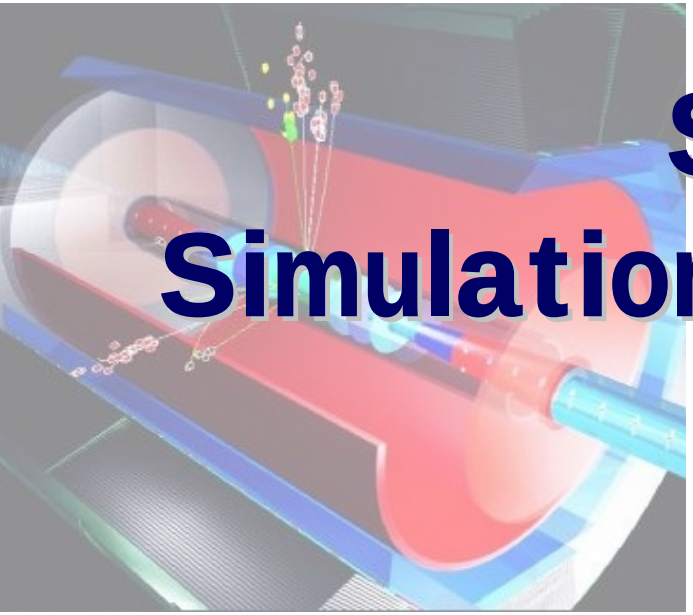


Summary of Simulation and Reconstruction Session

Akiya Miyamoto
KEK

22-March-2005, LCWS2005

I apologize if your topics is not covered properly.

Goals of our study

- Detector Concept studies are ahead of us.
  - Simulation and Reconstruction are key tools for this study.
  - Performance has to be studied based on realistic models.
    - Requires realistic simulation and reconstruction
- The design of ILC requires
  - Feed back from a detector point of view.
    - Physics impacts, backgrounds, …

Software Categories

- Generators
  - Physics events
  - Background events
- Simulators
  - Fast Simulators
  - Full Simulators
  - Special Simulators
- Reconstructions
  - Digitizer
  - Vertexing
  - Tracking
  - Clustering/PFA
  - PID

- Infrastructure
  - Framework
  - Event Display
  - Analysis tools
  - Conditions
  - Tools for beam tests

Good tools are crucial

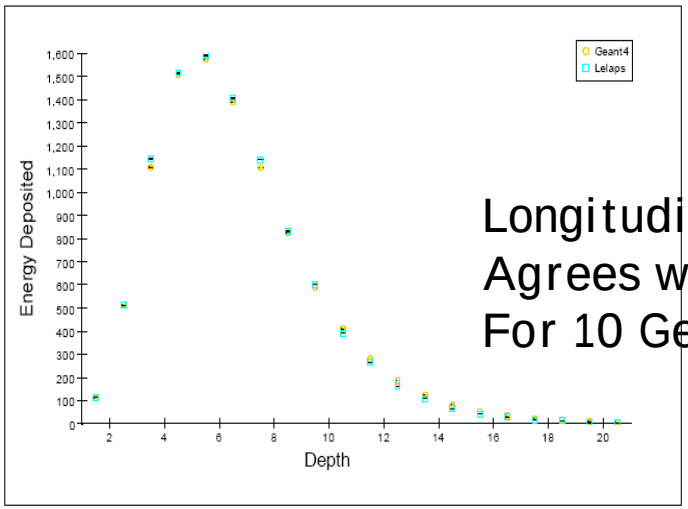
At this workshop,
- 4 sessions
- 23 talks
- 15min. discussion

Infrastructure

- File IO & Data model: LCIO widely accepted.
- Framework:
  - JSF (Miyamto)
    - C++, ROOT based framework for gen/sim/rec/analysis
  - Marlin (Frank Gaede)
    - C++ framework for modular analysis
    - Several users have started to use Marlin
    - Plan: Port Brahms Reconstruction code and have complete Marline based reconstruction
    - LCCD (Linear Collider Conditions Data)
      - A tool kit for conditions data.
      - Interface to MySQL data base using ConditionsDBMySQL
    - Marlin and LCCD are used for beam test data analysis (R.Poeschi)
  - org.lcsim (Tony Johnson)
    - Evolved hep.lcd and LCIOPlugin
    - hep.lcd is a Java based framework for FastMC, Reconstruction, Analysis, …
    - Goal: Provide detector independent package
    - Core part has implemented. Porting hep.lcd reconstruction

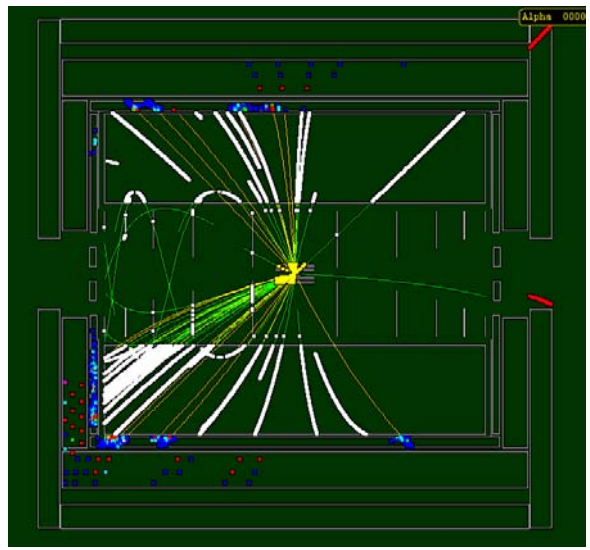
Fast Simulation

- SimDet
- QuickSim
- Lepaps(Willy Langeveld): Read StdHep and Output LCIO
  - Parameterized shower models for EM and HD Cal. Reproduced Geant4 well, except radial distribution
  - Geometry is defined by GODL(General Object Description Language)



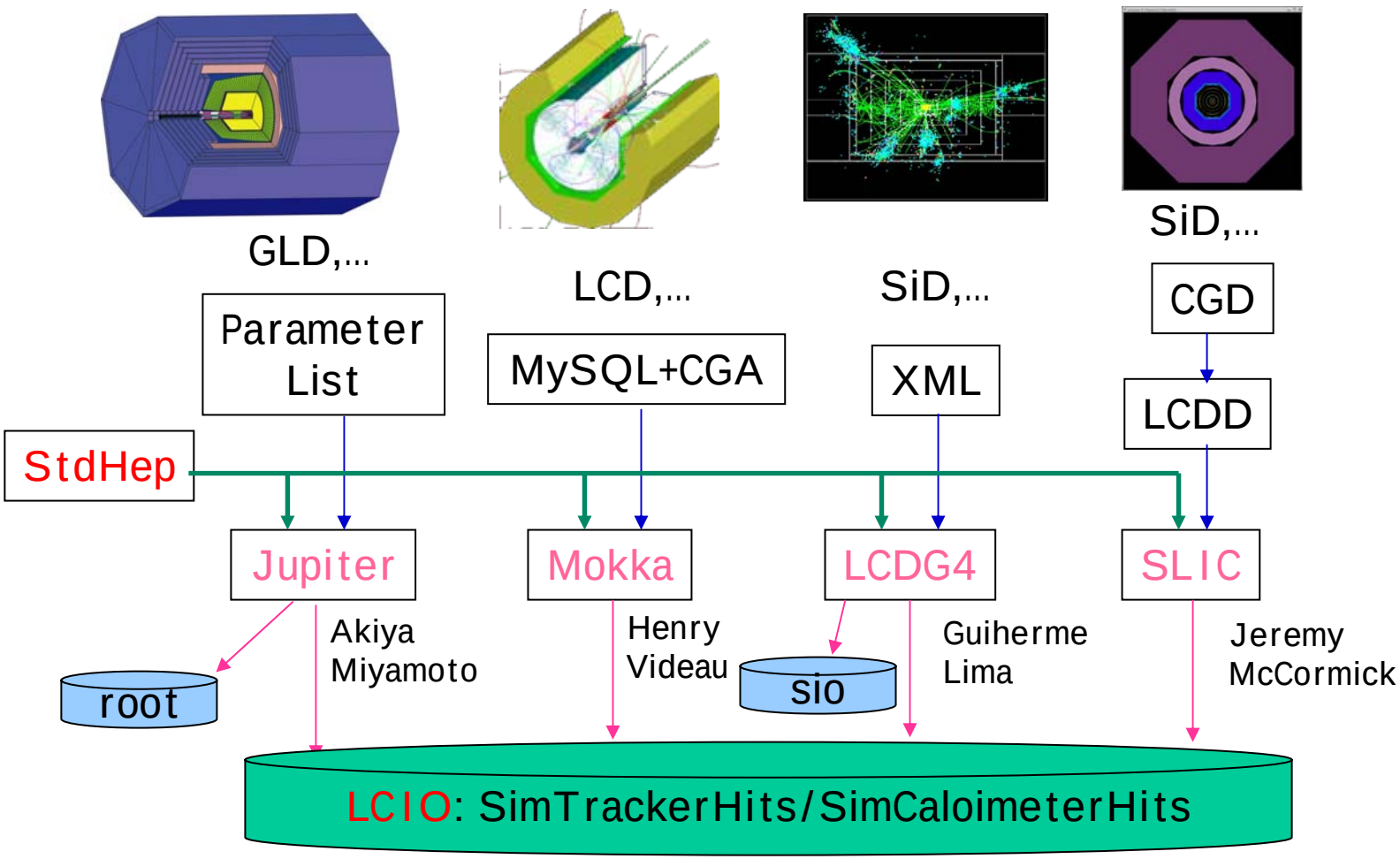
Longitudinal profile
Agrees well with Geant4
For 10 GeV electron

LD Lelaps



Full Simulation

- Geant4, StdHep and LCIO are common feature
- Each trying tobe generic with different different approach
  → different ways to define geometries



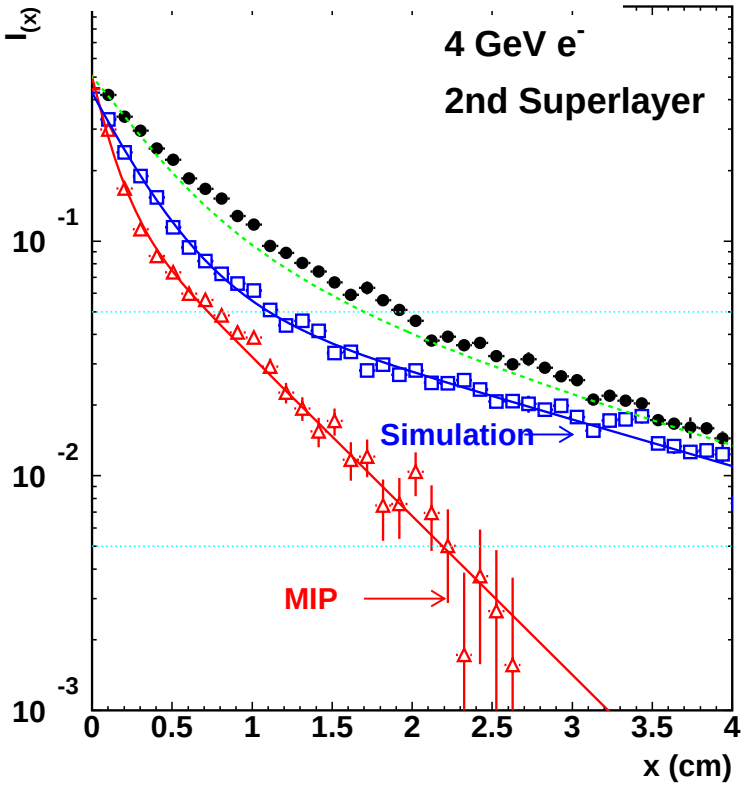
Geant4

- Geant4 is a common toolkit for full simulations
  - It develops rapidly
    - Geant4 7.0p1 (23-Feb-2005)
      - New features: G4UnknownParticle, Improvements in EM and Hadron physics, GDML fully supported.
    - New releases are planned in June/December
  - SLAC-Geant4 team is acting as a liaison between LC activities and Geant4.
    - Home page: http://geant4.slac.stanford.edu/
    - Physics list, LCPHYS, Physics list
      - Extensive tests and validations are/will be carried out
      - Base line to be used for LC related beam tests and full simulation
      - See Dennis Wright's talks at LCSIM05
        http://www.conf.slac.stanford.edu/lcsim05/talks/

Beam test vs Simulation

- EM Cal: Lateral spread of Shower compared with Geant3 simulation (H.Matsunaga)

Pb(4mm)+Scinti.(2mm)



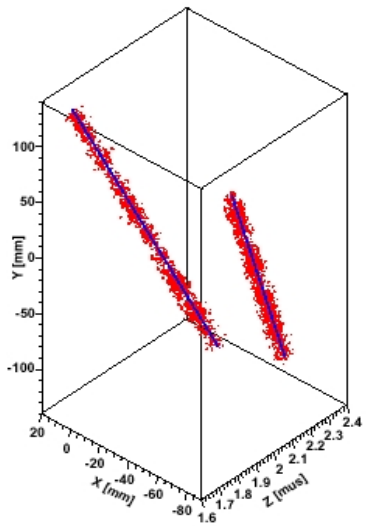
Needs Light leak correction

Systematic verification of Geant4 and data are very important !

Special Simulation Tools

- Shower Libs (B.Drummond)
  - Using LCDG4, Prepared as JAS3 plugin package
    - Create shower file ~ 30GB
    - Improves simulation time – 10 times faster

- TPC simulation (Astrid Munnich) based LCIO/Marlin
  - Simulate primary ionization, electron drift, and amplification by GEMs
  - Independent with Geant4. Handy tools for TPC study

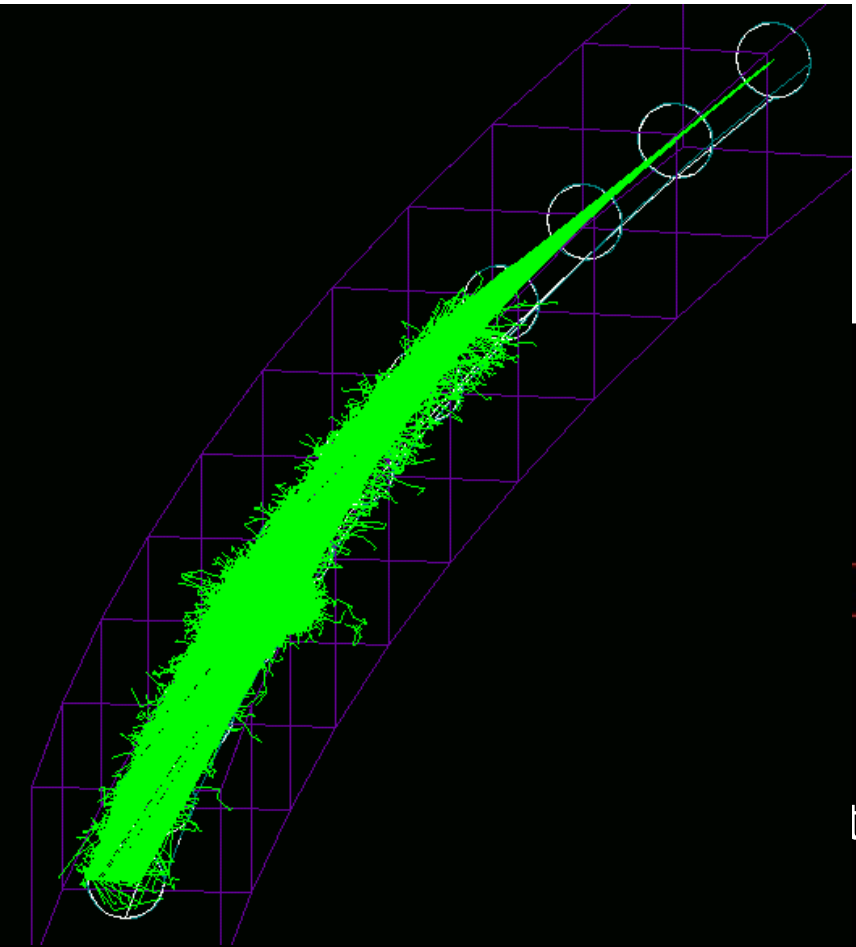


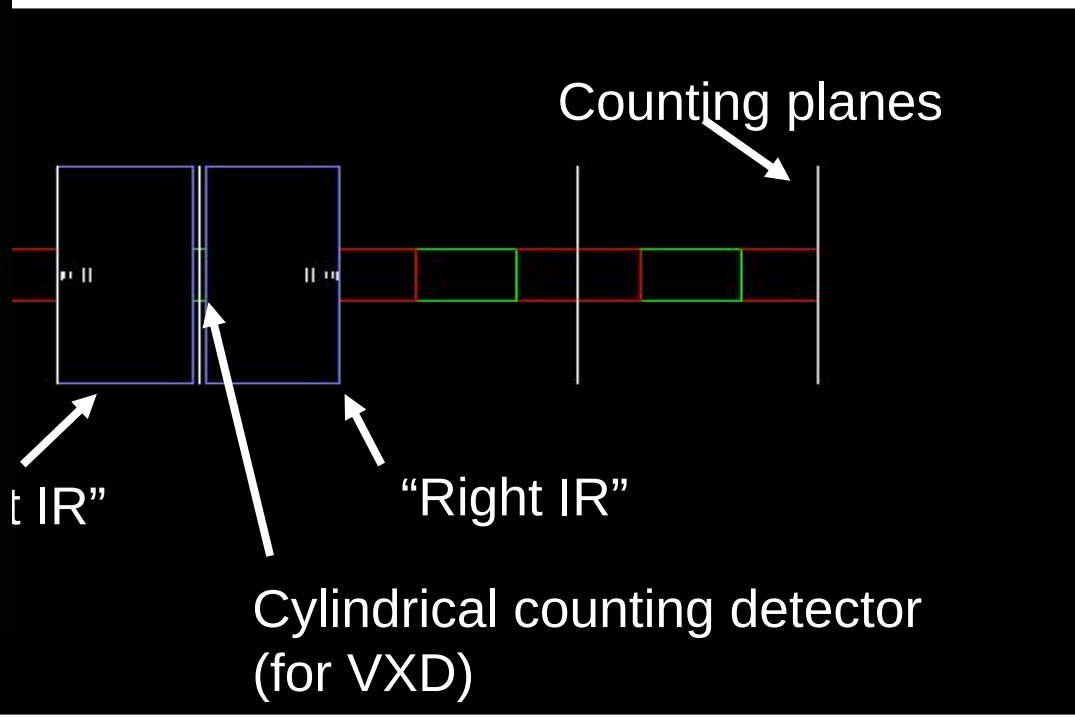
electron drift with gas properties simulated by MAGBOLTZ

BDSIM: Simulation for Beam Delivery System

Grahame Blair

- Includes, collimation, IR, extraction line
- Standalone package using Geant4
- MAD “optics” file input
- Processes: Geant4 + SR + Muon



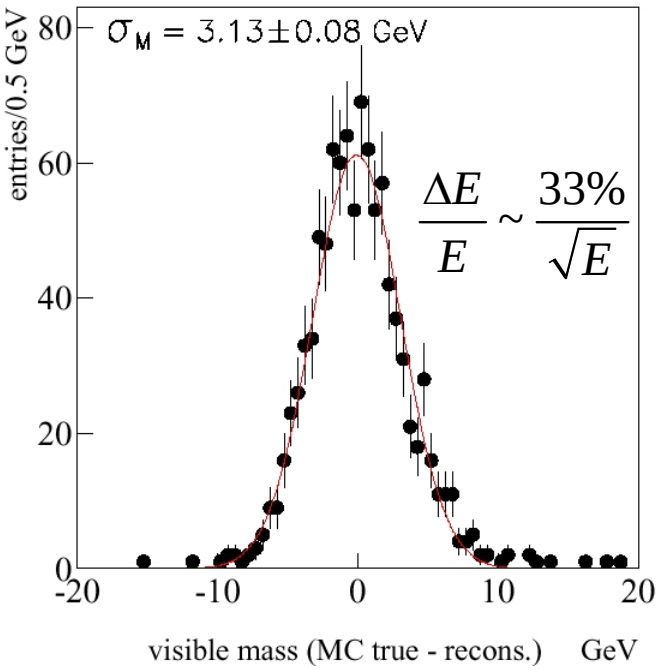


Need to a define suitable interface to detector simulators !

Reconstruction - PFA

- $\sigma_{jet}^2 = \sigma_{ch}^2 + \sigma_{\gamma}^2 + \sigma_{nh}^2 + \sigma_{confusion}^2 + \sigma_{threashold}^2$

Example performance:
TESLA TDR $e^+e^- \rightarrow Z$

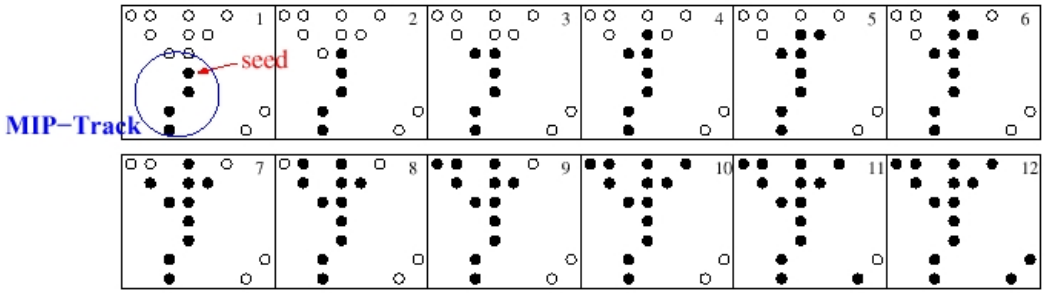


- Optimize Detector Configuration
- Optimize Reconstruction Algorithm
- Study performance in other processes

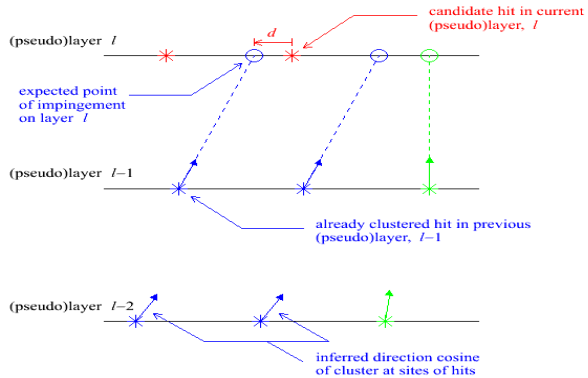
Common understanding based on a standard procedure is an important task in near future

Many studies on going, but not conclusive …

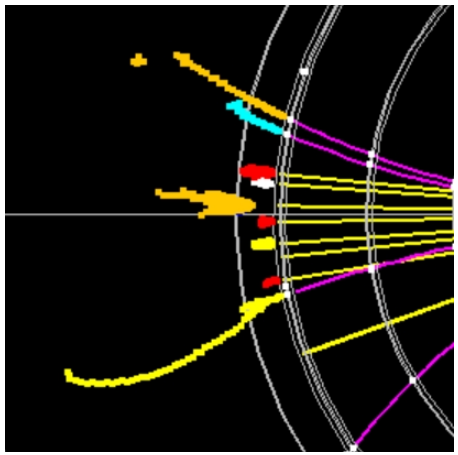
PFA - Calorimeter Clustering



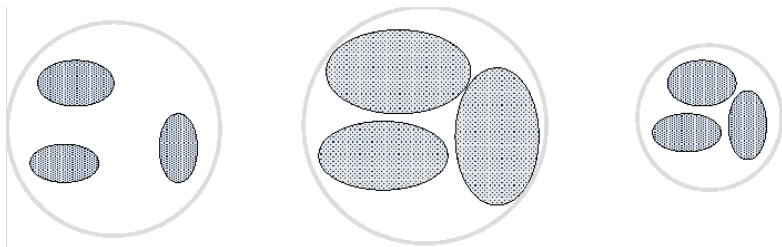
- Spanning Tree Tracking (Wolfgang Mader)



- Layer-by-Layer Clustering (Chris Ainsley)



- Neighbor-by-Neighbor clustering (Norman Graf)

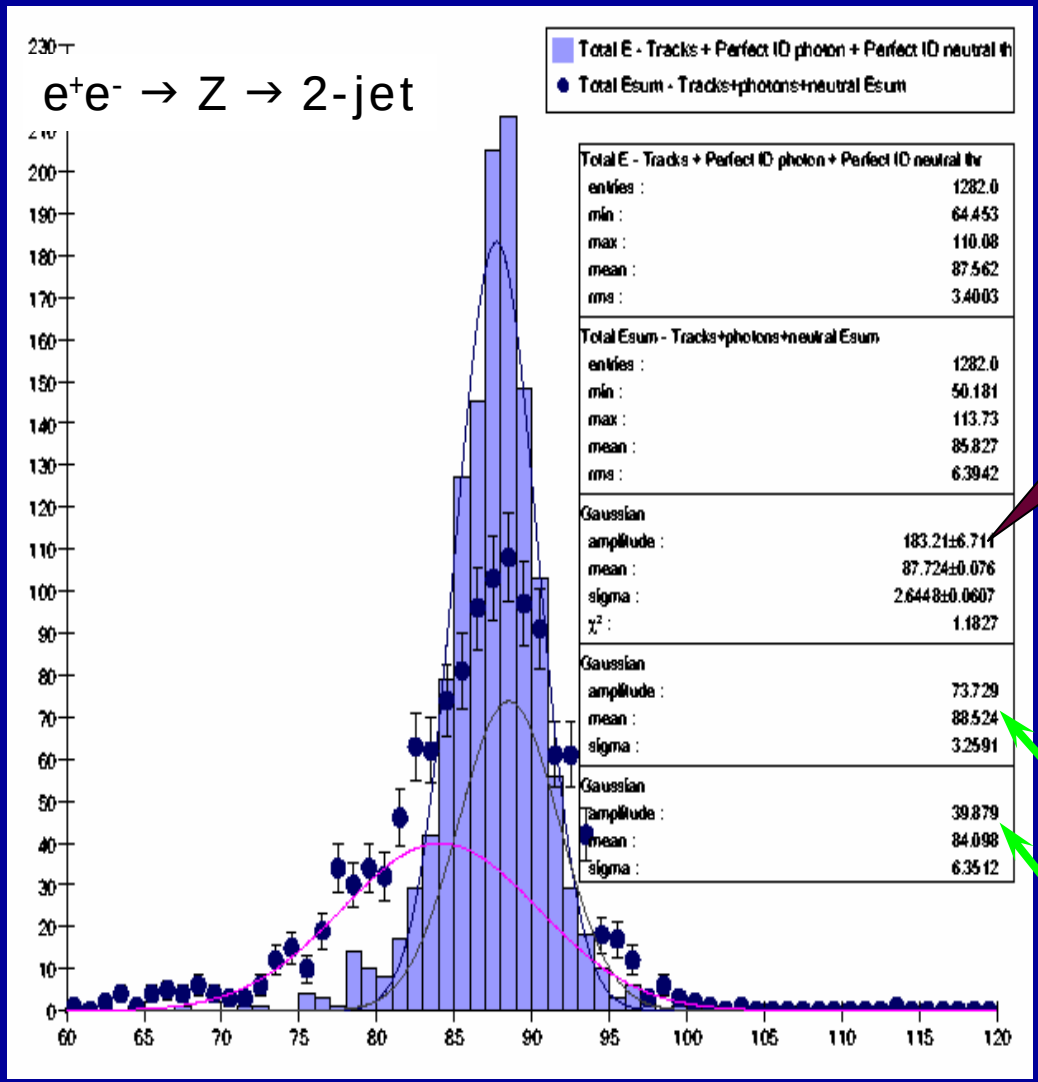


- DHCAL: Density-based Cal. Clustering (Dhiman Chakraborty)

PFA Development Status – True vs Current PFA

ANL/SLAC (Steve Magill) SiD

Track-Cell Association→ Photon finder → Neutral Clustering



True PFA (no confusion)

-> 28%/√E

Two component in reconstructe
Invairant mass. Newutral
Reconstruction is dificult

Current PFA Status

35%/√E (conical showers)

70%/√E (needs work!*)

* Improved with better neutral reconstruction

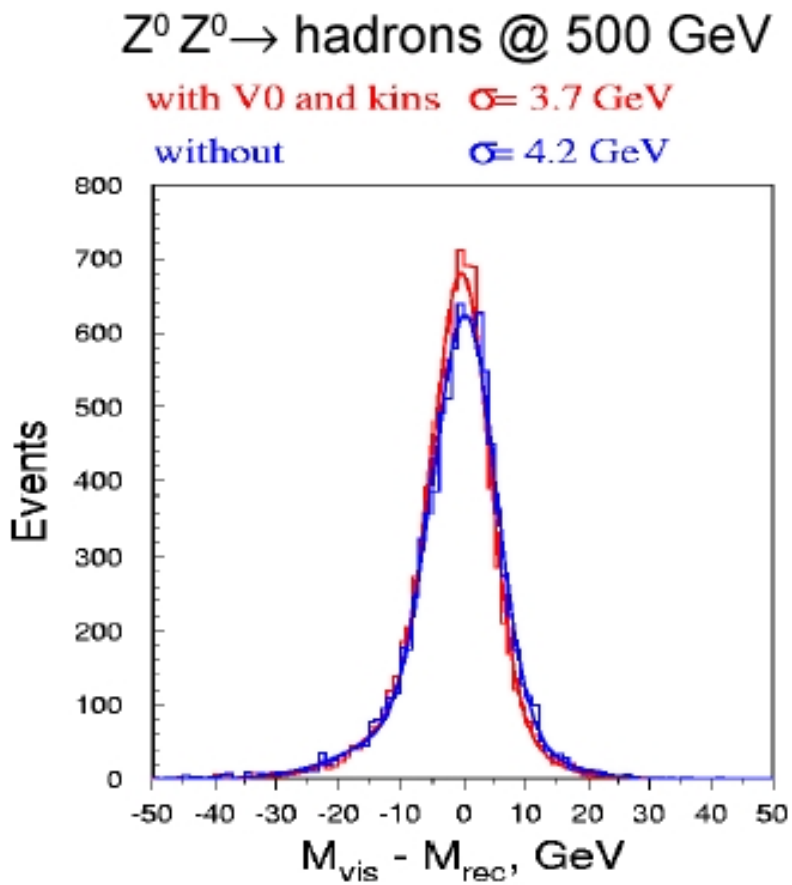
SNARK (DESY)

Tube along track → transverse profile to further collect hits → Neutral clustering (SNARK)

The best we've got so far @ DESY

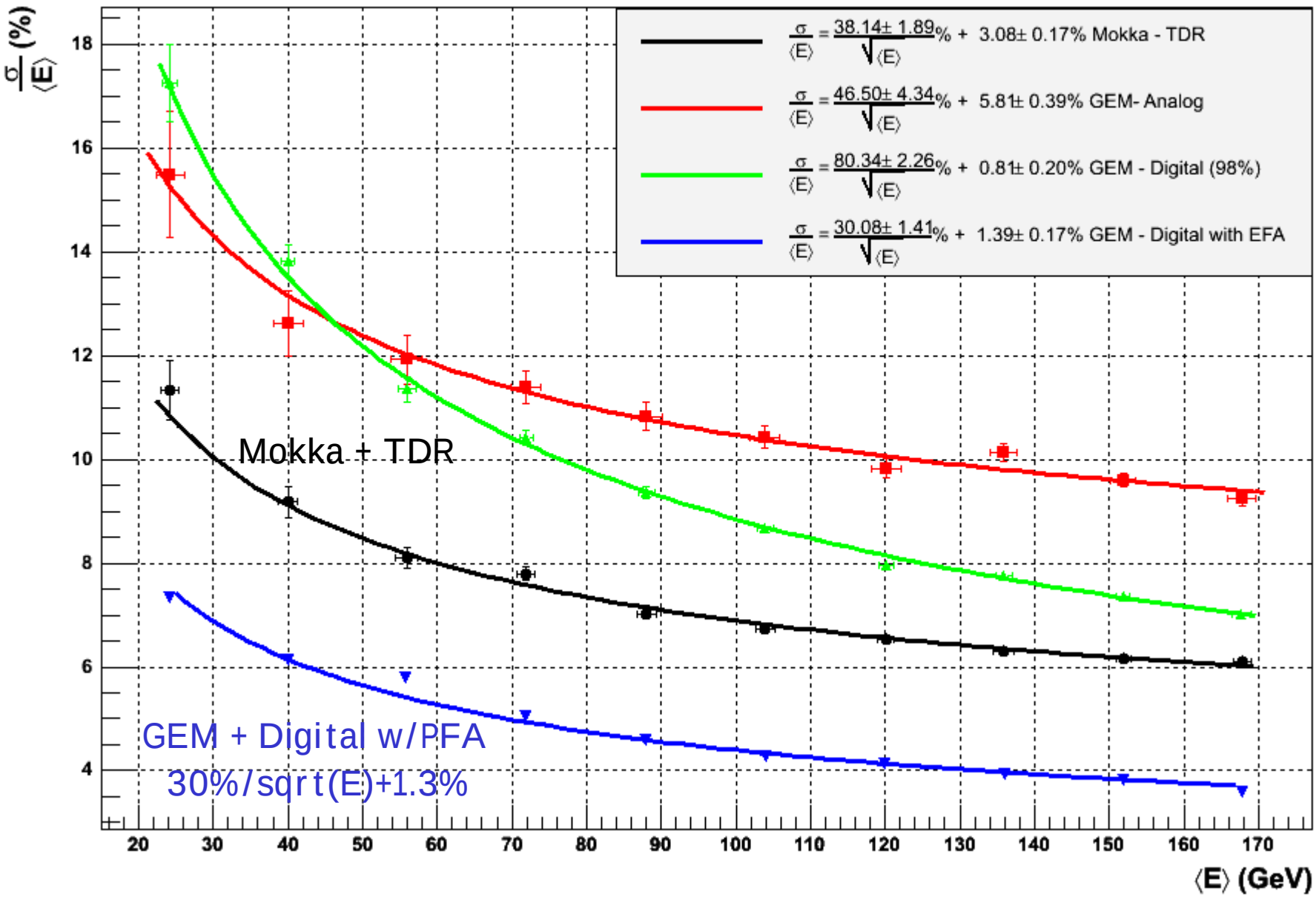
- **Realistic** simulation (BRAHMS)
- **Full & consistent** reconstruction
  - Tracking
  - PFlow (SNARK)
  - dedicated V0 & kink finding

$$\delta M / M = 38\% / \sqrt{M}$$



from LDC meeting @Paris, Jan, 2005

GEM HDCAL (Jae Yu)

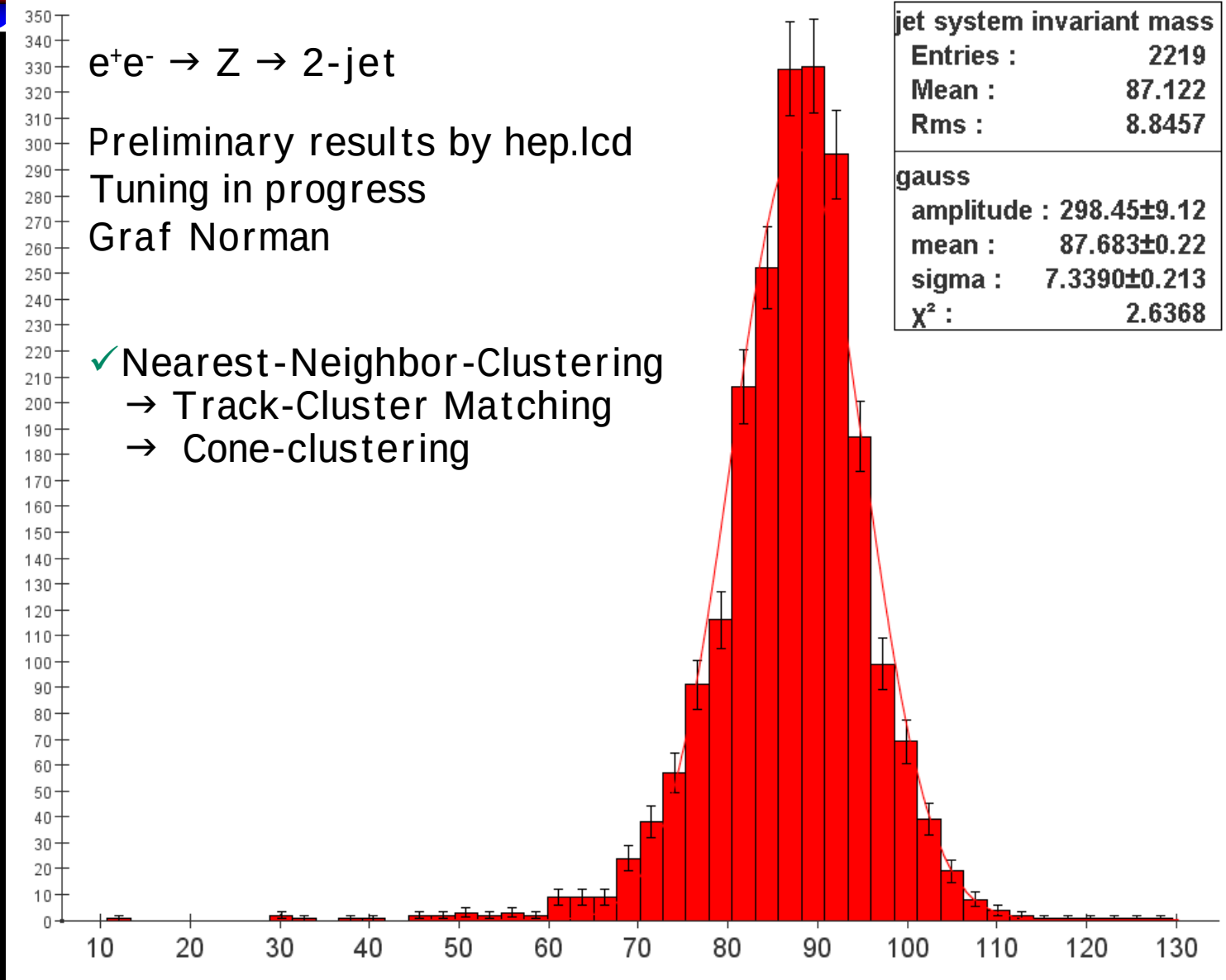


Preliminary Results: Dijet Mass

$e^+e^- \rightarrow Z \rightarrow$ 2-jet

Preliminary results by hep.lcd
Tuning in progress
Graf Norman

✓Nearest-Neighbor-Clustering
→ Track-Cluster Matching
→ Cone-clustering



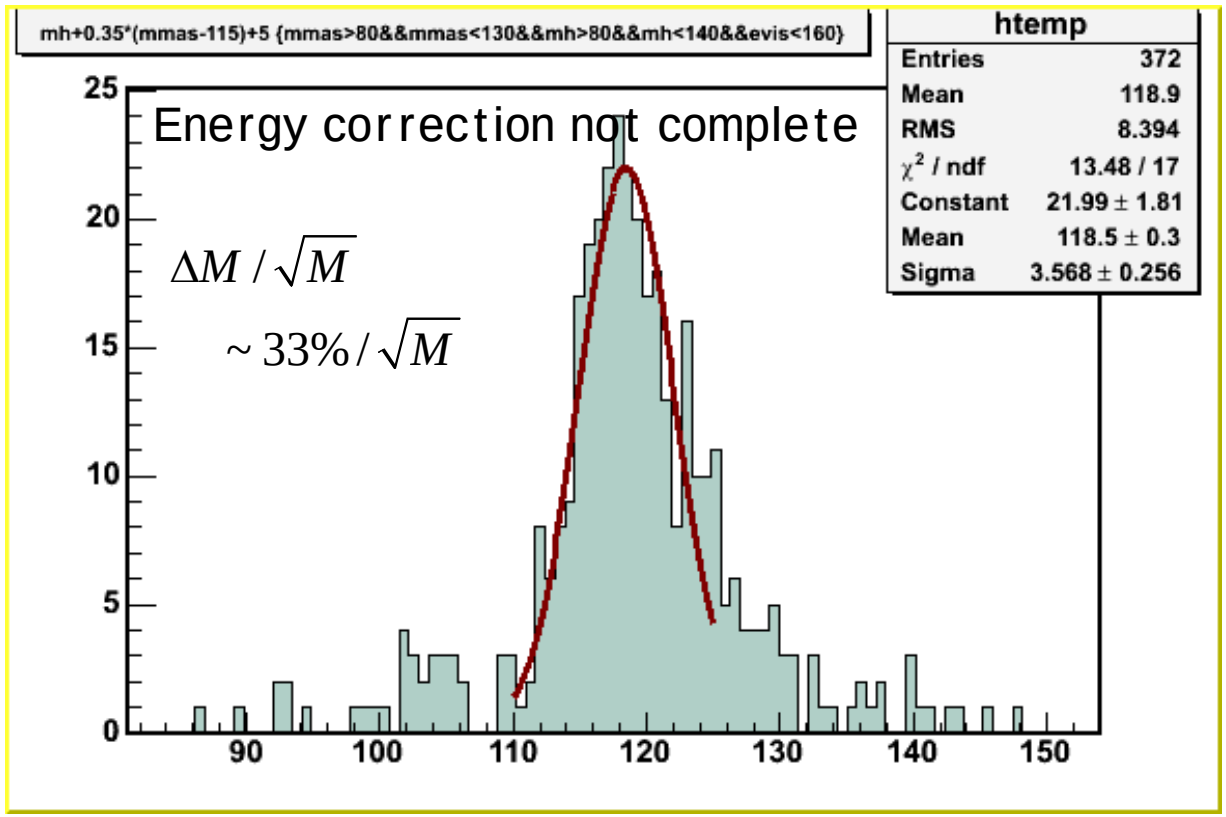
Jupiter and Satellites

by perfect PFA …

$e^+e^- \to ZH,\ Z \to \nu\bar{\nu}$ at 300GeV

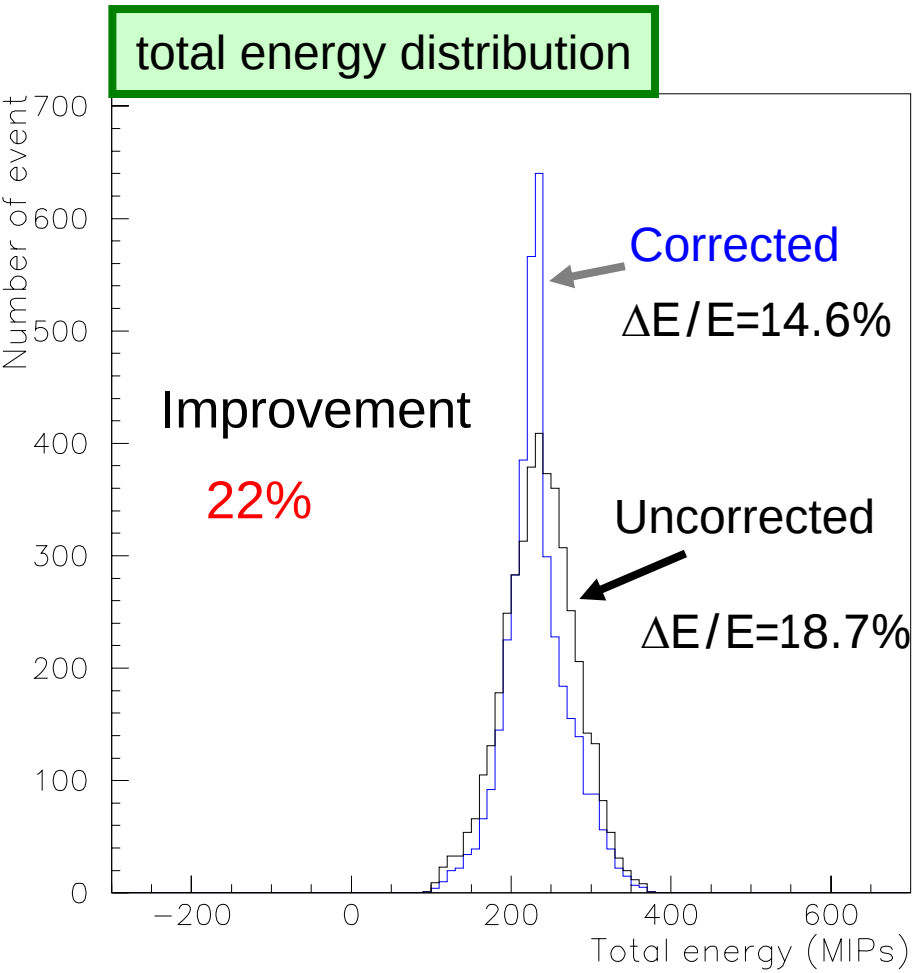
$H \to b\bar{b}, W^+W^-, \tau\bar{\tau}, ...$

Preliminary



Beam test data analysis

N.Nakajima



- T411 beam test @KEK, 1-4GeV
- 1 layer=Pb4mm+Sci.2mm
  42 SL of 5 layers (9.6λ)
- Pulse height correlation among short distance layers comes from π^0 production.
  → large ph=π^0 production, correct

Vertexing, Tracking, ID

- A lots of interesting studies, …
  - Vertexing
    - Nikolai Sinev : VTX based tracking
    - David Jackson : Vertex tagging in forward region
  - Cal based tracking/clustering
    - Dmitry Onoprienko : EM Cal. Associated tracking, K_S^0, Λ
  - Muon ID
    - Caroline Milstene : Muon ID and HCAL

Summary

- We see growing interests and activities on simulation / reconstruction studies at this workshop.
- Coherent efforts are highly important in many areas concerning software.
- This does not mean to select one package.
  We don't want "religious battle".
- But it's good to know well what others are doing
  (everybody are encouraged to participate multiple detector concept studies)
- It avoid unnecessary duplicated works.
- LCIO is becoming the first step.
- Another key word:
  - Open source : CVS, good documentation,…
  - Utilize web, TV meeting, …

Next step – Standard API

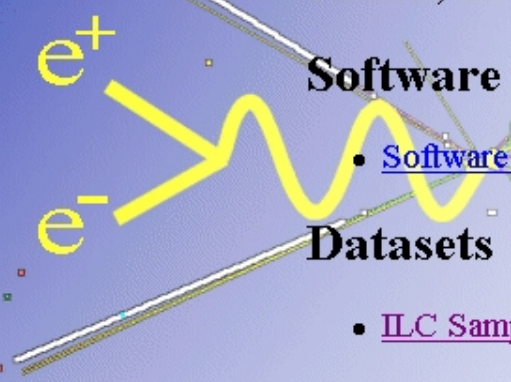
- Geant4: Common Physics List, Material data, …
- Geometry API : For simulator and reconstruction
  - Simple/Complex geometries
  - API to accelerator components :
    BD ? QC1 ? Return Yoke ? Optics ?
- Common Benchmark = Common generator data
  - Physics process
  - Beamspectrum generators
  - Background process : BS, Two-Photon, …
- Apply an algorithm to different detector designs, …
- May be much more …
  - Will help to list what are available/what are missing, …
- A mechanism to ensure a broad participation ?

Welcome to the Linear Collider Simulation Site

http://www.lcsim.org/

Introduction

This site is designed to provide physicists the tools needed to investigate the physics potential of a linear e collider. Many of the tools necessary to generate Monte Carlo events, simulate the response of typical detectors, and conduct the ensuing analysis of the "data" can be found at this site or others linked from here.



Software

- Software Homepage - index of all major ILC simulation software packages

Datasets

- ILC Sample Datasets - instructions for accessing datasets via anonymous FTP

Resources

- LinearCollider.org Forum - get feedback from the experts
- ILC Confluence Wiki - collaborative documentation site

ILC Simulation Groups

- LinearCollider.org Homepage - commons area for worldwide ILC collaboration
- ACFA LC Simulations - Asian Committee for Future Accelerators
- ALCPG Simulations - American Linear Collider Physics Group
- ECFA LC Simulations - European Committee for Future Accelerators