# Identification of: $\pi^+$, $\pi^-$ and $p$ in: $\gamma p \rightarrow \pi^+\pi^- p$

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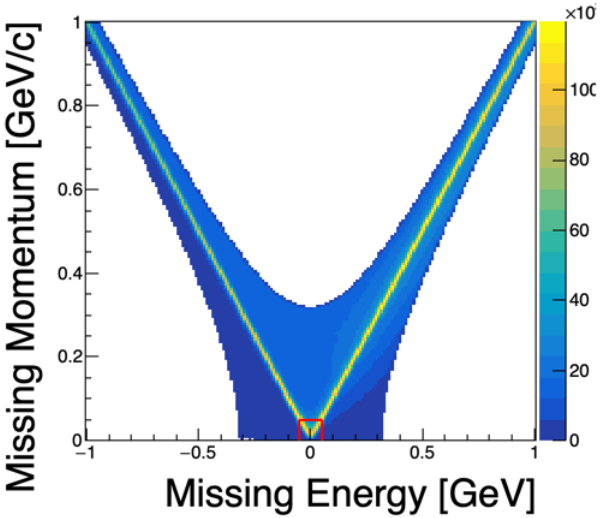
05/23/2019

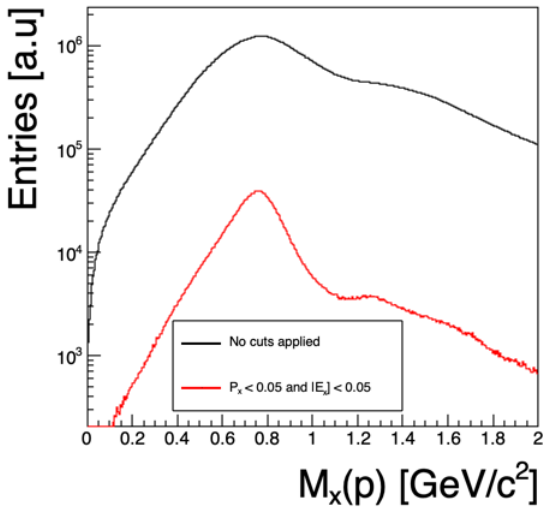
# Overview

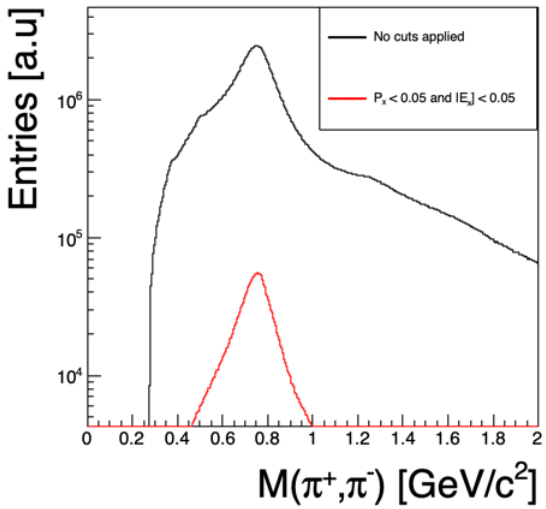
- Test PID-algorithms on measured data
- Define and understand efficiencies of algorithms
- Use specific channels to have "clean" particle samples:
  - i) For leptons: $\pi^0 \rightarrow e^+ e^- \gamma$
  - ii) For pions and protons: $\rho \rightarrow \pi^+ \pi^-$
  - iii) For kaons: $\Phi \rightarrow K^+ K^-$
- Today: channel ii) measured in 2017 GlueX data set
- **Goal:** Determine identification efficiencies for charged particles
- Algorithm used:
  - Neural Networks + Bayesian probabilities
  - Detailed description on input variables, training procedure and performance in PID tech-note

# Event Selection

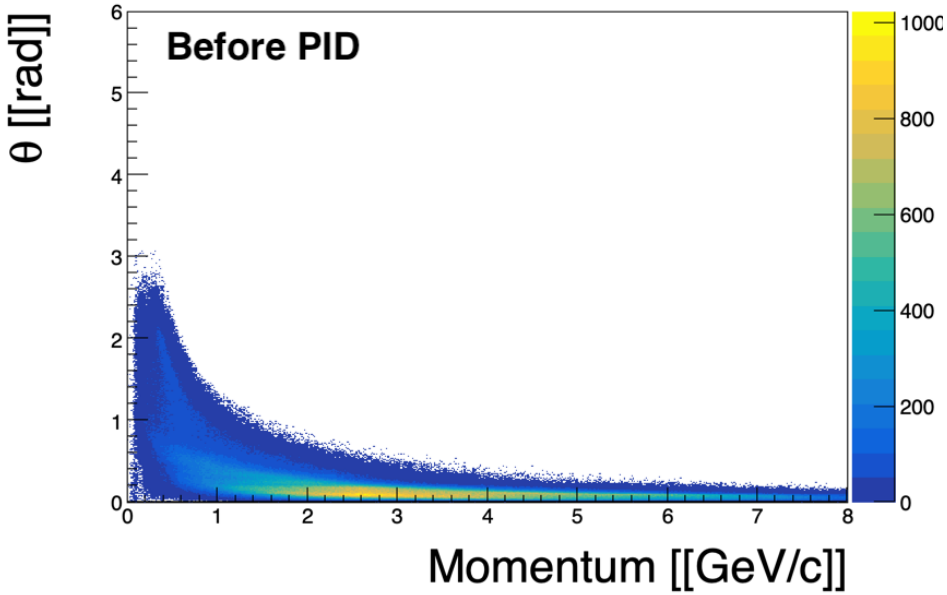
- Perform cut on missing momentum: $P_x < 50\,\mathrm{MeV/c^2}$ and missing energy: $E_x \in [-50\,\mathrm{MeV}, 50\,\mathrm{MeV}]$
- All results shown in the following are based on these cuts
- No kinematic fit applied $\rightarrow$ Only unfitted observables used

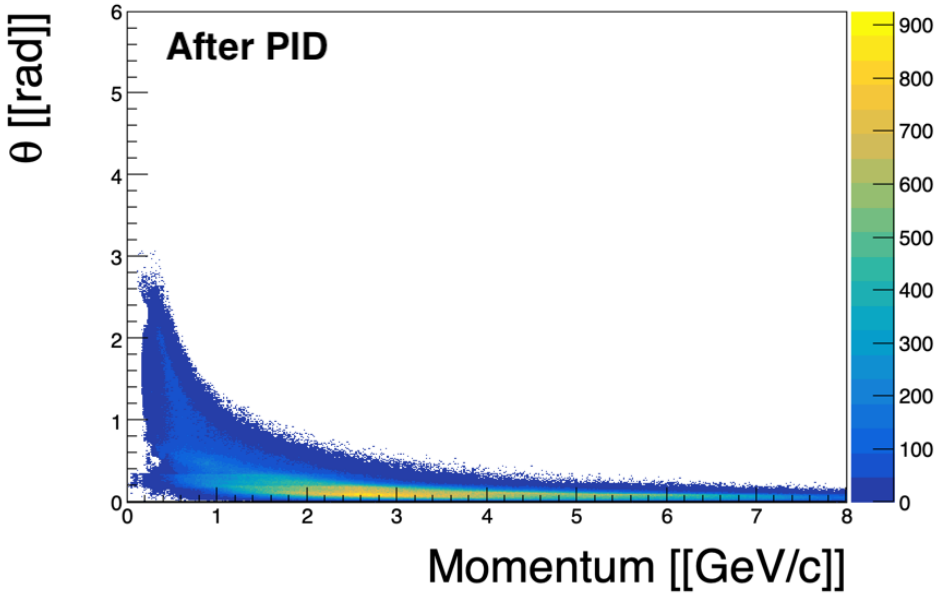


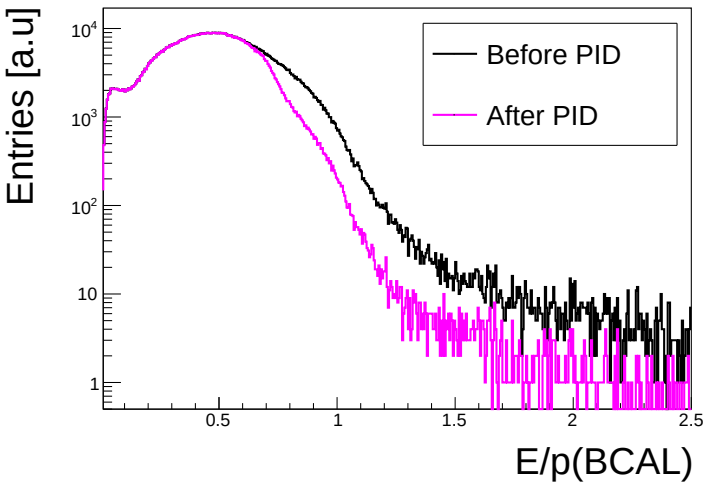



# Observables used to monitor Efficiencies

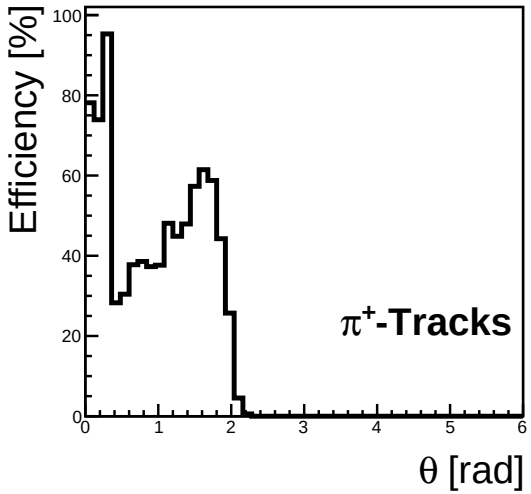


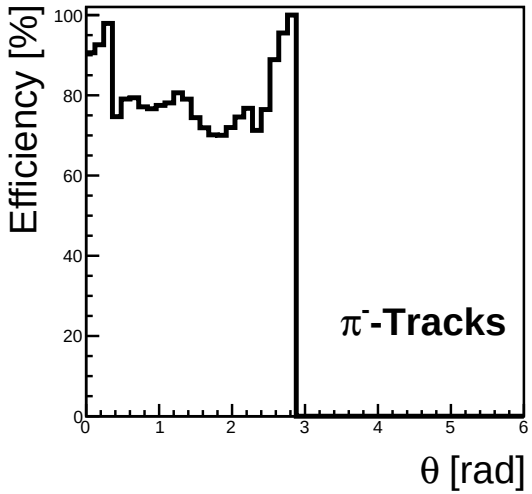



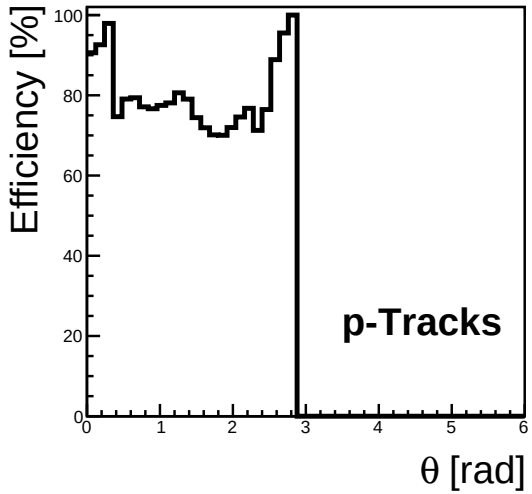



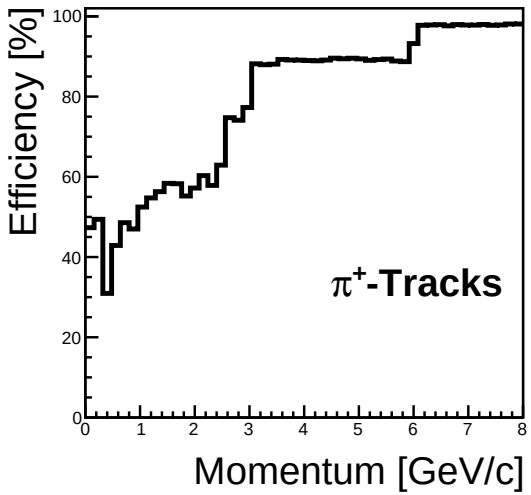

- Look at $\theta$, momentum and energy deposits in calorimeter
- Examples shown here: $\pi^-$-Tracks
- **Define efficiency:**
  **#Tracks before PID/#Tracks after PID**

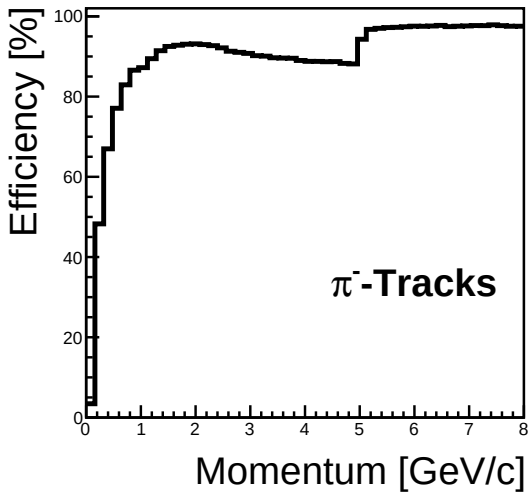
# Efficiencies in one Dimension

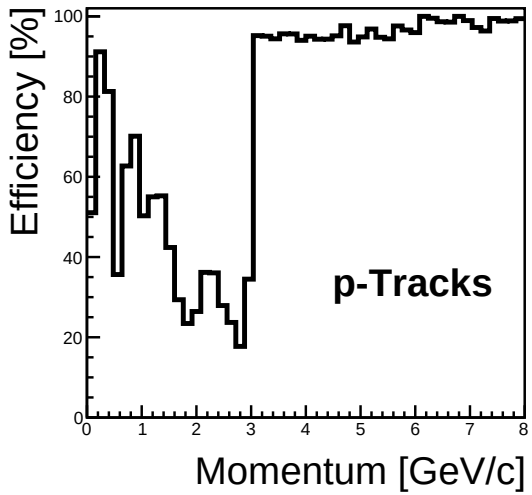


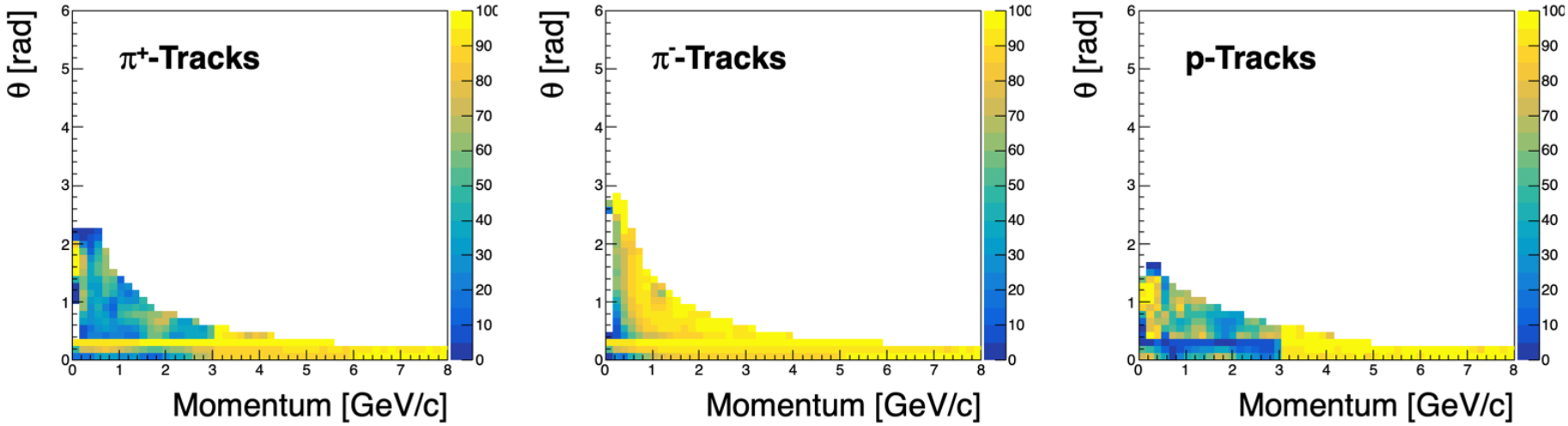



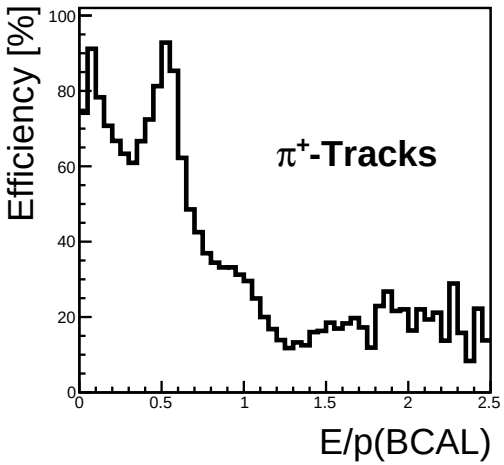

Identification for protons done for momenta $\leq 3\,\mathrm{GeV/c}$

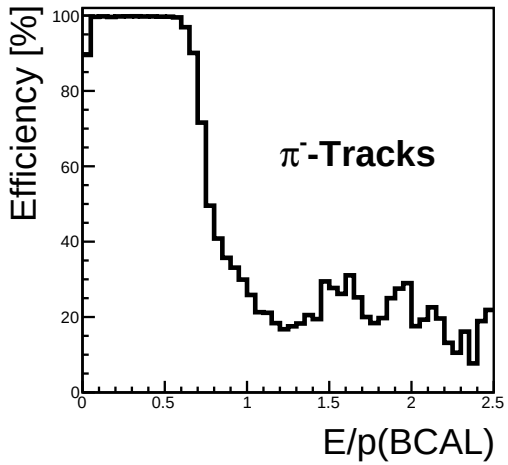
# Efficiencies in two Dimensions

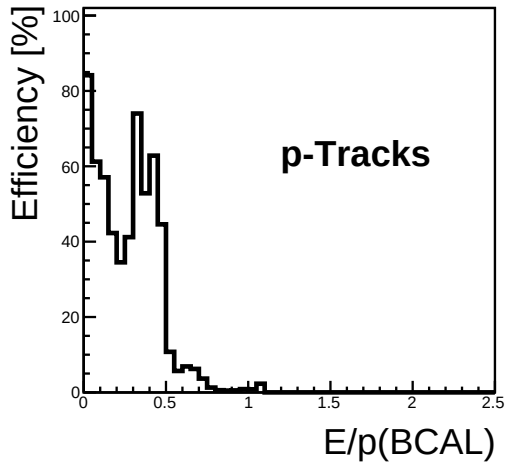


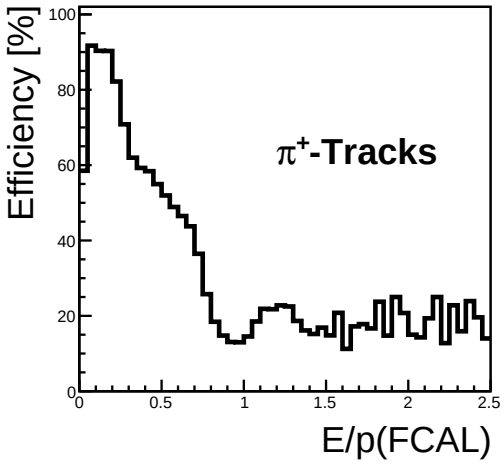

- Identification for protons done for momenta $\leq 3\,\mathrm{GeV/c}$
- Efficiencies shown on z-Axis

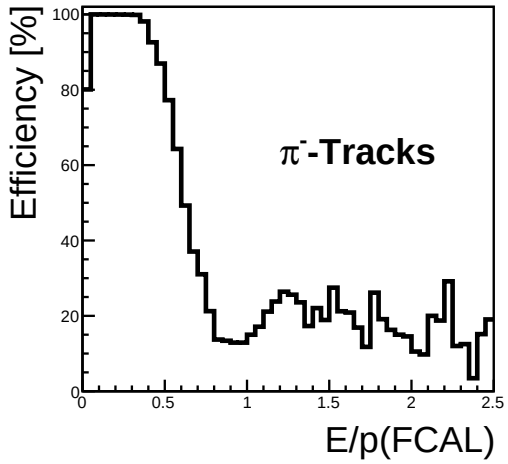
# Efficiencies in the Calorimeters

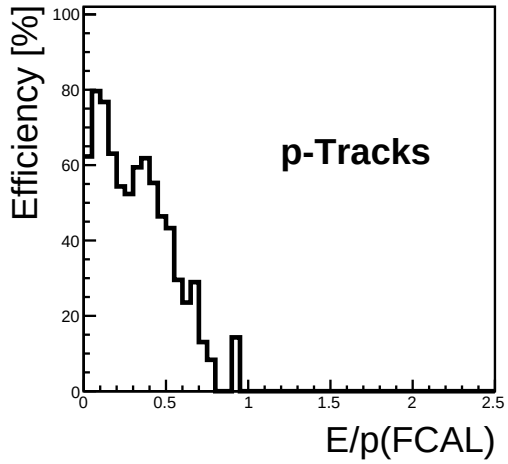



- Look at calorimeter to check lepton-misidentification
- Misidentify $\pi^{\pm}$ and p as leptons for $E/p \gtrsim 0.5$

# Summary and Outlook

- Checked identification efficiencies for $\pi^{\pm}$ and $p$
- Used $\rho \to \pi^+\pi^-$ within the 2017 data set
- Compare (integrated) efficiencies between measured and simulated (single) particle tracks:

| Particle | Efficiency ($\rho \to \pi^+\pi^-$) [%] | Efficiency (simulated single tracks) [%] |
|---|---|---|
| $\pi^-$ | 90 | 94 |
| $\pi^+$ | 71 | 73 |
| $p$ | 62 | 73 |

- Repeat study for simulated $\rho \to \pi^+\pi^-$ events
- Need to understand why agreement is bad for protons
- Next: check efficiencies for leptons in measured/simulated $\pi^0 \to e^+e^-\gamma$ events