High level reconstruction tools

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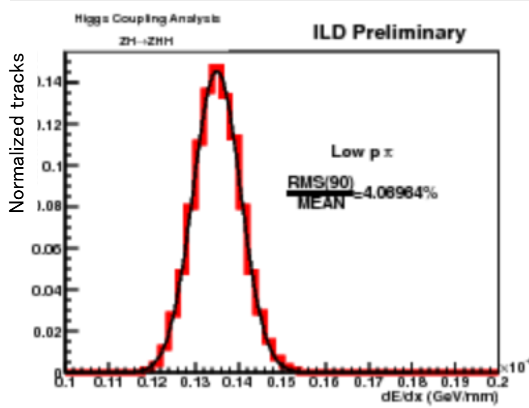
NEXT-ROUND RECONSTRUCTION

- Public event sample generation – Improved & new reconstruction tools should be included
  - Fixed overlay effect
  - Improved forward tracking
  - Silicon tracking
  - dE/dx using TPC info.
  - Shower profile info. in calorimeters
  - Improved LCFIPlus
  - (Primary vertex smearing)

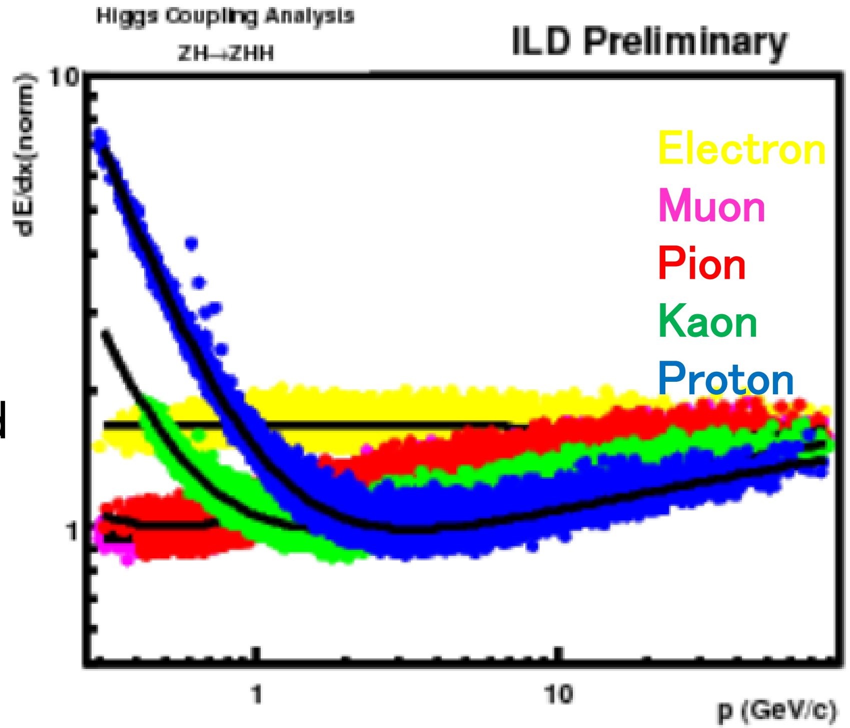
- Covering red topics
- Particle ID can be constructed

dE/dx from TPC

- Fluctuation of dE/dx using various type of tracks
  - Truncation method is used to avoid landau tail
  - Fluctuations of each particle/each momentum range in simulation: **3 – (<5)%!!** **TDR goal: 5%**
  - Including detector effect is necessary



- Momentum dependence of dE/dx for each particle
  - Polar angle dependence corrected
  - Num. of Hits dependence corrected
  - Scale to $\left\langle \frac{dE}{dx} \right\rangle = 1.0$ for MIP pion

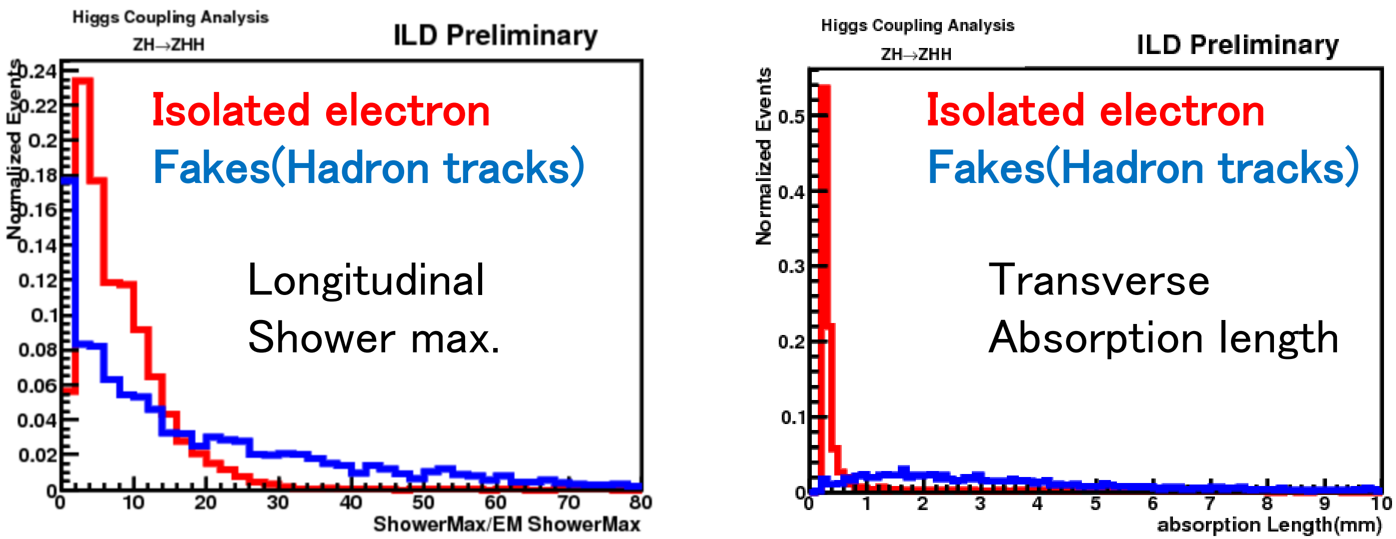


Shower profile

- Shower shapes in the calorimeter are different between electron/photon/muon/hadrons
- Information extraction is based on fitting to cluster hits:
  - Well-known EM shower profile

$$f(x_l, x_t) = ac\frac{(c(x - x_{l0}))^{b-1} \cdot \exp(-c(x - x_{l0})) \cdot \exp(-dx_t)}{\Gamma(b)}$$

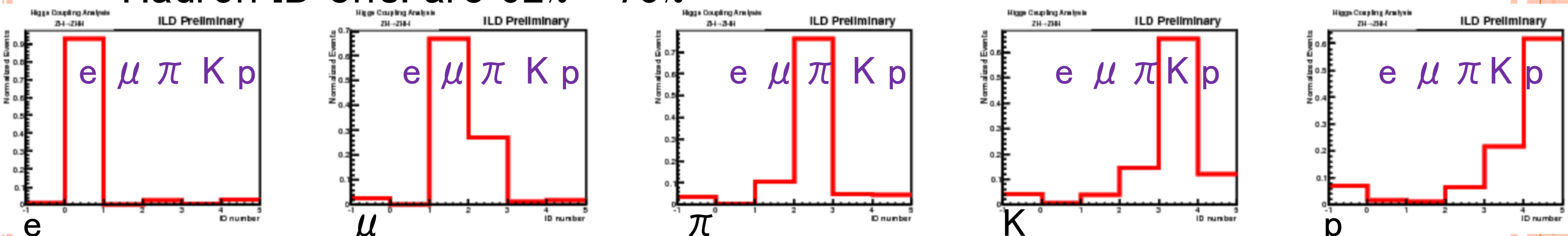
- In addition, hit based variable is also used(to identify shower start)
- Shower profile distributions(example)

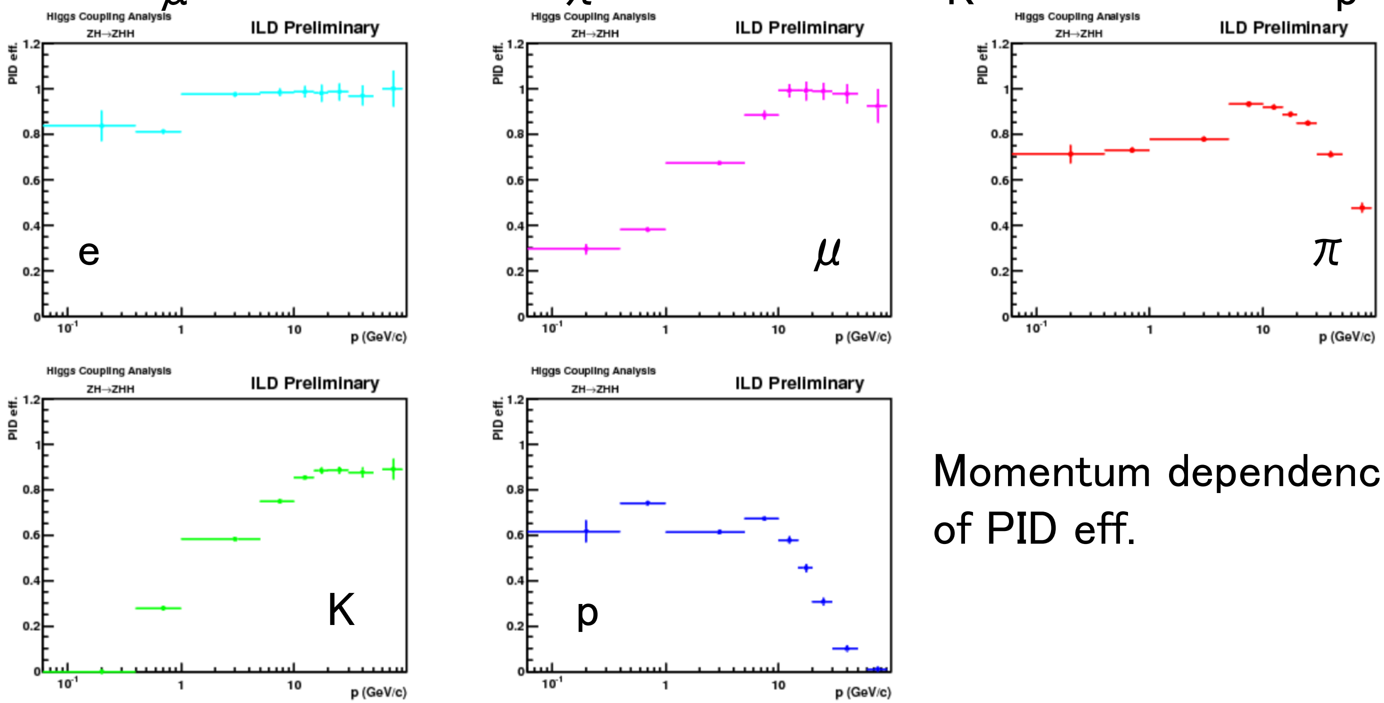


- Need to integrate with low energy μ / π separation technique (see Georgios' talk)

Particle ID

- New variables make Particle ID available −construct Particle ID
- Overall ID efficiency – using tracks in jets:
  - Electron can be identified almost perfectly(>90%)
  - Muon ID eff. is ～70% →due to low energy muons(μ / π separation)
  - Hadron ID effs. are 62%～75%





Momentum dependence of PID eff.

LCFIPlus improvement

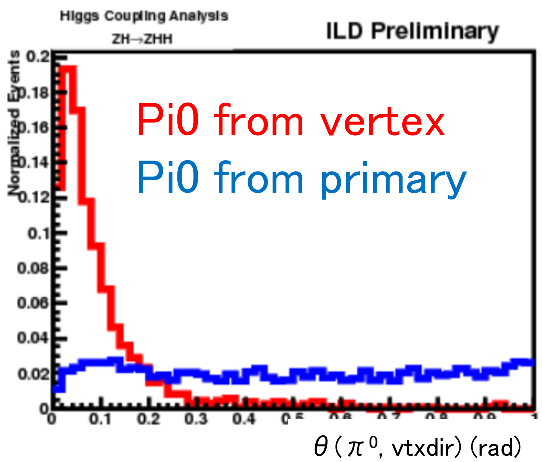
- DBD LCFIPlus has been successful
- LCFIPlus moves to the next step with extended collaboration
  - Taikan, Tomohiko, Jan and myself – We have had some meetings already
  - Start some studies

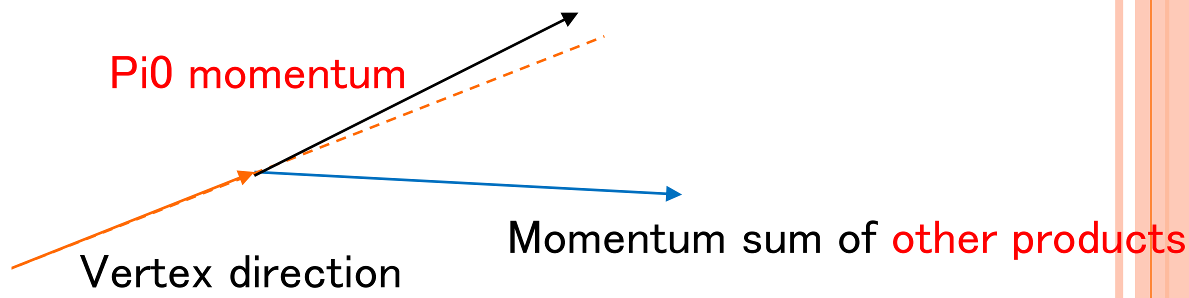
- There is much room to improve!
- Now, focusing on
  - Vertex Mass Recovery using pi0s
  - Flavor separation in the case of 0vtx jet
  - Vertex finding efficiency improvement itself

- Particle ID is one of the key to flavor tagging improvement
- Pi0 reco. is other key

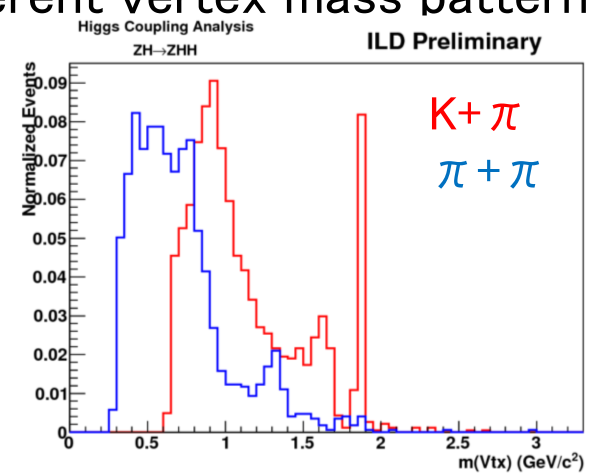
Vertex mass recovery

- Using pi0s which escape from vertices
  - Need to choose good pi0 candidates – construct pi0 vertex finder
  - Key issue – pi0 kinematics, very collinear to vertex direction





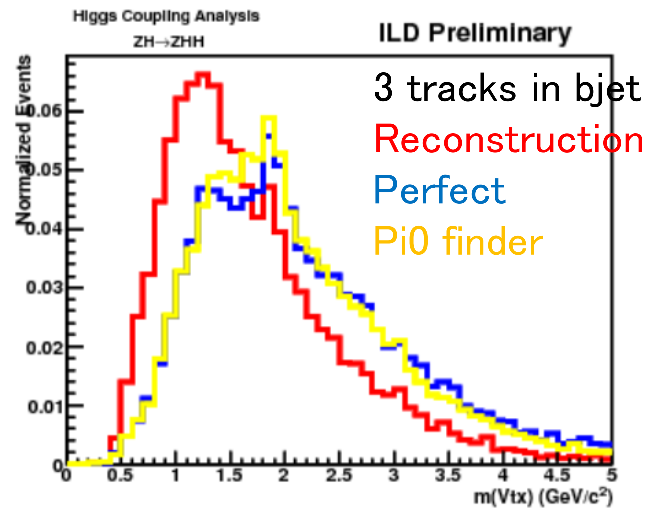
- Particle ID is the other key to classify vertices
  - Different particle patterns have different vertex mass patterns
  - e.g.) K+π v.s. π+π



- Construct Pi0 Vertex finder using MVA

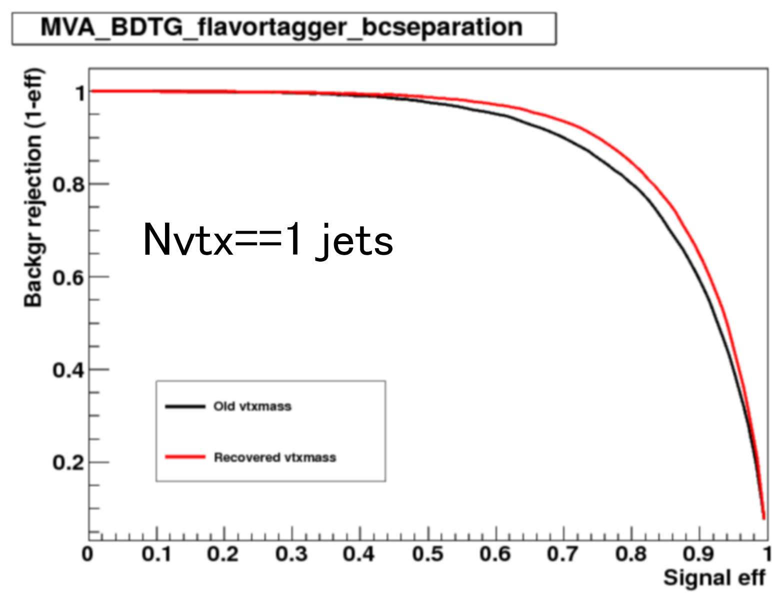
VTX MASS

- Vtx mass distribution example:
  - Difference is coming from mis-pairing of gammas(main source) and mis-attachment of pi0s(sub-source)



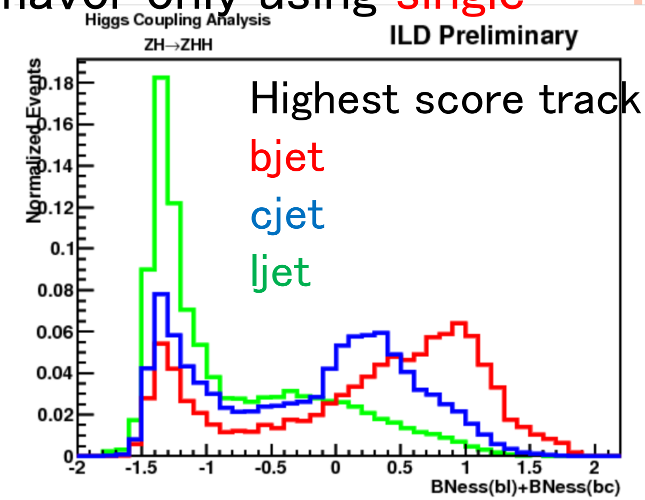
  - γ combinatorial problem has large effect
  - Good pi0 reco. @low energy is necessary (see. Graham's talk)

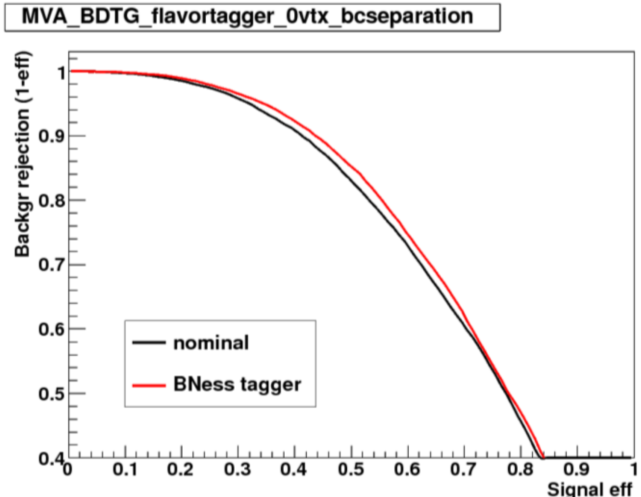
- Effect on flavor tagger
  - Convert vertex mass to recovered
  - Improvement can be obtained

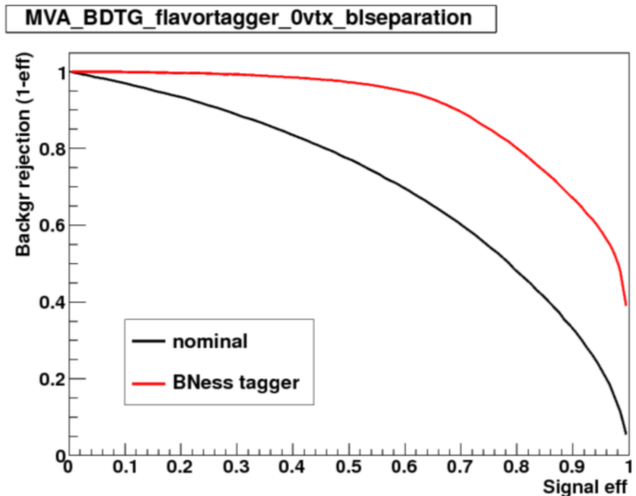


0VTX JET FLAVOR SEPARATION

- Flavor separation of 0vtx jet is most difficult situation
  - Only impact parameter implies the existence of secondary vertices for flavor separation
- BNess tagger is good for such a situation
  - Focus on individual tracks and evaluate jet flavor only using single track
  - Construct BNess tagger using MVA
  - c jet separation is necessary at ILC
- Effect on flavor tagging
  - Some improvement for b-c separation
  - Drastically improve b-l separation
  - @500GeV







New vertex finding algorithm

- Adaptive Vertex Fitting – include multi-vertex effect
  - Estimation of track probability on the vertices is not simple χ^2, but weight function:

$$w_{nk} = \frac{e^{-\chi^2_{nk}/2T}}{e^{-\chi^2_{\rm cut}/2T} + \sum_{i=1}^{N} e^{-\chi^2_{ik}/2T}}$$

k-th track's weight on n-th vertex

  - At the same time, using BNess tagger for fake track rejection
- Preliminary result: num. of jets with vertices
  - @500GeV

method	Bjet with 2vtx	Bjet with 1vtx	total
Nominal Algorithm	11715	21734	33449
AVF&BNess	14671	20153	34824

  - ～22% increase for 2 vtx jets
  - ～8% decrease for 1vtx jets
  - ～4% increase for total num. of jets with vtx
- Fake track rate per vtx

method	Bjet with 2vtx	Bjet with 1vtx
Nominal Algorithm	0.018±0.001	0.035±0.001
AVF&BNess	0.021±0.001	0.034±0.001

- More study is necessary
  - Reco. vertex quality check, c jet vertexing, fake track bias, etc…

SUMMARY

- For physics results improvement, we can use various aspects of detectors:
  - dE/dx in TPC and shower profile in cal.
- Studying particle ID:
  - Hadron ID eff. is 62%～75%
  - Particle ID eff. is >60% @1GeV/c–20GeV/c range
- Flavor tagger improvement:
  - LCFIPlus is going to next step
  - Vertex mass recovery using pi0s
    - It is hopeful!
    - Some improvement on flavor tagging can be provided
  - Flavor separation in 0vtx jet case
    - Introduce BNess tagger to identify jet flavor with single track
    - Both b–c and b–l separation will be improved
  - New algorithm for vertex finding
    - Vertex finding eff. will be improved with same fake track rate as nominal algorithm
    - Need to check vertex quality and vertexing c jet case
- We need to make the most of ILD detector performance and to explore the possibility of physics results improvement!

BACKUPS