

Installation Instructions for GEANT4 on Linux  
Updated for GEANT4.7.1

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## 1 Introduction

GEANT4 [G4NIM] is a program for tracking particles as they enter and exit geometries build from various materials. This guide assumes the reader understands the motivation for using particle simulation software and is only meant as an install and quick-start guide to GEANT4.

This guide assumes an intermediate knowledge of Linux. The designers of GEANT4 require the installer to be familiar with the concepts of static vs. dynamic libraries. Also, knowledge of the gcc compiler suite is recommended.

## 2 Installing CLHEP

Before installing GEANT4, the Class Library for High Energy Physics (CLHEP) must be installed. The version of CLHEP used in this manual is 1.9.2.1. At the time of writing this document, there exists a 2.0 version of CLHEP. It is currently unsuitable for GEANT4.

To get the CLHEP source, go to reference [CLHEP] and click on the desired version number after 'Installation Guide'. Choose the newest source package and download it to a temporary directory. To install CLHEP in the home directory:

```
tar -zxvf clhep-1.9.2.1.tgz
cd 1.9.2.1
cd CLHEP
./configure --prefix=$HOME
make
make install
```

The CLHEP libraries has now been installed in `$HOME/lib`. You will need to make sure that programs know where to access the CLHEP libraries. This can be accomplished by entering `export LD_LIBRARY_PATH=$HOME/lib:$LD_LIBRARY_PATH` at the command line. Alternatively, you can put it in an automatically executed file, such as `.bash_profile` for bash users.

## 3 Installing GEANT4

### 3.1 Getting GEANT4

First, we must create a place to put the GEANT4 installation. The recommended directory structure is to put GEANT4 in `$HOME/geant4/geant4.7.1/` so that other things can be put in `$HOME/geant4/`.

```
cd $HOME
mkdir geant4
cd geant4
```

To get the source of GEANT4, goto the GEANT4 web-site [G4Web]. Click on 'Download' and choose the GNU tar source file. The current GEANT4 version is 7.1 so the file is `geant4.7.1.gtar.gz`. Place this file in `$HOME/geant4/` and untared it by typing

```
tar -zxvf geant4.7.1.gtar.gz
```

which will create a new directory.

## 3.2 Configuring and Compiling GEANT4

Before attempting to configure GEANT4, it is highly recommended that the reader review the information on the GEANT4 web-site [G4Web].

Change to the newly created GEANT4 directory

```
cd geant4.7.1
```

Once in the GEANT4 directory, type (using only one dash before 'build')

```
./Configure -build
```

The program will output:

```
--- Geant4 Toolkit Installation ---
```

This installation shell script will examine your system and ask you questions to determine how the Geant4 Toolkit should be installed. If you get stuck on a question, you may use a ! shell escape to start a subshell or execute a command. Many of the questions will have default answers in square brackets; typing carriage return will set the default.

On AFS it is allowed to specify either absolute or relative paths (i.e. starting with the ~username construct).

[Type carriage return to continue]

Read the message and press ENTER to continue.

The prompt used in this script allows you to use shell variables and backticks in your answers. You may use `\$1`, `\$2`, etc... to refer to the words in the default answer, as if the default line was a set of arguments given to a script shell. This means you may also use `\$*` to repeat the whole default line.

Everytime there is a substitution, you will have to confirm. If there is an error (e.g. an unmatched backtick), the default answer will remain unchanged and you will be prompted again.

Running 'Configure -d' will bypass nearly all the questions and use the computed defaults (or answers saved in a configuration previously generated).

Type 'Configure -h' for a list of options.

You may also start interactively and then answer '`\& -d`' at any prompt to turn on the non-interactive behaviour for the rest of the execution.

[Type carriage return to continue]

Press ENTER.

Much effort has been spent to ensure that this shell script will run on any Unix system. If despite that you can't run Configure for some reason, you'll have to set the proper environment variables by hand and follow the "manual" installation as specified in the Geant4 Installation Guide.

[Type carriage return to continue]

There should be no problems running the GEANT4 configure script on a Linux system. It has run flawlessly on RedHat, Debian and Mandrake. Press ENTER to continue.

Definition of G4SYSTEM variable is Linux-g++.

That stands for:

1) OS : Linux

2) Compiler : g++

To modify default settings, select number above (e.g. 2)

[Press [Enter] for default settings]

Since this document assumes that you have installed Linux, press ENTER.

I can set things up so that your shell scripts and binaries are more portable, at what may be a noticeable cost in performance. In particular, if you ask to be portable, the following happens:

- 1) Shell scripts will rely on the PATH variable rather than using the paths derived above.
- 2) ~username interpretations will be done at run time rather than by Configure.

Do you expect to run these scripts and binaries on multiple machines? [n]

Select 'no' at this stage.

Where is Geant4 installed? [/home/ward/geant4/geant4.7.1]

If the sources are in /home/ward/geant4/geant4.7.1, then that is where GEANT4 should be installed.

Specify the path where Geant4 libraries and source files should be installed.

[/home/ward/geant4/geant4.7.1]

Press ENTER.

Do you want to copy all Geant4 headers in one directory? [n]

‘Yes’ is recommended. It makes searching for header files much easier if they are all in the same place. Press y then ENTER.

Please, specify default directory where ALL the Geant4 data is installed:

```
G4LEVELGAMMADATA: /home/ward/geant4/geant4.7.1/data/PhotonEvaporation
G4RADIOACTIVEDATA: /home/ward/geant4/geant4.7.1/data/RadiativeDecay
G4LEDATA: /home/ward/geant4/geant4.7.1/data/G4EMLOW3.0
NeutronHPCrossSections: /home/ward/geant4/geant4.7.1/data/G4NDL3.7
G4ELASTICDATA: /home/ward/geant4/geant4.7.1/data/G4ELASTIC1.1
```

You will be asked about customizing these next.

```
[/home/ward/geant4/geant4.7.1/data]
```

Change these options if needed. It may be more convenient to put the data in \$HOME/geant4/data. Enter the directory and press ENTER. You may be asked to confirm your choice if you chose another directory. Press ENTER. If the directory does not already exist, you may have to confirm your choice.

Please, specify default directory where the Geant4 data is installed:

```
1) G4LEVELGAMMADATA: /home/ward/geant4/data/PhotonEvaporation
2) G4RADIOACTIVEDATA: /home/ward/geant4/data/RadiativeDecay
3) G4LEDATA: /home/ward/geant4/data/G4EMLOW3.0
4) NeutronHPCrossSections: /home/ward/geant4/data/G4NDL3.7
5) G4ELASTICDATA: /home/ward/geant4/data/G4ELASTIC1.1
```

To modify default settings, select number above (e.g. 2)

```
[Press [Enter] for default settings]
```

Press ENTER unless you need to change one of these settings.

Could not find CLHEP installed on this system!

Please, specify where CLHEP is installed (set by default):

```
CLHEP_BASE_DIR: /usr/local
```

According to it will be set:

```
CLHEP_INCLUDE_DIR
```

```
CLHEP_LIB_DIR
```

You will be asked about customizing these next.

```
[/usr/local]
```

Type \$HOME then ENTER. Notice that \$HOME is needed, not \$HOME/lib. You will see the same prompt again. Do not be concerned if it claims that it cannot find the CLHEP libraries. Press ENTER.

You can customize paths of you CLHEP installation:

- 1) CLHEP\_INCLUDE\_DIR: /home/ward/include
- 2) CLHEP\_LIB\_DIR: /home/ward/lib
- 3) CLHEP\_LIB: CLHEP

To modify default settings, select number above (e.g. 2)  
[Press [Enter] for default settings]

If these settings are correct, press ENTER. If they are not correct, modify them as given by the directions above.

By default 'static' (.a) libraries are built.

Do you want to build 'shared' (.so) libraries? [n]

Select 'yes' here or the GEANT4 applications will balloon in size.

You selected to build 'shared' (.so) libraries.

Do you want to build 'static' (.a) libraries too? [n]

Generally, there's no real reason to build static libraries if shared libraries are being built. However sometimes a bug<sup>1</sup> will make it difficult to use shared libraries for everything. Therefore, you should select 'yes' and press ENTER.

Do you want to build 'global' compound libraries? [n]

Not building compound libraries is preferred. Press ENTER for 'no'.

Do you want to compile libraries in DEBUG mode (-g)? [n]

Debug mode is useful if you intend to use the gdb debugger. If the debug flag is set, optimization will be turned off and this may result in a significant performance hit. Unless you specifically need debugging select 'no'.

G4UI\_NONE

If this variable is set, no UI sessions nor any UI libraries are built. This can be useful when running a pure batch job or in a user framework having its own UI system.

Do you want to set this variable ? [n]

Press ENTER for the default 'no'.

G4UI\_BUILD\_XAW\_SESSION

G4UI\_USE\_XAW

Specifies to include and use the XAW interfaces in the application to be built. The XAW (X11 Athena Widget set) extensions are required to activate and build this driver. [n]

---

<sup>1</sup>See GEANT4 problem report 656 at [http://pcitapiww.cern.ch/asdcgi/geant4/problemreport/show\\_bug.cgi?id=656](http://pcitapiww.cern.ch/asdcgi/geant4/problemreport/show_bug.cgi?id=656)

Since GUI stuff must be compiled in and can not be easily activated later, it is recommended that one select 'yes' for this option.

```
G4UI_BUILD_XM_SESSION
```

```
G4UI_USE_XM
```

Specifies to include and use the XM Motif based user interfaces. The XM Motif extensions are required to activate and build this driver. [n]

Again, it is recommended that 'yes' be selected here.

```
G4VIS_NONE
```

If this variable is set, no visualization drivers will be built or used. Do you want to set this variable ? [n]

Press ENTER for 'no' or be unhappy.

```
G4VIS_BUILD_OPENGLX_DRIVER
```

```
G4VIS_USE_OPENGLX
```

It is an interface to the de facto standard 3D graphics library, OpenGL. It is well suited for real-time fast visualization and prototyping. The X11 version of the OpenGL libraries is required. [n]

Select 'yes' here. OpenGL is required for visualization as you would expect.

```
G4VIS_BUILD_OPENGLXM_DRIVER
```

```
G4VIS_USE_OPENGLXM
```

It is an interface to the de facto standard 3D graphics library, OpenGL. It is well suited for real-time fast visualization and prototyping. The X11 version of the OpenGL libraries and the Motif Xm extension is required. [n]

Again, select 'yes' here.

```
G4VIS_BUILD_DAWN_DRIVER
```

```
G4VIS_USE_DAWN
```

DAWN drivers are interfaces to the Fukui Renderer DAWN. DAWN is a vectorized 3D PostScript processor suited to prepare technical high quality outputs for presentation and/or documentation. [n]

Since postscript rendering requires DAWN, select 'yes' here.

```
G4VIS_BUILD_OIX_DRIVER
```

```
G4VIS_USE_OIX
```

The OpenInventor driver is based on OpenInventor technology for scientific visualization. The X11 version of OpenInventor is required. [n]

Select 'no'. If you know what this does and why it should be used, please edit this manual.

```
G4VIS_BUILD_VRML_DRIVER
G4VIS_USE_VRML
```

These driver generate VRML files, which describe 3D scenes to be visualized with a proper VRML viewer.

[n]

Select 'no'. If you know what this does and why it should be used, please edit this manual.

```
OGLHOME/include
OGLHOME/lib
```

You have selected to use OpenGL driver.

Specify the correct path (OGLHOME) where OpenGL is installed in your system.

It was found in:

```
[/usr]
```

Press ENTER unless the OpenGL library is kept somewhere different.

```
G4LIB_BUILD_G3TOG4
```

The utility module 'g3tog4' will be built by setting this variable. NOTE: it requires a valid FORTRAN compiler to be installed on your system and the 'cernlib' command in the path, in order to build the ancillary tools!

Do you want to build 'g3tog4' ?

[n]

Select 'yes' as it will be easier to select it now than have to recompile GEANT4. G3TOG4 stands for GEANT3 to GEANT4.

```
G4LIB_BUILD_ZLIB
```

Do you wish to activate compression for output files generated through the HepRep visualization driver ?

[n]

Press ENTER for 'no' unless you are using HepRep.

```
G4ANALYSIS_USE
```

Activates the configuration setup for allowing plug-ins to analysis tools based on AIDA (Abstract Interfaces for Data Analysis). In order to use AIDA features and compliant analysis tools, the proper environment for these tools will have to be set (see documentation for the specific analysis tools).

[n]

If you want to use AIDA select ‘yes’ here. AIDA is required for the built in histograms. If you will be using another system, such as Lucid, you may not need AIDA. However, it is easier to install here than compile later.

```
End of configuration phase.
```

```
Creating configuration setup file...
```

```
WARNING: the generated configuration file can be edited if necessary! You
can introduce any change to the configuration file
```

```
/home/ward/geant4/geant4.7.1/.config/bin/Linux-g++/config.sh before the
final installation. To do so, use a shell escape now (e.g. !vi
/home/ward/geant4/geant4.7.1/.config/bin/Linux-g++/config.sh).
```

```
Press [Enter] to start installation or use a shell escape to edit config.sh:
```

Press ENTER.

```
Now starting Geant4 libraries build...
```

Configuration of GEANT4 is done. The program should now compile. On a 1.8 GHz Pentium IV it took about 4 hours to compile GEANT4.7.1. See Appendix A for a listing of the set environment variables.

### 3.3 Environment Variables and Directories

After the program has finished compiling, the Configure script needs to be run again without the `-build` flag.

```
./Configure
```

This will create the files `env.csh` and `env.sh`. If using Bash, type

```
source env.sh
```

or for C-shell type

```
source env.csh
```

to set the GEANT4 environment variables as listed in Appendix A. The environment variables must be set before running or compiling GEANT4 applications.

When applications are compiled using the GEANT4 makefiles, the binaries will be placed in `$HOME/geant4/bin/Linux-g++`. This directory must be added to the path. Using bash syntax:

```
export PATH=$PATH:$HOME/geant4/bin/Linux-g++
```

For C-shell substitute `setenv` for `export`. Also, the libraries will be placed in

`$HOME/geant4/geant4.7.1/lib/Linux-g++` and this directory must be either added to the file `/etc/ld.so.conf` or `LD_LIBRARY_PATH` in order for GEANT4 applications to find the shared libraries when they are run.

```
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:$G4LIB/Linux-g++
```

It is more convenient to add these two lines to a script, such as `env.sh` or `env.csh` than type them in manually.

### 3.4 Examples

Now that GEANT4 has been installed, it should be tested by running a few examples. The examples can be found in `$HOME/geant4/geant4.7.1/examples` and one should start with `novice/N01`. When in the `N01` directory, type

```
make
```

to compile the example and

```
exampleN01
```

to run the example. The tracking information for three geantino, imaginary particles should be displayed on the console.

Now, to test the OpenGL libraries goto the second example, which is in the directory `N02`. Type

```
make
```

```
exampleN02
```

to compile and start the program. Two things should happen. First, an OpenGL window should open showing the geometry of the system. Second, a prompt should appear on the console. Typing

```
/run/beamOn
```

will cause a blue, positive particle to cross the screen. At this point, it is safe to say that the OpenGL portion of GEANT4 is working.

Congratulations! The basic installation of GEANT4 is complete. For some examples, such as `N04`, require physics lists to be installed. The next section will describe this step.

### 3.5 Compiling the GEANT4 Physics Lists

The GEANT4 physics lists are pre-defined physics lists for different applications. Some examples and programs that consider hadronic interactions require them so one may need to compile them.

Go to the directory that contains the physics lists

```
cd $HOME/genat4/geant4.7.1/physics_lists/hadronic/
```

and type

```
make
```

to compile all of the physics lists.

Ideally we could now use the shared libraries build by the above `make`. Due to GEANT4 problem report 656<sup>2</sup> we cannot use granular libraries and the shared physics list libraries at the same time. Instead we need to use static libraries. The easiest way to force programs to use the static libraries is to go to the library directory

```
cd $HOME/genat4/geant4.7.1/lib/plists/Linux-g++
```

and remove the shared libraries.

```
rm *.so
```

Assuming that static libraries have been built, they will now be used. When problem report 656 is resolved, this last step will become unnecessary.

It is now possible to compile and run example `N04`.

---

<sup>2</sup>More information at [http://pcitapiww.cern.ch/asdcgi/geant4/problemreport/show\\_bug.cgi?id=656](http://pcitapiww.cern.ch/asdcgi/geant4/problemreport/show_bug.cgi?id=656)

## 4 DAWN Postscript

The Drawer for Academic WritiNgs (DAWN) is used to output images to the postscript format. It is used alongside the OpenGL display.

### 4.1 Getting and Installing DAWN

DAWN can be obtained from reference [DAWN] and the current version as of writing this document is 3.86a. Download the source file to a temporary directory and untar it using the command

```
tar -zxvf dawn_3_86a.taz
```

and change to the new directory.

```
cd dawn_3_86a
```

There will be a configure script that is similar to the GEANT4 configure script. Running

```
./configure
```

will cause the script to prompt for input. It asks a few questions and the answers should be

```
C++ compiler : g++
Optimization level : -O2
Tcl/Tk window shell : wish
Xlib include directory : -I/usr/X11R6/include
Xlib lib directory : -L/usr/X11R6/lib
OpenGL include directory: -I/usr/include
-I/usr/include/GL
OpenGL lib directory : -L/usr/lib
OpenGL libraries : -lGLU -lGL
Socket libraries :
System name : Default
Remote visualization : n
```

Type "make" to start compilation.

After compilation, type "make install" for installation.

Then four executable files "dawn", "DAWN\_GUI", "dawnunixd", and "dawninetd" will be installed to /home/ward/bin.

noticing that the optimization flag uses a letter 'O' rather than the number 'zero'. When asked where to install dawn, you cannot use the environment variable \$HOME. Instead use /home/ward/bin and replace 'ward' with your user name. Type

```
make
make install
```

to compile and install DAWN.

## 4.2 Using DAWN

Before using DAWN, one can set two optional environment variables. A script to set these variables would look like

```
export G4DAWNFILE_DEST_DIR=[directory to store information for DAWN]
echo "Set G4DAWNFILE_DEST_DIR=$G4DAWNFILE_DEST_DIR"
export G4DAWNFILE_MAX_FILE_NUM=1000
echo "Set G4DAWNFILE_MAX_FILE_NUM=$G4DAWNFILE_MAX_FILE_NUM"
```

Setting these variables is optional and DAWN will use the present working directory to store its files if these options are not set. Do not forget the '/' at the end of the directory name.

When GEANT4 is running, at the command prompt, type the commands

```
/vis/open DAWNFILE
/vis/viewer/refresh
```

to create the file `g4_00.prim`. This file can then be used by DAWN to construct three-dimensional representations of the GEANT4 geometry.

```
dawn g4_00.prim
```

Navigate through the options using the '«' and '»' GUI buttons. Once all the options have been set, press 'OK' to see the image.

## 5 Conclusion

Now that GEANT4 is installed, refer to the examples and the documentation on the GEANT4 web-site [G4Web] for more information on how to use the software.

## A Environment Variables set by GEANT4's Configure Script

```
On this machine the G4SYSTEM=Linux-g++
On this machine the G4INSTALL=/home/ward/geant4/geant4.7.1
On this machine the G4INCLUDE=/home/ward/geant4/geant4.7.1/include
On this machine the G4TMP=/home/ward/geant4/geant4.7.1/tmp
On this machine the G4LIB=/home/ward/geant4/geant4.7.1/lib
On this machine the G4LEVELGAMMADATA=/home/ward/geant4/data/PhotonEvaporation
On this machine the G4RADIOACTIVEDATA=/home/ward/geant4/data/RadiativeDecay
On this machine the G4LEDDATA=/home/ward/geant4/data/G4EMLow3.0
On this machine the NeutronHPCrossSections=/home/ward/geant4/data/G4NDL3.7
On this machine the G4ELASTICDATA=/home/ward/geant4/data/G4ELASTIC1.1
On this machine the CLHEP_BASE_DIR=/home/ward
On this machine the CLHEP_INCLUDE_DIR=/home/ward/include
On this machine the CLHEP_LIB_DIR=/home/ward/lib
```

On this machine the CLHEP\_LIB=CLHEP  
On this machine the G4ANALYSIS\_USE=1  
On this machine the G4UI\_BUILD\_XAW\_SESSION=1  
On this machine the G4UI\_USE\_XAW=1  
On this machine the G4UI\_BUILD\_XM\_SESSION=1  
On this machine the G4UI\_USE\_XM=1  
On this machine the G4VIS\_BUILD\_DAWN\_DRIVER=1  
On this machine the G4VIS\_BUILD\_OPENGLX\_DRIVER=1  
On this machine the G4VIS\_BUILD\_OPENGLXM\_DRIVER=1  
On this machine the G4VIS\_USE\_DAWN=1  
On this machine the G4VIS\_USE\_OPENGLX=1  
On this machine the G4VIS\_USE\_OPENGLXM=1  
On this machine the G4LIB\_BUILD\_G3TOG4=1  
On this machine the G4LIB\_USE\_G3TOG4=1  
On this machine the G4LIB\_BUILD\_SHARED=1  
On this machine the G4LIB\_BUILD\_STATIC=1  
On this machine the G4LIB\_USE\_GRANULAR=1

## References

[CLHEP] *CLHEP Web-site*. <http://wwwasd.web.cern.ch/wwwasd/lhc++/clhep/>

[G4NIM] GEANT4 Collaboration. *Nucl. Instr. And Meth. A* 503 (2003) 250.

[G4Web] *GEANT4 Web-site*. <http://geant4.web.cern.ch/geant4/>

[DAWN] Tanaka, S. *DAWN Web-site* <http://geant4.kek.jp/~tanaka/>

All web-sites are accurate as of 6 July 2005.