

2026 SPS TB - HGCROC Readout

September 17, 2026

Friederike Bock



- 1 SPS 2026 - HV Scan
 - Overview
 - Pedestals
 - Muon Calibration 42V
 - Muon Calibration 42.5V
 - Muon Calibration 43V
 - Muon Calibration 43.5V
 - Muon Calibration 44V
 - Muon Calibration 44.5V
 - Muon Calibration 45V
 - Muon Calibration 45.5V
 - Muon Calibration 46V
- 2 HV Scan Comparison
- 3 Calibrations Summary

2026 SPS TB - HGCROC Readout HVScan - analysis status



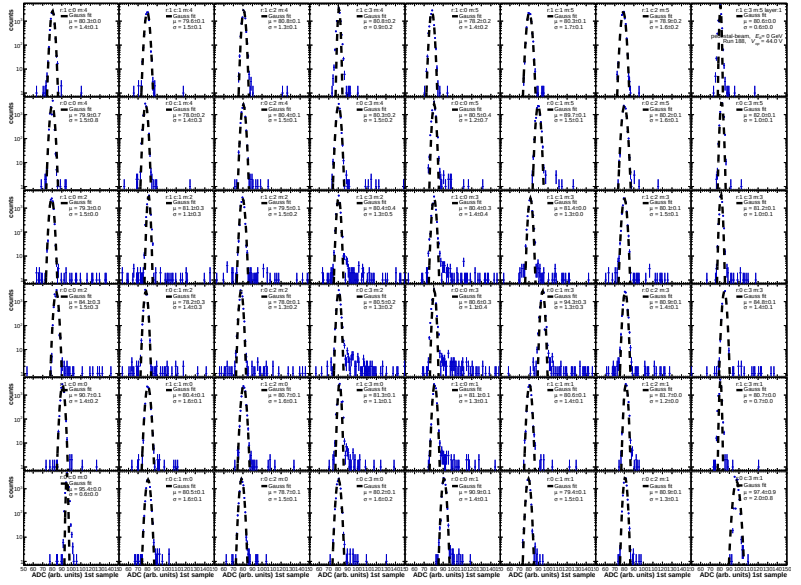
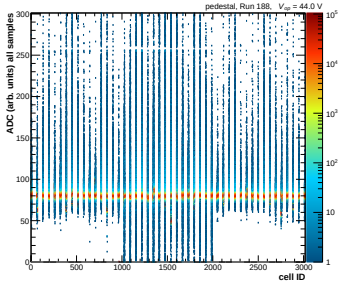
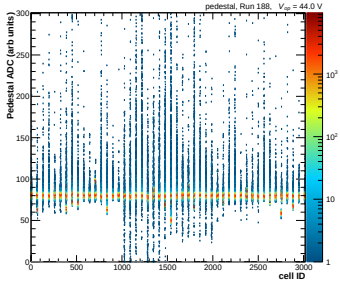
Muon HV Scan

Summing Board V2, μ^+ at (0,0), $E = 50$ GeV, gain settings: RF = 9, CF = 7, CC= 5, CFcomp=1
May 16, 14:42 - May 16, 17:32

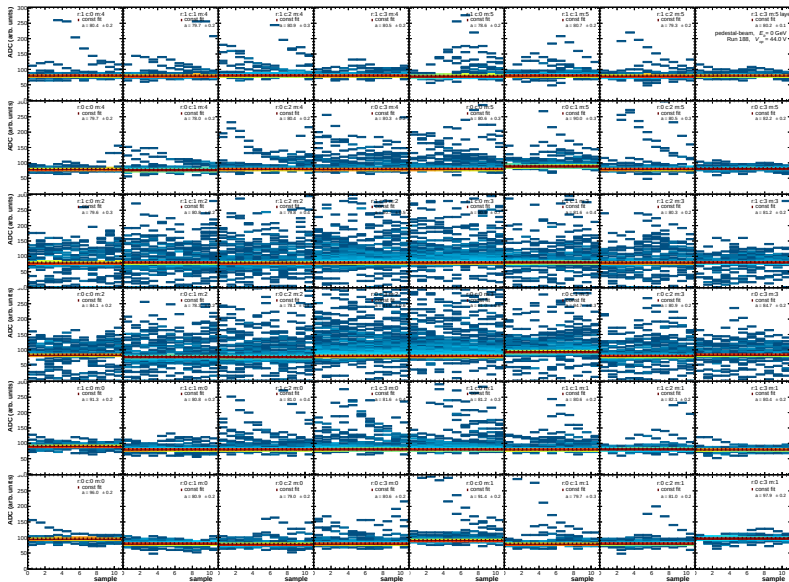
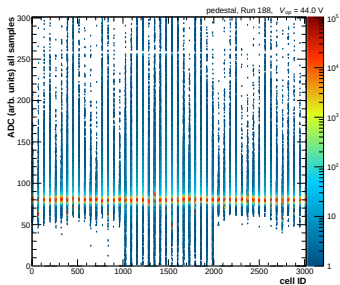
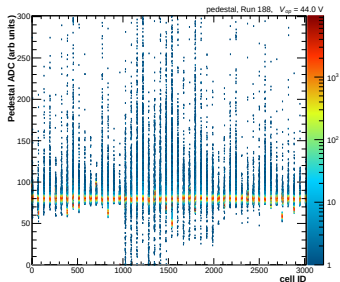
Gain scan:										
V_{op} (V)	44	42	42.5	43	43.5	44	44.5	45	45.5	46
type	ped	μ	μ	μ	μ	μ	μ	μ	μ	μ
runs	188	201	202	195	196	194	197	198	199	200
tot events	10K	156K	153K	290K	181K	150K	160K	155K	154K	155K

- time:
19.5.2026 20:22 - 20.5.2026 7:57
- V_{op} varying $V_{br} = 38.3$ V
- Gain settings:
 - RF = 9, CF = 7, CC= 5, CFcomp=1
- μ with large scintillator triggers only center position
 $\Rightarrow$ only 6x4 center tiles have enough statistics to be considered, outer columns and rows masked in bad channel map
- ToA calibration from run 194 applied to all, not primary concern as only mips considered in this campaign

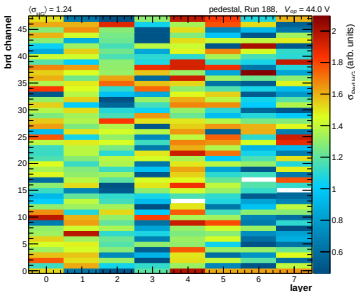
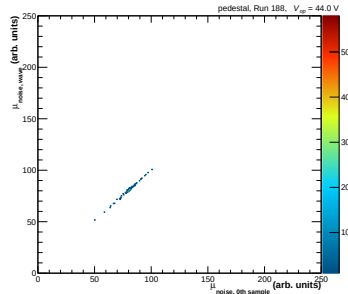
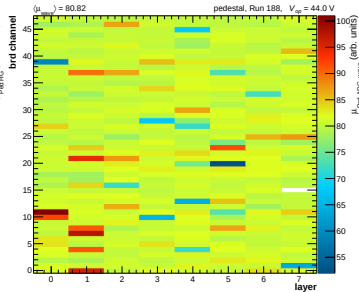
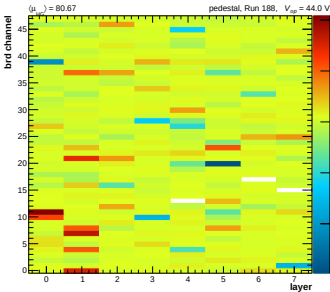
Pedestal calibration



Pedestal calibration

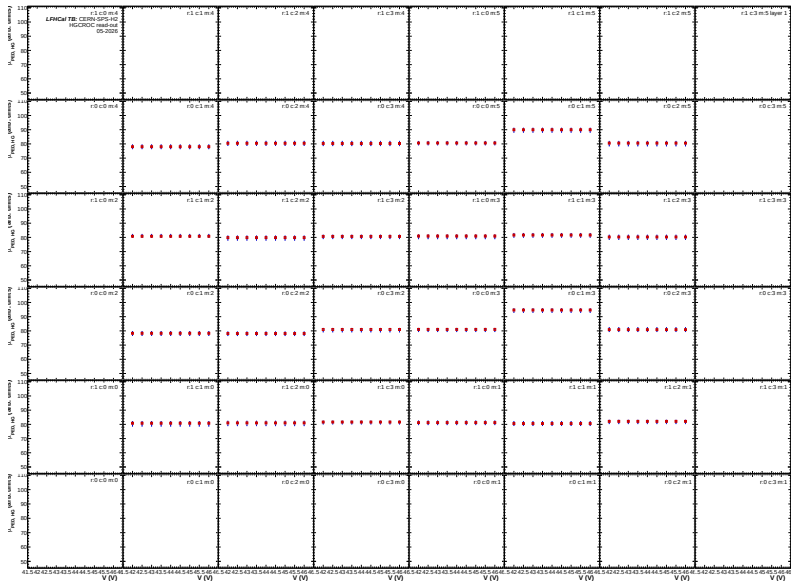
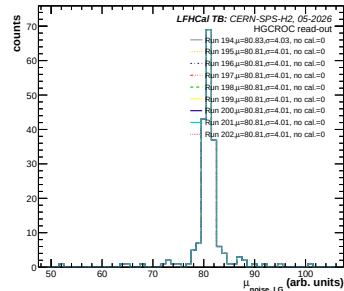
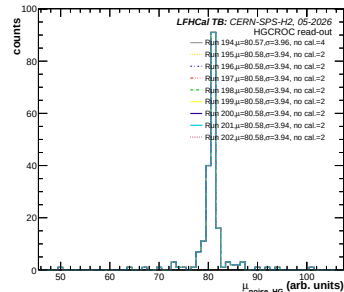


Pedestal calibration

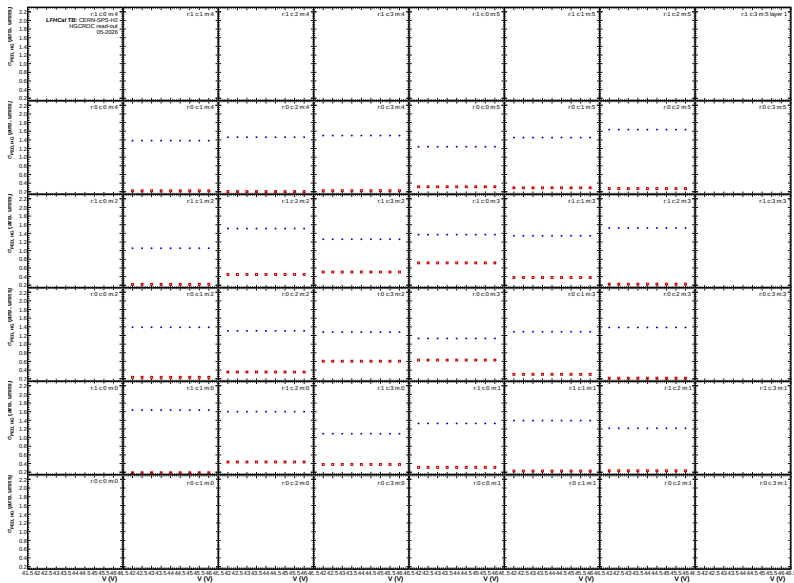
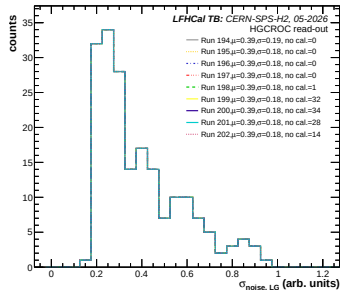
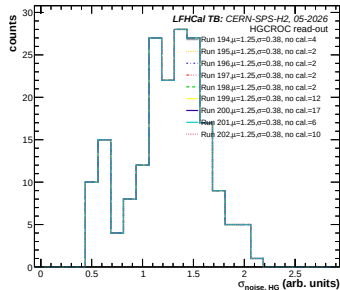


- Pedestal for all readout units set to 80 ADC
- Online calibration verified
- Fitting converges for most cells (3 missing)
- Good correlation between alternative fitting methods for pedestal
- Run at 44V used for runs as pedestal, anticipated changes in width not taken into account during mip fitting

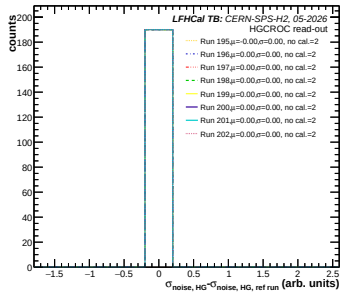
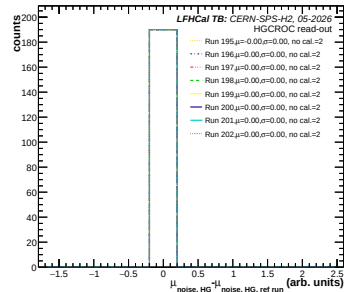
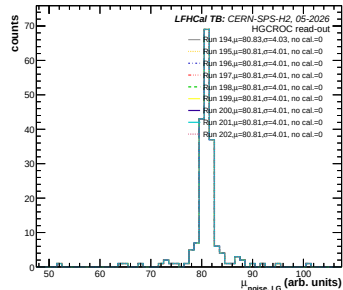
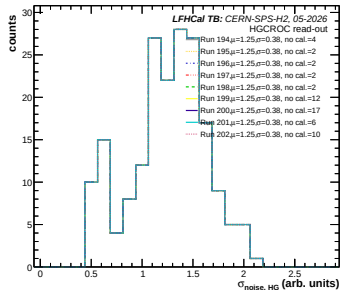
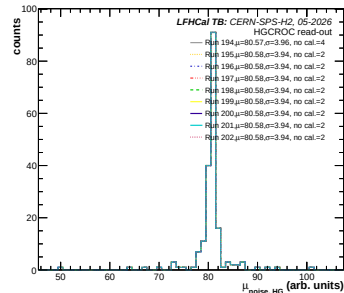
Pedestal Comparison



Pedestal Comparison



Pedestal Comparison



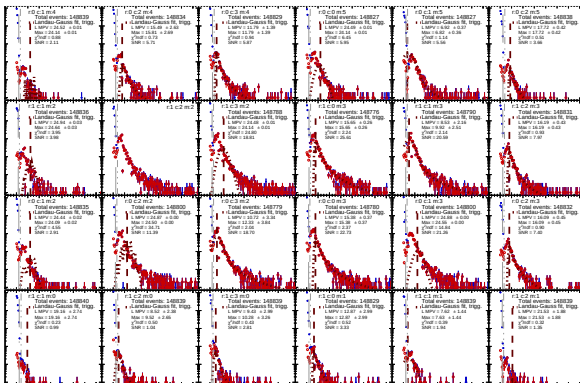
- Used same pedestal for all runs
- 'trivial comparison'

Muon Calibration chain - 42 V - Run 201



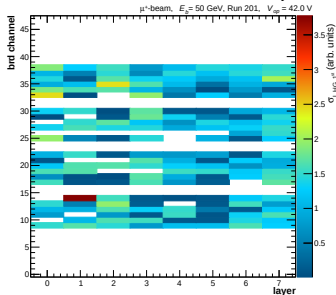
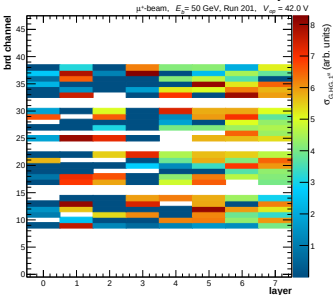
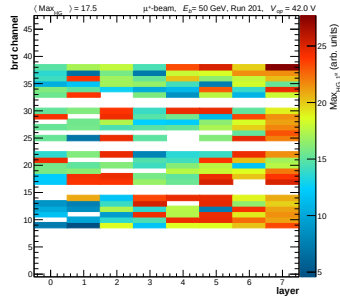
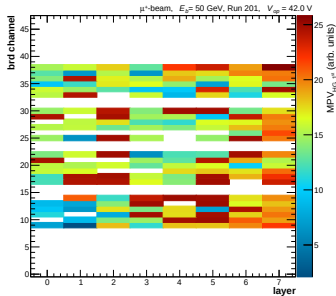
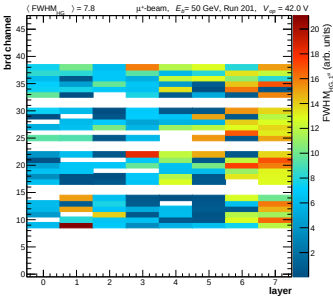
Muon calibration - 42V: Muons - init (blue)

Layer 1



Outer columns and rows masked due to too low statistics (plotting suboptimal).

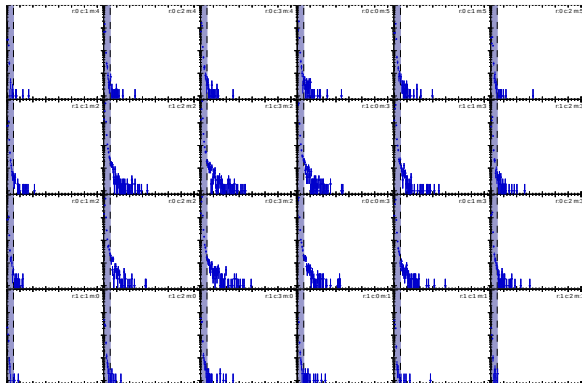
Muon calibration - 42V: Muons - init (blue)



- Most challenging starting point for fits, due to merging of pedestal & mip peak
- Nonetheless reasonable successrate for starting point
- $\langle \text{Max}_{mip} \rangle = 17.5$

Muon calibration - 42V: Muons - Trigger

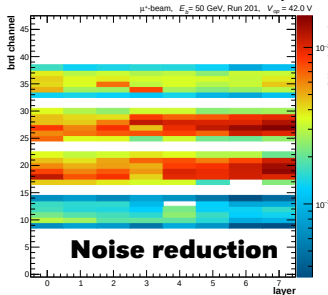
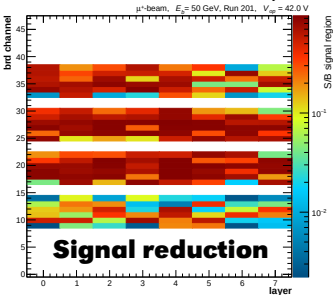
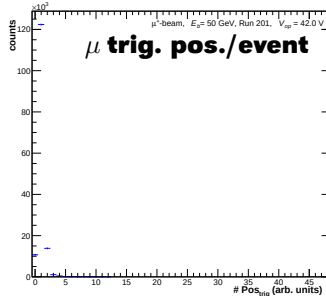
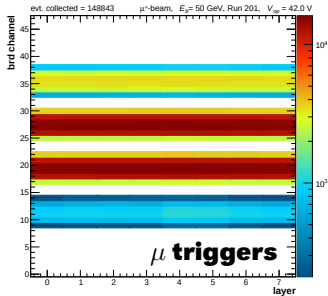
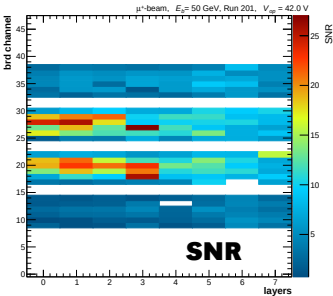
μ^+ -beam, $E_\mu = 50$ GeV
Run 201, $V_{dr} = 42.5$ V
Trigger primitives



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

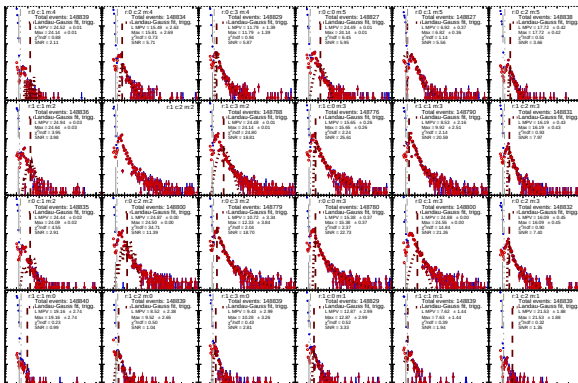
Muon calibration - 42V: Muons - Trigger



- 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)

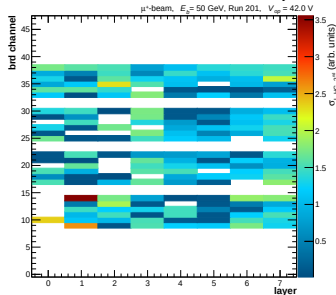
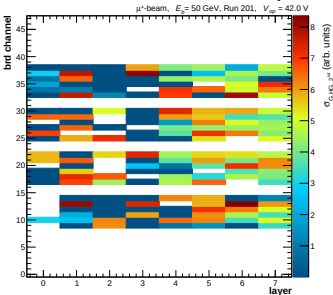
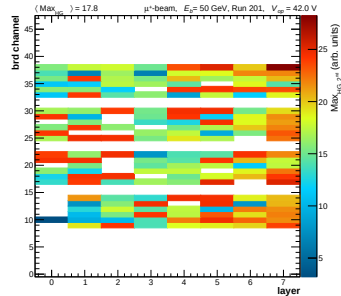
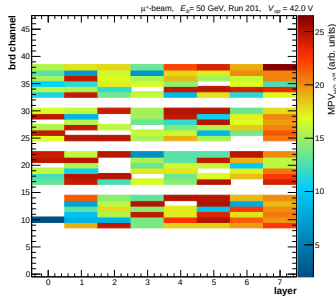
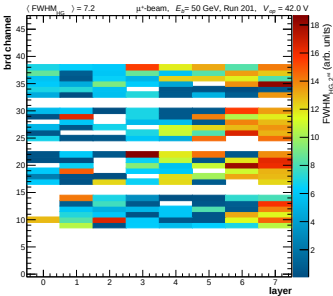
Muon calibration - 42V: Muons - 0th ite

Layer 1



Outer columns and rows masked due to too low statistics (plotting suboptimal).

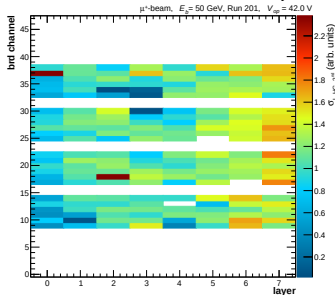
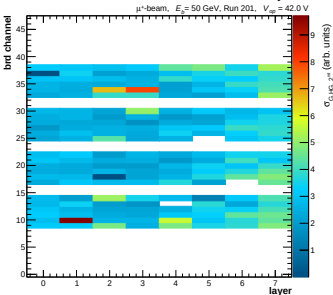
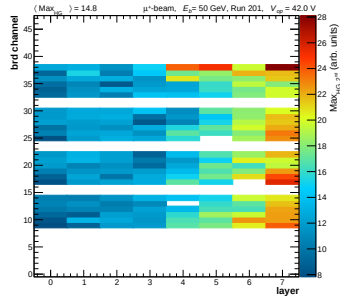
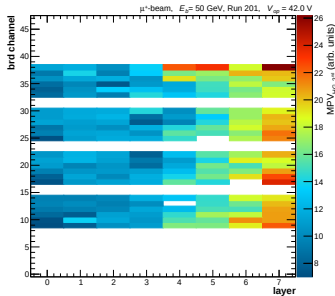
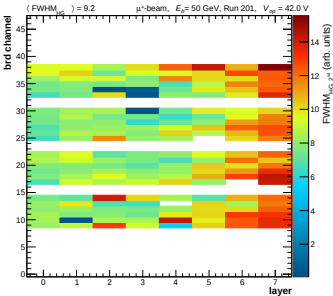
Muon calibration - 42V: Muons - 0th ite



- Some channels fail miserably
- Need significant improvements in particular in first few layers
- Large variations of parameter per layer indicate suboptimal fitting
- $\langle \text{Max}_{mip} \rangle = 17.8$

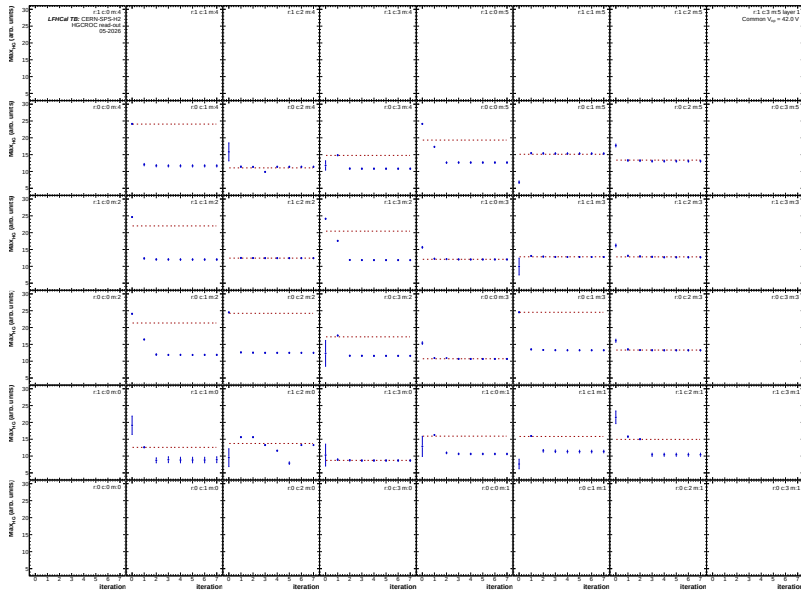


Muon calibration - 42V: Muons - 7th ite

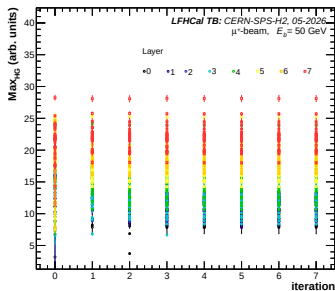
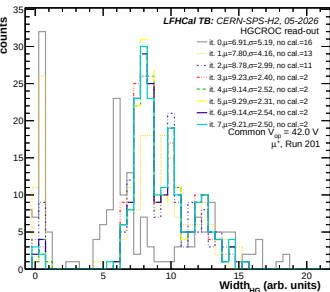
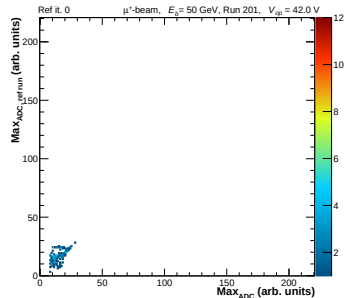
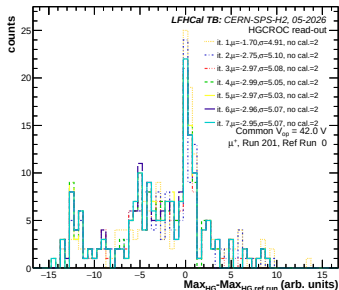
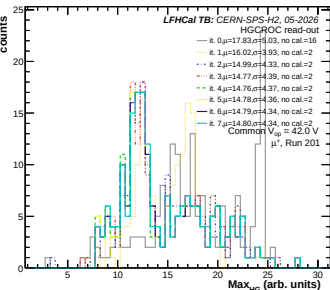


- Nearly all channels "fitable"
- Iterative fitting significantly improves fit successrate
- Introduced V_{ov} dependent fit ranges and parameter start points/limits
- 2nd row most challenging due to low statistics
- Significant reduction in variations of parameters by layer
- ⟨Max_{mip}⟩ = 14.8

Muon calibration - 42V: Muons - Iterations



Muon calibration - 42V: Muons - Iterations



- Reduced mip selection range for trigger primitives

$$0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$$

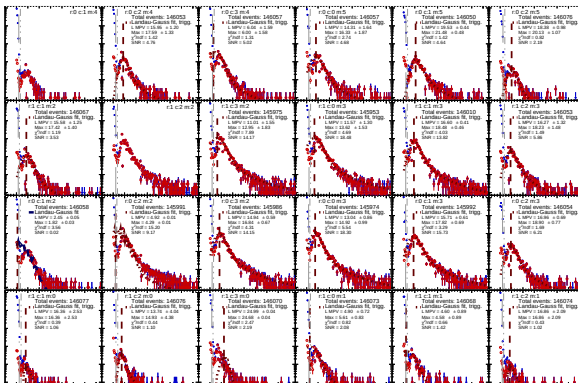
⇒ Further reduction of noise peak

- Significant variations from 0th iteration to 5th
- 0th iteration couldn't be used for calibration
- Some cells still not converged after 5th iteration

Muon Calibration chain - 42.5 V - Run 202

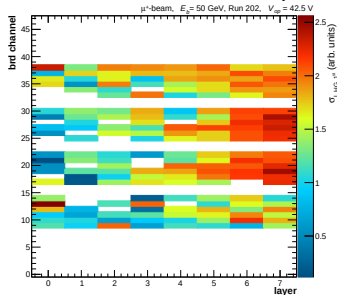
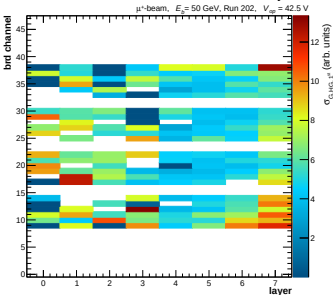
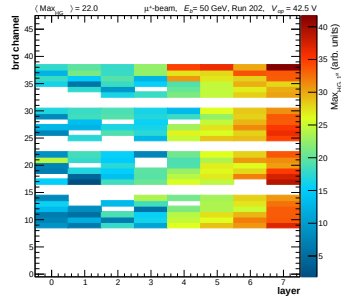
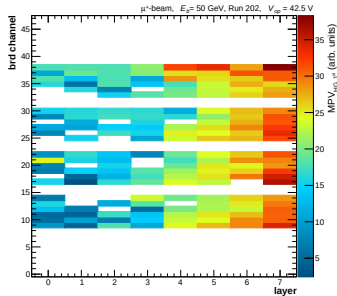
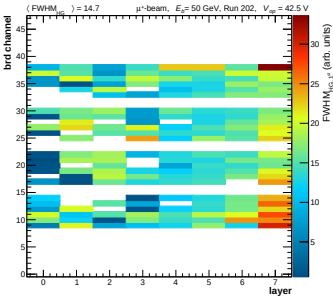


Muon calibration - 42.5V: Muons - init (blue)



Outer columns and rows masked due to too low statistics (plotting suboptimal).

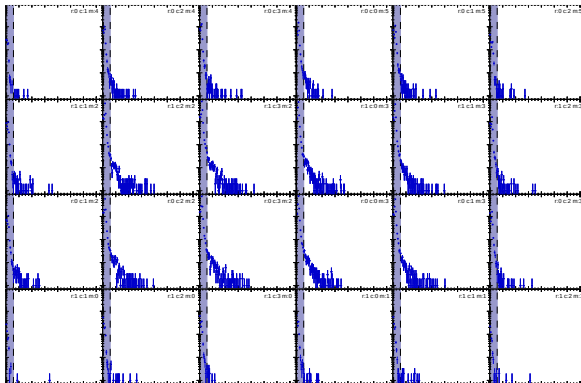
Muon calibration - 42.5V: Muons - init (blue)



- Pedestal peak & mip peak still very close, fitting difficult for first few layers in particular in initial fit
- Fits tend to converge at a too high Max
- $\langle \text{Max}_{mip} \rangle = 22.0$
- Large variations in parameters for initial fit per layer

Muon calibration - 42.5V: Muons - Trigger

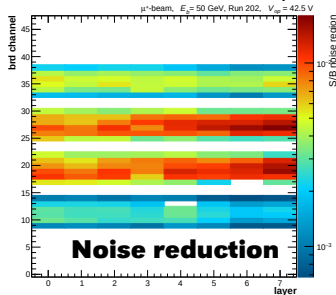
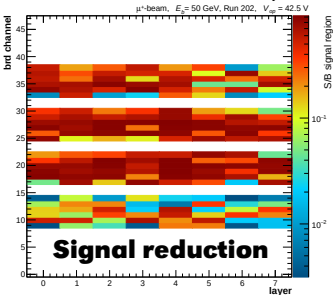
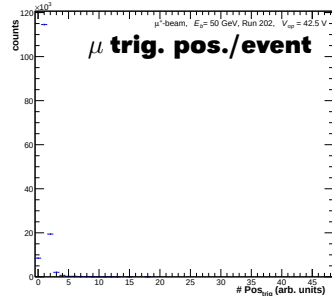
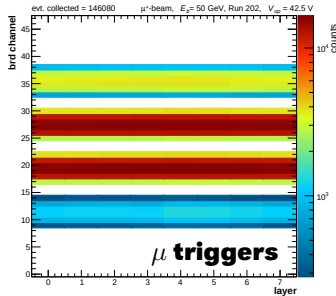
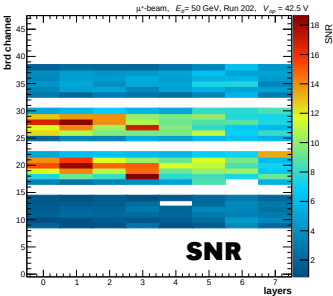
p^+ -beam, $E_p = 50$ GeV
Run 202, $V_{dr} = 42.5$ V
Trigger primitives



Layer 1

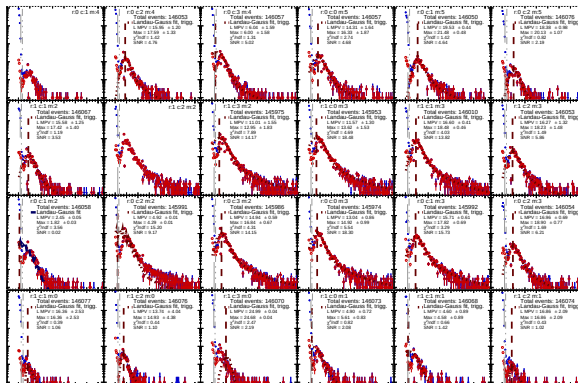
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 42.5V: 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)

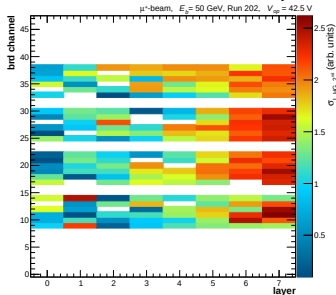
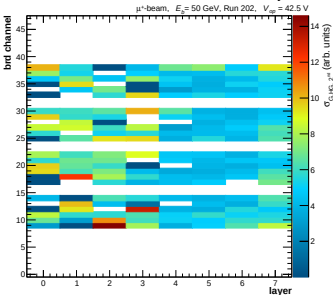
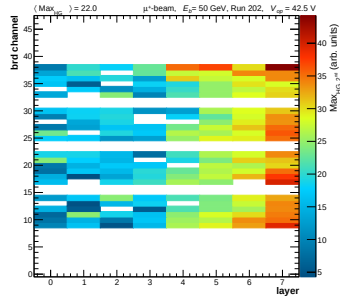
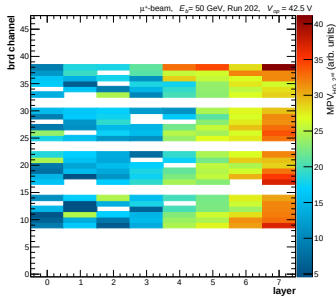
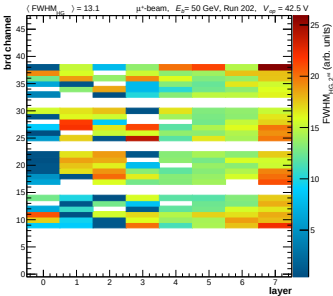
Muon calibration - 42.5V: Muons - 0th ite



Layer 1

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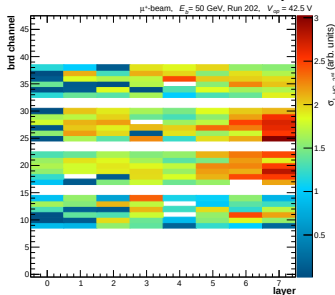
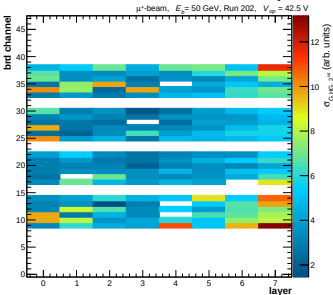
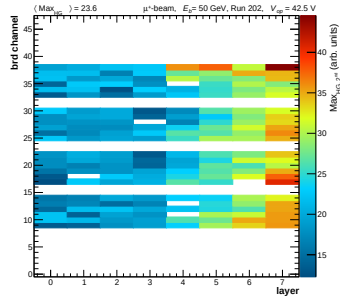
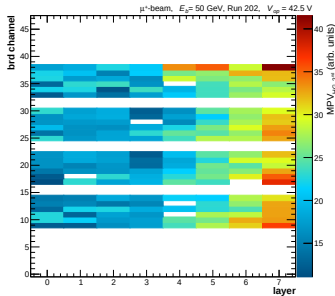
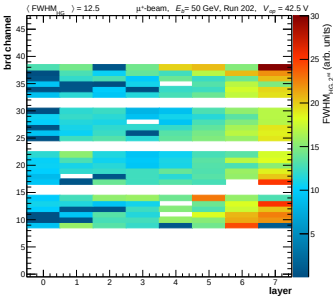
Muon calibration - 42.5V: Muons - 0th ite



- Even fitting first triggered distribution still yields large variation for parameters within same layer, fits very unstable
- $\langle \text{Max}_{mip} \rangle = 22.0$

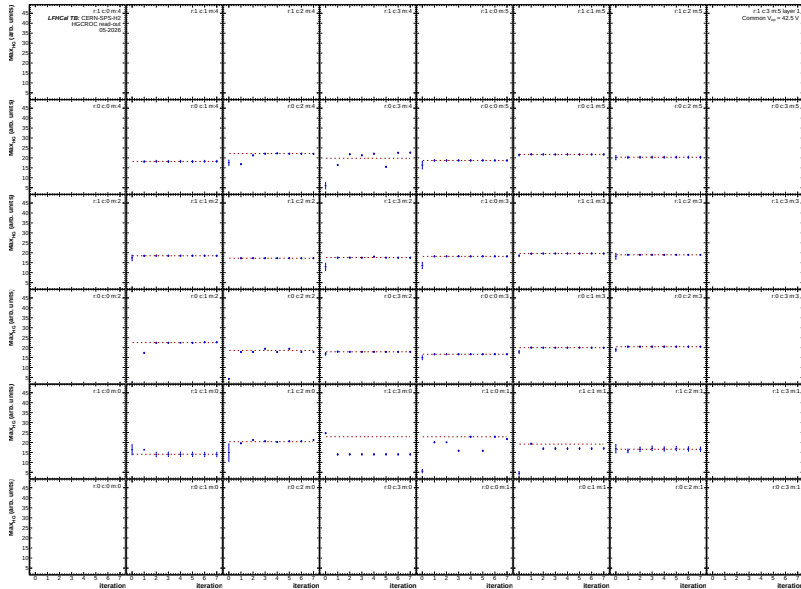


Muon calibration - 42.5V: Muons - 7th ite

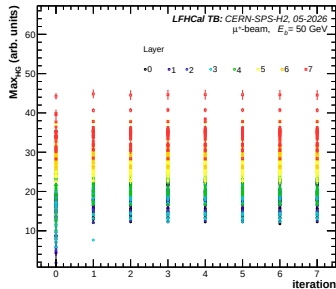
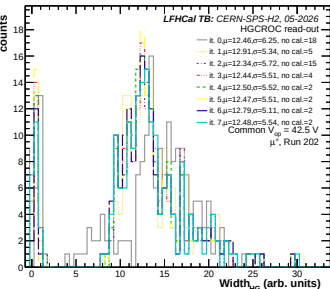
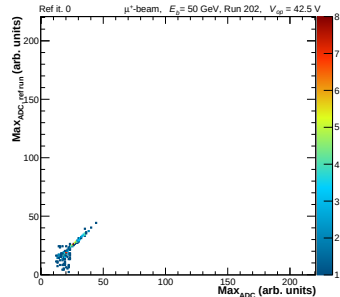
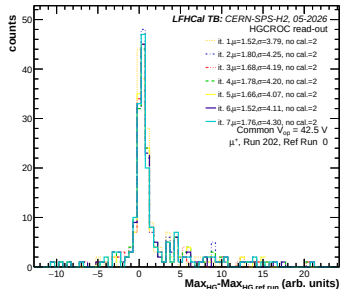
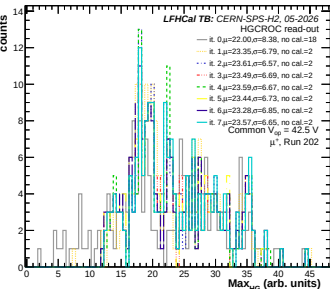


- Most channels possible to fit
- Iterative fitting significantly improves fit successrate
- Introduced V_{ov} dependent fit ranges and parameter start points/limits
- Still large variation for width within same layer, max still caught most of the time
- Statistics in 2nd row difficult to fit
- $\langle Max_{mip} \rangle = 23.6$

Muon calibration - 42.5V: Muons - Iterations



Muon calibration - 42.5V: Muons - Iterations



- Reduced mip selection range for trigger primitives

$$0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$$

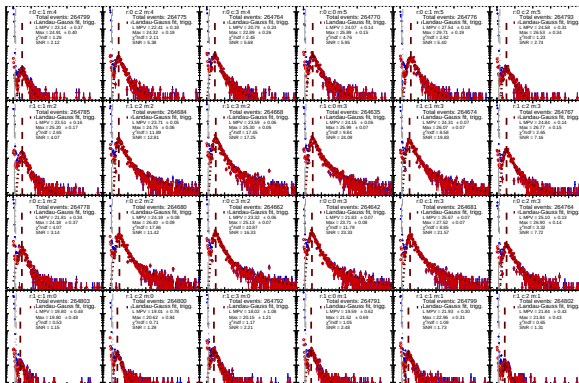
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Some cells still vary between 4th and 5th iteration (low statistics cells)
- 0th iteration not reliable for calibration

Muon Calibration chain - 43 V - Run 195



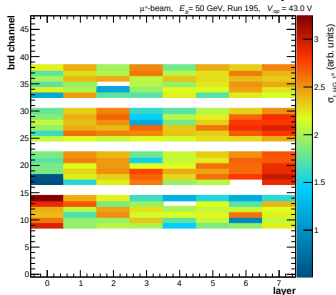
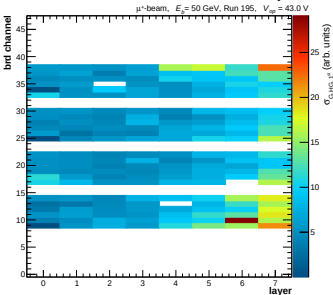
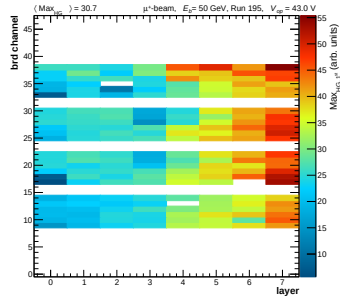
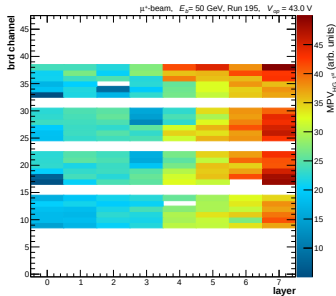
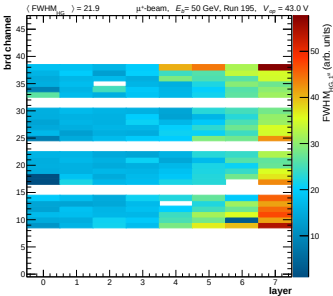
Muon calibration - 43V: Muons - init (blue)



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

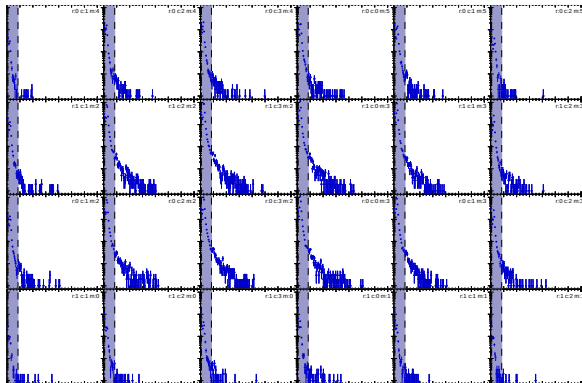
Muon calibration - 43V: Muons - init (blue)



- Sufficient separation between pedestal & mip peak, initial fit successrate very good
- Uniform parameter results per layer
- $\langle Max_{mip} \rangle = 30.7$

Muon calibration - 43V: Muons - Trigger

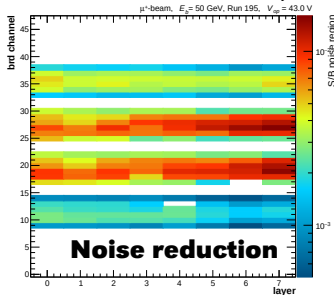
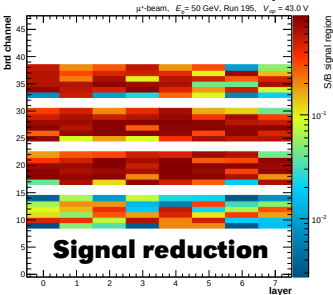
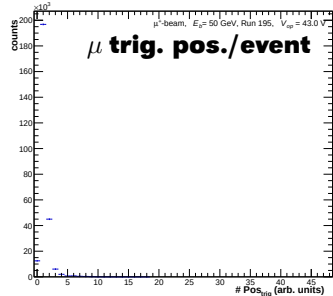
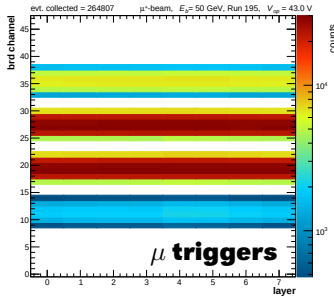
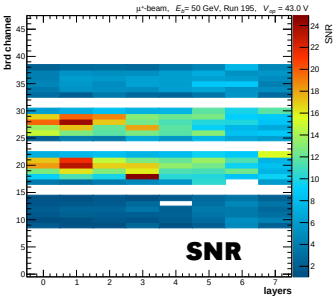
μ^+ -beam, $E_\mu = 50$ GeV
Run 195, $V_{dr} = 43.0$ V
Trigger primitives



Layer 1

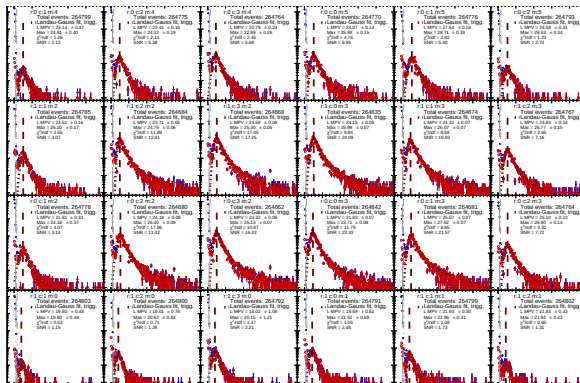
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 43V: 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)

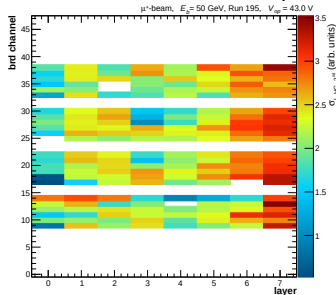
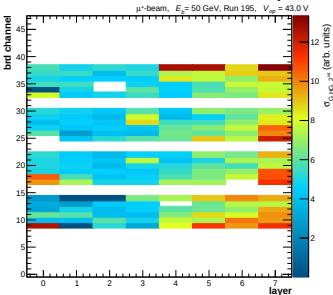
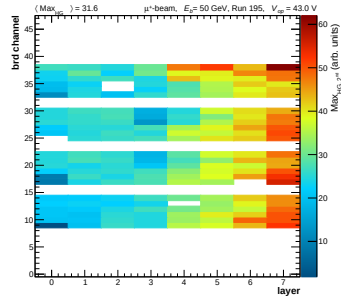
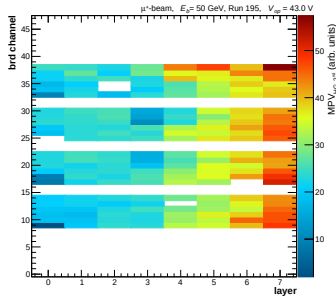
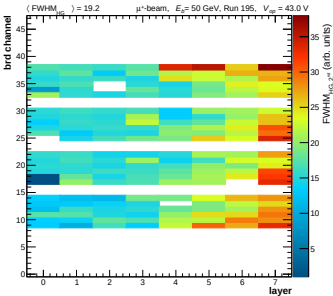
Muon calibration - 43V: Muons - 0th ite



Layer 1

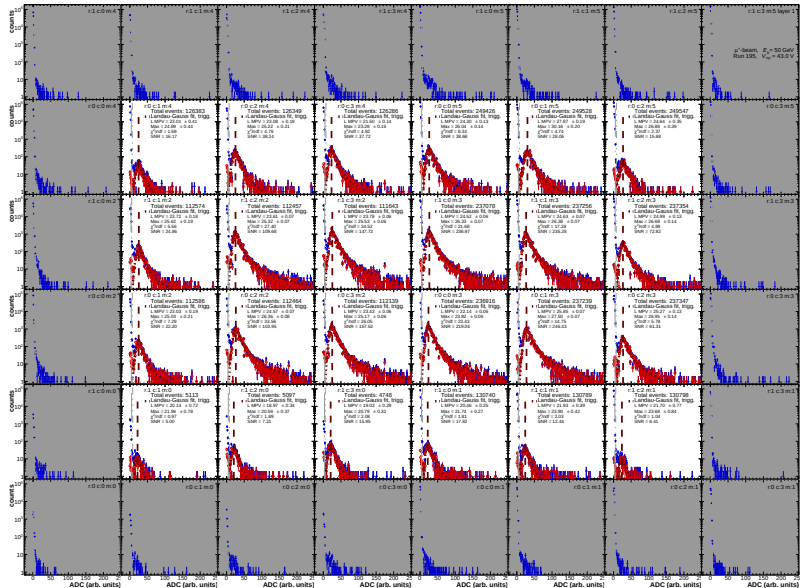
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 43V: Muons - 0th ite

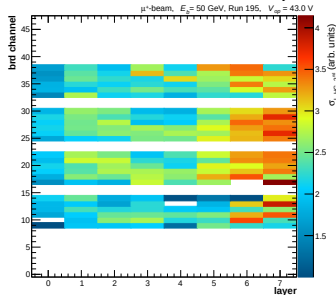
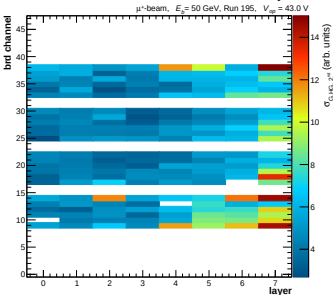
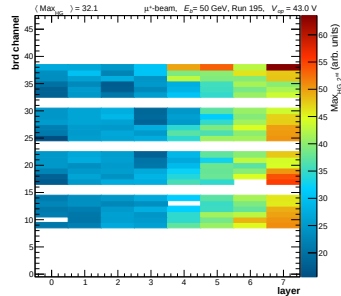
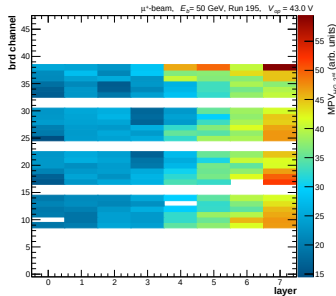
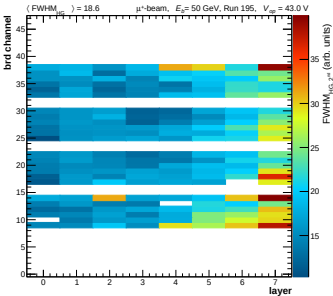


- High fit successrate & parameter uniformity
- $\langle Max_{mip} \rangle = 31.6$

Muon calibration - 43V: Muons - 7th ite

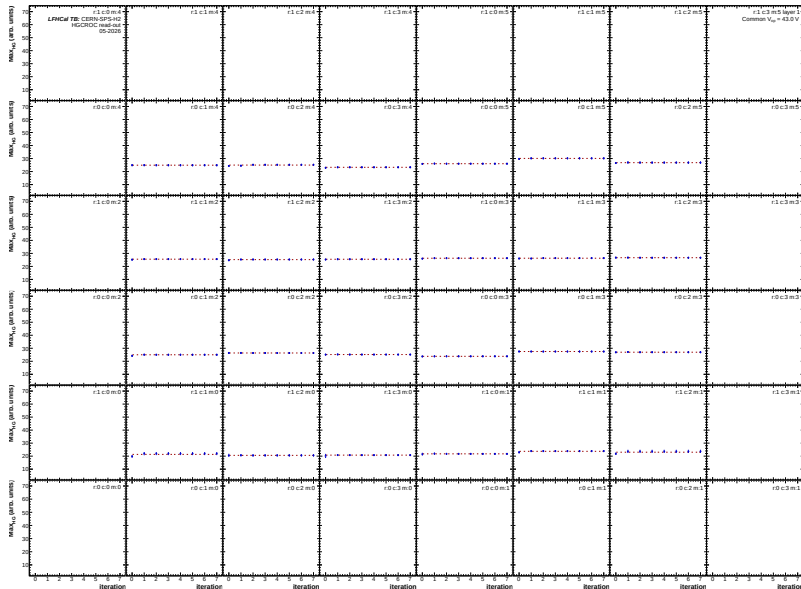


Muon calibration - 43V: Muons - 7th ite

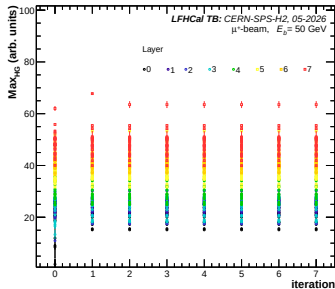
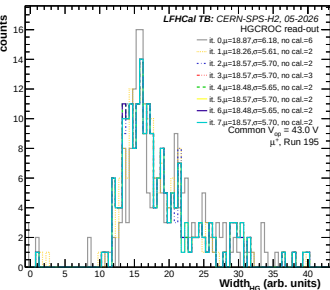
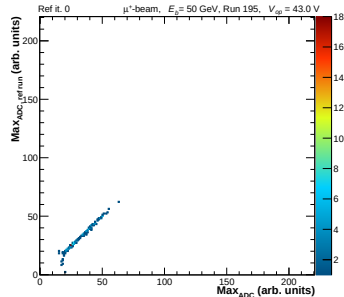
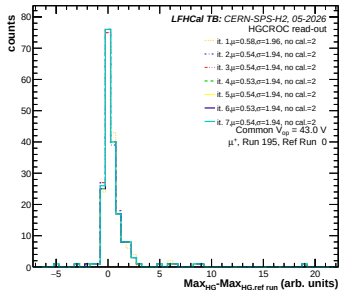
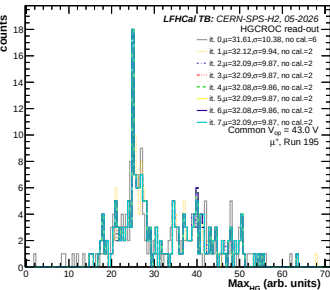


- Nearly all channels "fitable"
- Only outer edges problematic
- $\langle \text{Max}_{mip} \rangle = 32.1$

Muon calibration - 43V: Muons - Iterations



Muon calibration - 43V: Muons - Iterations



- Reduced mip selection range for trigger primitives
 $0.8 \langle \text{Max}_{\text{mip}} \rangle < \text{trigg}_{\text{prim}} < 2.5 \langle \text{Max}_{\text{mip}} \rangle$

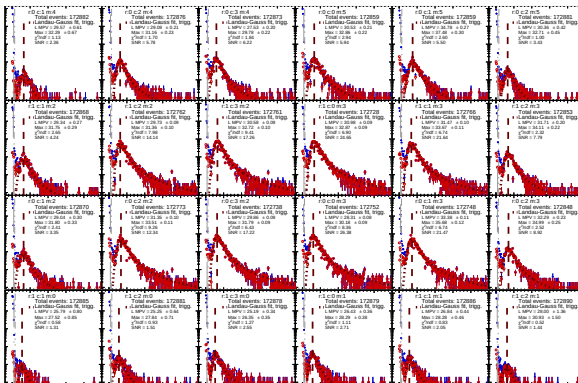
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations

Muon Calibration chain - 43.5 V - Run 196



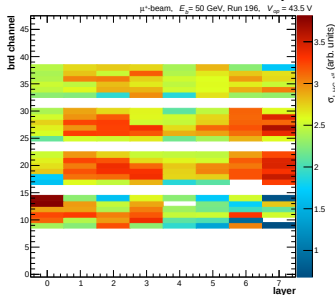
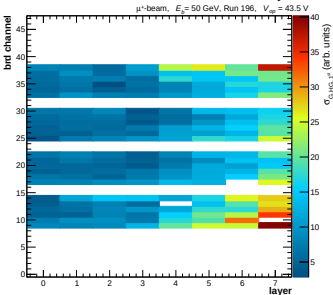
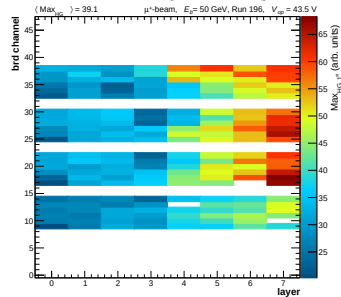
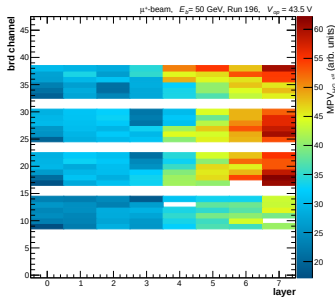
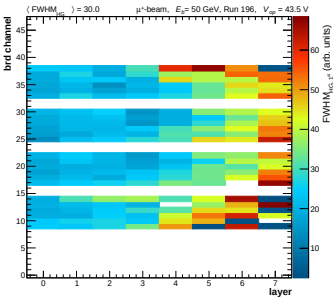
Muon calibration - 43.5V: Muons - init (blue)



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

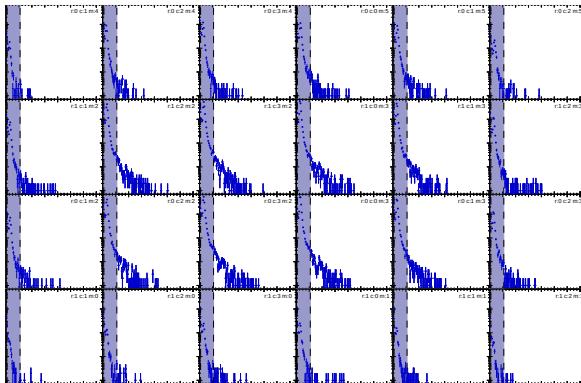
Muon calibration - 43.5V: Muons - init (blue)



- Very good separation of pedestal and mip peak, initial fit with excellent success rate for first layers, back layers less successful
- $\langle \text{Max}_{mip} \rangle = 39.1$

Muon calibration - 43.5V: Muons - Trigger

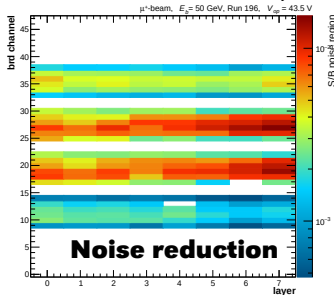
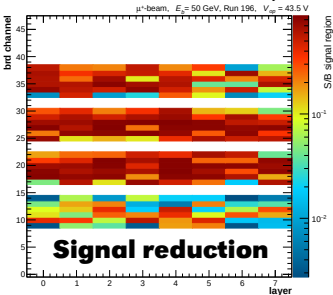
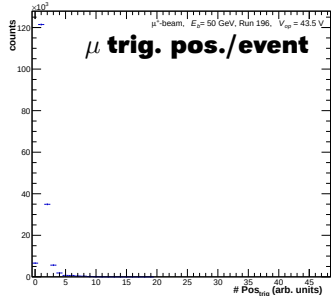
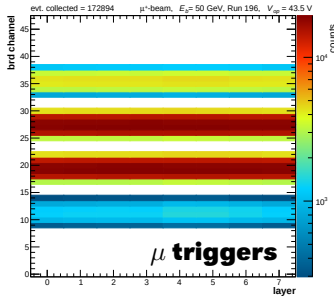
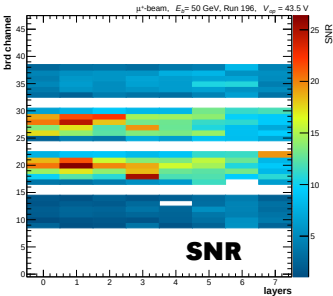
μ^+ -beam, $E_\mu = 50$ GeV
Run 195, $V_{dr} = 43.5$ V
Trigger primitives



Layer 1

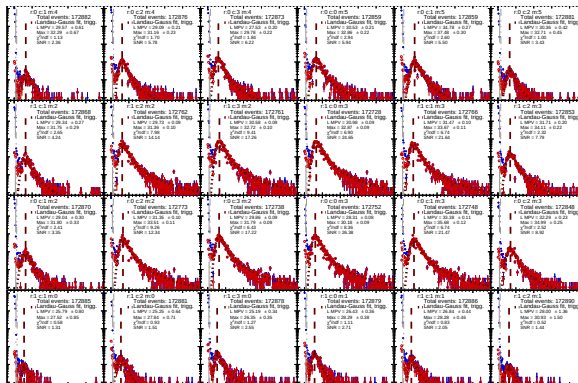
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 43.5V: 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)

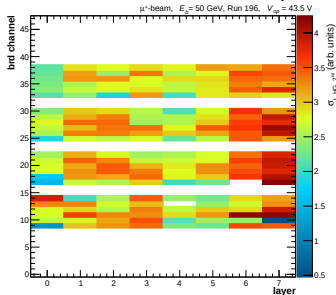
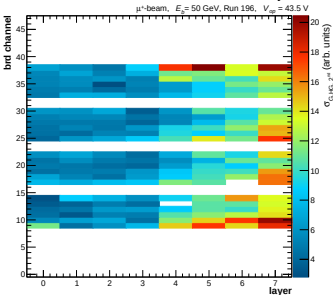
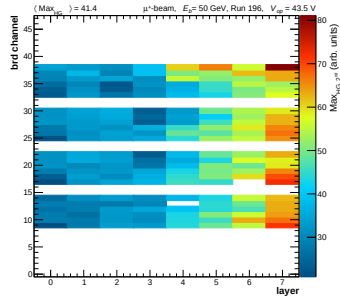
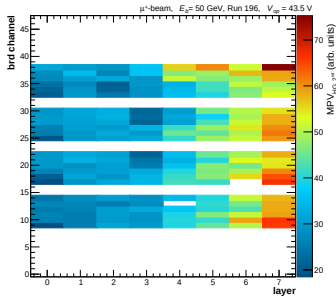
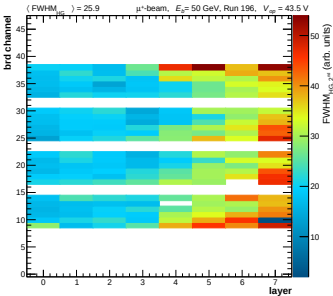
Muon calibration - 43.5V: Muons - 0th ite



Layer 1

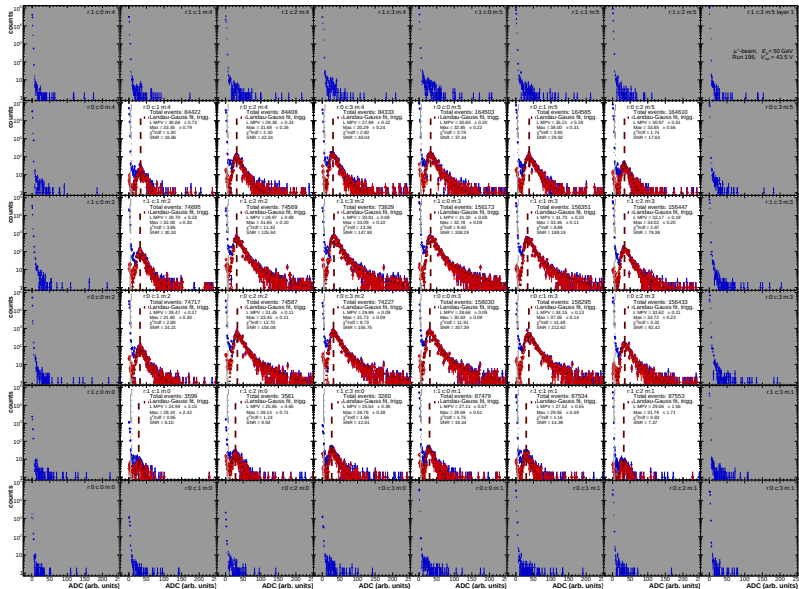
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 43.5V: Muons - 0th ite

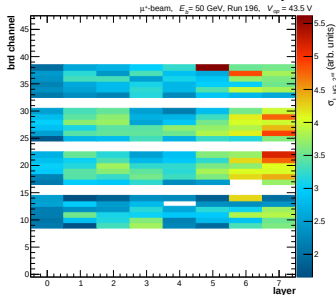
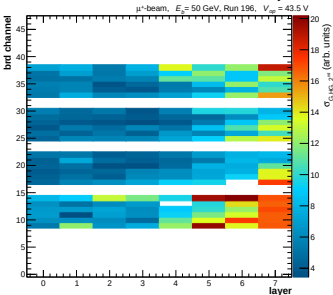
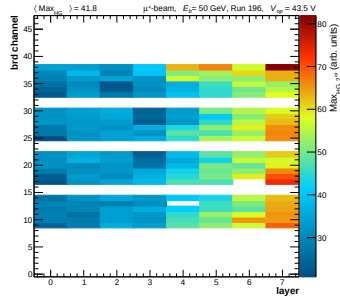
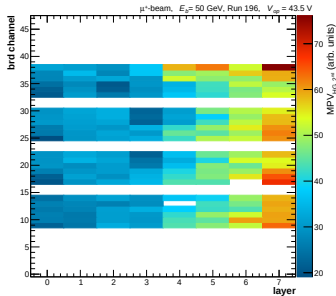
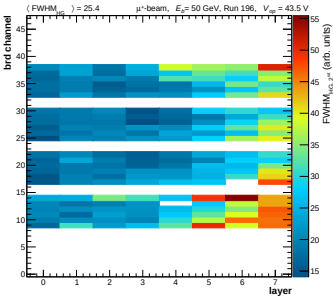


- Nearly all fits converge
- parameters vary significantly for low statistics cells & last 2 layers
- $\langle \text{Max}_{\text{mip}} \rangle = 41.4$

Muon calibration - 43.5V: Muons - 7th ite

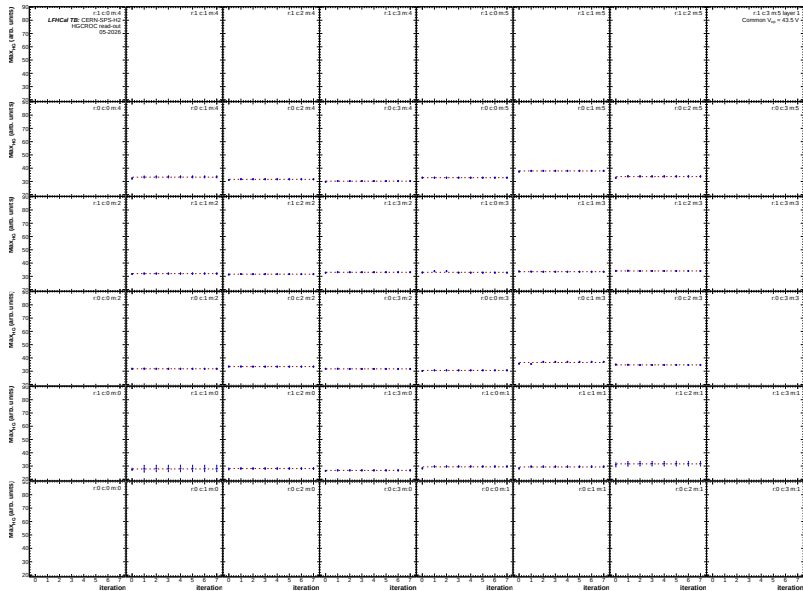


Muon calibration - 43.5V: Muons - 7th ite

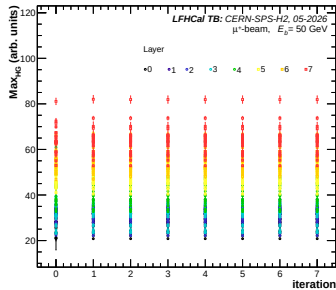
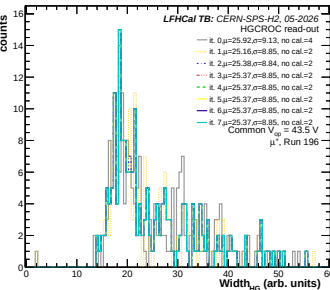
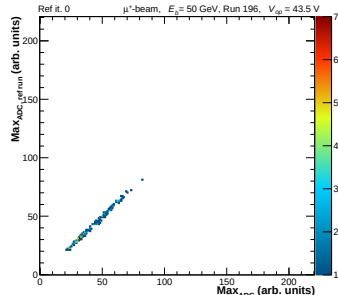
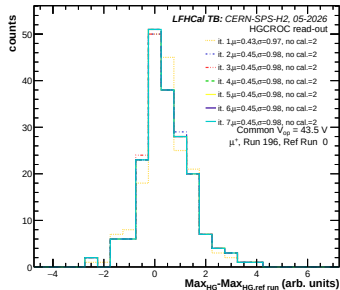
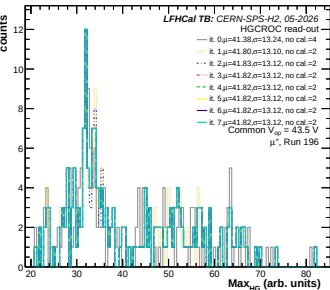


- Very good convergence of fits
- Suppressed pedestal peak in trigger spectrum & refinement of limits/starting parameters during improved fitting routine results in larger uniformity of parameters per layer
- $\langle \text{Max}_{\text{mip}} \rangle = 41.8$

Muon calibration - 43.5V: Muons - Iterations



Muon calibration - 43.5V: 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

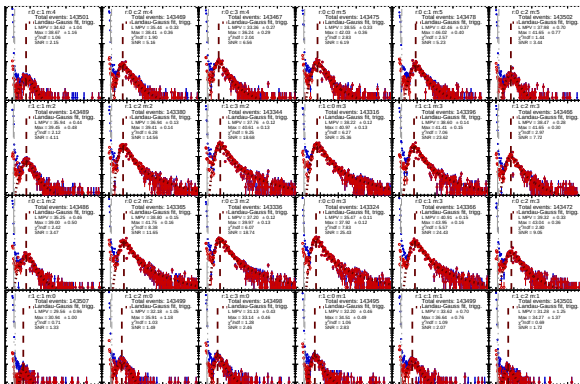
- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations

Muon Calibration chain - 44 V - Run 194



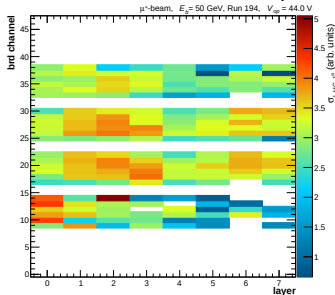
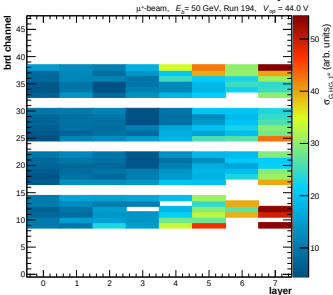
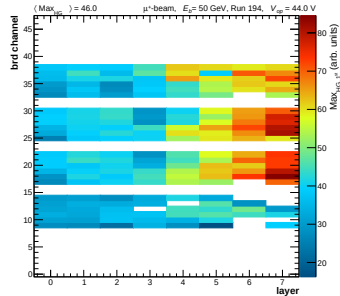
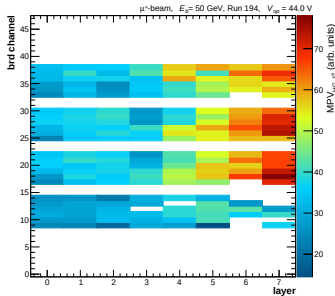
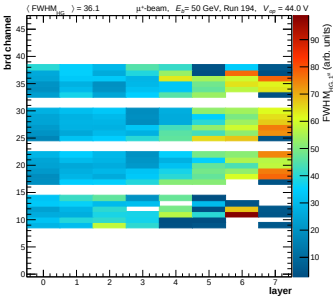
Muon calibration - 44V: Muons - init (blue)

Layer 1



Outer columns and rows masked due to too low statistics (plotting suboptimal).

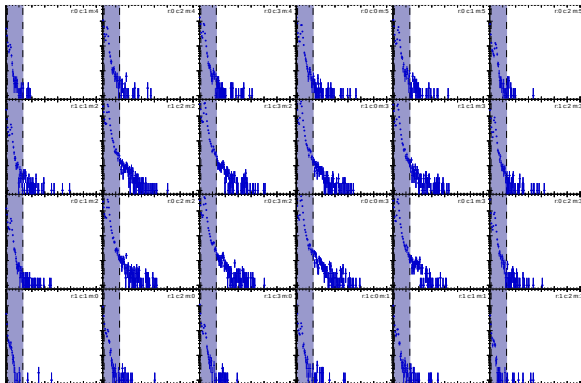
Muon calibration - 44V: Muons - init (blue)



- Most parameter start points optimized for 44V
→ very few failures
- Primarily failing for channels with low statistics
- $\langle Max_{mip} \rangle = 46.0$

Muon calibration - 44V: Muons - Trigger

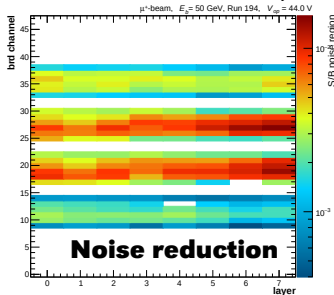
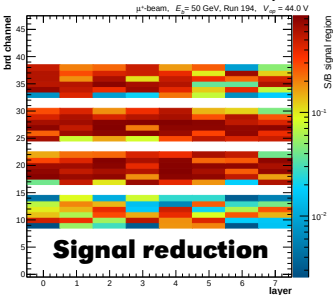
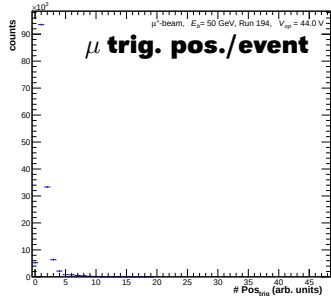
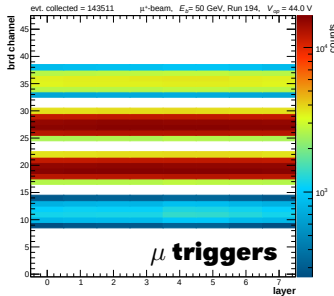
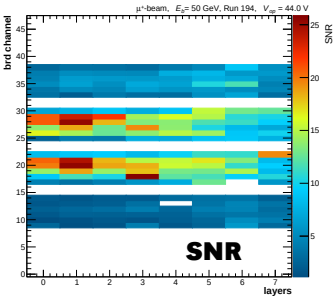
μ^+ -beam, $E_\mu = 50$ GeV
Run 194, $V_{44} = 44.0$ V
Trigger primitives



Layer 1

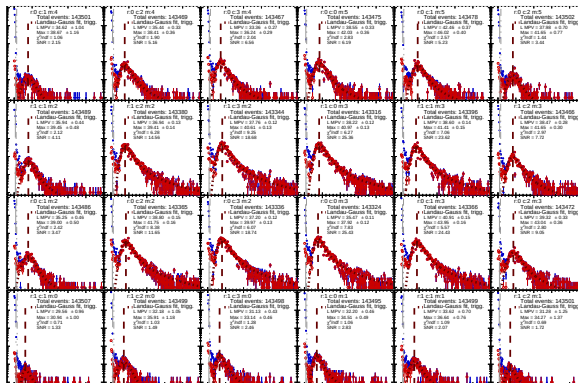
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 44V: 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)

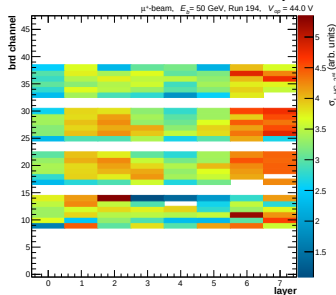
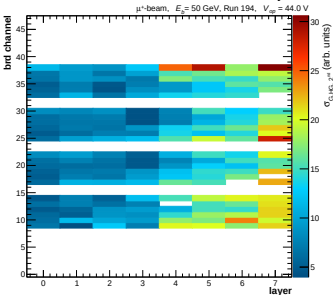
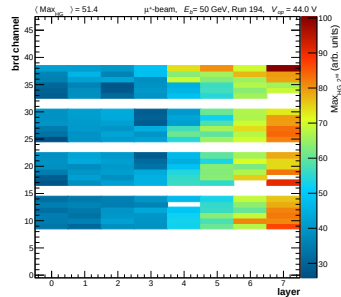
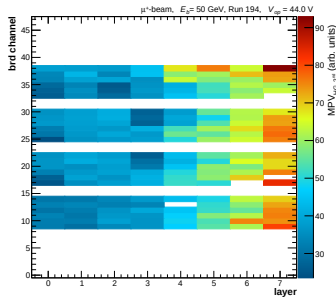
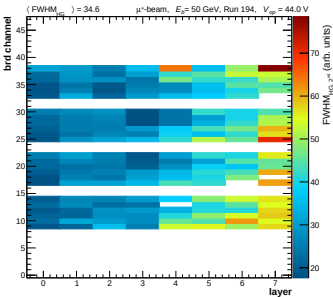
Muon calibration - 44V: Muons - 0th ite



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

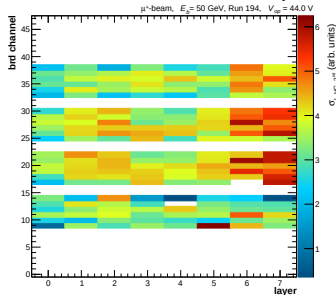
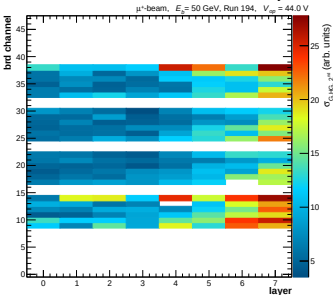
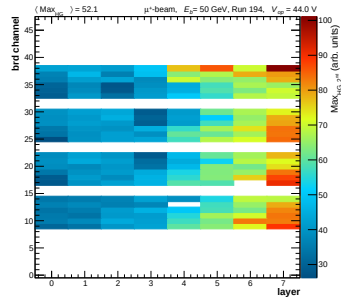
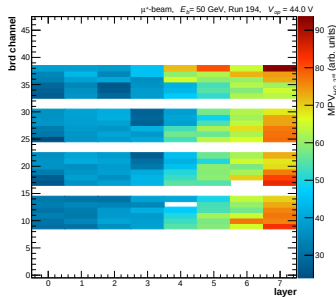
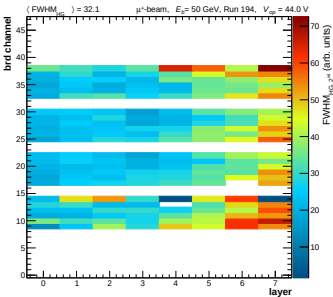
Muon calibration - 44V: Muons - 0th ite



- Nearly all channels able to fit in first trigger spectrum fit
- Good parameter uniformity per layer
- $\langle Max_{mip} \rangle = 51.4$

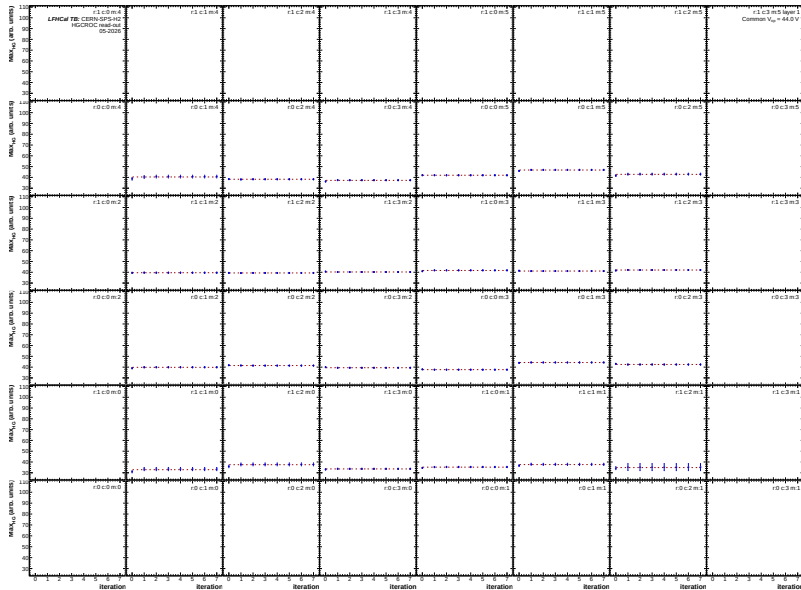


Muon calibration - 44V: Muons - 7th ite

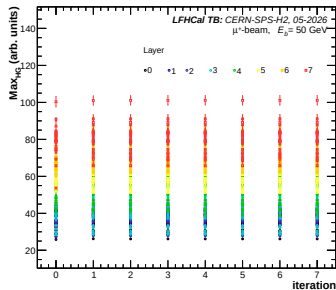
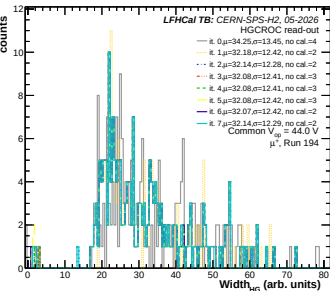
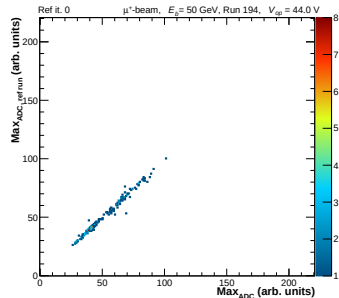
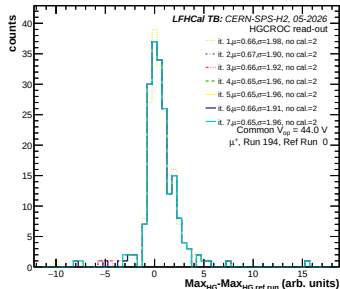
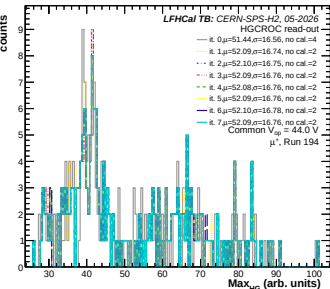


- Further improvements by suppressing pedestal peak during iterative fitting
- $\langle \text{Max}_{mip} \rangle = 52.1$

Muon calibration - 44V: Muons - Iterations



Muon calibration - 44V: Muons - Iterations



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

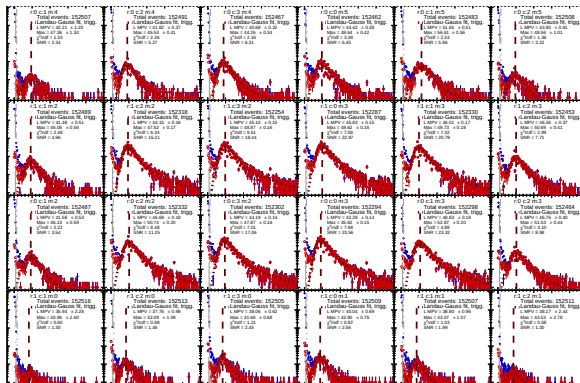
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations

Muon Calibration chain - 44.5 V - Run 197

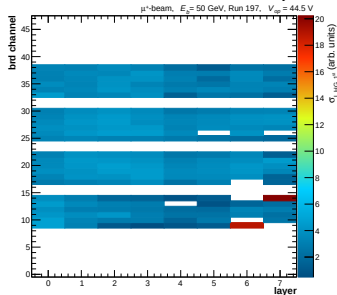
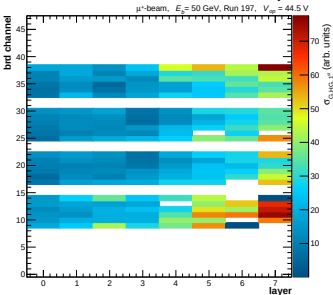
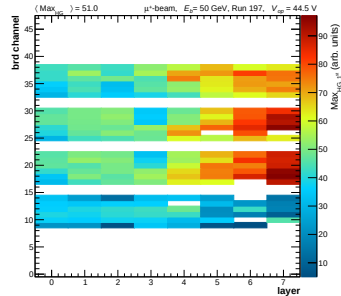
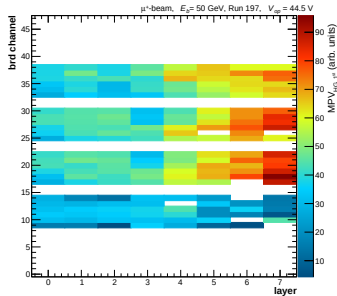
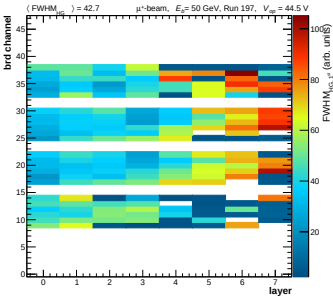


Muon calibration - 44.5V: Muons - init (blue)



Outer columns and rows masked due to too low statistics (plotting suboptimal).

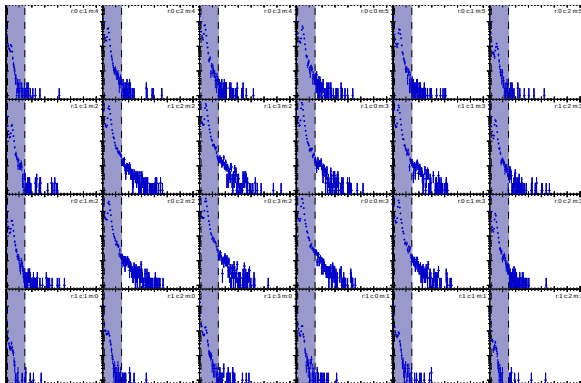
Muon calibration - 44.5V: Muons - init (blue)



- Good pedestal and mip peak separation $\rightarrow$ initial fits converge very well
- Fairly good parameter uniformity per layer
- FWHM for later layers at lower bound
- $\langle Max_{mip} \rangle = 51.0$

Muon calibration - 44.5V: Muons - Trigger

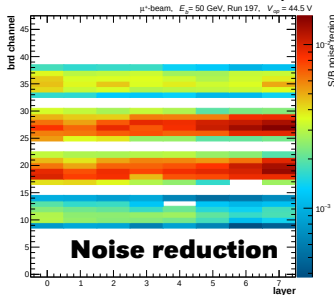
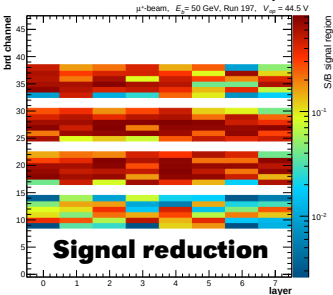
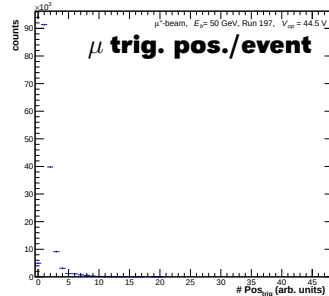
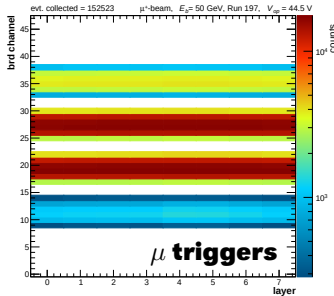
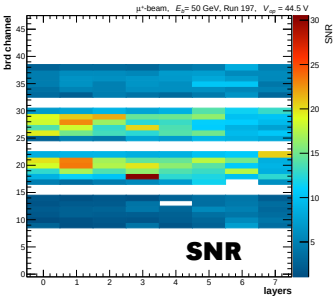
μ^+ -beam, $E_\mu = 50$ GeV
Run 197, $V_{dr} = 44.5$ V
Trigger primitives



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

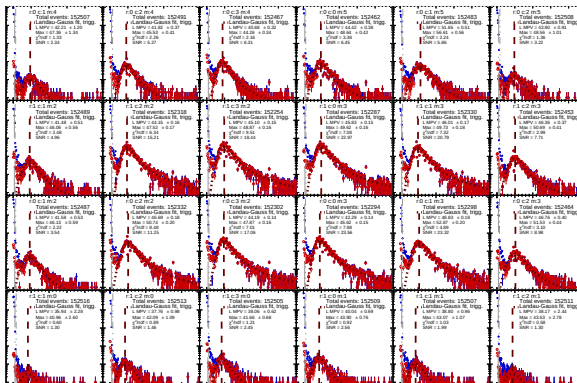
Muon calibration - 44.5V: Muons - Trigger



- 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)

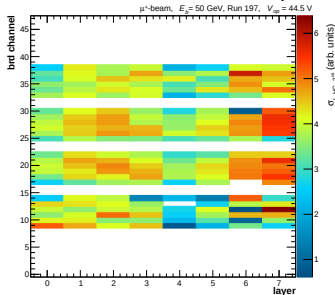
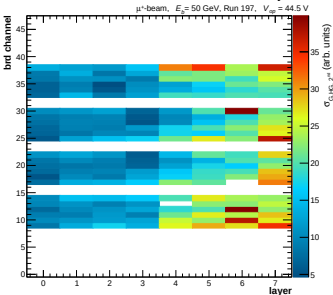
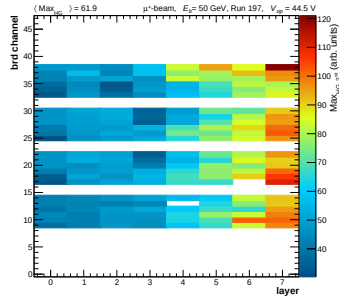
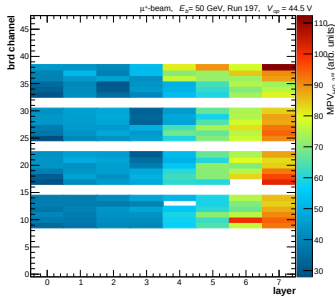
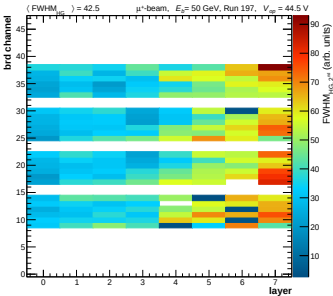
Muon calibration - 44.5V: Muons - 0th ite

Layer 1



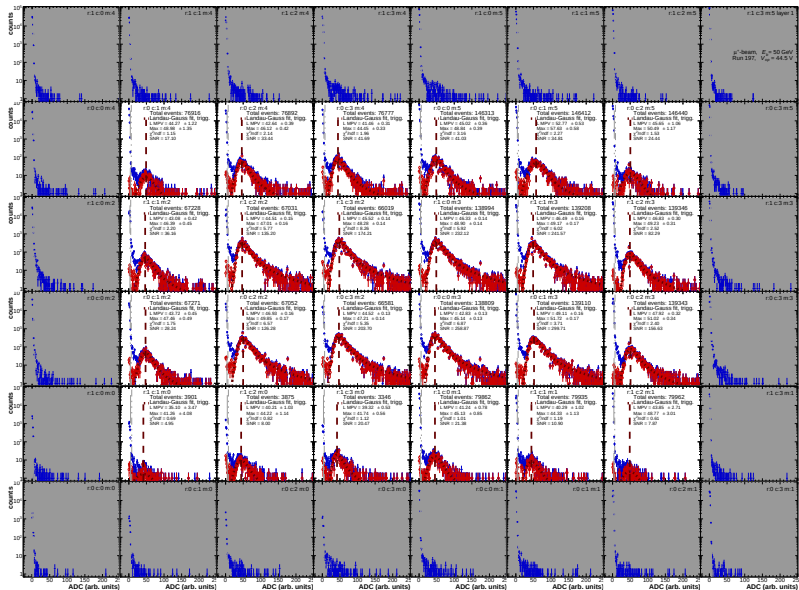
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 44.5V: Muons - 0th ite

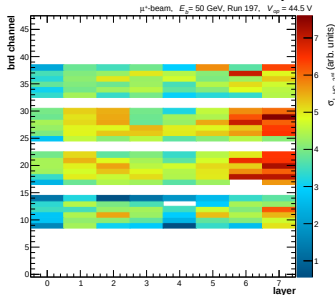
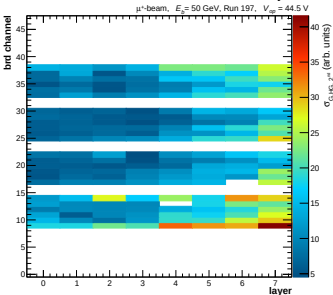
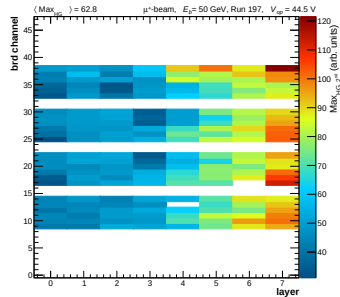
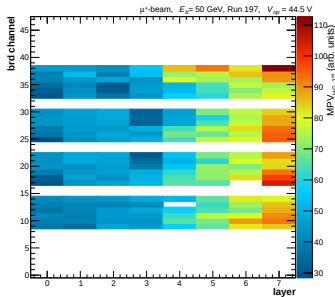
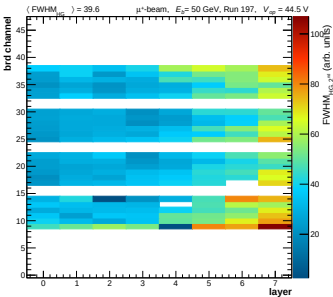


- Fits improved by reduction of pedestal peak
- FWHM more uniform, very few very low values, remaining parameters very uniform per layer
- $\langle Max_{mip} \rangle = 61.9$

Muon calibration - 44.5V: Muons - 7th ite

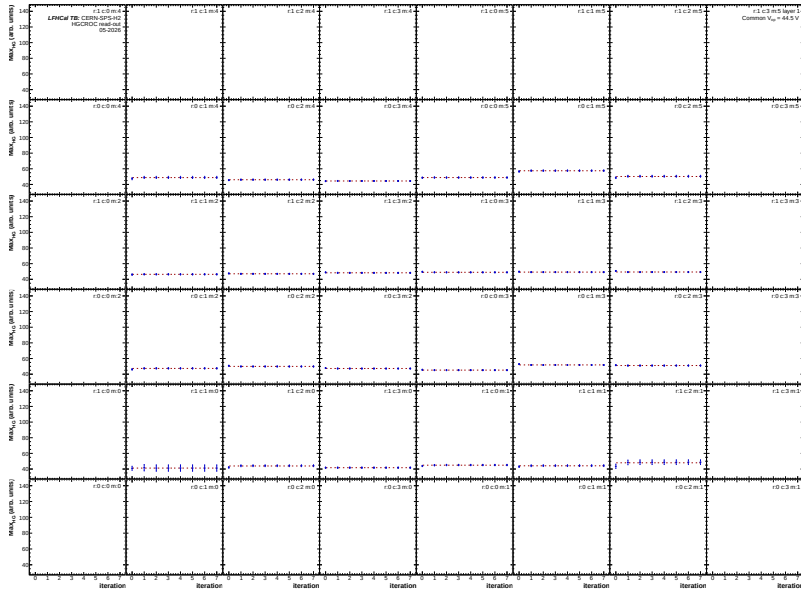


Muon calibration - 44.5V: Muons - 7th ite

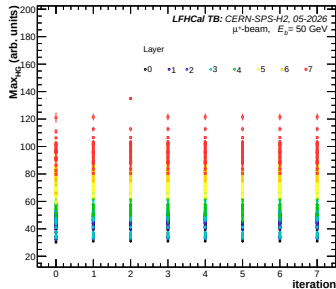
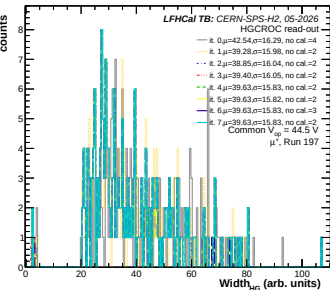
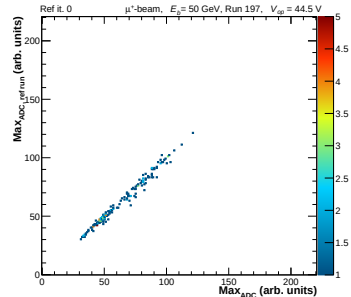
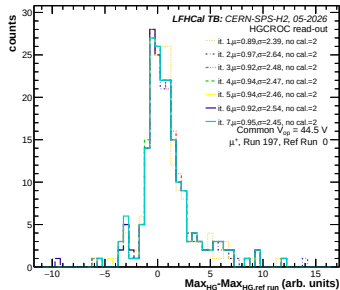
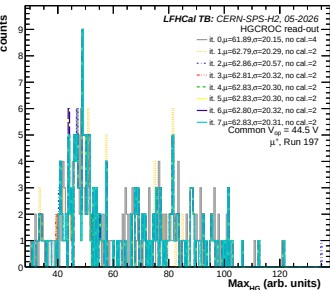


- Nearly all channels 'fitable'
- Remaining width instabilities cured
- $\langle \text{Max}_{mip} \rangle = 62.8$

Muon calibration - 44.5V: Muons - Iterations



Muon calibration - 44.5V: Muons - Iterations



- Reduced mip selection range for trigger primitives

$$0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$$

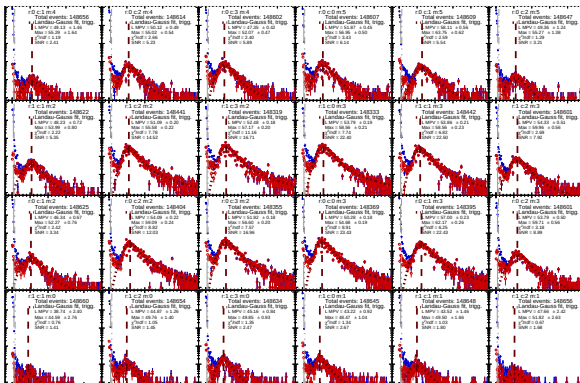
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations

Muon Calibration chain - 45 V - Run 198



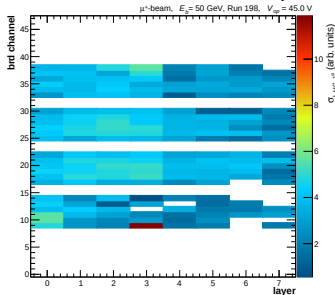
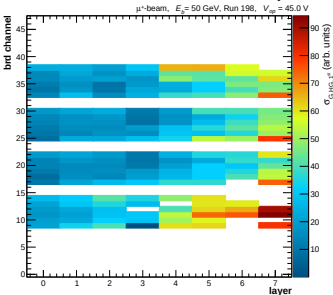
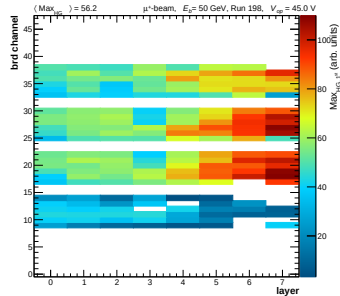
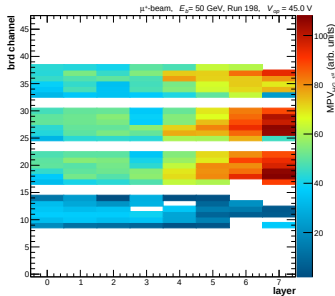
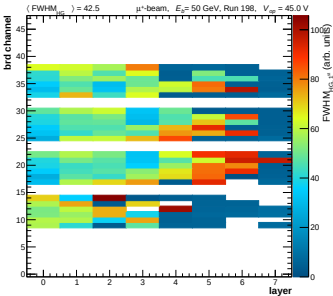
Muon calibration - 45V: Muons - init (blue)



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

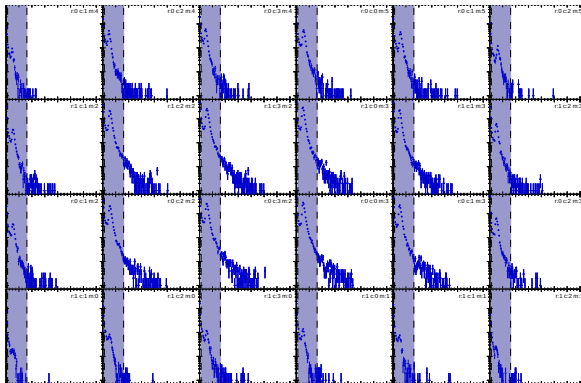
Muon calibration - 45V: Muons - init (blue)



- Initial fit hits upper limits for width parameters above layer 4 very often ⇒ average mip too low in initial iteration
- Start values & parameter limits in first step optimized for $43 \text{ V} < V_{op} < 44.5 \text{ V}$
- $\langle \text{Max}_{mip} \rangle = 56.2$

Muon calibration - 45V: Muons - Trigger

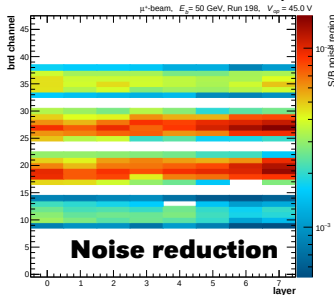
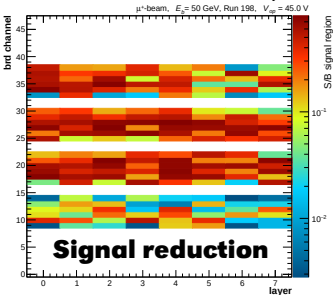
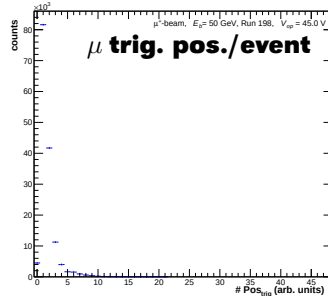
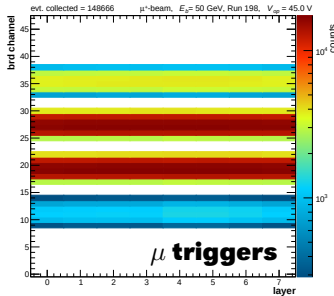
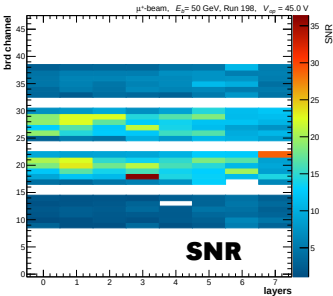
μ^+ -beam, $E_\mu = 50$ GeV
Run 195, $V_{dr} = 45.0$ V
Trigger primitives



Layer 1

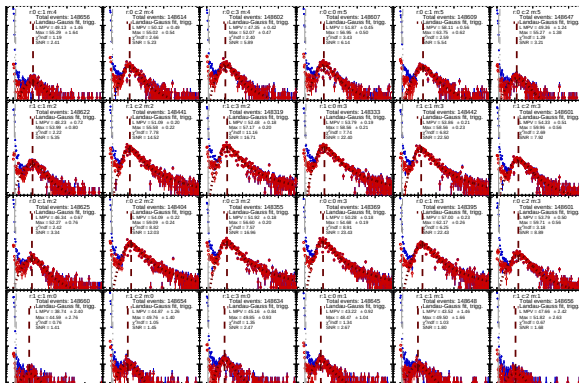
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 45V: 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)

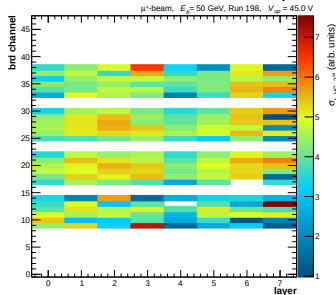
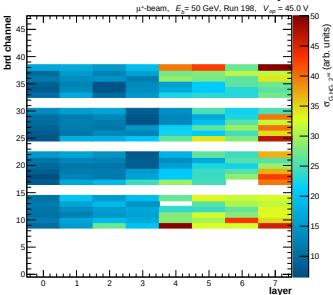
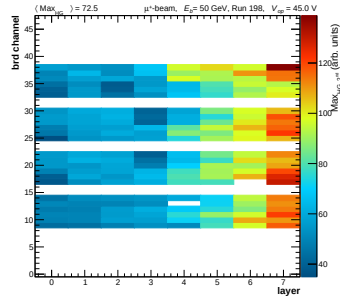
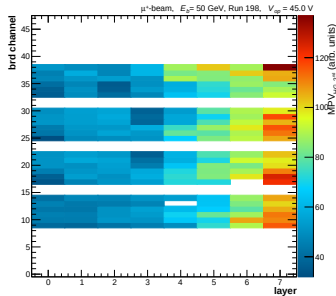
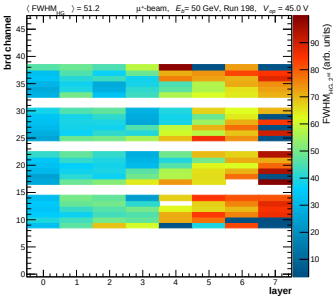
Muon calibration - 45V: Muons - 0th ite



Layer 1

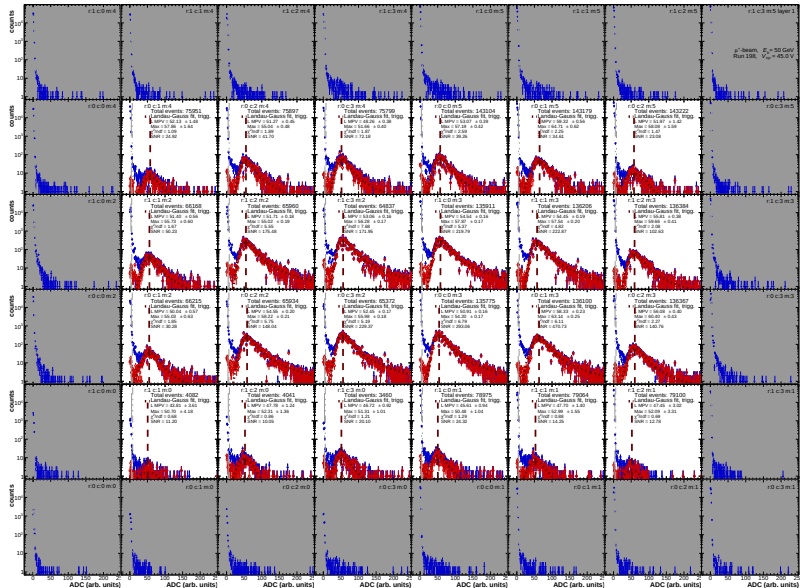
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 45V: Muons - 0th ite

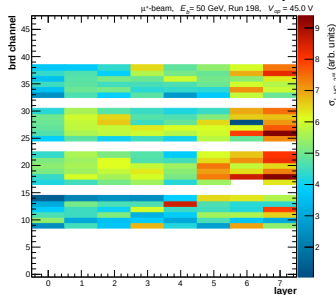
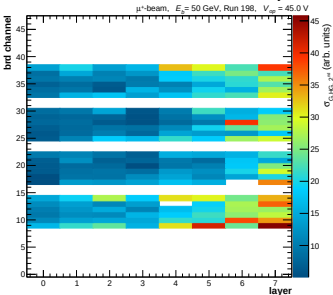
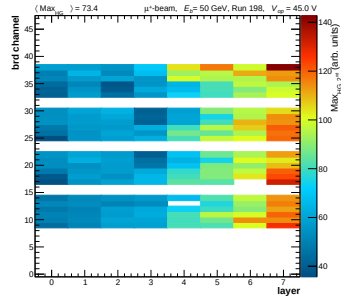
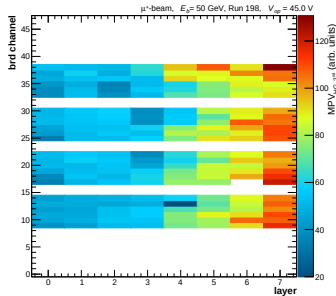
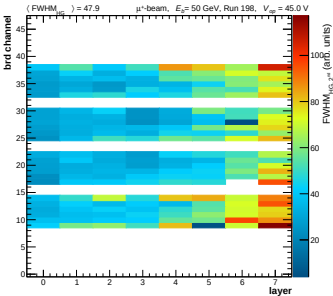


- Later layers fit much better due to adaptation of parameters based on initial fit results
- Much fewer limits reached, parameters more uniform within same layer
- $\langle \text{Max}_{mip} \rangle = 72.5$

Muon calibration - 45V: Muons - 7th ite

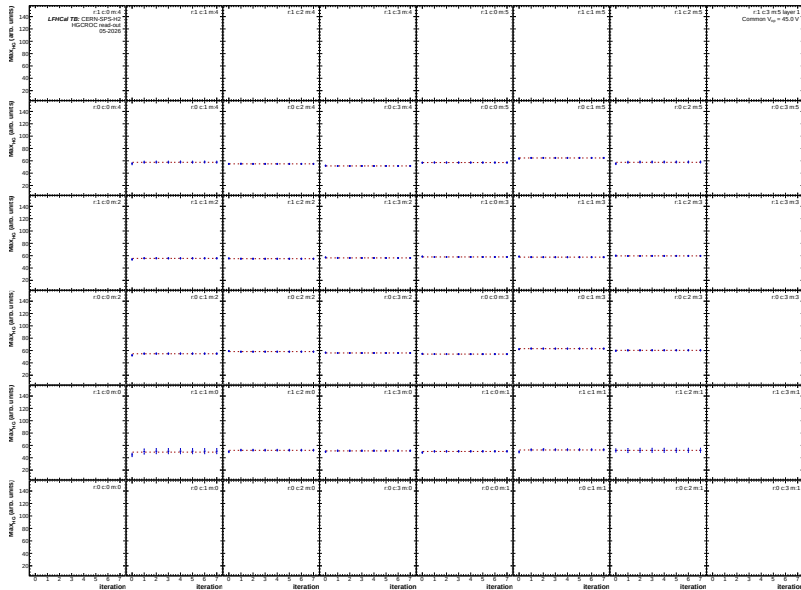


Muon calibration - 45V: Muons - 7th ite

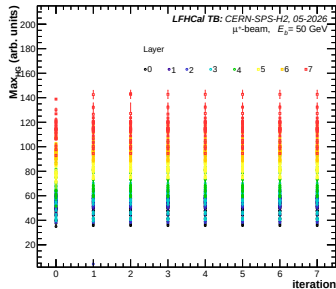
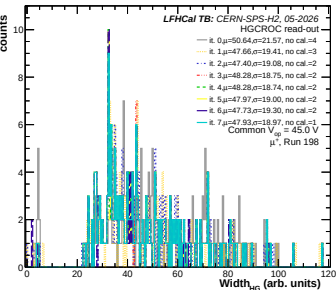
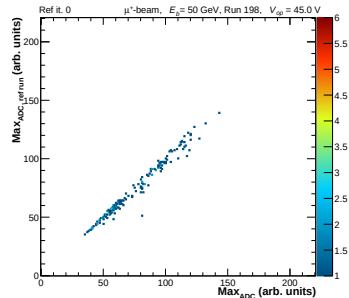
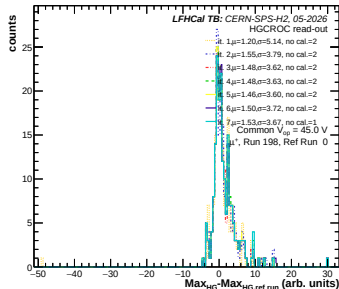
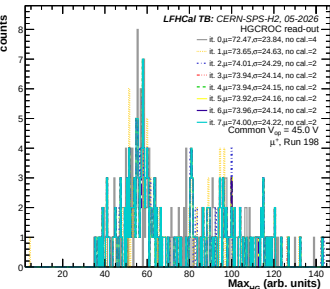


- Nearly all channels "fitable"
- Only channels with very low statistics slightly instable
- $\langle \text{Max}_{mip} \rangle = 73.4$

Muon calibration - 45V: Muons - Iterations



Muon calibration - 45V: Muons - Iterations



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

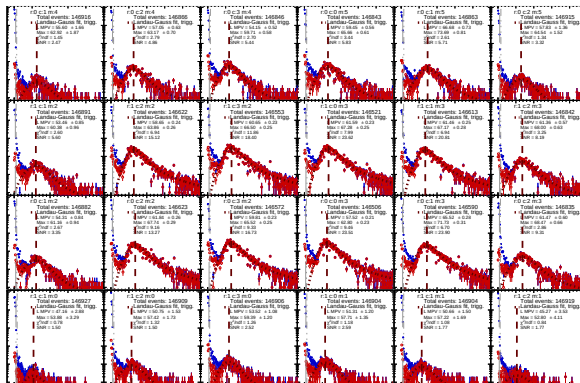
⇒ Further reduction of noise peak

- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations

Muon Calibration chain - 45.5 V - Run 199



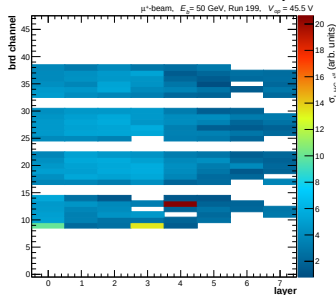
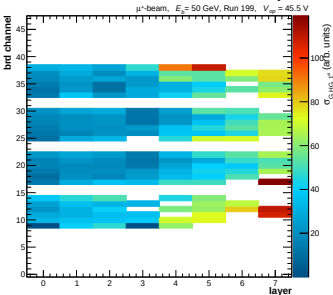
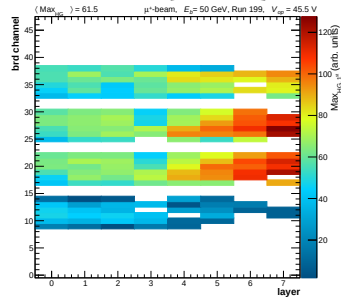
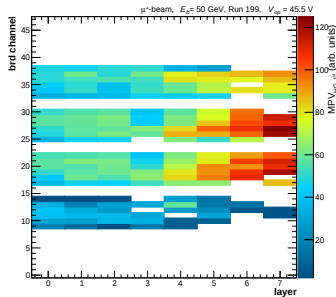
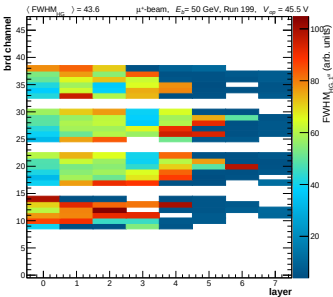
Muon calibration - 45.5V: Muons - init (blue)



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

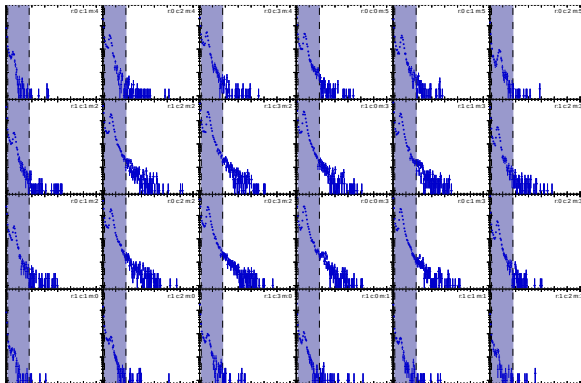
Muon calibration - 45.5V: Muons - init (blue)



- Initial fit parameter starting points optimized for lower V_{op} reaching limits on higher end for width for later layers
- Too low mean Max_{mip} as later layers not well represented in average
- $\langle Max_{mip} \rangle = 61.5$

Muon calibration - 45.5V: Muons - Trigger

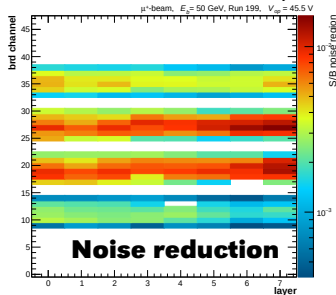
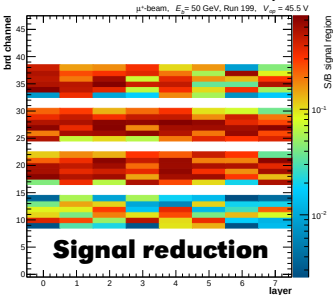
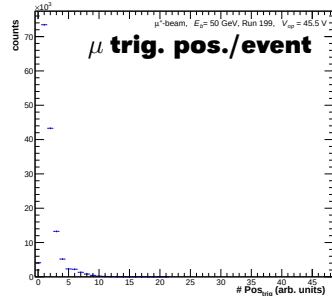
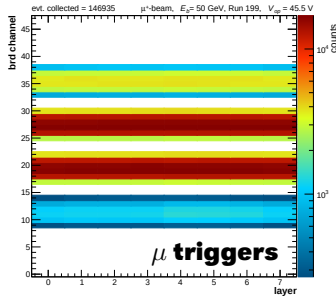
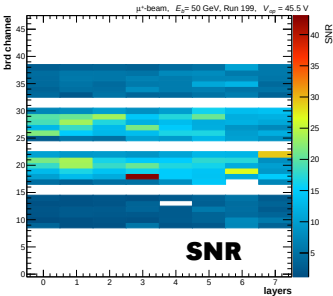
μ^+ -beam, $E_\mu = 50$ GeV
Run 199, $V_{dr} = 45.5$ V
Trigger primitives



Layer 1

Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 45.5V: Muons - Trigger

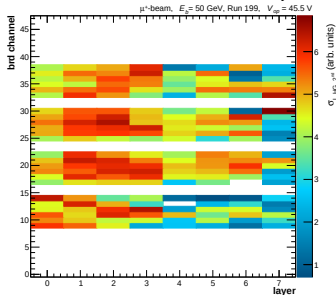
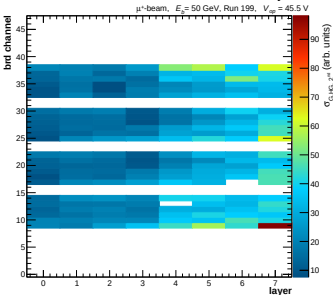
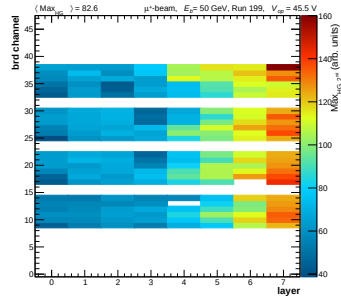
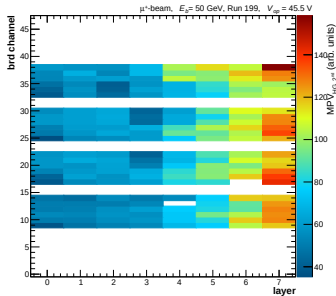
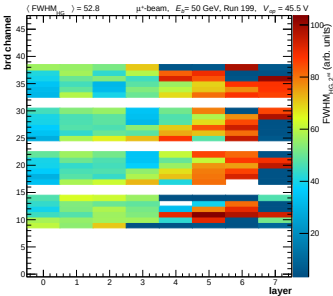


- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle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

T1 0.23 ms Total events: 140910 • Jovian-Gaia H₂ wings MAPV = 56.60 ± 1.98 MAP = 140.50 ± 0.81 Conf = 1.05 MAP = 1.27	T2 0.23 ms Total events: 140906 • Jovian-Gaia H₂ wings MAPV = 57.70 ± 0.93 MAP = 140.57 ± 0.70 Conf = 1.79 MAP = 0.96	T3 0.23 ms Total events: 140940 • Jovian-Gaia H₂ wings MAPV = 56.25 ± 0.52 MAP = 139.71 ± 0.52 Conf = 1.70 MAP = 0.84	T4 0.23 ms Total events: 140943 • Jovian-Gaia H₂ wings MAPV = 56.86 ± 0.68 MAP = 139.46 ± 0.81 Conf = 1.55 MAP = 0.83	T5 0.23 ms Total events: 140963 • Jovian-Gaia H₂ wings MAPV = 56.88 ± 0.73 MAP = 139.79 ± 0.81 Conf = 1.81 MAP = 0.71	T6 0.23 ms Total events: 140925 • Jovian-Gaia H₂ wings MAPV = 57.82 ± 1.26 MAP = 140.54 ± 1.32 Conf = 1.92 MAP = 0.92
T7 0.23 ms Total events: 140921 • Jovian-Gaia H₂ wings MAPV = 56.68 ± 0.56 MAP = 140.38 ± 0.59 Conf = 1.60 MAP = 0.90	T8 0.23 ms Total events: 140622 • Jovian-Gaia H₂ wings MAPV = 56.60 ± 0.21 MAP = 140.59 ± 0.26 Conf = 0.94 MAP = 0.22	T9 0.23 ms Total events: 140553 • Jovian-Gaia H₂ wings MAPV = 56.88 ± 0.23 MAP = 140.50 ± 0.23 Conf = 1.86 MAP = 0.40	T10 0.23 ms Total events: 140521 • Jovian-Gaia H₂ wings MAPV = 56.58 ± 0.23 MAP = 140.28 ± 0.23 Conf = 1.89 MAP = 0.40	T11 0.23 ms Total events: 140613 • Jovian-Gaia H₂ wings MAPV = 56.48 ± 0.25 MAP = 140.27 ± 0.29 Conf = 0.84 MAP = 0.20	T12 0.23 ms Total events: 140642 • Jovian-Gaia H₂ wings MAPV = 56.38 ± 0.37 MAP = 140.50 ± 0.52 Conf = 1.26 MAP = 0.37
T13 0.23 ms Total events: 140982 • Jovian-Gaia H₂ wings MAPV = 56.31 ± 0.64 MAP = 140.58 ± 0.69 Conf = 2.67 MAP = 1.30	T14 0.23 ms Total events: 140623 • Jovian-Gaia H₂ wings MAPV = 56.80 ± 0.26 MAP = 140.71 ± 0.26 Conf = 1.16 MAP = 0.27	T15 0.23 ms Total events: 140572 • Jovian-Gaia H₂ wings MAPV = 56.81 ± 0.23 MAP = 140.51 ± 0.23 Conf = 1.83 MAP = 0.78	T16 0.23 ms Total events: 140506 • Jovian-Gaia H₂ wings MAPV = 56.57 ± 0.21 MAP = 140.40 ± 0.21 Conf = 0.86 MAP = 0.20	T17 0.23 ms Total events: 140590 • Jovian-Gaia H₂ wings MAPV = 56.71 ± 0.23 MAP = 140.47 ± 0.23 Conf = 1.70 MAP = 0.90	T18 0.23 ms Total events: 140635 • Jovian-Gaia H₂ wings MAPV = 56.47 ± 0.80 MAP = 140.57 ± 0.80 Conf = 1.76 MAP = 0.86
T19 0.23 ms Total events: 140927 • Jovian-Gaia H₂ wings MAPV = 57.28 ± 0.98 MAP = 140.89 ± 0.98 Conf = 0.76 MAP = 0.90	T20 0.23 ms Total events: 140920 • Jovian-Gaia H₂ wings MAPV = 56.70 ± 0.50 MAP = 140.67 ± 0.50 Conf = 1.32 MAP = 0.50	T21 0.23 ms Total events: 140906 • Jovian-Gaia H₂ wings MAPV = 56.62 ± 0.58 MAP = 1			

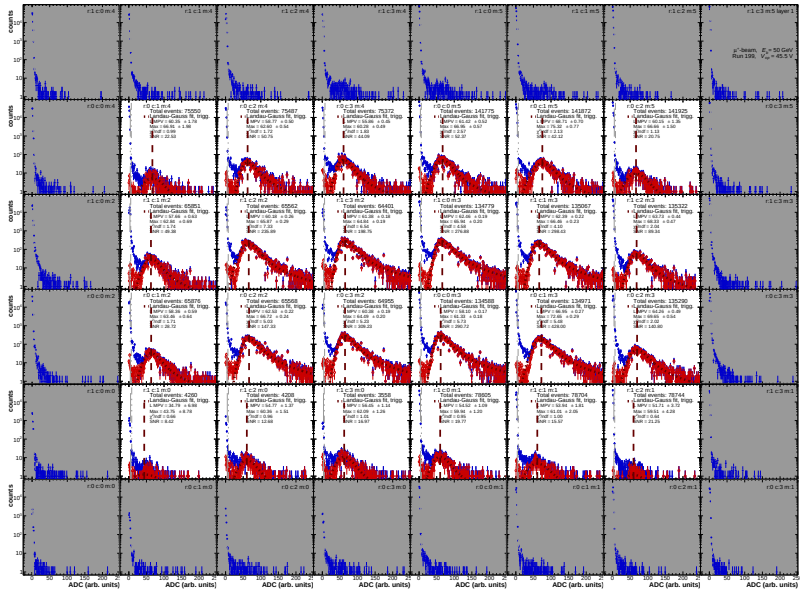
F. Bock

Muon calibration - 45.5V: Muons - 0th ite

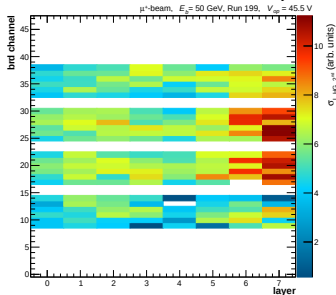
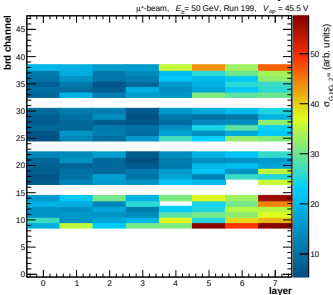
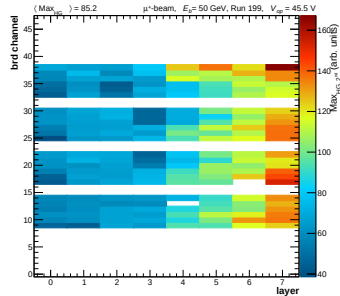
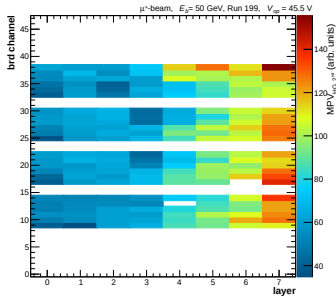
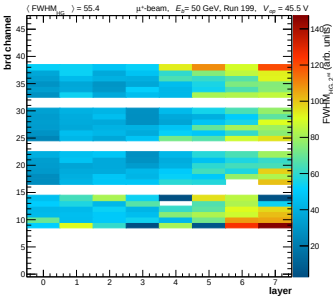


- Large fraction of channels succeeds in fitting routine, but results at lower or upper bound
- In particular width affected by fitting limits
- $\langle \text{Max}_{mip} \rangle = 82.6$

Muon calibration - 45.5V: Muons - 7th ite

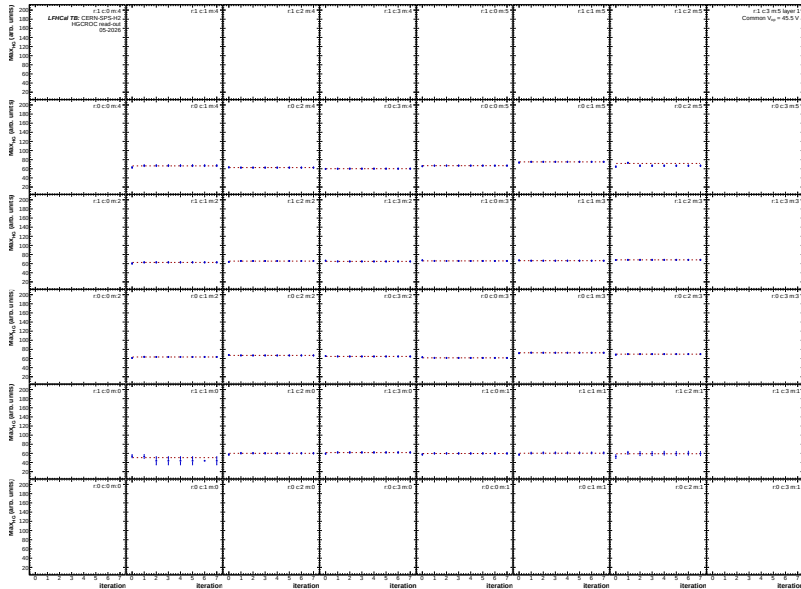


Muon calibration - 45.5V: Muons - 7th ite

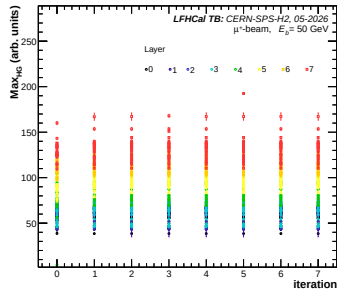
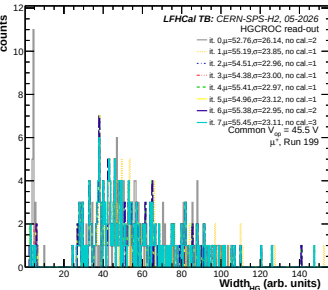
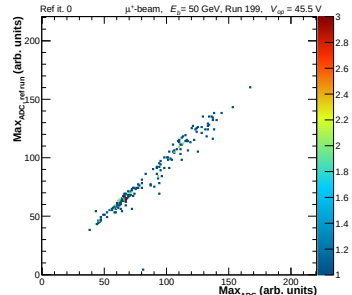
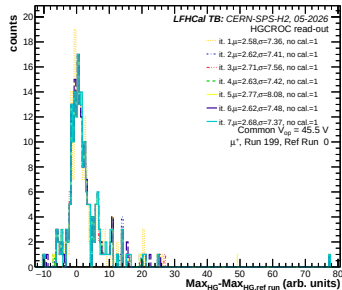
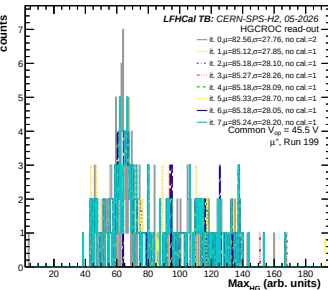


- Introduced V_{ov} dependent start parameters and limits for some of the Landau Gauss fits in improved routine
- Helps significantly to catch higher V_{op} mip peaks particularly in later layers (wider peak/ higher Max_{mip})
- $\langle Max_{mip} \rangle = 85.2$

Muon calibration - 45.5V: Muons - Iterations



Muon calibration - 45.5V: Muons - Iterations

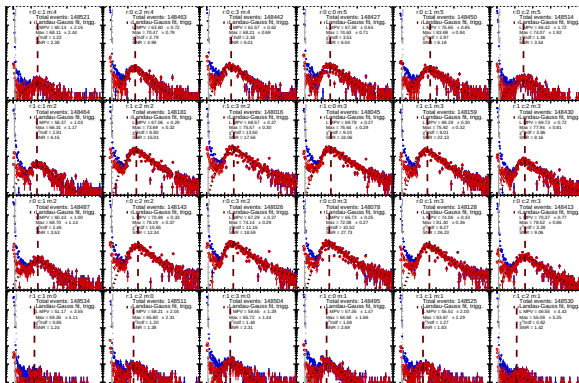


- Reduced mip selection range for trigger primitives
 $0.8 \langle Max_{mip} \rangle < trigg_{prim} < 2.5 \langle Max_{mip} \rangle$
- Further reduction of noise peak
- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Convergence of most cells within 2-3 iterations
 some cells with lower statistics still fluctuating even in 5th iteration

Muon Calibration chain - 46 V - Run 200

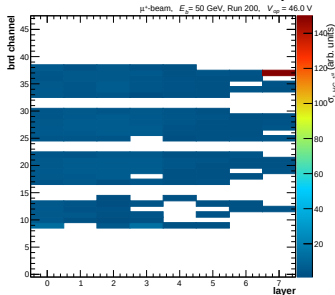
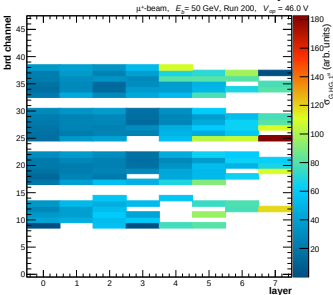
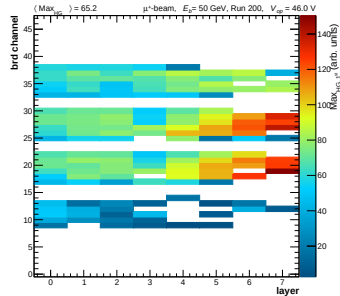
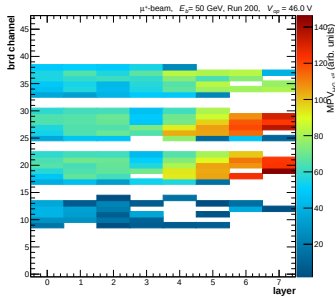
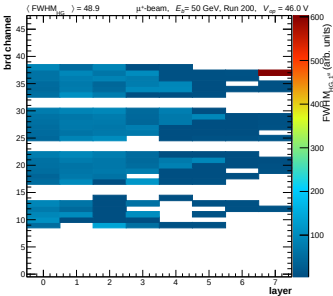


Muon calibration - 46V: Muons - init (blue)



Outer columns and rows masked due to too low statistics (plotting suboptimal).

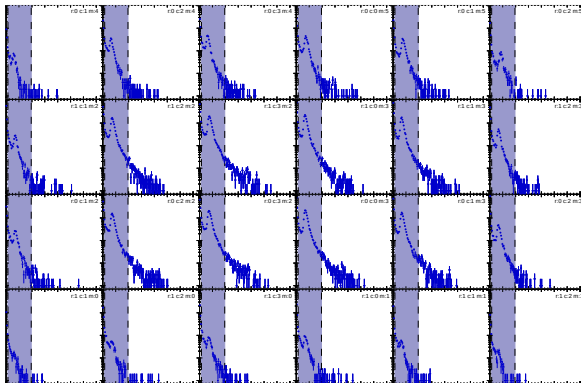
Muon calibration - 46V: Muons - init (blue)



- Initial fit for 46 V really not optimized, large fraction of fits fails for segments beyond layer 4
- Mean significant too low after initial fit, driven by first few layers
- Justifies rather wide window on higher end for trigger primitive selection
- $\langle Max_{mip} \rangle = 65.2$

Muon calibration - 46V: Muons - Trigger

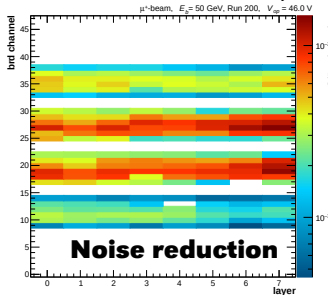
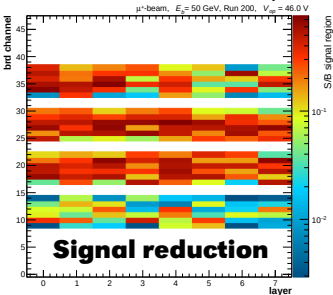
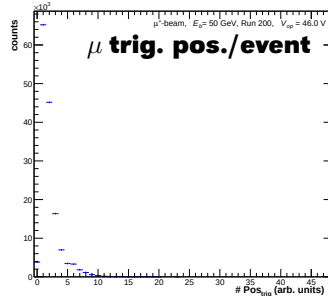
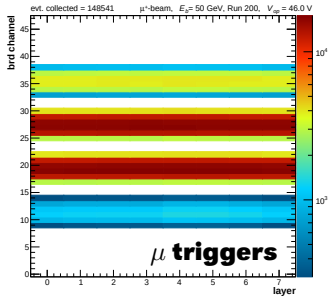
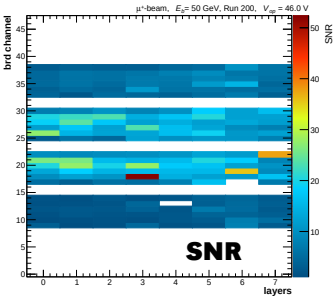
μ^+ -beam, $E_\mu = 50$ GeV
Run 200, $V_{\text{HV}} = 46.0$ V
Trigger primitives



Layer 1

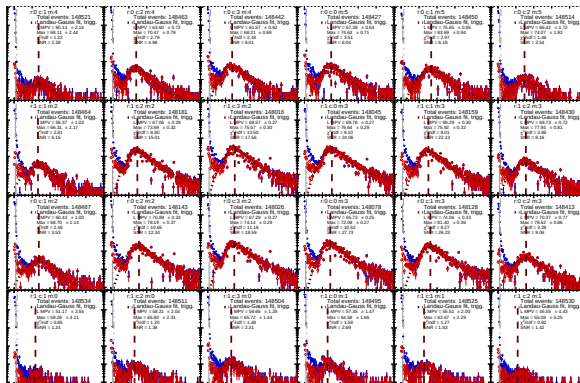
Outer columns and rows masked due to too low statistics (plotting suboptimal).

Muon calibration - 46V: Muons - Trigger



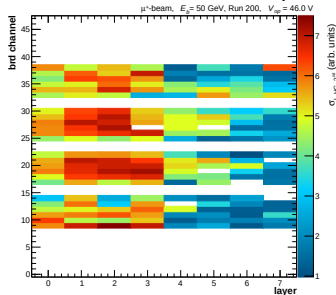
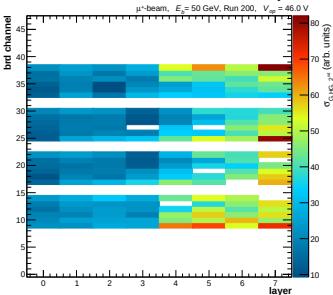
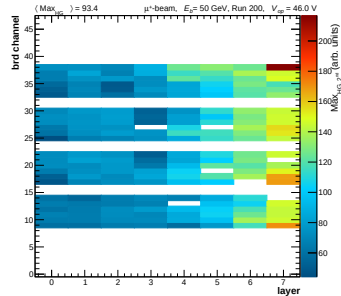
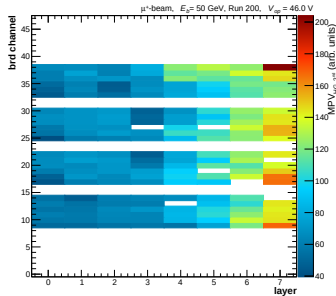
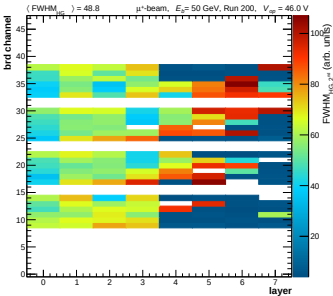
- Trigger evaluation for fixed column and row (all z-segments) if average signal summed over all active cells in $z > 3\sigma_{ped}$
- ⇒ Noise suppression could be improved by increasing $n\sigma_{ped}$
- Clear enhancement in trigger primitives, 0th level muon selection within $0.3\langle Max_{mip} \rangle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

Muon calibration - 46V: Muons - 0th ite



Outer columns and rows masked due to too low statistics (plotting suboptimal).

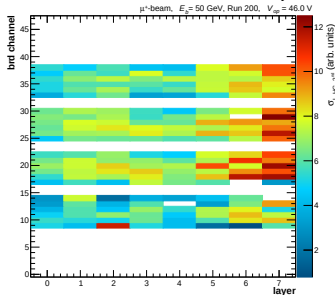
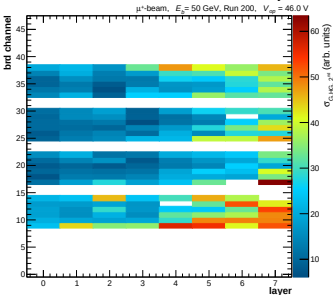
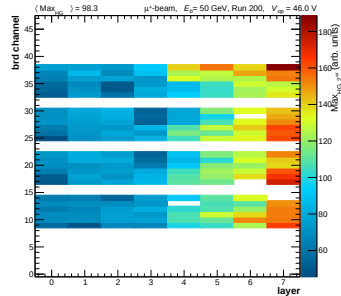
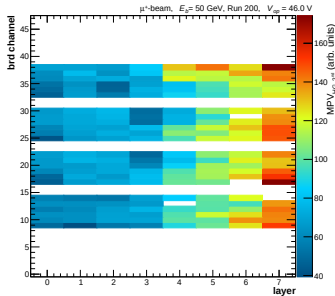
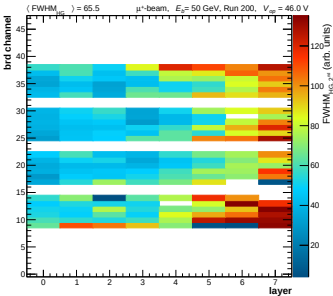
Muon calibration - 46V: Muons - 0th ite



- Most fits recover already in first triggered fit, some limits reached due to suboptimal mean in previous iteration
- Much more stable parameters per layer
- Large increase in mean Max_{mip} with respect to initial results
- $\langle Max_{mip} \rangle = 93.4$

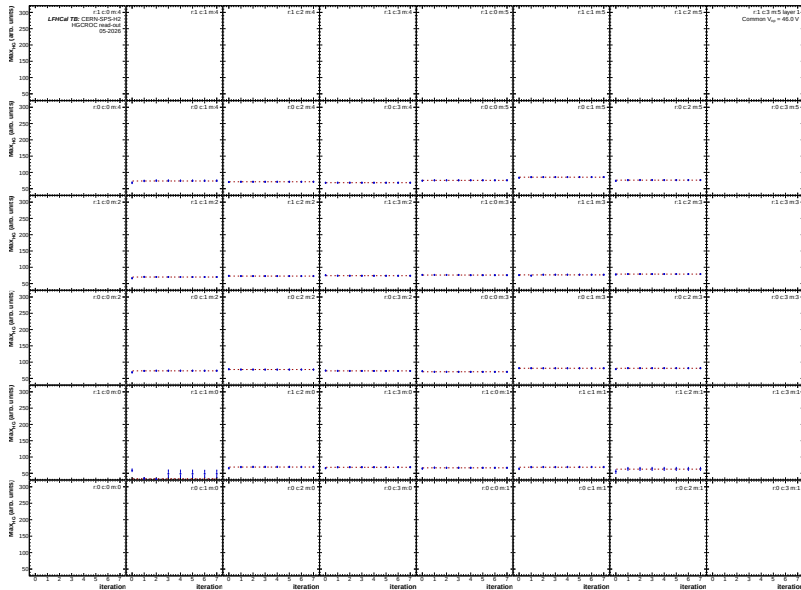


Muon calibration - 46V: Muons - 7th ite

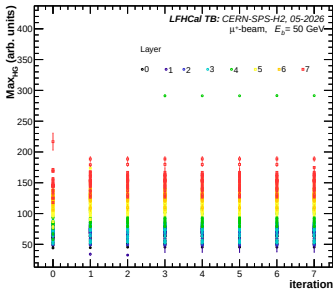
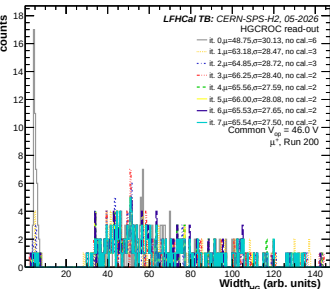
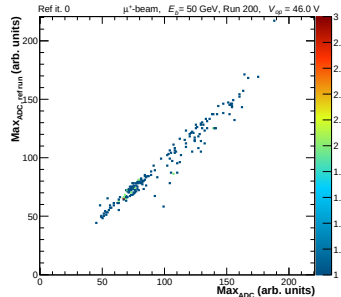
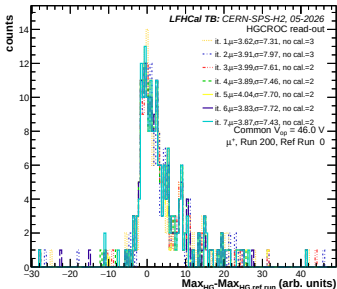
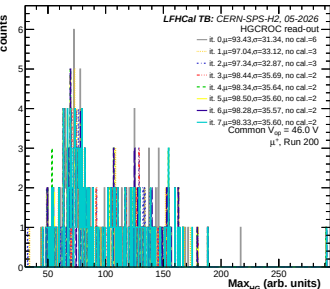


- Nearly all channels "fitable"
- Very few instable fits (primarily width parameter) in higher layers, otherwise parameters very stable for each layers
- $\langle Max_{mip} \rangle = 98.3$

Muon calibration - 46V: Muons - Iterations



Muon calibration - 46V: 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

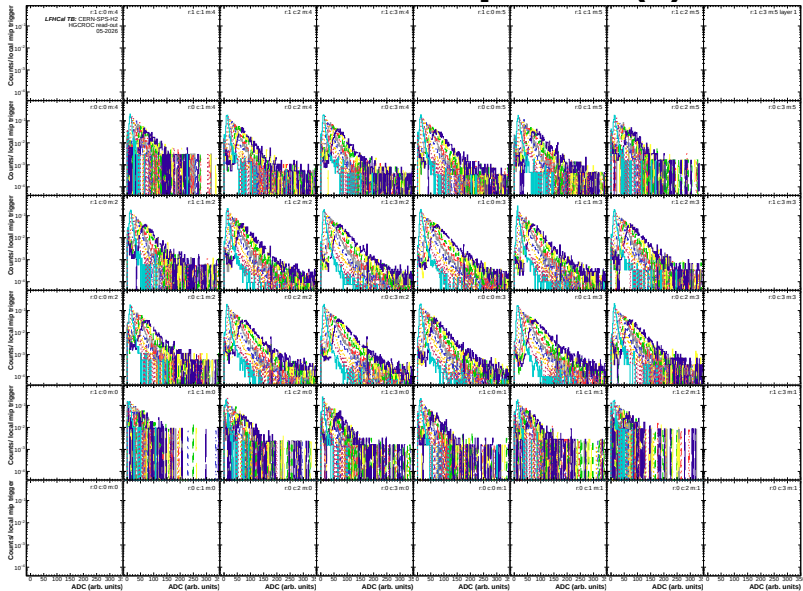
- Refined fitting during improved iterations using average mip from previous iteration as basis for constraints
- Still variations for later layers during 5th iteration, slowly converging
- Bulk of cells well calibrated after 3rd iteration

HV Scan comparison

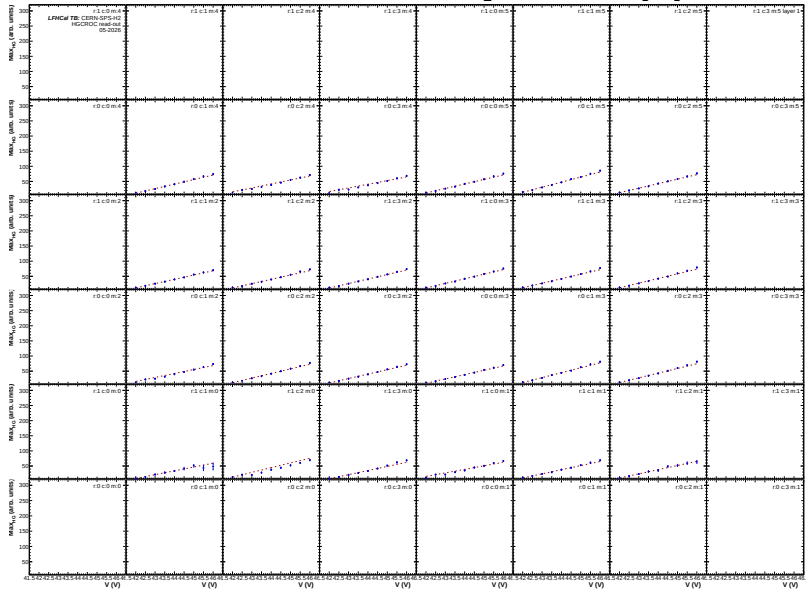
Initial look



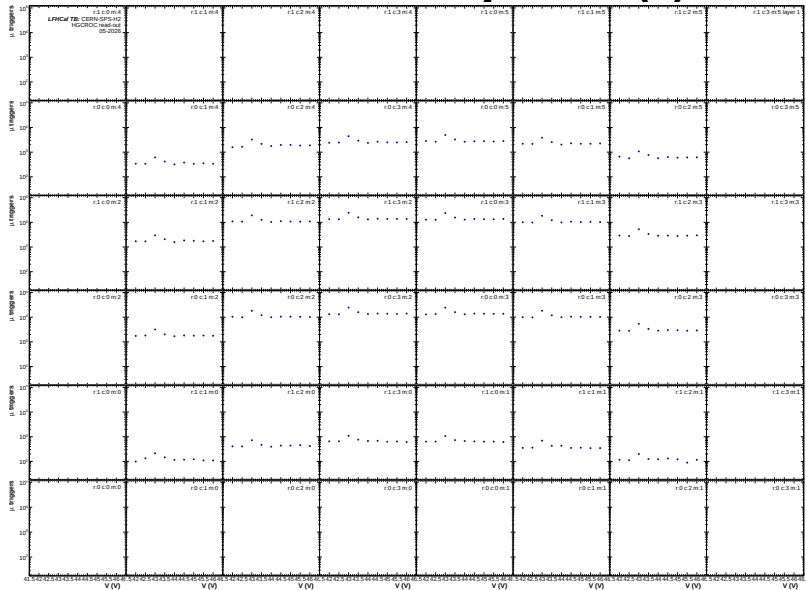
HV Scan - Comparison (1)



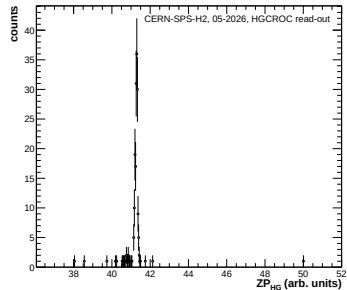
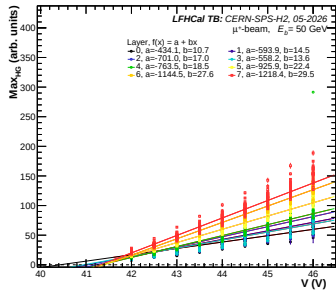
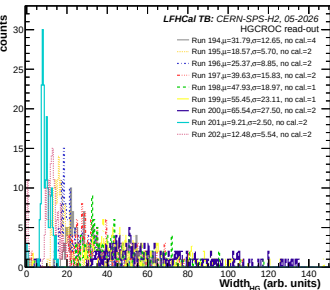
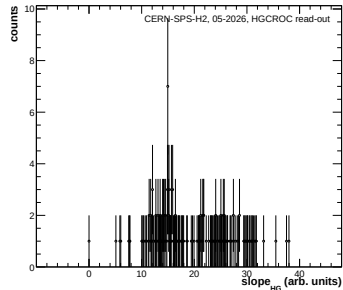
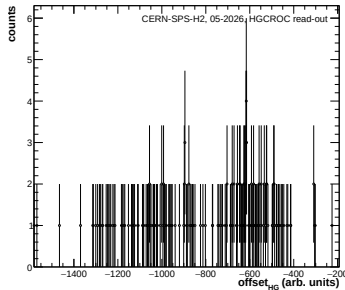
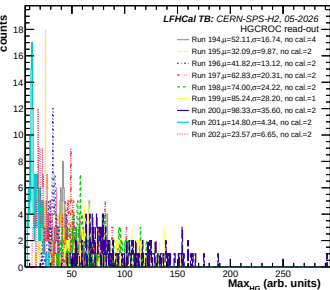
HV Scan - Comparison (1)



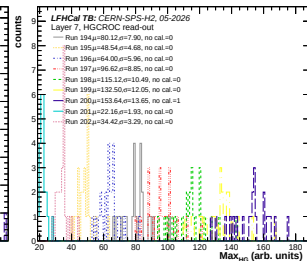
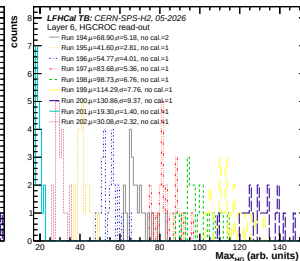
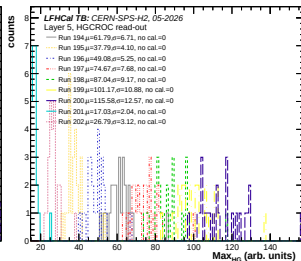
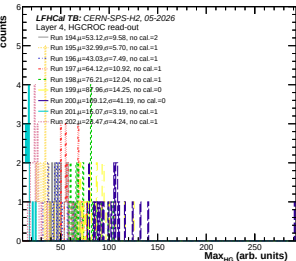
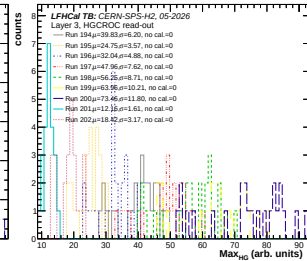
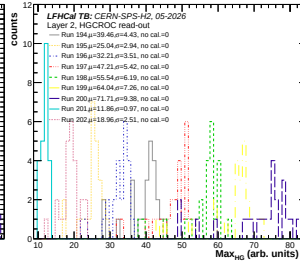
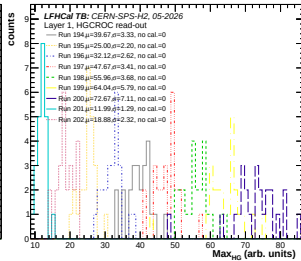
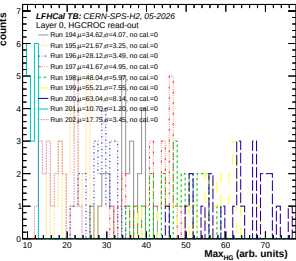
HV Scan - Comparison (1)



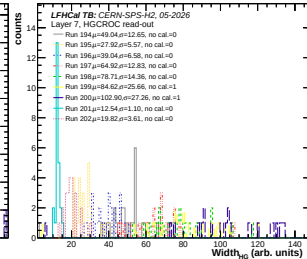
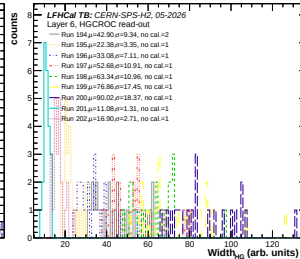
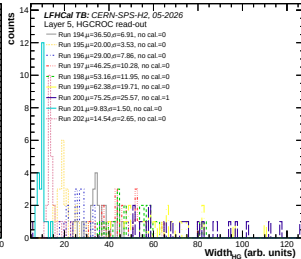
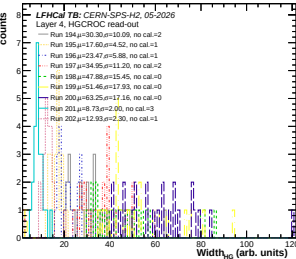
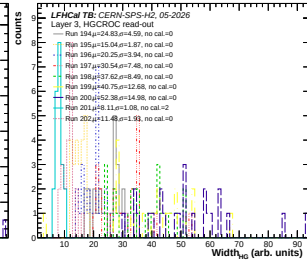
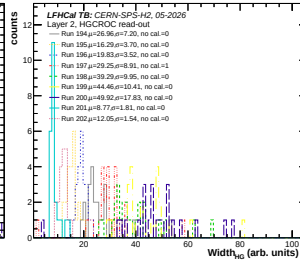
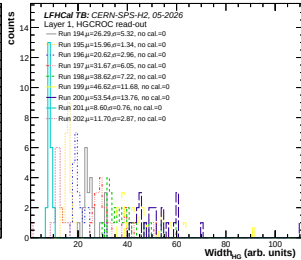
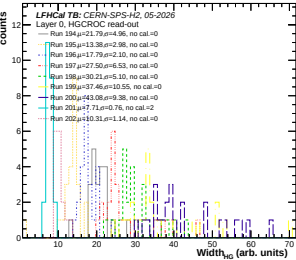
HV Scan - Comparison (2)



HV Scan - Max Mip per layer



HV Scan - FWHM Mip per layer



Calibration summary - HV Scan



Calibration summary

- All cells in outer column and rows masked, maximum number of good cells: 192
- ToA offset calibration taken from run 194 (muon run) for all runs
- Final calibration for each run can be found here
 - ▶ 42 V - run 201 [txt-file]
 - ▶ 42.5 V - run 202 [txt-file]
 - ▶ 43 V - run 195 [txt-file]
 - ▶ 43.5 V - run 196 [txt-file]
 - ▶ 44 V - run 194 [txt-file]
 - ▶ 44.5 V - run 197 [txt-file]
 - ▶ 45 V - run 198 [txt-file]
 - ▶ 45.5 V - run 199 [txt-file]
 - ▶ 46 V - run 200 [txt-file]