Reaction plane and pseudo rapidity dependence of inclusive photon - hadron $\Delta\phi - \Delta\eta$ correlation in Au+Au $\sqrt{S_{NN}}$=200 GeV collisions at RHIC-PHENIX

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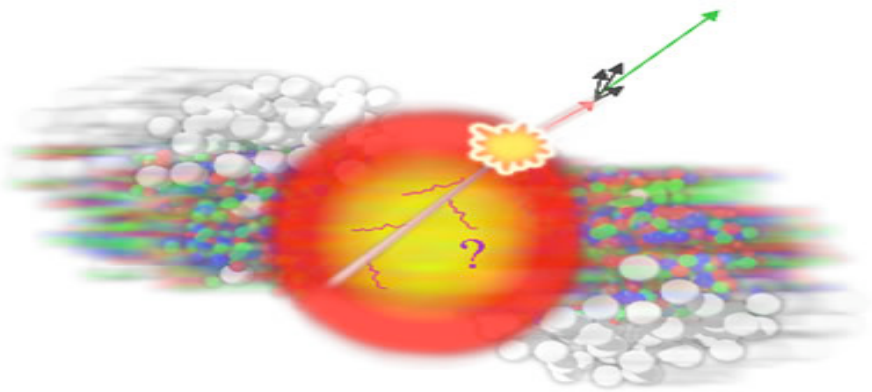
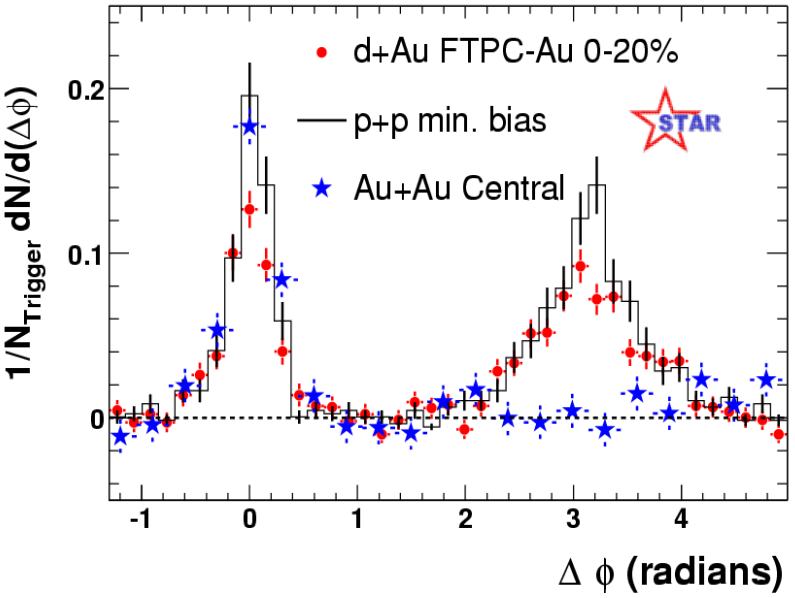
PHENIX

Outline

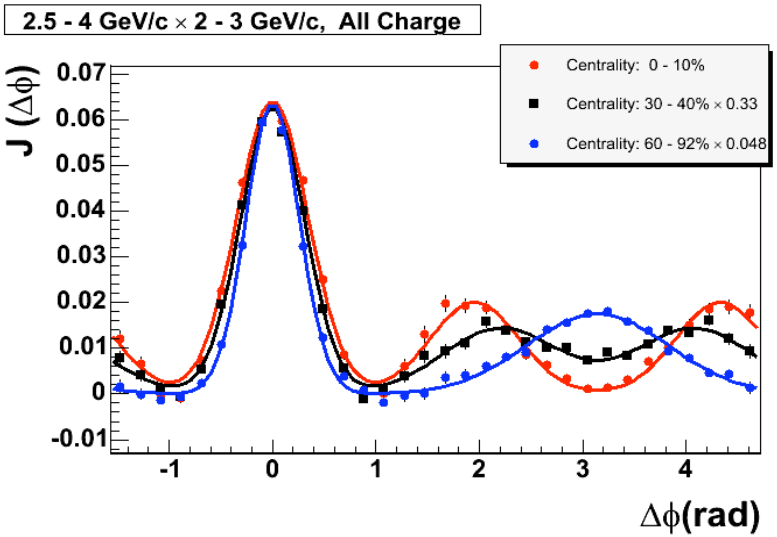
- Jet Physics in Heavy Ion collisions
- Trigger Selected $\Delta\phi$ correlation
- Physics Motivation
- Analysis
- Consistency check of $\Delta\phi - \Delta\eta$ correlation
- Summary

Jet physics in heavy ion collisions



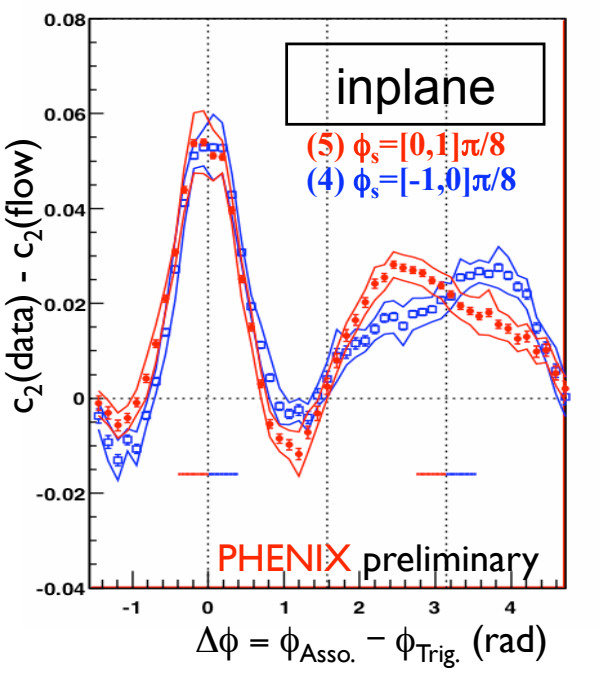


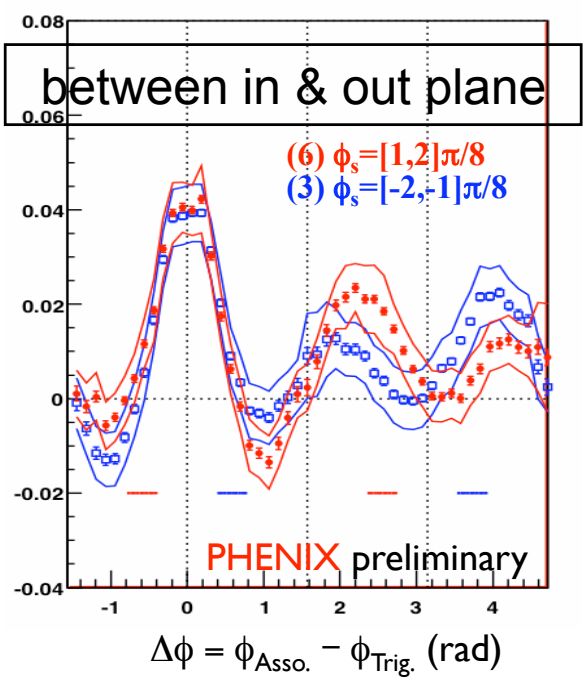
- Jet like correlation is useful probe to understand the mechanism of hot matter evolution in heavy ion collisions!!
  - Jet quenching
  - Mach Cone like structure
- As next step, trigger selected correlation study has started.

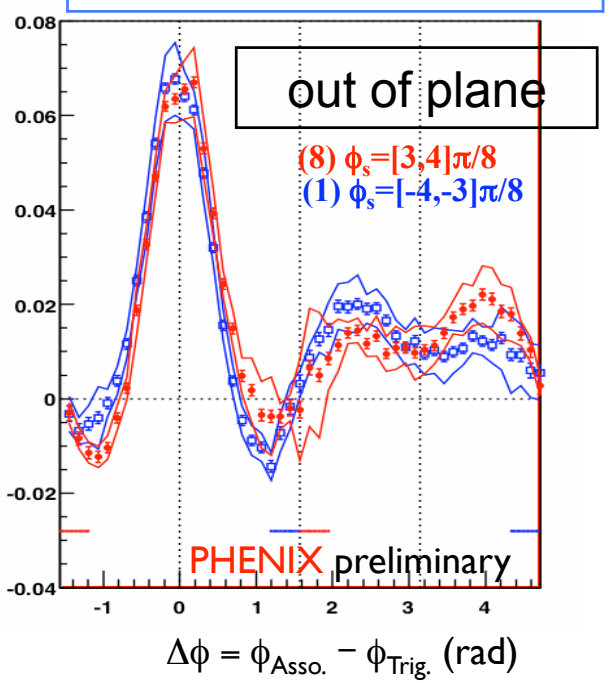


Trigger selected jet like Δφ correlation

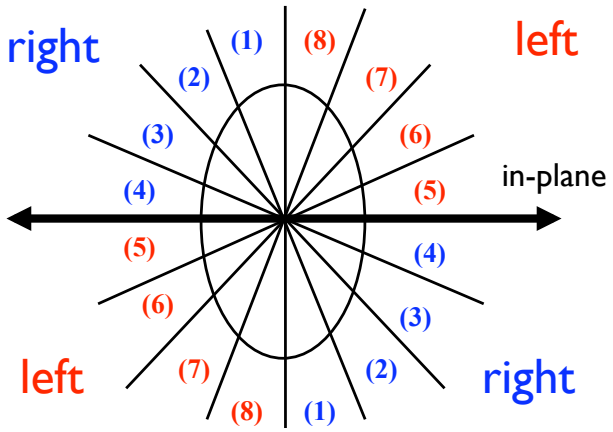
S. Esumi QM09





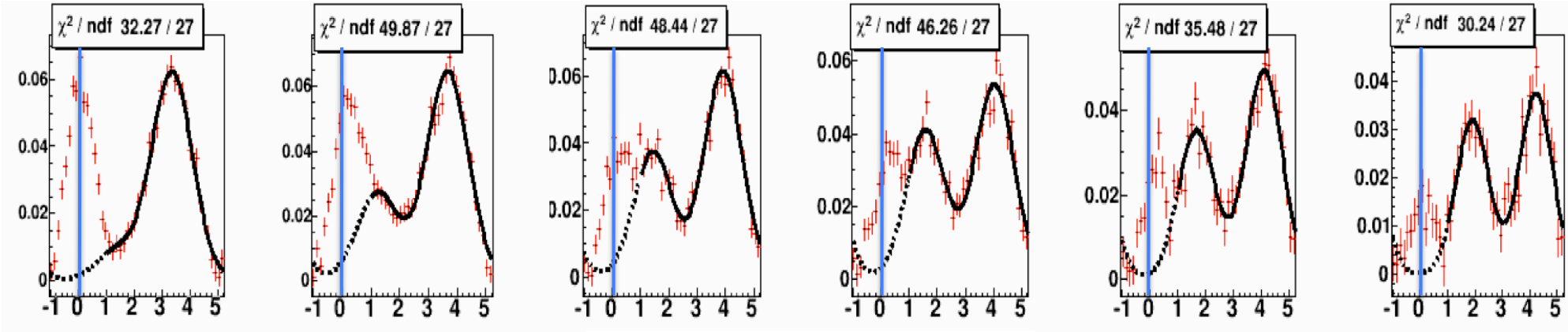


- Au+Au 200 GeV Hadron−Hadron (Run7)
- Centrality: 20−50%
- Pt^{Trig} :2−4GeV Pt^{Asso}: 1−2GeV
- By selecting trigger relative angle from reaction plane, correlation shape at away side changes.



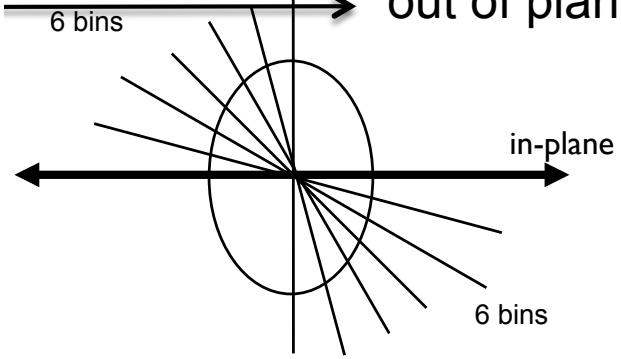
$\phi_s = \phi_{Trig.} - \Phi_{R.P.}$ $[-\pi/2,\pi/2]$

Trigger selected ridge like Δϕ correlation

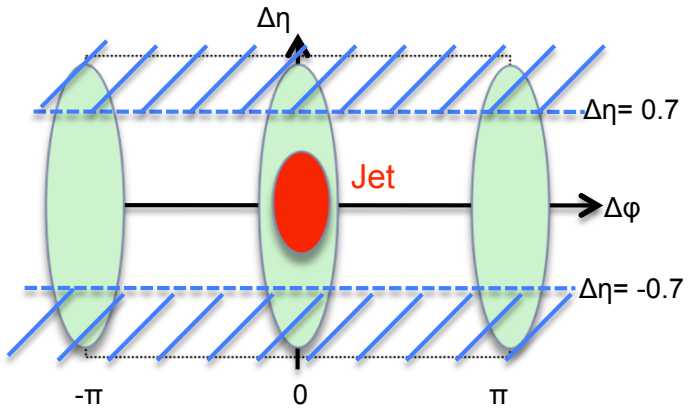


inplane ← $\Delta\phi = \phi_{Asso.} - \phi_{Trig.}$ (rad) → out of plane

- Au+Au 200GeV Hadron – Hadron
- Centrality : 20–60%
- Pt^{Trig} : 3–4GeV, Pt^{Asso}: 1–1.5GeV
- $|\Delta\eta|>0.7$, $\phi_{Trig}-\Phi_{R.P.}<0$
- Focus on only red line
- Near side peak shifts to "+" Δϕ direction when trigger angle moves from inplane to out of plane.

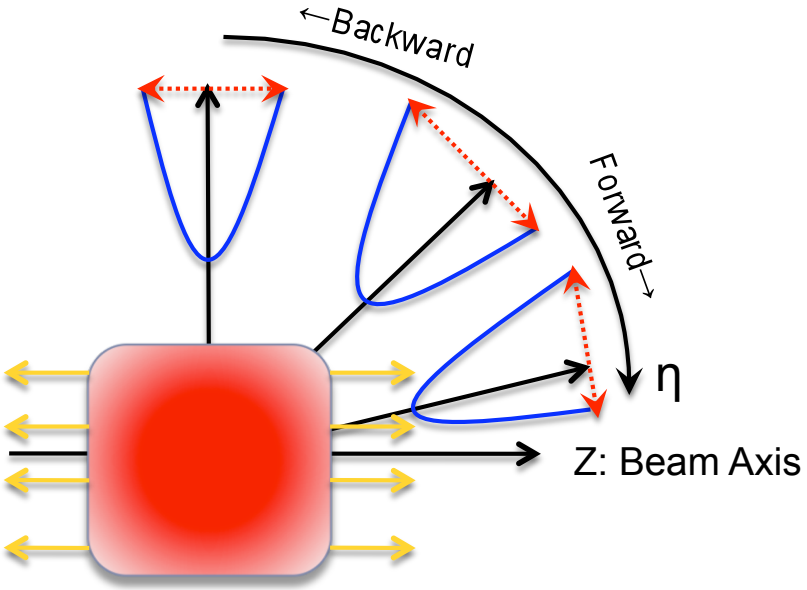


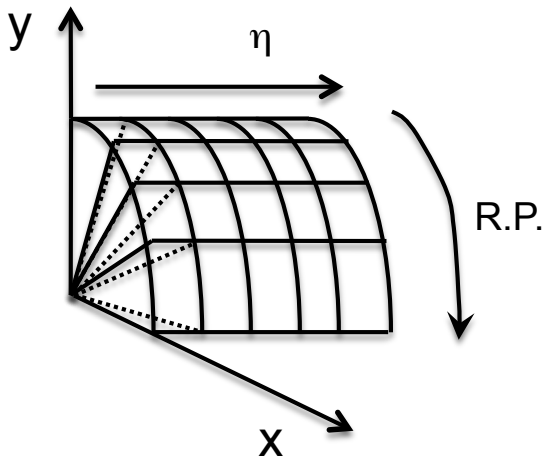
$\phi_s = \phi_{Trig.} - \Phi_{R.P.}$ $[-\pi/2,\pi/2]$



Physics Motivation

- It has been observed that $\Delta\phi$ correlation with respect to R.P. has right/left asymmetry given by almond like geometry and/or elliptic expansion.
- We might be able to discuss the mechanism of QGP expansion/geometry in η direction by the following analysis.
- To this aim, We confirm if there is existence of reaction plane and trigger η dependence in $\Delta\eta$ correlation at $\Delta\phi=0$.
  - Backward/Forward asymmetry with respect to selected trigger η
  - Reaction Plane dependence

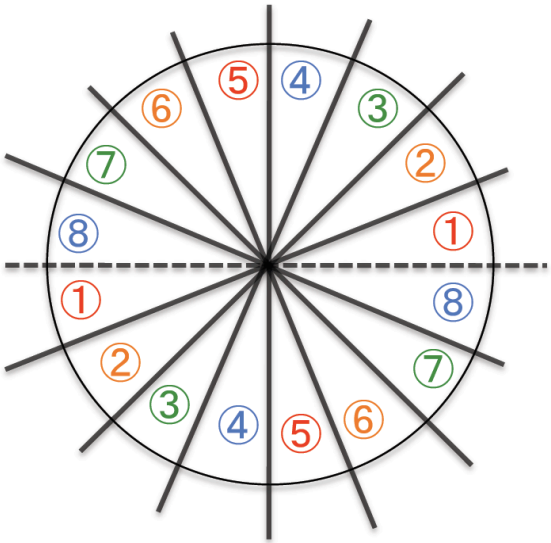




Analysis

- AuAu 200GeV taken by RHIC-PHENIX in Run7
- Inclusive Photon – Hadron $\Delta\phi$–$\Delta\eta$ correlation w.r.t. R.P. and trigger η
  - Trigger is Inclusive Photon at pT : 2–4GeV
  - Associate is Charged Hadron at pT :1–2GeV
  - The reason why I chose inclusive photon is that Inclusive photon – Hadron analysis is the first step towards Direct photon – Hadron Analysis.
- v2 modulated background was subtracted with ZYAM method.
- Trigger particle binning
  - R.P. is divided into 8 regions
  - η is also divided into 8 regions

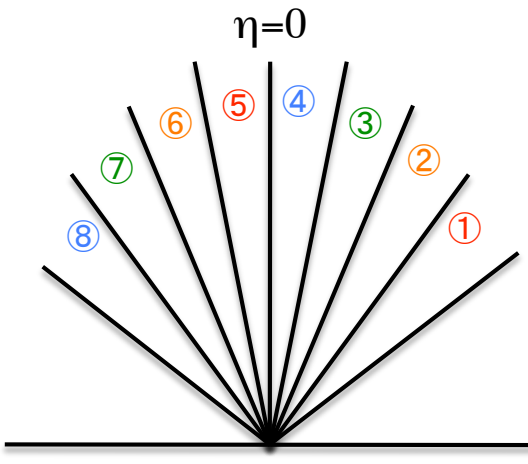
out of plane



in plane
Reaction Plane

η=–0.35

Pseudo Rapidity

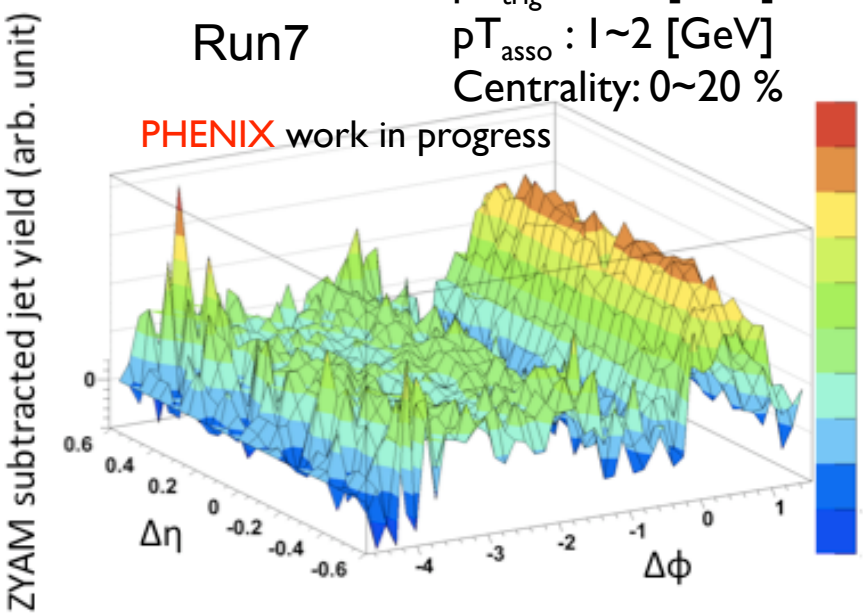


η= 0.35

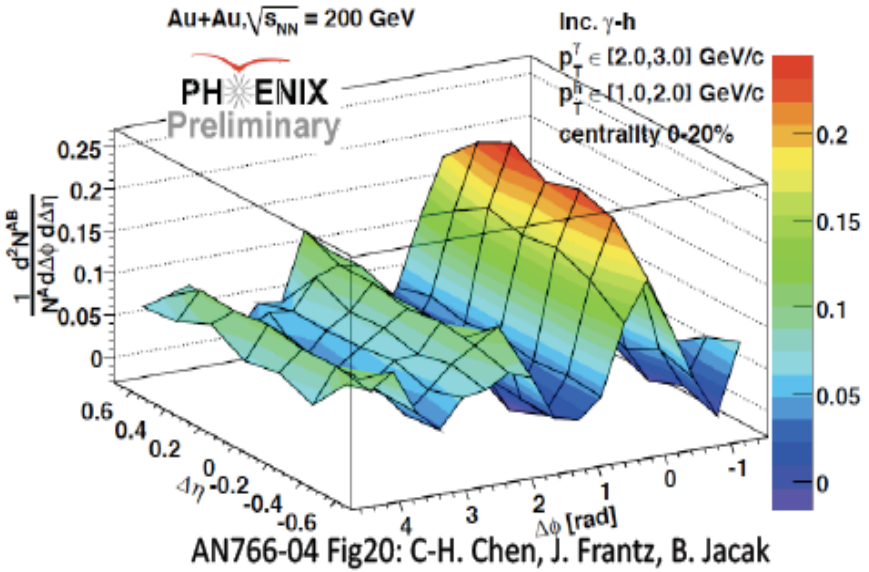
Consistency check of Δϕ – Δη correlation at central

Trigger: Inclusive Photon
Associate: Charged Hadron
pT_{trig} : 2~4 [GeV]
pT_{asso} : 1~2 [GeV]
Centrality: 0~20 %

Run7



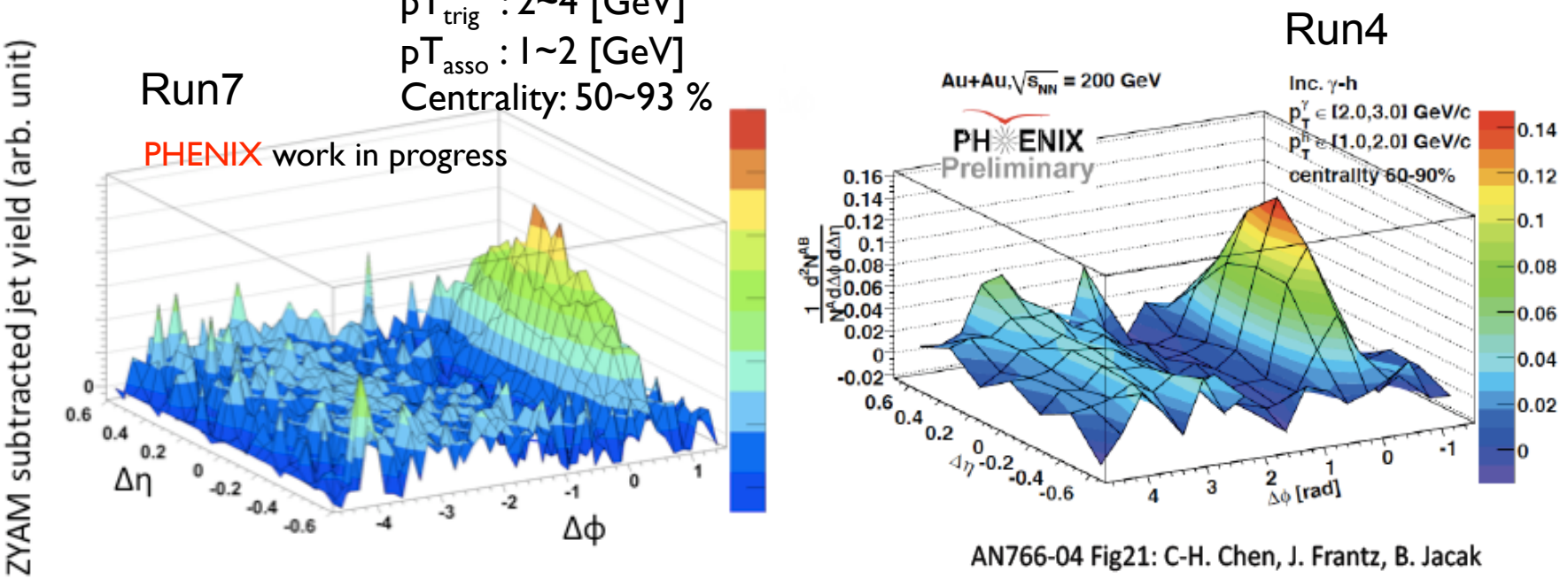
Run4



- We checked consistency of Δϕ – Δη correlation between Run7 and Run4
  - the left plot is the sum of the trigger selected Δϕ – Δη correlation
  - We can see the a certain level of consistency between those.

Consistency check of $\Delta\phi - \Delta\eta$ correlation at peripheral

Trigger: Inclusive Photon
Associate: Charged Hadron
pT_{trig} : 2~4 [GeV]
pT_{asso} : 1~2 [GeV]
Centrality: 50~93 %



AN766-04 Fig21: C-H. Chen, J. Frantz, B. Jacak

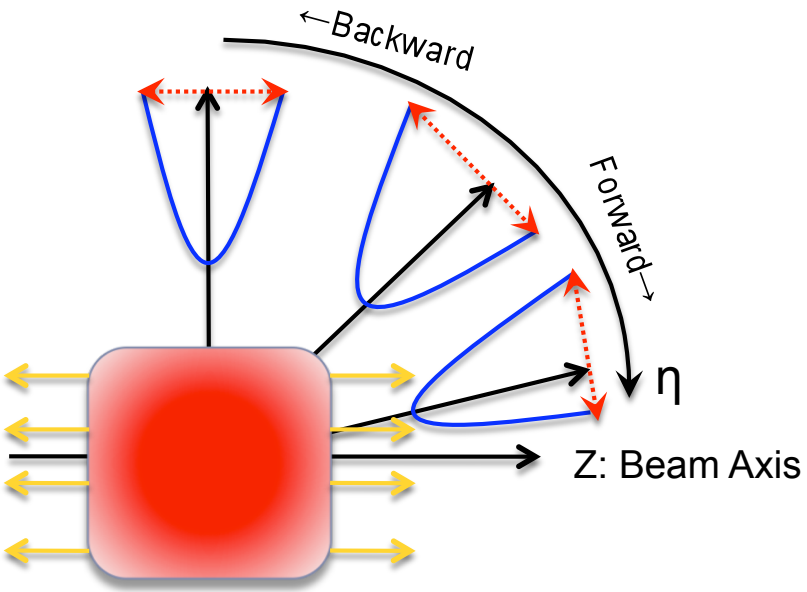
- We checked consistency of $\Delta\phi - \Delta\eta$ correlation between Run7 and Run4
  - the left plot is the sum of the trigger selected $\Delta\phi - \Delta\eta$ correlation
  - We can see the a certain level of consistency between those.

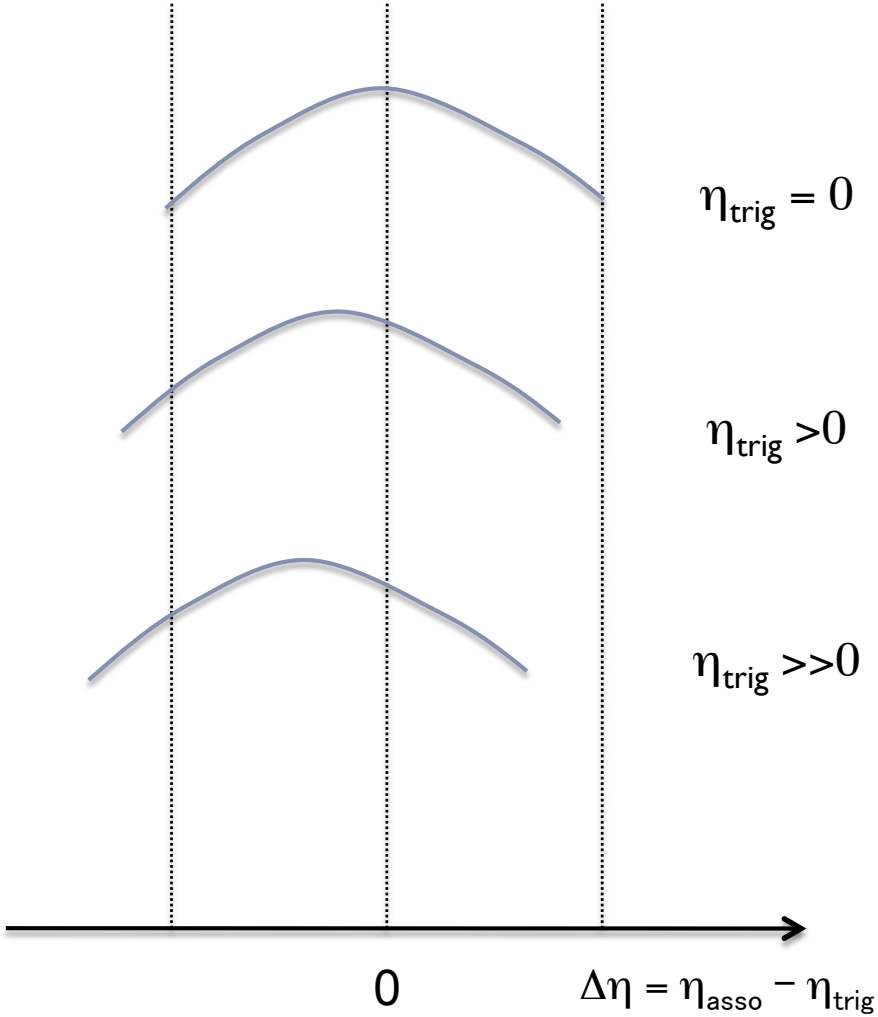
Summary & Outlook

- Summary
  - We observed right/left asymmetry in $\Delta\phi$ correlation w.r.t. R.P.
  - We checked the consistency of $\Delta\phi - \Delta\eta$ correlation between Run7 and Run4
- Outlook
  - We started the trigger selected $\Delta\phi - \Delta\eta$ correlation analysis w.r.t. R.P. and η_{trig}

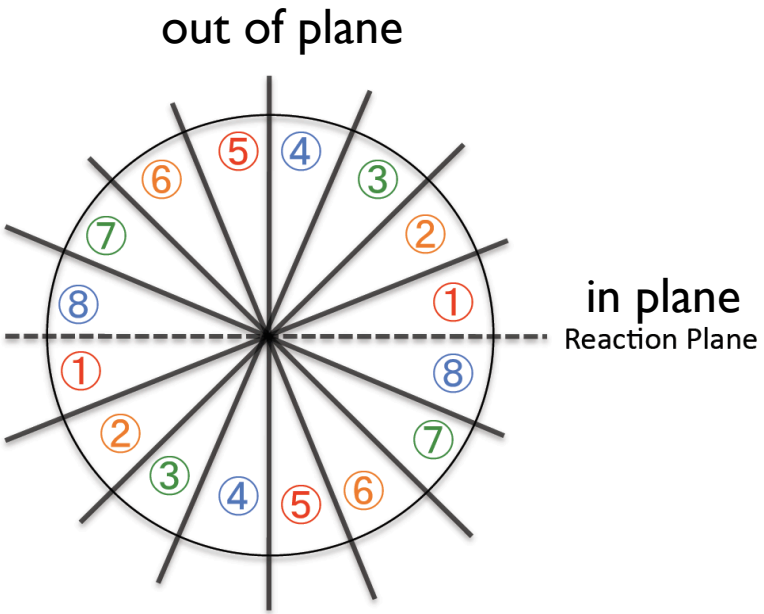
BACK UP

Δη correlation shape





Trigger Particle Binning



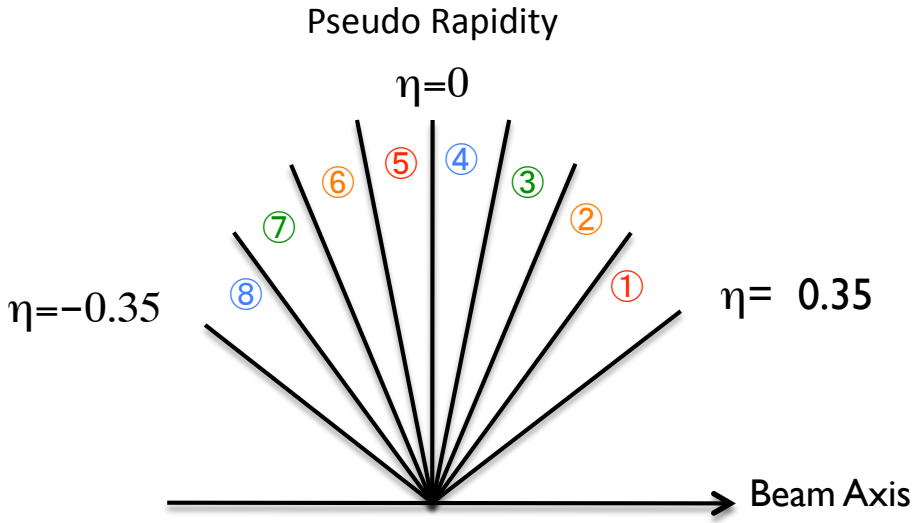
Regions ⑤~⑧ are folded ($\Delta\phi'=-\Delta\phi$) into ①~④

⑧->①

⑦->②

⑥->③

⑤->④



Regions ⑤~⑧ are folded ($\Delta\eta'=-\Delta\eta$) into ①~④

⑧->①

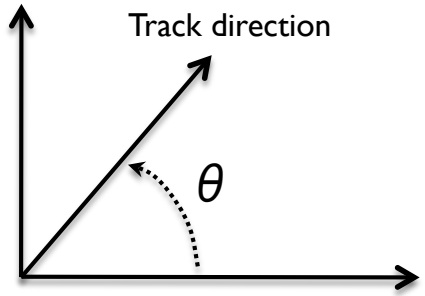
⑦->②

⑥->③

⑤->④

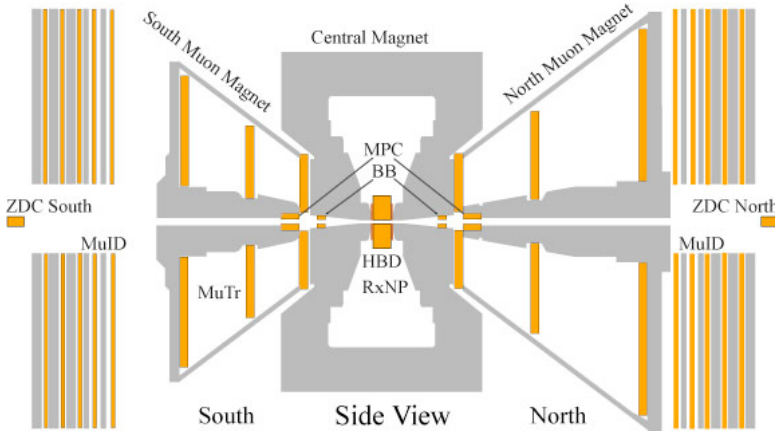
PHENIX detector

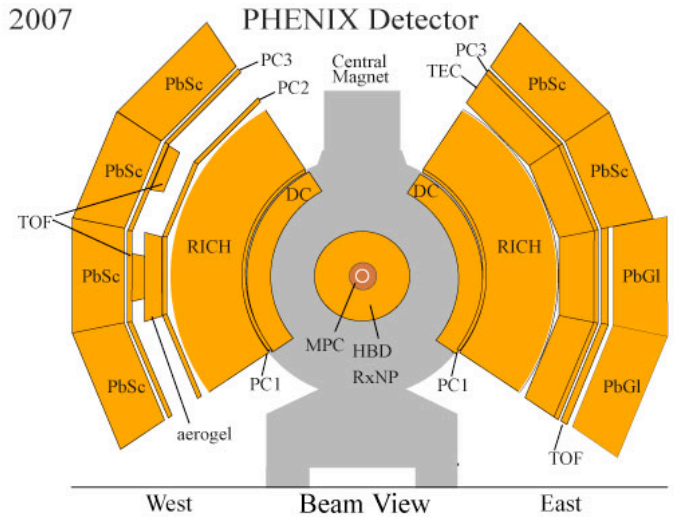
Azimuthal direction

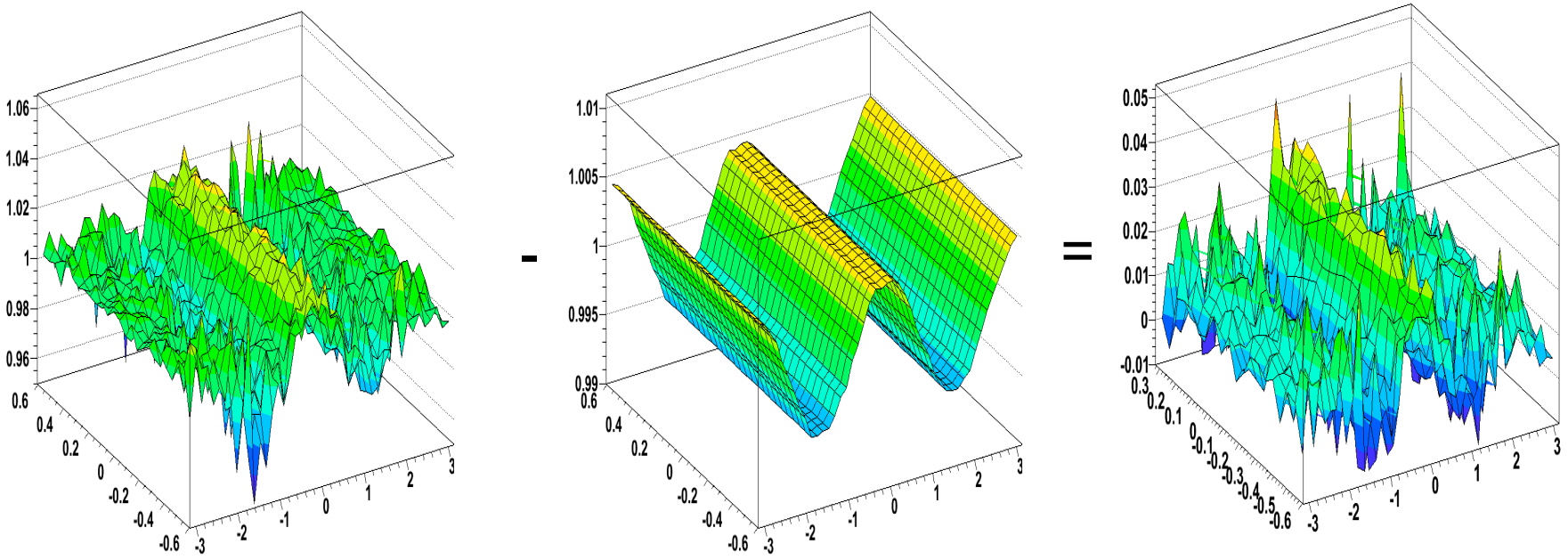


$$\eta = -\ln\tan(\theta/2)$$

Component	$\Delta\eta$	$\Delta\phi$	Purpose and Special Feature
Magnet: central (CM)	$\lvert\eta\rvert$ <0.35	360°	Up to 1.15 T·m
muon (MMS)	-1.1 to -2.2	360°	0.72 T·m for η=2
muon (MMN)	1.1 to 2.4	360°	0.72 T·m for η=2
BBC	$3.0 < \lvert\eta\rvert < 3.9$	360°	start timing, fast vertex
ZDC	±2 mrad	360°	Minimum bias trigger
DC	$\lvert\eta\rvert < 0.35$	90°×2	Good momentum and mass resolution $\Delta m/m$=0.4% at m=1.0 GeV
PC	$\lvert\eta\rvert < 0.35$	90°×2	Pattern recognition, tracking for nonbend direction
RICH	$\lvert\eta\rvert < 0.35$	90°×2	Electron identification
TOF	$\lvert\eta\rvert < 0.35$	45°	Good hadron identification, σ_{TOF} ~120ps
PbSc EMCal	$\lvert\eta\rvert$ <0.35	90°+45°	For both calorimeters, photon and electron detection
PbGl EMCal	$\lvert\eta\rvert$ <0.35	45°	Good $e^{\pm}/\pi^{\pm}$ separation $p > 2.0$ GeV/c by EM shower and $p < 0.35$ GeV by TOF $K^{\pm}/\pi^{\pm}$ separation up to 1 GeV/c by TOF
μ tracker(μTS)	-1.15 to -2.25	360°	Tracking for muons
μ tracker(μTN)	1.15 to 2.44	360°	Muon tracker north installed for Year-3
μ identifier(μIDS)	-1.15 to -2.25	360°	Steel absorbers and Iarocci tubes for
μ identifier(μIDN)	1.15 to 2.44	360°	muon/hadron separation
RxNP	$1.0 < \lvert\eta\rvert < 2.8$	360°	Good resolution for reaction plane







1. Projected $\Delta\Phi$-$\Delta\eta$ correlation to the $\Delta\Phi$ direction
2. Applied ZYAM Method to projected $\Delta\Phi$ correlation and extract b0
3. Adopted the b0 extracted in 2. for all $\Delta\eta$ range

$$\mathrm{Corr} = \mathrm{Rawcorr} - b0 * \mathrm{Flow}$$