Higgs self-coupling analysis with H→WW*

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Status

- dE/dx – working with Astrid to digitize the dE/dx correctly
  - Check the fluctuation of dE/dx
    - With several particles and momentum range
  - Start to try to obtain 5% accuracy

- Shower profile – going on
  - Correct misunderstanding
  - Answer Junping's questions
  - Integrating Ecal/Hcal is very difficult – pending…
  - Today's talk is the detail & basics for the study(based on Junping's questions)

dE/dx

dE/dx

- working with Astrid to digitize the dE/dx correctly
  - Check the landau tail effect
    - Does Landau tail effect input correctly on simulation?
  - Check the fluctuation of dE/dx
    - With several particles and momentum range

- dE/dx definition:
  - $\frac{dE}{dx} = \frac{energy\ deposit}{flight\ path\ in\ the\ hit(TPC)}$
  - dE/dx can be calculated at any hit point
  - Truncated mean is calculated as track dE/dx

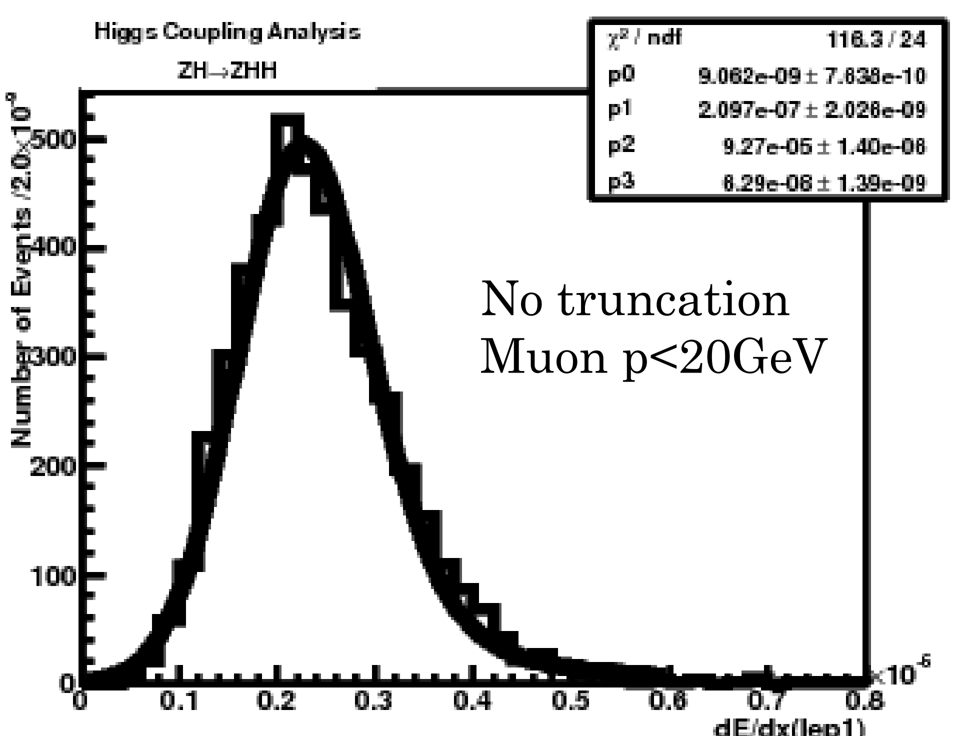
  $\left\langle\frac{dE}{dx}\right\rangle = \sum_i^n \frac{dE_i}{dx_i}$ upper 30%, lower 8% hits are discarded

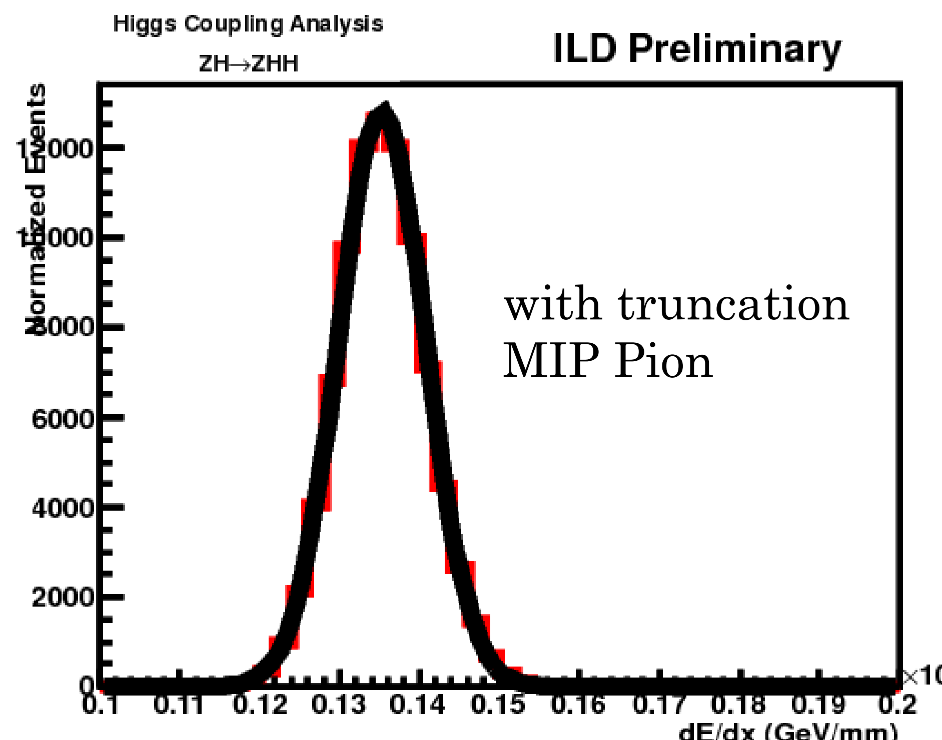
  to avoid Landau tail

  →optimization is necessary

Effect of Landau tail

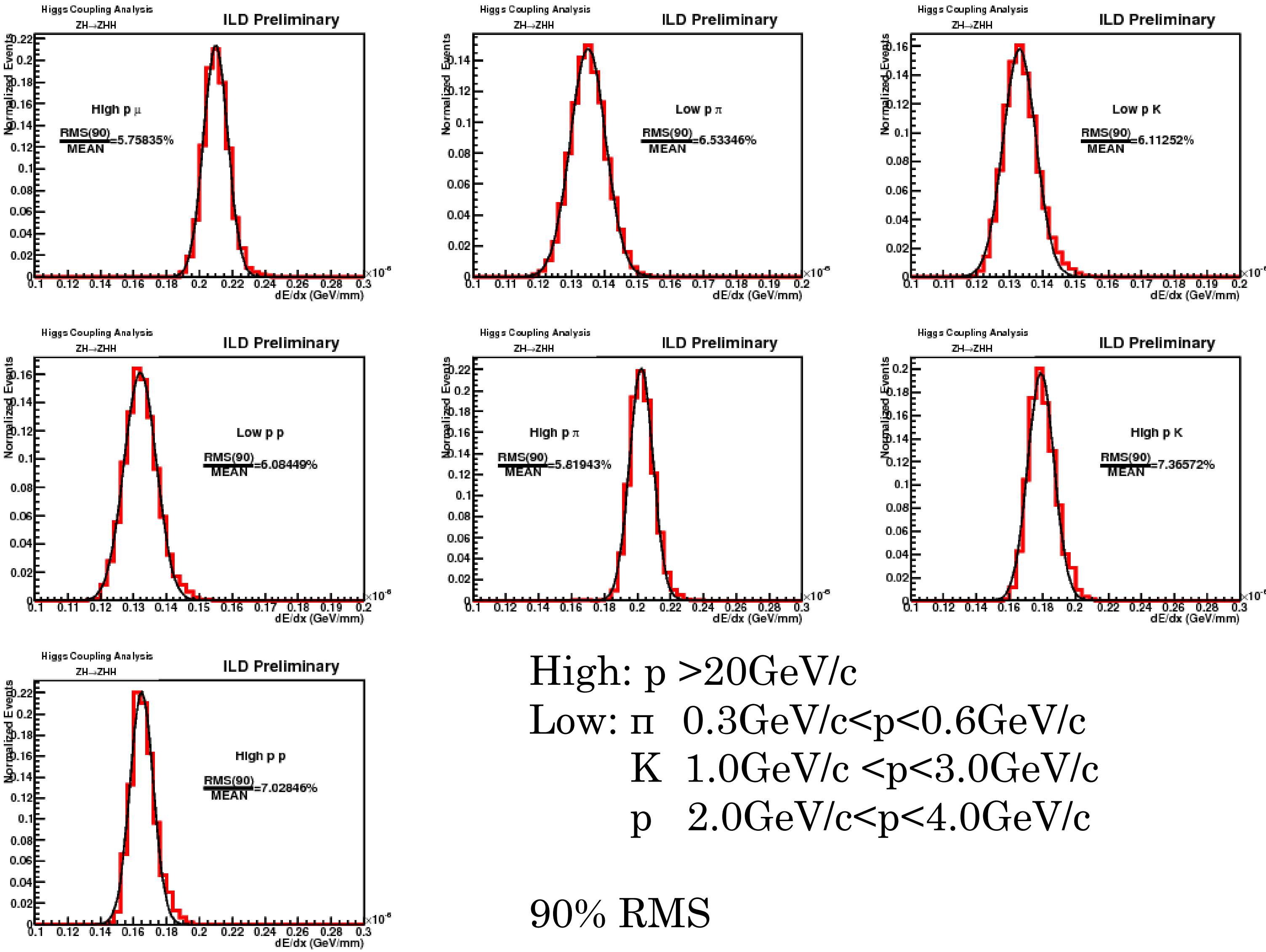
- Landau tail effect – muon tracks
  - dE/dx distribution of tracks
  - fitting - convolution of Gaussian and Landau → Thanks to Tino!
  - Tail can be seen in the case of no truncation
  - Agree with Astrid's study
- Truncated mean distribution – MIP pion(0.3GeV/c<p<0.6GeV/c)
  - Good Gaussian shape





dE/dx fluctuation

- Fluctuation of dE/dx using various type of tracks
  - Using truncated mean



High: p >20GeV/c

Low: π 0.3GeV/c<p<0.6GeV/c

K 1.0GeV/c <p<3.0GeV/c

p 2.0GeV/c<p<4.0GeV/c

90% RMS

Next step

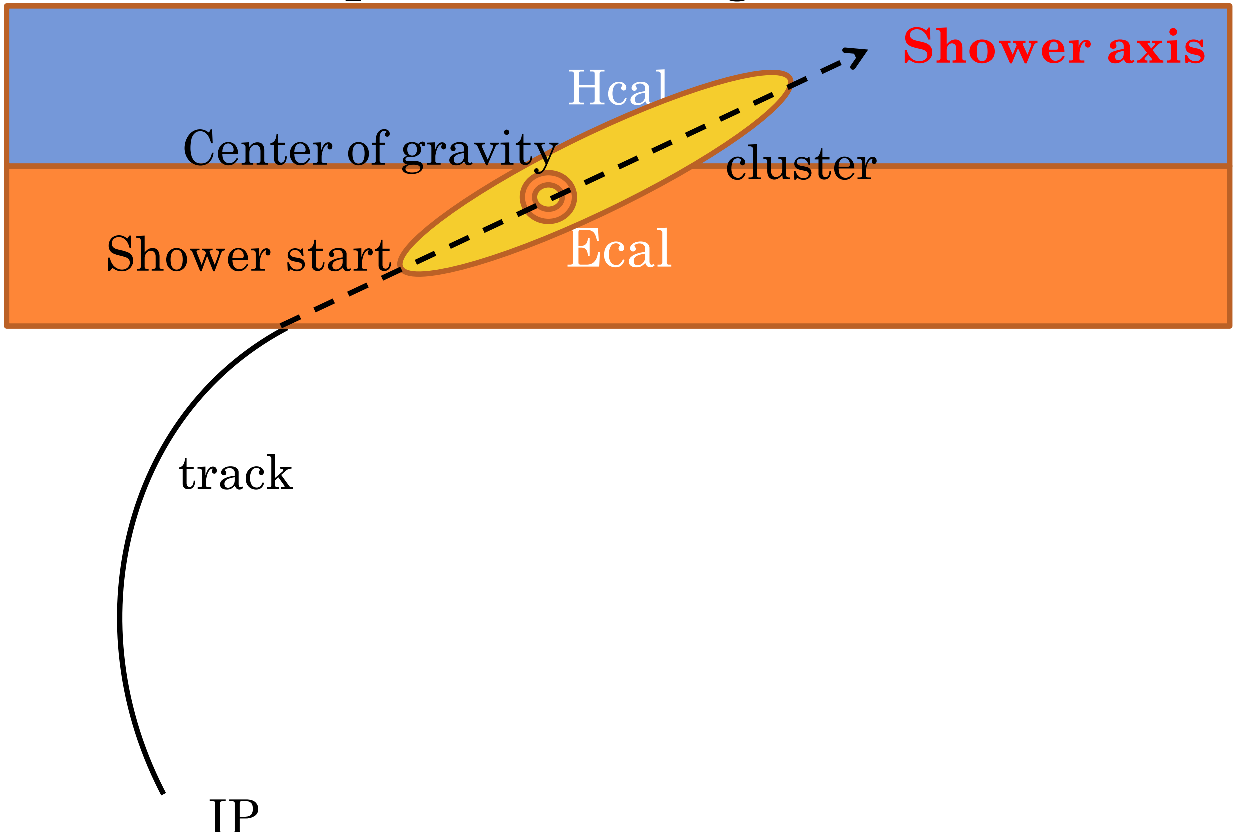
- dE/dx fluctuation is large on standard simulation…
  - Without any correction of dE/dx
  - My study: 6-7%
  - Astrid's study: 3-4% → it is reasonable
- Need to check the source of this large fluctuation
  - Truncation?
  - Gas effect?
  - Something else?
- Target is 5% accuracy!

- It is necessary to show the significance and advantage of using dE/dx
  - It is very important!

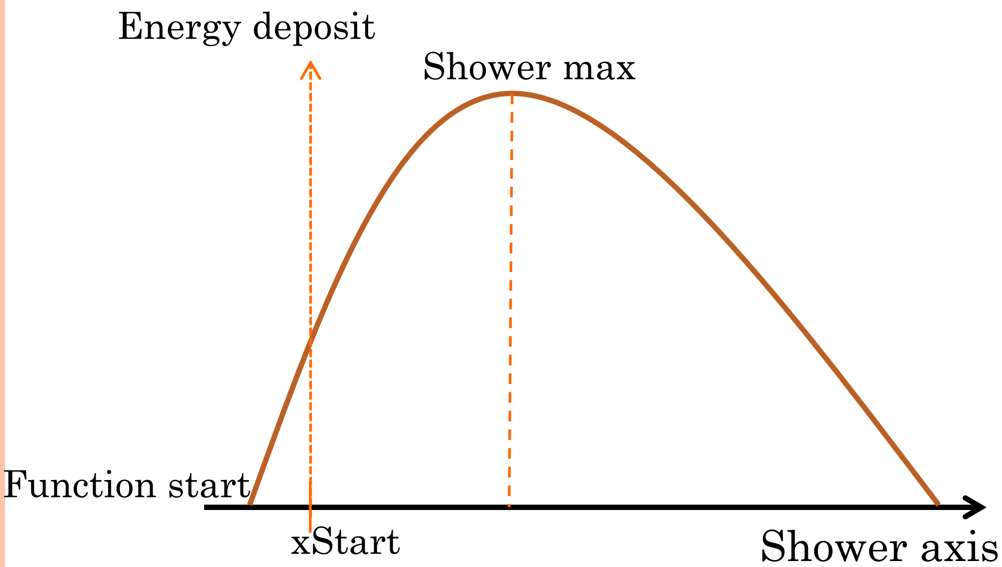
Shower profile

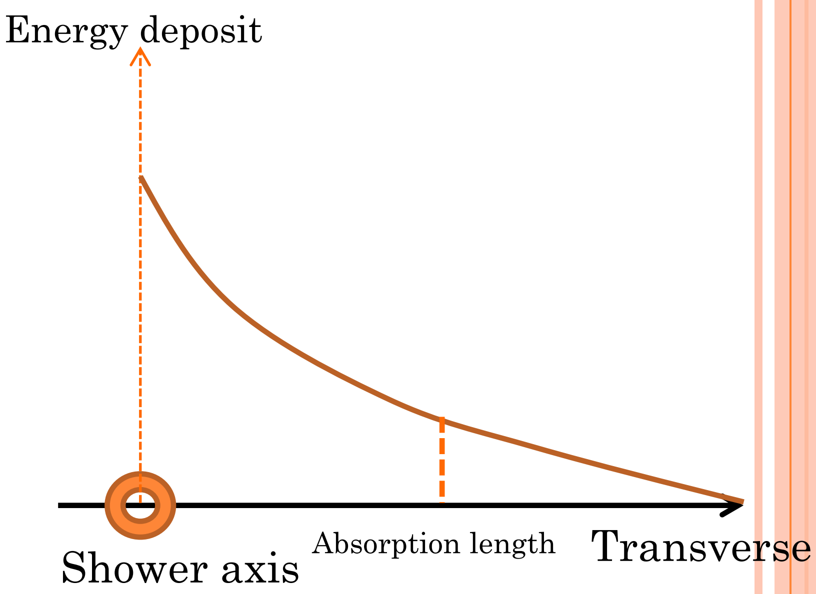
Definition of the shower axis

- Shower axis is the direction of the track intruding into calorimeter
  - This correction will change the shower start distribution from last talk
- All the hit points(x,y,z) are converted to longitudinal and transverse components along to the shower axis



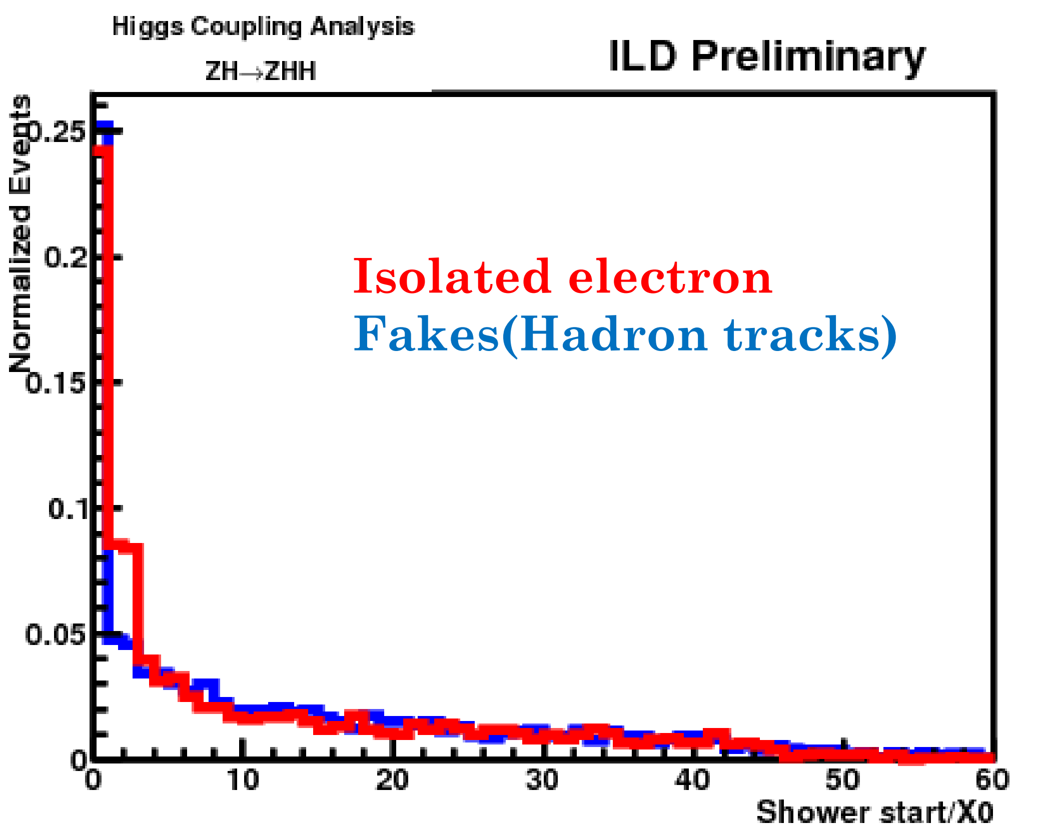
Shower profile





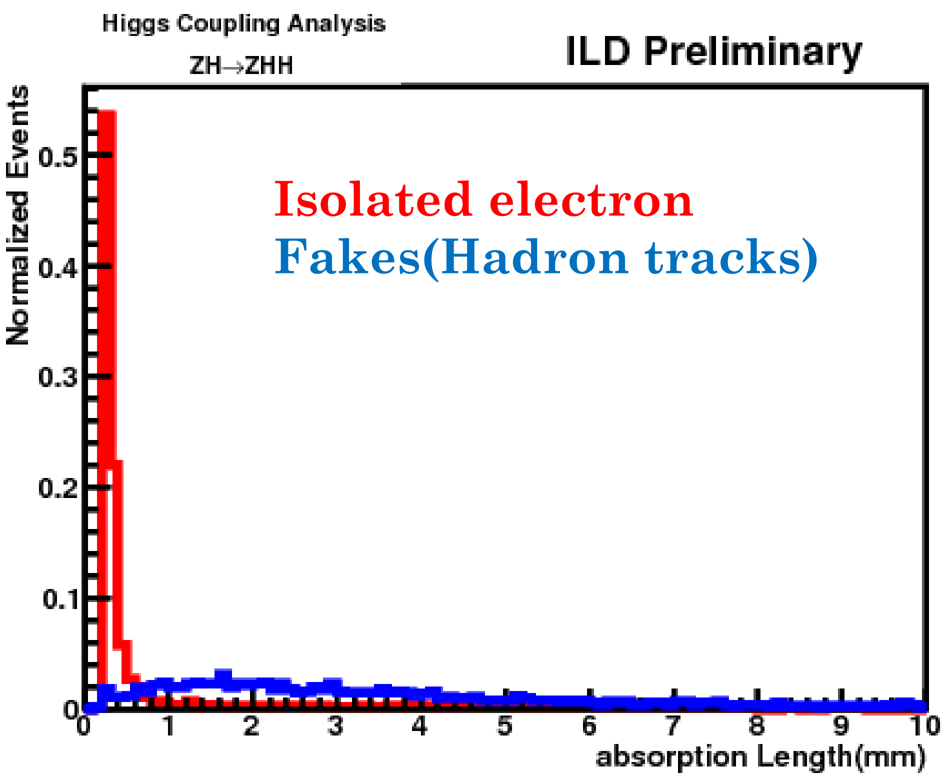
Shower start distribution

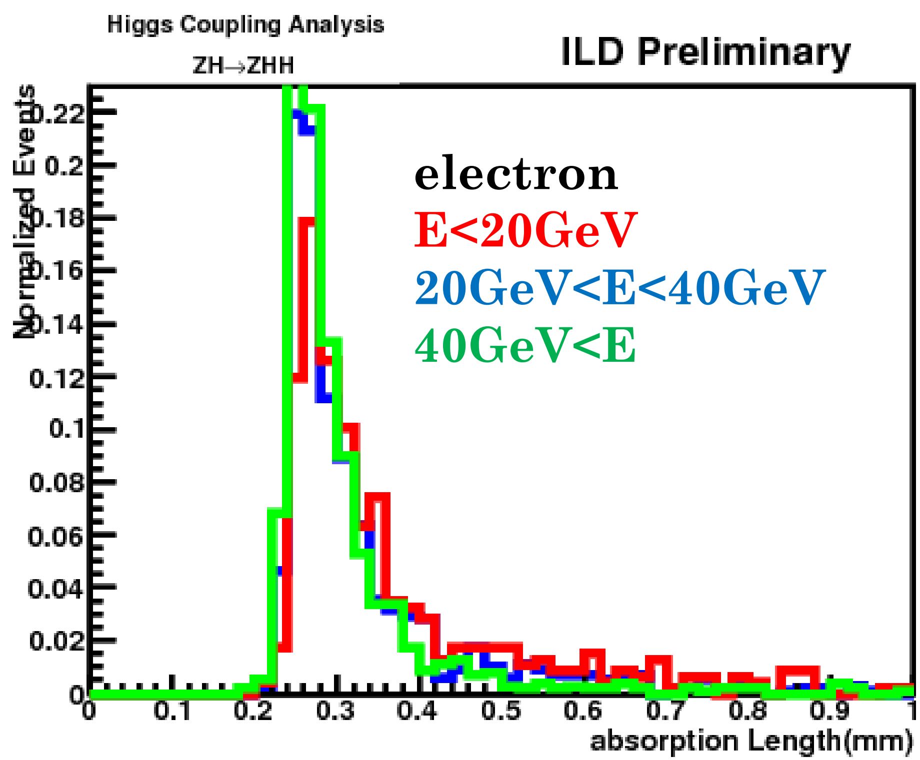
- Shower start depth(length) from calorimeter surface
  - Expectation: very shallow for EM, deeper for hadron…
- Very similar distribution – difference is slight…
  - Need to check fakes more precisely
  - Need a threshold for energy deposit? (hadron track has small energy deposit for first hit?)



Transverse components

- Transverse shower profile is characterized by absorption length
  - EM shower spread is very small
  - Hadron shower spread is wide – 90% energy within Moliere Radius
  - There is an energy dependence of course, but the effect is small in the case of electron

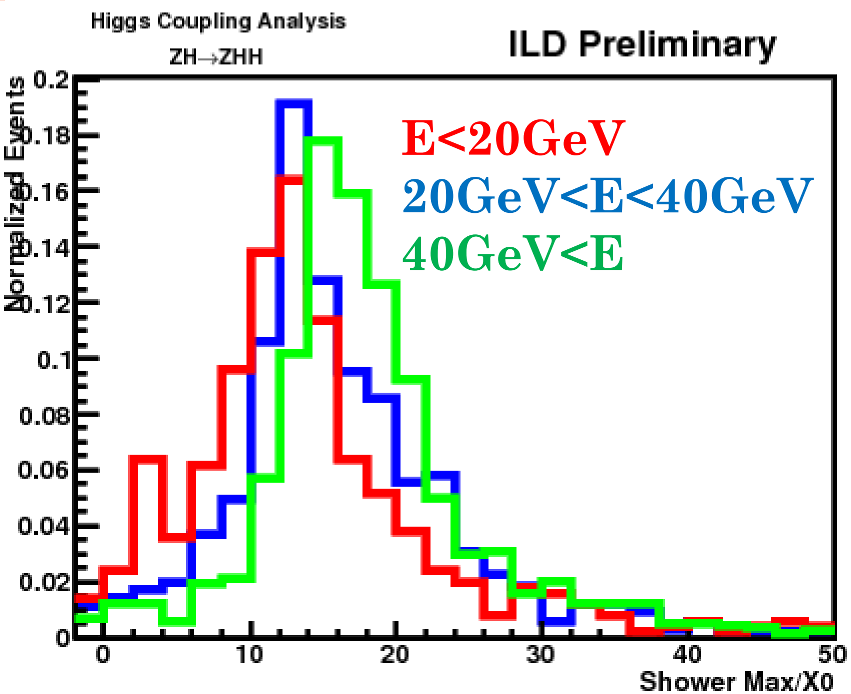


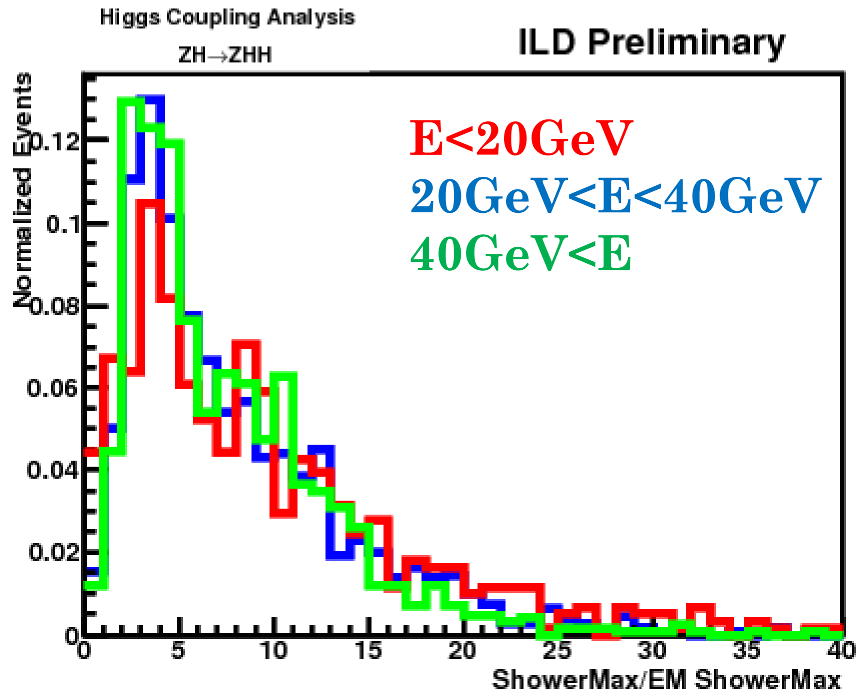


Shower Max

- Length from calorimeter surface to the point which has maximum energy deposit
  - Of course, there is an energy dependence
  - But, the dependence is logarithmic
  - Taking ratio with Expected shower Max

$$\text{Exp. Shower Max} = 1.0\left(\log\frac{E_0}{E_c} - 0.5\right), \quad E_c = 0.021\frac{X_o}{Rm}\text{GeV}$$





TODO

- More study of fake lepton sample
  - Components of fake lepton candidates
    - Pion? Kaon? Proton? - fraction
  - Is there any difference between fake lepton components?
    - Overall distribution doesn't have any difference…

- Apply to lepton ID
  - Performance check

- Study for muon type
  - Any difference between muon and (I guess) punch-through pion?

- Integrating Ecal/Hcal - good estimation in Hcal
  - Very difficult!!
  - Fit function gives up fitting…