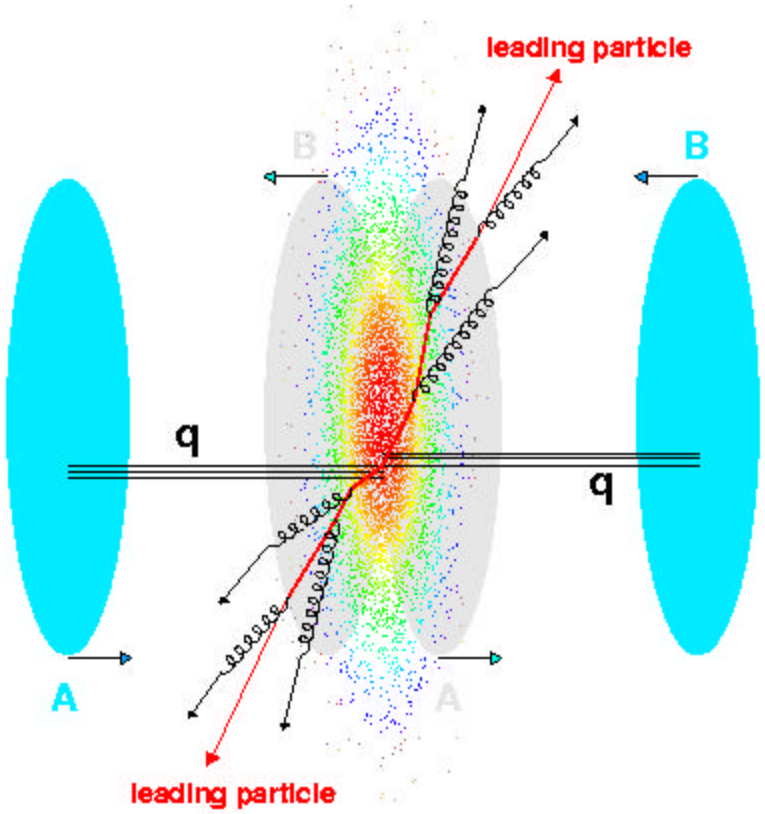
High transverse momentum charged particles azimuthal correlations in PHENIX

Jan Rak *for* PHENIX *collaboration*

- Hard scattering in nuclear collisions.
- Signals of hard scattering in *AA* collisions
  - inclusive particle yields
  - two particles correlations.
- Azimuthal correlation function
  - various sources of two particle correlation.
- Year 1 PHENIX azimuthal correlations @ $\sqrt{s}$ = 130 AGeV
  - centrality dependence
  - $p_{\perp}$ -dependence.
- Summary & outlook.

Hard scattering in Heavy Ion collisions

schematic view of jet production



Jets:

- primarily from gluons at RHIC
- produced early ($t<1fm$)
- sensitive to the QCD medium (dE/dx)

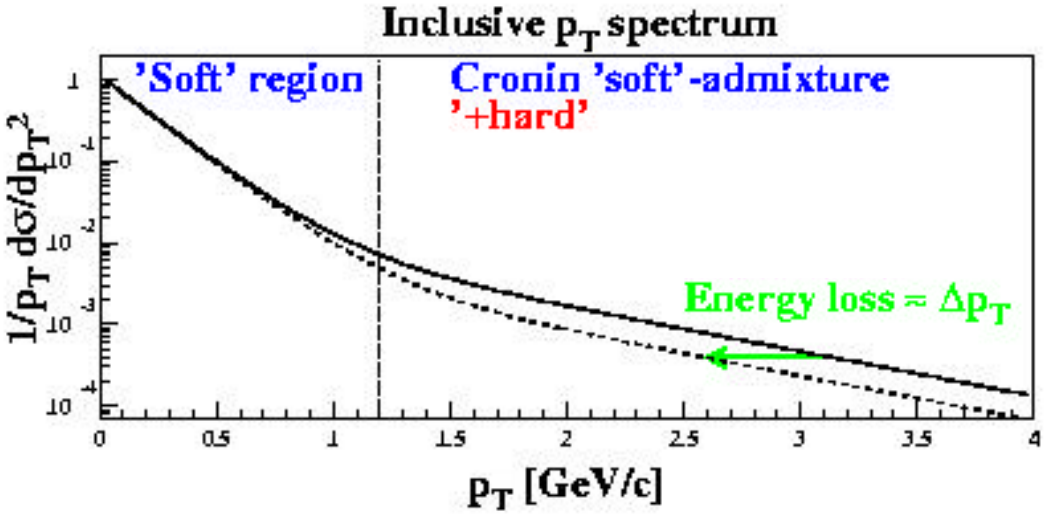
Observed via:

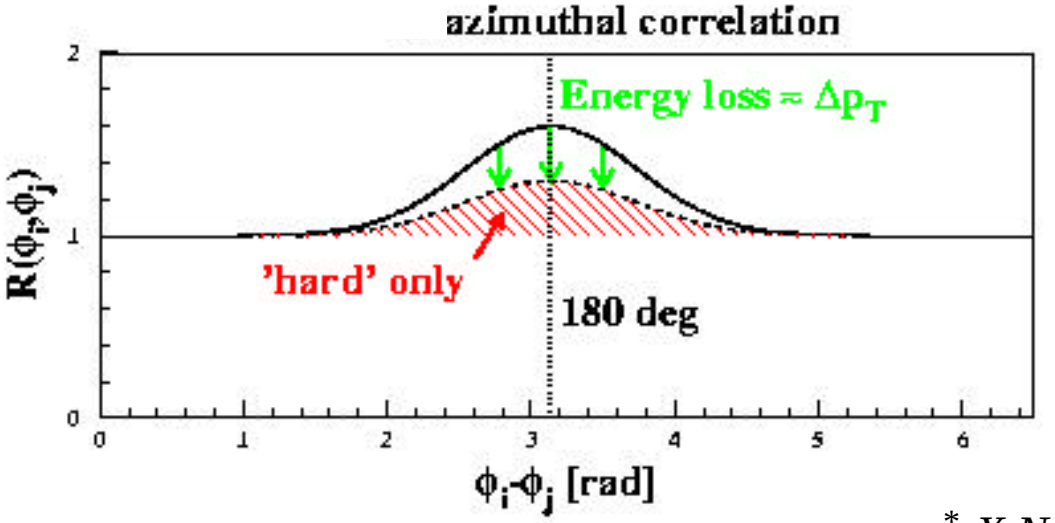
- fast leading particles or
- azimuthal correlations between them

Mechanisms of energy loss in vacuum (*pp)* is understood in terms of formation time and static chromoelectric field regeneration* . Any nuclear modification of this process could provide a hint of QGP formation.

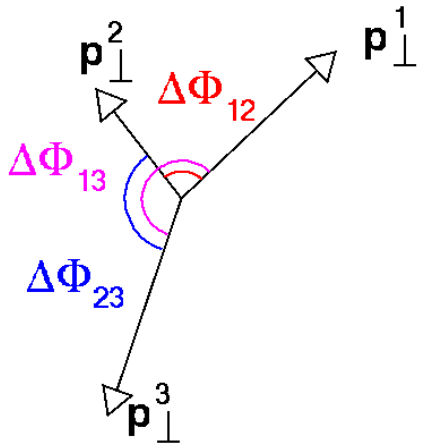
* *F.Niedermayer, Phys.Rev.D34:3494,1986.*

Hard scattering signals





Hard scattered partons should fragment into two back-to-back particles in azimuth.



Partonic energy loss may*

- reduce the back-to-back peak
- modify the fragmentation function - near angle peak

* *X.N. Wang, Phys.Rev.Lett.81:(1998)2655*

Correlation function

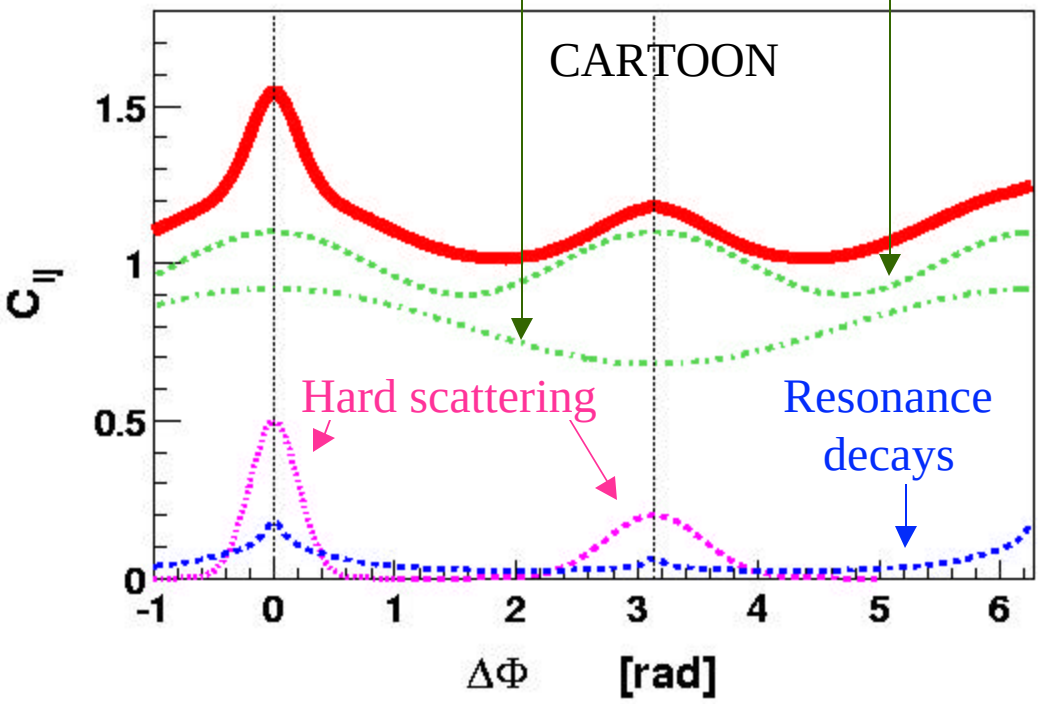
$$C(\Delta\phi) = \frac{N_{real}(\Delta\phi)}{N_{mixed\ events}(\Delta\phi)}$$

$$\Delta\phi = \phi_i - \phi_j$$

Directed flow | Elliptic flow

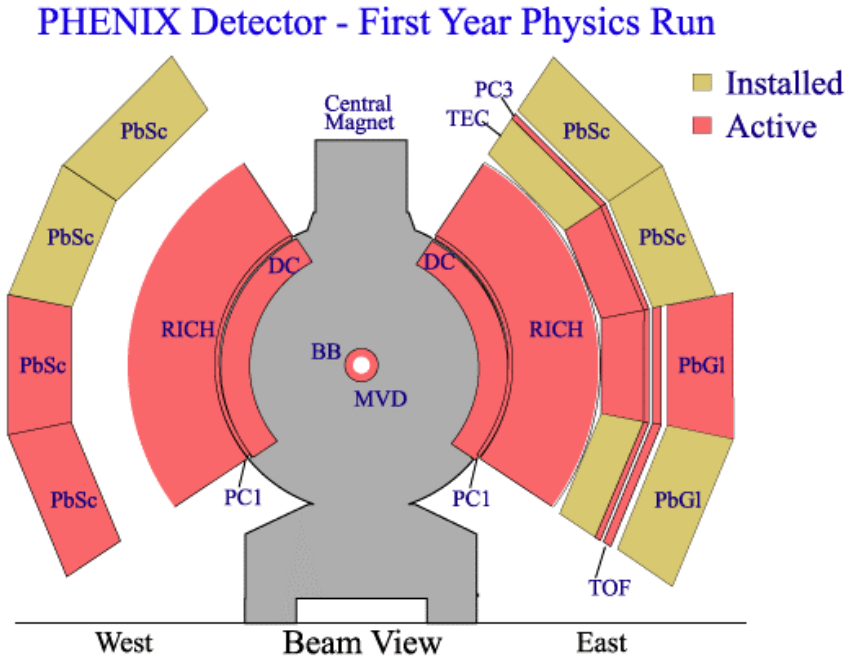
$$C(\Delta\phi)_{flow} \propto (1 + 2v_1^2\cos(\Delta\phi) + 2v_2^2\cos(2\Delta\phi))$$

Even @ RHIC energy, flow phenomena still dominates over signals from hard scattering.



J.Y.Ollitrault, nucl-th/0004026

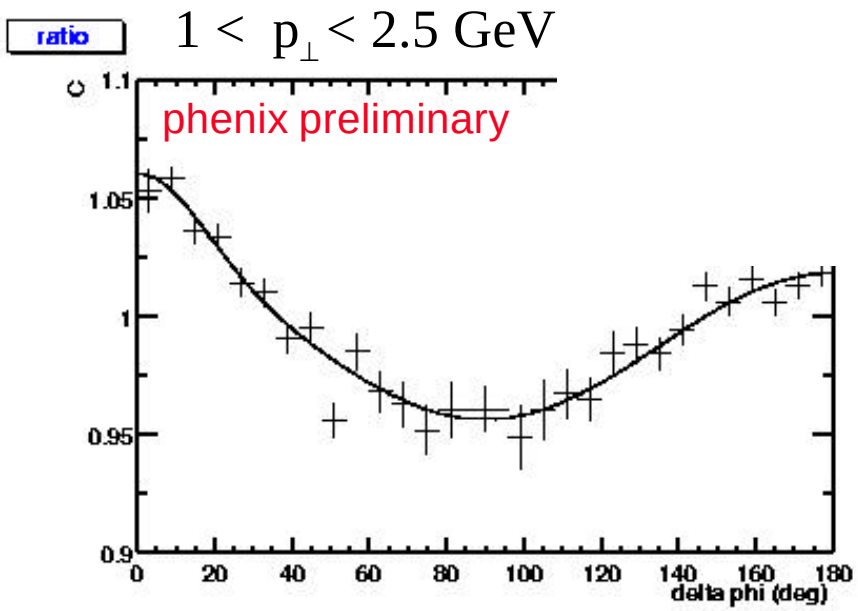
RUN1: summer 2000 ~5M events



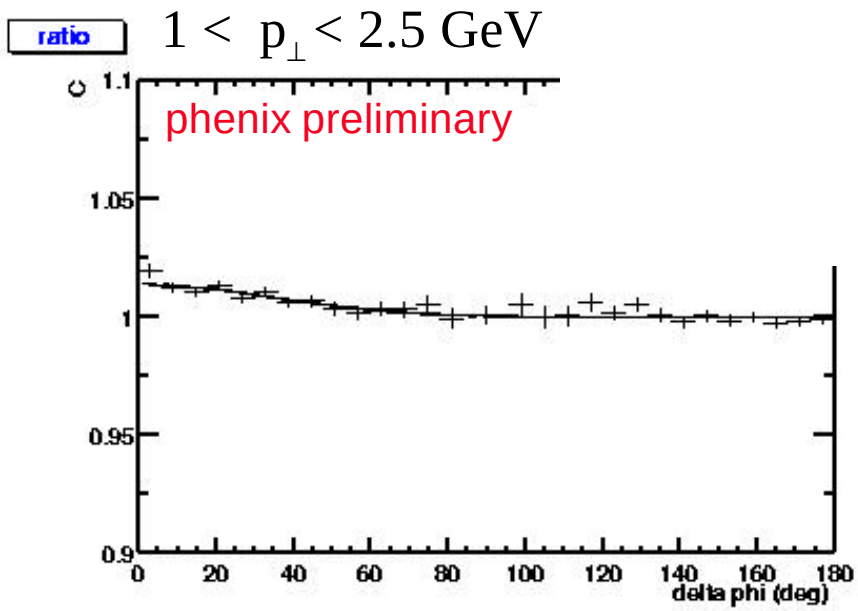
- 1.5M events analyzed
- -20 < collision vertex < 20 cm
- Central arm tracks
  - momenta from drift chamber tracks
  - 1 < pt < 2.5 GeV
- Correlation functions
  - mixed events from similar beam-vertex, centrality

Correlation function Au+Au ös = 130 AGeV

40 to 92%



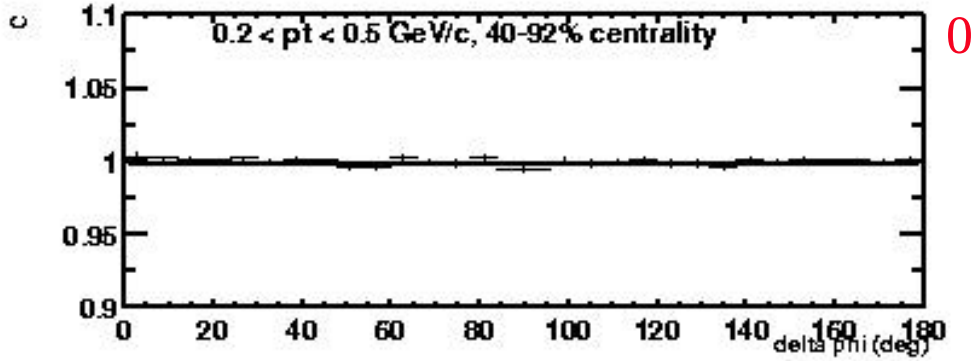
0 to 5%



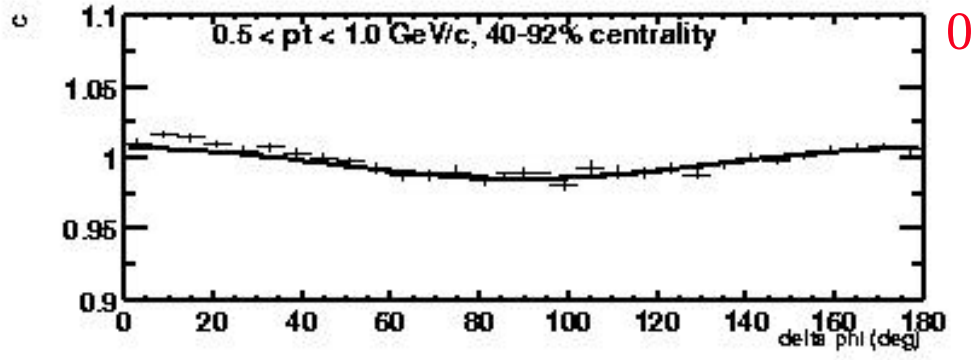
$$C(\Delta\ddot{o}) = \ddot{e}.e^{-0.5(\Delta\varphi/\sigma)^2} + 2\,v_2^{\,2}\cos(2\Delta\ddot{o}) + \text{offset}$$

- Near-angle correlation is stronger than back-to-back.
- Both correlations diminish in central collisions.

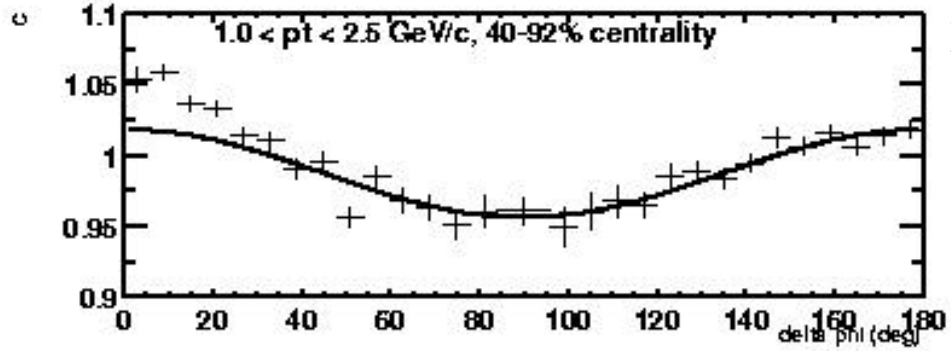
$p_\wedge$-dependence



$0.2 < p_\perp < 0.5$ GeV



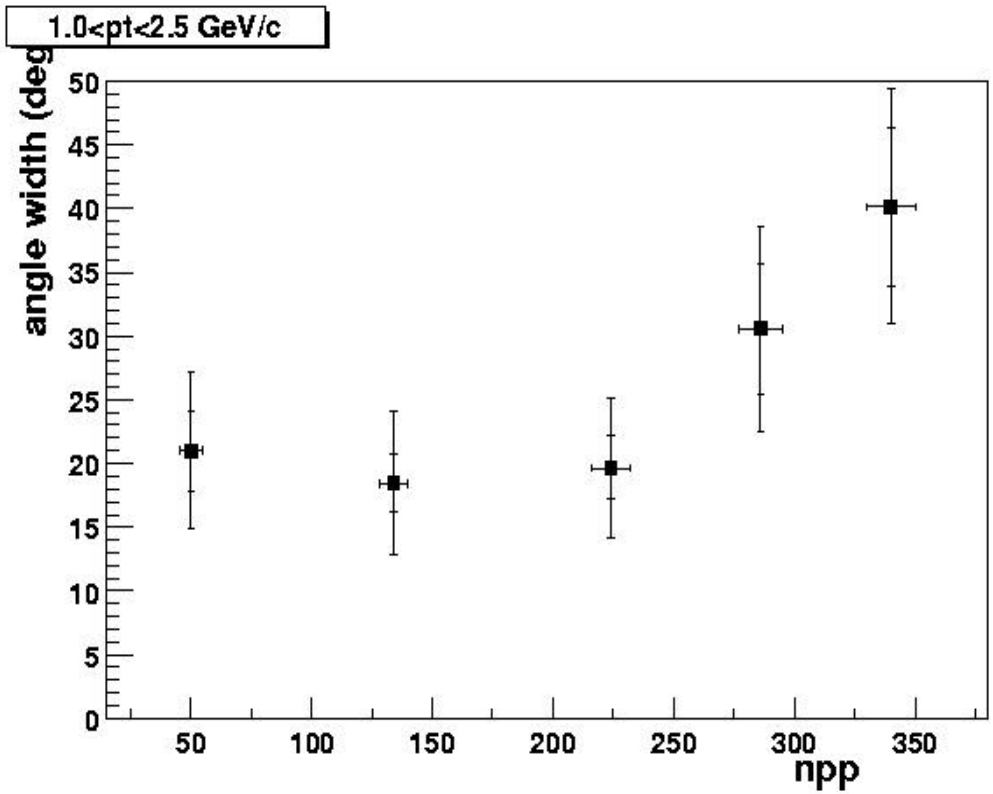
$0.5 < p_\perp < 1.0$ GeV



$1.0 < p_\perp < 2.5$ GeV

Grows with $p_\perp$, near-angle stronger than back-to-back correlations.

Angular width

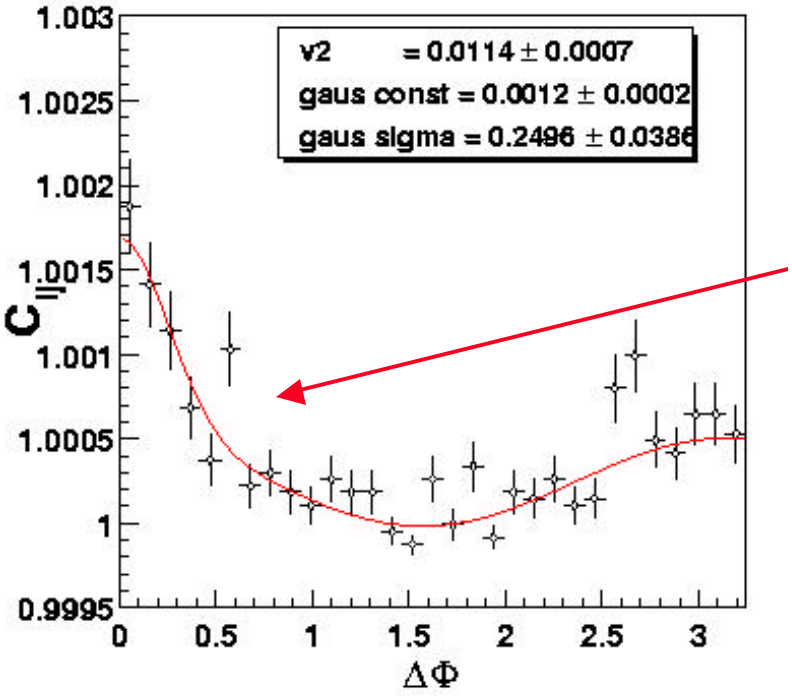


- Not modified jets would have an angular width ≈ 20 deg.
- Nuclear modification (dE/dz) could lead to the broadening of the correlation peak.
- This broadening should be stronger in central collisions. Do we see this?

The $p_{\perp}$ dependence of angular width should provide stringent test of presence of jet signals. More statistic needed.

Possible sources of angular correlation

UrQMD Monte-Carlo

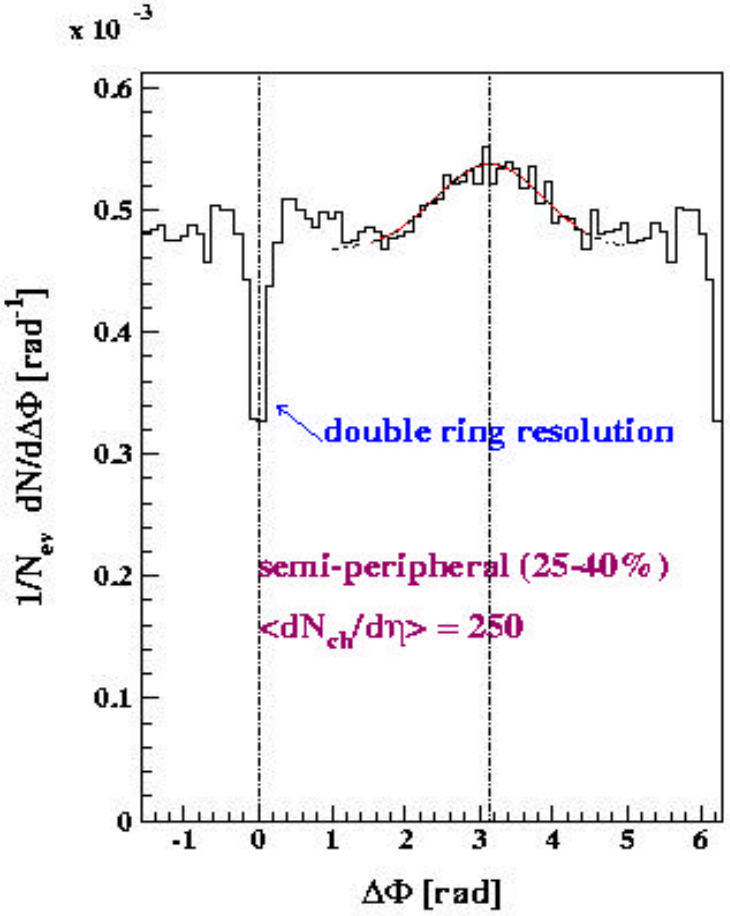


- Flow:
  - shape of the correlation is given by cos(ΔΦ) term. The relative contribution could be fixed by use of different techniques (reaction plane analysis).
- Resonance decay: (UrQMD simulation)
  - $p_\perp$-cut removes large fraction.
- Weak decay:
  - Long lived particles (K_S^0 $c\tau$=2.7cm, Λ $c\tau$=7.9cm) decays in the mag. field and the daughters look like high-$p_\perp$ particles.

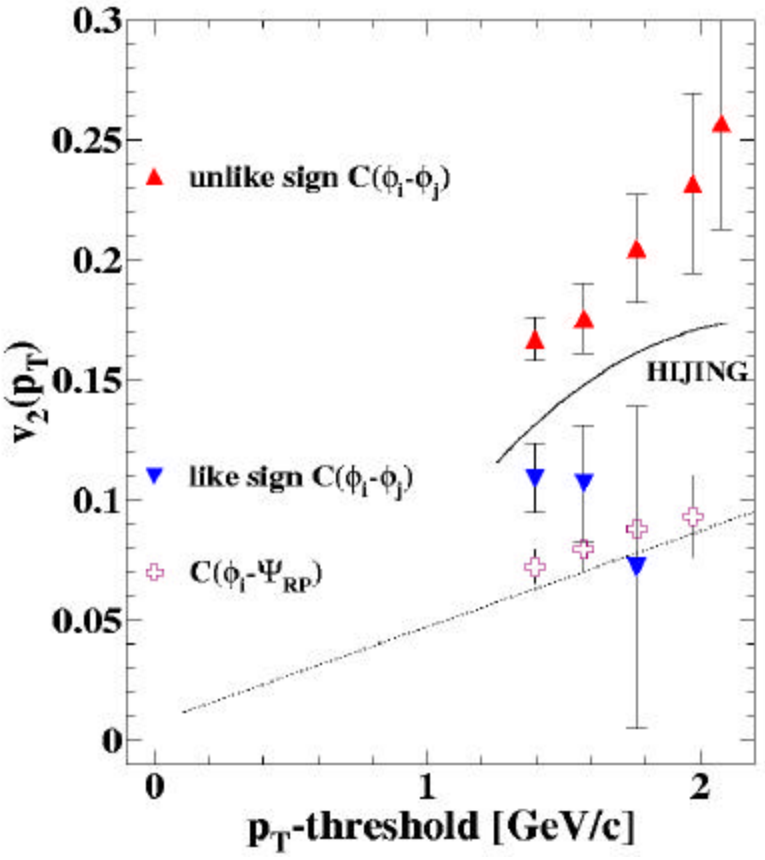
SPS high-$p_\wedge$ pions correlations

CERES experiment $\sqrt{s}$ = 17 GeV/c Identified $\pi^{\pm}$

Back-to-back more pronounced



v_2 like analysis



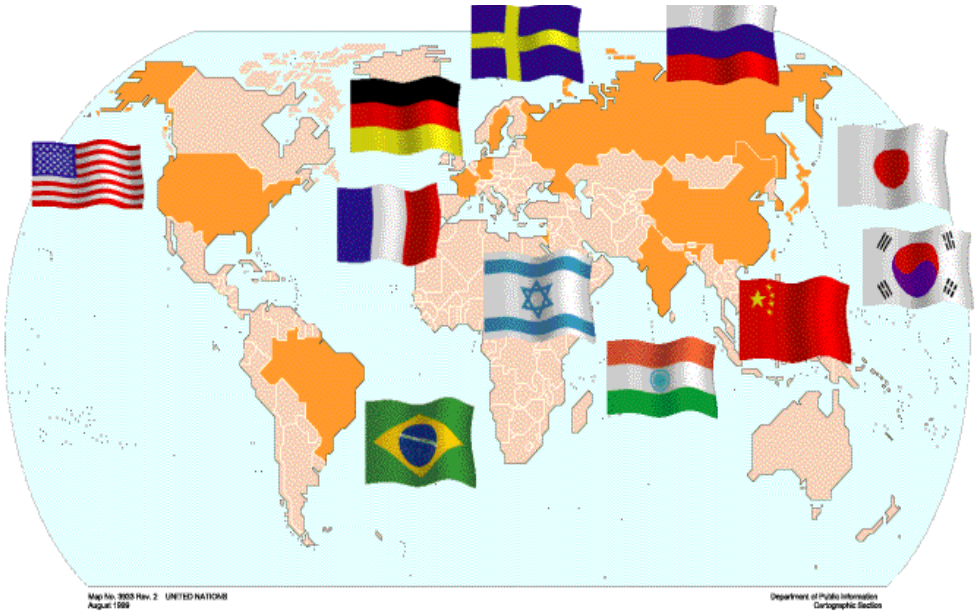
Summary & outlook

- Angular correlations seen in PHENIX data are in accord with elliptic flow measurement. Small excess at near-angle correlations above the flow contribution is observed.
- This excess grows with $p_\perp$.
- The angular width is rather constant with centrality, but starts to grow for most central bins.
- Not all possible sources of observed correlation are understood. The main remaining worry concerns the weak decays in magnetic field. Detailed Monte-Carlo simulation is in progress.

Outlook

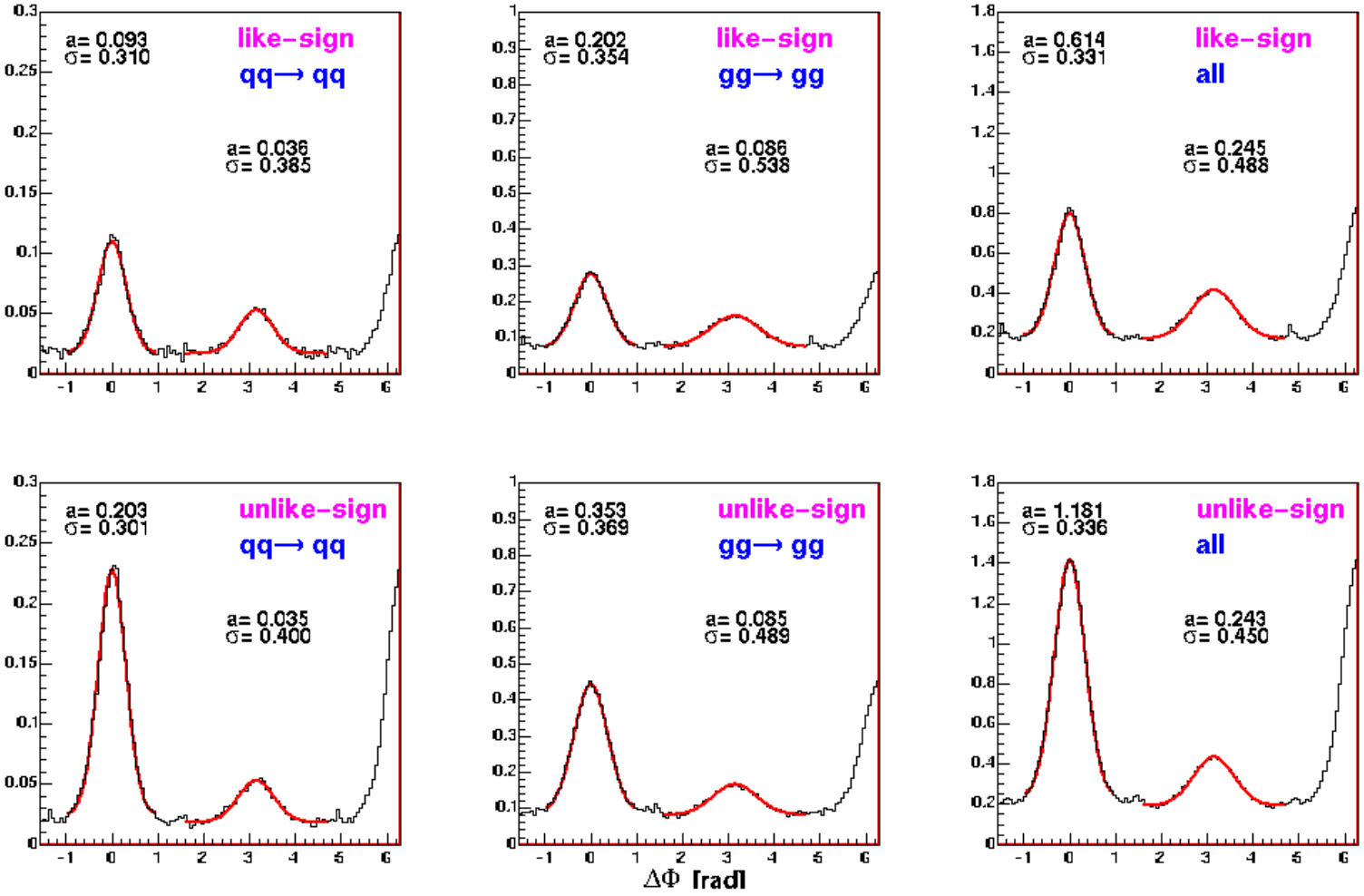
- New data @ 200 GeV is coming with better efficiency and much higher statistics.
- High- $p_\perp$ level-2 trigger is operational – allows to study the correlation in much higher $p_\perp$ range.

PHENIX



University of São Paulo, São Paulo, Brazil
Academia Sinica, Taipei 11529, China
China Institute of Atomic Energy (CIAE), Beijing, P. R. China
Laboratoire de Physique Corpusculaire (LPC), Universite de Clermont-Ferrand, 63170 Aubiere, Clermont-Ferrand, France
Dapnia, CEA Saclay, Bat. 703, F-91191, Gif-sur-Yvette, France
IPN-Orsay, Universite Paris Sud, CNRS-IN2P3, BP1, F-91406, Orsay, France
LPNHE-Palaiseau, Ecole Polytechnique, CNRS-IN2P3, Route de Saclay, F-91128, Palaiseau, France
SUBATECH, Ecole des Mines at Nantes, F-44307 Nantes, France
University of Muenster, Muenster, Germany
Banaras Hindu University,Banaras, India
Bhabha Atomic Research Centre (BARC),Bombay, India
Weizmann Institute, Rehovot, Israel
Center for Nuclear Study (CNS-Tokyo), University of Tokyo, Tanashi, Tokyo 188, Japan
Hiroshima University, Higashi-Hiroshima 739, Japan
KEK, Institute for High Energy Physics,Tsukuba, Japan
Kyoto University, Kyoto, Japan
Nagasaki Institute of Applied Science, Nagasaki-shi, Nagasaki, Japan
RIKEN, Institute for Physical and Chemical Research, Hirosawa, Wako, Japan
University of Tokyo, Bunkyo-ku, Tokyo 113, Japan
Tokyo Institute of Technology, Ohokayama, Meguro, Tokyo, Japan
University of Tsukuba, Tsukuba, Japan
Waseda University, Tokyo, Japan
Cyclotron Application Laboratory, KAERI, Seoul, South Korea
Kangnung National University, Kangnung 210-702, South Korea
Korea University, Seoul, 136-701, Korea
Myong Ji University, Yongin City 449-728, Korea
System Electronics Laboratory, Seoul National University, Seoul, South Korea
Yonsei University, Seoul 120-749, KOREA
Institute of High Energy Physics (IHEP-Protvino or Serpukhov), Protovino, Russia
Joint Institute for Nuclear Research (JINR-Dubna), Dubna, Russia
Kurchatov Institute, Moscow, Russia
PNPI: St. Petersburg Nuclear Physics Institute, Gatchina, Leningrad, Russia
Lund University, Lund, Sweden
Abilene Christian University, Abilene, Texas, USA
Brookhaven National Laboratory (BNL), Upton, NY 11973
University of California - Riverside (UCR), Riverside, CA 92521, USA
Columbia University, Nevis Laboratories, Irvington, NY 10533, USA
Florida State University (FSU), Tallahassee, FL 32306, USA
Georgia State University (GSU), Atlanta, GA, 30303, USA
Iowa State University (ISU) and Ames Laboratory, Ames, IA 50011, USA
LANL: Los Alamos National Laboratory, Los Alamos, NM 87545, USA
LLNL: Lawrence Livermore National Laboratory, Livermore, CA 94550, USA
University of New Mexico, Albuquerque, New Mexico, USA
New Mexico State University, Las Cruces, New Mexico, USA
Department of Chemistry, State University of New York at Stony Brook (USB), Stony Brook, NY 11794, USA
Department of Physics and Astronomy, State University of New York at Stony Brook (USB), Stony Brook, NY 11794-, USA
Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37831, USA
University of Tennessee (UT), Knoxville, TN 37996, USA
Vanderbilt University, Nashville, TN 37235, USA

Pythia *pp* ös = 130 AGeV



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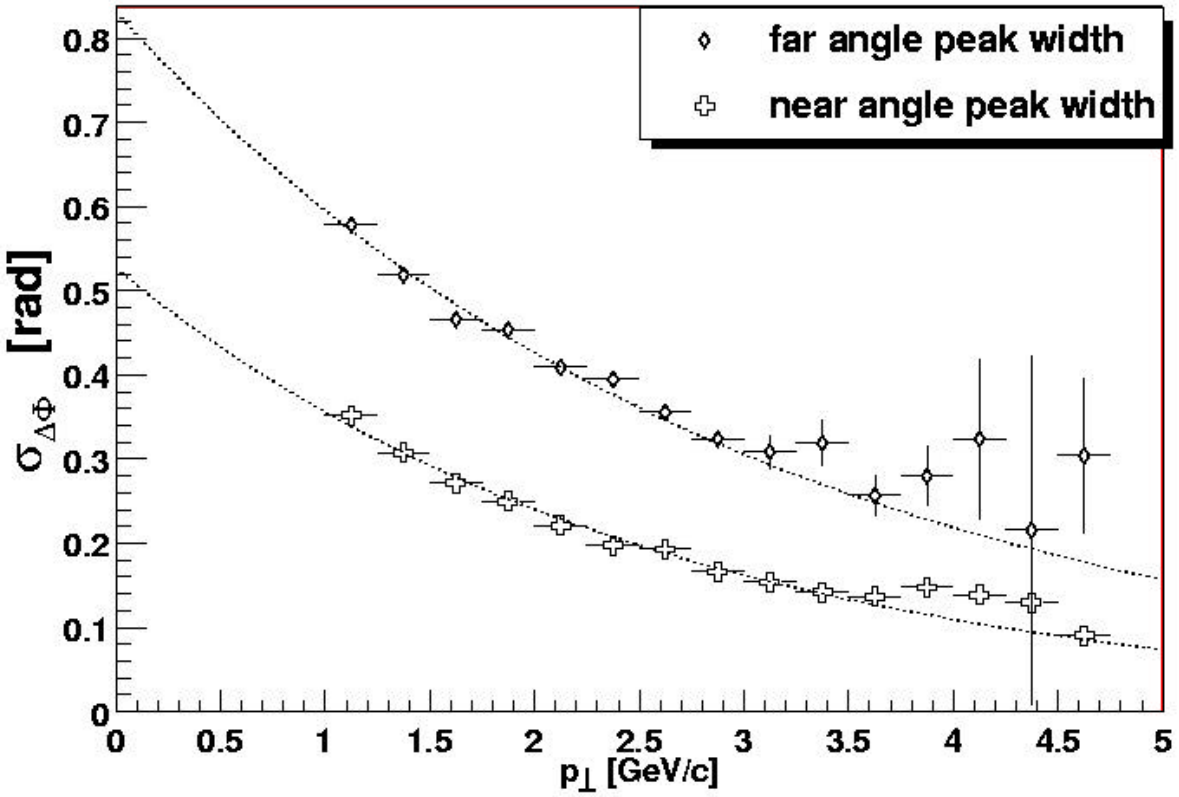
Angular width with $p_\perp$