GEANT4:
An Object-Oriented Toolkit for Simulation in High Energy Physics

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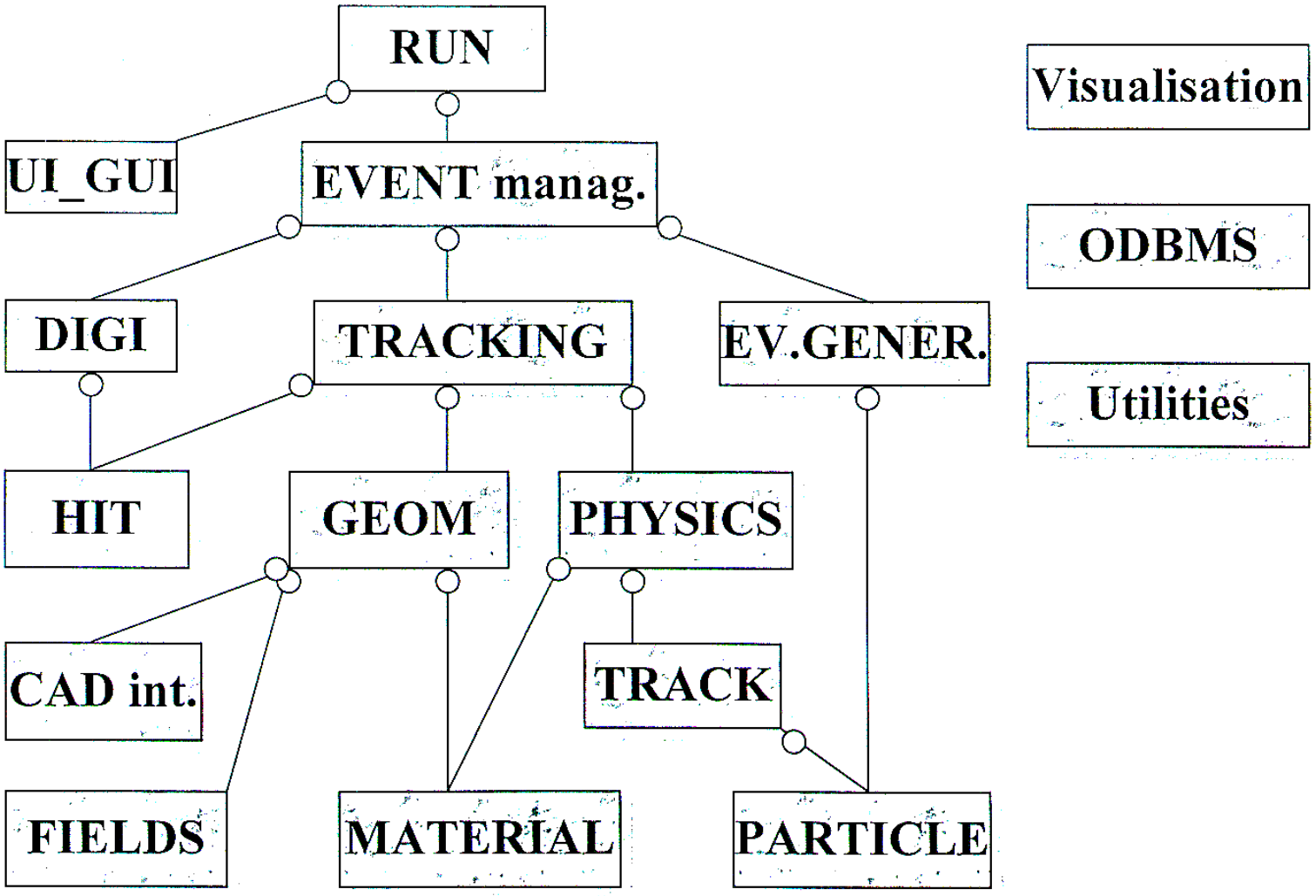
GEANT4 *Introduction*

- Objective:
  - OO toolkit for HEP detector simulation
- World-wide collaboration:
  - ~100 physicists, engineers, computer scientists
  - ~40 labs / institutes / universities
  - >10 experiments involved
- Time-scale: 4 years (end '94 to end '98)

GEANT4 *Strategy*

- Problem domain analysis and decomposition into sub-domains
- 15 working groups: ***Hits/Digi, Events, Geometry, GUI, Hadronics, E.M., LowE., Tracking, Visualisation, Particles/Matter, Fast MC, ODBMS, QA, Parallelism, UR***
- OOA&D and distributed software development
- Interfaces to standards

GEANT4 *Category diagram*



GEANT4 *Milestones*

- R&D approved at end '94 by CERN DRDC
- Milestones at end '95:
  - OO methods, problem domain, full OOA&D
  - tracking prototype, performance
- Milestones at spring '97
  - alpha version comparable to GEANT 3.21
  - ODBMS persistency (hits)
  - transparency of physics models for the users

GEANT4 *Alpha01*

- ISO STEP geometry + fields + RK integrators
- Runs, events + HEPEVT, pile-up, tracking
- EM showers as G3; low energy; optical photons
- Hadronic showers vs G3; models by energy range, material, element, particle
- Calorimeter + tracker hits; ODBMS persistency
- Visualisation design: **DAWN, OGL, OPACS, OI, VRML, PS, X11**
- 9 classes for user interaction + main()
- ~300000 lines of code in C++; ~600 C++ classes

GEANT4 *Milestones by end 97*

- LHCC/LCB Project Execution Plan
- Alpha02 and Alpha03:
  - Fast MC and shower parameterisations
  - Persistency of full simulation events via RD45
  - Availability of multiple visualisation and user-interface drivers
- BaBar fast MC in production with GEANT4

GEANT4 *Milestones 98*

- Mid-98: open beta-release
  - doc, examples and tutorials (beta)
  - persistency of geometry
  - physics simulation in CAD models via STEP
  - extend physics and low E neutron transport
  - performance optimisations
- End-98: first production version
  - code, doc, examples and tutorials

GEANT4 *Current achievements*

- Release+tag strategy - Release co-ordinator (SLAC)
- Approved documentation structure - Global editor (KEK)
- Alpha04
- Persistency class category
- CAD models ~10MB, lower-order integrators
- Muons models up to PeV, transition radiation
- LowE neutron cross sections, stopping Kaons
- Geometry performance optimisation

GEANT4 *Current developments*

- Alpha05 >>> Beta01
- Examples working group workshop (video-conference)
- **Geometry**: Booleans, volumes parameterised by solid, full STEP support, persistency
- **Physics**: E.M. from 1eV to 10 TeV, stopping pions, Lund++ interface, hadronic soft-interactions, intra-nuclear cascade, nuclei de-excitation and decay modes, neutrons
- **Performance**: tracking optimisation

GEANT4 *Future evolution*

- LHCC/LCB requires to put in place the management structure for the production phase of GEANT4 (which will start at about the end of 98)
- GEANT4 is recognised to be an inter-laboratory and inter-experiments effort
- Results of the first discussion iterations are to be presented in Spring at the LCB
- Final decision on the structure of the GEANT4 collaboration is to be taken around July 98