The Next Decade of Physics with PHENIX

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for the PHENIX Collaboration

BROOKHAVEN NATIONAL LABORATORY

http://www.phenix.bnl.gov/phenix/WWW/docs/decadal/2010/phenix_decadal10_full_refs.pdf

sQGP Matter

- RHIC: produce & study dense QCD matter

arXiv:1105.3928,
PRC82 011902,
PRL104 132301

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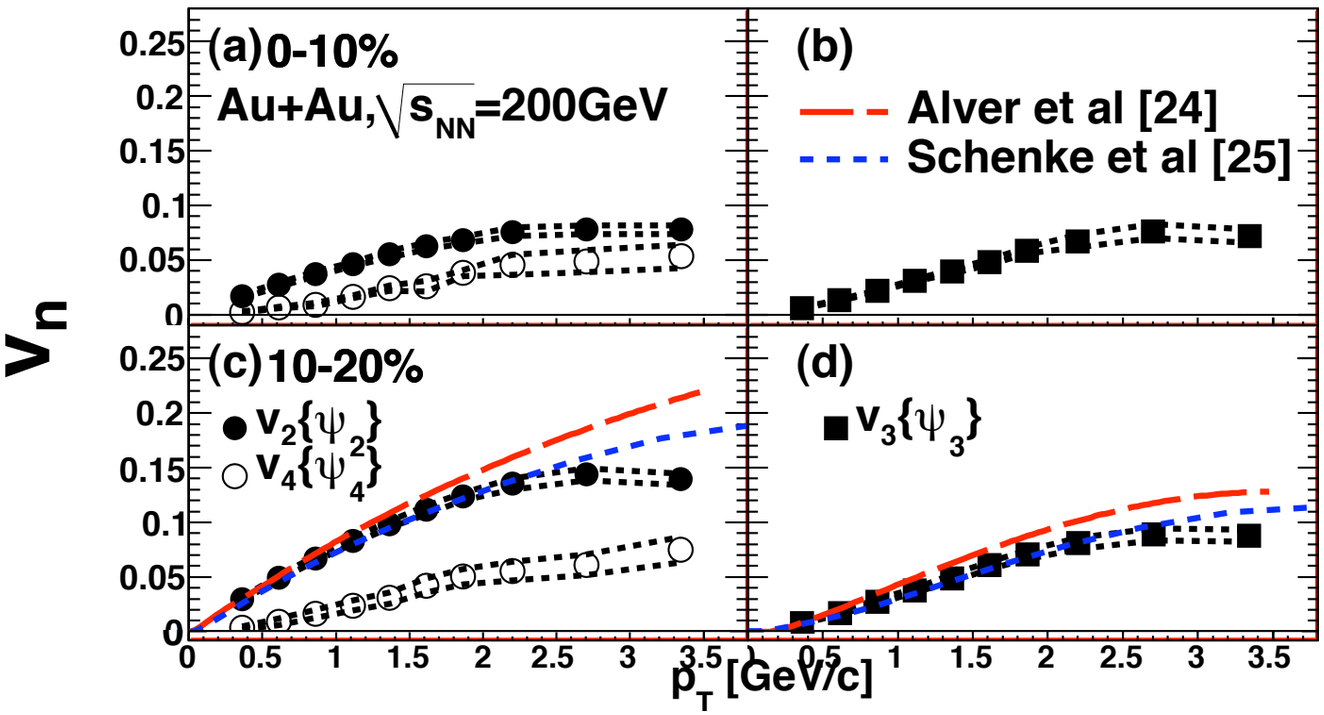

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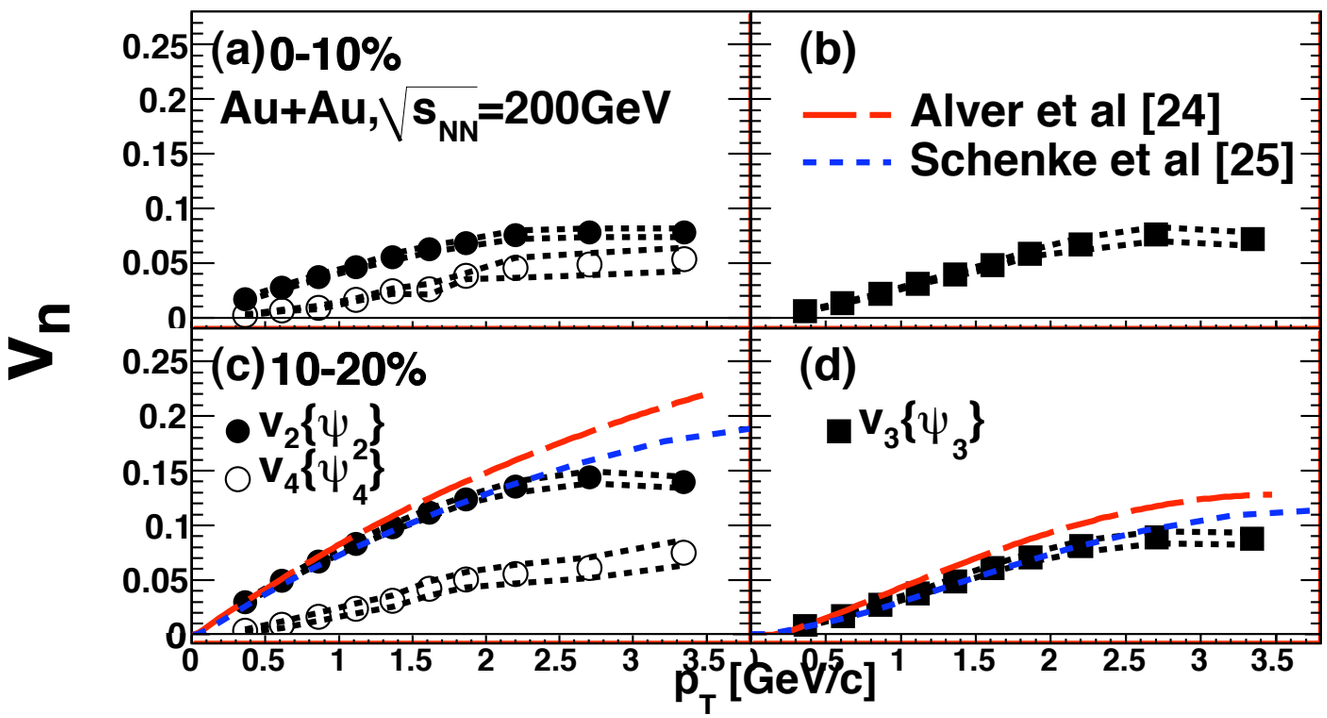

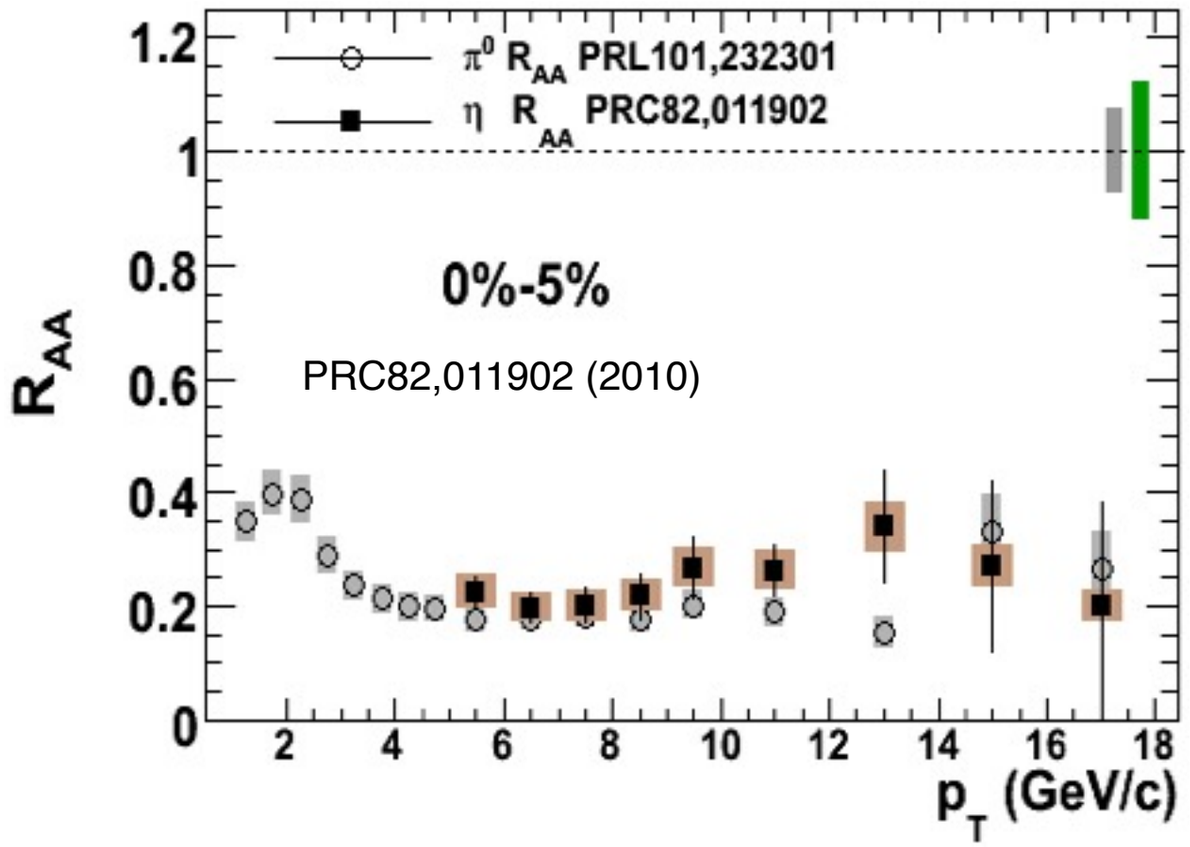

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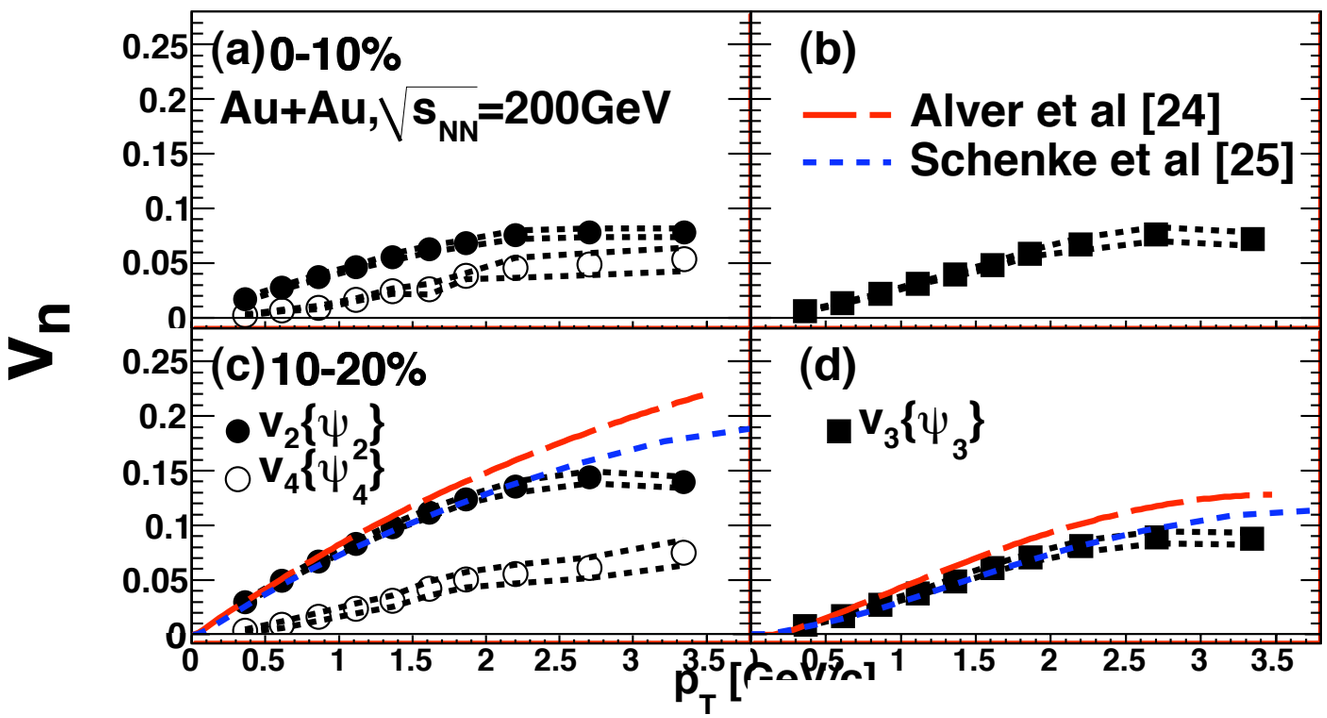

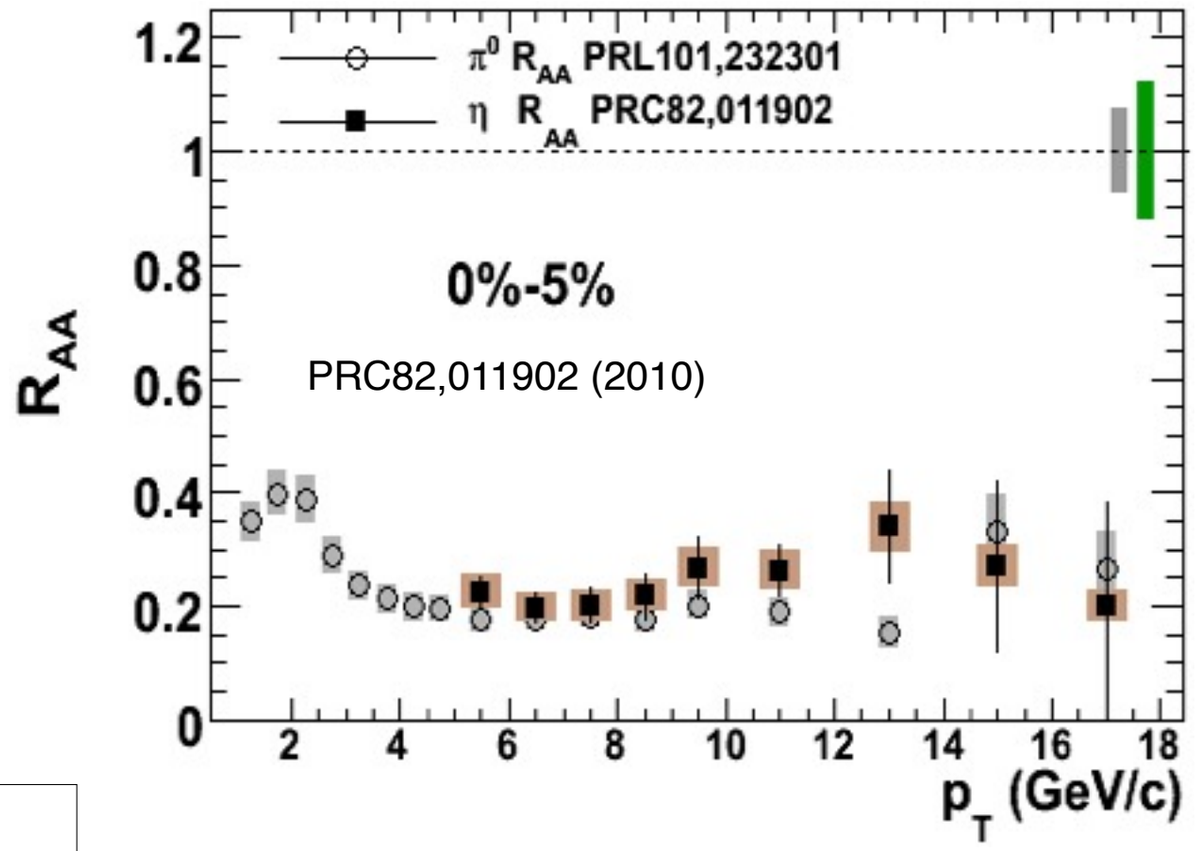

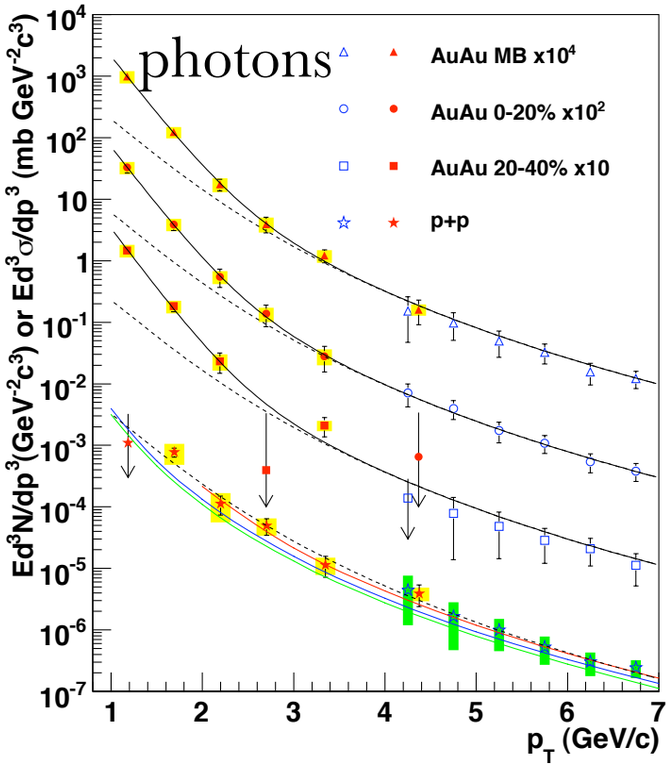

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PHENIX: detailed measurements

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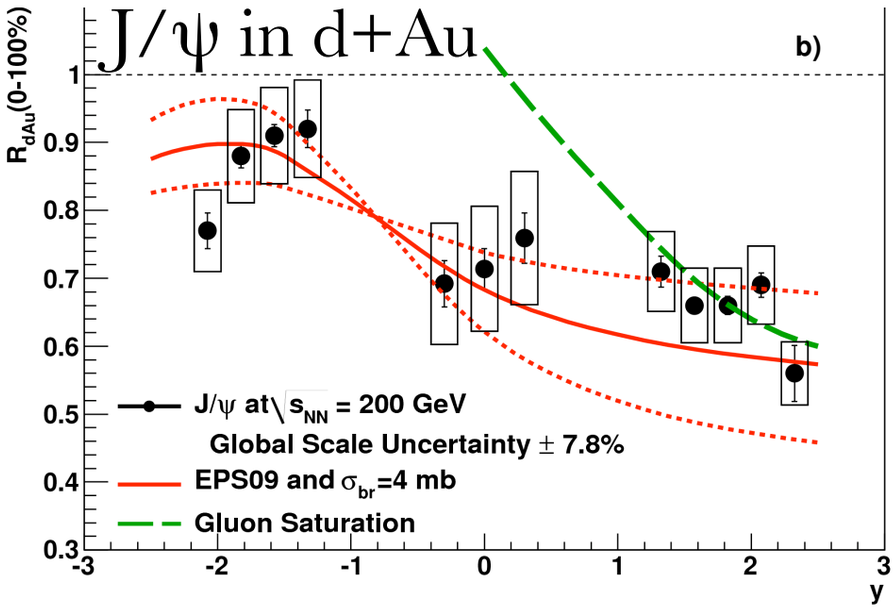

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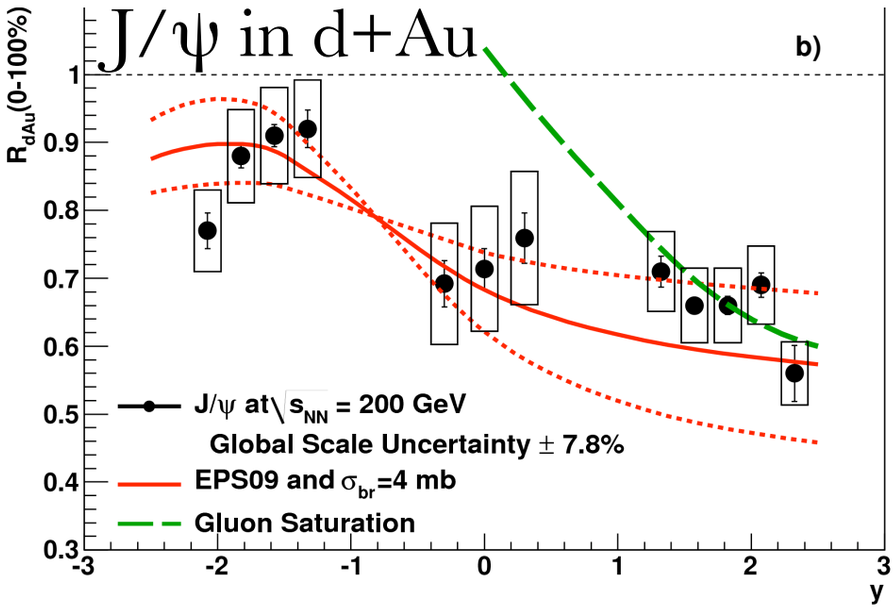

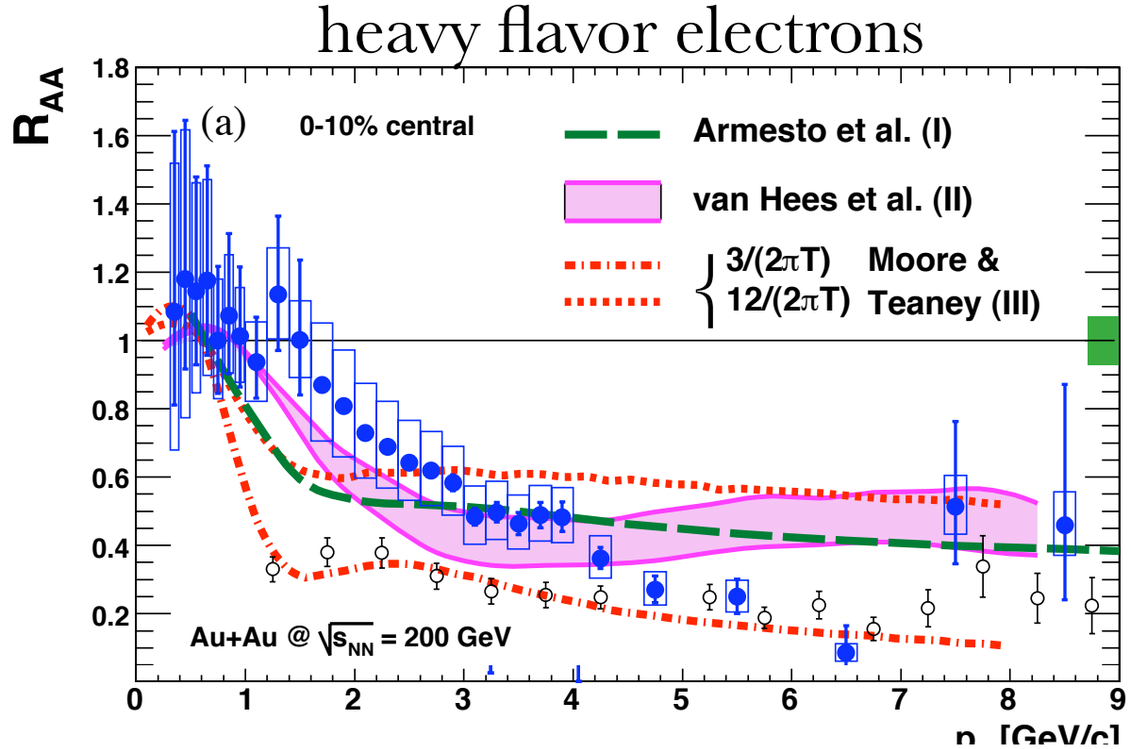

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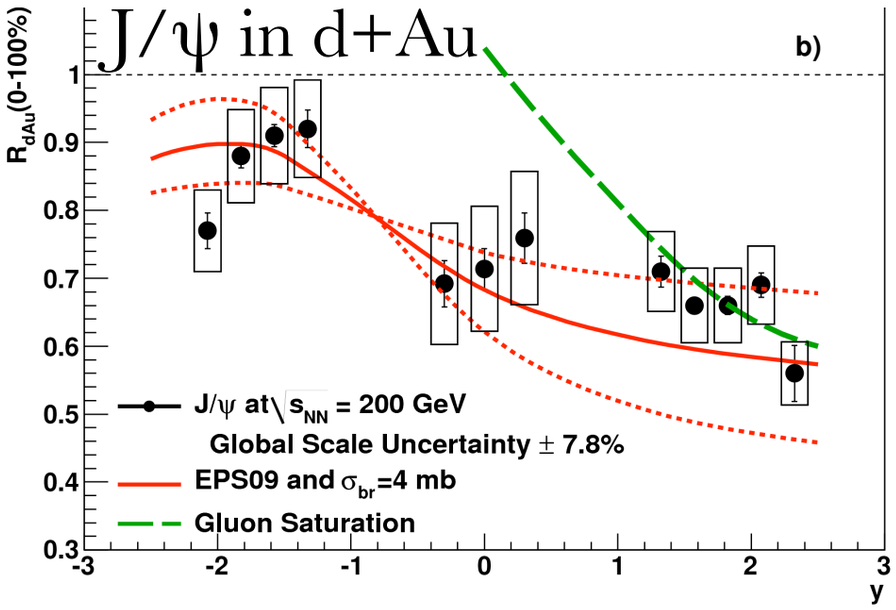

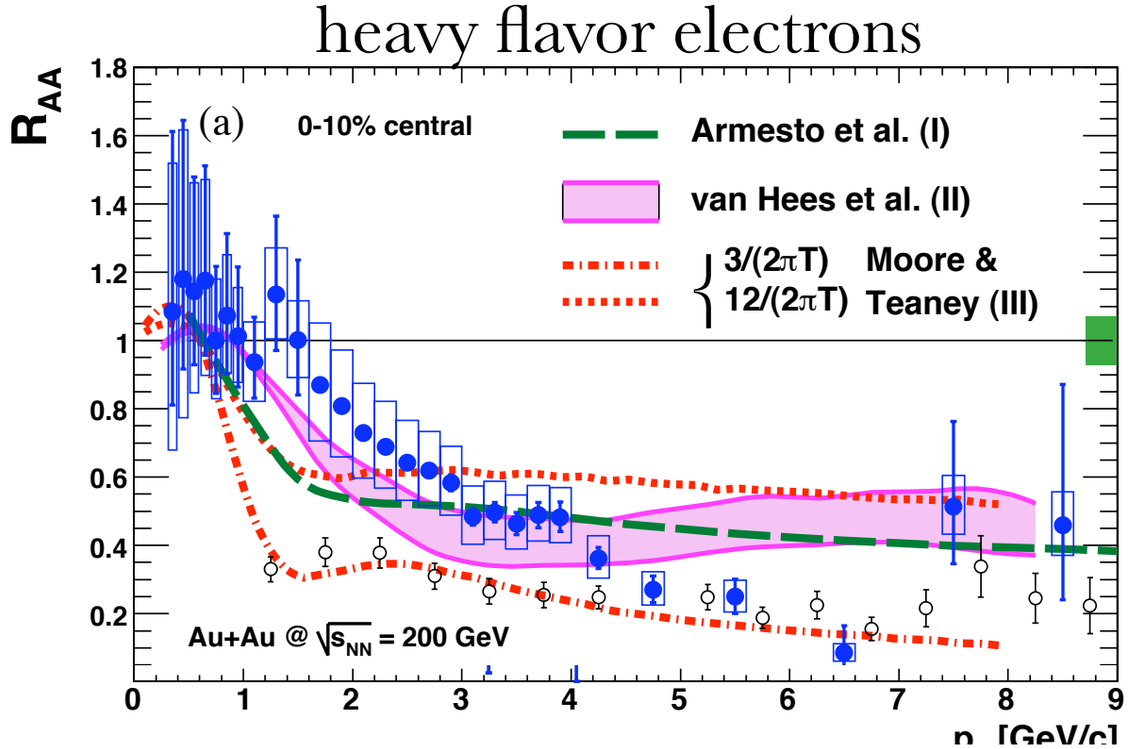

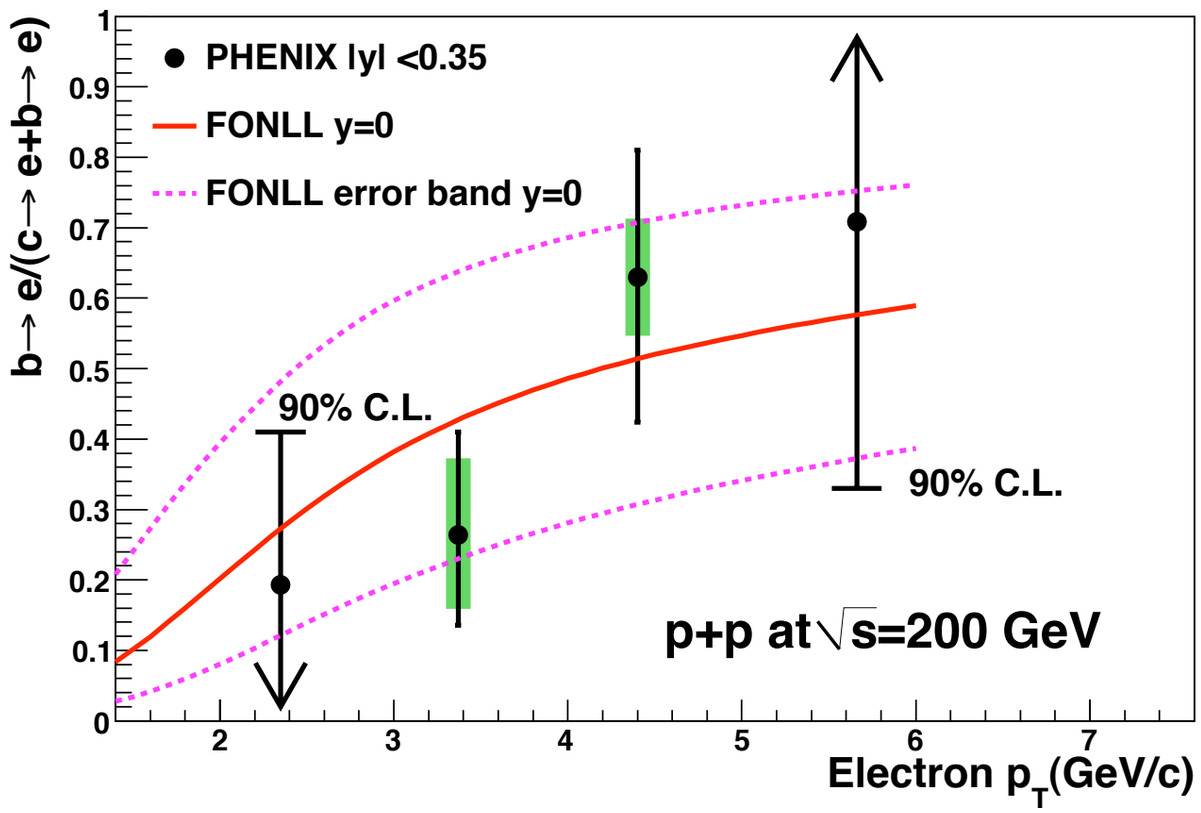

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- how is rapid equilibration achieved?

physics driven needs

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Questions

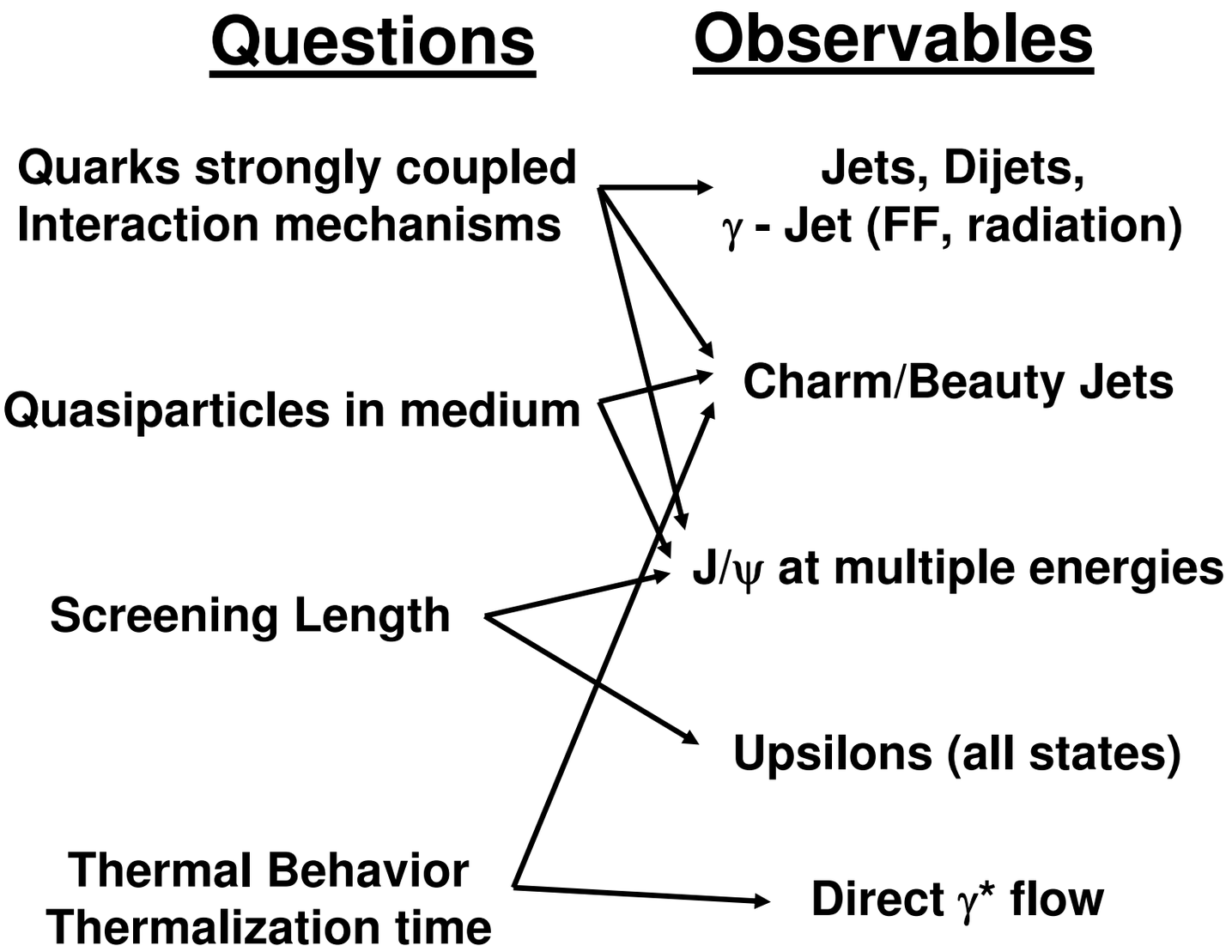
Quarks strongly coupled
Interaction mechanisms

Quasiparticles in medium

Screening Length

Thermal Behavior
Thermalization time

physics driven needs



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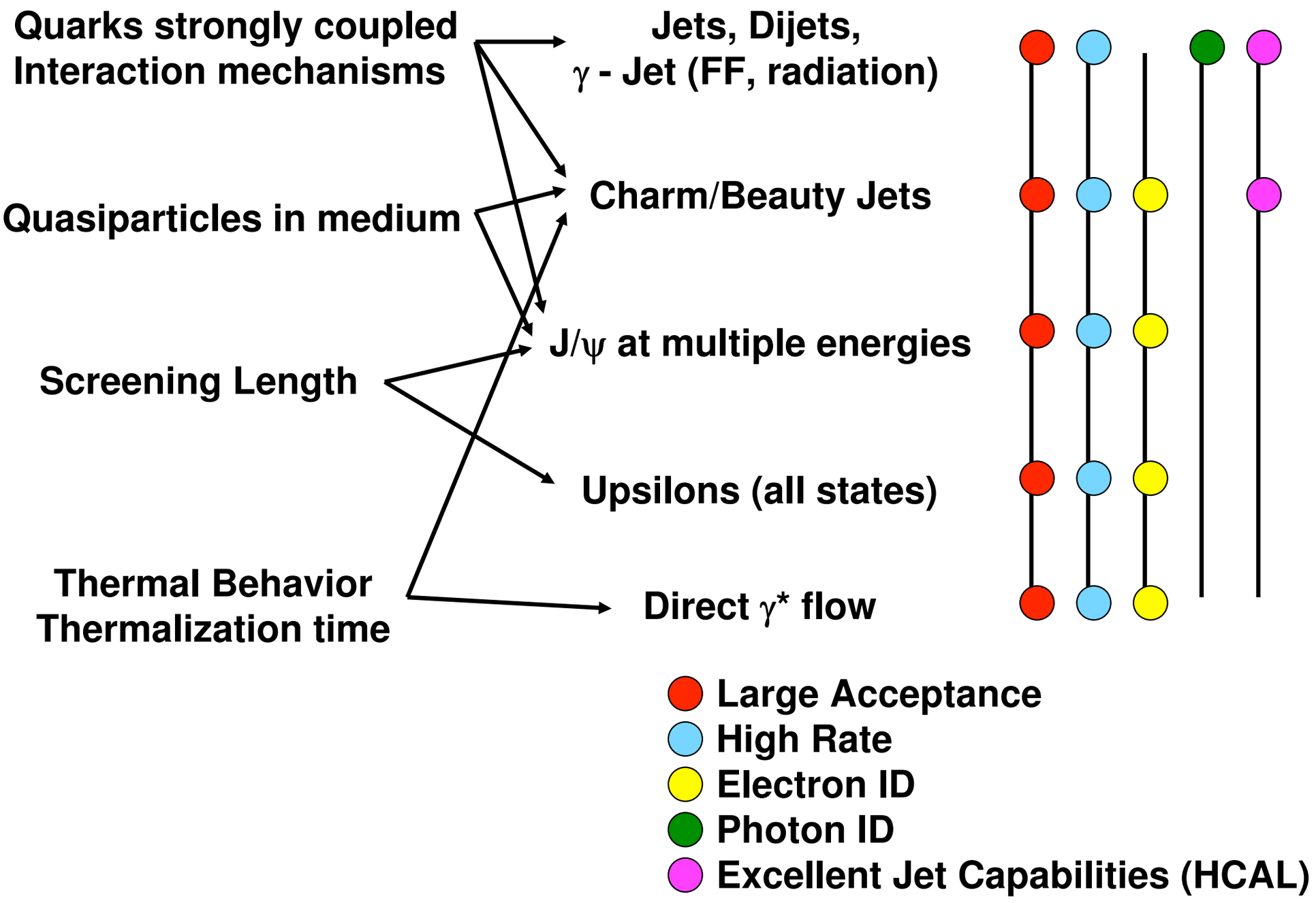
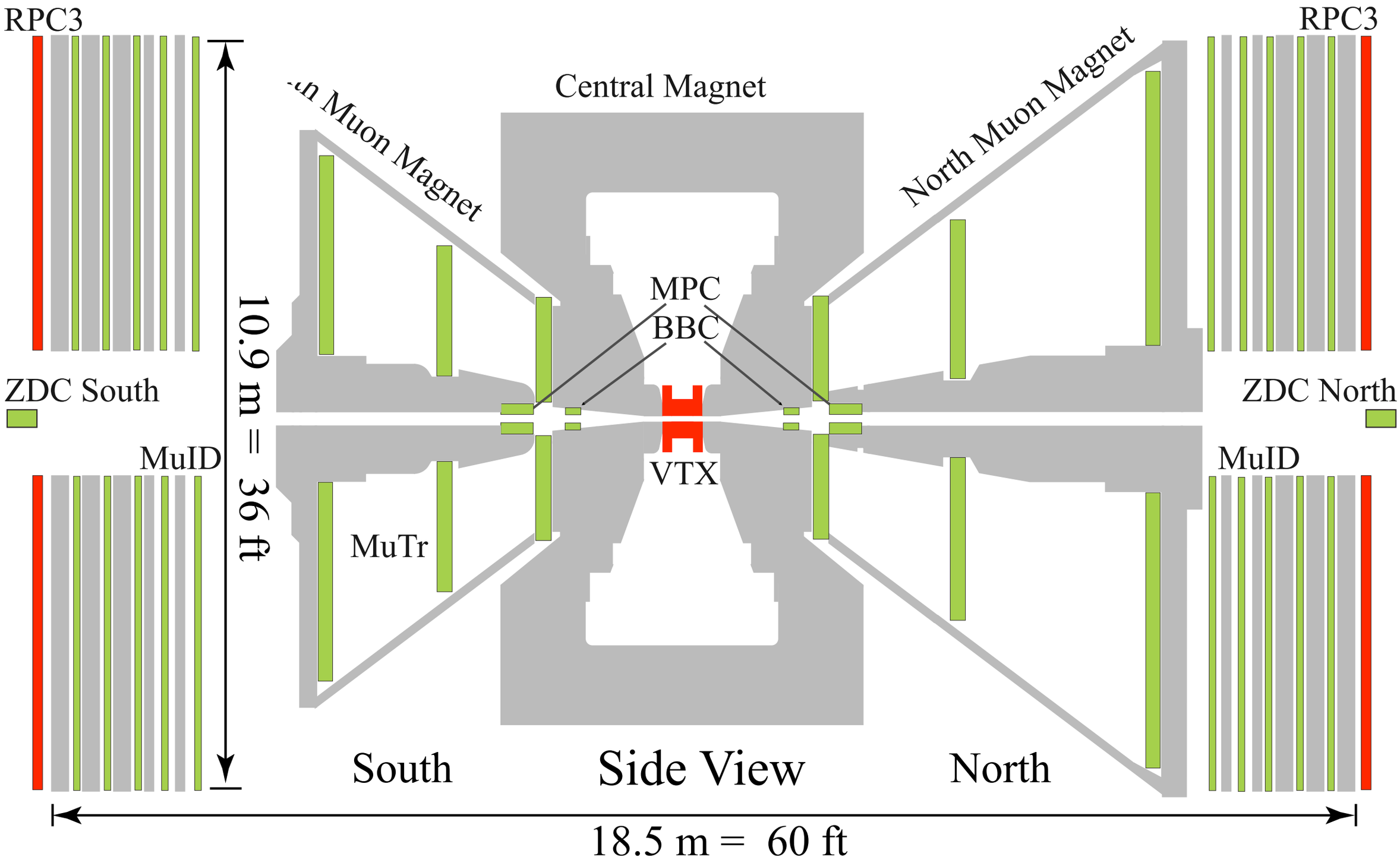


PHENIX → sPHENIX



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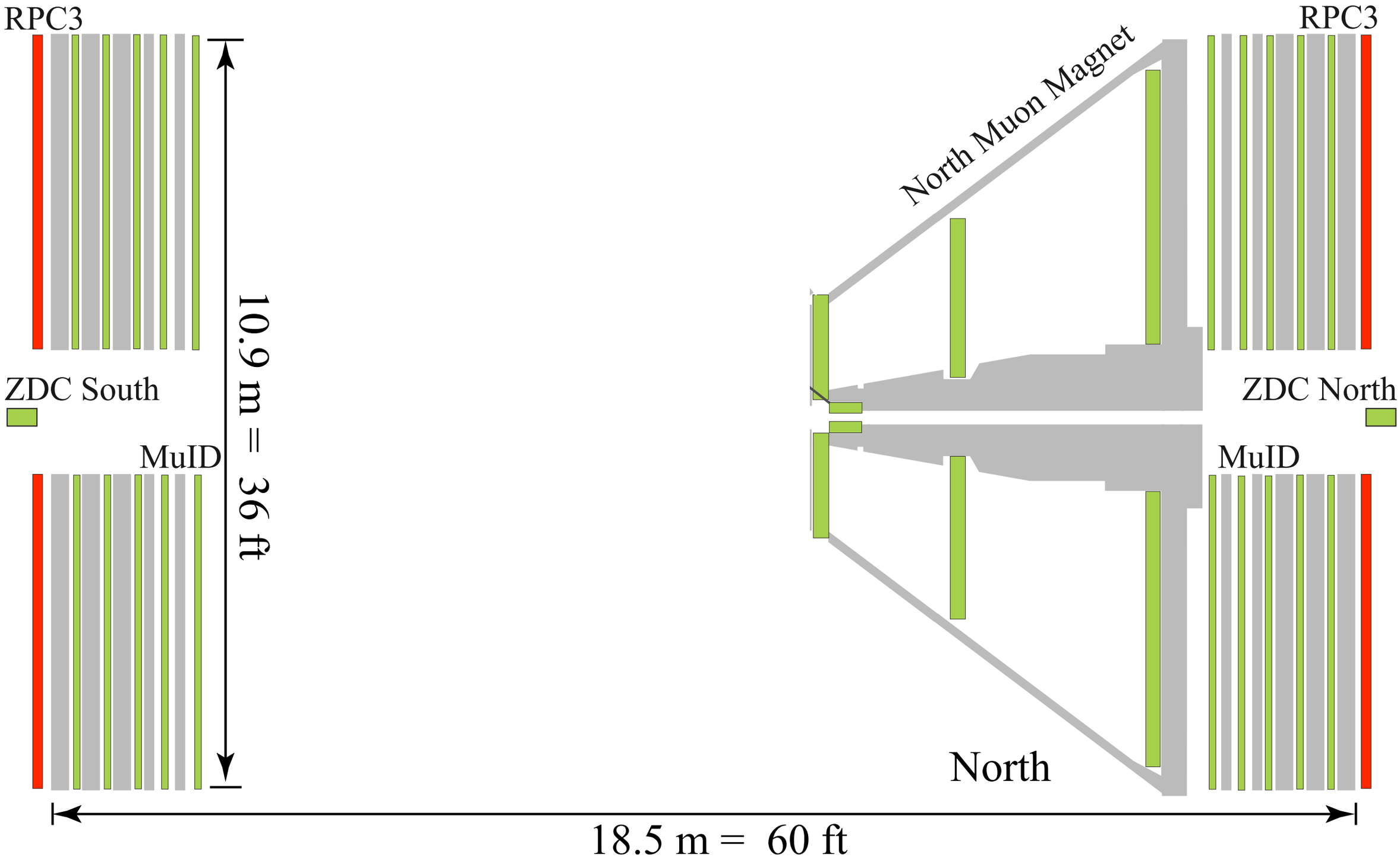

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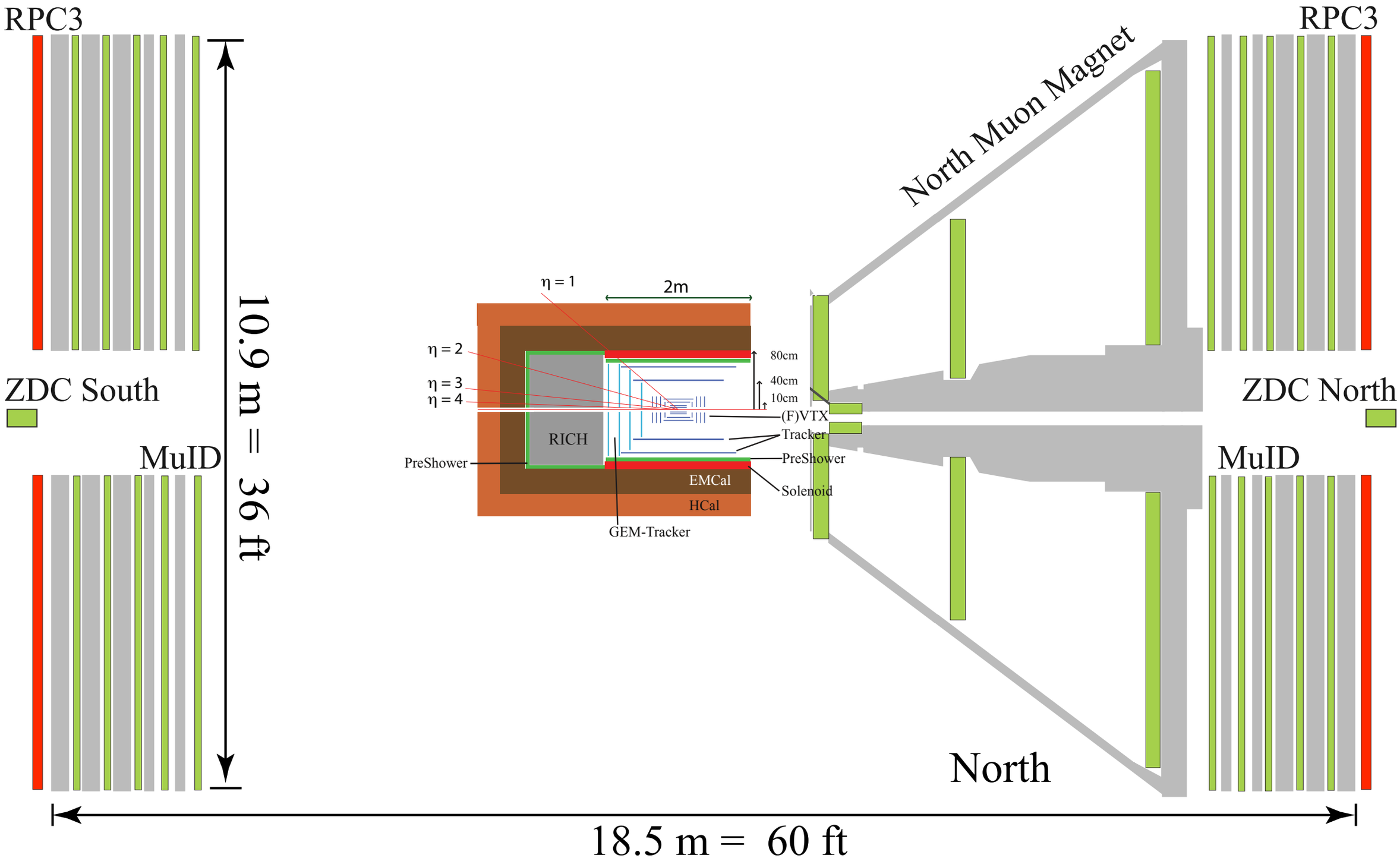
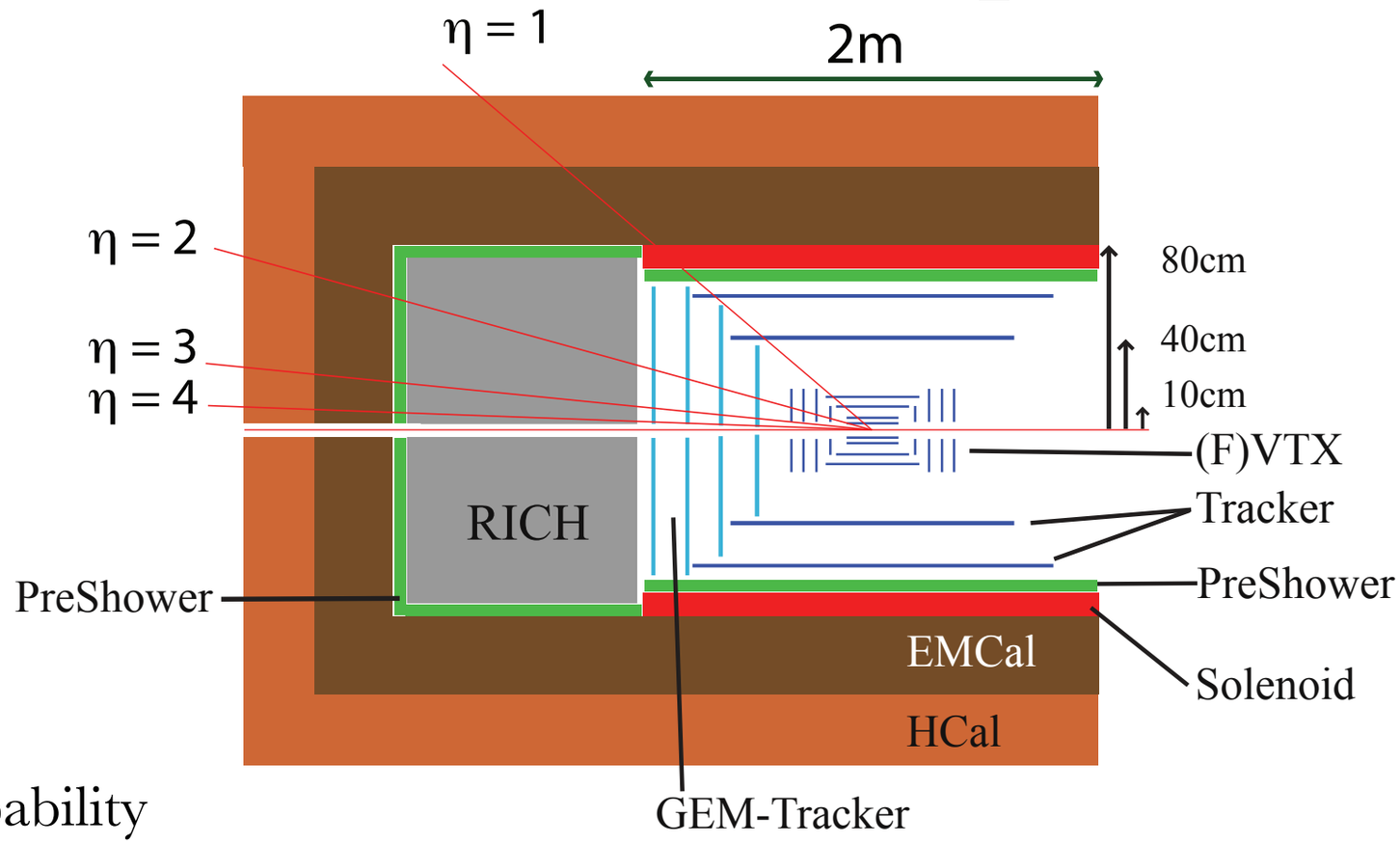


sPHENIX plan



- maintain PHENIX high rate capability
  - record lots of heavy ion data without rare triggers
- retain current (future) silicon vertex detectors (VTX, FVTX)
- large uniform acceptance
- hadronic calorimetry at midrapidity
  - first at RHIC
  - provides the jet resolution & efficiency to extend to high p_T
- forward detectors for useful for spin, asymmetric collisions & e-p/e-A, A-A

hard probes: RHIC & LHC

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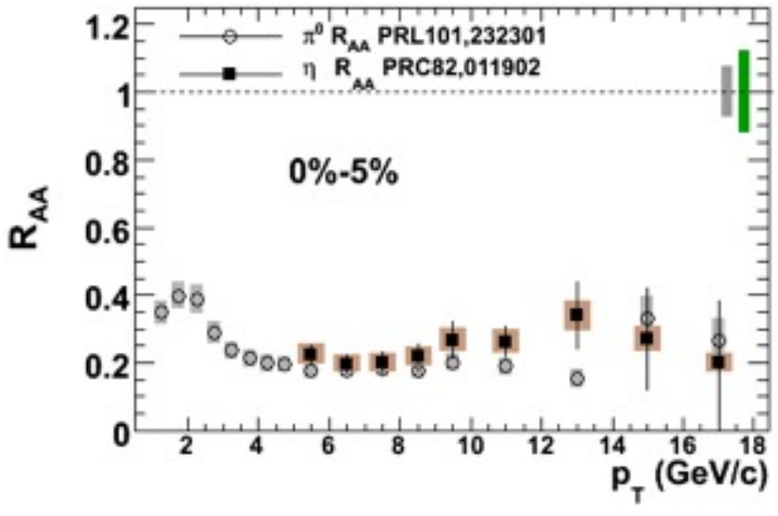

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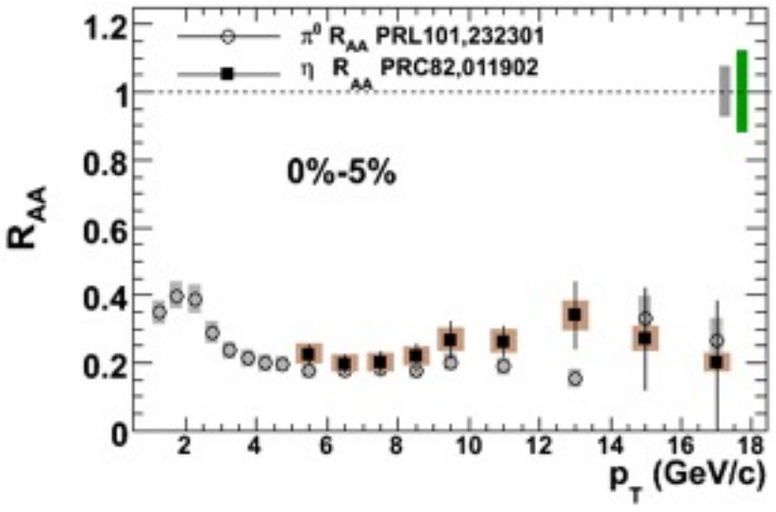

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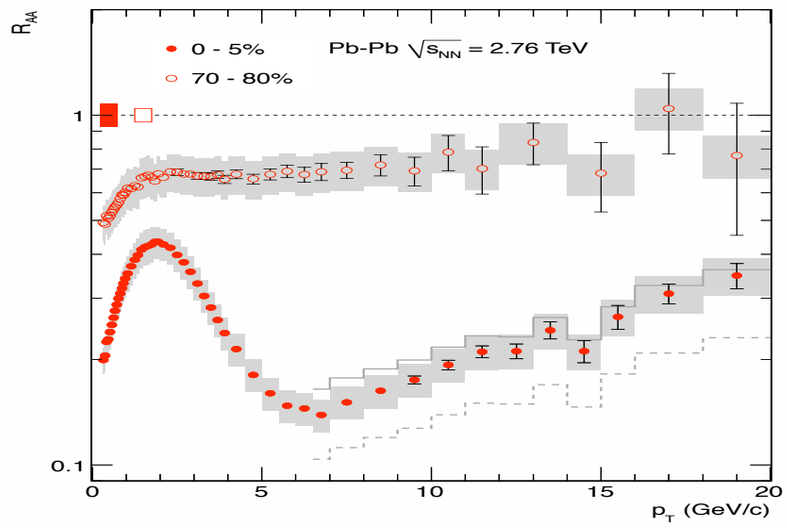

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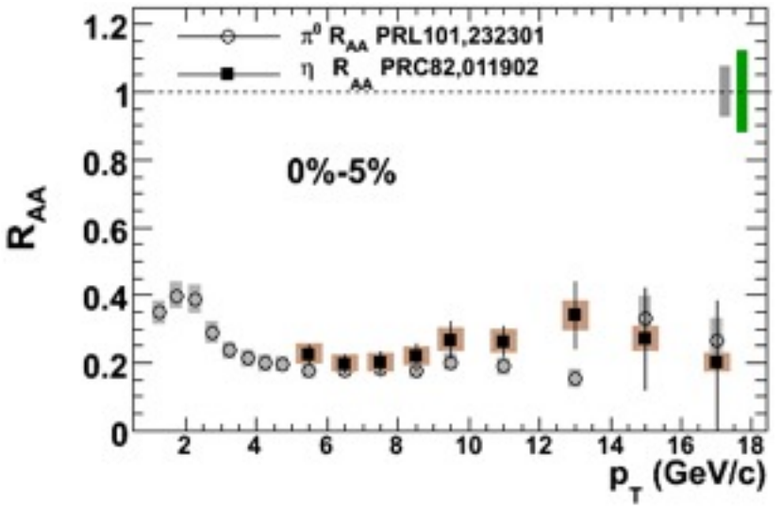

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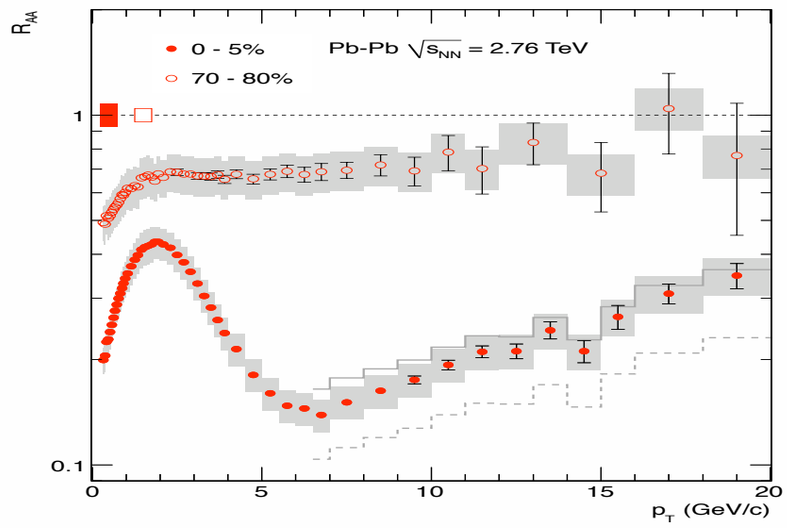
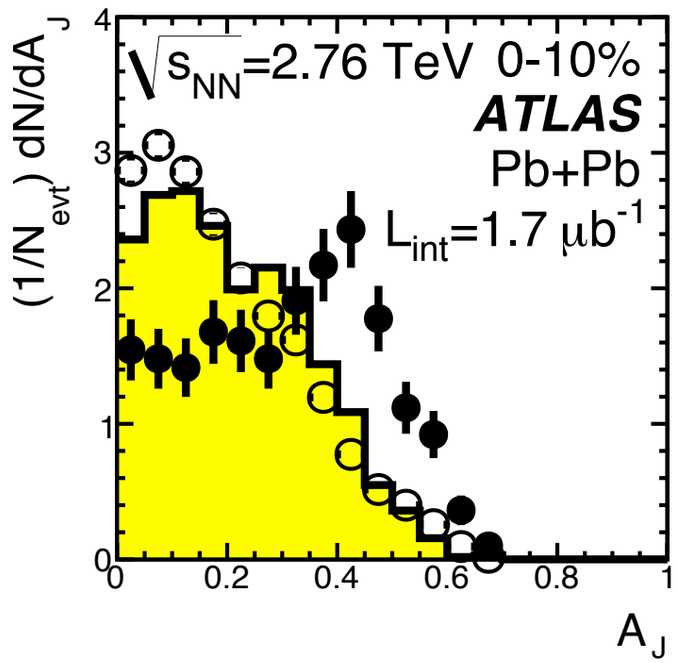


jets @ LHC



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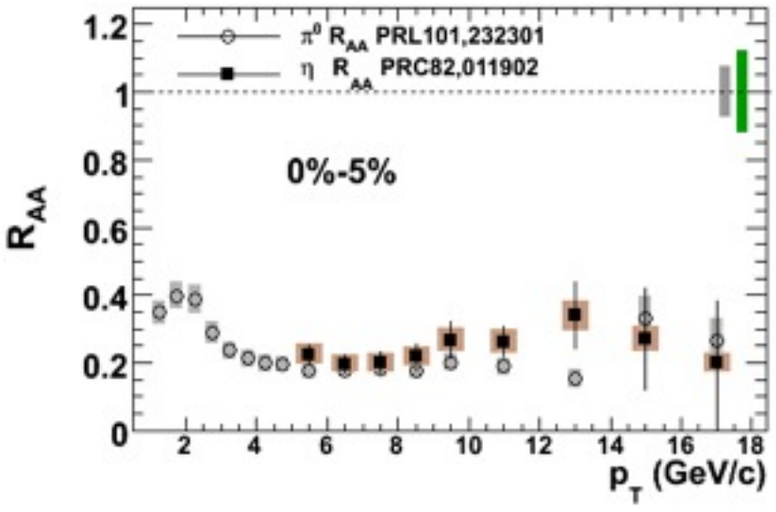

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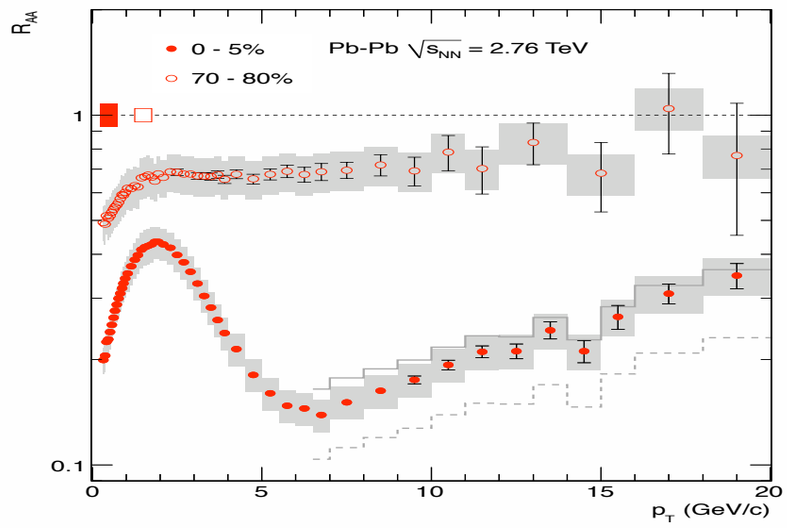

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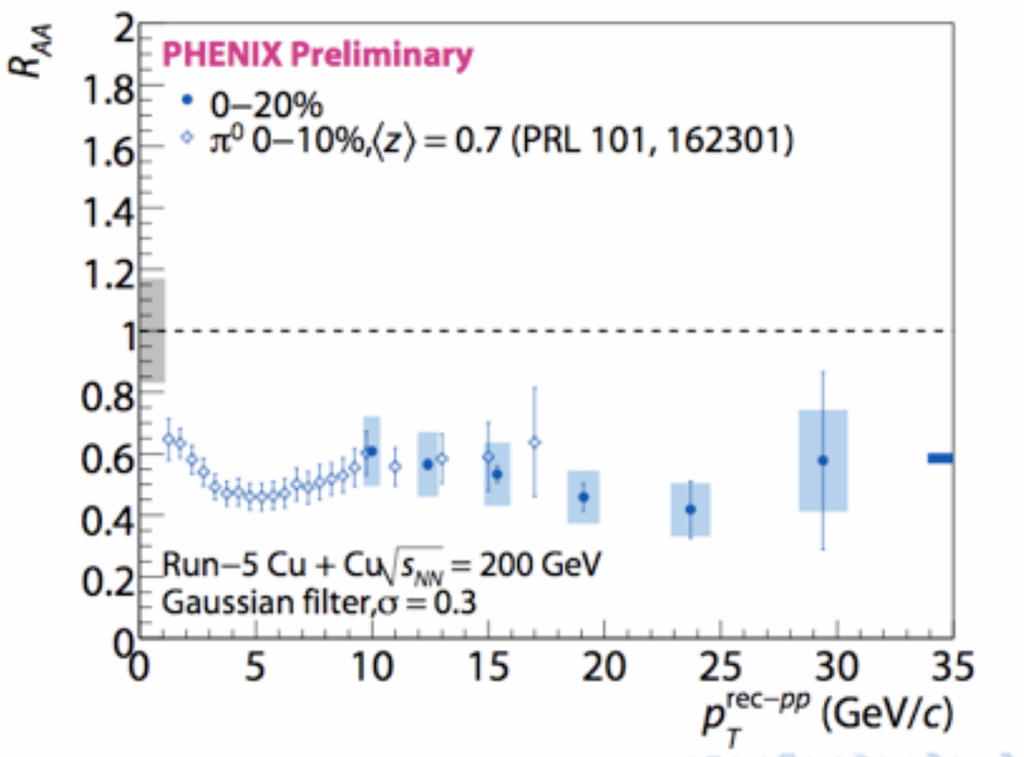

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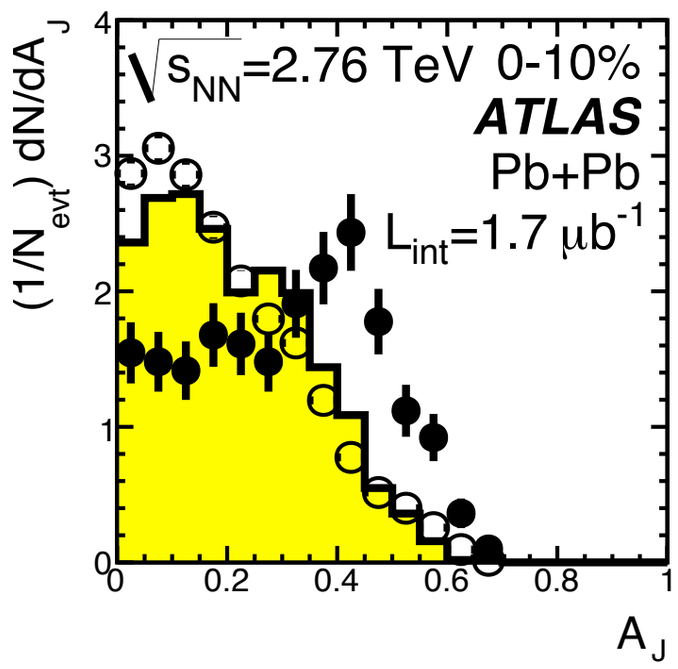
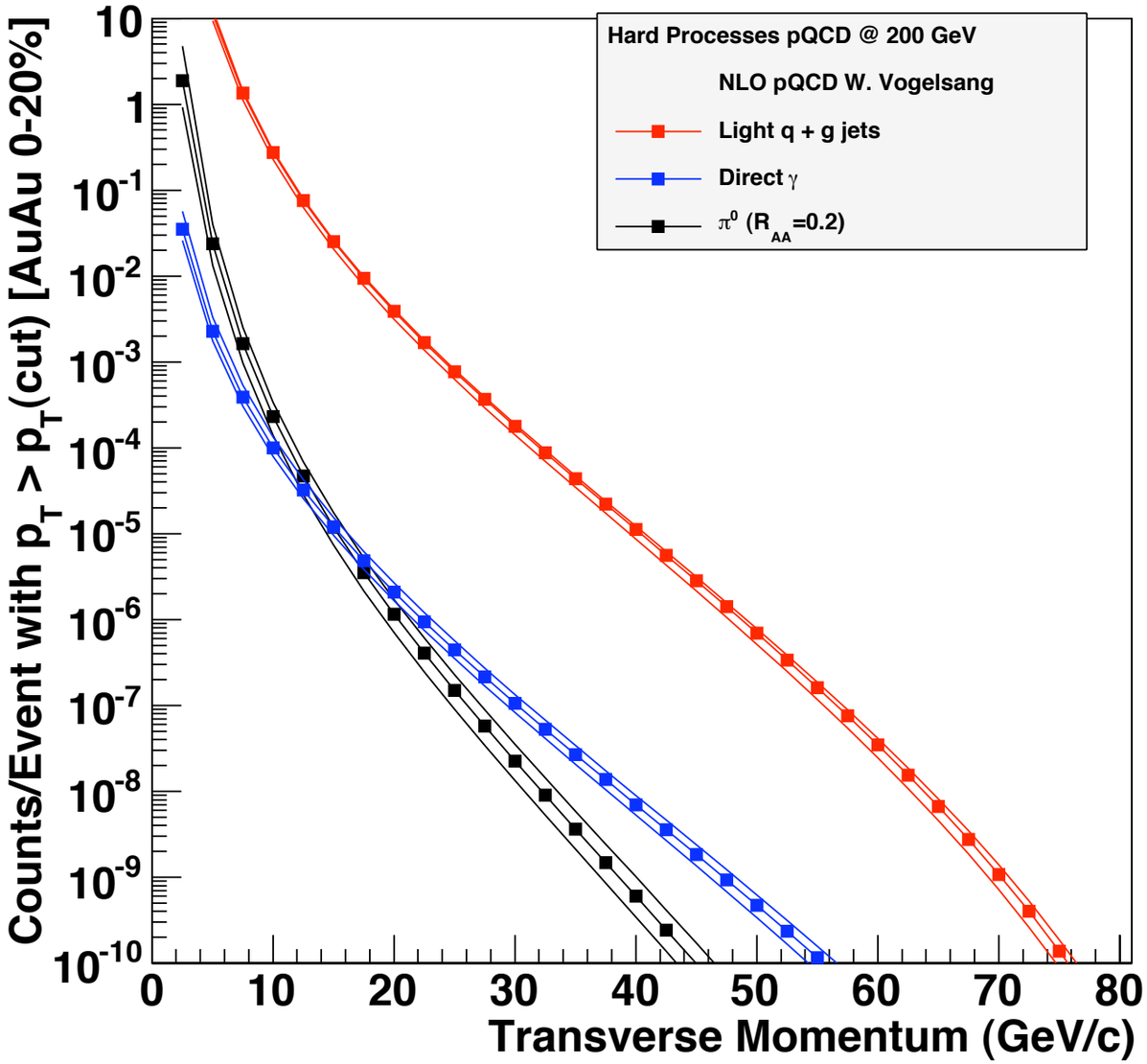


why jets at RHIC?

- how do the jet modifications compare between collision energies?
- softer underlying event allows measurements of lower energy jets
- dijets with similar asymmetry & very different jet energy at RHIC and LHC would give insight into energy loss mechanisms
- collision system versatility at RHIC
- cold nuclear matter effects

rates & acceptance



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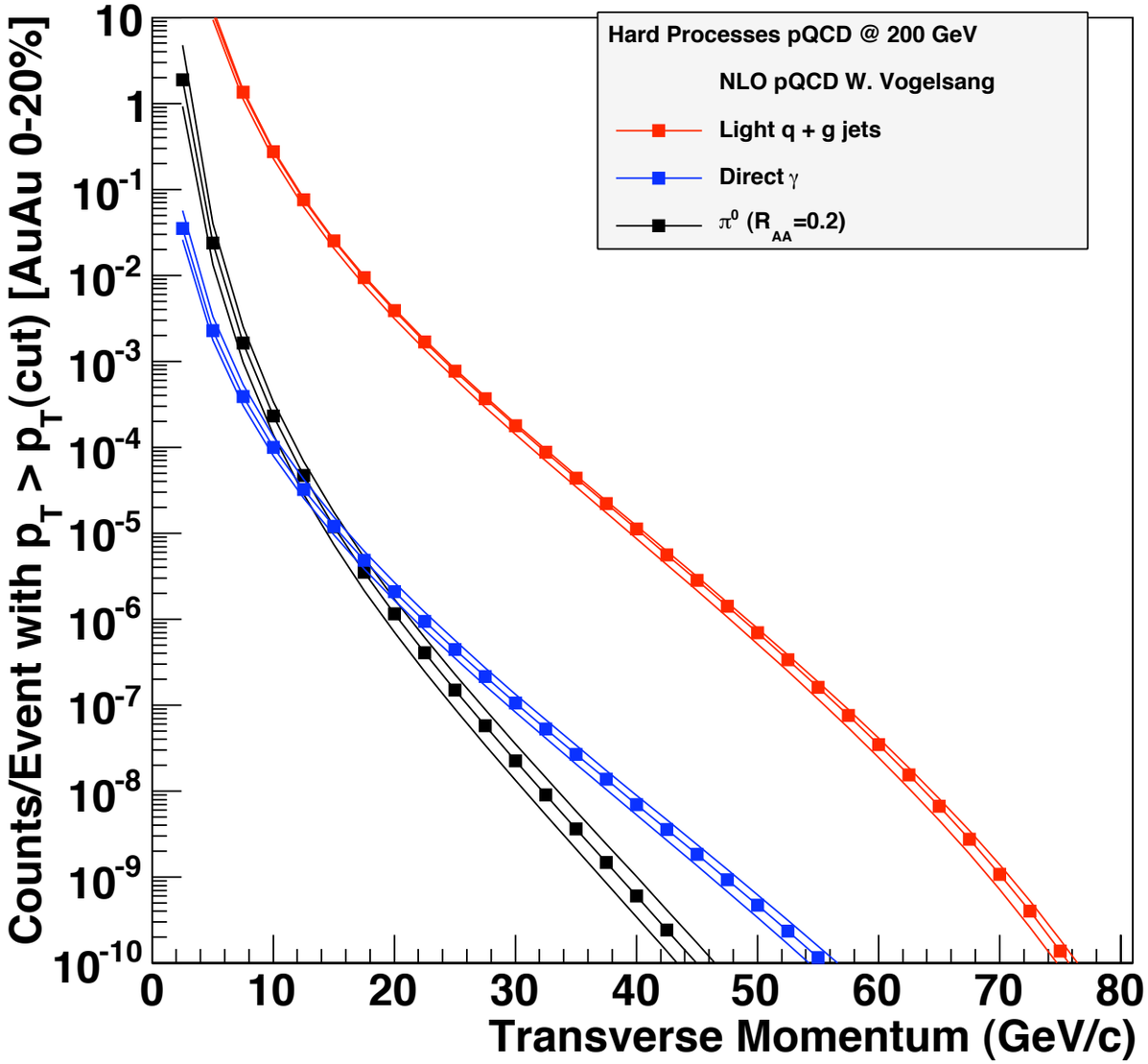

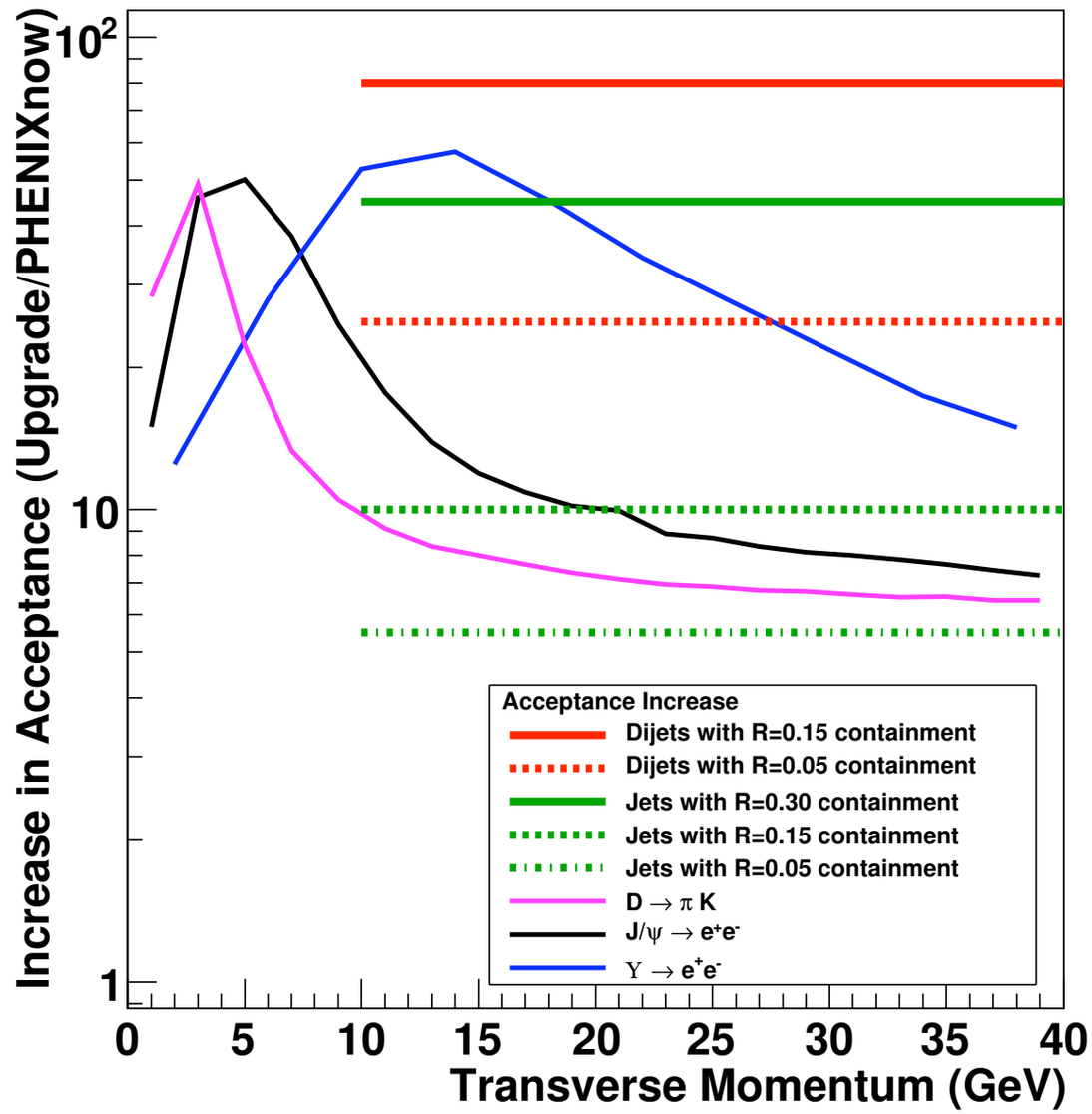

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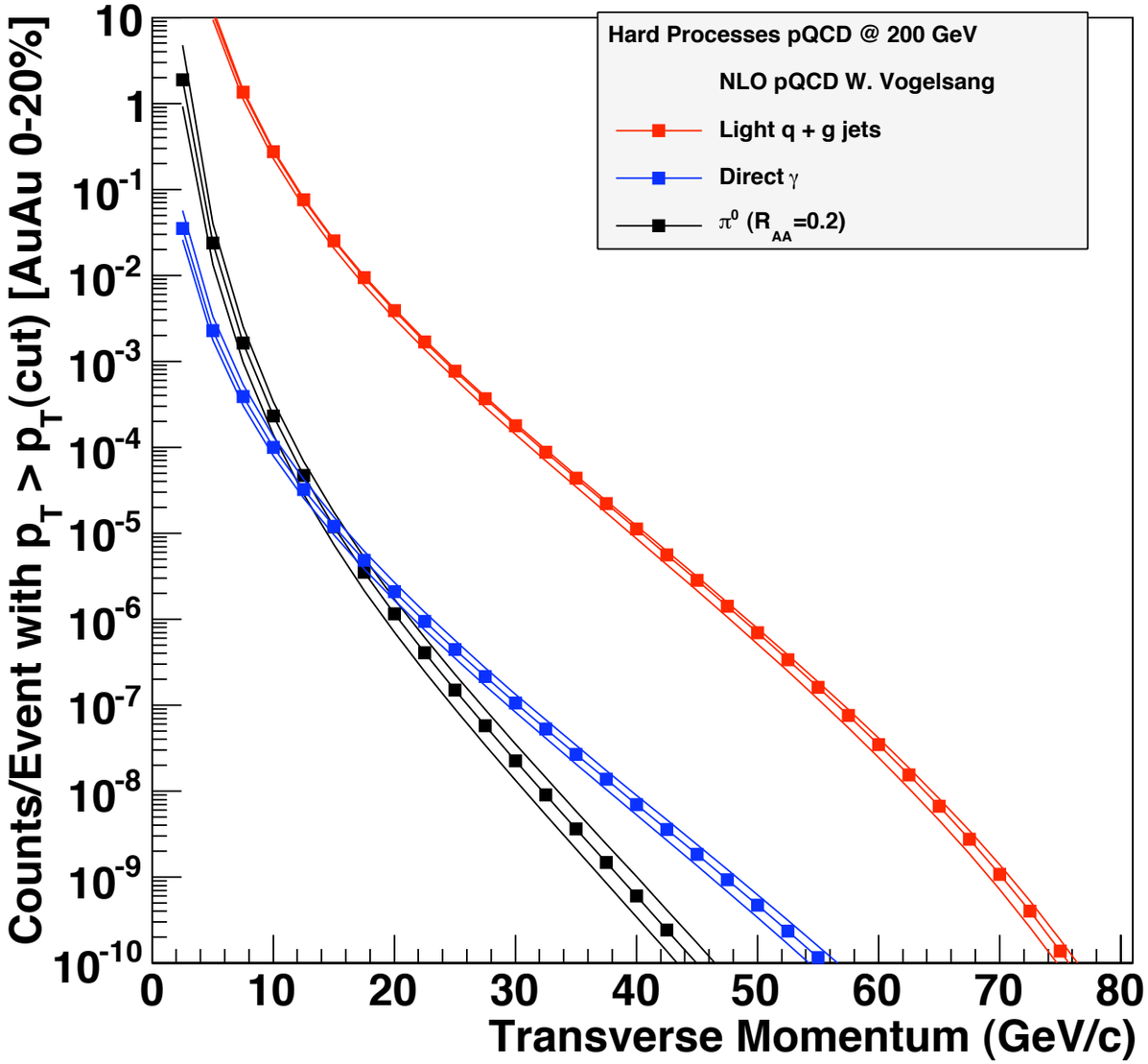
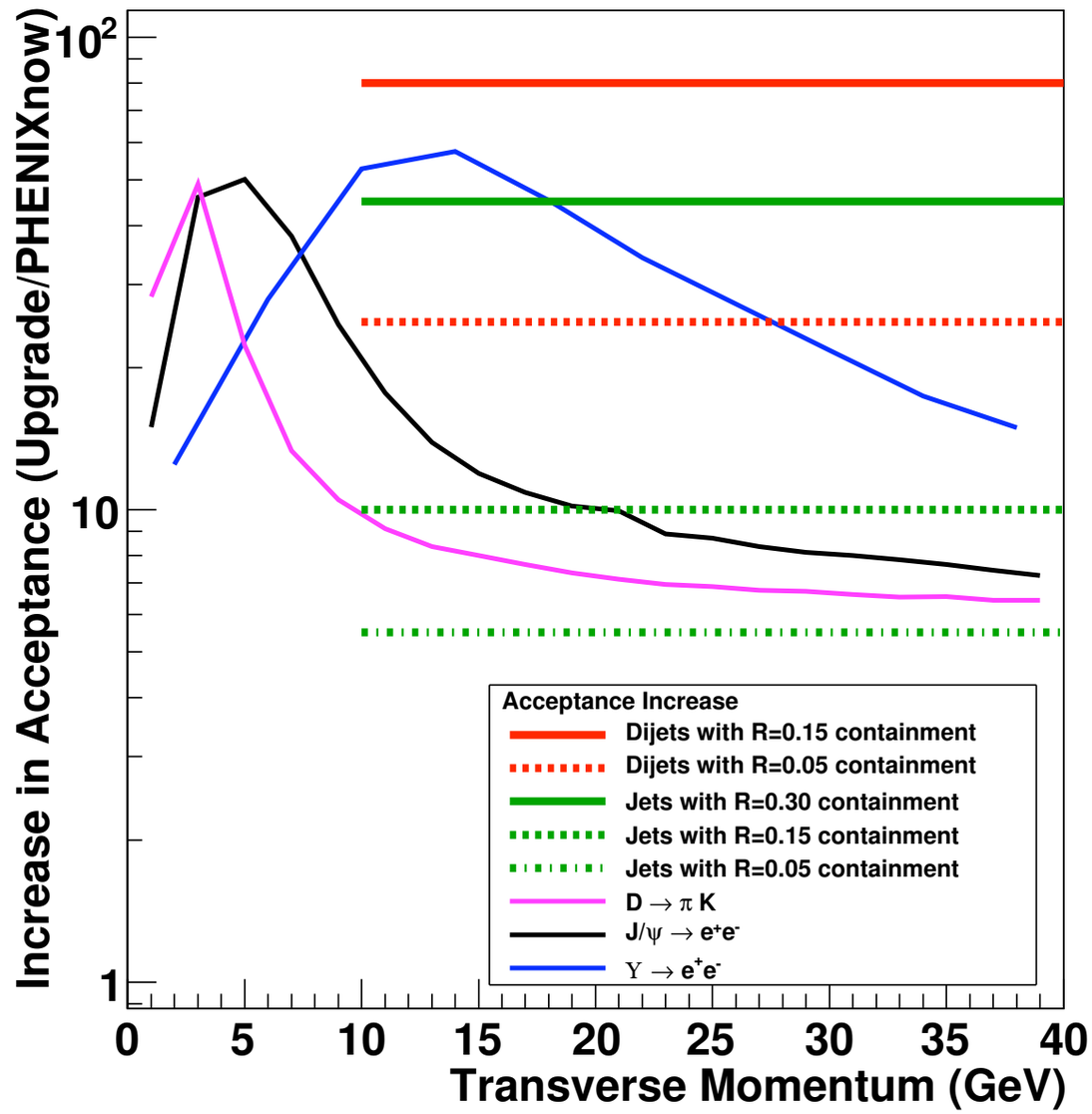
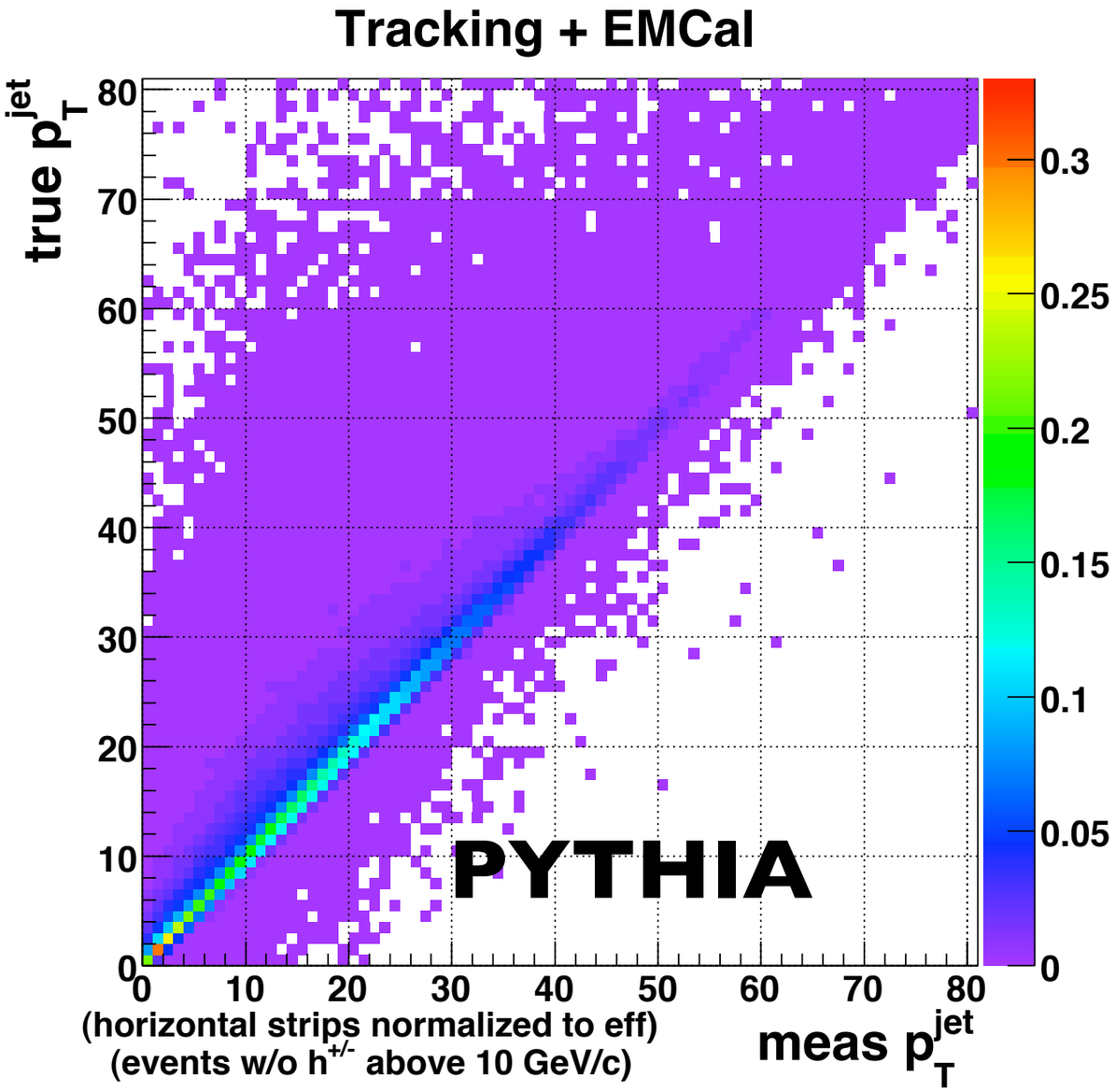




- RHIC luminosities: 20 week Au+Au run → 50B events
  - 25B minimum bias events
- allows not only jet measurements, but di-jet, jet shapes, quarkonia, heavy flavors...

hadronic calorimetry for jets

- jet correlations & asymmetric jets require high energy, ~60GeV
- tracking background limits efficiency & resolution at high energy
- comparable measurements between RHIC & LHC



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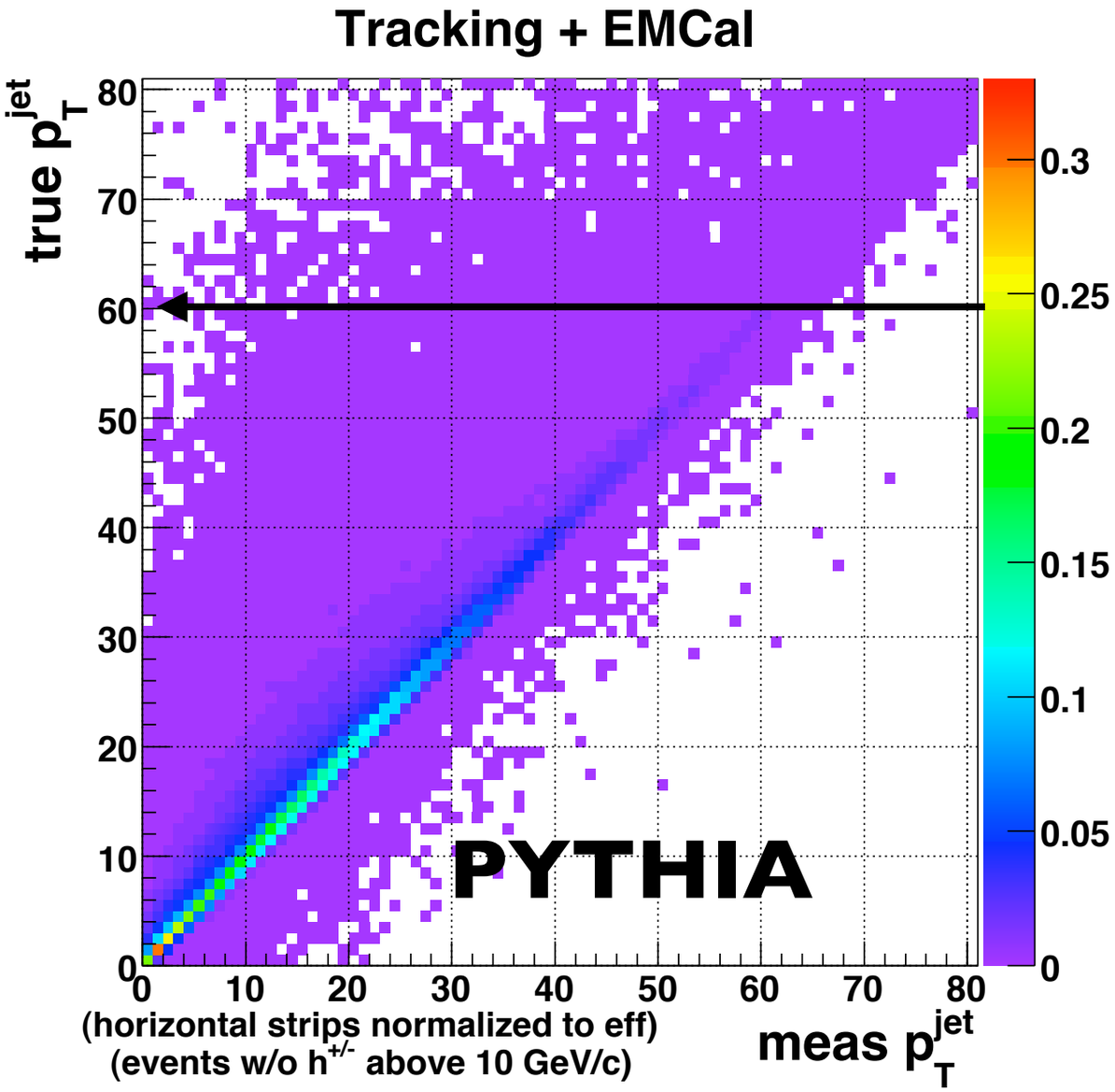

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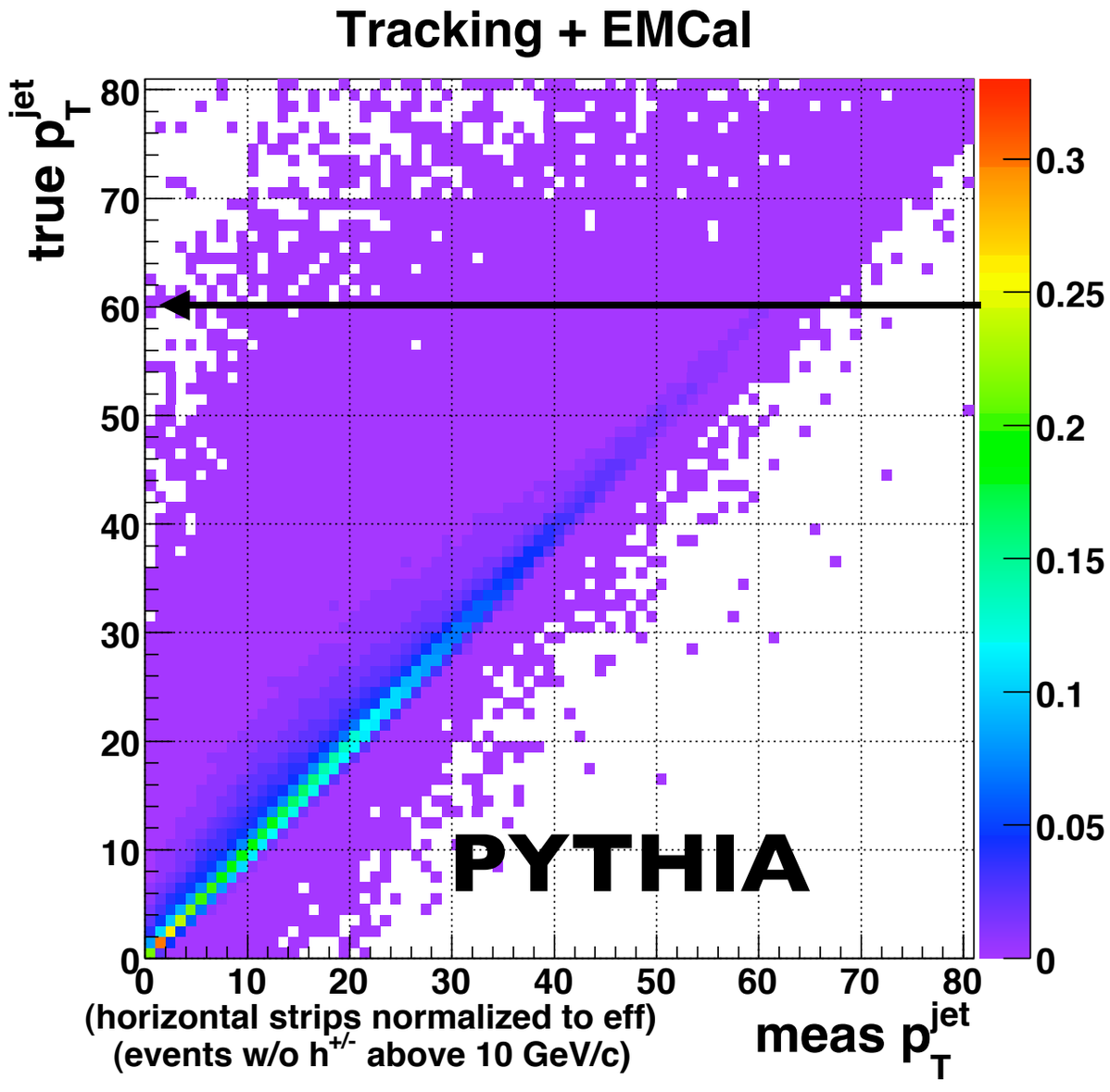

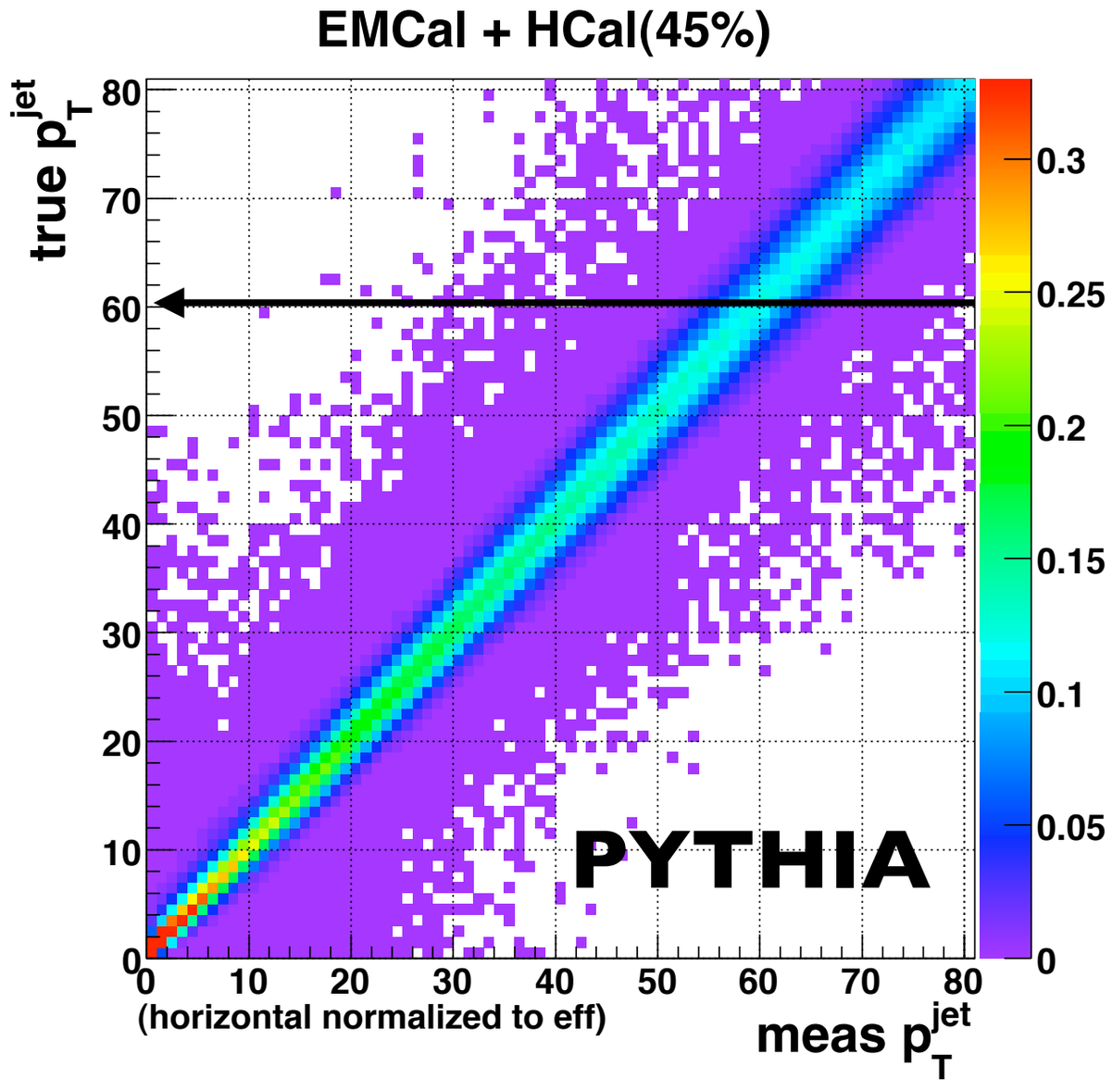

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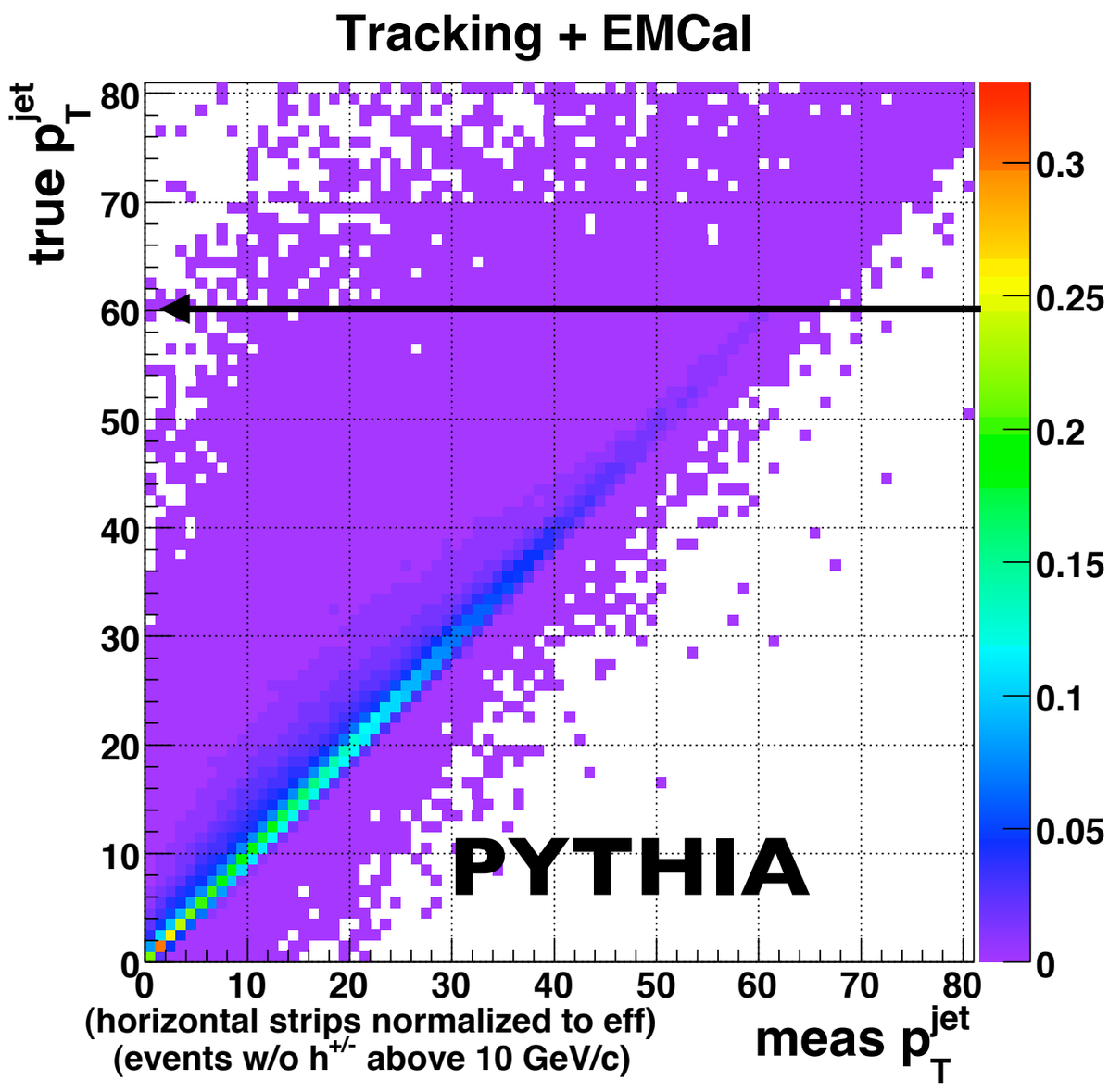
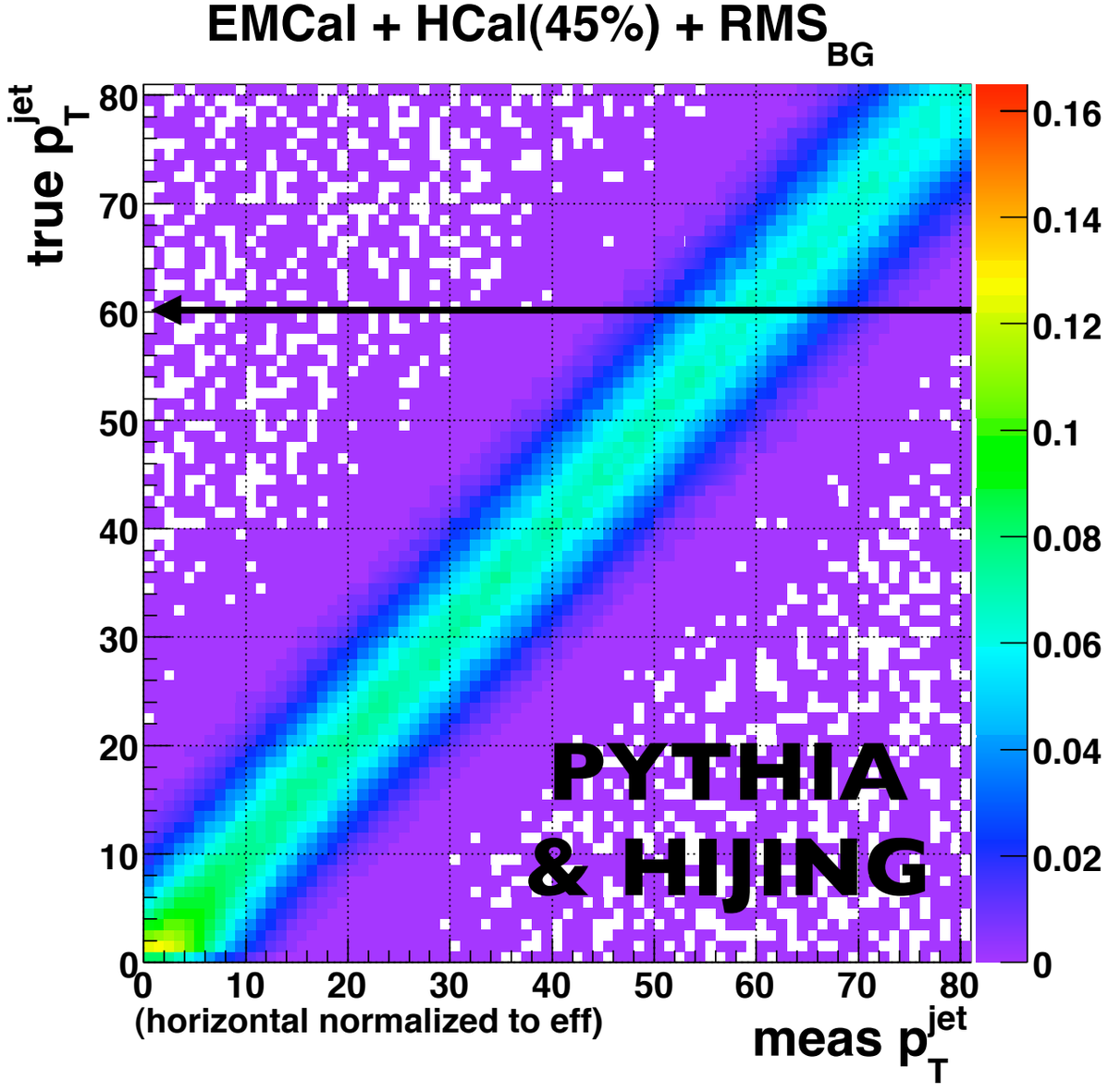
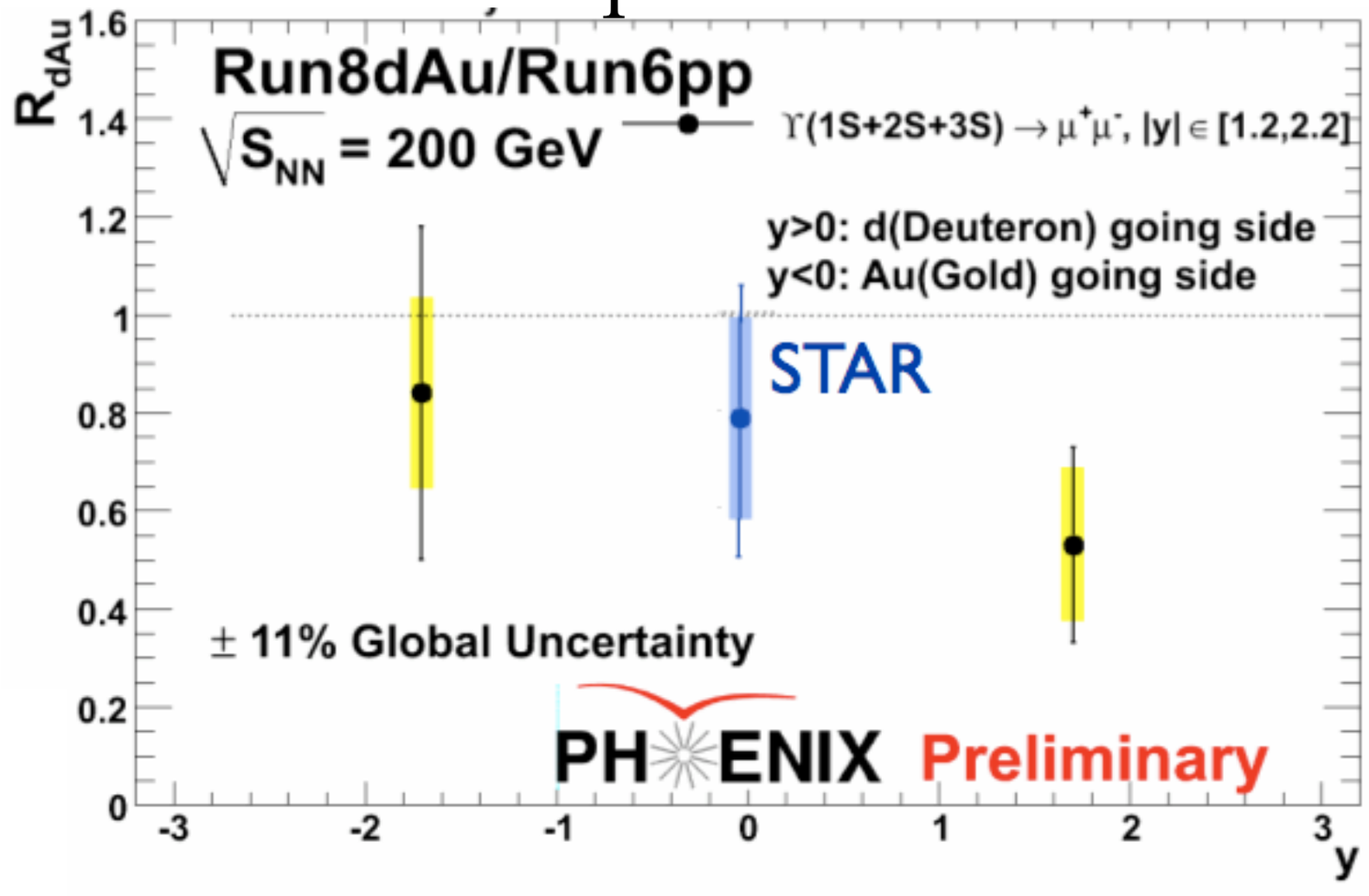




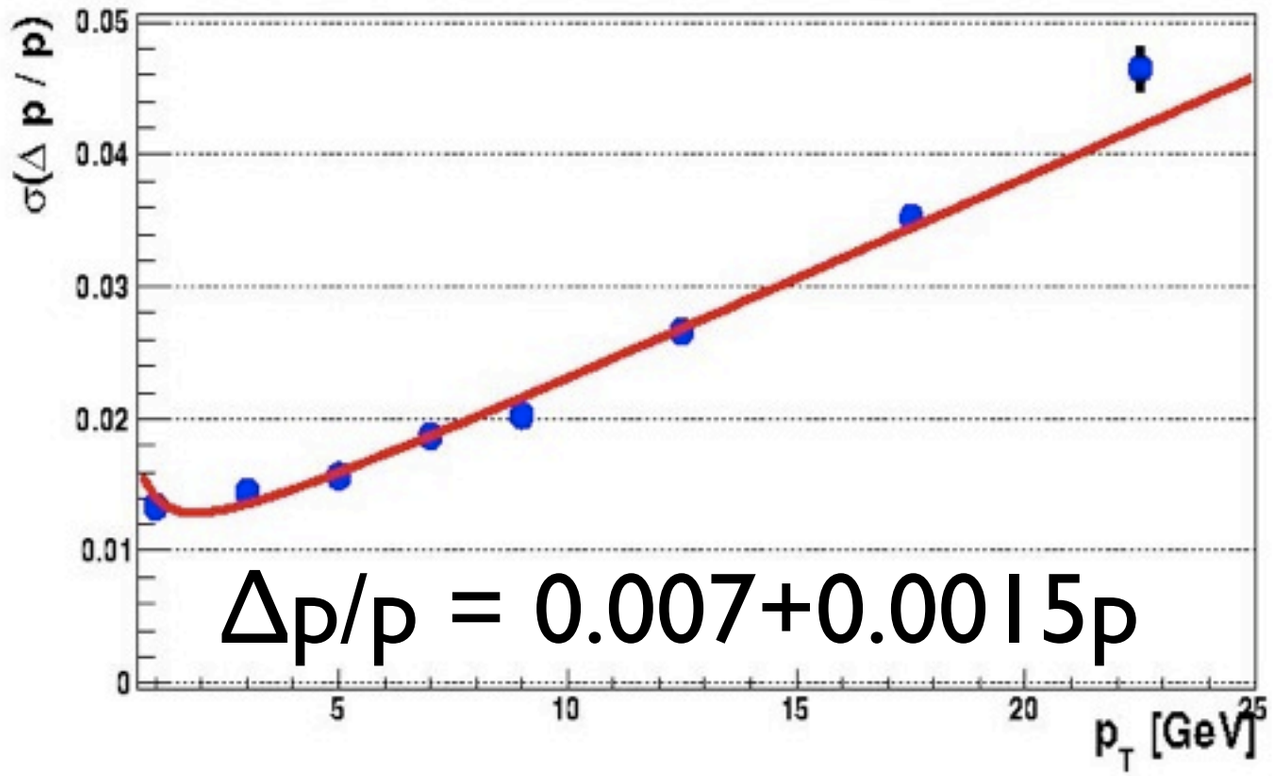
quarkonia

upsilons

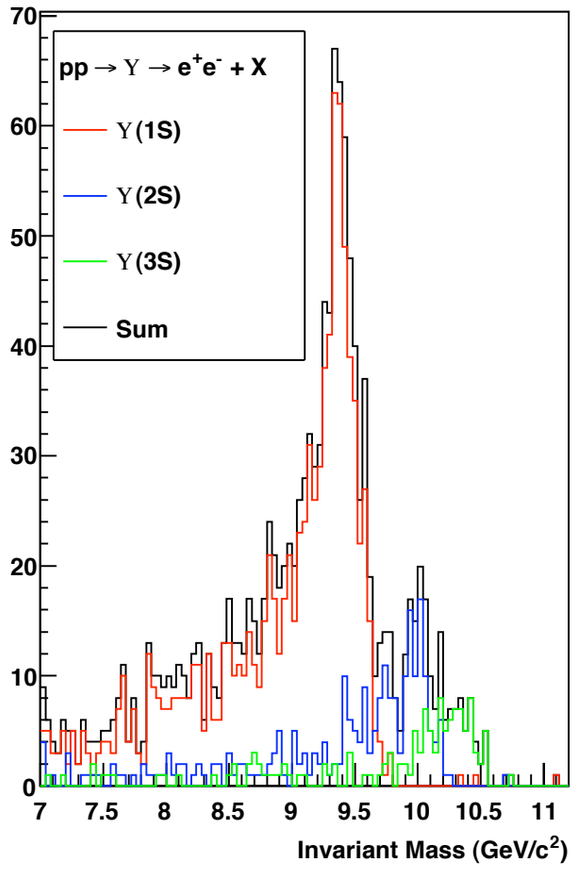


- measurements of J/ψ, ψ', χ_c, & Υ states in a variety of systems
- quarkonia production, cold nuclear matter effects, final state effects

geant 4 simulations



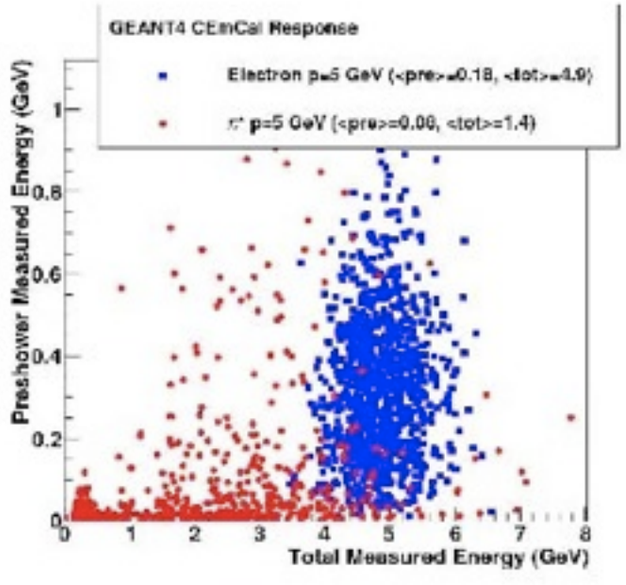
$\Delta p/p = 0.007 + 0.0015p$



reasonable EMCal occupancy
even @ R=60cm

Energy Threshold (MeV)	Layer 1 Occupancy	Layer 2 Occupancy
0	26%	49%
5	15%	22%
10	12%	20%
20	10%	15%
30	7%	12%
40	6%	10%
50	5%	8%

e/π separation



broad physics program

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- heavy ions: answer the compelling questions raised by the first 10 years of RHIC running
  - Are quarks strongly coupled to the QGP at all distance scales?
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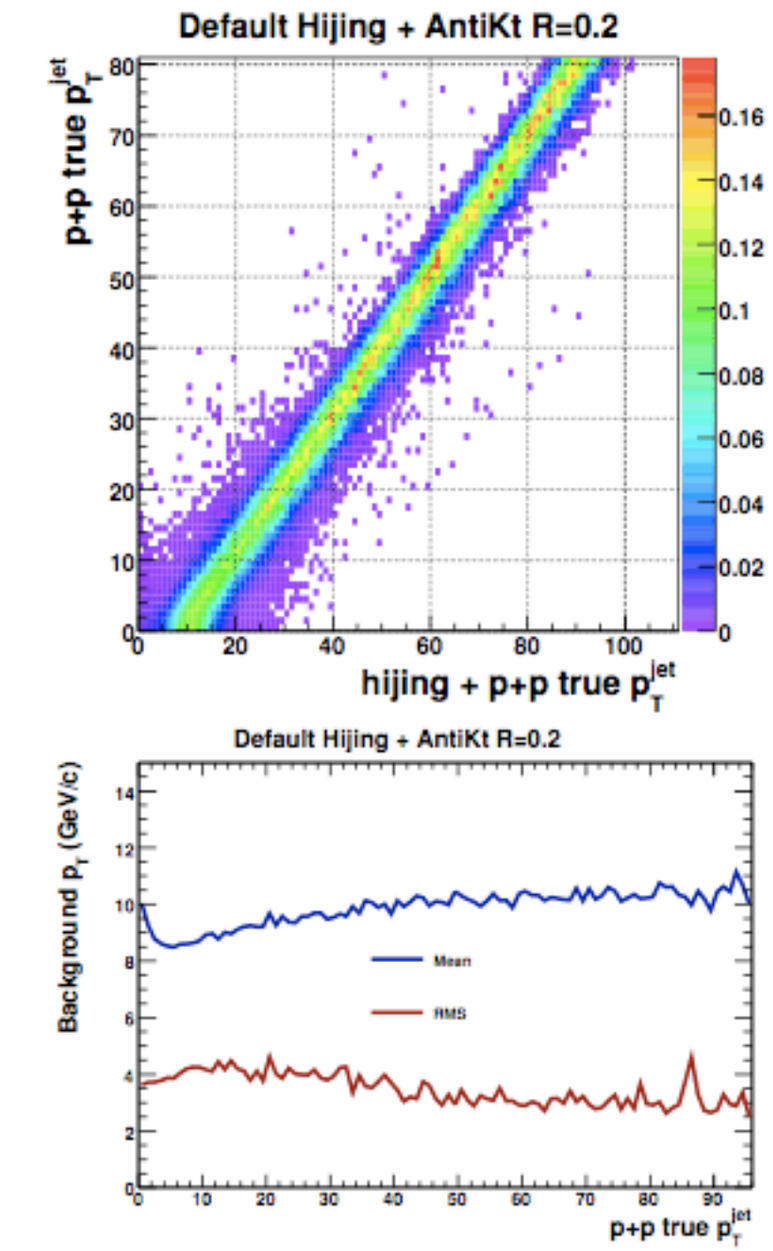
  - deeply virtual Compton scattering
- …

sPHENIX

- advance understanding of sQGP
  - qualitatively new measurements: jets, dijets, quarkonia, heavy flavor, ...
  - HCal, high rate and large acceptance
- new opportunities for eRHIC & spin physics
  - especially important in the forward direction
- sPHENIX heavy ions complementary to LHC and current RHIC measurements
- broad, flexible of physics within a single experiment allows for precise, systematic studies of QCD

BACKUPS


Default Hijing + AntiKt R=0.2
p+p true p_T^{jet}
hijing + p+p true p_T^{jet}
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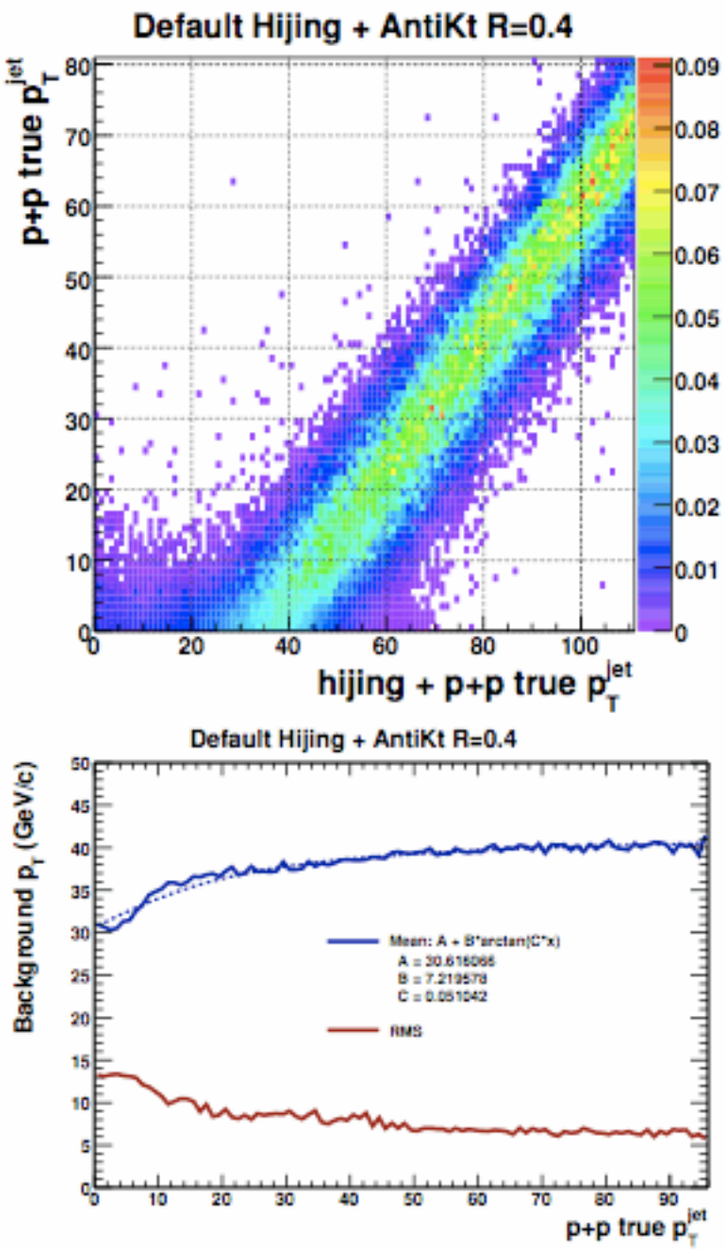
Background p_T (GeV/c)
Mean
RMS
p+p true p_T^{jet}


Default Hijing + AntiKt R=0.4
p+p true p_T^{jet}
hijing + p+p true p_T^{jet}
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Background p_T (GeV/c)
Mean: A + B*arctan(C*x)
A = 30.616066
B = 7.219578
C = 0.051042
RMS
p+p true p_T^{jet}

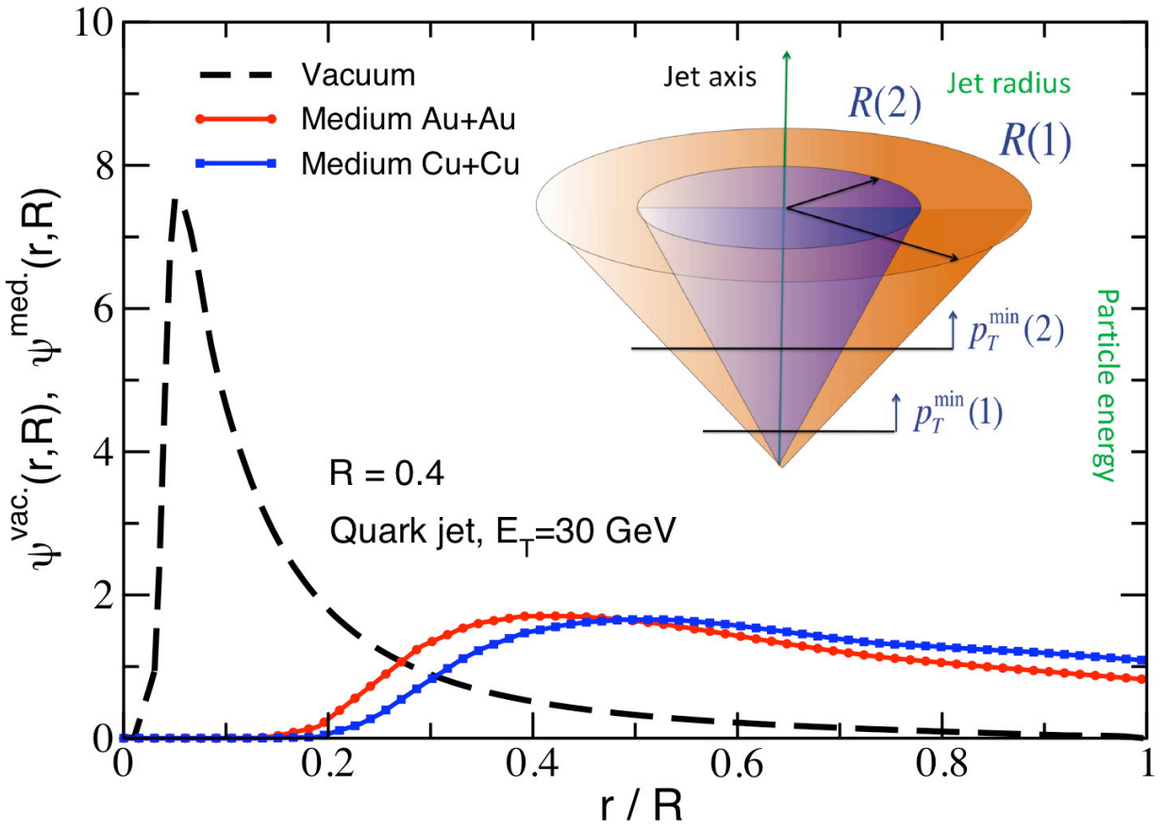
Modified jets

- minimum bias data avoids possible jet shape biases

Vitev & Zhang PRL 104 132001 (2010)

Modified jets

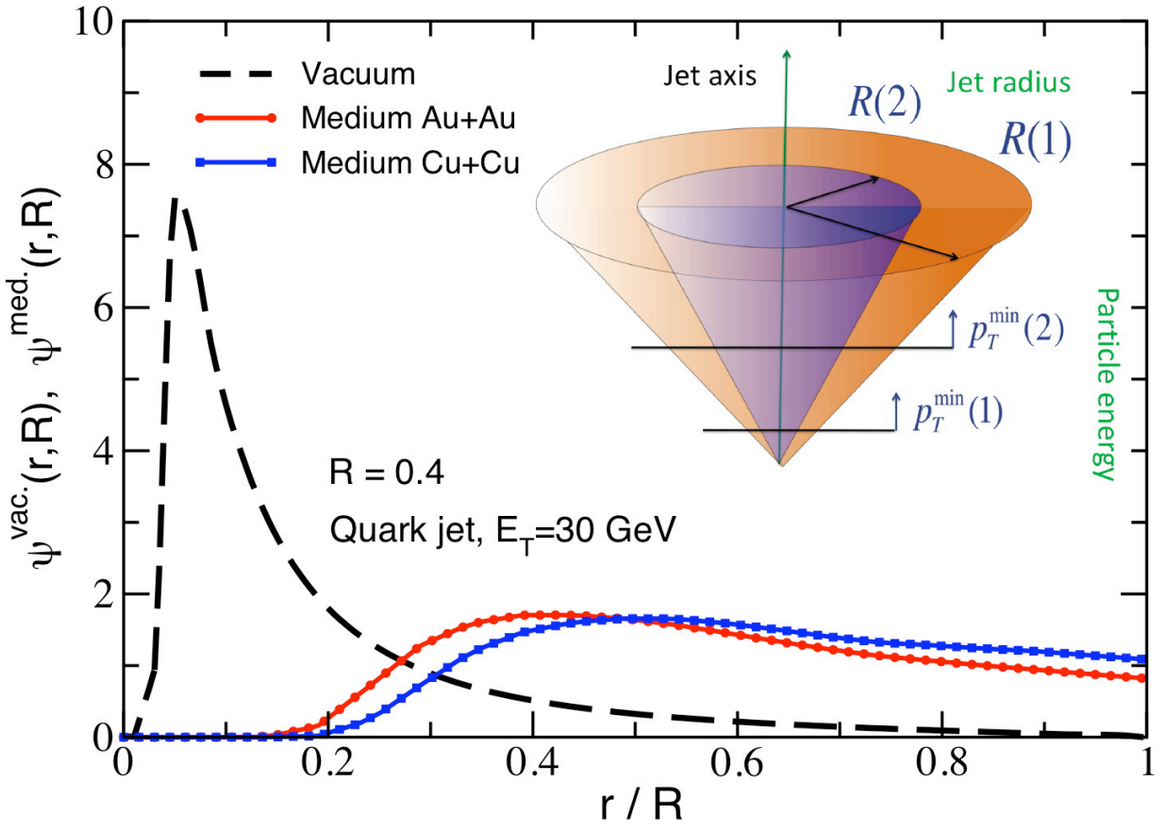
- minimum bias data avoids possible jet shape biases

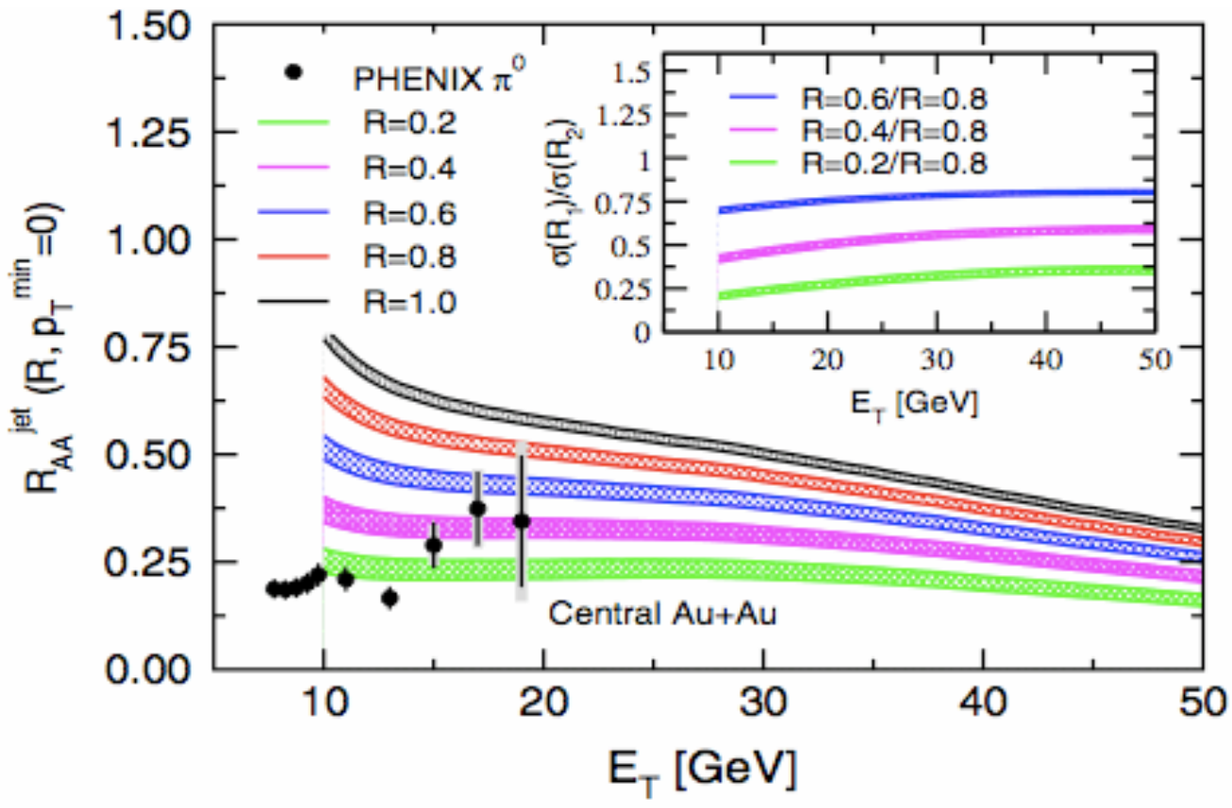


Vitev & Zhang PRL 104 132001 (2010)

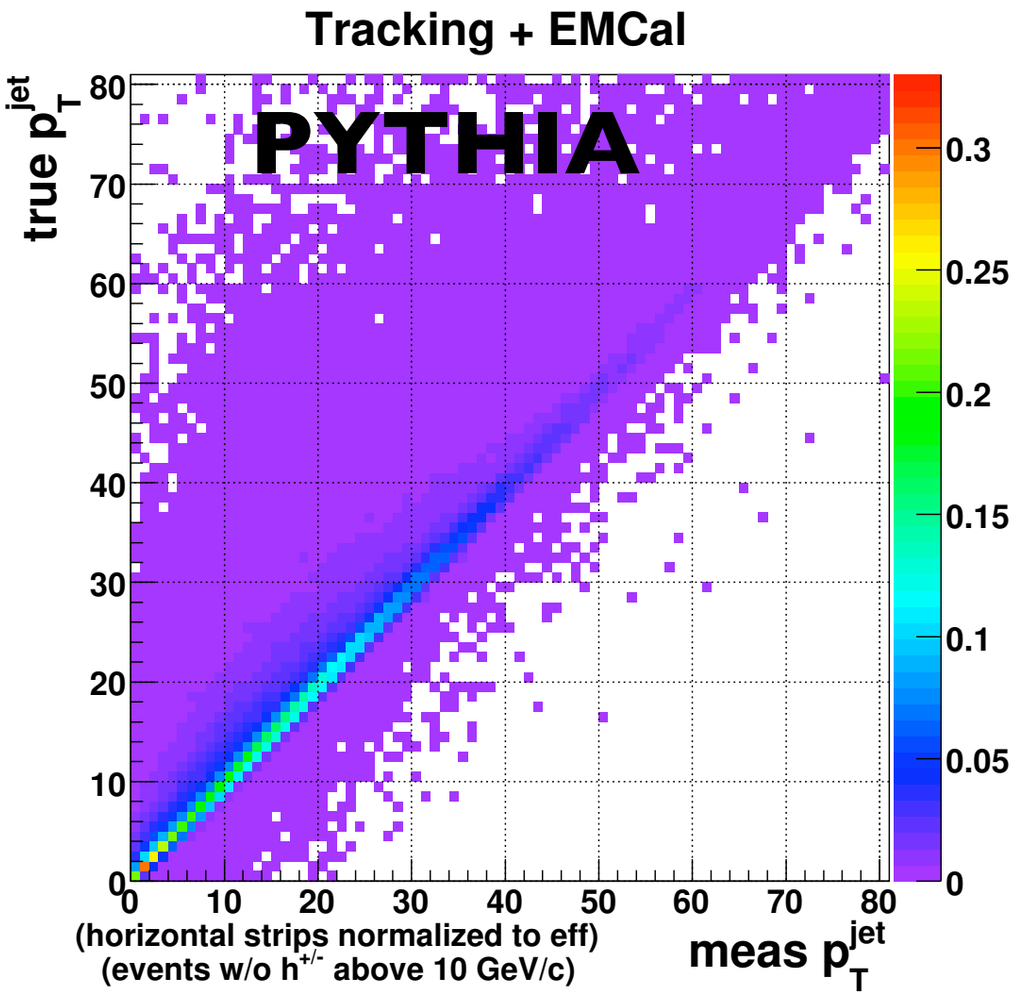
Modified jets

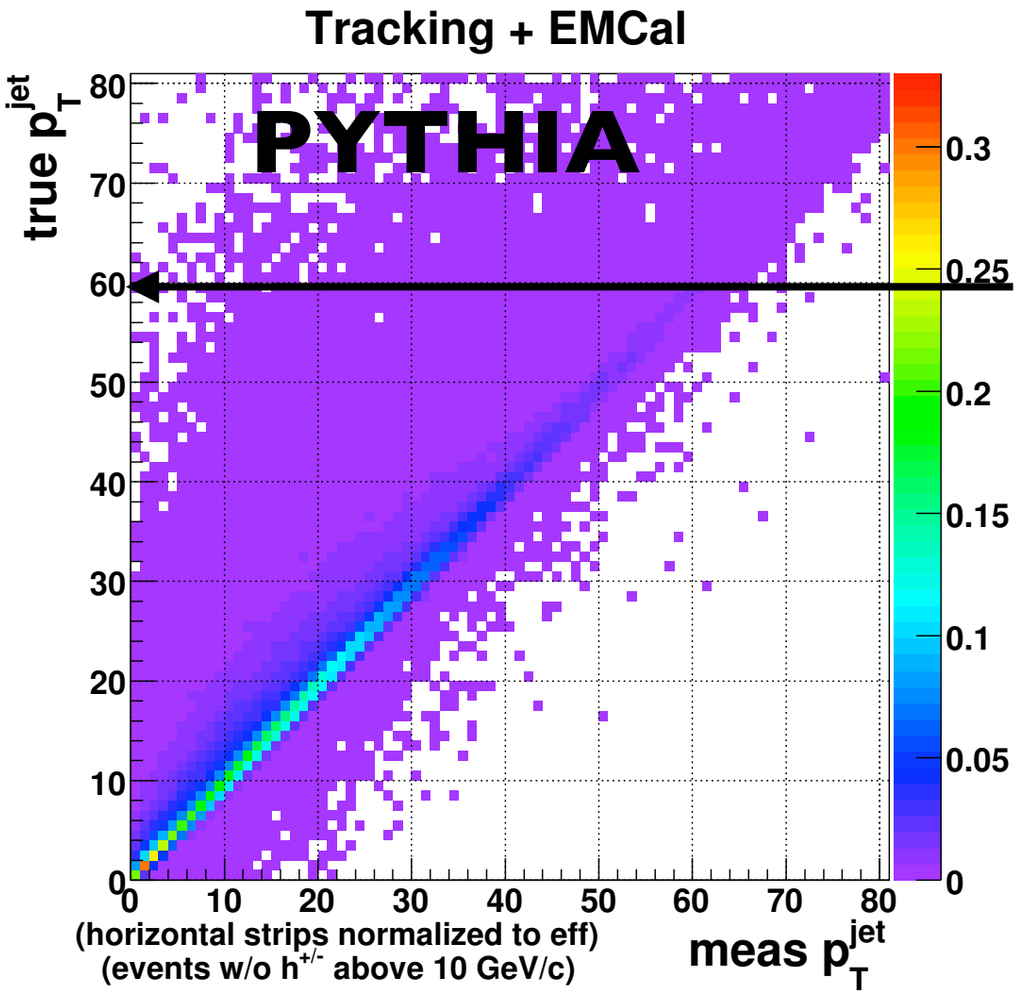
- minimum bias data avoids possible jet shape biases

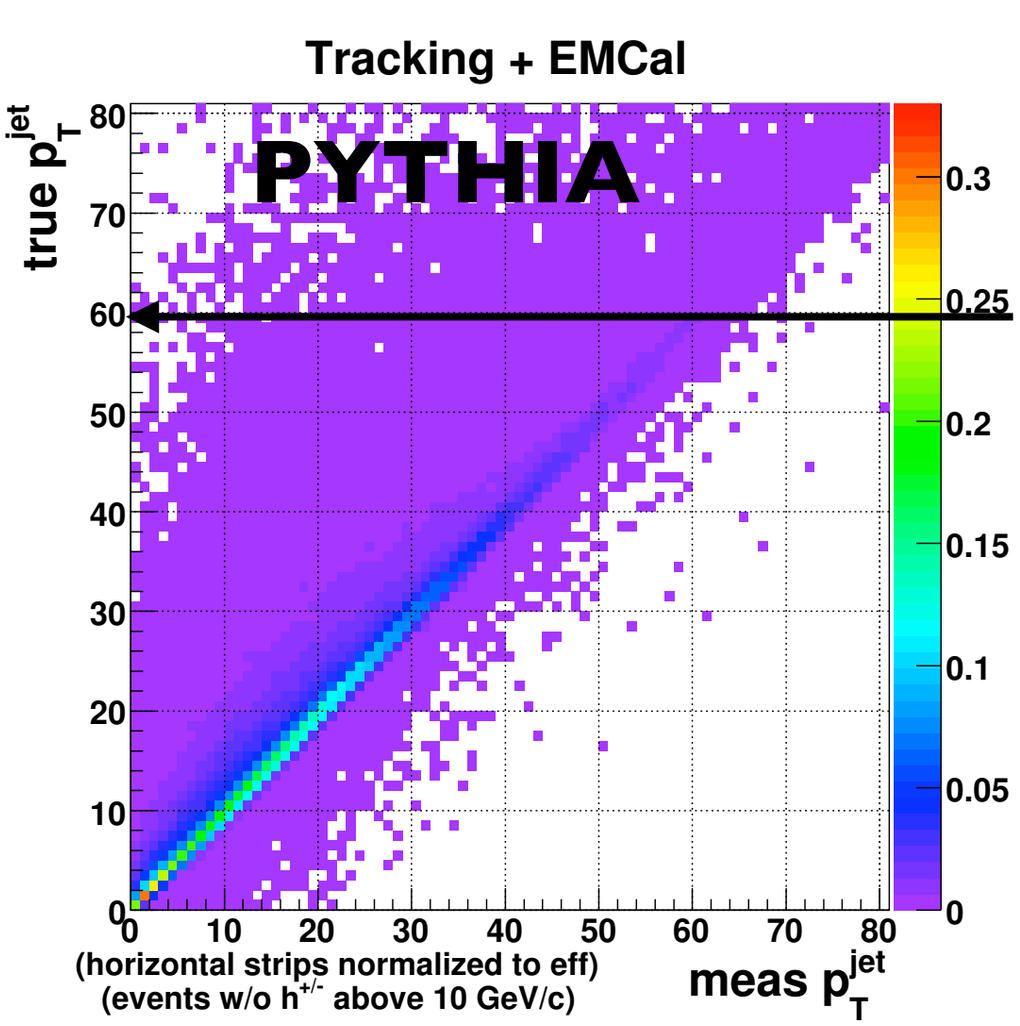


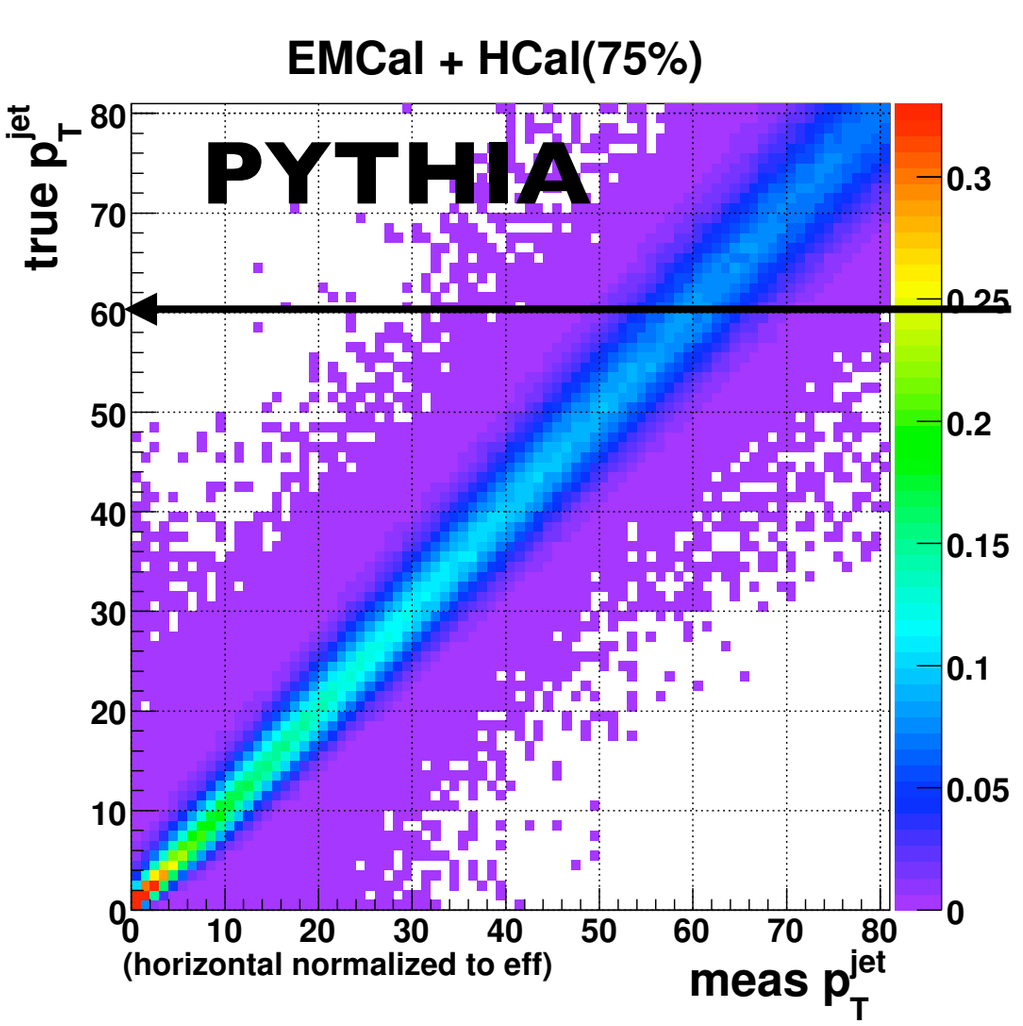


Vitev & Zhang PRL 104 132001 (2010)


Tracking + EMCal
PYTHIA
true p_T^{jet}
meas p_T^{jet}
(horizontal strips normalized to eff)
(events w/o $h^{+/-}$ above 10 GeV/c)
0
10
20
30
40
50
60
70
80
0.3
0.25
0.2
0.15
0.1
0.05
0

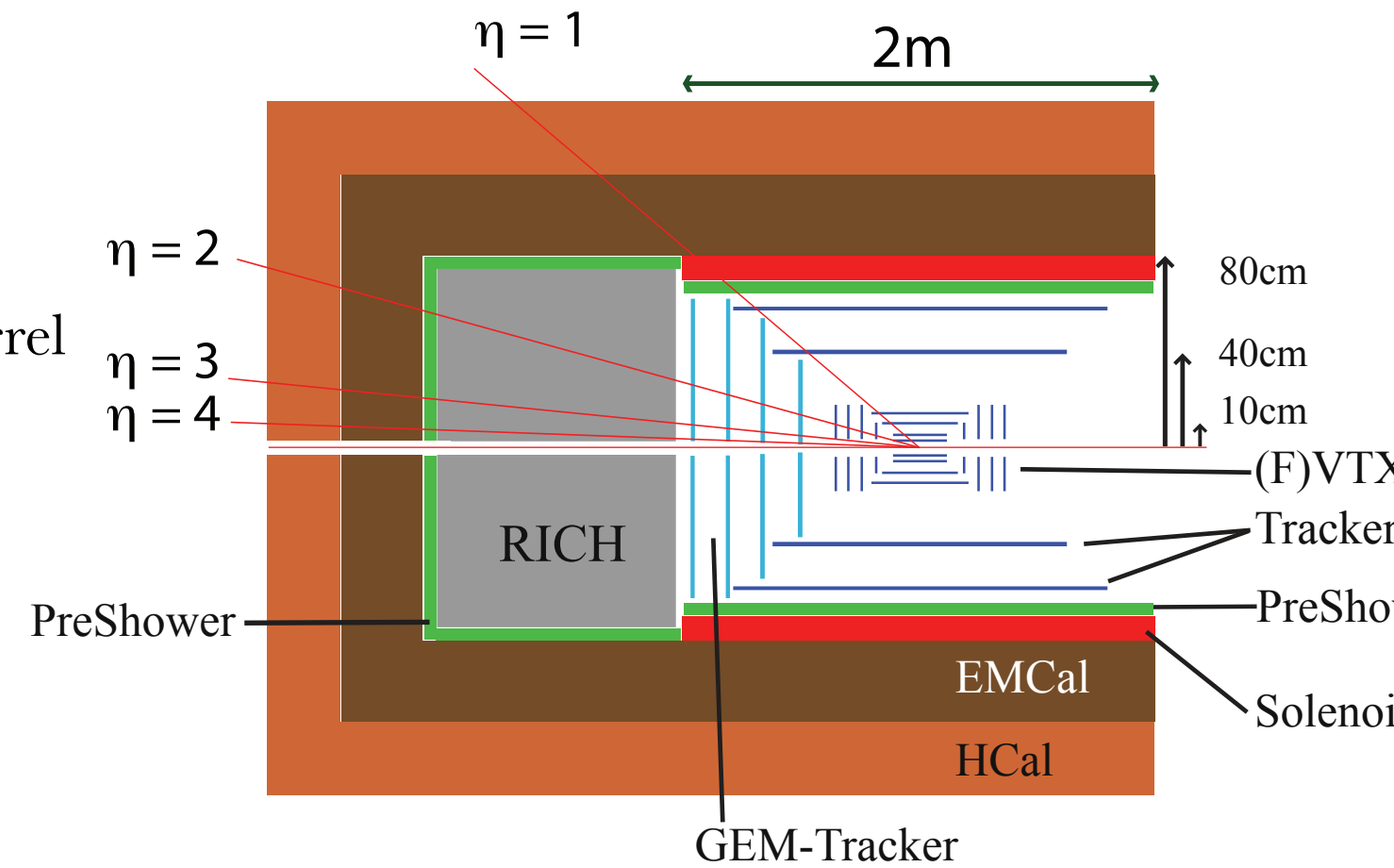

Tracking + EMCal
PYTHIA
true p_T^{jet}
meas p_T^{jet}
(horizontal strips normalized to eff)
(events w/o $h^{+/-}$ above 10 GeV/c)
0
10
20
30
40
50
60
70
80
0.3
0.25
0.2
0.15
0.1
0.05
0


Tracking + EMCal
PYTHIA
true p_T^{jet}
meas p_T^{jet}
(horizontal strips normalized to eff)
(events w/o $h^{+/-}$ above 10 GeV/c)


EMCal + HCal(75%)
PYTHIA
true p_T^{jet}
meas p_T^{jet}
(horizontal normalized to eff)

PHENIX Decadal Upgrade Detetor

- Carry over from existing PHENIX:
- VTX and FVTX
- EMCal in Forward Arm and perhaps barrel
- DAQ
- Infrastructure (LV, HV, Safety…)
- What is new:
- 2-3T solenoid (R = 60-100 cm)
- Preshower detector
- Barrel EMCal (maybe new)
- Hadronic Calorimetry
- Additional tracking layer of Si at ~ 40cm
- Forward Arm with RICH and GEM tracker



Can be built incrementally