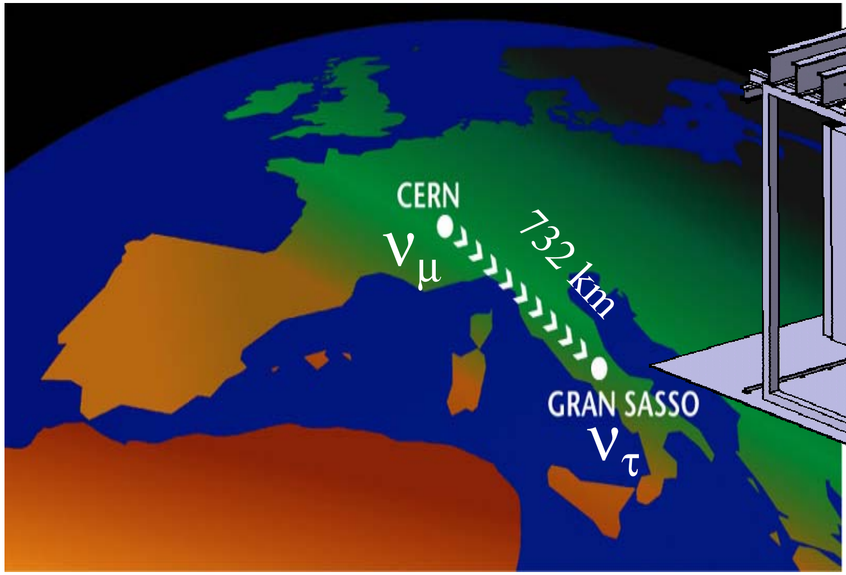
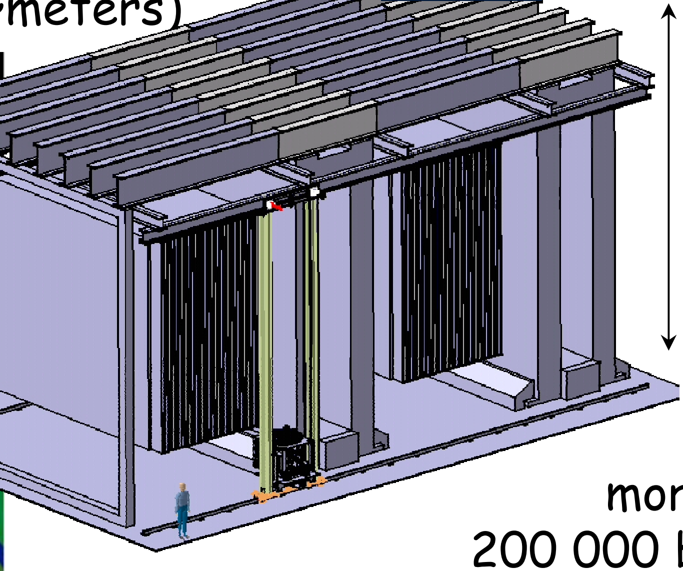
ROOT VMC in OPERA

- OPERA physics
- Software framework
- OpSim: VMC simulation package
- Specificities, requirements and milestones

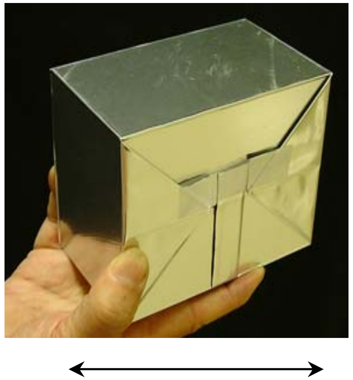
OPERA physics:

- « low » energy (~1-20 GeV)
- short (~microns) and long dist. (~meters)

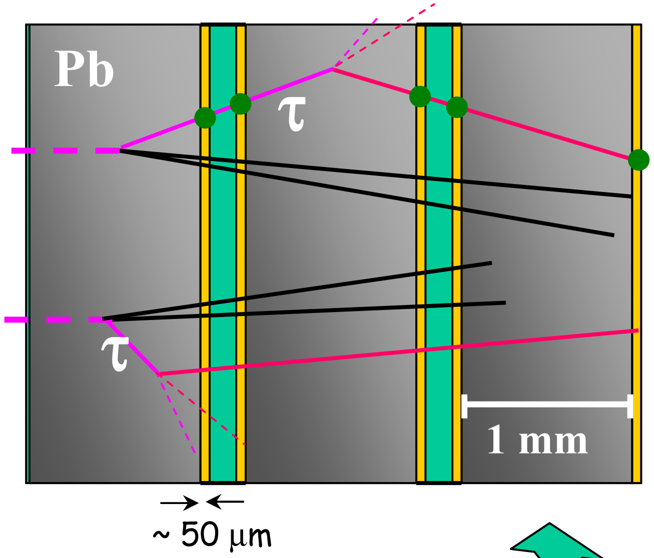




more than
200 000 bricks…



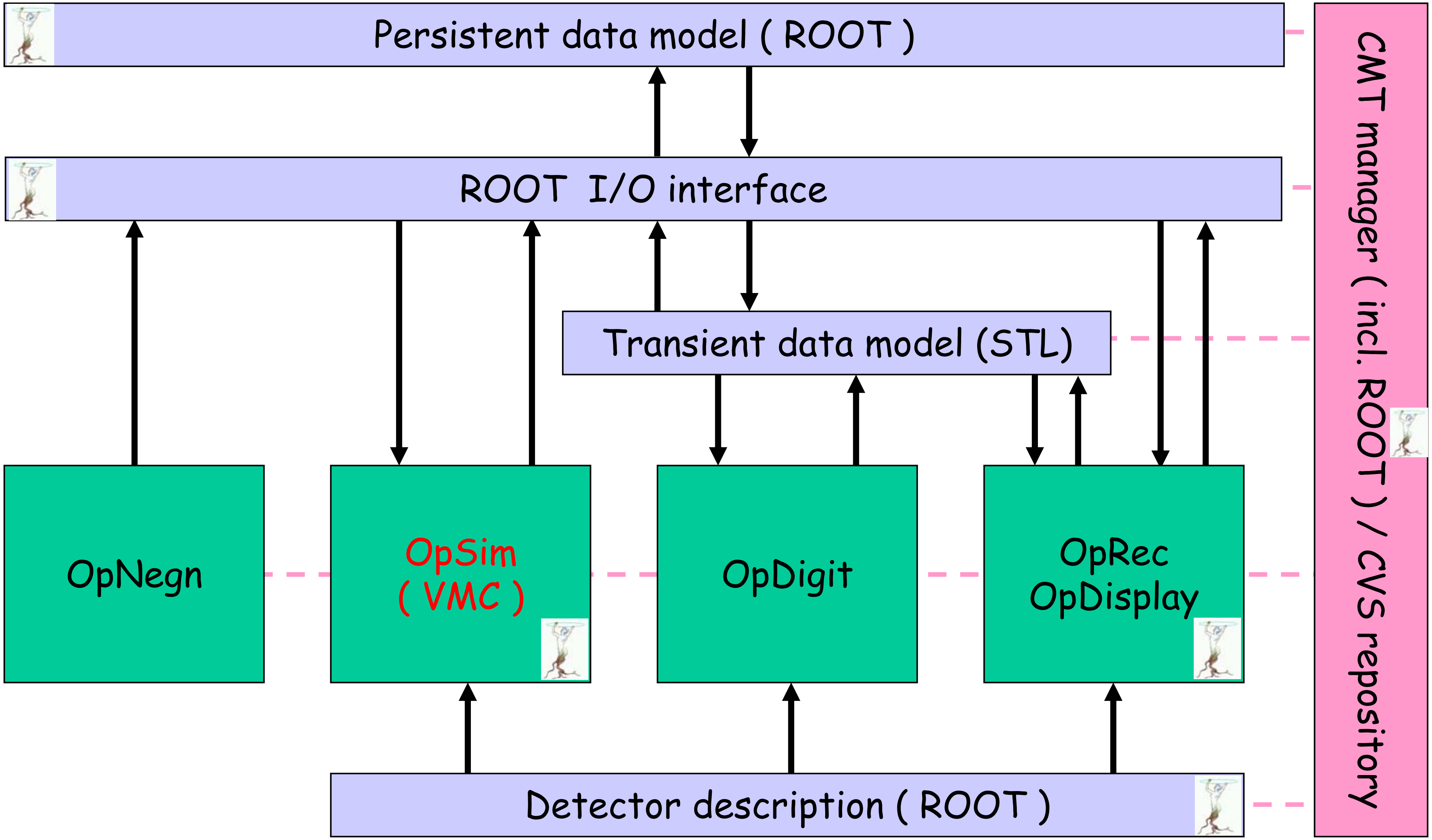
… photographic emulsions
scanned by microscopes…



… to find
the « kink »
of the tau

OPERA software framework:

- developed on RH7.3/cern, validated on SLC3
- a serie of CMT pakages compatible with last ROOT and last VMC versions
- OpSim (VMC) is one of the algorithms-like packages


Persistent data model (ROOT)
ROOT I/O interface
Transient data model (STL)
OpNegn
OpSim
(VMC)
OpDigit
OpRec
OpDisplay
Detector description (ROOT)
CMT manager (incl. ROOT) / CVS repository

Configuration Management Tool:

- all OPERA packages are CMT configured
  (Ch.Arnault, J.E. Campagne, LAL Orsay)

CMT interface to ROOT VMC (e.g. geant3)

```
package ROOTVMC

set ROOTVMC_DIR ‘‘${SOMEWHERE}/vmc’’

include_dirs ${ROOTVMC_DIR}/geant3

path_remove LD_LIBRARY_PATH ‘‘vmc’’
Path_append_ LD_LIBRARY_PATH \
        Linux‘‘${ROOTVMC_DIR}/geant3/lib/tgt_linux’’
```

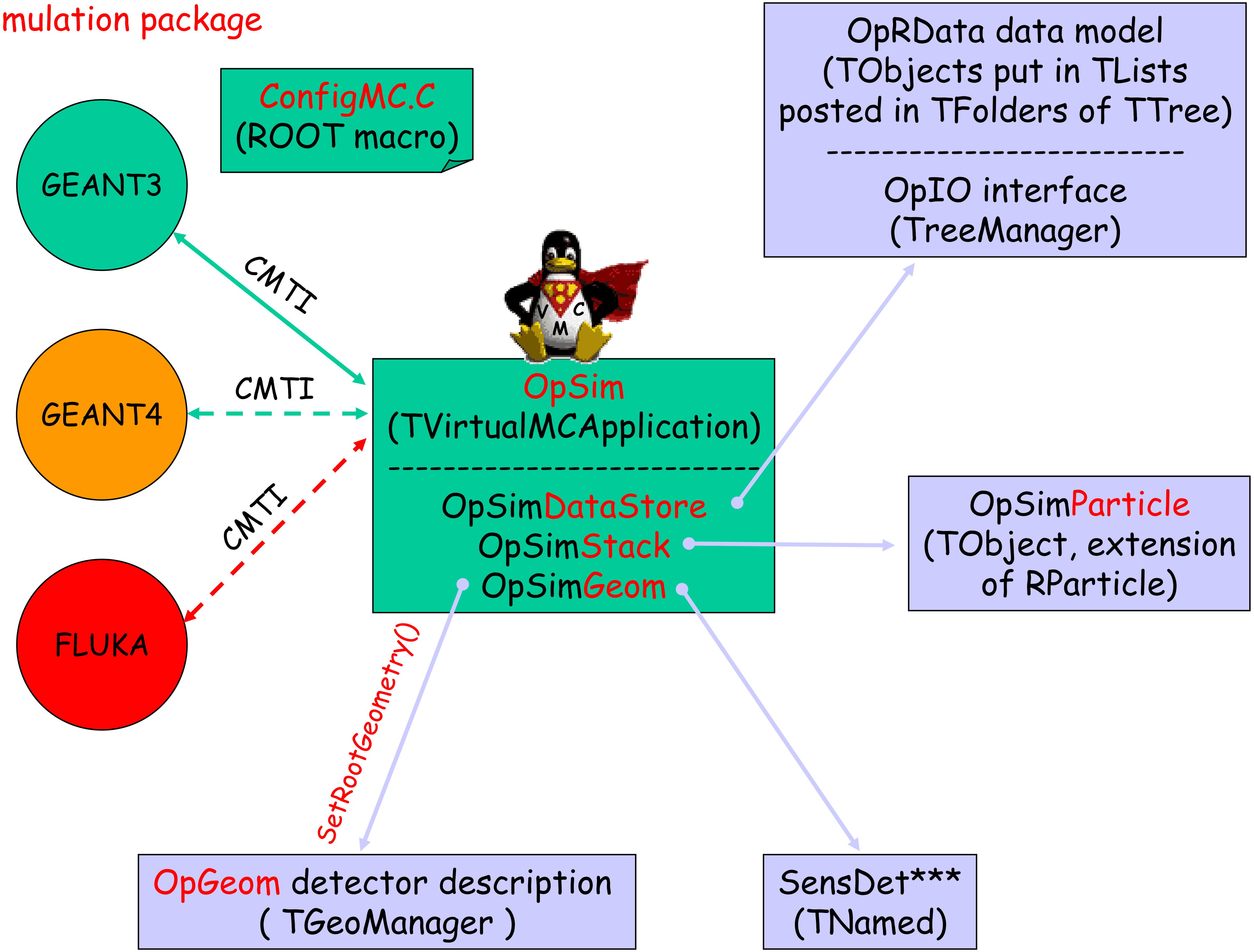
used in OpSim package:
(requirement file from
OpSim/v*/cmt)

```
package OpSim
author Toto

use OperaPolicy v*
use ROOTVMC     v* CMTI

branches doc
...
```

Some (not so difficult) problems:

- geant3: vmc library has the same name as cernlib one (libgeant321)
- geant4: vmc include files are put in several directories
- fluka ???

Simulation package



ConfigMC.C
(ROOT macro)

GEANT3

GEANT4

FLUKA

CMTI

CMTI

CMTI

OpSim
(TVirtualMCApplication)

OpSimDataStore
OpSimStack
OpSimGeom

SetRootGeometry()

OpRData data model
(TObjects put in TLists posted in TFolders of TTree)

OpIO interface
(TreeManager)

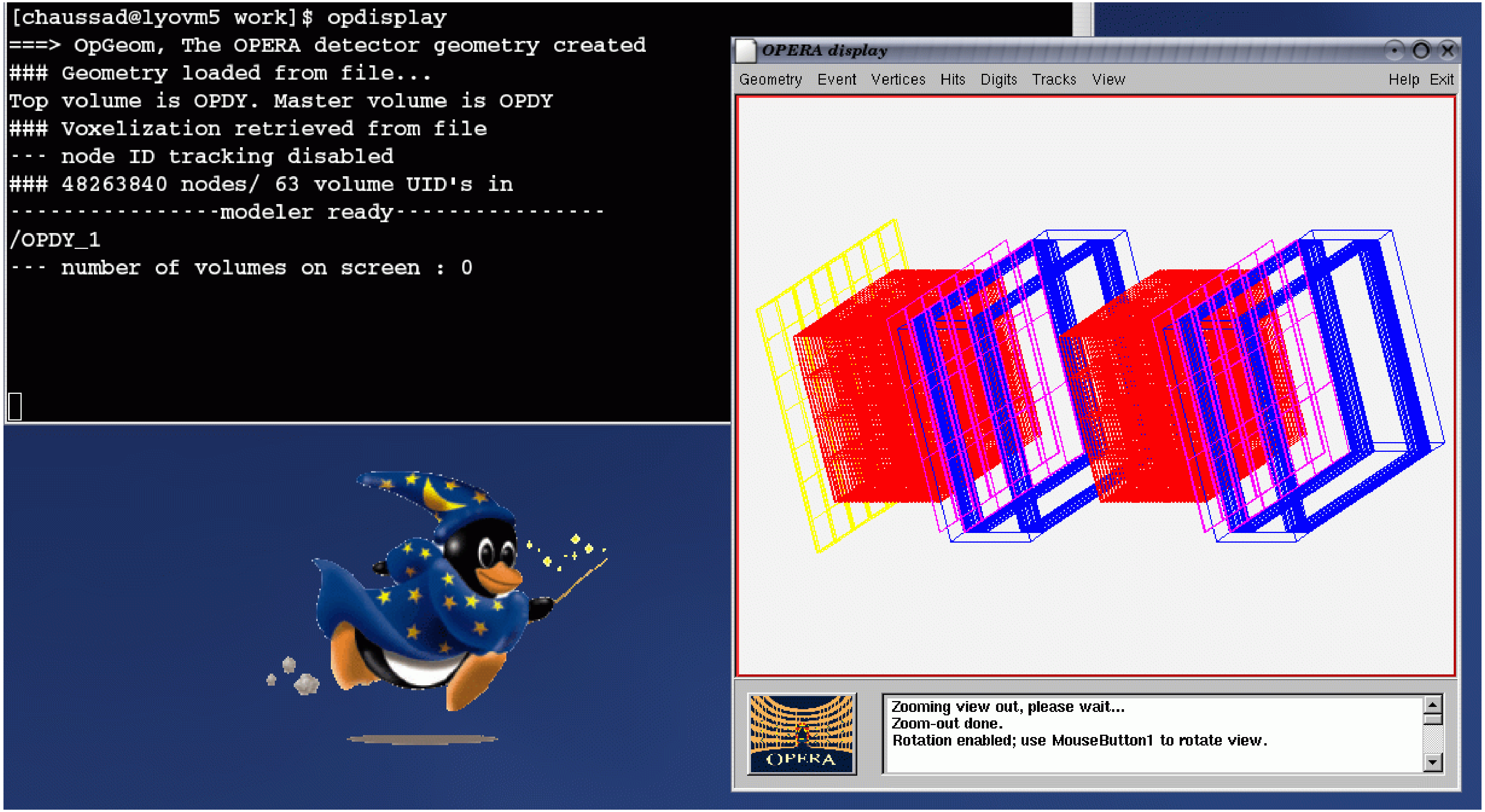
OpSimParticle
(TObject, extension of RParticle)

OpGeom detector description
(TGeoManager)

SensDet***
(TNamed)

OpGeom detector description:

- from the ROOT TGeoManager package
- OPERA volumes are « simple », try to avoid "MANY" flag
- OpGeom.root file, less than 120 kB, more than 48 Millions nodes
- use SetRootGeometry() in OpSim VMC application



```
[chaussad@lyovm5 work]$ opdisplay
===> OpGeom, The OPERA detector geometry created
### Geometry loaded from file...
Top volume is OPDY. Master volume is OPDY
### Voxelization retrieved from file
--- node ID tracking disabled
### 48263840 nodes/ 63 volume UID's in
----------------modeler ready----------------
/OPDY_1
--- number of volumes on screen : 0
```

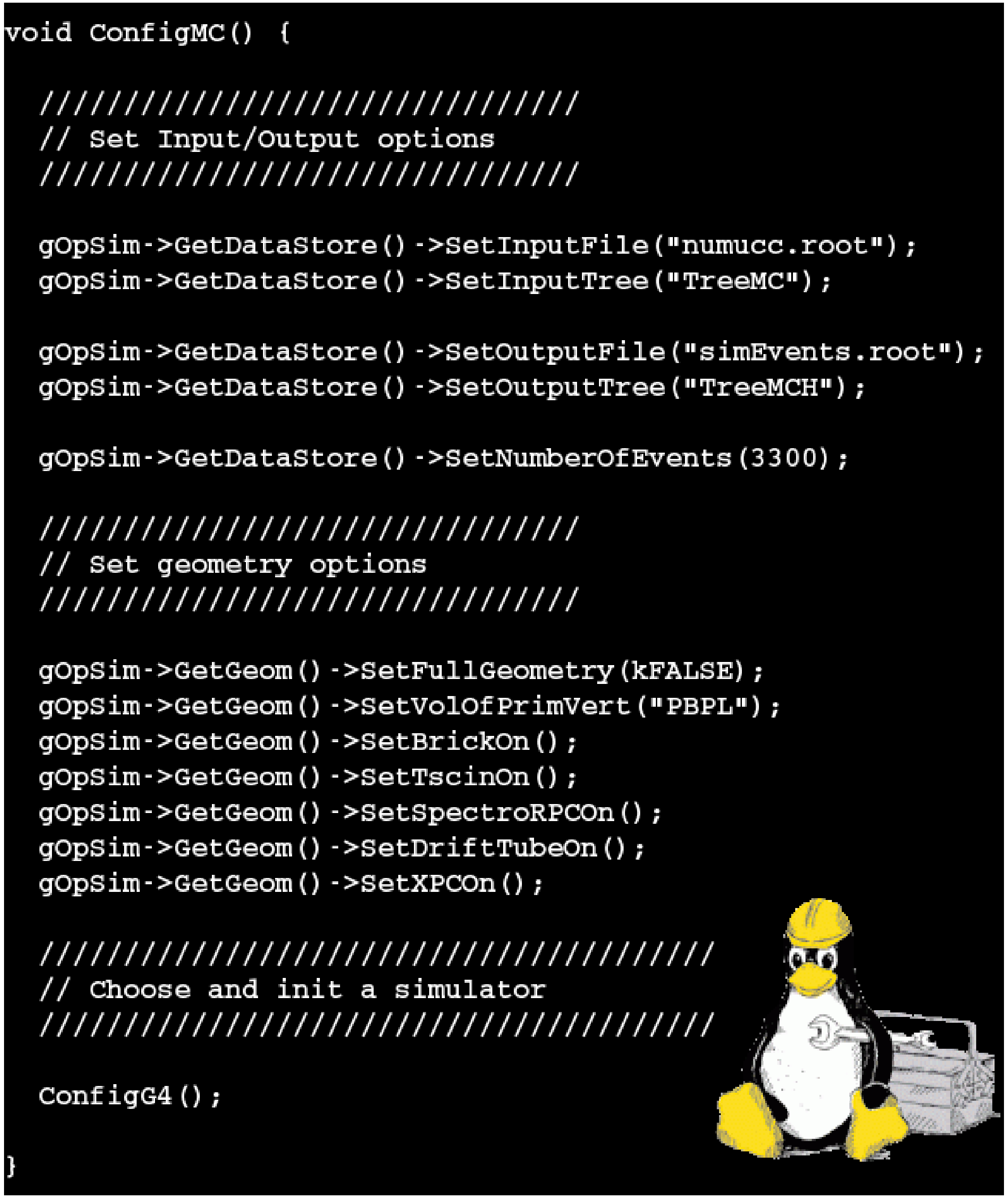
```
Zooming view out, please wait...
Zoom-out done.
Rotation enabled; use MouseButton1 to rotate view.
```

ConfigMC.C:

Configure datastore

Configure geometry

Configure simulator



```
void ConfigMC() {

  ////////////////////////////////
  // Set Input/Output options
  ////////////////////////////////

  gOpSim->GetDataStore()->SetInputFile("numucc.root");
  gOpSim->GetDataStore()->SetInputTree("TreeMC");

  gOpSim->GetDataStore()->SetOutputFile("simEvents.root");
  gOpSim->GetDataStore()->SetOutputTree("TreeMCH");

  gOpSim->GetDataStore()->SetNumberOfEvents(3300);

  ////////////////////////////////
  // Set geometry options
  ////////////////////////////////

  gOpSim->GetGeom()->SetFullGeometry(kFALSE);
  gOpSim->GetGeom()->SetVolOfPrimVert("PBPL");
  gOpSim->GetGeom()->SetBrickOn();
  gOpSim->GetGeom()->SetTscinOn();
  gOpSim->GetGeom()->SetSpectroRPCOn();
  gOpSim->GetGeom()->SetDriftTubeOn();
  gOpSim->GetGeom()->SetXPCOn();

  ////////////////////////////////////////
  // Choose and init a simulator
  ////////////////////////////////////////

  ConfigG4();

}
```

ConfigMC.C:

```
void ConfigG3() {

  gSystem->Load("libdummies.so");
  gSystem->Load("libgeant3vmc.so");

  TGeant3* geant3 = new  TGeant3("OPERA C++ Interface to Geant3");

  geant3->SetAUTO(1);

  geant3->SetPAIR(1);
  geant3->SetCOMP(1);
  geant3->SetPHOT(1);
  geant3->SetPFIS(0);
  geant3->SetDRAY(0);
  geant3->SetANNI(1);
  geant3->SetBREM(1);
  geant3->SetHADR(1);
  geant3->SetMUNU(0);
  geant3->SetDCAY(1);
  geant3->SetLOSS(2);
  geant3->SetMULS(1);
  geant3->SetRAYL(1);
  geant3->SetCKOV(1);
  geant3->SetSTRA(0);
  geant3->SetABAN(0);
  geant3->SetOPTI(2);

  geant3->SetMaxNStep(10e5);
```

```
  geant3->SetCut("CUTGAM",0.001);
  geant3->SetCut("CUTELE",0.001);
  geant3->SetCut("CUTNEU",0.01);
  geant3->SetCut("CUTHAD",0.01);
  geant3->SetCut("CUTMUO",0.01);
  geant3->SetCut("BCUTE",0.001);
  geant3->SetCut("BCUTM",0.001);
  geant3->SetCut("DCUTE",1000.);
  geant3->SetCut("DCUTM",1000.);

  geant3->SetSWIT(4,0);
  geant3->SetDEBU(0,0,0);

}
```

No specific difficulty

ConfigMC.C:

```
void ConfigG4() {

  gSystem->Load("$CLHEP_BASE_DIR/lib/libCLHEP");

  gSystem->Load("libG4global.so");
  gSystem->Load("libG4graphics_reps.so");
  gSystem->Load("libG4intercoms.so");
  gSystem->Load("libG4materials.so");
  gSystem->Load("libG4geometry.so");
  gSystem->Load("libG4particles.so");
  gSystem->Load("libG4track.so");
  gSystem->Load("libG4processes.so");
  gSystem->Load("libG4tracking.so");
  gSystem->Load("libG4digits_hits.so");
  gSystem->Load("libG4event.so");
  gSystem->Load("libG4readout.so");
  gSystem->Load("libG4run.so");

  gSystem->Load("libG4interfaces.so");

  gSystem->Load("libG4modeling.so");
  gSystem->Load("libG4vis_management.so");
  gSystem->Load("libG4Tree.so");
  gSystem->Load("libG4visXXX.so");
  gSystem->Load("libG4visHepRep.so");

  gSystem->Load("libG4FR.so");

  gSystem->Load("libGLU");
  gSystem->Load("libGL.so");
  gSystem->Load("libG4OpenGL.so");
  gSystem->Load("libG4RayTracer.so");
  gSystem->Load("libG4VRML.so");

  gSystem->Load("libG3toG4.so");

  gSystem->Load("libroottog4");
  gSystem->Load("libg4toxml");
  gSystem->Load("libgeant4vmc");

  TG4RunConfiguration* runConfiguration = new TG4RunConfiguration();
  TGeant4* geant4 = new TGeant4("TGeant4", "The Geant4 Monte Carlo", runConfiguration);
  geant4->ProcessGeantMacro("g4config.in");
```

Use only global GEANT4 libraries for the time being

geant4_vmc libraries

g4config.in:

```
/mcVerbose/all 0
/mcVerbose/runAction 1
/mcVerbose/physicsList 1
```

Pb: not really clear how to implement user's physics list…

ROOT VMC workshop - CERN - December 2004

Specificities:

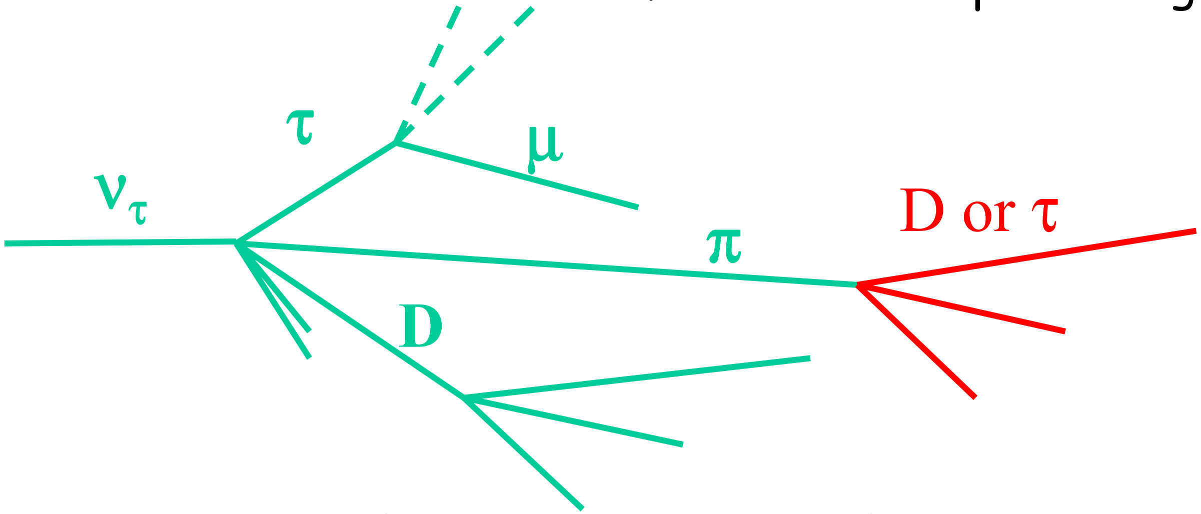
- It seems that everything works well with geant3 vmc

- Some « technical » difficulties to work with geant4 vmc (geometry control, physics list)

- News for FLUKA vmc ? (Help « may » be provided)

- tau generated particule and charmed generated particles are OPERA specific:

  - set lifetime to infinite
  - set decay modes to none (stable particules)
  - track these in emulsion and stop tracking on demand

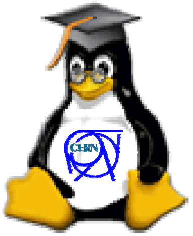


-Yet simulator induced particules should be tracked/decayed as usual…

Easy to implement in the vmc application using TGeant3::DefineParticle,
More difficult in the geant4 vmc case

Milestones :

- 2004 production (running):
    - still using « old » OpRoot package à la AliRoot
    - still using ROOT 3.*
    - still running on RH 7.3 / cern



- 2005 production (planned):
    - should be done with OpSim using geant3 vmc and ROOT 4.*
    - should be done on SLC3
    - test OpSim with geant4 vmc
    - looking forward to fluka vmc

- 2006 production (data taking!)
    - should be done with OpSim using fluka vmc