For better jet clustering

Masakazu Kurata

01/20/2017

Status

- Trying to establish better jet clustering algorithm
- Link particles to each color singlet state from which they coming using MCTruth
- Check some variables using that information

METHOD

- NN: parameters are changed track by track
  - Do not(cannot) consider a correlation of parameters
- So, change all the parameters at once

- Jade distance measure brings some changes

  →jet mass is sensitive to form jets?
- So, define an objective function:

  $L = \sum_i m(jet)_i^2 = \sum_{i,j,k} w_{ij} w_{ik} (E_j E_k - \overrightarrow{p_j} \cdot \overrightarrow{p_k})$

  constraints: $0 \leq w_{ij} \leq 1, \sum_i w_{ij} = 1$

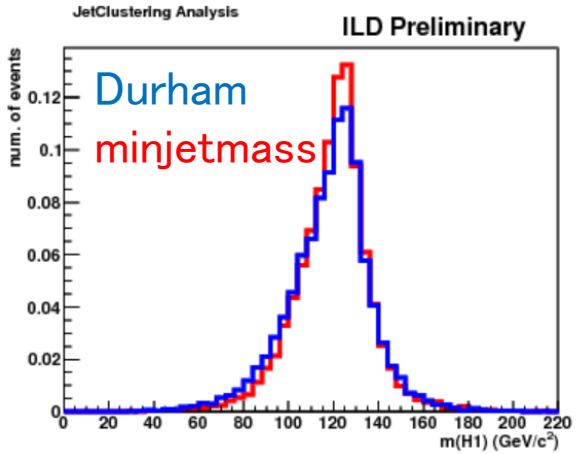
  i: jet number, j,k: track number

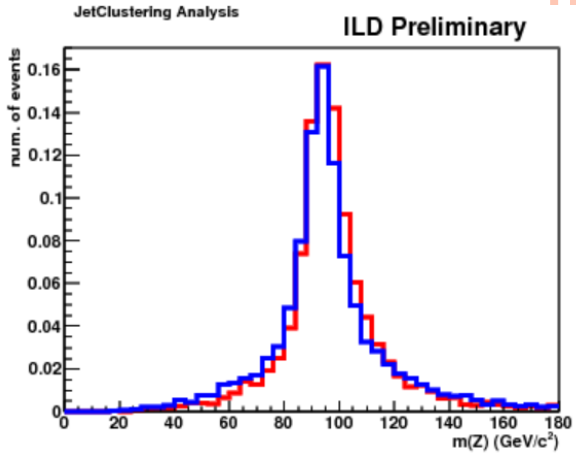
  minimize L under the constraints

- This can be realized using same way as kinematic fit
  - Need Lagrange multipliers method
  - Need first and second derivatives of parameter wij
  - Jacobian matrix is sparse, so not difficult to solve
- Just O(10) iteration is necessary(NN: O(1000) iteration)
  - Can obtain result in less CPUtime

Preliminary Results

- Using qqhh→qq(bb)(bb): 6 jet clustering
  - Use same event as original Durham clustering
  - Jet matching with MC truth is performed($\cos\theta$ >0.9 for all the b jets)
  - v01-17-10
  - Mass distribution:

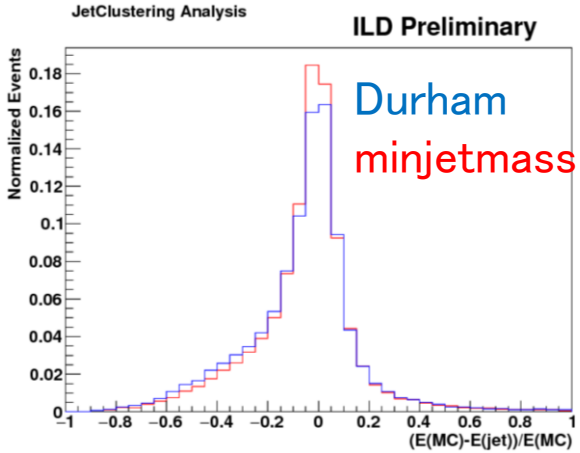




  - Num. of MC matched events:
    - ～2% more events are matched

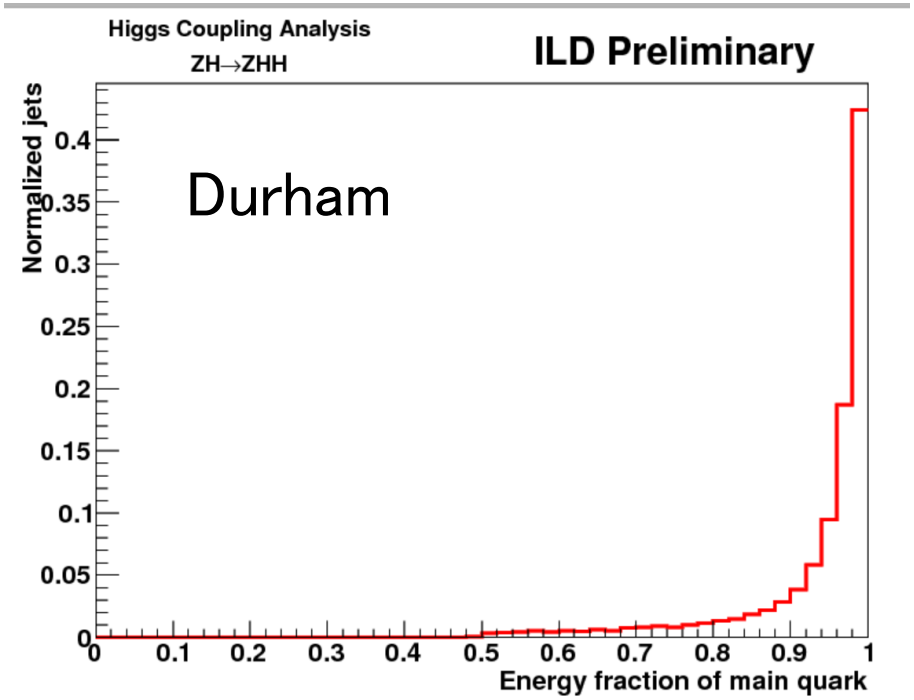
Method	Durham	minjetmass
Num. of events	7004	7112

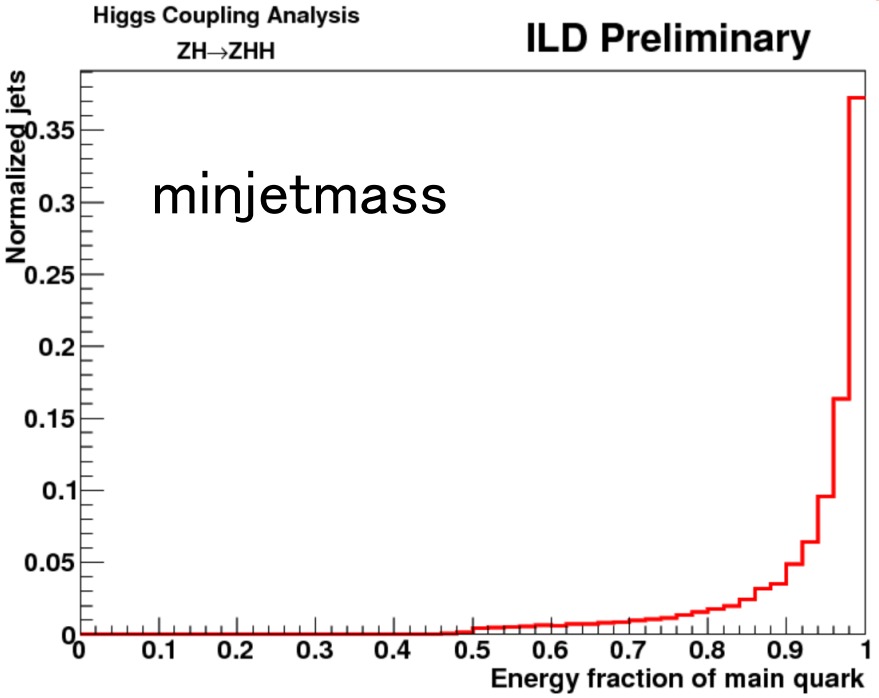
  - Jet Energy Resolution of bjets
    - Better JER



CHECK ENERGY FRACTION OF COLOR SINGLET STATE

- Check the energy fraction of color singlet state which contributes mainly
  - 3 independent color singlet states(Z, H1, and H2)



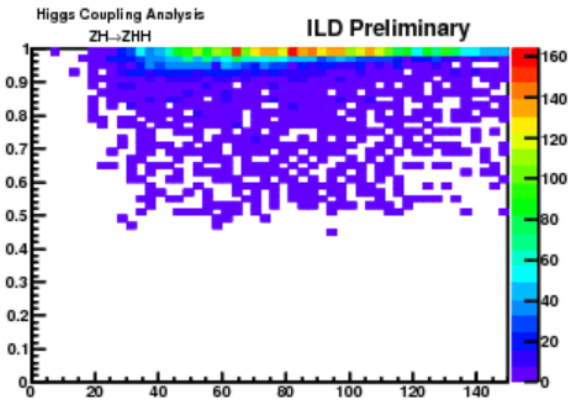


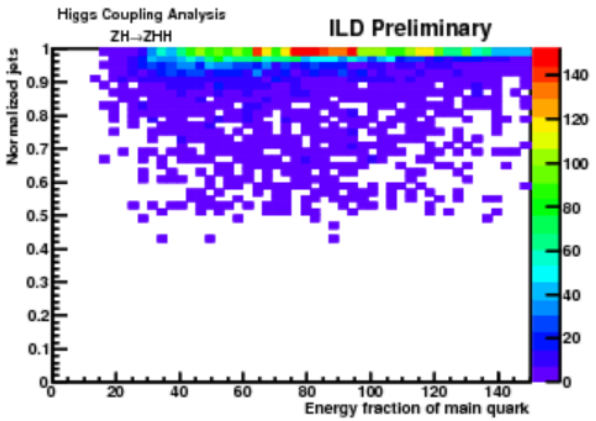
- Energy fraction is worse than Durham…

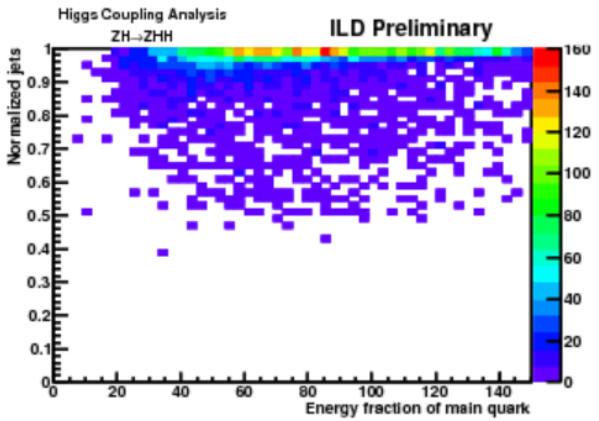
Check energy fraction of each jet

- Energy dependence of each jet(Durham)
  - 6 jet clustering
  - Ordering jets in energy descending order

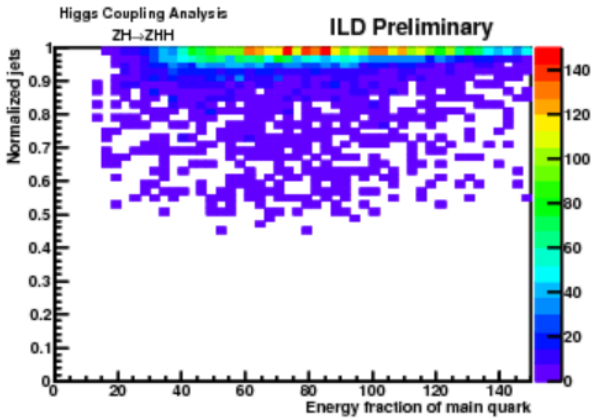
Energy fraction of main color singlet

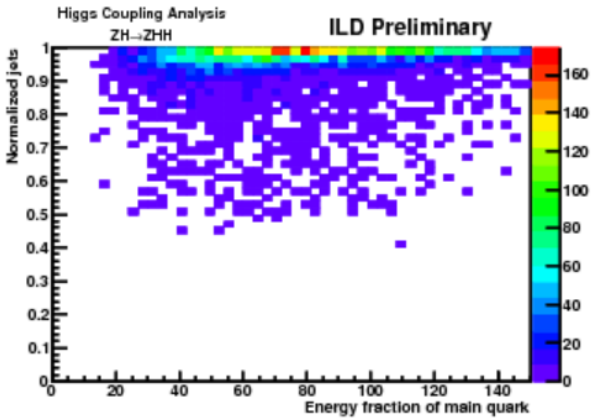


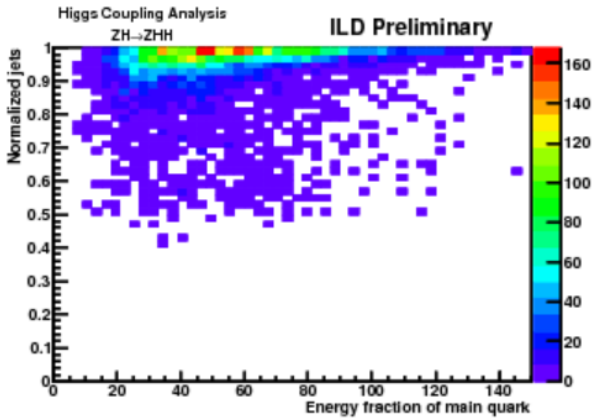




Jet energy

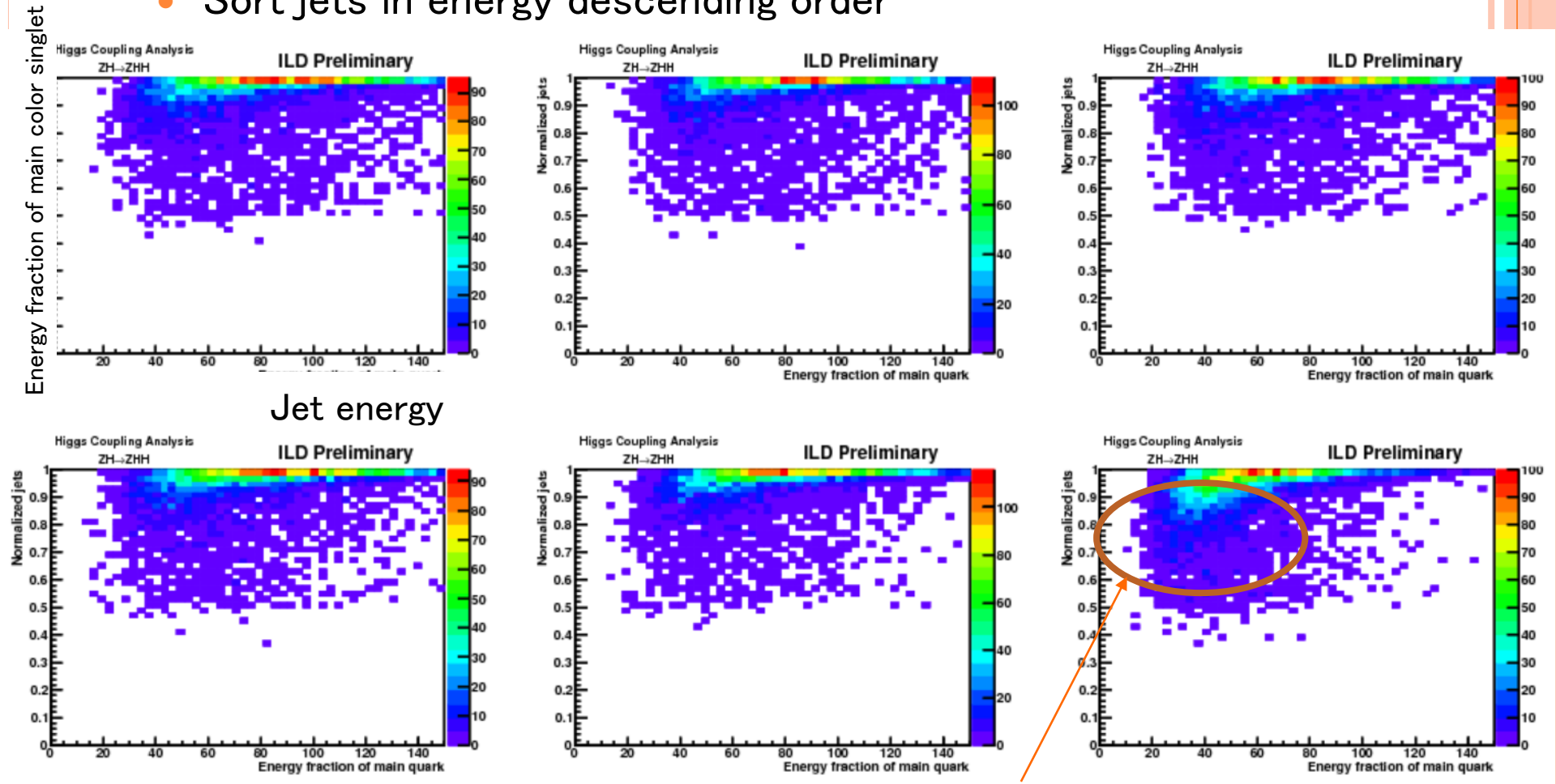






Check energy fraction of each jet

- Energy dependence of each jet (minjetmass)
  - 6 jet clustering
  - Sort jets in energy descending order



Summary

- Minjetmass jet clustering has some improvement in:
  - Higgs mass resolution
  - Jet energy resolution of bjets
  - Well-reconstructed events

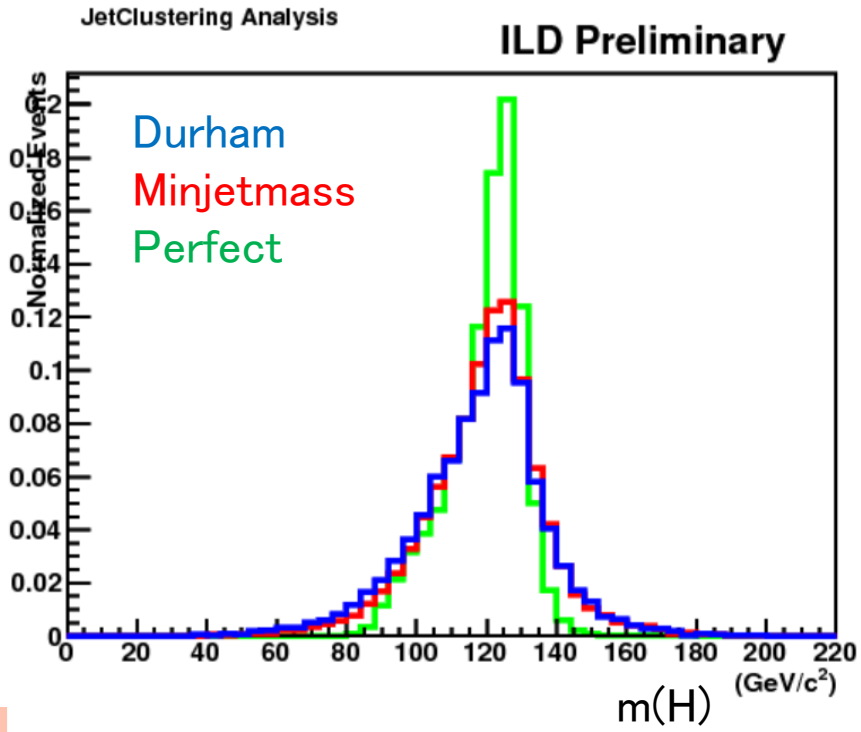
- But, composition of each jet is not going better…
  - Especially, composition of low energy jet is going bad

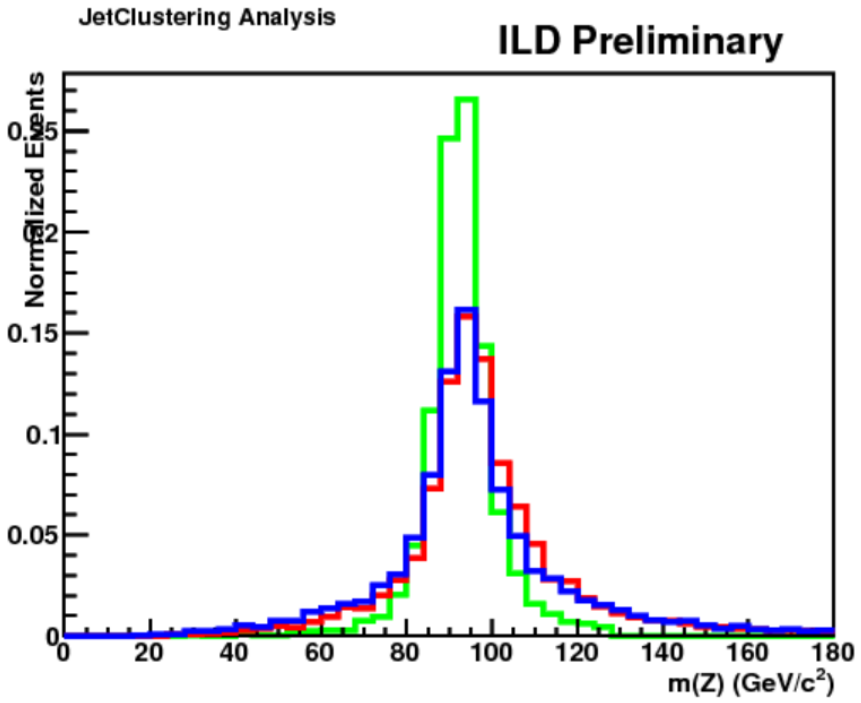
- And, finally,

Mass distribution

- Improvement is far from enough!!

- Prospect
  - We can obtain “answer” for each particle → can we have some hint??





BACKUPS

Realistic situation

- In realistic analysis, how is the situation changed?
  - Compare between NN and orig. Durham result
  - Using same qqHH sample, 6 jet clustering
  - Btag>0.3 is imposed for 4 bjet candidates in a event
  - Higgs masses are reconstructed using χ^2 mass constraint
- Compare the remained event
  - @ χ^2<5.0, ～10% signal event is increased
  - @ χ^2<5.0, ZZH event contamination is ～2%
- Going good direction, but of course, not enough

qqHH	Btag>0.30	Chi2<5.0	Chi2<10.0	Chi2<15.0
NN	6721	4217	5422	5935
Org. Durham	6771	3833	5079	5681
ZZH	**Btag>0.30**	**Chi2<5.0**	**Chi2<10.0**	**Chi2<15.0**
NN	3311	966	1791	2302
Org. Durham	3343	936	1836	2328

- First of all, events are limited by flavor tagging
  - So far, trained with Durham(default)