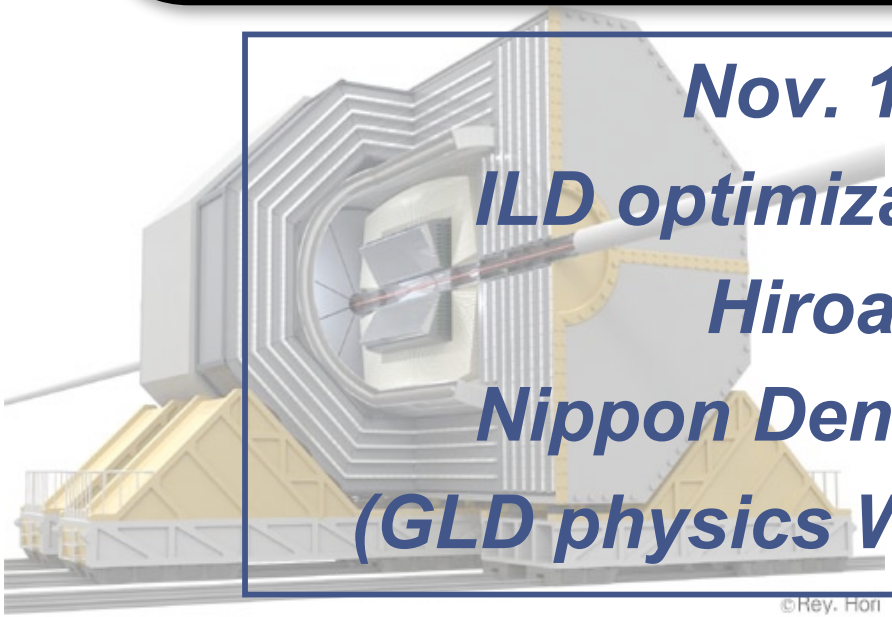
ZH Study in GLD



Nov. 14. 2007
ILD optimization meeting
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(GLD physics WG, ACFA-Sim-J)

ZH study

- Single Higgs production from ZH has already studied using Quick Simulator.
- Study the single ZH analysis using the current GLD full simulator (Jupiter/Sattellites) and PFA (cheated, GLD-PFA) with several mass
  - First, try to use cheated PFA (perfect clustering)
  - M_h = 120, 140, 160GeV mass reconstruction study.
- $Zh \rightarrow \nu\nu h$ reconstruction study with GLD-PFA (realistic PFA) and cheated PFA (perfect clustering)
  - Check the GLD-PFA performance compare to the cheated PFA by comparing mass peak and sigma of the reconstructed mass distribution.

Decay branch of Higgs

M_h=120GeV

Br(h→bb) = 68% (2 jets)

M_h=140GeV

Br(h→WW) = 48%

Br(h→bb) = 34% (2 jets)

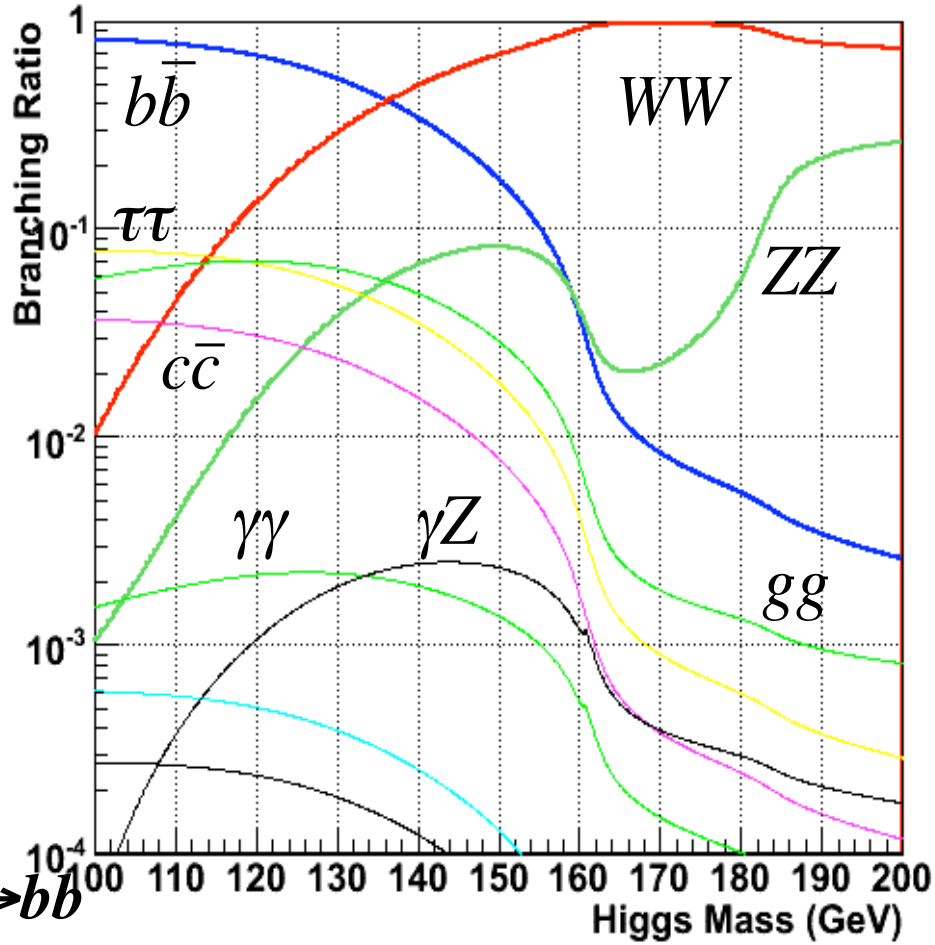
M_h=160GeV

Br(h→WW) = 91%

WW→qq'qq' (4 jets)

WW→lνqq' (lepton+2 jets)

WW→lνlν (2 leptons)



Main decay mode

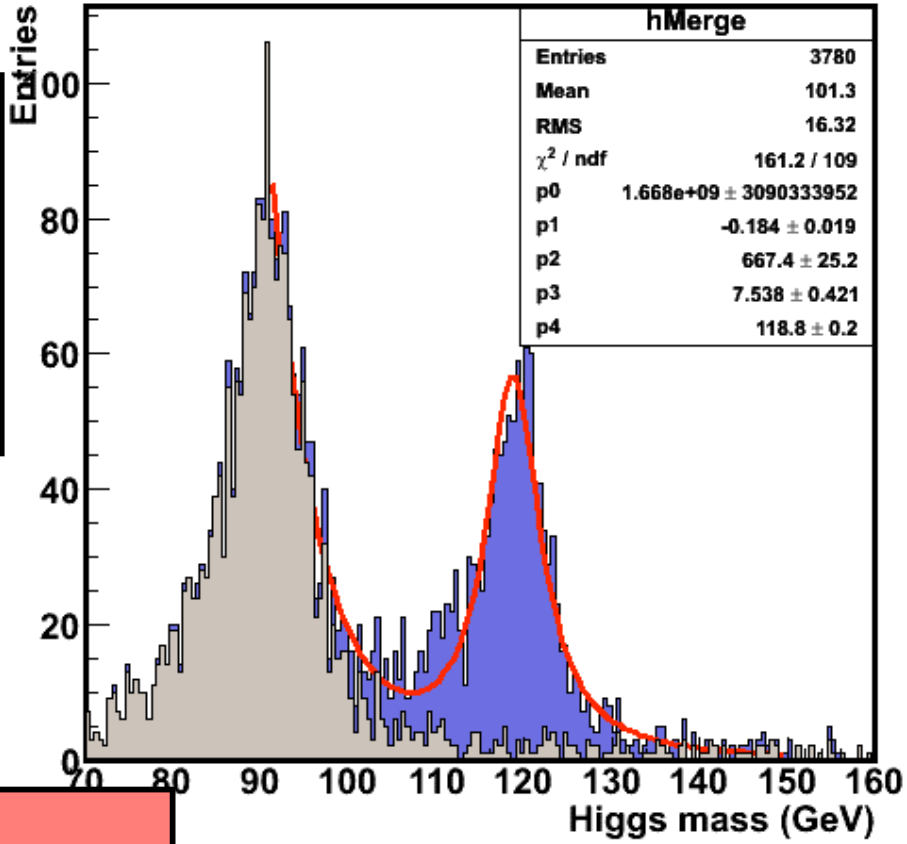
- **M_h=120GeV : *h→bb***
- **M_h=140GeV : *h→WW, h→bb***
- **M_h=160GeV : *h→WW***

$Zh \rightarrow \nu\nu h\ (h \rightarrow bb)$
$Ecm=350GeV,\ mh=120\ GeV$

Cheated PFA with ZZ background

cuts

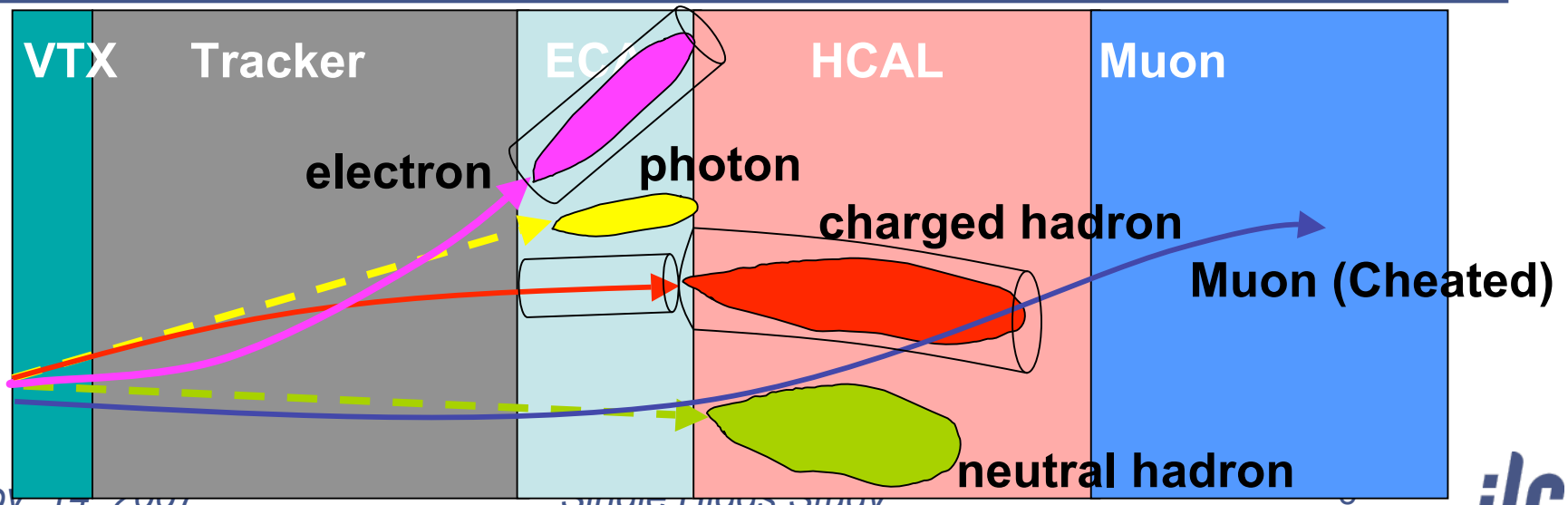
- Visible energy cut
  - $-90GeV < Evis < 200GeV$
- B tagging (*# of off vertex > 5*)
- $|cos\theta_j|<0.8$



Compare the performance of cheated PFA and Realistic GLD-PFA

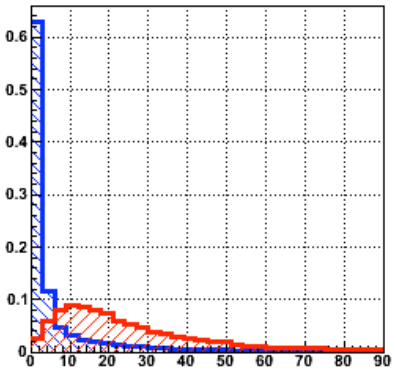
Realistic GLD-PFA scheme

1. Small clustering (Nearest neighboring method)
2. Photon finding (Calculate likelihood)
3. Charged hadron finding
4. Neutral hadron finding (Calculate likelihood)
5. Satellites hits finding

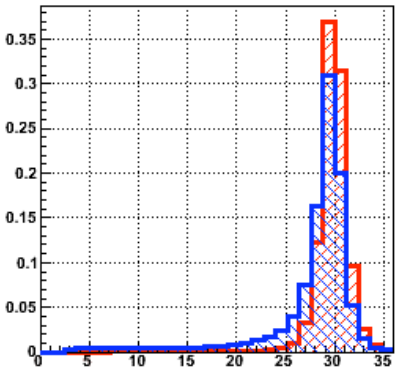


Detail of GLD-PFA (photon likelihood)

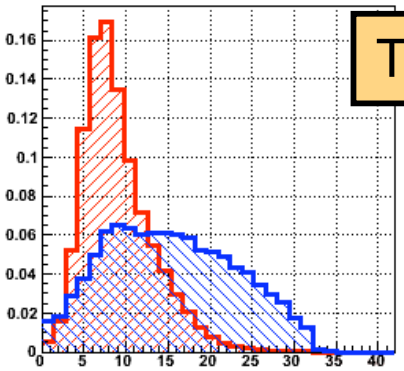
Track distance



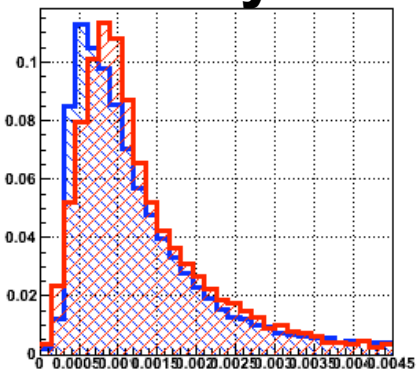
velocity



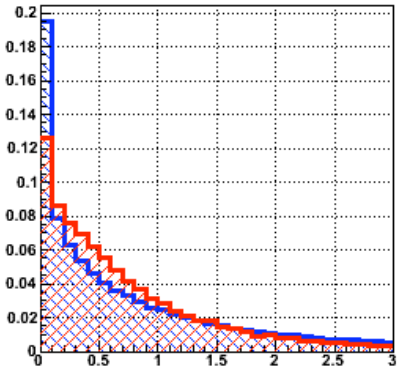
Edep/nhits



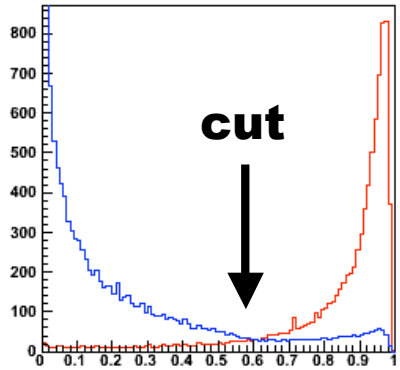
Mean layer ID



chi2

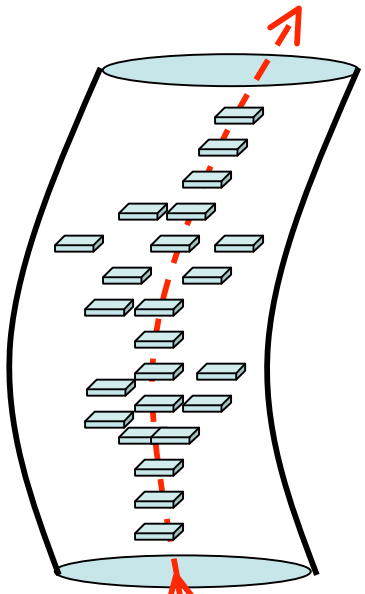


Photon likelihood



charged **photon**

Track-Cluster matching



Charged track

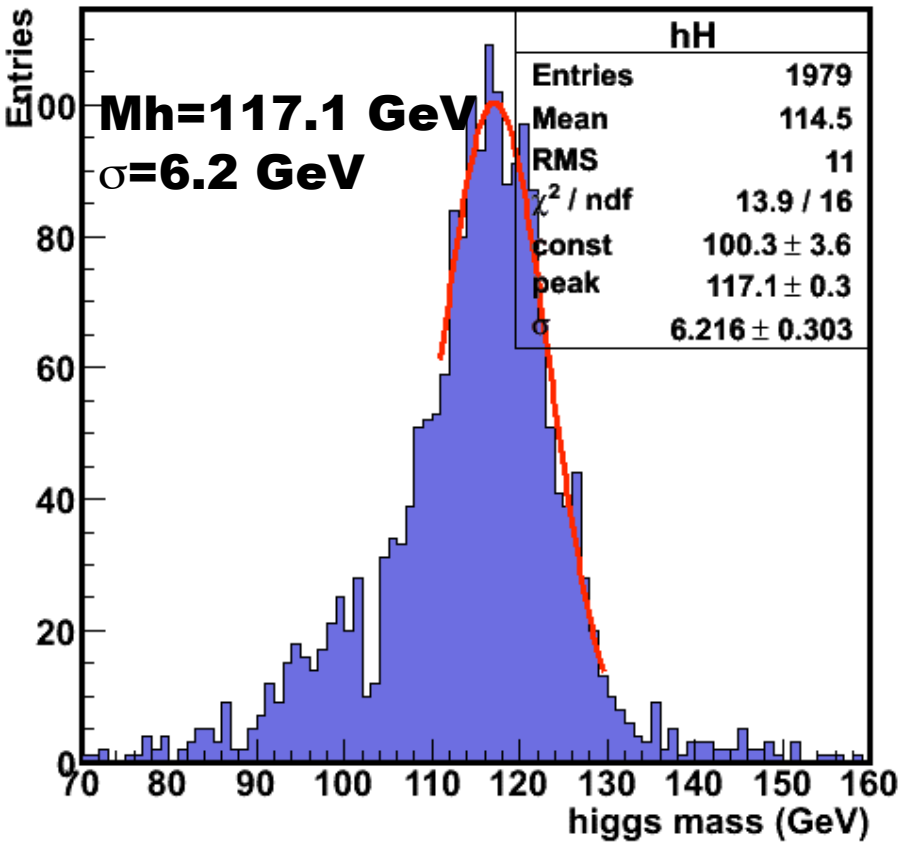
Clustering in tube

Same method has applied to neutral hadrons

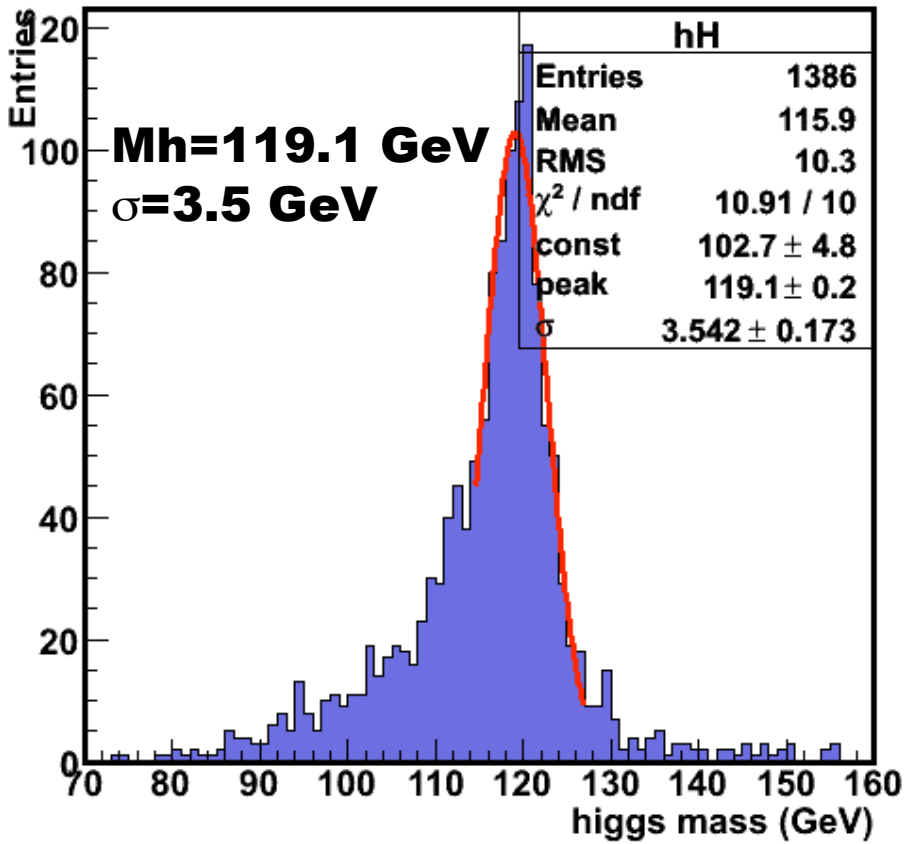
Higgs mass reconstruction with Realistic GLD-PFA

$e^+e^- \rightarrow Zh \rightarrow \nu\nu h$ (Mh=120GeV, Ecm=350GeV)

GLD-PFA



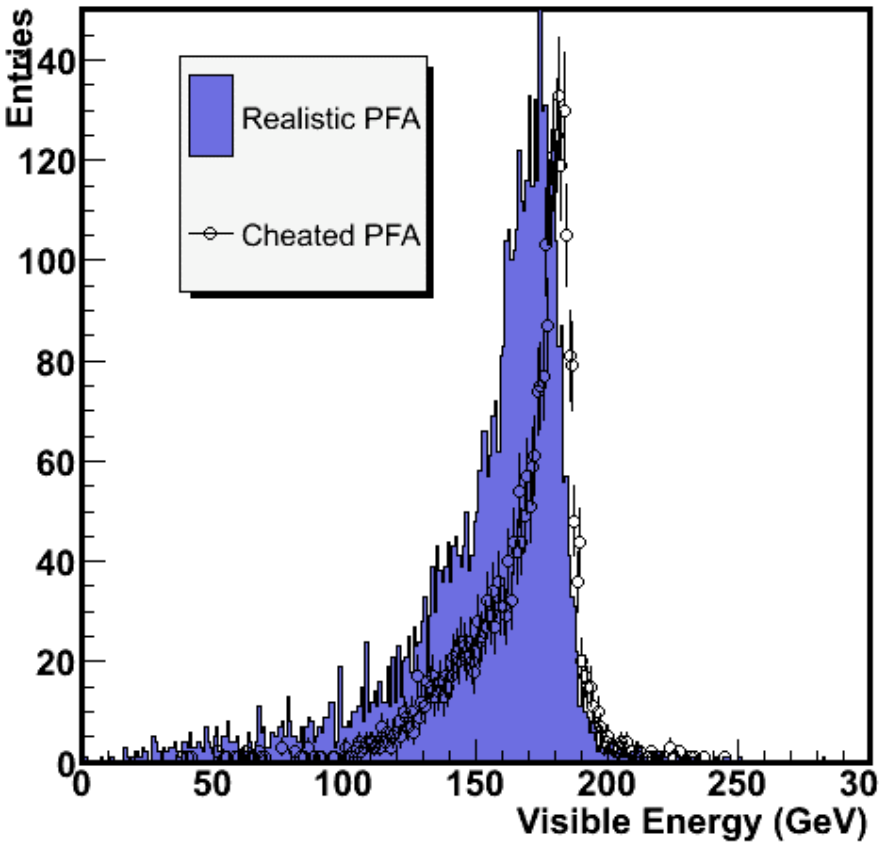
Cheated-PFA



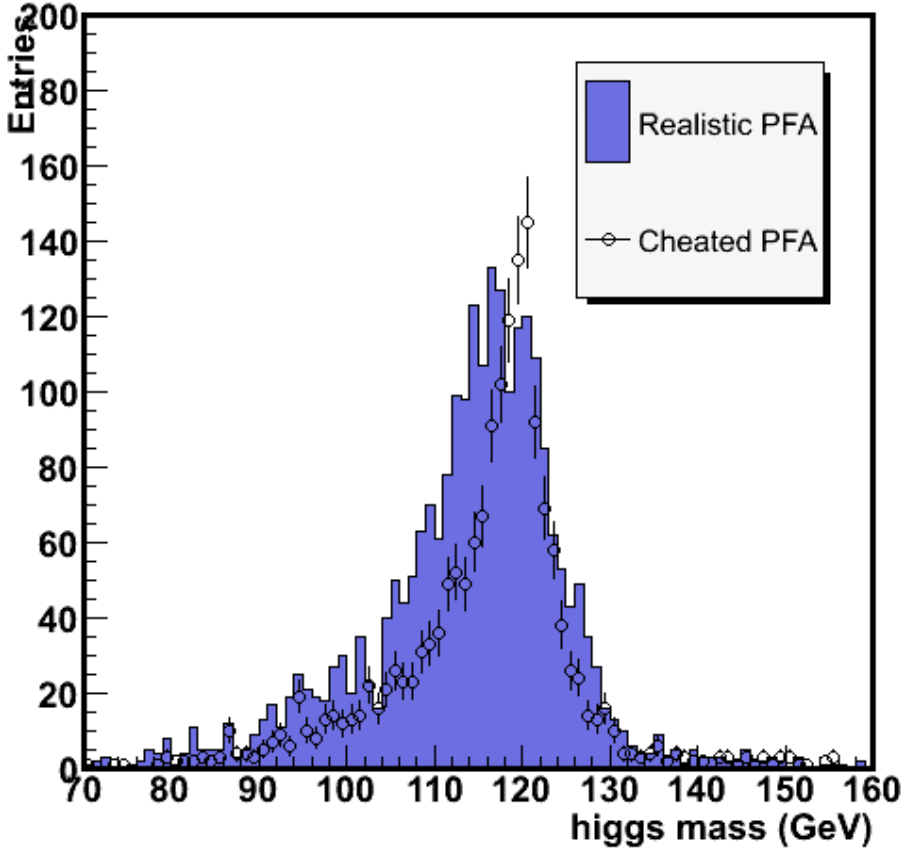
Fit by gaussian : mean -1σ ~ mean +2σ

Compare realistic and cheated PFA

Visible energy



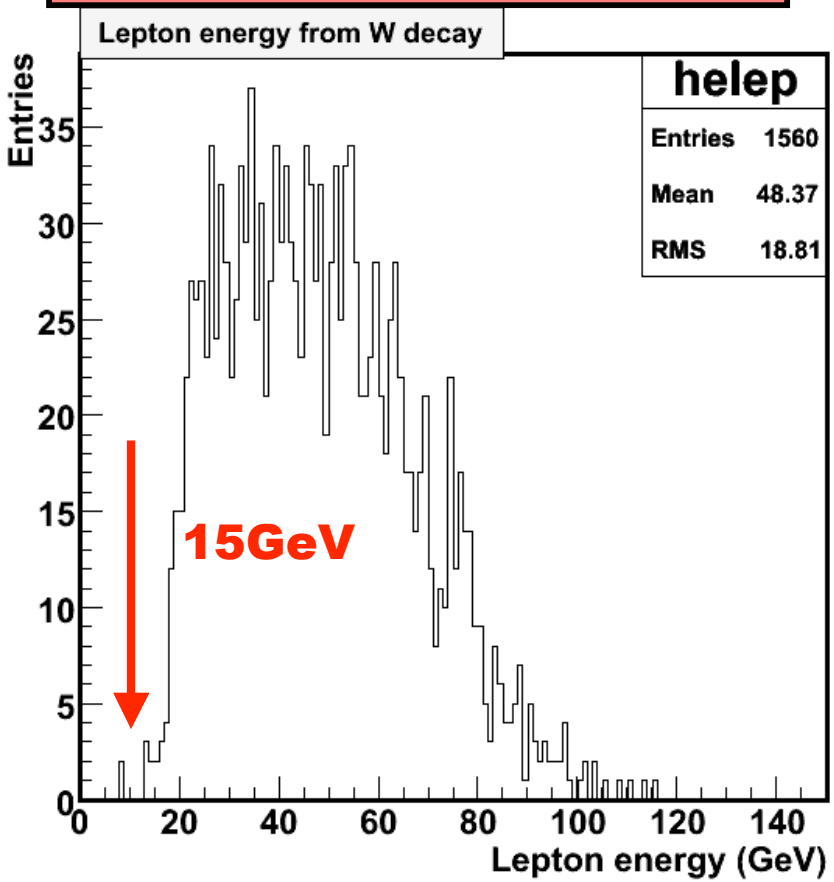
Reconstructed Higgs mass



GLD-PFA case, visible energy is smaller than cheated PFA

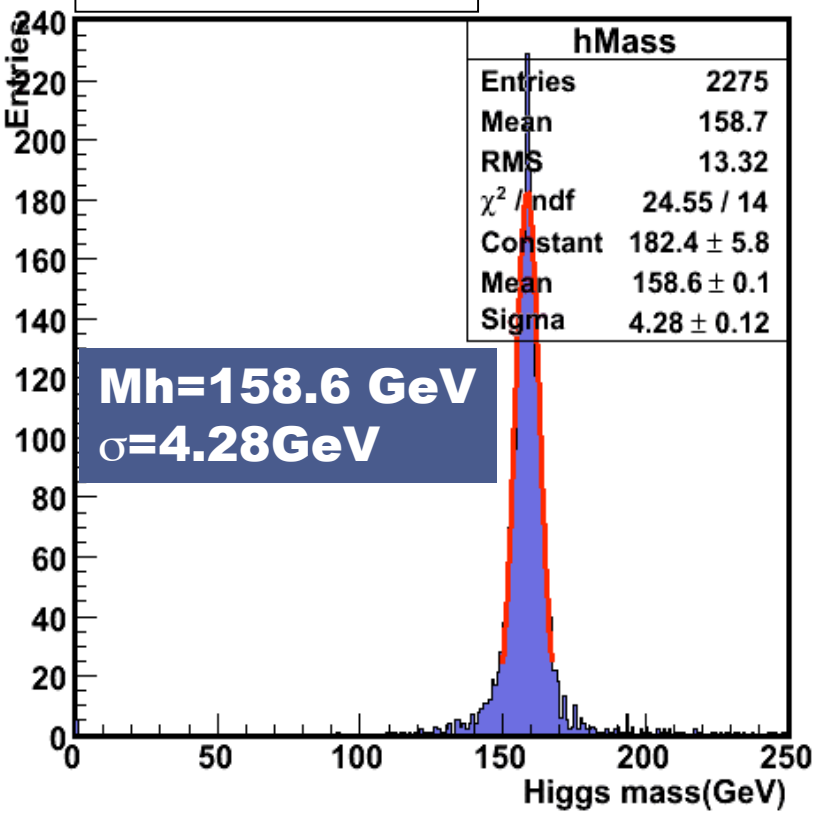
Higgs mass distribution of mh=160GeV

Lepton energy distribution from W decay (MC truth)



$e^+e^- \rightarrow Zh \rightarrow \nu\nu h$ (Ecm=350GeV)
$h \rightarrow WW$ (91%), $h \rightarrow qq'qq'$

Mh = 160 GeV



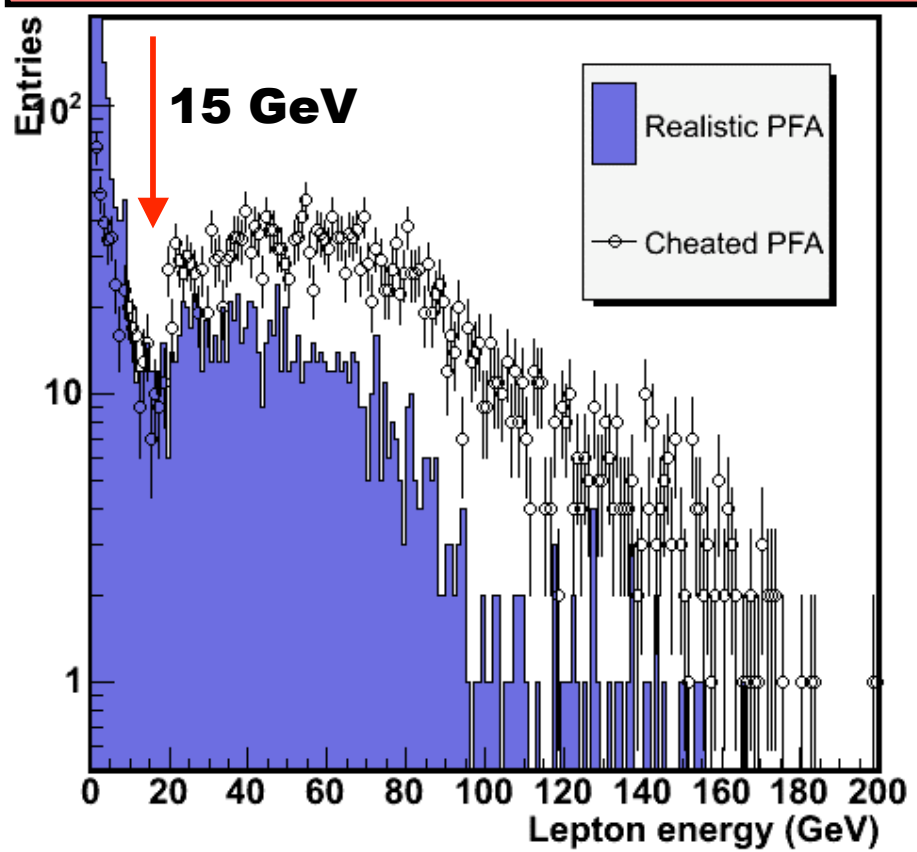
Invariant mass of all PFOs with cheated PFA

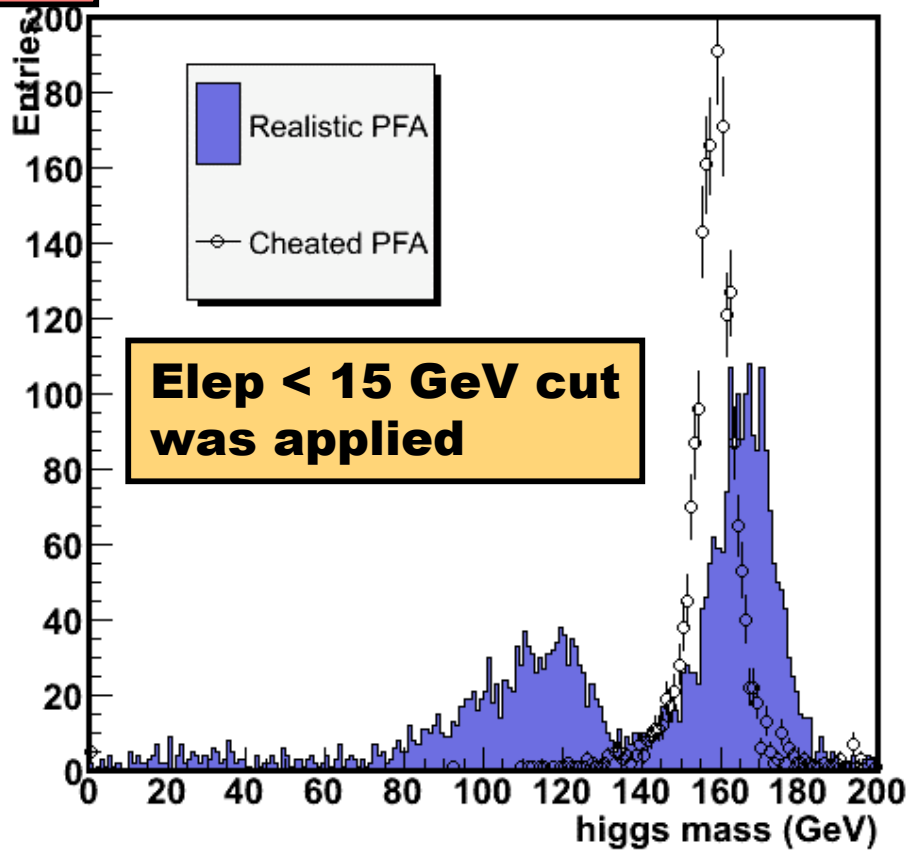
Realistic PFA with Mh=160GeV

$e^+e^- \rightarrow Zh \rightarrow \nu\nu h$ (Mh=160GeV, Ecm=350GeV)

Lepton energy distribution (PFOs)

Muon is cheated in GLD-PFA
Electron treatment is incorrect?



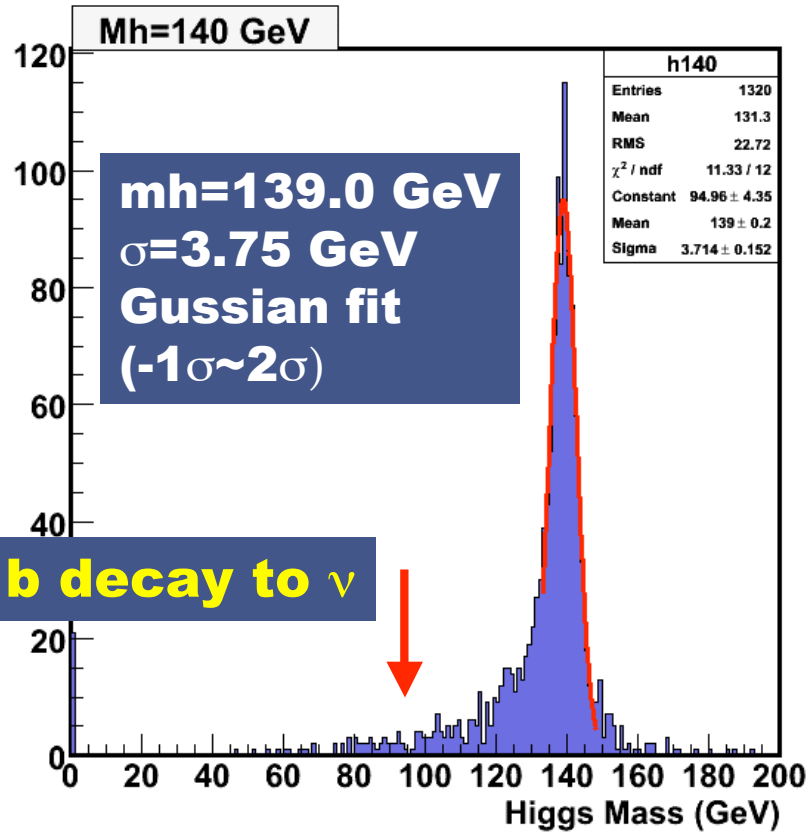


Higgs mass distribution of M_h=140GeV

$e^+e^- \rightarrow Zh \rightarrow \nu\nu h$ (Ecm=350GeV)
Mh=140 GeV

Br(h→WW) = 48%
WW→qq'qq' (4jets)
WW→lνqq' (lepton+2jets)
WW→lνlν (2leptons)
Br(h→bb) = 34% (2jets)

Cheated PFA

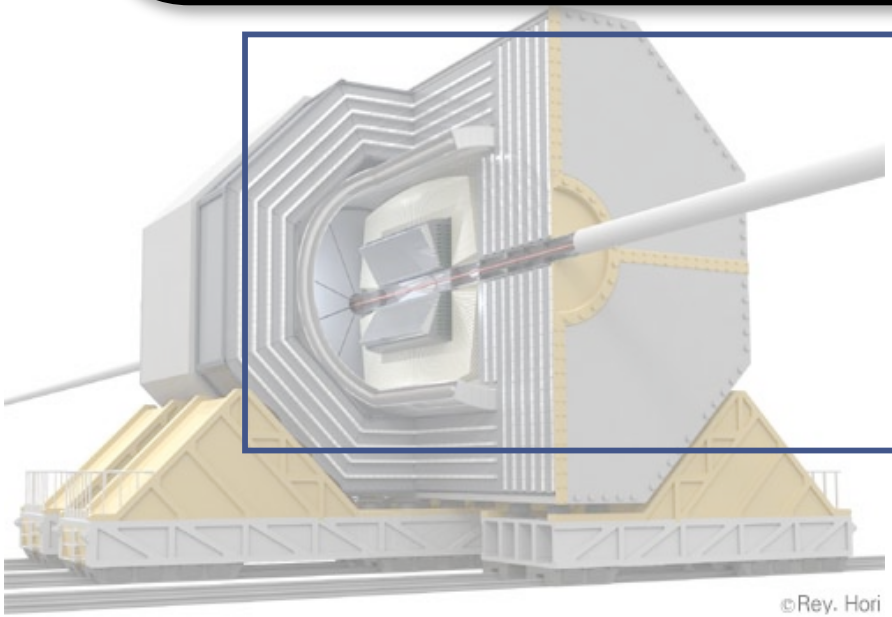


Invariant mass of all PFOs

Summary and next steps

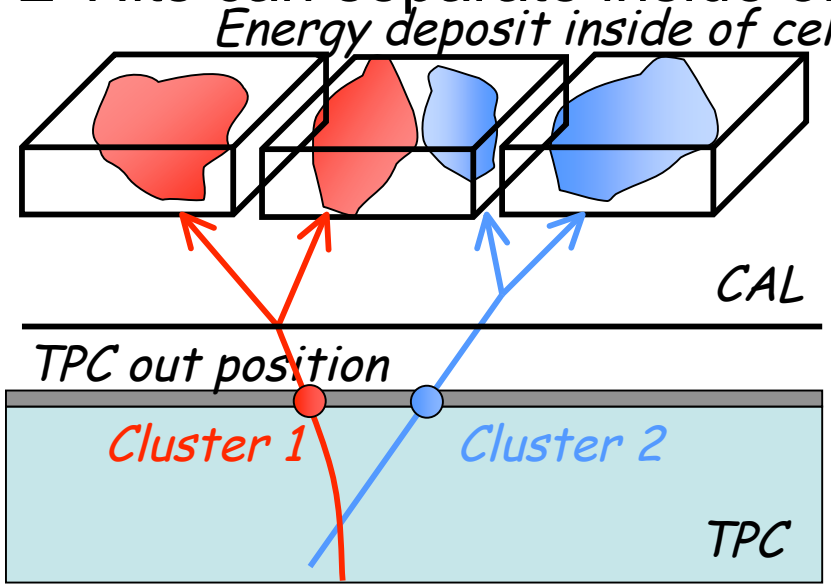
- We start to compare GLD-PFA performance with cheated PFA using single ZH event at several Higgs masses.
  - Peak of Higgs mass distribution at 120 GeV mass case, a little smaller than cheated PFA, also visible energy looks small. Consider the treatment of scattered events.
- Next step
  - Try to study 4, 6 jets event like $Zh \rightarrow qqh$ mode with Mh=120 GeV, Mh=160 GeV
  - Background study should be also performed.

Backup



Cheated PFA (Perfect clustering)

- Different mother particle's CAL hits have been clustered as different cluster (***perfect clustering***).
- Use track information for charged particle and remove charged track related cluster from CAL. (PFA)
- Hits can separate inside of cell (***Infinite segmentation***)



Switch merging at Satellites
- Not merged:
  - Infinite segmentation
- Merge hits:
  - Merge hits inside of the cell and mother particle is assigned as largest energy deposit