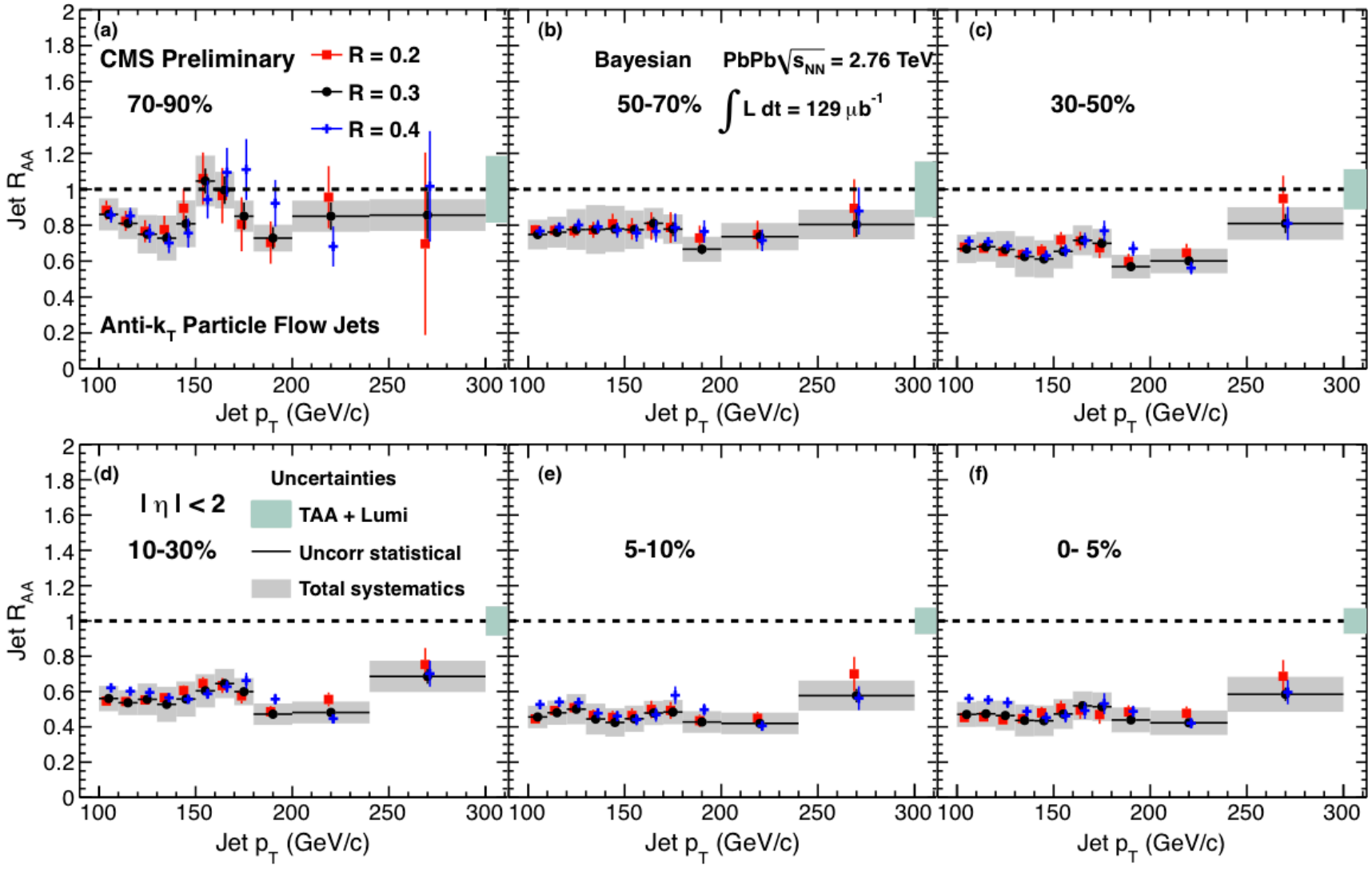
Ideas in data & MC comparisons

Yetkin Yilmaz

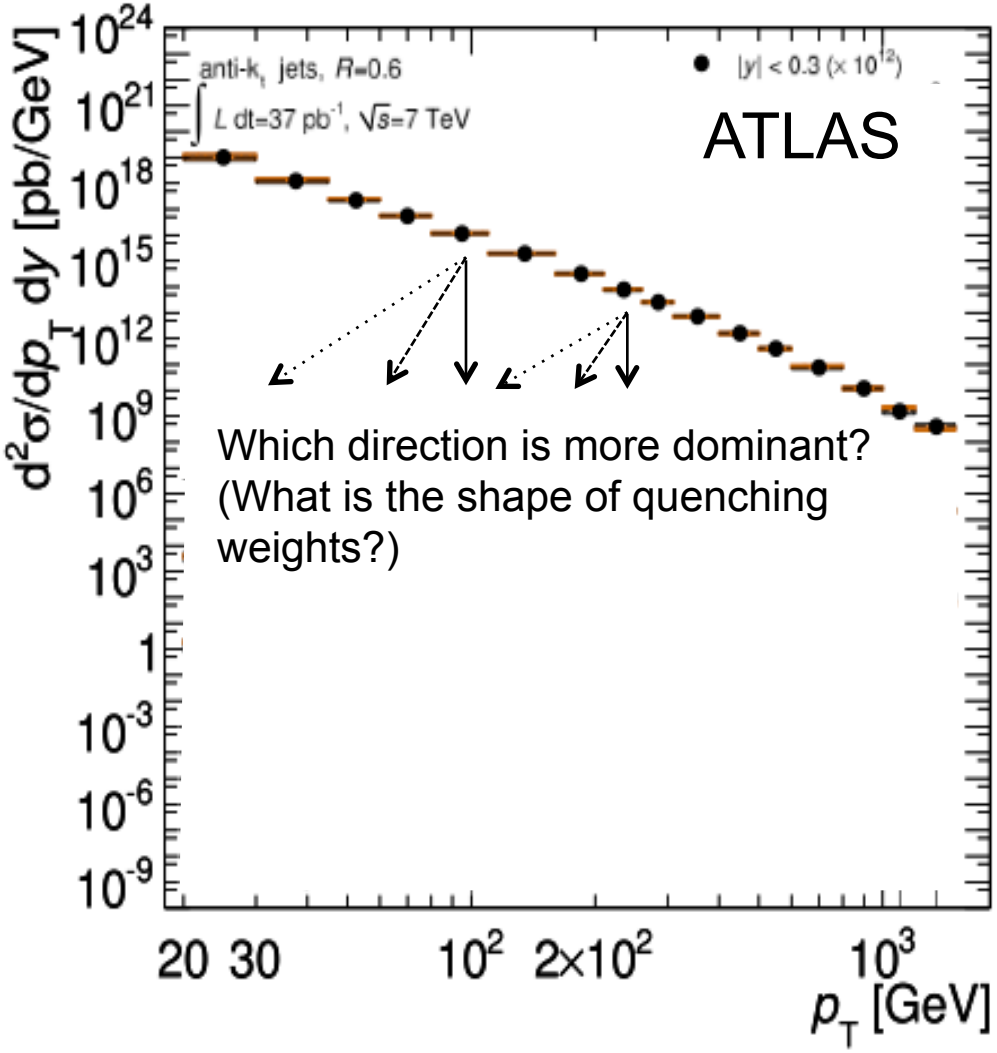
Modification of the inclusive jet spectra



CMS-PAS-HIN-12-004

Jet pT spectrum shifted
and/or
suppressed in PbPb

Interpreting R_{AA}

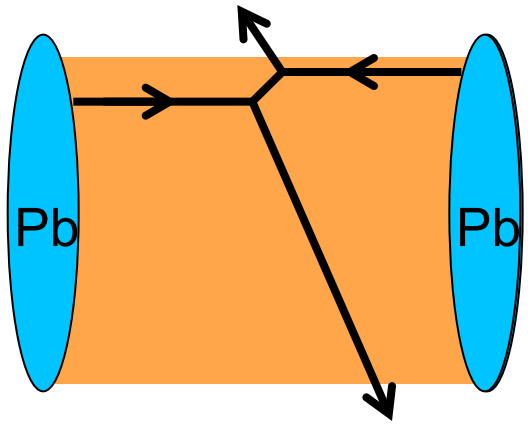


Results are unfolded for resolution effects – straightforward to compare with theory predictions.

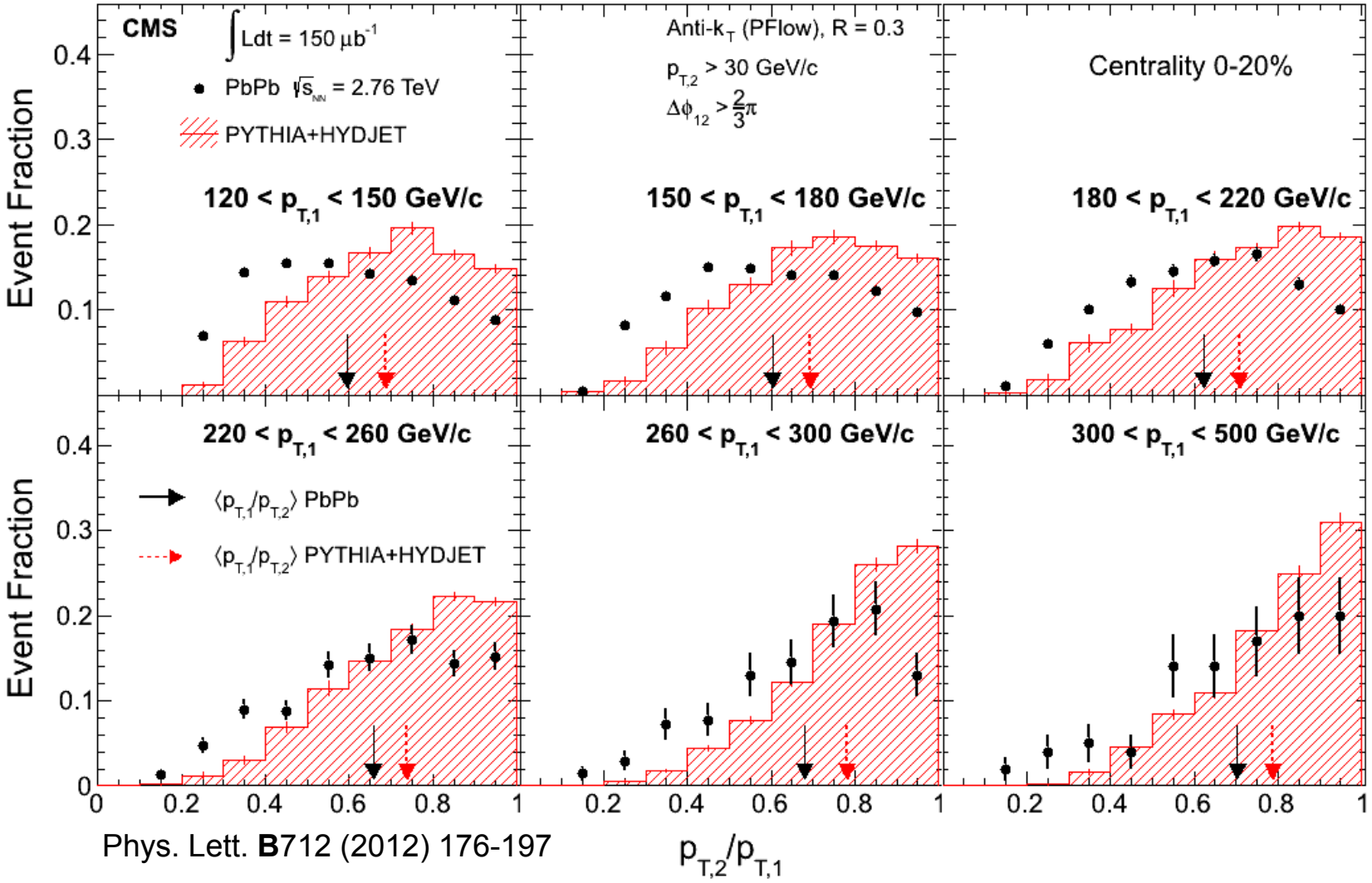
"Surface-biased" measurement: More sensitive to the **less-quenched** jets (not saying *geometry* - yet)

Are the jets quenched often by similar amounts, or by a wide variety of values?

Dijet and Photon+Jet correlations can answer more questions



Dijet imbalance



Phys. Lett. **B**712 (2012) 176-197

Imbalance changing in both MC-reference and PbPb.
Try to summarize the information with the **mean**.

p_T-dependence of the dijet imbalance

Reference itself has an increasing trend

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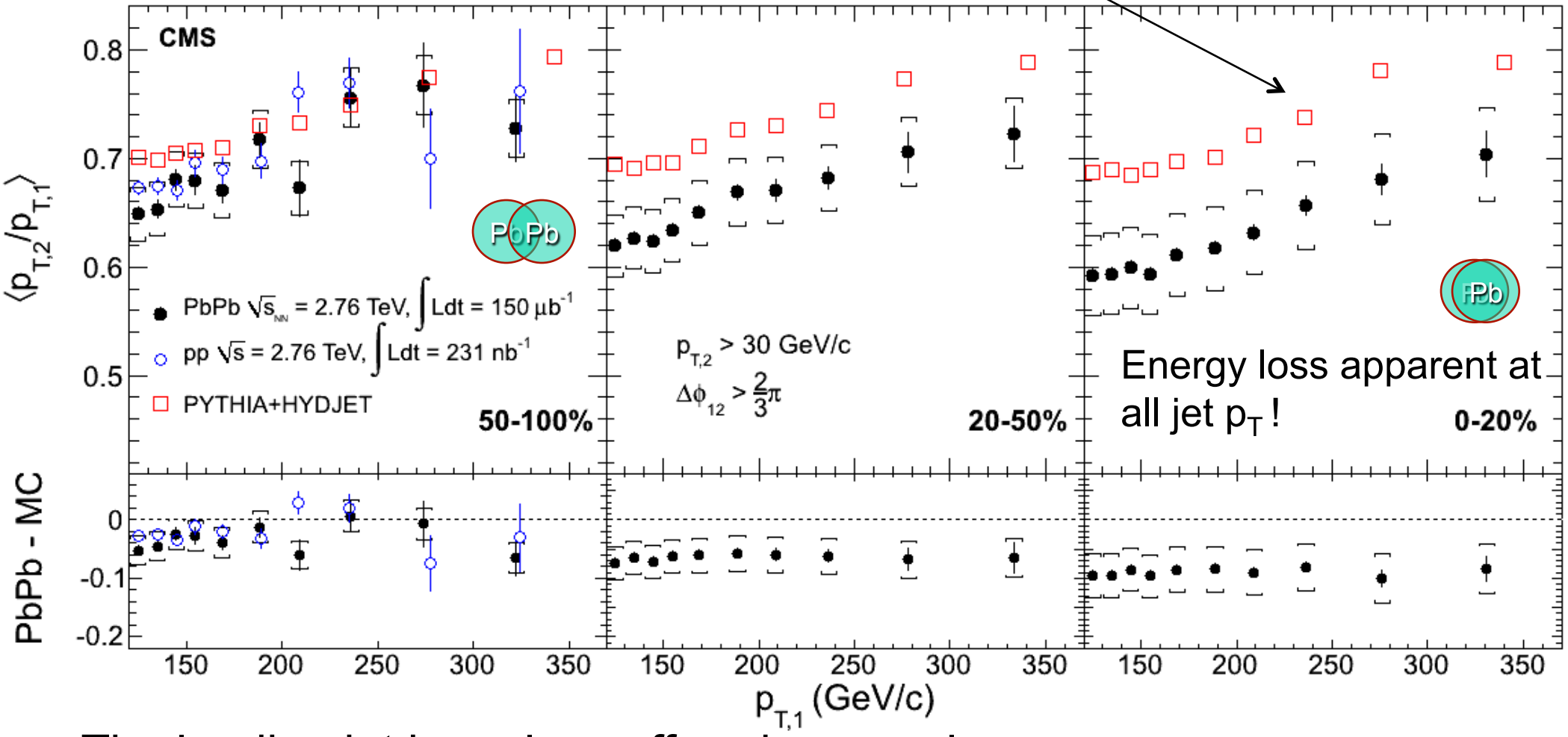
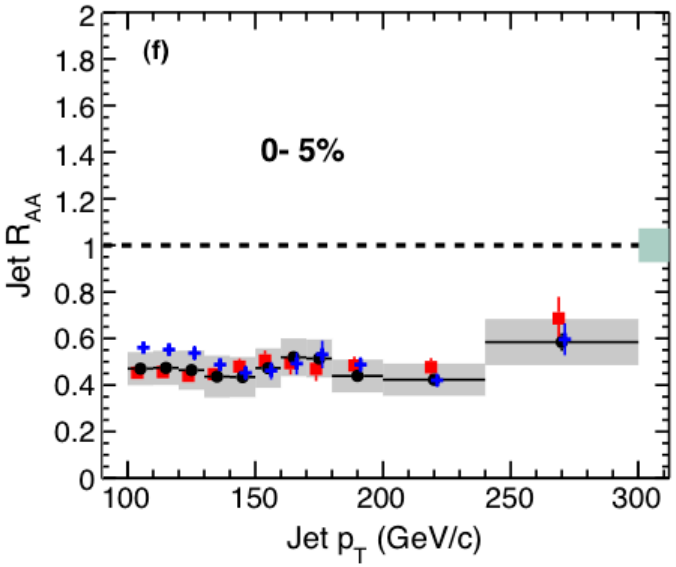


The leading jet has also suffered energy-loss

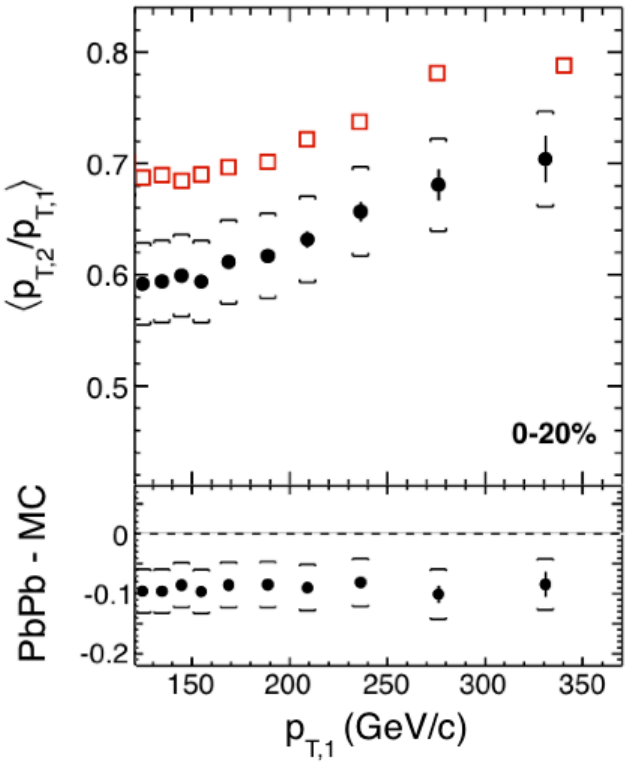
Modeling is needed to extract the exact p_T dependence

Putting the results together

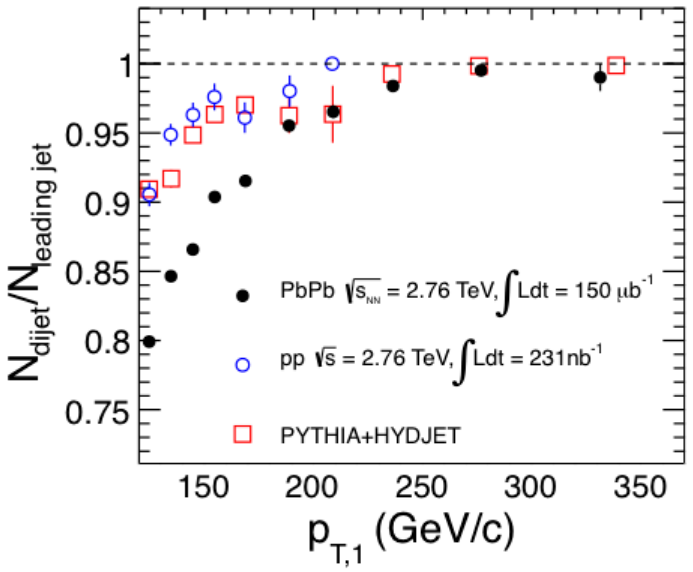


CMS-PAS-HIN-12-004

How much energy is lost on average



How much on average the away-side loses further



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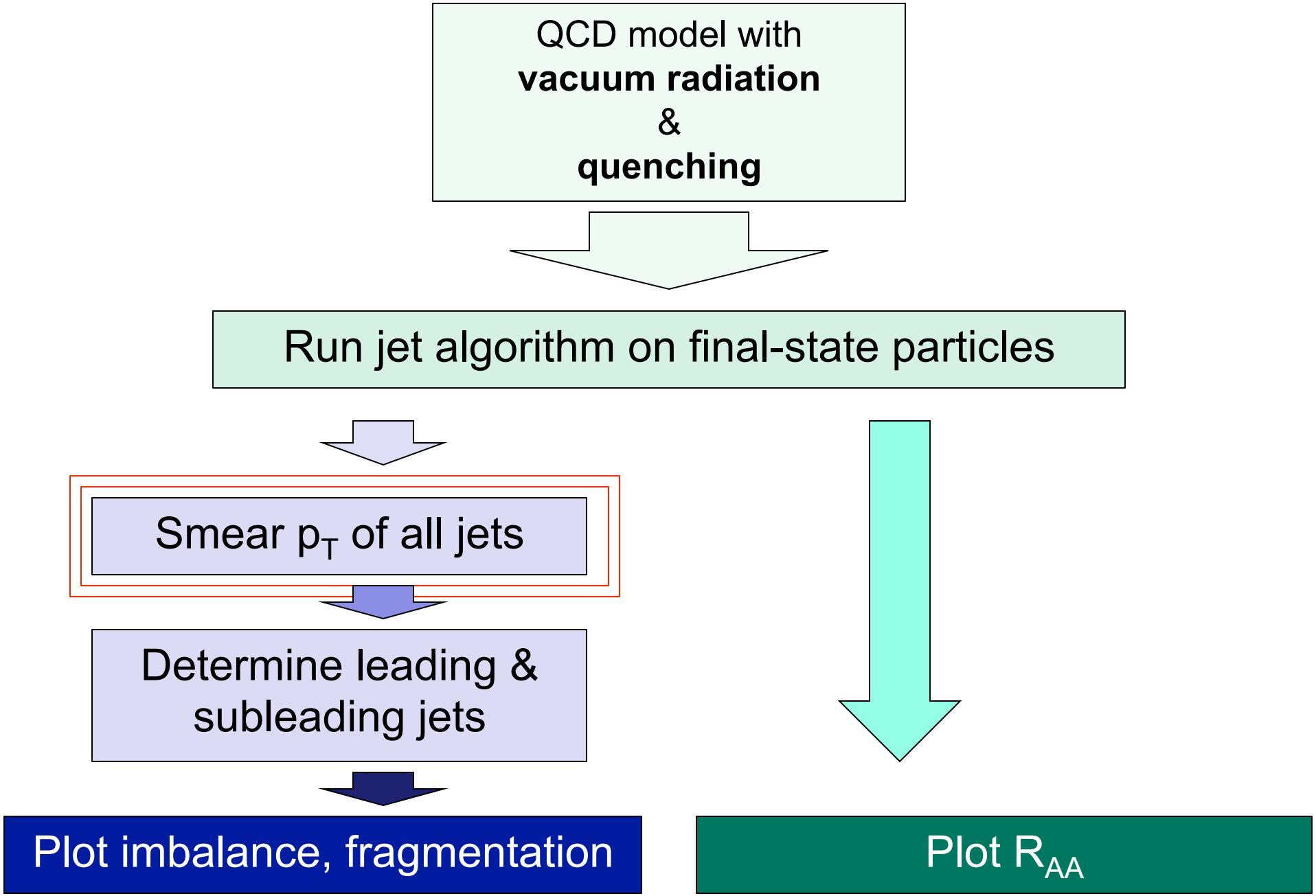
What is the maximum amount of energy-loss

Following slides present a simple modeling attempt in order to:

- illustrate a correct approach for comparison the data
- get a physical intuition, although not as precisely as from a realistic calculation

Good Data-MC comparison recipe

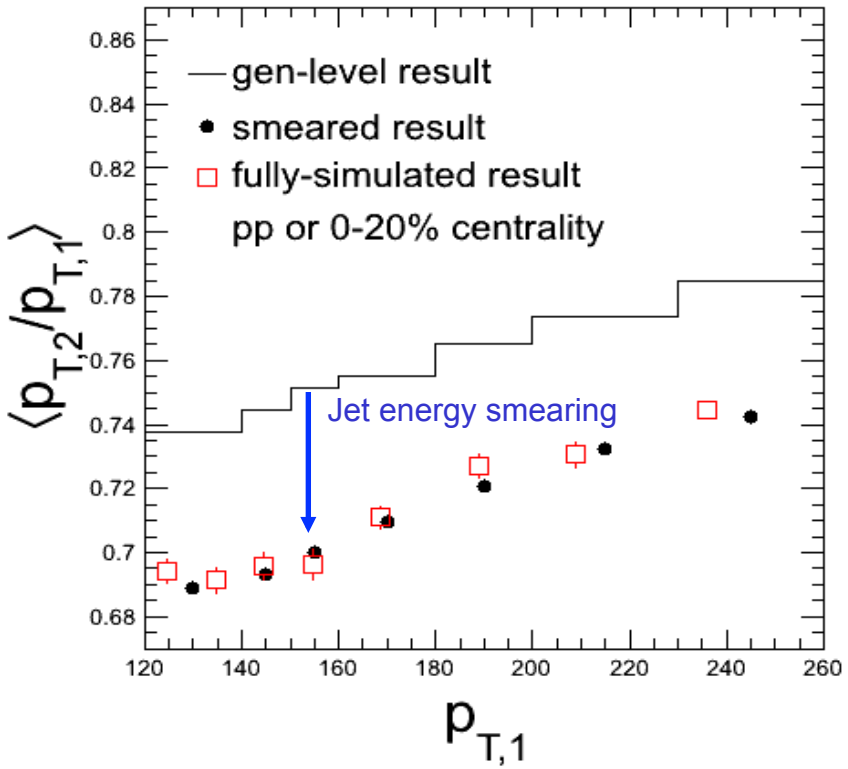


Jet resolution effects on imbalance

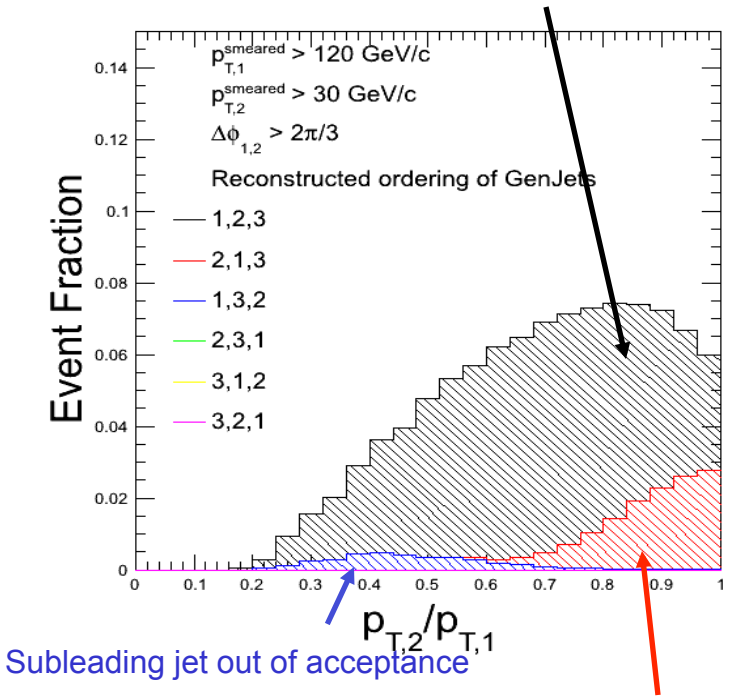
$$\sigma\left(\frac{p_{\mathrm{T}}^{\mathrm{Reco}}}{p_{\mathrm{T}}^{\mathrm{Gen}}}\right) = C \oplus \frac{S}{\sqrt{p_{\mathrm{T}}^{\mathrm{Gen}}}} \oplus \frac{N}{p_{\mathrm{T}}^{\mathrm{Gen}}},$$

The model calculation has to take into account the resolution effects when comparing with convoluted data

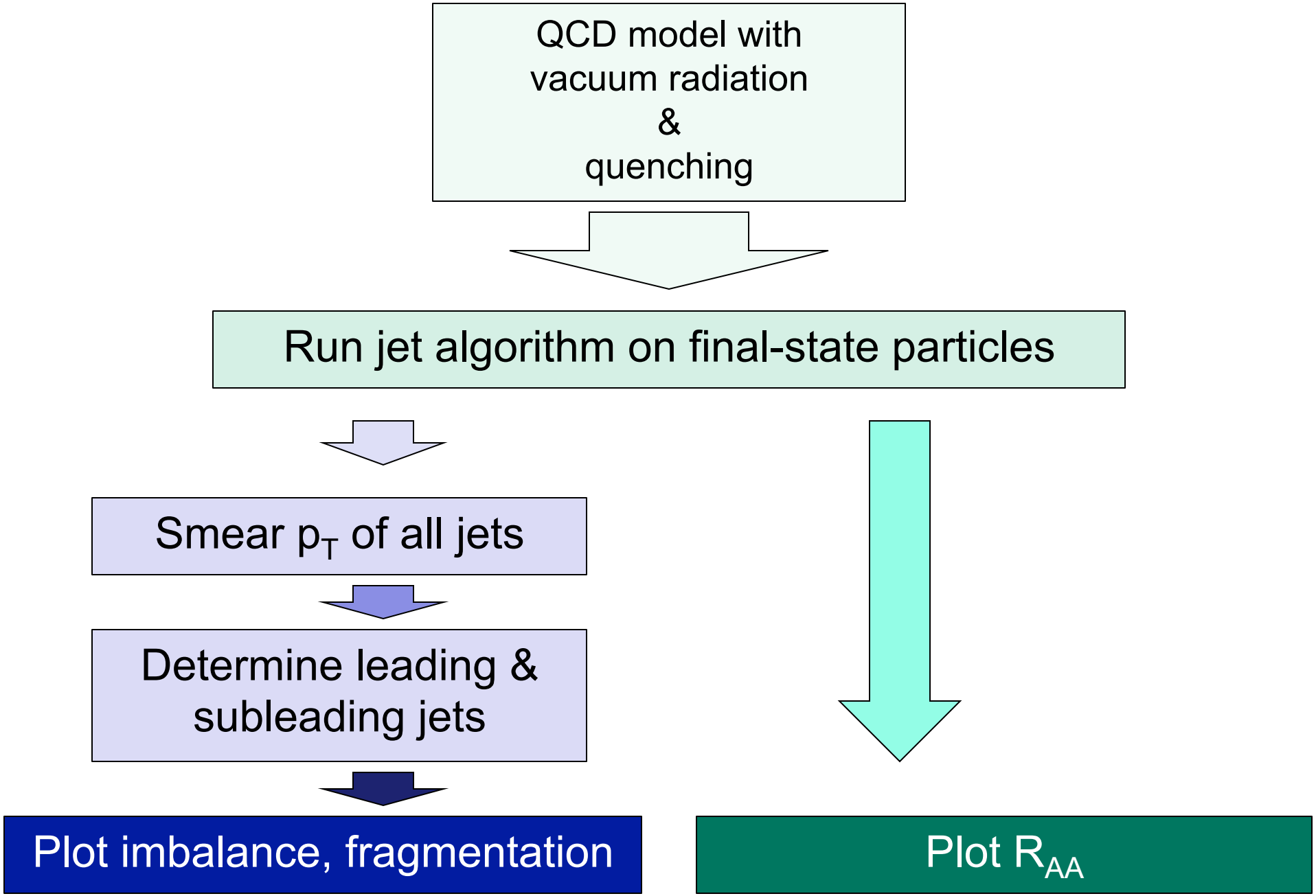
C	S	N (pp)	N (50–100%)	N (30–50%)	N (10–30%)	N (0–10%)
0.0246	1.213	0.001	0.001	3.88	5.10	5.23



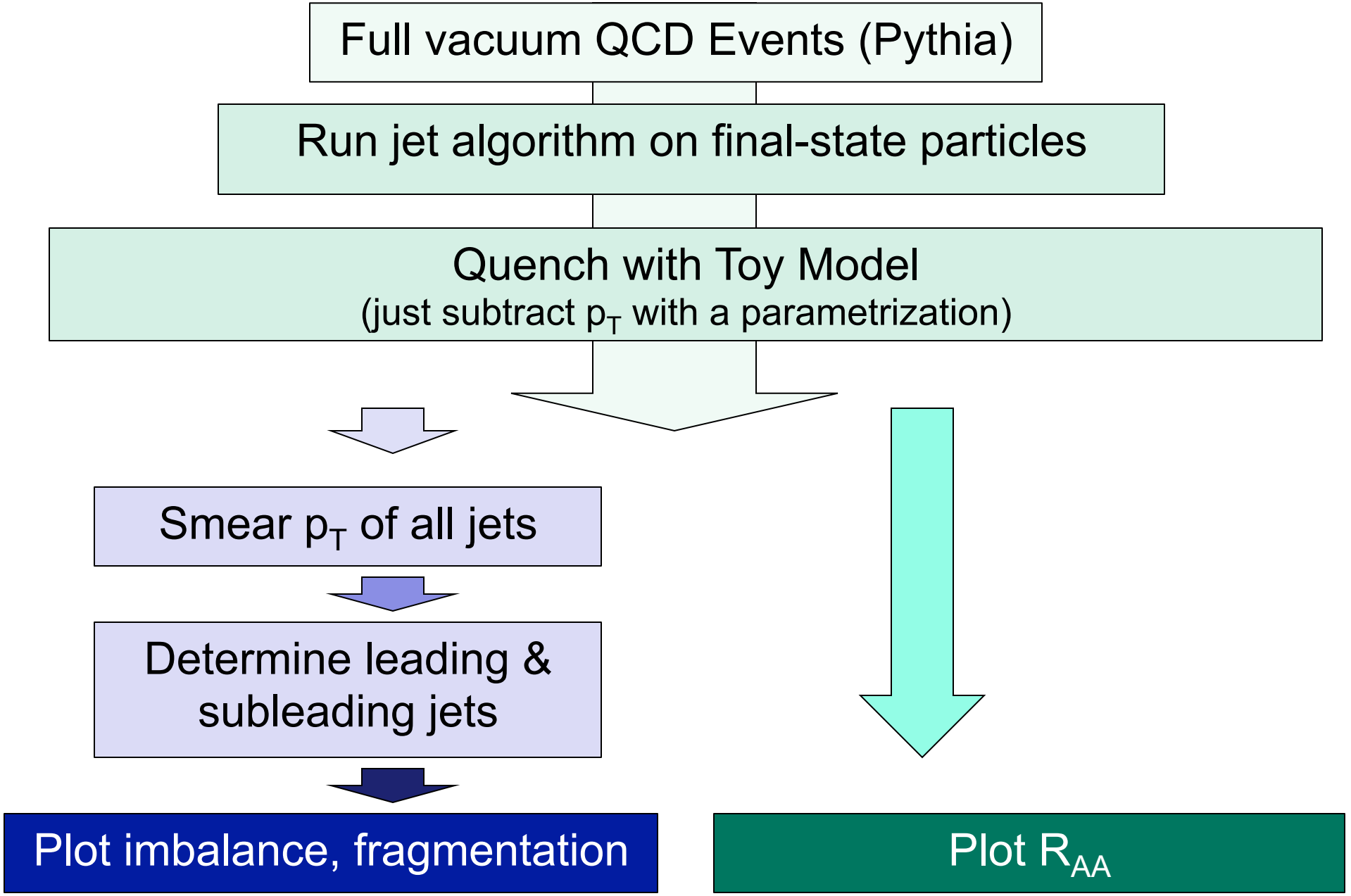
Generator level leading and subleading jets matches reco level



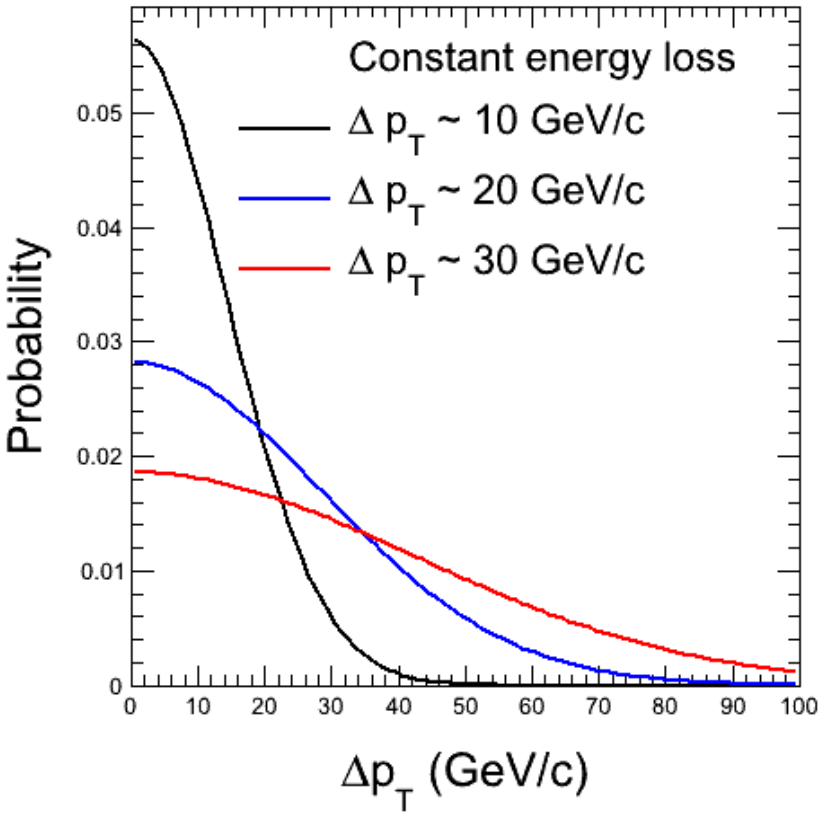
Good Data-MC comparison recipe



Toy model


Full vacuum QCD Events (Pythia)
Run jet algorithm on final-state particles
Quench with Toy Model
(just subtract p_T with a parametrization)
Smear p_T of all jets
Determine leading & subleading jets
Plot imbalance, fragmentation
Plot R_{AA}

Simple Toy Model: Independent quenching



An artificial energy-loss is applied on particle-jets in Pythia generated events

Each jet suffers a random energy-loss, completely independent on other jets in the event

No difference between quark vs gluon jets

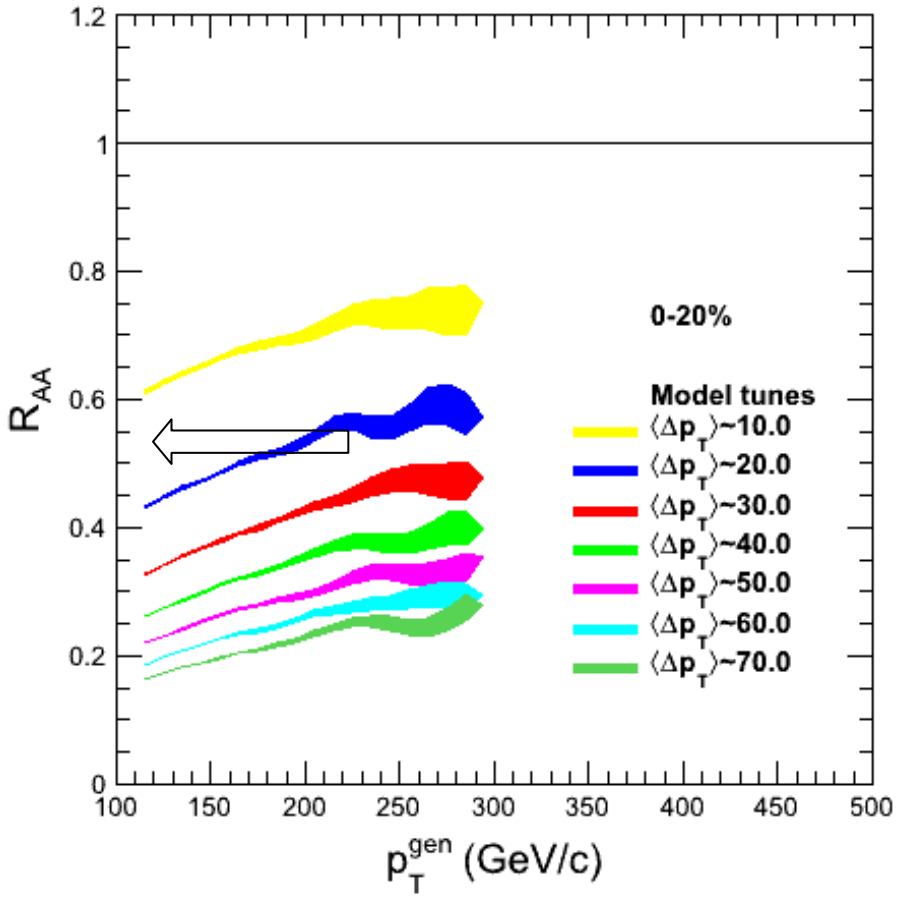
The probability distribution of energy-loss is modulated by

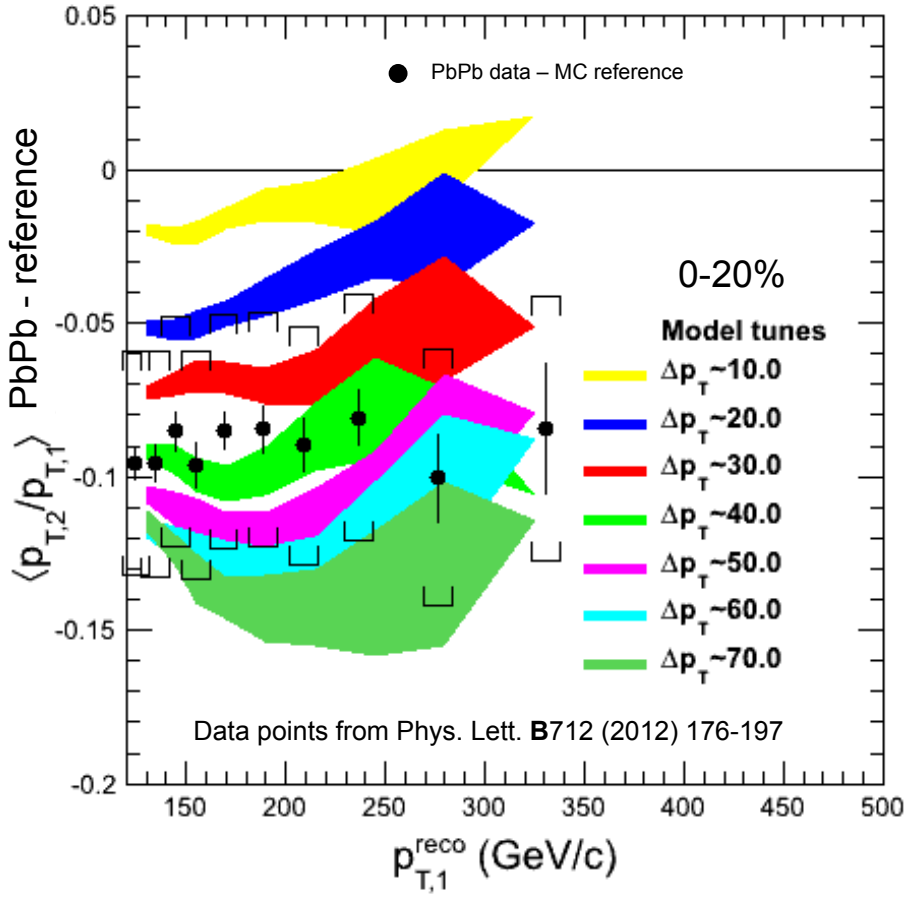
- the tuned mean amount

and

- momentum dependence

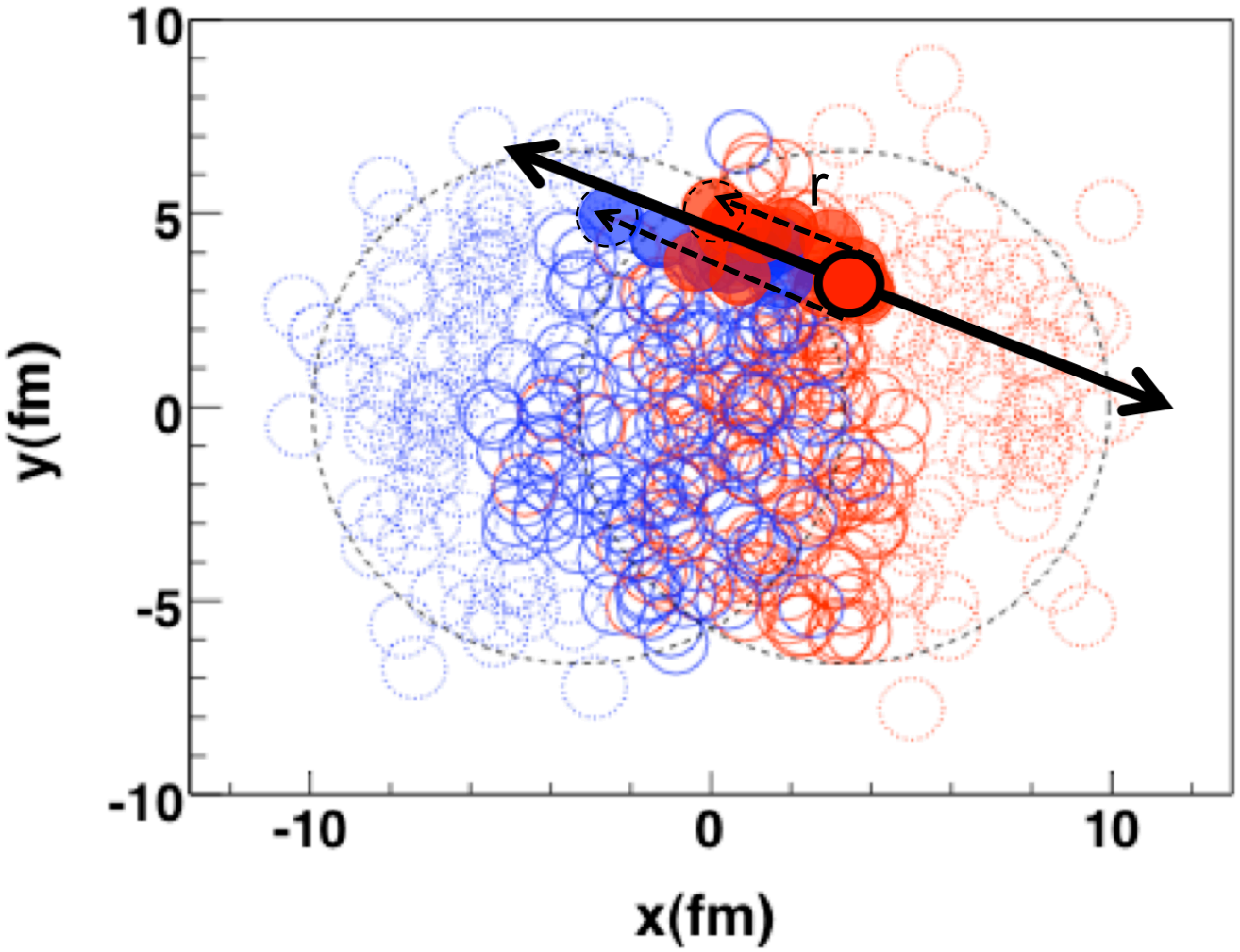
Simple model: Independent quenching





- Jet RAA suggests that about 20 GeV is lost on average
- This is not sufficient to cause imbalance as seen in data
- There should be a further anti-correlation between the two jets

Geometry-inspired toy-model

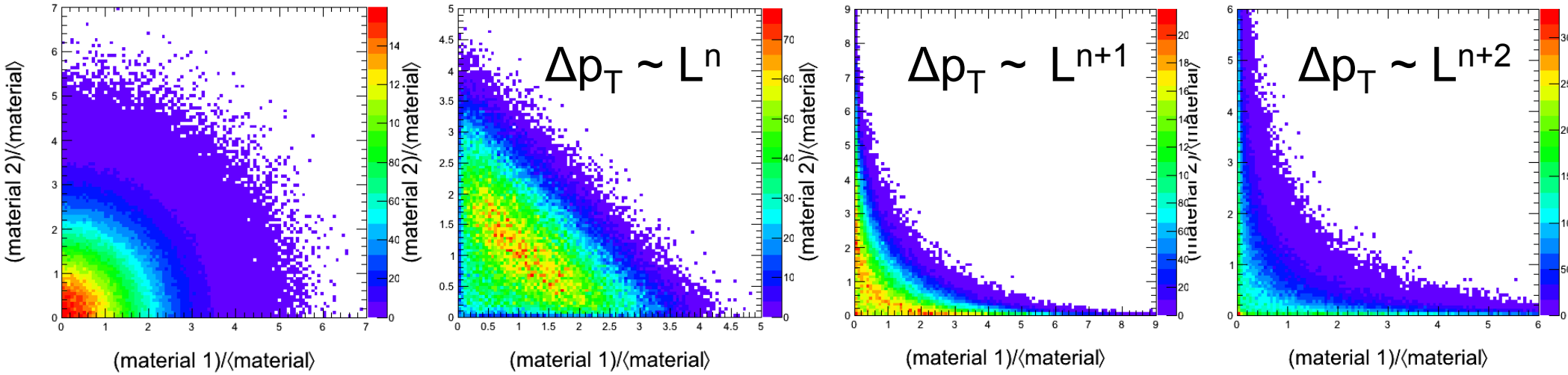


Nucleus A
Spectator
Participant
Traversed material

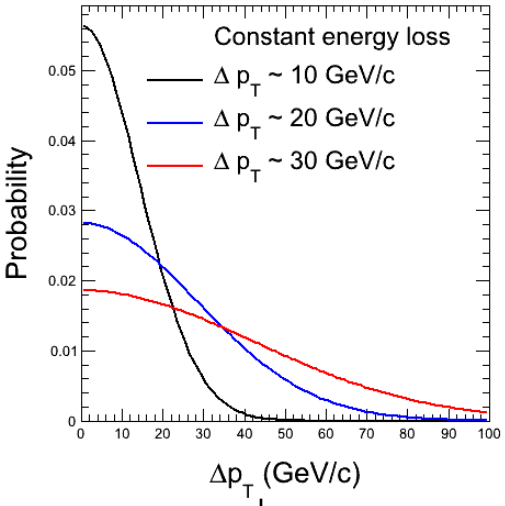
Nucleus B
Spectator
Participant
Traversed material

- The material along the trajectory of the jet is summed, weighted by a power of r
- r = distance between target nucleon and jet origin
- Static medium

Correlation between two jets

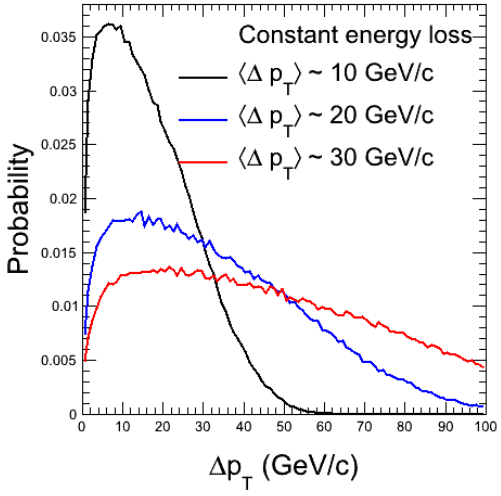


no geometry

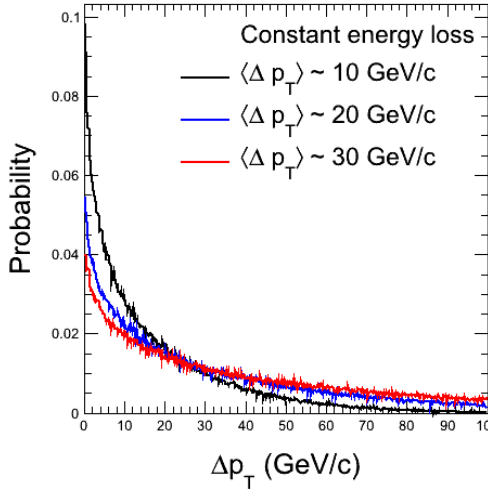


did not work

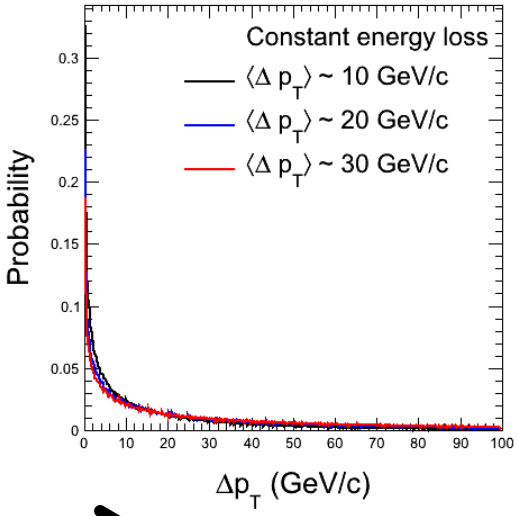
r^0-weighted



r^1-weighted

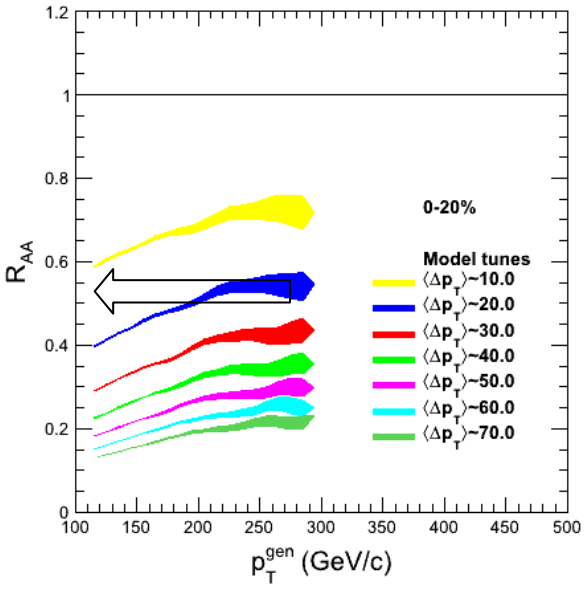


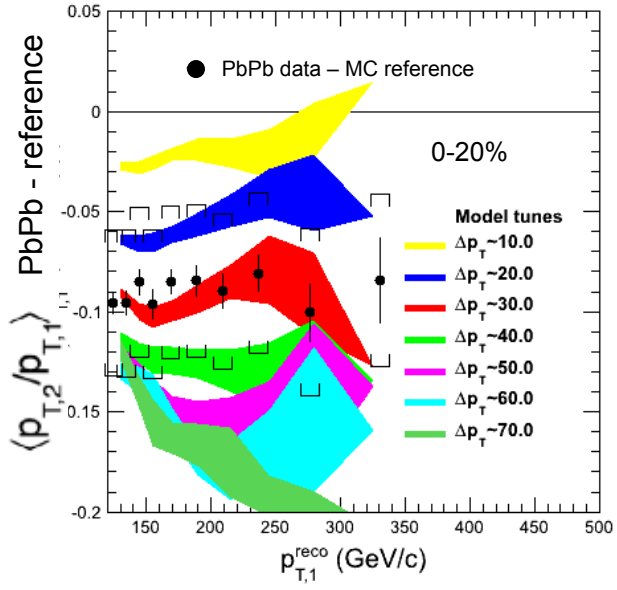
r^2-weighted

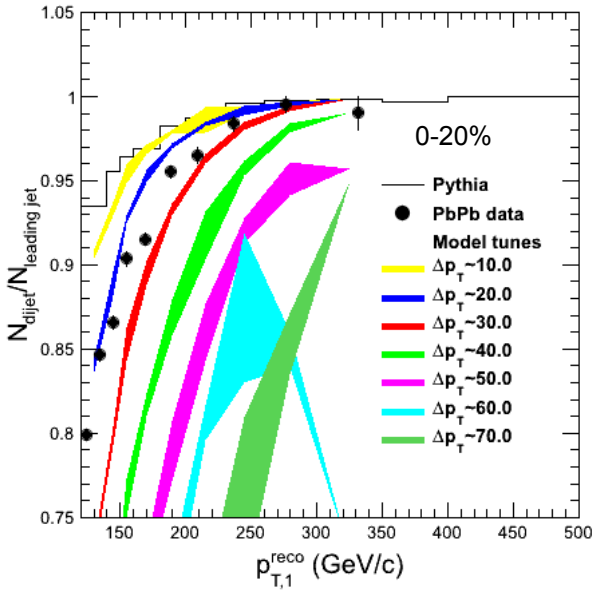


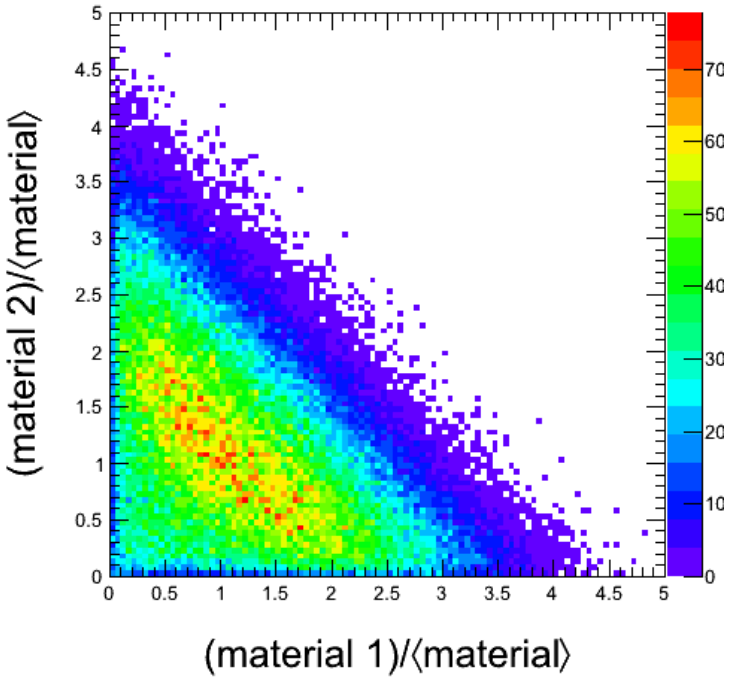
more anti-correlation induced

Material weighted by r^0







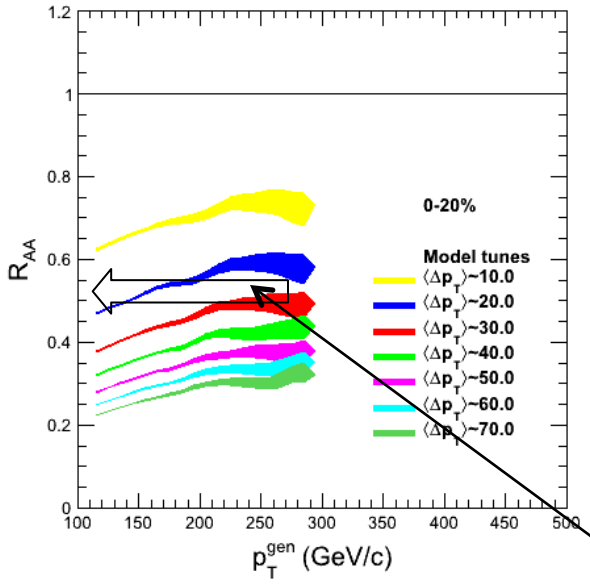


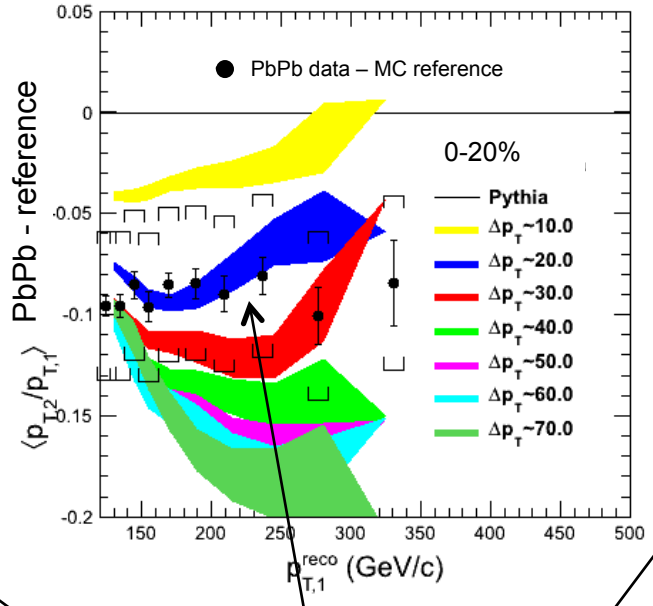
Moving towards more imbalance compared to independent quenching

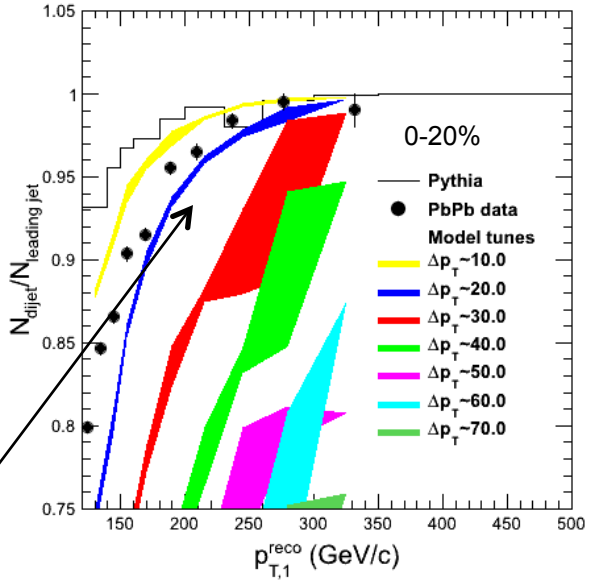
Blue is consistent with R_{AA} but
Red is better with $\langle p_{T,1}/p_{T,2}\rangle$

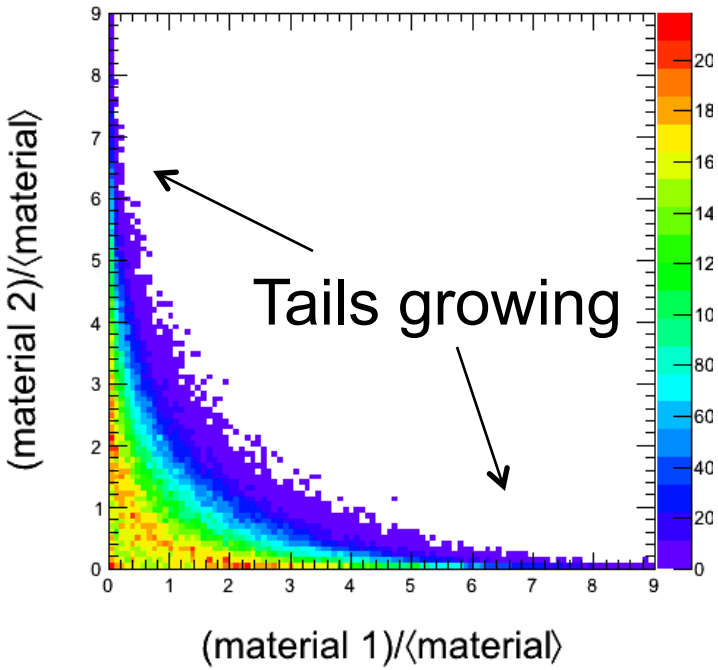
PbPb data
Model tunes
Δp_T~10.0
Δp_T~20.0
Δp_T~30.0
Δp_T~40.0
Δp_T~50.0
Δp_T~60.0
Δp_T~70.0

Material weighted by r^1









Starting to be compatible in all observables

PbPb data

Model tunes

Δp_T~10.0

Δp_T~20.0

Δp_T~30.0

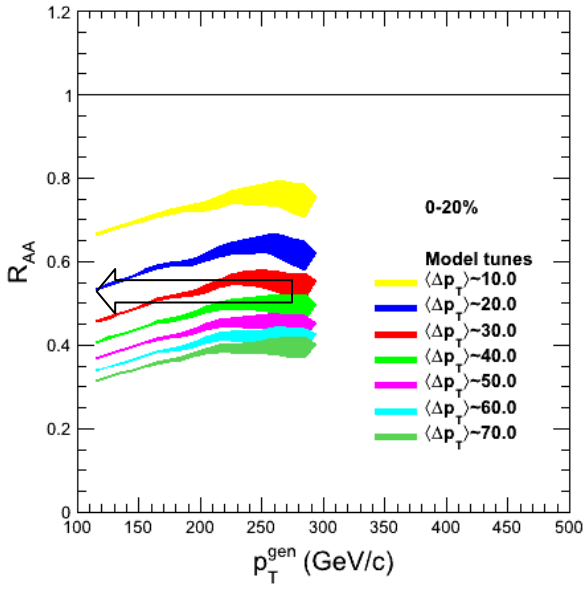
Δp_T~40.0

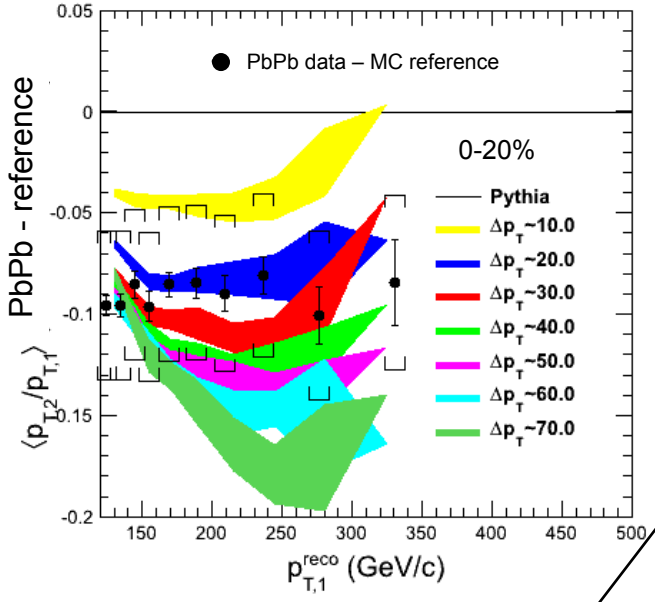
Δp_T~50.0

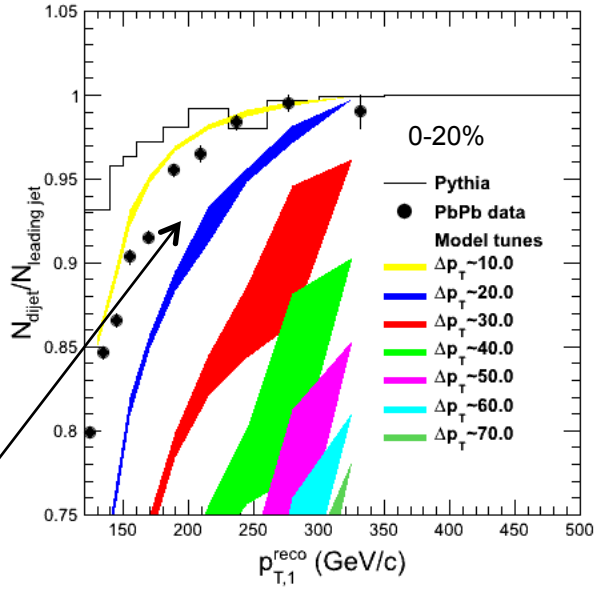
Δp_T~60.0

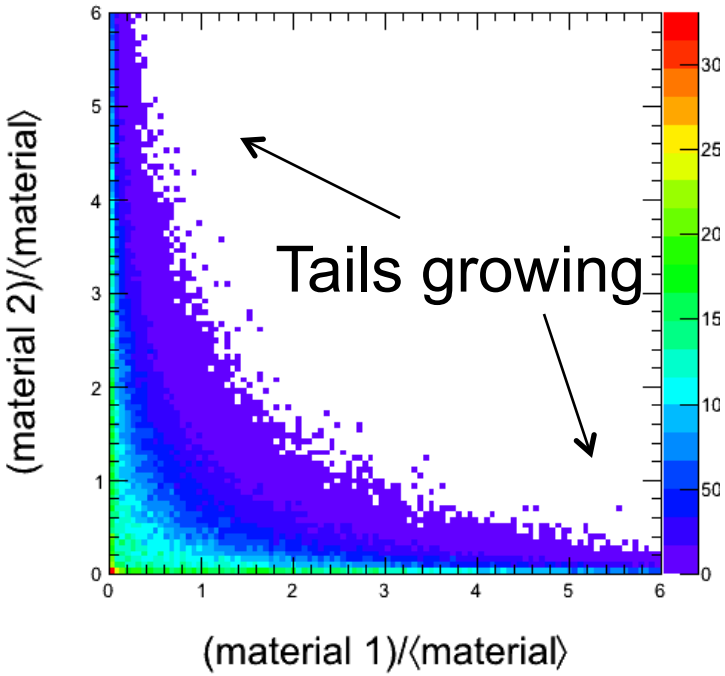
Δp_T~70.0

Material weighted by r^2







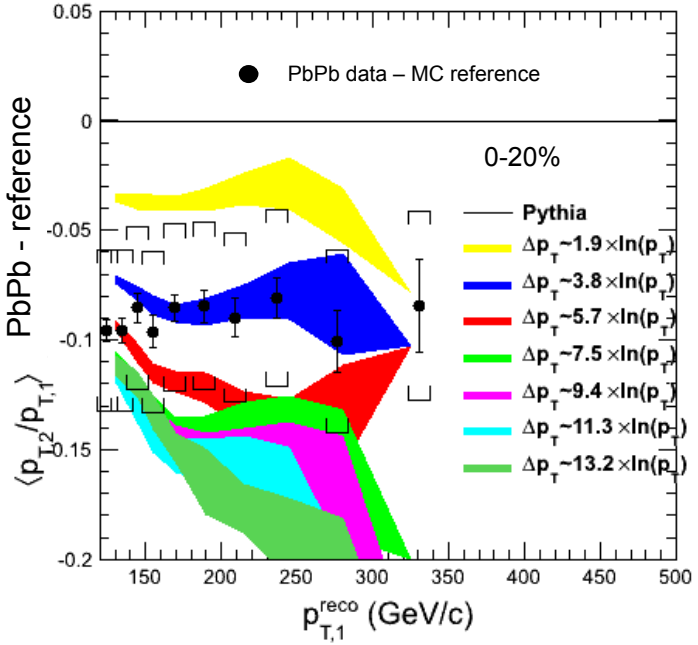


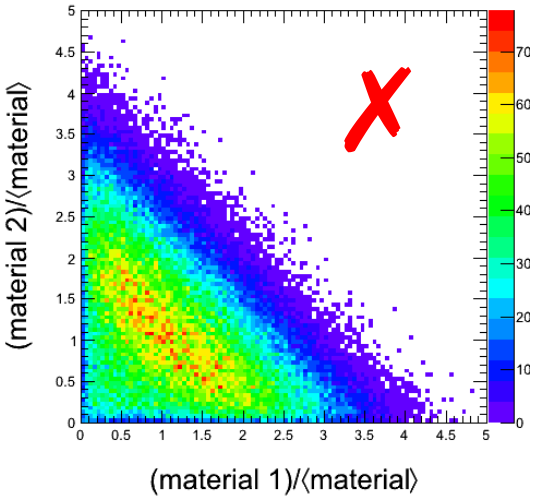
Too much energy-loss on the away side

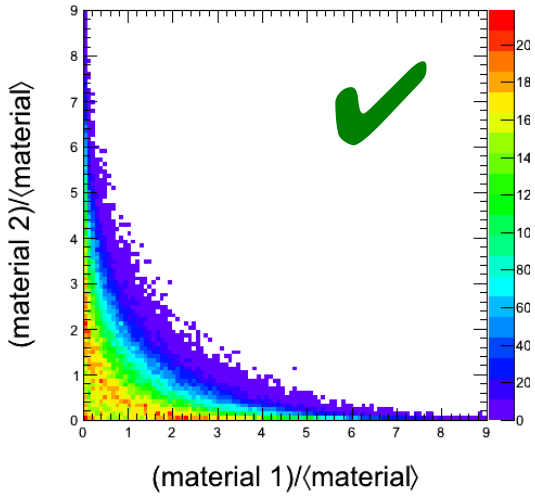
Model study

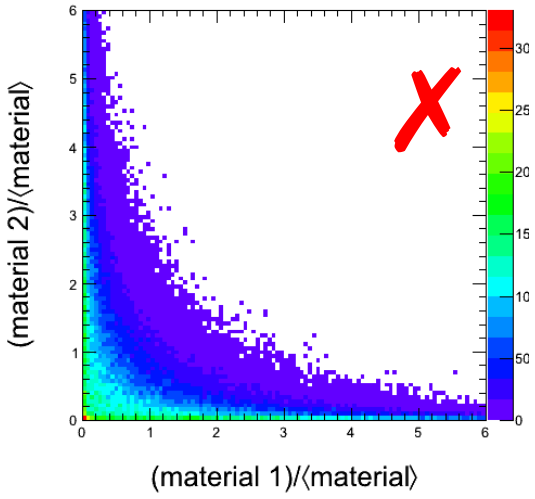
The trends observed in model with
r-weighted material,
with not much (perhaps logarithmic) p_T dependence,
resulting in ~20 GeV/jet energy-loss,
are consistent with data;

Any model, inducing similar correlations
(a combination of
geometry & radiation & parton-type
effects)
may be successful in description of data









Photon-Jet correlations

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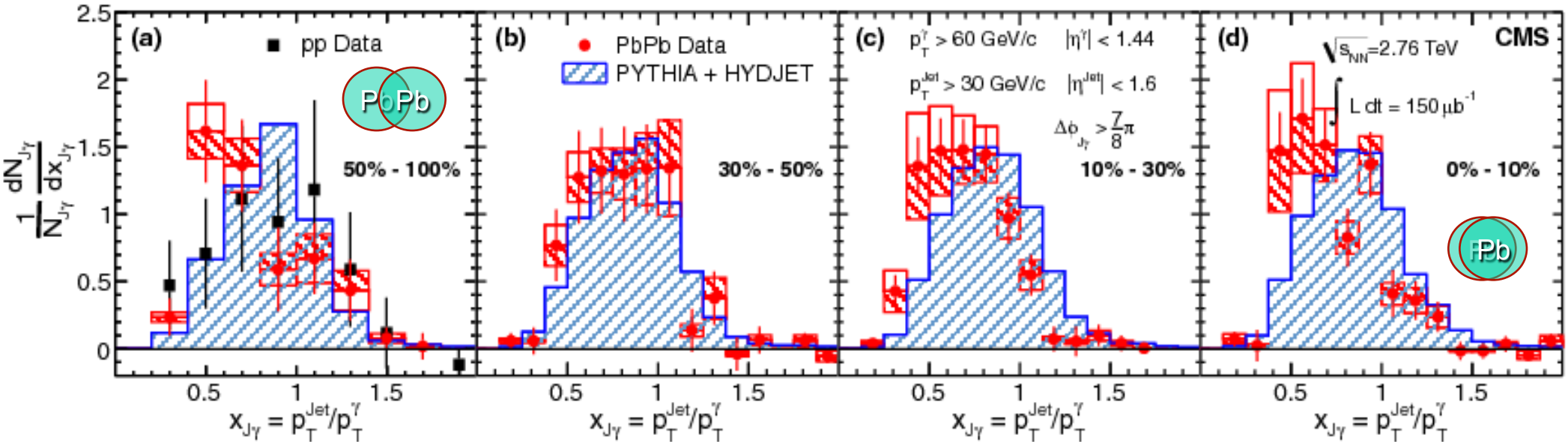
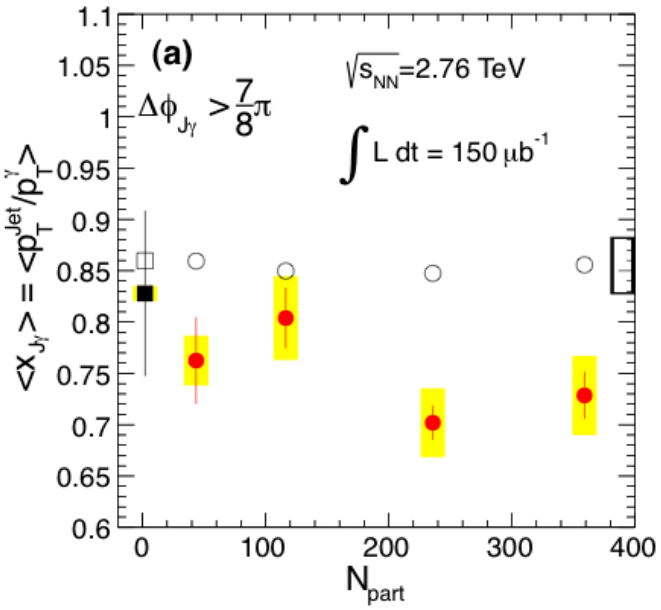
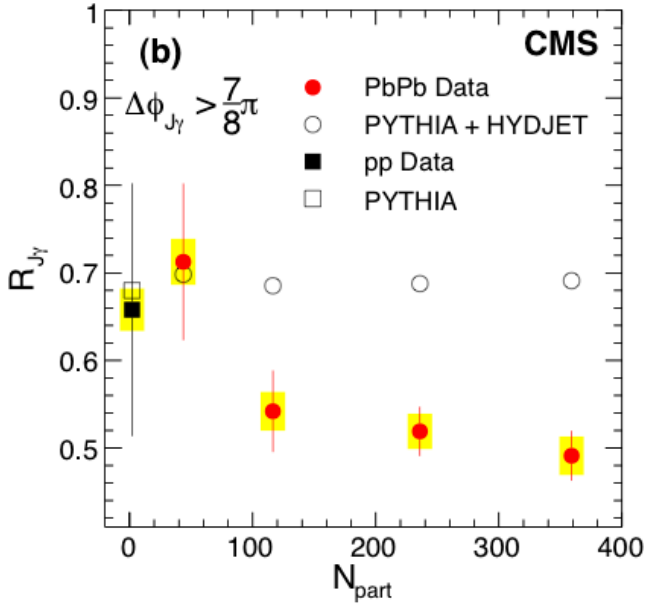






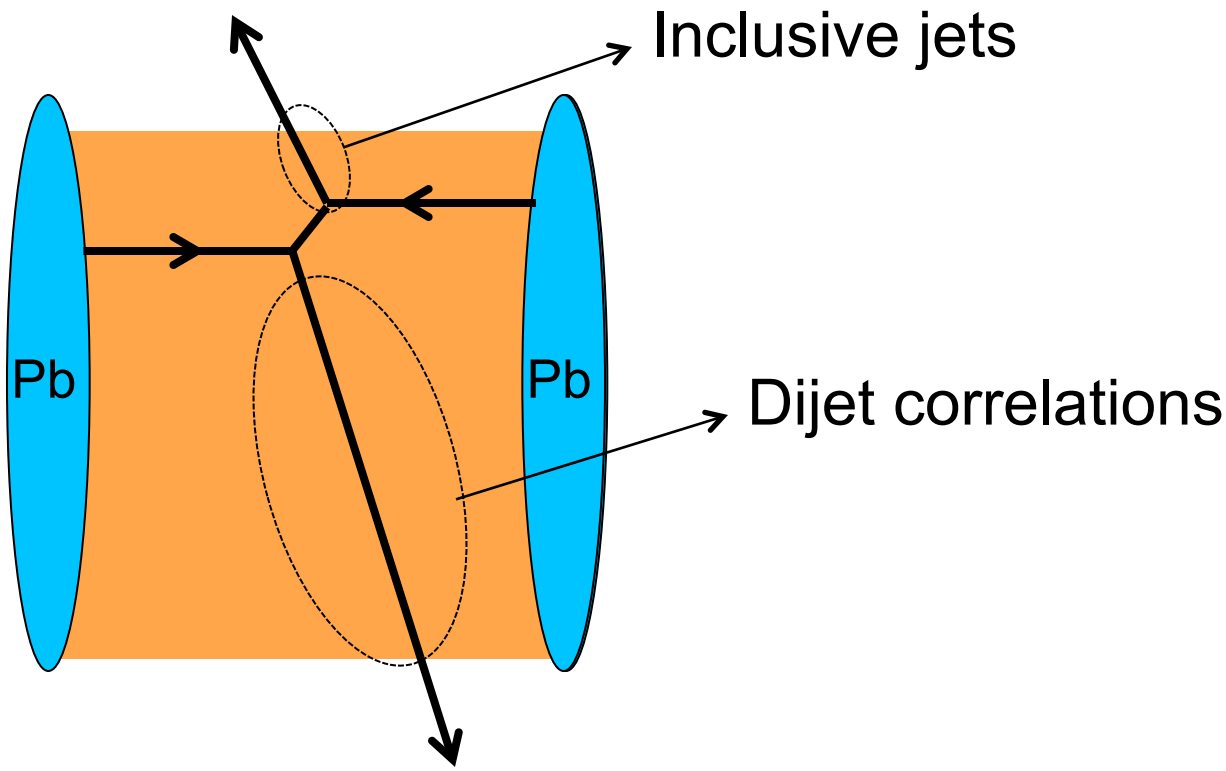
Equivalent information with jet R_{AA} and imbalance
-shift
-(potential) widening

Complementary:
-Different initial geometry
-Quark dominated

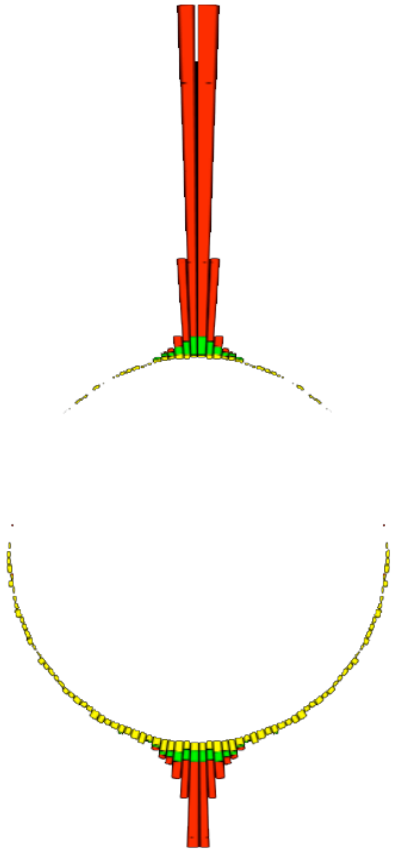
Same smearing procedure (for jet only) needed!

Conclusions

Inclusive jet R_{AA} and dijet imbalance provide complementary information on the energy-loss dynamics, which have been combined for the first time to isolate medium geometry-sensitive effects

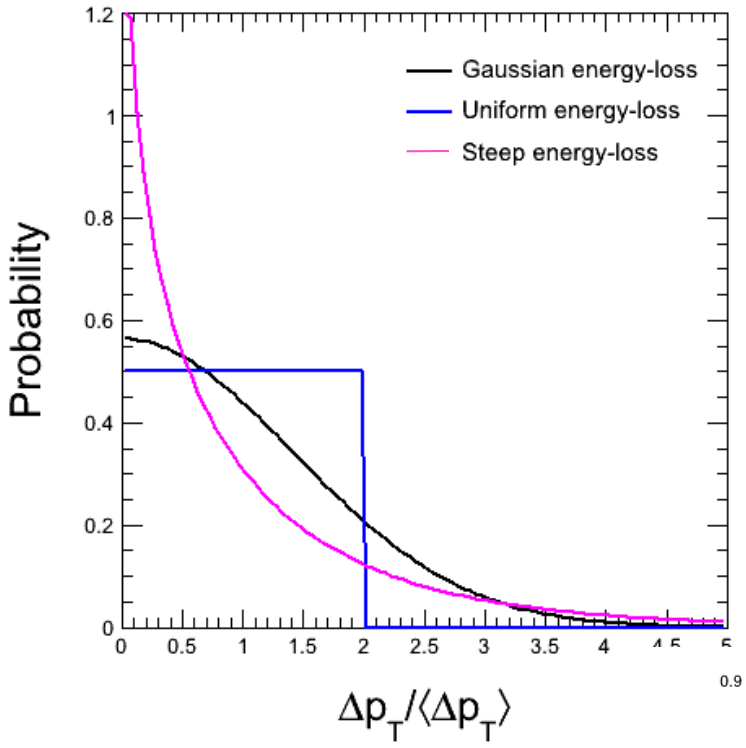


The end



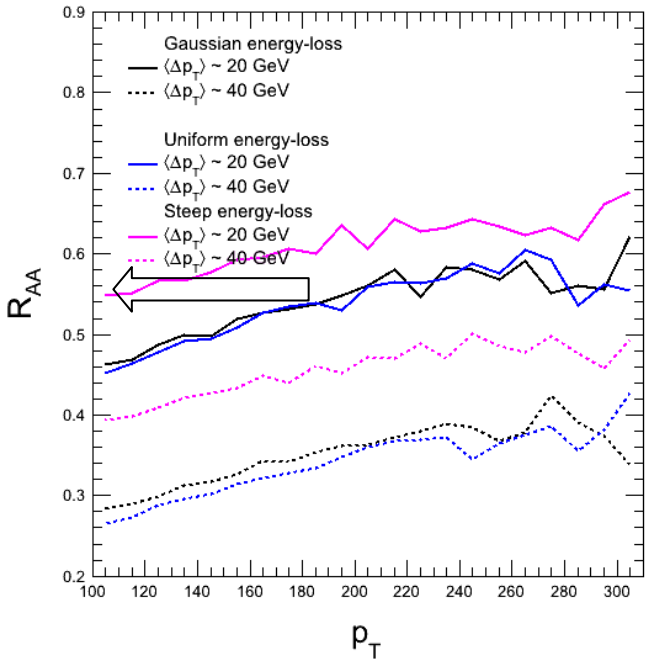
Next : back-up slides

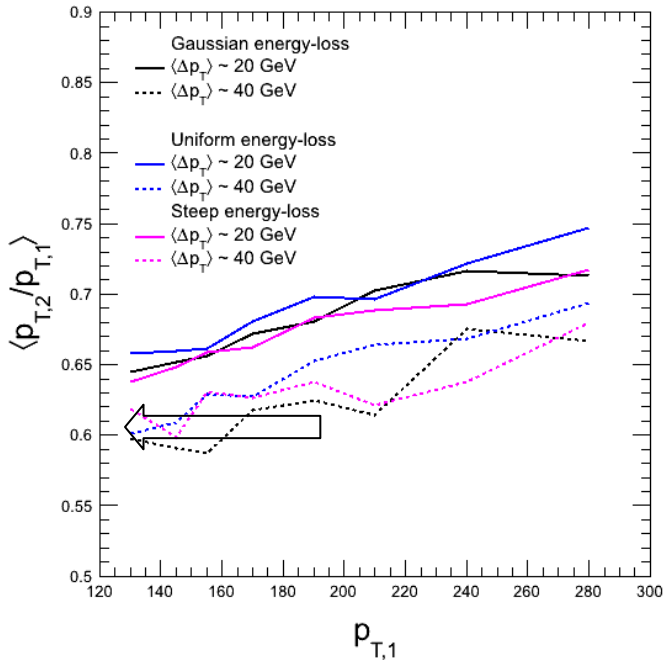
Tuning Quenching Weights



Try a different functional form for the probability distribution

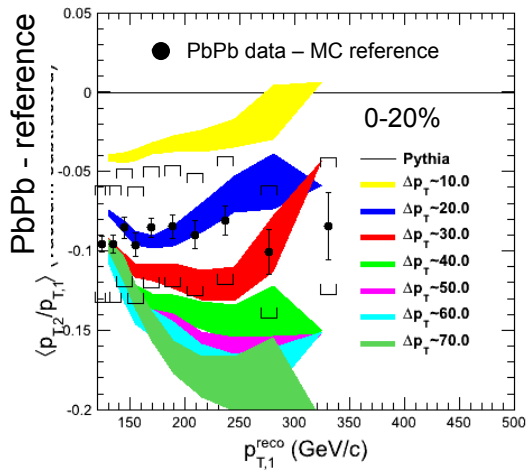
Not enough impact on results to account for the observed imbalance

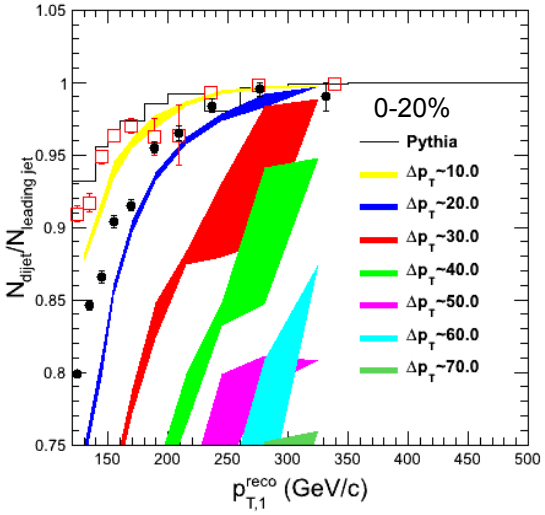




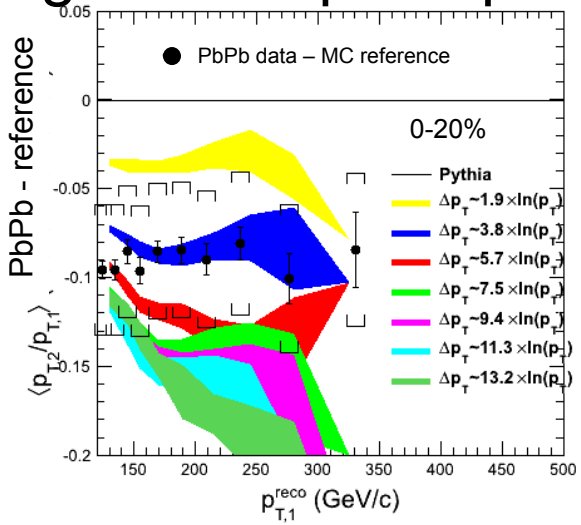
p_T dependence of energy-loss

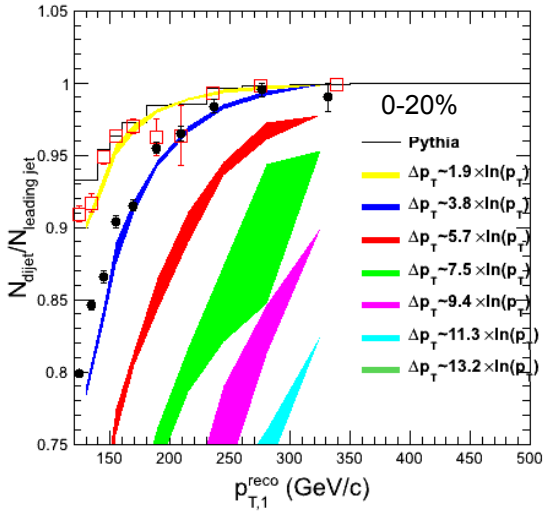
constant energy



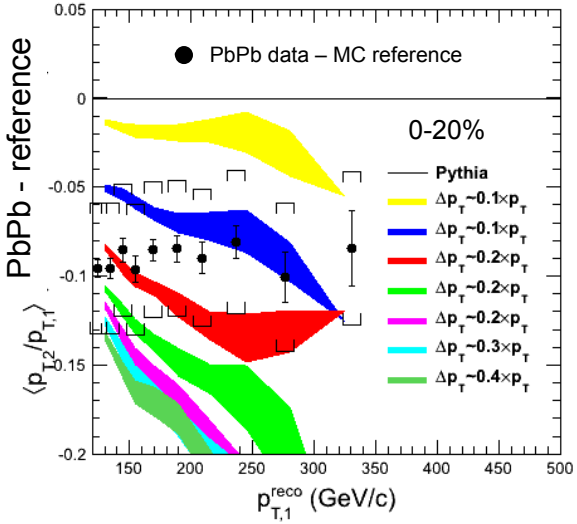


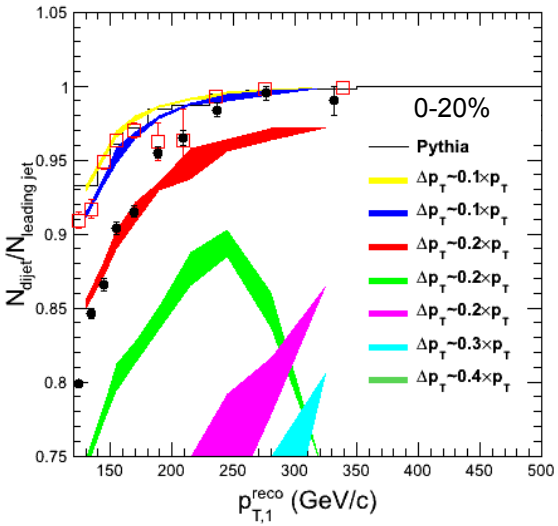
logarithmic pT dependence





constant fraction

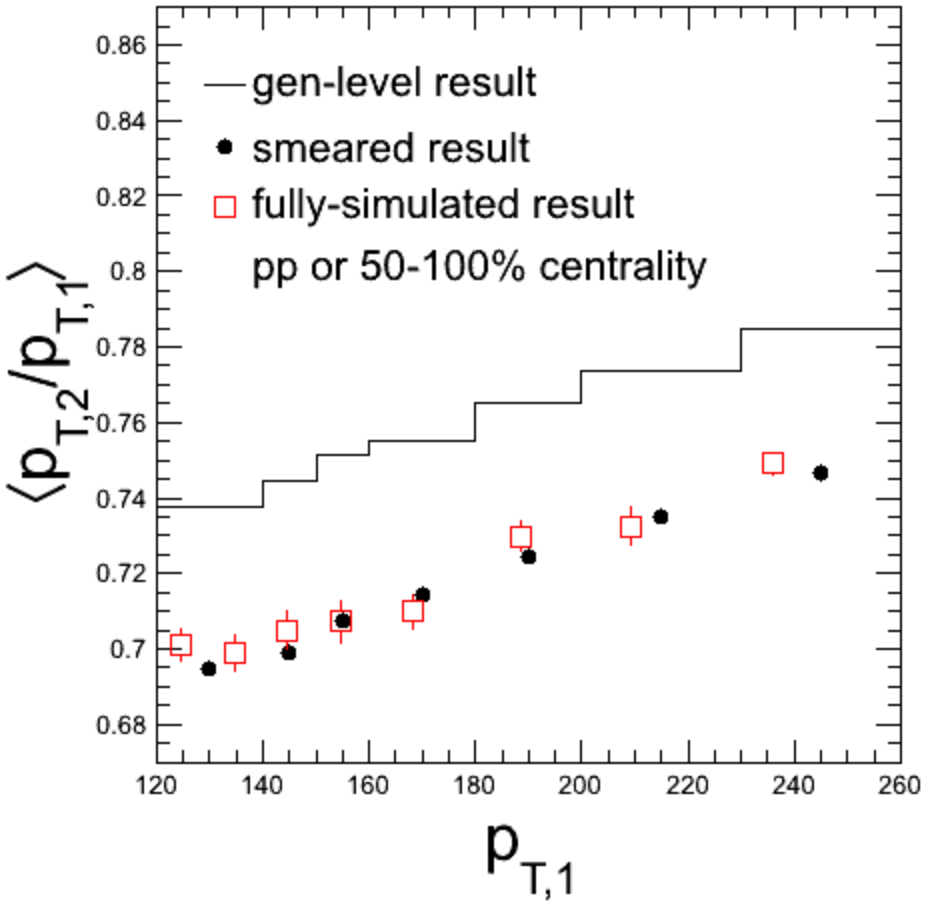




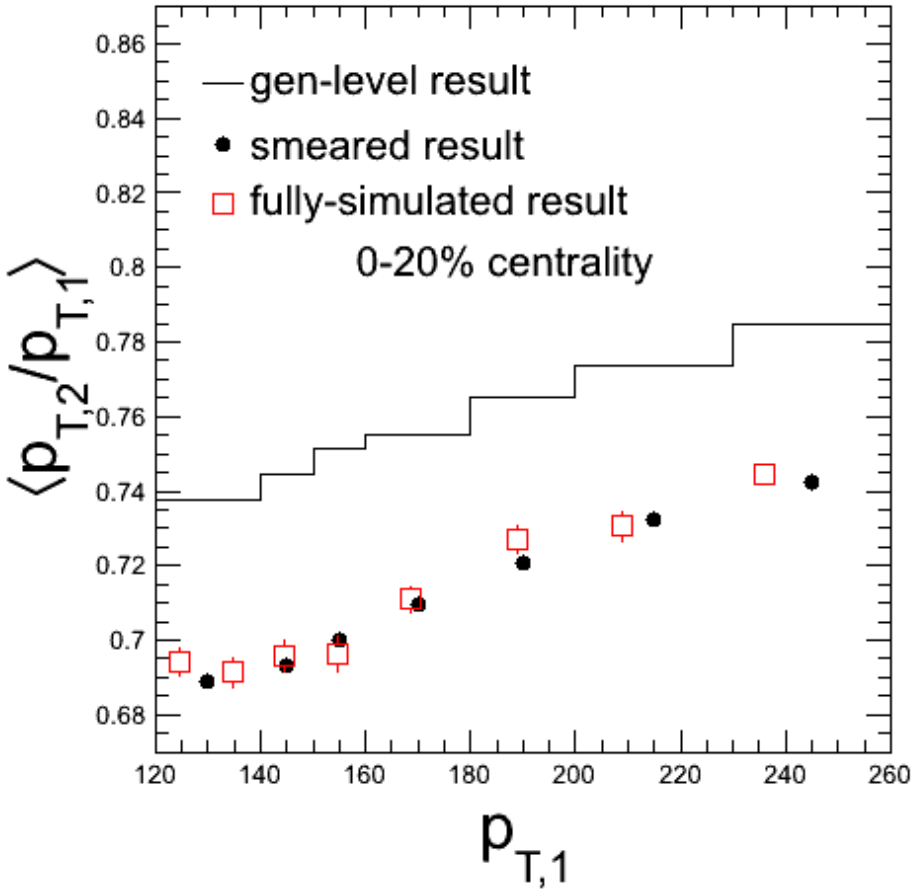
Mild p_T dependence, the first two parameterizations survive.
Similar lesson from other geometry models.

Centrality dependence of smearing

pp & peripheral



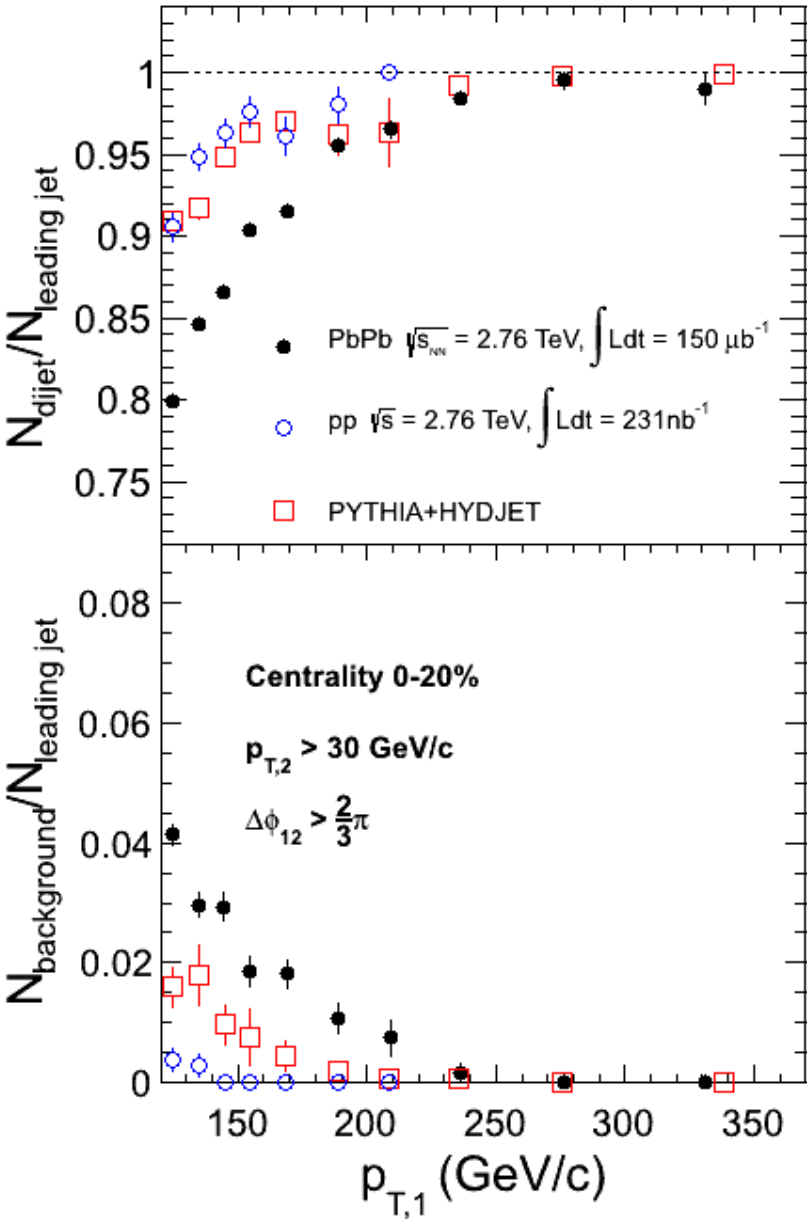
central



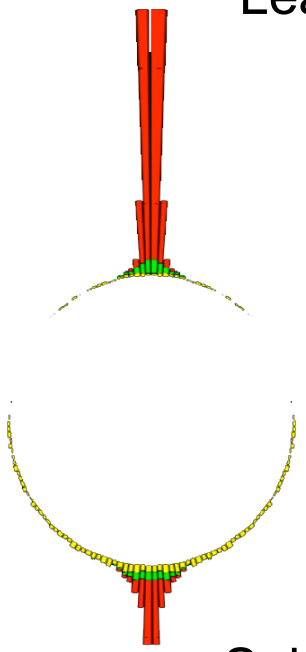
Smearing important in pp and peripheral PbPb as much as in central PbPb!

Dijet measurements

Phys. Lett. **B**712 (2012) 176-197



At high p_T, only very few jets get completely lost on the away side



Correlating the jets may teach us about the shape & width of the quenching weights