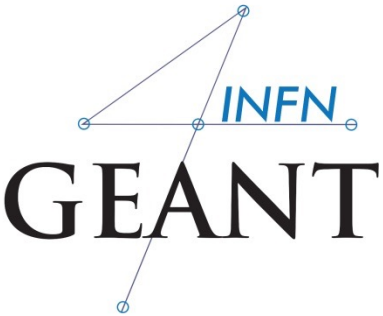

Compiling GEANT4 A SIMULATION TOOLKIT

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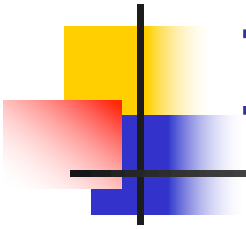
A lot of material by J. Pipek

Geant4 Course, Vienna (A), April 2024



Installation process

1. Check that you meet all the requirements
2. Download **Geant4** source code
3. **Configure** the build using **CMake**
4. **Make** & install
5. Configure your environment to use Geant4

https://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/InstallationGuide/html/index.html

1) Supported platforms and requirements

Virtual Machine:
CentOS 7 with gcc 8.3.1

- **Operating system**
  - "recent" Linux (e.g. CentOS 7), best support
  - macOS 10.10+
  - Windows 10 (limited support, not recommended)
- **Compilers**
  - C++11 compliance
  - such as GCC 8+, clang 8+, Visual C++ 2019+
- **CMake** (configuration generation tool) 3.16+
- System libraries (as development packages):
  - expat, xerces-c

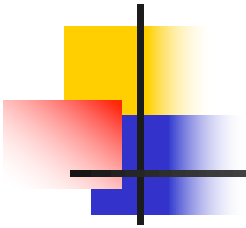
These may or may not be necessary. Just keep this in mind when compilation fails.

Pre-requirement: CMake intallation

The VM has **CMake** installed

- Geant4 build is configured by **CMake** (version >3.16)
- Depending on the OS installation, **CMake** may not be installed by default. In that case you have to install it:
  - **Linux**: it is recommended to use the CMake provided by the package management system of your distribution.
    If version **3.16+** is not available:
    1. download the latest version (`http://www.cmake.org/`)
    2. unzip the tar-ball
    3. **./bootstrap, make, make install**
  - **macOS**: install it using the Darwin64 dmg installerpackage
  - **Windows**: install it using the Win64/32 exe installerpackage

Pre-requirements: optional libraries

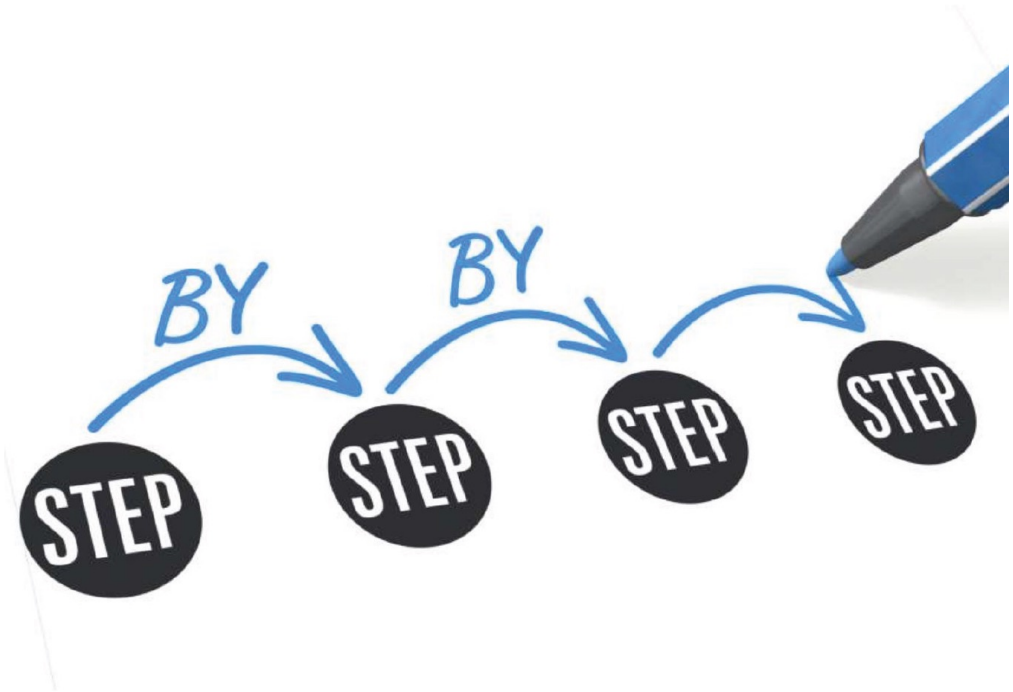


- **X11** for simple graphical user interface and ray-tracing
- **OpenGL** for visualization
- **Qt4** or **Qt5** for graphical user interface
- **ROOT** for data analysis (even inside Geant4)

Less frequently used libraries/tools:

Motif, OpenInventor, DAWN, RayTracer X11, HepRApp, WIRED JAS Plug-in, AIDA, VRML browser, (external) CLHEP, Wt...

Installation steps

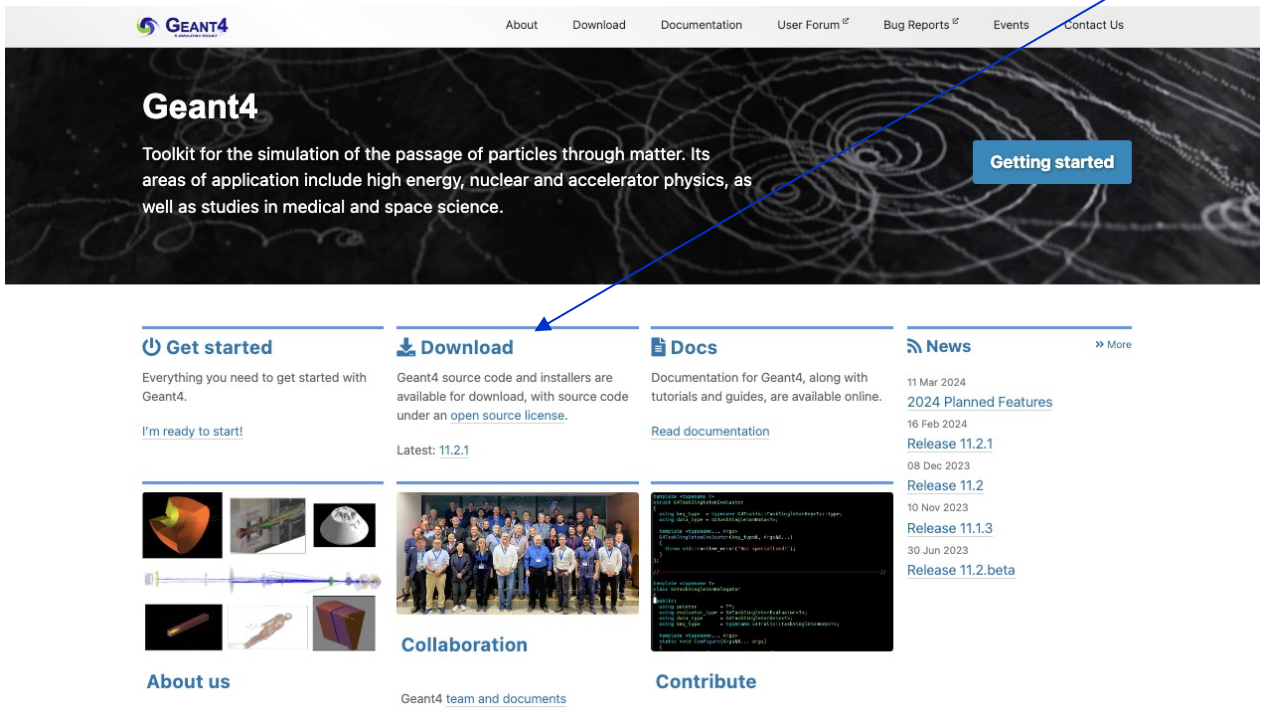


2) Download

- Go to the Geant4 webpage:

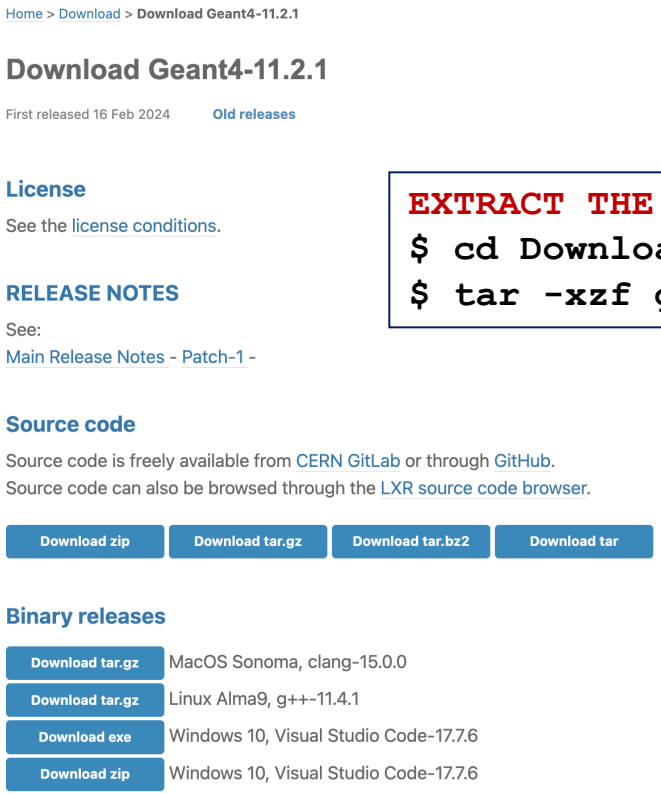
  http://geant4.org

Click here



… download GEANT4 A SIMULATION TOOLKIT

http://www.geant4.org/geant4/support/download

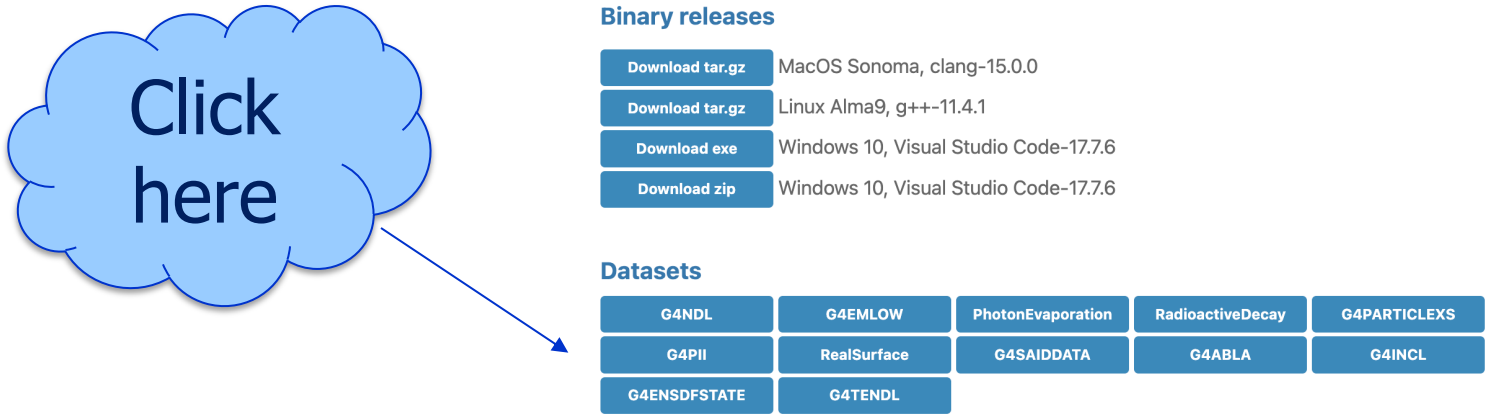


EXTRACT THE FILE

```
$ cd Downloads
$ tar -xzf geant4-v11.0.1.tar.gz
```

Download data (optional)

Option 1: download manually (slow connections)



Option 2: use **`CMake`** to download data automatically (preferred)

Pre-3) Directories for installation

Source directory: where you unpack the source

`/usr/local/geant4/geant4-v11.2.0` VM

Build directory: where you run **`CMake`** and build Geant4 ("working directory")

`/usr/local/geant4/geant4-v11.2.0-build` VM

Installation directory: where you install Geant4 to and which the applications compile against

`/usr/local/geant4/geant4-v11.2.0-install` VM

Only the **installation dir** is necessary to compile & run user apps.

3) Configuration with **CMake**

- Extract the package into **source directory**

```
tar xzf geant4-v11.2.0
```

- Create the **build directory**

```
mkdir geant4-build
```

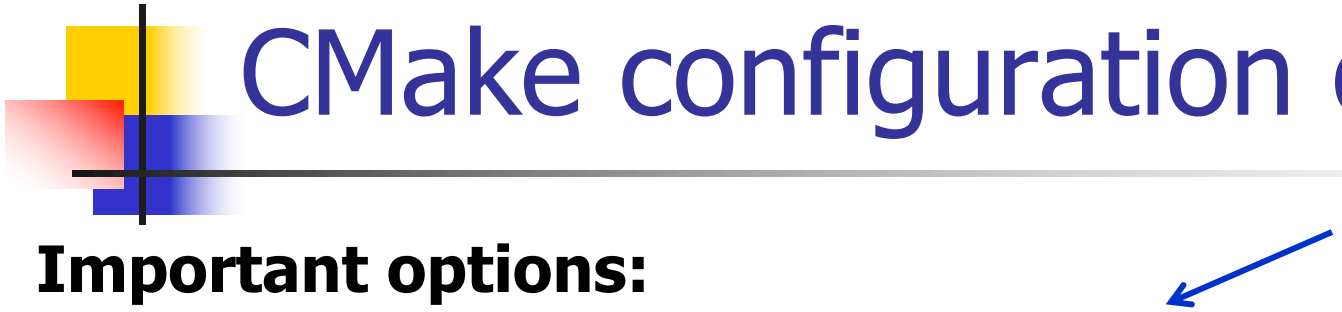
Choose name to your liking

- **Run** CMake in the **build directory**

```
cd geant4-build
```

```
cmake [options...] ../geant4-v11.2.0
```

CMake configuration options



Important options:

- -DCMAKE_INSTALL_PREFIX=*...installation_path...*
- -DGEANT4_INSTALL_DATA=ON/OFF
- -DGEANT4_BUILD_MULTITHREADED=ON/OFF

Further options:

- -DGEANT4_USE_OPENGL_X11=ON/OFF
- -DGEANT4_USE_QT=ON/OFF
- -DCMAKE_BUILD_TYPE=Release/Debug/RelWithDebInfo
- ...

https://geant4-userdoc.web.cern.ch/UsersGuides/InstallationGuide/html/installguide.html#geant4-build-options

Running CMake

- CMake configures the build and generates Unix **`Makefiles`** to perform the actual build:

```
cmake -DGEANT4_INSTALL_DATA=ON -DGEANT4_BUILD_MULTITHREADED=OFF
-DCMAKE_INSTALL_PREFIX=/usr/local/geant4/geant4.10.05.p01-install
/usr/local/geant4/geant4.v11.2.0
```

```
-- The C compiler identification is GNU 4.8.5
-- The CXX compiler identification is GNU 4.8.5
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc – works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Detecting C compile features
-- Detecting C compile features - done
...(~50 lines)...
-- Configuring done
-- Generating done
-- Build files have been written to:
/usr/local/geant4/geant4.10.05.p01-build
```

If you see that, you are successful !!!

If you see **errors** at this point, carefully check the messages output by CMake

(Random) installation notes

- Windows: See the installation guide (and good luck!)

  `http://geant4-userdoc.web.cern.ch/geant4-userdoc/UsersGuides/InstallationGuide/html/installguide.html#on-windows-platforms`

- Binary packages: Installation without compiling Geant4 is possible (but **not recommended**)
- Data packages: If you haven't used CMake to download them, unpack the downloaded files in the `share/Geant4-v11.2.0/data/` sub-directory of your installation

4) Compile

- Run `make` (and get a cup of coffee)

```
make -j2
```

Tip: If you have a **multi-core machine**, you can run the compilation in parallel using multiple jobs. Just add the `-jN` parameter, where N is the number of cores

```
Scanning dependencies of target G4ENSDFSTATE
Scanning dependencies of target G4NDL
[  0%] Creating directories for 'G4ENSDFSTATE'
[  0%] Creating directories for 'G4NDL'
[  0%] Performing download step (download, verify and extract) for 'G4NDL‘
...(4029 lines, ~1 hour of execution)
[100%] Built target G4visXXX
[100%] Building CXX object
source/visualization/gMocren/CMakeFiles/G4GMocren.dir/src/G4GMocrenIO.cc.o
[100%] Building CXX object
source/visualization/gMocren/CMakeFiles/G4GMocren.dir/src/G4GMocrenMessenger.cc.o
[100%] Linking CXX shared library
../../../BuildProducts/lib64/libG4GMocren.so
[100%] Built target G4GMocren
```

If you see that, you are successful !!!

… and install

- Run `make install` (this takes much less time)

```
make install
```

```
[  0%] Built target G4ENSDFSTATE
[  0%] Built target G4NDL
[  0%] Built target PhotonEvaporation
[  0%] Built target RadioactiveDecay
[  0%] Built target G4ABLA
...(42830 lines, ~2 minute of execution)
-- Installing: /usr/local/geant4/geant4.10.05.p01-
install/include/Geant4/G4VModelCommand.hh
-- Installing: /usr/local/geant4/geant4.10.05.p01-
install/include/Geant4/G4VModelFactory.hh
-- Installing: /usr/local/geant4/geant4.10.05.p01-
install/include/Geant4/G4VTrajectoryModel.hh
-- Installing: /usr/local/geant4/geant4.10.05.p01-
install/include/Geant4/G4VisTrajContext.hh
-- Installing: /usr/local/geant4/geant4.10.05.p01-
install/include/Geant4/G4VisTrajContext.icc
```

5) Set-up your environment

- Geant4 needs properly set environment variables:

```
G4ABLADATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/G4ABLA3.0"
G4ENSDFSTATEDATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/G4ENSDFSTATE2.1"
G4LEDATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/G4EMLOW6.50"
G4LEVELGAMMADATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-
10.5.1/data/PhotonEvaporation4.3.2"
G4NEUTRONHPDATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/G4NDL4.5"
…
G4REALSURFACEDATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/RealSurface1.0"
G4SAIDXSDATA="/usr/local/geant4/geant4.10.05.p01-install/share/Geant4-10.5.1/data/G4SAIDDATA1.1"
LD_LIBRARY_PATH="...:/usr/local/geant4/geant4.10.05.p01-install/lib64"
PATH="...:/usr/local/geant4/geant4.10.05.p01-install/bin"
```

- To set them up properly in your shell, run the script in Geant4 installation directory:

```
source /usr/local/geant4/geant4.v11.2.0-install/bin/geant4.(c)sh
```

- You can put this line your `~/.bashrc` file (or similar for other shells)

Your GEANT4 A SIMULATION TOOLKIT is ready now