Outline

- Geant4-based LCD detector simulations
- LCDG4
  - Introduction and features
  - “Certification”
  - Some event displays
  - Samples available for general use
- Current status
- Plans
Some Geant4-based simulations mentioned in this workshop:

- Mokka (most widely used)
- LCDG4
- Graham’s simulations (is it Mokka?)
- Ron Cassell’s package (under development)
- Test beam (standalone + Mokka-based)

Should we maintain more than one full-detector simulation tool?
What is LCDG4

- A Geant4-based detector simulator for the LC detector R&D
- Goal: replace Gismo
  - Input format: binary STDHEP
  - Output format: SIO for now (LCIO soon)
  - Several detector geometries are implemented via XML geometry files

Simplistic geometry for now: cylinders, disks and cones only, no cracks or support structure
Some LCDG4 features

- Significant bias towards HCal (also ECal)
- Virtual cells defined on-the-fly
- Energies deposited in absorbers are available (ASCII format only)
- Both projective and non-projective calorimeter geometries (forked versions)
- Code available from SLAC and NIU CVS repositories
Mokka and LCDMokka

- Mokka is another Geant4-based simulation framework for LCD
- Detector geometry is described using a MySQL database
- Based on Tesla model, many other models and prototypes have been added into the geometry database
- Input: ASCII StdHEP / Output: LCIO
- For more info, please visit Mokka web site: http://polywww.in2p3.fr/geant4/tesla/www/mokka/mokka.html
- LCDMokka: XML capabilities into Mokka, while LCDG4 is not able to use MySQL geometry files (e.g. Tesla)
LCDG4 vs. Mokka comparison

- Previous LCD studies based on Gismo
- Geant4-based LCD simulations are rather new, they need to be certified
- (LCD)Mokka and LCDG4 were developed independently. Both are based on Geant4, so they should provide compatible results
- Distributions used in comparisons:
  - Energy depositions per layer and per cell
  - Number of hits per layer
  - Dependence of Nhits with threshold
Fair comparison

- Geant4 version 5.2
- SDJan03 geometry (cylindrical layers with virtual cells)
- Physics list from Mokka v1.05
- Range cut of 0.1mm
- Identical I/O formats (binary stdhep input, text output) implemented into both simulators
- Same events processed in both detector simulators
  - single particles: 50 GeV $e^\pm$, $\mu^\pm$, $\pi^\pm$, $\theta = 90^\circ$, flat in $\phi$
- Same materials in sub-detectors (look at $X_0$, $\lambda_i$)
Ecal: energies per layer

Live energy per layer in ECal – Single particles, 50 GeV

G.Lima, January 09, 2004
Hcal: energies per layer

Live energy per layer in HCal – Single particles, 50 GeV

Some significant disagreements?
Ecal: energies per cell

Discrepancies!

ECal threshold at 0.04 MeV
Hcal: energies per cell

Slightly different slopes...

HCal threshold at 0.7 MeV
Number of hits per cal layer

Layers - hHitsPerLayer

# Hits / layer / 1000 evts

Layer (ECal = 0..29; HCal = 30..63)
Nhits dependence with thresholds

Number of ECal hits - Dependence on energy threshold - 50 GeV pions

Number of ECal hits - Dependence on energy threshold - 50 GeV pions

Number of ECal hits - Dependence on energy threshold - 50 GeV positrons

Number of HCAL hits - Dependence on threshold - 50 GeV particles

G.Lima, January 09, 2004
$e^+e^- \rightarrow Z \rightarrow \mu^+\mu^-$ (SDJan03)
$e^+e^- \rightarrow Z \rightarrow qq$ event (SDJan03)
$e^+e^- \rightarrow t\bar{t}$ event (SDJan03)
MC Samples for general use

- Samples currently available at NIU sftp server, 
  /pub/lima/lcdg4/v02-11

- 2K each of $e^\pm$, $\mu^\pm$, $\pi^\pm$, $\gamma$ at $\theta = 90^\circ$ and flat in $\varphi$
  energies = 2, 3, 5, 10, 15, 20, 30, 50 GeV
- 10K Z inclusive at 91 GeV
- 4K ttbar inclusive at 350 GeV
- 1.5K WW into (hadrons)(any) at 500 GeV
- 2K ZH into (any)(bbbar) at 500 GeV and $M_H=120$ GeV
- 2K ZH into (any)(bbbar) at 500 GeV and $M_H=160$ GeV

- More data samples can be requested, see
  http://nicadd.niu.edu/~jeremy/lcd/simreq/
How to access the MC samples

Several single-particle and physics data samples available at NIU data server:

- sftp scpuser@131.156.85.141
- password: lcd_2004
- cd pub/lima/lcdg4/v02-11
- ls (to see a list of .sio files available)
- mget muons-10gev*.sio (for example)
- quit

(see http://nicadd.niu.edu/~jeremy/admin/scp/index.html for more detailed access instructions, including access from windows winscp utility)

Output format compatible with Gismo
Please use them and report the problems you find!
LCDG4 status summary

- Detailed comparisons between LCDG4 v02-11 and LCDMokka 01-05 are in good agreement (discrepancies of ~20% to Gismo have been observed)
- LCDG4 faster than Mokka, but it cannot be used for Tesla geometry
- Only cylinders and disks supported by current LCDG4 version. More realistic geometries to be implemented in the medium term
- Several MC physics samples have been generated for algorithm development and studies (SIO format)
- Source code available from SLAC CVS repository
- For more information please check: http://nicadd.niu.edu/research/lcd
Plans for LCDG4

- Improve compatibility with Gismo output format
- LCIO output format and java analysis code
- Upgrades:
  - XML4C v5.0.2 to Xerces-C++ v2.4 (done)
  - Geant4.6.0 (done)
  - Generic HEP experiment physics list
- Repeat certification studies with Mokka 2.01
- Investigate origin of discrepancies on # of hits
- Merge projective and non-projective versions
- More realistic geometries (medium term)