ALCPG Software Framework
Overview & Updates
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ALCPG 2009
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](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

GeomConverter

Compact Description

LCDetectors

LCDD

Heprep

Icsim

slic

Wired

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" name="HADBarrel" type="CylindricalBarrelCalorimeter" readout="HcalBarrHits" vis="HADVis">
  <dimensions inner_r = "141.0*cm" outer_z = "294*cm" />
  <layer repeat="40">
    <slice material="Steel235" thickness="2.0*cm"/>
    <slice material="RPCGasDefault" thickness="0.12*cm" sensitive="yes" region="RPCGasRegion"/>
  </layer>
</detector>

- **Global unique identifier**: `id="3"`
- **Global unique name**: `name="HADBarrel"`
- **Detector type**: `type="CylindricalBarrelCalorimeter"`
- **Readout collection**: `readout="HcalBarrHits"`
- **Visualization settings**: `vis="HADVis"`
- **Dimensions**:
  - Inner radius: 141.0 cm
  - Outer radius: 294 cm
- **Layering**:
  - Layer repeat: 40
  - Absorber: Steel235, thickness: 2.0 cm
  - Sensitive layer: RPCGasDefault, thickness: 0.12 cm, sensitive: yes, region: RPCGasRegion
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
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
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](http://confluence.slac.stanford.edu/display/ilc/org.lcsim)
• [https://confluence.slac.stanford.edu/display/ilc/LCSim+Tutorials](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>
  <file>/path/to/myfile.slcio</file>
</inputFiles>

<execute>
  <driver name="MyDriver"/>
</execute>

<drivers>
  <driver name="MyDriver" type="org.lcsim.ADriver">
    <paramX>1.2</paramX>
    <paramXX>1.2 2.3 3.4</paramXX>
  </driver>
</drivers>
```
Maven

- Java build tool
  - [http://maven.apache.org](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](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!)