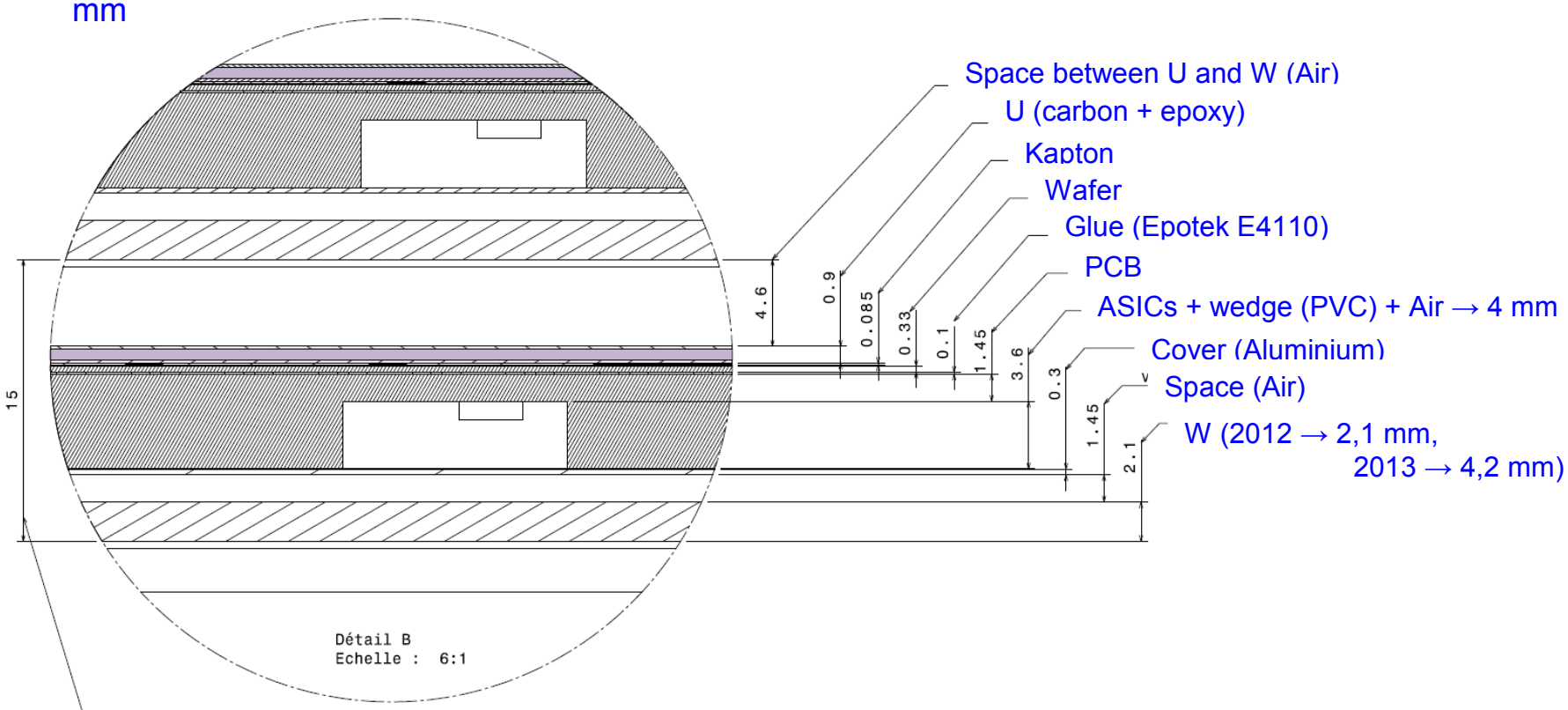
Summary:
Technological prototype simulation for DESY Test beam

Geometry

Thanks to Mickael and Rémi

Wafer: size = 88.49 mm
Interpixel = 0,05 mm

All the values in mm



Materials

Information from previous CALICE prototypes in Mokka, other experiments, manufacturers...
→ better to measure density and composition (if possible)

n → number of atoms
f → mass fraction

W - Tungsten - d=19.3 g/cm3

Kapton - d=1.42 g/cm3
+ Carbon; f=0.691133
+ Hydrogen; f=0.026362
+ Oxygen; f=0.209235
+ Nitrogen ; f=0.073270

U - d=1.6 g/cm3
+ Carbon; f=0.8466
+ Hydrogen; f=0.0426
+ Oxygen; f=0.0967
+ Nitrogen ; f=0.0141

Epotek4110 - d=2.57 g/cm3
+ Carbon; f=0.431
+ Hydrogen; f=0.046
+ Oxygen; f=0.125
+ Nitrogen ; f=0.014
+ Silver ; f=0.385

PVC - d=1.4 g/cm3
+ Hydrogen ; n=3
+ Carbon ; n=2
+ Chlorine ; n=1

Epoxy - d=1.3 g/cm3
+ Carbon; n=15
+ Hydrogen; n=44
+ Oxygen; n=7

Epotek
→ I considered homogeneous layer of Epotek4110 with reduced density to take into account space between glue dots. d=1.5 g/cm3

ASICs (packaging)+ wedge (PVC) + Air
→ I considered homogeneous layer of PVC with reduced density to take into account empty regions (ASICs packaging is assimilated to PVC). d=0.9 g/cm3

Wafer - Silicon - d=2.33 g/cm3

Cover - Aluminium - d=2.7 g/cm3

PCB - d=3. g/cm3
+ Copper ; f=0.4276
+ g10 ; f=0.5724

G10 - d=1.7 g/cm3
+ Epoxy; f=0.147
+ Quartz; f=0.773
+ Chlorine; f=0.08

Quartz - d=2.2 g/cm3
+ Silicon ; n=1
+ Oxygen ; n=2

Energy measurement in simulation - Digitization

- Total energy deposited in one pixel (step 1)
- Geometrical cuts (inter-pixel gap)
- Electron-hole pair production fluctuation
- Electron-hole transport diffusion (step 4)
- Scaling using the landau MPV (keV → ADC)

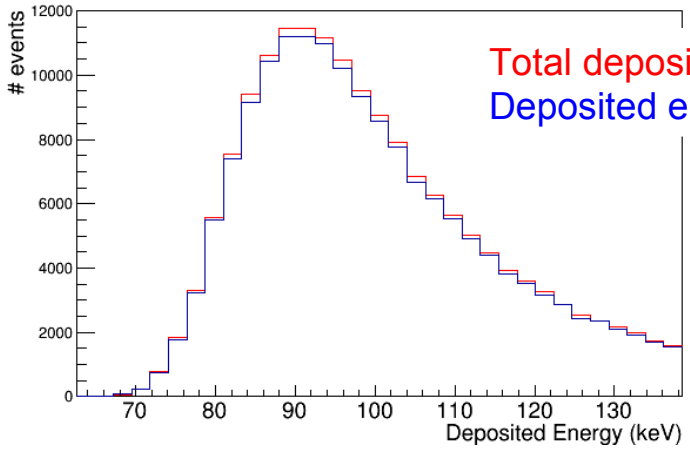
  + Add PA noise (sigma from 2 to 4 ADC)

    - Apply trigger threshold (1 threshold per channel)
- Add SS noise (sigma = 1.4 ADC)
- Add pedestal (+ 300 ADC)
- Remove channels with switched off PA
  - ASIC data structure in simulation: 1 chip, 1 column, 324 channels

Physics list:
EM option 3 (Standard G4)
e, gamma production cuts = 10 um
Cross section tables: 0,1 keV → 100 GeV (2000 bins)
Max step size in wafers = 5 um

Cf = 1,2 pF
→ modify scaling factor and noise for other gains

Not included: dispersion of channel response

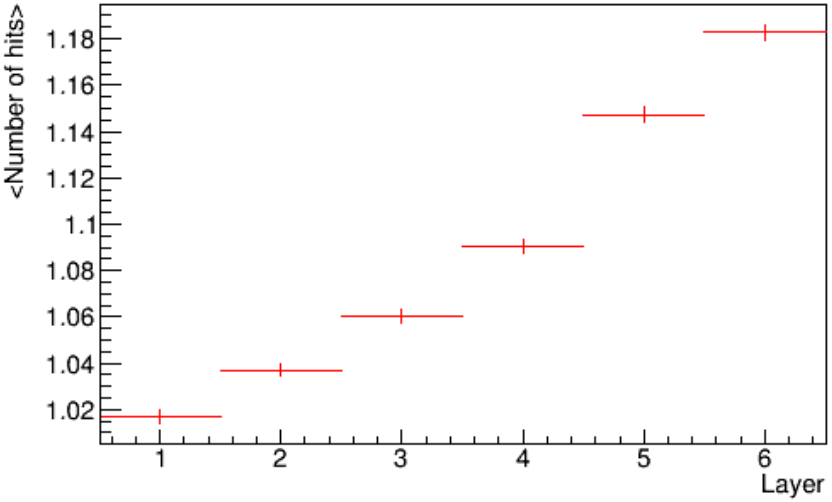


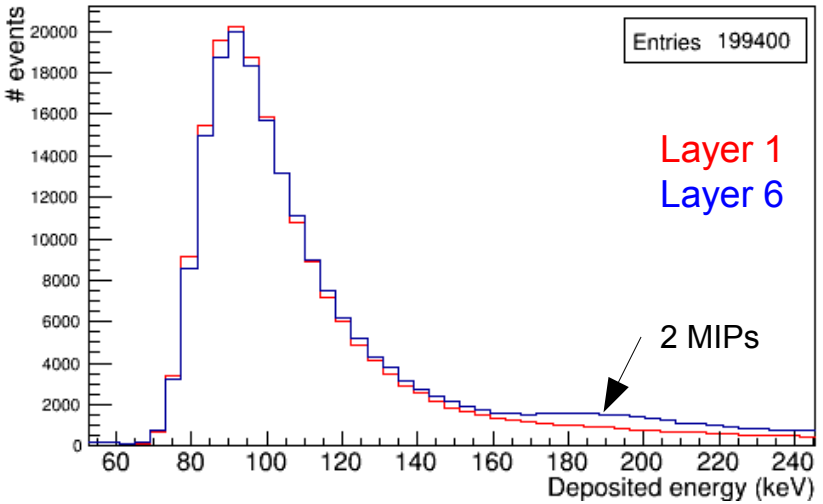
Total deposited energy (step 1)
Deposited energy @ step 4

Small effect of the geometrical cuts and electron-hole simulation → Negligible?

Effects of secondary particle production

Without trigger threshold cut





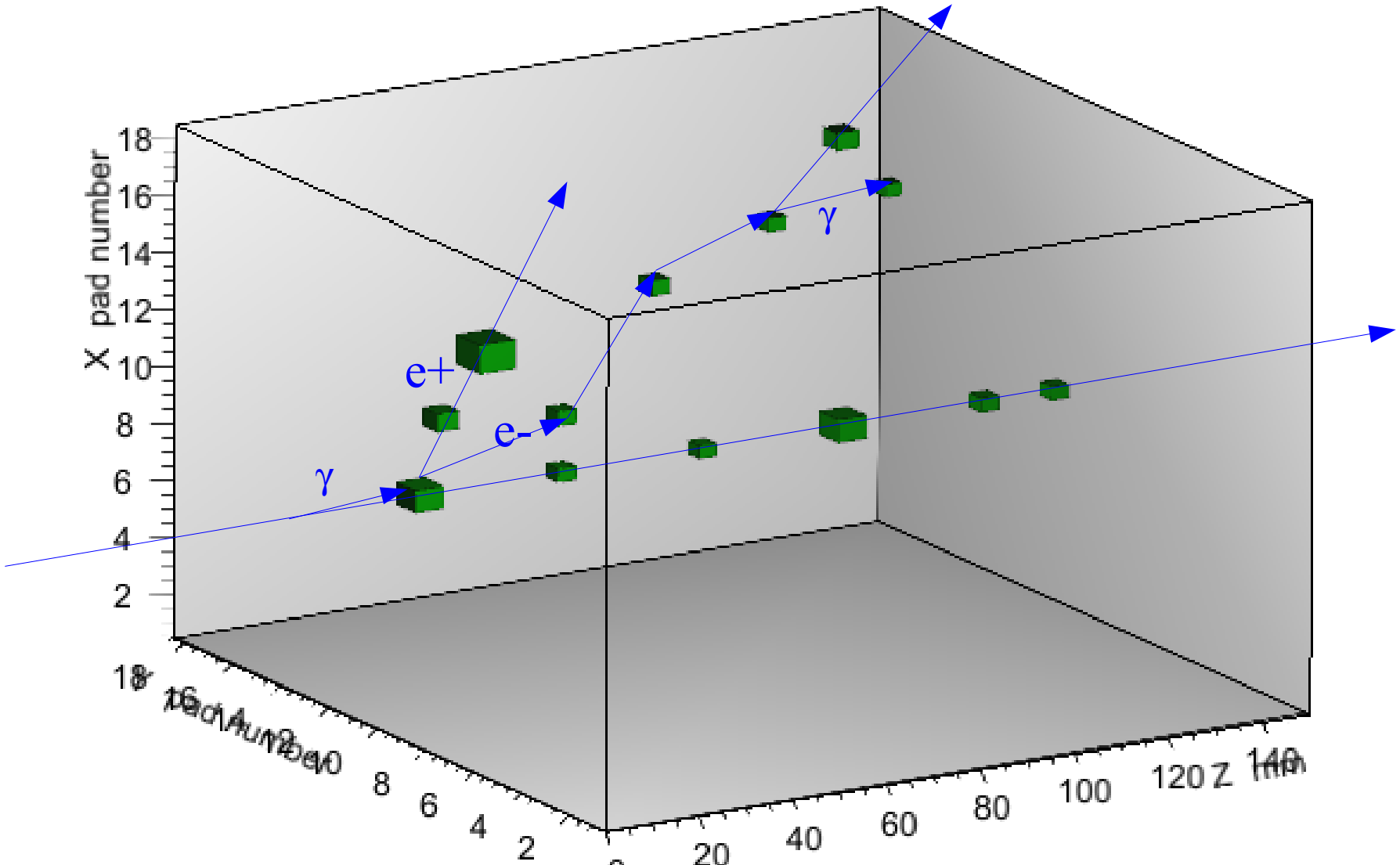
DESY:

- electron beam
- E from 1 GeV to 5 GeV

Not negligible probability to produce secondary particles → Mean number of particles increases as a function of the layer number:

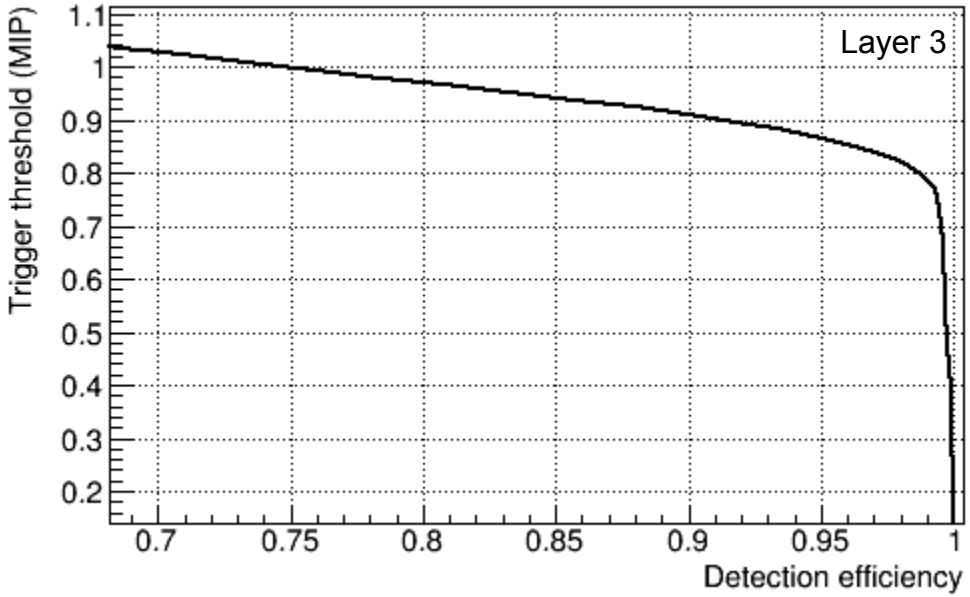
- Mean number of hits per event increases as a function of the layer number (effect on MIP detection efficiency calculation?)
- Energy spectrum is modified as a function of the layer number (effect on MIP energy calibration?)

Secondary particles

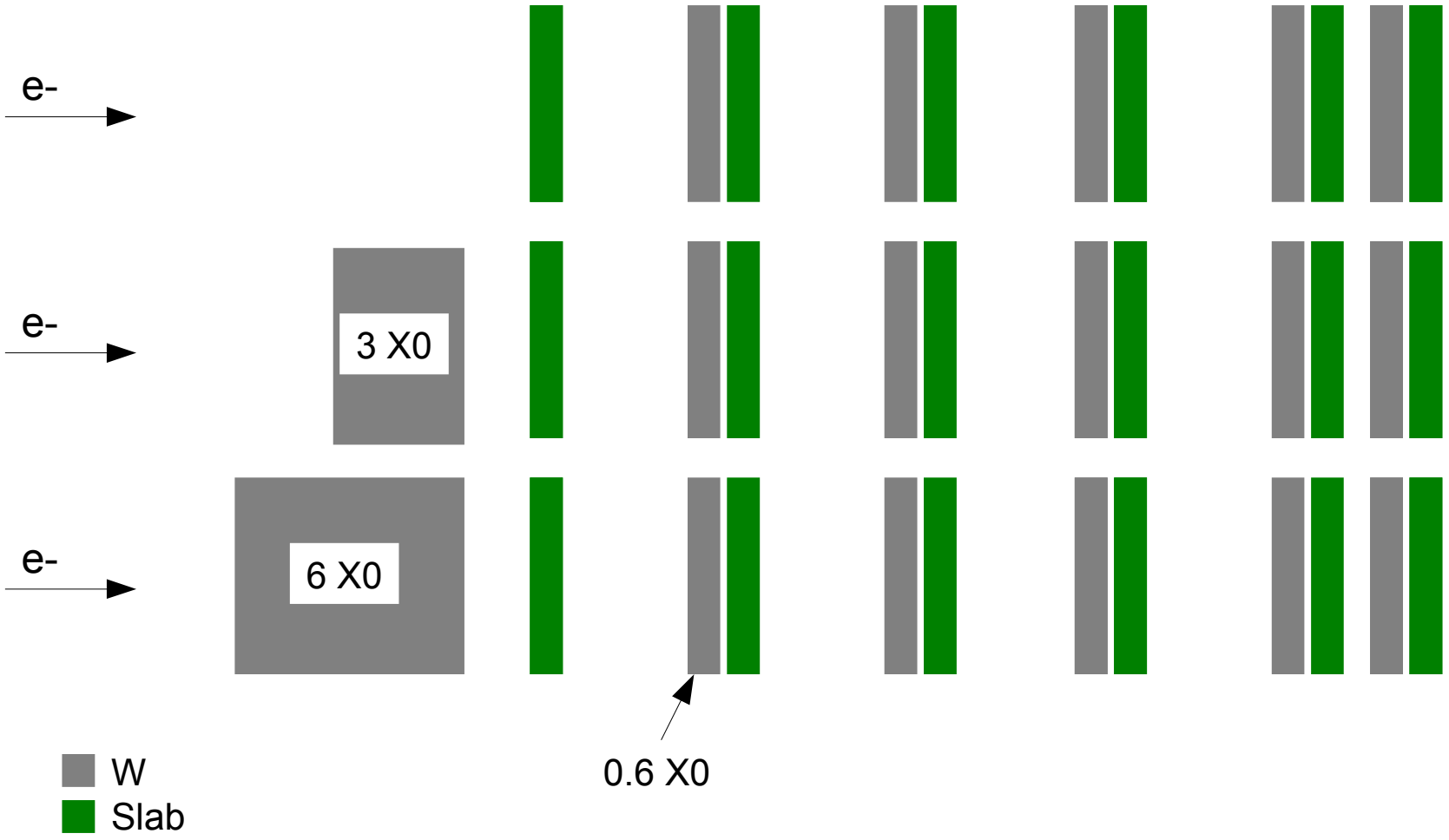


Trigger threshold

Only the effect of the trigger threshold is studied : with a trigger threshold @0, the detection efficiency is 100% (geometrical effects ==> inefficiency < 2% → not taken into account)

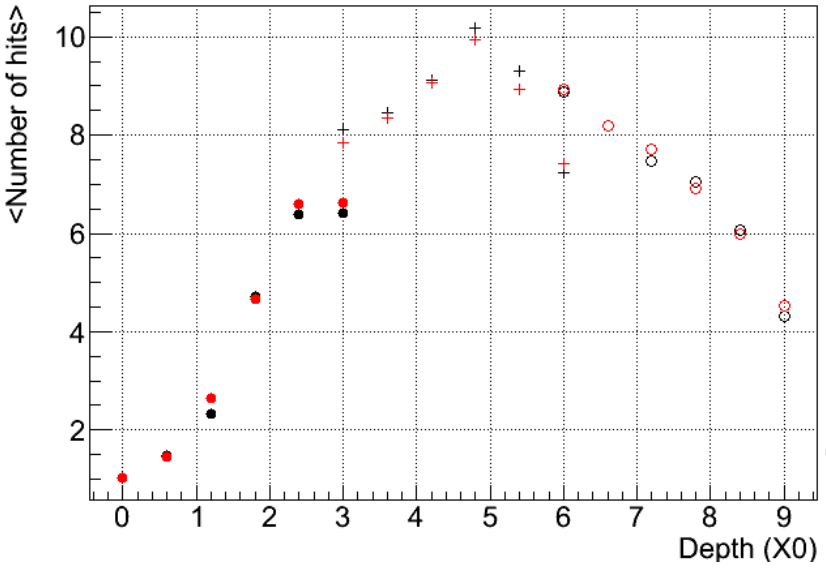


Application to showers (summer 2012)



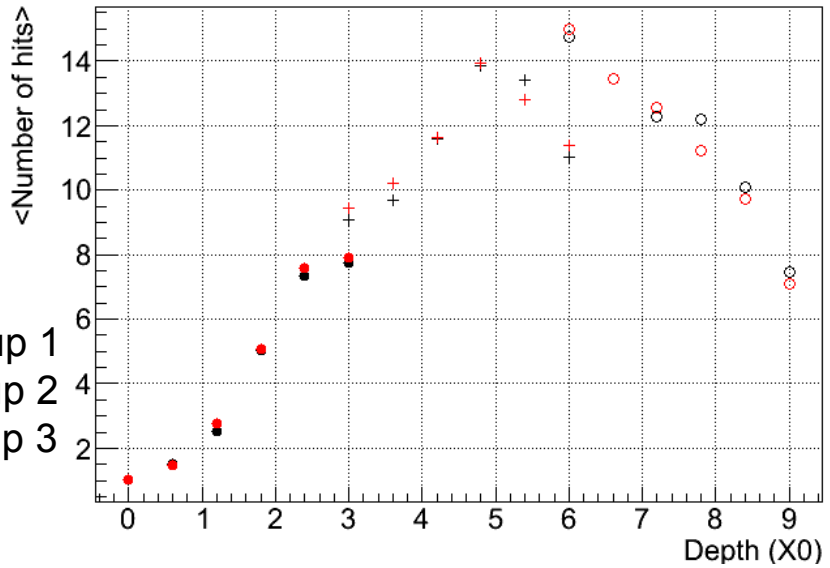
Application to showers (summer 2012)

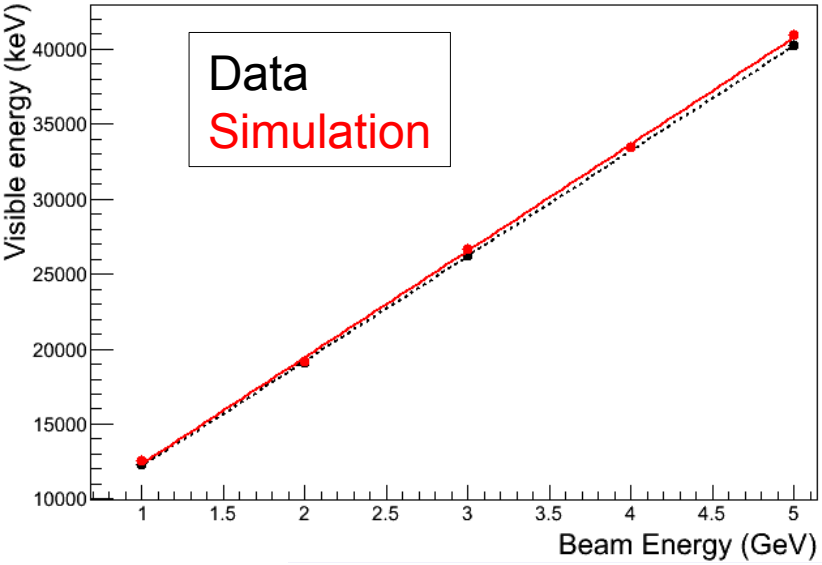
3 GeV



• Setup 1
+ Setup 2
o Setup 3

5 GeV





Improvements of the simulation to be applied to summer 2013 TB to improve the results showed at the last CALICE meeting.