Using multiple PID information in reconstruction

Agnese Ciocci, Giovanni Punzi, Paola Squillacioti
for the Italian b-group

B_s workshop
07-12-04

Data Sample

- Good runs of hbpp0c datasets (5.1 production)
- Trigger B_PIPI
- Release 5.3.1
- We selected a Λ and a K_s samples (we use for today a Λ sample as a first exercise)

Method to combine PID

Neyman-Pearson test: in separating two classes of events, of perfectly known distributions, with a cut, the minimal contamination, for any value of the cut, is achieved by cutting on the Likelihood Ratio:

$$L(A)/L(B)$$

But you must know well the properties of both signal and background

See Punzi's talk at bpak meeting of 06-04-04

Paola Squillacioti

Method

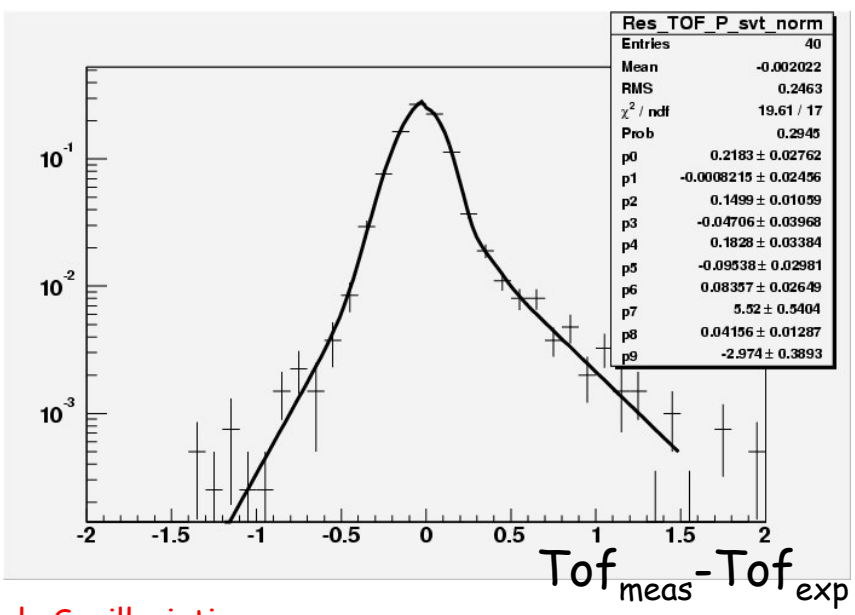
$$\frac{L(\pi)}{L(p)} = \frac{p(TOF \mid \pi)\, p\left(\frac{dE}{dx} \middle| \pi\right)}{p(TOF \mid p)\, p\left(\frac{dE}{dx} \middle| p\right)}$$

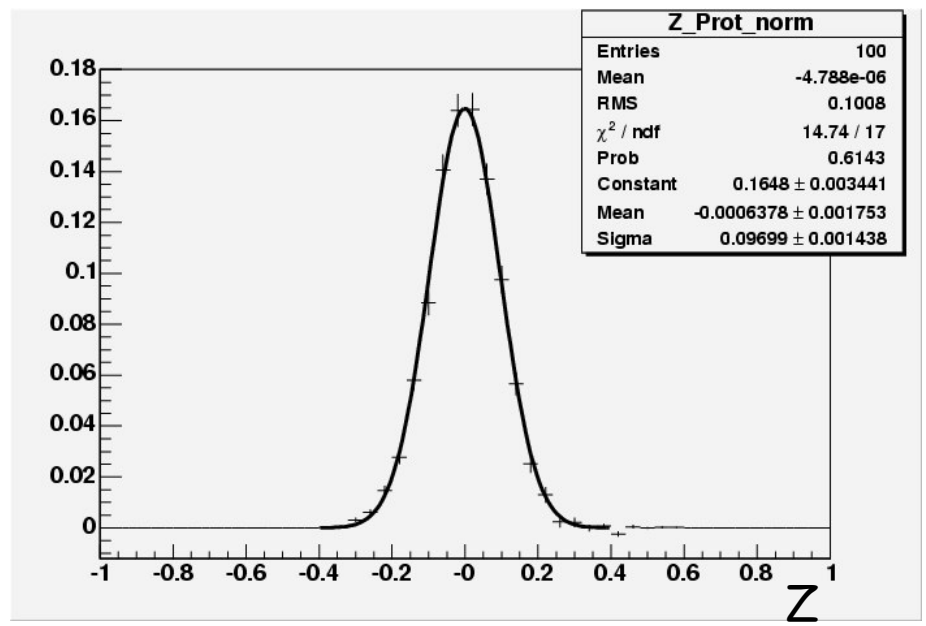
We use the Z variable that is, in a good approximation, a gaussian

$$Z = \log\left(\frac{dE/dx(measured)}{dE/dx(predicted)}\right)$$

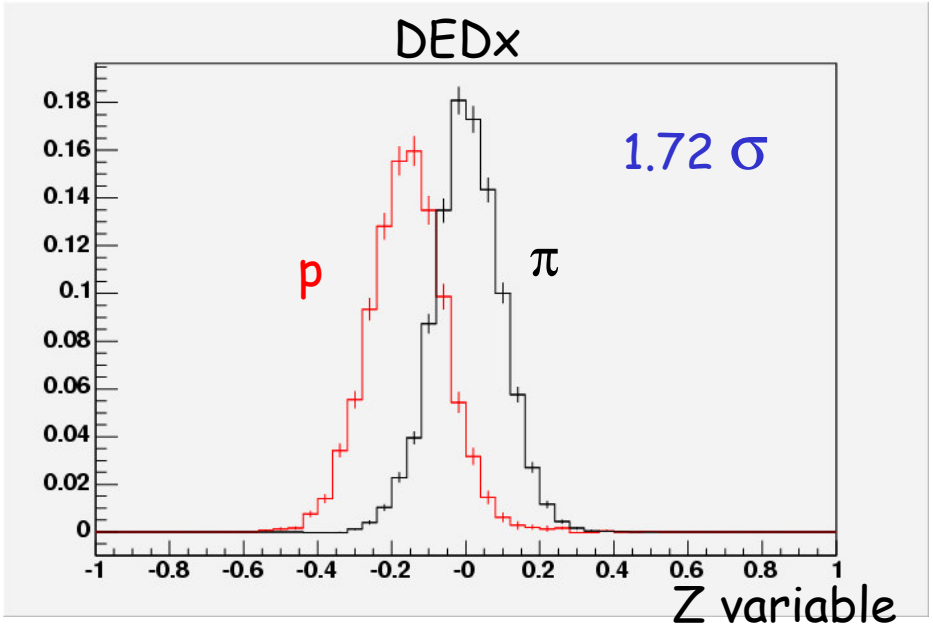
We fit the TOF residual distribution with 2 gaussians and 2 exponential for the tail

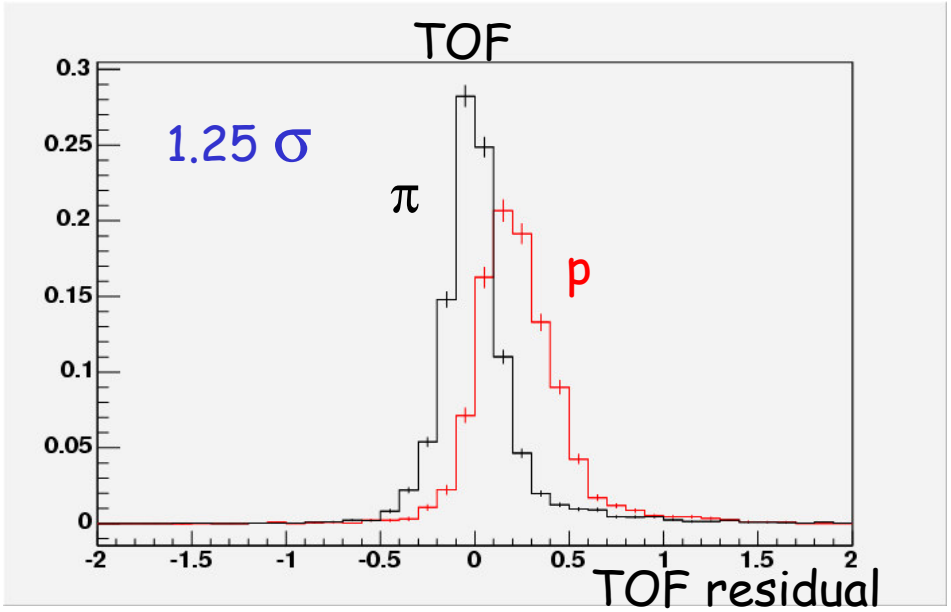
We used the UC's presented at the bpak meeting of 07-09-04



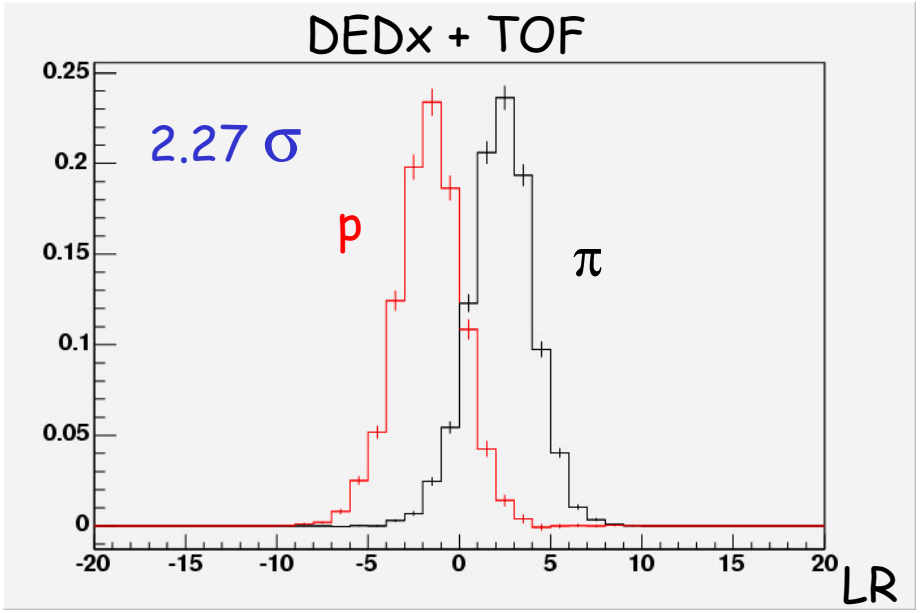


Paola Squillacioti



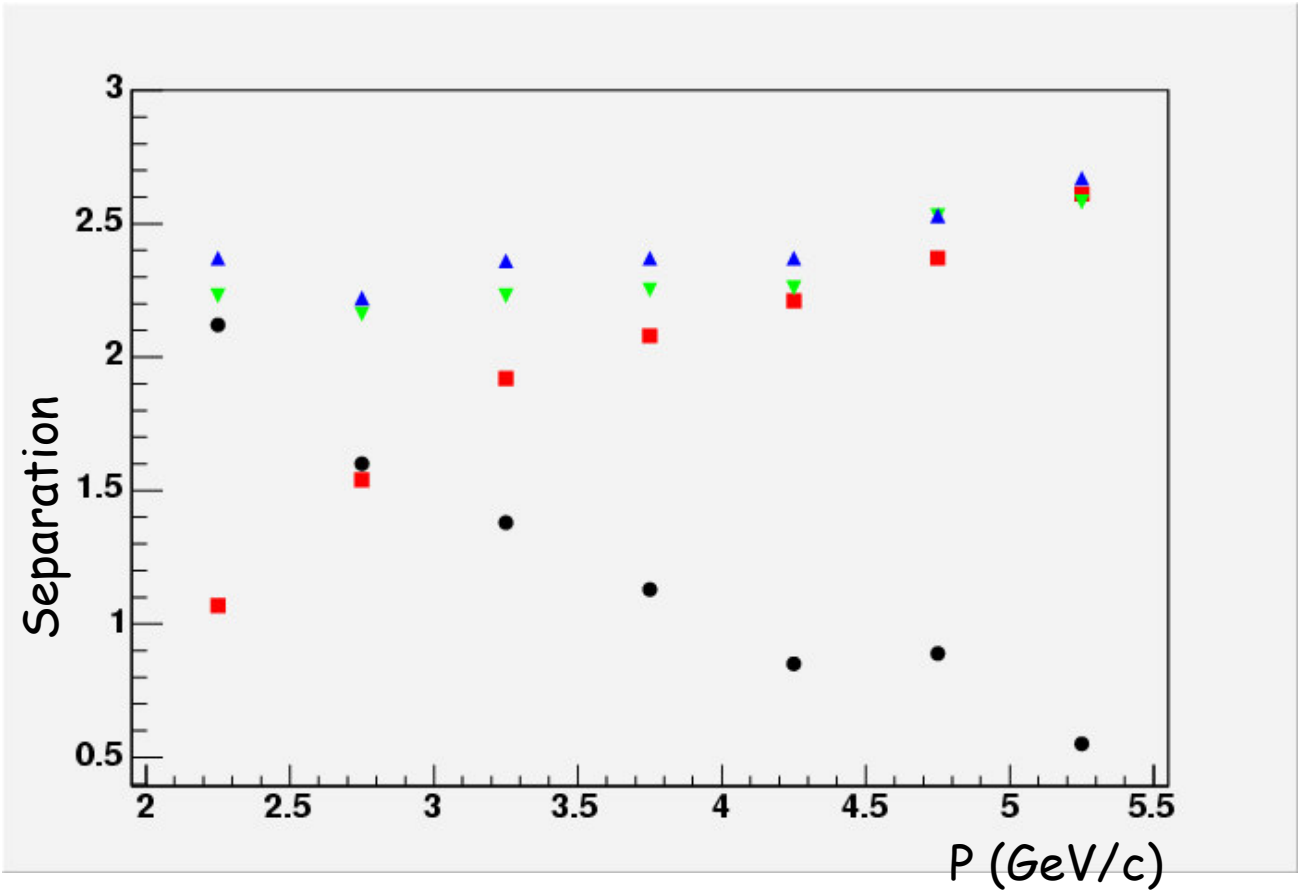


Full momentum range



The method to compute the separation is described in
http://www-cdf.fnal.gov/physics/statistics/notes/punzi-separation.ps

Separation vs momentum



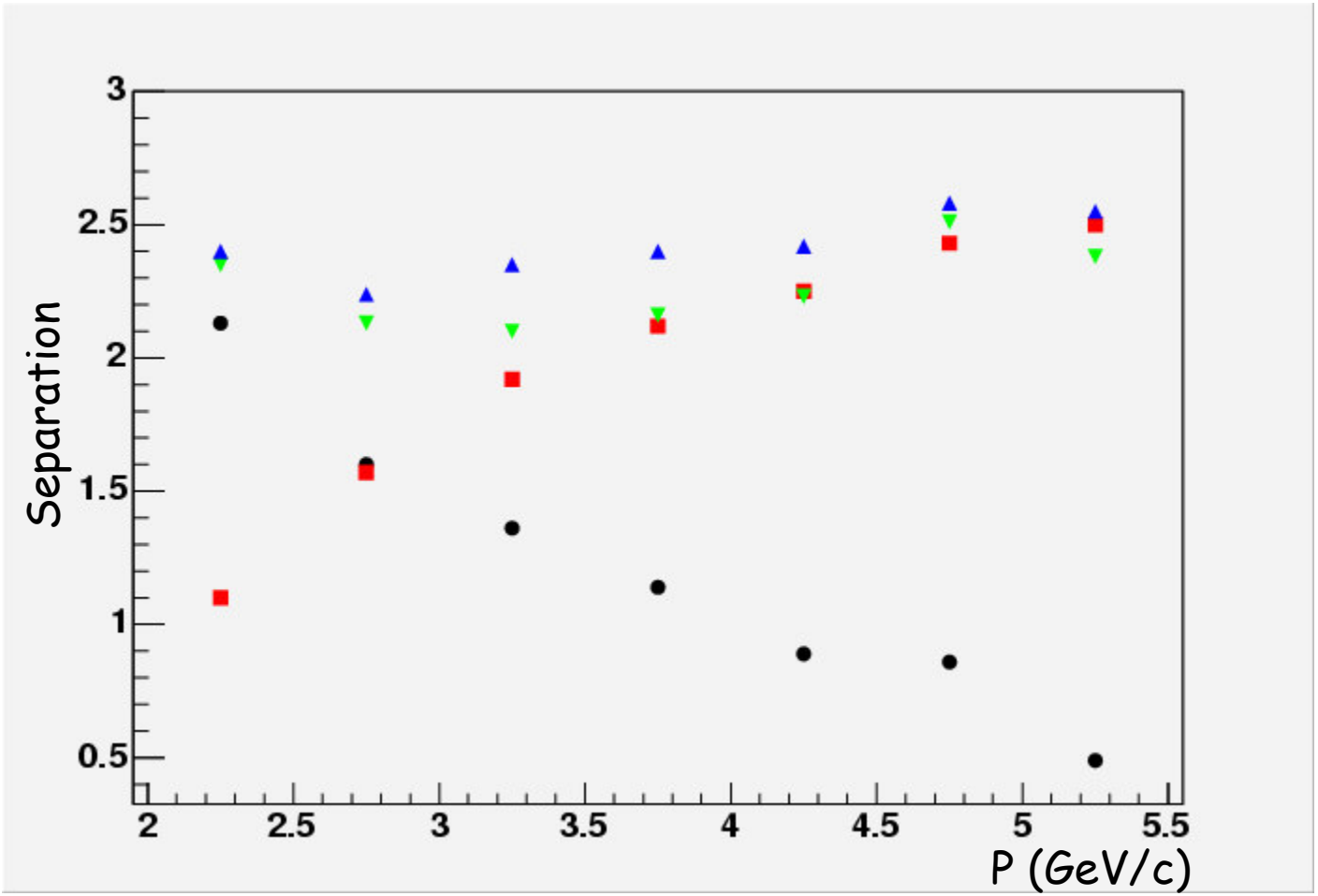
The separation is very close to the theoretical maximum. This confirms the validity of the LR method and also

- the validity of the parametrization of both TOF and dEdx
- the absence of spurious correlation between the two PIDs

- ● TOF separation
- ■ dE/dx separation
- ▼ combined separation TOF+dE/dx
- ▲ sqrt[(TOF sep)^2 + (dE/dx sep)^2]

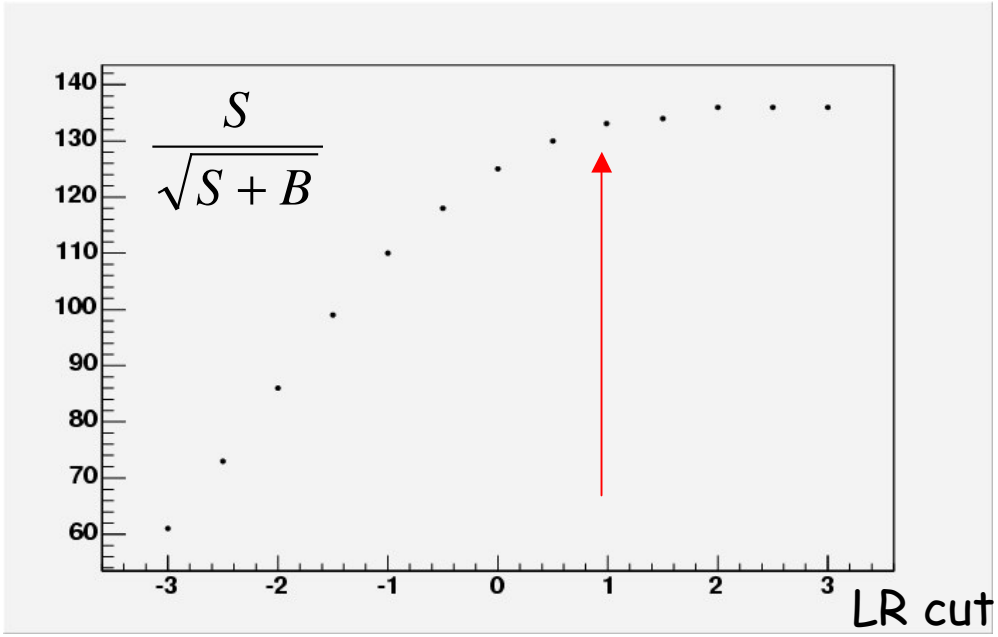
Paola Squillacioti

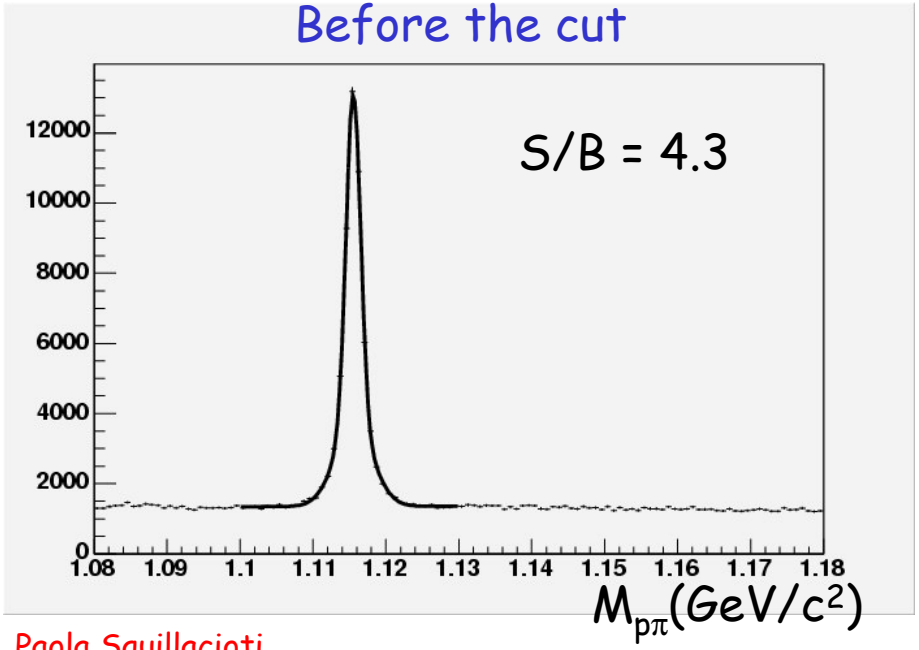
Separation vs momentum with gaussian hypothesis for TOF and dEdx residual

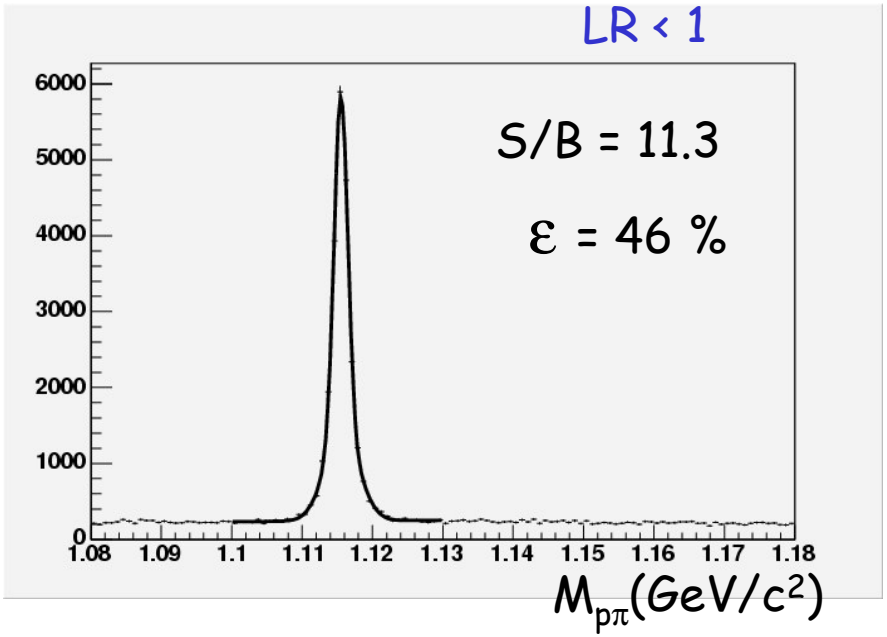


Paola Squillacioti

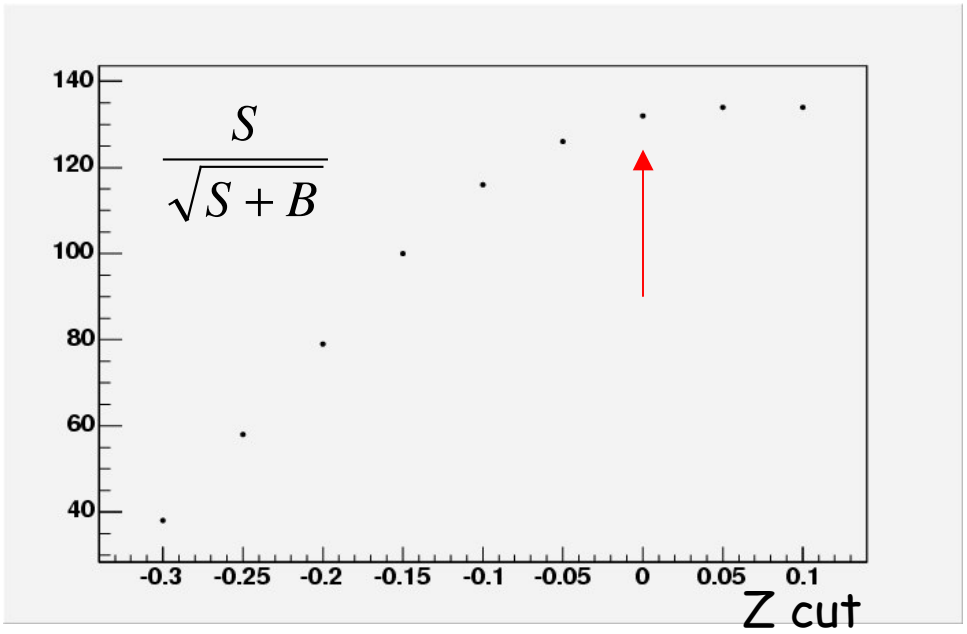
Try to apply a cut on LR

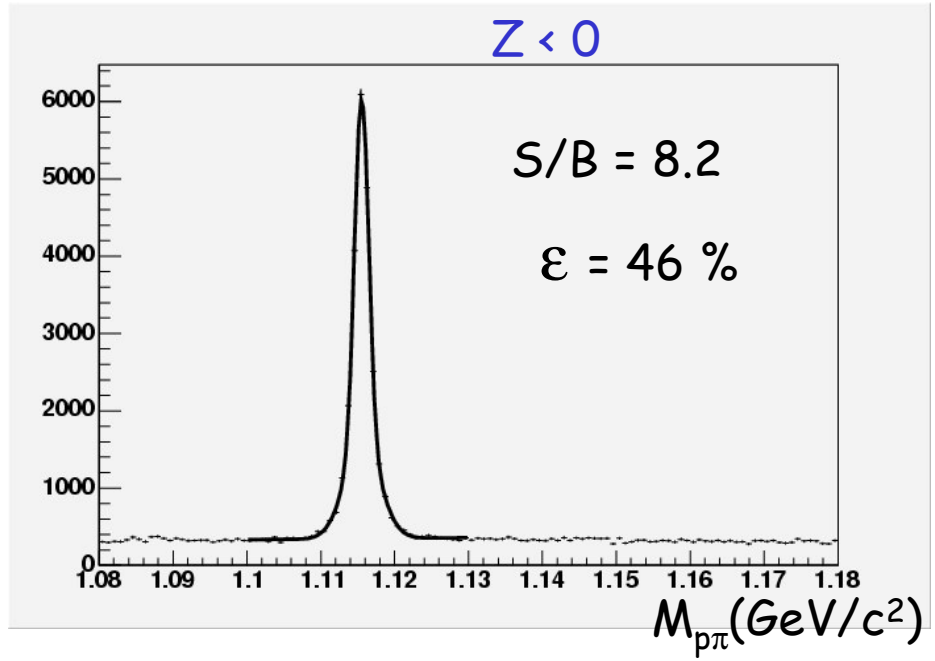






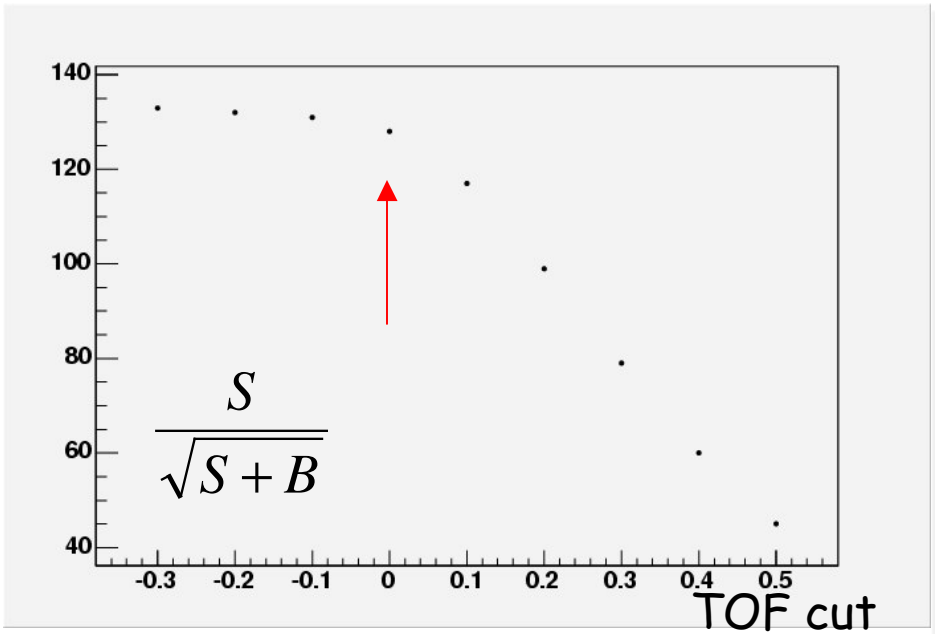
If we consider TOF and DEDx separately : DEDx

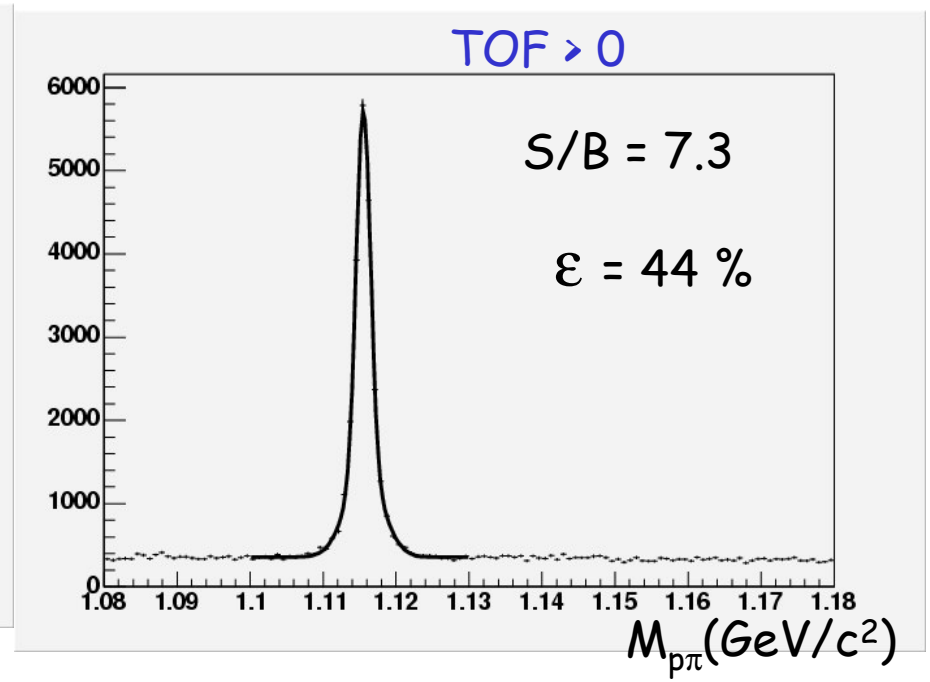




Paola Squillacioti

If we consider TOF and DEDx separately : TOF





	S/B
LR	11.3
dE/dx	8.2
TOF	7.3

Same efficiency
≈45 %

Conclusions

- We obtained a separation power of combined PID very close to to the theoretical maximum
- Using a LR cut on a sample channel (Λ), we obtained a significantly better S/B compared to using individual PIDs. This is useful in the B_s reconstruction, in particular we can suppres some reflections in channels like:
  - ✓ $B_s \rightarrow D_s \pi$, $D_s \rightarrow K_s K$, $K_s \rightarrow \pi \pi$ ($D^- \rightarrow K_s \pi$)
  - ✓ $B_s \rightarrow D_s \pi$, $D_s \rightarrow K^* K$, $K^* \rightarrow K \pi$ ($D^- \rightarrow K^* \pi$)

Currently, I'm processing $D^* \rightarrow D^0\pi \rightarrow (K \pi) \pi$ to have the pion-kaon separation with combined PID

To do

- Include the silicon dE/dx for no trigger track
- Include the TOF and dE/dx correlation when we are using more than one track in the same event (this can be a significant effect)
- Expand this method to provide L functions for all particle types an condition as a library of C functions that can easily be used by everybody to do anithing, from simple cuts to multidimensional unbinned fits

Paola Squillacioti

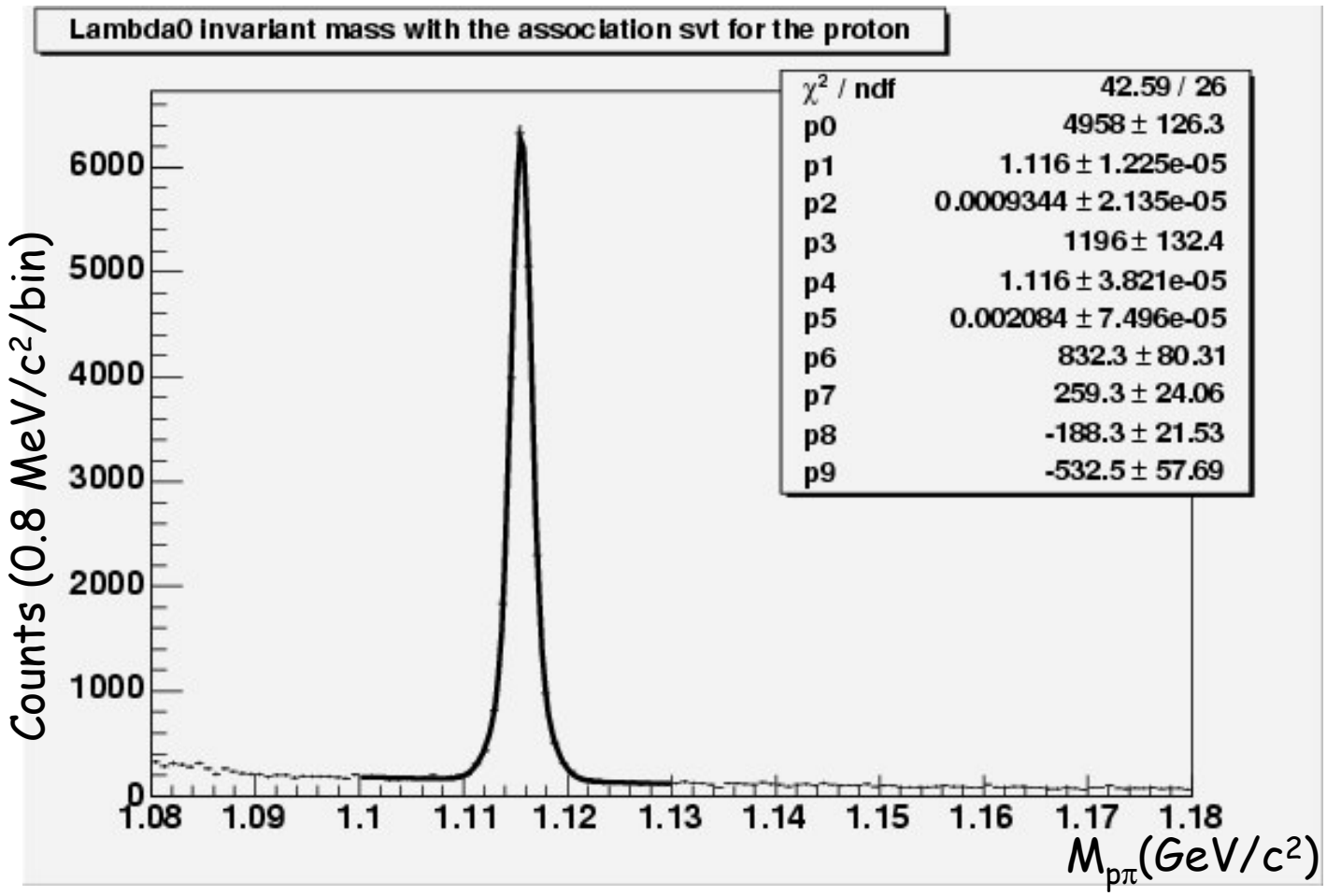
Backup

Default cuts:

- $Q1*Q2 < 0$
- $0.1\ GeV/c^2 < M_{12}(\pi\pi\ Hyp) < 1.5\ GeV/c^2$
- HasCOTHits (20,16,0,0,0,0)
- HasVertexFit & Lxy > 0.5 cm
- $|z_{01}-z_{02}| < 2$ cm
- SumPt > 1.1GeV/c
- χ^2 vertex < 10

Optimized cuts for Λ

Lxy > 0.85 cm
Win < 0.051 cm
$|I.P._{\Lambda}|$ < 0.007 cm



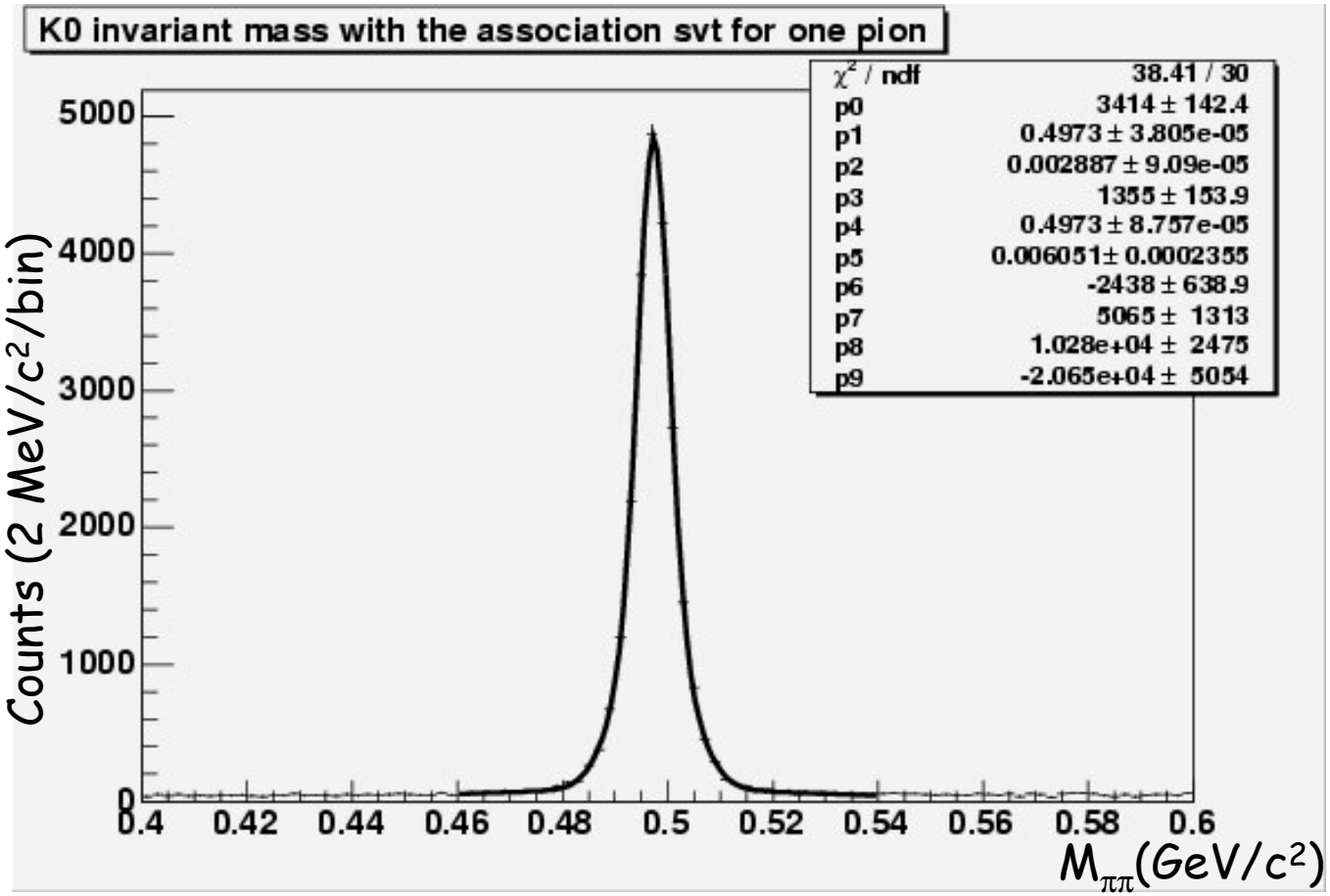
$$\frac{S}{B} = 20$$

~ 20000 Λ

Paola Squillacioti

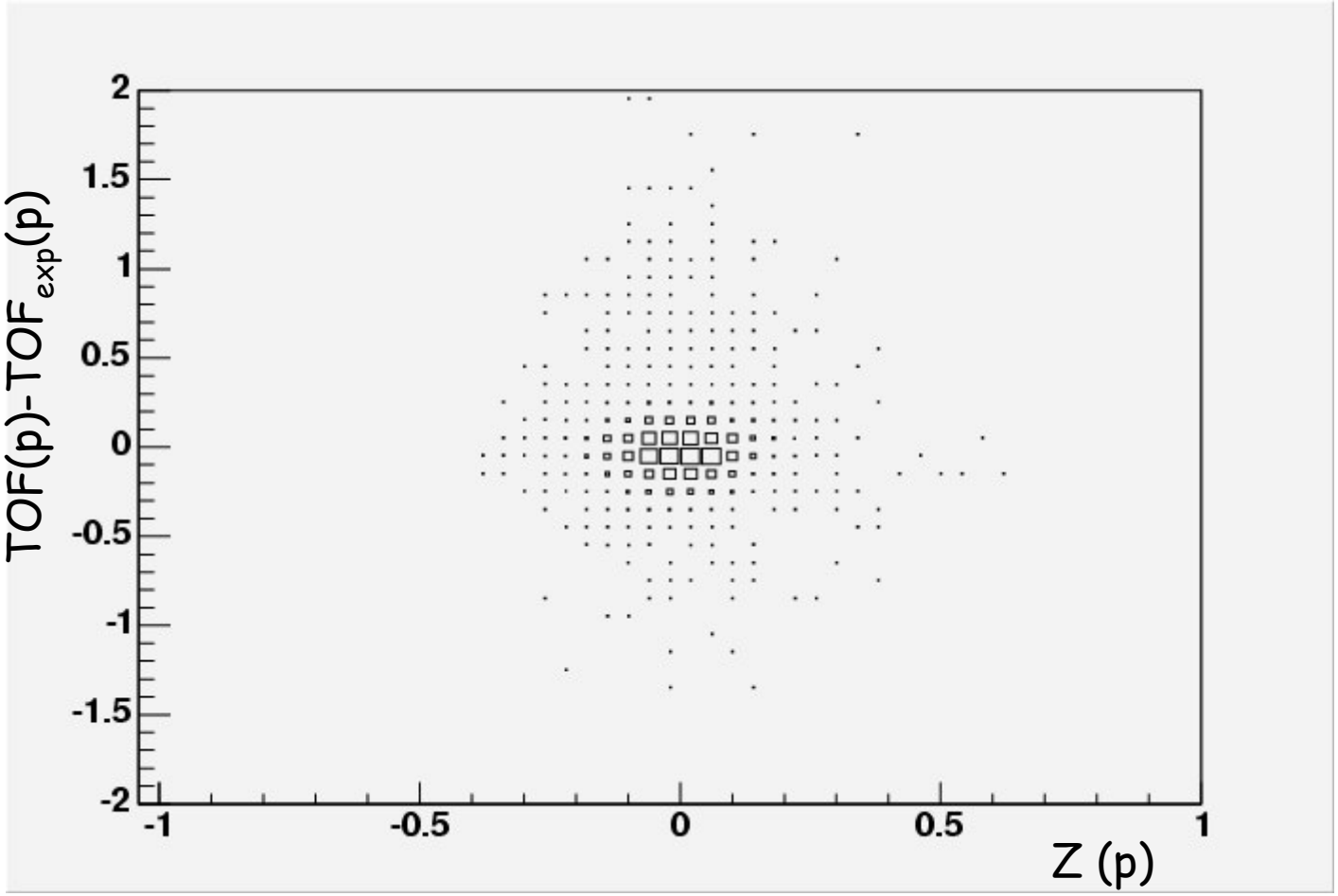
Optimized cuts for K^0_s

$|I.P._{K^0}| < 0.03$ cm
b (Armentero) > 0.105



$$\frac{S}{B} = 29$$

~ 21000 K^0_s

Paola Squillacioti

No correlation between TOF and dE/dx