
Studies on GEANT4 simulation of a TPC

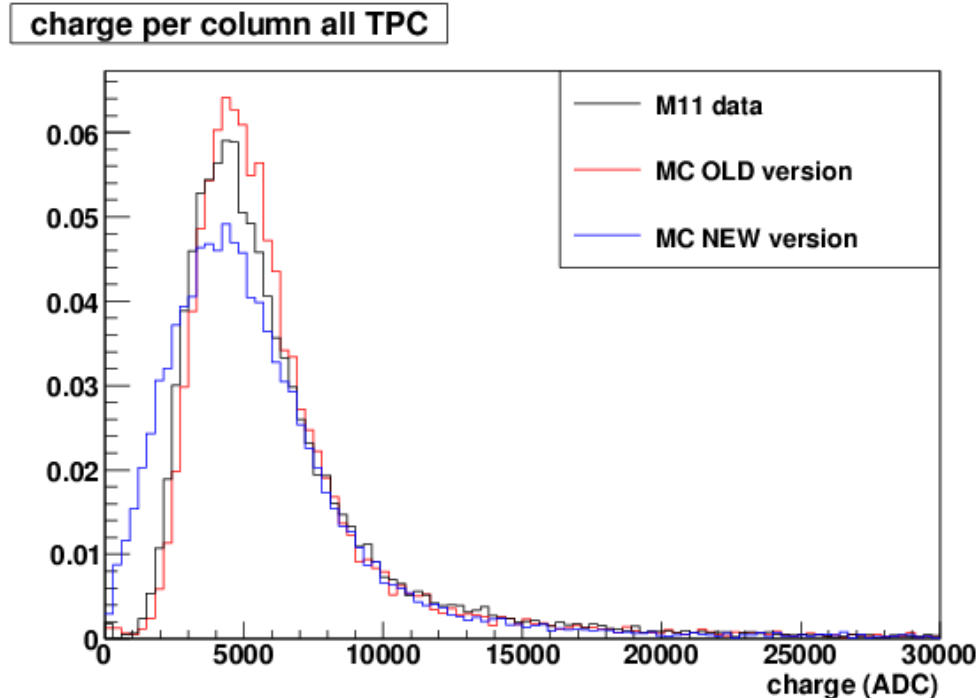
Claudio Giganti
CEA/Saclay

Introduction

- I am working on the T2K experiment. In this experiment we have 3 big TPCs. Each TPC is read by MicroMegas modules, with in total 72 columns. The length of each pad is ~ 1 cm.
- In particular I am working on the Particle Identification in the TPC. The PID is done using a truncated mean method.
- The detector is fully simulated with a software using GEANT4
- We noticed that with the PID methods:
 - Dep. energy resolution for monochromatic muons with beam test data 7%
 - Dep. energy resolution for muons with old version of the software 6% (using GEANT4 v8r2)
 - Dep. energy resolution for muons with new version of the software 10% (using GEANT4 v9r1 or v9r2)

Comparison beam test data - MC

- Generated MC muons with a momentum of 115 MeV in the TPC
- Compared the charge per cluster in the simulation to the one of the beam test data

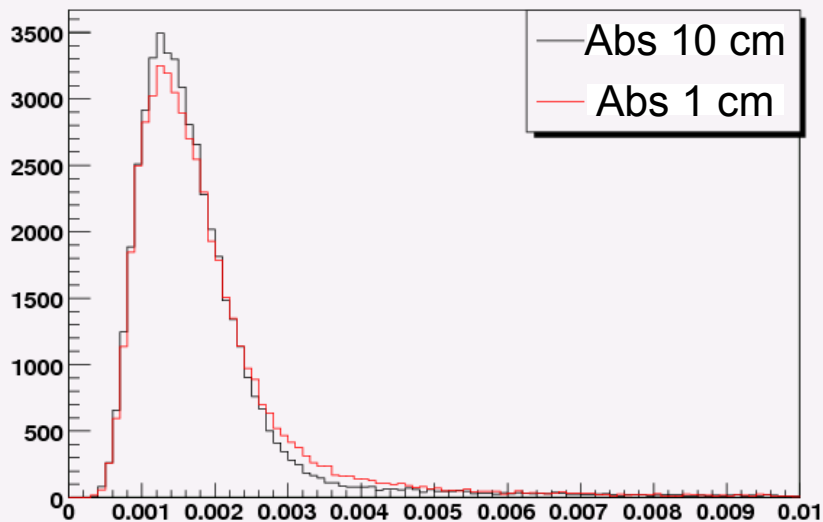


- With the new version of GEANT the distribution of the charge per column is larger and this cause a worst energy resolution

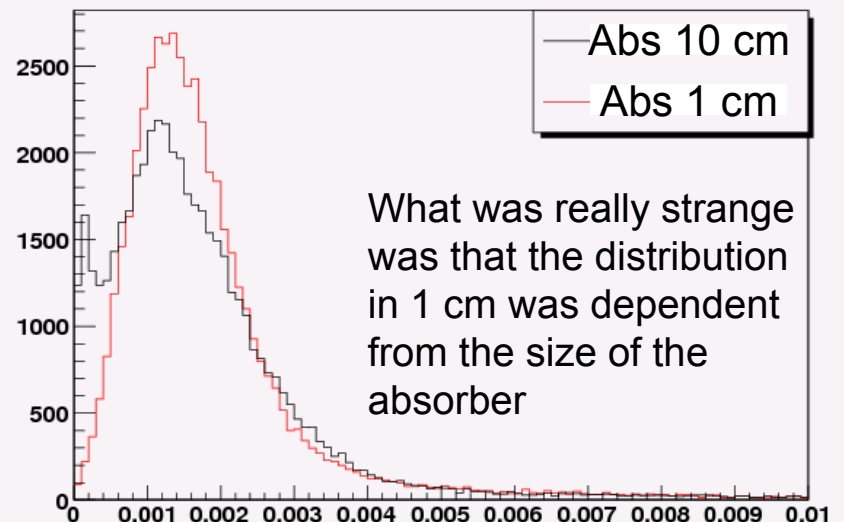
A bug in GEANT4?

- Then we tested GEANT4 using one of the EM examples (TestEm5)
- The detector was a box filled with Argon Gas, with a length of 1 or 10 cm
- Horizontal, monochromatic muons of 300 MeV
- Imposed a maximum length of the step of 1 mm
- Then we looked at the energy released in each cm of gas

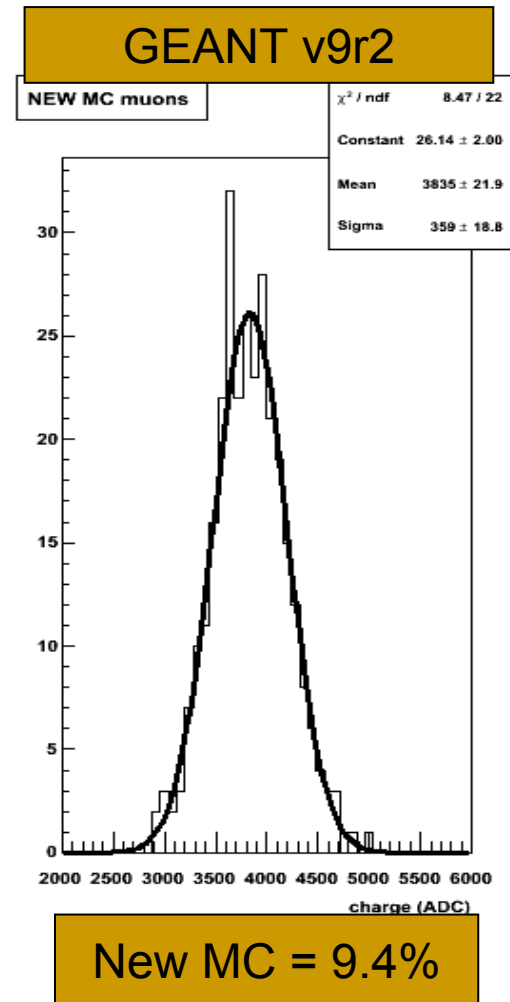
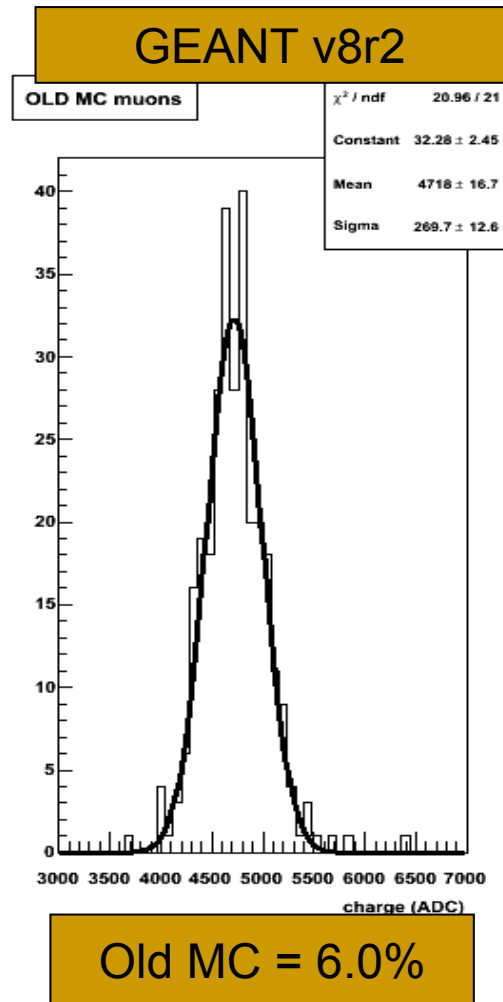
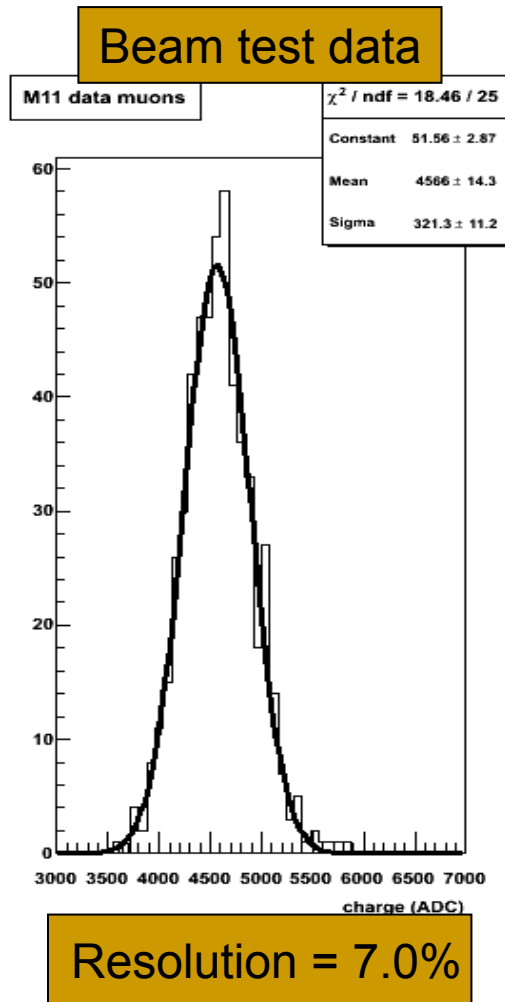
Energy deposited GEANT v4r8



Energy deposited GEANT v4r9

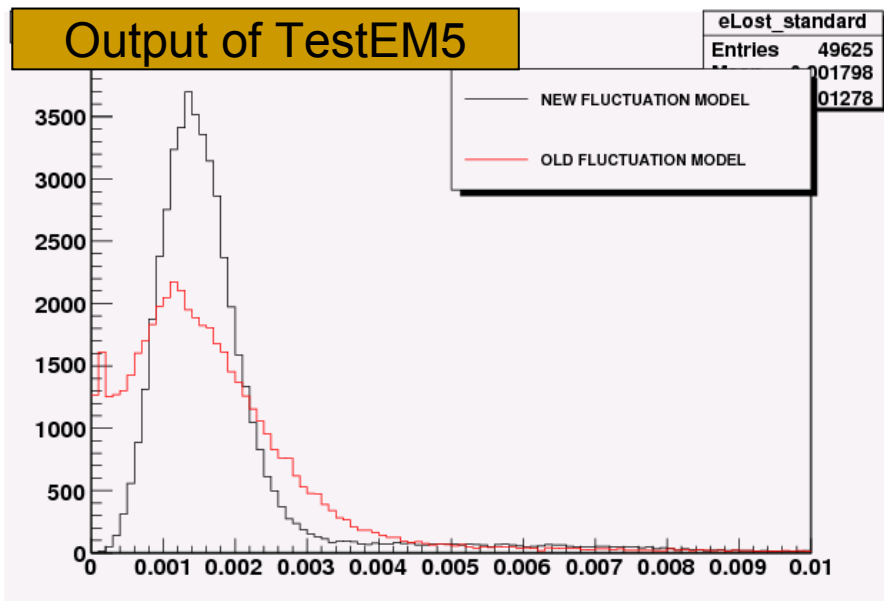


Impacts: deposited energy resolution



Solution

- We sent a message to the GEANT4 forum and we had discussions with Michel Maire, Vladimir Ivantchenko, Peter Gumplinger (many thanks to all of them)
- Finally the problem seems to be related to the new version of the G4UniversalFluctuation model
- Vladimir sent me a modified version of this model, I tried it with both, TestEm5 and T2K software and it seems to work



We implemented this correction also in the T2K software and we got an energy resolution for monochromatic muons of 6.3% → In agreement with the one obtained with v8r2 of GEANT

Conclusions

- As far as I understood Vladimir's changes regarded a way to compute fluctuations when step limitation was applied
- It seems that with this modification the TPC simulation works much better and we hope that it will be included in the GEANT4 code
- Many thanks to Michel, Vladimir and Peter to helping us in solving the problem