System size dependence of di-hadron correlations with identified strange particles in STAR at RHIC

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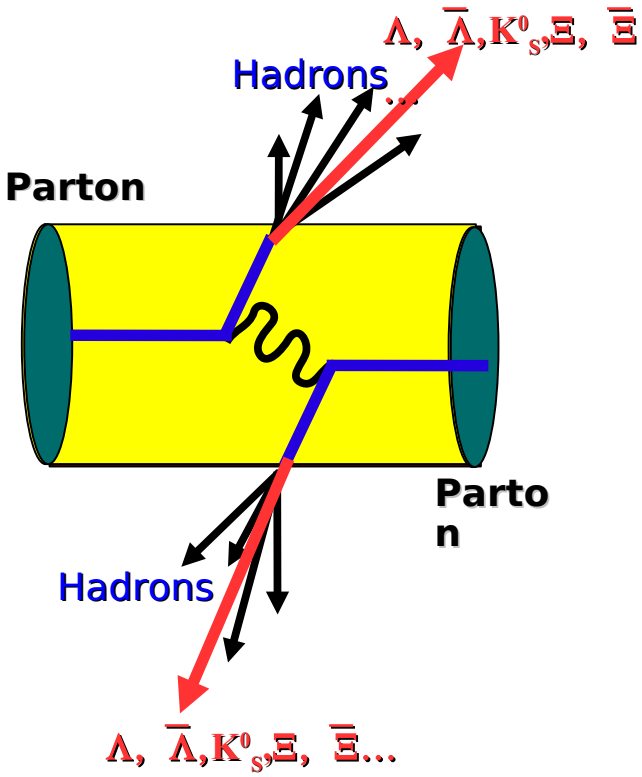
STAR Collaboration

Outline

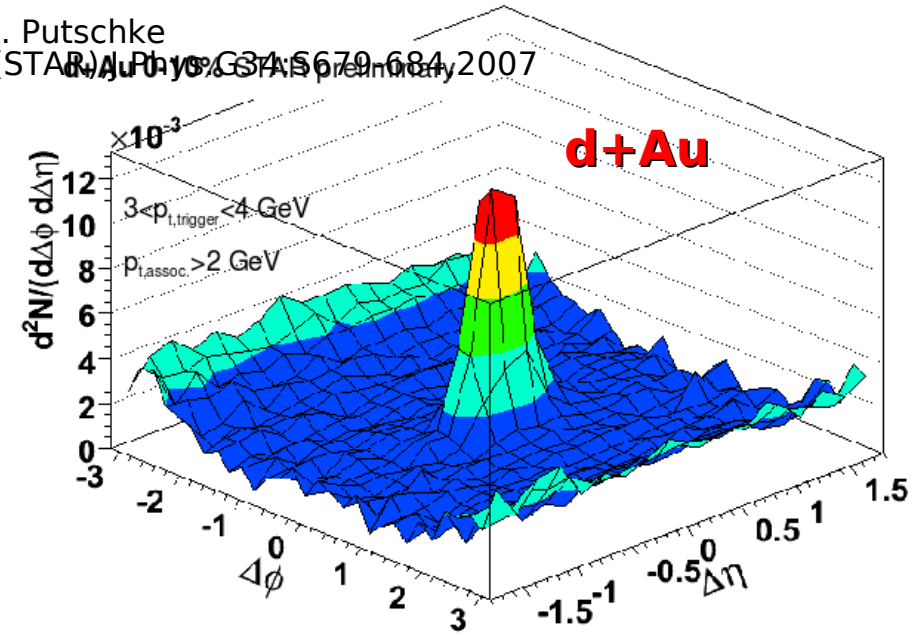
- Motivation
  - Interesting phenomena at intermediate p_T
  - Baryon/meson differences
- Method
- Comparisons of systems and energy
- Comparisons of unidentified to strange
- Conclusions

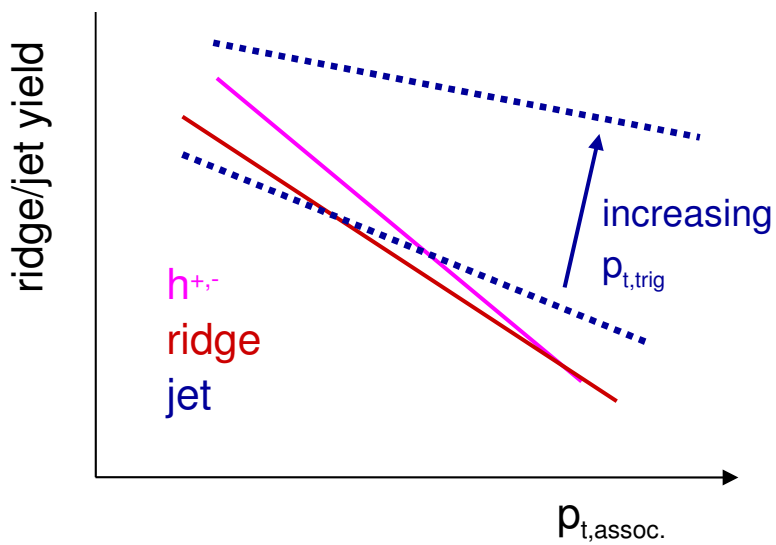


System	Energy	Number of events
Au+Au	200	24M central
Cu+Cu	200	34M
Au+Au	62	16M
Cu+Cu	62	24M

Motivation – *Jet* and *Ridge*

J. Putschke
(STAR) J. Phys. G34:S679-684, 2007





- Long-range pseudorapidity ($\Delta\eta$) correlations observed by STAR in Au+Au at intermediate p_T
- Near side jet peak sits on plateau (*Ridge*)
  - Significant contribution to the near-side yield in central Au+Au
- *Jet* harder than *Ridge*; *Ridge* closer to bulk

Ridge production mechanisms

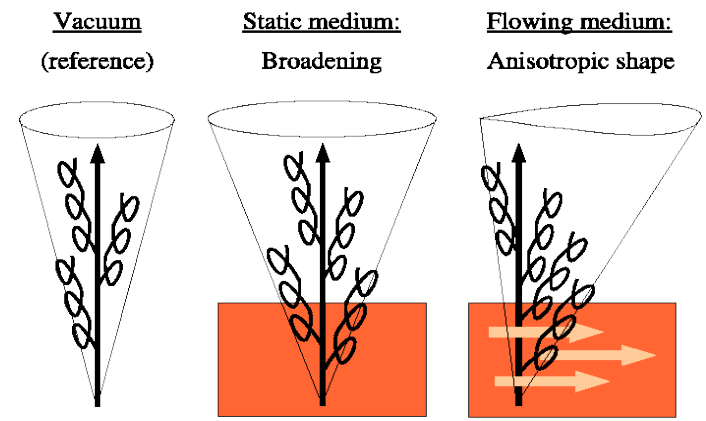
- **Radiated gluons, broadened by**
  - Longitudinal flow, Armesto et al, PRL 93 (2004)
  - QCD magnetic fields, Majumder et al,Phys.Rev.Lett.99:042301,2007
  - Anisotropic plasma, P. Romatschke, PRC,75014901 (2007)
- **Momentum-kick model**

  C.-Y. Wong , Phys.Rev.C76:054908,2007
- **Medium heating + recombination**

  Chiu & Hwa, PRC72, 034903
- **Radial flow + trigger bias**

  S. Voloshin, nucl-th/0312065, Nucl. Phys. A749, 287

  E. Shuryak, *Phys.Rev.C76:047901,2007*



Armesto et al, PRL 93 (2004)

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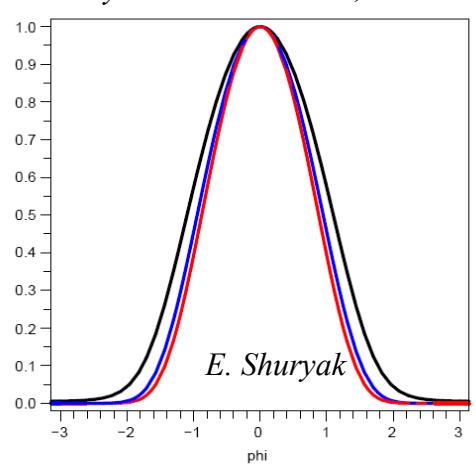
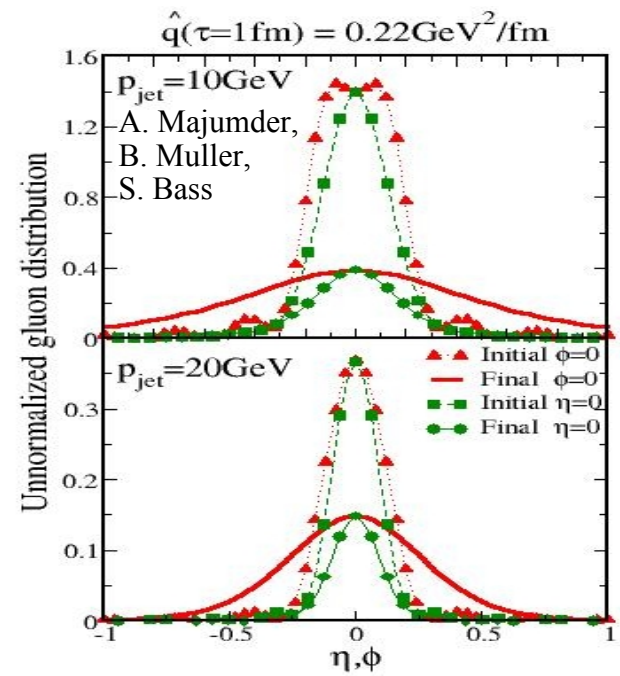
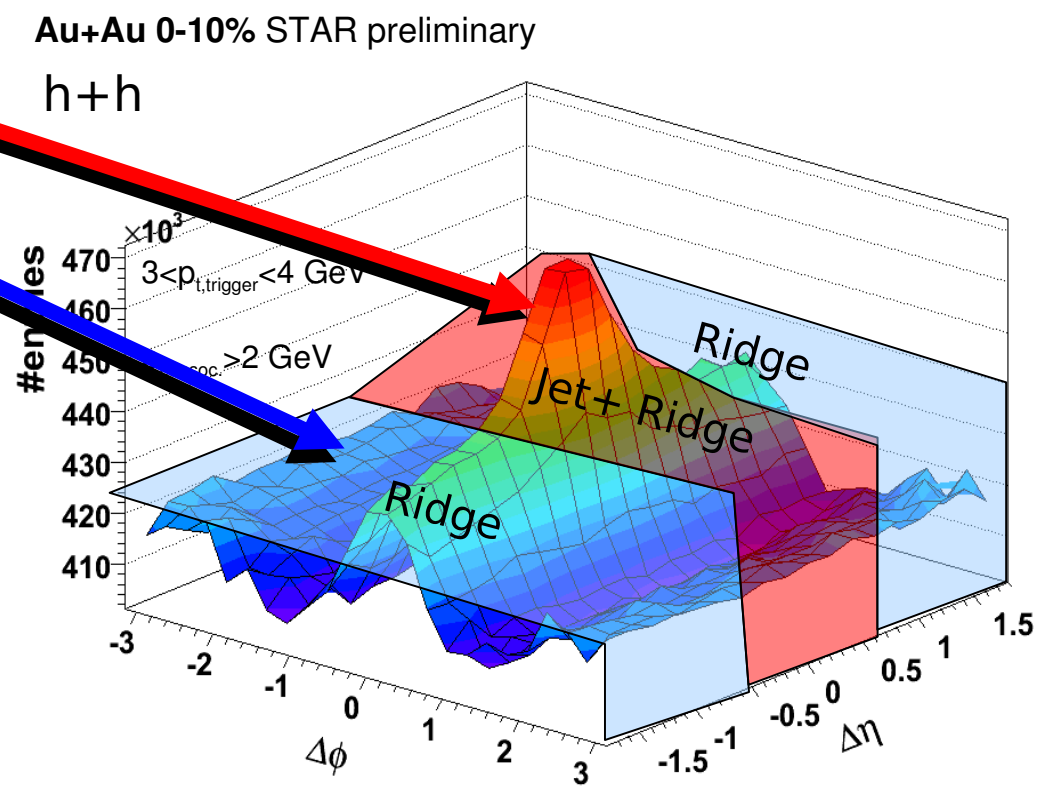




Phys.Rev.Lett.99:042301,2007

Method: Yield extraction

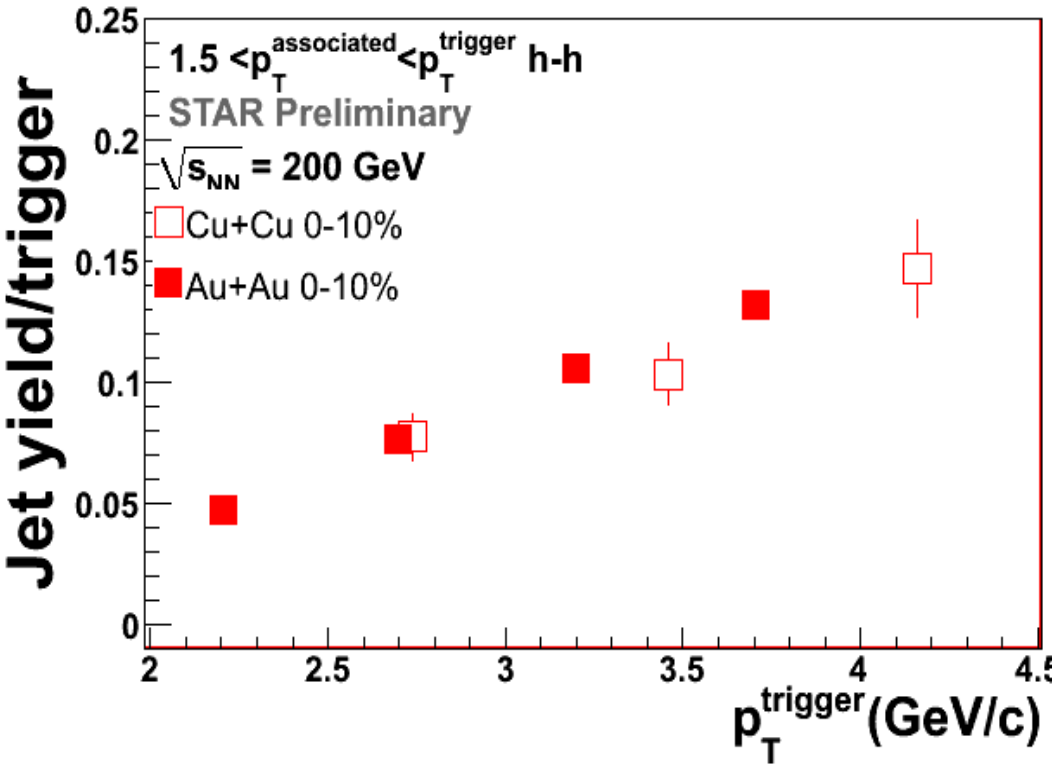
- *Ridge* previously observed to be independent of Δη in Au+Au
- Yield = number of associated particles/trigger particle
- To determine relative contributions, find yields for near-side, take ΔΦ projections in
  - -0.75<Δη<0.75 ***Jet + Ridge***
  - 0.75<|Δη|<1.75 ***Ridge***
  - *Jet* = (*Jet+Ridge*) – *Ridge**.75/1.0
  - *Ridge* = yield from -1.75<Δη<1.75 – *Jet* yield
- Flow contributions to jet cancel
  - v_2 independent of η for |η|<1
    - Phys. Rev. C72, 051901(R) (2005), Phys. Rev. Lett. 94, 122303 (2005)

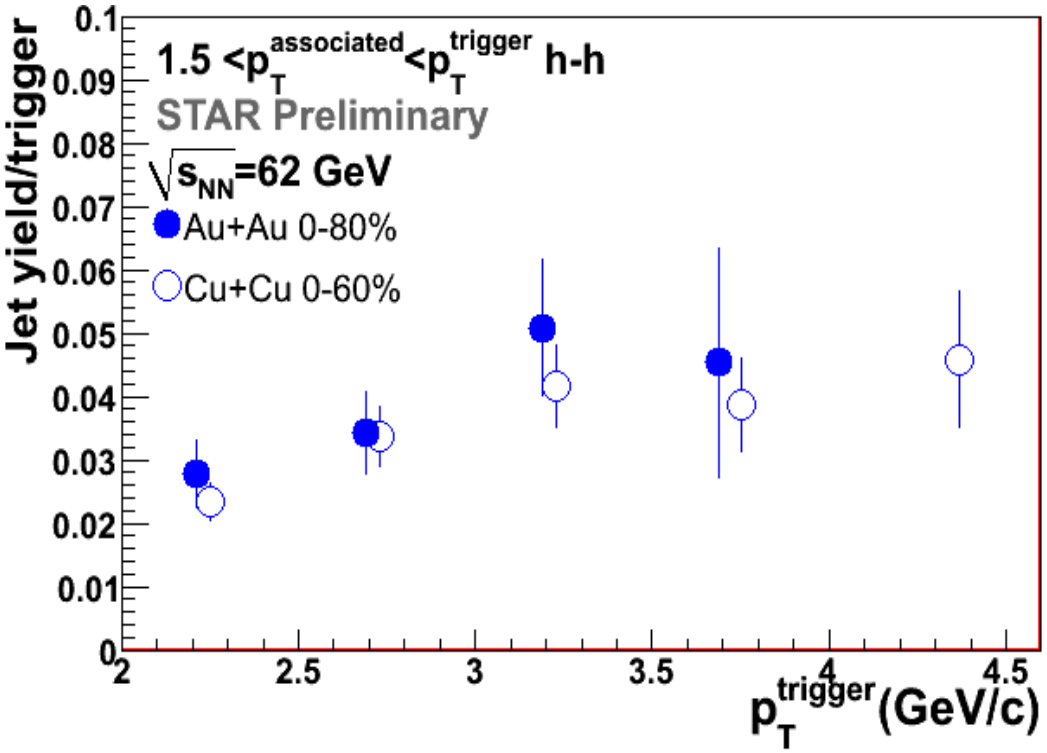


J. Putschke (STAR), J.Phys.G34:S679-684,2007

Unidentified particle correlations

Jet yield vs $p_T^{trigger}$





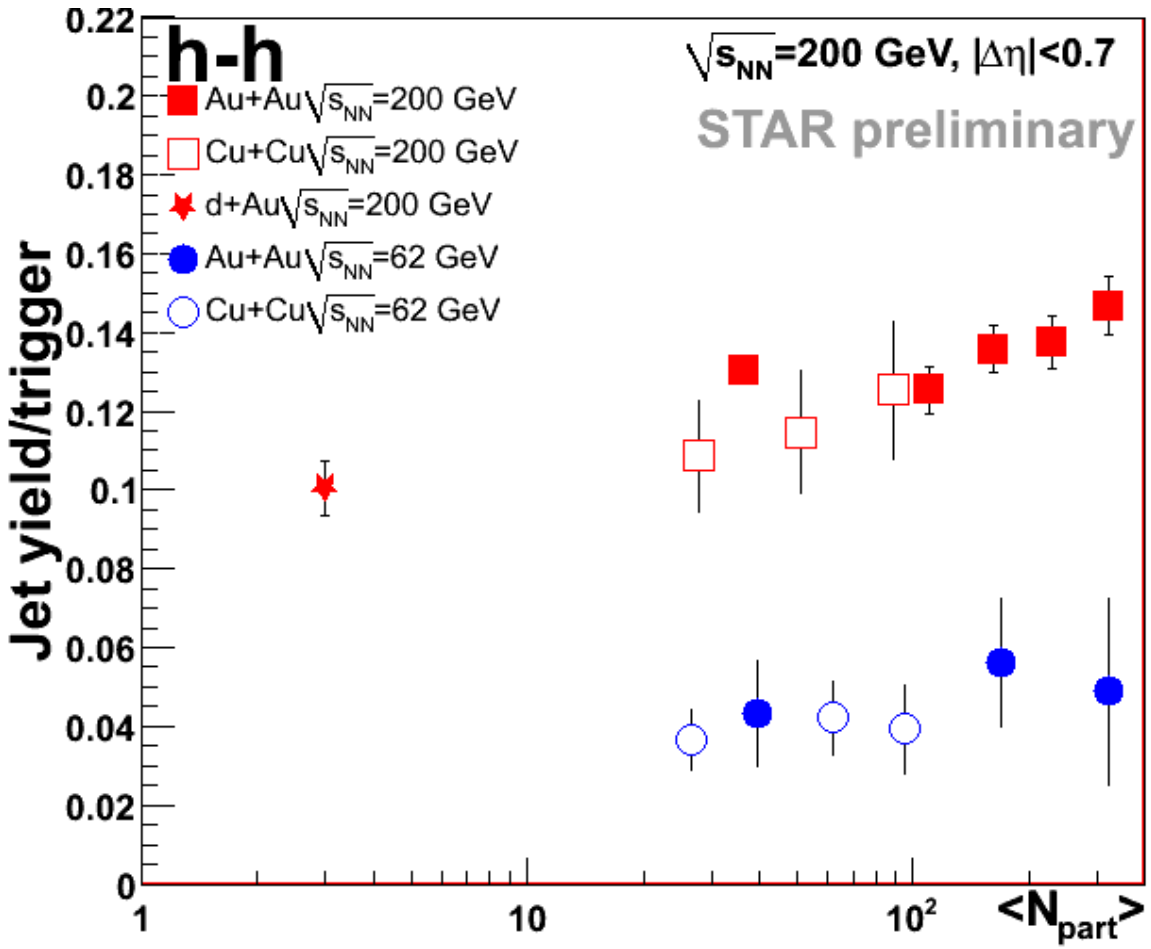
- *Jet* yield rises with $p_T^{trigger}$ in h-h
  - Central Au+Au and Cu+Cu jet yields comparable
- **Similar trend for $\sqrt{s_{NN}}$=62 GeV**

d+Au, Au+Au $\sqrt{s_{NN}}$=200 GeV from J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007
Data points at same $p_T^{trigger}$ offset for visibility

Near-side Yield vs N_{part}

- *Jet* yield
  - $\sqrt{s_{NN}}$=200 GeV:
    - Nearly independent of N_{part}
  - $\sqrt{s_{NN}}$=62 GeV
    - Also nearly independent of N_{part}
    - Yield/trigger smaller

3.0 GeV/c < $p_T^{trigger}$ 6.0 GeV/c; 1.5 GeV/c < $p_T^{associated}$ < $p_T^{trigger}$



d+Au, Au+Au $\sqrt{s_{NN}}$=200 GeV from J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

p_T-distribution of associated particles

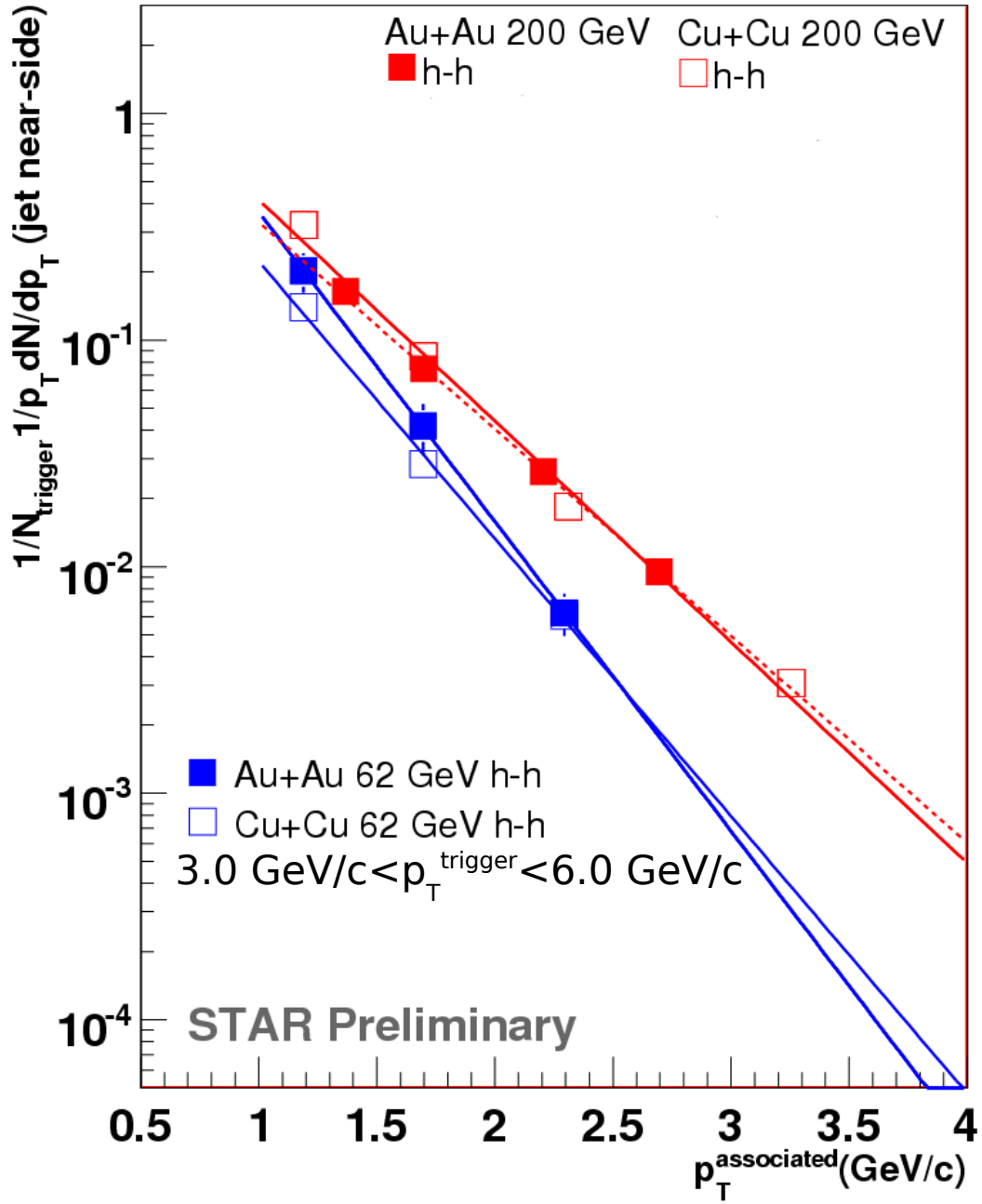
200 GeV

- *Jet* spectra similar in Cu+Cu, Au +Au

62 GeV

- Au+Au and Cu+Cu *Jet* similar
  - Softer than 200 GeV

System	Energy	T(Jet) MeV
Au+Au	200 GeV	478 ± 4
Cu+Cu	200 GeV	445 ± 20
Au+Au	62 GeV	317 ± 26
Cu+Cu	62 GeV	355 ± 21



$\sqrt{s_{NN}}$=200 GeV Au+Au 0-10% Cu+Cu: 0-54%
$\sqrt{s_{NN}}$=62 GeV Au+Au 0-80% Cu+Cu: 0-60%

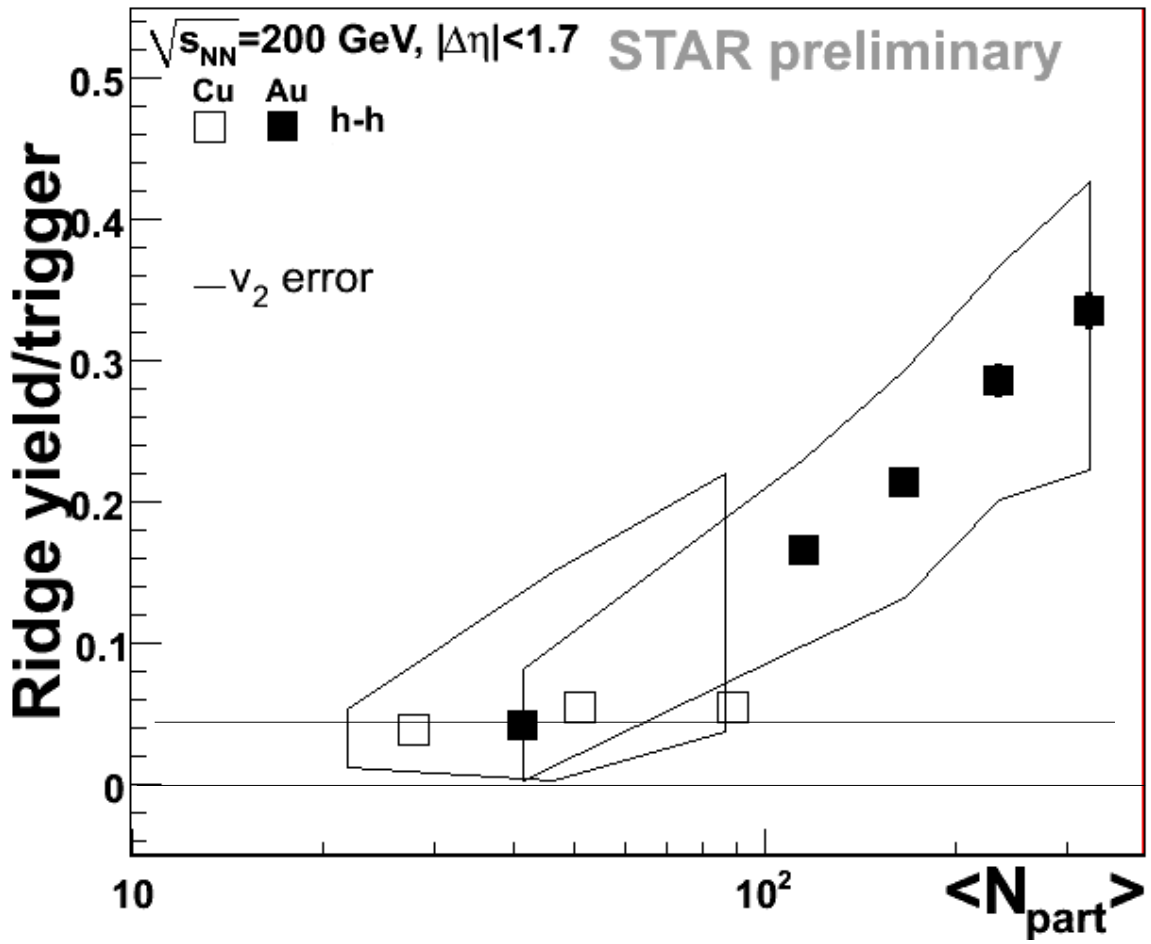
J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Nattrass (STAR), SQM2007

Fits assuming $1/p_T\ dN/dp_T = A\ p_T \exp(-p_T/T)$

Near-side Yield vs N_{part}

- *Ridge* yield
  - 200 GeV
    - No *Ridge* in d+Au
    - Increases with N_{part}
    - Cu+Cu consistent with Au+Au
  - 62 GeV
    - Also increases with N_{part} in $\sqrt{s_{NN}} = 62$ GeV
    - yield/trigger smaller

3.0 GeV/c < $p_T^{trigger}$ 6.0 GeV/c; 1.5 GeV/c < $p_T^{associated}$ < $p_T^{trigger}$



Jet yields: 10% error added h triggers to account for track merging
d+Au, Au+Au $\sqrt{s_{NN}}$=200 GeV from J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

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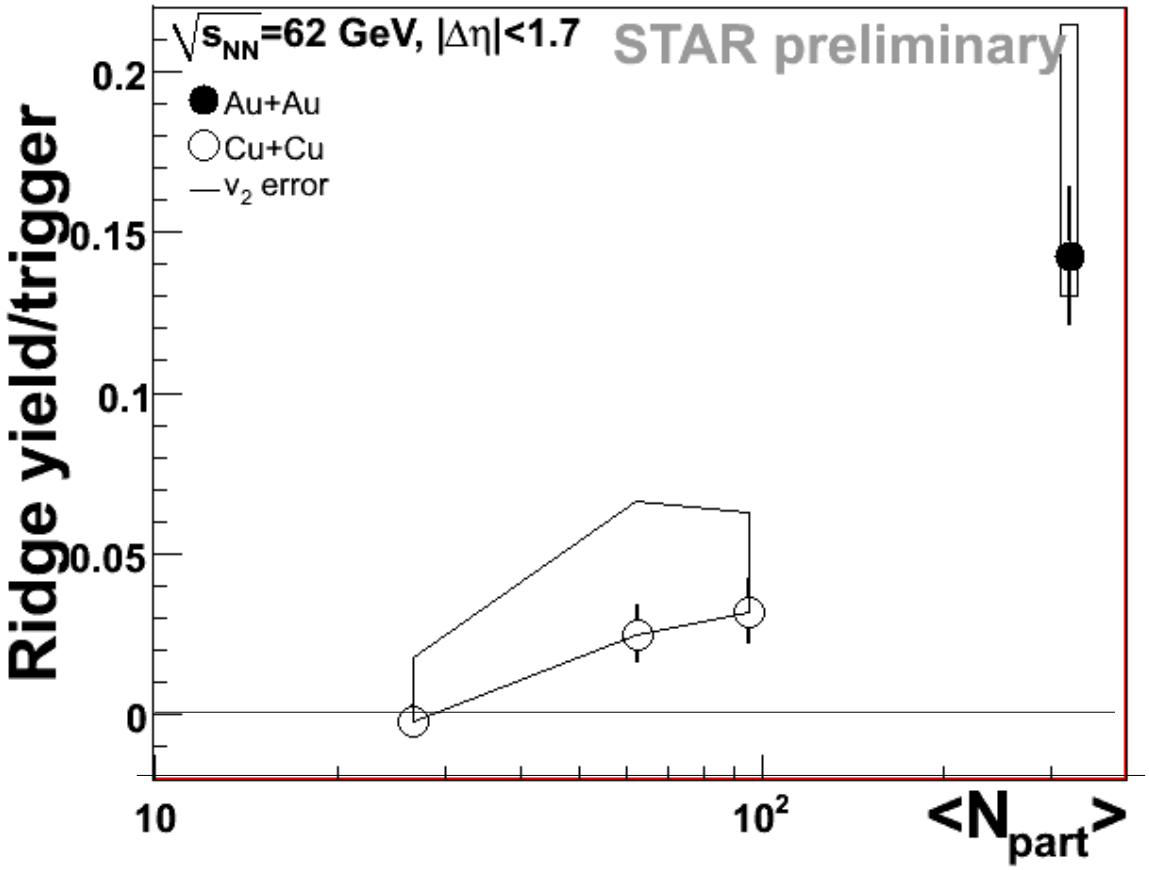

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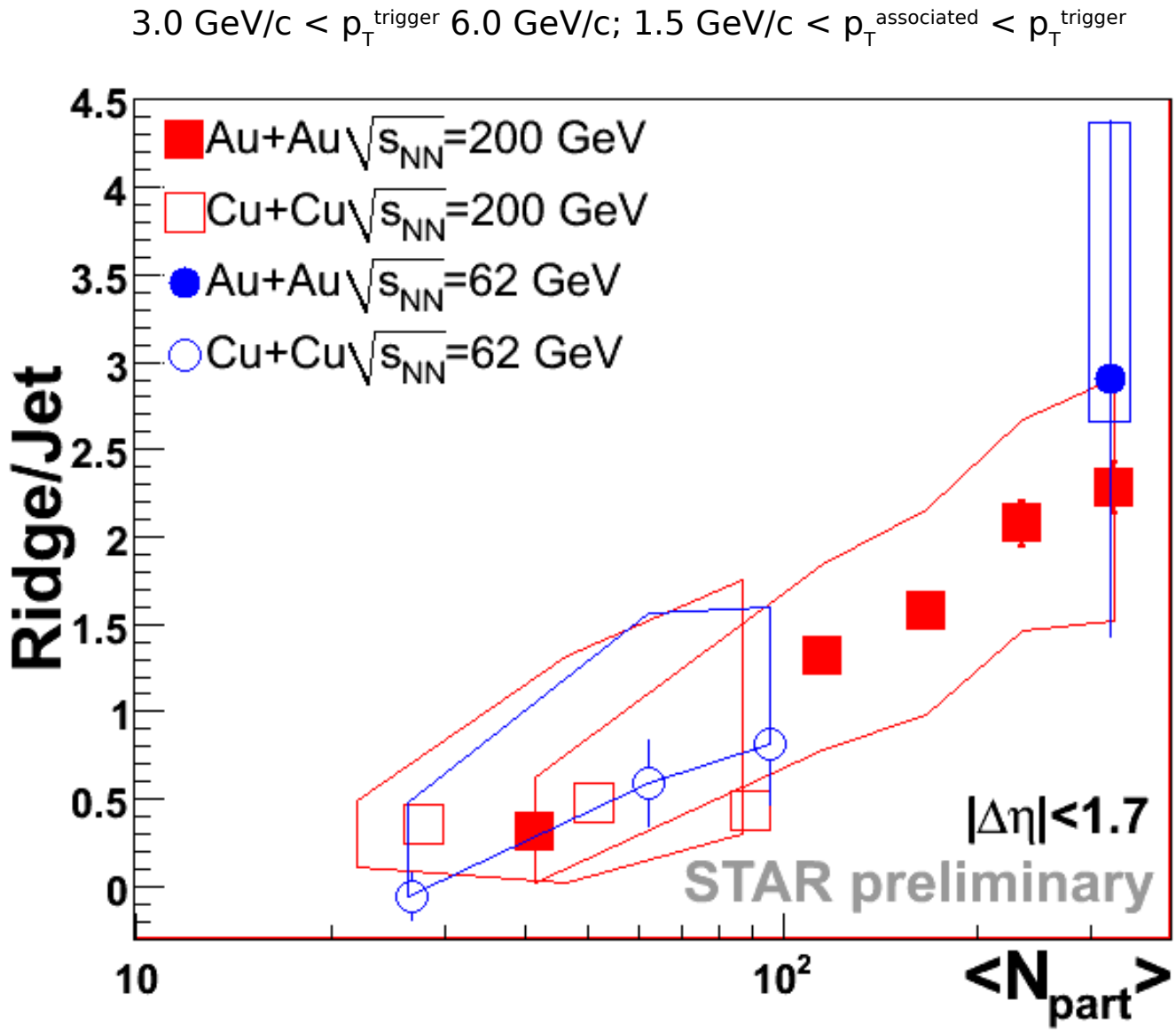
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

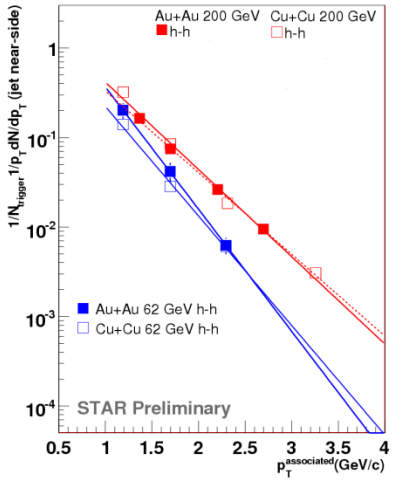
Ridge/Jet Ratio

- Ridge/Jet ratio independent of energy, system

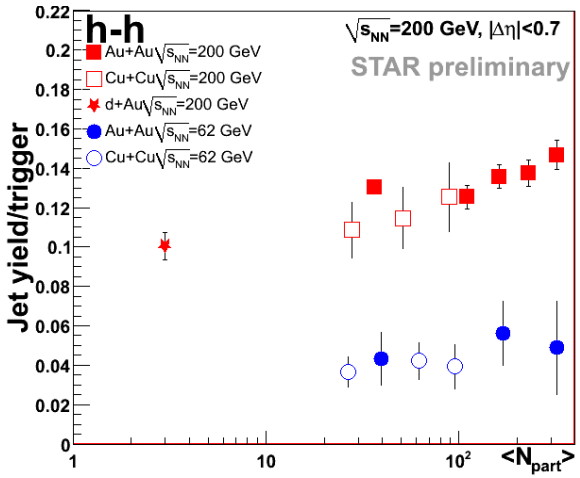


Au+Au $\sqrt{s_{NN}}$=200 GeV from J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

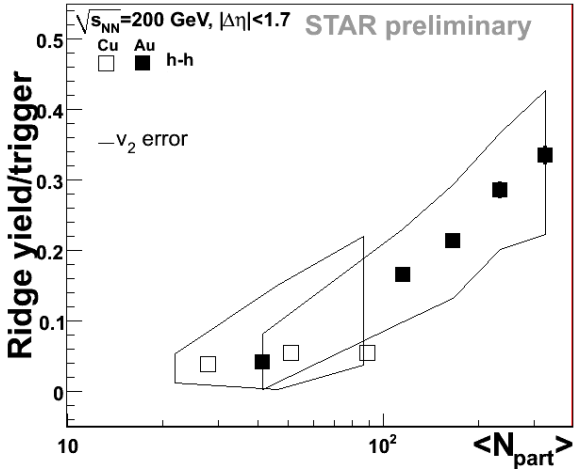
Unidentified summary



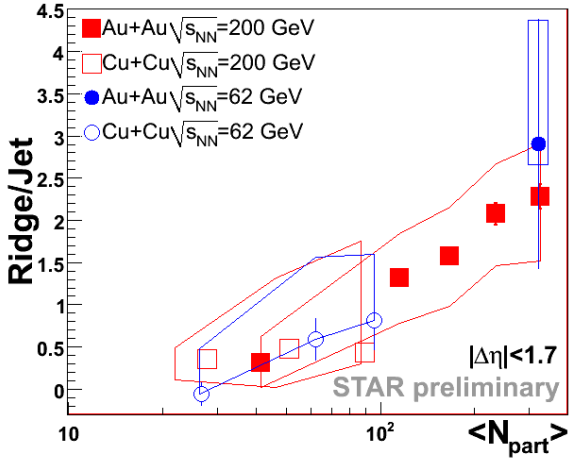
Jet: No dependence on system, falls off faster in $\sqrt{s_{NN}}$=62 GeV



Jet: No dependence on N_{part}, system



Ridge: No dependence on system, increasing with N_{part}



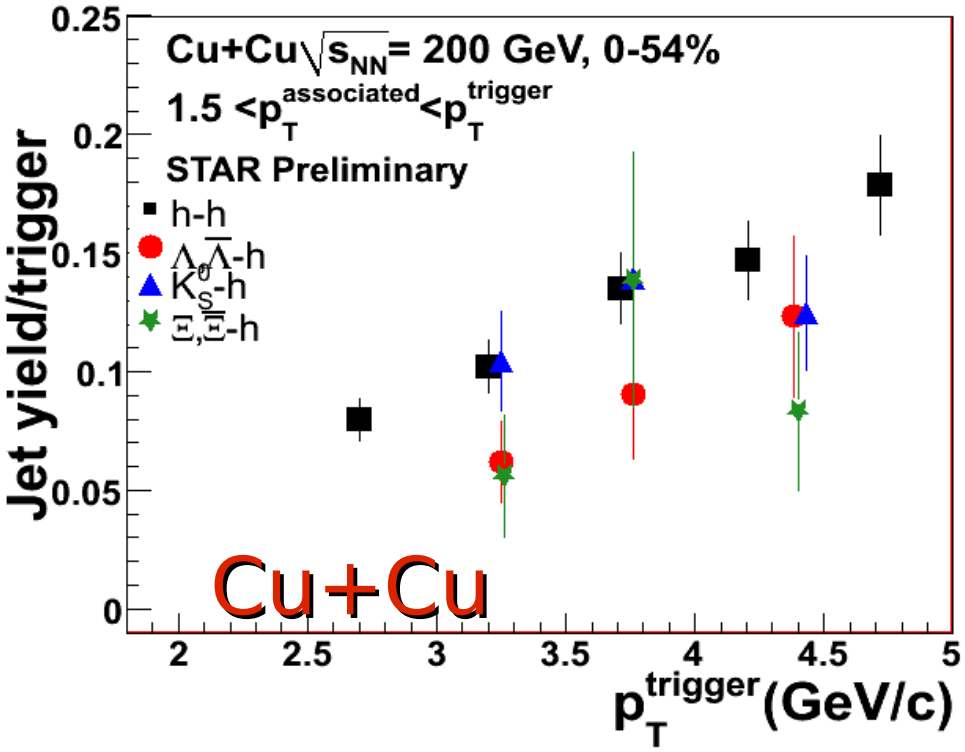
Ridge/Jet ratio the same at $\sqrt{s_{NN}}$=62,200 GeV

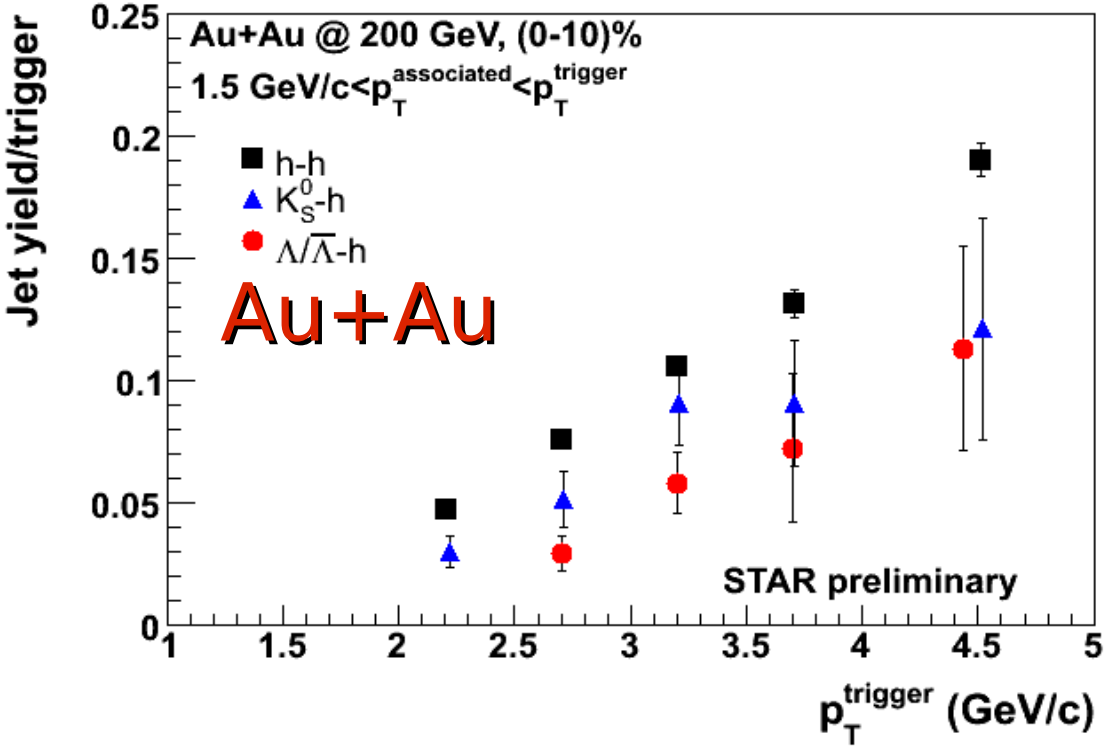
Identified particle correlations

Motivation

- Identified trigger particles
  - Effect of leading particle mass, flavor
- Identified associated particles
  - Probe *Jet* and *Ridge* composition

Jet yield vs $p_T^{trigger}$





No significant trigger type dependence

- Note: Additional systematic error due to loss of tracks at small $\Delta\eta$, $\Delta\phi$ not yet quantified

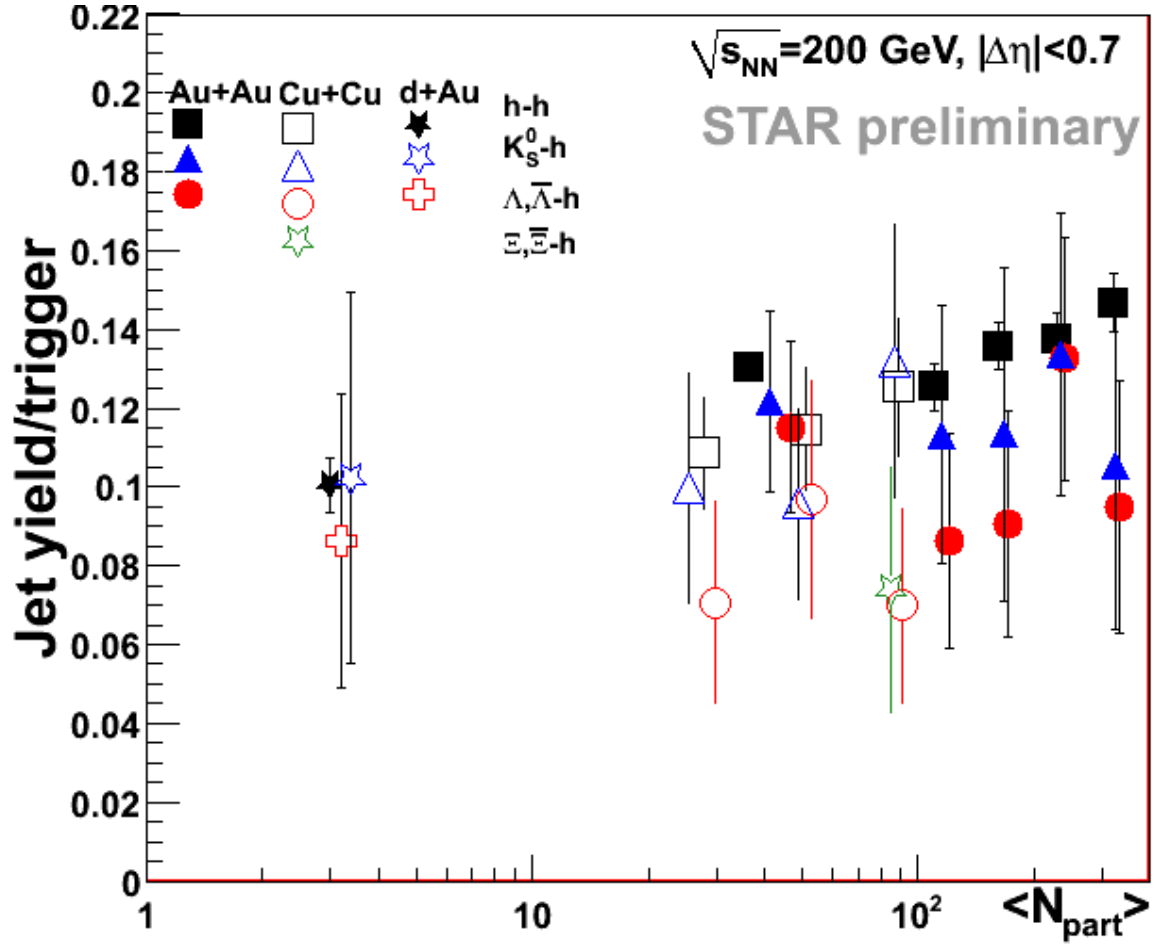
Au+Au $\sqrt{s_{NN}}$ = 200 GeV from J. Bielcikova (STAR), J.Phys.G34:S929-930,2007
Data points at same $p_T^{trigger}$ offset for visibility
Jet yields: 10% error added to V^0 and h triggers to account for track merging, 15% to Ξ triggers

Near-side Yield vs N_{part}

3.0 GeV/c < $p_T^{trigger}$ 6.0 GeV/c; 1.5 GeV/c < $p_T^{associated}$ < $p_T^{trigger}$

Jet yield -

- No significant trigger type dependence



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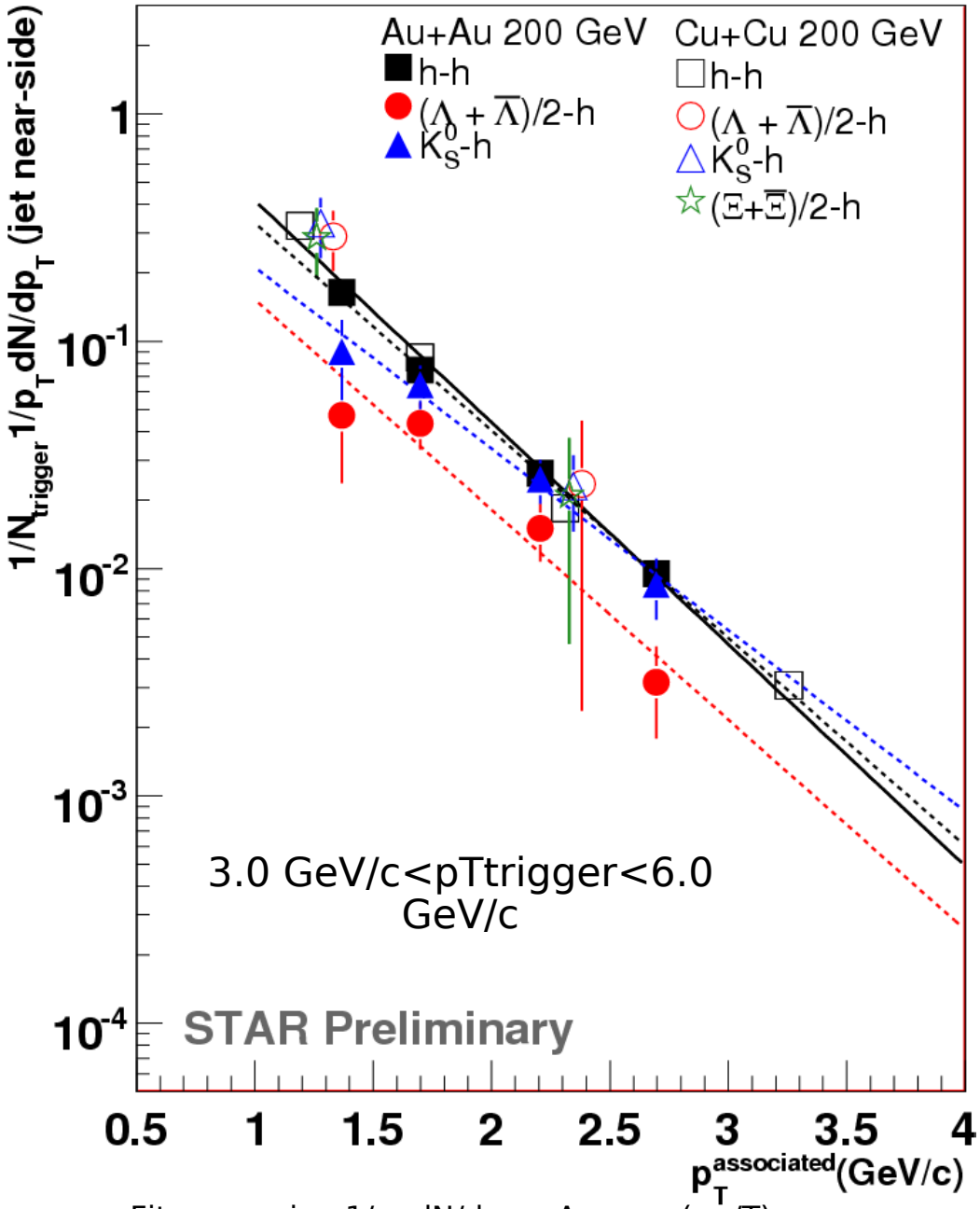
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

p_T-distribution of associated particles

- No significant trigger type dependence



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Near-side Yield vs N_{part}

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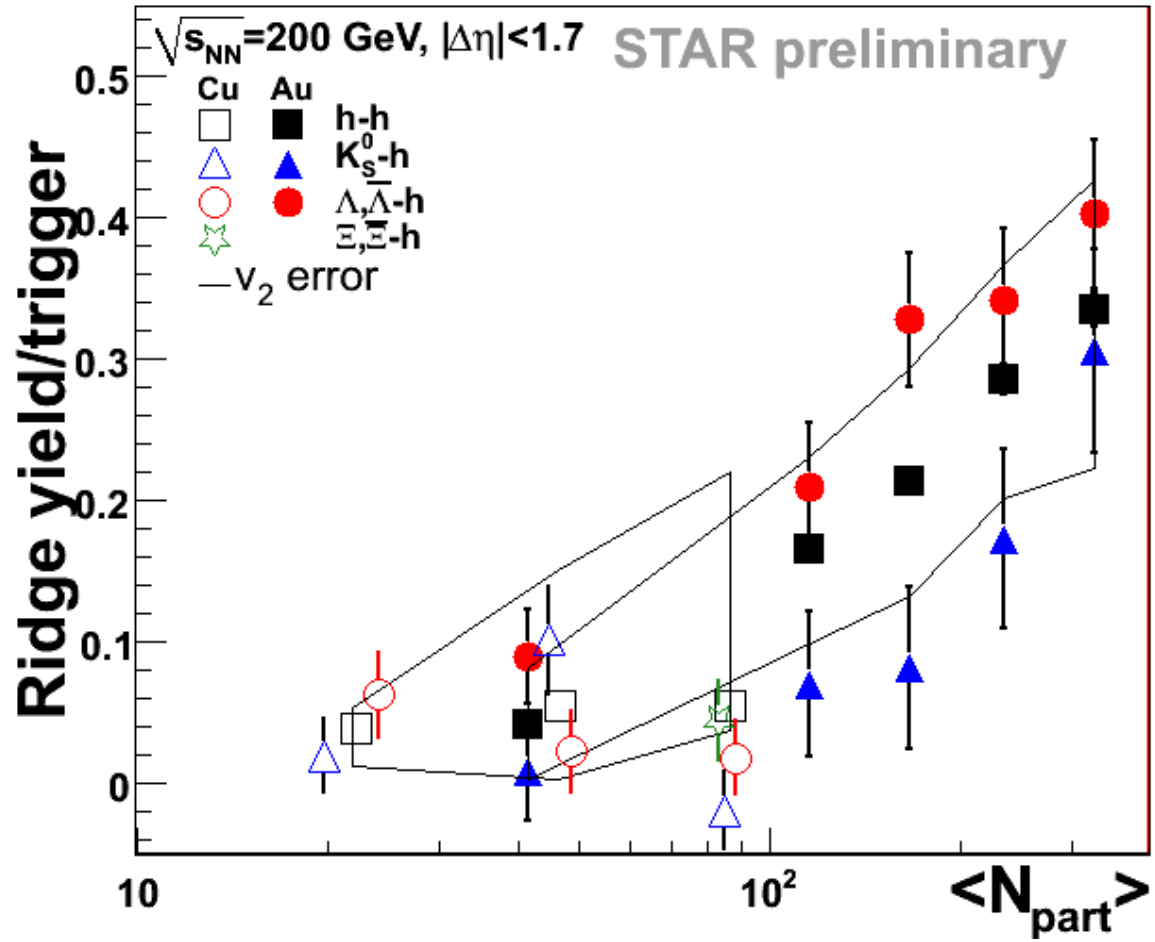
Ridge yield -

- Large systematic errors
- No significant difference? Depends on how correlated systematic errors (v_2) are



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v_2 errors shown only for h-h. K^0_S-h error bars comparable to h-h. Λ-h and Ξ-h errors roughly 1.5 times as large as h-h.
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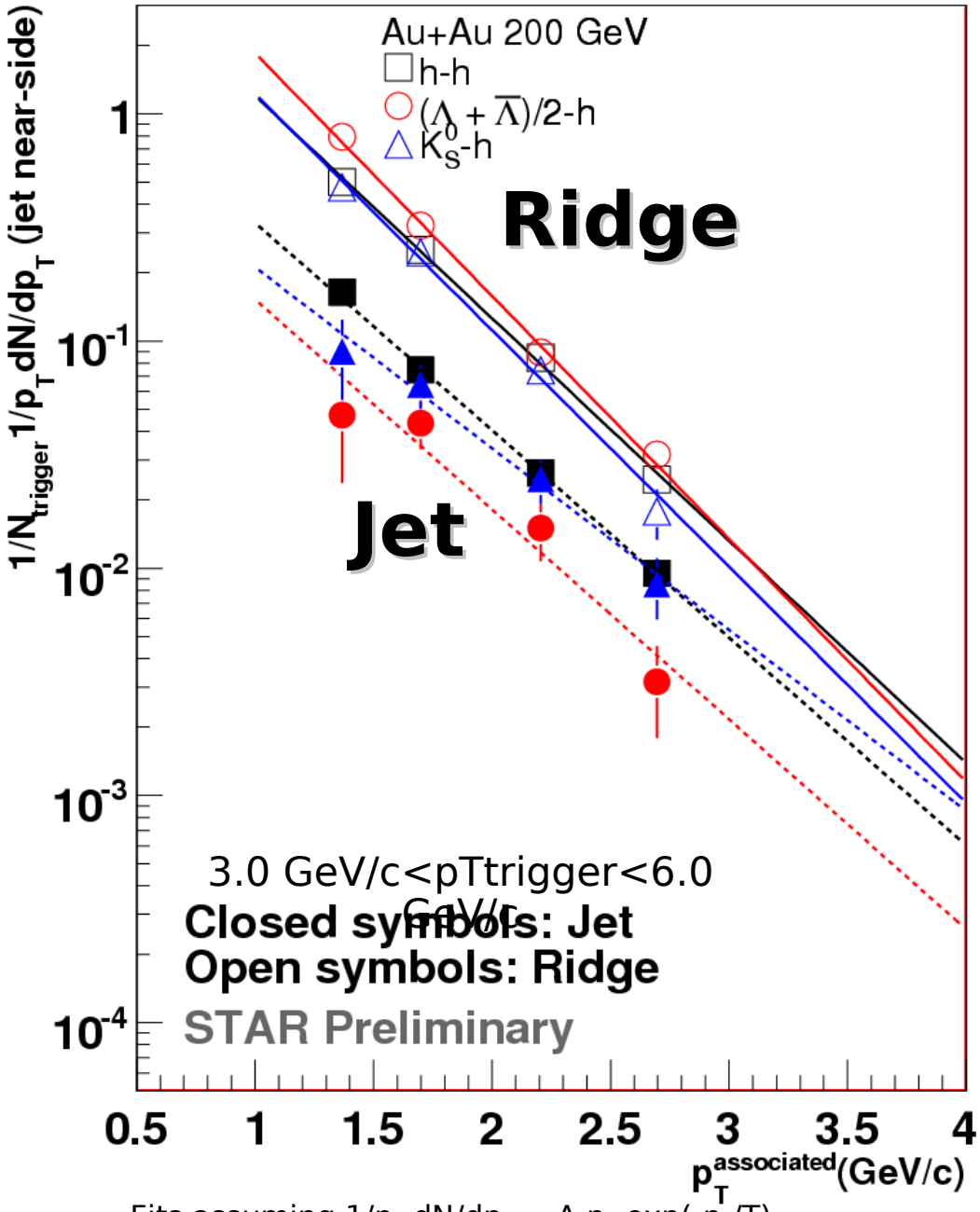
Cu+Cu $\sqrt{s_{NN}}$=200 GeV from C. Nattrass (STAR), SQM2007

p_T-distribution of associated particles

- No significant trigger type dependence
- Systematic errors under investigation
- Jet:
- loss of tracks at small $\Delta\eta$, $\Delta\phi$
- Ridge subtraction
- Ridge:
- systematic error from v_2



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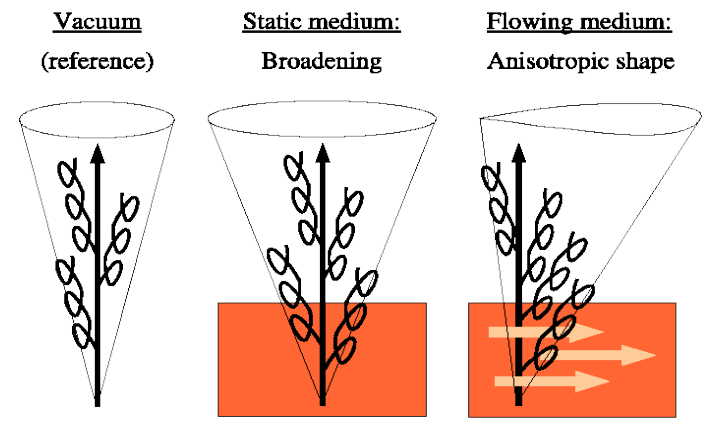
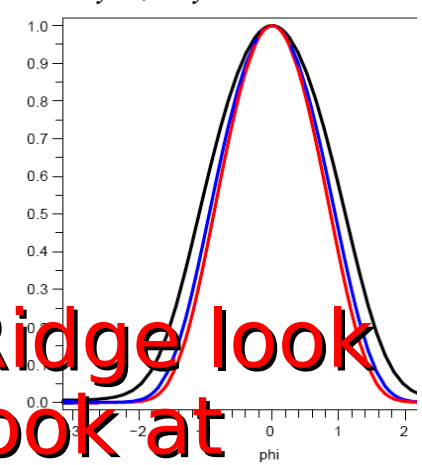
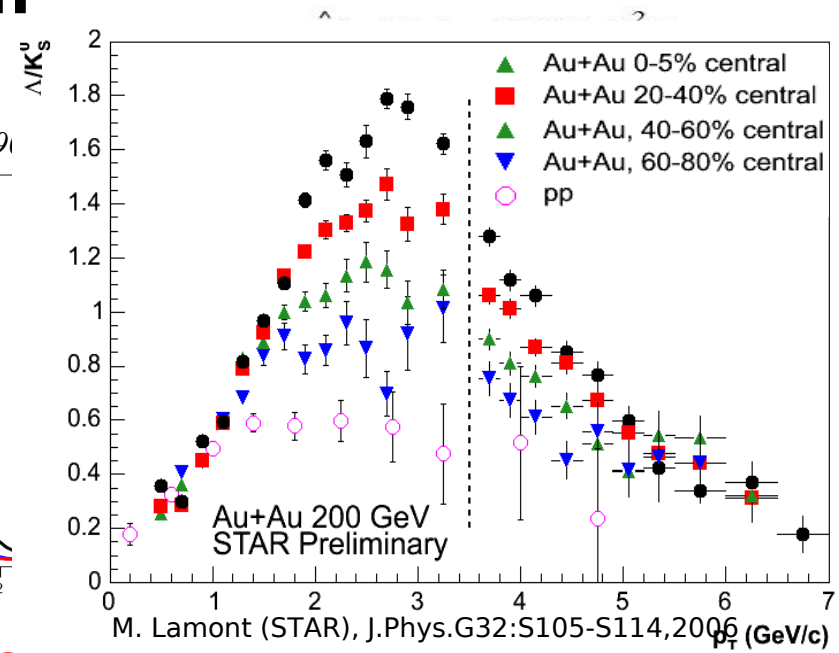


Armesto et al, PRL 93 (2004)

E. Shuryak, Phys.Rev.C76:0479



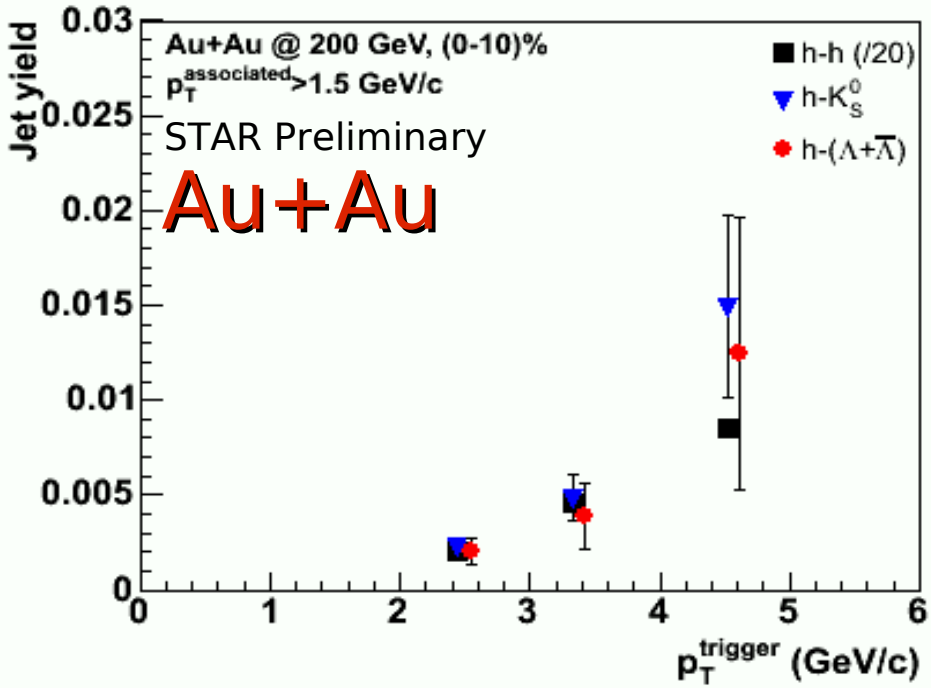


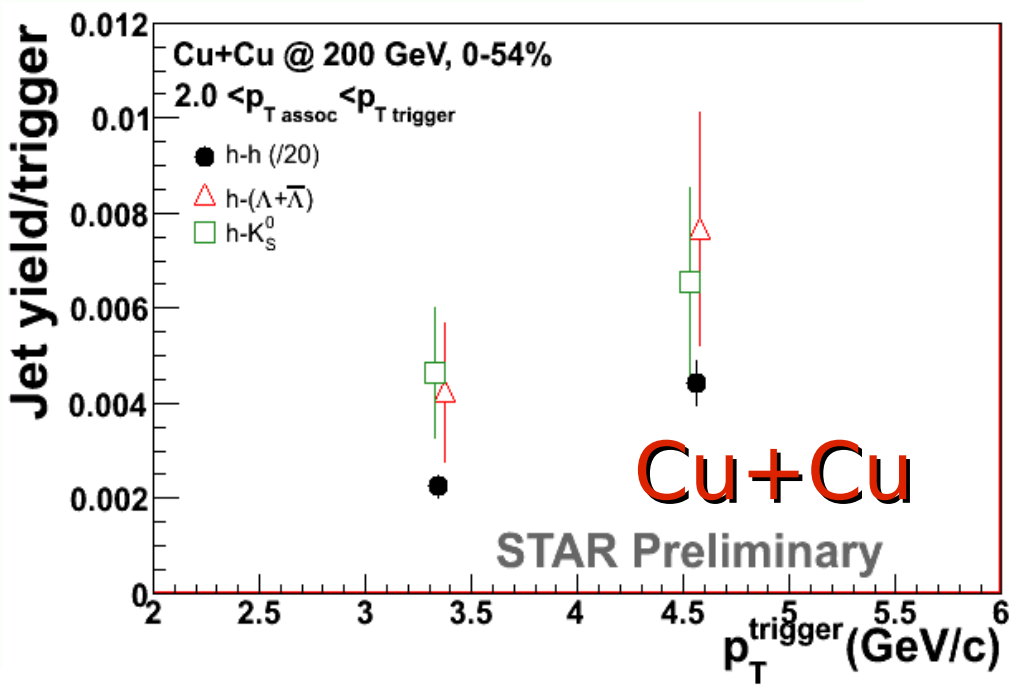
M. Lamont (STAR), J.Phys.G32:S105-S114,2006

Do particles in Ridge look like bulk? Look at dependence on particle type

STAR

$p_T^{trigger}$ of identified associated yield





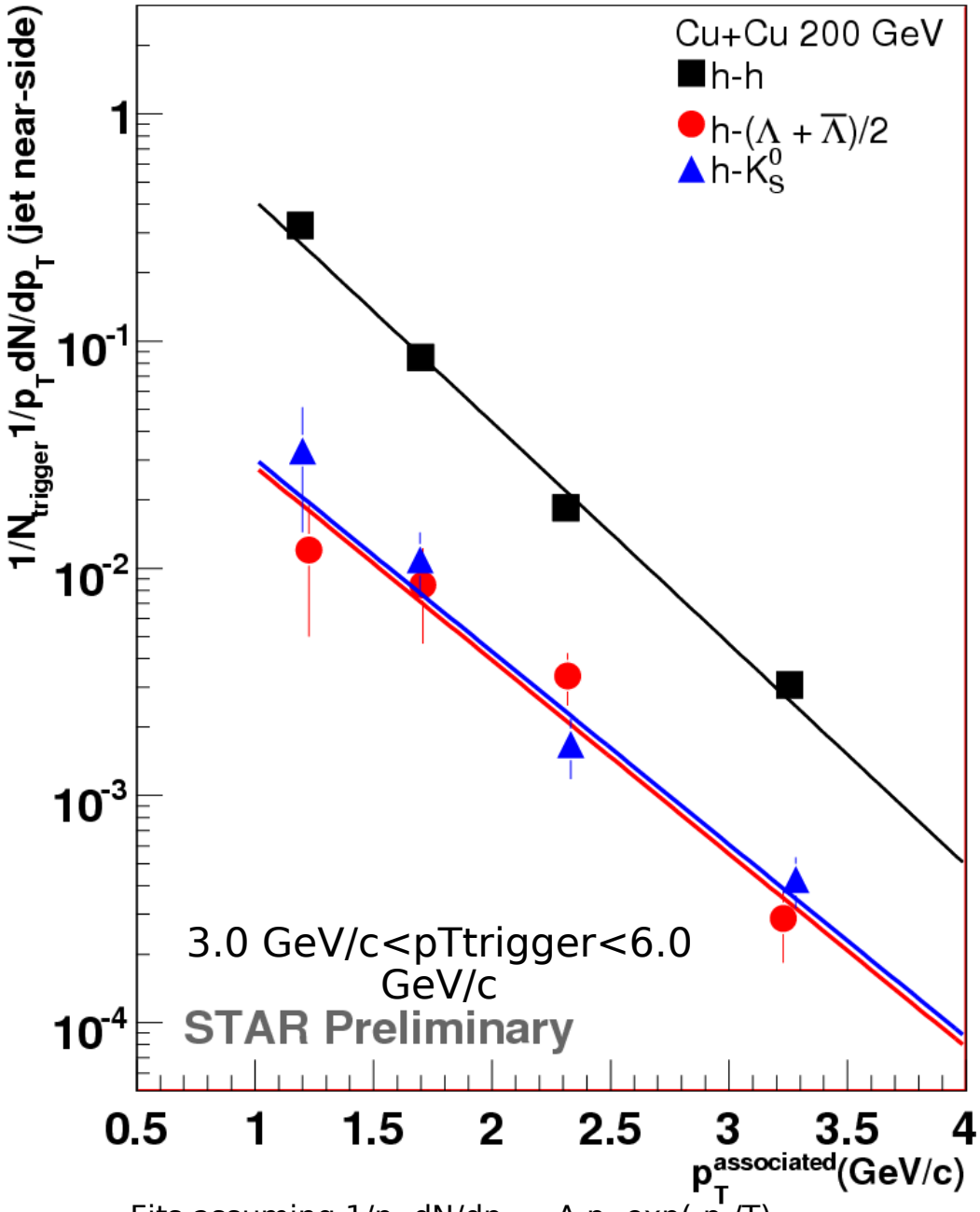
Identified associated

Jet: ($\bar{\Lambda}$+Λ)/2K^0_S ≈0.5 in both systems

Particle ratios in Jet similar to those in p+p

p_T-distribution of associated particles

$(\bar{\Lambda}+\Lambda)/2K^0_S \approx 0.5$ independent of $p_T^{associated}$



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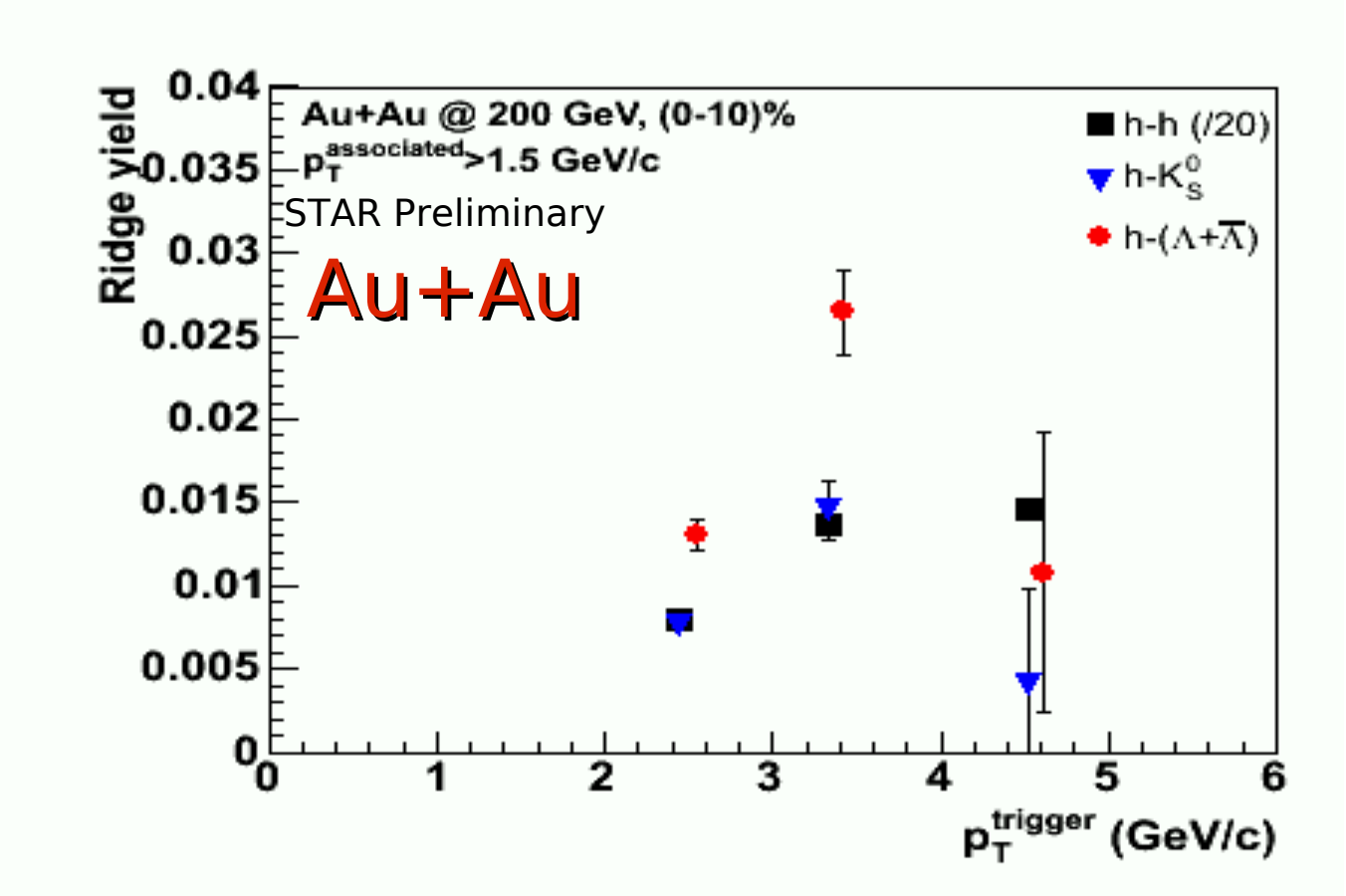
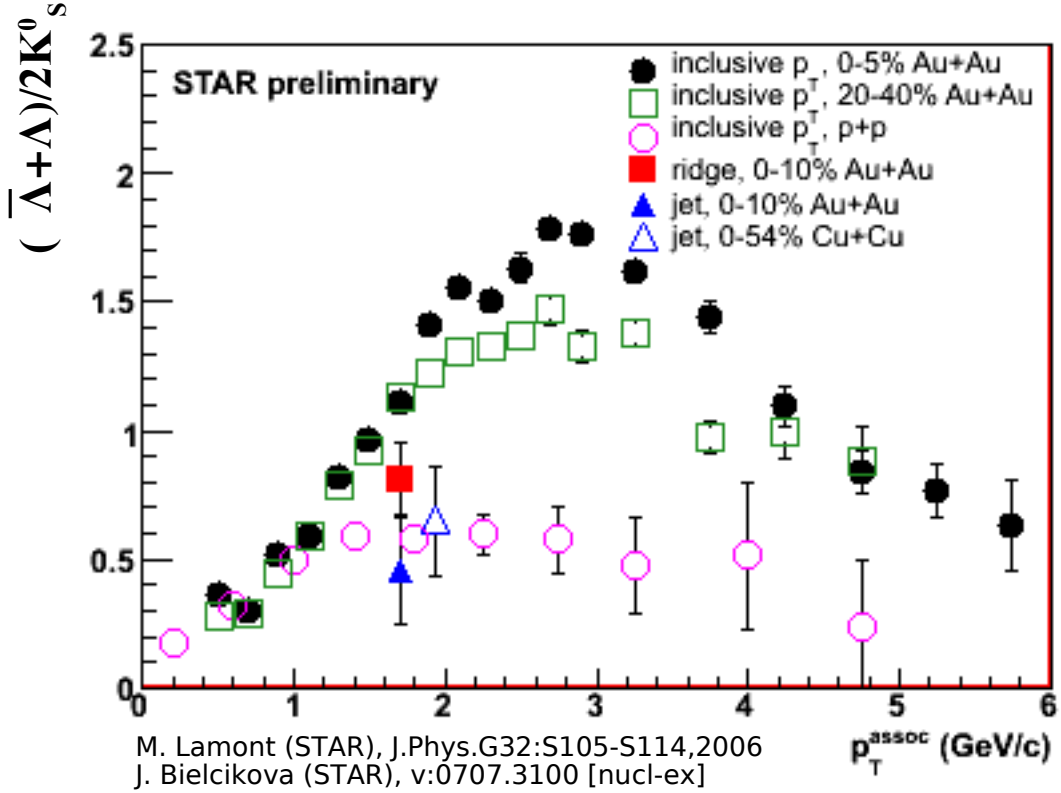
$p_T^{trigger}$ of identified associated yield



Identified associated

- Ridge: $(\bar{\Lambda}+\Lambda)/2K^0_S \approx 1$
- Note: systematic error due to v_2 not shown

$p_T^{trigger}$ of identified associated yield

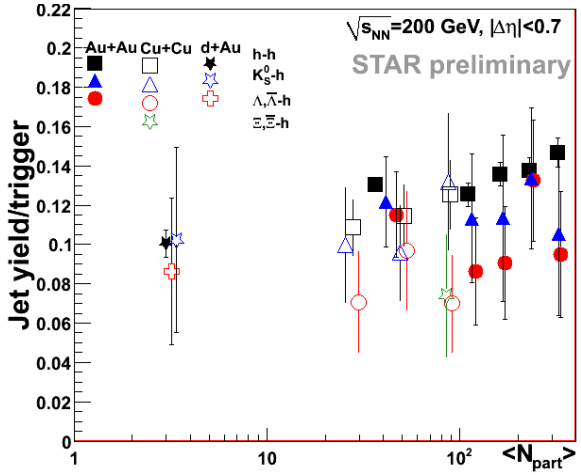


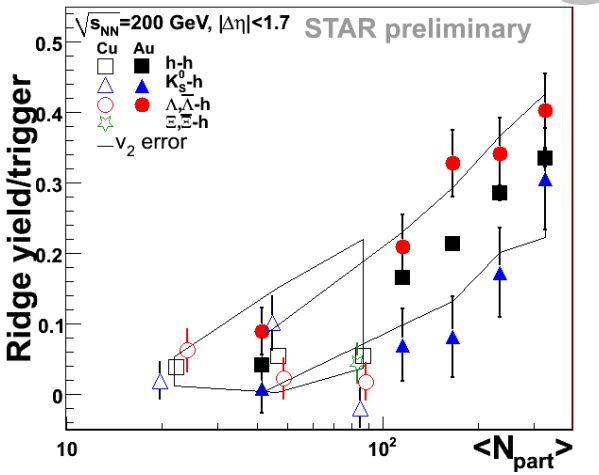
M. Lamont (STAR), J.Phys.G32:S105-S114,2006
J. Bielcikova (STAR), v:0707.3100 [nucl-ex]

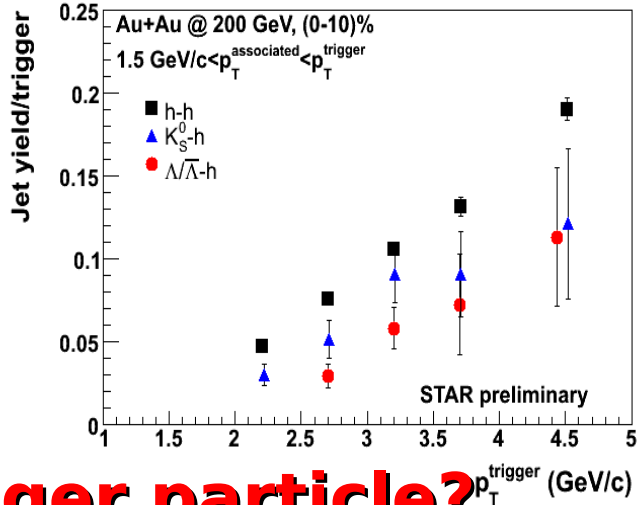
Particle ratios in Jet similar to those in p+p

Identified summary

Identified trigger

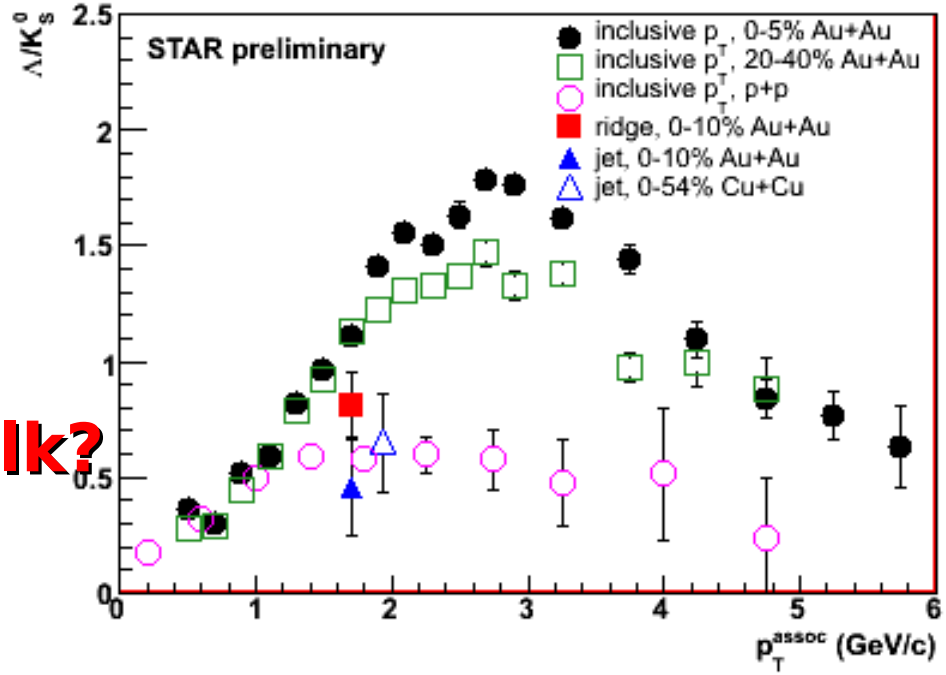






No significant dependence on trigger particle?

Identified associated



Jet looks like p+p
Ridge looks more like bulk?

Conclusions - Near-side

- Energy dependence:
  - Ridge present at $\sqrt{s_{NN}}$=62 GeV
  - Both *Jet* and *Ridge* yields smaller at $\sqrt{s_{NN}}$=62 GeV than $\sqrt{s_{NN}}$=200 GeV
  - *Ridge/Jet Ratio independent of collision energy*
- Identified trigger particles:
  - No significant dependence on trigger type
- Identified associated particles:
  - Jet $(\bar{\Lambda}+\Lambda)/2K^0_S$ similar to p+p
  - Ridge $(\bar{\Lambda}+\Lambda)/2K^0_S$ similar to bulk?

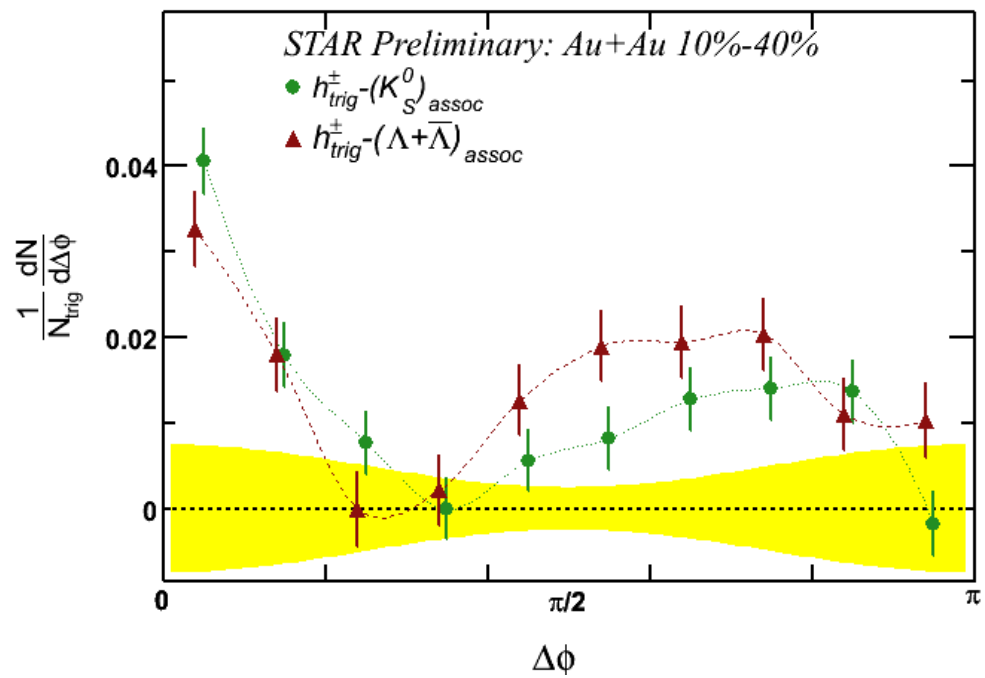
Outlook

- More Au+Au $\sqrt{s_{NN}}$ = 200 GeV from Year 7 – 4x statistics, EMC-triggered data
  - Allow separation of *Jet* and *Ridge* components of Ω triggered correlations?

Away side ($\bar{\Lambda}+\Lambda$)/2K^0_S

Poster

Jiaxu Zuo

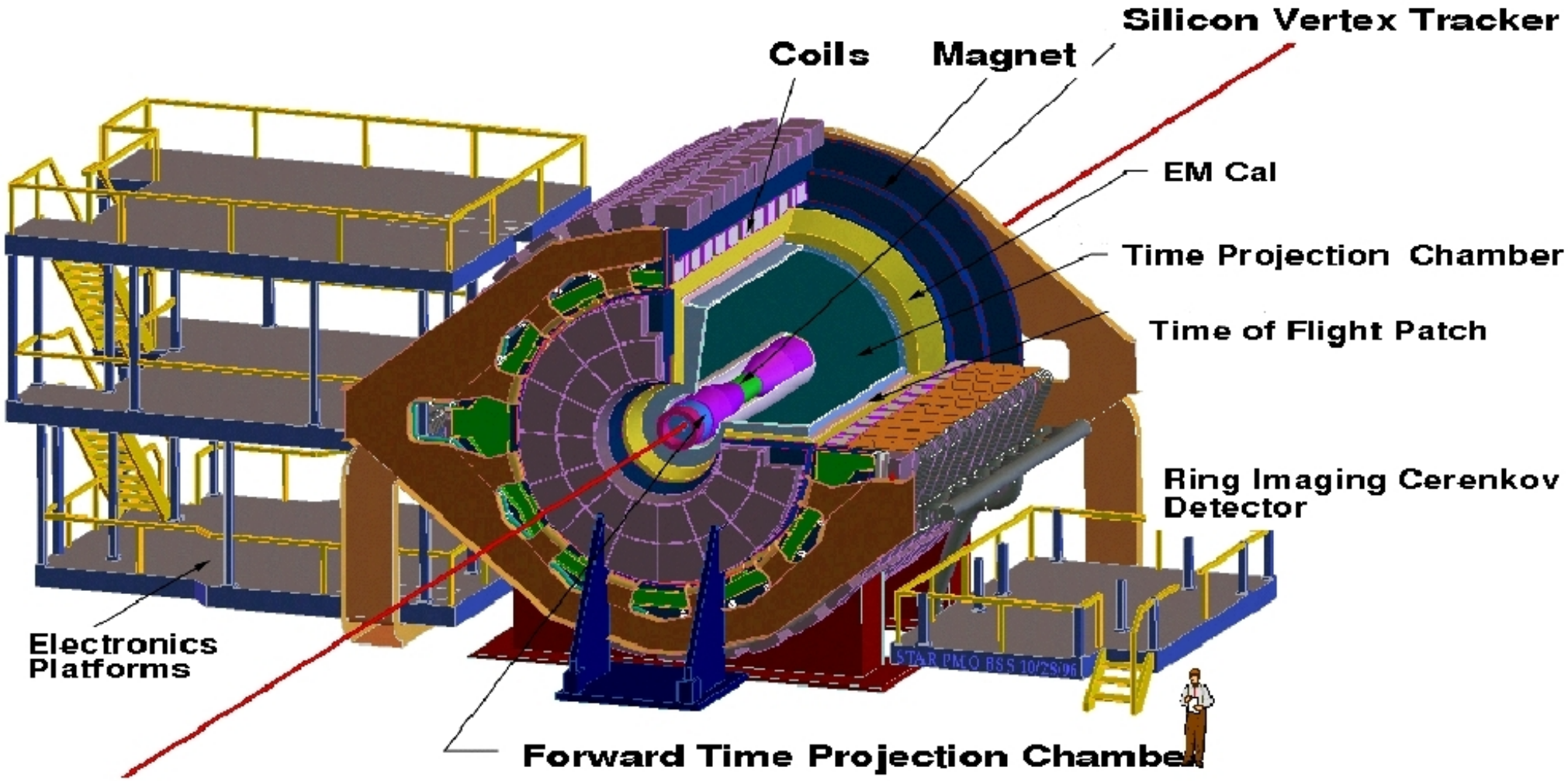


STAR Collaboration

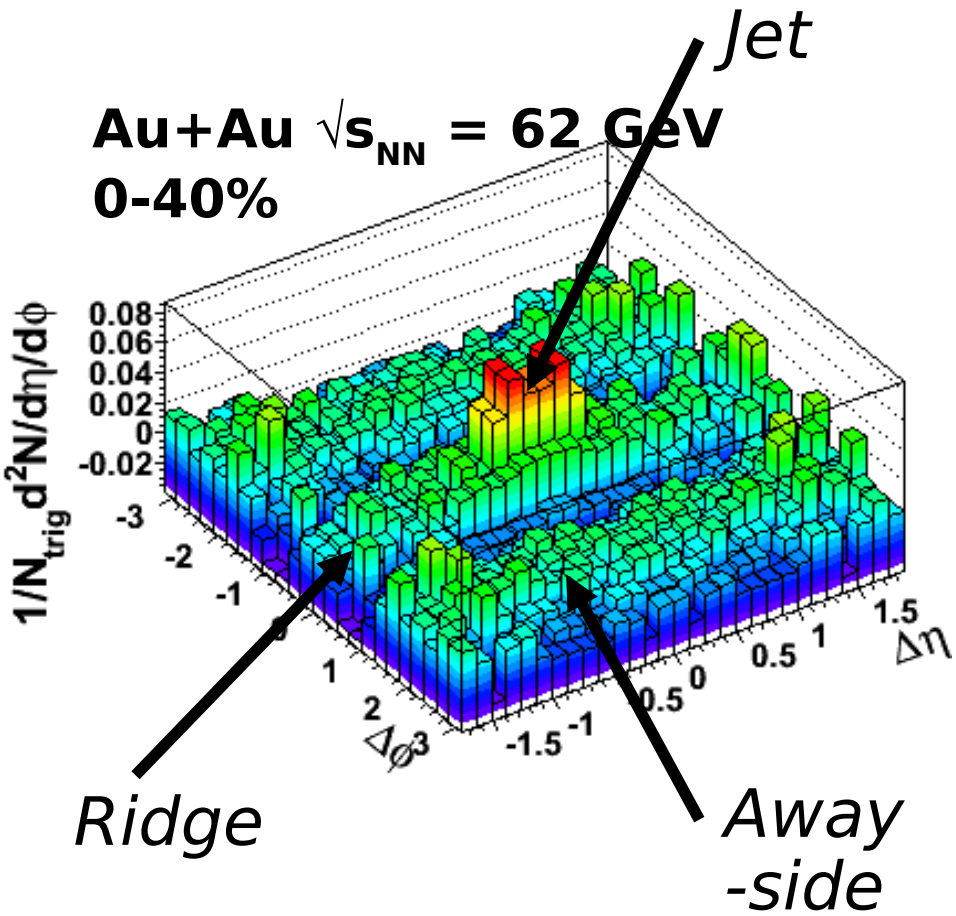
Argonne National Laboratory - University of Birmingham - Brookhaven National Laboratory - California Institute of Technology - University of California, Davis - University of California - University of California, Los Angeles - Carnegie Mellon University - University of Illinois at Chicago - Creighton 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

STAR

"Large acceptance hadronic detector"



Ridge in other systems and energies



- Ridge also present at $\sqrt{s_{NN}}$ = 62 GeV
- Lower statistics
- Weaker signal
- Apply method as done for $\sqrt{s_{NN}}$ = 200 GeV