LCD Simulation News

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LCD Simulation Overview

- Providing canonical data samples for LC community.
- Aim for more realistic simulation of detector response.
  - Better geometry descriptions in GEANT4.
  - Digitization of resulting hits in detectors.
  - Include all backgrounds (machine & physics)
- Developing more functional fast MC for rapid detector prototyping.
- Modularizing and improving reconstruction.
- Encourage collaboration!

Simulation workshop @ SLAC

- 4 day workshop devoted to simulation tools.
- Two days JAS/AIDA/Wired/Geant4
- Two days lcd-specific software
- AM presentations / PM tutorials
- Two dozen participants
- www-conf.slac.stanford.edu/lcsimworkshop/
- Would like to schedule another such workshop if interest exists.
  - Who? Where? When?

Data Samples - Backgrounds

- **Large sample of beam backgrounds available.**
  - e^+e^- pairs, photons, muons.
- **Full $\gamma\gamma \rightarrow$ hadrons sample being generated**
  - beamstrahlung-beamstrahlung - done
  - beam+bremsstrahlung & brem-brem – ongoing
- **Run through full detector simulations.**
- **All samples can be overlaid onto signal events at the detector hits level.**
  - Can adjust level + mix of backgrounds

Data Samples - Signal

- 500GeV 2ab^{-1} SM sample being generated
  - will complement the existing sample at 1TeV.
  - aimed at fast MC analyses.
  - only subsamples will be fully simulated.
- Signal samples:
  - WW, ZZ, Zh, Zhh, Zγ, t$\bar{\text{t}}$, q$\bar{\text{q}}$, $\tau\tau$, $\mu\mu$, SUSY(SPS1)...
  - Full detector simulations.
    - JAS server at lcddata01.slac.stanford.edu
    - ftp://ftp-lcd.slac.stanford.edu/lcd/NewData/
- "Single particle" diagnostic samples.

Intermediate Fast Simulations

- Fast Monte Carlo systems which generate hits in trackers and calorimeters.
- Used for rapid prototyping of detector configurations.
- Allow pattern-recognition questions to be answered within a fast MC framework.
- Lelaps (W. Langeveld)
- Java shower parameterizations (S. Pathak)

Lelaps

- Standalone C++ library & program.
- Internal diagnostic event generator or stdhep input.
- Multiple scattering and dE/dx for tracks.
- Photon conversions and V decays.
- Parameterizations for calorimeter showers.
  - EM showers for e, γ.
  - MIP in ECAL + had. showers for charged hadrons.
  - MIP traces in all calorimeters for muons.
- SDJan03 and LDMar01 detectors implemented.
  - Other configurations can easily be added.
- SIO output, LCIO in beta.

Lelaps event
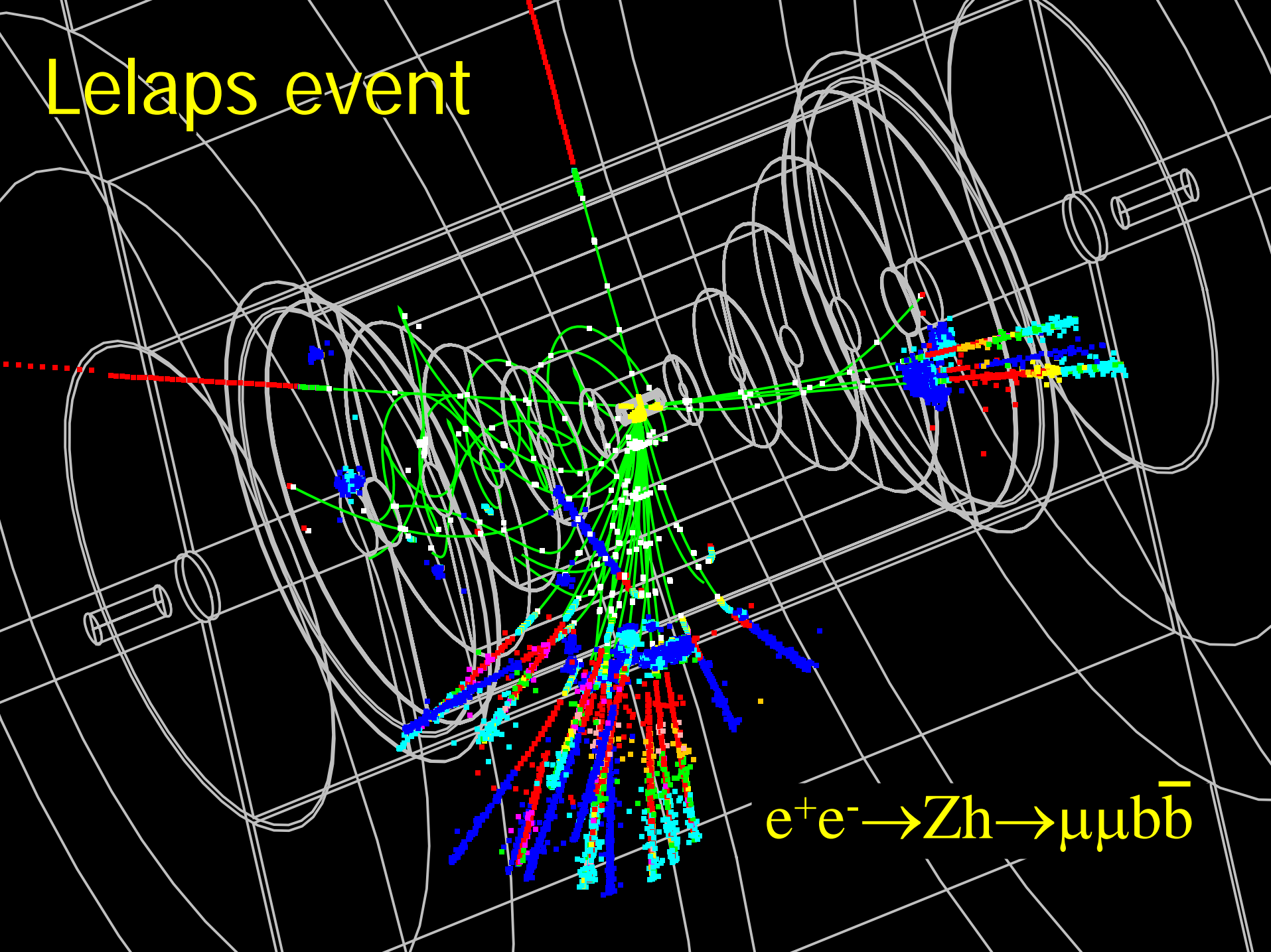
$e^+e^- \rightarrow Zh \rightarrow \mu\mu b\bar{b}$

Full Simulation

- LCDG4 producing sio output, lcio soon.
  - sdjan03, ldmar01
  - simplified TESLA detector for comparisons.
  - xml detector descriptions, easily modified.
- American xml detector geometry description also available within Mokka framework.
  - Complex beamline geometries added
  - LCIO output available
  - QA ongoing
- Merger of two desirable!

LCIO

- Simple, extensible data model.
- European & American standard for IO.
- Persistence uses, but not tied to, SIO.
- Java and C++ interface (Fortran also).
- v1 released!
- Implemented in Mokka & Ielaps. LCG4 soon.
- See Frank Gaede's talk for details.

Persistent Data: MC

- Event definition and framework.
- MC output formats defined for "generic" tracker and calorimeter hits.
  - SimTrackerHits for position-sensitive detectors
  - SimCalorimeterHits for energy-sensitive detectors.
- Monte Carlo Particle heirarchy classes.
  - Formalism exists for handling secondaries produced in full simulations.
  - Have both generator and simulator status words.

Persistent Data: Reconstruction

- Tracks & Calorimeter Clusters
  - Requirements well understood
  - First implementation ~written
  - Use cases being assembled
- ReconstructedParticle
  - Requirements still need to be fleshed out.
  - Hope to initiate discussion of requirements.
  - Persistent implementation not yet available.

Detector Response I

- Emphasis being placed on more realistic detector response.
- Replace MC hit smearing with full chain, e.g.
  - MC "hits" in VertexDetector $\rightarrow$ CCD Pixels
  - Associate CCD Pixels into clusters
  - Extract hit positions & uncertainties from clusters.
- VXD Hits$\rightarrow$Pixels based on SLD data (N. Sinev)
- Si Hits$\rightarrow$Strips: MC (C. Flacco, B. Schumm)
- Calorimeter MC Hits digitized$\rightarrow$ ADC hits.

Detector Response II

- Currently noise and inefficiencies added at the "hit level", replace with more realistic readout channel noise and inefficiencies.

- Digitization will allow effects of hit-merging & ghosting to be systematically studied.

- Could also study effects of readout thresholds, dead channels, crosstalk, etc.
  - More immediately useful for simulation of testbeam setups and readout.

Event Reconstruction Framework

- LCDEvent model being refactored to improve design and modularize components.

- Analysis examples being modified to access LCIO data instead of SIO.

- Aiming for analysis-framework-independent reconstruction capability.

  - Standalone reconstruction program produces lcio output and/or histograms/ntuples.

  - Analysis proceeds in framework of choice.

- Can also do everything within Integrated Analysis Environment.

Reconstruction

- Track finding/fitting being implemented for axial-only SiD tracker and forward tracker configurations.

- Calorimeter cluster analysis package available

- Several analyses targeted at a full "Energy Flow" reconstruction underway.

- Aim to characterize detector performance in terms of resolutions, efficiencies & fake rates based on full ab initio reconstruction of digitized ("raw") hits in presence of noise.

Documentation & Organization

- Tutorials and other documentation being updated as code base changes.
- Attempting to remove/improve outdated or incorrect webpages.
- Need feedback from users!
  - What works
  - What doesn't
- Encouraging use of cvs for archiving and storing software/documentation.
- Instituting formal testing + release schedule.

Status

- Simulation & Reconstruction efforts are currently in a state of flux:
  - GISMO/SIO transitioning to Geant4/LCIO.
  - JAS2 $\rightarrow$ JAS3
  - Smeared MC Hits $\rightarrow$ Digitized readout
- Using this occasion to refactor many aspects of the reconstruction packages.
  - Aim for seamless transition.
- International collaboration welcomed & encouraged.

Continuing Communication

- Mailing lists: lcd-sim, lcd-dev
  - http://www.slac.stanford.edu/cgi-bin/lwgate/LCD-SIM/subscribe.html
  - http://www.slac.stanford.edu/cgi-bin/lwgate/LCD-DEV/subscribe.html
- lcnews HyperNews forum
- Regular phone meetings (esnet?, VRVS?)
- New website being developed
  - Plan to start with fresh portal; only current information