

Manual Geant4 Installation Guide

Introduction

This guide provides a step-by-step process for manually installing the Geant4 simulation toolkit on a Linux system using command-line instructions. This method offers greater control over the installation and is suitable for users who prefer to avoid automated procedures. Familiarity with basic Linux terminal commands is beneficial. For comprehensive information, refer to the official Geant4 documentation:

<https://geant4.web.cern.ch/> .

Basic Terminal Commands

Here are some fundamental terminal commands used throughout this guide:

- **mkdir**: Create a new directory or folder.
- **cd**: Change the current directory.
- **rmdir**: Remove an empty directory.
- **ls**: List files and directories in the current directory.
- **touch**: Create a new empty file.
- **rm**: Remove files or directories.
- **kill** or **Ctrl+C**: Terminate a running process.
- **wget**: Download a file from a specified URL.
- **git clone**: Clone a repository from a given URL.

Note: It's often convenient to navigate to your desired working directory in the terminal before starting the installation process.

Terminal Shortcuts

- Copy: **Ctrl+Shift+C**
- Paste: **Ctrl+Shift+V**

Prerequisites

Before commencing the installation, ensure the following system requirements and software dependencies are met:

- **Operating System:** Linux or Windows Subsystem for Linux (WSL).
- **C++ Compiler:** A compatible C++ compiler (e.g., GNU GCC) and essential build tools (including **CMake**).
- **CMake:** Version 3.16 or later is recommended.
- **Git:** Required to clone the Geant4 source code repository.
- **Optional:** Python and Qt libraries for enhanced visualization capabilities.
- **System Privileges:** Administrator or **sudo** privileges for installing system-wide packages.
- **Command-Line Proficiency:** Basic familiarity with the Linux command-line interface.
- **Disk Space:** At least 10 GB of free disk space for downloading, building, and installing Geant4.
- **Internet Connection:** An active internet connection for downloading necessary files and dependencies.

Installation Steps

Let's begin the Geant4 installation process!

Distribution-Specific Dependencies

Depending on your Linux distribution, you'll need to install specific development packages. Follow the instructions corresponding to your system.

Ubuntu, Debian, Mint

1a. Update Your System

```
sudo apt update && sudo apt upgrade -y
```

2a. Install Required Dependencies

```
sudo apt install -y \  
cmake-curses-gui cmake g++ gcc binutils \  
libx11-dev libxpm-dev libxft-dev libxext-dev \  
libglew-dev libjpeg-dev libpng-dev libtiff-dev libgif-dev \  
libxml2-dev libssl-dev libfftw3-dev \  
qtbase5-dev qtchooser qttools5-dev-tools qt3d5-dev \  
libgl1-mesa-dev libglu1-mesa-dev libxmu-dev
```

Arch Linux

1b. Update Your System

```
sudo pacman -Syu --noconfirm
```

2b. Install Required Dependencies

```
sudo pacman -S --noconfirm \  
cmake gcc binutils \  
libx11 libxpm libxft libxext glew \  
libjpeg-turbo libpng libtiff giflib \  
libxml2 openssl fftw \  
qt5-base qt5-tools mesa glu libxmu
```

Fedora

1c. Update Your System

```
sudo dnf upgrade --refresh -y
```

2c. Install Required Dependencies

```
sudo dnf install -y \  
cmake cmake-curses-gui cmake-gui gcc gcc-c++ binutils \  
qt5-qtbase-devel qt5-qttools-devel qt5-qt3d-devel \  
glew-devel libjpeg-turbo-devel libpng-devel libtiff-devel giflib-devel \  
libxml2-devel openssl-devel fftw-devel \  
mesa-libGL-devel mesa-libGLU-devel libXmu-devel
```

openSUSE

1d. Update Your System

```
sudo zypper refresh
sudo zypper update -y
```

2d. Install Required Dependencies

```
sudo zypper install -y \
cmake cmake-curses-gui cmake-gui gcc gcc-c++ \
libX11-devel libXpm-devel libXft-devel libXext-devel \
glew-devel libjpeg-devel libpng-devel libtiff-devel giflib-devel \
libxml2-devel libopenssl-devel fftw3-devel \
libqt5-qtbase-devel libqt5-qttools-devel libqt5-qt3d-devel \
Mesa-libGL-devel Mesa-libGLU-devel libXmu-devel
```

Rocky Linux, RHEL

1e. Update Your System

```
sudo dnf upgrade --refresh -y
```

2e. Install Required Dependencies

```
sudo dnf install -y \
cmake cmake-curses-gui cmake-gui gcc gcc-c++ binutils \
libX11-devel libXpm-devel libXft-devel libXext-devel \
glew-devel libjpeg-turbo-devel libpng-devel libtiff-devel giflib-devel \
libxml2-devel openssl-devel fftw-devel \
qt5-qtbase-devel qt5-qttools-devel qt5-qt3d-devel \
mesa-libGL-devel mesa-libGLU-devel libXmu-devel
```

3. Create Geant4 Installation Folders

For better organization, let's create dedicated folders for the Geant4 source and build files:

```
mkdir Software
cd Software
mkdir Geant4
cd Geant4
```

4. Download Geant4 Source File

The latest stable version of Geant4 is currently 11.3.1. You can find the download link on the official Geant4 website: <https://geant4.web.cern.ch/download/11.3.1.html>. Download the Linux ‘.tar.gz’ archive using the following command:

```
wget https://gitlab.cern.ch/geant4/geant4/-/archive/v11.3.1/geant4-v11.3.1.tar.gz/
```

This will download the Geant4 source code archive to your current directory.

5. Extract the Source Archive

Unpack the downloaded ‘.tar.gz’ file using the following command:

```
tar -xzf geant4-v11.3.1.tar.gz
```

Where:

- **-x**: Extracts files from the archive.
- **-z**: Uncompresses the archive using gzip.
- **-f**: Specifies the filename of the archive.

6. Configure the Build

Create a separate build directory and navigate into it:

```
mkdir geant4-v11.3.1-build  
cd geant4-v11.3.1-build
```

Now, run the CMake configuration tool:

```
ccmake ../geant4-v11.3.1
```

A graphical configuration interface will appear.

Configuration: At the bottom of the ‘ccmake’ window, press the **c** key to configure the build settings.



Figure 1: cmake Initial Configuration Screen (Example)

Exiting Configuration: Once the initial configuration is done, a summary will be displayed. Press the **e** key to exit this configuration step.

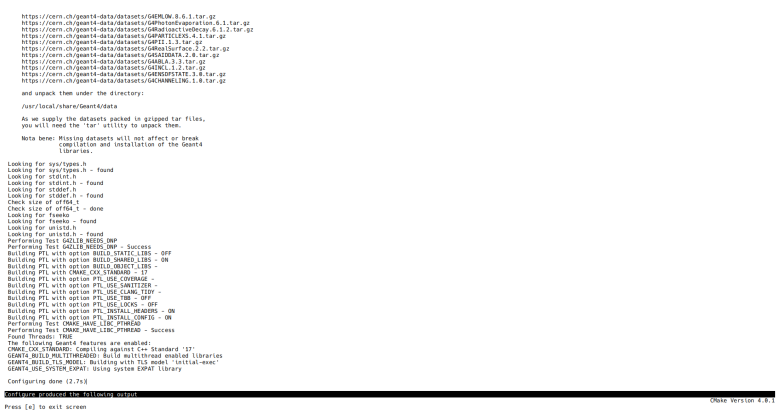


Figure 2: cmake Configuration Summary (Example)

Build Options: You'll return to the main 'cmake' screen. Don't be intimidated by the number of options!

```

CMAKE_BUILD_TYPE           *Release
CMAKE_INSTALL_PREFIX       /usr/local
GEANT4_BUILD_PMTIMEARCH    NO
GEANT4_INSTALL_DATA        NOFF
GEANT4_INSTALL_DATADIR     +
GEANT4_USE_CDFIOA           NOFF
GEANT4_USE_CERN             NOFF
GEANT4_USE_GWIN32           NOFF
GEANT4_USE_INVENTOR_QT      NOFF
GEANT4_USE_OPENGL_X11      NOFF
GEANT4_USE_RAYTRACER_X11    NOFF
GEANT4_USE_SYSTEM_CLIB      NOFF
GEANT4_USE_SYSTEM_EXPAT     NO
GEANT4_USE_SYSTEM_ZLIB      NOFF
GEANT4_USE_YIN              NOFF
GEANT4_USE_YN               OFF

```

```

CMake GUI - CMake GUI for Windows, Mac OS X, Linux, and FreeBSD. Testimonials: Download: Help: Feedback: Help/About/Help
Keys: [F1] Full on/off [F2] Hide on/off [F3] Show log output [F4] Configure [F5] Quit without generating
      [H] Help      [G] Toggle advanced mode (currently off)
CMake Version 4.0.0

```

Figure 3: cmake Main Build Options (Example)

Setting Installation Path and Enabling Options:

- Navigate to the `CMAKE_INSTALL_PREFIX` option (usually the second entry) using the up and down arrow keys. Press **Enter** to edit its value.
- Enter the desired installation directory for Geant4 (e.g., `/home/your_user/Geant4/geant4-v11.3.1-`). Press **Enter** to confirm. The path should update to reflect your input.
- Enable the following options by navigating to them with the arrow keys and pressing **Enter** to toggle the value to ON:
 - `GEANT4_INSTALL_DATA`
 - `GEANT4_USE_OPENGL_X11`
 - `GEANT4_USE_QT`
 - `GEANT4_USE_RAYTRACER_X11`

```

CMAKE_BUILD_TYPE           *Release
CMAKE_INSTALL_PREFIX       /home/your_user/Geant4/geant4-v11.3.1-
GEANT4_BUILD_PMTIMEARCH    NO
GEANT4_INSTALL_DATA        NOFF
GEANT4_INSTALL_DATADIR     +
GEANT4_USE_CDFIOA           NOFF
GEANT4_USE_CERN             NOFF
GEANT4_USE_GWIN32           NOFF
GEANT4_USE_INVENTOR_QT      NOFF
GEANT4_USE_OPENGL_X11      NOFF
GEANT4_USE_RAYTRACER_X11    NOFF
GEANT4_USE_SYSTEM_CLIB      NOFF
GEANT4_USE_SYSTEM_EXPAT     NO
GEANT4_USE_SYSTEM_ZLIB      NOFF
GEANT4_USE_YIN              NOFF
GEANT4_USE_YN               OFF

```

```

CMake GUI - CMake GUI for Windows, Mac OS X, Linux, and FreeBSD. Testimonials: Download: Help: Feedback: Help/About/Help
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      [H] Help      [G] Toggle advanced mode (currently off)
CMake Version 4.0.0

```

Figure 4: cmake Setting Installation Prefix and Options (Example)

Final Configuration and Generation: Press the `c` key again to configure with the new settings (you might need to press it multiple times until no more configuration changes are indicated). Once done, you should see an option at the bottom to press `g` to generate the build files.

[illegible]

Figure 5: ccmake Final Configuration and Generate (Example)

Generate Build Files: When you see the option to press **g** (generate), do so. This will create the necessary build files in your ‘geant4-v11.3.1-build‘ directory.

7. Build and Install Geant4

Now it's time to compile Geant4. Use the `make` command. The `-j12` option tells `make` to use up to 12 CPU cores for parallel building, which can significantly speed up the process. Adjust the number according to your system's capabilities.

```
make -j12
```

After the build process completes successfully, install Geant4 using the following command:

```
make install
```

To automatically set up the Geant4 environment each time you open a new terminal, you can add an alias to your `‘.bashrc’` file (or `‘.zshrc’` if you use Zsh). Open the file with a text editor:

```
vim /home/your_user/.bashrc # (Replace 'your_user' with your actual username)
```

Add the following line at the end of the file (adjust the path if you chose a different installation directory):


```
alias geant4make="source /home/your_user/Software/Geant4/geant4-v11.3.1-install/share/0
```

Save and close the file. Then, apply the changes to your current terminal session:

```
source /home/your_user/.bashrc # (Replace 'your_user' with your actual username)
```

Alternatively, you can simply close and reopen your terminal. Now, test the alias:

```
geant4make
```

If you don't see any error messages, the environment setup is working correctly.

8. Verify Installation with Basic Example

Congratulations on reaching this stage! Let's verify your Geant4 installation by building and running a basic example. First, navigate back to your 'Software/Geant4' directory:

```
cd ../.. # Go up two levels
ls
```

You should see the 'geant4-v11.3.1-install' directory. Now, navigate to the B1 example:

```
cd geant4-v11.3.1-install
cd share
cd Geant4
cd examples
cd basic
cd B1
```

Create a build directory within the B1 example directory and enter it:

```
mkdir build
cd build
```

Configure and build the B1 example:

```
cmake ..
make
```

If the build is successful without errors, list the contents of the 'build' directory:

```
ls
```

You should find an executable file named ‘exampleB1’. Run it:

```
./exampleB1
```

If you see a graphical output similar to the following image, your Geant4 installation is complete and functioning correctly!

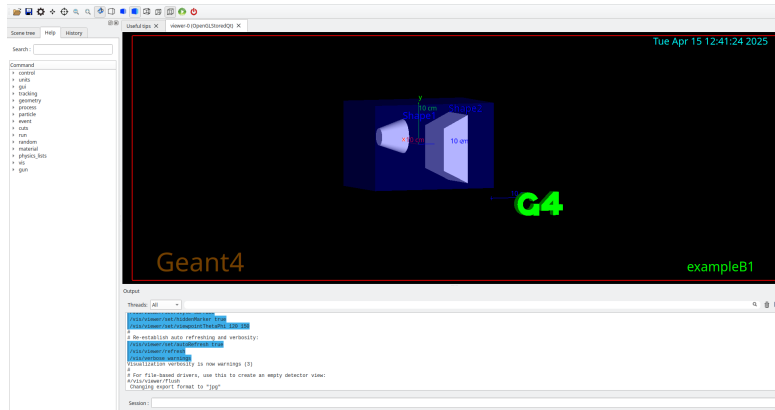


Figure 6: Example B1 Visualization

1 Conclusion

This guide has walked you through the manual installation of Geant4 on a Linux system. Remember to adjust commands and paths according to your specific distribution and installation preferences. For more advanced configurations and troubleshooting, please refer to the official Geant4 Installation Guide: <https://geant4.cern.ch/manuals/installationguide/>. You are now equipped to begin exploring the powerful capabilities of the Geant4 simulation toolkit!