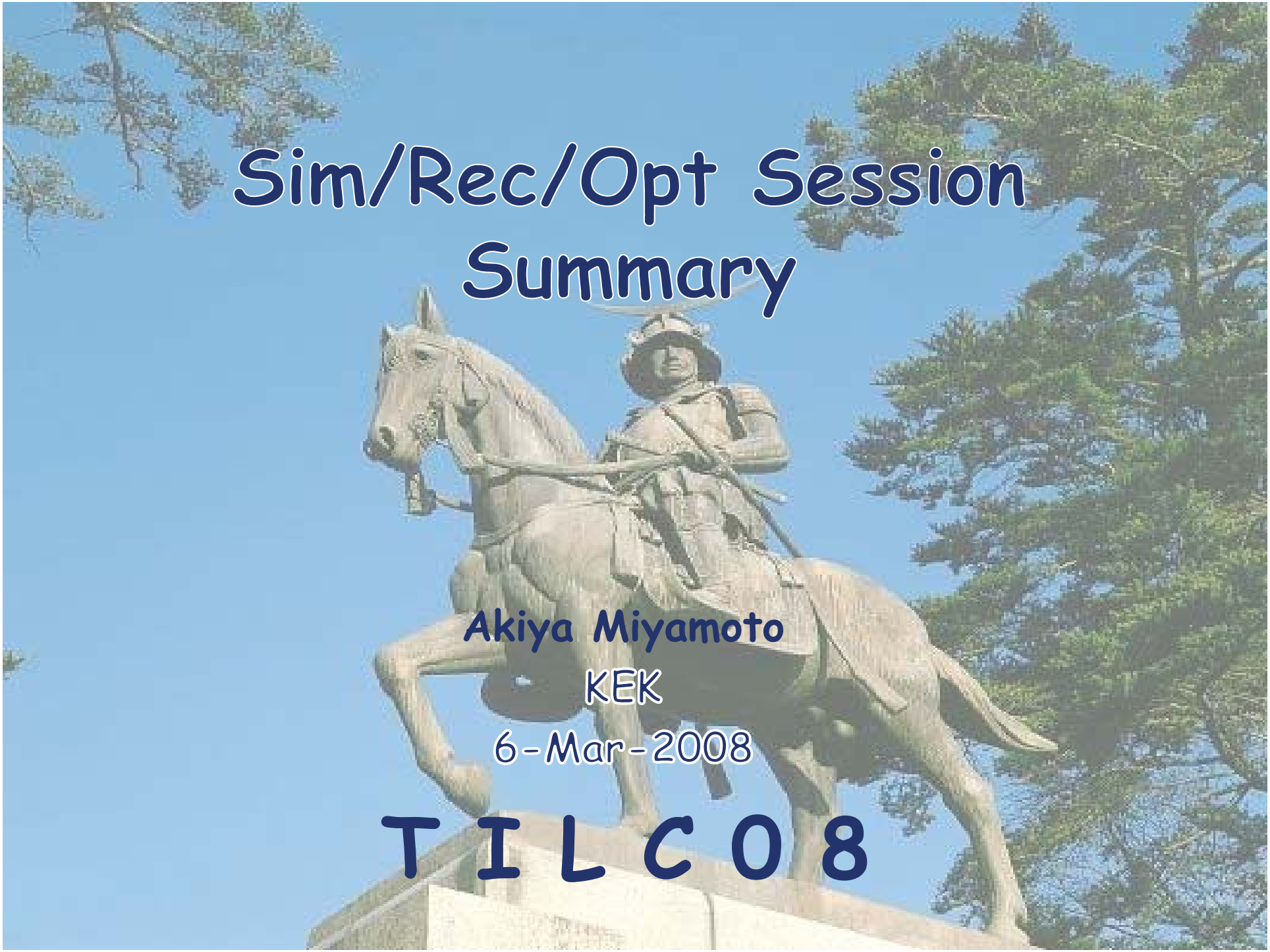


Sim/Rec/Opt Session Summary

Akiya Miyamoto
KEK

6-Mar-2008

TILC08

Subjects of this WG

Norman Graf, ACFA Plenary

From Physics Studies to Benchmarking

- We believe that the physics case for a TeV-scale linear e^+ e^- collider has been made.
- The emphasis of analyses now shifts towards
  - Optimization, evaluation and comparison of detector choices
  - Realities required by engineering: e.g. amount and distribution of support material
  - Realities required by realistic detector response simulations: e.g. electronics digitization
  - Realities required by reconstruction algorithms: e.g. track finding & fitting, PFA

Our subjects

Topics of our session

14 talks in 3 sessions

Simulator/Reconstruction framework

- ALCPG Detector Software Development (25') Norman Graf (*SLAC*)
- Mokka, Marlin and friends. Status of ILD_LDC framework (25') Frank Gaede (*DESY*)
- Jupiter/Satellites framework (20') Akiya Miyamoto (*KEK*)
- Preparation for jet analysis of Jupiter data using MarlinReco/PandoraPFA (20') Satoru Uozumi

Reconstruction

- Tracking in SiD and on PFA (20') Norman Graf (*SLAC*)
- The PandoraPFA (20') Mark Thomson (*University of Cambridge*)
- LCFI Vertex Package: Parameter Optimisation (20') Sonja Hillert (*Oxford*)
- PFA in a strip calorimeter (20') Daniel Jeans (*Kobe University*)
- Electron ID studies with the LDC detector (13') Roman Poeschl

Optimization/Benchmark

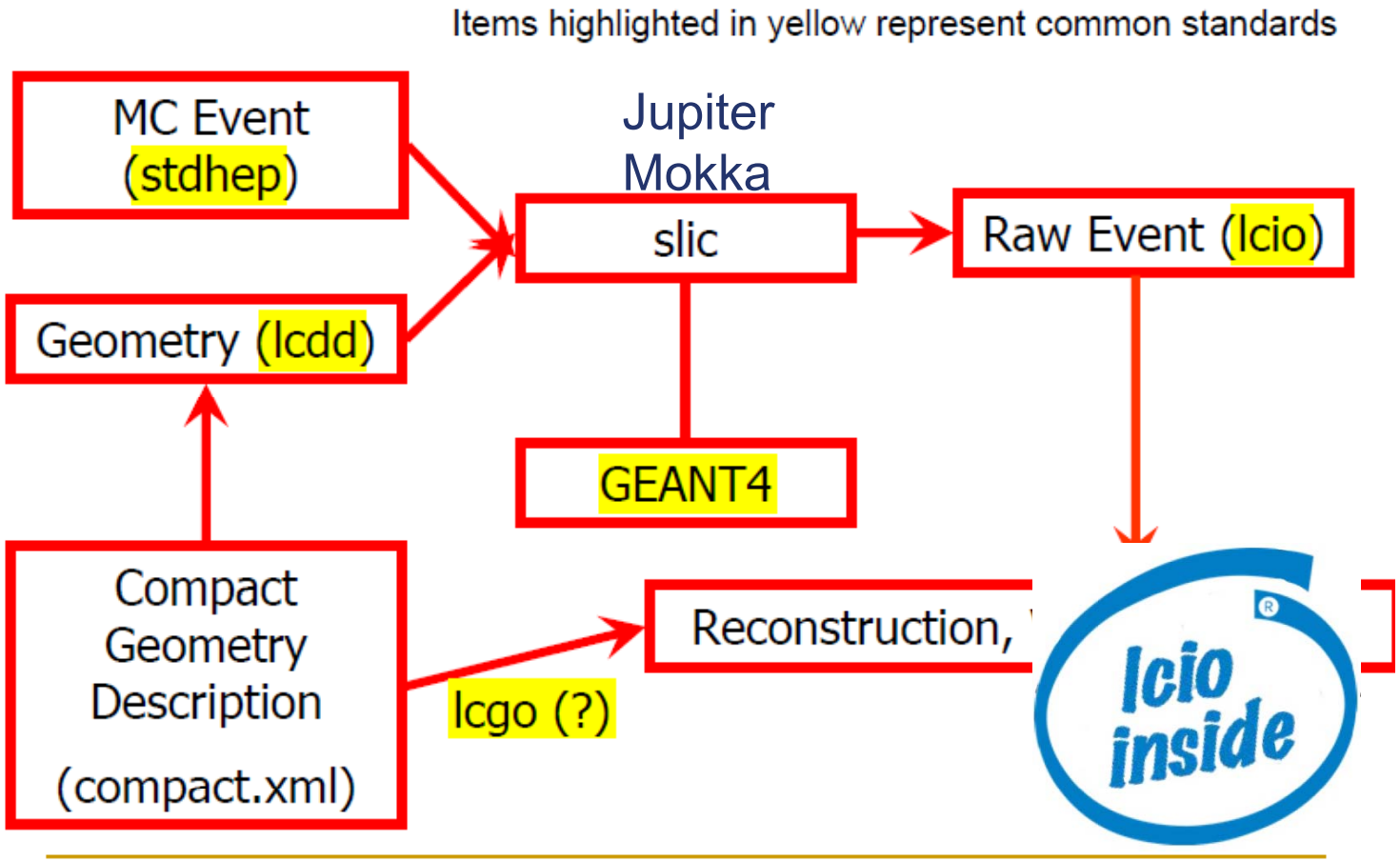
- SiD Global Parameter Optimization using PandoraPFA (18') Marcel Stanitzki (*Rutherford Appleton Laboratory*)
- SUSY analysis with full simulation (18') Tamaki Yoshioka (*ICEPP, Univ. of Tokyo*)
- Study of ZH recoil mass (18') Kazutoshi Ito (*Tohoku university*)
- ZH recoil mass analysis (18') Zhiqing Zhang (*LAL*)
- ZH study with full simulation (18') Hiroaki Ono (*Nippon Dental University*)

Apologies if your talk is not summarized properly. See program page for details

Simulators

LC Detector Full Simulation

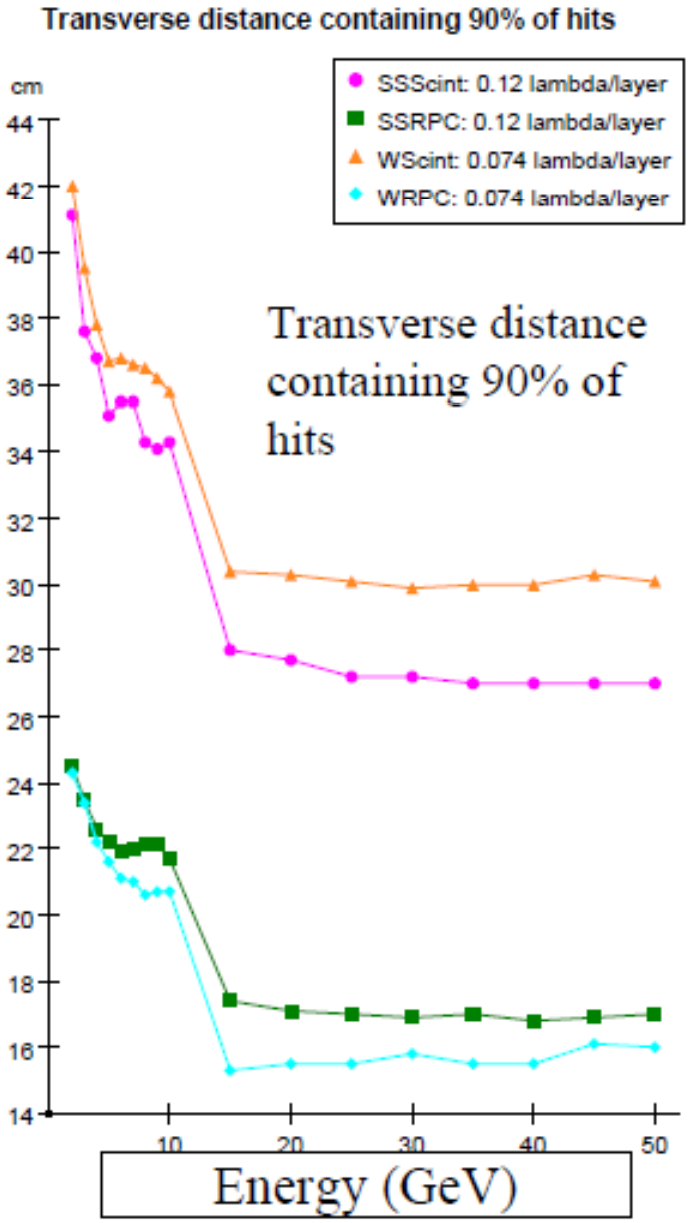
Norman Graph



Physics Lists & Hadron Showers

Norman Graf

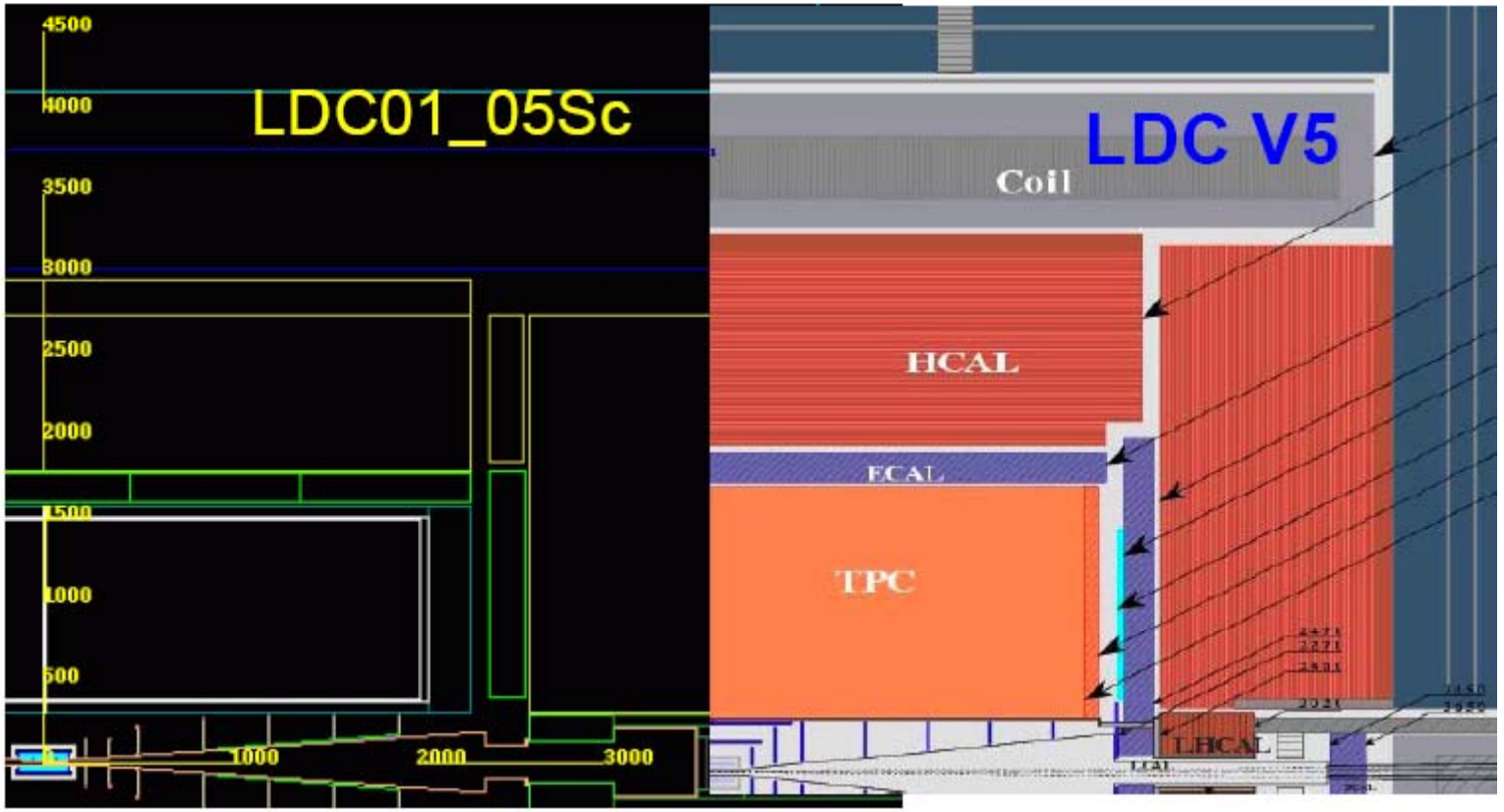
- Number of issues still unresolved with choice (or not) of showering models.
- For many neutral hadrons LHEP (Gheisha-inspired) is only choice.
- Transition regions still very worrisome.
- LCPhys is still default, but all lists available.
- FTFP_BERT looks good.



Towards realistic model

Frank Gaede

LDC detector in Mokka

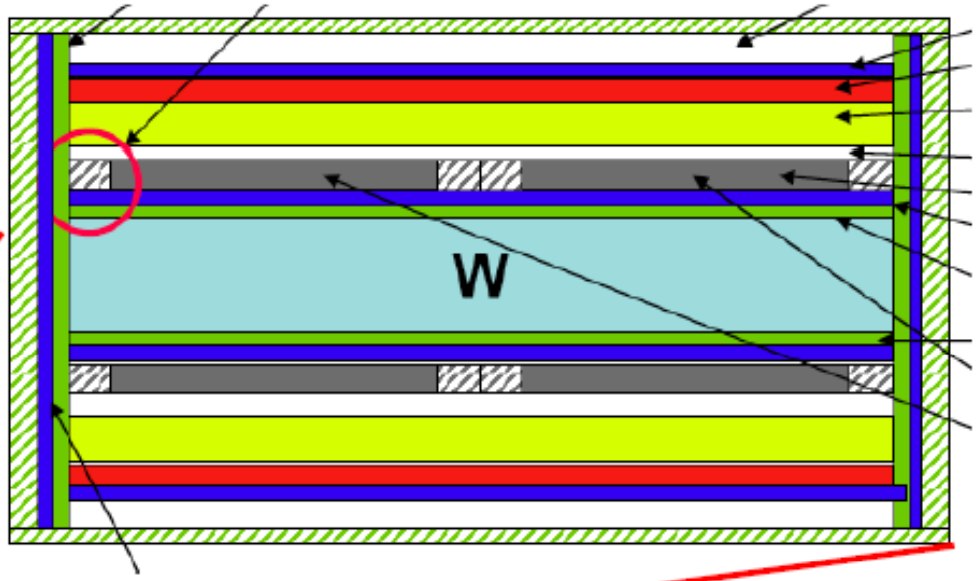


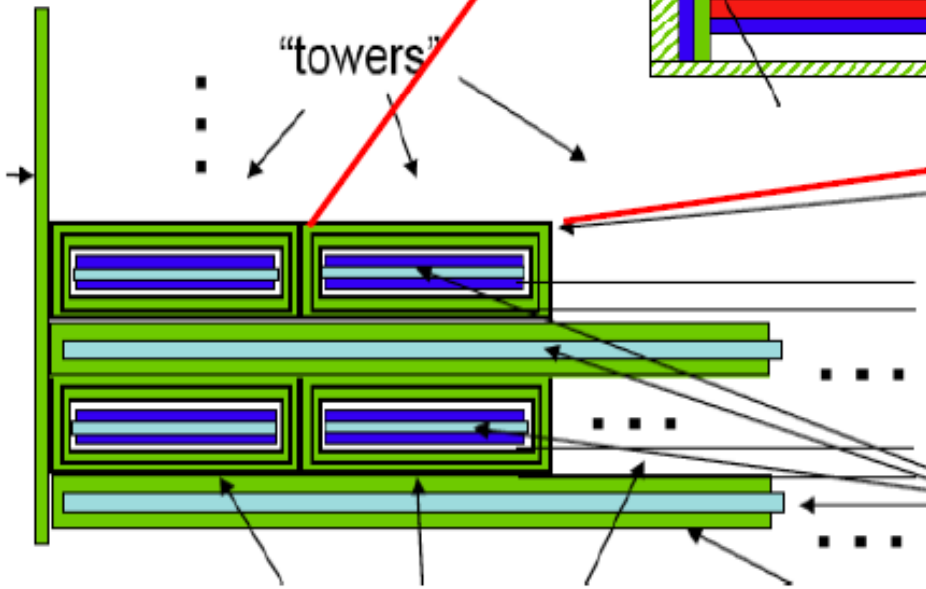
- **a detailed description of LDC exists in Mokka**
- close to proposed design of LDC V5
- lots of fixes and improvements in the last months:
  - HcalRing, Lcal, Ecal, SIT, FTD, ... (see next slide)

Frank Gaede, TILC08, Sendai, Japan, March 3-6, 2008

improved Ecal in Mokka (P.Mora)

- description on 'engineering level'
  -> **more realism & reduced performance**





N_FIBERS_ALVOULUS
X Ecal_fiber_thickness

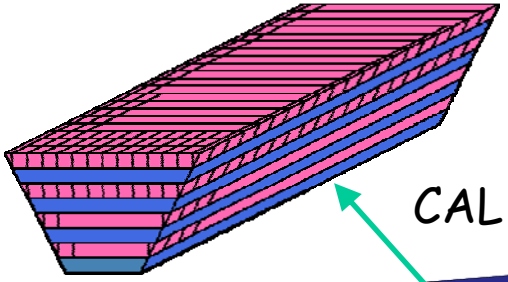
how much realism
do we want/need for LOI ?

W plates

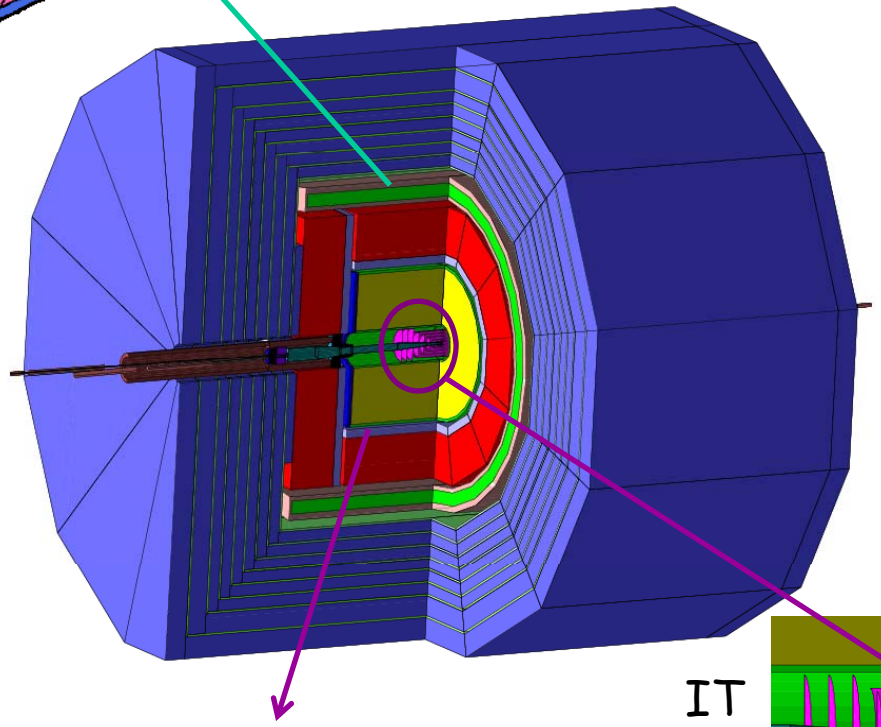
GLDPrime_v03 in Jupiter

Akiya Miyamoto

- Updates since since GLDPrime_v02 (Jan 08)
  - Parameters for VTX, TPC, CAL, Coil, MUD are updated.



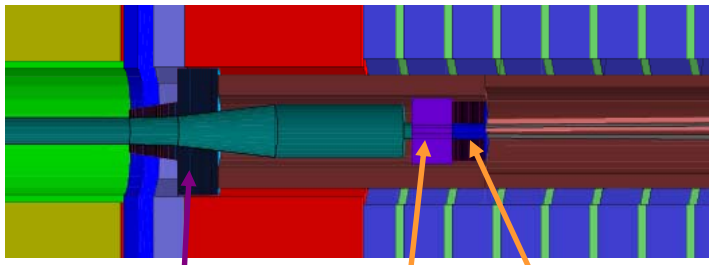
CAL module



Barrel-Endcap
10cm gap

VTX

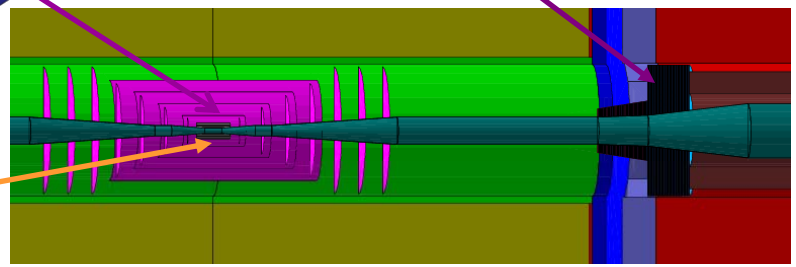
IT



FCAL

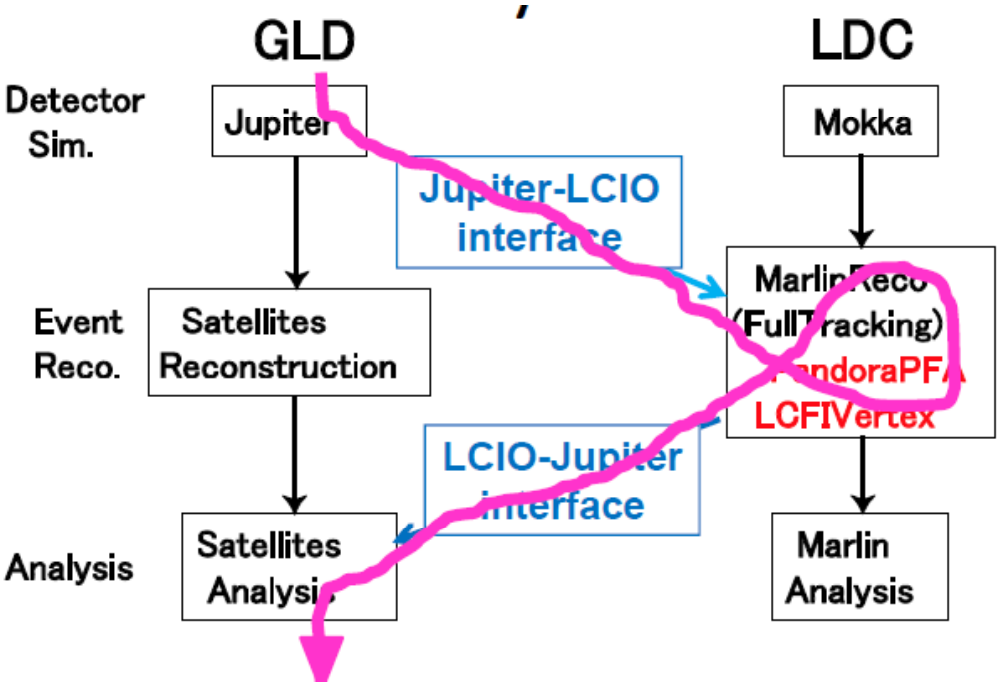
CH2mask

BCAL



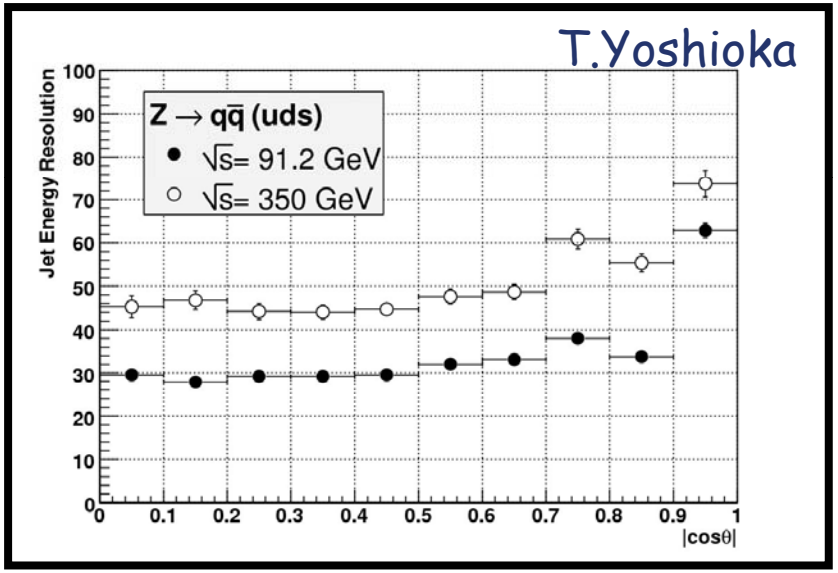
Jupiter → LCIO

Akiya Miyamoto



Satoru Uozumi

Jupiter data reconstructed with LDCFulltracking and PandoraPFA

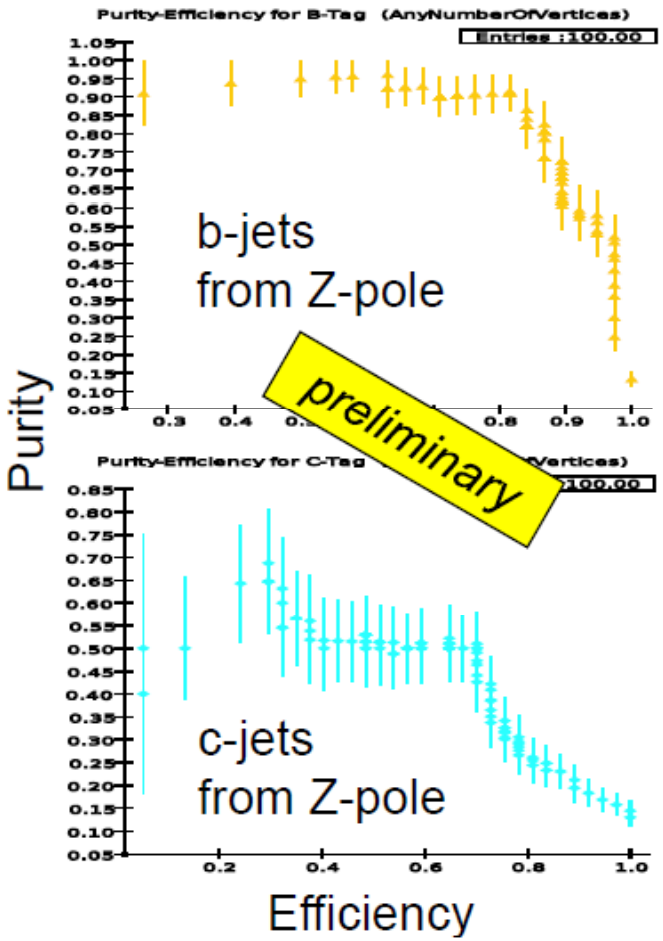


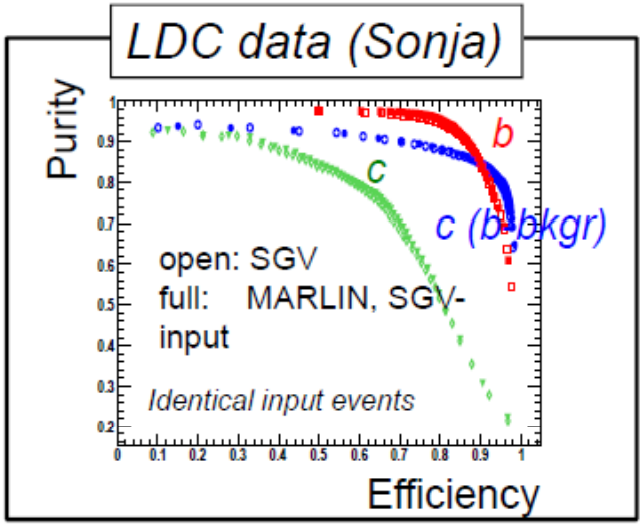
Ejet	JER ($\cos\theta < 0.7$)
45 GeV	30.1 ± 0.3
175 GeV	45.9 ± 0.7

Analize Jupiter data by LCFIVertex

Satoru Uozumi

Flavour tagging with LCFIVertex (Z-pole data by Jupiter&GLD)





- Same neural-net with LDC simulation is used.
- The b-tagging performance is reasonably good.
- c-tagging for c-jets is not yet as good as LDC case, need investigation.

Reconstruction Issues

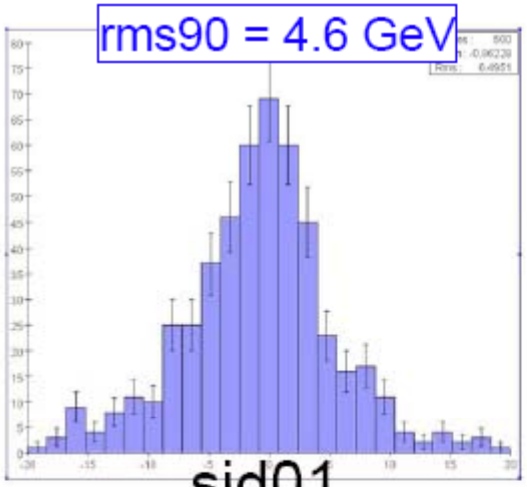
PFA

- Pandora PFA by Mark Tomson
- NA efforts by Norman Graf
  - Argonne (Magille) PFA
  - IOWA PFA
  - Pandora PFA
- PFA for Strip-Sinti. CAL. by Daniel Jeans.

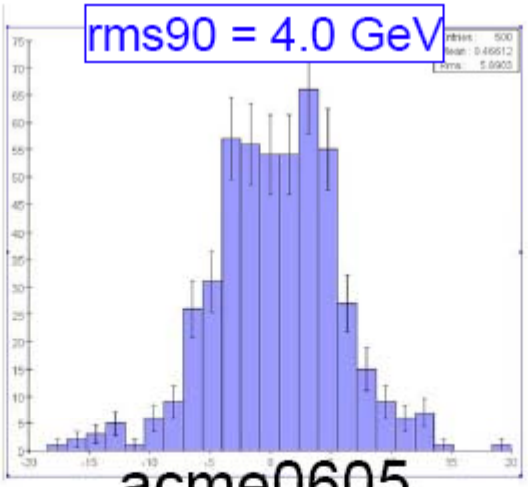
Norman Graf

Progress (Magill): Z-pole performance

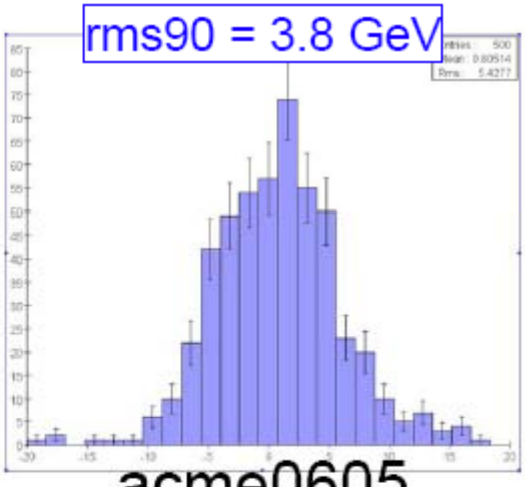
Showing dijet invariant mass for events with |cosθ|<0.9
KT algorithm used to find 2 jets.



sid01
Steel/RPC HCAL
ECAL radius
125cm



acme0605
W/Scint HCAL
ECAL radius
125cm



acme0605
W/Scint HCAL
ECAL radius
175cm

Scint HCAL helps a lot for this algorithm.
- That wasn't the case for perfect PFA... possibly due to E/p checking?

Bigger ECAL radius helps a bit

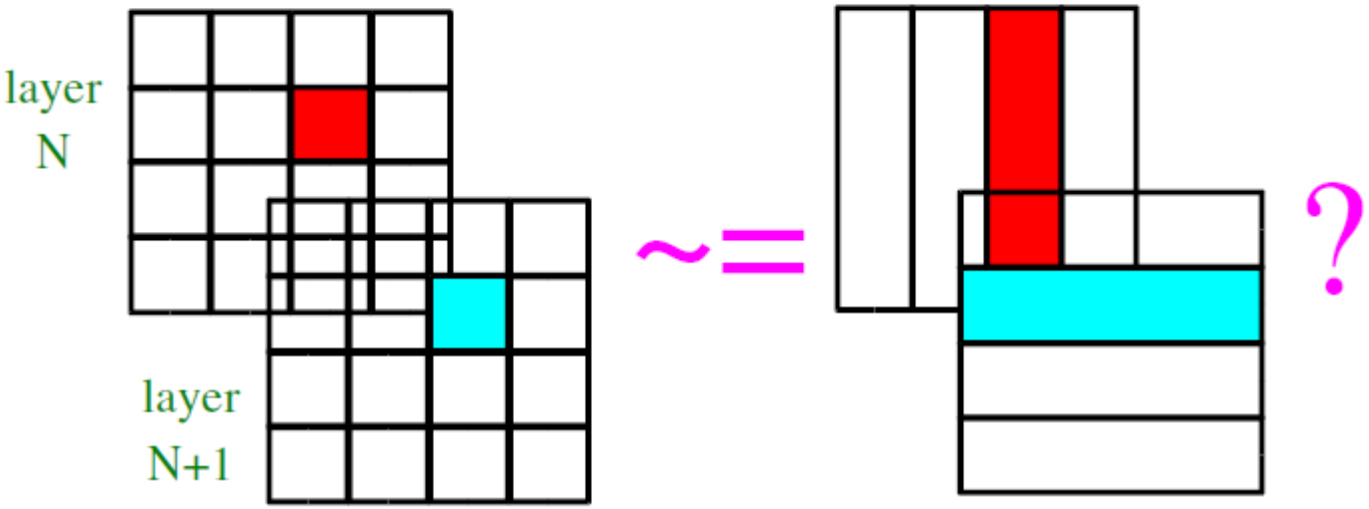
Daniel Jeans

introduction

active material of GLD calorimeter design has strips of scintillator rather than square cells

idea: performance of 1x5 cm^2 strips similar to 1x1 cm^2 cells ?

=> performance / cost (~= # photon sensors)



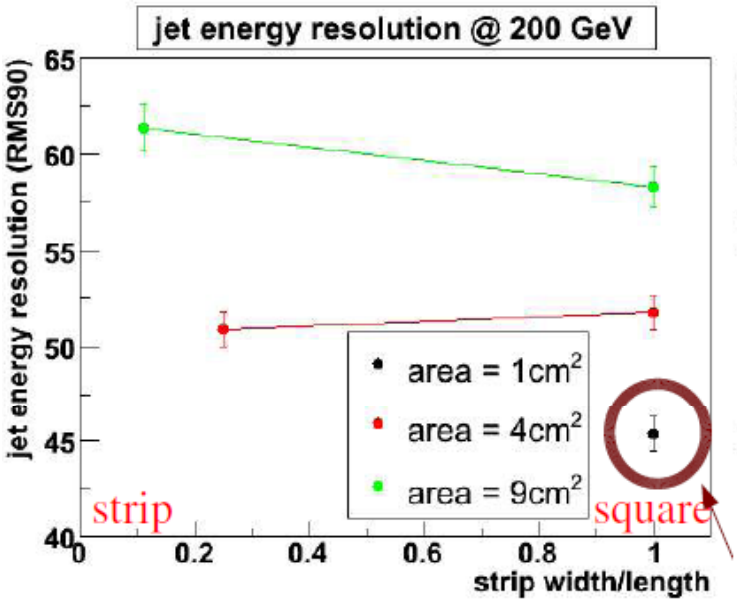
Strip Area/Aspect ratio dep.

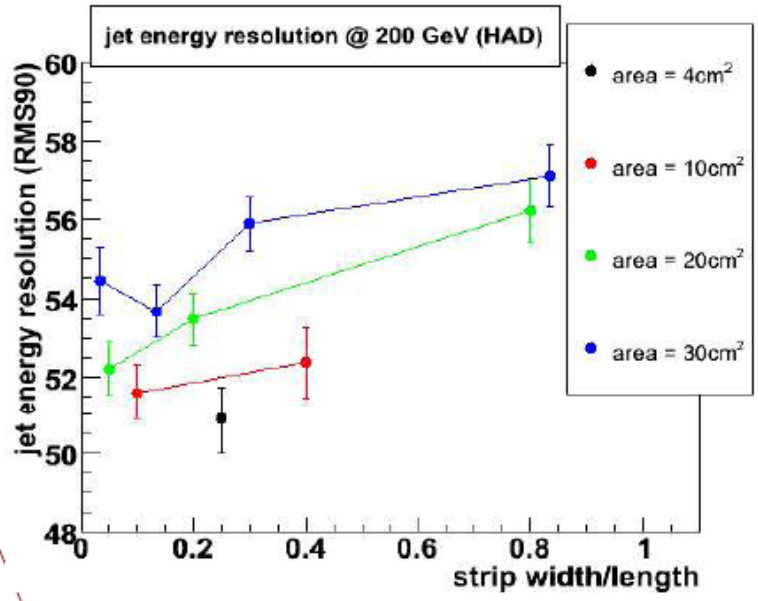
Daniel Jeans

200 GeV qq events (uds only)

all strips have same size

EM fixed (1x4cm^2), vary HD strips





area looks more important than aspect ratio

aspect ratio does have some effect

strip better than square

resolution worse than e.g. PANDORA at high energy

further algorithm development needed

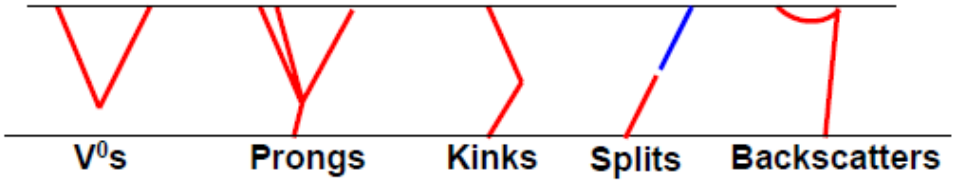
Pandora PFA

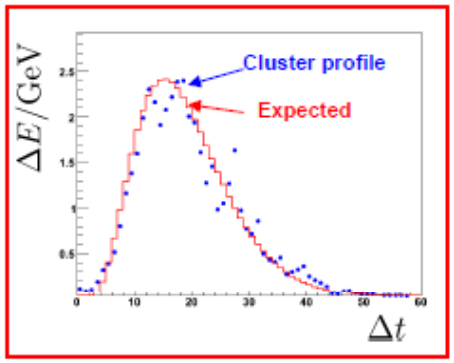
❹ From LCWS07 to Sendai

Mark Thomson

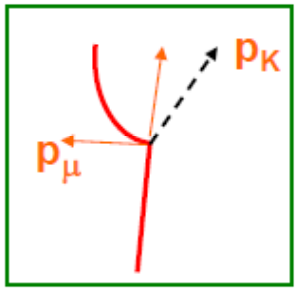
Step 1: improve low energy performance

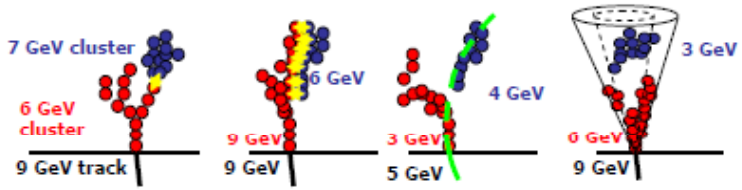
- ★ Technical Improvements/bug fixes
  - reduced memory footprint (~ factor 2) by on-the-fly deleting of temporary clusters, rather than waiting to event end
- ★ Improved track ID





- ★ Much improved photon Identification
  EM shower profile
- ★ Particle ID
  - Much improved particle ID : electrons, conversions, $K_S \to \pi^+\pi^-$, $\Lambda \to \pi^- p$ (no impact on PFA)
  - Some tagging of $K^\pm \to \mu^\pm \nu$ and $\pi^\pm \to \mu^\pm \nu$ kinks
- ★ More sophisticated identification of neutral fragments





+ Improved functionality and compatibilities to new LDC model, …

Pandora PFA performance NOW

LCWS → Sendai: LDC00 (Tesla TDR)

Cheated Tracks

LCWS07 PandoraPFA v01-01

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	0.295	4.4 %
100 GeV	0.305	3.0 %
180 GeV	0.418	3.1 %
250 GeV	0.534	3.3 %

PandoraPFA v02-α

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	0.226	3.3 %
100 GeV	0.293	2.9 %
180 GeV	0.392	2.9 %
250 GeV	0.534	3.3 %

★ For LDC00:

- Slight degradation when using FullLDCTracking
- Small difference may be due to degraded kink finding
- Track cuts not yet optimised

FullLDCTracking

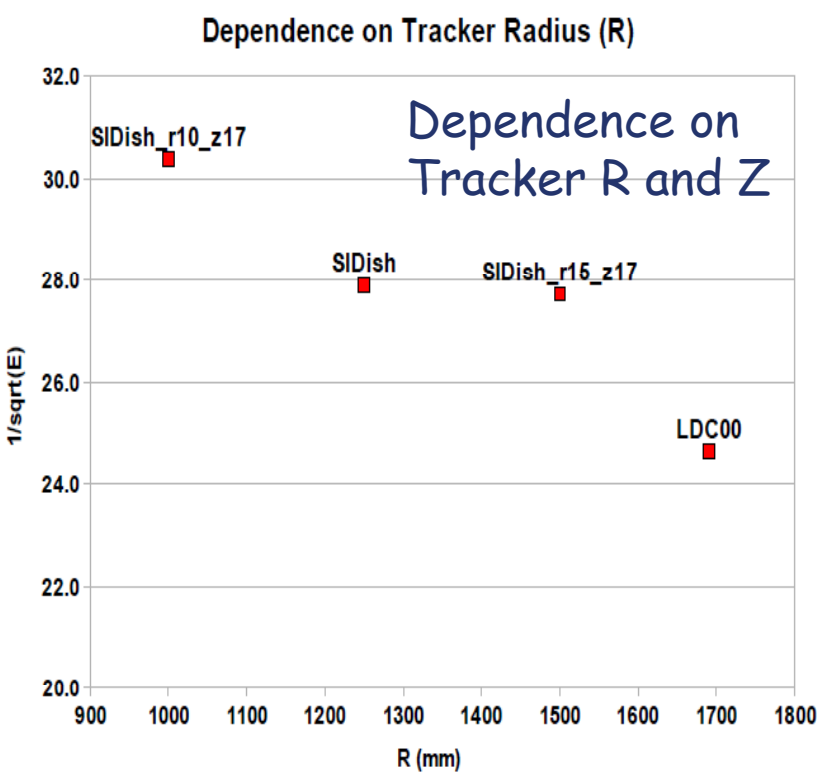
PandoraPFA v02-01

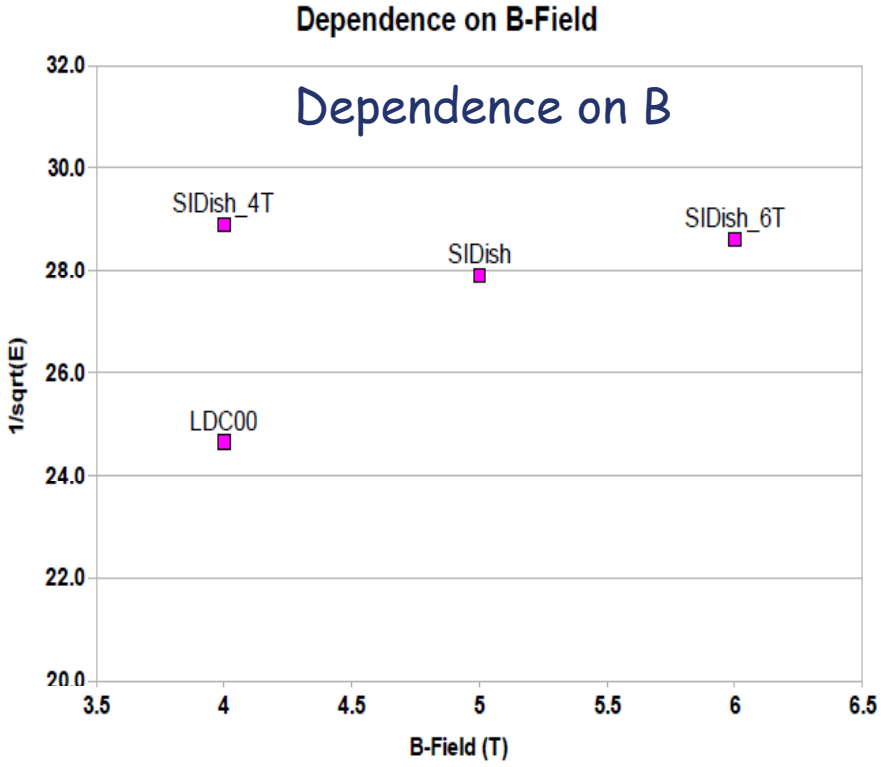
E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	0.235	3.5 %
100 GeV	0.306	3.1 %
180 GeV	0.427	3.2 %
250 GeV	0.565	3.6 %

SiD Global Parameter Optimization Using PandoraPFA

- "SiDish" detector using Mokka/Marlin framework
- Preliminary results of Z pole events (uds only)
- Plan to do study higher energy jets, different segmentation, etc.

Marcel Stanitzki

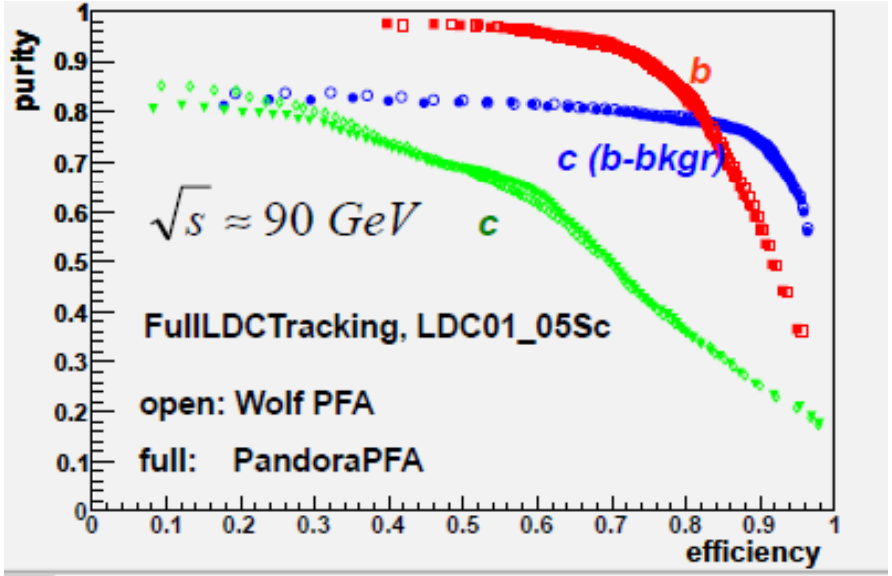




LCFI Vertex Package

Sonia Hillert

- LCFI Vertex is the standard vertexing package.
- Consistent performance with Pandora PFA and WOlfPFA



Need a training of neural network to apply to the flavor tagging.
Now preparing for trainings using mass production data

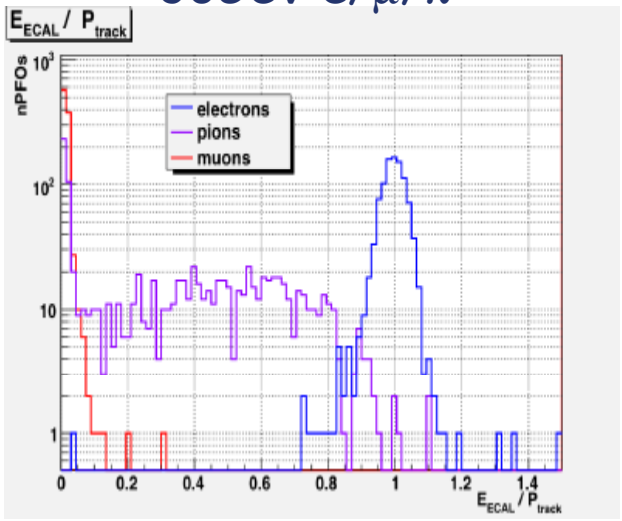
Cut-based electron ID

Roman Poschl

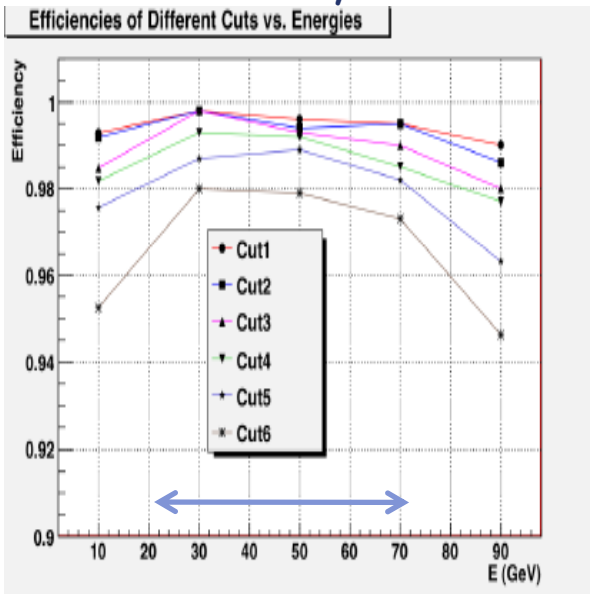
- At this stage, PandoraPFA is not able to identify electron
- Cut based electron ID
  - Variables: Ecal/Ptrack, Ecal/Etotal, Rp(cluster size)

Etrack/Ptrack

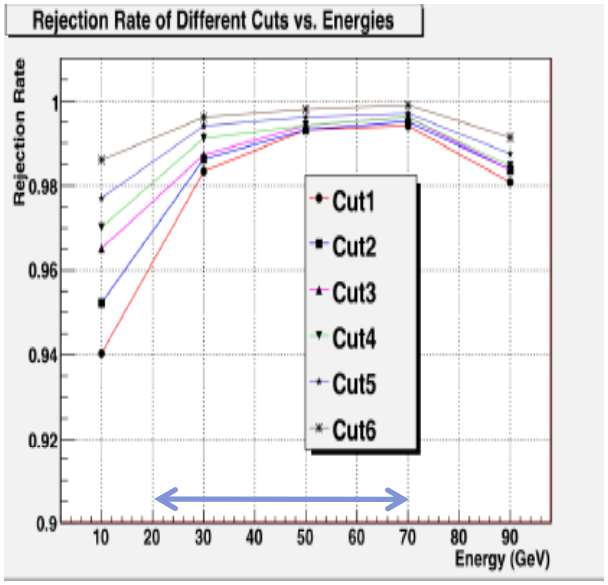
30GeV e/μ/π



Efficiency



Rejection rate



For ee→ZH→eeX, P = 20~70 GeV
Efficiency > 99.5%, Rejection rate for pion > 95~98%

Studies on Benchmark processes

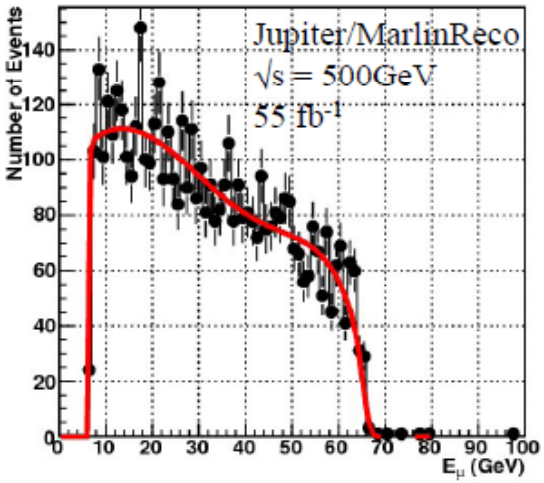
Studies on Benchmark processes

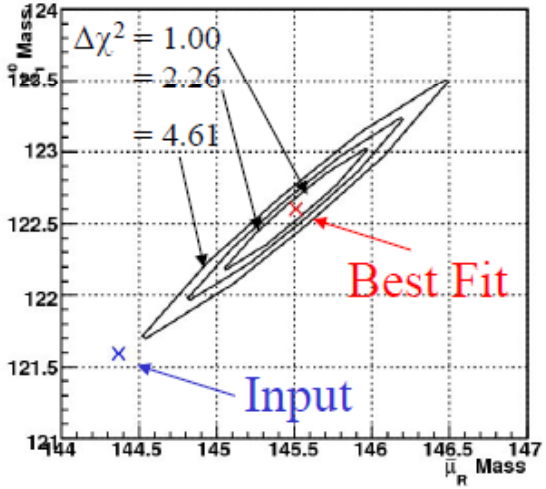
- Studies by Full Simulation, including preliminary results
- Processes
  - Smuon pair & Chargino : T.Yoshioka
  - ee→ ZH → μμX
    - K. Itoh
    - Z.Zhang
  - ee → ZH → ννH / qqH

Smuon and Chargino

Tamaki Yoshioka

- Smuon pair: √s=500GeV, 55fb^{-1}

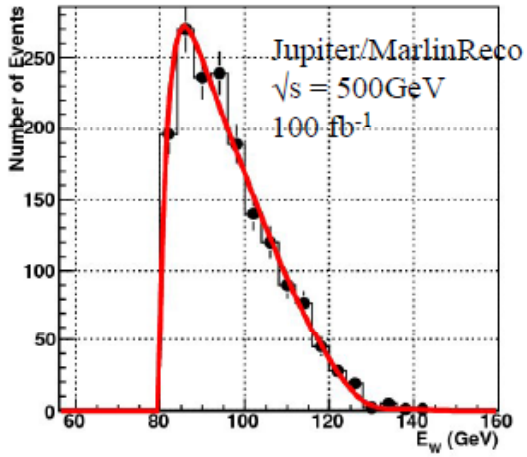


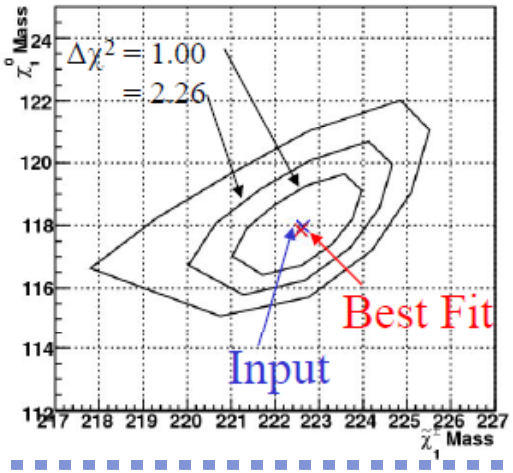


$$\Delta m(\tilde{\mu}_R) = 0.42\,\text{GeV}$$
$$\Delta m(\tilde{\chi}_0^0) = 0.42\,\text{GeV}$$

- ΔM is consistent with Quick-Sim results
- Mass sift of ~1 GeV is not seen if track cheater is used. ➔ need more study

- Chargino pair: √s=500GeV, 100fb^{-1}





$$\Delta m(\tilde{\chi}_1^{\pm}) = 1.10\,\text{GeV}$$
$$\Delta m(\tilde{\chi}_0^0) = 1.23\,\text{GeV}$$

- ΔM is consistent with Quick-Sim results

ZH → μμH - 1

Kazutoshi Itoh

Fitting function

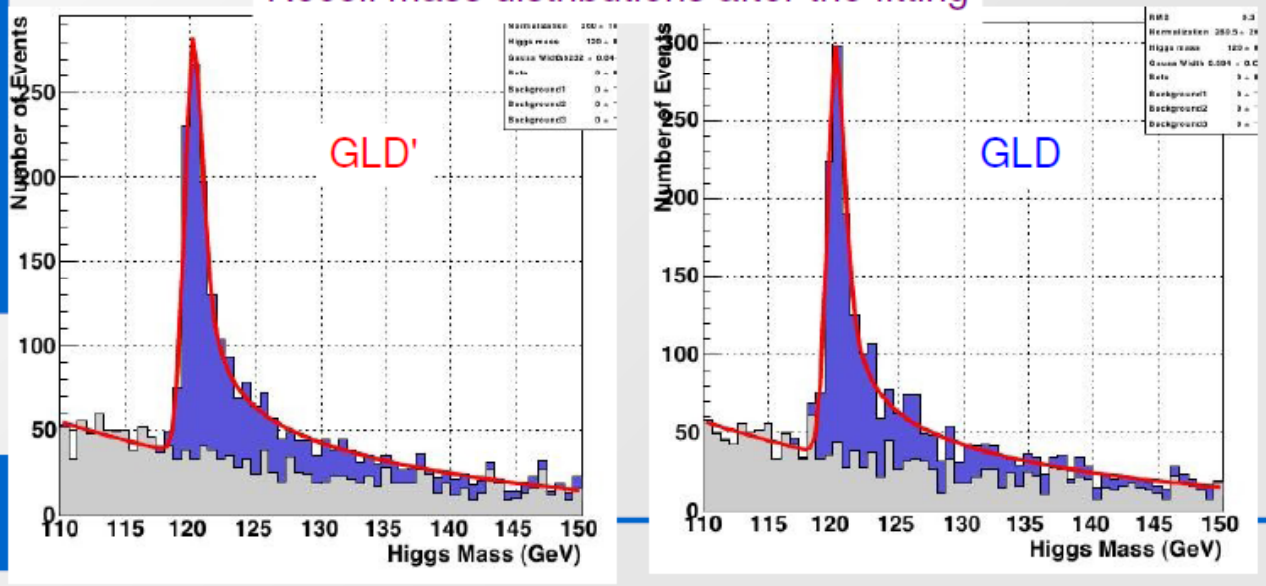
- The distribution of the recoil mass is fitted by a function:

$$F(m) = N_H \int F_H(m,t)\, e^{\frac{-t^2}{2\sigma^2}}\, dt + F_Z(m)$$

$$F_H(m,t) = \left(\frac{m+t-M_h}{\sqrt{s}-M_h}\right)^{\beta}$$

$$\beta = \frac{2\alpha}{2\pi \log \sqrt{s}/m_e - 1}$$

Recoil mass distributions after the fitting



- √s=250GeV,L=335fb^{-1}
- Visible Higgs decay assumed.
- Background: ZZ only

Results

Δσ : 3.1%(GLD')
3.0%(GLD)

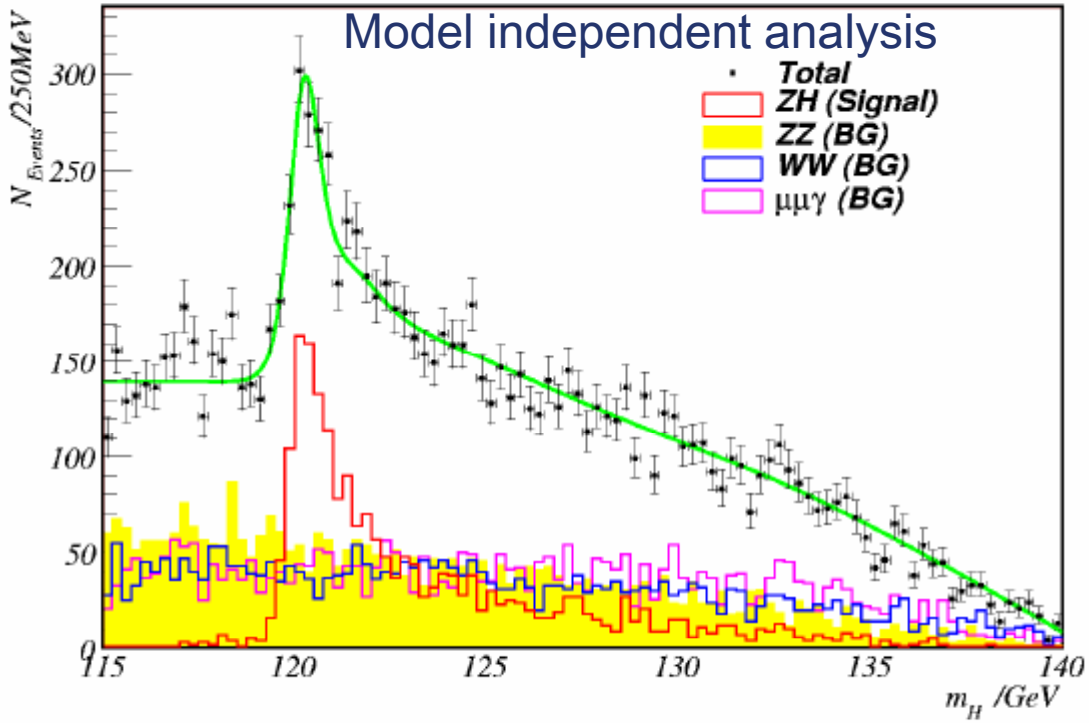
Δm_H: 40.8MeV(GLD')
37.9MeV(GLD)

(cf. Δp/p(GLD')
~ 1.2 Δp/p(GLD))

ZH → μμH - 1

Z.Zhang

- Analysis was updated using new μ-ID code
- Study at √s=230GeV, 500fb^{-1}
- Model independent result : Δm_H=39MeV
- Assuming SM like Higgs or Invisible Higgs, ΔM_H = 29 MeV



Beam parameter dependence
(√s GeV)
ΔM_H= 24.7 MeV (230)
= 31.9 MeV (250)
=109.1MeV (350)

L*=4.5m case.
Machine time is normalized to 500fb^{-1}@√s=500GeV

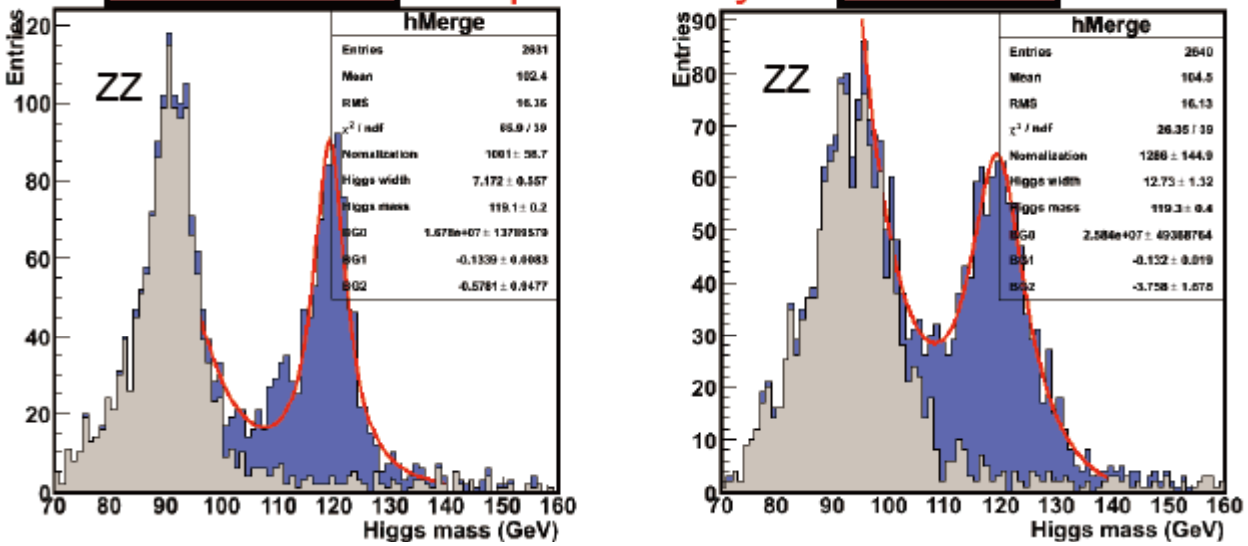
For the best ΔM_H, the optimization of the beam parameter is important as well as detector parameters

ZH → νν̄H, qq̄H

- Study using GLD-PFA(~ 30%/√E at Z^0, not good at higher energy) Hiroyuki Ono
- Studied at √s=350 GeV

ZH → νν̄H case

Cheated PFA preliminary GLD-PFA



- Luminosity : $\mathcal{L}$=200 fb^{-1}
- Higgs mass is calculated as reconstruct invariant mass of 2-jets
- Background events are only ZZ mode

δMh=180MeV (Cheated)
δMh=380GeV (GLD-PFA)

Higgs mass can be reconstructed for both PFA
but the width is still wider than cheated in GLD-PFA

Summary

- Geometry description of full simulators improve towards realistic simulation of detector performances
- Progresses of reconstruction codes were reported. They will play are central role in coming detector optimization and benchmark studies.
- Preliminary results of studies of benchmark processes using full simulation were reported.