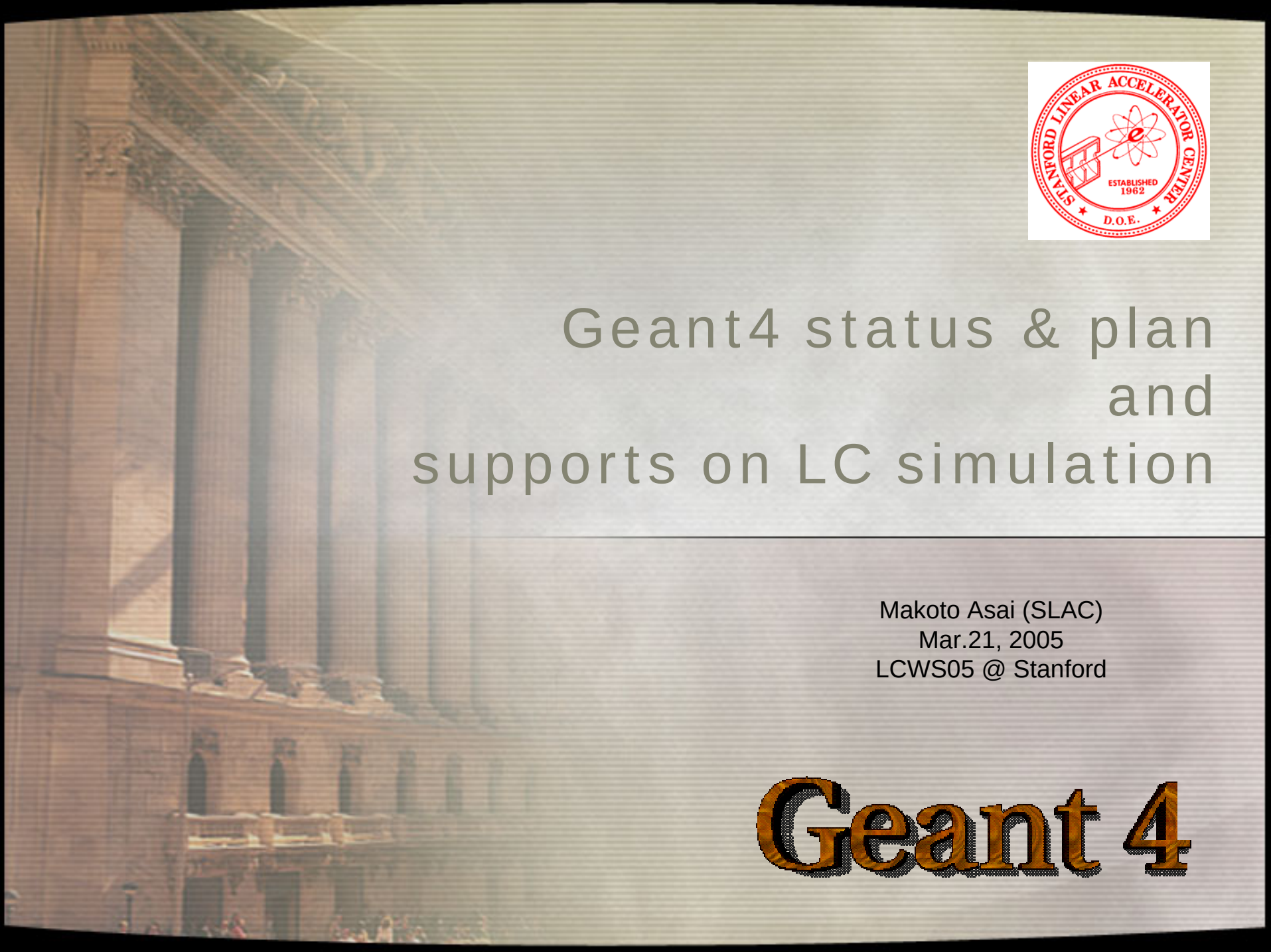


Geant4 status & plan and supports on LC simulation

Makoto Asai (SLAC)
Mar.21, 2005
LCWS05 @ Stanford

Geant 4

Contents

- Highlights of Geant4 v7.0
  - Emphasis on use of LC simulation
- Development plan of 2005
  - Again, emphasis on use of LC simulation
- Supports on LC simulation
  - SLAC Geant4 team

Highlight features of v7.0

- Released on December 17th, 2004.
  - Patch-01 on February 23rd, 2005.
- First introduction of **GFLASH**.
  - Refinements on usability ongoing.
- G4PhysicsTableHelper class is introduced for granular storage/retrieval of physics tables.
- **G4UnknownParticle**, G4UnknownDecay and new G4PrimaryTransformer classes enable the use of exotic particles tracked in Geant4.
  - An example for sleption and R-hadron will be released at v7.1.
- Dedicated G4StepLimiter process now takes care of maximum step length defined in G4UserLimits.
  - At v7.1, G4UserLimits can be assigned to a region.

Highlight features of v7.0

- EM physics
  - Added new utility class: G4EmCalculator, to access/calculate dedx, range, cross sections of EM processes.
  - Ion Ionization
    - Decoupled **G4ionIonisation** process from proton ionisation, use alpha stopping power tables for simulation of ion ionisation.
    - Added G4ionEffectiveCharge class needed to ion physics.
  - Added new process: positron annihilation to pion pair (G4eeToHadrons).
- Hadronic physics
  - Improvements in cross-sections

Highlight features of v7.0

- **GDML** is now fully supported for all CSG solids, some special solids (PCON, PGON) and Boolean solids.
- Allow consecutive corrections for stuck tracks in ComputeStep() up to 10 times before aborting the track.
- New example extended/runAndEvent/RE01
  - Derived from a sample code made for ILC
  - Demonstrates:
    - maintaining links between primaries, trajectories and hits
    - use of G4UnknownParticle

Highlights of 2005 developments

- We plan two releases this year
  - v7.1 end of June
  - v8.0 (or v7.2) middle of December
- Run, event, tracking, particle
  - Allow **non-nominal masses** for primary particles and pre-assigned decay products, and handle them with decay process
  - Merge concept of "envelope" to region
  - Scoring "detector" (in either tracking or parallel world)
  - Retrieval of particle properties from external source
- Material
  - Introduction of **NIST data-bank for materials**

Highlights of 2005 developments

- EM physics
  - Introduction of Single Coulomb Scattering process for very thin object
  - Upgrade of Photo Absorption Ionization model
  - Implementation of a new model for Synchrotron Radiation
  - Review and upgrade Transition Radiation models
  - Introduction of atomic de-excitation in Photo Electric effect
- Hadronic physics
  - Bertini Cascade model
    - Extension to kaons and hyperons
  - CHIPS model
    - Neutrino interactions

Highlights of 2005 developments

- Geometry
  - Prototype of a parallel navigator
    - E.g. a step can be limited on a surface of a volume in readout geometry
  - Mixing of placements and parameterized volumes
  - Generic twisted trapezoid shape with different endcaps
  - Prototype of a generic tessellated BREP solid with flat surfaces
  - New specific ellipsoid solid
- Visualization and graphics_reps
  - Support interoperability of the different visualization drivers
  - Visualization of readout geometry and region
  - Integrated visualization of field-lines
  - HepRepFile to DAWNFILE converter

Users workshop and tutorials

- Users workshop
  - November 3rd - 5th, @Bordeaux
- Users workshop for Geant4 physics
  - Mid July @CERN (under discussion)
- Tutorials
  - May 25th - 27th, @CERN
  - June 6th - 7th, @Helsinki
  - @FNAL or @Brookhaven (under discussion)
  - Let us know about your needs
- CD image of previous SLAC tutorial material is available at

  http://geant4.slac.stanford.edu/

SLAC Geant4 team

http://geant4.slac.stanford.edu/

- Covers most of the Geant4 categories
- Offers central maintenance and validation of a physics list most suitable for LC detector studies
- Is acting as a liaison for LC activities all over the world
  - Tell us any difficulties or requirements.
  - For example, the new example RE01 was originally made as a sample code for LC users.

LCPhys physics list

- It is essential to use the common physics list to make a comparison between different detector models.
  - And, to be honest, it is the most delicate part in Geant4 to choose appropriate physics list.
- SLAC Geant4 team offers central maintenance and validation of a physics list that is most suitable for LC detector studies

  http://geant4.slac.stanford.edu/

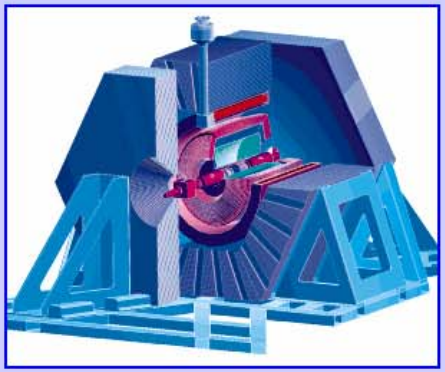
  → Using Geant4 at SLAC

  → Physics lists supported by SLAC

Available Physics Lists

Current physics lists include those developed to support experiments based at least in part at SLAC. These are:

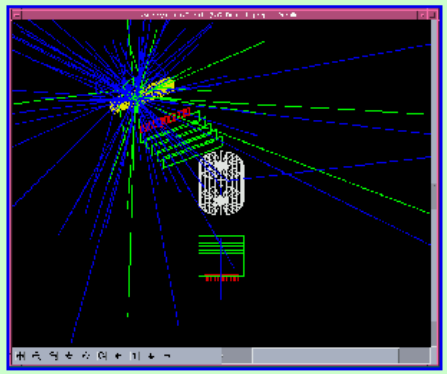
Medium energy vertex/tracker/calorimeter for B physics (BaBar)



Medium energy tracker/calorimeter for space applications (GLAST)

High energy tracker/calorimeter for colliders (ILC)

Simple and Fast Physics List - for getting started



More lists will be added in the near future:

- **Micro-devices**
- **General physics list with model selection**

Linear Collider Physics List Description

Last modified : *Tue, 15 Mar 2005 18:36:05 GMT*

Modular Physics List and Physics Constructors

The linear collider physics list contains the best-guess selection of electromagnetic and hadronic physics processes required to run a linear collider detector simulation. The processes and models are organized using a modula physics list LCPhysicsList.hh , LCPhysicsList.cc , and a set of physics constructors which allow related physics processes, models and particles to be grouped together. The physics constructors handle:

- bosons: LCBosonPhysics.hh , LCBosonPhysics.cc ,
- leptons: LCLeptonPhysics.hh , LCLeptonPhysics.cc ,
- hadrons: LCHadronPhysics.hh , LCHadronPhysics.cc ,
- light ions: LCIonPhysics.hh , LCIonPhysics.cc ,
- decays: LCDecayPhysics.hh , LCDecayPhysics.cc .

Boson Physics

The boson physics constructor LCBosonPhysics.hh , LCBosonPhysics.cc , defines the gamma and two fictitious particles, the Geantino and the ChargedGeantino.

Three processes are assigned to the gamma:

- conversion to e+ e- pairs
- Compton scattering
- photo-electric effect

The Geantino is a chargeless, massless, completely non-interacting particle which can be used for geometry and tracking diagnostics. The ChargedGeantino is also massless and non-interacting, but has a charge so that it car tracked properly in a magnetic field. Aside from the transportation process, neither of these particles can be assigned an interaction process.

Lepton Physics

The lepton physics constructor LCLeptonPhysics.hh , LCLeptonPhysics.cc , defines electrons, muons and taus along with their corresponding neutrinos. The following processes are assigned to each particle:

- electron:
  - multiple scattering
  - electron ionization
  - electron bremsstrahlung
- positron:
  - multiple scattering
  - electron ionization

LCPhys physics list

- For more detail of LCPhys physics list, refer to the talk given by D. Wright (SLAC) at recent LCSim05 workshop

  http://www-conf.slac.stanford.edu/lcsim05/

- We suggest you to use LCPhys at least for the baseline.
- We appreciate your feedbacks, especially the results of comparison with your beam test data.
- Given we are continuously maintaining it, please check the latest updates regularly.
  - And, use the latest version of Geant4.

A tip for EM calorimeter resolution

- Simulation of EM sampling calorimeter is sensitive to backward scattering of slow electrons from absorber.
  - Multiple scattering of electrons in shallow skin part of absorber plays the key role.
- To get the accurate resolution, limit the maximum step length for electrons in absorber.
  - Use G4UserLimits and G4StepLimiter classes.
  - Shortening range cut secondarily gives you the similar effect with more computing cost.
- For more detailed discussion, refer to the EM physics thread of Geant4 HyperNews.
  - Sample codes are available in example/extended/electromagnetic
- In v7.0p01, maximum step length should be much less affecting to simulation results of calorimeter resolution.
  - We are now verifying this.

Summary

- Highlights of most recent release Geant4 v7.0 and development plan of 2005 are introduced, putting emphasis on the use of LC simulation.
- Supports on LC simulation
  - SLAC Geant4 team
    - Offers central maintenance and validation of a physics list most suitable for LC detector studies
    - Is acting as a liaison for LC activities all over the world