Analysing events for the ILC, using Marlin and MarlinReco





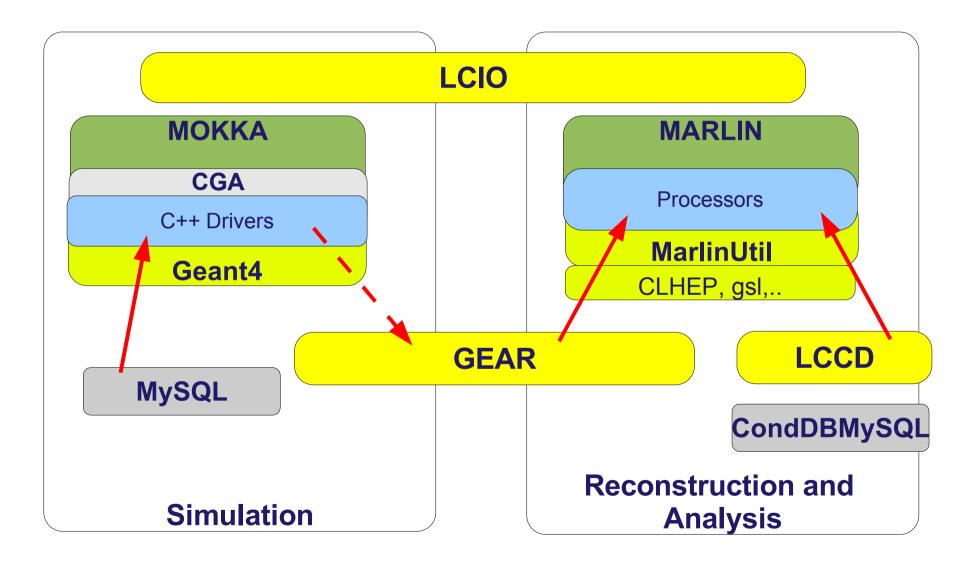


Bundesministerium für Bildung und Forschung

Outline

- LDC Simulation and Reconstruction Framework
- Marlin
- Processors for Marlin
- Software Packages and MarlinReco
- Event Reconstruction with MarlinReco on the GRID
- Summary

LDC Simulation and Reconstruction Framework

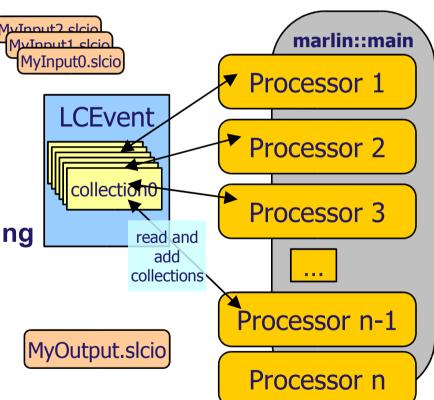


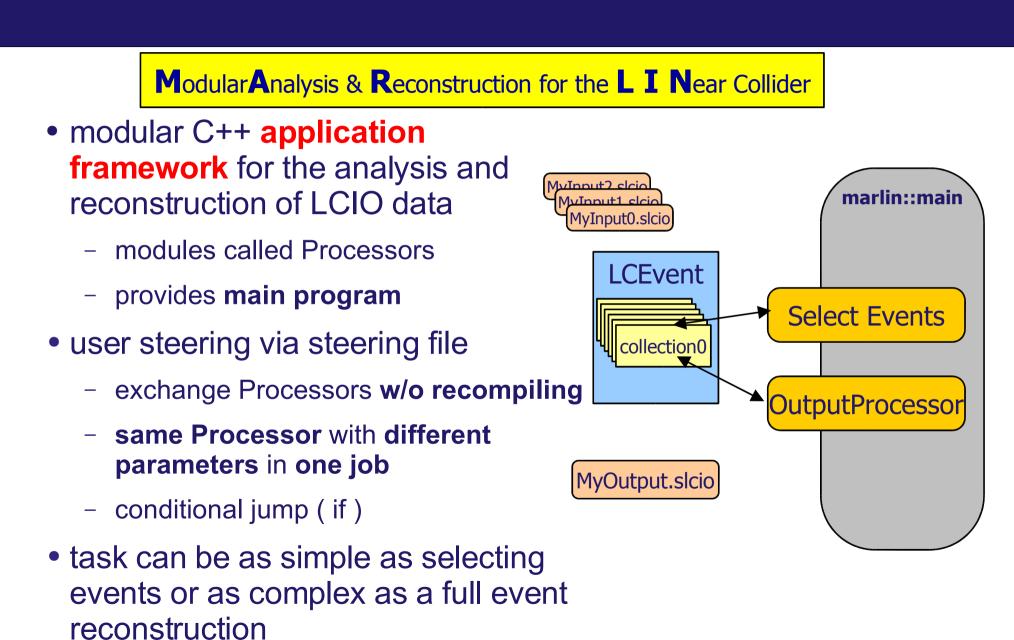


- modular C++ application framework for the analysis and reconstruction of LCIO data
 - modules called Processors
 - provides main program
- user steering via steering file
 - exchange Processors w/o recompiling
 - same Processor with different parameters in one job
 - conditional jump (if)
- task can be as simple as selecting events or as complex as a full event reconstruction







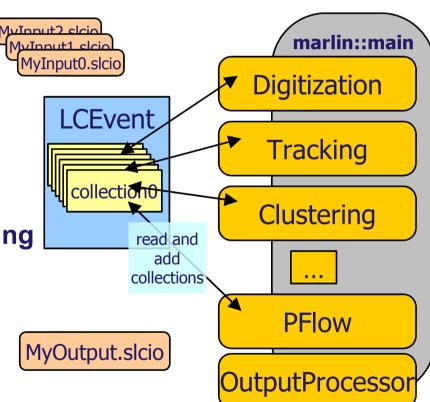


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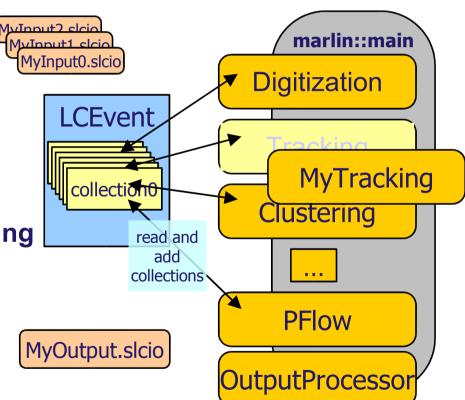






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Status of Marlin

- Marlin v00-09-02 available on the web
 - ➔ it allows to use GEAR and has updated documentation
- visit our **software portal**:

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Software packages — ILC Software Portal - Mozilla Firefox

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Processors for Marlin

> full set of Processors for event reconstruction available

Track Digitisation

- simple smearing

Calorimeter Digitisation

- 1. simple: calibration, ganging, threshold cut for energy
- 2. advanced: based on detector geometry, calibration, ganging

• Tracking

- algorithms taken from LEP (ALEPH and DELPHI)
- full tracking in TPC
- VTX, SIT hits included in the track fit
- TPC tracks used as 'seeds'

Processors for Marlin

• Clustering (Trackwise Clustering)

- spatial information needed only
- applicable to digital and analogue calorimeters
- minimal dependence on detector geometry
- can be used for different detector designs

• PFlow (Wolf)

- Track Cluster matching
- extrapolate tracks into the calorimeter
- get (E,p) for charged particles from track parameters
- get (E,p) for neutral particles from cluster
- Particle ID assigned by fraction of energy in ECAL / HCAL

Processors for Marlin

Track and Cluster Cheater

- use Monte Carlo information to combine hits to tracks and clusters
- tracker hits are fitted with simple helix hypothesis
- use instead of realistic tracks and clusters
- compare with them

Analysis

- Event Shapes:
- Thrust Reconstruction (Tasso & Jetnet algorithms)
- → Sphere (sphericity, aplanarity, ...)
- Satoru Jet Finder
- originally developed by Satoru Yamashita for OPAL

Software Packages for Marlin

Package = set of Marlin Processors, classes and functions

- MarlinReco \rightarrow full set of Processors for **event reconstruction**
 - Digitisation, Tracking, Clustering, PFlow and Analysis
- MarlinUtil \rightarrow utility and helper classes
- CEDViewer → simple event display client processor
- stand-alone software modules:
 - CED \rightarrow event display based on GLUT / OpenGL
 - RAIDA \rightarrow **AIDA to ROOT** interface (coming up soon)
- Packages are **not** fixed
 - MAGIC \rightarrow different Clustering, partly uses MarlinReco
 - PandoraPFA \rightarrow Clustering, PhotonID, Cluster Association

Status of MarlinReco

• to do

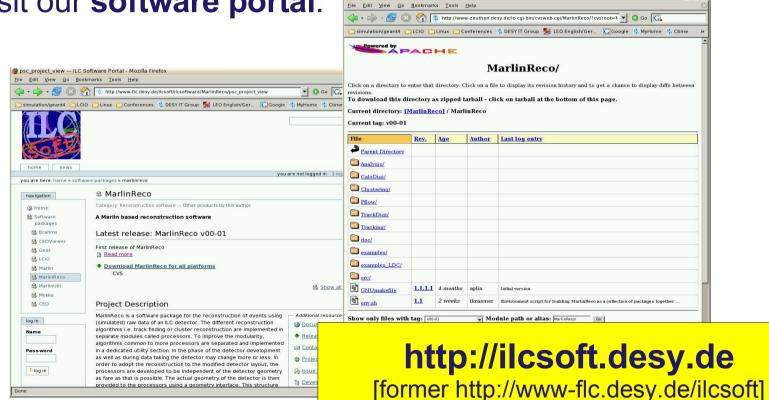
- more realistic track digitisation
 - → new VTX Digitiser (see talk of A. Raspereza)
- vertex and forward tracking
 - → new stand-alone PatRec for VTX (see talk of A. Raspereza)
- neutral / charged vertex and kink finding
- particle ID

- ...

your input / ideas are welcome !

Status of MarlinReco

- MarlinReco v00-01 available on the web
 - comprehensive manual available
- visit our **software portal**:



MarlinBeco/ - Mozilla Firefox

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MarlinReco on the GRID

- 'mass production' of events on the GRID
 - latest Mokka v05.04, 4 detector geometries and 2 magnetic fields
 - 2 different detectors: LDC00Sc and LDC01Sc
 - LDC00Sc: 30 + 10 ECAL Layers
 - LDC01Sc: 20 + 10 ECAL Layers
 - same overall thickness of ECAL, HCAL unchanged
 - 2 different sizes of TPC: (R)adius and (L)enght
 - overall 8 'different' detectors

| B field (T) | LDC01S | Sc (mm) | LDC008 | Sc (mm) | | |
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| | L = 2000 | L = 2200 | L = 2730 | L = 2930 | | |
| 4 | R = 1380 | R = 1580 | R = 1690 | R = 1890 | | |
| | L = 2000 | L = 2200 | L = 2730 | L = 2930 | | |

MarlinReco on the GRID

- Physics processes
 - WW, Zh, uds, cb, tt @ 360, 500 and 1000 GeV
 - Z @ 91.2 GeV
- ≈ 450000 events (500 GByte) of simulated data
- all data available on the **GRID** for ILC VO members
- meta data, logical filenames etc. stored in MC Database

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MarlinReco on the GRID

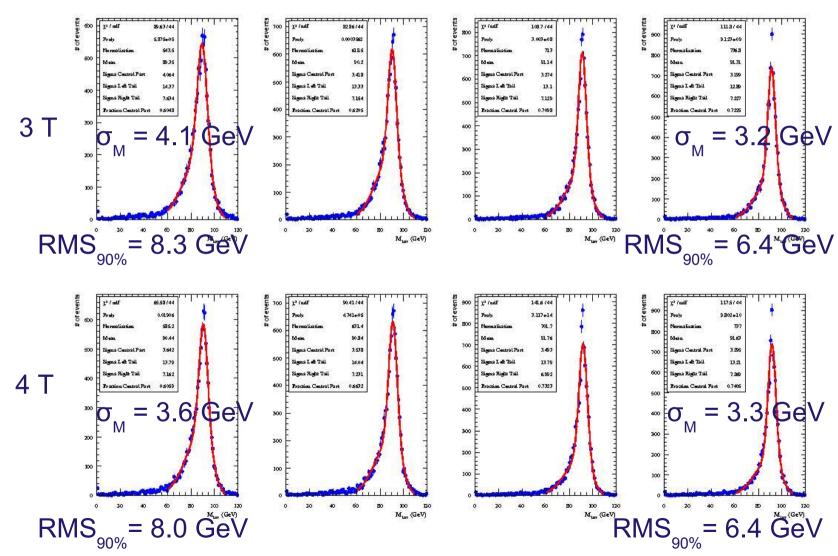
- run the reconstruction (MarlinReco) on the GRID
 - ≈ 70% finished
 - yet not all data analysed
- → GRID is a comprehensive, powerful and 'easy to use' tool

Reconstructed M_{inv} of Z⁰

- > TrackCheater used in reconstruction
- plot M_{inv} for the 4 different detectors and 2 different magnetic fields
- calculate $\sigma_{_{M}}$ and $\text{RMS}_{_{90\%}}$ for them
- dependencies on Geometries / magnetic fields

Reconstructed M_{inv} of Z⁰

Size \rightarrow

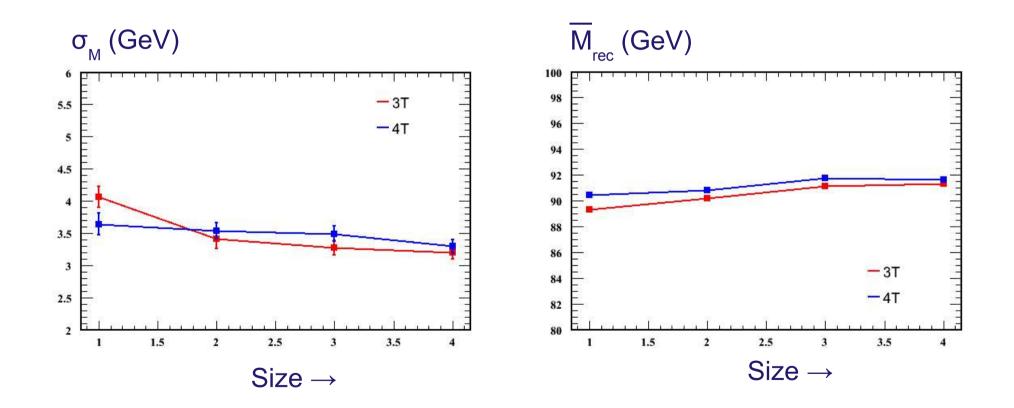


Z pole:

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Reconstructed M_{inv} of Z⁰

Z pole:



Reconstructed M_{inv} of Z^0

- Z reconstruction looks reasonable
 - → good to compare different algorithms in a certain parameter range
 - nice 'benchmark' plot
- NOT appropriate for detector optimisation
 - → CM energy to small (physics processes at 500 GeV)
 - $\rightarrow \sigma_{M}$ not depending on Geometry (within errors)
 - not so large number of tracks and clusters
 - not so many overlapping clusters
- → need WW, Zh or ttbar @ 500 GeV and 1000 GeV

ttbar @ 500 GeV

- calculate $\Sigma E_{rec} \Sigma E_{avail}$
- simple sum over all calorimeter cells (see talk of V. Morgunov)
 - $\sigma_{_{\rm F}}$ for 500 GeV ttbar: **12.6 GeV** (LDC00Sc, 4T)
- $\sigma_{_{\rm F}}$ of PFIow reconstruction with BRAHMS (SNARK)
 - $\sigma_{_{\rm E}}$ for 500 GeV ttbar: **9 GeV**
- energy resolutions of reconstruction with MarlinReco
 - $-\sigma_{r}$ for 500 GeV ttbar: **25.2 GeV** (LDC00Sc, 4T)
- problem in reconstruction code
 - not applicable for detector optimisation (same problem for WW)
 - → PFlow concept is **not** the reason (see SNARK)
 - might be a fundamental problem of the cluster-based approach

PROBLEM

Summary

- Marlin is a flexible and light-weighted **SW framework**
 - uses LCIO
- MarlinReco is a **reconstruction toolkit** for the ILC
 - full set of needed processors
 - extensible \rightarrow use / combine with other processors
 - reconstruction of 'mass data' on the GRID
- Reconstruction works fine for Z Pole
- problems with the reconstruction for ttbar @ 500 GeV
 - → studies are ongoing

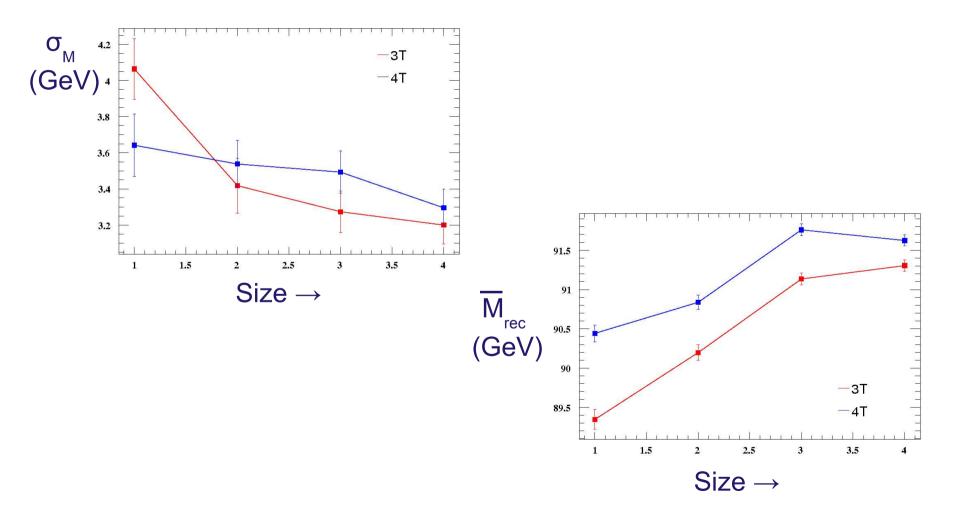
please feedback to: ilcsoft@desy.de Thanks to all developers: S. Aplin, F. Gaede, T. Kraemer, P. Krstonosic A. Raspereza (MPI Munich), J. Samson, H. Albrecht, D. Martsch, A. Vogel and V. Morgunov Backup Slides ...

Use PFlow algorithm for event reconstruction at the ILC

- different PFlow algorithms available
- detector optimisation studies ongoing (Geometries, B-Field)
- need a simple, flexible and lightweighted SW framework
- → easy to install, use and modify / expand
- → use widely accepted OO-language: C++
- based on international ILC data format: LCIO

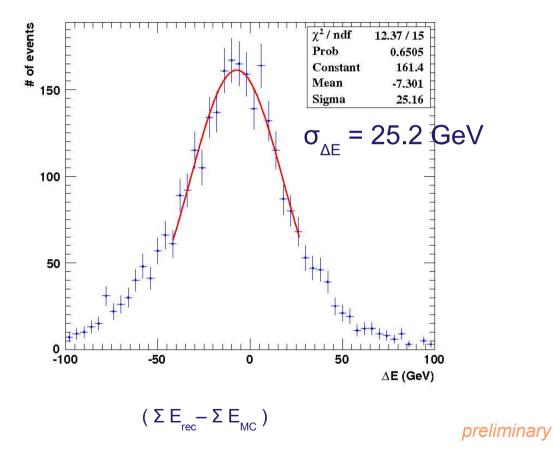
Reconstructed M_{inv} of Z^0

Z pole:



ttbar @ 500 GeV

Calculate whole energy per event and compare it with MC energy



 $\sigma_{\Delta E}$ = 12.6 GeV

