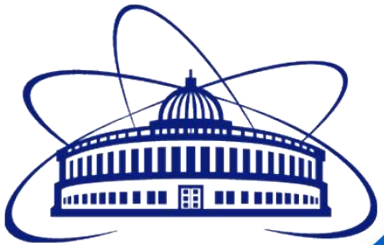
1st Computing Workshop for INTEREST students at MPD experiment

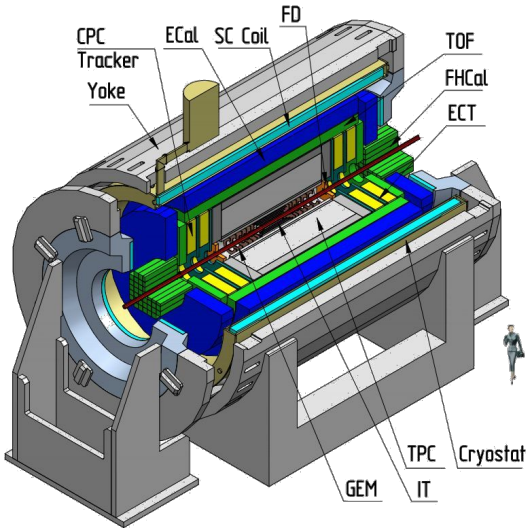
Mpdroot Software introduction, what is it? What you can do with it?

I. Maldonado
maldonado@jinr.ru



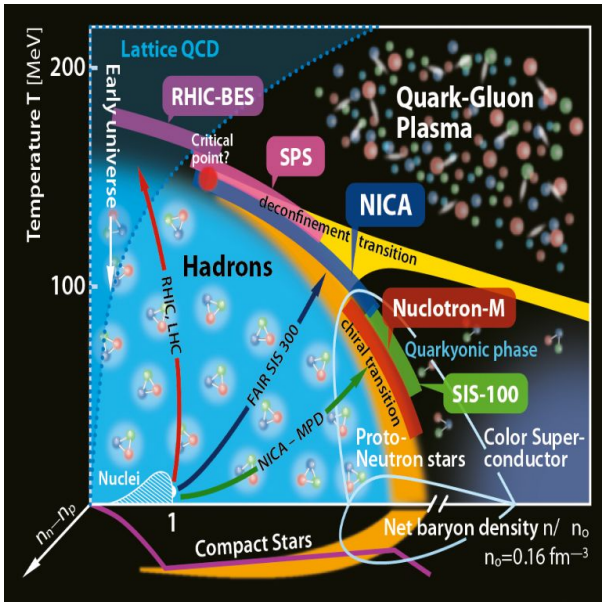
THE MPDRoot

Mpdroot is the off-line software framework for simulation, reconstruction and physics analysis of the simulated or experimental data for MPD experiment



https://mpdroot.jinr.ru/

Flujo de trabajo en los experimentos HEP (High Energy Physics)



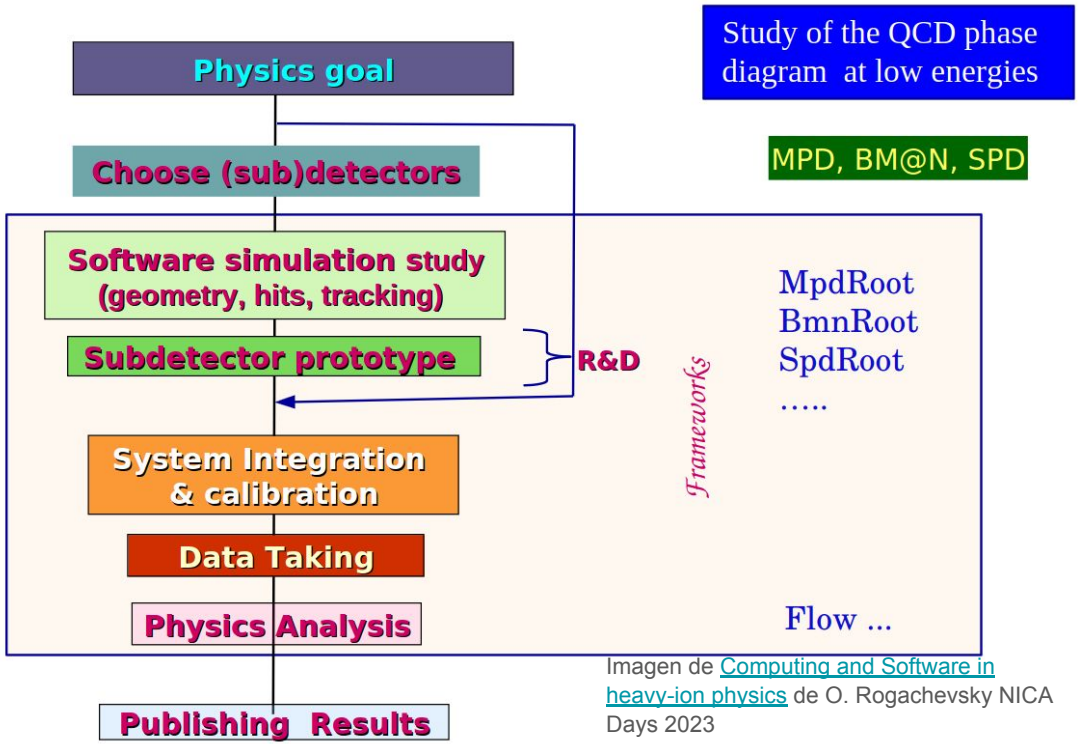


Imagen de Computing and Software in heavy-ion physics de O. Rogachevsky NICA Days 2023

Propósitos del marco de trabajo Mpdroot

- Estudios de rendimiento del detector
- Simulación de Eventos
- Desarrollo de algoritmos para reconstrucción y análisis de los datos registrados por el experimento MPD

Se basa en el entorno 

y el marco **FairRoot** desarrollado para los experimentos FAIR en el instituto GSI.

https://fairroot.gsi.de/

Conjunto de herramientas Orientado a Objetos (OO) escrito en C++

ROOT - Data Analysis Framework

Recursos:

ROOT Website: https://root.cern

Material online: https://github.com/root-project/training

More material: https://root.cern/getting-started

- Includes a booklet for beginners: **the “ROOT Primer”**

Reference Guide: https://root.cern/doc/master/index.html

Forum: https://root-forum.cern.ch

Curso: Tutorial

Flujo de datos en experimentos de HEP

Generadores de eventos

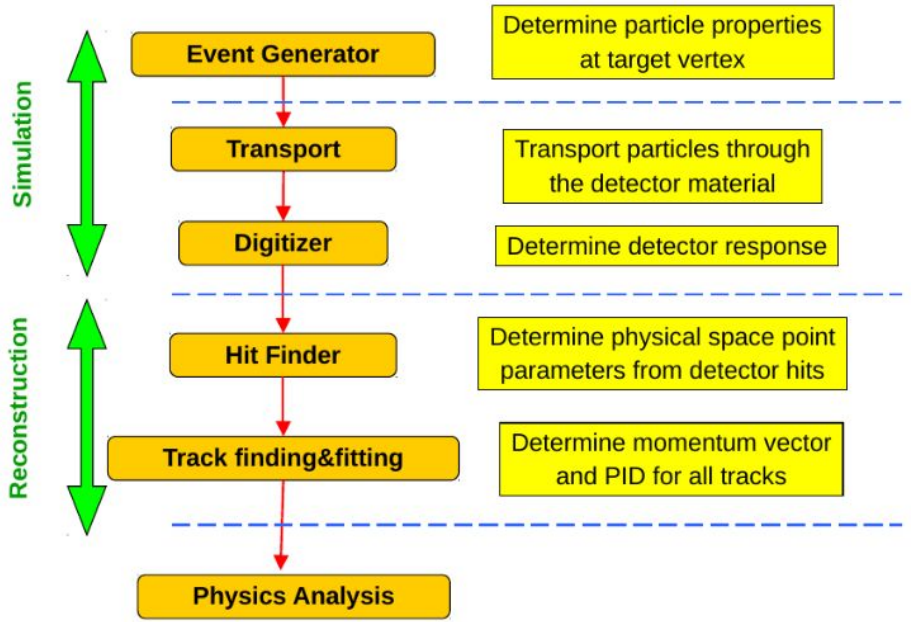
- UrQMD
- QGSM
- PHSD
- Pythia

Simulación del paso de partículas a través de la materia

- Geant 4, Geant 3

Métodos de análisis físicos

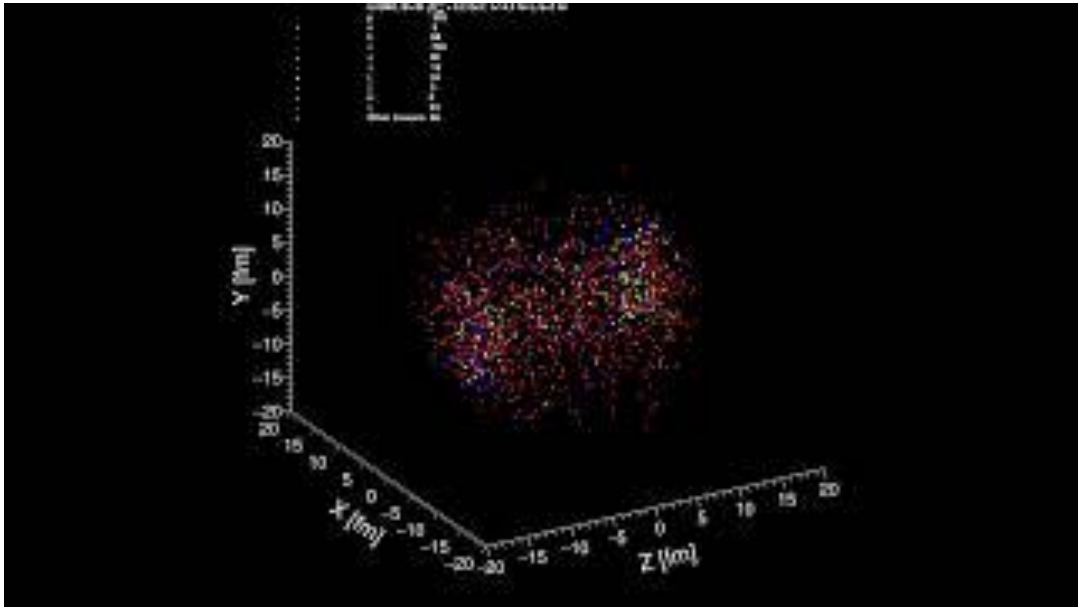
- Decaimiento de partículas
- Femtoscopía
- Flujo
- Dileptones
- …



Simulación de Bi+Bi at $\sqrt{s_{NN}}$ =9.2 GeV con UrQMD

Lista de partículas creadas en la colisión

- Posición
- Momento
- Energía
- Masa
- …



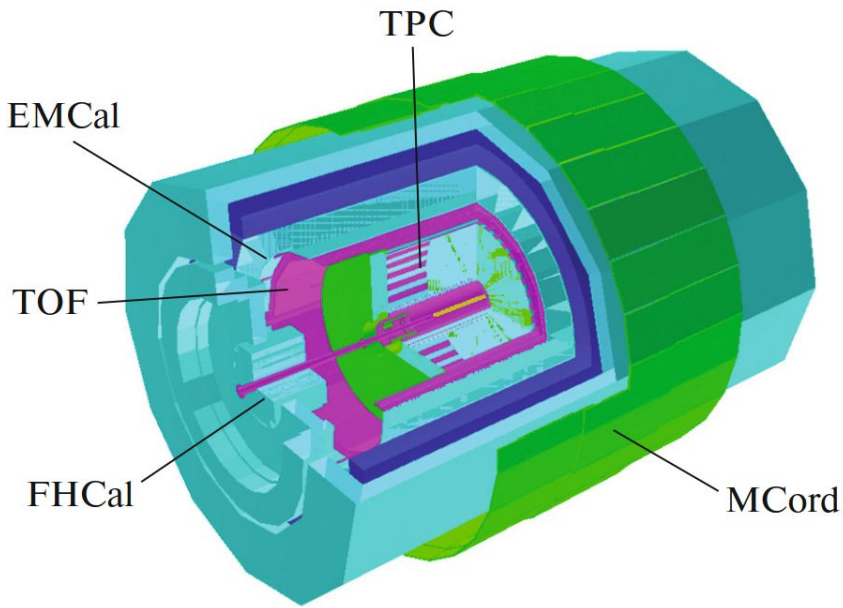
P. Nieto https://youtu.be/YHv8IjK8nYY?si=MBvIywHwXkp4rF2D

Simulación de Detectores

Geant3, Geant4. Clases implementadas en MpdRoot (ROOT)

The Geometry Package:

El paquete de geometría ROOT es una herramienta para construir, explorar, navegar y visualizar geometrías de detectores. El código funciona de forma independiente con respecto a cualquier motor Monte-Carlo de seguimiento; por lo tanto, no contiene ninguna restricción relacionada con la física. Sin embargo, las funciones de navegación proporcionadas por el paquete están diseñadas para optimizar el transporte de partículas a través de geometrías complejas, trabajando en correlación con paquetes de simulación como GEANT3, GEANT4 y FLUKA



Physics of Particles and Nuclei, 2021, Vol. 52, No. 4, pp. 817–820.

Reconstrucción de trazas

Algoritmo de reconstrucción de trazas a partir de un análisis combinatorio de los hits en cada elemento del detector Vector Finder Toolkit

Physics of Particles and Nuclei Letters, 2021, Vol. 18, No. 1, pp. 107–114.

VECTOR FINDER—A TOOLKIT FOR TRACK FINDING IN THE MPD EXPERIMENT

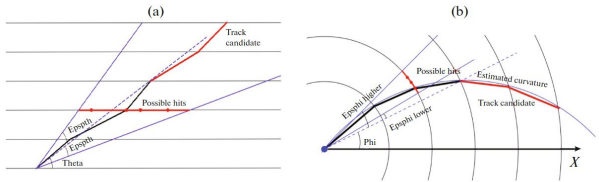
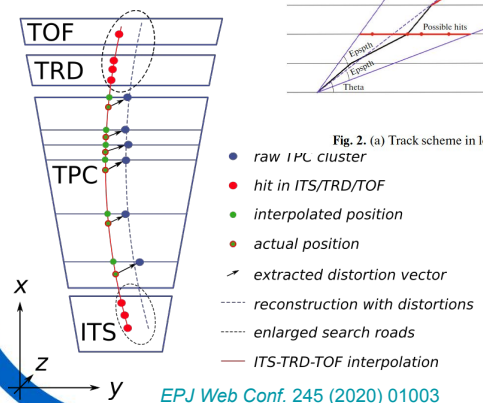
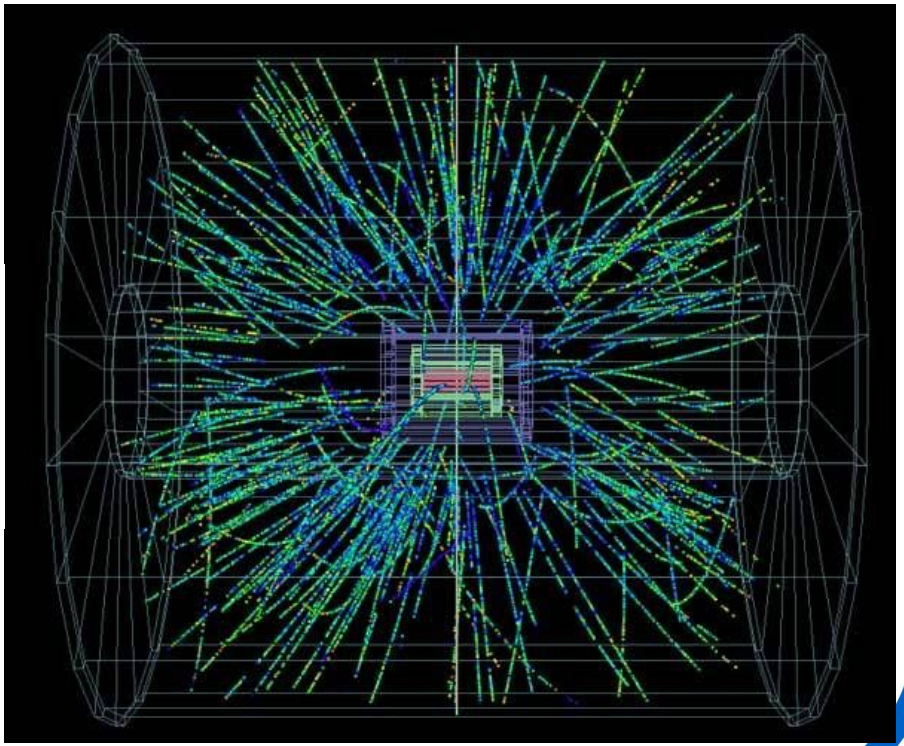


Fig. 2. (a) Track scheme in longitudinal projection. (b) Track scheme in transverse projection.



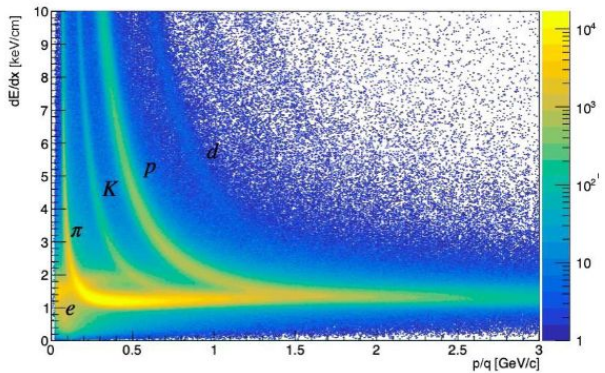


EPJ Web Conf. 245 (2020) 01003

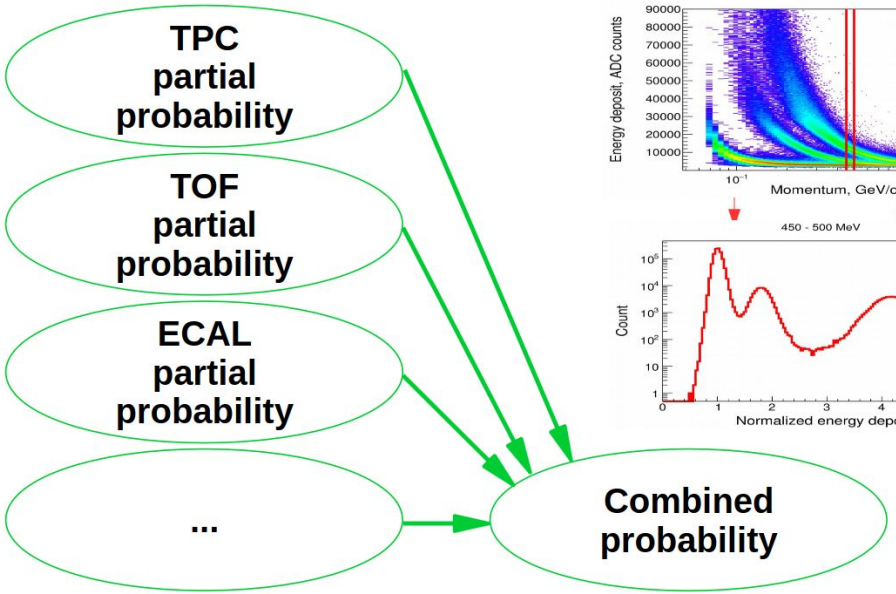
PID - Identificación de partículas

La energía perdida depende del tipo de partícula, su energía y las características el material con el que interactúa.

Deep Learning, gradient boosting.



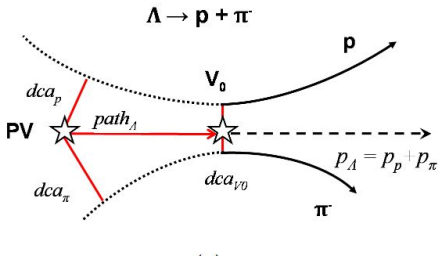
General idea of Particle Identification (PID)

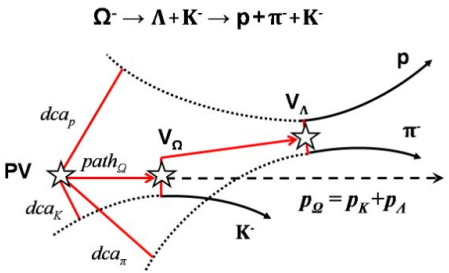


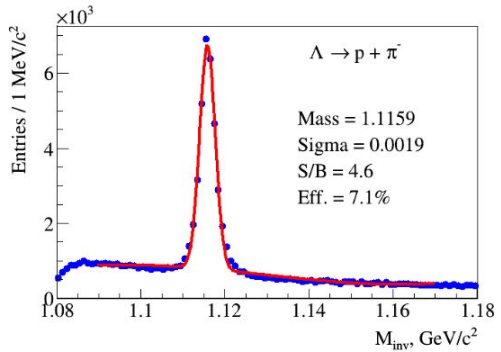
Parameterizations:
dE/dx (mean, sigma and amplitude vs momentum)
m^2 (mean, sigma and amplitude vs momentum)

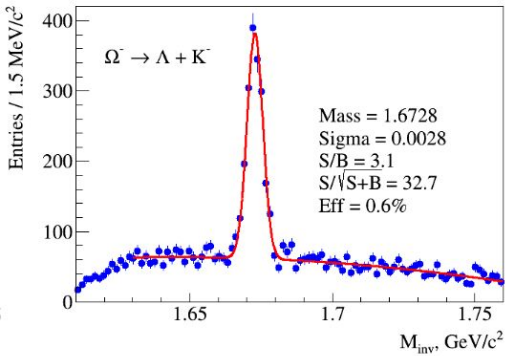
https://indico.cern.ch/event/638553/contributions/2757399/attachments/1552039/2438749/Mudrokh_PID.pdf

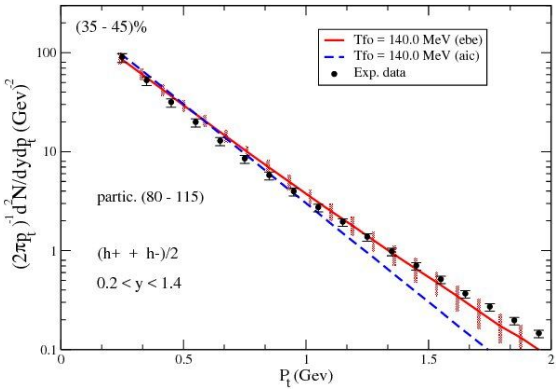
Masa Invariante, distribuciones de momento, etc…







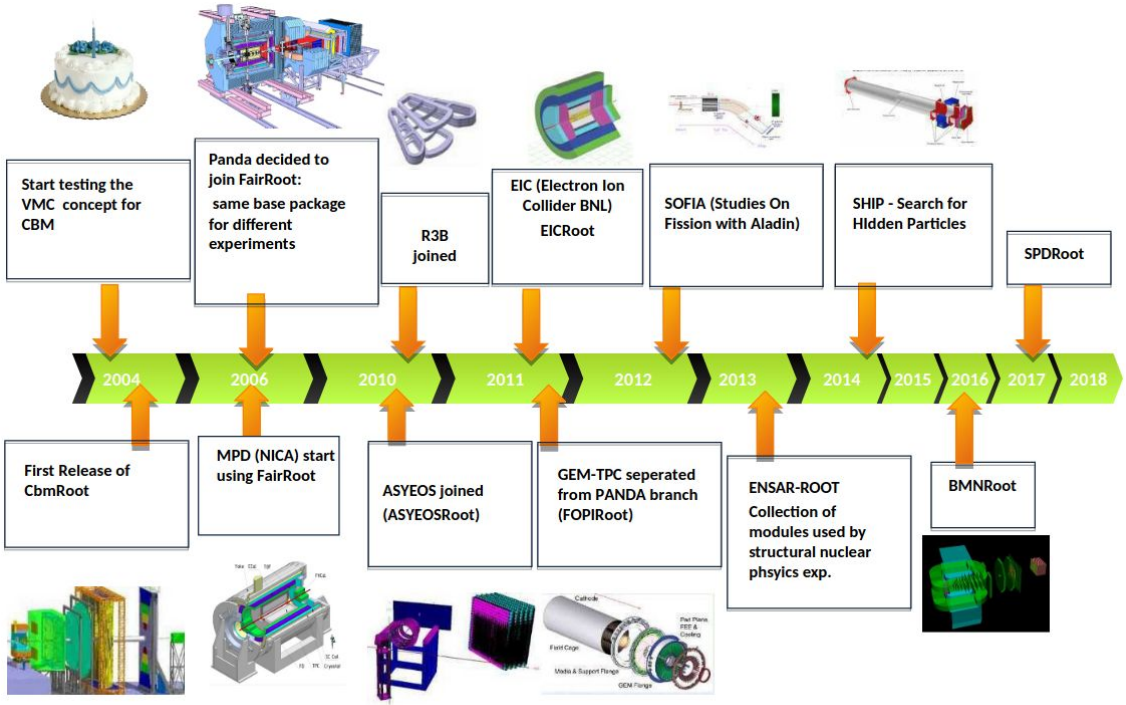




Ajuste de las variables medidas a diferentes modelos para extraer información del sistema creado en la colisión.

Particles 2021, 4, 178–185.

Otros marcos de trabajo con enfoque similar



- AliRoot → ALICE,
- cmssw → CMS,
- Athena → ATLAS
- Gaudino →HARP
- Key4hep →FCC, CLIC/ILC y CEPC
- …

Además de los que están basados en FairRoot

ROOT - Data Analysis Framework

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More material: https://root.cern/getting-started

- Includes a booklet for beginners: **the “ROOT Primer”**

Reference Guide: https://root.cern/doc/master/index.html

Forum: https://root-forum.cern.ch

Curso: Tutorial

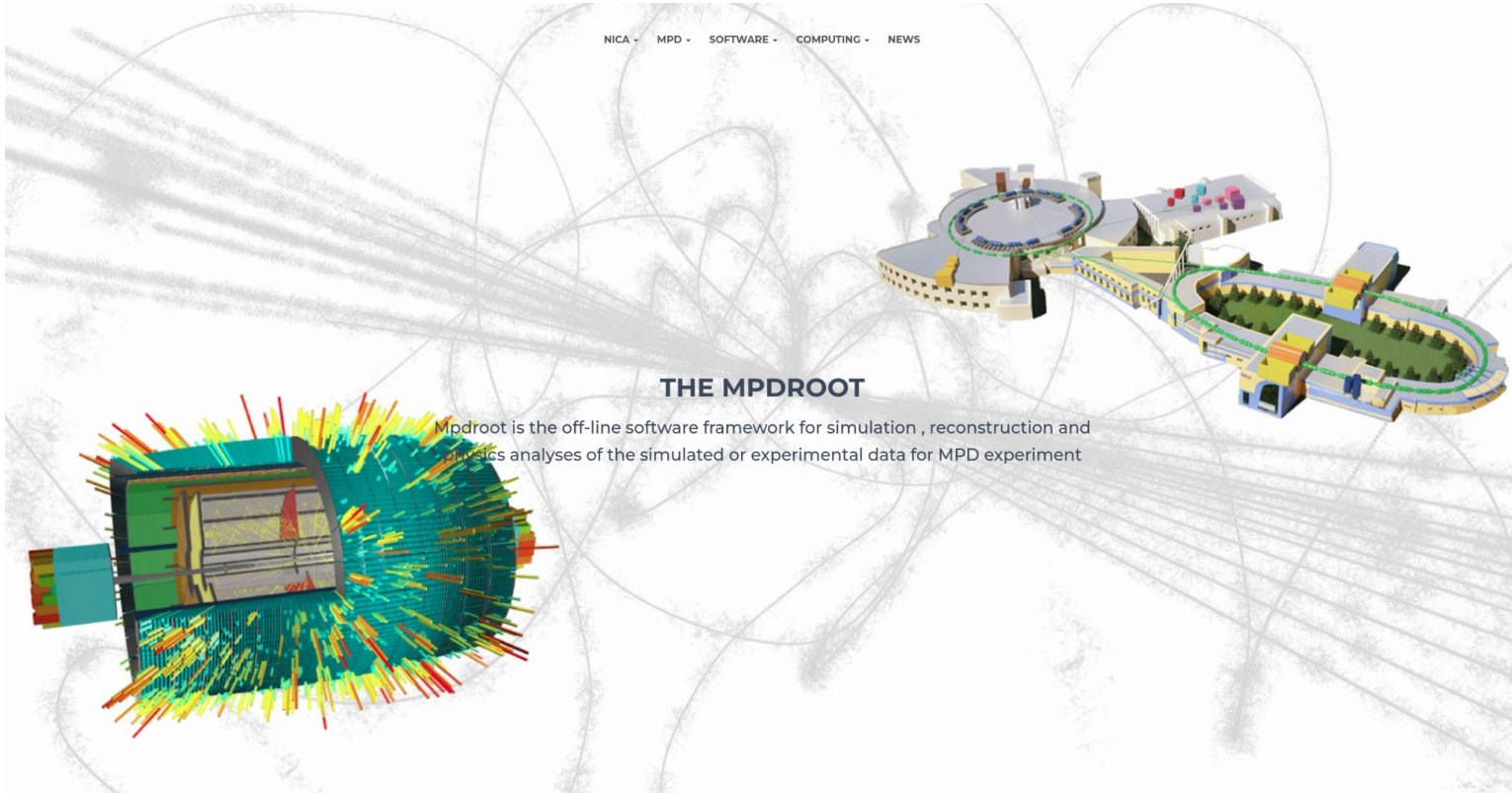
Instalación Local de MpdRoot

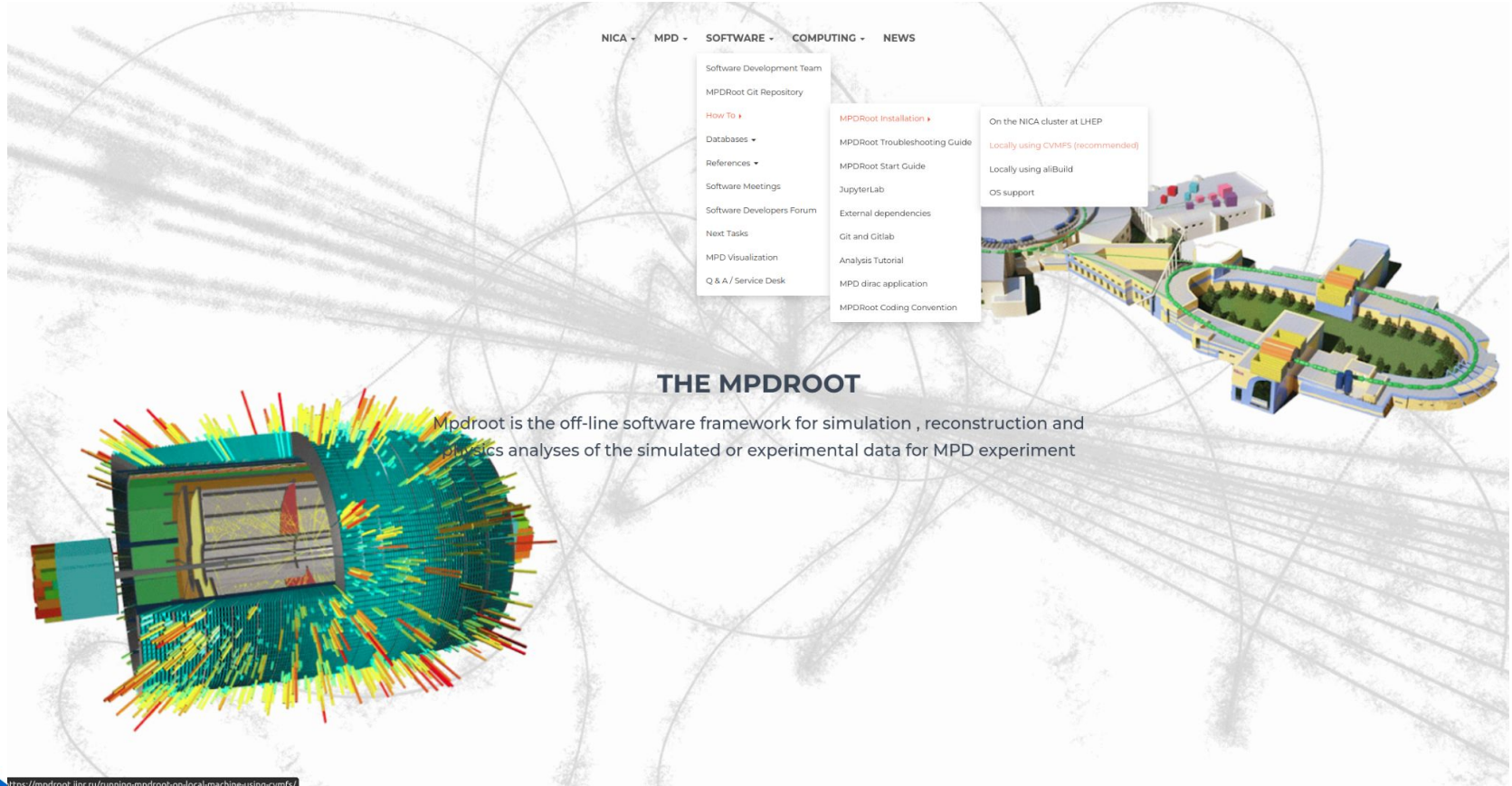
Sistemas operativos:

Fedora, CentOS, AlmaLinux, Ubuntu 22.04, 20.04, Debian 11, 12, Manjaro 21

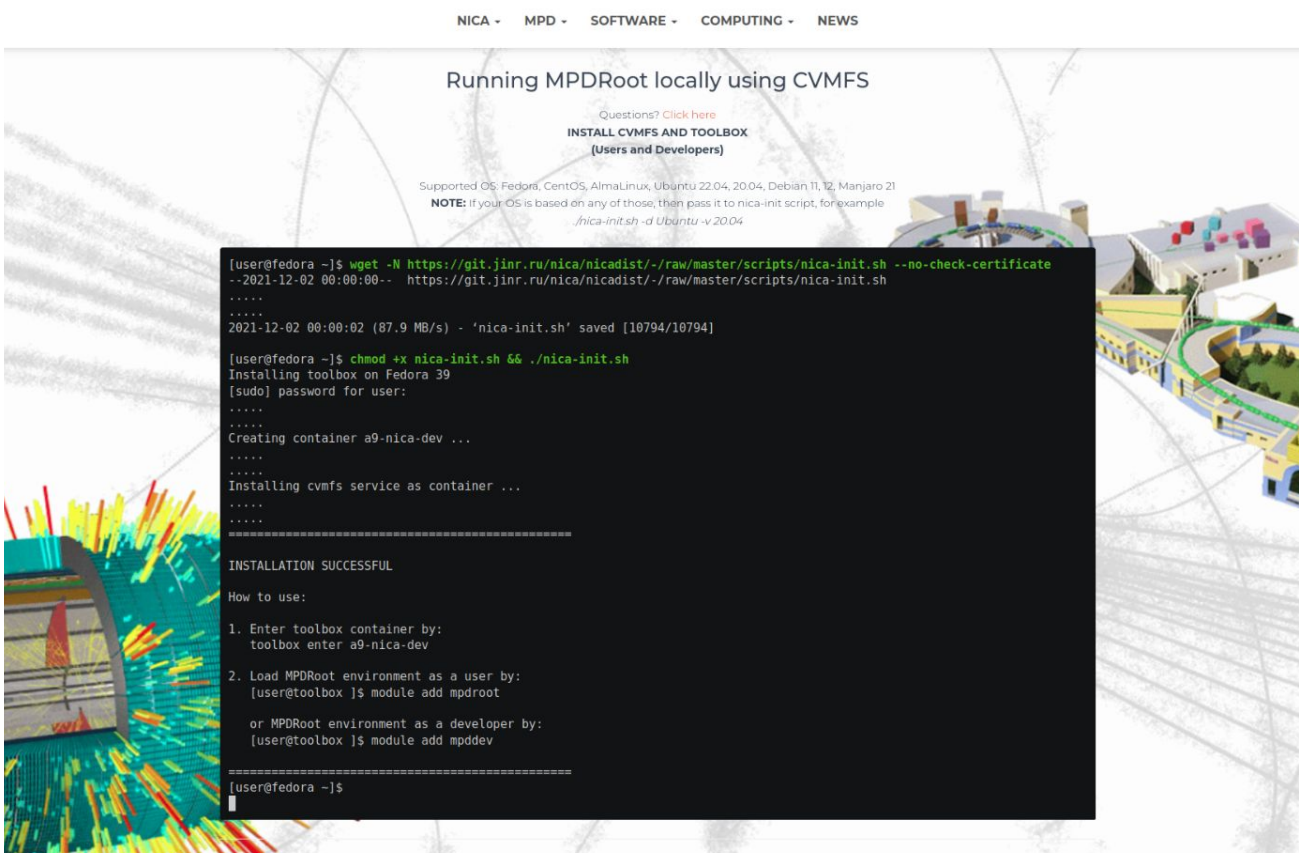
Espacio recomendado 50 GB libres para instalación y datos.

https://mpdroot.jinr.ru




NICA
MPD
SOFTWARE
COMPUTING
NEWS
Software Development Team
MPDRoot Git Repository
How To
Databases
References
Software Meetings
Software Developers Forum
Next Tasks
MPD Visualization
Q & A / Service Desk
MPDRoot Installation
MPDRoot Troubleshooting Guide
MPDRoot Start Guide
JupyterLab
External dependencies
Git and Gitlab
Analysis Tutorial
MPD dirac application
MPDRoot Coding Convention
On the NICA cluster at LHEP
Locally using CVMFS (recommended)
Locally using aliBuild
OS support
THE MPDROOT
Mpdroot is the off-line software framework for simulation , reconstruction and
physics analyses of the simulated or experimental data for MPD experiment

nica-init.sh


NICA
MPD
SOFTWARE
COMPUTING
NEWS
Running MPDRoot locally using CVMFS
Questions? Click here
INSTALL CVMFS AND TOOLBOX
(Users and Developers)
Supported OS: Fedora, CentOS, AlmaLinux, Ubuntu 22.04, 20.04, Debian 11, 12, Manjaro 21
NOTE: If your OS is based on any of those, then pass it to nica-init script, for example
./nica-init.sh -d Ubuntu -v 20.04
[user@fedora ~]$ wget -N https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh --no-check-certificate
--2021-12-02 00:00:00-- https://git.jinr.ru/nica/nicadist/-/raw/master/scripts/nica-init.sh
.....
.....
2021-12-02 00:00:02 (87.9 MB/s) - 'nica-init.sh' saved [10794/10794]
[user@fedora ~]$ chmod +x nica-init.sh && ./nica-init.sh
Installing toolbox on Fedora 39
[sudo] password for user:
.....
.....
Creating container a9-nica-dev ...
.....
.....
Installing cvmfs service as container ...
.....
.....
==========
INSTALLATION SUCCESSFUL
How to use:
1. Enter toolbox container by:
toolbox enter a9-nica-dev
2. Load MPDRoot environment as a user by:
[user@toolbox]$ module add mpdroot
or MPDRoot environment as a developer by:
[user@toolbox]$ module add mpddev
==========
[user@fedora ~]$


USERS
NOTE: If you are using CentOS 7 instead of "toolbox enter a9-nica-dev" command, type:
"source /cvmfs/nica.jinr.ru/sw/os/login.sh"
Software is installed into $MPDROOT directory
[user@fedora ~]$ toolbox enter a9-nica-dev
●[user@toolbox [a9-nica-dev] ~]$ module add mpdroot
●[user@toolbox [a9-nica-dev] ~]$ echo $MPDROOT; echo $MPDROOT_MACROS; echo $GEOMPATH; echo $CONFIG_DIR
/cvmfs/nica.jinr.ru/sw/slc7_x86-64/mpdroot/v23.03.23-1
/cvmfs/nica.jinr.ru/sw/slc7_x86-64/mpdroot/v23.03.23-1/macros
/cvmfs/nica.jinr.ru/sw/slc7_x86-64/mpdroot/v23.03.23-1/geometry
/cvmfs/nica.jinr.ru/sw/slc7_x86-64/mpdroot/v23.03.23-1/gconfig
●[user@toolbox [a9-nica-dev] ~]$ root -b -q $MPDROOT_MACROS/common/runMC.C
| Welcome to ROOT 6.26/10 https://root.cern |
| (c) 1995-2021, The ROOT Team; conception: R. Brun, F. Rademakers |
| Built for linuxx8664gcc on Dec 14 2022, 15:23:00 |
| From tag v6-26-10, 16 November 2022 |
| With c++ (GCC) 10.2.0 |
| Try '.help', '.demo', '.license', '.credits', '.quit'/'.q' |
Processing /cvmfs/nica.jinr.ru/sw/slc7_x86-64/mpdroot/v23.03.23-1/macros/common/runMC.C...
.....
.....
Macro finished successfully.
●[user@toolbox [a9-nica-dev] ~]$ exit
logout
[user@fedora ~]$
DEVELOPERS
NOTE: If you are using CentOS 7 instead of "toolbox enter a9-nica-dev" command, type:
"source /cvmfs/nica.jinr.ru/sw/os/login.sh"
Software is installed into $MPDROOT directory
[user@fedora ~]$ toolbox enter a9-nica-dev
●[user@toolbox [a9-nica-dev] ~]$ git clone -b dev --recursive git@git.jinr.ru:nica/mpdroot.git
Cloning into 'mpdroot'...
.....

Desarrolladores - https://git.jinr.ru/nica/mpdroot

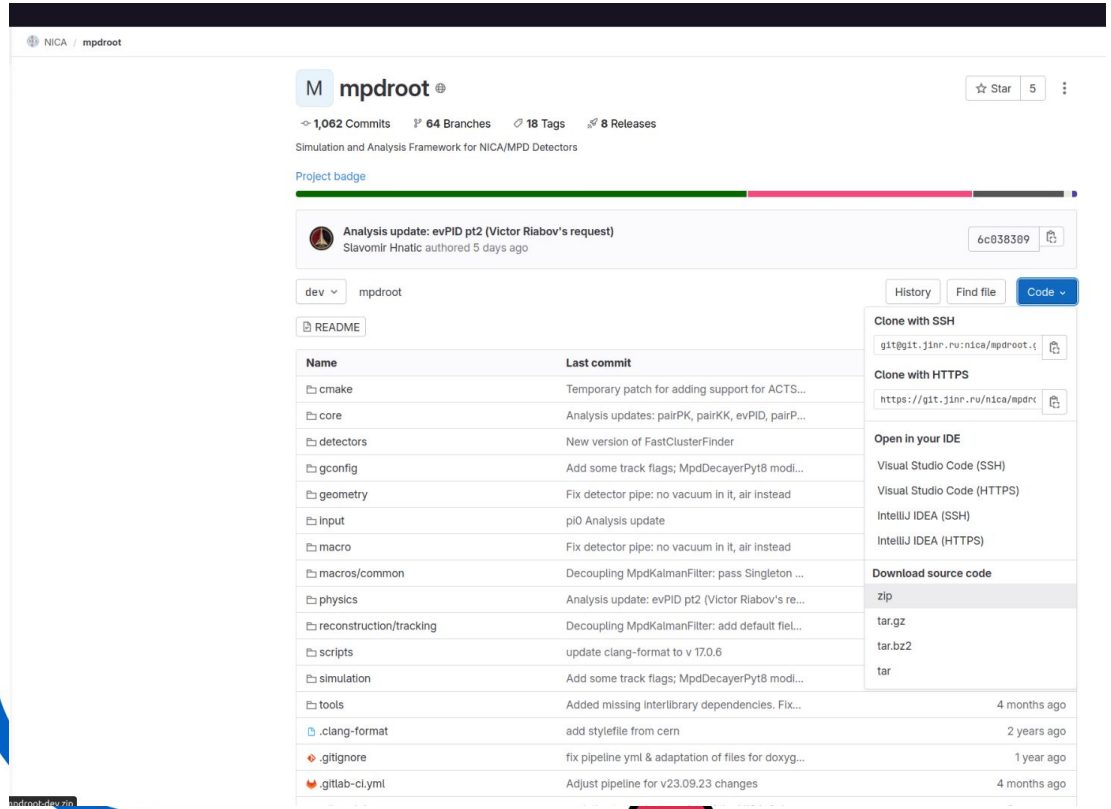
DEVELOPERS

NOTE: if you are using CentOS 7 instead of "toolbox enter a9-nica-dev" command, type:
"source /cvmfs/nica.jinr.ru/sw/os/login.sh"

Software is installed into $MPDROOT directory

```
[user@fedora ~]$ toolbox enter a9-nica-dev

●[user@toolbox [a9-nica-dev] ~]$ git clone -b dev --recursive git@git.jinr.ru:nica/mpdroot.git
Cloning into 'mpdroot'...
.....
.....
Resolving deltas: 100% (265/265), done.
Submodule path 'macro/mpd_scheduler': checked out '22e1f3f893371579d614113fab824776b31a2fc9'

●[user@toolbox [a9-nica-dev] ~]$ module add mpddev

●[user@toolbox [a9-nica-dev] ~]$ cp mpdroot/scripts/pre-commit mpdroot/.git/hooks/

●[user@toolbox [a9-nica-dev] ~]$ mkdir mpdroot/build && cd mpdroot/build

✔ ~/mpdroot/build [dev L|✔]
02:19 $ export MPDROOT=~/mpd

✔ ~/mpdroot/build [dev L|✔]
02:20 $ cmake ..
-- The C compiler identification is GNU 10.2.0
.....
.....
-- Build files have been written to: /home/user/mpdroot/build

✔ ~/mpdroot/build [dev L|✔]
02:20 $ make -j16 install
[  1%] Generating G__PassiveDict.cxx, G__PassiveDict_rdict.pcm, ../lib/libPassive.rootmap
.....
.....
-- Installing: /home/user/mpd/lib/libLHETrack.so

✔ ~/mpdroot/build [dev L|✔]
02:24 $ source $MPDROOT/config/env.sh

✔ ~/mpdroot/build [dev L|✔]
02:24 $ echo $MPDROOT; echo $MPDROOT_MACROS; echo $GEOMPATH; echo $CONFIG_DIR
/home/user/mpd
/home/user/mpd/macros
/home/user/mpd/geometry
/home/user/mpd/gconfig

✔ ~/mpdroot/build [dev L|✔]
02:25 $ root -b -q $MPDROOT_MACROS/common/runMC.C

   ------------------------------------------------------------------
  | Welcome to ROOT 6.26/10                        https://root.cern |
  | (c) 1995-2021, The ROOT Team; conception: R. Brun, F. Rademakers |
  | Built for linuxx8664gcc on Dec 14 2022, 15:23:00                 |
  | From tag v6-26-10, 16 November 2022                              |
  | With c++ (GCC) 10.2.0                                            |
  | Try '.help', '.demo', '.license', '.credits', '.quit'/'.q'       |
   ------------------------------------------------------------------
```

Desarrolladores - https://git.jinr.ru/nica/mpdroot



En lugar del comando

mpdroot$ git clone -b dev --recursive git@git.jinr.ru:nica/mpdroot.git

Descargar el archivo con extensión tar.gz y copiarlo al directorio de trabajo

user$ cp mpdroot-dev.tar.gz ~/Software/mpdroot/

Descomprimir el archivo

mpdroot$ tar -czvf mpdroot-dev.tar.gz

Manos a la obra