Yale

Jet-Hadron Correlations Examined with Monte Carlo Models

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01/12/16

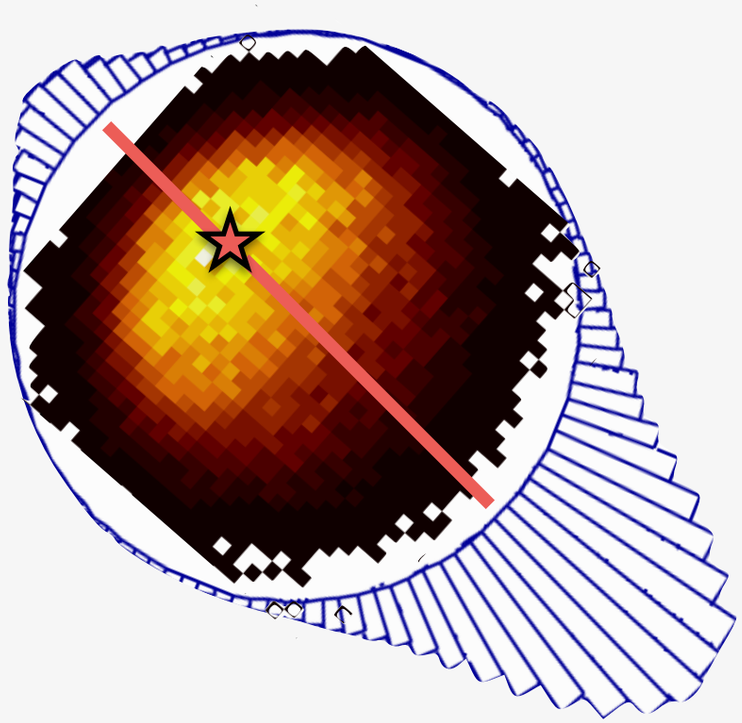
Introduction: Jet-Hadron Correlations

Azimuthal distribution of hadrons in jet-triggered events

Near-Side Peak:

- surface biased

(trigger conditions)



Away-Side Peak:

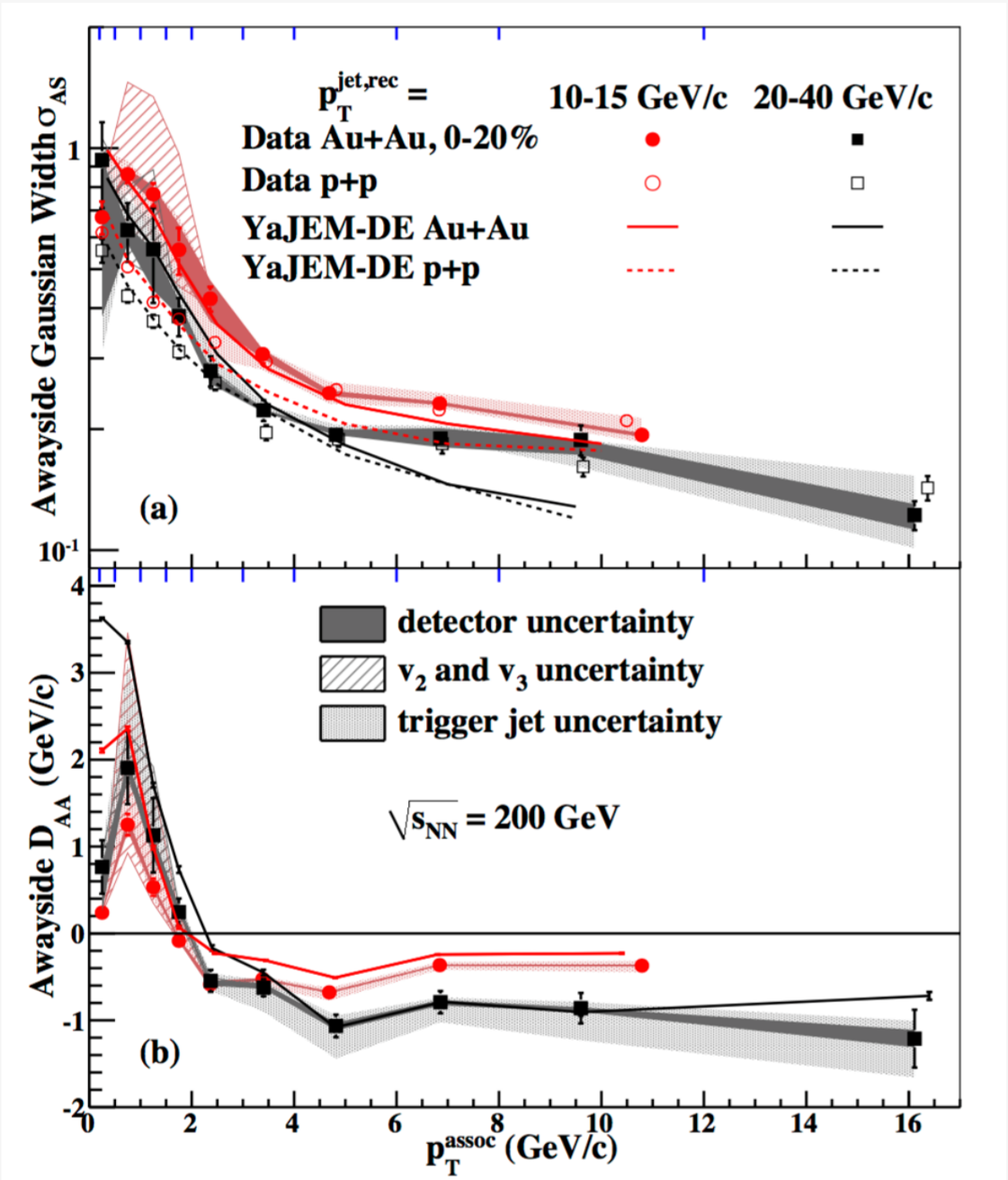
- longer in-medium path
- shower broadening
- softening of the FF

Reference:

“vacuum” AS peak,

measured in pp collisions

Experimental Measurements



Phys.Rev.Lett. 112 (2014) 12, 122301

STAR jet-hadron measurement

- hint for the AS peak broadening in AuAu collisions w.r.t. pp reference
- systematics doesn't allow for a conclusive statement
- data well described by YaJEM

On-going analysis:

- PbPb at 2.76 TeV J.Phys.Conf.Ser. 446 (2013) 012009
- also feasible with new 5.02 TeV data

Need for theoretical predictions!

Models

JEWEL — explicit pQCD treatment of hard parton scattering on partons of the medium (recoils can be kept or discarded)

K. Zapp *et al.* JHEP 1303 (2013) 080, EPJC C60 (2009) 617

YaJEM — scattering on constituents is not modeled explicitly

Hard parton acquires virtuality from the medium:

$$\Delta Q^2 = \kappa \int \epsilon^{3/4}(\xi)\, d\xi$$

enhanced radiation ⇒ broadening and softening of the shower

Free parameter κ must be tuned to reproduce exp. data (R_{AA})

T. Renk, Phys. Rev. C 84 (2011) 067902 and refs therein

Models

JEWEL 2.0.2

- complete event generator
- 1+1 Bjorken-type hydro
- hard scatterings from PYTHIA

YaJEM 1.15

- not an event generator
- in-medium showering routine
- “user” has to implement own workflow:
  - hydro input — ε(x,y,z,t)
    - (1+1) hydro — from JEWEL
    - (2+1) hydro — superSONIC

    https://sites.google.com/site/revihy/
  - hard scattering events

(vertex, energy, parton type)

Simulation and Analysis Setup

- AuAu@200 GeV, b = 0
- T_{in} = 370 MeV, T_{fin} = 170 MeV
- t_{in} = 0.5 fm

Jet reconstruction:

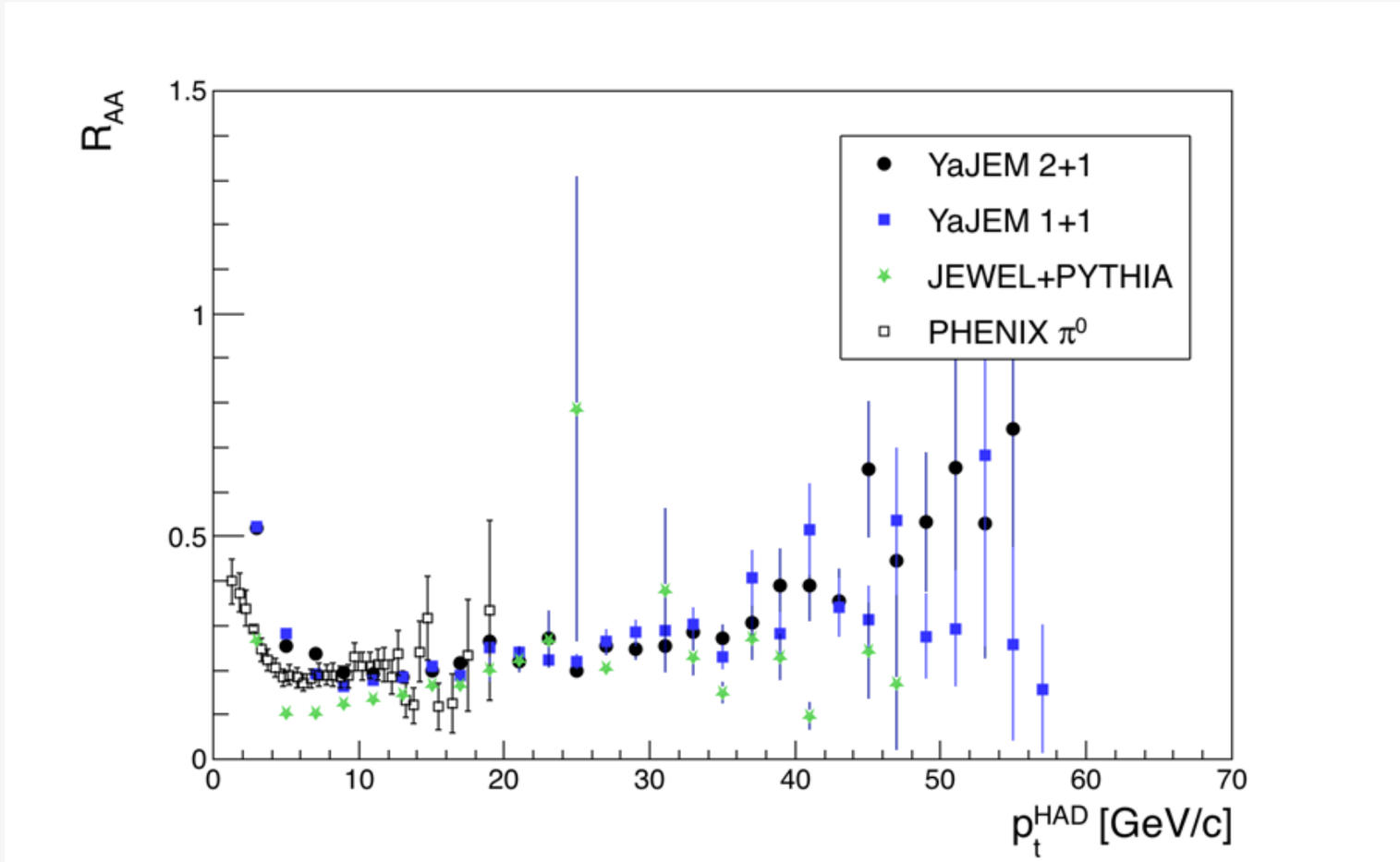
- FastJet, antikt, **R = 0.4**
- constituents p_T > 2 GeV
- hard track p_T > 6 GeV

- PbPb@2.76(5) TeV, b = 0
- T_{in} = 470 (500) MeV, T_{fin} = 170 MeV
- t_{in} = 0.5 fm

Jet reconstruction:

- FastJet, antikt, **R = 0.2**
- constituents p_T > 3 GeV
- hard track p_T > 6 GeV

Hadron R_{AA} AuAu @ 200 GeV

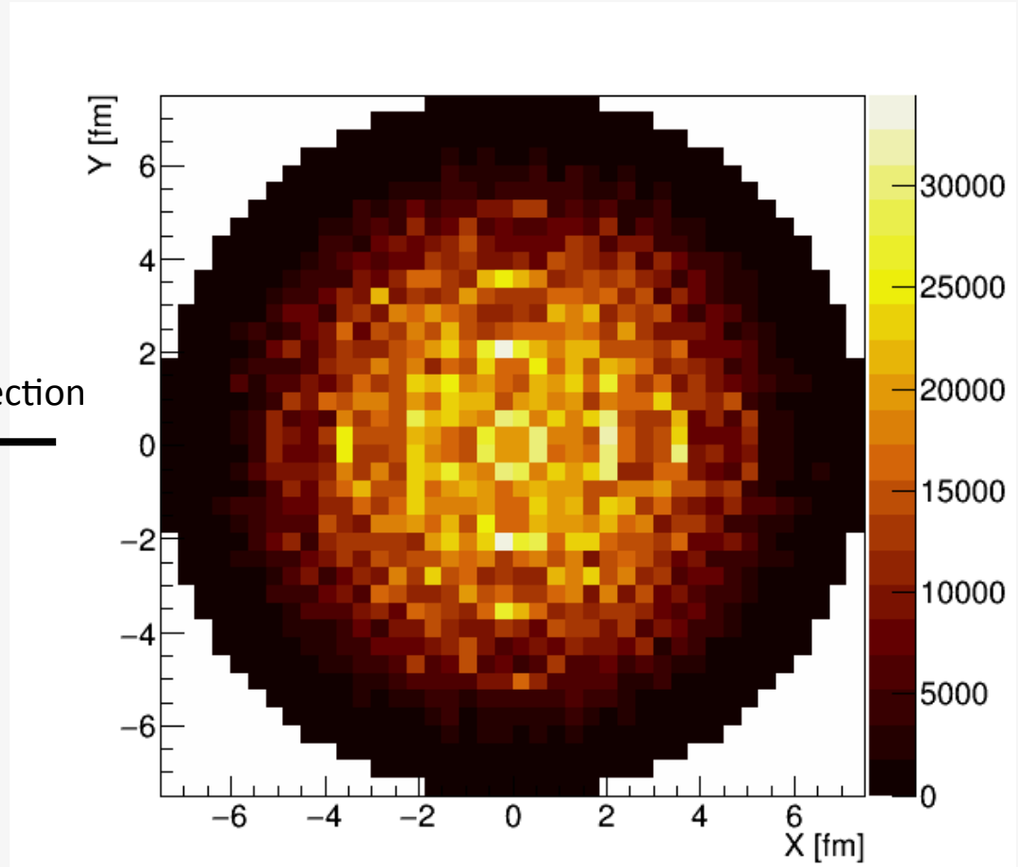


- YaJEM tuned to reproduce hadron R_{AA} at RHIC, $\kappa \sim 2$
- JEWEL — default parameters v2.0.2
- Models agree very well in p_t range (15,40) GeV

Surface Bias: AuAu @ 200 GeV

YaJEM ***TRANSPARENT MEDIUM***

trigger jet direction



- XY-distribution of hard scattering vertices
- w/o jet quenching hard scattering vertices

are distributed according to the overlap function

Surface Bias: AuAu @ 200 GeV

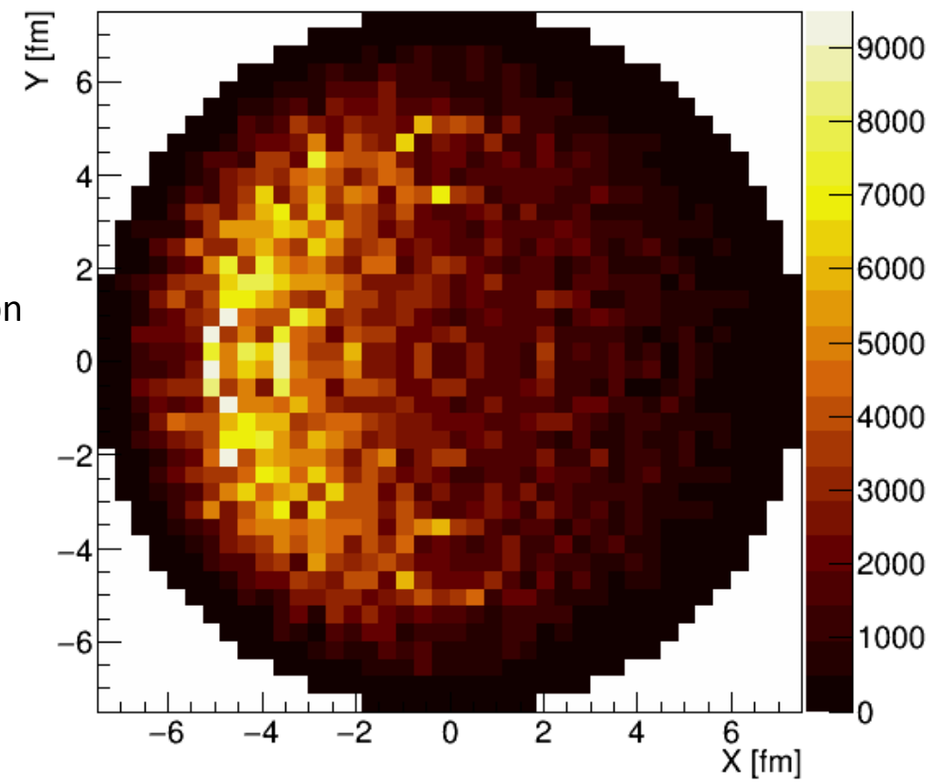
YaJEM 2+1 hydro

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

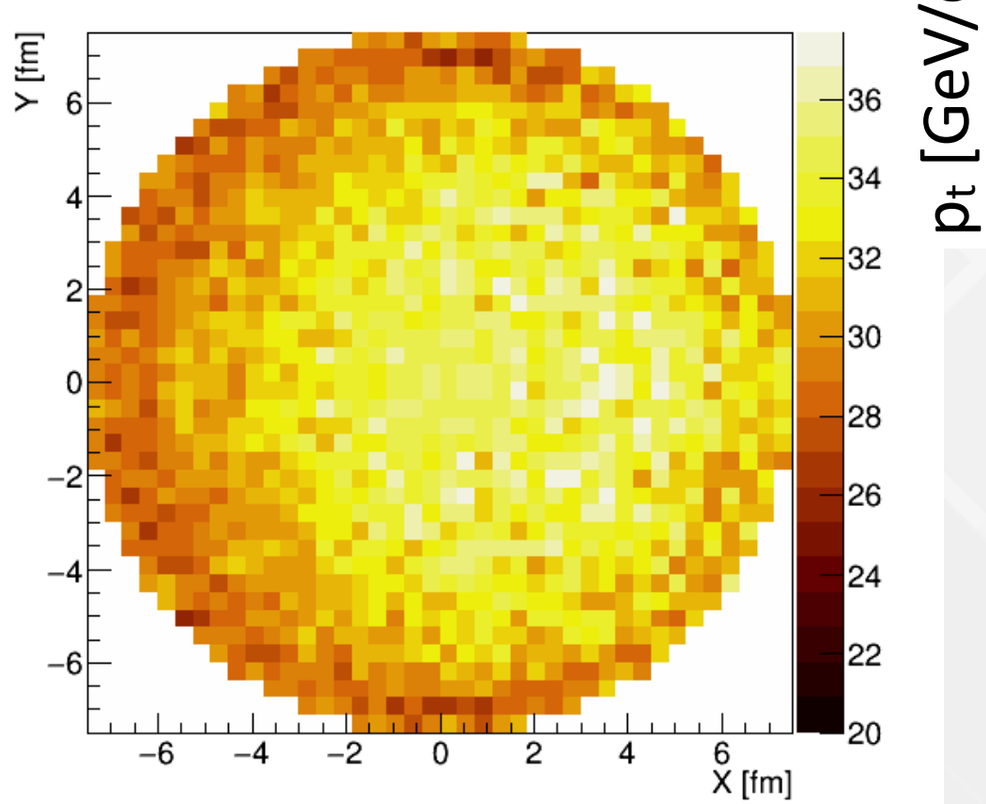
leading jet 20-40 GeV

< X > = − 1.4 fm

trigger jet direction



average hard scattering p_t satisfying the trigger cond.

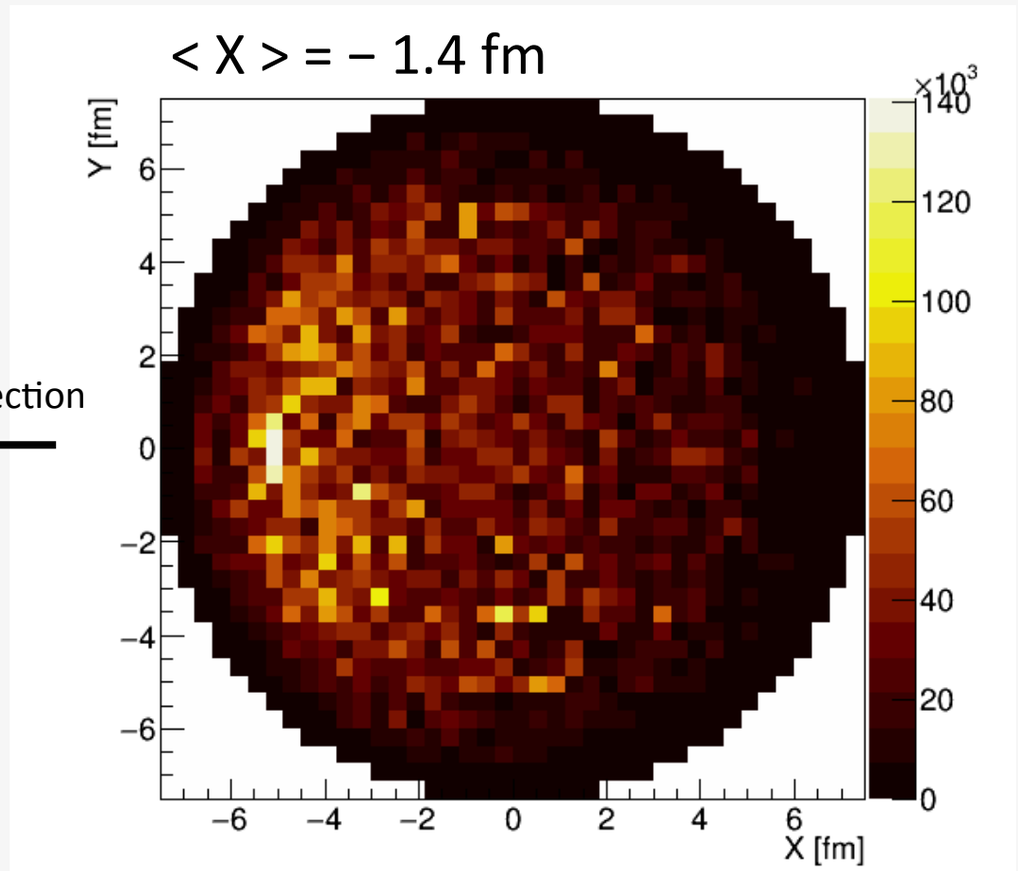


Surface Bias: AuAu @ 200 GeV

YaJEM 2+1 hydro

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

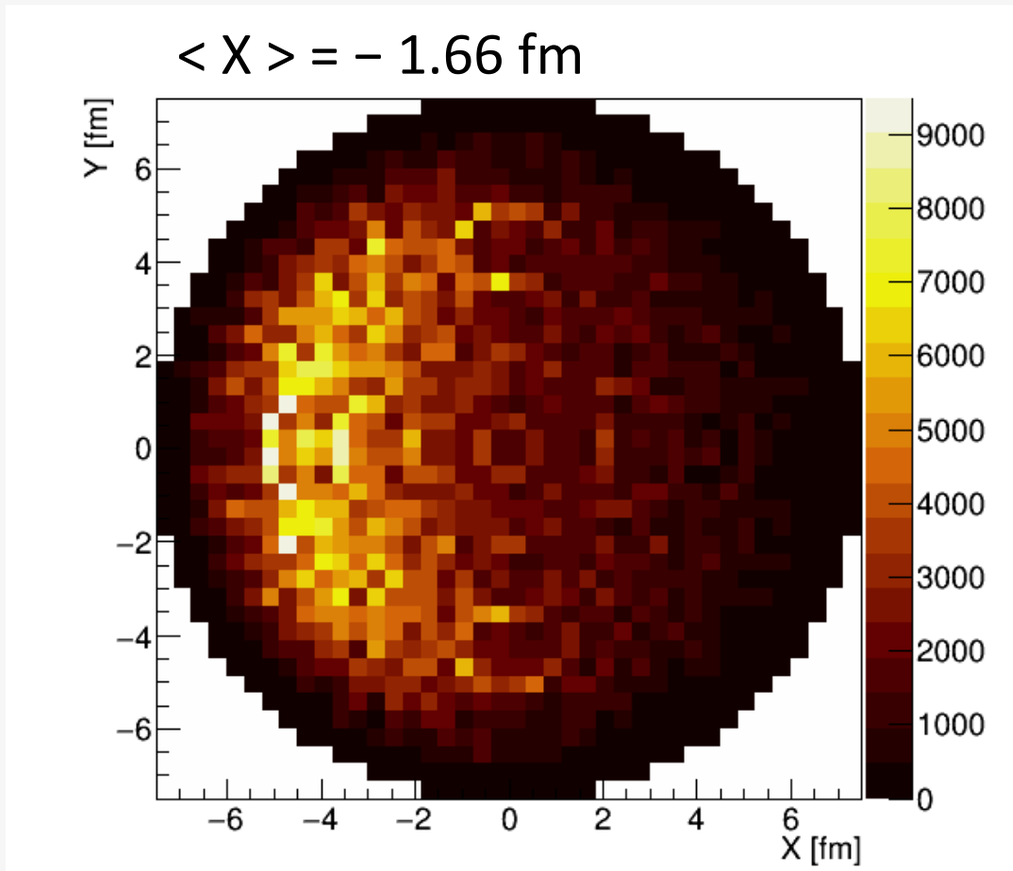
leading jet 10-15 GeV



trigger jet direction

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

leading jet 20-40 GeV

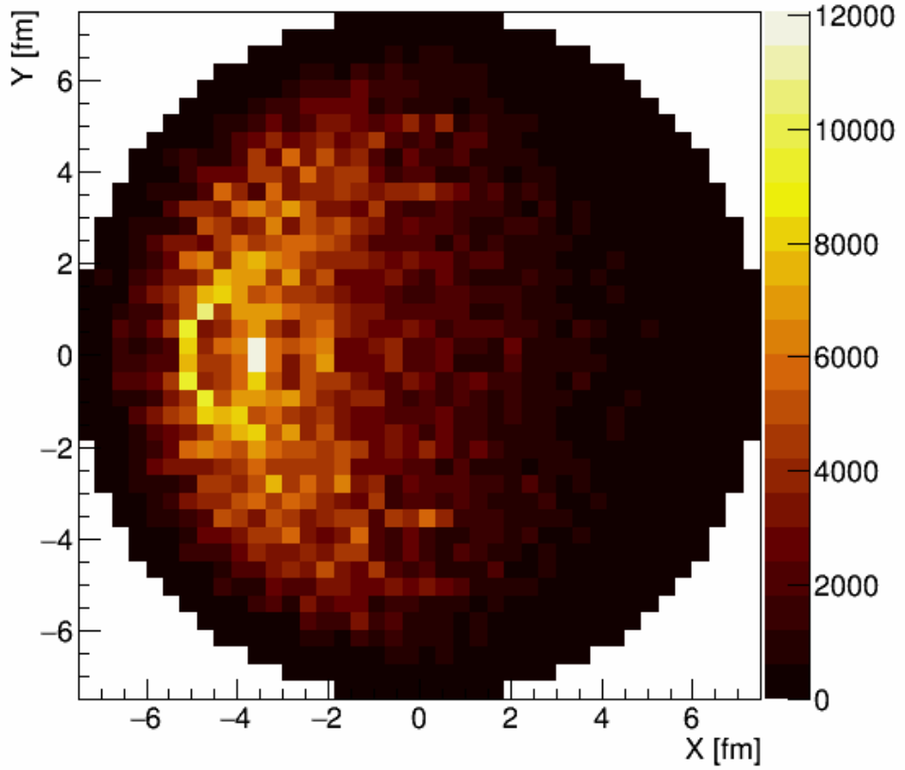


Surface Bias: AuAu @ 200 GeV

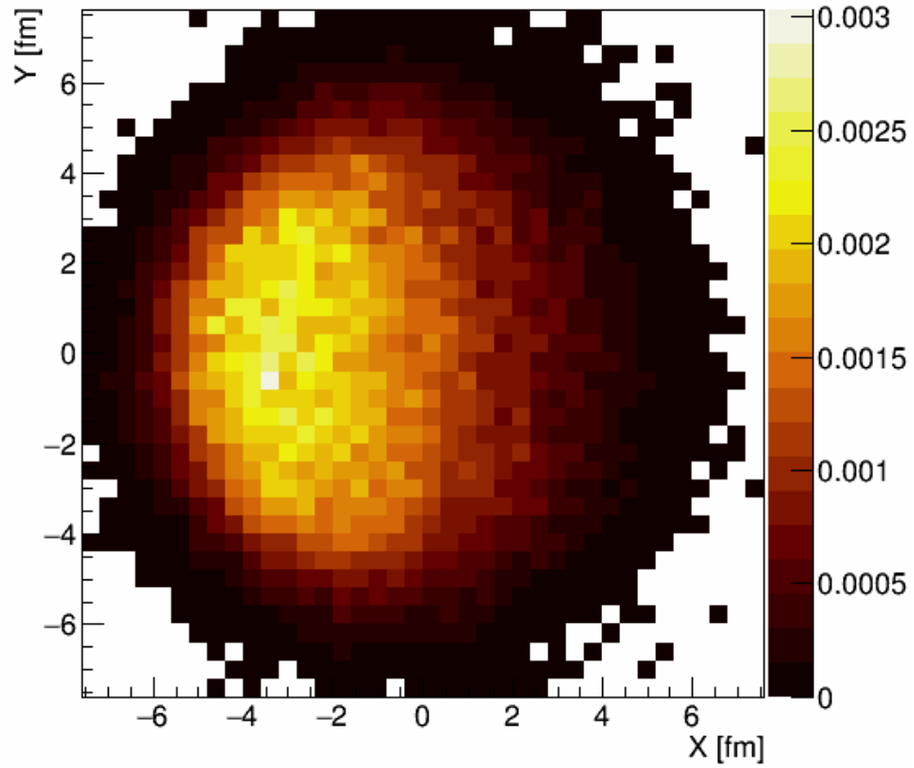
YaJEM 1+1 hydro **JEWEL 1+1 hydro**

leading jet 20-40 GeV constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

< X > = − 2.1 fm



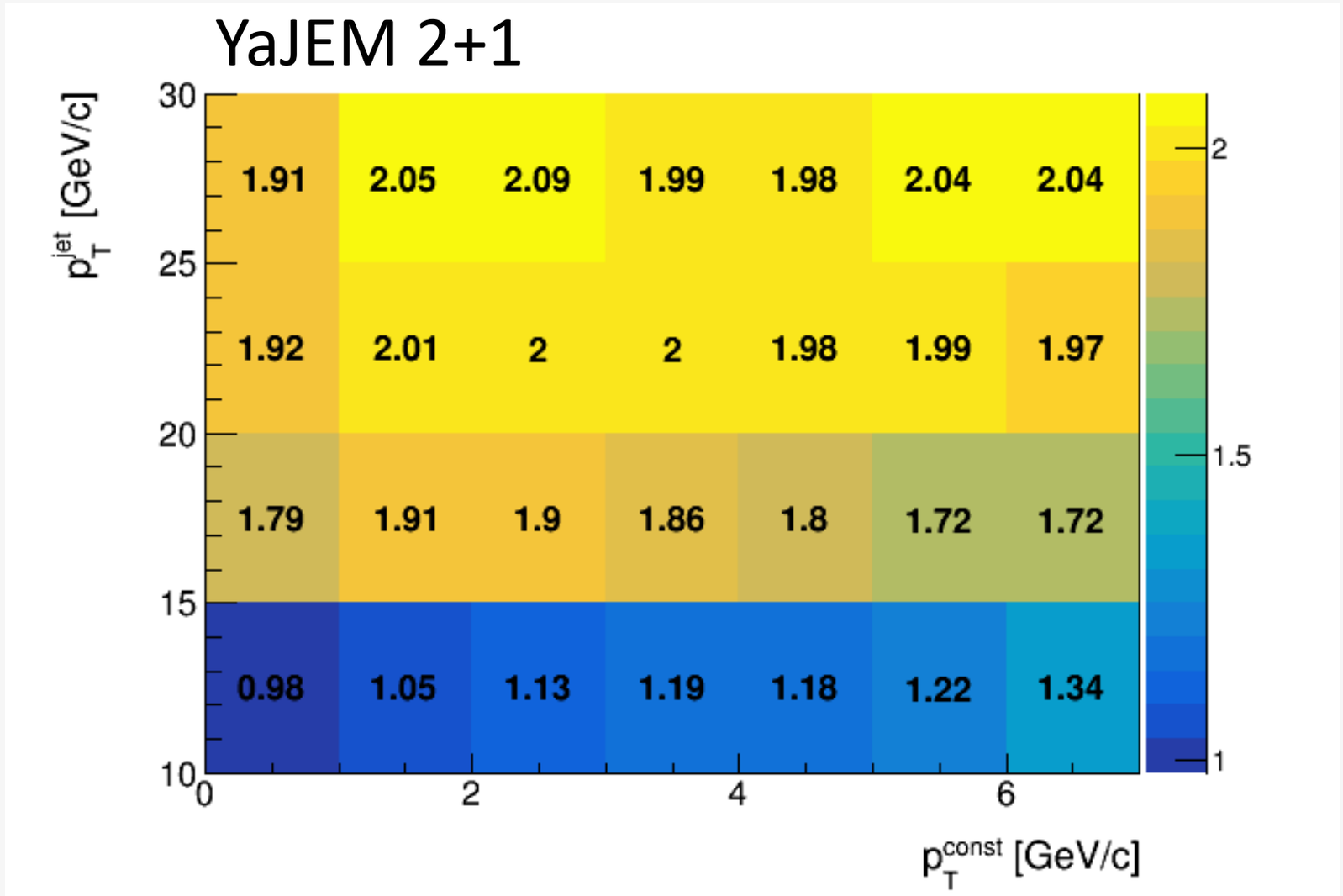
< X > = − 1.6 fm



- same hydro input used for two models
- same qualitative picture, details differ

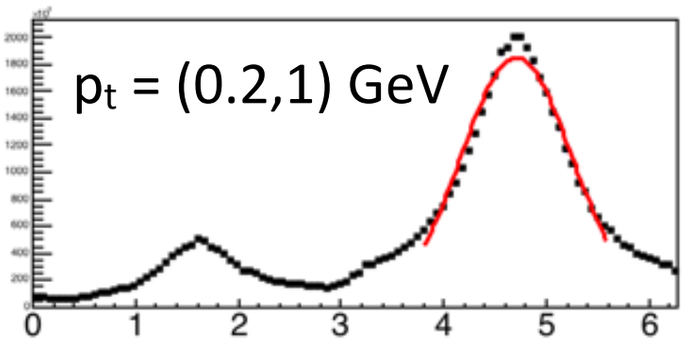
Surface biases for AuAu@200

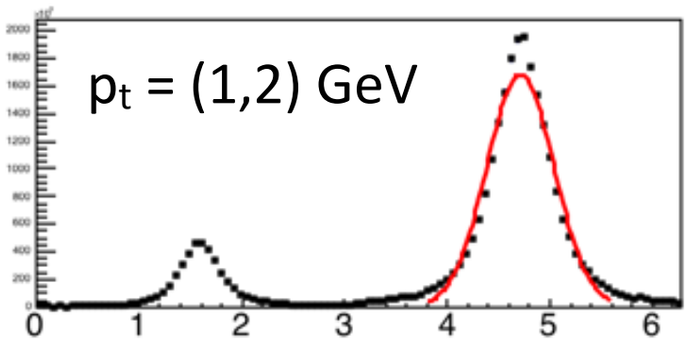
$s = N_{vertices}\ (x < 0) / N_{vertices}\ (x > 0)$

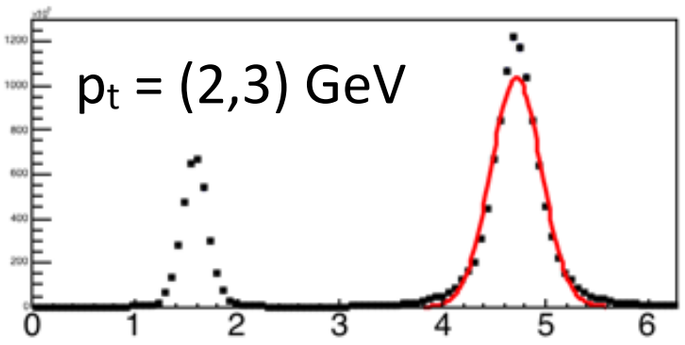


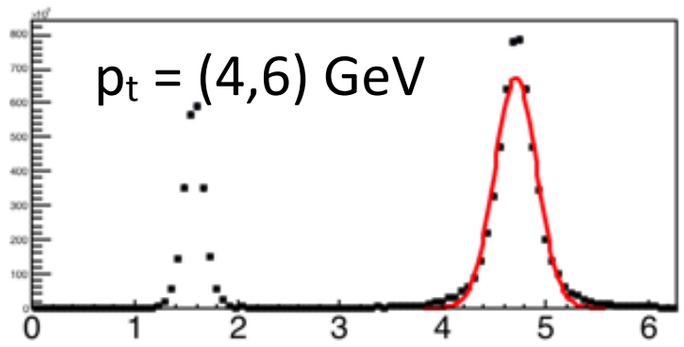
- Surface bias depends on the trigger configuration
- Many more variables: R, hard track requirement, …

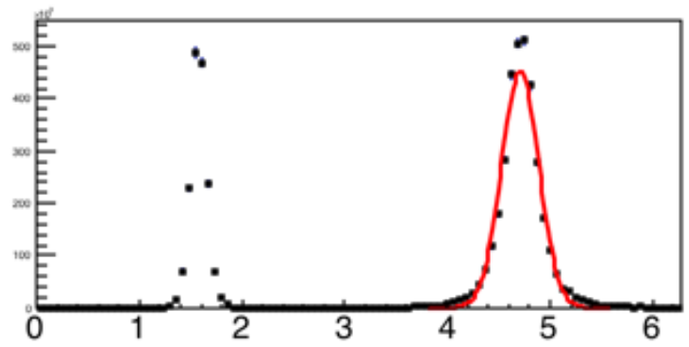
pp@200 AS fits jet 20-40 GeV

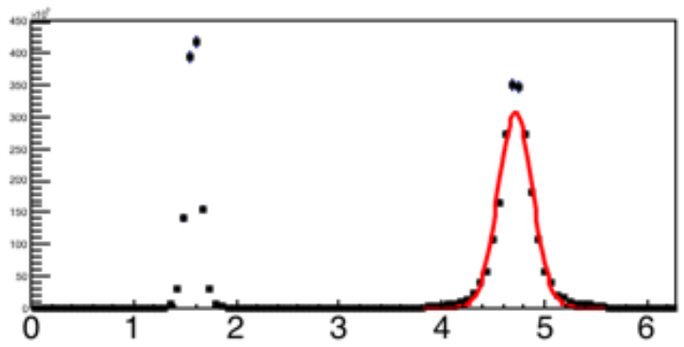


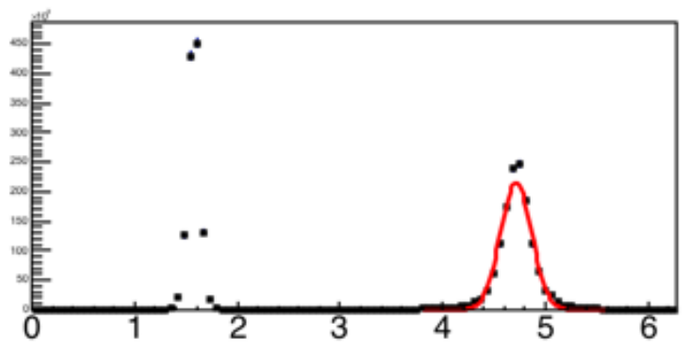


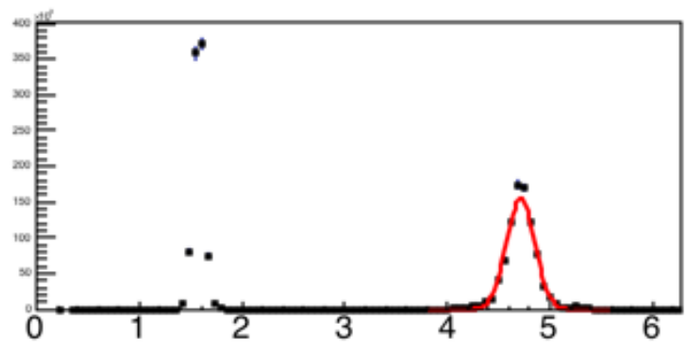


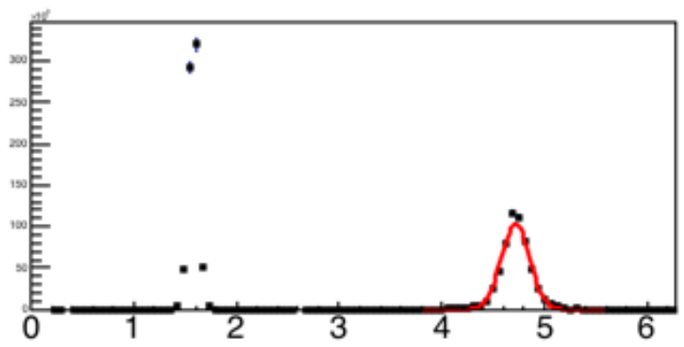


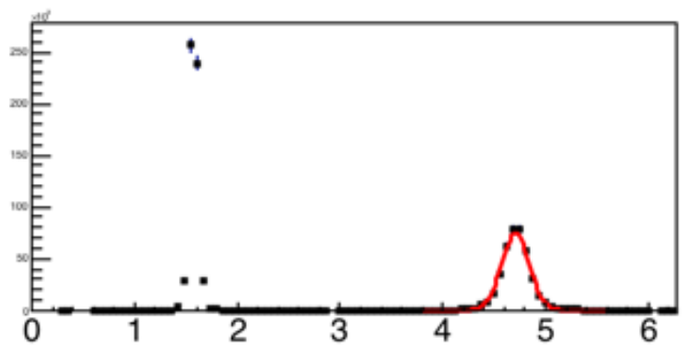


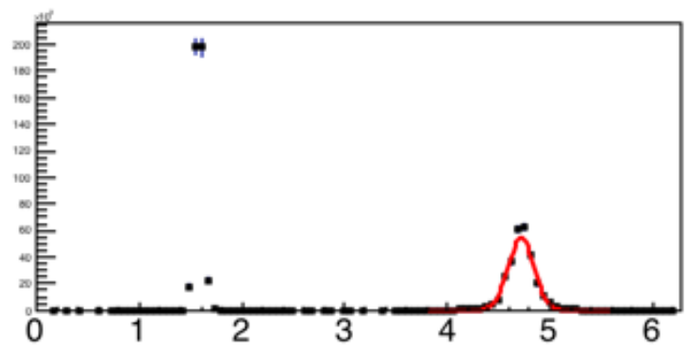




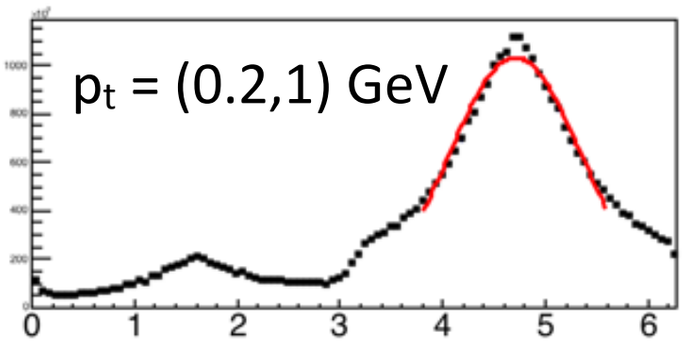


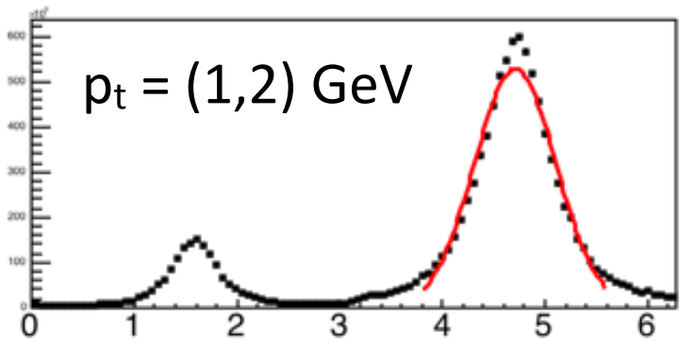


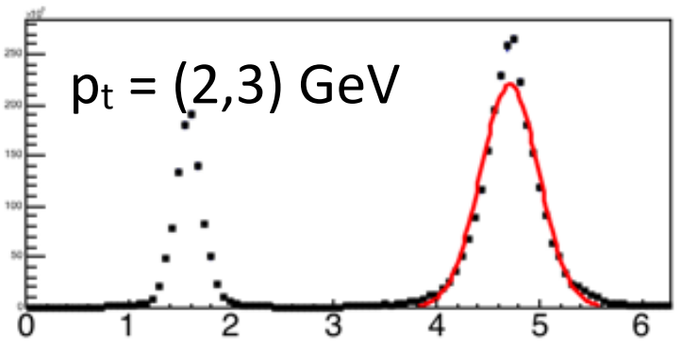


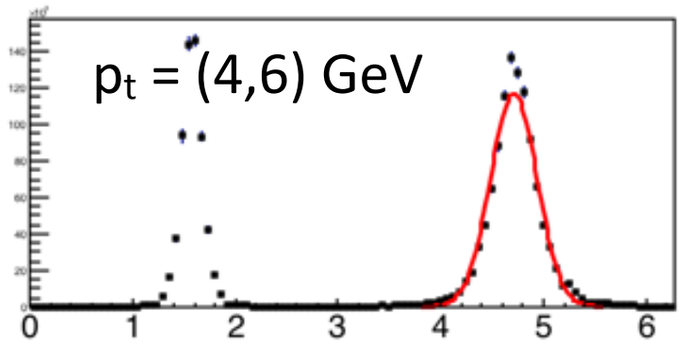


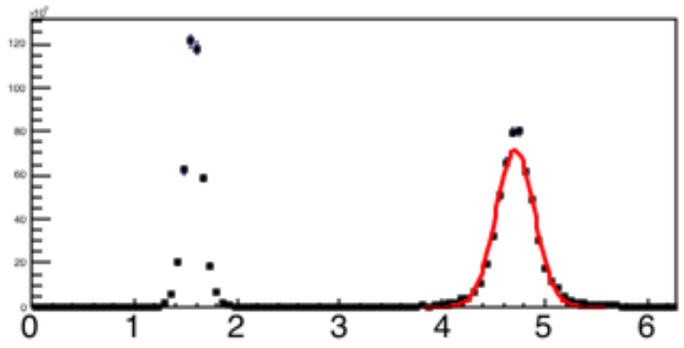
AuAu@200 AS fits jet 20-40 GeV

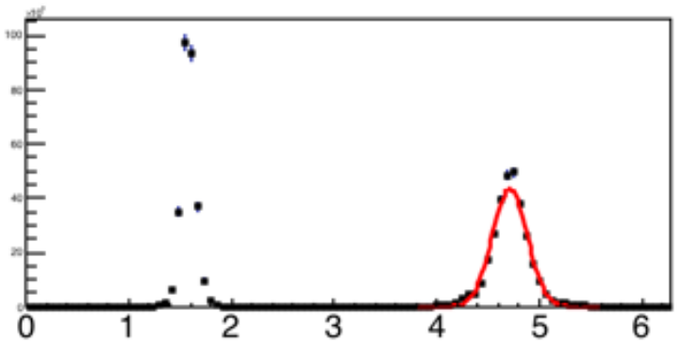


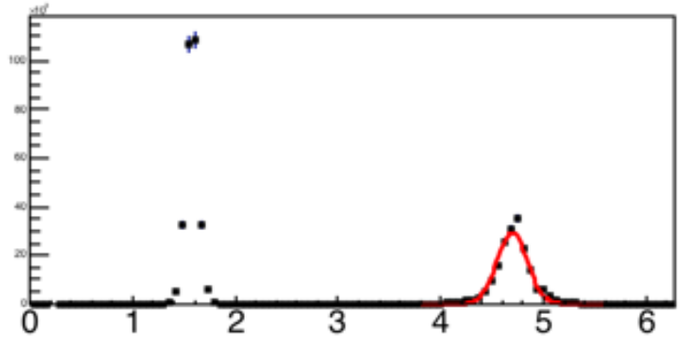


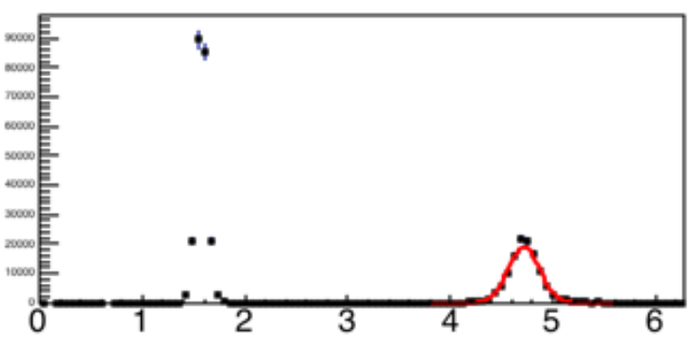


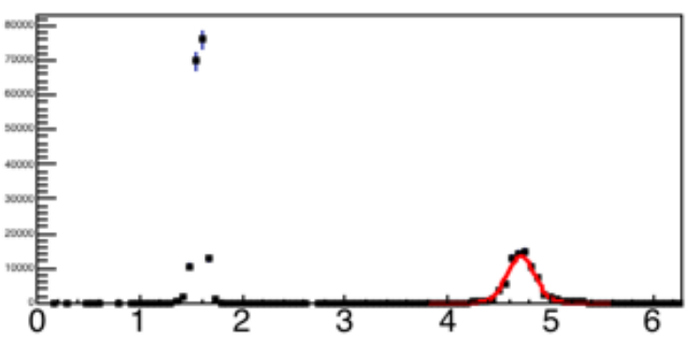


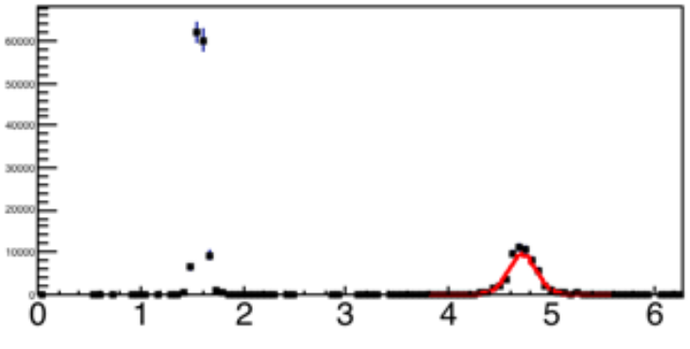


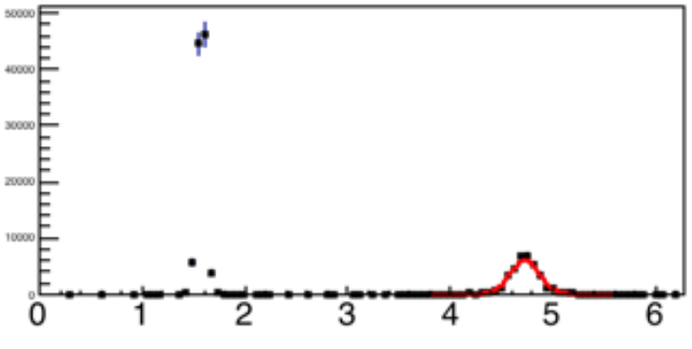








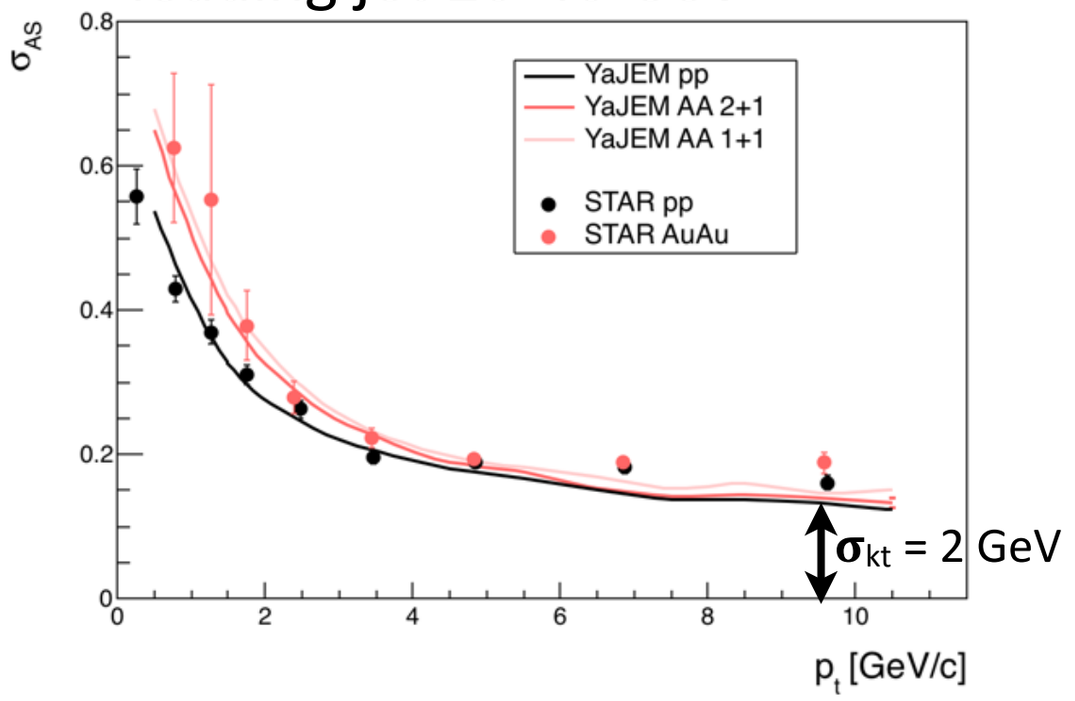




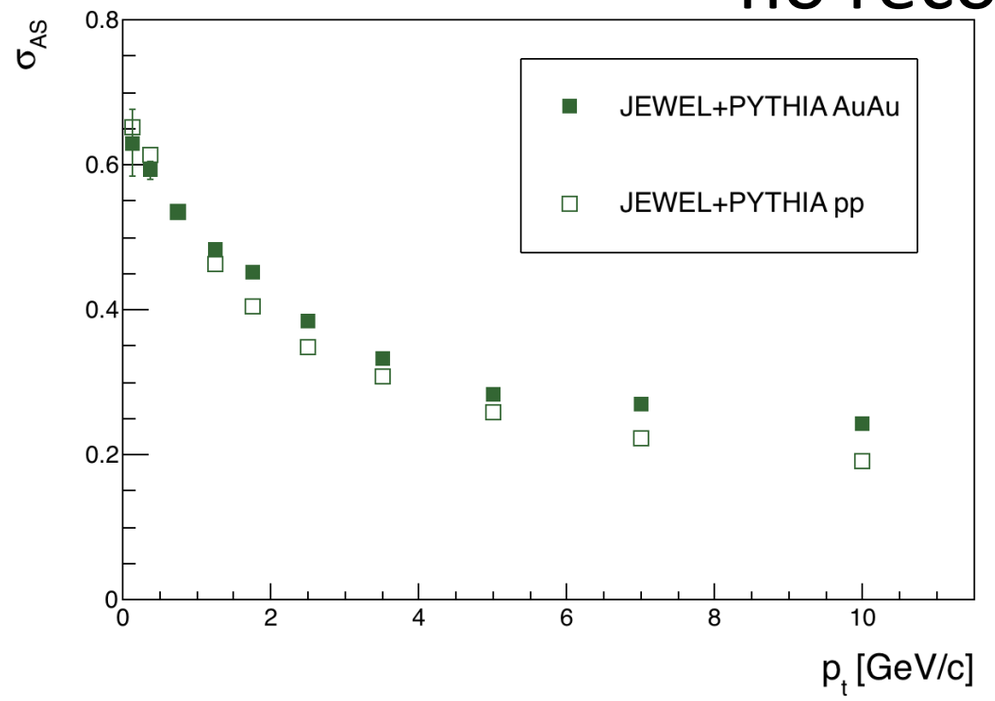
AS widths: AuAu @ 200 GeV

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

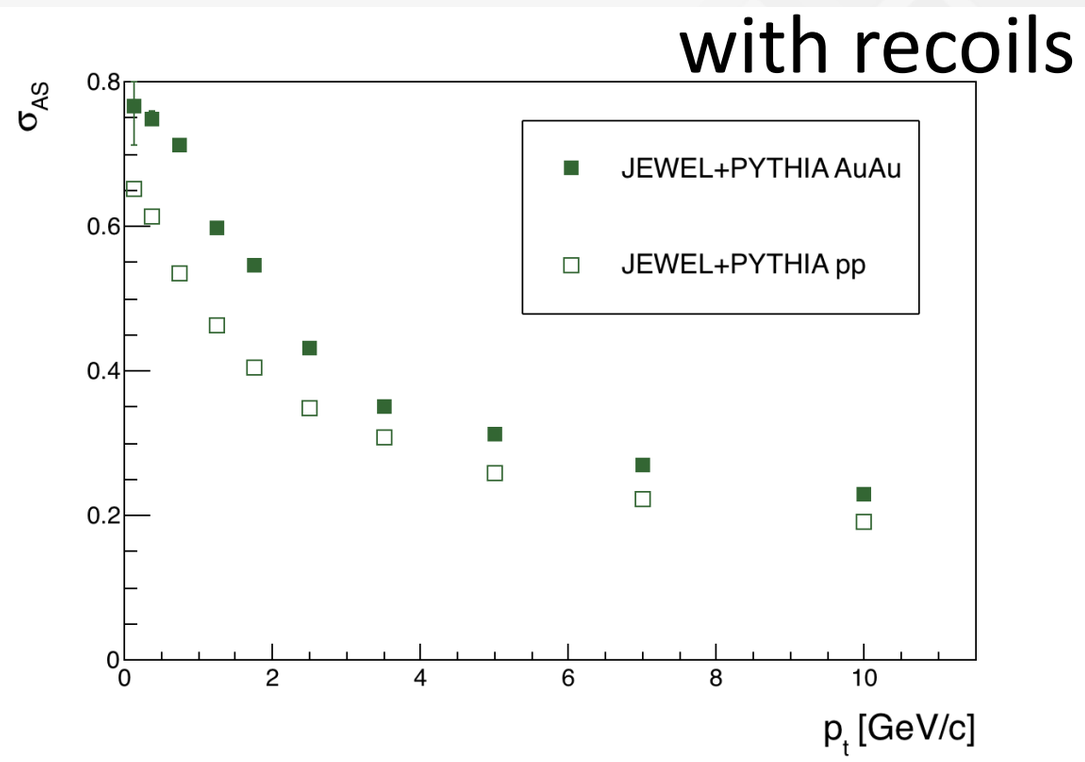
leading jet 20-40 GeV



no recoils

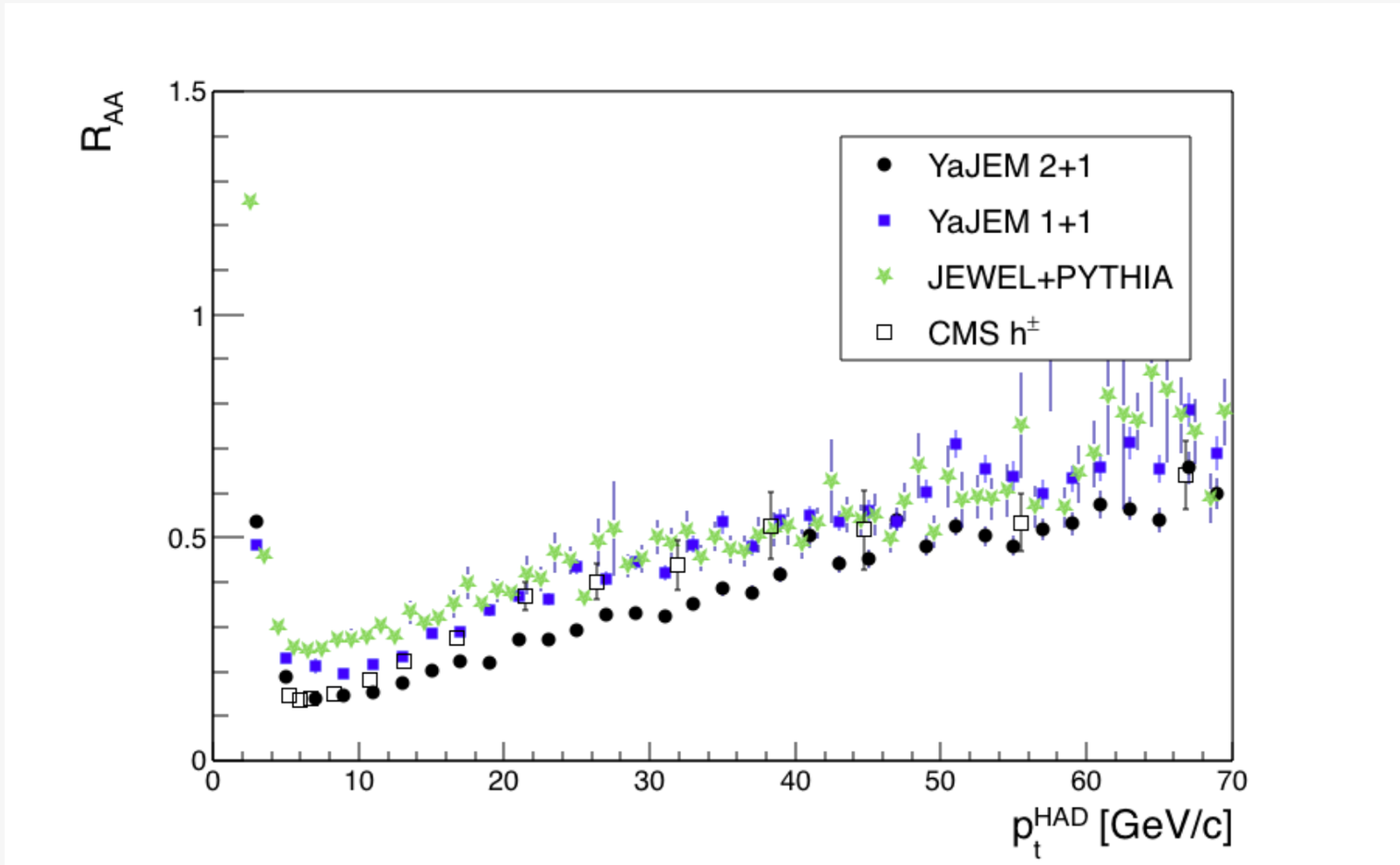


with recoils



- test of the YaJEM implementation ✓
- different results for JEWEL with and without recoils

Hadron R_{AA} PbPb @ 2.76 TeV

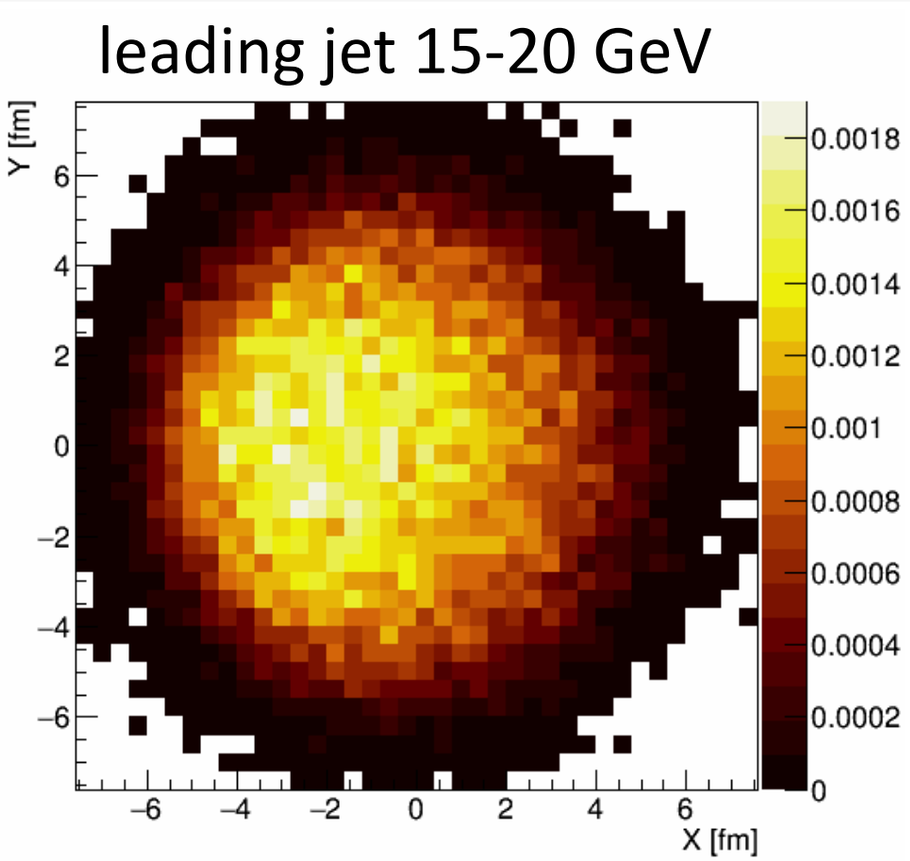


- Model parameters fixed at RHIC energies

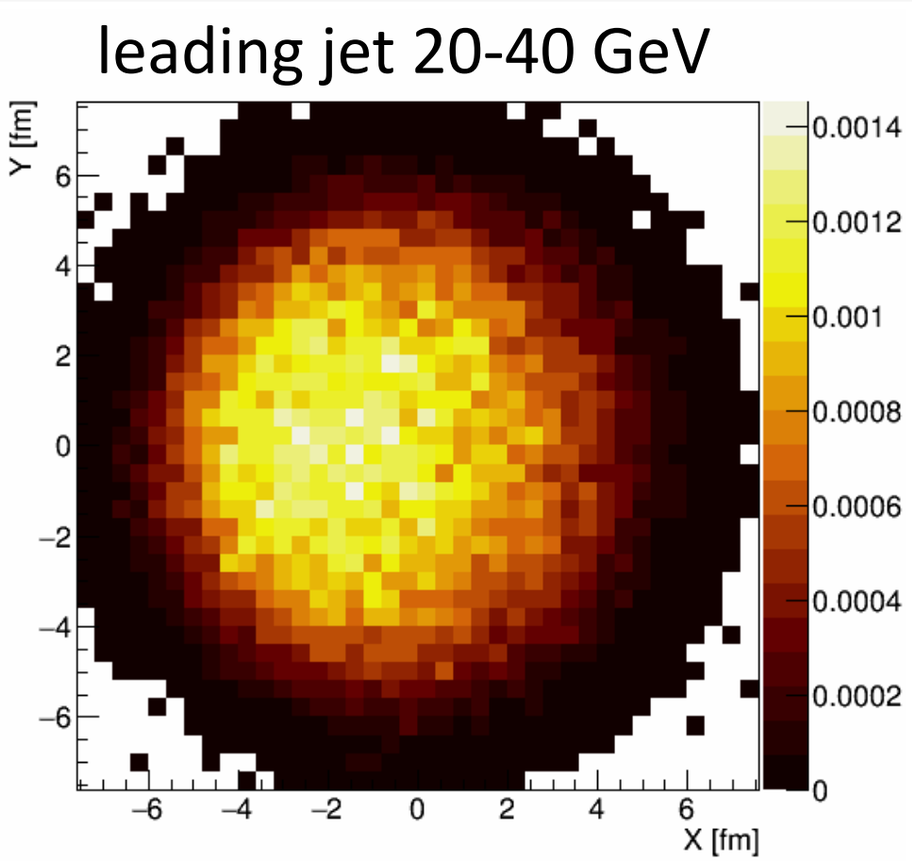
Surface Bias: PbPb @ 2.76 TeV

JEWEL 1+1 hydro

constituents p_T > 3GeV & hard track p_T > 6 GeV



constituents p_T > 3GeV & hard track p_T > 6 GeV



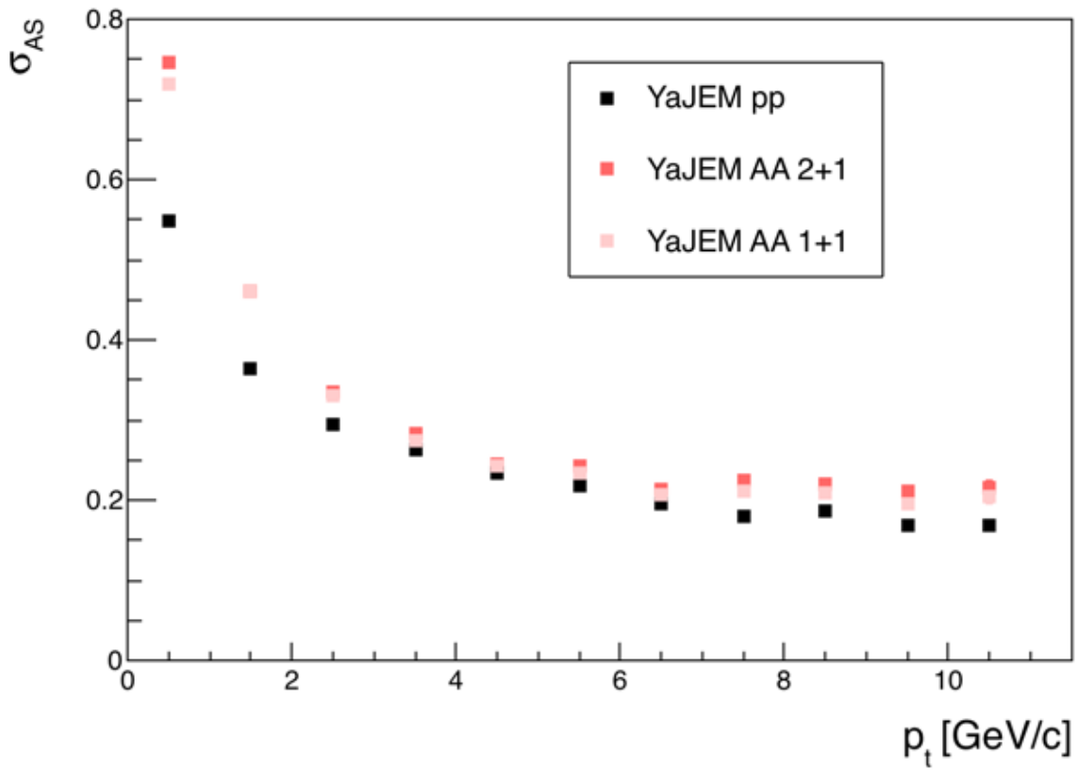
- less pronounced surface bias at LHC

AS widths: PbPb @ 2.76 (5) TeV

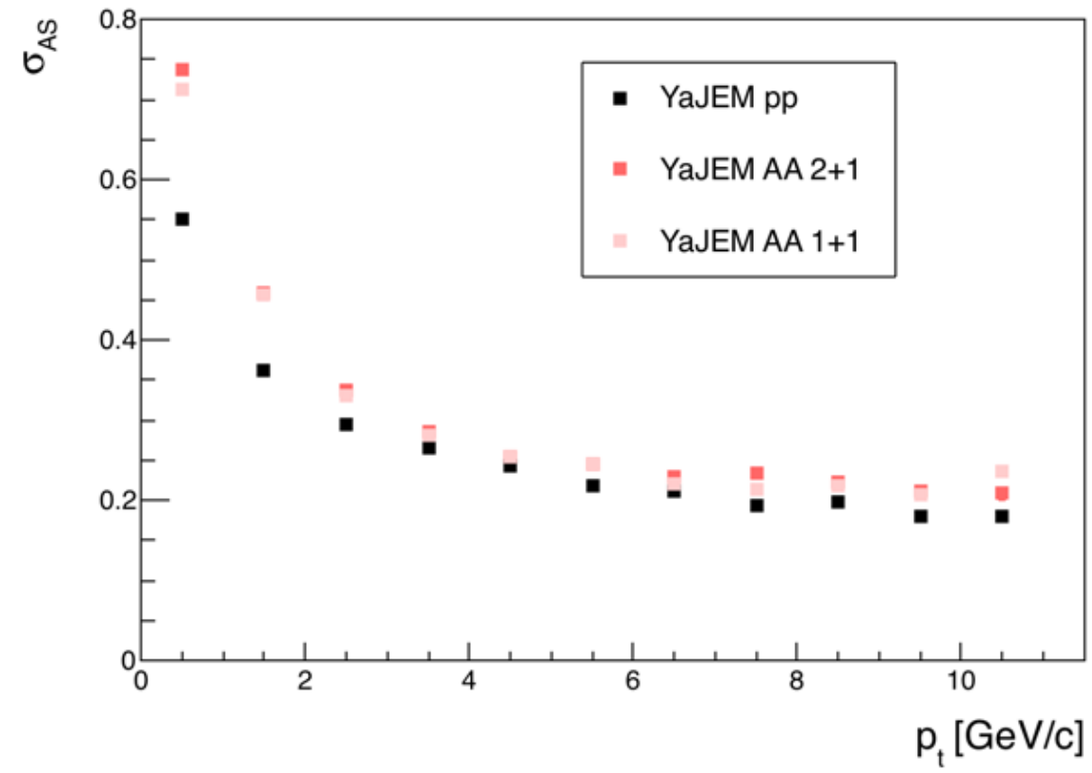
constituents $p_T > 3$ GeV & hard track $p_T > 6$ GeV

leading jet 20-40 GeV

PbPb 2.76 TeV



PbPb 5 TeV



- increased effect to be expected at LHC

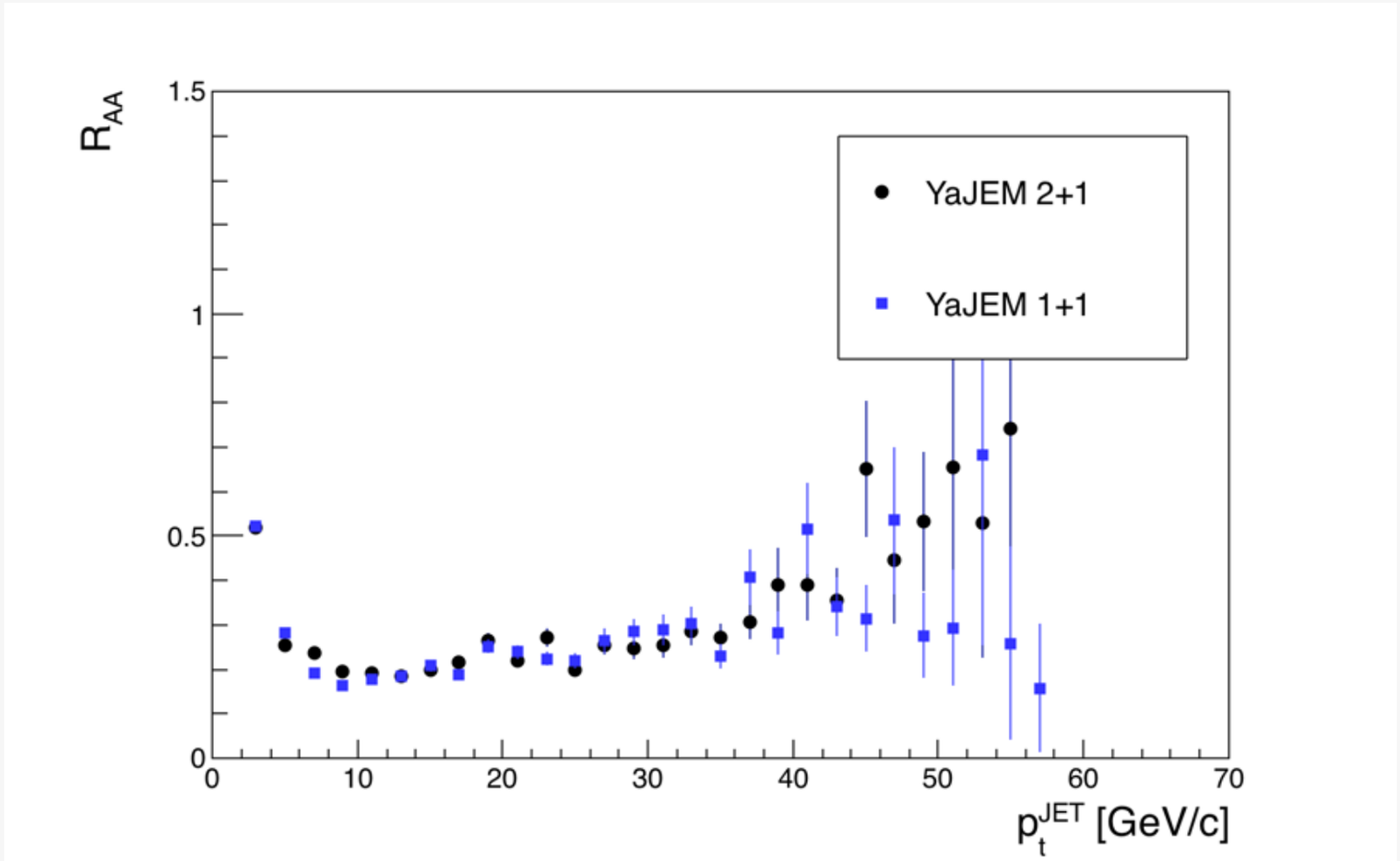
Summary and outlook

- YaJEM workflow implemented
- Jet-hadron correlations and surface biases studied with YaJEM and JEWEL
- Predictions for LHC are made
- New high-precision data are awaited

- Other observables (dijets, …)
- Other models (q-PYTHIA, AdS/CFT MC?)

Backup slides

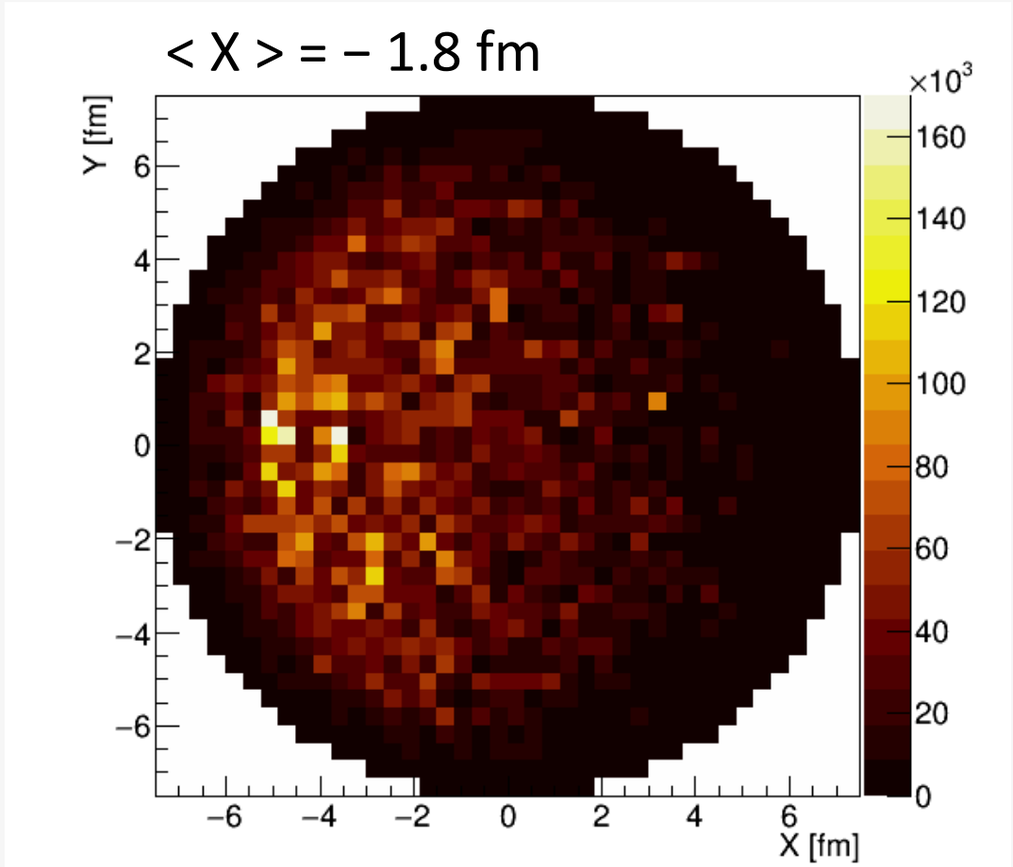
Jet R_{AA} AuAu @ 200 GeV



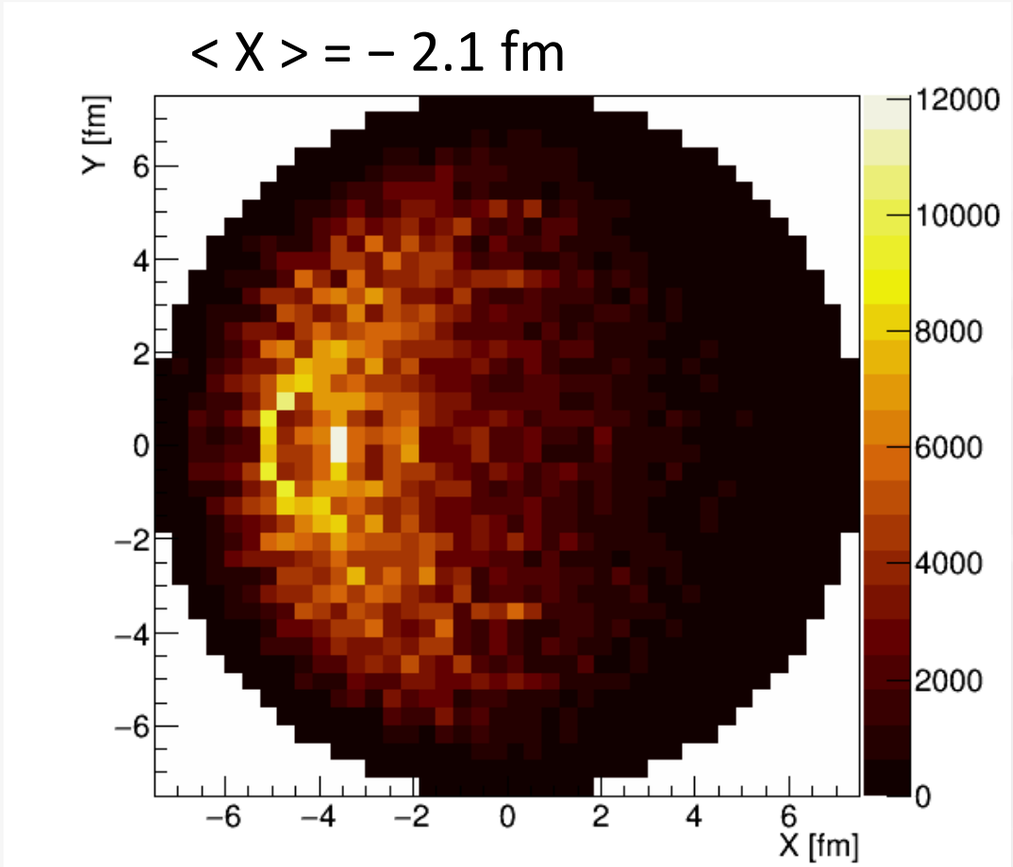
Surface Bias: AuAu @ 200 GeV

YaJEM 1+1 hydro

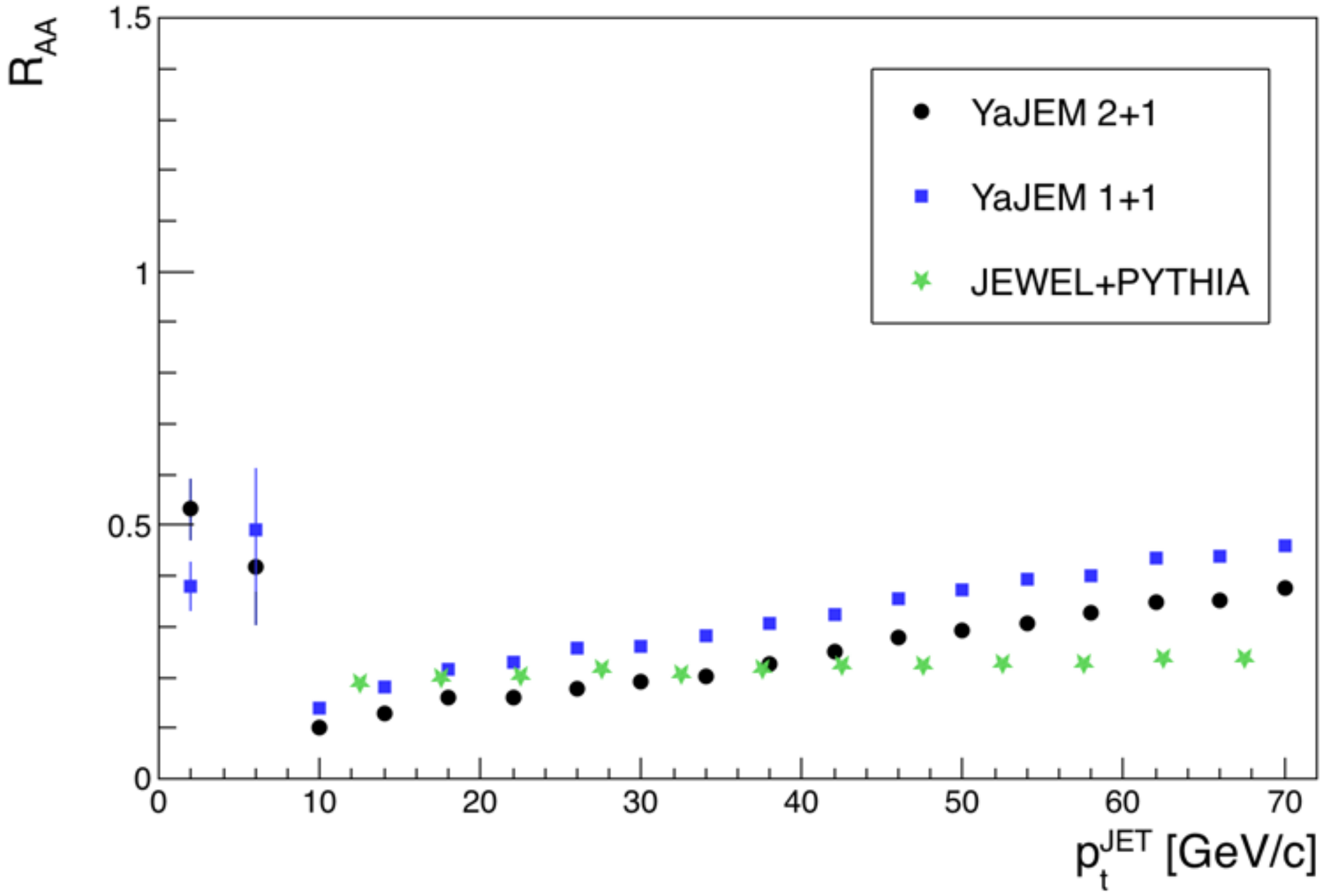
leading jet 10-15, 2 GeV, 6 GeV



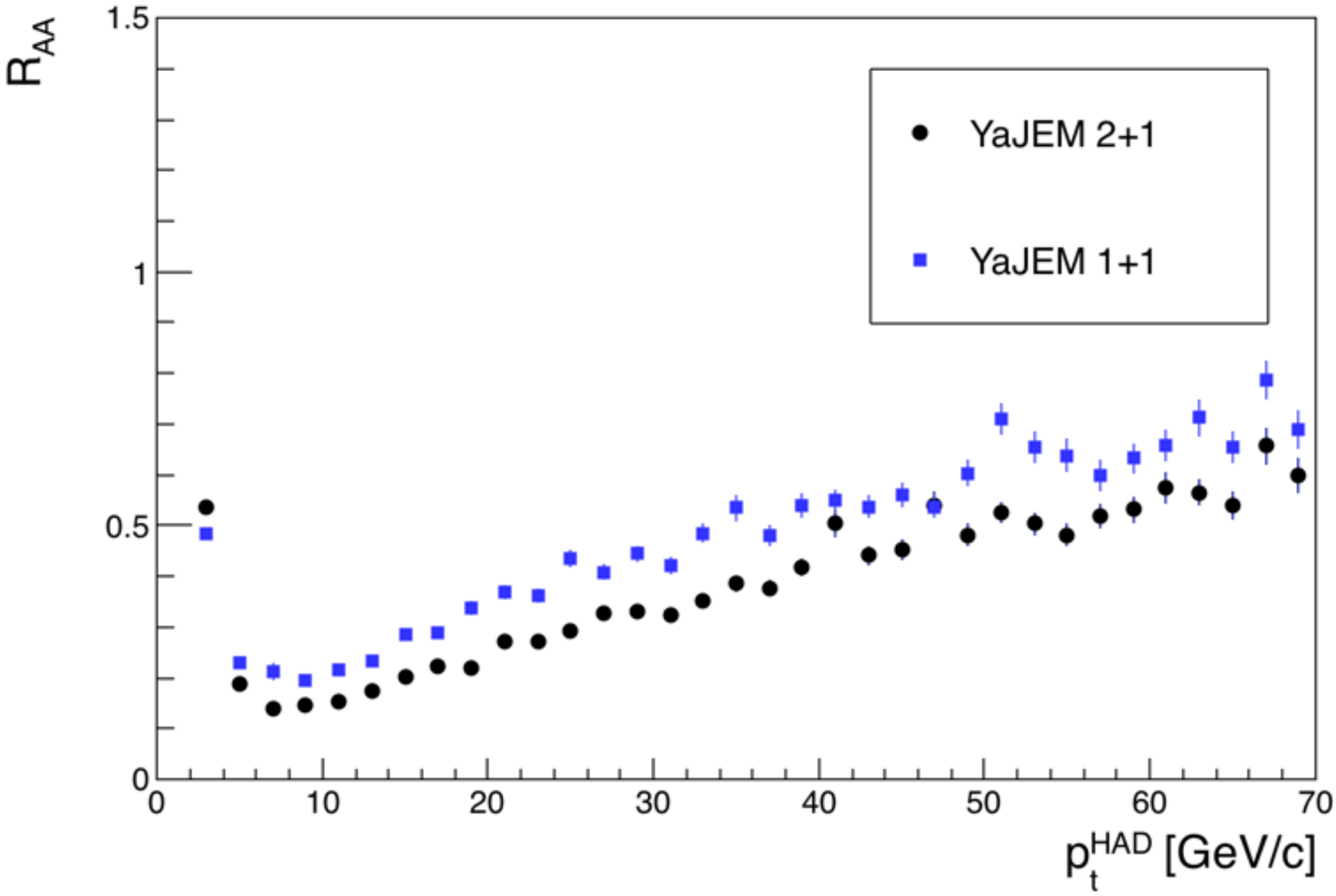
leading jet 20-40, 2 GeV, 6 GeV



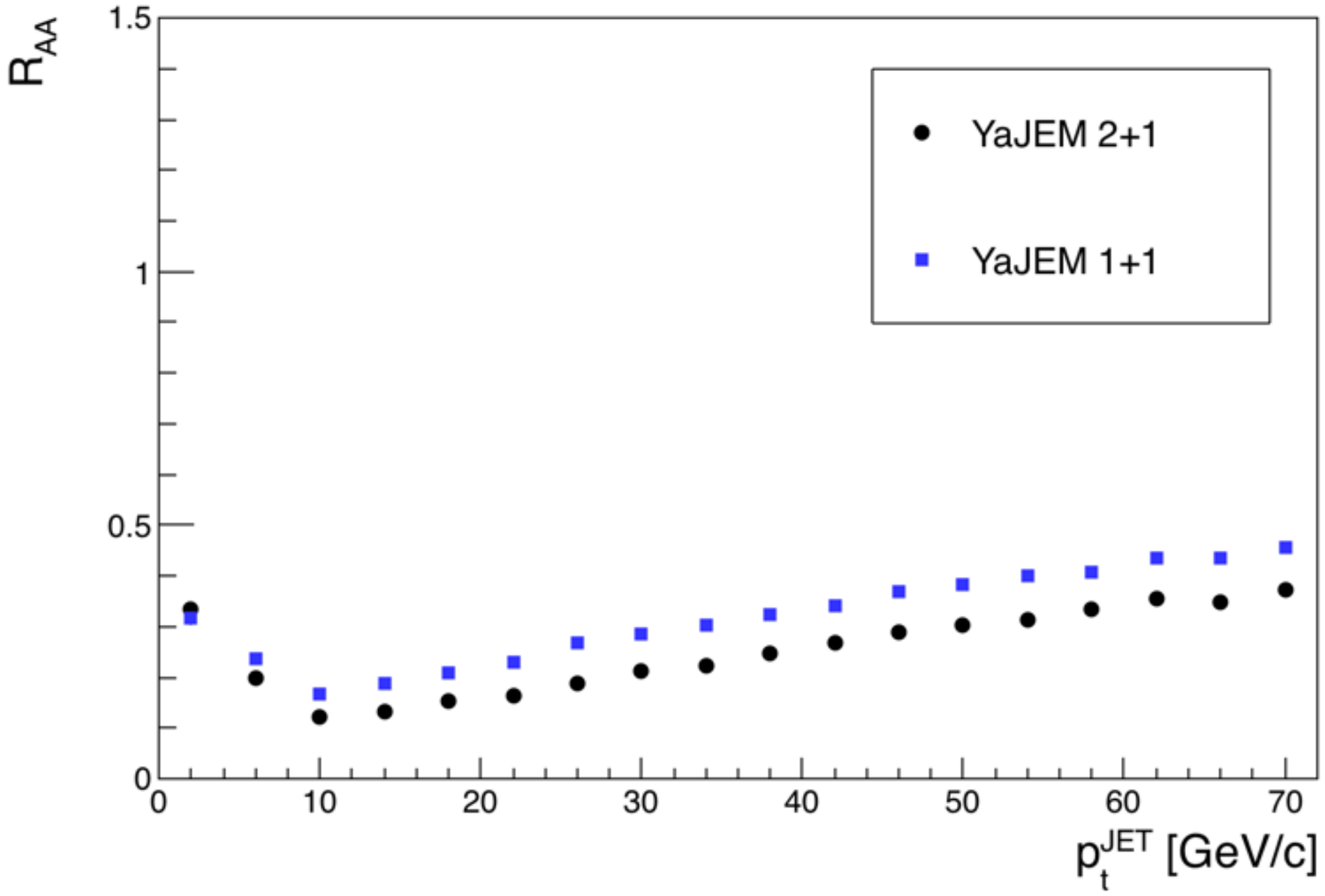
Jet R_{AA} PbPb @ 2.76 TeV



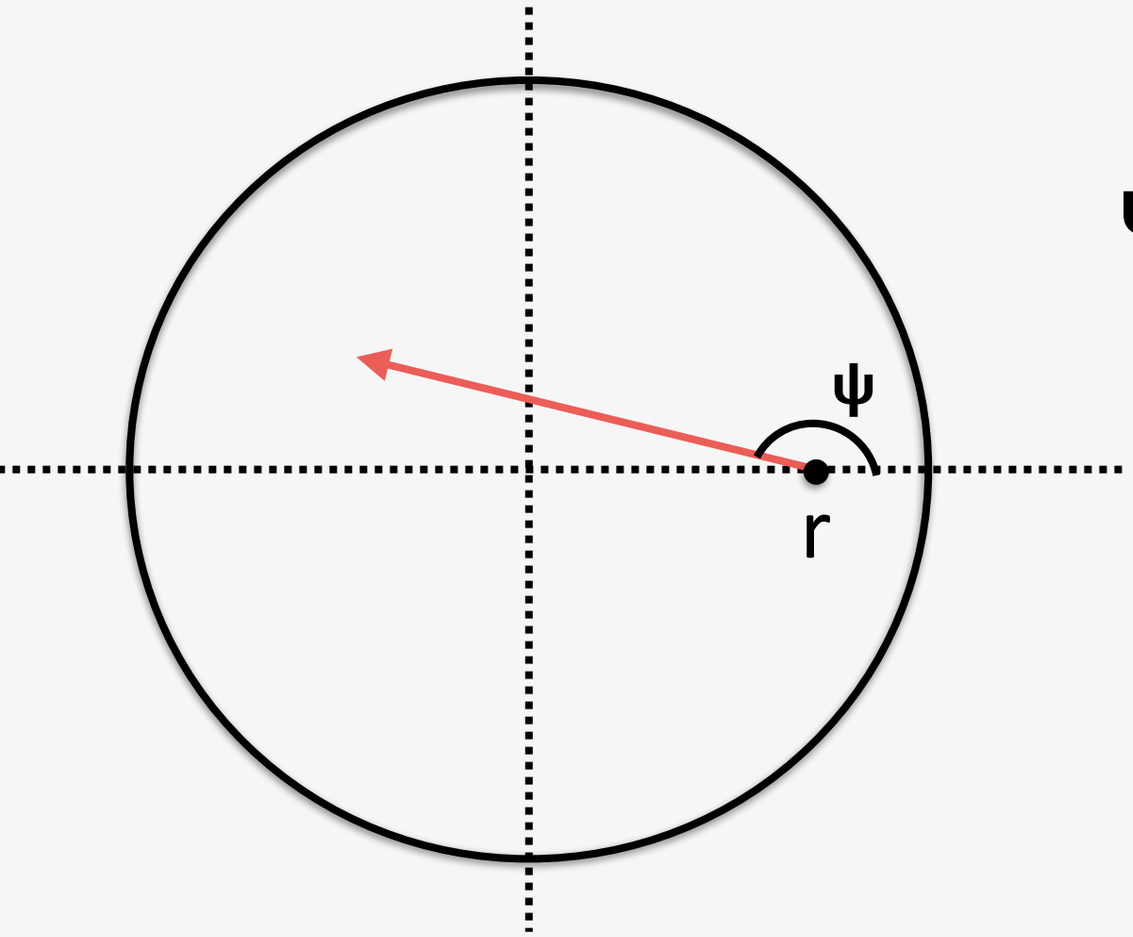
Hadron R_{AA} PbPb @ 5 TeV



Jet R_{AA} PbPb @ 5 TeV



Medium as seen by a parton



$\int \varepsilon^{3/4}(\xi_1) d\xi_1$

AuAu@200, b = 0

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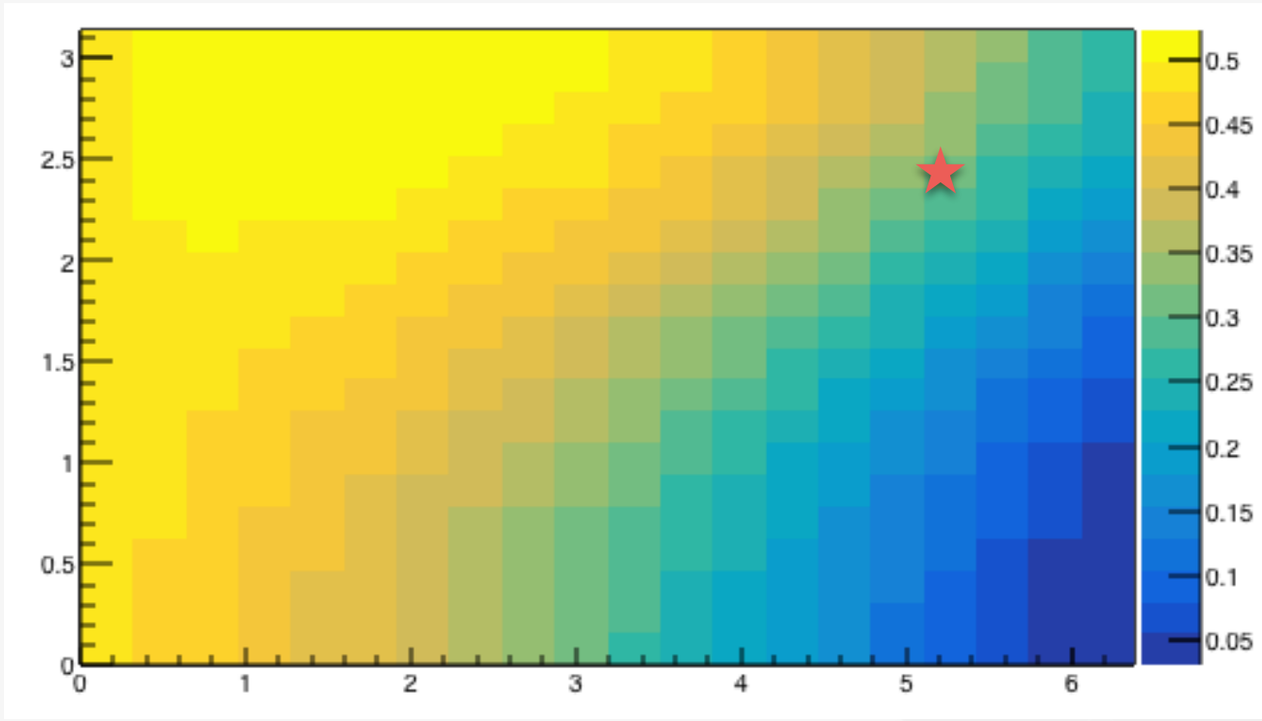

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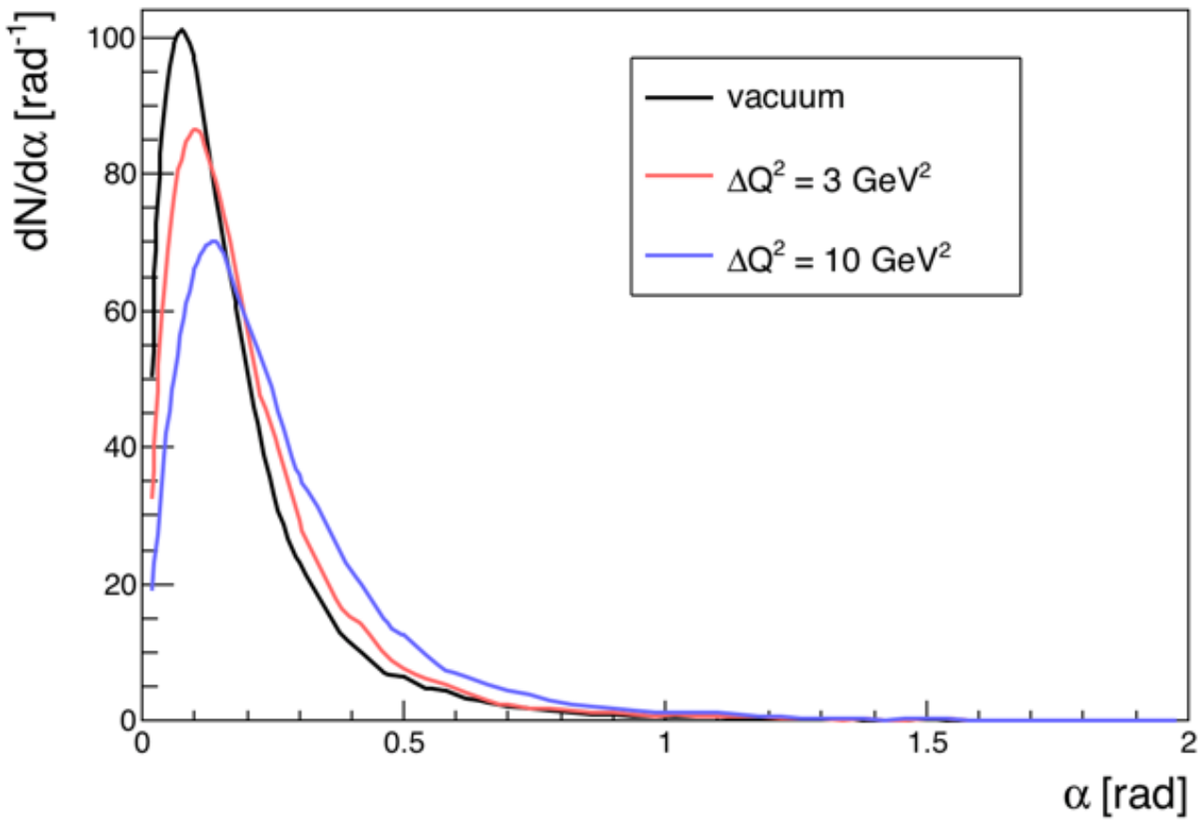
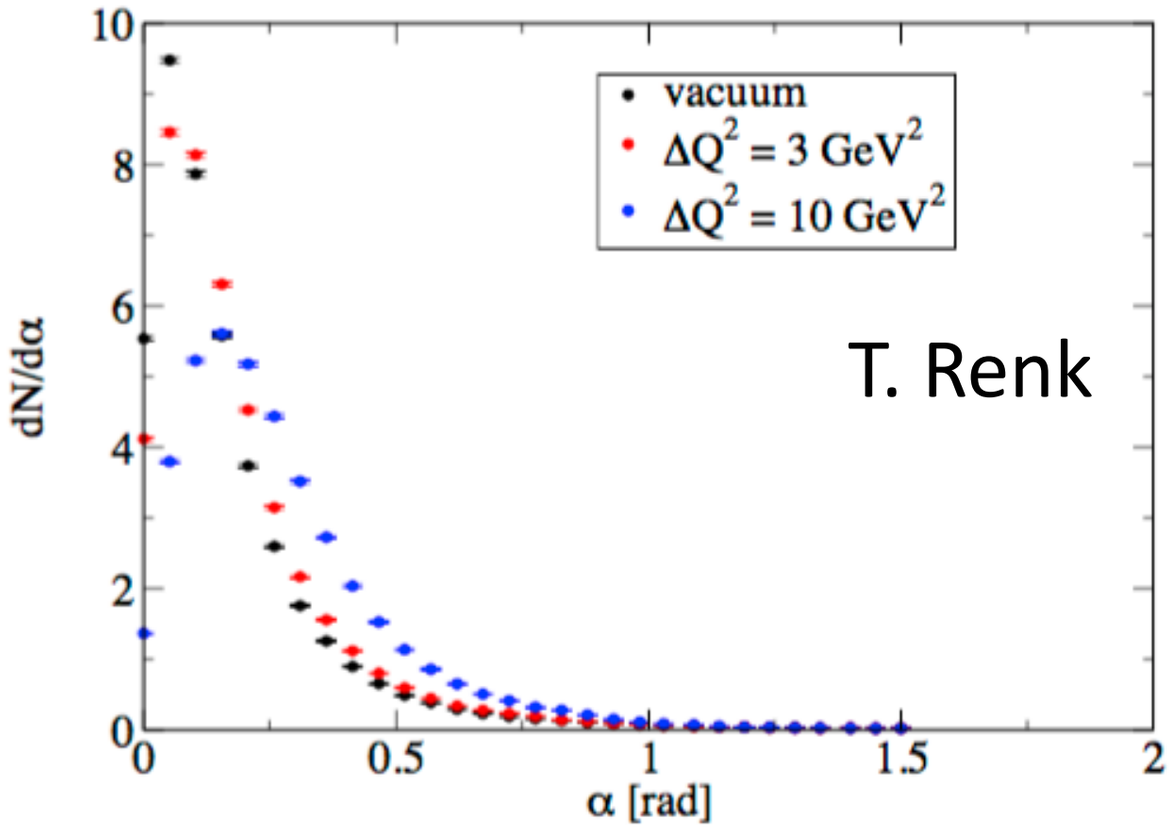
Shower profile

q_E = 20 GeV, 2 GeV const cut



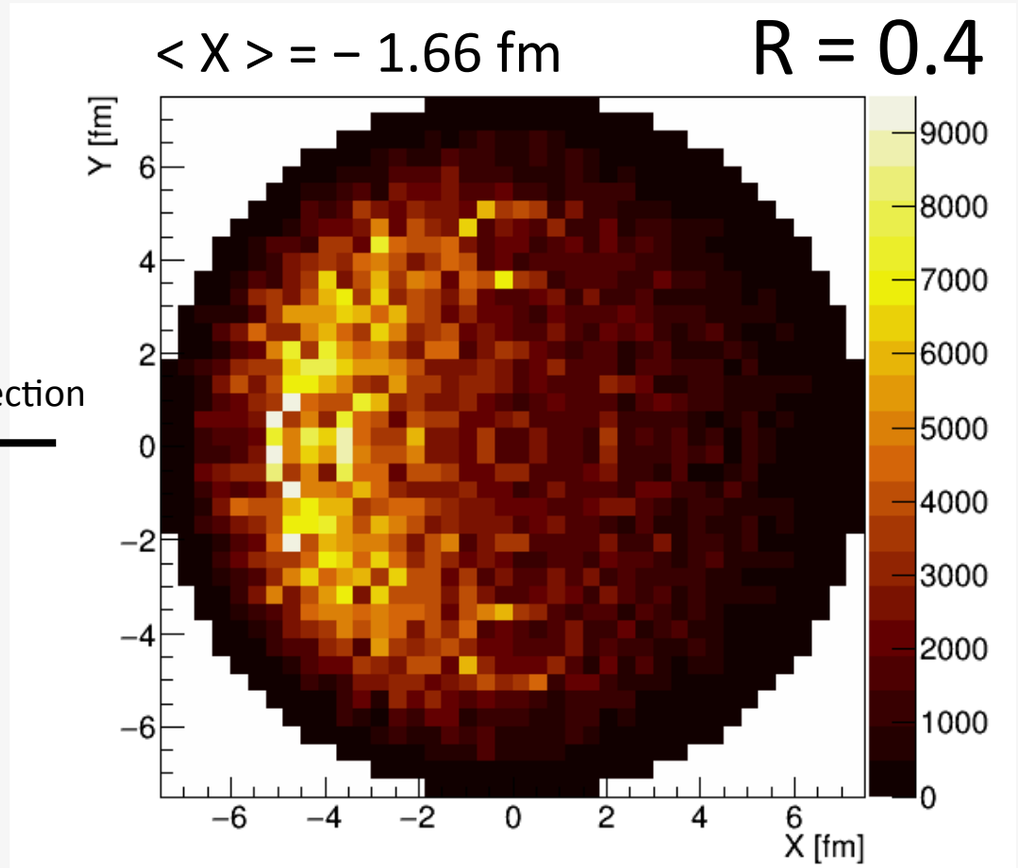


Surface Bias: AuAu @ 200 GeV

YaJEM 2+1 hydro

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

leading jet 20-40 GeV



trigger jet direction

constituents $p_T > 2$ GeV & hard track $p_T > 6$ GeV

leading jet 20-40 GeV