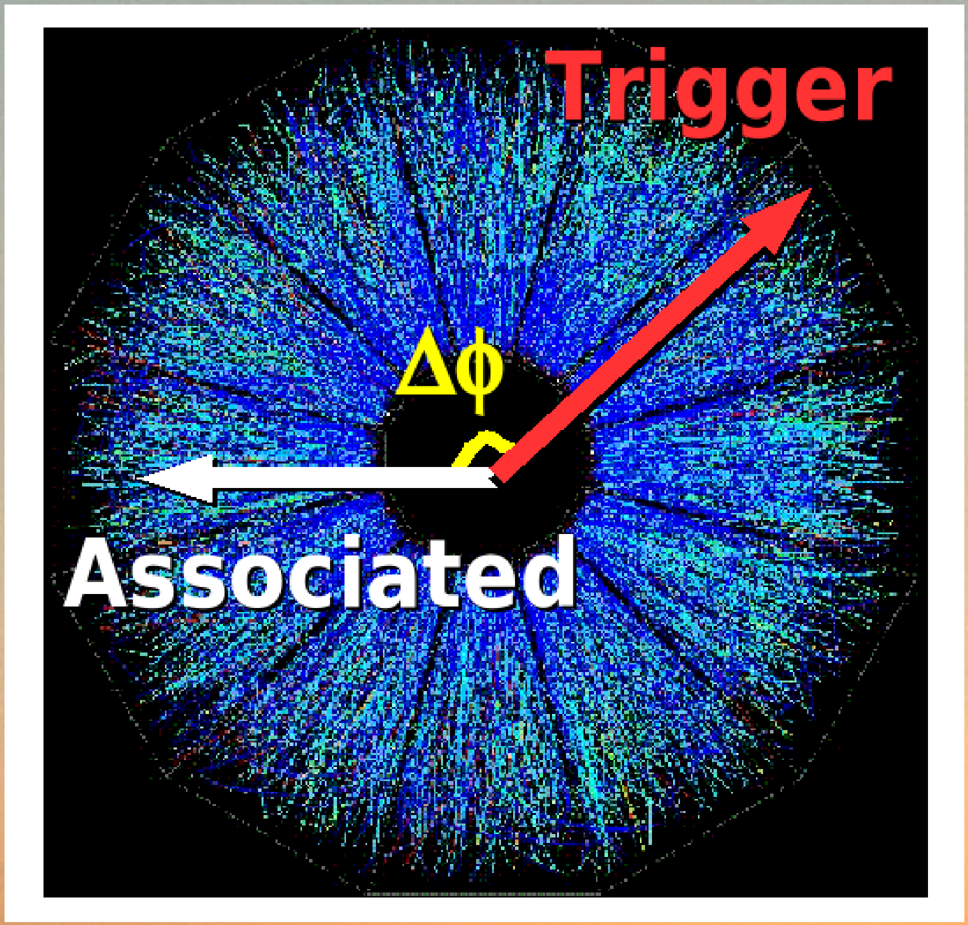
# System size dependence of azimuthal correlations at RHIC

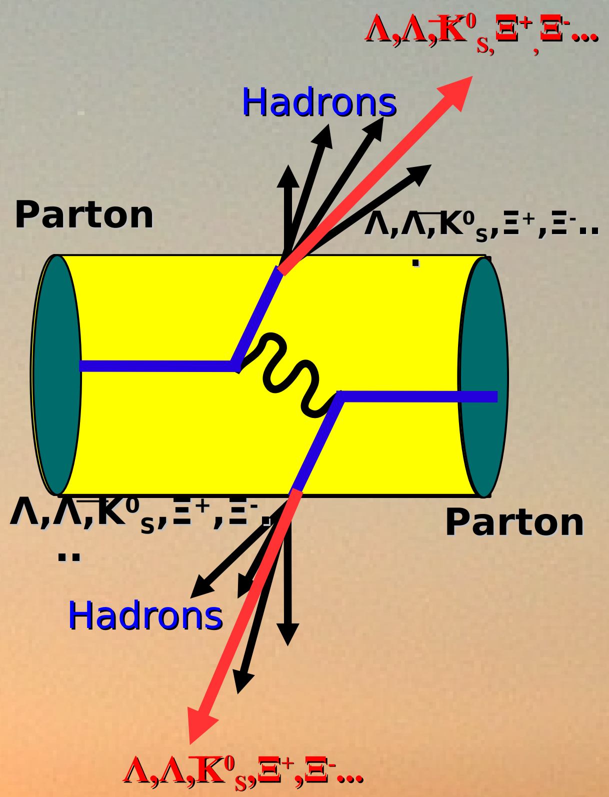
**Christine Nattrass**
Yale University
Star Collaboration

# Outline

- Motivation
- Analysis technique
- Results
- Conclusions

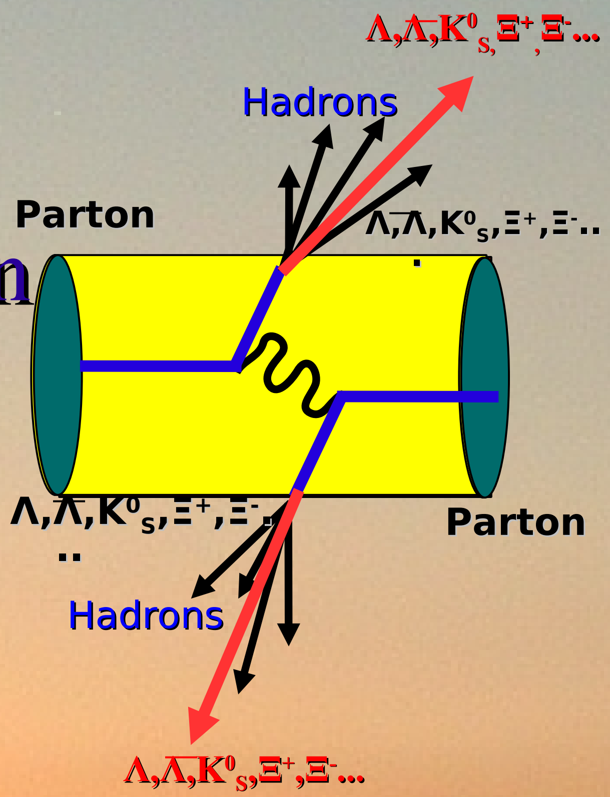
# Motivation – particle identification in jets

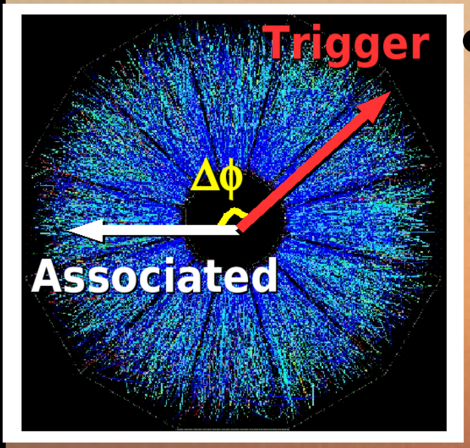


# Motivation – particle identification in jets

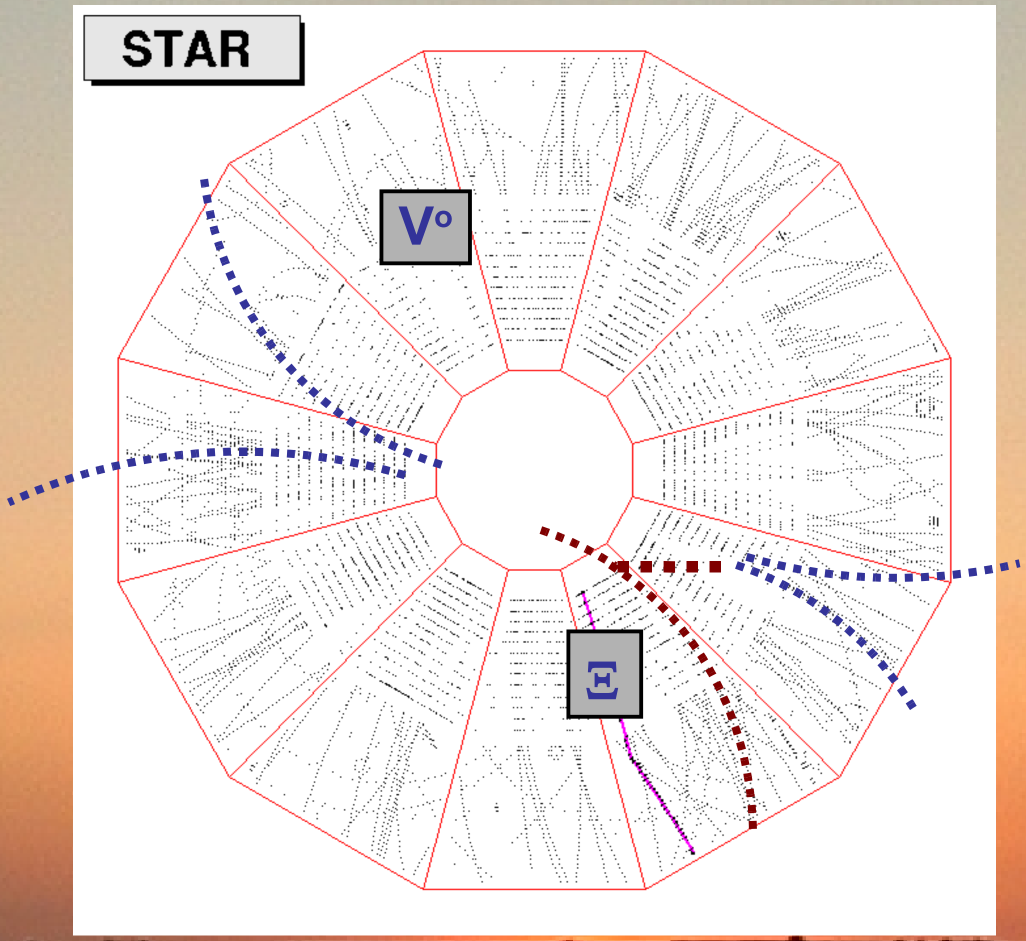
- Particle/antiparticle differences
  - Quark vs gluon jets
- Meson/baryon differences
  - Coalescence/ recombination mechanisms
    - Consistent with particle ratios
    - Testable with identified particle correlations?



# Strange particle identification

- Full azimuthal acceptance
  - Reconstruction of decay vertices possible
  - ~95% purity in Cu+Cu high $p_T$



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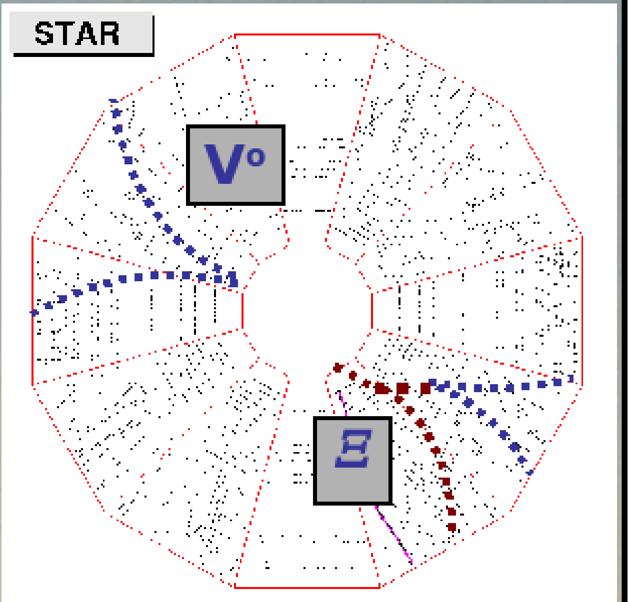


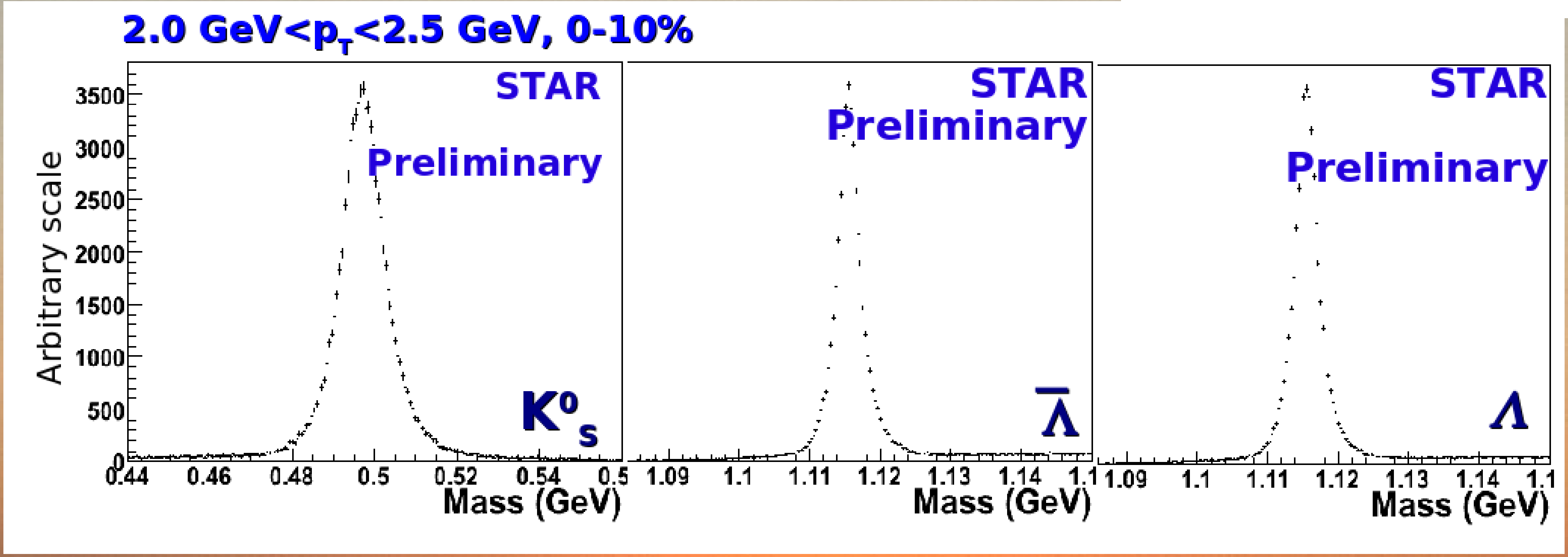




Christine Nattrass (STAR Collaboration), Yale University, DNP 10 October 2007, Newport News, Virginia

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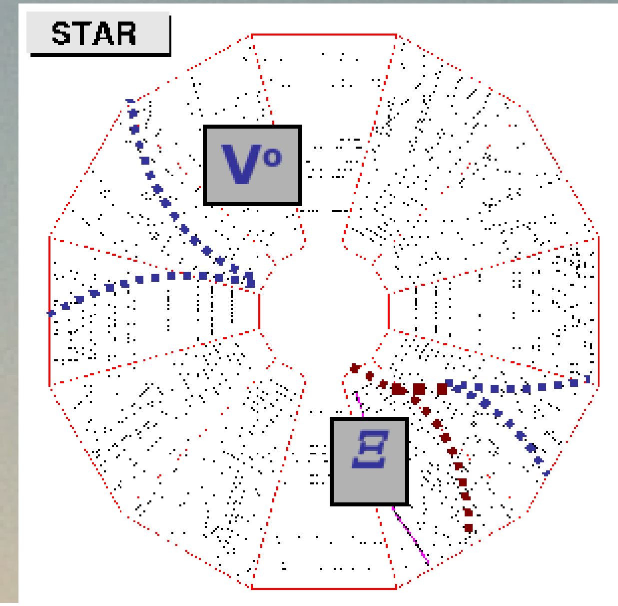
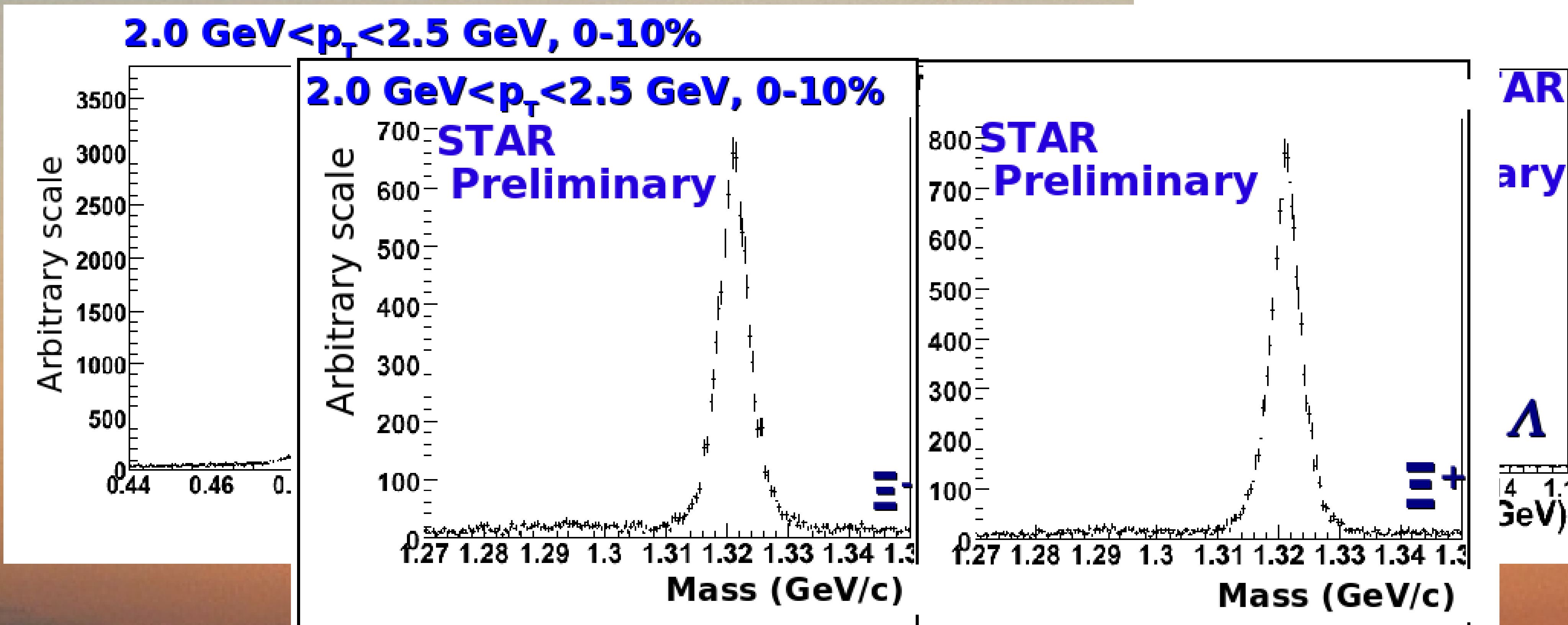
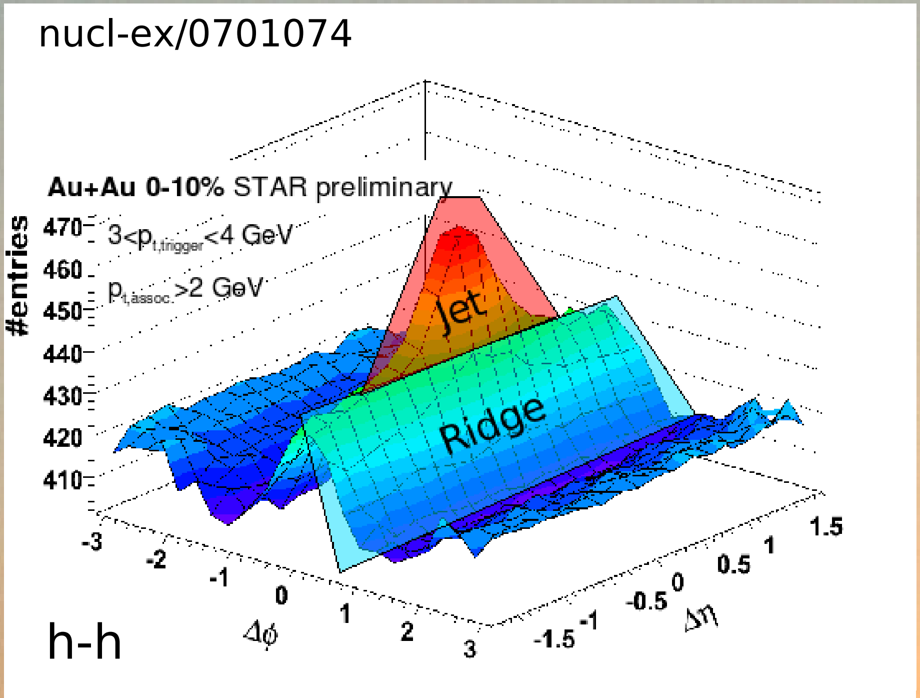


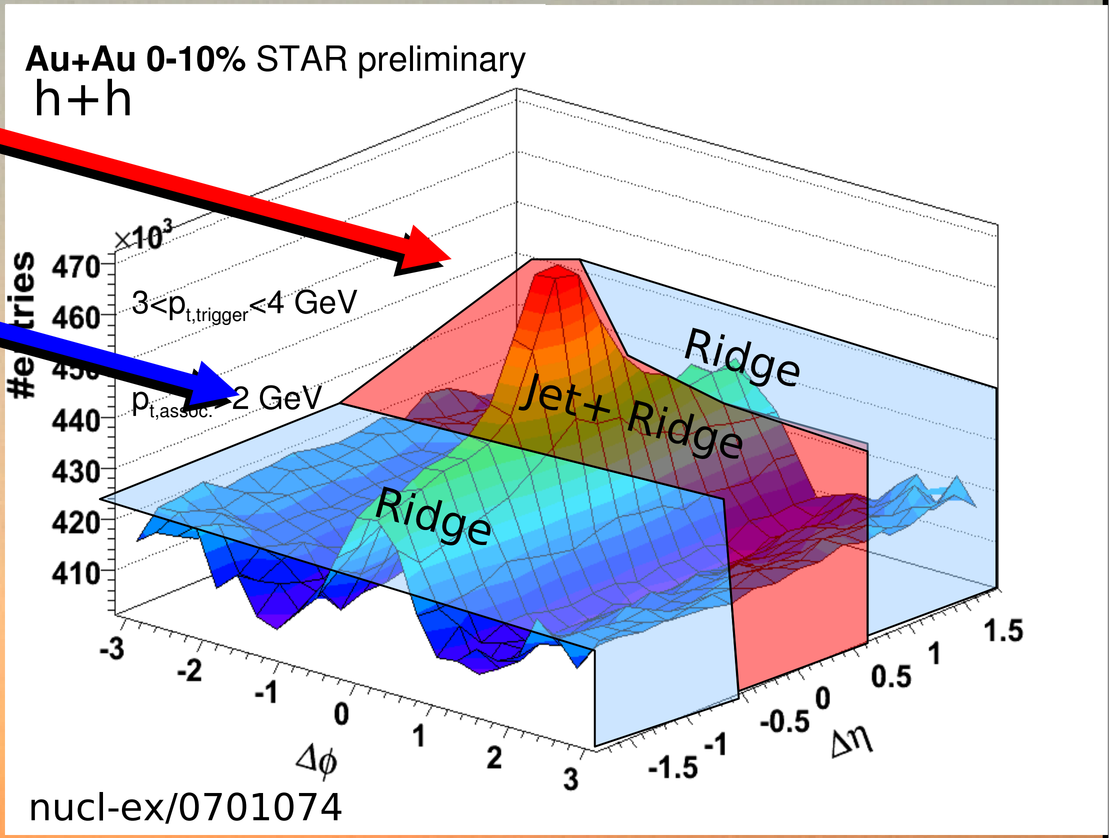
# Motivation - Long-range pseudorapidity correlations



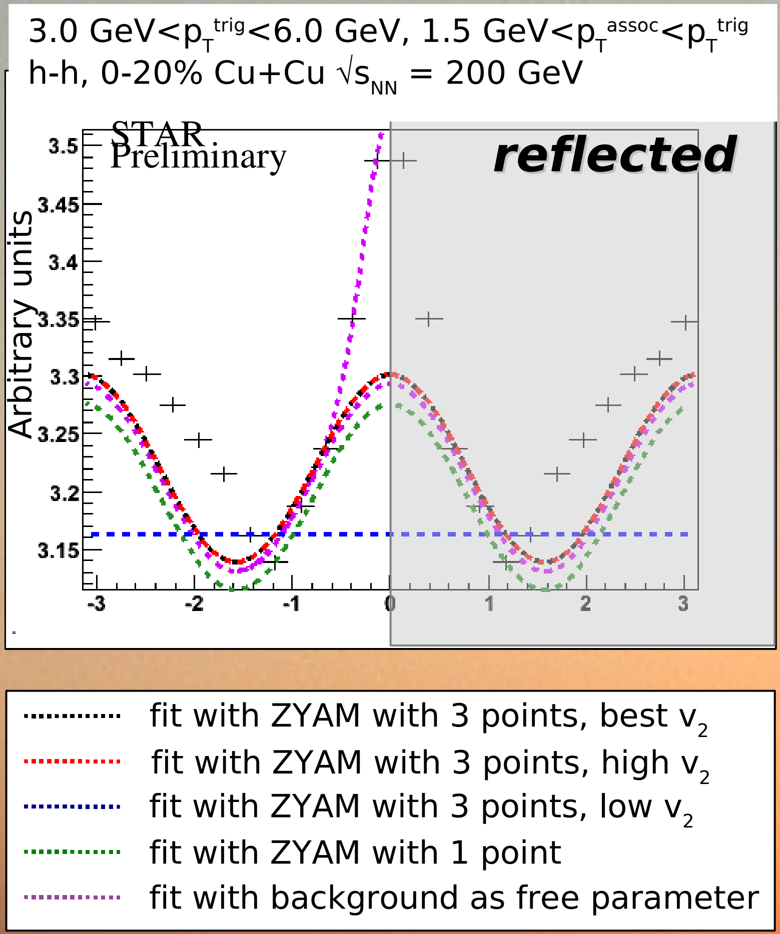

- Long-range pseudorapidity ($\Delta\eta$) correlations observed by STAR in Au+Au at intermediate $p_T$
- Near side jet peak sits on plateau (*Ridge*)
  - Significant contribution to the near-side yield in central Au+Au
- Look for particle and system size dependencies which might reveal information about production mechanism

# ΔΦ-Δη Correlations - Method

- *Ridge* previously observed to be flat in Δη in Au+Au
- 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****.75/1.75
  - ***Ridge*** = yield from -1.75<Δη<1.75 – ***Jet*** yield
- Flow contributions to jet cancel
  - $v_2$ flat with η for |η|<1
    - Phys. Rev. C72, 051901(R) (2005), Phys. Rev. Lett. 94, 122303 (2005)



# Determination of yields and errors




- Background:
  $B(1+2\, v_2^{trig}\, v_2^{assoc} \cos(2\Delta\Phi))$
- Different fit methods for determination of B
  - *Z*ero *Y*ield *A*t *M*inimum (ZYAM)
  - 1 point, 3 points
  - B as Free parameter (used as best guess)
- $v_2$ error
  - $v_2$ measurements in progress
    - Upper bound for $v_2$ measured
      - $v_2 \approx$ 10-15% depending on $p_T$, centrality
    - Estimate for lower bound, near 0
  - $\Lambda,\Lambda,K^0_{S}, \Xi^+, \Xi^-$... $v_2$ not measured
    - Assume quark scaling of h $v_2$ in Cu+Cu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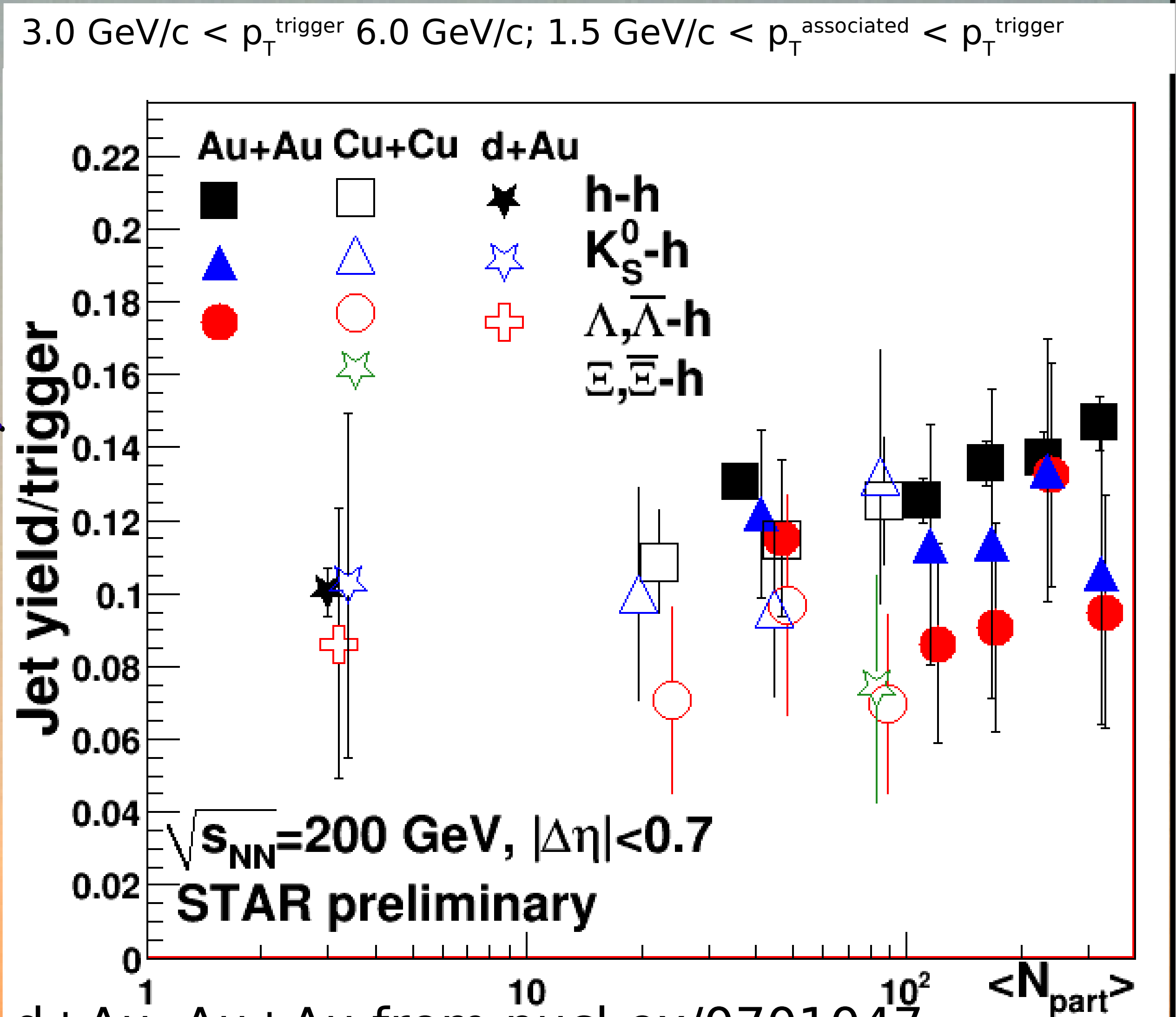
# Near-side Yield vs $N_{part}$ Cu+Cu vs Au+Au

*Identified triggers:*

- ***Jet* yield**
  - Nearly flat with $N_{part}$ within errors across d+Au, Cu+Cu, Au+Au
  - No $v_2$ or background error due to method
  - No trigger dependence within errors
- ***Ridge* yield**
  - No *Ridge* within errors in d+Au
  - Rises with $N_{part}$ in Cu+Cu and Au+Au
  - No trigger dependence within errors




d+Au, Au+Au from nucl-ex/0701047

Data points at same $N_{part}$ offset for visibility

Jet yields: 10% error added to $V^0$ and h triggers to account for track merging, 15% to $\Xi$ triggers

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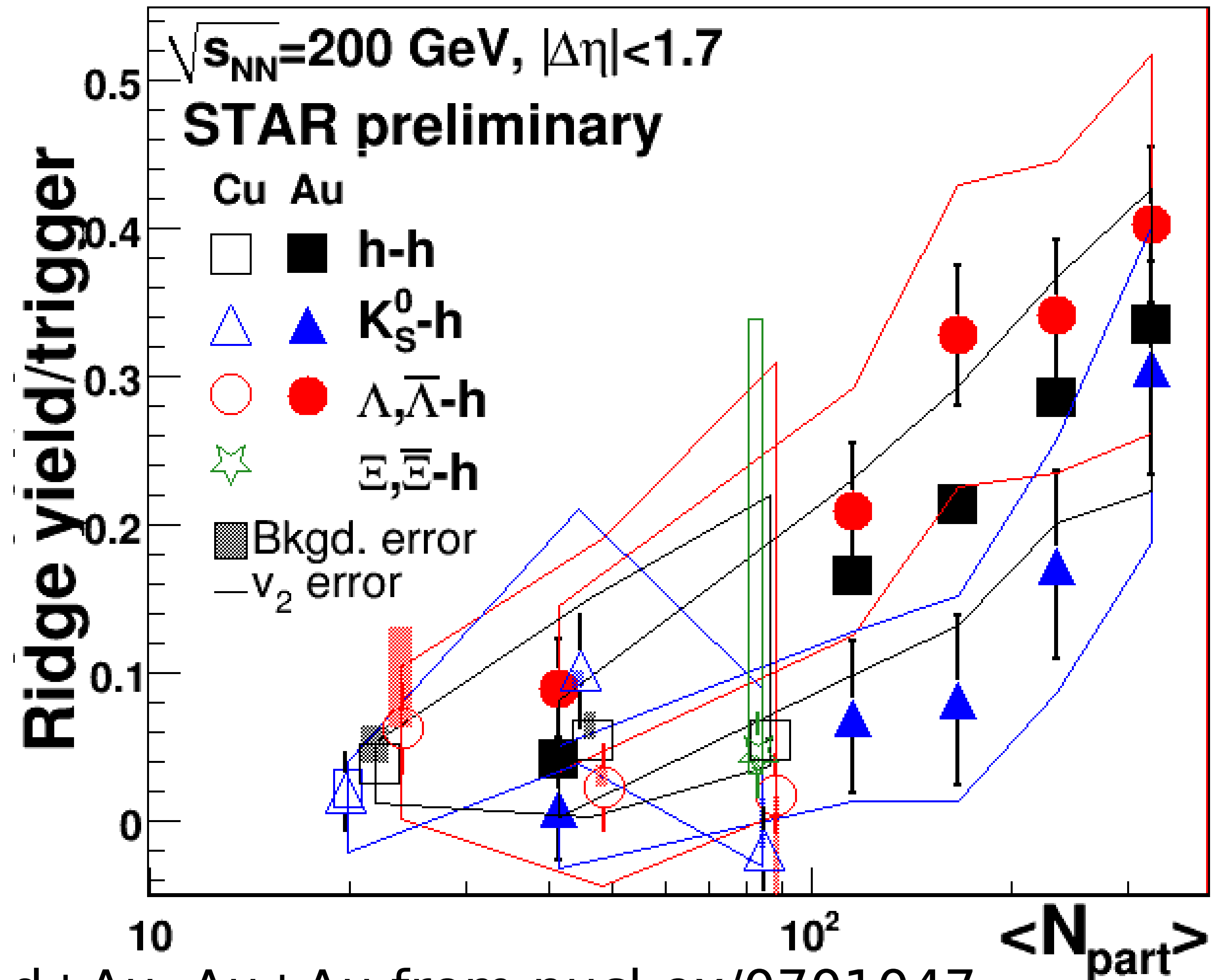
3.0 GeV/c < $p_T^{trigger}$ 6.0 GeV/c; 1.5 GeV/c < $p_T^{associated}$ < $p_T^{trigger}$

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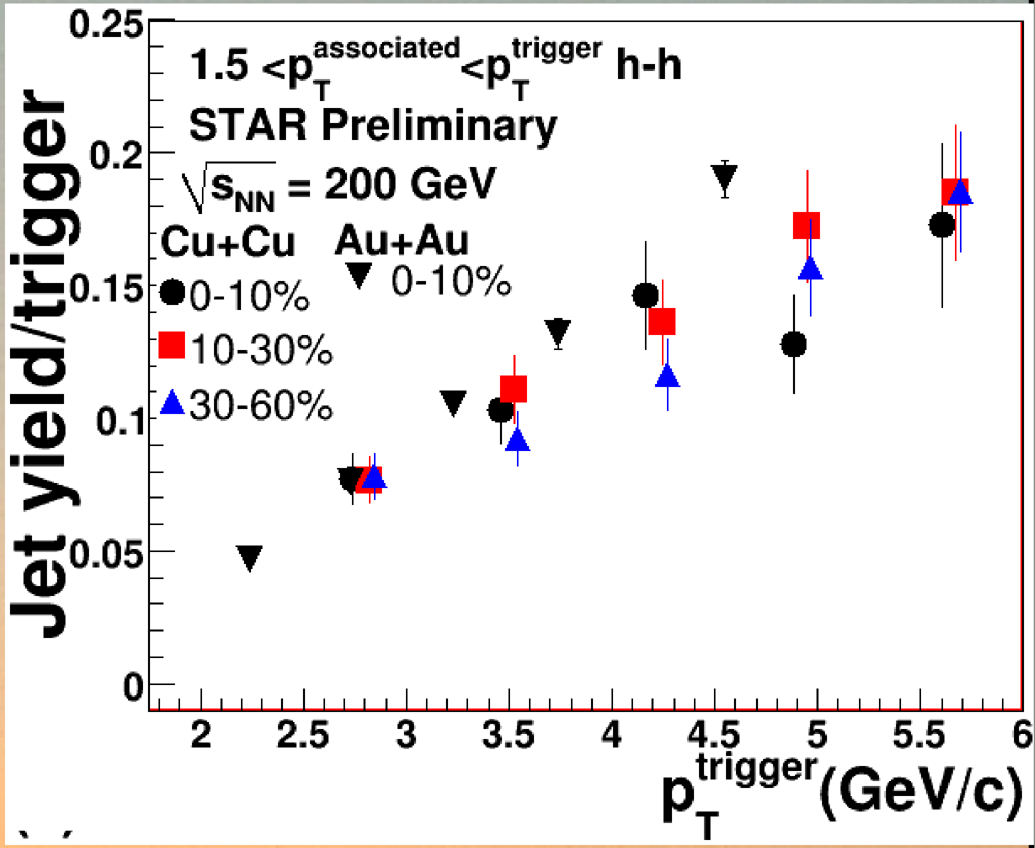
# *Jet* yieldvs $p_T^{trigger}$

## *Identified triggers:*

- *Jet* yield rises with $p_T^{trigger}$ in h-h
  - Yield roughly constant with centrality
  - Central Au+Au and 0-60% Cu+Cu jet yields comparable
- No particle type dependence within error bars

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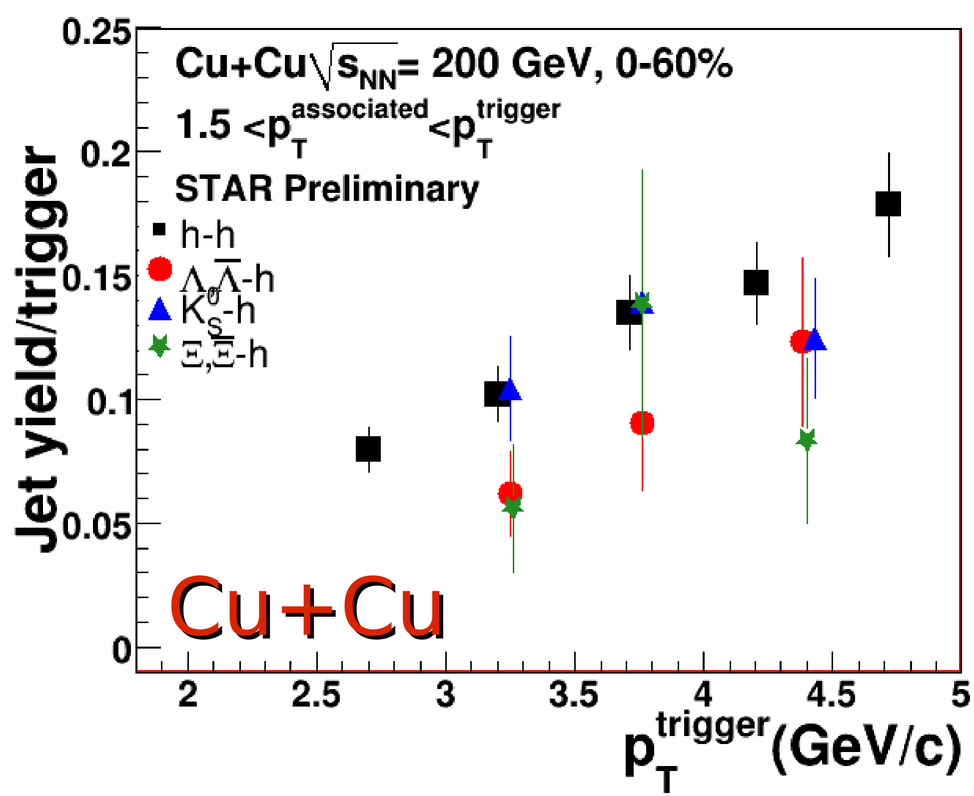


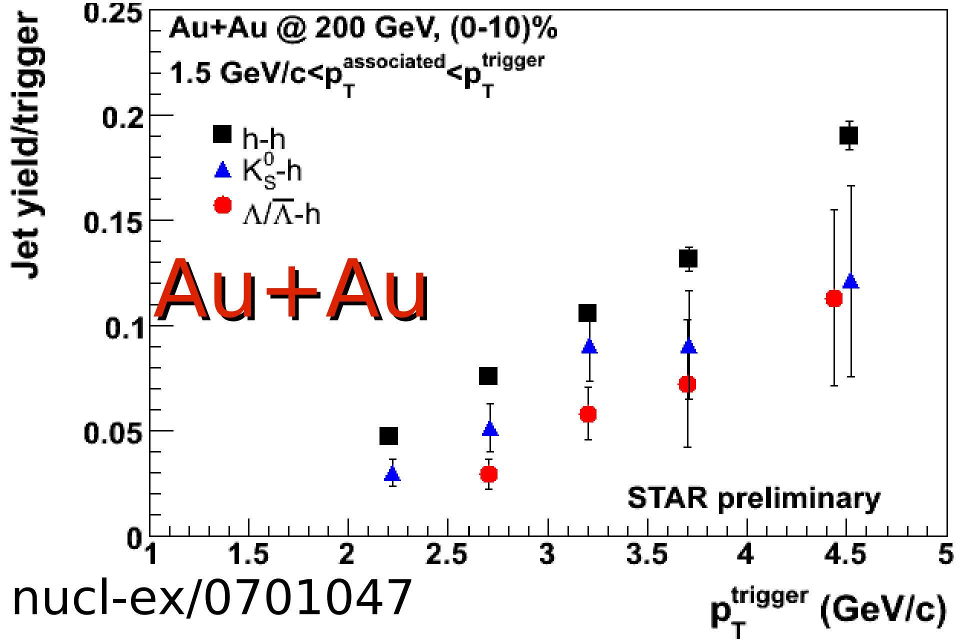


nucl-ex/0701047

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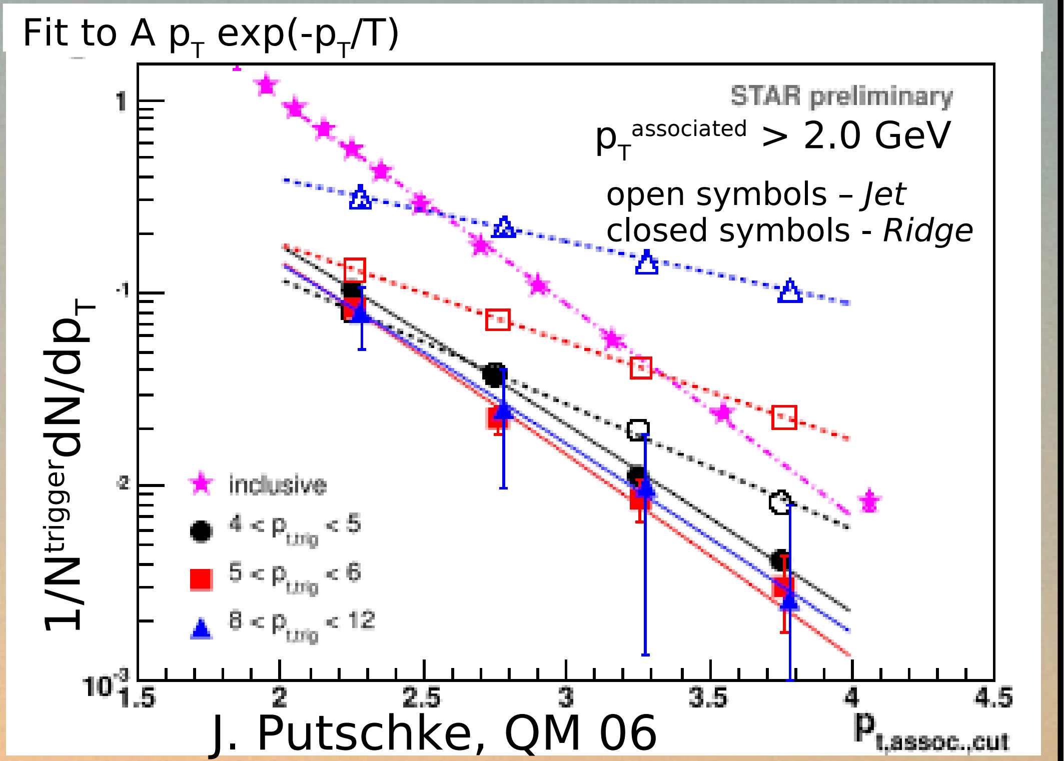
# $p_T$-distribution of associated particles

*Identified triggers:*

- *Ridge* spectra similar to the bulk
  - Cu+Cu measurements probably not possible
- *Jet* spectra are slightly harder
  - Cu+Cu fit only to h-h
  - Inverse slope T consistent between Cu+Cu and Au+Au




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

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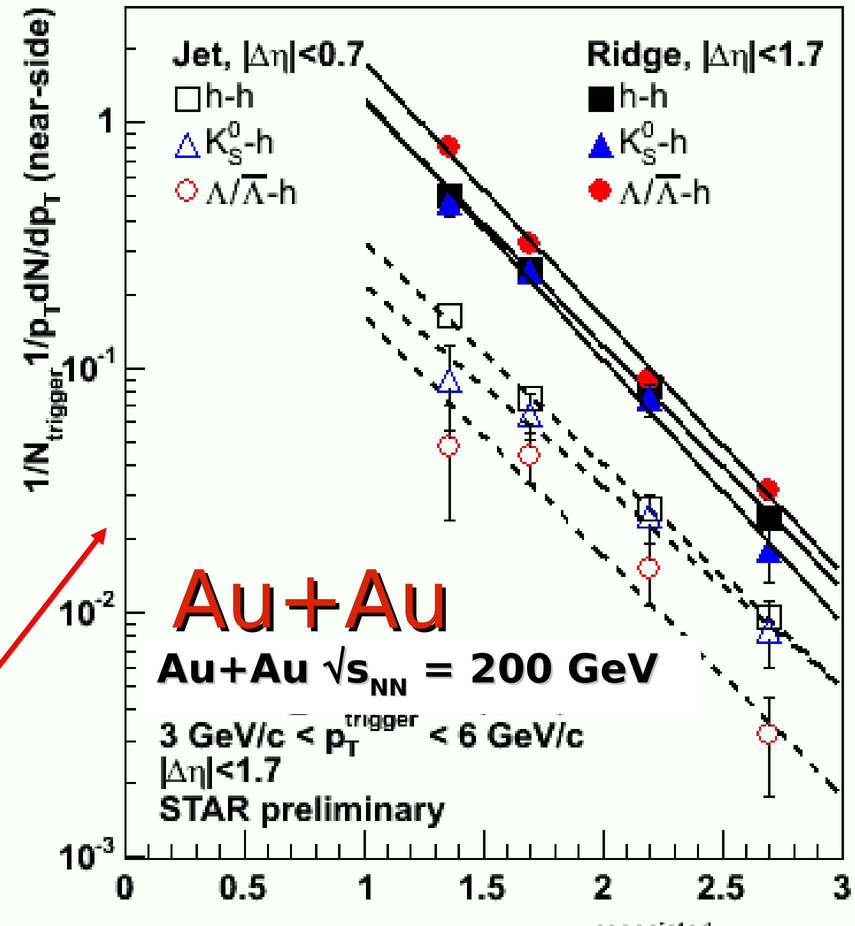


Fit to A exp($-p_T$/T)

| Trigger particle | T(ridge) MeV | T (jet) MeV |
|---|---|---|
| $h^{+/-}$ | 438 ± 4 (stat.) | 478 ± 8 |
| $K^0_S$ | 406 ± 20 (stat.) | 530 ± 61 |
| Λ | 416 ± 11 (stat.) | 445 ± 49 |
| Inclusive slope fit above 2.0 GeV: 355 +/- 6 | | |

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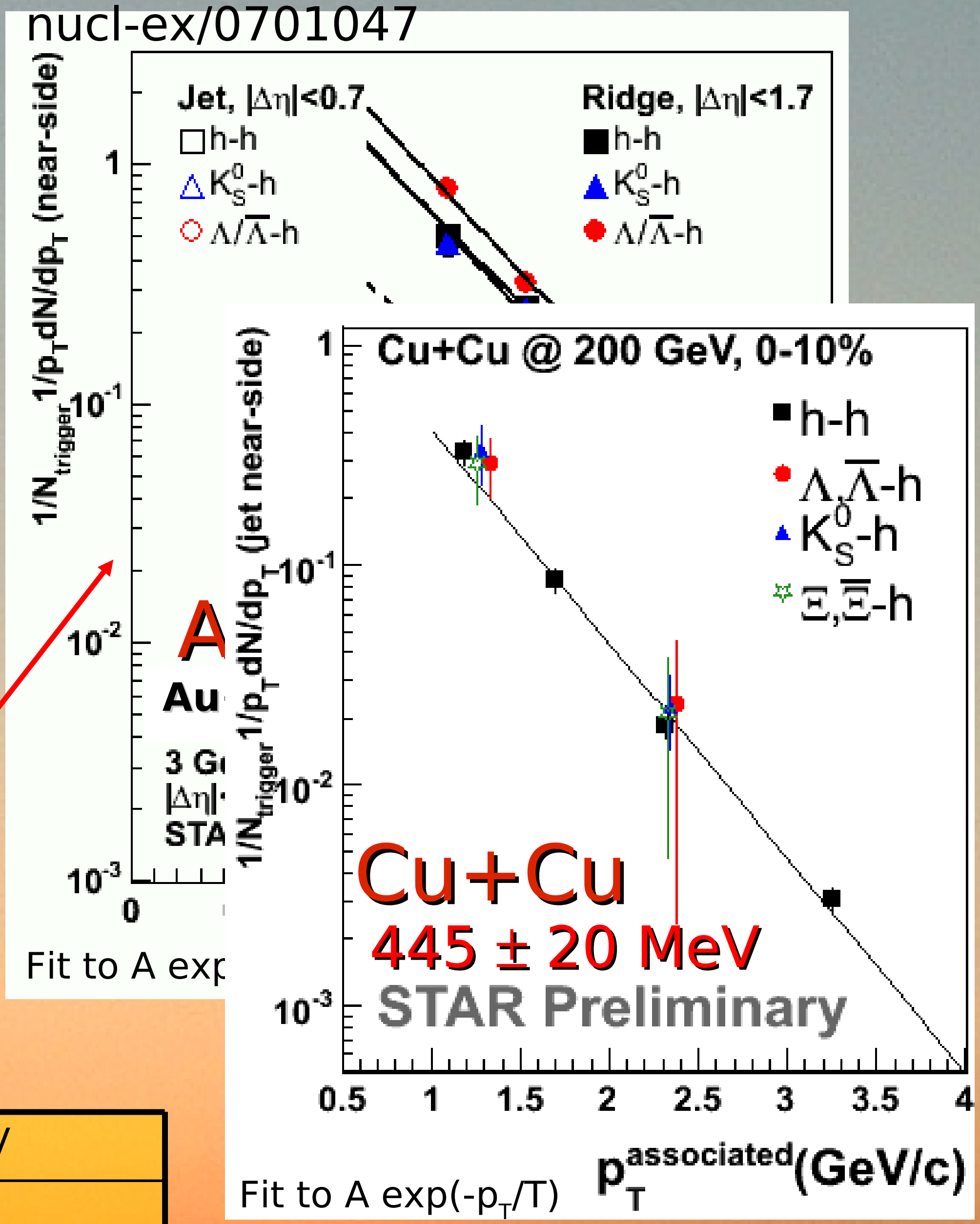


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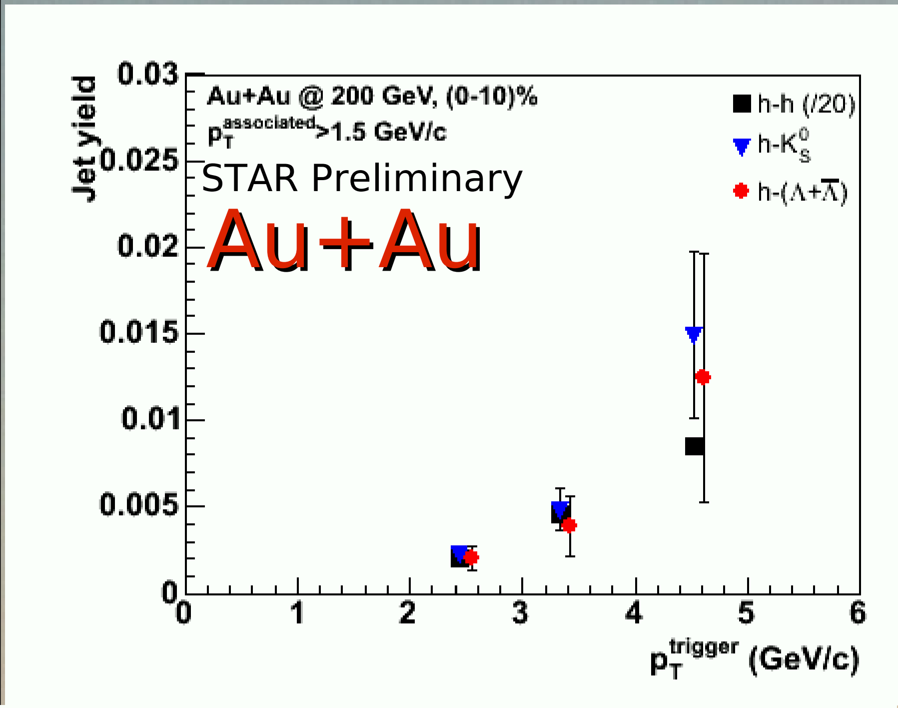
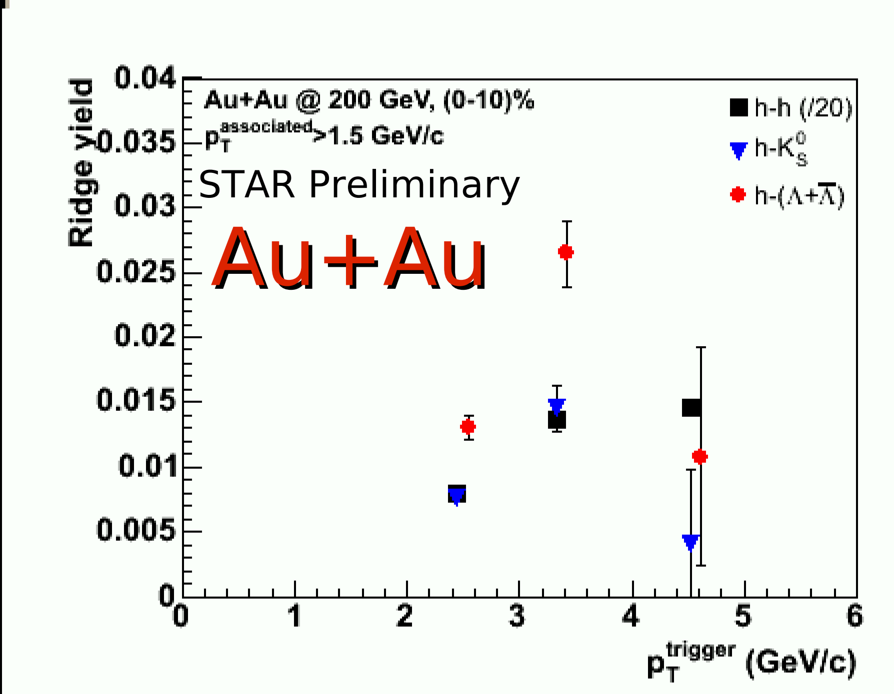
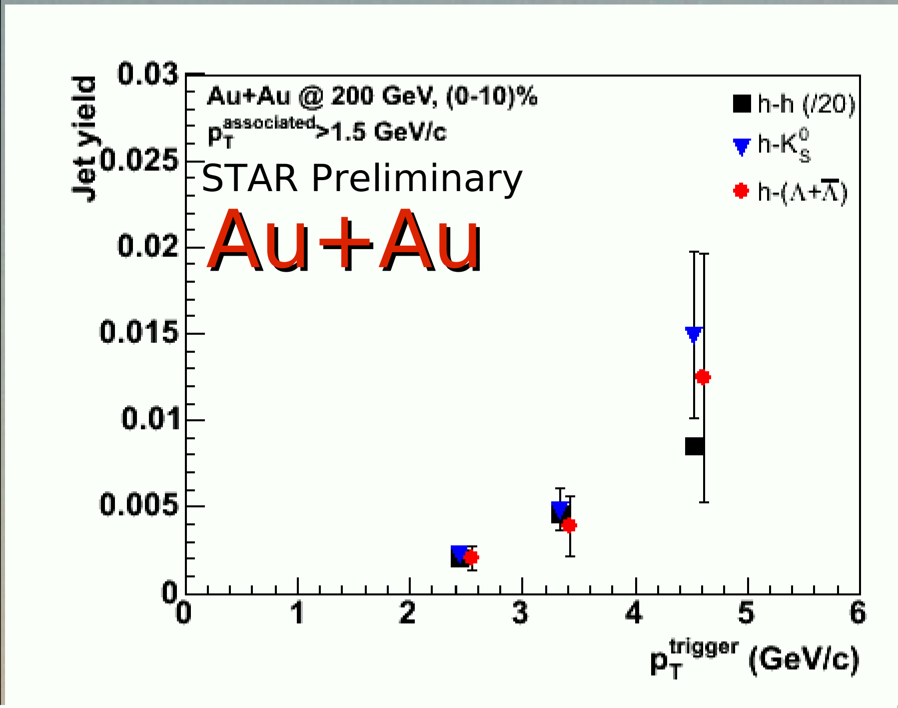
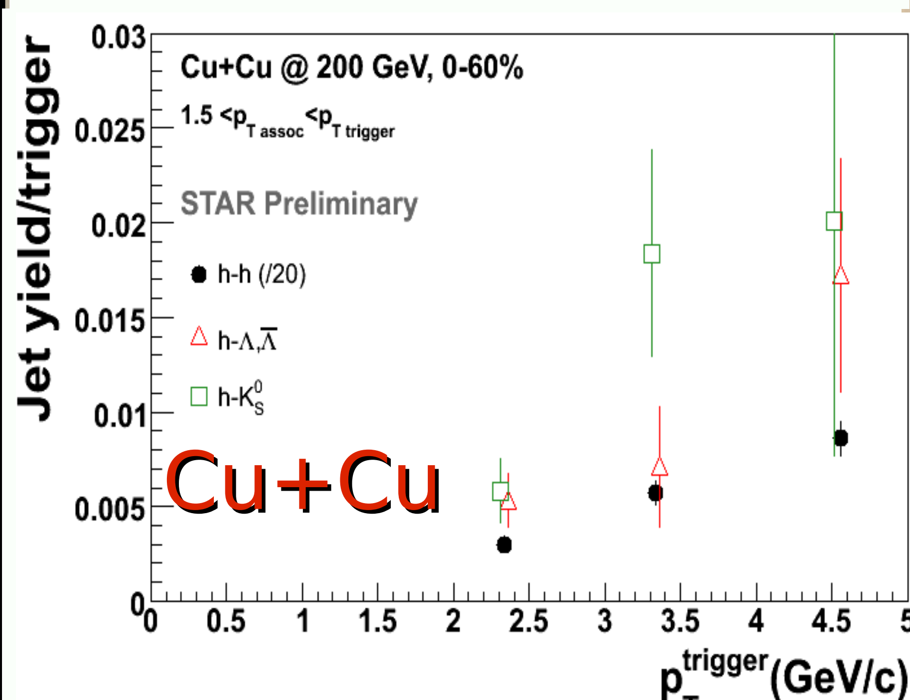
# Identified associated yield vs $p_T^{trigger}$




- In Au+Au
  - *Jet:* $(\Lambda+\bar{\Lambda})/K^0{}_S \approx 1$
    - *similar to vacuum fragmentation*
  - *Ridge:* $(\Lambda+\bar{\Lambda})/ K^0{}_S \approx 2$
    - *similar to the bulk*
- In Cu+Cu
  - *Ridge*: data not attainable
  - *Jet:* $(\Lambda+\bar{\Lambda})/ K^0{}_S \approx 1$




# Identified associated yield vs $p_T^{trigger}$

- In Au+Au
  - *Jet: $(\Lambda+\bar{\Lambda})/K^0_S \approx 1$*
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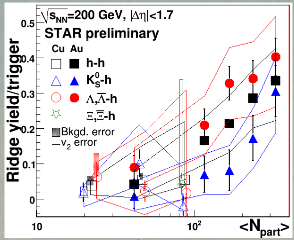
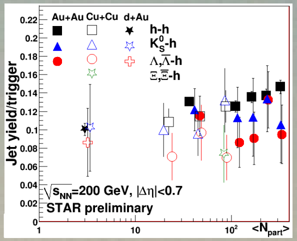
  - *Ridge: $(\Lambda+\Lambda)/K^0_S \approx 2$*
    - *similar to the bulk*
- In Cu+Cu
  - *Ridge*: data not attainable
  - *Jet: $(\Lambda+\Lambda)/K^0_S \approx 1$*

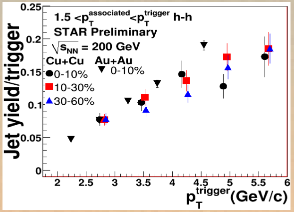
# Conclusions

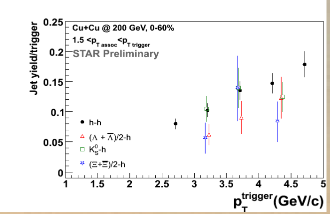
- Identified triggers
  - *Ridge* yields
    - Cu+Cu very small
    - Cu+Cu and Au+Au consistent at the same $N_{part}$



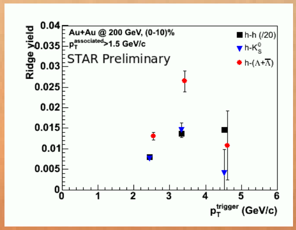



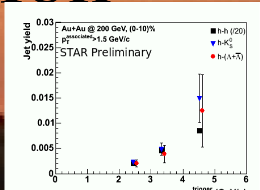

  - *Jet* yields
    - d+Au, Cu+Cu,Au+Au nearly consistent at the same $N_{part}$
    - Increases with $p_{T\ trigger}$
      - Constant with centrality
      - Independent of system




  - No trigger particle type dependence within errors
    - Including non-strange, and singly and doubly strange triggers
- Identified associated
  - *$(\Lambda+\bar{\Lambda})/K^0_S$* in *Ridge* similar to inclusive
  - *$(\Lambda+\Lambda)/K^0_S$* in *Jet* similar to vacuum fragmentation
    - In Cu+Cu and Au+Au



# STAR Collaboration

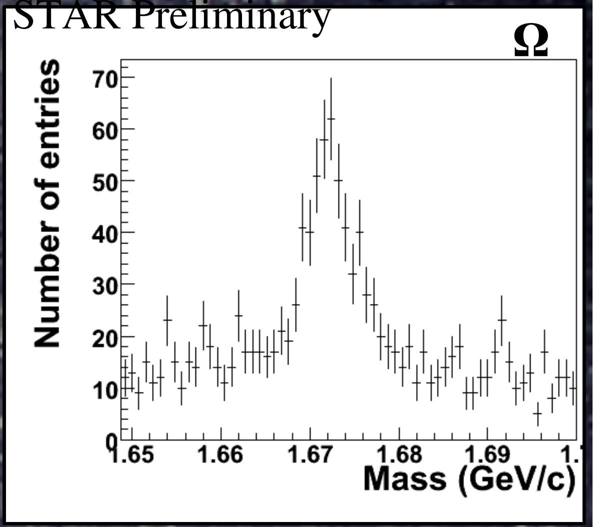
Argonne National Laboratory - University of Birmingham - Brookhaven National Laboratory - California Institute of Technology - University of California, Davis - University of California - University of California, Los Angeles - Carnegie Mellon University - University of Illinois at Chicago - Creighton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

# Backup slides


The End

# Future work

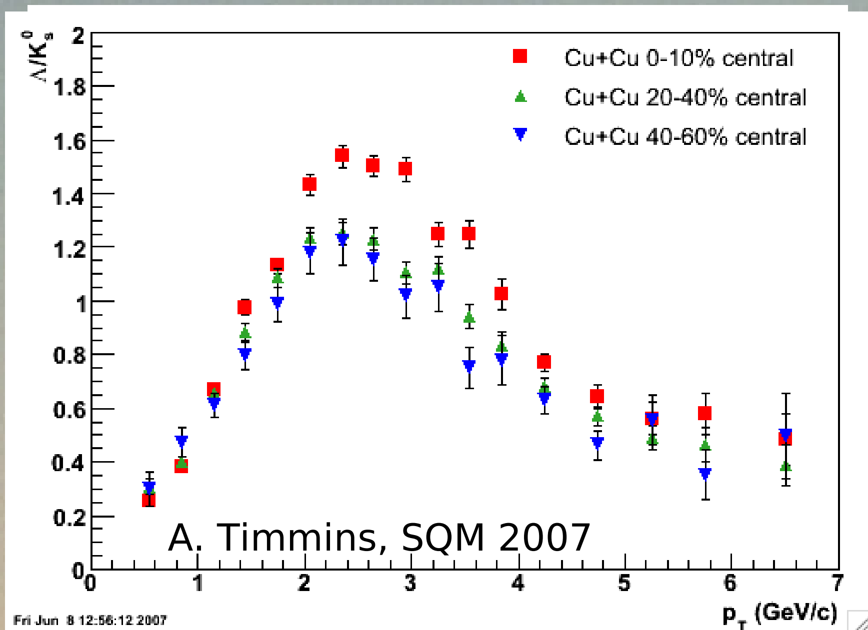
- Systematics
  - Reduce systematic error from $v_2$
  - Identified particle $v_2$
- Expand identified associated analysis
- Coming soon
  - Ω triggers
    - Comparisons to Au+Au – See B. Abelev's SQM talk
    - Away-side yields
    - Energy dependence of Jet and Ridge yields

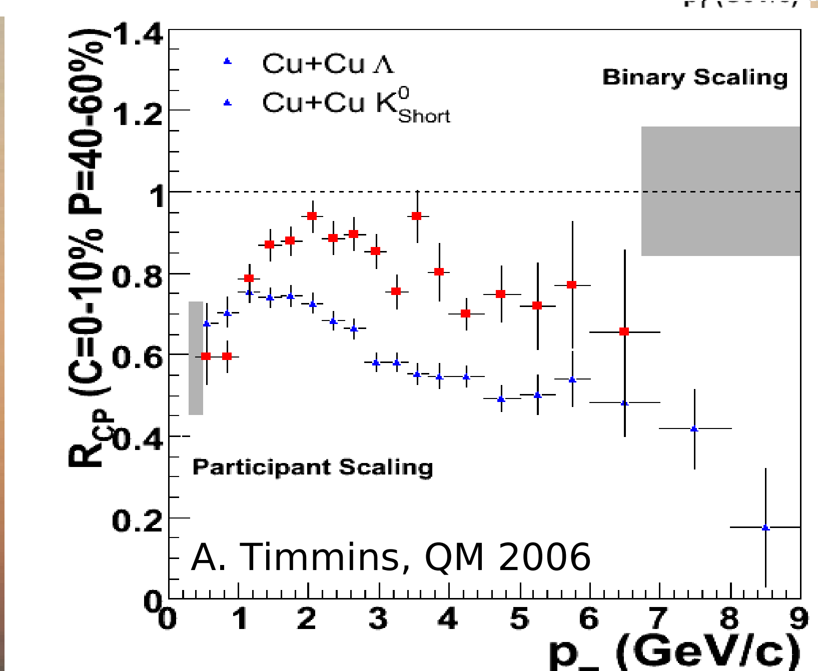



~1000 Ω triggers in central Cu+Cu with $p_T$>2.5 GeV/c!

~2000 in central Au+Au

# Intermediate $p_T$ baryon/meson enhancement

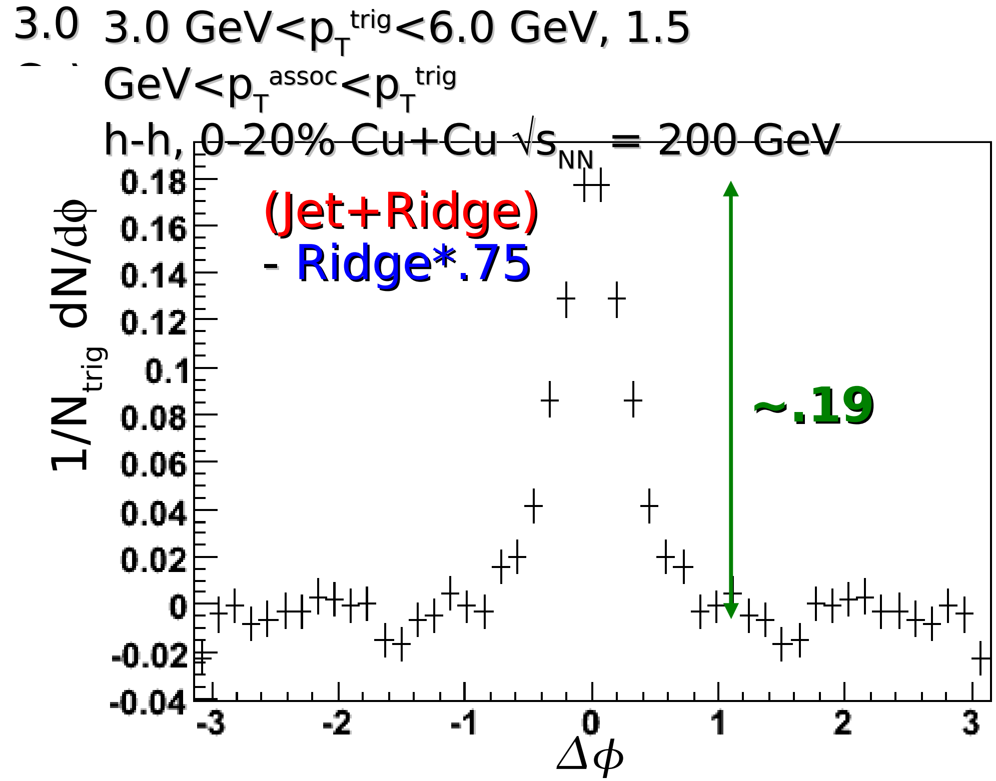


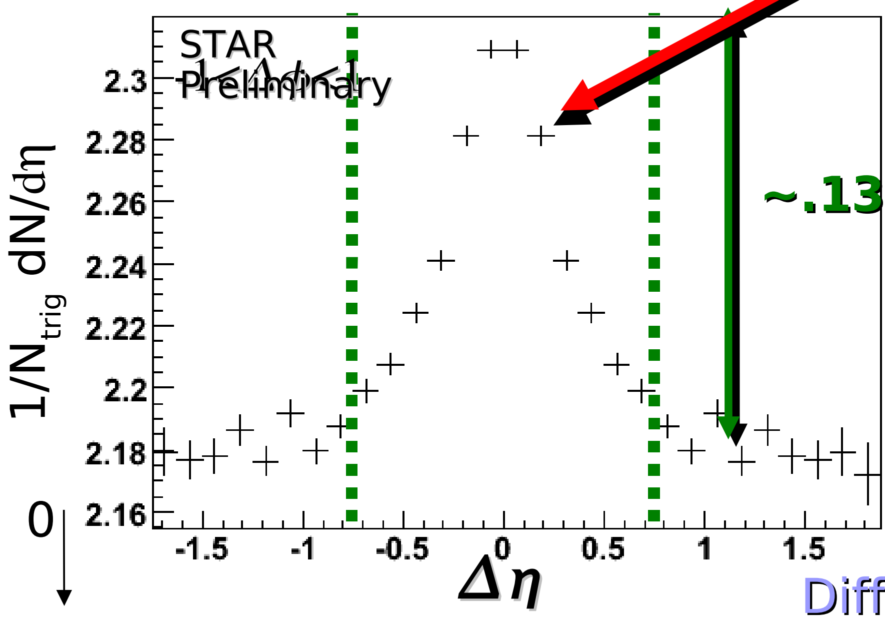



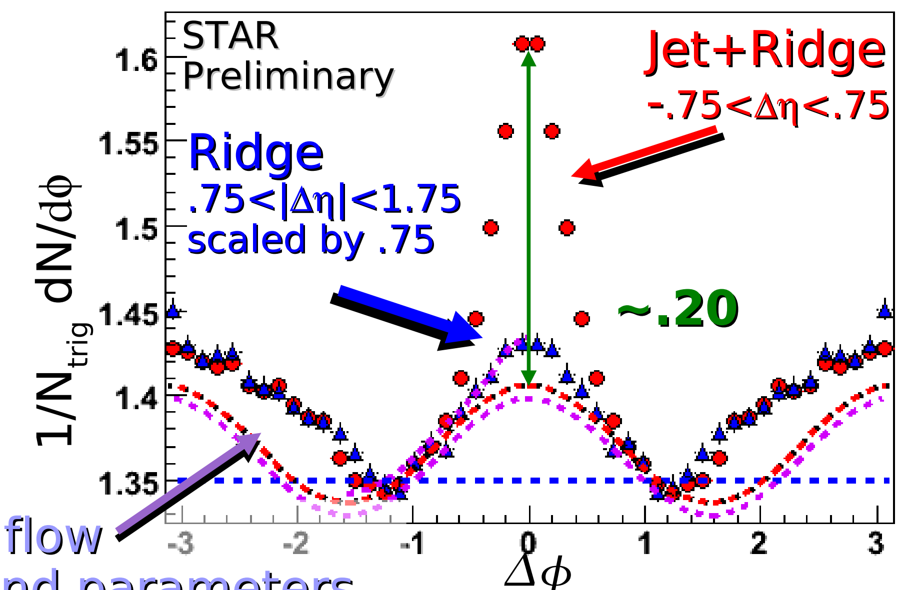

- Large enhancement of baryon/meson ratio in central collisions relative to p+p
  - in both Au+Au and Cu+Cu
  - reaches maximum at $p_T$ ~ 2-3 GeV/c
  - not unmodified jet fragmentation
- Baryon/meson splitting of $R_{cp}$
  - strange and non-strange particles show similar suppression

# The Ridge in Cu+Cu

- Is there a Ridge in Cu+Cu?
- Δη projection flat at large Δη
- Small and large Δη regions match on away side
- Small yield above background in large Δη region
- Jet yield in Δη consistent with Jet in Δη subtracting (Jet+Ridge)-Ridge




Different flow background parameters