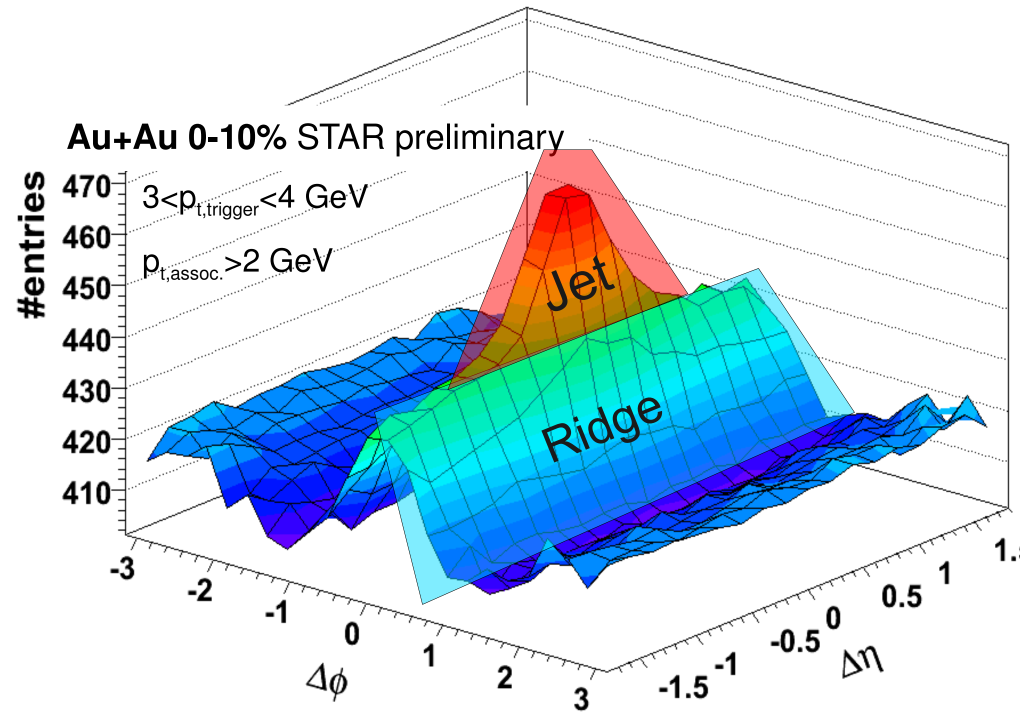
System size and energy dependence of the near-side of high-p_T triggered correlations in STAR

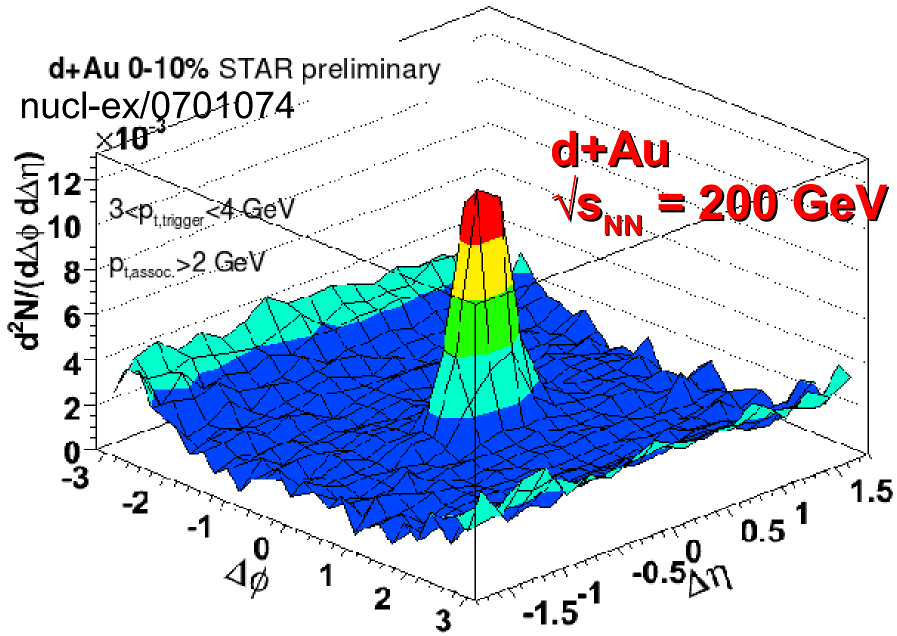
Christine Nattrass (Yale University)

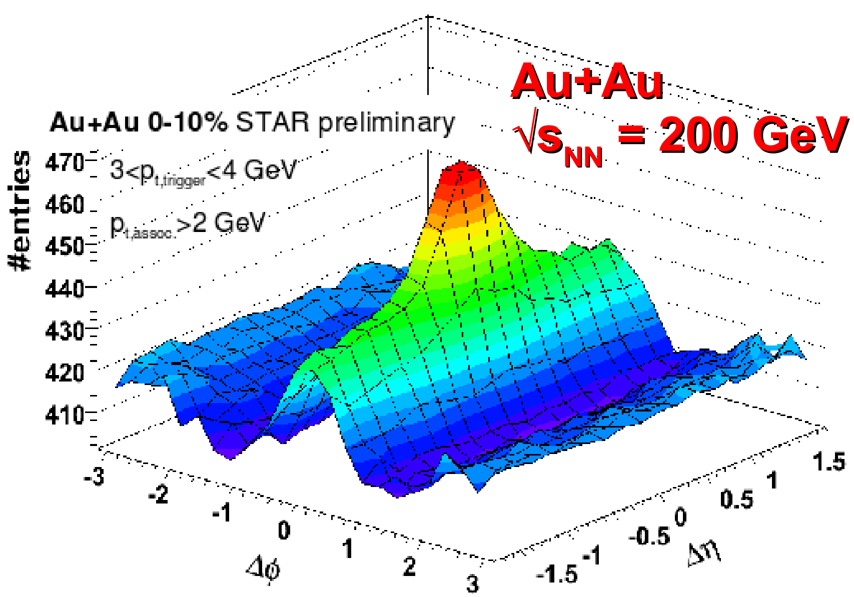
Outline

- Introduction
- The *Jet*
- The *Ridge*
- Conclusions from RHIC data
- At the LHC?



Motivation – *Jet* and *Ridge*





- In d+Au peak narrow in ΔΦ, Δη even for small $p_T^{trigger}$
- Long-range pseudorapidity (Δη) correlations observed by STAR in Au+Au at intermediate p_T
- Significant contribution to the near-side yield in central Au+Au at intermediate p_T^{assoc},$p_T^{trigger}$
- Yield/trigger – number of particles in p_T^{assoc} range associated with trigger particle with $p_T^{trigger}$ range

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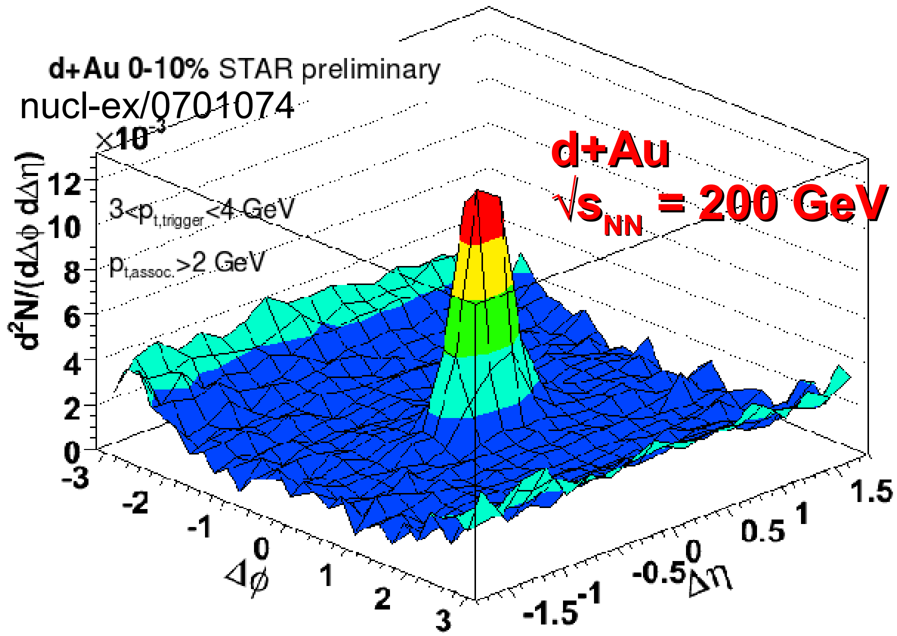

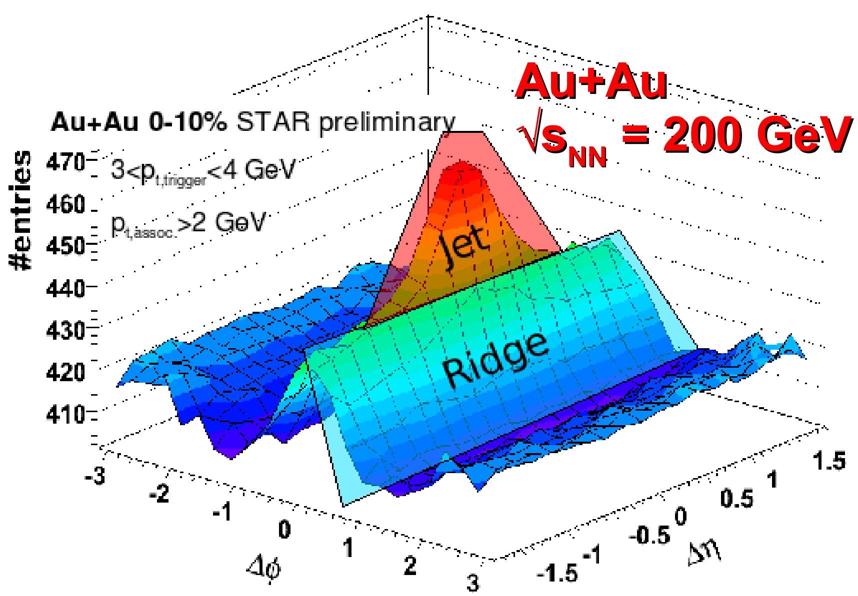

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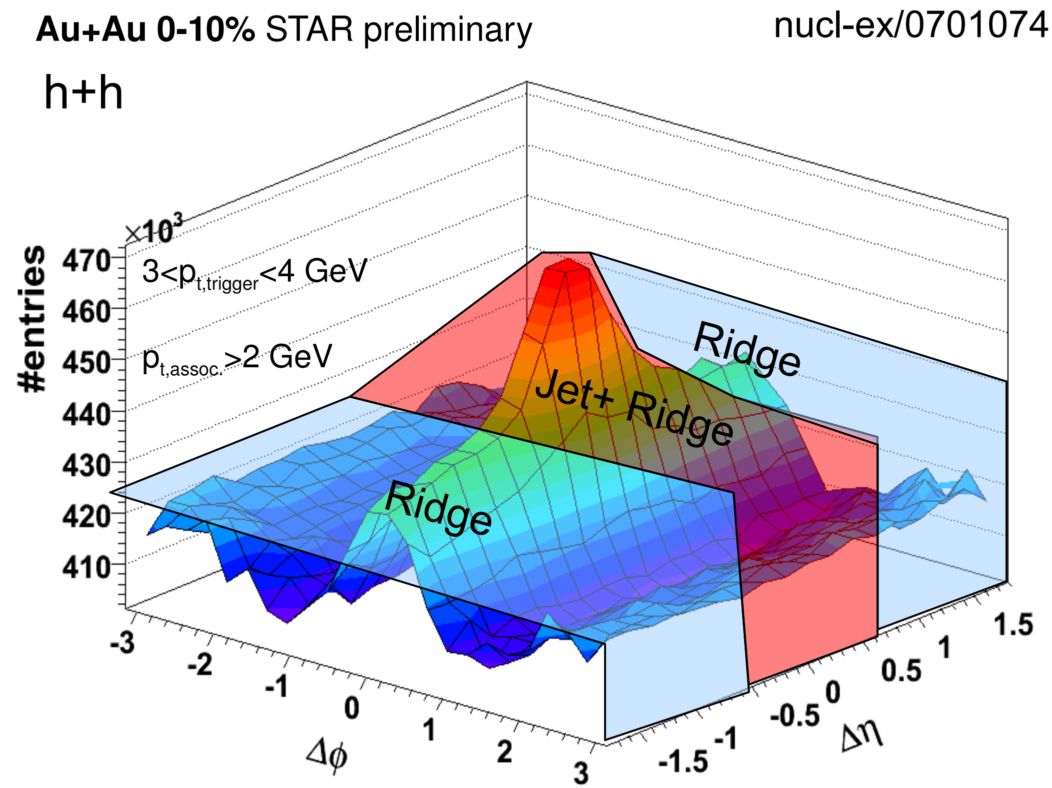
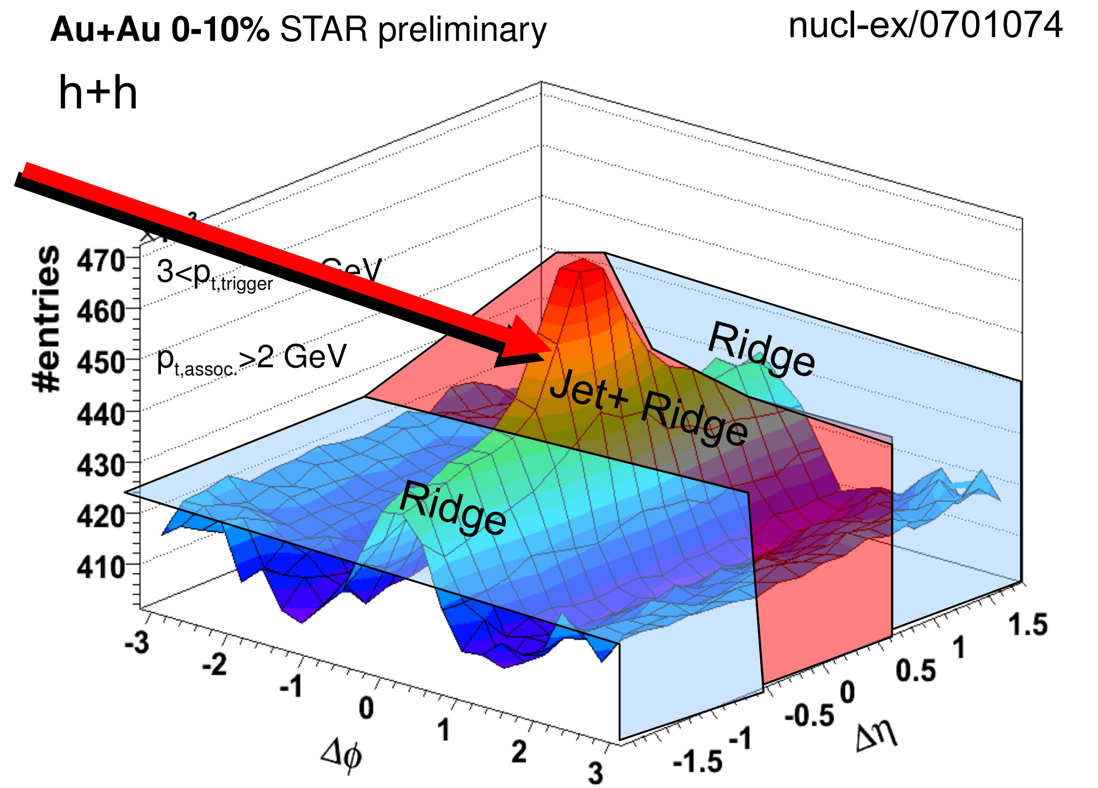
Method: Yield extraction

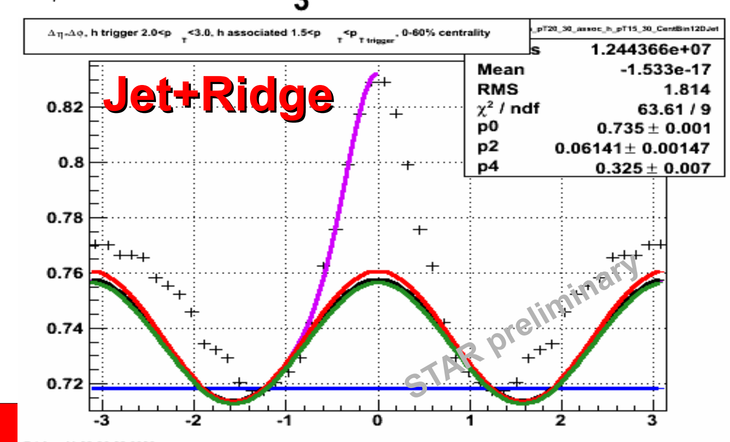
- *Ridge* previously observed to be independent in Δη in Au+Au
- To determine relative contributions, find yields for near-side (-1<ΔΦ<1), take ΔΦ projections in



Method: Yield extraction

- *Ridge* previously observed to be independent in $\Delta\eta$ in Au+Au
- To determine relative contributions, find yields for near-side ($-1<\Delta\Phi<1$), take $\Delta\Phi$ projections in
  - $-0.75<\Delta\eta<0.75$ ***Jet + Ridge***





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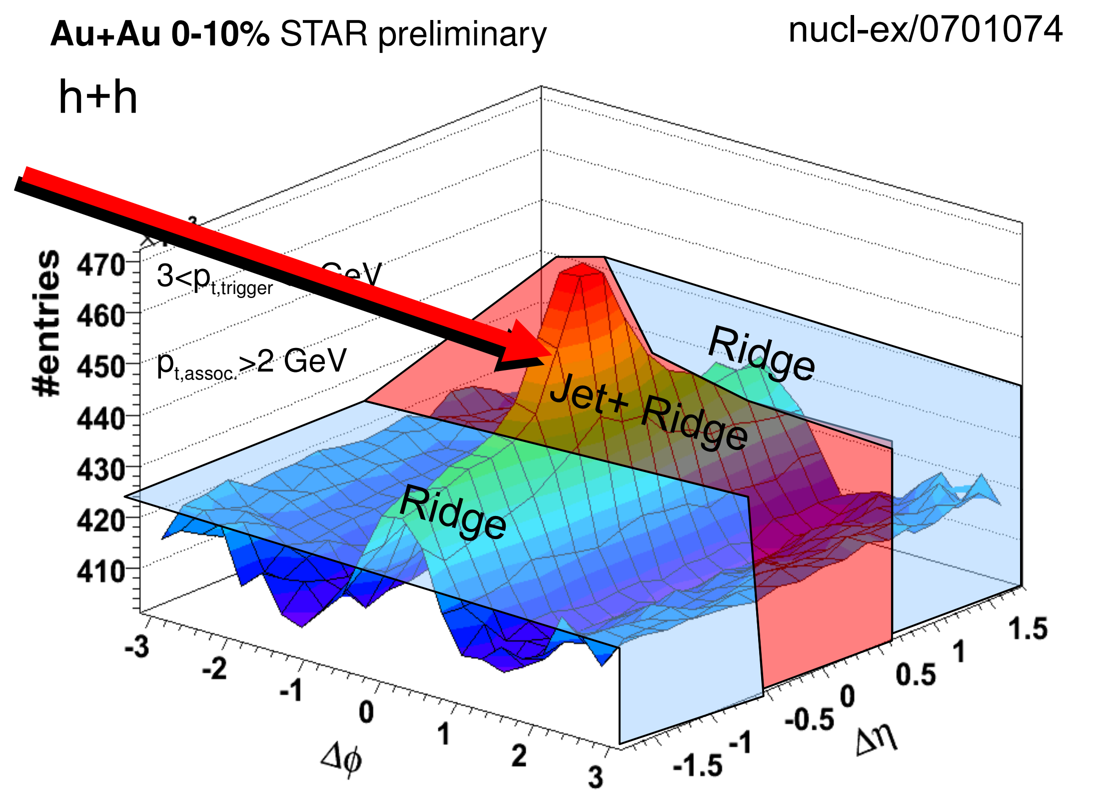

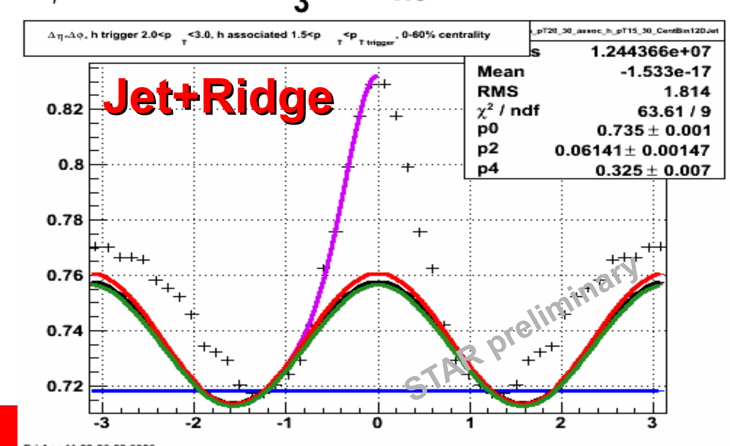

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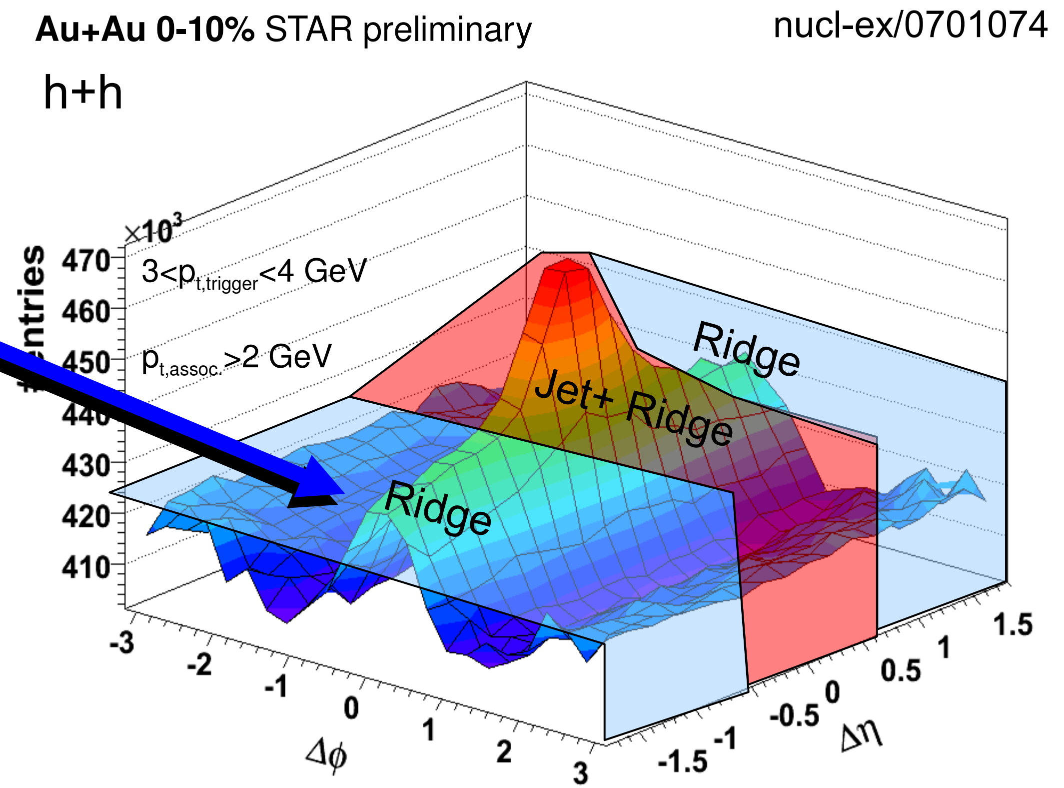

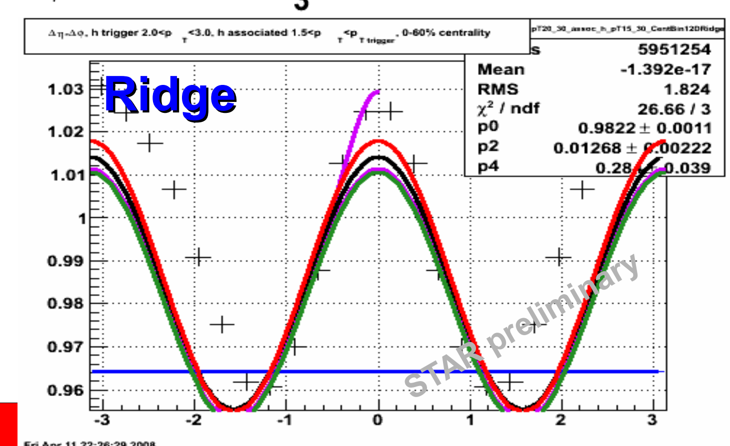

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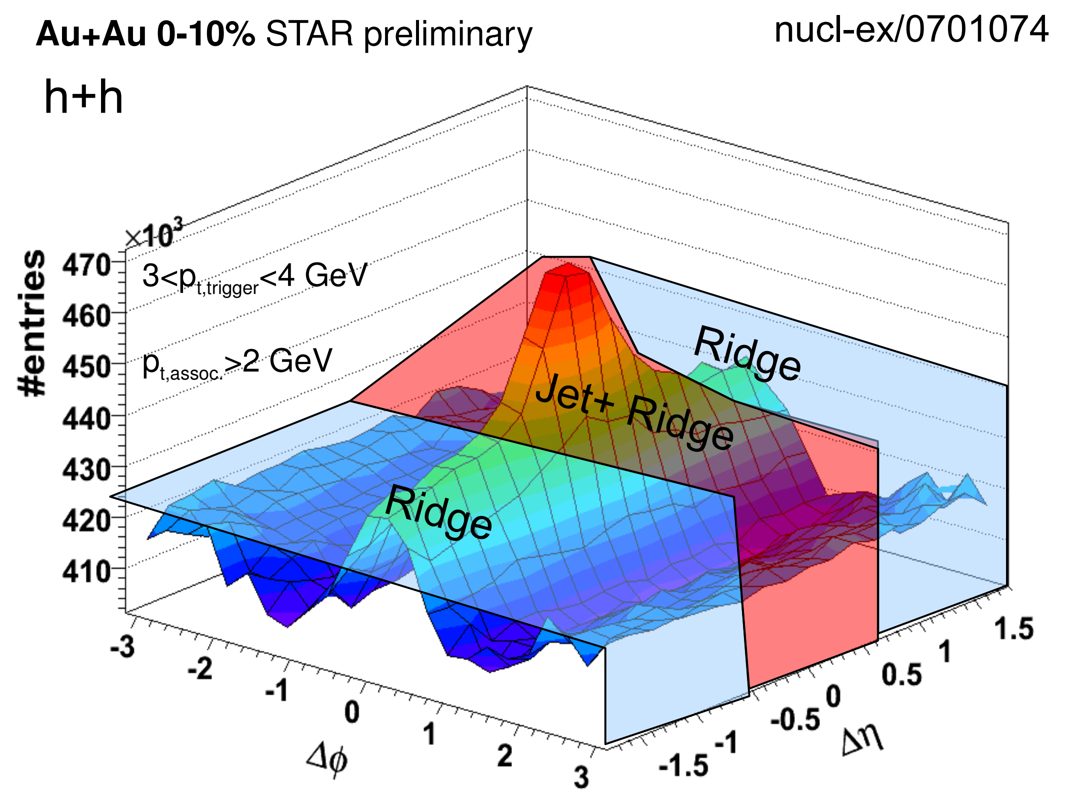
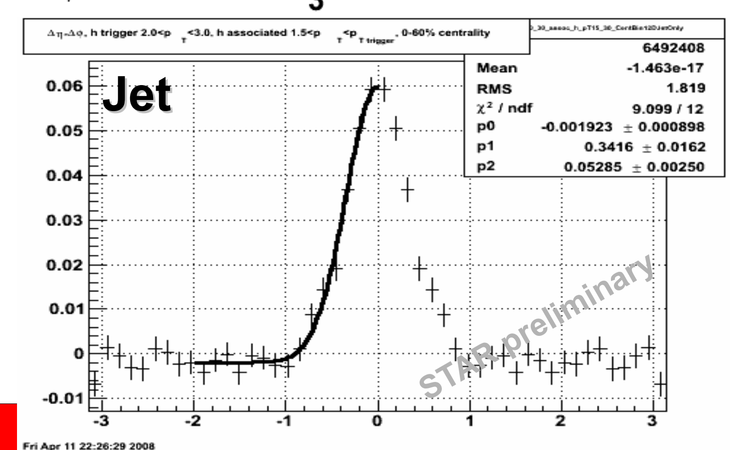
  - *Jet* = (*Jet+Ridge*) – *Ridge**.75/1.0





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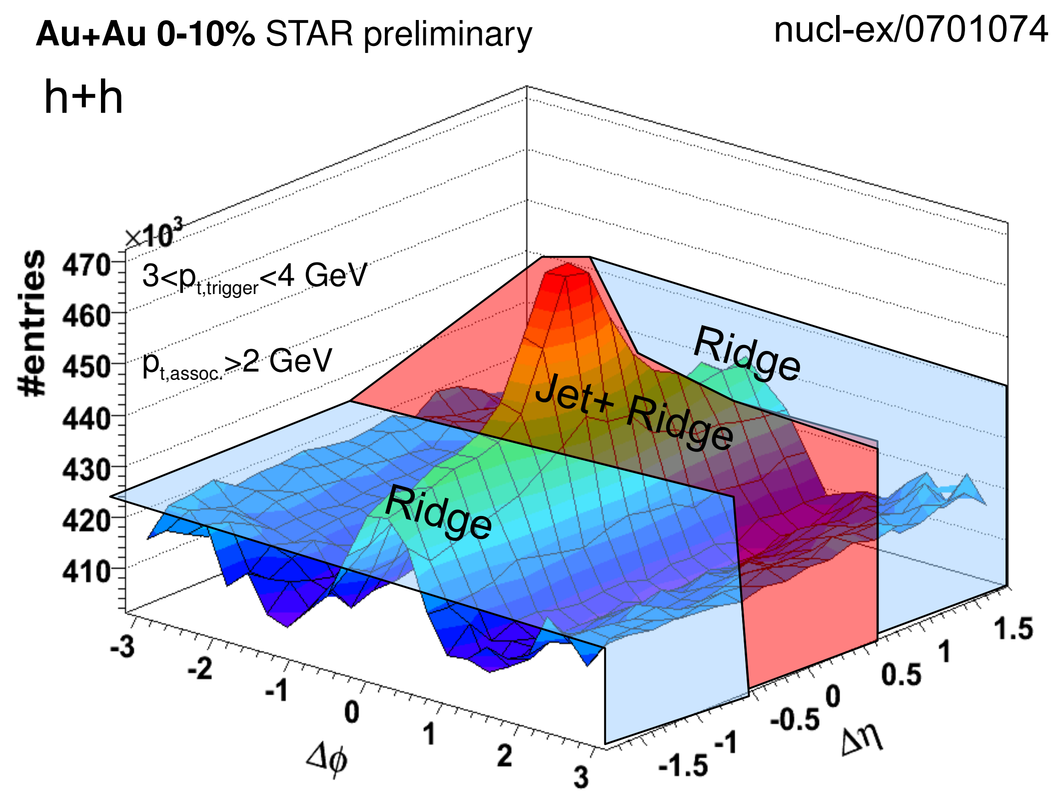

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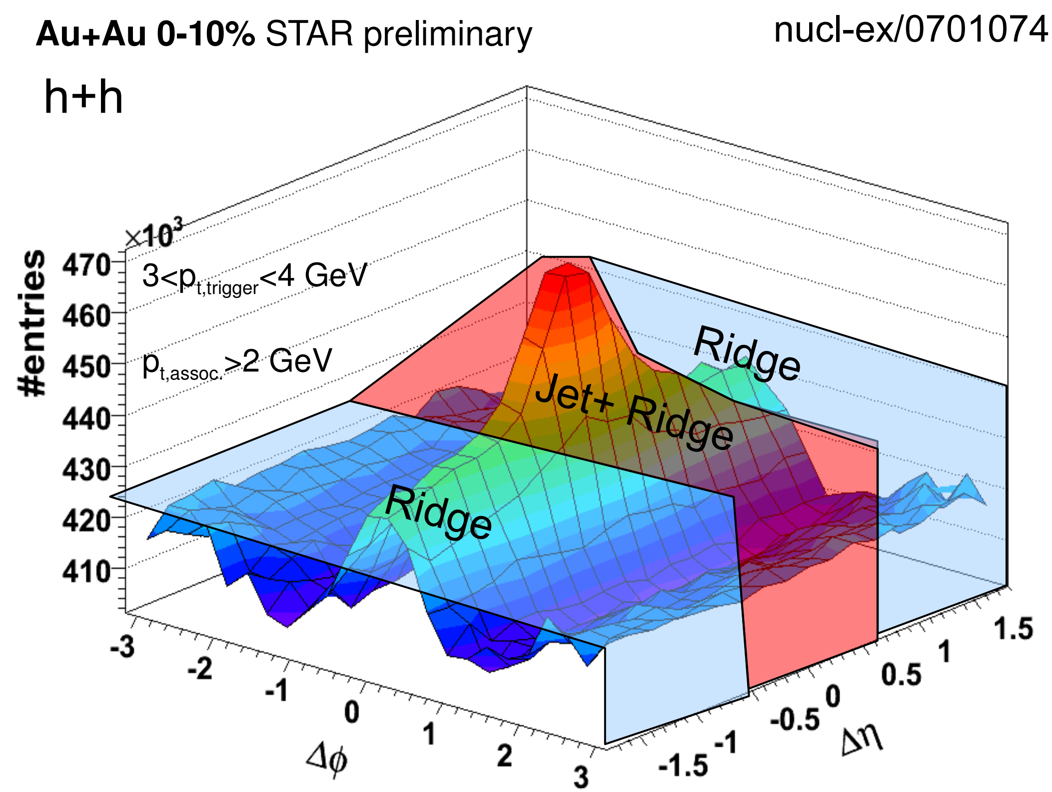

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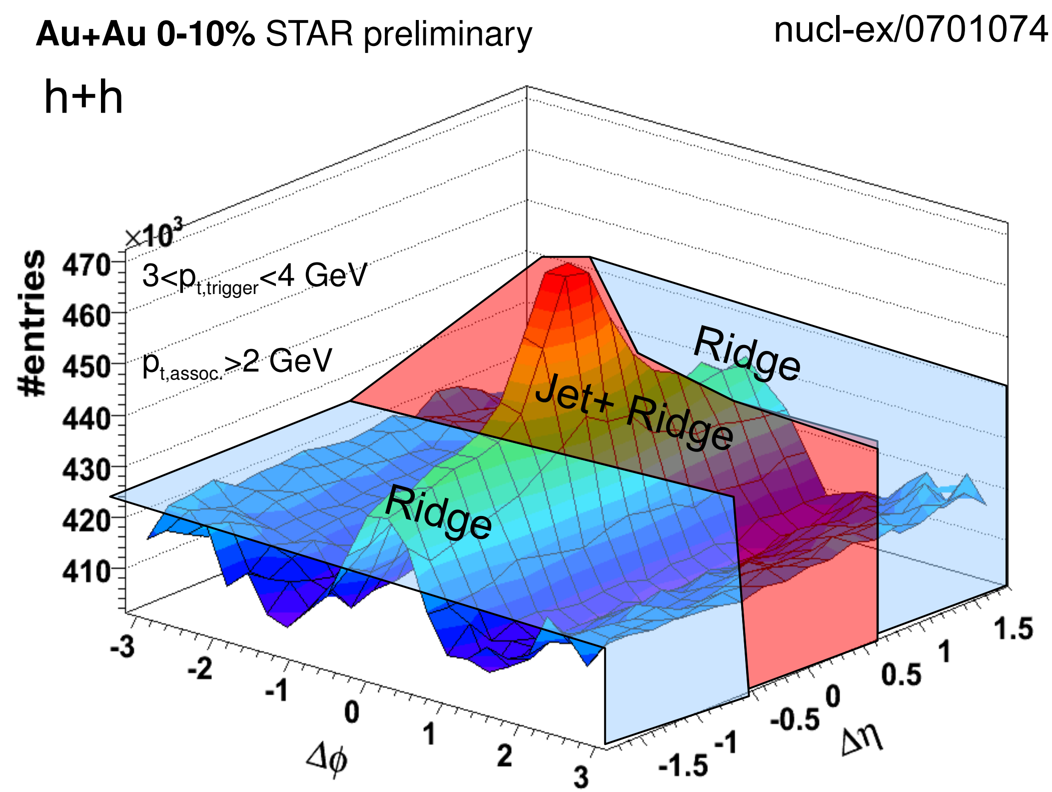
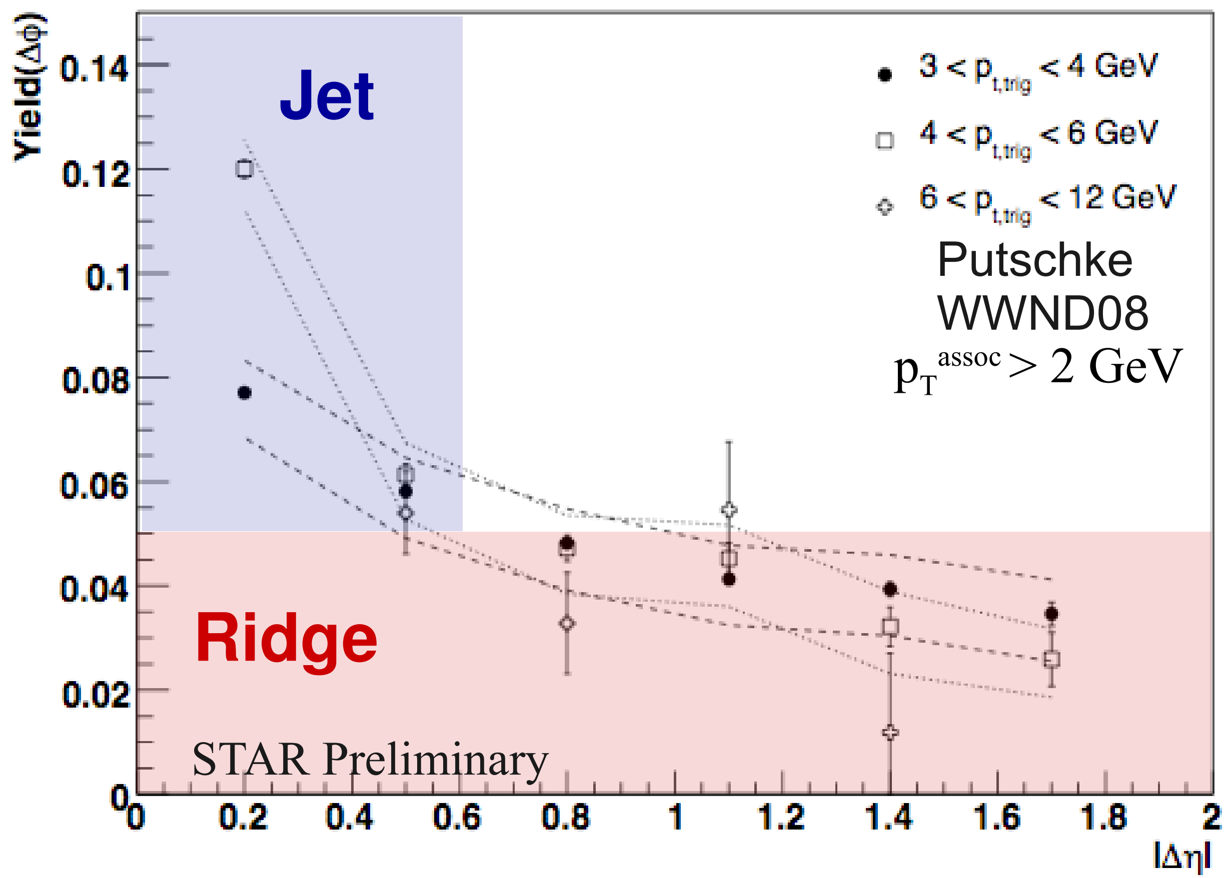


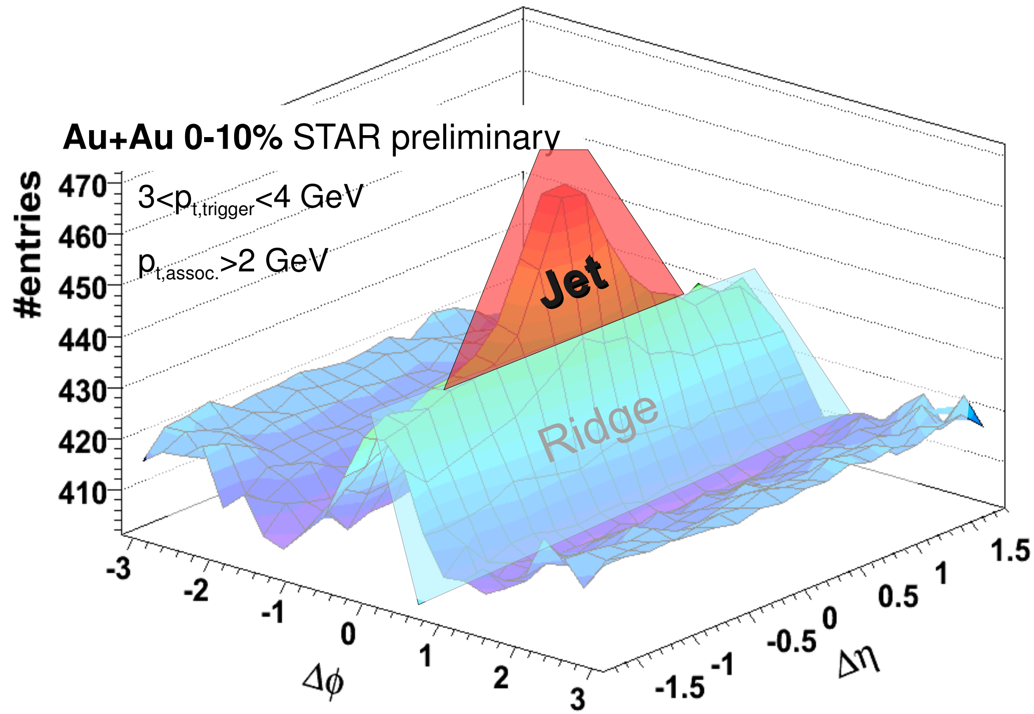
- $3.0<p_T^{trigger}<6.0$ GeV/c; $p_T^{assoc}>1.5$ GeV/c unless otherwise stated

Extent of *Ridge* in $\Delta\eta$



- *Ridge* yield approximately independent of $\Delta\eta$ in STAR acceptance
  - PHOBOS (arXiv:0804.3038v3) showed independence on $\Delta\eta$ out to $\Delta\eta = 4$
- *Jet-like* increases with $p_T^{trigger}$, *Ridge* roughly constant

The *Jet*



Au+Au 0-10% STAR preliminary
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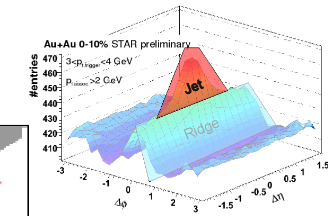
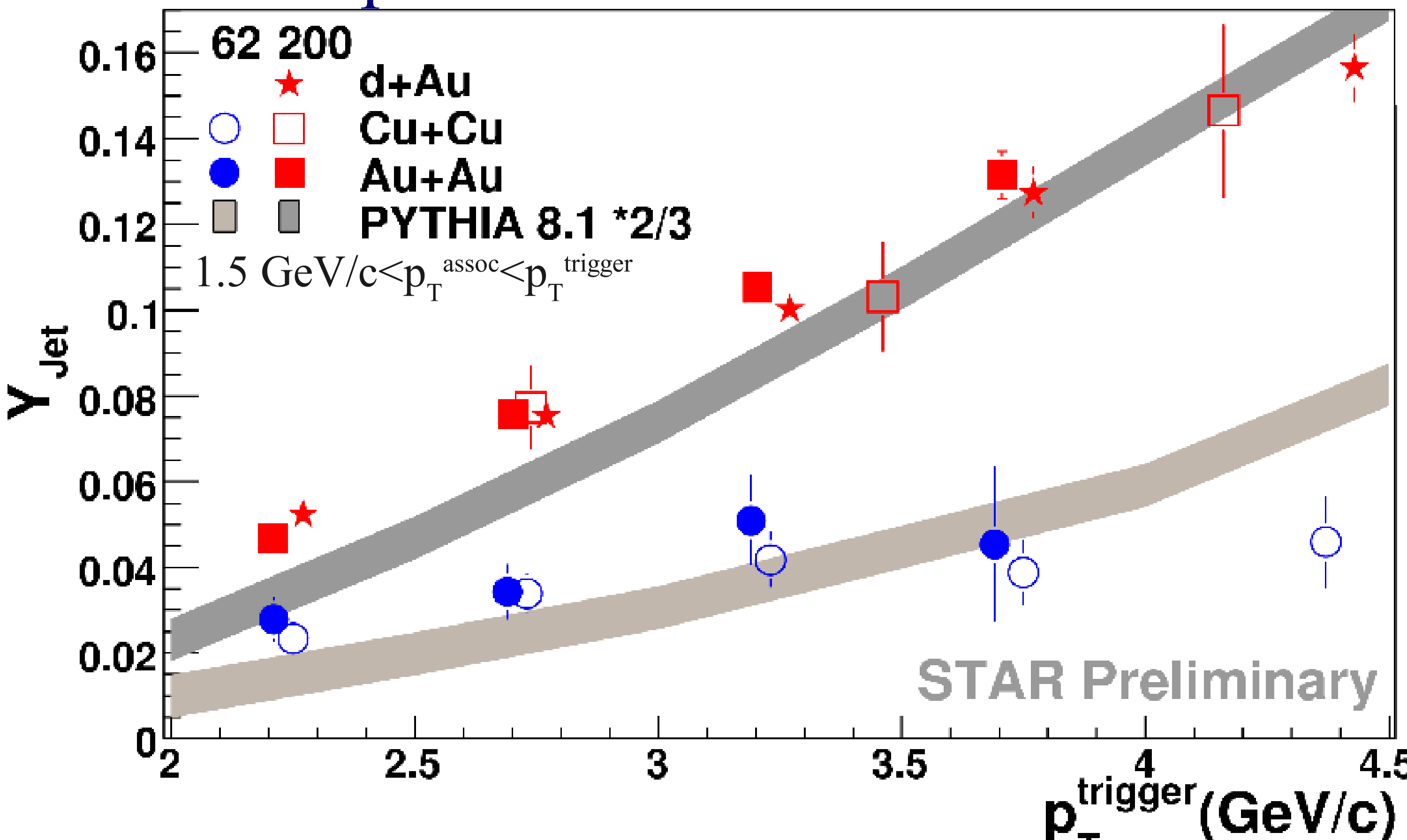
0.5
1
1.5
Δη

$p_T^{trigger}$ dependence

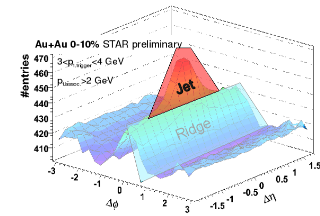


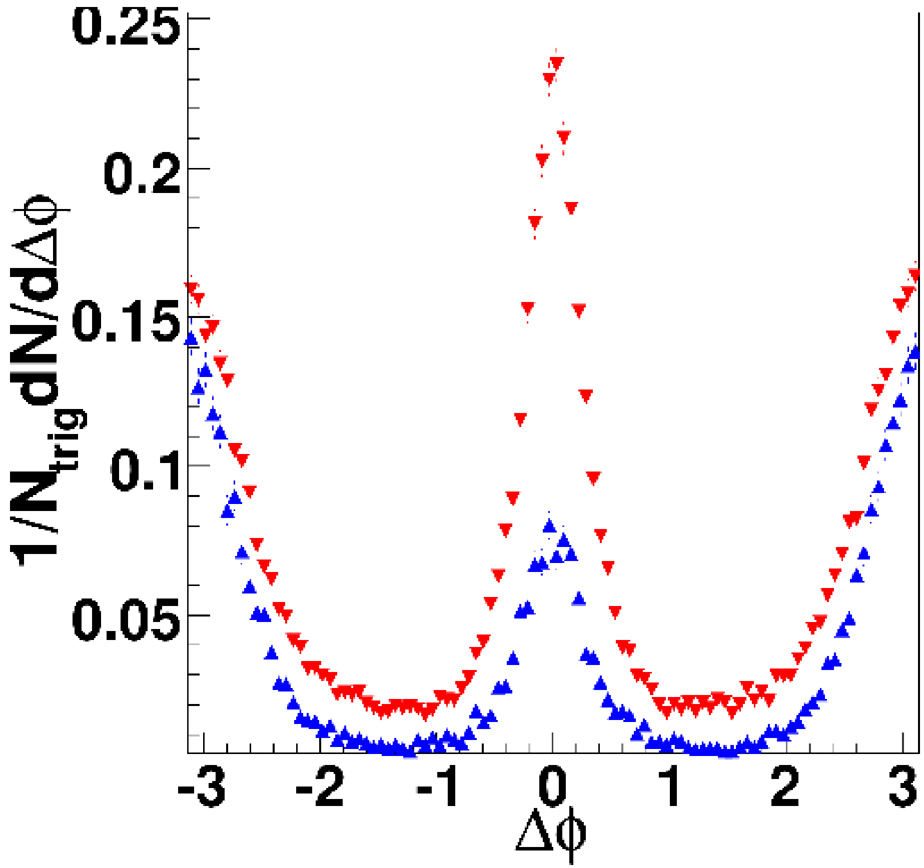


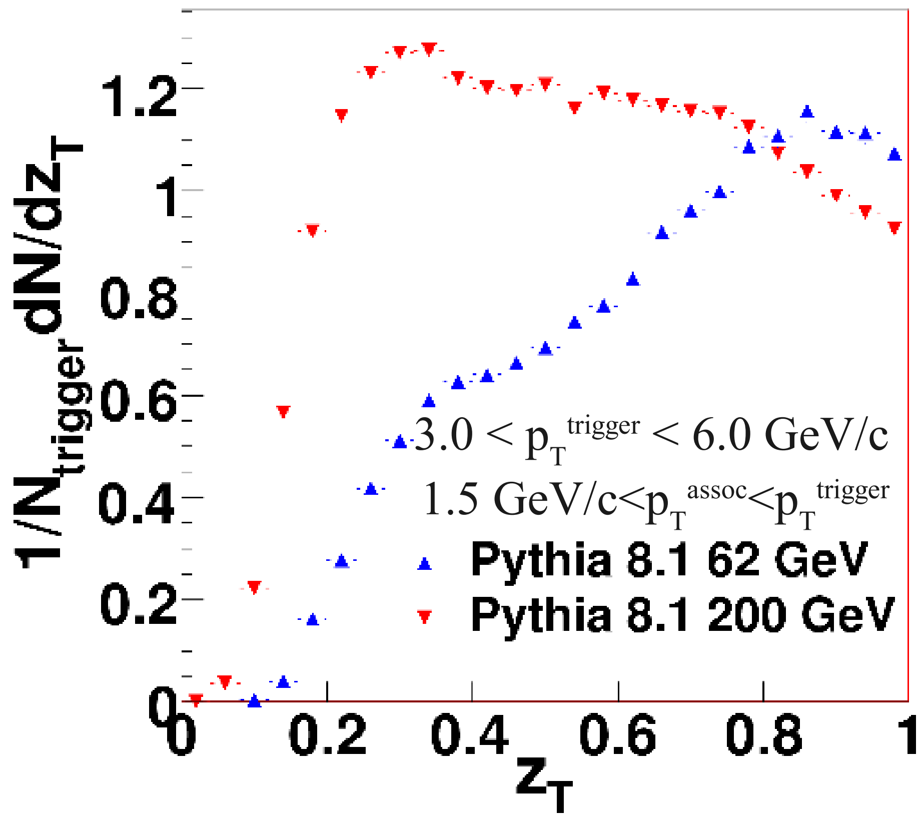
- Yields similar for d+Au, Cu+Cu and Au+Au at same $\sqrt{s_{NN}}$
- Pythia 8.1 describes trends in data up to a scaling factor
  - Gets energy dependence right → this is a pQCD effect
  - Stronger deviations at low $p_T^{trigger}$, as expected

J. Bielcikova (STAR), arXiv:0806.2261/nucl-ex
C. Nattrass (STAR), arXiv:0804.4683/nucl-ex

Pythia 8.1 comparisons







$z_T = p_T^{trigger}/pTHat$

- What can Pythia tell us?
  - Higher z_T (lower jet energy) in 62 GeV for same $p_T^{trigger}$

pTHatMin = the parameter in Pythia for the minimum transverse momentum in the hard subprocess

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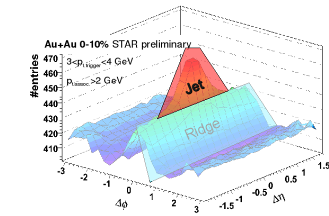

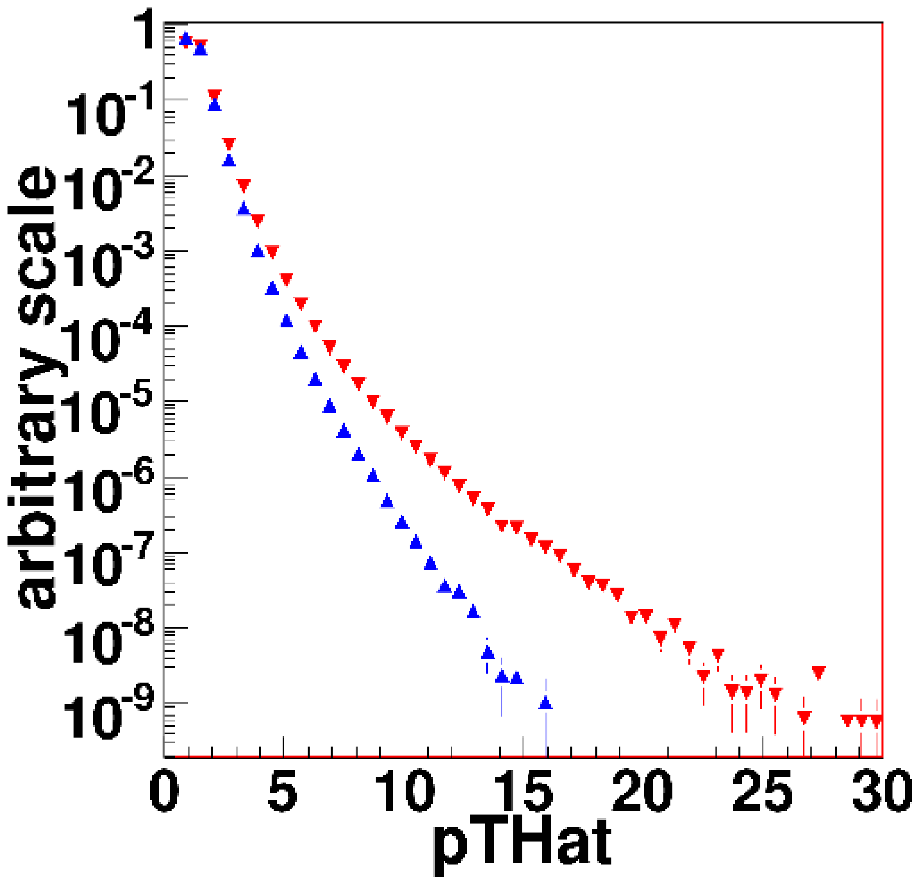

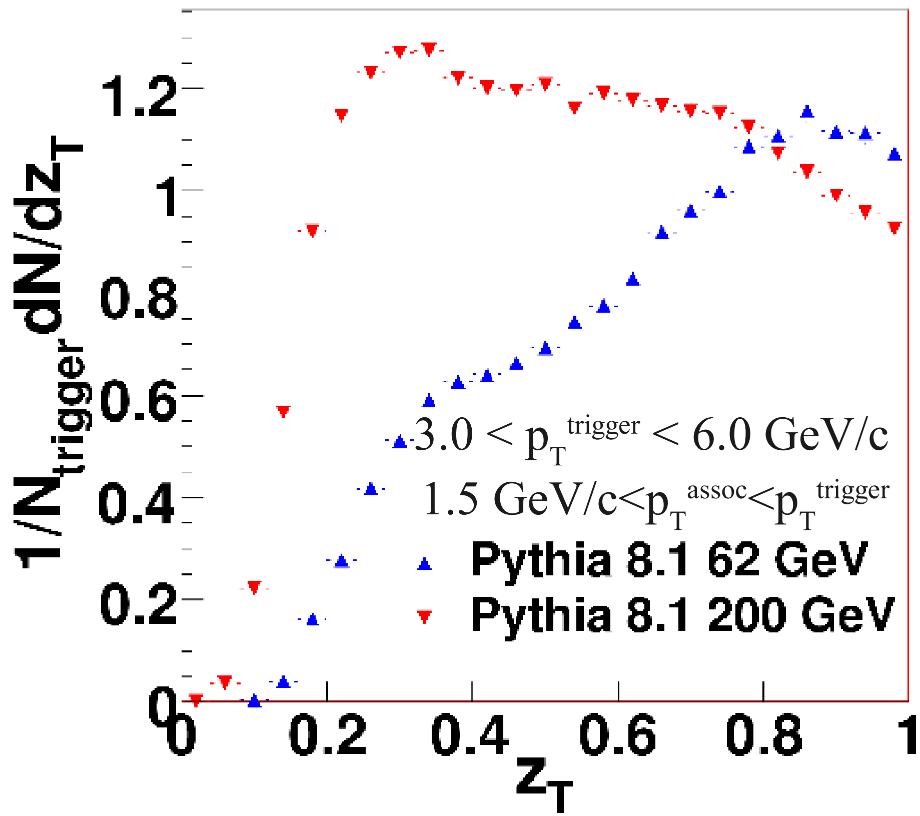

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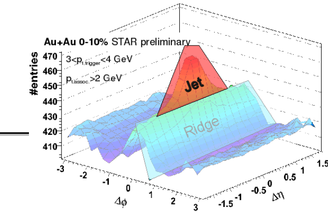
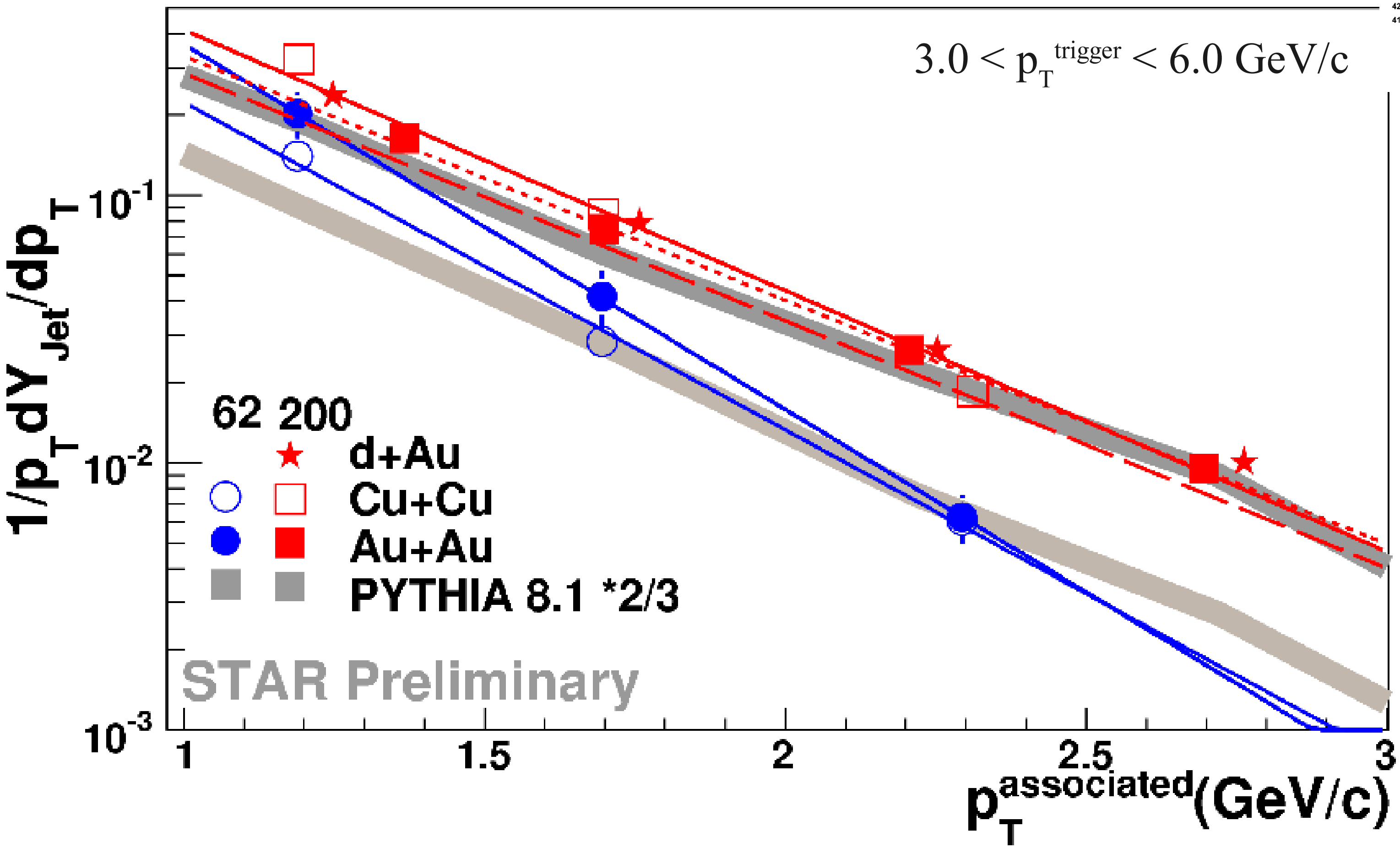
$p_T^{associated}$ dependence





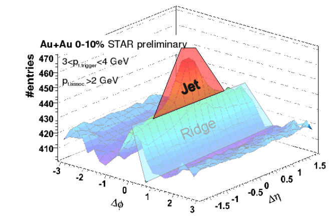
- No system dependence
- Pythia 8.1 slightly harder than data
- Diverges slightly from Pythia 8.1 at lower $p_T^{associated}$

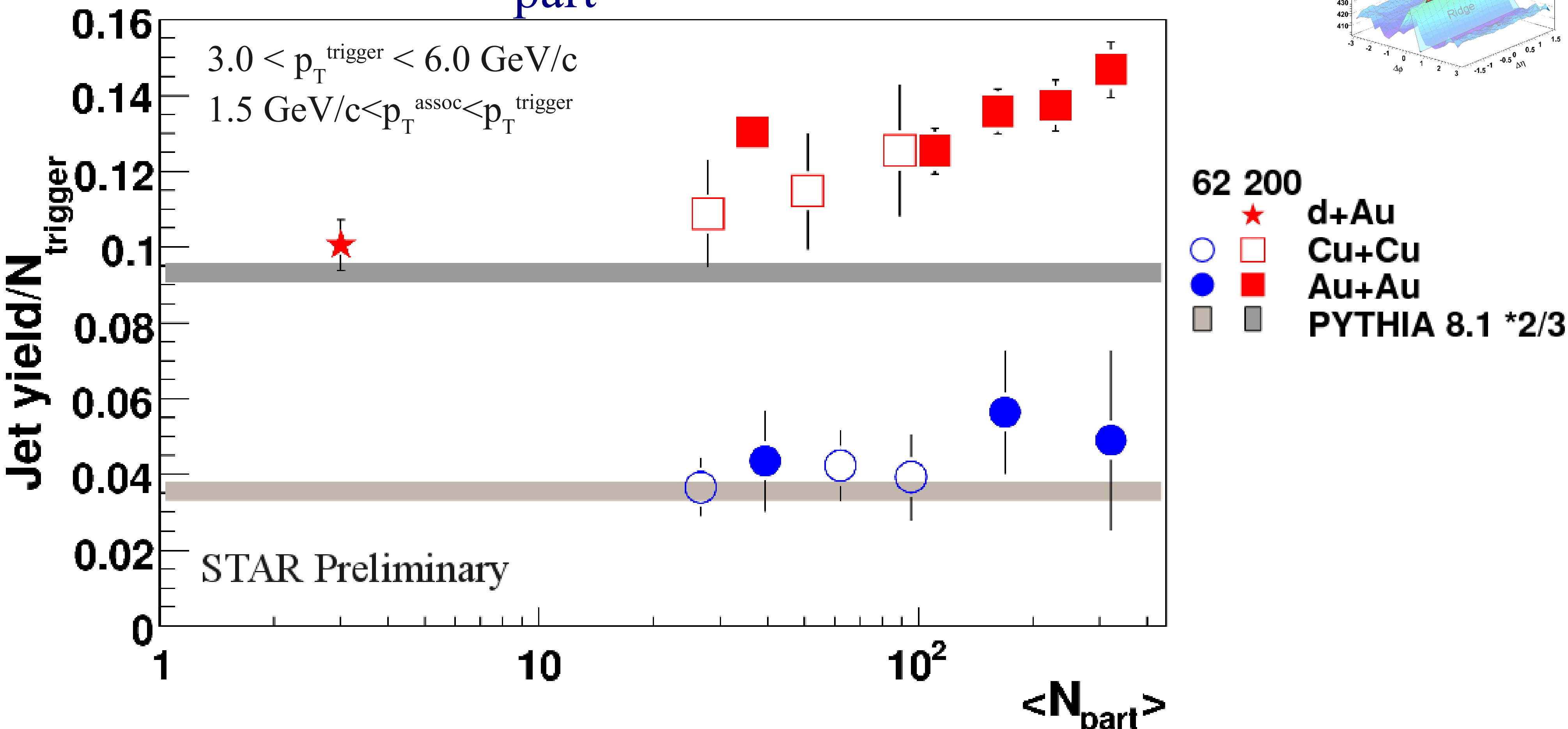
Inverse slope parameter

	$\sqrt{s_{NN}}$ = 62 GeV	$\sqrt{s_{NN}}$ = 200 GeV
Cu+Cu	317 ± 26	445 ± 20
Au+Au	355 ± 21	478 ± 8
d+Au		469 ± 8
Pythia	417 ± 9	491 ± 3

Statistical errors only

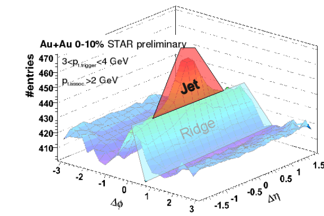
N_{part} dependence



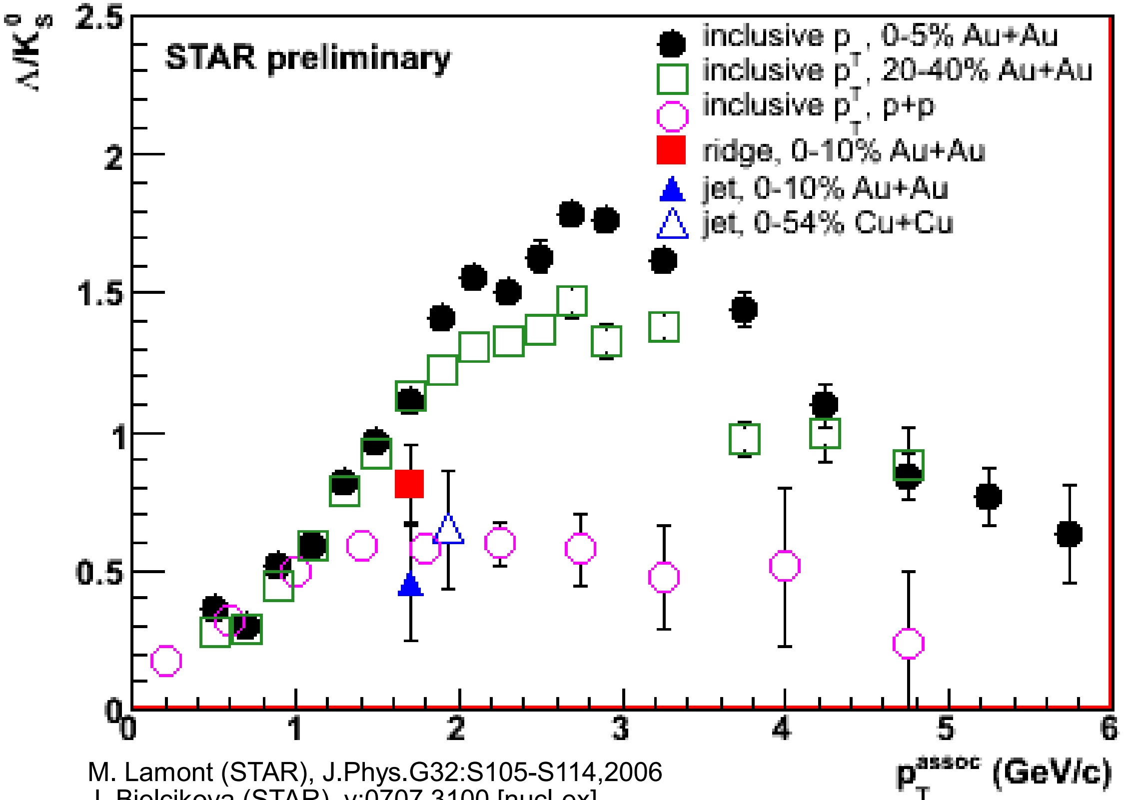


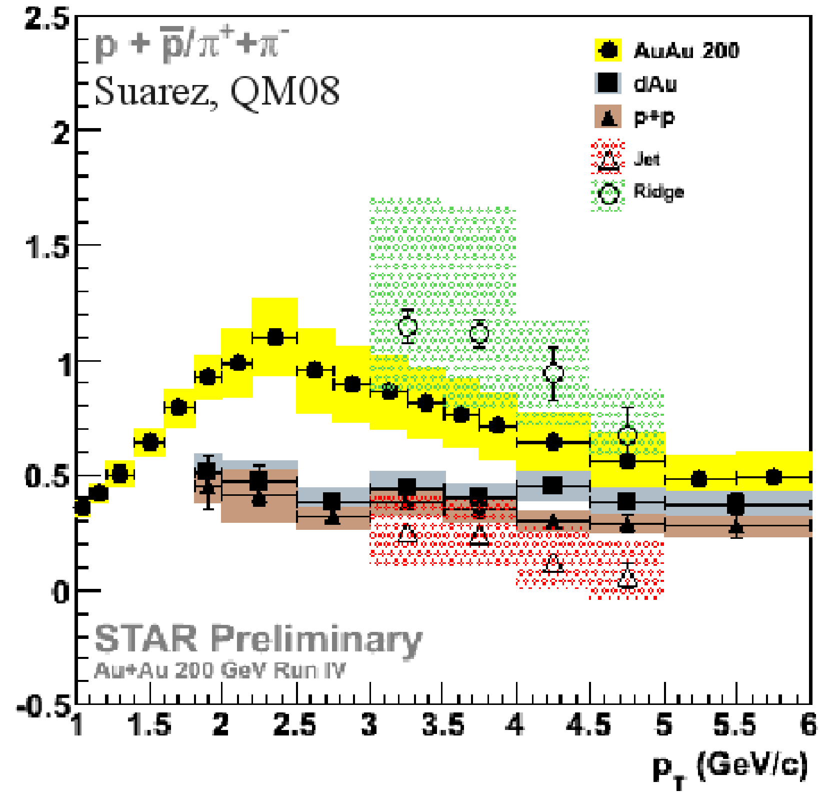
- No system dependence
- Some deviations from Pythia 8.1 with increase in N_{part}
  - Incomplete *Ridge* subtraction?
  - Jet modification at low p_T?

J. Bielcikova (STAR), arXiv:0806.2261/nucl-ex
C. Nattrass (STAR), arXiv:0804.4683/nucl-ex



Jet composition





M. Lamont (STAR), J.Phys.G32:S105-S114,2006
J. Bielcikova (STAR), v:0707.3100 [nucl-ex]
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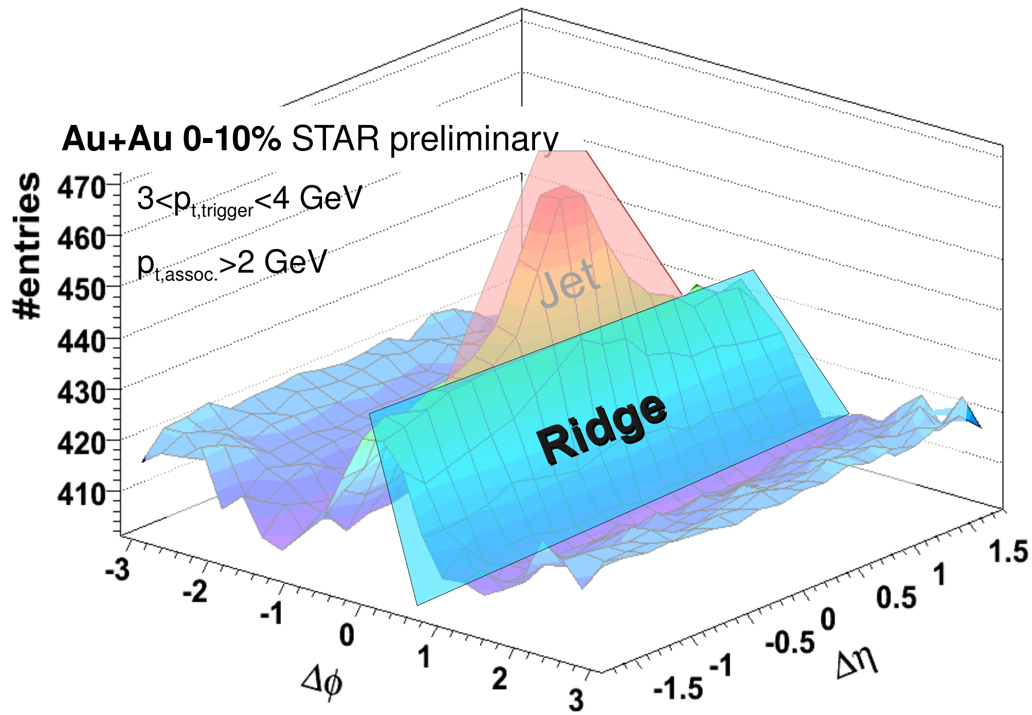
- Baryon/meson ratios in *Jet* in Cu+Cu and Au+Au similar to p+p for both strange and non-strange particles

The *Ridge*



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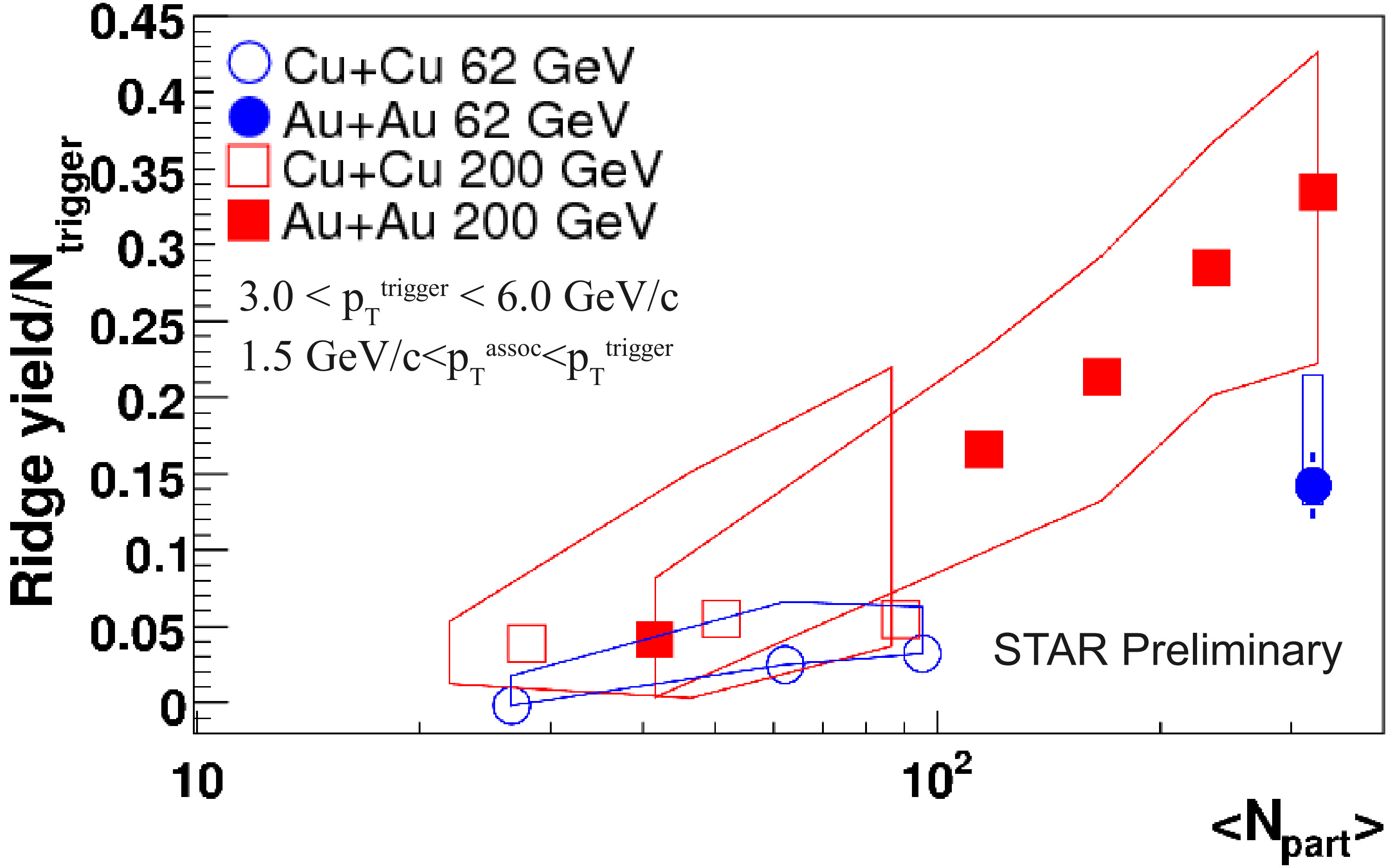
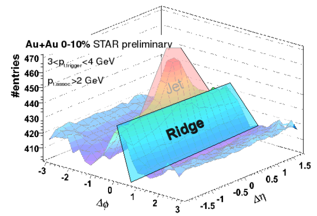
Ridge vs N_{part}





- No system dependence at given N_{part}

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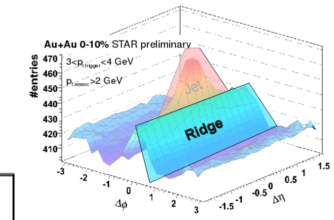

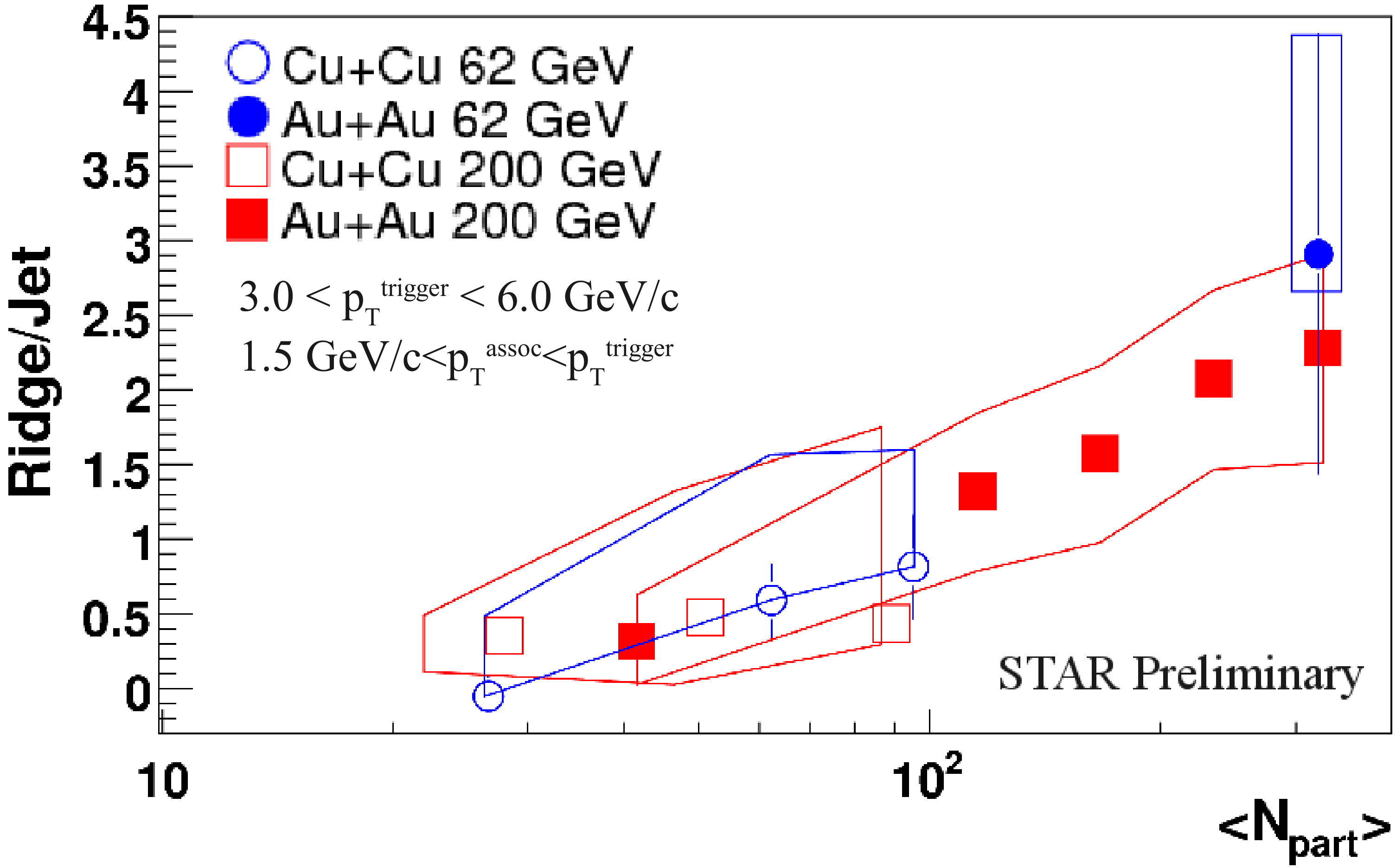

- No system dependence at given N_{part}
- *Ridge/Jet* Ratio independent of collision energy

J. Bielcikova (STAR), arXiv:0806.2261/nucl-ex
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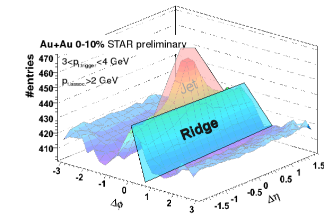
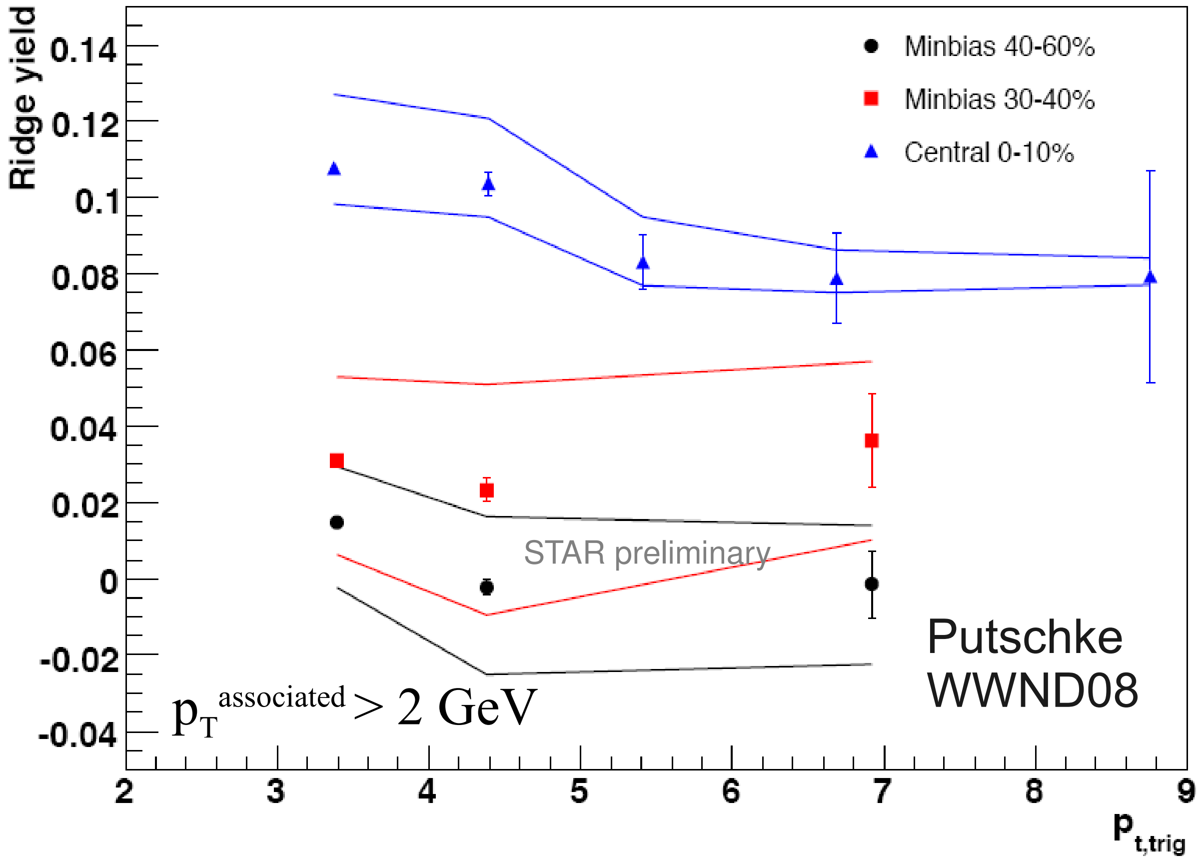
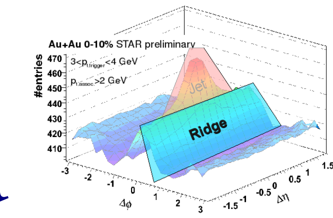
Ridge yield vs. $p_T^{trigger}$ in Au+Au

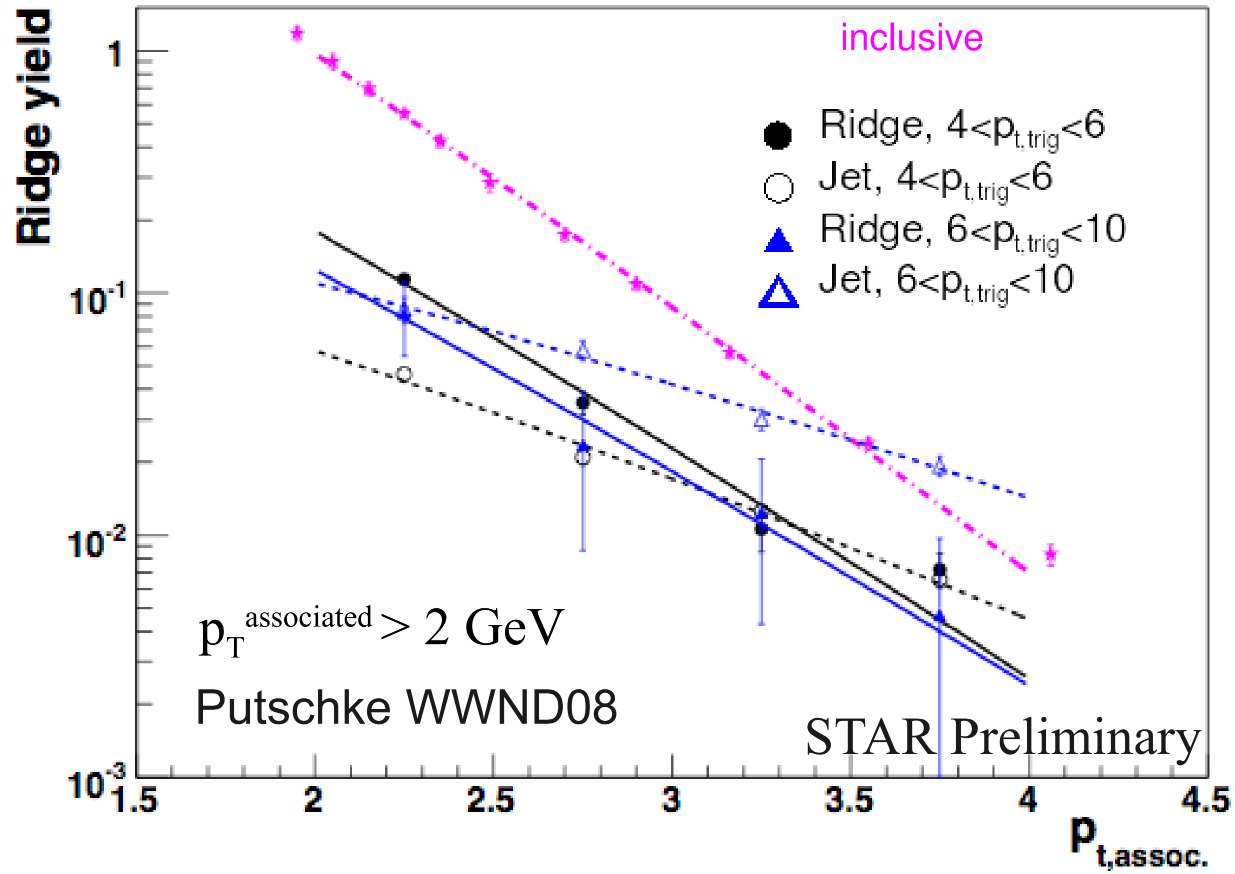




- *Ridge* yield persists to high $p_T^{trigger}$

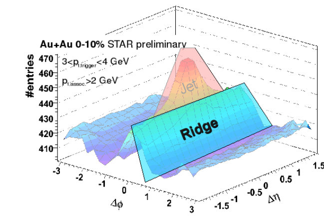


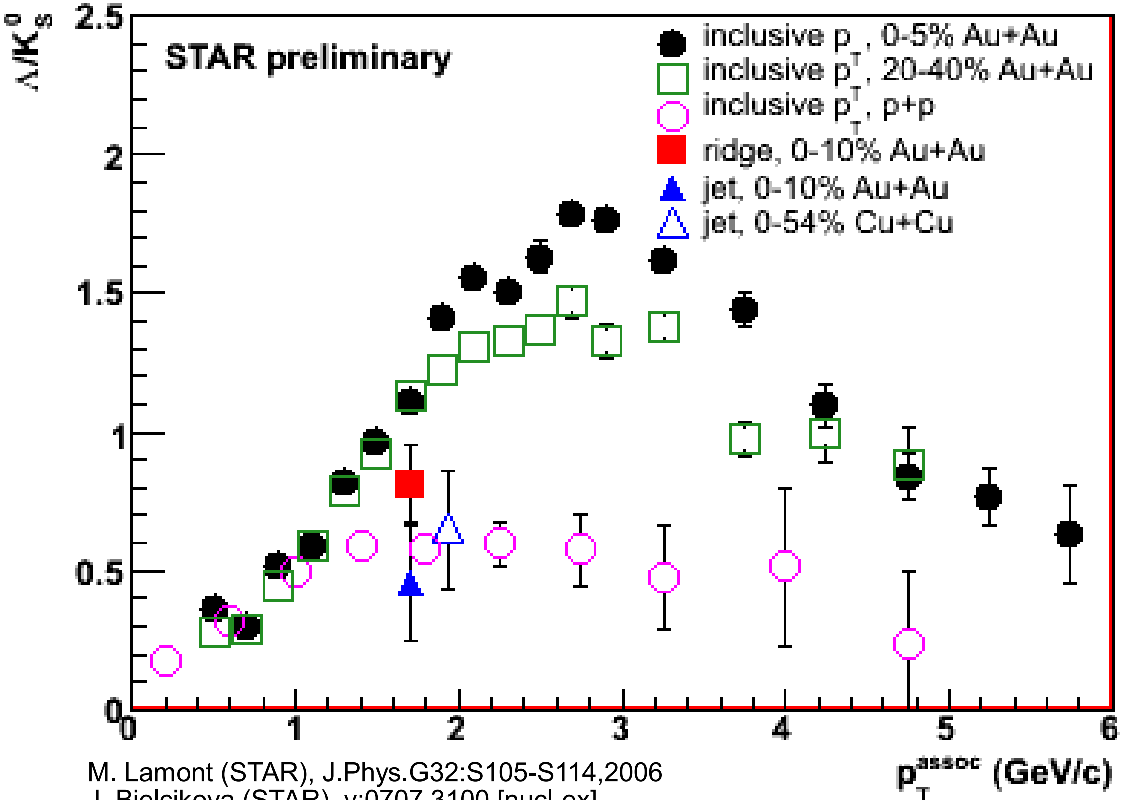
Ridge yield vs. $p_T^{associated}$ in Au+Au



- Spectra of particles associated with *Ridge* similar to inclusive

Ridge composition





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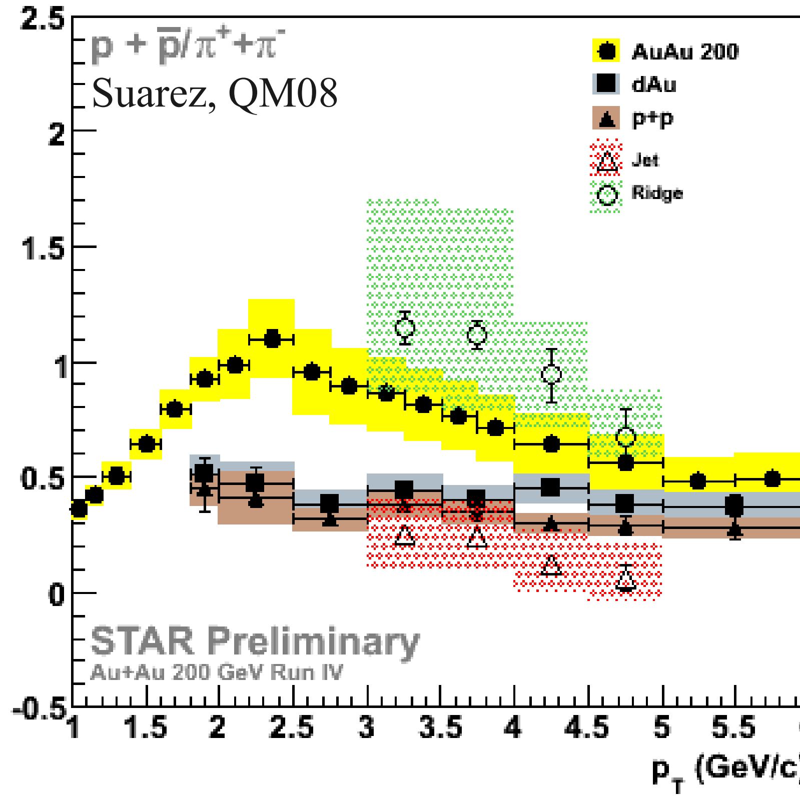
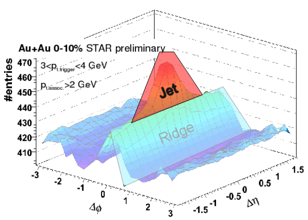


- Baryon/meson ratios in *Ridge* similar to bulk for both strange and non-strange particles

Conclusions: RHIC data

Jet



- Pythia describes data well
  - Scaling factor needed but Pythia 8.1 is not as tuned as earlier versions
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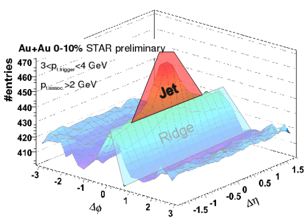

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→ *Jet* production mechanism dominated by fragmentation

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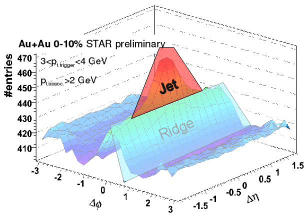

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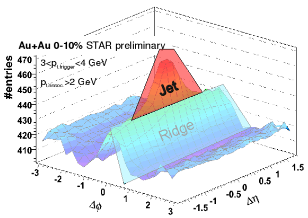
- *Jet-like* yield agreement between different systems, with scaled Pythia
  - Simulations can be used to approximate z_T distribution for comparisons of data to models?

Conclusions: RHIC data

- Pythia describes data well
  - Scaling factor needed but Pythia 8.1 is not as tuned as earlier versions
  - Energy dependence in *Jet-like* yield is pQCD effect
  - Trends for $p_T^{trigger}$, p_T^{assoc} dependence right

Jet

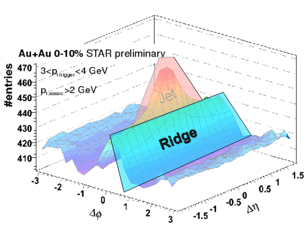


- Particle ratios similar to p+p
- No system dependence

→ *Jet* production mechanism dominated by fragmentation

- *Jet-like* yield agreement between different systems, with scaled Pythia
  - Simulations can be used to approximate z_T distribution for comparisons of data to models?

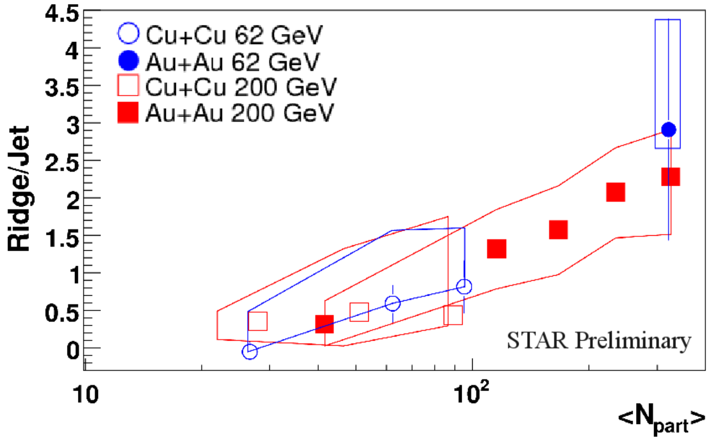
Ridge



- Extensive data on Ridge
  ...but what is it?

Models: RHIC and LHC

Naïve assumptions from data...



- *Ridge/Jet* roughly independent of collision energy *for the same kinematic cuts*

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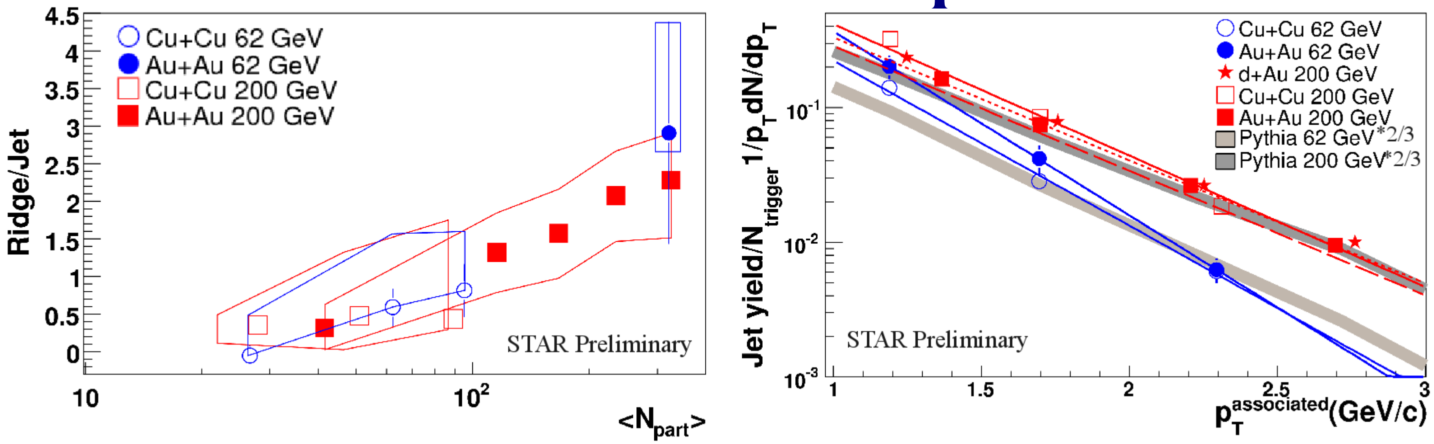

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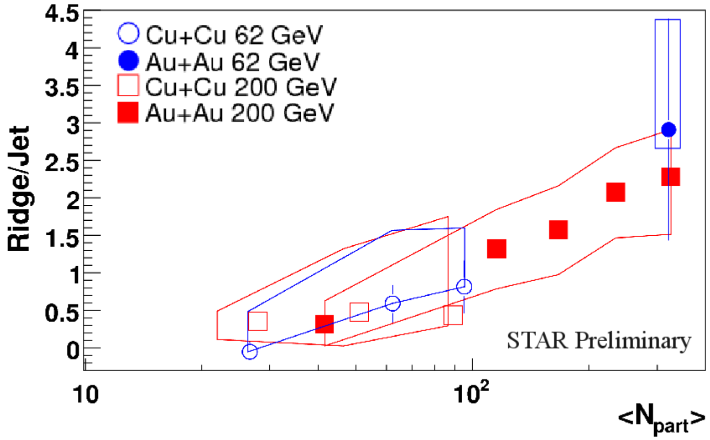

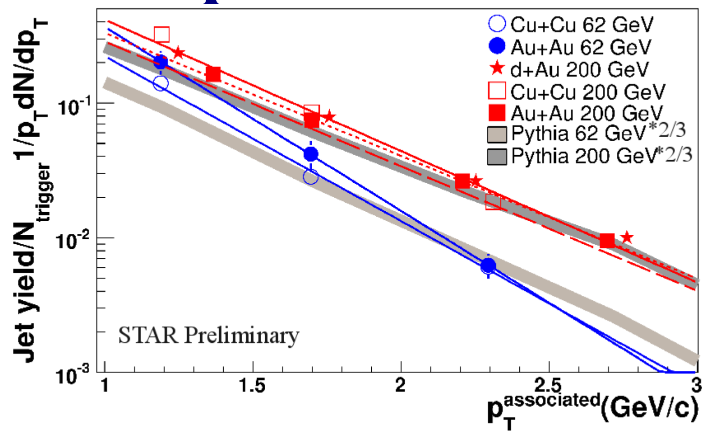

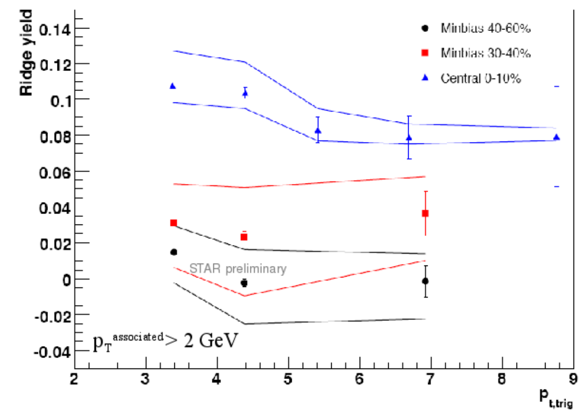

- *Ridge/Jet* roughly independent of collision energy *for the same kinematic cuts*
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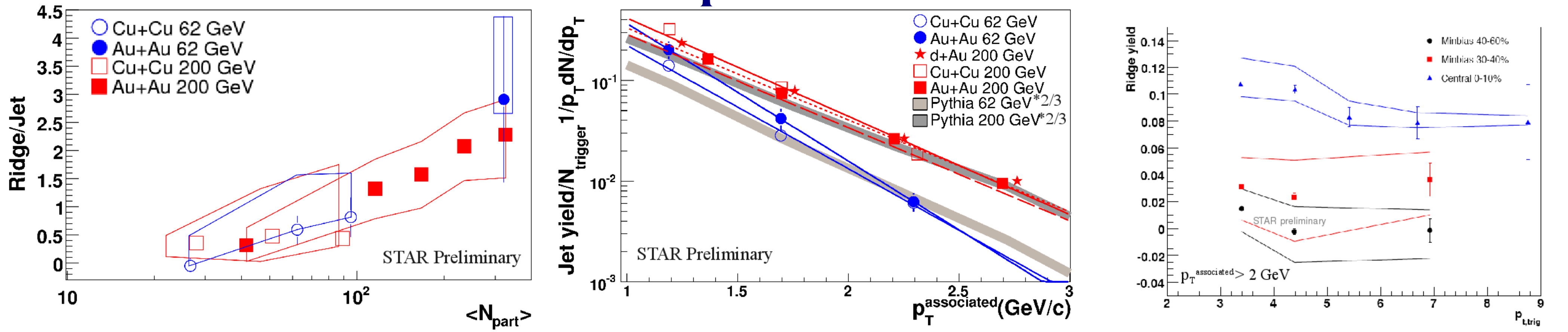

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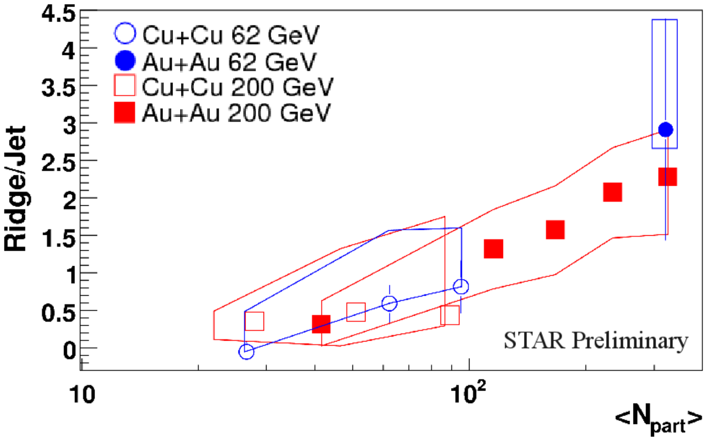

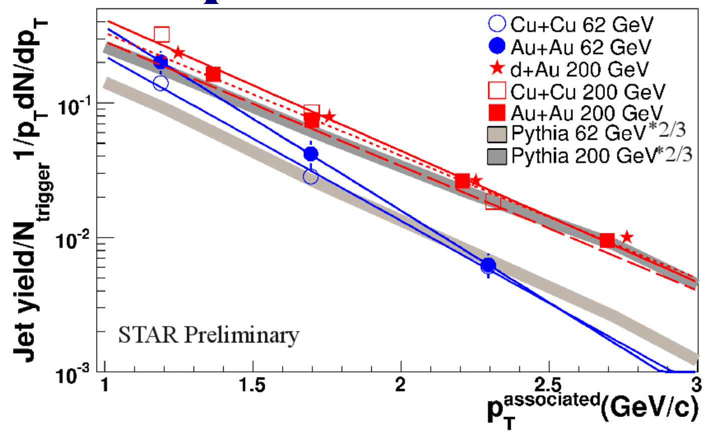

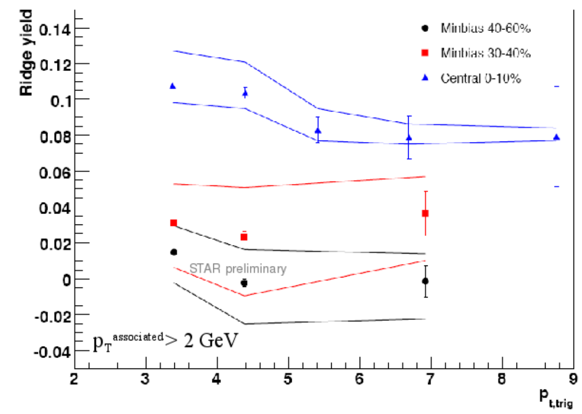

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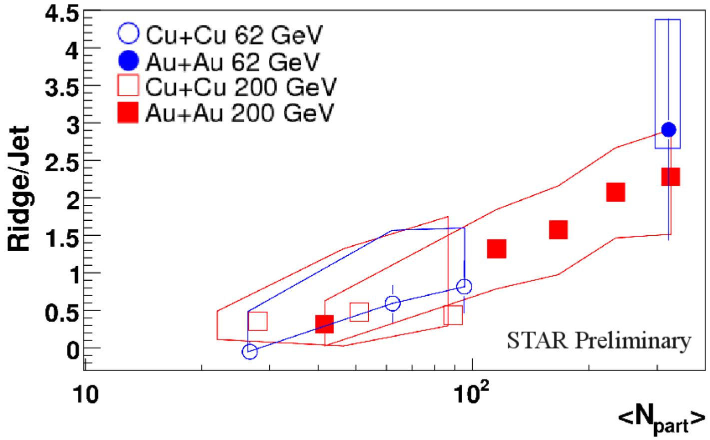

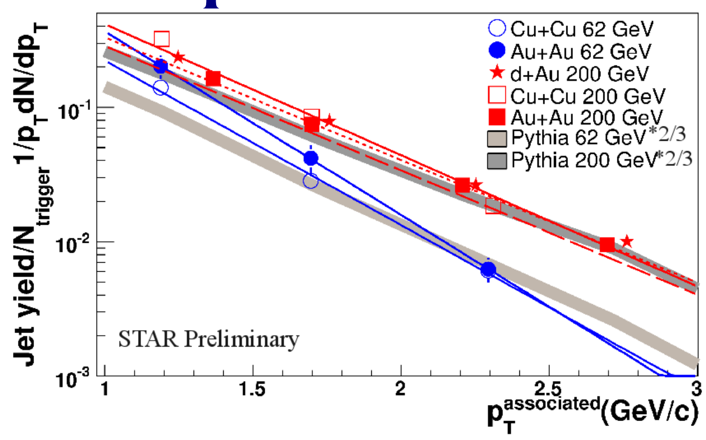

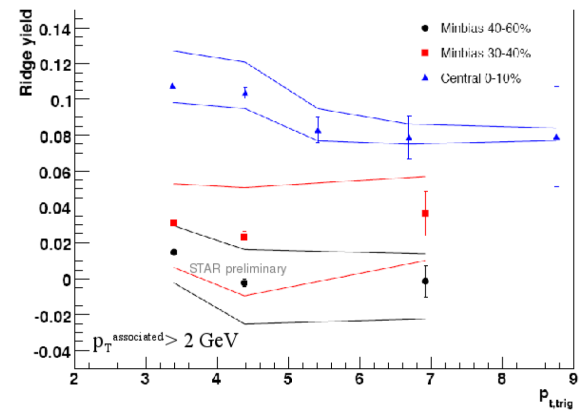

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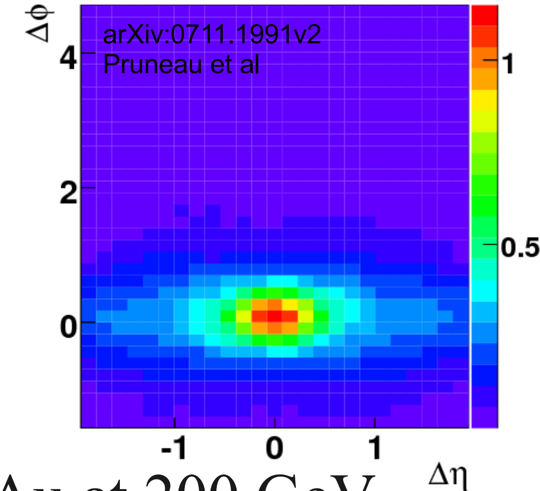
- At the LHC, the *Ridge* should naïvely be the same size as at RHIC for the same kinematic cuts...
- BUT background will be higher, so unless v_2 is much smaller than at RHIC, the background may make measurements unfeasible

Models

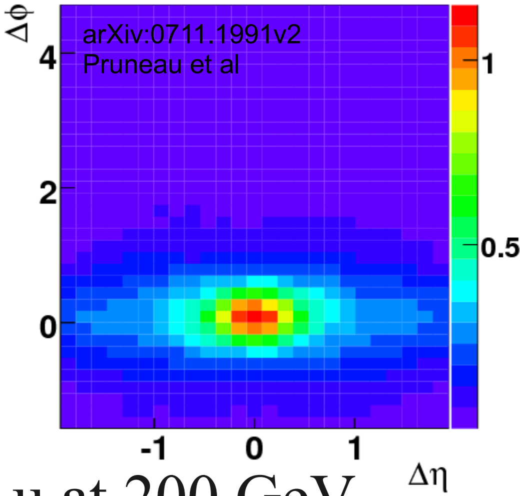


- Radial flow+trigger bias

  S. Voloshin, nucl-th/0312065, Nucl. Phys. A749, 287
  C.. Pruneau, S. Gavin, S. Voloshin, arXiv:0711.1991v2
  E. Shuryak, *Phys.Rev.C76:047901,2007*

  – At RHIC:
    - Works for one set of kinematic cuts in central Au+Au at 200 GeV
    - Need more detailed comparisons (energy dependence)
    - Model needs some refinements (momentum conservation)

Models



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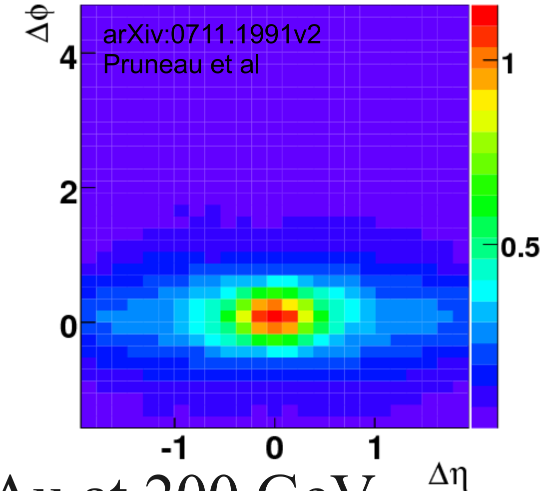

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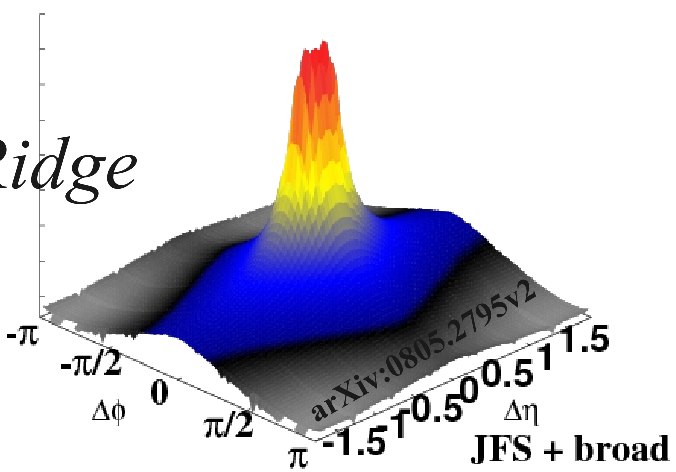
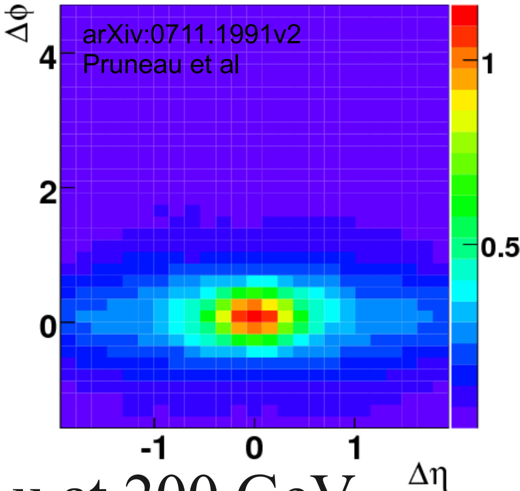
  QCD magnetic fields, Majumder et al,Phys.Rev.Lett.99:042301,2007
  Anisotropic plasma, P. Romatschke, PRC,75014901 (2007)

  - At RHIC: So far unable to make enough *Ridge* without Radial flow+trigger bias



Models



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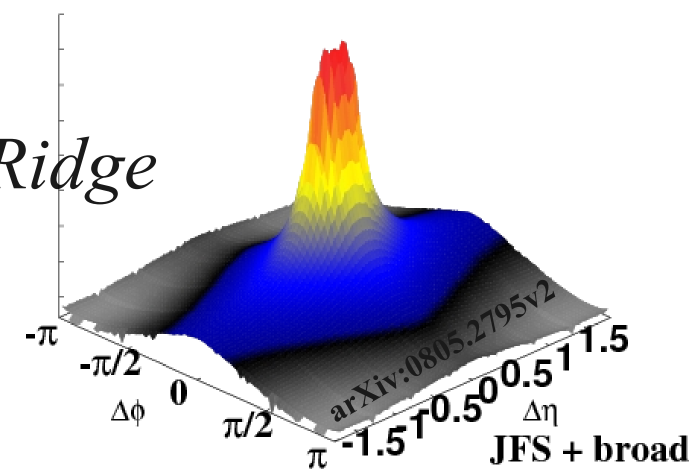
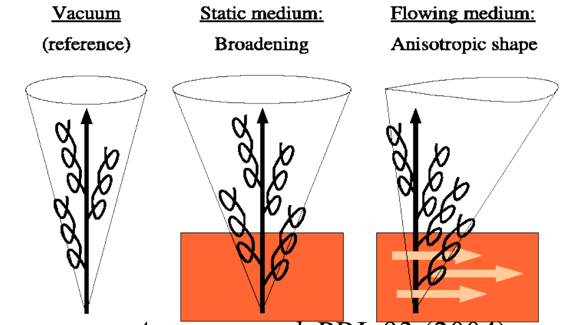


Models

- Longitudinal flow
  Longitudinal flow, Armesto et al, PRL 93 (2004)
  - At RHIC: Problems due to Δη width



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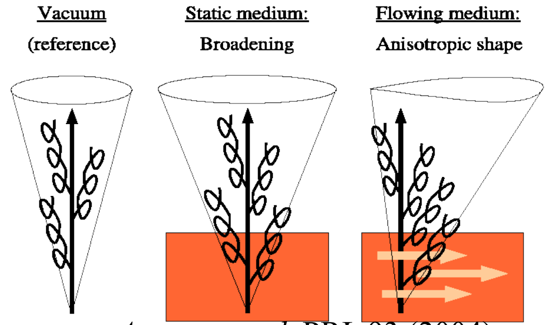

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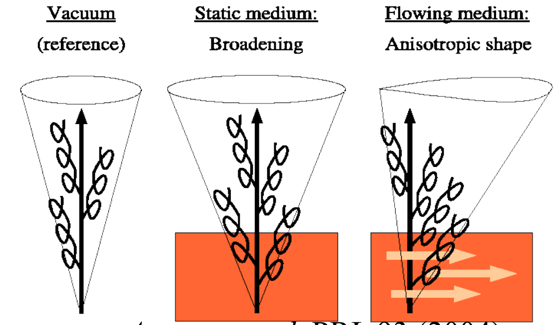

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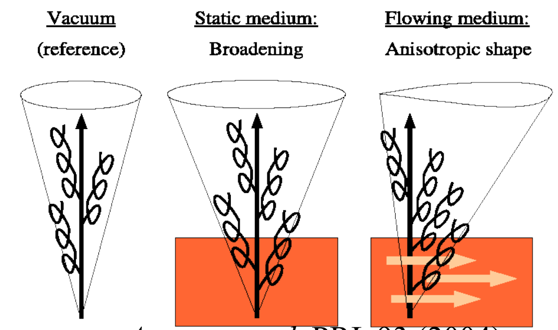

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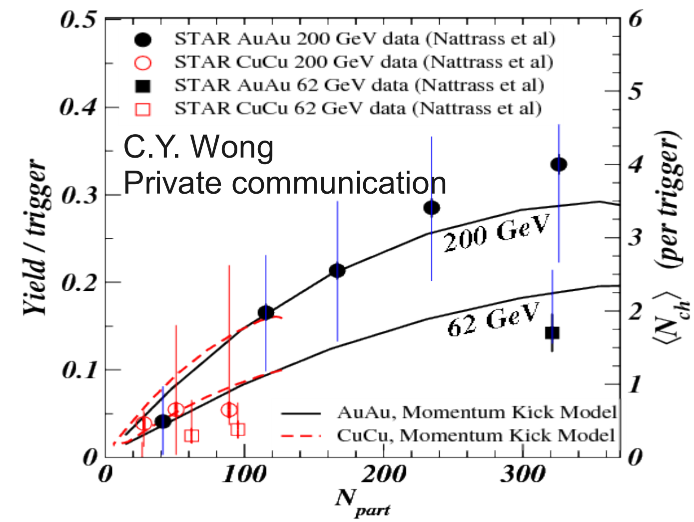
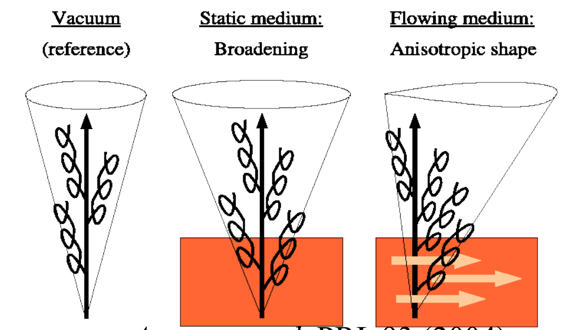


Models



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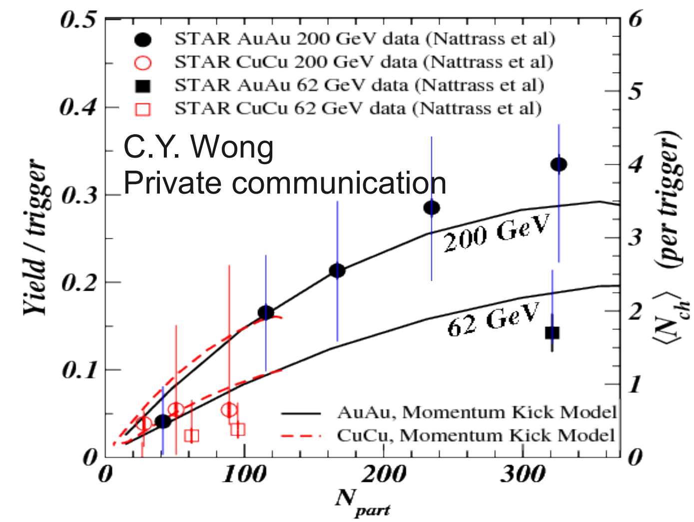

- Recombination

Medium heating + recombination, Chiu & Hwa, PRC72, 034903

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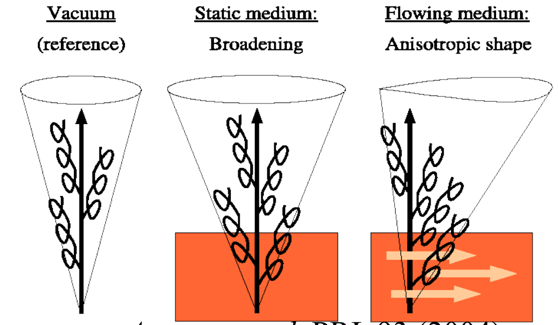
Models



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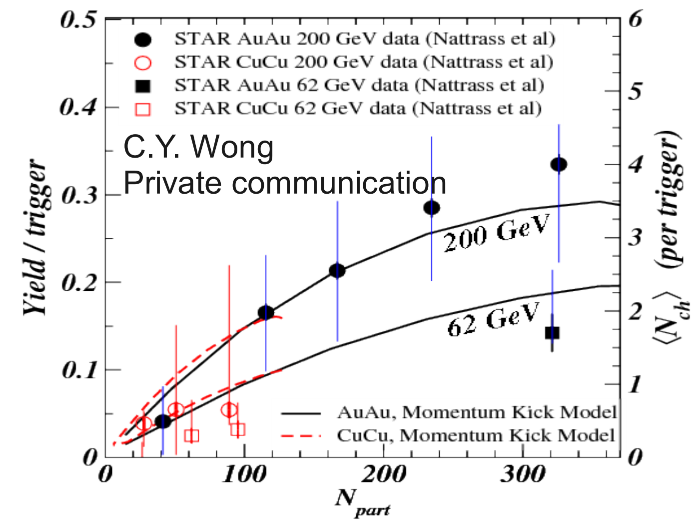

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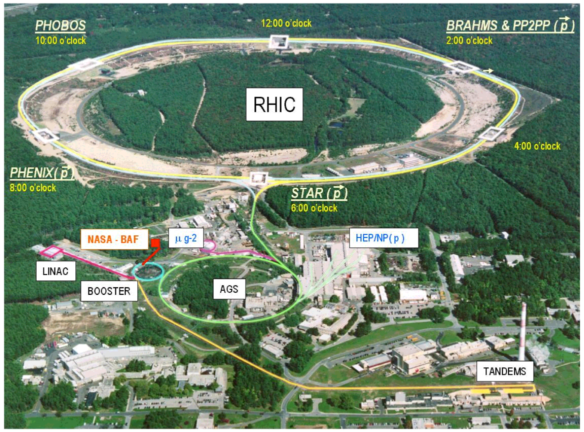
  – At RHIC: No quantitative comparisons

  – At LHC: Should be there if Recombination observed in spectra

Conclusions: Models

RHIC



- Several models available
- Need more quantitative comparisons

LHC

- Generally expect the *Ridge*
- Can it be measured?

STAR Collaboration

Argonne National Laboratory - University of Birmingham - Brookhaven National Laboratory - California Institute of Technology - University of California, Davis - University of California - University of California, Los Angeles - Carnegie Mellon University - University of Illinois at Chicago - Creighton University - Nuclear Physics Institute Prague - Laboratory for High Energy (JINR) - Particle Physics Laboratory (JINR) - University of Frankfurt - Institute of Physics, Bhubaneswar - Indian Institute of Technology, Mumbai - Indiana University, Bloomington - Institut de Recherches Subatomiques - University of Jammu - Kent State University - Institute of Modern Physics, Lanzhou - Lawrence Berkeley National Laboratory - Massachusetts Institute of Technology - Max-Planck-Institut fuer Physik - Michigan State University - Moscow Engineering Physics Institute - City College of New York - NIKHEF and Utrecht University - Ohio State University, Columbus - Panjab University - Pennsylvania State University - Institute of High Energy Physics, Protvino, Russia - Purdue University - Pusan National University, Pusan, Republic of Korea - University of Rajasthan, Jaipur - Rice University - Universidade de Sao Paulo - University of Science & Technology of China - Shanghai Institute of Applied Physics - SUBATECH, Nantes, France - Texas A&M University - University of Texas - Tsinghua University - Valparaiso University - Variable Energy Cyclotron Centre, Kolkata, India - Warsaw University of Technology - University of Washington - Wayne State University - Institute of Particle Physics, CCNU (HZNU), Wuhan - Yale University - University of Zagreb