Performance of the Time-of-Flight Counter in PHENIX

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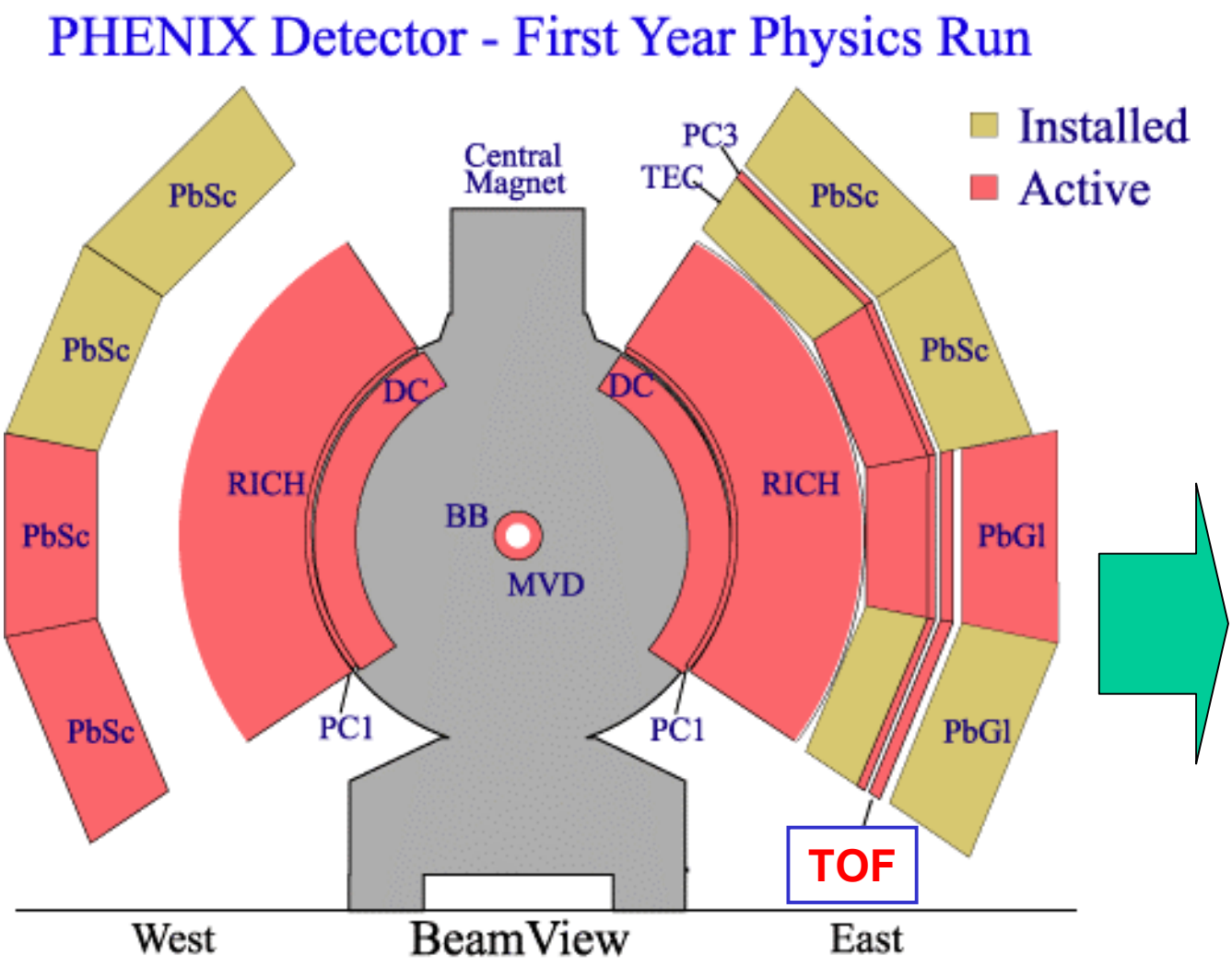


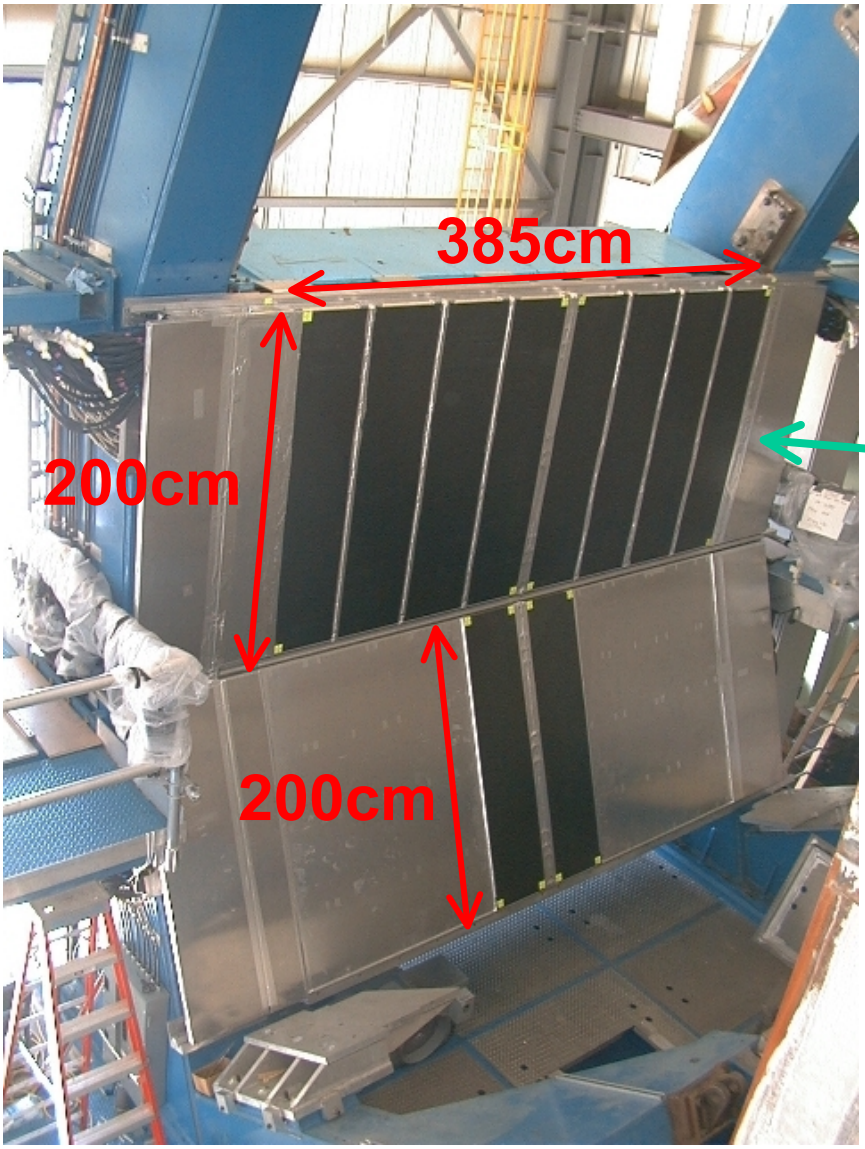
- **Location** : 5m from the vertex
- **Acceptance** : driven by HBT and ϕ meson
  - $\Delta\theta = 40^{o}$, $\Delta\varphi = 45^{o}$, Ω ~1/3 Sr
- **Segmentation** : keep the occupancy < 10%

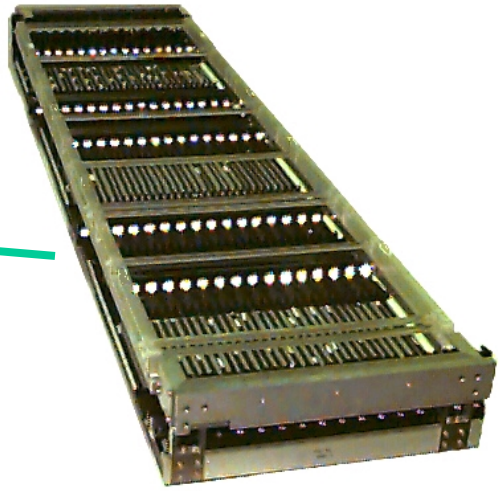
$$\frac{dN_{ch}}{dy} \cong 1500 \longrightarrow \cong 1000 segments$$

$\Delta\phi = 45$ deg. , $\Delta\eta = 0.7$

~ 100 cm^2/segment at 5 m from vertex

PHENIX-TOF Component





Panel: 96 slats

PMT
and
Bleeder

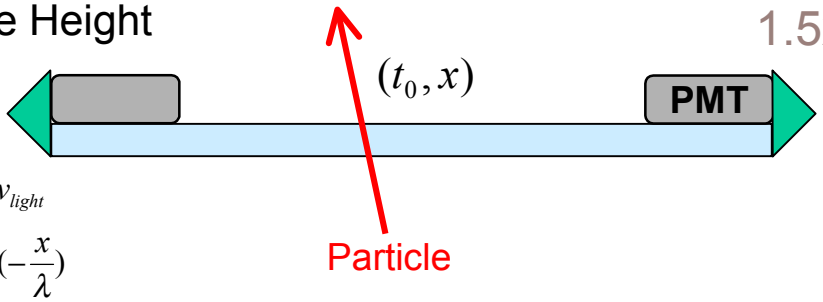
Slat: Plastic scintillator w. 2 PMT's

- 960 plastic scintillators with 1920 PMT's

Basic Design

Timing
Pulse Height

Scintillator:
1.5x1.5x64cm



$$\begin{cases} t_1 = t_0 + x / v_{light} \\ a_1 = a_0 \exp(-\frac{x}{\lambda}) \end{cases}$$

$$\begin{cases} t_2 = t_0 + (l - x) / v_{light} \\ a_2 = a_0 \exp(-\frac{l - x}{\lambda}) \end{cases}$$

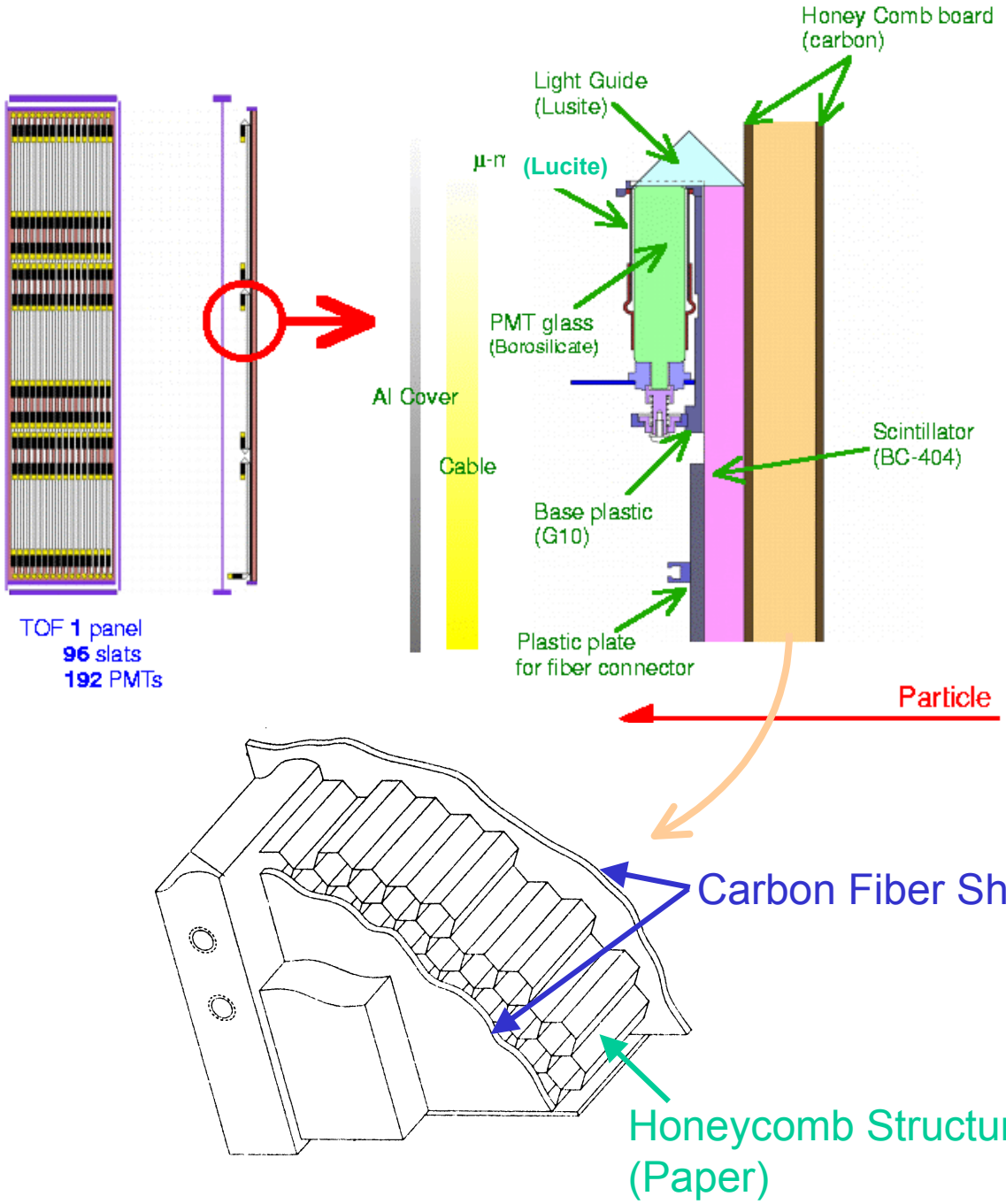
$$\therefore \begin{cases} t_0 = \frac{t_1 + t_2}{2} - l / v_{light} \\ x = \frac{t_1 - t_2}{2} v_{light} \end{cases}$$

$$\delta t_0 = \sqrt{(\frac{\delta t_1}{2})^2 + (\frac{\delta t_2}{2})^2} \cong \frac{\delta t_1}{\sqrt{2}} \longrightarrow \textbf{80 ps}$$

$$\delta x = v_{light} \sqrt{(\frac{\delta t_1}{2})^2 + (\frac{\delta t_2}{2})^2} \cong \frac{v_{light} \delta t_1}{\sqrt{2}} \longrightarrow \textbf{1.3 cm}$$

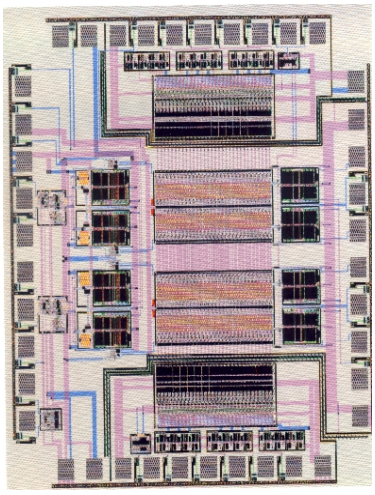
- Scintillator: Bicron BC404
  - decay constant : 1.8 ns
  - attenuation length : 160cm
- PMT : Hamamatsu R3478S
  - rise time : 1.3 ns
  - transit time : 14 +– 0.36 ns
- HV Bleeder with chip resisters

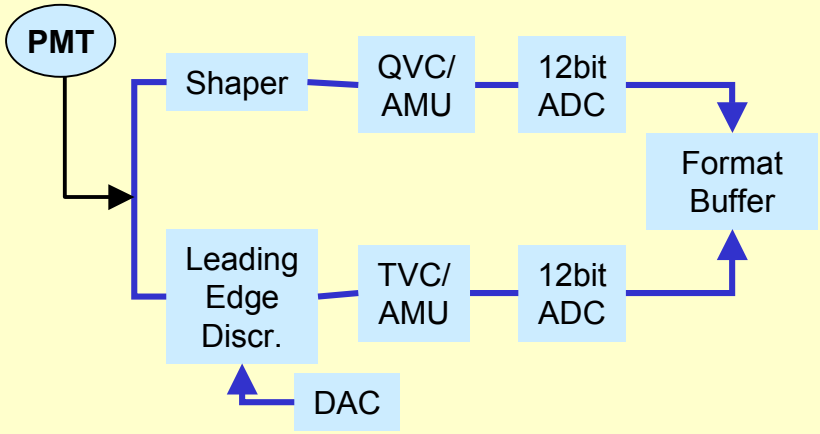
Structure

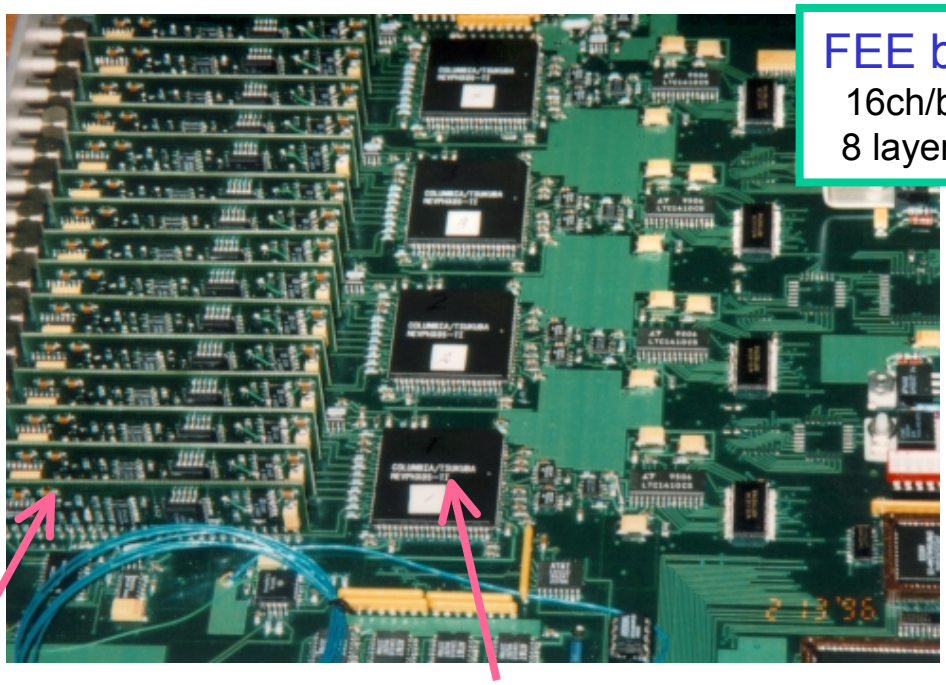


- UsedHoneycomb Board
  - Rigid structure with mass-less in 2.0x0.5m
  - Carbon fiber sheet + “honeycomb” structure
  - Uniform structure

Front End Electronics (FEE)







FEE board
16ch/board
8 layers PC

Discriminator(Sub-board)

TVC+AMU chip (4ch/chip)

- Custom made chips of TVC+AMU and QVC+AMU
  - Overall timing resolution of <25 ps
  - First pipeline TDC with high resolution.
- Use of Analog memory Unit.

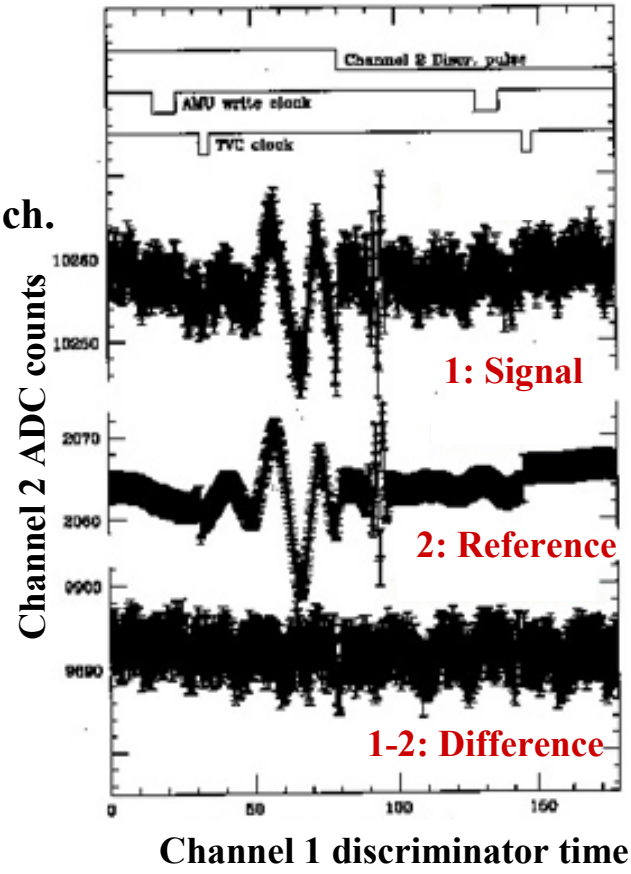
FEE (cont.)

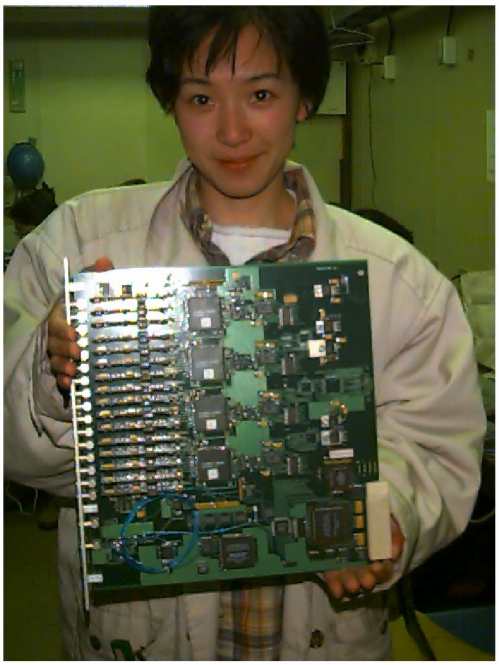
- **Elimination of Cross Talk between adjacent channels**

Each channel consists of two independent ch.

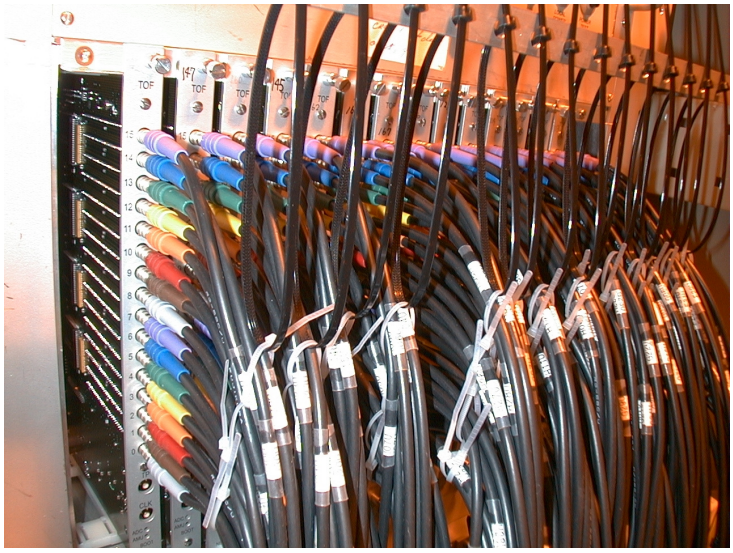
1. Signal : connected to PMT
2. Reference: antenna for cross talk elimination

No cross talk in differential output

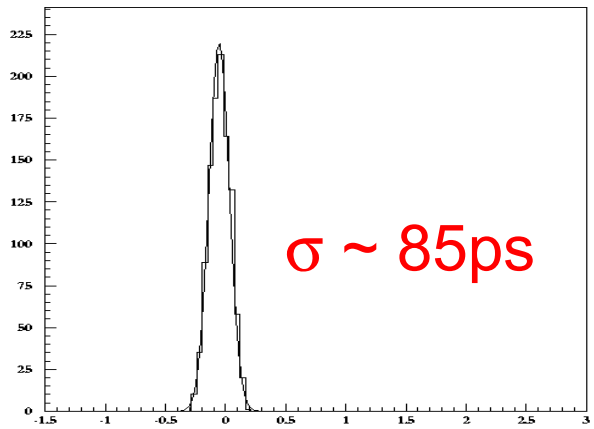


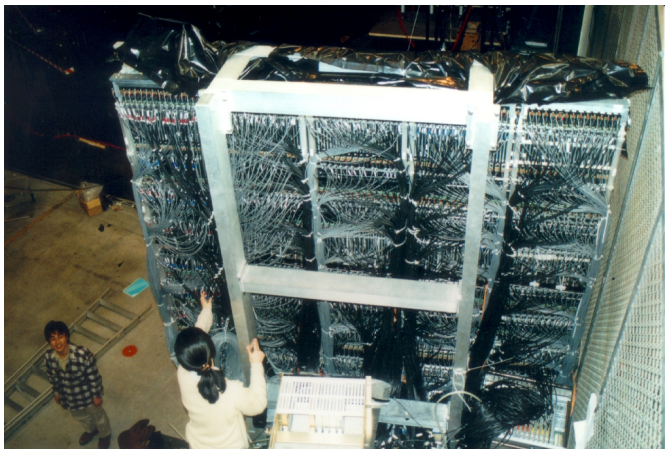


Photo



TOF Performance at CERN-WA98





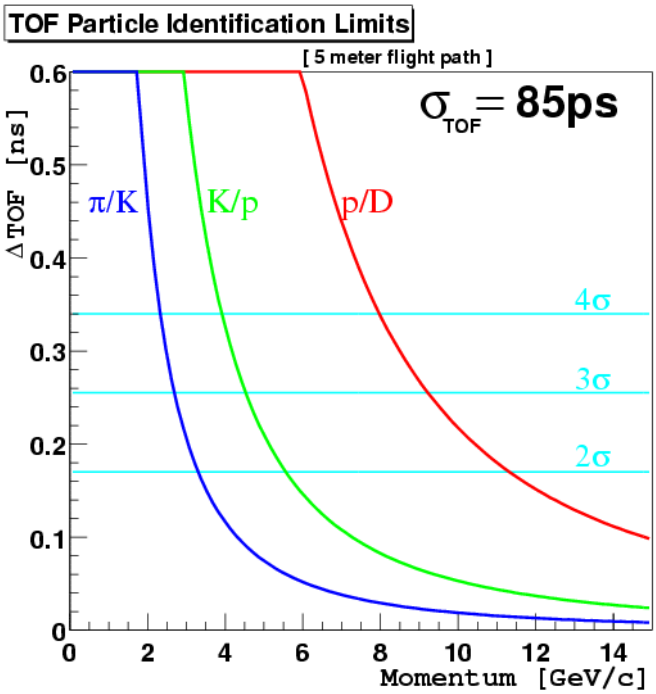
(1996)

Used high momentum π
TOF resolution for all 500 slats

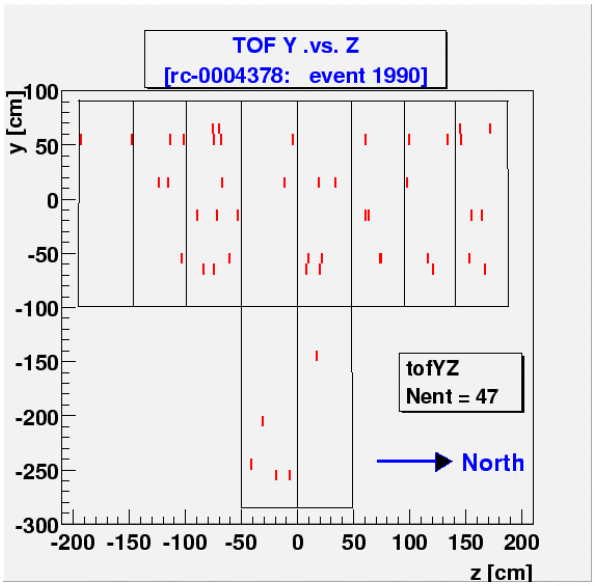
- 5 panels of TOF tested at CERN-WA98.
- Overall TOF resolution of < 85ps obtained.

TOF PID Capability at RHIC-PHENIX

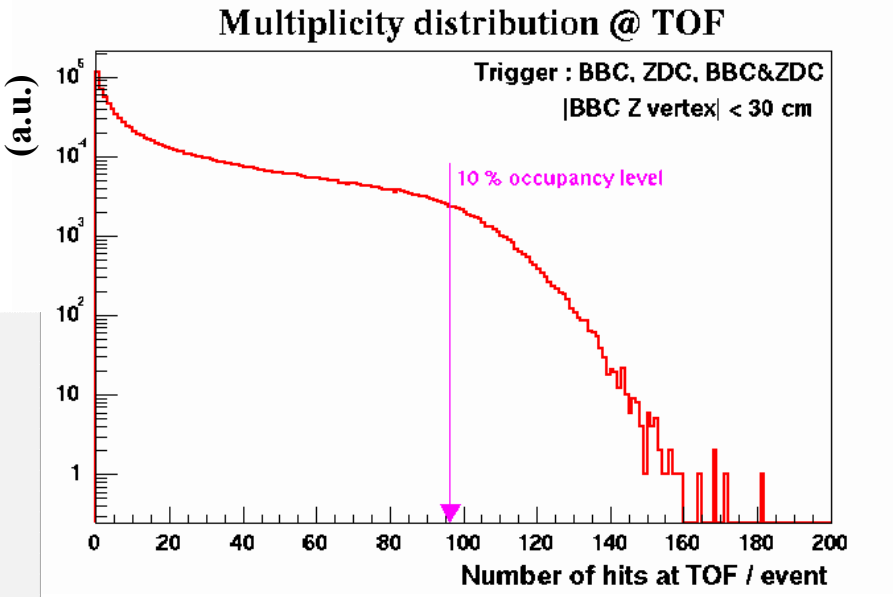
Time Resolution: σ ~ 85 ps
π/K separation to **2.4 GeV/c**
K/p,p separation to **4.0 GeV/c**

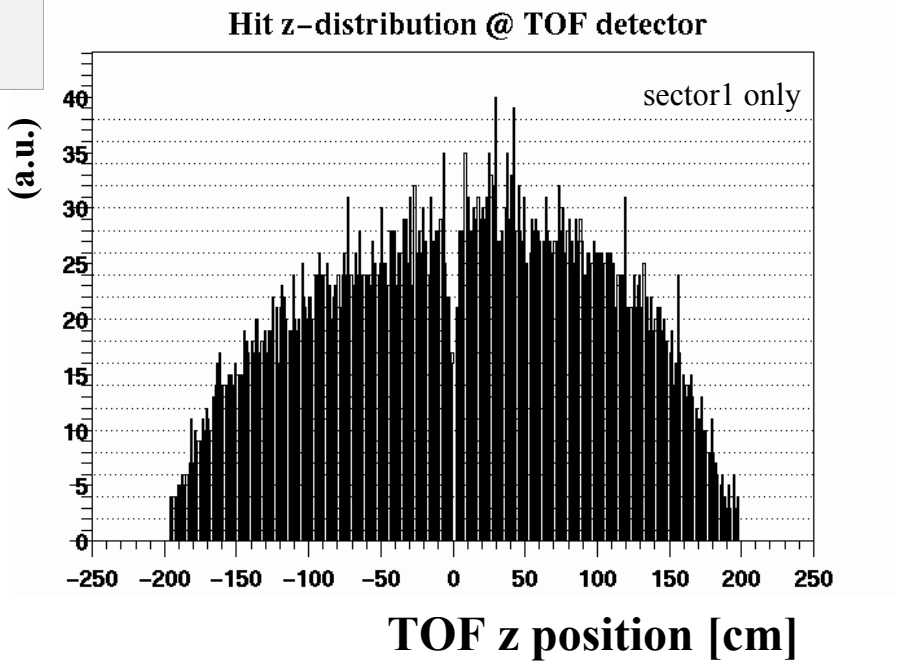


TOF multiplicity and Z distribution

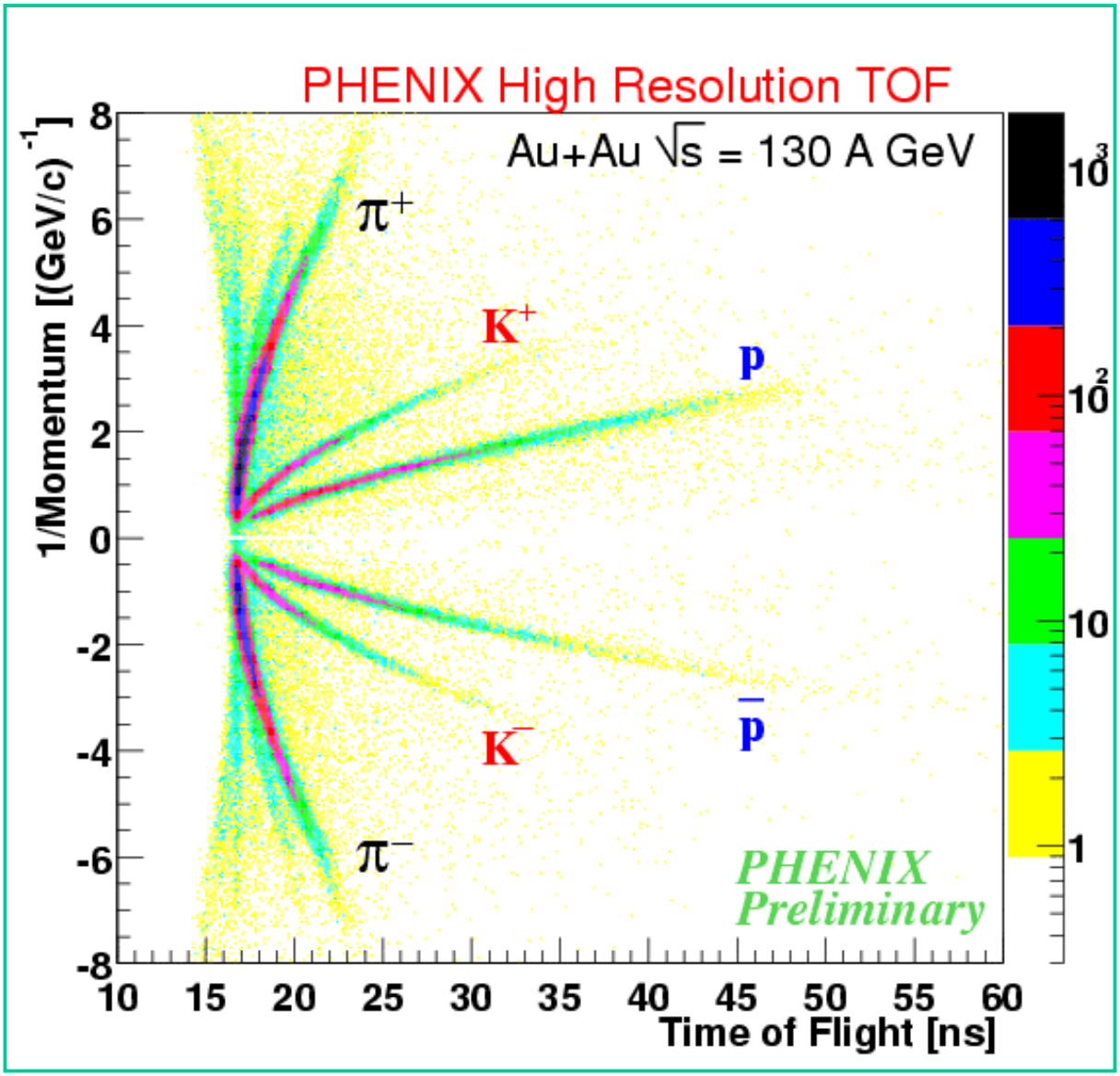


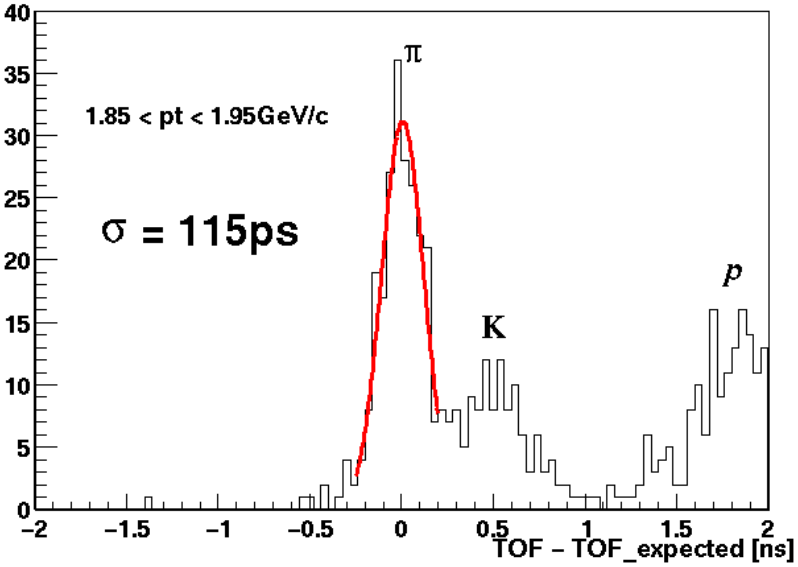
event display
at PHENIX first collision
(6/15/2000)





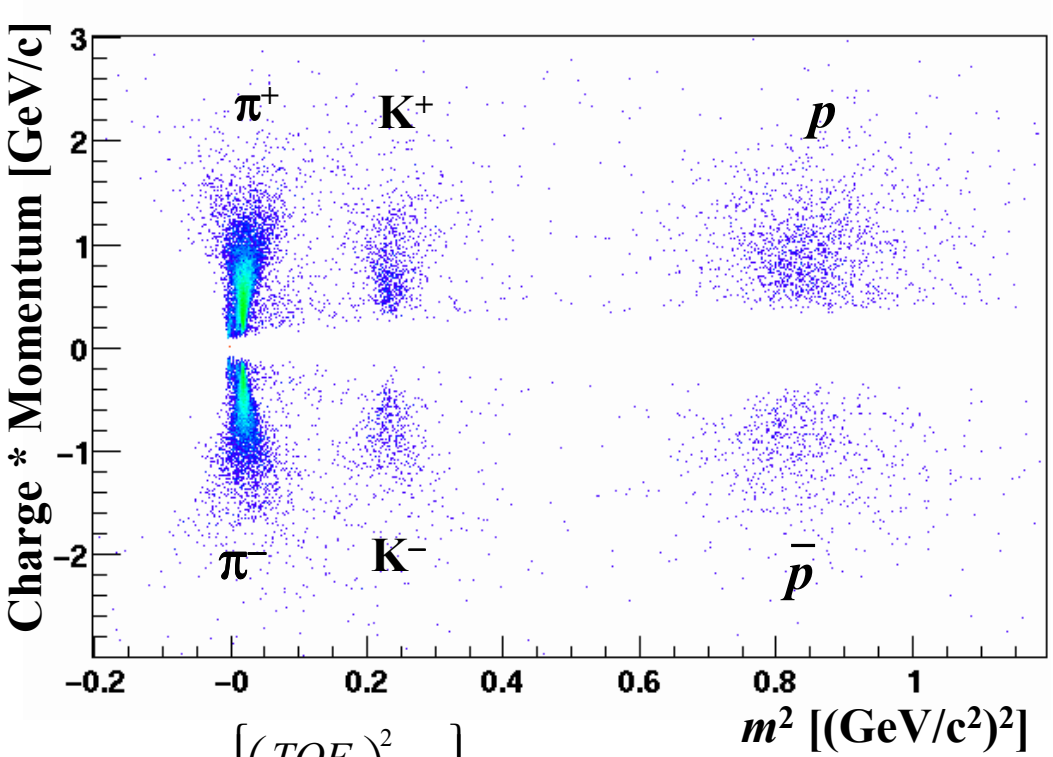
Particle Identification



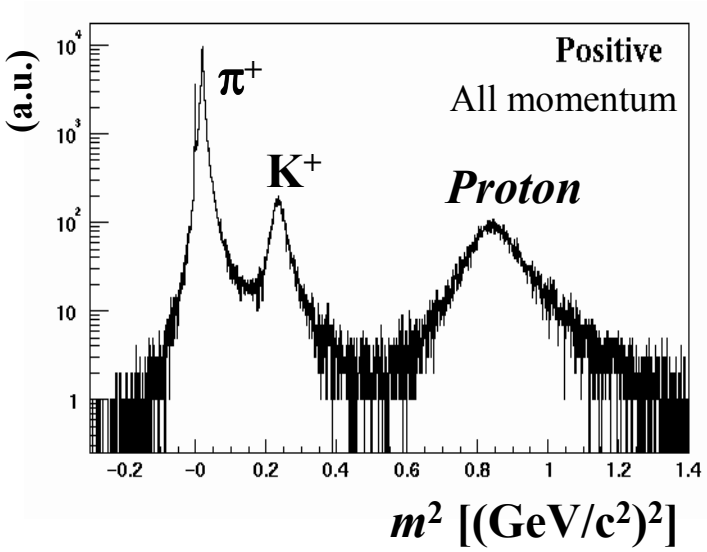


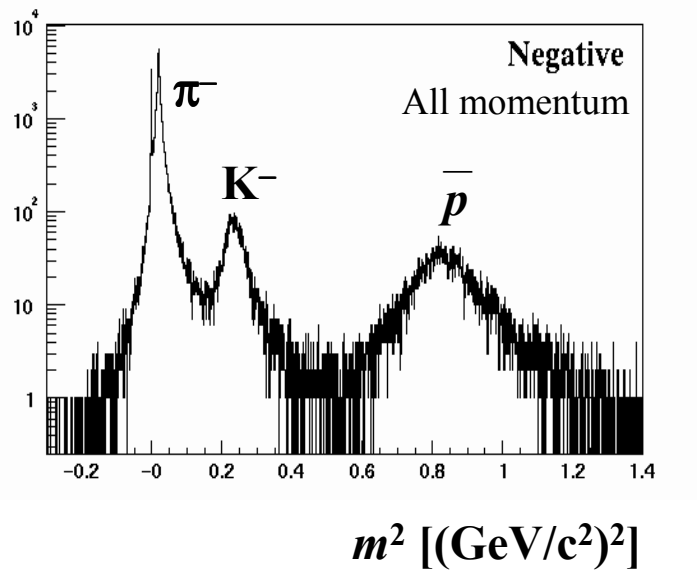
- We can see clear π,K,p separation

Mass squared distribution

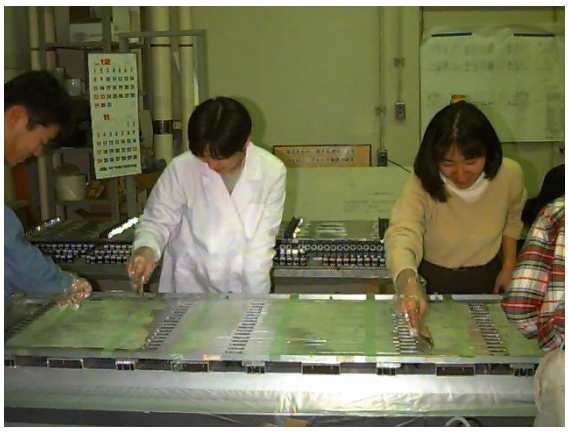


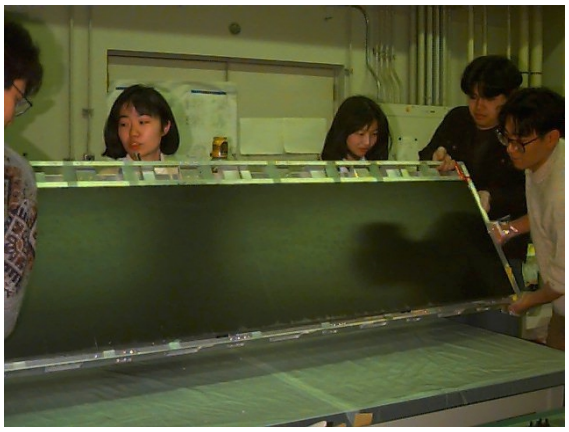
$$m^2 = p^2\left\{\left(\frac{TOF}{L}\right)^2 - 1\right\}$$

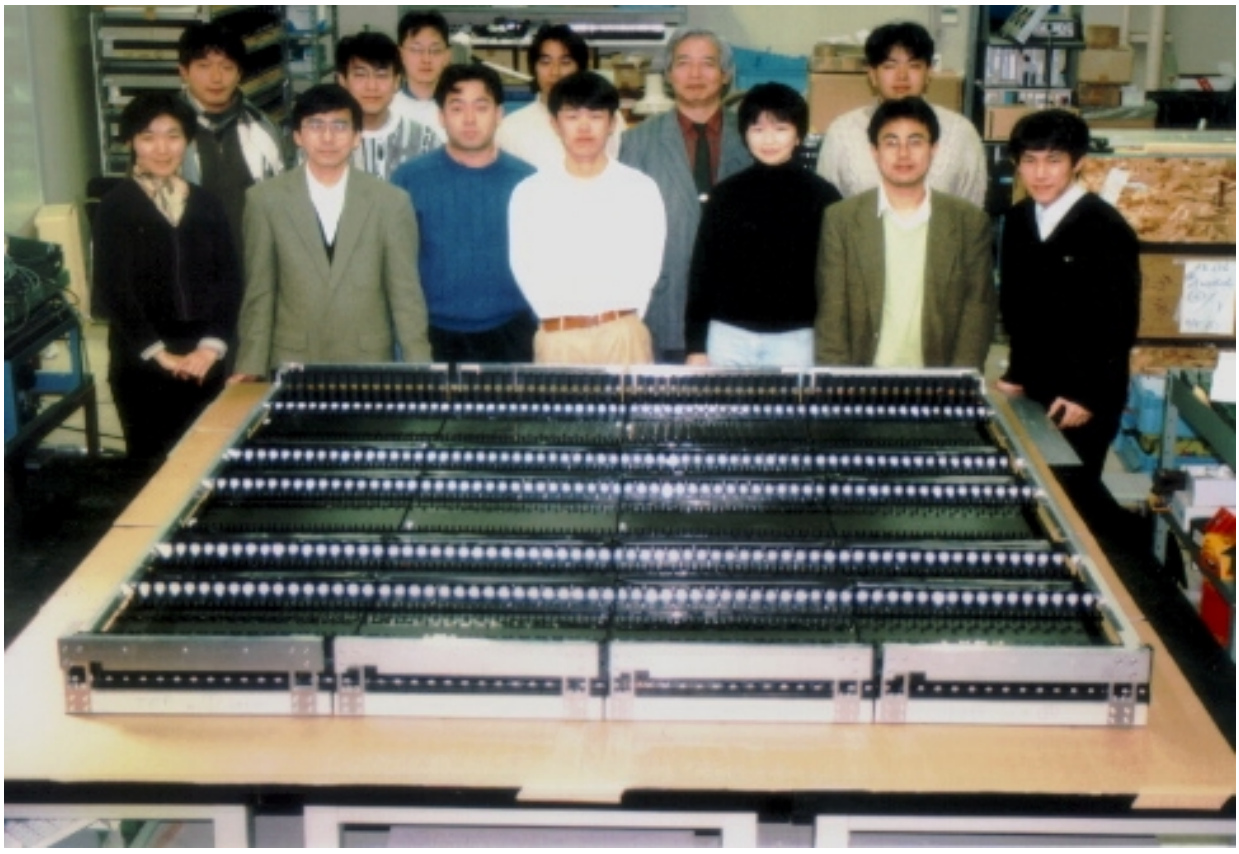




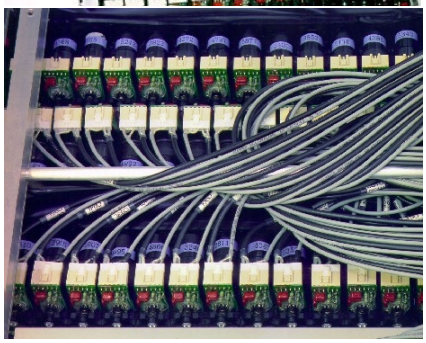
Construction at Tsukuba (1996-1998)

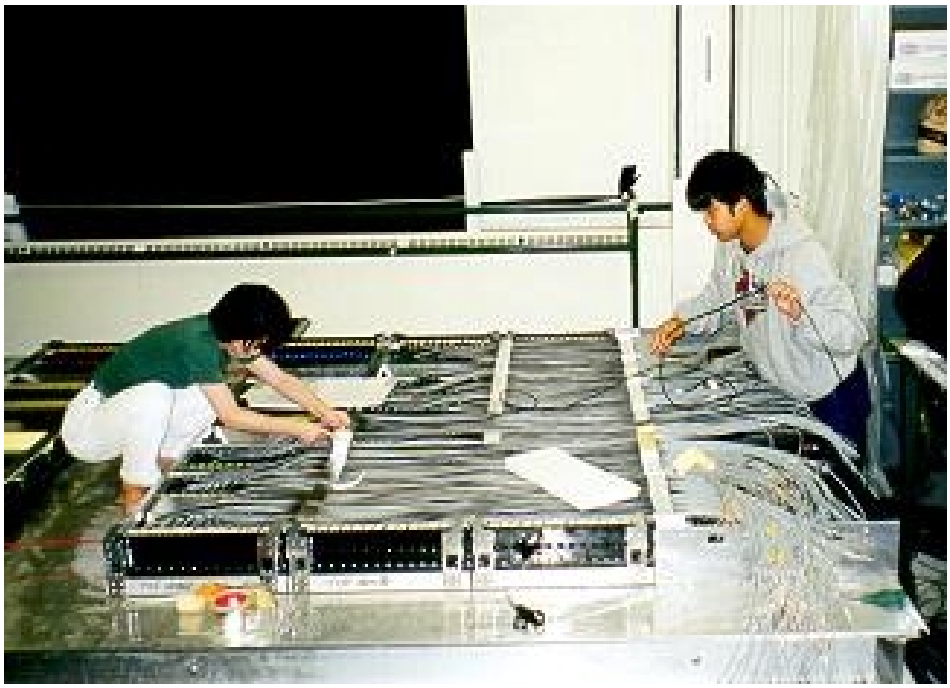






Construction at BNL (1998-1999)





Installation in PHENIX (August 1999)