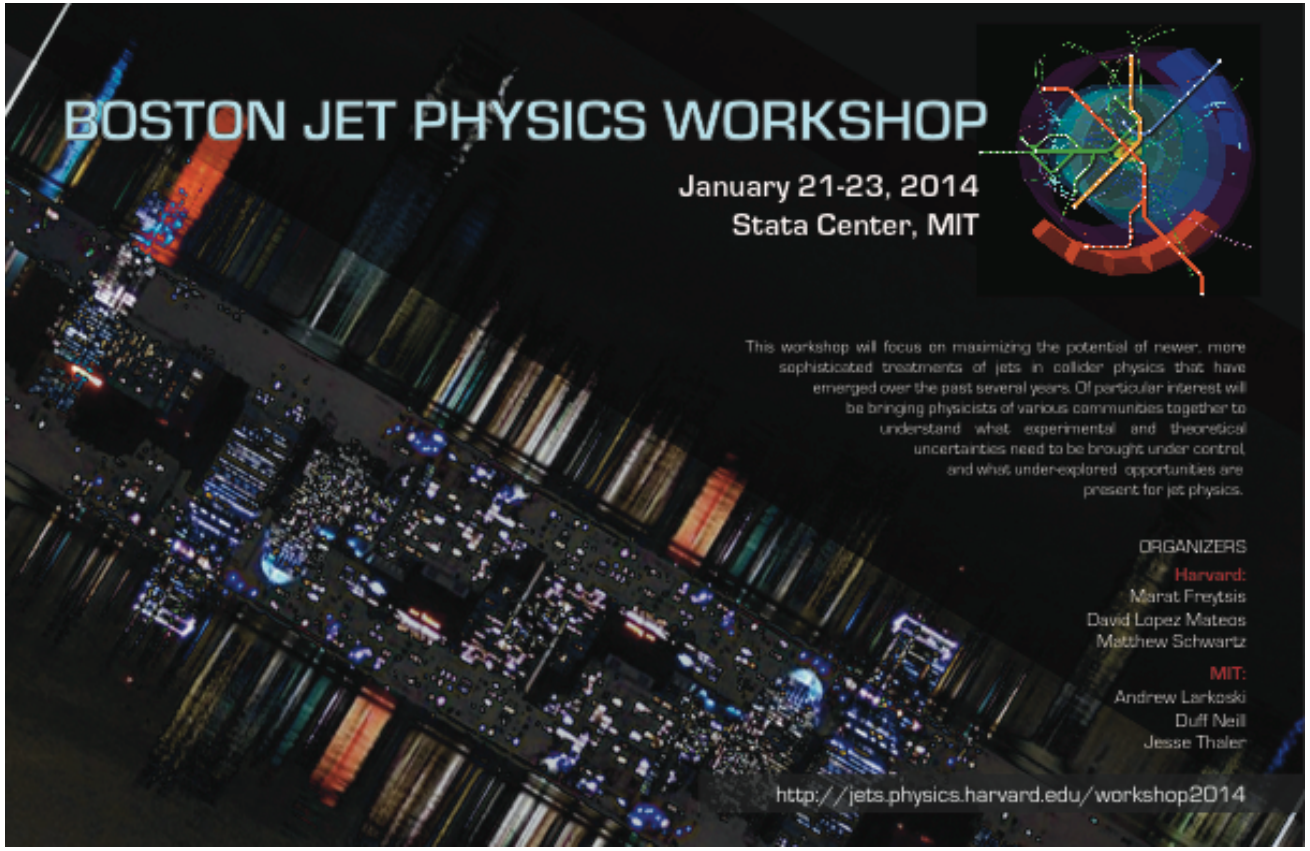
Workshop Summary: An Experimental Perspective



David López Mateos, Harvard University

2nd Boston Jet Workshop, January 23rd, 2014

Workshop Goals

- Encourage discussions across experimental communities and between theory/experiment

- Through those discussions advance more quickly towards a better understanding of jet physics and its potential at the LHC

- Some overlap with BOOST, but note: a lot of jet physics at the LHC is not boosted

Jets vs. Subjets vs. Particles	Issues in Soft QCD
Hammers and Nails	Precision Jet Physics
The Elegance of Jets	Assessing Standard Candles
Pile-Up Mitigation and Validation	Jet from Heavy Ions

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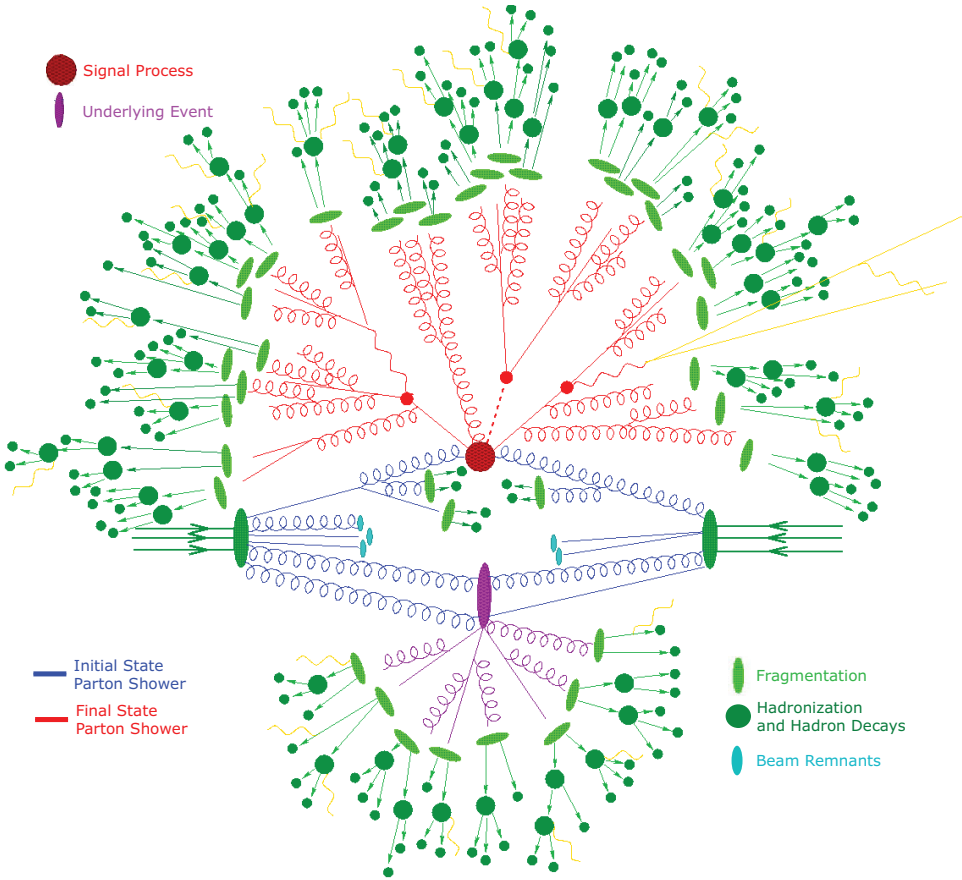

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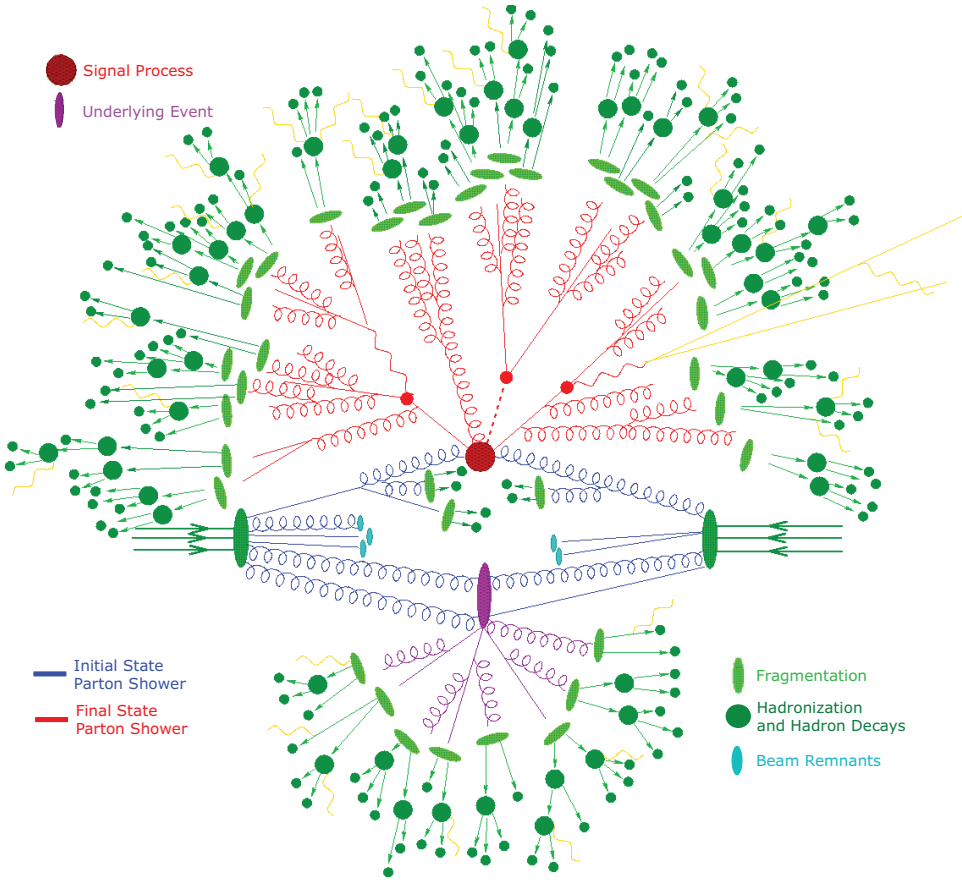
⇒BOOST without prejudice (and with a bit more discussion)



Day by day

Day 1

- Soft QCD and pile-up
- Jets vs subjets vs particles

Day 2

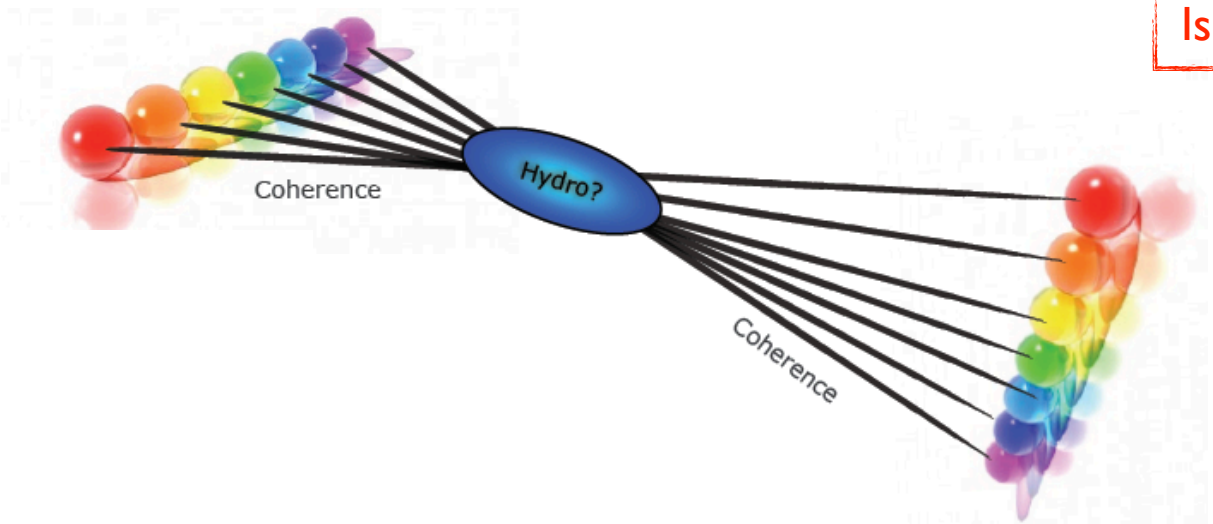
- Jets in heavy ion collisions
- Jet substructure (for searches)

Day 3

- Precision QCD
- Jet searches (with and w/o substructure)

Color connections

Issues in Soft QCD



(*) P. Skands

- Can collective effects help improve the description of underlying event observables?

⇒ Some of these effects impact pile-up simulation: understanding of pile-up effects

Gluon Splitting

Issues in Soft QCD

Less singular than gluon emission: single log

$$P(g \to q\bar{q}) \propto \frac{1}{m^2_{q\bar{q}}}$$

→ *Less* precise, from parton-shower viewpoint

Massive quarks → not even singular

Predictions for g→cc,bb differ greatly between models

(*) P. Skands

- We don't think of gluon splitting to heavy flavors as part of the tune, but right now it is, and not very well constrained
- Quite important for certain substructure analyses

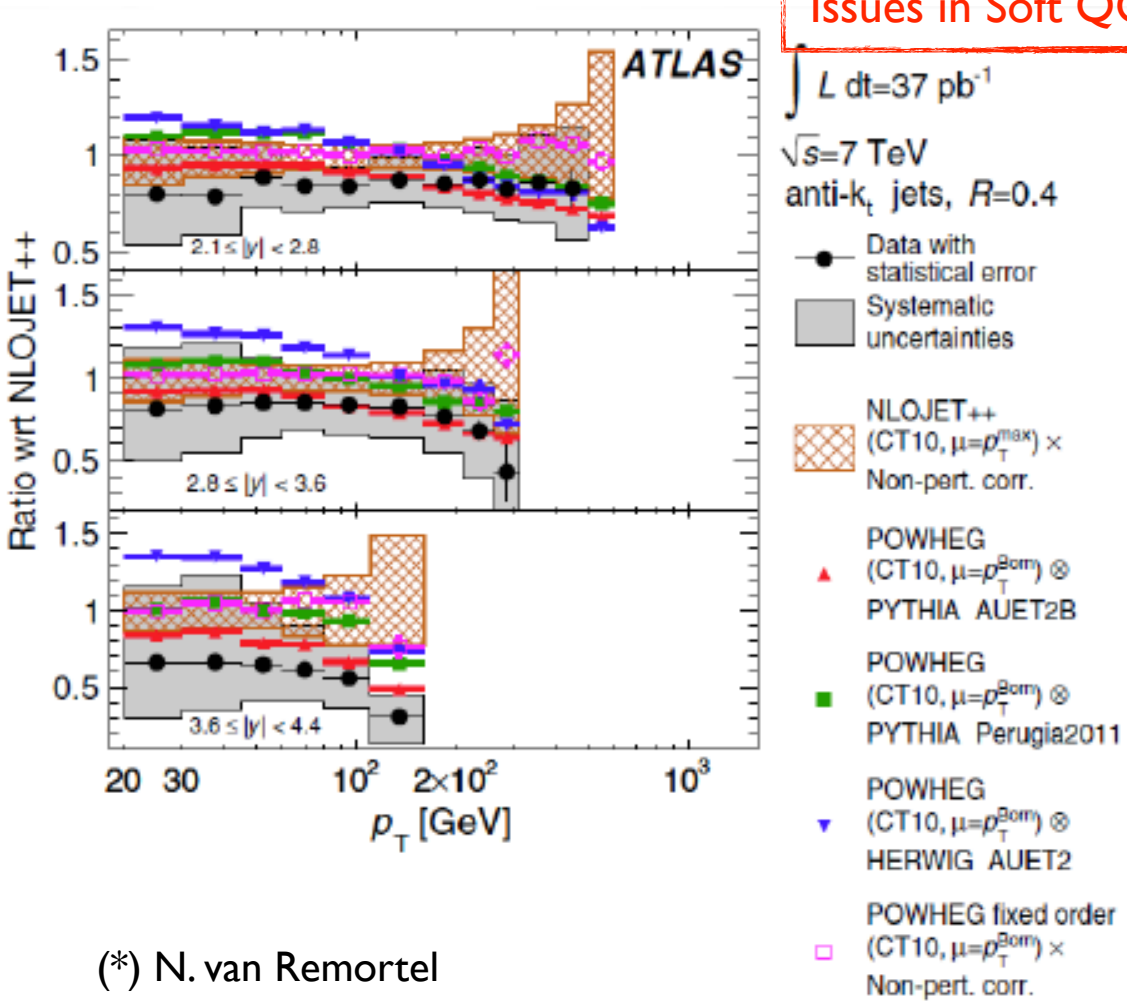
⇒ Can we provide measurements to help this tuning?

Soft QCD and "Hard" QCD

- Reminder: tune affects low-x behavior and parton shower evolution

⇒ Certain observables are more sensitive to the tune than expected

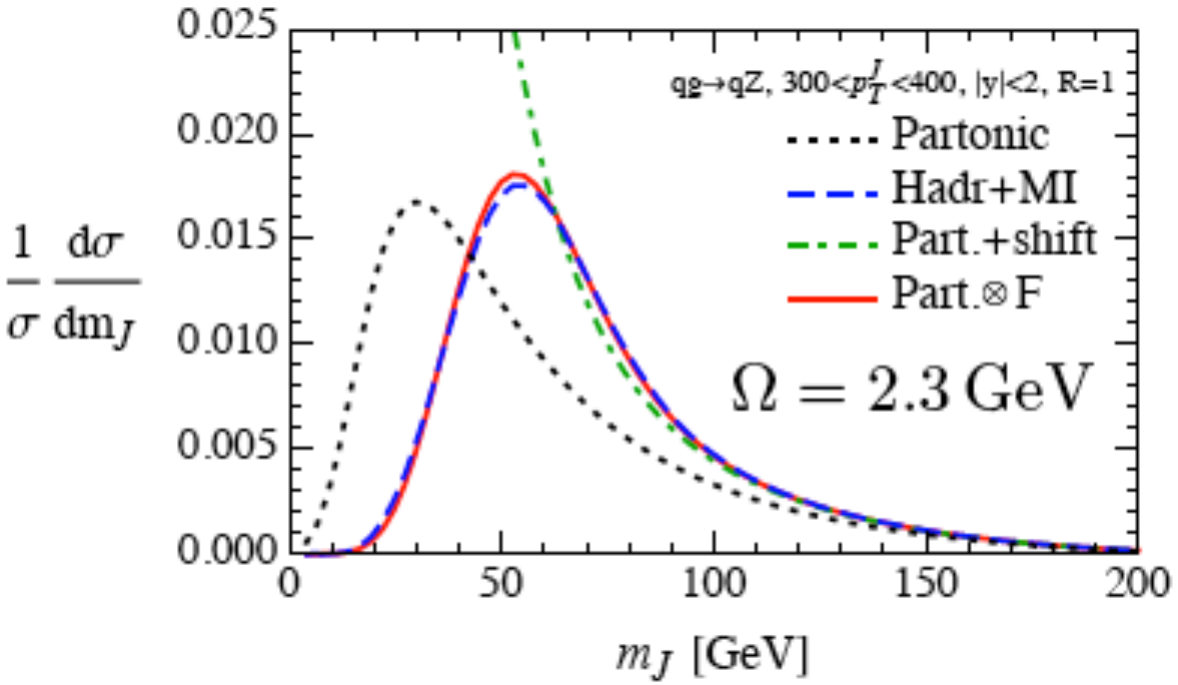
⇒ NLO+PS MCs can be quite sensitive to the tunes



(*) N. van Remortel

Underlying Event through Factorization?

Issues in Soft QCD



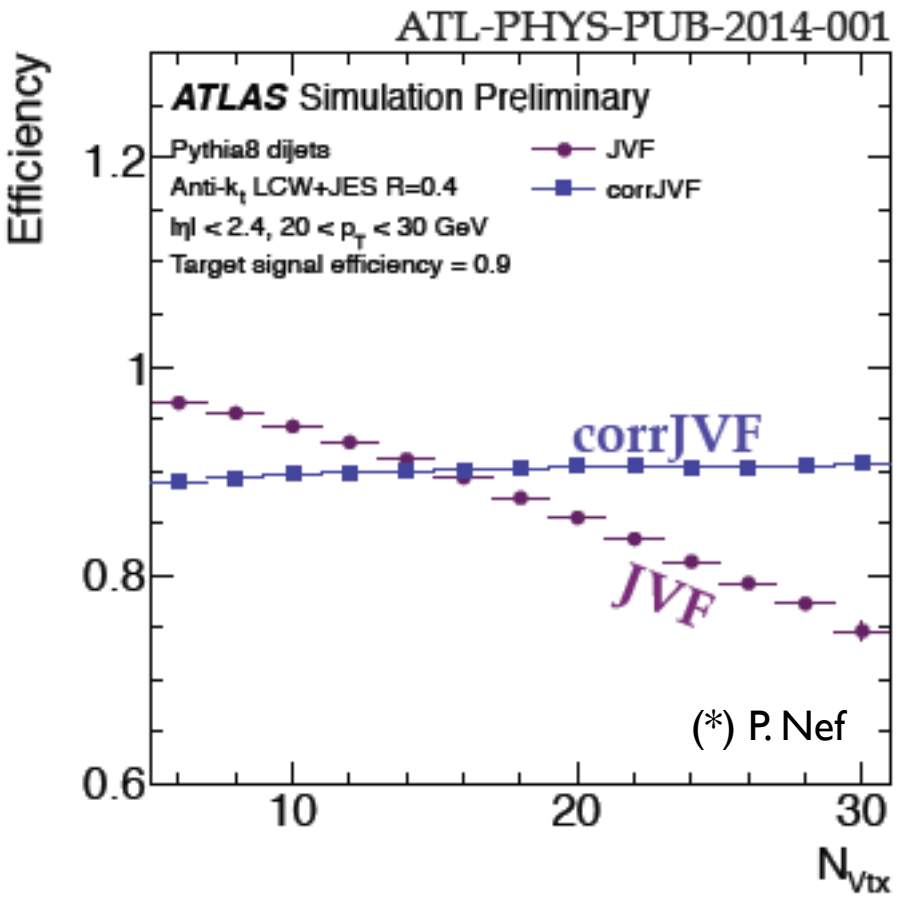
(*) W. Waalewijn

- The underlying event might be described through factorization

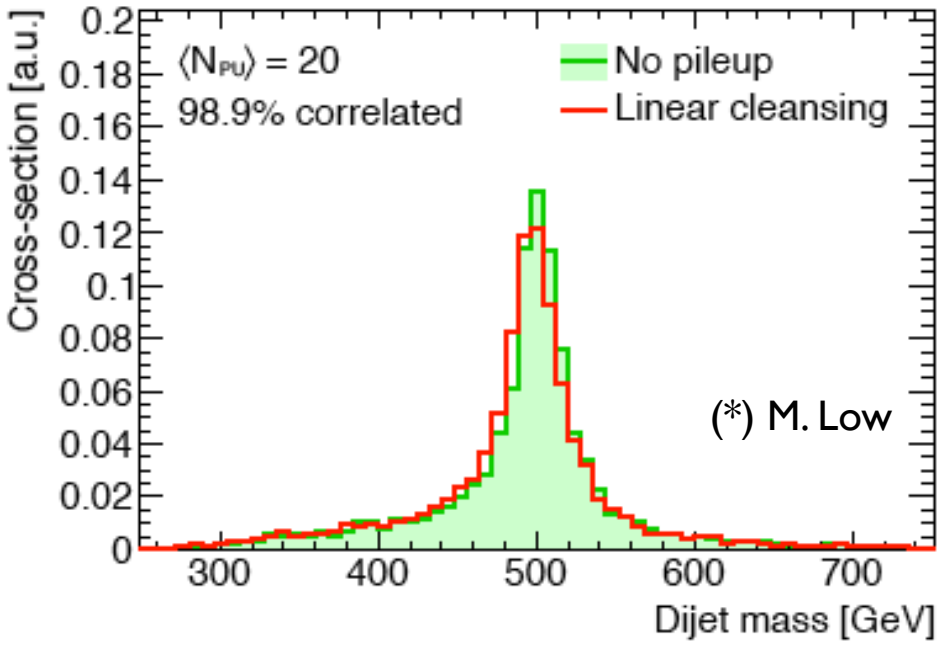
⇒ How different are these predictions to what Pythia provides?

⇒ Are we sensitive to those differences?

Updates on Pile-up



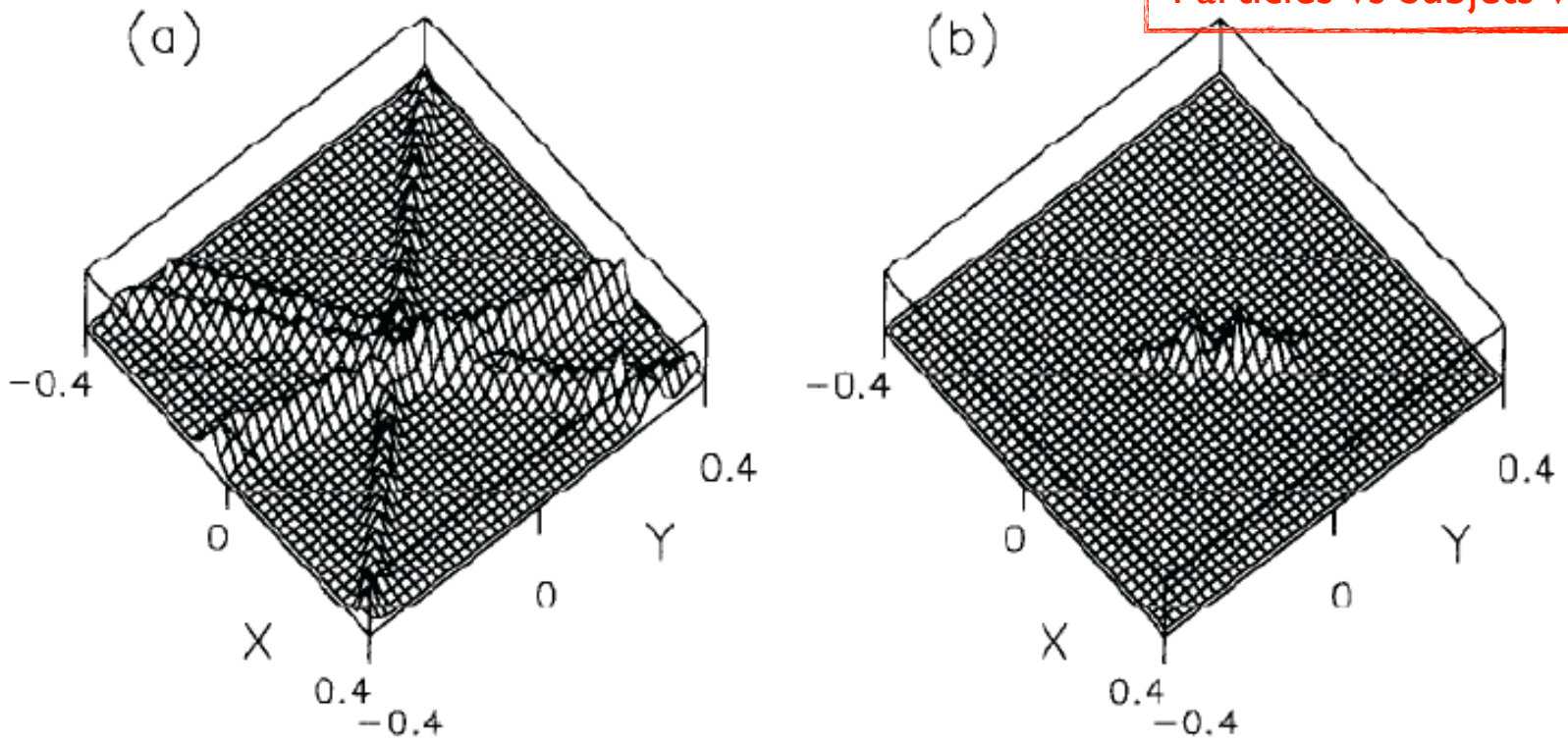
Pile-up Mitigation



- Standard pile-up mitigation depends on amount of pile-up: found fixes for that
- Cleansing already reported at BOOST: first results from ATLAS showing feedback on that

Vertex Substructure?

Particles vs Subjets vs Jets

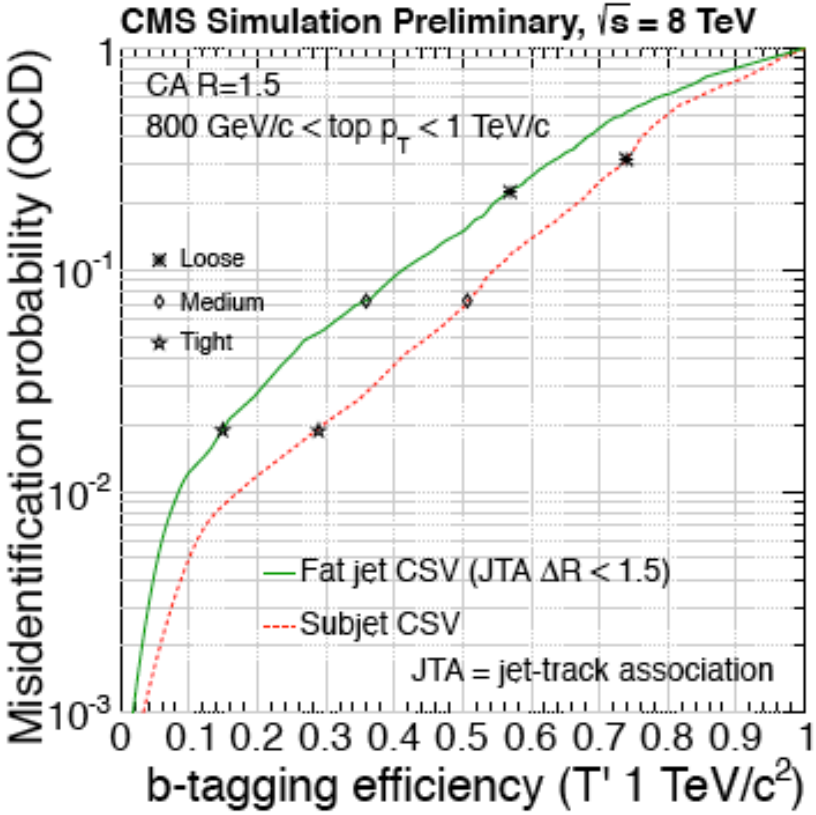


(*) A. Schwartzman

- Nice review of at what level experiments use jets, subjets, particles

⇒ Experiments should be able to be more precise about angular scales for different types of particles

Subjet b-tagging



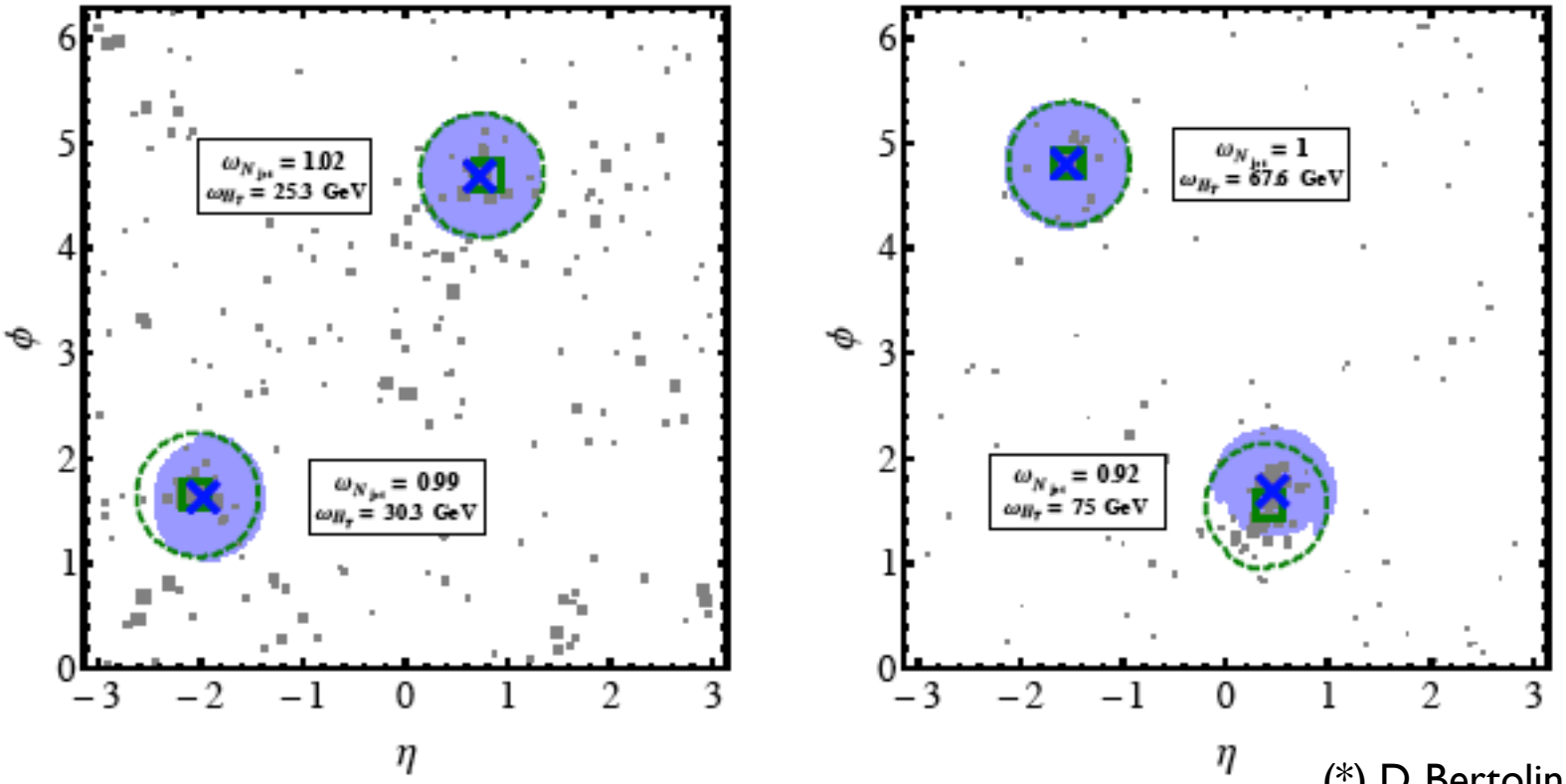
(*) J. Dolen

- Being developed in ATLAS, already calibrated in CMS: subjet b-tagging

⇒ Clearly lots of potential, I hope we can discuss more details in the future

To Jet or Not To Jet

Hammers and Nails



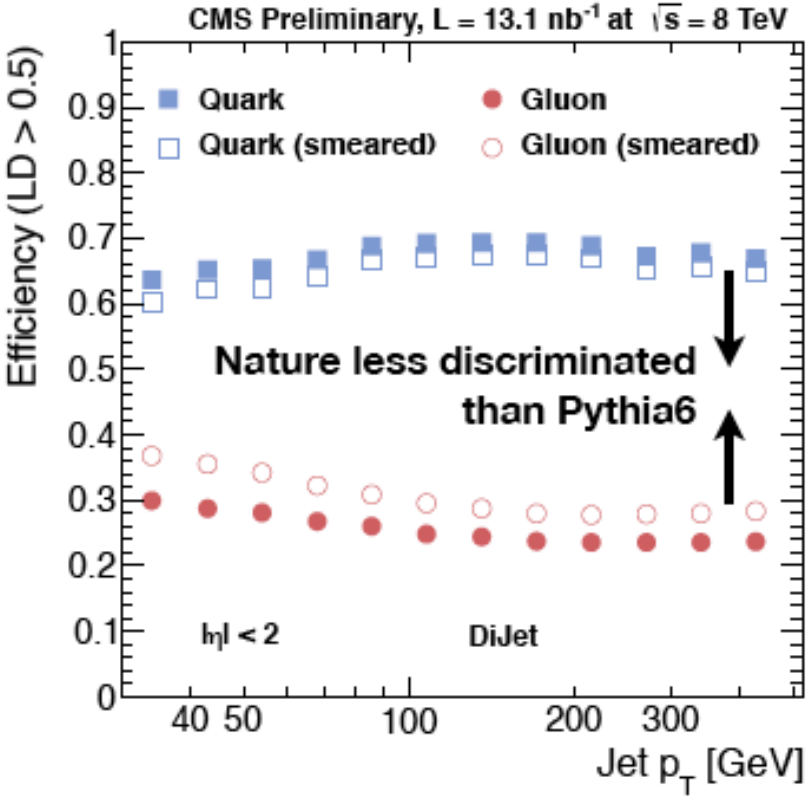
(*) D. Bertolini

- Reconstruction of jet axes might be fast/IR safe alternative to full recombination

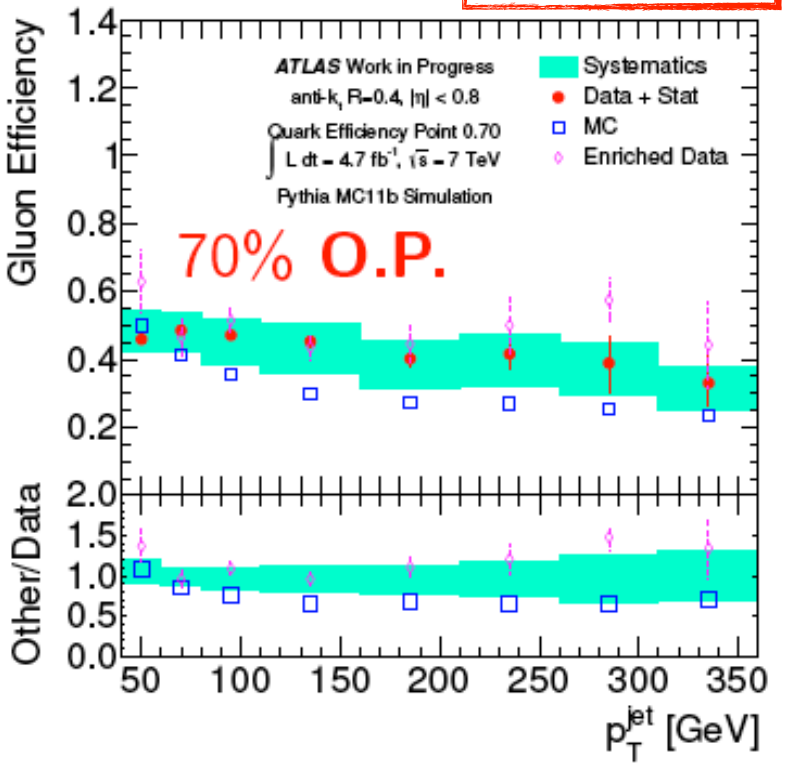
⇒ Already thinking of doing this in the trigger, but need to understand correlations with anti-k_T algorithms

Quark/Gluon Tagging

Several topics



(*) F. Pandolfi



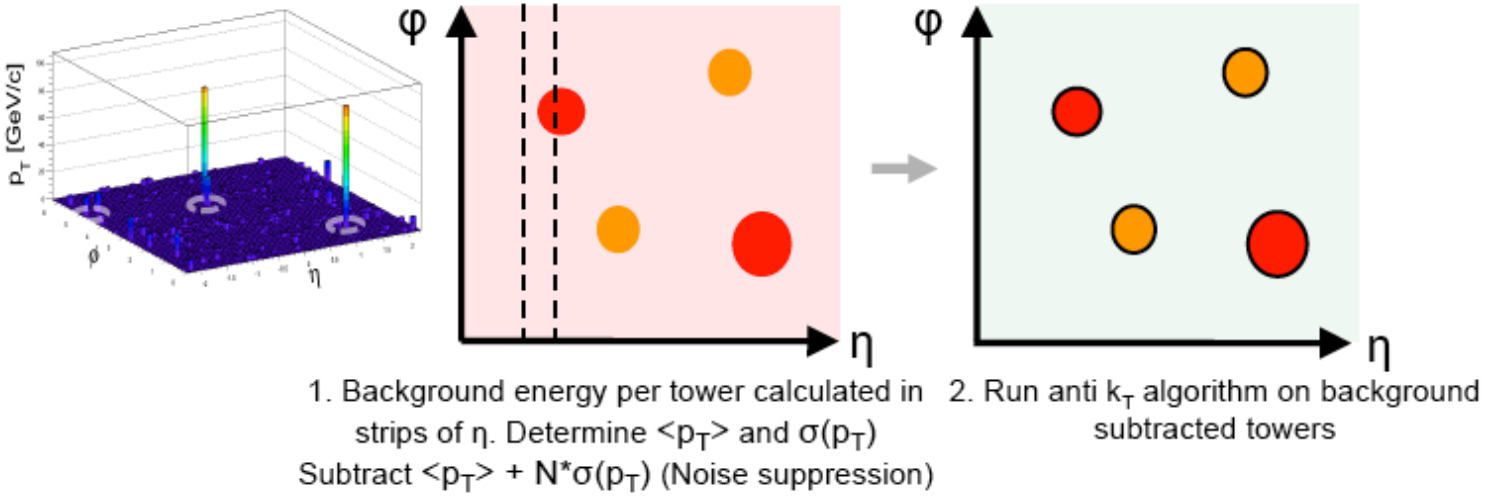
(*) M. Swiatlowski

- Quite different analyses in ATLAS and CMS, but we both agree: gluons look wrong

⇒ Can the theory community use some of the available measurements to understand these, do we need new ones?

Heavy Ion Calibration

Jets in Heavy Ions



1. Background energy per tower calculated in strips of η. Determine $\langle p_T \rangle$ and $\sigma(p_T)$
Subtract $\langle p_T \rangle + N^*\sigma(p_T)$ (Noise suppression)

2. Run anti k_T algorithm on background subtracted towers

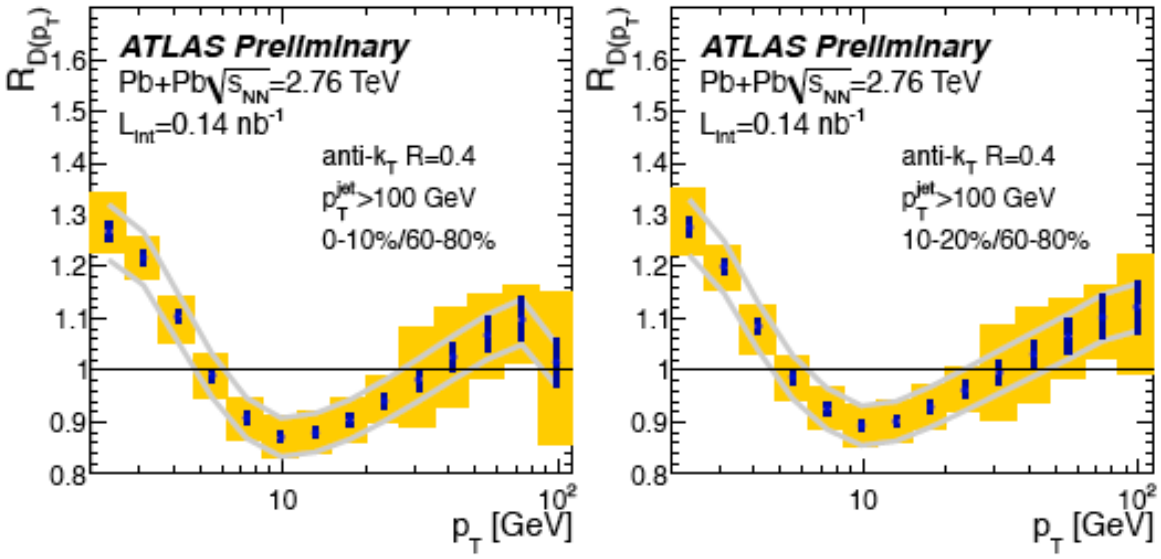
(*) Y.-J. Lee

- We heard a lot of detail about the heavy ion calibration, I learnt quite a few things

⇒ Do we fully understand the interplay between p-p and Pb-Pb calibrations, can we improve?

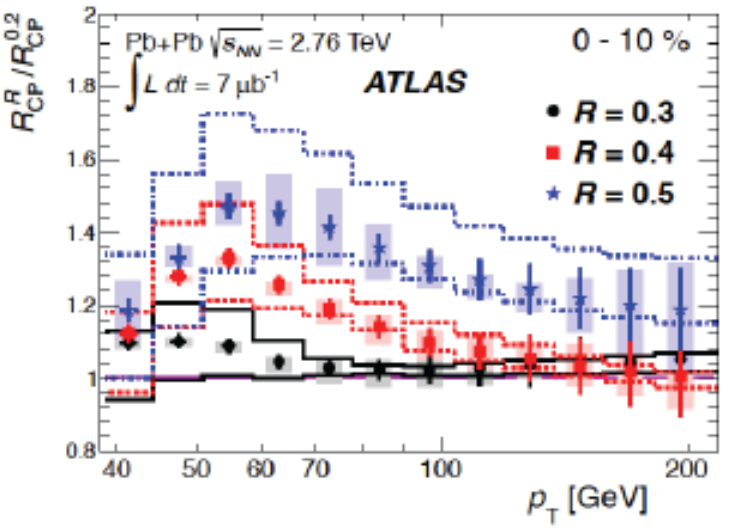
Looking inside jets in Heavy Ions

Jets in Heavy Ions



(*) B. Cole

- Can easily wipe out the Radius dependence of jet observables (also for di-jets)



The medium induced parton shower is not fully dissipated in the medium

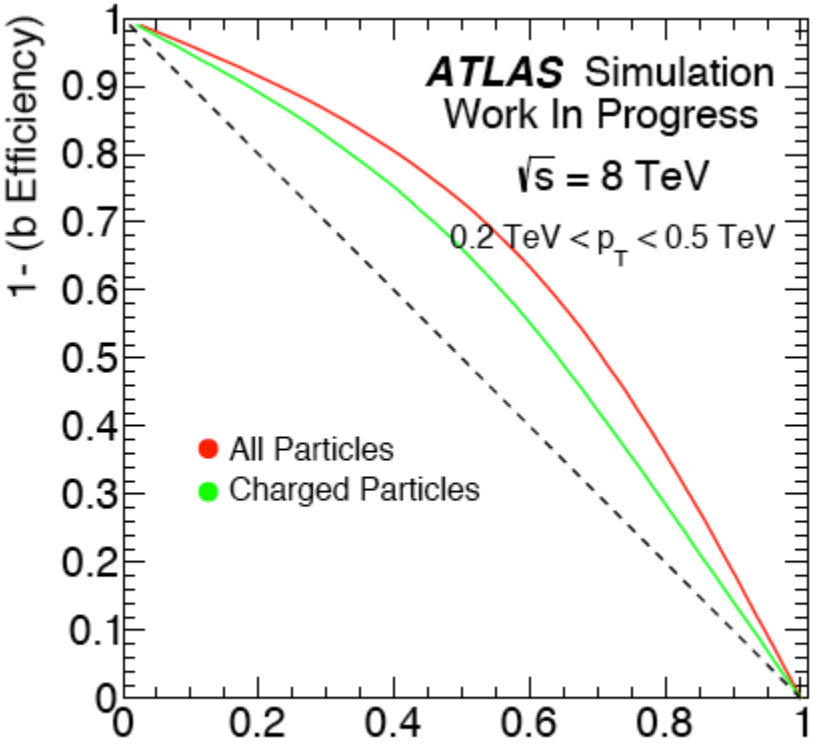
(*) I.Vitev

- Heavy ion community starting to look at differences inside jets

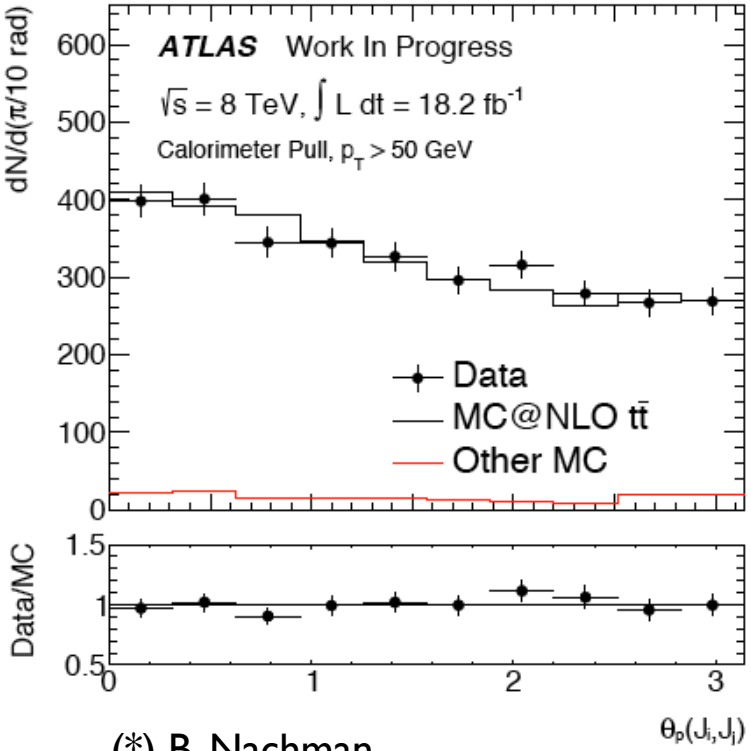
⇒ Can some of the variables that we use in the p-p community help tell the difference between different quenching models?

The Elegance of Jets

And Hammer and Nails



(*) B. Nachman



(*) B. Nachman

- Pull is a sensitive variable for tagging, but also probe the color structure of events

⇒ Other final states where we can probe color structure/reconnections?

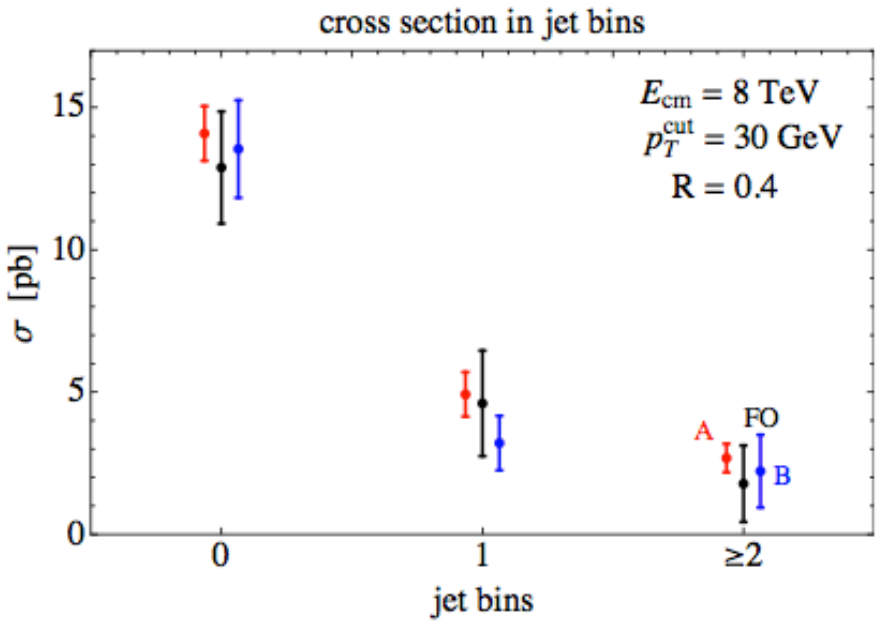
Workshop cross polination

Precision QCD

(*) C. Lee

- dQCD vs SCET, different language, but can be put in a common framework: motivated by a similar workshop to this one, 4 years ago

Theory Errors for Higgs



bin-by-bin uncertainties reduced
by a factor of 2 over FO

Precision QCD

cross section in the WW analysis

$$\sigma_{WW} = \epsilon_0^{acc}\sigma_0 + \epsilon_1^{acc}\sigma_1 + \epsilon_{\geq 2}^{acc}\sigma_{\geq 2}$$

acceptances from analysis cuts
(jet bin cuts, leptonic cuts,
reconstruction efficiencies)

need to determine
the theoretical uncertainty
on this cross section

(*) J.Walsh

- Jet-bin to jet-bin theory correlations

⇒ May be key to reduce theoretical systematic uncertainties in Higgs measurements

Closing Comments

- I had a lot of fun discussing with all of you, I hope you did too
- I had a lot of new ideas of helpful/interesting things to do
- Some people have started putting together wish-lists for their favorite theoretical observables (please circulate)
- Thanks to all of you for your great contributions/comments and lively discussions
- And thanks to my co-organizers for their great work in spite of the weather
- Let the discussion continue...

BACK-UP SLIDES

Wish List

- g->bb (cc) xqq=mqq2/pTg2, z=Eb/(Eb+Ebbar), P(z) z2+(1-z)2, phi*
- Quark/gluon tagging: particle multiplicities
- Charged/neutral ratio (energy or pT)
- Lumpiness/structure of transverse (UE) region (or just N-jettiness, collinear structure)