

HADRON IDENTIFICATION IN SIDIS RECONSTRUCTION

EIC_NET meeting | ePIC collaboration

June 27^o 2024

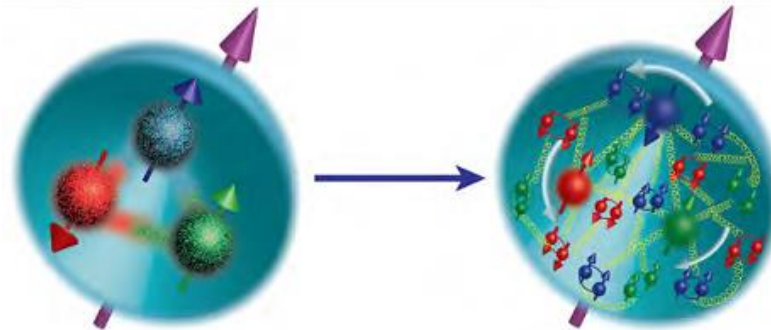
Lorenzo Polizzi | University of Bologna

SEMI-INCLUSIVE DEEP INELASTIC SCATTERING, WHY?

Deep Inelastic Scattering (DIS) processes offers a first 1D image of the hadron structure through the **Parton Distribution Functions** (PDFs).

SIDIS processes provide detailed 3D imaging through the implementation of the **Transverse Momentu-Dependent** (TMD) **PDFs**.

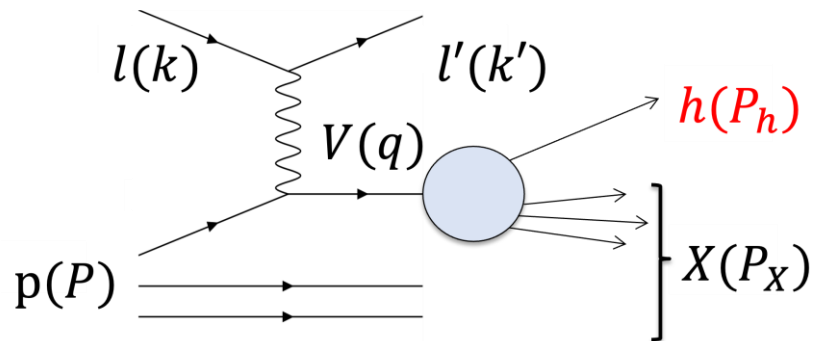
SIDIS identifies hadron in the final state and combines its **longitudinal** and **transversal** information.



VARIABLE RECONSTRUCTION

This analysis presents a first study of the reconstruction capabilities of positive and negative **pions**, **kaons** and **protons** as a function of: Q^2 , x_B , z , P_{hT} , η (pseudorapidity), φ (polar angle), and P_h as the hadron momentum at **ePIC**.

$$\ell(k) + p(P) \rightarrow \ell'(k') + h(P_h) + X$$



DIS variables (**Double Angle** method) and **SIDIS** variables:

$$y = \frac{\tan \frac{\varphi}{2}}{\tan \frac{\varphi}{2} + \tan \frac{\theta}{2}}$$

(θ, φ) : electron and id-hadron angle

$$Q^2 = 4E_0^2 \cot^2 \frac{\theta}{2} (1 - y)$$

$$z = \frac{P \cdot P_h}{P \cdot q}$$

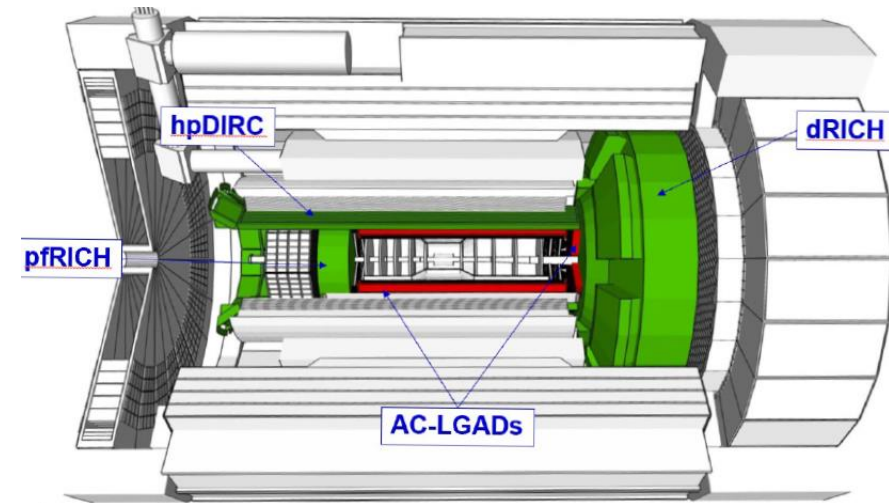
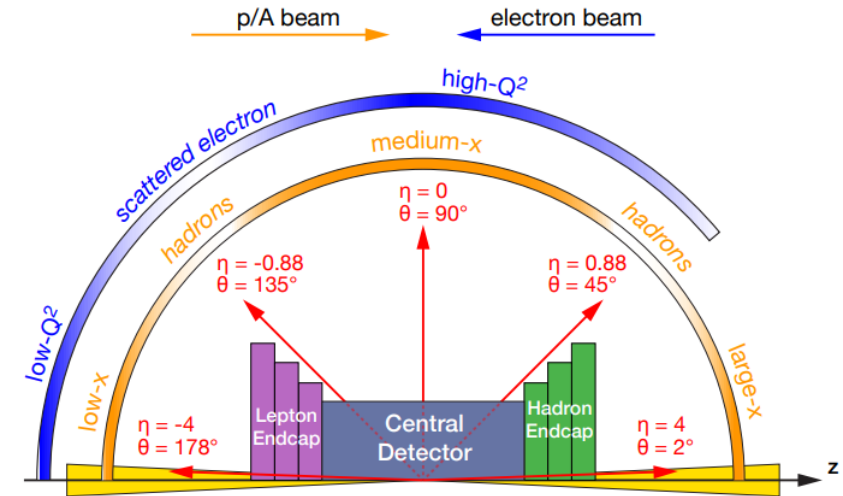
$$x_B = \frac{Q^2}{4E_0 E_p y}$$

$$\vec{P}_{hT} = \vec{P}_h - \frac{\vec{P}_h \cdot \vec{q}}{|\vec{q}|} \hat{q}$$

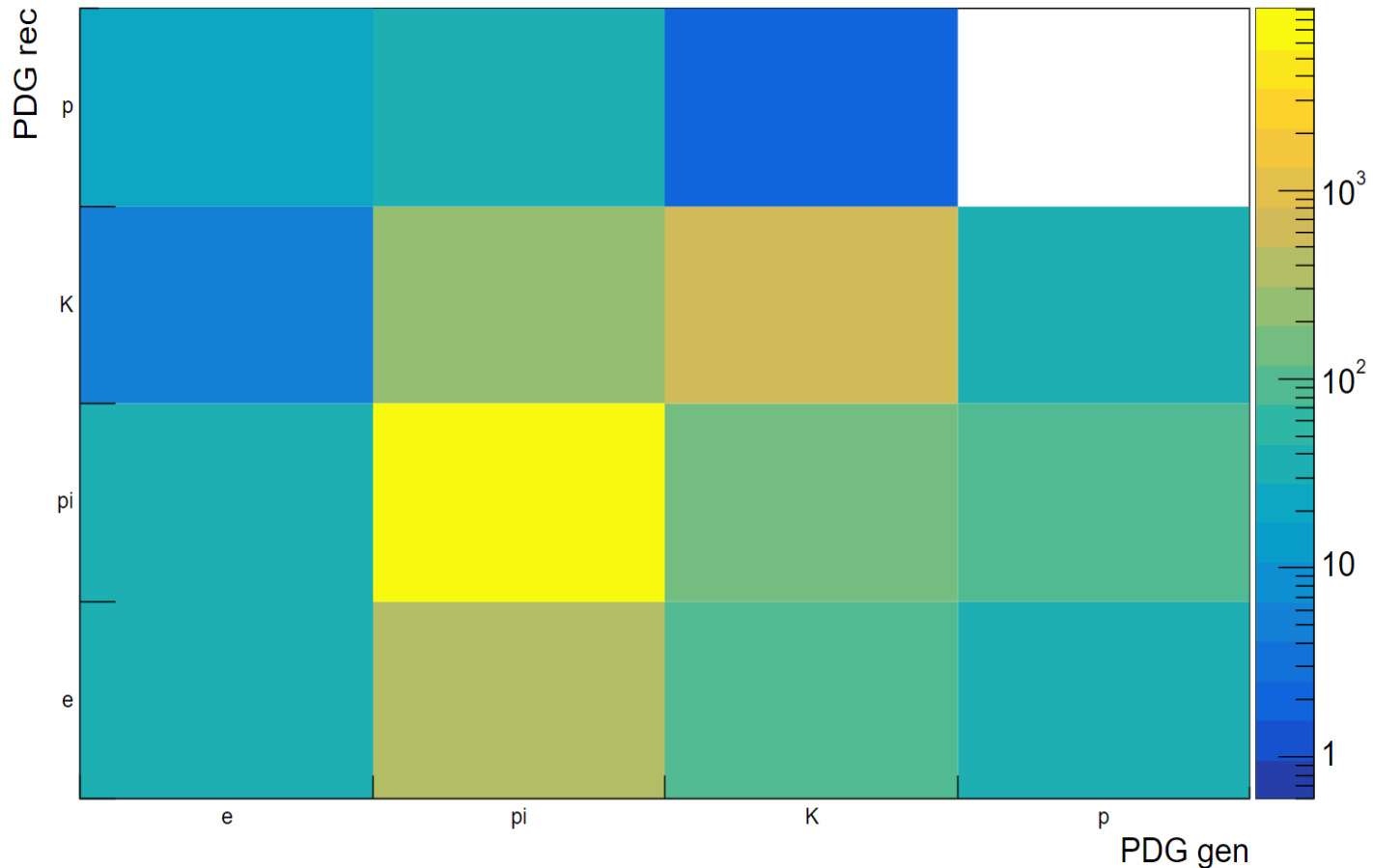
DATA ANALYZED

The data provided belong to:

- **Dataset:** ePIC simulation, 24.05.0 campaign. First PID implementation.
- **Generator:** Pythia6.4eic with no radiative correction.
- **Beam:** e/p at 18×275 GeV.
- **Scale:** $10^{-7} < Q^2 < 1$ GeV²
- **Cut:** $-3.7 < \eta < 3.7$, here only 49.72% of particles survive.
- **PID systems (in the current data):** pfRICH, hpDIRC, ToF and dRICH.



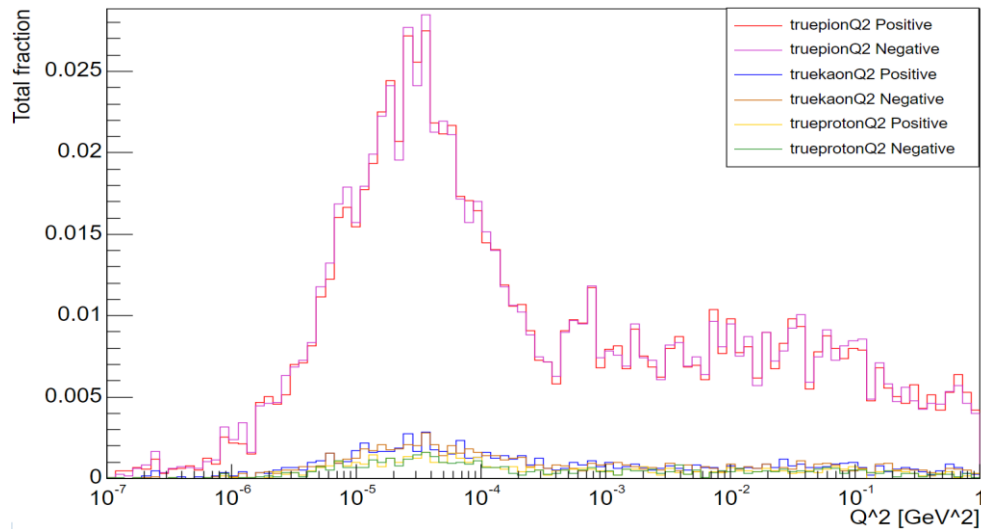
PID



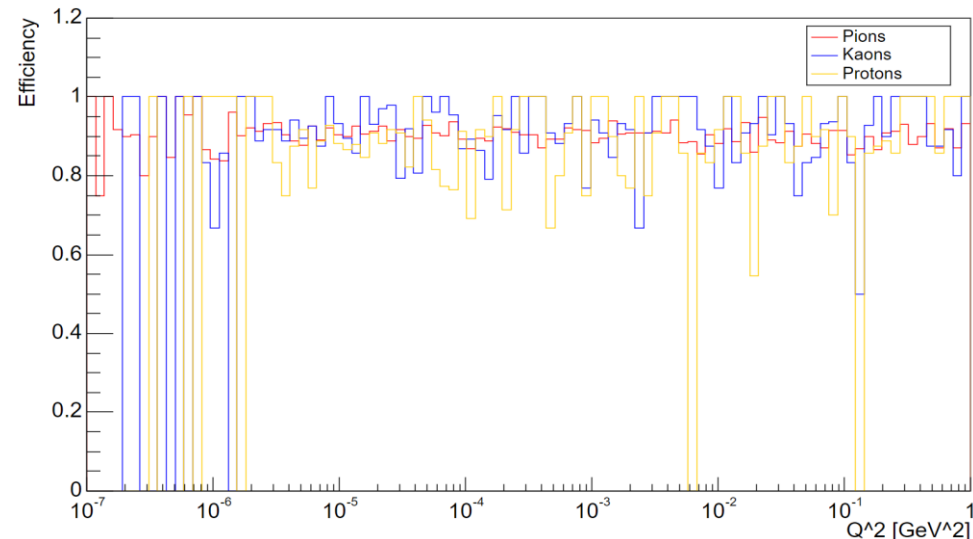
- The **PID** is based on Look-Up tables.
- Around the **65.95%** of pions are reconstructed as pions.
- Almost the **54.5%** of generated kaons are reconstructed as kaons.
- **All the generated protons are reconstructed as other particles!** (further analyses required)
- The **31.7%** of the total particles are **not reconstructed**.

PRODUCTION & EFFICIENCY OVER Q^2 | POSITIVE CASE

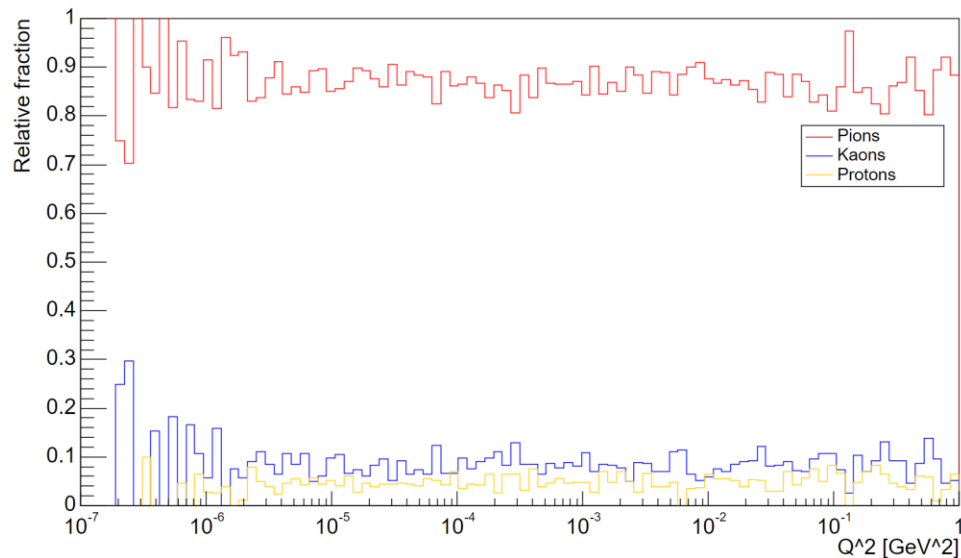
Overlay of positive and negative particles | 18x275 GeV



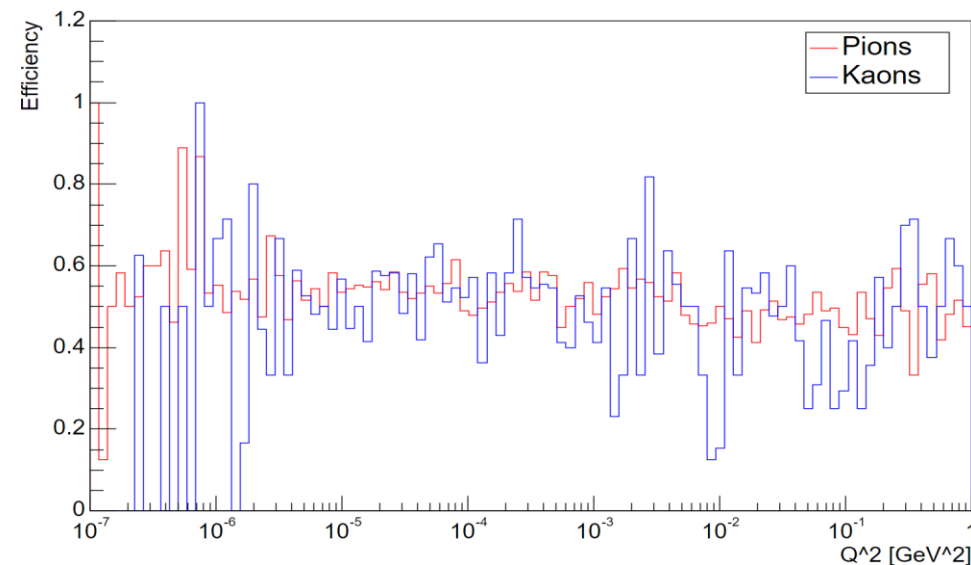
Efficiency reconstruction with MC ID | Q^2 | 18x275 GeV



Reconstructed production of positive particles | Q^2 | 18x275 GeV

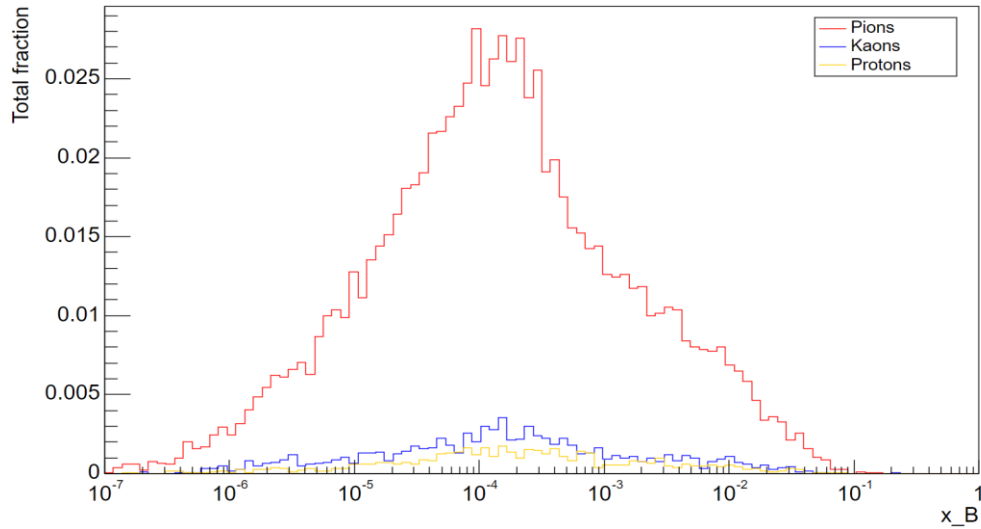


Reconstruction x PID efficiency | Q^2 | 18x275 GeV

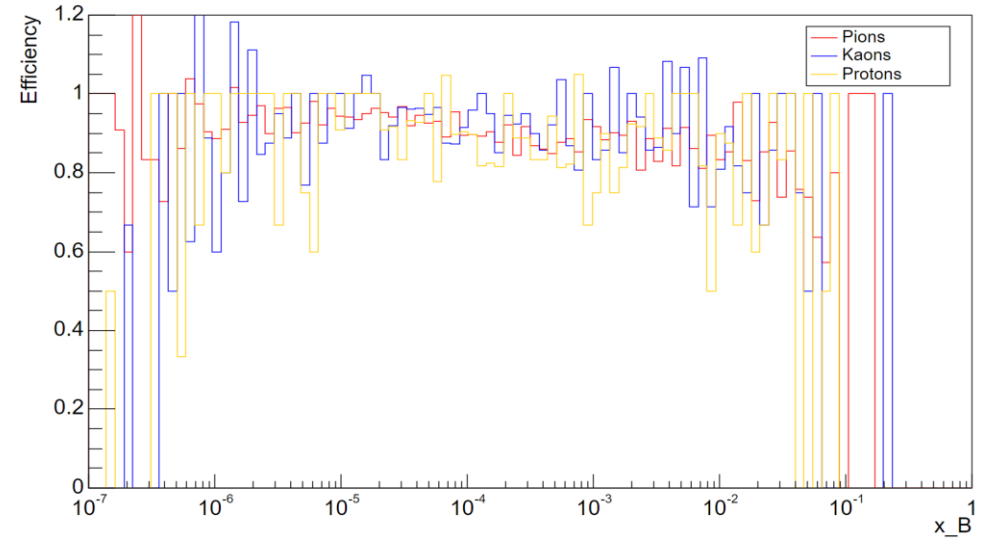


PRODUCTION & EFFICIENCY OVER x_B | POSITIVE CASE

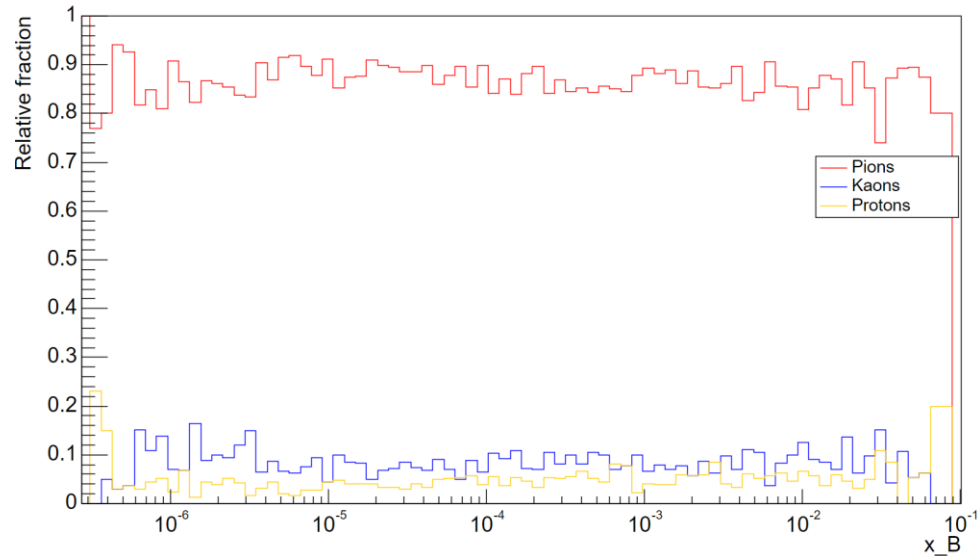
Reconstruction of positive particles | 18x275 GeV



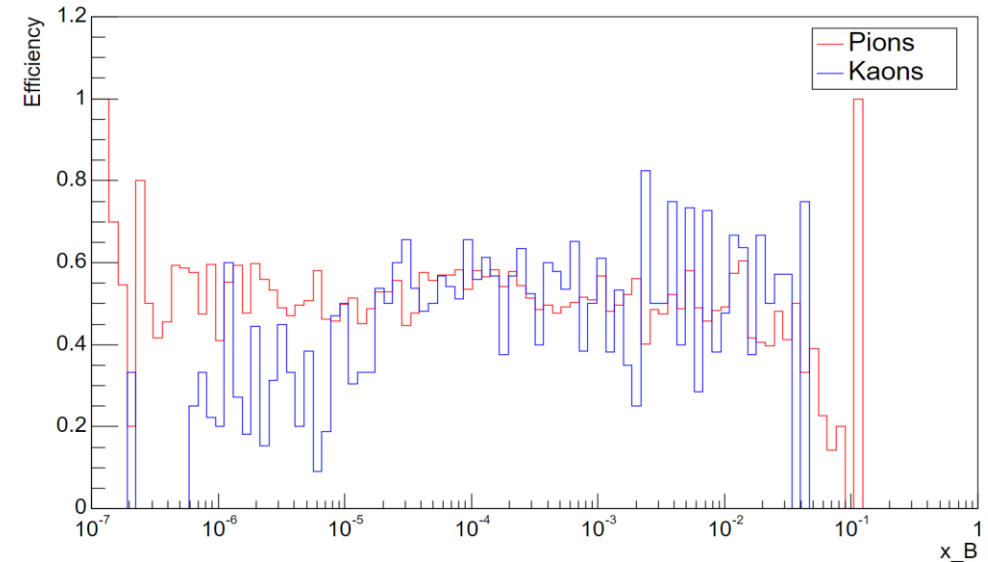
Efficiency reconstruction with MC ID | x_B | 18x275 GeV



Reconstructed production of positive particles | x_B | 18x275 GeV

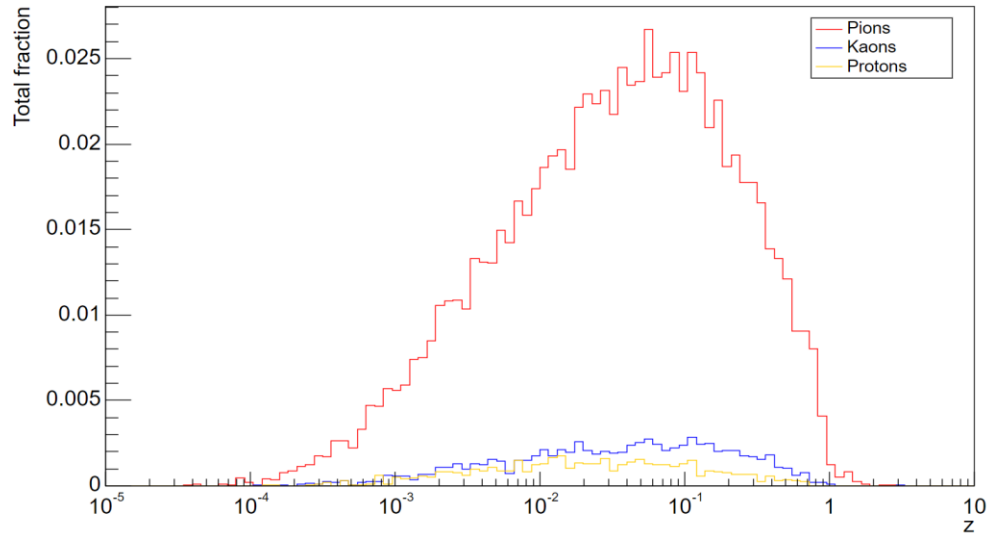


Reconstruction x PID efficiency | x_B | 18x275 GeV

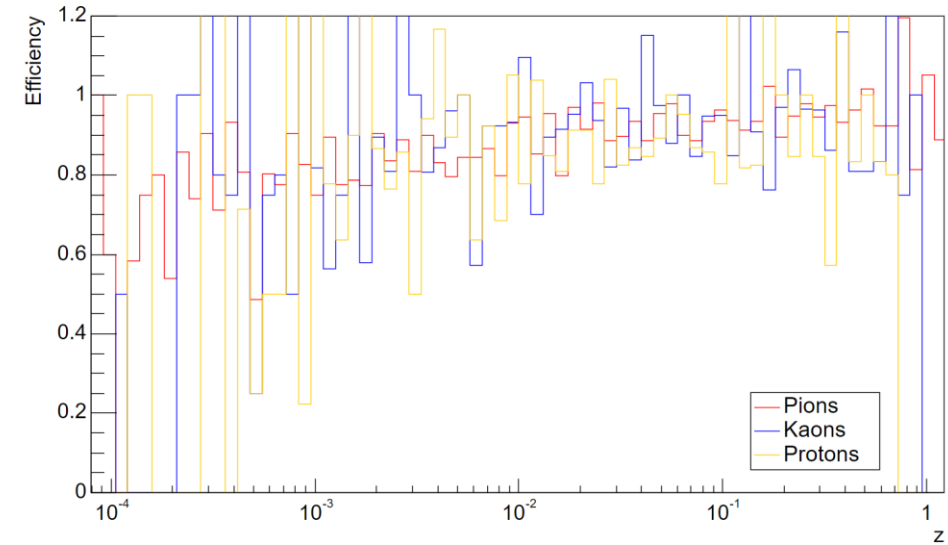


PRODUCTION & EFFICIENCY OVER z | POSITIVE CASE

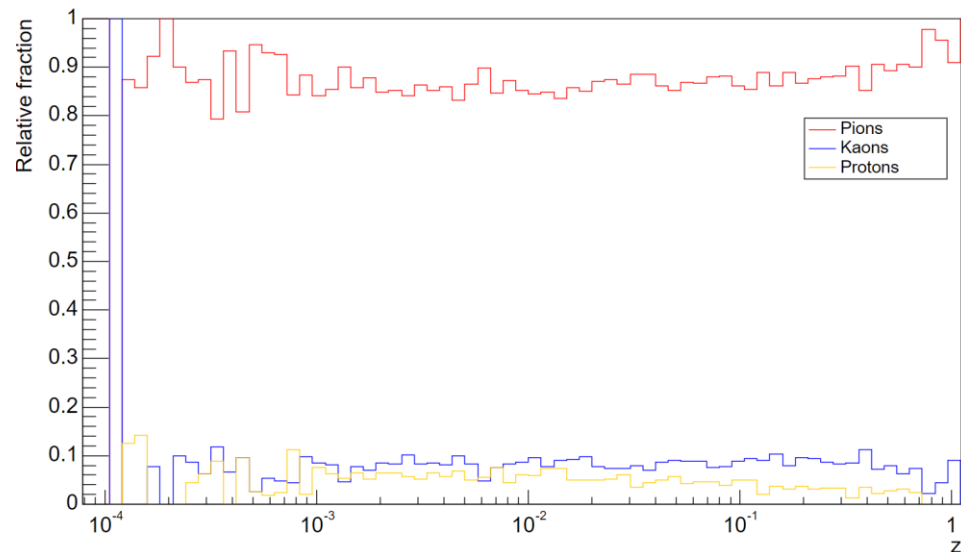
Reconstruction of positive particles | 18x275 GeV



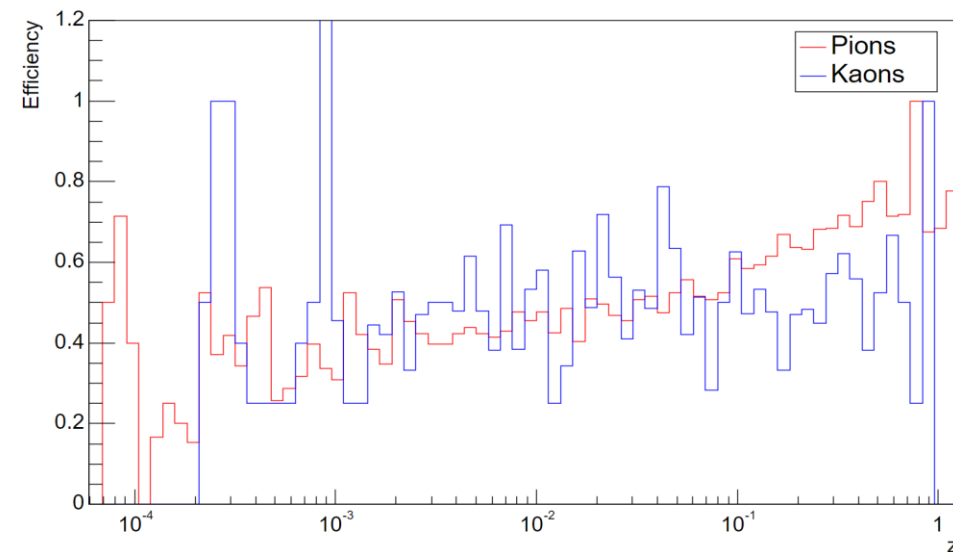
Efficiency reconstruction with MC ID | z | 18x275 GeV



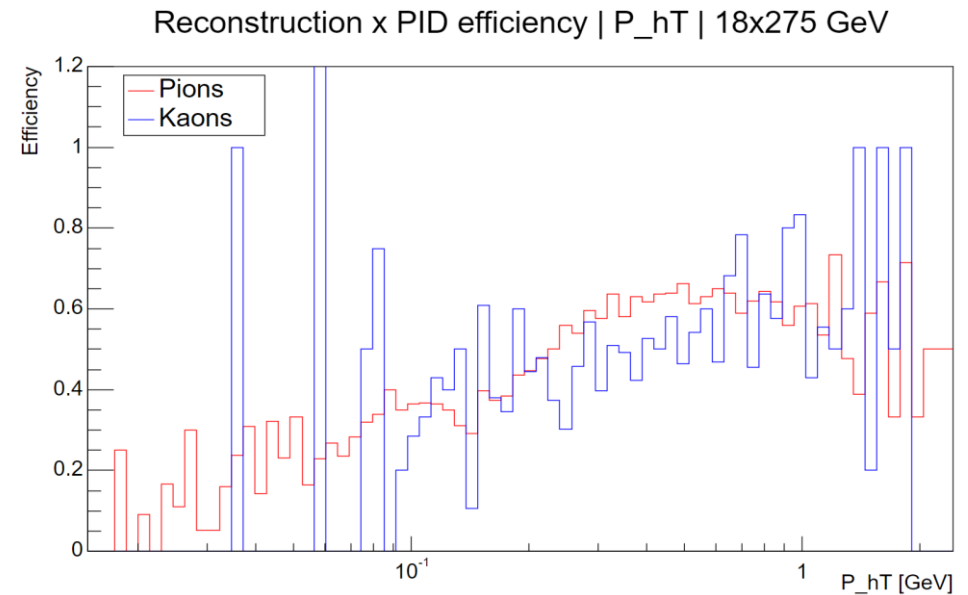
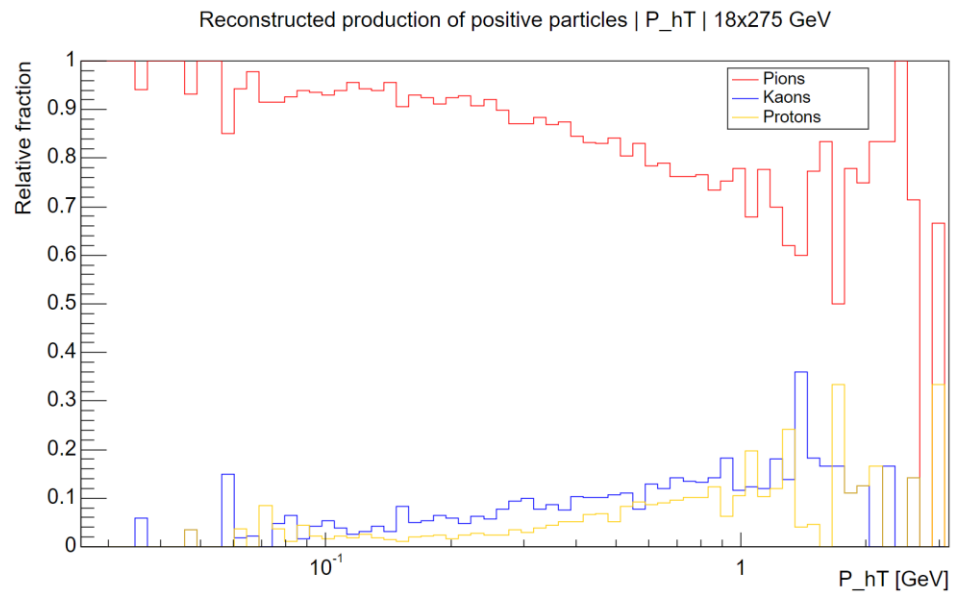
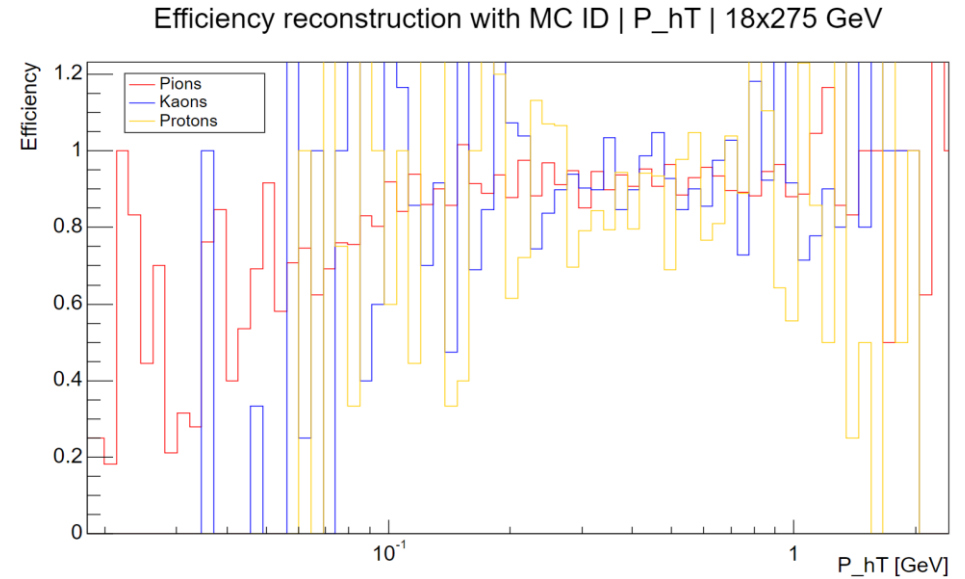
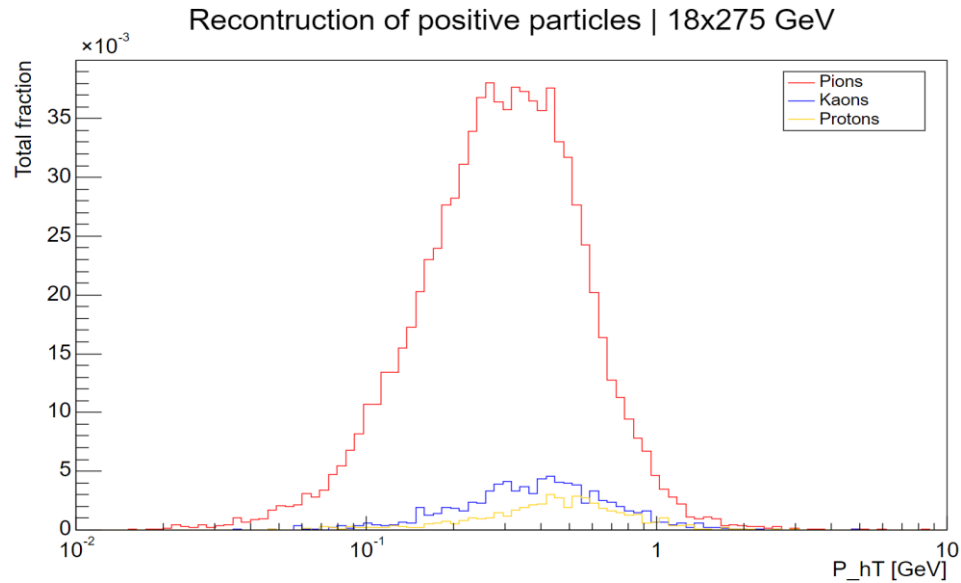
Reconstructed production of positive particles | z | 18x275 GeV



Reconstruction x PID efficiency | z | 18x275 GeV

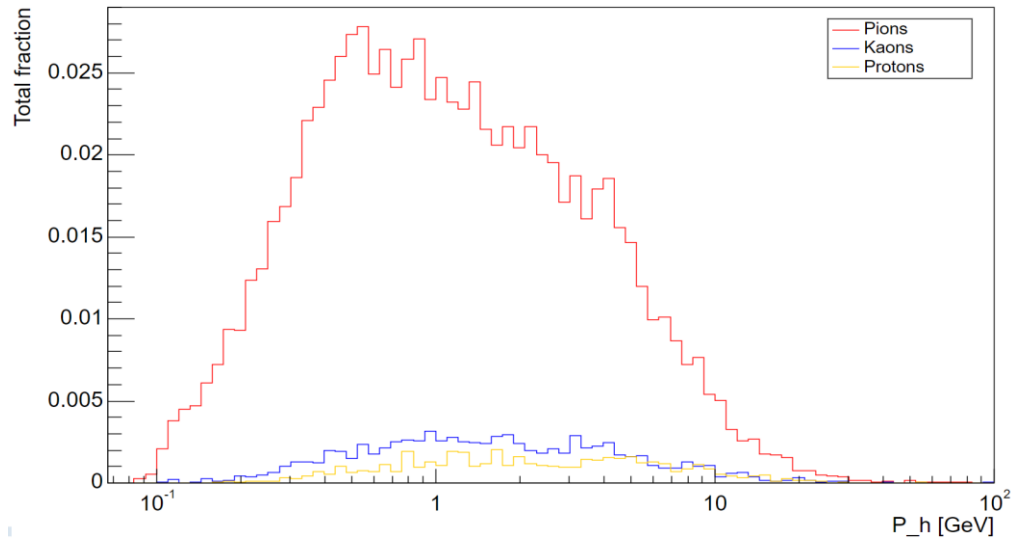


PRODUCTION & EFFICIENCY OVER P_{hT} | POSITIVE CASE

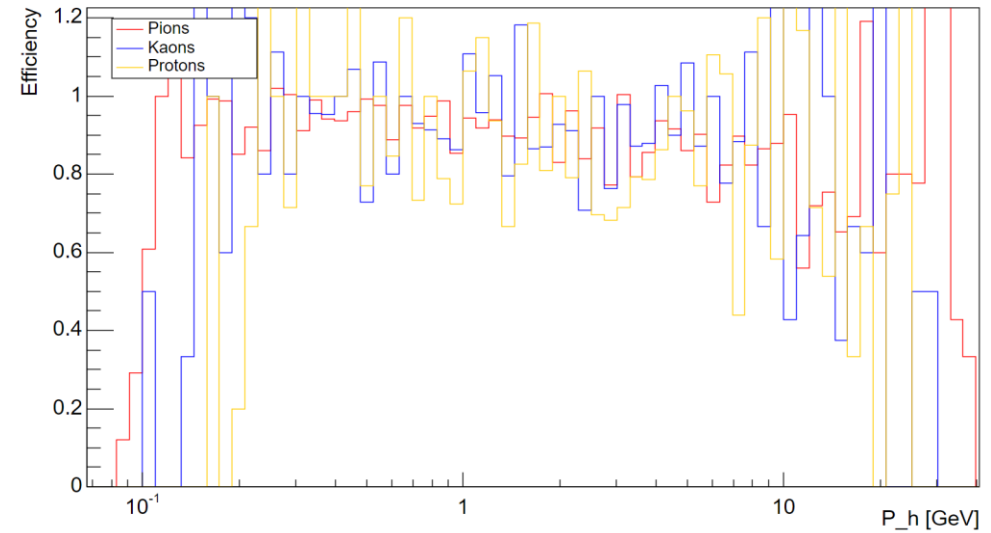


PRODUCTION & EFFICIENCY OVER P_h | POSITIVE CASE

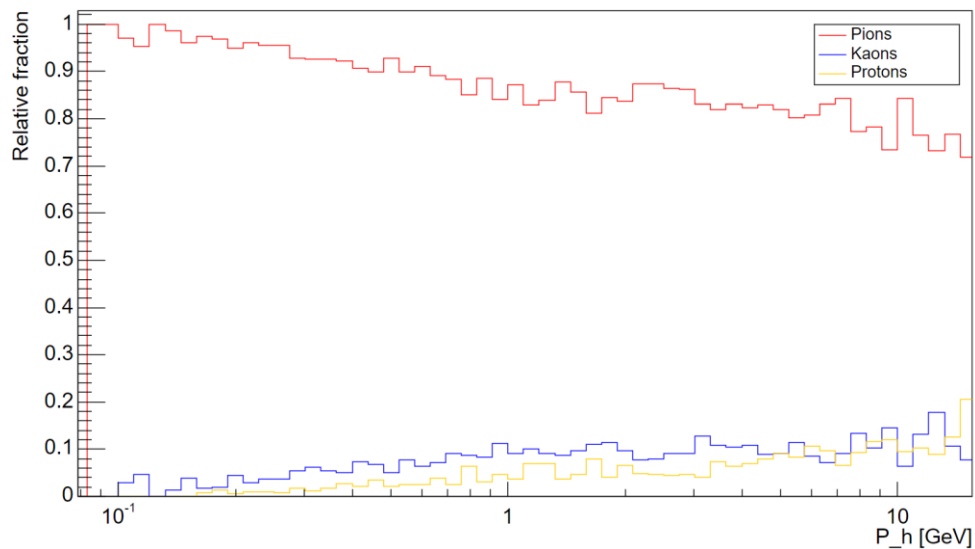
Reconstruction of positive particles | 18x275



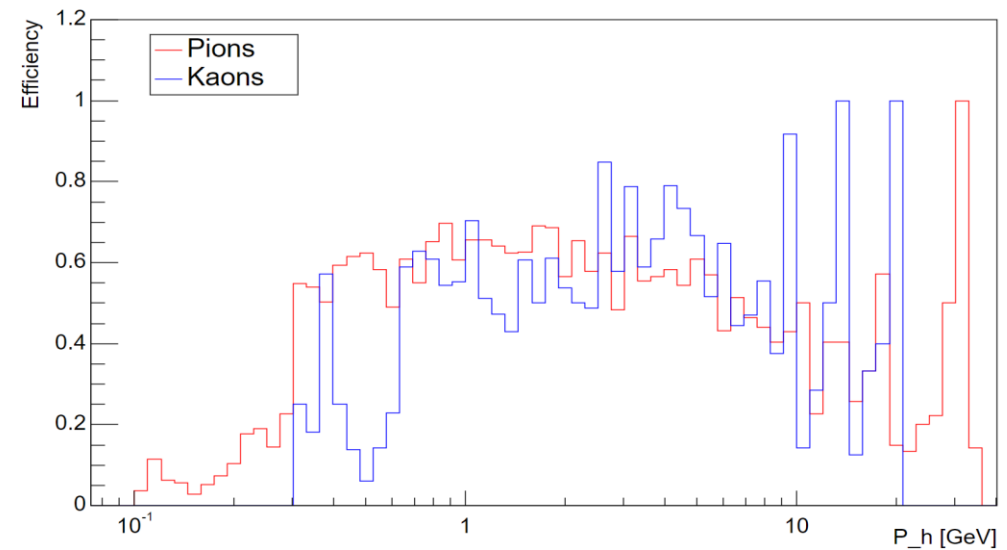
Efficiency reconstruction with MC ID | P_h | 18x275 GeV



Reconstructed production of positive particles | P_h | 18x275 GeV

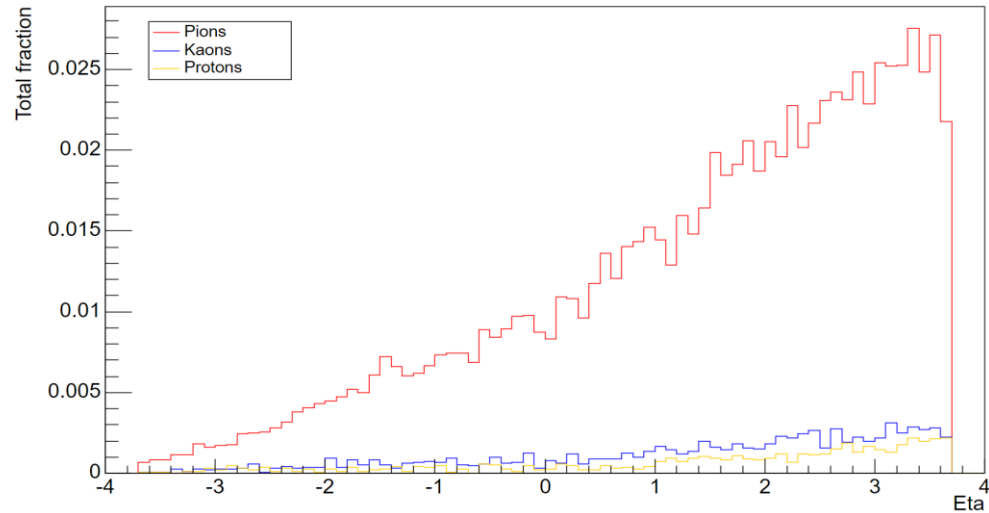


Reconstruction x PID efficiency | P_h | 18x275 GeV

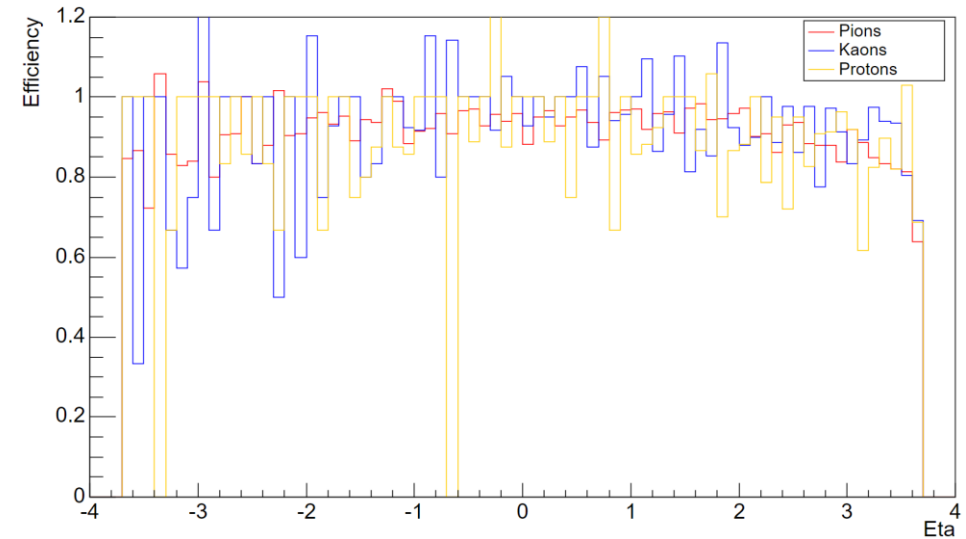


PRODUCTION & EFFICIENCY OVER η | POSITIVE CASE

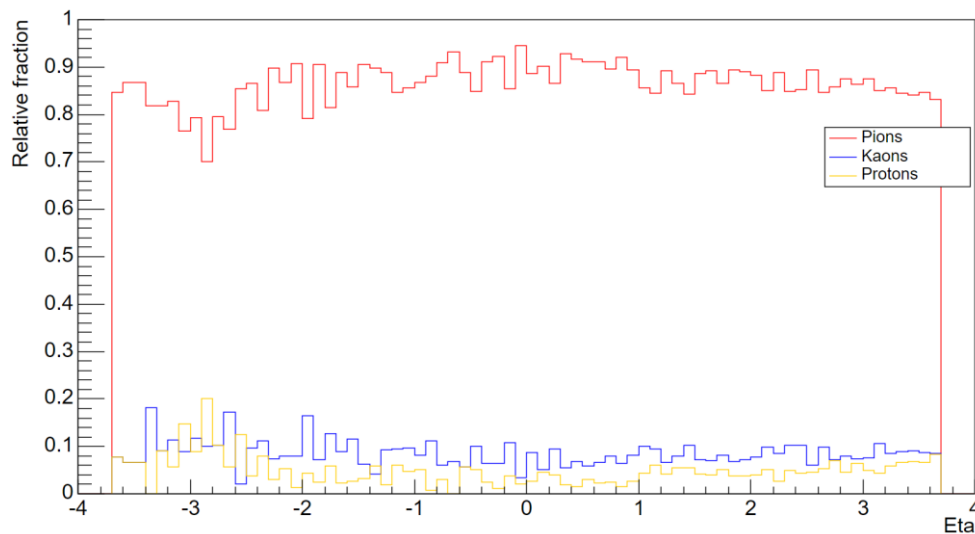
Reconstruction of positive particles | 18x275 GeV



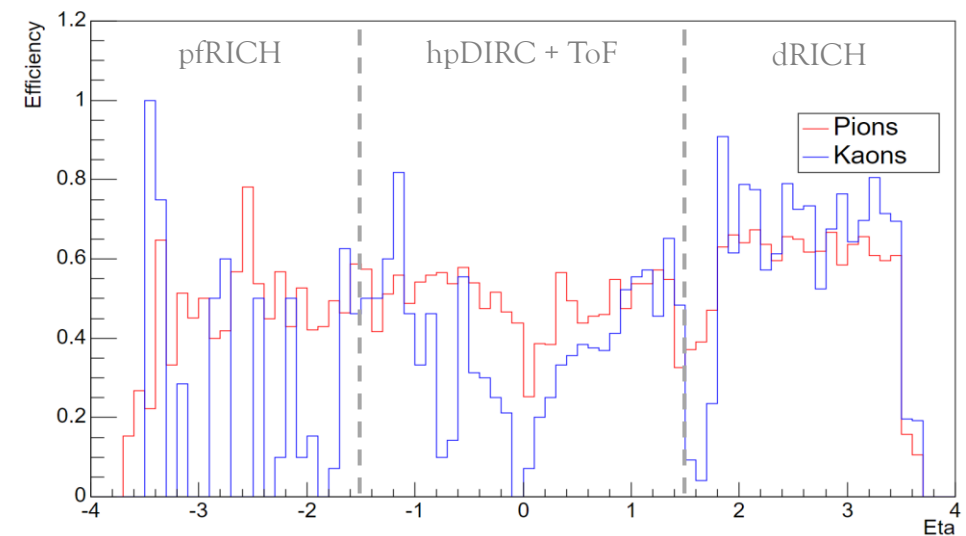
Efficiency reconstruction with MC ID | Eta | 18x275 GeV



Reconstructed production of positive particles | Eta | 18x275 GeV



Reconstruction x PID efficiency | Eta | 18x275 GeV



SUMMARY

OBSERVATIONS

- Most interesting regions for SIDIS studies.
- PID current performances.
- Suggestions on priorities for future improvements.

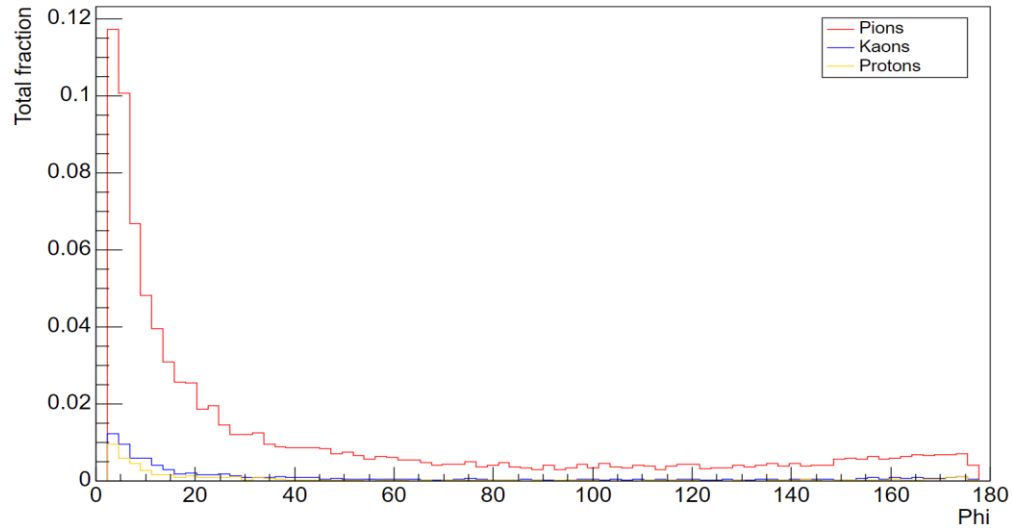
IMPROVEMENTS

- Future generated data with improved PID performances.
- Additional kinematic cuts.
- More statistics to enhance the SIDIS reconstructions.

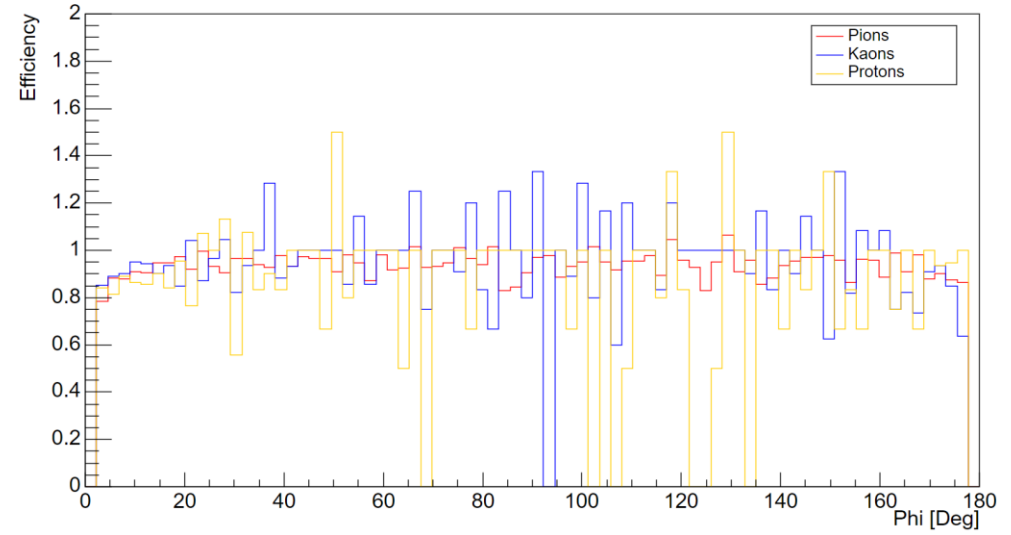
THANKS FOR YOUR ATTENTION

PRODUCTION & EFFICIENCY OVER φ | POSITIVE CASE

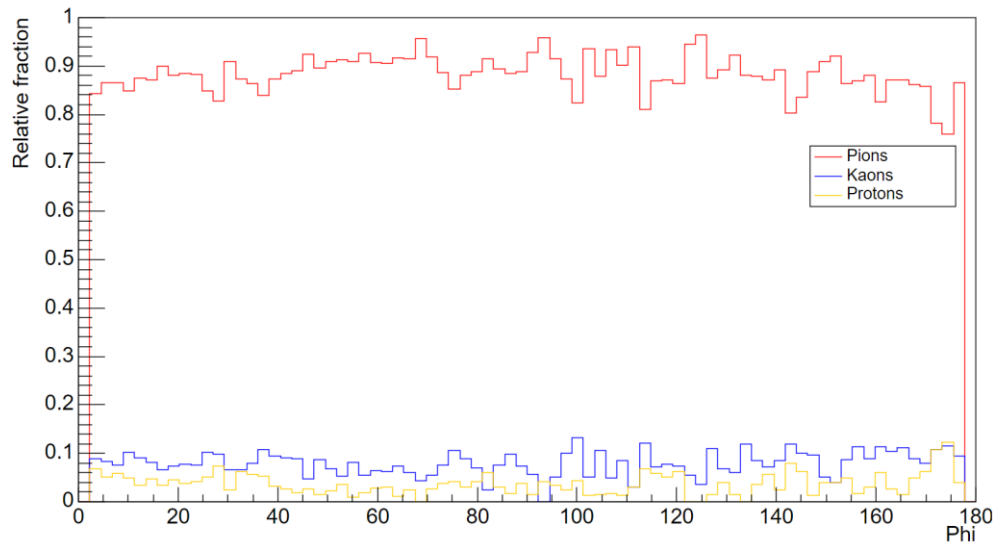
Reconstruction of positive particles | 18x275 GeV



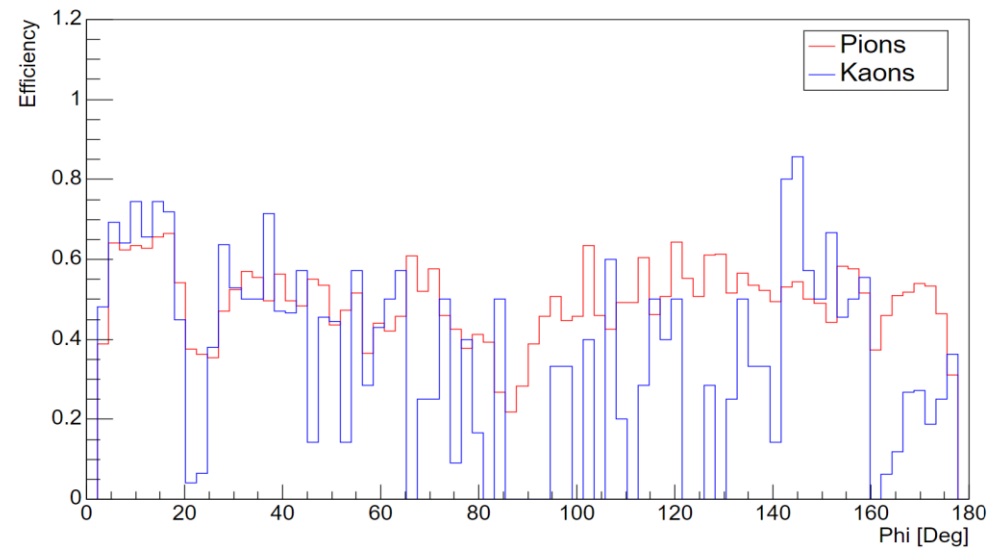
Efficiency reconstruction with MC ID | Phi | 18x275 GeV



Reconstructed production of positive particles | Phi | 18x275 GeV

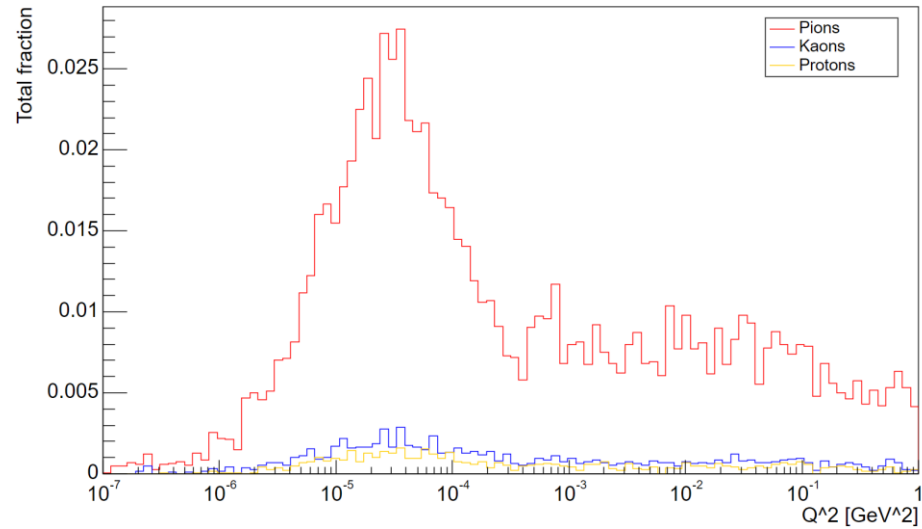


Reconstruction x PID efficiency | Phi | 18x275 GeV

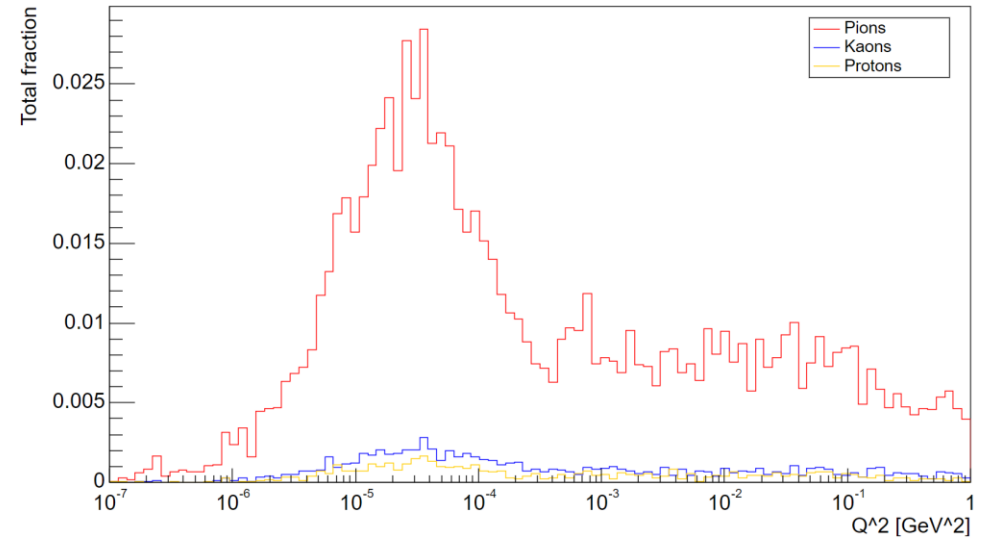


RELATIVE FRACTION vs Q^2

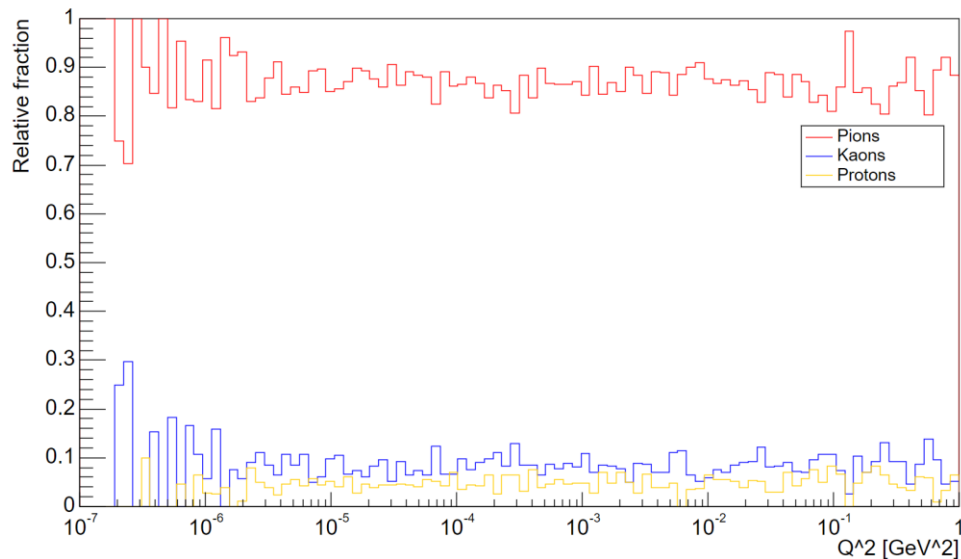
MC Production of positive particles | 18x275 GeV



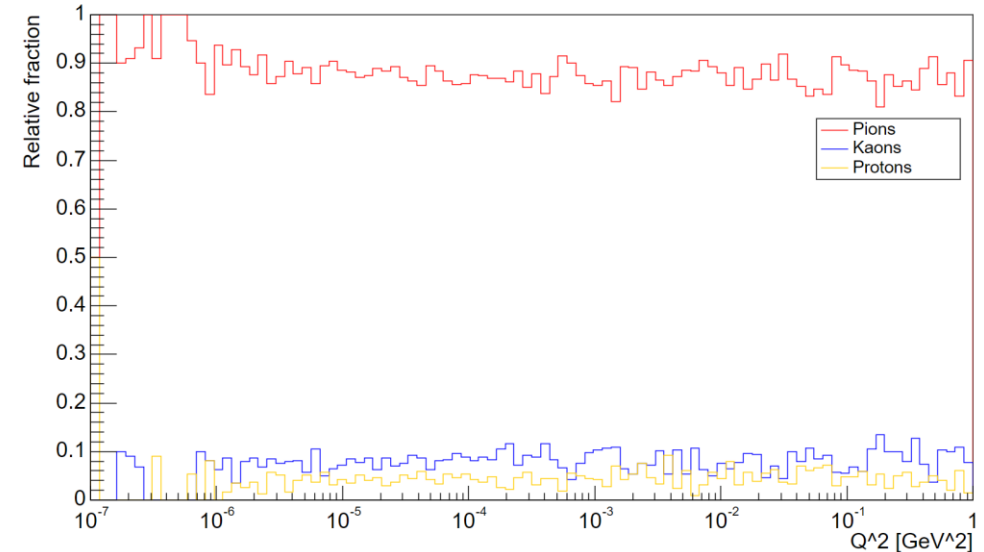
MC Production of negative particles | 18x275 GeV



Reconstructed production of positive particles | Q^2 | 18x275 GeV

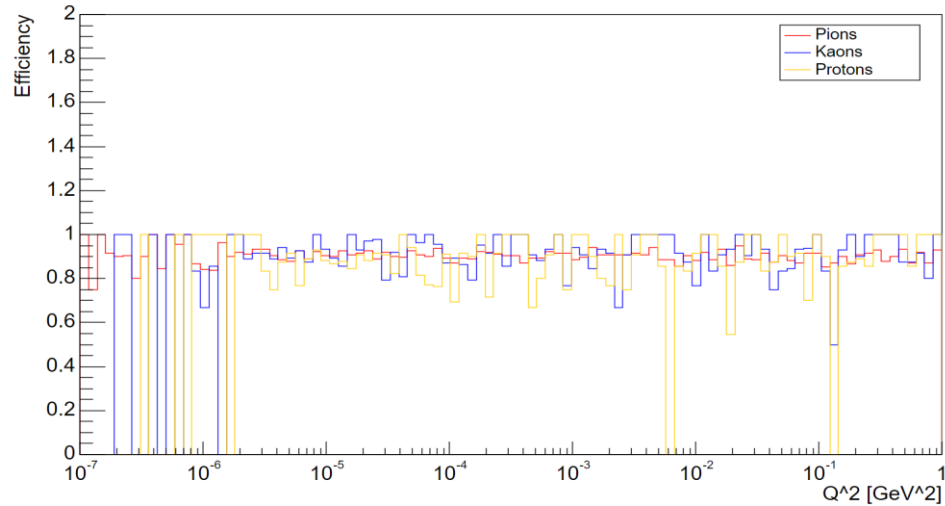


Reconstructed production of negative particles | Q^2 | 18x275 GeV

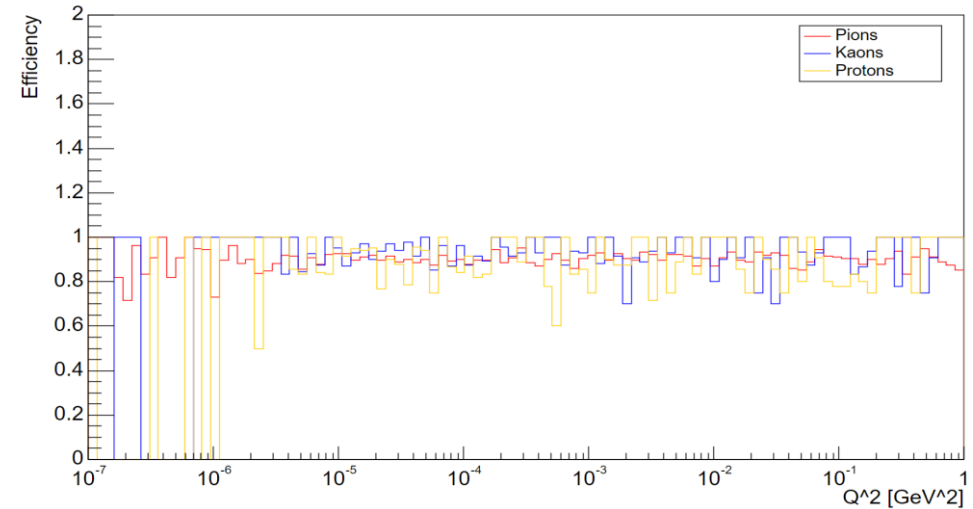


EFFICIENCY RECONSTRUCTION vs Q^2

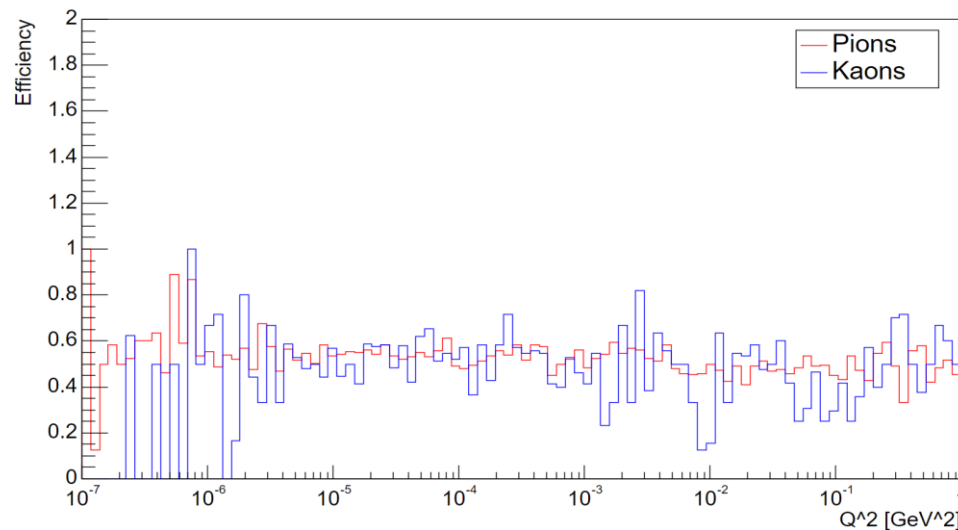
Efficiency reconstruction with MC ID | Q^2 | 18x275 GeV



Efficiency reconstruction with MC ID | Q^2 | 18x275 GeV



Efficiency reconstruction with PID | Q^2 | 18x275 GeV



Efficiency reconstruction with PID | Q^2 | 18x275 GeV

