Elliptic flow measurements of J/Psi and light hadrons in 200AGeV Au+Au collisions at RHIC–PHENIX

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Azimuthal anisotropy

Spatial anisotropy in non-central collision provides azimuthal anisotropy of particle emission.

The large anisotropy is an evidence of the formation of a hot and dense partonic matter.

\[
\frac{dN}{d\Phi} \propto 1 + 2v_2 \cos 2(\Phi - \Psi)
\]

\(\Psi\) : reaction plane angle
Motivation of $v_2$ measurement

Large $v_2$ was observed in RHIC

The values agreed with hydro-dynamical models

It suggests rapid thermalization and quark flow.
The values of $v_2$ are in proportion to the number of quarks.

-heavy particle shifts to high $p_T$

-These agree very well by $kE_T/n_q$ scaling at low $p_T$ range.

\[
K E_T = \sqrt{(M^2 - P_T^2)} - M
\]
New reaction plane detector “RxP”

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RxP measure more particles and the particles with more large $v_2$.

RxP : $\eta = \pm 1\sim 2.8$ (blue)
BBC : $\eta = \pm 3.1\sim 4$ (red)
New Reaction Plane Resolution

\[ v_2 \text{ plane} \]

| Reaction Plane | \(|\eta|\) |
|----------------|---------|
| RxPinner       | 1.5 - 2.8 |
| RxPouter       | 1.0 - 1.5 |
| MPC            | 3.0 - 4.0 |
| BBC            | 3.1 - 3.9 |
| CNT            | 0 - 0.35  |
| SMD            | > 6      |

\[ v_{2\text{observe}} = v_{2\text{real}} \times \left\langle \cos 2 \left( \Psi_{\text{real}} - \Psi_{\text{observe}} \right) \right\rangle \]

\[ \delta v_2 \sim \frac{1}{\left\langle \cos 2 \left( \Psi_{\text{real}} - \Psi_{\text{observe}} \right) \right\rangle} \times \frac{1}{\sqrt{N}} \]
How to get PID $v_2$ (deuteron)
\[ v_2 \text{ before and after} \]

Before (Run4)
- BBC RP resolution (< 0.4)
- 0.8 billion events

After (Run7)
- Better resolution of RxP (< 0.75)
- Higher statistical (3.5 billion)
Quark number and KE$_T$ scaling

$$KE_T = \sqrt{(M^2 - P_T^2)} - M$$

The $v_2$ of proton and anti-proton show clear deviation from the number of quark scaling at KE$_t$/n 1 GeV. This may indicate a change of particle production mechanism.
Heavy flavor and J/ψ $v_2$

The data at low $p_T$ favor the models that include quark level elliptic flow of charm.

B meson decay becomes a significant source above 2.5 GeV/c
Summary

RxP has worked very well during the PHENIX Run7 period and demonstrated the design performance.

- resolution is improved by a factor of two (0.4 $\Rightarrow$ 0.75)

We are analyzing the data with RxP.

- $\pi$, K, proton, deuteron, single electron and J/$\Psi$ have been measured and also preparing for the publications.

(Anti)Proton show clear deviation from mesons.

Please wait for $\Lambda$ and $\Phi$. 
Back up
Reaction Plane Detector (RxP)

The reaction plane detector was installed just before Run7 (2007).
Correlation effect

$v_2$ is over estimated by correlation effect.

According to HIJING+PYTHIA, the effect by jet does not have any problem with $\eta>1.5$
Design and Geant simulation

Detector parameters were optimized with Geant simulation

Thickness
- Scintillator 2cm
- Converter 2cm

Φ division into 12

π0 → 2γ (98.8%) ct=25.1[nm]
Configuration of RxP