The inclusive jet cross-section measurement at $\sqrt{s}$=200 GeV p+p collisions at STAR

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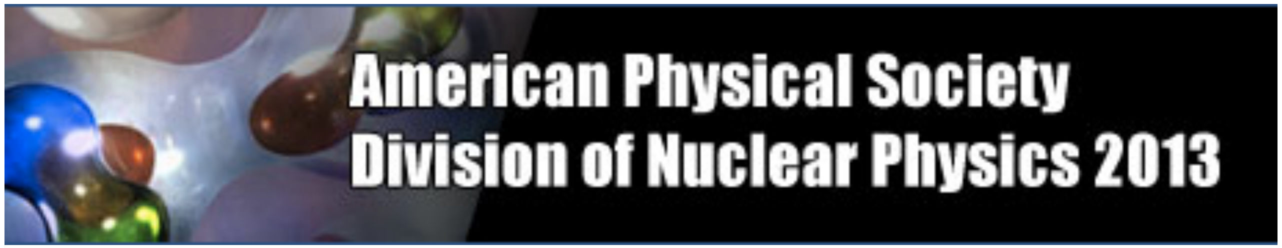
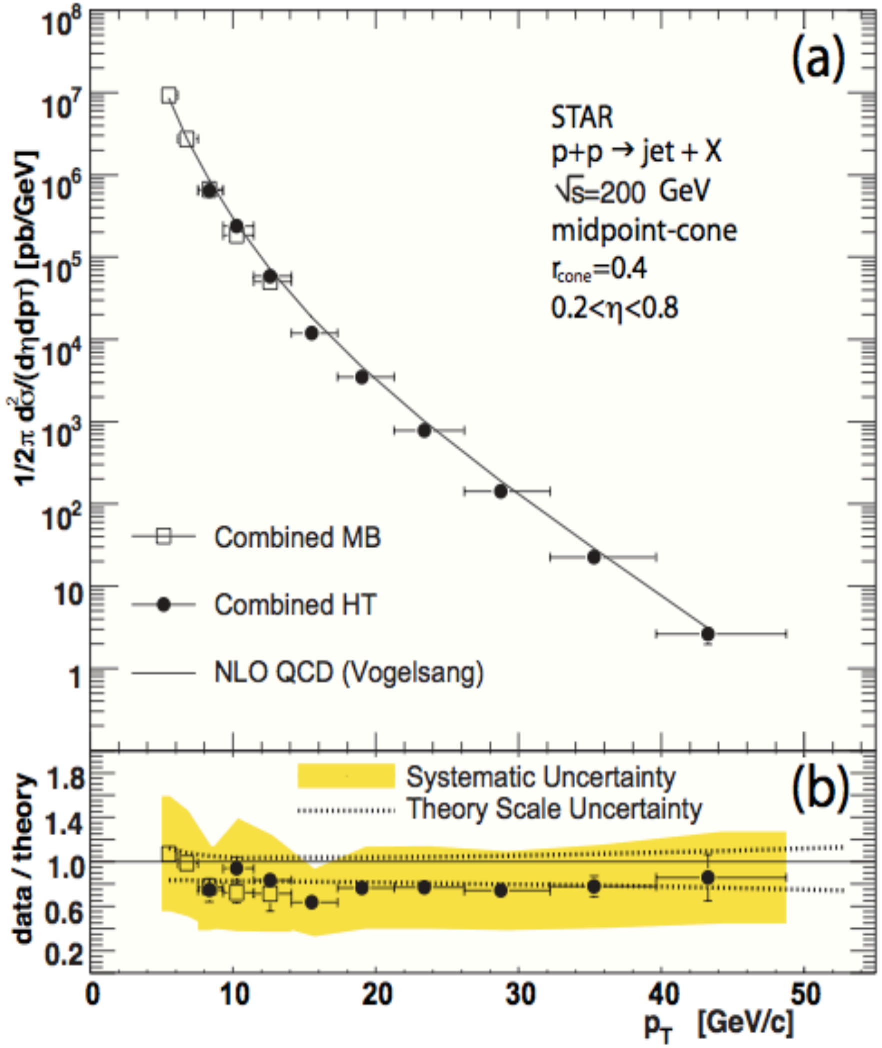
(Temple University)



Motivation

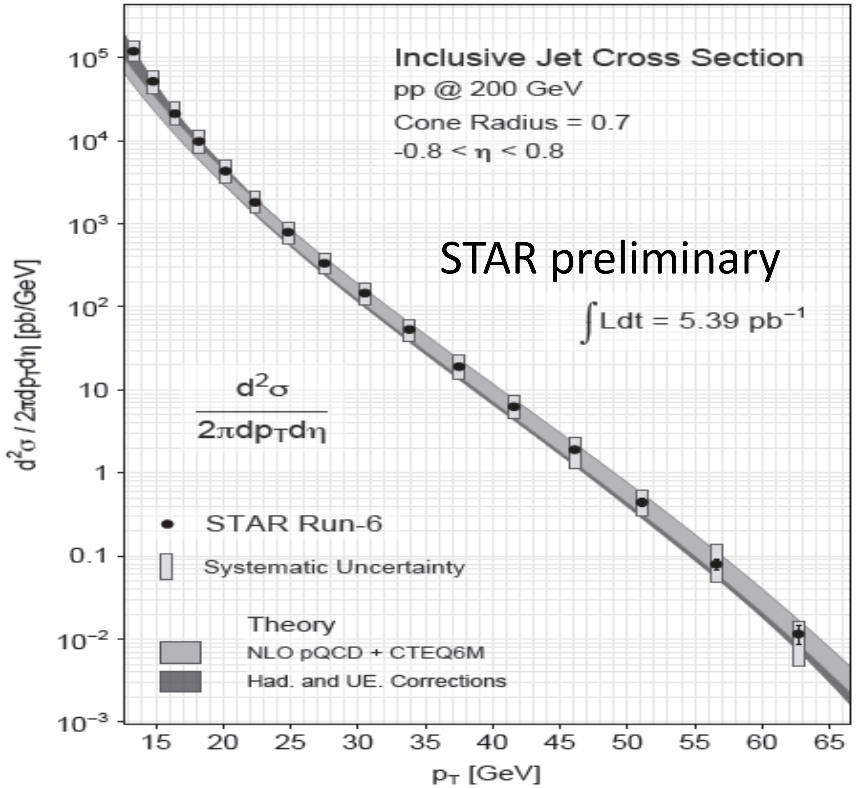
- The inclusive jet cross section measurement is one of the fundamental observables to test QCD.
- Understand the jet energy scale as well as trigger and detector efficiencies for the inclusive jet longitudinal double spin asymmetry A_{LL} measurement.
- Previous measurements:
  - Limited acceptance (half detector installed, now we have full detector).
  - No corrections for the underlying event (UE, energy due to beam beam remnants, soft spectator interaction and multiple parton scattering)/hadronization (partons fragment into hadrons) contributions.

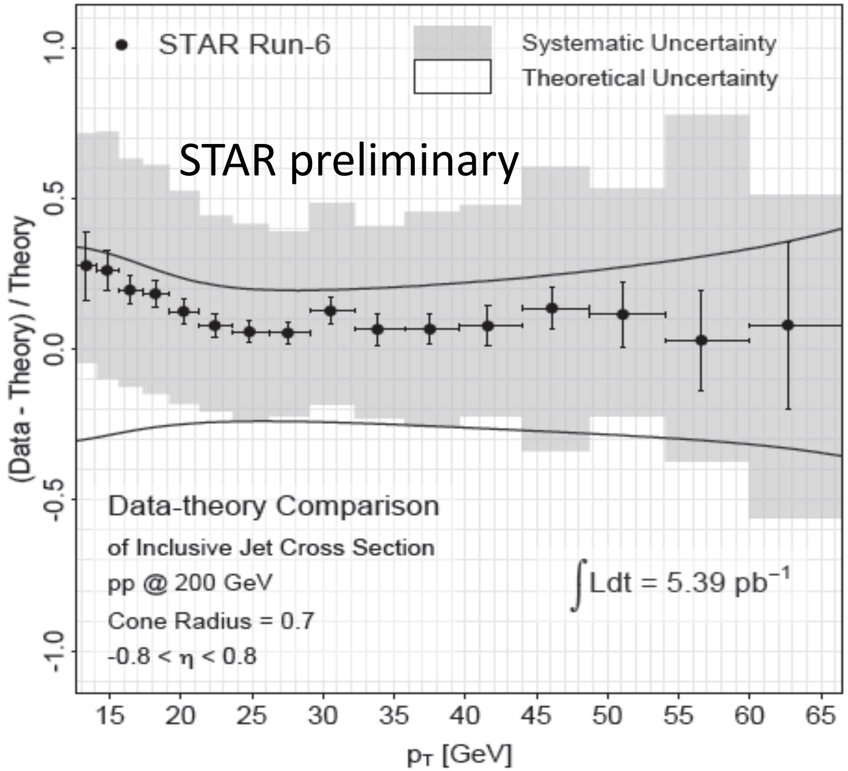
Phys.Rev.Lett.97:252001



Analysis goal

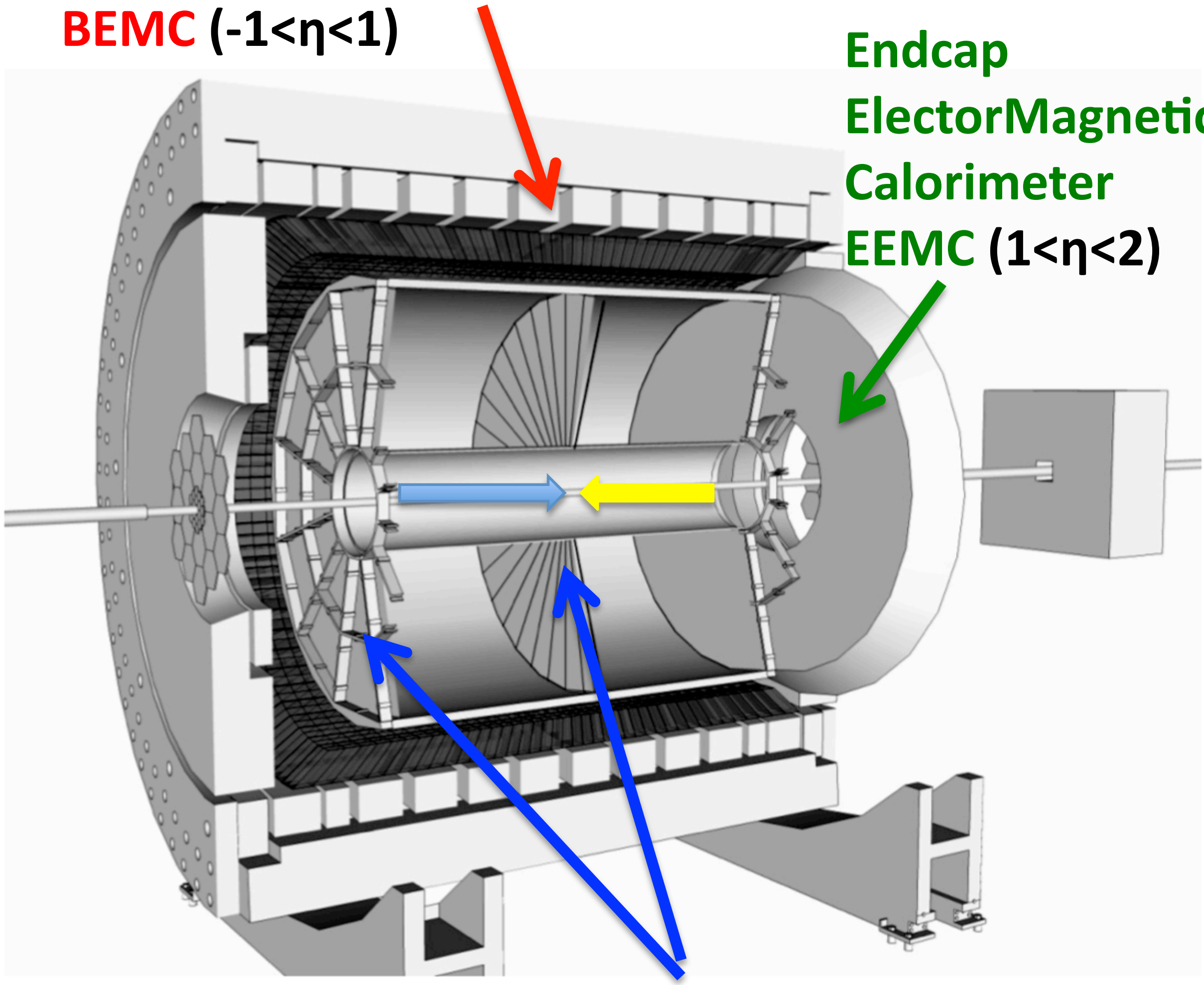
- The 2006 inclusive jet cross section preliminary results only used midpoint cone algorithm.





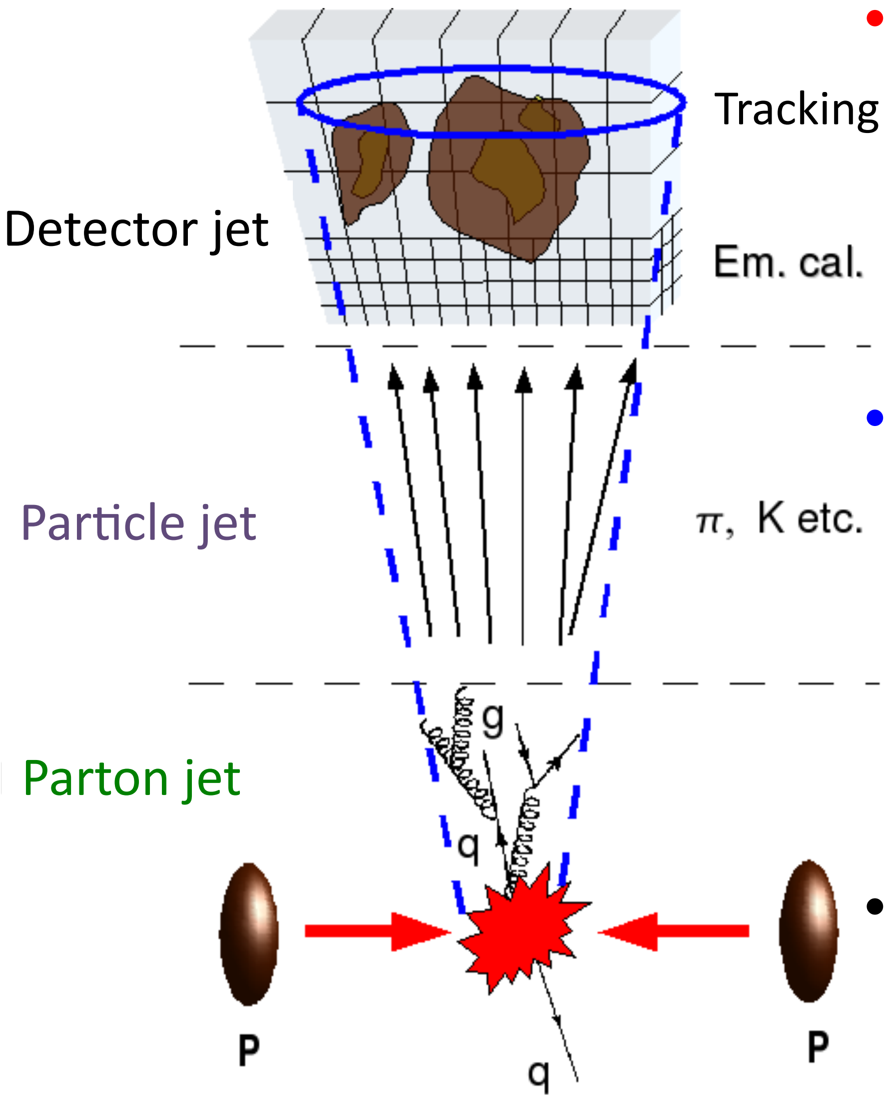
- In addition to cone algorithm, apply with anti-k_t algorithm (less UE contribution and pileup leading to less systematical errors) for the 2009 inclusive jet cross section (for $|\eta|<1$, $|\eta|<0.5$ and $0.5<|\eta|<1$) similar to inclusive jet A_{LL} analysis in 2009 (see Zilong Chang's talk).

STAR detector



- STAR calorimetry has nearly full azimuthal coverage in pseudo rapidity region [-1,4].
- In 2009, STAR has |η|<1.3 tracking capability.
- For mid-rapidity jet reconstruction: TPC, BEMC and EEMC are used.
- STAR collected 25 pb^{-1} luminosity of data for 2009 200GeV pp collisions. 20.9±1.6pb^{-1} is used for inclusive jet analysis.

Jet algorithms

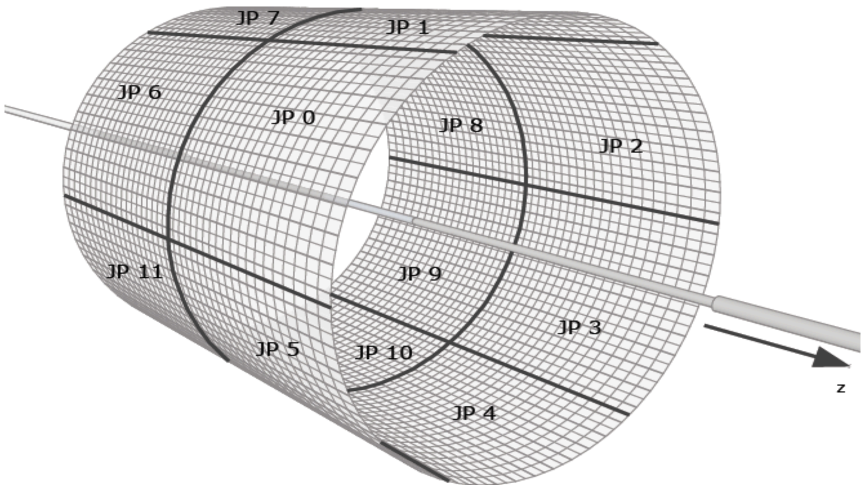


- Midpoint Cone algorithm[aXiv:hep-exp/0005012]:
  - Collect towers+tracks within a cone of radius ($R=\sqrt{\Delta\eta^2+\Delta\phi^2}$) 0.7.
  - Split/Merge fraction 0.5.
- Anti-k_T algorithm[JHEP 0804:063,2008]:
  - $d_{ij} = \min(\frac{1}{k_{T,i}^2}, \frac{1}{k_{T,j}^2}) \frac{\Delta_{ij}^2}{R^2}$ $\quad \Delta_{ij}^2 = (y_i - y_j)^2 + (\varphi_i - \varphi_j)^2$
  - Collect towers+tracks based on particle $1/k_{T,i}^2$. Select R=0.6.
  - less UE and pile up.
  - Infrared and collinear safe.
- Apply both jet algorithms on detector, particle and parton jet in data and embedding.

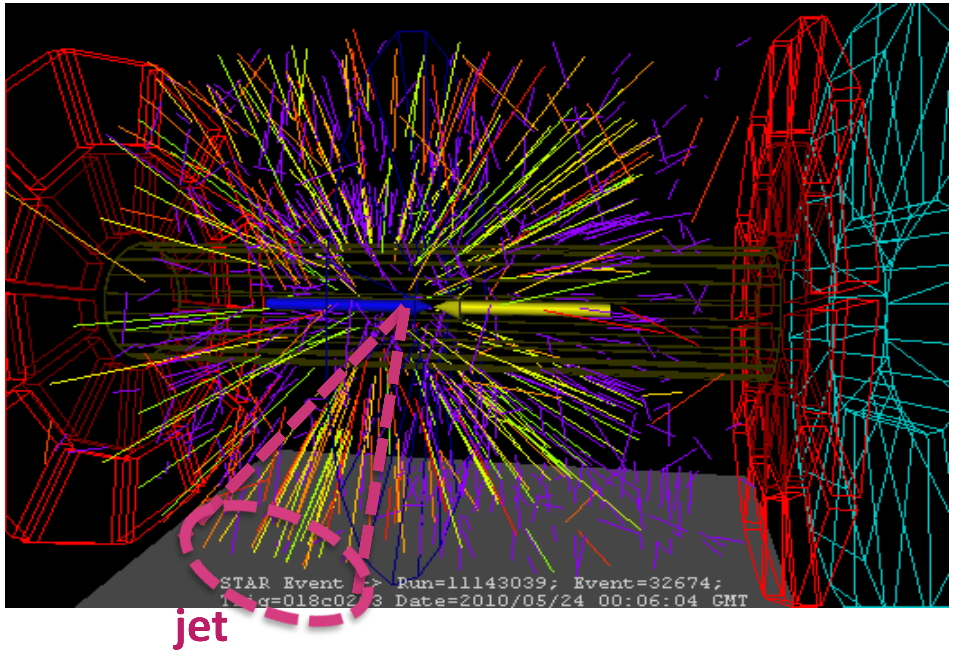
Embedding: simulation (PYTHIA 6.426 with Perugia 320 + GEANT) embedded with zero bias data events.

Triggers and cuts

BEMC jet patch mapping



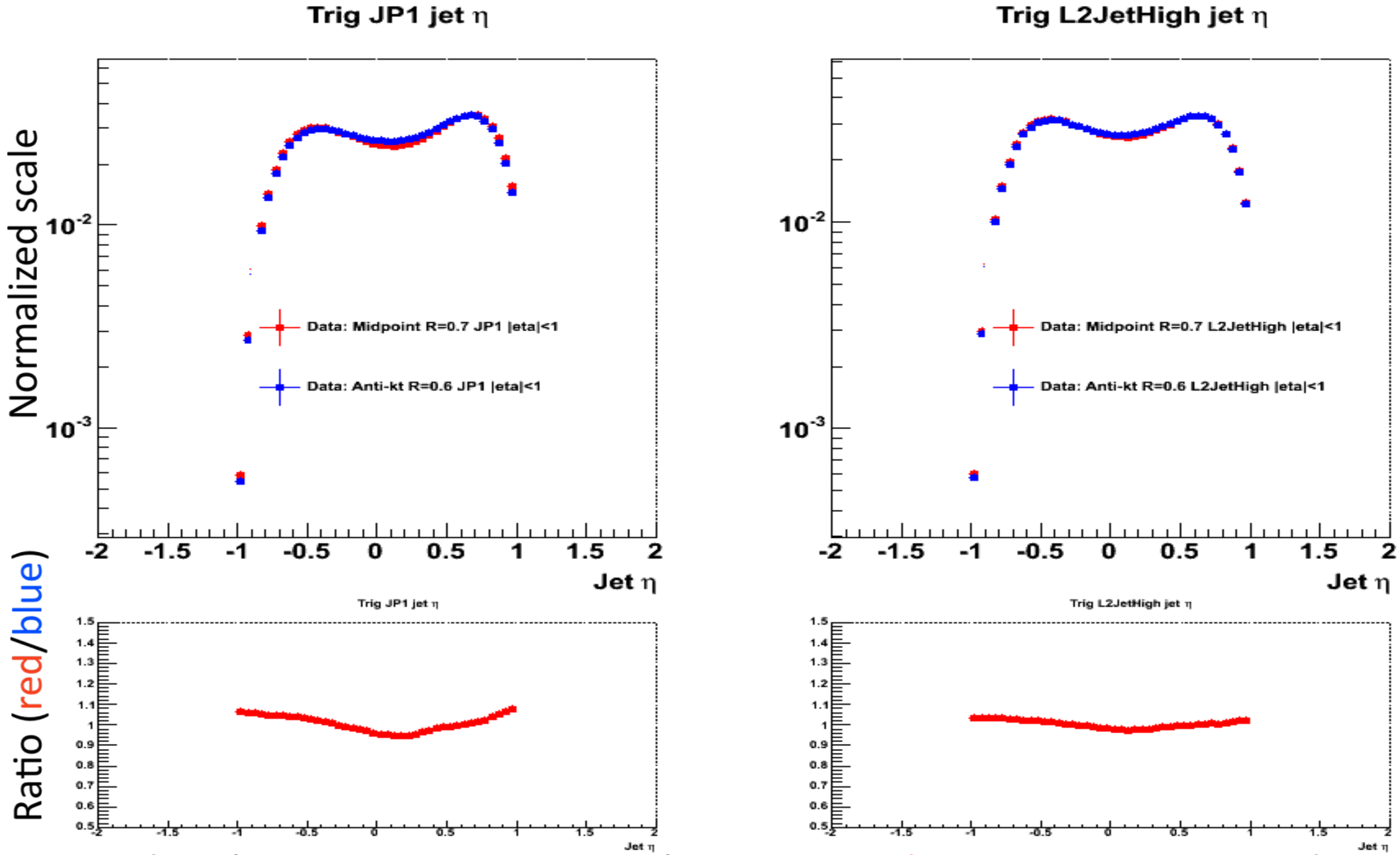
Event display of jet



- Triggers for inclusive jet:
  - 30 BEMC, EEMC jet patches are used for jet triggers.
  - JP1: L0 trigger require jet patch E_T>5.4GeV/c.
  - L2JetHigh: based on L0 trigger, level 2 algorithm looks for jet in calorimeter only (no tracking info). JP E_T>6.5GeV/c + 10% random accept.
- Event cuts
  - z vertex: $|z_{vert}| < 90$cm.
- Jet cuts
  - (1) jet $p_T > 6$GeV/c
  - (2) neutral energy fraction $R_T < 0.94$
  - (3) Σ(tracks p_T) > 0.5GeV/c
  - (4) -0.7 < detector η < 0.9
  - (6) Jet must point toward a triggered Jet Patch or Adjacent Jet Patch.

Jet η comparison with different algorithms (Data)

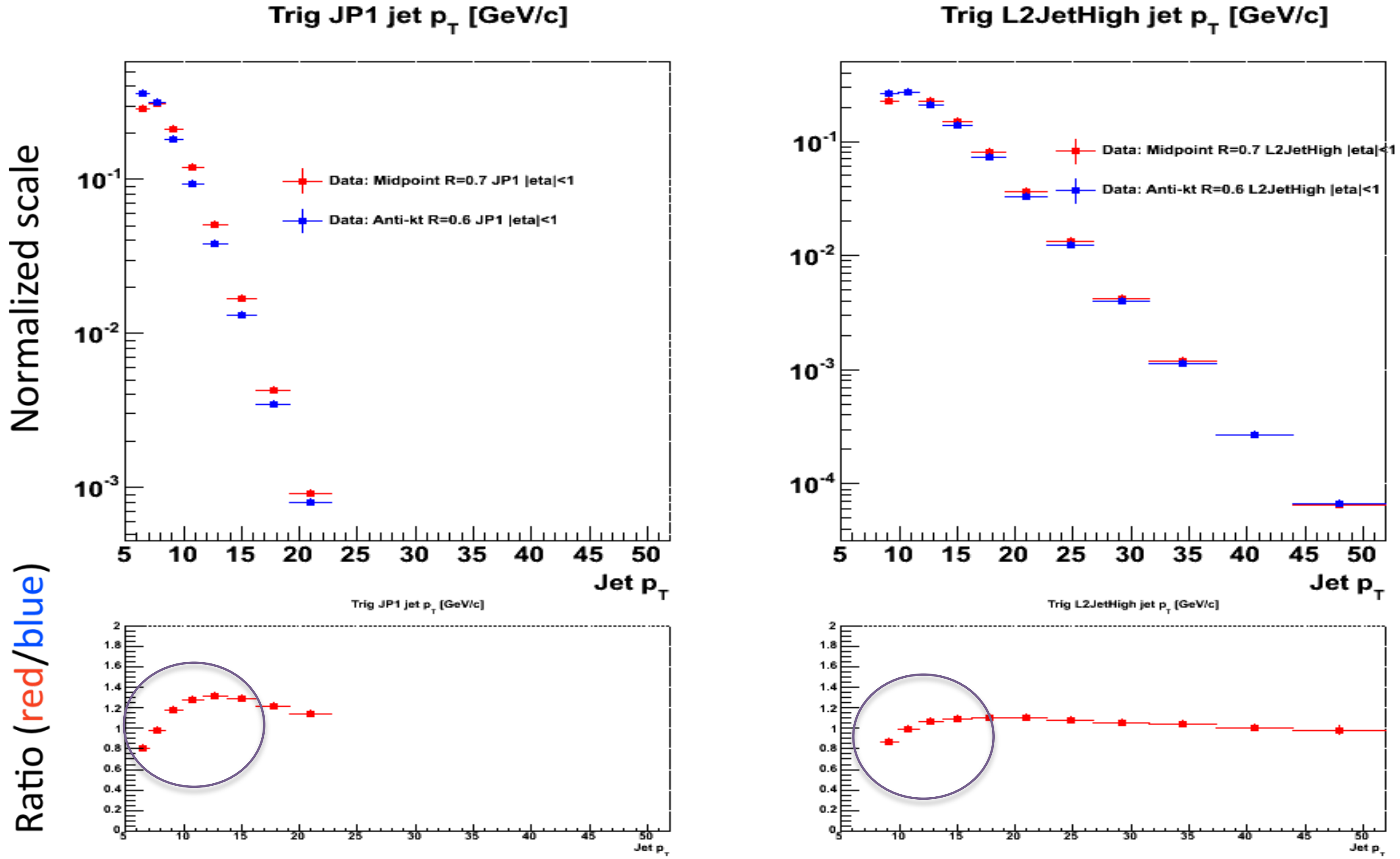
- Jet η with Midpoint cone R=0.7 and anti-k_T R=0.6 in data.
- JP1 jet $p_T > 6.0$GeV/c (left) and L2JetHigh jet $p_T > 8.4$GeV/c (right).



- Jet η distributions are consistent between Midpoint cone R=0.7 and anti-k_T R=0.6 algorithms.

Jet p_T comparison with different algorithms (Data)

- Jet p_T with Midpoint cone R=0.7 and anti-k_T R=0.6 in data.
- JP1 jet p_T > 6.0GeV/c (left) and L2JetHigh jet p_T > 8.4GeV/c (right).



- The ratios of Jet p_T in the Midpoint cone R=0.7 over that in the anti-k_T R=0.6 indicate different underlying event contribution with different algorithms.

Jet η comparison with different algorithms (Embedding)

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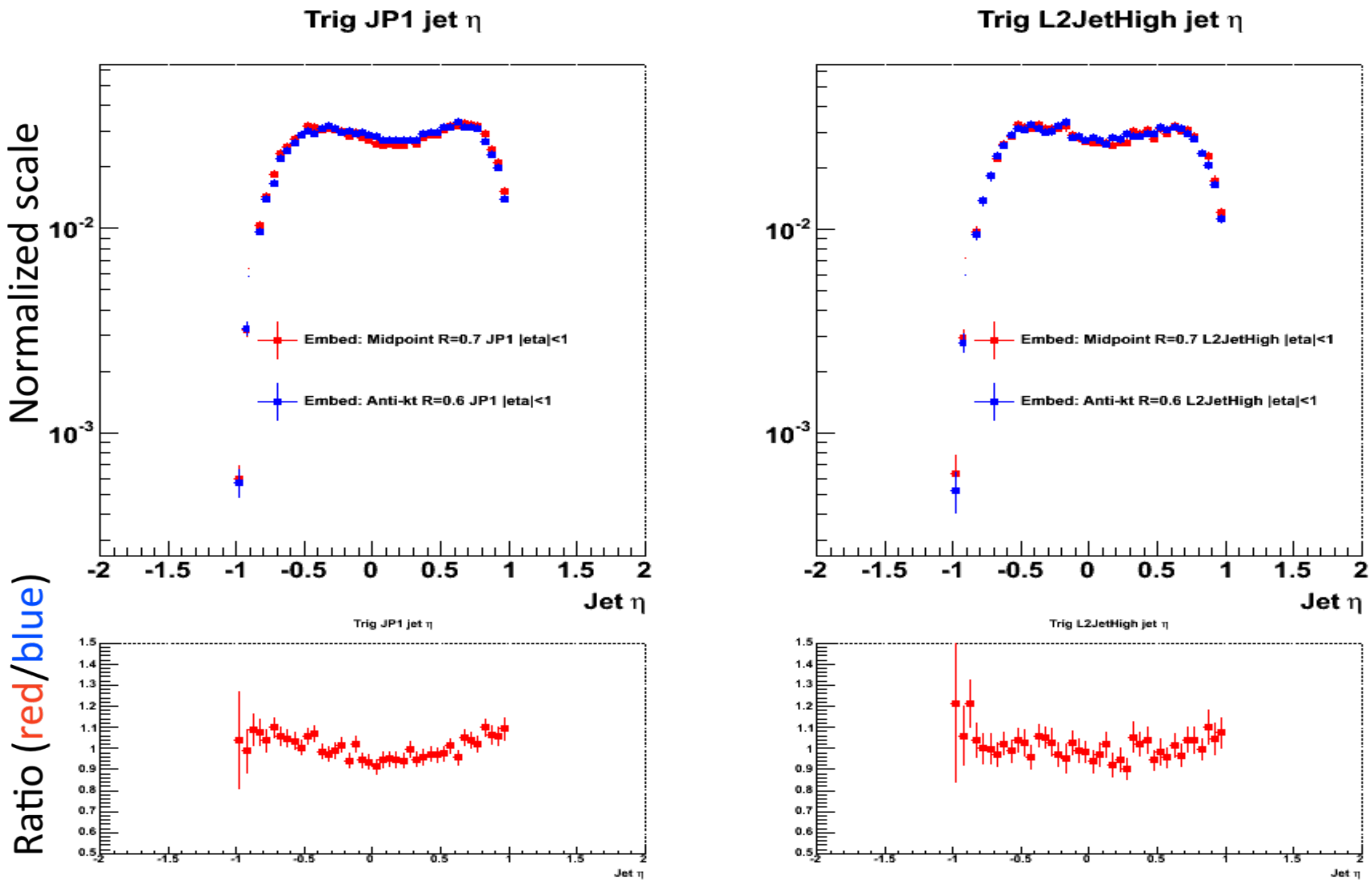

- Like results in data, jet η distributions are consistent between Midpoint cone R=0.7 and anti-k_T R=0.6 algorithms.

Jet p_T comparison with different algorithms (Embedding)

- Jet p_T with Midpoint cone R=0.7 and anti-k_T R=0.6 in data.
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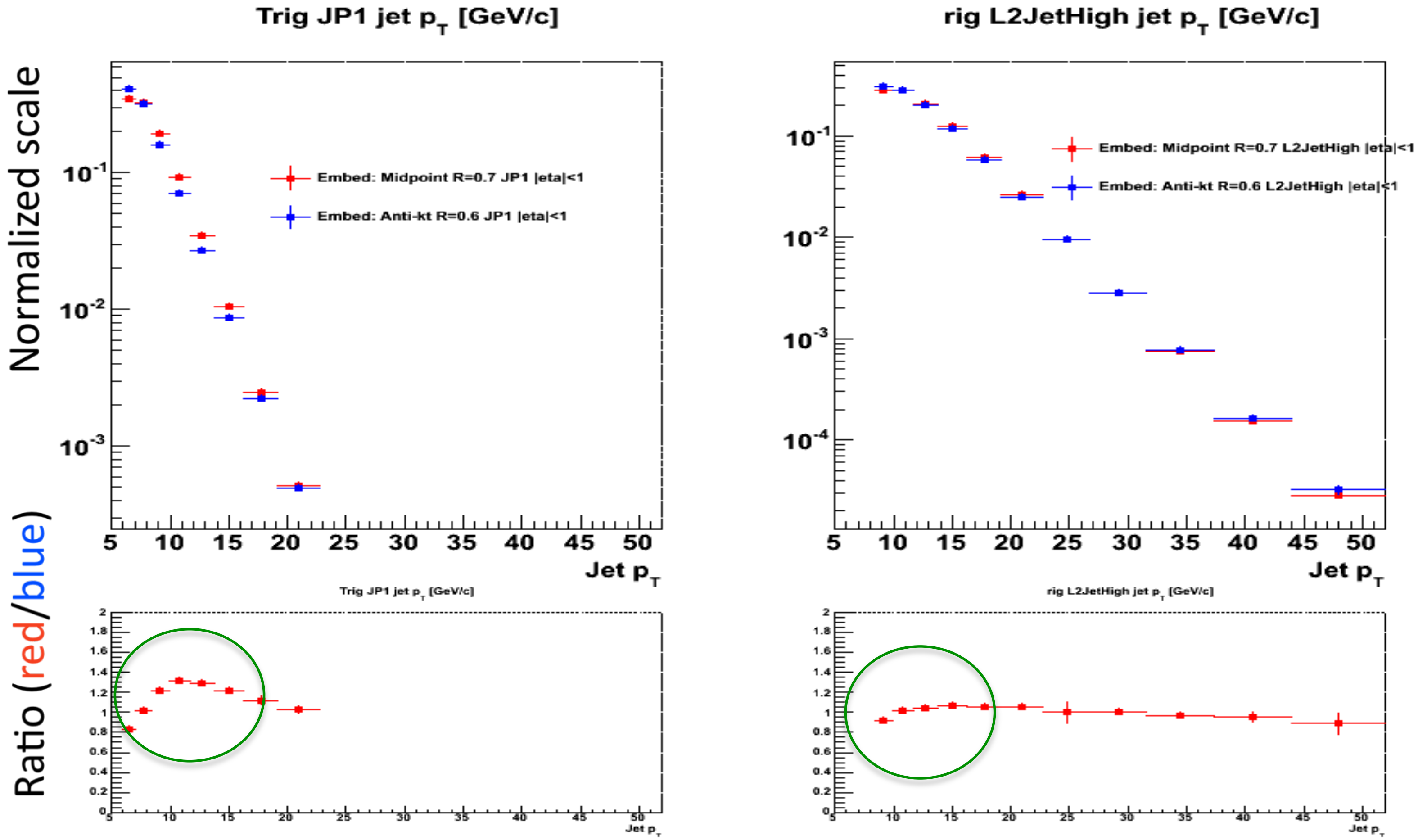


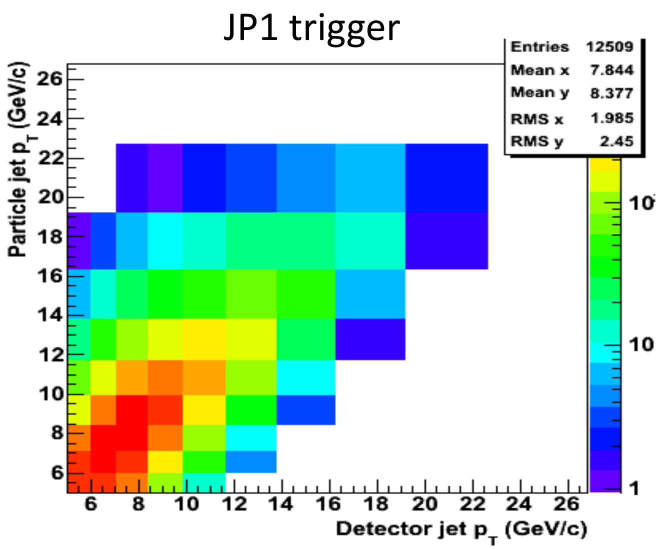
- Like results in data, the ratios of Jet p_T in the Midpoint cone R=0.7 over that in the anti-k_T R=0.6 indicate different underlying event contribution with different algorithms.

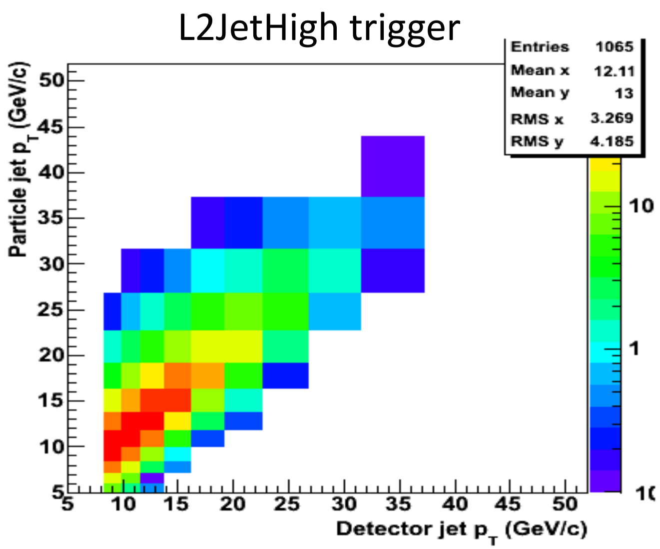
Particle jet p_T VS Detector jet p_T

- JP1 jet p_T > 6.0GeV/c and L2JetHigh jet p_T > 8.4GeV/c.
- JP1 jet p_T upper limit is 22.7GeV/c due to mis-reconstruction of high p_T tracks.

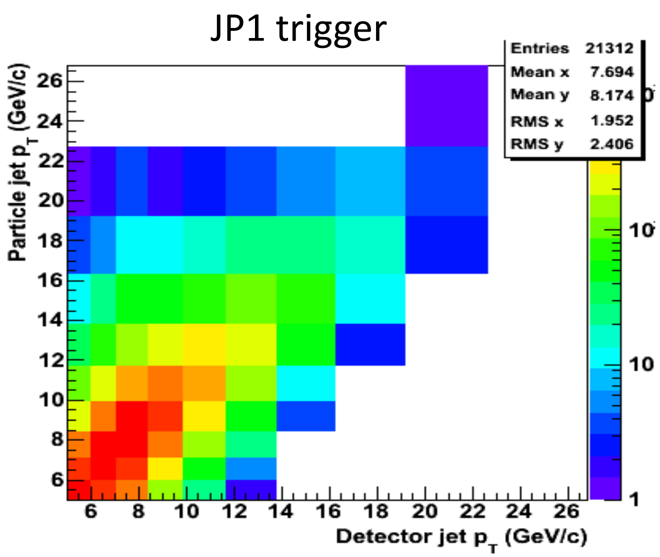
Matched particle jet has minimum distance r relative to the detector jet and r<0.5.

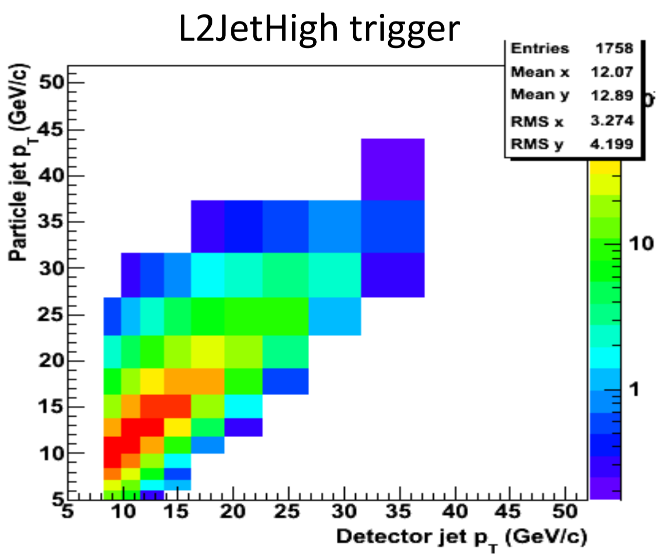
Midpoint Cone
R=0.7





Anti k_T
R=0.6





Parton jet p_T VS Detector jet p_T

- JP1 jet p_T > 6.0GeV/c and L2JetHigh jet p_T > 8.4GeV/c.
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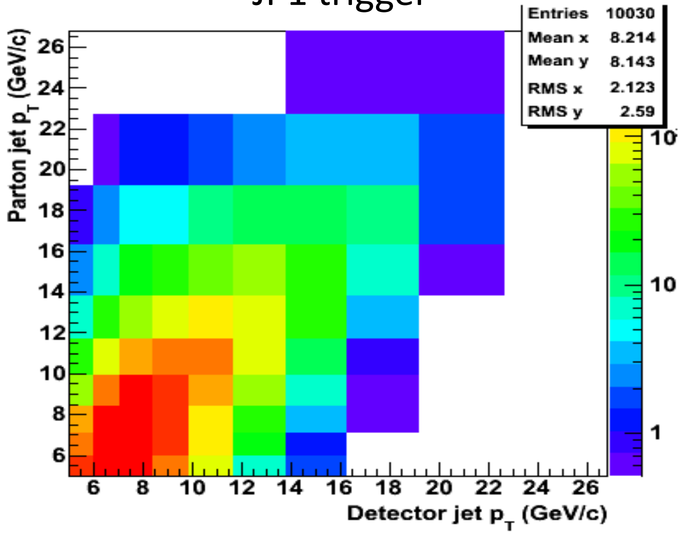
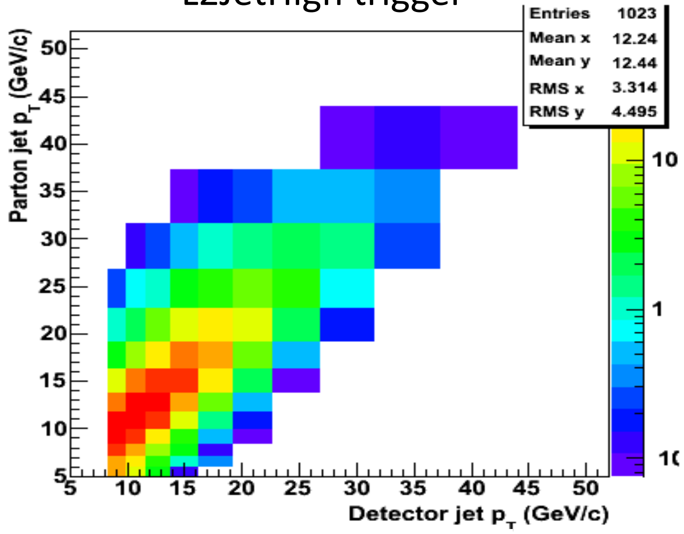
Matched parton jet has minimum distance r relative to the detector jet and r<0.5.

Midpoint Cone
R=0.7

JP1 trigger

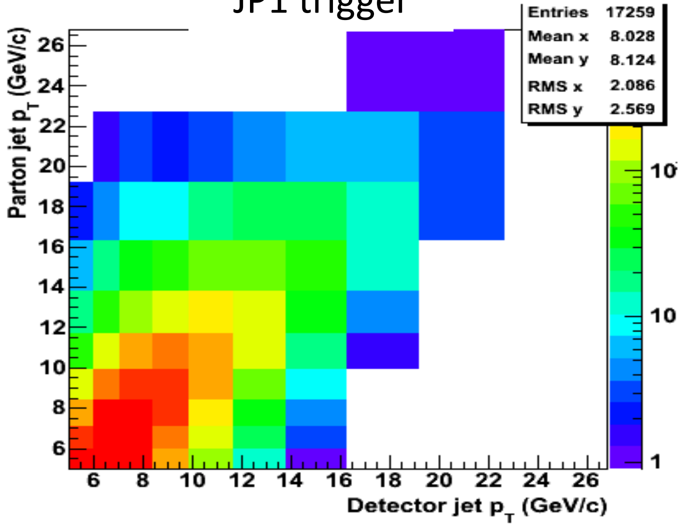


L2JetHigh trigger

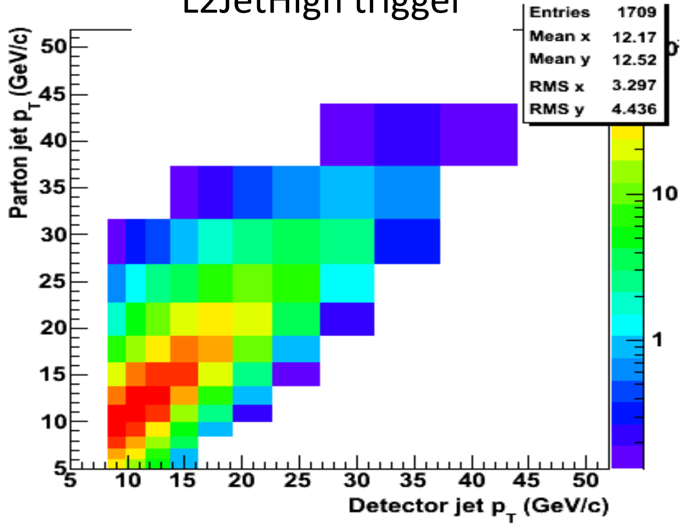


Anti k_T
R=0.6

JP1 trigger



L2JetHigh trigger



p_T shift (Particle jet p_T - Detector jet p_T)

- JP1 jet $p_T > 6.0$GeV/c and L2JetHigh jet $p_T > 8.4$GeV/c.
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Midpoint Cone
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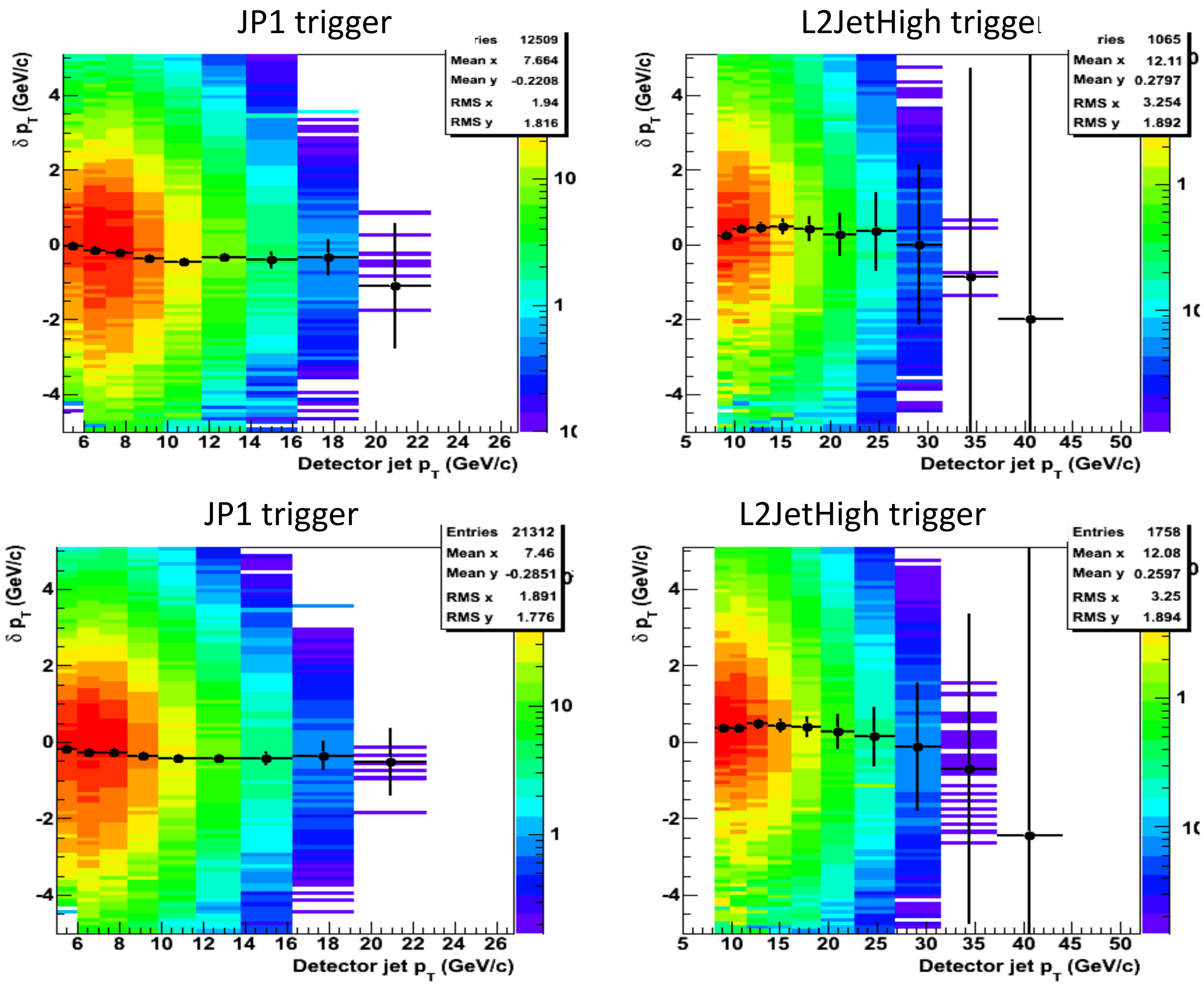
Anti k_T
R=0.6



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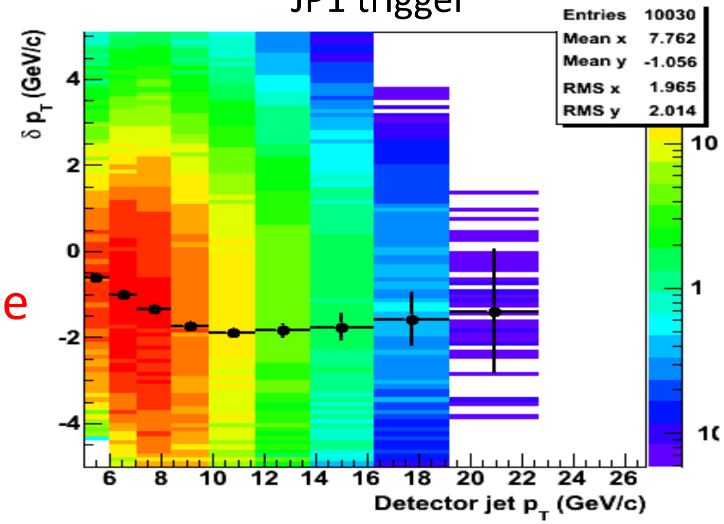
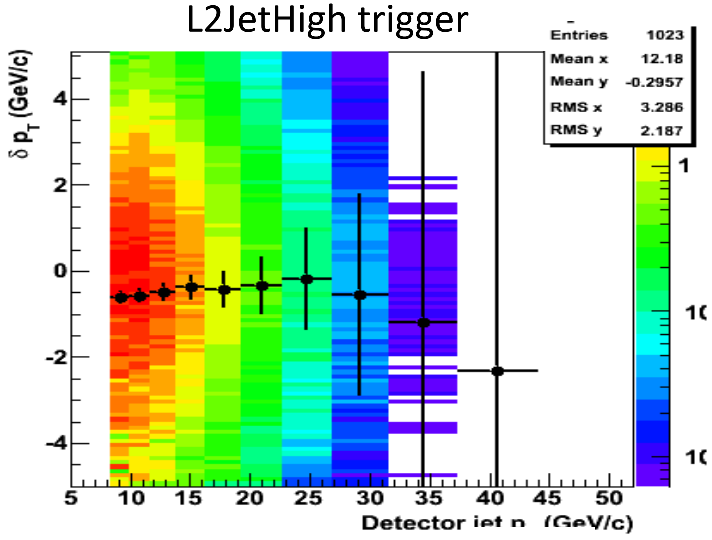
Midpoint Cone
R=0.7

JP1 trigger

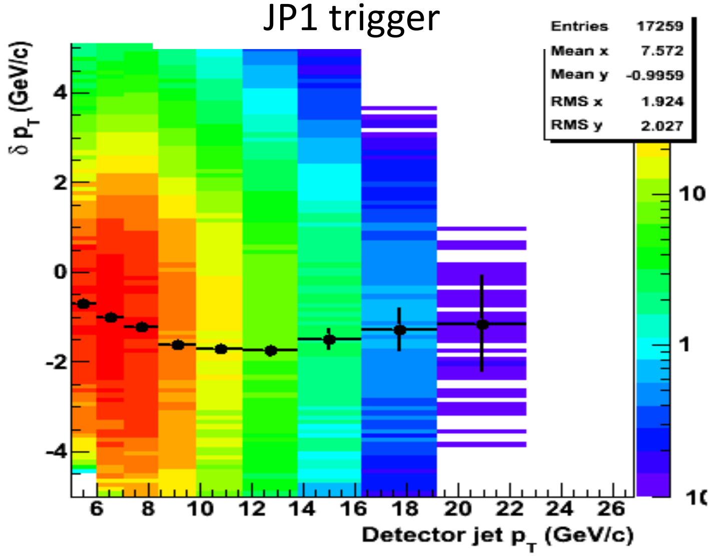


L2JetHigh trigger

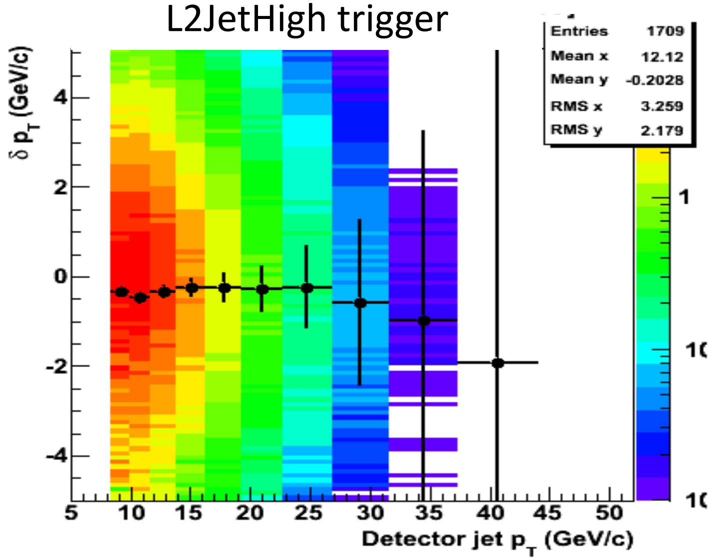


Anti k_T
R=0.6

JP1 trigger



L2JetHigh trigger



Summary

- From STAR 2009 200GeV p+p inclusive jet analysis,
  - Underlying event contributions to jet energy change with jet algorithm.
  - the reconstructed detector jets are matched with both particle jets and parton jets.
  - The p_T shift values are in a reasonable region.

Outlook

- Understand the underlying event and hadronization contributions to the jet cross section, may use different PYTHIA tunes which will change the jet p_T yields in the embedding .
- Unfolding and Systematic studies.
- Compare data with NLO theory curves for the Midpoint cone and anti-k_t algorithms.