

**GEANT4**  
A SIMULATION TOOLKIT

Version 10.7.p02

# Geant4 Installation

Makoto Asai  
SLAC National Accelerator Laboratory



NATIONAL  
ACCELERATOR  
LABORATORY
























U.S. DEPARTMENT OF  
**ENERGY**














Office of Science

# Contents

- This installation instruction is for Linux and Mac.
- Alternative installation options are appended at the bottom of this presentation.

## Geant4 Physics & Applications

A Monte Carlo toolkit for passage of particles through matter

### Geant4 Hadronic Physics

Hadronic interactions involve three main regimes: high energy, with string models (Quark Gluon String (QGS), Fritiof (PYTHIA)), intermediate energy, with intranuclear cascade models (Bertini (BERT), Binary (BIC)), and low energy, with precompound, Fermi break-up, fission/evaporation, capture at rest models and radioactive decays. From 20 MeV down to thermal energy neutrons are handled by means of cross-section databases, with the High Precision (HP) package.

**High Energy**  
Quark/gluon dominating behavior

**Intermediate Energy**  
Nucleon dominating behavior

**Low Energy**  
Nucleus dominating behavior

Neutron simulation down to thermal energies:

Geant4 can use the same neutron data library that MCNPX. Verification codes of Geant4 and Geant4 source of outgoing neutrons produced in neutron collision.

**Uranium Nucleus Size**

### HEP Applications

High Energy Physics has been the first domain to use Geant4 in production, with the BaBar experiment. LHC experiments have been using Geant4 in detector design and are using it in physics analysis. Geant4 is also the simulation engine choice of the next generation of electron machines.

The CMS detector

The ATLAS detector

The recent Higgs boson discovery

Responding to the simulation needs of the LHC era, with the Higgs boson hunting, had been the initial motivation of the creation of the proto-Geant4 project, RD44, in 1994.

### Geant4 Electromagnetic Physics

The electromagnetic physics covers interactions of gamma, muons and electrons, and ionization of all charged particles. A "standard" package offers an implementation suited for applications disregarding effects below a few ~10 keV, and a "low energy" one provides approaches (Livermore, Penelope) for more accurate modeling of atomic shell effects allowing simulation down to ~250 eV. A very low extension, Geant4-DNA, includes particle-molecule effects for an energy limit of ~10 eV. The same approach is developed for silicon.

**Proton neutron**

**Carbon ion**

**Electron**

**Water Molecule Size**

**Gamma**

### Space Applications

Applications of Geant4 in space cover planetary scale simulation for soil level media activation studies, soil composition through X-Py re-emission, space ship simulation for radio-protection and electronic single event upset predictions, electronic chip scale simulation for accurate understanding of single event upset generation. It includes also underground, ground level or satellite cosmic ray experiments simulation.

XMM Newton X-ray telescope, launched in 1999

Radiation effects on its instruments were modeled with Geant4 prior to its launch.

Planetocosmos: a simulation tool for planetary scale particle transport. The red curve is a proton trajectory in the earth magnetic field. Irradiation level around a planet, at ground level, and with related activated isotopes can then be predicted.

**Very Low Energy**  
Atomic and molecular structures dominating

### DNA Scale Level Simulation

Project initiated by the ESA, in view of manned mission to Mars: it is a bottom-up approach of dosimetry. Physics processes are extended down to a few eV, based on particle-molecule cross-sections. The approach is applied also to silicon, for accurate simulation of Single Upset events.

DNA geometry model simulated: 46 Simulation of water chemical species migration chromosomes, 32k chromosome pieces, 30 million nucleosomes, 6 billions base pairs...

DNA geometry model simulated: 46 Simulation of water chemical species migration chromosomes, 32k chromosome pieces, 30 million nucleosomes, 6 billions base pairs... accepting for electrical mutual interaction after a 50-90 millions nucleosomes, 6 billions base pairs... attacks amount for ~60% of total damages on DNA.


### Medical Applications


Medical Applications interest in Monte Carlo is the accuracy capability in complex structures. Geant4 is used for radio-, proton & carbon-therapy medical research fields. It is used also in optimization of brachytherapy devices, radio-protection and nuclear imaging. Large user communities exist in US, Europe and Japan. CPU performance boosting, allowed by Geant4 MT or by GPU prototype versions open the possibility for routine usage in treatment planning.


Proton beam line, range shifter and dose deposit simulations at HIMAC (Japan). The proton energy is 150 MeV. (T. Aso, IEEE, NSS 2007, 666-1)

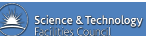
DICOM geometry and dose visualization with g4Macrom's tool.


Projectile de Broglie  $\lambda$  (fm)
















Geant4

## Overview

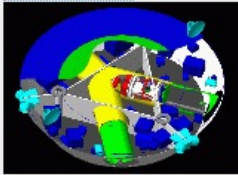
Geant4 is a toolkit for the simulation of the passage of particles through matter. Its areas of application include high energy, nuclear and accelerator physics, as well as studies in medical and space science. The three main reference papers for Geant4 are published in Nuclear Instruments and Methods in Physics Research [A 506 \(2003\) 250-303](#), IEEE Transactions on Nuclear Science [53 No. 1 \(2006\) 270-278](#) and Nuclear Instruments and Methods in Physics Research [A 835 \(2016\) 186-225](#).

### Applications



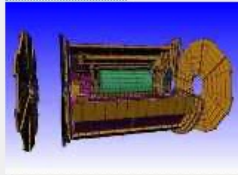
[A sampling of applications, technology transfer and other uses of Geant4](#)

### User Support



[Getting started, guides and information for users and developers](#)

### Publications



[Validation of Geant4, results from experiments and publications](#)

### Collaboration



[Who we are: collaborating institutions, members, organization and legal information](#)

### News

2021-03-10

[2021 planned developments.](#)

2021-02-05

**Patch-01 to release 10.7** is available from the [Download area](#).

2020-11-06

**Patch-03 to release 10.6** is available from the [Download archive area](#).

## Events

[Virtual] [Geant4 Beginners Course @ CERN](#), CERN (Geneva), 25-31 May 2021.

[Virtual] 26<sup>th</sup> Geant4 Collaboration Meeting, 20-24 September 2021.

[Past events](#)

## User Support

- [Getting started](#)
- [Training courses and materials](#)
- [Source code](#)
  - [Download page](#)
  - [LXR code browser](#)
  - [doxygen documentation](#)
  - [GitHub](#)
  - [GitLab @ CERN](#)
- [Frequently Asked Questions \(FAQ\)](#)
- [Bug reports and fixes](#)
- [User requirements tracker](#)
- [User Forum](#)
- [Documentation](#)
  - [Introduction to Geant4](#) [ pdf ] [ epub ] [ kindle ]
  - [Installation Guide](#) [ pdf ] [ epub ] [ kindle ]
  - [Application Developers Guide](#) [ pdf ] [ epub ] [ kindle ]
  - [Toolkit Developers Guide](#) [ pdf ] [ epub ] [ kindle ]
  - [Physics Reference Manual](#) [ pdf ] [ epub ] [ kindle ]
  - [Physics List Guide](#) [ pdf ] [ epub ] [ kindle ]
- [Examples](#)
- [User Aids](#)
  - [Tips for improving CPU performance](#)
- [Contact Coordinators & Contact Persons](#)

### Related Links

- [Object Oriented Analysis & Design](#)
- [Archive of previous releases](#)
- [Mailing list subscription](#)
- [User requirements document \(pdf\)](#)
- [Technical Forum](#)

🏠 [Geant4 Homepage](#)

Geant4 Installation Guide



10.7 (doc Rev5.0)

## CONTENTS

[Geant4 System/Software Prerequisites](#)

[Building and Installing from Source](#)

[Postinstall Setup](#)

[How to Use the Geant4 Toolkit Libraries](#)

[Appendices](#)

[Docs](#) » Installation Guide

## Installation Guide

There are several ways to install Geant4 on your computer either from binary packages or by compiling from scratch, and these are described below. Which one is available or best for you depends on both your operating system and usage requirements. In all cases, always use the most recent Geant4 release to ensure use of the latest bug fixes, features, and help the developers and community to provide quick user support.

### Build and Install Geant4 from Source

Geant4 uses [CMake](#) to configure a build system for compiling and installing the toolkit headers, libraries and support tools from scratch. To follow this method, please see [Geant4 System/Software Prerequisites](#) for the operating system and software requirements, followed by [Building and Installing from Source](#).

Whilst every effort has been made to make this installation method robust and reliable, the multitude of platforms and system configurations mean we cannot guarantee that problems will not be encountered on platforms other than those listed in [Supported and Tested Platforms](#).

In case of issues with building and installing Geant4, we welcome questions as well as feedback via our [Discourse Forum](#). To help us deal with your problem as quickly as possible, please include as much detail as possible on the problem you have encountered. At minimum, you should let us know the platform and operating system version, C++ compiler type and version, CMake version, and any error messages. It also helps to list the sequence of commands you used so we can try and reproduce the issue.

If you feel you have found a genuine bug in the Geant4 CMake build, please report it to the CMake category on our [Bugzilla](#). As with reports to [Discourse](#), please include as much information as possible so that we can triage the bug and track it down quickly. We also welcome general feature requests and feedback on the system through both [Discourse](#) and [Bugzilla](#).



Geant4

[Home](#) » [User Support](#)

## Geant4 10.7

first released 4 December 2020 (patch-01, released 5 February 2021)

The Geant4 source code is freely available. See the [licence conditions](#).

Please read the [Release Notes](#) before downloading or using this release. The patch below contains bug fixes to release 10.7, we suggest you to download and apply the latest patch for release 10.7 (see the additional notes for [patch-01](#), or download the complete source with the patch applied; in any case, it is required to apply a full rebuild of the libraries.

### Source files

Please choose the archive best suited to your system and archiving tool:

<a href="#">Download</a>	GNU or Linux tar format, compressed using gzip (34.5Mb, 36217226 bytes) <i>After downloading, unpack using <a href="#">GNU tar</a>.</i>
<a href="#">Download</a>	ZIP format (48.9Mb, 51279540 bytes) <i>After downloading, unpack using e.g. WinZip.</i>

Please choose the archive best suited to your system and archiving tool:

### Data files (\*)

For specific, optional physics processes some of the following files are required. The file format is compatible with Unix, GNU, and Windows utilities.

<a href="#">Download</a>	G4NDL4.6, Neutron data files (with thermal cross-sections) – version 4.6 (572.1Mb, 599862135 bytes)
<a href="#">Download</a>	G4EMLOW7.13, data files for low energy electromagnetic processes – version 7.13 (284.8Mb, 298636910 bytes) <a href="#">?</a>
<a href="#">Download</a>	G4PhotonEvaporation5.7, data files for photon evaporation – version 5.7 (9.6Mb, 10089240 bytes) <a href="#">?</a>
<a href="#">Download</a>	G4RadioactiveDecay5.6, data files for radioactive decay hadronic processes – version 5.6 (1.0Mb, 1059792 bytes) <a href="#">?</a>
<a href="#">Download</a>	G4SAIDDATA2.0, data files from evaluated cross-sections in SAID data-base – version 2.0 (37.6kb, 38502 bytes)
<a href="#">Download</a>	G4PARTICLEXS3.1.1, data files for evaluated particle cross-sections on natural composition of elements – version 3.1.1 (8.2Mb, 8613102 bytes)

### Related Links

- [Previous Releases of Geant4](#) (since release 9.6).
- [LXR source code browser](#) .
- [GitHub](#) .
- [GitLab @ CERN](#) .

- C++ Compiler and Standard Library supporting the C++11 Standard:
  - Linux: GNU Compiler Collection 4.9.3 or higher
  - macOS: Apple Clang (Xcode) 11 or higher
    - The command line tools must also be installed by running *xcode-select --install* from the terminal.
- CMake 3.8 or higher
- Xerces-C++ headers and library (v3.0 or higher) must be installed, compiled against the same C++ compiler as Geant4 (C++11 by default).
  - On Unix systems, it should also be configured and built with *netaccessor-curl*, and the used *libcurl* should support SSL in order to access schema files over https.
- Qt5 headers and libraries
  - You will need to register personally as an open software developer to obtain a free personal version of Qt.
- X11 headers and libraries (XQuartz on macOS)
  - OpenGL or MesaGL headers and libraries

- Create a clean directory and locate the downloaded Geant4 tar-ball.  
\$ cd ~  
\$ mkdir *myG4*  
\$ cd *myG4*  
\$ mv *your\_download\_directory*/geant4.10.07.p02.tar.gz .
- Unpack the tar ball  
\$ tar -xzf geant4.10.07.p02.tar.gz  
\$ ls  
    geant4.10.07.p02  geant4.10.07.p02.tar
- Create *build*, *install* and *work* directories  
\$ rm geant4.10.07.p02.tar.gz  
\$ mkdir build install work  
\$ ls  
    build      geant4.10.07.p02      install      work
- Go to build directory and start ccmake  
\$ cd build  
\$ ccmake ../geant4.10.07.p02



CMAKE_INSTALL_PREFIX	<i>/full_path_to_your_home/myG4/install</i>
GEANT4_BUILD_MULTITHREADED	ON
GEANT4_INSTALL_DATA	ON
GEANT4_INSTALL_DATADIR	<i>/full_path_to_your_home/myG4/install/data</i>
GEANT4_USE_GDML	ON
GEANT4_USE_OPENGL_X11	ON
GEANT4_USE_QT	ON
GEANT4_USE_RAYTRACER_X11	ON

- Apply “c” repeatedly until “g” command is available, and then “g”.

```
$ ccmake ../geant4.10.07.p02
```

```
$ make -j 8
```

```
$ make install
```

# Make and run the first example

- **VERY IMPORTANT**

- Every time you open a new terminal window, make sure to set the necessary environment variables.

```
$ source ~/myG4/install/bin/geant4.csh    (or .sh)
```

```
$ cd ~/myG4/work
```

```
$ cp -r ../geant4.10.07.p02/examples/basic/B1 .
```

```
$ ls
```

```
    B1
```

```
$ cd B1
```

```
$ ls
```

```
    CMakeLists.txt    History    exampleB1.cc    exampleB1.out    init_vis.mac    run2.mac    vis.mac  
    GNUmakefile      README    exampleB1.in    include          run1.mac    src
```

```
$ cmake .
```

```
$ make -f Makefile
```

```
$ ./exampleB1
```

exampleB1

Useful tips viewer-0 (OpenGLStoredQt)

Scene tree Help History

Search :

Command

- > control
- > units
- > profiler
- > gui
- > geometry
- > tracking
- > particle
- > event
- > cuts
- > run
- > random
- > process
- > material
- > physics\_lists
- > vis
- > heptst
- > physics\_engine
- > gun

Output

Threads: All

```

/vis/scene/notifyHandlers
/vis/viewer/set/style surface
/vis/viewer/set/hiddenMarker t
/vis/viewer/set/viewpointTheta
#
# Re-establish auto refreshing
/vis/viewer/set/autoRefresh tr
/vis/viewer/refresh
/vis/verbose warnings
Visualization verbosity changed
#
# For file-based drivers, use th
#/vis/viewer/flush
    
```

Session :

Type  
/run/beamOn 100

exampleB1
Useful tips viewer-0 (OpenGLStoredQt)

Scene tree, Help, History

Scene tree Help History

Search :

Command

- > control
- > units
- > profiler
- > gui
- > geometry
- > tracking
- > particle
- > event
- > cuts
- > run
- > random
- > process
- > material
- > physics\_lists
- > vis
- > heptst
- > physics\_engine
- > gun

Output

Threads: All

```

G4WT0 > run Summary
G4WT0 >   Number of events processed : 51
G4WT0 >   User=0.000000s Real=0.003170s Sys=0.000000s [Cpu=0.0%]
G4WT0 >
G4WT0 > -----End of Local Run-----
G4WT0 > The run consists of 51 gamma of 6 MeV
G4WT0 > Cumulated dose per run, in scoring volume : 1.69161 picoGy  rms = 0.801104 picoGy
G4WT0 > -----
G4WT0 >
G4WT1 > -----End of Local Run-----
G4WT1 > The run consists of 49 gamma of 6 MeV
G4WT1 > Cumulated dose per run, in scoring volume : 1.22893 picoGy  rms = 0.693542 picoGy
G4WT1 > -----
G4WT1 >

```

Session:

- If your platform can use or has CVMFS installed, Geant4 is available through the LCG Releases from the *sft.cern.ch* repository for CentOS7.

```
$ source /cvmfs/sft.cern.ch/lcg/releases/gcc/8.3.0/x86_64-centos7/setup.sh
$ export GEANT4_DIR=/cvmfs/geant4.cern.ch/geant4/10.7.p01/x86_64-centos7-
gcc8-optdeb-MT
$ export QT5_HOME=/cvmfs/sft.cern.ch/lcg/releases/LCG_97/qt5/5.12.4/x86_64-
centos7-gcc8-opt
$ export Qt5_DIR=$QT5_HOME
$ export QT_QPA_PLATFORM_PLUGIN_PATH=$QT5_HOME/plugins
$ export QT_XKB_CONFIG_ROOT=/usr/share/X11/xkb
$ cd ${GEANT4_DIR}/bin
$ source ./geant4.sh

$ cd ~/myG4/work
```

- Install Geant4 via a Package Manager
- **Warning**
  - These packages are not maintained by the Geant4 developers, but by helpful members of the community. Please go through each package manager's standard channels to report any installation issues or to request packaging of the latest release/patch.
- Spack on Linux/macOS
  - Spack 's Geant4 package may be installed with  
\$ spack install geant4
  - Spack allows different variants of Geant4 to be installed, and to see these run  
\$ spack info geant4
- Homebrew on macOS/Linux
  - Homebrew's Geant4 formula may be installed with  
\$ brew install geant4
- Conda on Linux/macOS
  - A Conda package for Geant4 is available via conda-forge and may be installed into an environment via  
\$ conda create -c conda-forge --name <my-environment> geant4  
\$ conda activate <my-environment>
  - Please see the associated feedstock for further information and support.
- Macports
  - MacPorts supplies a port for Geant4 which may be installed with  
\$ sudo port install geant4