

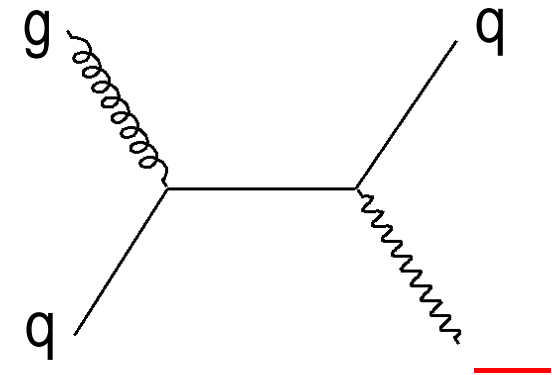
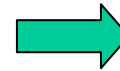
Measurement of Inclusive Photon in Au+Au collisions by Conversion Method at RHIC-PHENIX

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Photon as a signal from QGP

Thermal Photon is one of important observable to probe early stage of collision --- QGP

Thermal Photon excess will appear in less than 3GeV/c in some predictions.



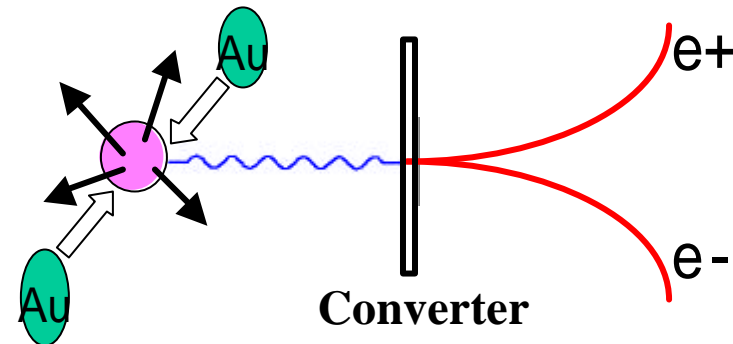
Photon is not affected by strong interaction in final stage of collision



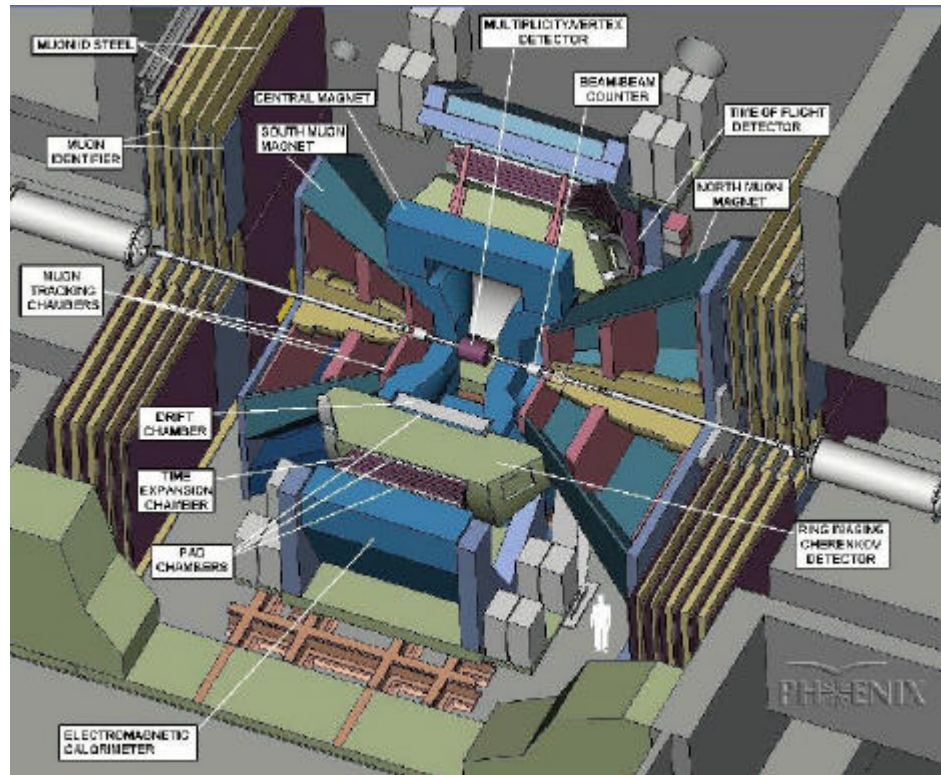
We can measure hot and dense matter directly.

The characteristics of QGP (Temperature, Energy Density) can be measured

We measure photon through their conversion into e^+e^- pairs



PHENIX Experiment



Trigger

- Beam Beam Counter
- Zero Degree Calorimeter

Collision vertex

- Beam Beam Counter

Purpose :

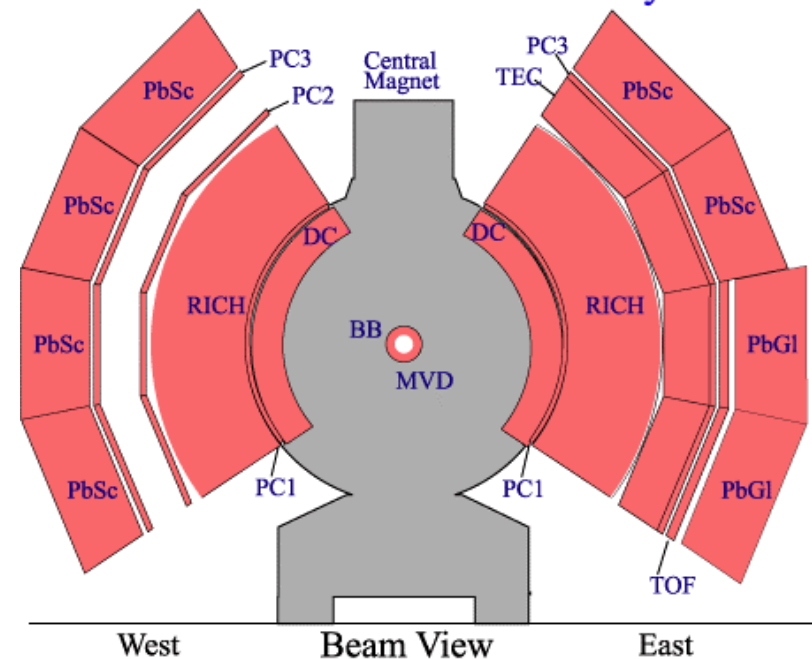
- Search for the signals from QGP produced $s_{NN}=200\text{GeV}$, Au+Au collisions

Coverage:

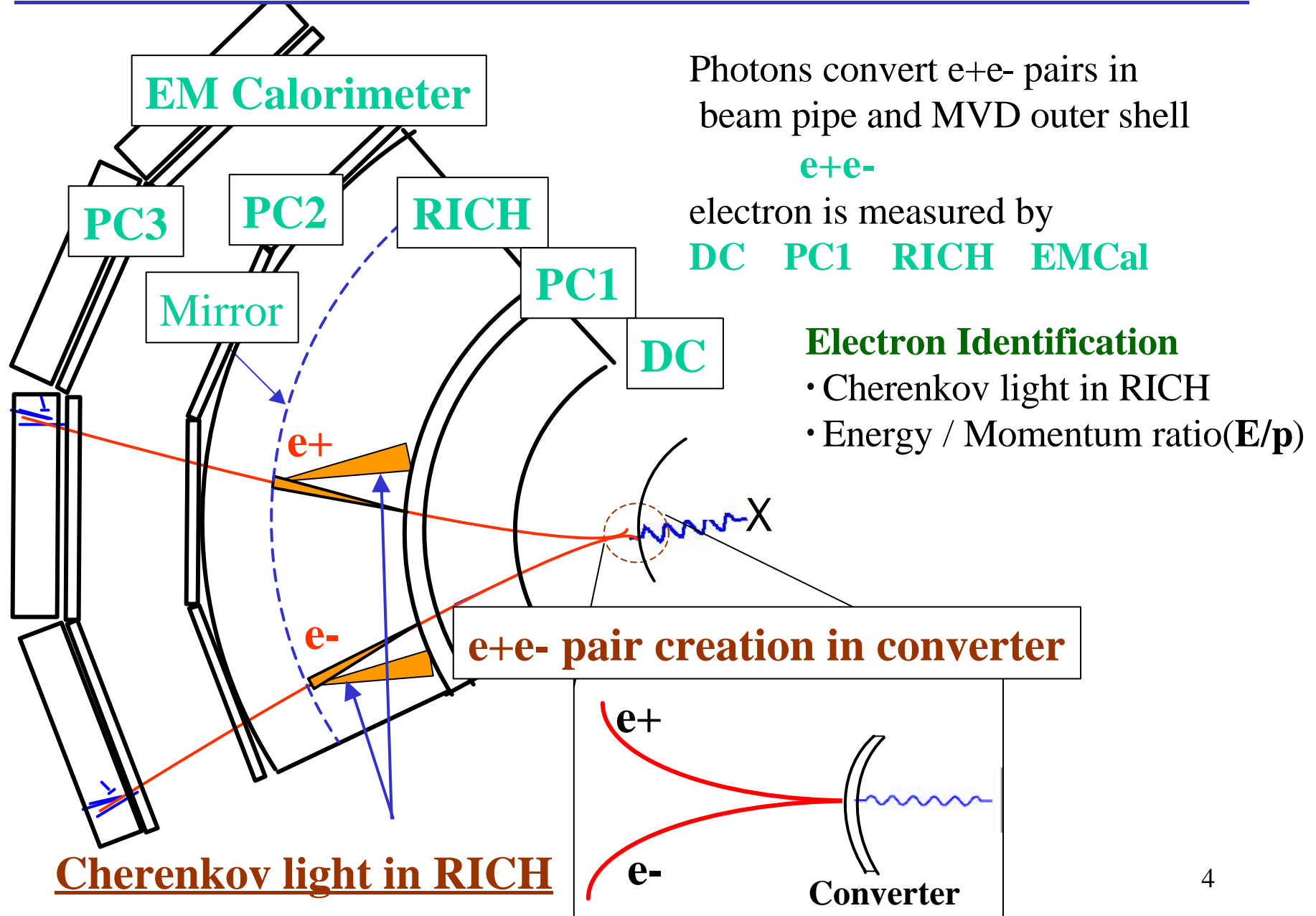
Central Arm

- $-0.35 < \eta < 0.35$
- $30^\circ < |\phi| < 120^\circ$

PHENIX Detector - Second Year Physics Run

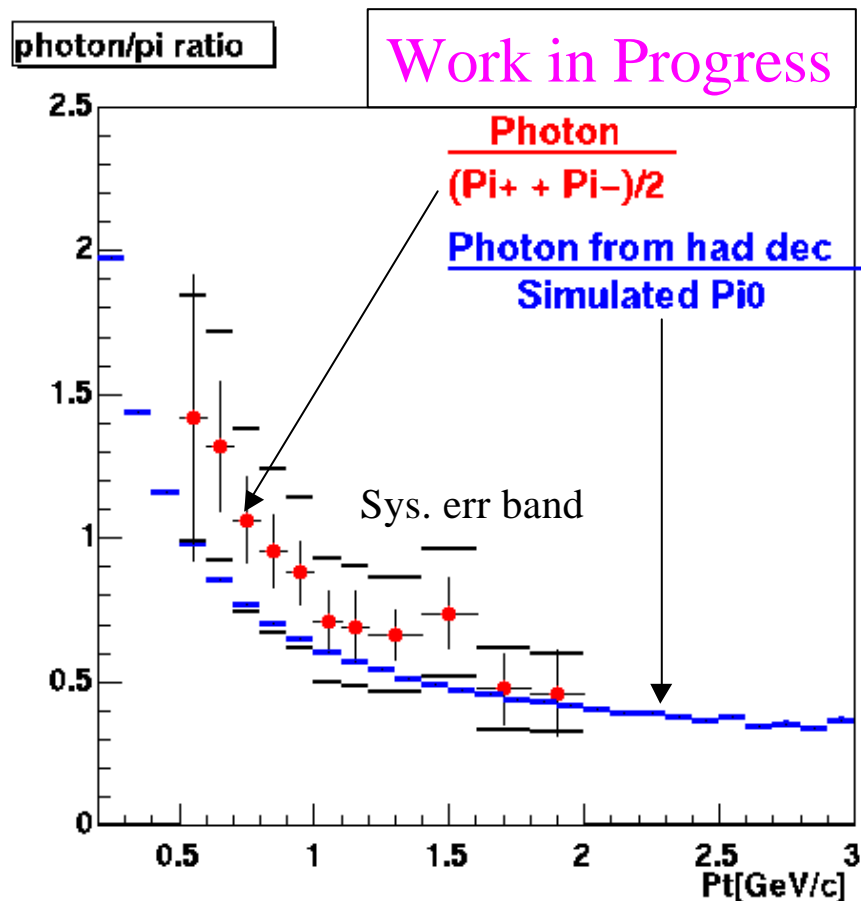


Photon Measurement via Photon Conversion



/ ratio in Data and Simulation : Run 1 Status

Shown at Hawaii meeting.



- γ/π is measured in Run 1 data.
- Systematic Error in data is roughly 30% (black band)
- γ/π from Data is not inconsistent with expected γ/π ratio within Systematic & Statistical Error.

We have much larger statistics
in Run 2.

Photon Converter in Run 2

Photon Converter



Photon Converter :

- Brass shim
(Zn:30 Cu:70%,)
- 600mm*2 *0.254 mm
- Rad. length : 1.7 %

Special runs with a photon converter.

Benefit of the converter

- We can measure **the conversion pairs** from the converter.
- We can measure the **single electron** from conversion
- We can know the **efficiency** of electron completely

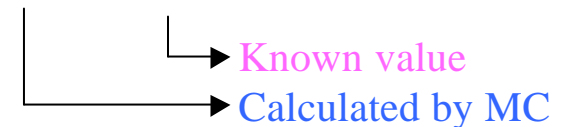
By using with and without the converter

$$N_{ee}^{Conv} \cdot ?^{e?} \cdot ??^{e?} \cdot ?^{Geom}_{ee} \cdot ?^{Conv} \cdot N?$$

$$N_{e?}^{Conv} \cdot ?^{e?} \cdot ? \cdot ?^{Geom}_{e?} \cdot ?^{Conv} \cdot N?$$

$$N_{e?}^{Conv} \cdot ?^{e?} \cdot ??^{e?} \cdot ?^{Geom}_{e?} \cdot ?^{Conv} \cdot N?$$

It is a powerful tool



Electron Identification

RICH – our primary eID device

- Number of Hit PMT per electron track
- χ^2 of Ring shape

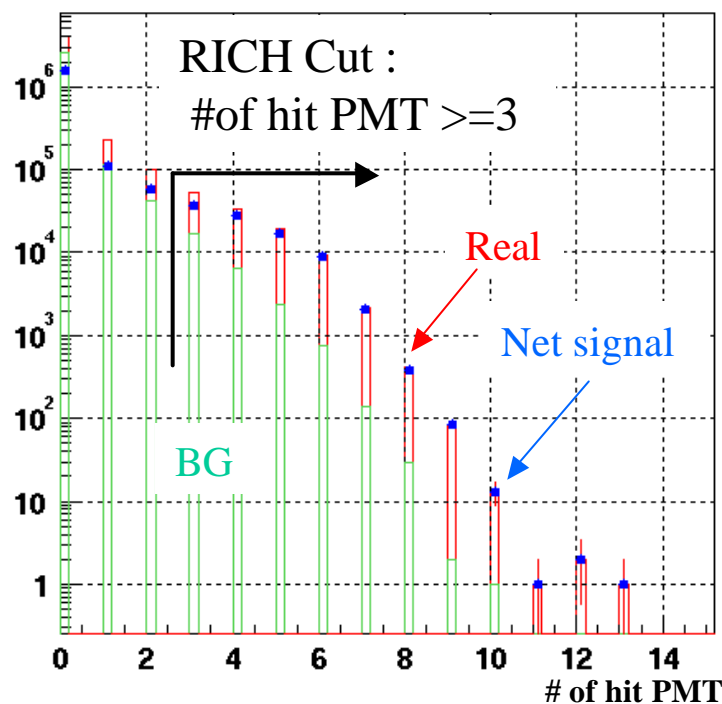
E/p matching – reject hadron Background

E : Energy measured by the EMCal

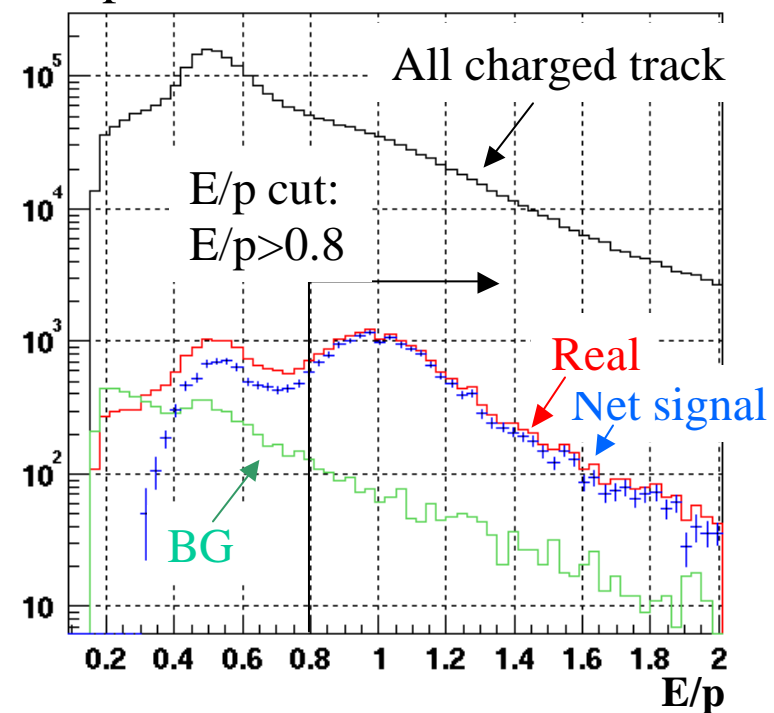
p : Momentum measured by the Dch.

The peak at $E/p=1$ is electron signal

of hit PMT



E/p ratio



Electron signals are clearly measured.

Invariant Mass Spectrum of e+e- pairs

Event selection:

$|Z| < 35\text{cm}$

Min. bias event sample

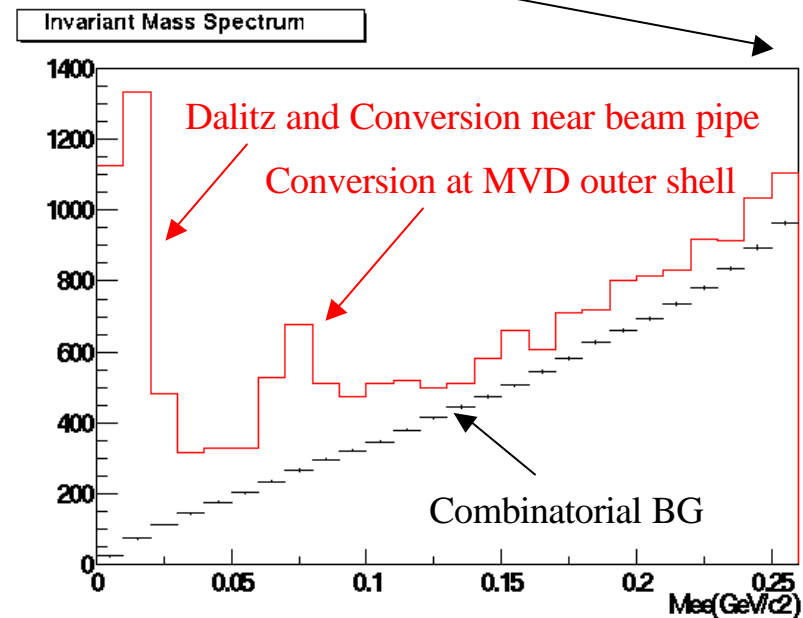
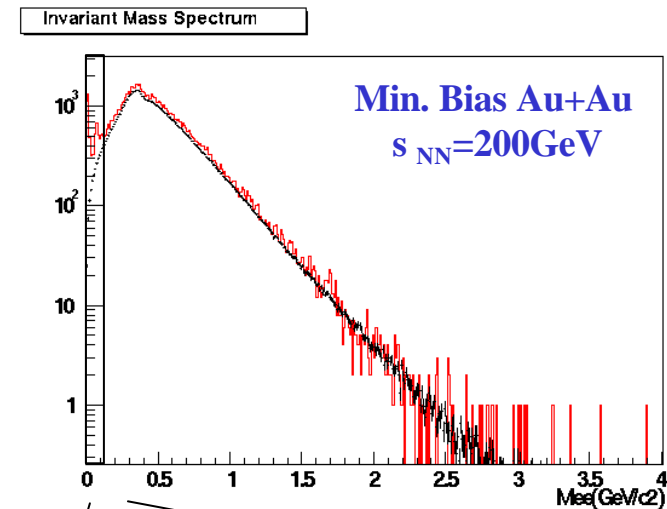
Electron ID:

$N_0 > 2, \chi^2 < 10, E/p > 0.8$

Red : Real

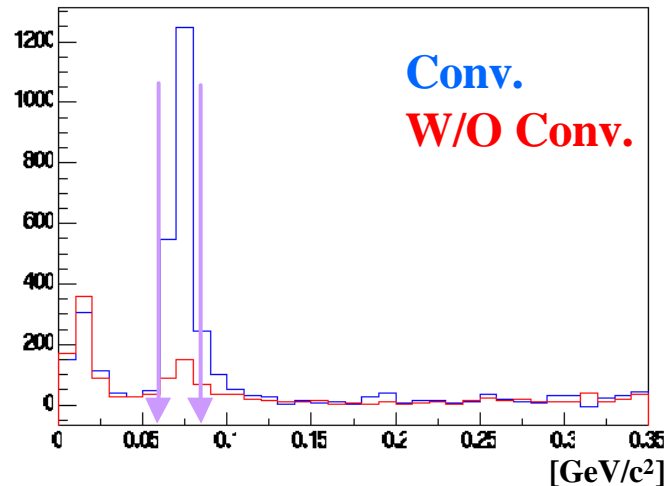
Black : Combinatorial BG

Due to our tracking algorithm,
conversion pairs at a large radius from
the vertex make the peak (at $75\text{MeV}/c^2$)
in mass distribution



Method 1: Measurement of $e^+ e^-$ pairs

Invariant mass

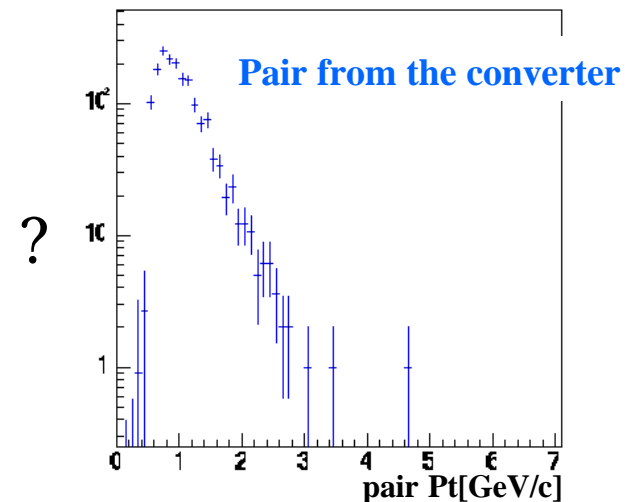
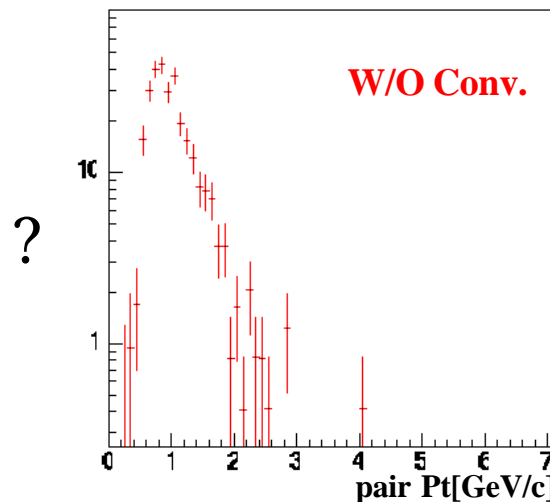
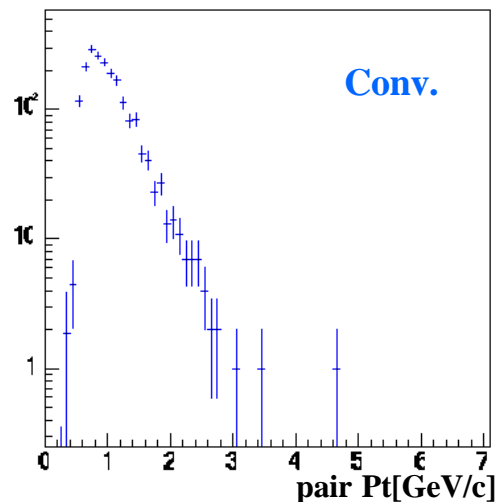


- Combinatorial BG is subtracted
- Clear peaks are shown at 75MeV
- 6 times higher --- consistent with Rad. length

Mass region in $60\text{MeV} < M_{ee} < 85\text{MeV}$ is used.
--- e^+e^- pairs coming from the conversion

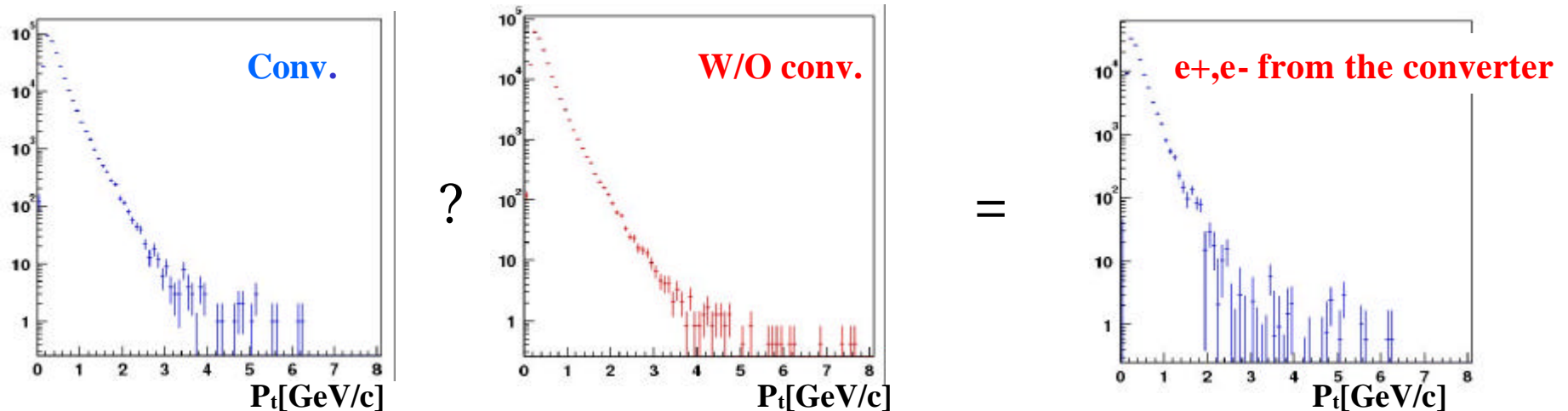
Need to correct the tracking efficiency, etc.

Un-corrected P_t spectra of e^+e^- pairs



Method 2: Measurement of $e^+(e^-)$ from the conversion

Un-corrected P_t Spectra of electron



We can measure a electrons from purely photon conversion.

? Photons can be measured.

$$\frac{d\sigma_e}{dp_T} \quad \frac{d\sigma_\gamma}{dp_T}$$

- We can also measure inclusive electron ----- including charm decay.

In Run 1,

we measured prompt electrons and derived charm cross section.

Link : nucl-ex/0202002

Statistics in Run 2

Comparison of statistics (min. bias)

Run 1 : 1.3M

Run 2 Converter : 5M

W/O converter : 87M

Total min. bias events : 92M

LVL2 triggered events : 80M (min. bias equivalent)

Acceptance is 4 times larger than Run 1

70 x 4 times larger statistics

In this analysis:

- 25% of the data with the converter.
- 3% of the data without the converter.

Summary

- We have started the photon conversion analysis in Au+Au collisions at $\sqrt{s_{NN}}=200\text{GeV}$.
- Large statistics (170M events) is obtained in Run 2 .
- Comparison of the data with and without the converter is useful for photon measurement.
- (Un-corrected) Pt spectra of conversion pairs and single electron from photon conversion are measured.

Next Step:

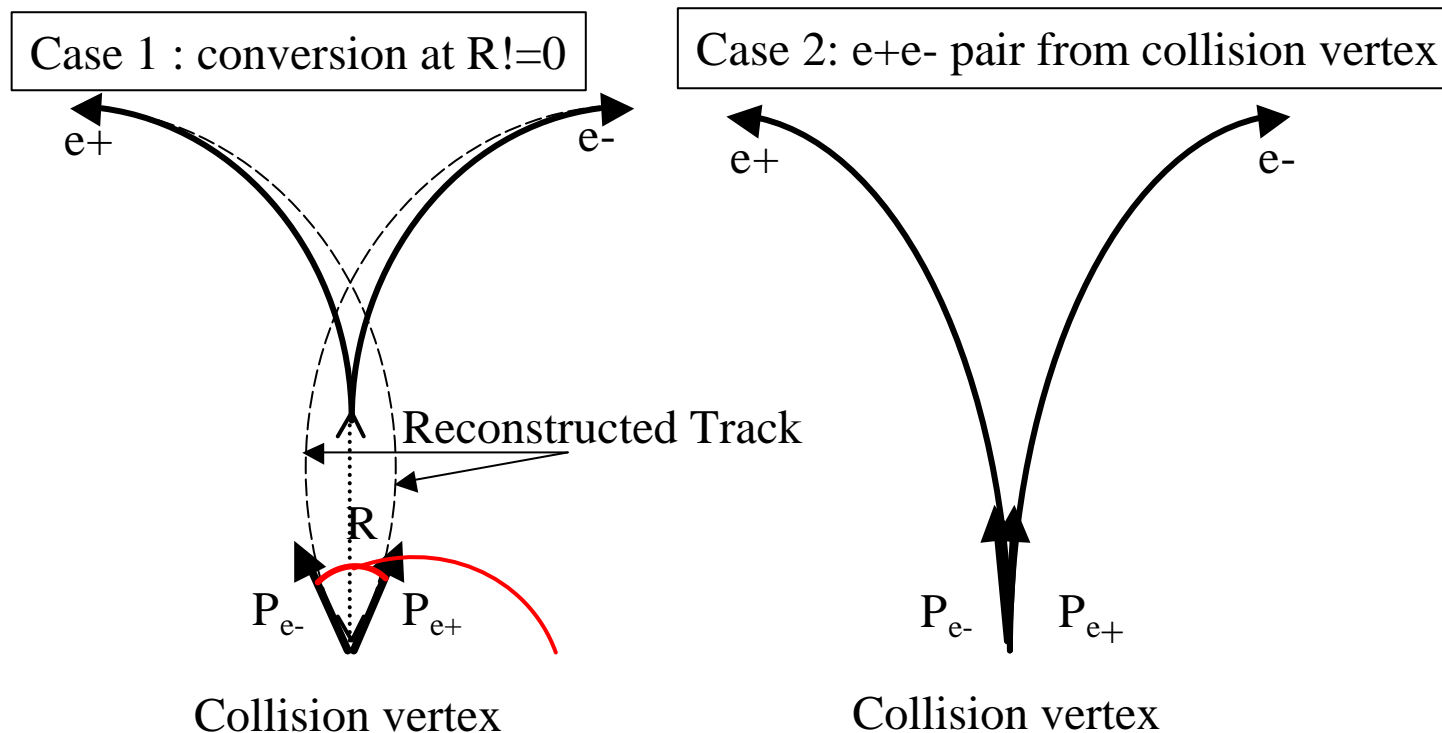
- Determine the efficiency correction factor to measure invariant yield of inclusive photon.

Backup Slide

Shift of Invariant Mass

Our tracking algorithm require position of collision vertex.

For photon conversion at $R \neq 0$, opening angle of e^+e^- pair is reconstructed effectively large. It is affected to M_{ee} position



Comparison Data with expected photon from hadron decay

To evaluate photon yield, Photon/Pion ratio from data is compared with expected Photon/Pion from hadron decay.

- Both of Photon and Pion yield are measured at PHENIX.

Expected photon yield from conventional photon source
(neutral mesons decay)

- π^0 , η , η' are taken into account.
- Pt slope of π^0 is obtained by fit to the average of PHENIX charged data with power law function
- Pt slopes of other hadrons are obtained by mT scaling of
- $\pi^0/\eta=0.55$, $\eta'/\eta=0.25$, $\eta/\pi^0=1.0$ at High Pt from p+p data

PHENIX RICH

- EMCal とTECと併用することで 10^{-4} のハドロンを退ける
- PHENIXの中心アームに乗っている
 - $|y| < 0.35$; $\theta = 90 \text{ degrees} \times 2$
- チェレンコフ光の媒質ガス
 - CO_2 ($\rho_{\text{th}} \sim 35$)
 - eID p_t range : $\sim 4 \text{ GeV}/c$
- 使用PMT数
 - 5,120 本
- 体積 40m^3

