Status of Geant4 VMC in FairRoot

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... or better...

What PANDA has learnt from VirtualMC

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Overview

- Why Geant4 VMC in PandaRoot?
- Software release
- Installation issues
- Geometry and transport
- Physics results
- CPU Performances

Why Geant4 in PandaRoot ?

The PANDA collaboration strongly pushed to use Geant4

since the "birth" of PandaRoot

not CBM ⇒ Geant3

Known issues of Geant4 ⇒

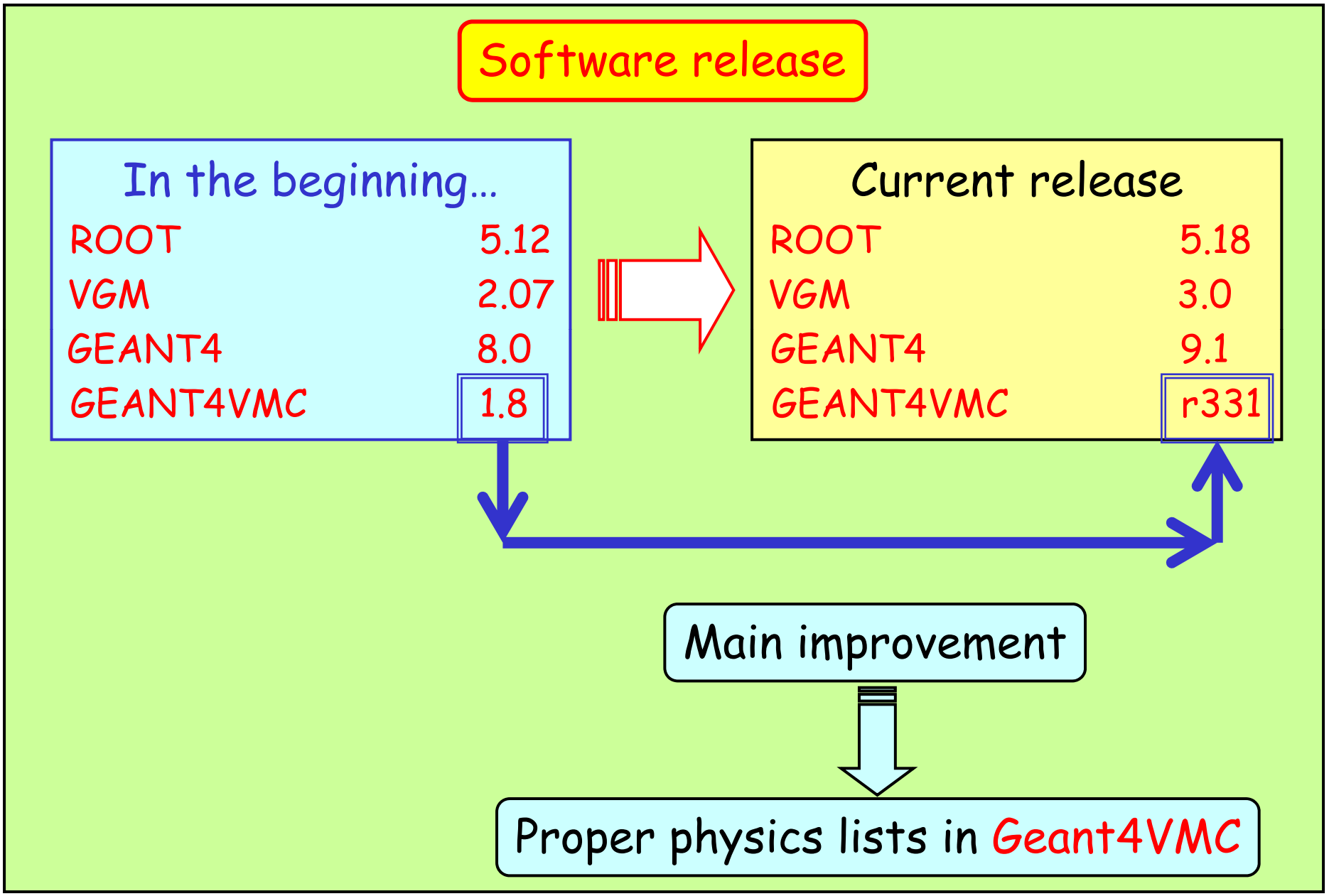
- slower than Geant3
- still under development
- must be tuned (physics lists)

... several reasons...

Many people think: "Geant4 is cool, Geant3 is bad"

Previous data analysis done with G4 ⇒ TPR Physics booklet

Results comparison is required


Software release
In the beginning…
ROOT 5.12
VGM 2.07
GEANT4 8.0
GEANT4VMC 1.8
Current release
ROOT 5.18
VGM 3.0
GEANT4 9.1
GEANT4VMC r331
Main improvement
Proper physics lists in Geant4VMC

Installation issues

All the external packages come in a tar file

GEANT3/GEANT4
ROOT/VMC

installation by
one single
configuration script

the user should only:

- **download** the tar ball
- **unpack** it
- **launch one single script**
- take a coffee (maybe many)
- cross the fingers

missing graphical libraries

libXm, openGL, Motif, wxGTK

- everything compiles
- analysis does not run (missing libs)

```
Loading Geant4 granular libraries ...
Error in <TUnixSystem::DynamicPathName>: libG4OpenGL[.so | .sl | .dl | .a | .dll] does not exist
```

Geometry and transport

Exactly the same geometry file / same media definition

fRun->SetName("TGeant3");

fRun->SetName("TGeant4");

```
void SetCuts()
{
  cout << "SetCuts Macro: Setting Processes.." <<endl;

  gMC->SetProcess("PAIR",1); /** pair production*/
  gMC->SetProcess("COMP",1); /**Compton scattering*/
  …
  Double_t cut1=1.0E-3; //GeV

  cout << "SetCuts Macro: Setting cuts.." <<endl;

  gMC->SetCut("CUTGAM",cut1);   /** gammas (GeV)*/
  gMC->SetCut("CUTELE",cut1);   /** electrons (GeV)*/
  …
}
```

new TG4RunConfiguration ("geomRoot",
"QGSP_BERT_EMV+optical",
"specialCuts");

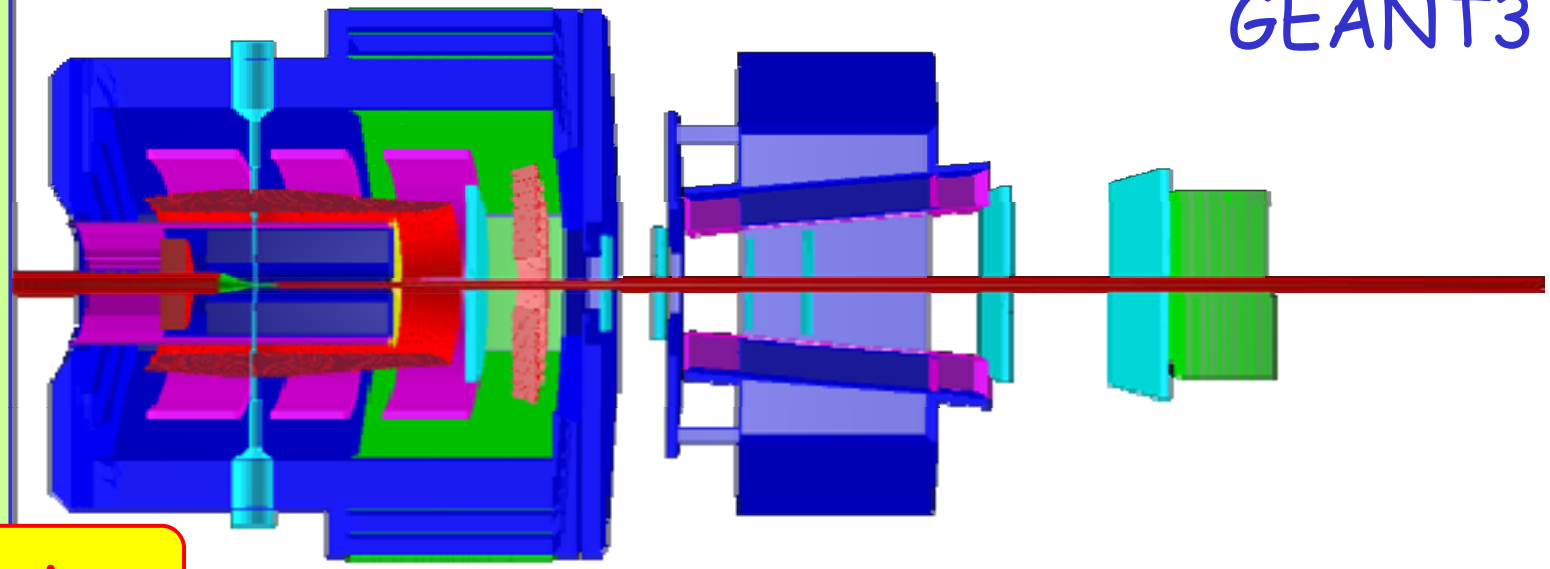
to set physics lists

(in theory)
the same physics cuts

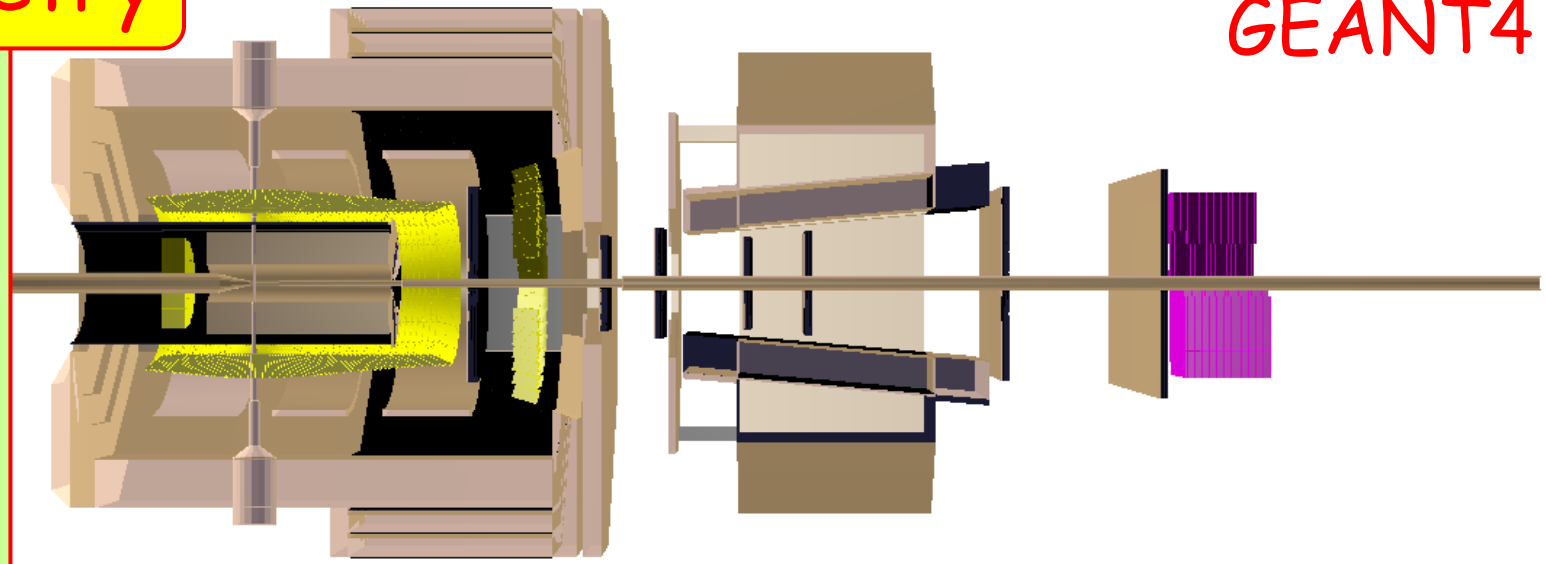
G4: conversion from energy → range

Geometry

GEANT3



GEANT4



Geometry

Using exactly the same geometry file/same media definition

```
fRun->SetName("TGeant3");
```

Everything OK

```
fRun->SetName("TGeant4");
```

strange warnings

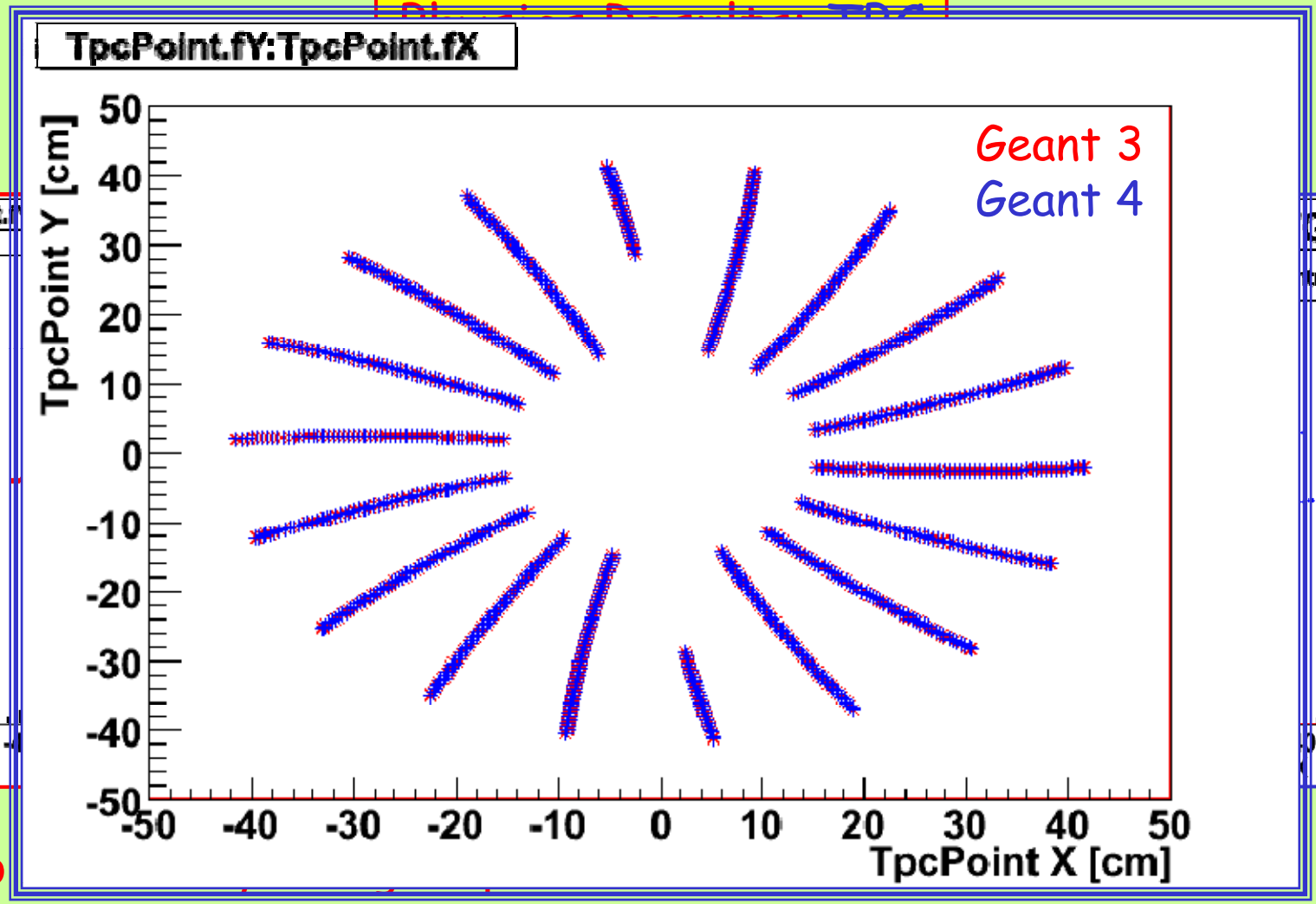
G4

```
Info in <TGeoShapeAssembly::DistFromInside>:
Cannot compute distance from inside the assembly (but from a component)
```

G4

```
No physical volume found at track vertex: (927.786,21176.1,28363.8)
++++  TG4Warning:  ++++
    TG4TrackingAction::UserProcessHits:
    Cannot locate track vertex.
++++++++++++++++++++++++
```

What is happening ?

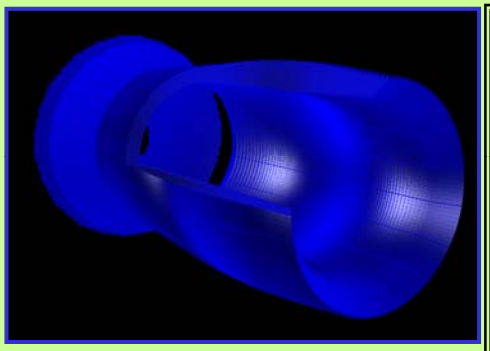


Too

G3 needs manual step size for TPC

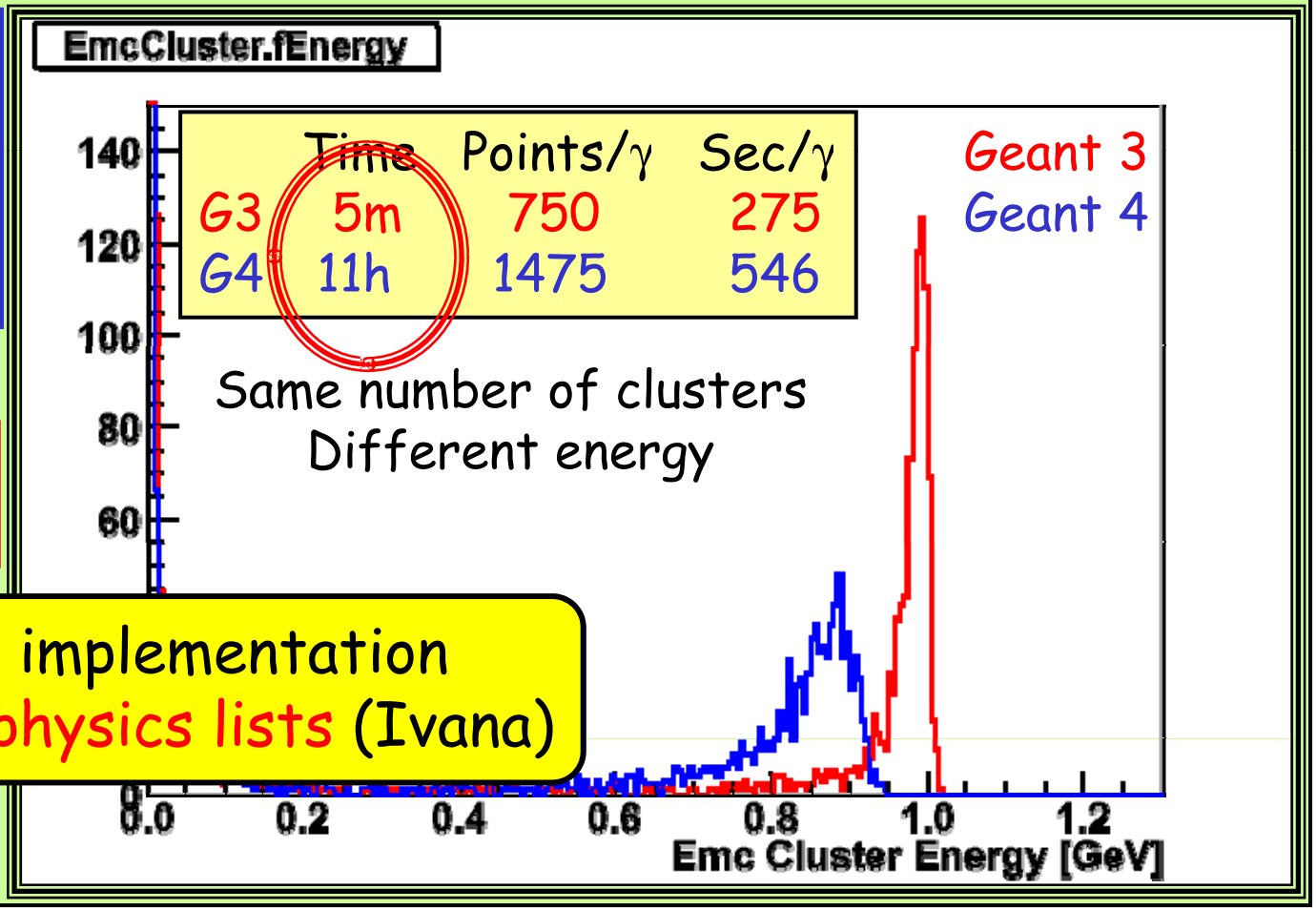
Past Physics Results: EMC photons (clusters)

1000 γ @ 1GeV



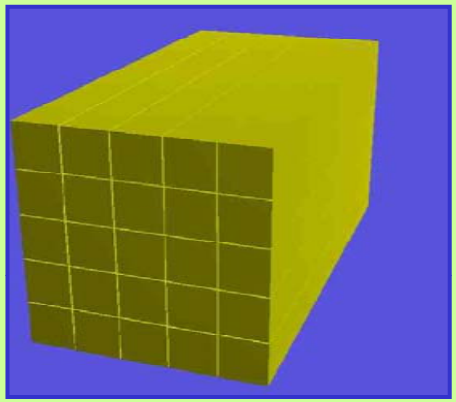
PWO crystals

Geant4 8.2
Geant4_vmc 2.0



Before implementation
of proper physics lists (Ivana)

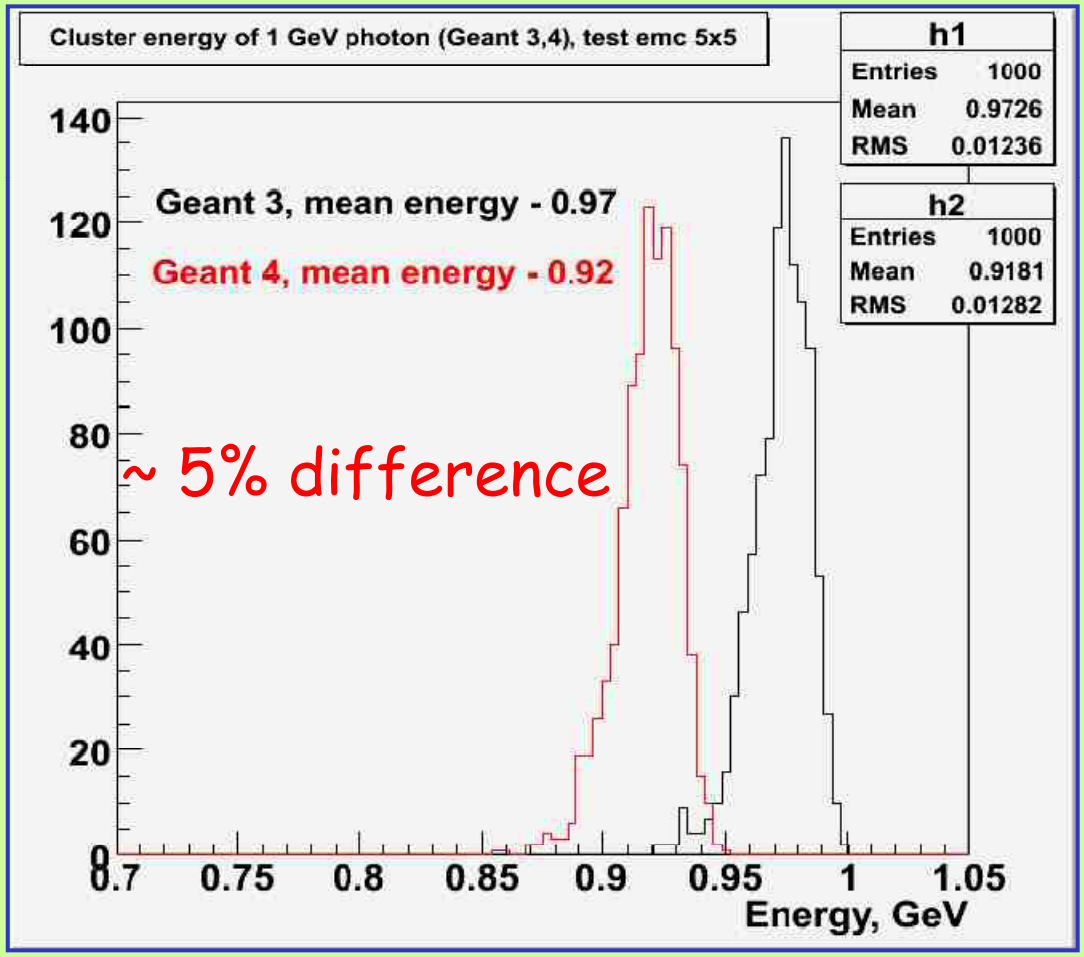
Current Physics Results: EMC photons (clusters)



5x5 test setup
PWO crystals

Geant4 9.1
Geant4_vmc r331
emStandard

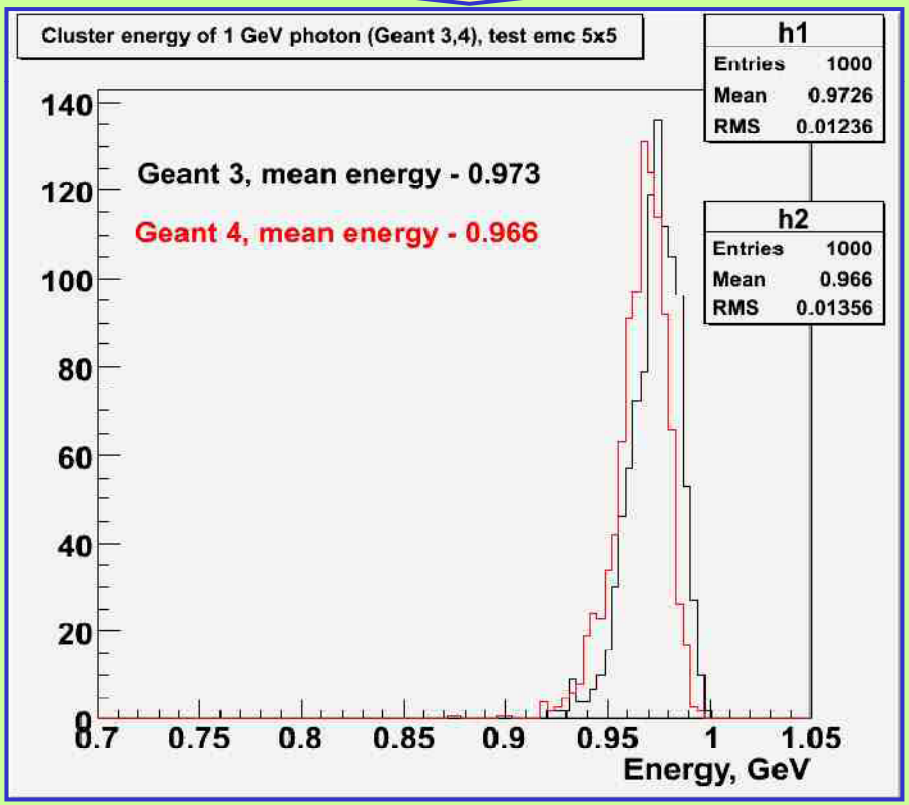
1000 γ @ 1GeV



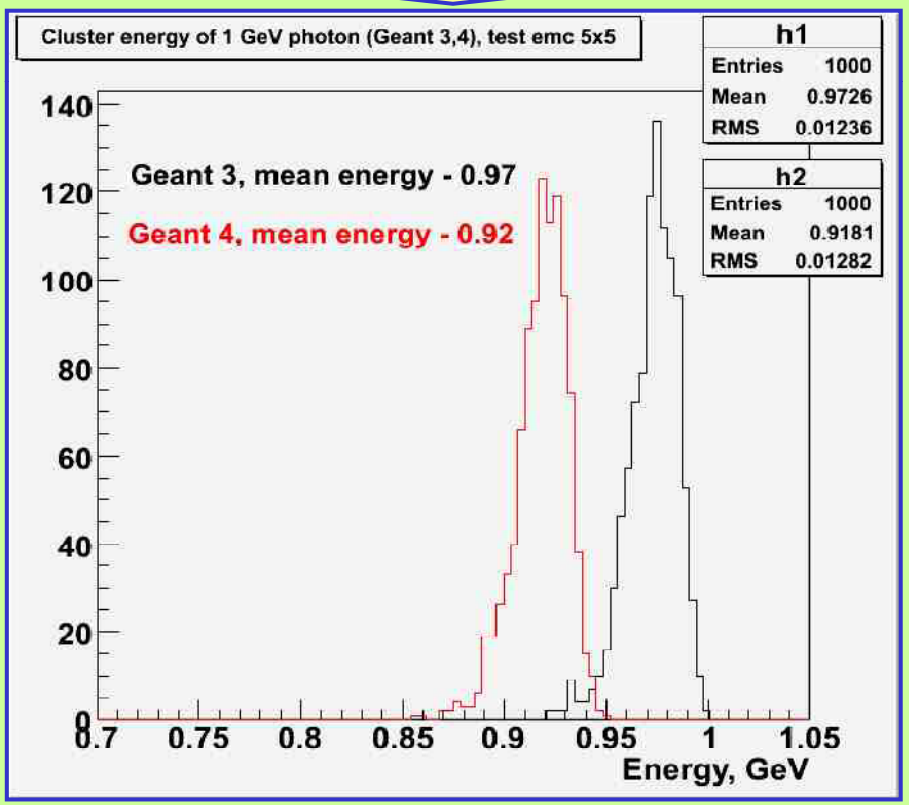
Work done by Dima Melnichuk

Current Physics Results: EMC photons (clusters)

new TG4RunConfiguration
("geomRoot", “emStandard“)



new TG4RunConfiguration
("geomRoot", “emStandard“, ”specialCuts”)



Work done by Dima Melnichuk

Current Physics Results: EMC photons (clusters)

1000 γ @ 1GeV

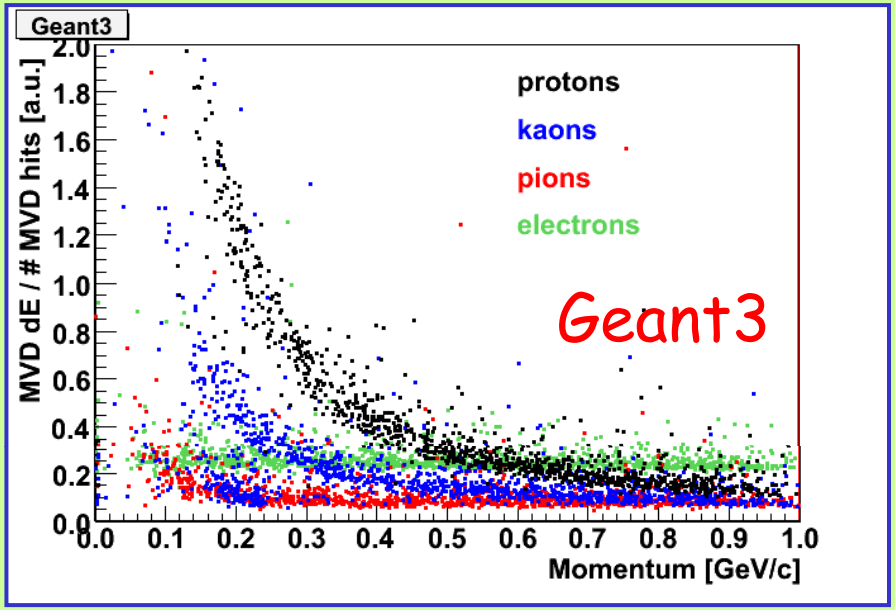
```
void SetCuts()
{
  …
  gMC->SetCut("CUTELE",cut1);   /** electrons (GeV)*/
  …
}
```

dependence on CUTELE

CUTELE	Mean Energy
10 MeV	0.9343 GeV
1 MeV	0.9181 GeV
0.1 MeV	0.9219 GeV
0.01 MeV	0.9234 GeV
0.1 keV	0.9240 GeV

G4 problems with specialCuts not connected to CUTELE

Work done by Dima Melnichuk

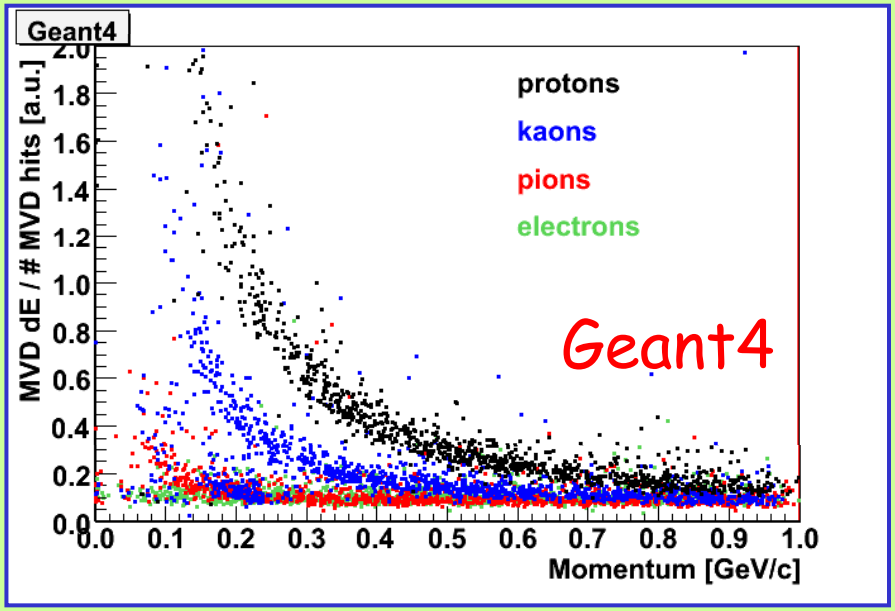


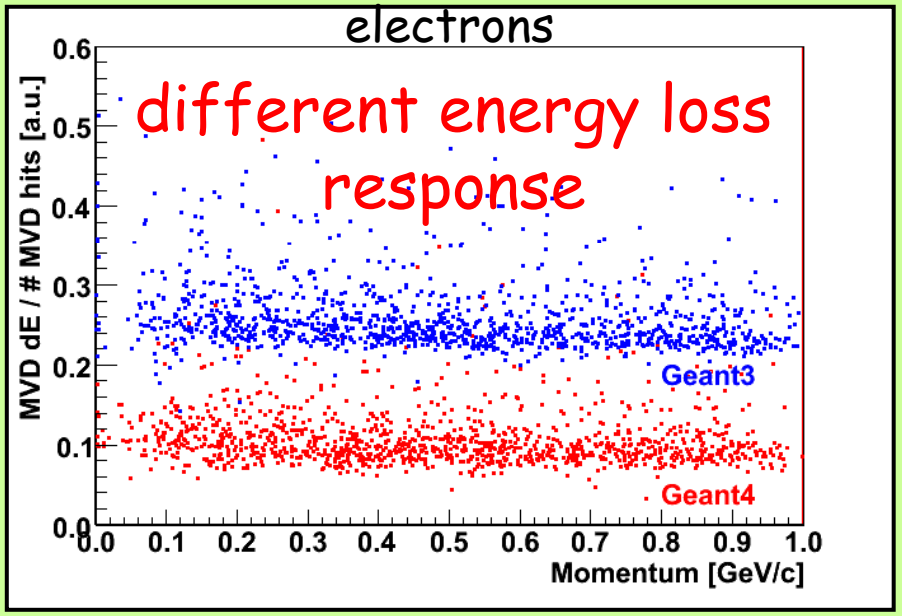
Physics results: MVD

thin silicon layers
~ 300 μm

new TG4RunConfiguration
("geomRoot", "QGSP_BERT_EMV")

no G4 specialCuts

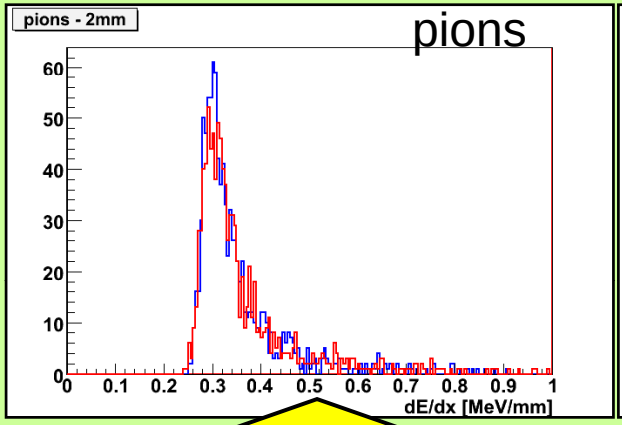


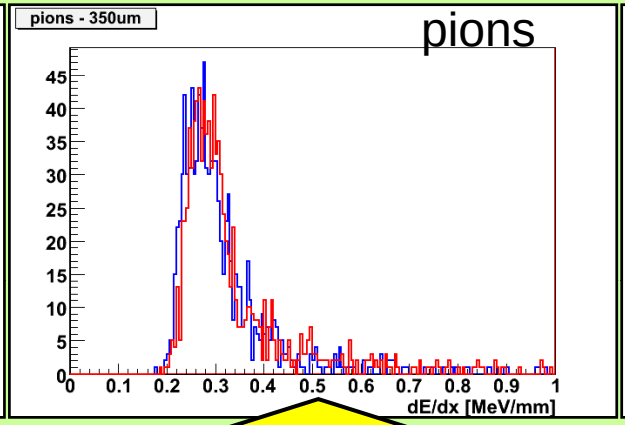


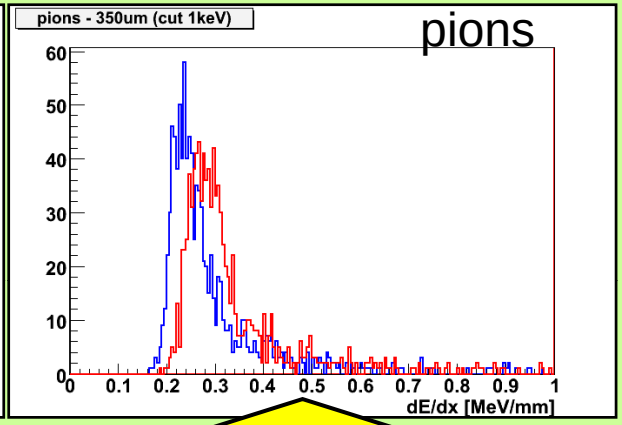
Geant3
Geant4

Physics results: thin silicon layer

studies on STRA ongoing



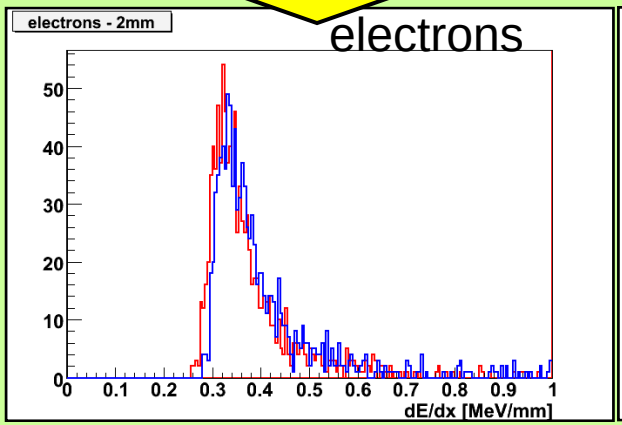


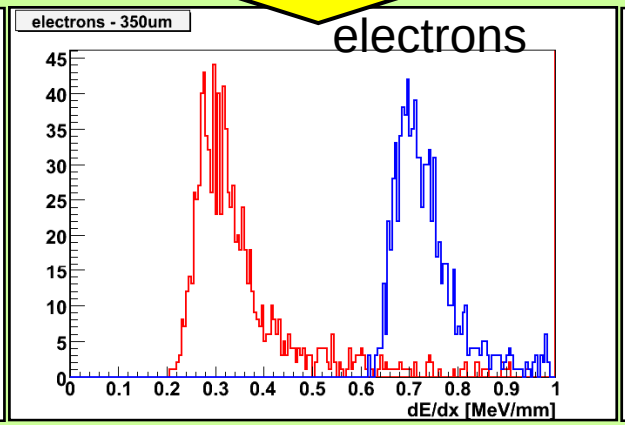


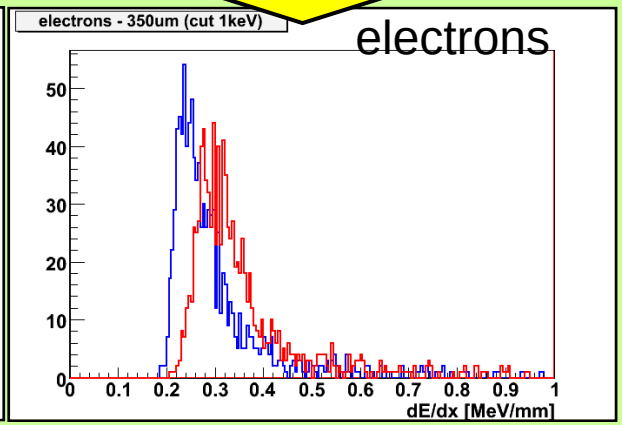
thickness 2mm (cut 1MeV)

thickness 350µm (cut 1MeV)

thickness 350µm (cut 1keV)







CPU Performances

Full geometry: MVD+TPC+DIRC+TOF+EMC+DCH+MUON

Dual Parton Model event generator: $\bar{p}p@2GeV/c$

fRun->SetName("TGeant3");

init → CPU Time: 12.5 s

1k evt → CPU Time: 1434.5 s; File Size: 195 Mb

fRun->SetName("TGeant4");

init → CPU Time: 53.8 s

1k evt → CPU Time: 9661.9 s; File Size: 195 Mb

Enabling G4 specialCuts

1k evt → CPU Time: 3918.8 s; File Size: 74 Mb

Conclusions

- VirtualMC is a powerful tool used successfully by PandaRooters
- Geant4 VMC is running and tested under several physics cases

VirtualMC allows us to crosscheck the detector response even to estimate the "quality" of our code

- The specialCuts implementation needs improvements
- A better understanding of our cuts is mandatory