ILD Software
Overview, Status and Plans

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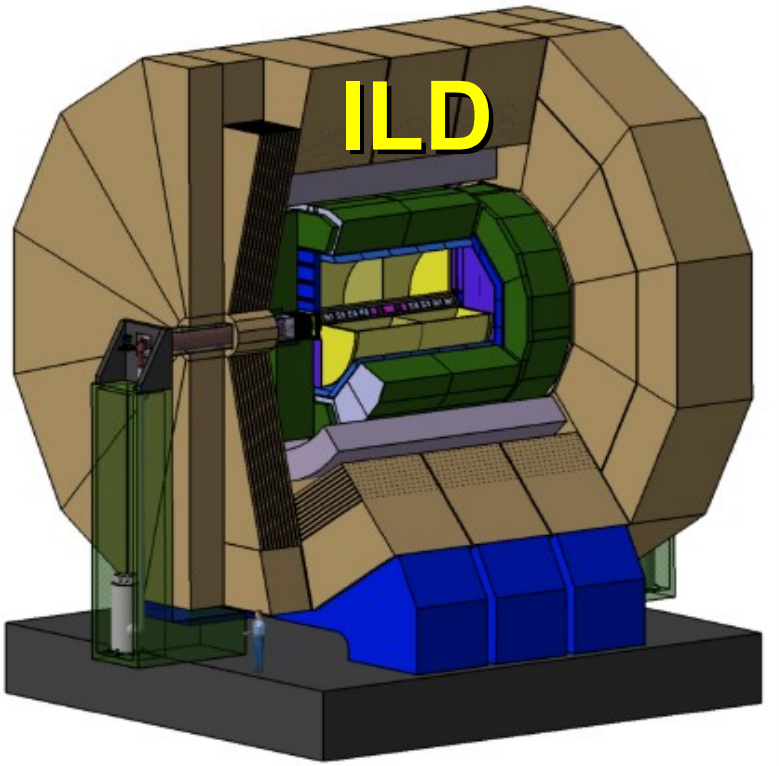
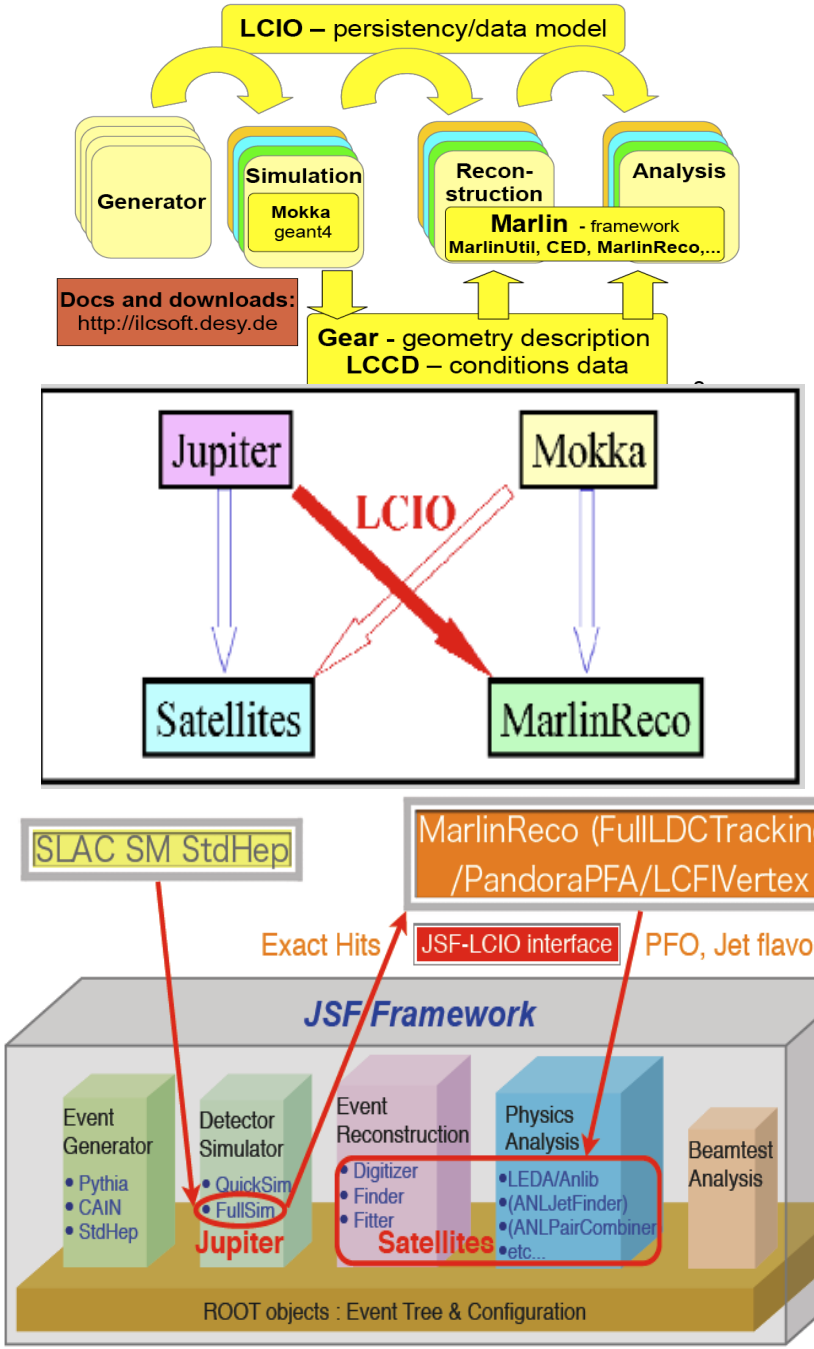
Outline

- Introduction
- Overview
  - install tools
  - simulation
  - reconstruction
- Plans
  - framework
  - simulation, geometry, tracking, PFA
  - LCIOv2
- Summary



ILD Software Introduction

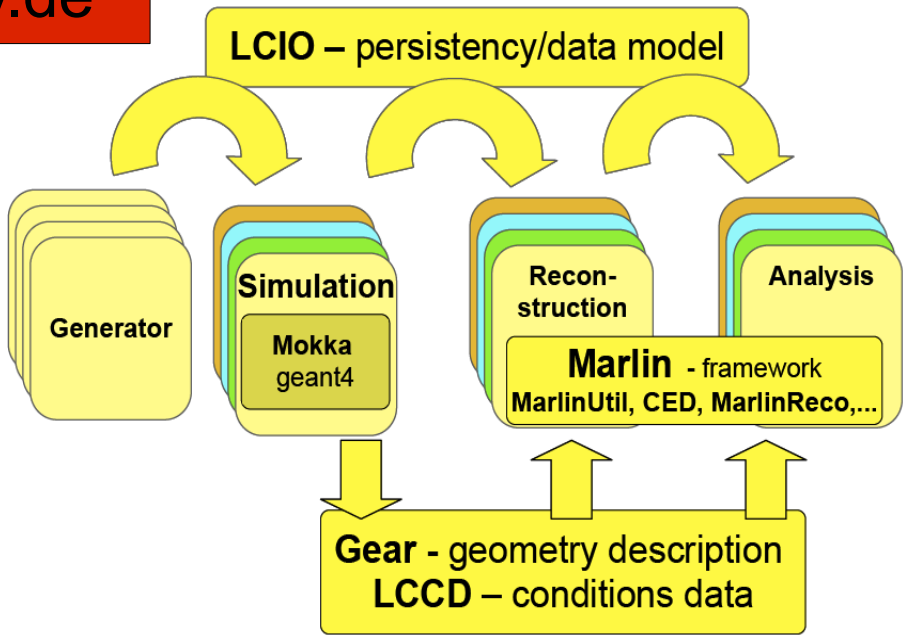


- ILD had two frameworks at beginning of LOI phase
- both frameworks 'battle proven' in massive Monte Carlo production
  - see Steve's talk for details and 'lessons learned'
- started to move towards a common ILD software framework – based on Marlin, LCIO with 'Goddies from Jupiter&Satellites

ILD Core Software Tools

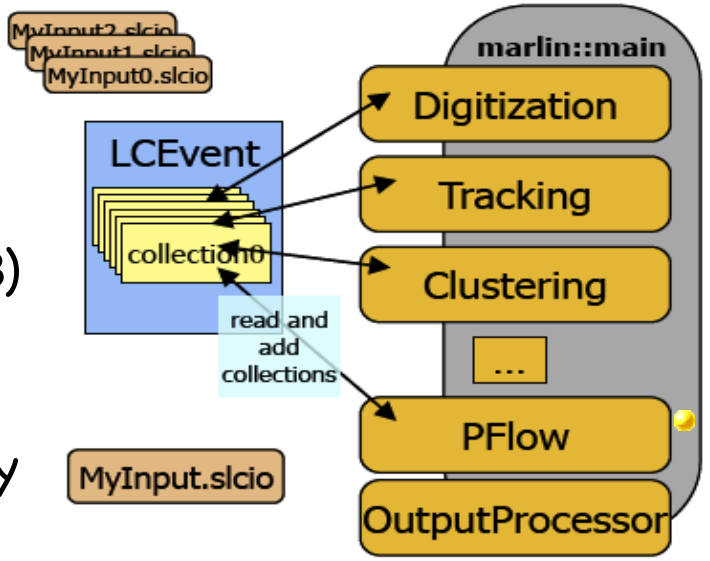
http://ilcsoft.desy.de

- **Mokka** (LLR)
  - geant4 simulation application
- **LCIO** (DESY/SLAC)
  - international standard for persistency format / event data model
- **Marlin**
  - core application framework for reconstruction & data analysis
- **GEAR** geometry package f. reconstruction
- **LCCD**
  - conditions
  - data toolkit (DB)
- **CED**
  - 3d event display



- complete framework used in Monte Carlo & 'real experiments':
  - **ILD detector concept** studies
  - **Calice** calo testbeam
  - **LC-TPC** testbeam
  - EUDET - **Pixel Telescope**

synergies between testbeam and global detector optimization



ILD software builds and installation

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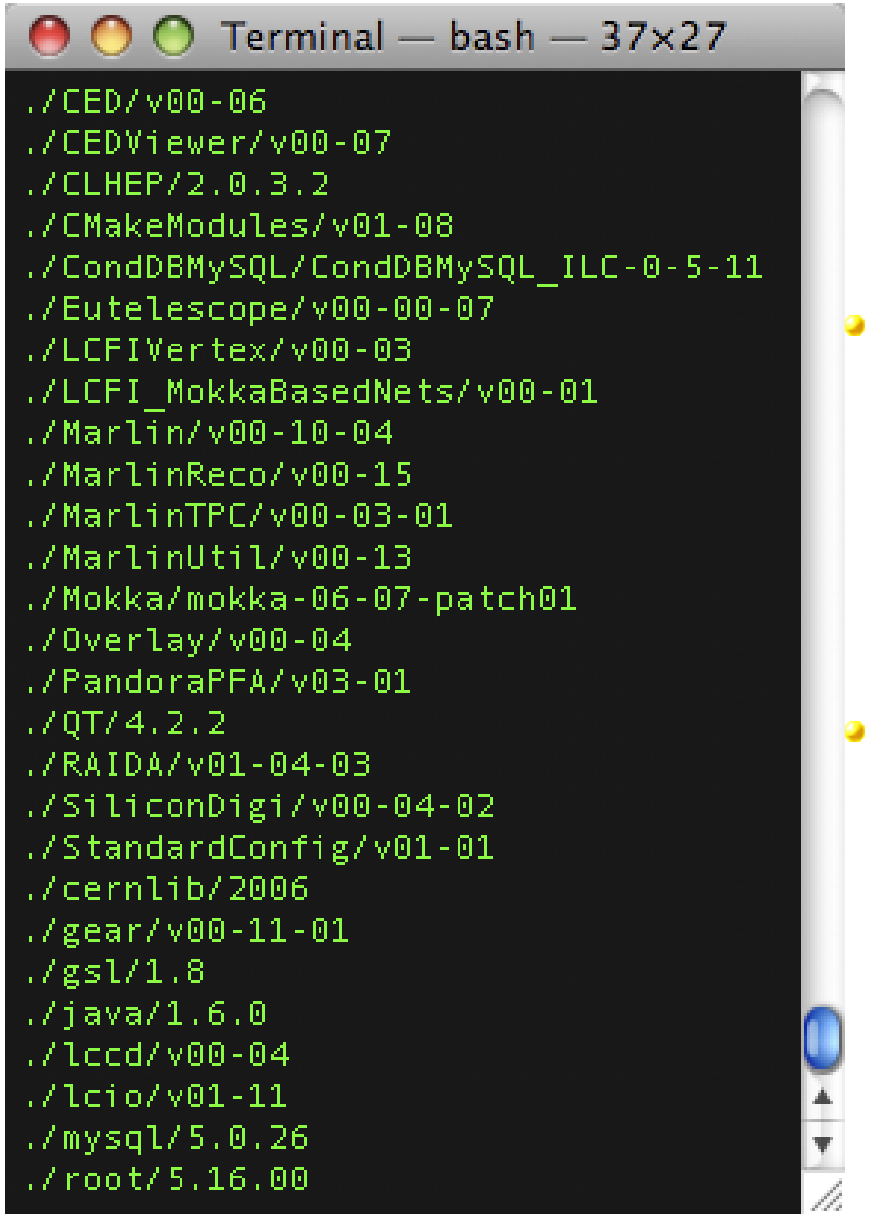
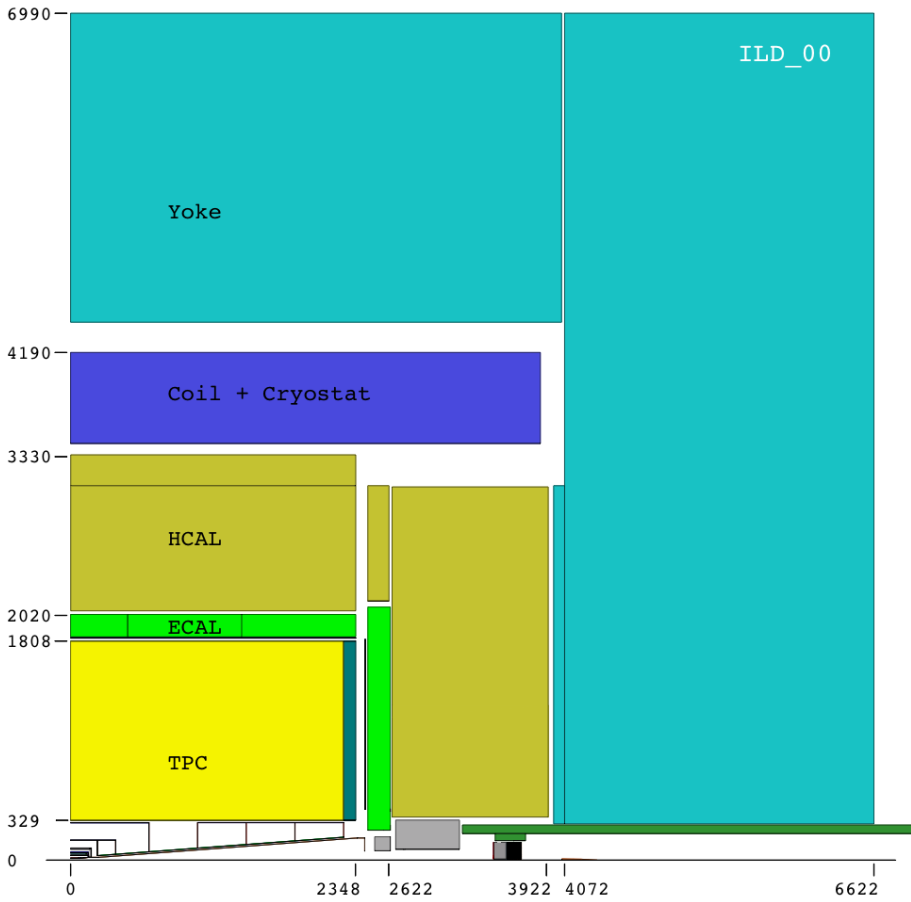
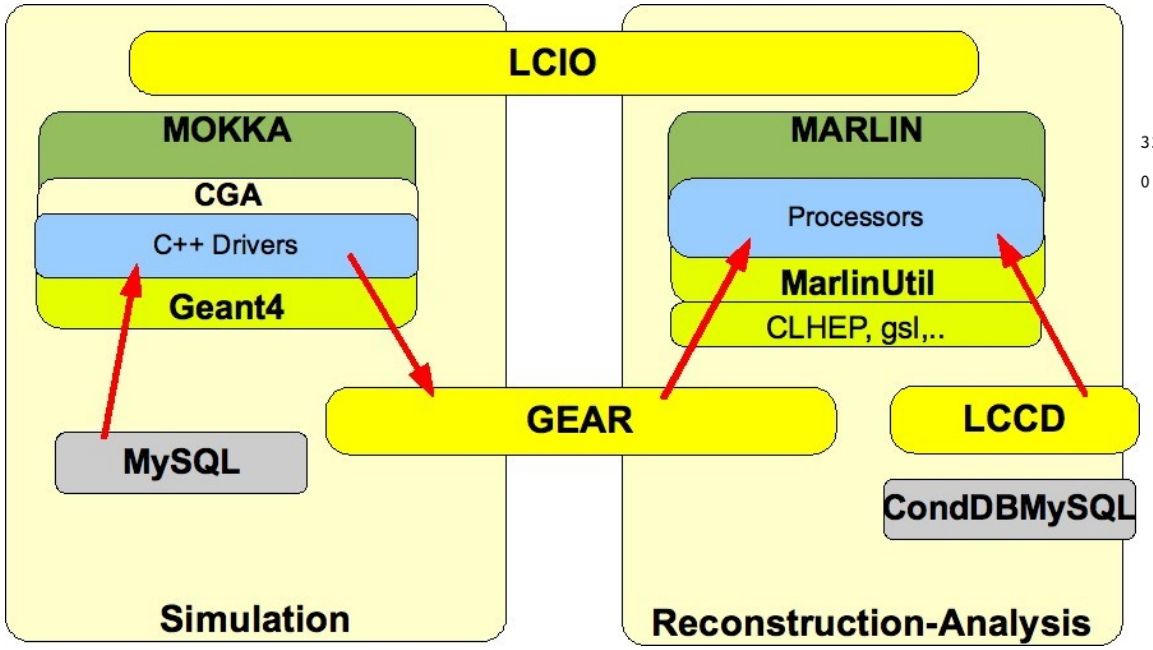


- **ilcinstall** tool: python scripts to download, build and install all ILD and external packages (incl. Jupiter&Satellites)
- 'edit and start configure script - go to lunch - run ILD software'
  - on 'scratch' disk - provided geant4, root and mysql are installed
- used for
  - **reference installations** in afs (SL4/5)
  - **grid installations** (all WLCG sites supporting VO ILC)
  - **binary tar-balls** (SL4/5)

Mokka Simulation

- defined 'ILD simulation reference model' after LOI optimization process LDC and GLD
- engineering level of detail for most subdetectors:
  - support structures
  - dead material (cabling, cooling)
  - cracks





Mokka writes out GEAR xml files with complete geometry and material parameters that are need for reconstruction and analysis

Digitization

- MarlinReco processors for digitization:
- VXD, SIT, FTD, SET, ETD Silicon hits
  - smearing of 3d space points (SimTrackerHits) according to envisaged detector resolutions
    - as established by R&D groups
- TPC hits
  - smearing of 3d space points (SimTrackerHits) taking into account drift distance, polar and azimuthal angle of track
    - parameterization from TPC R&D groups
- ECal, HCal, LCal, Bcal, LHCal, Muon Calo hits
  - calibration (single particle resolution)

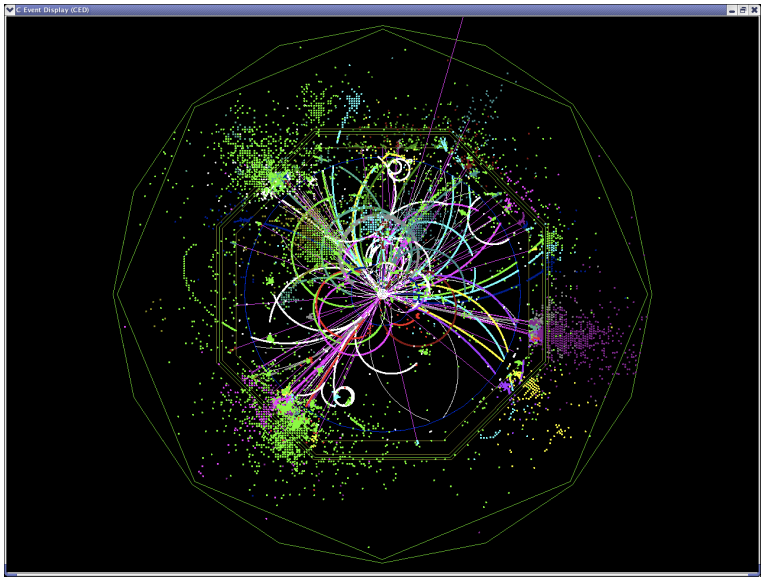
Marlin based Reconstruction

- Tracking
  - standalone tracking in Silicon detectors and TPC
  - Kalman filtering: wrapped f77 code from LEP
- Particle Flow Algorithm
  - PandoraPFA: best PFA to date
- JetFinder
  - Durham jet finder (run for 2-6 jets)
- Flavour Tagging
  - LCFIVertex package: ZVTop, ZVRes + Neural Network Fl.Tag
- DST Maker
  - ReconstructedParticles, Jets, Tracks and Clusters (25k/evt)

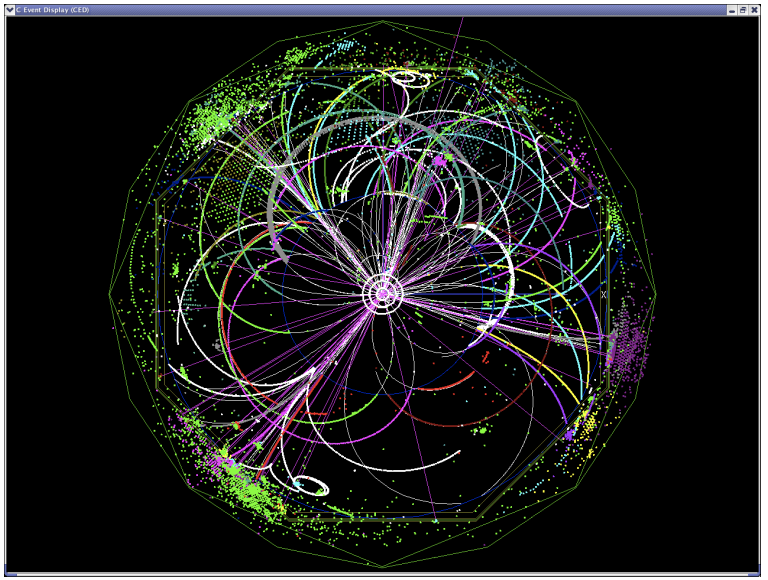
StandardConfig package has reference steering file for Marlin

Some Recent Developments

- improved CED event display
  - fish eye view
  - picking (under development)



- improved tracking code for background studies
  - Overlay processors
  - silicion digitizers (cluster sizes)
  - TPC bunch train integration of machine backgrounds



Plans for ILD software

- after LOI it is time to further improve ILD software and get ready for TDR phase (2012)
- plan to:
  - merge goodies from JSF into framework
  - develop a test system
  - develop new GRID production system
  - improve the simulation
  - improve the geometry description
  - improve the reconstruction (tracking & PFA)
  - develop LCIOv2

Merge goodies from JSF in to ildsoft

- port useful features of the core framework such as command line options to Marlin
- adopt selected JSF modules to be run as Marlin processors, e.g. the QuickSim fast simulator
- port subdetector simulation code from Jupiter to Mokka for technologies that are not present in Mokka, such as the Scint. ECal
- make existing analysis code from JSF available and compatible with LCIO (possibly via ROOT dictionaries)

Test system for ILD software

- develop test system for ILD software including:
- unit tests
  - 'technical' software tests on class/function level
- integration tests
  - technical tests of packages and their interplay
- physics quality
  - check algorithms, physics performances, hit maps,...
- comment: such a test systems would probably have saved us some hassle in the past - and will make future development more efficient !
- need to be pragmatic about this: look into existing testing tools and/or extend our installation toolkit

new GRID production system

- during LOI Monte Carlo production realized that current system needed quite some manual interference and 'baby sitting'
- in order to save manpower with next major production started development of new GRID production system:
  - properly design data base schema (performance)
  - based on python scripts (flexibility & maintainability)
  - better robustness and error handling
  - easy to use (share work of production)

Extend and Improve Simulation

- need 'baseline detector' in simulation, with
  - proven subdetector technology
  - including realistic description of 'faults and imperfections'
- need to develop additional technology subdetector drivers for Mokka, such as:
  - SciEcal and DHCal options (ongoing)
  - FPCCD vertex detector
- need to improve realism for some subdetectors wrt. LOI model ILD_00, eg.
  - silicon trackers: SIT, SET, ETD, FTD (currently cylinder and disks w/ parameterized support material)

develop a generic geometry Toolkit

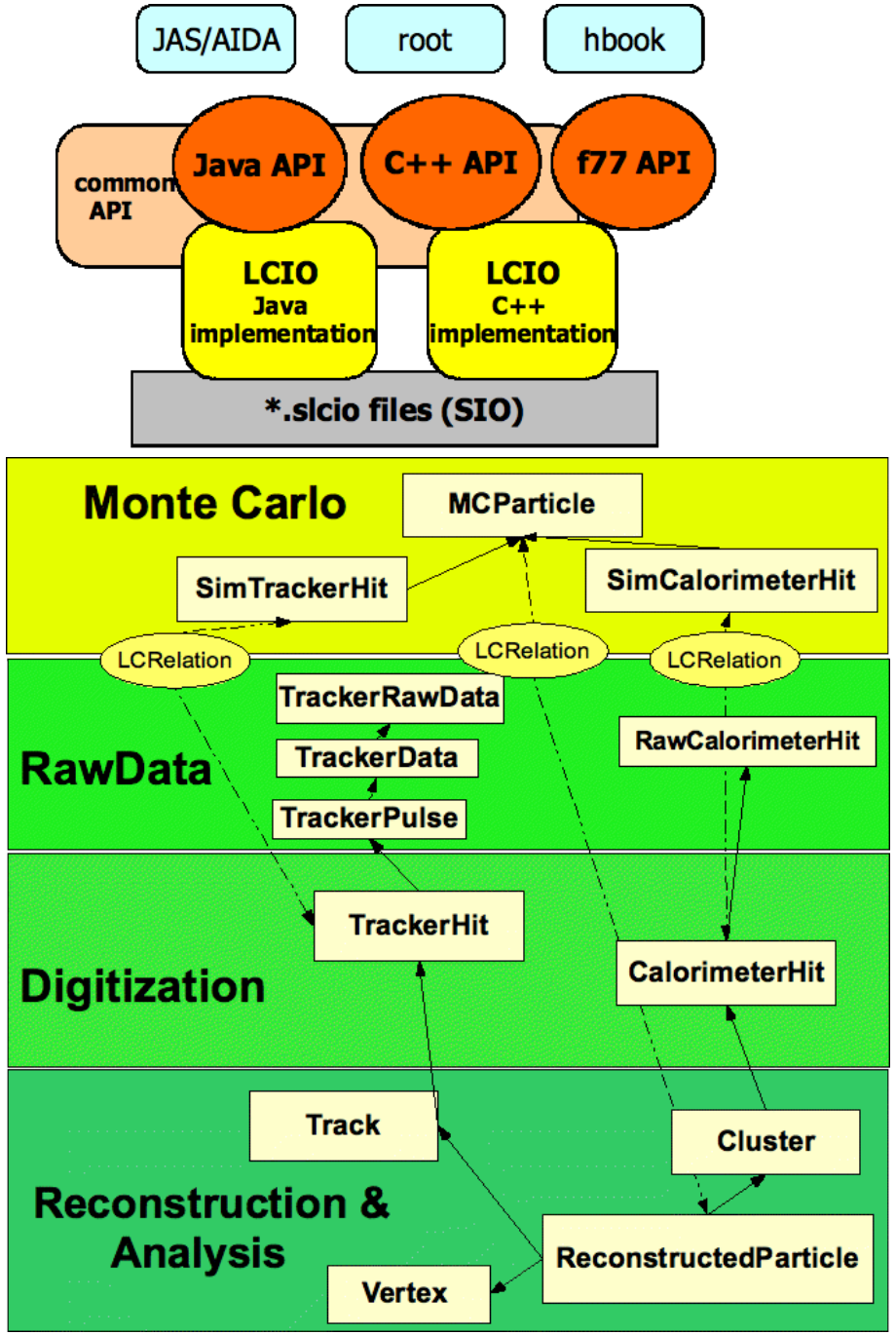
- description of complex shapes, materials and sensitive detectors
  - with interfaces to:
  - full simulation programs (geant4, fluka?)
  - fast simulation programs
  - reconstruction algorithms
    - high level interface a la GEAR
    - questions that need to be answered during reconstruction tracking and clustering/PFA
  - visualization tools (ROOT, VRML, etc.)
- allow for misalignment of detector components
- small memory footprint
- efficient tracking in geometry hierarchy and fields
- ...

ideally collaborate with other HEP groups on that !

Improve Reconstruction Tools

- digitization:
  - improve description of spacial resolution (R&D groups)
  - introduce ghost hits for strip detectors
- tracking:
  - develop modern tracking and pattern recognition software to replace f77 LEPTracking
  - need code for proper treatment of strip detectors
    - ghost hits from stereo layers,...
  - tracking in non-uniform B field (anti-DID)
- clustering/PFA
  - modularize and improve PandoraPFA

LCIO: persistency & event data model



- joined DESY and SLAC project – first presented @ CHEP 2003
- provides persistency (I/O) and an event data model (EDM) to ILC detector R&D community
- features:
  - Object I/O (w/ pointer chasing)
  - schema evolution
  - compressed records
  - hierarchical data model
  - decoupled from I/O by interfaces
    - C++, Java (and Fortran)
  - some generic user object I/O

LCIO is used by ILD, SID, Calice, EUPixelTelescope, LCTPC,...

LCIOv2

- further improve LCIO -> LCIOv2
- event data model
  - 1d, 2d hits
  - Track class - multiple fits per track
- Improve I/O
  - splitting of files
  - direct access
  - partial reading of events
- investigate the use of ROOT with LCIO
  - LCEvent in ROOT macros
  - look into optional ROOT I/O for LCIO

continue successful horizontal collaboration with SID on LCIO

ROOT I/O for LCIO

- started to investigate optional ROOT I/O for LCIO
- created dictionary with rootcint for LCIO classes
  - thanks to ROOT team for their help and for adding some features to ROOT 5.24.00 needed for LCIO
  - => write and read LCEvents transparently to/from ROOT files
    - no change in user code !
  - => use LCEvents in ROOT macros
    - rapid development of analysis code based with LCIO in ROOT !
- issues:
  - no branches due to pointers between object
  - no partial reading and splitting of events over files
  - need proper interface to ROOT I/O for java implementation

-> need to work with ROOT team to resolve these issues...

Summary

- ILD has a complete software framework that is battle proven in LOI mass production for detector optimization and physics analyses
- now entered new phase
- merging the two frameworks into one common ILD framework
- further improve the tools to get ready for the TDR 2012 :
  - more realism for some detectors – additional technologies
  - develop a new and modern tracking package
  - develop a geometry description
  - further improve the digitization and reconstruction algorithms