ALCPG Monte Carlo Framework

Simulation Pipeline

1) Simulation Job Requests
2) Detector Description
3) Event Generation
4) Full Simulation
5) LCIO Datasets
6) Analysis

SLIC

- http://confluence.slac.stanford.edu/display/ilc/SLIC+FAQ
- Frontend that integrates all necessary packages for Full MC
  - Geant4, CLHEP
  - GDML, LCDD, Xerces
  - LCPhys
  - LCIO
- Command Line interface
- Geant4 macro language
- StdHep event input
- LCDD geometry input
- GDML geometry output (GDMLWriter)
- LCIO event output
- Geant4 visualization system
  - OpenGL, HepRep, Open Inventor, VRML
- Performance
  - Approximately 1 minute per physics event in cylindrical SiD-type detector
- Binaries available on the web (SimDist)
  - http://www.lcsim.org/dist/slic

Simulation Job Requests

- Simulation requests should be directed to Norman Graf <ngraf@slac.stanford.edu>
- Please include …

a) Name of detector

b) Event type (single particles, physics, etc.)

c) Number of events

d) Other custom job parameters

- Expect a turnaround time of at least 24 hours.
- When completed, you will receive an email with containing an ftp url pointing to your datasets.
- You may be pointed to existing datasets if they already exist.
- For custom detectors, it is preferable that you provide a compact detector description or turnaround time will likely be greatly increased.
- All events generated by default with LCPhys physics list. (Other Geant4 physics lists are available but not recommended!)

LCIO Datasets Online

- LCIO datasets are available via anonymous ftp.
  - ftp://ftp-lcd.slac.stanford.edu/lcd/ILC
- Event types
  - Single particles
  - Zpole
  - ILC500
  - ILC1000
- Structure
  - Event type / detector / format / simulator
  - Example
    - Zpole / sid01 / lcio / slic / *.slcio

Geant4 Detector Description

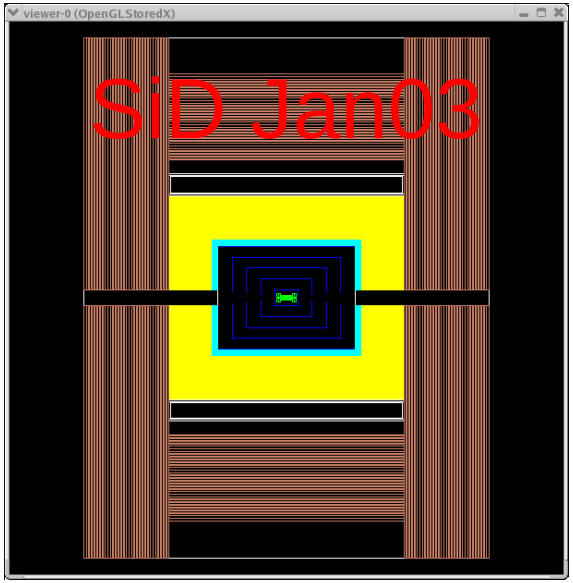
LCDD

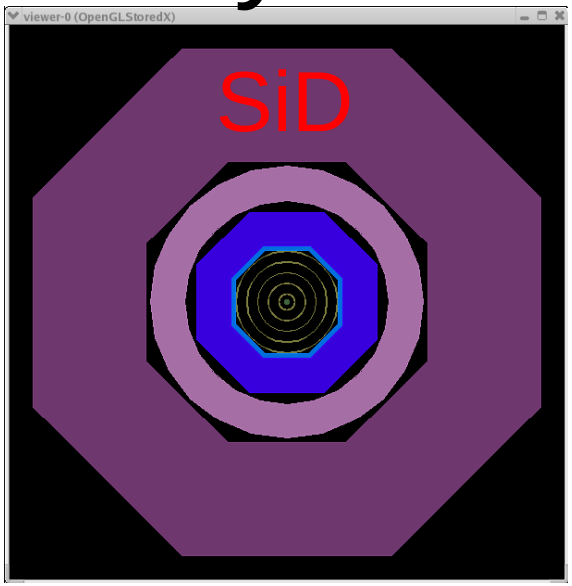
- Identifiers
- Sensitive Detectors
- Regions
- Physics Limits
- Visualization
- Magnetic Fields

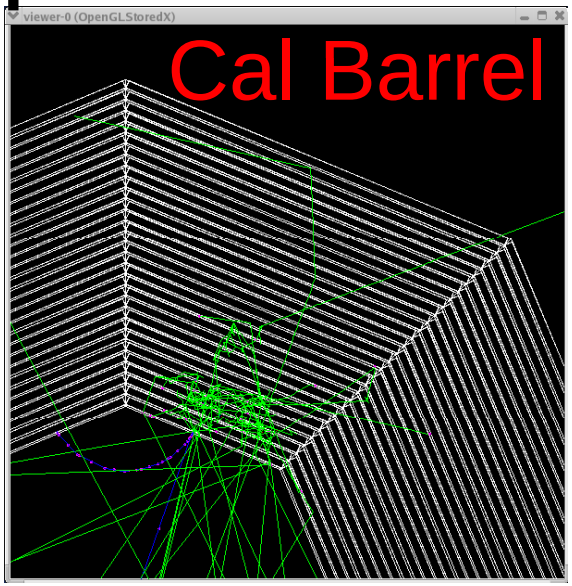
GDML

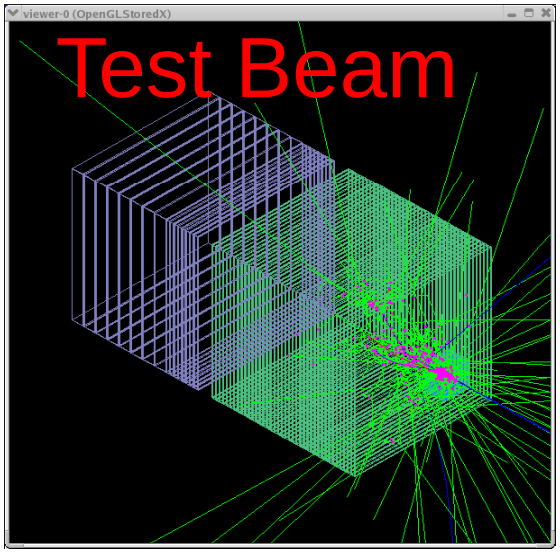
- Expressions (CLHEP)
- Materials
- Solids
- Volumes

Geometry Examples

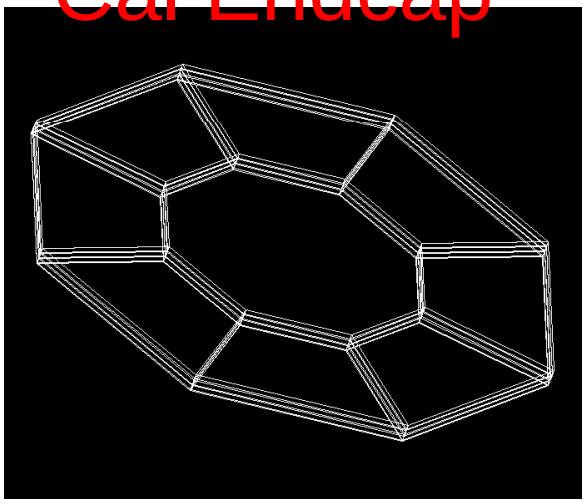




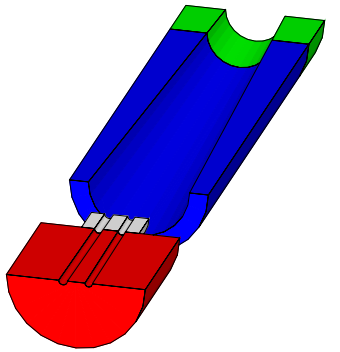




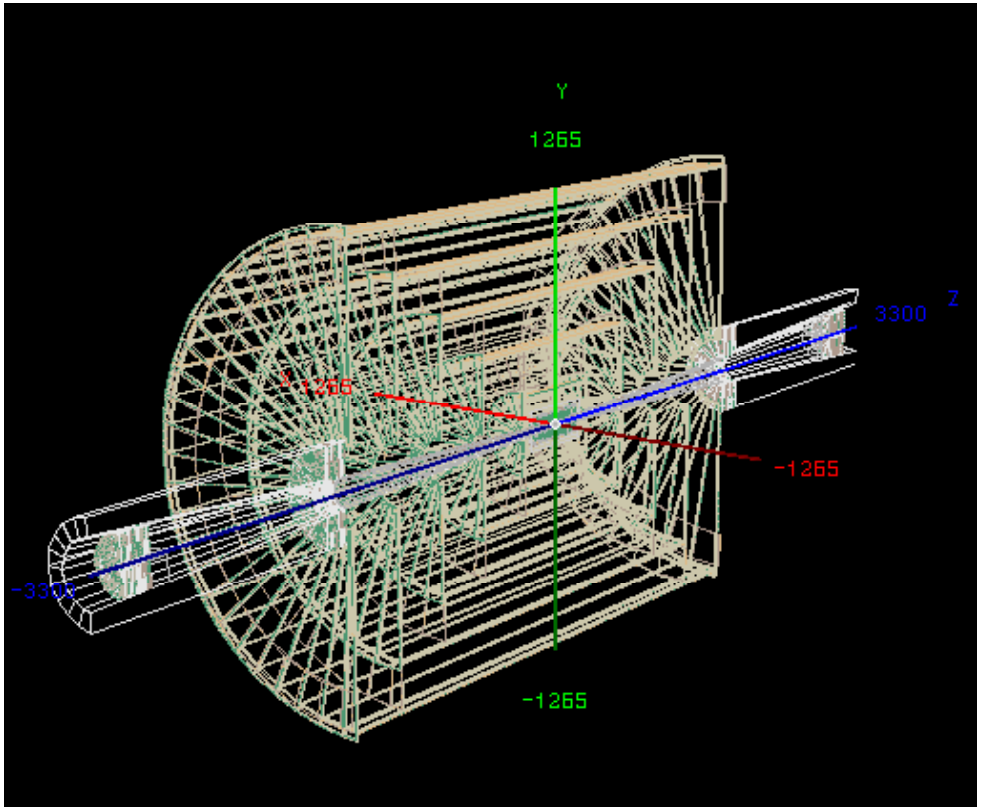
Cal Endcap

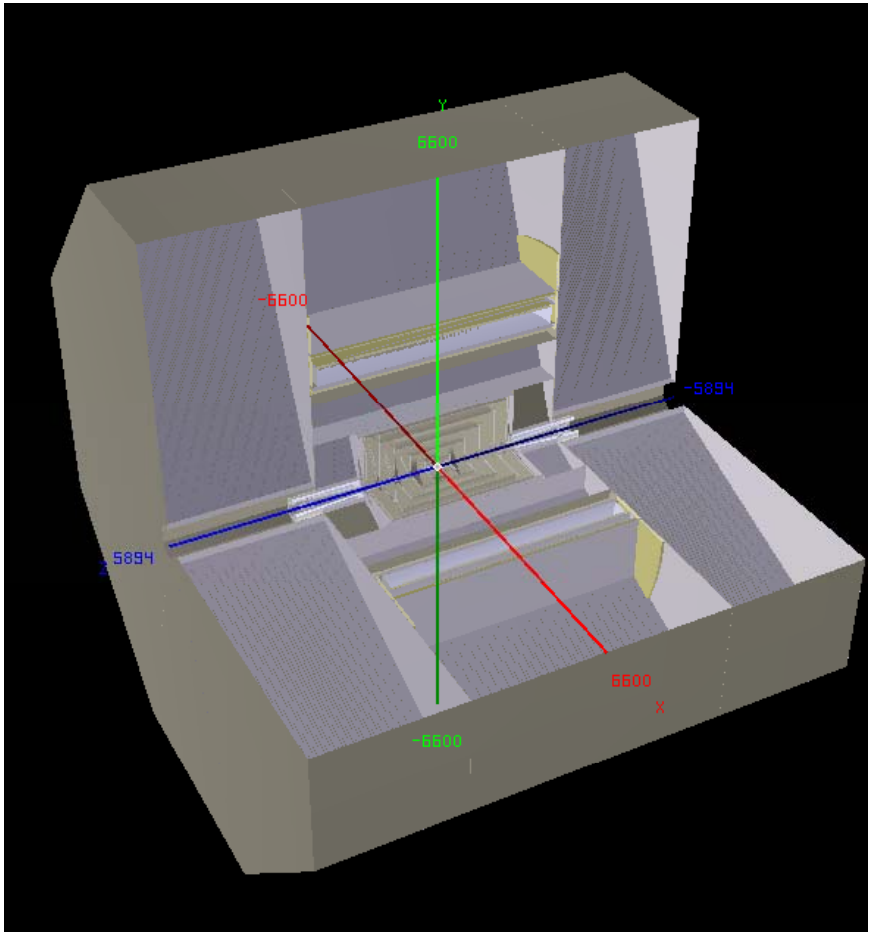


MDI-BDS



More Geometry Examples





Compact Detector Description

- The end user does not generate the Geant4 detector description directly, as it is too detailed and complicated.
- Instead a much reduced XML format is authored.
- Includes all the necessary data structures both for conversion to Geant4 description and directly usable by the reconstruction.
  - Variables, expressions, etc.
  - Detectors with layering structure and sensitive layer assignment
  - Readouts for generating hits collections, including virtual readout parameters such as cell sizes; also includes identifier hierarchy
  - Magnetic field
- Available detector types
  - Cylindrical barrel and endcap calorimeters
  - Disk barrel and endcap trackers
  - Polyhedra (stave) barrel and endcap calorimeters
  - SiTrackerBarrel with planar modules; SiTrackerEndcap in progress
  - Test beam calorimeter and trackers
  - Polycone dead material

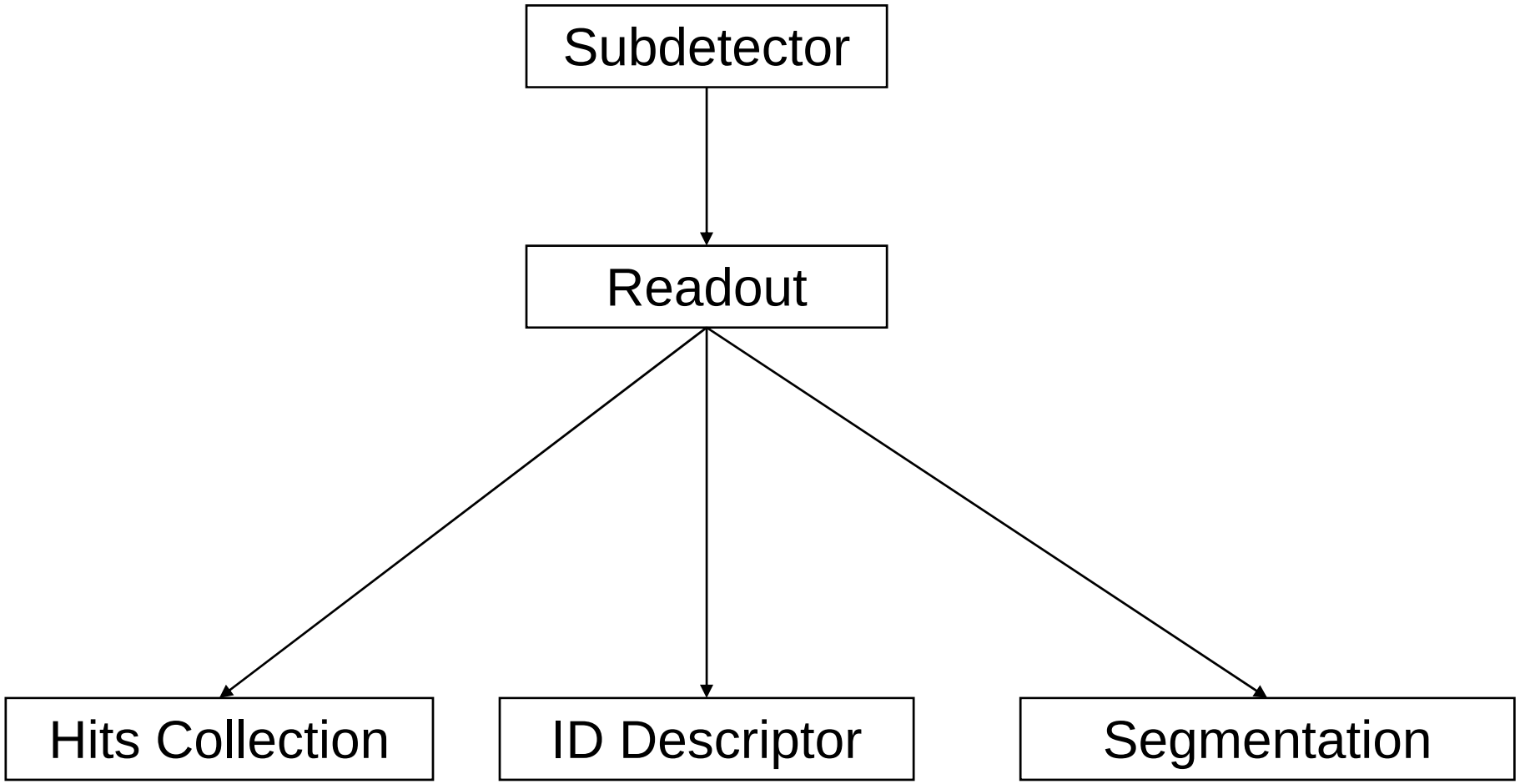
Available Detector Models

- Detector models are available from the LCDetectors cvs project.
- The detector XML file and associated conditions data are bundled as zip files.
  - http://www.lcsim.org/detectors
  - Includes other conditions data such as sampling fractions, detector-specific data for algorithms, etc.
  - LCDD files for Geant4 are also included.
- Detectors are tagged with a descriptive name such as ‘sid01’ written into each event header.
- Sample detectors …
  - sid01, sid01_polyhedra, acme0605, ldcaug05, …

Event Generation

- Many available ILC event generators.
  - PYTHIA
  - HERWIG
  - ISAJET
  - …
- Standalone applications: Not integrated with the framework.
- Produce binary StdHep file with HEPEVT event blocks.
- A large database of event files exists and is publically accessible.
  - Physics at 500 GeV center of mass energy
  - Z Pole diagnostics
  - Single Particles
- Before generating events yourself, see what is already out there.
  - Avoid duplication.
  - Avoid “gotchas” of various generators.

Compact Readout Schematic



Geometric Identifiers

- Primary connection between the simulated MC geometry and the geometry in reconstruction via geometry identifiers.
- Copy numbers
- Virtual segmentation fields
  - Example - z, phi
- All sub-volumes in the same logical volume must be unique.
- The stack of identifiers should form a 64-bit id identifying a unique geometry volume.
- Possibility that id on a hit may NOT be a unique geometry id.
  - SimTrackerHit currently only points to a layer
- The id MAY be unique for certain sub-systems.
  - Calorimeters hits will be unique because the cell ids are included into the 64-bit id.

LCIO Binding

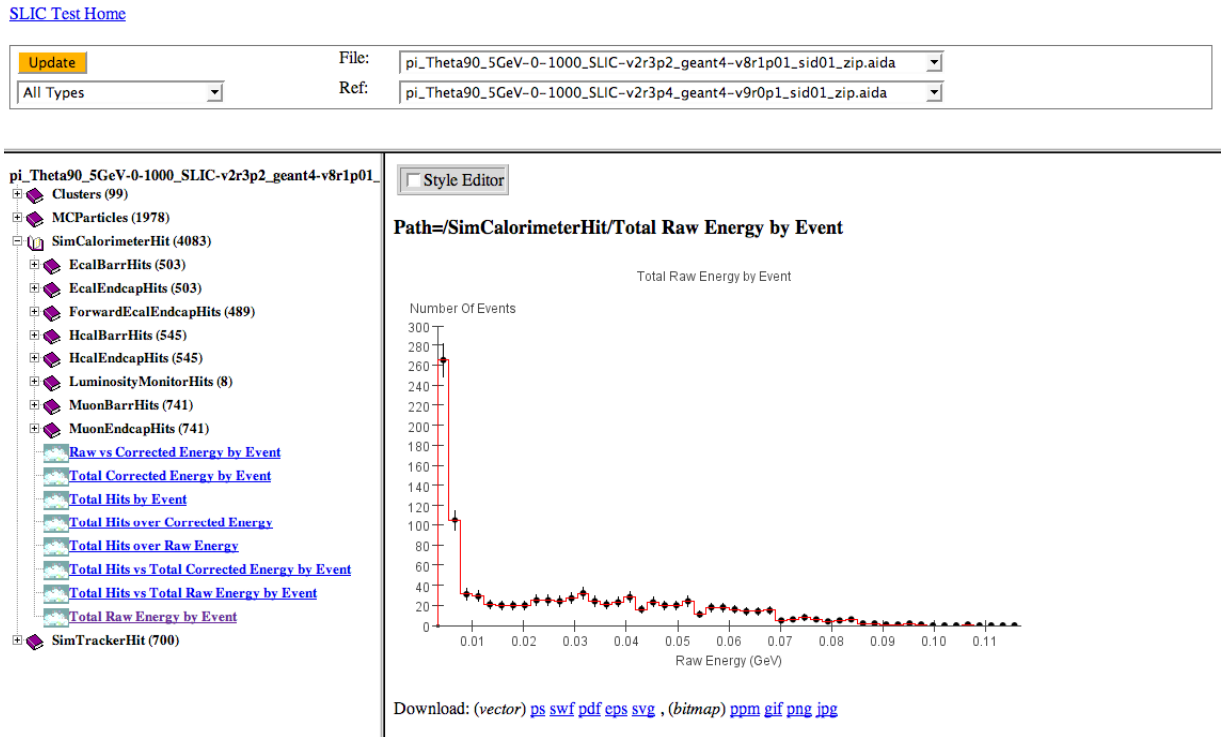
- SimCalorimeterHit
  - Geometric ID
  - Position of cell center
  - Time (min)
  - Total energy deposition
  - Individual MCParticle energy depositions
- SimTrackerHit
  - Geometric ID
  - Position of energy deposition
  - Start and End Point, i.e. sensor layer entry and exit point
  - dEdx
- MCParticle
  - Translated from Geant4 tracks / trajectories
  - Origin and end points
  - Charge
  - Energy
  - Momentum
  - Generator and simulator status

LCPhys Physics List

- Physics lists for ILC events written by Dennis Wright (SLAC)
- Also used by Mokka (ILD)
- Lepton / Boson Physics
  - Standard Geant4 EM physics
    - Multiple scattering
    - Bremstrahlung
    - Ionization
    - annihilation
  - plus gamma nuclear
- Hadron physics
  - multiple scattering
  - hadron ionization
  - hadron elastic scattering
  - Inelastic - Bertini Cascade (pi, K, proton, neutron)
    - 0 - 9 or 13 GeV
    - Above this uses parameterized (LHEP)
  - parameterized (anti-neutron, other hadrons)
- Ion physics
- Decay physics

Diagnostics Histograms

- A standard diagnostics program, SlicDiagnostics, provides a full set of histograms generated automatically for all hit and MCParticle collections in an LCIO event.
- Histos all available on the web from SlicDiagWeb application.
  - http://www.lcsim.org/SlicDiagWeb/



Grid

- The Grid represents the future of computing in HEP.
  - LHC experiments
- LCG grid
  - DESY
  - Ilc VO
  - http://confluence.slac.stanford.edu/display/ilc/How+do+I+use+the+LCG+grid
  - Used by CALICE, ILD
- OSG grid
  - Ilc VO
  - Fermilab
  - 150 concurrent nodes available
- Condor batch system
  - JDL
- SLIC
  - Bootstrap by downloading dist from lcsim.org

Links

- http://confluence.slac.stanford.edu
- http://www.lcsim.org
  - http://www.lcsim.org/software
  - http://www.lcsim.org/detectors
  - http://www.lcsim.org/dist/slic
  - http://www.lcsim.org/software/slic
  - http://www.lcsim.org/software/lcphys