User Documents and Examples

Geant4 Tutorial at Chalk River

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Outline

- User Documents

- Examples
  - basic
  - extended
  - advanced

- User Support
  - LXR and Doxygen source code browsers
  - Discourse User Forum

Your First Stop: Geant4 Web Pages
www.geant4.org

Installation Guide

- Geant4 main page → User Support → Item 8b

- List of supported platforms
  - currently Linux, Mac OSX, Windows
- List of required software
  - C++ compiler, CMake, Make (Linux/MAC only), Geant4 toolkit
  - choices for visualization software

- How to install using CMake
- How to make an executable program
  - geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/ch02s08.html

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Application Developers' Guide

- Geant4 main page → User Support → Item 8c

- Introduces new users to Geant4 toolkit

- Describes the most useful tools

- Describes how to set up and run a simulation application

- Intended as an overview of the toolkit, not an exhaustive treatment. For more details:
  - Physics Reference Manual
  - Toolkit Developers' Guide

Toolkit Developers Guide

- Geant4 main page → User Support → Item 8d

- For developers and experienced users of Geant4
  - already familiar with functionality of Geant4 toolkit as explained in the "User's Guide For Application Developers"
  - a working knowledge of programming using C++ is assumed

- Includes
  - a description of the object oriented design of the Geant4 toolkit
  - philosophy behind design choices
  - a guide for users who want to extend the functionality of Geant4: adding new solids, modifying the navigator, creating new fields, etc.

Physics Reference Manual

- Geant4 main page → User Support → Item 8e

- Presents the theoretical formulation, model or parameterization of the physics interactions included in Geant4

- Describes the probability of occurrence of an interaction and the sampling mechanisms required to simulate it

- Serves as a reference for toolkit users and developers who wish to consult the underlying physics of an interaction

- The manual contains some gaps in documentation – we're working on it

Examples

- Extensive set of examples distributed with the toolkit

- Varying complexity:
  - Basic: complete applications demonstrating simple features of toolkit – good for tutorials
  - Extended: demonstrating specific features of Geant4 and more complex use cases – some require external (non-Geant4 libraries)
  - Advanced: complex, "real life" applications with complex geometries and physics focused on specific user communities

- Documentation provided in README files in each example, and web pages

Basic Examples

- B1
  - A few simple solids and simple placements

  - Total dose scoring in user-selected volume

  - User action classes
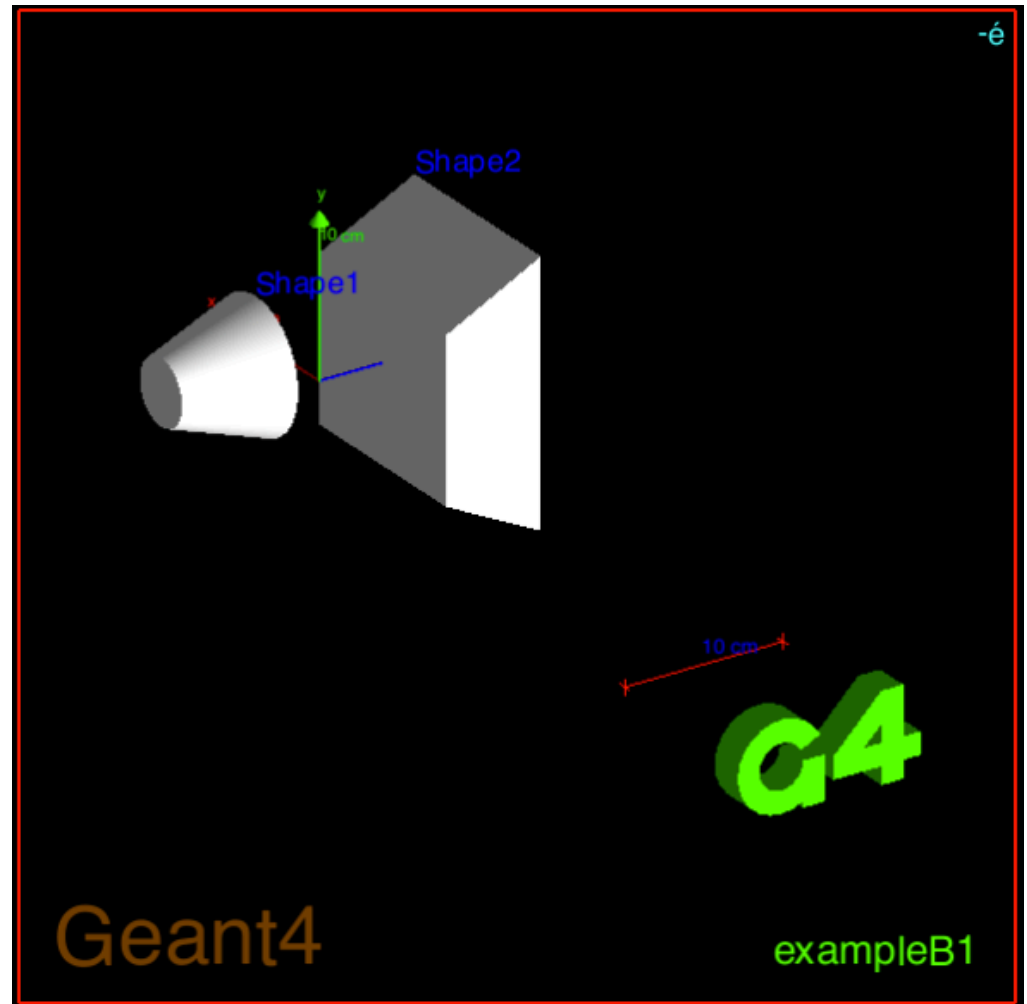
Basic Examples

- B2
    - Magnetic field, parameterized placements
    - Scoring in tracker using sensitive detector and hits
    - Geant4 physics list (FTFP_BERT) with step limiter
- B3 (schematic PET system)
    - Simple placements with rotations
    - Scoring within crystals using Geant4 scorers
    - radioactive source, modular physics list using builders
- B4
    - geometry with replicas
    - multiple scoring methods
    - histograms (1D) and ntuples saved in output file

Basic Examples

- B5 (double-arm spectrometer)
  - Complex geometry with rotation, replicas, parameterization
  - Scoring in multiple volumes with sensitive detector and hits
  - Defining local UI commands
  - Histograms (1D, 2D) and ntuples saved in output file
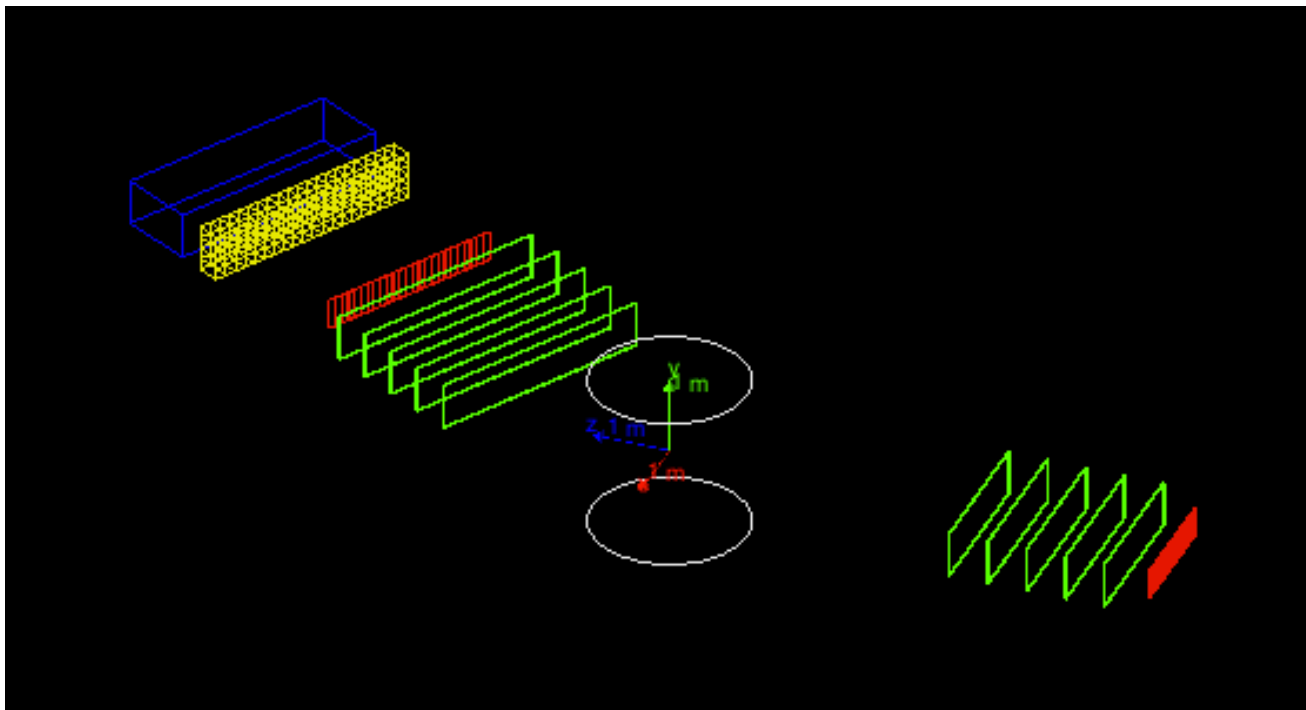
A Sampling of Extended Examples

- Analysis – histogramming using G4tools

- Biasing – event biasing, scoring and reverse Monte Carlo

- Electromagnetic – many EM physics simulations with histogramming (some also used as part of Geant4 testing)

- Hadronic – same as EM but with hadronic models

- Parallel – examples of parallel computing

- Visualization – specific visualization features and graphics customizations

21 Extended Examples

- analysis/
- biasing/
- common/
- electromagnetic/
- errorpropagation/
- eventgenerator/
- exoticphysics/
- field/
- g3tog4/
- geometry/

- hadronic/
- medical/
- optical/
- parallel/
- parameterisations/
- persisitency/
- physicslists/
- polarisation/
- radioactivedecay/
- runAndEvent/
- visualization/

Advanced: Gamma Ray Telescope

Simulation of a gamma ray space telescope

> very similar to Fermi Gamma Space Telescope
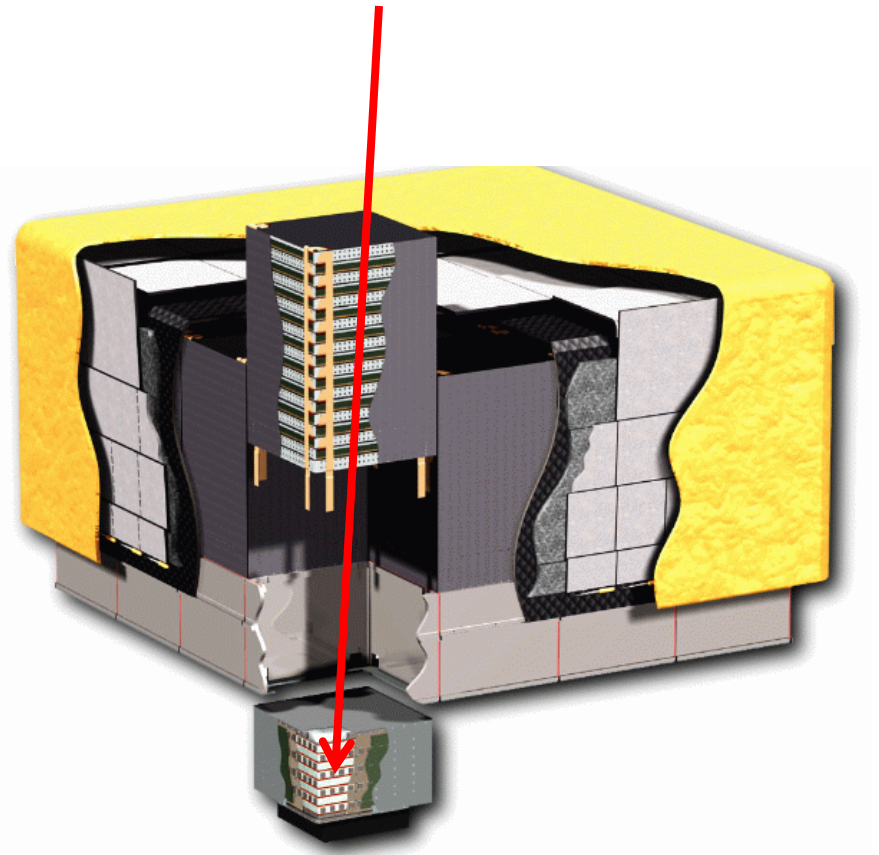
Studies the tracking and calorimetry of ~GeV gammas

> 16 Si foil tracker towers
>
> 16 CsI calorimeters
>
> GammaRayTelPhysicsList
>
> customized particle generator
>
> AIDA-based analysis

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Advanced: X-ray Telescope

Simulation of XMM Newton telescope

first application of Geant4

Studies the focusing of background protons onto focal plane arrays

carbon fiber tube, x-ray mirrors

XrayTelPhysicsList

G4hMultipleScattering is main process

General Particle Source

AIDA-based analysis

Advanced: Underground Physics

Realistic example of underground dark matter search experiment

Full lab geometry

desks, cupboards, door and window

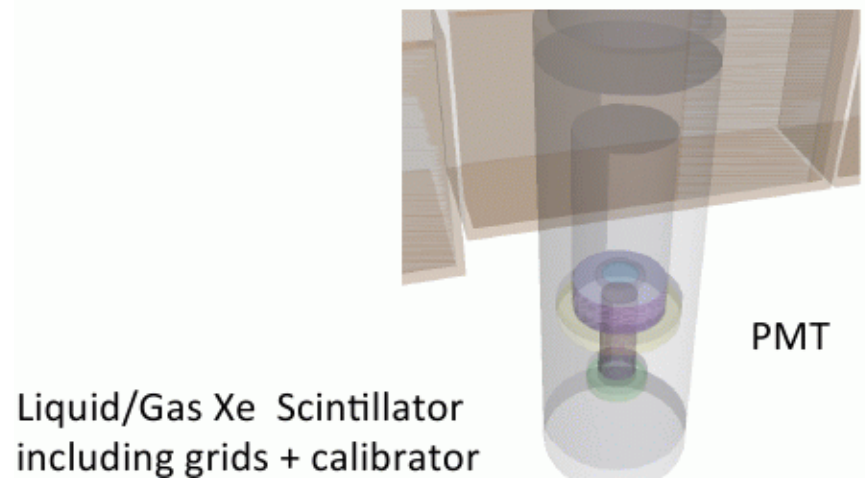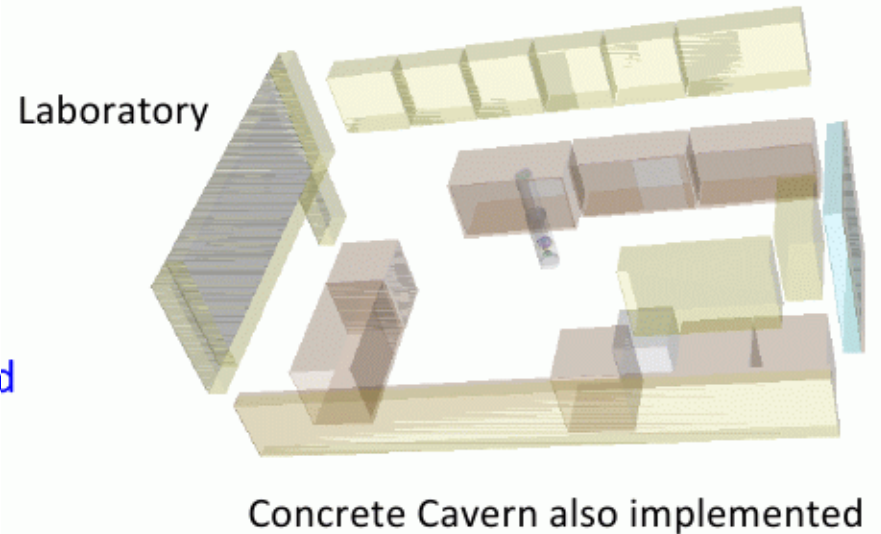important for neutron scattering

Physics

low energy, standard EM

neutron HP

optical processes

radioactive decay

General Particle Source

Laboratory

Concrete Cavern also implemented

PMT

Liquid/Gas Xe Scintillator
including grids + calibrator

Advanced: Hadron Therapy

Specifically developed to address needs of proton and ion therapy
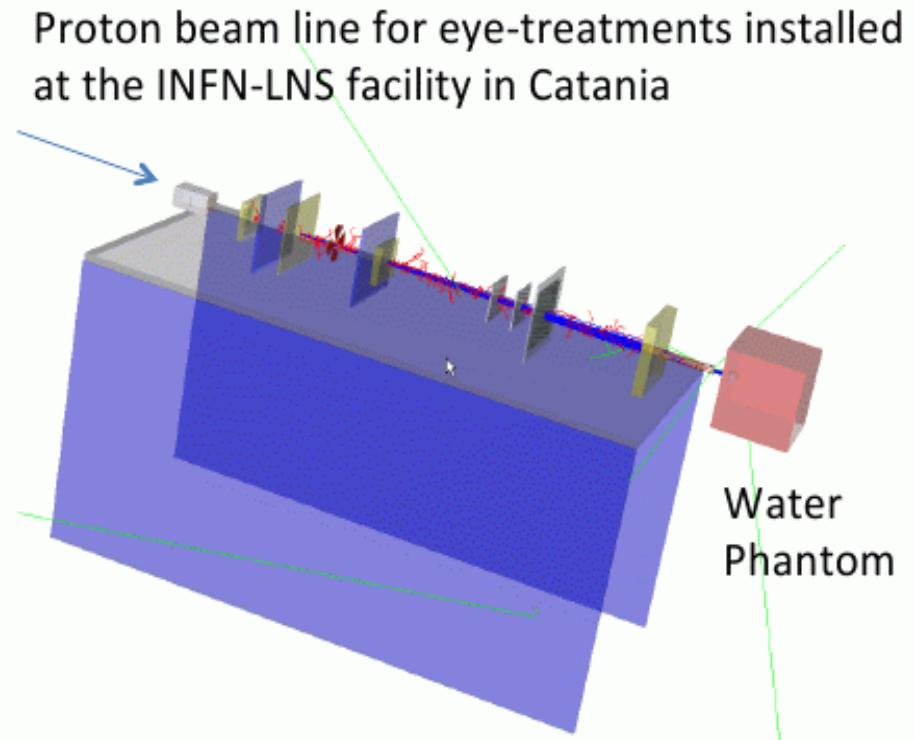
Proton beam line

Standard geometry for IAEA benchmark

Physics

- uses Reference Physics Lists
- specific "local" physics list for ion-ion interactions

Proton beam line for eye-treatments installed at the INFN-LNS facility in Catania

Water Phantom

Advanced: Human Phantom

Anthropomorphic phantoms for Geant4 simulations

Two models are available:
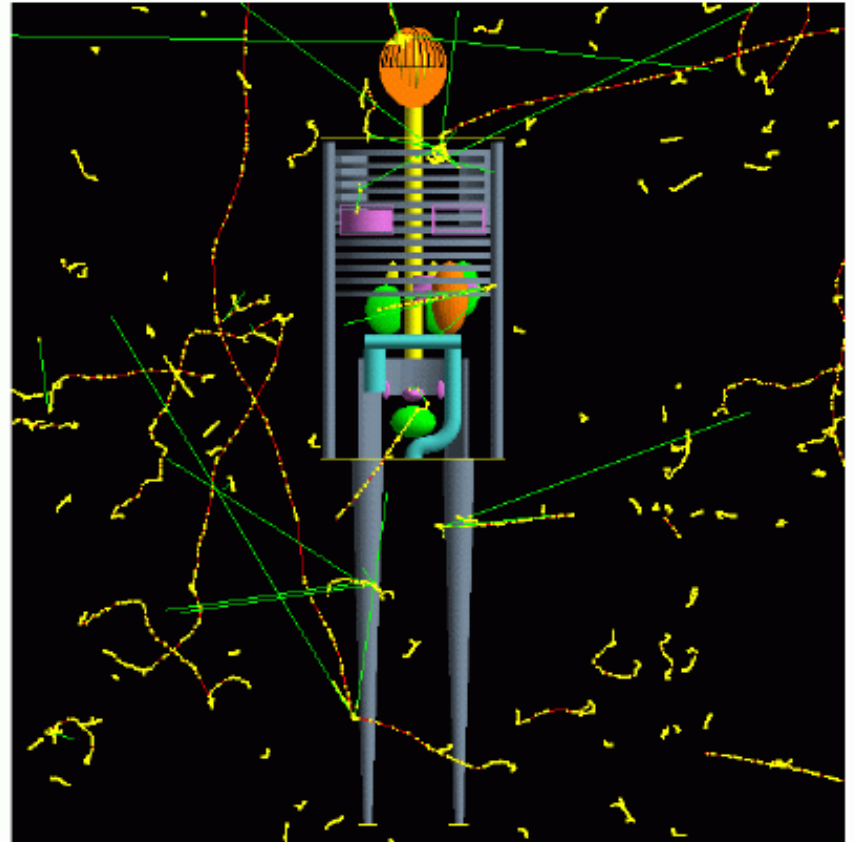
MIRD and ORNL

male and female for each model

Some geometries are implemented through GDML

Physics processes

standard EM processes

MIRD Female Phantom with particle tracks

22 Advanced Examples

- air_shower/
- amsEcal/
- brachytherapy/
- ChargeExchangeMC/
- composite_calorimeter/
- doiPET/
- eRosita/
- gammaknife/
- gammaray_telescope/
- hadrontherapy/
- human_phantom/
- iort_therapy/
- lAr_calorimeter/
- medical_linac/
- microbeam/
- microelectronics/
- nanobeam/
- purging_magnet/
- radioprotection/
- underground_physics/
- xray_fluorescence/
- xray_telescope/

User Support: LXR Code Browser

- URL: www-geant4.kek.jp/LXR/

- Search entire Geant4 source tree by
  - filename (e.g. G4Track.hh)
  - identifier
  - text

- Result: a source file fully hyper-linked to classes and methods
  - tells where classes and methods are defined
  - also where they are referenced

- Also have a doxygen version:
  - www-geant4.kek.jp/Reference

Static Public Member Functions I Private Member Functions I
Static Private Attributes I List of all members

G4Alpha Class Reference

Inheritance diagram for G4Alpha:

```
        G4ParticleDefinition
                ▲
                │
            G4Ions
                ▲
                │
            G4Alpha
```
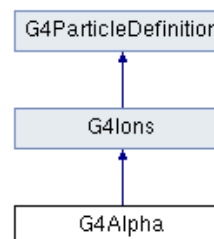
Static Public Member Functions

static **G4Alpha** *	**Definition** ()
static **G4Alpha** *	**AlphaDefinition** ()
static **G4Alpha** *	**Alpha** ()

▸ Static Public Member Functions inherited from **G4Ions**

▸ Static Public Member Functions inherited from **G4ParticleDefinition**

Private Member Functions

G4Alpha ()
~G4Alpha ()

Static Private Attributes

static **G4Alpha** *	**theInstance**

Additional Inherited Members

Discourse User Forum

- URL: https://geant4-forum.web.cern.ch

- See also top of Geant4 home page

- Replaces old SLAC HyperNews forum

- Discuss problems with other users, post questions for experts, etc.

- 9 fora to cover Geant4 categories

- Switched in early June from SLAC HyperNews

  - all old topics are archived and accessible from new forum

- To join: go to above URL, click on "Sign Up"

  - a Geant4 Discourse admin will approve your request

Summary

- Installation, Application, Toolkit and Physics Guides take you from making your first Geant4 installation to developing your own application to developing advanced Geant4 features

- Three levels of examples: ranging from very easy to complex
  - basic – getting started
  - extended – exploring specific features of Geant4
  - advanced - real world applications

- User support includes:
  - cross reference code browser (LXR, Doxygen)
  - user forum is available for sharing ideas, asking questions
  - periodic tutorials