π^0 Azimuthal Anisotropy in Central d+Au Collisions at 200 GeV with PHENIX at RHIC

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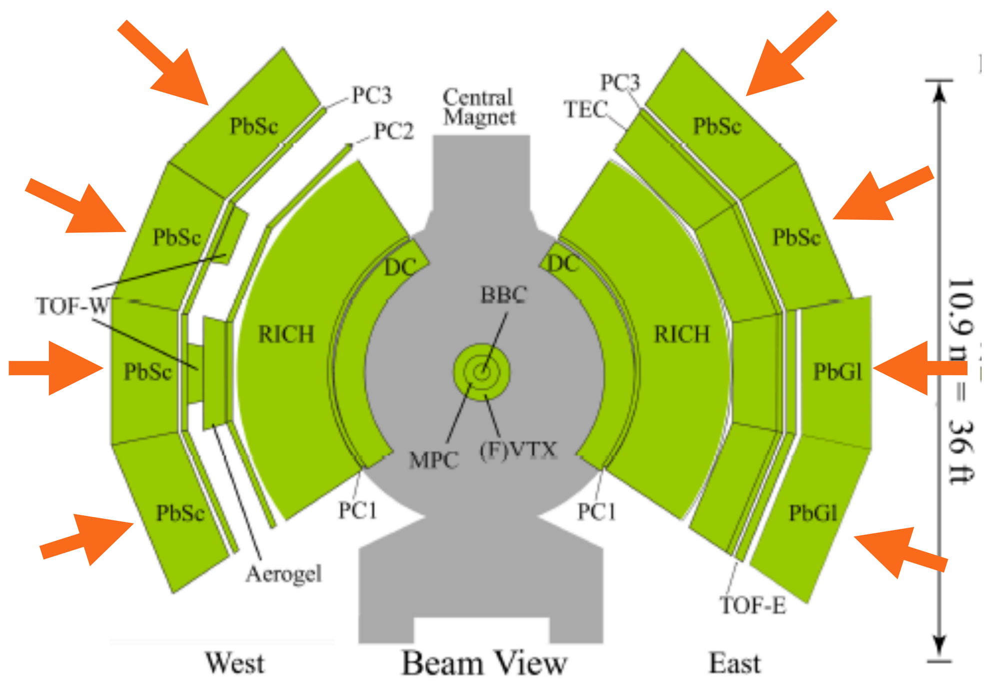
1. Abstract

The study of anisotropic flow provides strong constrains to the evolution of the medium produced in heavy ion collisions and its event-by-event geometry fluctuations. These observables have long been related to collective behavior in the formed medium. Recent results both at RHIC and LHC provide strong evidence for the formation of such medium in smaller systems. RHIC has had a broad program to study the physics of small systems by systematically varying the collision energy and Ion configuration for a better understanding of the underlying physics. PHENIX recorded data from d+Au collisions at 200GeV and smaller energies in 2016 using a special trigger which enhances statistics for the very central collisions. Here we show our recent anisotropic flow measurements for fully reconstructed π^0 at $-0.35 < \eta < +0.35$ in d+Au collisions.

2. Motivation

- A large Elliptic flow v_2 has been found in d+Au collision at 200 GeV for charge particles and identified charged pions and protons up to 2.5 GeV
- The low p_T behavior has been accurately predicted by hydrodynamical models
- Other signs of plasma formation, which include modification of the hadronization mechanisms and jet quenching, are present in heavy ion collisions but have not yet been identified in small systems
- We analyze the anisotropic flow measured of identified neutral pions over a large transverse momentum (0.8 up to 12 GeV) range
- Results provide unprecedented handle for the dynamics at high p_T in small systems

3. Experimental Setup



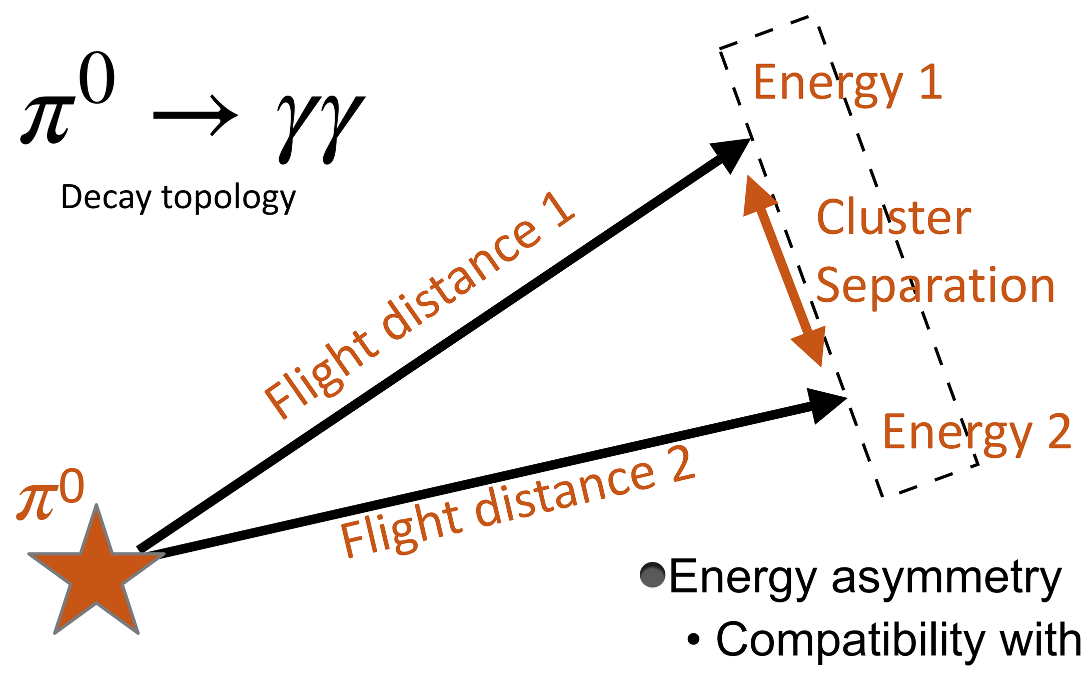
Beam Beam Counter

- Consists of 64 channels distributed in full azimuth
- Pseudorapidity span [3.1, 3.9]

Electromagnetic Calorimeter

- Consists of eight sectors (four at each side) with more than 25k channels
- Pseudorapidity span [-0.35, +0.35]

4. π^0 Identitication



- Cluster shape
  - Compatible with photon-like signature
- Time of flight (ToF) from interaction point to center of cluster
  - Compatibility with photon-like ToF
- Energy asymmetry
  - Compatibility with energy balanced photons
- Cluster centroid separation
  - Avoids cluster merging between two photons

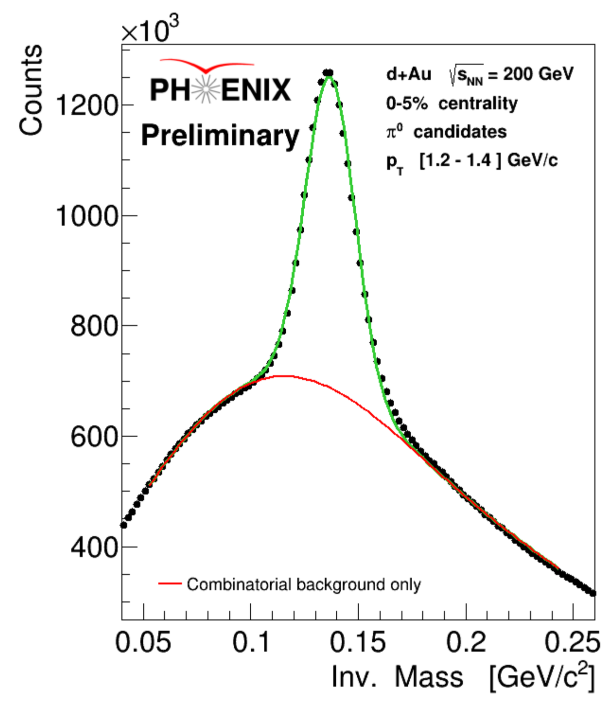
5. Azimuthal Anisotropy

Extraction of π^0 v_2

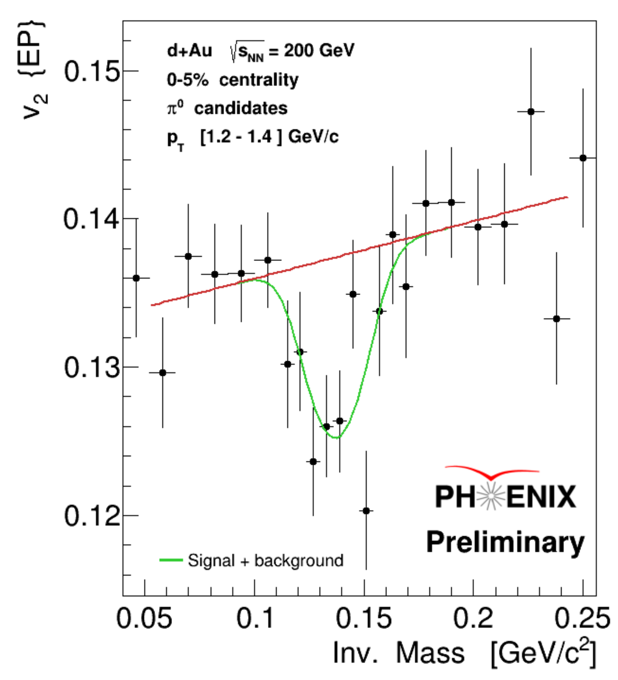
$$(S+B)\,v_n = S\,v_n^S + B\,v_n^B, \quad \rightarrow \quad v_n(W) = f_S(W)\,v_n^S + f_B(W)\,v_n^B(W),$$

where

$$f_S(W) = \int_\Delta \mathrm{d}w \frac{S(w)}{S(w)+B(w)} \qquad f_B(W) = \int_\Delta \mathrm{d}w \frac{B(w)}{S(w)+B(w)}$$

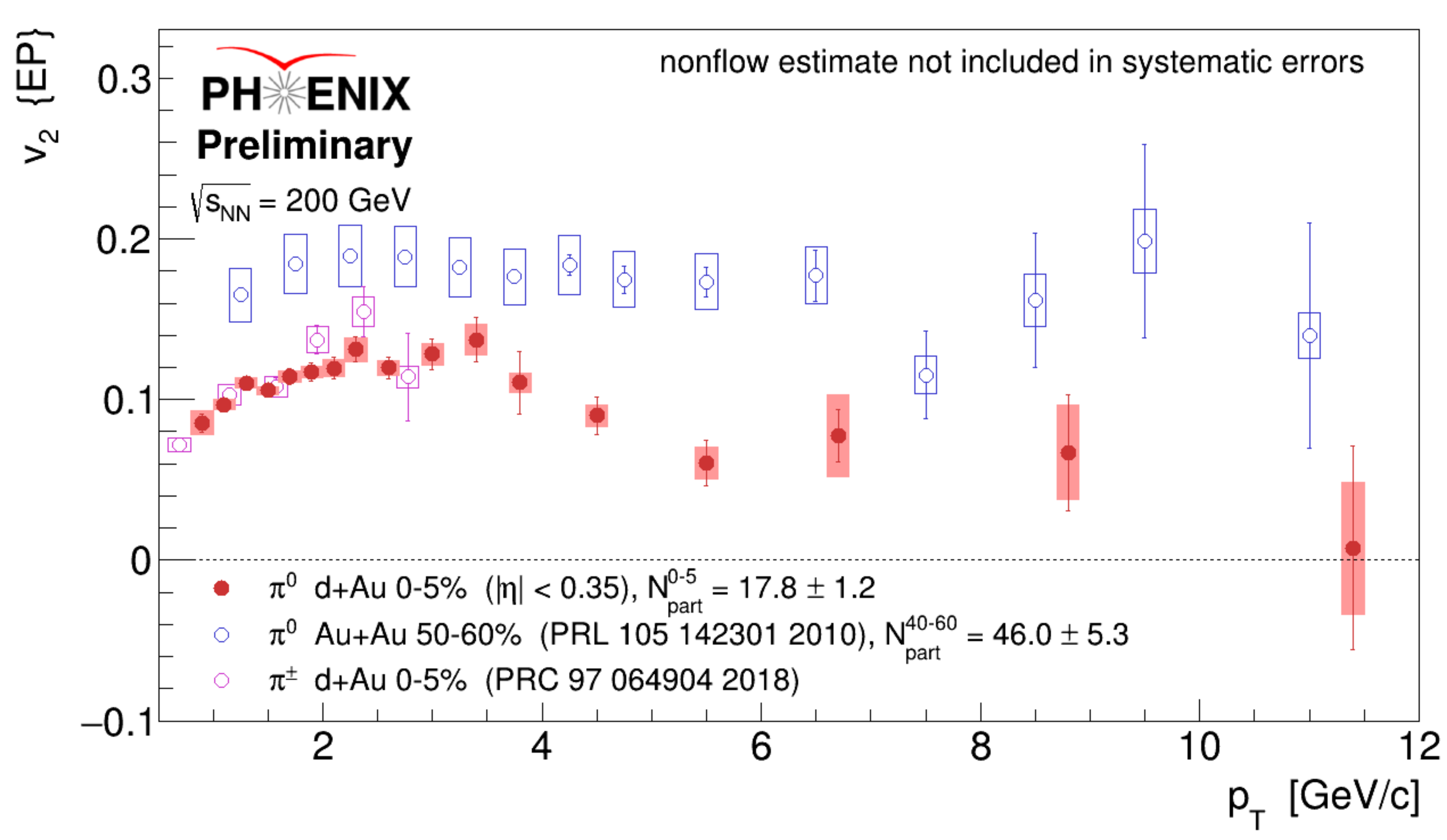


Example of the invariant mass distribution for π^0 candidates. Background is estimated via mix-event sample.



Example of v_2 for candidates as a function of their invariant mass. The background flow is modeled continuously via different polynomial shapes.

6. Results



Our new results on π^0 v_2 at d+Au 0-5% (in red) agrees with previous publication of charged pions (PRC).

Our new results in d+Au has a similar trend when compared to our previous publication on most peripheral Au+Au collisions (PRL). No scaling via N_{part} was done, however we quote the N_{part} for d+Au system and for Au+Au collisions in slightly wider centrality class.

7. Discussion

- New π^0 v_2 measurement from 0.8 up to 12 GeV in p_T was presented.
- At low p_T, v_2 of π^0 and π^{+-} are fully compatible pointing to a common origin.
- At high p_T, π^0 v_2 seems to saturate to a positive value. Moreover the overall shape of the anisotropy is similar to that found in Au+Au collisions at high p_T. Could they both share the underlying phenomena? Path length dependence?
- The analysis of other small systems will complement the current results and provide additional information to the physics of small systems.