SPS data analysis on mini-FoCal

2019/03/08

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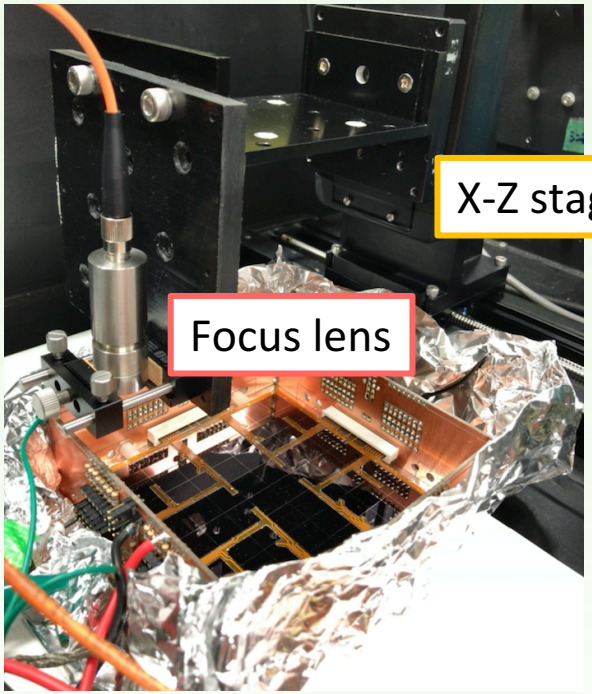
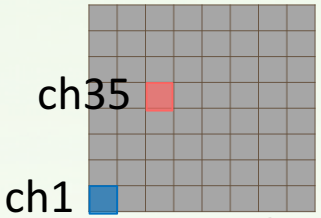
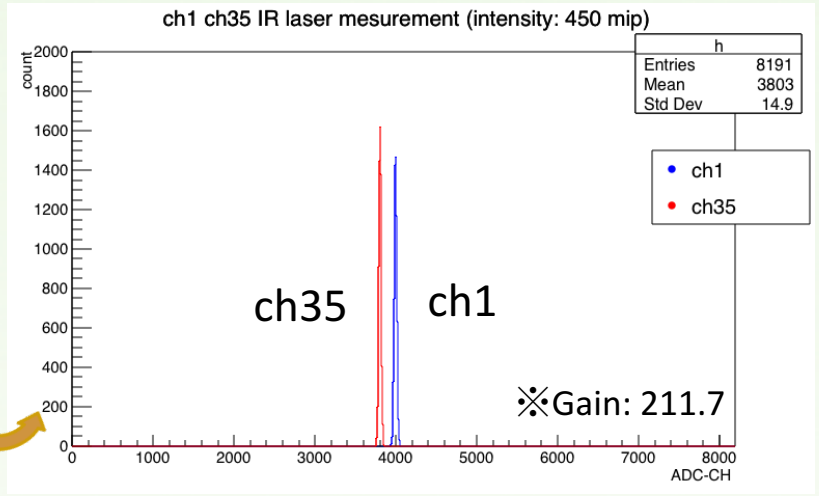
Si Pad test with IR laser



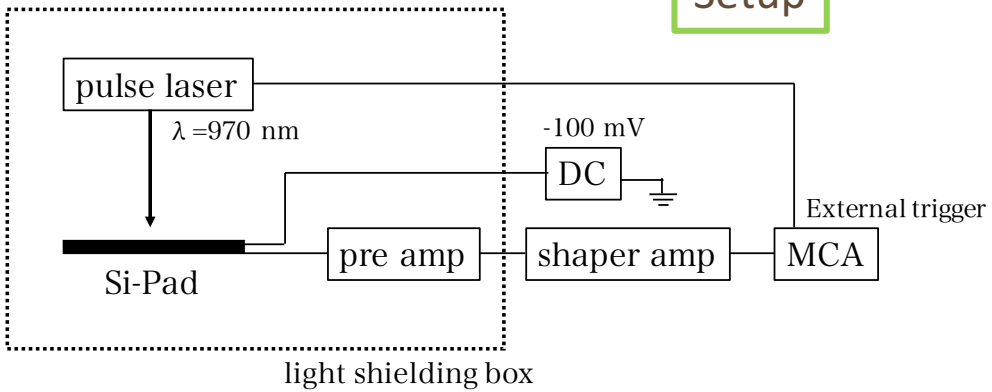
＊location dependence



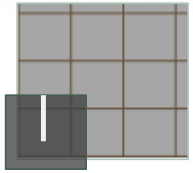


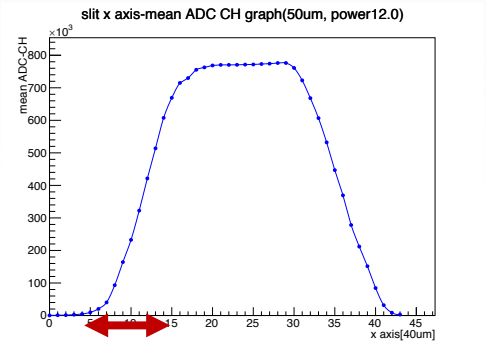
Si Pad test with IR laser (970 nm, 465 mips)
→the difference between 2 channels is 22 mips (=5%)

Setup



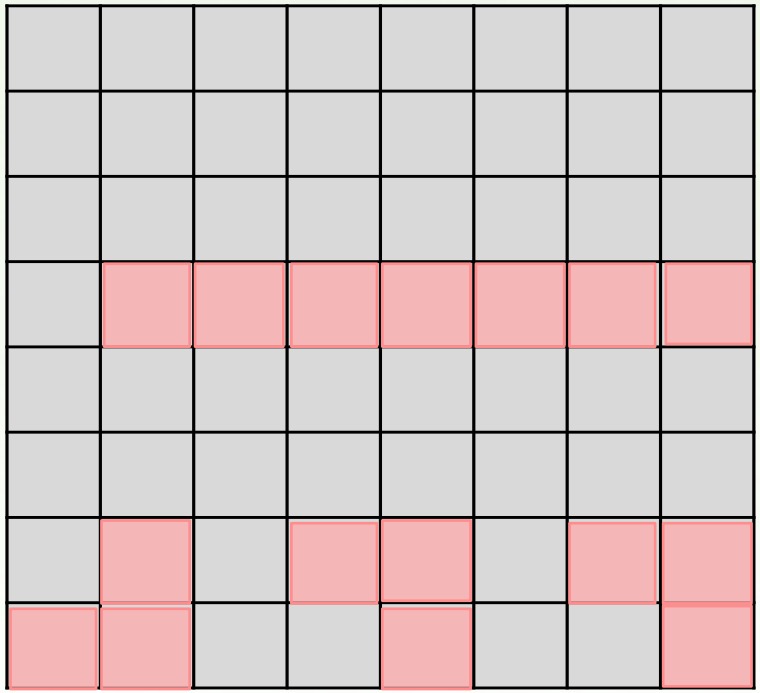
＊Scan with 1mm slit

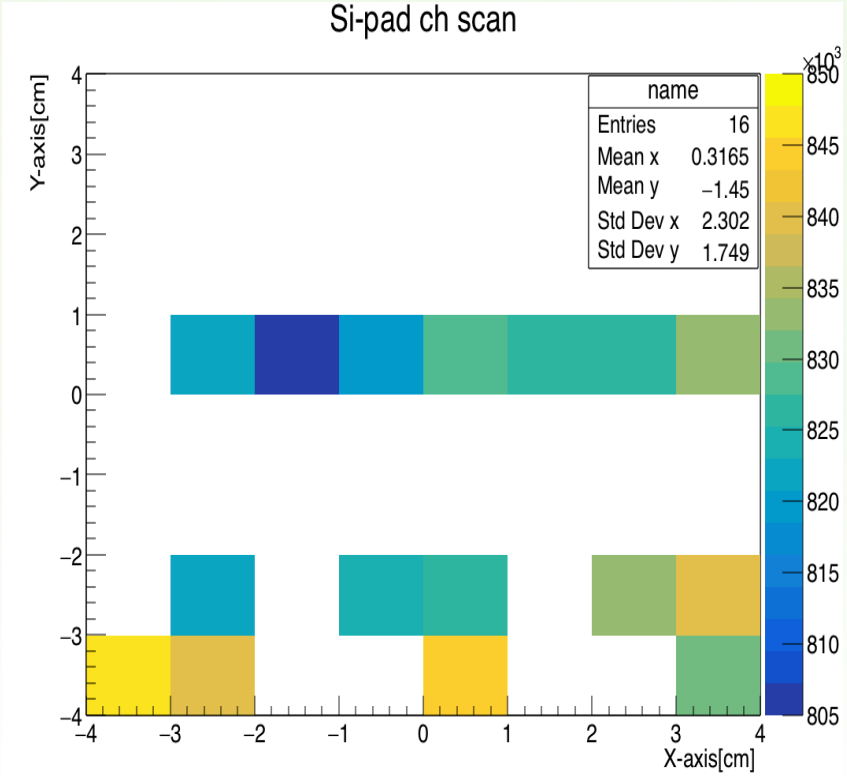




~520um →spot size

Location dependence

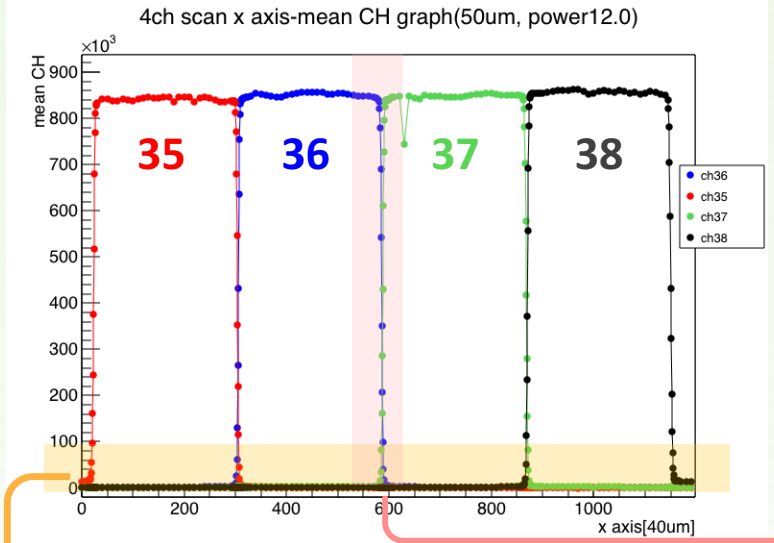


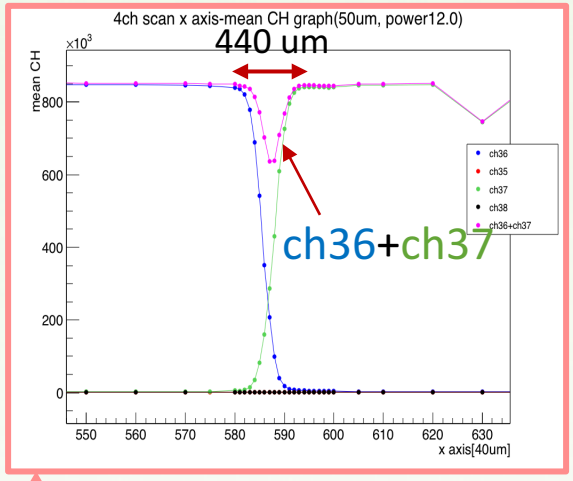


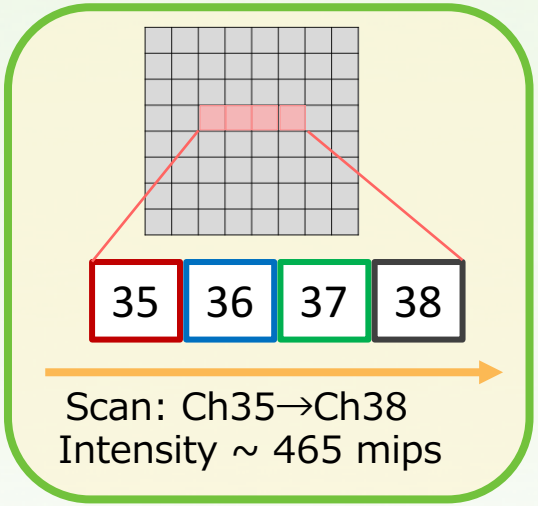
: Target Pad

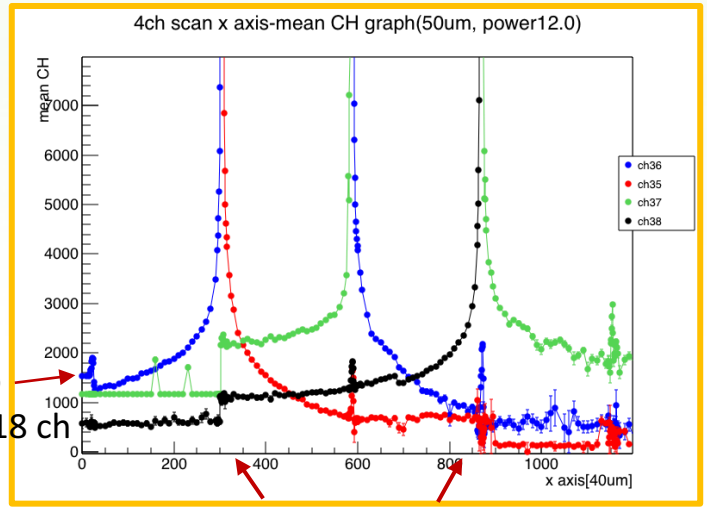
IR laser : 970 nm, 465 mips

Cross talk measurement









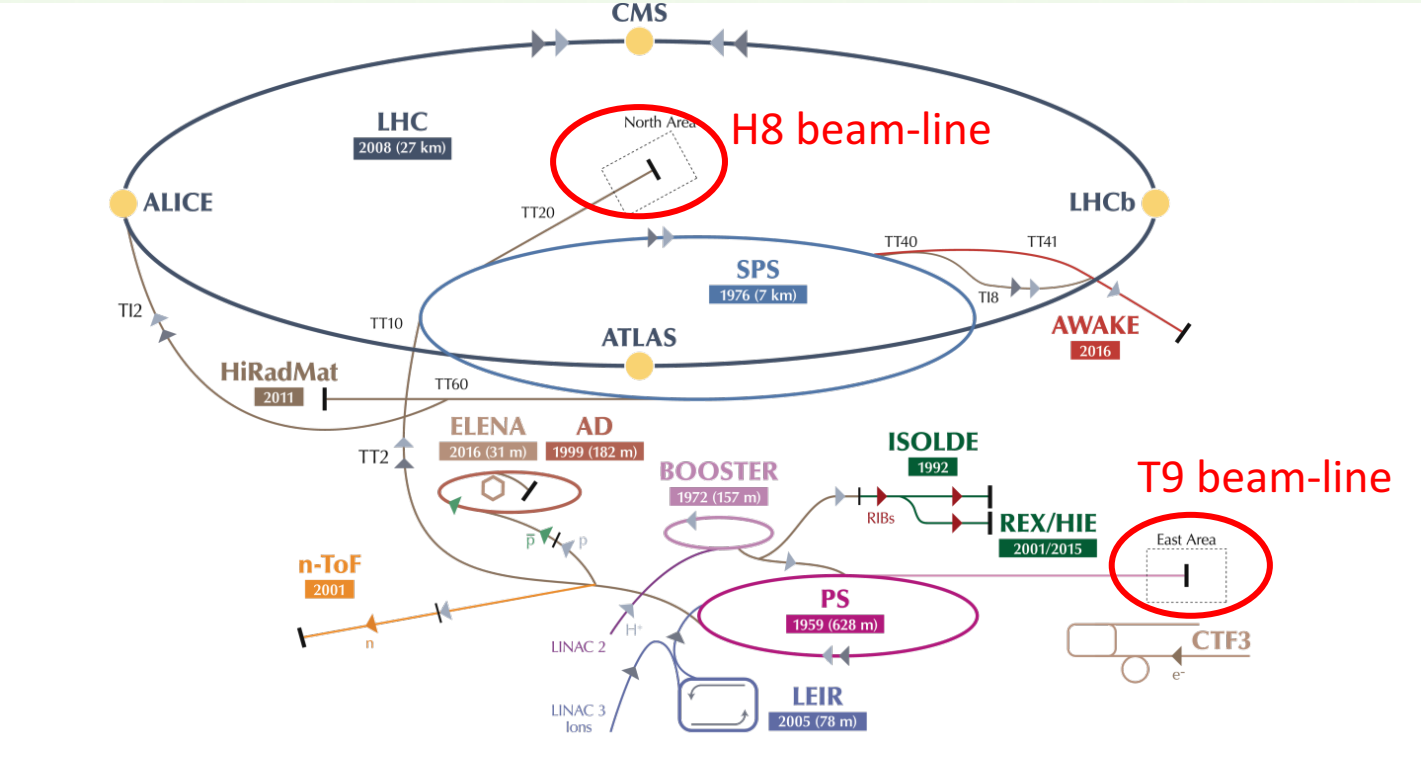
1mip
=1818 ch

Step signal

- ✓ no overlap between Si-Pad
- ✓ Cross-talk signal: 0.2~0.6 mip （=0.1 %）

(Step signal : cross-talk
Slope signal : light expansion)

PS/SPS beam test on mini-FoCal



Beam information

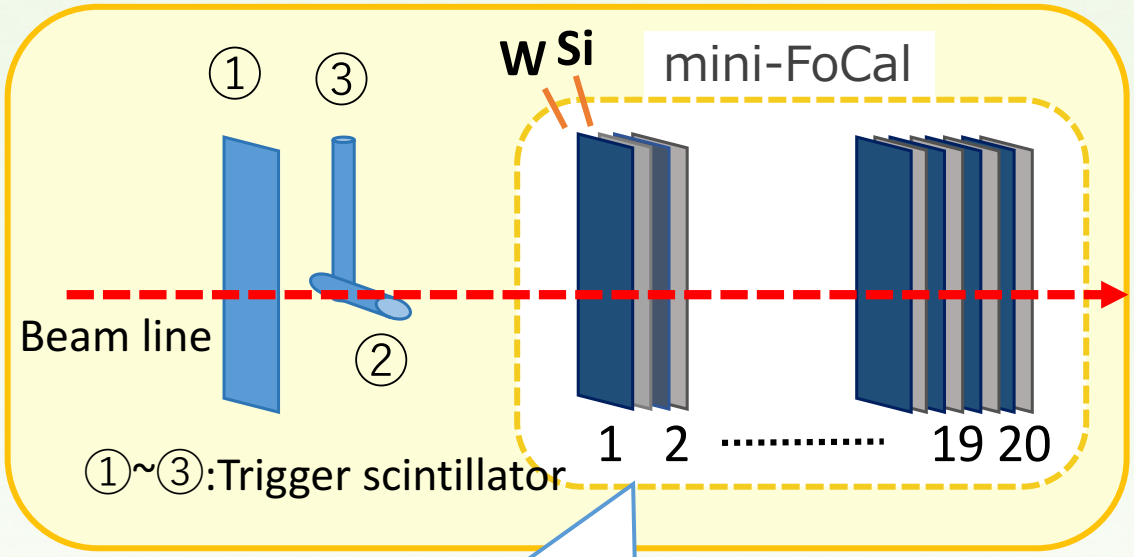
＊ Secondary beam from high energy proton beam

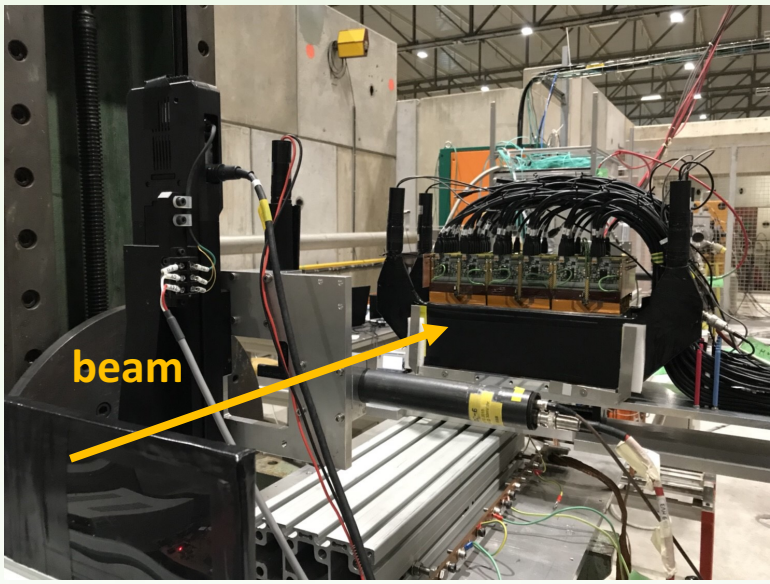
PS side: 1~9 GeV negatively charged particle

SPS side: 100~150 GeV positively charged particle → This talk

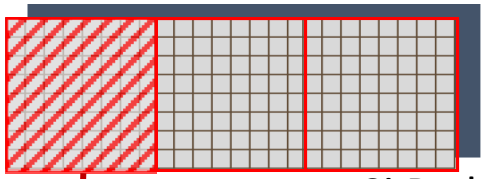
250 GeV negatively charged particle

Mini-FoCal Prototype and Set-up

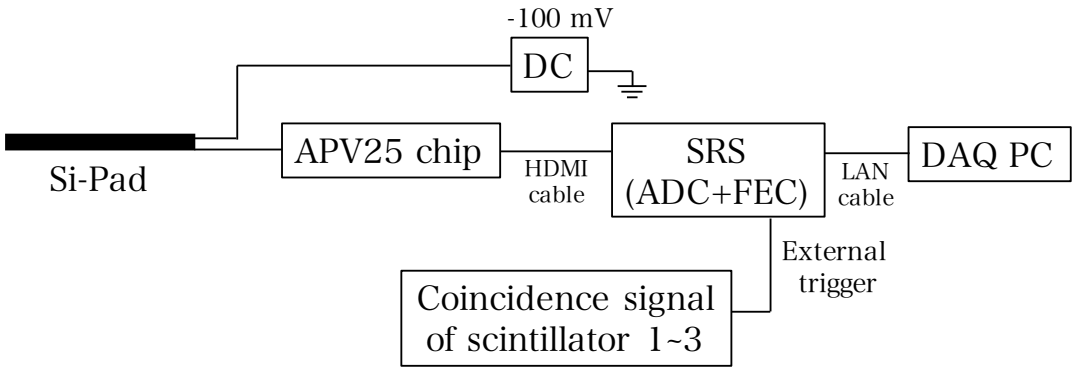




64 pads × 20 layers × 3 towers



1 tower was selected for data-taking



Note: We have not calibrate between pads and layers

Analysis method (in this talk)

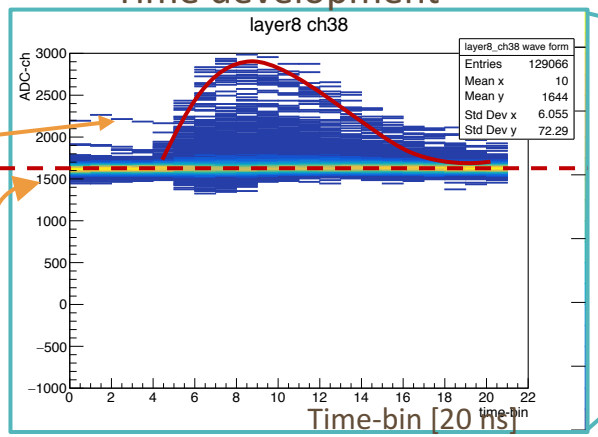
Layer-8 (@$9X_0$)

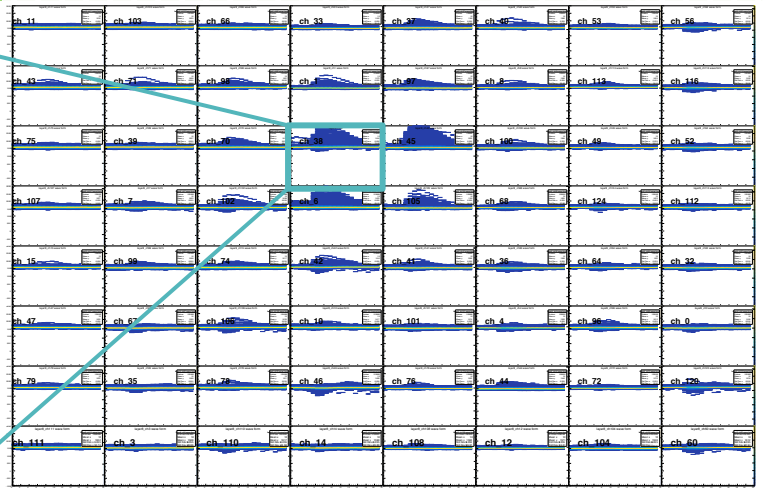
Signal definition

SPS data@150 GeV

Signal
= integral of the form

Time development

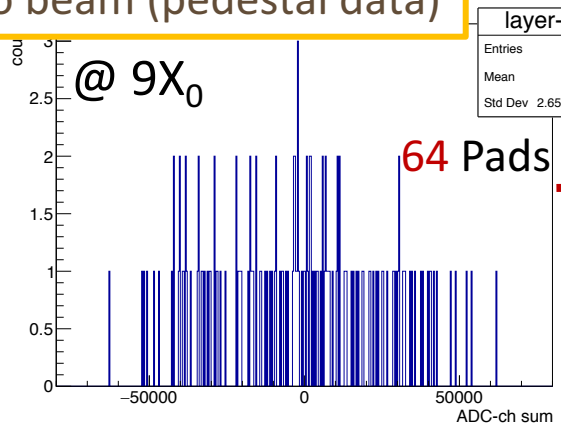




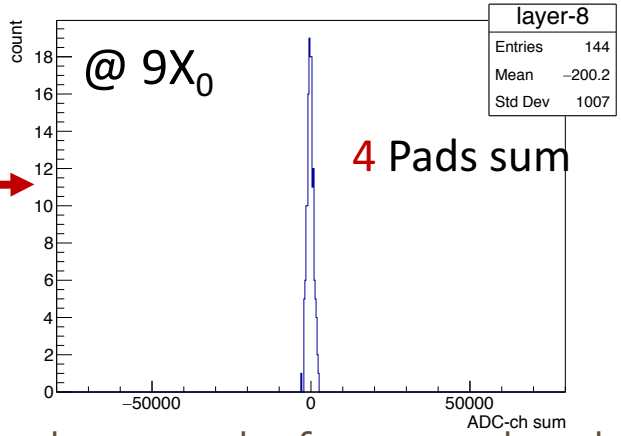
Pedestal level = average ADC value of the first 3 time-bin
→ calculated for each channel and event

Common noise subtraction

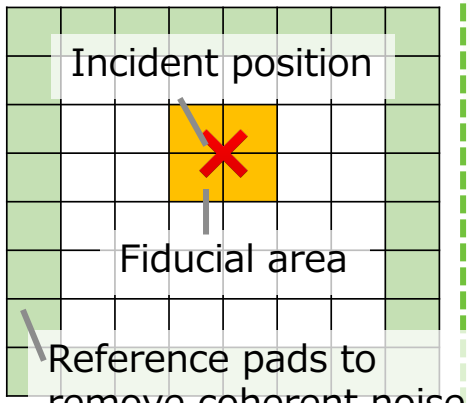
No beam (pedestal data)



64 Pads sum



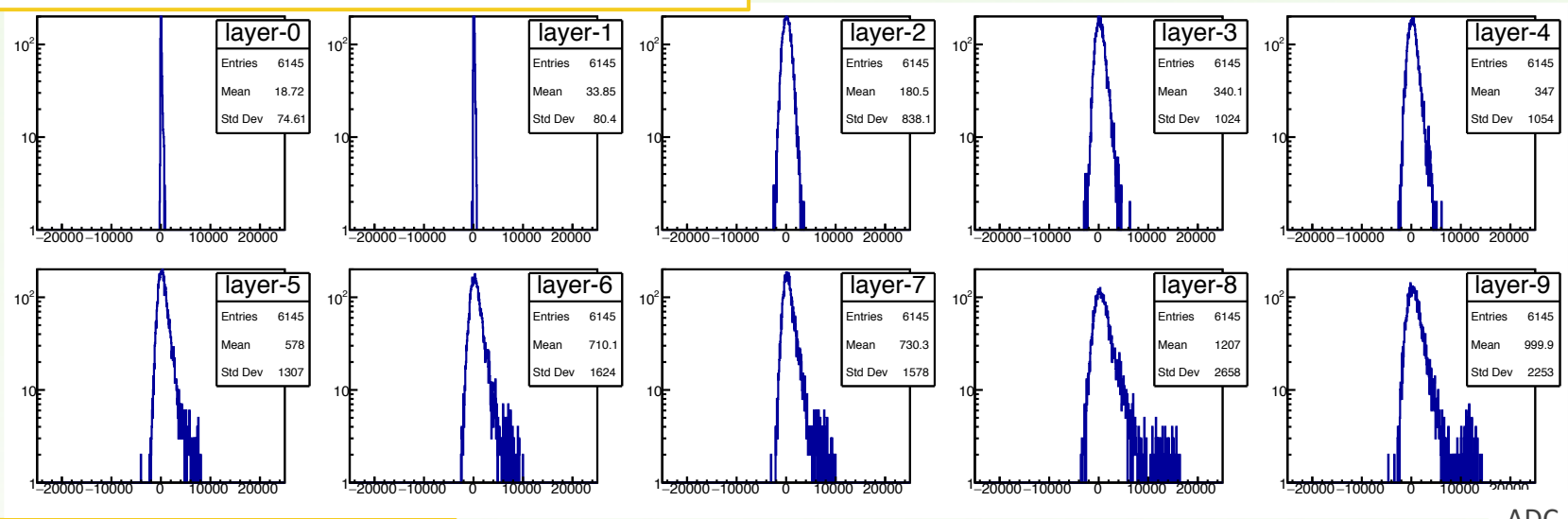
4 Pads sum



＊4pads sum and reference pads reduce the coherent noise

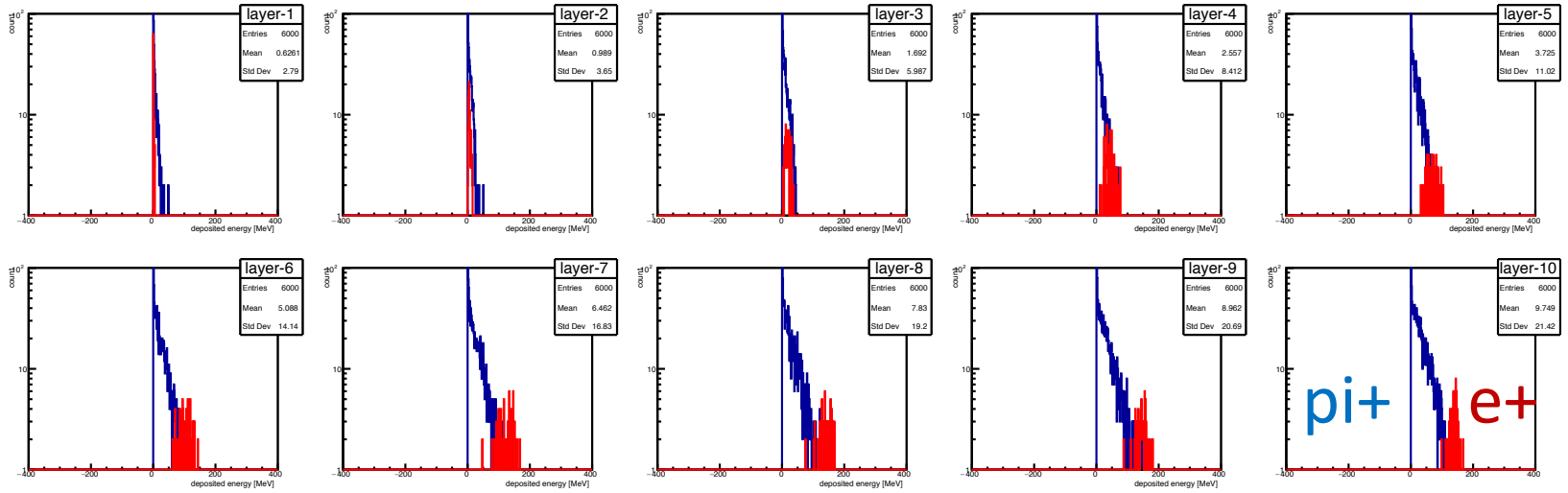
SPS data vs. Geant4 simulation (1~10 X_0)

150 GeV positively charged particle (1~10 X_0)



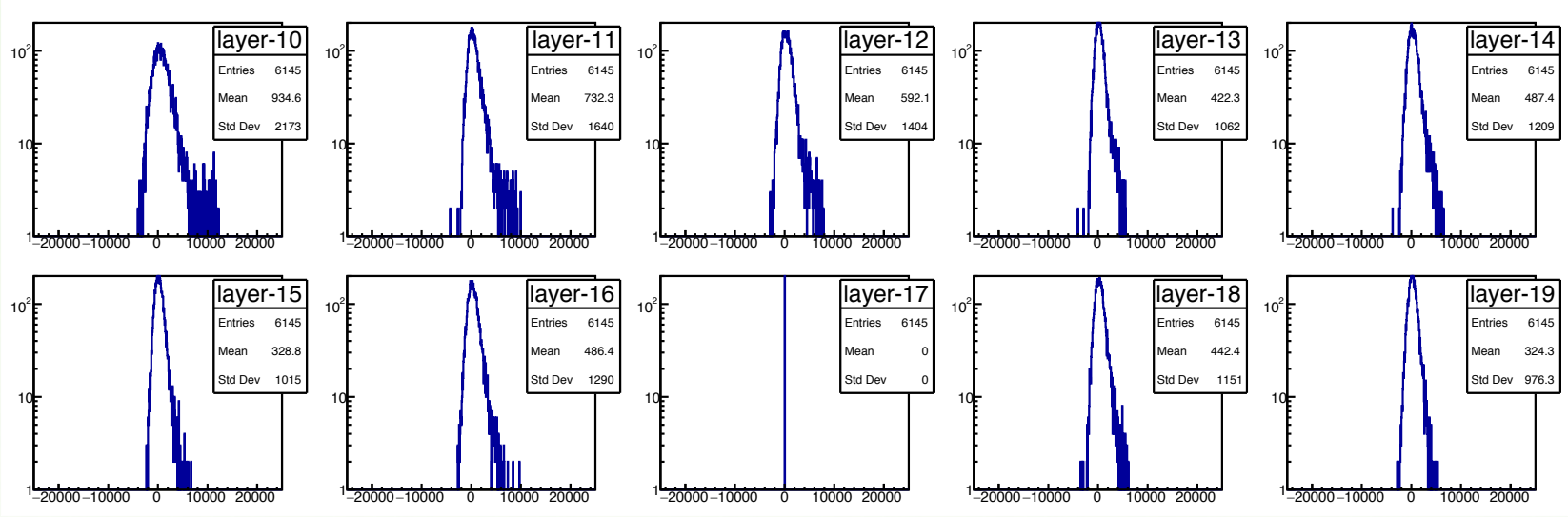
Geant4 simulation (1~10 X_0)

(Assuming the beam contains ~2% positron ... from data)



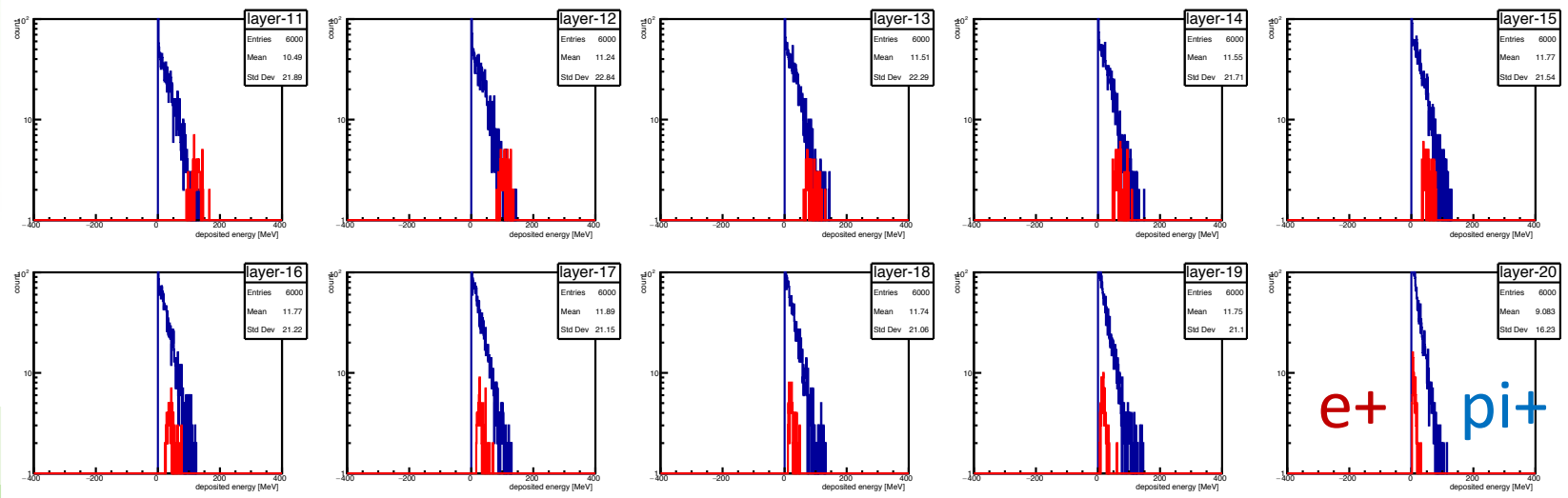
SPS data vs. Geant4 simulation (11~20 X_0)

150 GeV positively charged particle (11~20 X_0)



Geant4 simulation (11~20 X_0)

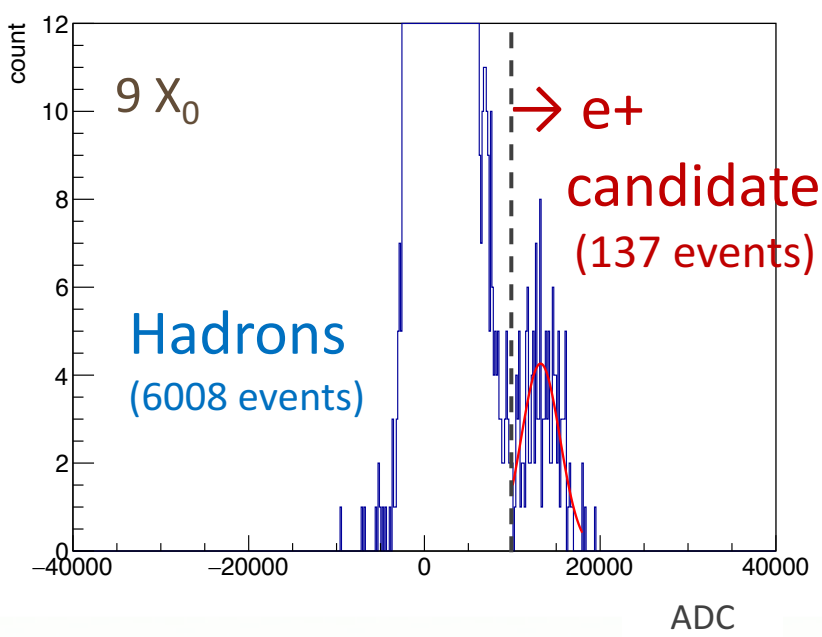
(Assuming the beam contains ~2% positron ... from data)



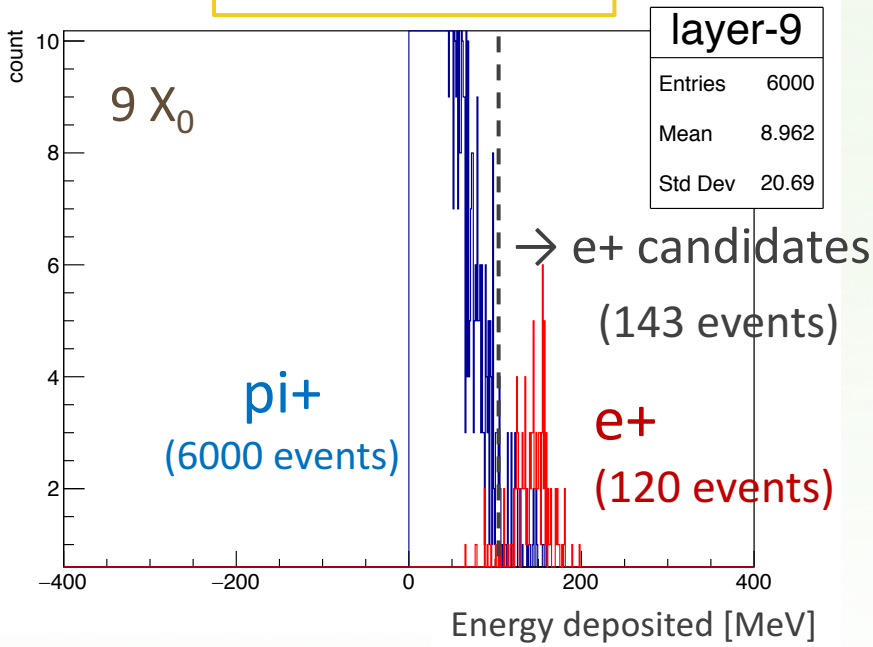
Positron event selection

* Setting the threshold at 9 X_0 layer

SPS data @150 GeV



Geant4 simulation

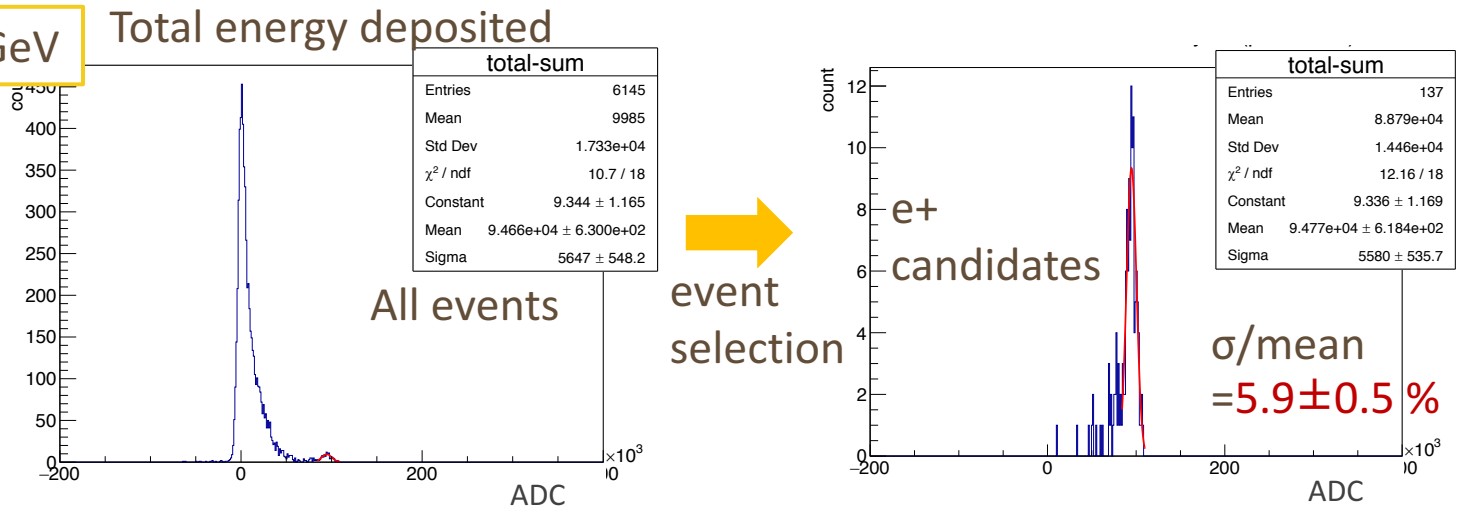


e+ purity of e+ candidates

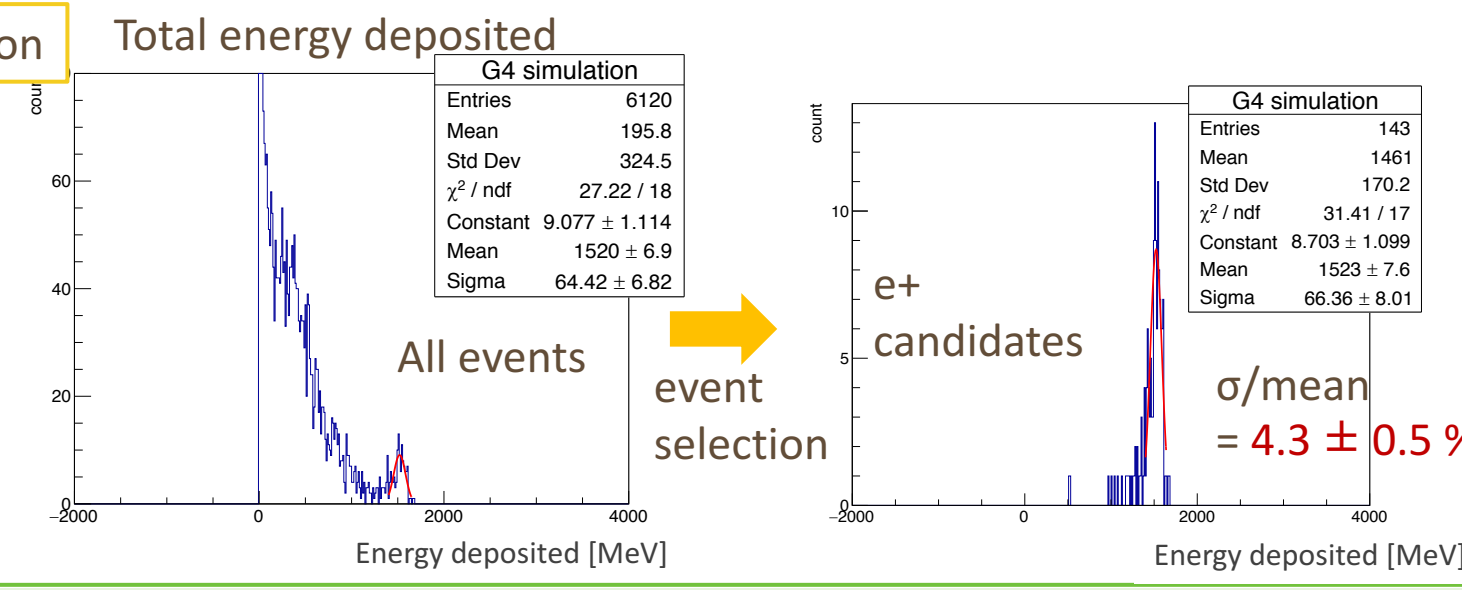
$$\frac{\text{Positron candidate(e+)}}{\text{Positron candidate(all)}} = \frac{110}{143} = 77\ \%$$

Total energy deposited of e+ candidates

SPS data @150 GeV

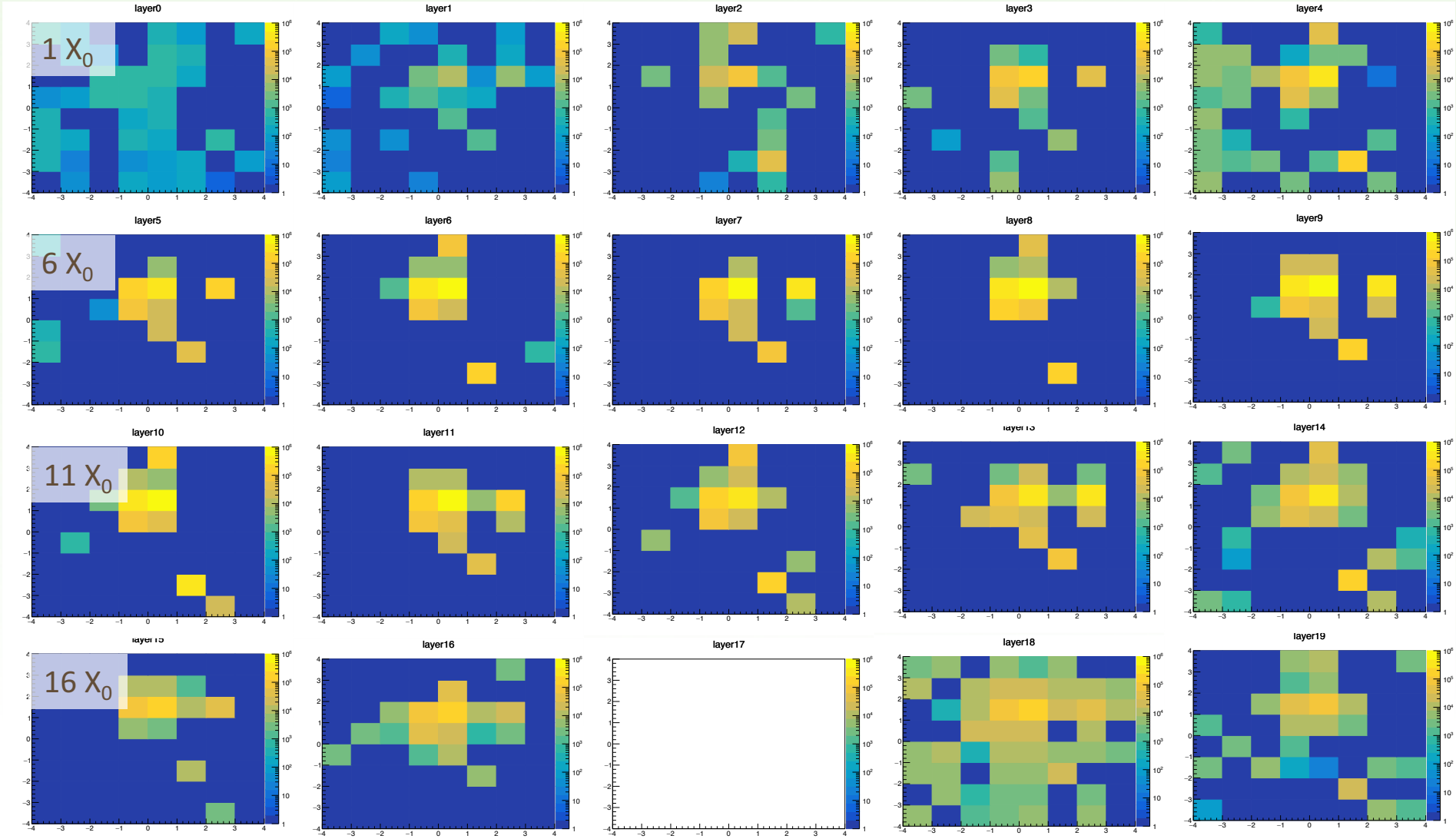


Geant4 simulation



Note: with Pure e+ simulation → σ/mean = 4.0±0.1 % @150 GeV

Hit map

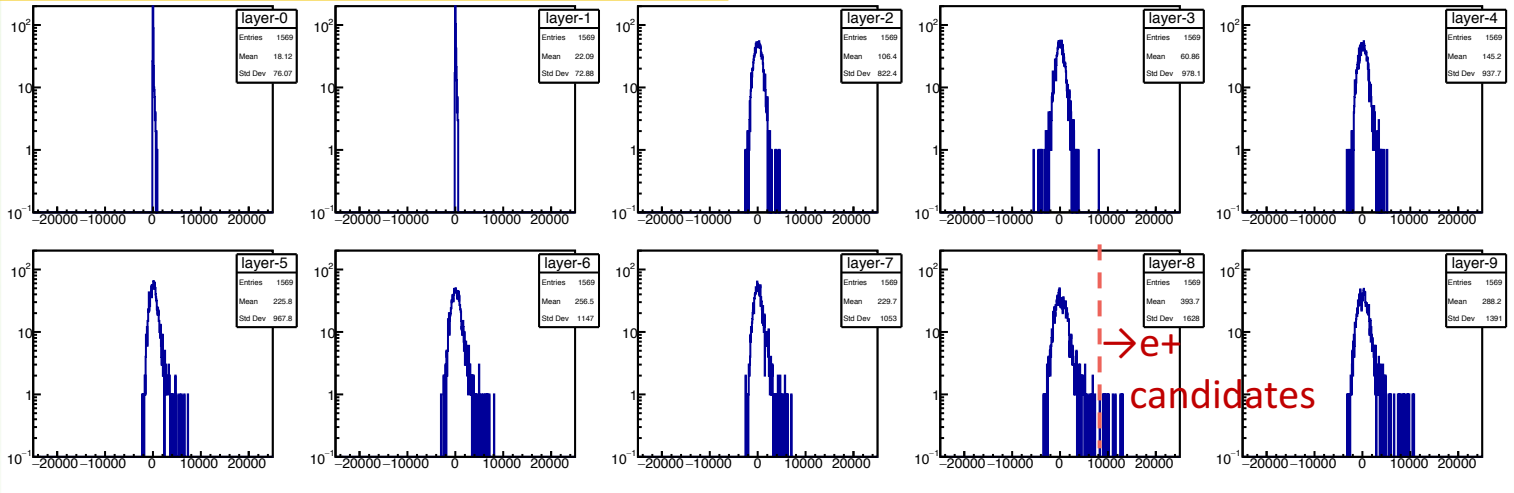


SPS Positron candidates @150 GeV

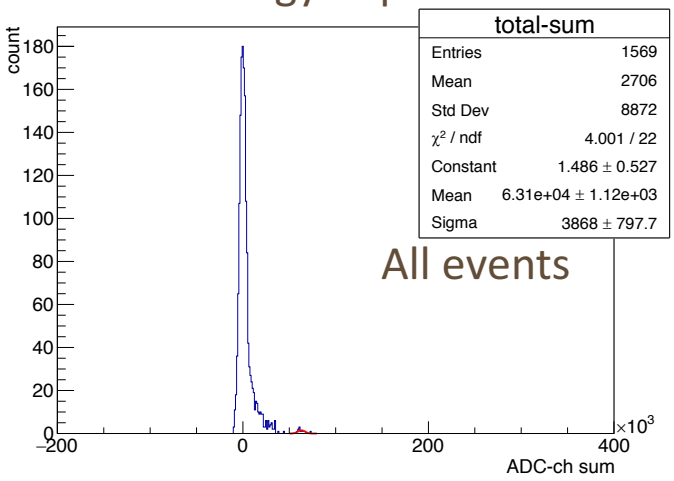
SPS data @110 GeV

110 GeV positively charged particle (1~10 X_0)

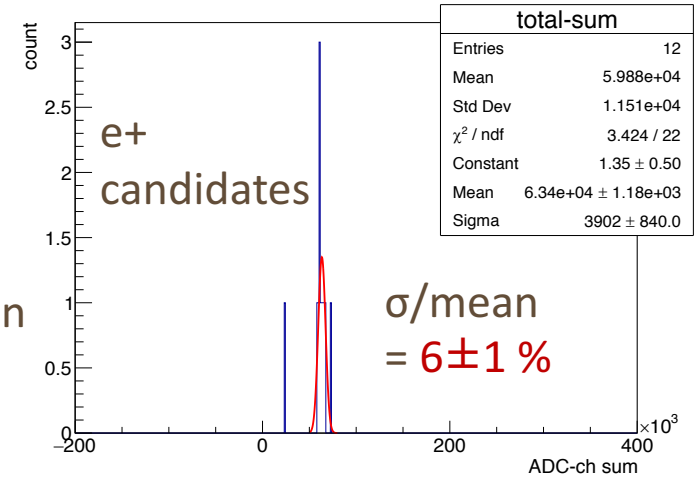
Not so much events at 110 GeV



Total energy deposited



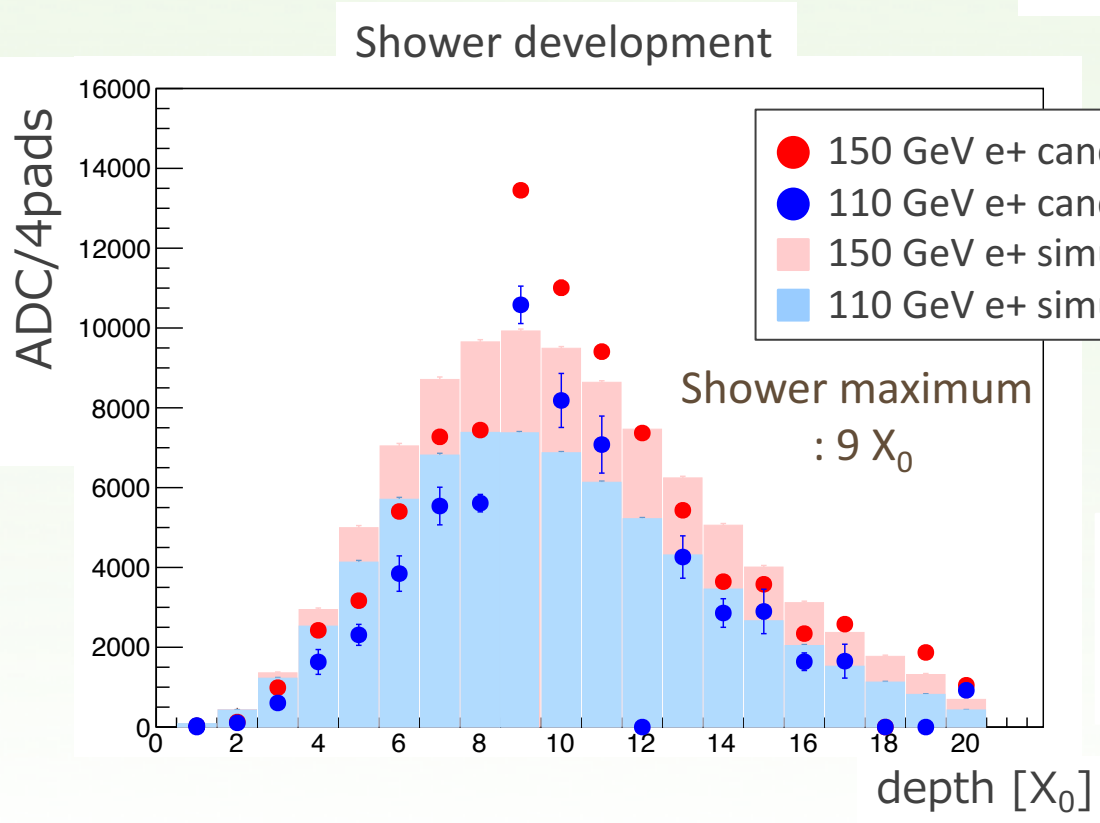
event selection



Note: with Pure e+ simulation @110 GeV → σ/mean = 5.0±0.2 %

EM shower development

uncalibrated data between Pads and layers

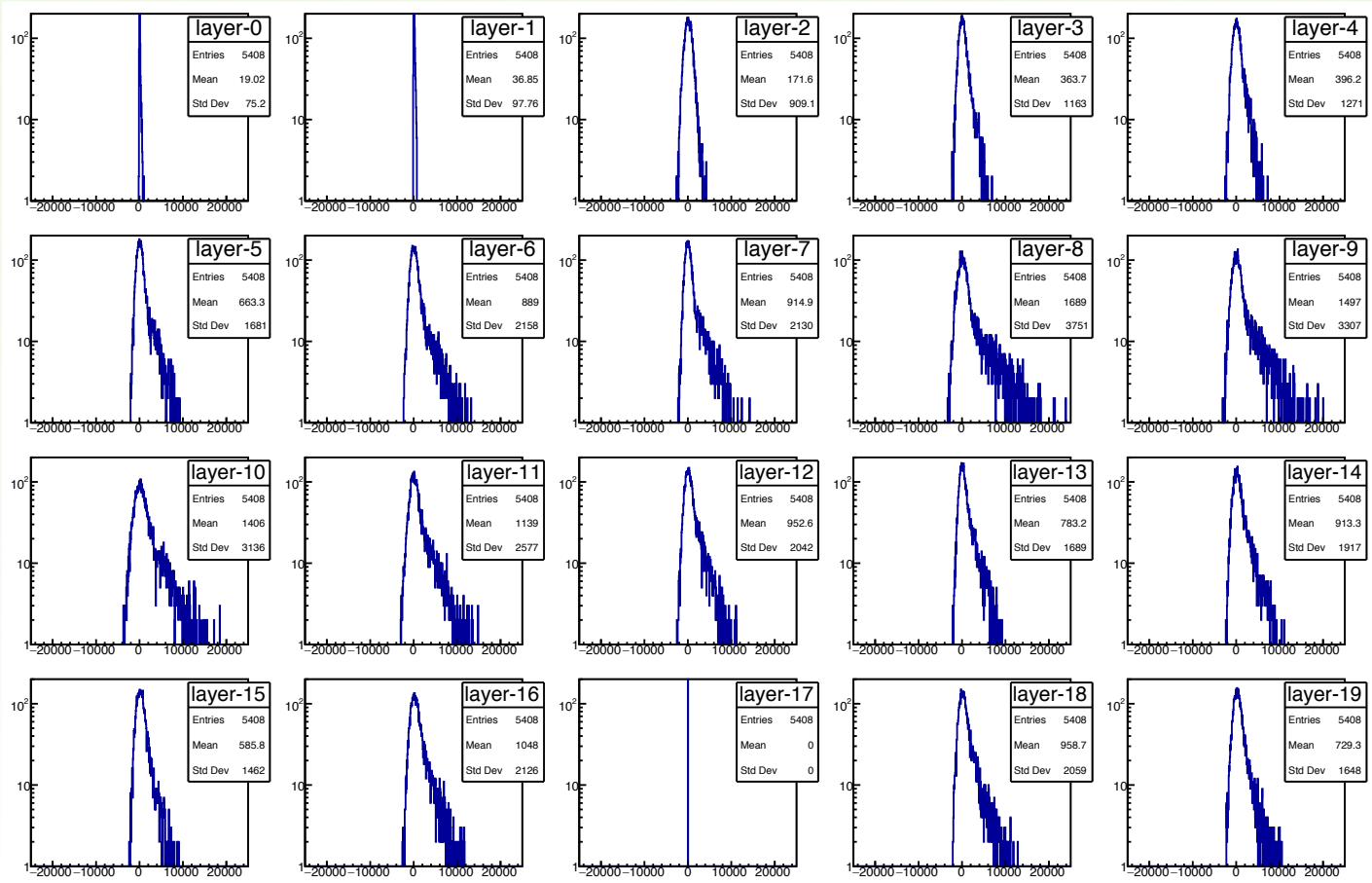


$$\frac{\text{total energy deposited(150 GeV)}}{\text{total energy deposited(110 GeV)}} = 1.50 \pm 0.03$$

(simulation expectation: 1.477 ± 0.003)

✓The EM shower and convergence are measured @110 GeV and 150 GeV.
✓The shower max depth found at 9 X_0 as expected by Geant4 simulation.

SPS data @250 GeV



It seems hard to distinguish electron events from hadron events
→ the ratio of electron events to hadron events is slightly low

Summary

✓ I have analyze the data of SPS beam test on mini-FoCal.
(preliminary analysis)

✓ The energy resolution of 150 GeV positron candidates is 5.9±0.5 %.
(pure e+ simulation → 4.0±0.1 %)

✓ The EM shower and convergence are measured @110 GeV and 150 GeV.

✓ The comparison of 110 GeV and 150 GeV data is similar with simulation.

✓ 250 GeV data seems hard to analyze, because it contains only few electrons.