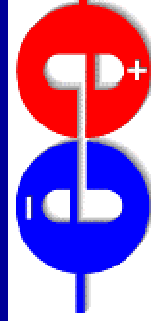




ALCPG Software Framework Overview & Updates

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Requirements Overview

- Software should be easy to install and straightforward to use.
- Researchers should be able to easily create their own analysis programs.
- Framework should support LCIO data format.
- Grid ready (simulation/reconstruction)
- easily support multiple detector models
 - allow researchers to author their own detectors
- JAS3 plugin
 - AIDA, Wired, Java

Framework Diagram

Software

Pythia (etc.), Stdhep



SLIC, LCDD, Geant4, LCIO



Icsim, GeomConverter, LCIO



Icsim, AIDA, LCIO

Framework

Event Generation



Simulation



Reconstruction



Analysis

SLIC - Overview

- full simulation of physics events in detector geometry
- developed at SLAC
- Geant4 binding
- designed for iterative detector development
- generated ~70 million events for SiD LOI on grid and LSF batch system (FNAL, SLAC, other)
- supports simplified cylindrical geometries as well as more realistic detectors
- easy to use
- fast to load/run
- <https://confluence.slac.stanford.edu/display/ilc/SLIC>

SLIC - Features

- grid ready
 - can be setup to require no external connections
 - minimal dependencies on dynamic libraries
 - Condor and LSF scripts available
- SimDist build kit
 - GNU autoconf
 - binary distributions available for Linux, OSX, & Cygwin
- autonaming of output files
- LCIO output binding
- event generation input
 - GPS, Stdhep, Particle Gun, LCIO (beta)
- LCDD/GDML compatible
- logging system for easy debugging
- simple and familiar command line interface

SLIC – Command Line Interface

- Most types of batch jobs can be run using only the command line interface.
- direct binding to G4 macro commands
 - creates a command queue
- execute a single macro or series of macros in order
- interactive or batch mode
- job examples
 - batch

slic -g geom.lcdd -i events.stdhep -x -O -r 1000 -p LCPhys

– batch with single macro

slic run.mac

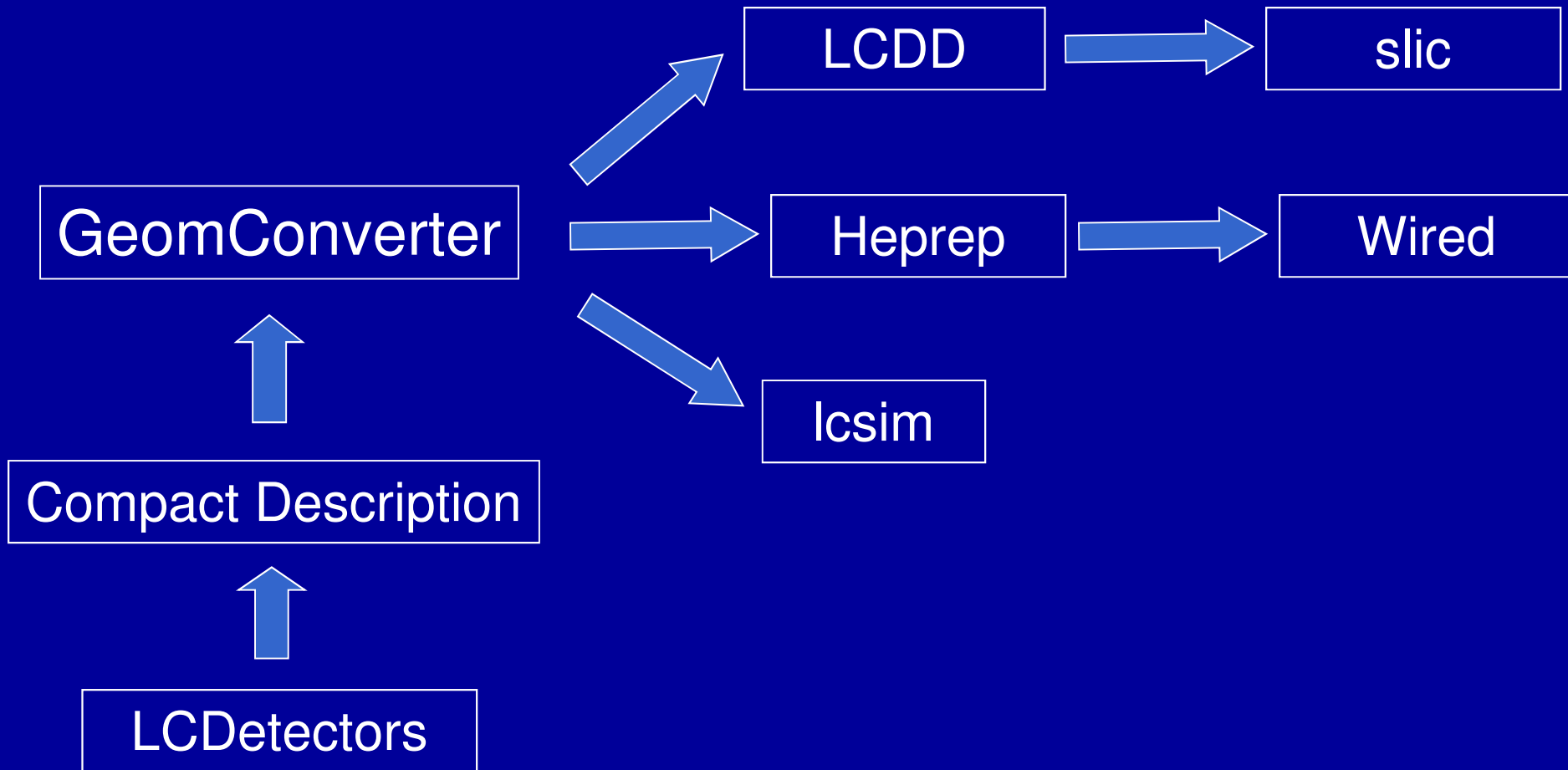
– interactive

slic -g mygeom.lcdd -m vis.mac -n

SLIC – New Features

- Optical Physics
 - can be used with any physics list supported by slic
- HEPPDT
 - supports extended SM and SUSY particle set using input data table
 - simple transport (charged will bend in field)
 - simple dEdx to create hits in detector
- VRML writer (alpha version)
 - writes cylindrical geometries ok
- additional segmentors for planar geometries
 - CartesianGridXY, CartesianGridXZ
- geant4 9.2
 - physics lists

Geometry System



<http://www.lcsim.org/software/geomconverter/>

LCDD - Overview

- XML detector description format
- high level of detail
 - An LCDD file specifies ALL parameters required for full detector simulation.
- extends GDML (Geometry Description Markup Language)
- generated by GeomConverter from compact detector description (XML), which is written by hand
- possible to create from scratch (though tedious)
- loads fast
 - C++ SAX Parser (low memory footprint)
 - no external database connection required
- <http://www.lcsim.org/software/lcdd/>

LCDD - Features

- regions
 - production cuts
- physics limits
 - track length, step length, etc.
- visualization
 - color, level of detail, wireframe/solid
- sensitive detectors
 - calorimeter, optical calorimeter, tracker
 - segmentation
- IDs
 - 64 bit ID specification
 - volume identifiers (physvolid)
- magnetic fields
 - dipole, solenoid, field map
- utilities
 - information on Geant4 stores
 - GDML load/dump

GDML

- basic geometry description format
- supported by multiple toolkits
 - ROOT
 - Geant4
 - slic
 - GeomConverter (write)
- makes all geometry information explicit
 - no black box code with magic numbers
- flexible
 - also usable for ATLAS Upgrade, test beams, etc.
- includes parameters, shapes, materials, volumes, volume hierarchy

Compact Description - Overview

- high level detector description format
 - sid02 (LOI) = 10 pages of XML
- geometry and detector description parameters
 - variables, detectors, segmentation and readout, fields, visualization
 - materials database
- GeomConverter output bindings
 - LCDD
 - HepRep
 - Java (org.lcsim.geometry, org.lcsim.detector)
- detector geometry drivers
 - cylindrical calorimeters and trackers
 - planar calorimeters and trackers
 - support structures

Compact Description - Example

```
<detector  
  id="3" ← global unique identifier  
  name="HADBarrel" ← global unique name  
  type="CylindricalBarrelCalorimeter" ← detector type  
  readout="HcalBarrHits" ← readout collection  
  vis="HADVis"> ← visualization settings  
  <dimensions inner_r = "141.0*cm" outer_z = "294*cm" />  
  <layer repeat="40"> ← layering  
    <slice material="Steel235" thickness="2.0*cm"/>  
    <slice material="RPCGasDefault" thickness="0.12*cm"  
      sensitive="yes" region="RPCGasRegion"/>  
  </layer>  
</detector>
```

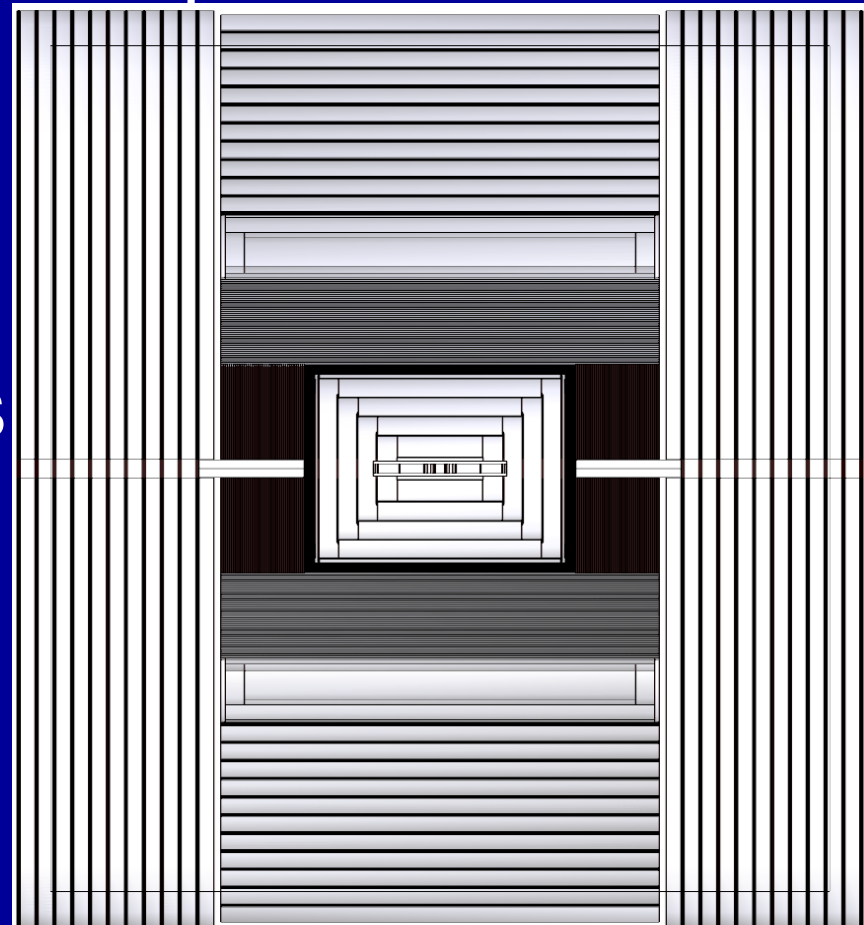
← absorber

← sensitive layer

GeomConverter – Cylindrical Detectors

- used in SiD LOI
- builds series of nested cylinders based on layering in compact description
- not realistic
- very fast to simulate
- being phased out for more realistic models
- many models and variations in detector database

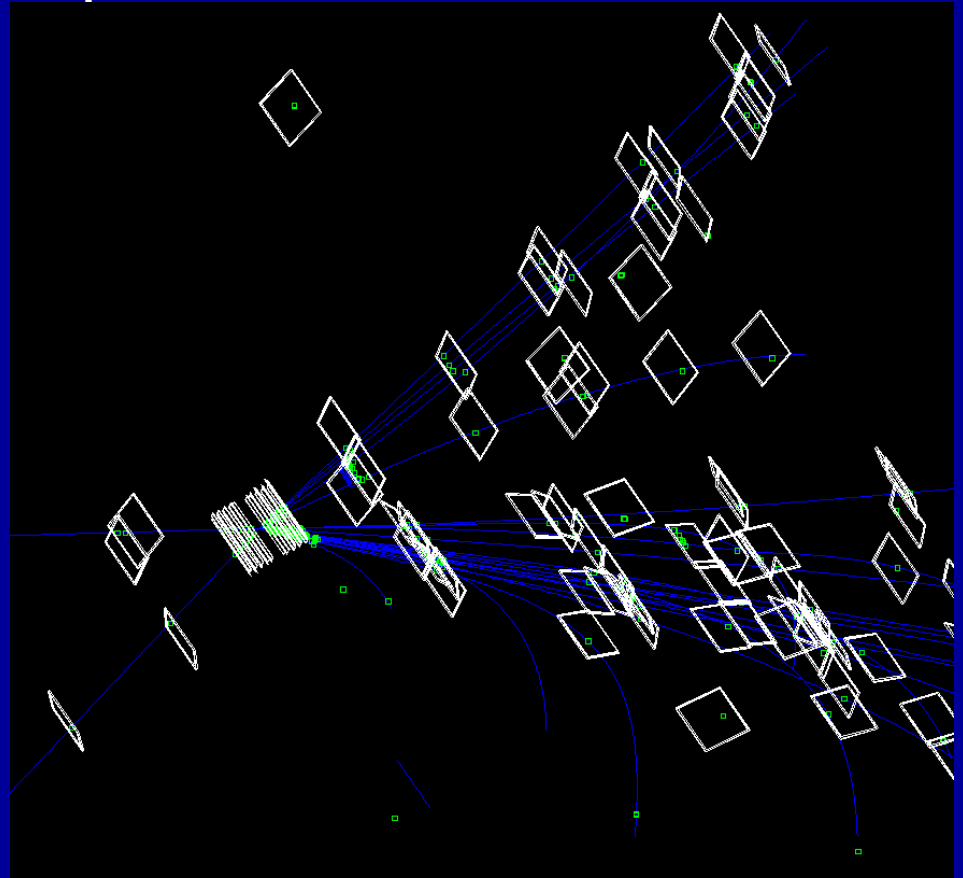
sid02



GeomConverter – Planar Trackers

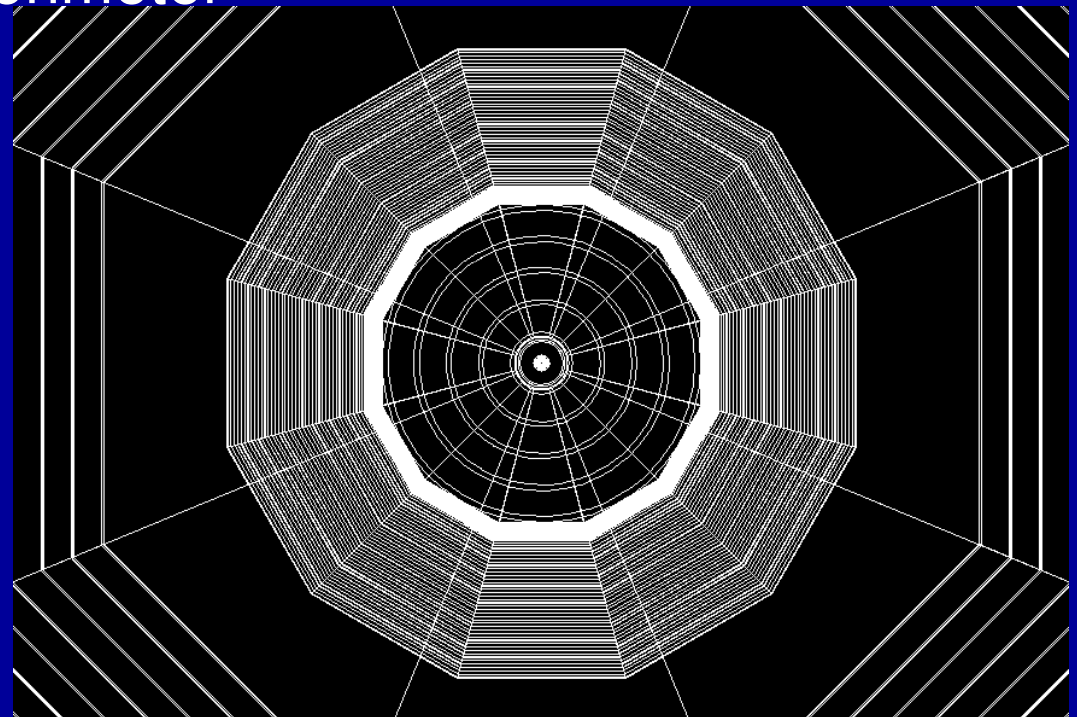
- Si trackers and vertex detectors
- planar modules
- size/layout/material parameters specifiable
- segmented into pixels/strips
 - digitization
 - sisim (Tim Nelson)
- Seed Tracker
- subdetector models
 - SiTrackerBarrel
 - SiTrackerEndcap
 - SiTrackerEndcap2

sidloi2



GeomConverter – Planar Calorimeters

- new calorimeter detector components
 - PolyhedraBarrelCalorimeter
 - PolyhedraEndcapCalorimeter
 - EcalBarrel
- parameters
 - number of sides
 - inner R
 - Z
 - layering
- simplified structure
 - plan to add tolerances for stay clears
 - additional support structures could be added also



LCSim - Overview

- Java reconstruction and analysis framework
- GeomConverter dependency provides compact and detailed detector models.
- AIDA (Abstract Interfaces for Data Analysis)
 - plotting in JAS3
 - clouds, histograms, data point sets, tuplus, etc.
- users
 - SiD Group/LOI, ATLAS Upgrade, test beams, dual readout studies, CLIC, etc.
- <http://confluence.slac.stanford.edu/display/ilc/org.lcsim>
- <https://confluence.slac.stanford.edu/display/ilc/LCSim+Tutorials>

LCSim – XML Interface

- input format to lcsim for batch jobs
- creates drivers with input parameters
- automatically accepts single arguments based on setter functions (Java Beans)
 - Java primitive types
 - 1D arrays of primitive types
 - custom XML element
 - global expression evaluation
- easy to add external libraries
 - URL to jar file
- input files
 - remote (ftp, http) or local files
- control arguments
 - number of events, logging, data caching, etc.
- JobControlManager

LCSim – XML Example

`<inputFiles>` ← list of input LCIO files

`<file>/path/to/myfile.slcio</file>`

`</inputFiles>`

`<execute>` ← Driver execution order

`<driver name="MyDriver"/>`

`</execute>`

`<drivers>` ← Driver definitions

`<driver name="MyDriver"` ← unique name of Driver

`type="org.lcsim.ADriver"/>` ← Java type of Driver

`<paramX>1.2</paramX>` ← single parameter

`<paramXX>1.2 2.3 3.4</paramXX>`

`</driver>`

← array parameter

`</drivers>`

Maven

- Java build tool
 - <http://maven.apache.org>
- used by all lcsim-based projects
- project management
 - project version
 - cvs and repository information
 - versioned dependencies
 - build & test
- repository
 - <http://www.lcsim.org/maven2>
- IDE support
 - Netbeans
 - Eclipse

Future Plans

- full reconstruction with new geometry components
 - planar calorimeters and trackers
- improve realistic detector models
 - calorimeter stay clears, support structures
 - look at CAD models for guidance
- “standard” Geant4 physics list instead of LCPhys
- VRML writer with realistic geometries
 - currently bug in coordinate system from G4 to VRML
- better support for dual readout calorimetry
- add more features to lcsim xml / JobControlManager for batch runs
- publications - slic, LCDD
- improve the documentation (always!)