
SiD LOI Benchmark Simulation and Reconstruction

Norman Graf (SLAC)
LCWA09, Albuquerque
September 30, 2009

The LOI Physics Benchmarks Process

- The Letter of Intent (LOI) process required a number of physics analyses to be conducted with full-detector simulation, *ab initio* event reconstruction, and analysis.
- The benchmark processes were deliberately chosen to highlight the intrinsic detector performance, to facilitate comparisons between the concept designs.
- Although still far from “real”, the physics benchmarking requirements presented us with a large-scale, end-to-end exercise which stressed most aspects of the software systems.
 - Event Generation
 - Detector Simulation
 - Event Reconstruction
 - Physics Analysis

Work Plan for 2012

- We have been asked by the RD to iterate on this process, viz.
 1. Demonstrate proof of principle on critical components.
 2. Define a feasible baseline design.
 3. Complete basic mechanical integration of the baseline design...
 4. Develop a realistic simulation model of the baseline design, including the identified faults and limitations.
 5. Develop a push-pull mechanism, ...
 6. Develop a realistic concept of integration with the accelerator ...
 7. Simulate and analyze updated benchmark reactions with the realistic detector model.
Include the impact of detector dead zones and updated background conditions.
 8. Simulate and study some reactions at 1 TeV, including realistic higher energy backgrounds, demonstrating the detector performance.
For 7 and 8, Specific physics channels will be investigated and defined by the Physics Common Task Group and supported by the Software Common Task Group.
 9. Develop an improved cost estimate.

LOI and post-LOI

- Details of the SiD LOI and post-LOI production, simulation and reconstruction can be found at silicondetector.org/display/SiD/LOI
- Summaries can be found in talks at the TILC09 workshop in Tsukuba.
- Would like here to step back and see if there are any lessons we can learn from the simulation, reconstruction and analysis process.
- Can we apply the lessons learned during the LOI process to 2012 Work Plan?

Event Generation

- A number of important issues in the common data sample event generation were unresolved at the time of the transition from the WWS, regional-based software working group to the ILC/GDE, concept-based software panel.
- All concepts used events from a common pool, but details varied.
- Details matter! Need to ensure that the next set of benchmark processes is rigorously defined.
- Would like to see ILD & SiD use the SAME events the next time around. Can we do this?

Analyses

- For the LOI analyses, SiD used files containing events as they would appear in the data itself (modulo event weighting of some high cross section processes).
 - 80% - 30% mixture of beam polarization
 - Mixture of ~all SM processes
- For the post-LOI followup analyses, individual samples of signal and background were generated, although still a mix of polarizations.
- Need to discuss with ILD whether a common ground can be found for the next analyses.

Beam Parameters

- A new ILC machine configuration is being defined, SB2009.
- Need to ensure that we receive a correct and complete set of parameters for each energy point for which the benchmarks are defined.
- Draft proposal due Dec. 2009.
- Review Jan. 2010.
- Expect final versions available at LCWS meeting in Beijing, Mar. 2010.
- Will need to generate common samples to use for beam-background overlays.

Event Generation Details

- Whizard was used for all processes.
 - Have received requests for improvements, e.g.
 - Include all top decay modes
 - tau polarization in decay other than tau-pair process
- Should we include other, dedicated generators for some processes such as Bhabha production?
- Should we change the Pythia fragmentation from its default to the LEP-tuned values?
- Propose to continue with stdhep, as no viable alternative exists.

LCIO

- Access to a common event data model and a common persistence format played a large part in the successful use of cross-concept software packages, e.g. LCFIVertex.
- Events from SiD Java-based reconstruction were further processed using MarlinReco.
 - No need for a single monolithic framework.
 - Functionality of the tools themselves and common event data model more important than the framework into which they plug.
- Discussions initiated on LCIO2.0 in response to user experiences to-date.

The Grid

- SiD made extensive use of both the LCG and OSG grids.
 - LCG primarily RAL Tier 1 but also DESY, in2p3, ...
 - OSG running opportunistically on the CMS grid
- In general, no problems with the concept software
 - SiD software (slic & org.lcsim) just worked (also ran MarlinReco on LCG where it was installed).
- Number of issues with Grid job submission, monitoring and file transfers.
- Grid is still high-maintenance & very LHC-centric.
- In the end, responsible for successfully processing many tens of millions of events.
- See talk by Jan Strube for details.

Processing Strategy

- Successfully completing this exercise required the use of all available resources.
- The 500 GeV events were processed using the LCG (primarily RAL Tier 1)
 - Analysis groups were at Oxford.
- The 250GeV sample was processed at SLAC and on the FermiGrid.
 - Analysis groups primarily at SLAC.
- Use of SLAC Isf batch system by far the easiest.
 - Borrowed “fair shares” from BaBar and ATLAS
- Will we have Grid access when LHC starts?

org.lcsim Event Reconstruction

- Tracking
 - Digitized the SimTrackerHits to produce silicon pixel and silicon microstrip hits, track finding and fitting
 - See talk by R. Partridge for details.
- Calorimeter clustering and track-cluster association using IowaPFA
 - See talk by U. Mallik.
- Lepton ID post-processing applied for certain analyses.
 - See talk by R. Cassel.
- Produced final list of ReconstructedParticles.

Analysis Reconstruction

- The tasks of jet-finding, flavor-tagging and additional processing were delegated to the analysis groups.
- LCIO allowed LCFIVertex package to be run in MarlinReco.
- Individual analyses were conducted in a variety of ways using whatever tools were best matched to the needs of the individual or group.

Beyond sid02

- The detector model sid02 was a necessary compromise between the desire to include all the details of the engineering designs and the need to complete the large-scale physics benchmarking simulations in a timely fashion.
- Since then have developed a detector model which includes more realistic detectors.
 - Benefits from engineering work done for the LOI.
 - Allows much more realistic subdetector performance studies to be undertaken.

sidloi

- This model attempts to incorporate the detector as described in the LOI in as much detail as possible.
- Still a work in progress, as many of the details remain to be documented.
- Expect that detector optimization will continue.

Reconstruction

- Much of the reconstruction software will have to be modified or rewritten to accommodate the new geometries.
 - New neighboring definitions and clustering code for the calorimeter.
 - New tracking code for digitization in planaar silicon detectors, finding and fitting.
 - New extrapolation and track-cluster association code.
 - Loss of key individuals and lack of infrastructure support at the labs makes this very challenging.
-

Summary

- With a lot of hard work by a very small number of individuals we were able to simulate the detector response of SiD to the benchmark physics processes and to then reconstruct the events to provide input to the analysis groups.
- Work is already ongoing to improve both the detector model and the reconstruction code necessary to accomplish the goals of the 2012 Work Plan.
- New groups and individuals are welcomed.

Additional Information

- SiD – <http://silicondetector.org>
- lcsim.org - <http://www.lcsim.org>
- ILC Forum - <http://forum.linearcollider.org>
- Wiki - <http://confluence.slac.stanford.edu/display/ilc/Home>
- org.lcsim - <http://www.lcsim.org/software/lcsim>
- Detectors - <http://www.lcsim.org/detectors>
- LCIO - <http://lcio.desy.de>
- SLIC - <http://www.lcsim.org/software/slic>
- JAS3 - <http://jas.freehep.org/jas3>
- AIDA - <http://aida.freehep.org>
- WIRED - <http://wired.freehep.org>