MarlinReco

A Marlin based Reconstruction Toolkit for the ILC

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Outline

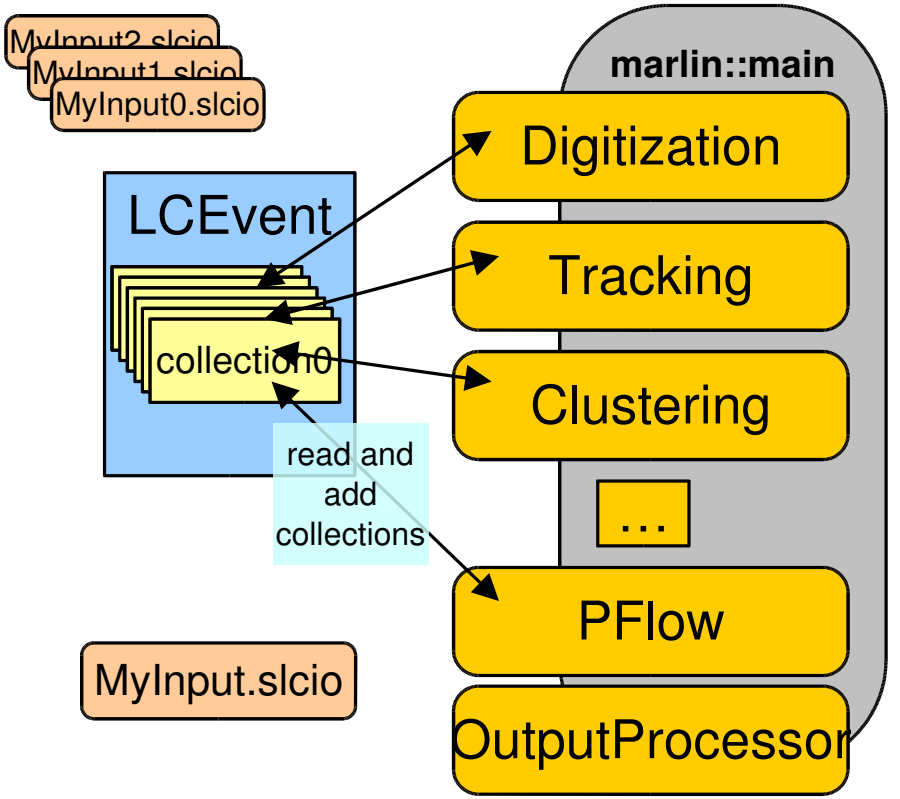
- Introduction
  - Marlin, Gear
- Overview MarlinReco
  - Reconstruction algorithms
  - PFlow
  - Utilities
- Status
- Summary/Outlook

MarlinReco developers:
S. Aplin, F. Gaede, T. Kraemer, P. Krstonosic, A.Raspereza, J. Samson, O. Wendt

Marlin

Modular**A**nalysis & **R**econstruction for the **L I N**ear Collider

- modular C++ **application framework** for the analysis and reconstruction of LCIO data
- uses LCIO as transient data model
- software modules called Processors
- provides main program !
- provides simple user steering:
  - program flow (active processors)
  - user defined variables
    - per processor and global
  - input/output files



Gear

GEometry **A**PI for **R**econstruction

```
- <gear>
  - <!--
      Example XML file for GEAR describing the LDC detector
    -->
  - <detectors>
    - <detector id="0" name="TPCTest" geartype="TPCParameters" type
        <maxDriftLength value="2500."/>
        <driftVelocity value=""/>
        <readoutFrequency value="10"/>
        <PadRowLayout2D type="FixedPadSizeDiskLayout" rMin="386.0"
        maxRow="200" padGap="0.0"/>
        <parameter name="tpcRPhiResMax" type="double"> 0.16 </para
        <parameter name="tpcZRes" type="double"> 1.0 </parameter>
        <parameter name="tpcPixRP" type="double"> 1.0 </parameter>
        <parameter name="tpcPixZ" type="double"> 1.4 </parameter>
        <parameter name="tpcIonPotential" type="double"> 0.00000003
      </detector>
    - <detector name="EcalBarrel" geartype="CalorimeterParameters">
        <layout type="Barrel" symmetry="8" phi0="0.0"/>
        <dimensions inner_r="1698.85" outer_z="2750.0"/>
        <layer repeat="30" thickness="3.9" absorberThickness="2.5"/>
        <layer repeat="10" thickness="6.7" absorberThickness="5.3"/>
      </detector>
    - <detector name="EcalEndcap" geartype="CalorimeterParameters">
        <layout type="Endcap" symmetry="2" phi0="0.0"/>
        <dimensions inner_r="320.0" outer_r="1882.85" inner_z="2820.
        <layer repeat="30" thickness="3.9" absorberThickness="2.5"/>
        <layer repeat="10" thickness="6.7" absorberThickness="5.3"/>
      </detector>
    </detectors>
  </gear>
```

compatible with US – compact format

- well defined geometry definition for reconstruction that
  - is flexible w.r.t different detector concepts
  - has high level information needed for reconstruction
  - provides access to material properties - planned
- abstract interface (a la LCIO)
- concrete implementation based on XML files
  - and Mokka-CGA – planned

MarlinReco

- Marlin serves as a **framework** for the distributed development of reconstruction algorithms
  - provides a well defined modularity
- MarlinReco is a **toolkit** which aims at providing reconstruction algorithms for detector concept studies
  - (almost) complete set of standard reconstruction (pflow)
  - cheaters for cross checks (and replacements)
  - all processors can seamlessly be combined together with other reconstruction code or plugged into your analysis
    - e.g. together with MAGIC-clustering (see talk by C. Ainsley)

MarlinReco packages

- **TrackDigi**
  - FTDDigi
  - VTXDigi
  - TPCDigi
- **CaloDigi**
  - LDCCaloDigi
- **Tracking**
  - BrahmsTracking
  - TrackCheater
- **Clustering**
  - TrackwiseClustering
  - ClusterCheater
- **Pflow**
  - Wolf
- **Analysis**
  - EventShapes
  - SatoruJetFinder

most MarlinReco processors (algorithms) are geometry independent
–> they can be applied to other detector concepts (via Gear file)

MarlinReco Digitization

- Tracker (S.Aplin)
  - TPC: Gaussian smearing of position in z and r-phi
  - Silicon: exact position from simulation –
    - more meaningful clustering under development (A.Raspereza)
- Calorimeter (A.Raspereza)
  - calibration only - no smearing
  - optional energy cut
  - ganging (investigate different granularity)

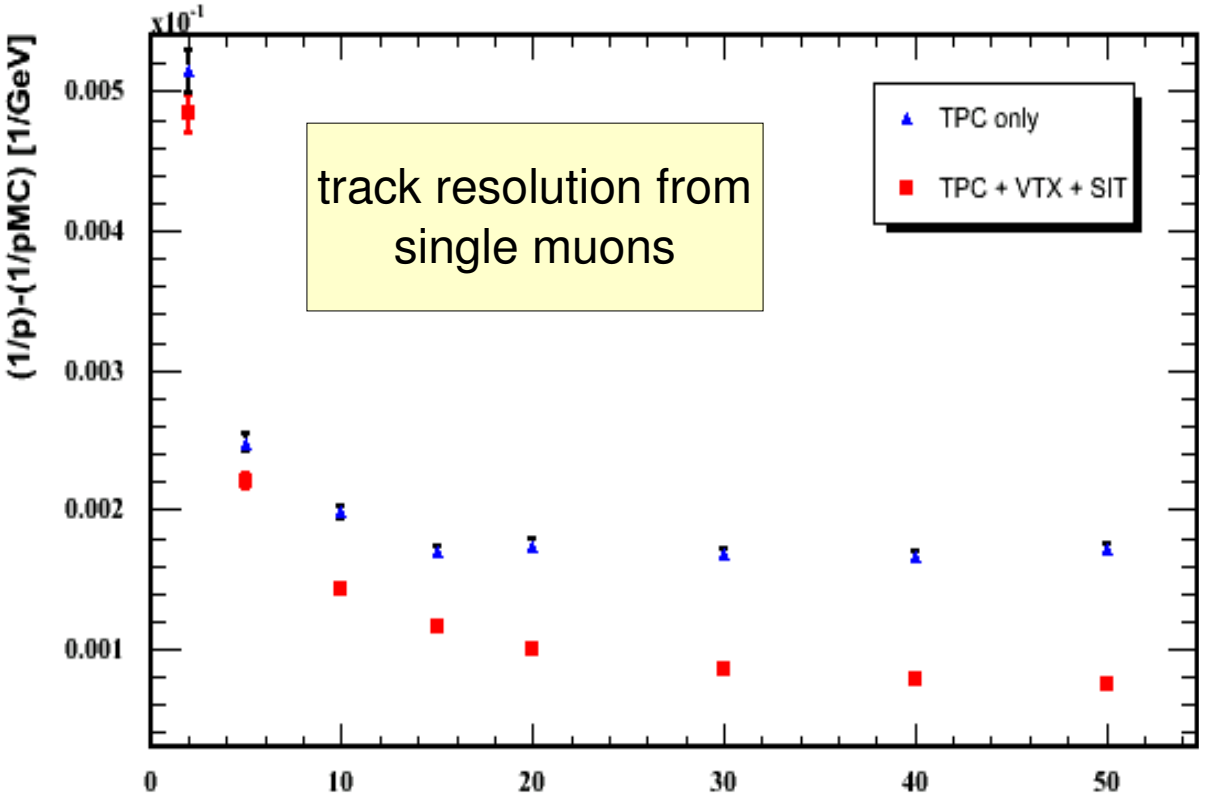
MarlinReco Tracking

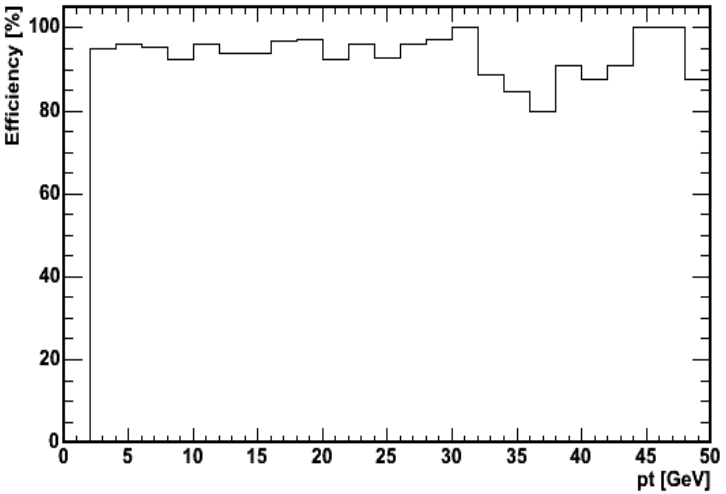
- Central Tracks: (S.Aplin)
  - algorithms taken from LEP (ALEPH and DELPHI)
  - f77 code from Brahms
    - track finding based on out-in search using circle fit
    - fit with Kalman Filter takes material into account
    - start with TPC tracks and then include VTX hits (next slide)

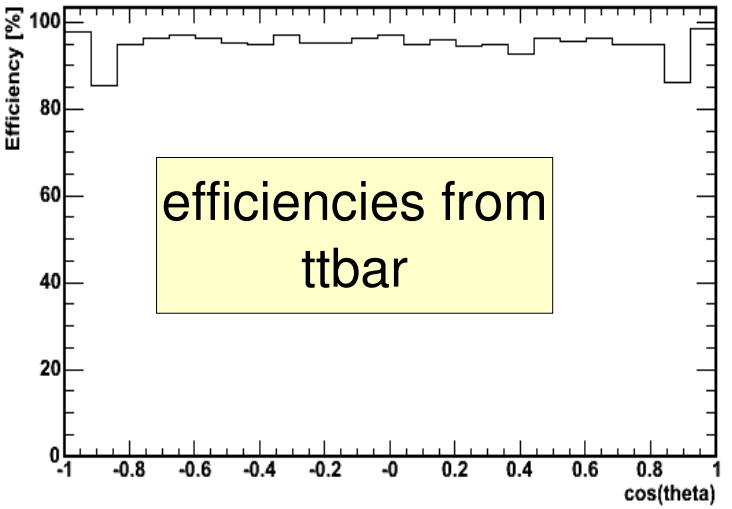
- Track Cheater (A.Raspereza)
  - uses Monte Carlo for track finding
  - fitted with a helix hypothesis

Tracking including VTX hits

- vtx hits now included in track fit
- use TPC tracks as 'seed'
- standalone VTX tracking under development







S.Aplin, O.Wendt

MarlinReco Clustering

- Trackwise Clustering (A.Raspereza)
  - algorithm needs spatial information only
    - -> applicable to both digital and analogue calorimeters
  - minimal dependence on detector geometry
    - -> can be used for other detector concepts

- Cluster Cheater (A.Raspereza)
  - uses Monte Carlo to combine hits into clusters
  - proximity criterion for 'realistic' clusters

PFlow

- Track-Cluster matching (A.Raspereza)
  - extrapolate tracks into the calorimeter
    - use only outer track hits and apply helix fit
    - proximity criterion to assign cluster to track
  - charged objects (E,p) from track
  - neutral particles (E,p) from cluster
- Particle ID (A.Raspereza)
  - cluster shape analysis
    - fraction of energy in ECAL
    - longitudinal and transverse profile
    - test of MIP hypothesis

Analysis

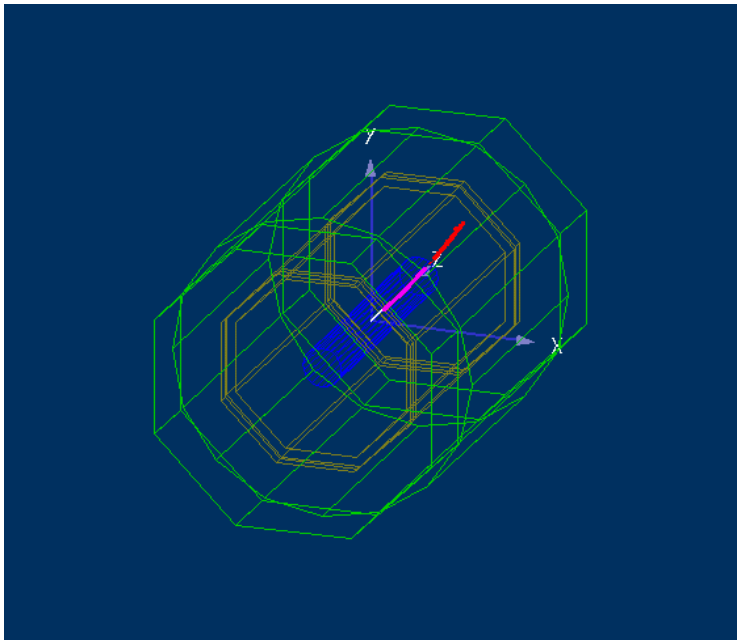
- Event Shapes (T. Kraemer, P. Krstonic)
  - ThrustReconstruction: Tasso & Jetnet algorithms
  - Sphere: sphericity, aplanarity, ...
- SatoruJetFinder (J. Samson)
  - originaly developed by Satoru Yamashita for OPAL
- BenchmarkPlots
  - not yet -> input needed

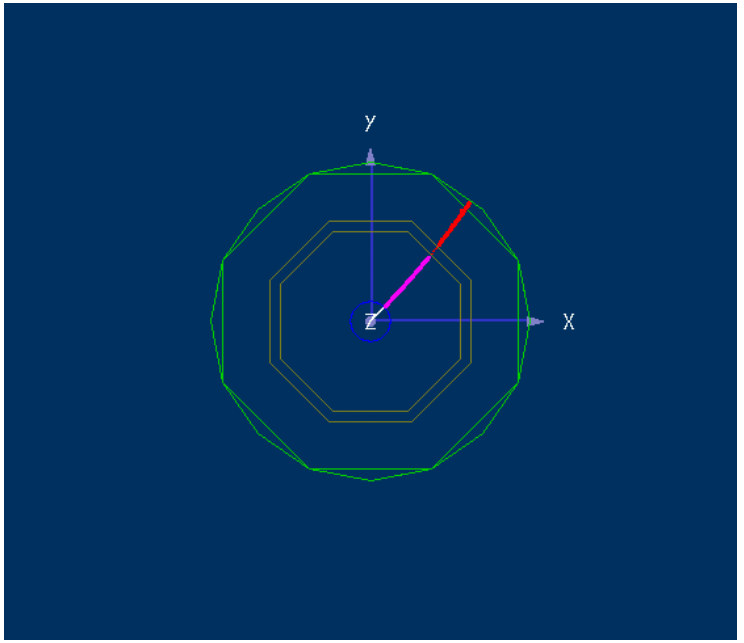
MarlinReco support packages

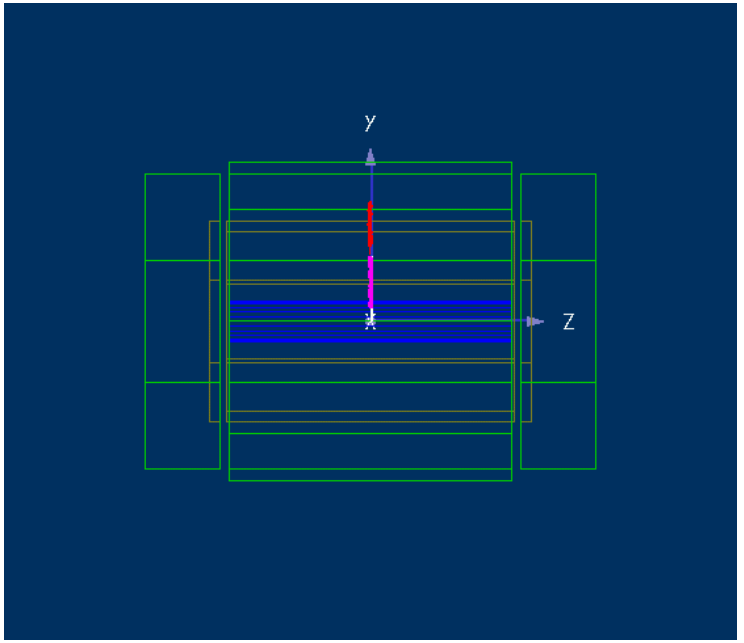
- MarlinUtil (O. Wendt)
  - Utility and Helper classes
    - helix fitter
    - cluster shapes
    - common code for CED
- CED (A. Zhelezov)
  - event display based on GLUT/ OpenGL
  - client server architecture
- CEDViewer
  - event display client processors

CEDViewer

simple example taken from
$MarlinReco/examples/LDC
steer_ldc.xml
gear_ldc.xml

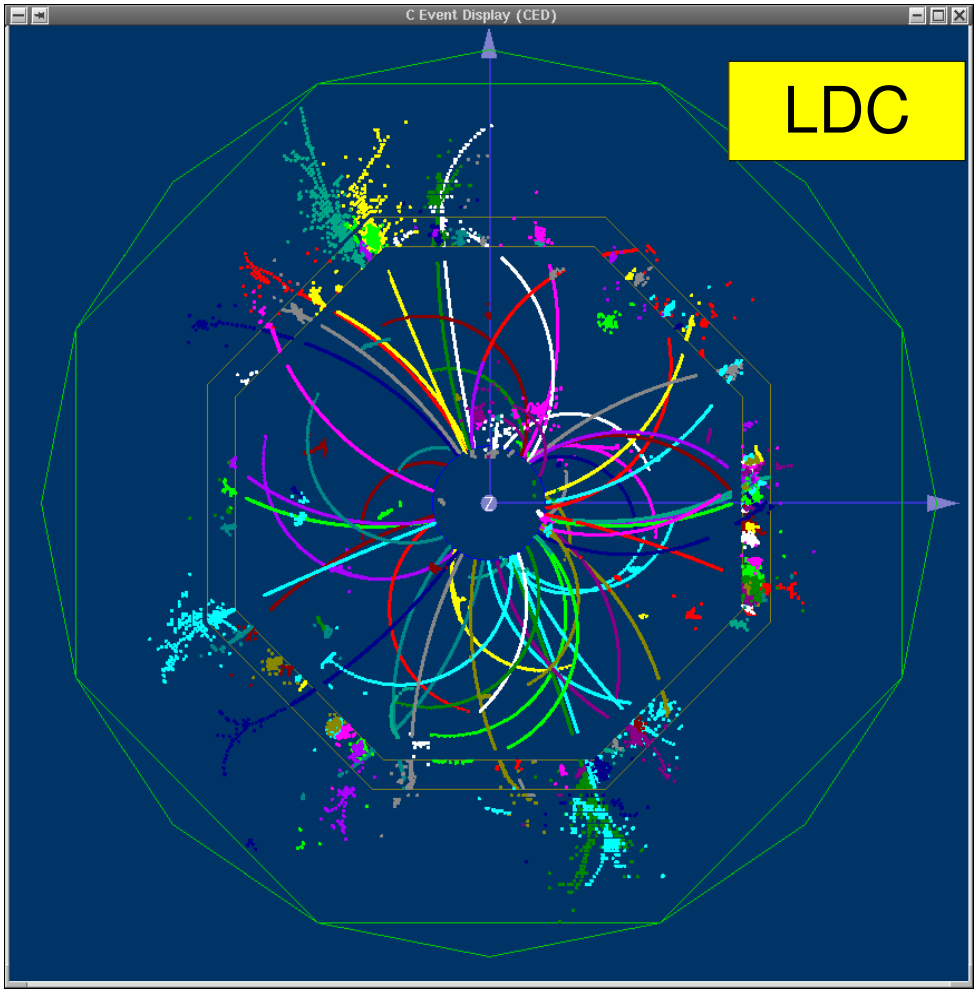


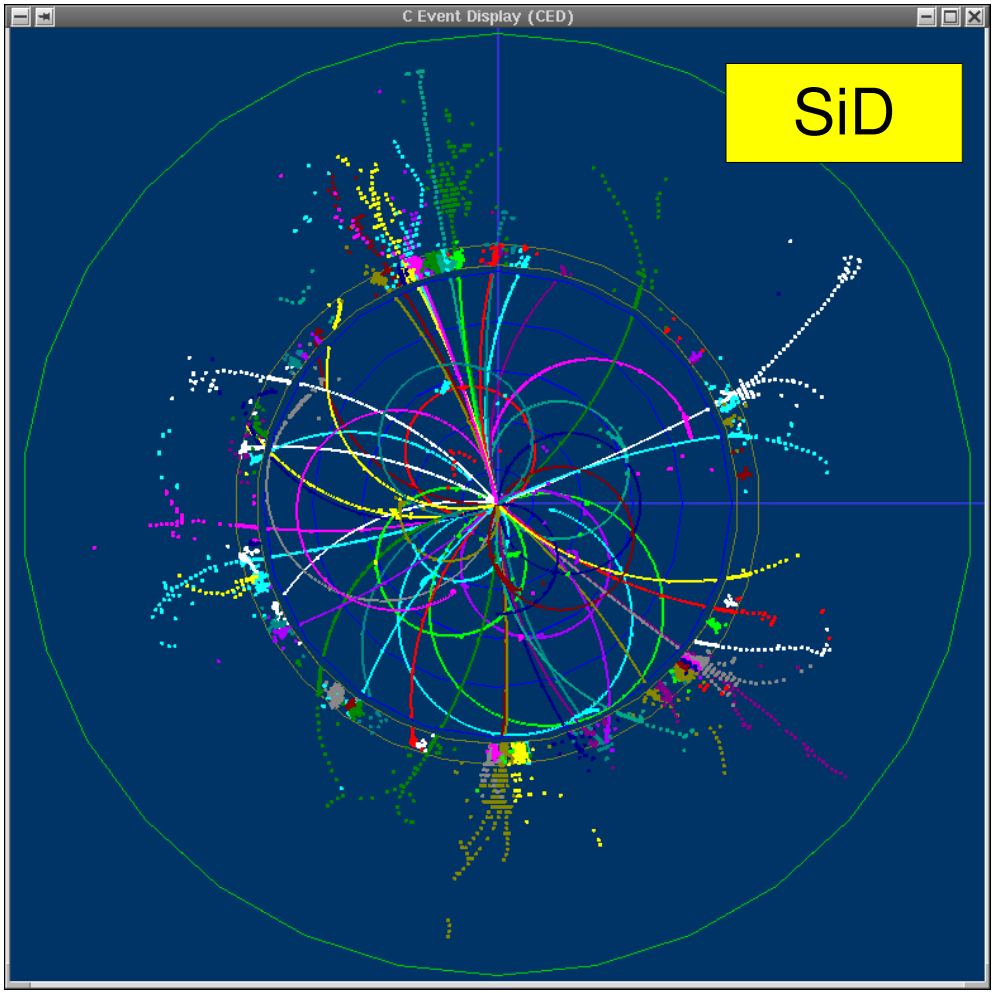




ttbar events with MarlinReco

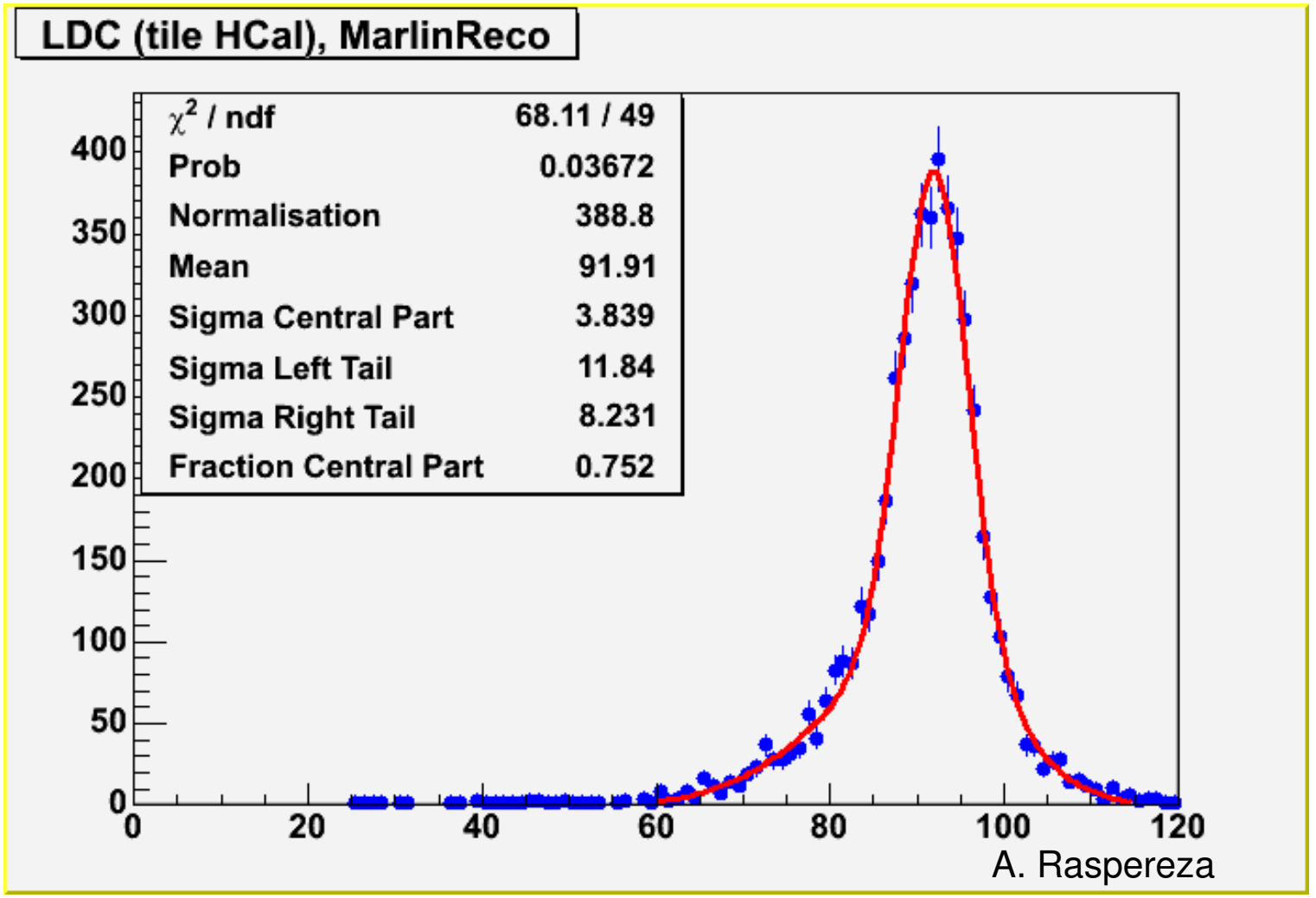
No cheaters, only full reconstruction





Initial results

- e+e- –> Z –> qqbar using full reconstruction



Status I

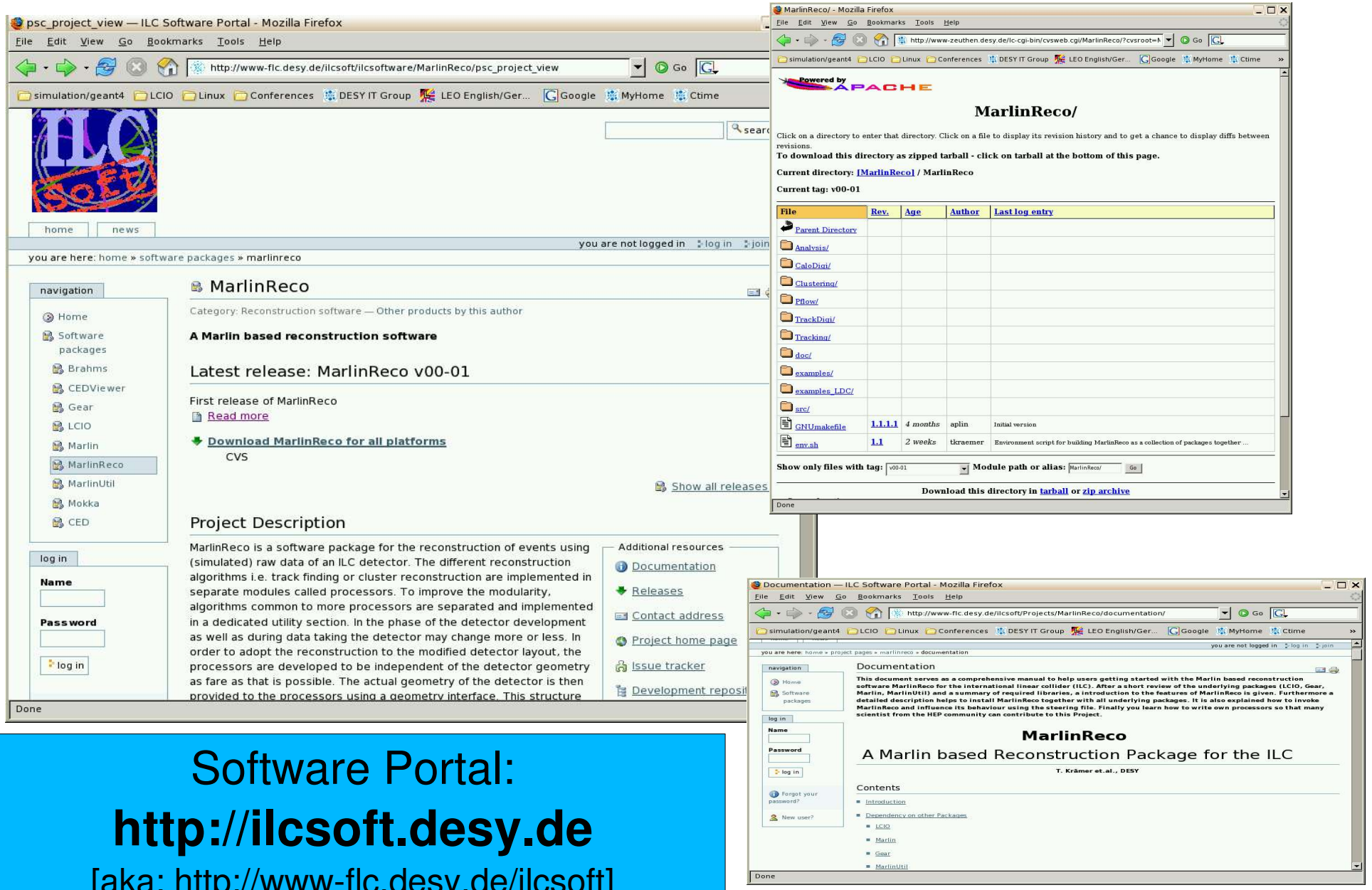
- first official release of MarlinReco: v00-01
  - changes wrt. snowmass DVD:
    - comprehensive manual (T.Kraemer)
    - including VTX hits for central tracking
    - detailed API documentation for every processor
  - utility packages released:
    - CEDViewer v00-01
    - MarlinUtil v00-01
    - CED v00-01
  - works with
    - Gear v00-02
    - Marlin v00-09-02

Status II – To Do

- neutral vertex and kink finding algorithms
- more realistic digitization
- vertex tracking
- forward tracking
- vertexing
- particleID
- ...

your input (code) is welcome !

MarlinReco on the web



Software Portal:

http://ilcsoft.desy.de

[aka: http://www-flc.desy.de/ilcsoft]

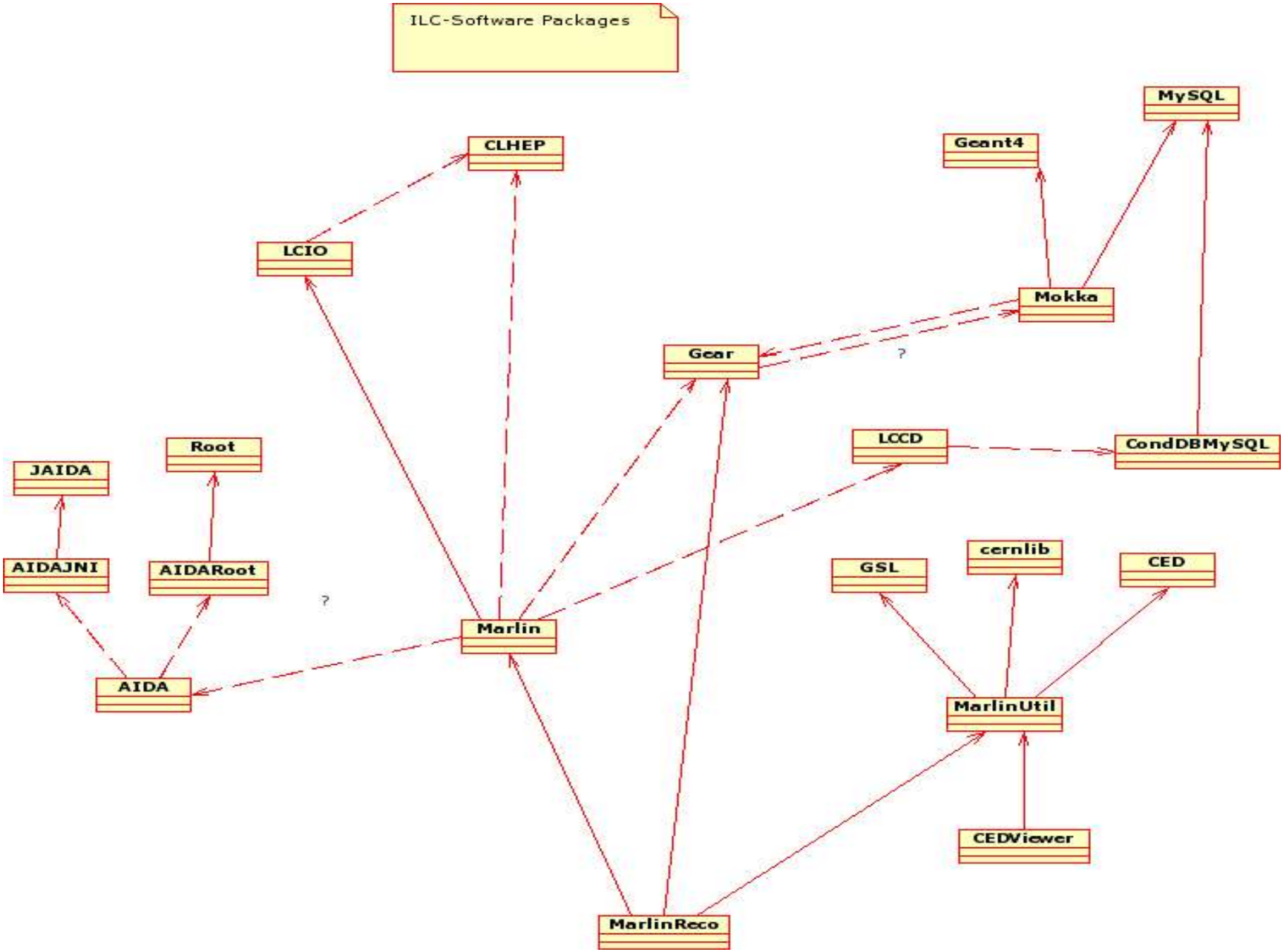
Summary/Outlook

- MarlinReco is a reconstruction toolkit for the ILC
  - (almost) complete set of standard reconstruction
  - cheaters for cross checks (and surrogates)
  - **flexible**: can be used for other detector concepts
  - **extensible**: use/combine with other processors
- v00-01 released
  - plans to extend functionality exist
  - your input is welcome !

MarlinReco is a tool for answering the questions raised by the detector concept studies
-> use it now !

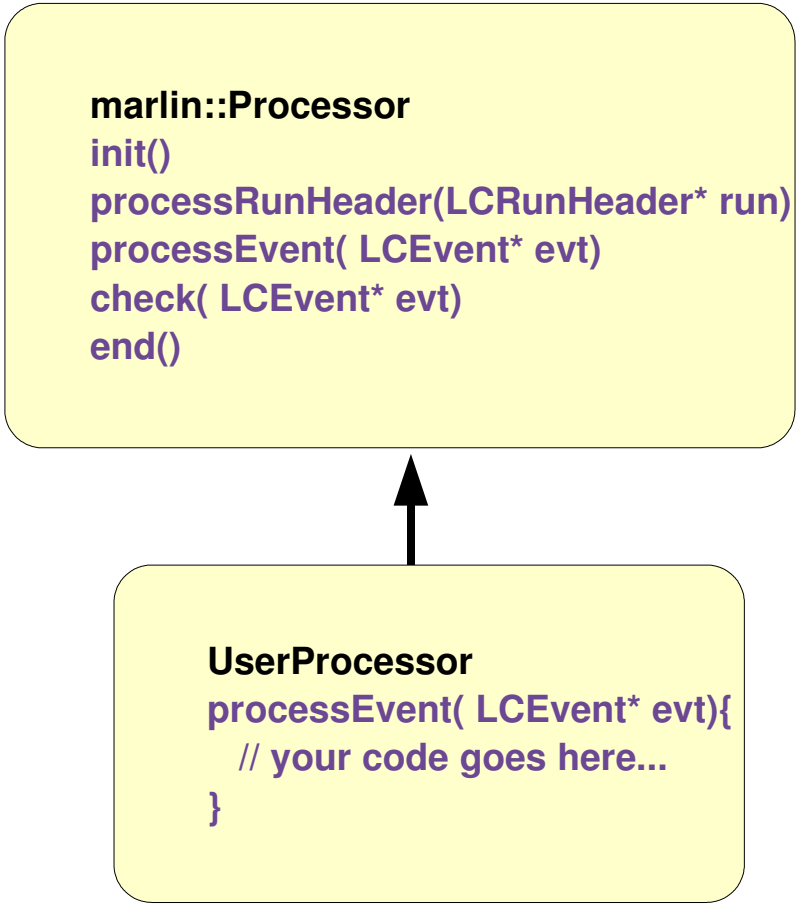
Backup slides...

MarlinReco dependencies



Marlin Processor

- provides main user callbacks
- has own set of input parameters
  - int, float, string (single and arrays)
  - parameter description
- naturally modularizes the application
- order of processors is defined via steering file:
  - easy to exchange one or several modules w/o recompiling
  - can run the same processor with different parameter set in one job
- processor task can be as simple as creating one histogram or as complex as track finding and fitting in the central tracker



XML files configure a Marlin Application

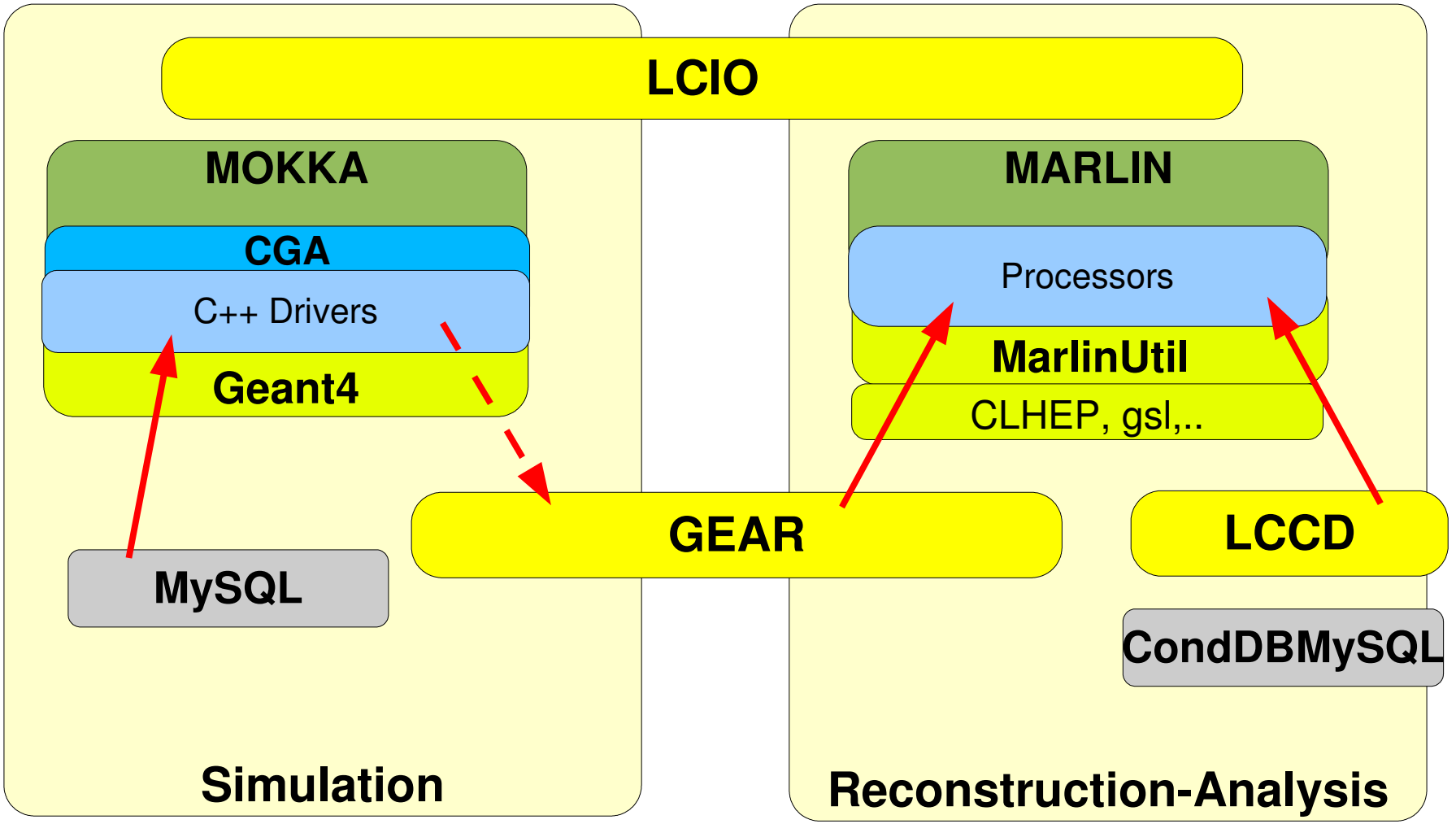
```
- <marlin>
  - <execute>
      <processor name="MyAIDAProcessor"/>
      <processor name="MyEventSelection"/>
    - <if condition="MyEventSelection">
        <group name="Tracking"/>
        <processor name="MyClustering"/>
        <processor name="MyPFlow"/>
        <processor name="MyLCIOOutputProcessor"/>
      </if>
    </execute>
  - <global>
      <parameter name="LCIOInputFiles"> simjob.slcio </parameter>
      <parameter name="MaxRecordNumber" value="5001"/>
      <parameter name="SupressCheck" value="false"/>
    </global>
  - <processor name="MyLCIOOutputProcessor" type="LCIOOutputProcessor">
      <parameter name="LCIOOutputFile" type="string">outputfile.slcio </parameter>
      <parameter name="LCIOWriteMode" type="string">WRITE_NEW</parameter>
    </processor>
  - <group name="Tracking">
      <parameter name="NTPCLayers" value="200"/>
      <processor name="MyTrackfinder" type="Trackfinder"/>
    - <processor name="MyTrackfitter" type="Trackfitter">
        <parameter name="Algorithm" value="DAF"/>
      </processor>
    </group>
    <!-- ... -->
</marlin>
```

- Active processors defined in <execute>...</execute> section
- Logical conditions from booleans set by preceding processors

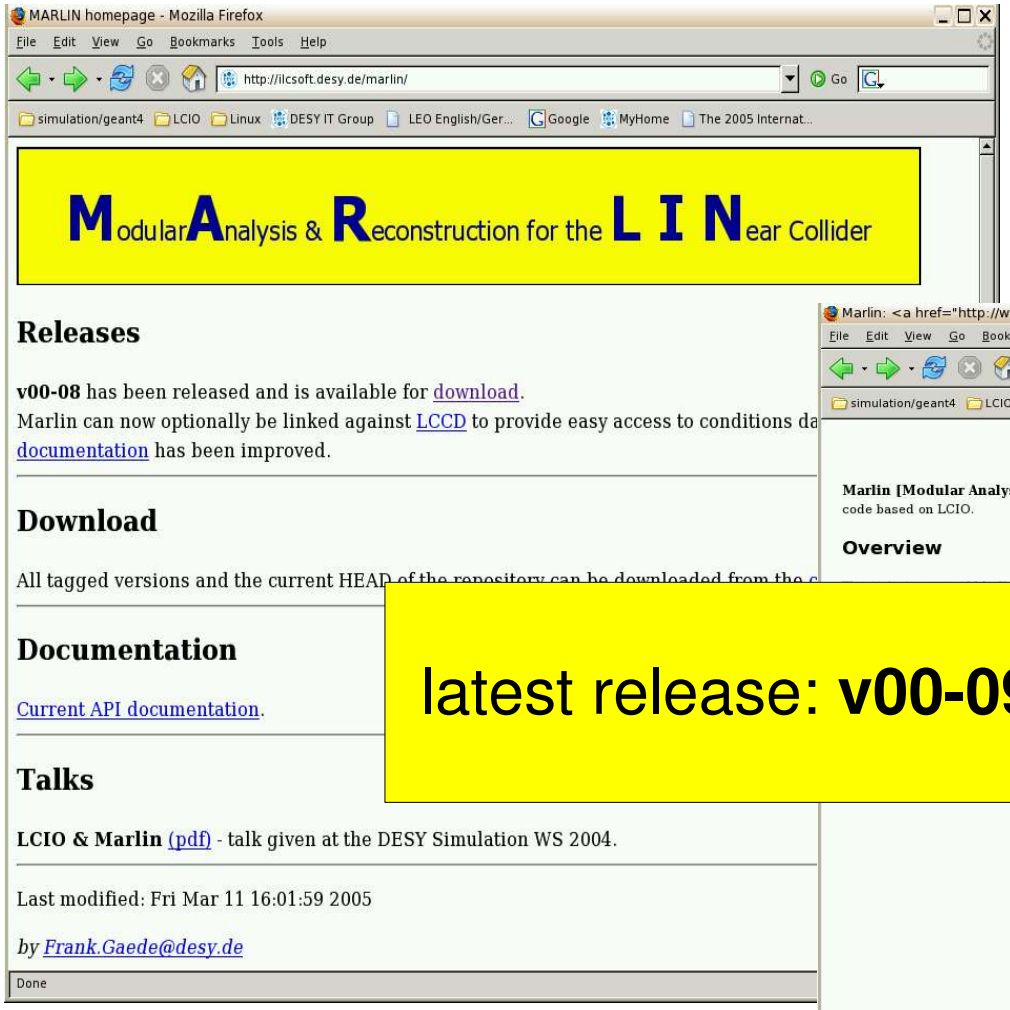
- Parameters: global and per processor
- Parameters defined as content of <parameter/> tag or as its value attribute

- Processors can be enclosed by <group/> tag
- Parameters in <group/> joined by all processors

LDC simulation framework



Marlin on the web



http://ilcsoft.desy.de/marlin

latest release: **v00-09-02**