Azimuthal correlations with high p_T multi-hadron cluster triggers in Au+Au collisions at sqrt(s) = 200 GeV from STAR

Brooke Haag for the STAR Collaboration
University of California at Davis

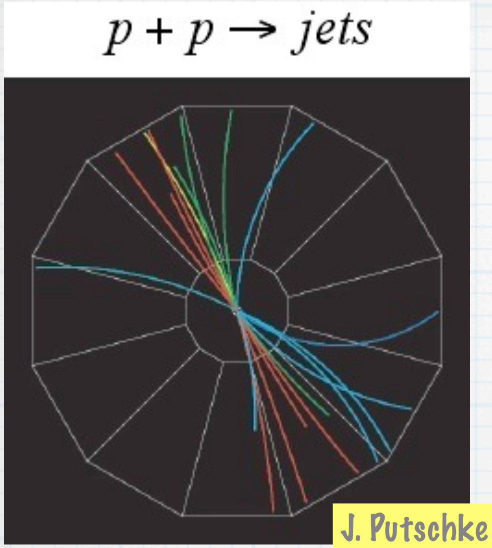
Presented at the 24th Winter Workshop on Nuclear Dynamics
April 5-12 2008
South padre Island, Texas

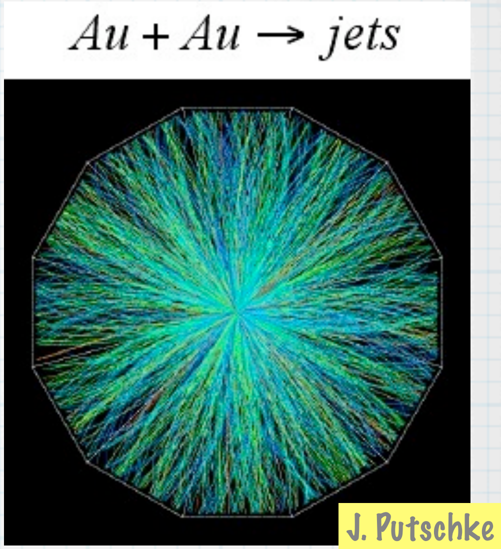
STAR

OUTLINE

* Introduction / Analysis Technique
* Explanation of multi-hadron trigger results
  * away-side yields for different p_T trigger bins:
    10 to 12 GeV/c, 12 to 15 GeV/c, and 15 to 18 GeV/c
  * pythia predictions of away-side yields for different p_T trigger bins:
    10 to 12 GeV/c, 12 to 15 GeV/c, and 15 to 18 GeV/c
  * ratios of all single + multi-hadron away-side yields to di-hadron away-side yields
* Conclusions and Outlook

Introduction





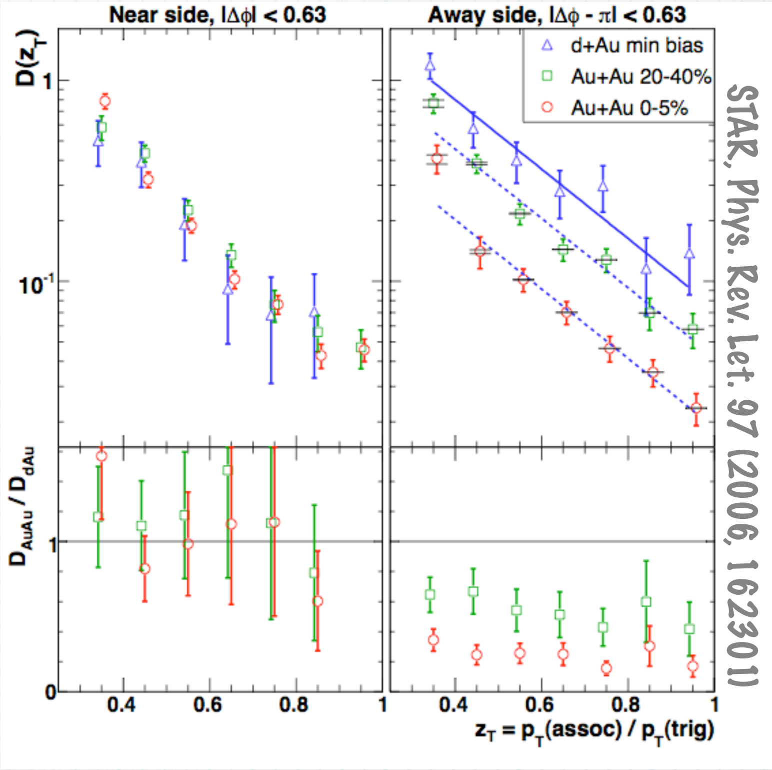
* Measuring jets in HI collisions, much more difficult than in p+p collisions
* So far our major method in sorting jets from HI events is Di-hadron correlations

We look for a **leading hadron** which we assume carries most of the energy of the jet. We make associations between the leading hadron and other tracks.

Di-hadron Correlation

Introduction

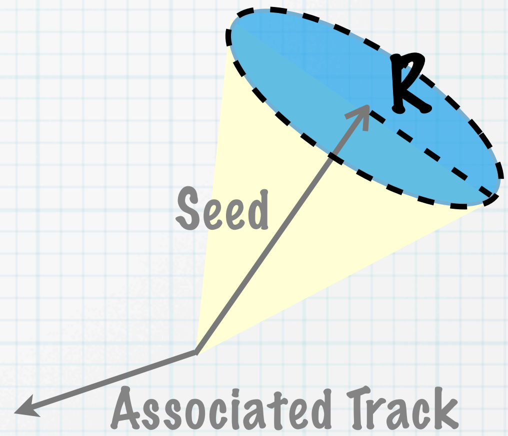
- Using Di-hadron correlations we try to measure fragmentation functions - parameterizing how partons become confined hadrons
- Fragmentation function D(z) depends on z defined as $p_T/E_{T,jet}$
- Because we assume $p_T(trig) \approx E_T(jet)$ the current method of Di-hadron correlation has limited sensitivity to true fragmentation functions
- We may be able to better constrain $E_{T,jet} \sim p_{T(trig)}$ with a multi-hadron trigger



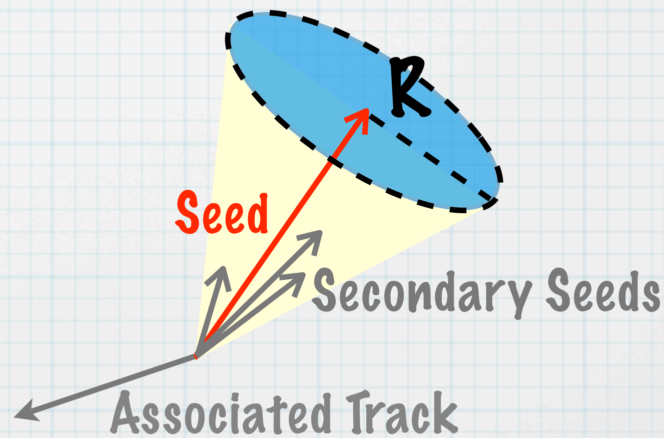
STAR, Phys. Rev. Let. 97 (2006) 162301

Analysis Technique

- Collect all seed tracks $p_T > 5.0$ GeV
- Collect all "secondary seeds" with $p_T > 2, 3, 4$ GeV/c
- Cone $R=(\Delta\eta^2 + \Delta\phi^2)^{1/2}$ centered on each seed track
- Trigger p_T = sum of all associated tracks and secondary seeds in cone
- Study recoil (away-side) associated yield relative to highest trigger cluster in event
- Background estimate: uniform in $\Delta\phi$, normalize with ZYAM



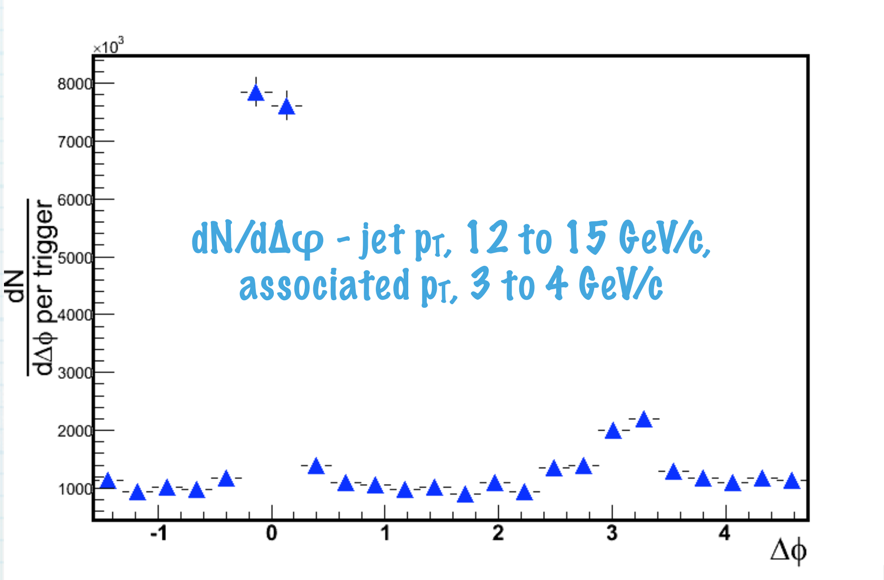
Di-hadron Correlation

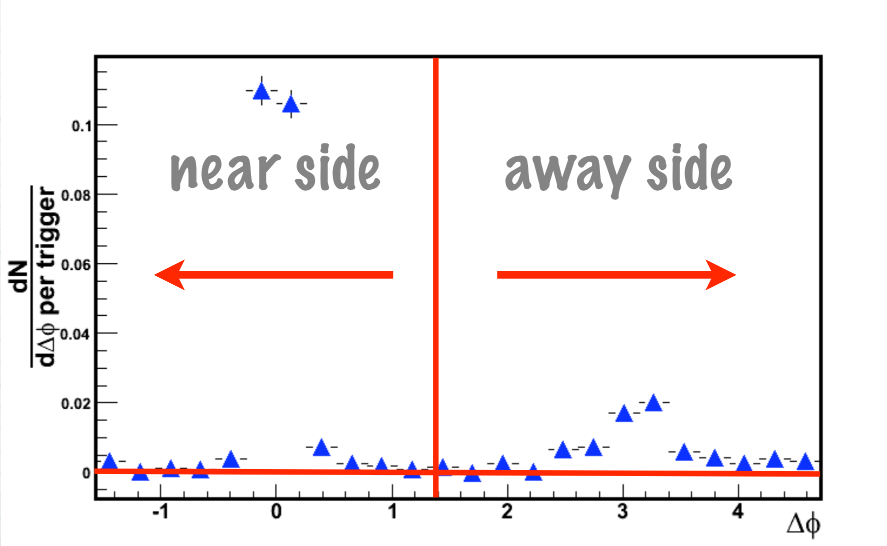


Multi-hadron Correlation

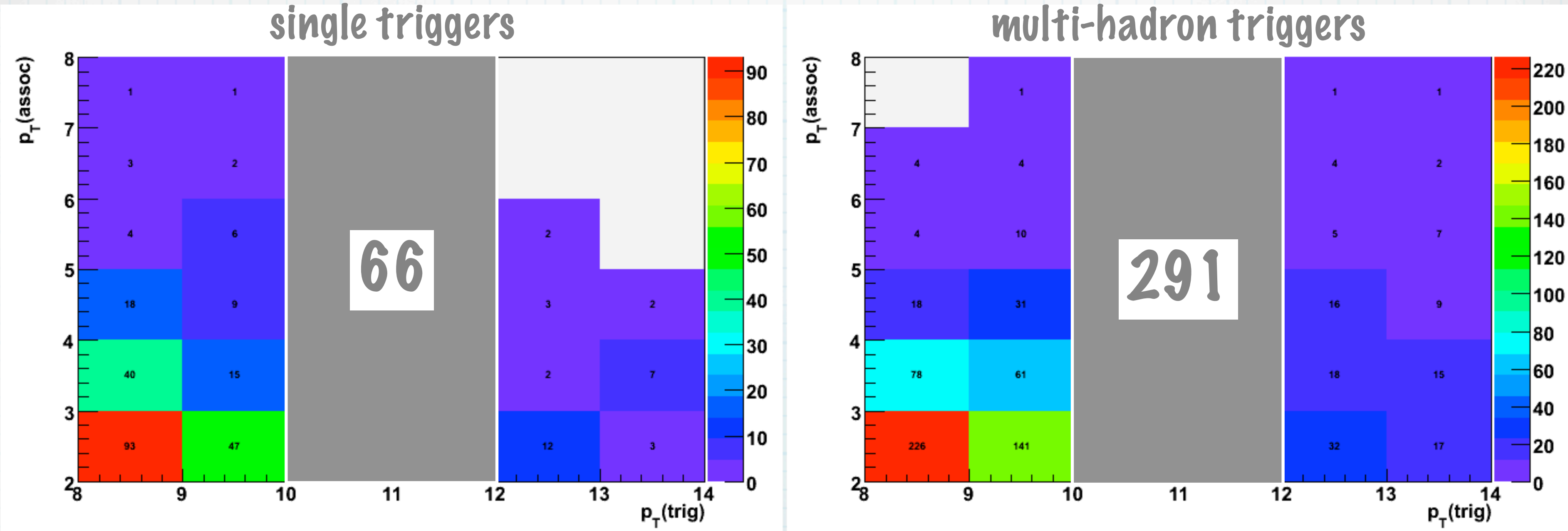
Analysis Technique - cont'd

- Study recoil (away-side) associated yield relative to highest trigger cluster in event
- Background estimate: uniform in $\Delta\phi$, normalize with ZYAM
- Yields extracted for p_T (trig)
  - 10 to 12 GeV/c
  - 12 to 15 GeV/c
  - 15 to 18 GeV/c
- p_T (assoc)
  - 3 to 4, ... 10 to 11 GeV/c



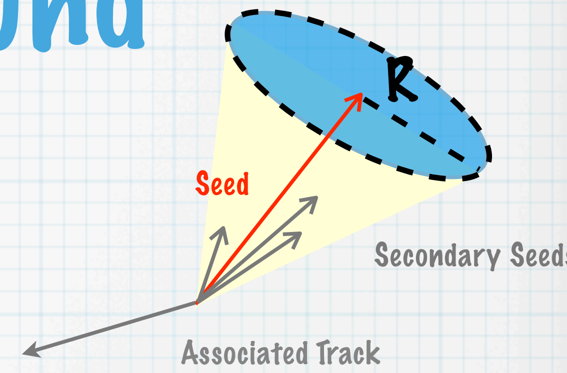


Comparison of single vs. multi-hadron trigger statistics - dAu

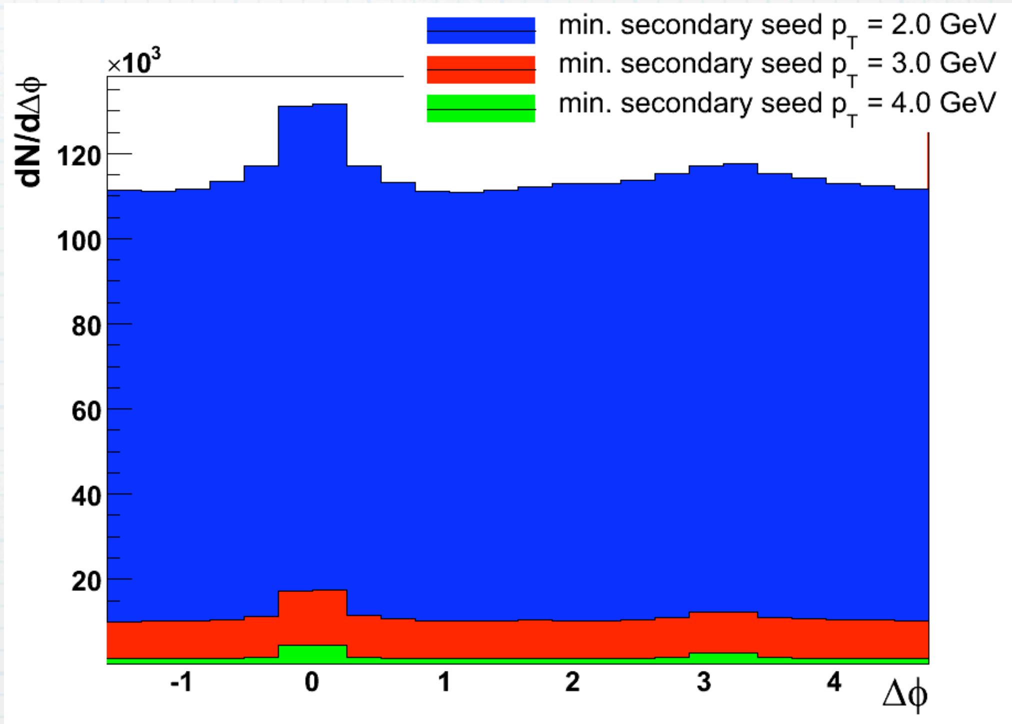


* allowing clusters add up to p_T(trig), not just requiring a single particle to carry p_T(trig) --> more triggers
* Important to note that Multi-hadron correlations reach into lower region of jet p_T as compared to Di-hadron analysis
  * a 10 GeV Di-hadron trigger = a 10 GeV hadron
  * a 10 GeV Multi-hadron trigger = 8 + 2 GeV, or 5+3+2 GeV, or ...

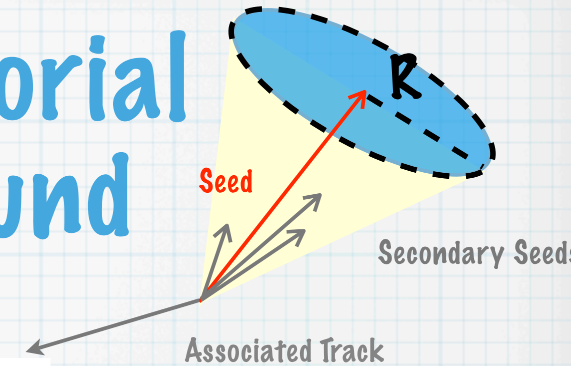
Combinatorial Background



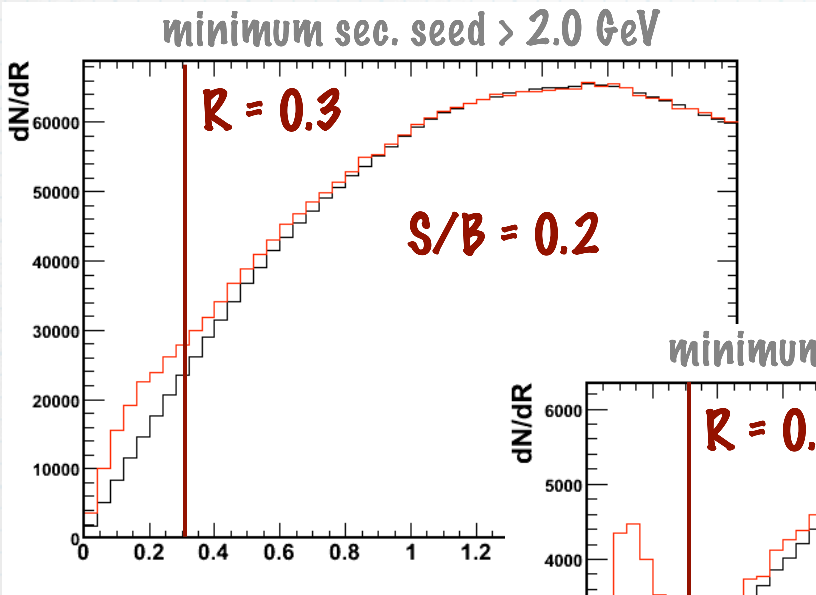
* random combinations occur in the multi-hadron algorightm
* p_T seed > 5.0 GeV/c
  * we vary the minimum secondary seed p_T to test the effect of combinatorial background in Au+Au

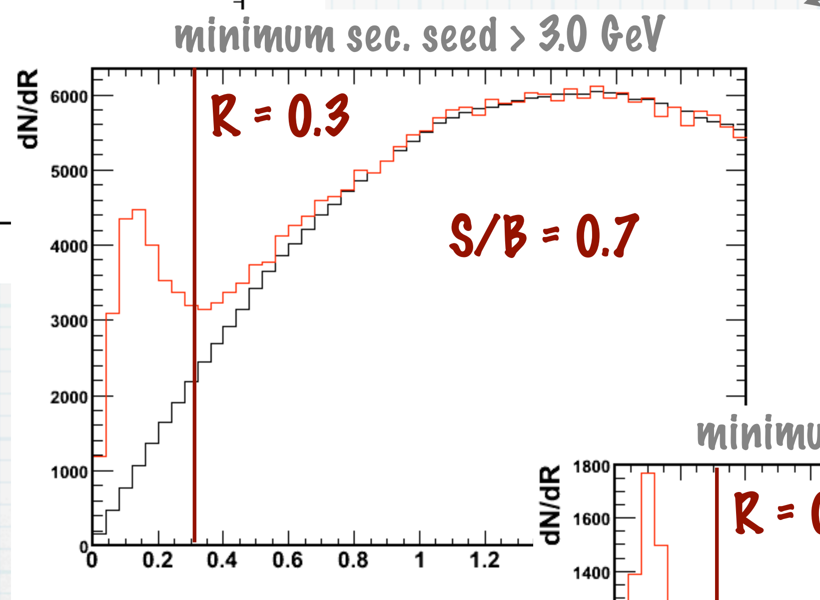


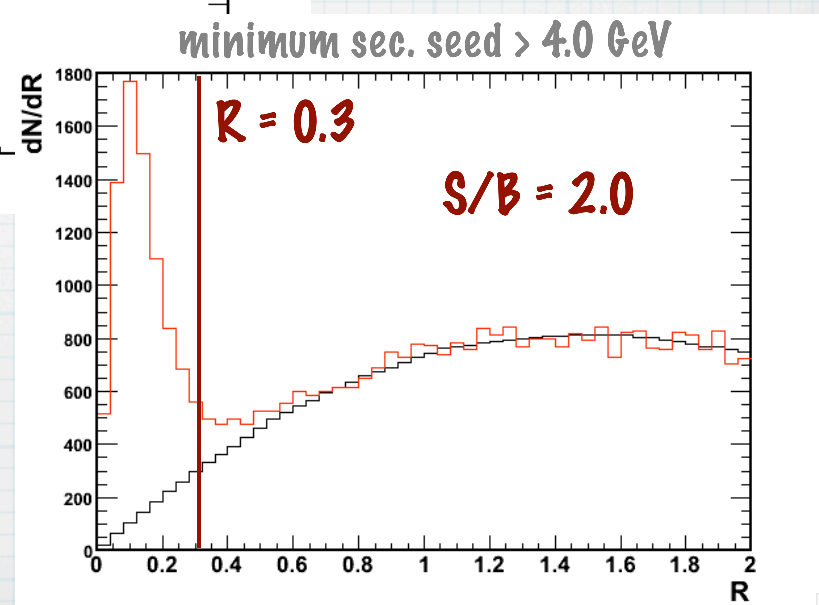
Combinatorial Background



* red = signal
* black = untriggered background



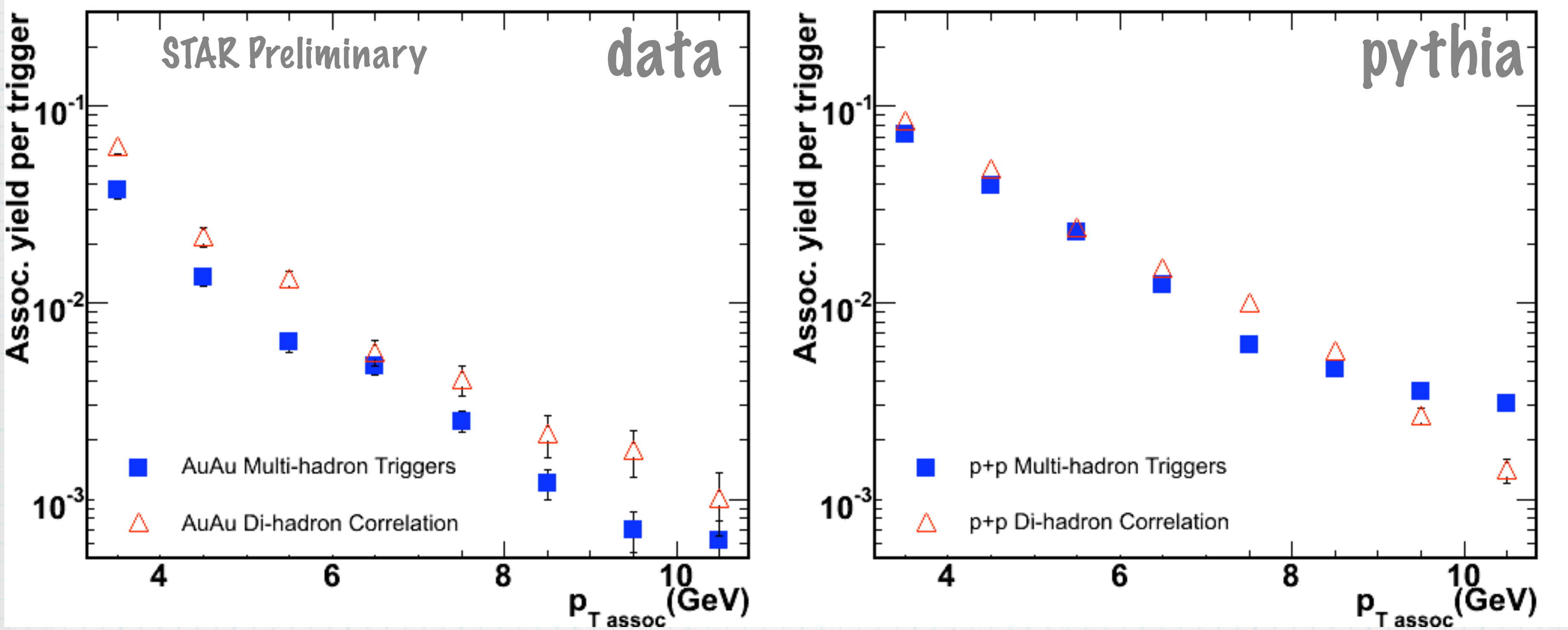




* R is defined between the multi-hadron trigger and associated track
* for background estimate, R is defined between a multi-hadron trigger and associated track from another event

Away Side Yields: 10 GeV/c < p_T(trig) < 12 GeV/c

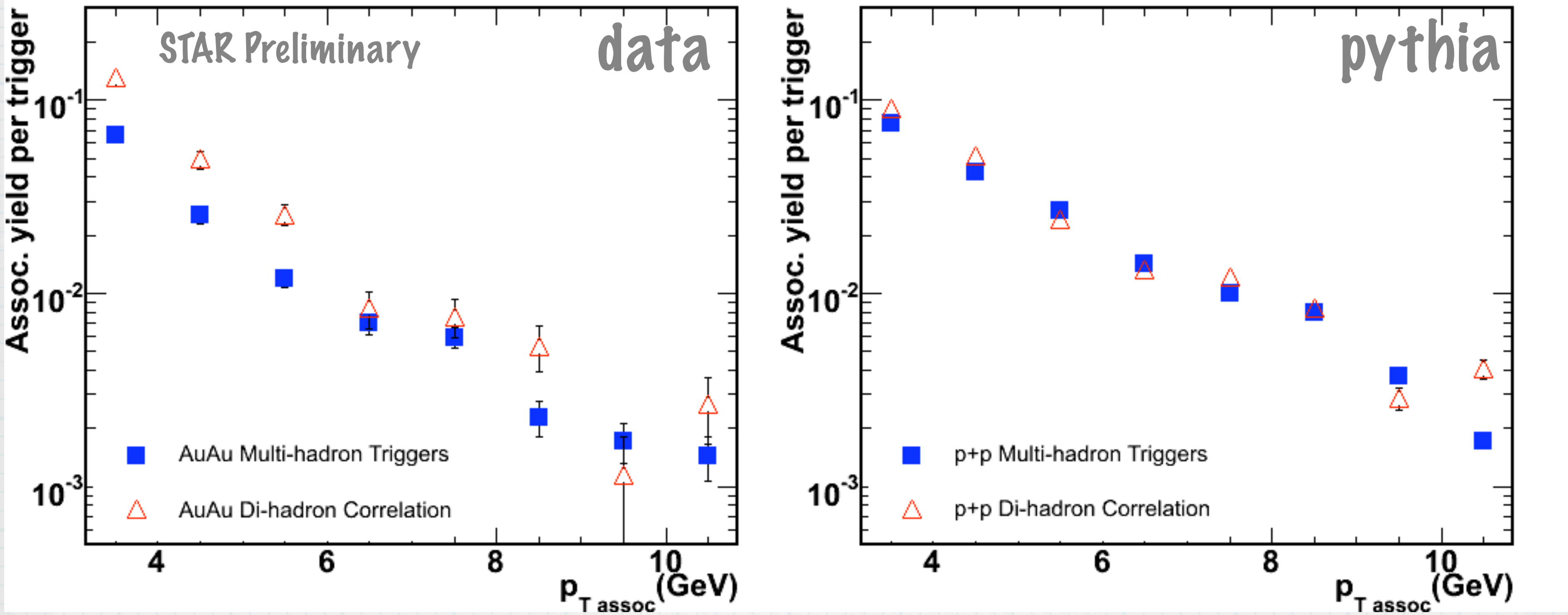
Min. sec. seed cut = 2.0 GeV



* Data : Multi-hadrons are below Di-hadrons, likely due to the effect of random clusters bringing down the yield
* Pythia: Multi-hadrons largely match Di-hadrons

Away Side Yields: 12 GeV/c < p_T(trig) < 15 GeV/c

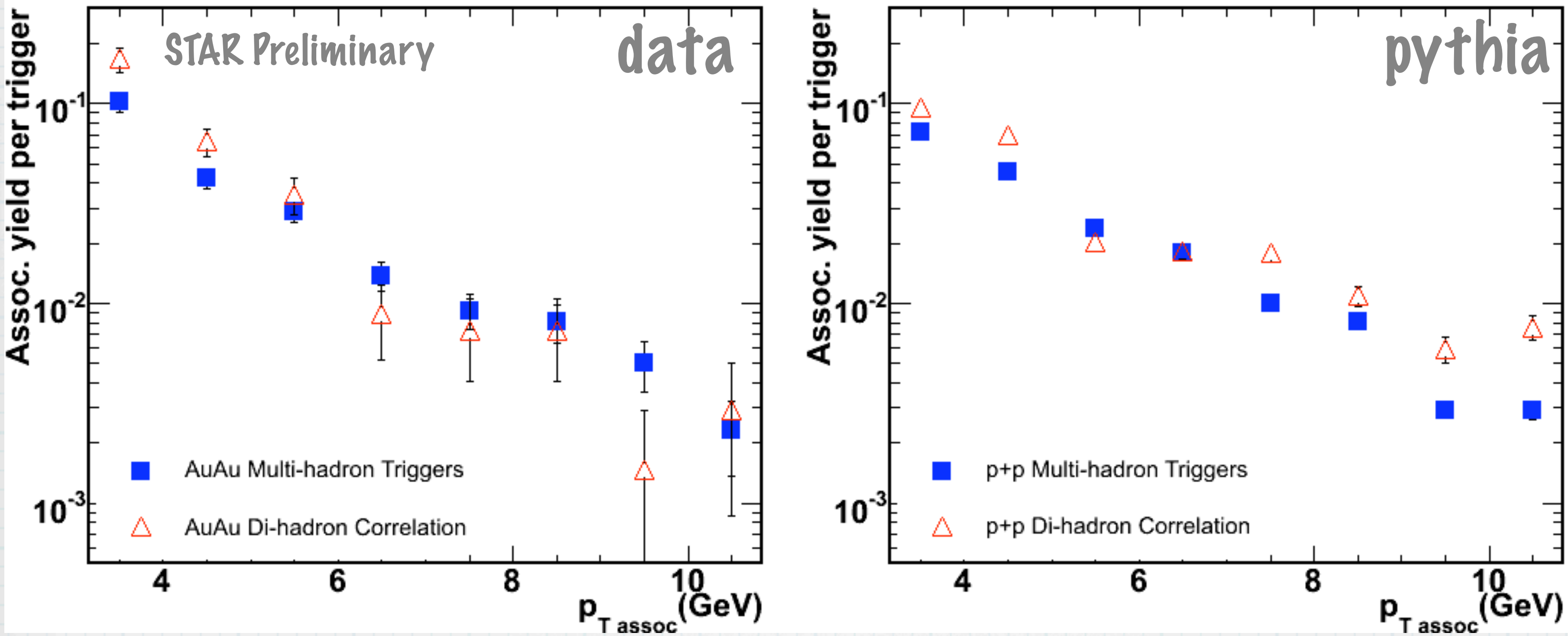
Min. sec. seed cut = 2.0 GeV



* Even with an increase in p_T(trig)
  * Data : Multi-hadrons are below Di-hadrons - random clusters
  * Pythia: Not much change; Multi-hadrons continue to match Di-hadrons

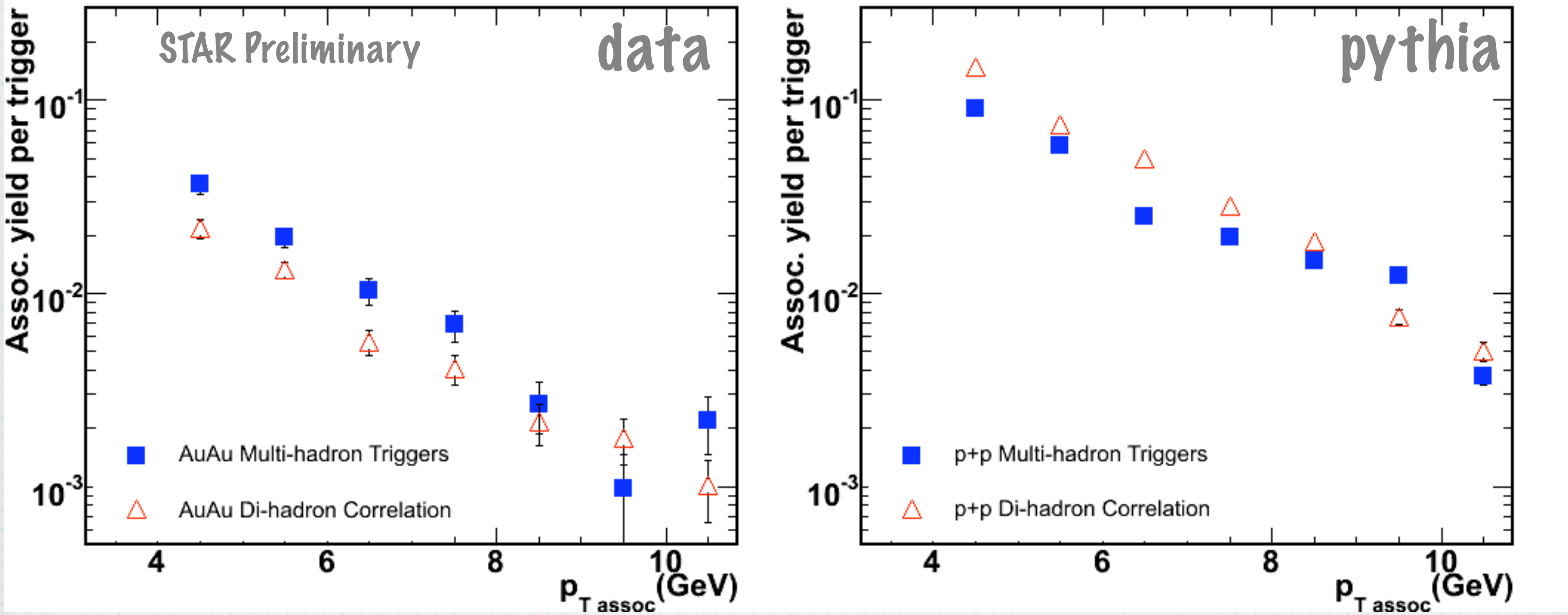
Away Side Yields: 15 GeV/c < p_T(trig) < 18 GeV/c

Min. sec. seed cut = 2.0 GeV



* A further increase in p_T(trig):
  * Data : Multi-hadrons move up and toward Di-hadrons, because of the higher trigger pT we see less random triggers
  * Pythia: Not much change; Di-hadrons fall slightly above Multi-hadrons

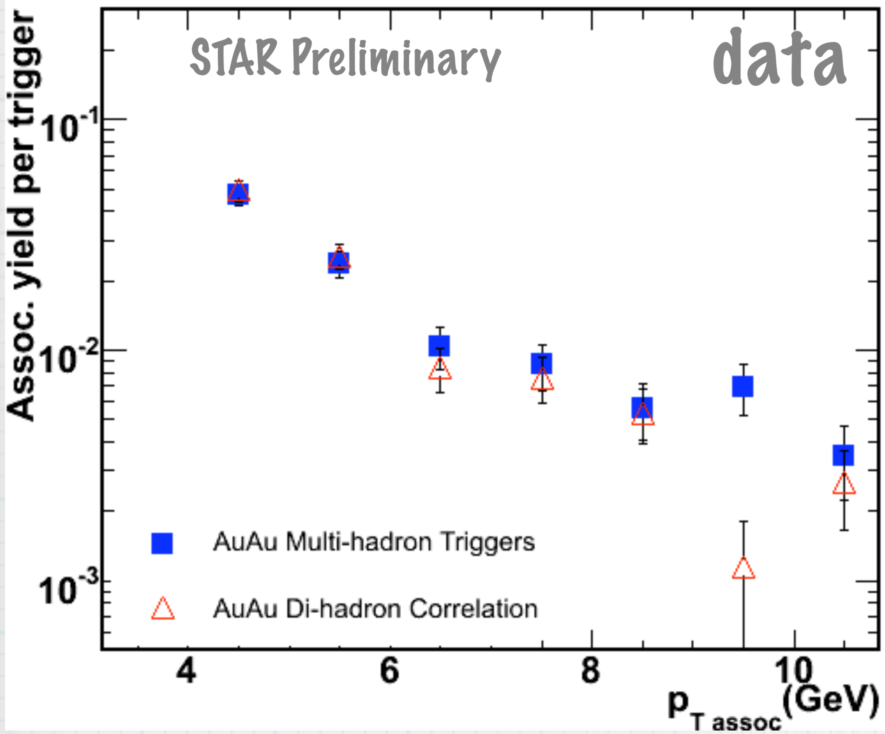
Away Side Yields: 10 GeV/c < p_T(trig) < 12 GeV/c
Min. sec. seed cut = 4.0 GeV

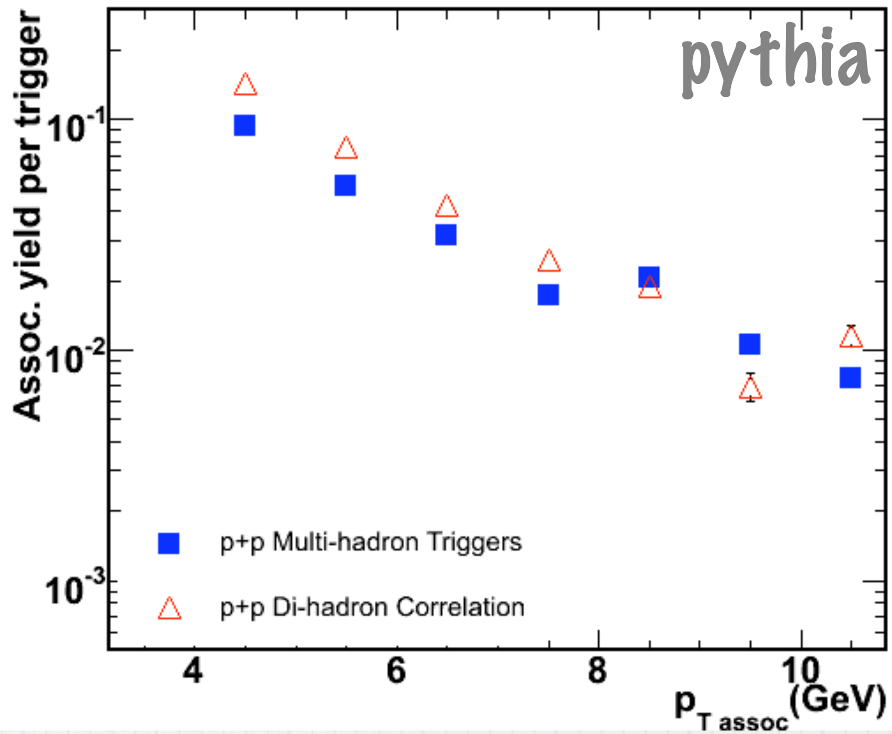


* Data : Di-hadrons are below Multi-hadrons, in the Multi-hadrons we should be seeing mostly real jet triggers because of the minimum secondary seed cut of 4.0 GeV/c
* Pythia: Multi-hadrons fall slightly above Di-hadrons

Away Side Yields: 12 GeV/c < p_T(trig) < 15 GeV/c

Min. sec. seed cut = 4.0 GeV

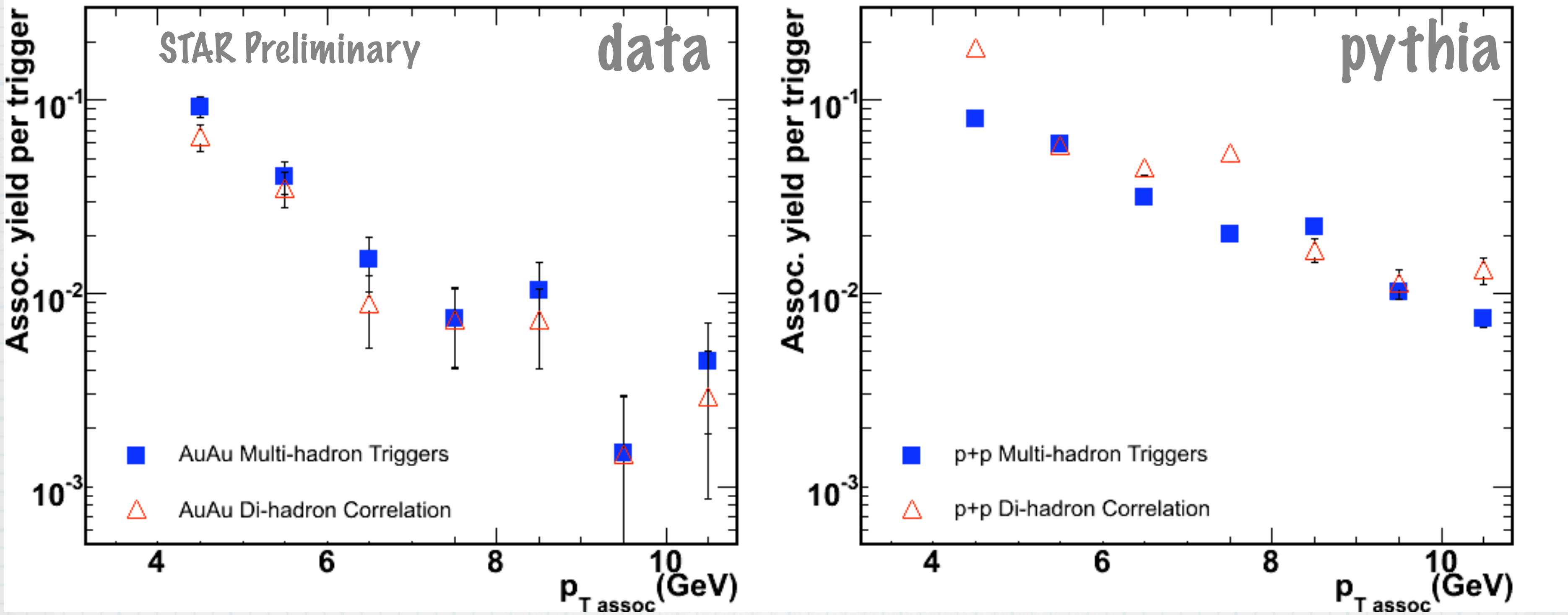




- With an increase in p_T(trig)
  - Data : Di-hadrons move up to meet Multi-hadrons - pretty good matching
  - Pythia: Not much change

Away Side Yields: 15 GeV/c < p_T(trig) < 18 GeV/c

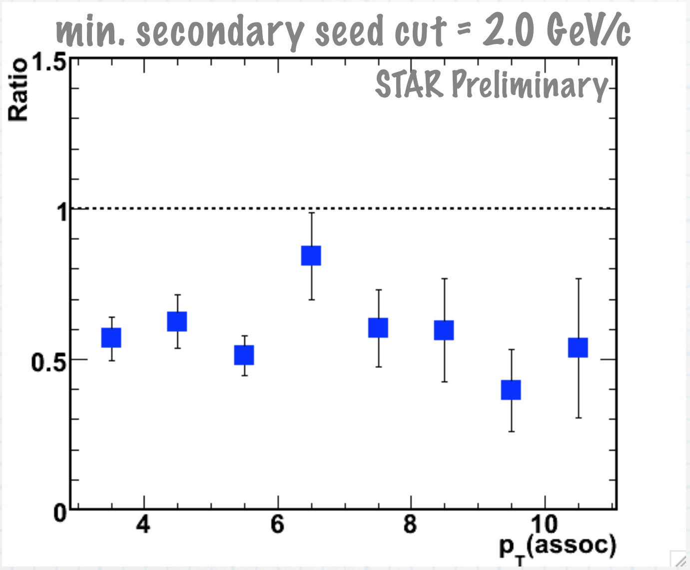
Min. sec. seed cut = 4.0 GeV

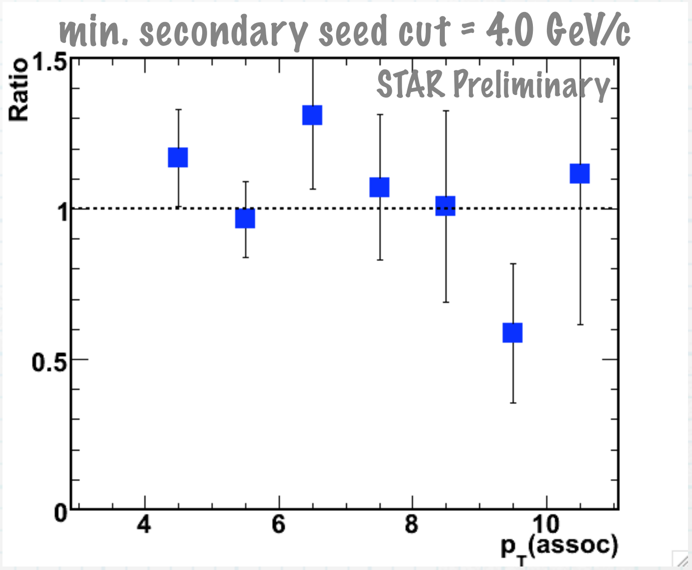


* A further increase in p_T(trig):
  * Data : Statistics are not as good, but still relatively good matching between Multi-hadrons and Di-hadrons
  * Pythia: Not much change in Multi-hadrons, Di-hadrons scatter slightly

Ratios: Single+Multi-hadron Away Side Yield to Di-hadron Away Side Yield

- 10 GeV/c < p_T (trig) < 12 GeV/c -

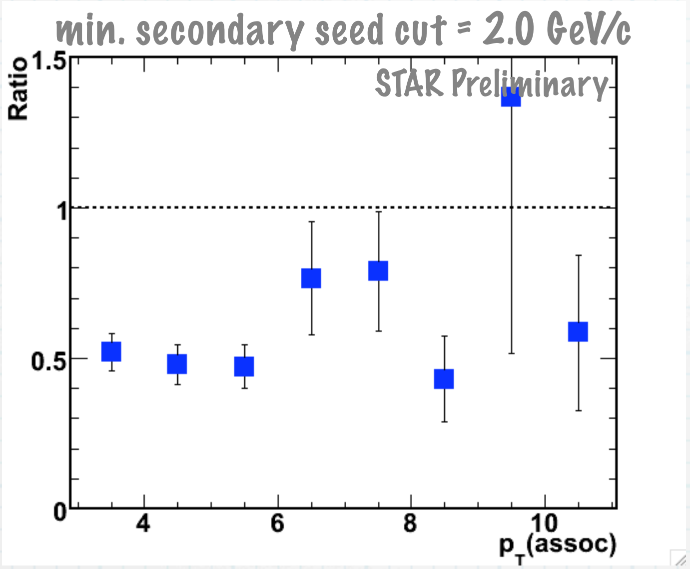


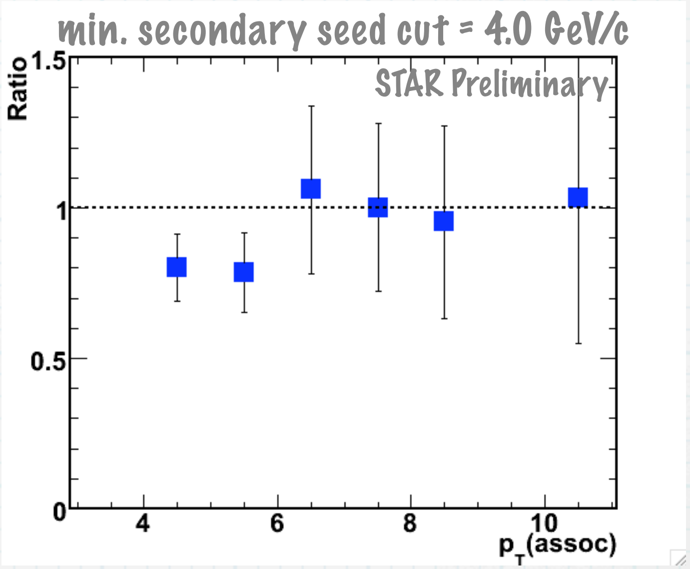


* Ratios (statistical errors only) fall around unity and are relatively flat.
    * For a minimum secondary seed cut of 2.0 GeV random clusters pull the ratio down. For a minimum secondary seed cut of 4.0 GeV, the ratio is close to unity, there are much less random Multi-hadron triggers, so the ratio falls even closer to unity.
* The single+multi-hadron triggers sample same kinematics as di-hadron correlations

Ratios: Single+Multi-hadron Away Side Yield to Di-hadron Away Side Yield

- 12 GeV/c < p_T (trig) < 15 GeV/c -



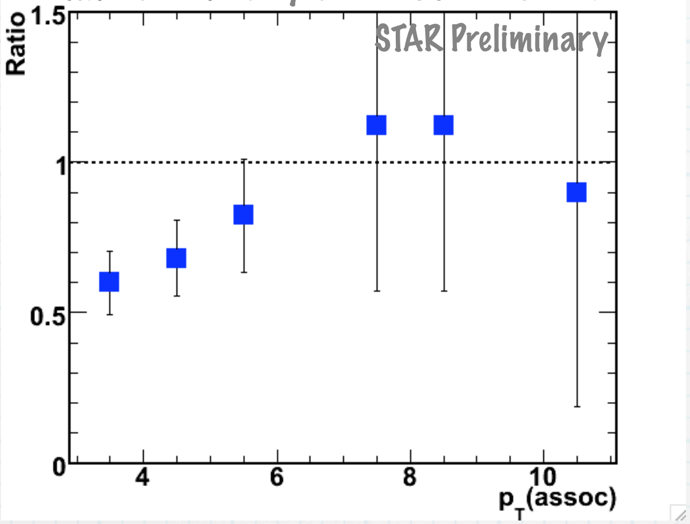


* Ratios (statistical errors only) fall around unity and are relatively flat.
    * Even with a higher p_T bin, with a minimum secondary seed cut of 2.0 GeV random clusters pull the ratio down. With a minimum secondary seed cut of 4.0 GeV, the ratio is still close to unity.
* The single+multi-hadron triggers sample same kinematics as di-hadron correlations

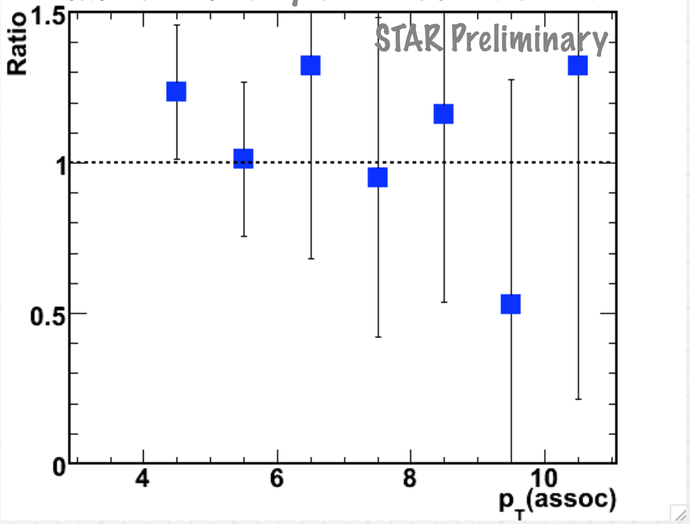
Ratios: Single+Multi-hadron Away Side Yield to Di-hadron Away Side Yield

- 15 GeV/c < p_T (trig) < 18 GeV/c -

min. secondary seed cut = 2.0 GeV/c



min. secondary seed cut = 4.0 GeV/c



- With an even higher p_T bin, the ratio with a minimum secondary seed cut of 2.0 GeV begins to fall more around unity. Though statistics are not as good, we see with a minimum secondary seed cut of 4.0 GeV, the ratio is still close to unity.

- The single+multi-hadron triggers sample same kinematics as di-hadron correlations

Conclusions and Outlook

* We have investigated Multi-hadron triggers as the next step toward full jet reconstruction ...
  * We see that a cone radius of ~ 0.3 and a minimum secondary seed cut of 4.0 GeV maximizes the signal to background ratio
  * The yields on the away side for Multi-hadron correlations are consistent with the yields observed via Di-hadron measurements
  * Multi-hadron trigger correlations extend di-hadron correlation measurements to a lower z_T range
* Method is promising, more work is needed
  * Calculate corrected yield with an estimate of the background cluster yield
  * Look at Multi-hadron triggers in other systems: p+p, d+Au

BACKUP SLIDES