Geant4 Review
Part I – Focus on Functionality

[2] Kernel capabilities

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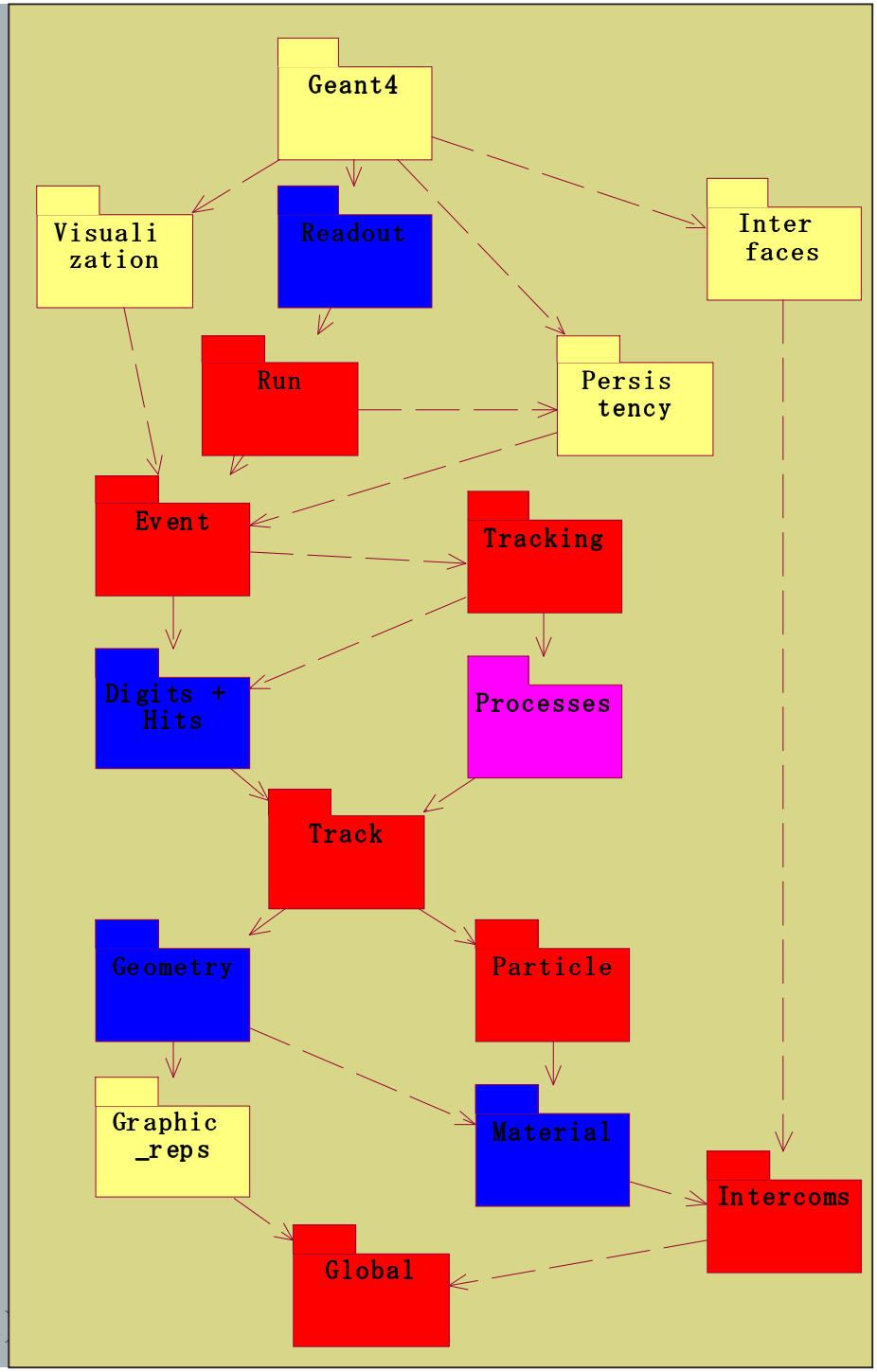
Categories covered by this talk

- *Kernel categories*
  - *Run, Event, Tracking*
  - *Track, Particle*
  - *Intercoms, Global*
- *Detector description*
  - *Material*
  - *Geometry*
  - *Readout, Digits+Hits*
- *Process management*



Kernel Categories

- *Provides basic framework for Geant4 simulation toolkit.*
  - *Run – Initialization, Event loop, Termination*
  - *Event – Stack management, Primary generation*
  - *Tracking – Tracking / Stepping procedures*
  - *Track - Basic classes which represent a track*
  - *Particle – Static definition of particles*
  - *Intercoms – Inter-category communications*
  - *Global – Lowest layer basic classes*
- *These categories are basically stable since the first release.*

Run and Event categories
- main activities in 1999-2000

- *Migration to ISO/ANSI C++ and STL*
- *Storing/restoring random number engine status*
- *Introduction of generic particle source primary generator*
  - *For radioactive volumes*
- *Introduction of "pre-assigned lifetime" for primary particle*
- *Improvements of documents and examples*
- *On going development*
  - *Interface to HepMC and PYTHIA*

Tracking category
- main activities in 1999-2000

- *Migration to ISO/ANSI C++ and STL*
- *Minor bug fixes and performance improvements*
- *Improvements of documents and examples*

Track and Particle categories
- main activities in 1999-2000

- *Migration to ISO/ANSI C++ and STL*
- *New G4DynamicParticle class for exotic nuclei*
  - *Dynamically defined with charge and electron occupancy*
- *Introduction of G4VIsotopeTable as a table of nuclei properties*
  - *Mass, lifetime, decay branch for radioactive decay process*
- *Introduction of "sub-type"*
  - *E.g. all K mesons share the "kaon" sub-type*

Intercoms category
- main activities in 1999-2000

- *Introduction of a new program state "Abort"*
  - *Provides a user hook to store some information before G4 is aborted*
- *Some classes have been imported for better use-relation*
  - *G4VFlavoredParallelWorld*
  - *G4VGlobalFastSimulationManager*
  - *G4VGraphicsScene, G4VVisManager*
- *Migration to ISO/ANSI C++ and STL*
- *Improvements of documents and examples*

Global category

- main activities in 1999-2000

- *Some portions have been exported to CLHEP*
- *Migration to ISO/ANSI C++ and STL*
- *Introduction of some new basic classes*
  - *G4PhysicsLnVector*
  - *G4Integrator*
- *Some classes have been imported from other categories for better use-relation*
  - *G4VStateDependent, G4StateManager*
- *Improvements of documents and examples*

Detector description

- *Material*
  - *Definition of material*
  - *Cross-section tables*
- *Geometry*
  - *Geometry description*
  - *Navigation and transportation in the geometry model*
- *Readout, Digits+Hits*
  - *Description of detector sensitivity*

Material category

- status and evolution in 1999-2000

- *Material category currently provides*
  - *Description scheme of material, element and isotope*
  - *Description scheme of optical and surface properties*
- *Some improvements for optical property description are done in 1999-2000.*
  - *Co-working with optical processes*

Geometry category
– status and evolution in 1999-2000

- *Geometry category currently provides*
  - *Geometry description and tracking optimization algorithms*
  - *Volume positioning*
    - *placements, parameterized, replicated*
  - *Navigation and transportation of a particle in the geometry model*
  - *Definition of solids types*
    - *CSG, BREP, Boolean, detector specific*
  - *Interface to CAD systems*
    - *through ISO-10303-203 protocol*
  - *Integration of the public-domain NIST STEP reader*

Geometry category
– status and evolution in 1999-2000

- *Geometry category currently provides (continued)*
  - *Propagation of a particle in field*
    - *Magnetic or electric*
  - *Variety of algorithms for stepping in field*
  - *Conversion tool for translation of simple G3 geometry models*

Geometry category
– status and evolution in 1999-2000

- *Main activities on stability and robustness*
  - *Improvements and testing of Solids*
    - *CGS, Boolean, BREPS*
  - *First performance evaluation and tuning of transportation in field*
    - *Stability in relativistic limit*
    - *Extension to electric field*
  - *Optimization of memory used for voxels*
    - *In some large detectors (BaBar, ATLAS-EMcal)*

Geometry category
– status and evolution in 1999-2000

- *Main activities on new developments and upgrades*
  - *Assembly factory for positioning of sets of volumes with fixed relative positioning*
  - *New detector specific solids*
  - *Upgrade of NIST STEP reader*
  - *Propagation of a particle's spin in magnetic fields according to the BMT equation*
    - *V. Bargmann, L. Michel and V.L. Telegdi, Phys. Rev. Letters 2, 435 (1959)*

Readout & Digits+Hits categories
– status and evolution in 1999-2000

- *Readout and Digits+hits categories currently provide*
  - *Description scheme of detector sensitivity and readout*
  - *Description scheme of artificial geometry for readout segmentation*
  - *Base classes for user's hit/digit classes*
- *Main activities on*
  - *Migration to ISO/ANSI C++ and STL*
  - *Improvements of documents and examples*

Process Management

- *Defines the key abstract class for all processes – G4VProcess*
  - *Three pairs of virtual methods to abstract all possible features of a process*
    - *AtRestGetPhysicalInteractionLength*
    - *AtRestDoIt*
    - *AlongStepGetPhysicalInteractionLength*
    - *AlongStepDoIt*
    - *PostStepGetPhysicalInteractionLength*
    - *PostStepDoIt*
- *Is stably working and gives opportunities of implementations for various physics processes and application fields*