Some Midpoint jet algorithm studies/thoughts

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General remarks

There are three issues that currently limit the sensitivity of QCD tests involving jet measurements

1. limited knowledge of parton distributions
2. systematic uncertainties related to jet energy calibration
3. limited accuracy of fixed order perturbative calculations due both to incomplete nature of calculations and difficulty of precise matching of jet algorithms at the parton and detector level

- #2 is an experimental problem, #'s 1 and 3 are phenomenological
- One of the goals for #3 is to reduce jet algorithm problem(matching parton level to detector level) to order of 1-2%
  - ambiguous goal since different problems when matching to Herwig or matching to NLO
  - you've all seen n^nth talks on midpoint algorithm, so no need to review on what it is
  - Steve Ellis, Matthias Tonnesmann and I have been continuing to work on understanding of this parton-jet matching

Documentation

- We are currently revising our CDF note (which will also be a stand-alone publication but with a better title)

BUILDING BETTER CONE JET ALGORITHMS

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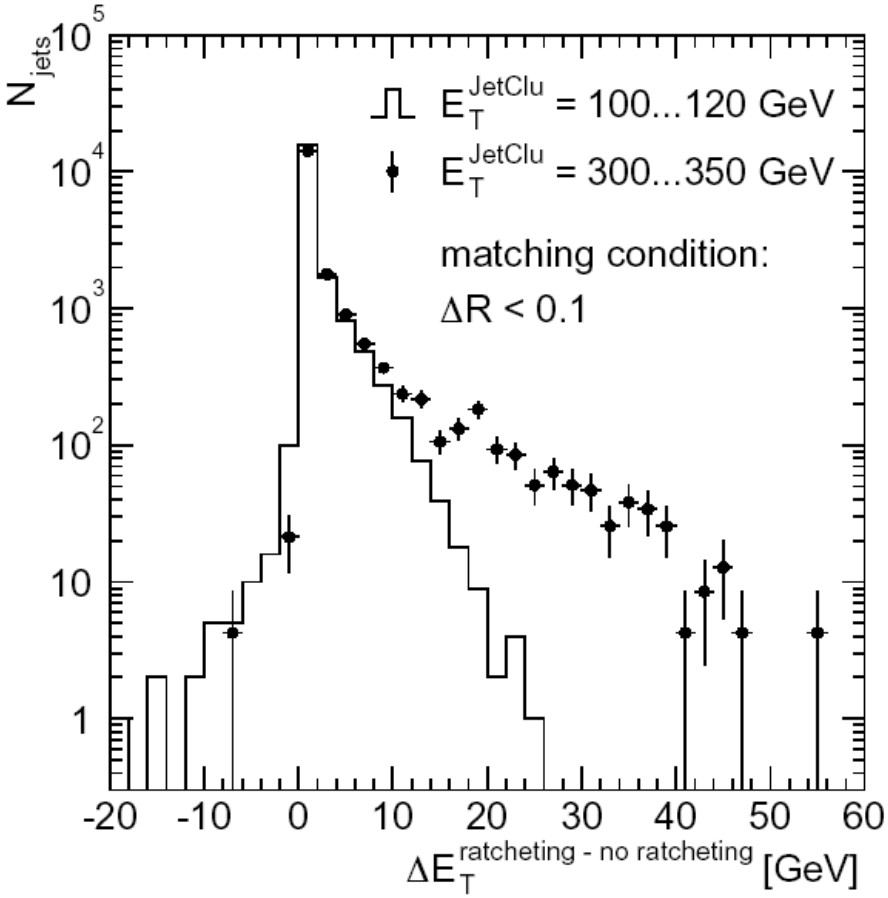
The search for physics beyond the Standard Model is being greatly enhanced by improved theoretical tools and ideas at the same time that vast amounts of new high energy data are becoming availiable. To make the most of this situation it is essential that we simultaneously improve our phenomenological tools, such as jet algorithms, to more reliably bridge the gap between theory and experiment. We present recent results on the development of better cone jet algorithms.

Old problem

- JetClu has ratcheting
  - no seed tower is left behind
  - can not be modelled on a partonic level
  - order of 5% problem in cross section



New problem

- Midpoint does not have ratcheting
  - which is good, except for the black towers, i.e. towers not included in any jet, which is bad, or at least psychologically disturbing

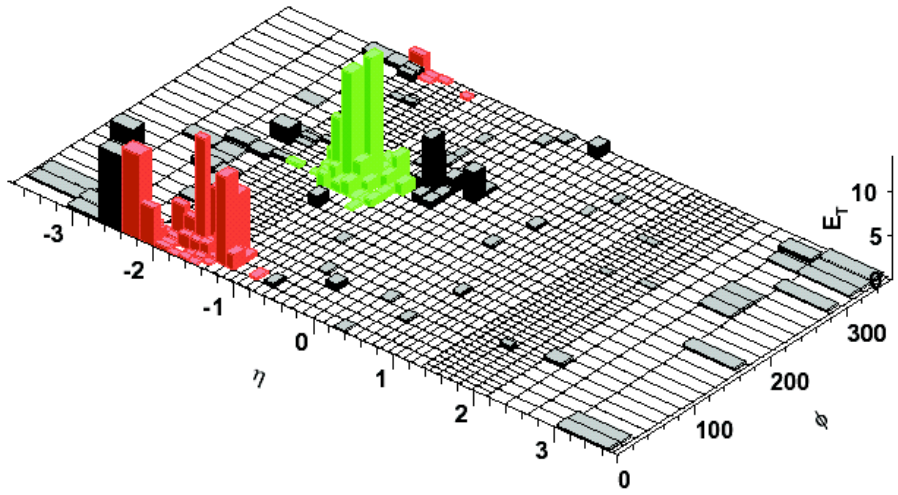


FIG. 9: Result of applying the Midpoint Algorithm to a specific Monte Carlo event in the CDF detecto

Honey, I shrunk the jet cone

The problem is that due to parton showering and hadronization, there is no stable jet solution for a seed tower at the periphery of a larger jet

The minimum in the potential disappears and there's no force in the universe that can bring it back, unless…

…you start the jet cone search with smaller cones so that the potential does not see the influence of far-away energy from the larger jet

then after you have found the jets, expand to full-size

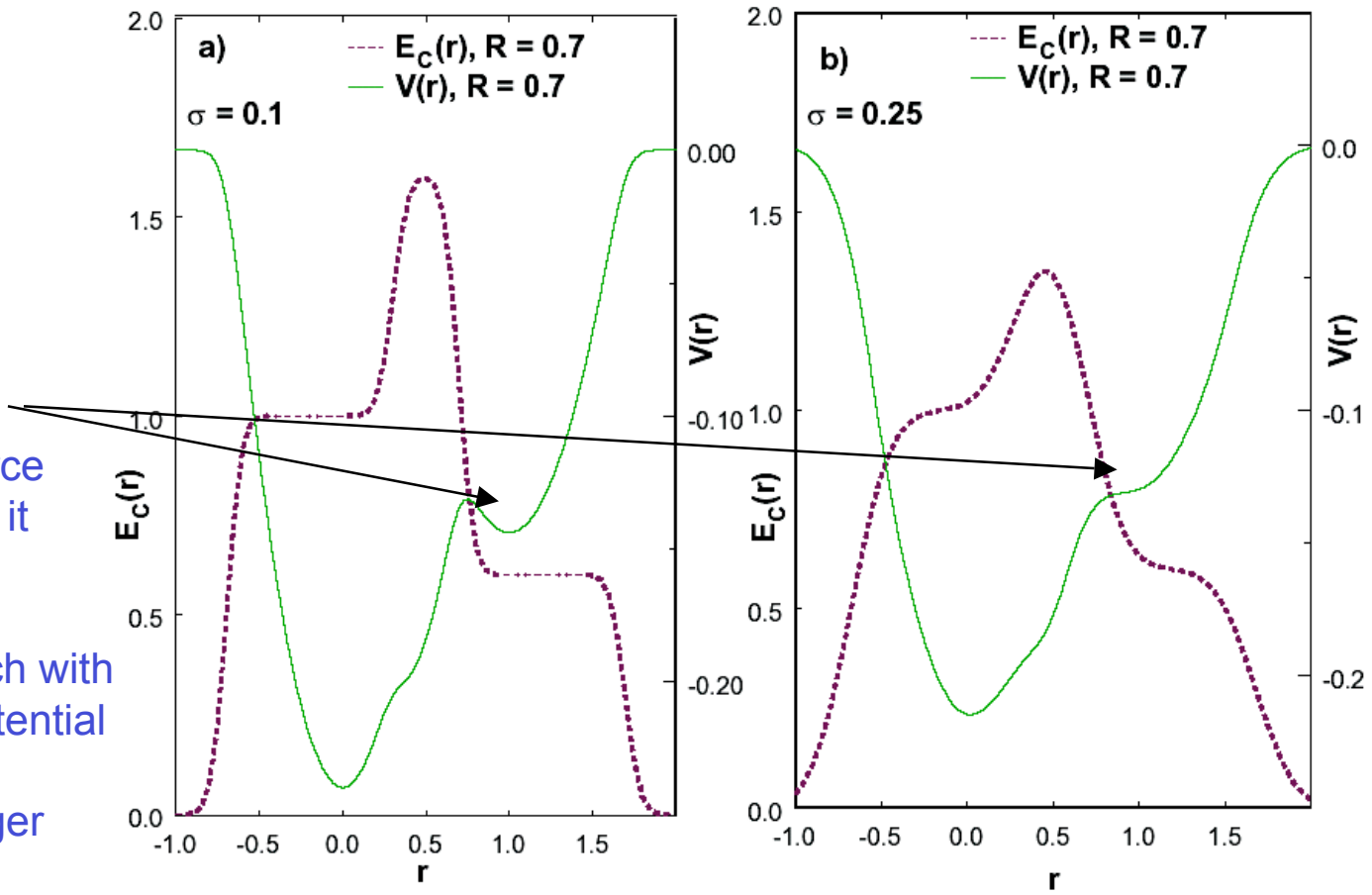
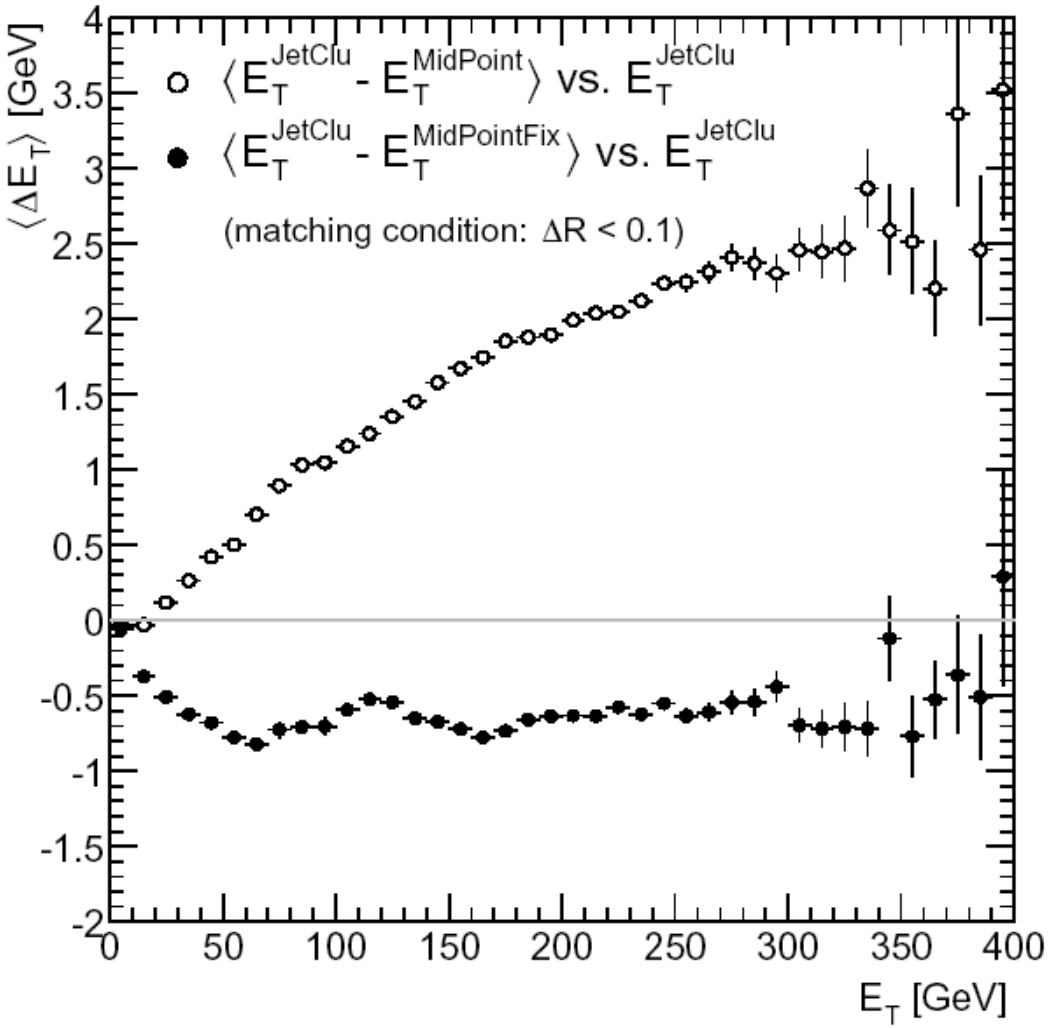


FIG. 5: The distributions $V(r)$ and $E_C(r)$ *with* $d = 1.0$ and $z = 0.6$ for smearing width $\sigma =$ a) 0.1; b) 0.25.

Solution

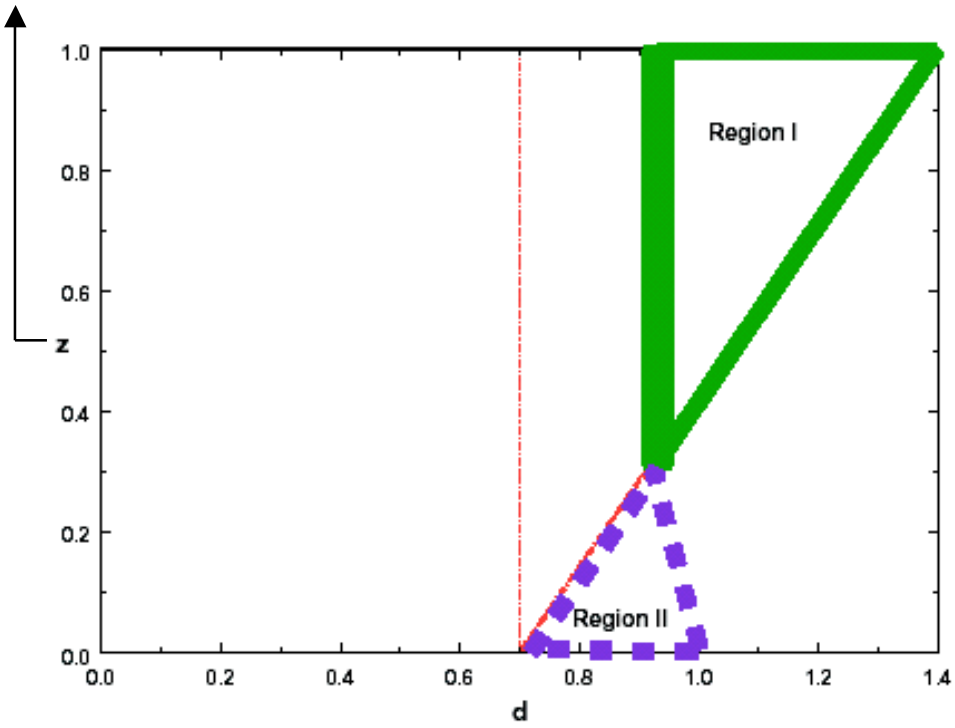
- CDF and D0 have agreed (at our joint jet meeting last December) to use a common initial search cone size of R/2
- The resultant algorithm ends up with more energy than JetClu
  - "am I pleased or alarmed?" *John Belushi Continental Divide*



d vs z plot

- Currently, in NLO PT there can be at most 2 partons in a jet
- In region II, where the 2nd parton is much smaller than the first, JetClu combines the 2nd parton with the first to make a higher energy jet
  - disturbing
- The original midpoint algorithm would ignore the energy of the 2nd parton and would only find one jet with the energy of the first parton
  - disturbing, but PT in most cases splits the 2 partons into 2 jets
- The fixed midpoint algorithm would suck up even more energy into the first jet

$z=E_{parton1}/E_{parton2}$



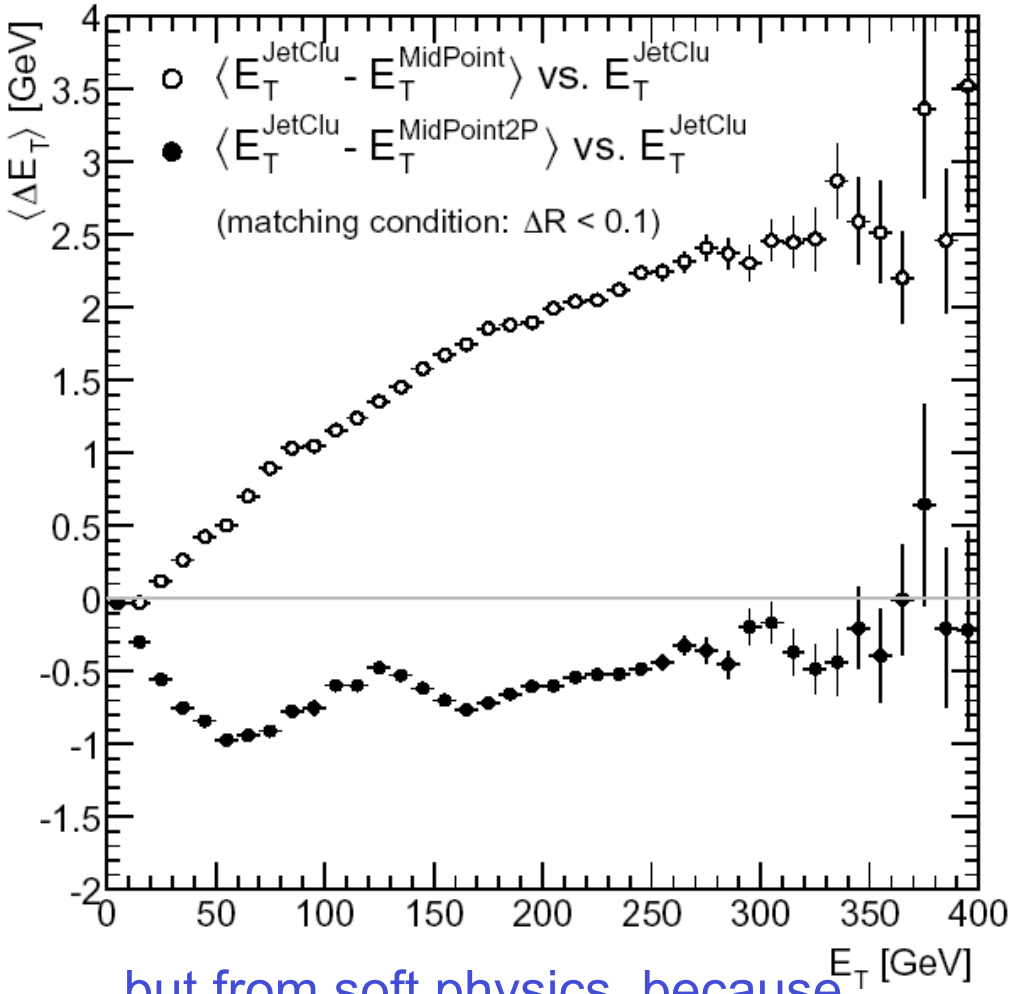
parton separation □R

- is this a mis-match with pert theory then? Do we care?

WWPTD?

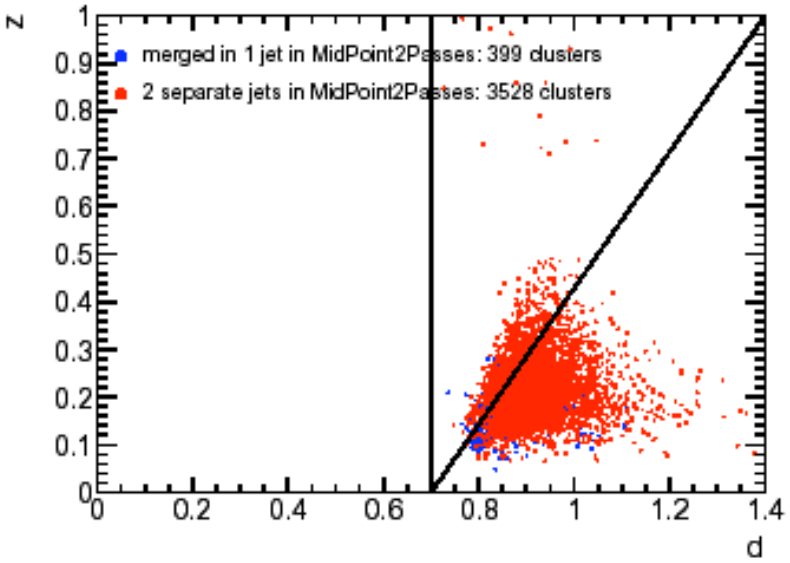
- It's ok for the fixed mid-point jet to have more energy than JetClu if that energy is honestly earned
  - from hadronization effects for example,which PT does not know about
  - but not from hard gluon radiation which PT does know about
- One possibility is to use 2 passes in the jet algorithm
  - in the first pass, the jet cones are established
  - in the second pass, the original jet cone towers are zeroed out and second pass jets are searched for
  - then everybody is brought together for splitting and merging
  - and they live happily ever after

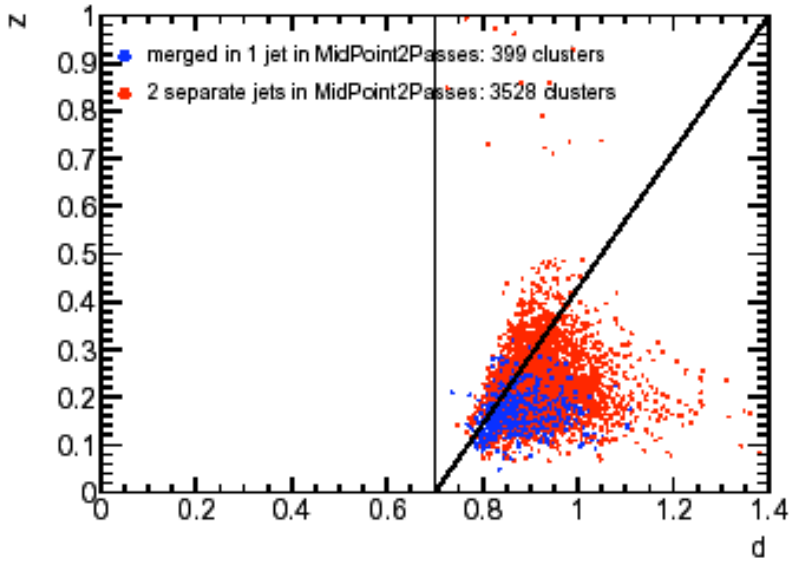
still more energy than JetClu

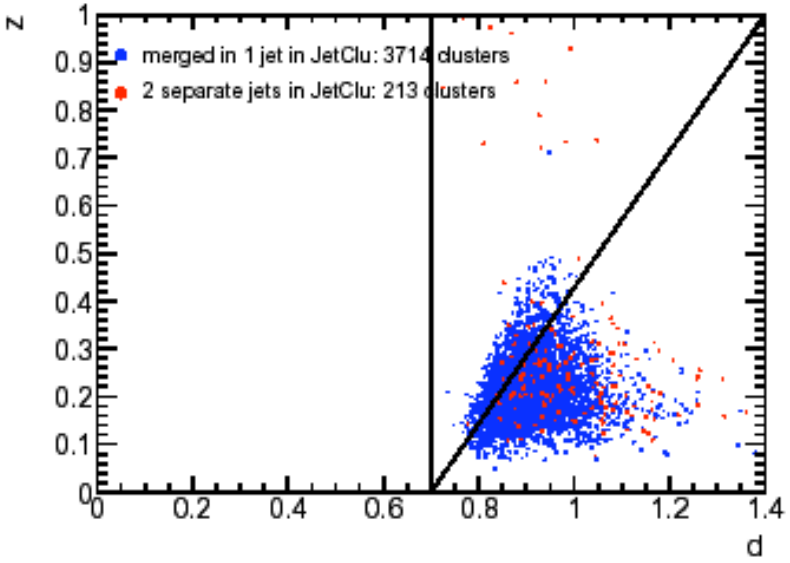


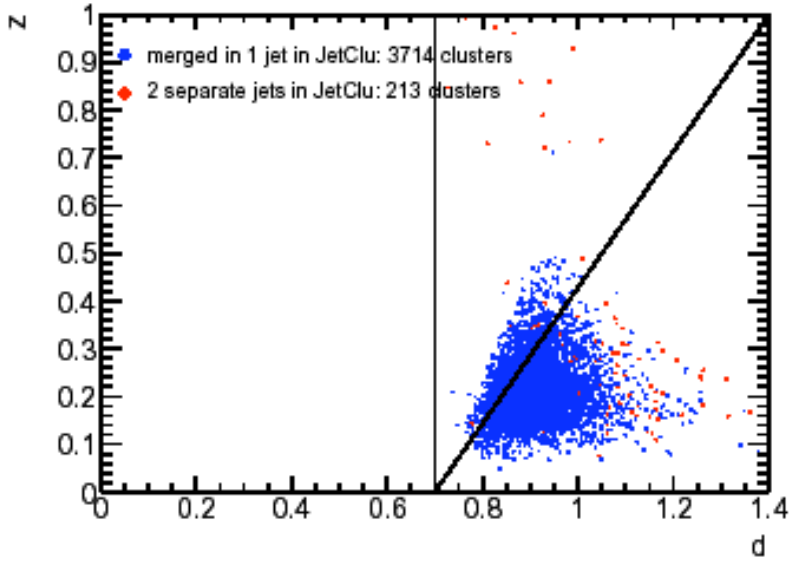
but from soft physics, because

More 2nd jets found in 2 pass Midpoint than in JetClu

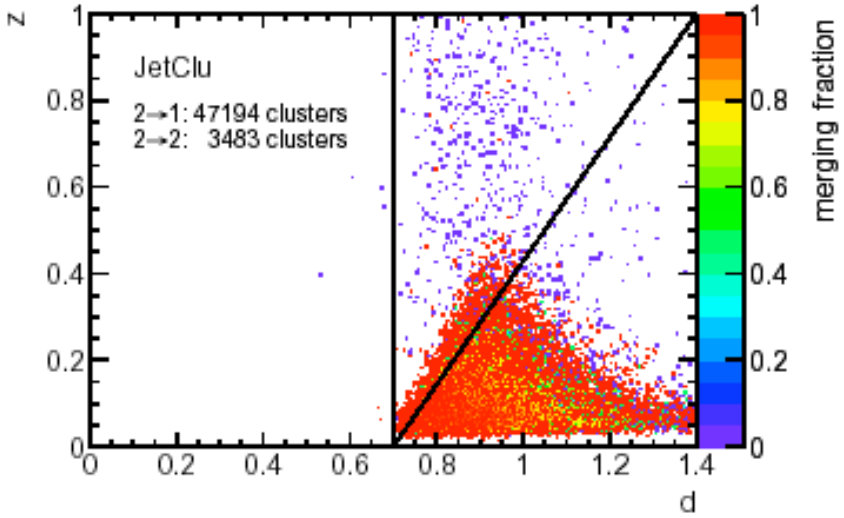


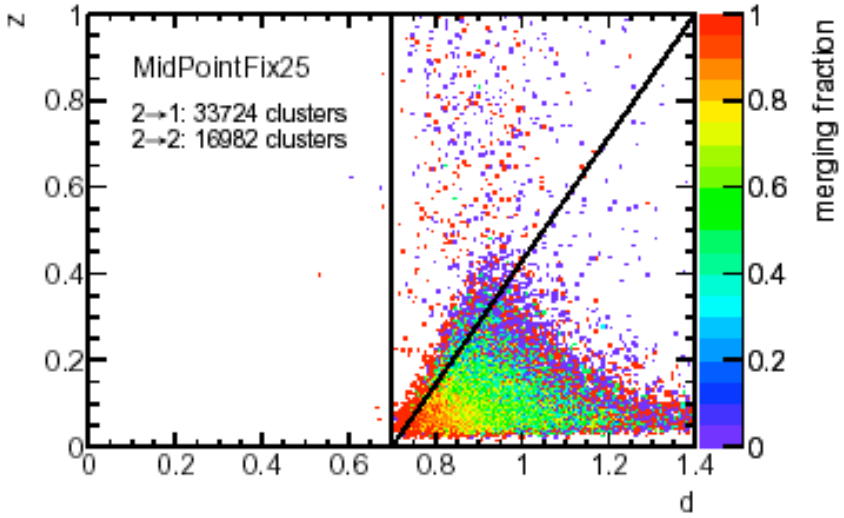


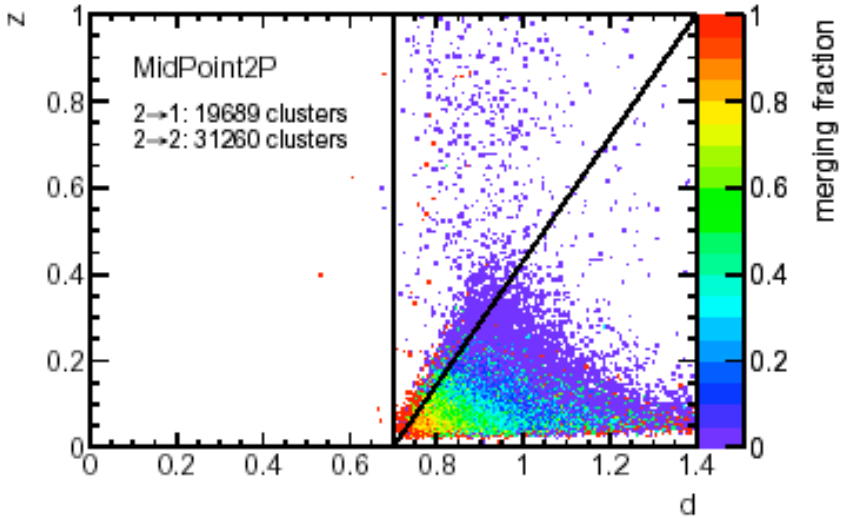




1 jet, 2 jet info in d,z space







Plot from Matthias last night so still digesting it
have to understand why MidpointFix and Midpoint2P have more energy than JetClu when JetClu does more merging

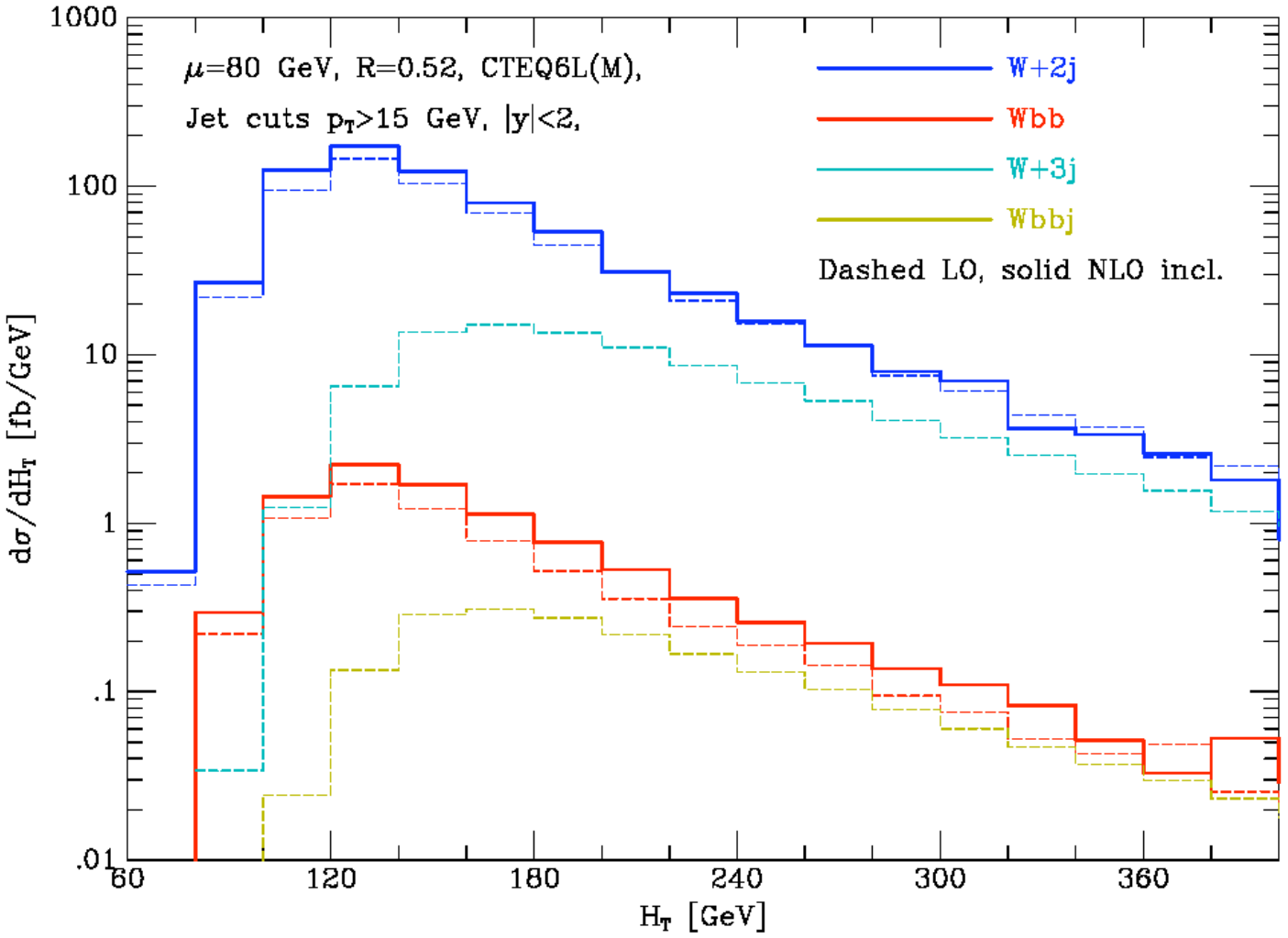
Conclusions

- Still trying to think this through and make recommendations
- And waiting for Matthias to finish his f****** thesis

Coming Attractions

I'll be giving a talk at the lepton+jets meeting next week updating my study with John Campbell of W(bb)+jets at NLO

For example, to the right are the HT distributions at LO and NLO



Wbb and Wjj slopes not the same at NLO