
How to Install and Run vGATE (CT example)

Han Gyu Kang

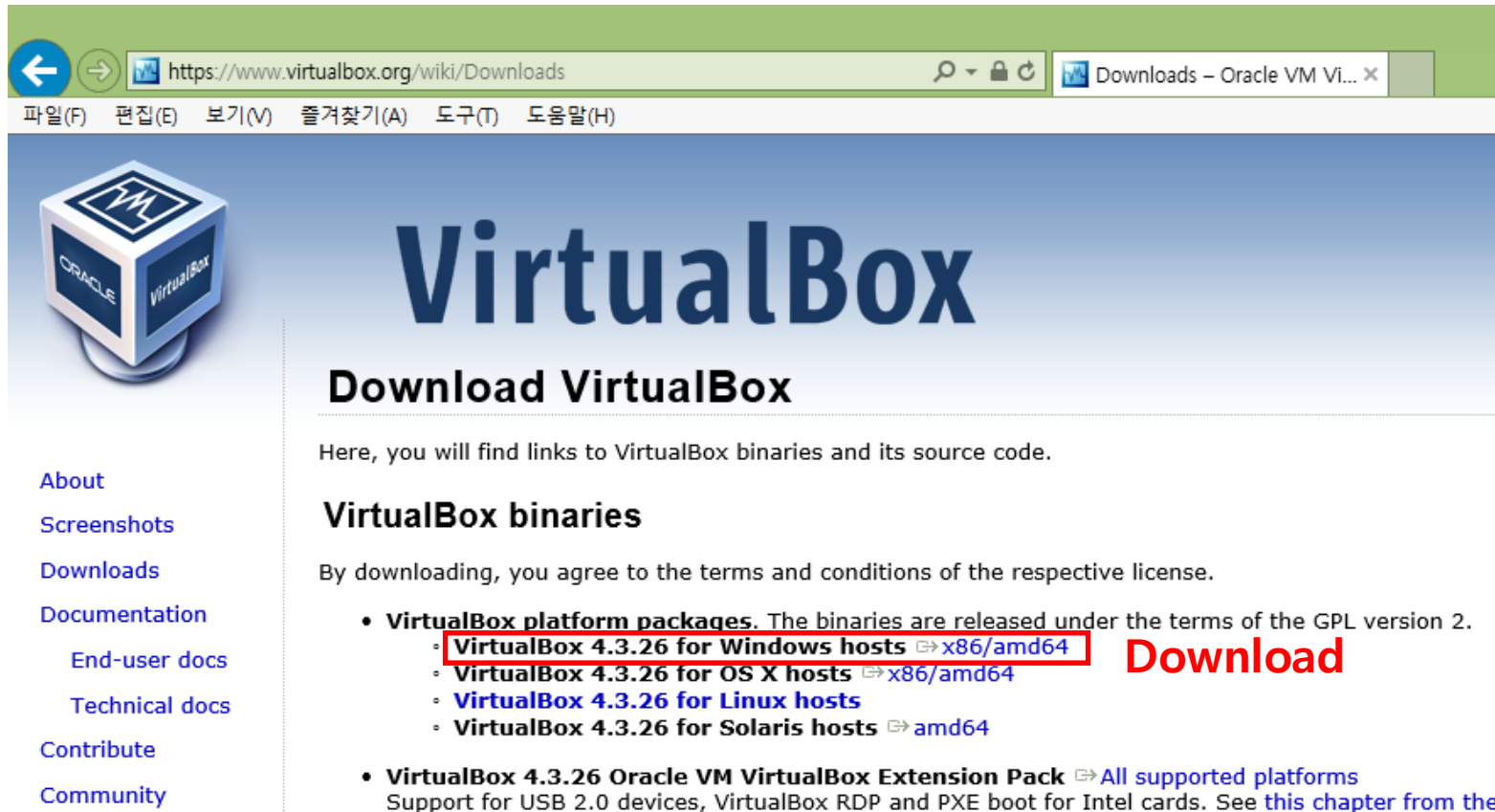
National Institute of Radiological Sciences (NIRS) in National
Institutes for Quantum and Radiological Science and Technology (QST)
2018.07.18.(Wednesday)

How to Install and Run vGATE

- 1. Virtual Box installation
- 2. Install vGATE 3.0 on the virtual box
- 4. How to run **CT_example** GATE simulation
- 5. How to analyze the ROOT output file
- 6. Install the recent version ROOT

Virtual Box download

- 1. Virtual Box download
 - <https://www.virtualbox.org/wiki/Downloads>



The screenshot shows a web browser window with the URL <https://www.virtualbox.org/wiki/Downloads>. The page features the VirtualBox logo on the left and a navigation menu with links for About, Screenshots, Downloads, Documentation, End-user docs, Technical docs, Contribute, and Community. The main content area is titled "Download VirtualBox" and includes a sub-section "VirtualBox binaries". A list of download links is provided, with "VirtualBox 4.3.26 for Windows hosts" highlighted in a red box and labeled "Download".

VirtualBox

Download VirtualBox

Here, you will find links to VirtualBox binaries and its source code.

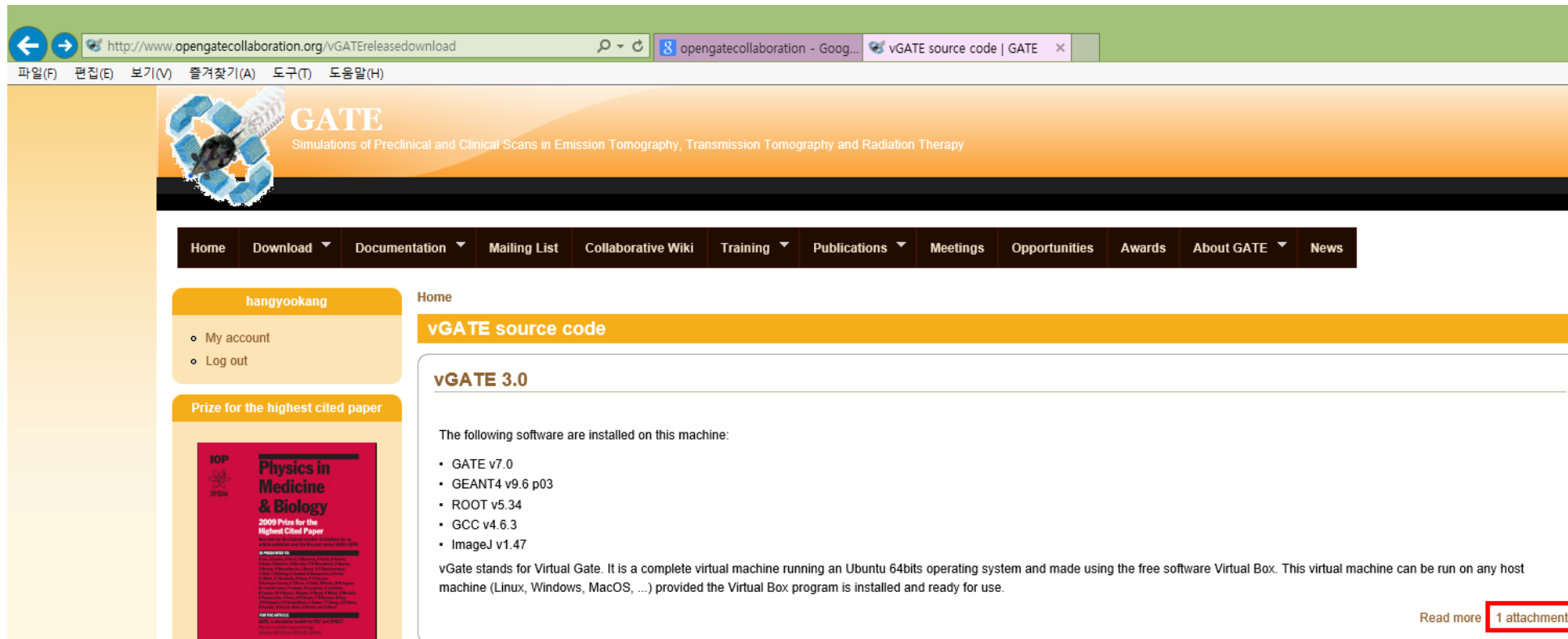
VirtualBox binaries

By downloading, you agree to the terms and conditions of the respective license.

- **VirtualBox platform packages.** The binaries are released under the terms of the GPL version 2.
 - **VirtualBox 4.3.26 for Windows hosts** ⇨ x86/amd64 **Download**
 - **VirtualBox 4.3.26 for OS X hosts** ⇨ x86/amd64
 - **VirtualBox 4.3.26 for Linux hosts**
 - **VirtualBox 4.3.26 for Solaris hosts** ⇨ amd64
- **VirtualBox 4.3.26 Oracle VM VirtualBox Extension Pack** ⇨ [All supported platforms](#)
Support for USB 2.0 devices, VirtualBox RDP and PXE boot for Intel cards. See [this chapter from the I](#)

vGATE 3.0 download

- 1. vGATE 3.0 download
 - <http://www.opengatecollaboration.org/vGATEreleasedownload>



The screenshot shows a web browser window with the URL <http://www.opengatecollaboration.org/vGATEreleasedownload>. The page features the GATE logo and navigation menu. The main content area is titled "vGATE source code" and includes a section for "vGATE 3.0" with a list of installed software and a description of the virtual machine.

GATE
Simulations of Preclinical and Clinical Scans in Emission Tomography, Transmission Tomography and Radiation Therapy

Home Download Documentation Mailing List Collaborative Wiki Training Publications Meetings Opportunities Awards About GATE News

hangyookang

- My account
- Log out

Prize for the highest cited paper

Physics in Medicine & Biology
2009 Prize for the Highest Cited Paper

vGATE 3.0

The following software are installed on this machine:

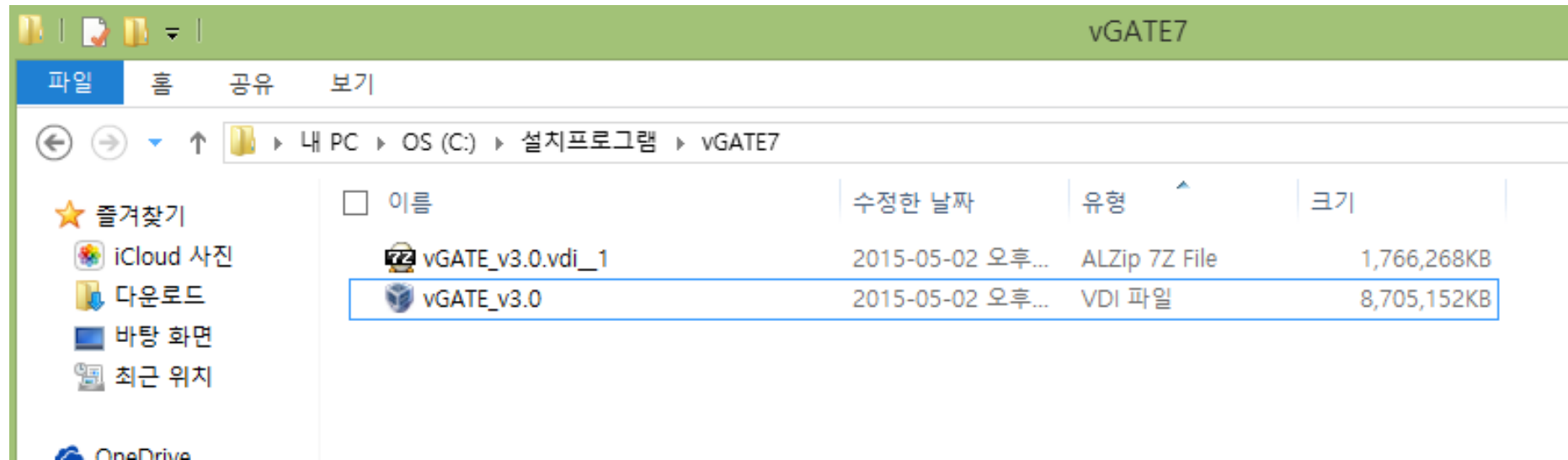
- GATE v7.0
- GEANT4 v9.6 p03
- ROOT v5.34
- GCC v4.6.3
- ImageJ v1.47

vGate stands for Virtual Gate. It is a complete virtual machine running an Ubuntu 64bits operating system and made using the free software Virtual Box. This virtual machine can be run on any host machine (Linux, Windows, MacOS, ...) provided the Virtual Box program is installed and ready for use.

Read more [1 attachment](#) **download**

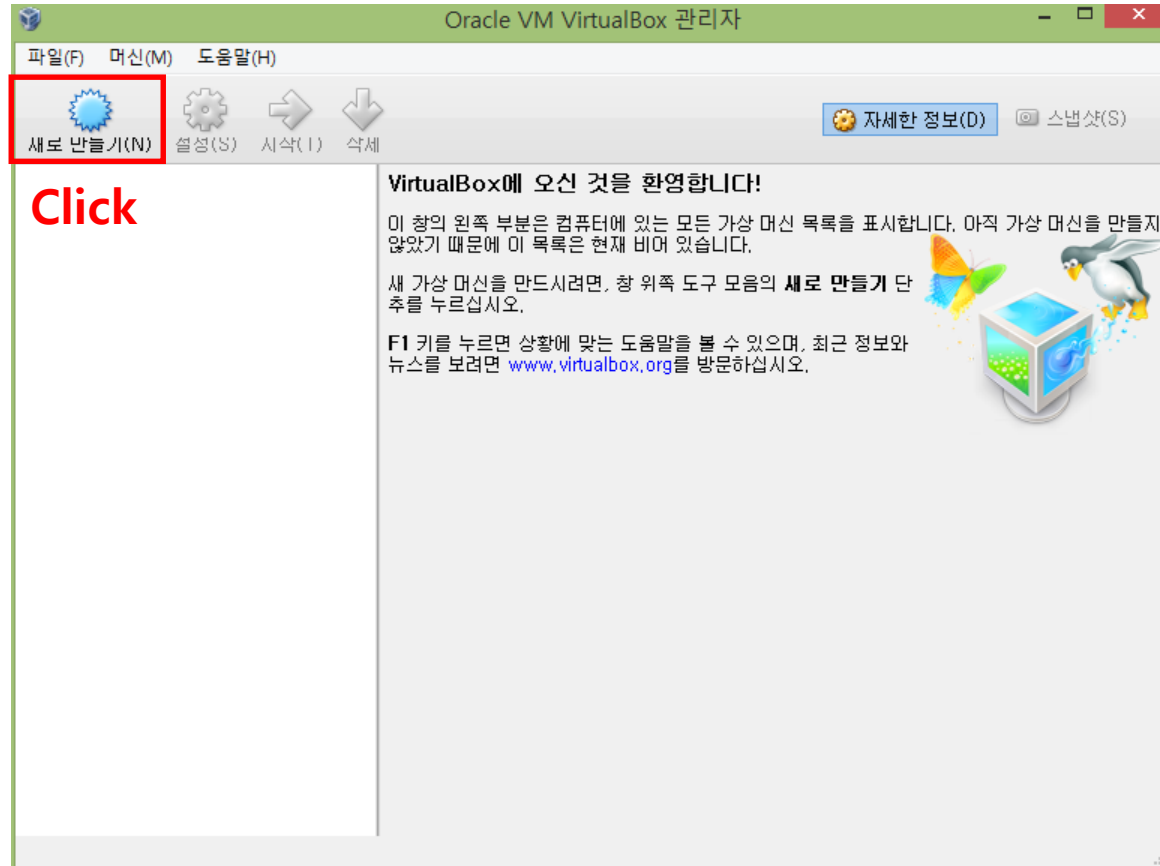
Extract the “vGATE_v3.0.vid_1” file

“vGATE_v3.0.vid” file is generated after the extraction of “vGATE_v3.0.vid_1”

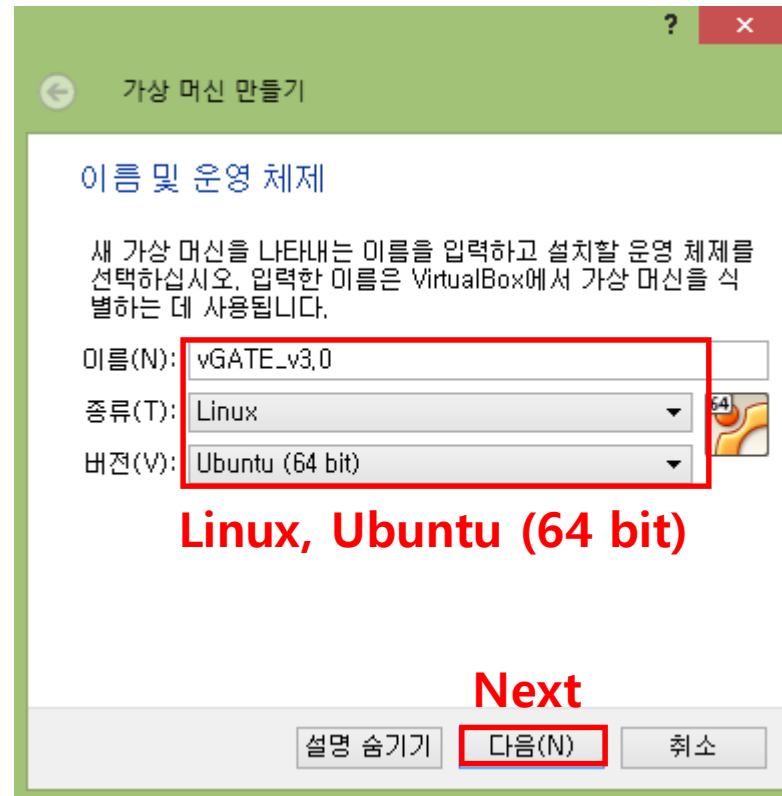


Virtual box

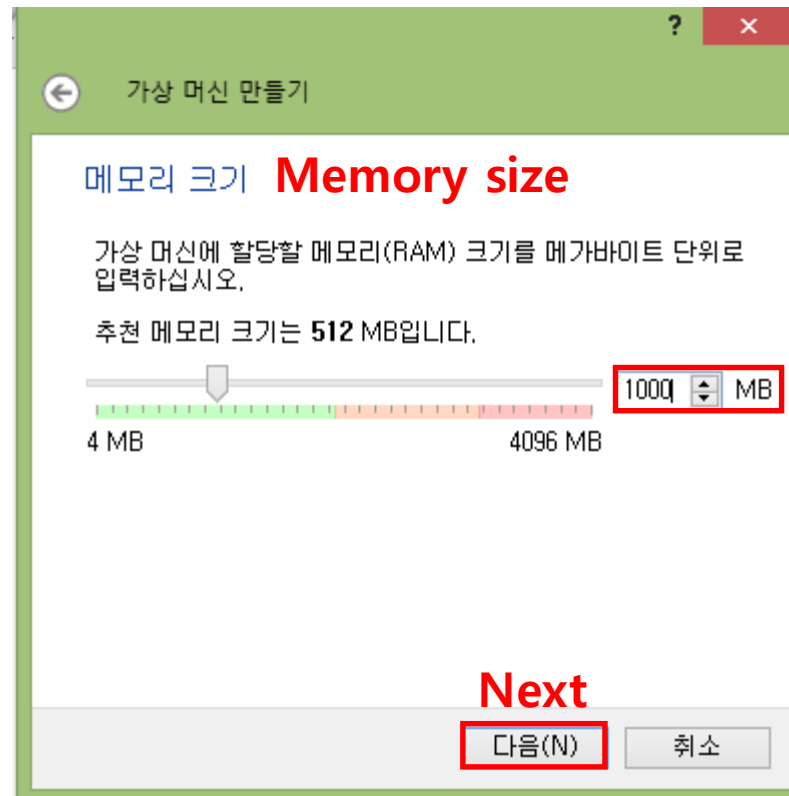
" 새로 만들기(New)" 클릭



Linux, Ubuntu(64 bit)



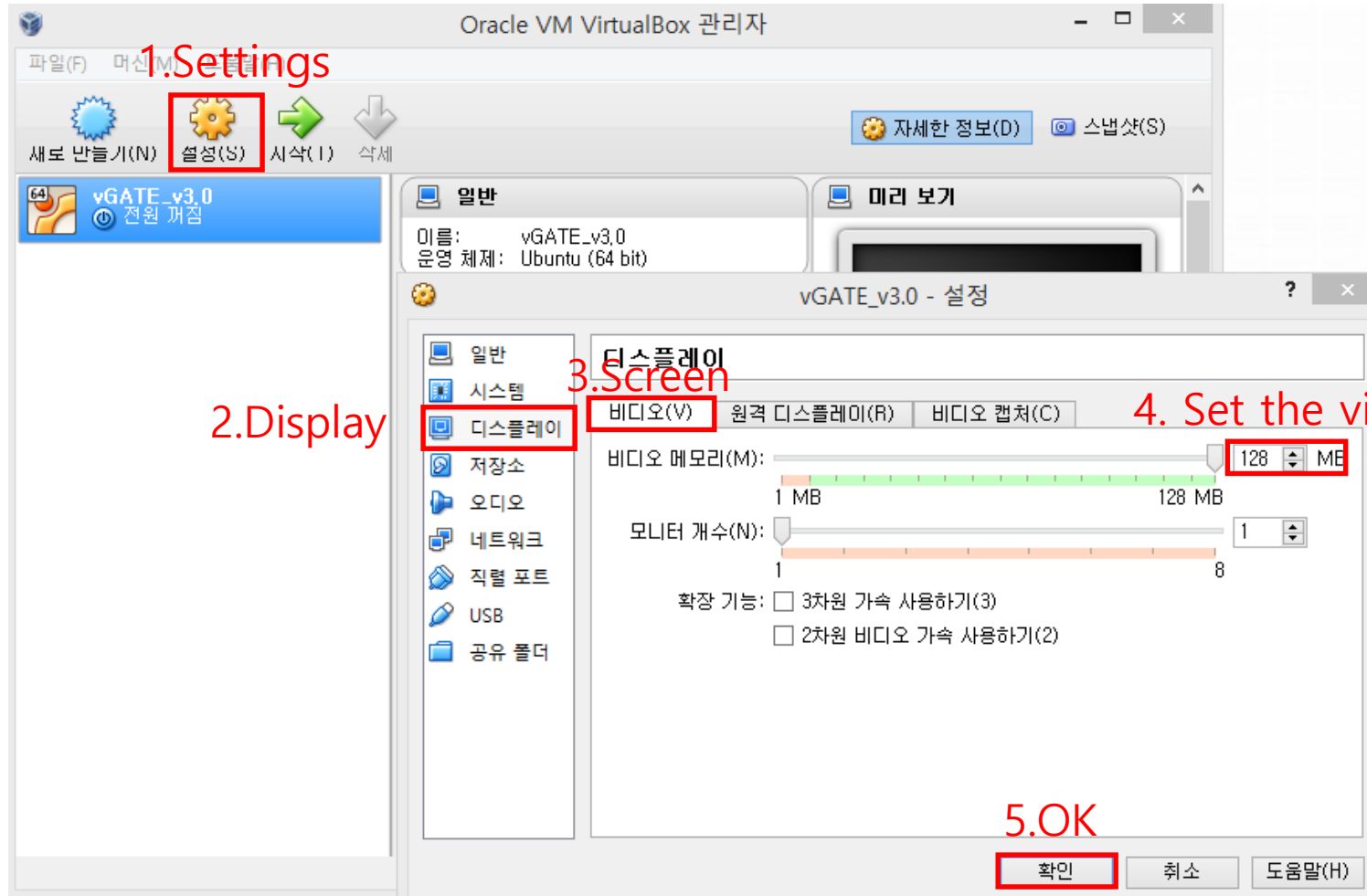
Change the memory size: 512 MB -> 1000 MB



512 MB -> 1000 MB

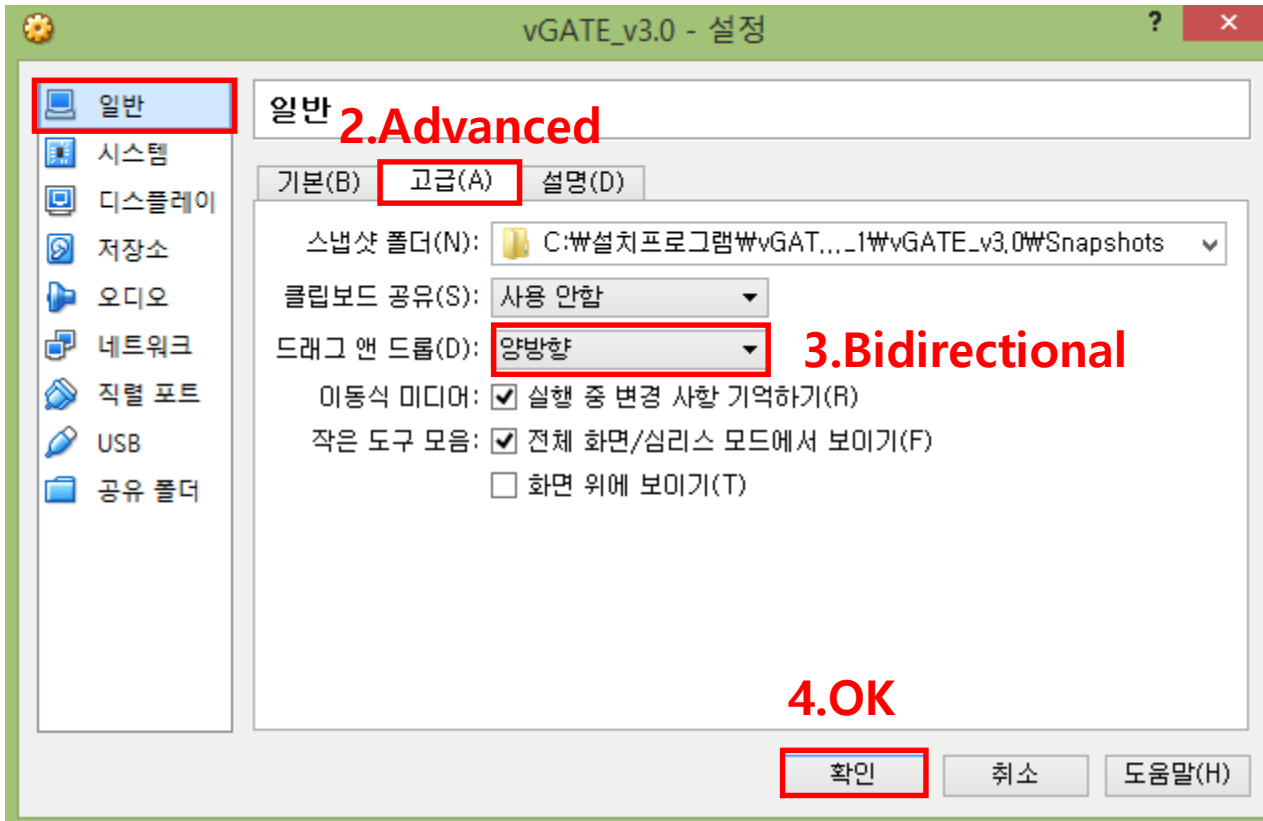


Settings-> Display -> Screen ->Set the Video memory -> OK



Setting -> General -> Advanced -> Drag and drop -> Bidirectional

1.General

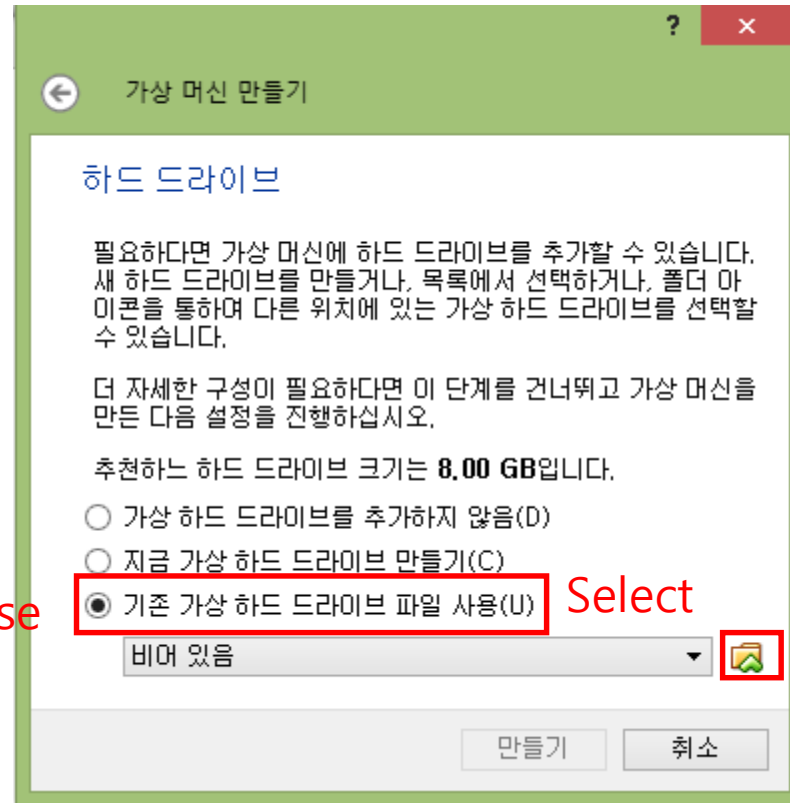


2.Advanced

3.Bidirectional

4.OK

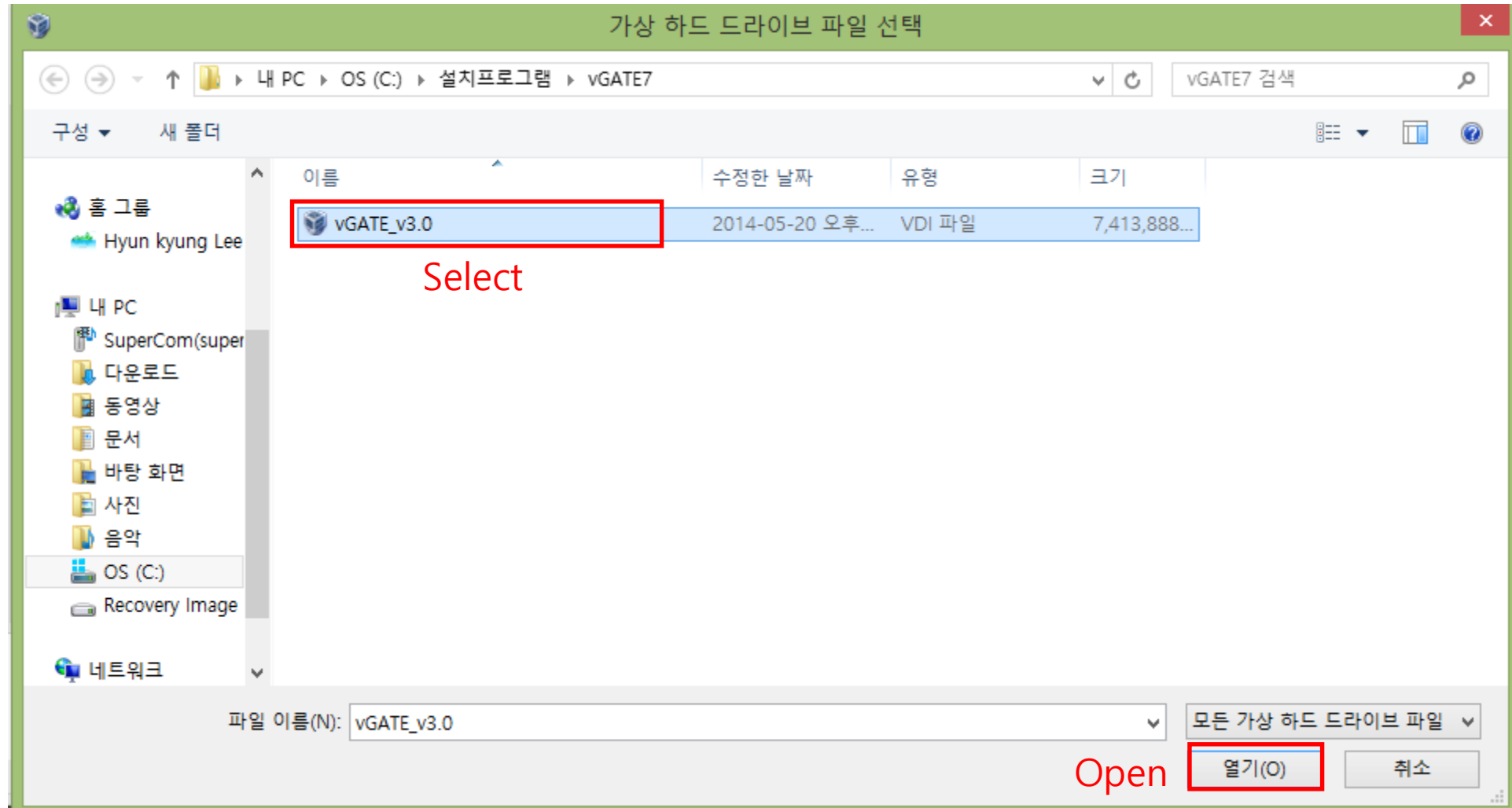
Create a virtual machine



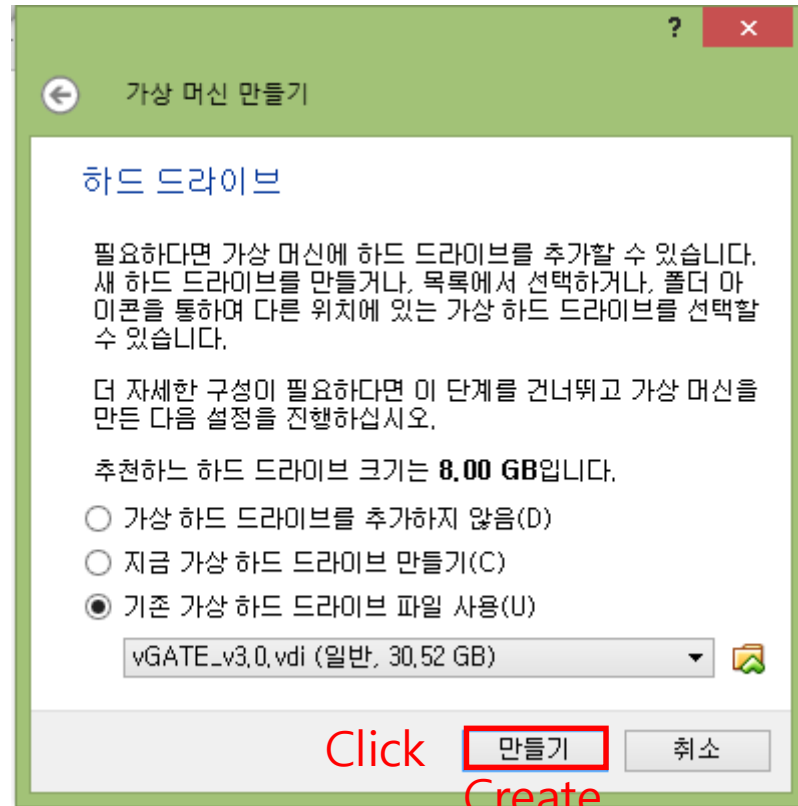
Existing virtual hard drive file use

Click

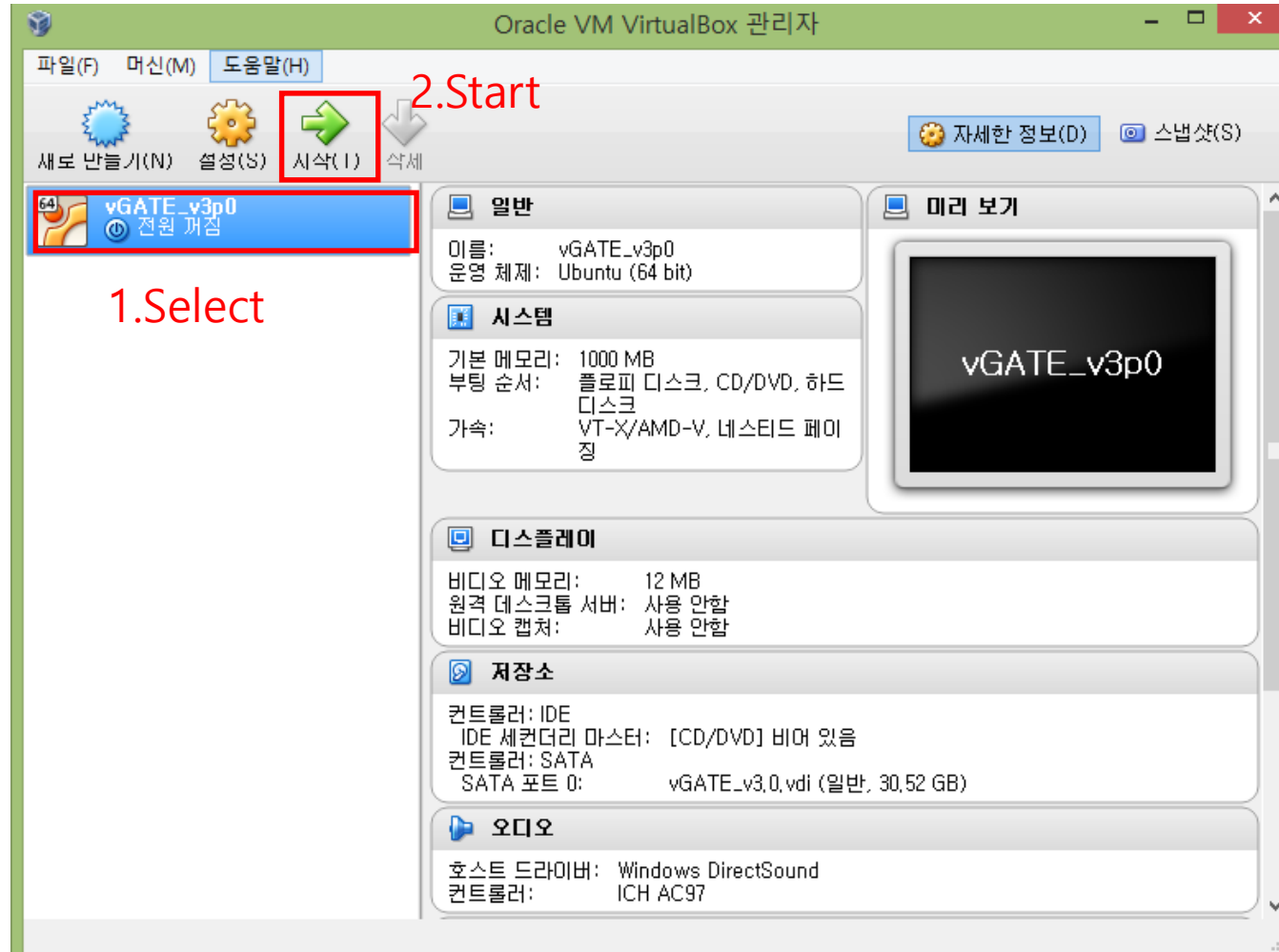
Select "vGATE_v3.0.vid" file



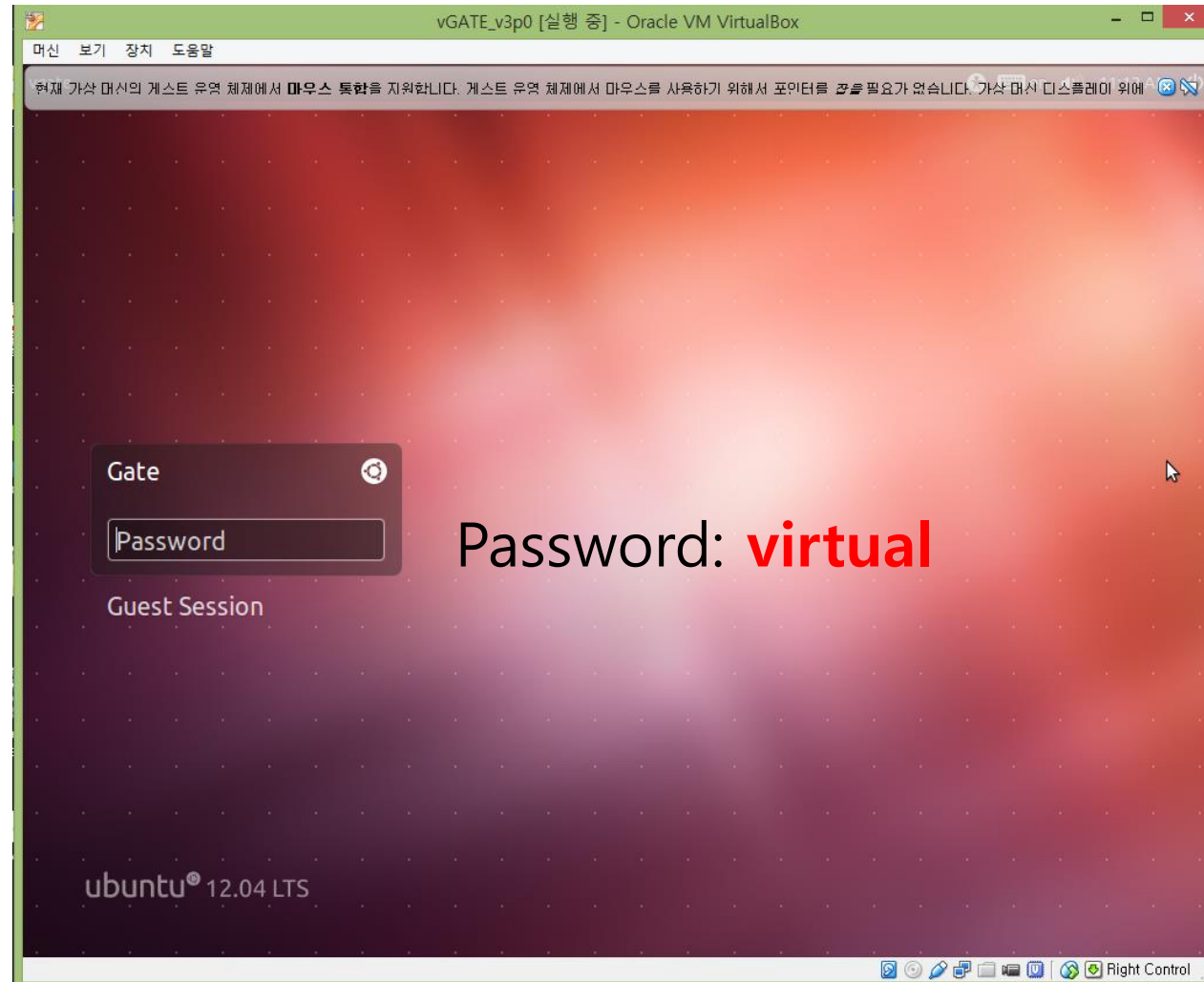
Create virtual machine (vGATE_v3.0.vid file is selected)



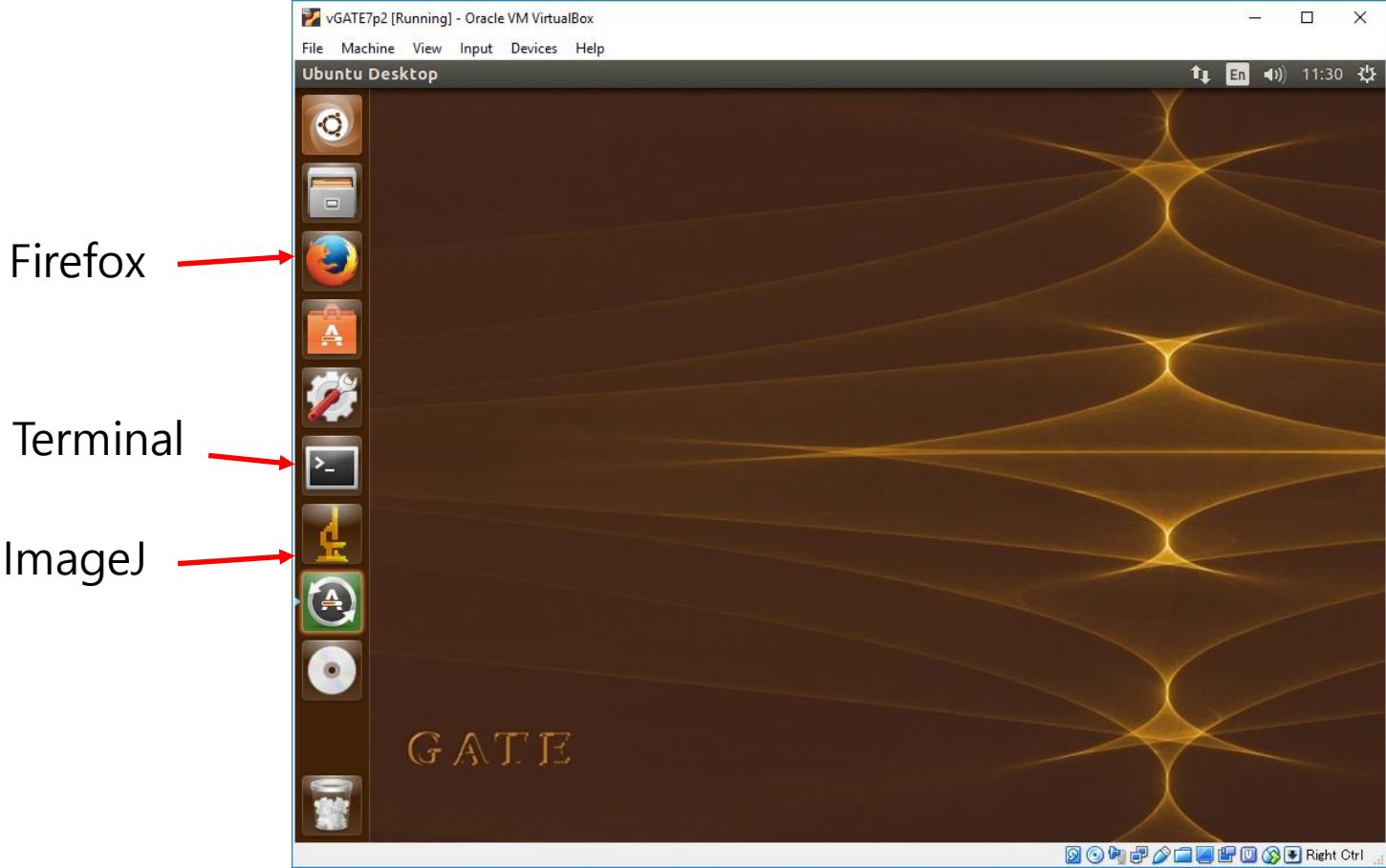
Run the vGATE_v3.0



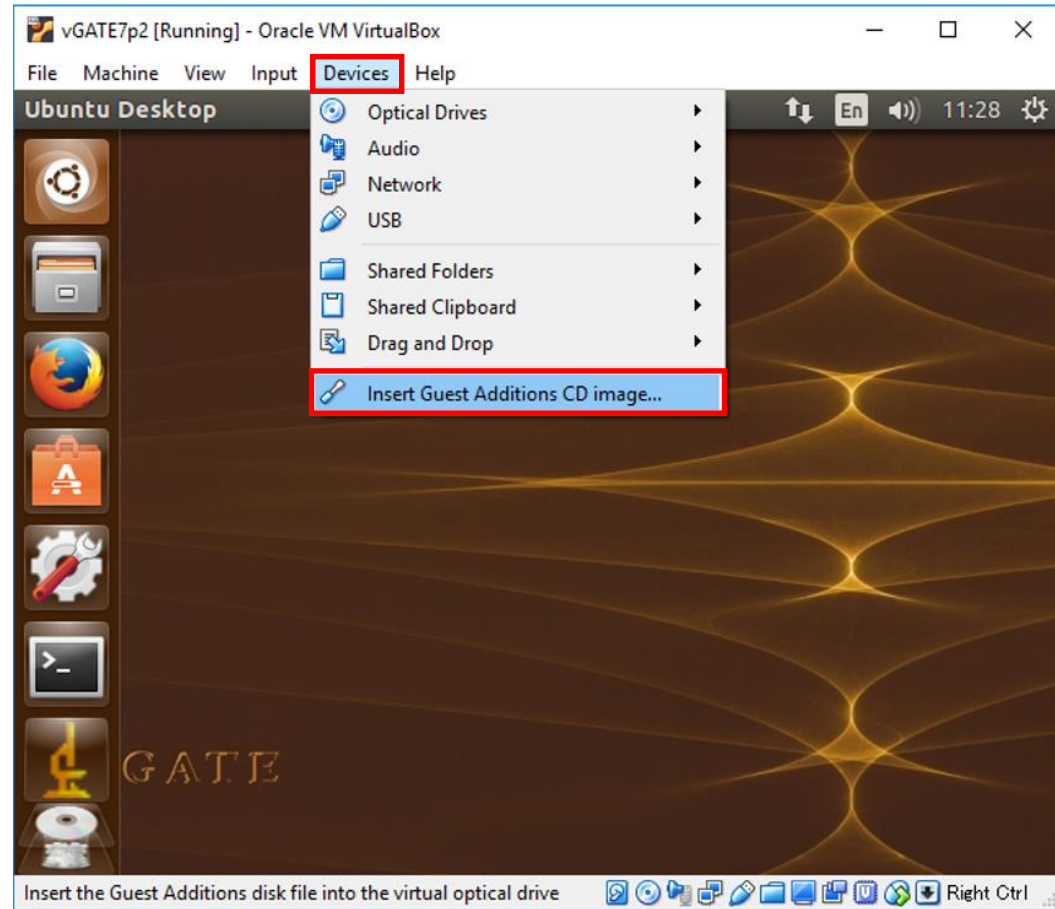
Password : **virtual**



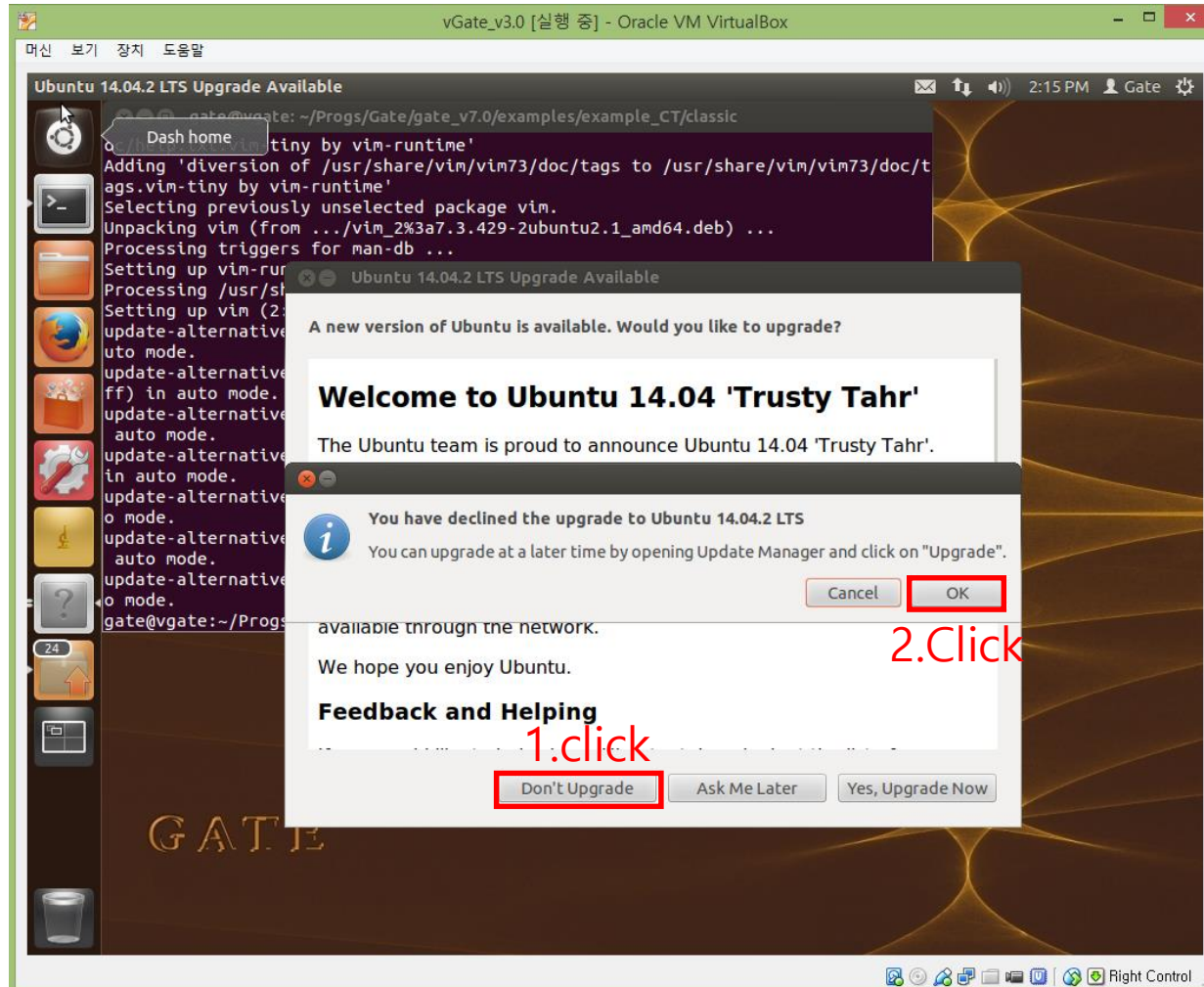
vGATE_v3.0 screen



How to improve the screen resolution (Device->Insert Guest Additions CD image)

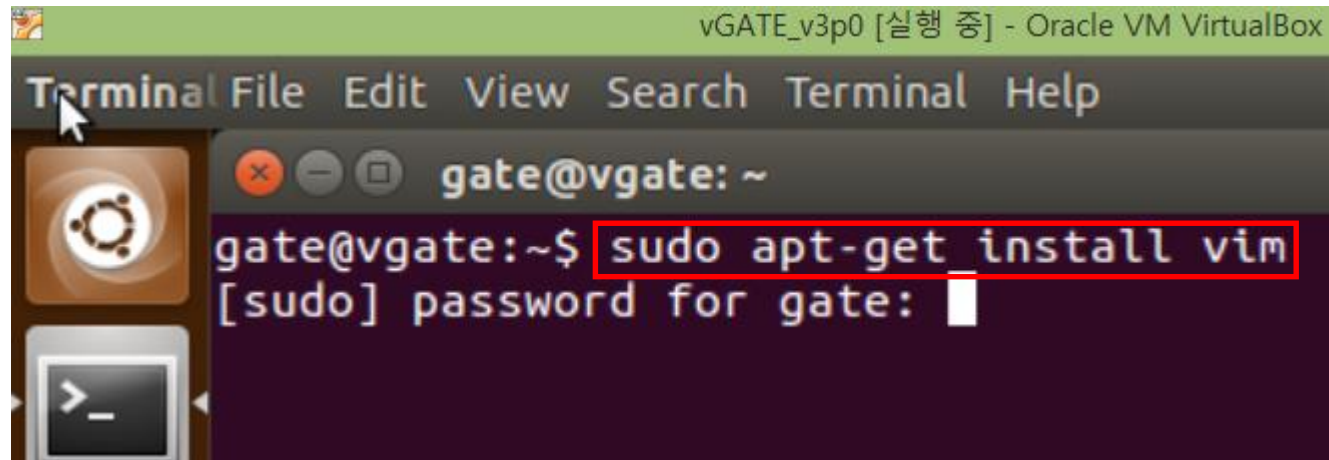


Click "Don't Upgrade"



Vi editor installation

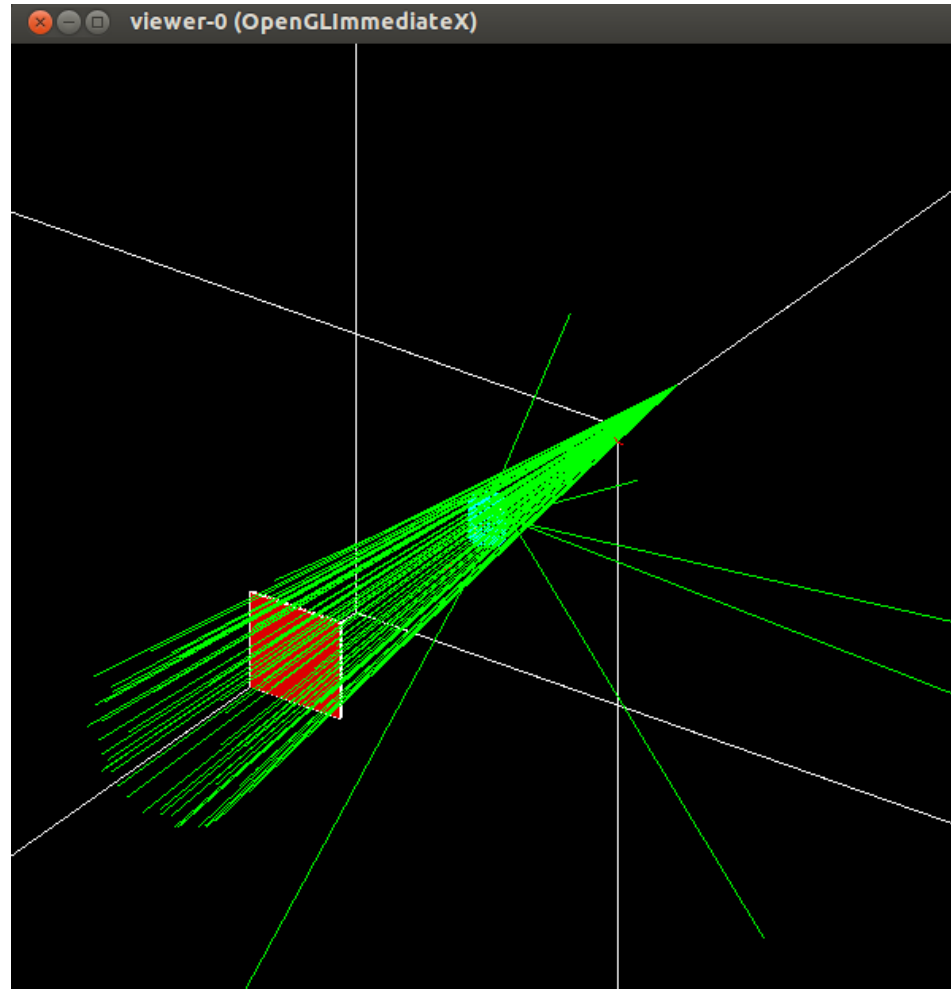
Open a terminal and run the below command
sudo apt-get install vim



```
vGATE_v3p0 [실행 중] - Oracle VM VirtualBox
Terminal File Edit View Search Terminal Help
gate@vgate: ~
gate@vgate:~$ sudo apt-get install vim
[sudo] password for gate: 
```

Password: **virtual**

How to run the "CT example" (small animal CT)



CT example simulation method(1) **small animal CT!**

1. Move to the CT example folder

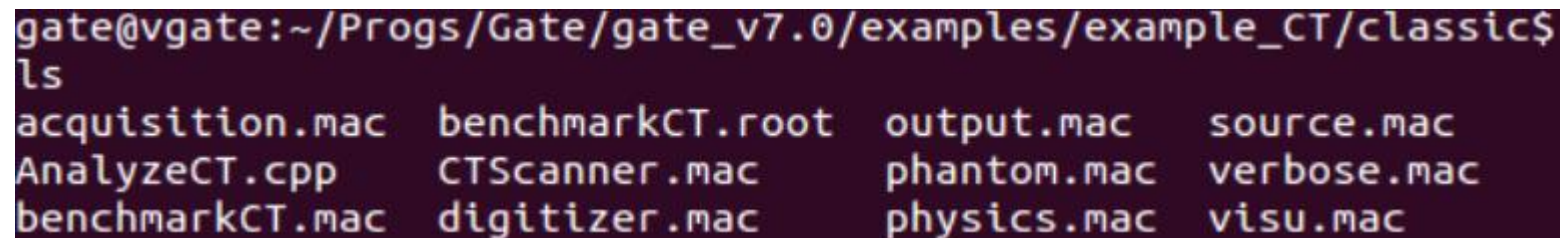
cd /home/gate/Progs/Gate/gate_v7.0/examples/example_CT/classic



```
gate@vgate: ~  
gate@vgate:~$ cd /home/gate/Progs/Gate/gate_v7.0/examples/example_CT/classic
```

2. Check the file list in the example_CT/classic folder

ls



```
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$  
ls  
acquisition.mac  benchmarkCT.root  output.mac  source.mac  
AnalyzeCT.cpp   CTScanner.mac    phantom.mac  verbose.mac  
benchmarkCT.mac  digitizer.mac    physics.mac  visu.mac
```

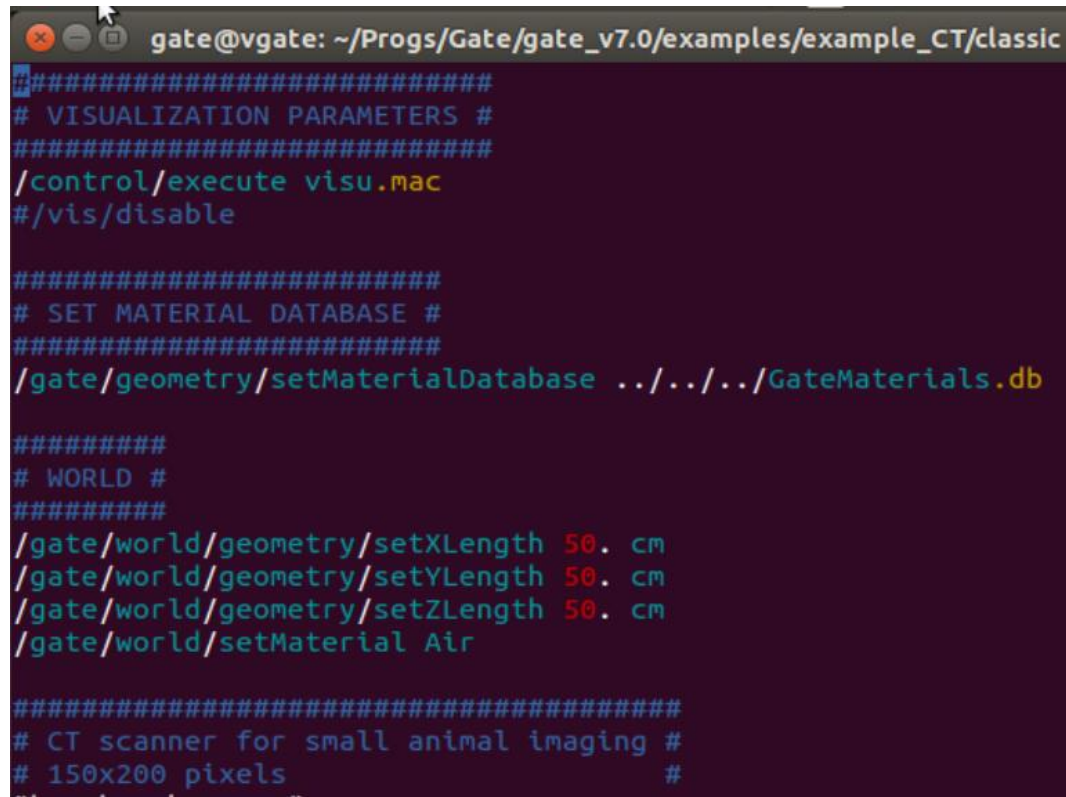
CT example simulation method(2)

3. Open the benchmarkCT.mac file using Vi editor

Vi benchmarkCT.mac

```
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$  
vi benchmarkCT.mac
```

4. benchmarkCT.mac file with Vi editor



```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic  
#####  
# VISUALIZATION PARAMETERS #  
#####  
/control/execute visu.mac  
#/vis/disable  
  
#####  
# SET MATERIAL DATABASE #  
#####  
/gate/geometry/setMaterialDatabase ../../../../GateMaterials.db  
  
#####  
# WORLD #  
#####  
/gate/world/geometry/setXLength 50. cm  
/gate/world/geometry/setYLength 50. cm  
/gate/world/geometry/setZLength 50. cm  
/gate/world/setMaterial Air  
  
#####  
# CT scanner for small animal imaging #  
# 150x200 pixels #
```


CT example simulation method (3)

5. Change to the "insert mode" by typing **insert** key

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
#####
# VISUALIZATION PARAMETERS #
#####
/control/execute visu.mac
#/vis/disable

#####
# SET MATERIAL DATABASE #
#####
/gate/geometry/setMaterialDatabase ../../../../GateMaterials.db

#####
# WORLD #
#####
/gate/world/geometry/setXLength 50. cm
/gate/world/geometry/setYLength 50. cm
/gate/world/geometry/setZLength 50. cm
/gate/world/setMaterial Air

#####
# CT scanner for small animal imaging #
# 150x200 pixels #

-- INSERT --
```

insert mode

CT example simulation method(4)

6.Enable the visualization by changing as below in the vi editor

(Before) `#!/control/execute visu.mac` -> (After) `/control/execute visu.mac`
(Before) `/vis/disable` -> (After) `#!/vis/disable`
`/gate/world/vis/forceWireframe` (Added)

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
# VISUALIZATION PARAMETERS #
#####
/control/execute visu.mac
#/vis/disable

#####
# SET MATERIAL DATABASE #
#####
/gate/world/vis/forceWireframe

#####
# WORLD #
#####
/gate/world/geometry/setXLength 50. cm
/gate/world/geometry/setYLength 50. cm
/gate/world/geometry/setZLength 50. cm
/gate/world/setMaterial Air

#####
# CT scanner for small animal imaging #
# 150x200 pixels #
#

-- INSERT --
```

Added

insert mode

CT example simulation method(5)

7. Write and quit from vi editor (Click **Esc** button -> **shift+:** -> **wq**)

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
#####
# VISUALIZATION PARAMETERS #
#####
/control/execute visu.mac
#/vis/disable

#####
# SET MATERIAL DATABASE #
#####
/gate/geometry/setMaterialDatabase ../../../../GateMaterials.db

#####
# WORLD #
#####
/gate/world/geometry/setXLength 50. cm
/gate/world/geometry/setYLength 50. cm
/gate/world/geometry/setZLength 50. cm
/gate/world/setMaterial Air

#####
# CT scanner for small animal imaging #
# 150x200 pixels #
:wq
```

w: write
w: quit

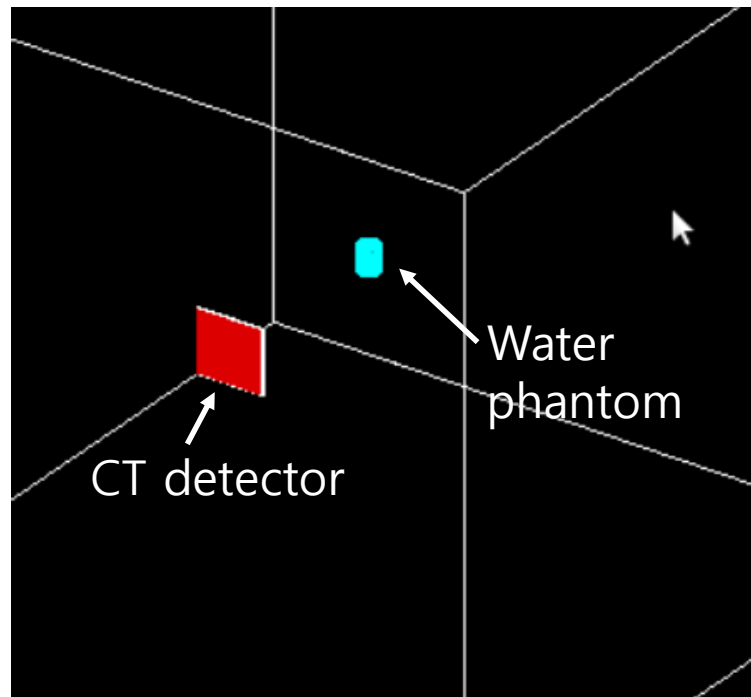
CT example simulation method(6) **small animal CT!**

8.Run the GATE simulation using the below command!

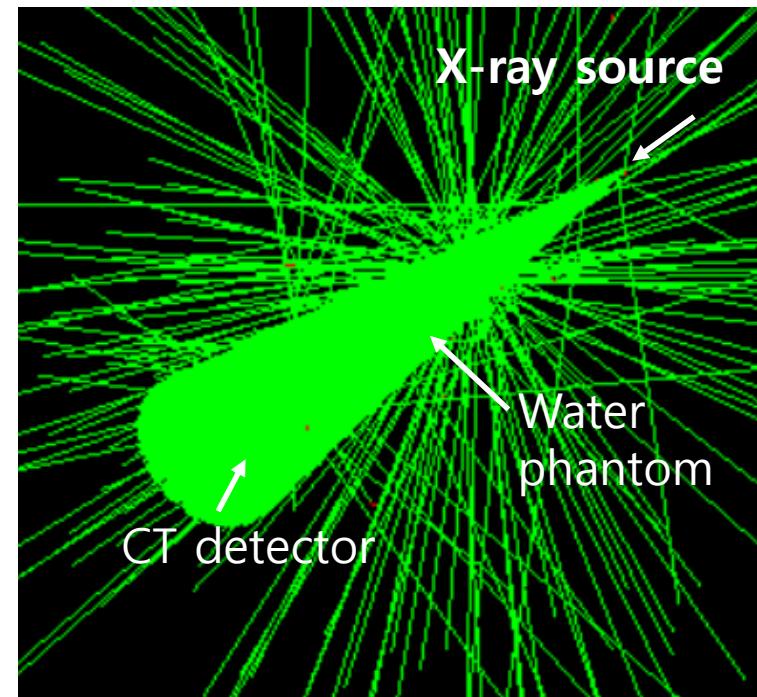
Gate benchmarkCT.mac

```
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$  
Gate benchmarkCT.mac
```

GATE simulation (W/O X-ray)



GATE simulation (W/ X-ray)



Green: X-ray

Analyze the CT example output file using ROOT (1)

Open the root file using ROOT software

root benchmarkCT.root

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$ ls -sorth
total 3.6M
4.0K -rw-rw-r-- 1 gate 191 May 12 2014 visu.mac
4.0K -rw-rw-r-- 1 gate 218 May 12 2014 verbose.mac
16K -rw-rw-r-- 1 gate 13K May 12 2014 source.mac
4.0K -rw-rw-r-- 1 gate 687 May 12 2014 physics.mac
4.0K -rw-rw-r-- 1 gate 1.8K May 12 2014 phantom.mac
4.0K -rw-rw-r-- 1 gate 459 May 12 2014 output.mac
4.0K -rw-rw-r-- 1 gate 322 May 12 2014 digitizer.mac
4.0K -rw-rw-r-- 1 gate 2.1K May 12 2014 CTScanner.mac
16K -rw-rw-r-- 1 gate 15K May 12 2014 AnalyzeCT.cpp
4.0K -rw-rw-r-- 1 gate 1.6K May 2 14:19 benchmarkCT.mac
4.0K -rw-rw-r-- 1 gate 613 May 2 14:19 acquisition.mac
40K -rw-rw-r-- 1 gate 40K May 2 14:20 benchmarkCT_000.dat
3.5M -rw-r--r-- 1 gate 3.5M May 2 14:20 benchmarkCT.root
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$ root benchmarkCT.root
```

Analyze the CT example output file using ROOT (2)

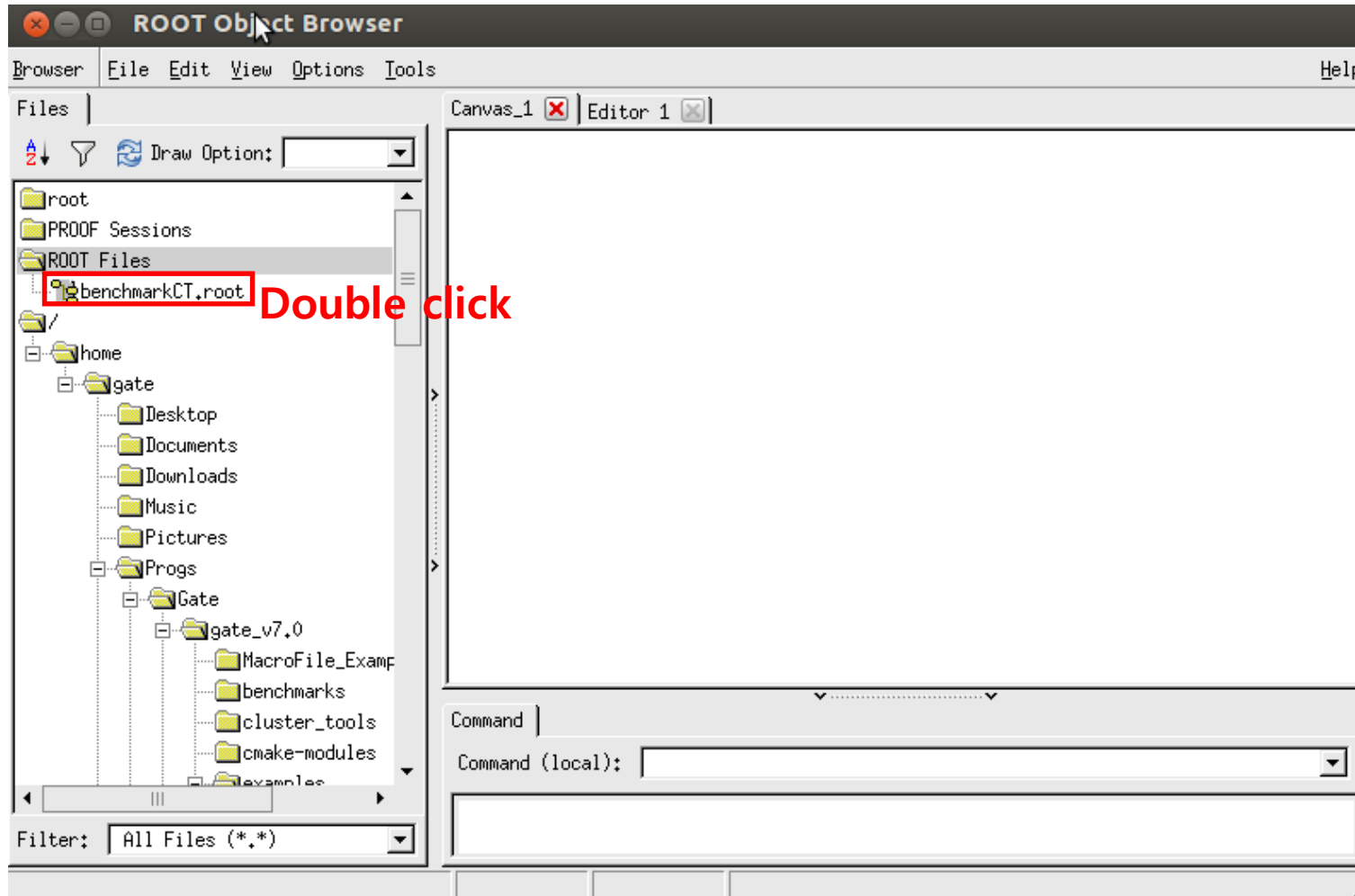
10. Open a TBrowser
TBrowser b;

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
trying "fixed". Please fix your system so helvetica can be found,
this font typically is in the rpm (or pkg equivalent) package
XFree86-[75,100]dpi-fonts or fonts-xorg-[75,100]dpi.
*****
*                               *
*      W E L C O M E  t o  R O O T      *
*                               *
*   Version   5.34/30      23 April 2015   *
*                               *
* You are welcome to visit our Web site *
*      http://root.cern.ch      *
*                               *
*****

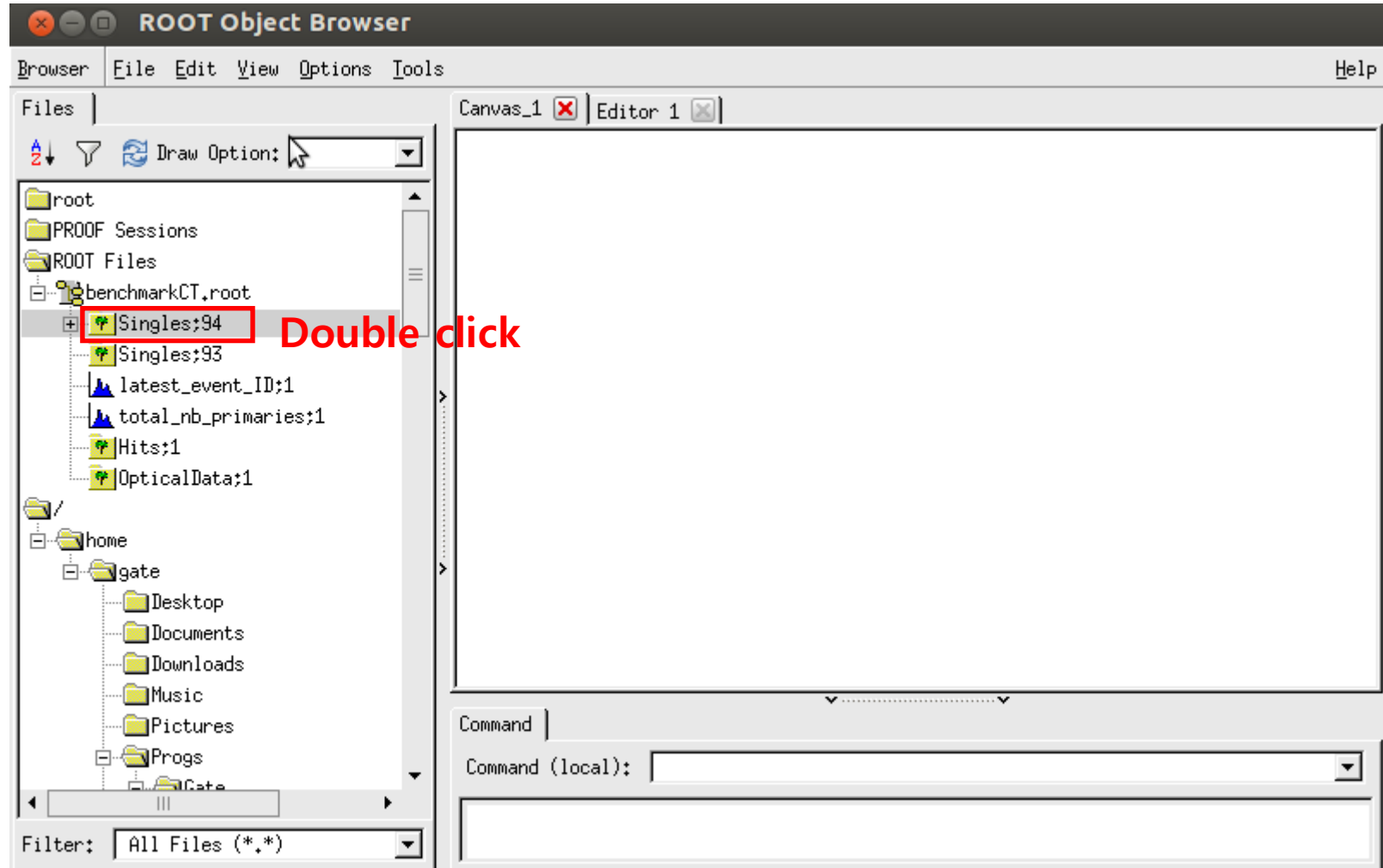
ROOT 5.34/30 (v5-34-30@v5-34-30, Apr 23 2015, 18:31:46 on linuxx8664gcc)

CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0]
Attaching file benchmarkCT.root as _file0...
root [1] TBrowser b;
```

Analyze the CT example output file using ROOT (3)



Analyze the CT example output file using ROOT (4)



Analyze the CT example output file using ROOT (5)

“Singles.energy”: Energy, position, time information of the detected X-ray

The screenshot shows the ROOT Object Browser interface. On the left, a file tree displays the directory structure: root > PROOF Sessions > ROOT Files > benchmarkCT.root > Singles:94. The 'energy' file is highlighted with a red box, and the text "Double click" is written next to it. The main canvas displays a histogram titled "energy" showing the "Number of photons" (y-axis, 0 to 35000) versus "Energy [MeV]" (x-axis, 0.01 to 0.04). The histogram shows a sharp peak at approximately 0.017 MeV. A red text label "X-ray energy spectrum of CT detector" is placed over the plot. In the top right corner of the plot area, a statistics box is displayed with the following data:

htemp	
Entries	93027
Mean	0.01763
RMS	0.003176

The "Entries" value of 93027 is highlighted with a red box, and a red arrow points to it with the text "Total number of X-ray". At the bottom of the interface, there is a "Command" field and a "Command (local):" dropdown menu.

Analyze the CT example output file using ROOT (6)

Visualize the 2D detector response

Singles.Draw("globalPosY:globalPosX");

The image shows a terminal window and the ROOT Object Browser interface. The terminal window displays the following commands and output:

```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
Enclose multiple statements between { }.
root [0]
Attaching file benchmarkCT.root as _file0...
root [1] TBrowser b;
root [2] Singles.Draw("globalPosY:globalPosX");
root [3]
```

The ROOT Object Browser window shows the following structure:

- root
- PROOF Sessions
- ROOT Files
 - benchmarkCT.root
 - Singles:94
 - runID
 - eventID
 - sourceID
 - sourcePosX
 - sourcePosY
 - sourcePosZ
 - time
 - energy
 - globalPosX
 - globalPosY
 - globalPosZ
 - gantryID
 - moduleID
 - clusterID
 - pixelID
 - ...

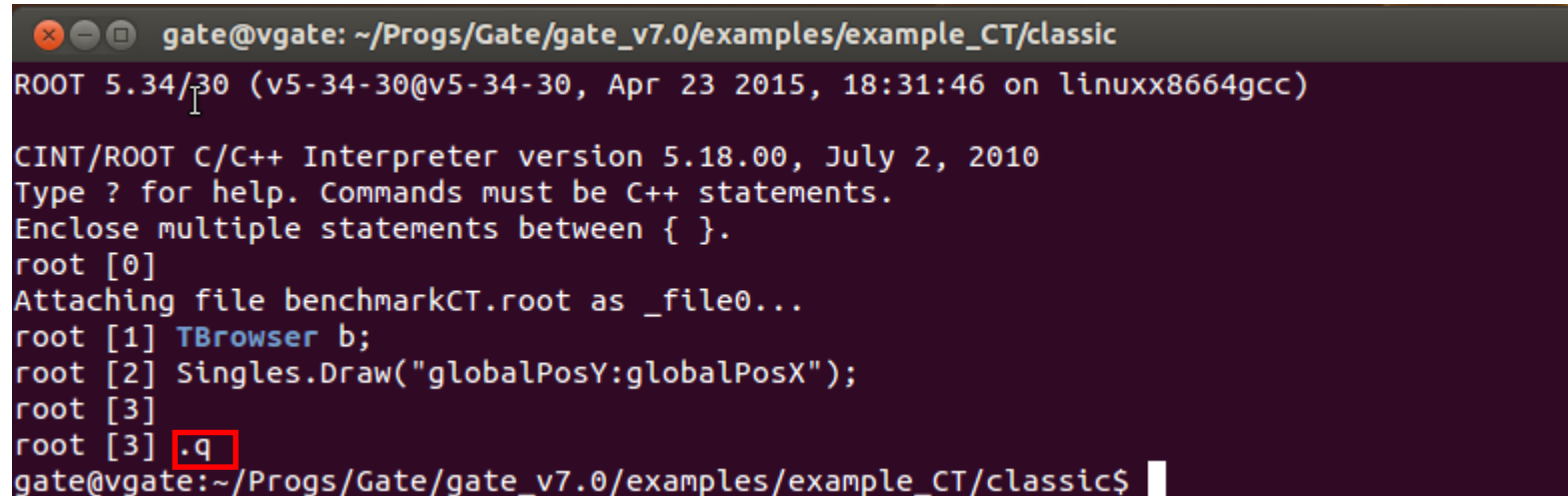
The plot in the ROOT Object Browser shows a 2D detector response. The x-axis is labeled "globalPosX" and ranges from -30 to 20. The y-axis is labeled "globalPosY" and ranges from -20 to 20. The plot displays a dense distribution of points, with a bright central region and a darker outer region, indicating a detector response.

Analyze the CT example output file using ROOT (6)

Exit the ROOT software

.q

```
root [2] .q
```



```
gate@vgate: ~/Progs/Gate/gate_v7.0/examples/example_CT/classic
ROOT 5.34/30 (v5-34-30@v5-34-30, Apr 23 2015, 18:31:46 on linuxx8664gcc)
CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0]
Attaching file benchmarkCT.root as _file0...
root [1] TBrowser b;
root [2] Singles.Draw("globalPosY:globalPosX");
root [3]
root [3] .q
gate@vgate:~/Progs/Gate/gate_v7.0/examples/example_CT/classic$
```

Backup

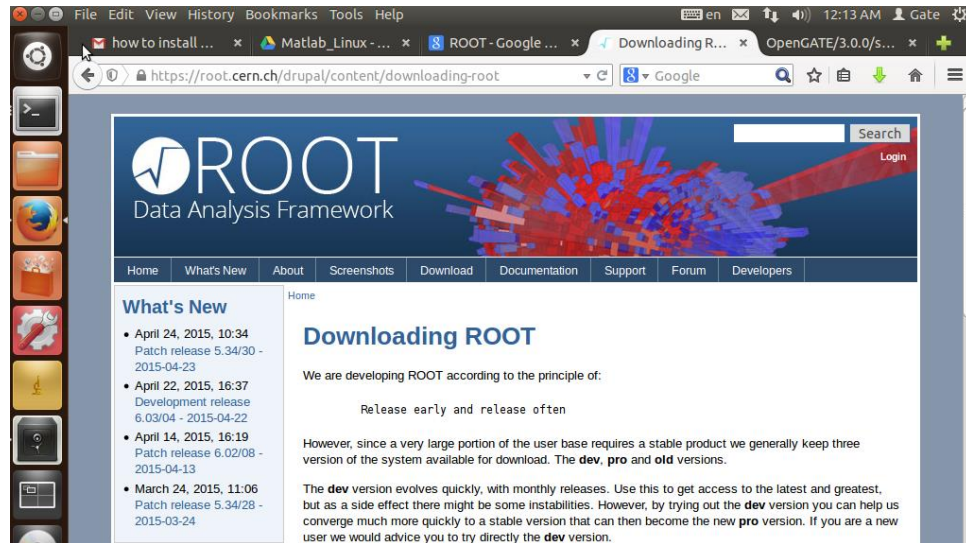
Problem> TBrowser b; command is not working in ROOT

Solution>

- 1.Install a new ROOT**
- 2.Re install GATEv7.0**

ROOT download

<https://root.cern.ch/drupal/content/downloading-root>



The following versions are available for download:

ROOT 6:

- **Dev**, version 6.03/04 (see also the [release notes](#))
- **Pro**, version 6.02/08 **recommended** (see also the [release notes](#))
- **Old**, version 6.00/00 (see also the [release notes](#))

ROOT 5:

- **Pro**, version 5.34/30 (see also the [release notes](#))
- **Old**, version 5.32/04 (see also the [release notes](#) and [development notes](#))
- **Old**, version 5.30/06 (see also the [release notes](#) and [development notes](#))
- **Old**, version 5.28/00h (see also the [release notes](#) and [development notes](#))

Download(Filename:**root_v5.34.30.source.tar.gz**)

ROOT recent version install

Prerequisite: xpm, xft

1. Install xpm

```
sudo apt-get install libxpm-dev
```

```
gate@vgate:~/Progs/root$ sudo apt-get install libxpm-dev
```

2. Run update command

```
sudo apt-get update
```

```
gate@vgate:~/Progs/root$ sudo apt-get update
```

3. Install Xft

```
sudo apt-get install libXft-dev
```

```
gate@vgate:~/Progs/root$ sudo apt-get install libXft-dev
```

ROOT recent version installation

4.Extract the ROOT file

tar zxvf **root_v5.34.30.source.tar.gz**

```
gate@vgate:~/Progs$ ls
Gate Geant4 root root_v5.34.30.source.tar.gz
gate@vgate:~/Progs$ tar zxvf root_v5.34.30.source.tar.gz
```

5.Generate a Makefile

cd root

./configure

```
gate@vgate:~/Progs$ cd root/
gate@vgate:~/Progs/root$ ls
bin          config.log   fonts       icons       Makefile    README     tutorials
bindings    config.status geom         include    man         roofit
build        configure   graf2d      io          math        rootx
cint         core        graf3d      lib         misc        sql
cmake        doc         gui         LICENSE    montecarlo  test
CMakeLists.txt documentation hist        macros     net         tmva
config       etc         html        main       proof       tree
gate@vgate:~/Progs/root$ ./configure
```

6.Compile ROOT

make

```
gate@vgate:~/Progs/root$ make
```

ROOT installation is done!

Reinstall GATEv7.0 (1)

```
gate@vgate: ~/Progs/Gate/gate_v7.0-build
gate@vgate: ~/Progs/... x gate@vgate: ~/Downl... x gate@vgate: ~/Downl... x gate@vgate: ~/Progs/... x
gate@vgate:~$ cd /home/gate/Progs/Gate/gate_v7.0-build
gate@vgate:~/Progs/Gate/gate_v7.0-build$ ls
benchmarks          ExternalData          install_manifest.txt
CMakeCache.txt      Gate                  itk-mhd
CMakeFiles          GateBenchmarkData_config.cmake  Makefile
cmake_install.cmake GateConfiguration.h
examples            GateExampleData_config.cmake
gate@vgate:~/Progs/Gate/gate_v7.0-build$ ccmake ../gate_v7.0
```

Reinstall GATEv7.0 (2)

```
gate@vgate: ~/Progs/Gate/gate_v7.0-build
gate@vgate: ~/Progs/Gat... x gate@vgate: ~/Downloads x gate@vgate: ~/Downloads x gate@vgate: ~/Progs/Gat... x
Page 1 of 1
CMAKE_BACKWARDS_COMPATIBILITY 2.4
CMAKE_BUILD_TYPE Release
CMAKE_INSTALL_PREFIX /home/gate/Progs/Gate/gate_v7.0-install
CUDA_BUILD_CUBIN OFF
CUDA_BUILD_EMULATION OFF
CUDA_SDK_ROOT_DIR CUDA_SDK_ROOT_DIR-NOTFOUND
CUDA_TOOLKIT_ROOT_DIR CUDA_TOOLKIT_ROOT_DIR-NOTFOUND
CUDA_VERBOSE_BUILD OFF
EXECUTABLE_OUTPUT_PATH
GATE_ANALYSIS_USE_FILE ON
GATE_ANALYSIS_USE_GENERAL ON
GATE_DOWNLOAD_BENCHMARKS_DATA OFF
GATE_DOWNLOAD_EXAMPLES_DATA OFF
GATE_USE_ECAT7 OFF
GATE_USE_GEANT4_UIVIS ON
GATE_USE_GPU OFF
GATE_USE_LMF OFF
GATE_USE_OPTICAL ON
GATE_USE_ROOT ON
GATE_USE_SYSTEM_CLHEP OFF
Geant496_COMPATIBILITY ON
Geant4_DIR /home/gate/Progs/Geant4/geant4.9.6.p03-install/lib/Gea
LIBRARY_OUTPUT_PATH
ROOTCINT_EXECUTABLE /home/gate/Progs/root/bin/rootcint

CMAKE BACKWARDS COMPATIBILITY: For backwards compatibility, what version of CMake commands and synt
Press [enter] to edit option CMake Version 2.8.7
Press [c] to configure Press [g] to generate and exit 2. Type "g"
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
```

1. Type "C "

2. Type "g"

Reinstall GATEv7.0 (2)

Compile GATEv7.0

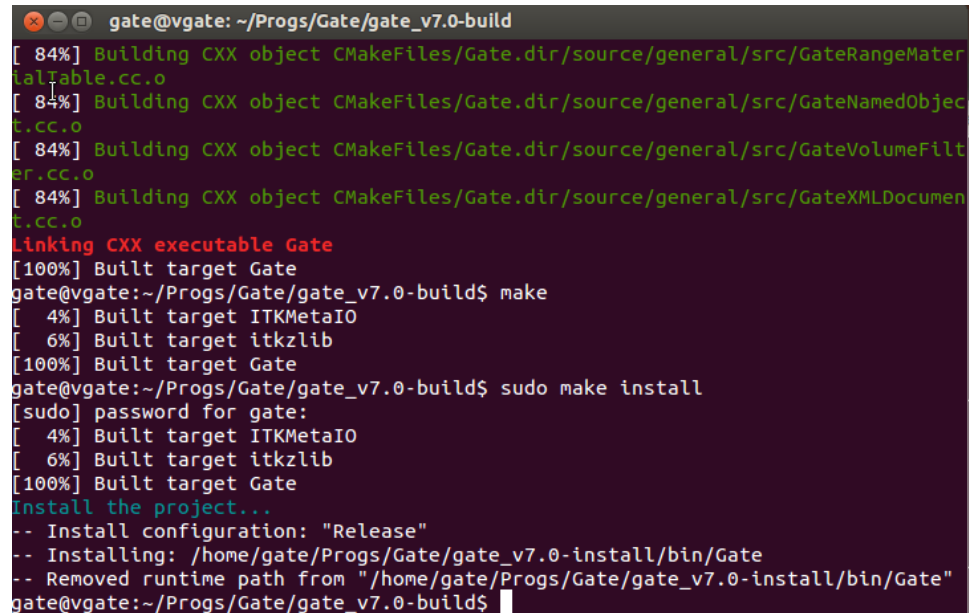
make

```
gate@vgate:~/Progs/Gate/gate_v7.0-build$ make
```

Compile GATEv7.0

sudo make install

```
gate@vgate:~/Progs/Gate/gate_v7.0-build$ sudo make install
```



```
gate@vgate: ~/Progs/Gate/gate_v7.0-build
[ 84%] Building CXX object CMakeFiles/Gate.dir/source/general/src/GateRangeMaterialTable.cc.o
[ 84%] Building CXX object CMakeFiles/Gate.dir/source/general/src/GateNamedObject.cc.o
[ 84%] Building CXX object CMakeFiles/Gate.dir/source/general/src/GateVolumeFilter.cc.o
[ 84%] Building CXX object CMakeFiles/Gate.dir/source/general/src/GateXMLDocument.cc.o
Linking CXX executable Gate
[100%] Built target Gate
gate@vgate:~/Progs/Gate/gate_v7.0-build$ make
[ 4%] Built target ITKMetaIO
[ 6%] Built target itkzlib
[100%] Built target Gate
gate@vgate:~/Progs/Gate/gate_v7.0-build$ sudo make install
[sudo] password for gate:
[ 4%] Built target ITKMetaIO
[ 6%] Built target itkzlib
[100%] Built target Gate
Install the project...
-- Install configuration: "Release"
-- Installing: /home/gate/Progs/Gate/gate_v7.0-install/bin/Gate
-- Removed runtime path from "/home/gate/Progs/Gate/gate_v7.0-install/bin/Gate"
gate@vgate:~/Progs/Gate/gate_v7.0-build$
```

GATEv7.0 re-installation has be finished!!