Table of Contents:

- Introduction
- Heavy-ion physics
- Physics at RHIC
- Physics with STAR BEMC
  - Elliptic flow of inclusive photons.
  - Neutral pions reconstruction.
- Summary

Ahmed M. Hamed

Toward elliptic flow of direct photons.
The partonic degrees of freedom are largely “frozen” in nuclear physics, just as the nucleonic ones are frozen in atomic physics.

- Nuclear density $\rho_0 \sim 0.15$ nucleons/fm$^3$
- Specific volume $\nu \sim 6$ fm$^3$
- Typical hadronic volume $\sim 1$-3 fm$^3$
- The average inter-nucleon distance in the nucleus $\sim 1.8$ fm

Is there new physics above $\sim 3\rho_0$?
**Introduction: Structure functions**

- **Parton Model:** DIS is incoherent sum of the interactions with the individual partons.

- Self similarity in the internal structure of the strongly interacting particles.

- A depletion in the number of low x quarks and antiquarks for the bound nucleon.

- **Soft and hard physics at RHIC** $x \approx 2P_t/\sqrt{s}$

- **What is the underlying theory of the quark and gluon interactions?**

---

**Ahmed Hamed (WSU)**

**Texas A&M 04-28-06**
**Introduction: Standard Model**

What is Experimental physics ➜ Matter to Particle. How do they interact ➜ Theoretical physics ➜ Force to Field

- Quantum Mechanics.
- Special Relativity.
- Relativistic Quantum Mechanics.
- A relativistic theory must treat space and time coordinates on an equal footing.

**Quantum Field Theory**

“What provide a natural framework for quantum theories that obey the principles of special relativity”

Electromagnetism ➜ Electroweak Interaction ➜ General Relativity ➜ Standard Model ➜ SU(3) x SU(2) x U(1)

**What is the QFT of the strong interaction?**
According to the quark model, one can concoct a lagrangian:

\[ \mathcal{L}_0 = \sum_f \bar{q}_f (i \gamma^\mu \partial_\mu - m_f) q_f \quad \text{where} \quad q_f \equiv \text{column}(q_f^1, q_f^2, q_f^3) \]

\[ \mathcal{L}_{\text{QCD}} = \frac{1}{4} (\partial^\mu G_\mu^a - \partial^\nu G_\nu^a)(\partial_\mu G_\mu^a_v - \partial_\nu G_\nu^a_v) + \sum_f \bar{q}_f^a (i \gamma^\mu \partial_\mu - m_f) q_f^a \]

Free term propagator

Interaction term

\[ + g_s G_\mu^a \sum_f \bar{q}_f^a \gamma^\mu \left( \frac{\lambda^a}{2} \right) q_f^\beta \]

Self interaction term

\[ - \frac{g_s^2}{2} f^{abc} (\partial^\mu G_\mu^a_v - \partial^\nu G_\nu^a_v) G_\mu^b G_\mu^c_v - \frac{g_s^2}{4} f^{abc} f^{def} G_\mu^a G_\nu^b G_\rho^c G_\sigma^d \]

\[ \frac{d}{d \mu} \frac{d \alpha}{d \mu} = \alpha \beta(\alpha) \]

\[ \beta(\alpha) = \beta_1 \frac{\alpha}{\pi} + \beta_2 \left( \frac{\alpha}{\pi} \right)^2 + \cdots \]

\[ \beta_1 = \frac{2N_f - 11N_c}{6} \]

Who renormalized the QCD?
Press Release: The 2004 Nobel Prize in Physics
5 October 2004

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2004 "for the discovery of asymptotic freedom in the theory of the strong interaction" jointly to

David J. Gross
Kavli Institute for Theoretical Physics, University of California, Santa Barbara, USA,

H. David Politzer
California Institute of Technology (Caltech), Pasadena, USA, and

Frank Wilczek
Massachusetts Institute of Technology (MIT), Cambridge, USA

What was so special about QCD renormalization?

- Usually for experiments, rather than theory
- Often shared, rather than individual

Ahmed Hamed (WSU) Texas A&M 04-28-06
Heavy-ion Physics: Asymptotic freedom


\[ \alpha_s(M_Z^2) = 0.118 \pm 0.005 \]

\[ \alpha_s(Q^2) = \frac{12\pi}{(33 - 2n_f)\log(Q^2/\Lambda^2)} \]

\[ \Lambda^2 = \mu^2\exp\left[\frac{-12\pi}{(33 - 2n_f)\alpha_s(\mu^2)}\right] \]

Gluon polarization drives \( \alpha_s \) down (anti-screening) at small distance.
At small distance \( r \leq 0.1 \text{fm} \) (one gluon exchange) \( \alpha_s \) is small, *Asymptotic freedom*.
At large distance \( r \geq 1 \text{fm} \) (no longer one gluon exchange) \( \alpha_s \) is large, *Confinement*.

**So what?**

Ahmed Hamed (WSU) 
Texas A&M 04-28-06

“In this case, one must expect the hadrons to overlap, and their individuality to be confused. Therefore, we suggest that matter at such high densities is a quark soup.”

**What is the equation of state?**

**What is the nature of the phases of hadronic matter?**

**Where?**

*The interior of neutron stars.*

*The collisions of heavy ions at very high energy per nucleon.*

*Early universe*

At $E_c \approx 1\text{GeV/fm}^3$, $\alpha_s \approx 1$ perturbative description is highly questionable.

**How to do calculations in the non-pQCD regime?**

Ahmed Hamed (WSU)  
Texas A&M 04-28-06
Ken Wilson: break up space and time into a lattice points—“Discretising”

Lattice QCD: conditions for this phase transition: “Two light and one heavier quark flavors” $T_c = 173 \pm 15 \text{MeV}$, $E_c = 0.7 \pm 0.2 \text{GeV/fm}^3$. F. Karsch, Nucl. Phys. A 698 199c (2002), hep-ph/0103314.

$$\varepsilon_{SB} = \left\{ 2_f \times 2_s \times 2_q \times 3_c + 2_s \times 8_c \right\} \frac{7}{8} \frac{\pi^2}{30} T^4 = 37 \frac{\pi^2}{30} T^4$$

The exact order of phase transition is not known.

Smooth nature of the transition increases the experimental challenges.

QGP near $T_c$ should not be regarded as an ideal gas of quarks and gluons. “sQGP”.

How to achieve such phase transition experimentally?

Ahmed Hamed (WSU) Texas A&M 04-28-06
Did we satisfy the phase transition conditions at RHIC?

The space-time picture and the different evolution stages of a relativistic heavy-ion collision.
Physics at RHIC: Energy density

\[ \langle \varepsilon(\tau_{\text{Form}}) \rangle = \frac{dN(\tau_{\text{Form}})}{dy} \]

\[ \langle m_T \rangle = \frac{dE_T(\tau_{\text{Form}})/dy}{dN(\tau_{\text{Form}})/dy} \approx \frac{dE_T/d\eta}{dN/d\eta} \] (Final state)

\[ \tau_{\text{Form}} \approx 0.35\text{fm/c} \quad \tau_{\text{Therm}} = 0.6\text{-}1.0\text{fm/c} \]

\[ <\varepsilon> = 15\text{GeV/fm}^3 \quad <\varepsilon> = 5.4\text{ to } 9.0\text{GeV/fm}^3 \]

\[ t = \hbar/m_T \]

AuAu at \( \sqrt{s} = 200\text{GeV} \)

\[ 15 \text{GeV/fm}^3 \]

\[ 5.4 \text{ to } 9.0 \text{GeV/fm}^3 \]

- RHIC collisions achieved energy density greater than the one predicted by lattice QCD for phase transition.

- What are the signatures for the new formed matter?

Ahmed Hamed (WSU)  
Texas A&M 04-28-06
Hydrodynamic calculations assume local thermal equilibrium in the early stage $t \leq 1 \text{ fm/c}$ to reproduce the magnitude of the observed $v_2$ at RHIC.

What about the elliptic flow of the non strongly interacting particles?
The invariant cross section for $\pi^0$ production in pp collisions at $\sqrt{s}=200\text{GeV}$ agrees with NLO PQCD predictions over the range $2.0 \leq p_T \leq 15\text{GeV}/c$.

The suppression of $\pi^0$s and $\eta$s is very similar which supports the conclusion that the suppression occurs at the parton level.

The binary scaling of direct photons is strong evidence that the suppression is not an initial state effect.

Why does the direct photon yield show such nice binary scaling?
Physics with STAR BEMC: Collective flow

Collective flow

- Longitudinal expansion
- Radial transverse flow
- Anisotropic transverse flow

Anisotropic flow $\equiv$ correlations with respect to the reaction plane

\[ v_1 = \langle p_x / p_T \rangle \]
\[ v_2 = \langle (p_x / p_T)^2 - (p_y / p_T)^2 \rangle \]
\[ \frac{d^2 N}{d\phi d\eta} = N_0 (1 + 2v_2 (p_T) \cos(2\phi)) \]

\[ \varepsilon = \frac{\langle y^2 \rangle - \langle x^2 \rangle}{\langle y^2 \rangle + \langle x^2 \rangle} \]

- Directed flow
- Elliptic flow
- Higher harmonics flow

\[ \frac{dN}{d\phi} \neq \text{const.} \]

No symmetry in the configuration space

Anisotropy in the momentum space

\[ v_2 \text{ is a measure of interactions in the system} \]

Why elliptic flow and how to measure it?

Ahmed Hamed (WSU) Texas A&M 04-28-06
**Physics with STAR BEMC: Elliptic flow**

- Elliptic flow can provide early time information on the collectivity of particles from Heavy-ion collisions.

$$v_2 = \frac{\langle p_x^2 \rangle - \langle p_y^2 \rangle}{\langle p_x^2 \rangle + \langle p_y^2 \rangle}$$

- Non-Central AA collisions result in an azimuthally anisotropic distribution of particles in coordinate-space.
- Density gradients and interactions between the particles lead to an asymmetry in momentum-space.
- Signal is self-quenching with time- **EARLY TIME OBSERVABLE!**

- Fourier Expansion:

$$\frac{d^3N}{d^3p} = \frac{1}{2\pi} \frac{d^2N}{p dp dy} \left( 1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi_r)] \right)$$

where

$$v_n = \langle \cos[n(\phi - \Psi_r)] \rangle,$$

and

$$\phi = \tan^{-1}(p_y/p_x)$$

- “Non-flow” – Any contribution to the azimuthal correlations and is not related to the reaction plane orientation, such as resonance decay, inter and intra jet correlations.

---

**Which photons are we after?**

---

Ahmed Hamed (WSU)  
Texas A&M 04-28-06
**Physics with STAR BEMC:**  Direct real photons

**Non-Thermal photons:**  
1. Prompt photons.  
2. Pre-equilibrium photons.

**Thermal photons:**  
1. QGP photons.  
2. Hadron gas photons.

**Background Photons:**  
Decayed photons.

**A+A collisions:**

- **Low $p_T$:**
  - Photons don’t strongly interact with fireball.

- **High $p_T$:**
  - Allow test of binary scaling for hard processes.
  - Important for interpretation of high-$p_T$ hadron suppression at RHIC.

**Why $v_2$ of direct photons is important?**

---

Ahmed Hamed (WSU)  
Texas A&M 04-28-06
Physics with STAR BEMC: \( \nu_2 \) of inclusive \( \gamma \)

What is the origin of the binary scaling of direct photon?

* "Jet quenching" photons.

- Bremsstrahlung
  * Enhancement

- Scattering
  * Suppression
  B.G. Zakharov, JETP Lett. 80, 1 (2004)

\( \nu_2 \) of Direct photons:

- Help to disentangle the different production mechanism of direct photon.
  - Coulomb: \( \nu_2=0 \)
  - Scattering: \( \nu_2>0 \) “tracks hadronic \( \nu_2 \)”
  - Bremsstrahlung: \( \nu_2<0 \)

- Thermal photons reflect the dynamical evolution of the formed matter.
  - STAR BEMC can probe for further higher transverse energy.
  - \( \nu_2 \) of inclusive photon is the first step toward \( \nu_2 \) of direct photon.

How to measure elliptic flow of inclusive photons?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
Physics with STAR BEMC: Analysis details and technique

Standard Method:
- Event plane reconstruction

\[ \psi_{EP} = \text{atan2}(\sum_i \sin^2 \varphi_1 i + \sum_i \sin^2 \varphi_2 i, \sum_i \cos^2 \varphi_1 i + \sum_i \cos^2 \varphi_2 i) \]

FTPC:
\[ 2\psi_{EP} = \text{atan2}(\sum_i \sin^2 \varphi_{w1} i + \sum_i \sin^2 \varphi_{w2} i + \sum_i \sin^2 \varphi_{E1} i + \sum_i \sin^2 \varphi_{E2} i, \sum_i \cos^2 \varphi_{w1} i + \sum_i \cos^2 \varphi_{w2} i + \sum_i \cos^2 \varphi_{E1} i + \sum_i \cos^2 \varphi_{E2} i) \]

Remove the acceptance bias:
- Event plane recentering:

\[ \sin^2 \varphi \rightarrow \frac{\sin^2 \varphi - M < \sin^2 \varphi / M >}{\cos^2 \varphi \rightarrow \frac{\cos^2 \varphi - M < \cos^2 \varphi / M >}{M: \text{number of tracks in each sub-event}} \]

Photons from BEMC:
- 2400 Towers \(0.05 \times 0.05\)
- \(0 < \eta < 1\), \(0 < \phi < 2\pi\), \(\delta E = 0.16 \sqrt{E}\)
- Each track is extrapolated to the BEMC face and the charged particles veto cut for the target tower is used

Energy Threshold:
- Minimum Bias: \(E > 0.1 \text{GeV}\)
- High Tower: \(E > 3 \text{GeV}\)

QA of BEMC:
- Check the uniformity of BEMC.

Correlating inclusive photon with event plane:
\[ v_2 \text{ Observed} = < \cos(2\delta_{\text{tower}} - 2\psi_{EP}) > \]

Finite multiplicity:
- Correction for event plane resolution:
\[ v_2 \text{ Real} = \frac{v_2 \text{ Observed}}{\sigma} \]

What is the result?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
At low and intermediate $E_T$, the $\nu_2(E_T)$ behavior of inclusive $\gamma$ is consistent with that of other mesons which indicate the dominance of $\pi^0$ in that range.

At high $E_T$, although the statistical errors are large, it is clear that $\nu_2$ decreases with $E_t$ but it is still finite.

**Is the finite value of $\nu_2$ at high $P_t$ flow or non flow effect?**
The scalar product is the same for all collision systems in the case of only "non-flow".

The difference results from the collective motion and/or effects of medium modification.

There is a clear contribution from the so called "non-flow" in TPC.

The azimuthal correlations is dominated by nonflow effects at high $E_t$.

How to reduce the non flow effect?
Physics with STAR BEMC: reducing non-flow effect

- The so-called “nonflow” contribution in FTPC is very negligible.
- The behavior of the azimuthal correlations with centrality shows strong evidence for elliptic flow at low and moderate Et.
- The quantitative similarity between $v_2(E_t)$ of inclusive photons with that of hadrons is a promising sign for negligible amount of $v_2(E_t)$ of direct photons.

Toward direct photons!

Ahmed Hamed (WSU)  Texas A&M  04-28-06
Physics with STAR BEMC:

- Cross Section for 2 Towers

**Towers**

\[ \phi \text{-Cross Section for 2 Towers} \]

\[ \sim 0.05 \times 0.05, \sim 20X_0, \delta E \approx 16\% \sqrt{E} \]

**SMDs**

\[ \sim 0.007 \times 0.007, \sim 5X_0, \delta E = 12\% E + 86\% \sqrt{E} (GeV) \]

\[ \sigma_\eta (mm) = 2.4 + 5.6/\sqrt{E} (GeV) \]

\[ \sigma_\phi (mm) = 3.2 + 5.8/\sqrt{E} (GeV) \]

Ahmed Hamed (WSU)  
Texas A&M 04-28-06
Physics with STAR BEMC: Reasons for new cluster finder

- Heavy peak at low invariant mass region.
- No $\pi^0$ invariant mass peak is seen in the high multiplicity system.
- No low invariant mass peak in simulation.

How we can solve these problems!

Ahmed Hamed (WSU)  Texas A&M 04-28-06
Physics with STAR BEMC: BEMC and $\pi^0$ decay kinematics

- Cluster size is small to resolve the two decayed photons at high $P_t$.
  - How much small is small? $\theta_{\min} = 2 \sin^{-1} \left( \frac{m_{\text{inv}}}{E} \right)$, $\tau \sim 10^{-17} \text{ s}$
  - Towers ($\sim 0.05 \times 0.05$), Strips ($\sim 0.007 \times 0.007$), $d \sim 2.2 \text{ m}$ at $\eta = 0$, $l \sim 2.93 \text{ m}$.

- The separation between the two decayed photons at the BEMC face $\leq 2$ towers for a $\pi^0$ with $P_t \geq 2.8 \text{ GeV}$.

- The asymmetry increases with the $\pi^0$ energy at the same opening angle.
  $$\alpha = \sqrt{1 - \frac{m_{\text{inv}}^2}{E^2}} \sin^2(\theta/2) \quad \text{where} \quad \alpha = \frac{|E_1 - E_2|}{E_1 + E_2}$$
  $\theta$: opening angle, $E$: total energy of $\pi^0$, $E_1$ and $E_2$: energies of $\gamma$s

What are the right variables for the ideal case?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
Physics with STAR BEMC: No clustering just Monte Carlo

Energy asymmetry vs. opening angle

Under this line each $\gamma$ have energy $\geq 0.25\text{GeV}$ and 7.33% efficiency is lost.

Asymmetric decay

Under this line each $\gamma$ have energy $\geq 0.75\text{GeV}$ and 23.79% efficiency is lost.

5k neutral pions

$5.0\text{GeV/C} \leq P_t \leq 6.0\text{GeV/C}$

$0 < \eta < 1$

$-\pi < \phi < \pi$

Lower momentum bands

Higher momentum bands

Entries

$\pi^0 \rightarrow 2\gamma$

$P_t$

Range (GeV/C)

Efficiency lost %

$E_{\gamma_1,\gamma_2} \geq 0.25\text{GeV}$

$E_{\gamma_1,\gamma_2} \geq 0.75\text{GeV}$

1-2

16.56

28.77

84.24

53.46

2-3

12.52

9.36

37.72

28.77

3-4

16.56

7.33

23.79

28.77

4-5

12.52

6.40

19.54

15.28

6-7

5.49

4.63

16.74

15.28

7-8

4.63

4.84

14.18

14.18

9-10

4.11

3.95

11.73

11.68

10-11

3.07

2.79

9.39

9.39

11-12

2.82

3.07

7.92

9.62

12-13

14-15

3.95

2.79

9.39

9.39

What is the clustering algorithm?

Geometrical efficiency dependence of the decayed photon energies

Ahmed Hamed (WSU)

Texas A&M 04-28-06
**Physics with STAR BEMC: New cluster finder’s algorithm**

**General Criteria:**

1. The central strip of each cluster is included completely in one tower.
2. The cluster size is three strips in Eta and seven strips in Phi.
3. The minimum distance between two points is two strips in Eta or three strips in Phi.
4. The distance between the center of the tower to the point’s position $\leq 0.03$.

**Position:**

- $X$ and $Y$ components are determined from Phi strips.
- $Z$ component is determined from Eta Strips.

**Energy:**

- EM shower characteristics.
- Relative position to the center of the tower.
- Separation between the two points “only if the separation $\leq 2$ towers”.

**Is there cluster splitting?**
Low Invariant mass for this \( P_t \) bin and \( \pi^0 \) candidate for the next higher \( P_t \) bin.

High Invariant mass for this \( P_t \) bin and \( \pi^0 \) candidate for the next lower \( P_t \) bin.

\[ \text{Energy asymmetry vs. opening angle} \]

\[ \text{5k neutral pions} \]
\[ 5.0 \text{GeV/C} \leq P_t \leq 6.0 \text{GeV/C} \]

\[ \text{Why cluster splitting is of big concern for } \pi^0 \text{ reconstruction?} \]

\[ \text{Are the dots outside the band } \pi^0 \text{s?} \]

Assuming perfect resolution: Certainly they aren’t \( \pi^0 \)s with \( p_t \) between 5 and 6GeV/c but they are \( \pi^0 \) candidates for other \( p_t \) bins.

\[ \text{Is the asymmetry cut efficient here?} \text{It is obvious NO.} \]

\[ \text{Are all the dots inside the band } \pi^0 \text{s?} \]
Physics with STAR BEMC: Cluster splitting consequences

New Cluster Finder:
Energy seedTower & SMDs $\geq 0.25 \text{GeV} \& \geq 0.2 \text{GeV}$

Energy of the original decayed photons is very close to the energy of the $\pi^0$ and unusual small opening angle b/w the two photons “splitting from the original one” will result in small invariant mass and right momentum.

Fake $\pi^0$
For $\pi^0$ with high energy, the energy of the original decayed photon is high and the small invariant mass overlaps with $\pi^0$ mass region and finally we have right mass and right momentum.

Cluster splitting doesn't just smear the $\pi^0$ peak but can create $\pi^0$ too.

What is effective cut for cluster splitting?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
Physics with STAR BEMC: Cluster splitting removal

- No successful study for the EM shower shape so far using STAR BEMC.
- No cluster splitting effect for the large opening angle decayed photons.
  - The distribution is peaked heavily around the minimum opening angle.
  - The energy threshold is already greater than energy of one of the decayed photon in the asymmetric decay case for $\pi^0$ with low $P_t$.

Use the $\pi^0$ decay kinematics to remove the cluster splitting.

1. No conditions but the energy seeds as long as the separation between the decayed photons is greater than two towers.
   
   The cuts must change with the $\pi^0$ energy since the kinematics change with $\pi^0$ energy. How do you know the $\pi^0$ energy before reconstructing the $\pi^0$?!

2. Adjacent tower:
   
   a) $E_{\text{photon}} < 10\text{GeV}$: $E_{\text{tower}} = 1.2\text{GeV}$, $\alpha_{\text{tower}} = 0.6$
   b) $E_{\text{photon}} > 4\text{ GeV}$: $E_{\text{point1}} + E_{\text{point2}} > 5.5\text{GeV}$.
   c) $E_{\text{photon}} > 10\text{GeV}$: $E_{\text{tower}} = 3\text{GeV}$, $\alpha_{\text{tower}} = 0.6$

3. Same tower: $E_{\text{tower}} > 10\text{GeV}$

4. Adjacent towers or same tower, same module and same sub:
   
   $E_{\text{smds}} > 0.25\text{GeV}$ and $\alpha_{\text{SMDs}} < 0.66$

5. Across the modules cut: Adjacent modules and Tower Id2=Tower Id1+20: $\alpha_{\text{tower}} \leq 0.35$

Does it work?
No proper removing of cluster splitting can create $\pi^0$
How much cluster splitting is still left?

- Improving efficiency of the higher $p_t$ bins produces cluster splitting in lower $p_t$ bins.
- The invariant mass plot, $p_t$ of the reconstructed pairs plot, and the distribution in the opening angle plot are not enough to distinguish between fake and real $\pi^0$.
- It should be shown that the algorithm doesn’t create fake $\pi^0$.

What about the real data?

Simulation: 5k event, 3 photons in each event, $1 \leq p_t \leq 15\text{GeV/c}$, uniform distribution in $\eta$ and $\phi$.

Cut: Cluster splitting removal

$
\begin{align*}
\text{Cluster splitting efficiency after cut} & \quad \text{Cluster splitting efficiency before cut} \\
\text{\textbullet \, \pi^0 \, efficiency after cut} & \quad \text{\textbullet \, \pi^0 \, efficiency before cut}
\end{align*}
$

Ahmed Hamed (WSU) Texas A&M 04-28-06
Physics with STAR BEMC: New cluster finder results

Extrapolate the track to the BEMC face and set the energy of the target tower to zero.

Simulation
All Paris
Rejected pairs
Accepted pairs
All pairs+ α ≤ 0.3

MinBias

pp@200GeV

pp@200GeV

MinBias

dAu@200GeV

High tower 1

MinBias

dAu@200GeV

High tower 2

3.5GeV/C ≤ Pt ≤ 4.0GeV/C

2.0GeV/C ≤ Pt ≤ 2.5GeV/C

14.0GeV/C ≤ Pt ≤ 15.0GeV/C

Does it work too in the other collision systems?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
Physics with STAR BEMC: New cluster finder results

Who was wearing glasses in the first slide?

Ahmed Hamed (WSU)  Texas A&M 04-28-06
The elliptic flow of non strongly interacting particles is very important for confirming the collective motion of the hadronic particles in the formed matter at RHIC.

The similarity of the elliptic flow of inclusive photons with that of other mesons implements that the elliptic flow of direct photons is negligible.

The elliptic flow of inclusive photons decreases with transverse momentum at high $P_t$ but it is still finite.

The azimuthal correlations results using the scalar product method show the dominance of non flow effect at high $P_t$.

The cluster splitting in the new cluster finder is very well understood and it is under control.

The invariant mass plot and $p_t$ of the reconstructed pairs plot are not enough to distinguish between fake and real $\pi^0$. It should be shown the algorithm doesn’t create fake $\pi^0$.

All the relevant problems with $\pi^0$ reconstruction at STAR BEMC are solved.

Two important steps toward the final results of direct photons elliptic flow are made.
Many thanks to:
Rene Bellwied  Thomas Cormier  Claude Pruneau  Sergei Voloshin
All STAR Collaborators
And especial thanks to all of you

“I must seem like an ostrich who forever buries its head in the relativistic sand in order not to face the evil quanta”

“I think I can safely say that nobody understands quantum Mechanics”