

(Jet) Physics with Calorimetry in

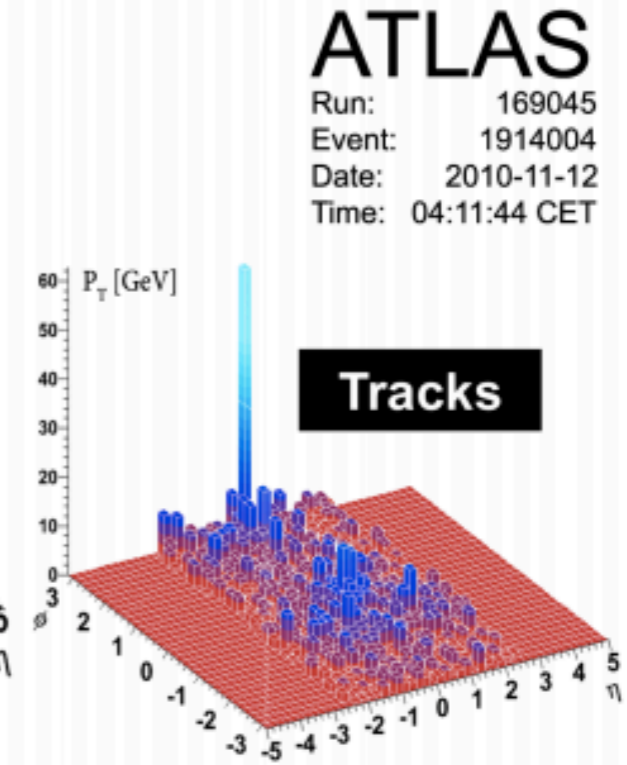
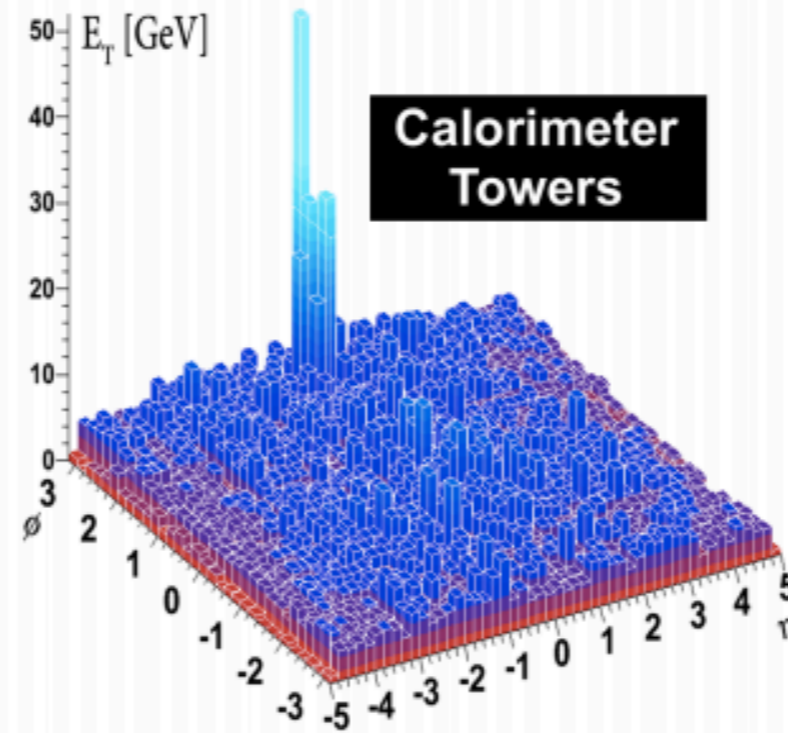
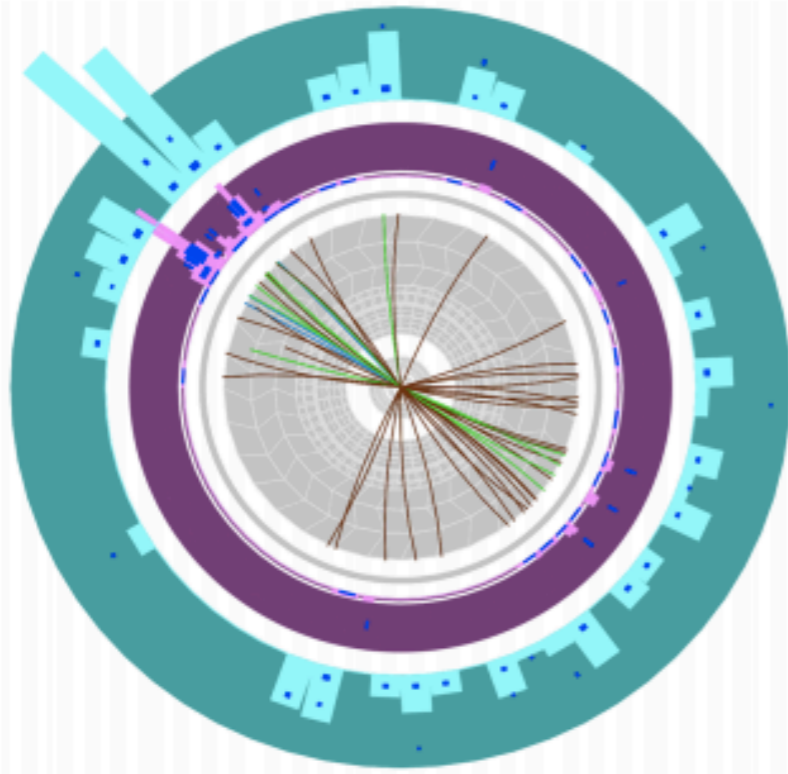


Michael P. McCumber
(University of Colorado)

PHENIX Decadal R&D Workshop
Brookhaven National Laboratory
14 December 2010

Jet Energy Loss

Jets have become a primary channel for studying energy loss...

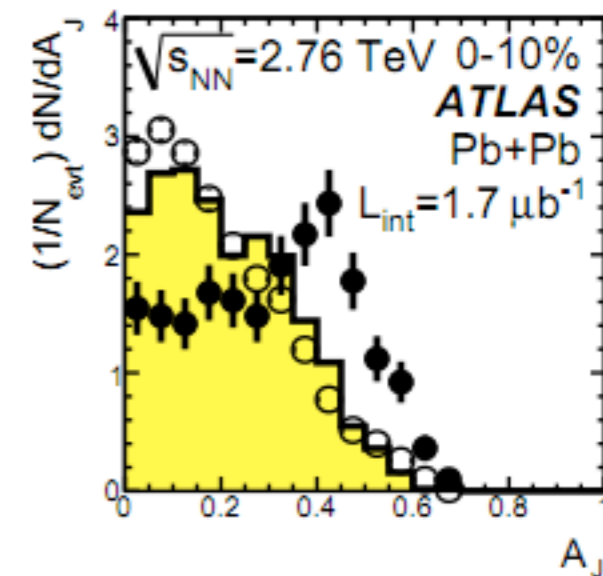
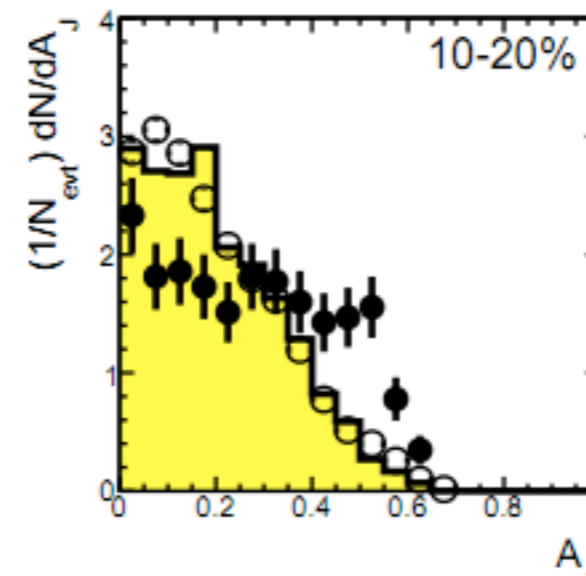
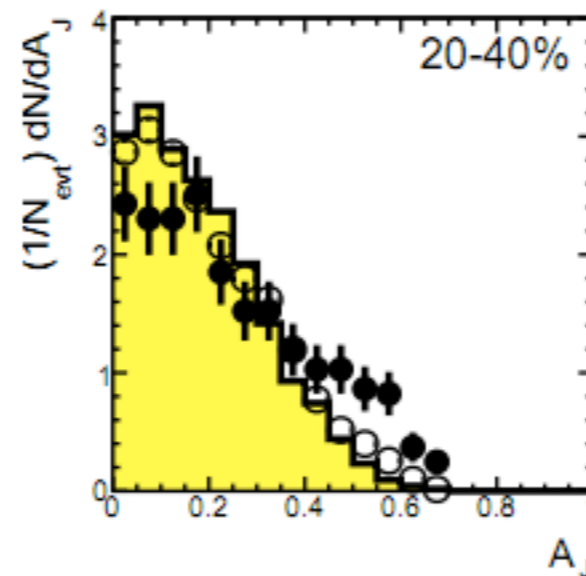
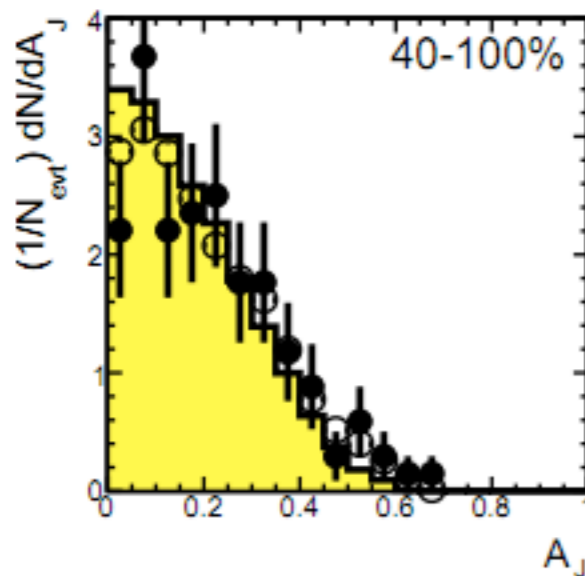


ATLAS

Run: 169045
Event: 1914004
Date: 2010-11-12
Time: 04:11:44 CET

$$A_J = \frac{E_{T1} - E_{T2}}{E_{T1} + E_{T2}}$$

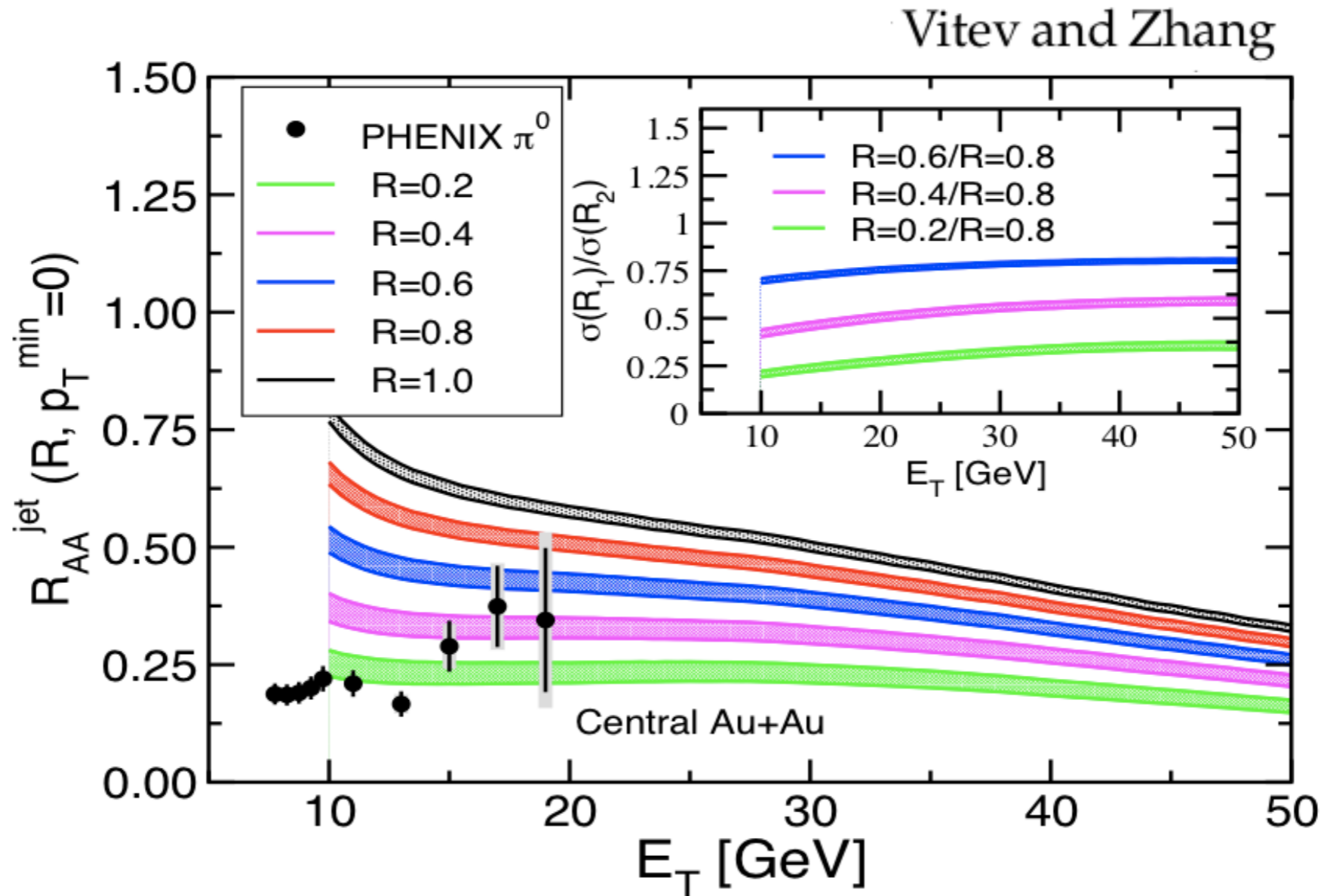
[arXiv:1011.6182v2](https://arxiv.org/abs/1011.6182v2)



Jet Observables: Rate

Reconstructed jets are a high rate, information rich observable...

Medium interactions broaden jets and reduce their multiplicity...

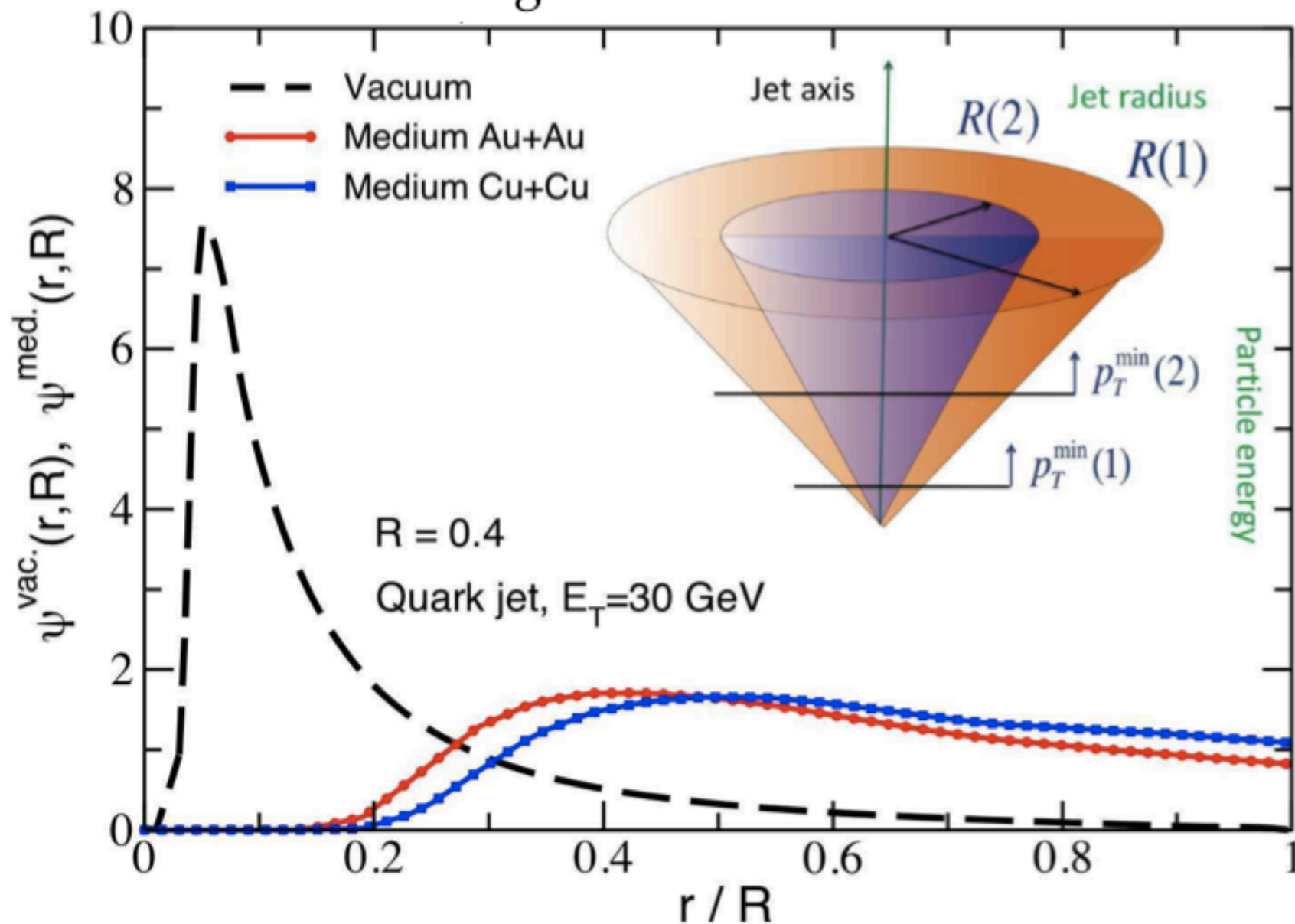


Jet Observables: Shape

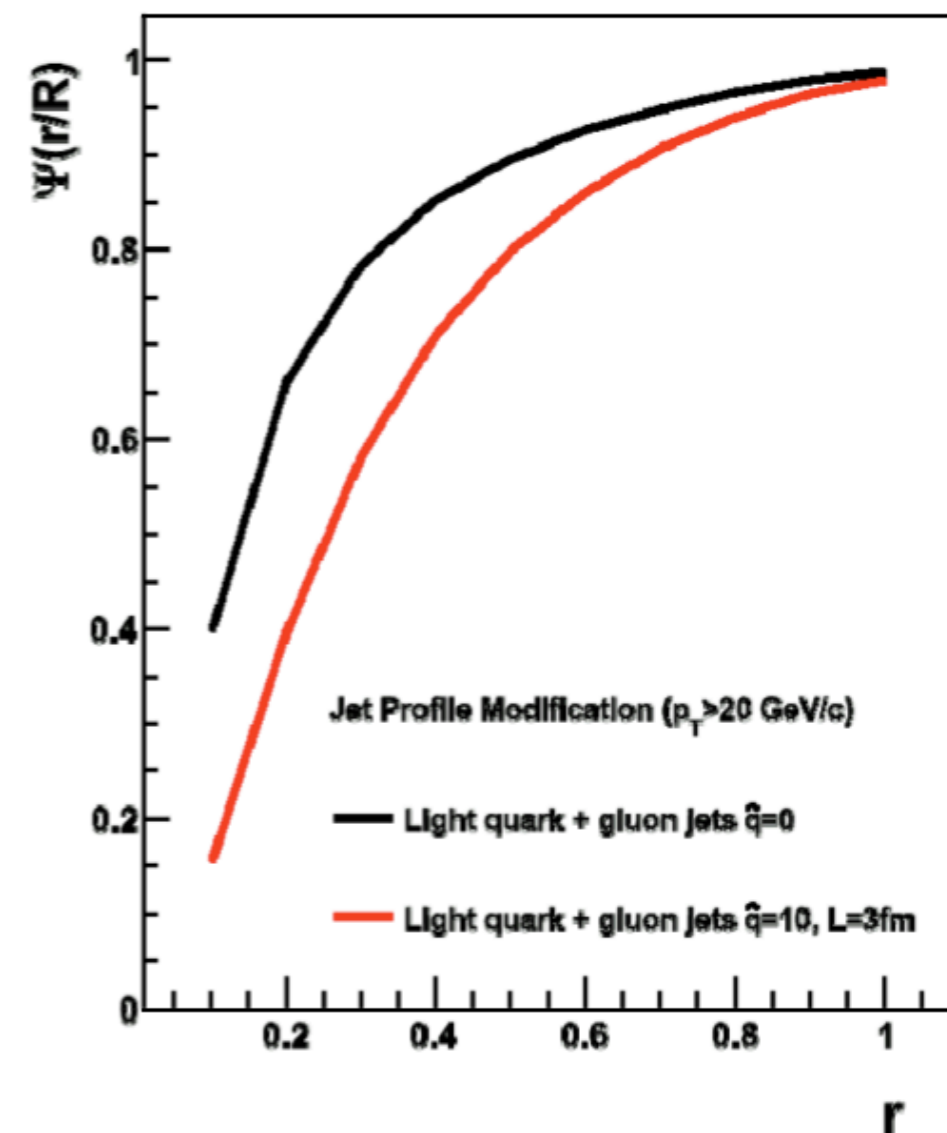
Reconstructed jets are a high rate, information rich observable...

Medium interactions with the medium modify the shape of the jet

Vitev and Zhang



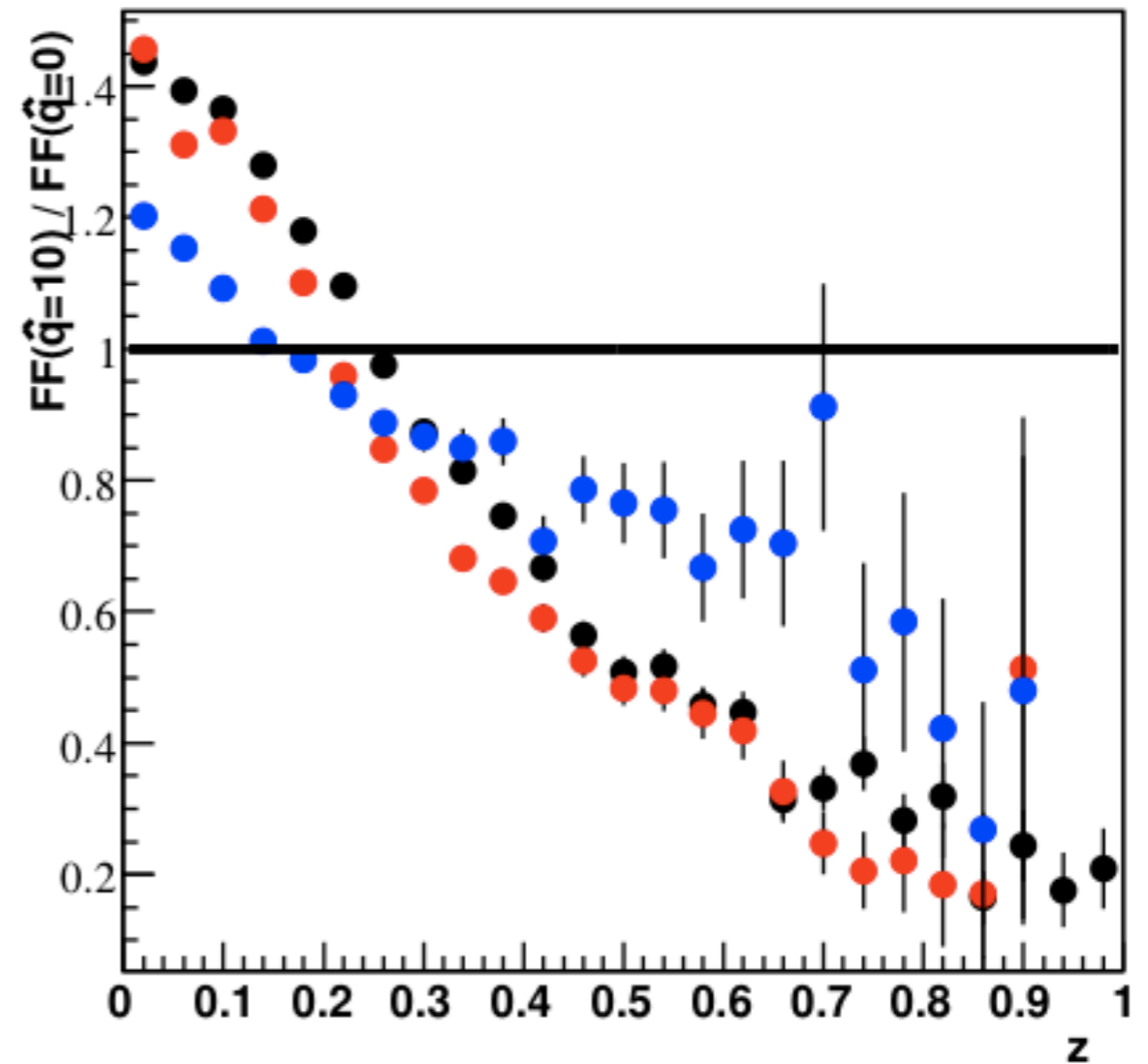
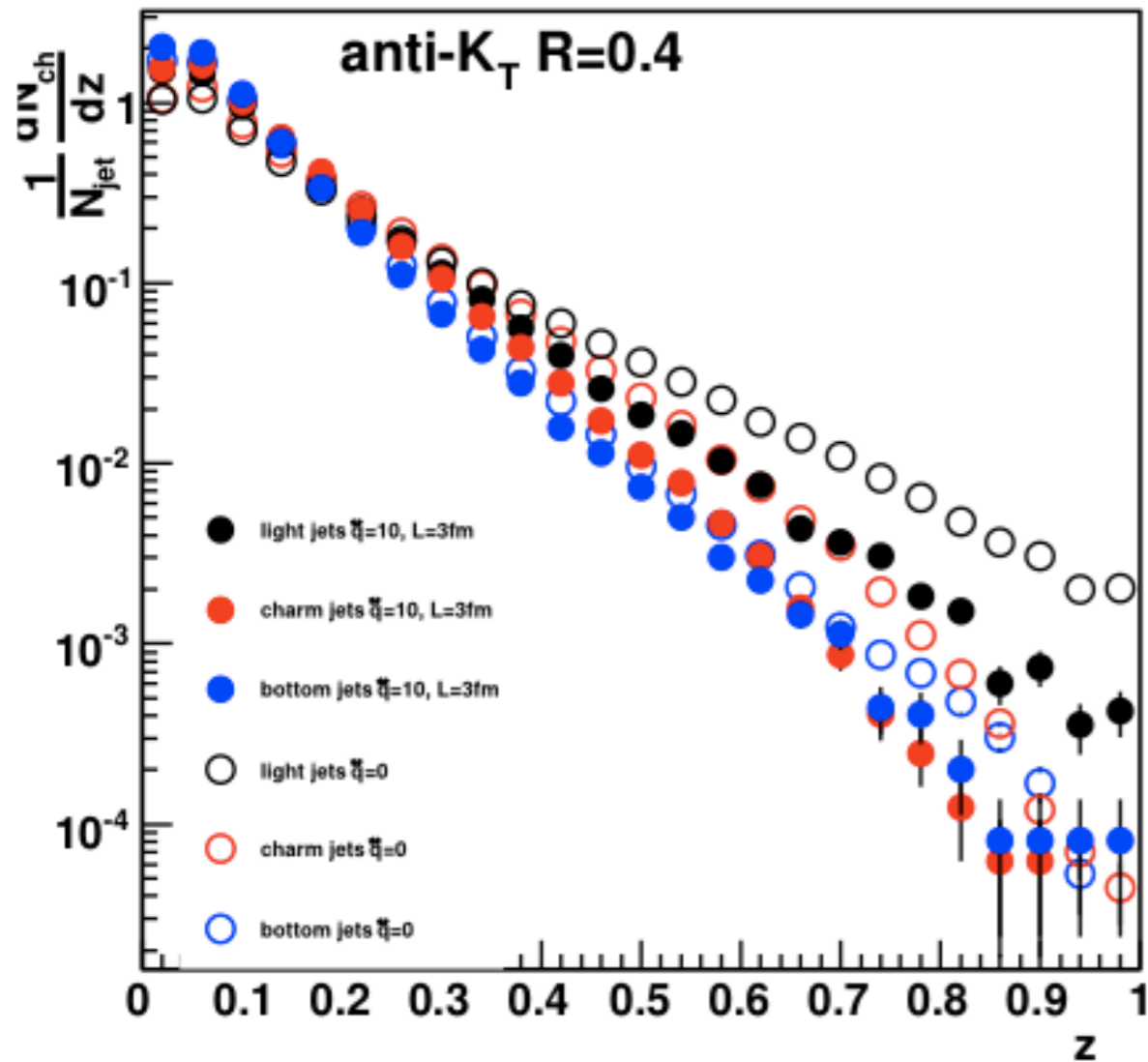
QPYTHIA



Jet Observables: Fragmentation

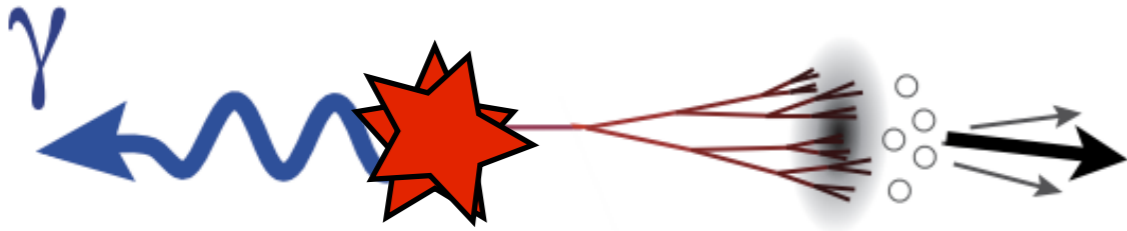
Reconstructed jets are a high rate, information rich observable...

Medium interactions alter the fragmentation pattern of jets



Additional Di-jet Observables

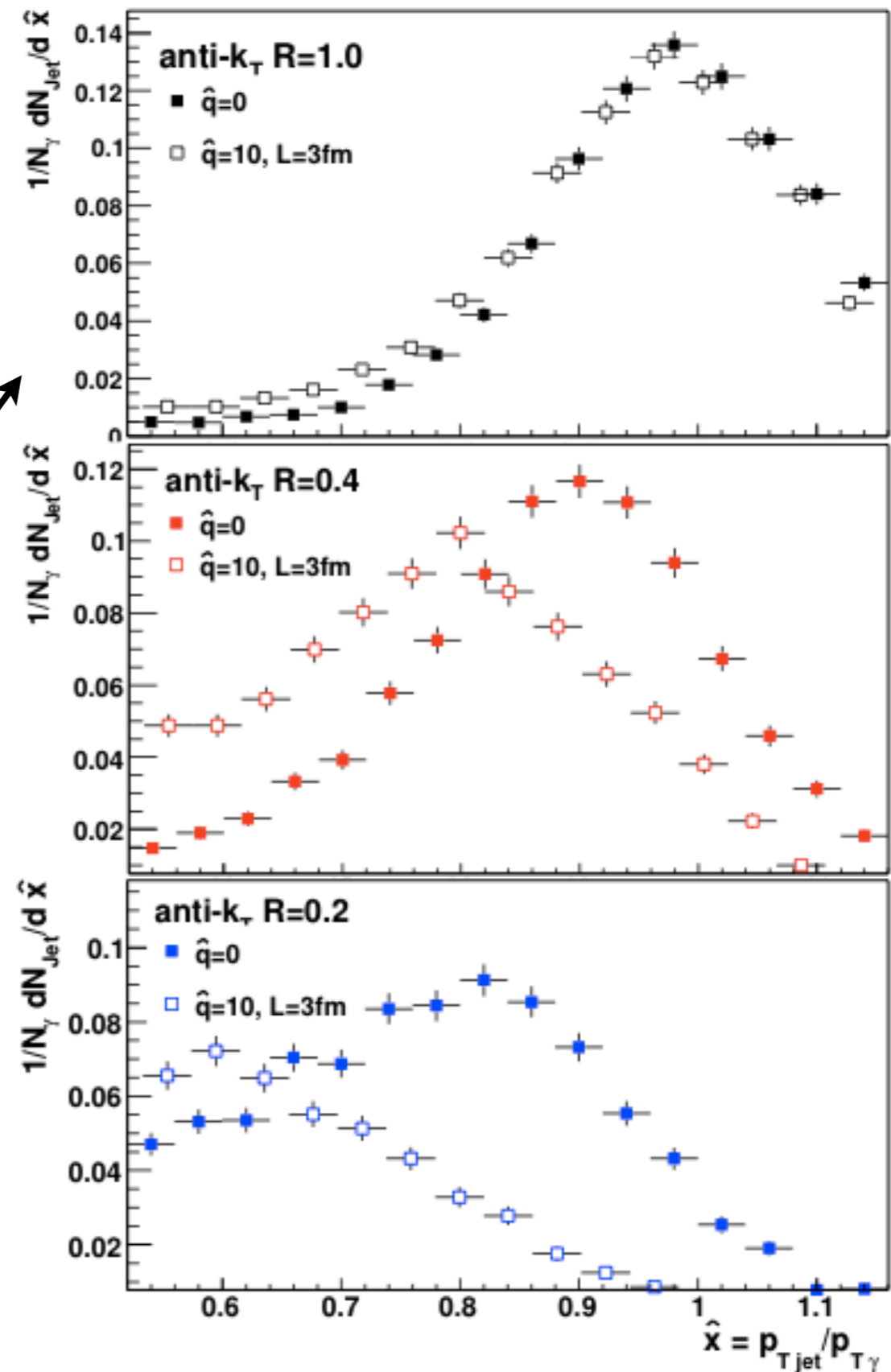
Reconstructed jets are a high rate, information rich observable...



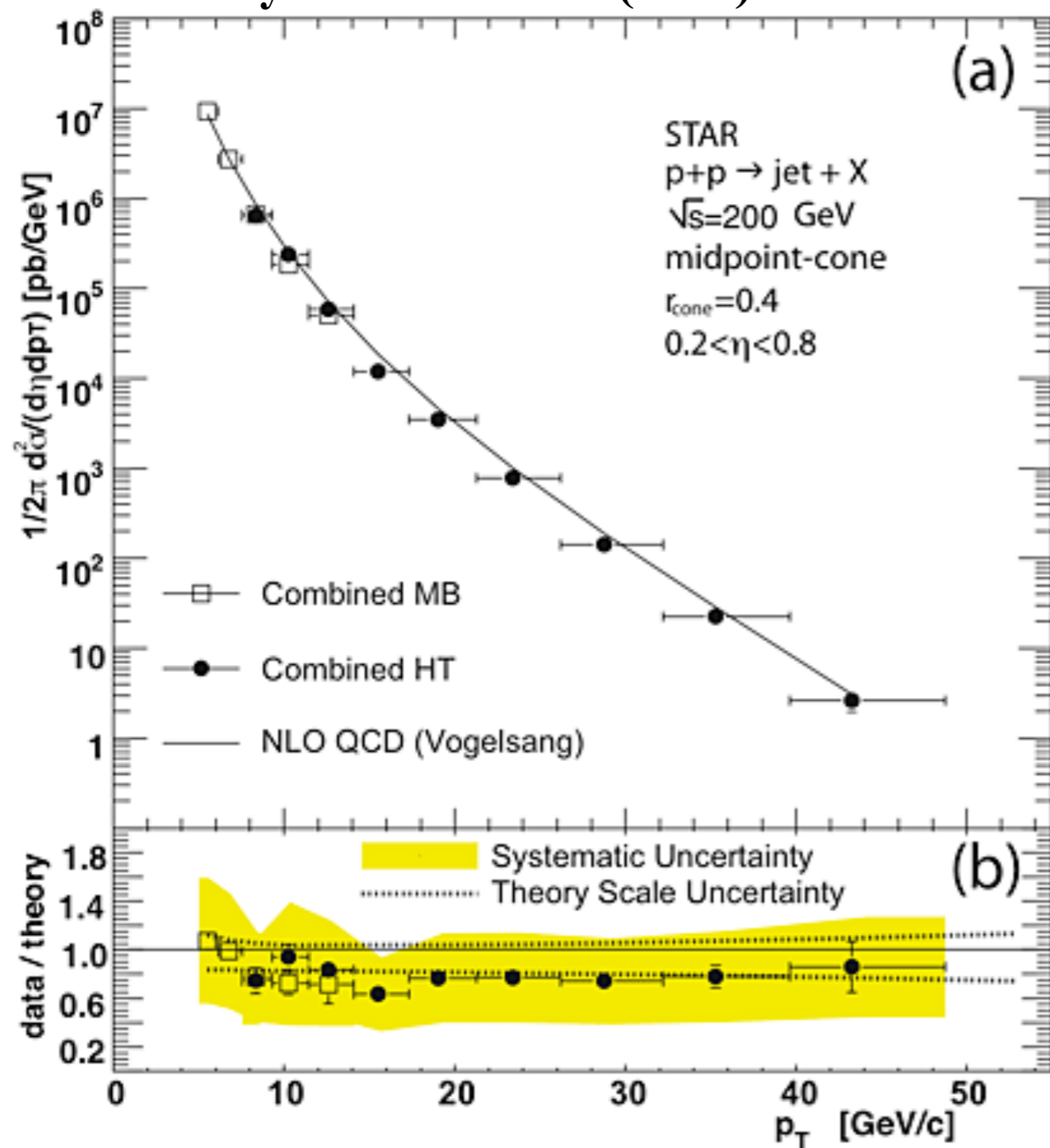
“Golden” channel measurement

Different energy uncertainties

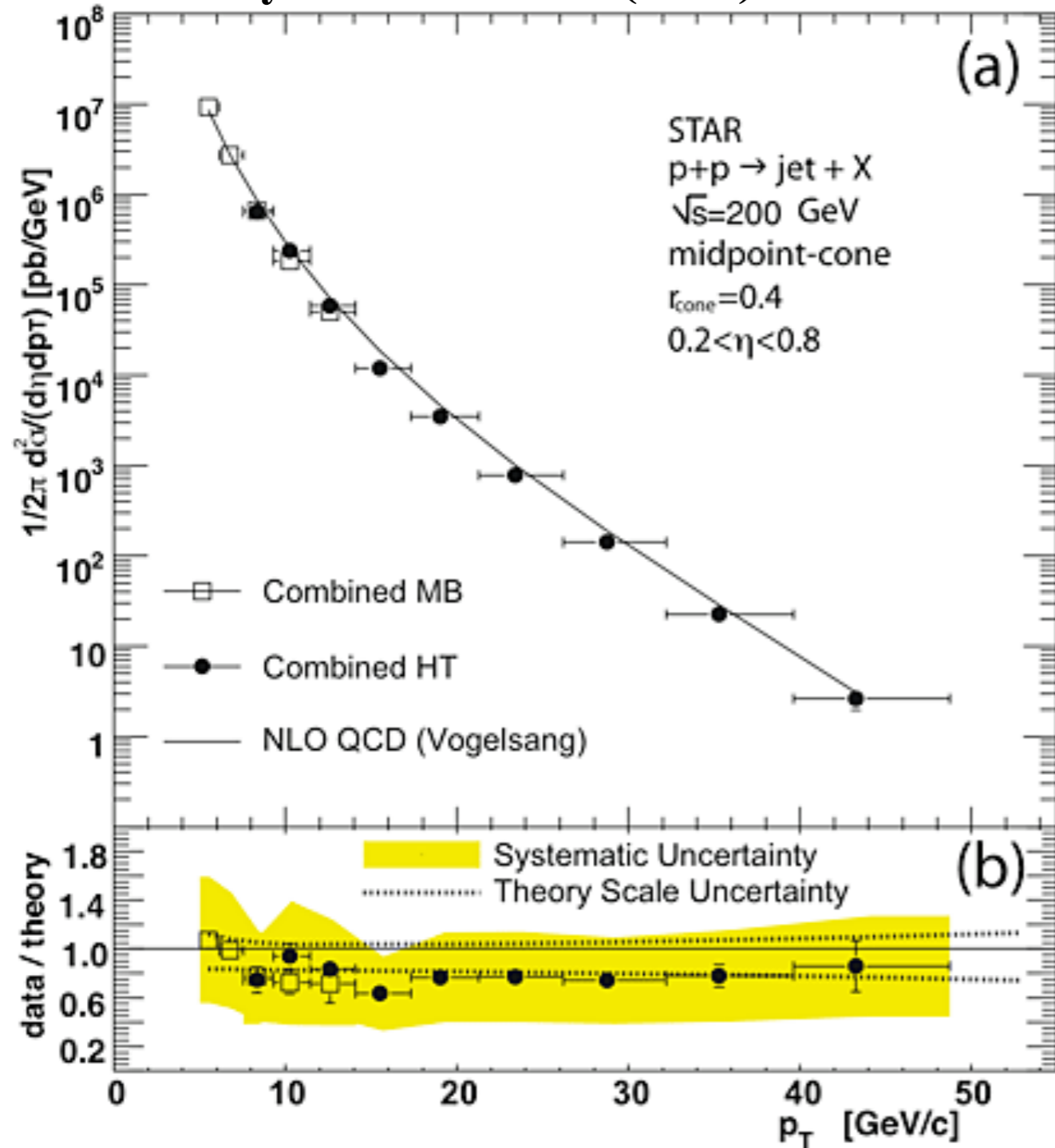
Recovery of “lost” energy



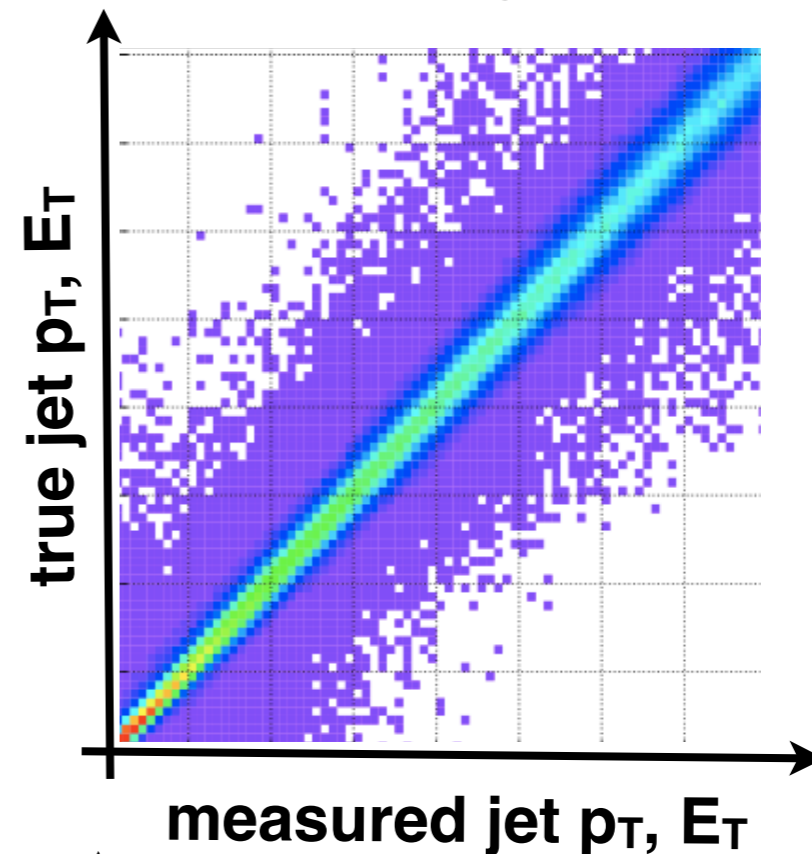
Phys. Rev. Lett. 97 (2006) 252001



Phys. Rev. Lett. 97 (2006) 252001

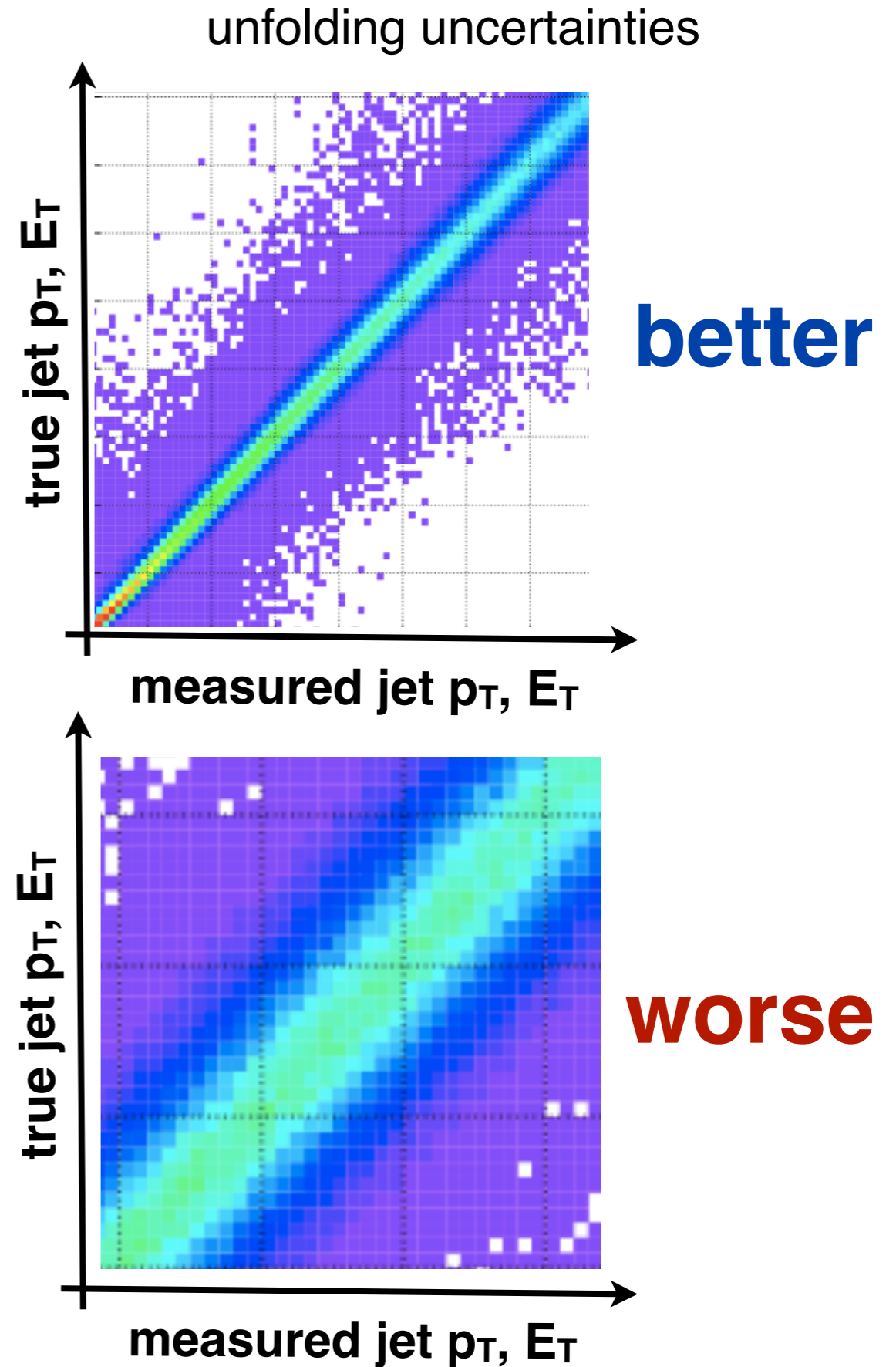
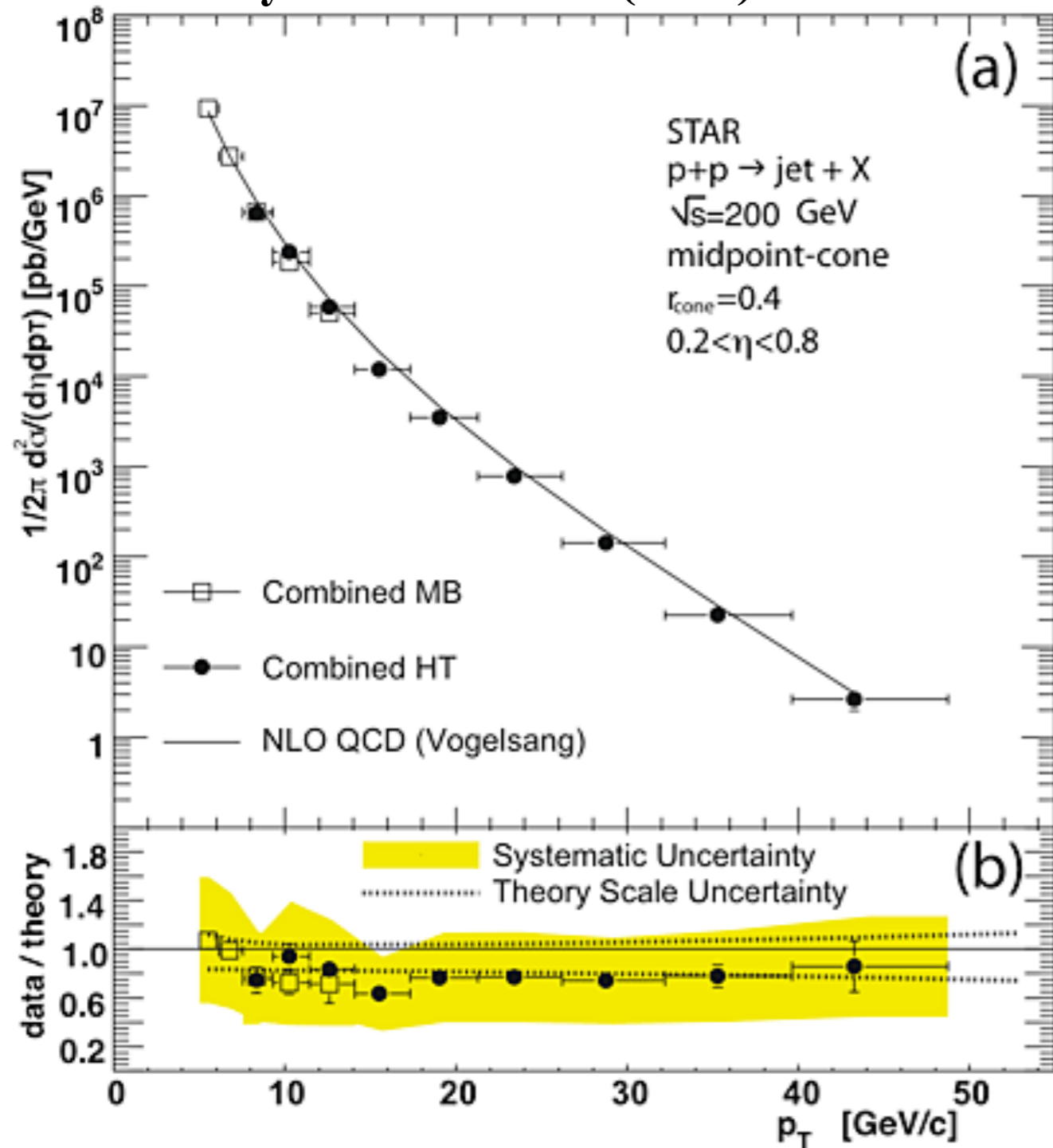


unfolding uncertainties

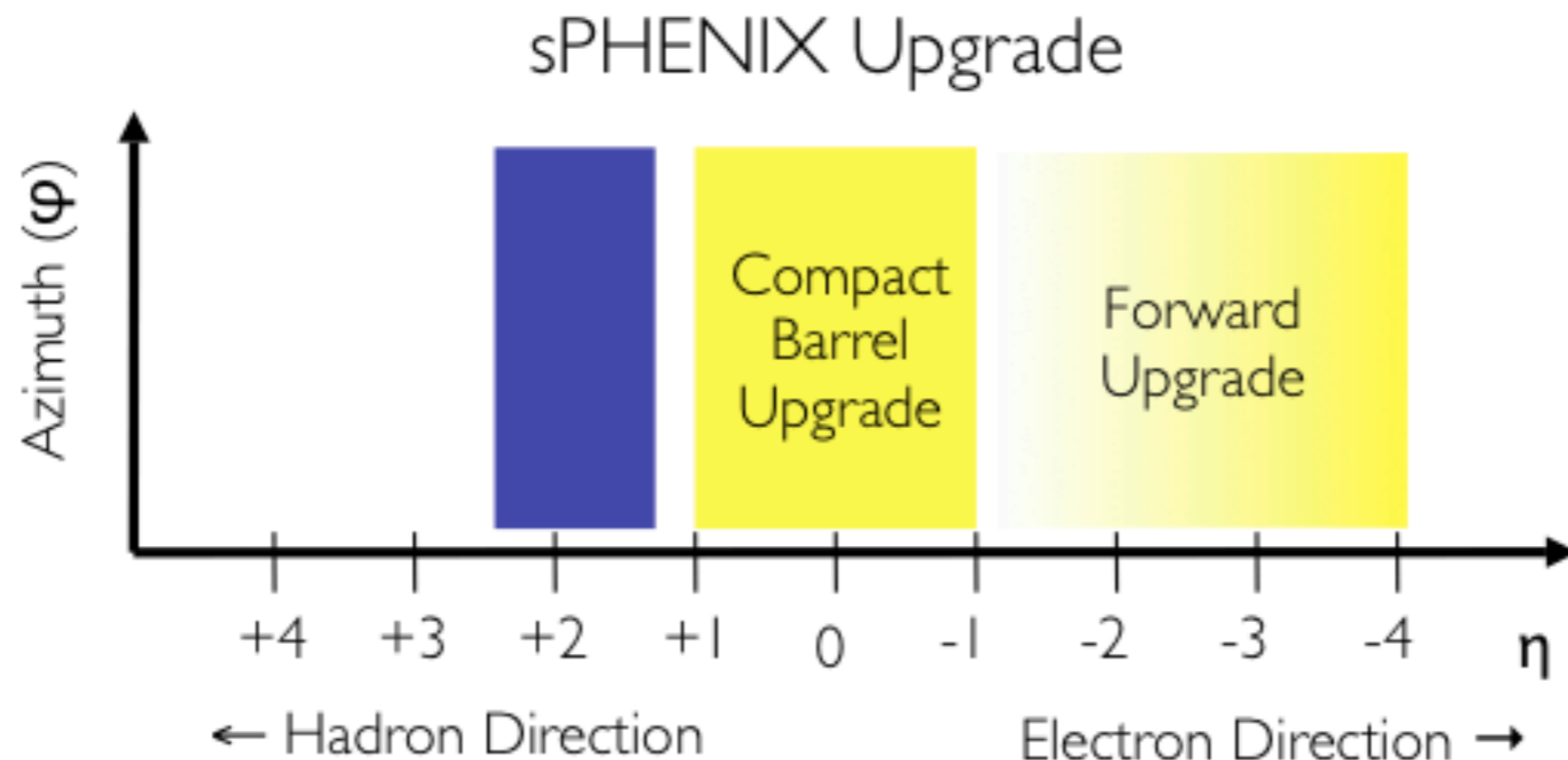
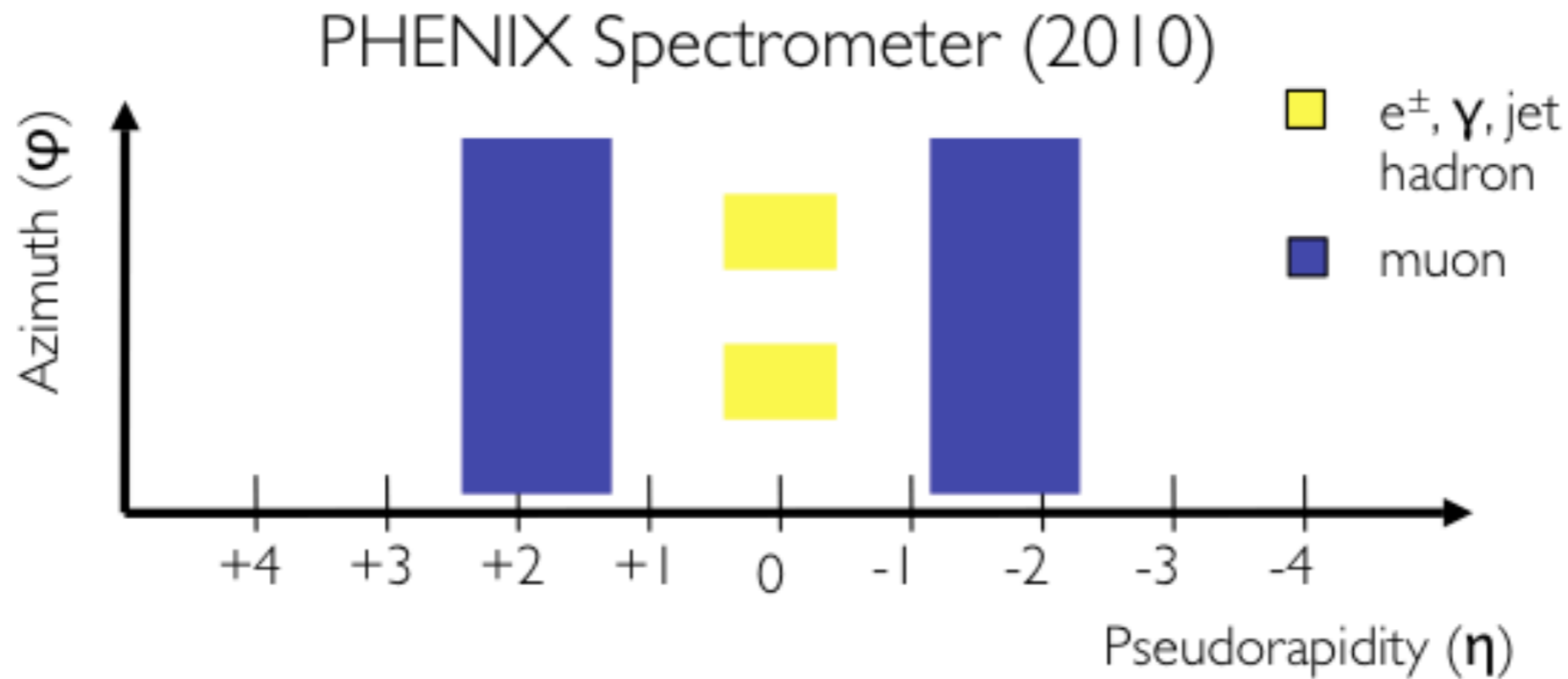


better

Phys. Rev. Lett. 97 (2006) 252001

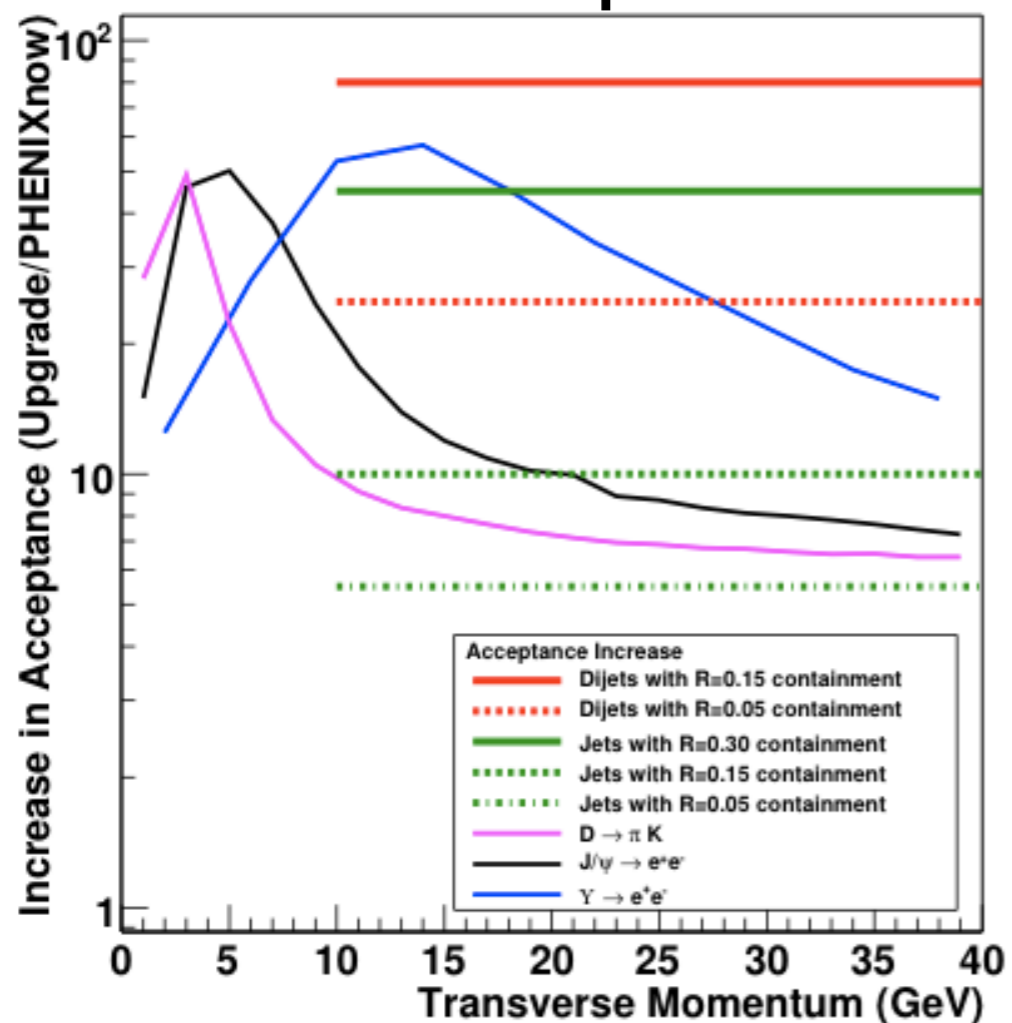


Needs: A Large Uniform Acceptance...

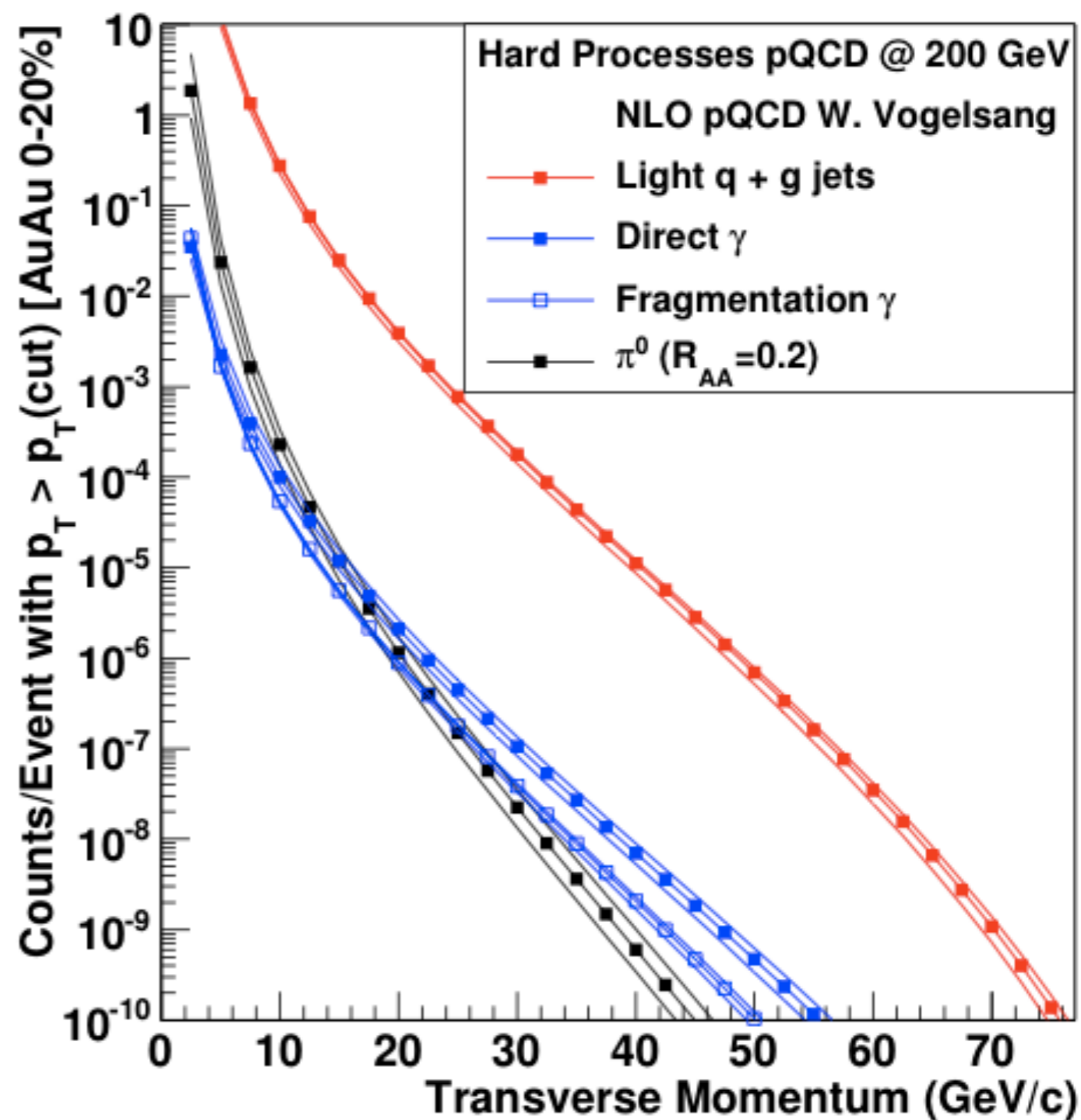


Needs: A High Rate...

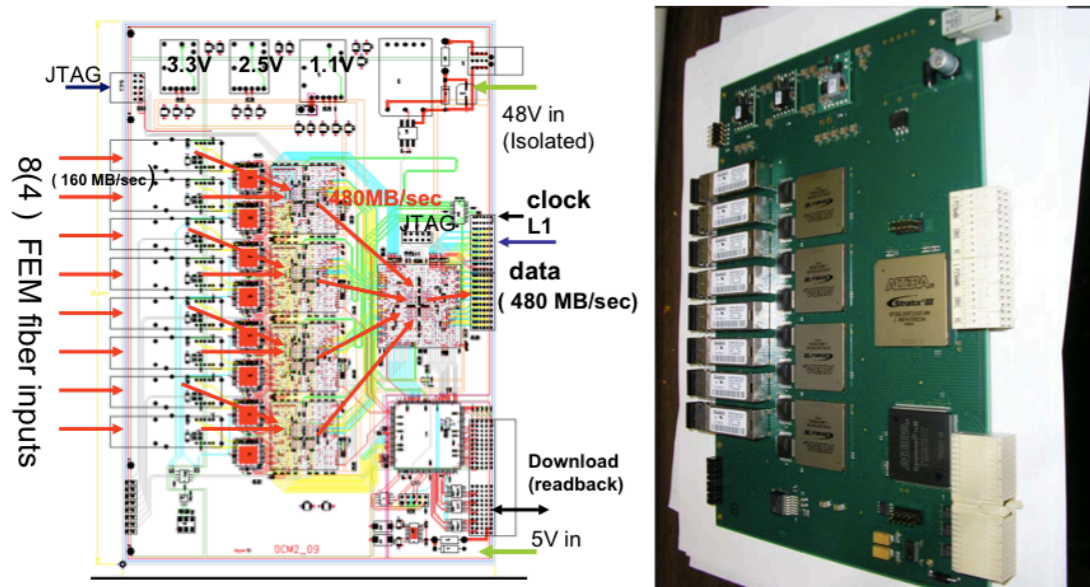
from Acceptance



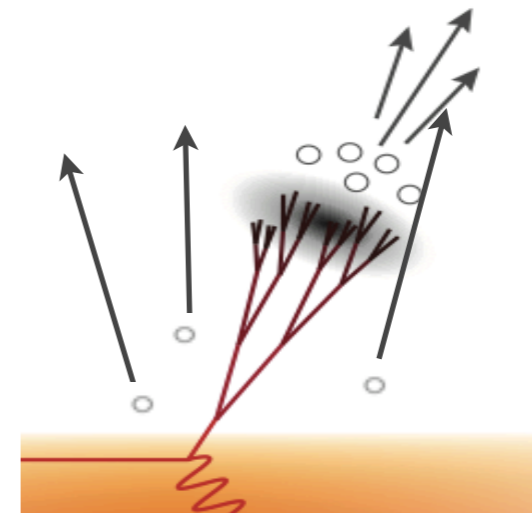
from RHIC Luminosity



from SuperDAQ

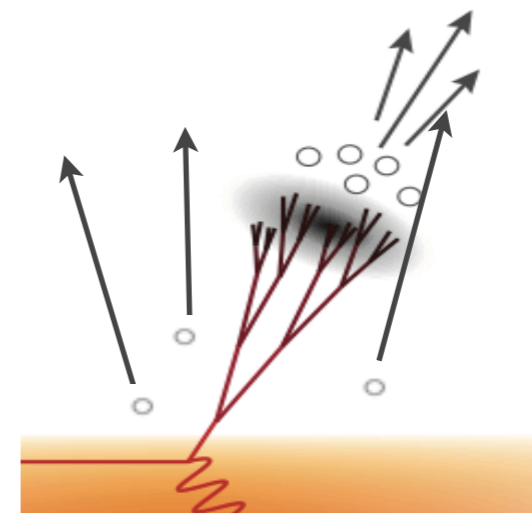


Pythia jets embedded
into HIJING

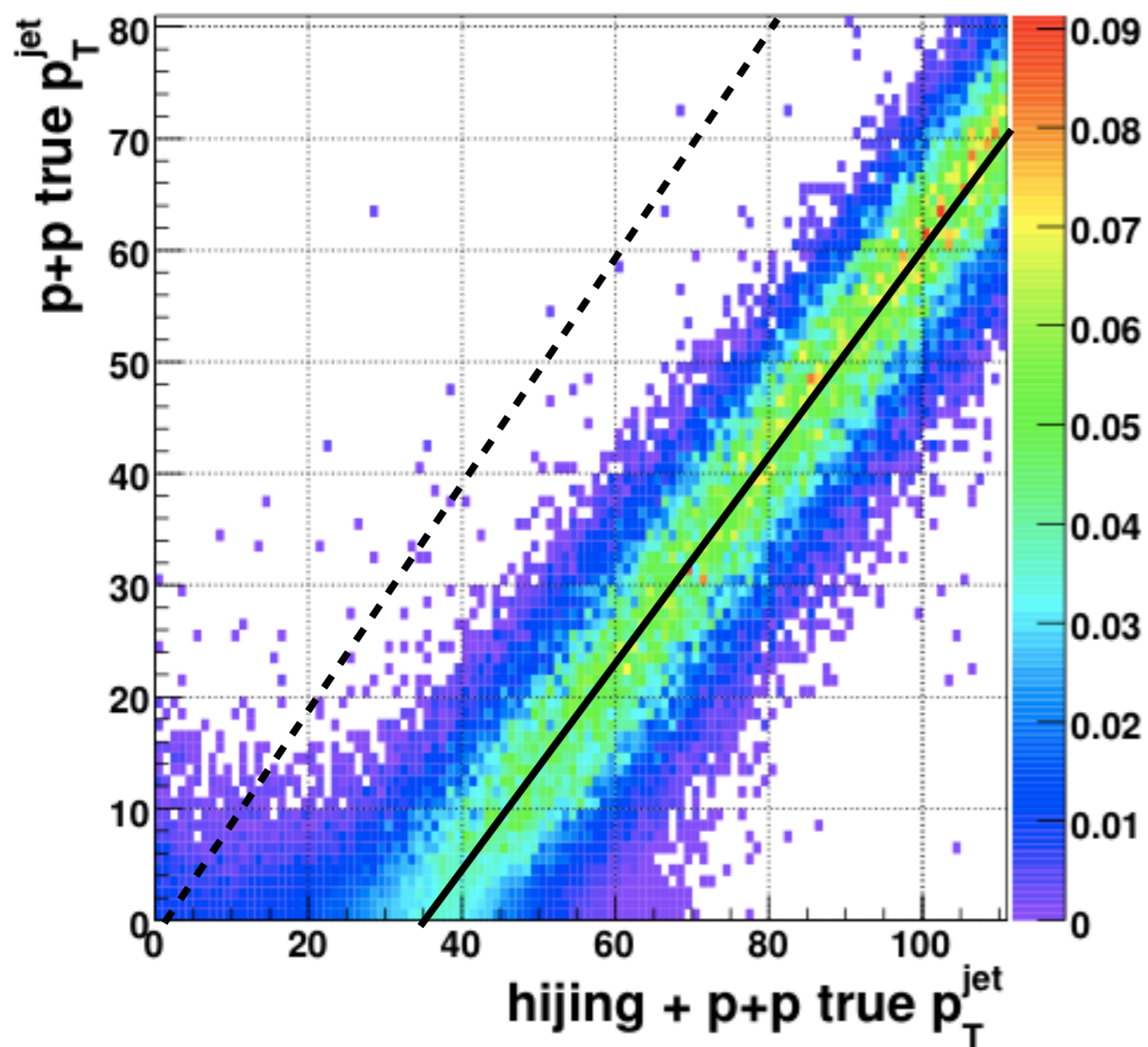


Event Background in Jets

Pythia jets embedded
into HIJING

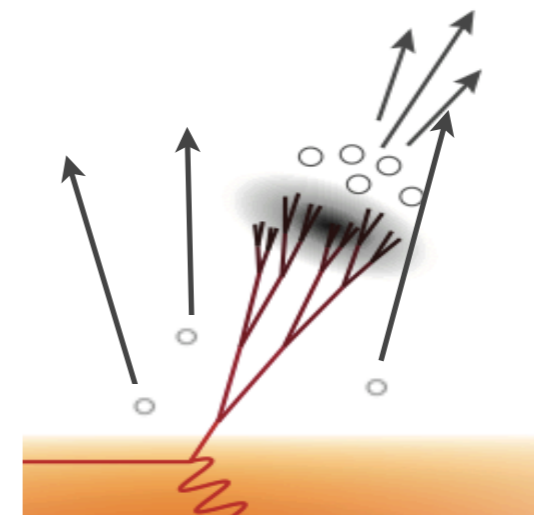


Default Hijing + AntiKt R=0.4

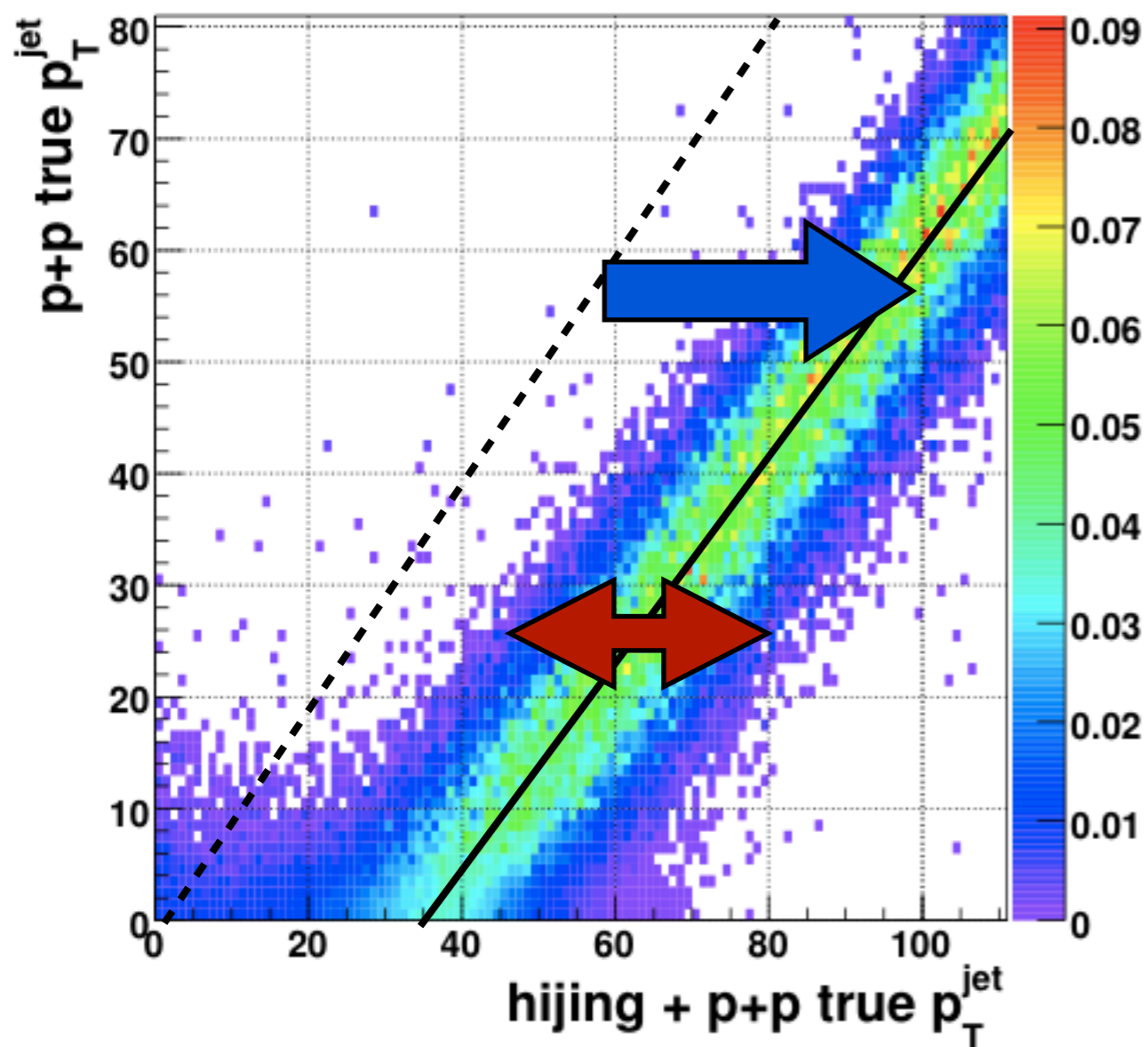


Event Background in Jets

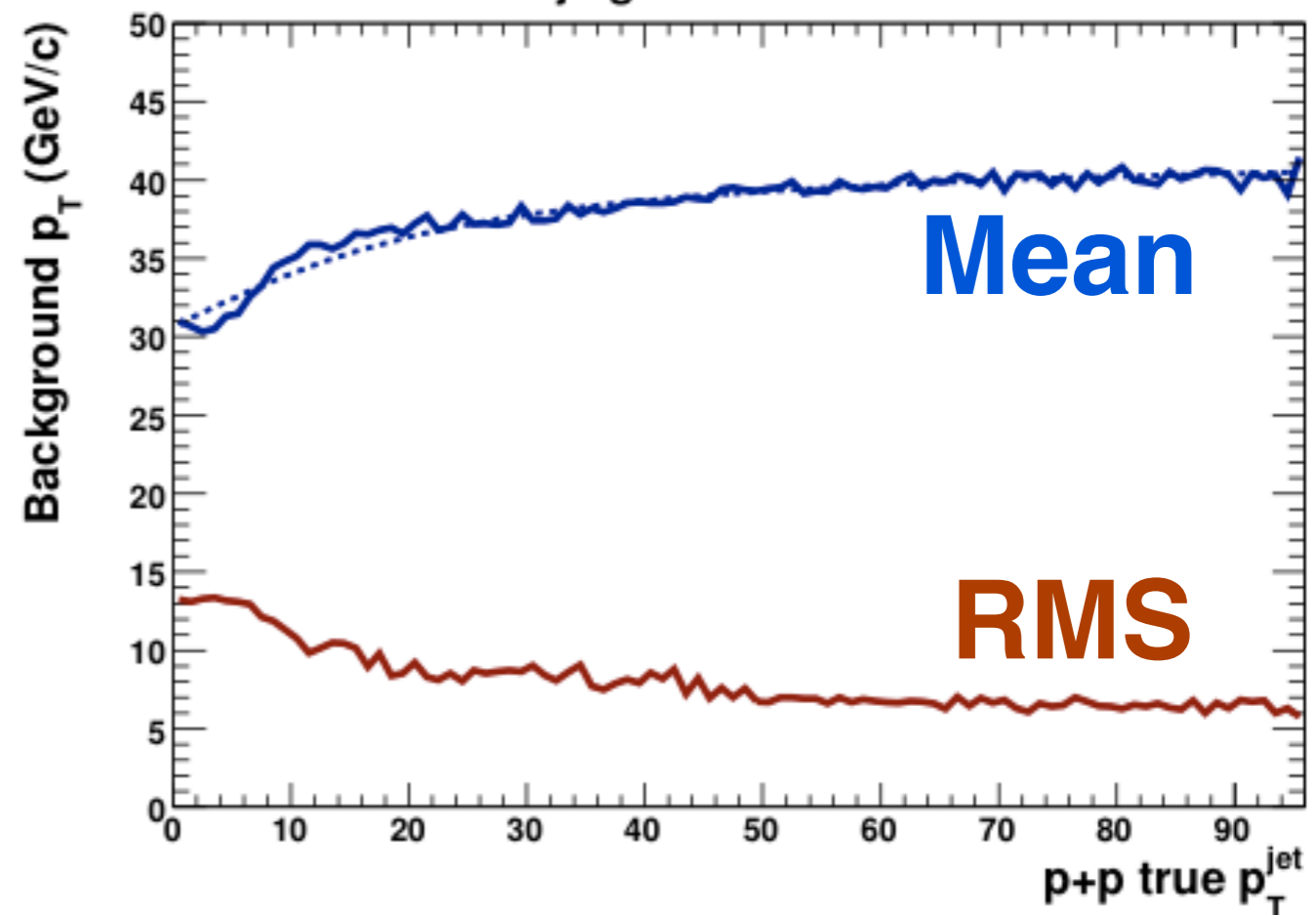
Pythia jets embedded into HIJING



Default Hijing + AntiKt R=0.4



Default Hijing + AntiKt R=0.4



Au+Au at RHIC, jets $> \sim 20$ GeV/c

Au+Au at LHC, jets $> \sim 60-70$ GeV/c

Parton-Medium Interactions

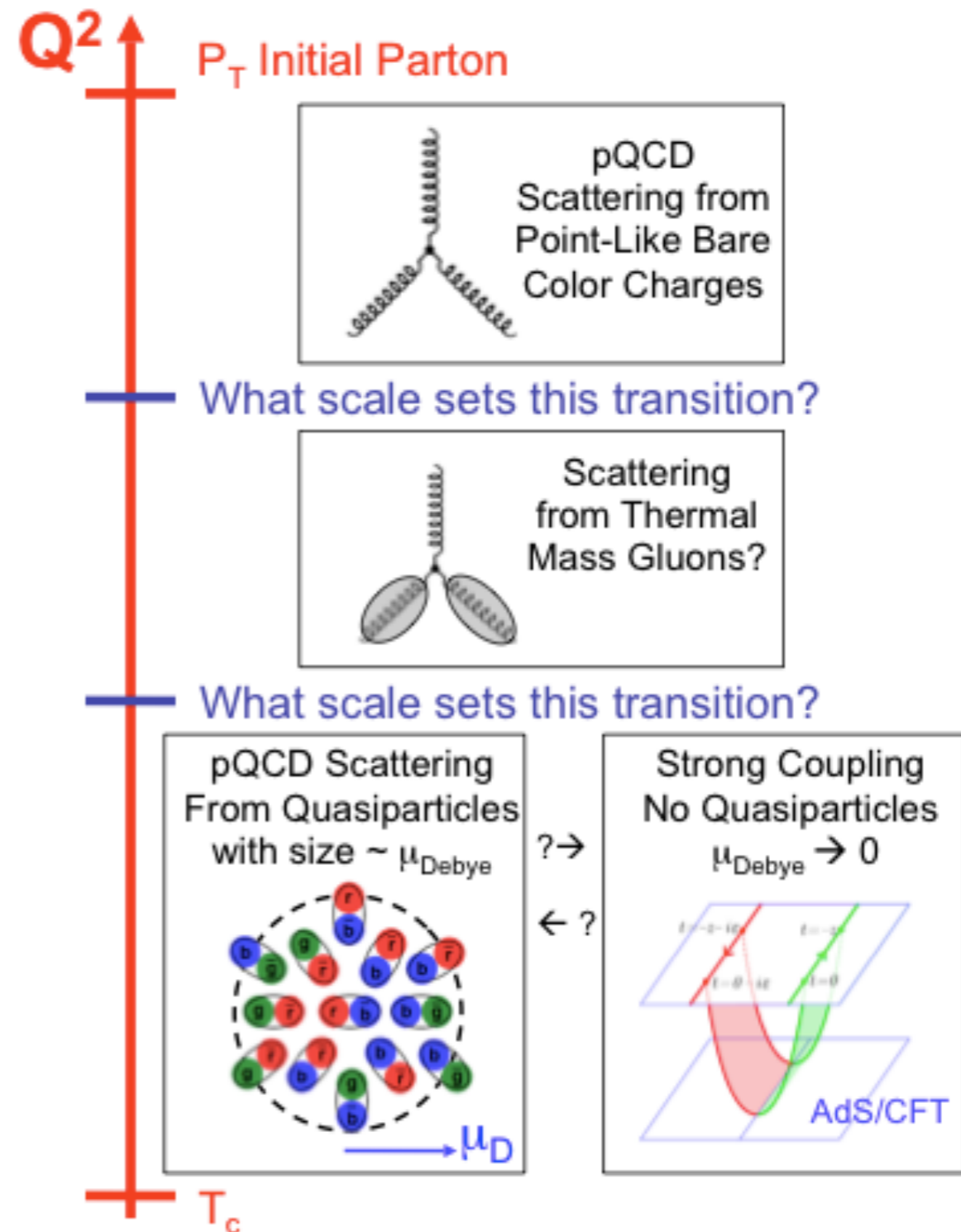
How do pQCD interactions at high scale gives over to collective interactions with a bulk medium?

Initial p_T set the scale of the interactions

Need: A large dynamic range reaching both low and high Q^2

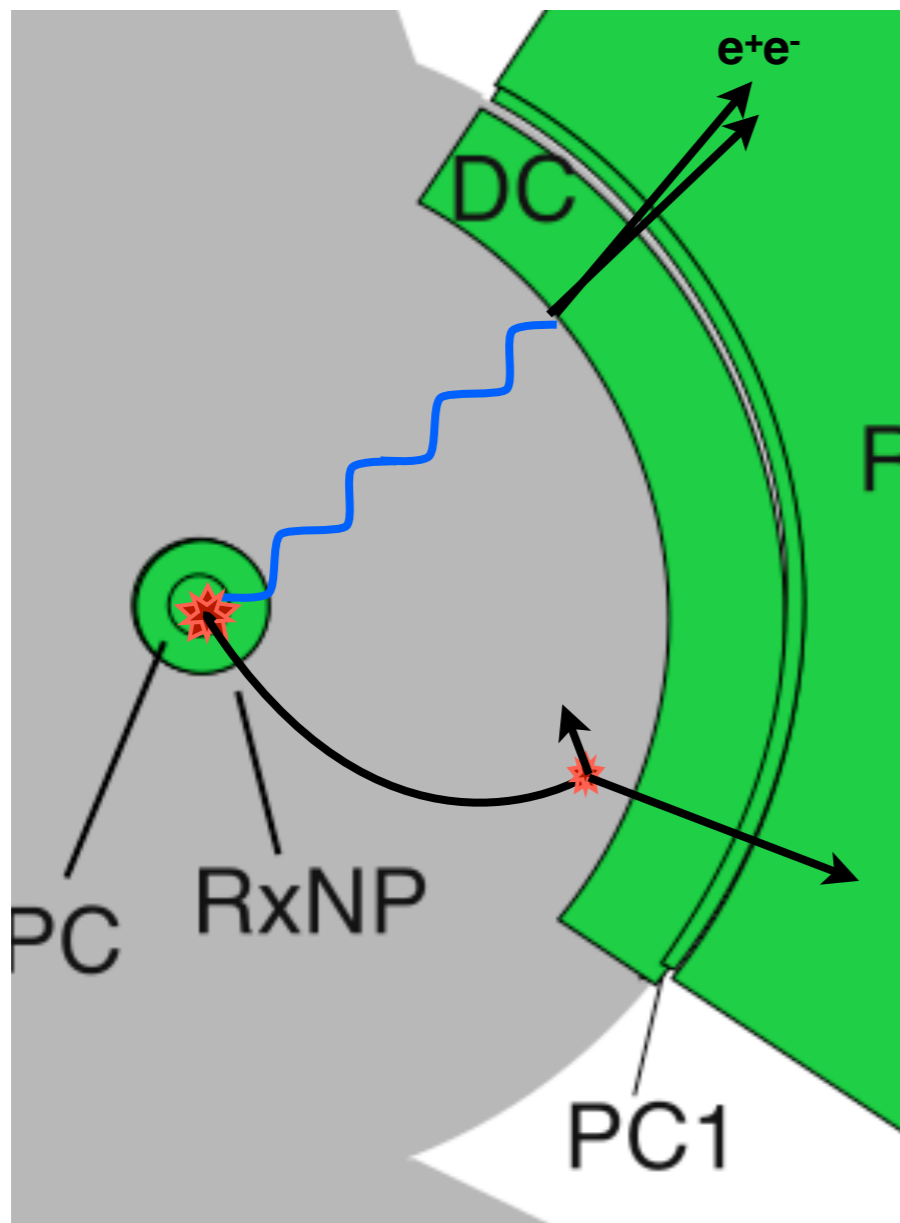
Could be achieved at RHIC

Challenging at the LHC due to the aforementioned backgrounds

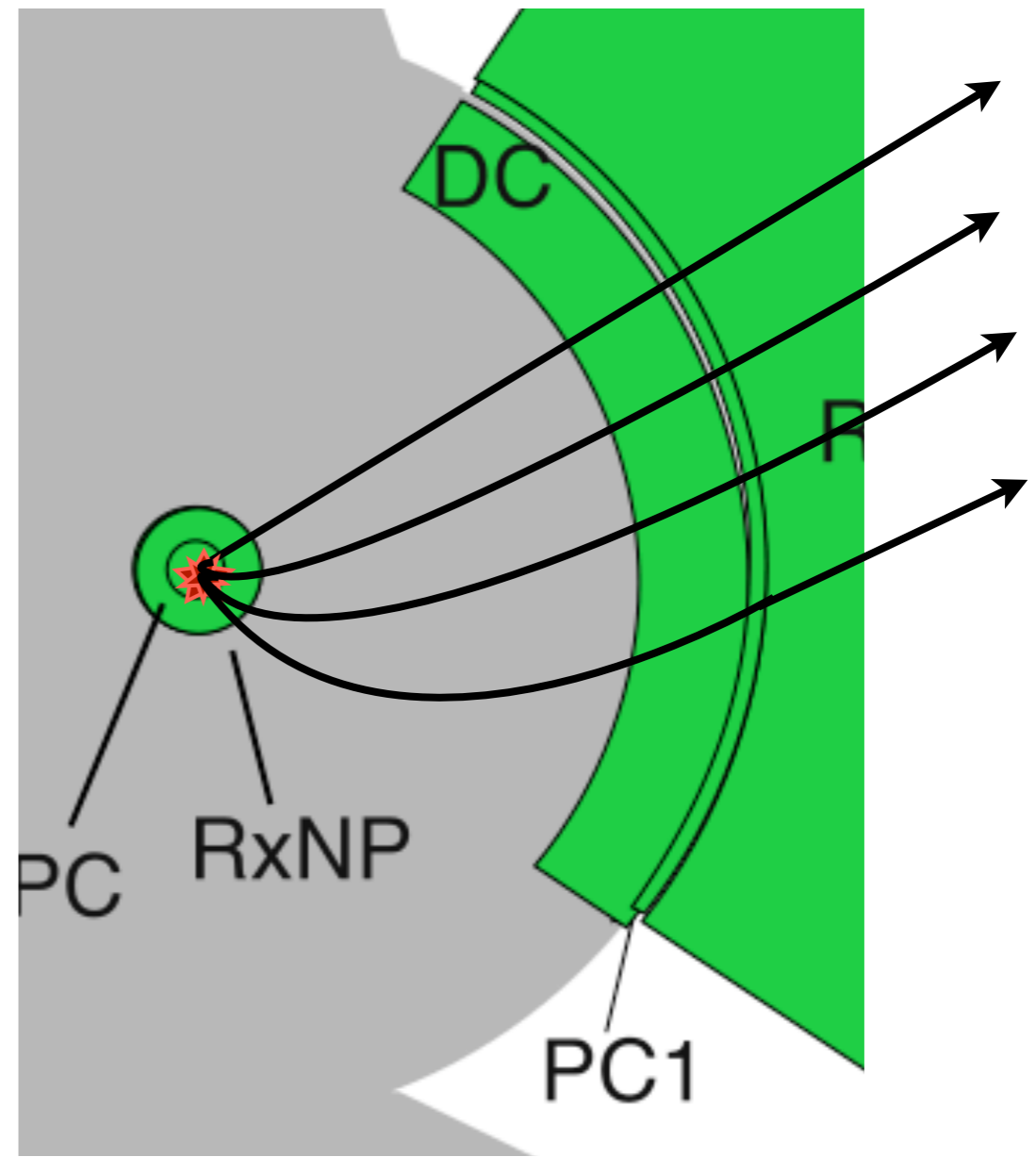


The Trouble with Tracking

Backgrounds



Irresolution

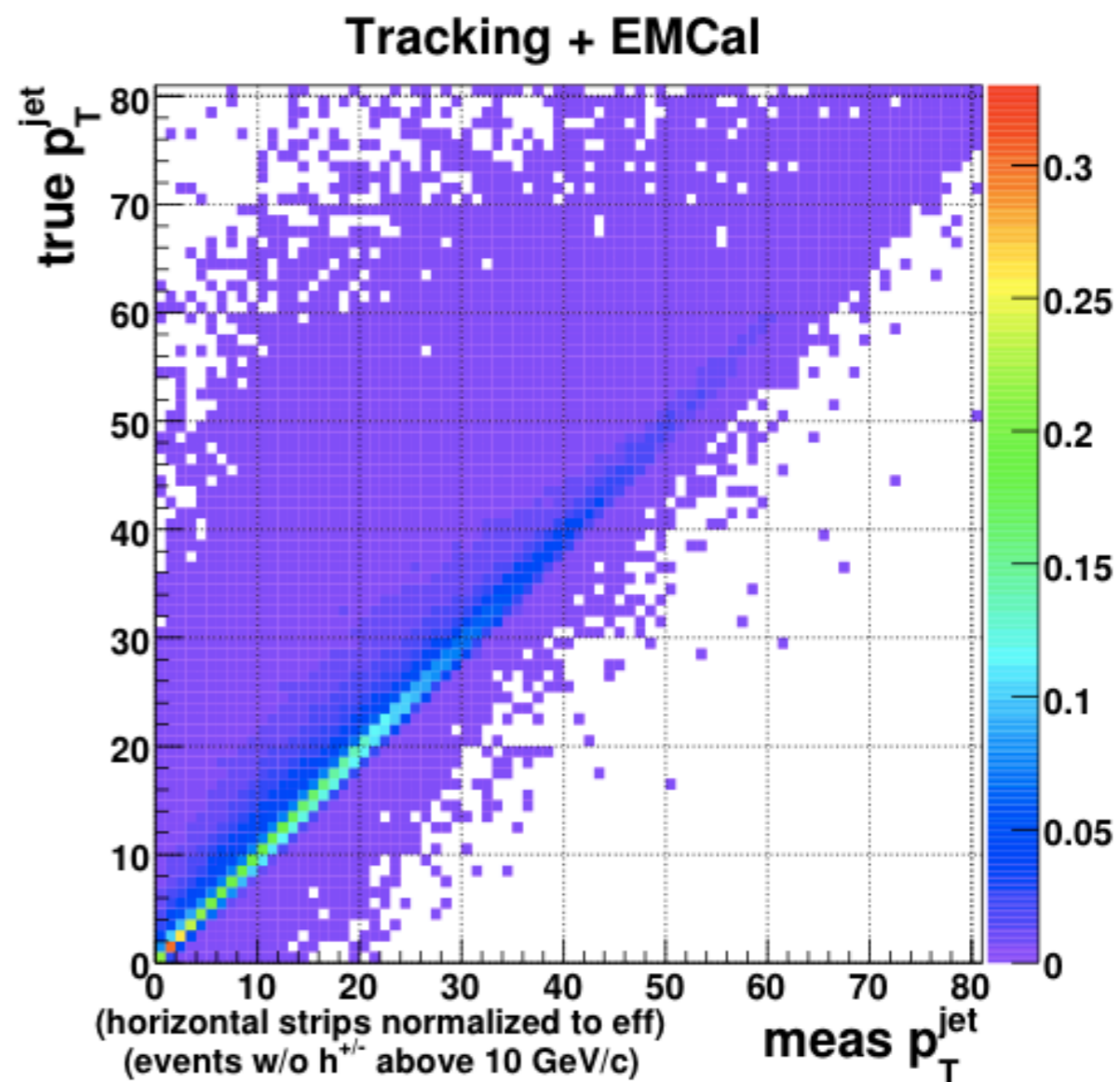
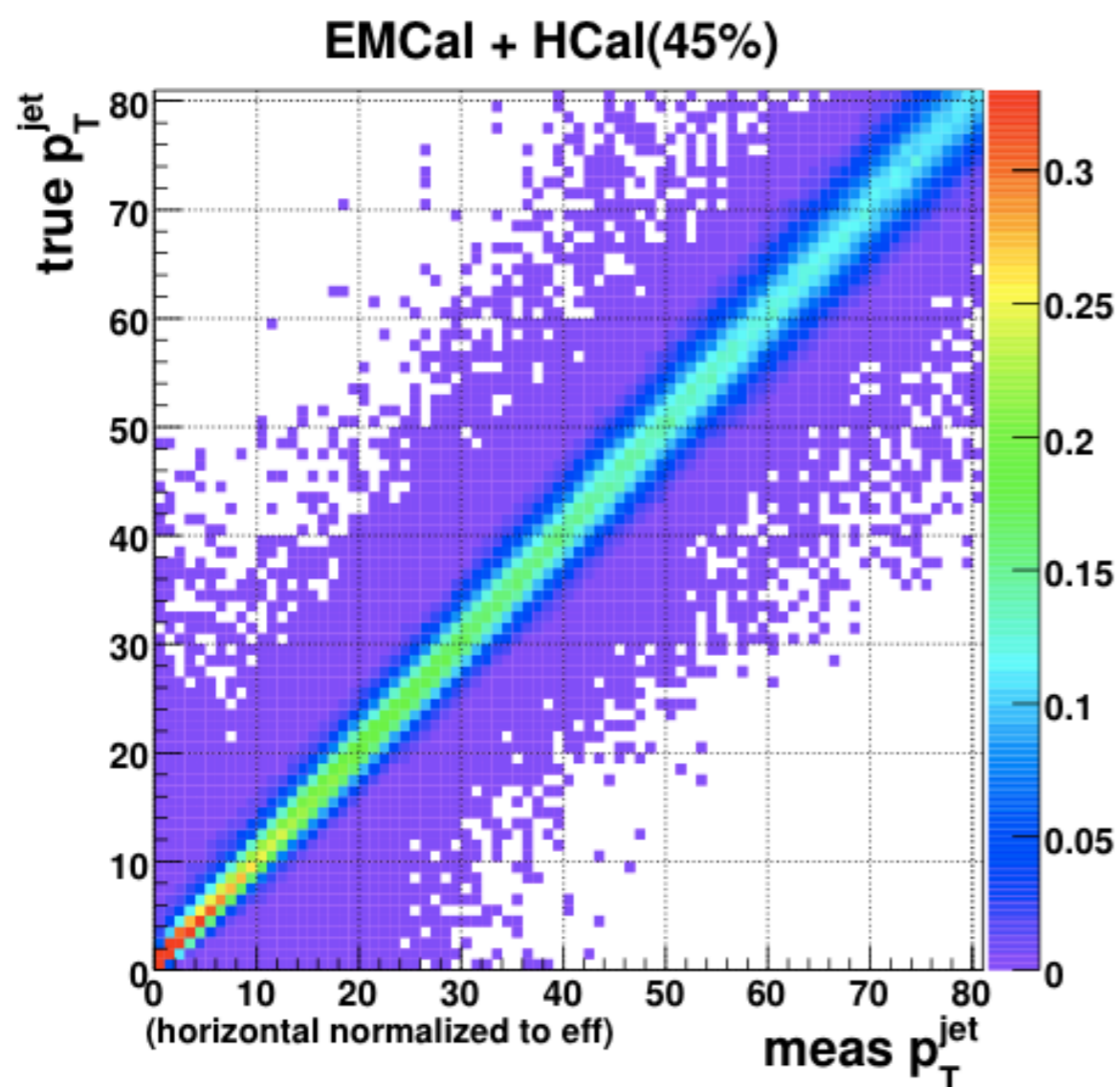


As such cuts discarding event containing large momentum hadrons are common place

How: Via Energy Flow... or Tracking

Energy reconstruction
through calorimetry

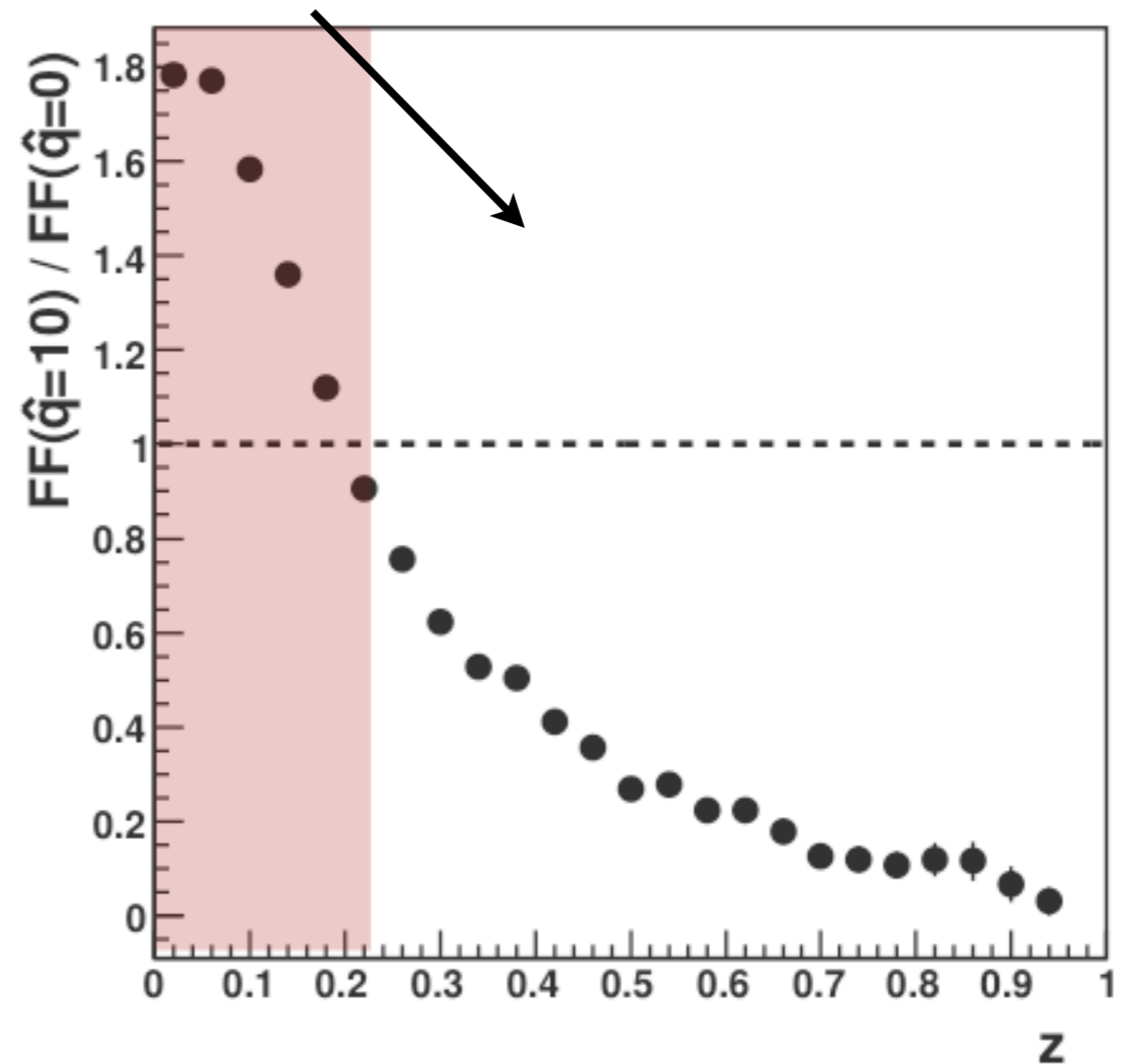
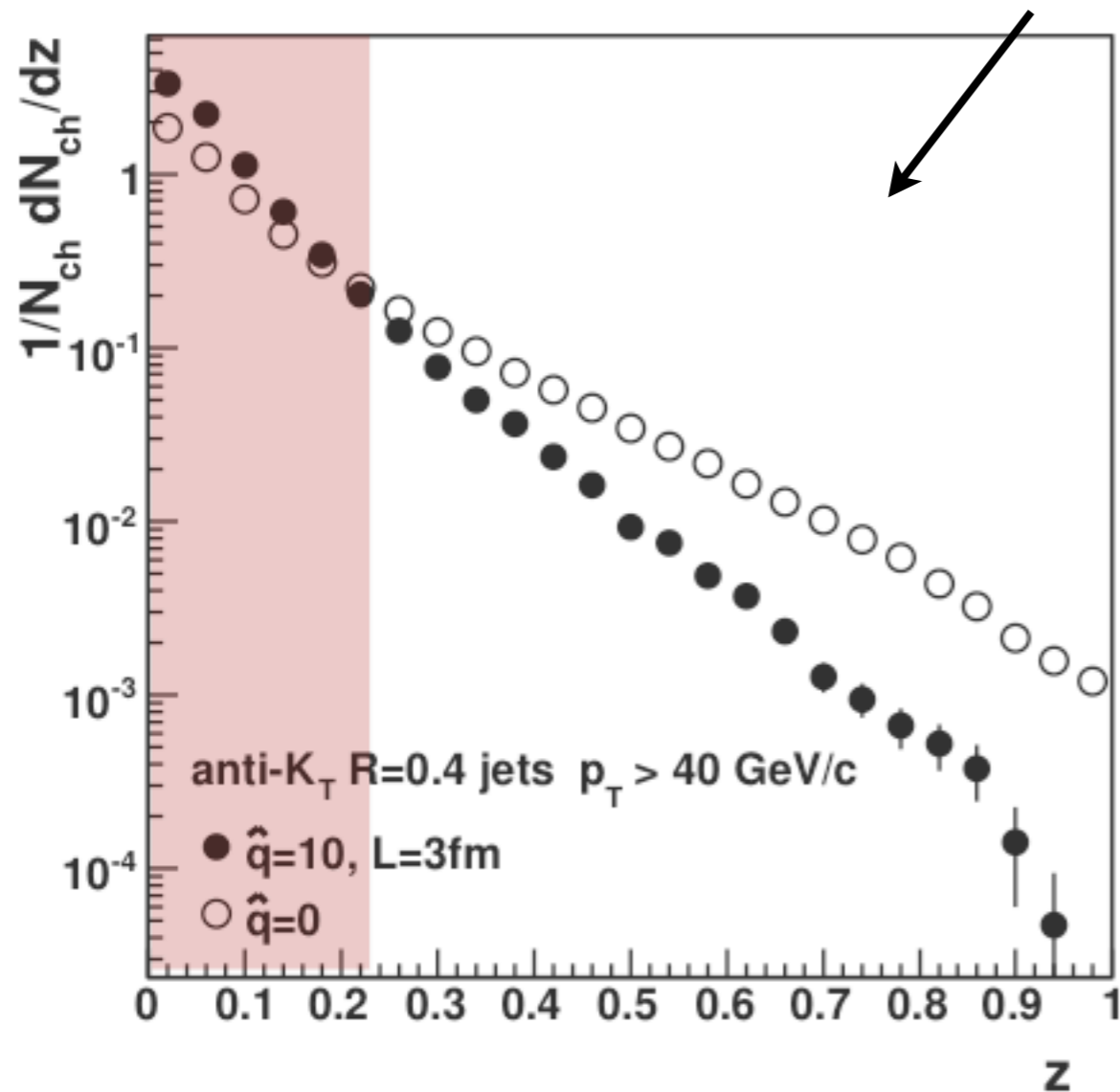
Can perform better at large
momentum than tracking



for instance:

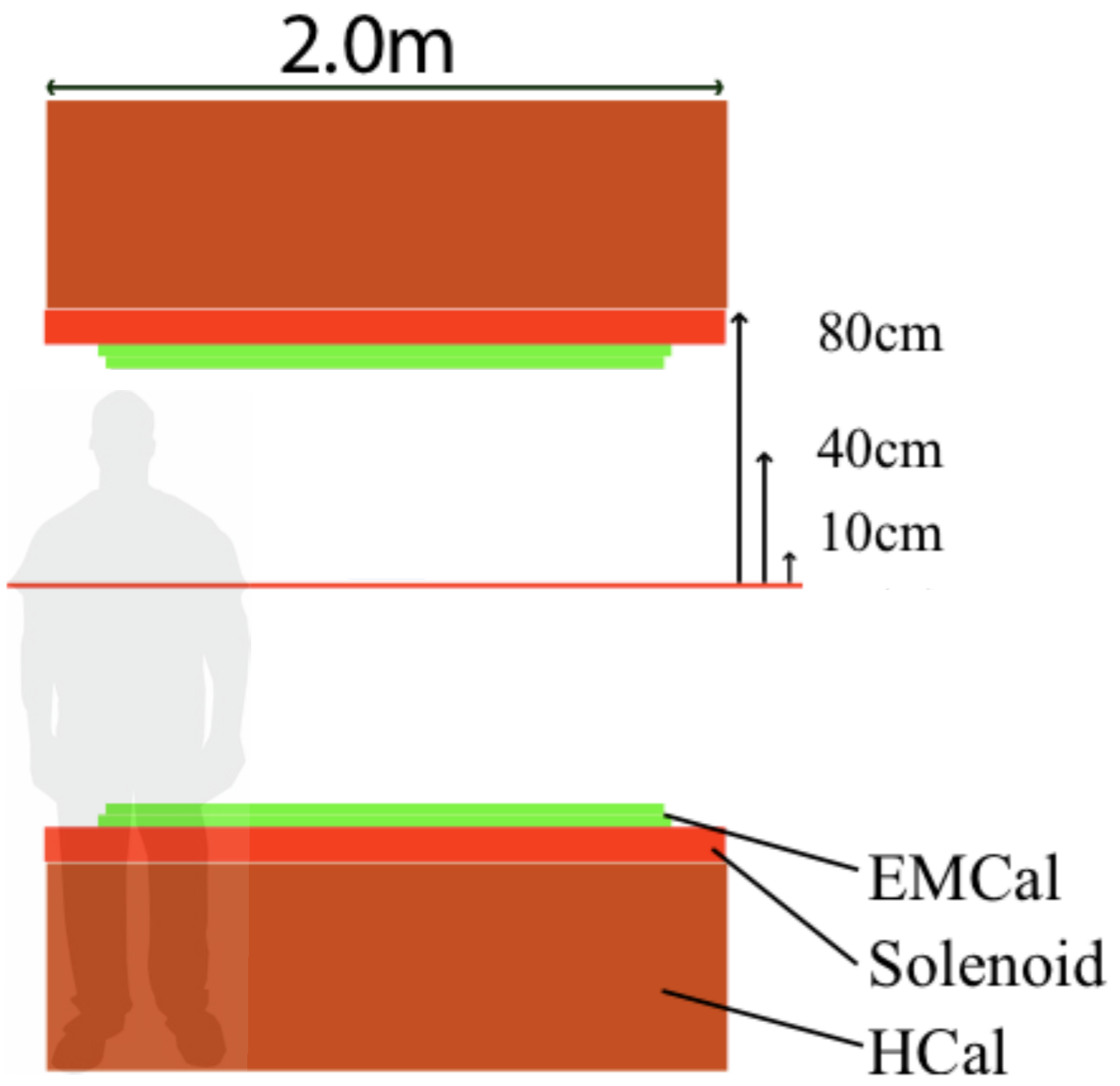
event cuts can exclude measurement of large momentum fragmentation functions

white areas excluded with tracking

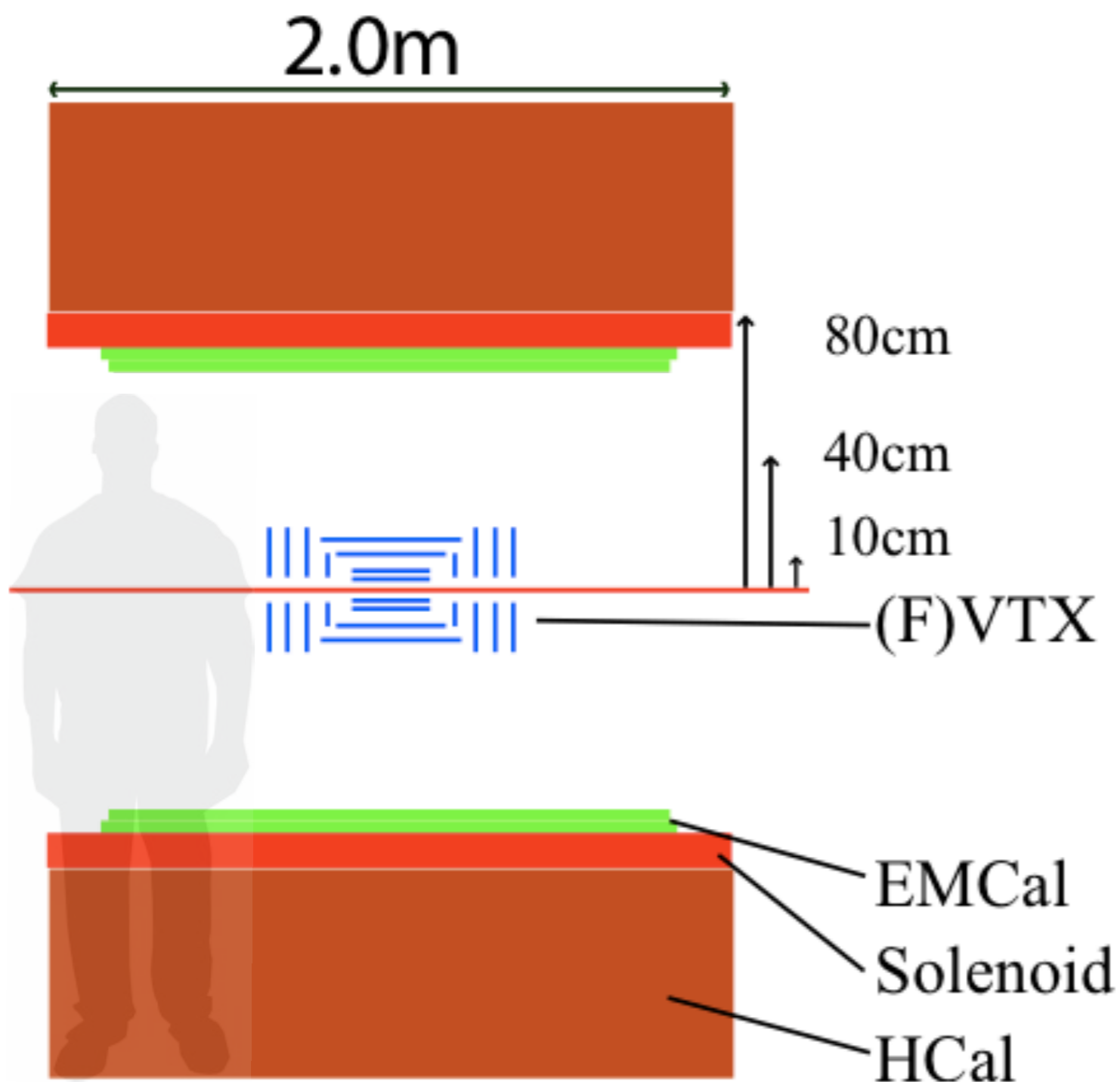


An Upgraded PHENIX Central Barrel...

Calorimetric jets
via EMCal + HCal



An Upgraded PHENIX Central Barrel...

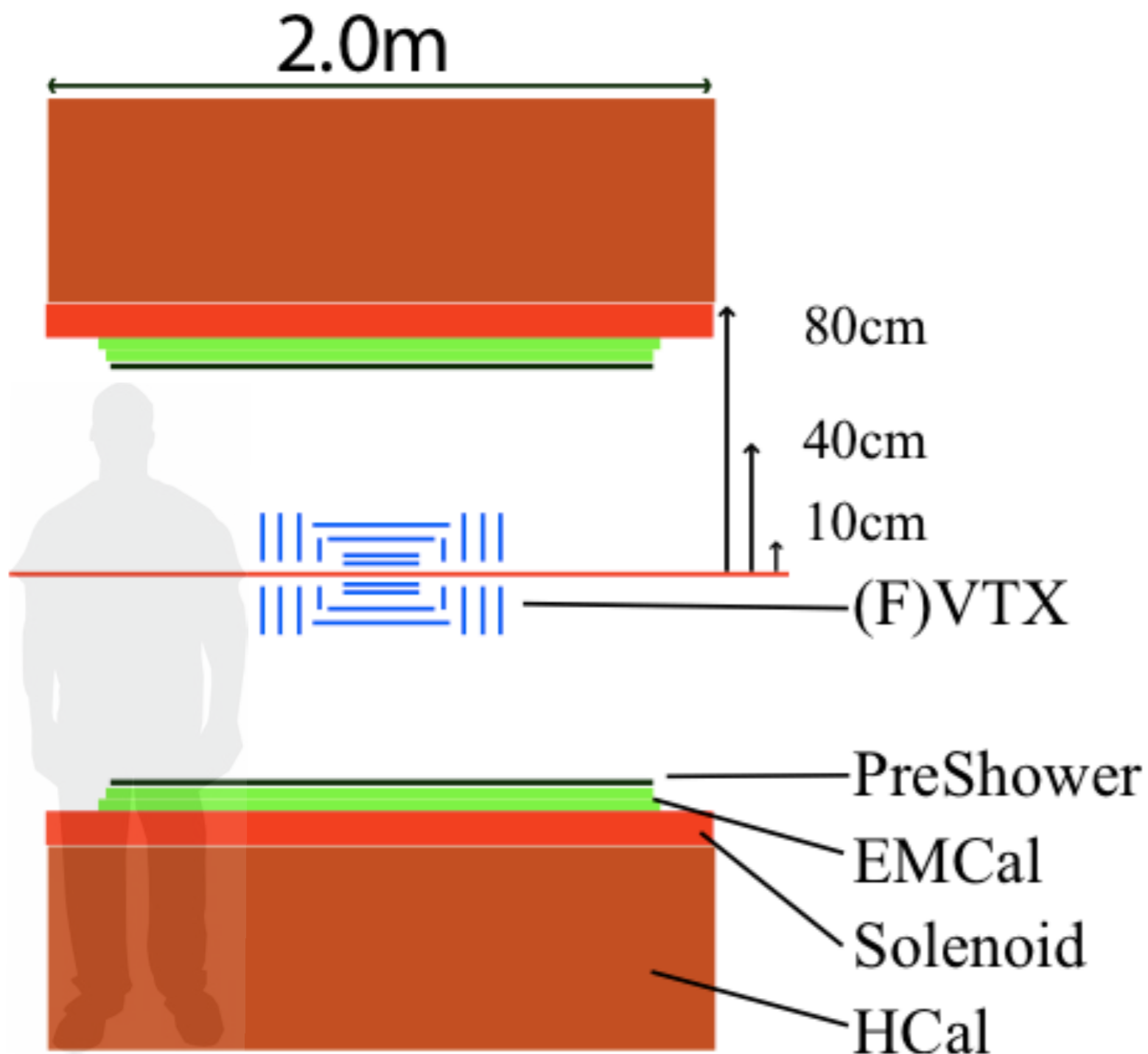


Calorimetric jets
via EMCal + HCal

Additional jet channel
via EMCal + Tracking

(+) Open heavy flavor
identification

An Upgraded PHENIX Central Barrel...



Calorimetric jets
via EMCal + HCal

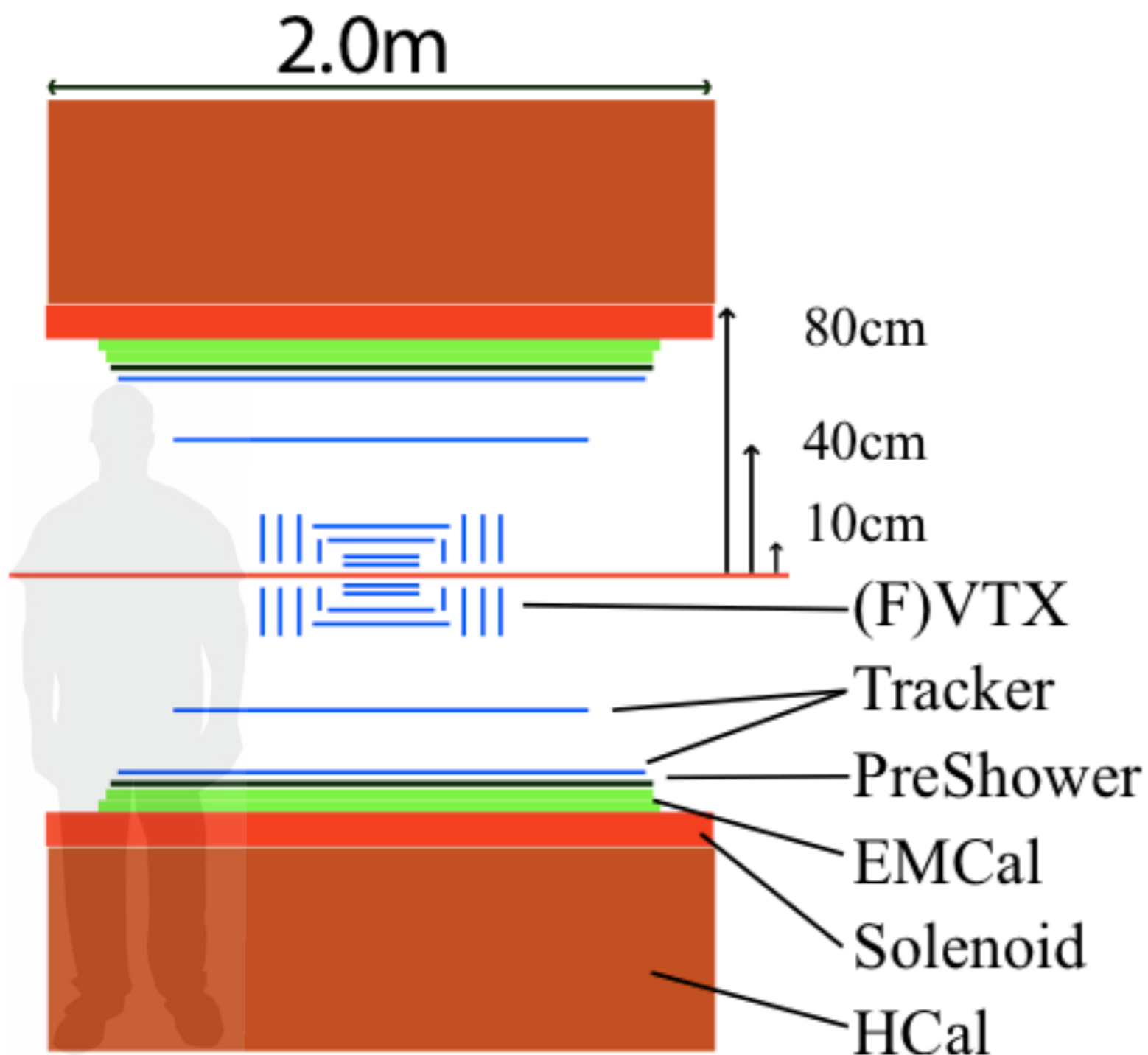
Additional jet channel
via EMCal + Tracking

(+) Open heavy flavor
identification

(+) γ , π^0 Separation

γ -jets

An Upgraded PHENIX Central Barrel...



Calorimetric jets
via EMCal + HCal

Additional jet channel
via EMCal + Tracking

(+) Open heavy flavor
identification

(+) γ , π^0 Separation

γ -jets

(+) e^\pm identification

Heavy flavor jets

Summary of Design

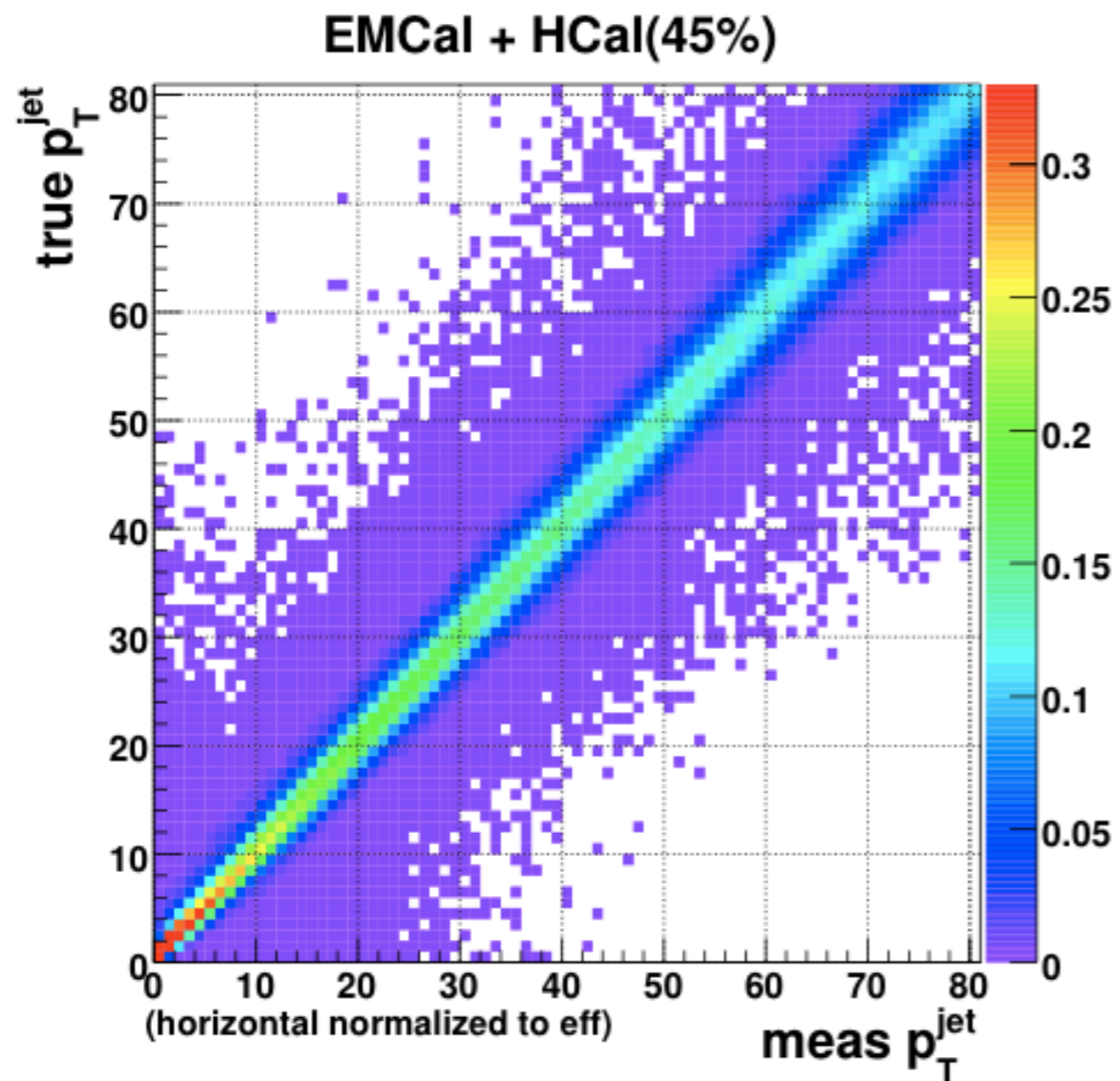
- Uniform **large acceptance**
- **High rate** capabilities
- Precision inner and outer **tracking**
- Full coverage **hadronic calorimetry**
- **Electron identification** over a broad momentum range
- **Displaced vertex tagging** of heavy flavor decays

sBackups

How: Via Energy Flow...

Energy reconstruction
through calorimetry

Calorimeter smearing alone



How: Via Energy Flow...

Energy reconstruction
through calorimetry

Event background dominates the
resolution

Calorimeter smearing alone

+ event background smearing

