

ROOT tutorial

— part I —

1st April 2015

Adrian Perieanu

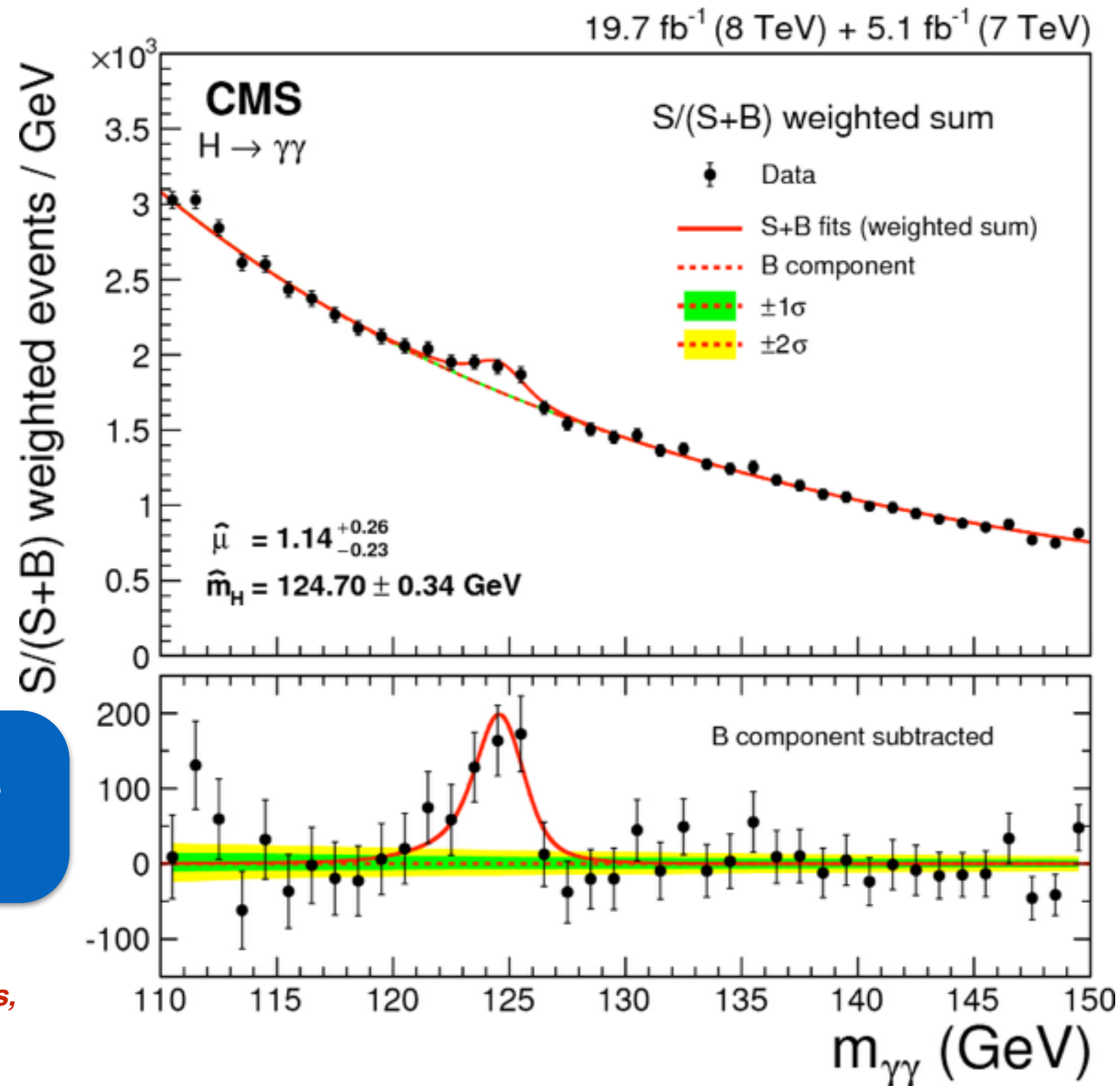


why ROOT?

this plot is worth a
Nobel prize !
and it was done with ROOT

* intuitive, clean and clear graphics
* fast interactive analysis

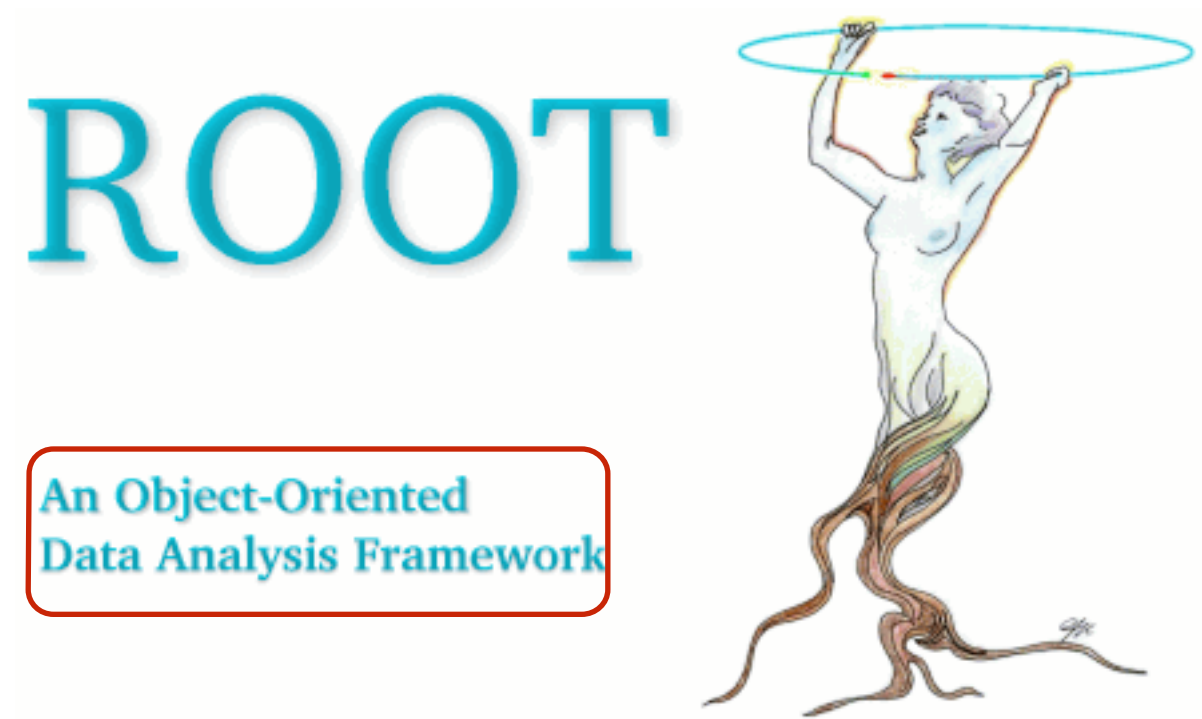
*is used mainly in high energy/particle physics,
don't be surprised if your fellow physicists
ask what is it — they are not high enough :)*



ROOT

— a data analysis framework —

what is ROOT?



<https://root.cern.ch/drupal/>

is not the beginning, but also not the end...

ROOT tutorial: goals

- * how to install it
- * how to find/read documentation
- * perform an interactive analysis with ROOT
- * design and write own analysis macros
- * how to store results of your analysis

ROOT tutorial: installation

The screenshot shows the ROOT Data Analysis Framework website. The browser address bar displays `https://root.cern.ch/drupal/`. The website header features the ROOT logo and the text "Data Analysis Framework". A navigation menu includes links for Home, What's New, About, Screenshots, Download, Documentation, Support, Forum, and Developers. The main content area has three sections: Screenshots, Download, and Documentation. The "Download" section contains the text "Go ahead and [download](#) the latest build of ROOT." A red arrow points from a red box labeled "download link" to this text.

ROOT Data Analysis Framework

Home What's New About Screenshots Download Documentation Support Forum Developers

Screenshots
Get a taste of ROOT's capabilities by sampling some [screenshots](#).

Download
Go ahead and [download](#) the latest build of ROOT.

Documentation
Get the inside scoop on how to fully utilize ROOT. Also, search the [Reference Guide](#), the [HowTo's](#) and the [user forums](#).

download link

ROOT installation: I. read

RFM:
run field manager in CMS,
but not here



The screenshot shows the ROOT Data Analysis Framework website. The browser address bar displays `https://root.cern.ch/drupal/content/downloading-roc`. The page features the ROOT logo and a navigation menu with links: Home, What's New, About, Screenshots, Download, Documentation, Support, Forum, and Developers. On the left sidebar, there are sections for 'What's New' (listing recent patch releases and development releases) and 'Recent Blog Posts' (listing topics like Main Histogram Changes in ROOT 6, Saving Canvas in TeX, ROOT6 and Backward Compatibility, Defining C++14, and Rainbow?). The main content area is titled 'Downloading ROOT' and explains the development principle: 'Release early and release often'. It details three versions: **dev** (development), **pro** (production), and **old** (previous production). The **dev** version evolves quickly with monthly releases. The **pro** version is a stable release candidate. The **old** version is the previous production version. The page also mentions that full source and pre-compiled binaries are provided for most supported platforms.

read the details

ROOT installation: II. search

look for “available for download”

you should not do what is recommended to, but what do you think it is suiting your laptop/PC

The following versions are available for download:

ROOT 6:

- [Dev](#), version 6.03/02 (see also the [release notes](#))
- [Pro](#), version 6.02/05 **recommended** (see also the [release notes](#))
- [Old](#), version 6.00/00 (see also the [release notes](#))

ROOT 5:

- [Pro](#), version 5.34/28 (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](#))

ROOT installation: II. search

if you feel comfortable go for

The screenshot shows the ROOT Data Analysis Framework website. The header includes the ROOT logo, the text "Data Analysis Framework", a search bar, and a "Login" button. A navigation menu contains links for Home, What's New, About, Screenshots, Download, Documentation, Support, Forum, and Developers. The main content area features a "What's New" section with a list of recent releases, a "Production Version 6.02" section with details about availability and source, and a "Recent Blog Posts" section. A red arrow points from the text "if you feel comfortable go for" to the "Source" section, which lists the ROOT 6.02.05 complete source tree for all systems (100 MB) and provides instructions on how to install it.

ROOT Data Analysis Framework

Search Login

Home What's New About Screenshots Download Documentation Support Forum Developers

What's New

- March 24, 2015, 11:06
Patch release 5.34/28 - 2015-03-24
- February 20, 2015, 13:35
Patch release 5.34/26 - 2015-02-20
- February 16, 2015, 9:55
Patch release 6.02/05 - 2015-02-09
- January 28, 2015, 12:36
Development Release 6.03/02 - 2015-01-28

Recent Blog Posts

- Main Histogram Changes in ROOT 6
- Saving Canvas in TeX
- ROOT6 and Backward Compatibility
- Defining C++14
- Rainbow 2

Production Version 6.02

production version

Availability

ROOT is available in binary and source form. The binaries are available for most supported platforms. The source is available as a tarball or from [git](#) and can easily be compiled on any [supported platform/compiler combination](#).

For what is new in this version see the [release notes](#). For the subsequent patch versions see the [6.00 patches release notes](#).

Source

- [ROOT 6.02.05 complete source tree](#) for all systems (100 MB).
After unpacking read "Installing ROOT From Source" or the file `README/INSTALL`.

Documentation

- [ROOT 6.02.05 classes html documentation](#) compressed tar file (919 MB).

ROOT installation: II. choose

Binaries

Note: Before downloading a binary version make sure your machine contains the right run-time environment. In most cases it is not possible to run a version compiled with, e.g., gcc 4.8 on a platform where only gcc 4.3 is installed. In such cases you'll have to install ROOT from source. See [the configurations used to build the binaries below](#).

To install, unzip and untar the file do:

```
$ gunzip root_v6.02.05.Linux-slc6_amd64-gcc4.8.tar.gz  
$ tar xvf root_v6.02.05.Linux.slc6_amd64.gcc4.8.tar
```

This will create the directory `root`. Before getting started read the file `README/README`. Remember, you can find the full documentation of the ROOT classes on this web site at the location [Classes and Members](#). The distribution also contains all tutorials and a set of test programs.

Linux SLC6

- Linux RHEL 6 (SLC6) x86-64 with gcc 4.8, version 6.02.05 (141 MB).

OSX

- OSX 10.9 x86-64 with clang 6.0, version 6.02.05 (130 MB).
- OSX 10.10 x86-64 with clang 6.0, version 6.02.05 (130 MB).

Cygwin (Windows)

- Unfortunately, the Windows/Cygwin build is currently unavailable, due to an issue with gcc 4.8 not being able to compile clang/llvm.

if not, go for binaries



ROOT installation: III. choose wisely

if you do not have gcc 4.8, go for ROOT 5.34

The following versions are available for download:

ROOT 6:

- Dev, version 6.03/02 (see also the [release notes](#))
- Pro, version 6.02/05 **recommended** (see also the [release notes](#))
- Old, version 6.00/00 (see also the [release notes](#))

ROOT 5:

- **Pro, version 5.34/28** (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](#))

what does it mean: gcc 4.8


← https://gcc.gnu.org ↻ 🔍 gcc ☆ 📄 ⬇ 🏠 📶 🔒 ABP 🗨 ☰

GCC, the GNU Compiler Collection

The GNU Compiler Collection includes front ends for [C](#), [C++](#), Objective-C, [Fortran](#), [Java](#), Ada, and Go, as well as libraries for these languages ([libstdc++](#), [libgccj](#),...). GCC was originally written as the compiler for the [GNU operating system](#). The GNU system was developed to be 100% free software, free in the sense that it [respects the user's freedom](#).


We strive to provide regular, high quality [releases](#), which we want to work well on a variety of native and cross targets (including GNU/Linux), and encourage everyone to [contribute](#) changes or help [testing](#) GCC. Our sources are readily and freely available via [SVN](#) and weekly [snapshots](#).

Major decisions about GCC are made by the [steering committee](#), guided by the [mission statement](#).



About GCC

- [Mission Statement](#)
- [Releases](#)
- [Snapshots](#)
- [Mailing lists](#)
- [Contributors](#)
- [Steering Committee](#)

 @gnutools

 gnutools

Documentation

← https://gcc.gnu.org/gcc-4.8/ ↻ 🔍 Suchen

GCC 4.8 Release Series

December 19, 2014

The [GNU project](#) and the GCC developers are pleased to announce the release of GCC 4.8.4.

This release is a bug-fix release, containing fixes for regressions in GCC 4.8.3 relative to previous releases of GCC.

Release History

- GCC 4.8.4
December 19, 2014 ([changes](#), [documentation](#))
- GCC 4.8.3
May 22, 2014 ([changes](#), [documentation](#))
- GCC 4.8.2
October 16, 2013 ([changes](#), [documentation](#))
- GCC 4.8.1
May 31, 2013 ([changes](#), [documentation](#))
- GCC 4.8.0
March 22, 2013 ([changes](#), [documentation](#))

what does it mean: GNU



"GNU's Not Unix!"

a Unix-like computer operating system made out of free software



* gnu = wildebeest

ROOT installation: II. choose wisely

more options, more compilers

Linux SLC5

- Linux RHEL 5 (SLC5) ia32 with gcc 4.3, version 5.34.26 (57 MB).
- Linux RHEL 5 (SLC5) x86-64 with gcc 4.3, version 5.34.26 (57 MB).

Linux SLC6

- Linux RHEL 6 (SLC6) x86-64 with gcc 4.4, version 5.34.28 (70 MB).
- Linux RHEL 6 (SLC6) x86-64 with gcc 4.7, version 5.34.28 (71 MB).
- Linux RHEL 6 (SLC6) x86-64 with gcc 4.8, version 5.34.28 (71 MB).

Linux CC7

- Linux CentOS 7 (CC7) x86-64 with gcc 4.8, version 5.34.28 (72 MB).
- Linux CentOS 7 (CC7) x86-64 with gcc 4.9, version 5.34.28 (73 MB).

Fedora

- Fedora 20 x86-64 with gcc 4.8, version 5.34.28 (57 MB).

Ubuntu

- Ubuntu 12.04 x86-64 with gcc 4.6, version 5.34.28 (58 MB).
- Ubuntu 14.04 x86-64 with gcc 4.8, version 5.34.28 (62 MB).

OSX

- OSX 10.8 x86-64 with clang 5.1, version 5.34.28 [tar.gz](#) or [dmg](#) (58 MB).
- OSX 10.9 x86-64 with clang 6.0, version 5.34.28 [tar.gz](#) or [dmg](#) (56 MB).
- OSX 10.10 x86-64 with clang 6.0, version 5.34.28 [tar.gz](#) or [dmg](#) (56 MB).

Oracle Solaris 11

- Solaris 11 ia32 with CC5.5, version 5.34.02 (58 MB).

IBM AIX 7

- AIX 7.1 PowerPC with xLC v9.0, version 5.34.02 (73 MB).

Windows

Windows 7/Vista/XP/NT/2000 are supported. We offer two packaging types:

- **MSI/exe**: a regular Windows installer package also setting up the required environment variables. With uninstall via "Control Panel" / "Add or Remove Programs". Simply download and start, or open directly. You can double-click ROOT to start it, ROOT files get registered with Windows.
- **tar**: the traditional variant. Unpack e.g. with [7zip](#). Start ROOT in a Microsoft Visual Studio Prompt (in Start / Programs / Microsoft Visual Studio / Tools). If you installed ROOT to C:\root then call C:\root\bin\thisroot.bat before using ROOT to set up required environment variables.

Important installation notes:

- Do not untar in a directory with a name containing blank characters.
- Take the release version if performance matters.
- If you want to debug your code you need the debug version of Windows (you cannot mix release / debug builds due to a Microsoft restriction).
- You need MS VC++ ≥ 8 for the VC++ 9 build, MS VC++ 10 (2010) for the VC++ 10 build, MS VC++ 11 (2012) for the VC++ 11 build, and MS VC++ 12 (2013) for the VC++ 12 build. For information, there is a [no-cost version of Visual Studio 2010](#).
- If you don't know which one to take: the **bold** versions are recommended.

	Release	Debug
VC++ 9 (2008)	MSI (65.9 MB)	MSI (157 MB)
	tar (66.1 MB)	tar (158 MB)
VC++ 10 (2010)	exe (47 MB)	exe (93 MB)
	zip (64 MB)	zip (140 MB)
VC++ 11 (2012)	exe (48 MB)	exe (99 MB)
	zip (65 MB)	zip (152 MB)
VC++ 12 (2013)	exe (47 MB)	exe (99 MB)
	zip (64 MB)	zip (153 MB)

Note that the performance of cygwin/gcc binaries being very poor, we don't provide this build anymore. **The ROOT team will not answer any messages related to problems with the win32gcc version.** For more information see these [web](#) and [ftp](#) sites.

start to forget about windows, now!!!



on your laptop:

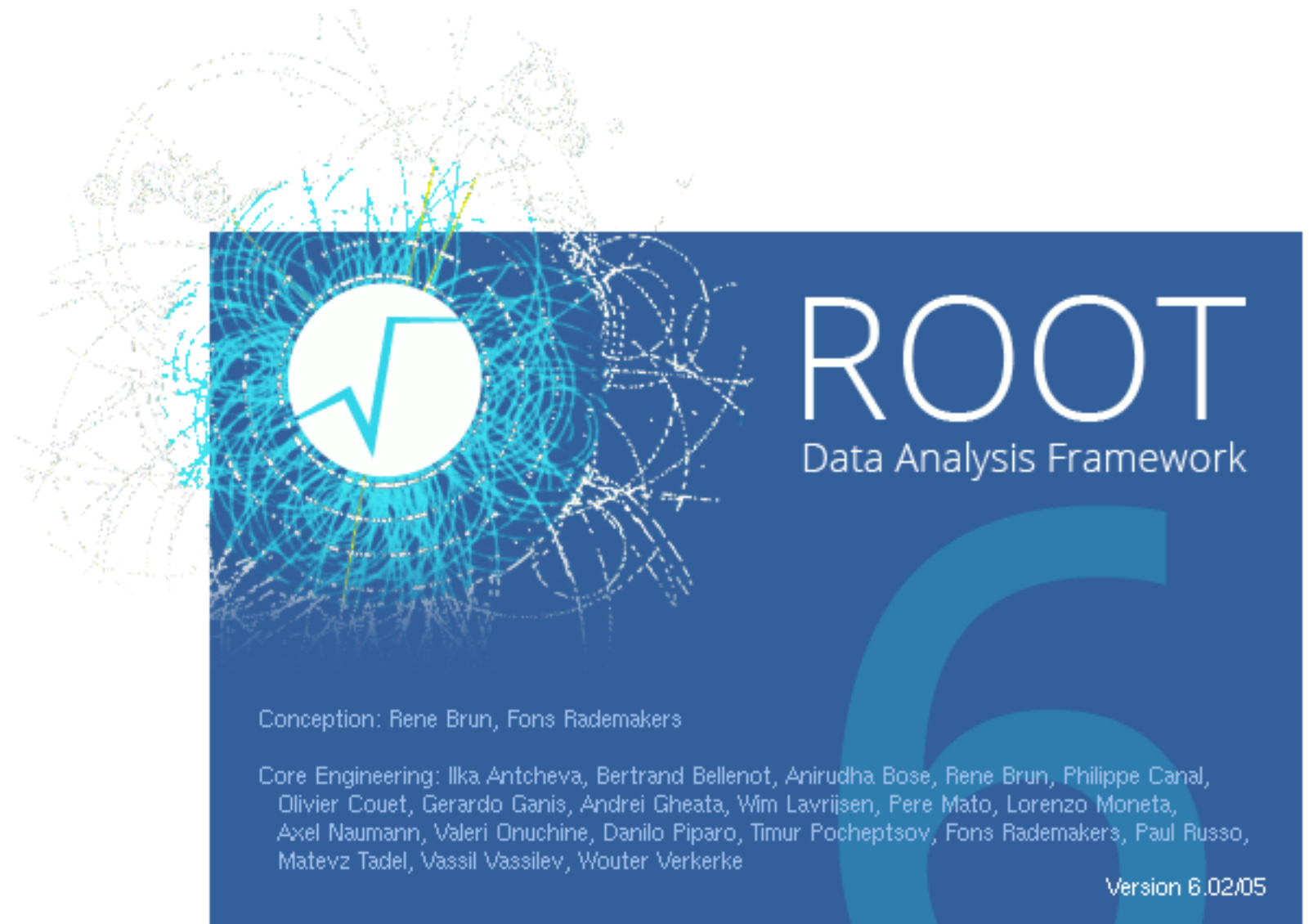
**follow previous steps and install the
binaries**

with your PC accounts:

- > log in with your user name on the terminal machine**
- > log in remotely: `ssh your.username@nafhh-cms03.desy.de -XY`**

> once logged in
> setup environment:

```
[perieanu@nafhh-cms03]~% source /afs/cern.ch/sw/lcg/external/gcc/4.8/x86_64-slc6/setup.sh
[perieanu@nafhh-cms03]~% cd /afs/cern.ch/sw/lcg/app/releases/ROOT/6.02.05/x86_64-slc6-gcc48-dbg/root
[perieanu@nafhh-cms03]/afs/cern.ch/sw/lcg/app/releases/ROOT/6.02.05/x86_64-slc6-gcc48-dbg/root% source bin/thisroot.sh
[perieanu@nafhh-cms03]/afs/cern.ch/sw/lcg/app/releases/ROOT/6.02.05/x86_64-slc6-gcc48-dbg/root% cd -
~
[perieanu@nafhh-cms03]~% root
```



```
-----
| Welcome to ROOT 6.02/05                               http://root.cern.ch |
|                                                         (c) 1995-2014, The ROOT Team |
| Built for linuxx86_64gcc                               |
| From tag v6-02-05, 9 February 2015                    |
| Try '.help', '.demo', '.license', '.credits', '.quit'/.q' |
|-----
```

root [0] █

with your PC accounts:

if you want to run on Scientific Linux 5

> log in with your user name on the terminal machine

> log in remotely: `ssh your.username@nafhh-cms02.desy.de -XY`

> once logged in
> setup environment:

```
[nafhh-cms02] ~ $ source /afs/cern.ch/sw/lcg/external/gcc/4.3.2/x86_64-slc5/setup.sh
[nafhh-cms02] ~ $ cd /afs/cern.ch/sw/lcg/app/releases/ROOT/5.34.03/x86_64-slc5-gcc43-opt/root/
[nafhh-cms02] /afs/cern.ch/sw/lcg/app/releases/ROOT/5.34.03/x86_64-slc5-gcc43-opt/root $ source bin/thisroot.sh
[nafhh-cms02] /afs/cern.ch/sw/lcg/app/releases/ROOT/5.34.03/x86_64-slc5-gcc43-opt/root $ cd -
```

```
~
[nafhh-cms02] ~ $ root
*****
*
*      W E L C O M E  t o  R O O T      *
*
*   Version   5.34/03   27 October 2012 *
*
* You are welcome to visit our Web site *
*      http://root.cern.ch              *
*
*****

ROOT 5.34/03 (tags/v5-34-03@46856, Oct 27 2012,
CINT/ROOT C/C++ Interpreter version 5.18.00, Jun 14 2012)
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] █
```



ROOT tutorial: let's check which version do you have

**ROOT files written in a later version might
not be readable in a previous ROOT
version**

probably to most used commands with ROOT

> root

**to start root type in
your shell:) root**

**you can see that my
root version is not
the latest one:
5.34/28**

**once a “Pro”
version is installed
it can be used for a
while**

```
perieanus-MacBook-Pro% root
*****
*                               *
*      W E L C O M E  to  R O O T      *
*                               *
*   Version   5.34/18      14 March 2014   *
*                               *
*   You are welcome to visit our Web site *
*      http://root.cern.ch                *
*                               *
*****
ROOT 5.34/18 (v5-34-18@v5-34-18, May 28 2014, 11:18:25 on macosx64)

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] █
```


probably to most used commands with ROOT

root[0]: .q

**you can see that my
root version is not
the latest one:
5.34/28**

**once a “Pro”
version is installed
it can be used for a
while**

**to exit root type in
your shell: .q**

```
perieanus-MacBook-Pro% root
*****
*                               *
*      W E L C O M E  to  R O O T      *
*                               *
*   Version   5.34/18      14 March 2014   *
*                               *
*   You are welcome to visit our Web site *
*      http://root.cern.ch                *
*                               *
*****

ROOT 5.34/18 (v5-34-18@v5-34-18, May 28 2014, 11:18:25 on macosx64)
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] .q
perieanus-MacBook-Pro%
```

if you do not want to see the ROOT logo

> root -l

```
perieanus-MacBook-Pro% root
*****
*                                     *
*      W E L C O M E  to  R O O T      *
*                                     *
*   Version   5.34/18      14 March 2014   *
*                                     *
* You are welcome to visit our Web site *
*      http://root.cern.ch      *
*                                     *
*****

ROOT 5.34/18 (v5-34-18@v5-34-18, May 28 2014, 11:18:25 on macosx64)

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] .q
perieanus-MacBook-Pro% root -l
root [0] █
```

> root -l -q

```
perieanus-MacBook-Pro% root
*****
*                                     *
*      W E L C O M E  to  R O O T      *
*                                     *
*   Version   5.34/18      14 March 2014   *
*                                     *
* You are welcome to visit our Web site *
*      http://root.cern.ch      *
*                                     *
*****

ROOT 5.34/18 (v5-34-18@v5-34-18, May 28 2014, 11:18:25 on macosx64)

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] .q
perieanus-MacBook-Pro% root -l
root [0] .q
perieanus-MacBook-Pro% root -l -q
root [0]
perieanus-MacBook-Pro% █
```

with -l -q one starts
and exits in one line

summary: installation

- * go to: <https://root.cern.ch/drupal/>
(or: google > ROOT cern ch)
- * check download section
- * choose the binaries suited for your laptop configuration
(is time starting to avoid windows)
- * on local PC: run the trick with the root from CERN afs
- * start and exit ROOT

***afs: comes from “Andrew File System”
— distributed file system with a set of trusted servers used to
present a homogeneous, location-transparent file name space
to all the client workstations (Carnegie Mellon University — Andrew Project)***

clever people are per definition lazy

— and we are —

shell scripts (crash course)

*all we can do by typing a command
in the shell script can be done faster
by a “script”*

edit shell script

```
[nafhh-cms02] ~ $ nano iniroot.sh
[nafhh-cms02] ~ $ chmod 700 iniroot.sh
[nafhh-cms02] ~ $ source iniroot.sh
~
[nafhh-cms02] ~ $
```

setup the rights:
who is allowed to run the script:

```
zsh ... zsh
GNU nano 1.3.12 File: iniroot.sh
#!/bin/zsh
source /afs/cern.ch/sw/lcg/external/gcc/4.3.2/x86_64-slc5/setup.sh
cd /afs/cern.ch/sw/lcg/app/releases/ROOT/5.34.03/x86_64-slc5-gcc43-opt/root/
source bin/thisroot.sh
cd -
```

setup the shell type: bash, z-shell
here: we deal with a z-shell

copy & paste your line commands

run your script

Permissions: 751 -rwxr-x--x

	Owner	Group	Other
Read	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Write	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Execute	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Numeric mode:

From one to four octal digits
Any omitted digits are assumed to be leading zeros.

The first digit = selects attributes for the set user ID (4) and set group ID (2) and save text image (1)
The second digit = permissions for the user who owns the file: read (4), write (2), and execute (1)
The third digit = permissions for other users in the file's group: read (4), write (2), and execute (1)
The fourth digit = permissions for other users NOT in the file's group: read (4), write (2), and execute (1)

The octal (0-7) value is calculated by adding up the values for each digit

User (rwx) = 4+2+1 = 7
Group(rx) = 4+1 = 5
World (rx) = 4+1 = 5
chmod mode = 0755

clever people are per definition lazy
— and we are —



time for a break and (a lot of) questions

*afterwards we go to the most unloved aspect of your next days:
finding documentation*