Performance of High Resolution Time-of-Flight detector for Study of Identified Hadron Production at RHIC-PHENIX experiment

Univ.of Tsukuba:

JPS meeting @Niigata University

• PHENIX-TOF
• Basic Design
• Construction/Operation
• Performance
• Summary
PHENIX-TOF

- 960 plastic scintillators with 1920 PMT’s
- locate at 5m from the vertex
- Acceptance: driven by HBT and f meson
  \[ \Delta \theta = 40^\circ, \Delta \phi = 45^\circ, \Omega \sim 1/3 \text{ Sr} \]
Particle Identification using TOF

TOF

Time Resolution: $\sigma \sim 80$ ps

$\pi / K$ separation to 2.4 GeV/c

$K / p, \bar{p}$ separation to 4.0 GeV/c

TOF performance at WA98 (1996)

$\sigma \sim 85$ps

Used high momentum $\pi$

TOF resolution for all 500 slats

- WA98 used 5 panels of PHENIX TOF system.
Basic Design

PMT: R3478
Scinti.: BC404

Precise TOF & Hit position

Typical resolution
- Electronic pulse at Discr.: < 25 ps
- Laser Pulse on PMT: 50 ~ 100 ps

Double hit
- Lose timing information

\[
\begin{align*}
\begin{aligned}
\left\{ \begin{array}{l}
t_1 &= t_0 + x / v_{\text{light}} \\
a_1 &= a_0 \exp\left(\frac{-x}{\lambda}\right)
\end{array} \right.
&\quad \left\{ \begin{array}{l}
t_2 &= t_0 + (l - x) / v_{\text{light}} \\
a_2 &= a_0 \exp\left(\frac{-l-x}{\lambda}\right)
\end{array} \right.
\end{aligned}
\end{align*}
\]

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\begin{align*}
\begin{aligned}
\therefore \left\{ \begin{array}{l}
t_0 &= \frac{t_1 + t_2}{2} - l / v_{\text{light}} \\
x &= \frac{t_1 - t_2}{2} v_{\text{light}}
\end{array} \right.
&\quad \delta t = \sqrt{\frac{\delta t_1^2}{2} + \frac{\delta t_2^2}{2}} \equiv \frac{\delta t_1}{\sqrt{2}}
\end{aligned}
\end{align*}
\]

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\begin{align*}
\begin{aligned}
\delta x &= v_{\text{light}} \sqrt{\frac{\delta t_1^2}{2} + \frac{\delta t_2^2}{2}} \equiv \frac{v_{\text{light}} \delta t_1}{\sqrt{2}}
\end{aligned}
\end{align*}
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\begin{align*}
\begin{aligned}
\delta t &\rightarrow 80 \text{ ps} \\
\delta x &\rightarrow 1.3 \text{ cm}
\end{aligned}
\end{align*}
\]
FEE
Construction at Tsukuba (1996-1998)
Construction at BNL (1998-1999)

- PMT installation
- Cable Assemble
- Signal Check
Instoration in PHENIX
(August 1999)

- All 10 panels were installed.
Operation at PHENIX year1

West

East

Detector instrumented

Detector installed

Install in summer 2000
Track matching and TOF intrinsic timing resolution

- $\sigma_{\text{TOF-TEC}} = 2\text{cm}$:
  - Corresponding timing resolution is $120 \text{ ps}$.
  - $120 \text{ ps}$ is consistent with TOF intrinsic timing resolution for NO slewing correction.

\[ \sigma \approx 120 \text{ ps} \]
Particle Identification

We can see clear $\pi, K, p$ separation

- No Slewing correction
TOF resolution

- Select High-momentum pion.
- Current Time of Flight resolution is $\sim 170$ ps.
  - BBC, TOF, Tracking Chamber
- aaa
- bbb
Summary

• TOF intrinsic timing resolution is 120 ps from TEC/TOF matching without slewing correction.
• Time-of-Flight resolution is 170 ps