Geometry in ROOT – TGeo

Andrei Gheata, 24 Feb 2010

Snapshot

- CSG modeller using containment as main constraint - à la GEANT
- Large set (20+) of primitive solids
  - Extension possible (ABC TGeoShape)
  - Boolean compositions of solids possible
- Built-in navigation features
  - Benchmarked and optimized using a large set (30) real experiment detector geometries
  - Parralel navigation possible
  - Finely tuned to eliminate rounding effects
- Several useful built-in tools
  - Overlap checker, geometry builder, interactive visualization
- Fast I/O, export as C++ code, GDML import/export, STEP export (under development)

Solids

- 20+ primitives, a good match to GEANT4 ones
  - Few extra exotic ones in each (i.e. TGeoScaledShape, TGeoArb8, G4TwistedTubs)
  - Some were implemented for matching reasons, some can be easily mapped from one to another
- No BREP (too slow and of limited usage) or tessellated solids
- Boolean composition possible both in TGeo and GEANT4

Model features

- Logical hierarchy: TGeoVolume ↔ G4LogicalVolume, TGeoNode ↔ G4PhysicalVolume
  - Replicas, divisions, assemblies, parameterisations
  - Parameterisations are build-time in TGeo
  - Assemblies look like real volumes, allowing optimizations
- No direct link to physics in TGeo
  - Like regions, user limits or sensitive volumes
  - Geometry in TGeo is made to work as an external standalone plugin to simulation, reconstruction or event display
- Interfaces for G3, G4 and FLUKA using TGeo available via VMC framework
  - Geometry conversion tools available (like VGM) but they have some limitations
  - G4 simulation using externally TGeo as navigator works as fast as with its native navigator.

Additional features

- Geometry can be dynamically simplified
  - Parts or details of the geometry can be switched on/off runtime
- Geometry can be navigated in parallel
  - Arbitrary number of navigators
  - Tested to work with a modified G3 (see CHEP'09 #460)
    - CPU time scaling, small memory penalty
- Geometry can be dynamically misaligned
  - Misalignment applied on top of ideal geometry
  - Stored in the geometry itself or taken as external misalignment objects

Useful tools

- Collision (overlap) checker
  - Very fast and efficient sampler, using the navigation features
  - Direct OpenGL visualization of overlaps
- Navigation testing tools based on ray-tracing
- Full geometry builder package
  - Not a CAD, but having many nice features
- Powerful interactive GL visualization
  - Clipping, context menu, transparency, light models
  - Well optimized and used natively by event displays
- Fast ROOT I/O + other export options
  - Individual volumes can be saved
  - One can immediately generate C++ code starting from a geometry in binary format