Linear Collider Physics & Detector Simulation Software

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Charge

- Summarize the status of the regional physics and detector simulation efforts.

Simulation Mission Statement

- Provide full simulation capabilities for Linear Collider physics program:
  - Physics simulations
  - Detector designs
- Need flexibility for:
  - New detector geometries/technologies

Goals

- Facilitate contribution from physicists in different locations with various amounts of time available
- Provide a general-purpose framework for physics software development.
- Use standard code interface & data formats.
- Simulate benchmark physics processes on different full detector designs.
- Analyze physics performance based on full reconstruction and iterate.

ILC software packages

	Description	Detector	Language	IO-Format	Region
Simdet	fast Monte Carlo	TeslaTDR	Fortran	StdHep/LCIO	EU
SGV	fast Monte Carlo	simple Geometry, flexible	Fortran	None (LCIO)	EU
Lelaps	fast Monte Carlo	SiD, flexible	C++	SIO, LCIO	US
Mokka	full simulation – Geant4	TeslaTDR, LDC, flexible	C++	ASCI, LCIO	EU
Brahms-Sim	Geant3 – full simulation	TeslaTDR	Fortran	LCIO	EU
SLIC	full simulation – Geant4	SiD, flexible	C++	LCIO	US
LCDG4	full simulation – Geant4	SiD, flexible	C++	SIO, LCIO	US
Jupiter	full simulation – Geant4	JLD (GDL)	C++	Root (LCIO)	AS
Brahms-Reco	reconstruction framework (most complete)	TeslaTDR	Fortran	LCIO	EU
Marlin	reconstruction and analysis application framework	Flexible	C++	LCIO	EU
hep.lcd	reconstruction framework	SiD (flexible)	Java	SIO	US
org.lcsim	reconstruction framework (under development)	SiD (flexible)	Java	LCIO	US
Jupiter-Satelite	reconstruction and analysis	JLD (GDL)	C++	Root	AS
LCCD	Conditions Data Toolkit	All	C++	MySQL, LCIO	EU
GEAR	Geometry description	Flexible	C++ (Java?)	XML	EU
LCIO	Persistency and datamodel	All	Java, C++, Fortran	-	AS,EU,US
JAS3/WIRED	Analysis Tool / Event Display	All	Java	xml,stdhep, heprep,LCIO,	US,EU

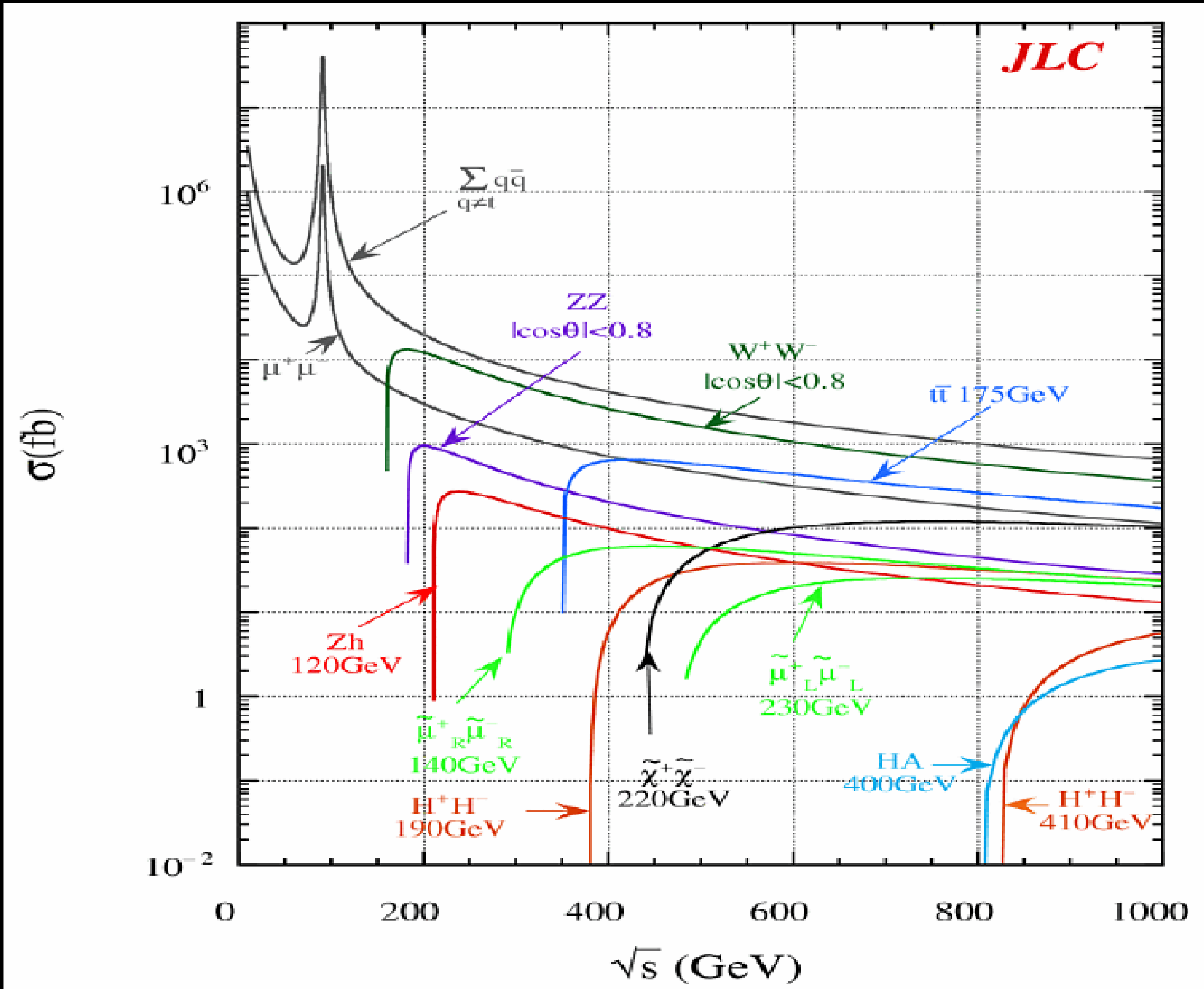
Overview

- Event Generation (stdhep as standard format)
- LCIO (event data model and persistency format)
- Fast detector response simulations
  - 4-vector smearing or simple swimming and parameterized showers.
- Full detector simulations
  - Complex detector geometries, full Geant4 response
- Common datasets
- Grid
- Future

"Signal" and Diagnostic Samples

- Number of canonical data samples have been established:
- simple single particles: γ, μ, e, $\pi^{+/-}$, n, …
- composite single particles: π^0,ρ, $K^0{}_S$,τ, ψ
- Z Pole events: comparison to SLD/LEP
- WW, ZZ, tt, qq, tau pairs, mu pairs, $Z\gamma$, Zh, …
- http://www.lcsim.org/datasets/ftp.html
- Beam backgrounds from GuineaPig and CAIN for standard ILC configurations also available.

"Standard Model Background"

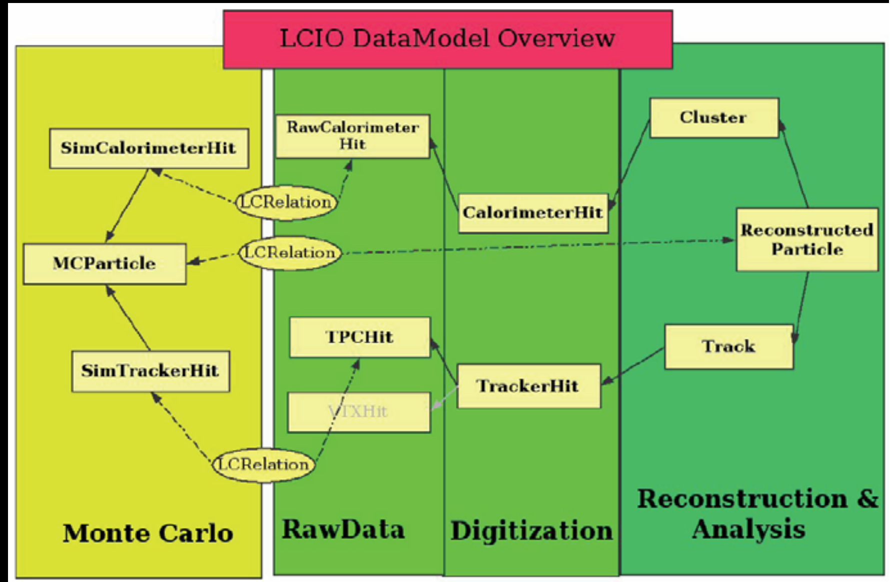


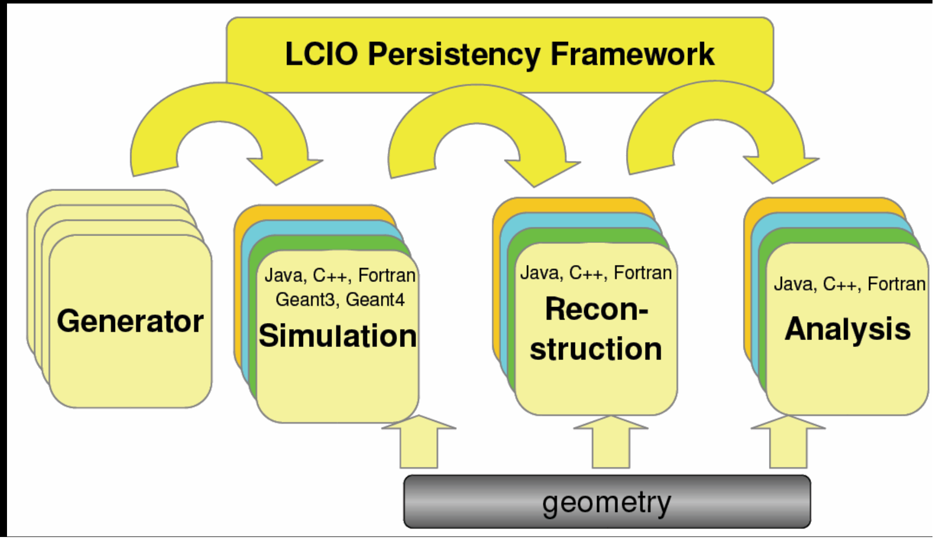
"Standard Model Background"

- Generate an inclusive set of MC events with all SM processes + backgrounds arising from beam- and brems-strahlung photons and machine-related particles. 500 fb^{-1} @ 0.5 TeV, 2 ab^{-1} @ 1.0 TeV
  - WHIZARD Monte Carlo used to generate all 0,2,4,6-fermion and t quark dominated 8-fermion processes.
- Used for realistic analyses and represents a "standard" sample.
- Canonical background for Beyond-SM searches.
- 100% e^- and e^+ polarization used in generation. Arbitrary electron, positron polarization simulated by properly combining data sets.
- Fully fragmented MC data sets are produced. PYTHIA is used for final state QED & QCD parton showering, fragmentation, particle decay.
- 1 year's worth of stdhep files fits on one external harddrive.

LCIO

- Object model and persistency
  - Events:
    - Monte Carlo Hierarchy
    - SimTrackerHits
    - SimCalorimeterHits
  - Parameters, relations, attributes, arrays, generic objects, …
- Enables cross-checks between data from different simulators
- Read/write LCIO from
- Fast MC / Full Simulation
- Different detectors
- Different reconstruction tools





Fast Detector Response Simulation

- Covariantly smear tracks with matrices derived from geometry, materials and point resolution using Billoir's formulation.
- Smear neutrals according to expected calorimeter resolution (EM for γ, HAD for neutral hadrons)
- Create reconstructed particles from tracks and clusters (γ, e, μ from MC, $\pi^{+/-}$, K^0_L for others)
- Can also dial in arbitrary effective jet energy resolution.
- Uses runtime geometry (compact.xml).

lelaps

- Fast detector response package.
- Handles decays in flight, multiple scattering and energy loss in trackers.
- Parameterizes particle showers in calorimeters.
- Produces LCIO data at the hit level.
- Uses runtime geometry (compact.xml $\rightarrow$ godl).
- An excellent tool for designing tracking detectors!

http://lelaps.freehep.org/index.html

QuickSim overview

- VTX, IT, TPC, CAL
- Model for Tracker
  - circular trajectory → parabolic trajectory
  - With multiple scattering, without energy loss
  - Equally spaced sampling
- Model for Calorimeter
  - EM signal by e/γ, HD signal by hadron, muon no signal
  - Segmented calorimeter. Lateral spreads are generated by an analytic form.
- Uses runtime geometry from ASCII file.

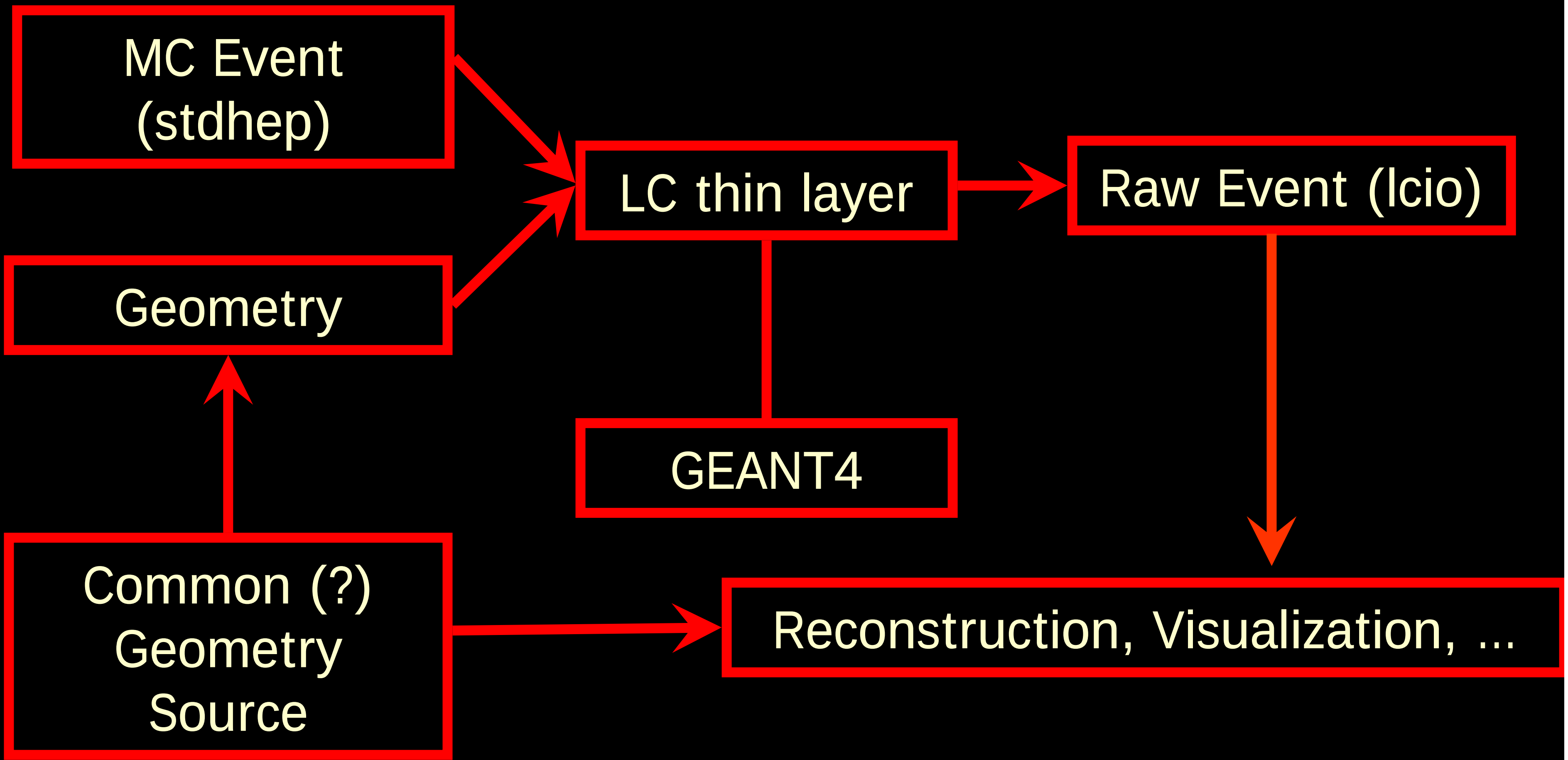
SimDet

- Parameterized fast Monte Carlo (f77)
- Hard coded geometry: TESLA TDR Detector
- Smears tracks with full covariance matrix and produces calorimeter clusters representing particle showers.
- Response tuned to correspond to full detector simulation + reconstruction (Brahms, Geant3).
- Writes LCIO.
- Development halted.

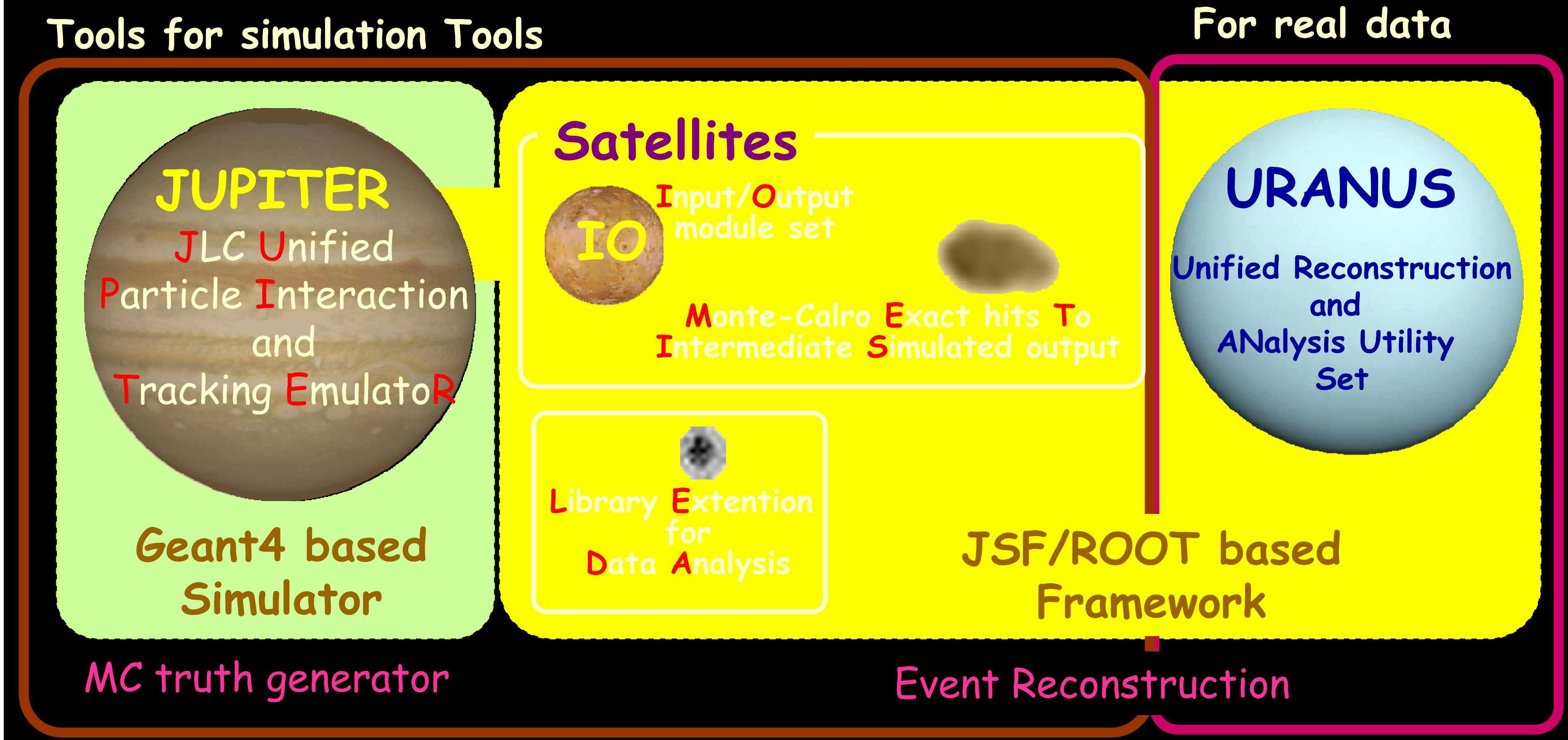
Full Detector Response Simulation

- Use Geant4 toolkit to describe interaction of particles with matter and fields.
- Thin layer of LC-specific C++ provides access to:
  - Event Generator input (binary stdhep format)
  - Detector Geometry description (various solutions)
  - Detector Hits (LCIO)

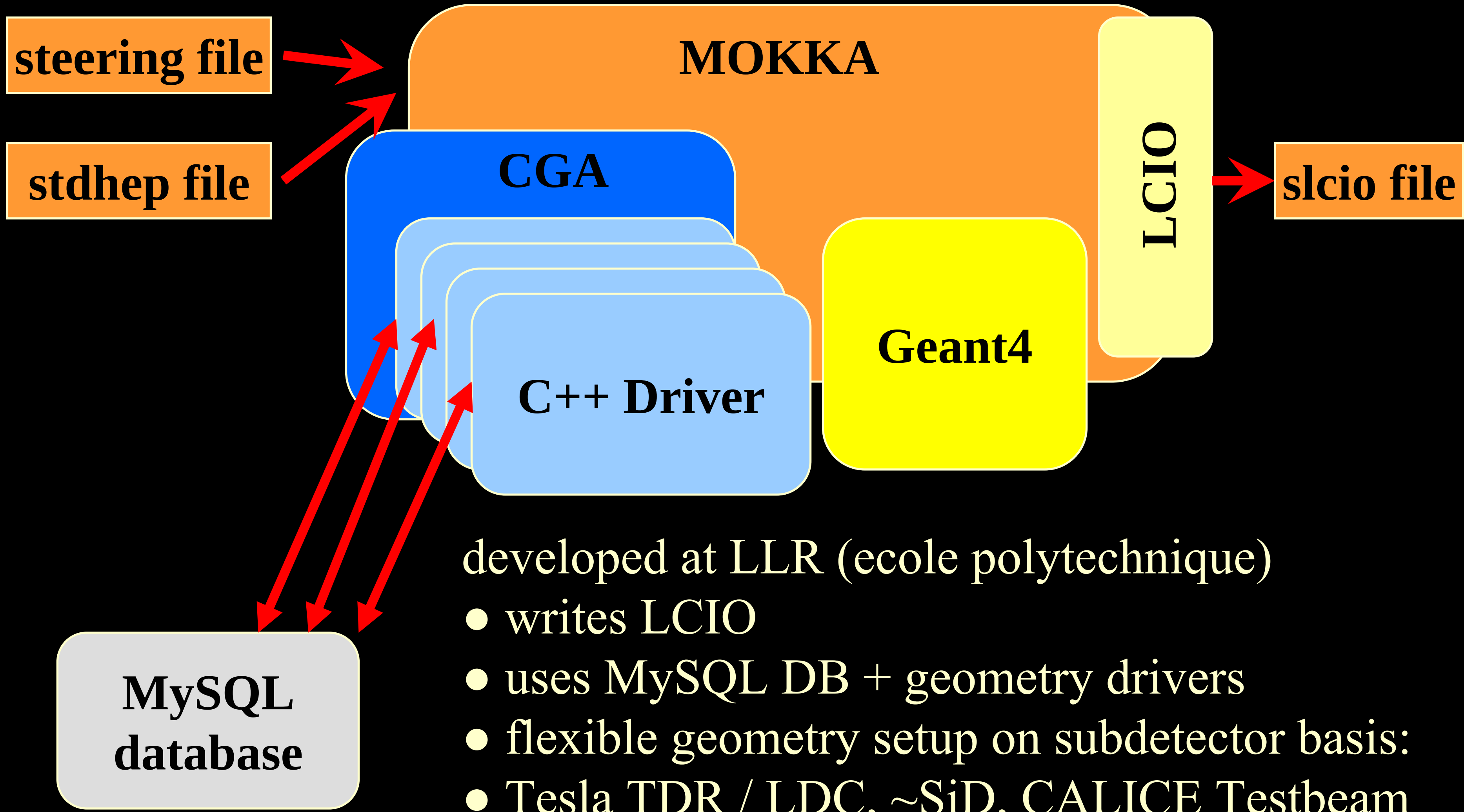
LC Detector Full Simulation



ACFA-ILC Full Simulation Tools



Mokka Overview



developed at LLR (ecole polytechnique)

- writes LCIO
- uses MySQL DB + geometry drivers
- flexible geometry setup on subdetector basis:
- Tesla TDR / LDC, ~SiD, CALICE Testbeam

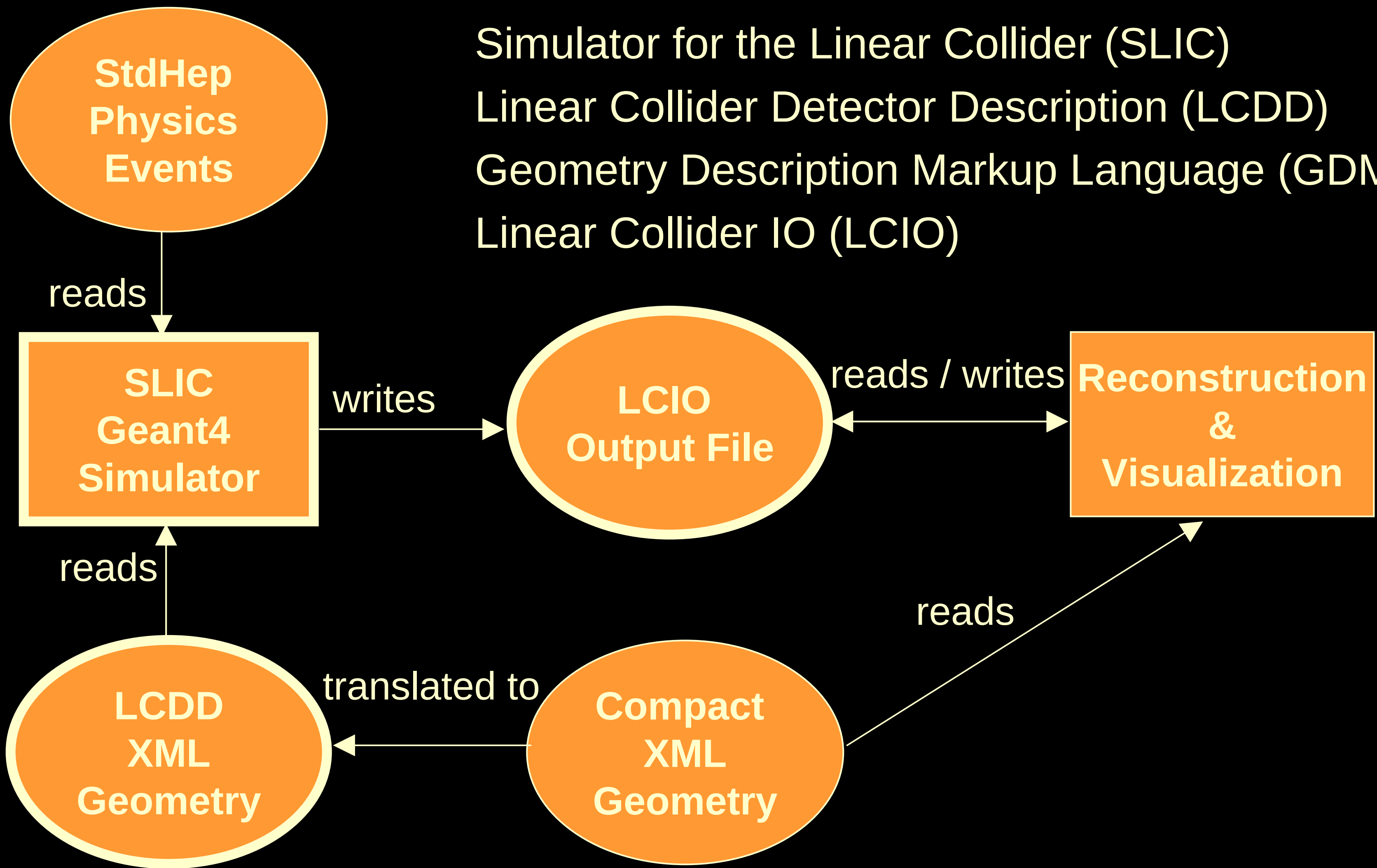
SLIC

Simulator for the Linear Collider (SLIC)

Linear Collider Detector Description (LCDD)

Geometry Description Markup Language (GDML)

Linear Collider IO (LCIO)



SLIC Distribution

- SLIC requires
  - Geant4, CLHEP, GDML, LCDD, Xerces, LCPhys, LCIO
  - Automated build system provided
- Binary downloads
  - http://www.lcsim.org/dist/slic
  - Linux, Windows (Cygwin), OSX
  - All packages (dist) or just runtime dependencies (bin)
- Or checkout and build from scratch
  - cvs –d :pserver:anonyous@cvs.freehep.org:/cvs/lcd co SimDist
  - cd SimDist; ./configure; make
- Installed at SLAC, NICADD, FNAL, IN2P3, UC, ...

Geant4 Calorimeter Studies

- Still investing a lot of time understanding Geant4!
- Strong EM calorimeter resolution dependence on range cuts, reported several years ago, appears to be fixed in latest Geant4 releases.
- Energy non-conservation in hadron showers.
  - Bugs found in GEISHA and patches provided for G4 several years ago, not all of which were adopted.
  - n and n treated with different models.
  - Dennis Wright (SLAC) appointed hadronics co-coordinator. More rapid turnaround on fixes.

Geant4 Physics Lists

- Have standardized on the LCPhys list created and supported by Geant4 development team (D. Wright)
- standard Geant4 EM physics
- hadronic models
  - Bertini Cascade
    - 0 to 9.9 GeV for p, n, pi+, pi-
    - 0 to 13 GeV for K+, K-, K0L, K0S, Lambda, Sigma+, Sigma-, Xi0, Xi-
  - Low energy parameterized models
    - 9.5 to 25 GeV
  - Quark-Gluon String Model: use for
    - 12 GeV to 100 TeV for p, n, pi+, pi-, K+, K-, K0L, K0S
- additional neutron processes
  - neutron-induced fission
  - neutron capture
- gamma-nuclear

Other Available Physics Lists

- FTFC
  - Fritjof with CHIPS
- FTFP
  - Fritjof with precompound
- LHEP
  - low / high energy parameterised
- QGSC
  - Quark-Gluon String with CHIPS
- QGSP
  - Quark-Gluon String with precompound
- QGSP_BERT
  - Quark-Gluon string with precompoind + Bertini Cascade
- LHEP_BERT
  - low / high energy parameterised + Bertini Cascade

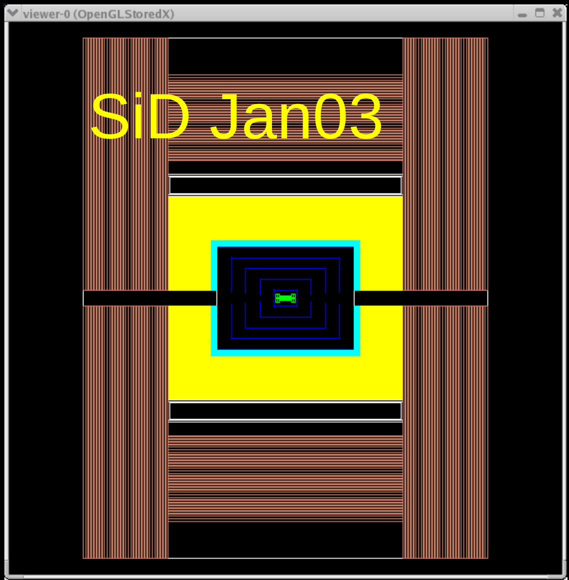
Detector Descriptions

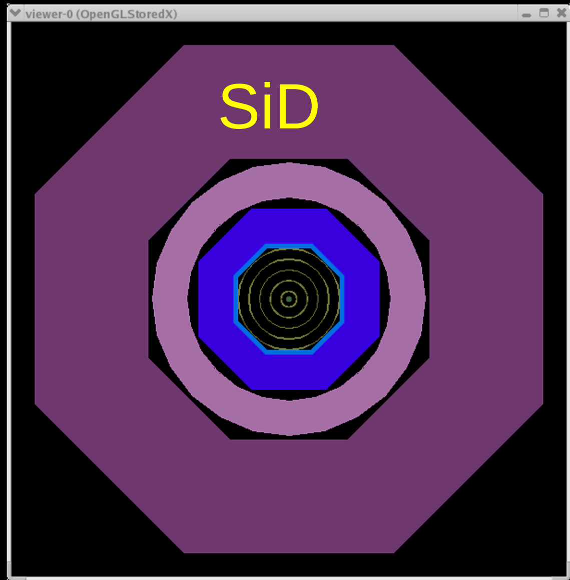
- Jupiter and MOKKA target subdetectors
  - Each new subdetector type requires a driver to be written in C++ to be linked in and to get access to geometry.
  - Reconstruction geometry not necessarily the same
- SLIC targets Geant4 classes
  - Geometry (including regions, fields, limits) and sensitive detector segmentation, etc. fully described at runtime via xml file.
  - Common source for simulation & reconstruction geometry.

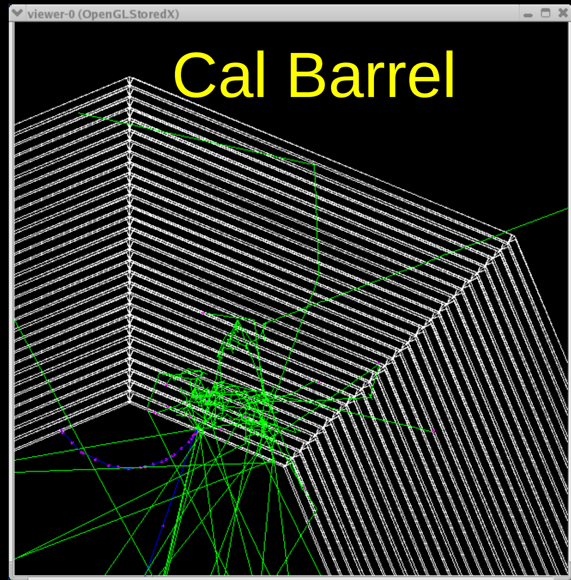
Detector Variants

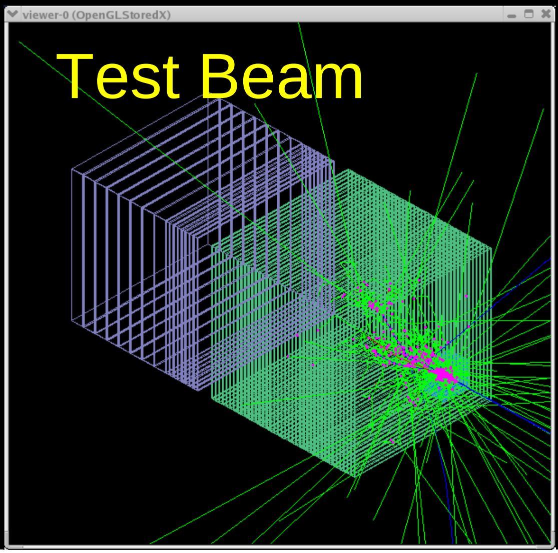
- Runtime XML format allows variations in detector geometries to be easily set up and studied in slic:
  - Stainless Steel vs. Tungsten HCal sampling material
  - RPC vs. GEM vs. Scintillator readout
  - Layering (radii, number, composition)
  - Readout segmentation (size, projective vs. nonprojective)
  - Tracking detector technologies & topologies
    - TPC, Silicon microstrip, SIT, SET
    - "Wedding Cake" Nested Tracker vs. Barrel + Cap
  - Field strength
  - Far forward MDI variants (0, 2, 14, 20 mr)

Example Geometries

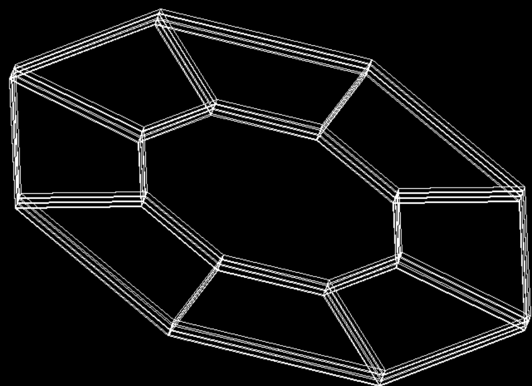




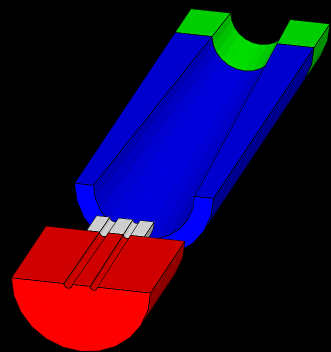




Cal Endcap



MDI-BDS



Detector Simulations

Common LCIO event data model
and persistency format
enables data exchange

Geometry

- LCIO allows data files generated by different simulators to be exchanged between regions & detectors.
- However, as detector designs become more realistic and geometries become more complex, problem of how to access the detector description becomes more severe.
- Most important short-term task for software groups is to solve this problem.

Software Portals

- A number of software portals is available for further information, primarily maintained by the regional software working groups.
- Working to establish one point of contact under the aegis of the WWS, but not there yet.

Software tools for GLD studies - Microsoft Internet Explorer

http://ilcphys.kek.jp/soft/

Software tools for GLD studies

Getting started

Please visit SimTools page

FAQ and other information related to GLD simulation

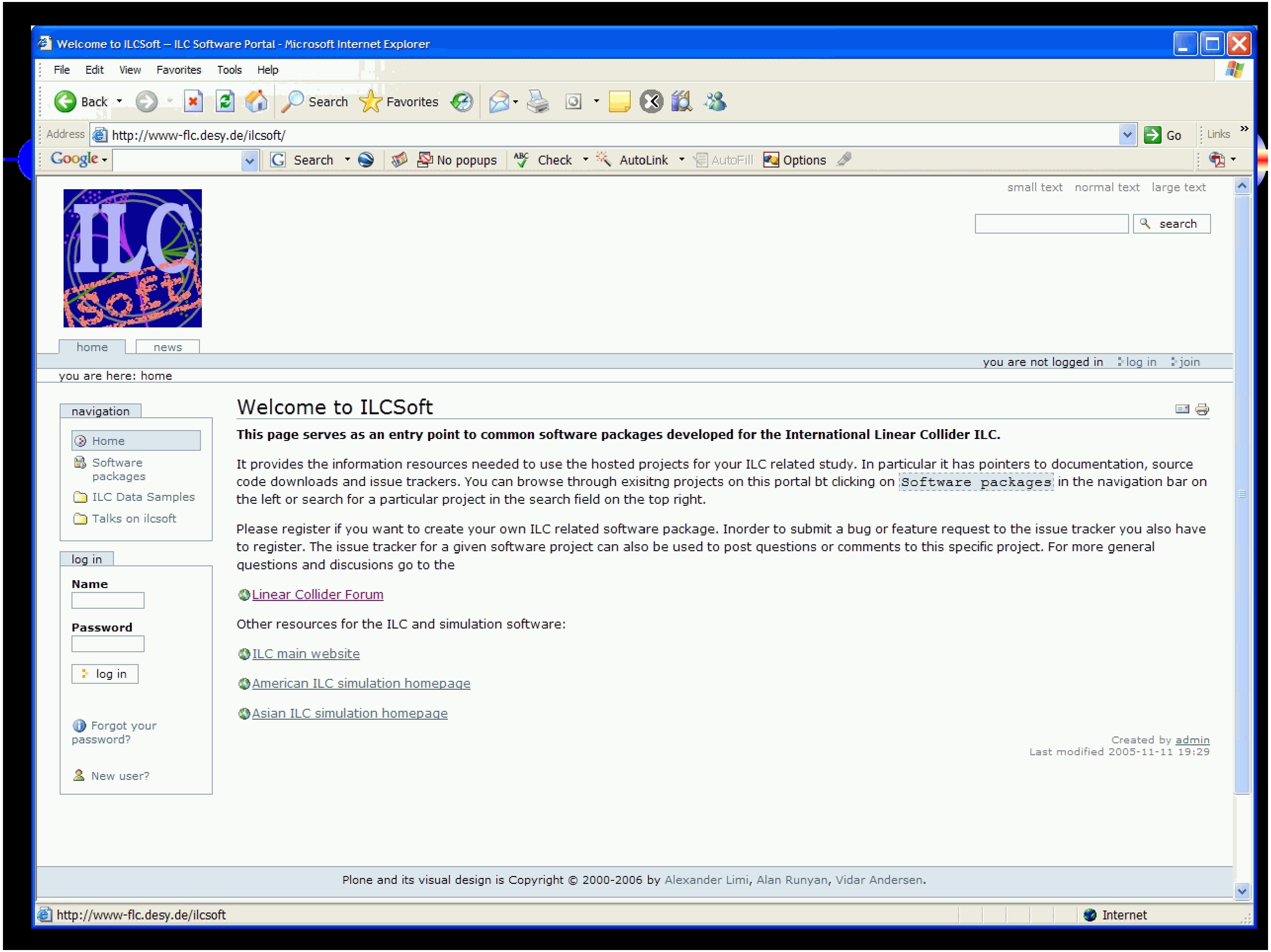
- Detector geometry
  Please see geometry information in Dec05 data production. (latest at 20-Jan-2006)
- Information related to studies on IR/FCAL/BCAL
  - Meanings of IR geometry parameters
  - Meanings of IR and beamline geometry
  - Sugimoto's recomendation of IR geometry, excel file
    Corresponding Geometry data Prepared by Fujishima san(Saga Univ.) (Files are local on jlclogin2)
  - Meanings of values in the excel file
  - Q magnet coordinates
  - Magnetic field information Q and DID
  - Magnet Parameters for 14 mrad and L=4.51m and others.html
  - Fujishima's home page about IR geometry
- BSGEN: Data for generations of beamstrahlung spectrum
- Generator misc. information
- Quick Sim parameters to study physics impacts of momentum resolution

Sample data

- Data samples with jun06/CLX geometry(Using Release 1.29)
- Data samples with may06/CLX geometry(Using Release 1.25)
- Data samples with mar06 geometry(Using Release 1.24)
- Data samples for DOD studies
- Data samples for Snowmass 05

- 500 GeV CAIN background data created by T.Tauchi on jlclogin2.

http://ilcphys.kek.jp/soft/geom/dod/JupiterIR.pdf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File Edit View Favorites Tools Help
Back Search Favorites
Address http://www-flc.desy.de/ilcsoft/ Go Links
Google Search No popups Check AutoLink AutoFill Options
small text normal text large text
search
home news
you are not logged in log in join
you are here: home
navigation
Home
Software packages
ILC Data Samples
Talks on ilcsoft
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Name
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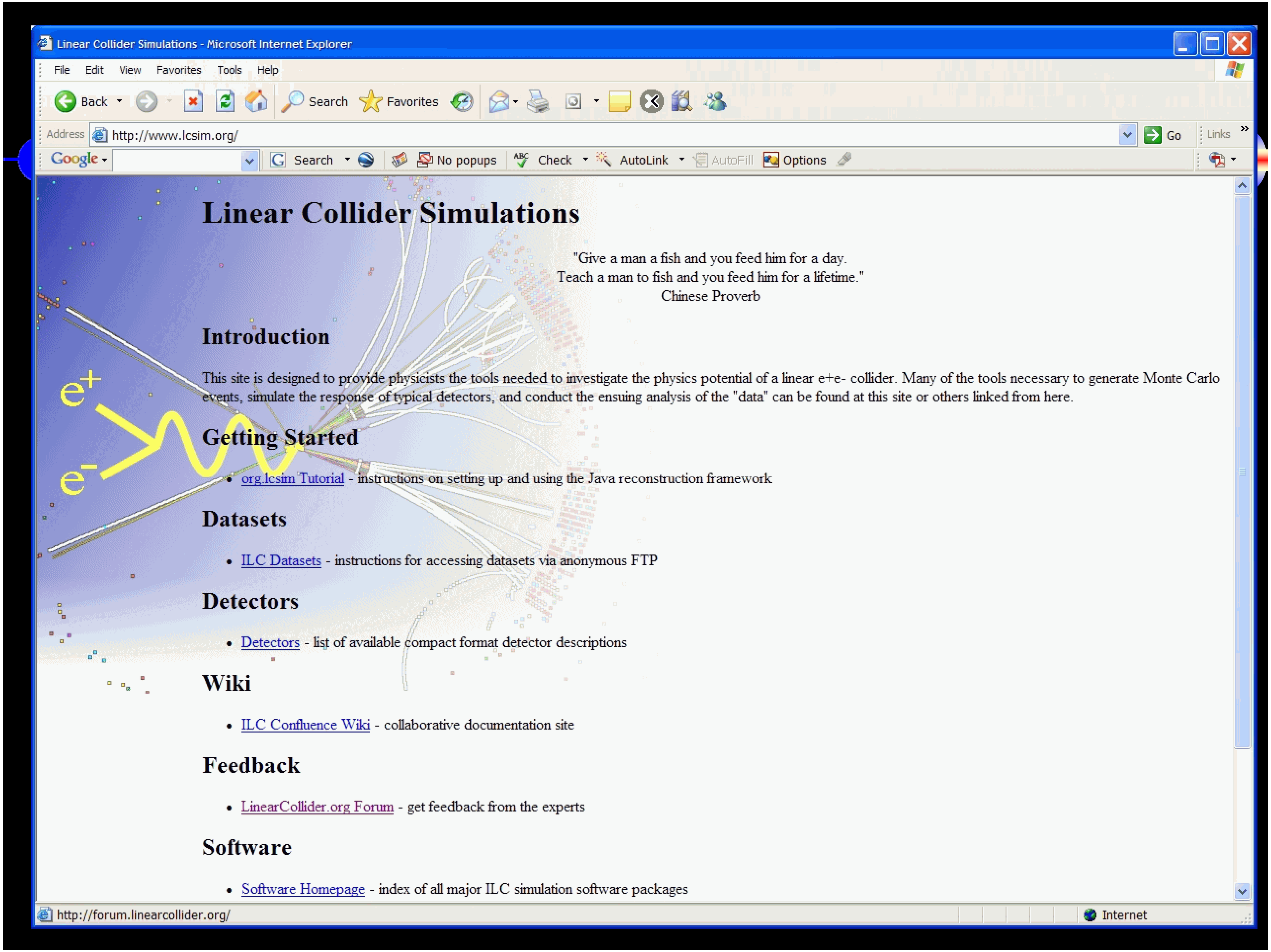
log in
Forgot your password?
New user?
Welcome to ILCSoft
This page serves as an entry point to common software packages developed for the International Linear Collider ILC.
It provides the information resources needed to use the hosted projects for your ILC related study. In particular it has pointers to documentation, source code downloads and issue trackers. You can browse through exisitng projects on this portal bt clicking on Software packages in the navigation bar on the left or search for a particular project in the search field on the top right.
Please register if you want to create your own ILC related software package. Inorder to submit a bug or feature request to the issue tracker you also have to register. The issue tracker for a given software project can also be used to post questions or comments to this specific project. For more general questions and discusions go to the
Linear Collider Forum
Other resources for the ILC and simulation software:
ILC main website
American ILC simulation homepage
Asian ILC simulation homepage
Created by admin
Last modified 2005-11-11 19:29
Plone and its visual design is Copyright © 2000-2006 by Alexander Limi, Alan Runyan, Vidar Andersen.
http://www-flc.desy.de/ilcsoft
Internet



Linear Collider Simulations

"Give a man a fish and you feed him for a day.
Teach a man to fish and you feed him for a lifetime."
Chinese Proverb

Introduction

This site is designed to provide physicists the tools needed to investigate the physics potential of a linear e+e- collider. Many of the tools necessary to generate Monte Carlo events, simulate the response of typical detectors, and conduct the ensuing analysis of the "data" can be found at this site or others linked from here.

Getting Started

- org.lcsim Tutorial - instructions on setting up and using the Java reconstruction framework

Datasets

- ILC Datasets - instructions for accessing datasets via anonymous FTP

Detectors

- Detectors - list of available compact format detector descriptions

Wiki

- ILC Confluence Wiki - collaborative documentation site

Feedback

- LinearCollider.org Forum - get feedback from the experts

Software

- Software Homepage - index of all major ILC simulation software packages

The Grid

- Why the GRID now?
  - At the moment: it is not user friendly, you have to get a certificate, it only works under linux, the control language is painful, …
  - but expect LHC usage to improve matters with time.
- It's mostly a matter of resources:
  - "At least in Europe for serious processing of ILC data there is simply no alternative to the GRID!"
  - Similar situation in Asia.
  - ALCPG has been ready for the Grid for quite some time, but existing computing resources at SLAC have been sufficient to-date.

ACFA-ILC GRID View

Most computing resources hidden behind firewall

- Current solutions
  - WEB/FTP : needs to transfer data inside fire wall to outside
  - VPN : Can make a direct connection, but not efficient to transfer large data
- Future solutions
  - Share data by Data GRID
  - Middle ware:
    - EU – LCG, NA – OSG, Belle Other GRID system
    - ECFA group: Developed ILC VO on LCG
    - KEKCC: Development – new middle ware. Will support LCG.
  - How to proceed
    - Define ILC VO using KEKCC hardware + disks for ILC

ECFA-ILC and the Grid

- The VOs ‘ilc’ and ‘calice’ are hosted at DESY w/ all core services
- Registration to ‘ilc’ is managed by LCG (http://lcg-registrar.cern.ch) and has become a so-called global VO in EGEE
- ‘ilc’ currently supported by ~10 UKI sites, LAL, Freiburg, DESY (3500 CPUs, 42 TB)
- Data have been moved to SLAC with Grid tools

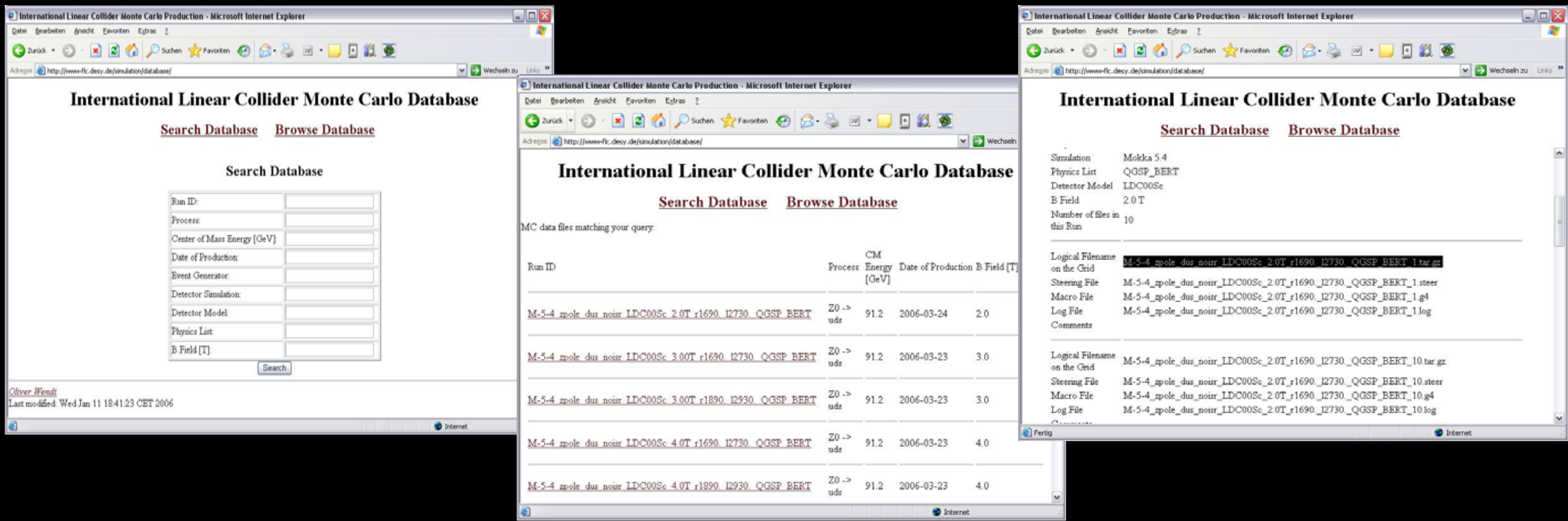
\- Visit http://grid.desy.de for more information.

Access to ACFA-ILC Data Samples

- Full simulation data sample for detector studies
  - Data sets: dec05, mar06, may06, jun06
  - Links available at http://ilcphys.kek.jp/soft/
  - Single γ, k0L, μ, π0, e-, at 1 – 500 GeV : 1K or 10k events
  - e+e- $\rightarrow$ uds quarks pair, ccbar, bbbar at 91.18, 200, 350, 500, 10k-20k events
  - Cain background data
  - e+e- $\rightarrow$ ZH $\rightarrow$ lepton + qqbar, 4-jet, 2-jet events at 350 GeV

Access to ECFA-ILC Data Samples

- Browse database at http://ilcsoft.desy.de



- install LCG-software packages
- have valid grid-certificate for the VO „ilc“
- Use LFN from database to retrieve files

Access to ALCPG Data Samples

- LCIO data samples available via anonymous FTP
  - http://www.lcsim.org/datasets/ftp.html
- singleParticle diagnostic events
- Z Pole diagnostic events
- ILC500
  - WW, ZZ, tt, qq, tau pairs, mu pairs, Zγ, Zh, …
    - stdhep (contains MC input events + provenance)
    - detector used for simulation
      - slcio
        - slic (lelaps, Mokka, Jupiter) : simulator package used
        - logs: full information on jobs

Future Plans

- Continue efforts to target interfaces and collaborate/cooperate as much as possible between the regions.
- Continue to develop and improve LCIO.
- Package interoperability limited not only by language barriers (C++, Root, Java).
- Critical need for a geometry interface to allow sharing of detector designs as well as data.

Future of Simulations

- The physics and detector simulation software developer community is very small.
- The expectations are large.
- Not clear how this effort competes against detector hardware R&D efforts to secure resources.
  – Primarily supported by labs: DESY, KEK, LLR, SLAC.
- Severely manpower limited. Additional resources map directly onto increased functionality!

Additional Information

- ILC Forum - http://forum.linearcollider.org
- LCIO - http://lcio.desy.de
- lcsim.org - http://www.lcsim.org
- ECFA-ILC - http://ilcsoft.desy.de
- ACFA-ILC - http://ilcphys.kek.jp/soft/