Geant4 installation from source guide

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With no administrator privileges on mac Monterey 12.4, M1 chip

Made by Maya Maciurzynska

Acknowledgements and notes

This guide builds on the “Proton Calorimetry/Detector Simulation” guide which includes a Geant4 installation guide on PBT wiki, with instructions specific for the computer set-up which I have been working with.

The “Proton Calorimetry/Detector Simulation” page is available at:

https://www.hep.ucl.ac.uk/pbt/wiki/Proton_Calorimetry/Detector_Simulation?fbclid=IwAR09XLN9EWoJlIZVQVSLqun2eJYs06ePrc3Hn3zyS-4utS7DmA8bHjCuv4U

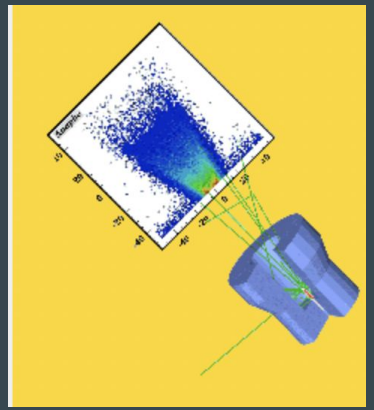
Why GEANT4?

Geant4 - short for “**for ge**ometry **a**nd **t**racking” is a platform for "the simulation of the passage of particles through matter" with applications in high energy physics, accelerator physics, medical physics and more.

Geant4 allows the user to model the geometry (physical lay-out of the experiment), tracking and the response of the given simulation e.g. a detector or an accelerator. It also provides a visualisation of the simulation. Electromagnetic, strong and weak interaction physics processes are built-in.

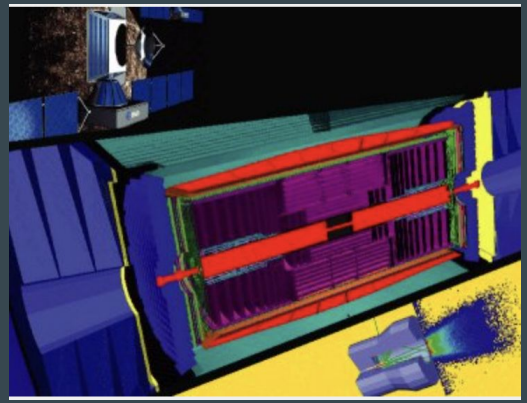
Amongst other organisations, Geant4 has been used by CERN, the European Space Agency. The source code is available for free on the CERN website.

Geant4 logo



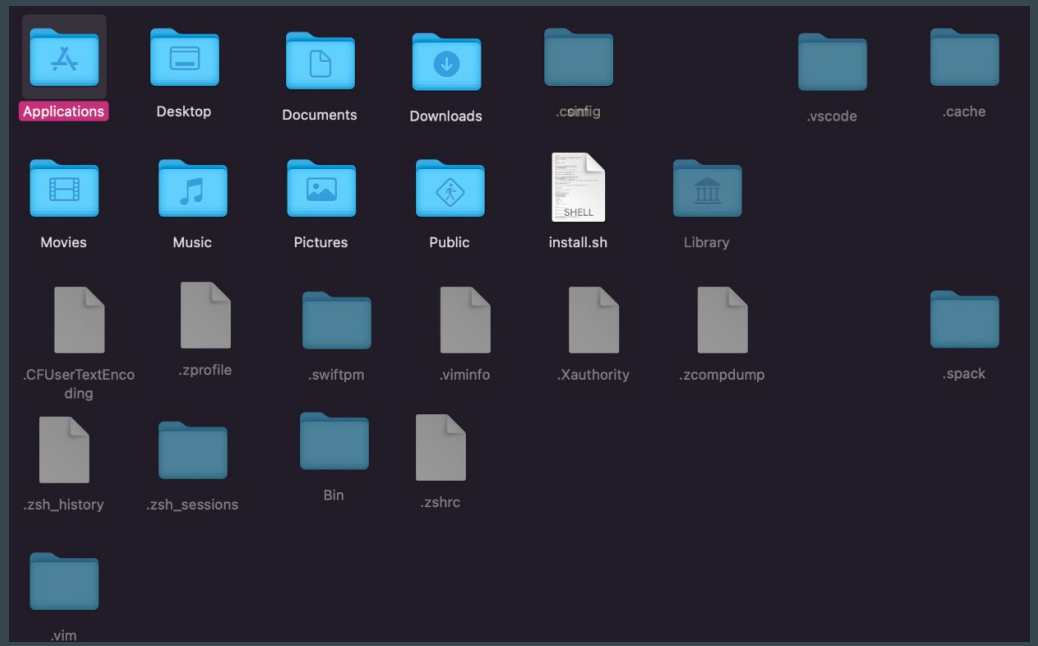
A superficial brachytherapy device and the resulting dose distribution, simulated with Geant4 and analysed with CERN's Anaphe analysis tool.

National Institute for Cancer Research, Genova & INFN Genova



An artist's impression of the BepiColombo spacecraft arriving at the planet Mercury, European Space Agency

Hidden files



Hidden z shell files (e.g. .zprofile, .zshrc) will be needed at various steps of this installation. To access hidden files, go to the user profile and press command+shift+period. The hidden files should now appear.

The main two hidden files that will be used in this installation guide are .zprofile and .zshrc:

- **.zprofile** - it is loaded only once at login time; anything that needs to be loaded only once can be saved there (e.g. environment variables)
- **.zshrc** - it is loaded after .zprofile; typically used to define aliases (an alias is a shortcut that can be used in the terminal for long functions). Any command that is run everytime a new shell is launched should be saved in .zshrc

There are other files such as .zsh_history or .zcompdump - more information on z shell files available here:

https://velog.io/@zivary/ZSH-.zprofile-.zshrc-.zlogin-What-goes-where

Installing the prerequisites

Xcode - it is a developers toolset; it will be used to create C++ files

- Install Xcode 13 or higher from the Mac App Store and install command line tools by executing in a terminal window `$ xcode-select --install`
- Agree to the Xcode license: sudo xcodebuild -license
- **ADMINISTRATOR PRIVILEGES ARE NEEDED FOR THIS**

XQuartz - XQuartz will be used for visualisation of the simulations

- Install XQuartz (from https://www.xquartz.org/)
- XQuartz may come pre-installed if using a UCL HEP pool computer - otherwise, **ADMINISTRATOR PRIVILEGES ARE NEEDED FOR THIS**

Installing the prerequisites - CMake

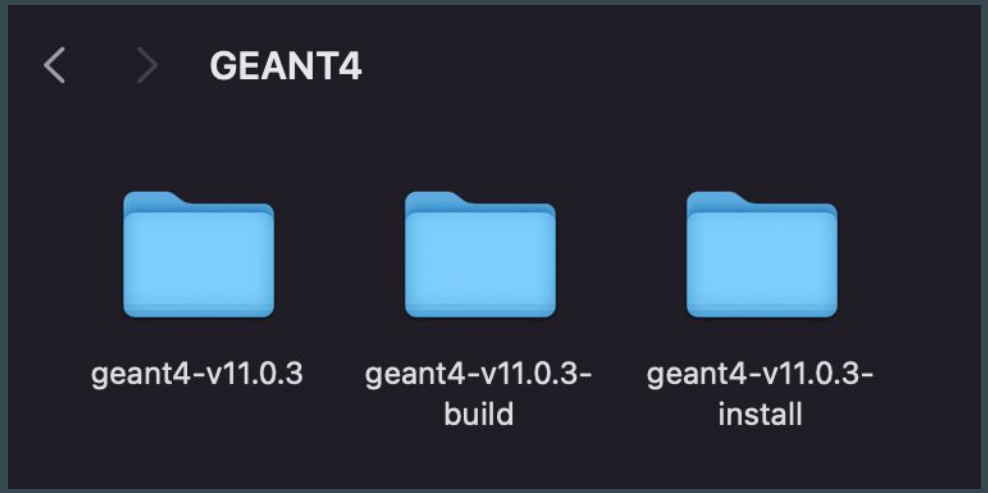
CMake - CMake is used to control the software compilation process

- Download in the user applications folder https://cmake.org/download/ and follow the installation guide to install CMake as an application
- Install CMake for command line use by adding it to the PATH One may add CMake to the PATH; add the line “export PATH=$PATH:/Users/username/Applications/CMake.app/Contents/bin” to the .zprofile file and save it
- To test if CMake was installed correctly, type $which cmake into the terminal - it should return /Users/username/Applications/CMake.app/Contents/bin/cmake

Setting-up for Geant4 installation

In your user applications folder (/Users/username/) create a folder called GEANT4

Within the GEANT4 folder, create three, where the names correspond to the Geant4 version number you're downloading (in my case, 11.0.3)



Downloading and unpacking the files

From https://geant4.web.cern.ch/support/download, download the source file geant4-v11.0.0.tar.gz

Note: your default browser should be safari; the file may not download if you are using Firefox or Google Chrome

Unpack the file into /Users/username/Applications/GEANT4/geant4-v11.0.3 - this is now your source directory

Configuring Geant4

In the mac terminal, change the directory into the Geant4 build directory

```
$ cd /Users/username/Applications/GEANT4/geant4-v11.0.3-build
```

Once in the build directory, execute:

```
$ cmake
-DCMAKE_INSTALL_PREFIX=/Users/username/Applications/GEANT4/geant4-v11.0.3-install
-DGEANT4_BUILD_MULTITHREADED=ON -DGEANT4_INSTALL_DATA=ON
-DGEANT4_USE_GDML=OFF -DGEANT4_USE_QT=OFF
-DGEANT4_USE_OPENGL_X11=ON -DGEANT4_USE_RAYTRACER_X11=ON
-DGEANT4_USE_SYSTEM_EXPAT=OFF -DGEANT4_USE_SYSTEM_ZLIB=OFF
../geant4-v11.0.3
```

```
$make -jN
```

Where N is the number of cores in your machine(/how many cores you wish to use if you want to use fewer) - e.g for my machine, there are 8 cores

```
$make install
```

CMake settings key

`-DGEANT4_BUILD_MULTITHREADED=ON` -enables multithreading which speeds up the installation process

`DGEANT4_INSTALL_DATA=ON` -activates the installation of Geant4's datasets

`-DGEANT4_USE_GDML=OFF` -default setting - disables GDML, one of the ways of constructing detector geometries

`-DGEANT4_USE_QT=OFF` - default setting - does not enable the use of Qt (visualisation software which is not used in this installation)

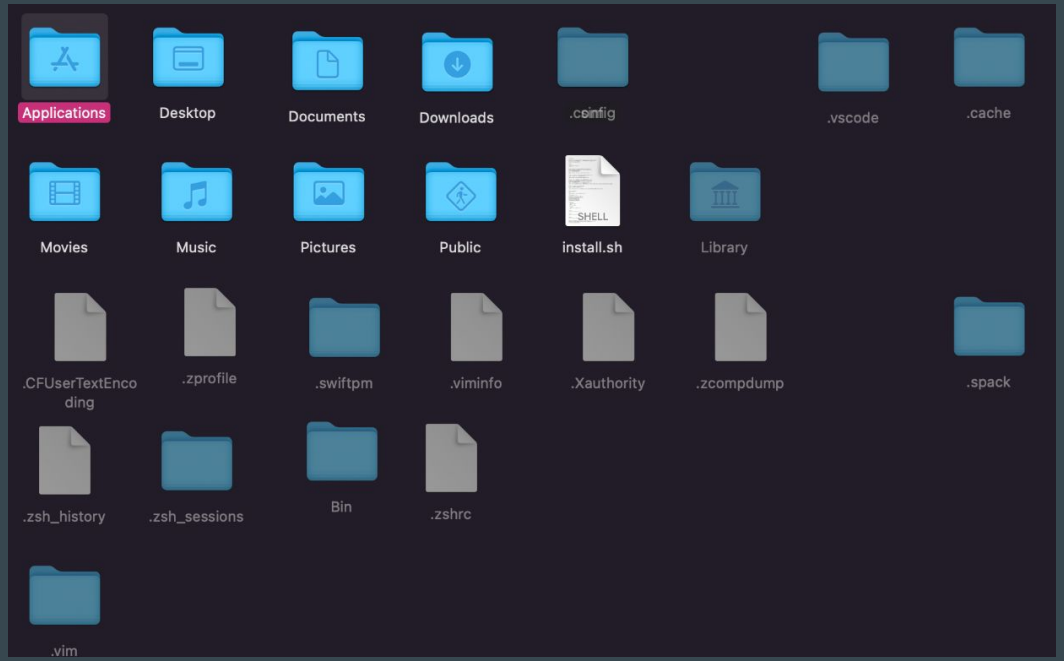
`-DGEANT4_USE_OPENGL_X11=ON` -enables OpenGL, programming interface for rendering 2D and 3D vector graphics

`-DGEANT4_USE_RAYTRACER_X11=ON`-builds X11 RayTracer which allows for smoother rendering of the screen

`-DGEANT4_USE_SYSTEM_EXPAT=OFF`- does not enable the use of the system EXPAT library

`--DGEANT4_USE_SYSTEM_ZLIB=OFF` - default setting - does not enable the use of the system ZLIB library

Sourcing the geant4.sh script



Your user directory should reveal all the hidden files after pressing command+shift+ .

Set up sourcing the the geant4.sh script such that it is sourced automatically every time a new terminal window is open

Add the following line to the .zprofile file in TextEdit - /users/username/Applications/GEANT4/Geant4-11.0.3-install/bin >/dev/null; . geant4.sh; popd >/dev/null

Make sure you save the changes to the file

Sourcing the geant4.sh script - alternative approach

The method described in the slide above did not work for the machine I am using; the following error message appears when the terminal is opened:

```
/Users/zcapaci/.zprofile:.:3: no such file or directory: geant4.sh
```

NOTE: there are no issues sourcing the script if you are using a bash shell

Instead, the file will be sourced manually every time the terminal is opened. To make this quicker, an alias for the Geant4 bin folder was created - the following line was added in the **.zshrc** file:

```
alias  geant4bin='cd /Users/username/Applications/GEANT4/geant4-v11.0.3-install/bin'
```

When opening terminal, type in:

```
$ geant4bin
```

Which changed the directory to bin (of geant4-v11.0.3), and then type

```
$ source geant4.sh
```

Testing the installation - example B1

To test whether Geant4 was installed correctly, run one of the precompiled example simulations, B1:

First, in the user documents folder, create a folder called “B1” and a subfolder called “build”

Then, copy the contents of /Users/username/Applications/GEANT4/Geant4-v11.0.3-install/share/Geant4-11.0.3/examples/basic/B1 into the B1 folder that you just created in the user’s Documents folder

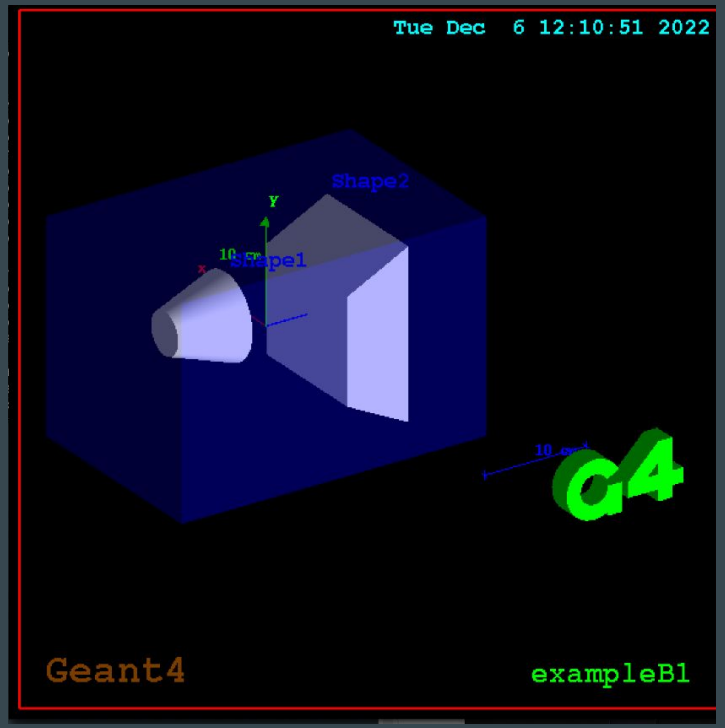
In terminal, change directory into /Users/username/Documents/B1/build and execute the lines:

```
$ cmake -DCMAKE_PREFIX_PATH=/Users/username/Applications/GEANT4/geant4-v11.0.3-install/lib/Geant4-11.0.3/ ../

$make -jN

$./exampleB1
```

If Geant4 was installed correctly, XQuartz should open showing the following simulation:



Geant4 Tutorials

https://www.youtube.com/playlist?list=PLLybgCU6QCGWgzNYOV0SKen9vqg4KXeVL

The playlist of recommended Geant4 tutorials for beginners. For PBT, it is recommended that you complete the first 10-13 tutorials.

“This tutorial series explains how to create your own Geant4 project from scratch. It starts with creating an empty template and then shows how to add physics lists, detector components, and multithreading compatibility. At the end you will have a fully working detector simulation framework using a Cherenkov detector as one example.”