Di-jet Hadron Correlations in Au+Au Collisions at STAR at $\sqrt{s_{NN}}$ = 200 GeV

Nick Elsey for the STAR Collaboration
Wayne State University

U.S. DEPARTMENT OF ENERGY | Office of Science

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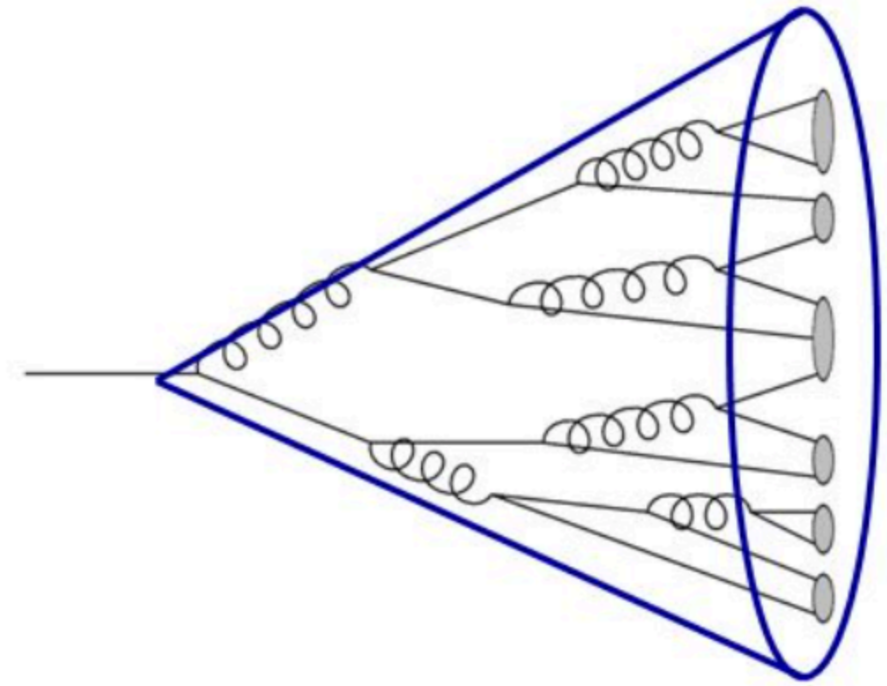
STAR

Jets



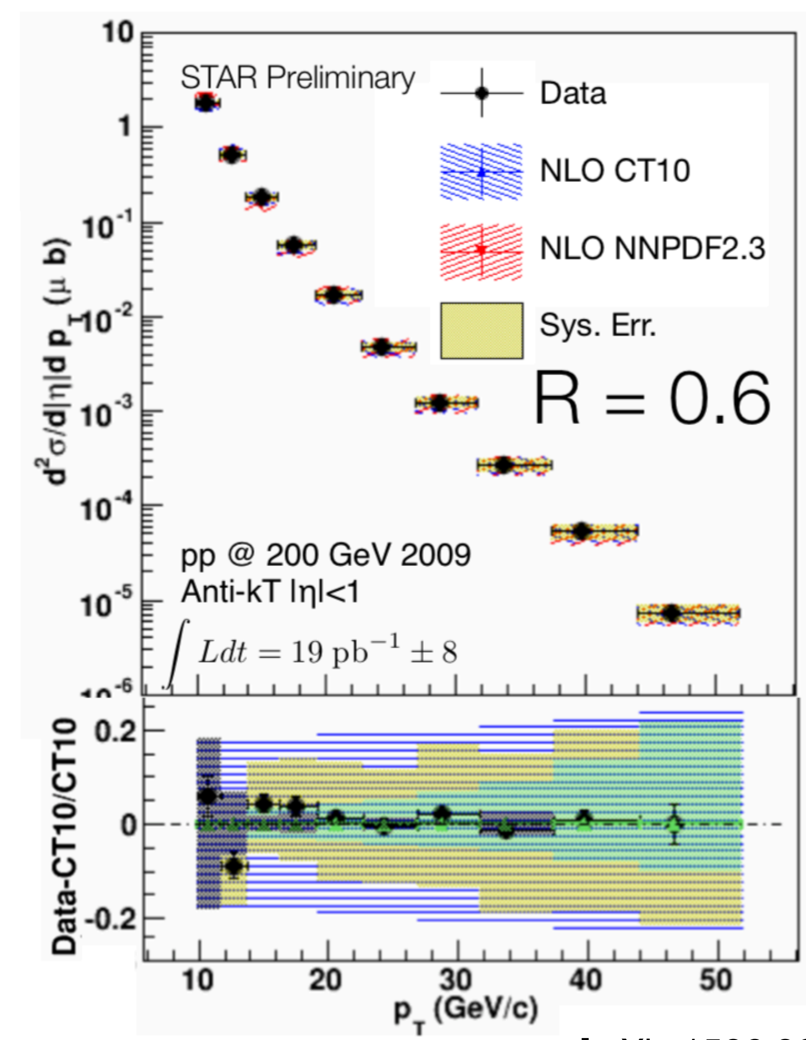
theory: X —> $q\bar{q}$ (or g)

experiment: collimated shower of hadrons

theory → jetfinding → experiment

jets are calculable: pQCD

experimental agreement with theoretical predictions →

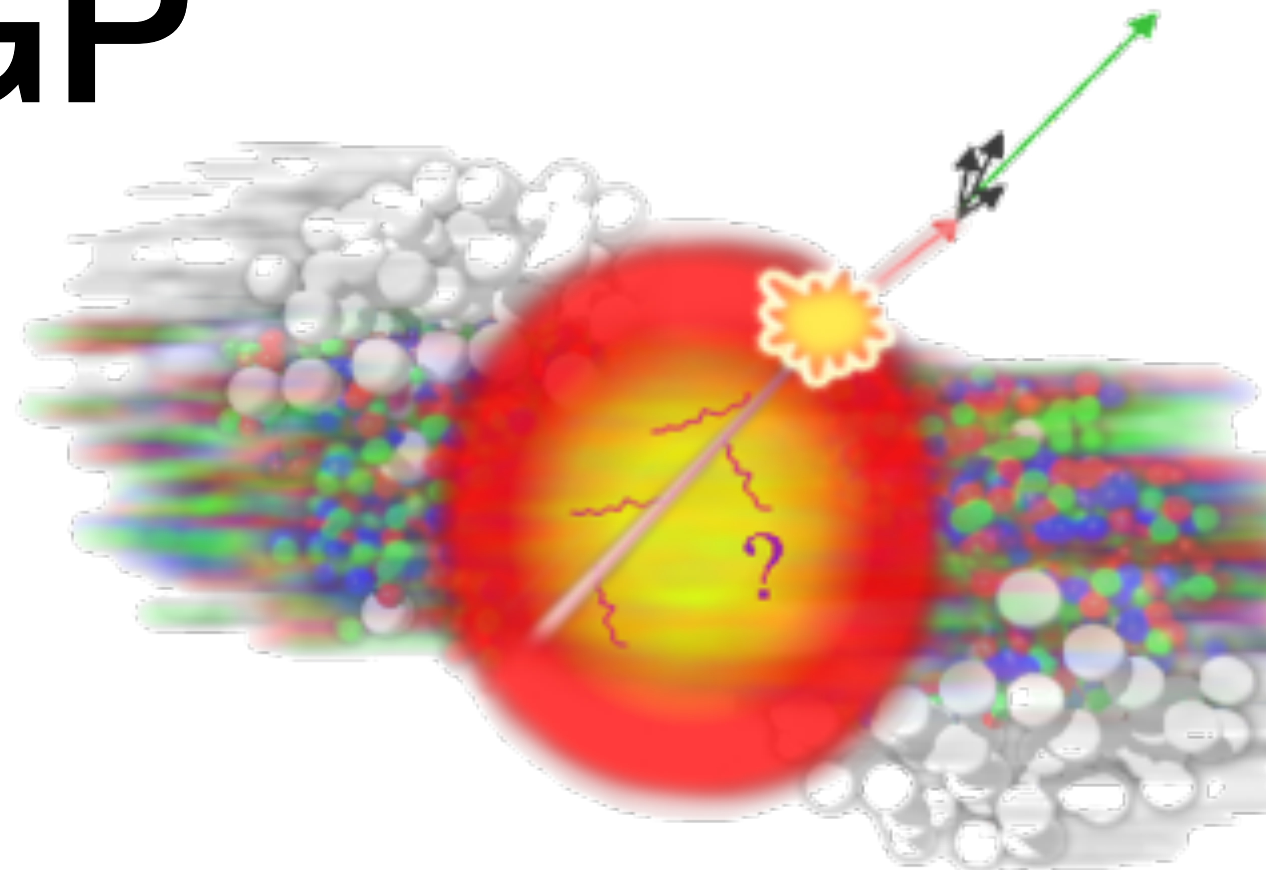


[arXiv:1506.06314]

FastJet

M. Cacciari, G.P. Salam and G. Soyez, Eur.Phys.J. C72 (2012) 1896 [arXiv:1111.6097]

Jets in the QGP



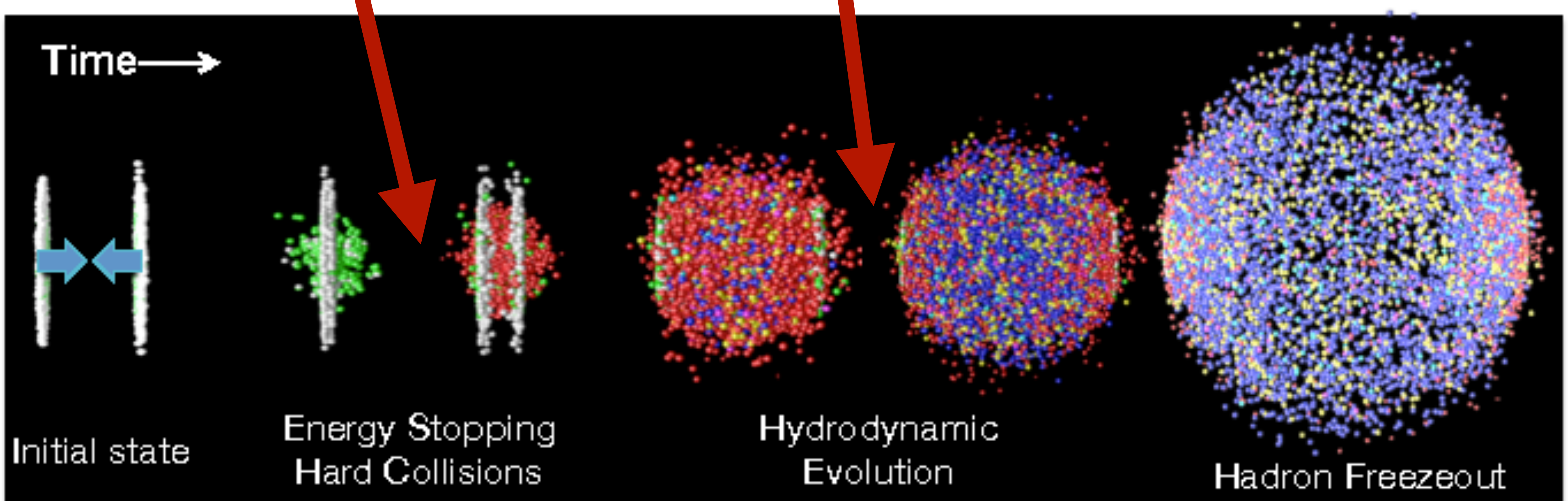
hard scattering happens early

internal probe of the QGP

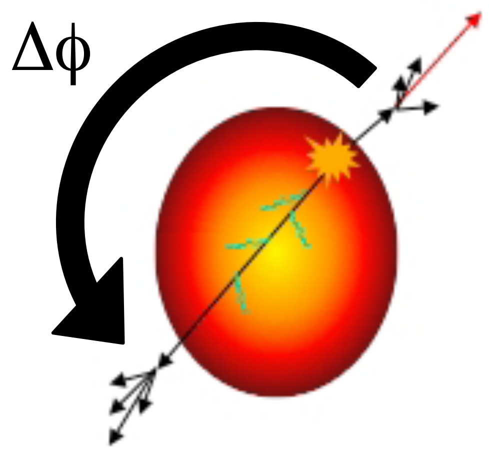
partonic energy loss

→ **broadening & softening**

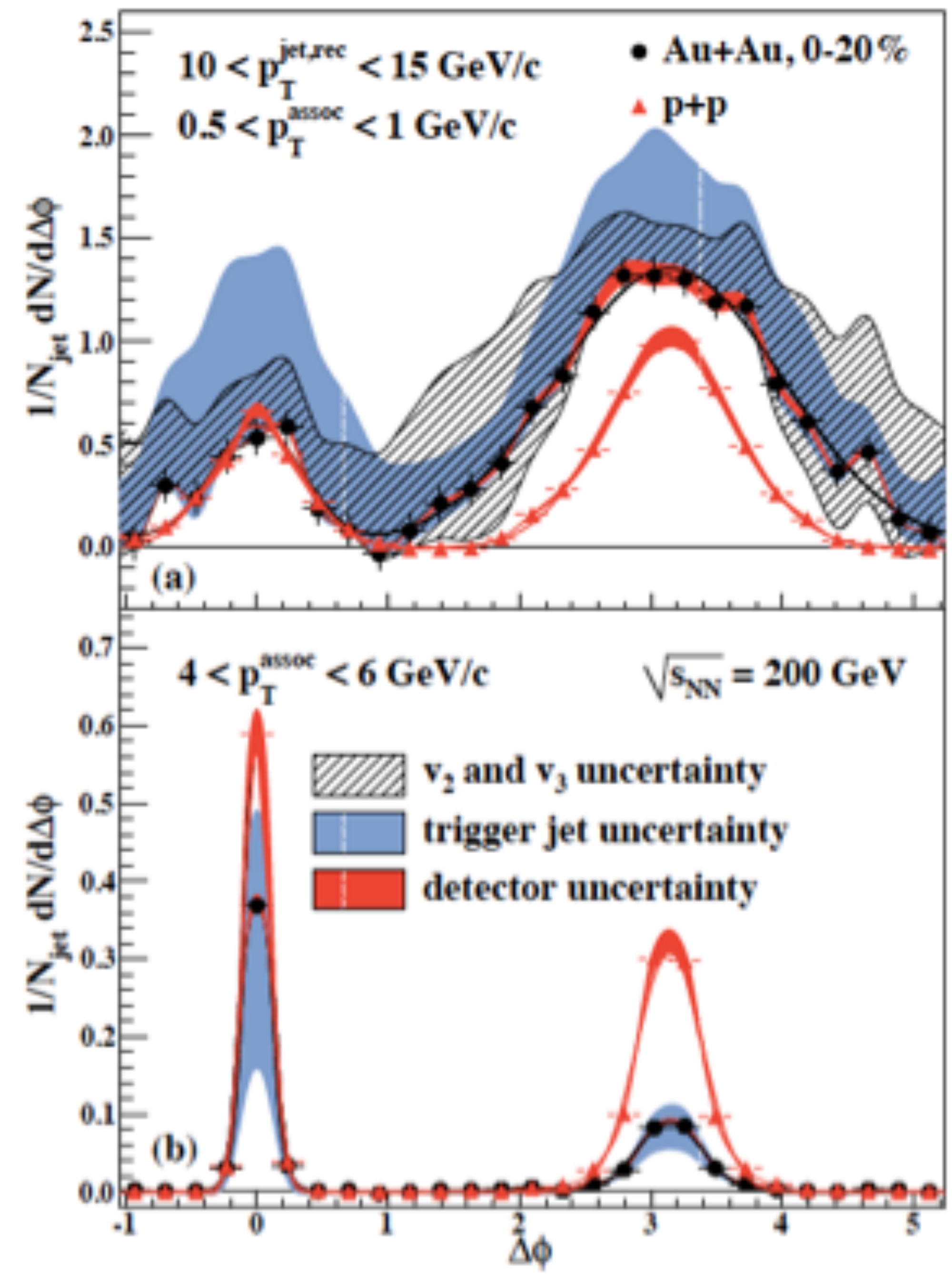
jet production **probes medium evolution**



Jets in the QGP at STAR



jet-hadron correlations



STAR, PRL **112**, 122301 (2014)

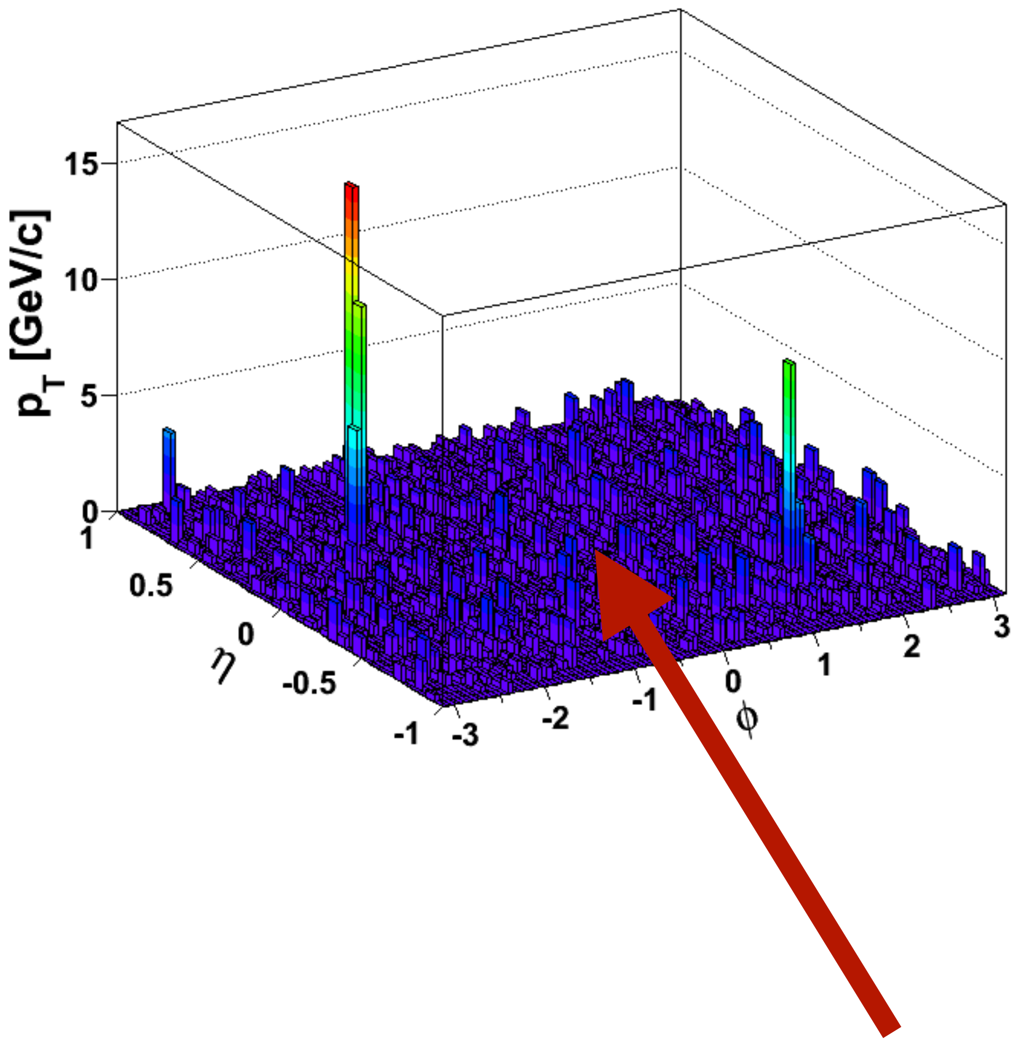
enhancement of recoil jet low p_T constituents

suppression of recoil jet high p_T constituents

how to measure jet-by-jet energy loss?

Hard core jets at STAR

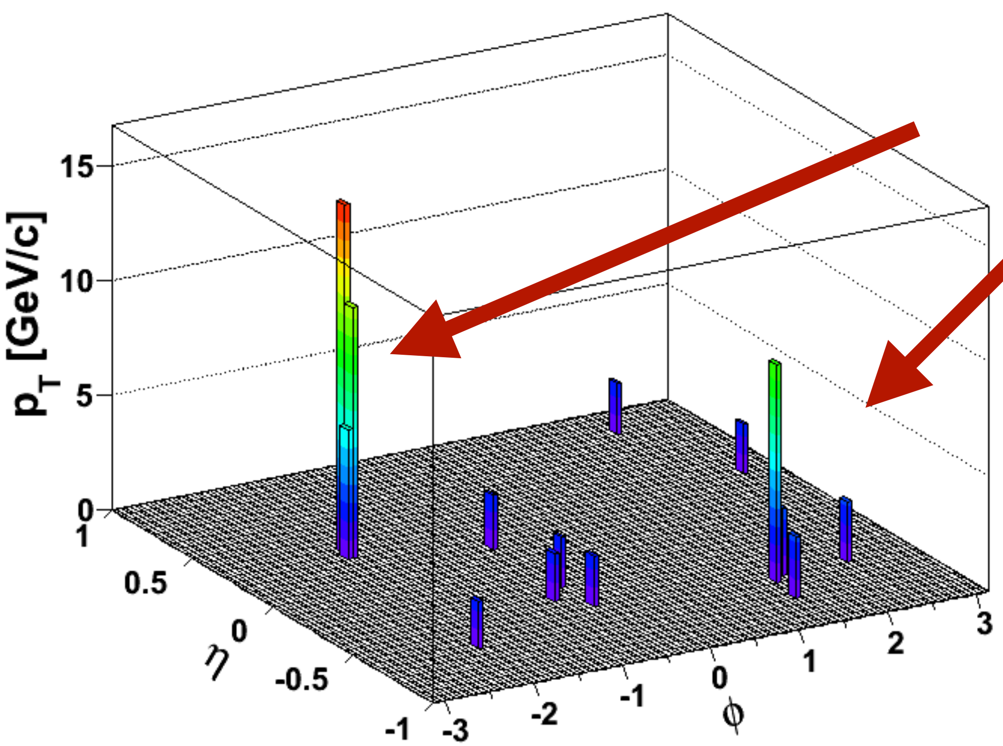
in a heavy ion background



large background energy density

Hard core jets at STAR

in a heavy ion background



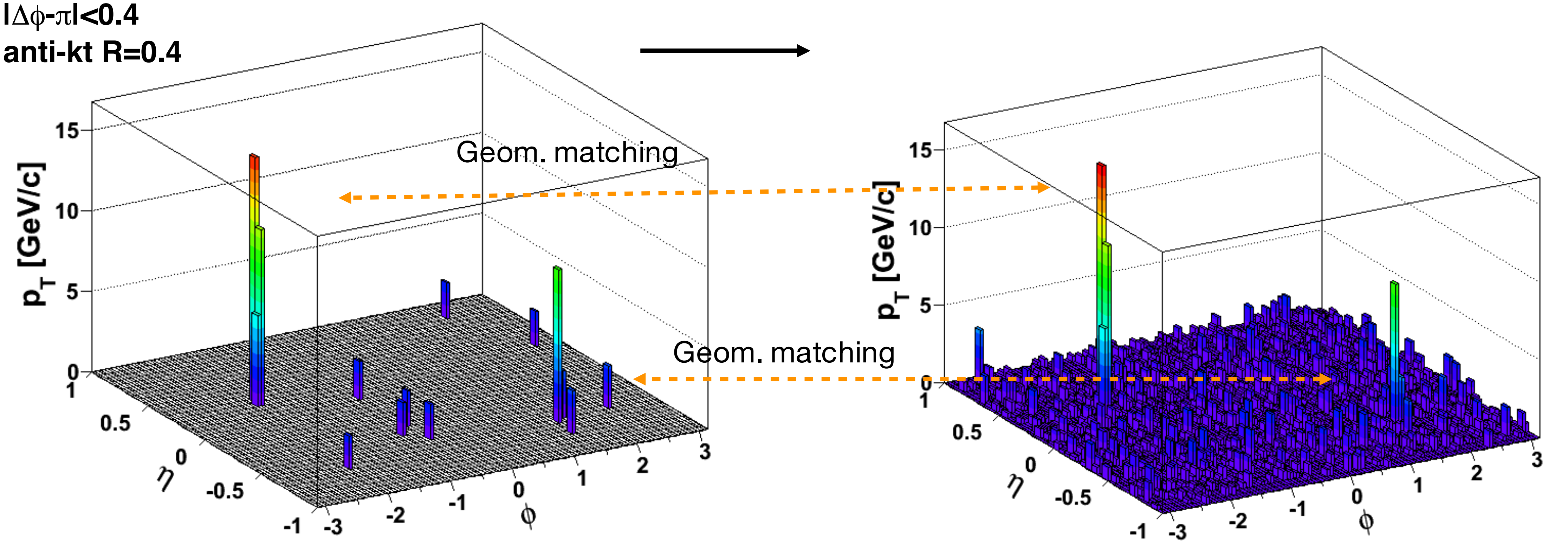
clear jet signal

p_T^{const}>2 GeV/c cut → removes almost all background

Hard core jets at STAR

in a heavy ion background

p_T^{Cut}=2 GeV/*c*
p_T^{Lead}>20 GeV/c
$p_T^{SubLead}$>10 GeV/*c*
$|\Delta\phi-\pi|$<0.4
anti-kt R=0.4



p_T^{const}>2 GeV/c cut → removes almost all background

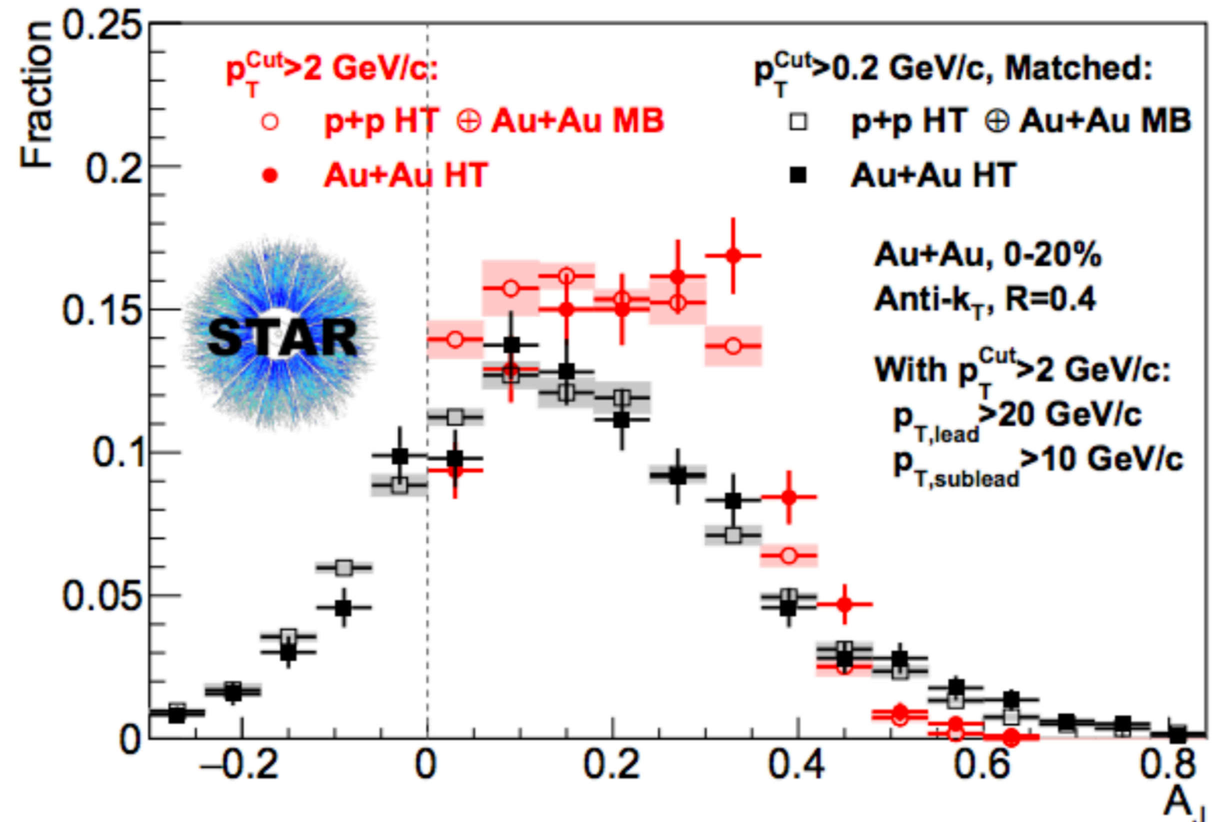
geometric matching → no combinatoric jets, recover all constituents

Di-jet imbalance at STAR

$$A_J = \frac{p_T^{\mathrm{Lead}} - p_T^{\mathrm{SubLead}}}{p_T^{\mathrm{Lead}} + p_T^{\mathrm{SubLead}}}$$

hard core di-jets imbalanced with respect to p+p

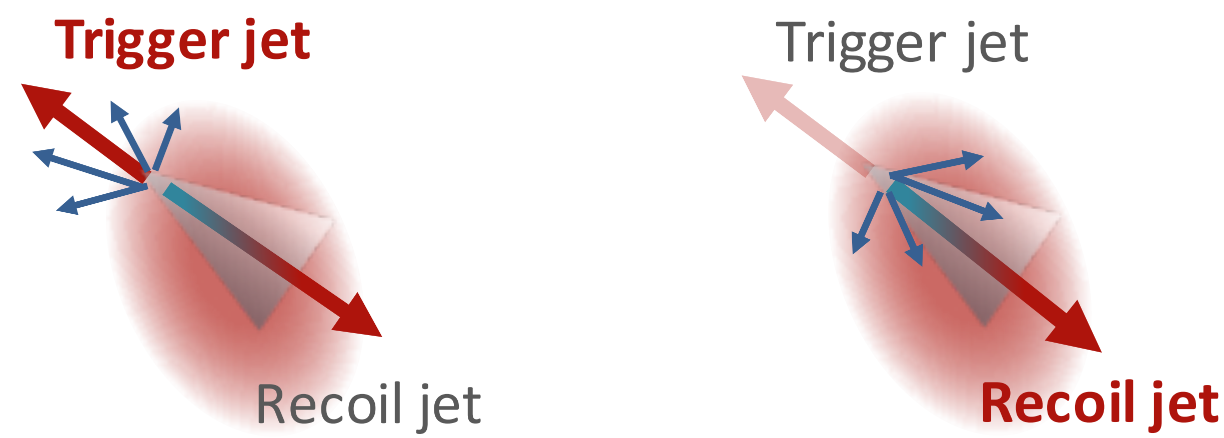
when soft constituents are included: balance restored to the level of p+p in R=0.4



STAR Collaboration, Phys. Rev. Lett. 119, 062301 (2017)

more differential → di-jet hadron correlations

Di-jet hadron correlations



di-jet definition

p_T^{Cut}=2 GeV/c
p_T^{Lead}>20 GeV/c
$p_T^{SubLead}$>10 GeV/c
$|\Delta\phi-\pi|<0.4$
anti-k_T R = 0.4

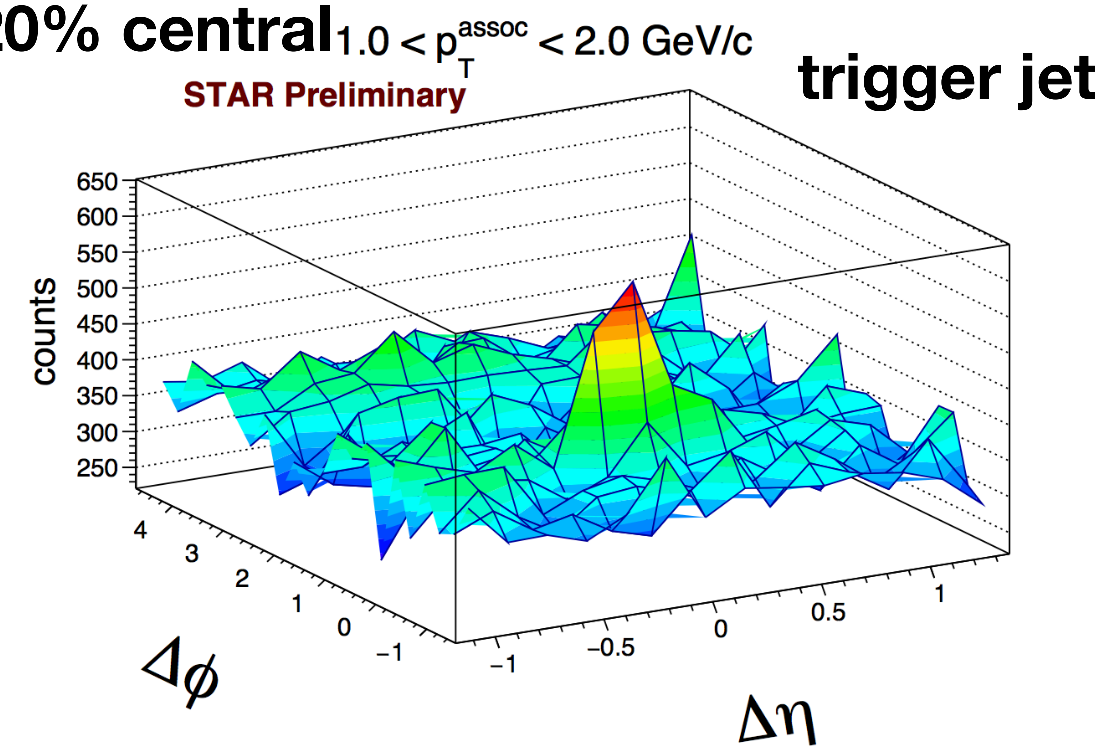
correlations

$\Delta\eta = \eta^{jet}-\eta^{track}$
$\Delta\varphi = \varphi^{jet}-\varphi^{track}$

jetfinding → **detector level**

correlations & yields → **particle level**

Au+Au
0-20% central



trigger jet

systematic uncertainties

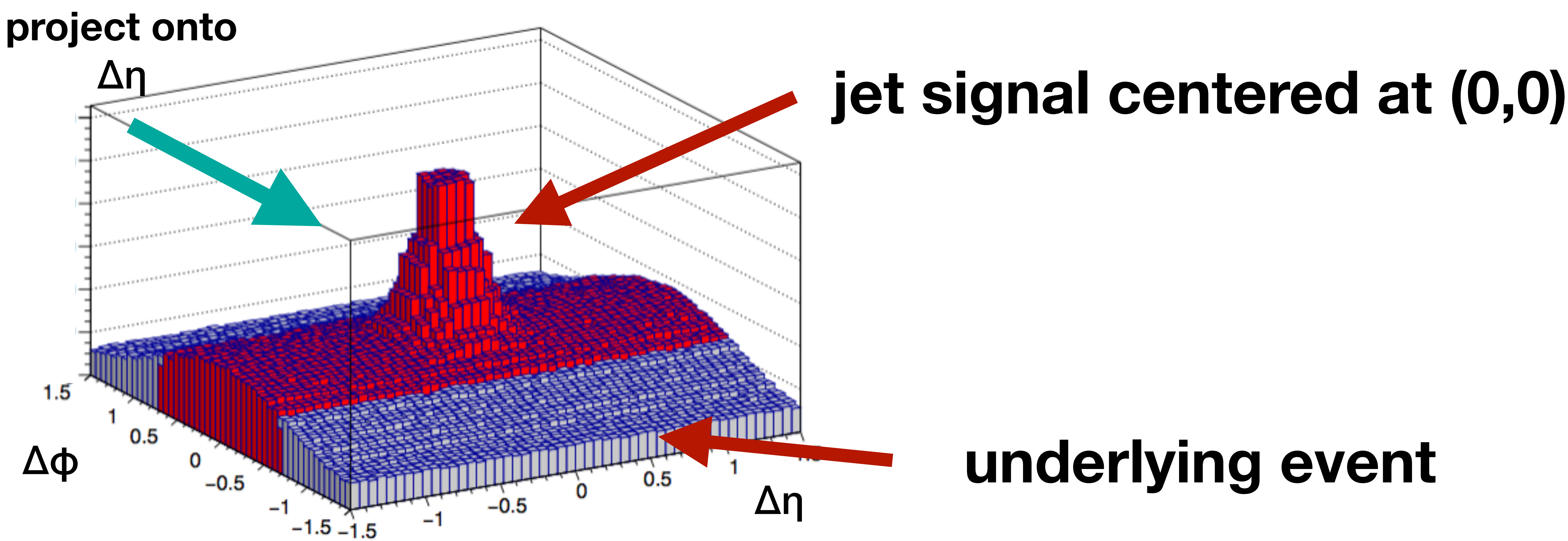
→ **tracking efficiency (±5%)**

→ **relative jet energy scale**

relative tracking efficiency (±7%)

relative tower energy scale (±2%)

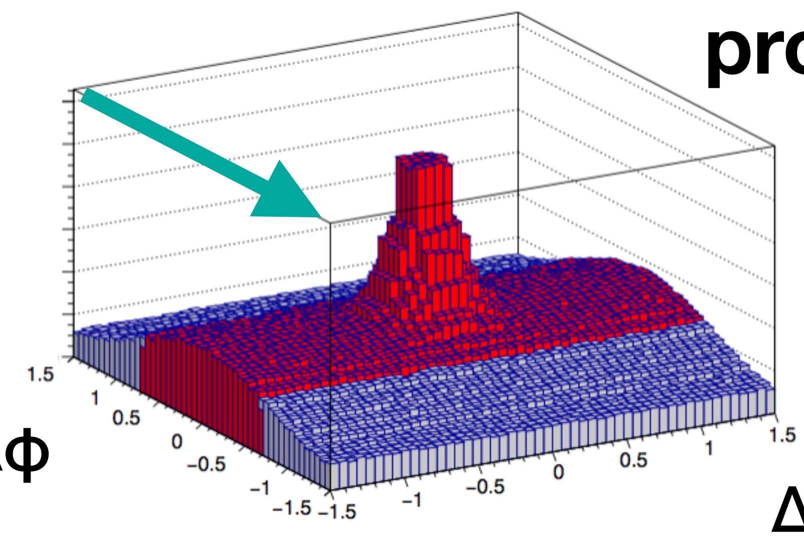
Correlations in Δη



fit with a constant+gaussian constant subtracted as background

Correlations in Δη

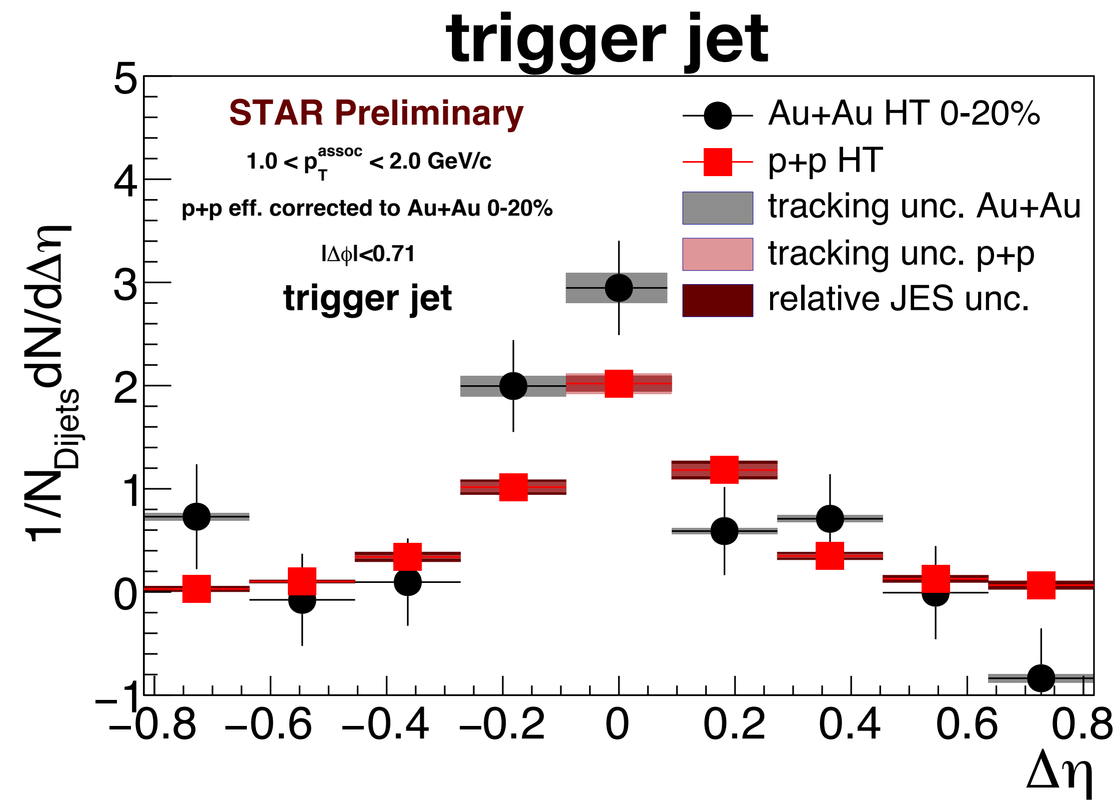
$1.0 < p_T^{assoc} < 2.0$ GeV/c

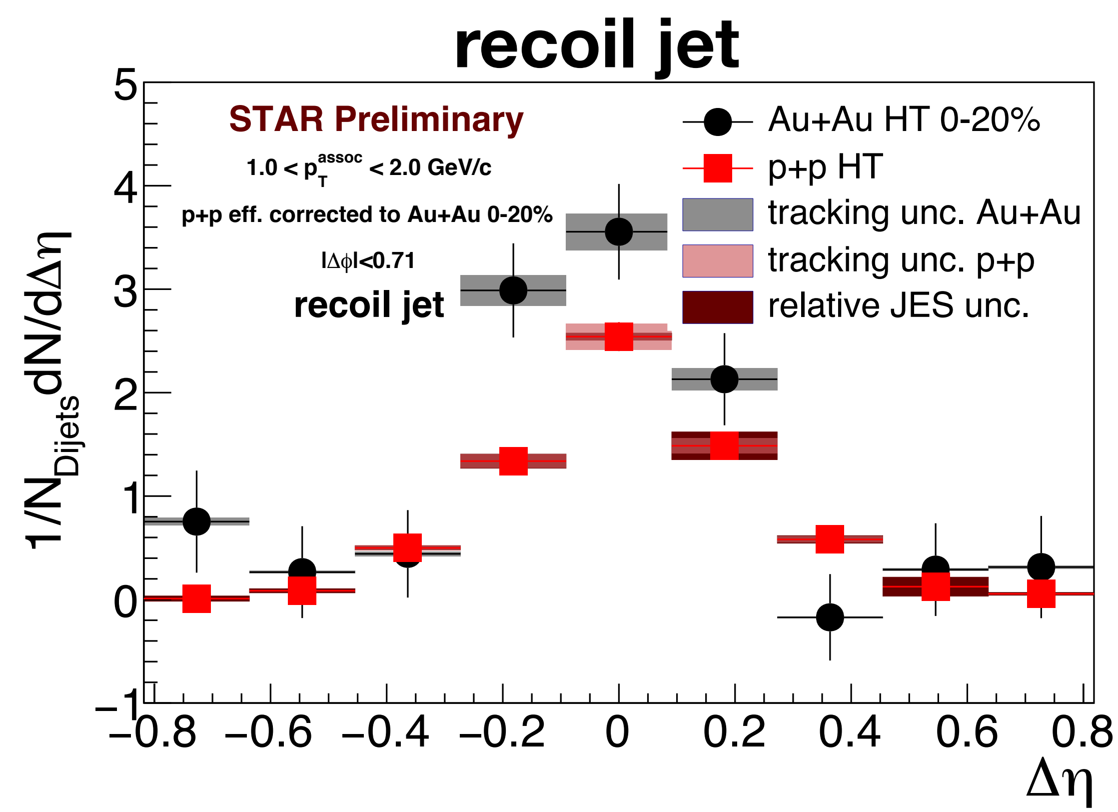


projection range

|Δϕ| < 0.71

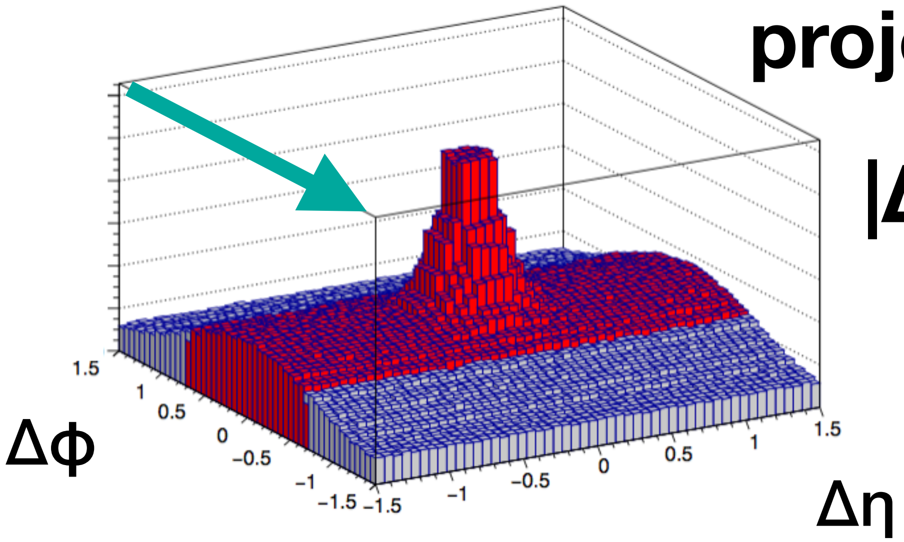
→ **yield contained within jet radius R=0.4**





Correlations in Δη

$3.0 < p_T^{assoc} < 4.0$ GeV/c

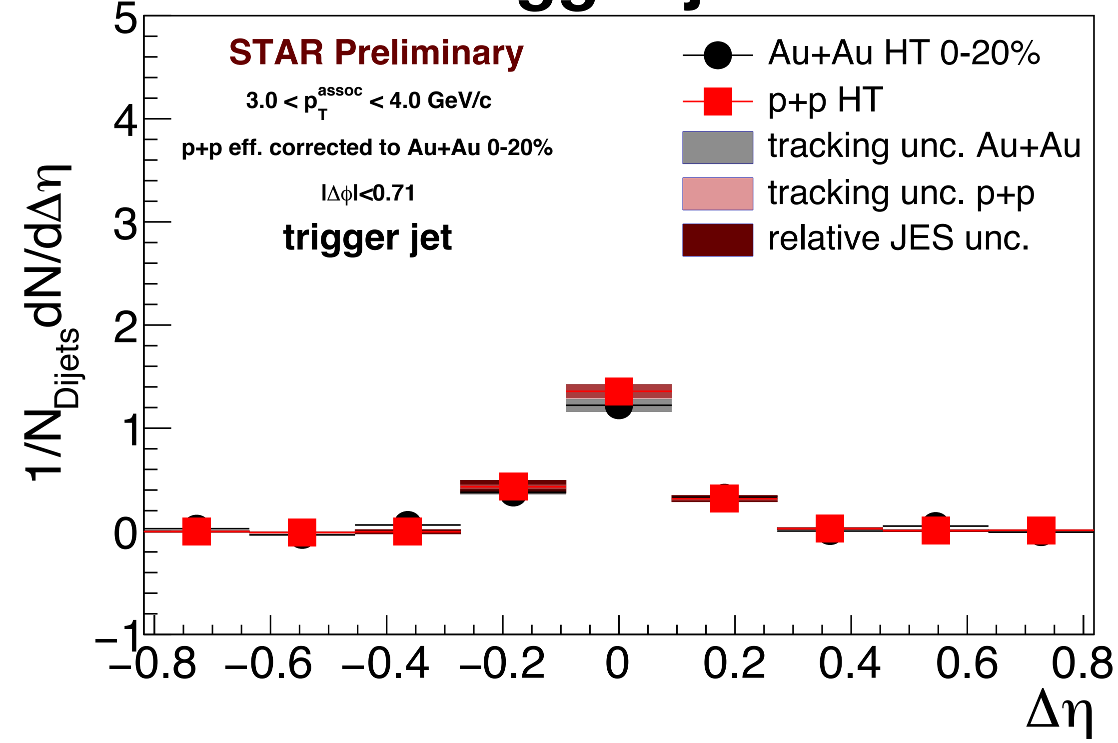


projection range

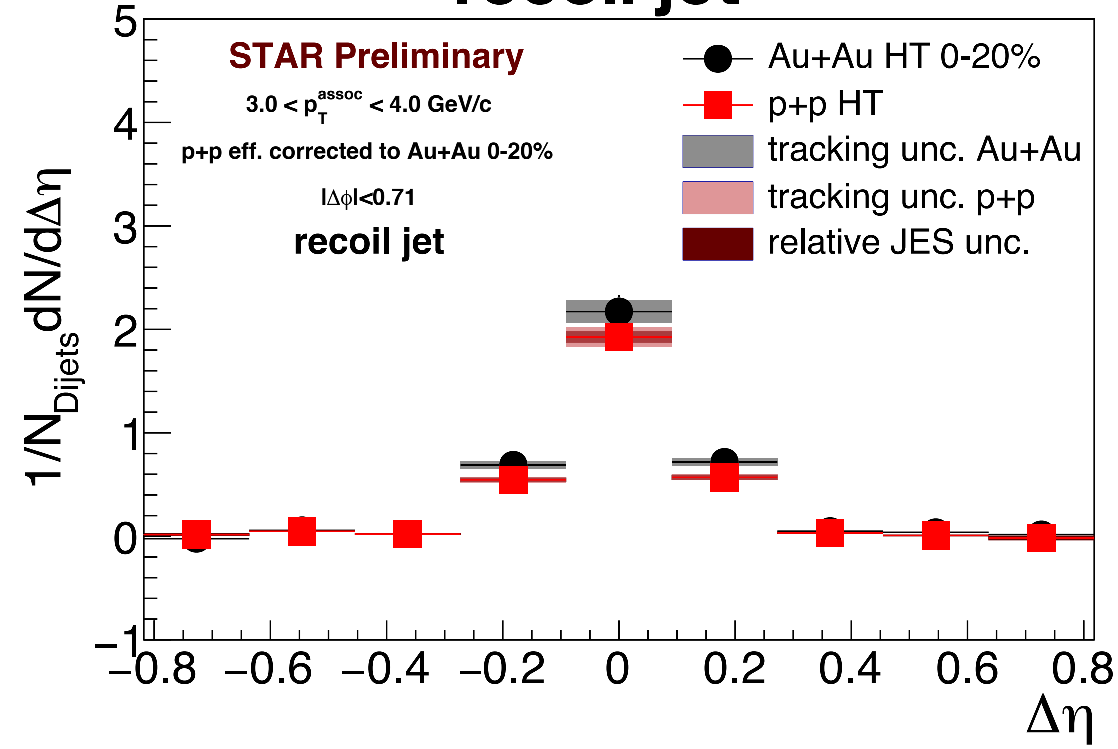
|Δϕ| < 0.71

yield contained within jet radius R=0.4

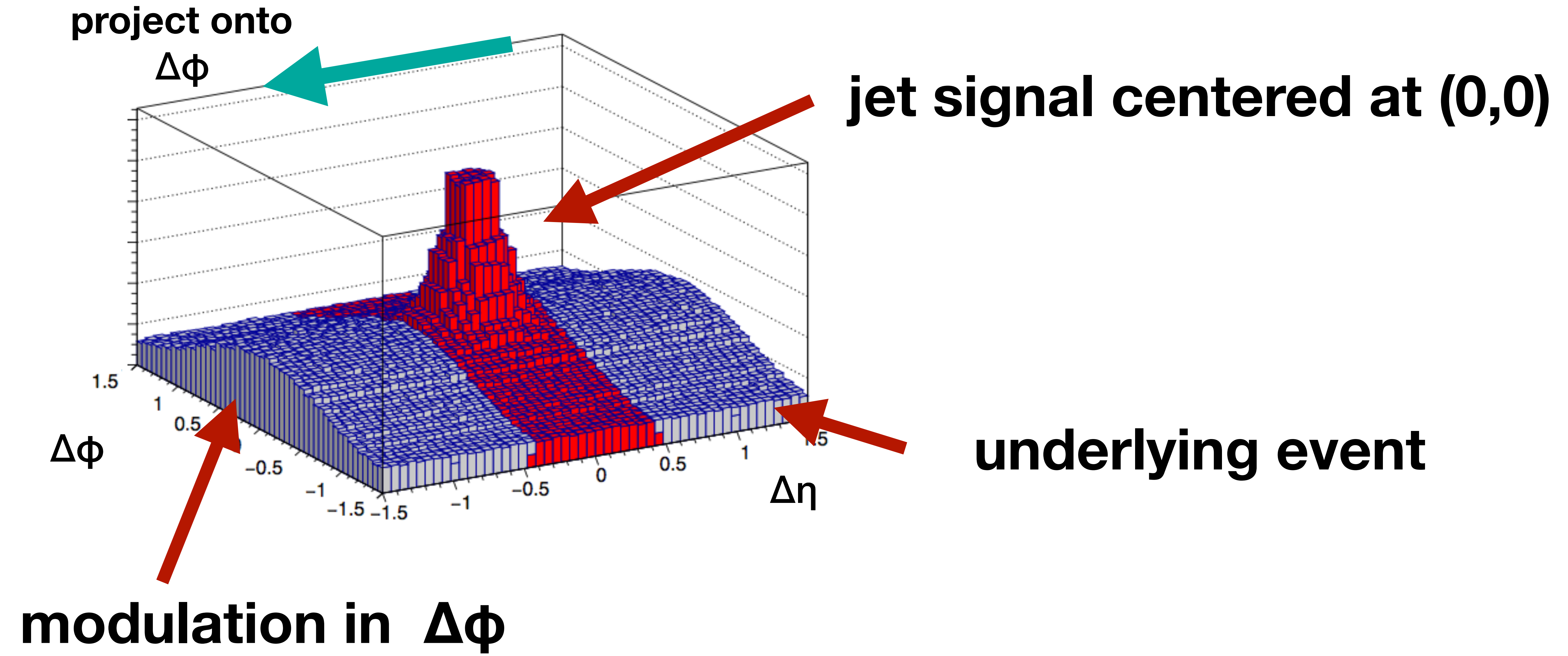
trigger jet



recoil jet

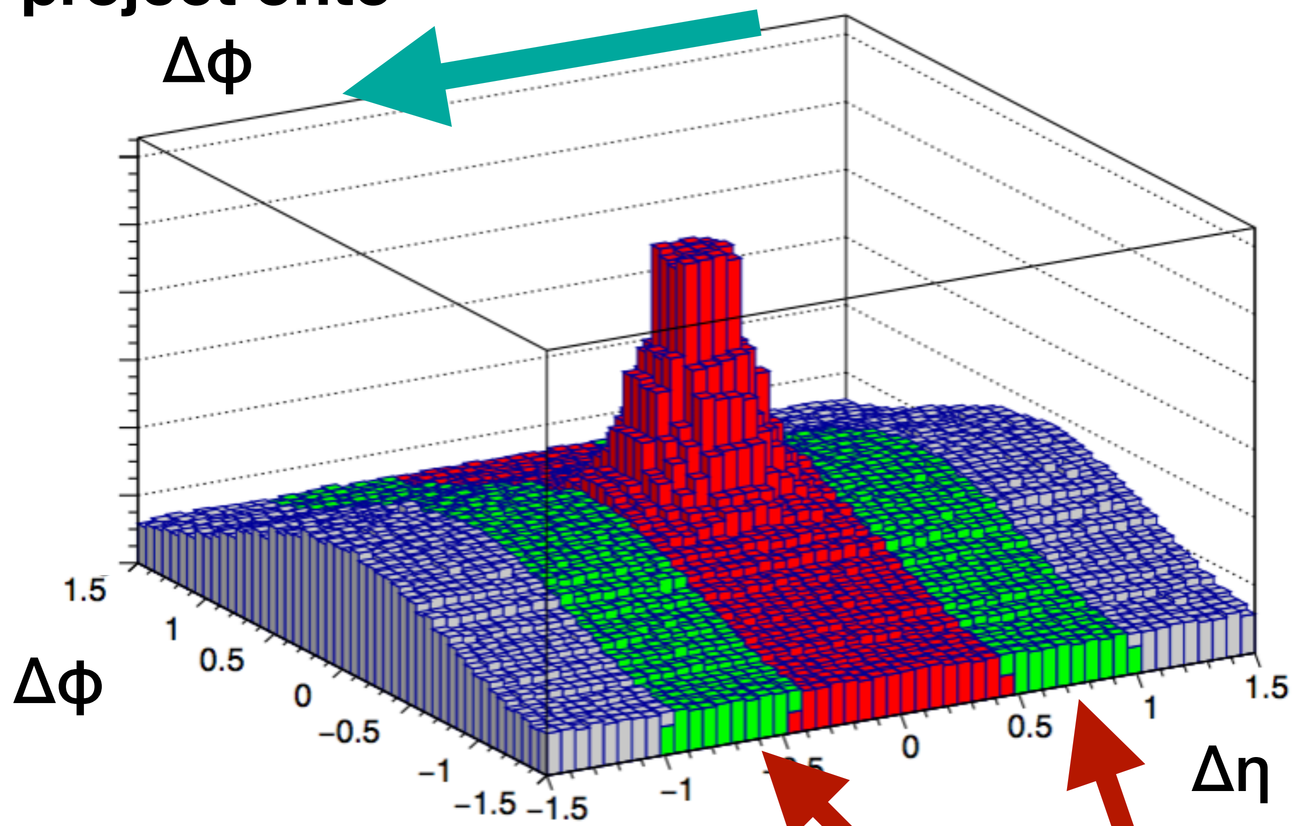


Correlations in Δϕ



Correlations in Δϕ

project onto Δϕ

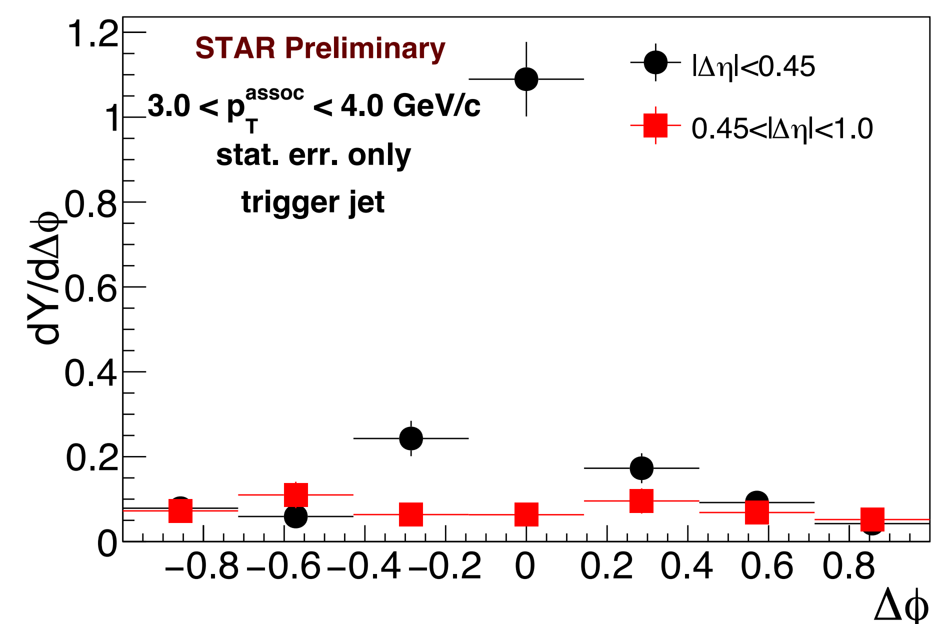


jet signal centered at (0,0)

underlying event

modulation in Δϕ

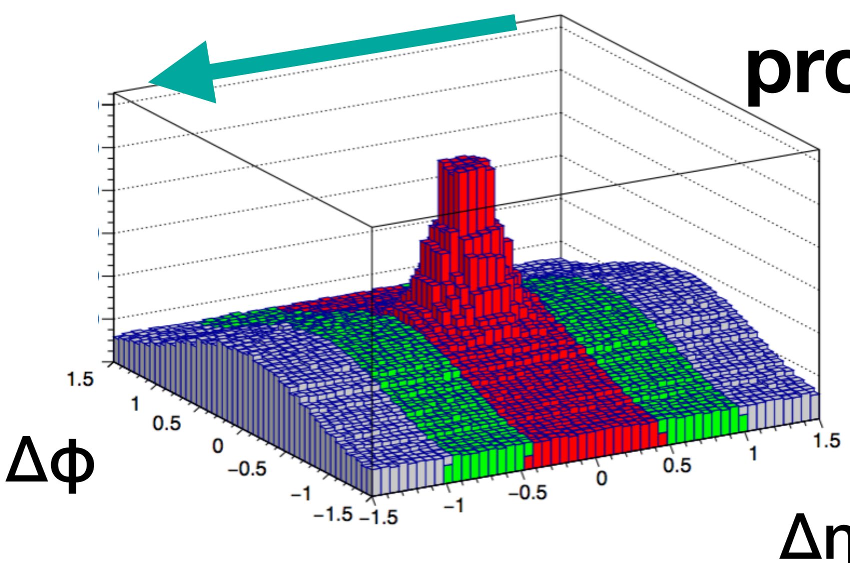
side bands



use sideband subtraction to account for flow in underlying event

Correlations in Δϕ

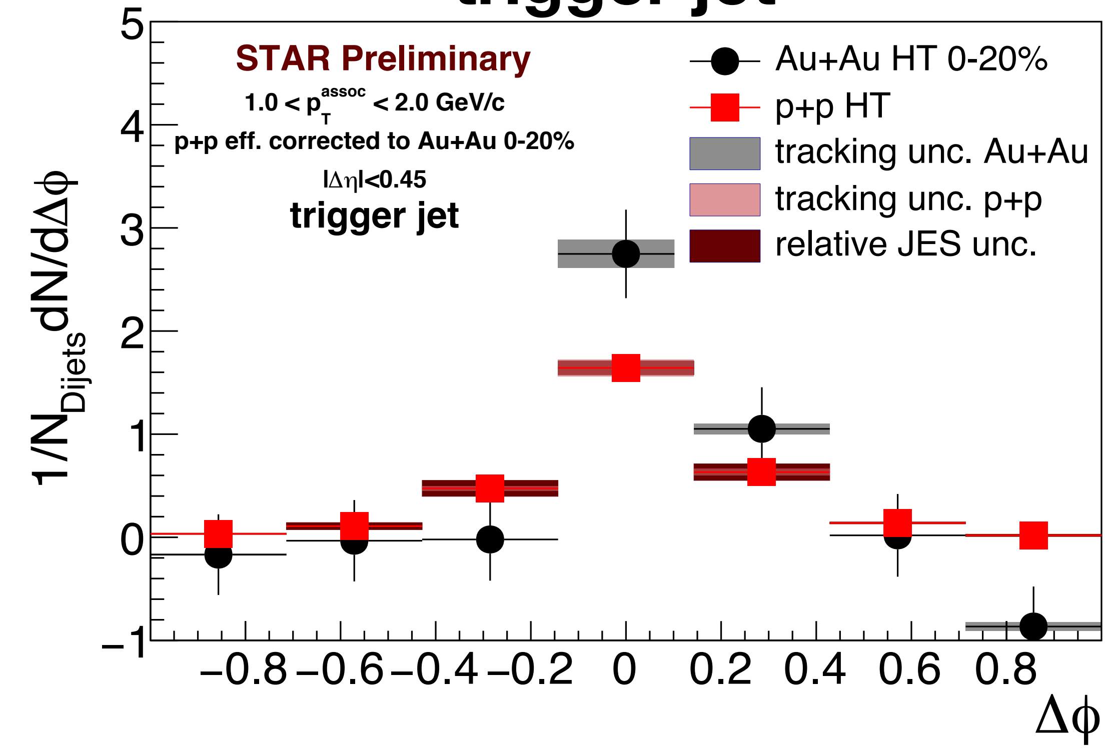
$1.0 < p_T^{assoc} < 2.0$ GeV/c



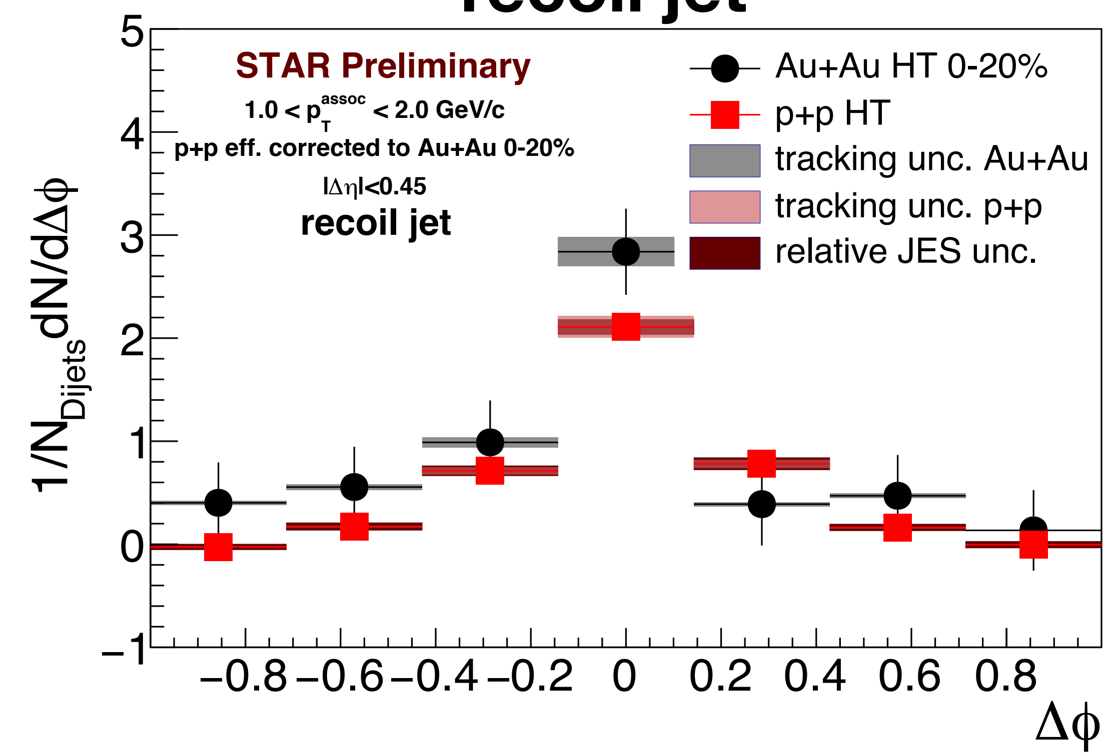
projection range

$|\Delta\eta| < 0.45$

trigger jet



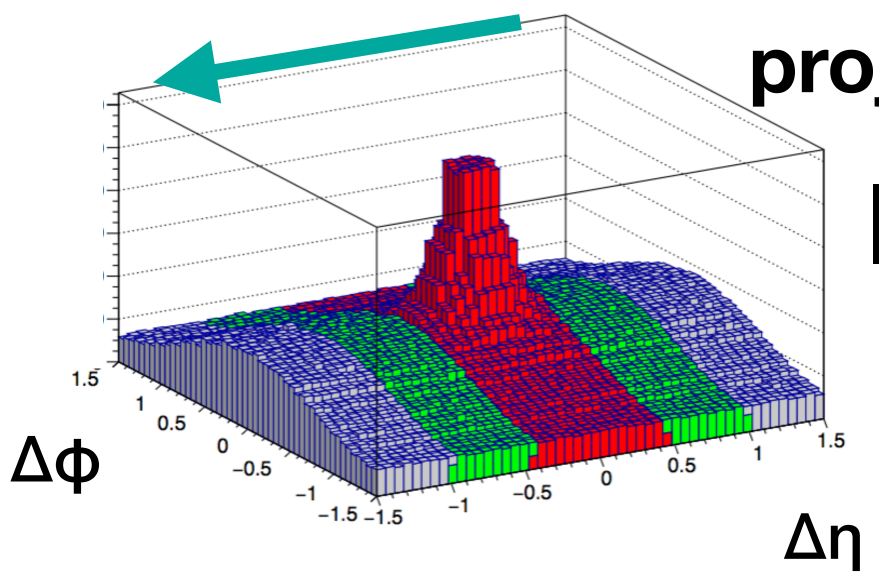
recoil jet



- **yield contained within jet radius R=0.4**
- **similar to Δη**
  ~ circular jets

Correlations in Δφ

$3.0 < p_T^{assoc} < 4.0$ GeV/c



projection range

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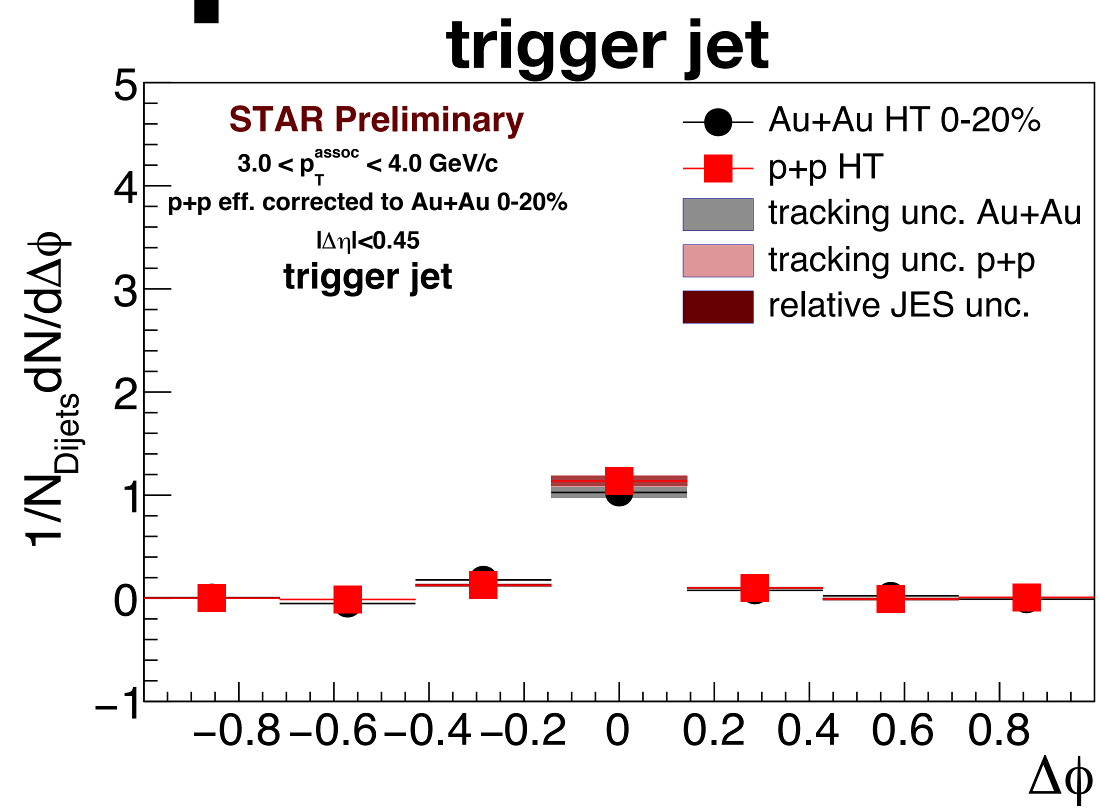
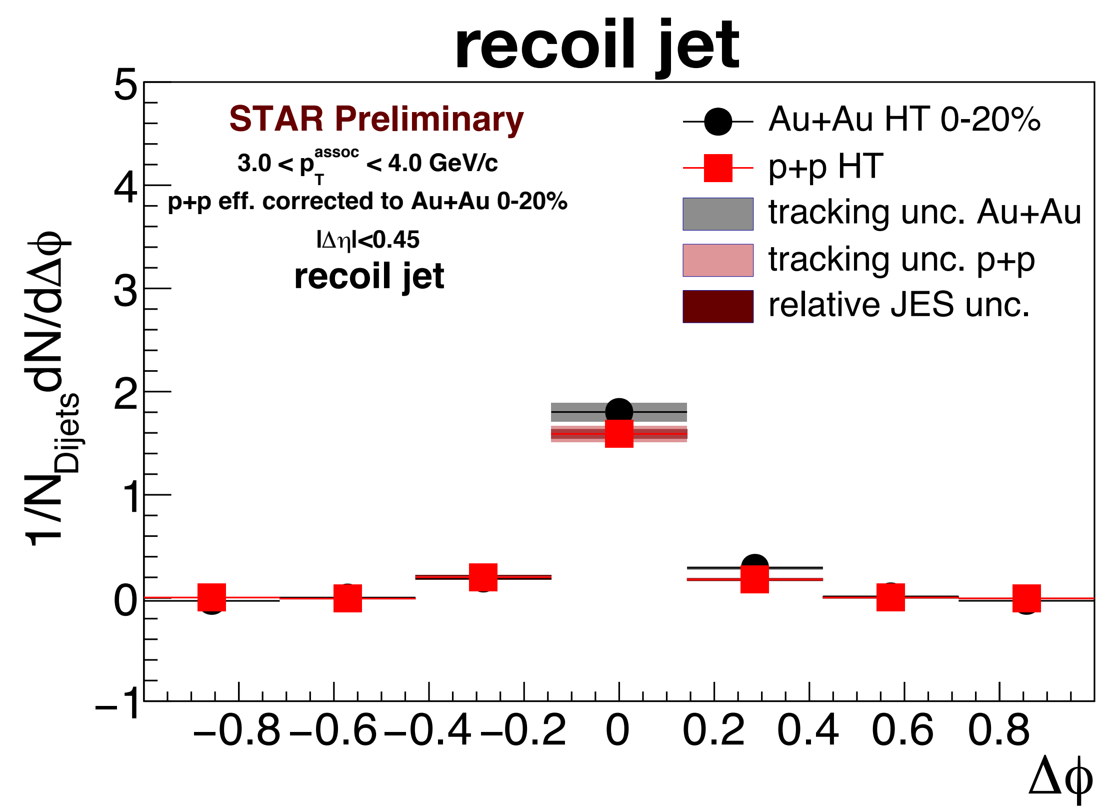




- **yield contained within jet radius R=0.4**
- **similar to Δη ~ circular jets**

Jet constituent Yields

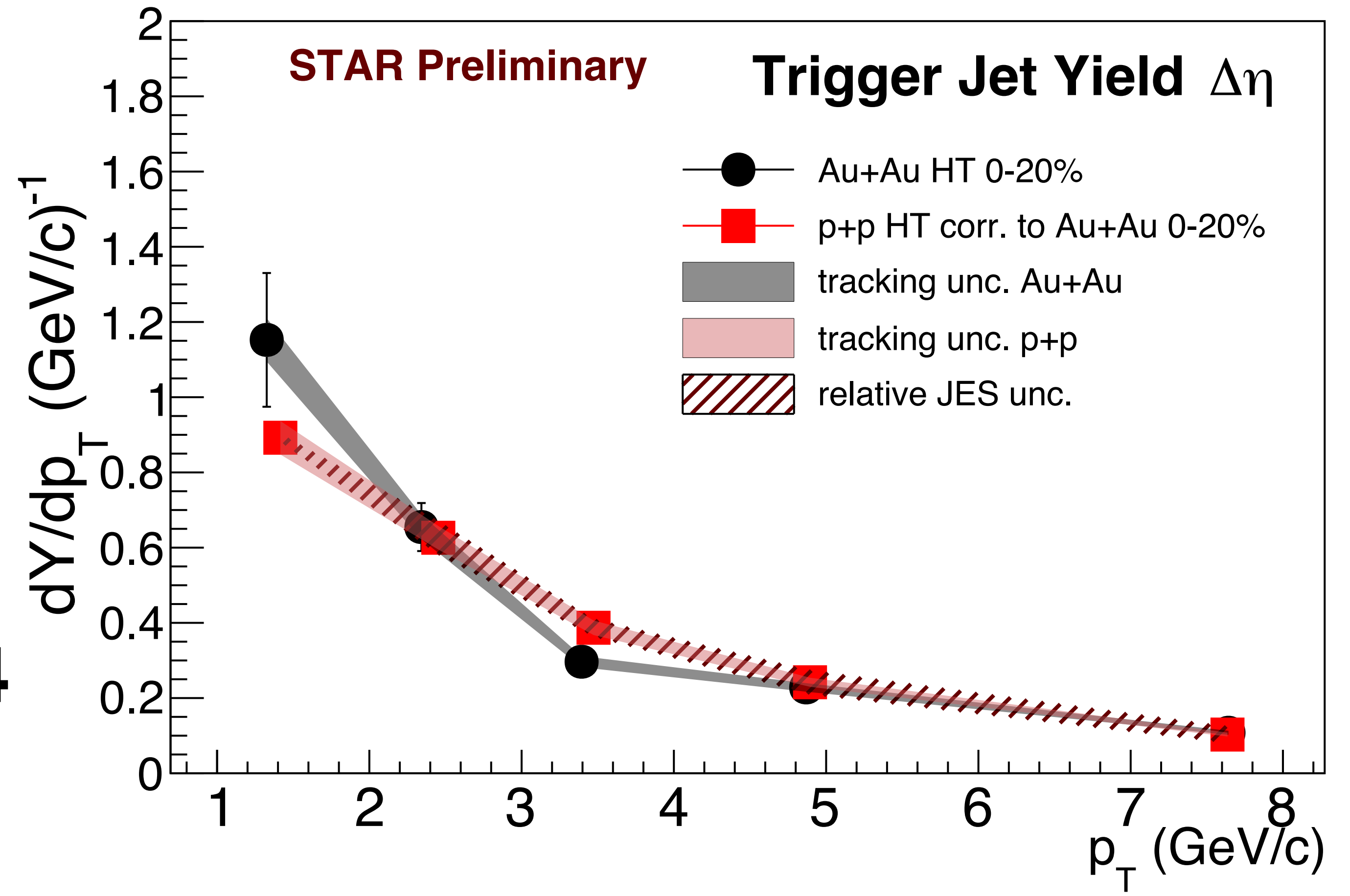
yields consistent between $\Delta\phi$ & $\Delta\eta$

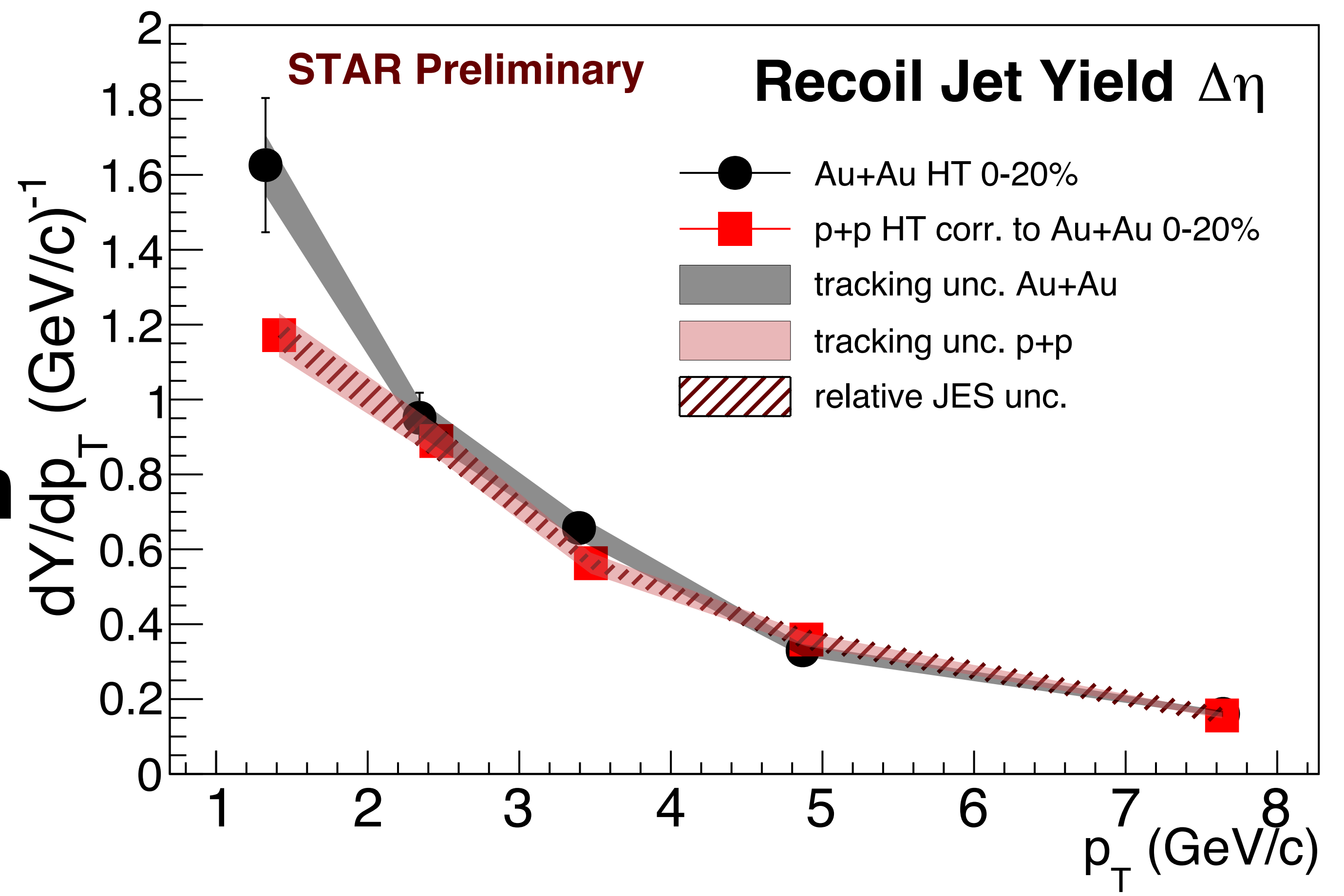
→ **yield contained within R=0.4**

trigger jet: unmodified

→ **"surface bias"**

recoil jet: hint of modification for p_T^{assoc}<2.0 GeV/c





Consistent with A_J?

How is the energy distributed?

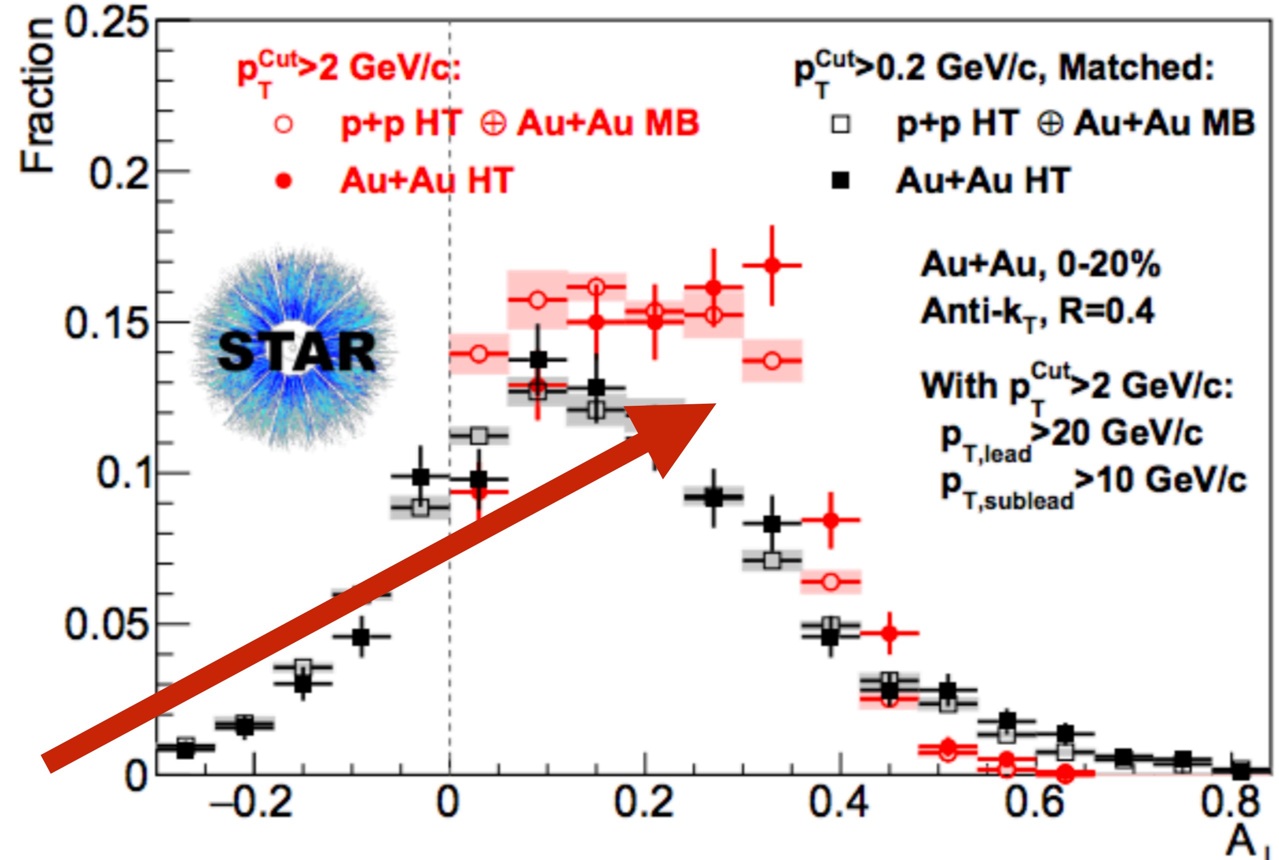
minimal modification at high p_T for both trigger & recoil jets

possible enhancement at low p_T in recoil jet

A_J enhances sensitivity to modification

effect is diluted in ensemble measurements like di-jet hadron correlations

Why a small effect?



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Conclusions

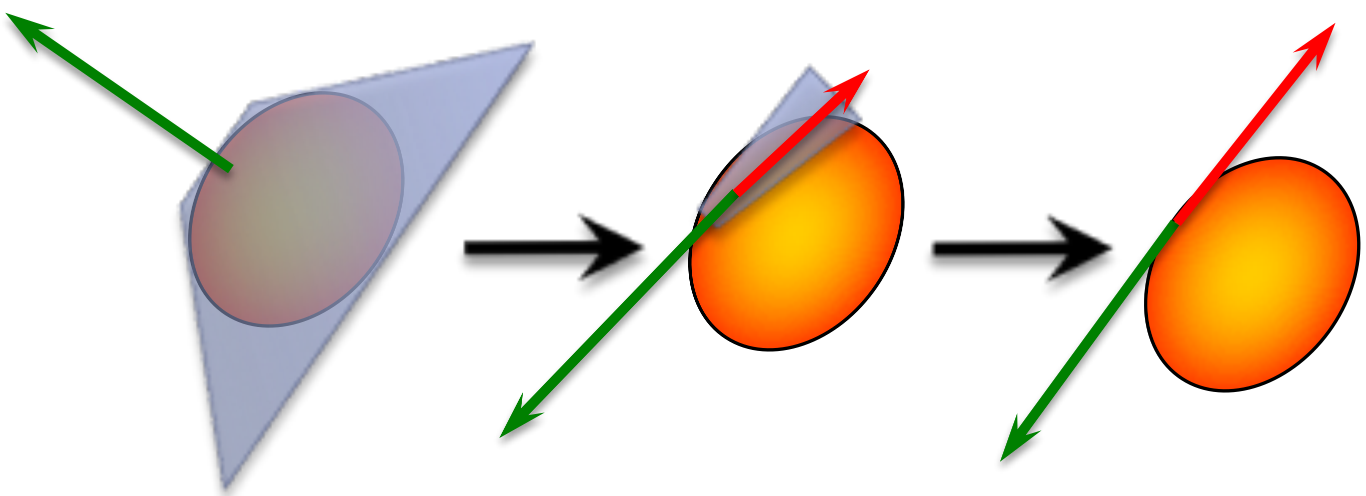
“Hard-Core" di-jets at STAR:

- **energy recovered within R=0.4**

- **hint of modification of A_J jets on recoil side**

towards the future:

large new data set

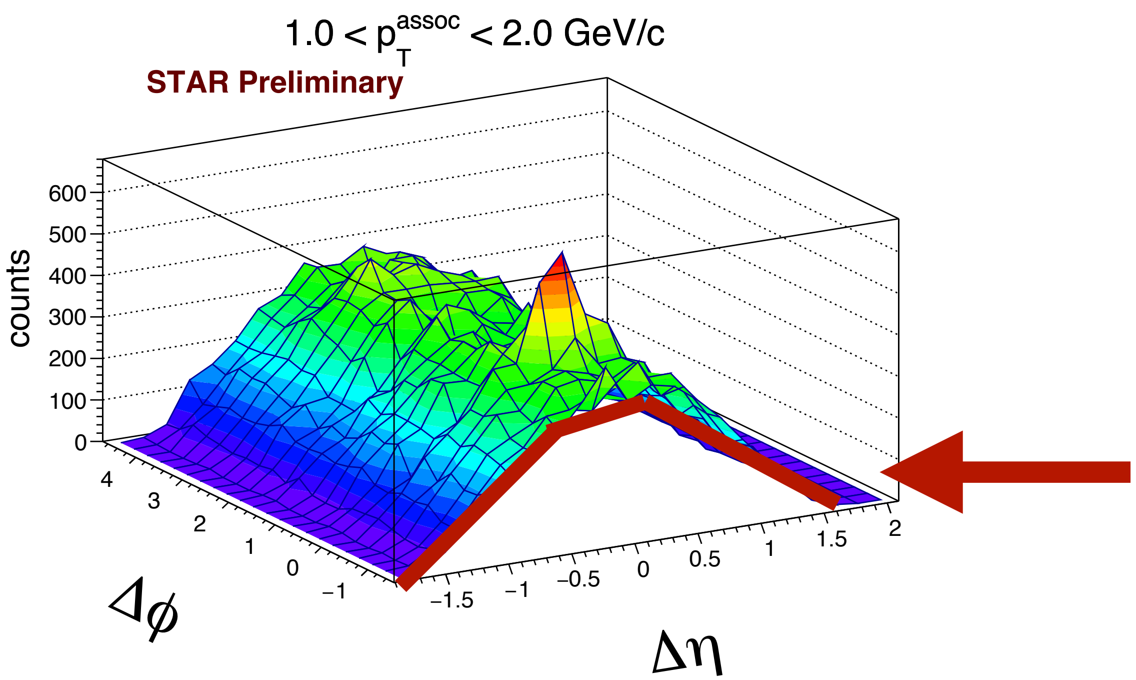


systematically explore di-jet cuts to constrain path length of jet in medium

- **“jet geometry engineering”**

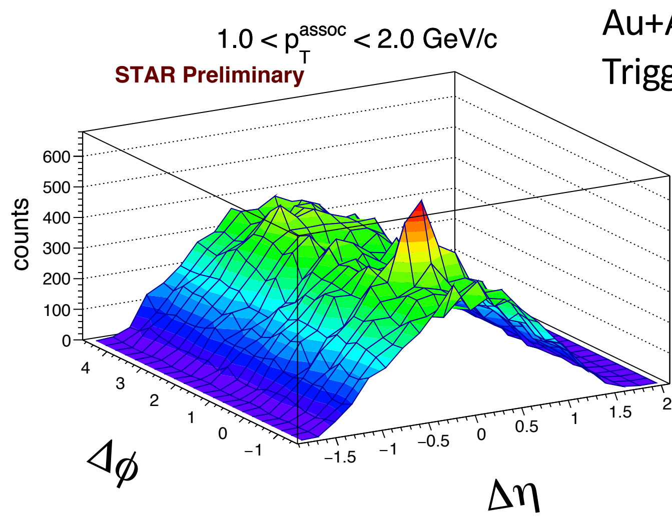
Thank you :)

Event mixing



flattened triangle in signal

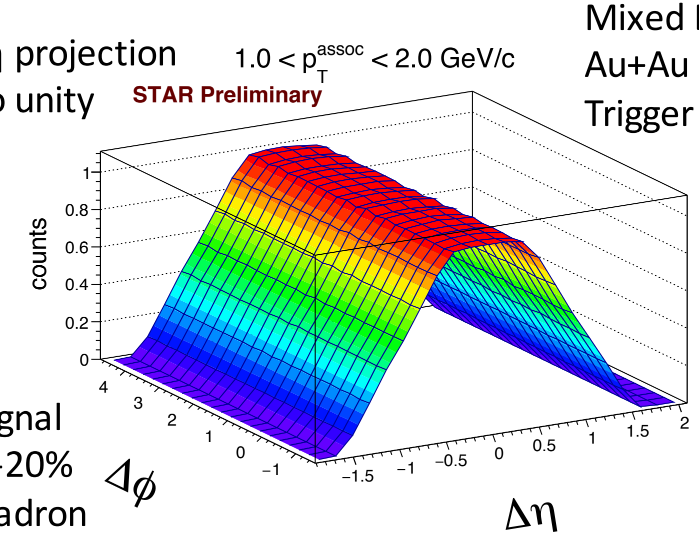
effect of pair acceptance



Correlation signal
Au+Au HT 0-20%
Trigger jet-hadron

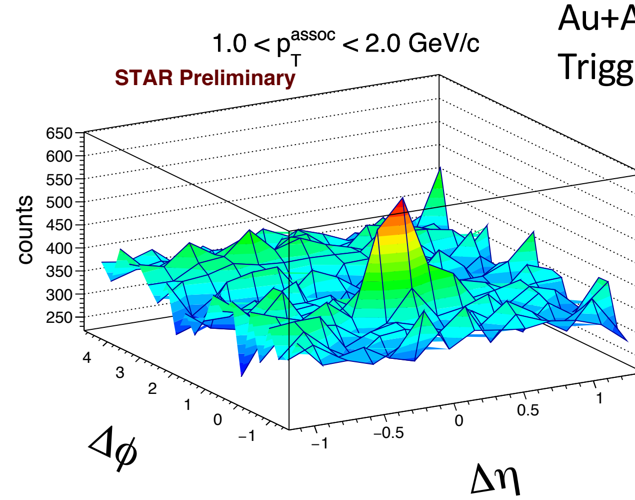
Division

Max bin in Δη projection
normalized to unity

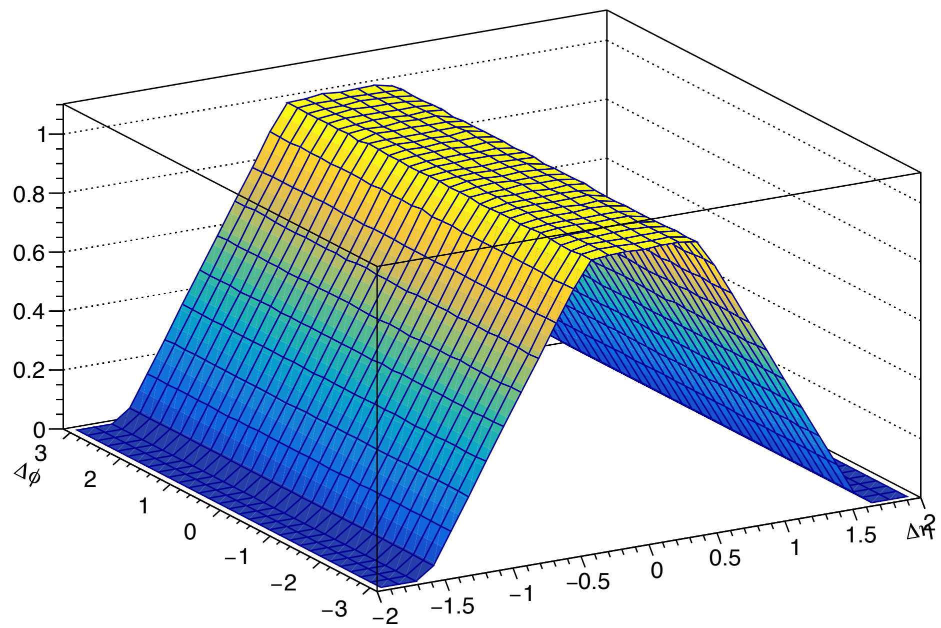


Mixed Events
Au+Au HT 0-20%
Trigger jet-hadron

Corrected Signal
Au+Au HT 0-20%
Trigger jet-hadron



Event mixing

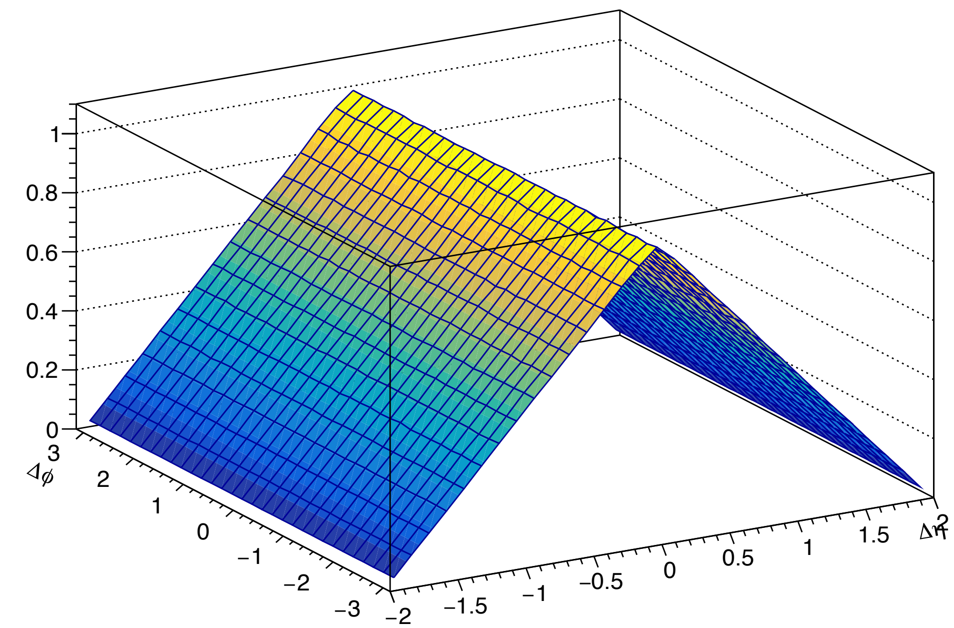


$|\eta^{assoc}| < 1.0$

$|\eta^{trigger}| < 1.0 - R$

example:

jet-hadron event mixing



$|\eta^{assoc}| < 1.0$

$|\eta^{trigger}| < 1.0$

example:

hadron-hadron event mixing