User documents and Examples

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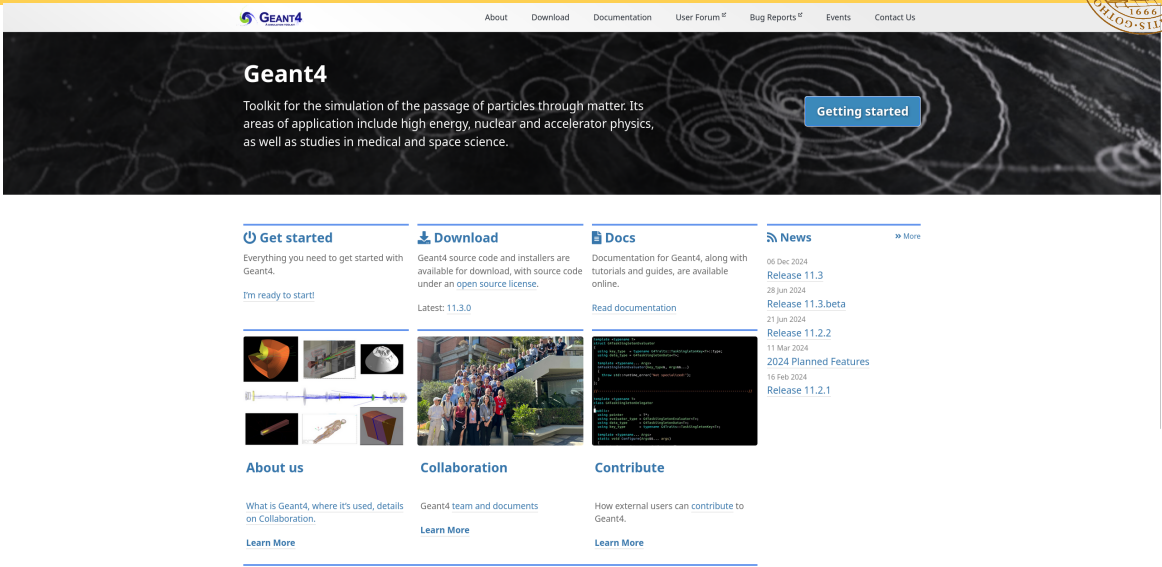
(Some slides/inspiration from Dennis Wright)

12th International Geant4 Tutorial in Korea, Pohang 2025.

Your entry point to Geant4 (https://geant4.org/ https://geant4.web.cern.ch)



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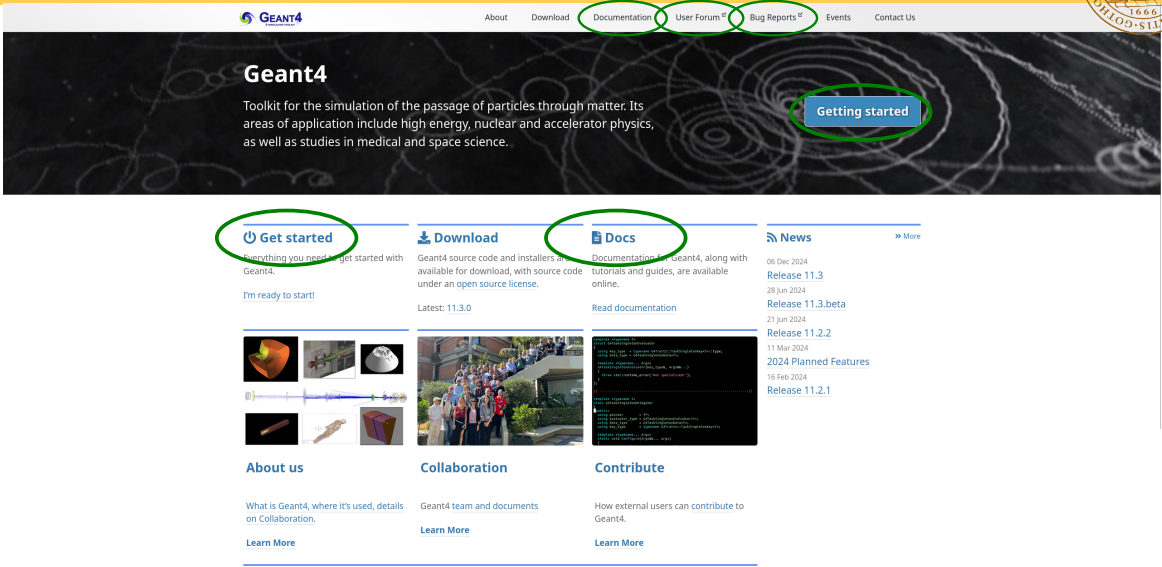

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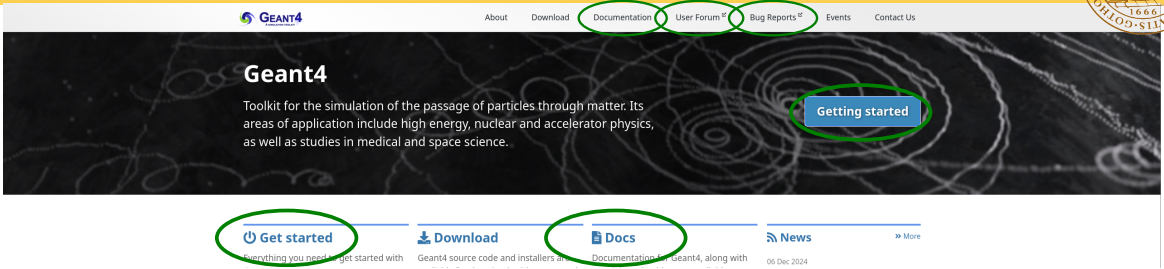

-> How to download and install

-> Where to get information/documentation

-> How to write an application

-> Example application

-> User guides (html, pdf, epub, and kindle)

-> Frequently Asked questions / User forum

-> Bug reporting

Geant4 User Guides

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On this page

Introduction to Geant4

html - pdf - epub - kindle

This document gives you a more complete introduction to Geant4.

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We strongly recommend installing the Geant4 toolkit under your computing environment before starting to read the following user's guides. You will gain much more from the user guides if you can check things out with a working version while you are reading them. This installation guide instructs you in the setting up of the Geant4 toolkit on your computer.

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User guides

All guides combined into one web-hierarchy in order to allow searching across all documents: Combined Web Guides

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Particularly useful when you have no clue where to begin with

Introduction to Geant4

Geant4 main page → Docs → Introduction to Geant4

- Geant4 scope of application
- History of Geant4
- Overview of functionality
- Geant4 User support
- Software Knowledge Required to Use the Geant4 Toolkit
- Computing Environment Required by the Geant4 Toolkit

Installation Guide

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- Build and Install Geant4 from Source
- Install Geant4 via a Package Manager
  - several managers available (caveat: developed by Geant4 users but not maintained by Geant4, except ArchLinux Maintained by Pico[1])

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- Geant4 System/Software Prerequisites
  - Suported and tested OSs, prerequisites for optional components of Geant4

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- Postinstall Setup
  - Required Environment Settings on UNIX (GNU/Linux, MacOS) and Windows
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- How to Use the Geant4 Toolkit Libraries
  - CMake Build System: Geant4Config.cmake
  - Other Unix (GNU/Linux, MacOS) Build Systems: geant4-config

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- Appendices

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Book for Application Developers

Geant4 main page → Docs → For Application Developers

- Getting Started with Geant4 - Running a Simple Example
- Toolkit Fundamentals
- Detector Definition and Response
- Tracking and Physics
- User Actions
- Control
- Visualization
- Analysis
- Language Bindings

Basically this *would be* your go to reference guide after taking this tutorial

Users Guide for Toolkit Developers

Geant4 main page → Docs → For Toolkit Developers

- Getting Started with Geant4 - Running a Simple Example
- For developers and experienced users of *Geant4* who:
  - are already familiar with Geant4 functionality as explained in Application Developers guide
  - have a working knowledge of programming in C++

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  - have a working knowledge of programming in C++
- Includes:
  - a description of the object-oriented design of Geant4
  - philosophy behind the choices
  - a guide for users who want to extend the functionality of Geant4: adding new solids, physics models, creating new EM and other fields, etc.

Physics Reference Manual

Geant4 main page → Docs → Physics Reference Manual

- 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 who wish to consult the underlying physics of an interaction
- Does not discuss code implementation or how to use interactions in a simulation
  - see Application Developer's Guide instead

Physics List Guide

Geant4 main page → Docs → Physics List Guide

- Lists the Reference Physics Lists and describes their content
  - cross sections
  - physics models
  - energy ranges of application

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  - recommends how they should be applied
- Discusses some hadronic physics options and extra features

Examples Documentation

Geant4 main page → Docs → Examples

- Describes the Geant4 examples (Doxygen)
  - Basic, Extended, Advanced
  - How to build and run an example
  - Tips on running in multi-threaded mode
  - How to navigate the examples documentation

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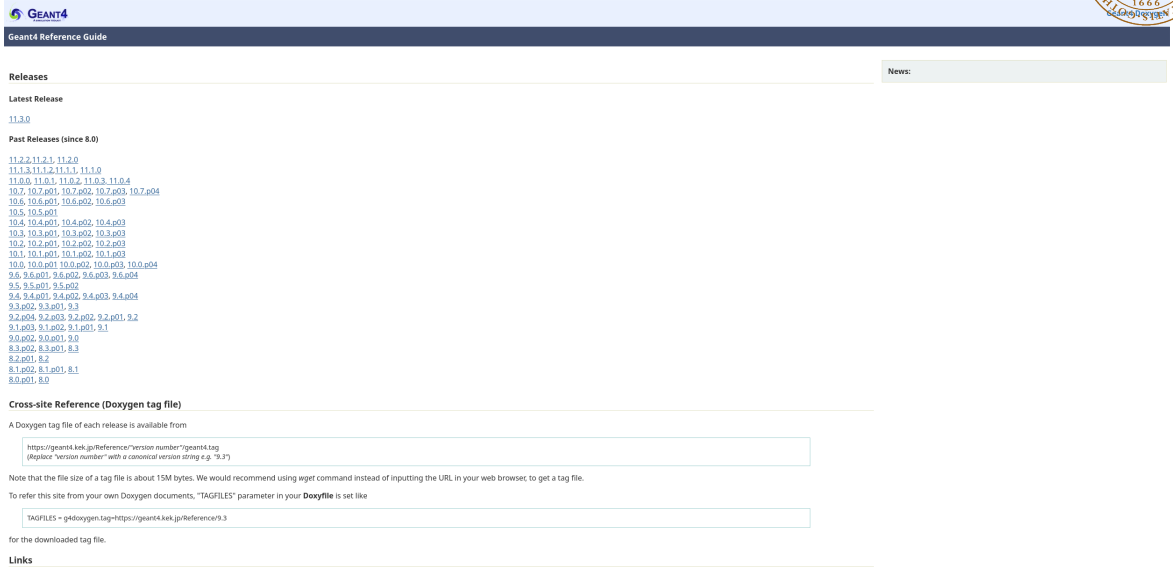
  - links to authors/maintainers
- Links to Examples Working Group

Geant4 Source Code Documentation

Doxygen and LXR Code Browser



GEANT4

Geant4 Reference Guide

Releases

Latest Release

11.3.0

Past Releases (since 8.0)

11.2.2, 11.2.1, 11.2.0
11.1.3, 11.1.2, 11.1.1, 11.1.0
11.0.0, 11.0.1, 11.0.2, 11.0.3, 11.0.4
10.7, 10.7.p01, 10.7.p02, 10.7.p03, 10.7.p04
10.6, 10.6.p01, 10.6.p02, 10.6.p03
10.5, 10.5.p01
10.4, 10.4.p01, 10.4.p02, 10.4.p03
10.3, 10.3.p01, 10.3.p02, 10.3.p03
10.2, 10.2.p01, 10.2.p02, 10.2.p03
10.1, 10.1.p01, 10.1.p02, 10.1.p03
10.0, 10.0.p01 10.0.p02, 10.0.p03, 10.0.p04
9.6, 9.6.p01, 9.6.p02, 9.6.p03, 9.6.p04
9.5, 9.5.p01, 9.5.p02
9.4, 9.4.p01, 9.4.p02, 9.4.p03, 9.4.p04
9.3.p02, 9.3.p01, 9.3
9.2.p04, 9.2.p03, 9.2.p02, 9.2.p01, 9.2
9.1.p03, 9.1.p02, 9.1.p01, 9.1
9.0.p02, 9.0.p01, 9.0
8.3.p02, 8.3.p01, 8.3
8.2.p01, 8.2
8.1.p02, 8.1.p01, 8.1
8.0.p01, 8.0

Cross-site Reference (Doxygen tag file)

A Doxygen tag file of each release is available from

https://geant4.kek.jp/Reference/*"version number"*/geant4.tag
(*Replace "version number" with a canonical version string e.g. "9.3"*)

Note that the file size of a tag file is about 15M bytes. We would recommend using *wget* command instead of inputting the URL in your web browser, to get a tag file.

To refer this site from your own Doxygen documents, "TAGFILES" parameter in your **Doxyfile** is set like

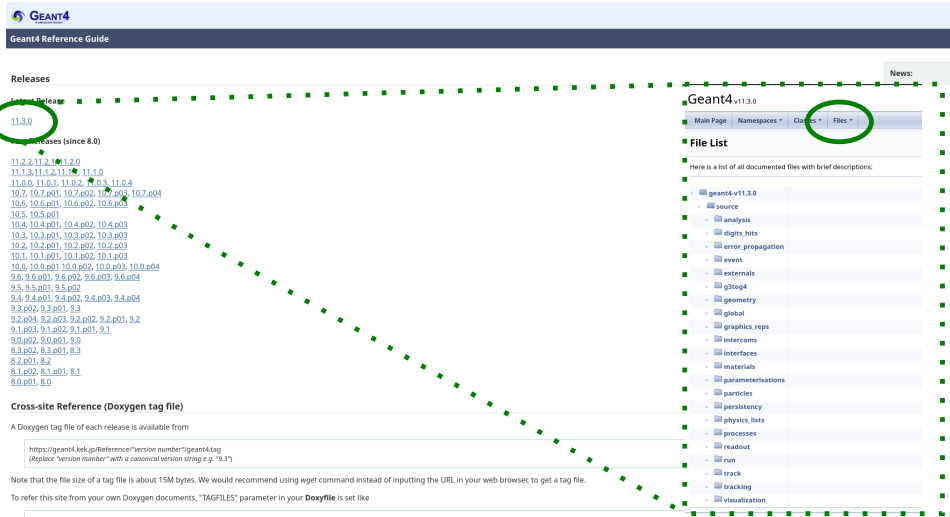
TAGFILES = g4doxygen.tag=https://geant4.kek.jp/Reference/9.3

for the downloaded tag file.

Links

News:

Doxygen and LXR Code Browser



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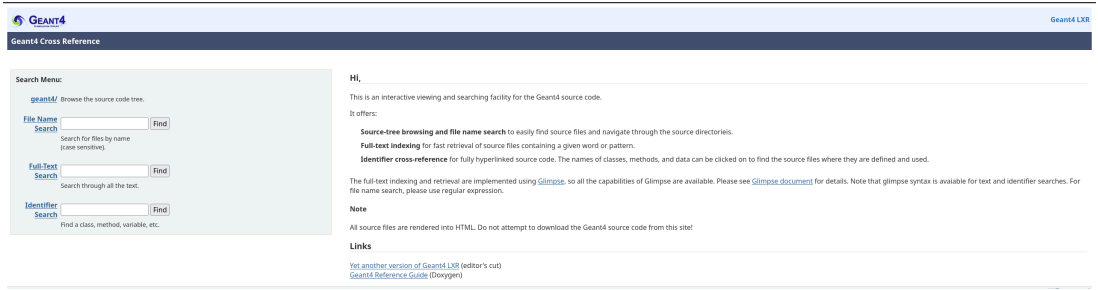

Example Applications

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

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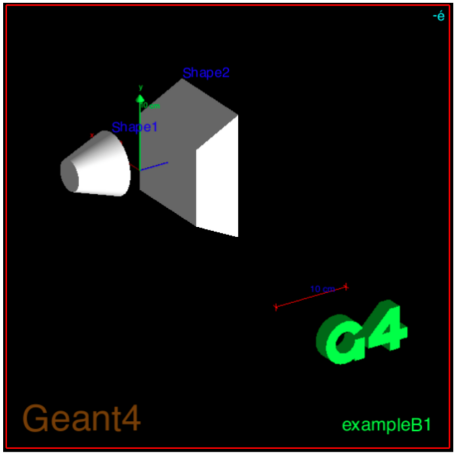
- Documentation provided in `README` files in each example, and web pages

Basic Examples

- B1
  - A few simple solids and simple placements
  - Total dose scoring in user-selected volume
  - User action classes

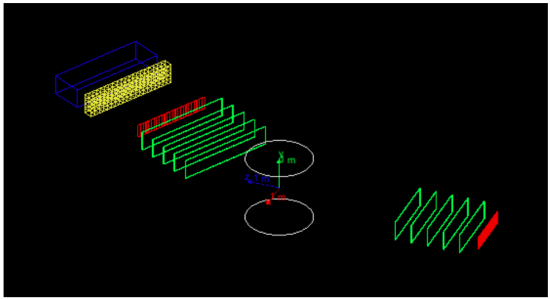


Basic Examples

- 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 n-tuples 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
  - 1D, 2D histograms and n-tuples saved in output file



Extended Examples

```
((geant4-11-03-ref-00))
   pico omega     ../geant4/examples/extended
      ls -d */
analysis//              field//          parameterisations//
biasing//               g3tog4//         persistency//
common//                geometry//       physicslists//
electromagnetic//       hadronic//       polarisation//
errorpropagation//      medical//        radioactivedecay//
eventgenerator//        optical//        runAndEvent//
exoticphysics//         parallel//       visualization//
```

21 advances examples

Examples of the Extended Examples

... out of those 21, let's sample

Analysis	histogramming using `G4tools`
Biasing	event biasing, scoring and reverse Monte Carlo
Electromagnetic	many EM physics simulations with histogramming
Hadronic	same as EM but with hadronic models
Parallel	examples of parallel computing
Visualization	specific visualization features and graphics customizations

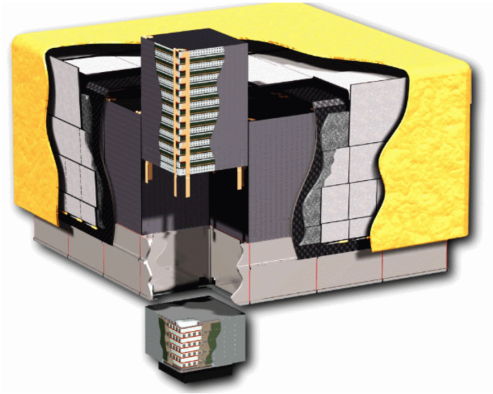
Advanced Examples

```
((geant4-11-03-ref-00))
   pico omega    ../geant4/examples/advanced
      ls -d */
air_shower//                    human_phantom//
amsEcal//                       ICRP110_HumanPhantoms//
brachytherapy//                 ICRP145_HumanPhantoms//
CaTS//                          iort_therapy//
ChargeExchangeMC//              lAr_calorimeter//
composite_calorimeter//         medical_linac//
dna//                           microbeam//
doiPET//                        microelectronics//
eFLASH_radiotherapy//           nanobeam//
eRosita//                       purging_magnet//
exp_microdosimetry//            STCyclotron//
fastAerosol//                   stim_pixe_tomography//
gammaknife//                    underground_physics//
gammaray_telescope//            xray_fluorescence//
gorad//                         xray_SiliconPoreOptics//
hadrontherapy//                 xray_telescope//
HGCal_testbeam//                xray_TESdetector//
```

34 extended examples

Advanced Example: 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
  - Analysis package

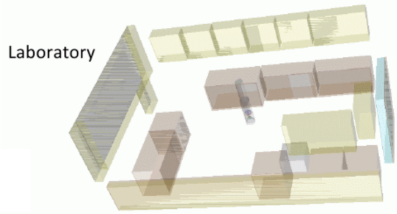


Advanced Example: X-ray Telescope

- Simulation of XMM Newton telescope
  - first real-life application of Geant4
- Studies the focusing of background protons onto focal plane arrays
  - carbon fiber tube, x-ray mirrors
  - XrayTelPhysicsList
  - G4hMultipleScattering is the critical process
  - General Particle Source is used
  - Analysis package

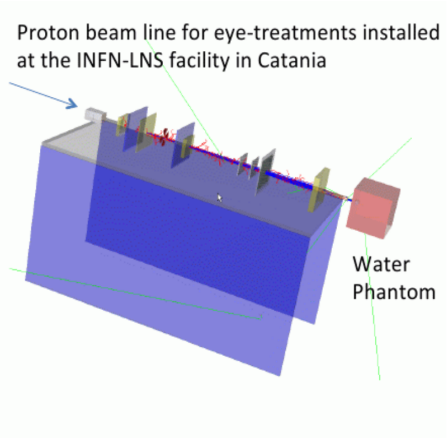
Advanced Example: Underground Physics

- Realistic example of underground dark matter search experiment
- Full lab geometry
  - desks, cupboards, doors, windows
  - important for neutron scattering
- Physics
  - low energy and standard EM
  - high precision neutron model
  - optical processes
  - radioactive decay process
  - General Particle Source



Advanced Example: Hadron Therapy

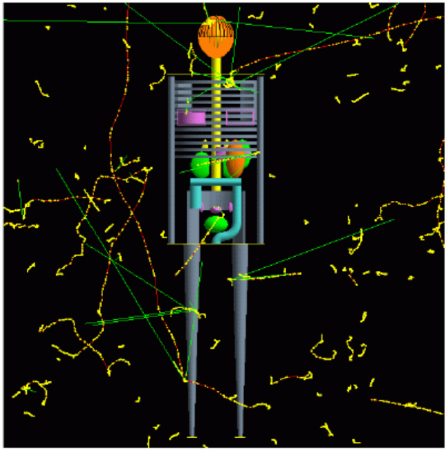
- Developed to address needs of proton and ion therapy
- Proton beam line geometry
- Standard geometry for IAEA benchmark
- Physics
  - uses reference physics lists
  - specific “local” physics list for ion-ion interactions



Advanced Example: Human Phantom

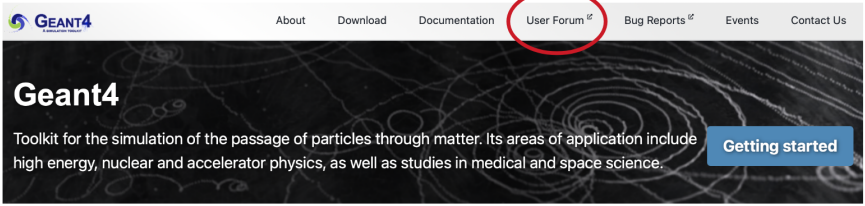
- Anthropomorphic phantoms for Geant4 simulations
- Several phantom models available
  - MIRD, ORNL, ICRP110, ICRP145, ...
  - male and female for each model
- Some geometries are implemented using GDML
- Physics
  - Standard EM processes and models

MIRD Female Phantom with particle tracks



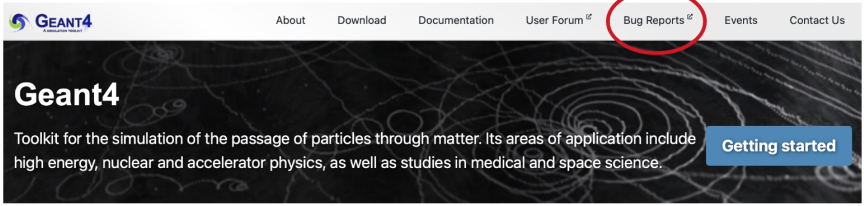
User Support

User Forum



- Problems? Try the user forum.
- Geant4 developers and expert users post answers
- See if your problem has already been solved
- If not, post your problem to the forum

Bug Reports



- If you spot a bug in Geant4 code, log in to Bug Reports
- Make sure your Geant4 version is up-to-date before posting
- Geant4 developers will address the problem on a time-available basis

Summary (all links)

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- Six user guides
  - Introduction to Geant4, Installation Guide, Application Developers Guide
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