Update on Cluster Counting Efficiency Studies with Garfield

- Finer momentum binning
- Use “experimental” instead of “generated” time difference as dead time
- First rough estimate of effect of S/N ratio

G. Finocchiaro
INFN – LNF
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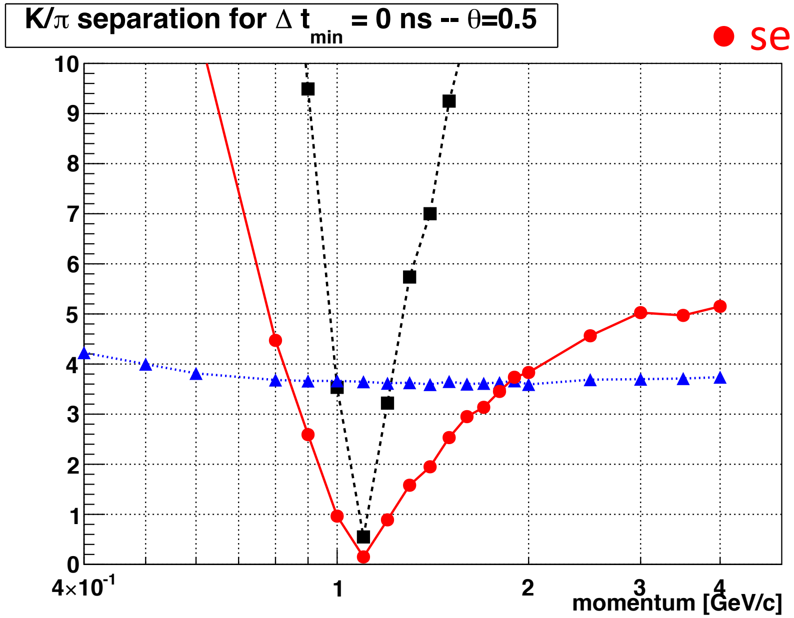
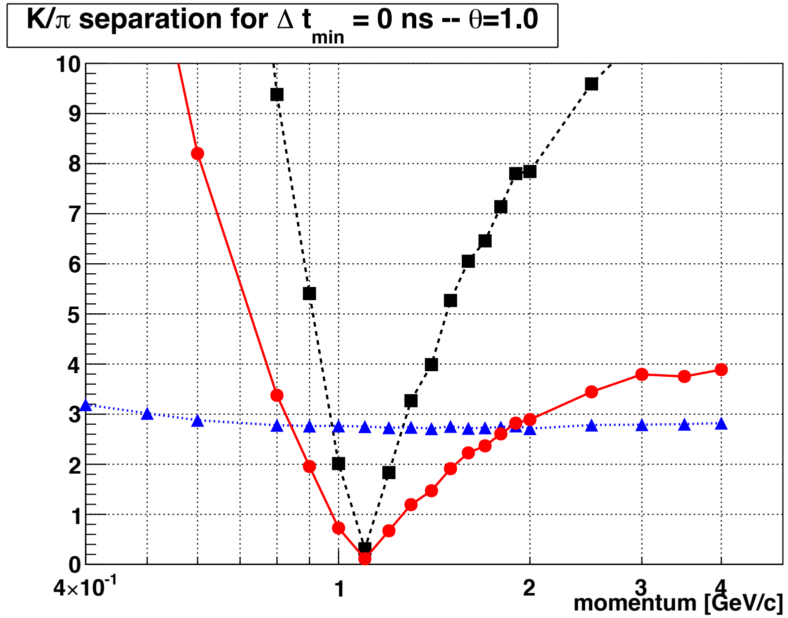
K/π separation for ε=1

■ $|N_K\text{-}N_\pi|/10$
▲ $\langle\sigma\rangle/10$
● separation





- Total track length normalized to a drift chamber with 40 layers of 1.2cm high rectangular cells.
- Note: although I like better the definition $\langle\sigma\rangle \equiv \sqrt{\sigma_K^2 + \sigma_\pi^2}$, for the sake of comparison I'm using here $\langle\sigma\rangle \equiv (\sigma_K + \sigma_\pi)/2$
- separation $\equiv |N_K\text{-}N_\pi|/\langle\sigma\rangle$

K/π separation vs Δt_{min}

- Definition:

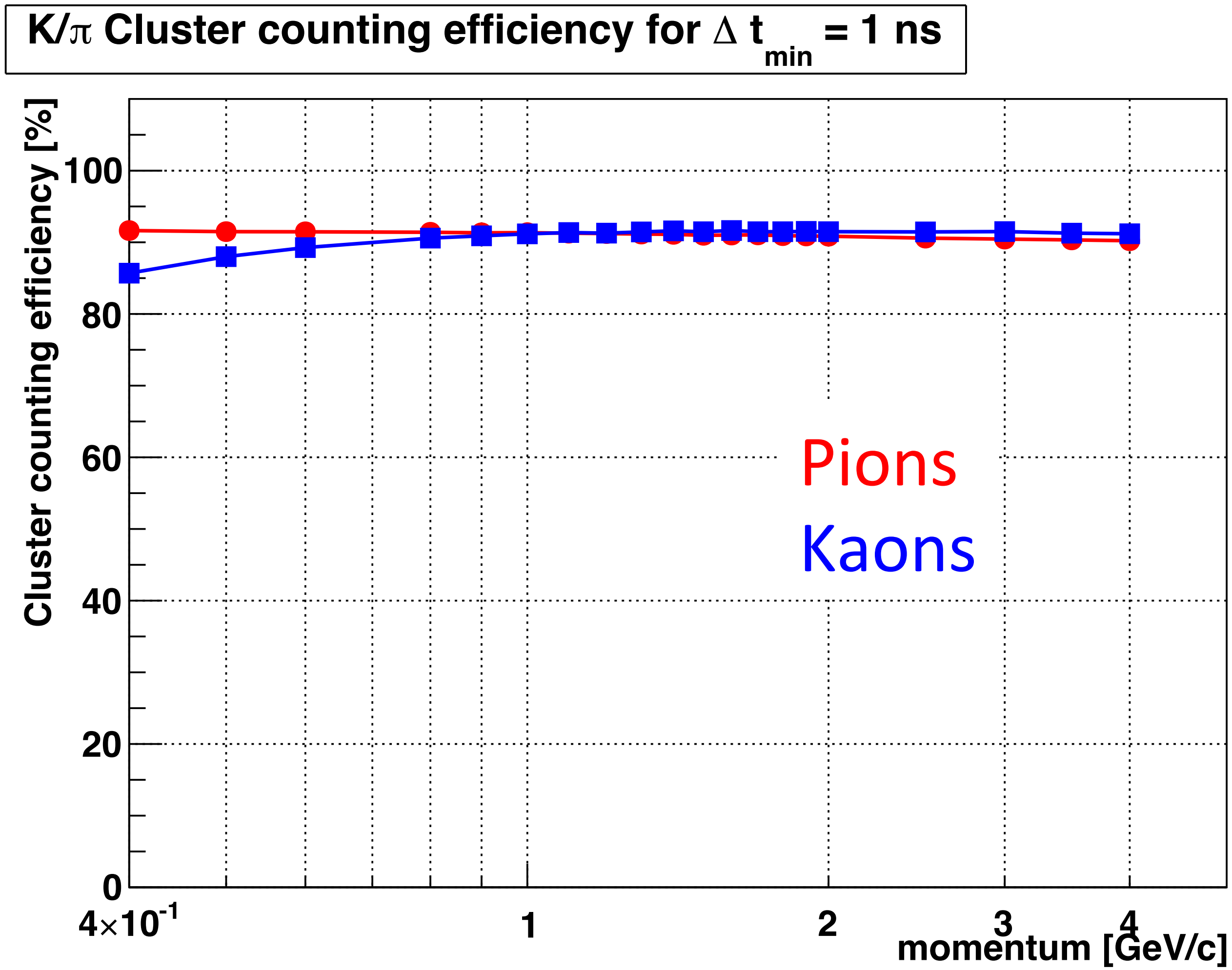
  $\Delta t_{exp} \equiv$ t(cluster # i) – t(previous found cluster)

  - In my last presentation, I used

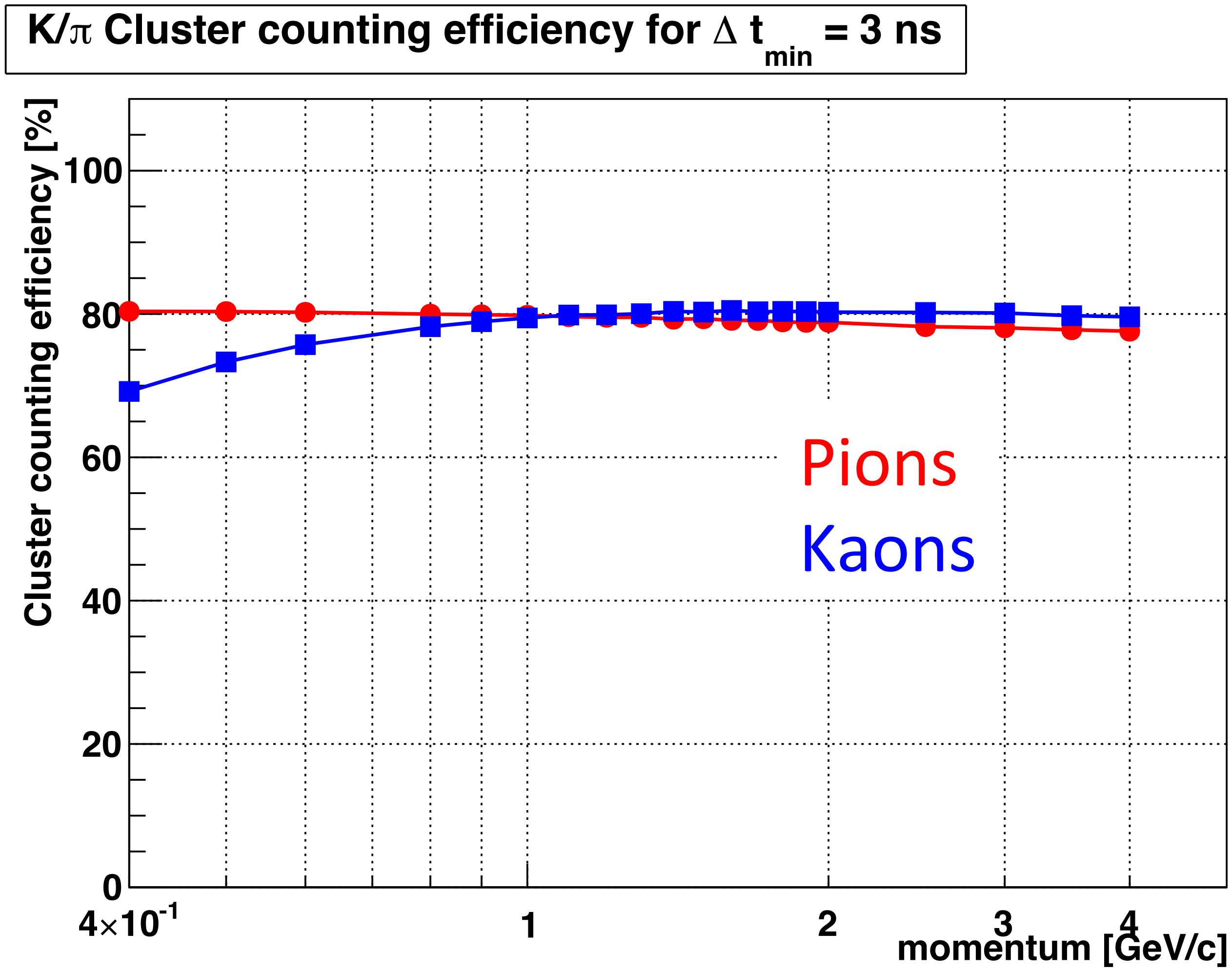
    $\Delta t_{generated}$ = t(cluster # i) – t(cluster # i-1)

  - Plots in this talk use the experimentally relevant variable Δt_{exp}

ε(cluster counting) vs. p for Δt_{min}=1ns



ε(cluster counting) vs. p for Δt_{min}=3ns



ε(cluster counting) vs. p for Δt_{min}=5ns

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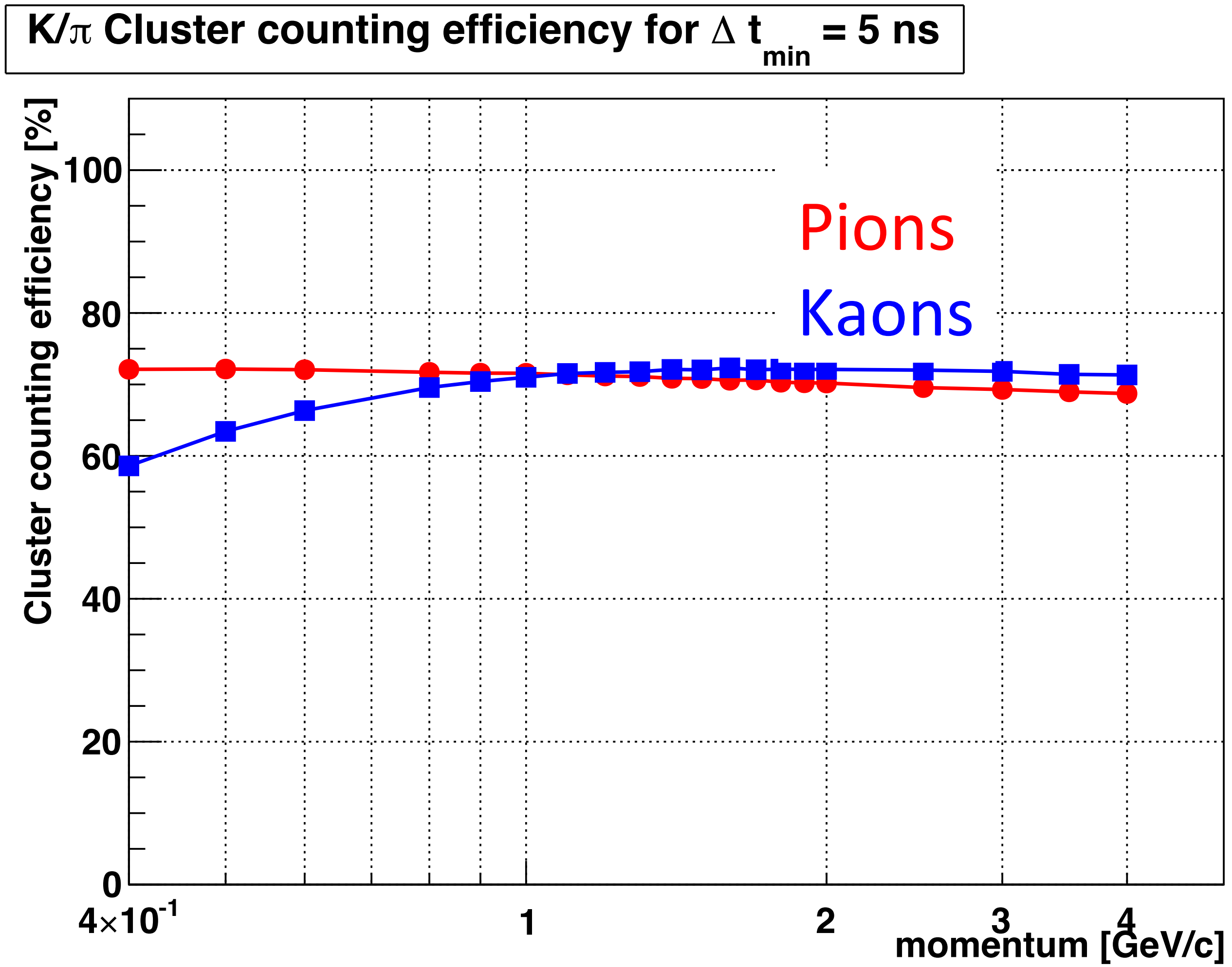
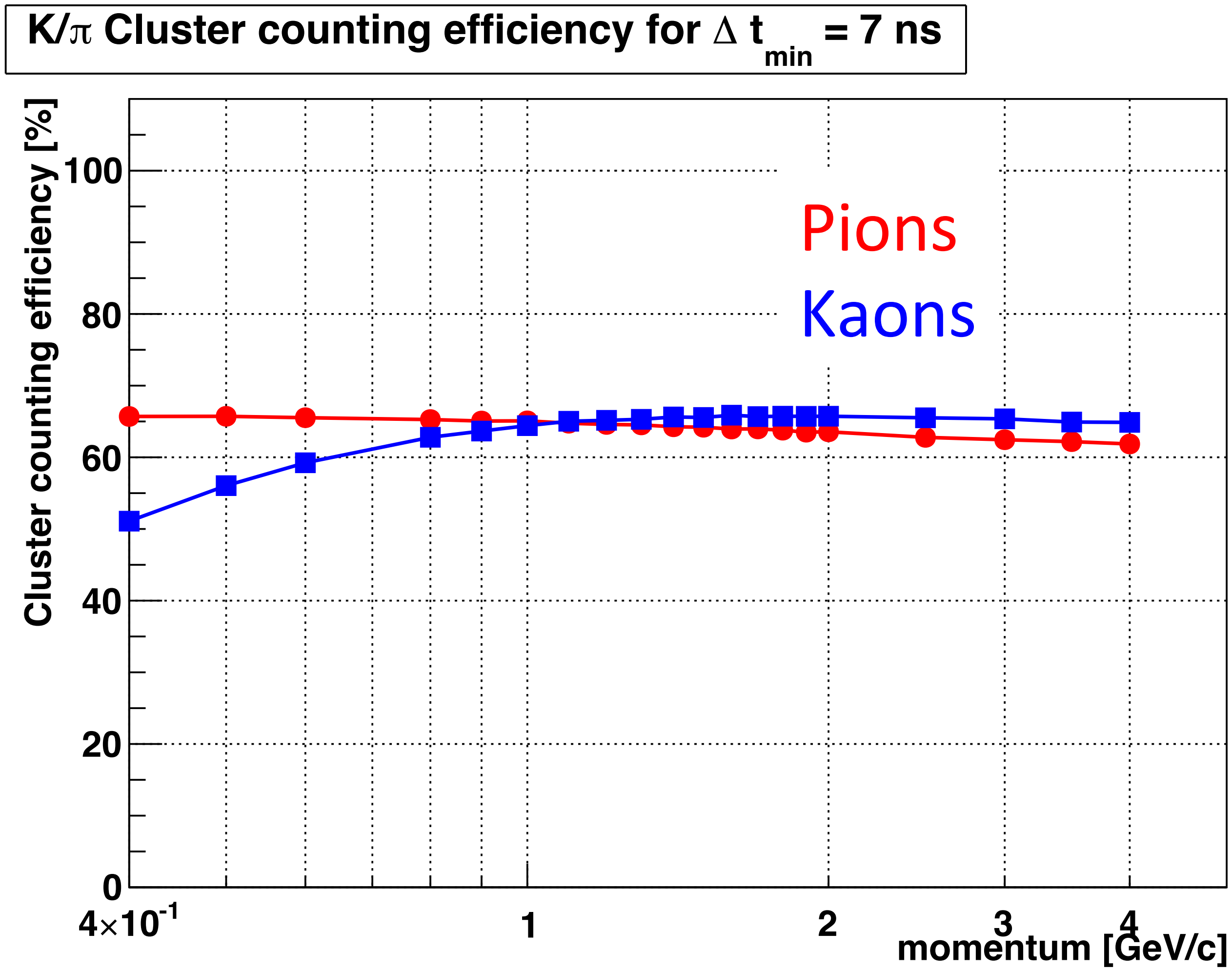
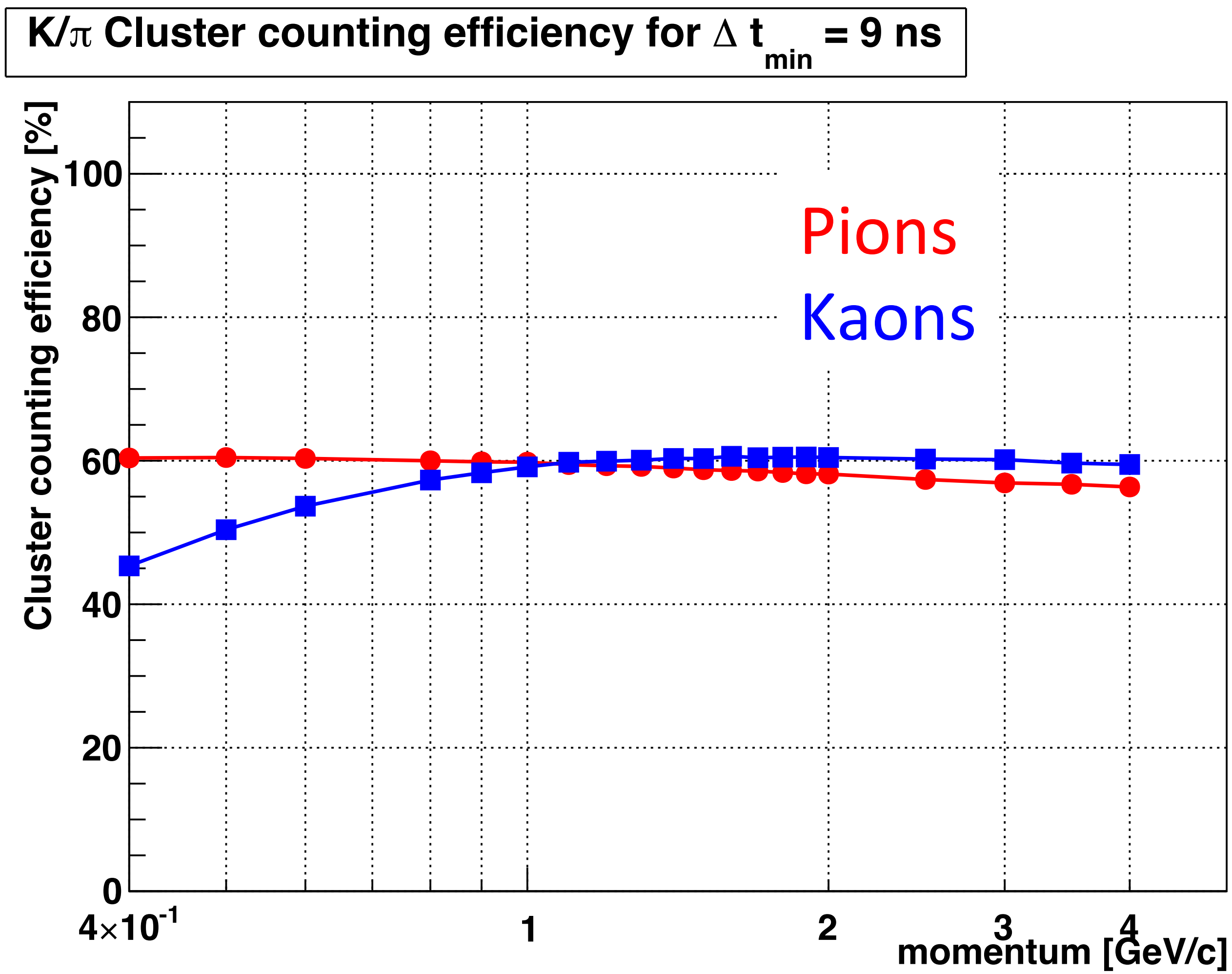


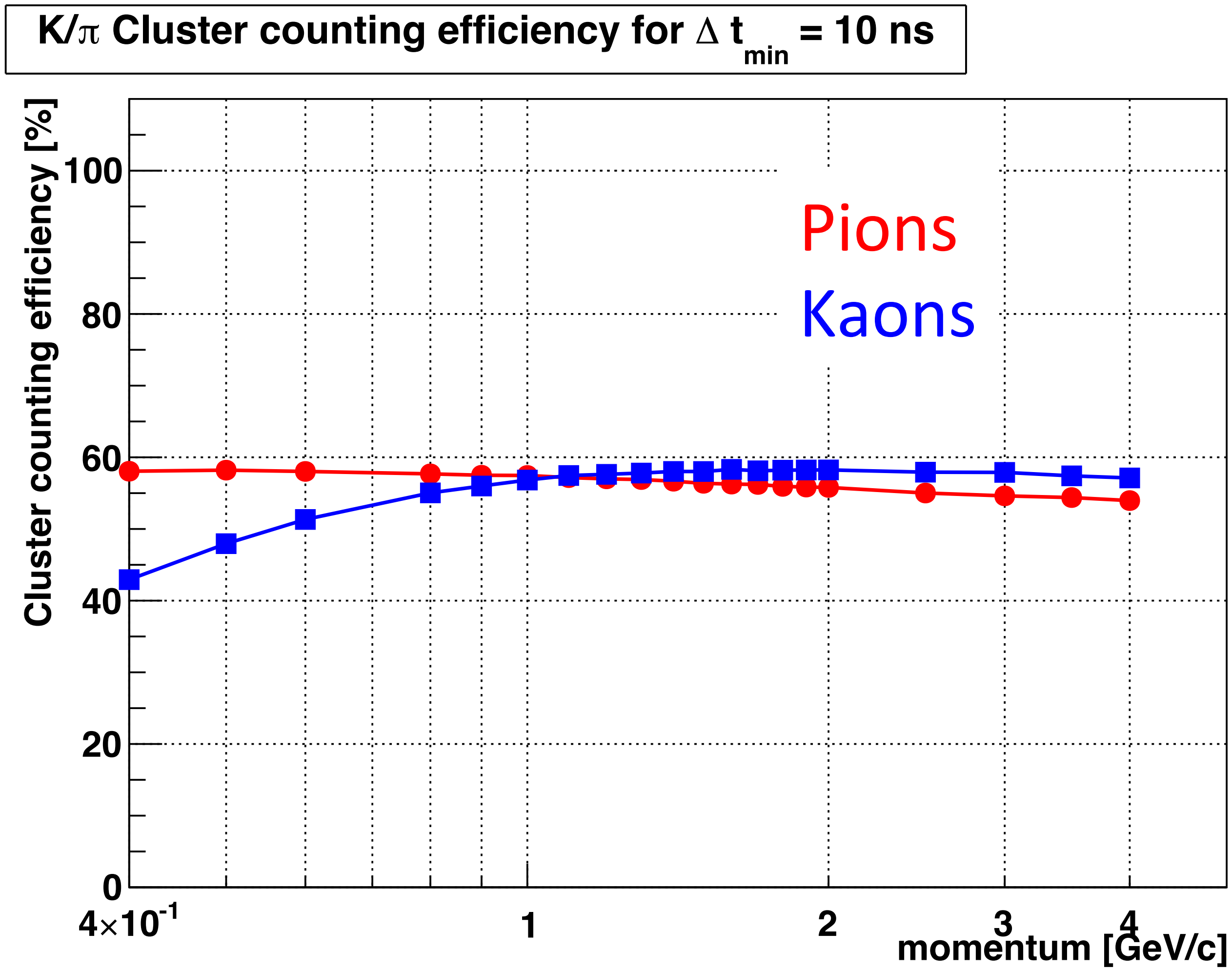
ε(cluster counting) vs. p for Δt_{min}=7ns



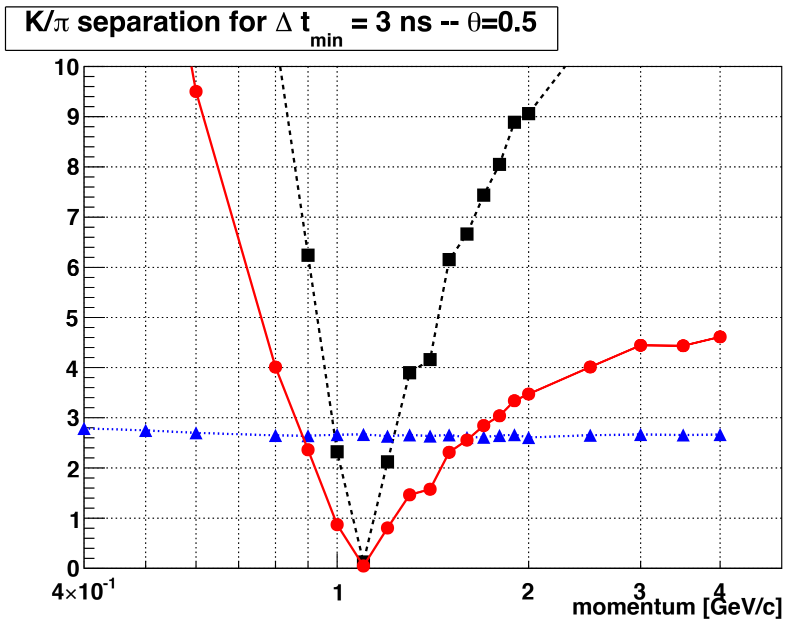
ε(cluster counting) vs. p for Δt_{min}=9ns

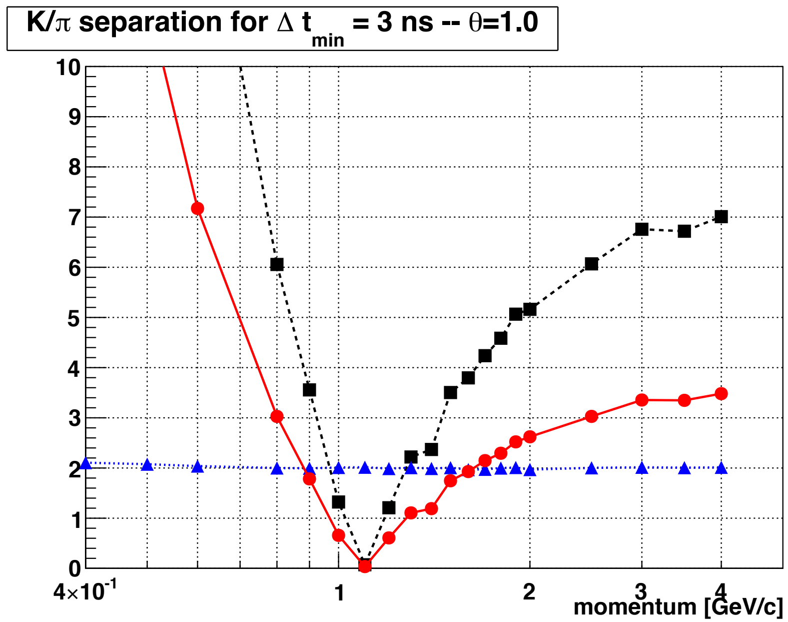


ε(cluster counting) vs. p for Δt_{min}=10ns



K/π separation for $\Delta t_{min} = 3ns$



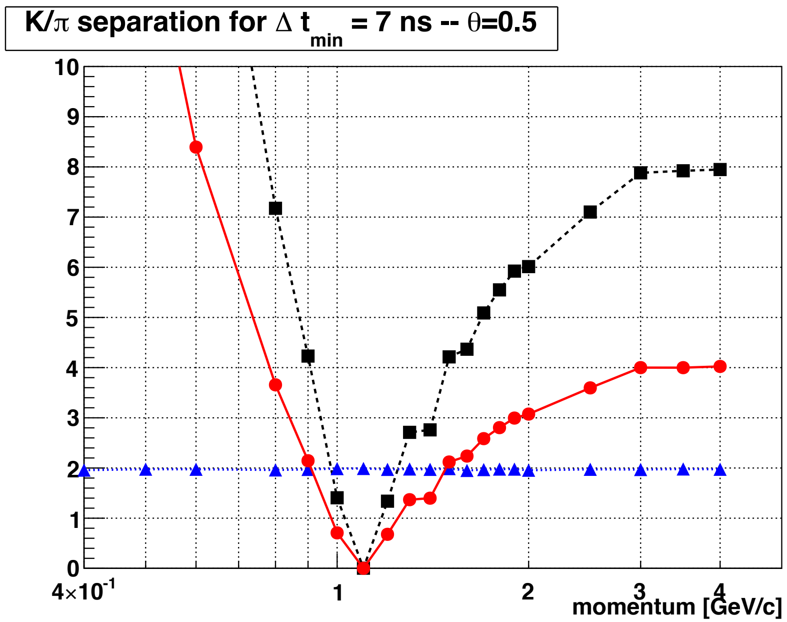


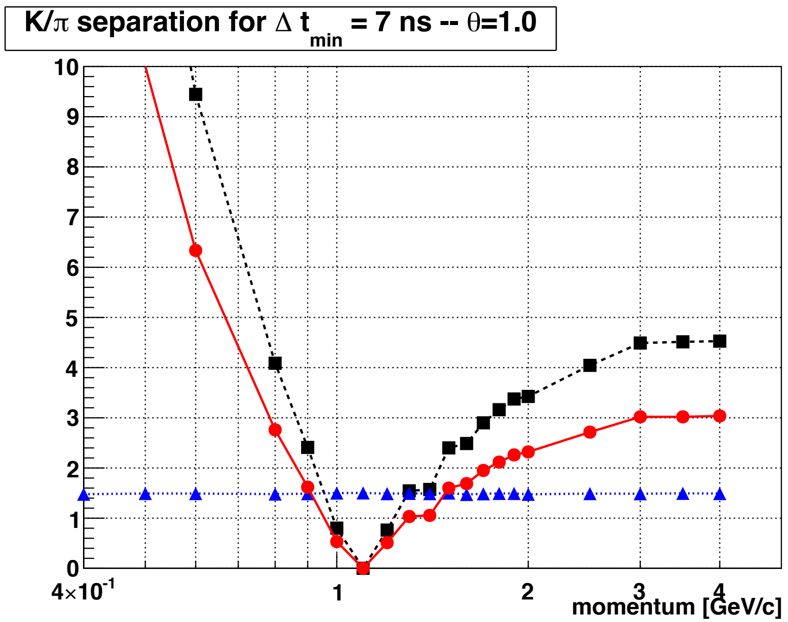
■ $|N_K - N_\pi|/10$

▲ $\langle\sigma\rangle/10$

● separation

K/π separation for Δt_{min} = 7ns





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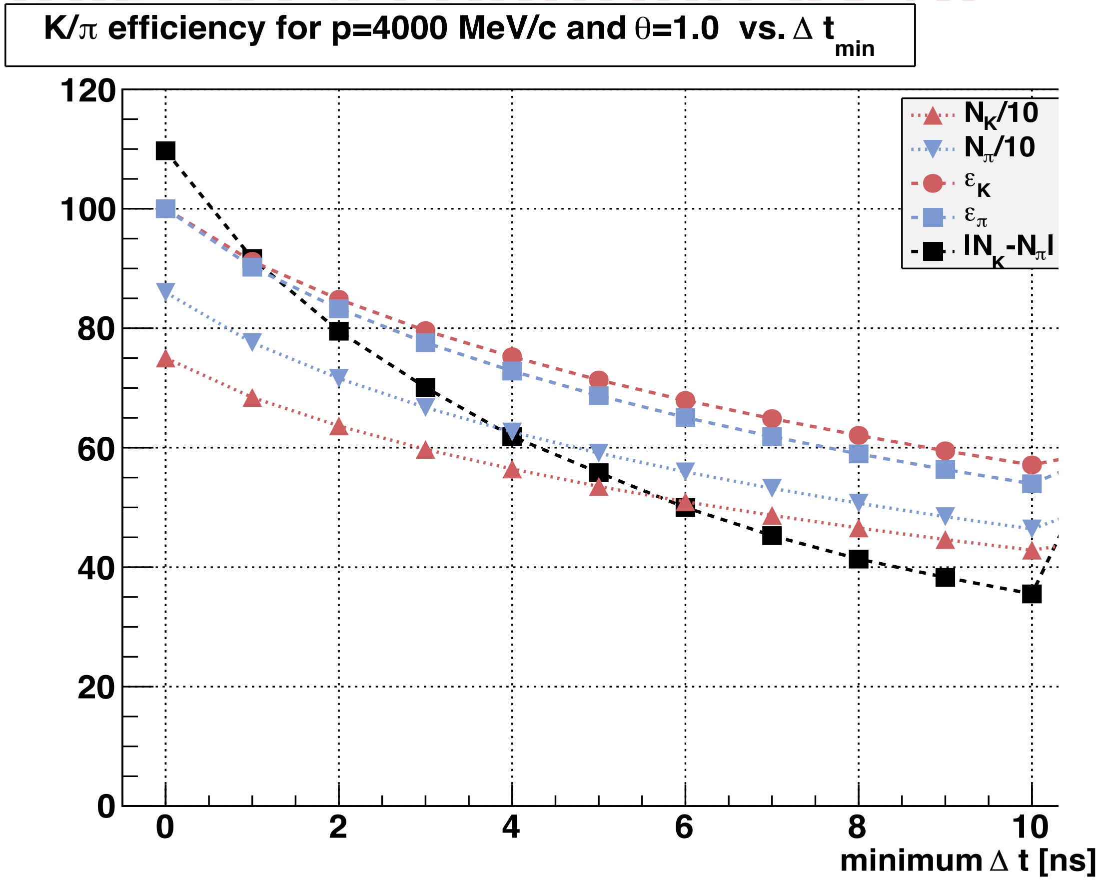
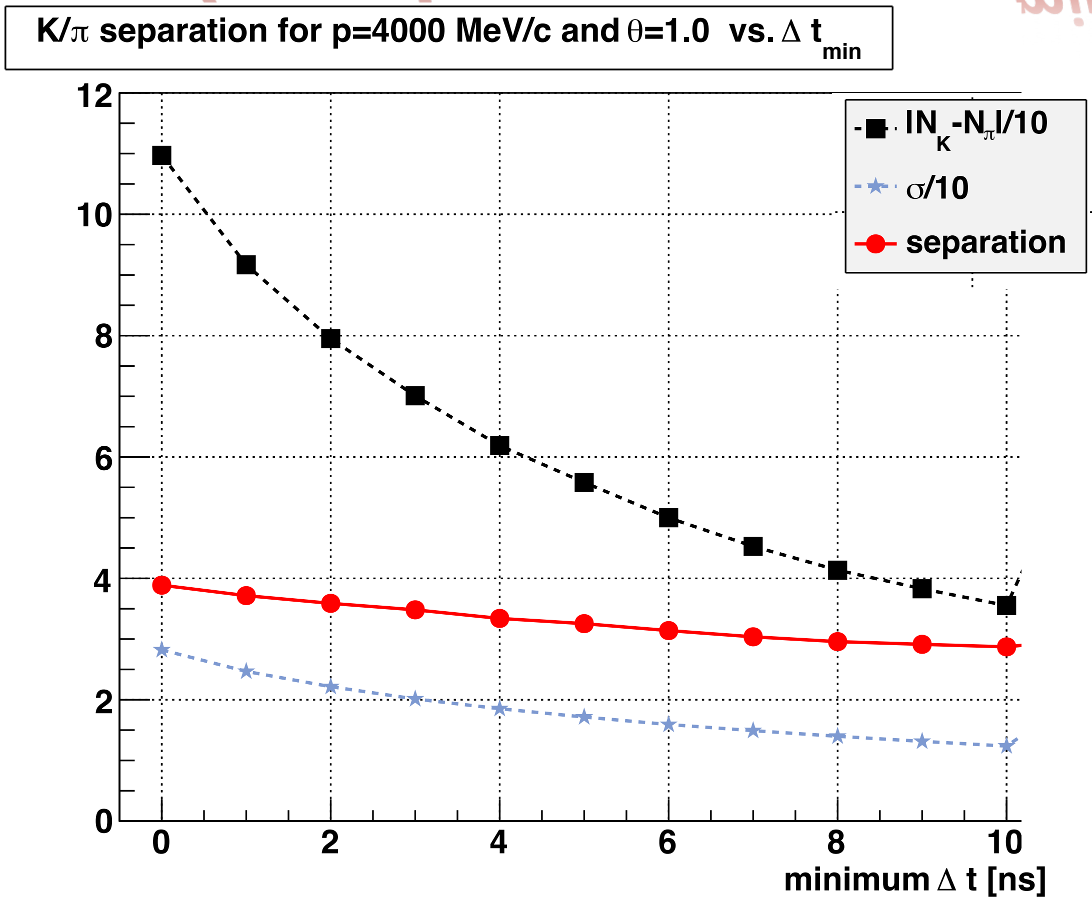
Example: K/π counting vs Δt_{min} p=4GeV/c



- A small difference in pion vs. kaon efficiency generates a decrease of $|N_K - N_\pi|$

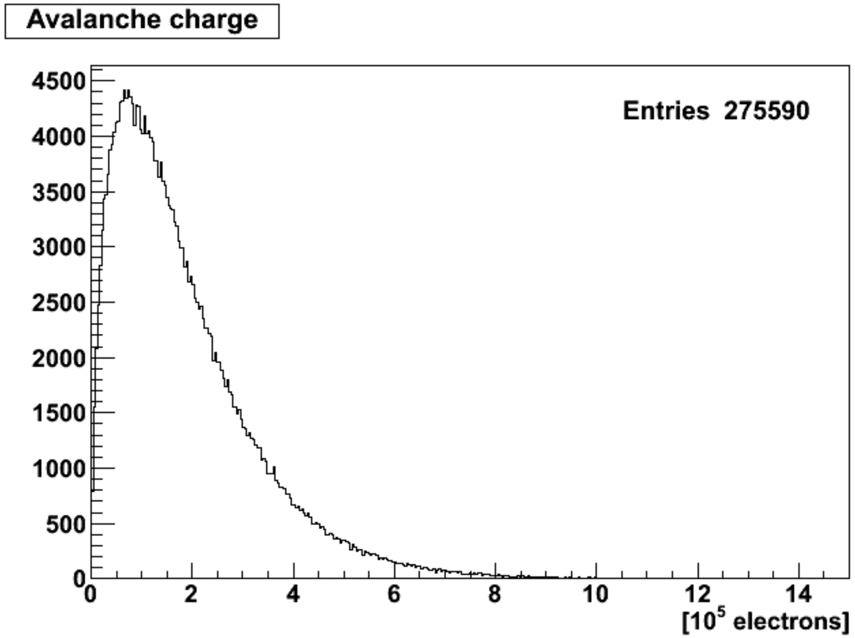
Example: K/π separation vs Δt_{min} p=4GeV/c



- A small difference in pion vs. kaon efficiency generates a decrease of $|N_K - N_\pi|$
  - $\Delta N=110$ @Δt_{min}=0ns → $\Delta N=36$ @Δt_{min}=10ns

Signal-to-noise Ratio

- In addition to the rearming time of the counting algorithm, also the noise level must be taken into account
  - "any algorithm has a threshold"
- Example: charge in the electron avalanche
  - A Polya distribution with mean 1.8×10^5 and $\theta = 0.6$



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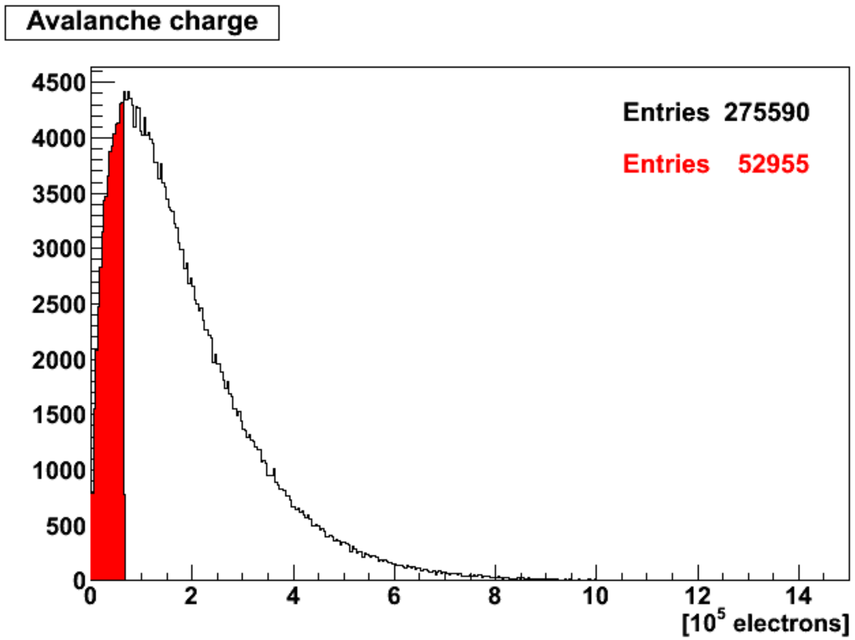

SNR=10 – ε = 81.1%

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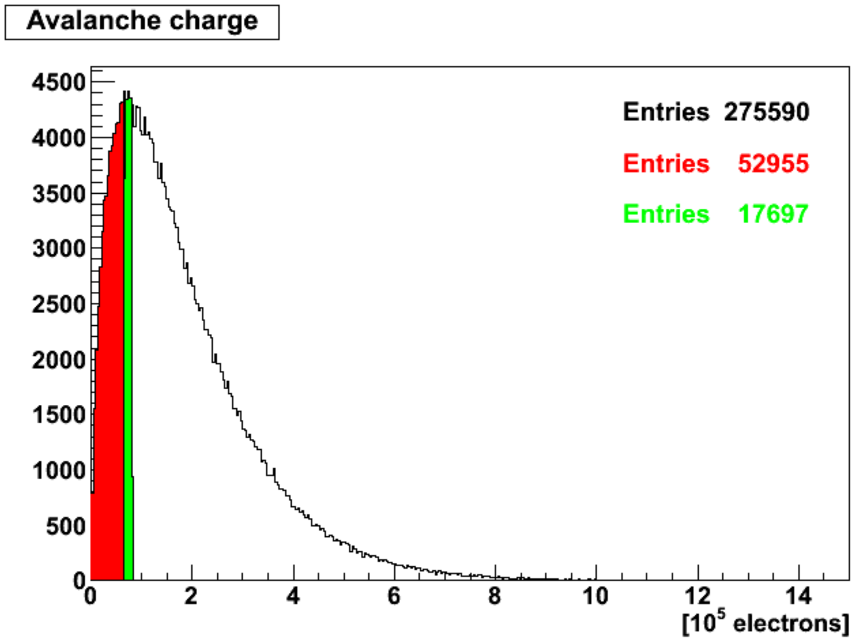

SNR=10 – ε = 81.1%

SNR= 8 – ε = 74.7%

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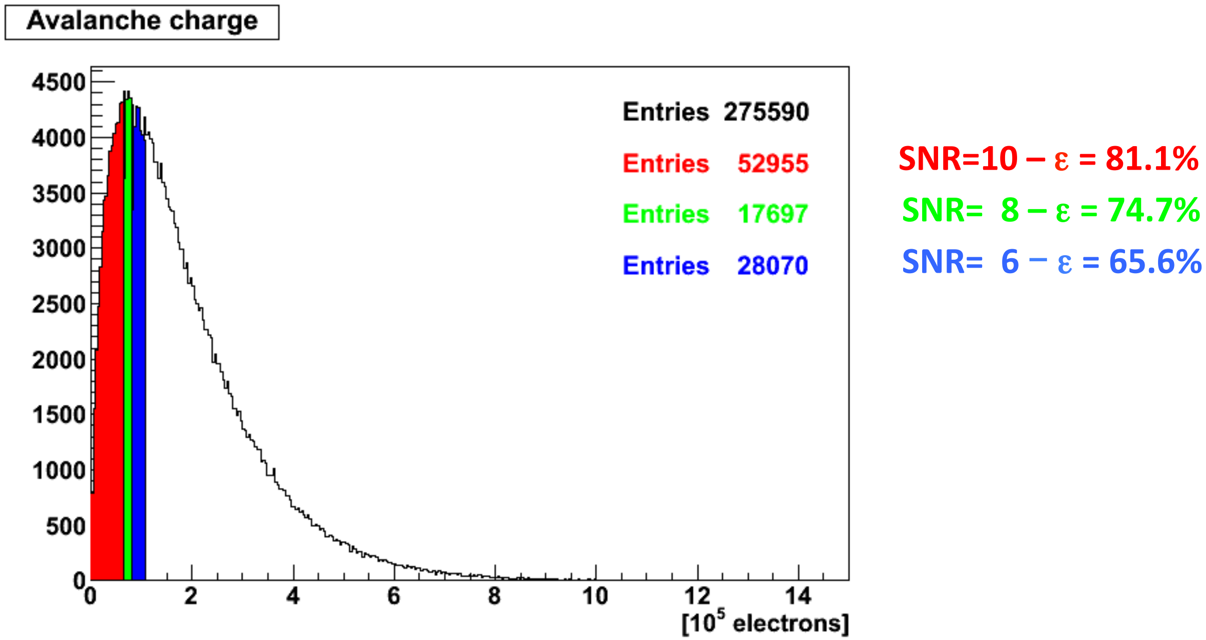
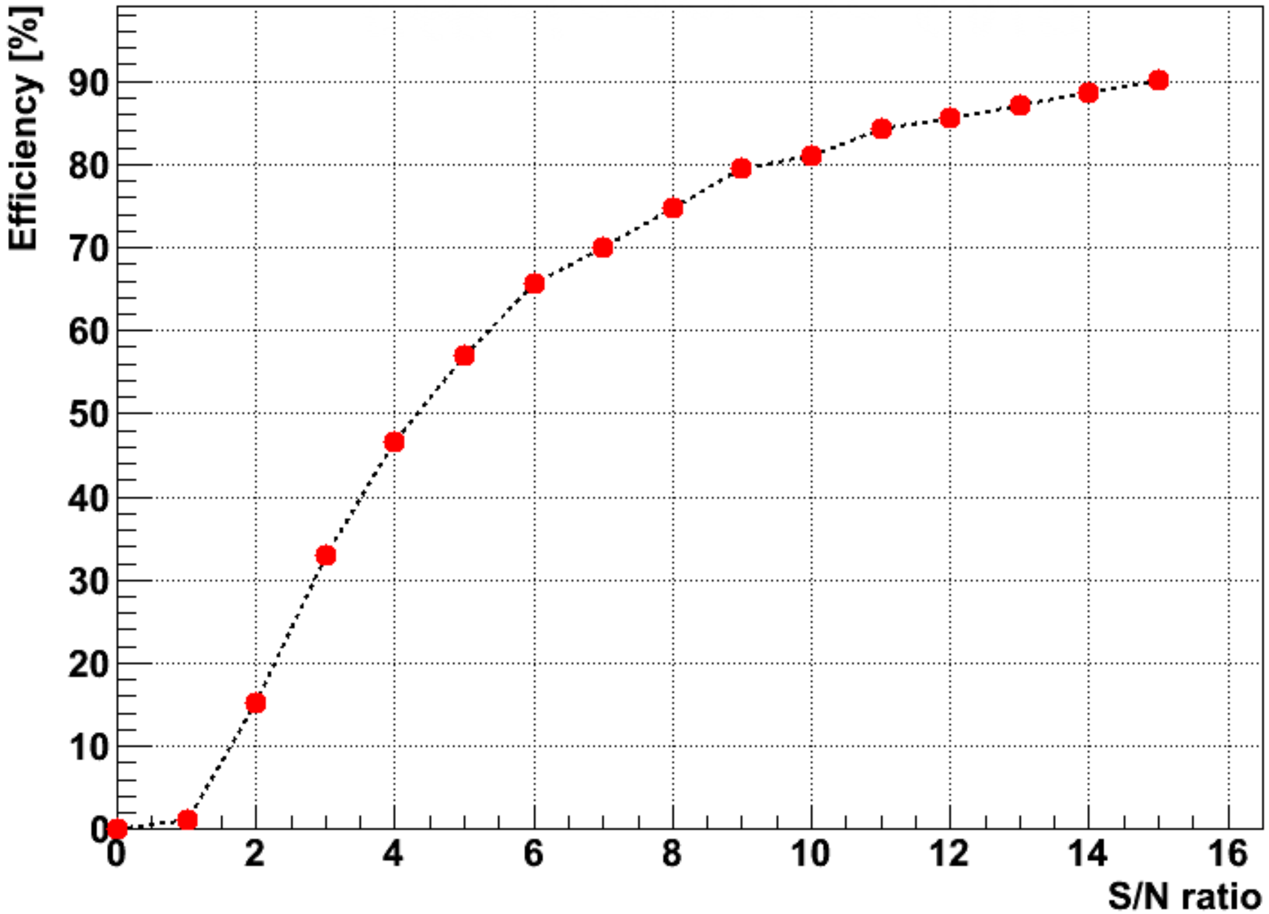


Efficiency vs SNR



- Typical average single-electron amplitude in prototype 2: 20mV
  - typical RMS noise: 3.6mV ⇨ **SNR ~ 5.5** (!!)

Summary

- Minimum time separation among clusters + SNR ratio both affect the detection efficiency (and achievable K/π separation)
- Caveat: analysis shown used *cluster* time separation. When *electrons* are considered, some inefficiency is recovered thanks to diffusion
  - Topic for a future talk