

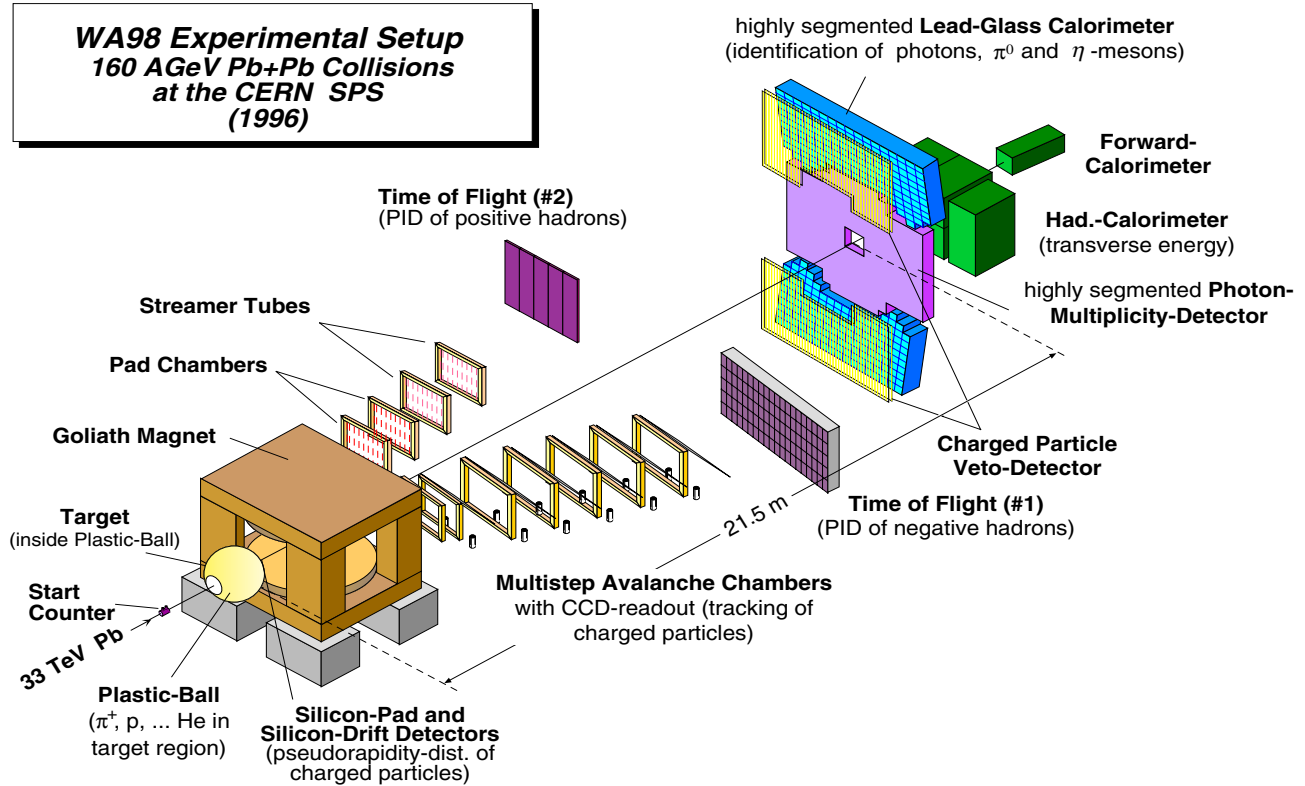
# TOF Calibration in WA98

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- WA98 setup
- Timing chart and Sampling
- Measurement
- Calibration Process
- PID Performance

# WA98 setup

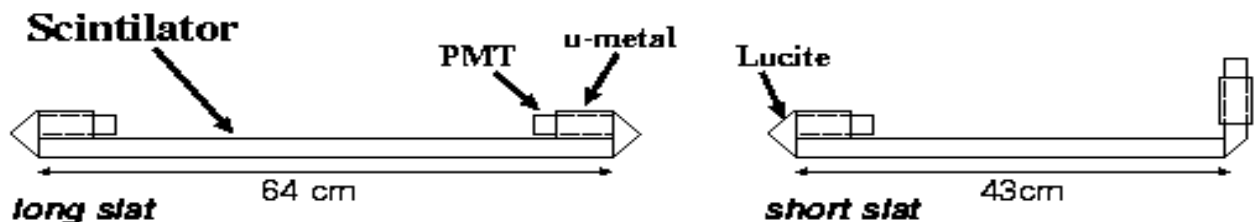
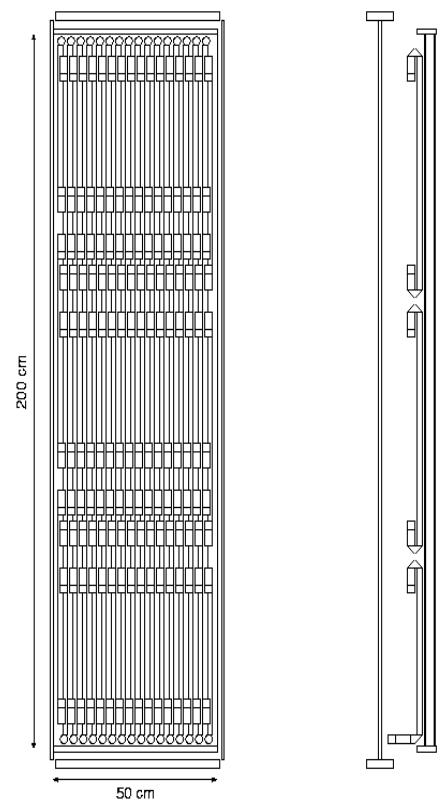


TOF counter (jTOF)  
 5 panel, 480slats (960ch)

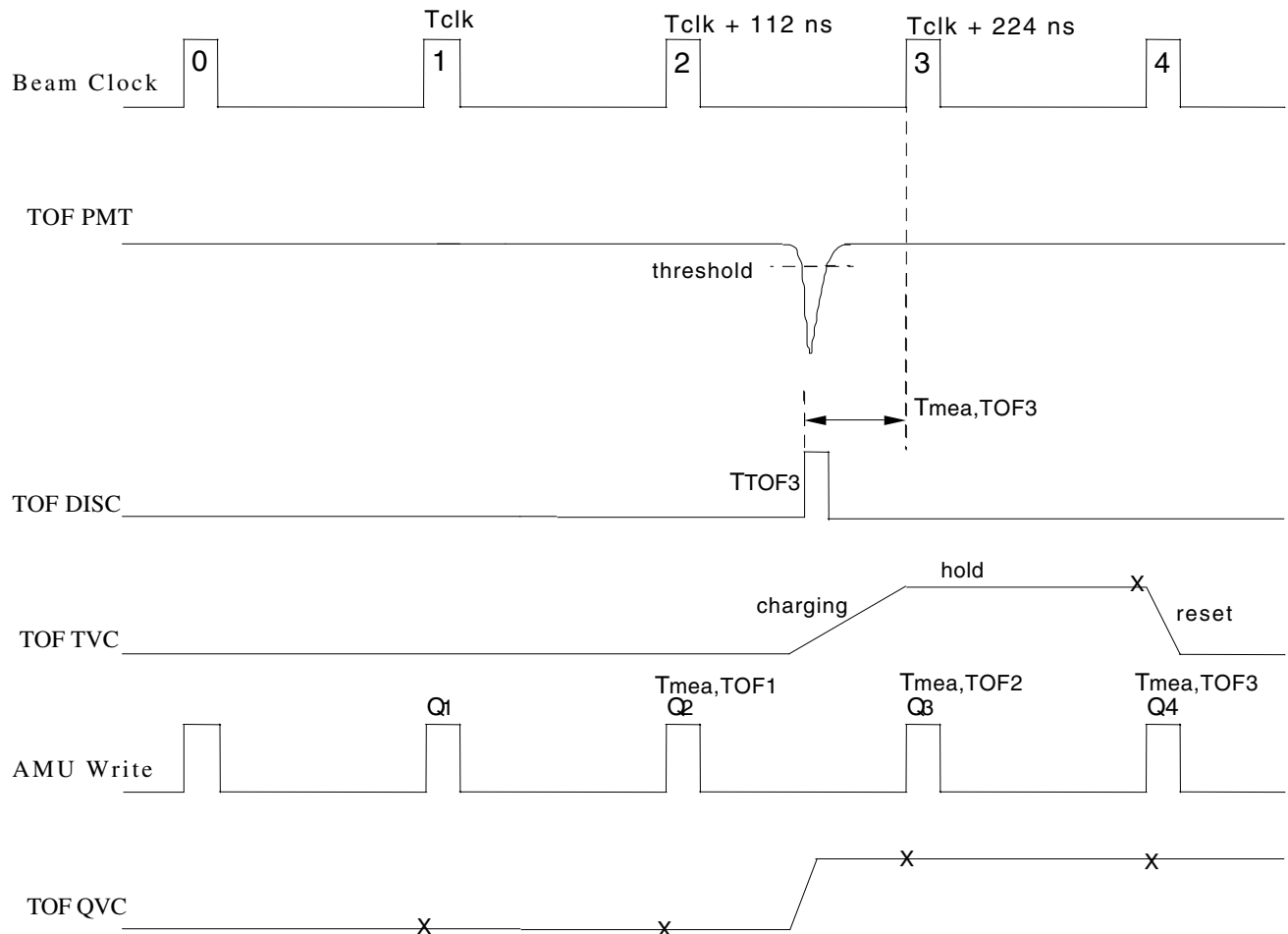
Gas Cherenkov beam counter  
 for start timing (2ch)

61 FEM's boards (976ch)

Location  
 17.8 m from the vertex



# Timing Chart and Sampling



TVC/QVC sampling clock = 112 ns

(RHIC bunch crossing)

Clock of FEE is not synchronized with beam timing.  
Both TOF and Start counter timing were measured by FEE.

TVC takes 3 clock cycle per valid hit.  
(sampling, charge up, reset)

QVC is sampled at each clock cycle.

The integrated charge of PMT

$$\Delta QVC = QVC3 - QVC1$$

# Measurement

$$\text{TOF} = \{ \text{TVC}[\text{up}] * \text{Ct}[\text{up}] + \text{TVC}[\text{down}] * \text{Ct}[\text{down}] - (s[\text{up}] + s[\text{down}]) \} / 2 \\ - ( \text{STVC}[\text{up}] * \text{Ct}[\text{str,up}] + \text{STVC}[\text{down}] * \text{Ct}[\text{str,down}] ) / 2 \\ - T_0 - T_0[\text{global}] - T_0[\text{TVC}]$$

$$Y = v/2 * ( \text{TVC}[\text{up}] * \text{Ct}[\text{up}] - \text{TVC}[\text{down}] * \text{Ct}[\text{down}] ) + Y_0$$

$$\Delta \text{QVC} = \text{QVC}3[\text{i}] - \text{QVC}1[\text{i}]$$

$$\text{ELOSS} = C_q * \text{sqrt}(\Delta \text{QVC}[\text{up}] * \Delta \text{QVC}[\text{down}])$$

## Measured value

QVC[i]	QVC channel of the TOF
TVC[i]	TVC channel of the TOF
STVC[i]	TVC channel of the start counter

## Calibration parameter

		No. of Parameters	Calibration period
T0	Time offset of each slat	No. of slats	every 50 runs
T0[global]	Time offset of a run	1	every run
T0[TVC]	Time offset of each TVC	(No. of slats)*5	every 50 runs
Y0	Y-position offset	No. of slats	every 50 runs
Cq	QVC gain conversion [eV/ch]	No. of slats	constant
Ct[i]	TVC time conversion [ps/ch]	No. of PMTs	constant
s[i]	Slewing correction function	2 (up, down)	every 50 runs
v	light velocity in the scintillator	No. of slats	every 50 runs

# Calibration Process

0: TVC time calibration (by Bench test)

-->  $Ct[i]$

1: QVC gain calibration

-->  $Cq$

Min.Ion Particle ~ 3MeV (scint. 1.5 cm)

2: Slewing correction

-->  $s[i]$

3: Time offset calibration slat by slat

-->  $T0, T0[TVC]$

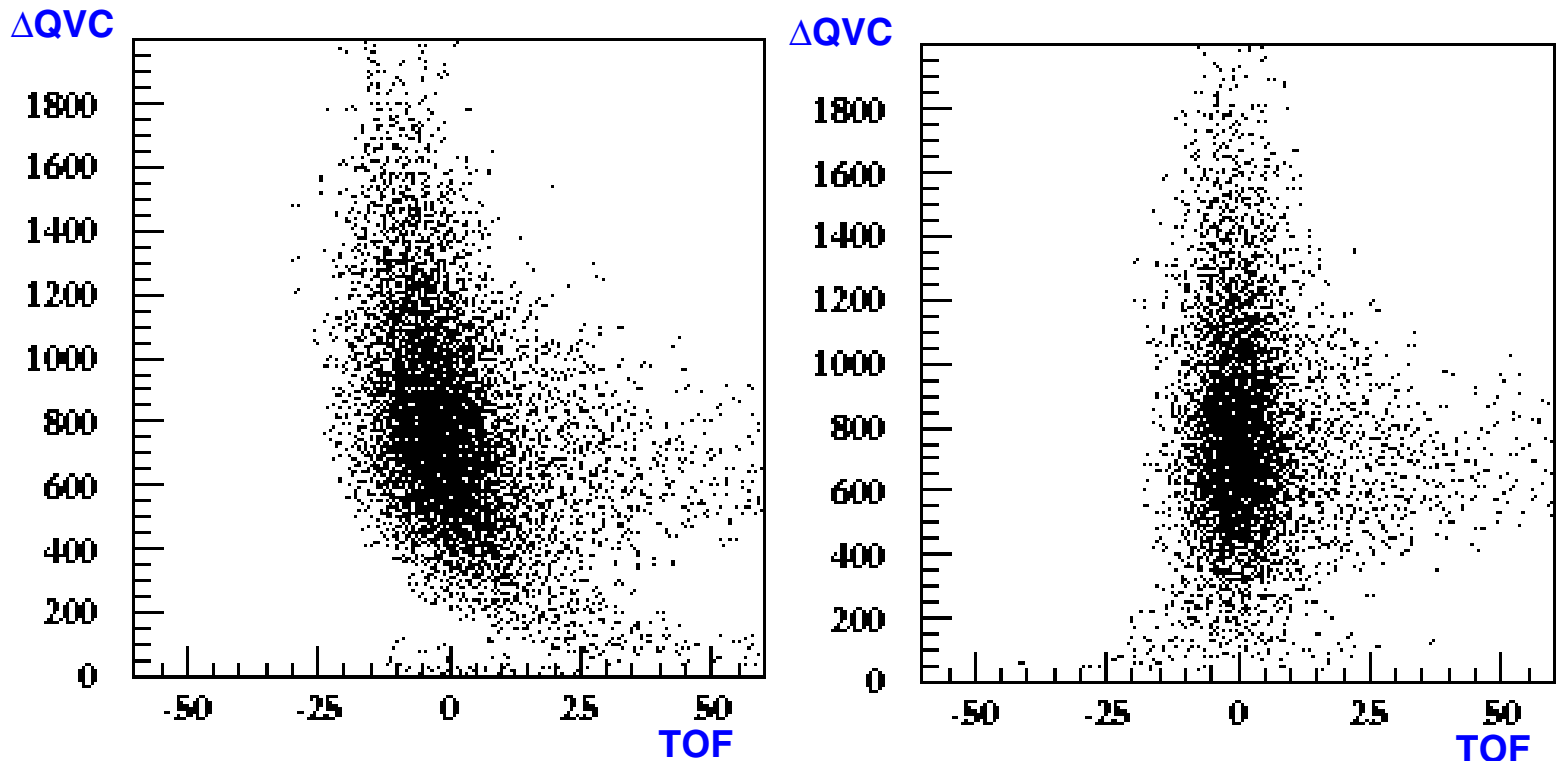
4: Time offset calibration run by run

-->  $T0[global]$

5: TDC–Ypos calibration

-->  $Y0, v$

# Slewing Correction



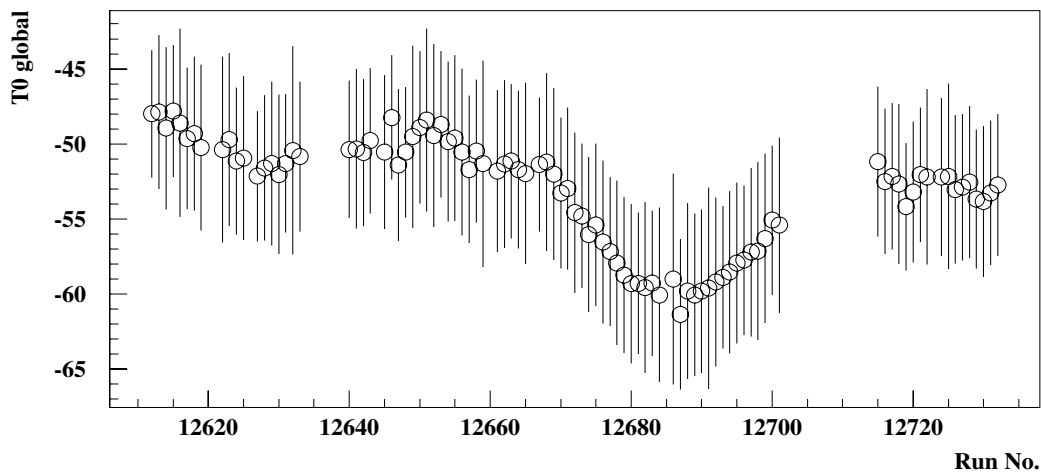
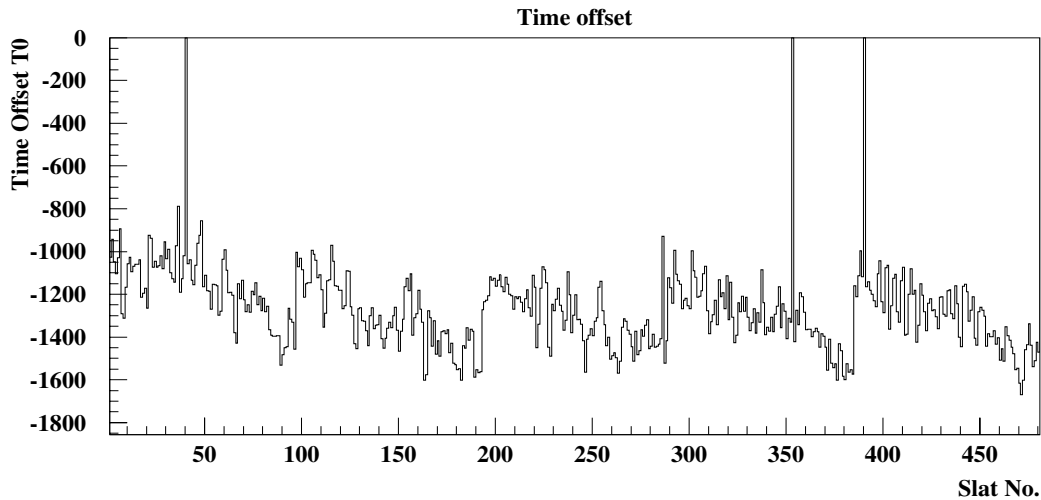
Correct the timing difference due to the variance of the pulse height of analog signal

Fitting function

$$s[i] = a[i] + b[i]/\sqrt{\Delta QVC[i]}$$

$$TOF = TOF - (s[up] + s[down])/2$$

# Time offset



Select high momentum charged particle (mostly pion)

$$\text{TOF}\pi = L/c\beta_\pi$$

T0 : correct for each slat

$$\text{T0} = \text{TOF} - \text{TOF}\pi$$

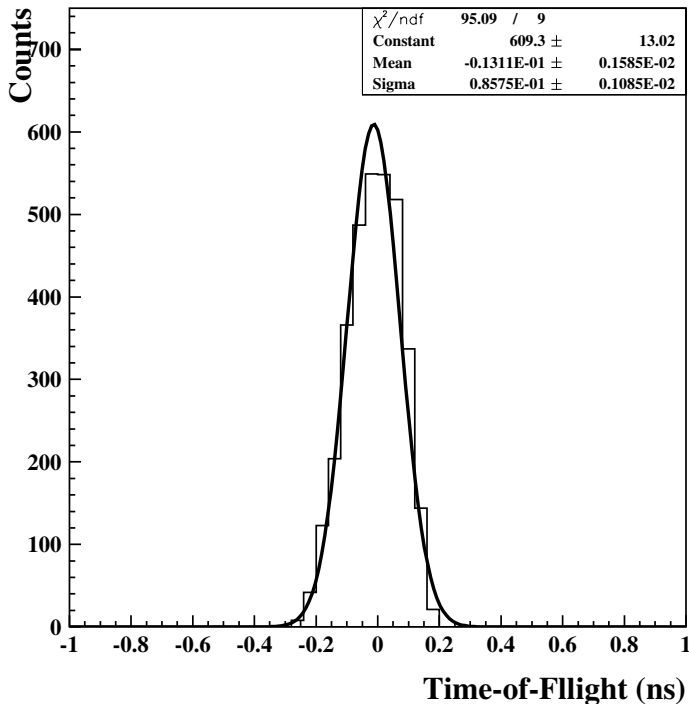
T0[global] : correct the timing shift for each run

$$\text{T0[global]} = \text{TOF} - \text{TOF}\pi - \text{T0}$$

T0[TVC] : cancel out the non-linearity of the TVC

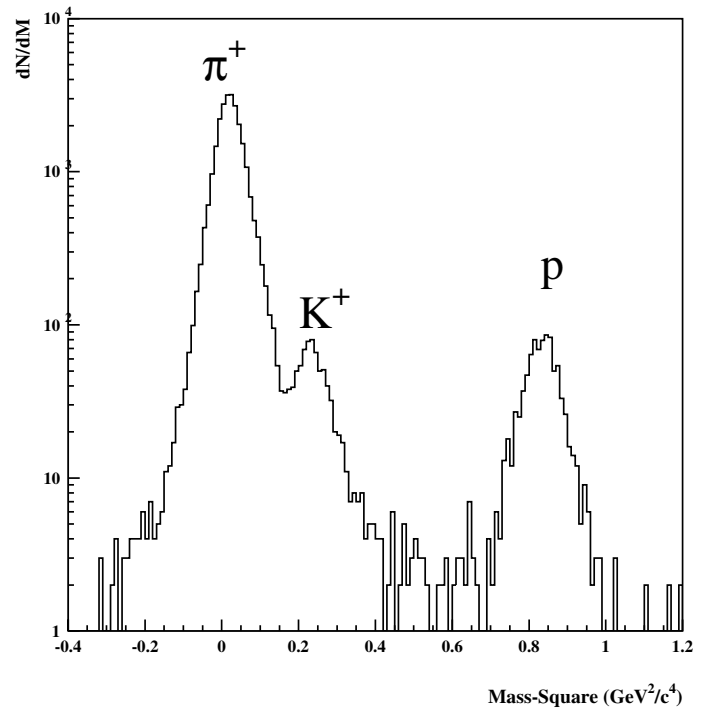
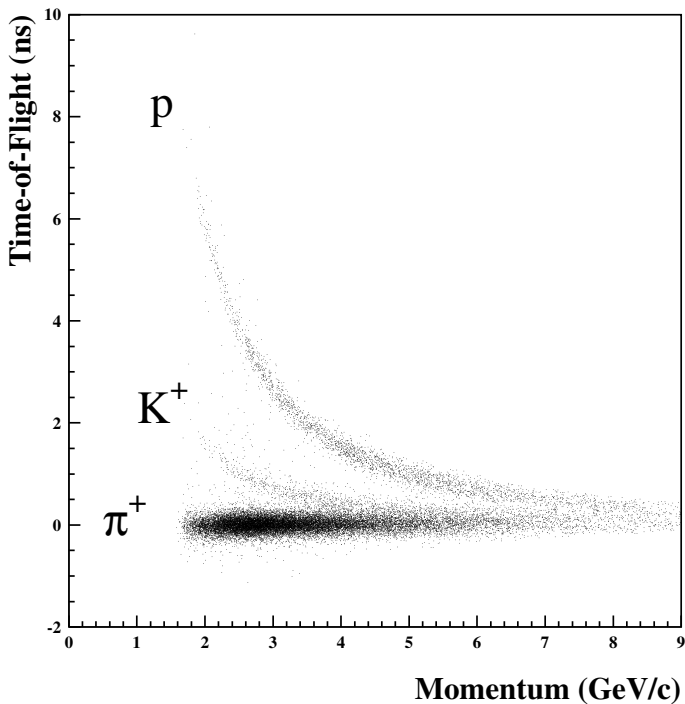
$$\text{T0[TVC]} = \text{TOF} - \text{TOF}\pi - \text{T0} - \text{T0[global]}$$

# PID Performance in WA98



High momentum pions

$\sigma_{\text{TOF}} \sim 85 \text{ ps}$



Clear particle separation among  $\pi^+$ ,  $K^+$ ,  $p$

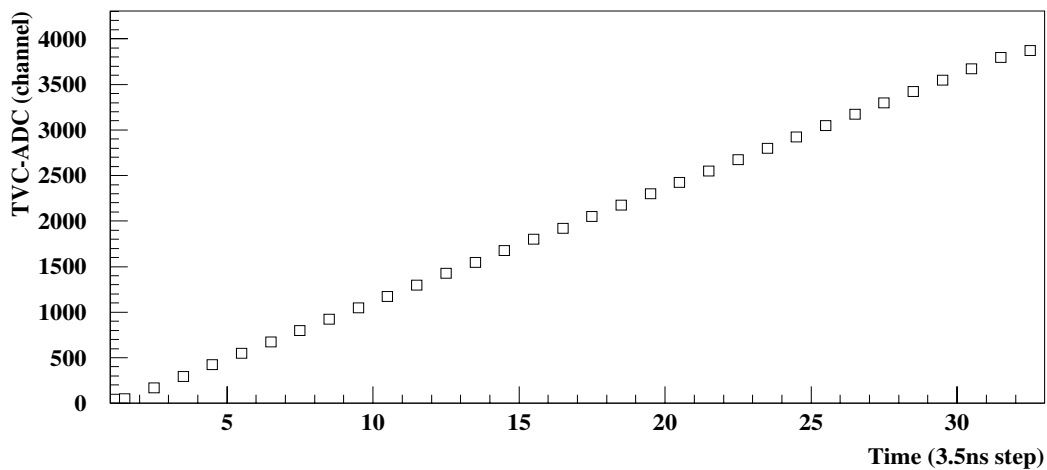
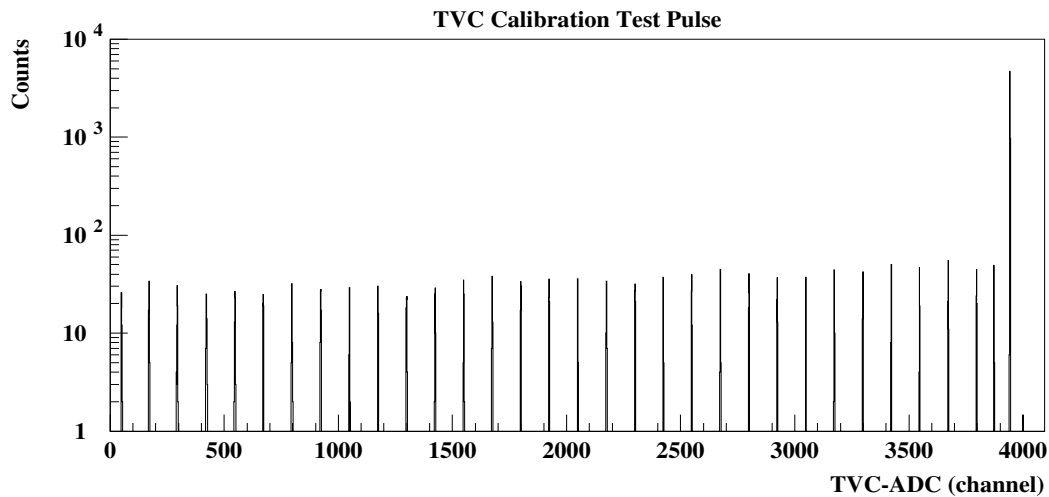
At a flight path of 17.8m;

$\pi/K$  separation to 4.0 GeV/c

$K/p$  separation to 8.0 GeV/c



# Bench Test at Navis Lab. (1996)



Programable test pulse with 3.5 ns step generated  
by system clock module

Estimation of time conversion factor

--> Average 27 [ps/ch]

Integrated linearity <-- +-1 channel

# Summary

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- Overall TOF resolution ~ 85ps