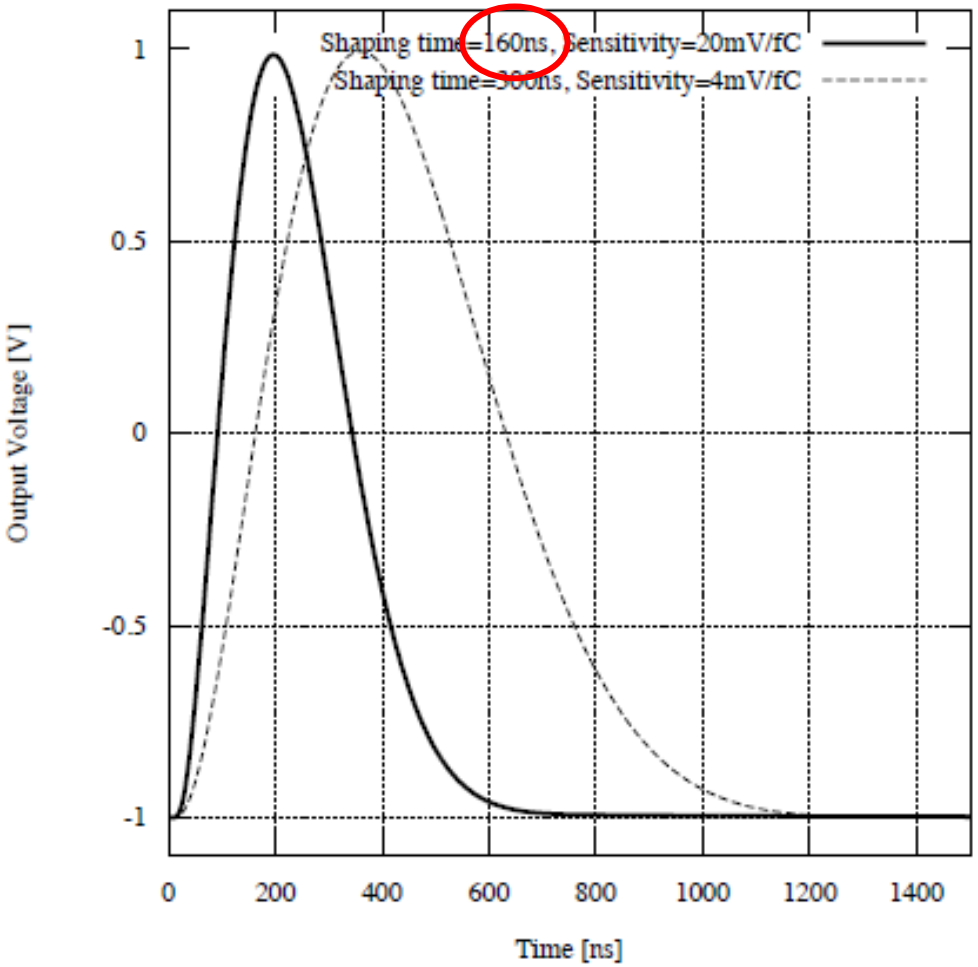
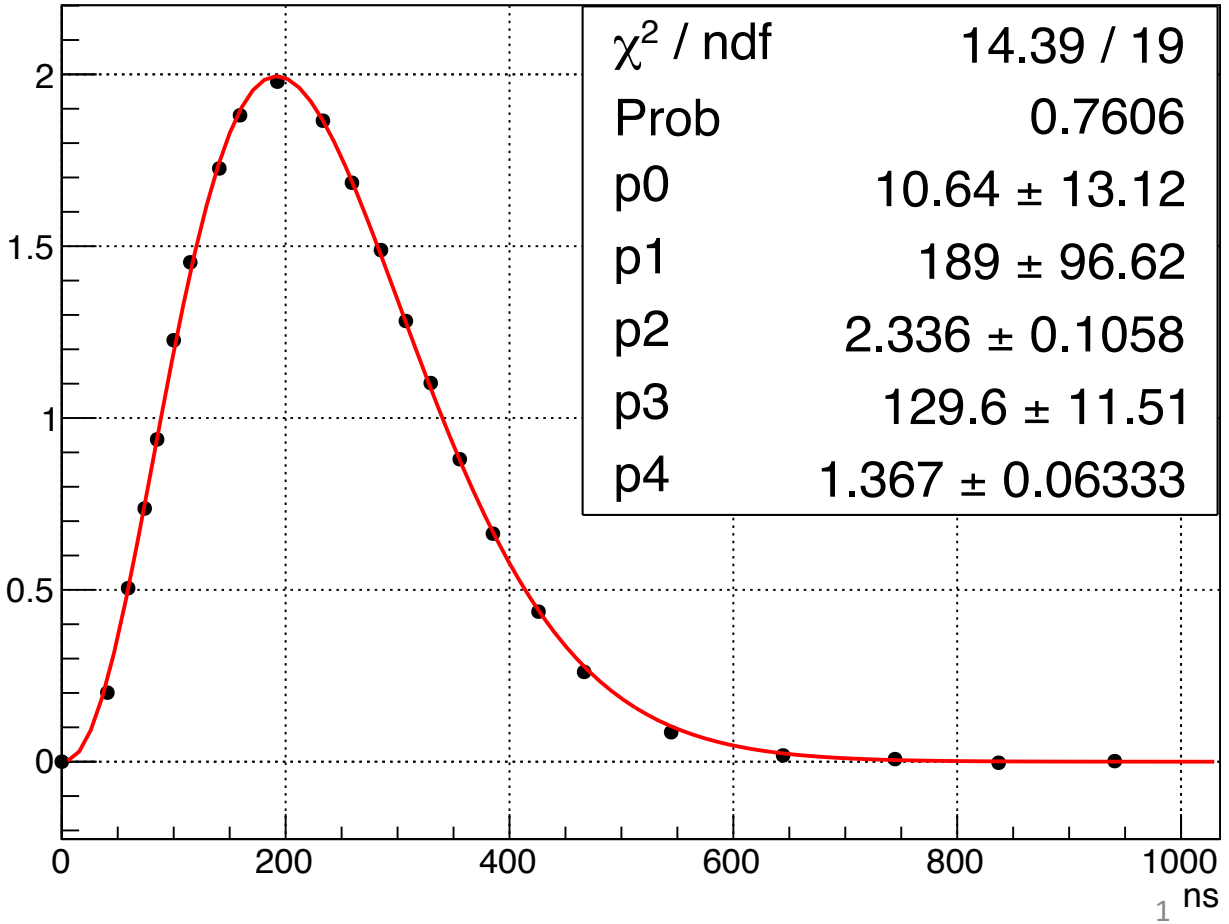
Extracting SAMPA response function

- Using plot digitizer to read off points from the plot and do a fit to get the SAMPA response function
- Shape reasonably well described by functional form: $p_0 \left(\frac{t}{p_1}\right)^{p_2} e^{-\left(\frac{t}{p_3}\right)^{p_4}}$

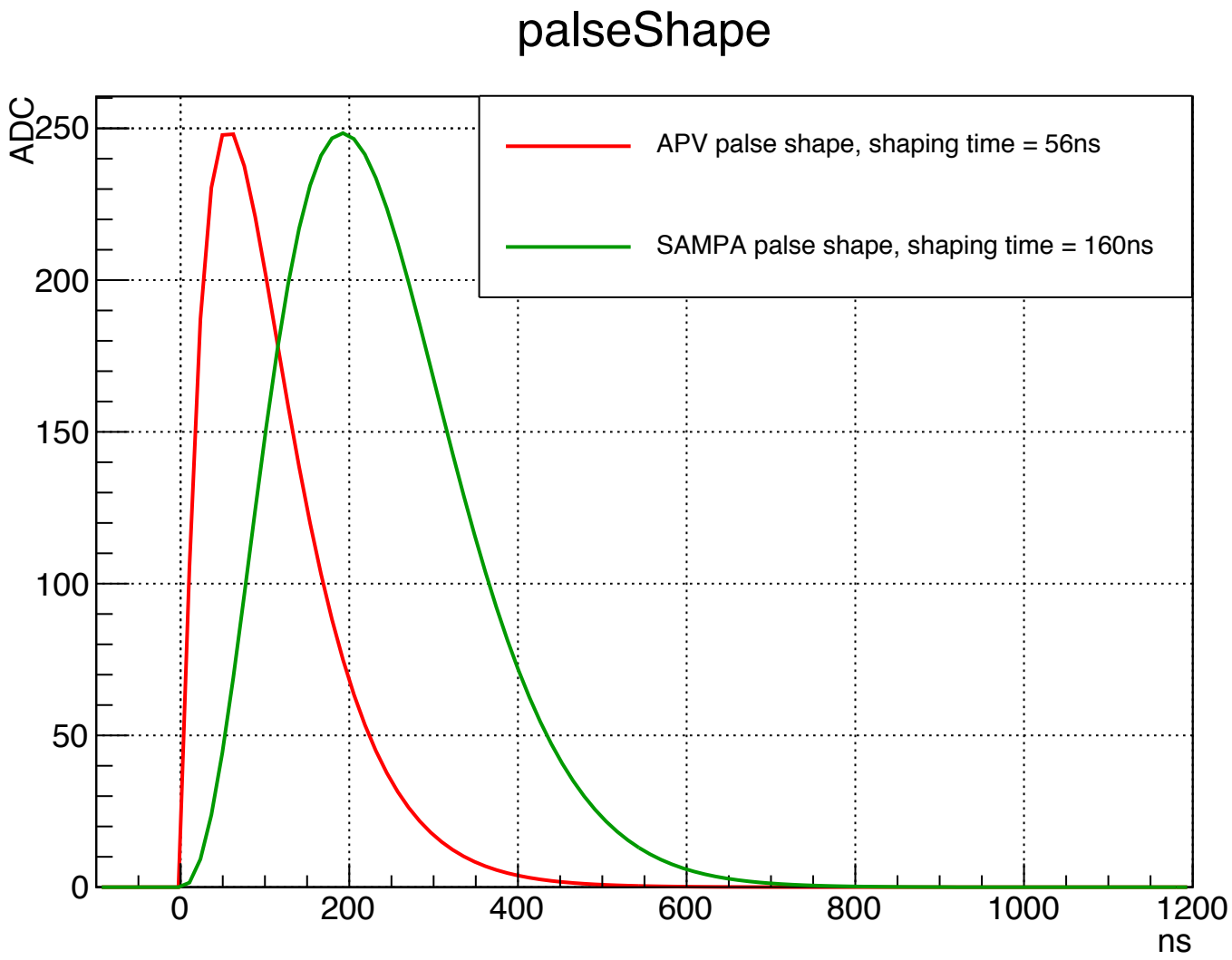


SAMPA palse shape



Response function comparison: SAMPA vs APV25

- The SAMPA response curve is much longer than APV25
- The shortest sampling time for SAMPA is 50ns while APV25 uses 25ns
- These two reasons will likely increase the pile-up effects and occupancies
- It is unlikely we will have good results (>90%) for tracking if we only take 1 sample with SAMPA
- It will be better to have at lest 3 samples using SAMPA
- For current study, I use 6 time samples



Signal to pedestal noise ratio

- If taking only one time sample, typically we will have the worst signal to pedestal noise ratio

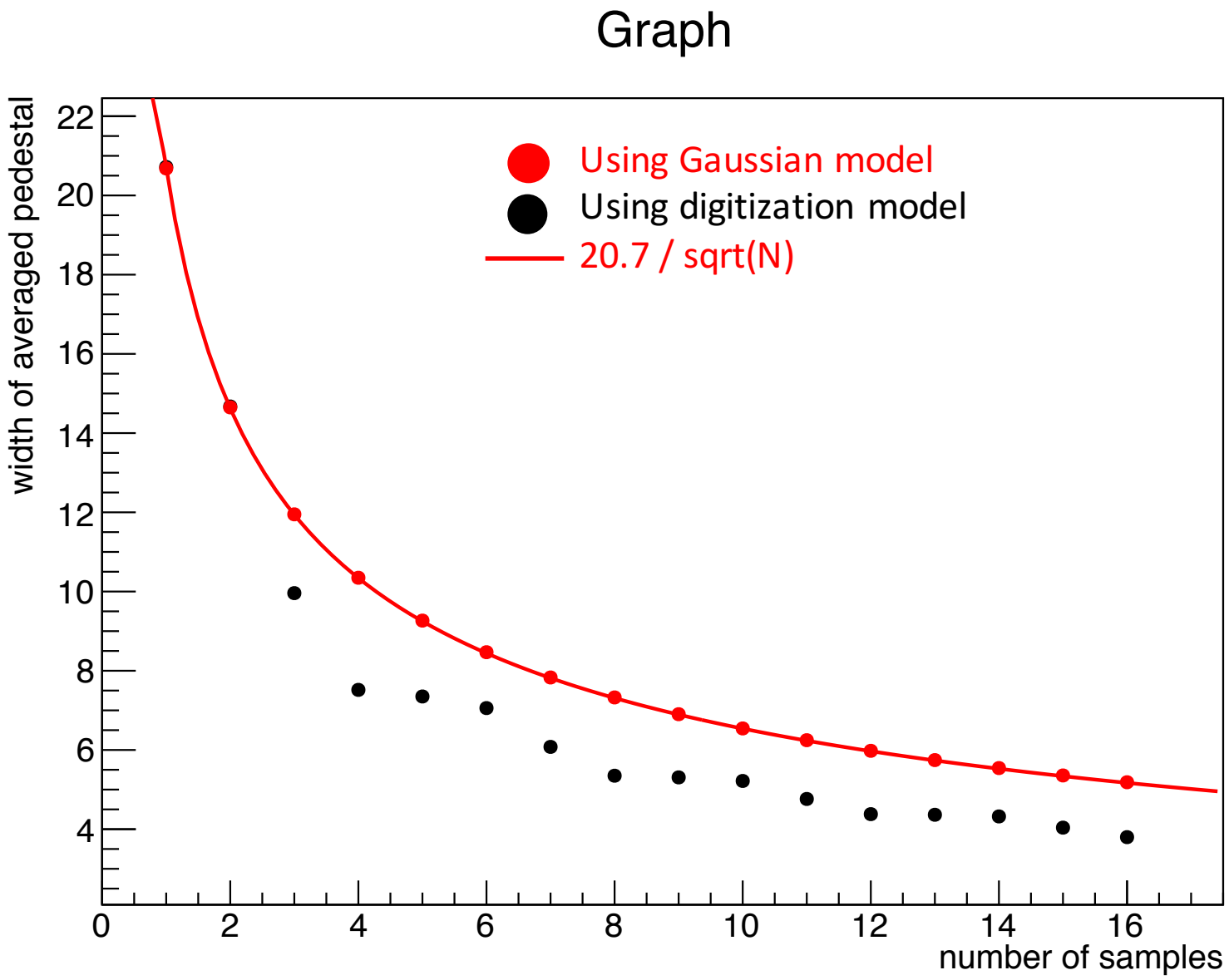
- If we have multiple samples, we can use the average of the samples, which is more likely to have better signal to pedestal noise ratio, as the signal is always positive but noise is randomly fluctuating around 0
  1. If the noise the Gaussian (around 0), there should be always cancelation if we sum more samples
  2. If there is also sinusoidal noise, the cancelation may not be obvious if the sampling time is much shorter than the period of the noise

- For the current pedestal noise we put in the digitization, it is a Gaussian + sinusoidal noise with period 200ns (digitization model)

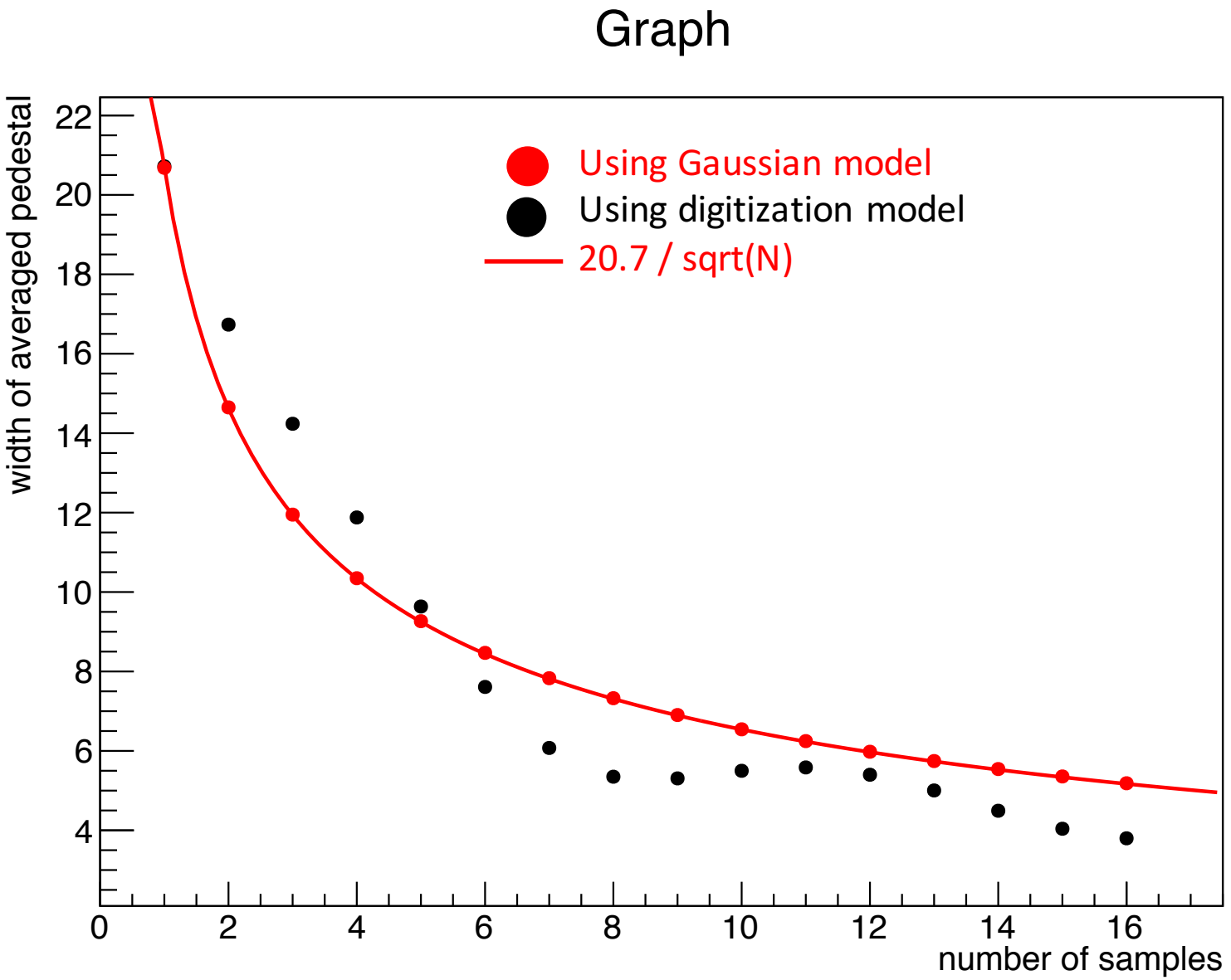
- If we take one sample, and look at the pedestal noise distribution, it is still quite Gaussian with width = 20.7 ADC

- Even though it is good to maximize the signal to pedestal noise ratio, we should always the record the full leading edge of the signal as it contains most of the time information (unless we plan not to use timing at all)

Signal to pedestal noise ratio – SAMPA (50ns sampling period)



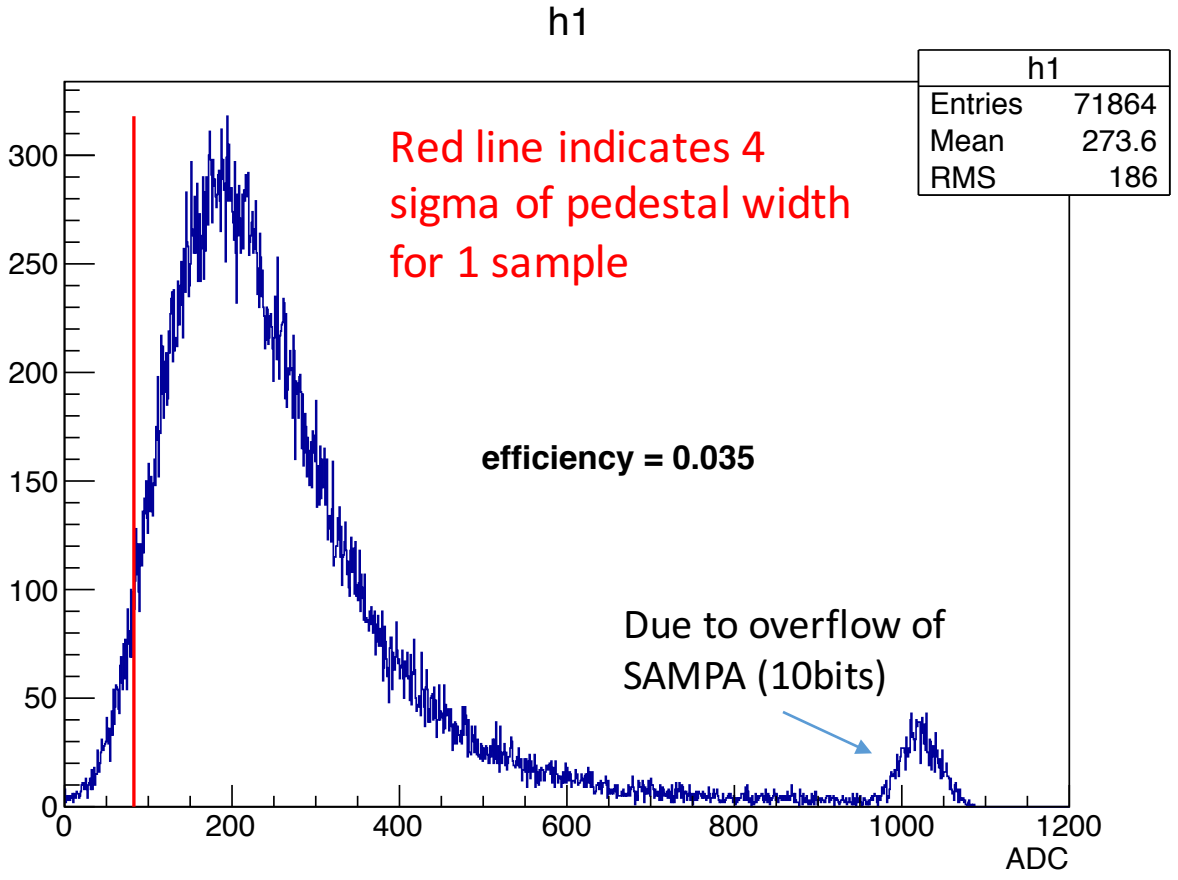
Signal to pedestal noise ratio – APV 25 (25ns sample period)



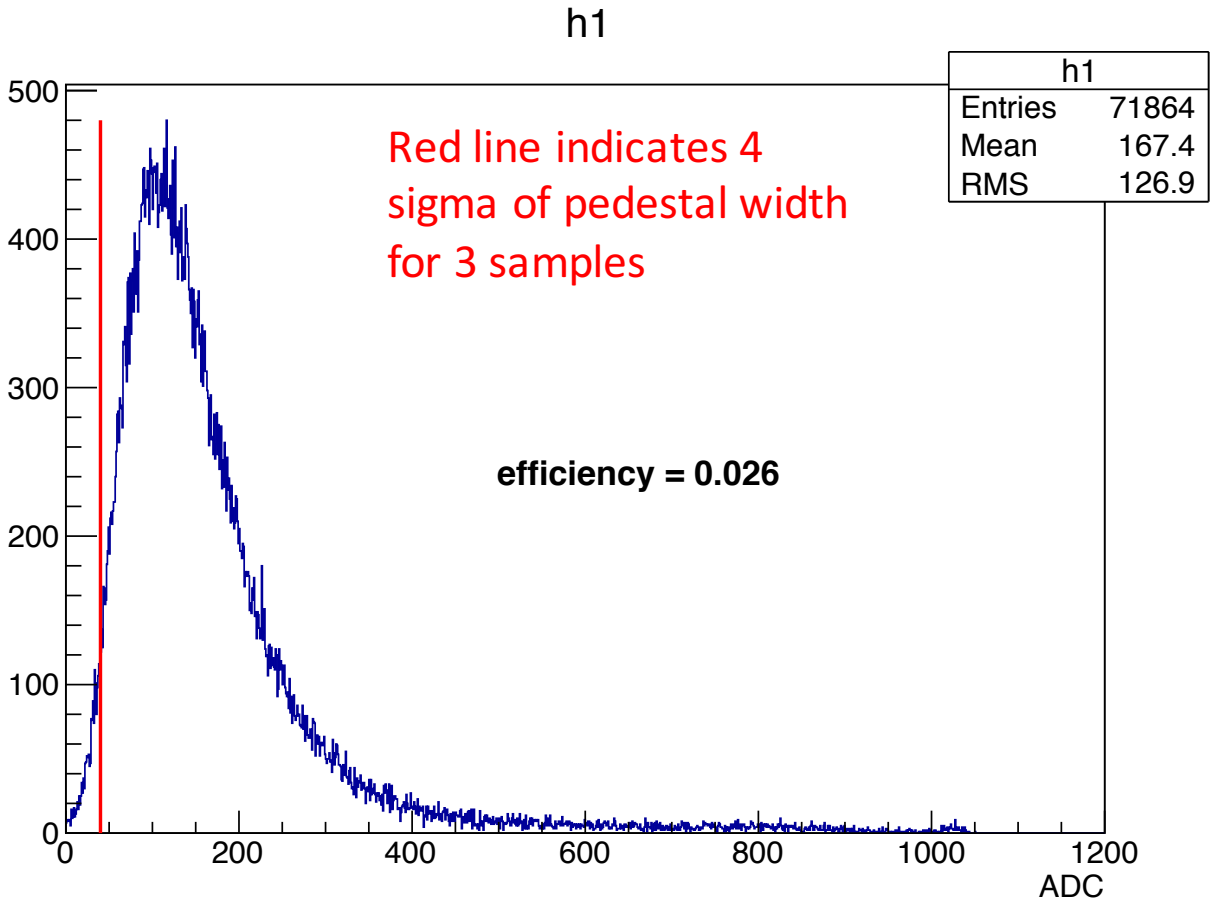
Signal to pedestal noise ratio – SAMPA (50ns sampling period)

Using ADCs on strip at cluster center

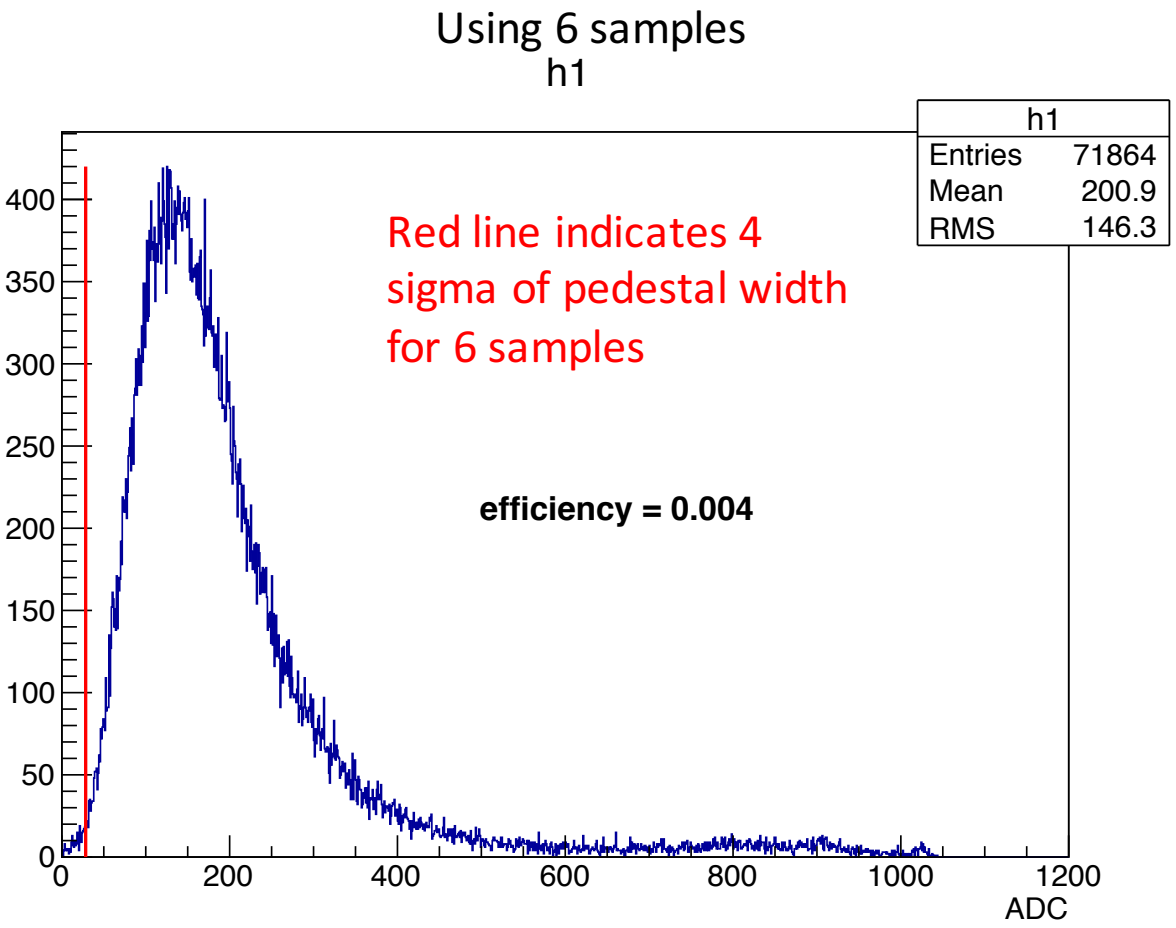
Using 1 sample (maximum one)

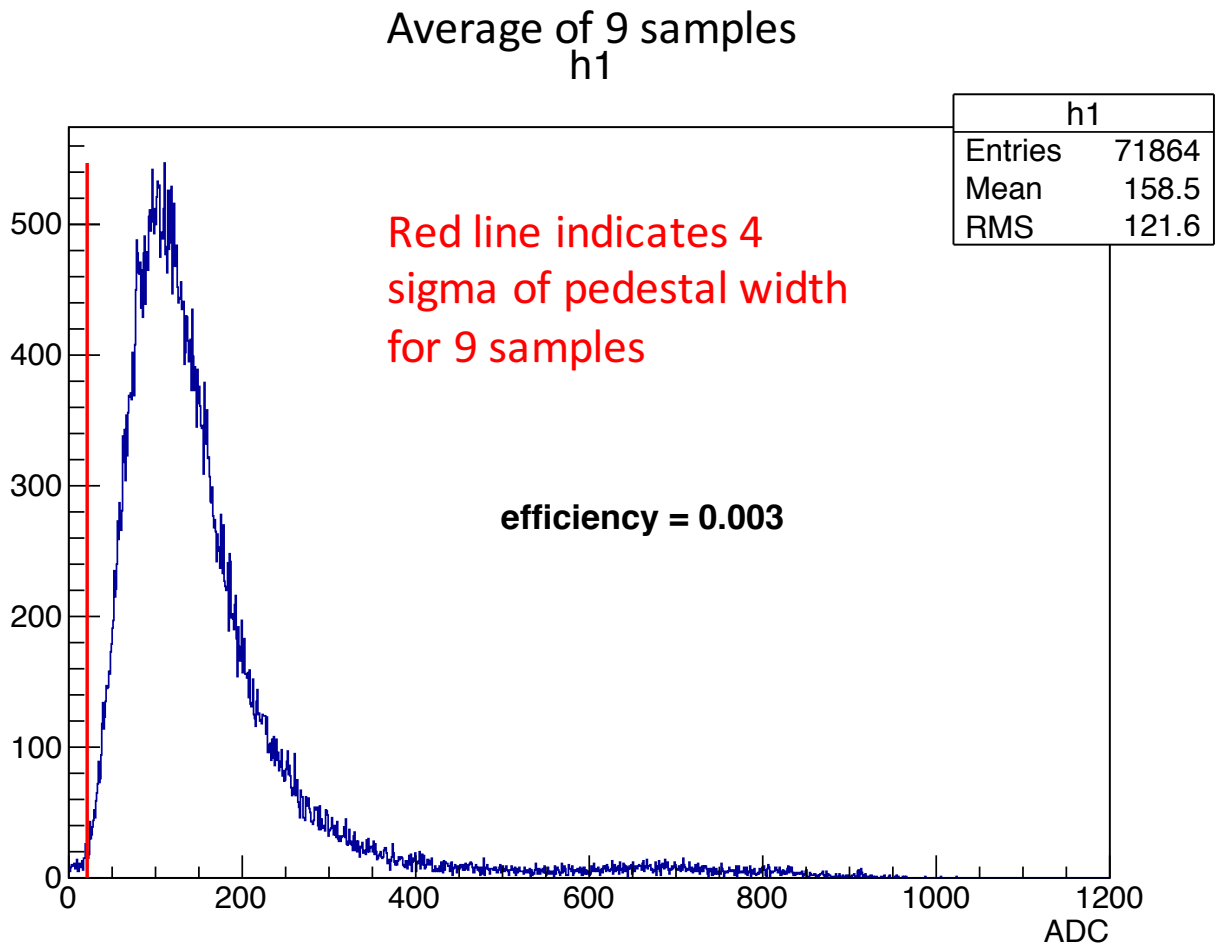


Average of 3 samples



Signal to pedestal noise ratio – SAMPA (50ns sampling period)





Background simulation in digitization and noise rejection

- When using APV25, we used a 275ns time window for the background simulation (200ns before trigger start time and 75ns after), because the pulse length is short and we consider at most taking 3 samples after the trigger start time

- When using APV25 with 3 samples, we compared the relative amplitudes between samples to reject out-of-time events (require leading edge)

- Currently for SAMPA, I use in total 1100ns time window for the background simulation (600ns before trigger start time and 500ns after), because the pulse length gets much longer and we will likely need up to 9 samples

- Still simply use the relative ratio between samples to reject out-of-time events, having in mind that there are more advanced algorithm for this purpose (like fitting to get more precise time info for instance)

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- Still simply use the relative ratio between samples to reject out-of-time events, having in mind that there are more advanced algorithm for this purpose (like fitting to get more precise time info for instance)
  - Require the maximum must be either the 2^{nd}, 3^{rd} or 4^{th} sample and the first sample must have less ADC than the maximum

Occupancy - 1 sample

- Raw occupancy means the # of strips above threshold cut / total # of strips
- Noise rejected occupancy means the # of strips above threshold cut and out-of-time noise rejection cut / total # of strips
- For 1 sample, raw occupancy would be the same as noise rejected occupancy

	Raw occupancy	**Noise-rejected occupancy**
SIDIS plane 1	4.00%	-
SIDIS plane 2	13.7%	-
SIDIS plane 3	5.79%	-
SIDIS plane 4	3.76%	-
SIDIS plane 5	3.36%	-
SIDIS plane 6	2.50%	-

Occupancy - 6 sample

- Raw occupancy means the # of strips above threshold cut / total # of strips
- Noise rejected occupancy means the # of strips above threshold cut and out-of-time noise rejection cut / total # of strips

	Raw occupancy	**Noise-rejected occupancy**
SIDIS plane 1	10.0%	4.33%
SIDIS plane 2	26.3%	11.0%
SIDIS plane 3	14.2%	6.14%
SIDIS plane 4	9.20%	3.93%
SIDIS plane 5	8.67%	3.80%
SIDIS plane 6	6.50%	2.85%

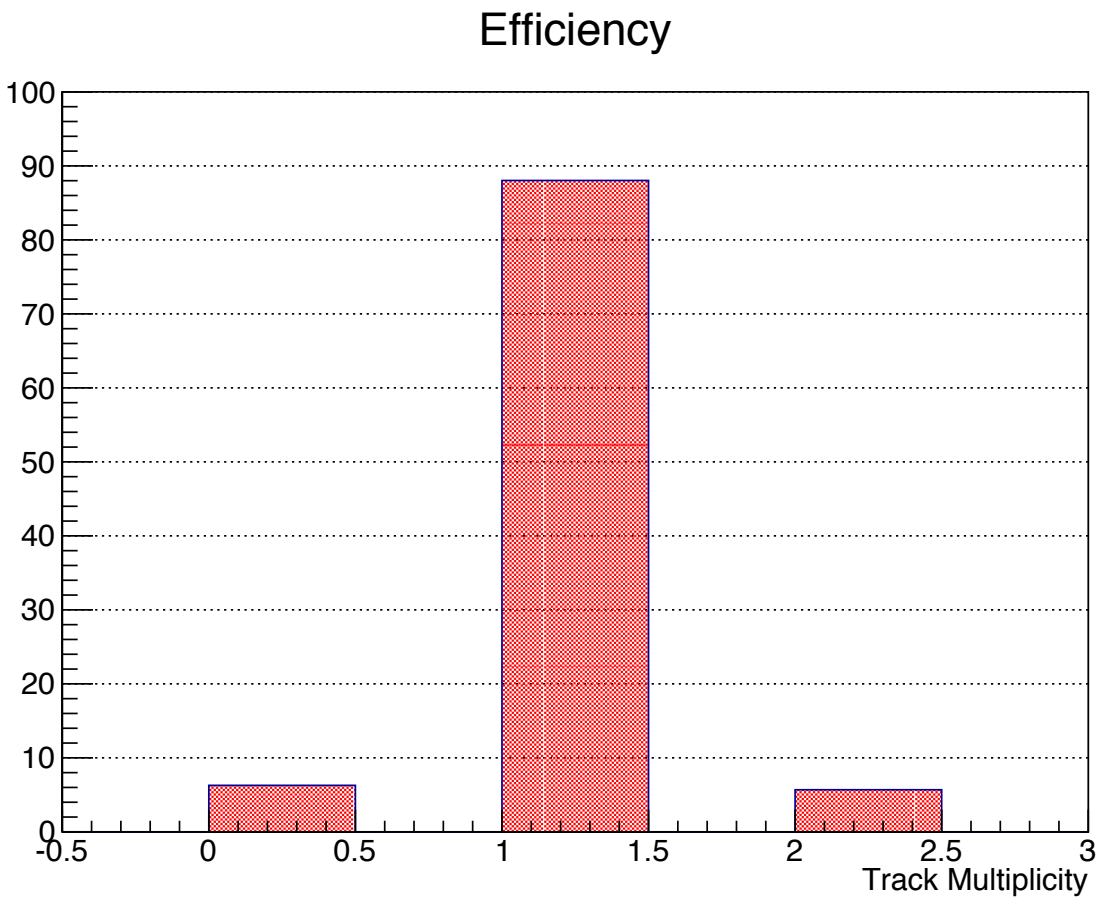
Occupancy - 9 sample

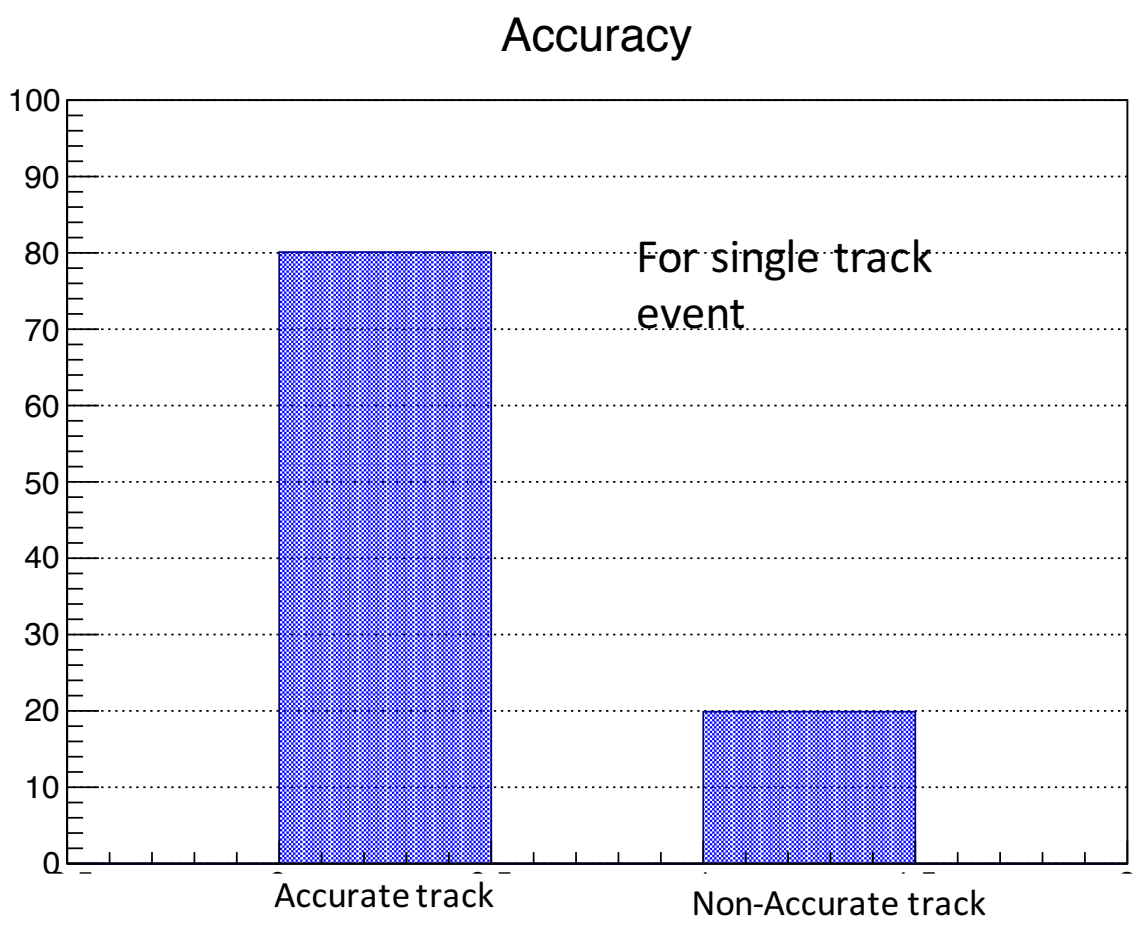
- Raw occupancy means the # of strips above threshold cut / total # of strips
- Noise rejected occupancy means the # of strips above threshold cut and out-of-time noise rejection cut / total # of strips

	Raw occupancy	**Noise-rejected occupancy**
SIDIS plane 1	8.50%	6.10%
SIDIS plane 2	30.3%	13.2%
SIDIS plane 3	17.9%	8.38%
SIDIS plane 4	11.9%	5.56%
SIDIS plane 5	11.3%	5.43%
SIDIS plane 6	8.53%	4.10%

Tracking results – SIDIS FA

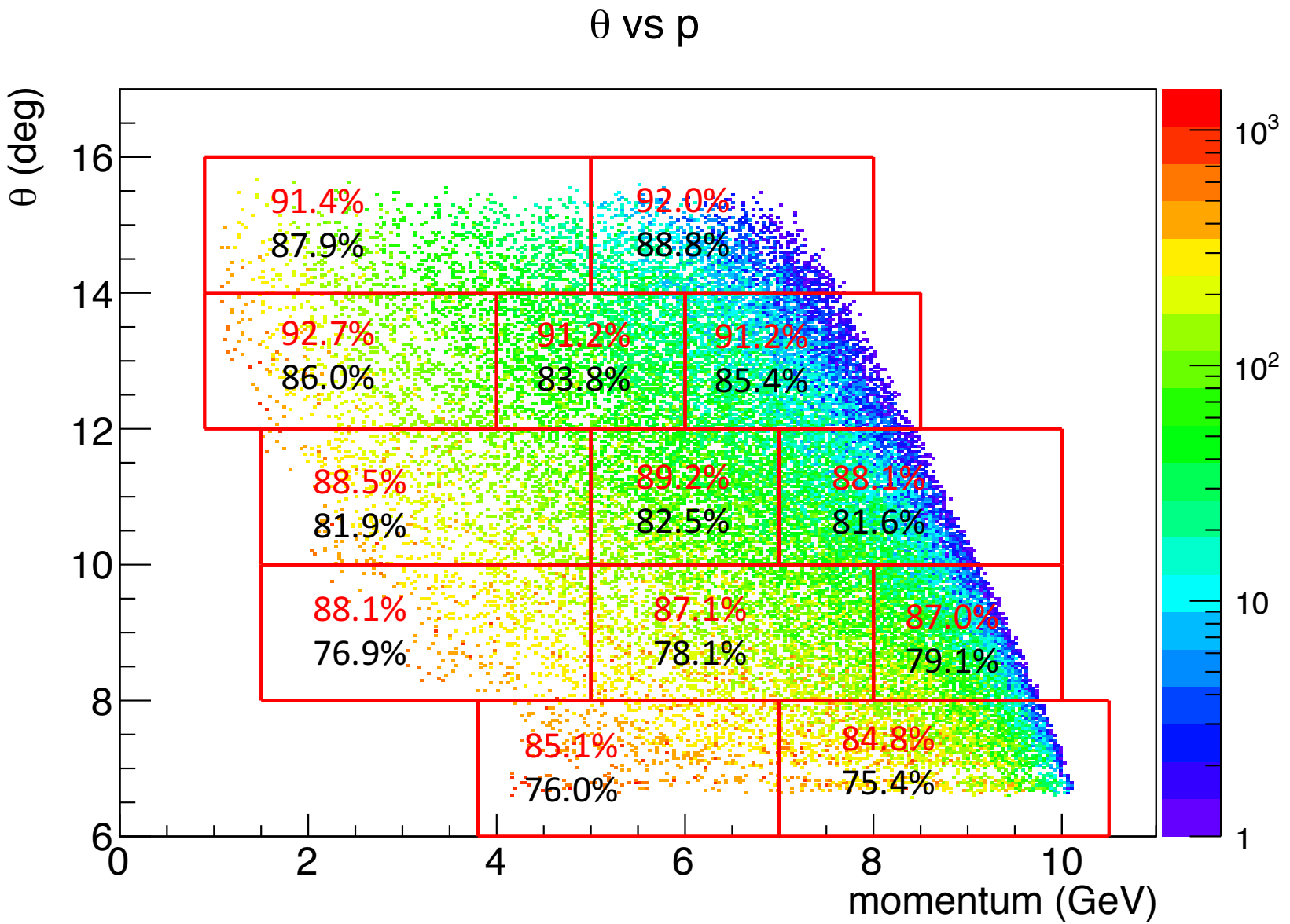
- Accurate track requires all hits of the track must be the ”best” reconstructed hit for the MC hit
- “best” reconstructed hit requires the hit must be the closest reconstructed hit for the MC hit, it must contains contribution from the MC, and the reconstructed hit cannot be over 3 strips away from the MC hit
- Number weighted by DIS cross section





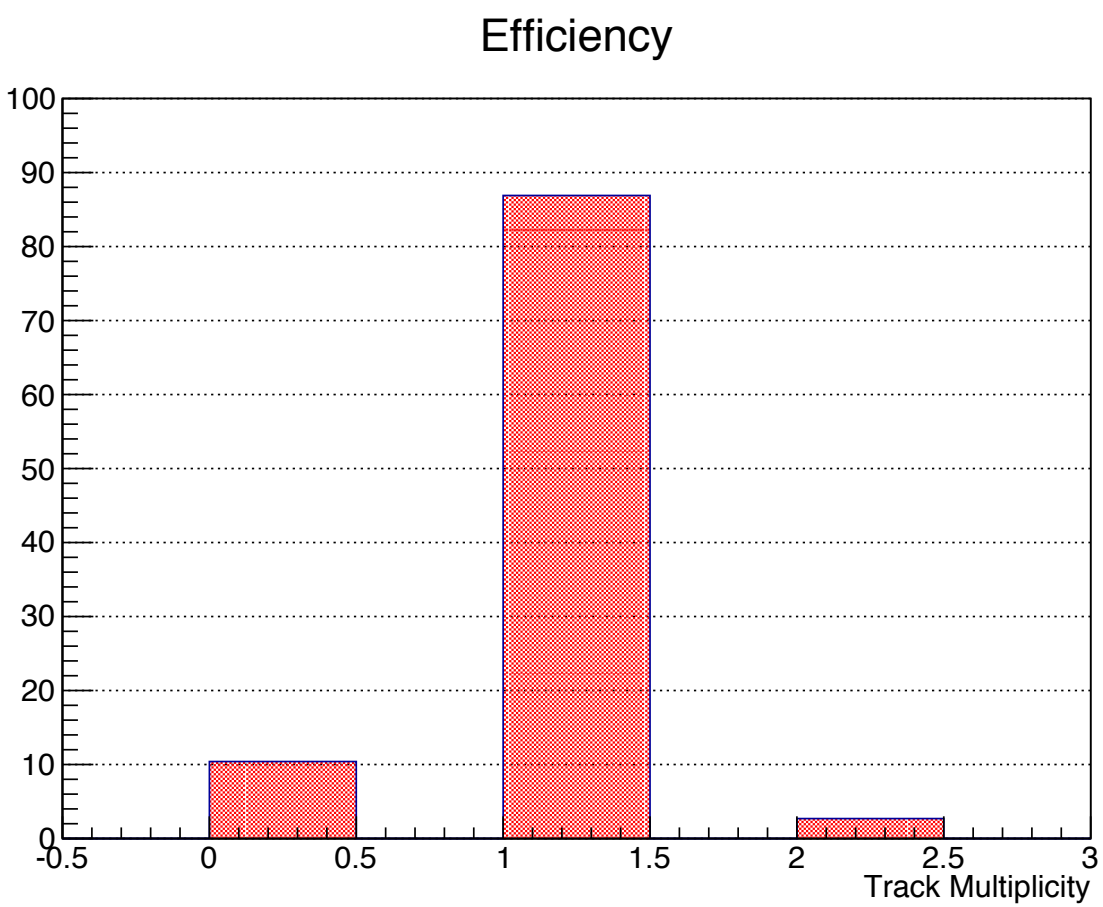
Tracking results – SIDIS FA

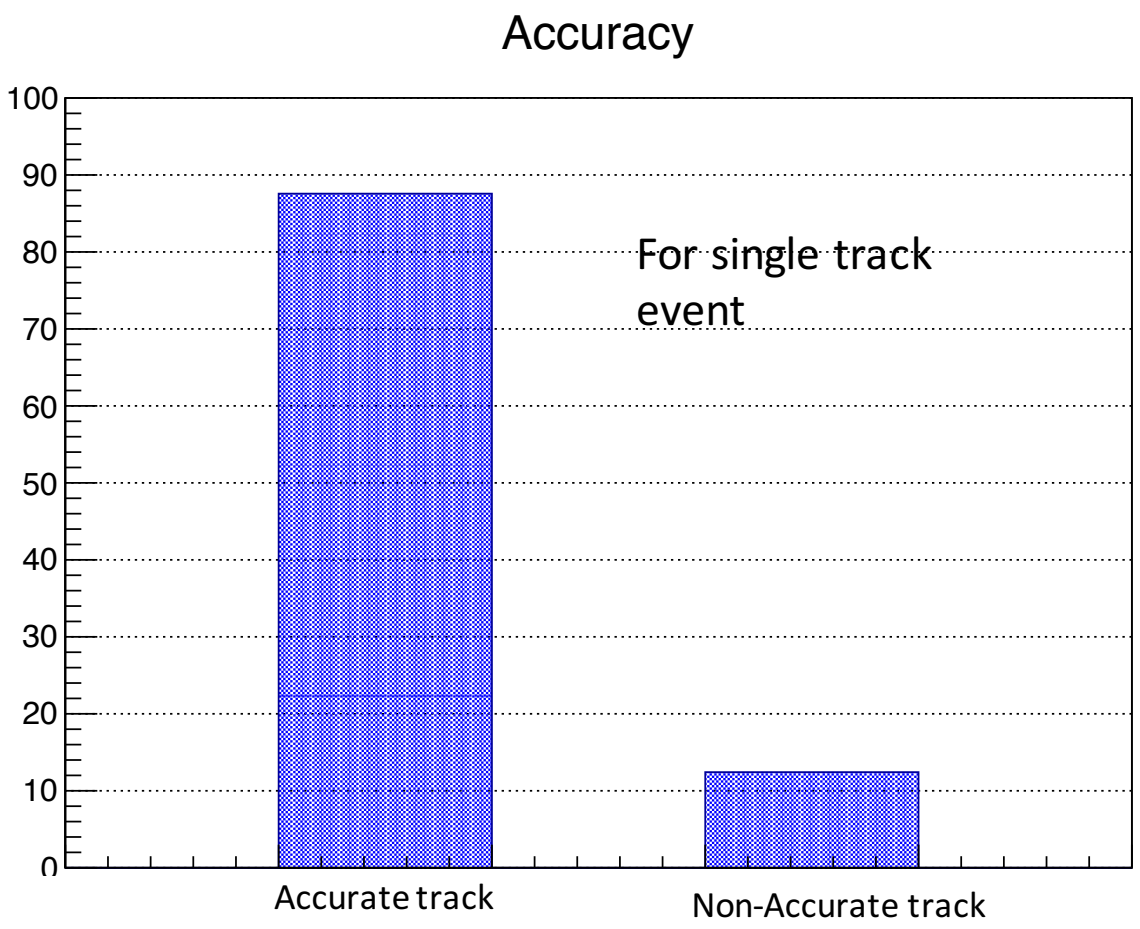
Efficiency in red
Accuracy in black



Tracking results – SIDIS LA

- Accurate track requires all hits of the track must be the ”best” reconstructed hit for the MC hit
- “best” reconstructed hit requires the hit must be the closest reconstructed hit for the MC hit, it must contains contribution from the MC, and the reconstructed hit cannot be over 3 strips away from the MC hit
- Numbers weighted by DIS cross section





Tracking results – SIDIS LA