



九州大学
KYUSHU UNIVERSITY



HIGGS SELF COUPLING ANALYSIS USING THE EVENTS CONTAINING $H \rightarrow WW^*$ DECAY

Masakazu Kurata, Tomohiko Tanabe
The University of Tokyo
Junping Tian, Keisuke Fujii
KEK
Taikan Suehara
Kyushu University

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BUT... THE TALK IS

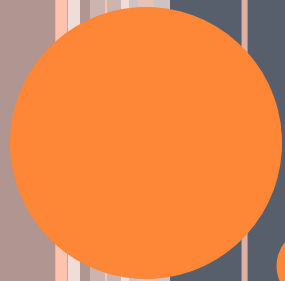
**TRYING TO STUDY THE TRACK PROPERTY
& STATUS OF SOME IDEA FOR THE
IMPROVEMENT**

Masakazu Kurata

01/18/2014

FOR BETTER ANALYSIS AND RESULT

- So far, all the analyses are going on extensively
 - Using all the variables which can be obtained within the present framework as many as possible
 - So, the analyses results are saturated within the uncertainty of the variables(e.g. energy resolution, momentum resolution, etc)
 - Also, analysis technique is limited due to the variables obtained
- Need to explore details of the track properties
 - There is room to get some fundamental variables for particle ID
 - Using them gives the improvement for the analysis?
 - Especially, lepton ID improvement – It must be!
 - Good for jet clustering, b-tagging, etc. ?
- Introducing some idea is also necessary
 - Going to MVA technique
 - Lepton ID
 - Of course for background rejection
 - Other idea?



SHOWER PROFILE STUDY

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SHOWER PROFILE EXTRACTION

- **Very basic idea to characterize a shower profile:**

- Variables:

- **Shower max(longitudinal)**
- Expected shower max when the track is electron
- Absorption length(transverse)

電磁シャワー

- ❖ Critical Energy E_c (bremsstrahlungと dE/dx によるエネルギー損失が等しくなるエネルギー) になるまでシャワーが続く

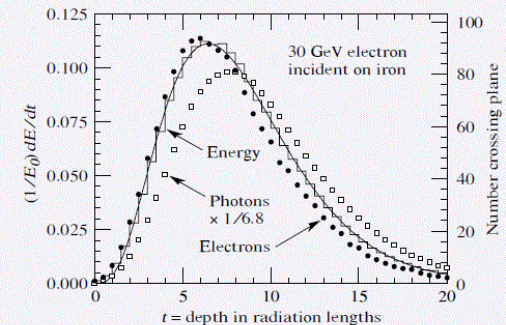
- ◆ 縦方向

$$t_{max} = \ln \frac{E_0}{E_c} \frac{1}{\ln 2}$$

$$t_{95\%} = t_{max} + 0.08Z + 9.6$$

- ◆ 横方向 (モリエール半径)

$$R_M = \frac{21 \text{ MeV}}{E_c} X_0 \quad [g/cm^2]$$



STRATEGY FOR SHOWER PROFILE EXTRACTION

- Fitting the function to the cluster shower shape

- Fit function:

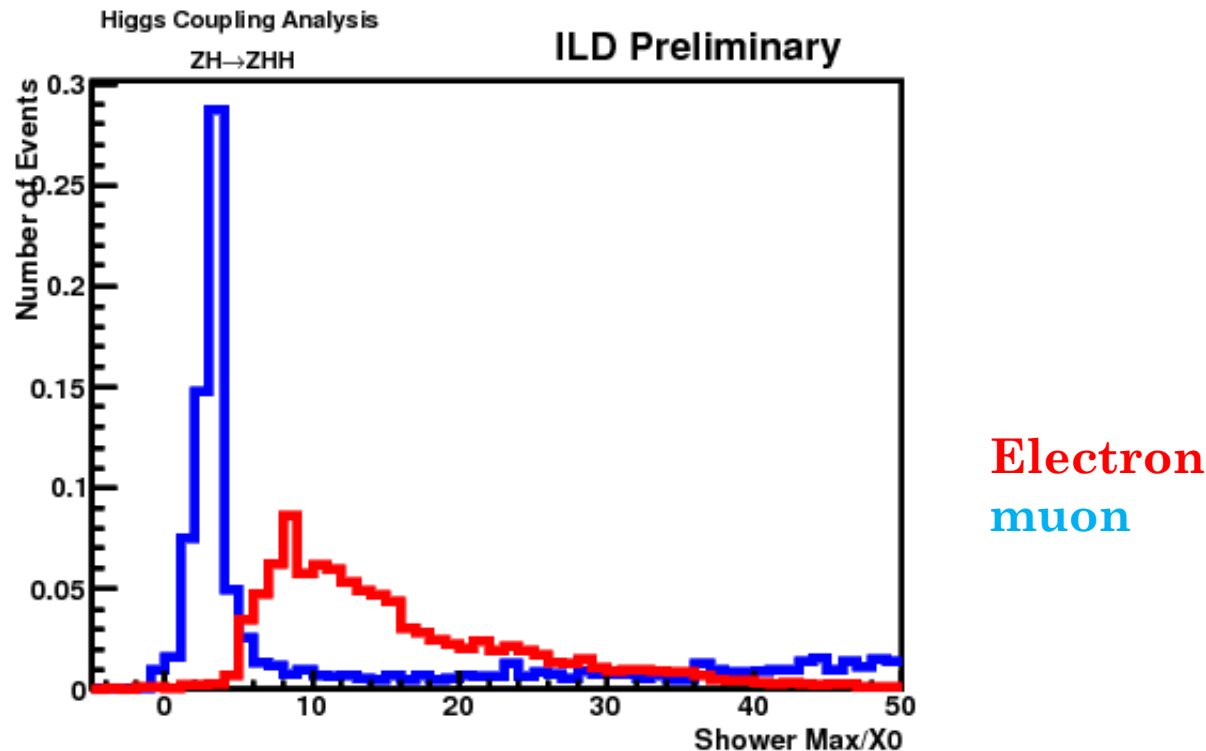
- $f(xl, xt) = a(xl - xl_0)^b \exp(-c(xl - xl_0)) \exp(-d \cdot xt)$
 - xl : longitudinal position of the calorimeter hit
 - xt : transverse position of the calorimeter hit
 - xl_0 : shift the function
 - a : amplitude
 - $1/d$: absorption length

- Expected shower max when the track is electron:

- $showerMax = \frac{1}{\log(2)} \cdot \log\left(\frac{E_{max}}{E_c}\right)$ (strange?)
- $E_c = 0.021X_0/Rm$ (GeV)

FIRST TRY TO SHOWER PROFILE STUDY

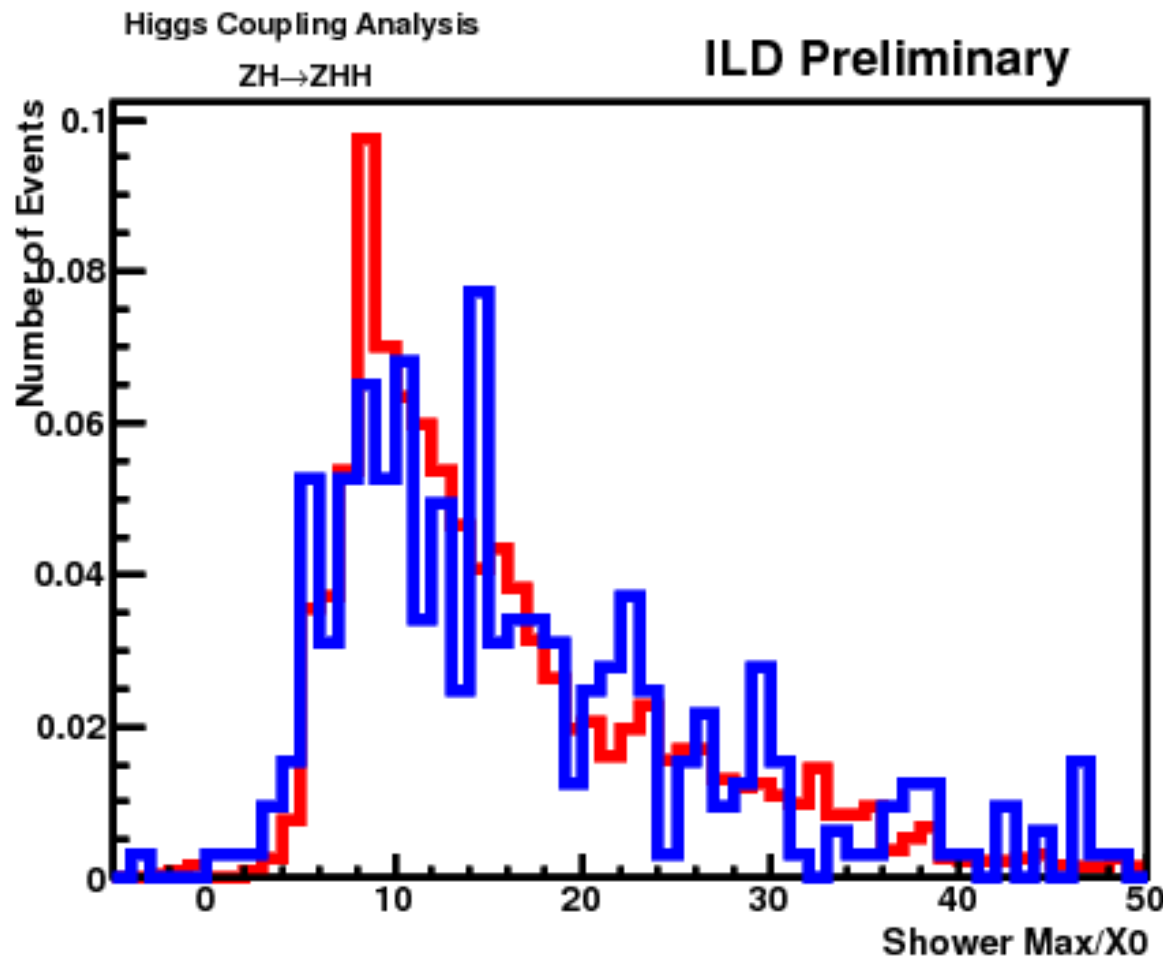
- Checking with electron-like and muon-like tracks



- Shower max: looks ok?
 - Other variables: can't show... need to correct
- Tendency is ok, but something wrong...

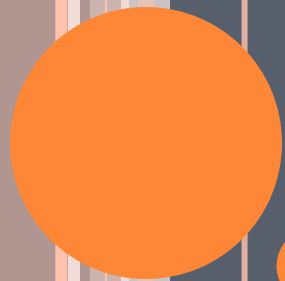
FIRST TRY TO SHOWER PROFILE STUDY

- Checking with Isolated lepton vs. fake leptons



Isolated leptons
Soft leptons

- Need more study...



DE/DX STUDY

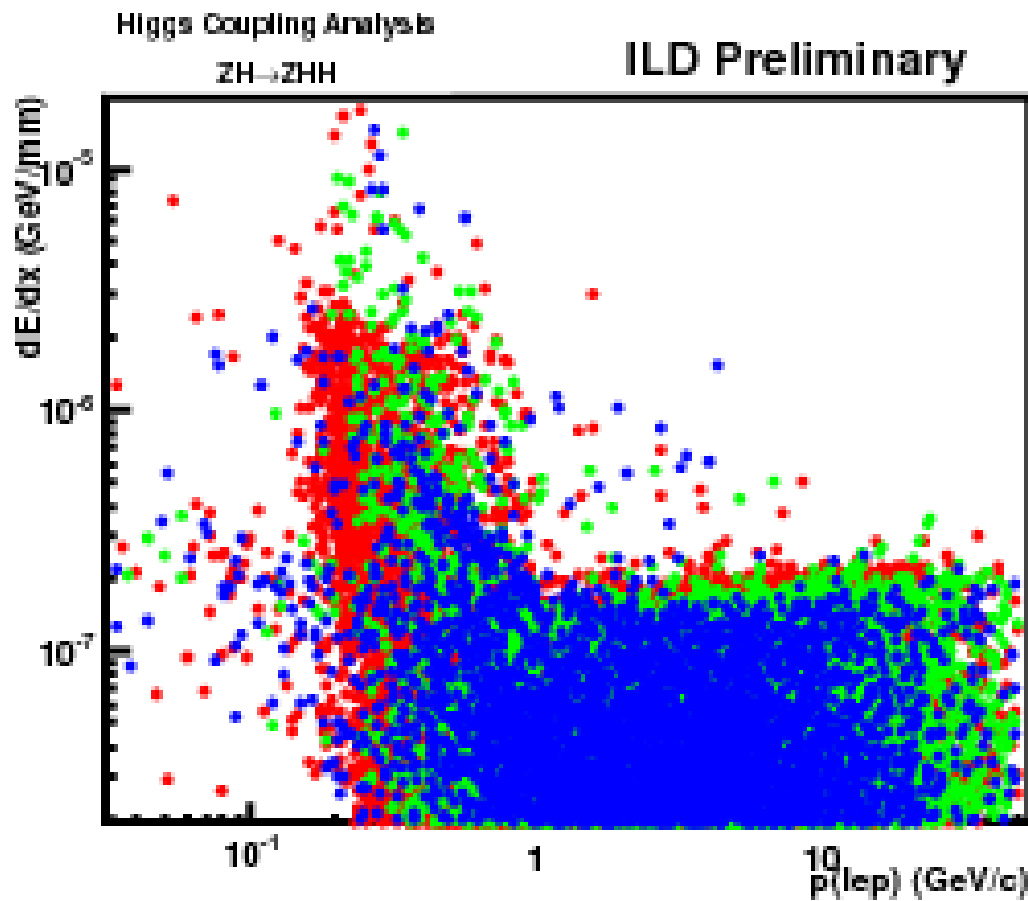
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DE/DX EXTRACTION

- Using the hit points in the trackers
- Now, using very simple criteria to obtain dE/dx:
 - $\frac{dE}{dx} = \frac{\text{total energy deposite of all the hit points}}{\text{total length between the hit points}}$
- Watching the momentum dependence
 - Can see the Bethe-Bloch line?
 - Looking good for the $\pi/K/p$ separation?
- Now, doesn't consider silicon or TPC

dE/dX

- Can see something $\sim 0.1-1\text{GeV}/c$????
- Looking bad for separation of the particles
- Need some treatment and something



Pion
Kaon
Proton

PROBLEMS

- Shower profile
 - Radiation length & Moliere length??
 - Necessary to check EM & HAD independently?
 - Good way to fit? (fitting is the good way?)
- dE/dx
 - correct dE/dx calculation
 - Necessary to check silicon & TPC independently?
- But, I can do anything and pass the results to the DST file
 - I have only to know the correct way to get the track properties.
 - Need some advice and help of experts



LEPTON ID USING LIKELIHOOD

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BASIC IDEA

- Lepton ID using likelihood is introduced:
 - Lepton selection imposing just one cut
- Target is to find the leptons from W boson as Higgs daughter
 - In some case, lepton energy is so small
 - Form general lepton ID to make the analysis easier
 - Want to apply it to Z lepton finding too
- Likelihood definition:
 - Isolated lepton likeliness

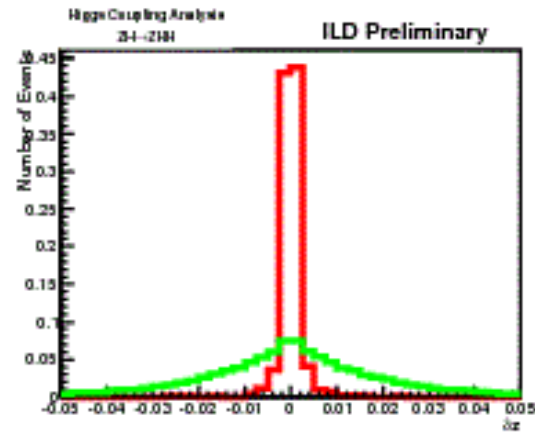
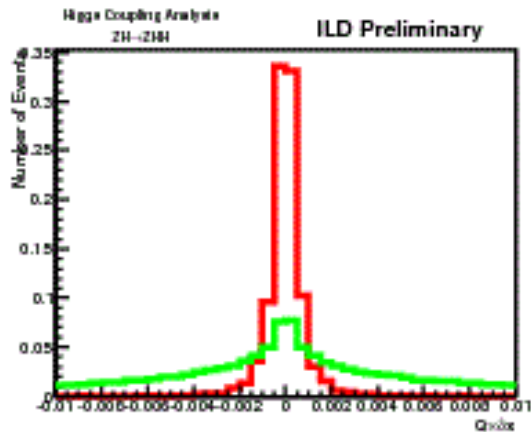
$$L = \frac{\prod s}{\prod s + \prod b},$$

s:pdfs of signal variables

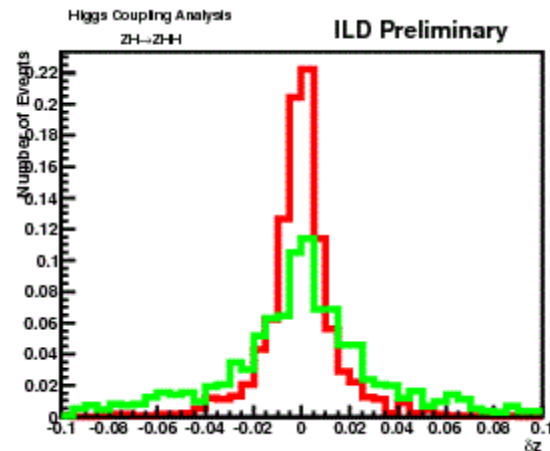
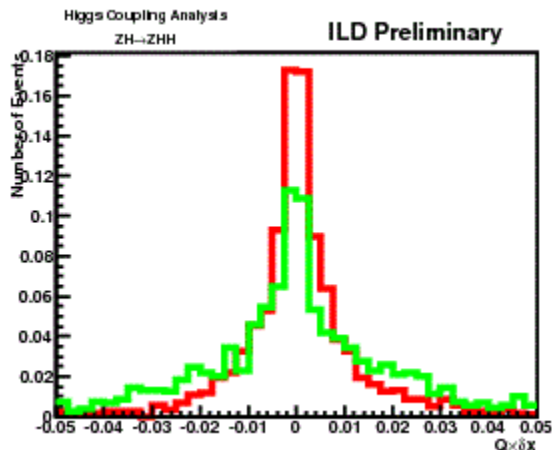
b:pdfs of background variables

INTRODUCE VARIABLES

- Variables are almost same as cut based:
 - E/P, EM/(EM+HAD), $|d_0|$, $|Z_0|$, cone energy
 - Using these variables as pdf
- Introduce new variables:
 - $Q \times \Delta x$, Δz – distance between the cluster position and expected position when tracks are extrapolated to the radius of the cluster position (Q is charge)



Isolated lepton
Soft lepton



STATUS OF LEPTON ID

- Single lepton ID

- Set the operation point@ same signal eff.

type	signal	ttbar- lep+jets	ttbar - allhad
Cut based	98.4	71.4	7.9
Likelihood	98.1	70.3	3.1

- leptonID for $Z \rightarrow ll$

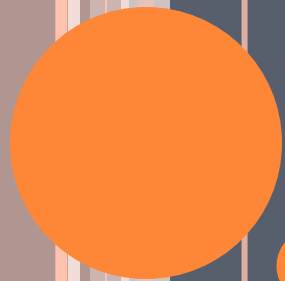
type	ttbar - lep+jets	ttbar - dilepton
Cut based	0.79	17.3
Likelihood	0.59	18.9

- Slightly good

- Need to optimize the operation point

SUMMARY

- Trying to extract track properties:
 - dE/dx
 - Shower profile
- Lepton ID using likelihood
 - Some improvement achieved
- Todo & Prospects:
 - More study for track properties
 - Introducing some idea
 - Bayesian technique for jet pairing – trying soon
 - Bayesian technique for jet clustering?
 - Jet energy correction?
 - B-tagging categorizing strategy



BACKUPS

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