BeamCal Simulations with Mokka

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30 Jun 2009 – FCAL Meeting
Forward region of the ILC
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**Beam calorimeter (BeamCal)** - monitor the beam parameters at the interaction point; adjacent to the beampipe.

**Luminosity detector (LumiCal)** – covers larger polar angles; luminometer of the detector.

**The gamma detector (GamCal)** – together with BeamCal, measures beamstrahlung photons, which are very collinear to the beam.
Guinea Pig Beam-Beam interaction simulation

When linear e+ e- bunches collide

- Bunches are deformed by electromagnetic attraction $\rightarrow$ LUMINOSITY ENHANCEMENT
- Needed high luminosity (since each pair of bunches has only one chance to cross and interact) $\rightarrow$
- These high EM Fields bend the particles (DISRUPTION) $\rightarrow$
- Transverse acceleration $\rightarrow$
- Energy loss in the form of synchrotron radiation: BEAMSTRAHLUNG $\rightarrow$
- BACKGROUNDS:
  - Electromagnetic (Pairs) : e+e- $\rightarrow$ gamma-gamma $\rightarrow$ e+e- ...
  - Hadronic : e+e- $\rightarrow$ gamma-gamma $\rightarrow$ hadrons
Guinea Pig Beam-Beam interaction simulation

GP simulates collision of two bunches (e-e+ or e-e-) for a given set of input parameters in **ACC.DAT**:

*Energy* = 250.0 GeV  
*Particles* = 2 (per BX)  
*Charge_sign* = -1 (this is the relative sign of charges → e+e-)  

**Beam sizes, Angles**

*Store_beam*= 1 → produce beam1.dat + beam2.dat with the particles of the first and second beam respectively, after the beam-beam collision.

*Do_photons*= 1 *Store_photons*= 1 → produce photon.dat with the Beamstrahlung photons after interaction

*Do_compt*= 0 → no Compton Background  
*Do_hadrons*= 0 → no Hadronic Background

*Do_pairs*= 1 *Track_secondaries*= 1 *Store_secondaries*= 1 → produce secondaries.dat with the e+e-incoherent pairs generated by Beamstrahlung photons

**SECONDARIES.DAT** (in Ascii):  
Energy in GeV/c (positive for e-, negative for e+); x,y,z Velocity (v/c); x,y,z position (nm), process labels (Breit-Wheeler, Bethe-Heitler, Landau-Lifshitz)
Mokka

- Full C++ simulation using Geant4 and a realistic description of a detector for the future linear collider.

- Geometry data driven, able to simulate several detector models from its geometry database (via MySQL C++ wrapper).

- Using Geant4, builds the detector geometry and simulate events in this geometry.

- Data driven at run time via steering files, interactive command dialogues, macro files.

- Can read Pythia event files.

- Event output files can be written on disk in ASCII or LCIO file formats.
Mokka general software schema
Mokka-input files

MACRO.MAC
/generator/generator secondaries.dat
/run/beamOn 10 → Number of events (1BX)

MOKKA_BCAL.STEER
/Mokka/init/detectorModel ILD_00 → detector model
/Mokka/init/dbHost pollin1.in2p3.fr → host machine
→ MySql username and password
/Mokka/init/EditGeometry/rmSubDetector all → removes all detectors
/Mokka/init/EditGeometry/addSubDetector SLcal02 600 → adds LumiCal
/Mokka/init/EditGeometry/addSubDetector BeamCal01 800 → adds BeamCal
→ global geometry parameters that may change at runtime
/Mokka/init/initialMacroFile ./macro.mac → macro file to be executed after startup
/Mokka/init/lcioFilename mokka.slcio → LCIO output file
I. LOG FILE:
1) Reading and executing steering lines
2) Connecting to the database "models03"
3) Asking for the model ILD_00: found.
4) Connecting to detectors, subdetectors, drivers,subdrivers
5) Running 10 events of BeamCal and LumiCal

Event 7, scanning sub-detectors
LumiCalCollection from the LumiCal sensitive detector has 0 hits.
BeamCalCollection from the BeamCal sensitive detector has 31 hits.

II. MOKKA.SLCIO with events data → Analyzed by Marlin
Marlin

Modular Analysis and Reconstruction for the LINear collider

Simple modular application framework for analysis and reconstruction code based on LCIO.
Marlin

I. XML steering file:

- **order of processors to be executed:**
  ```xml
  <!—processor name="MyTestProc"/>
  ```

- **global parameters:**
  - LCIO input files (mokka.slcio)

- **processor parameters:**
  - Collections analyzed (BeamCalCollection, MCParticle)

II. Predefined and User Defined Processors:

The heart of the reconstruction package are the Marlin processors which hold the different modules of algorithms to **get runs, events, racks and clusters from the simulated data**.

*My Test Processor: gets events and tracks from BeamCal and MonteCarlo Collections*
Event number: 1 has 0 pads hits – BeamCal
Event number: 2 has 0 pads hits – BeamCal
Event number: 3 has 0 pads hits – BeamCal
Event number: 4 has 3 pads hits and 1 MC particles - BeamCal
  x: 128.884 y:-81.1788 z: 3744.88 E[GeV]: 0.000129556
cell ID0 : 30445582 cell ID1 : 0
  x:-25.8615 y: 111.691 z: 3745.96 E[GeV]: 0.000303077
cell ID0 : 30492685 cell ID1 : 0
  x: 37.6266 y: 130.386 z: 3745.51 E[GeV]: 0.000337587
cell ID0 : 30483470 cell ID1 : 0
  Total Energy Deposition [GeV] : 0.000770219
  E[GeV]: 1.38255
  PDG ID : 11
  Total Monte Carlo Energy Deposition [GeV] : 1.38255
Event number: 5 has 0 pads hits – BeamCal
Event number: 6 has 0 pads hits - BeamCal
Event number: 7 has 31 pads hits and 20 MC particles - BeamCal
Event number: 8 has 0 pads hits – BeamCal
Event number: 9 has 0 pads hits – BeamCal
Event number: 10 has 7 pads hits and 4 MC particles - BeamCal
MyTestProc processed 10 events in 1 runs
Future steps

- Higher statistics & Graphics (ROOT).
- Study of background distribution & fluctuations in calorimeter cells, for 1 BX, integrate for several BXs.
- Algorithm for high energy electron signal reconstruction.
- Electron detection efficiency under several background conditions, for different regions of the calorimeter.
- Optimization of the calorimeter segmentation.

THANK YOU VERY MUCH FOR LISTENING !!