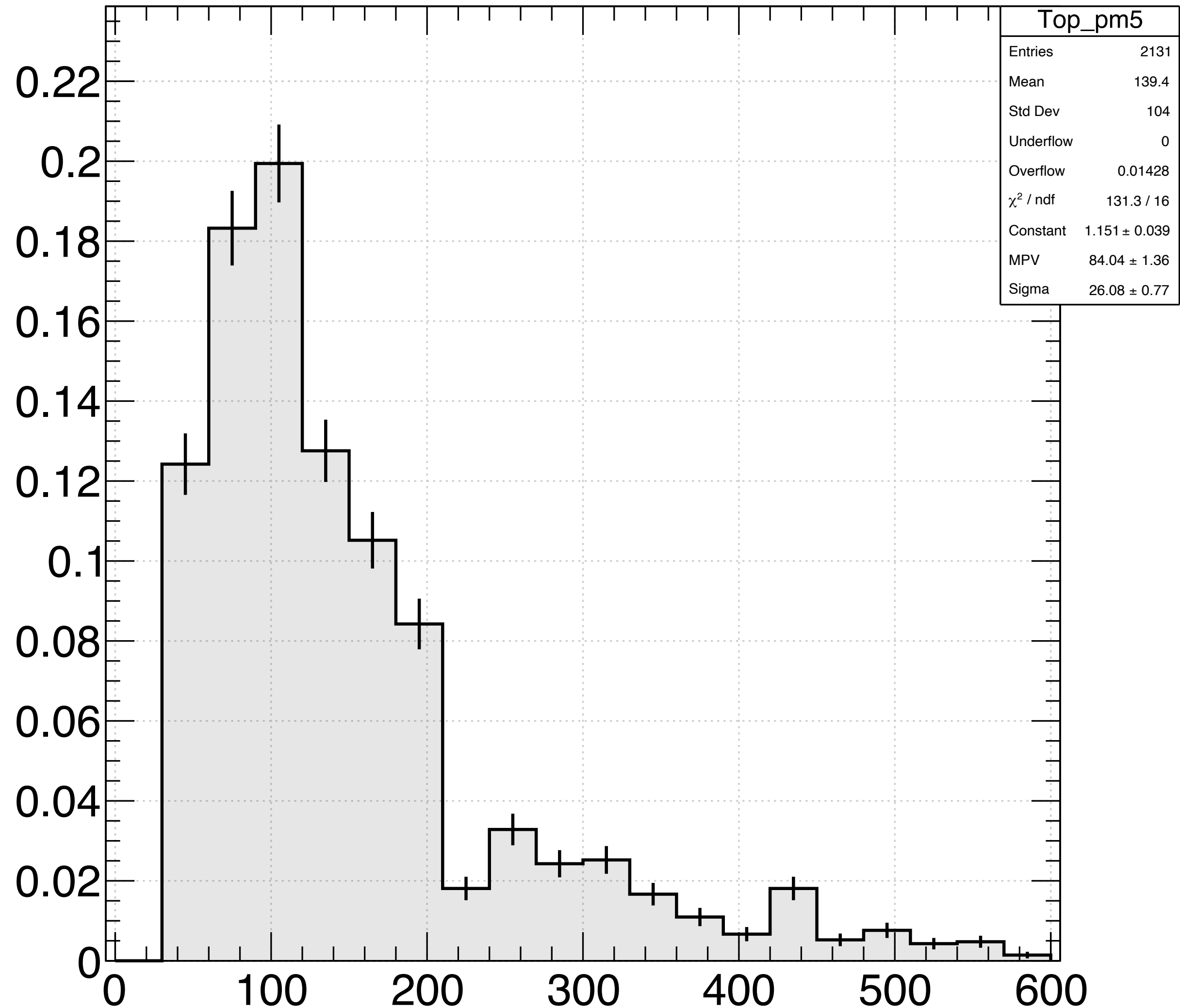


# **MIP peak search**

Genki Nukazuka (RIKEN)

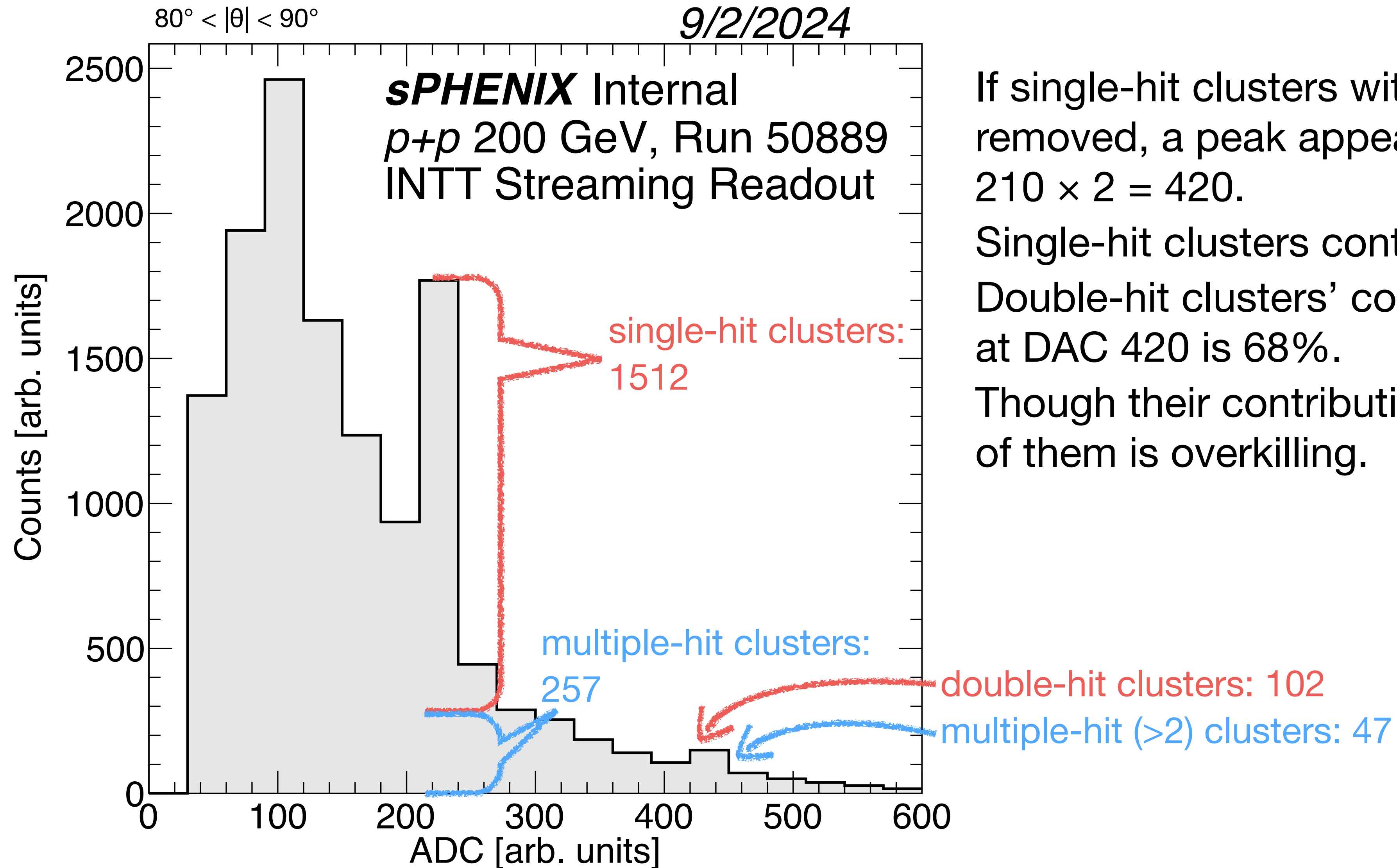
# Status at the last INTT meeting

## DAC distribution



The dropping point at DAC = 210 attracted attention of everybody. It was made by a cut, which rejects single-hit clusters with DAC 210.

# Contributions of hits with DAC210



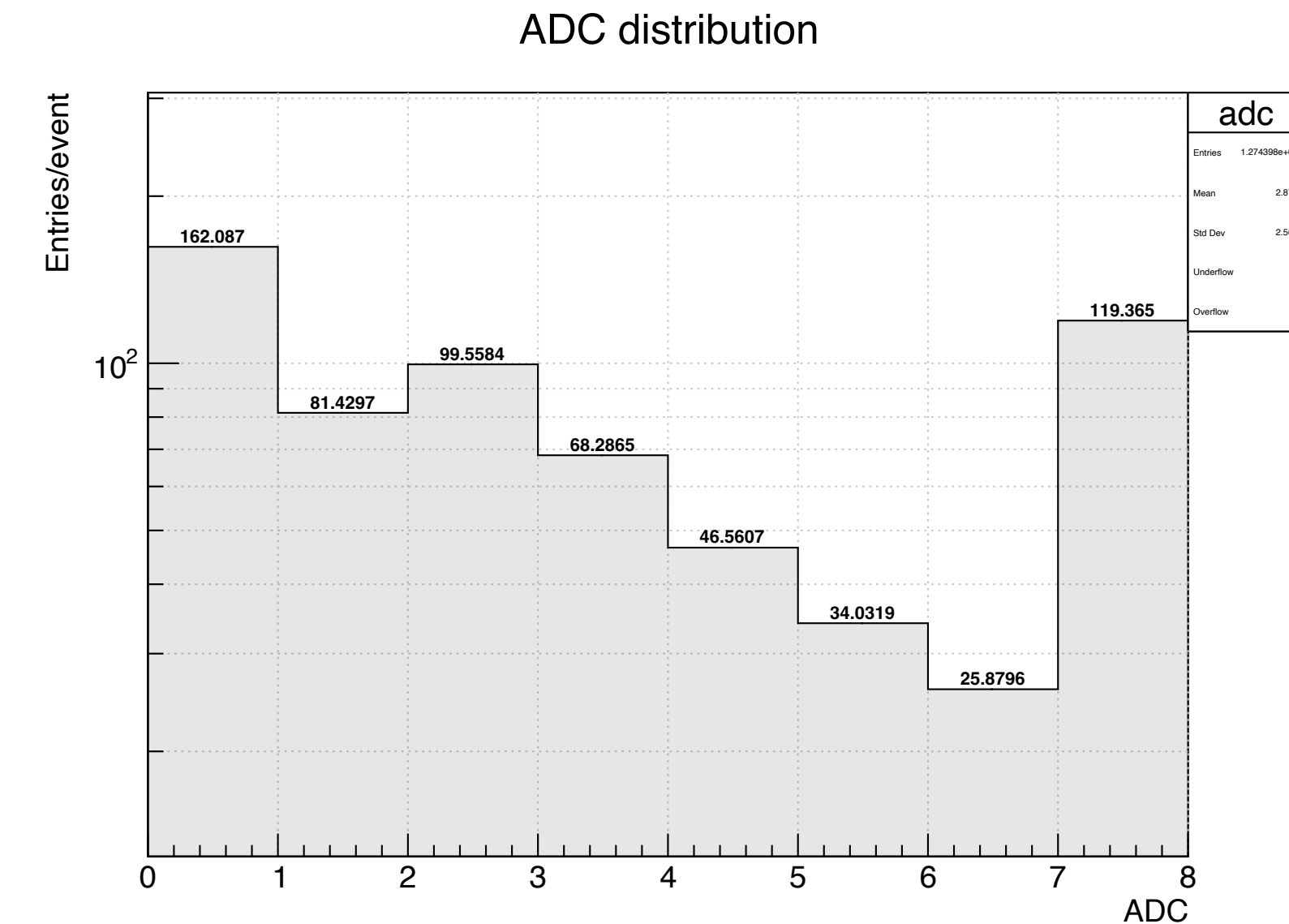
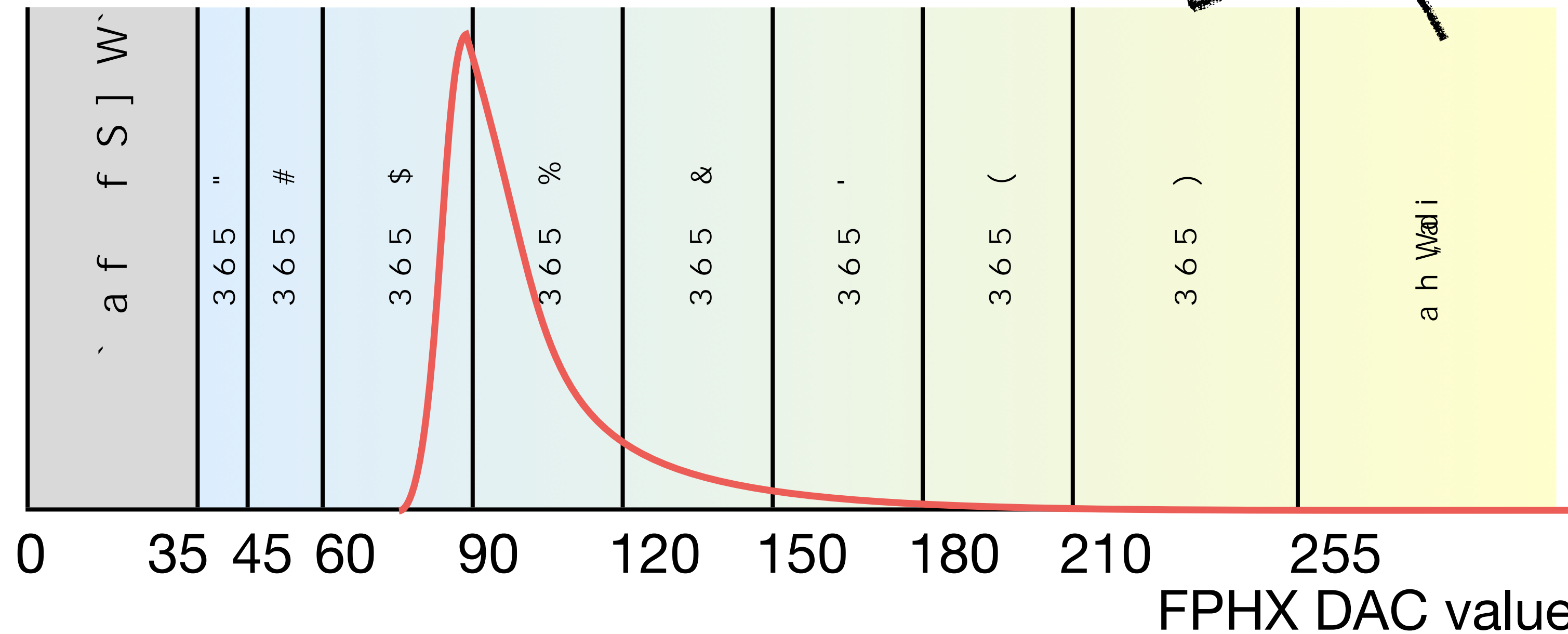
If single-hit clusters with DAC 210 are not removed, a peak appears at DAC 210 and  $210 \times 2 = 420$ .

Single-hit clusters contribute to the peak by 85%!  
Double-hit clusters' contribution to the peak at DAC 420 is 68%.

Though their contribution is too high, removing all of them is overkilling.

# ADC-DAC configuration of FPHX chip

Too large signals are assigned to ADC 7



We naively expect that ADC7 covers from DAC 210 to 255, but it covers from DAC 210 to  $\infty$  in my understanding.

A ratio of the number of hits  $\frac{\sum_{DAC=210}^{255} N}{\sum_{DAC=210}^{\infty} N}$  should be able to modify the number of hits with ADC7

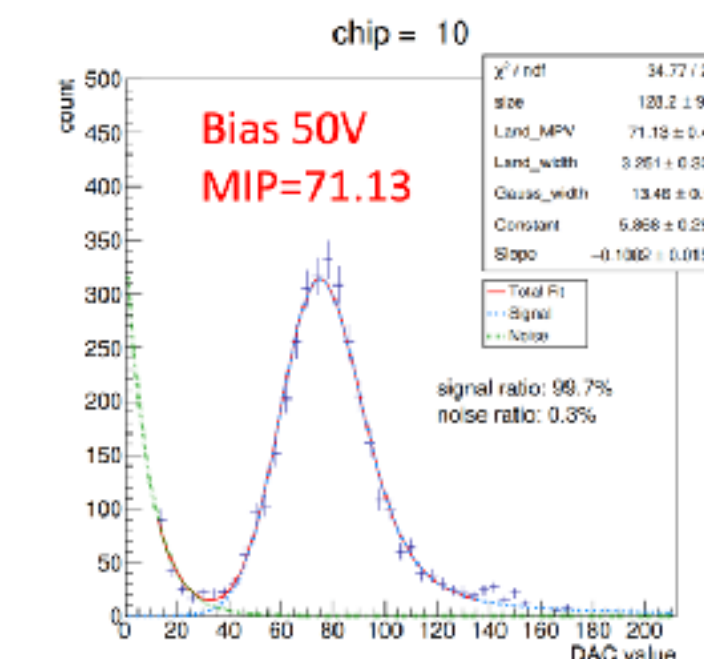
to as we expect.

# The modification factor for hits with ADC7

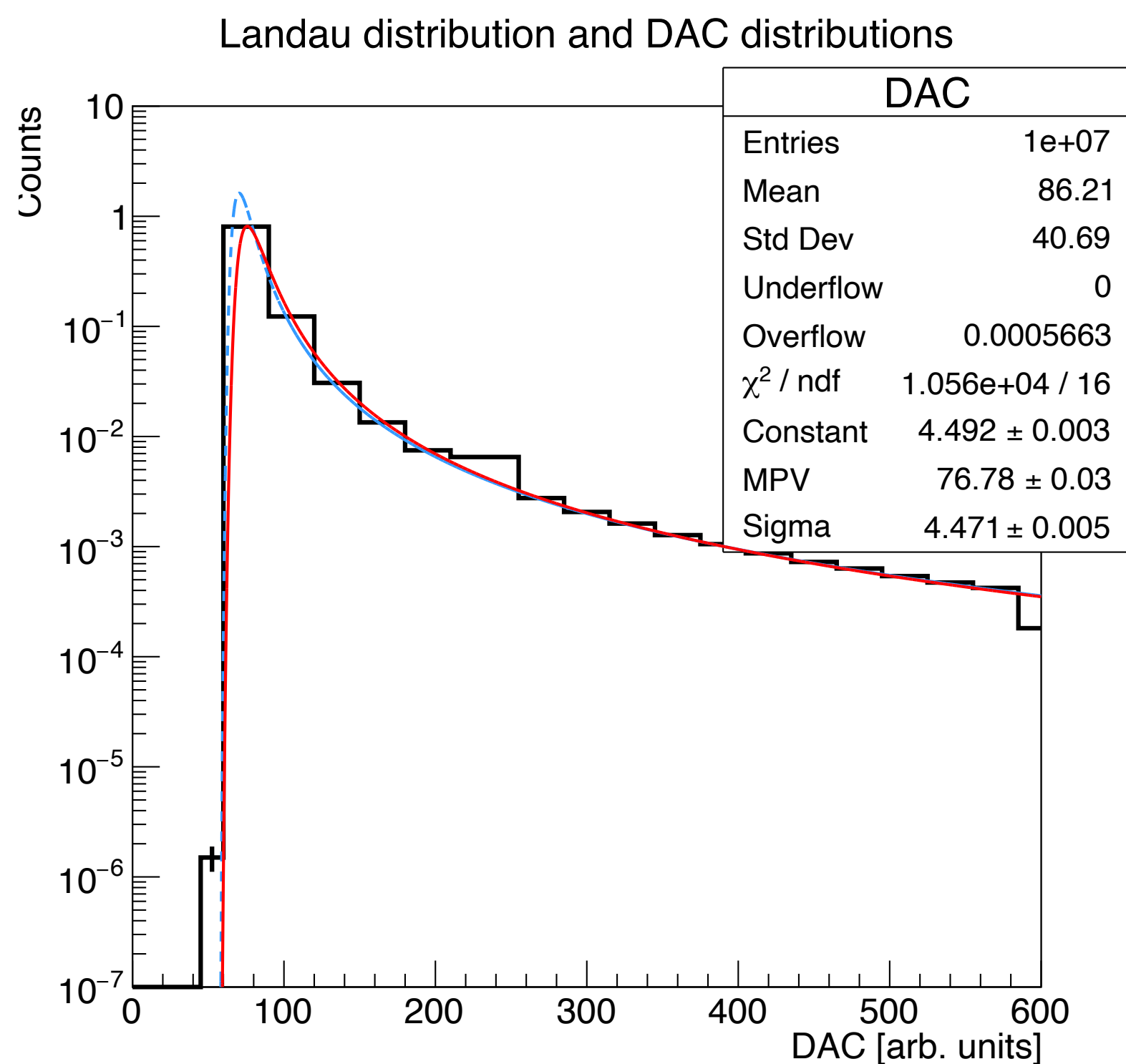
Parameters of landau distribution were taken from Yuka's study of DAC scan in the test beam experiment:

- MPV: 71.13
- width: 3.251

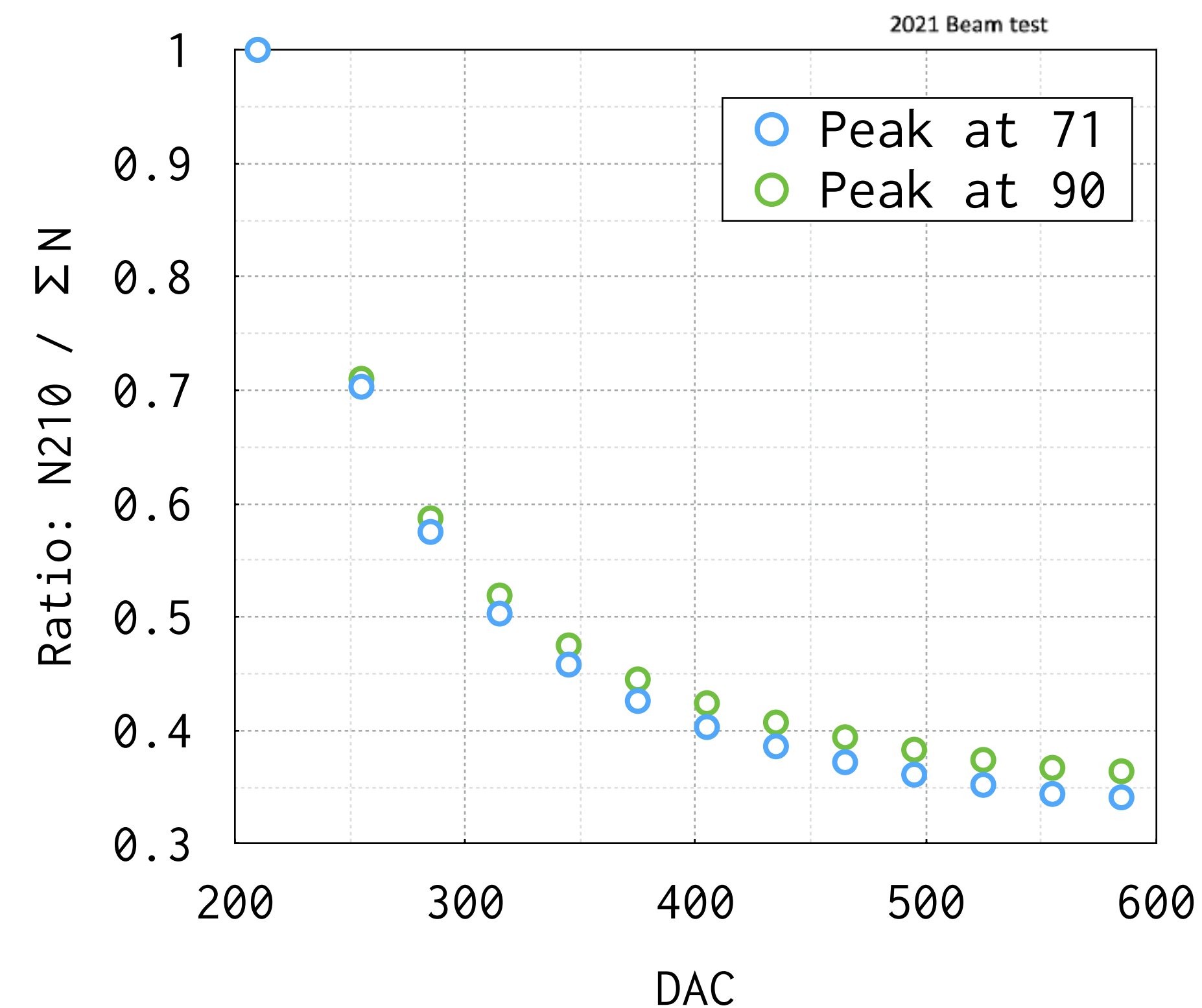
Note: The peak position is expected to at DAC 90



$$\frac{N(\text{DAC} = 210)}{\sum_{\text{DAC}=210}^{\text{DAC}'} N}$$



ADC	DAC	Value	Ratio
9	210	0.00651	100%
10	255	0.00276	70.3%
11	285	0.00206	57.5%
12	315	0.00162	50.3%
13	345	0.00127	45.8%
14	375	0.00105	42.6%
15	405	0.000869	40.3%
16	435	0.000726	38.6%
17	465	0.000632	37.2%
18	495	0.00054	36.1%
19	525	0.000472	35.2%
20	555	0.000421	34.4%
21	585	0.000181	34.1%



0.35 is reasonable for the modification factor

# Position of MIP peak

**予想されるエネルギー損失**

- μ粒子(1GeV)が320μm厚シリコンセンサー通過時のエネルギー損失
  - 単位密度単位長さあたりの損失エネルギー: 約1.15 [MeV/g·cm<sup>-2</sup>]
  - Siの密度: 2.329 [g/cm<sup>3</sup>]
$$\text{損失エネルギー} = 1.15 [\text{MeV/g}\cdot\text{cm}^{-2}] \times 2.329 [\text{g/cm}^3] \times 0.032 [\text{cm}] \cong 85.7 [\text{keV}]$$
- エネルギー損失量を eV→mV に変換
  - 1電子正孔対生成に必要なエネルギー: 3.62 [eV], 電子1個の電荷: 1.6 × 10<sup>-19</sup> [C]
$$\frac{85.7 \text{ keV}}{3.62 \text{ eV}} \times 1.6 \times 10^{-19} \times 10^{15} \cong 3.79 [\text{fC}]$$
  - FPHXチップでの増幅率: 100[mV/fC], オフセット: 210[mV]
$$\text{エネルギー損失時の出力波高の電圧値} = 3.79 [\text{fC}] \times 100 [\text{mV/fC}] + 210 = 589 [\text{mV}]$$

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**予想されるエネルギー損失**

- エネルギー損失量を mV→DAC値 に変換
  - エネルギー損失時の出力波高の電圧値とDAC値の関係式は、  
 $V [\text{mV}] = 210 + 4 \times \text{DAC 値}$

電圧値[mV]	DAC値
562	88
578	92
594	96
610	100
626	104
642	108
658	112
674	116

予想されるエネルギー損失量  
 $\cong 85.7 [\text{keV}]$   
 $\cong 589 [\text{mV}]$   
 $\cong \text{DAC値} 92$

ADC分布(エネルギー損失分布)

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## Energy loss

Energy loss of μ with 1 GeV in silicon with thickness of 320 μm:  
 1.15 MeV/g cm<sup>-2</sup>

Density of silicon: 2.329 g/cm<sup>3</sup>  
 ∴ Energy loss: 85.7 keV

## Conversion of energy loss to charge

Energy to create a electron-hole pair: 3.62 eV  
 Charge by a MIP: 85.7 keV / 3.62 eV × e = 3.79 fC

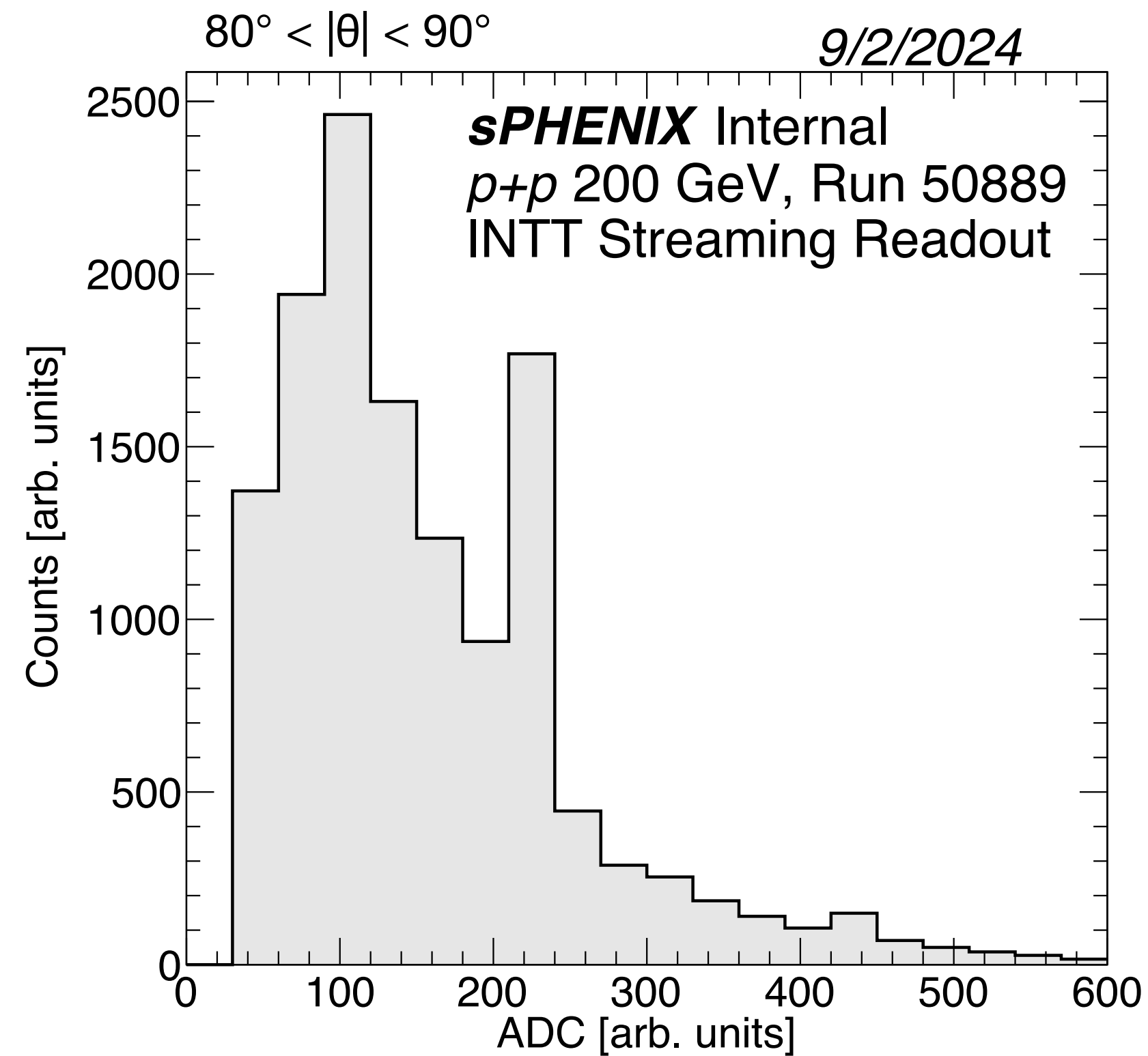
## Pulse height

Amplification in an FPHX chip: 100 mV/fC  
 Pulse height: 3.79 fC × 100 mV/fC = 589 mV

## Conversion from pulse height to DAC value

$V \text{ mV} = 210 + 4 \text{ DAC}$   
 ∴ DAC = 92

# Modification of #hits with DAC210



## DAC210

Single-hit clusters:  $1512 \times 0.35 = 529.2$

Multiple-hit clusters: 257 (no change)

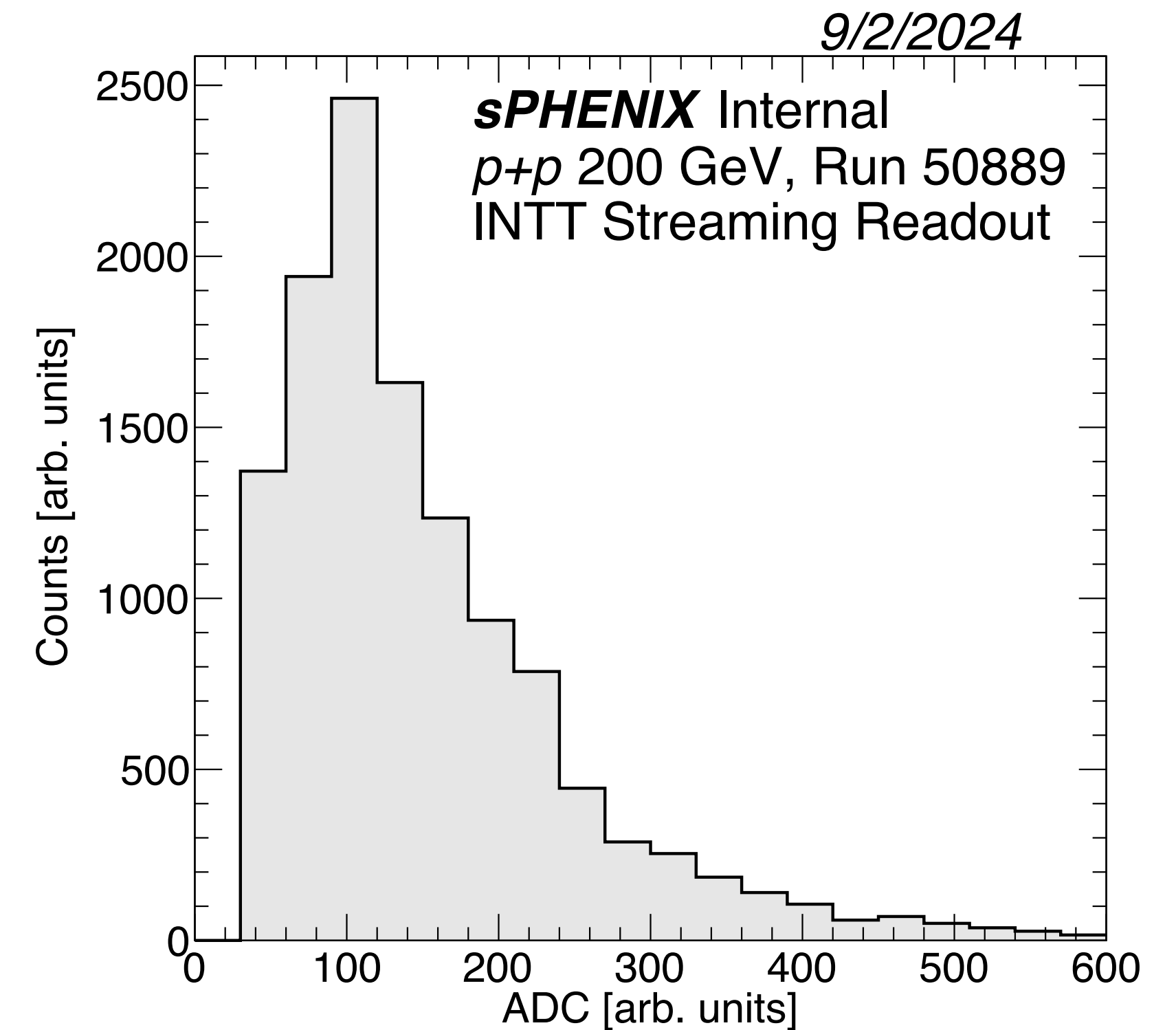
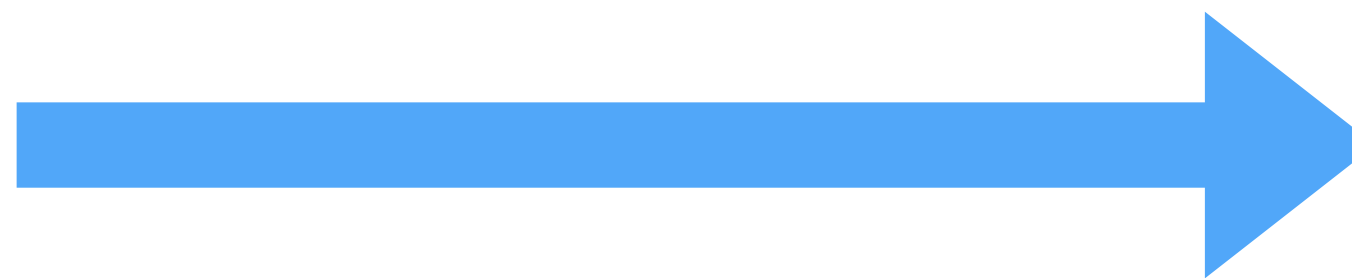
Sum: 786.2

## DAC 420

Double-hit clusters:  $102 \times 0.35^2 = 12.5$

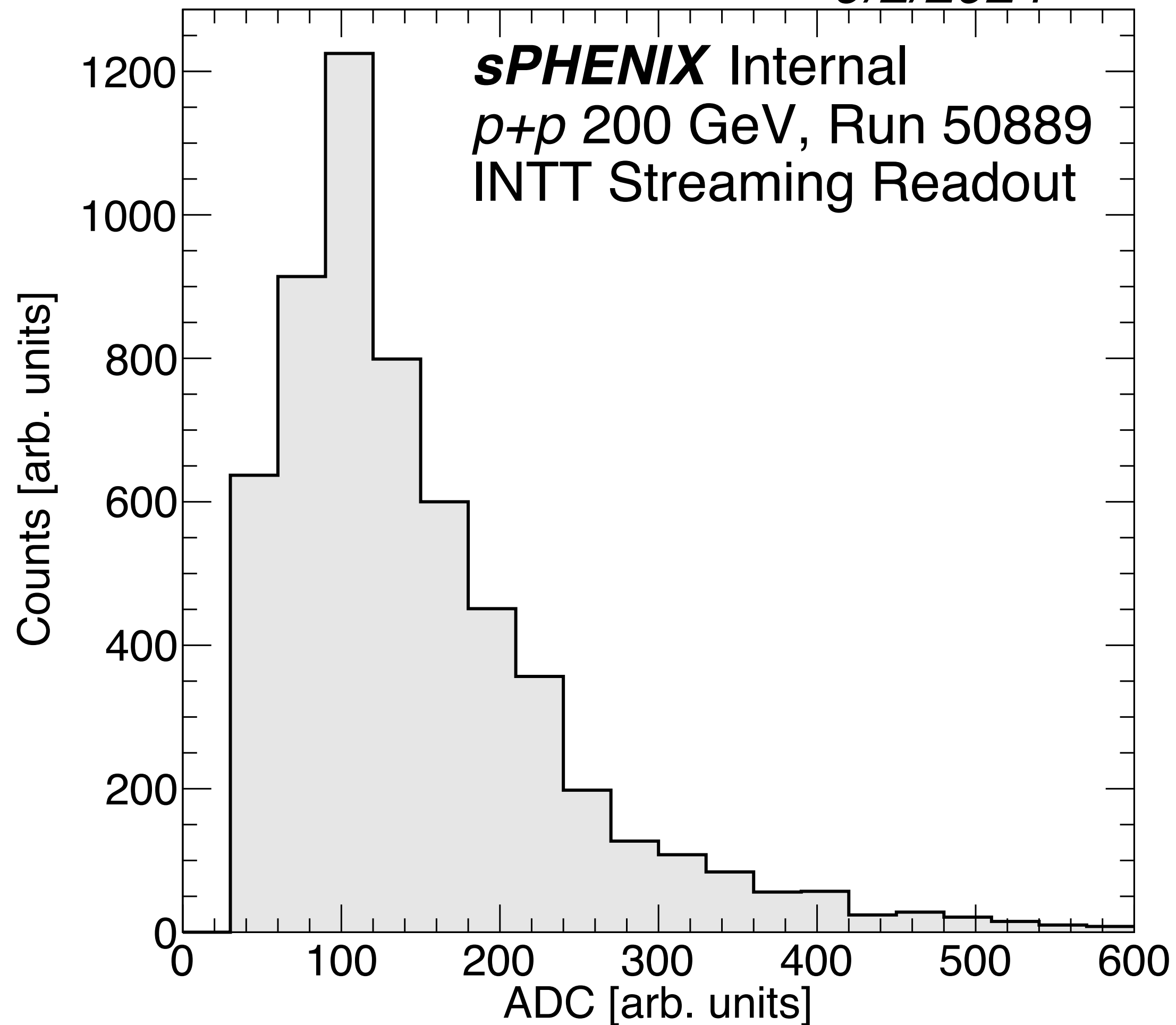
Multiple-hit (>2) clusters: 47

Sum: 59.5



# Cuts and updates

9/2/2024



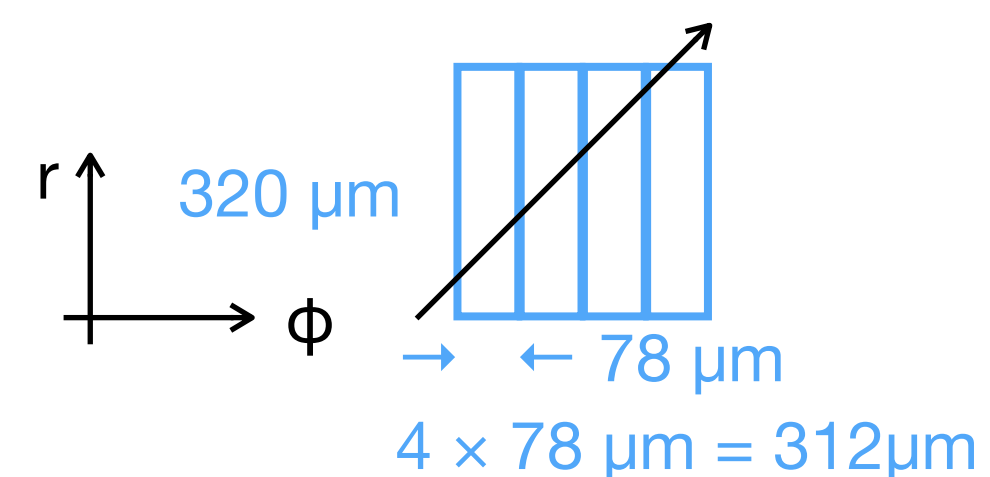
I thought that I used all  $\theta$  last week but only  $\theta > 0$  was used. It was fixed.

## Cuts:

- Hot channel rejection
- Event selection
  - $N_{\text{inner}} > 3$
  - $N_{\text{outer}} > 3$
  - $N > 6$
  - $|N_{\text{inner}} - N_{\text{outer}}| / N < 10\%$
- Cluster selection
  - cluster size (only  $\phi$ )  $< 5$
  - association to an INTT tracklet

Events with very low multiplicity are rejected

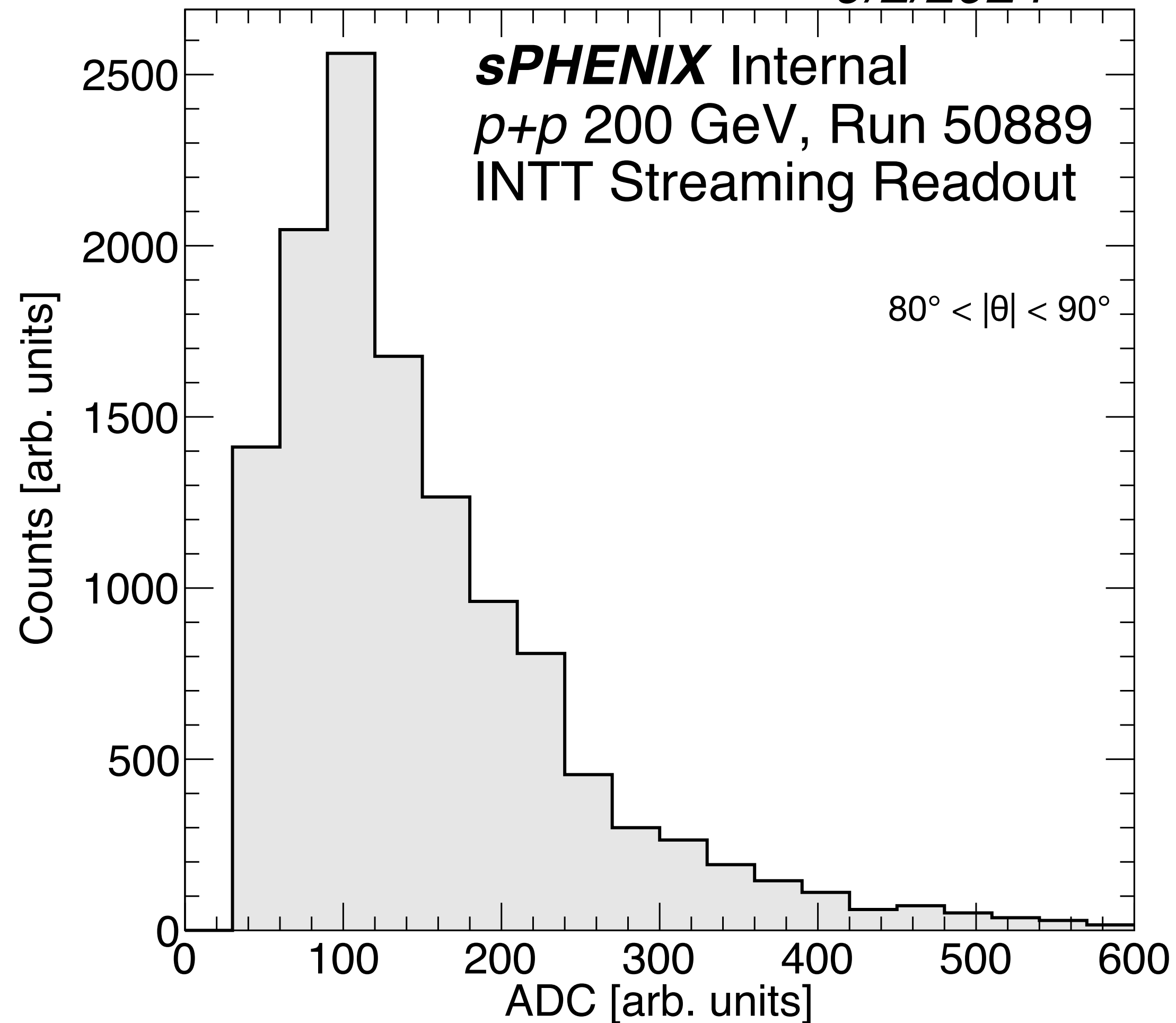
More or less same amount of clusters for both barrels.





# Cuts and updates

9/2/2024



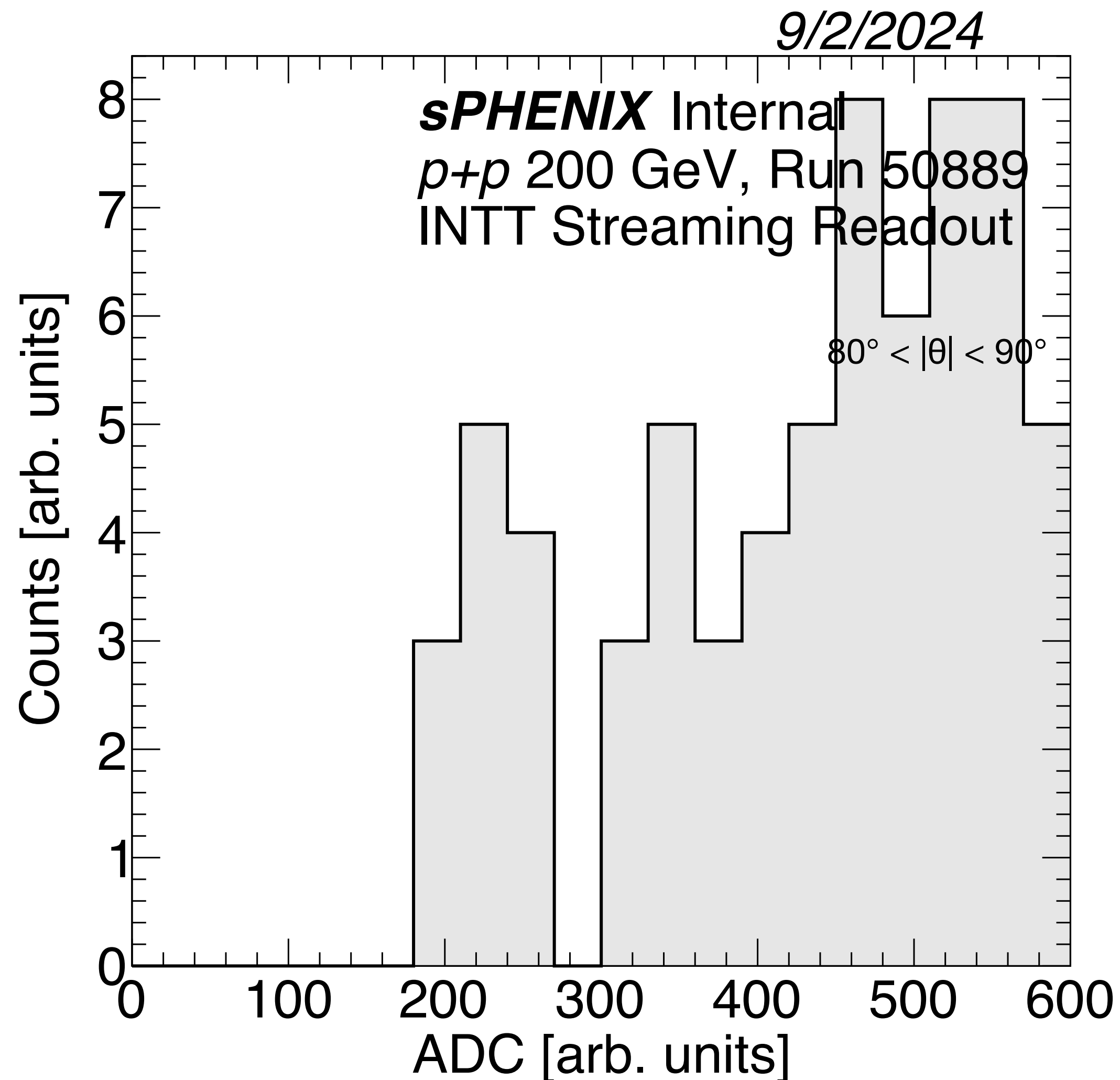
I thought that I used all  $\theta$  last week but only  $\theta > 0$  was used. It was fixed.

## Cuts:

- Hot channel rejection
- ~~Event selection~~
  - ~~$N_{\text{inner}} > 3$~~
  - ~~$N_{\text{outer}} > 3$~~
  - ~~$N > 6$~~
  - ~~$|N_{\text{inner}} - N_{\text{outer}}| / N < 10\%$~~
- Cluster selection
  - cluster size (only  $\phi$ )  $< 5$
  - association to an INTT tracklet

The event selection decreases clusters at ADC 35 little bit.

# Cuts and updates



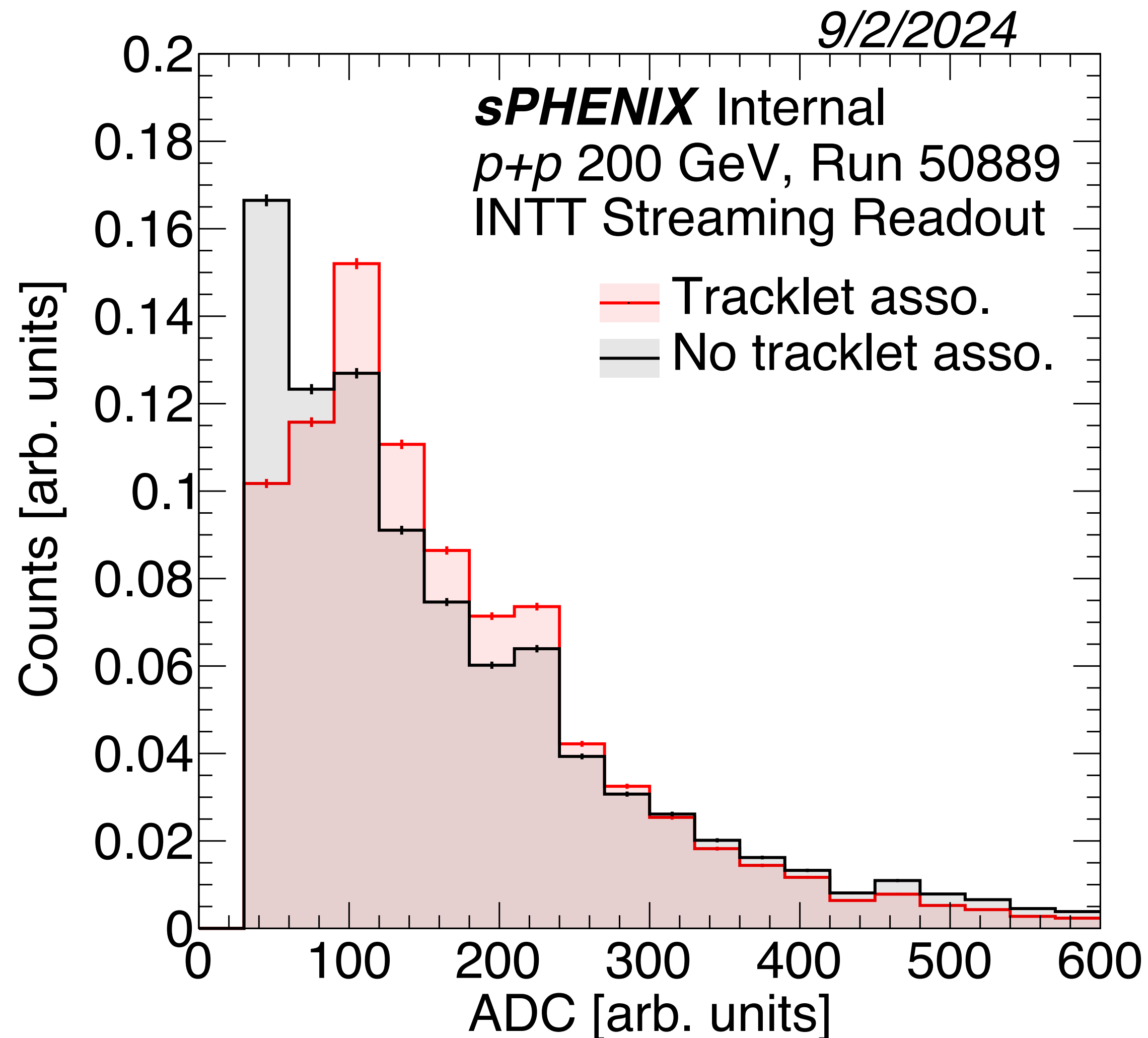
I thought that I used all  $\theta$  last week but only  $\theta > 0$  was used. It was fixed.

Cuts:

- Hot channel rejection
- Event selection
  - $N_{\text{inner}} > 3$
  - $N_{\text{outer}} > 3$
  - $N > 6$
  - $|N_{\text{inner}} - N_{\text{outer}}| / N < 10\%$
- Cluster selection
  - cluster size (only  $\phi$ ) > 5
  - association to an INTT tracklet

The cluster size cut has almost no effect... But it's fine to keep it.

# Cuts and updates



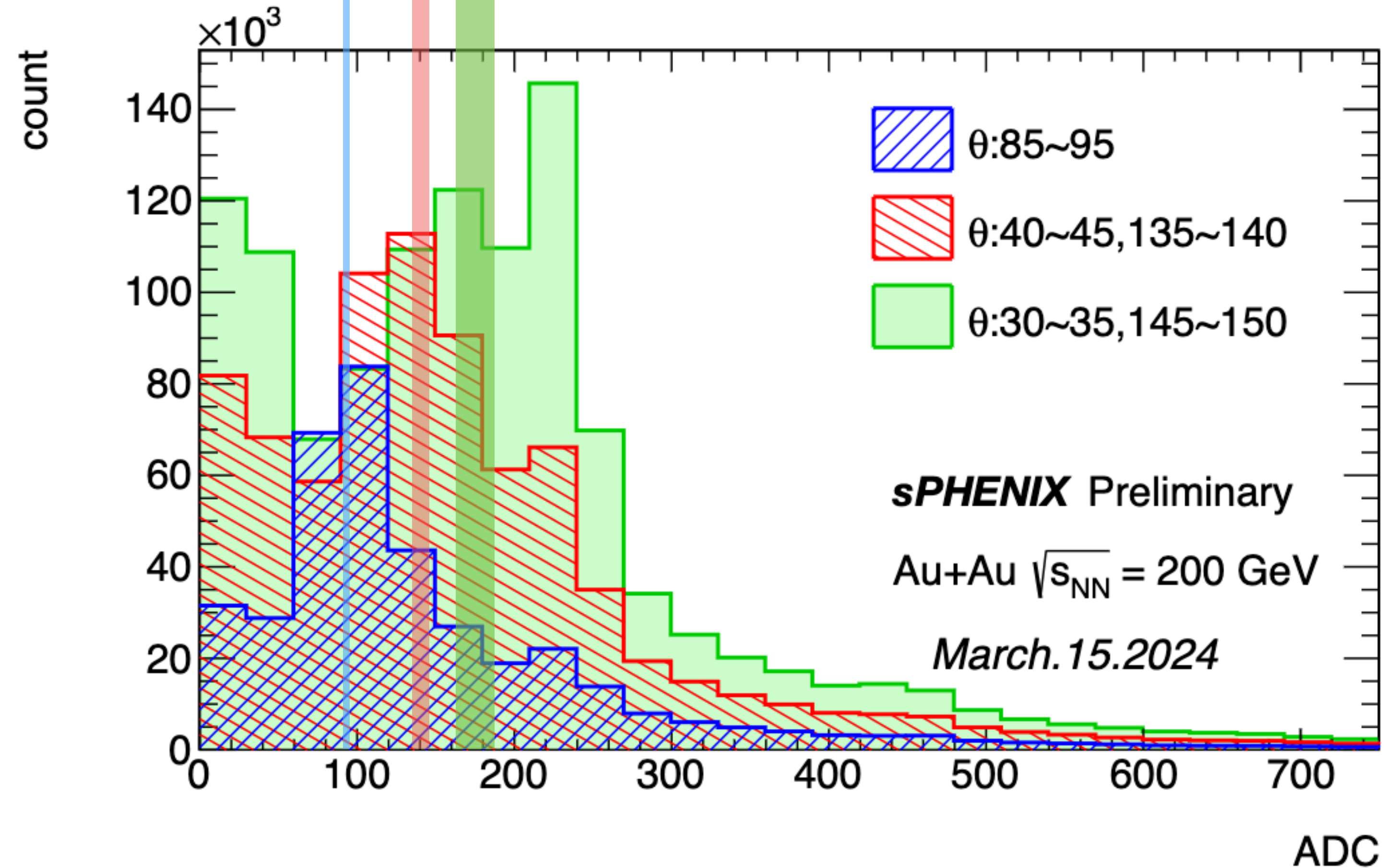
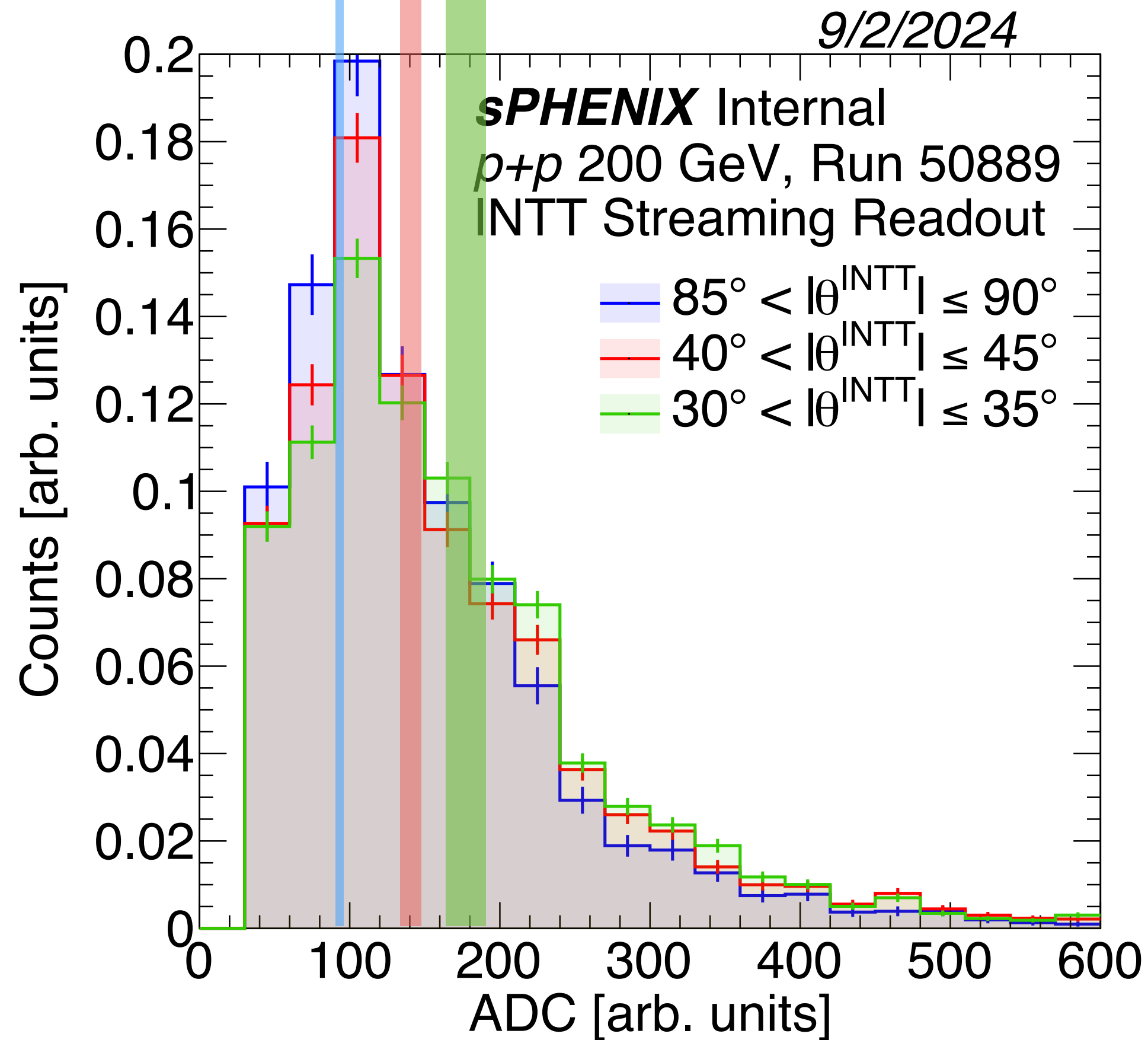
I thought that I used all  $\theta$  last week but only  $\theta > 0$  was used. It was fixed.

## Cuts:

- Hot channel rejection
- Event selection
  - $N_{\text{inner}} > 3$
  - $N_{\text{outer}} > 3$
  - $N > 6$
  - $|N_{\text{inner}} - N_{\text{outer}}| / N < 10\%$
- Cluster selection
  - cluster size (only  $\phi$ )  $> 5$
  - **association to an INTT tracklet**

Suppression of clusters at ADC 35, i.e. great noise reduction!

# Comparison to Misaki's results



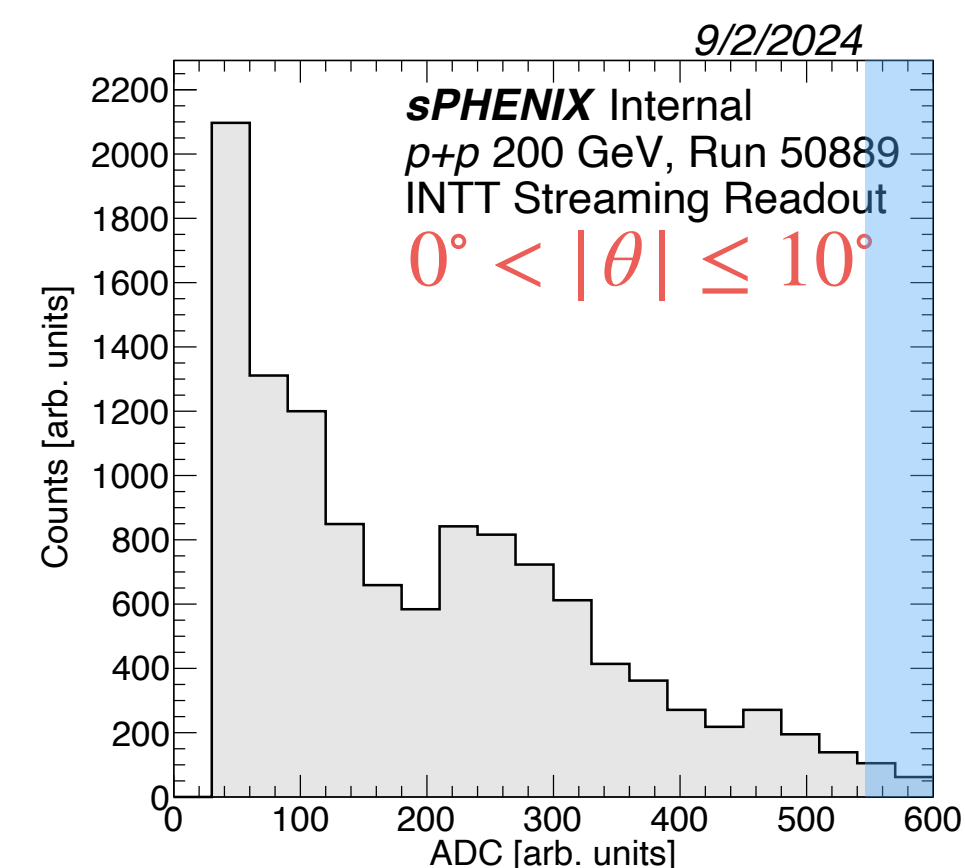
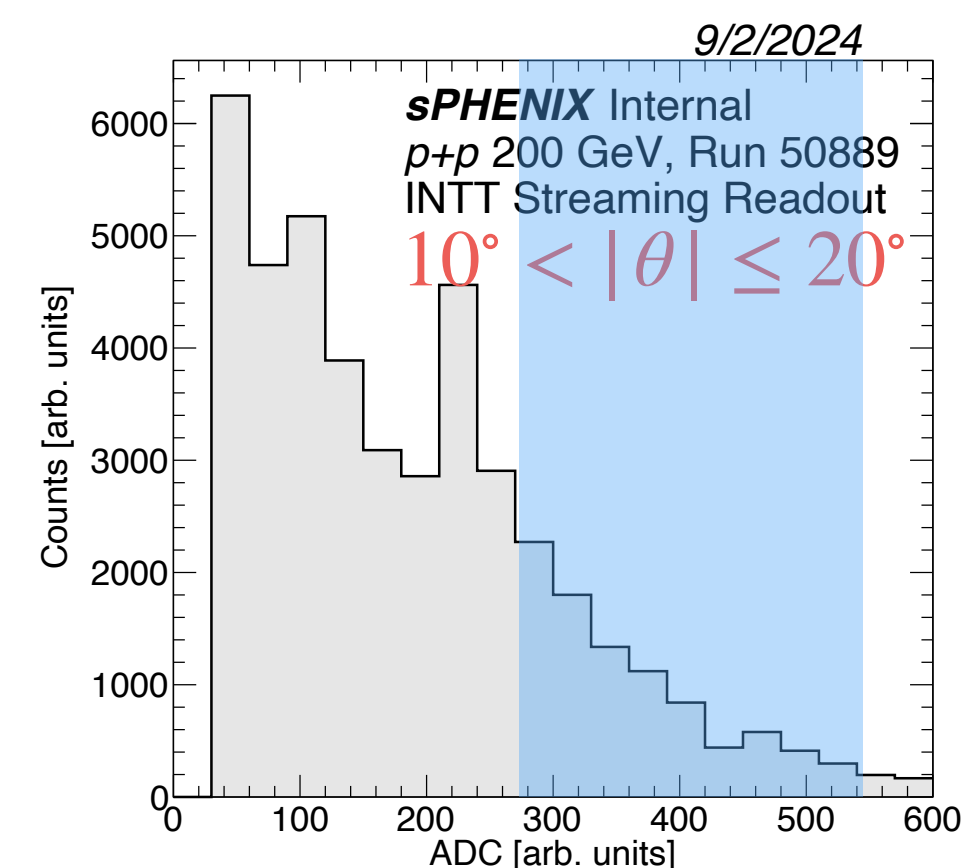
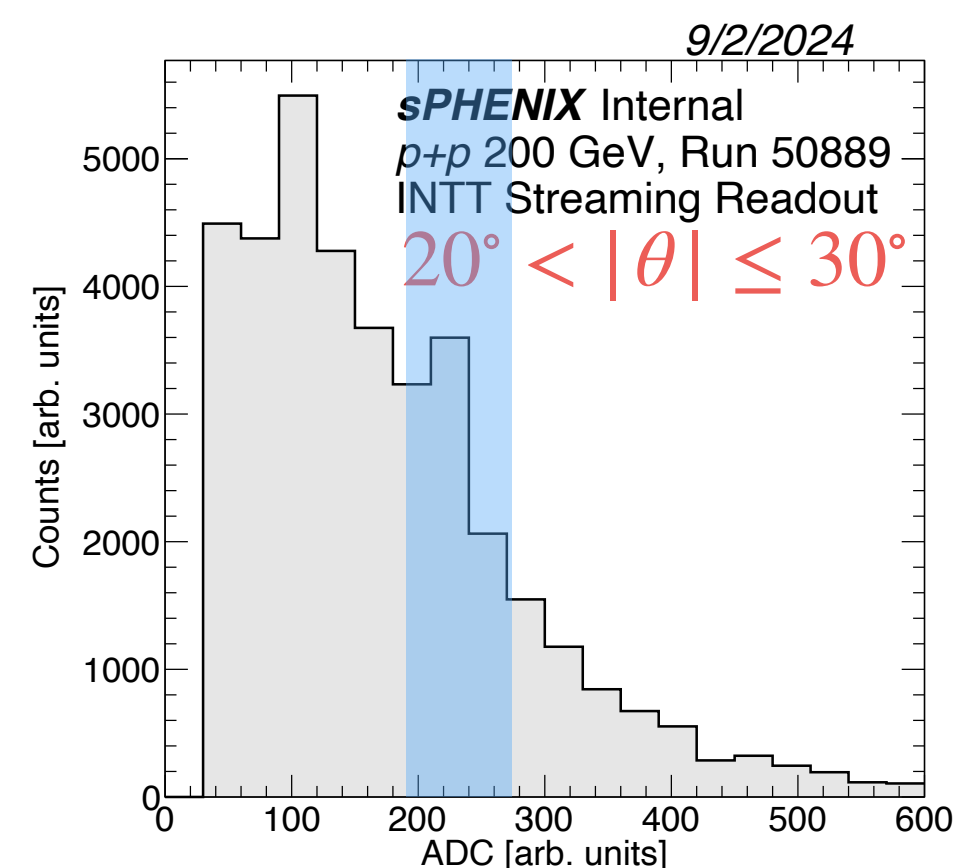
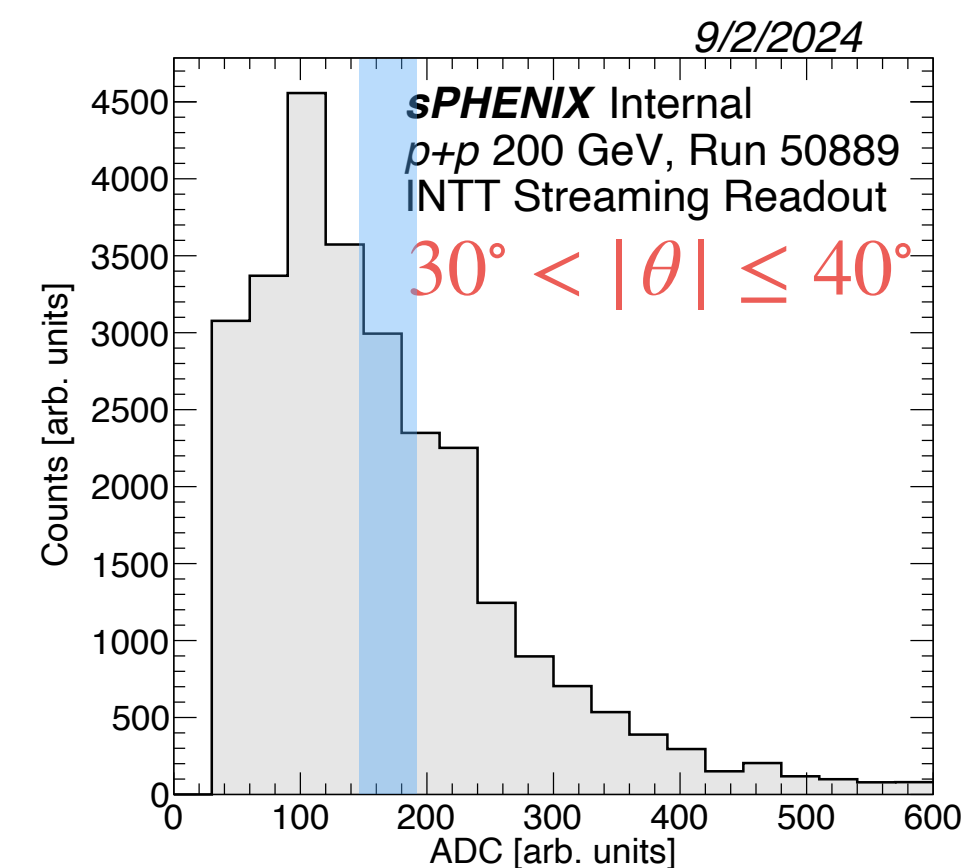
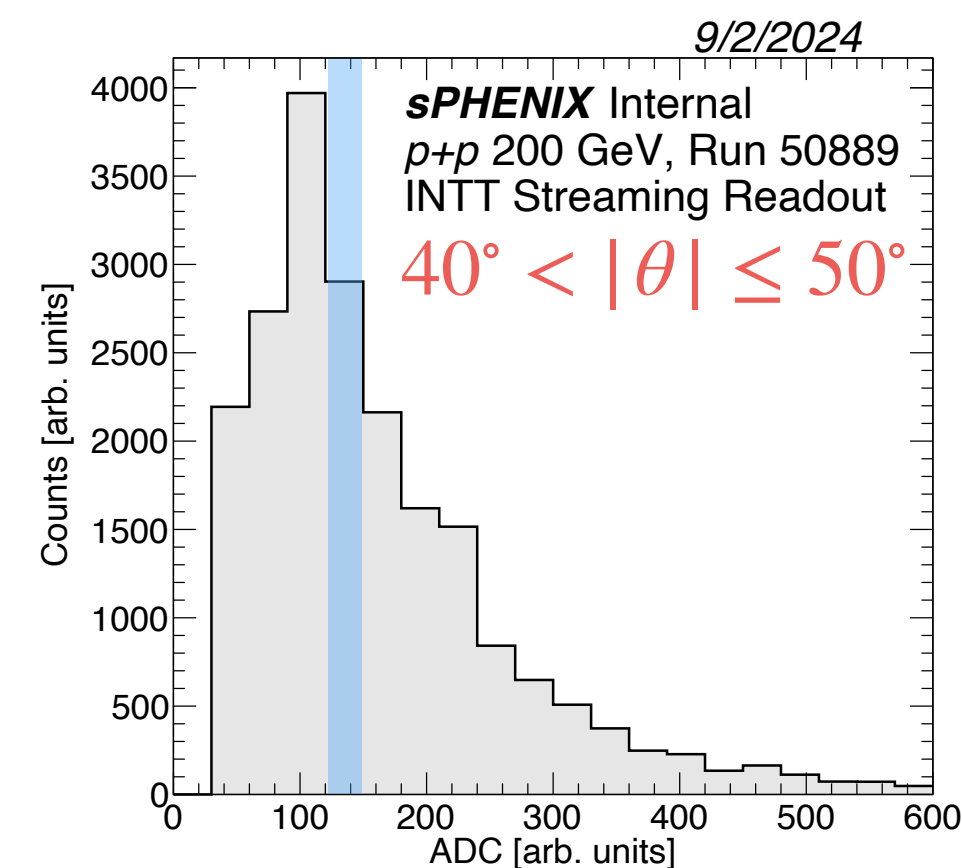
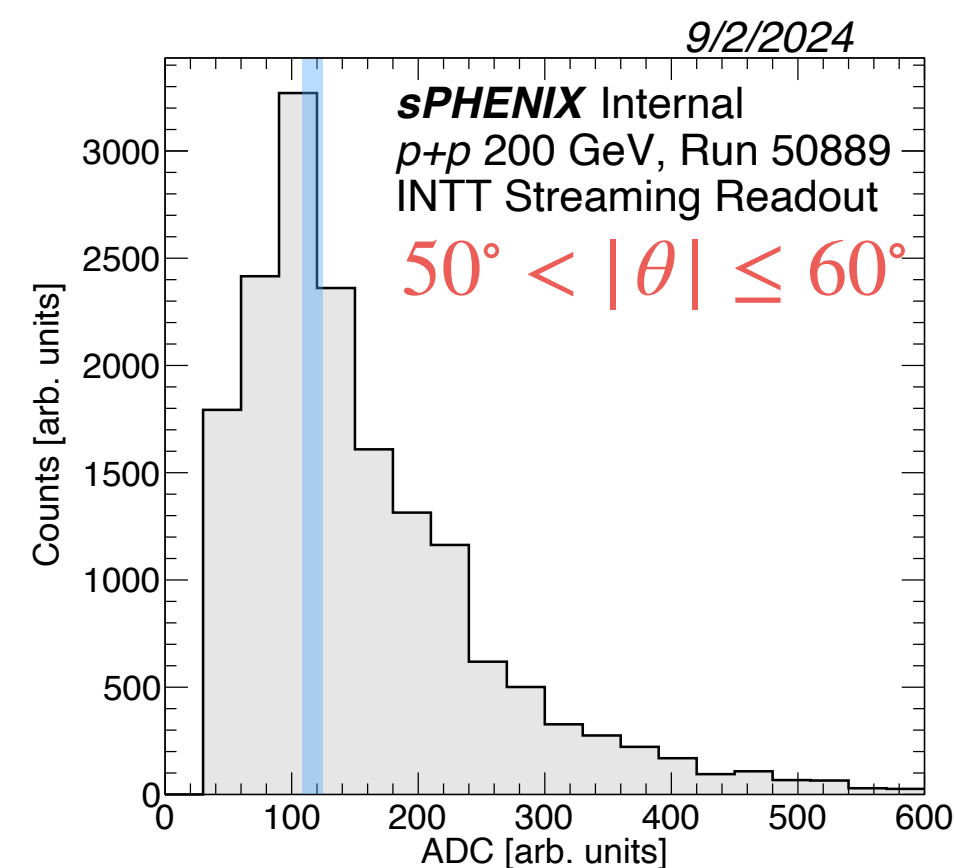
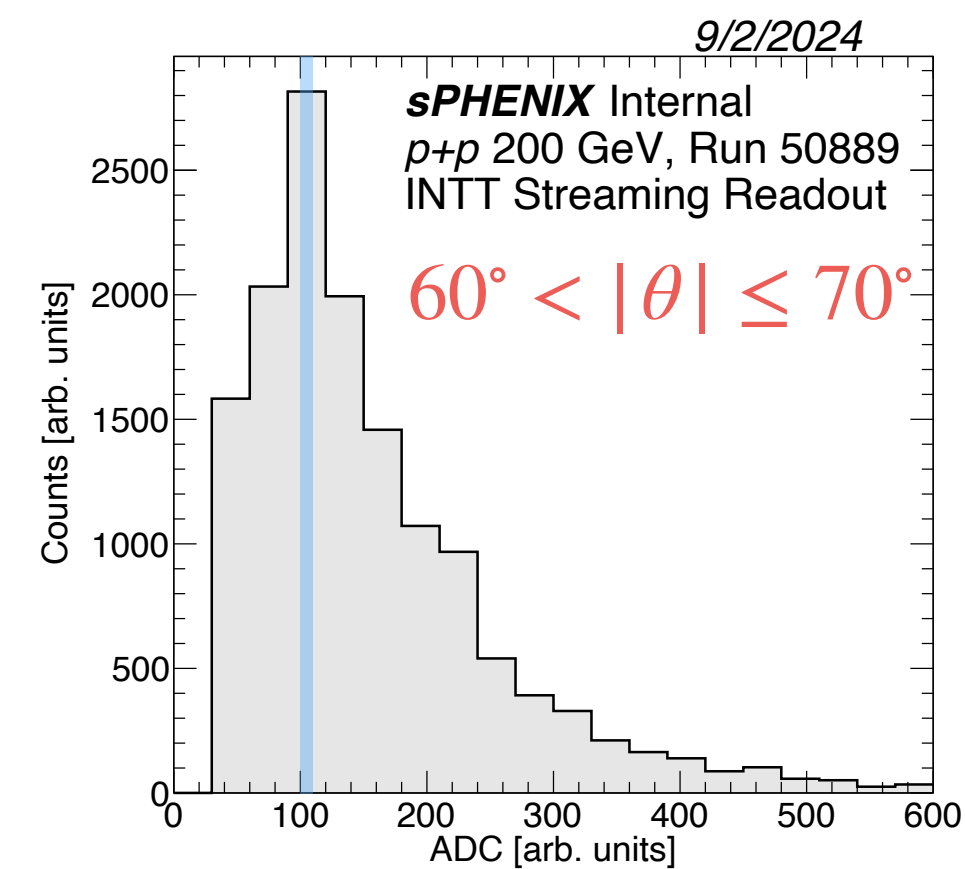
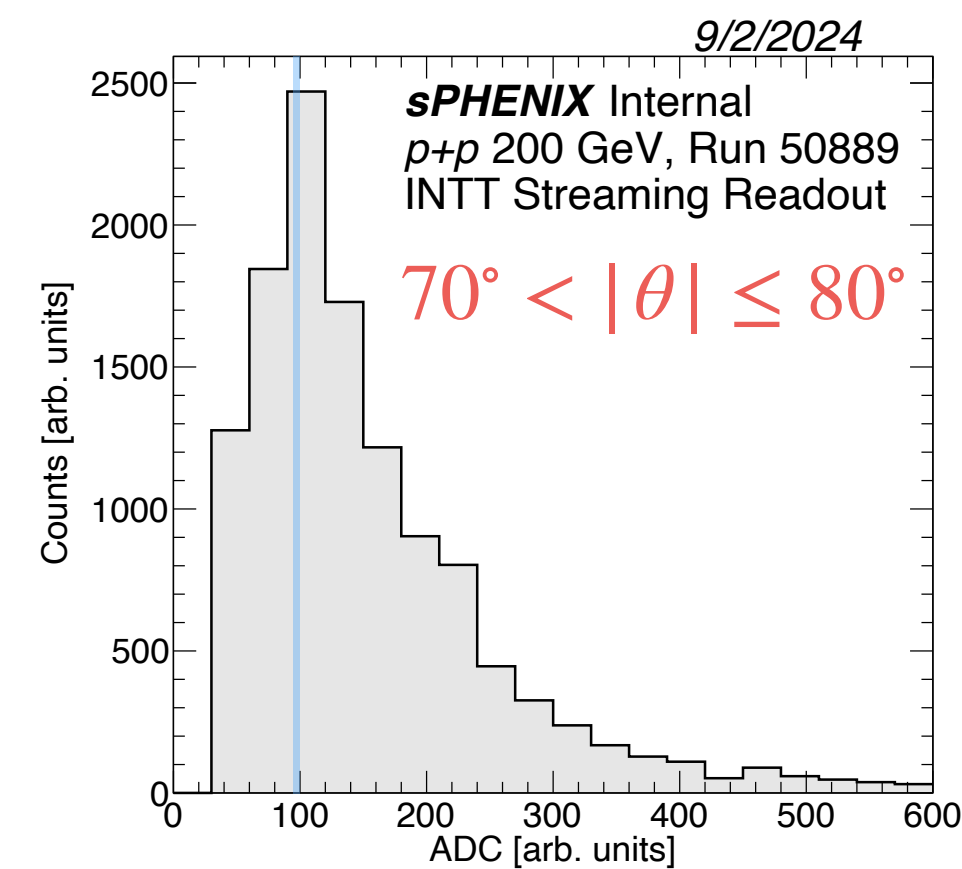
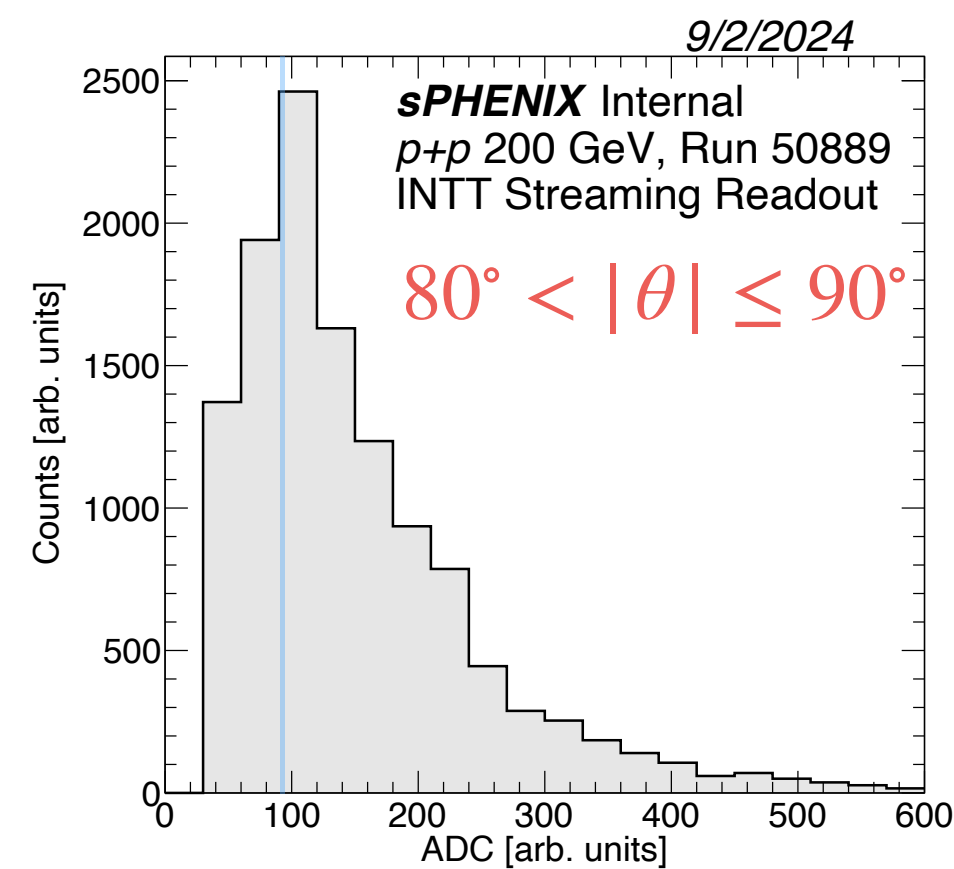
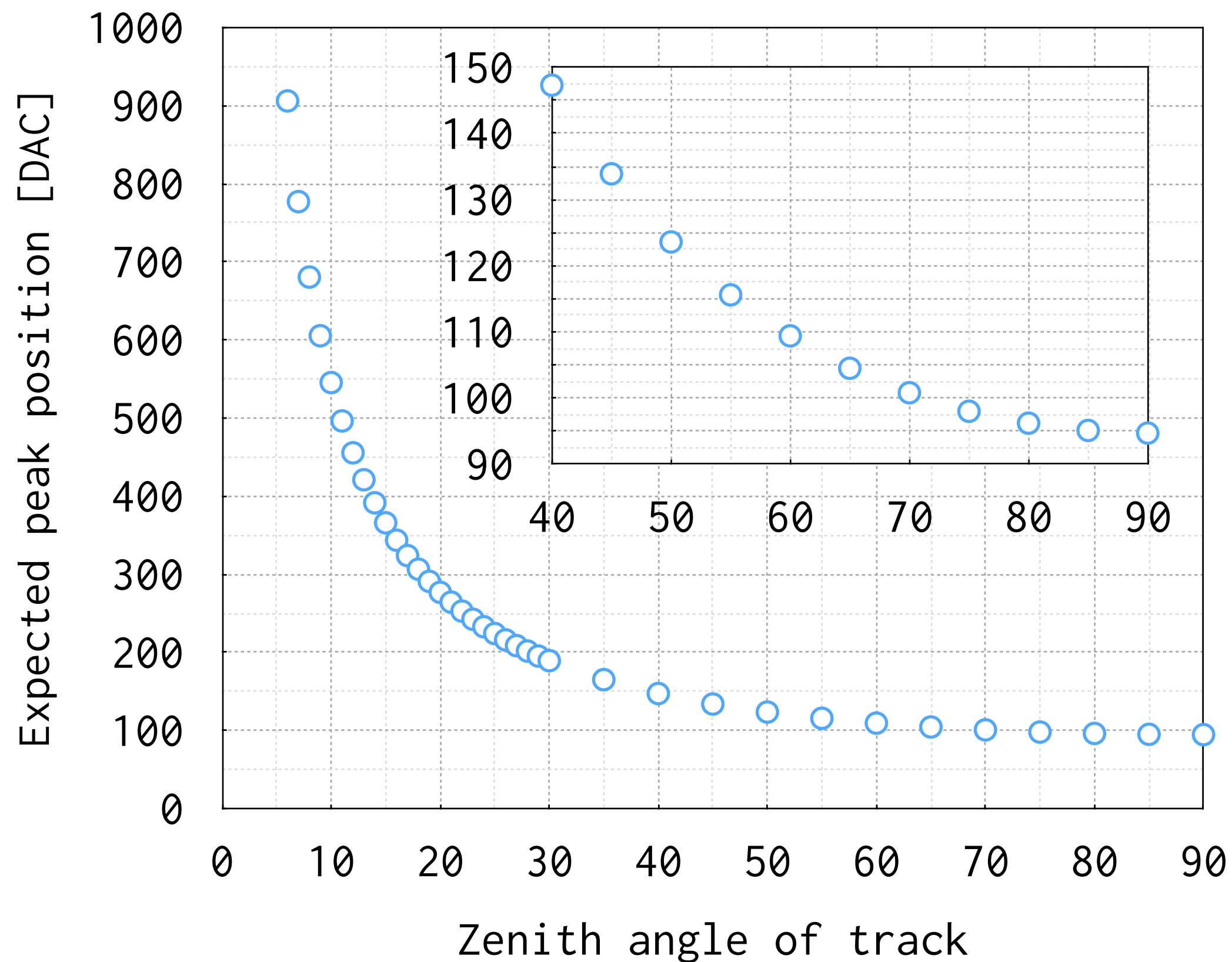
## Expected peak region from calculation

- $85^\circ < |\theta| < 90^\circ$  : DAC 94 — 95
- $40^\circ < |\theta| < 45^\circ$  : DAC 134 — 147
- $30^\circ < |\theta| < 35^\circ$  : DAC 165 — 189

Misaki's results agree with the prediction well while mine are not....

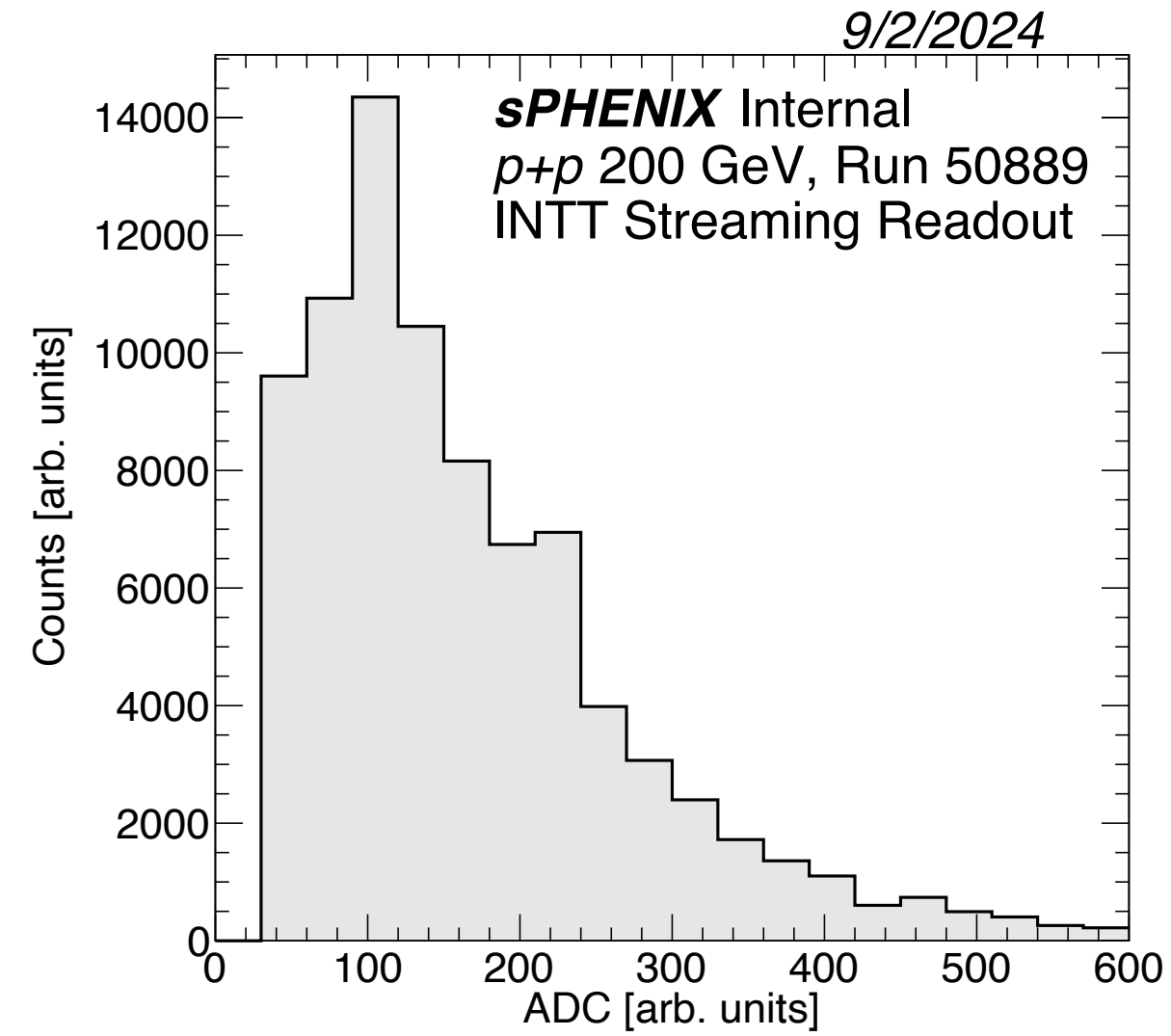
# ADC distribution with a selection of $\theta^{\text{INTT}}$

Expected peak position from calculation



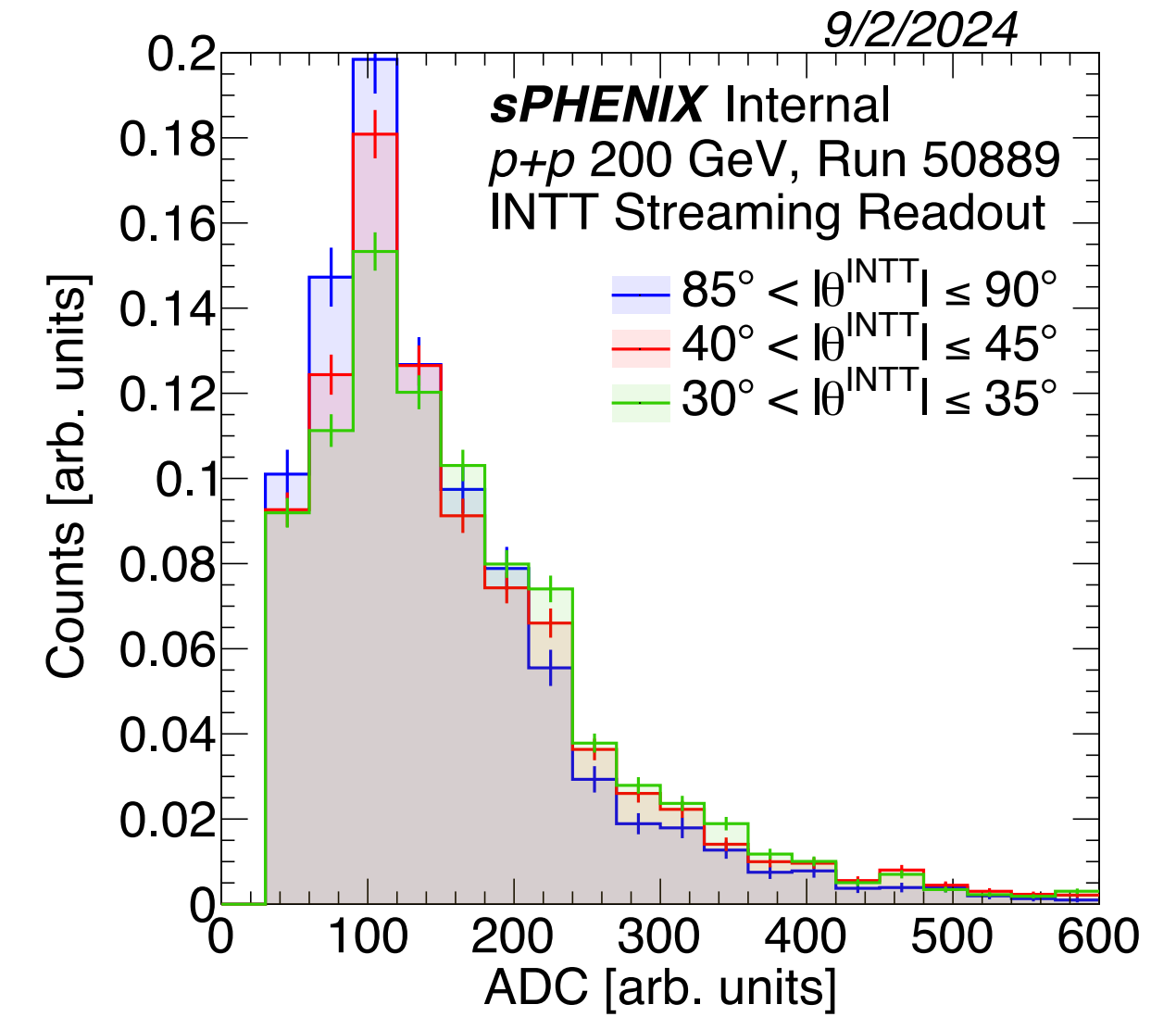
# Plots

## Single histogram

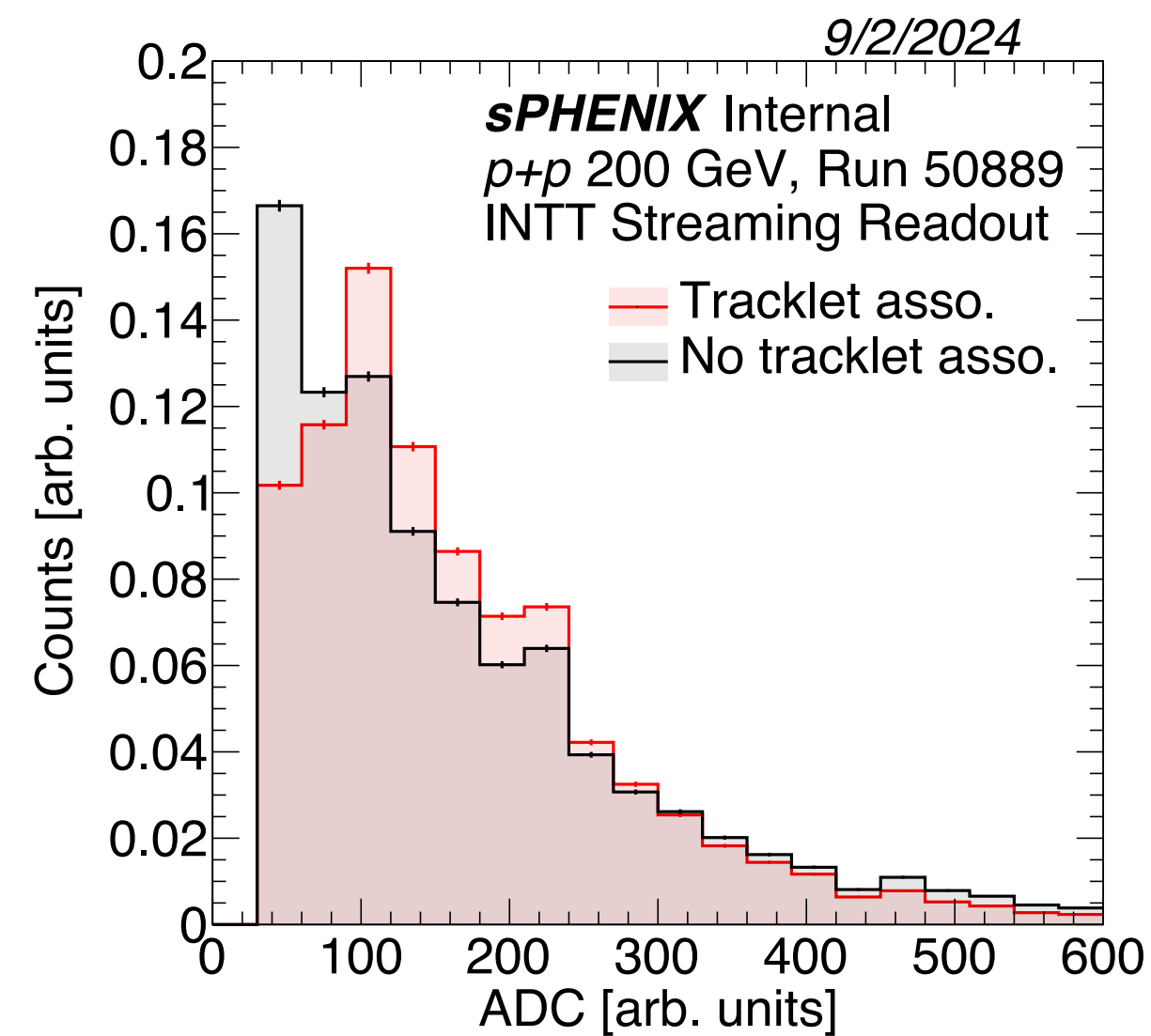


No tracklet angle selection

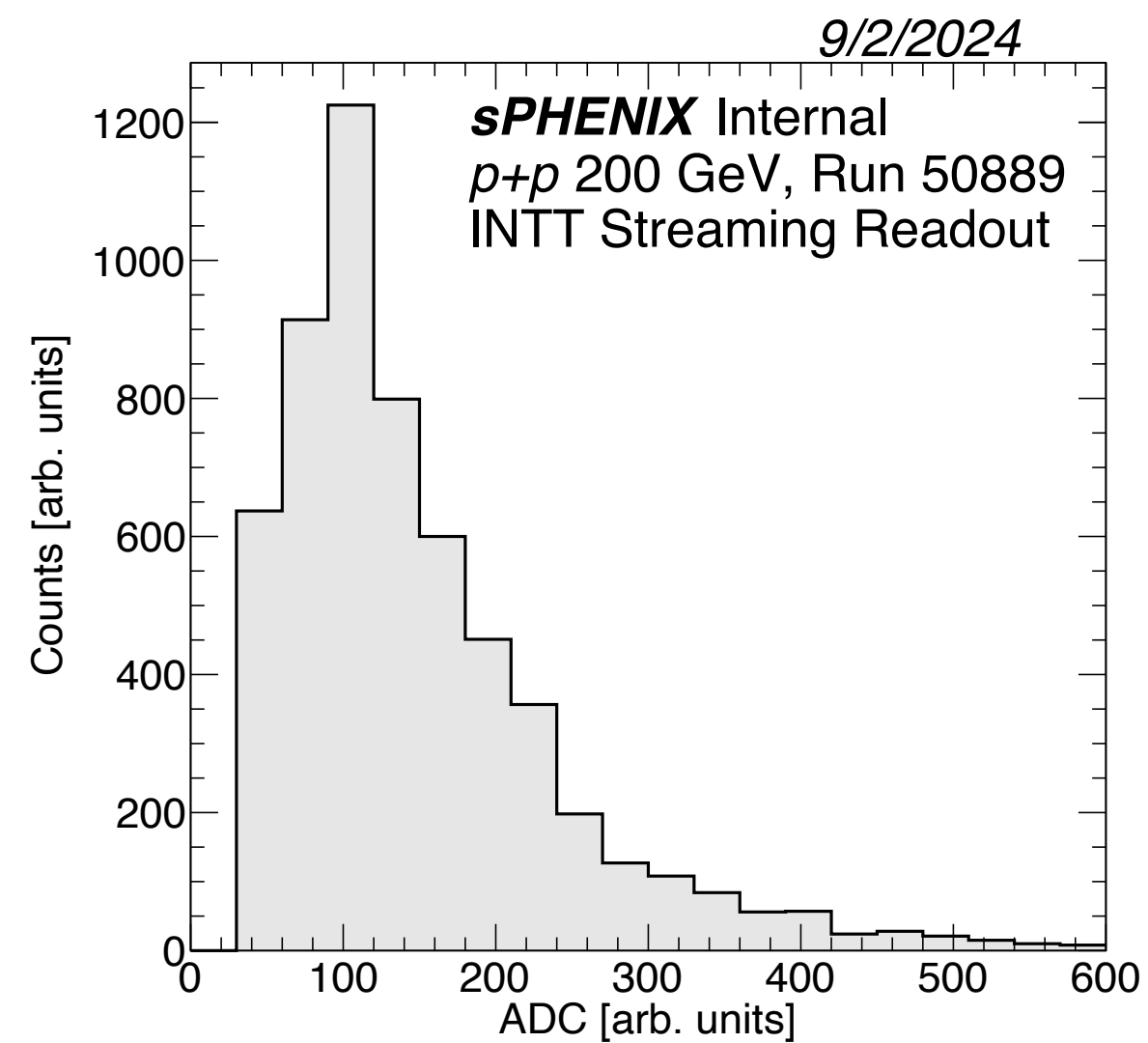
## Tracklet angle dependence



## W/WO tracklet association

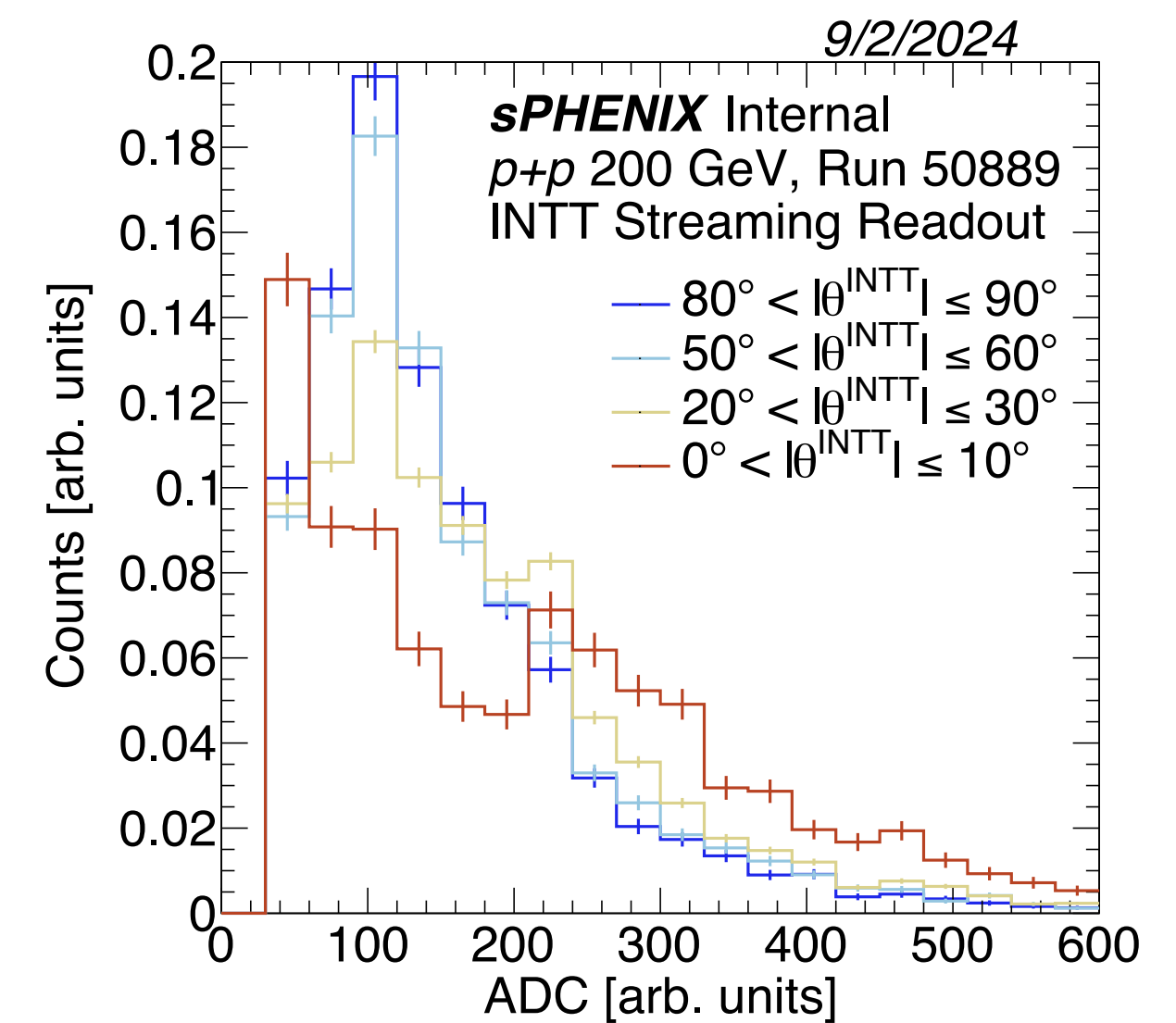


→ No need to ask for preliminary  
but good to show at the general meeting.



$80^\circ < |\theta| \leq 90^\circ$

→ The bottom plot is better



→ These are too early to release