Get Started with CEPC Software

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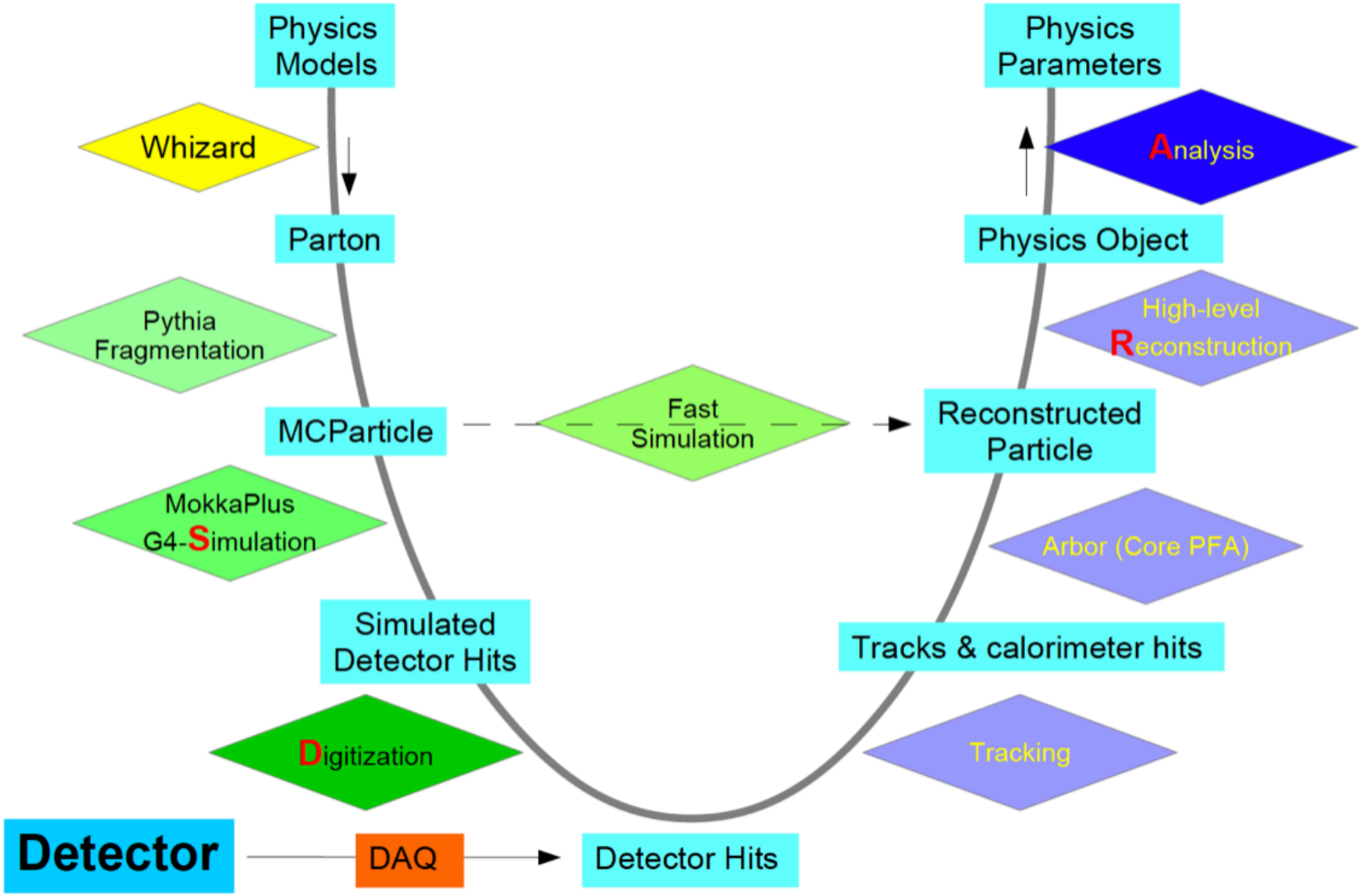
CEPC Software - SDRAM



Objective

- Run the examples prepared
- Understand how the software chain works
- Be able to use these software after this training
- Become more interested in the future particle accelerator physics

Day 1

Subjects:

- Setup the software
- Try to simulate a particle in the detector, and reconstruct it
- Display the particle

Optional:

- Modify the detector model and visualize it
- Know how to read the database
- Simulate and reconstruct a ZH event using generator

Setup

- On your own computer (better copy the virtual machine in advance)
  - Install VirtualBox: https://www.virtualbox.org/
  - Copy /Volumes/Samsung_T5/VirtualBox VMs/CEPCTraining to your computer
  - Click Add, chose CEPCTraining.vbox
  - Double click CEPCTraining, the machine starts
  - Click Terminal

- On IHEP cluster (will be deleted after this training, slow for display)
  - ssh -X cepctmp01@lxslc6.ihep.ac.cn (01-03)
  - password: cepc2019! (PLEASE DO NOT CHANGE IT)
  - mkdir /cefs/higgs/training(01-)
  - cd /cefs/higgs/training(01-)
  - source /cvmfs/cepc.ihep.ac.cn/software/cepcenv/setup.sh
  - cepcenv use 0.1.0-rc9
  - cp -r /cefs/higgs/KAIST01/CEPCTraining YOUDIR/.

VirtualBox

About
Screenshots
Downloads
Documentation
End-user docs
Technical docs
Contribute
Community

Download VirtualBox

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

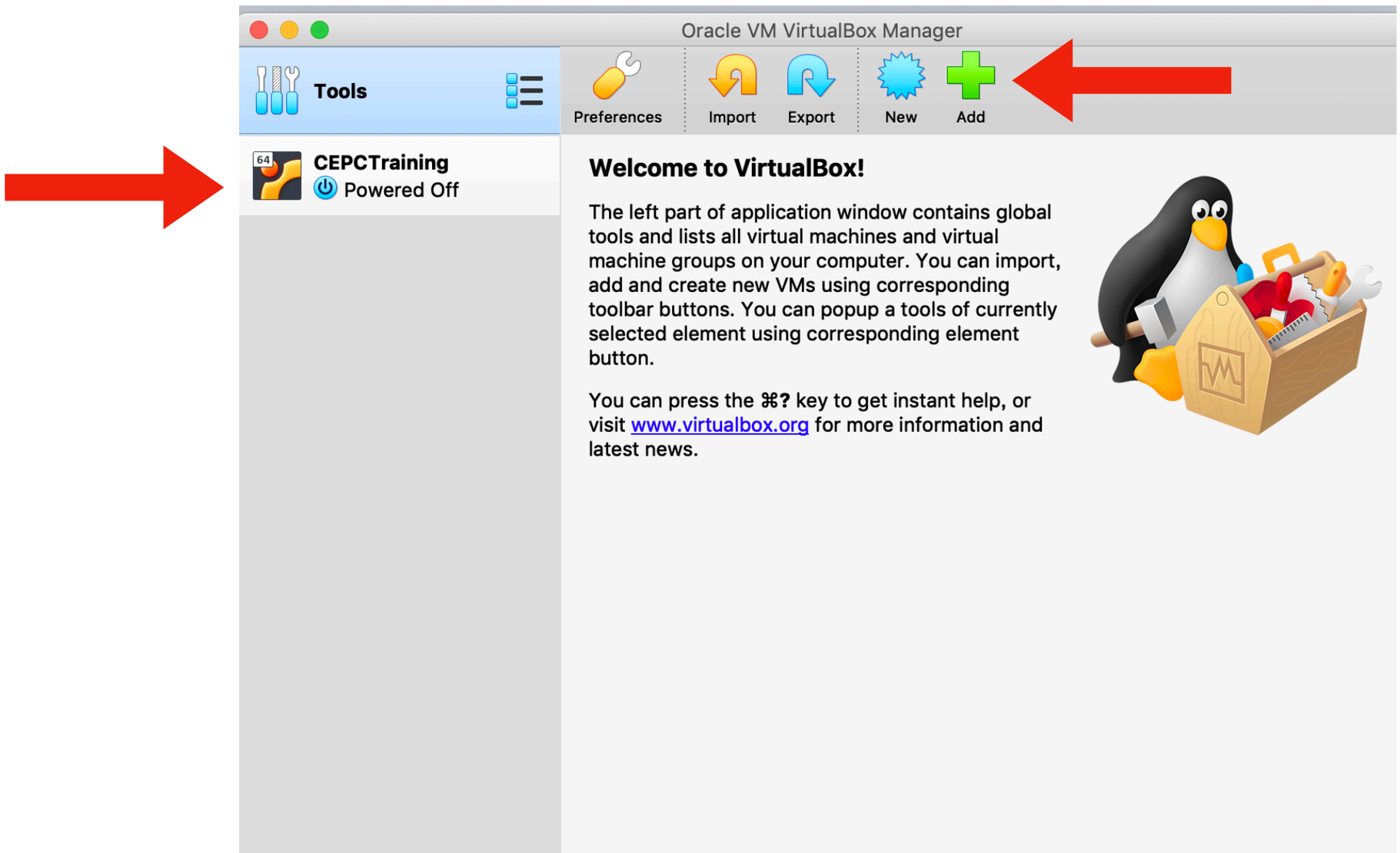
VirtualBox binaries

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

If you're looking for the latest VirtualBox 5.2 packages, see VirtualBox 5.2 builds. Please also use version 5.2 if you still need support for 32-bit hosts, as this has been discontinued in 6.0. Version 5.2 will remain supported until July 2020.

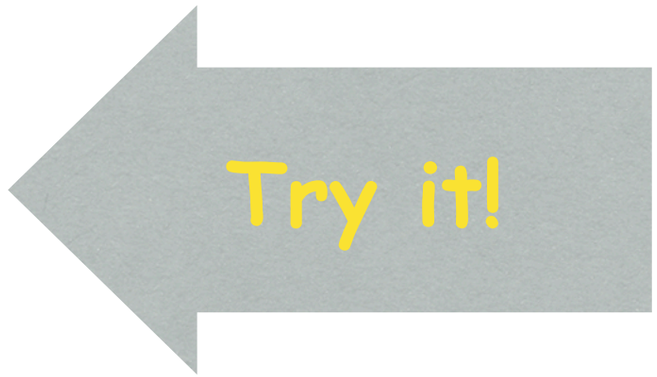
VirtualBox 6.0.8 platform packages

- Windows hosts
- OS X hosts
- Linux distributions
- Solaris hosts



Simulation

- Tool: Mokka
  - A parametric geometry package on top of Geant4 (a toolkit for the simulation of the passage of particles through matter)
  - Define the parameters for subdetectors
  - Output data format: LCIO file (http://lcio.desy.de/)
- Example:
  - cd ~/CEPCTraining/Simu
  - sh default_Single.sh
- Outputs: ~/CEPCTraining/Samples/Simu



Simulation

- macFile: describe the events, direction, energy, …
  - particleGun:
    - particle names: http://fismed.ciemat.es/GAMOS/GAMOS_doc/GAMOS.5.1.0/x11519.html
  - Event generator: see default_hep.sh
- steer file: define the detector model
- Simu_e-_10GeV.slcio: events simulated, including MC particles, hits, …
- GearOutput.xml: geometry parameters (to be called in reconstruction)

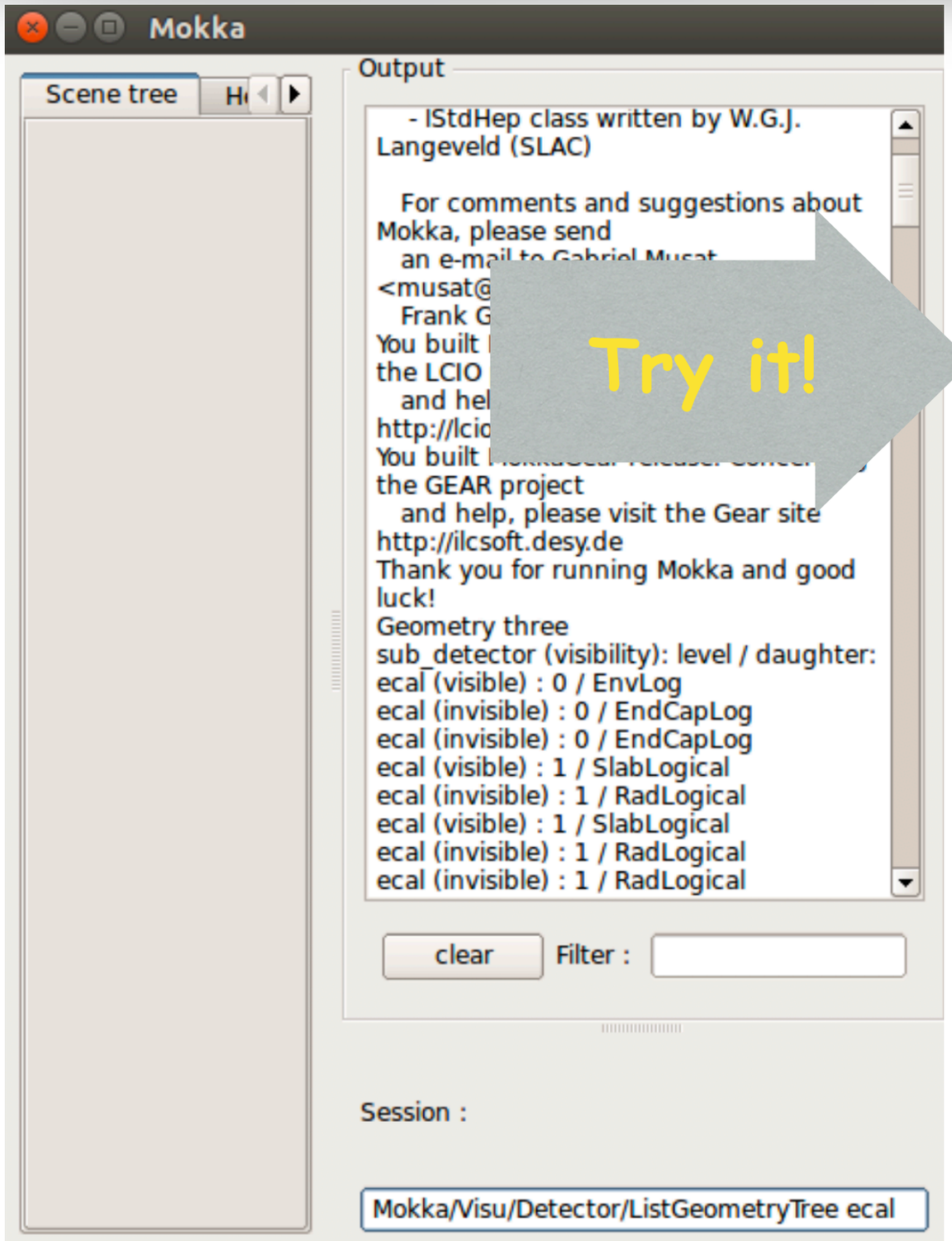
```
/generator/generator particleGun
/gun/position 0 0 0 mm
/gun/direction 0.1 0.49 0.0
/gun/momentum 10 GeV
/gun/phiSmearing 10 deg
/gun/directionSmearingMode uniform
/gun/thetaSmearing 180 deg
/gun/particle e-
/run/beamOn 100
```

```
/Mokka/init/BatchMode true
/Mokka/init/printLevel 2
/Mokka/init/detectorModel CEPC_v4

/Mokka/init/dbHost 202.122.37.75
/Mokka/init/user consult
/Mokka/init/dbPasswd consult
```

Visualize Geometry

- Mokka define the geometry
- Save in gdml format
- Transfer to root file
- Display in Druid

Visualize Geometry

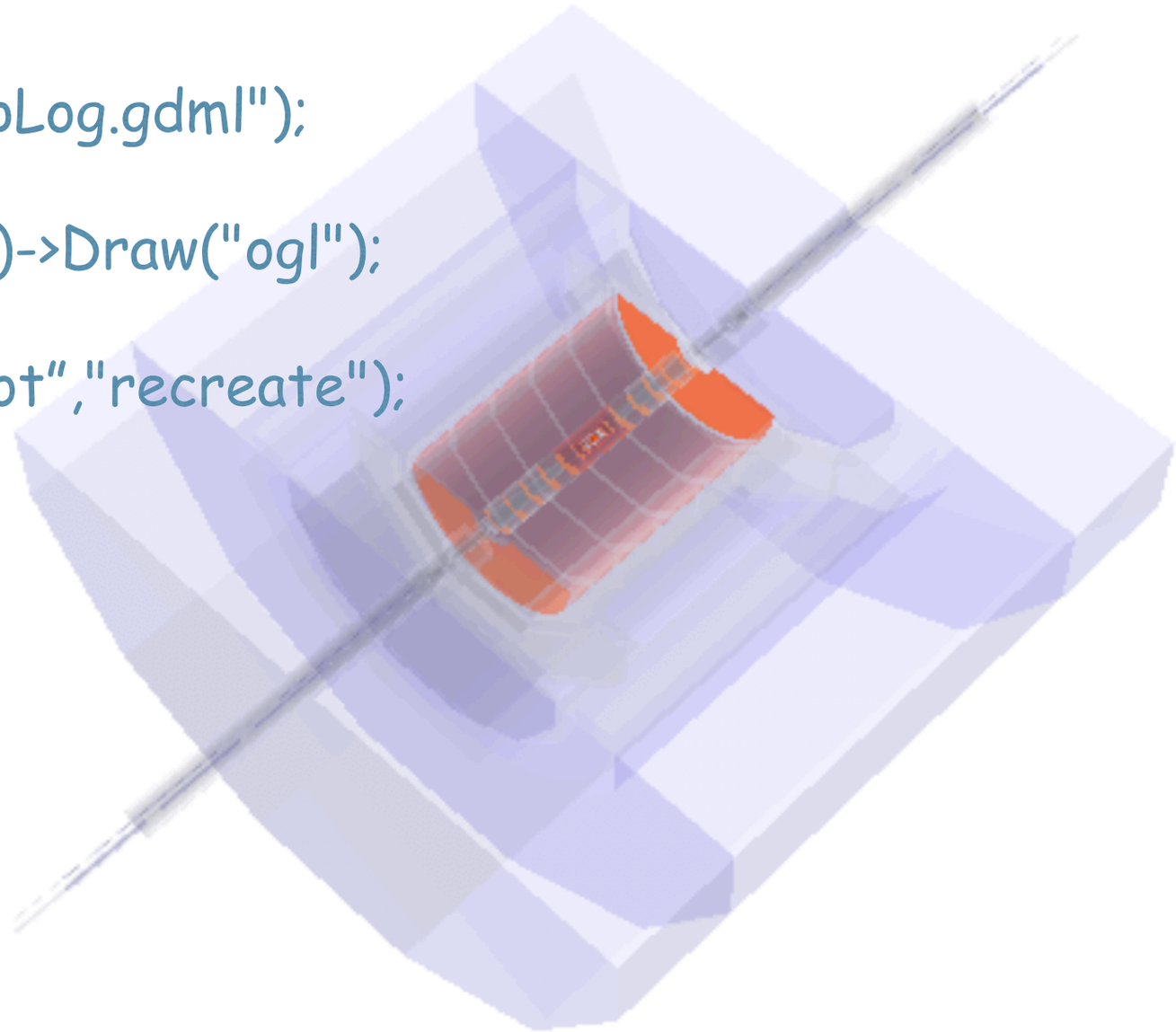


- Mokka -U Mokka_Model.macro (you can modify the parameters in it, or remove sub-detectors)
  - detectors: SEcal05… (Or see backup)
  - > Mokka/Visu/Detector/DumpGDML (produce total detector "World.gdml")
  - >Mokka/Visu/Detector/DumpGDML ecal EndCapLog (produce a stave "EndCapLog.gdml")
  - (>Mokka/Visu/Detector/ListGeometryTree ecal) (to see the logical names)
  - >exit

```
/Mokka/init/detectorModel CEPC_v4

#/Mokka/init/EditGeometry/rmSubDetector all
#/Mokka/init/EditGeometry/addSubDetector SEcal05

/Mokka/init/globalModelParameter TPC_outer_radius 1808
/Mokka/init/globalModelParameter TPC_Ecal_Hcal_barrel_halfZ 2350
/Mokka/init/globalModelParameter Ecal_Sc_Si_mix 0000000000

/Mokka/init/globalModelParameter Ecal_nlayers1 13
/Mokka/init/globalModelParameter Ecal_nlayers2 6
/Mokka/init/globalModelParameter Ecal_nlayers3 0

/Mokka/init/globalModelParameter Ecal_radiator_layers_set1_thickness 3.15
/Mokka/init/globalModelParameter Ecal_radiator_layers_set2_thickness 6.3
/Mokka/init/globalModelParameter Ecal_radiator_layers_set3_thickness 0
/Mokka/init/globalModelParameter Ecal_cells_size   10
```

Visualize Geometry

- Use root to save the geometry:
  - root -l
  - TGeoManager::Import("EndCapLog.gdml");
  - gGeoManager->GetTopVolume()->Draw("ogl");
  - TFile *f=new TFile("EndCap.root","recreate");
  - gGeoManager->Write();
  - f->Close()
- In Druid:
  - Druid EndCap.root

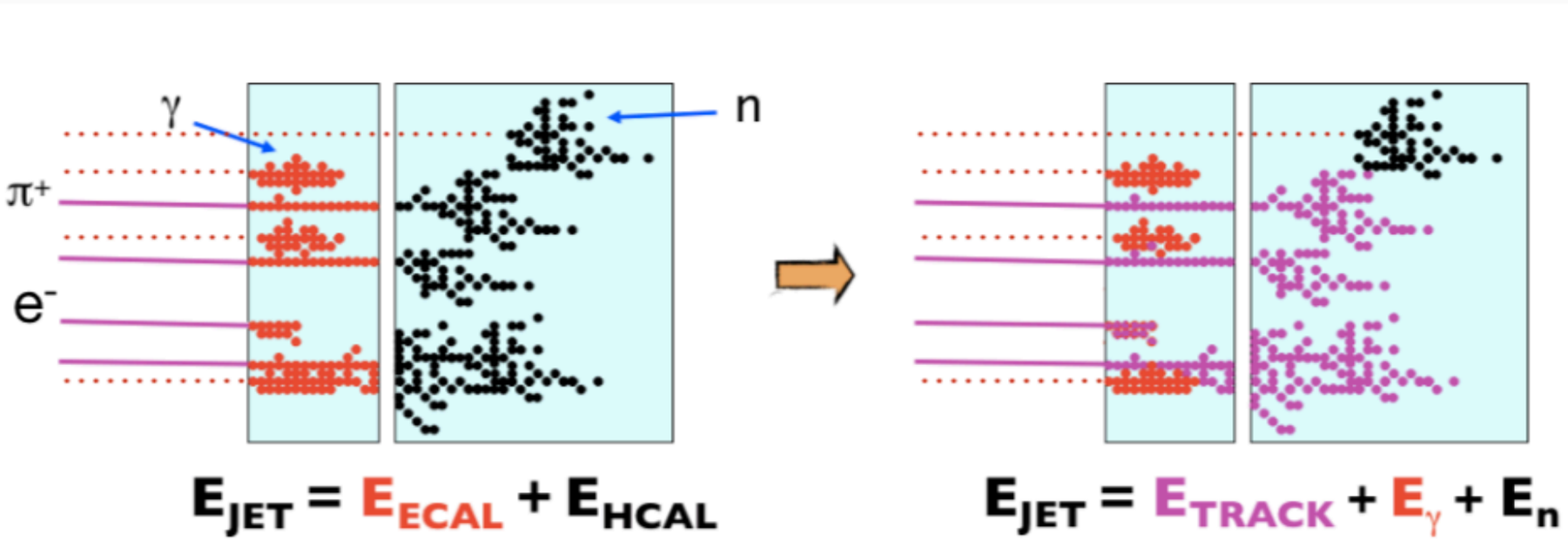


Particle Flow Algorithm

Aim: separate hadronic decay of bosons

Principle: reconstructing all the final state particles - different sub-detectors suitable for different kind of particles.

- final physics objects recognized with high efficiency and purity
- jets: 63% charged + 27%photon + 10% neutral hadron
- Jet Energy Resolution (JER)

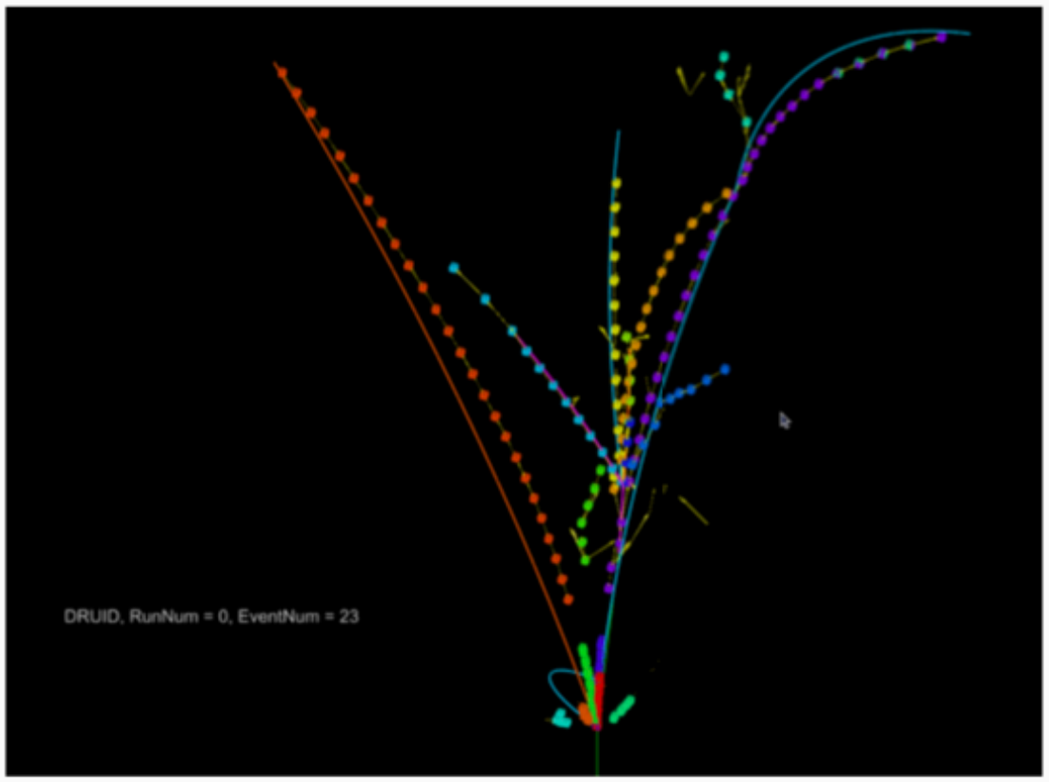


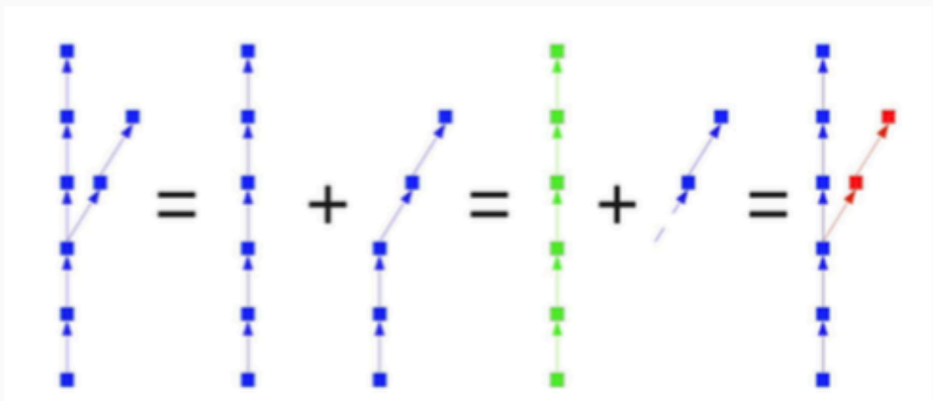
Arbor

Principle: The spatial configuration of a particle shower follows a tree configuration.

Steps:

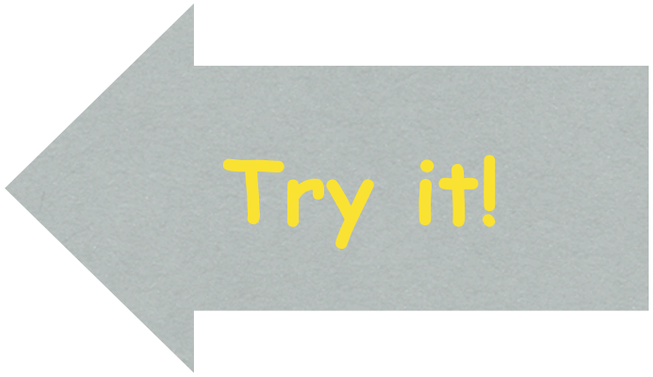
- Build connectors
- Clean connectors
- Iteration





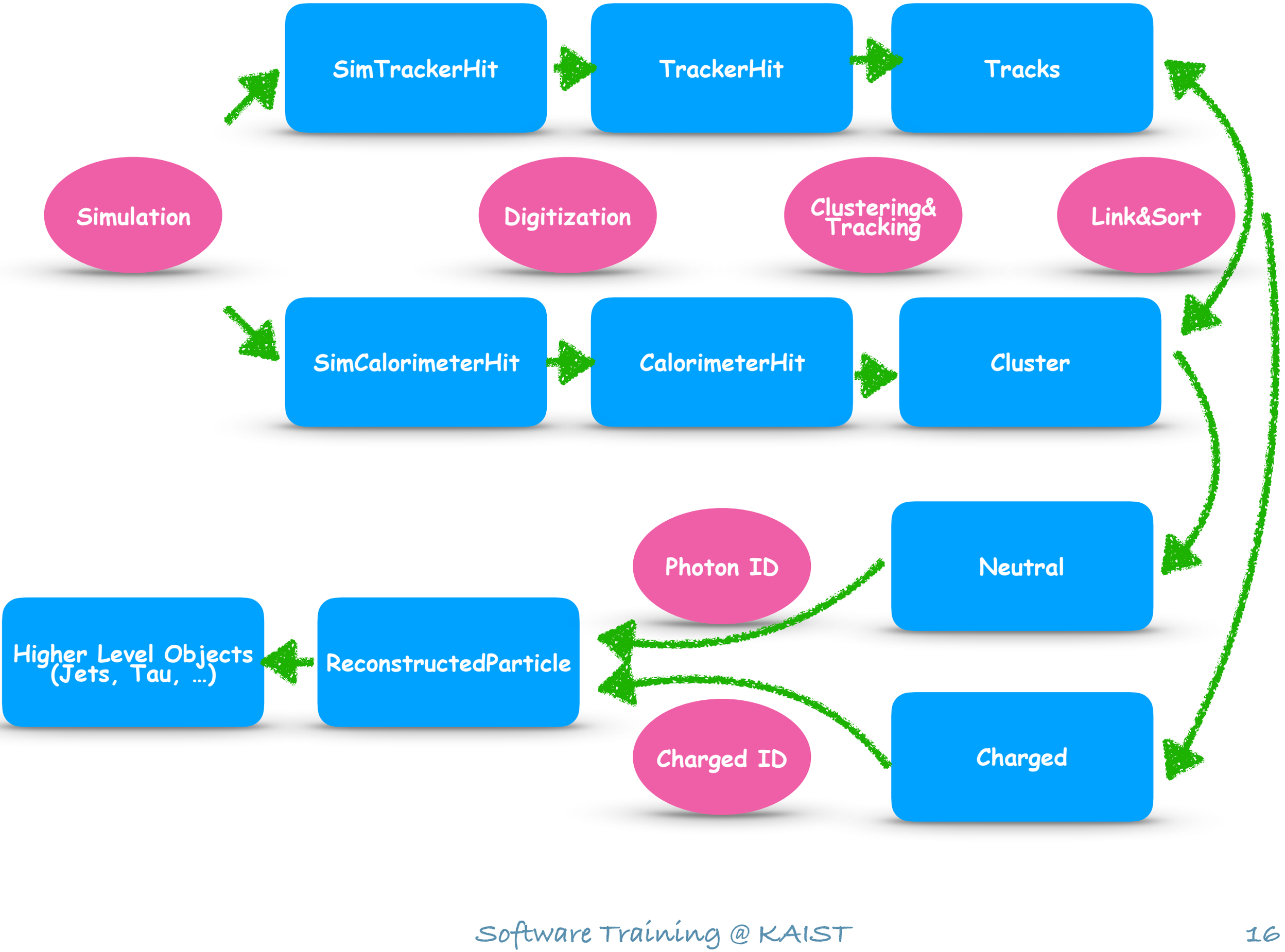
Reconstruction

- Tool: Marlin
  - modular C++ application framework for reconstruction and analysis.
  - processors: plug-in modules that can be loaded at runtime to implement some core functionality
  - processors called in execute, definitions comes after
- Example
  - cd ~/CEPCTraining/Reco
  - Marlin reco.xml



Reconstruction

- Digitization:
  - Smear the position/energy of SimTrackerHit/ SimCalorimeterHit generated in Mokka
- Reconstruction:
  - CalorimeterHit -> Branches -> Clusters
  - TrackerHit -> Tracks -> Link with clusters


SimTrackerHit
TrackerHit
Tracks
Simulation
Digitization
Clustering&
Tracking
Link&Sort
SimCalorimeterHit
CalorimeterHit
Cluster
Photon ID
Neutral
Higher Level Objects
(Jets, Tau, ...)
ReconstructedParticle
Charged ID
Charged

Reconstruction

```
<processor name="MyAIDAProcessor"/>
<!-- ========== track digitization and tracking  === -->
<processor name="VXDPlanarDigiProcessor"/>
<processor name="SITPlanarDigiProcessor"/>
<processor name="SITSpacePointBuilder" />
<processor name="FTDPixelPlanarDigiProcessor"/>
<processor name="FTDStripPlanarDigiProcessor"/>
<processor name="FTDSpacePointBuilder"/>
<processor name="SETPlanarDigiProcessor"/>
<processor name="SETSpacePointBuilder" />
<processor name="MyTPCDigiProcessor"/>
<!-- ========== the new C++ tracking =============== -->
 <processor name="MyClupatraProcessor" />
 <processor name="MySiliconTracking_MarlinTrk"/>
<processor name="MyForwardTracking"/>
 <processor name="MyTrackSubsetProcessor" />
 <processor name="MyFullLDCTracking_MarlinTrk"/>
 <!-- ========== the digitization ============== -->
 <processor name="MyG2CDArbor"/>
 <processor name="MySimpleBCalDigi"/>
 <processor name="MySimpleLCalDigi"/>
 <processor name="MySimpleLHCalDigi"/>
 <processor name="MySimpleMuonDigi"/>
 <!-- ========== the reconstruction =============== -->
 <processor name="MyMarlinArbor"/>
 <processor name="MyBushConnect"/>
 <processor name="MyLICH"/>
 <processor name="MyRecoMCTruthLinker"/>
 <processor name="MyLCIOOutputProcessor"/>
```

TrackerHit Digitization

Tracking

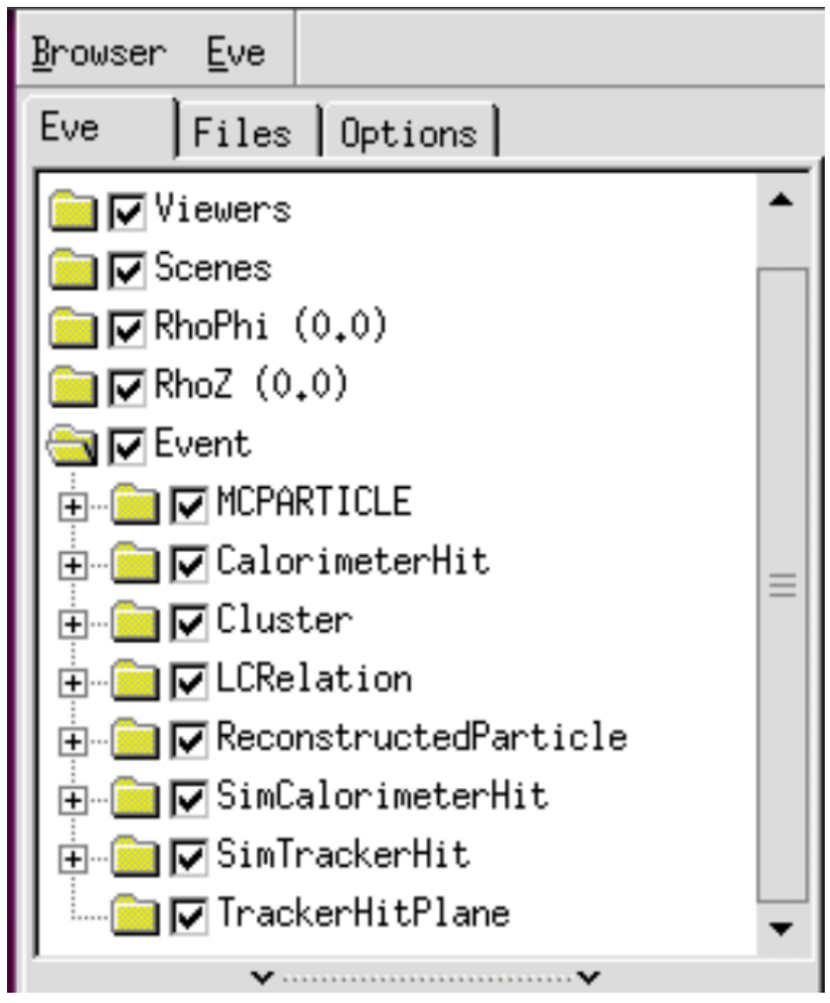
CalorimeterHit Digitization

Clustering, ID, output

Display

- Druid ~/CEPCTraining/Sample/Reco/Reco_e-_10GeV.slcio
  - you can chose the collections to display
- Druid ~/CEPCTraining/Sample/Reco/Reco_e-_10GeV.slcio ~/CEPCTraining/Sample/Reco/Detector.root

Try it!



Working Time

- Simulate and reconstruct another particle in a modified geometry
  - (will be used later)
- Display it
- Enjoy!

Day 2

Subjects:

1. Know how to extract information from LCIO files
2. Read root files

Optional:

1. Try to make a processor reading information you are interested in

Day 3

Subjects:

1. Calculate the recoil mass of $\mu\mu$ in $\mu\mu$H events
2. Calculate the invariant mass of di-jets in vvH(H to gg) events

Optional:

1. Calculate the recoil mass of ee in eeH events
2. Calculate the invariant mass of di-jets in ZZ/WW events

Backup

Database

- mysql –h 202.122.37.75 -uconsult –pconsult
- >use models03;
- show tables;
- describe model; (sub_detector, ingredients, …)
  - ex:
    - select * from model where name='CEPC_v4';
    - select sub_detector from ingredients where model='CEPC_v4';
    - select * from sub_detector where name='SEcal05';
    - select * from sharing where driver='SEcal05';
    - select parameter, driver_default_value, default_value from sharing, parameters where parameter = name and driver='SEcal05';
- https://indico.ihep.ac.cn/event/4287/contribution/24/material/slides/0.pdf

Database

```
[mysql> show tables;
 +--------------------+
 | Tables_in_models03 |
 +--------------------+
 | detector_concept   |
 | ingredients        |
 | model              |
 | model_parameters   |
 | parameters         |
 | scripts            |
 | setup              |
 | setup_parameters   |
 | sharing            |
 | sub_detector       |
 | tmp_databases      |
 | tmpdatabases       |
 +--------------------+
```

xxx: select * from c

select a from b where c='xxx'

```
mysql> describe ingredients;
+--------------+------------+------+-----+---------+----------------+
| Field        | Type       | Null | Key | Default | Extra          |
+--------------+------------+------+-----+---------+----------------+
| id           | bigint(4)  | NO   | PRI | NULL    | auto_increment |
| model        | char(80)   | NO   |     |         |                |
| sub_detector | char(80)   | NO   |     |         |                |
| build_order  | bigint(4)  | NO   |     | 0       |                |
+--------------+------------+------+-----+---------+----------------+
```

ROOT's GL viewer

En 09:07

File Camera Help

Style | Guides | Clipping | Extras

Name

GLViewer::TGLSAViewer

Update behaviour

- [ ] Ignore sizes
- [x] Reset on update

Update Scene

Camera Home

Max HQ draw time: 5000

Max LQ draw time: 100

Clear Color

Light sources:

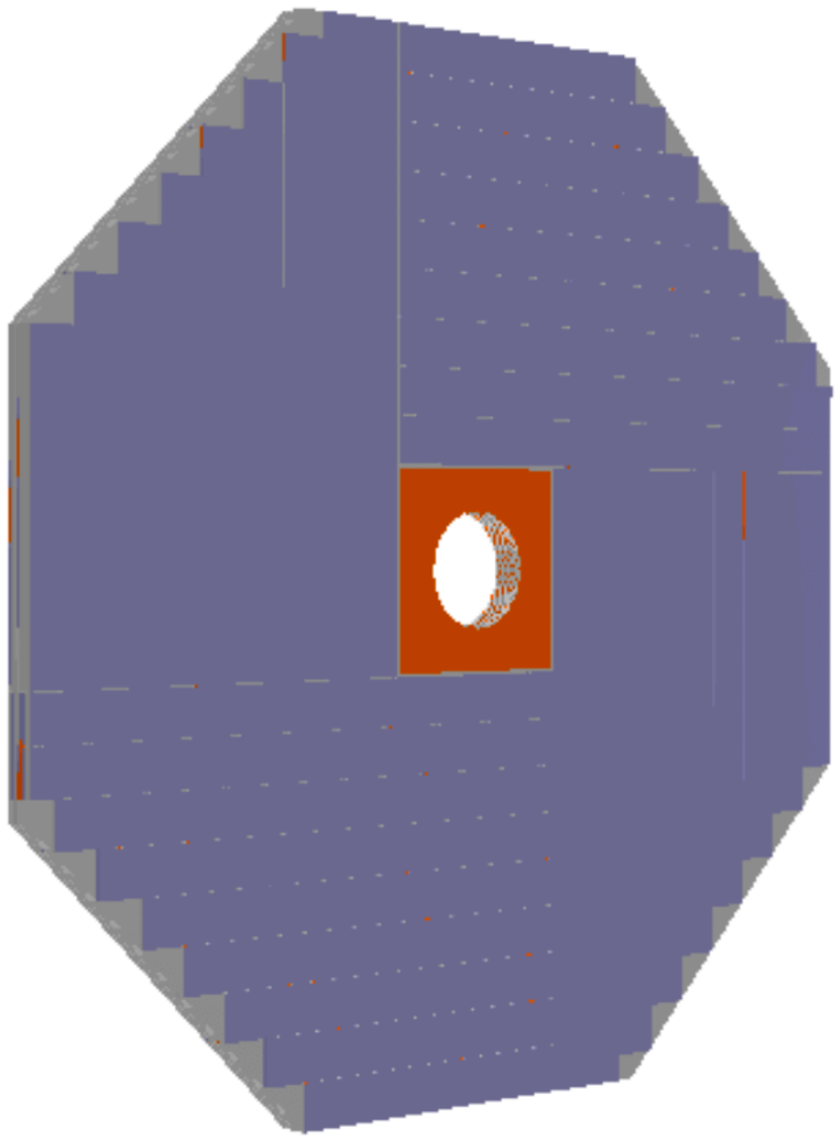
- [x] Top
- [x] Bottom
- [x] Left
- [x] Right
- [x] Front
- [x] Specular

Point-size scale: 1.0

Line-width scale: 1.0

Wireframe line-width 1.0

Outline line-width: 1.0



```
cepc@cepc-VirtualBox:~/CEPCTraining/SIMU$ root -l
root [0] TGeoManager::Import("EndCapLog.gdml")
Info in <TGeoManager::Import>: Reading geometry from file: EndCapLog.gdml
Info in <TGeoManager::TGeoManager>: Geometry GDMLImport, Geometry imported from
GDML created
Info in <TGeoManager::SetTopVolume>: Top volume is EndCapLog. Master volume is E
ndCapLog
Info in <TGeoNavigator::BuildCache>: --- Maximum geometry depth set to 100
Info in <TGeoManager::CheckGeometry>: Fixing runtime shapes...
Info in <TGeoManager::CheckGeometry>: ...Nothing to fix
Info in <TGeoManager::CloseGeometry>: Counting nodes...
Info in <TGeoManager::Voxelize>: Voxelizing...
Info in <TGeoManager::CloseGeometry>: Building cache...
Info in <TGeoManager::CountLevels>: max level = 3, max placements = 1119
Info in <TGeoManager::CloseGeometry>: 34320 nodes/ 10 volume UID's in Geometry i
mported from GDML
Info in <TGeoManager::CloseGeometry>: ----------------modeler ready-------------
---
(class TGeoManager*)0x1608f10
root [1] gGeoManager->GetTopVolume()->Draw("ogl")
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
root [2] TFile *f=new TFile("EndCap","recreate")
root [3] gGeoManager->Write()
(Int_t)35409
root [4] f->Close()
root [5]
```

ROOT—In Case

- Open a root file "file"
  - root file.root
- See what's in this file
  - .ls
- See what are the branches values of first entry in the tree "Tree"
  - Tree->Show(1)
- Draw a branch "Val1" in "Tree", then another branch "Val2" in the same plot
  - Tree->Draw("Val1")
  - Tree->Draw("Val1","","sames")
- Draw a 2-D plot
  - Tree->Draw("Val1:Val2")
- Open a browser
  - TBrowser *b

ROOT—In Case

- https://root.cern/
- https://docs.google.com/presentation/d/189f0qsDEnMSk2R5KWLRPz2TdEV5kTfXH1VcuAra4cnU/edit#slide=id.g2a150e6c26_0_0

backup

- http://cepcsoft.ihep.ac.cn/guides/scratch/docs/local/#install-cepcenv
- apt-get install libtool*
- find / -name "libstdc++.so.6"
- cp /*/libstdc++.so.6 $CEPCSOFT/GCC/lib64/.
- sudo ln -s /etc/apparmor.d/usr.bin.evince /etc/apparmor.d/disable
- sudo /etc/init.d/apparmor restart

My errors installing mg

- Symbol not found: __PyErr_ReplaceException:
  - if you go to /System/Library/Frameworks/Python.framework/Versions/ and copy the folder 2.7 into /Library/Frameworks/Python.framework/Versions it solves the problem
- Error: cannot open file “AvailabilityMacros.h"
  - xcode-select --install
  - open /Library/Developer/CommandLineTools/Packages/macOS_SDK_headers_for_macOS_10.14.pkg