GEANT4 simulation of the TB 2011

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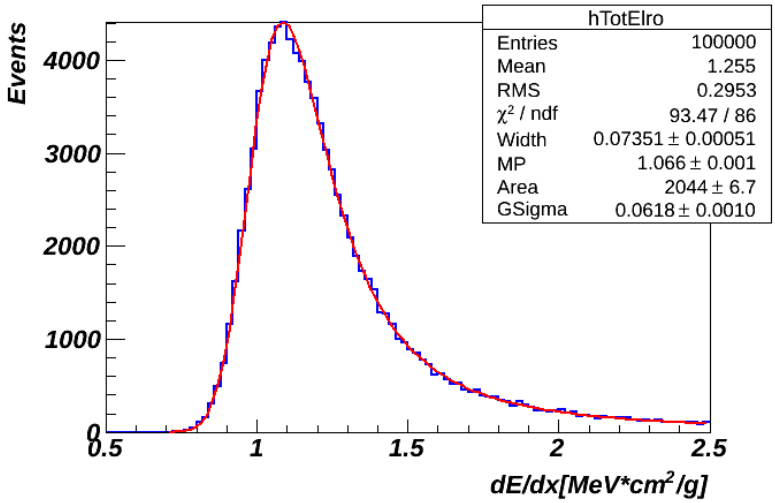
Outline

1. GEANT4 simulation of the deposited energy in GaAs sensor
   - Fluctuation of the energy deposition in GaAs
   - Distribution of e-h pairs
   - Comparison with TB data
2. GEANT4 simulation of the longitudinal development of EM shower in Tungsten, registrated with a GaAs sensor
   - Deposited energy spectrum in GaAs sensor for t_W=1 X_0, 2 X_0, 3 X_0 ..... 14X_0
   - Distribution of N_{e^-, e^+}, and N_γ after a given width of Tungsten layer
   - Comparison of the simulated deposited energy with TB data
   - Gamma fits of the simulated deposited energy and TB data
3. Conclusions

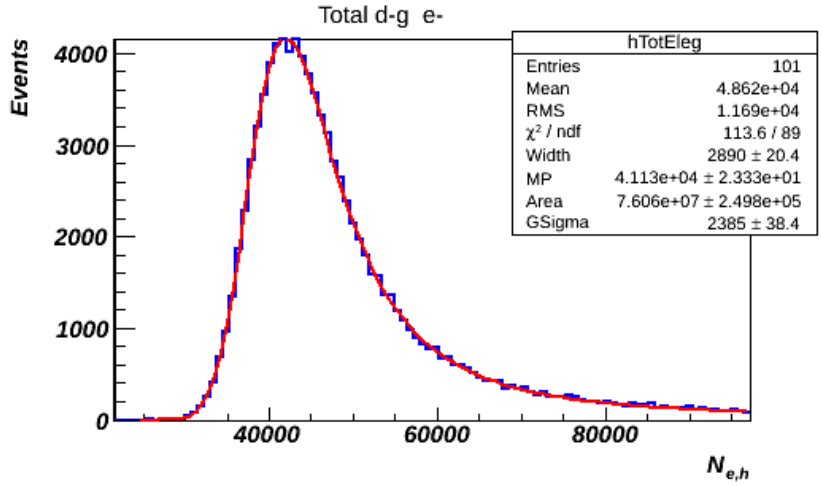
GEANT4 $\Delta E/\Delta x$ fluctuation in GaAs sensor



E_{e^-}=1, 2, …, 10 GeV
width_{GaAs} = 300 μm
Step = 1 μm

$< \Delta E >_{sim}$= 1.255 $MeV * cm^2/g$ for 300 μm $GaAs$
$< \Delta E >_{NIST}$= 1.862 $MeV * cm^2/g$

Number of e-h pairs in GaAs sensor

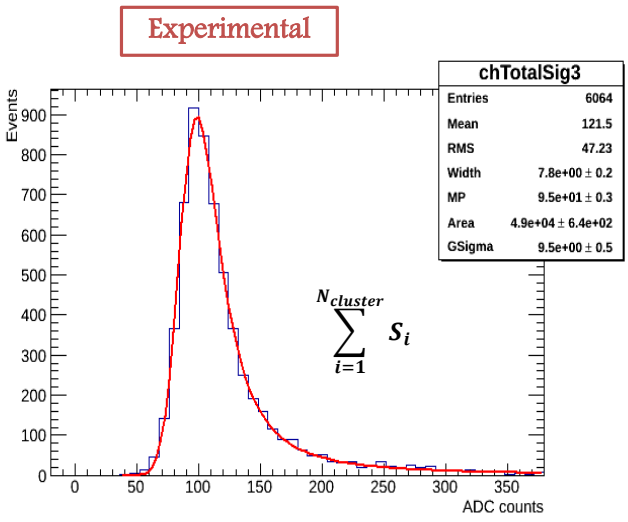


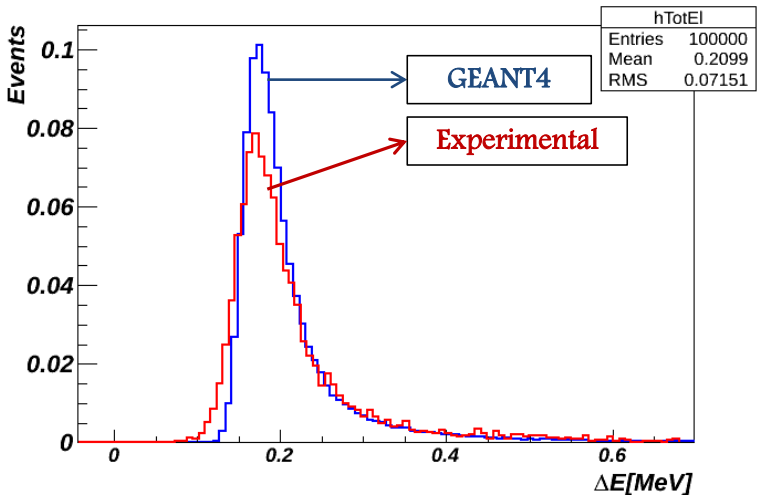
$N_{\mathrm{e-h}_{max}} = 137\ pairs/\mu\mathrm{m}$

$< N_{e-h} >= 162$ pairs $/\mu$m (161 e –h, Olga Thesis, 2013, p 105)

Average energy for creation on an e-h pairs in GaAs = 4.1 eV

A comparison between experimental and simulation data





1. there is a difference between the experimental and GEANT4 dE/dx distributions
2. In GEANT4 simulation was changed only the step but it was used default mean ionisation potential Imin =384.9 eV.
3. Necessary to take into account electromagnetic interaction of incident electron with atomic electrons on different energetic levels.

Tungsten layers & GaAs sensor

Experimental and simulation conditions

Experimental

- E_{e^-}=4 GeV
- 1 GaAs sensor after t=2 X_0, 4 X_0 ..... 14 X_0

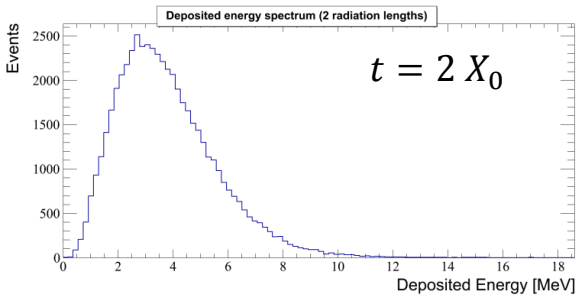
Simulation

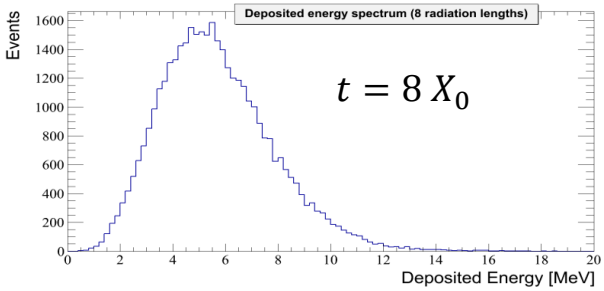
- E_{e^-}=4 GeV
- 1 GaAs sensor after t=1 X_0, 2 X_0, 3 X_0 ..... 14 X_0

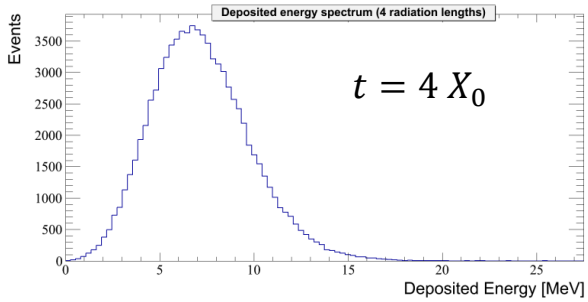
Main task was to determine

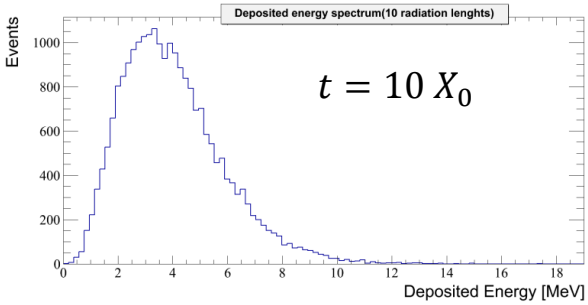
1. Deposited energy in GaAs sensor after each W layer
2. Number , coordinates, energies of e^-, e^+, and γ on the GaAs sensor
3. Comparison of simulated data with avalaible experimental data in FCAL
4. Gamma function fits of simulated and experimental data

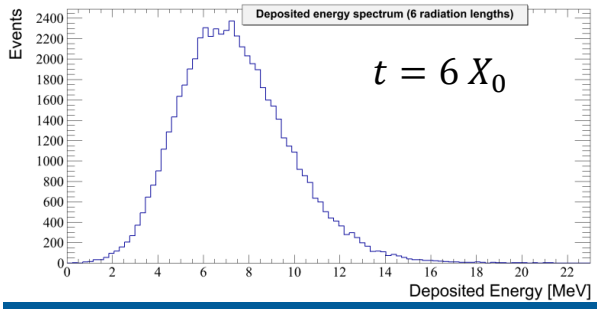
Simulation of deposited energy spectrums

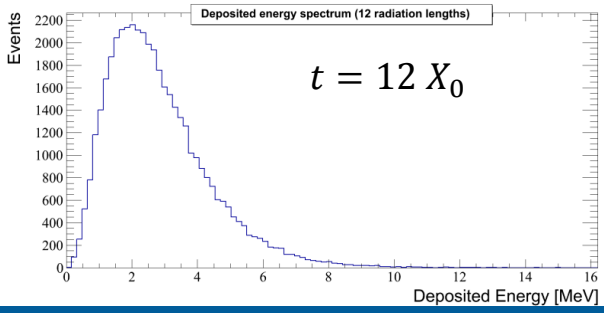




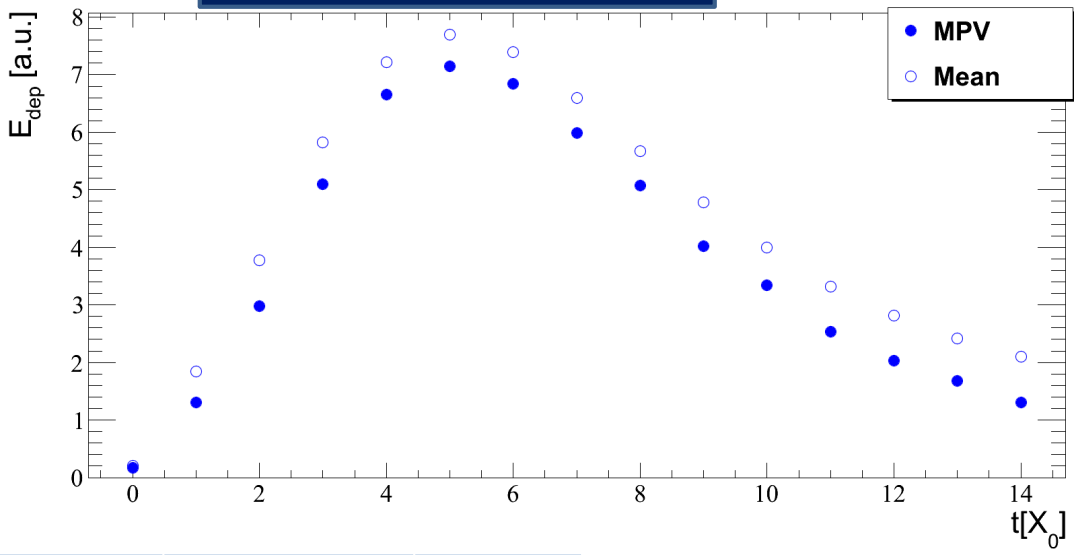








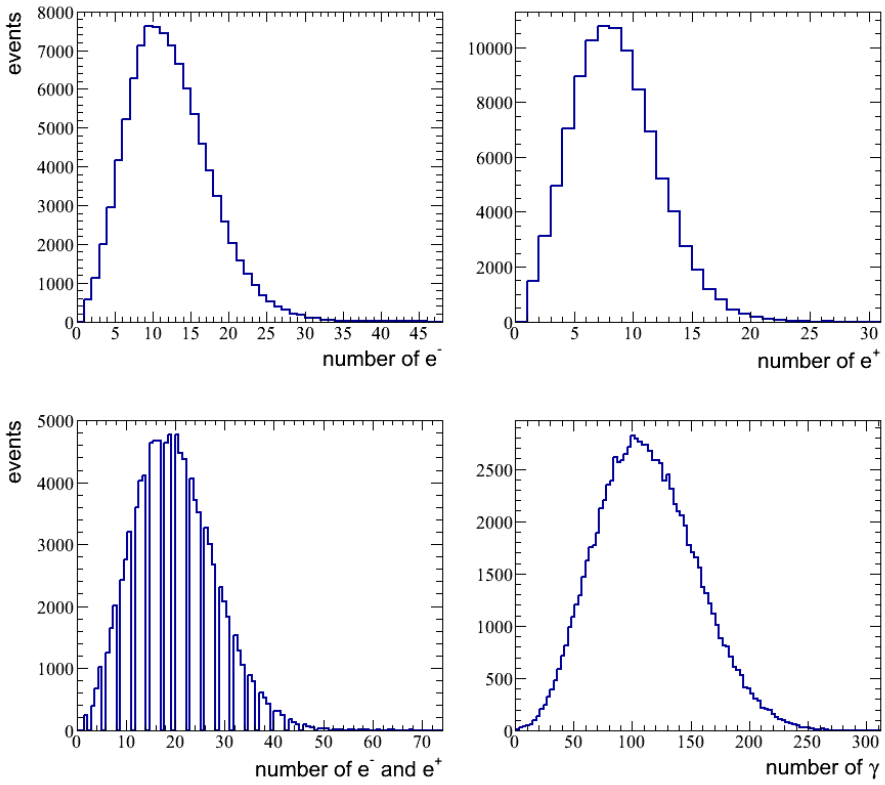
Energy deposition (t)



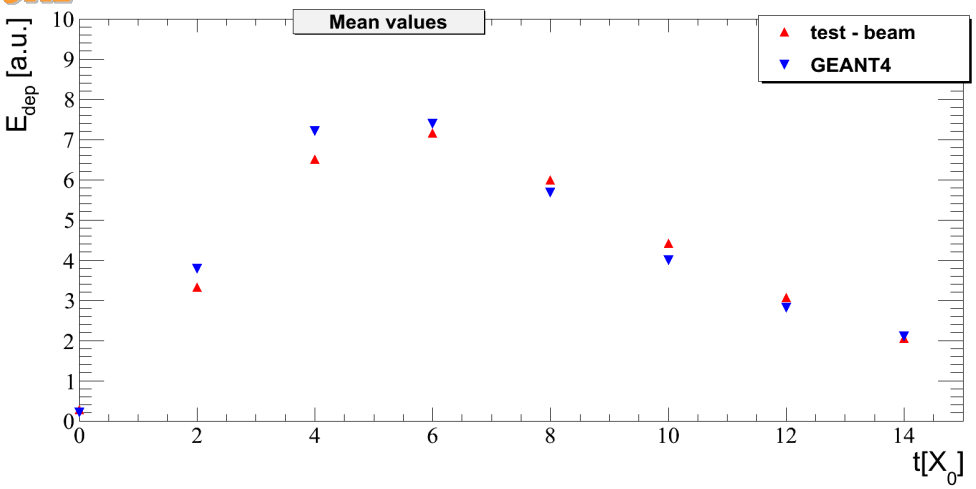
	Fabjan & Geanotti 2003	Rossi
Ec [MeV]	8.10	7.43
X_0 [mm]	3.5	0.31
t_{max} [x_0]	5.7	5.3
t_{95} [x_0]	21.2	20.1

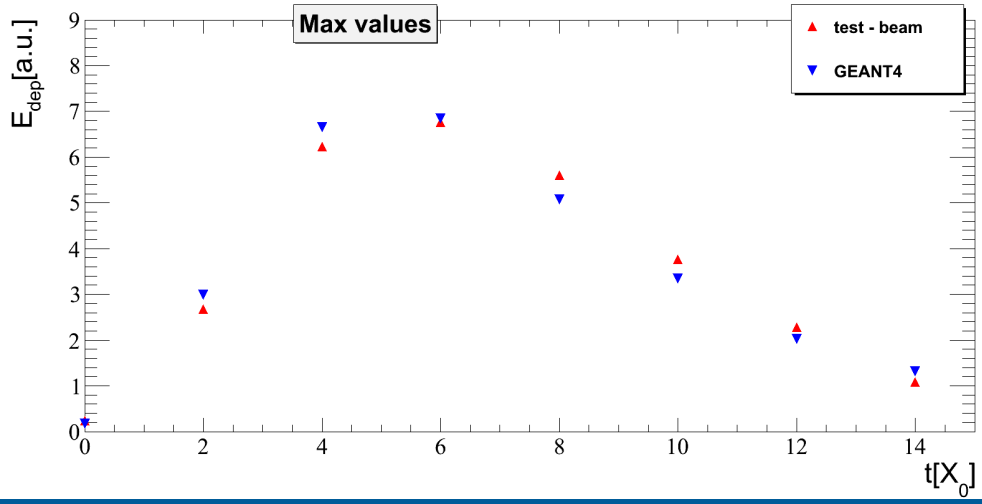
R_M = 9.1 mm (2.6 X_0)

Spectrums of e^-, e^+, and γ numbers at $t = 4\,X_0$



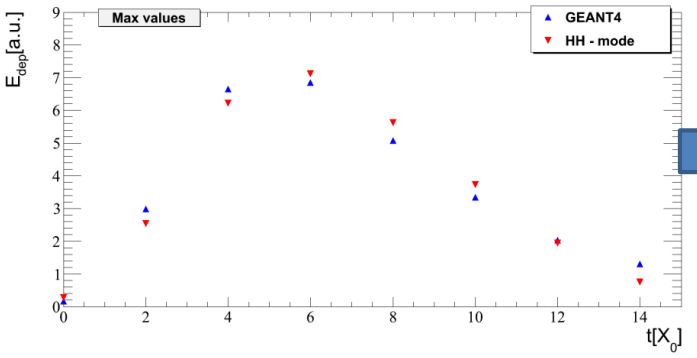
Comparison between experimental and GEANT4 data (1)



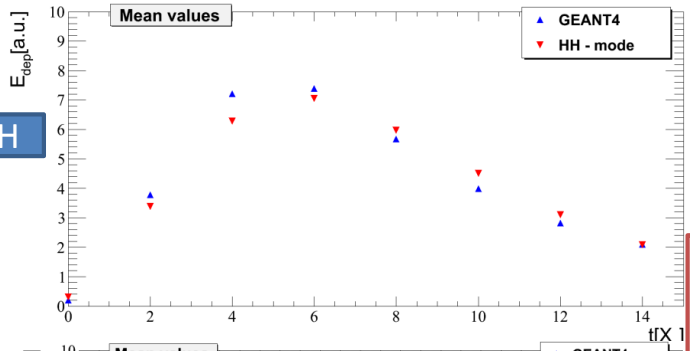


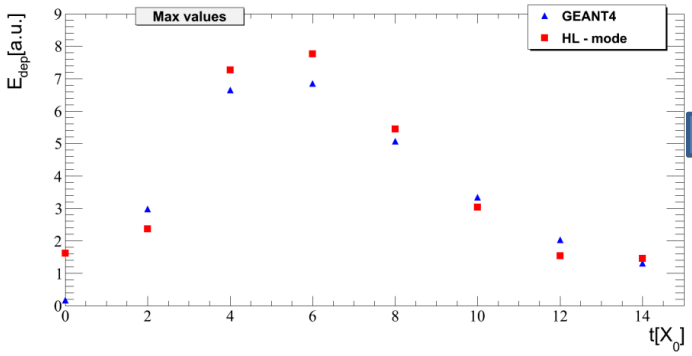
- The experimetal data - HH mode (ref. Veta&Titi FCAL Workshop 2013 Cracow)

(2)

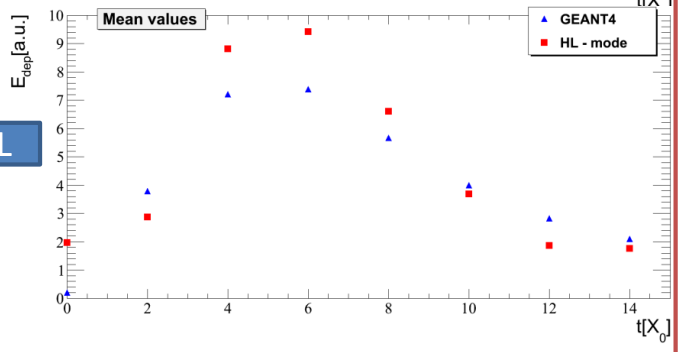


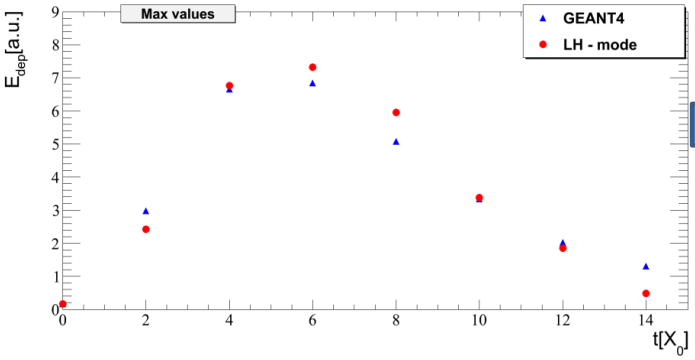
HH



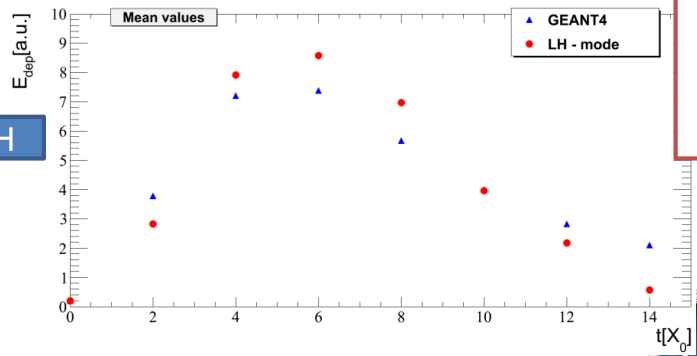


HL



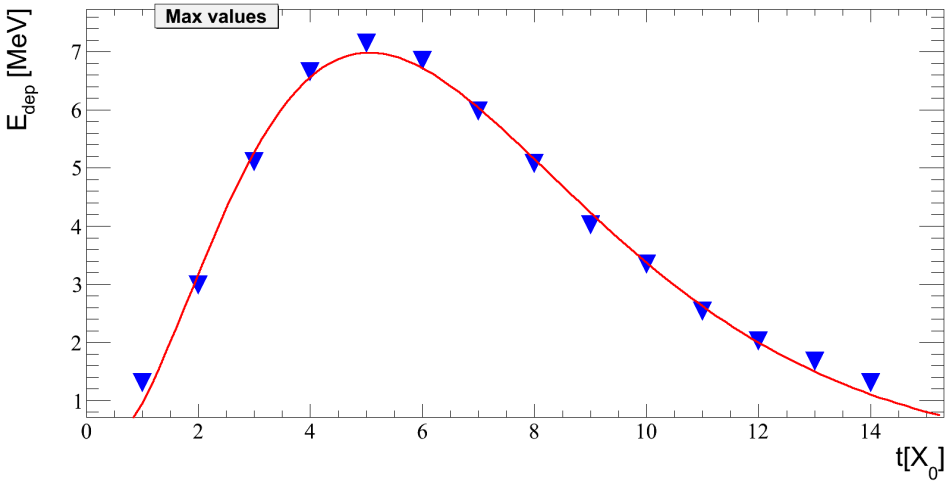


LH



Exp. data from Olga's thesis

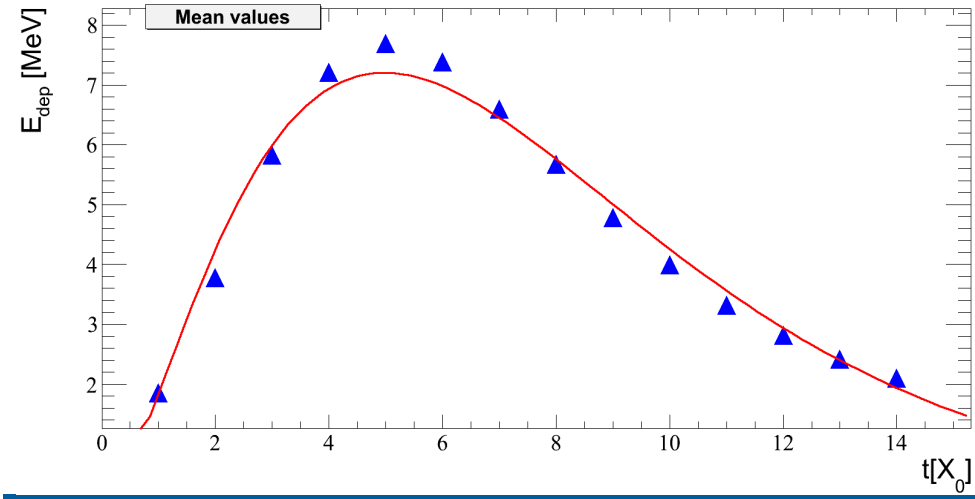
Description of the longitudinal shower profile (1) - GEANT4



$$\frac{dE}{dt} = E_0 b \frac{(bt)^{a-1} e^{-bt}}{\Gamma(a)}$$

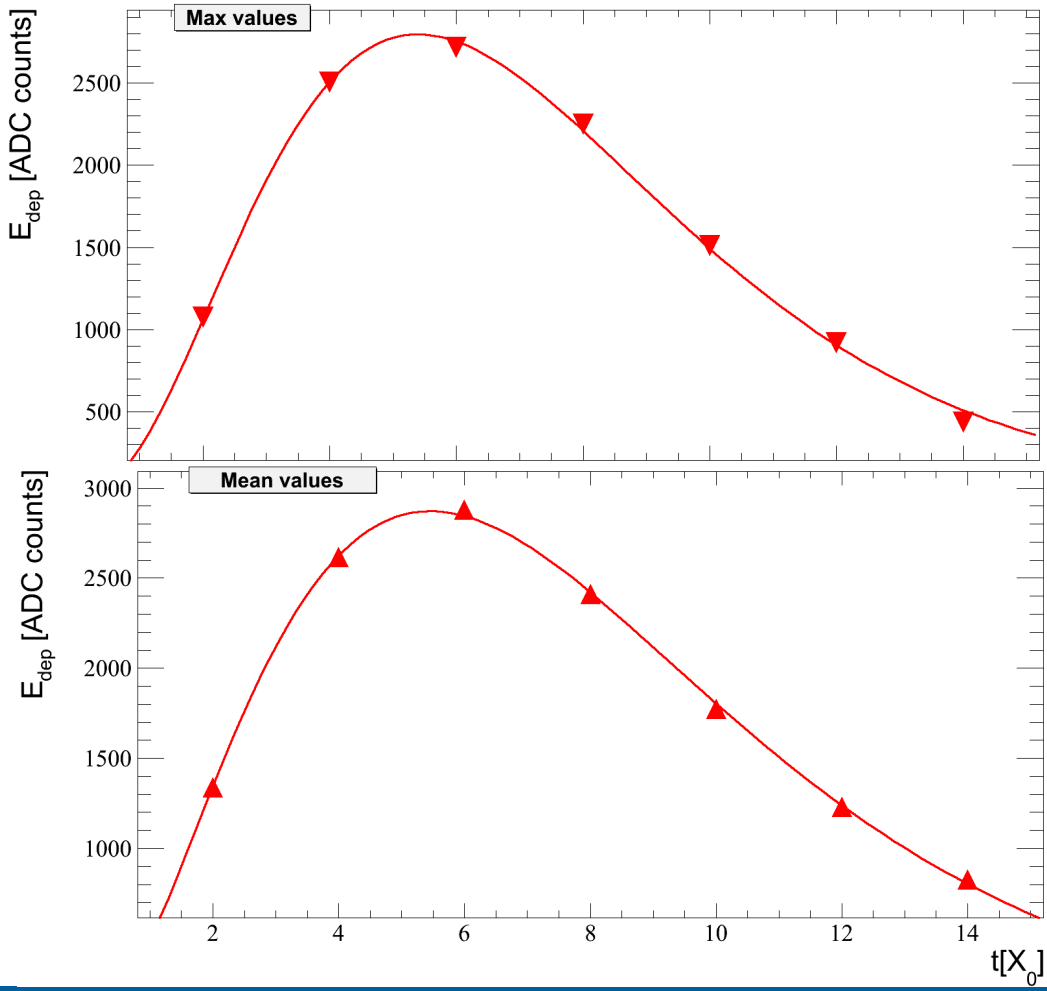
$$t_{max} = (a-1)/b$$

a= 3.45 $\pm$0.1
b= 0.48 $\pm$ 0.02
t_{max} = 5.05 X_0



a = 2.69 $\pm$ 0.001
b = 0.4 $\pm$ 0.0
t_{max} = 4.98 X_0

Description of the longitudinal shower profile (2) - Experimental

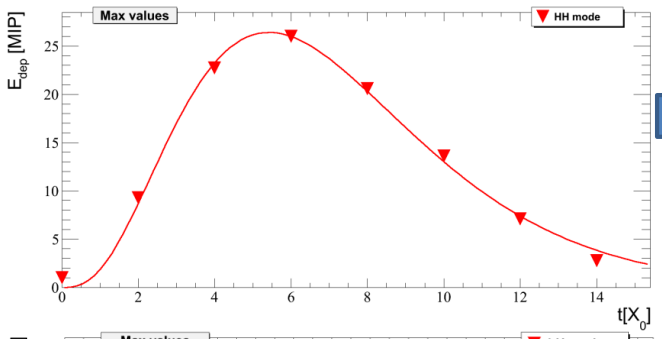


ref. Veta&Titi

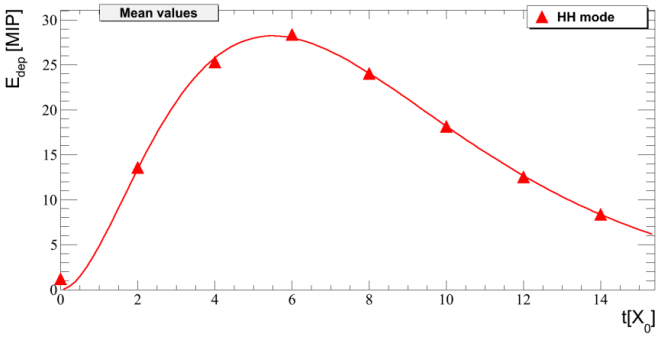
a= 3.66 $\pm$0.09
b= 0.5 $\pm$0.01
t_{max} = 5.4 X_0

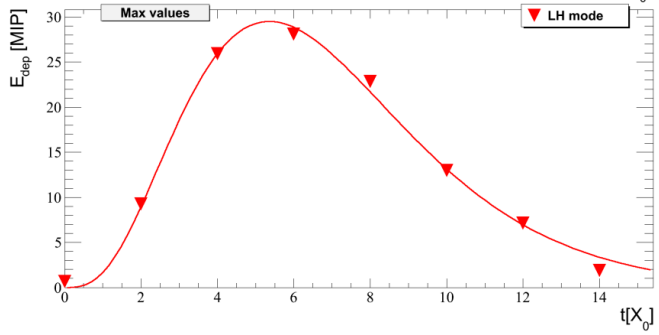
a= 3.75 $\pm$ 0.001
b= 0.37 $\pm$ 0.001
t_{max} = 5.46 X_0

Description of the longitudinal shower profile (3) - Experimental

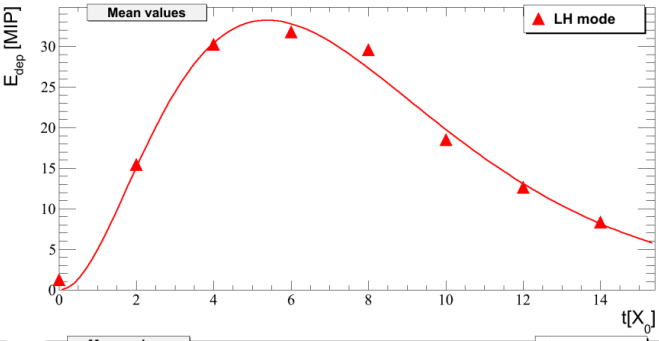


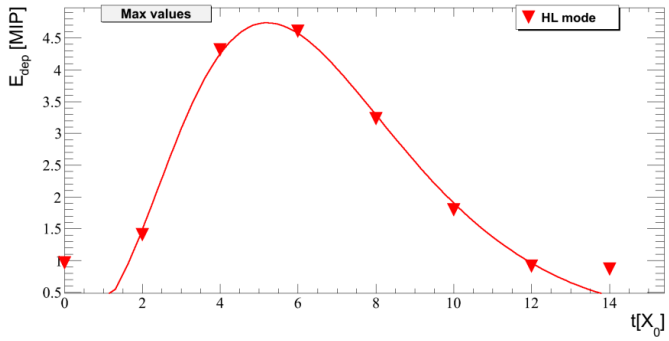
HH



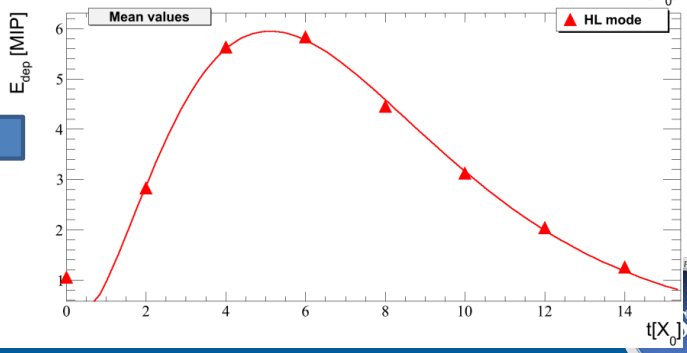


LH





HL



Conclusions

1. GEANT4 simulation of the e- passage through GaAs sensor with **step=1 μm** and **Imin =384.9 eV** doesn't reproduce satisfactory TB data.
2. GEANT4 simulation of the longitudinal EM shower development by 4 GeV electrons is in quite good agreement with experimental data in HH mode
3. The shapes of simulated & TB longitudinal shower profiles are well described by fits based on Gamma function.