Filimon Roukoutakis

some past background…

- Marie Curie EST@CERN (FP6 RTN “MITELCO”, 2006-2009)
- PhD (University of Athens, 2010)
- “Phi and K* resonance analysis with/out pid and with kink kinematic pid in ALICE-LHC”
- Greek nationality

present status:

- Marie Curie ER@INFN-LNF, Frascati (RM), Italy since April 2010
- Working on: P12 (Optimization of Monte Carlo Tools and Comparison with Benchmark Data)
- Under the supervision of Stefano Miscetti

The job:
(as defined in P12 description)

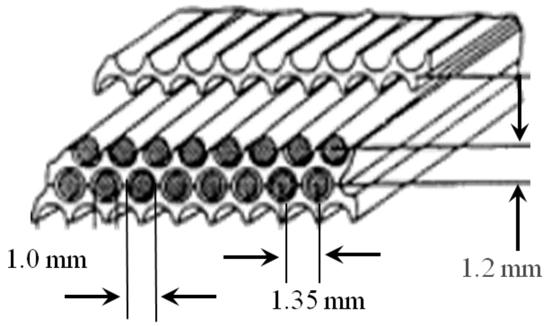
- Detailed simulation of lead/scintillating fibre (Scifi) calorimeters of different structures using Monte Carlo tools (Fluka, Geant4) is relevant to evaluate and improve their energy response and sensitivity to neutrons.
- Two simulation programs with Fluka/Geant4 to describe neutron interaction on calorimeters
- Geant4 version in close collaboration with the CERN group
- Fluka version in collaboration with INFN Milan
- Qualification of the programs with dedicated data-MC comparisons
- Extensive use of benchmark data of neutron interaction on calorimeters taken with the KLOE detectors

The problem:

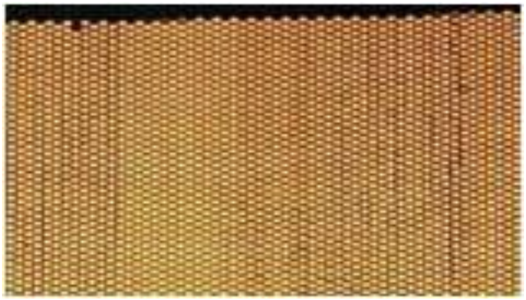
Consistent detector description for several MC particle transport codes

- GEANT3: The de-facto standard for many years
  - Excellent handling of EM physics
  - Hadronic physics not really including newer models
- Geant4: mature enough to replace GEANT3 in most applications from the point of view of physics simulation and detector description
  - Modern, modular C++ design and newer physics models
  - Many interfaces for I/O and visualization
- FLUKA: Quite advanced physics models quoted
  - Rather unique I/O structure makes interaction with other packages challenging
  - FLUGG interface quoted as unstable for ALICE detector and has not been recently maintained
  - Flair seems convenient for standalone FLUKA usage though…

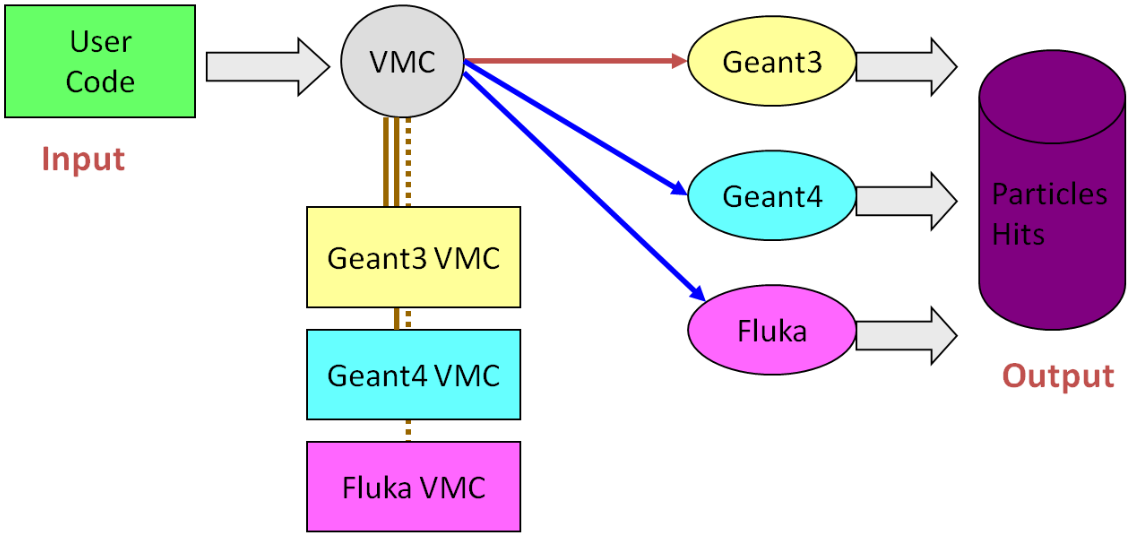
Each framework has its own way of defining geometries, materials boundaries and interaction limits!



Describe this geometry and variants in a simulation-independent way if possible!



A possible solution: Virtual Monte Carlo



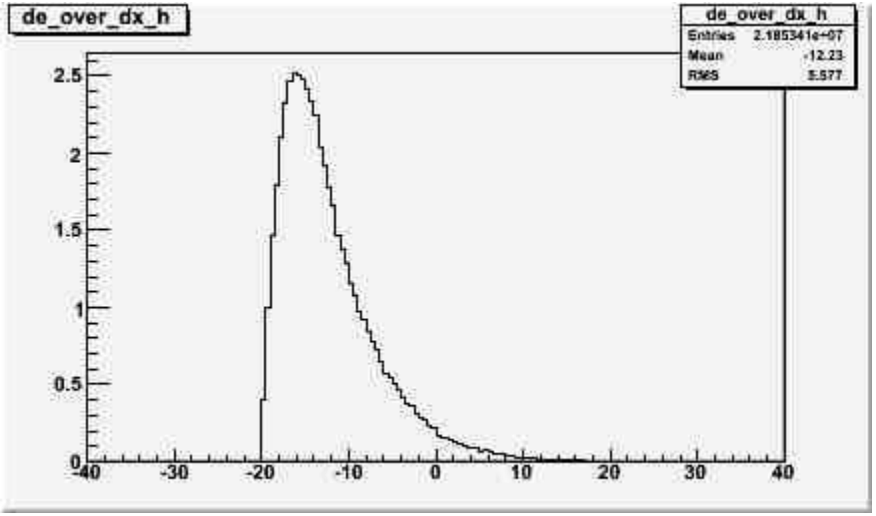
Developed and tested by ALICE-LHC collaboration
Based on ROOT, the de-facto framework for physics analysis in HEP

- ✓ Front-end is ROOT C++ code. User creates geometry in ROOT Geometric Modeller. Can be saved as .root file, .xml file, visualized within ROOT
- ✓ Change of all parameters (materials, geometry, active physics processes) from within a unique set of C++ macros
- ✓ Except the Geant4 and Fluka simulation requirement, GEANT3 simulation comes “as a bonus”

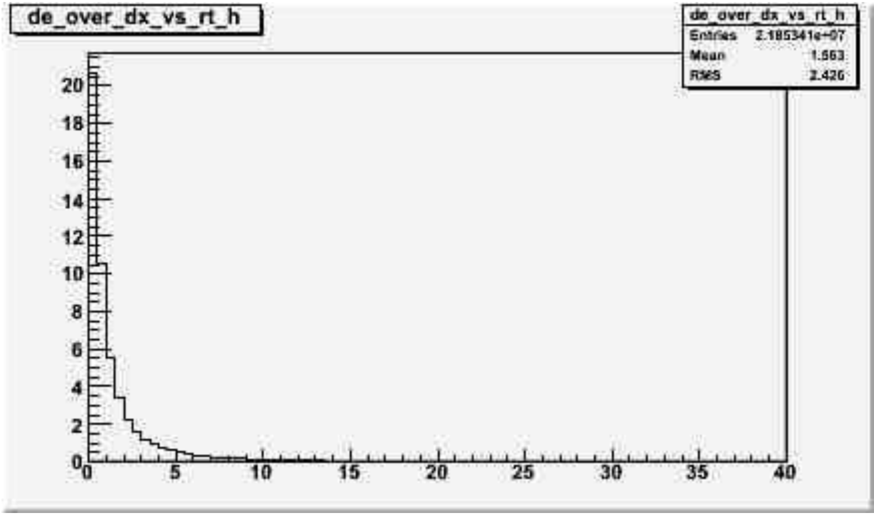
My contribution:

- Develop a software suite based on VMC but as generic as possible to be used outside KLOE too
- The idea is to use ROOT interpreter-reflection capabilities to configure the application on-the-fly with detector geometry, material and physics configuration
- A ROOT-loadable library allows the description of the detector and the physics configuration with standard C++ code, just like FORTRAN-like cards in FLUKA
- Different primary particle generators can be plugged in (for the moment we have a simple particle gun with fixed momentum and direction and a source that simulates the test-beam setup done in TSL, Uppsala in 2008
- The geometry was extracted from existing GEANT3 code, checked also against FLUKA and reference documentation

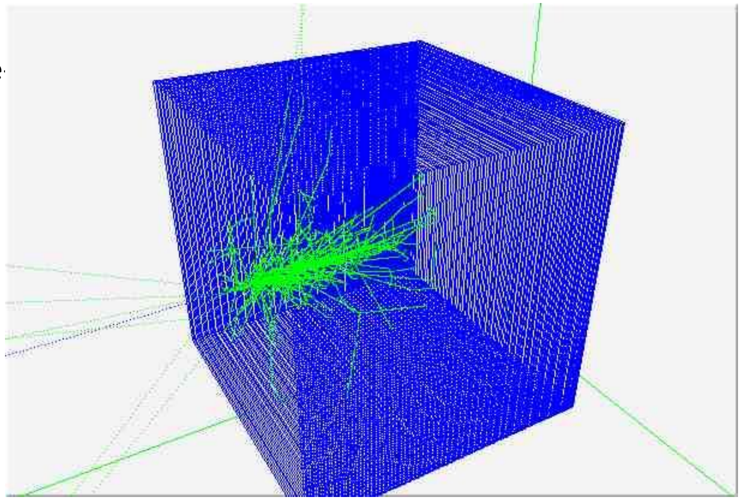
E/M shower preliminary analysis (1)



Longitudinal shower profile
GEANT3, 1000 events of 500 MeV e-

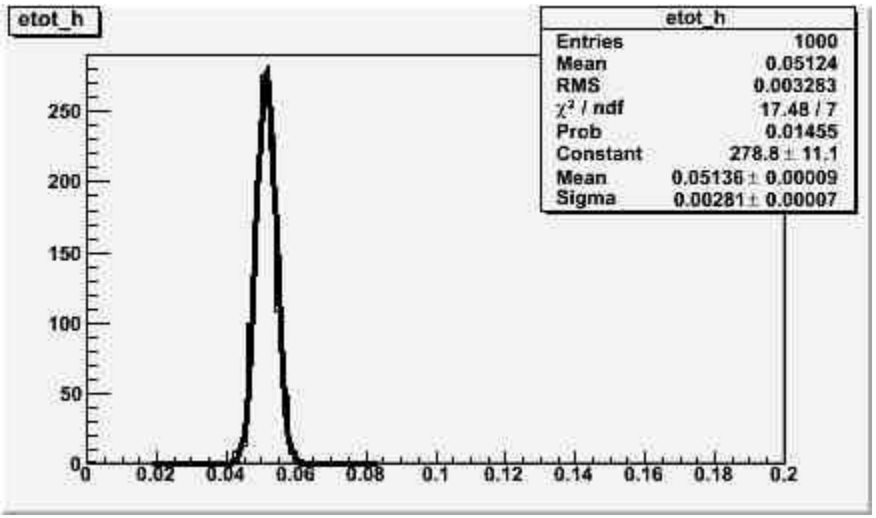


Lateral shower profile,
GEANT3, 1000 events of 500 MeV e-



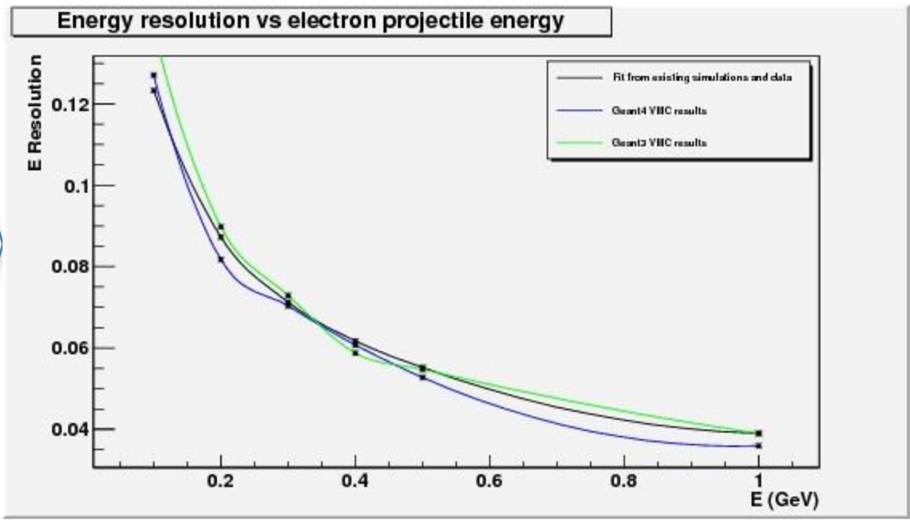
Shower visualization,
GEANT3, 500 MeV e-

E/M shower preliminary analysis (2)

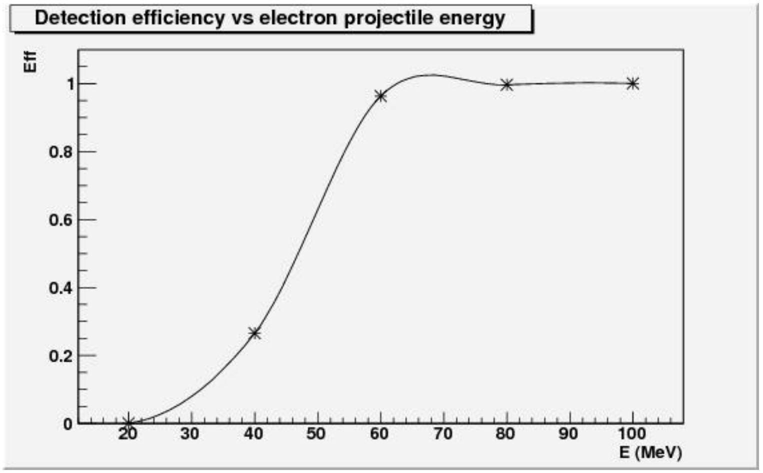


Example of resolution calculation for an energy slot (Energy deposition of 1000 incident 500MeV electrons in the sensitive volume (scintillator) and Gaussian fit)

Various energies of incident electron

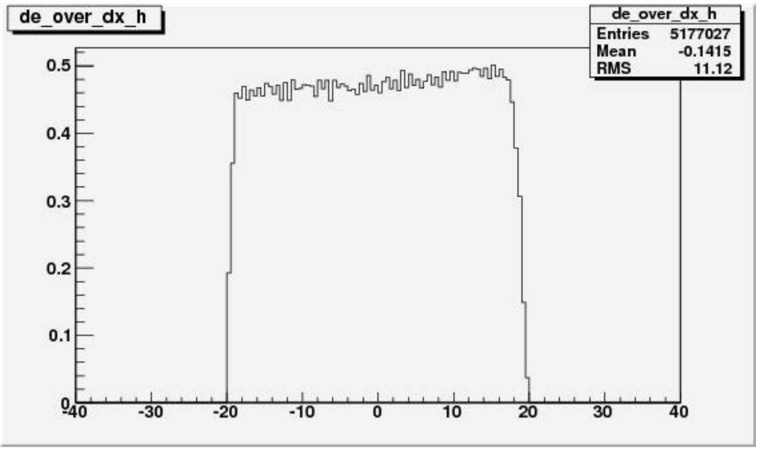


Preliminary comparison of resolution obtained with GEANT3 (green), Geant4 (blue) versus test beam data fitted result (black)



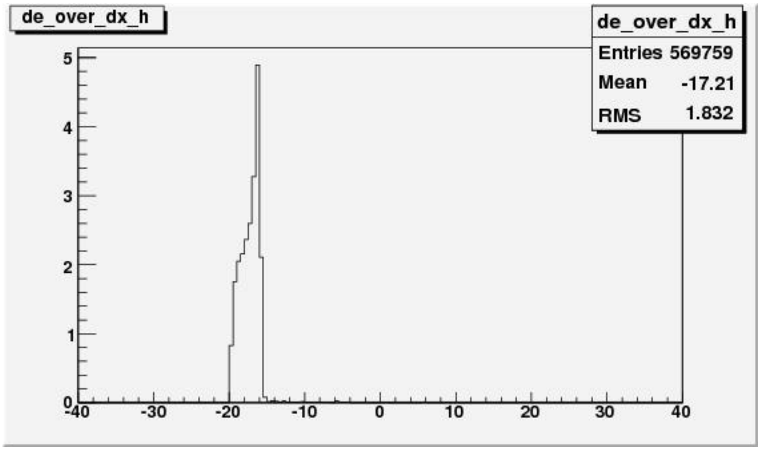
Detection efficiency vs electron projectile energy
G4, 1000 events per energy bin

Longitudinal E/M shower profile
Other particles



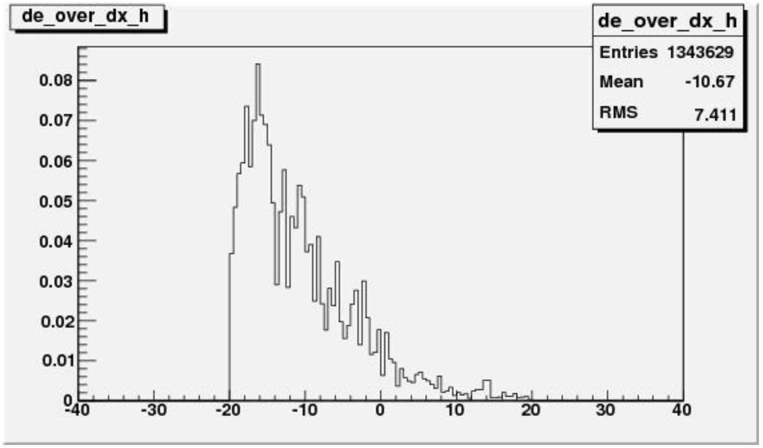
Longitudinal shower profile

GEANT4, 1000 events of 500 MeV mu-



Longitudinal shower profile

GEANT4, 1000 events of 500 MeV p



Longitudinal shower profile

GEANT4, 1000 events of 100 MeV n

Overview - Training

- 30/1-2/2/2010: 2nd MC-PAD Network Training Event (before start of contract)
- 10-14/5/2010: The XV LNF Spring School "Bruno Touschek" in Nuclear, Subnuclear and Astroparticle Physics, in INFN-LNF, Italy
- 30/6-5/7/2010: ESOF 2010 and Marie Curie Satellite Event, Turin Lingotto, Italy
- Several lectures on LNF site
- Travel arrangements already made to attend “International Conference on Computing in High Energy and Nuclear Physics (CHEP), Taipei, Taiwan (18-22/10/2010)
- 1-14/9/2010: I was assigned as a reviewer for a paper submitted in Nuclear Instruments and Methods in Physics Research A (editor-in-chief Fabio Sauli, the inventor of GEM)

Overview - Results

- Poster presented at the Marie Curie Satellite Event
- Abstract accepted for a poster to be presented in IEEE NPSS Nuclear Science Symposium 2010, Knoxville, USA (30/10-6/11/2010)
- The developed software suite will be available when finished from a webpage, providing a « turn-key » solution for generic detector simulation using ROOT geometry
- Aiming at a peer-reviewed publication once some physics results are available

Conclusions and plans

- ✓ A generic VMC application has been developed that allows the simulation of an arbitrary detector geometry without need to rebuild the code. An elegant solution that seems to solve the problem of a consistent detector description and parameterized analysis
- ✓ Preliminary results for electromagnetic showers show agreement between GEANT3, Geant4 and test beam data
- ✓ The "hits" part of the simulation is complete. Need to implement the digitization of the signal, from the scintillation to the PMT readout
- ✓ After validation of the electromagnetic calorimeter, move to proton/neutron projectiles to simulate hadronic calorimetry
- ✓ VMC allows the straightforward change of the geometric/material parameters thus enabling us to find the optimum cell size (minimum scintillator material for maximum efficiency)
- ✓ P12-D1, P12-D3 in progress for Geant4/3, tbd for Fluka
- ✓ Contacts and work with CERN experts