Using Geant4 in BaBar

Dennis Wright
Geant4 Users Workshop
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CP Asymmetries in B Decays
BaBar Detector
Beam Pipe and Vertex Tracker
BaBar Simulation Architecture

Event Generator

Bogus (Geant4)

Detector Response Simulation

Reconstruction + Analysis

Objectivity database
Geant4 Features Used in Bogus (1)

• Geometry
  – CSG solids, boolean volumes, G4Materials
  – Diagnostics (overlap scanner, material scanner)

• Hit scoring
  – G4 virtual sensitive detector, manager

• Visualization Interfaces and Drivers
  – Mostly OPENGL, some VRML
Geant4 Features Used in Bogus (2)

• Physics processes
  – Standard EM (ms, brems, pair, …)
  – Decay (long-lived particles)
  – Hadronic (E<10 GeV)

• Particles/Range Cuts
  – Now using material-dependent range cuts
  – Soon to be replaced by region-dependent cuts
Geant4 Features Not Used in Bogus

- Transportation
  - Alternative stepper developed for specific BaBar needs

- Detector response
  - Response code mostly complete before Geant4

- Persistence
  - BaBar database, framework require their own objects
Geant3/Geant4/Data Comparison

• Phase I
  – Gross comparison based on 1.5 million events
  – Validate standard EM, decay processes in low-mass region of detector
  – Validate BaBar material model
  – Compare tracking resolution
  – Compare energy loss
Material Model Validation

Conversions in $\gamma\gamma$ events

G3 8series over Data (points)

G4 10series over Data (points)
EM Process Validation
Tracking, dE/dx Validation (1)
Tracking, dE/dx Validation (2)

**SP4 J/ψK⁺**

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<td>46</td>
<td>73.52</td>
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<td>P1</td>
<td>40.03 ± 5.623</td>
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<tr>
<td>P2</td>
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<td>P5</td>
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**SP4 J/ψK⁺**

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Geant3/Geant4/Data Comparison

• Phase II
  – Detailed Geant4/data comparison using 25 million events
  – Comparisons in all sub-detectors
  – Validate G4 hadronic processes (E<10 GeV)
  – Repeat EM validation
Bogus/Geant4 Performance

• Except for initialization time (100 s), as fast as Geant3

• Low crash rate (few events per million) on Linux and Sun

• Large-scale simulation production
  – 300 million events so far
  – 15 sites in US and Europe