

dE/dx studies for particle identification

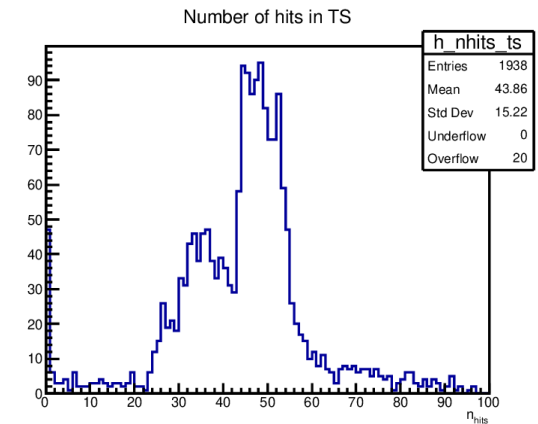
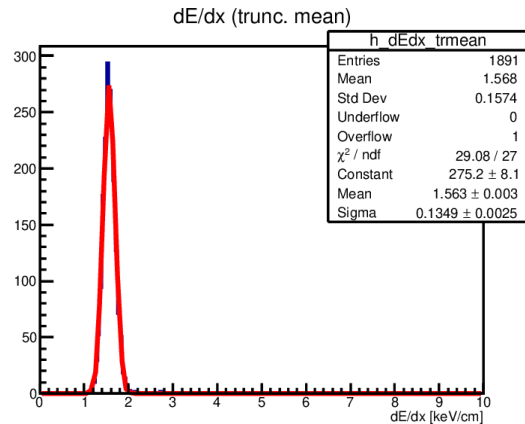
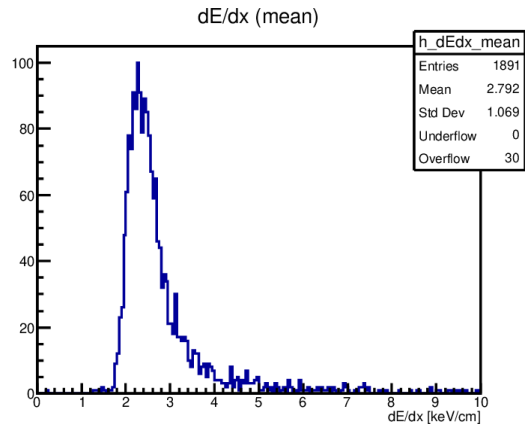
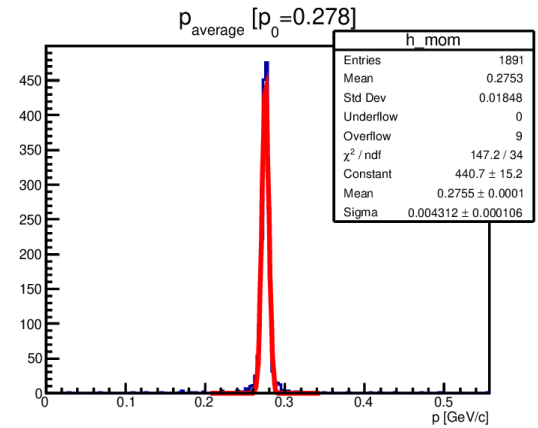
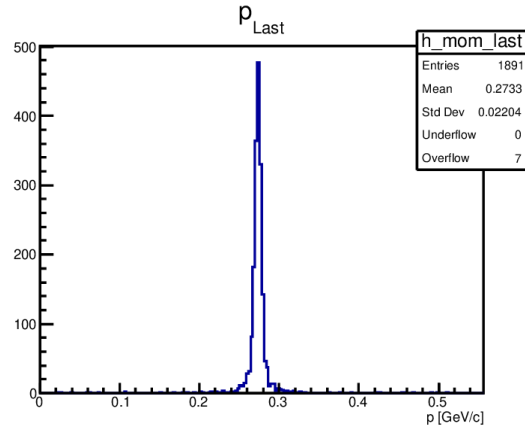
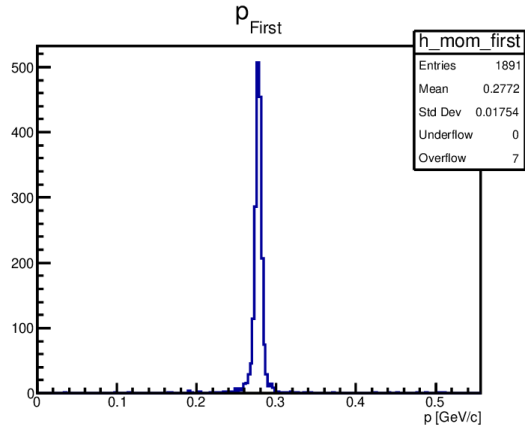
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SPD S&C meeting, Dec 7, 2021

Goal of study

- Development of methodology for PID using dE/dx in straw detector
 - Fit (parameterization) of truncated mean dE/dx distribution
 - Calculation of probabilities, efficiencies, and purities

Artificial samples analysis



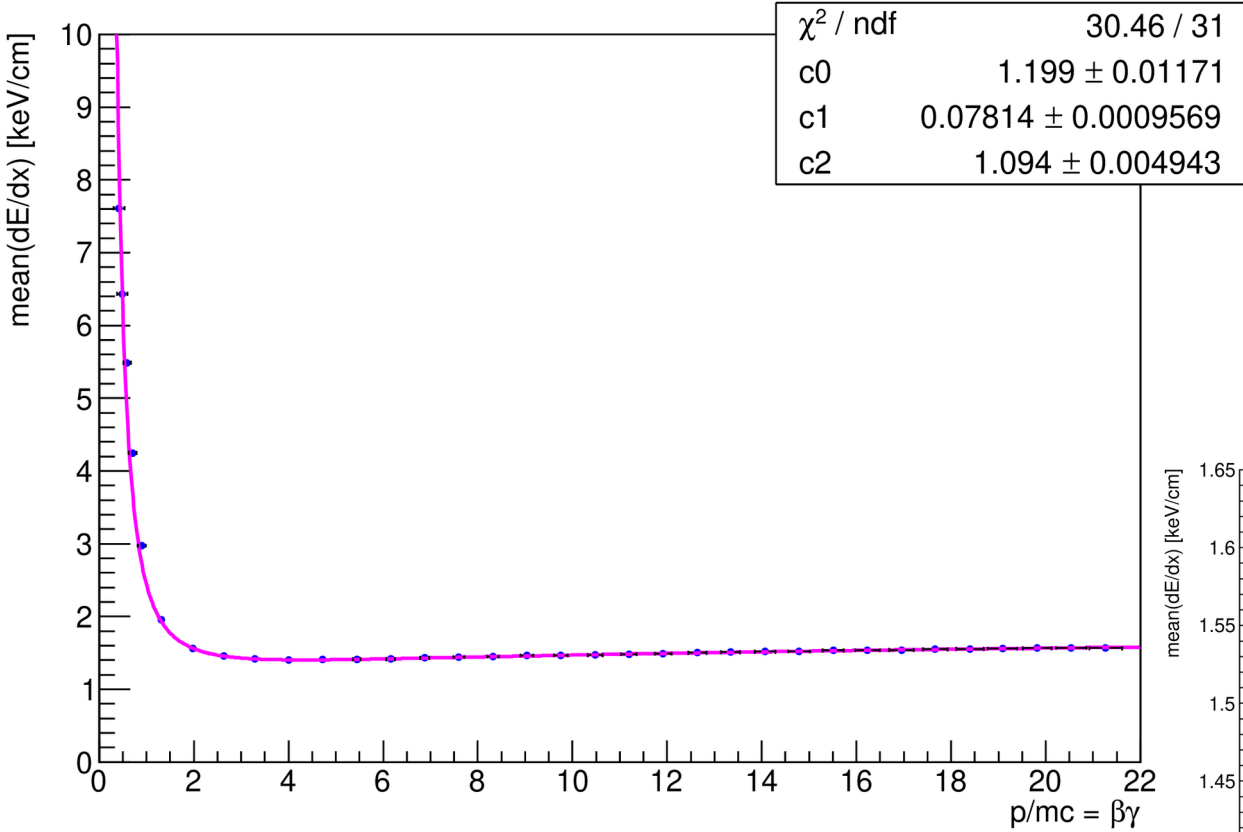
Parameterization of dE/dx distribution

$$\text{mean}(dE/dx) = \frac{c_0}{\beta^2} + \frac{c_1}{\beta^2} \ln(\beta \gamma) - (c_0 - c_2) \left(1 + \frac{\ln(\beta^2)}{\beta^2}\right)$$

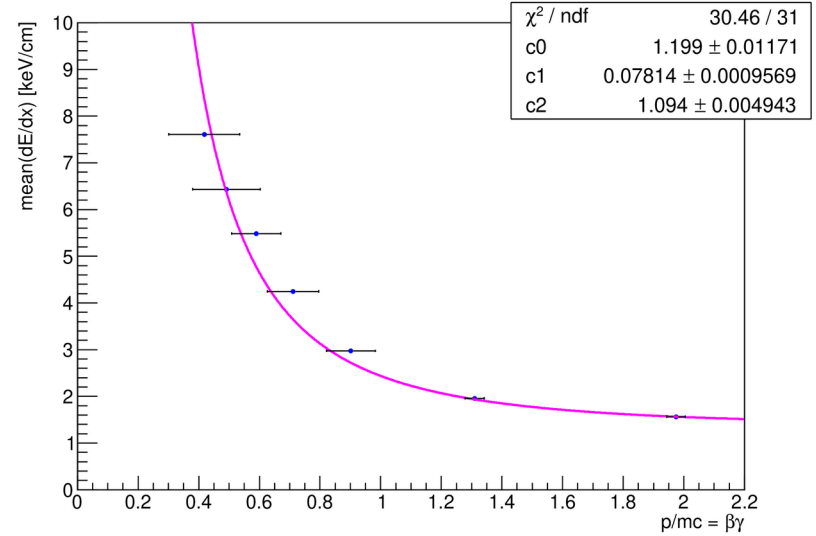
$$\beta \gamma = p/m, \quad \beta^2 = \frac{(p/m)^2}{(p/m)^2 + 1}$$

$$\sigma(dE/dx) = R \cdot \text{mean}(dE/dx)$$

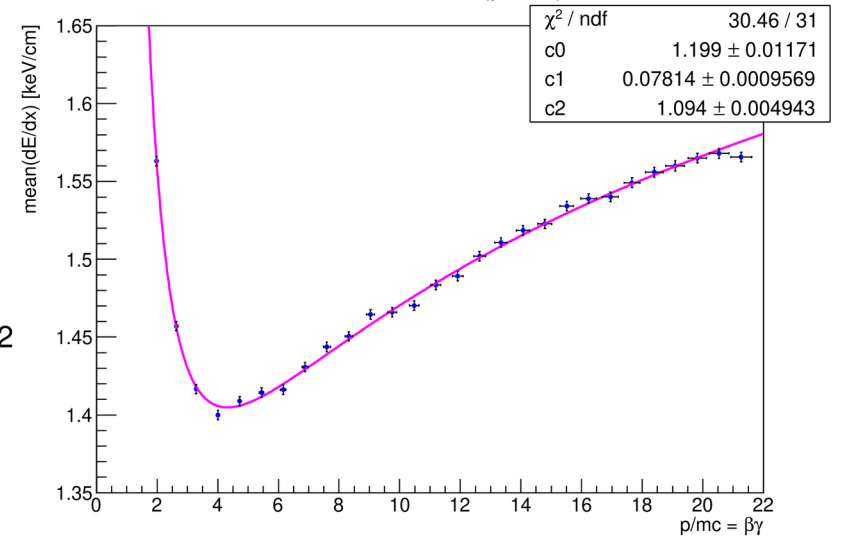
Mean of dE/dx (pions)



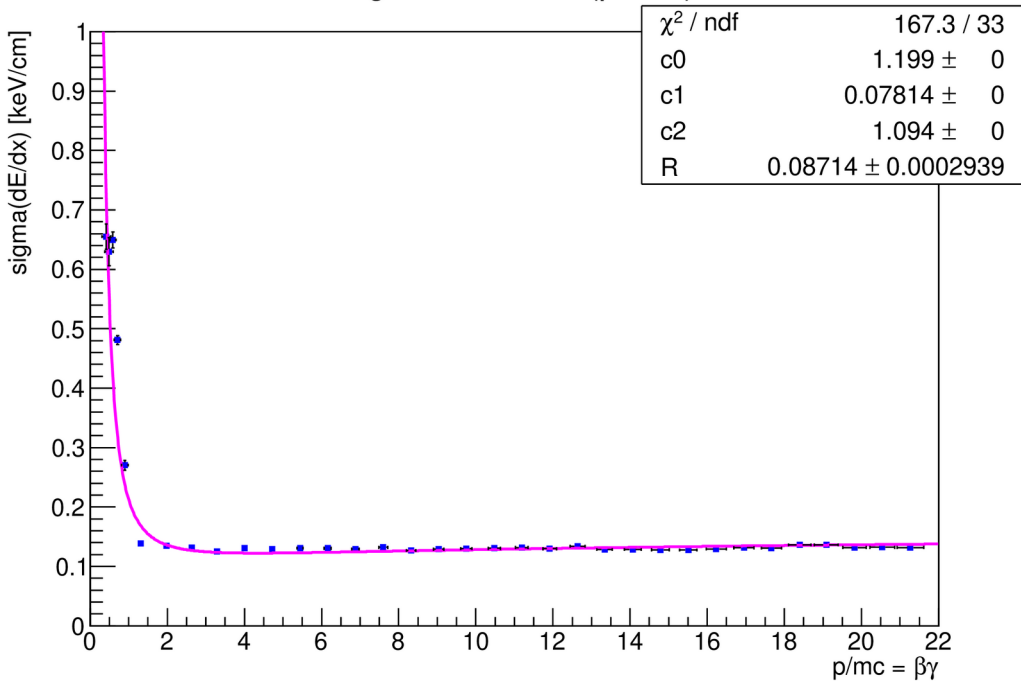
Mean of dE/dx (pions)



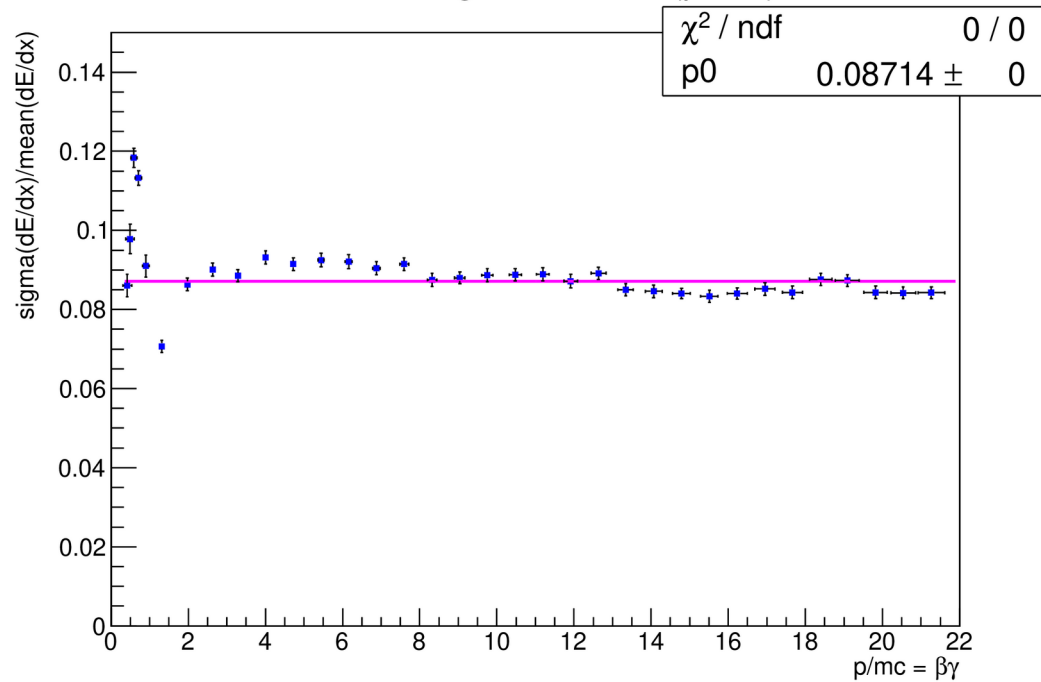
Mean of dE/dx (pions)



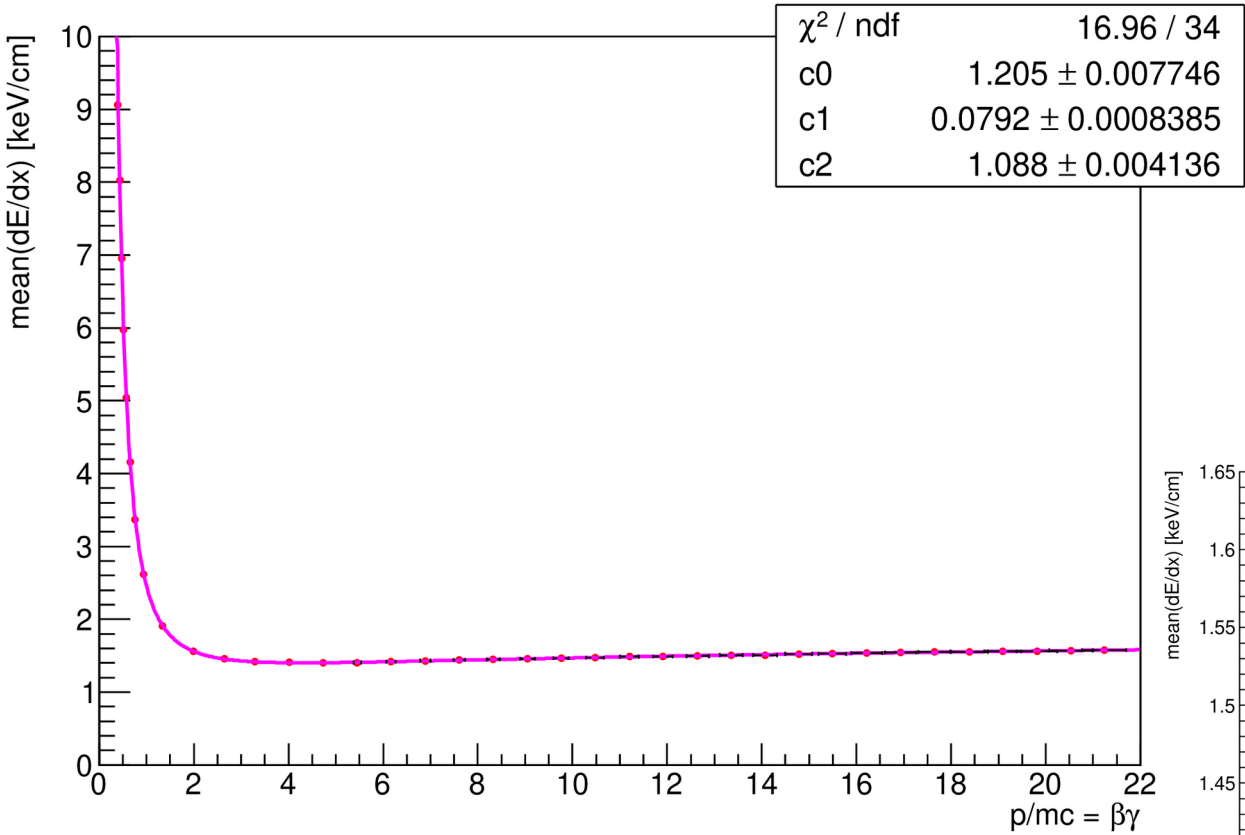
Sigma of dE/dx (pions)



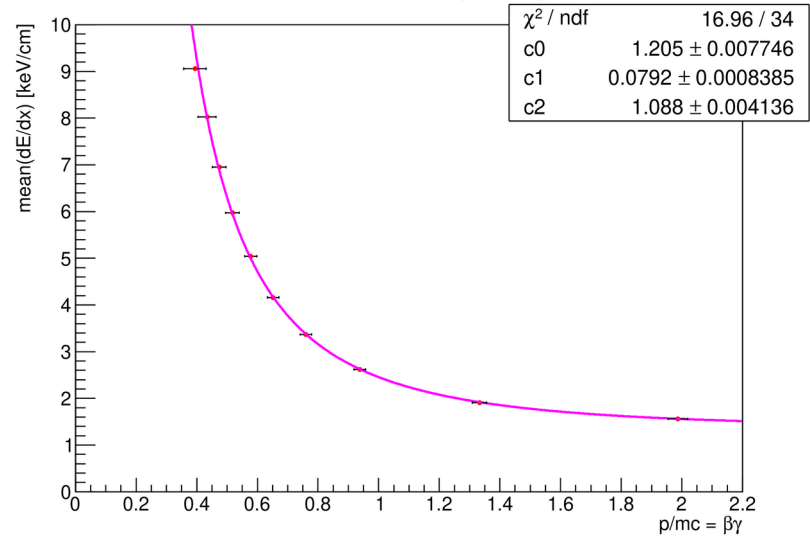
Relative sigma of dE/dx (pions)



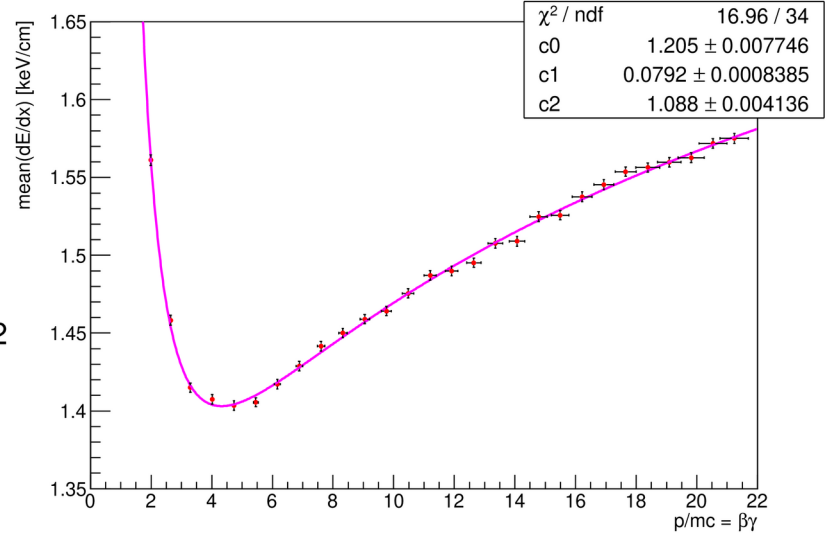
Mean of dE/dx (kaons)



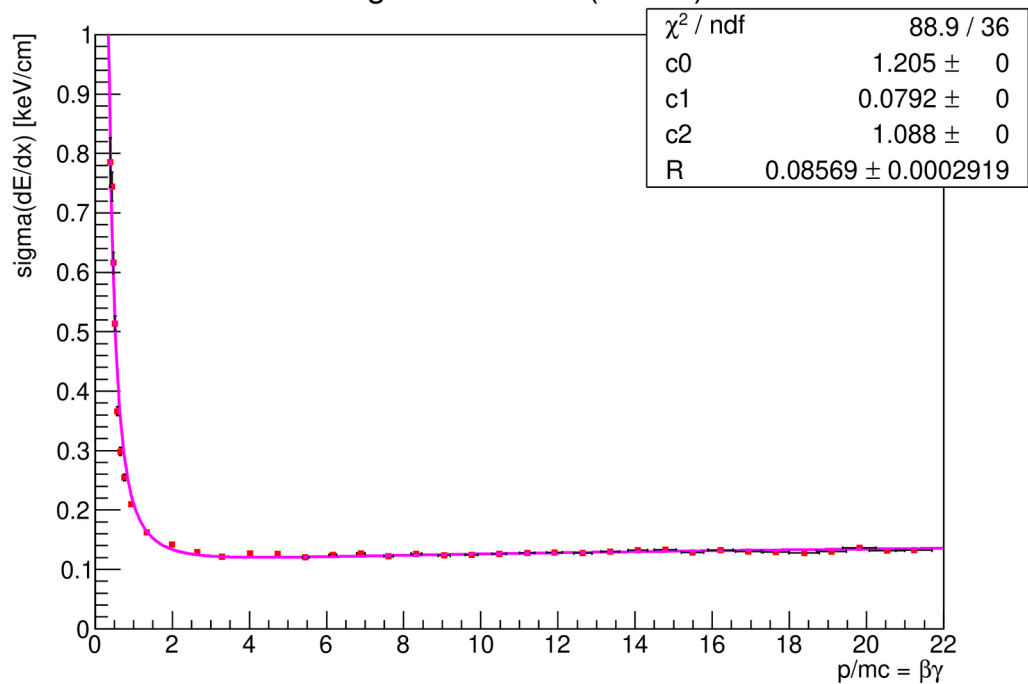
Mean of dE/dx (kaons)



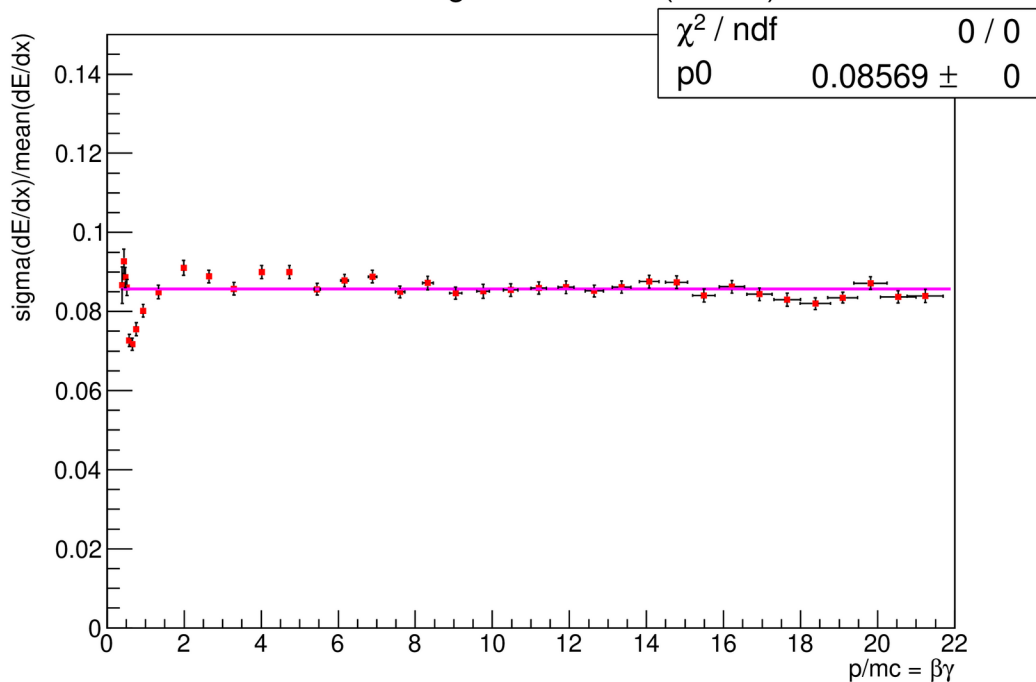
Mean of dE/dx (kaons)



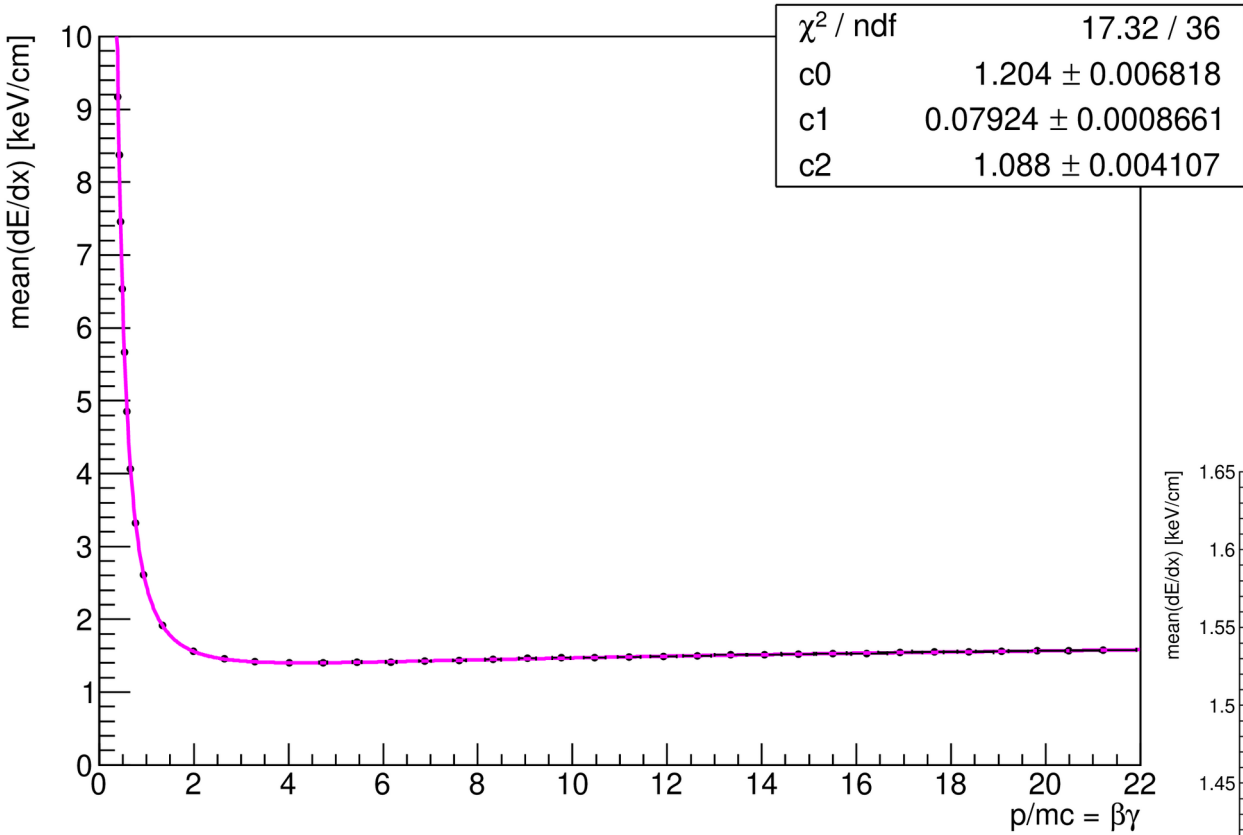
Sigma of dE/dx (kaons)



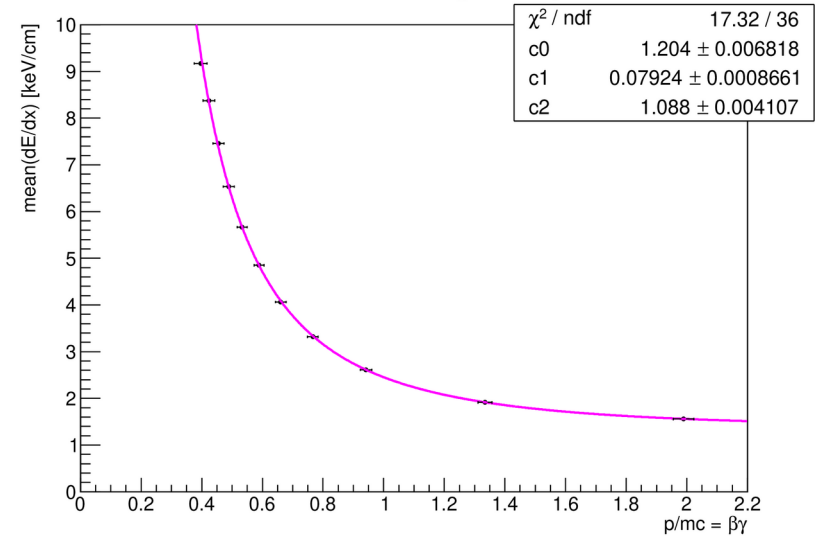
Relative sigma of dE/dx (kaons)



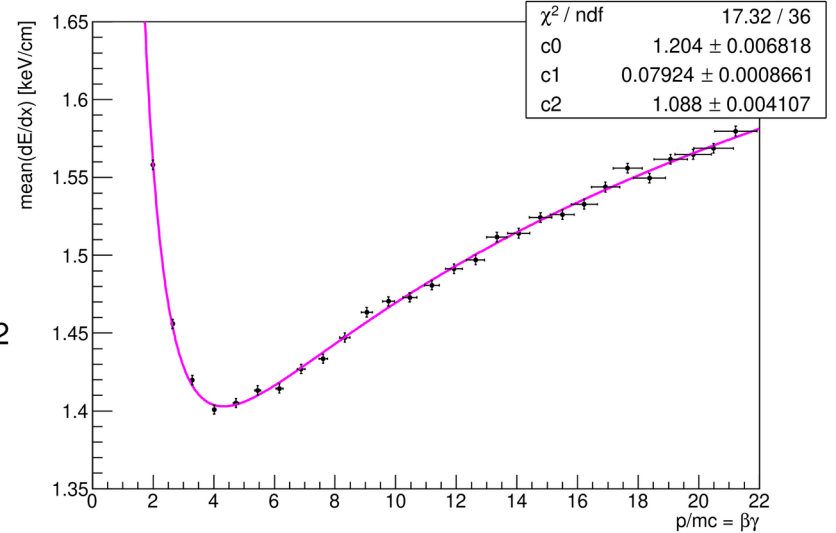
Mean of dE/dx (protons)



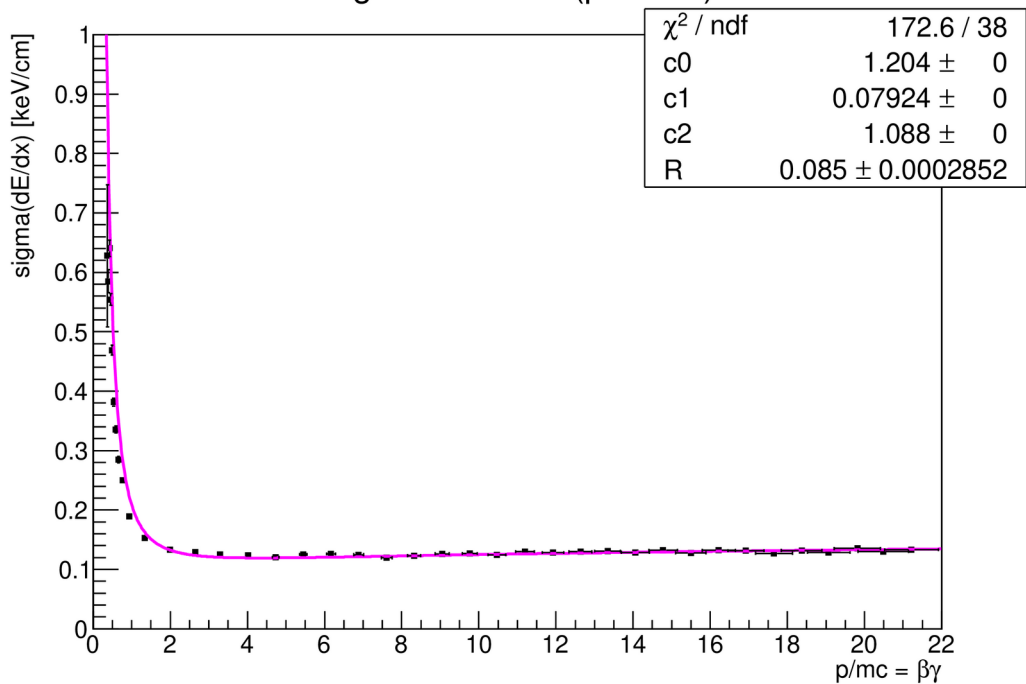
Mean of dE/dx (protons)



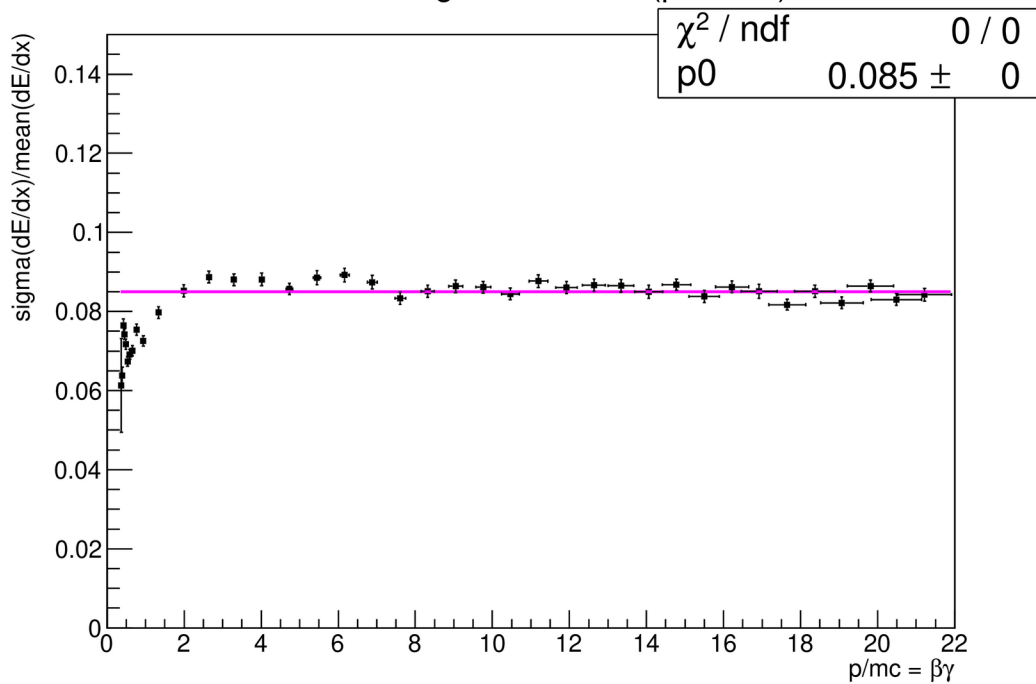
Mean of dE/dx (protons)



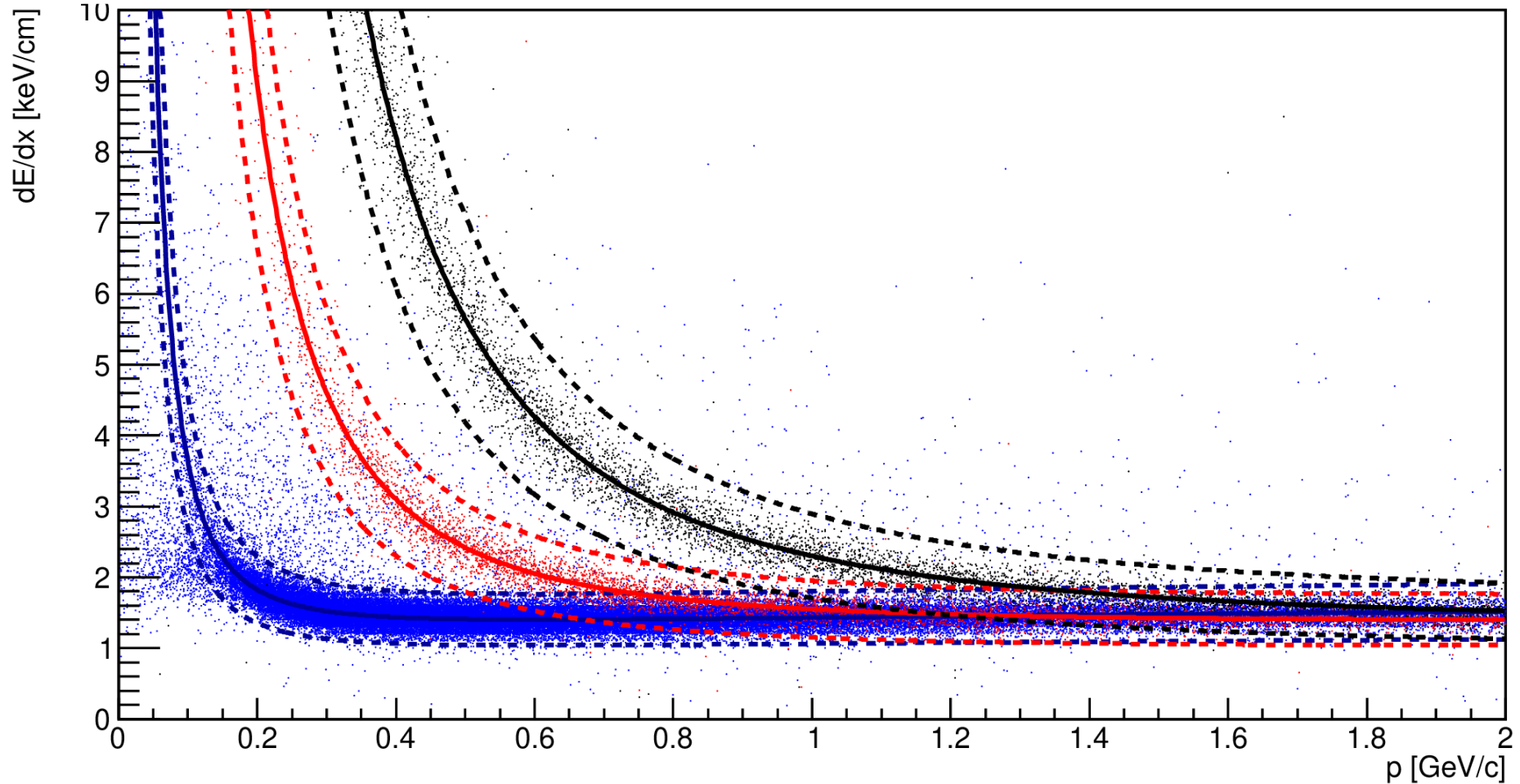
Sigma of dE/dx (protons)



Relative sigma of dE/dx (protons)



dE/dx (truncated mean) vs momentum



Probabilities

$$\text{pdf}\left(\frac{dE}{dx} \mid p, i\right) = \frac{1}{\sqrt{2\pi}\sigma_i(p)} \exp\left(-\frac{1}{2}\left(\frac{\frac{dE}{dx} - \text{mean}_i(p)}{\sigma_i(p)}\right)^2\right), \quad i = \pi, K, p$$

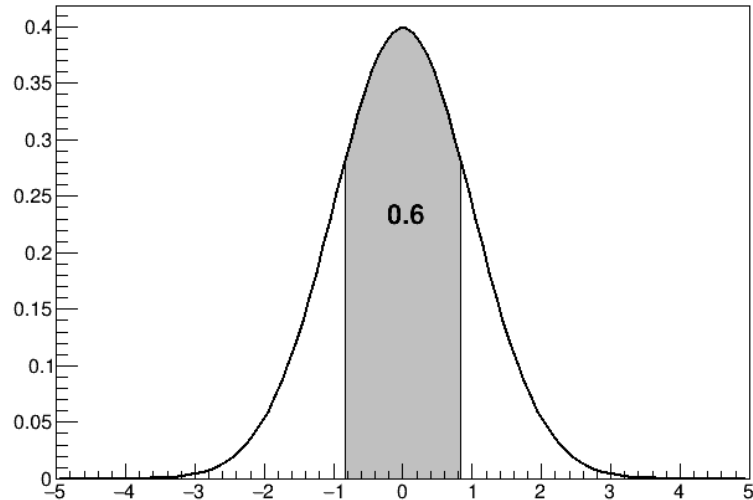
$$P = 0.6$$

$$x = \pm\sqrt{2} \text{erf}^{-1}(0.6) = \pm 0.8416$$

$$\text{pdf}(x) = 0.28 \text{ (for standard normal distribution)}$$

$$x = m \pm 0.8416 \sigma$$

$$\text{pdf}(x) = \frac{1}{\sigma} 0.28 \text{ (general case)}$$



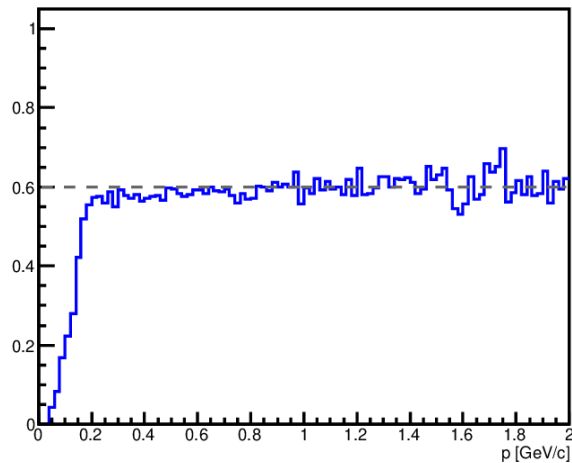
Efficiencies and purities

$$\text{efficiency}_i = \frac{N_i(P_i=0.6)}{N_i}, \quad i = \pi, K, p$$

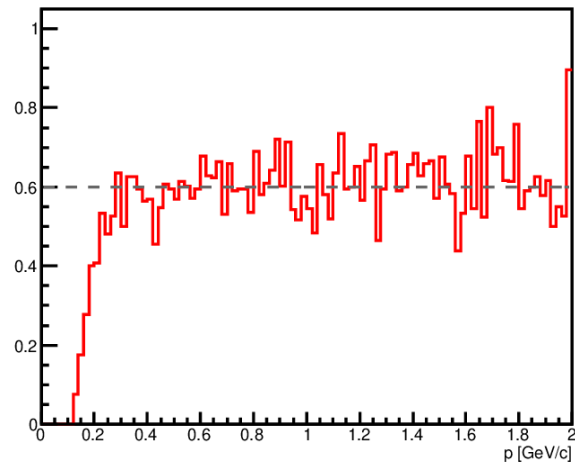
$$\text{purity}_i = \frac{N_i(P_i=0.6)}{N_{all}(P_i=0.6)}, \quad i = \pi, K, p$$

Efficiencies and purities

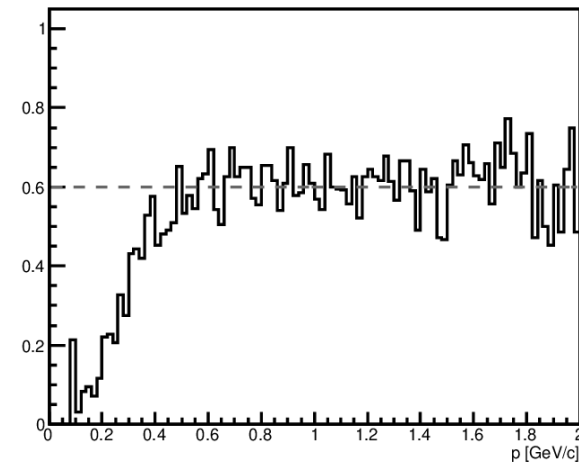
efficiency pions



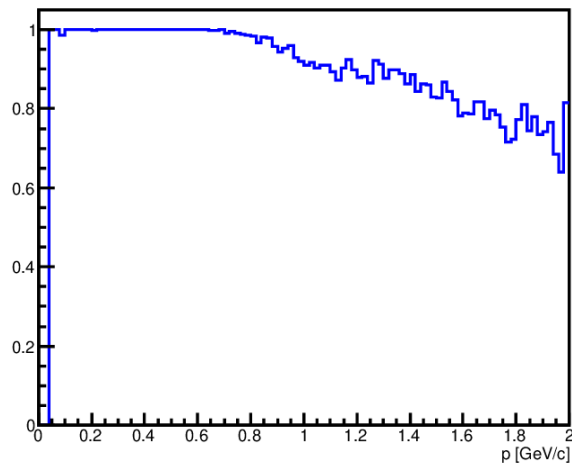
efficiency kaons



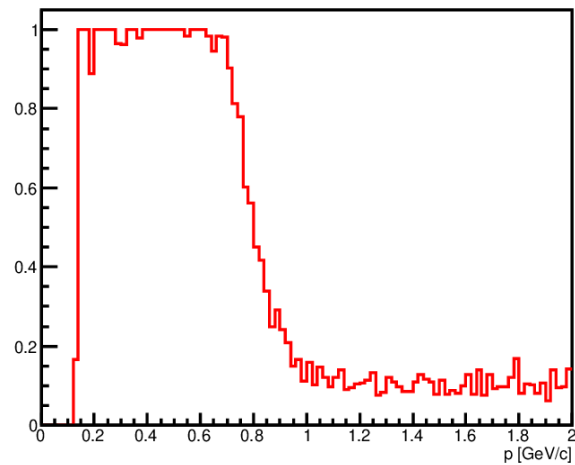
efficiency protons



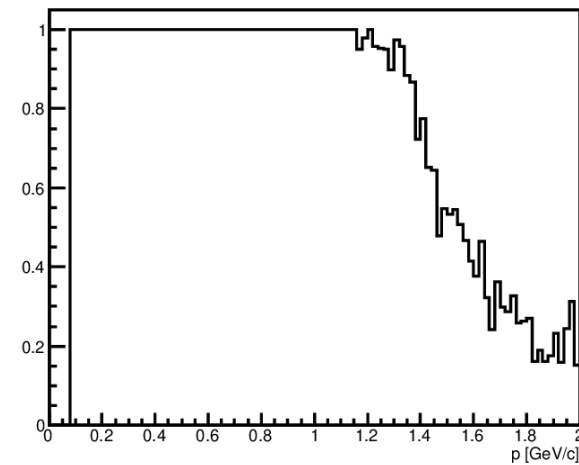
purity pions



purity kaons



purity protons



Plans for future

- To understand what causes problems at small (<0.2) momenta.
- To incorporate in SpdRoot.
- To combine with TOF.