

sPHENIX INTT - Beam Test 2021

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2023/02/10 INTT meeting



Scattering and residual study

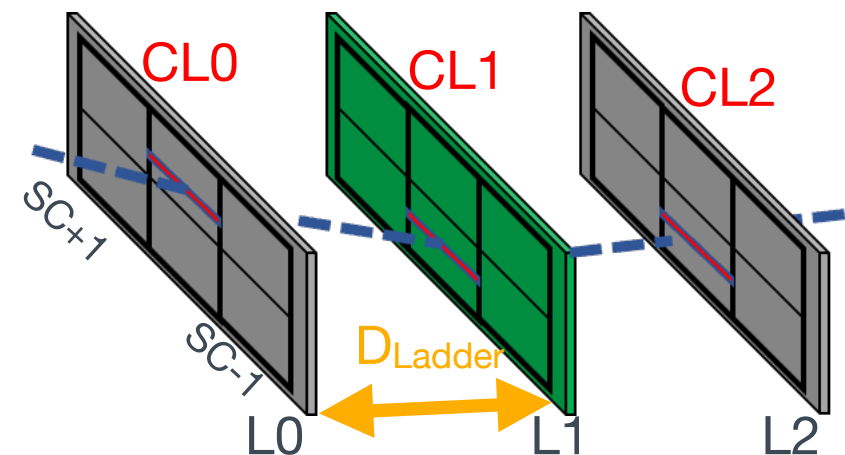
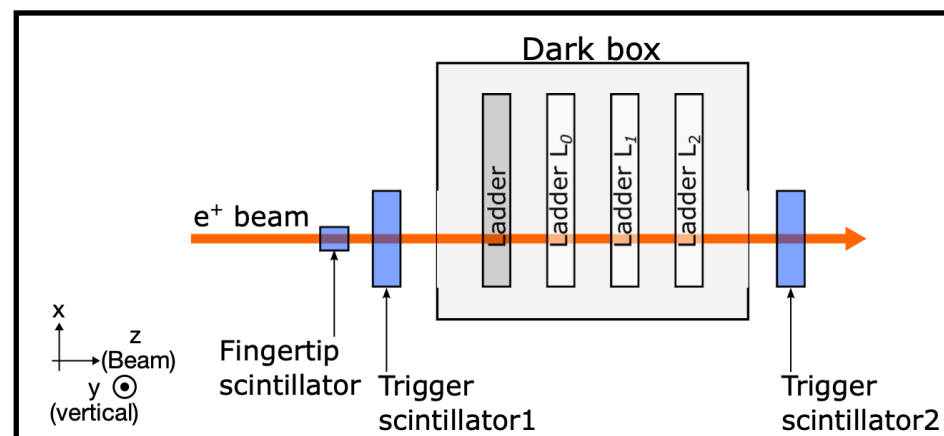
Distance between L0 and L1 (D_{Ladder}): 29.552 mm

Tracking	No double saving hits (no clone hits)
	Single Cluster in selected chip (SC) of L0 (SCL0), L1 (SCL1) and L2 (SCL2) required
	No cluster in adjacent chips (SC-1 & SC+1) required
	Cluster size == 1 for all clusters (to suppress the charge sharing effect)

Correction (data)

Alignment correction

Middle layer (L1), single chip



Calculation

Scattering	$[(\text{CL2}-\text{CL1})/D_{\text{Ladder}}] - [(\text{CL1}-\text{CL0})/D_{\text{Ladder}}]$
Residual	$[(\text{CL2}+\text{CL0})/2] - \text{CL1}$

Same data but different calculation

Scattering - MC comparison

MC sampling (ELPH beam condition ON) :

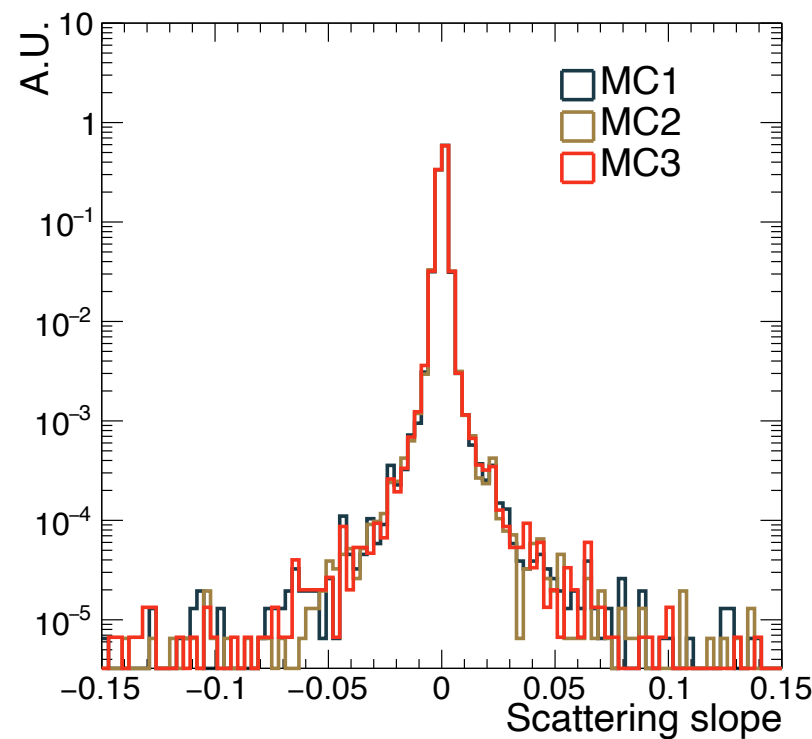
1. Original set up + Sci. Al foil
 2. Original set up + Sci. Al foil + 10% HDI metal thickness increase
 3. Original set up + Sci. Al foil + 10% HDI metal thickness increase + precise physics list
 4. Original set up + Sci. Al foil + 10% HDI metal thickness increase + precise physics list + L1 Y-axis offset
 5. Original set up + Sci. Al foil + 10% HDI metal thickness increase + precise physics list + L1 Y-axis offset + INTT box vertical rotation
- 2 new MC samples

Recap

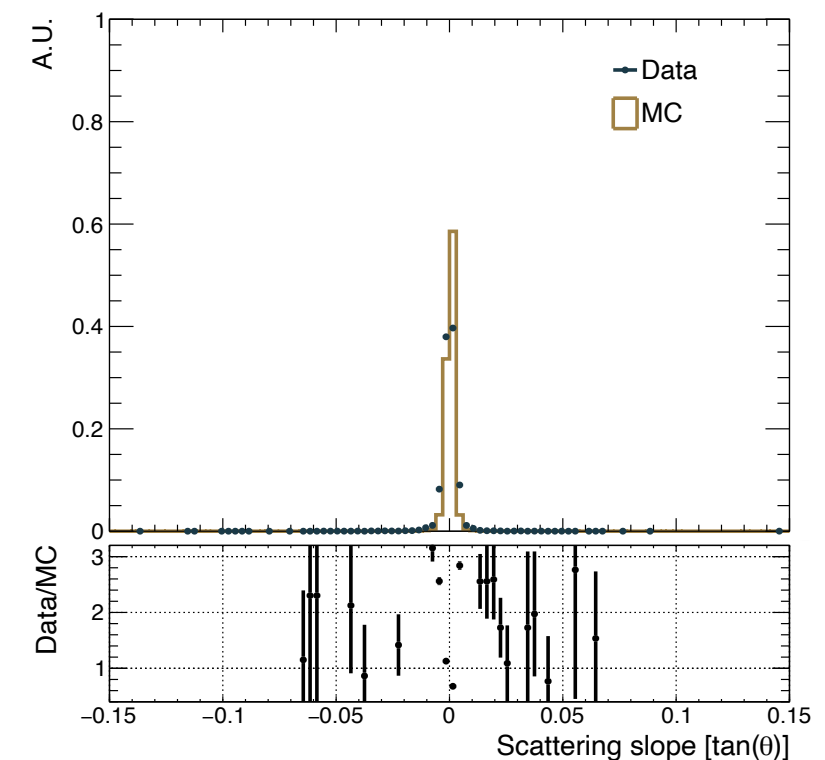
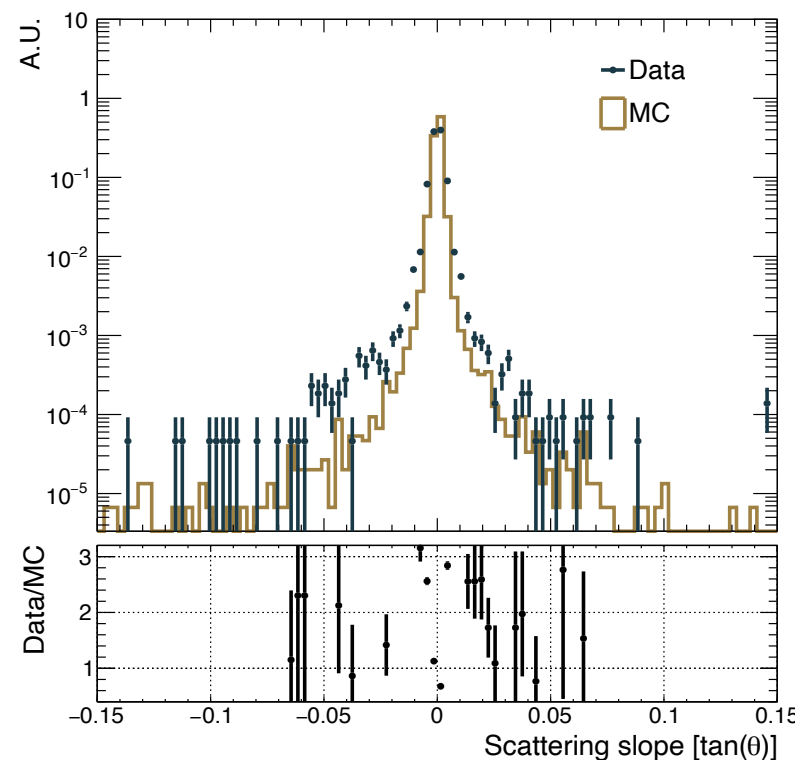
Data run52 U8 vs MC3

N of bins : 100

Bin width : 0.003



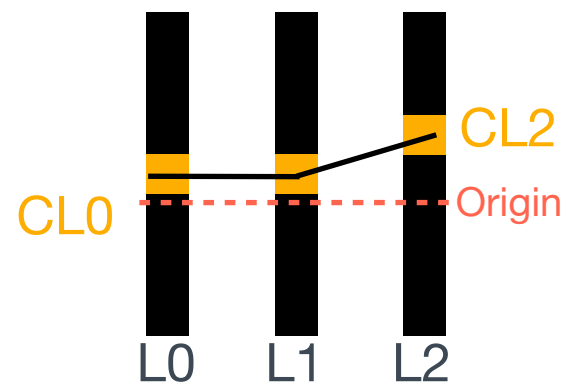
Almost no difference !



The discrepancy is quite huge between Data and MC

Scattering slope

CL0 : 0.039 mm (chan. 127)
CL1 : 0.039 mm (chan. 127)
CL2 : 0.117 mm (chan. 126)

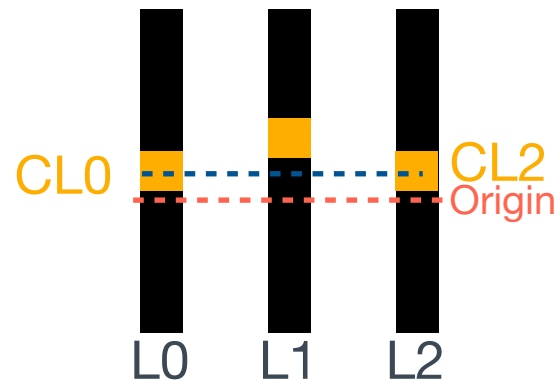


$$(0.117 - 0.039) / 29.552 - (0.039 - 0.039) / 29.552 = 0.002639$$

New beam width

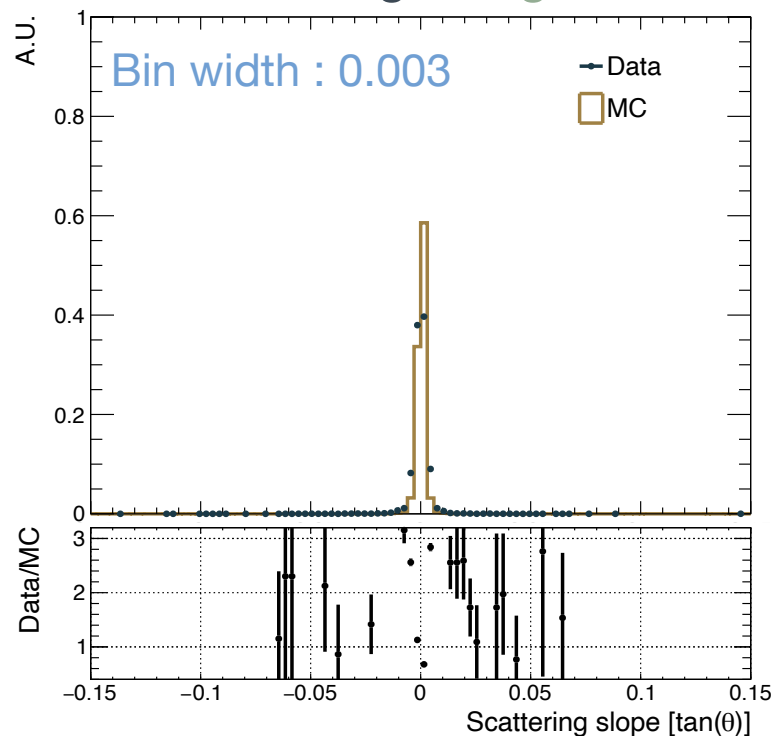
Residual

CL0 : 0.039 mm (chan. 127)
CL1 : 0.117 mm (chan. 126)
CL2 : 0.039 mm (chan. 127)

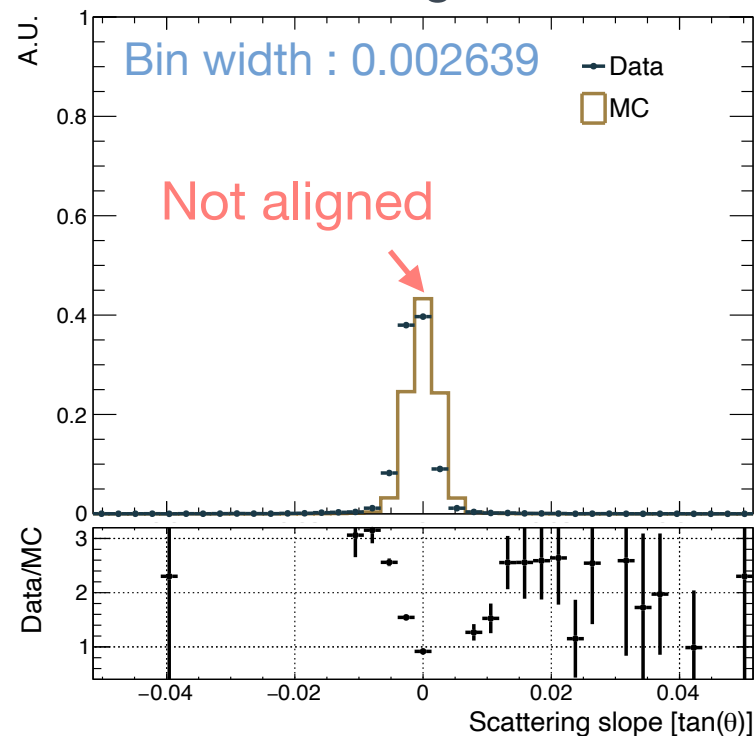


New beam width : 0.078 mm

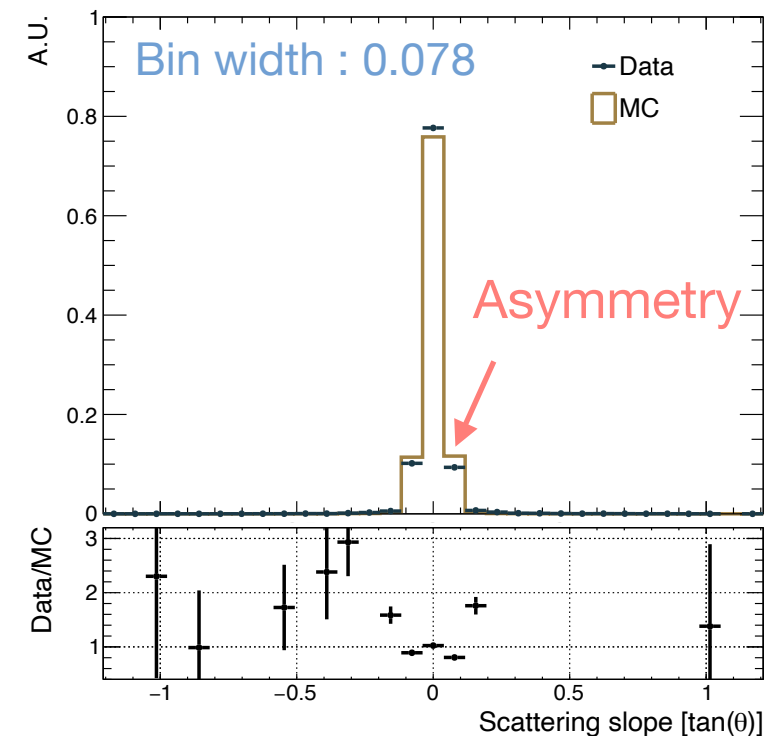
Scattering - original



Scattering - new

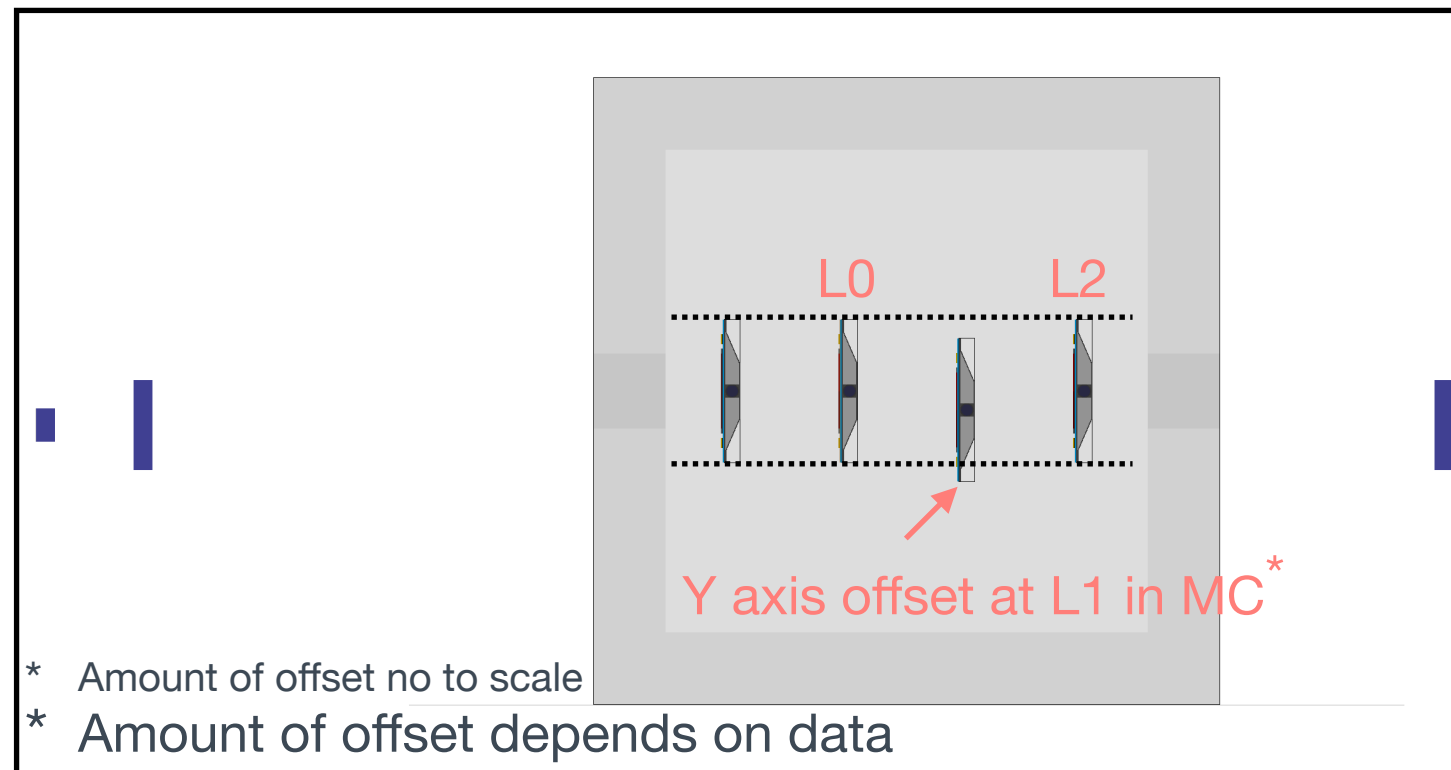


Residual - new



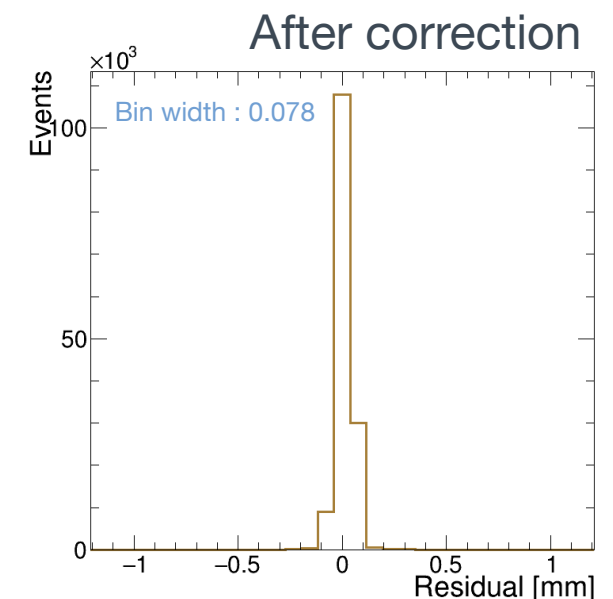
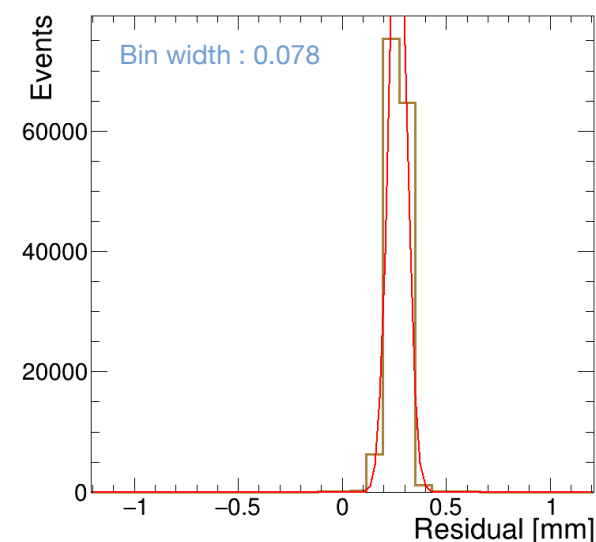
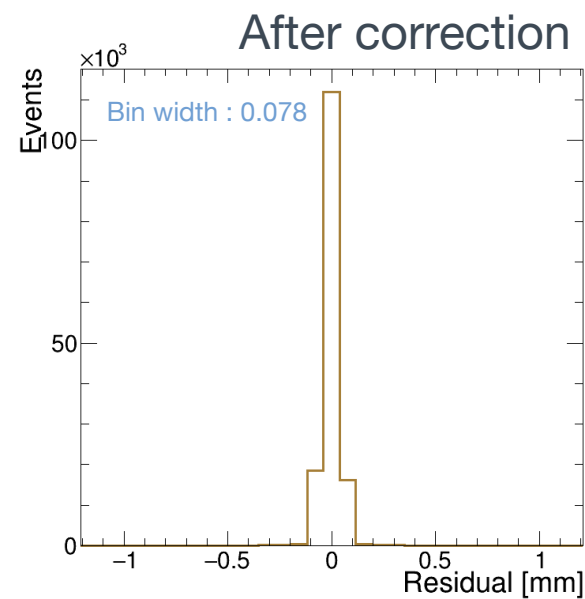
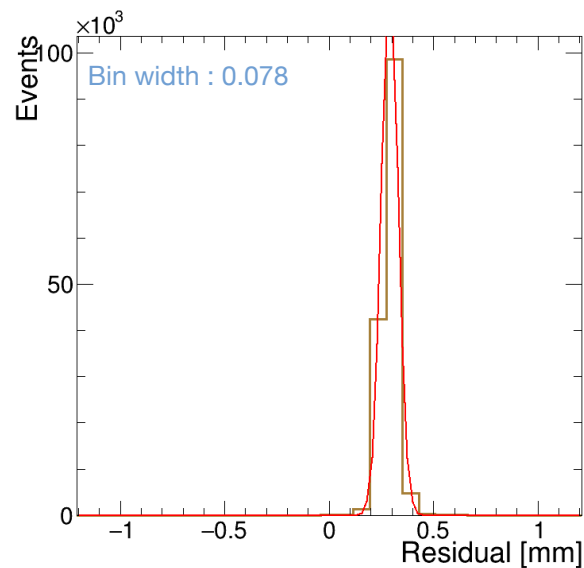
Introduction of misalignment in MC

With MC3 condition + L1 vertical misalignment = MC4



Amount of correction : 2.89928×10^{-1} mm
Based on run52 U8

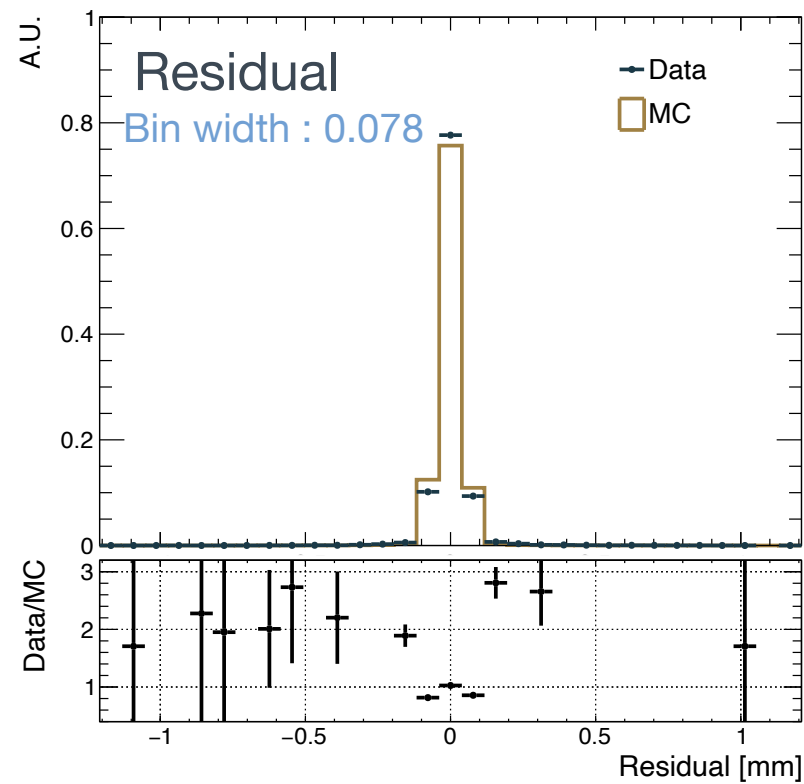
Amount of correction : 2.66304×10^{-1} mm
Based on run52 U9



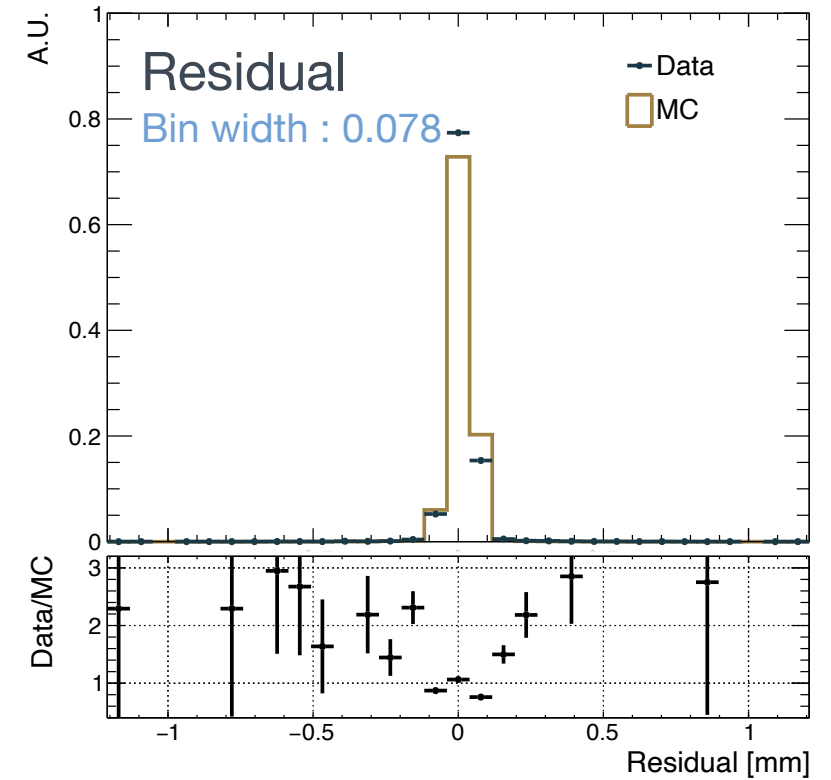
Introduction of misalignment in MC

MC : MC4

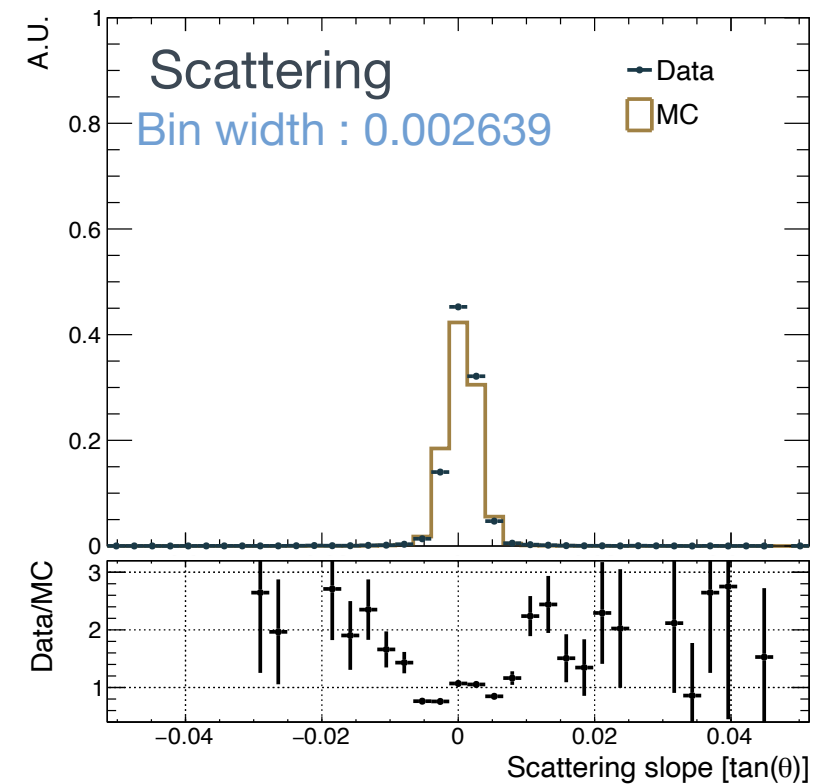
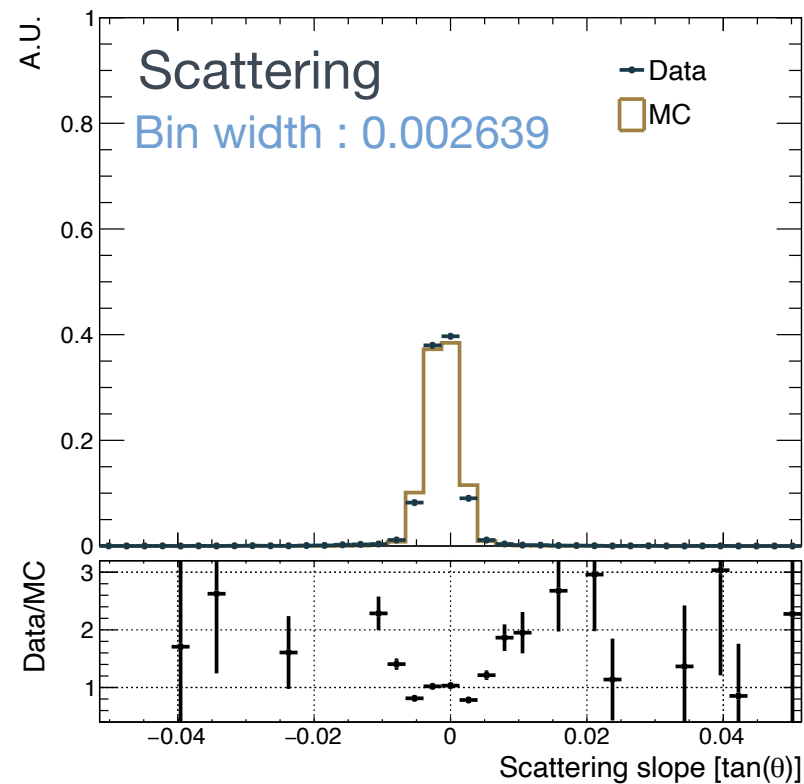
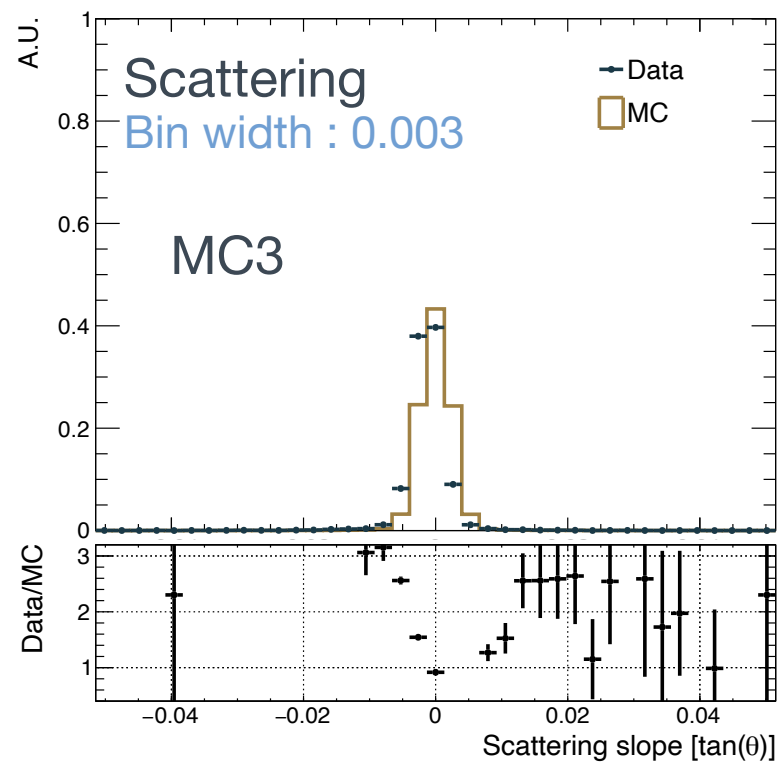
U8



U9



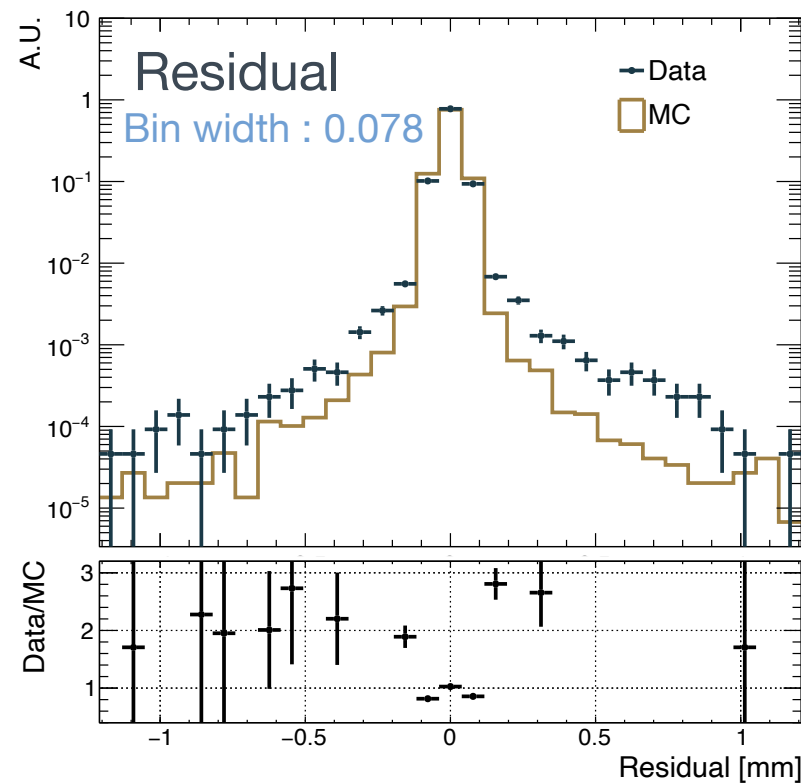
Previous result



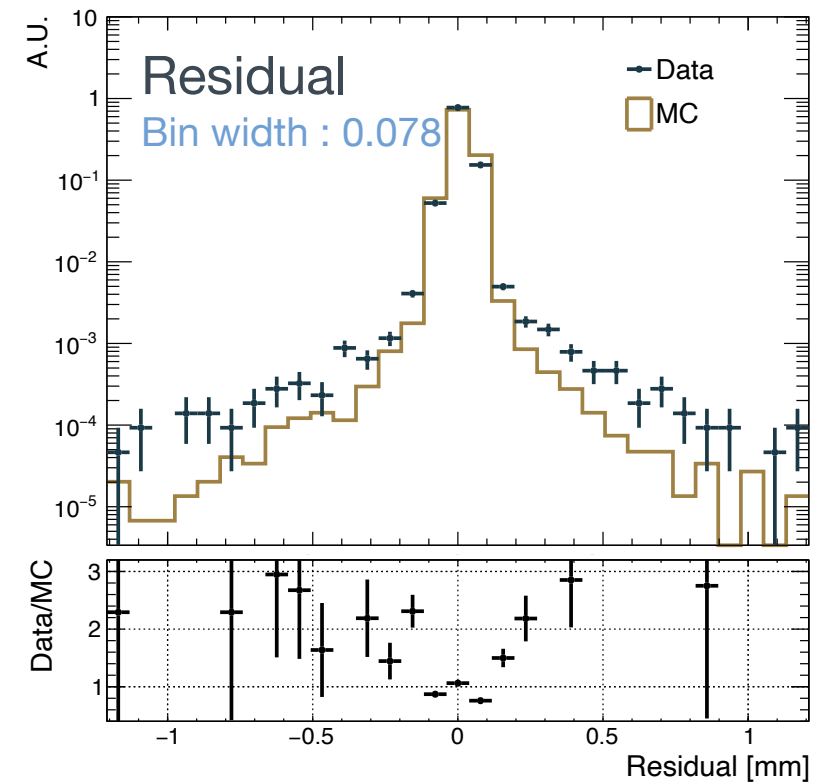
Introduction of misalignment in MC

MC : MC4

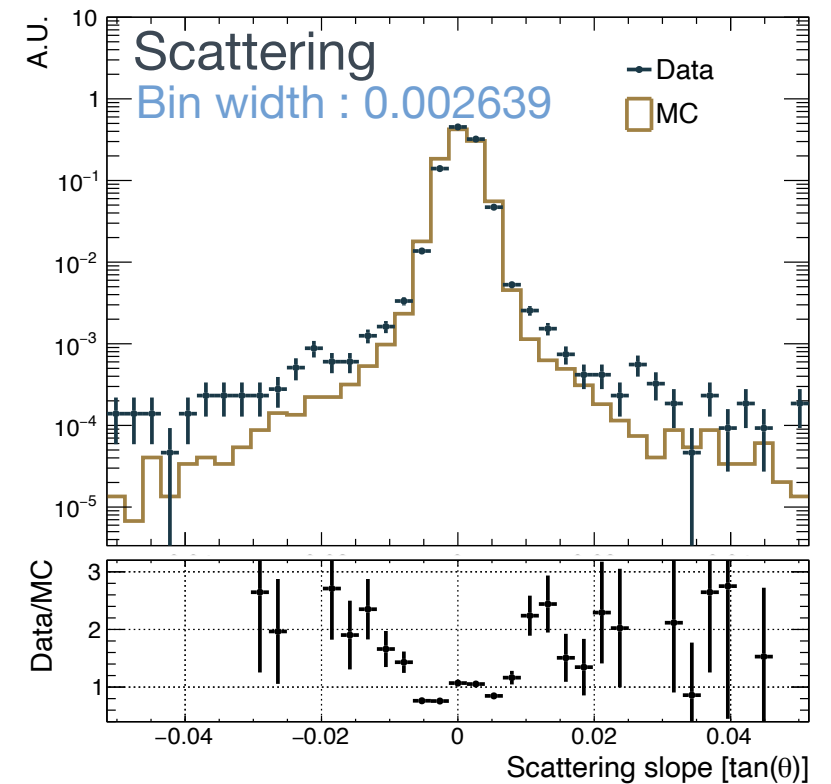
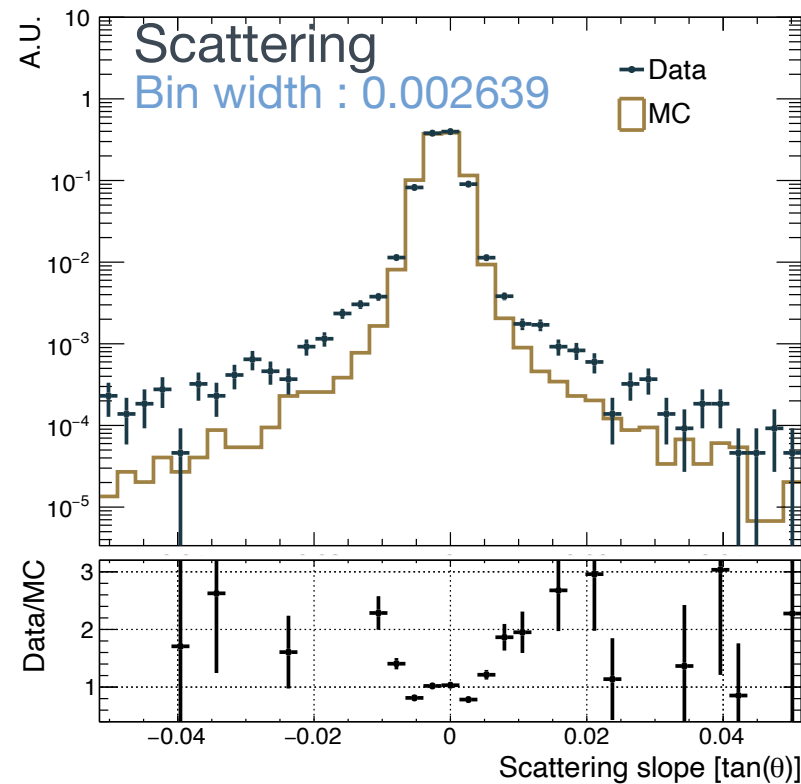
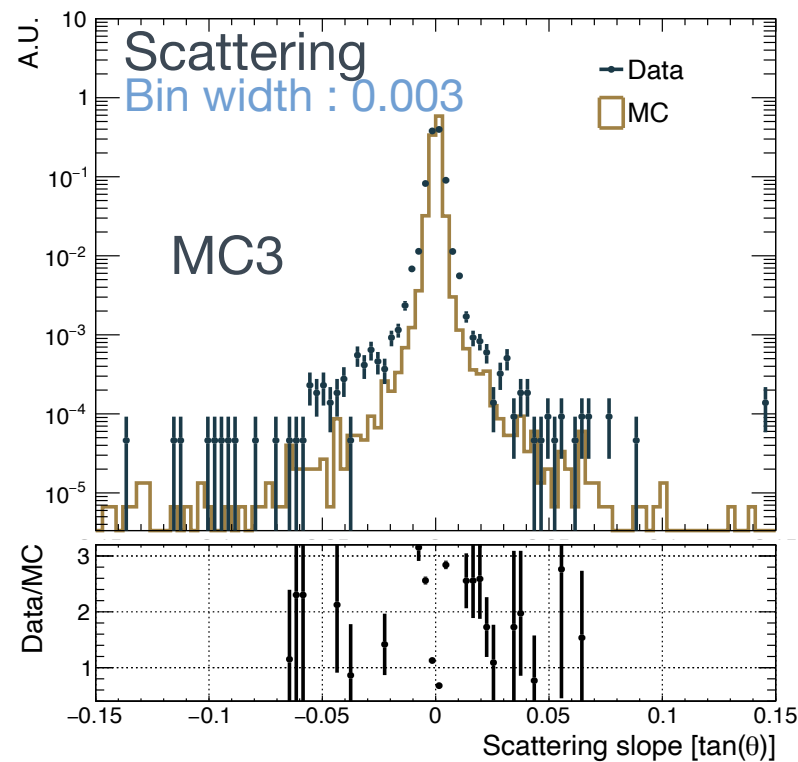
U8



U9



Previous result

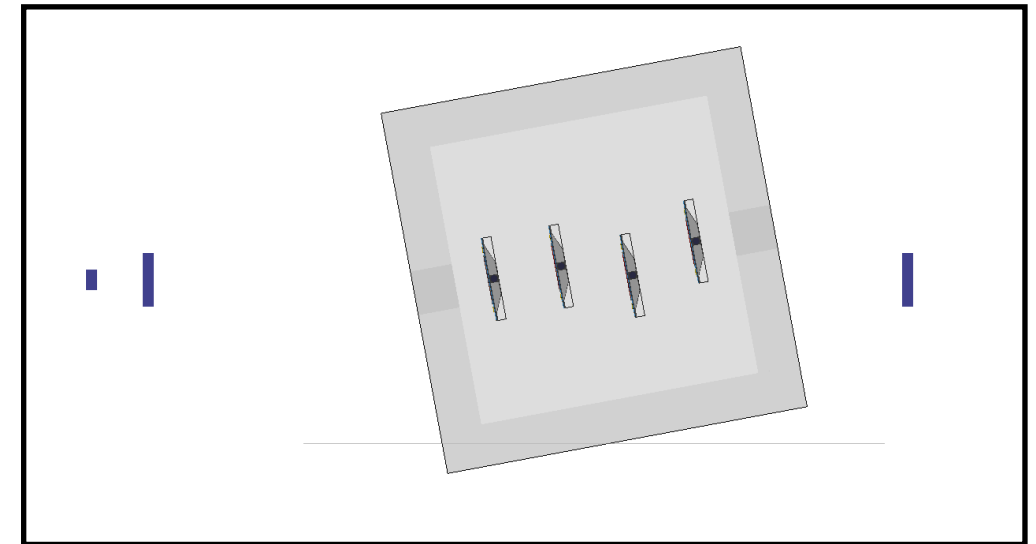
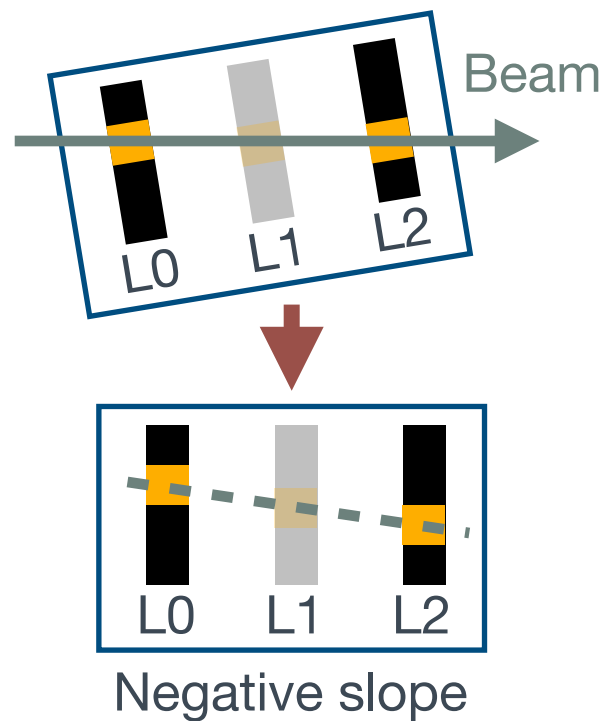
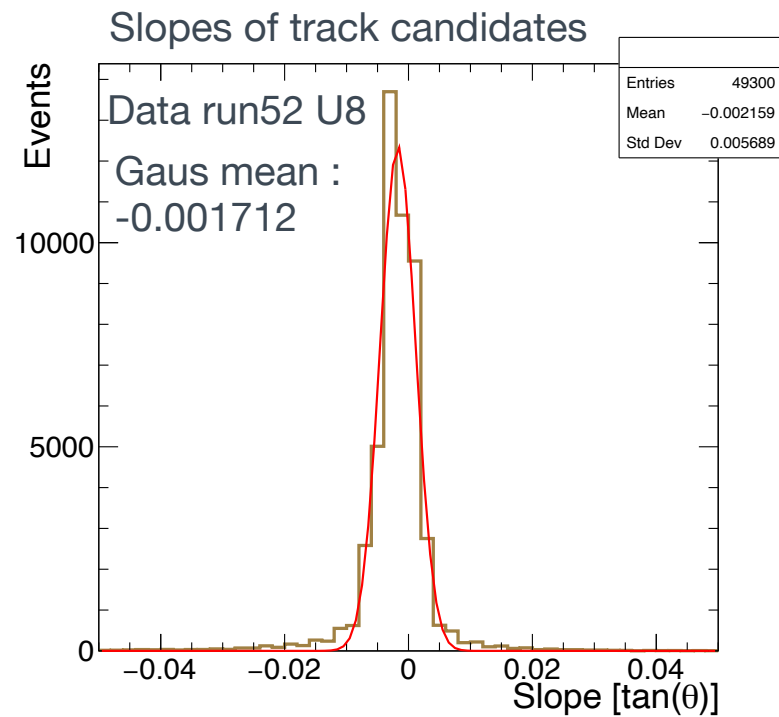


Introduction of the Dark box vertical rotation

With MC4 condition + vertical rotation = MC5

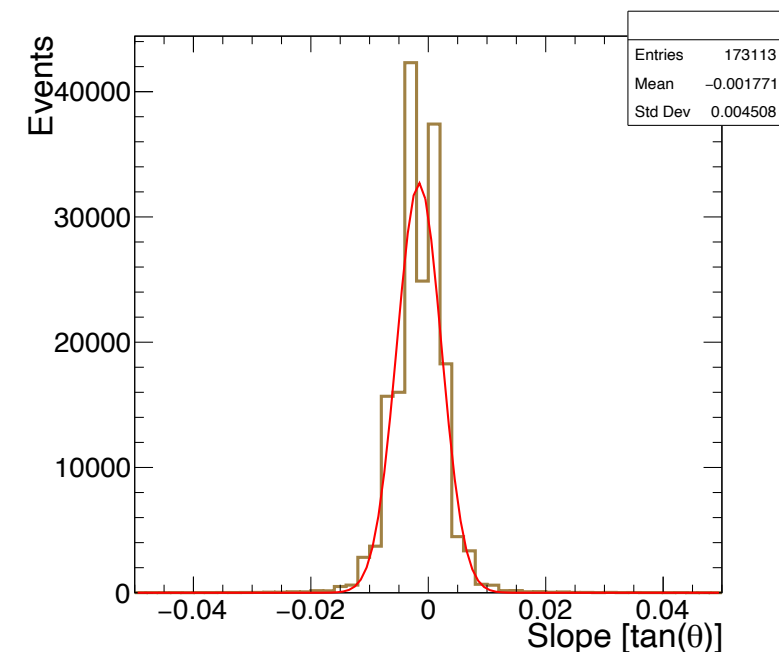
Recap

Track candidates	Single Cluster in selected chip (SC) of L0 (abbr. SCL0) and L2 (abbr. SCL2) required
	No cluster in adjacent chips (SC-1 & SC+1) required



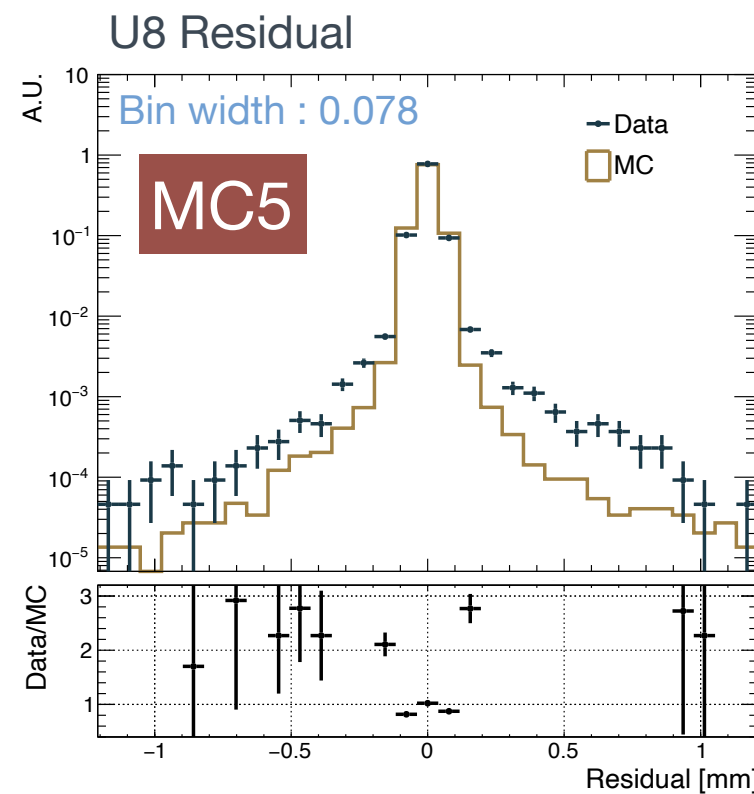
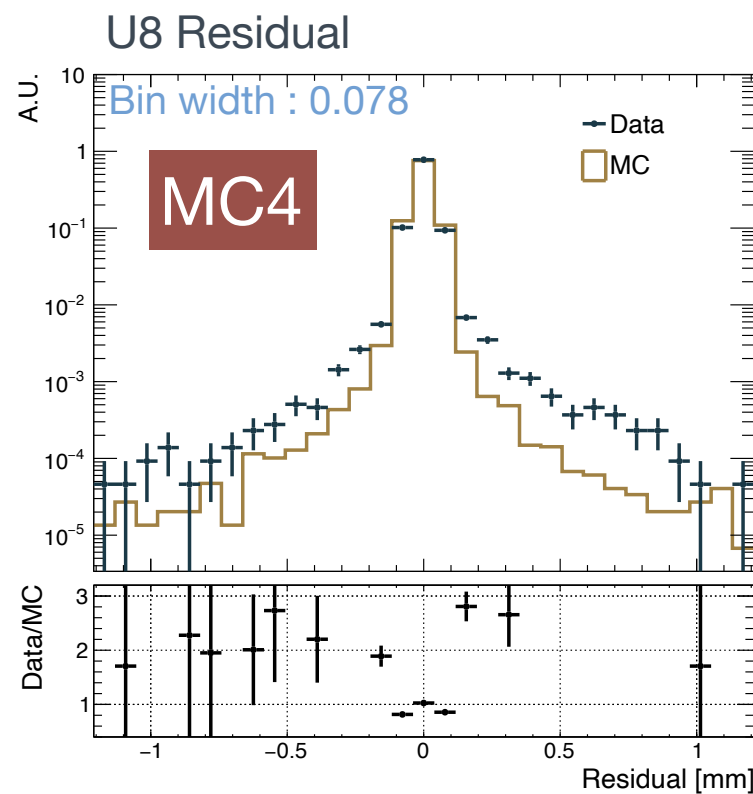
Amount of the applied vertical rotation is not to scale, based on data

- MC5 :
 - Set : -0.001712 (9.809e-02 degree)
 - Outcome : -0.00156313 (Gaus fit)

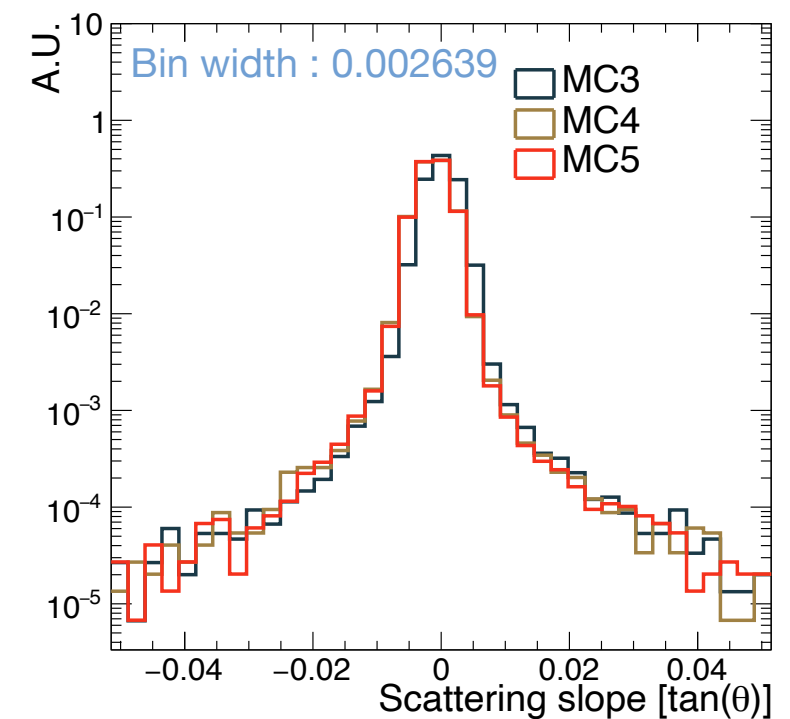


MC sampling (ELPH beam condition ON) :

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5. Original set up + Sci. Al foil + 10% HDI metal thickness increase + precise physics list + L1 Y-axis offset + INTT box vertical rotation



very small improvement



Cluster size and cluster adc



Distance between L0 and L1: 29.552 mm

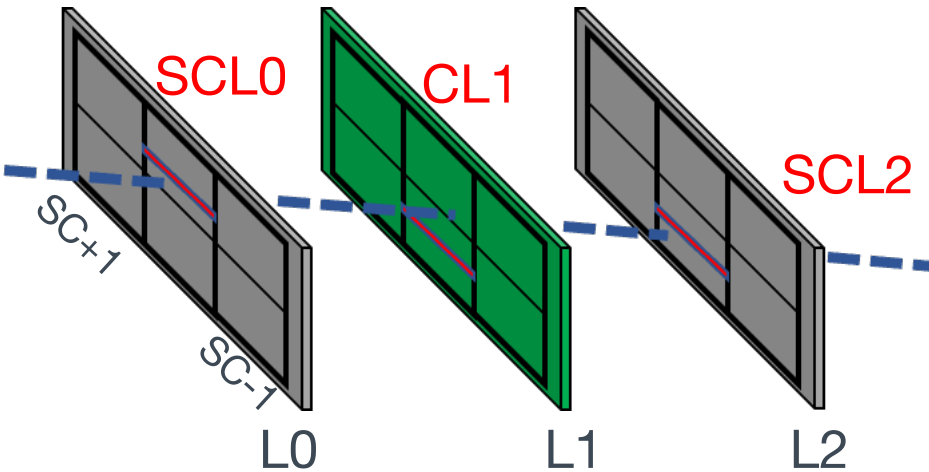
Tracking	No double saving hits (no clone hits)	
	Single Cluster	in selected chip (SC) of L0 (abbr. SCL0) and L2 (abbr. SCL2) required
	No cluster	in adjacent chips (SC-1 & SC+1) required

Event selection	Edge exclusion	(ladder bottom edge + 5 ch) < Y-pos of SCL0 and SCL2 < (ladder top edge - 5 ch)
	Cluster ADC	Sum of ADC of SCL0 > adc0 && Sum of ADC of SCL2 > adc0
	Slope cut	fabs(slope of SCL2 - SCL0) < 0.01

Good track classification	Residual	fabs(CL1 - the extrapolation position) < 3 strips (0.234 mm, currently used)
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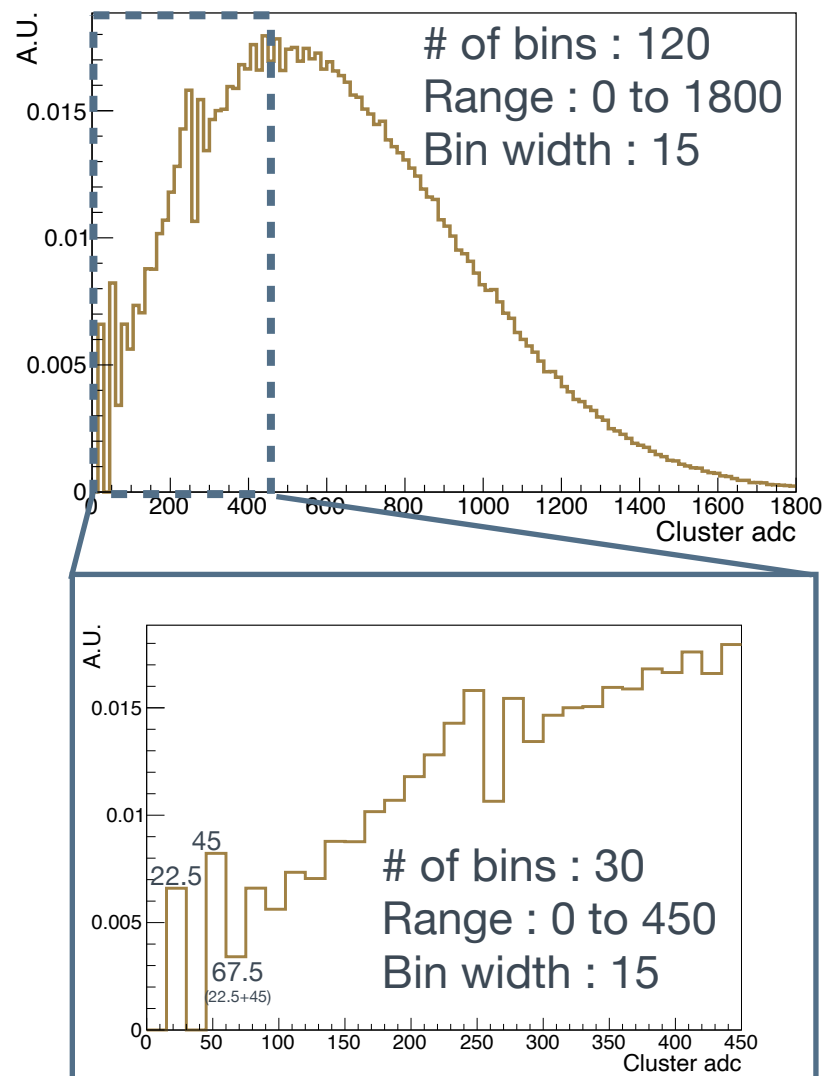
Corrections

Alignment correction	Middle layer (L1), single chip
Slope correction	For the slope cut

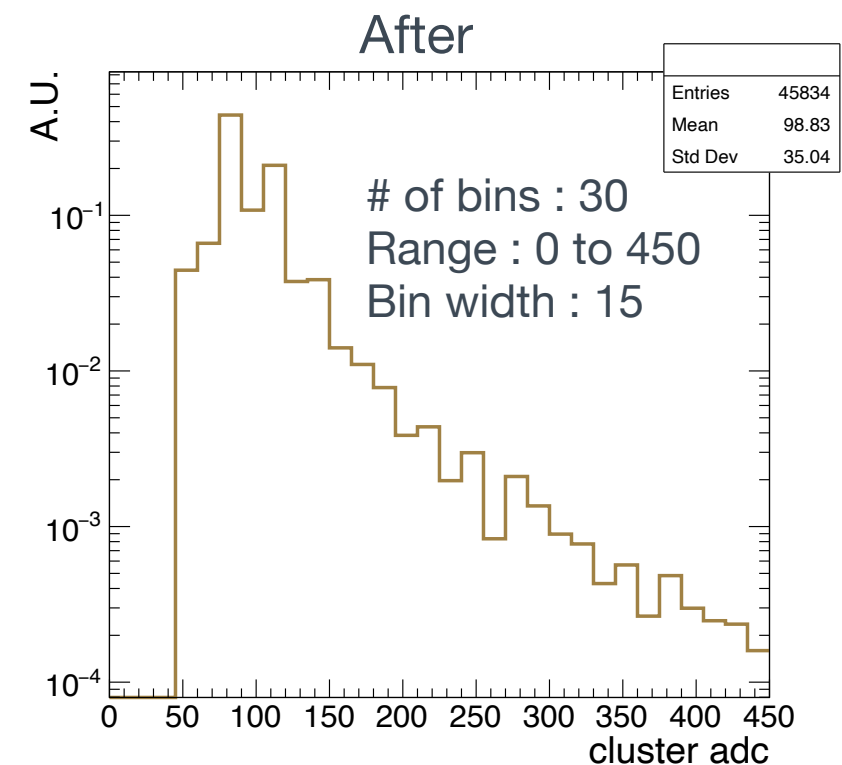
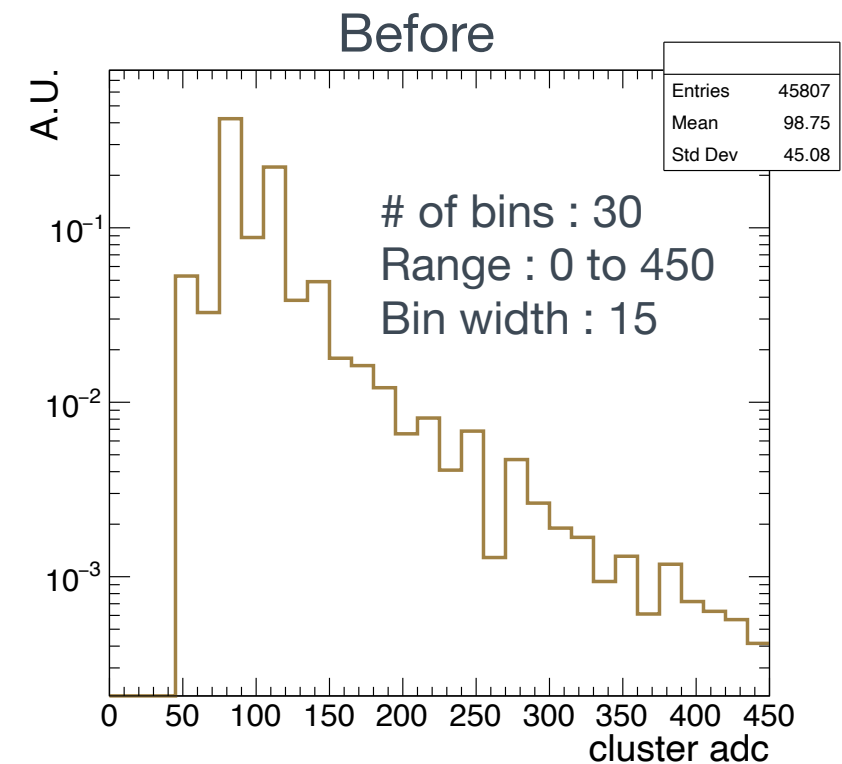


Cluster ADC - ADC combination factor cancellation

- DAC setting : 15, 30, 60, 90, 120, 150, 180, 210, 240
 - adc value : 22.5, 45, 75, 105, 135, 165, 195, 225
- Randomly determine the size of the cluster
 - Cluster size range : 1 to 19
 - Flat distribution
 - In the code : `int( TRandom3::Uniform(0, 20) )`
- Randomly determine the adc value of each hit in a cluster
 - Flat distribution with range 0 to 7
 - In the code : `int( TRandom3::Uniform(0, 8) )`

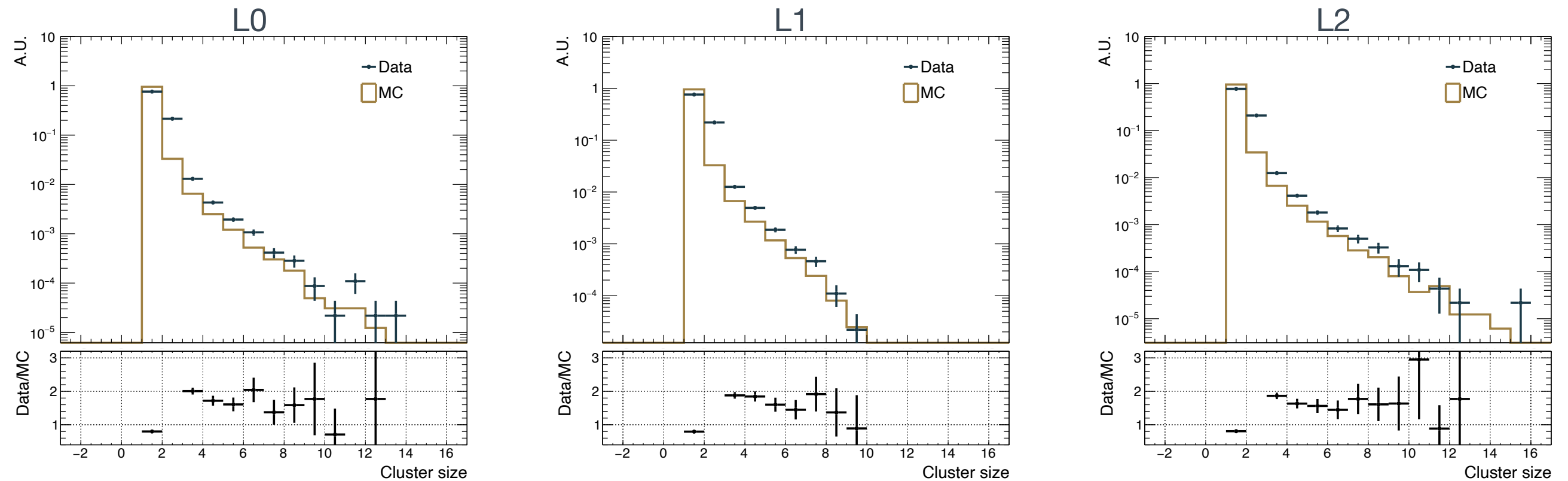


Consider this distribution as the bin calibration factor

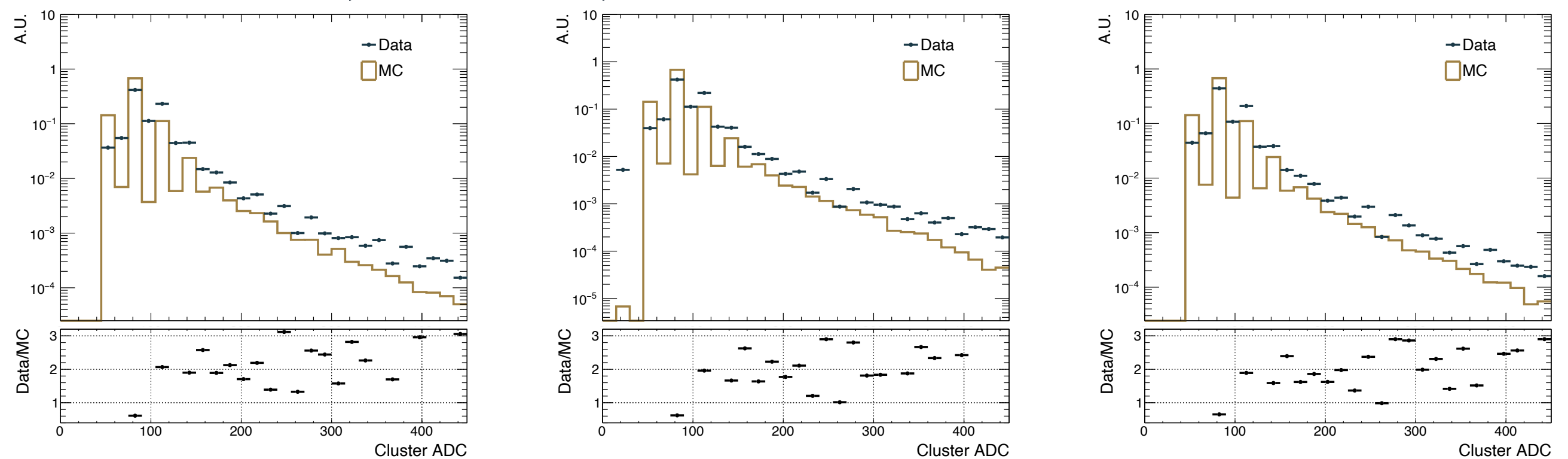


Cluster size and cluster adc - with selection

Cluster size distributions, Data : Run52 U8, MC : MC4

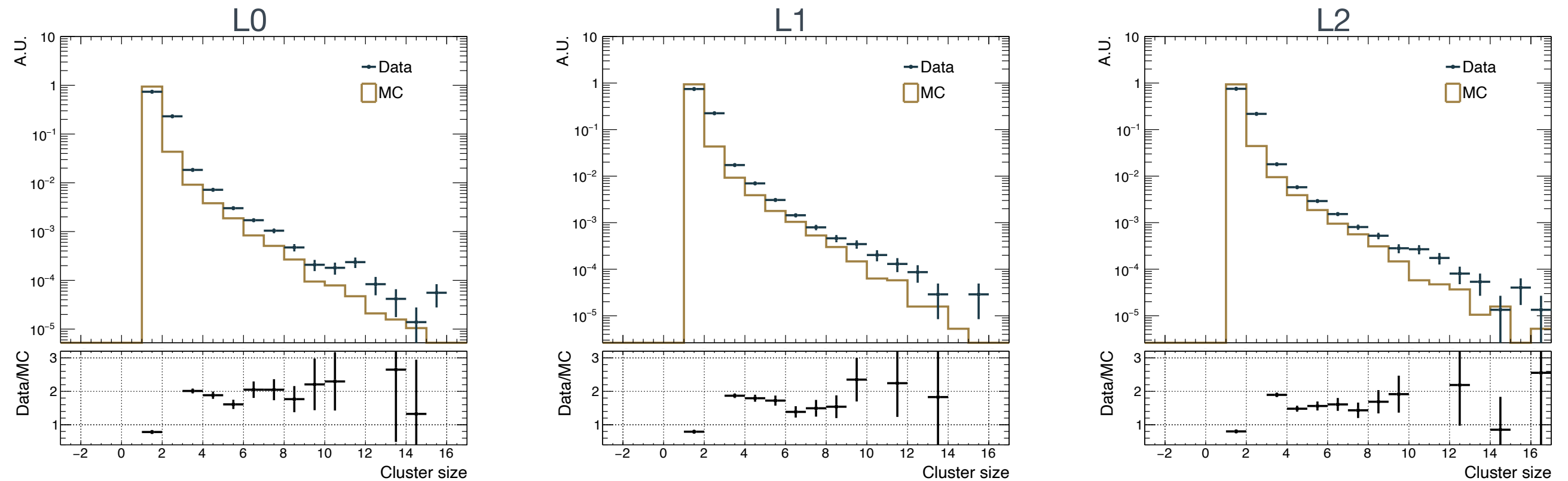


Cluster ADC distributions, Data : Run52 U8, MC : MC5

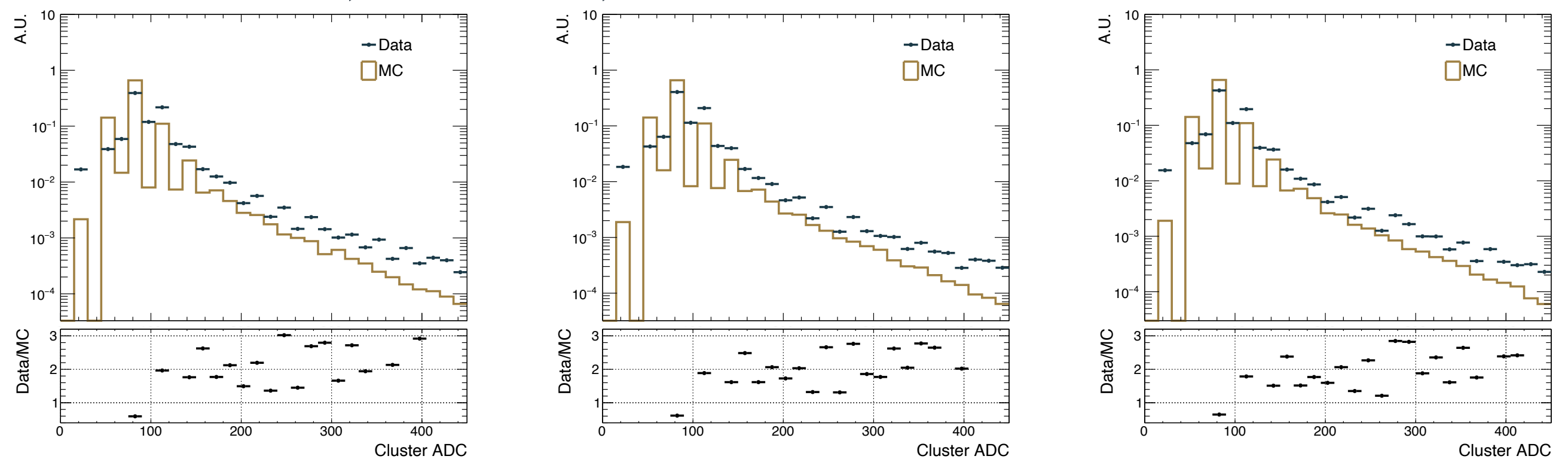


Cluster size and cluster adc - without selection

Cluster size distributions, Data : Run52 U8, MC : MC4



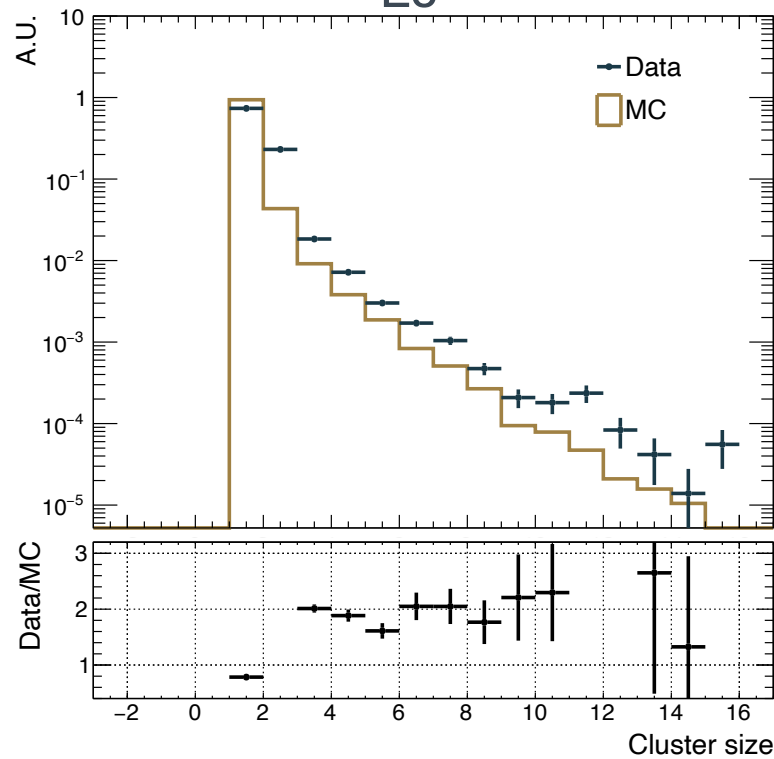
Cluster ADC distributions, Data : Run52 U8, MC : MC5



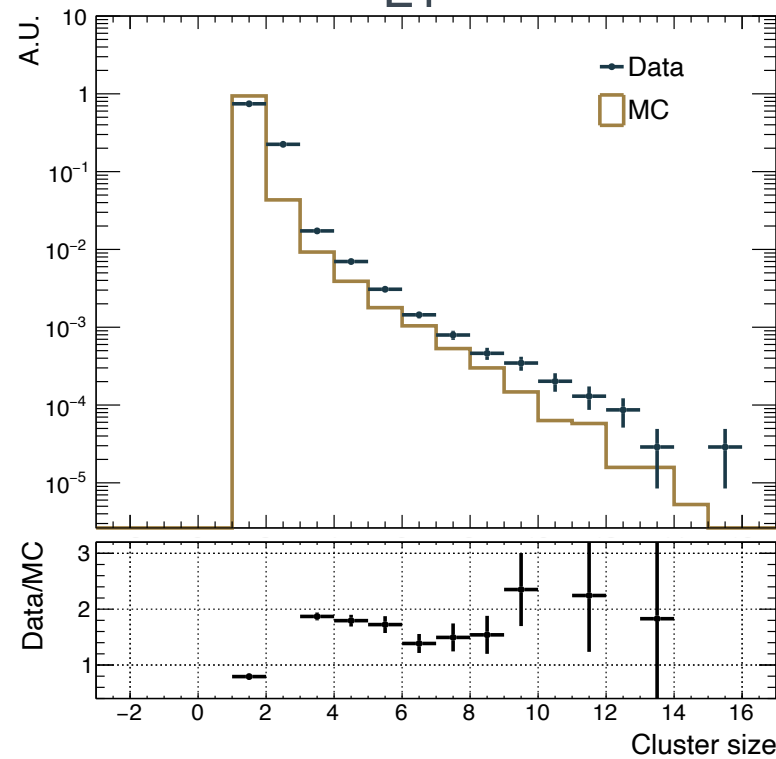
Cluster size - compare with run61 (without cut)

Data : Run52 U8, MC : Run52 MC4

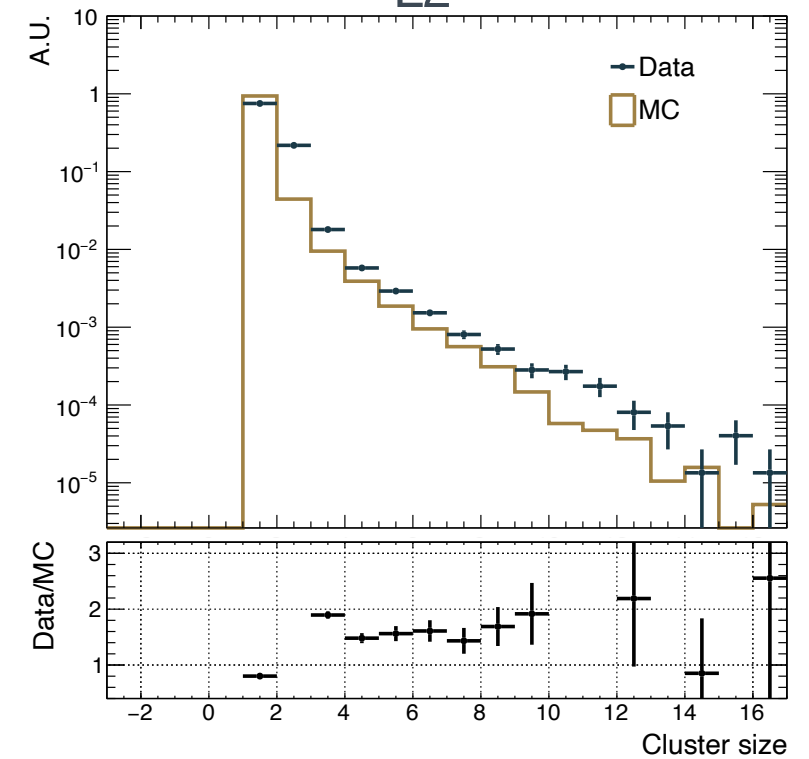
L0



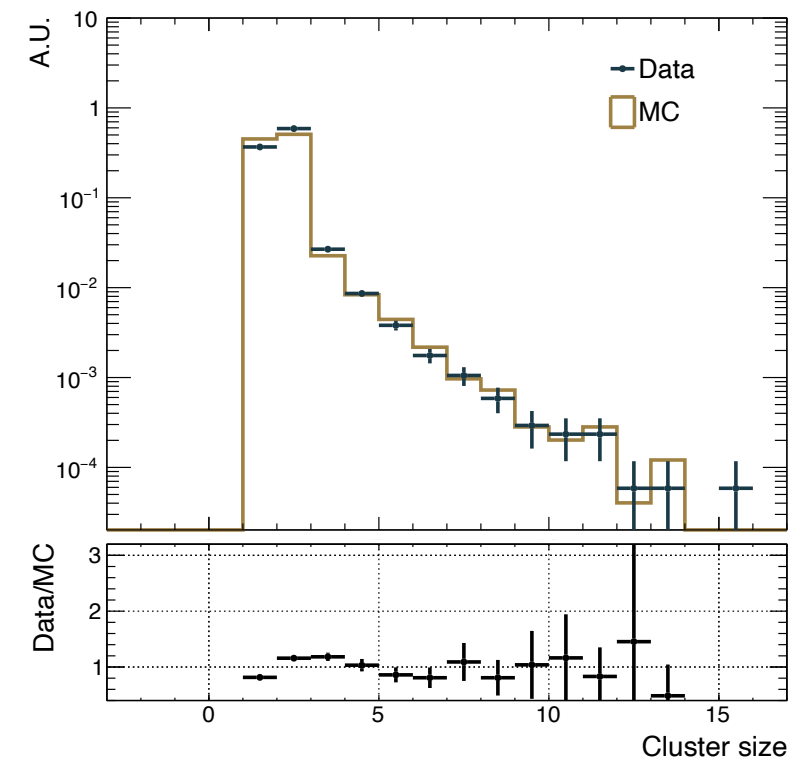
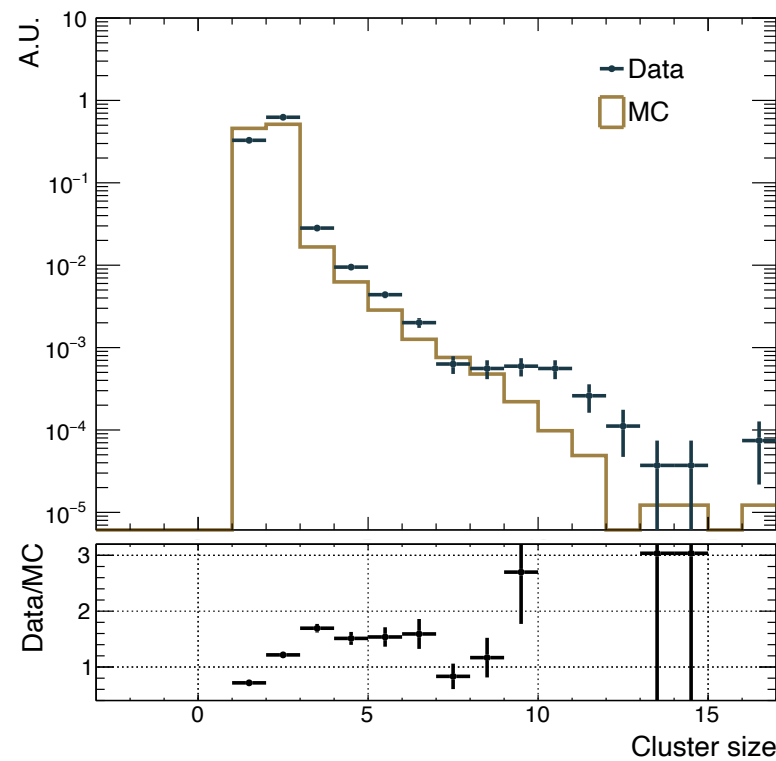
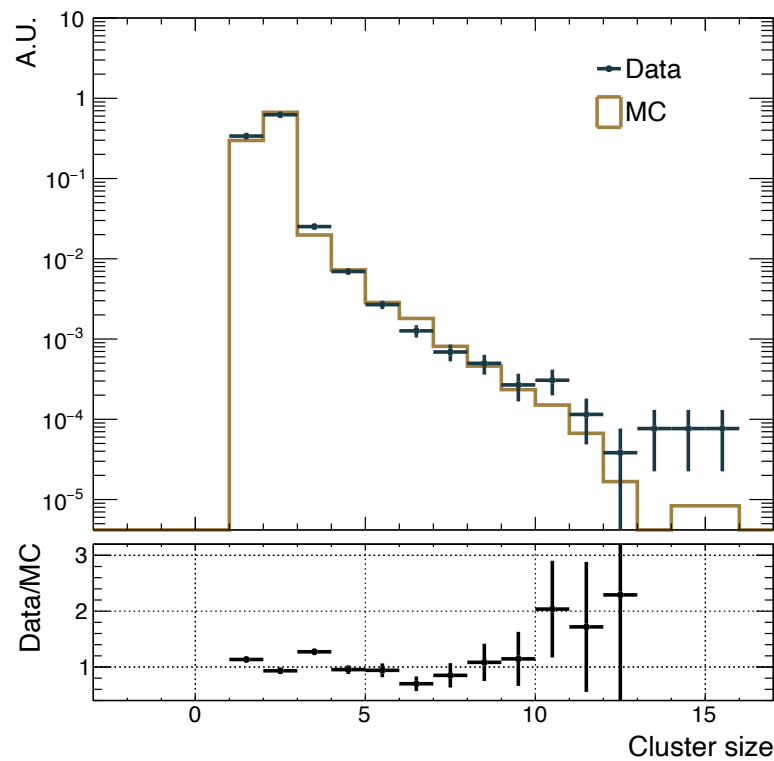
L1



L2



Data : Run61 U11, MC : Run61 MC4 condition



- The bin width is reconsidered, and the misalignment in MC is introduced
 - The agreement between data and MC becomes better, for both residual and scattering distribution. At least the tendency looks similar for the peak region
- The dark-box vertical rotation is also considered. The improvement is minor
- The cluster-size distribution of data is wider than the one of MC, which is as expected
 - Charge-sharing effect is not considered in MC, which is also the reason of the fish-bone like distribution in MC cluster ADC distribution
- The agreement of the cluster-size distributions between data and MC with run61 condition is somehow well.

- Ladder geometry & material review
 - Improvement is expected to be small
 - The thermal glue between HDI and stave is not included yet
- Physics list
 - Checked by run64 (with lead plate), working on it now
 - Simple material

Backup

Deep study of the MC cluster adc distribution

- DAC setting : 15, 30, 60, 90, 120, 150, 180, 210, 240
 - adc value : 22.5, 45, 75, 105, 135, 165, 195, 225

- Possible cluster adc :

22.5

45

67.5

75

90

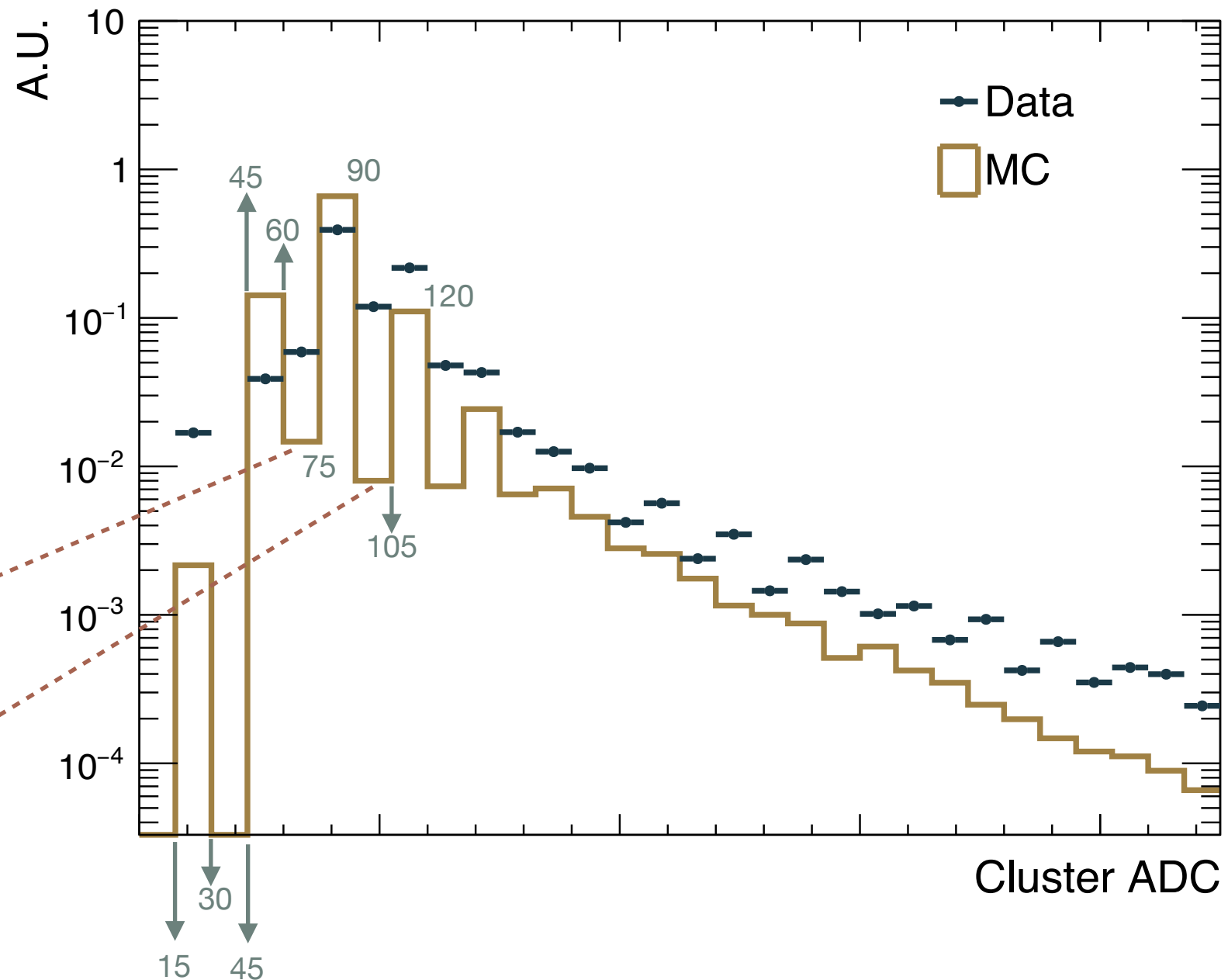
97.5

105

112.5...

Cluster size > 1

- Bin 15 ~ 30 : cluster ADC 22.5
- Bin 45 ~ 60 : cluster ADC 45
- Bin 60 ~ 75 : cluster ADC 67.5
- Bin 75 ~ 90 : cluster ADC 75
- Bin 90 ~ 105 : cluster ADC 90 & 97.5
- Bin 105 ~ 120 : cluster ADC 105 & 112.5



The bins with low entries can be filled only by multi-hits clusters.
In the MC, no charge sharing consideration

