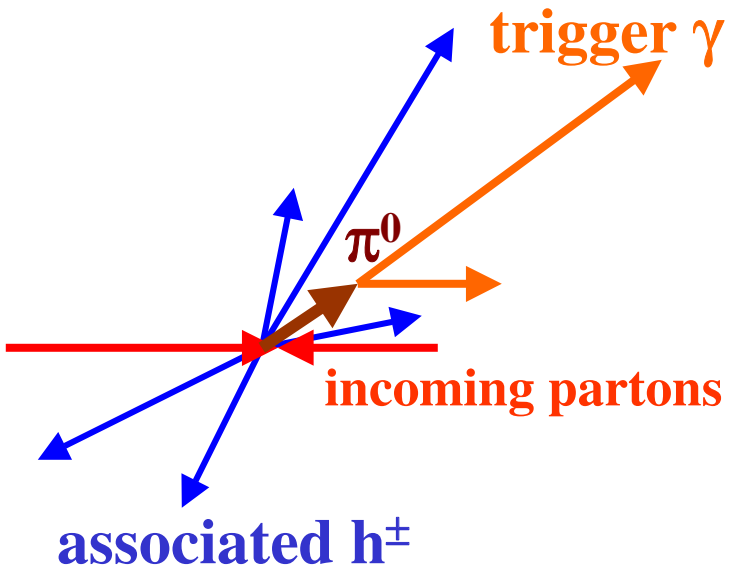
Charged-Neutral Correlations from a Trigger Gamma

Mickey Chiu,
Columbia University,
for the

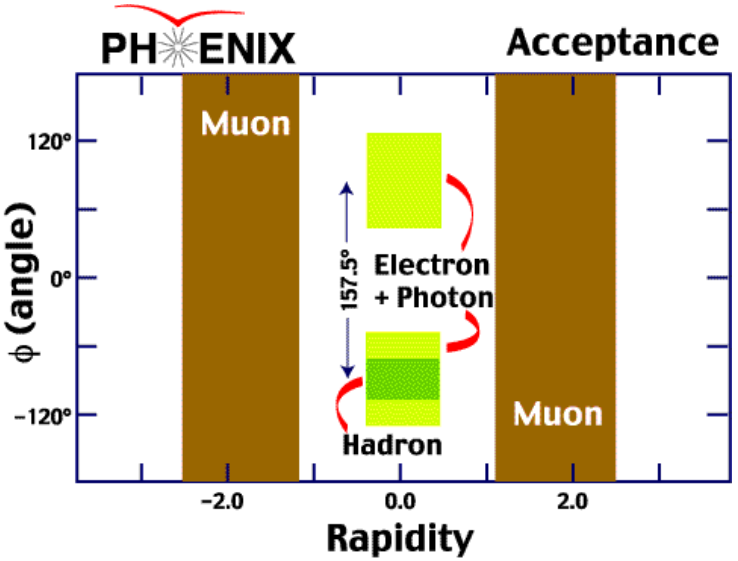
Collaboration

Using Trigger Photons to Identify Jets



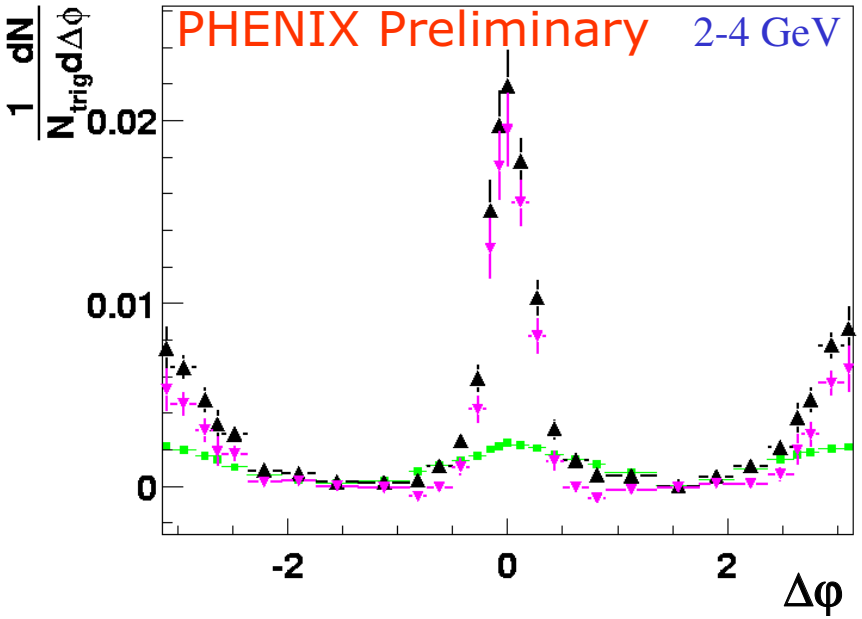
- Select events with a photon of pt > 2.5 GeV.
  - Mostly γ's from decay of a high pt π^0
- Lie approximately along underlying jet axis.
- Then look at distributions in (φ,η) space of the charged hadrons relative to these trigger photons.
- Since events are triggered, we are studying the structure of high-pt events only.

- We use the PHENIX Central Arms.
- Tracking Detectors followed by EMCal.
- PHENIX Acceptance comparable to jet size.
- Acceptance effects need to be corrected out.



Correcting for Acceptance

raw differential yields



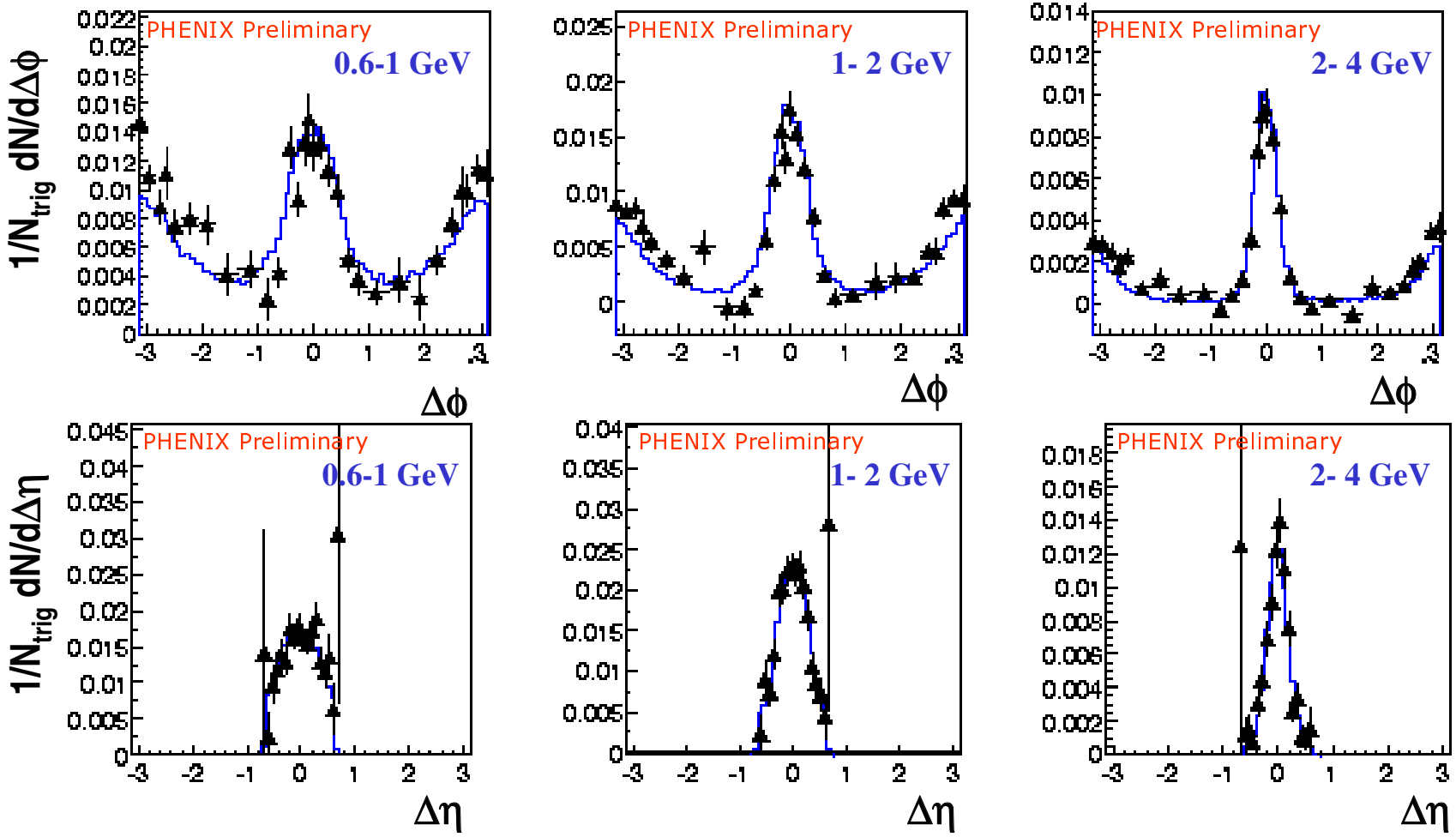
- black = pair distribution
- green = mixed event pair distribution
- purple = bkg subtracted distribution

We fit the below formula, assuming that the distributions in p-p are given by a flat background plus PYTHIA.

$$\frac{1}{N_{trig}}\frac{dN}{d\Delta\phi} = a_{bkg}\frac{1}{N_{trig}}\frac{dN_{mixed}}{d\Delta\phi} + a_{pythia}A(\Delta\phi)\langle\epsilon\rangle\frac{1}{N_{pyt}}\frac{dN}{d\Delta\phi}$$

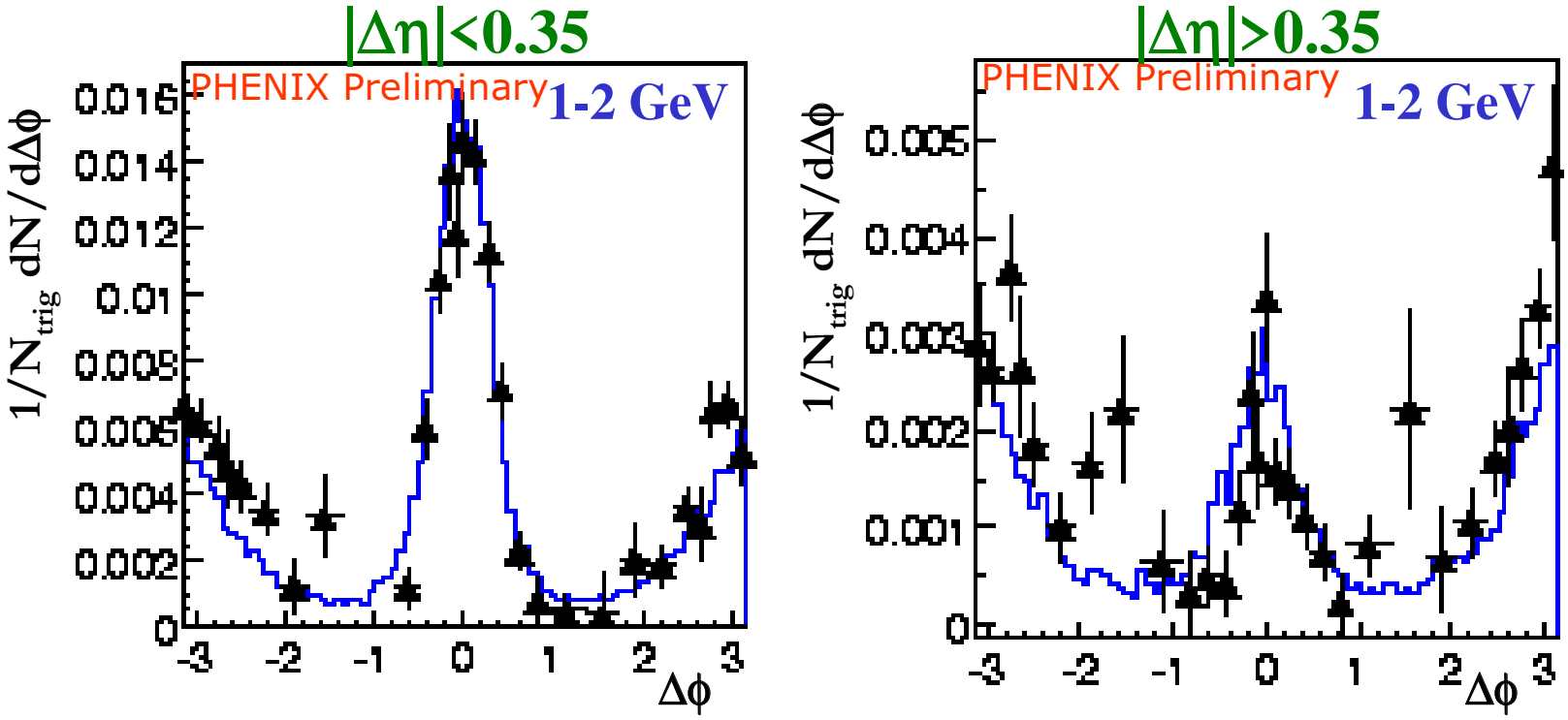
- Acceptance $A(\Delta\phi)$ = mixed event shape normalized to integral of 2π.
- Average Efficiency $\langle\varepsilon\rangle$ can be evaluated via Monte Carlo & Embedding.
- a_{bkg} parametrizes amount of flat background in triggered events.
- a_{pythia} is the amplitude of the PYTHIA signal.
  - $a_{pythia} = 1.0$ for pure jet events and a perfect detector.

Excess Above Flat Background, p-p



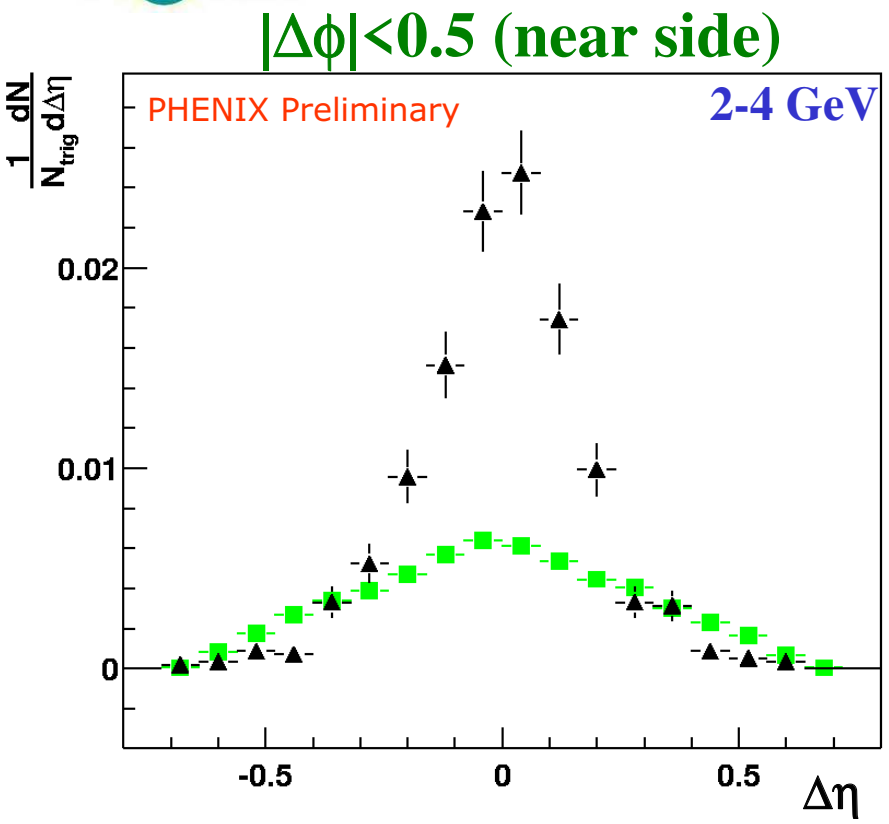
- Data points (black) are background subtracted and acceptance corrected.
- Blue is the PYTHIA curve * a_{pythia} * $\langle\varepsilon\rangle$

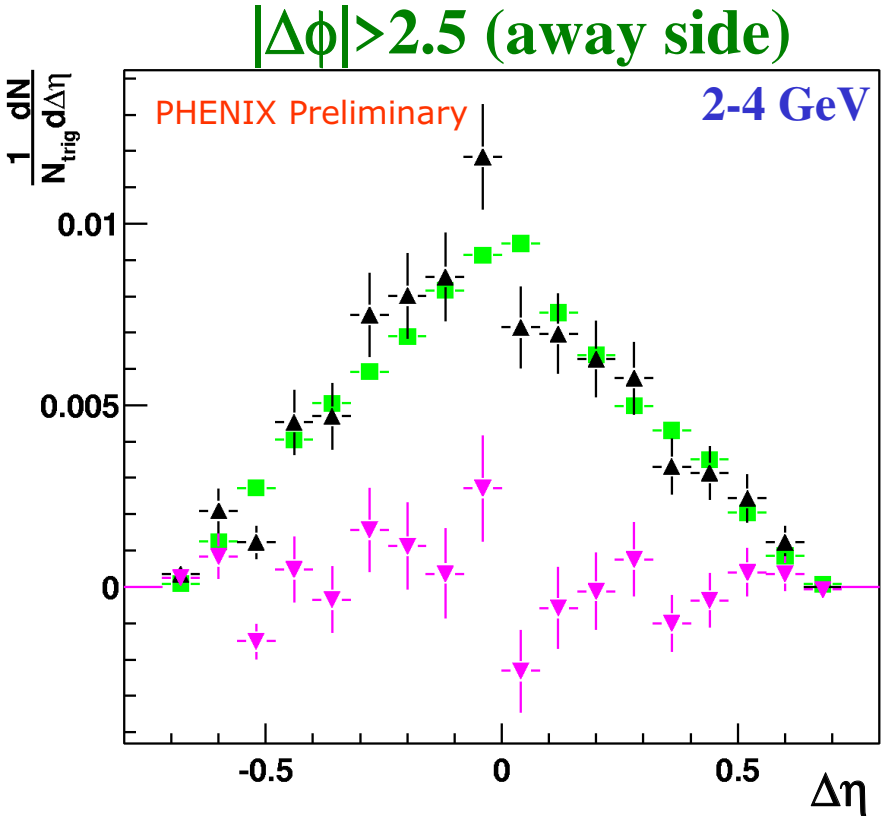
Jet Test 1: $\Delta\eta$ Cuts, p-p



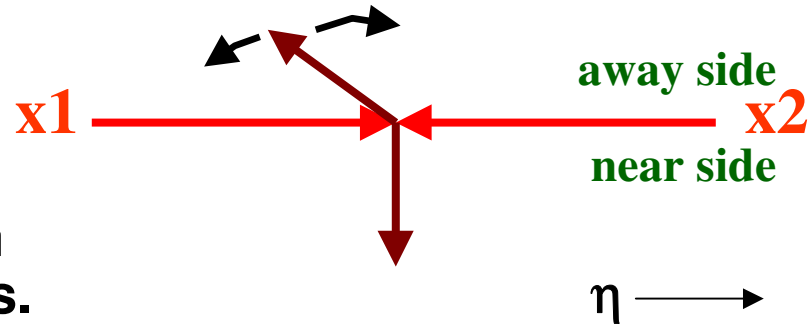
- We make $|\Delta\eta|$ cuts in our p-p Data and PYTHIA.
- Small $|\Delta\eta|$, near-side jet remains, but large $|\Delta\eta|$ suppresses it.
- Our data is well described by PYTHIA even with the cuts. Implies the shape measured matches a jet-like shape in both η and φ, near and away in $\Delta\eta$.

Jet Test 2: Away Side Δη, p-p



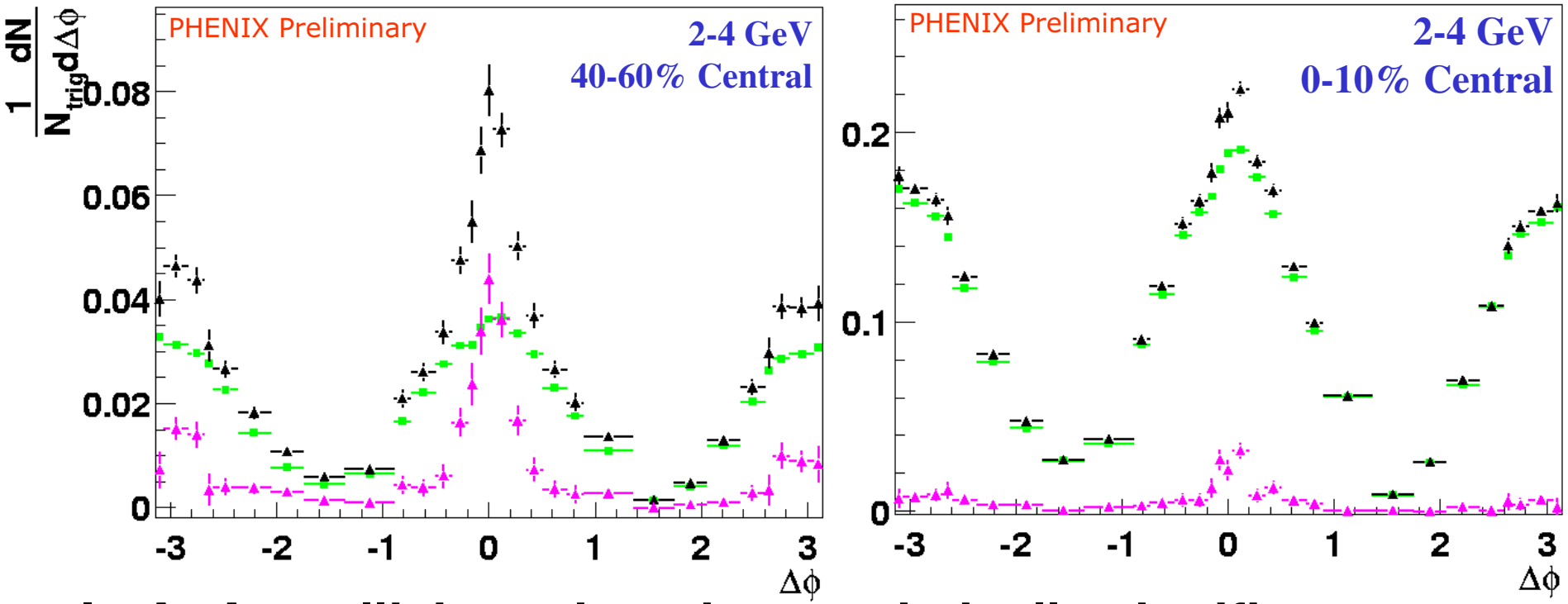


- Clear excess from flat in near side.
- Away side consistent with flat.
- Consistent with jet behavior.
  - One jet falls in PHENIX acceptance, away side jet has η determined from x1, x2 and angle of outgoing partons.



Excess from Flat Bkg, Au-Au

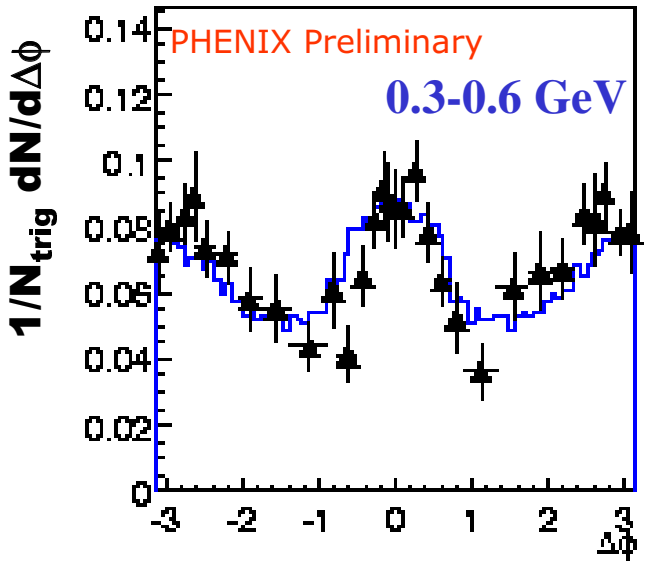
black = associated charged particles, green = mixed, purple = subtracted

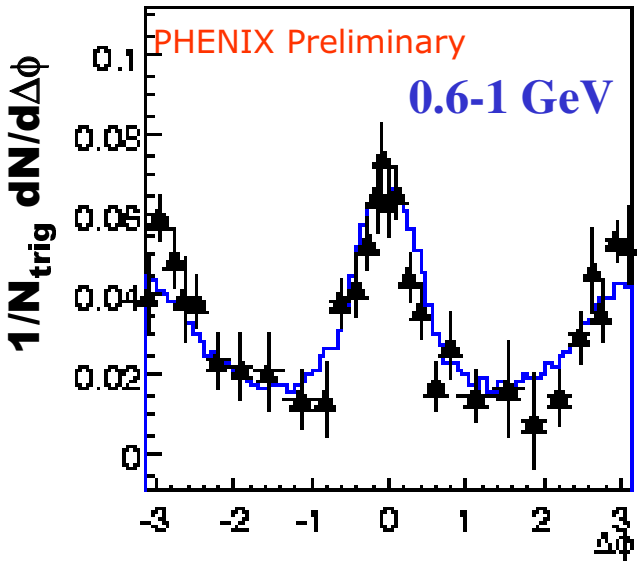


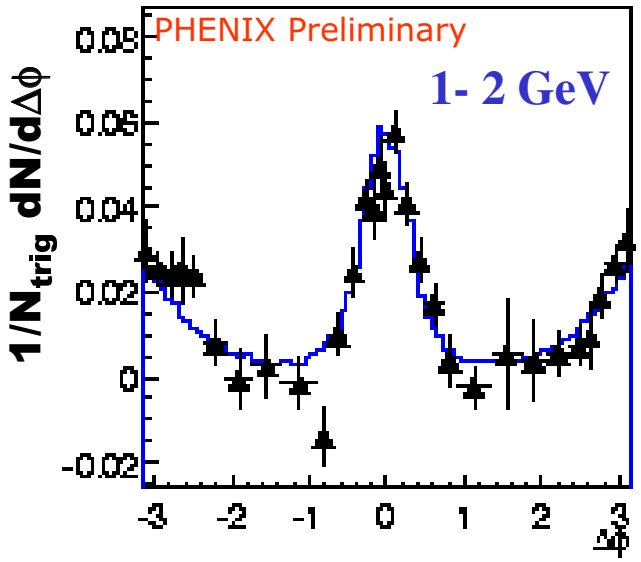
- In AuAu collisions there is a statistically significant excess from a flat distribution at all centralities and all pt bins.
- So what is that excess? Try both PYTHIA only and also PYTHIA + elliptic flow contribution.

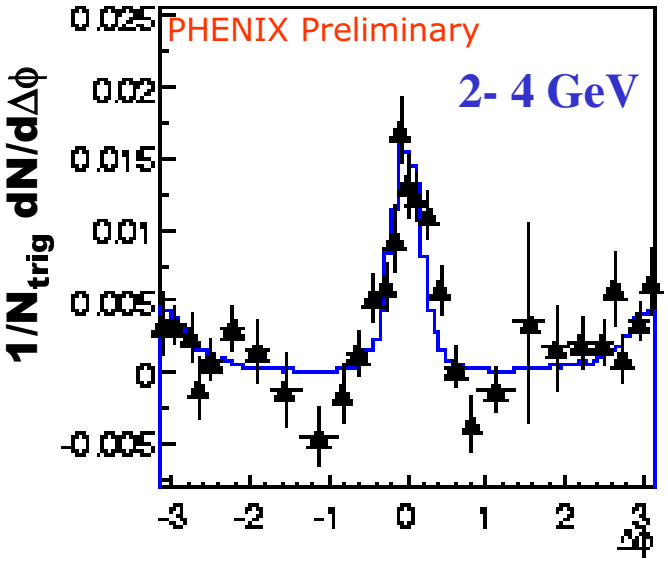
Comparison to Pythia, Au-Au

20-40% Central



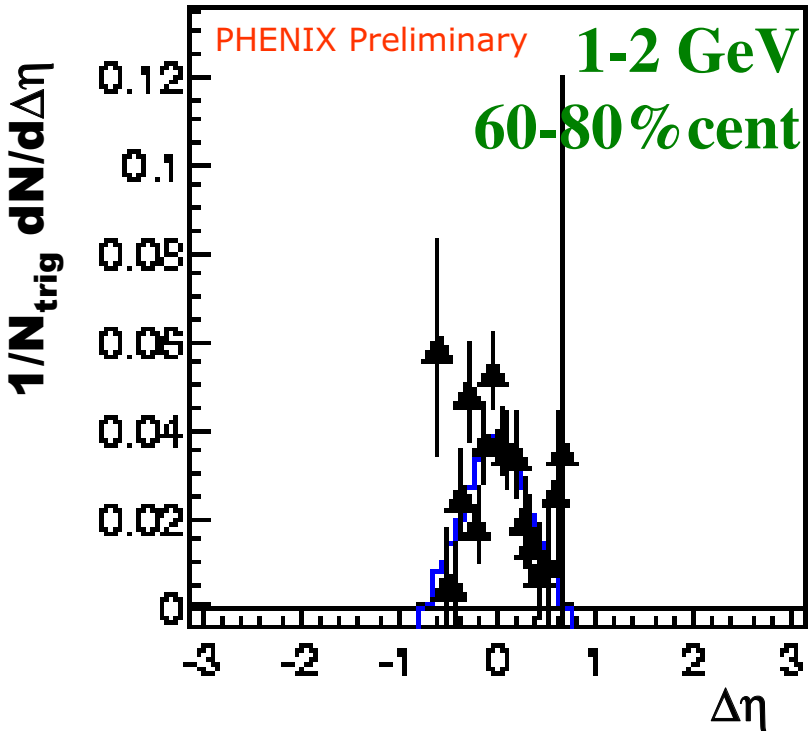


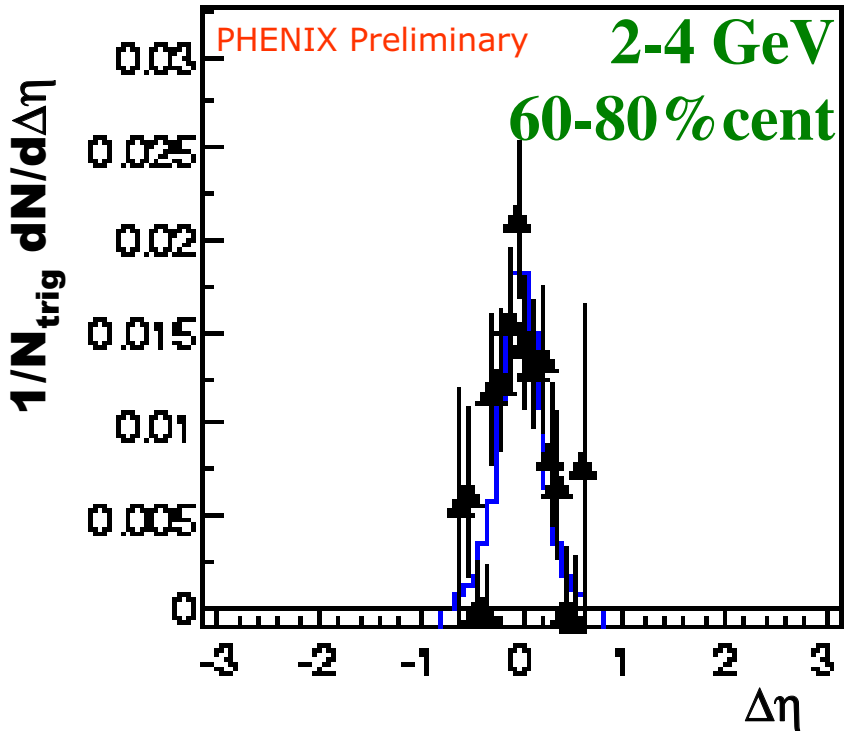




- Using the same technique as in p-p, we see that a fit to PYTHIA works fairly well in AuAu.
- Only 20-40% Centrality shown, but all centralities show similar behavior.

$\Delta\eta$ Correlation, AuAu

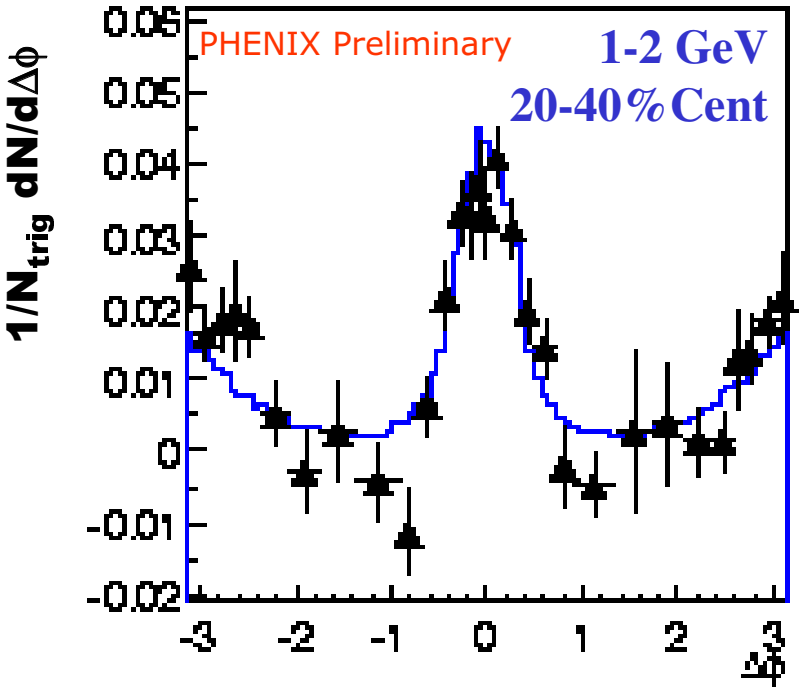




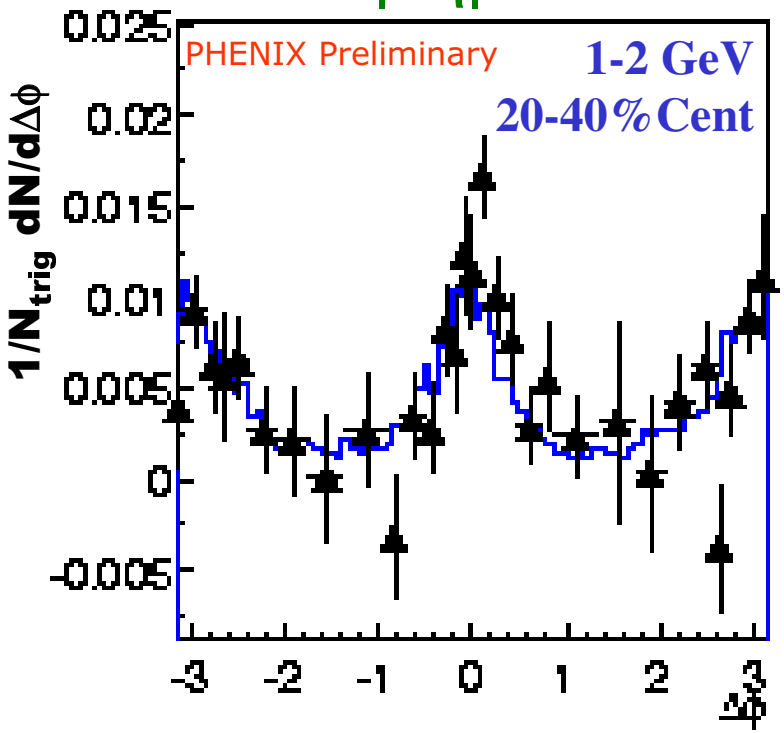
- We also see a correlation in $\Delta\eta$ for the high-pt and more peripheral centralities.
- At lower pt and more central collisions, the signal strength is weak enough that we don't see a signal above the background.

Jet Test1: $\Delta\eta$ Cuts, Au-Au

$|\Delta\eta|<.35$



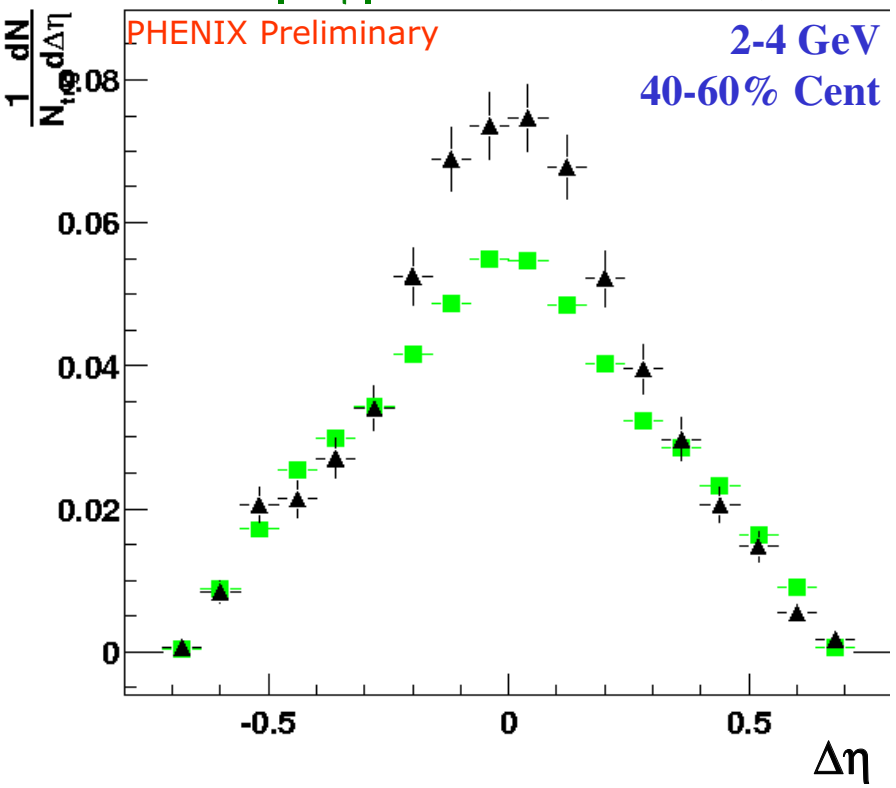
$|\Delta\eta|>.35$



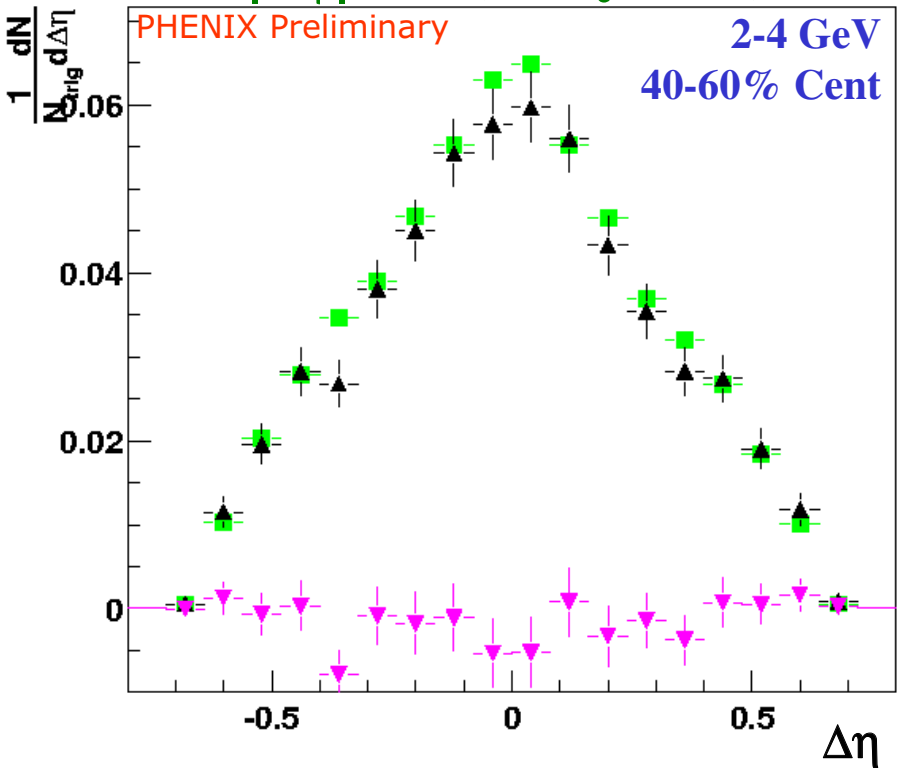
- **Even in AuAu, our data are described well by PYTHIA for cuts in "near" $\Delta\eta$ and "far" $\Delta\eta$.**
- **This implies we see a correlation in both $\Delta\eta$ and $\Delta\phi$ simultaneously.**
- **Again, only 20-40% central shown, but is true for all centralities.**

Jet Test 2: Away Side $\Delta\eta$, Au-Au

$|\Delta\phi|<0.5$(near side)

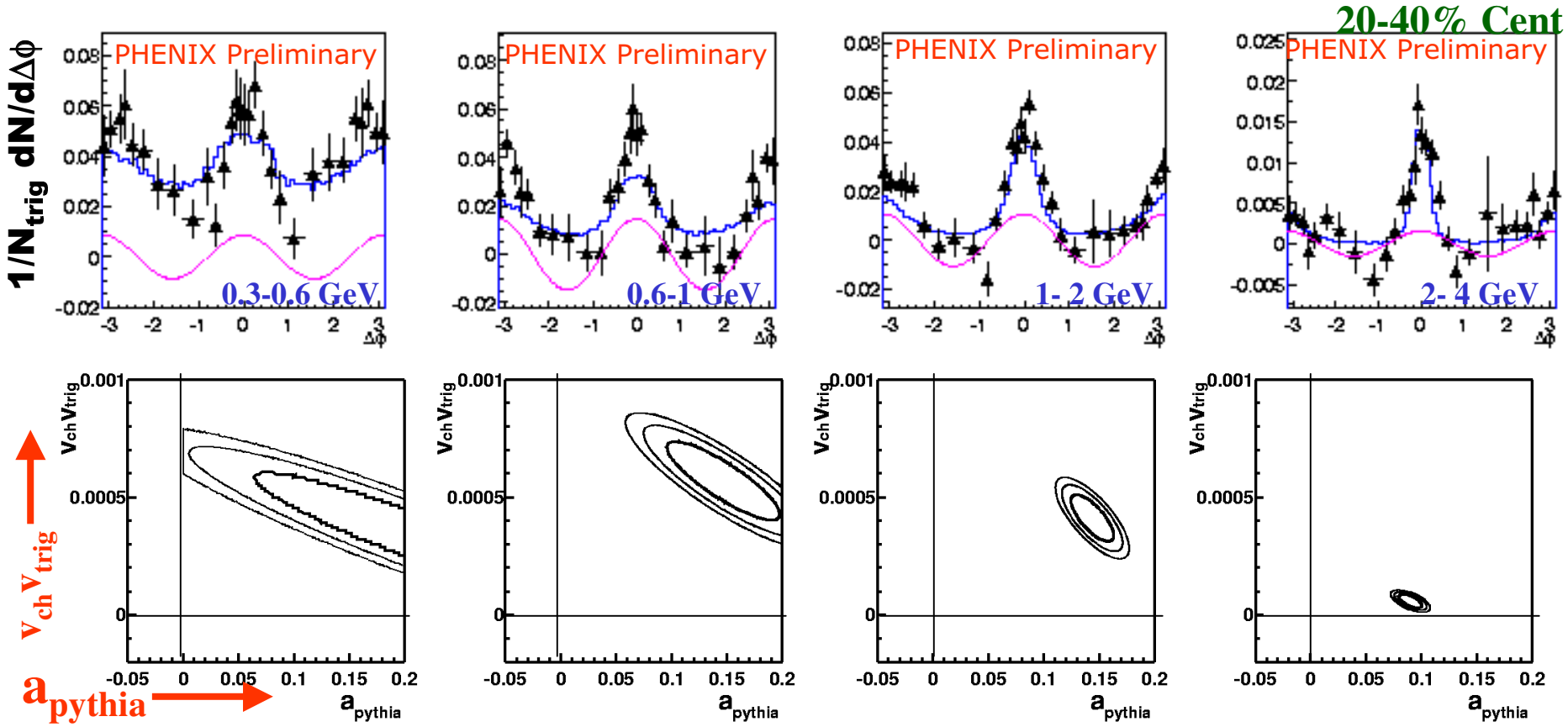


$|\Delta\phi|>2.5$(away side)



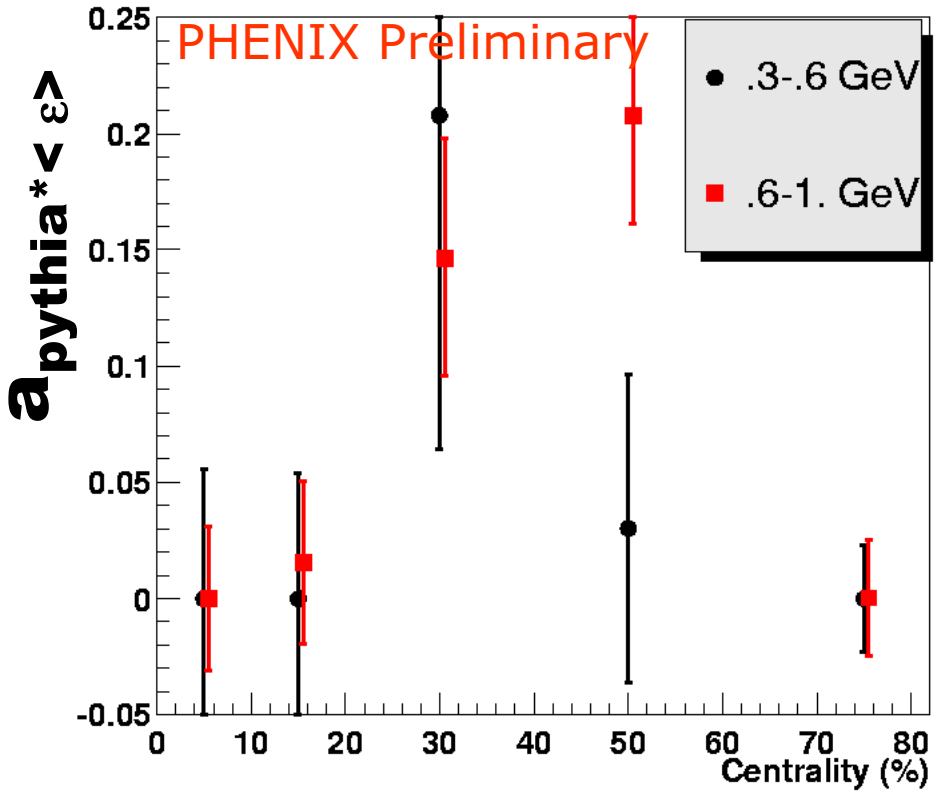
- The away side $\Delta\eta$ correlation is flat.
- In conclusion, in p-p and Au-Au we see a signal above a flat background which is consistent with a jet-like hypothesis, across all centralities for many tests of the $\Delta\eta$, $\Delta\phi$ correlations.

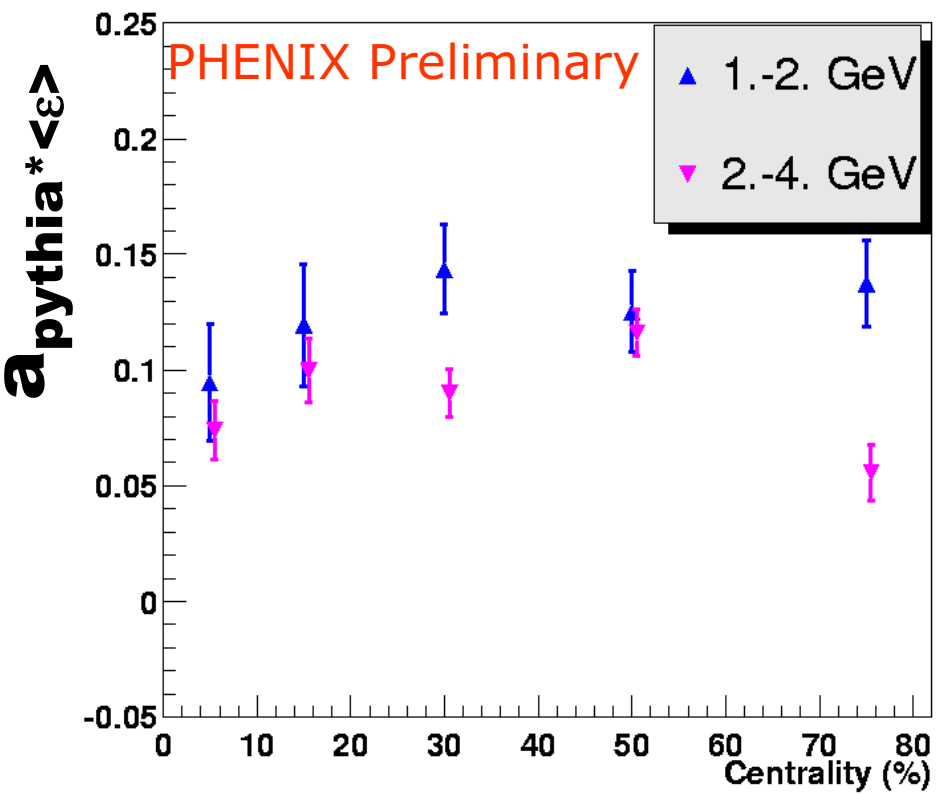
Fitting Pythia + $2v_{ch}v_{trig}\cos(2\phi)$, pt dependence



- For lower pt, ambiguity between the contribution from the elliptic flow component and the jet-like component.
- At higher pt (2 GeV and above), the jet-like component dominates over any elliptic flow component.

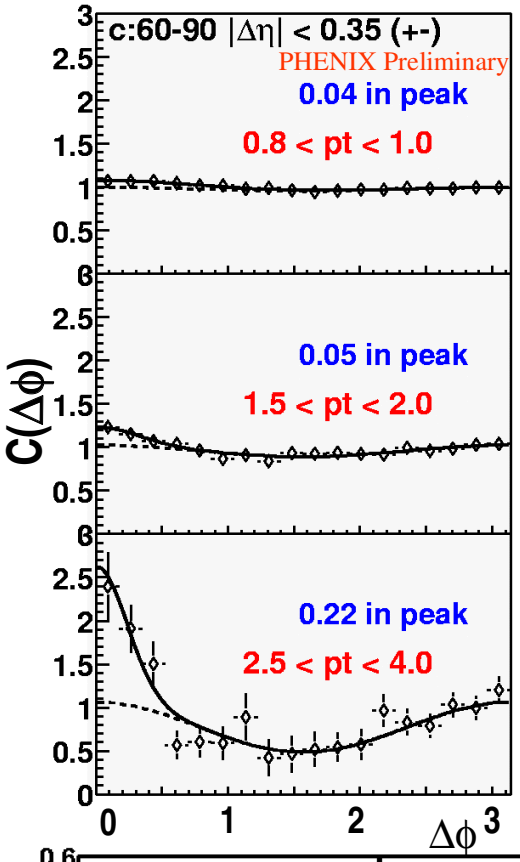
a_{pythia} vs. centrality





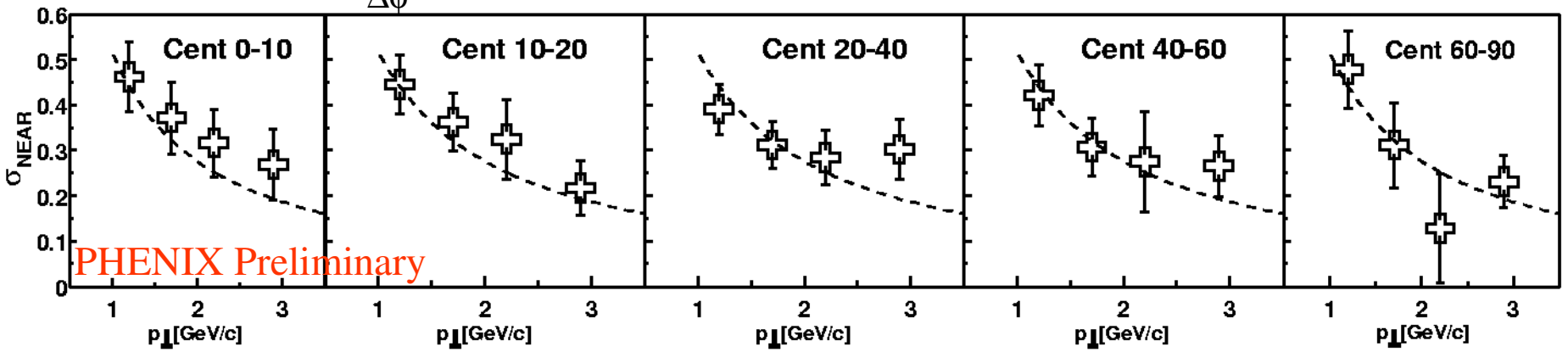
- No clear signal is seen at lower pt.
- For the higher pt bins, there is evidence for a signal.
- No obvious centrality dependence is observed, though there are corrections which have not yet been applied.

Charged-Charged Correlations*



- Correlation fcn for charged hadrons.
- Observe large asymmetry
- Fit to gaussian + cos2ϕ.
- Width of gaussian peak vs. pt.
- For a jet, the transverse momenta $\langle j_T \rangle$ ~ 400 MeV, independent of pt (dashed curve below).
- Another indication of a jet like signal in PHENIX at high pt in a different channel, different technique.

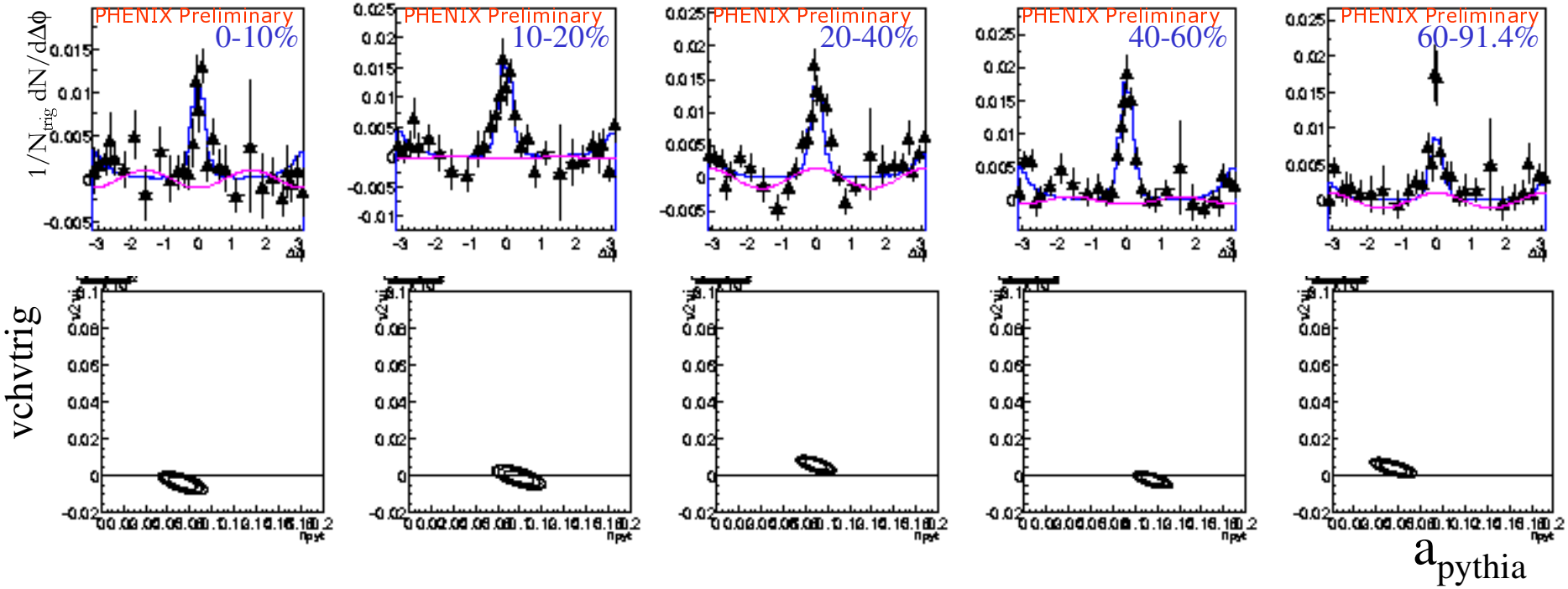
*see P. Constantin poster



Summary & Conclusions

- We see a jet signal in the angular shape of the associated production of charged hadrons from a high pt trigger photon for p-p collisions at $\sqrt{s}$ = 200 GeV.
- Correlation in (φ,η) agrees well with PYTHIA.
- The same channel in Au-Au collisions at same $\sqrt{s}$, after subtracting flat background and correcting for acceptance, also agrees very well with PYTHIA, with high statistical significance.
- At high pt for all centralities, jet signal is unambiguous.
- At lower pt there is an ambiguity with elliptic flow.
- Now that jets identified, p-p data provides a baseline for future quantitative jet measurements in Au-Au.
- Our PYTHIA fit parameter a_{pythia} shows no obvious centrality dependence at high pt, though no corrections have been applied.

Fitting Pythia + $2v_{ch}v_{trig}\cos(2\phi)$, centrality dependence



- **In the highest pt bin, the jet-like picture dominates across all centralities, with little contribution from an elliptic flow component.**