HNOTE 825

Summary of SELEX RICH Efficiency Measurements

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1 Introduction

The efficiency of the RICH for identifying particles is measured for Protons, Kaons and Pions. For Proton, we reconstruct Λ's, and apply different cuts on the proton. For the kaon, we reconstruct Φ's and apply different cuts for both Kaons. By fitting the remaining peaks, the efficiency can be calculated. All these measurements get performed as a function of momentum. We will use the expression $\mathcal{L}(p)$ ($\mathcal{L}(K)$, $\mathcal{L}(\pi)$, etc.) to denote the likelihood for a track to be a proton (kaon, pion, etc.)

2 Proton efficiencies using Lambda's

For this study we used stripped Λ's from strip8a. This was the last (and largest) dataset done without any RICH cut during production. The file are available in fmss and contain about 50000 Λ's, reconstructed only by vertex2.

The plots are all obtained in the same way: Fill two histograms with the invariant mass of the $p\pi$ vertex, once with and once without RICH cut, in slices of the proton momentum. A Gauss fit is applied to the resulting distribution, and the obtained ratios are plotted as a function of the proton momentum. The routine is in soap within the *monitor* package, and is called *ric_lambda.F*. It can be switched on with `exec monitor` and `set on partid ric_lambda`. The default bin size in momentum is $8\,\mathrm{GeV}/c$, and can be set in units of $4\,\mathrm{GeV}/c$ with `set cut partid ric_lambin 1`.

Figure 1 shows the efficiency to identify a proton for two special cuts: in the upper plot, $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 1$ (also shown in the RICH paper [1]) and in the lower plot $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 1$. The fit function describes the decrease in efficiency at high momenta very well. It assumes a ring radius resolution of "sigma" and calculates the overlap for two gauss functions around the radius corresponding to the particle masses printed. We conclude a ring radius resolution of about 1.75 mm from this study.

Plots for efficiencies for other RICH cuts are shown in fig 2 and 3, and the miss-identification rate (how often do we call a pion a proton?) are provided in fig. 4 and 5.

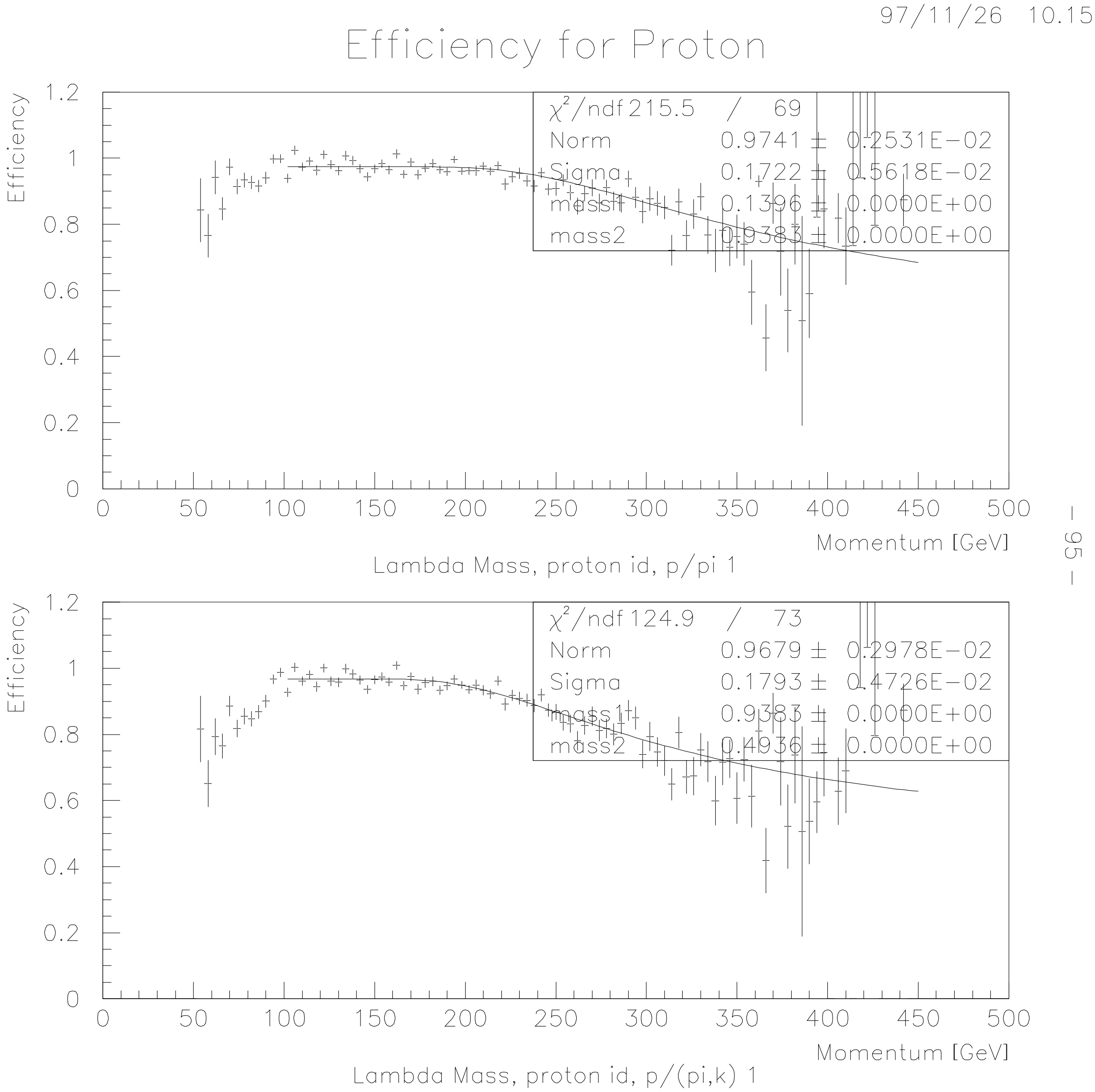

Figure 1: Efficiency for identifying a proton with $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 1$ (top), and $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 1$ (bottom). For the line, see description in the text.

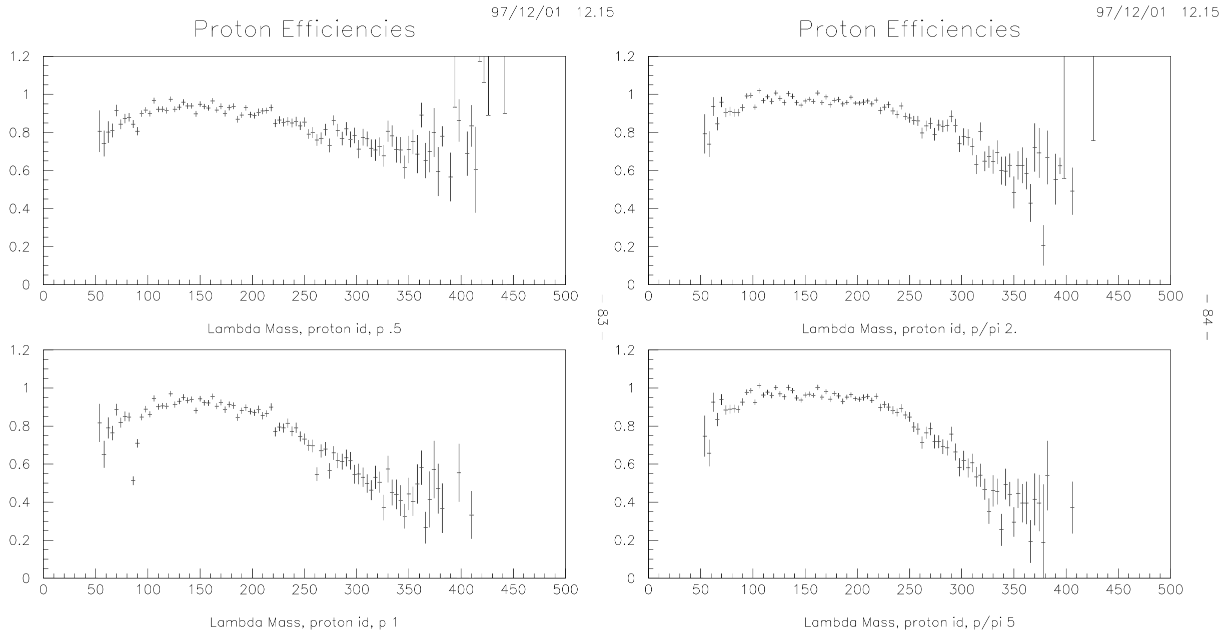

Figure 2: Efficiency for identifying a proton with $\mathcal{L}(p) > 0.5$ (top left), $\mathcal{L}(p) = 1$ (bottom left), $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 2$ (top right), and $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 5$ (bottom right).

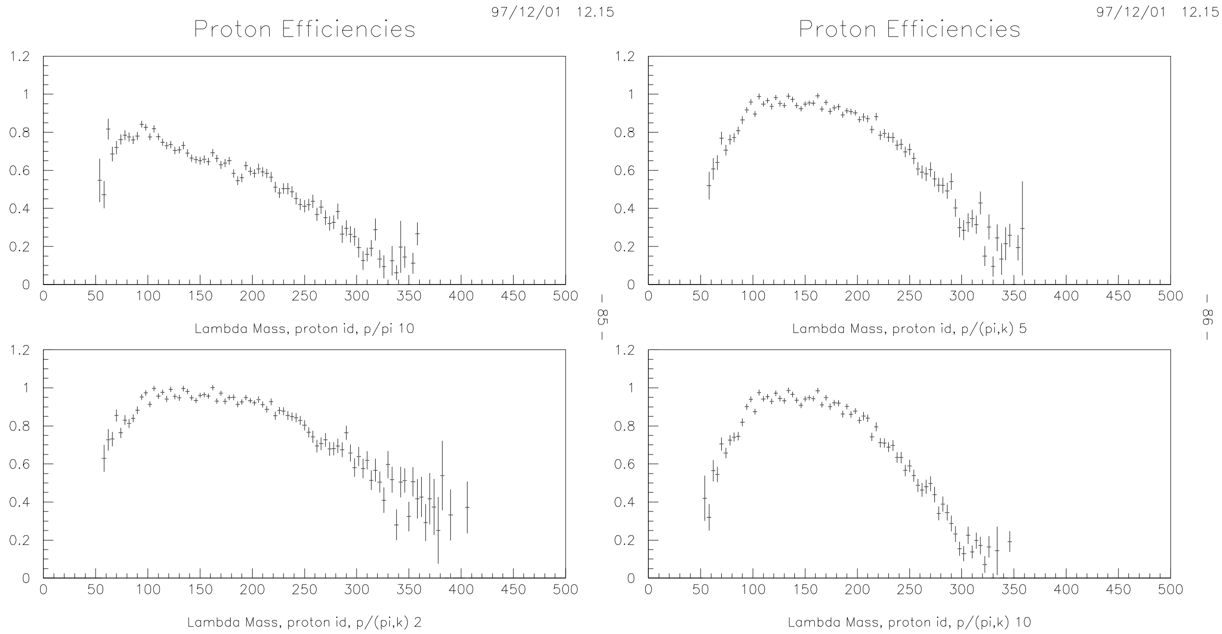

Figure 3: Efficiency for identifying a proton with $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 10$ (top left), $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 2$ (bottom left), $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 5$ (top right), and $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 10$ (bottom right).

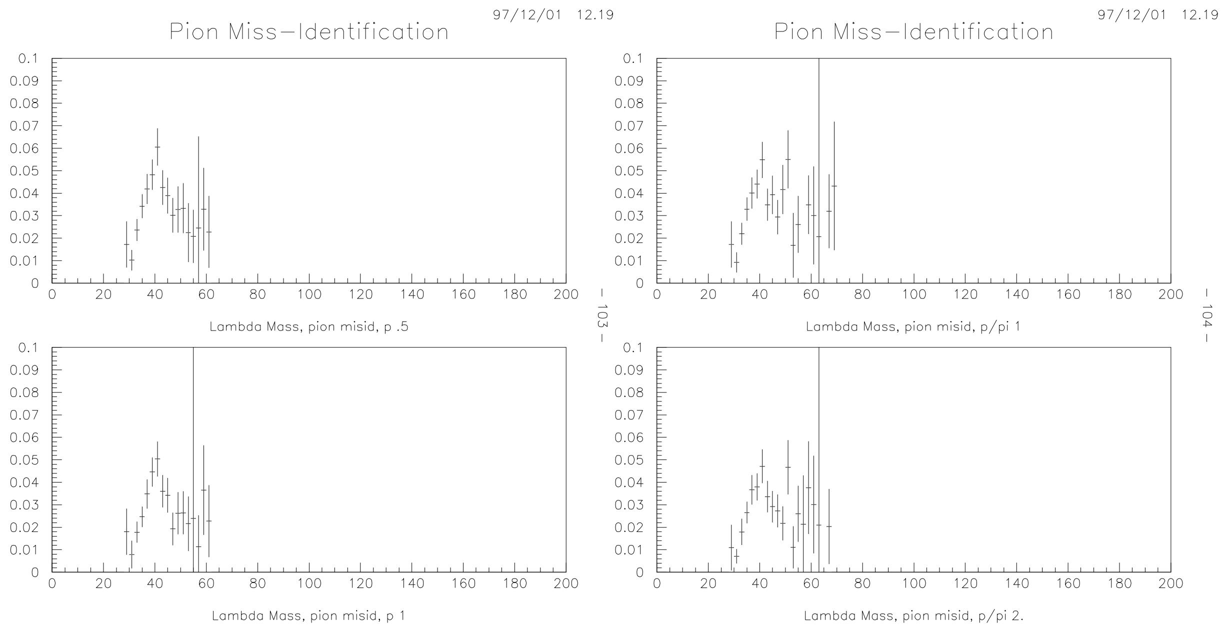

Figure 4: Efficiency for miss-identifying a pion as a proton with $\mathcal{L}(p) > 0.5$ (top left), $\mathcal{L}(p) = 1$ (bottom left), $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 1$ (top right), and $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 2$ (bottom right).

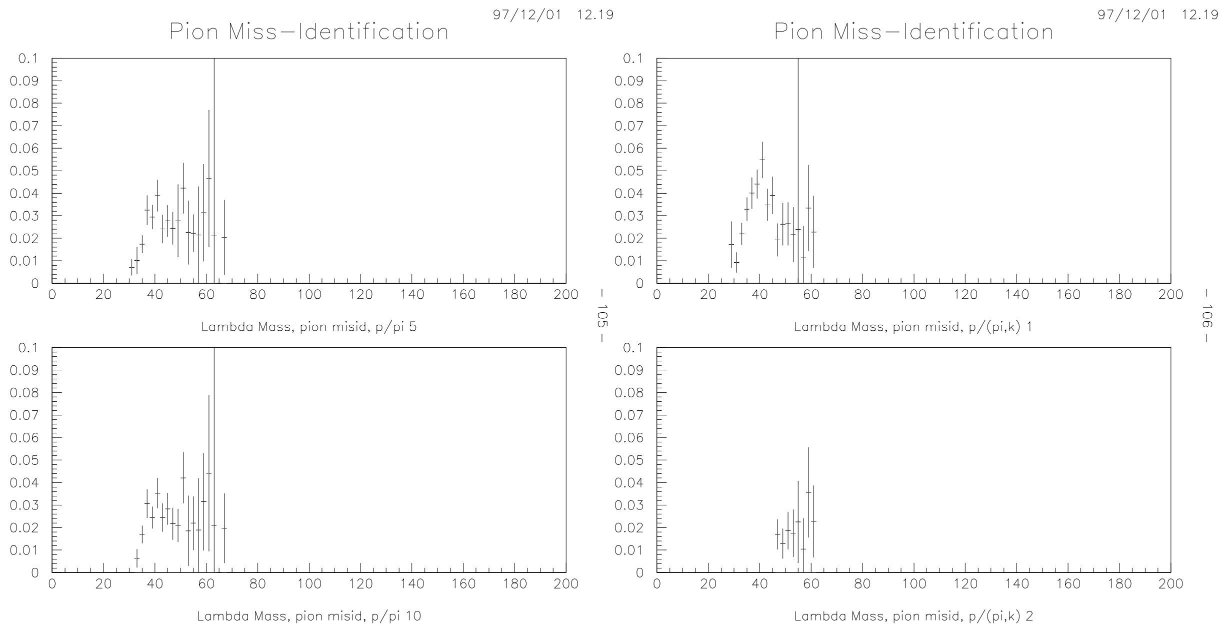

Figure 5: Efficiency for miss-identifying a pion as a proton with $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 5$ (top left), $\mathcal{L}(p)/\mathcal{L}(\pi) \geq 10$ (bottom left), $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 1$ (top right), and $\mathcal{L}(p)/\max(\mathcal{L}(K), \mathcal{L}(\pi)) \geq 2$ (bottom right).

3 Kaon efficiencies using Φ's from exclusive triggers

To study the efficiency for kaons, we used the exclusive trigger sample. In this sample, the background is low enough to see a Φ peak even without RICH cuts, so a reliable normalization is possible. The statistics is much lower, so only a few momentum slices can be analyzed. The fig. 6 also appears in the RICH paper ([1]). A clear peak of the Φ can be seen, and the

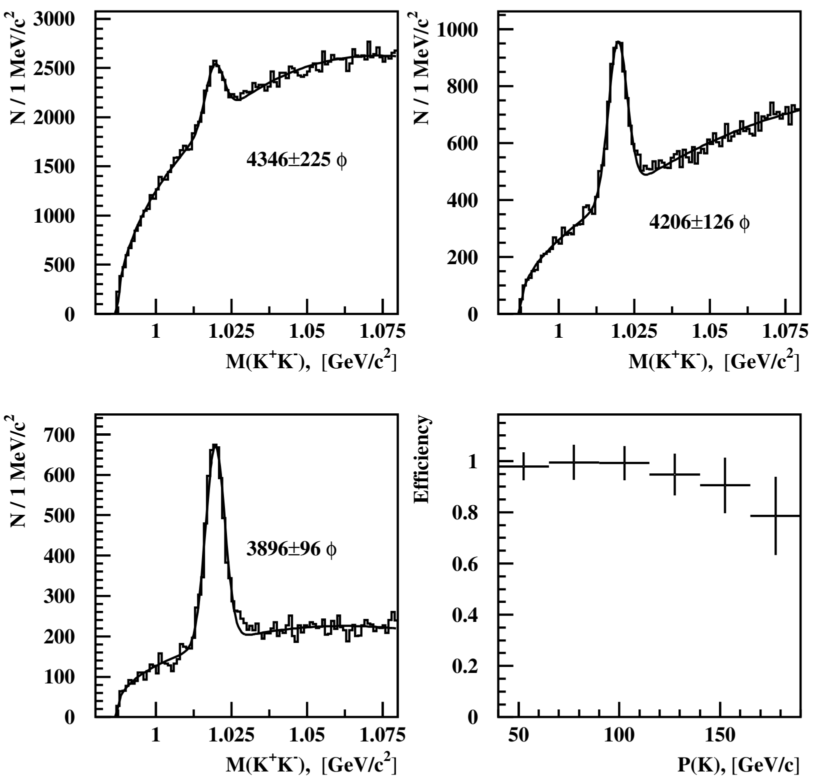

Figure 6: Invariant mass of K^+K^-. Top left: No identification of the kaons. Top right: One kaon is identified. Bottom left: Both kaons identified. Bottom right: Efficiency for the RICH identifying a kaon as a function of its momentum. For identification, $\mathcal{L}(K)/\mathcal{L}(\pi) \geq 1$.

RICH identification has a very high efficiency for identifying the kaons. This confirms the proton result.

4 Pion efficiencies using Lambda's

Using a Lambda sample from strip8a (the only sample which does not have any rich cut at strip level) we measured the efficiency for identifying pions with the cuts used during pass1.

There we accept as a pion all tracks if they are outside the RICH acceptance, and, if inside the RICH acceptance, we require $\mathcal{L}(\pi) \geq 0.1$ (or better: the ratio of the pion likelihood to anything else).

To measure the efficiencies, Lambda's are reconstructed with and without a cut of 0.1 on pions within the RICH acceptance. No cut on the proton is applied. In fig. 7 you can see a high efficiency without turn-on as a function of the pion momentum.

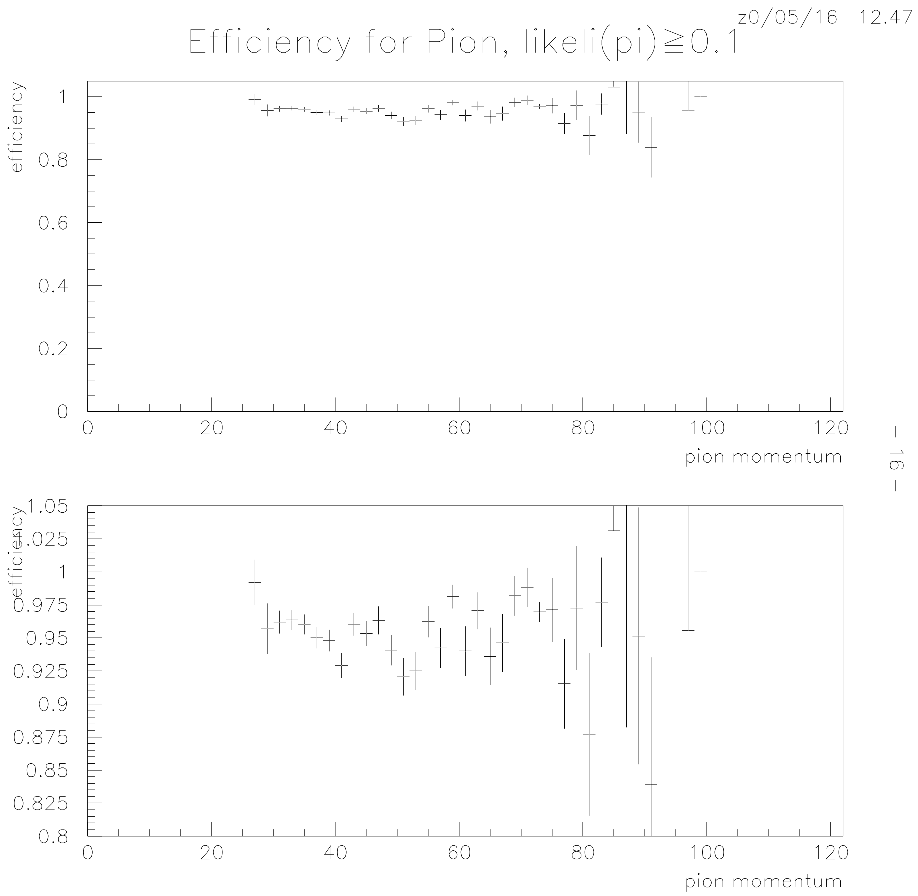

Figure 7: Efficiency to identify pions in the RICH acceptance. The cut used here is $\mathcal{L}(\pi) \geq 0.1$. The observed in-efficiency is compatible with tracking errors and is probably not due to the RICH.

References

[1] J. Engelfried et al., The SELEX Phototube RICH Detector. *Nucl. Instr. and Meth.* **A431** (1999) 53-69.