

2026 SPS TB - HGCROC Readout

September 15, 2026

Friederike Bock



- 1 SPS 2026 Set D - 45V
 - Overview
 - Pedestals
 - TOA offset calibration
 - Muon Calibrations
- 2 Calibrations Summary

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



Overview - Set D

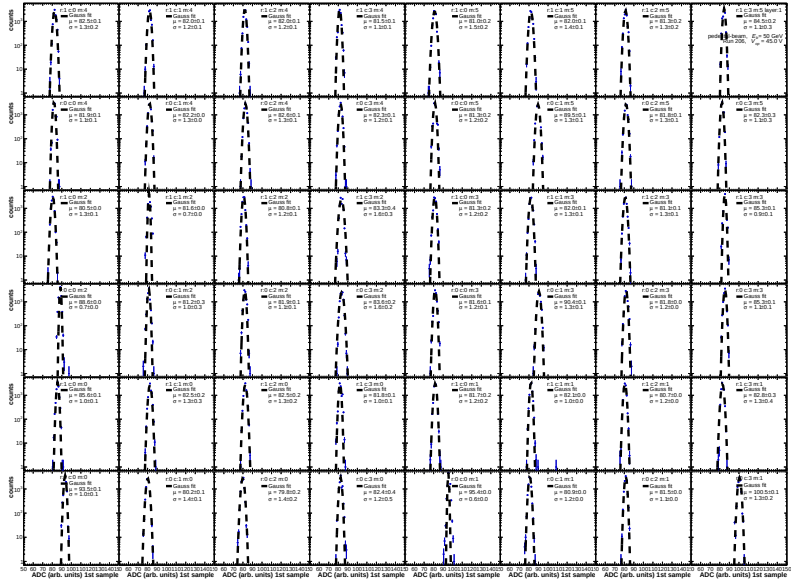
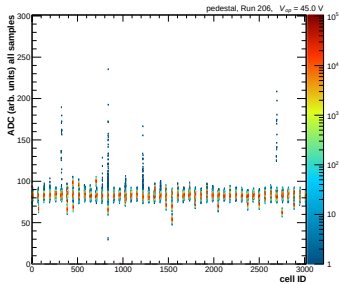
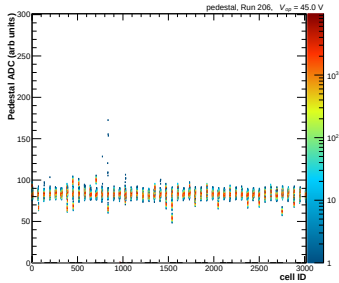
Full Set D

Summing Board V2, $V_{op} = 45$ V, gain settings: RF = 9, CF = 7, CC= 4, CFcomp=1
May 16, 22:11 - May 17, 14:31

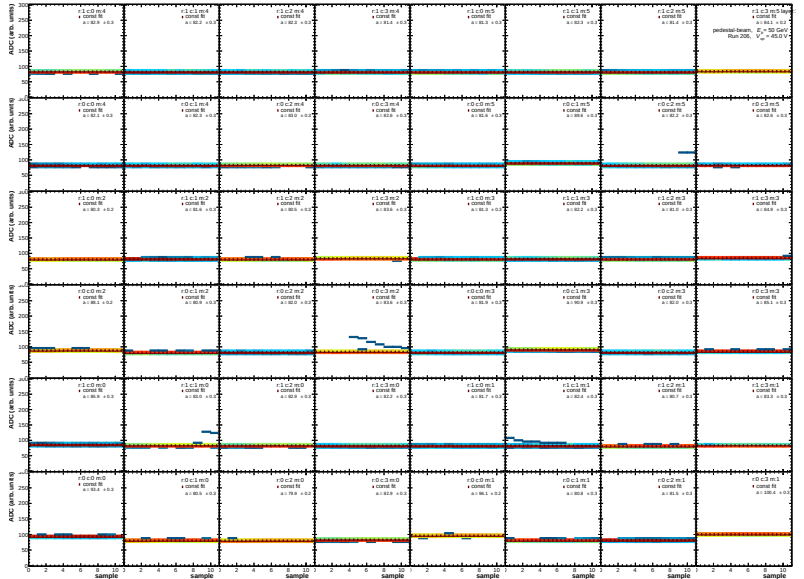
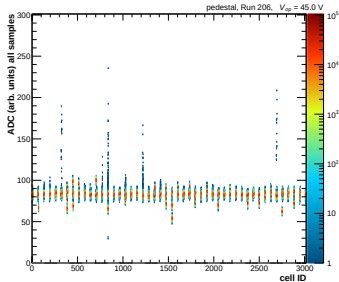
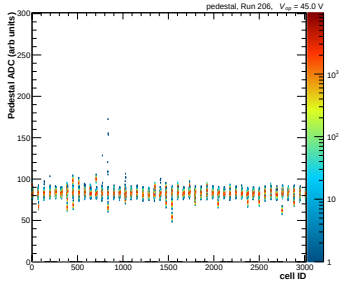
Calibration sets:																
μ table position	ped	(-15,10)	(15,0)	(-15, -10)	(-5,10)	(-5,0)	(-5,-10)	(5,10)	(5,0)	(5,-10)	(-15,10)	(15,0)	(-15, -10)			
1 st	runs	206	215	214	213	216	217	218	221	220	219	222	224			
	tot events	10K	154K	154K	154K	153K	152K	153K	154K	154K	151K	150K	151K			
	μ table position	ped	(10,-5)	(10,5)	(-10, -5)	(-10,5)	(0,0)									
	runs	209	210	211	212	208										
	tot events	152K	184K	154K	153K	152K										
	μ table position	ped	(10,-5)	(10,5)	(-10, -5)	(-10,5)	(0,0)									
2 nd	runs	264	267	268	269	270	266									
	tot events	10K	150K	156K	155K	157K	152K									
Electron set:																
E (GeV)	20	30	40	50	80	100										
e ⁻	runs	225	226	227	228	229	231									
	tot events	255K	256K	267K	251K	251K	259K									
e ⁺	runs	232	233	234	235	236	237									
	tot events	257K	254K	259K	254K	285K	250K									
Hadron set:																
E (GeV)	20	30	40	50	60	70	80	90	100	150	200	250	300	325	350	
h ⁻	runs	238	239	240	241	242	243	244	245	246	248	249				
	tot events	252K	259K	251K	270K	251K	348K	259K	255K	252K	251K	259K	256K			
h ⁺	runs	250	251	252	253	255	256	257	258	259	260	261	262	271	272	273-274
	tot events	254K	257K	250K	259K	253K	254K	251K	273K	279K	250K	251K	252K	256K	251K	503K

- time:
16.5.2026 22:11 - 17.5.2026 14:31
- $V_{op} = 45$ V, $V_{br} = 38.3$ V
- Gain settings:
 - RF = 9, CF = 7, CC= 4, CFcomp=1
- μ with large scintillator triggers:
 - 17 positions Scan "_1"
 - 5 positions Scan "_2"
- e^- and $h^\pm$ with small scintillators

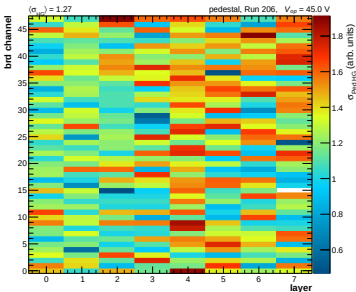
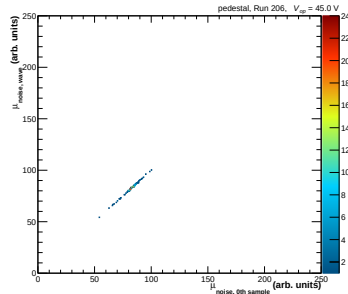
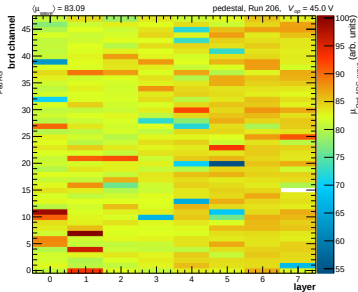
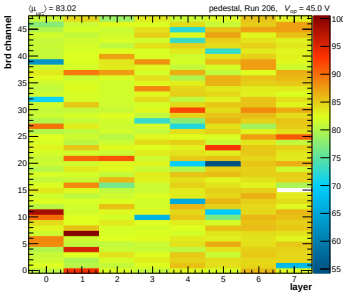
Muon calibration - Set 1: Pedestals



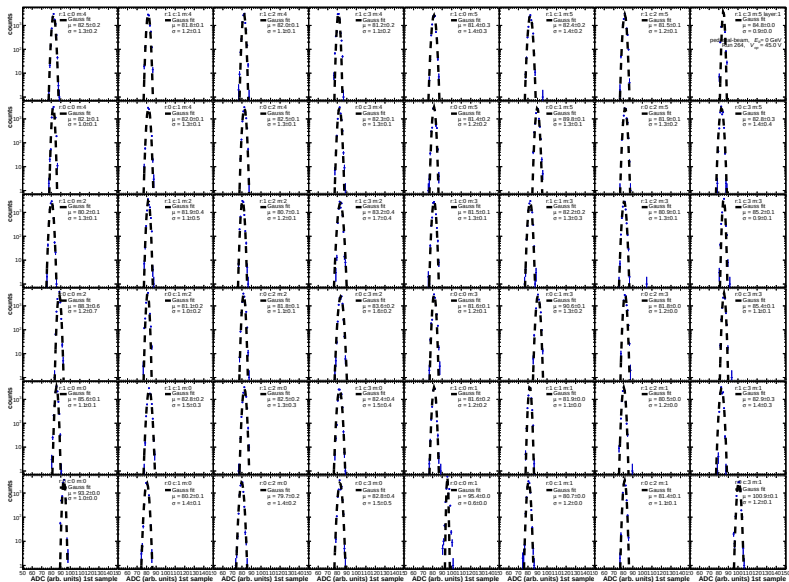
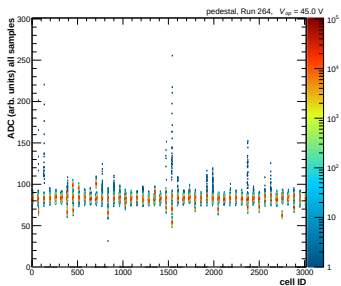
Muon calibration - Set 1: Pedestals



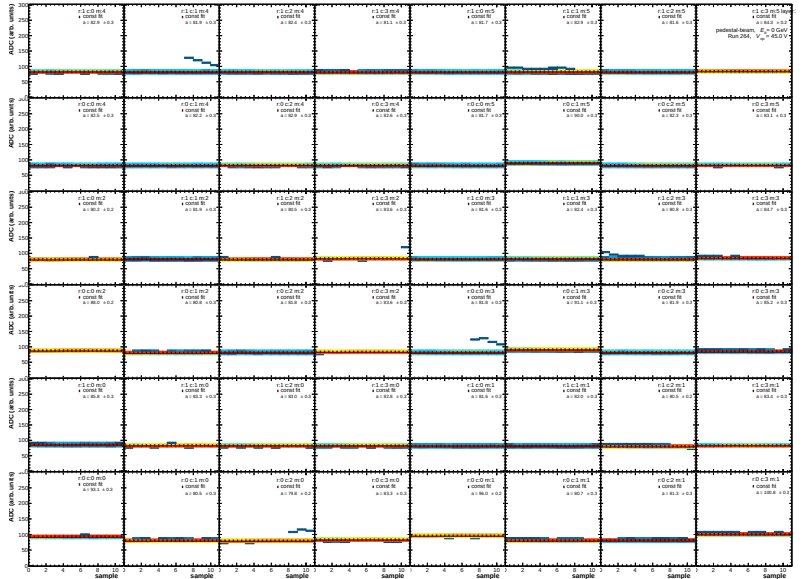
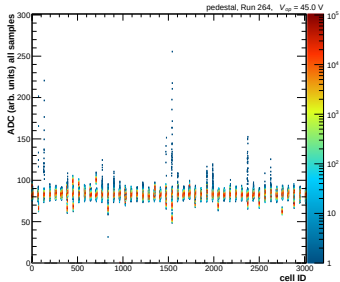
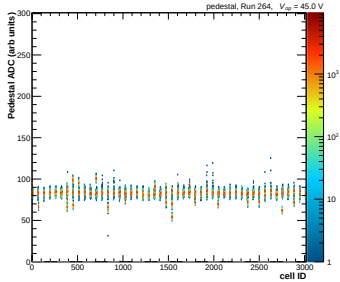
Muon calibration - Set 1: Pedestals



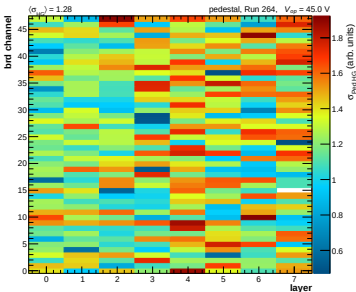
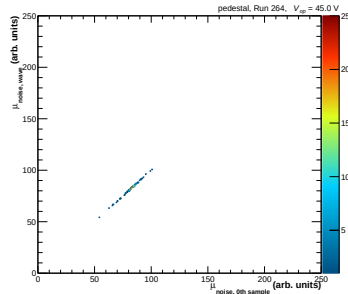
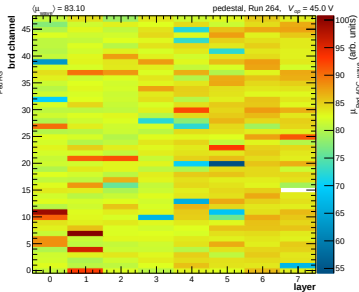
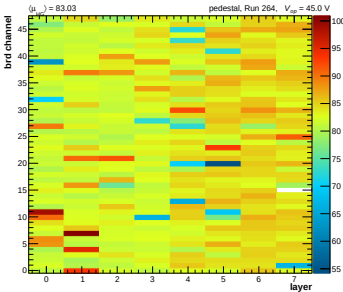
- Pedestal for all readout units set to 80 ADC
- Online calibration verified
- Fitting converges for most cells (1 missing)
- Good correlation between alternative fitting methods for pedestal



Muon calibration - Set 2: Pedestals

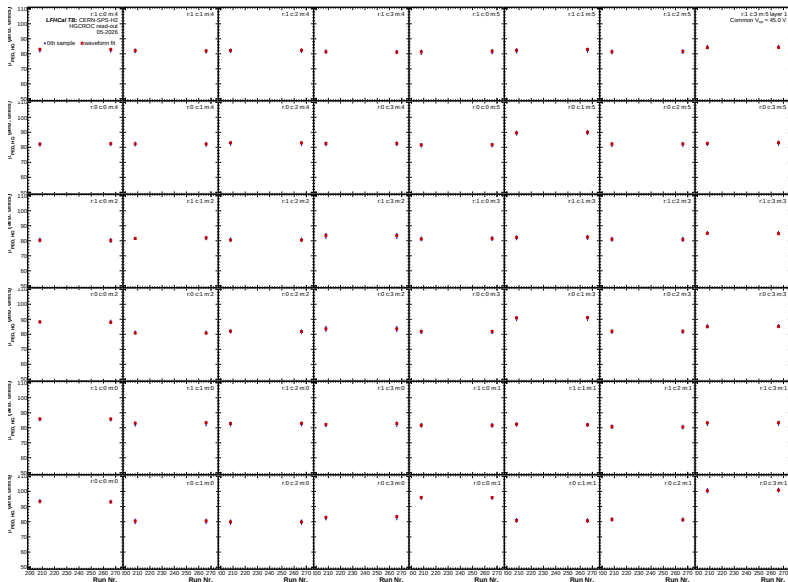
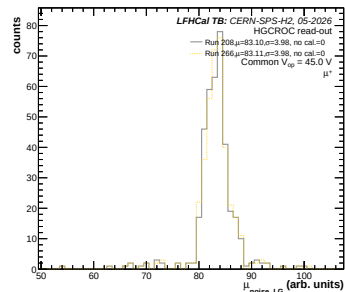
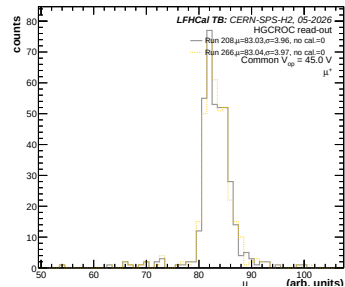


Muon calibration - Set 2: Pedestals

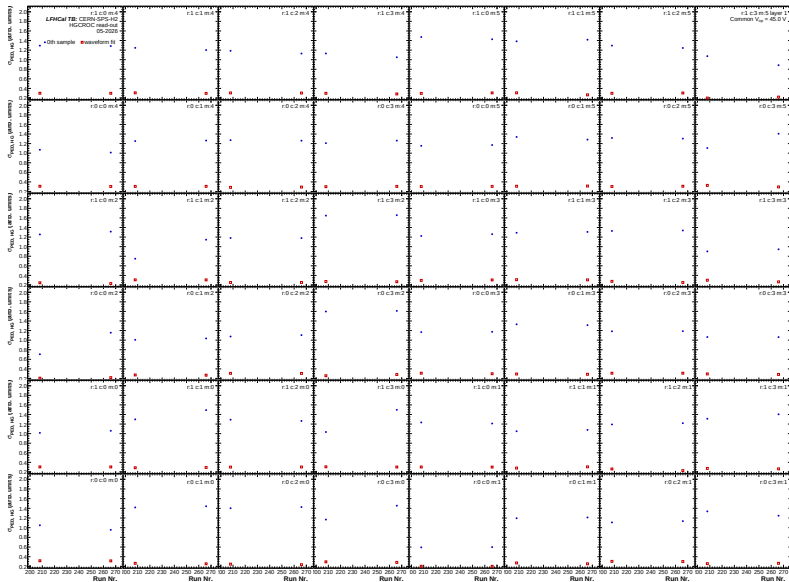
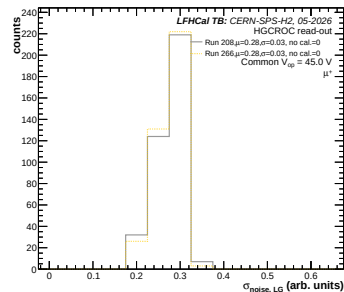
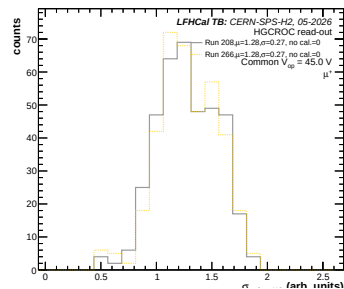


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- Online calibration verified
- Fitting converges for most cells (1 missing)
- Good correlation between alternative fitting methods for pedestal

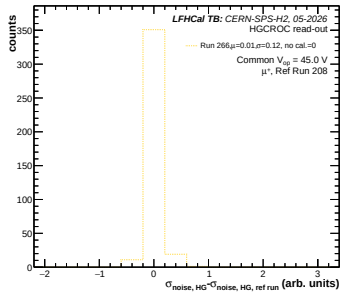
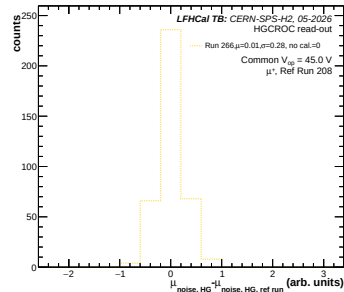
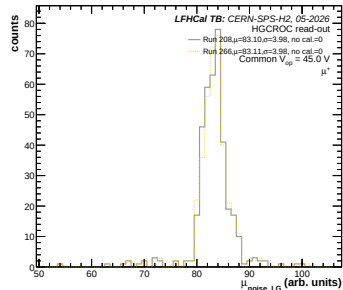
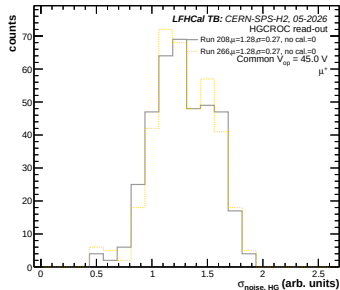
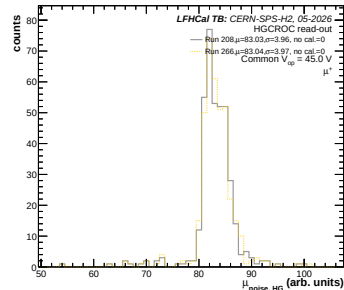
Muon calibration - Pedestal Comparison



Muon calibration - Pedestal Comparison

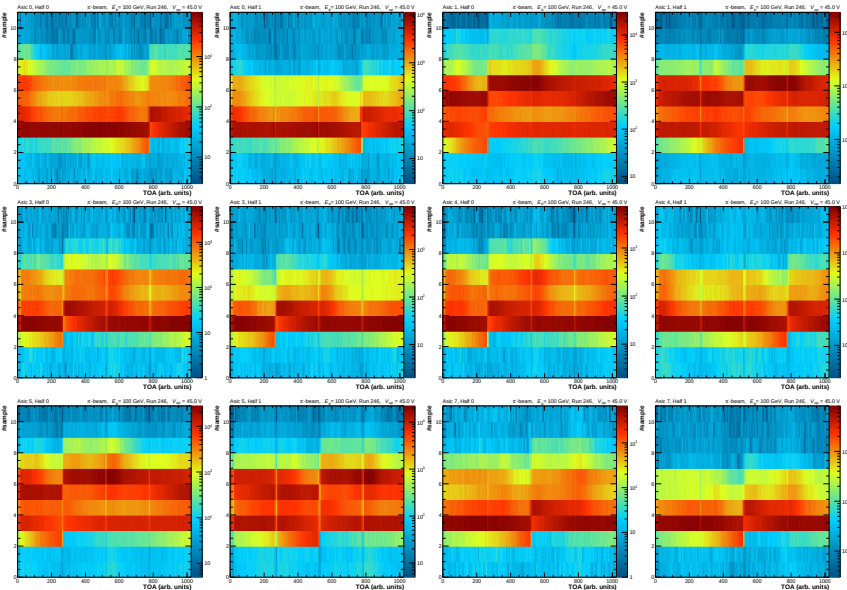


Muon calibration - Pedestal Comparison



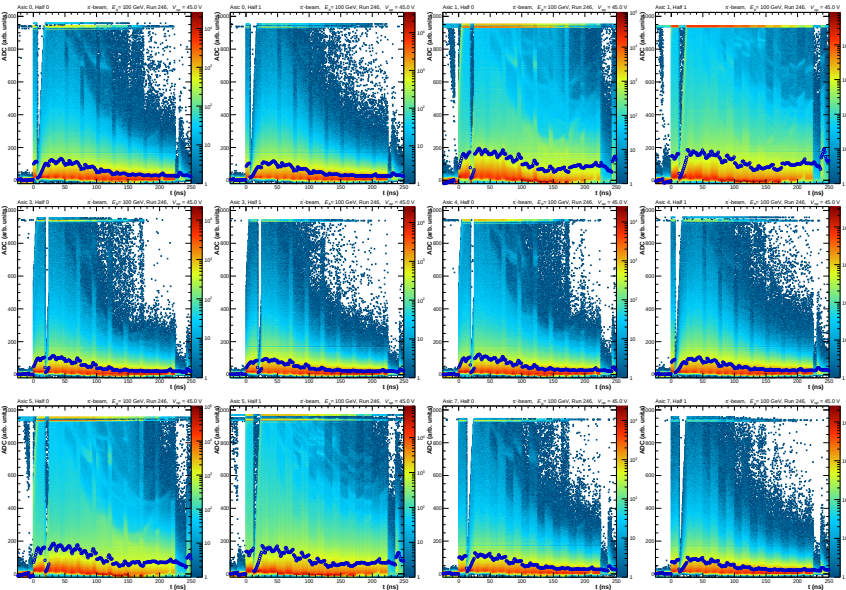
- Very similar pedestal position for both pedestal runs
- Width varies slightly between runs, but within fitting uncertainties
- Either run could be used for corrections

TOA offset calibration



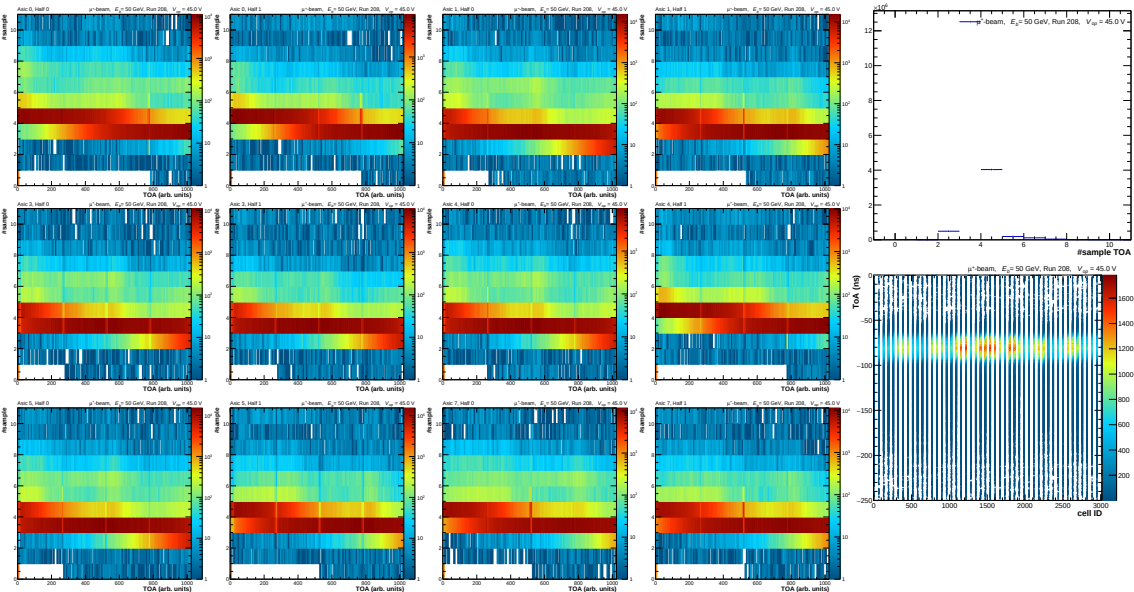
- Estimated using first negative pion run (246) at 100 GeV
- Based on ToA vs nSample plot
- Applied consistently to full set
- [TOA calib offset file]

TOA offset calibration

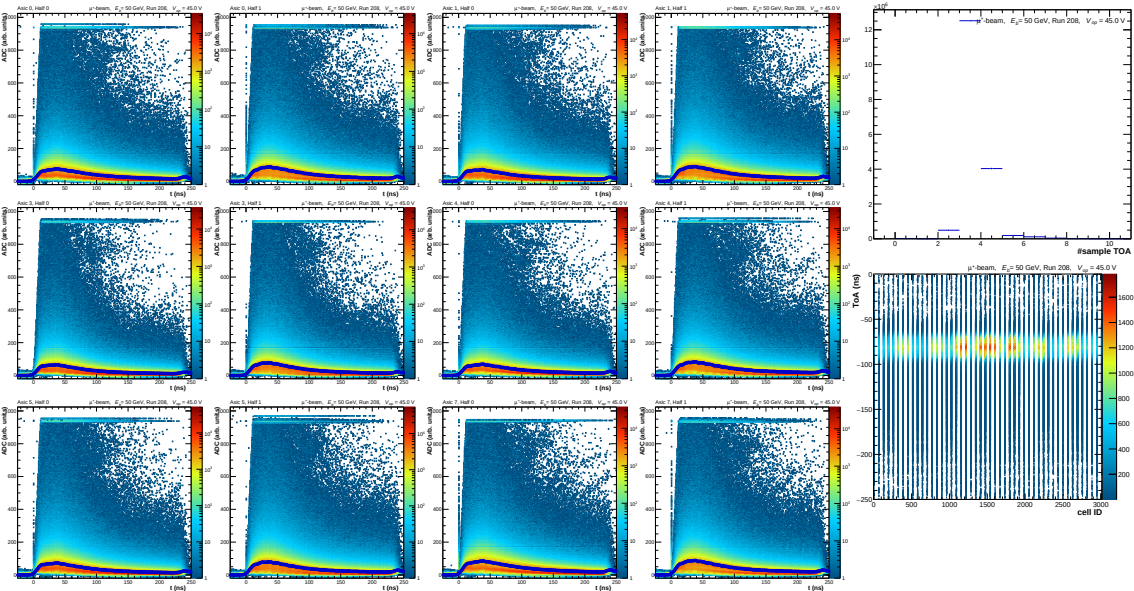


- Estimated using first negative pion run (246) at 100 GeV
- Based on ToA vs nSample plot
- Applied consistently to full set
- [TOA calib offset file]

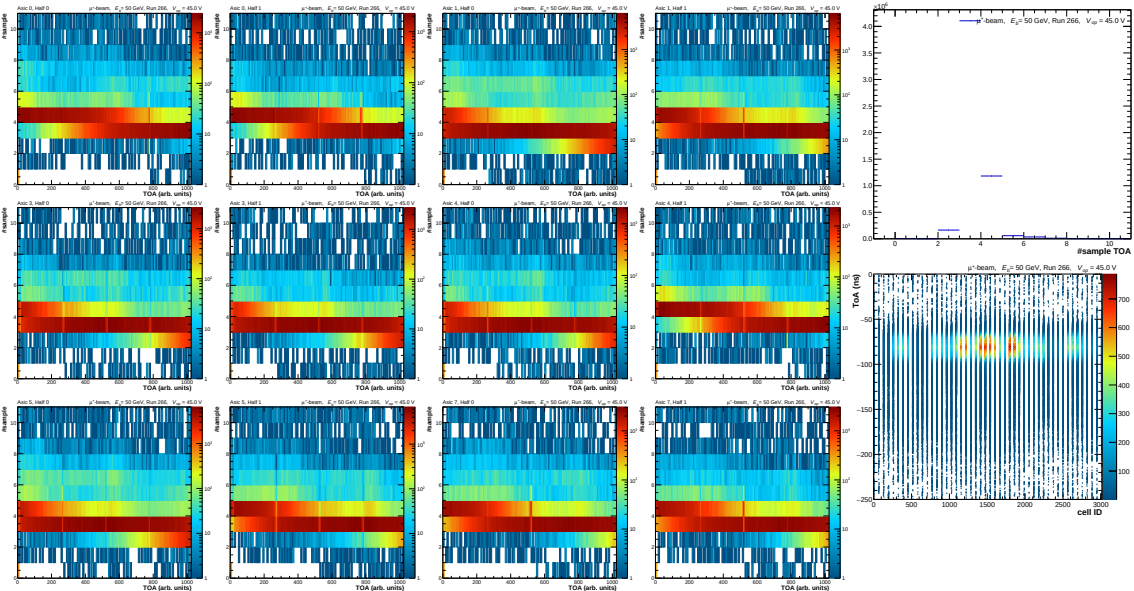
TOA offset calibration - Applied Set 1



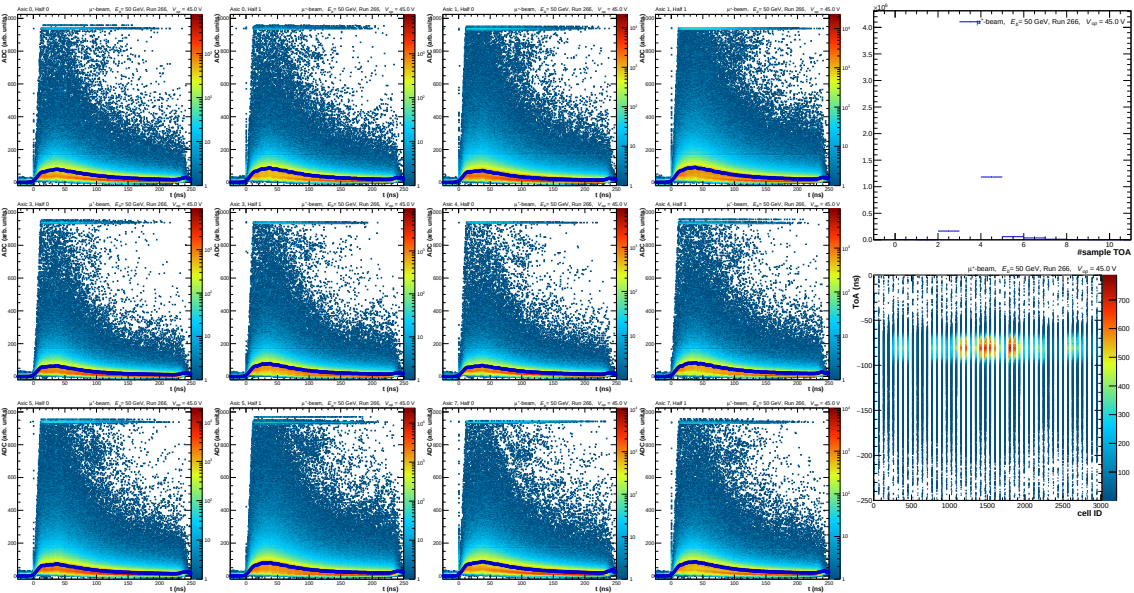
TOA offset calibration - Applied Set 1



TOA offset calibration - Applied Set 2

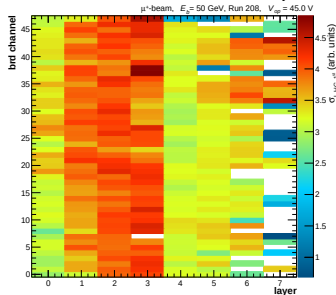
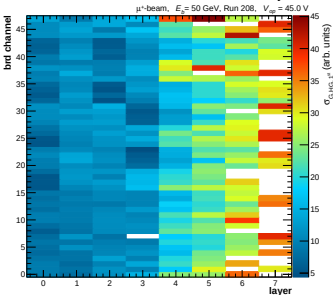
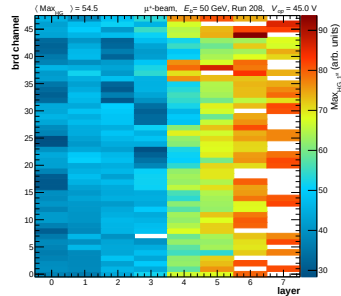
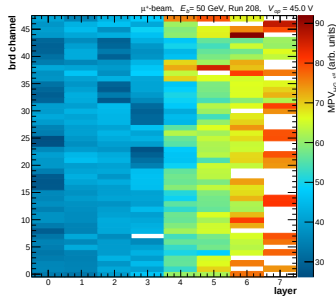
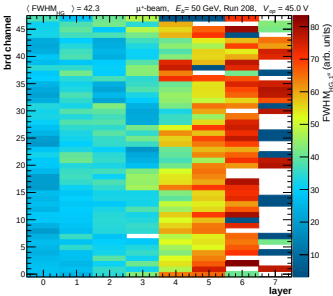


TOA offset calibration - Applied Set 2



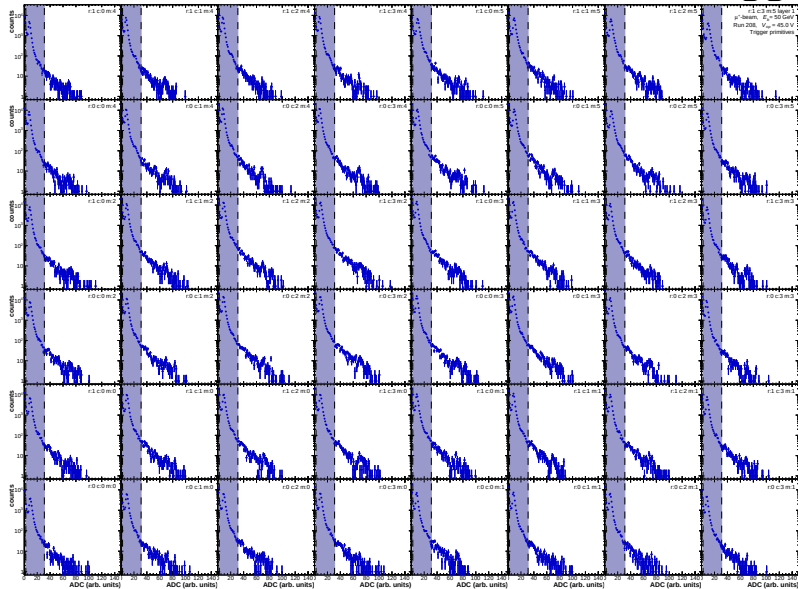


Muon calibration - Set 1: Muons - init (blue)

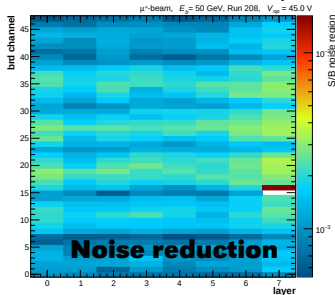
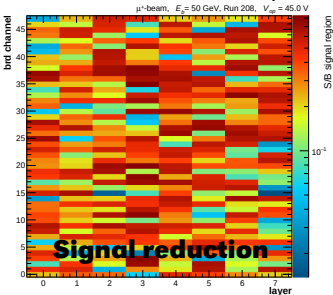
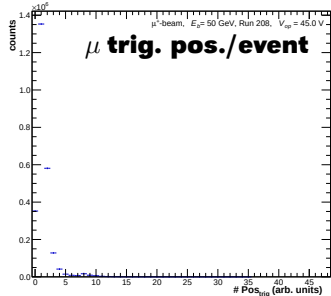
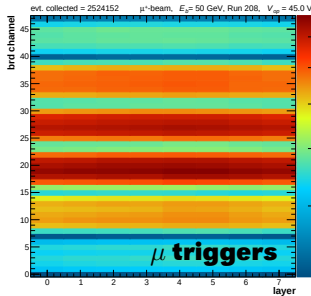
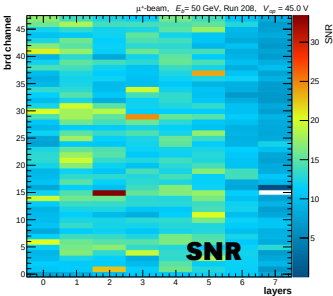


- Initial fit for 45 V & RF=9 quite stable, only layers in the back fail partially in initial fit (blue distribution previous slide)
- $\langle \text{Max}_{\text{mip}} \rangle = 54.5$
- channels with lower statistics not well fitted

Muon calibration - Set 1: Muons - Trigger

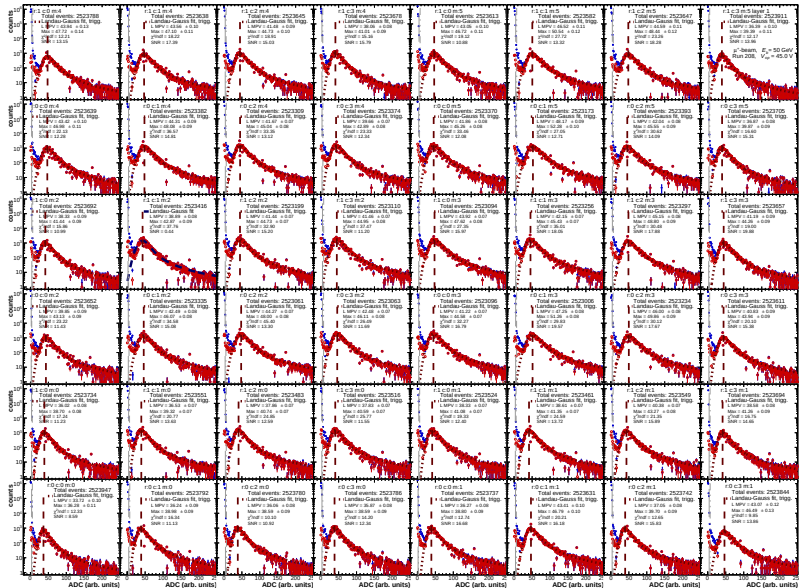


Muon calibration - Set 1: Muons - Trigger

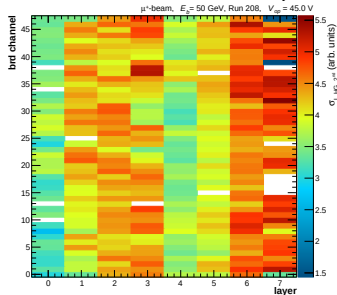
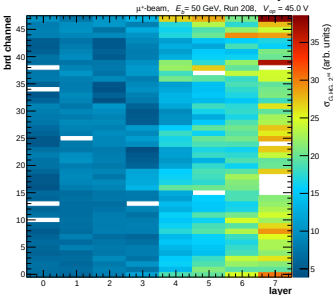
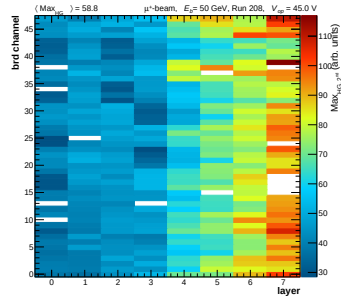
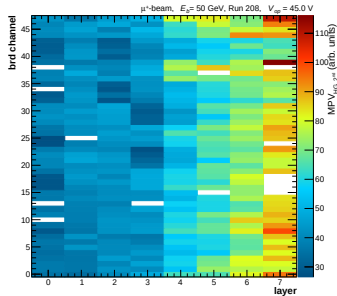
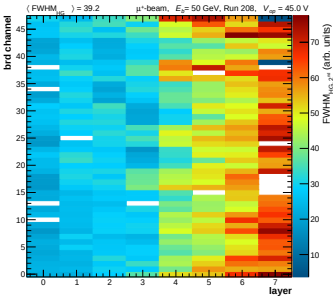


- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle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

Muon calibration - Set 1: Muons - 0th ite



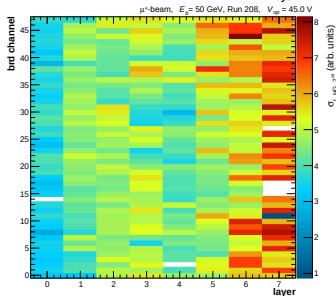
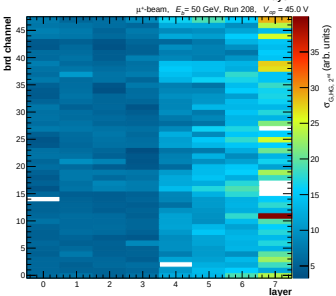
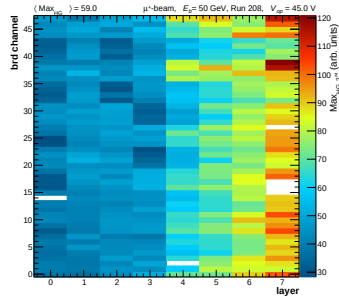
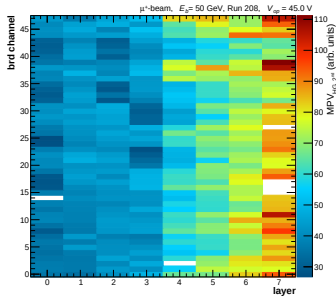
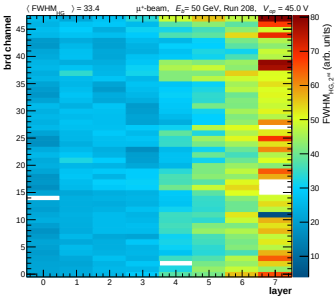
Muon calibration - Set 1: Muons - 0th ite



- Most channels "fitable"
- 2 channels identified as bad
- Constrained fit much more in width
- $\langle \text{Max}_{mip} \rangle = 58.8$

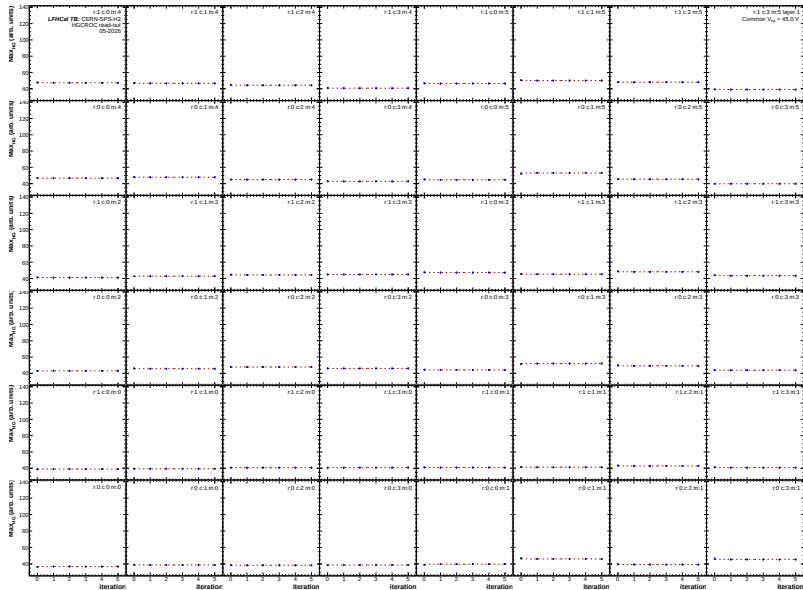


Muon calibration - Set 1: Muons - 5th ite

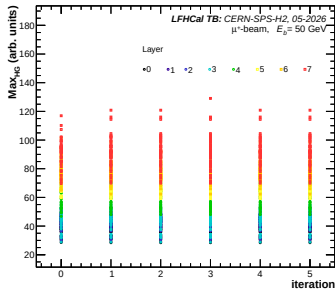
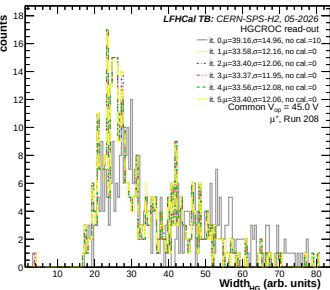
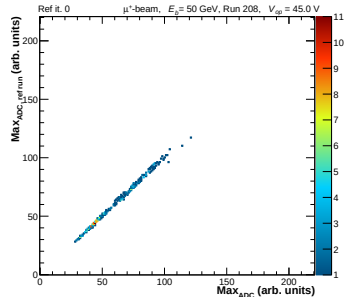
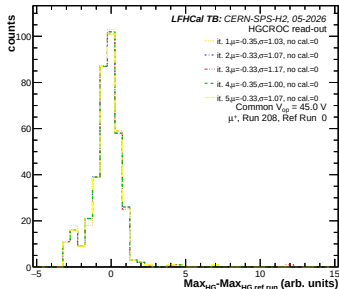
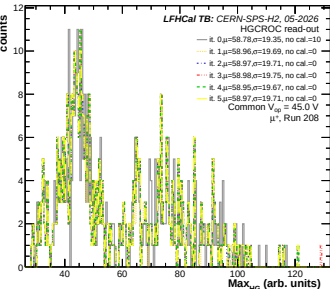


- Nearly all channels "fitable"
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 59.0$

Muon calibration - Set 1: Muons - Iterations



Muon calibration - Set 1: Muons - Iterations

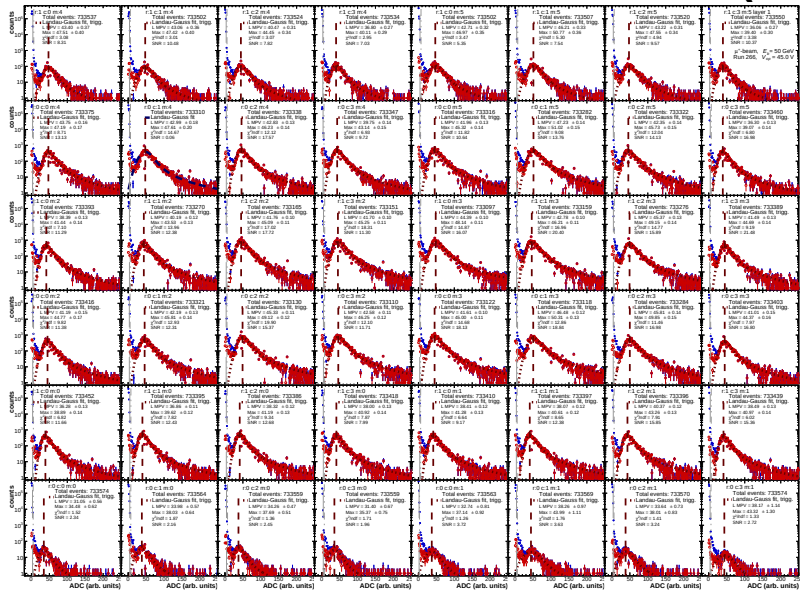


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$

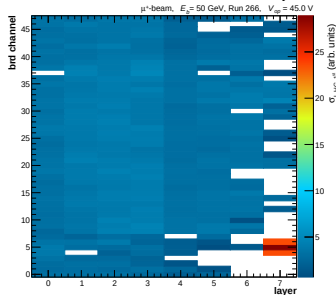
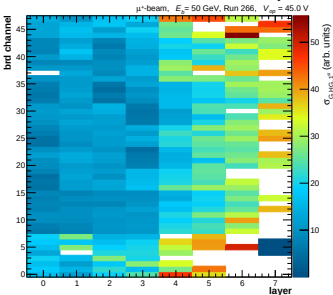
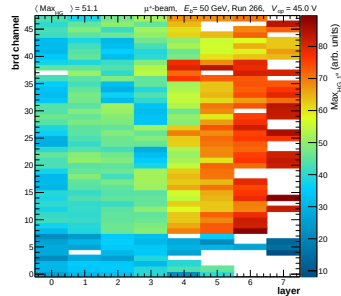
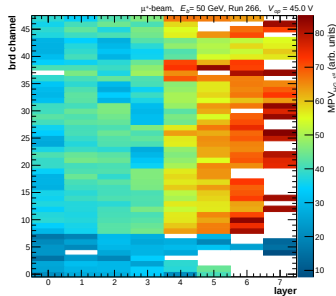
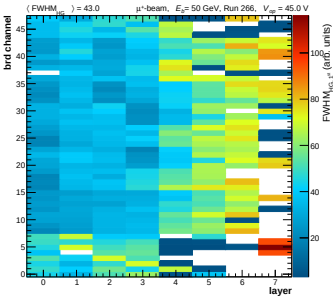
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations, small variations for single cells even in 5th iteration

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

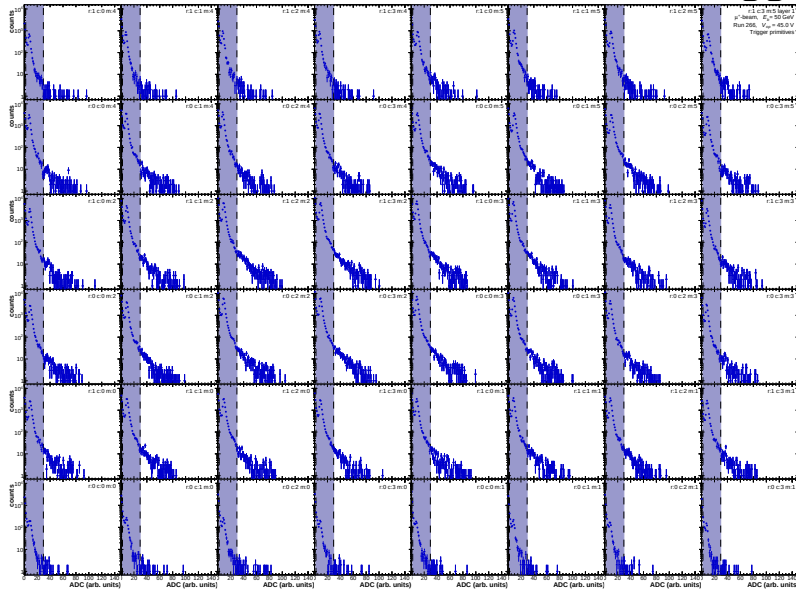


Muon calibration - Set 2: Muons - init (blue)

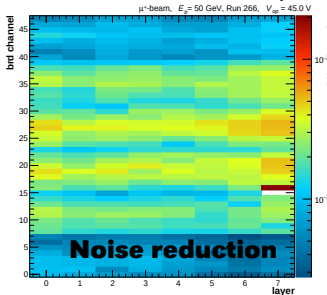
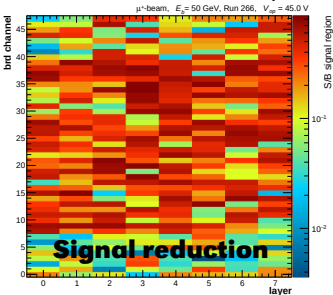
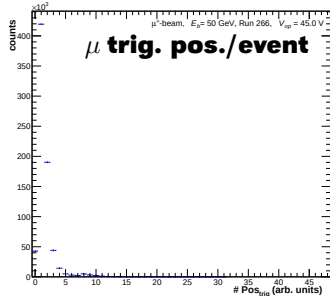
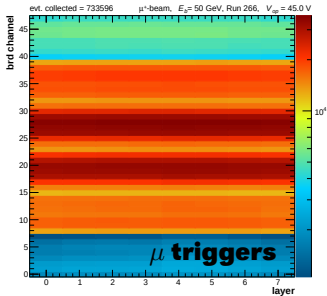
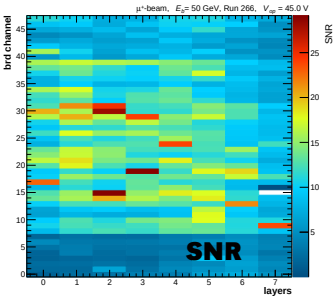


- Initial fit for 45 V & RF=9 slightly less stable, primarily layers in the back fail in initial fit (blue distribution previous slide)
- $\langle Max_{mip} \rangle = 51.1$
- No strong ch-by-ch variations in individual parameters per layer

Muon calibration - Set 2: Muons - Trigger

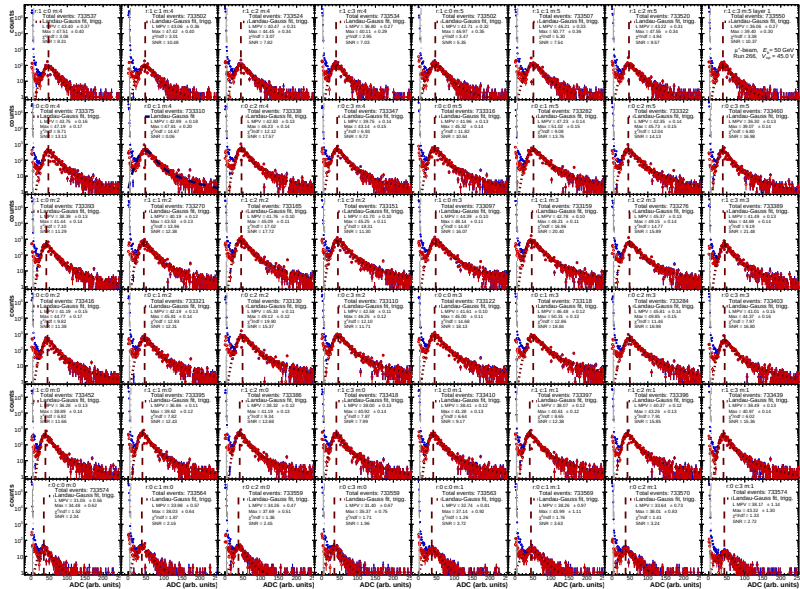


Muon calibration - Set 2: Muons - Trigger

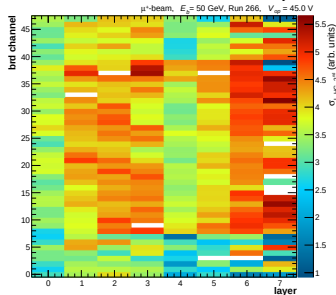
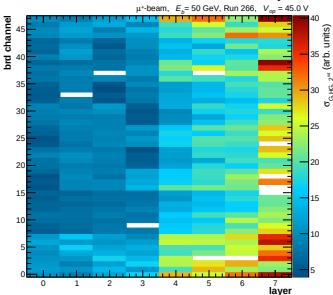
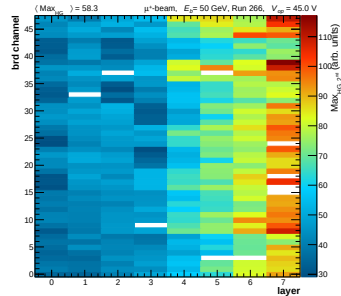
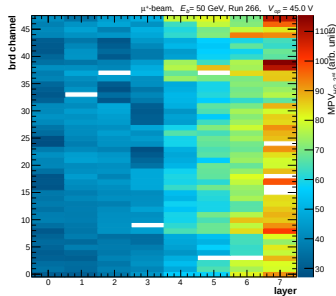
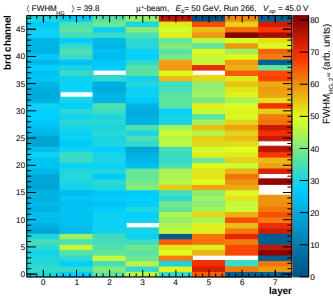


- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle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

Muon calibration - Set 2: Muons - 0th ite

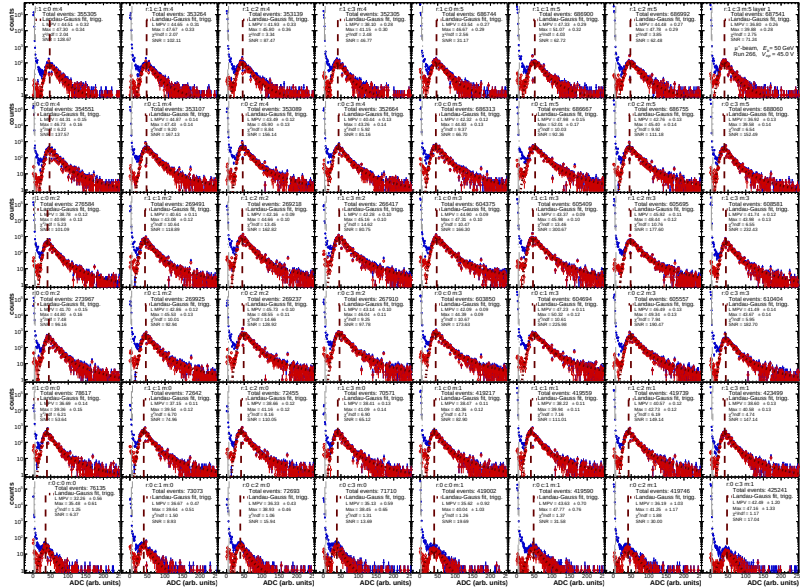


Muon calibration - Set 2: Muons - 0th ite

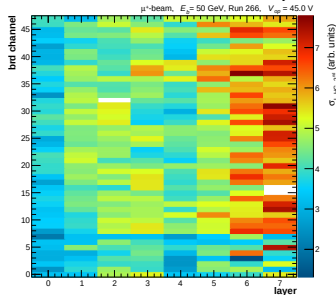
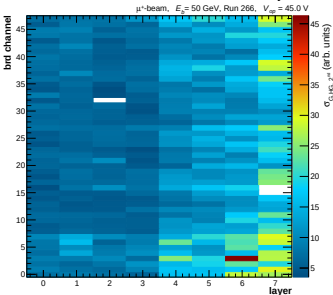
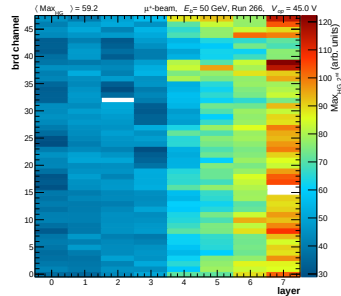
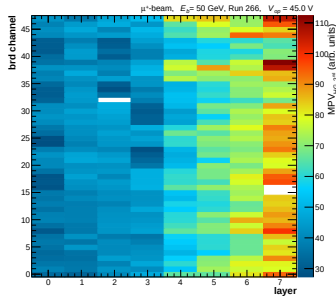
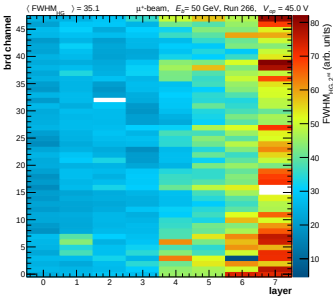


- Nearly all channels "fitable"
- 2 channels identified as bad
- Constrained fit much more in width
- $\langle \text{Max}_{mip} \rangle = 58.3$

Muon calibration - Set 2: Muons - 5th ite

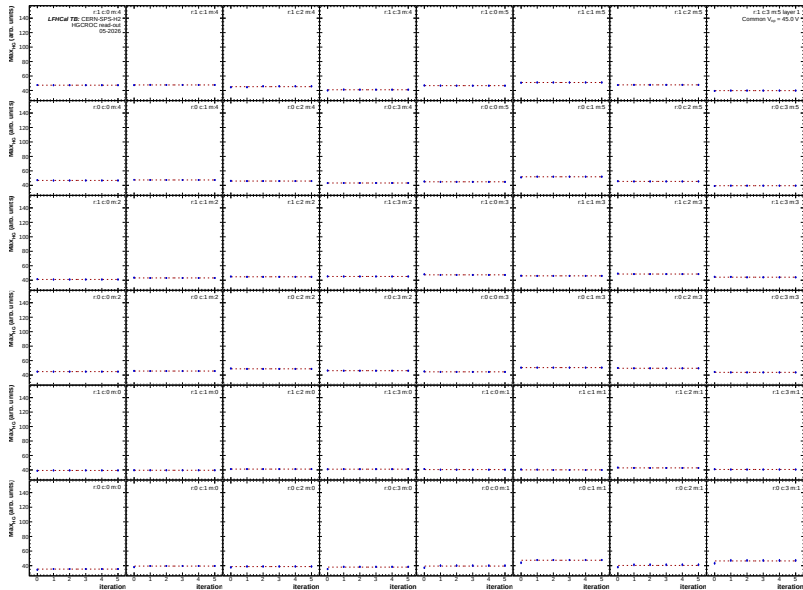


Muon calibration - Set 2: Muons - 5th ite

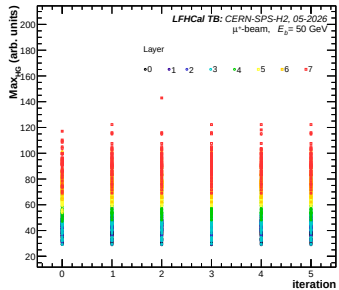
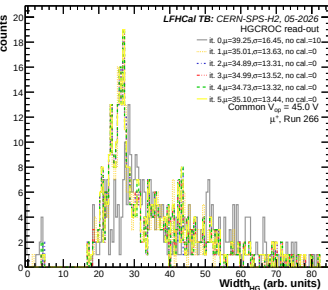
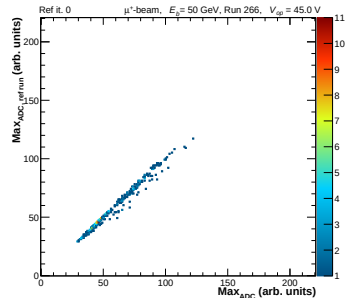
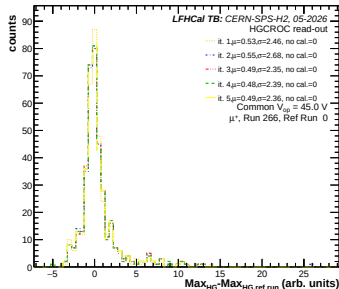
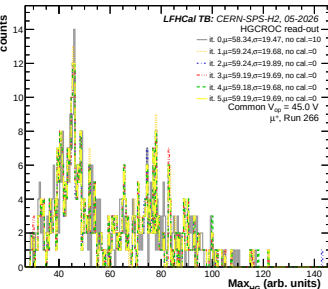


- Nearly all channels "fitable"
- 2 channels identified as bad
- $\langle \text{Max}_{mip} \rangle = 59.2$

Muon calibration - Set 2: Muons - Iterations



Muon calibration - Set 2: Muons - Iterations

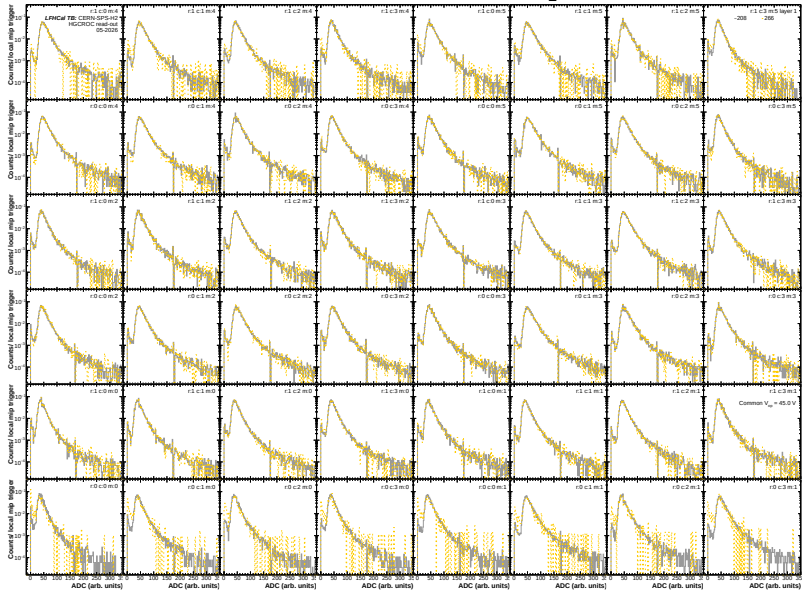


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$

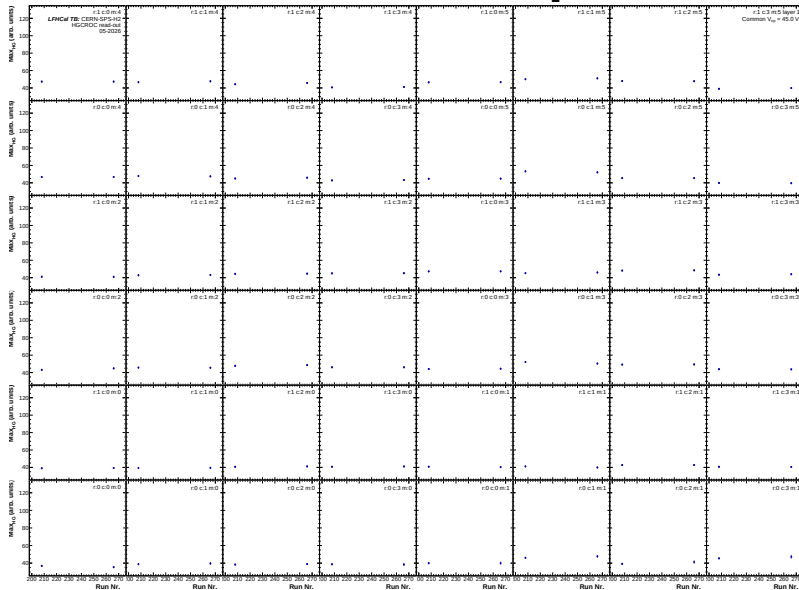
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations, small variations for single cells even in 5th iteration

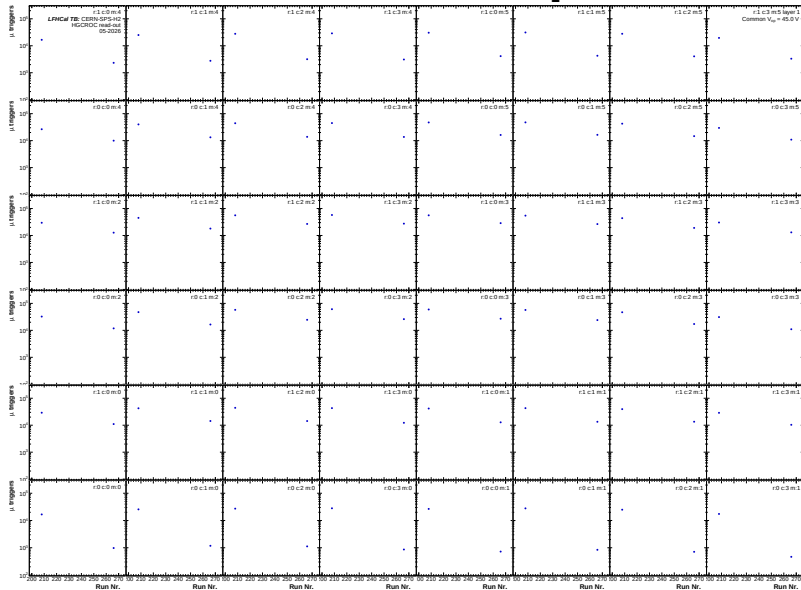
Muon calibration - Comparison Sets



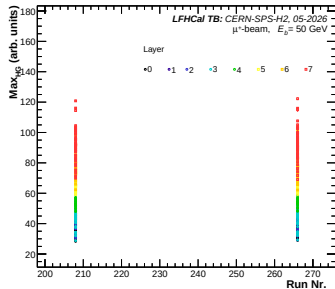
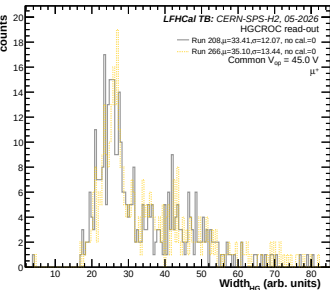
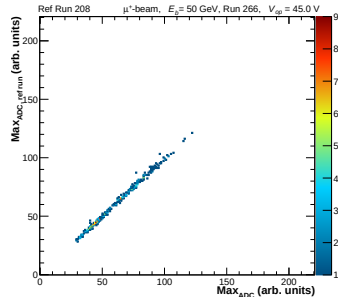
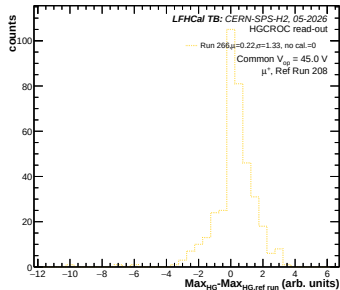
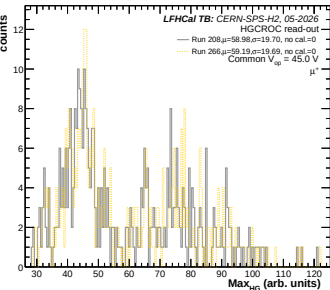
Muon calibration - Comparison Sets



Muon calibration - Comparison Sets



Muon calibration - Comparison Sets



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

Calibration summary - Set D



Calibration summary

- Besides 2 bad channels identified in this data set no further channels found problematic
- ToA offset calibration estimated on 100 GeV h^- run (pion) run valid for all runs of set D
- Final calibration based off 'Set_1' (17 beam positions) due to higher statistics & better coverage
 - ▶ Calib file FullSet D 1st [txt-file]
 - ▶ Calib file FullSet D 2nd [txt-file]