Particle identification (PID) efficiency studies for GMP Experiment

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Outline

- Introduction to particle identification (PID)
- High resolution spectrometer and detector layout
- Cut efficiency
- Selection of good events
- Conclusion

Introduction to PID

- **The GMp experiment requires good particle identification to detect the maximum number of electrons and minimize pion contamination in the cross sections**
- **Number of electron detected:** $$(N_d) = L \frac{d\sigma}{d\Omega} \Delta\Omega \, A \epsilon$$

Where, $\frac{d\sigma}{d\Omega}$ → **Differential cross-section related to solid angle** $\Delta\Omega$

A → **Acceptance of the spectrometer**

L → **Integrated luminosity,**

ϵ → **Total detection efficiency**

- **To achieve this, a combination of a gas Cerenkov detector and lead glass Calorimeter was used on each arm of the High resolution spectrometers**
- **The gas Cerenkov is a threshold detector designed such that the lighter particles like electrons will emit Cerenkov radiation when passing through Co_2 gas, whereas, a heavier particle such as pion will not**

Introduction to PID

- **The high energy particles that pass through the lead glass will produce a cascade of secondary particles as a shower of particles which propagate through the medium. The particle's energy is converted to light, which then collected and used to determine the the initial energy of the electron.**
- **Cerenkov efficiency depends on fraction of electron missed the mirror, size and direction of the cone, which is intern depends on momentum in some extent**
- **Calorimeter energy resolution improves with momentum**
- **π/e ratios changes at different kinematic**

HRS and Detector Layouts

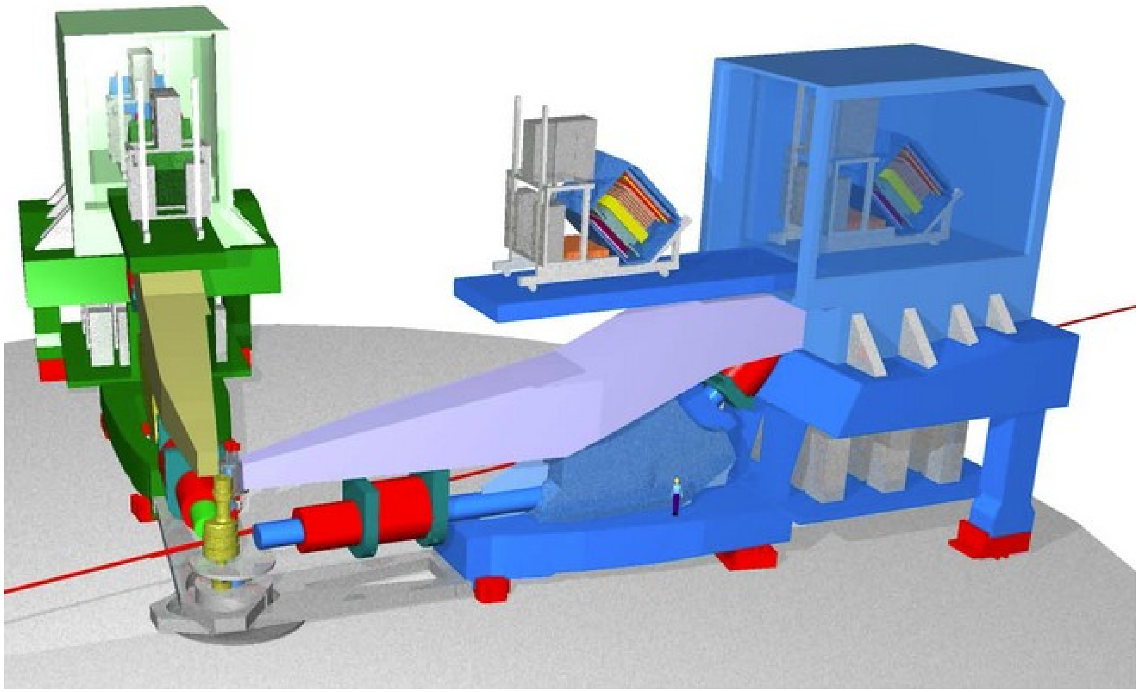


Fig: The High resolution spectrometer

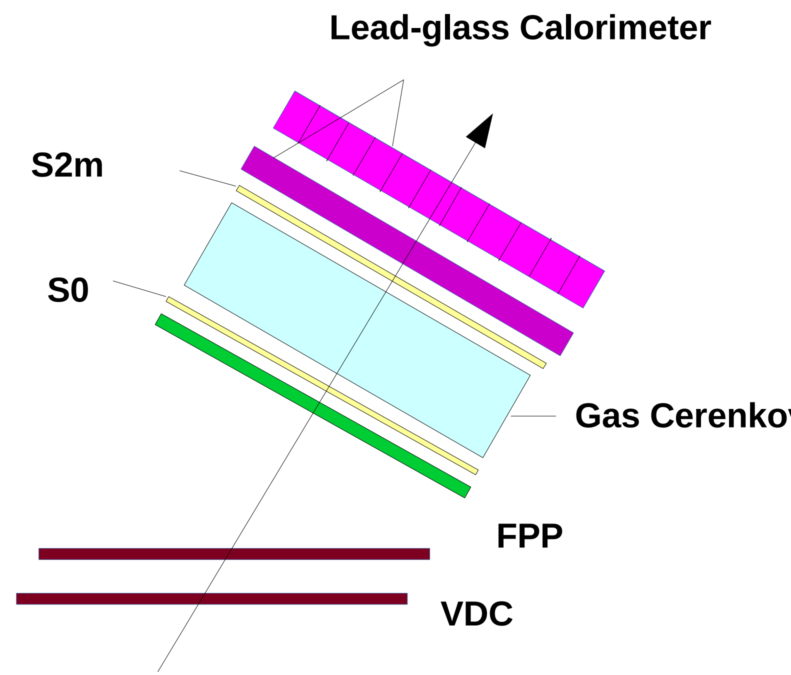


Fig: The HRS detector package

Cut Efficiency

For Cerenkov, first the events are selected from a tight cut on the electron region in the pre-shower vs shower plot (should). Then we counted the no. that triggered the Cerenkov detector (did) and vice versa for calorimeter . The detection efficiency can be:

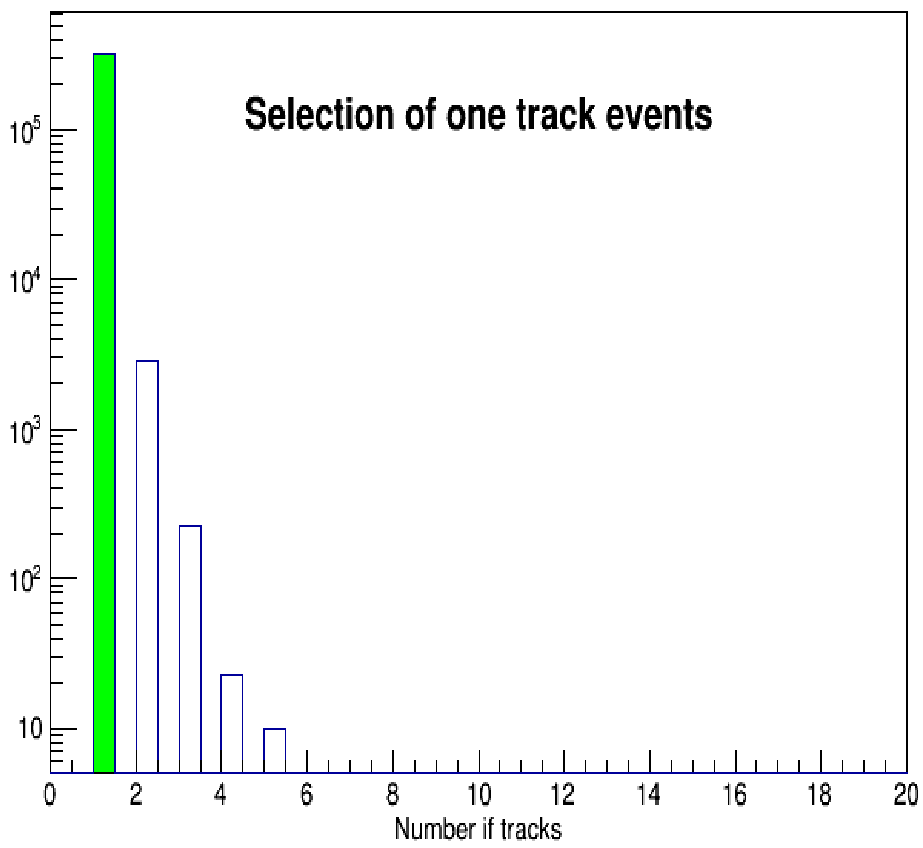
$$\epsilon_{det} = \frac{n_{did}}{n_{should}}$$

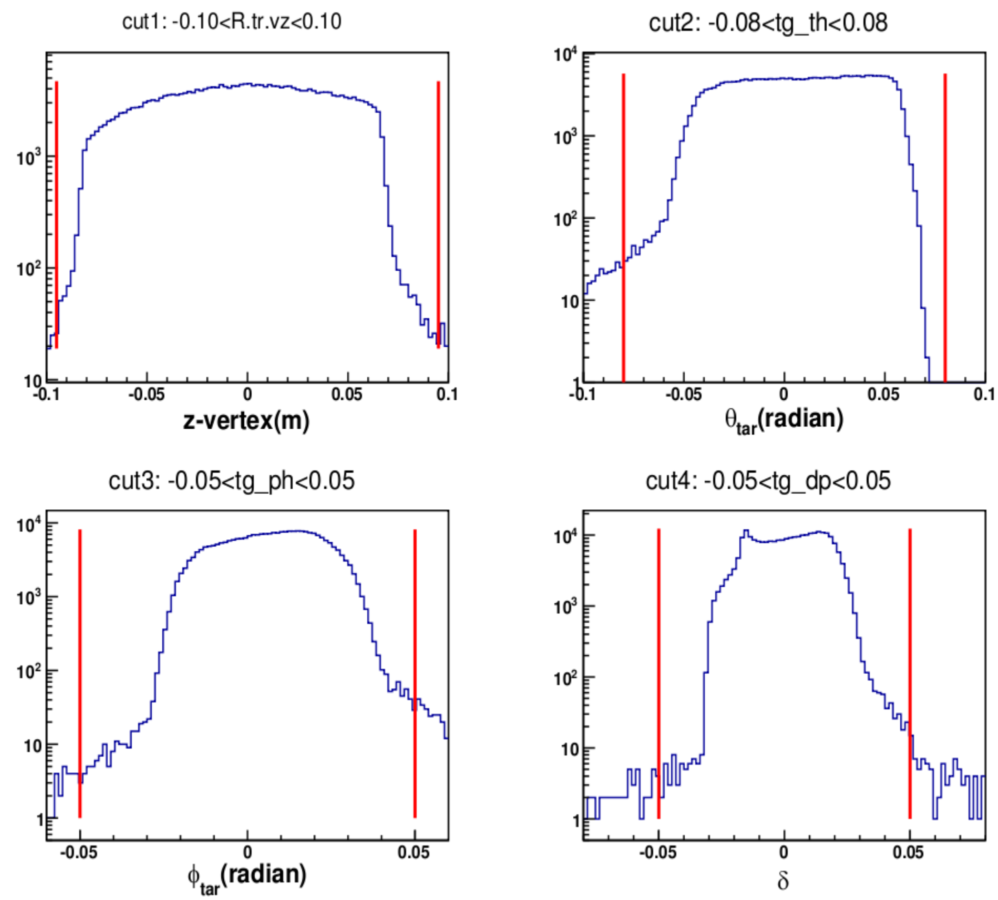
Cut efficiency:

The goal of the PID cut is to reject as many pions as possible while keeping a high electron efficiency. For this we choose cuts in each detector and calculate the cut efficiencies.

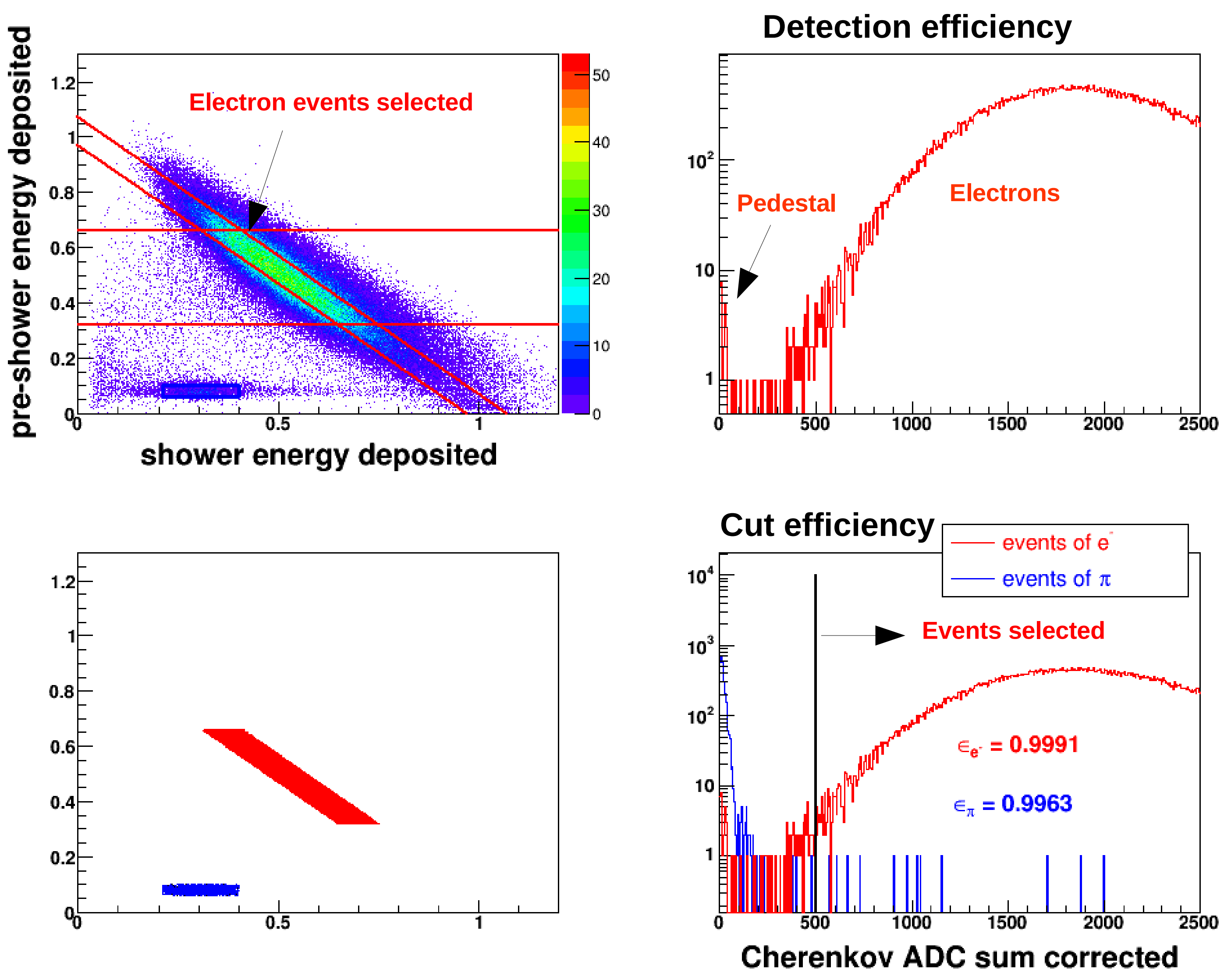
Selection of good events

- **In order to select good events we use a cut require only on track events**
- **Also made cuts on variables target quantities z-vertex, x'_{tar}, Y'_{tar}, and δ to get rid of events on the edge of the acceptance**

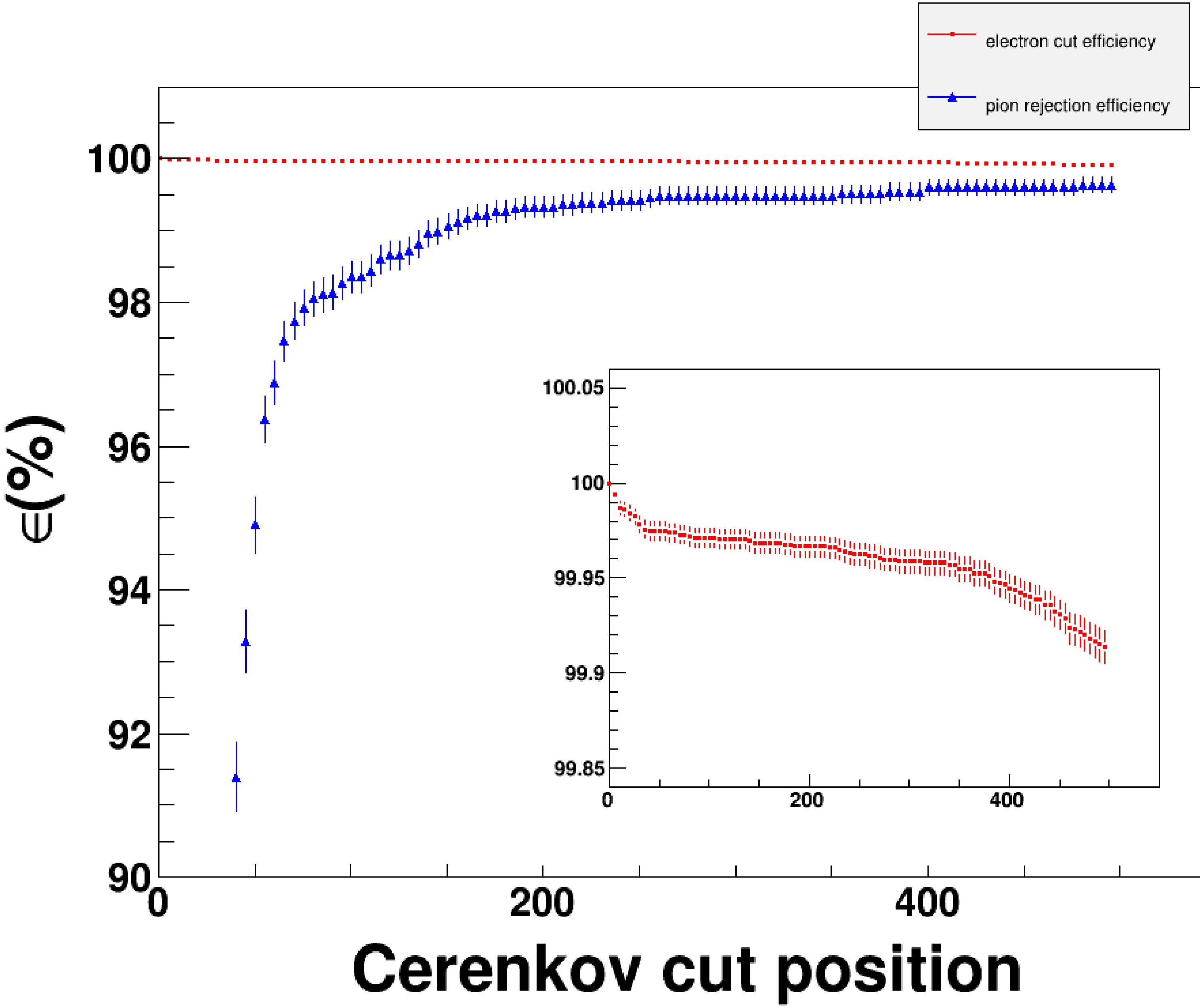




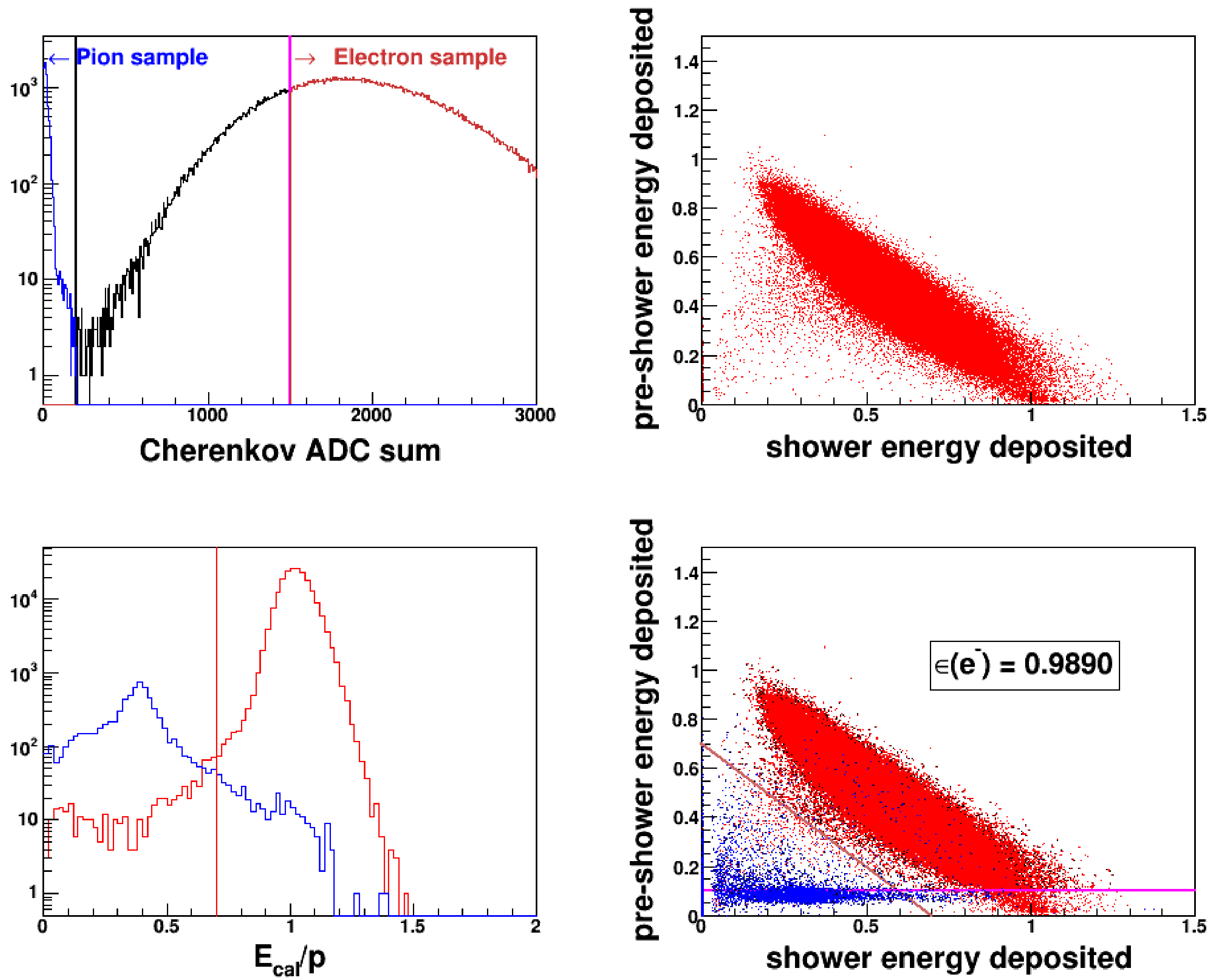
Cerenkov efficiency:



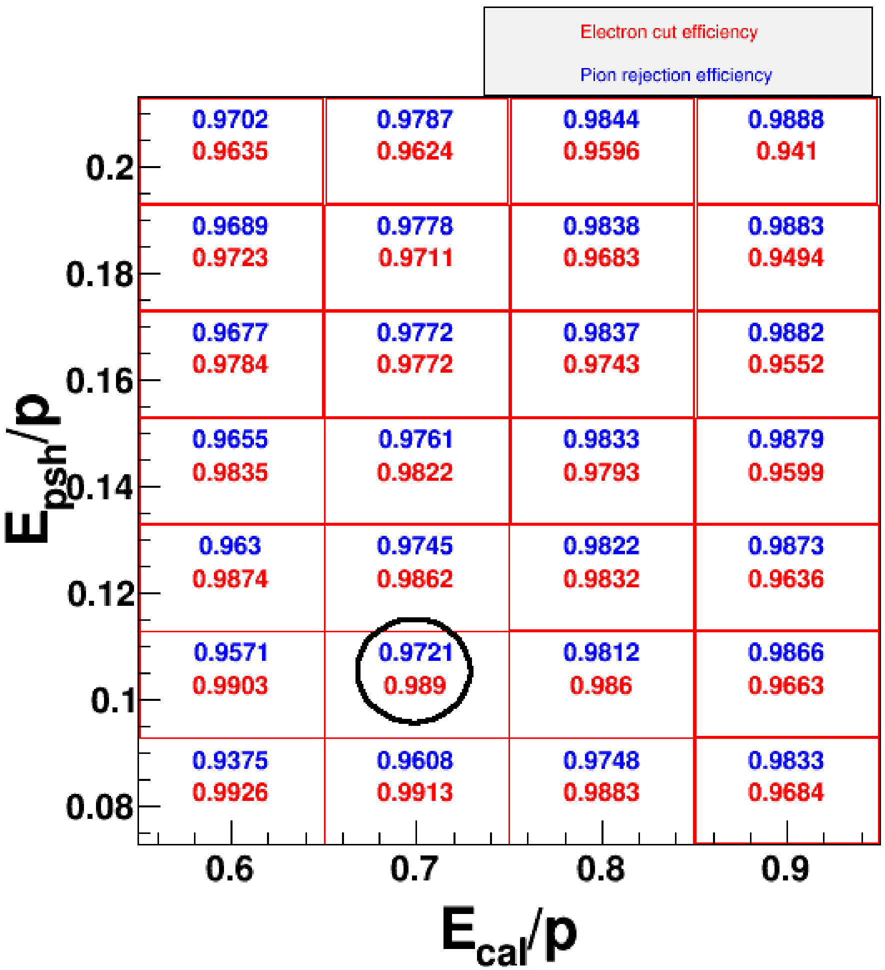
Cerenkov efficiency:



Calorimeter efficiency:



PID cuts and Final pi/e ratio:



Cuts: Cherenkov ADC sum>500

$E_{cal}/p>0.7$, $E_{psh}/p>0.1$

$N_i = e_i + \pi_i$ ------(1) (Total initial with Acceptance cuts)

$N_f = e_f + \pi_f$ ------(2) (Total final With all cuts)

$e_f = \epsilon_{e'} \times e_i$ ------(3) (Final electron)

$\pi_f = (1-\epsilon_{\pi}) \times \pi_i$ ------(4) (Final Pions)

$\epsilon_{e'} = \epsilon_{e'}^{cer} \times \epsilon_{e'}^{cal} = 0.9882$ ------(5)

$\epsilon_{\pi} = 1 - (1-\epsilon_{\pi}^{cer})(1-\epsilon_{\pi}^{cal}) = 0.9999$ ------(6)

$$e_f = \frac{\epsilon_{e'}(N_f - N_i(1-\epsilon_{\pi}))}{(\epsilon_{e'} + \epsilon_{\pi} - 1)}$$

$$\frac{\pi}{e}_{initial} = \frac{N_i - e_i}{e_i} = 0.0306$$

$$\frac{\pi}{e}_{final} = \frac{N_f - e_f}{e_f} = 3.1752015e-06$$

Conclusion:

- Particle identification was done at E = 2.222 GeV/c and θ = 42° and the cuts were set to select good electron events
- Combined PID efficiency at this pass is found to be 98.8% and the final π/e ratio is ~10^{-6}