

KILC12, Daegu, Korea



Norman Graf (SLAC)

Overview

- Physics Benchmarking Data Samples
- Detector Response Simulation
- Event Reconstruction
- Beyond the DBD

Presentations

- iLCSoft - Status and Plans: F. Gaede
- lcsim Status: N. Graf
- Report of AIDA WG2 meeting: F. Gaede
- Common DBD samples: M. Berggren
- 1TeV Pair Backgrounds in ILD: A. Miyamoto
- Scintillator ECAL reconstruction: K. Kotera
- Hybrid ECAL study: H. Ueno
- New C++ Tracking in iLCSoft: F. Gaede
- FPCCD reconstruction: D. Kamai
- LCFIPlus Update: T. Suehara

Generators Common WG

- A cross-region and cross-concept working group was created to coordinate event generation.
 - Tim Barklow, SiD/Americas
 - Akiya Miyamoto, ILD/Asia
 - Mikael Berggren, ILD/Europe
 - Stephane Poss, CLiC
- DBD Benchmarks @ 1TeV

$$e^+e^- \rightarrow \nu\bar{\nu}h^0 \quad e^+e^- \rightarrow W^+W^- \quad e^+e^- \rightarrow t\bar{t}h^0$$

DBD Physics Benchmark Samples

■ 1 TeV

- $\nu\nu h$: signal done. $t\bar{t}(6f)$ as background done. yet to be copied to GRID after fixing file names, ...
- $t\bar{t}h$, $t\bar{t}b\bar{b}$, $t\bar{t}z$: done (50k events), on GRID
- 4f for WW: done. Generated $1ab^{-1}$ samples
Note: $s \sim O(10)pb$. $1ab^{-1} \sim O(10)M$ events. Too much ...
- 2f : done and on GRID. ($ee\gamma$ with a cut for ee)
- Pair backgrounds: done 1300 BX on GRID ($\sim 1/2$ of bunch train)
- Low Pt, $\gamma\gamma$ background (pythia): done but not on GRID
- High Pt $\gamma\gamma$ and $e\gamma$ background (whizard): done but not on GRID
- High Pt $\gamma\gamma$ mini-jets : Need optimization of generation level cut.

■ 500 GeV

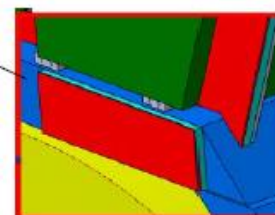
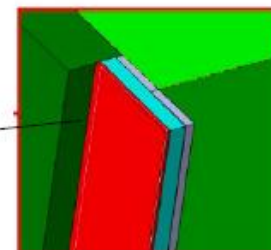
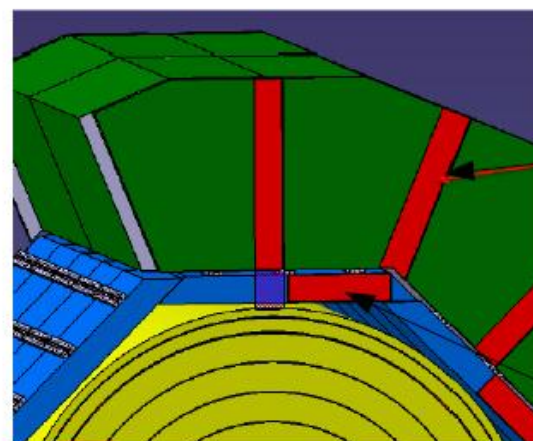
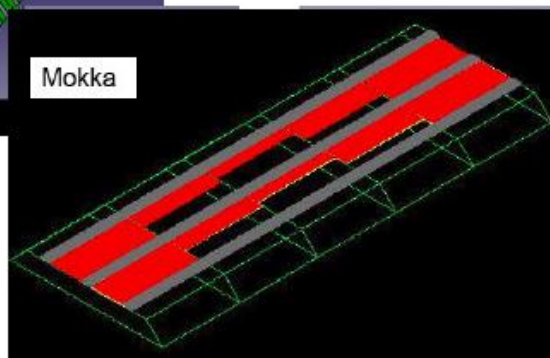
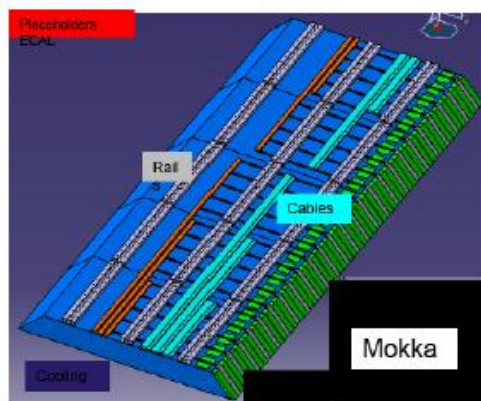
- 6f for $t\bar{t}$: Issues – LOI or New samples ?
- Meta info web at DESY, KEK, will be in SLAC.
- Some details of the analyses remain to be decided.

iLCSoft

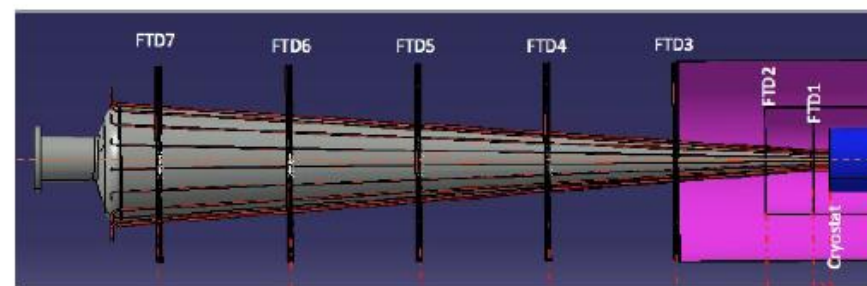
- improved/adopted core tools
 - LCIOv2, GEAR, CED,...
- improved realism of the simulation
 - include gaps, imperfection and services
- complete re-write of tracking code !
 - old code unmaintainable and cannot easily cope with high backgrounds
- adaption of reconstruction algorithms (PFA, Flavor tag) to new technology options

increased realism in ILD_OX models

- added cabling and services for TPC, ECal & Hcal (C.Clerc, G.Musat)
- including inner detector services as defined by R&D groups



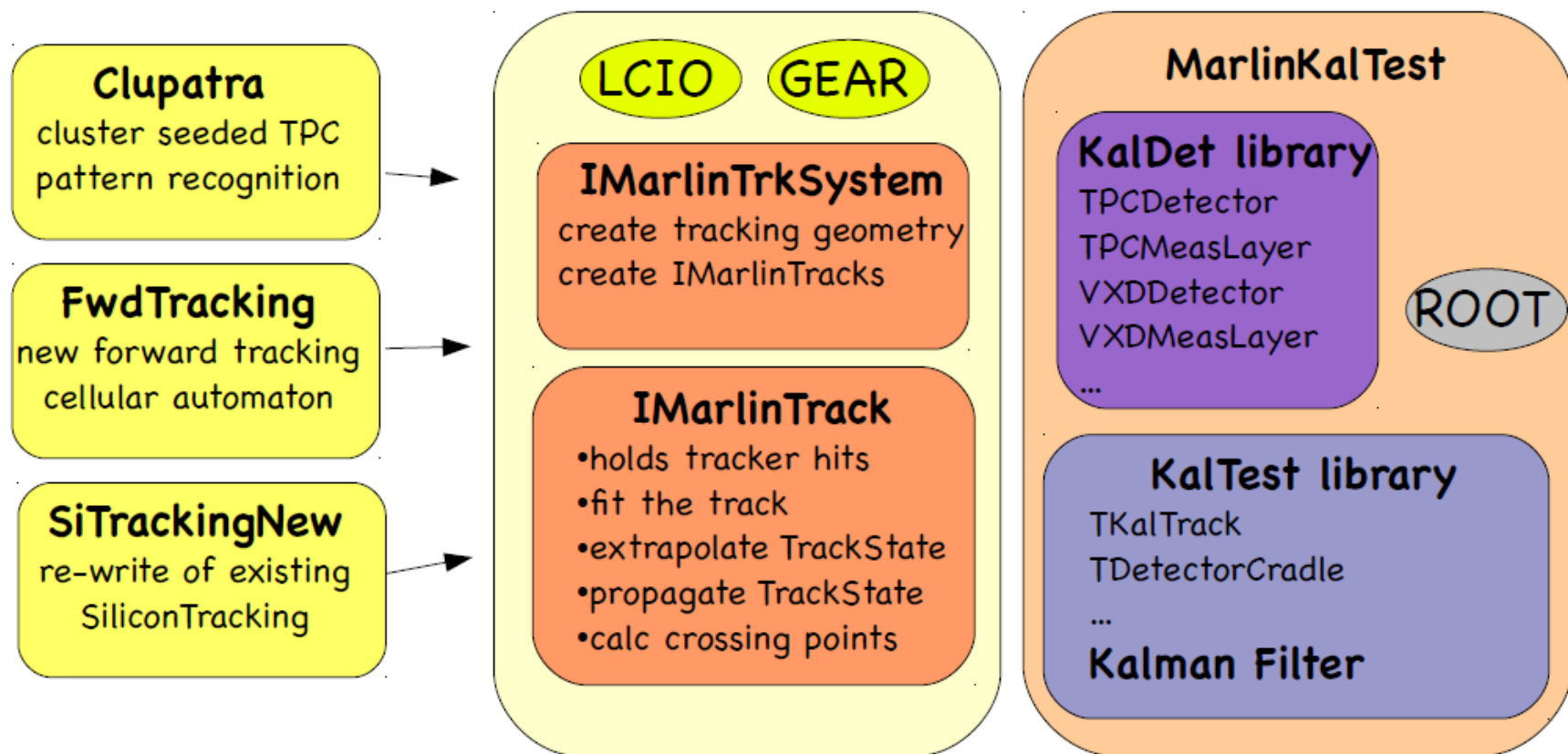
big step forward in
increasing realism of ILD
detector simulation !



power supply cables

new C++ tracking: MarlinTrk

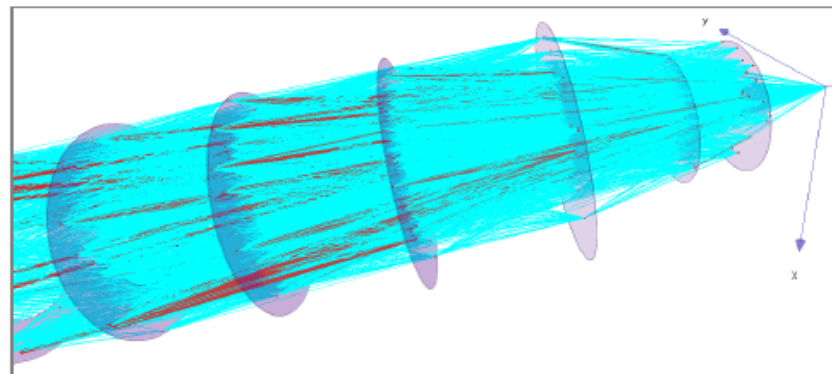
- new common API for developing tracking code (TPC, Silicon, Fwd)
- provides **loose coupling** between patrec and fitting
- defined abstract interface IMarlinTrk and implement using KalTest/KalDet
- currently lives in MarlinTrkProcessors



new C++ tracking: patrec activities

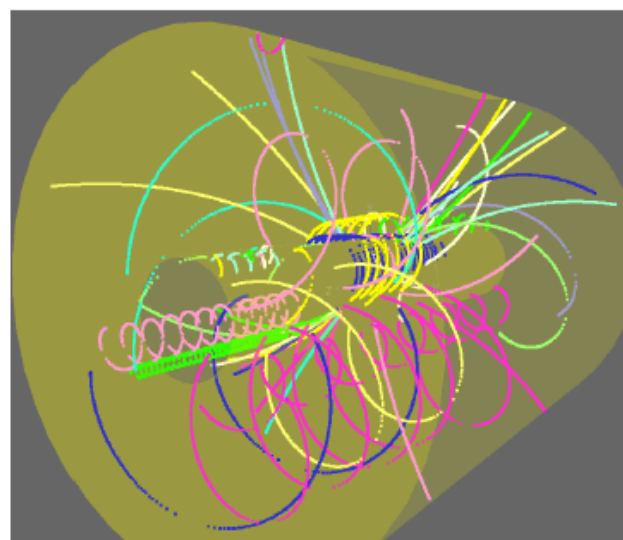
• ForwardTracking

- new forward tracking patrecusing cellular automaton
(R.Glattauer)



• Clupatra

- new TPC patrec - recently:
 - fixed memory consumption
 - cleaned up code & algorithm
 - use new IMarlinTrk/MarlinKalTest



• MarlinTrkProcessors

- rewrite of 'old' SiTracking and FullLDCTracking using MarlinTrk/MarlinKalTest
- recently added proper 1D strip measurements

Summary & Outlook

- new tracking for ILD has been developed and released in iLCSoft v01-13-05:
 - Clupatra (topological TPC patrec)
 - C++ re-write of SiliconTracking and FullLDCTracking
 - ForwardTracking
- recently included the proper treatment of 1d hits for double strip stereo layers in SIT/SET and FTD
- started to combine ForwardTracking and SiliconTracking

- To Do
 - test everything more thoroughly
 - understand (in)efficiencies (and fix issues)
 - iterate the material description to get probabilities and pulls right
 - time before DBD Monte Carlo production is short
 - let's see...

lcsim

- Large amount of work still to be done to complete the DBD physics benchmark analyses.
- Optimize global system design
- Improving realism of detector model
- Improving and characterizing tracking
- Adapting reconstruction software to latest versions of LCIO, PandoraPFA and LCFIPlus
- Benefitted enormously from the CLiC CDR effort
 - Reconstruction of high energy and high background
 - Automation of Grid submission of jobs

slic

- Updated to Geant4 9.5
- Store and save calorimeter hit positions within cells to enable more refined hit calculations.
- mesh2gdml provides CAD interface
- Improvements for non-ILC users
 - HPS@Jlab
 - Muon Collider

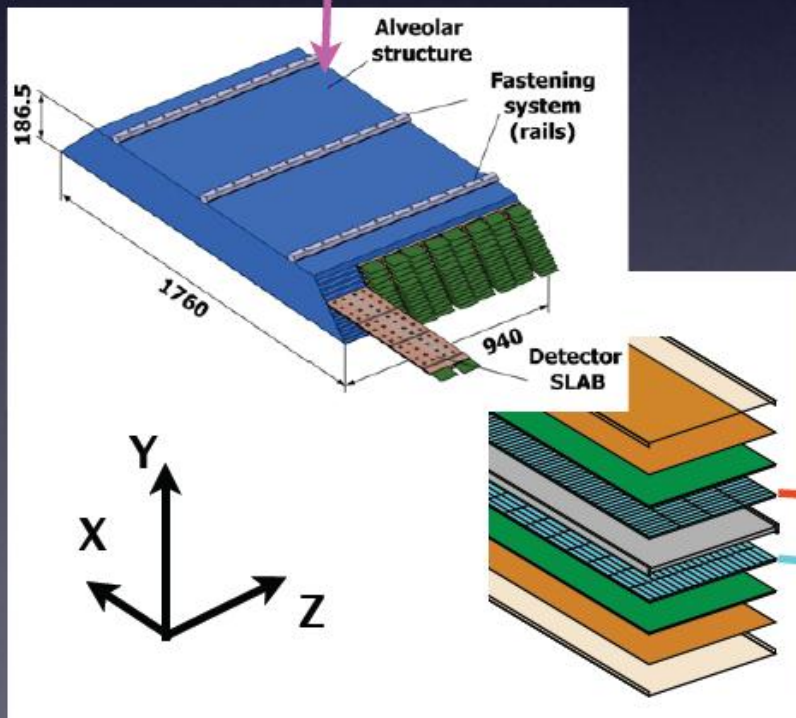
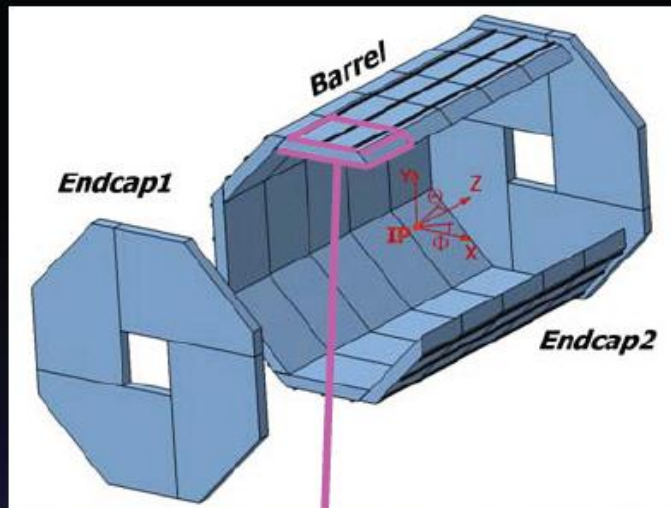
Icsim Tracking

- PixSim provides an extremely flexible and detailed silicon response simulation package.
- trf toolkit contains a well-tested detector model, track & hit classes and Kalman filter fitting code which accounts for energy loss and MCS.
- ftf toolkit provides a fast, efficient, pattern recognition package based on a conformal mapping of hits on topological layers.

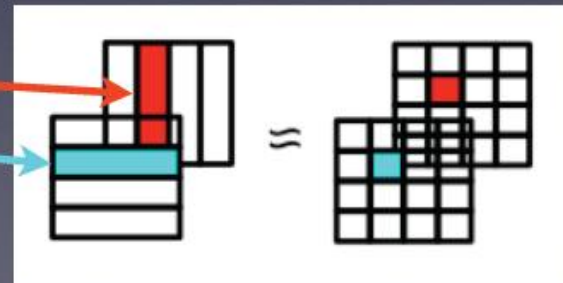
ILD Calorimeter Reconstruction

- Two efforts involved in development of alternatives to Si-W Ecal
- Overlapping scintillator strips 5 x 2 x 45 mm
 - Strip Splitting Algorithm developed, “pseudo cells” fed to PandoraPFA
 - Jet Energy Resolution comparable to SiEcal
 - Optimizing Layer Structure and PFA tune
- Hybrid uses Si & Scintillator as active layer.
 - Calibration procedures developed
 - Performance will be characterized
 - Design will be optimized

Scintillator strip ECAL for ILD



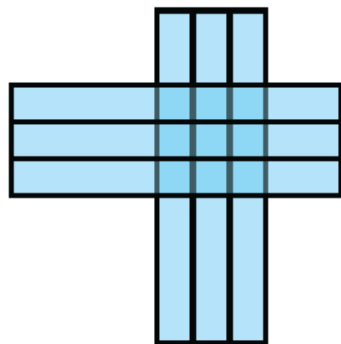
- In an example of Model
 - 25 absorber layers
 - 3 mm thick W $\rightarrow 21.5X_0$
 - plastic scintillator
 - 5 mm wide
 - 45 mm length
 - 2 mm thick
 - $JER/\sqrt{E} < 30\%$ @ $\sqrt{s} = 91$ GeV necessary.
- strips in odd layers are orthogonal with respect to those in even layers.



Hybrid ECAL Configuration

Sc layer

45mmx5mm strips

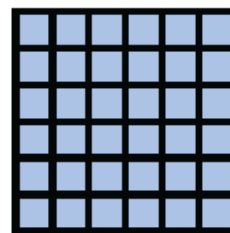


orthogonal

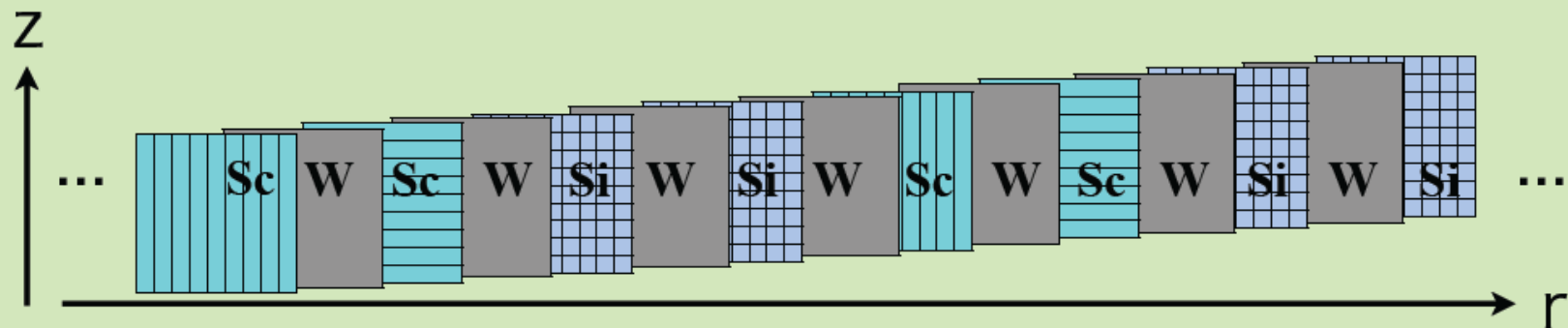
- 5mmx5mm spacial resolution
- possibility of ghost

Si layer

5mmx5mm cells



The configuration of Hybrid ECAL



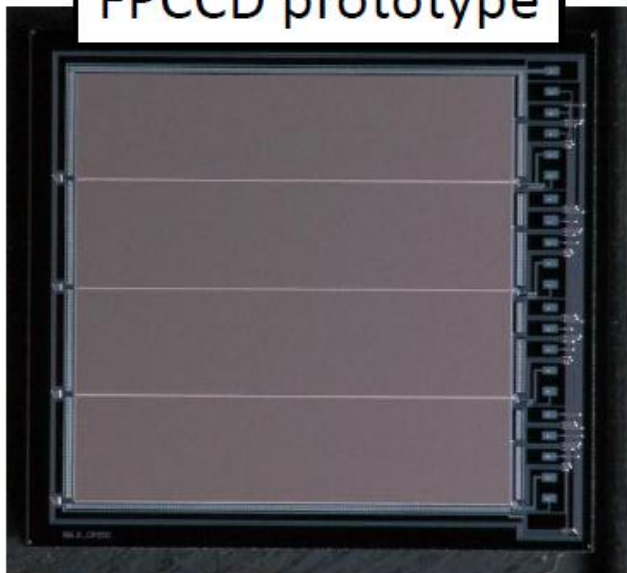
FPCCD vertex detector

3

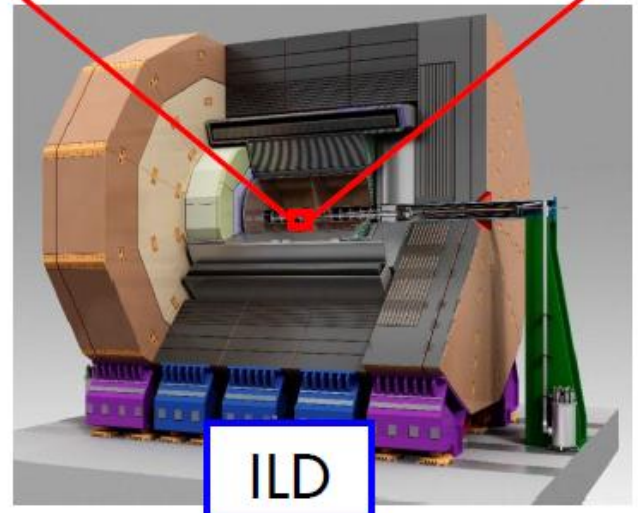
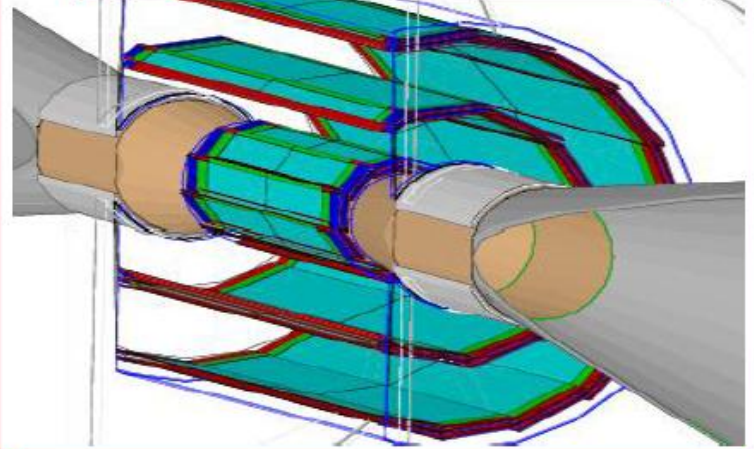
■ FinePixelCCD vertex detector

- Pixel size : $5 \times 5 \text{ } \mu\text{m}^2$
- Number of pixels : $\sim 10^{10}$
- Read out time : Inter-train
- Fully depleted sensor

FPCCD prototype



3 doublets structure



ILD

FPCCD Software

- FPCCDDigitizer

- Converts SimTrackerHits to raw pixel hits

- FPCCDClustering

- Clusters neighboring pixels, calculates energy weighted centroid and uncertainties
 - Cluster shape used to reject background hits.

- FPCCDOverlayBX

- merges background into physics event

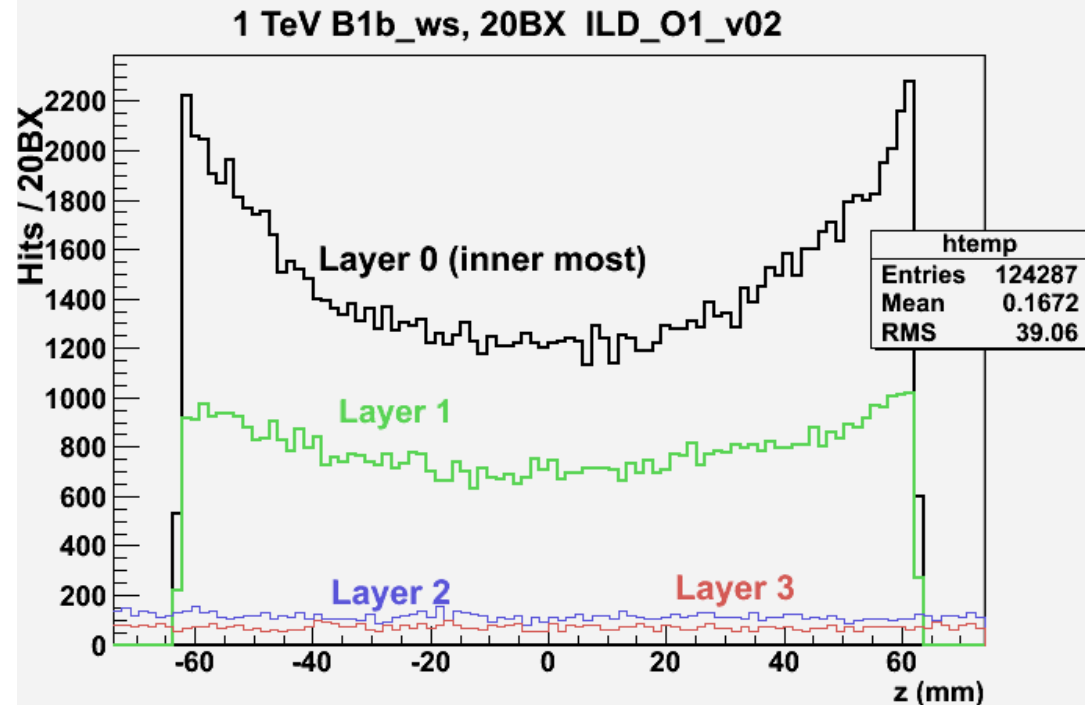
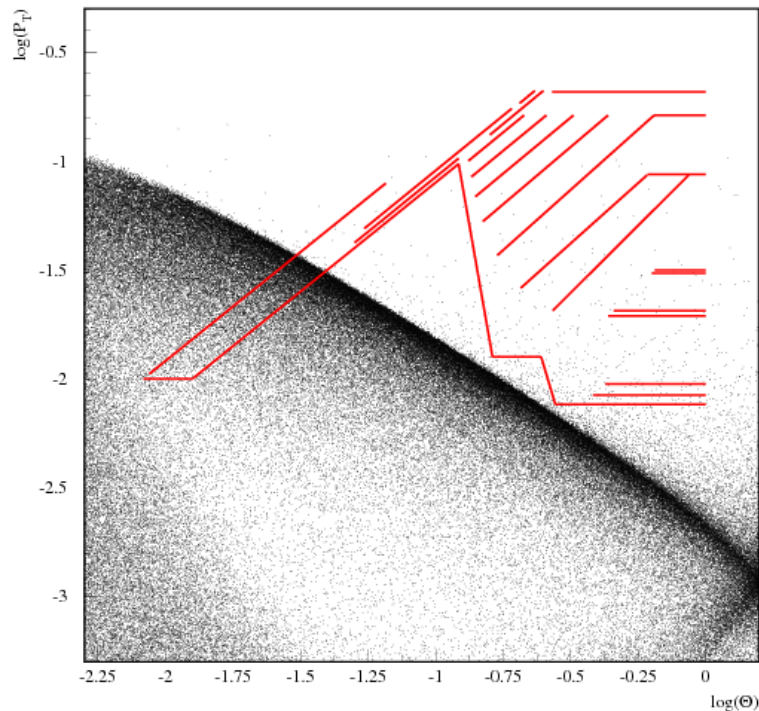
- Developed and installed into MarlinReco.

- Improved resolution wrt LOI detector

- Incorporated into latest ILD Tracking

1 TeV Pair Backgrounds in ILD

- Although “cone of death” avoids the detector, direct and albedo tracks contribute to large backgrounds in vertex detector.



1 TeV Pair Backgrounds in ILD

- Studied latest GDE beam parameters for 1 TeV and 500 GeV
 - ILD_O1_v02 , Mokka-07-07-p06
- VXD
 - 500 GeV result is consistent with LOI result (assume 4pixels/hit)
 - CMOS-like VXD
 - Hit occupancy of SimTrackerHit at 1 TeV was about x4 of 500 GeV
 - Accounting phi-dependence of hit distribution, occupancy \sim x3 larger
 - Faster readout would be required.
 - FPCCD-like VXD (smaller pixels, inter-pulse readout)
 - Occupancies at the inner layers would be higher.
- TPC, FTD, BCAL : 3~4 times more hits at 1 TeV-B1b
- 500 GeV ILD_O1_V02 \sim x3 more TPC hits than ILD_00fwp01
- Causes of the difference being investigated

LCFIPlus

NIM A 610 573 (2009)

LCFIVertex

- ★ vertex finder & flavor tagger for LOI
- ★ neural net difficult to extend

rewrite

LCFIPlus

- ★ vertex finding, jet finding, flavor tagger in one package
- ★ exploit **TMVA**
- ★ flexible XML configuration

arXiv:1110.5785

Jet Finding

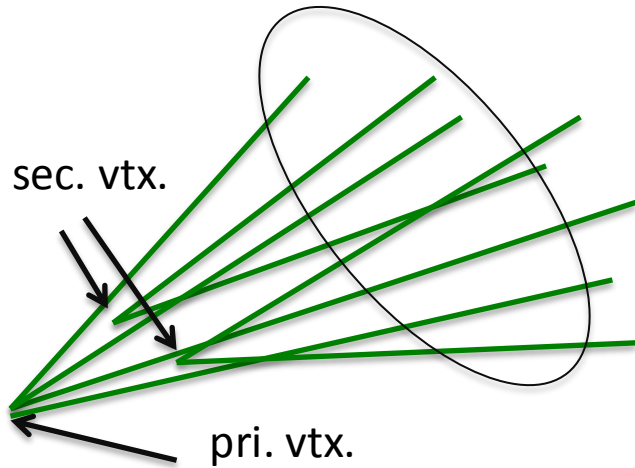
- ★ need to improve for **multi-jet events**
- ★ vertex first, jet second approach

implement

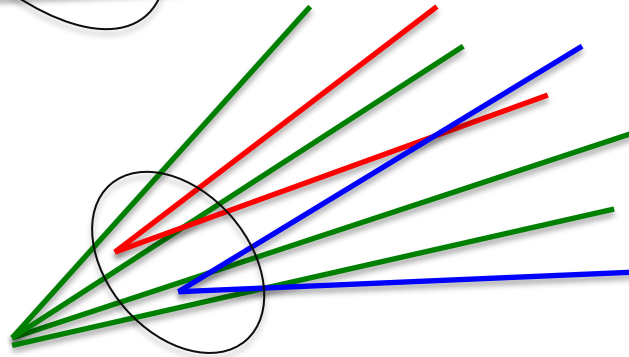
Included in ilcsoft since v01-13

Vertex-Jet Finding Overview

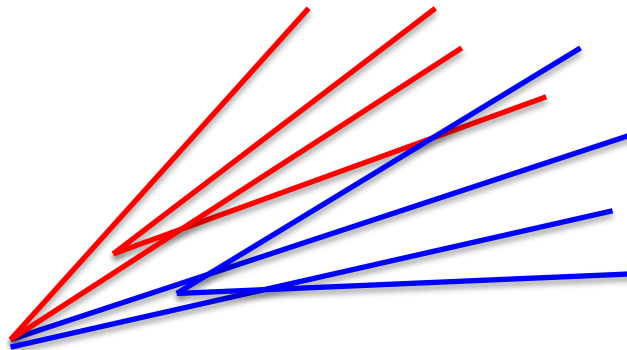
arXiv:1110.5785



1. Difficult to separate two b-jets which are close. Ordinary kt algorithm tends to merge them.



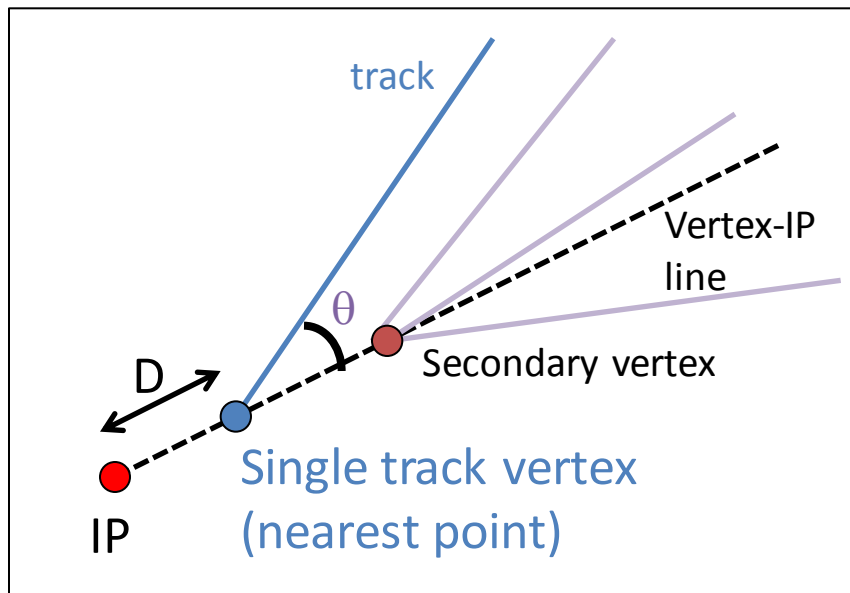
2. To overcome this, find secondary vertices first, and use them as *seeds* for jet finding.



3. This results in an increased chance of correct jet separation.

This effect is particularly pronounced for final states with many b jets, e.g. Zhh

Single (“Ghost”) Track Selection



- Normal vertex finder needs > 2 tracks
-> loose many vertices
- Single track vertex can be found by using other vertex direction
- Improves b-tagging performance

| Event | 0 vtx | 1 vtx | ≥ 2 vtx |
|------------|-------|-------|--------------|
| bb normal | 322 | 1052 | 426(24%) |
| bb +single | 322 | 459 | 1019(57%) |
| cc normal | 1003 | 779 | 18(1.0%) |
| cc +single | 1003 | 715 | 82(4.6%) |

LCFIPlus Summary and Outlook

- Software infrastructure now in place for ILD DBD production
→ have complied with technical requests, to be included into the next ilcsoft cycle (~few weeks)
- Will continue working with SiD for a smooth transition from LCFIVertex to LCFIPlus
- Physics performance not yet satisfactory. Need a better understanding of **physics** and **TMVA behavior**. In particular:
 - additional tuning of vertex/jet finding & input variables
 - alternative multivariate algorithms ?
 - normalization of output classifiers ?

SiD DBD

- Benchmark analyses
 - Will produce pre-mixed files with 80%/20%, incl. SM/machine backgrounds.
 - Samples will be made available for Snowmass2013
- Simulation/Reconstruction
 - sid_dbd (Baseline) ~LOI geometry with more realistic detector description
 - Options: Pixel tracker, Analog scintillator HCAL, ...
 - Most likely just performance characterization, not benchmark analyses.

Optimizations and test of reconstruction tools in progress ...

Benefitted enormously from the CLIC_CDR exercise

Reconstructions of high energy and high background events

DIRAC based production tools

- MC Production
 - Hope to start production as soon as remaining details of analysis are resolved, probably simulation first.

ILD DBD

■ Benchmark analyses

- Simulate/Reconstruct full set of polarization sample. Mixed to 80%/20% at analysis.
- Background overlay after simulation

■ Simulation/Reconstruction

- 3 options:
 - SiECAL+AHCAL
 - SiECAL+DHCAL
 - SciECAL+AHCAL
- Mokka validation in progress
- Full C++ tracking developed.
- PFA and LCFI+ validation in progress

| detector | person | status |
|----------|----------------------|------------|
| VXD | G.Voutsinas | ongoing |
| SIT/SET | K.Androsov | to be done |
| FTD | J.Duarte | to be done |
| TPC | S.Aplin | done |
| ECal | D.Jeans | done |
| AHCal | Sh.Lu | done |
| SDHcal | G.Grenier | done |
| FCal | A.Rosca, B.Pawlik | ongoing |
| Muon | A.Saveliev | ongoing |

start MC production, once all sub detectors are 'approved'

Beyond the DBD...

- Meeting of software developers at CERN, 2/12, to discuss future of sim/reco efforts
 - general consensus to work towards a common simulation application
 - build on the ongoing work for detector description and geometry (AIDA WP2)
 - define a geometry API for reconstruction
 - setup a working group to work towards that goal
 - work towards a common track reconstruction package in C++ (e.g. ftf or trf for Si-Tracking)
 - Devote additional effort to digital HCal in PandoraPFA
 - Proposed common DST format for basic analyses
 - should start when DBD software work reduces
- ALCPG supporting HPS@Jlab, Muon Collider physics and detector studies, and Snowmass 2013.

AIDA WP 2: Common Software

- 4 year EU project to develop core software tools that are experiment-independent and useful for the HEP community
- USolids Geometry: one common C++ package of 3D primitives for Geant4, root & others
- DD4Hep: Generic Detector Description Model
- Generic Tracking
- Calorimeter reconstruction based on PFA
- Alignment

Thanks!

- To those working on simulation, reconstruction and analysis infrastructure and to the speakers presenting the results.
- Thanks again to the local organizing committee and support staff for an enjoyable and rewarding conference.