Higgs self-coupling analysis with H→WW*

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Components for better results

- Physics results are saturated within present analysis framework
- Basic components for better sensitivity:
  - Lepton ID: Isolated leptons can be identified well, and very good fake suppression

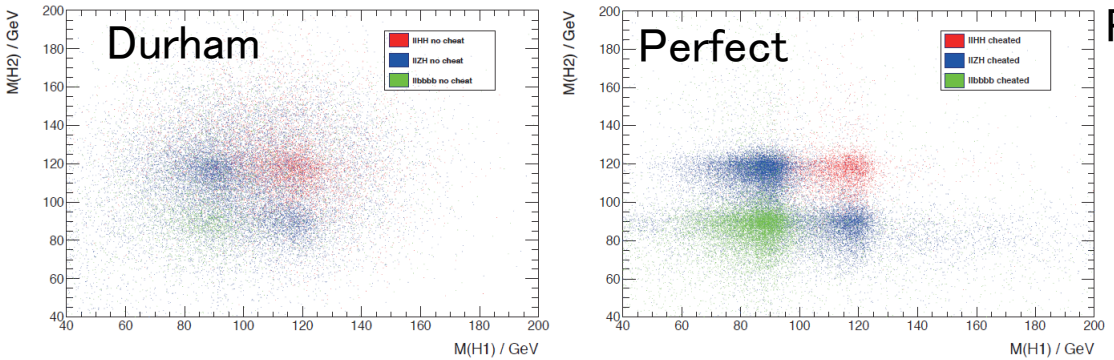
    →many idea have been introduced
  - B-tagging: better b-tagging algorithm provides better background suppression
  - Jet pairing: good jet pairing can obtain good kinematic variables, which leads to good background suppression
  - Good energy & momentum resolution: of course, but limited by the detector performance

    →particle ID will be the key to energy correction
  - Jet clustering: jet reconstruction is the key to the analysis, but it is difficult
  - Good background rejection: of course main theme in analyses
- All the components are related each other

JET CLUSTERING

- Jet reconstruction is the key to obtain better physics variables
- Impact of better jet clustering is very large
  - e.g.) Higgs self-coupling

    ～40% improvement of the sensitivity if jet clustering is perfect

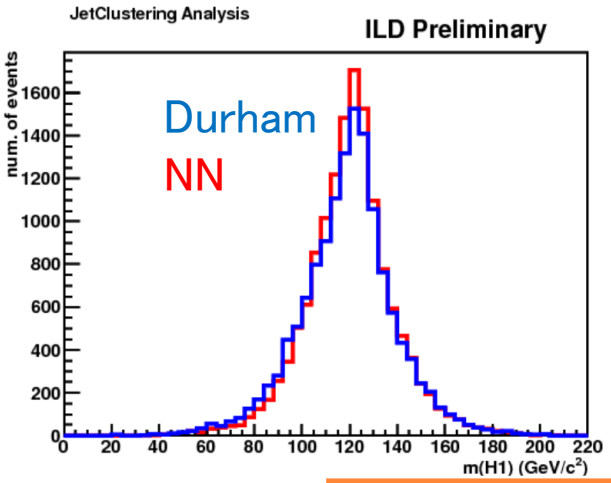


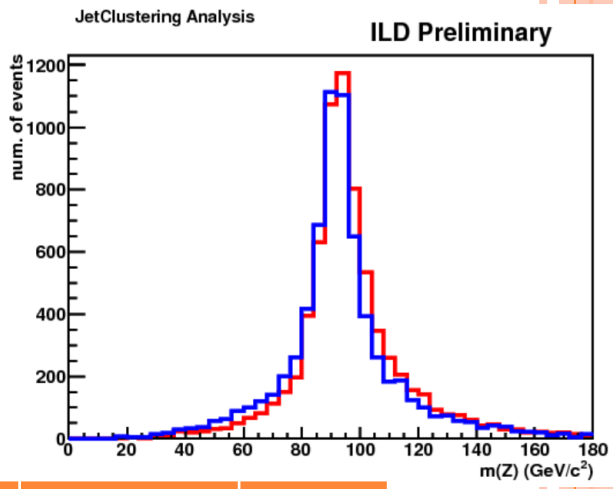
Ref. Junping's study on TDR

- So, tackling better jet clustering in multi-jet situation is very important
- But, cause of mis-clustering is very complicated
- So far, trying for better jet clustering using Neural Network

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)
  - Mass distribution:

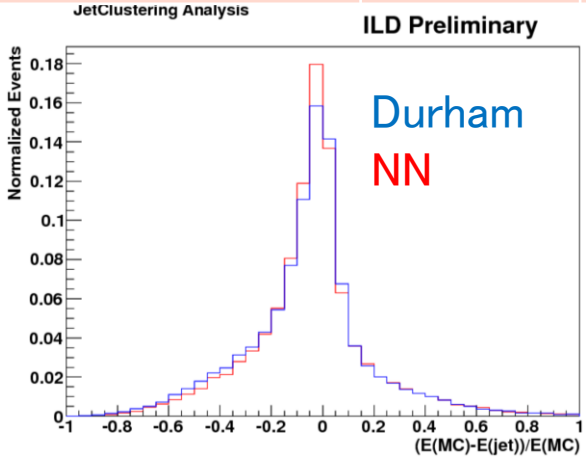




  - Num. of MC matched events:
    - ～4% more events are matched

Method	Durham	NN
Num. of events	6993	7170

  - Jet Energy Resolution of bjets
    - Better JER

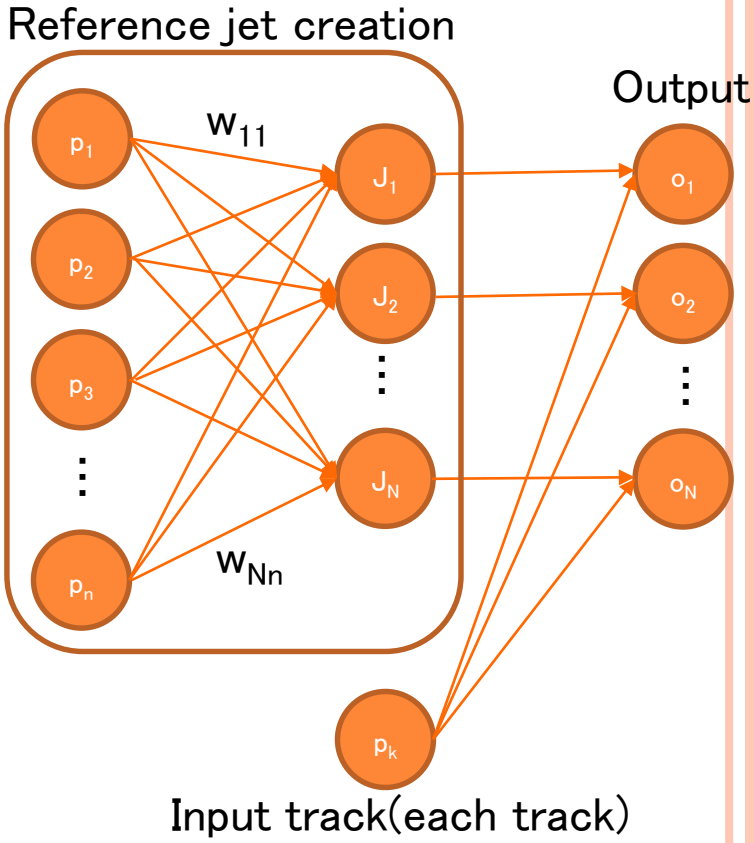


PROBLEMS

- Everything is going to good direction, but the improvement is not enough
  - Need more good idea
  - Need to investigate inside jets and catch some hints
- Neural network training is not perfect
  - Result is robust when shifting far from default…
- Same as the usual neural network, CPUtime for training is relatively large
  - When num. of tacks is large, need more CPUtime
- We need to try everything for better jet clustering
  - Of course, it is very difficult

BACKUPS

Network architecture



- Create reference jets:
  - $J_j = \sum w_{jk} p_k, 0 \leq w_{jk} \leq 1$
  - p_k: track 4-momentum in an event
  - J_j: (reference) jet 4-momentum
  - Default: Durham clustering result
- Introducing the objective function for jet clustering:

$$L = \sum_j^N \sum_i^n h_j d(p_i, J_j)^2$$

h_j: $1\ if\ d(p_i, J_j)^2\ is\ smallest, 0\ if\ other$ – NN output

- Network training: adjust w_{jk} to minimize L
- Learning Method: Back Propagation(usual way for Neural Network)
  - Basic idea can be seen everywhere
- $d(p_i, J_j)^2$: take Jade distance measure $d_{ij}^2 = \frac{2E_i E_j (1-\cos\theta_{ij})}{E_{vis}^2}$

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)