Preshower
and
muon system

Update

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Outline

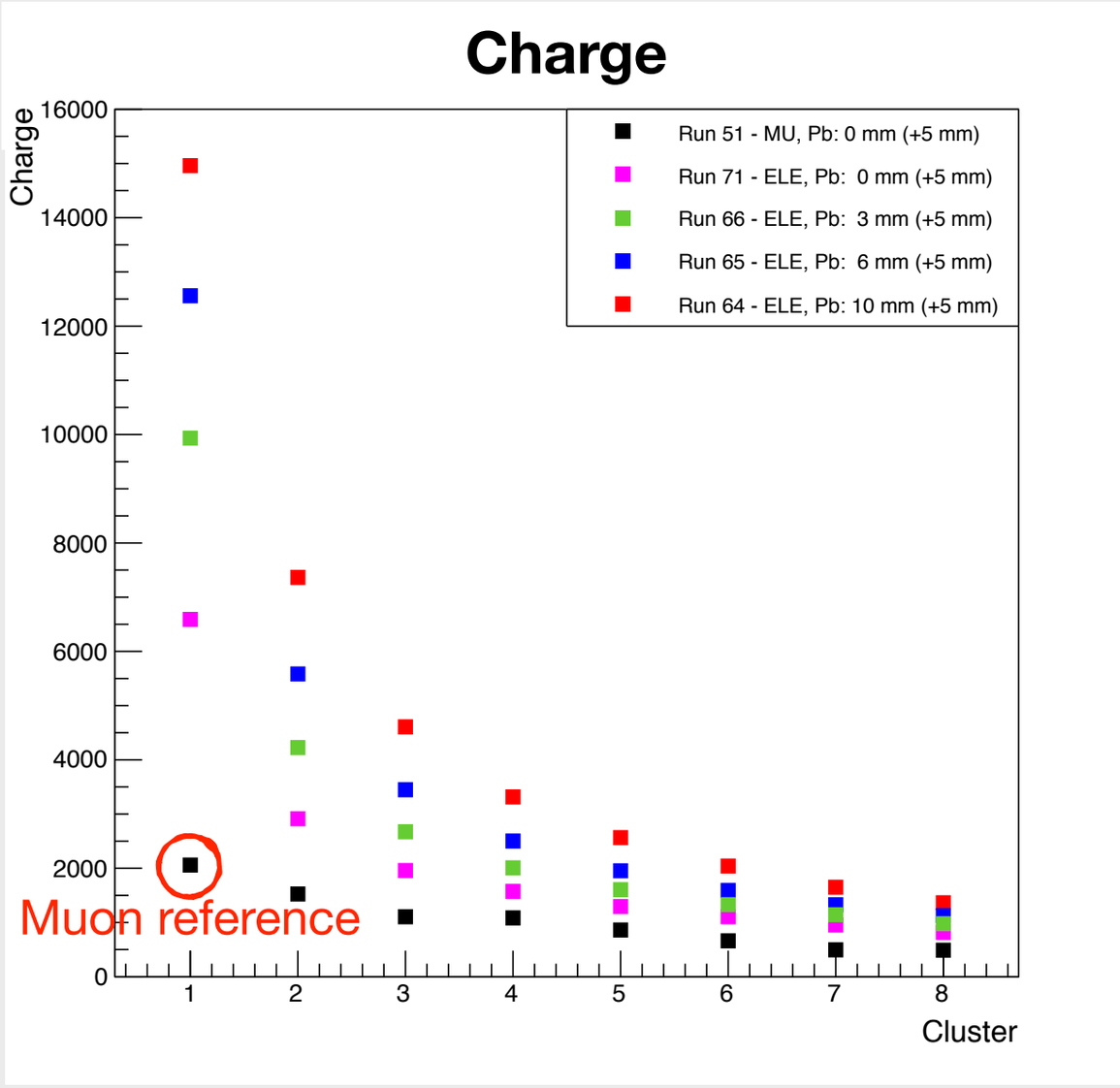
- Particle counting methods
- Clustering from simulation data
- Extrapolation of preshower information to calorimeter
- Purity of preshower and muon system only selection wrt ancillaries

General info

- Lead thickness scan with electron beam
- Muon / Electron beam with no additional lead
  - 5 mm lead always in front of all pre-shower and muon system detectors
- Runs used:
  - 51 (calo #12688): MUON 40 GeV - Pb: 0 mm (+ 5 mm) = ~ 1.0 X_0
  - 71 (calo #12709): ELECTRON 20 GeV - Pb: 0 mm (+ 5 mm) = ~ 1.0 X_0
  - 66 (calo #12705): ELECTRON 20 GeV - Pb: 3 mm (+ 5 mm) = ~ 1.5 X_0
  - 65 (calo #12704): ELECTRON 20 GeV - Pb: 6 mm (+ 5 mm) = ~ 2.0 X_0
  - 64 (calo #12703): ELECTRON 20 GeV - Pb: 10 mm (+ 5 mm) = ~ 2.5 X_0

Counting particles

- Took **muon average cluster charge of the most charged cluster as reference = 1 particle**
- **Divided cluster charge of electron clusters by muon reference cluster charge** and got a guess on how many particles are in each electron cluster
- Same procedure using cluster size of electron clusters divided by the reference muon cluster size
- Comparison between **GEANT simulation**, **Charge** method, **Size** method



Counting particles

- Tested 6 methods, some of them show similar results, here the best 4 are described and shown

Counting particles

1

charge/charge(ref)

- < 1 → n = 1
- ≥ 1 → n = lower int

2

charge/charge(ref)

- < 0.5 → n = 1
- ≥ 0.5 → n = nearby int

3

charge/charge(ref)

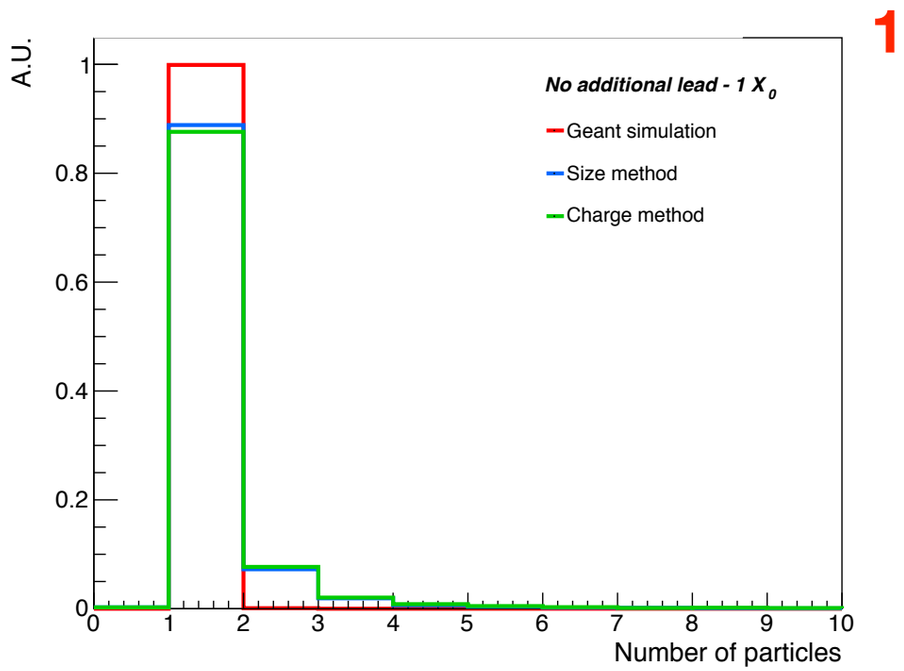
- < # strip SAT → n = # strip SAT
- ≥ # strip SAT
  - n < 0.5 → n = 1
  - n ≥ 0.5 → n = nearby int

4

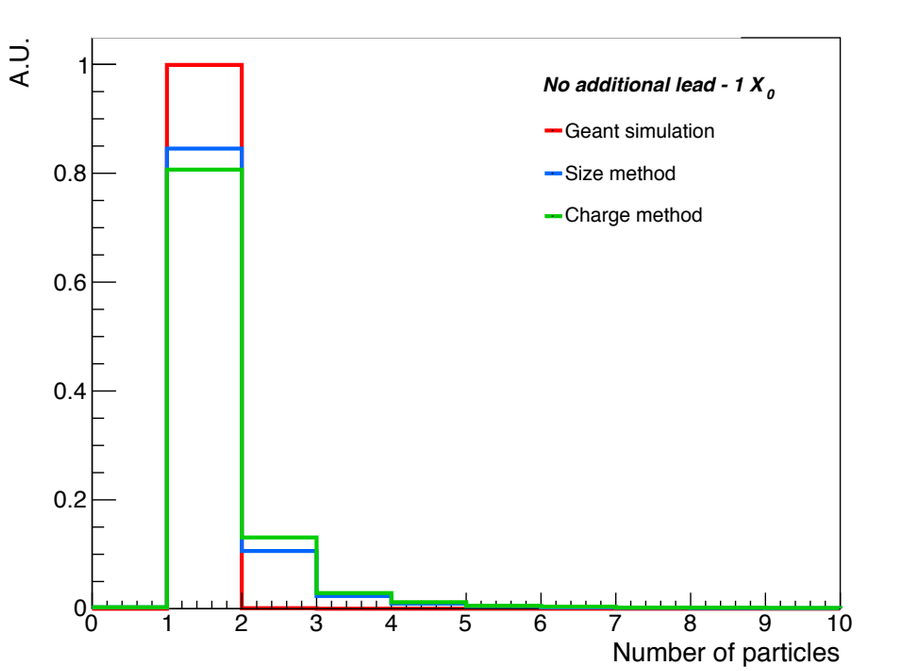
charge/charge(ref)

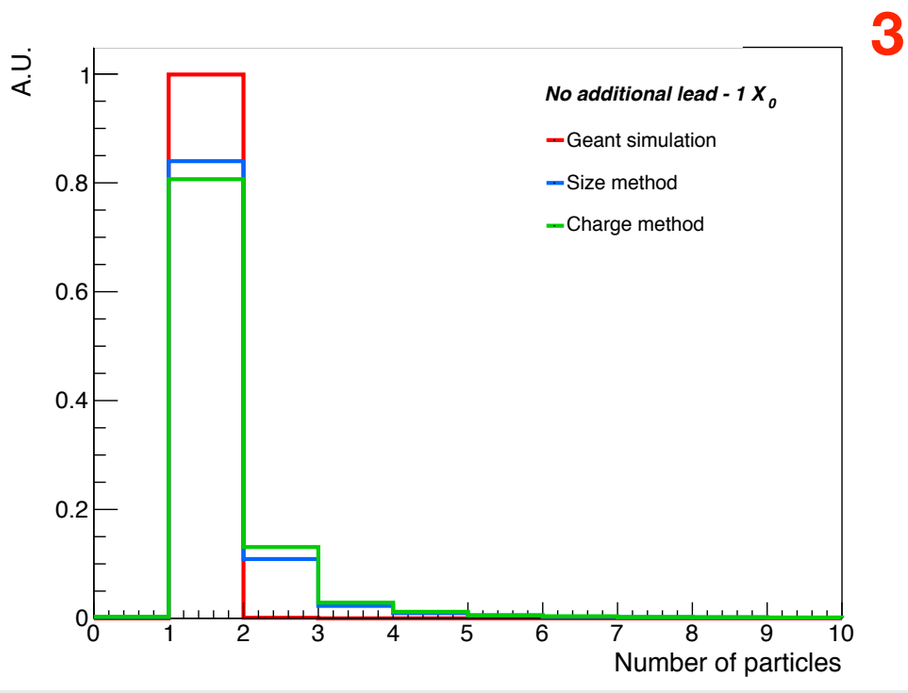
- < # strip SAT → n = # strip SAT
- ≥ # strip SAT
  - n < 1 → n = 1
  - n ≥ 1 → n = lower int

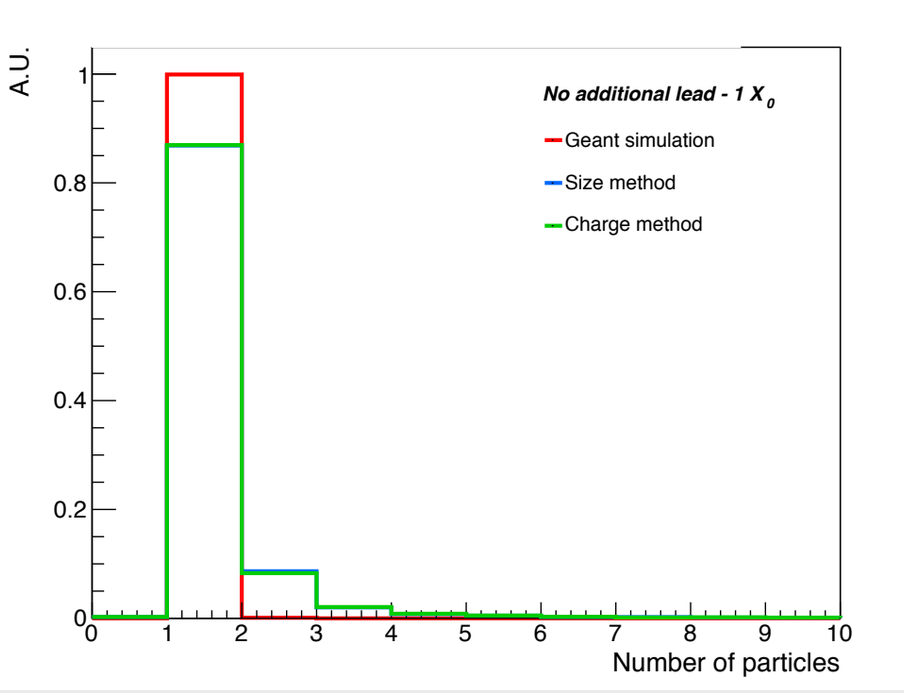
Counting particles



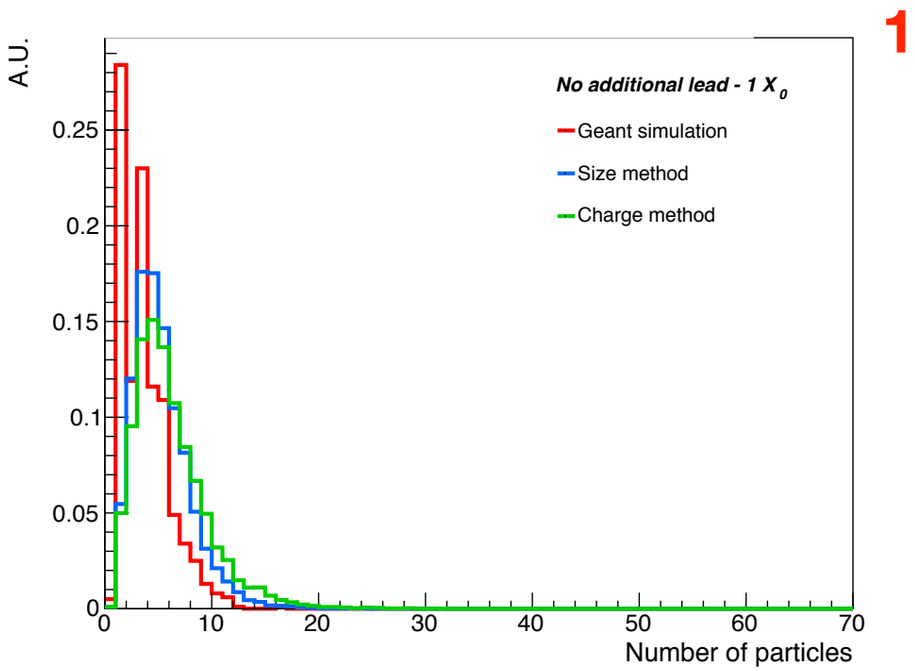
Run 51
MU
No +Pb



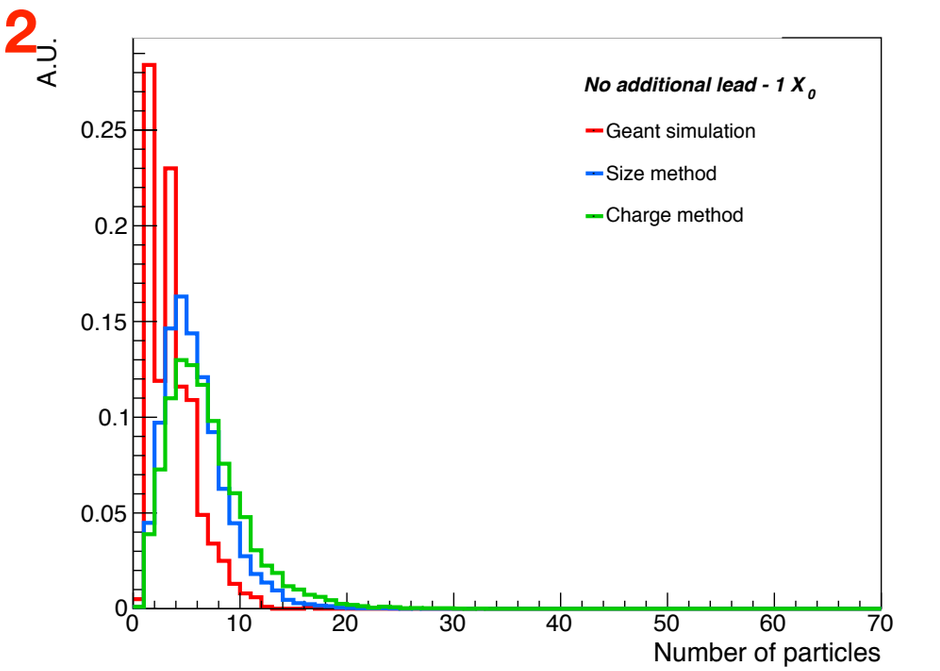


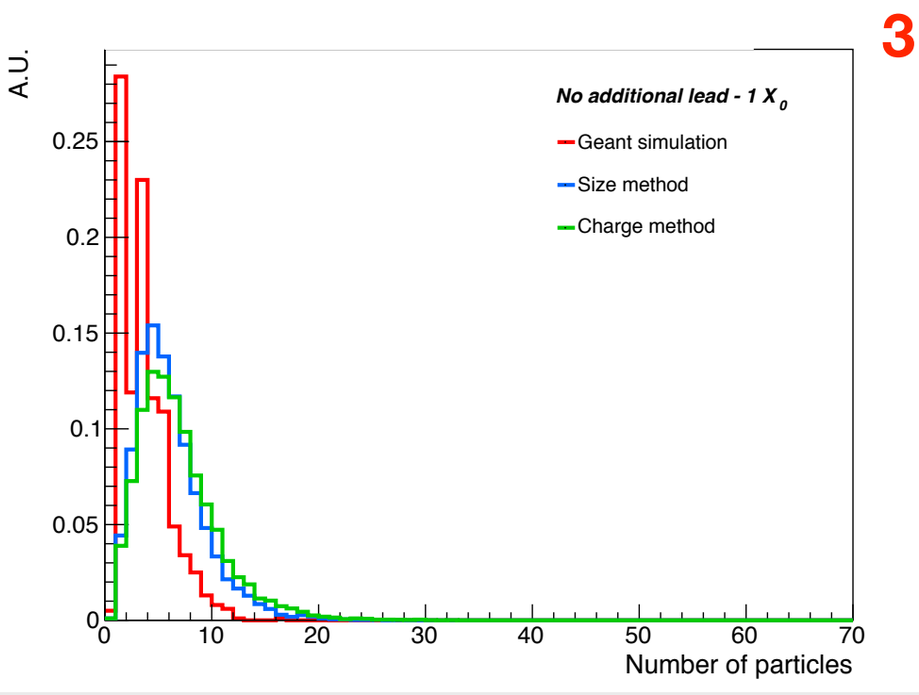


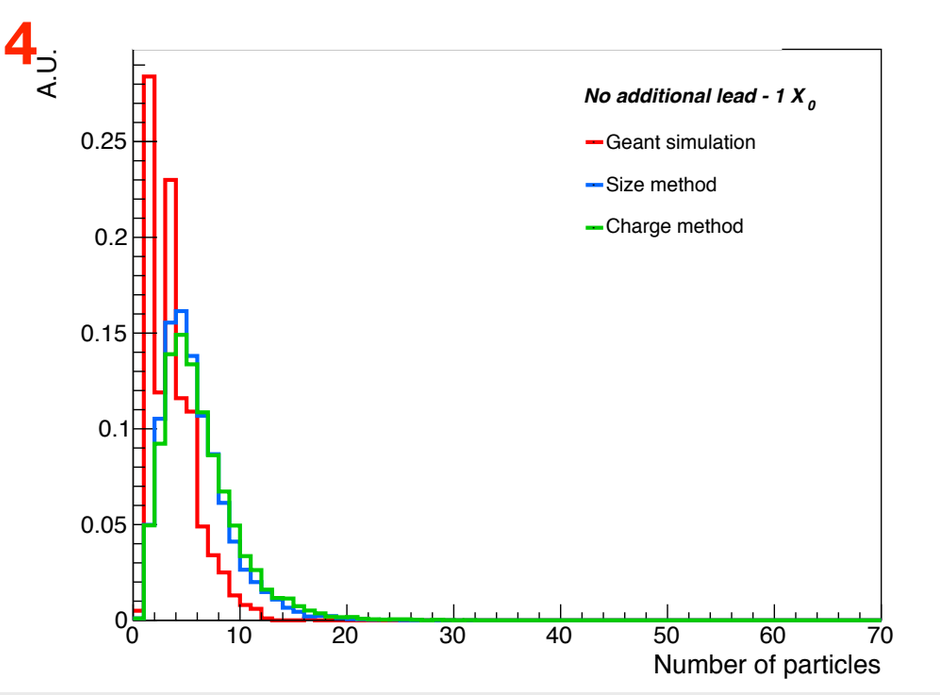
Counting particles



Run 71
ELE
No +Pb



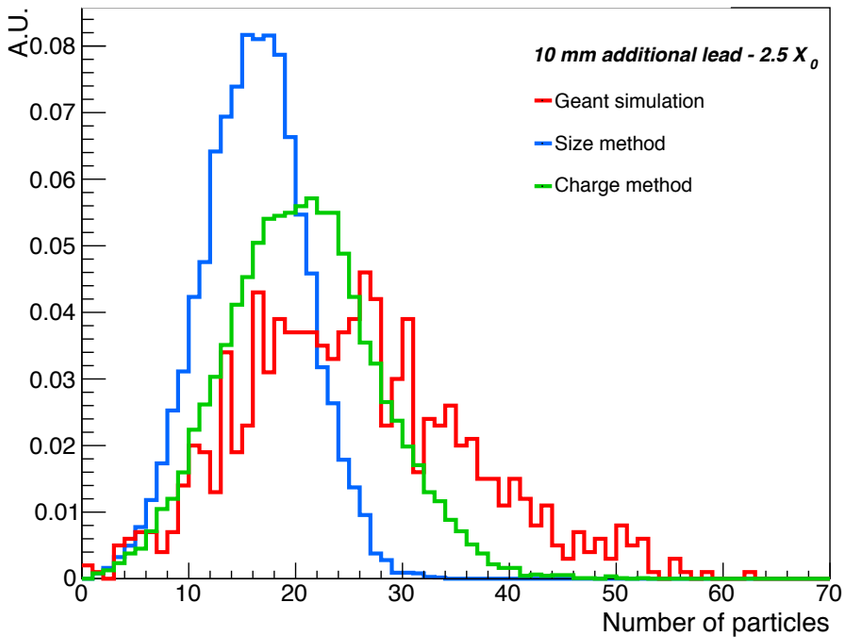




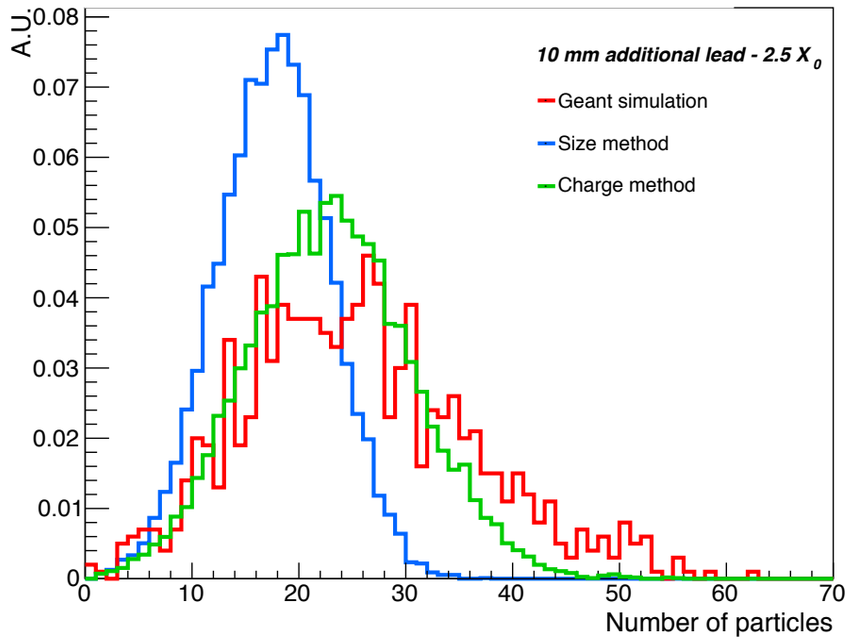
Counting particles

Run 64
ELE
+10 mm Pb

1



2



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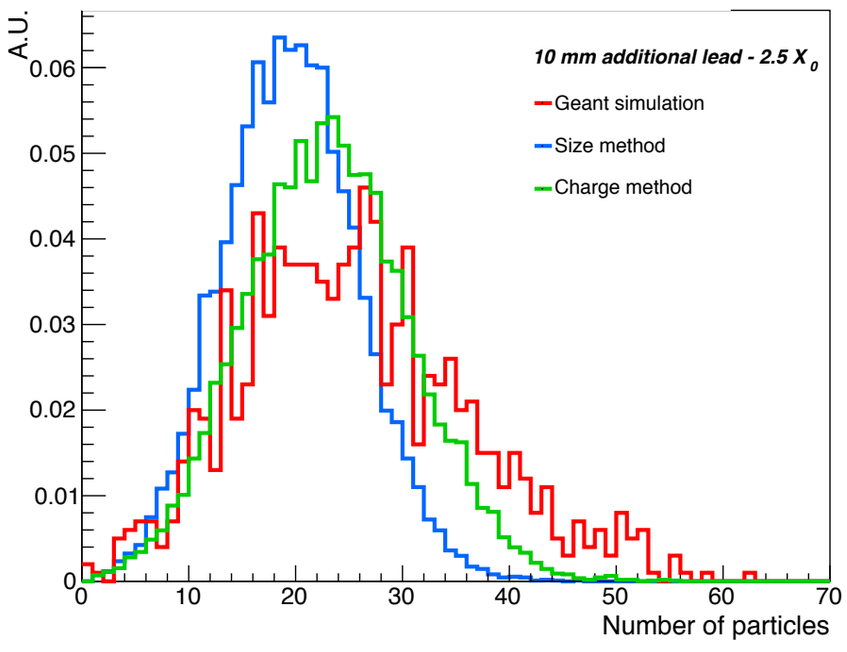
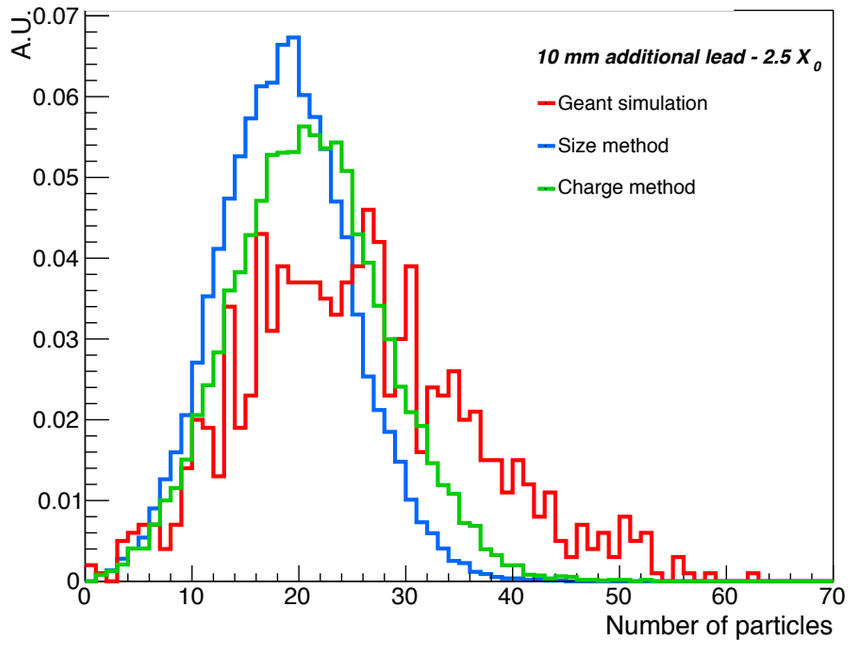


4

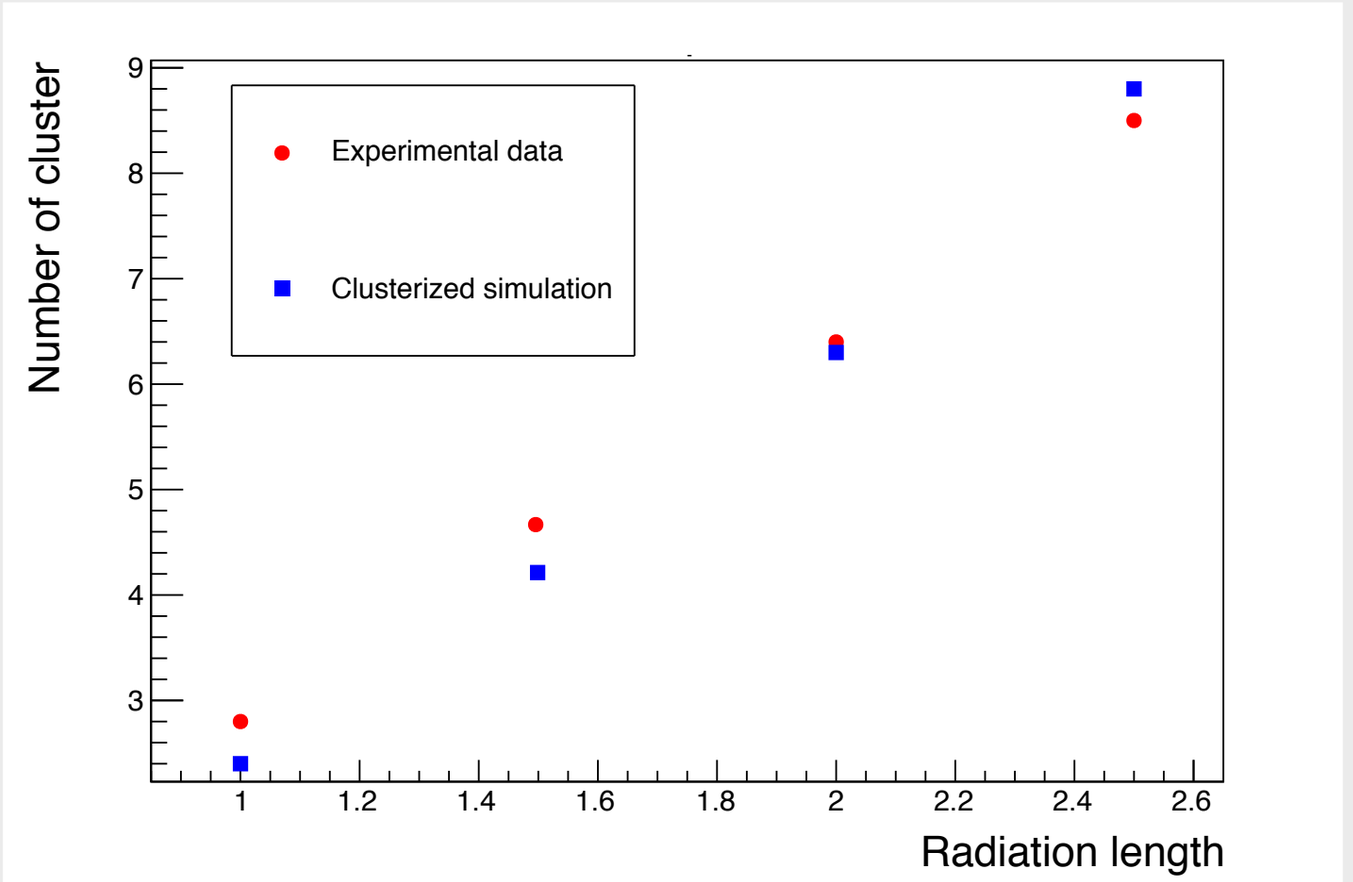


Counting particle

- All methods are not perfect: the ones that perform better with no +Pb are not so good with +10 mm Pb, and viceversa
- In general, it is more accurate to select a method with the corrections for number of saturated strips

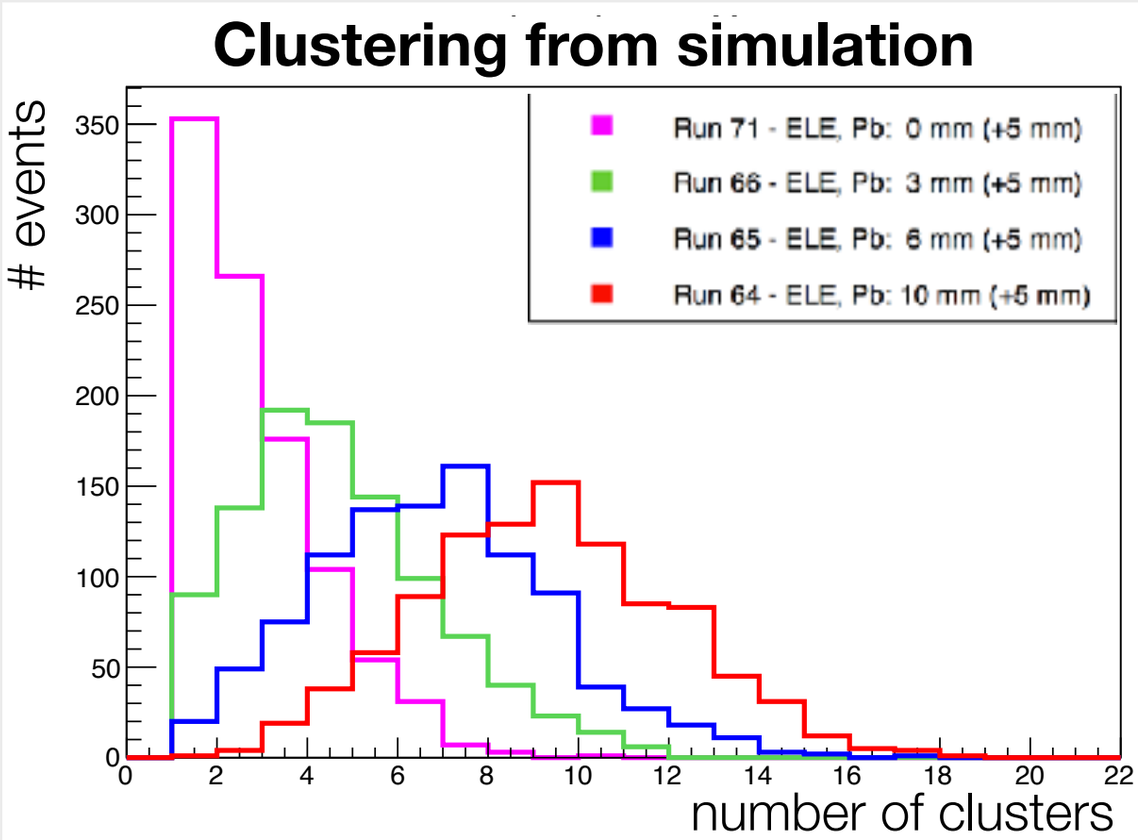
Clustering from simulation data

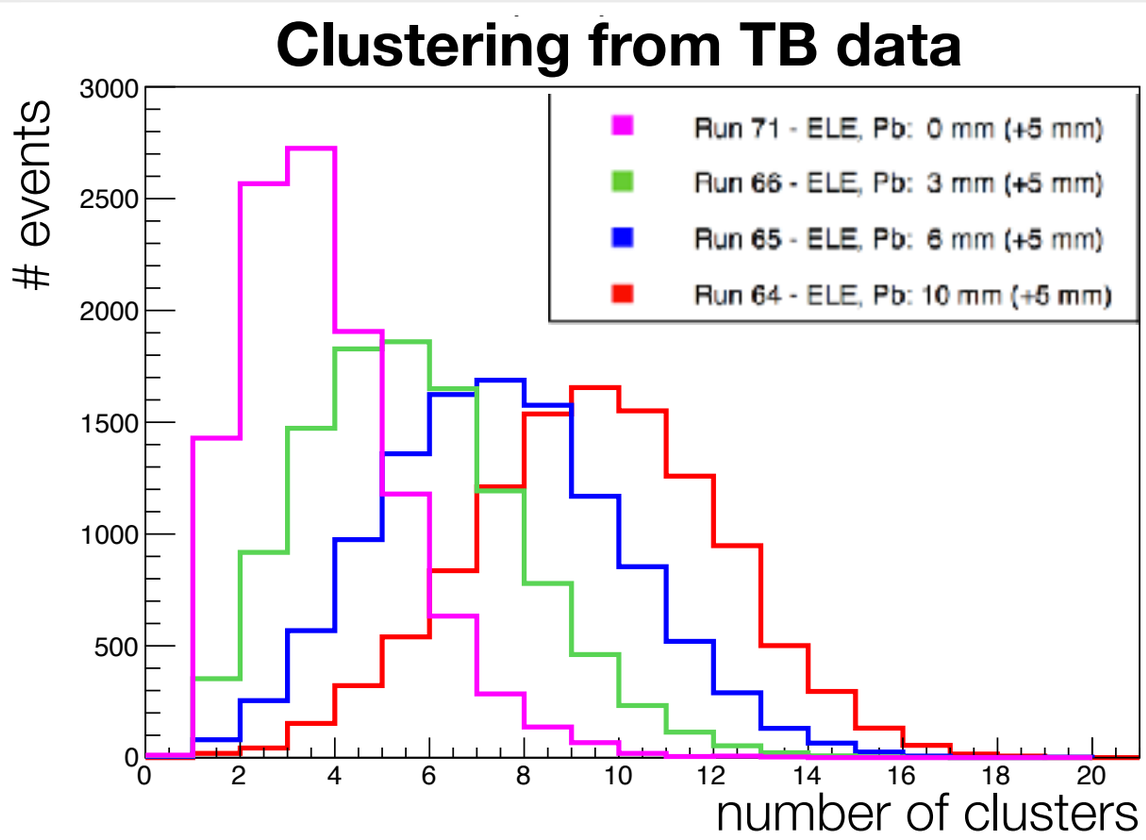
- Alternative method to count particles: **CLUSTERING** from simulation data and then inverse function to compute the number of particles from data
- Comparison with data: average number of clusters
  - this method uses average cluster size from data in any case (1.7 mm taken from muon run)
  - Energy cut: > 5 MeV



Clustering from simulation data

- Comparison between number of clusters distributions obtained with clustering on simulation data and on experimental data
  - Energy cut: > 5 MeV





FullSimulation of the detector in the same TB conditions implies a lot of time and work : probably out of this analysis goal

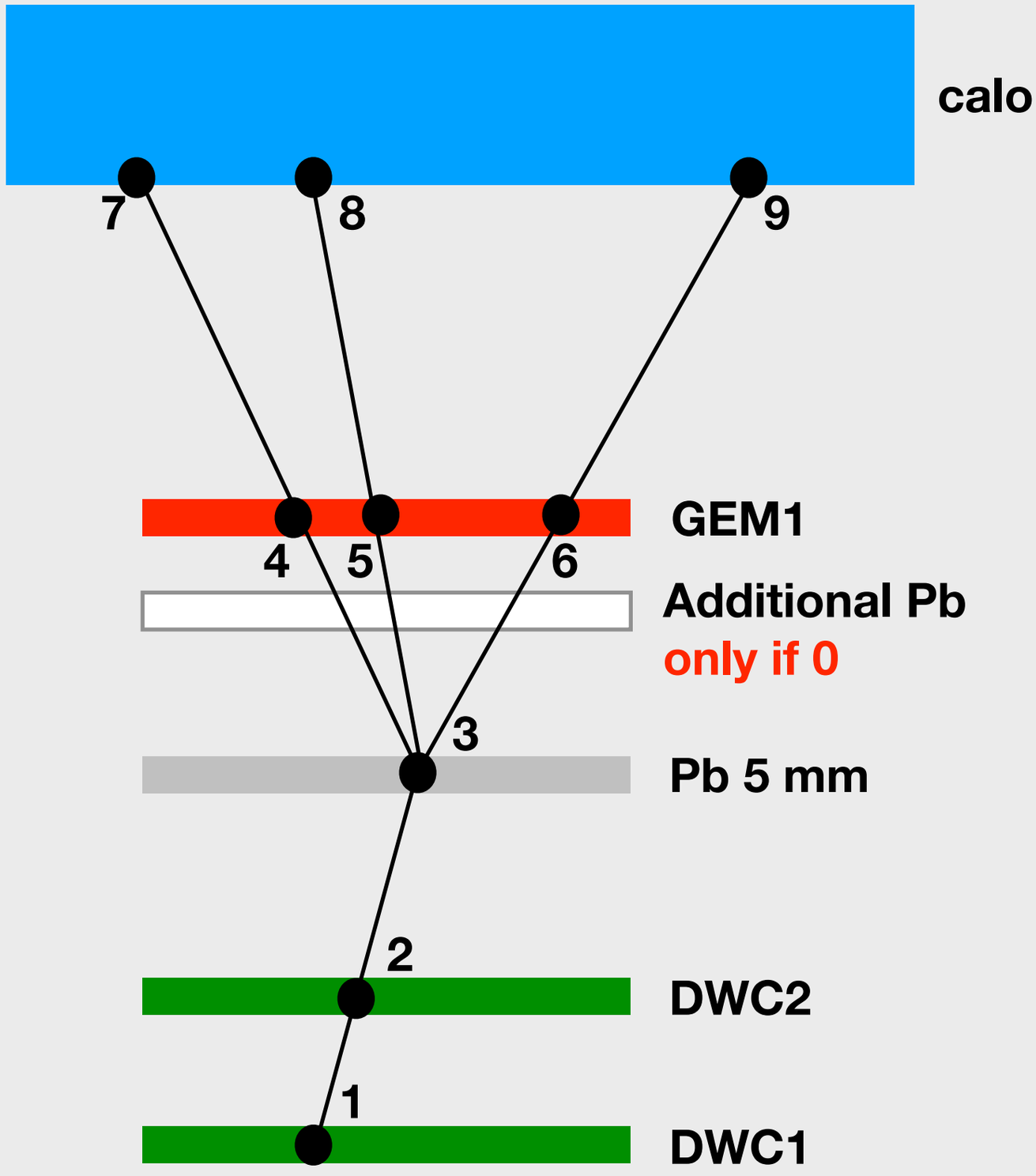
Extrapolation to calo

The goal is to extrapolate position (and number ?) of electrons from preshower to calorimeter

!! Only if Additional Pb is 0 otherwise we have another change in direction and number of particle in the Additional Pb that we cannot measure

merged_runDREAM_12709_runGEM_71.root

Extrapolation to calo



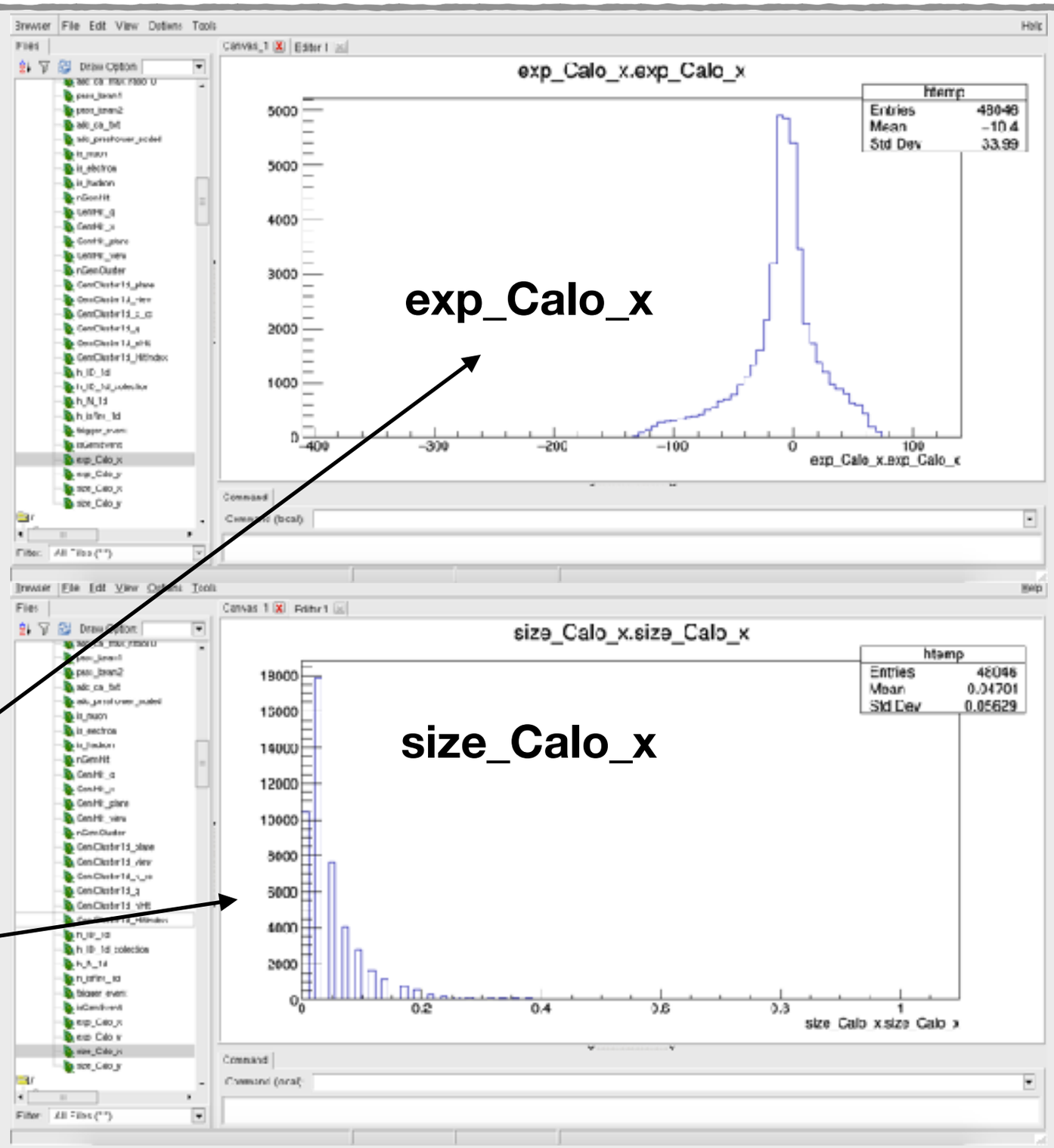
Extrapolation to calo

- Computed the **expected position on the calorimeter surface**
  (assuming distance between GEM1 and calo ≃ 60 cm)
  - Added this info to the MERGED ROOT file
    (a vector of expected positions per event)

- Scaled the size (# of strips) of each cluster in the range [0 , 1] where 0 (1) is the smallest (biggest) cluster in the Run. This gives an idea on how big the **uncertainty on the position** is.
  If the cluster is big, it probably contains more than one particle, but we give only one position i.e. the center of the cluster, with a big “scaled size info”
  - Added this info to the MERGED ROOT file
    (a vector of scaled size of clusters per event)

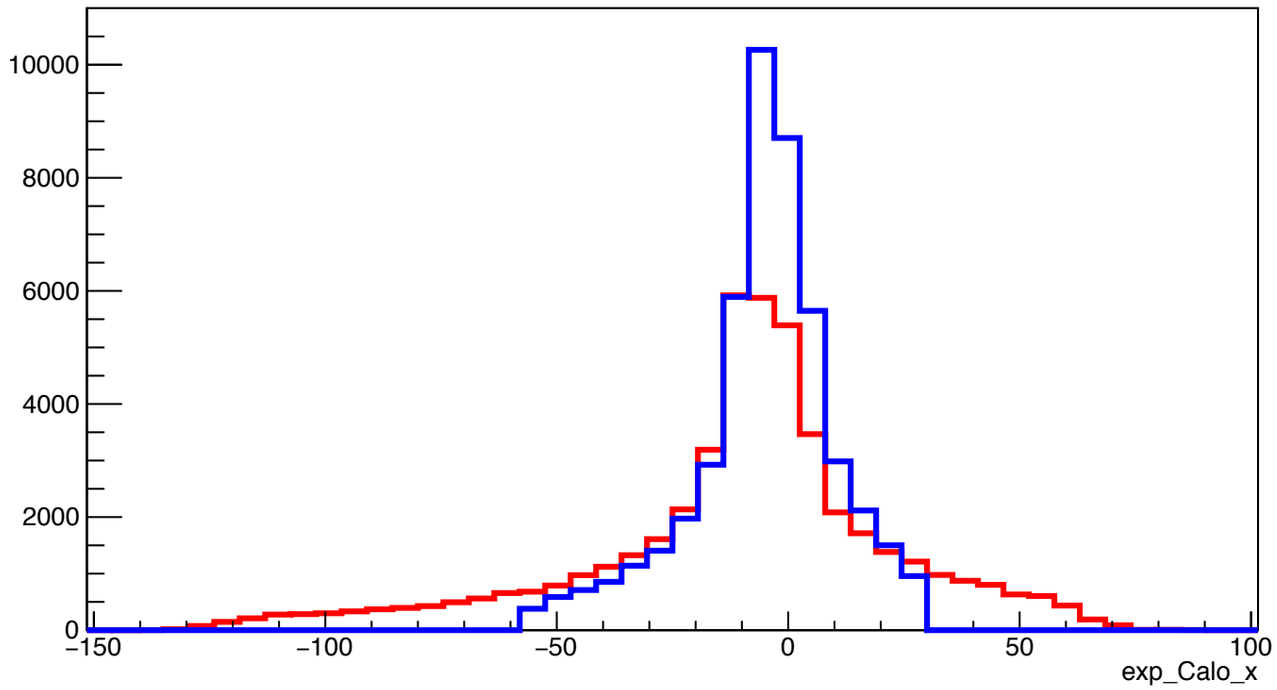
- This procedure is not dependent on the particles counting method

Extrapolation to calo



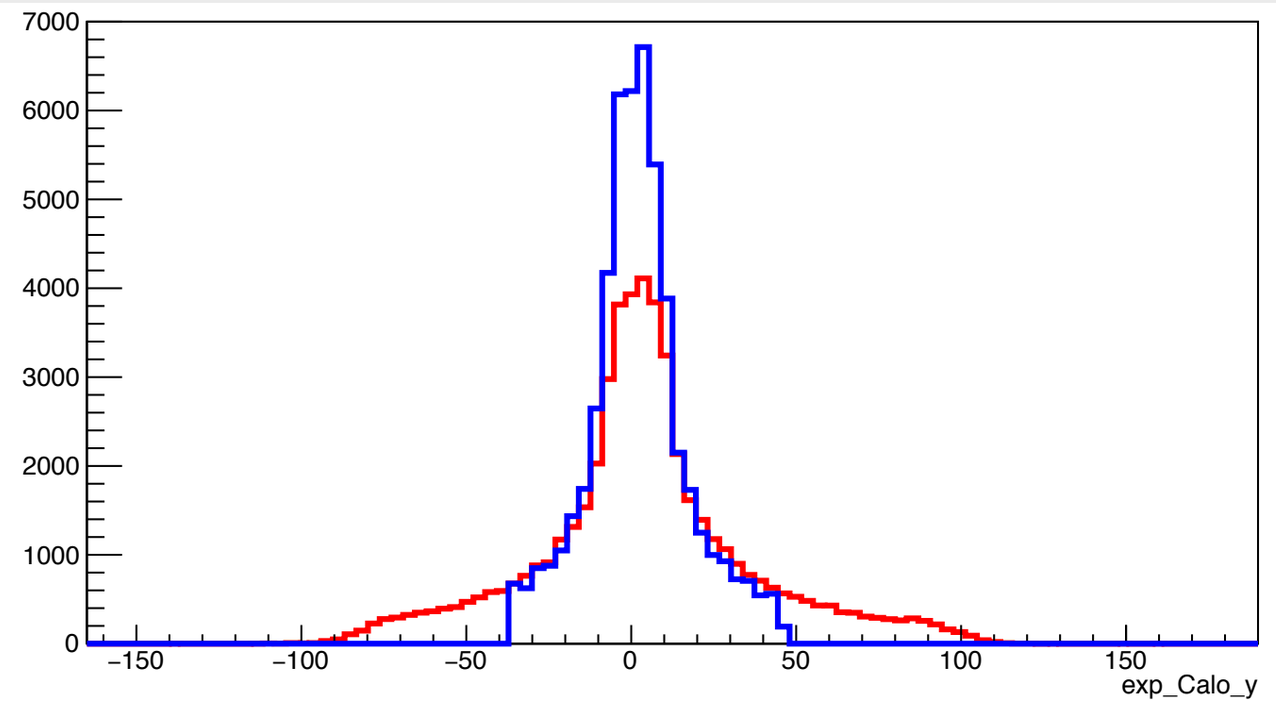
Extrapolation to calo

x position



Beam profile:
GEM 1
expected calo surface

y position



Beam profile:
GEM 1
expected calo surface

Purity of the signal selection

For Muons (same procedure for electrons):

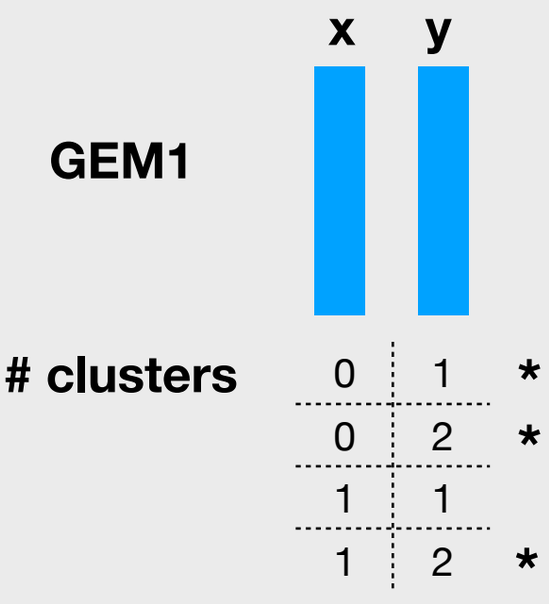
$$\textbf{Efficiency}\ (\text{of GEM selection wrt Ancillaries}) = \frac{\textbf{MU}_{\textbf{GEM}}\ \&\ \text{MU}_{\text{Ancillaries}}}{\text{MU}_{\text{Ancillaries}}}$$

$$\textbf{Fake Rate}\ (\text{of GEM selection wrt Ancillaries}) = \frac{\textbf{MU}_{\textbf{GEM}}\ \&\ (\text{ELE}_{\text{Ancillaries}} + \text{OTHER}_{\text{Ancillaries}})}{(\text{ELE}_{\text{Ancillaries}} + \text{OTHER}_{\text{Ancillaries}})}$$

Purity of the signal selection

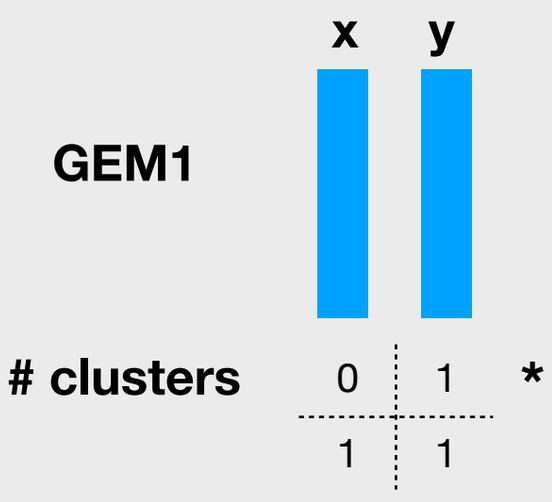
- Ancillaries:
  - MUON : (adc_preshower - adc_ped_mean_preshower) < 20 && (adc_muon - adc_ped_mean_muon) > 10
  - ELECTRON : (adc_preshower - adc_ped_mean_preshower) > 30 && (adc_muon - adc_ped_mean_muon) < 8
  - OTHER : *what does not enter in the previous selections*
- Preshower + Muon System: *** = and viceversa**

muon *tight*

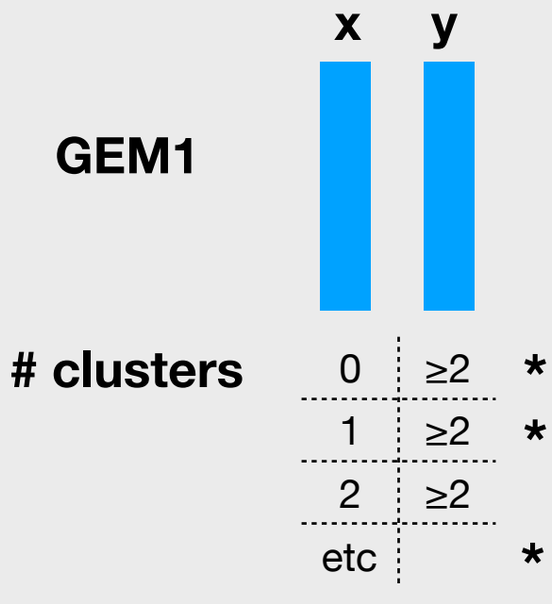


+ ≥ 2 layers hit in the muon system

muon *loose*



electron



+ VETO on muon system

Purity of the signal selection

MUONS : *merged_runDREAM_12688_runGEM_51.root*

number of events per "category"

Ancillaries categorization:

Muon	27398
Electron	3163
Other	12652

Preshower + muon system:

Muon T	33666
Muon L	37333
Electron	3301

Preshower + muon system

Ancillaries	Muon tight	Muon loose	Electron
Muon	25179	25926	26
Electron	48	318	2604
Other	8439	11089	671

Efficiency $_{\text{MU tight}}$ = 25179 / 27398 = 91.9 %

Efficiency $_{\text{MU loose}}$ = 25926 / 27398 = 94.6 %

FakeRate $_{\text{MU tight}}$ = (48+8439) / (3163+12652) = 53.7 %

FakeRate $_{\text{MU loose}}$ = (318+11089) / (3163+12652) = 72.1 %

Purity of the signal selection

ELECTRONS : *merged_runDREAM_12709_runGEM_71.root*

NO +Pb

number of events per "category"

Ancillaries categorization:

Muon	41
Electron	10973
Other	3981

Preshower + muon system:

Muon T	85
Muon L	3380
Electron	11336

Preshower + muon system

Ancillaries	Muon tight	Muon loose	Electron
Muon	38	39	0
Electron	0	1099	9863
Other	47	2242	1473

Efficiency $_{ELE}$ = 9863 / 10973 = 89.9 %

FakeRate $_{ELE}$ = (0+1473) / (41+3981) = 36.6 %

Purity of the signal selection

ELECTRONS : *merged_runDREAM_12703_runGEM_64.root*

+10 mm Pb

number of events per "category"

Ancillaries categorization:

Muon	40
Electron	11082
Other	3909

Preshower + muon system:

Muon T	90
Muon L	404
Electron	14417

Preshower + muon system

Ancillaries	Muon tight	Muon loose	Electron
Muon	36	37	1
Electron	1	16	11059
Other	53	351	3357

Efficiency $_{ELE}$ = 11059 / 11082 = 99.8 %

FakeRate $_{ELE}$ = (1+3357) / (40+3909) = 85.0 %

Backup