ILC Detector R&D Paper – LCSIM Toolkit

Major R&D Efforts:

Simulation of physics processes and detector response is crucial to the design of new HEP experiments such as those proposed for the ILC. There are stringent requirements on the design of tools for detector R&D which differentiate them from typical experiment-specific simulation and reconstruction code. They must:

- allow easy reconfiguration to support different detector geometries and technologies,
- make it easy to develop, implement and compare new reconstruction algorithms,
- be very easy for users to set up and quickly become productive with,
- work on a wide variety of operating systems and computing platforms,
- be easy to develop and support using a fraction of the manpower that would be available to an established experimental collaboration.

The lcsim physics and detector response simulation and event reconstruction toolkit was developed at SLAC to provide a flexible and performant suite of software programs to allow fast and efficient studies of multiple detector designs for the ILC. The primary goal of the group has been to develop computing infrastructure to allow physicists from universities and other labs to quickly and easily conduct physics analyses and contribute to detector R&D. These tools include the Geant4-based detector response simulation program (slic), and the Java-based reconstruction and analysis tools (org.lcsim) [1].

(Software) Engineering Challenges:

The lcsim software pioneered the use of runtime-defined detector geometries. Although LCIO [2] provided a common event data model for all ILC groups, the community was never able to agree upon a common geometry system for both simulation and reconstruction. DD4hep [3] is an effort within the AIDA Common Software Tools project to provide such functionality. Although it adopted many lcsim concepts, the implementation of the software has taken its own course. The largest challenge to the lcsim effort at the moment (beyond lack of funding) is to maintain some connection to the geometry definition functionality promised by DD4hep.

Detector R&D Plans:

The core functionality is being kept current by upgrading to the latest versions of Geant4, etc. Due to lack of funding, the project is currently primarily responding to user requests for additional functionality.

Collaborating Institutes:

The core software has been developed at SLAC. A number of packages were contributed by university and other national lab groups when such efforts were supported by DOE.

Applications beyond the ILC:

The flexibility and power of this simulation package make it not only useful for the application domain for which it was developed (viz. HEP collider detector physics), but also for other physics experiments, and could very easily be applied to other disciplines, e.g. biomedical or aerospace, to efficiently use the full power of the Geant4 toolkit to simulate the interaction of particles with fields and matter. The Heavy Photon Search experiment [4] at Thomas Jefferson National Laboratory has adopted slic as its detector response simulation package and the org.lcsim toolkit for its event reconstruction needs. Physics and detector studies for CLIC [5] and the Muon Collider [6] have also used both slic and the org.lcsim software. The software could be easily used for physics and detector studies at detectors at future circular colliders.

[1] http://www.lcsim.org
[2] http://lcio.desy.de/
[3] http://aidasoft.web.cern.ch/DD4hep
[4] https://confluence.slac.stanford.edu/display/hpsg/Heavy+Photon+Search+Experiment
[5] http://clicdp.web.cern.ch/
[6] http://map.fnal.gov/