CKOV ANALYSIS

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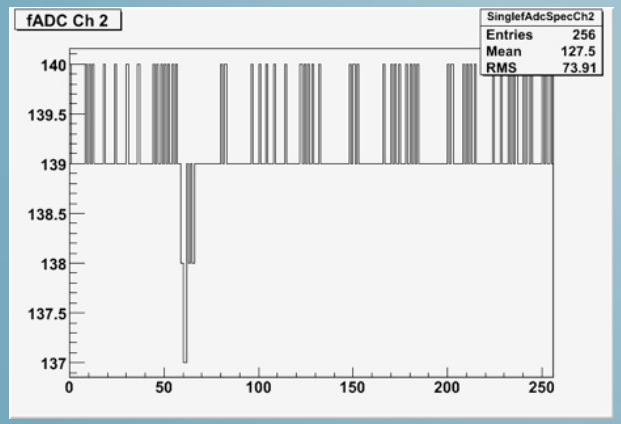
MICE VC 27

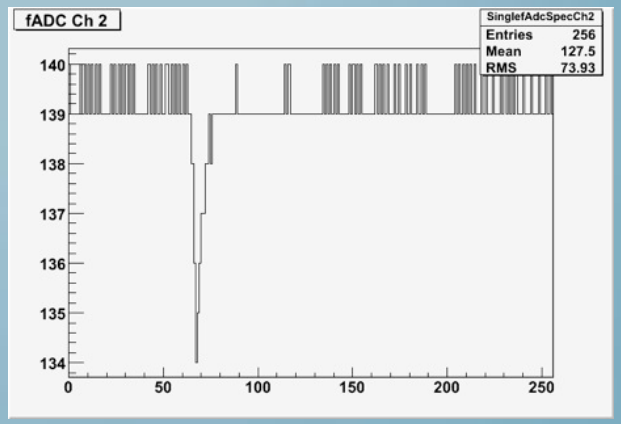
OVERVIEW

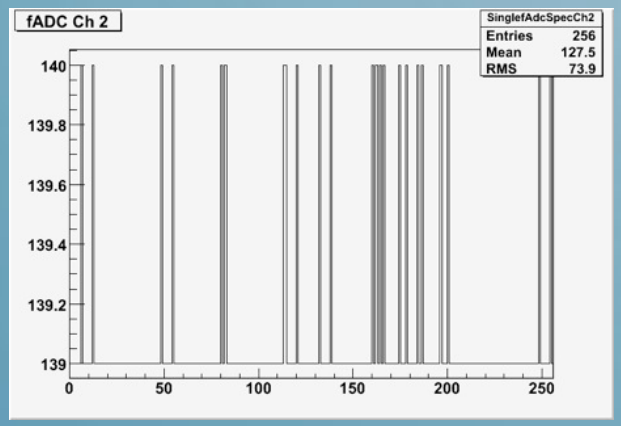
1. *Calibration*
    1. *Data*
    2. *Determine Pedestals*
    3. *Subtract Pedestals*
    4. *Fit data*
    5. *Single photoelectrons*
2. *Analysis*
    1. *Data*
    2. *NPE/TOF (Beta)*
    3. *FADC Problems*
3. *Summary and ToDo*

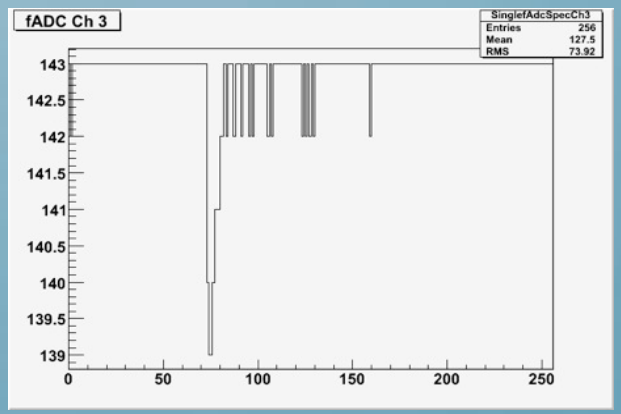
CALIBRATION DATA

- *Runs 1080 (Ckov A) and 1081 (Ckov B) taken Sep. 2009*
- *Approx. 100 000 events from LED pusler*



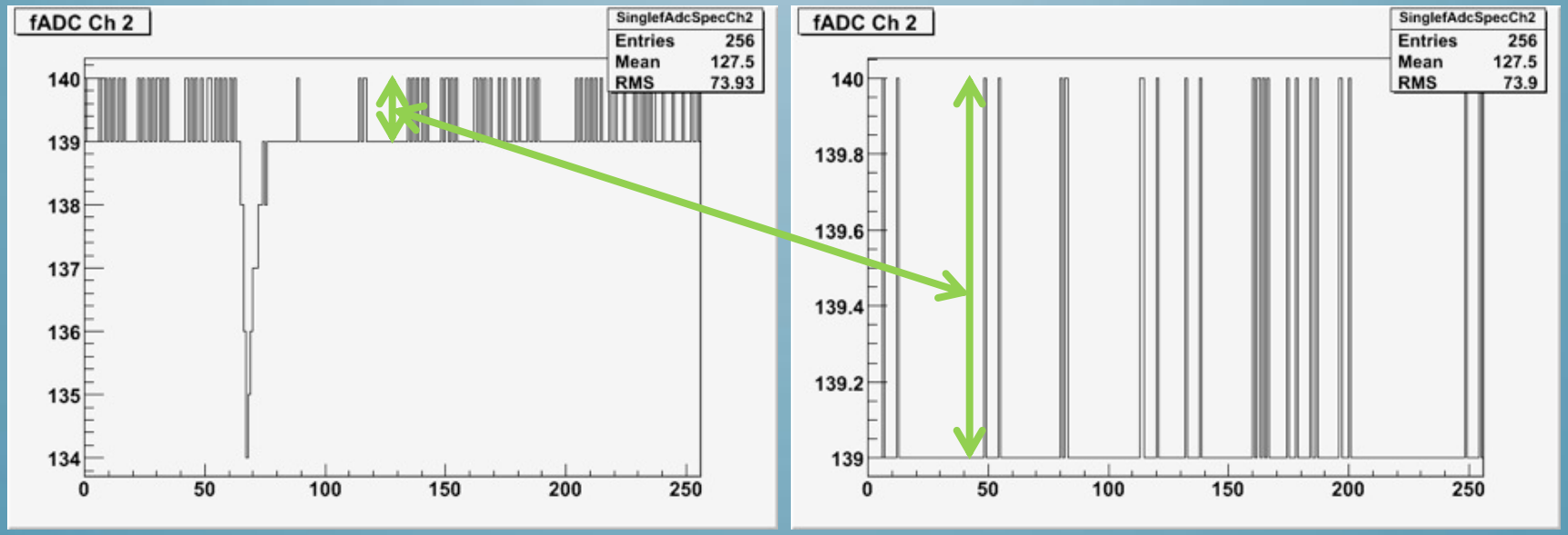






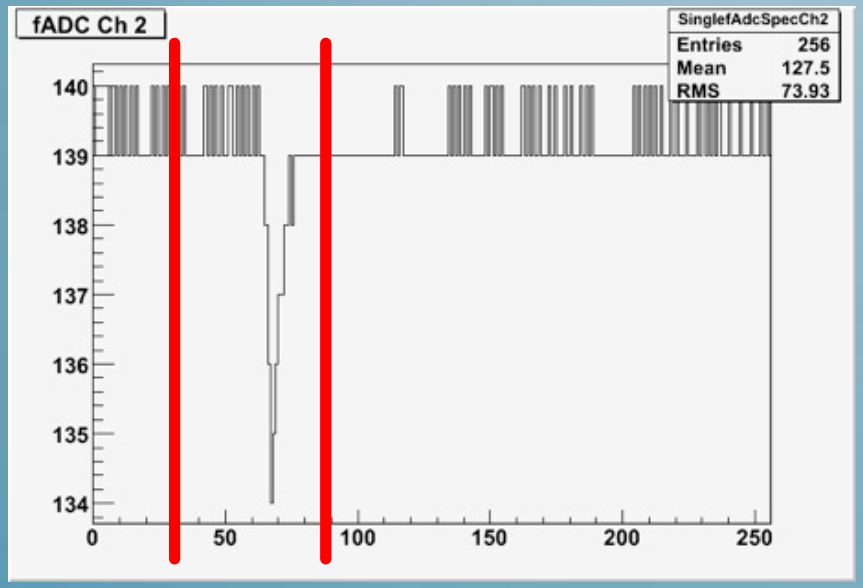
FLASH ADC PROBLEM

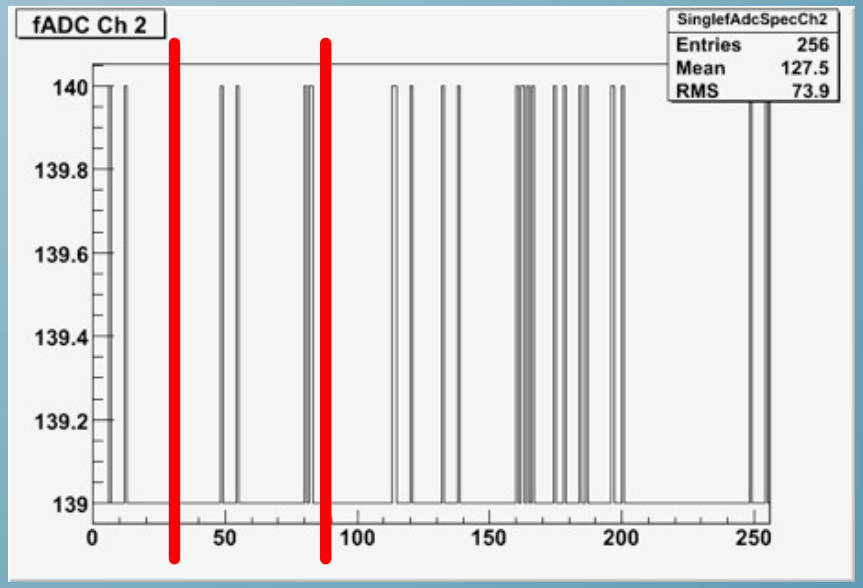
1. Double data header in CAEN fADC V1731:
   **** *ERROR in MDpartEventV1731::Init: INVALID particle Event* ****
2. Baseline cannot be determined easily



CALIBRATION ALGORITHM 1

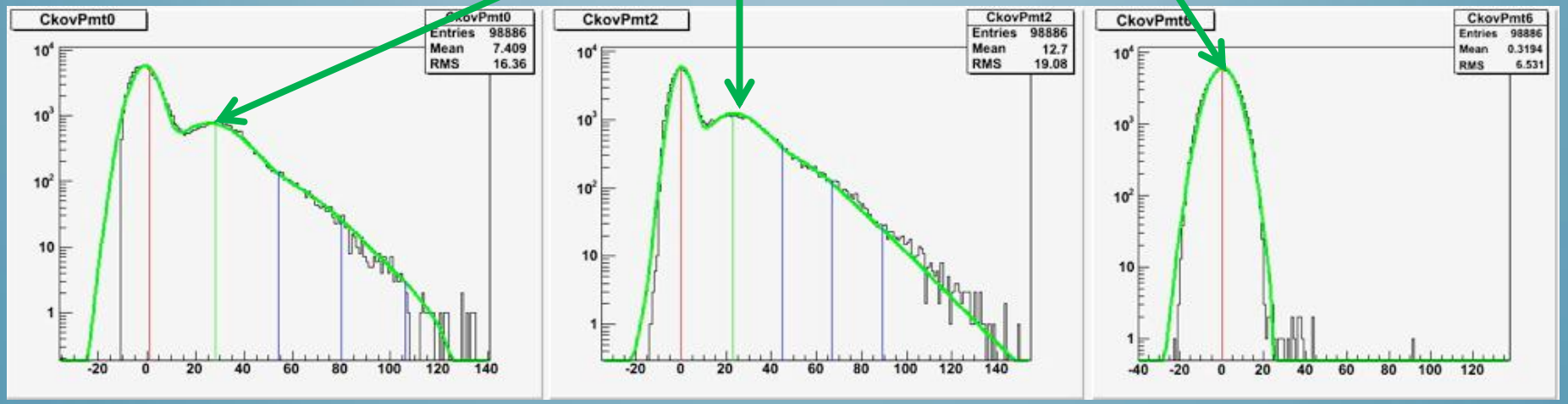
1. Take the data only in specified (for each channel) range. The ADC is basically the integral (sum) of all samples inside the sample.
2. These ADC values are filled into a histogram and the pedestal is determened for each channel.





CALIBRATION ALGORITHM 2

3. Pedestals are subtracted from the data
4. Data is fitted to determine the single photoelectron peaks and sigmas for single photoelectrons as well as pedestals



Green line – single photoelectron peak
Red line – pedestal position
Blue lines – 2, 3, .. Etc. photoelectron peaks

CALIBRATION
FIT FUNCTION

$$F(x) = A \cdot \sum_{n=0}^{N} \frac{\mu^n e^- \mu}{n!} \cdot ((1-w)G_n(x) + w\theta(x) I_{G_n \otimes E}(x))$$

where A is the number of events, $G_n(x)$ is the nth Gaussian convoluted with the pedestal-Gaussian and $I_{G_n \otimes E}(x)$ is the nth Gaussian convoluted with and exponential background with w the probability of such an exponential background event occuring. The function $\theta(x)$ is a step function being 0 for $x < P_n$ and 1 for $x > P_n$.

$G_n(x) = \frac{1}{\sigma_n \sqrt{2\pi})} e^{\frac{-(x-P_n)^2}{2\sigma^2}}$ with $P_n = P_0 + n \cdot P_1$ the ADC position of the nth Gaussian with width . The index 0 refers to the pedestal and n=1,2,... is the number of photo-electrons.

$$I_{G_n \otimes E}(x) = \frac{\alpha}{2} e^{-\alpha(x - P_n - \alpha\sigma_n^2)} \left[erf\left(\frac{|P_0 - P_n - \alpha\sigma_n^2|}{\sigma_n \sqrt{2}}\right) + sign(x - P_n - \alpha\sigma_n^2) \cdot erf\left(\frac{|x - P_n - \alpha\sigma_n^2|}{\sigma_n \sqrt{2}}\right) \right]$$

is the convolution of the nth Gaussian with the exponential background leading to a tail for each Gaussian on the right side of the peak.

The Fit parameters are:

1. P_0 : pedestal position
2. σ_0 : pedestal width (**FIXED** from fit to pedestal only)
3. P_1 : single photo electron peak position
4. σ_1 : single photo electron peak width
5. α : exponential background
6. w : probability of exponential background
7. μ : **MEAN NUMBER OF PHOTO ELECTRONS**

Source: http://www.jlab.org/Hall-D/software/wiki/index.php/Fiber_Test_Stand_at_JLAB

CALIBRATION
SINGLE PHOTOELECTRONS

PMT #	CKOV	Pedestal	SPE
1	A	5010	26.2
2	A	5645	32.3
3	A	4900	22
4	A	5440	31.4
5	B	5120	26.1
6	B	4880	30.1
7	B	5880	26.5
8	B	6140	25.2

The ratios between the single photoelectrons are approx. the same as with the old settings (fADC & Shaper)

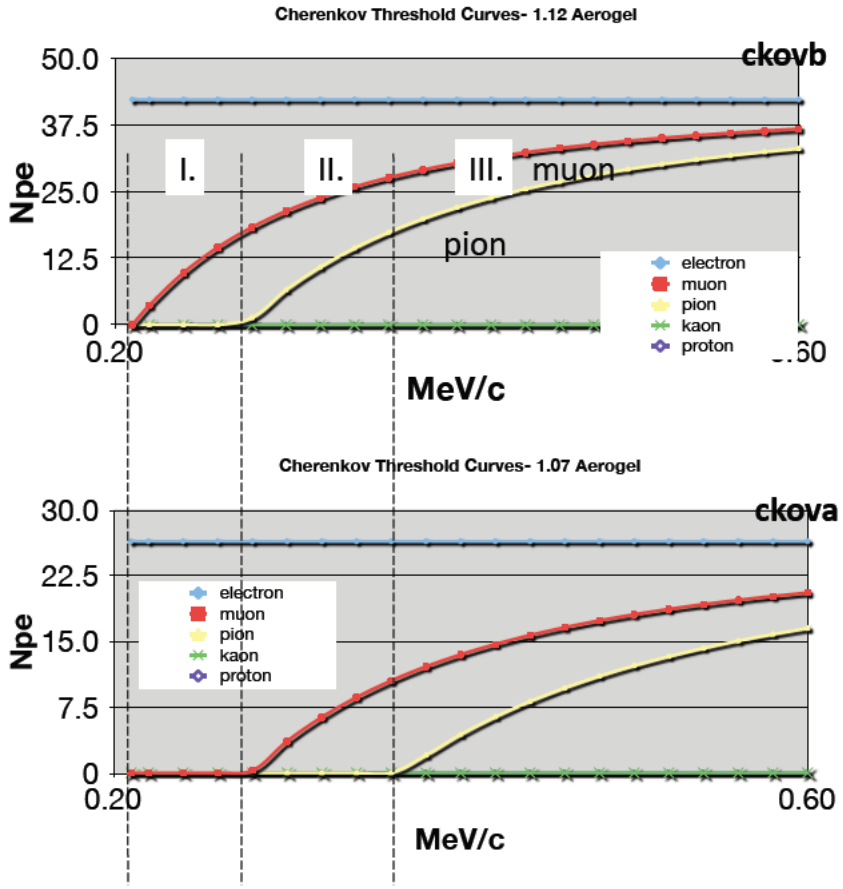
ANALYSIS

- *2 runs taken December 2009*
  - *Muons – run 1411, 337 MeV/c (at target)*
  - *Electrons – run 1412, 300 MeV/c (at target)*

- *5 runs taken May 2010*
  - *Pions – runs 1691 1692 1693 1694 1695*
    275 – 290 MeV/c (at target)

ANALYSIS
CKOV A & CKOV B

CKOV Reconstruction



Digital Reco

- Determine Prob(mu)-Prob(pi) by *ON-OFF reco pattern* per momentum region I, II, III.

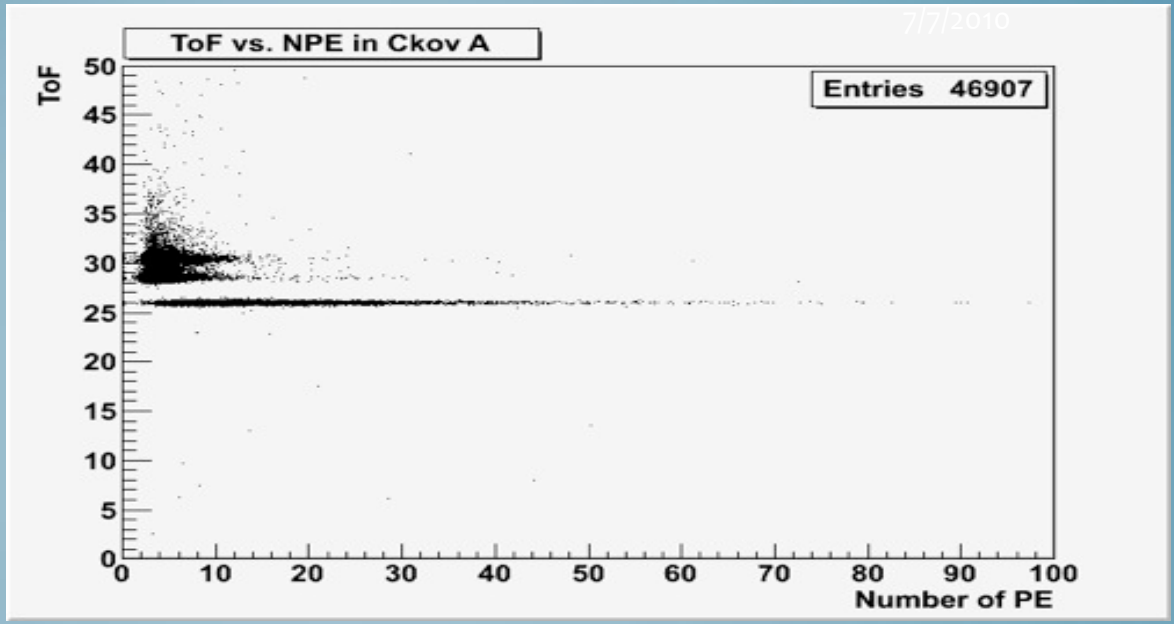
Analogue Reco

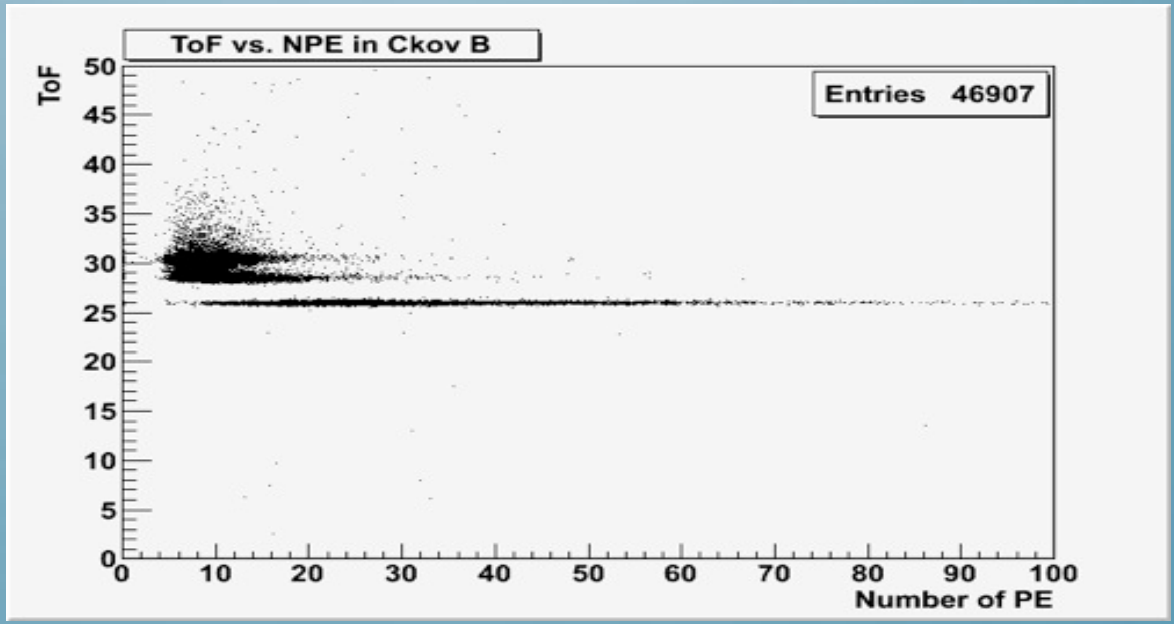
- Determine Prob(mu)-Prob(pi) by *expected and seen light yields* per momentum region I, II, III.

- PE(x,y) light map required.

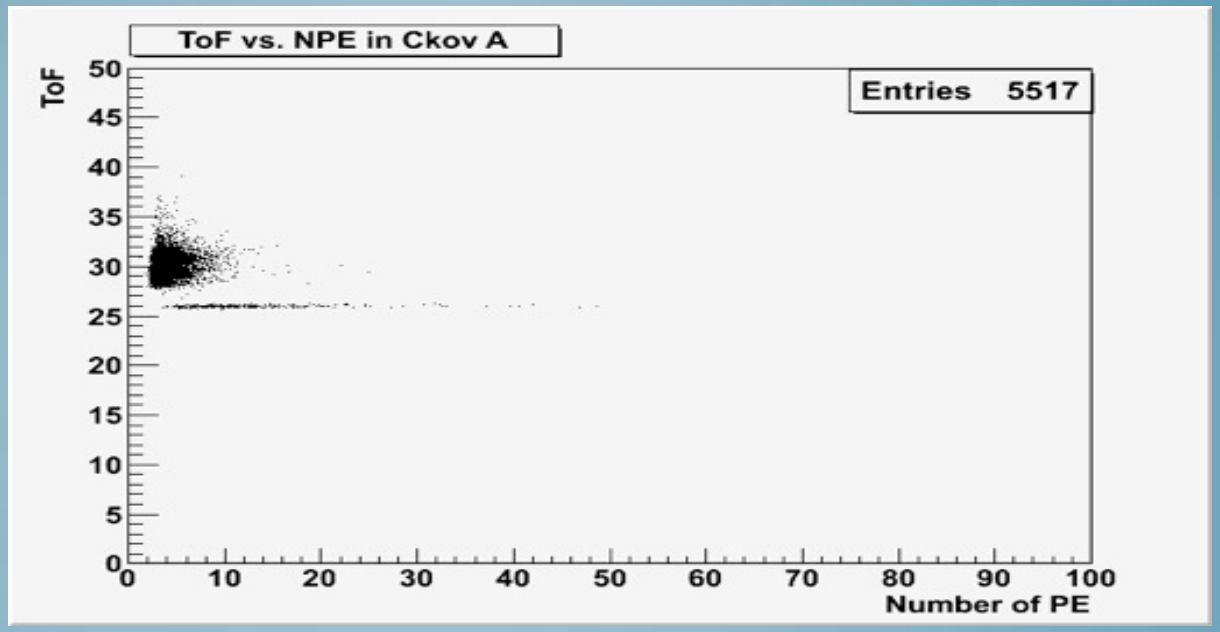
- TOF0(x,y)/CKOV coincidence.

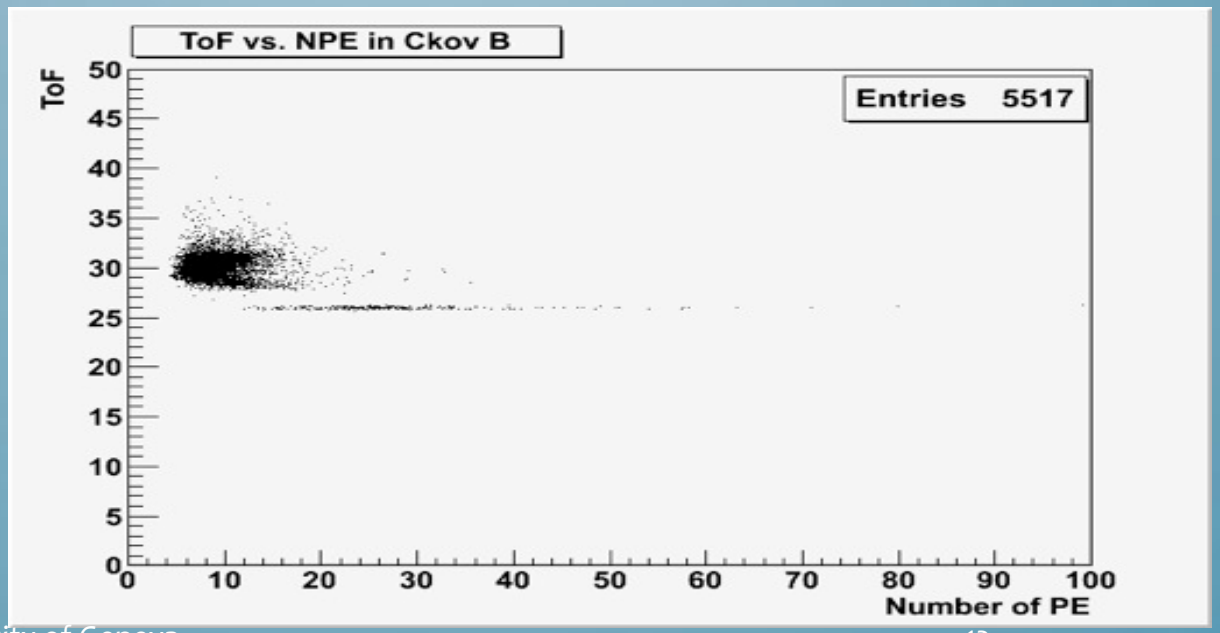
ANALYSIS
300 MEV/C ELECTRONS





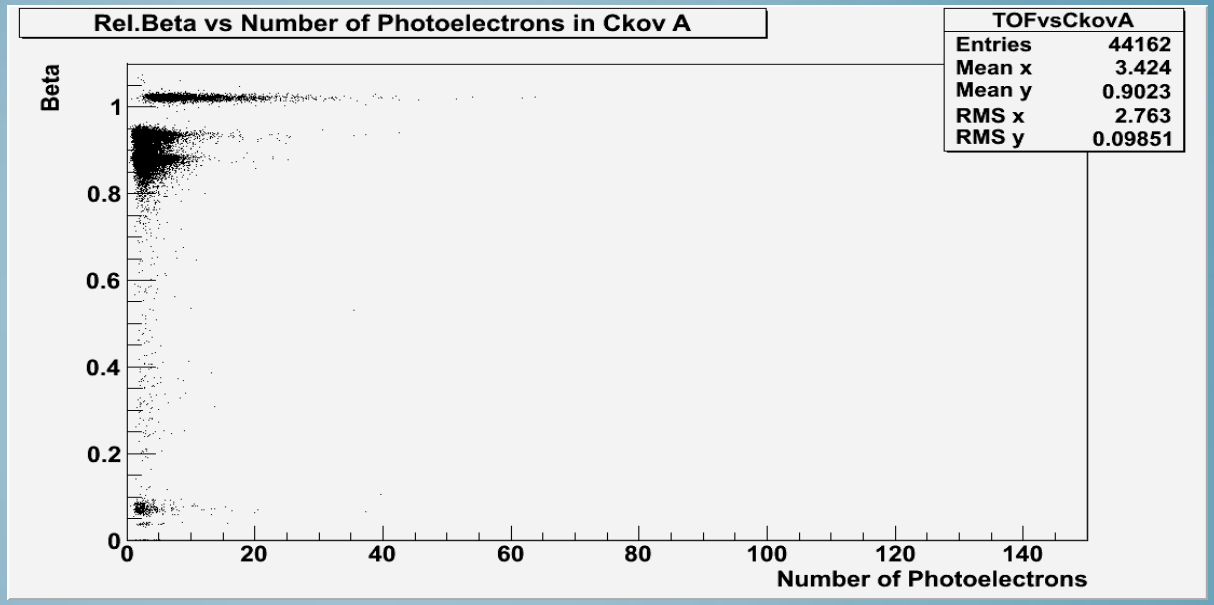
ANALYSIS
337 MEV/C MUONS

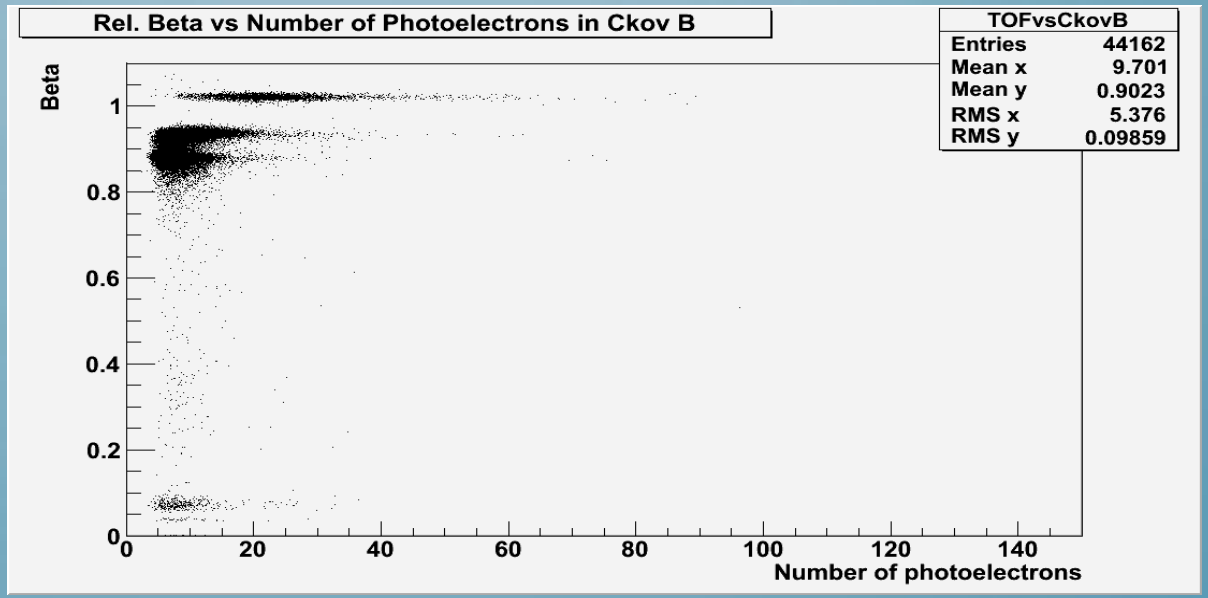




ANALYSIS 275 MEV/C PIONS

Using relativistic beta instead of ToF

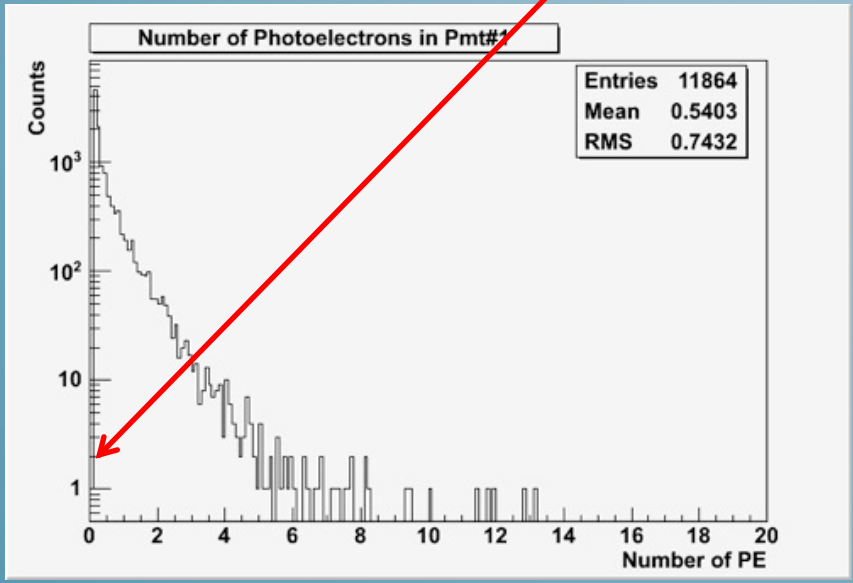


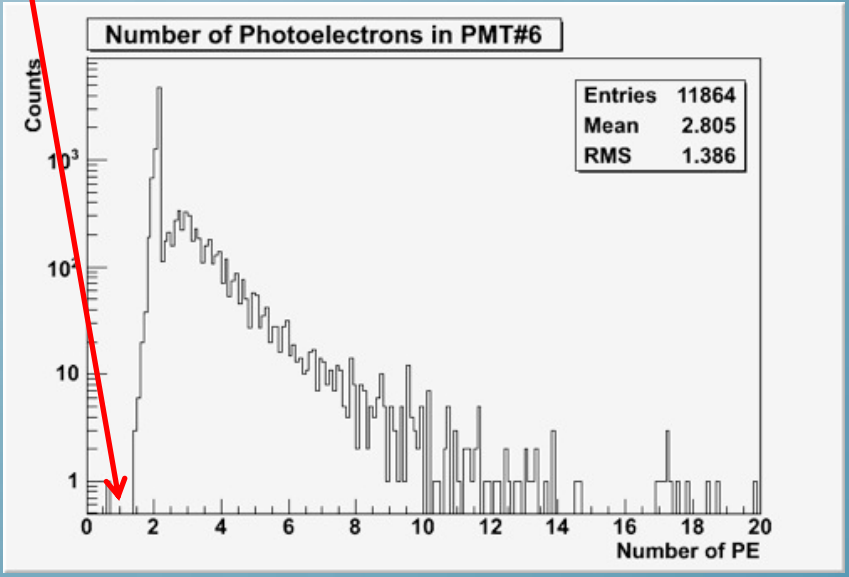


ANALYSIS
PEDESTALS PROBLEM

The pedestal peak is not at 0. For some PMTs the offset is almost 2 photoelectrons!

Probable reason: Baseline changed between the time of calibration and the time data was taken (~2 months)





SUMMARY & TODO

Summary:

- More precise calibration procedure was implemented
- Analysis using TOF reconstruction
- SPE position changes with time

To Do:

- CKOV C++ classes in G4MICE
- Better understanding of the detector is needed
- Analysis to take into account the particle momentum at CKOV