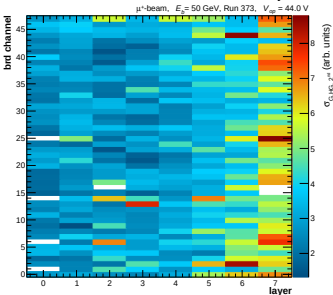
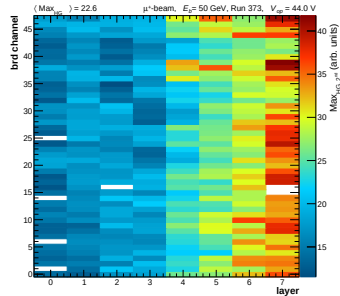
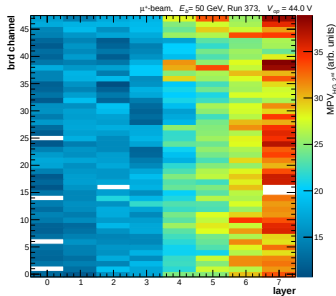
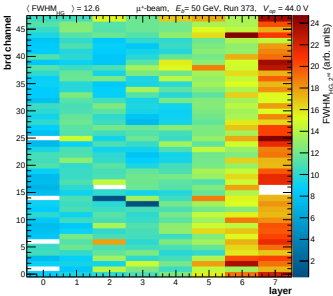


- Increased successrate, but still lots of failures in lower layers
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.6$

Muon calibration - Set 1: Muons - 5th ite

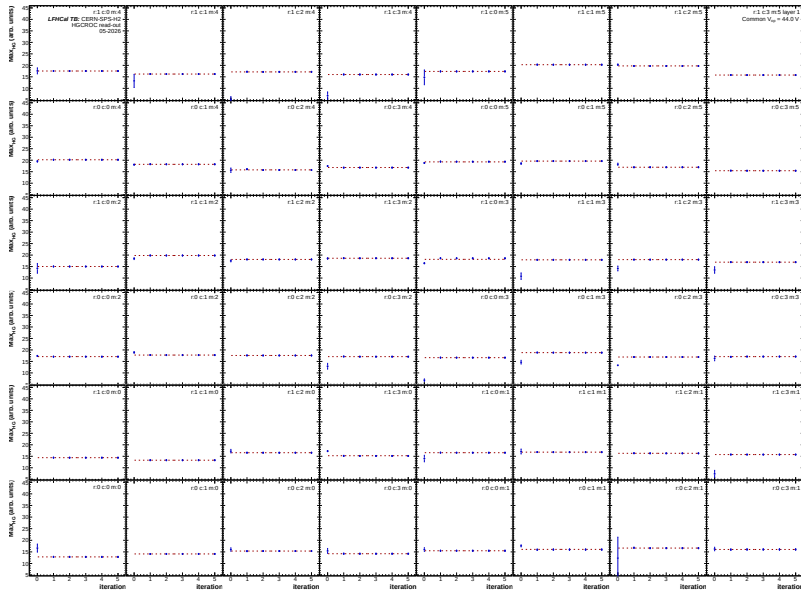


Muon calibration - Set 1: Muons - 5th ite

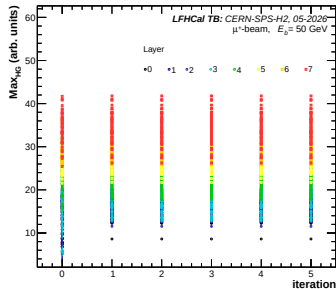
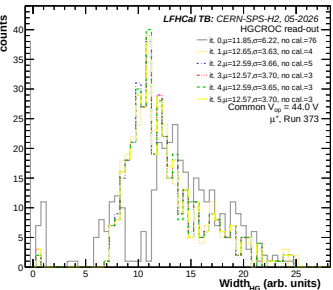
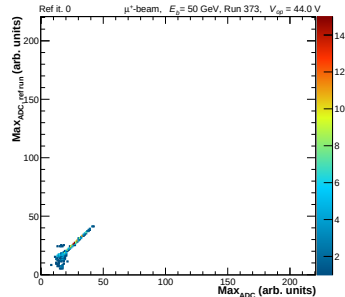
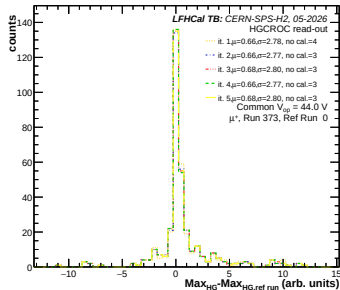
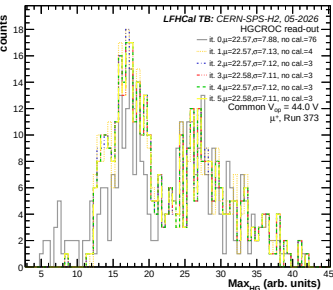


- Nearly all channels "fitable"
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.6$

Muon calibration - Set 1: Muons - Iterations



Muon calibration - Set 1: Muons - Iterations

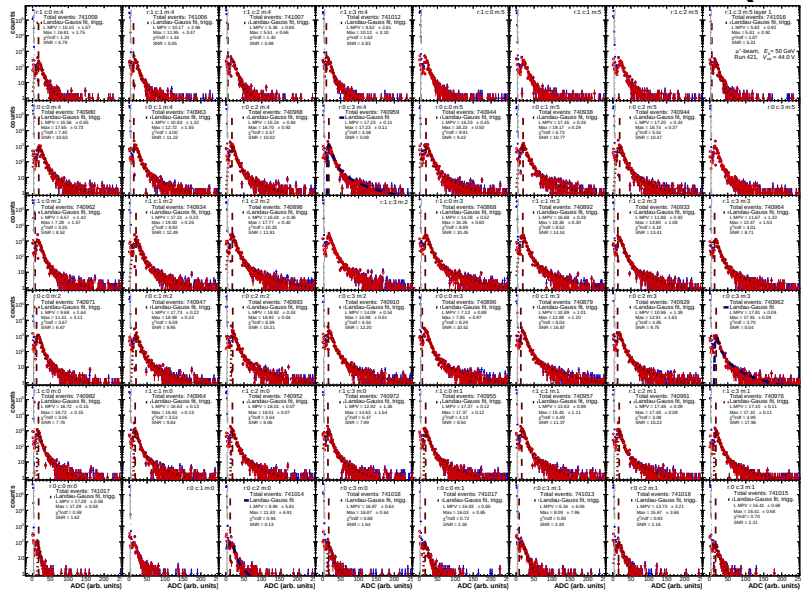


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$

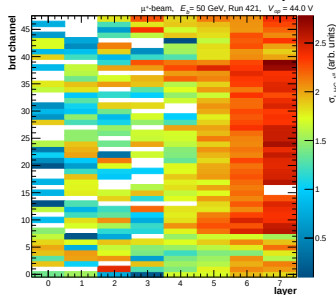
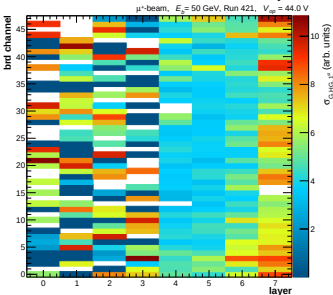
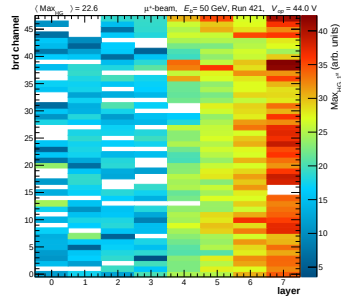
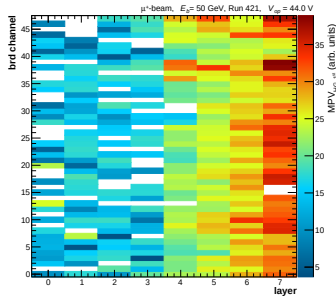
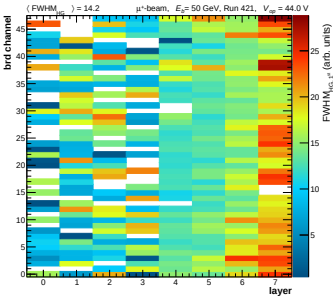
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 3-4 iterations, very few cells still fail after 5 iterations

Muon calibration - Set 2: Muons - init (blue)

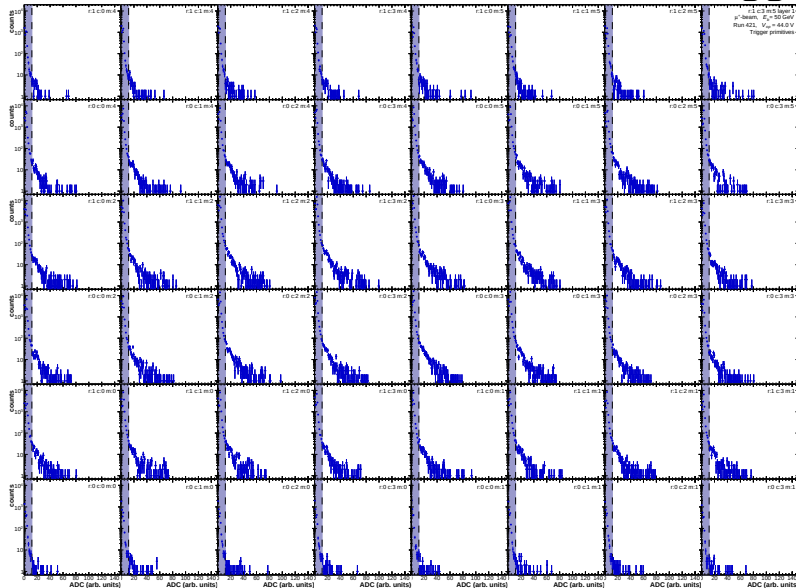


Muon calibration - Set 2: Muons - init (blue)

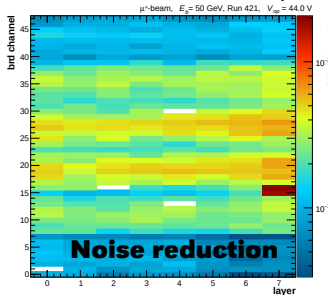
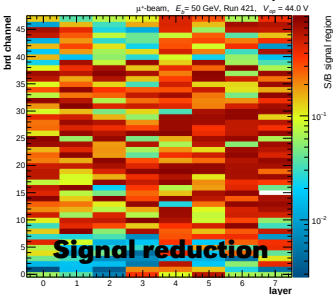
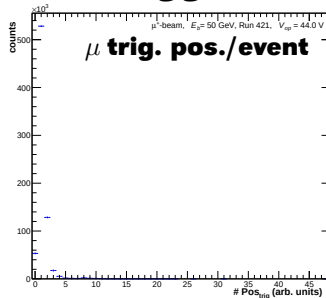
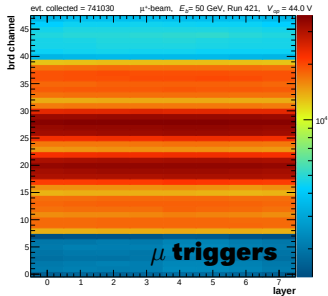
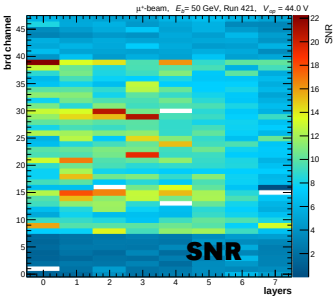


- Initial fit for 44 V & RF=12, with lots of non converging cells, most of front layers fail initial fit (too bad separation between pedestal & mip)
- $\langle \text{Max}_{\text{mip}} \rangle = 22.6$
- No strong ch-by-ch variations in individual parameters per layer

Muon calibration - Set 2: Muons - Trigger

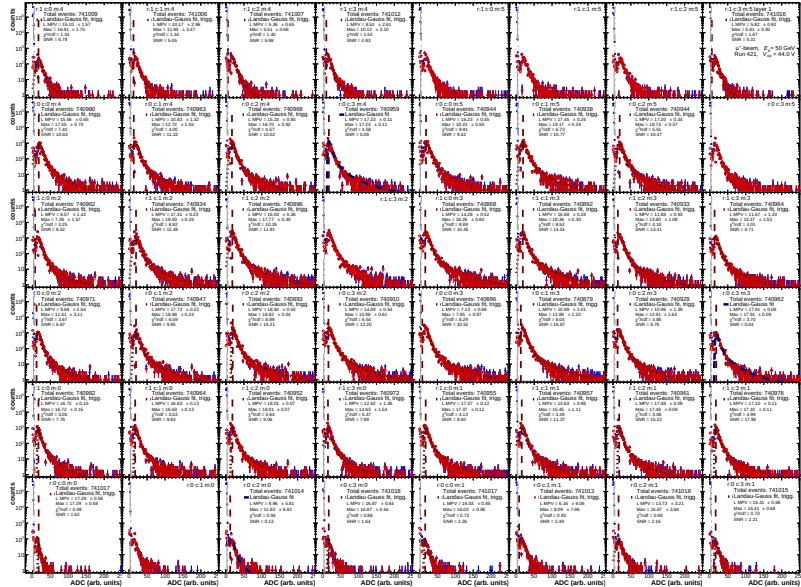


Muon calibration - Set 2: Muons - Trigger

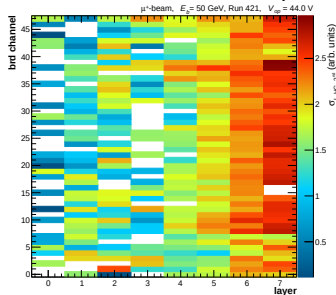
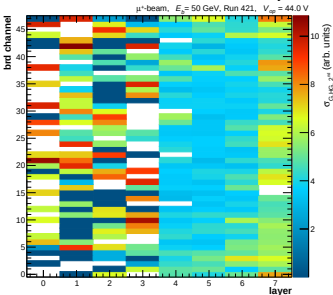
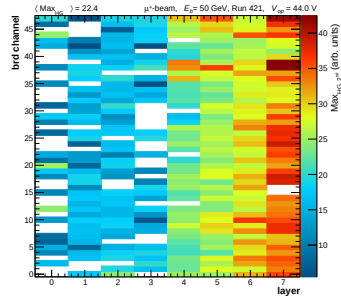
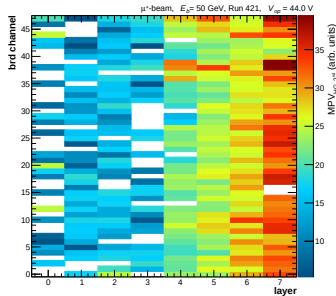
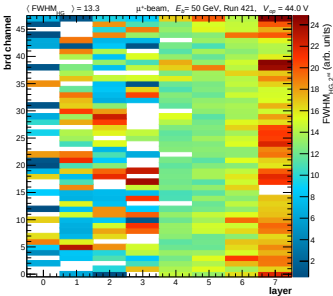


- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle < trigg_{prim} < 4\langle Max_{mip} \rangle$
- Same range used for skimming
- Significant reduction of noise peak (red vs. blue on next page)

Muon calibration - Set 2: Muons - 0th ite

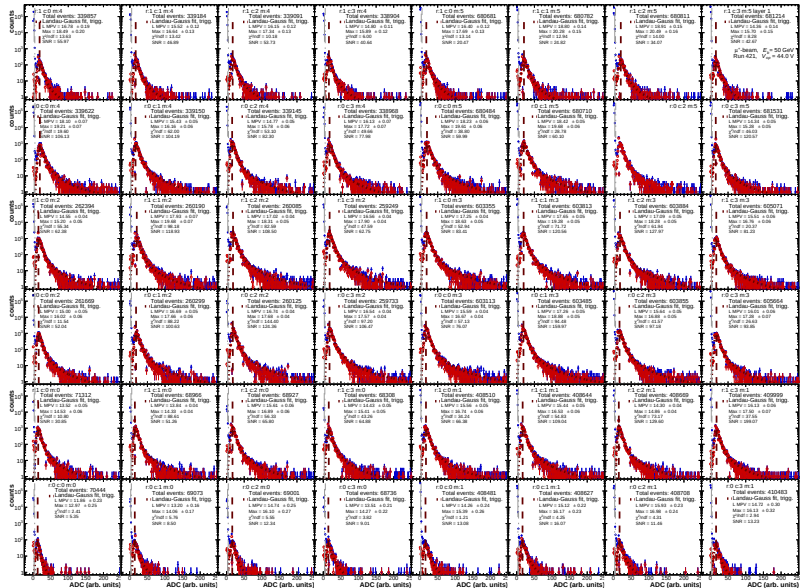


Muon calibration - Set 2: Muons - 0th ite

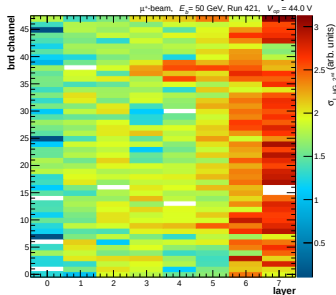
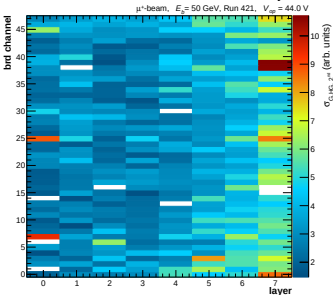
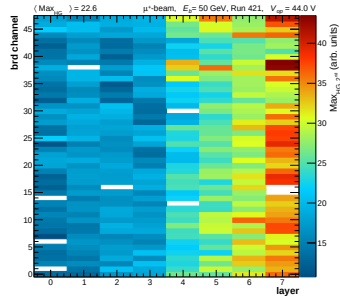
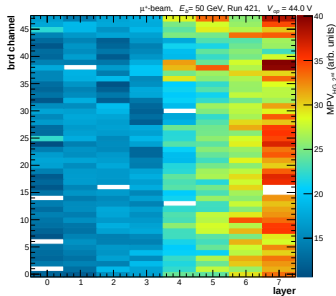
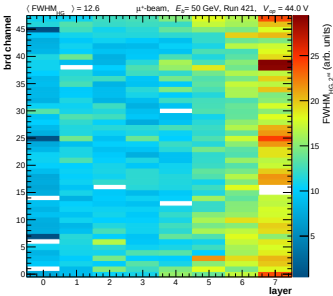


- Increased successrate, but still lots of failures in lower layers
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.4$

Muon calibration - Set 2: Muons - 5th ite

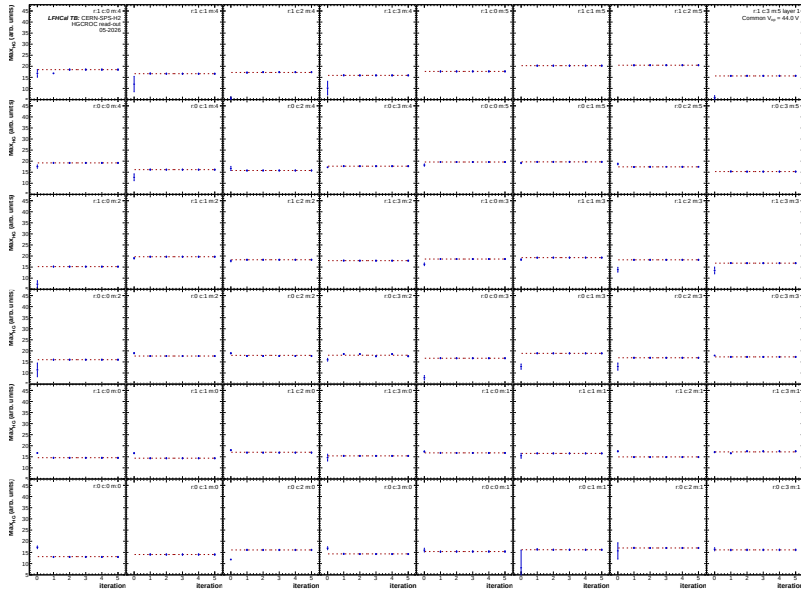


Muon calibration - Set 2: Muons - 5th ite

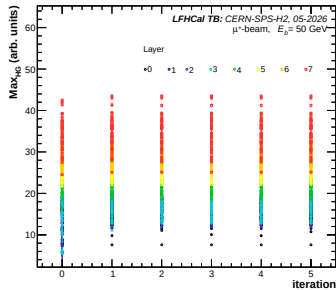
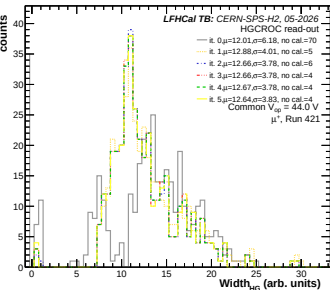
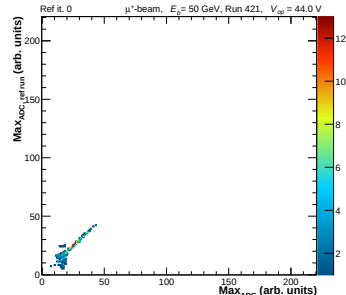
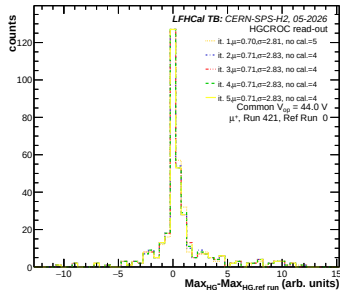
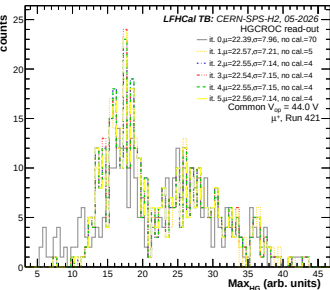


- Nearly all channels "fitable"
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.6$

Muon calibration - Set 2: Muons - Iterations



Muon calibration - Set 2: Muons - Iterations

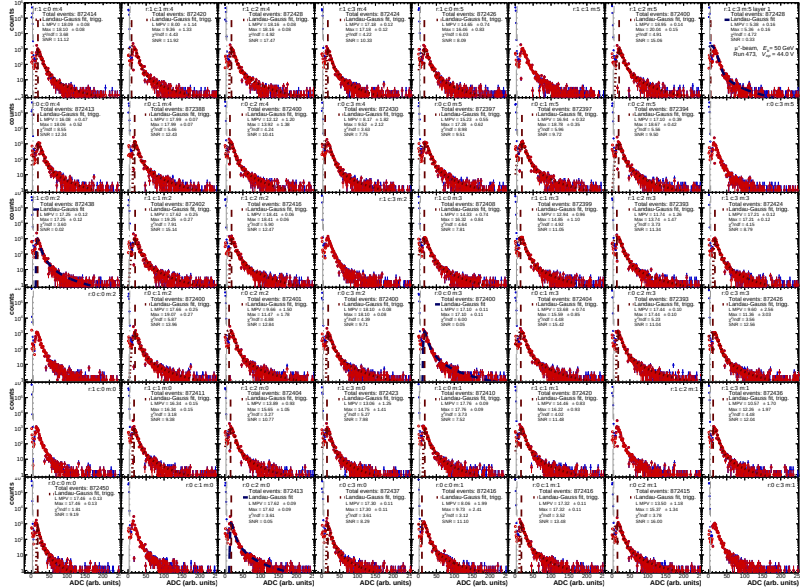


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$

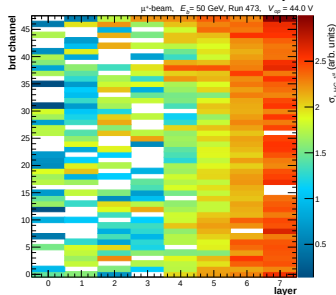
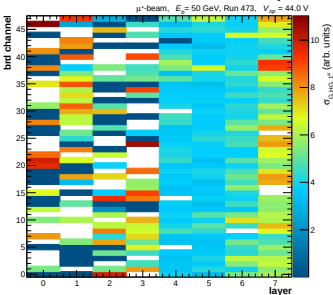
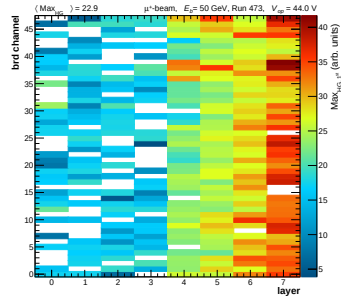
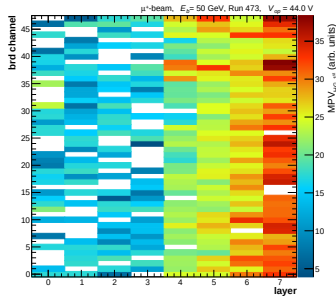
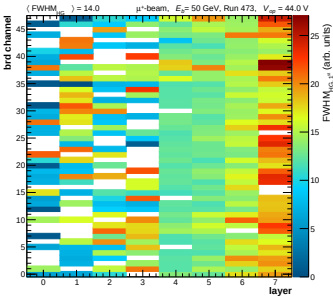
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 3-4 iterations, very few cells still fail after 5 iterations

Muon calibration - Set 3: Muons - init (blue)

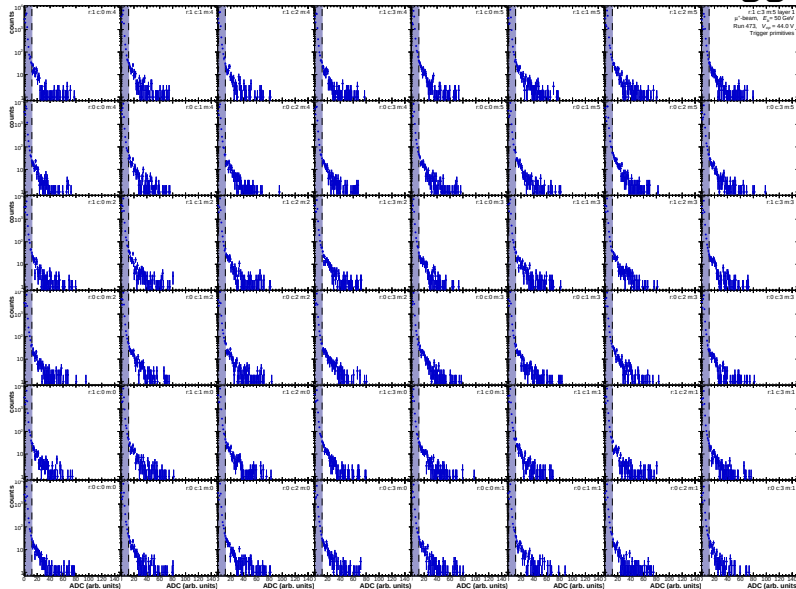


Muon calibration - Set 3: Muons - init (blue)

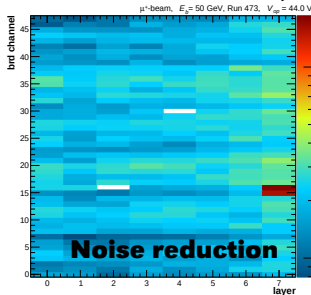
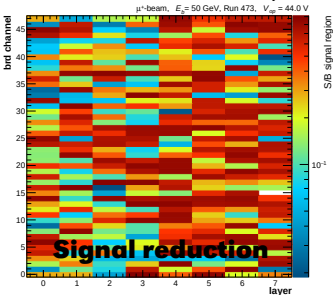
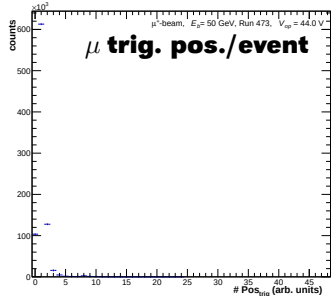
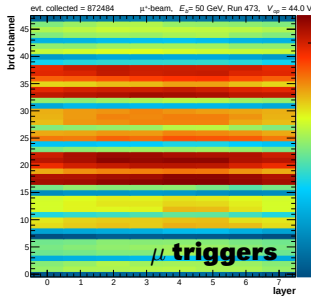
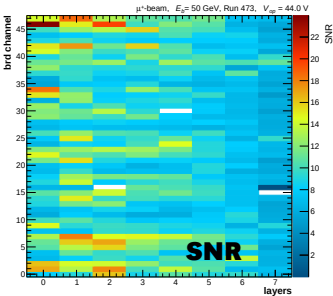


- Initial fit for 44 V & RF=12, with lots of non converging cells, most of front layers fail initial fit (too bad separation between pedestal & mip)
- $\langle \text{Max}_{mip} \rangle = 22.9$
- No strong ch-by-ch variations in individual parameters per layer

Muon calibration - Set 3: Muons - Trigger



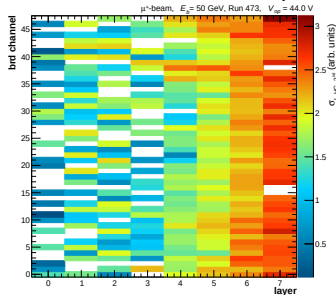
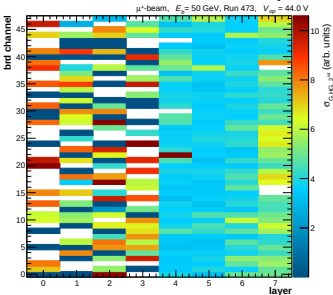
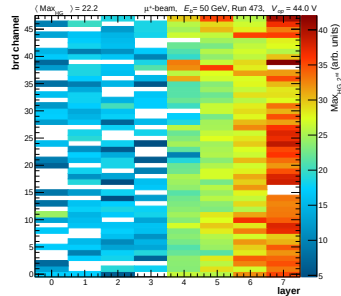
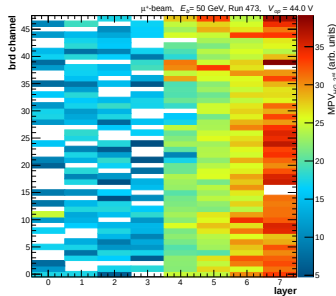
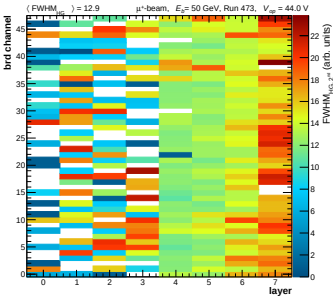
Muon calibration - Set 3: Muons - Trigger



- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle < trigg_{prim} < 4\langle Max_{mip} \rangle$
- Same range used for skimming
- Significant reduction of noise peak (red vs. blue on next page)

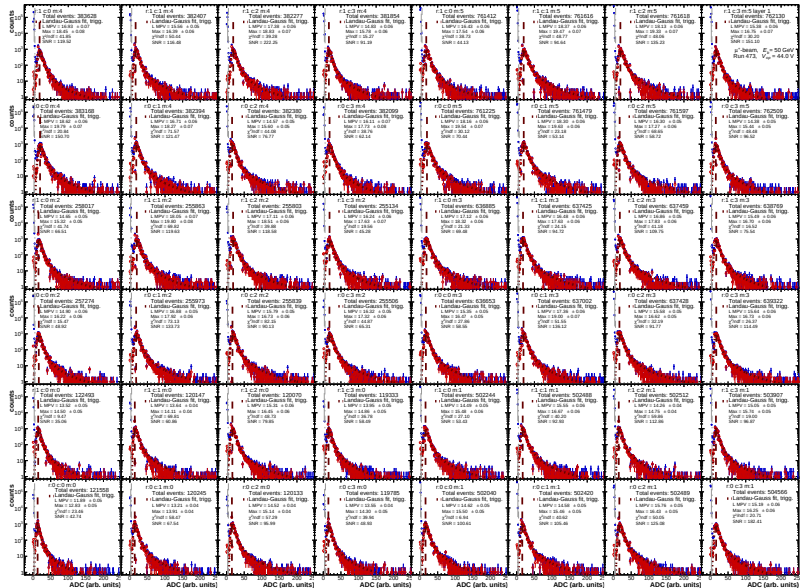


Muon calibration - Set 3: Muons - 0th ite

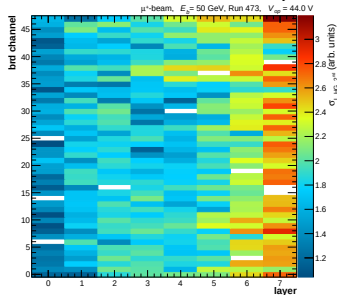
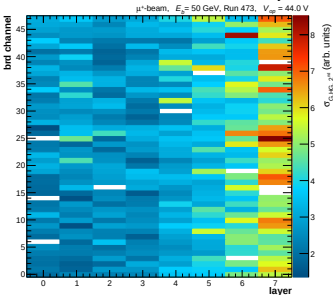
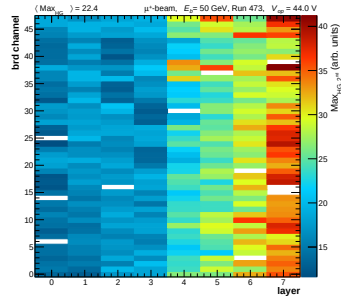
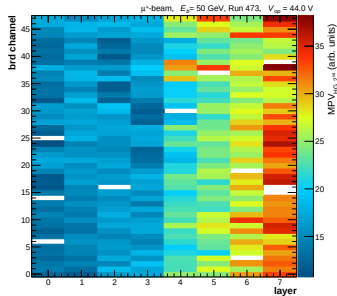
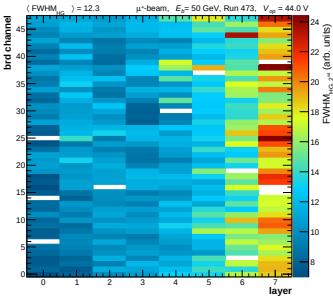


- Increased successrate, but still lots of failures in lower layers
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.2$

Muon calibration - Set 3: Muons - 5th ite

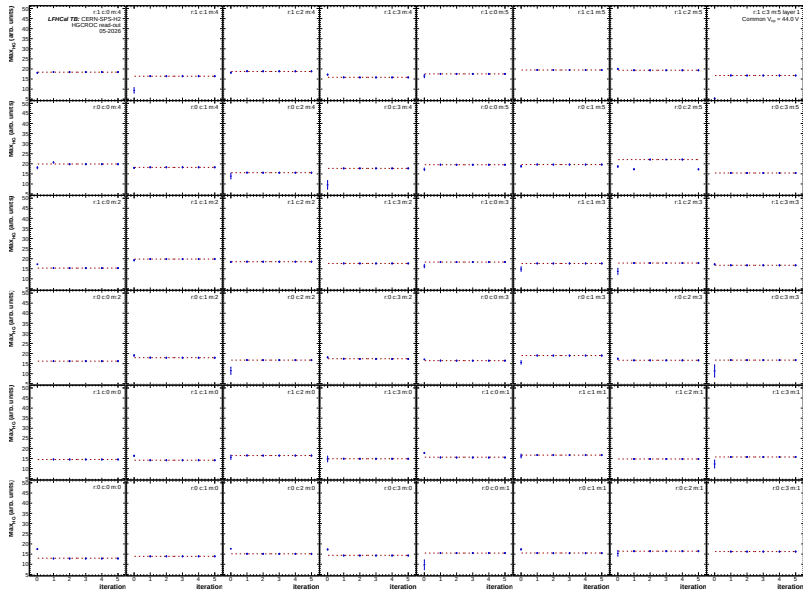


Muon calibration - Set 3: Muons - 5th ite

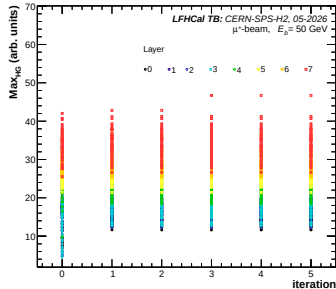
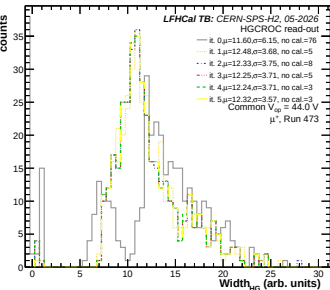
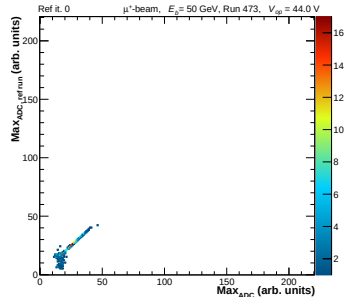
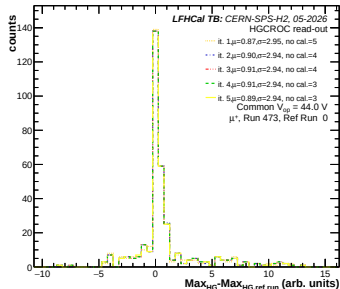
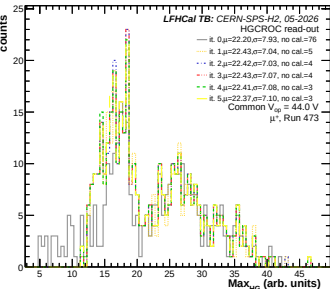


- Nearly all channels "fitable"
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 22.4$

Muon calibration - Set 3: Muons - Iterations



Muon calibration - Set 3: Muons - Iterations

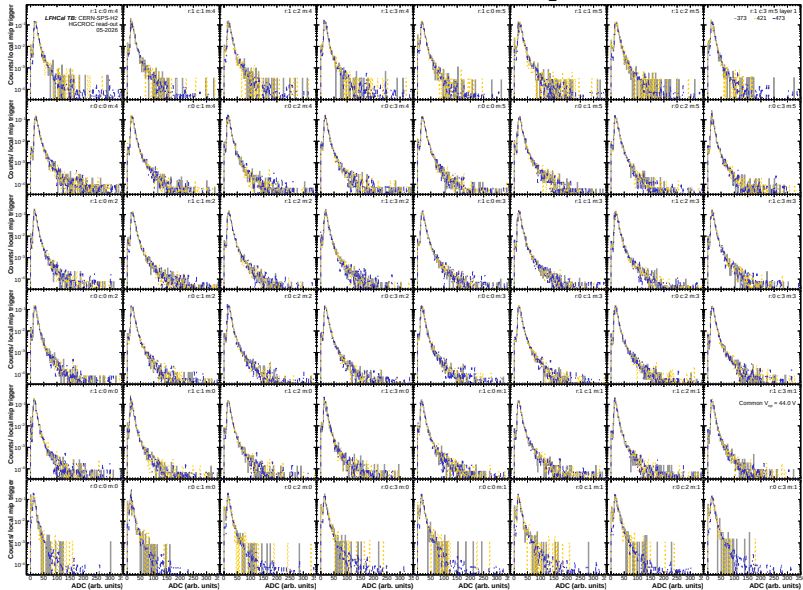


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$

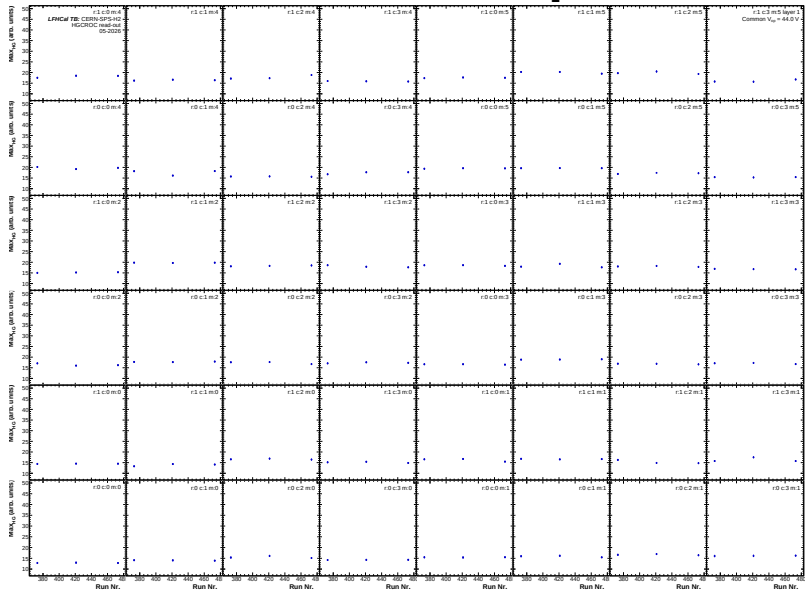
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 3-4 iterations, very few cells still fail after 5 iterations

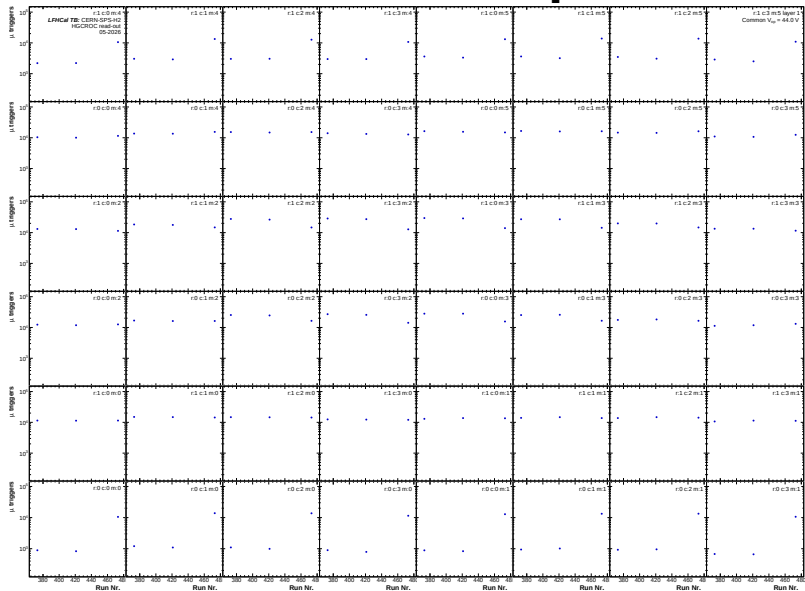
Muon calibration - Comparison Sets



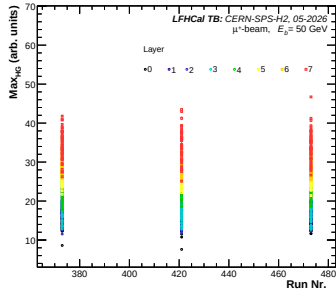
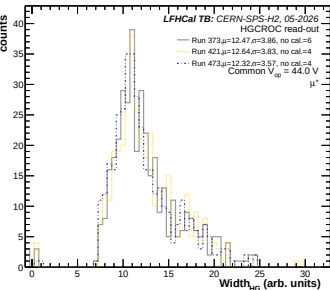
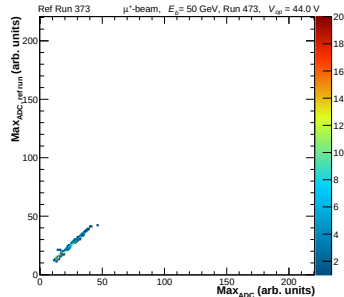
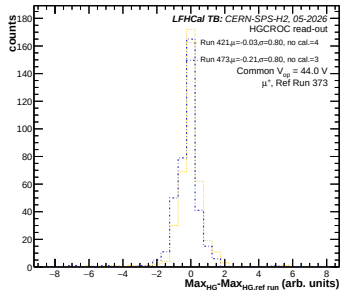
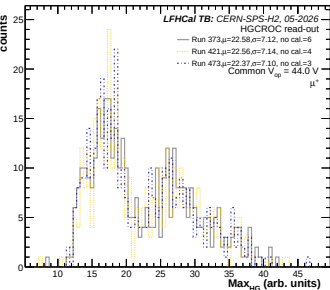
Muon calibration - Comparison Sets



Muon calibration - Comparison Sets



Muon calibration - Comparison Sets



- 3rd set significantly higher statistics at edges
- mip deviations within estimated fitting uncertainties
- very good correlation for same channel
- will use 3rd set for final calibration (1st or 2nd for possible error estimates)

Calibration summary - Set E



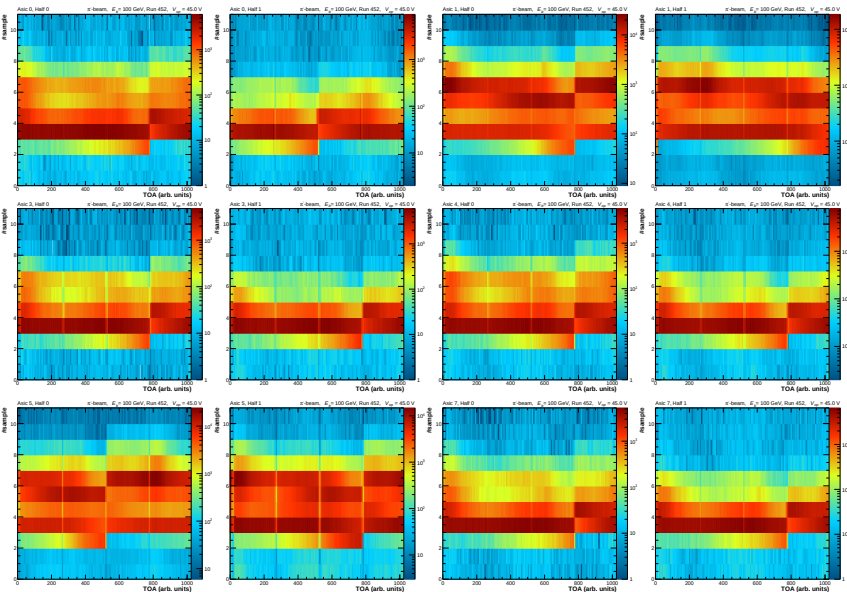
Calibration summary

- Besides 2 bad channels identified in this data set no further channels found problematic
- ToA offset calibration estimated on initial muon run valid for all runs of set C
- Final calibration based off 'Set_3' (6 beam positions) due to higher statistics & better coverage
 - ▶ Calib file FullSet E 1st [txt-file]
 - ▶ Calib file FullSet E 2nd [txt-file]
 - ▶ Calib file FullSet E 3rd [txt-file]

Additional material

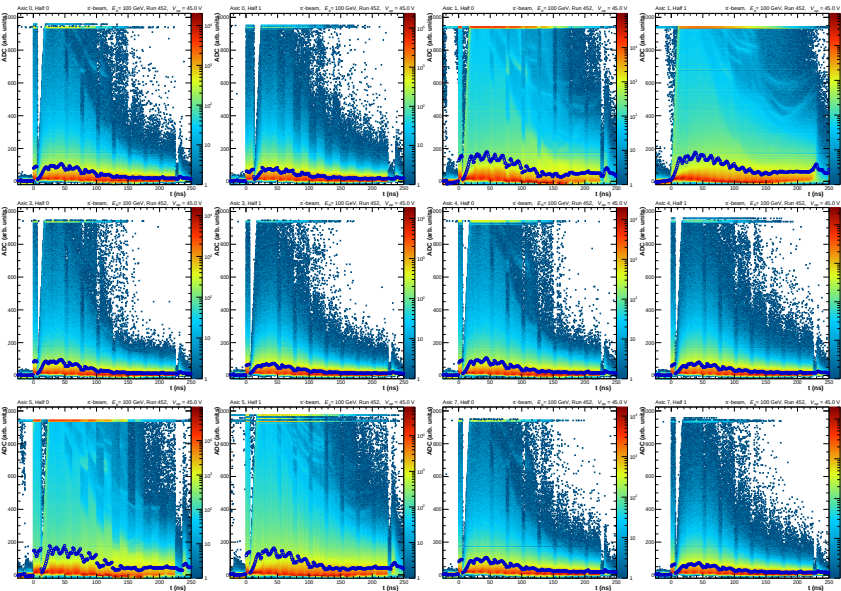


TOA offset calibration 3rd set



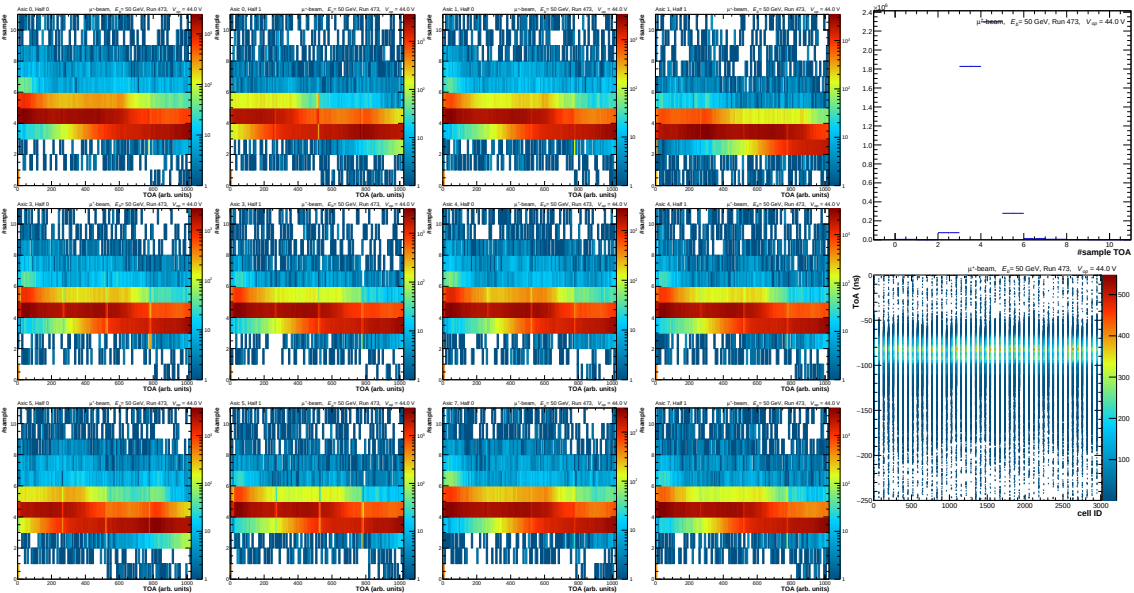
- Estimated using 100 GeV pion run (452)
- Based on ToA vs nSample plot
- Using ToA offsets from run 452 (Full Set F) for 3rd subset
- [TOA calib offset file (3)]

TOA offset calibration 3rd set



- Estimated using 100 GeV pion run (452)
- Based on ToA vs nSample plot
- Using ToA offsets from run 452 (Full Set F) for 3rd subset
- [TOA calib offset file (3)]

TOA offset calibration - Applied Set 3



TOA offset calibration - Applied Set 3

