

User Documents and Examples


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Geant4 Tutorial at Jefferson Lab

25 March 2024

Geant4 User Guides


Your First Stop: geant4.web.cern.ch

 [About](#) [Download](#) [Documentation](#) [User Forum](#) [Bug Reports](#) [Events](#) [Contact Us](#)

Geant4

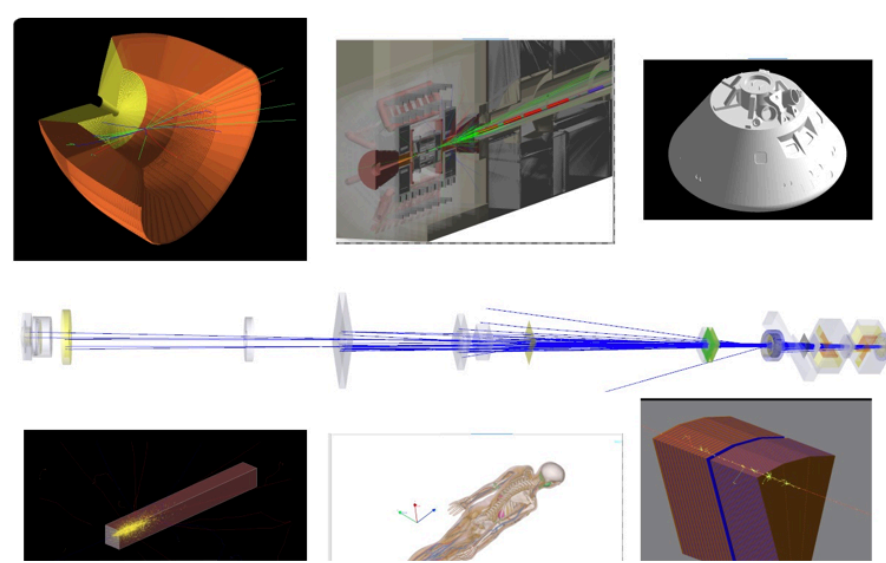
Toolkit for the simulation of the passage of particles through matter. Its areas of application include high energy, nuclear and accelerator physics, as well as studies in medical and space science.

[Getting started](#)

 **Get started**

Everything you need to get started with Geant4.


[I'm ready to start!](#)



About us

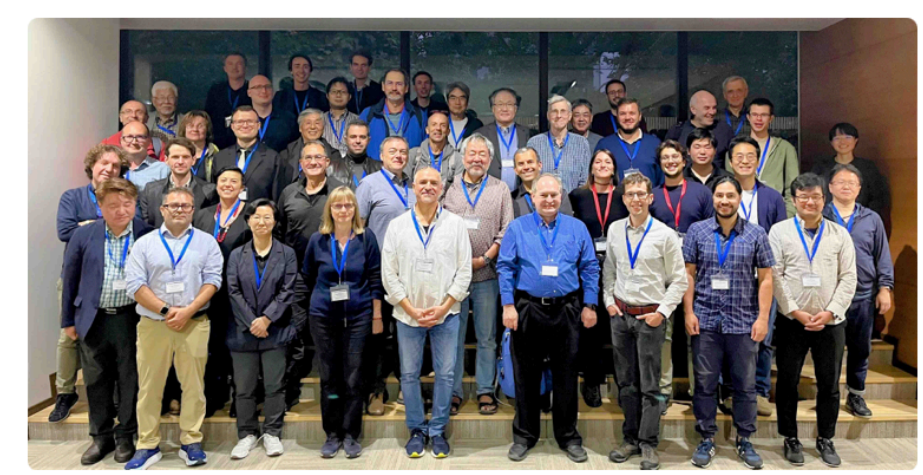
[What is Geant4, where it's used, details on Collaboration.](#)

[Learn More](#)

 **Download**

Geant4 source code and installers are available for download, with source code under an [open source license](#).


Latest: [11.2.1](#)



Collaboration

Geant4 [team and documents](#)

[Learn More](#)

 **Docs**

Documentation for Geant4, along with tutorials and guides, are available online.

[Read documentation](#)

```
template <typename T>
struct G4TaskSingletonEvaluator
{
    using key_type = typename C4Traits::TaskSingletonKey<T>::type;
    using data_type = G4TaskSingletonData<T>;

    template <typename... Args>
    G4TaskSingletonEvaluator(key_type&, Args&&...)
    {
        throw std::runtime_error("Not specialized!");
    }
};

//-----
template <typename T>
class G4TaskSingletonDelegator
{
public:
    using pointer = T*;
    using evaluator_type = G4TaskSingletonEvaluator<T>;
    using data_type = G4TaskSingletonData<T>;
    using key_type = typename C4Traits::TaskSingletonKey<T>;

    template <typename... Args>
```

Contribute

How external users can [contribute](#) to Geant4.

[Learn More](#)

 **News** [» More](#)

16 Feb 2024
[Release 11.2.1](#)

08 Dec 2023
[Release 11.2](#)

10 Nov 2023
[Release 11.1.3](#)

30 Jun 2023
[Release 11.2.beta](#)

19 Jun 2023
[Release 11.1.2](#)

Get Started

- Where to get information
- How to download and install
- Example applications
- How to write an application
- FAQ and User Forum
- User guides (all guides available in html, pdf, epub and kindle)
- Bug reporting

Geant4

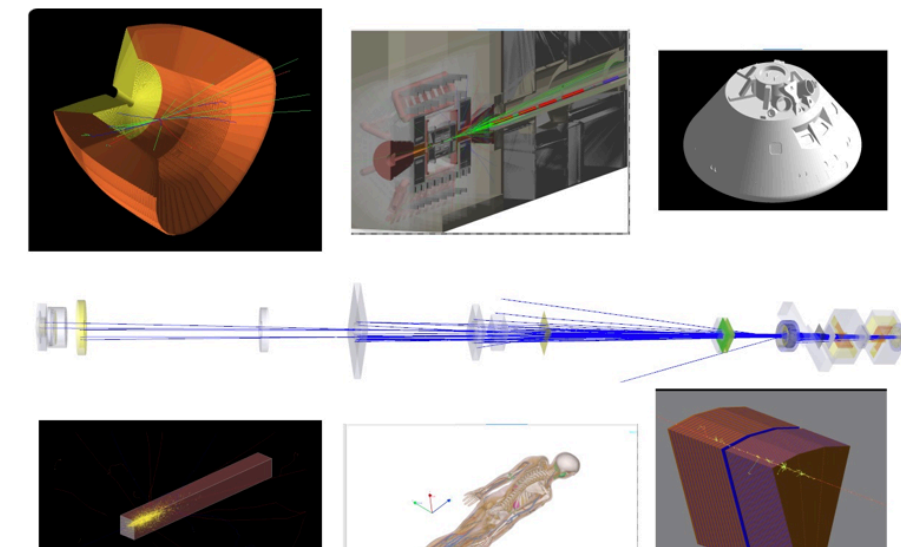
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30 Jun 2023

[Release 11.2.beta](#)

19 Jun 2023

[Release 11.1.2](#)

Introduction to Geant4

- [Geant4 main page](#) → [Docs](#) → [Introduction to Geant4](#)
- Geant4 scope of application
- History of Geant4
- Overview of functionality
- User support
- Software knowledge required
- Computing environment required

Installation Guide

- [Geant4 main page](#) → [Docs](#) → [Installation Guide](#)
- How to build and install from source
- Installation via package manager
 - [several managers available \(caveat: developed by Geant4 users but not maintained by Geant4\)](#)
- System and software prerequisites
 - [supported and tested platforms](#)
 - [prerequisites for optional components of Geant4](#)
- Post-install setup
 - [required environment settings for Linux, Windows](#)
 - [environment variables for data sets](#)
- Using the Geant4 libraries
 - [build with CMake or use geant4-config \(UNIX only\)](#)

Book for Application Developers

- [Geant4 main page](#) → [Docs](#) → [For Application Developers](#)
- Introduces new users to the toolkit
 - and provides useful reference for experienced users
- Describes the most useful tools
- Describes how to set up and run a simulation application
- Intended as a detailed overview of toolkit, not an exhaustive treatment
 - getting started, toolkit fundamentals, detector definition and response, tracking and physics, user actions, control, visualization, analysis, examples
- To go deeper, see
 - [Physics Reference Manual](#)
 - [Toolkit Developers' Guide](#)

Users Guide for Toolkit Developers

- [Geant4 main page](#) → [Docs](#) → [For Toolkit Developers](#)
- 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++
- 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
- Lists the electromagnetic physics constructors
 - describes their content
 - 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
 - [basic, extended, advanced](#)
 - [how to build and run an example](#)
 - [tips on running in multi-threaded mode](#)
 - [how to navigate the examples documentation](#)
- Table of all advanced examples
 - [links to documentation of each example](#)
 - [links to authors/maintainers](#)
- [Links to Examples Working Group](#)

Geant4 Code Documentation

LXR Code Browser

Geant4 Cross Reference

Search Menu:

[geant4/](#) Browse the source code tree.

[File Name Search](#) Find

Search for files by name
(case sensitive).

[Full-Text Search](#) Find

Search through all the text.

[Identifier Search](#) Find

Find a class, method, variable, etc.

Hi,

This is an interactive viewing and searching facility for the Geant4 source code.

It offers:

Source-tree browsing and file name search to easily find source files and navigate through the source directories.

Full-text indexing for fast retrieval of source files containing a given word or pattern.

Identifier cross-reference for fully hyperlinked source code. The names of classes, methods, and data can be clicked on to find the source files where they are defined and used.

The full-text indexing and retrieval are implemented using [Glimpse](#), so all the capabilities of Glimpse are available. Please see [Glimpse document](#) for details. Note that glimpse syntax is available for text and identifier searches. For file name search, please use regular expression.

Note

All source files are rendered into HTML. Do not attempt to download the Geant4 source code from this site!

Links

[Yet another version of Geant4 LXR](#) (editor's cut)
[Geant4 Reference Guide](#) (Doxygen)

Doxygen Code Browser



News:

Releases

Latest Release

[11.2.0](#)

Past Releases (since 8.0)

- [11.1.3](#), [11.1.2](#), [11.1.1](#), [11.1.0](#)
- [11.0.0](#), [11.0.1](#), [11.0.2](#), [11.0.3](#)
- [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](#)

Geant4 v11.2.0

Main Page | Namespaces ▾ | Classes ▾ | **Files ▾** | Examples |

Geant4 Documentation

Generated by [doxygen](#) 1.9.2

Geant4 v11.2.0

Main Page | Namespaces ▾ | Classes ▾ | **Files ▾** | Examples |

File List

Here is a list of all documented files with brief descriptions:

[detail level 1 2 3 4 5 6 7 8 9]

▼	geant4-v11.2.0	
▼	source	
▶	analysis	
▶	digits_hits	
▶	error_propagation	
▶	event	

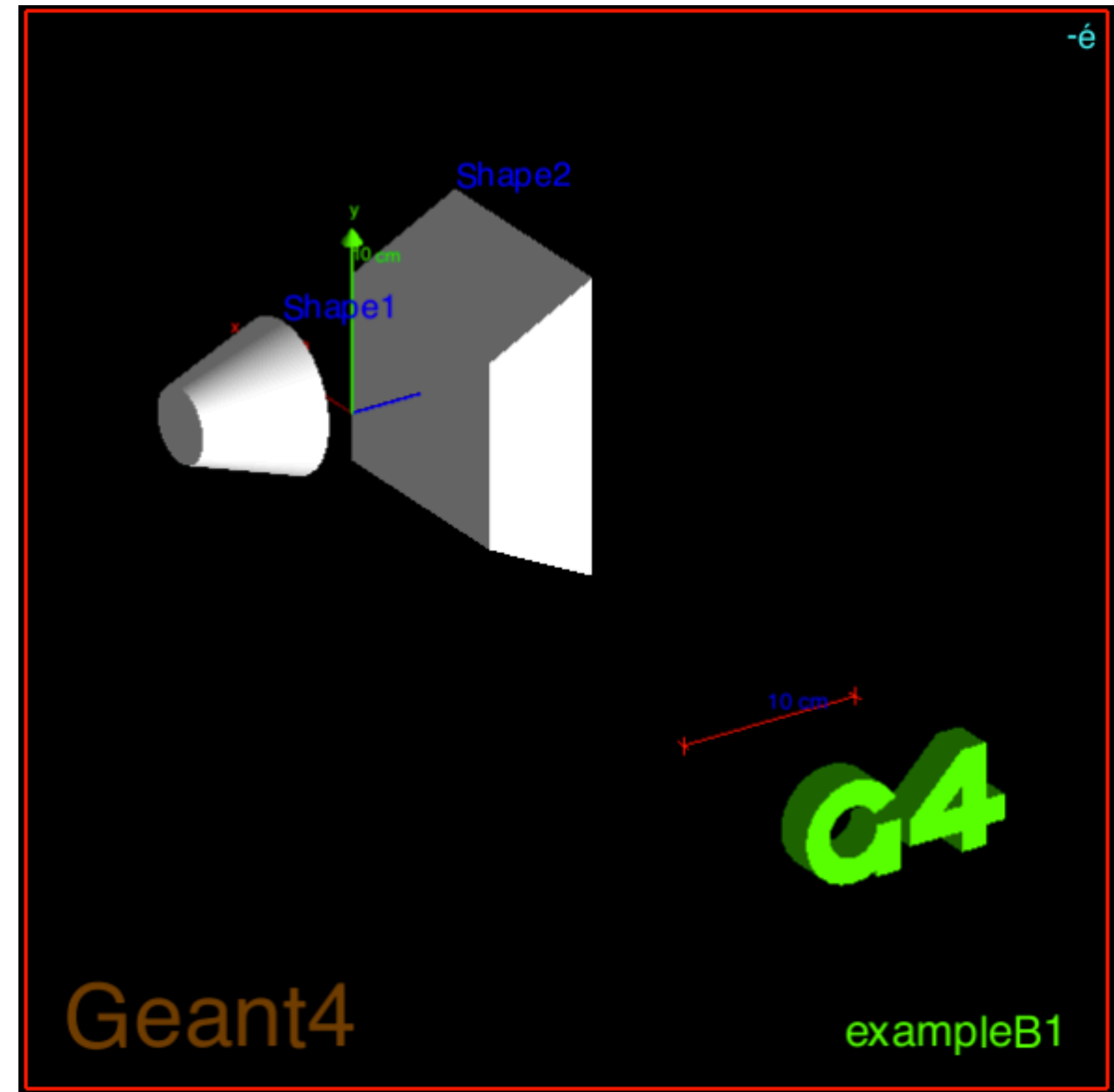
Example Applications

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
- 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

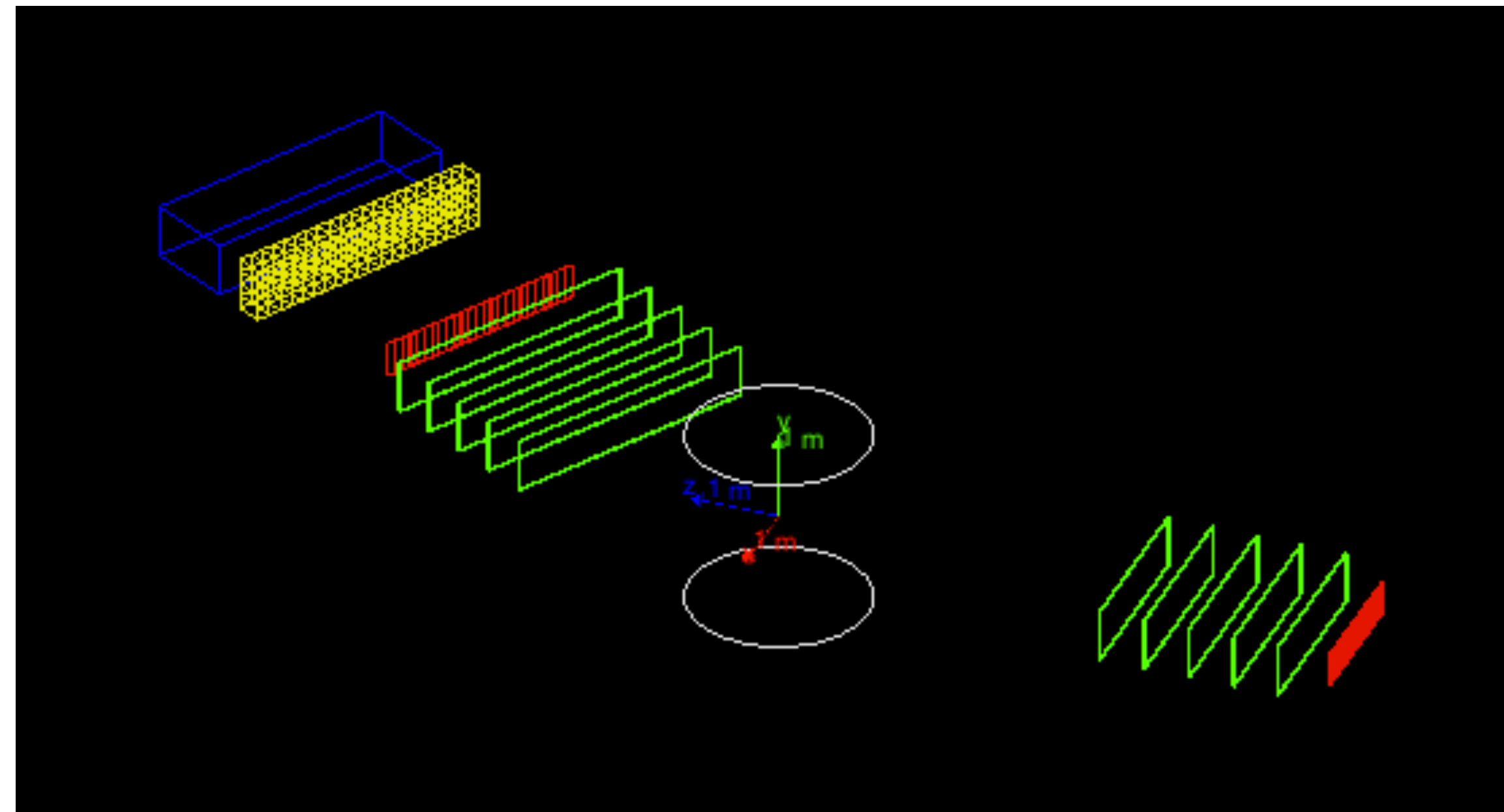


Basic Examples

- 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



A Sampling of Extended Examples

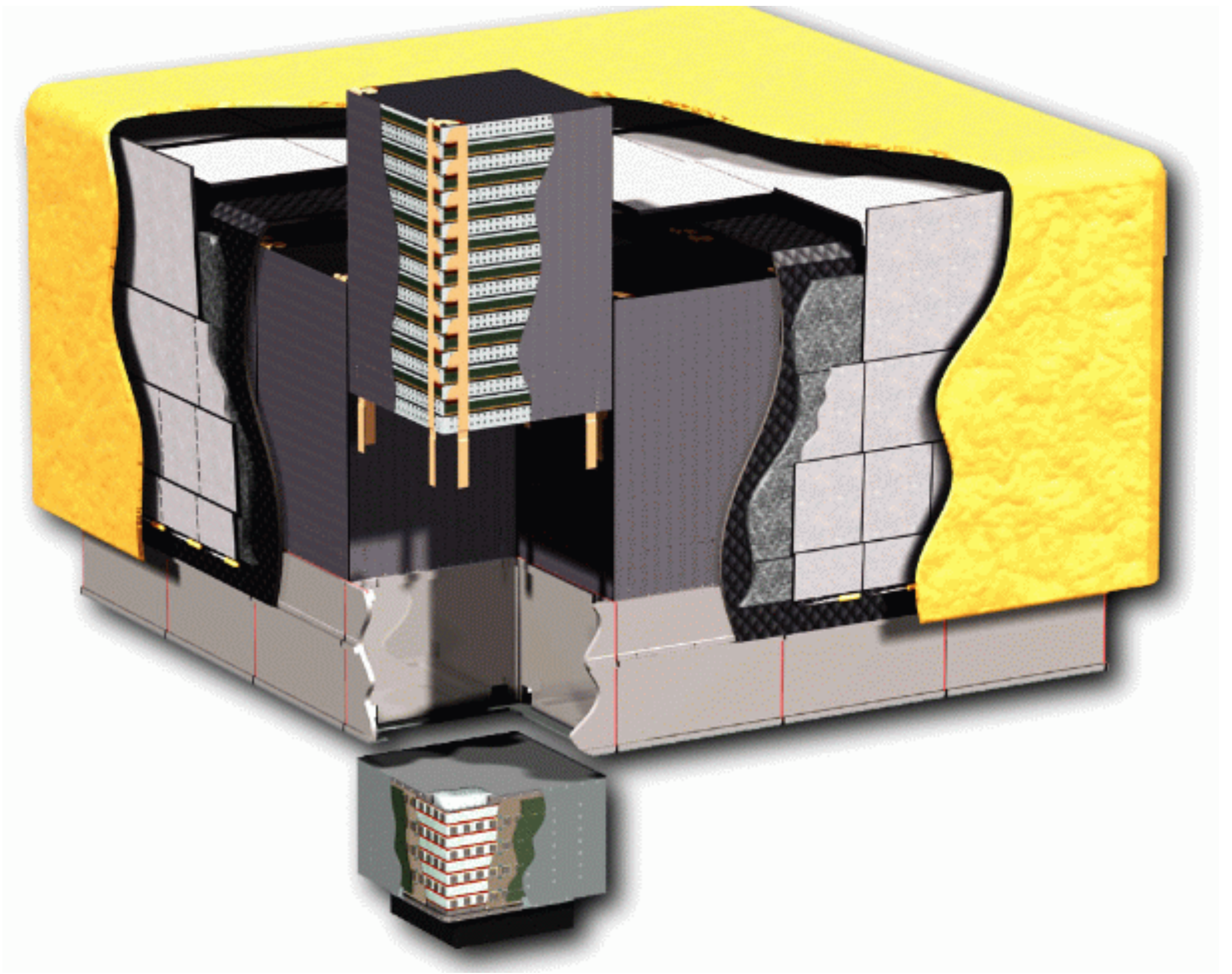
- Analysis – histogramming using G4tools
- Biasing – event biasing, scoring and reverse Monte Carlo
- Electromagnetic – many EM physics simulations with histogramming (some also used as part of Geant4 testing)
- Hadronic – same as EM but with hadronic models
- Parallel – examples of parallel computing
- 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 \sim GeV gammas
 - 16 Si foil tracker towers
 - 16 CsI calorimeters
 - GammaRayTelPhysicsList
 - Customized particle generator
 - Analysis package



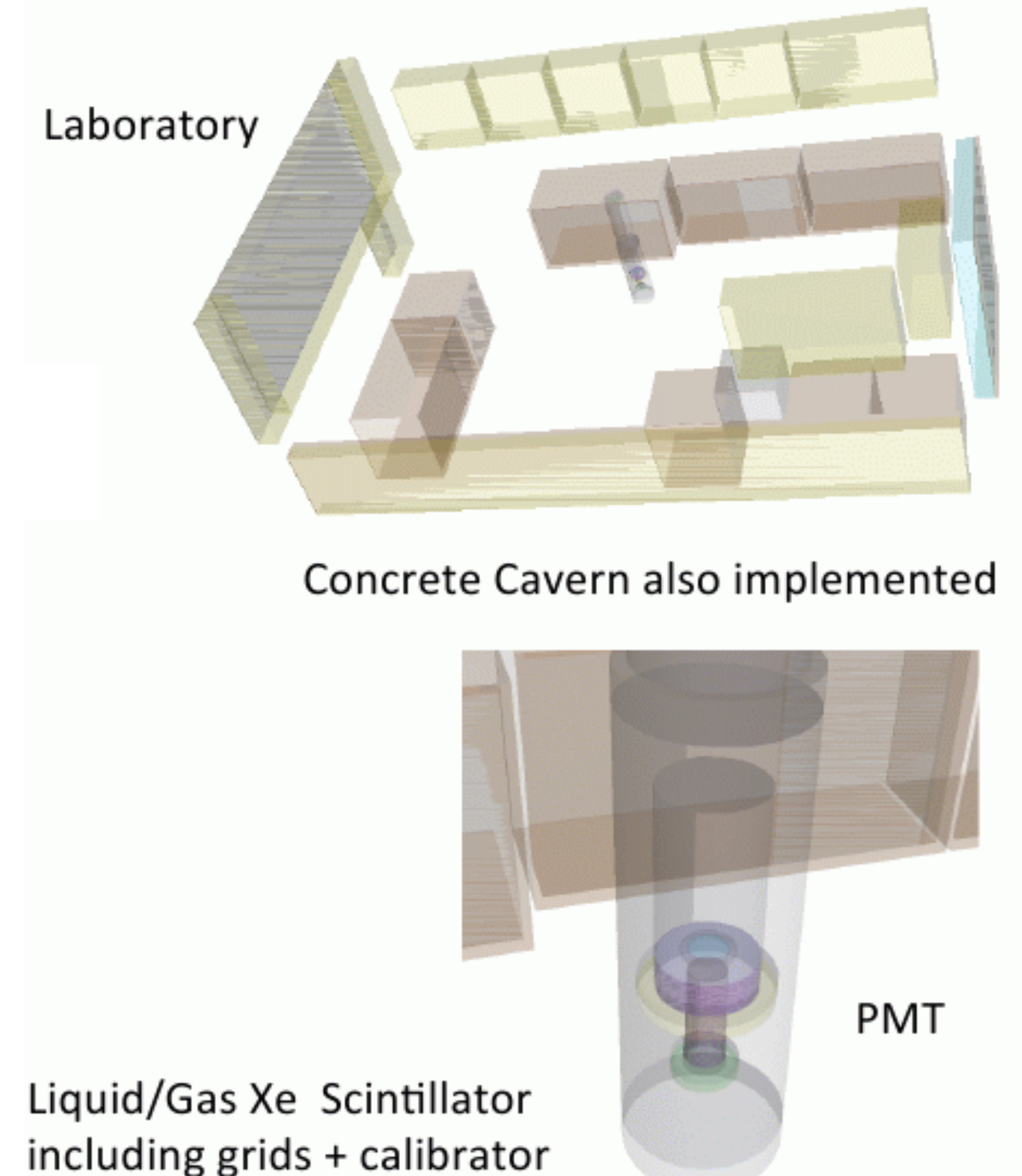
Advanced: X-ray Telescope

- 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



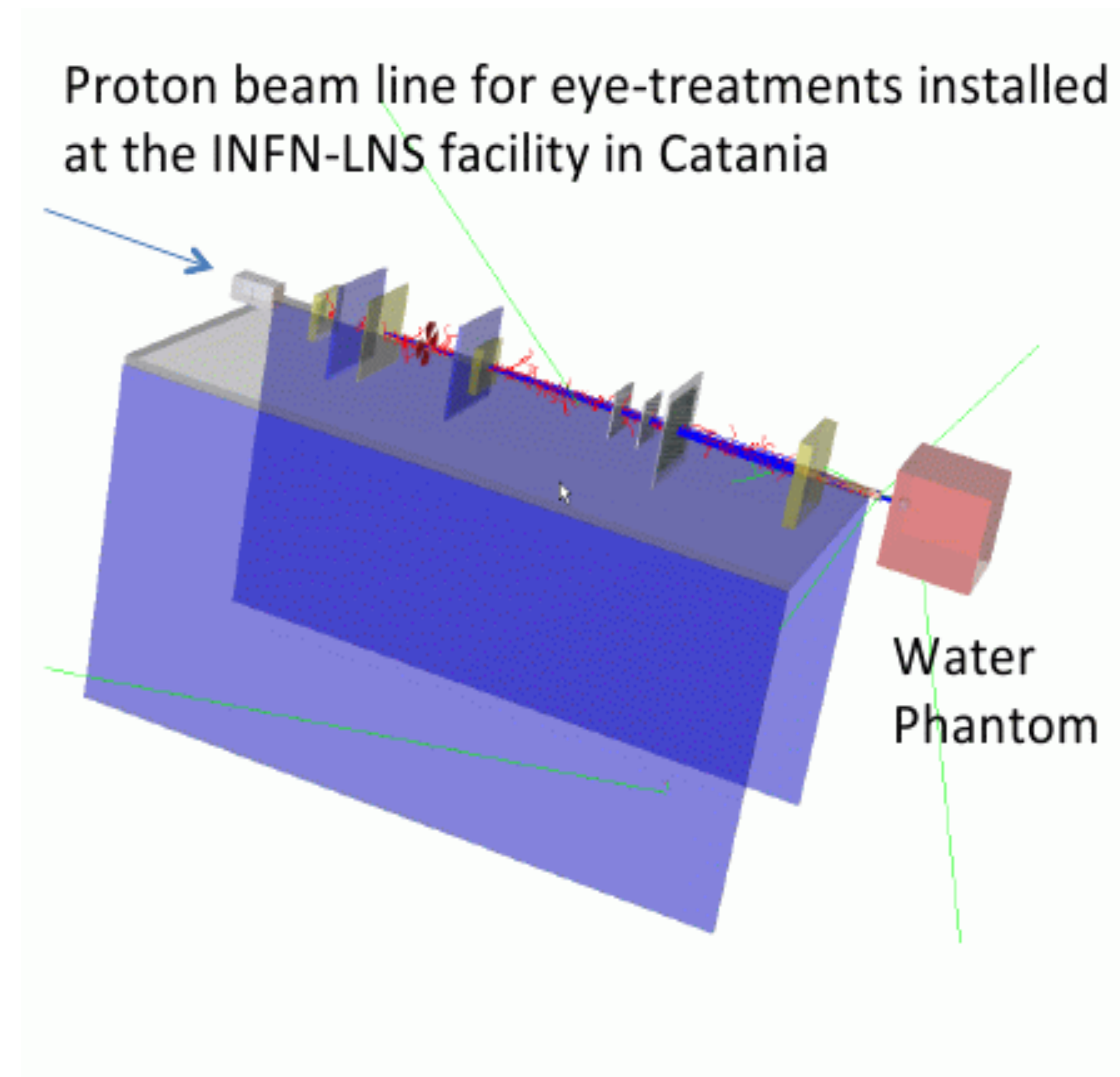
Advanced: Underground Physics

- 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: Hadron Therapy

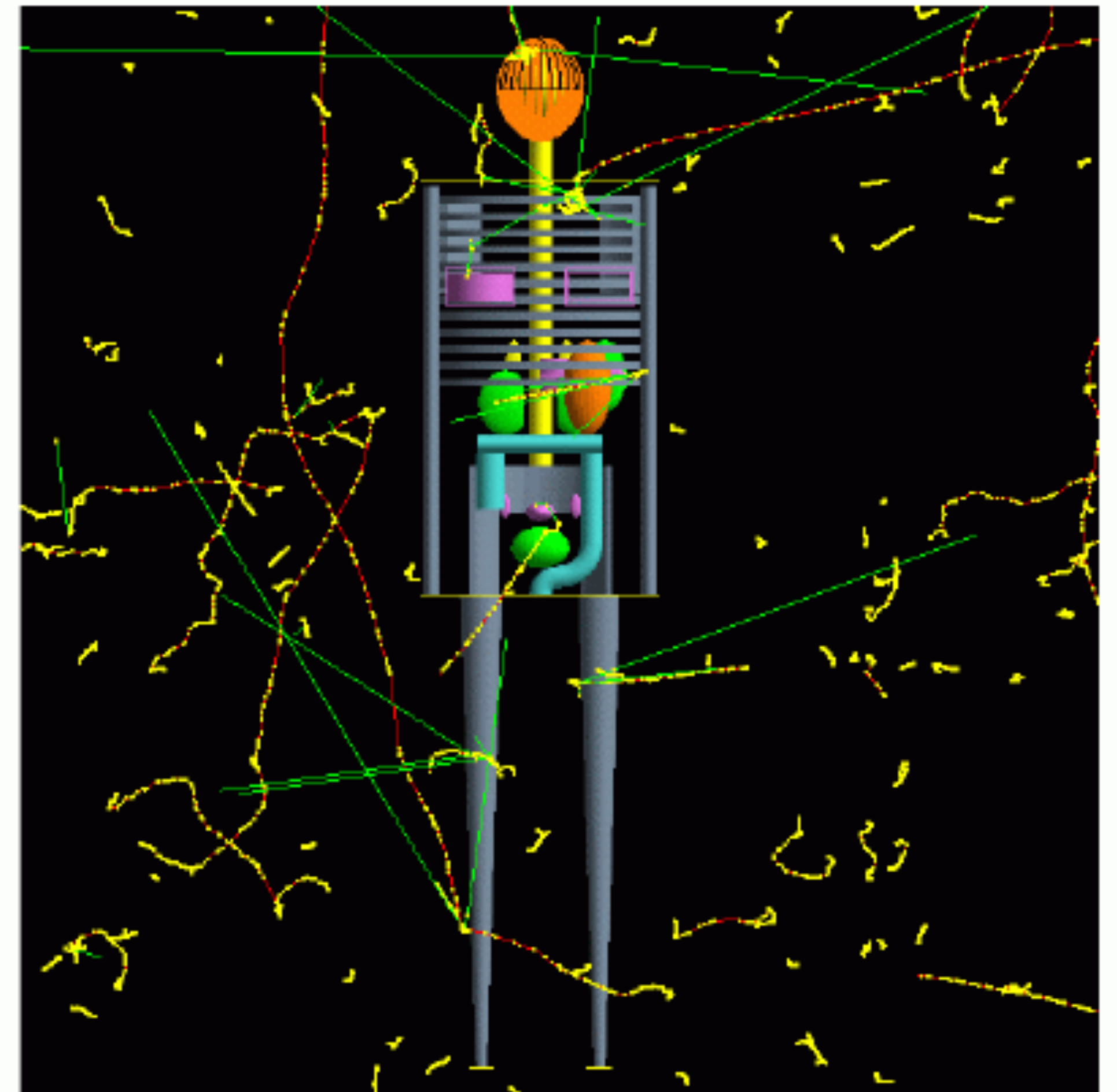
- Developed to address needs of proton and ion therapy
- Proton beam line geometry
- Standard geometry for IAEA benchmark
- Physics
 - uses reference physics lists
 - specific “local” physics list for ion-ion interactions



Advanced: 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

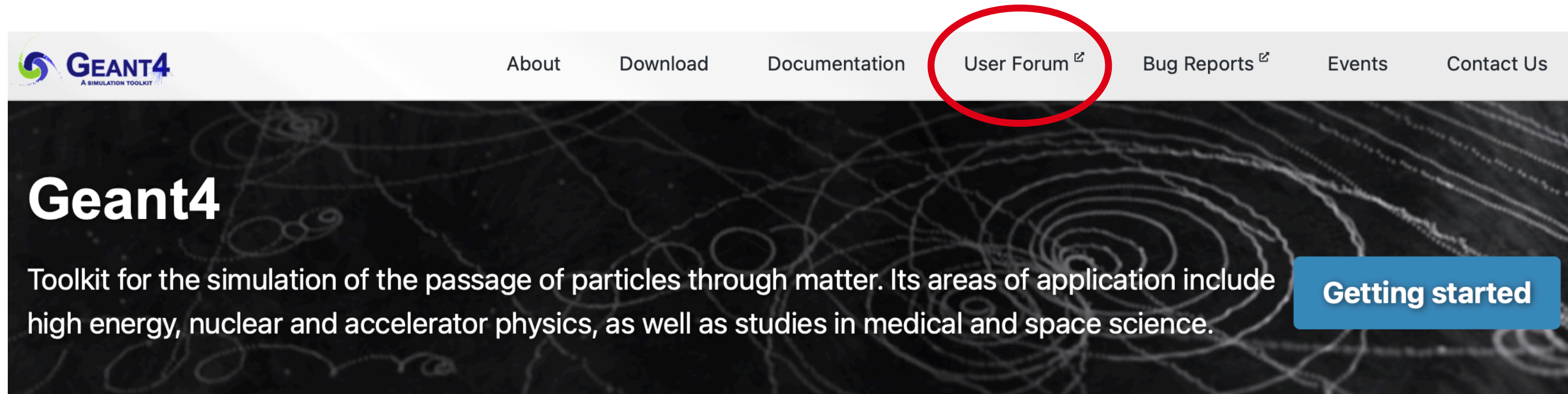


33 Advanced Examples

- air_shower/
- ams_Ecal/
- brachytherapy/
- CaTS/
- ChargeExchangeMC/
- composite_calorimeter/
- doiPET/
- eFLASH_radiotherapy
- eRosita/
- exp_microdosimetry/
- fastAerosol/
- gammaknife/
- gammaray_telescope/
- gorad/
- HGCal_testbeam/
- hadrontherapy/
- human_phantom/
- ICRP110_HumanPhantoms
- ICRP145_HumanPhantoms
- iort_therapy/
- lAr_calorimeter/
- medical_linac/
- microbeam/
- microelectronics/
- nanobeam/
- purging_magnet/
- STCyclotron/
- stim_pixe_tomography/
- underground_physics/
- xray_fluorescence/
- xray_telescope/
- xray_TESdetector/
- Xray_SiliconPoreOptics/

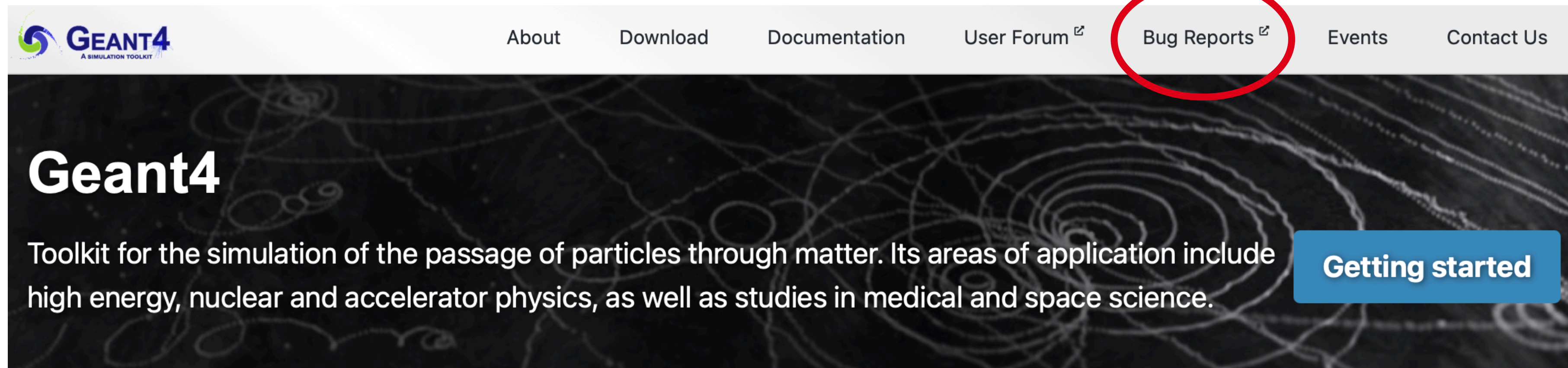
User Support

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

- Extensive documentation is available from the Geant4 web page
- Six user guides
 - Introduction to Geant4, Installation Guide, Application Developers Guide
 - Toolkit Developers Guide, Physics Reference Manual, Physics List Guide
- Two code browsers
 - LXR, Doxygen
- Many example applications
 - basic, extended, advanced
- User support
 - User forum, Bug reports