Fluka and Geant4

Using Fluka for CALICE

- Motivation
- Method
- Initial results
- Future

David Ward (Cambridge) for

Nigel Watson (CCRLC-RAL & Birmingham)
Motivation

- Systematic comparison of Mokka and Fluka physics modelling of CALICE test beam
- Particularly interesting for hadronic interactions
  - See G3/G4 studies (DRW, George Mavromanolakis)
- Wish to...
  - Test new Mokka detector models
  - Investigate full TDR type geometry
  - Avoid coding each geometry directly in Fluka
    - error prone, may introduce non-physics differences
- Issues
  - Fluka geometry defined by data cards
  - Only limited geometrical structures supported
  - Repeated structures at 1 level only
"Flugg" Package (P. Sala et al)

- Geometry & physics decoupled in G4 and Fluka
- Wrappers for f77/C++
- Fluka authors' comparisons of G4 with Flugg (FLUka+G4 Geometry)
  - Simple detectors, identical results
  - Complex T36 calorimeter: 81 layers Pb (10mm)-scint.(2.5mm)
    Consistent results
- My first test
  - Use T36 calorimeter as above

[From ATL-SOFT-98-039]
Transverse response of T36 calo. to 10 GeV $\pi^-$ in flugg

User control available:
- at every tracking step, via rudimentary drawing routine (slow)
- at every energy deposition event

Note
- For G4 replicated or parametrised volumes (correspond to Fluka “lattice volumes”)
  - Region index is degenerate
  - Boundary crossings sometimes not detected
Volume Ambiguity

- fluka 'sees' 3x32 Si volumes
- id for wafers degenerate
  - in z (x3 towers)
  - in y within a stack of 5 detector slabs
    (10 Si layers)
Current Status

- **Mokka running within flugg/Fluka framework**
  - Using Mokka-01-05 + Geant4.5.0.p01 + clhep1.8.0 + gcc3.2
  - Flugg05 (Jan. 2003)
  - Fluka 2002.4 (May 2003)

- **Procedure: start from Mokka release and delete:**
  - all classes except for detector construction, detector parametrisation, magnetic field construction
  - corresponding #include, variable, class definitions in .cc/.hh
  - anything related to G4RunManager, DetectorMessenger
  - code where SensitiveDetector is set
  - interactive code, visualisation, etc.

- **Validation**
  - Minimal debugging tools in flugg, e.g. P55 prototype geometry
  - Library/compiler consistency (fluka object-only code)
Two pass operation

- **One-time initialisation**
  - Read G4 geometry/material definitions
  - Generate fluka input cards
    - Material/compound definitions
    - Material to volume assignments

- **Subsequent runs with a given geometry model**
  - Use generated Fluka cards
  - Tracking within G4 geometry
  - Physics processes from Fluka
First pass, G4 → Fluka conversion

Connecting to the database models

Building sub_detector P66WNominal, geometry db P66WNominal, driver proto01:
Ecal prototype driver with W ideal thickness (reference)

Connecting to the database P66WNominal
proto01: proto size is (499.600000,160.800000,378.200000) mm
proto01: placing prototype at (0.000000,236.000000,0.000000) mm
Sub_detector P66WNominal DONE!

Connecting to the database models

Building sub_detector SinglehcalFeRPC1, geometry db SinglehcalFeRPC1
Single module Hcal Fe & RPC as prototype
Connecting to the database SinglehcalFeRPC1
The sensitive model in Hcal chambers is RPC1
Iron is the radiator material being placed.
Sub_detector SinglehcalFeRPC1 DONE!

Building Hcal...
Detector construction done.

* G4PhysicalVolumeStore (0x401b5288) has 2424 volumes.
* Storing information...
  + Tungsten: dens. = 19.3 g/cm³, nElem = 1
    Stored as TUNGSTEN
  + TungstenModified: dens. = 11 g/cm³, nElem = 1
    Stored as TUNGST02
  + Copper: dens. = 8.96 g/cm³, nElem = 1
    Stored as COPPER
  + Silicium: dens. = 2.33 g/cm³, nElem = 1
    Stored as SILICIUM
  + SiVXD: dens. = 8.72 g/cm³, nElem = 1
    Stored as SIVXD
  + Iron: dens. = 7.87 g/cm³, nElem = 1
    Stored as IRON
  + Aluminum: dens. = 2.7 g/cm³, nElem = 1
  + TetraFluoEthane: dens. = 0.00455 g/cm³
    Stored as TETRAFLU
    Stored as RPCGAS1
    Stored as GRAPHITE
  + Mix: dens. = 2.15747 g/cm³, nElem = 9
    Stored as MIX

--------------- … ----------------
* Printing FLUKA materials...
* Printing FLUKA compounds...
* G4PhysicalVolumeStore (0x401b5288) has 2424 volumes.
* Printing ASSIGNMAT...
* Printing Magnetic Field...
  No field found...
*** Entering UsrIni.f!! ***
*** Entering HistIn.f!! ***
### GEANT4 Volume Index

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### Material Definitions

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<th>Cross Section</th>
<th>Area Product</th>
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### Material to Region Assignments

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In these plots, Fluka has energy deposited in all material, not just active layers.
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[G3/G4 plots from DRW]
Fluka with G3/G4

In these plots, fluka has energy deposited in all material, not just active layers.

Nigel Watson / CCLRC-RAL & [G3/G4 plots from DRW]
Ongoing Work

- Restrict study to energy deposited in active layers
- Improve reliability for larger samples
  - ~understood technical issue
- Review energy thresholds/step size in Fluka
  - default min. K.E. > 100 keV
  - neutrons, 19.6 MeV
  - energy e/γ > 500 keV (??)
  - low energy neutron cross-sections
- Compare systematically with G3/G4 results,
  - Same initial conditions
  - Thresholds, mip normalisation, etc.
  - Adopt same output format as DRW/GM
Summary

Identified “easy” way of comparing G4/Fluka
- Alternative to deprecated G-Fluka
- Preferable to “standalone” Fluka as more efficient for variations in geometry

Integration with Mokka geometry classes
- Need to feed changes back to Mokka developers

Will be useful input when devising test beam programme/strategy