A first glance at shower data

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for the SiW-ECAL CALICE team

Introduction

- Prepare analysis tools to estimate the response of the SLABs to EM showers
  - Comparison with «standard» EM profiles
  - Comparison with simulations (TBD)
- Look for unexpected effects
  - Mis-calibration
  - Saturation effects from electronics, sensors, ...
  - …
- Have a preliminary tool for coming BT
  - Use of python analysis framework (numpy, scipy on root data)
- All results are very preliminary

Data used

- Located in:

  TB2017-06/DESY/ConvertedData/pass3/Tungsten/**conf{1,2,3}**/grid20/**{1,2,3,4,5,5.8}**GeV_build.root

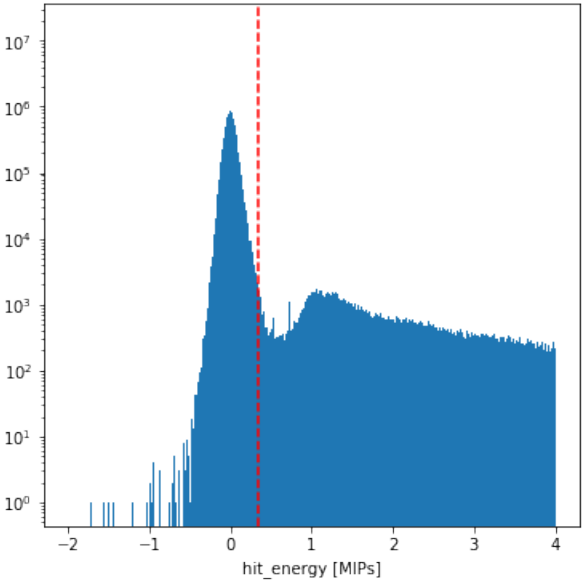
  Complete calibrated data to single mips by Adrián.

- Tungsten configurations:

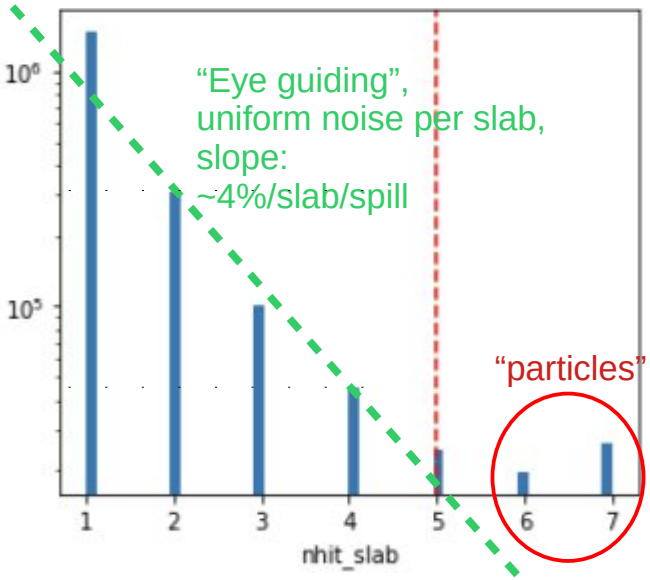
  - W-configuration 1: 0.6, 1.2, 1.8, 2.4, 3.6, 4.8 and 6.6 X_0
  - W-configuration 2: 1.2, 1.8, 2.4, 3.6, 4.8, 6.6 and 8.4 X_0
  - W-configuration 3: 1.8, 2.4, 3.6, 4.8, 6.6, 8.4 and 10.2 X_0

Global Selection

- Cut hits below μ+5σ of (gaussian) hit_energy noise

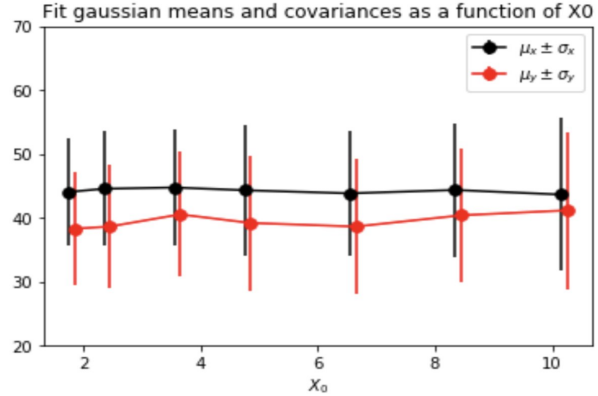


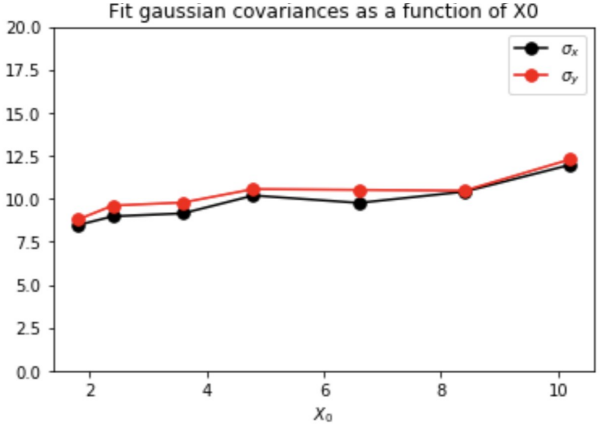
- Reject events where slab hits <= 5

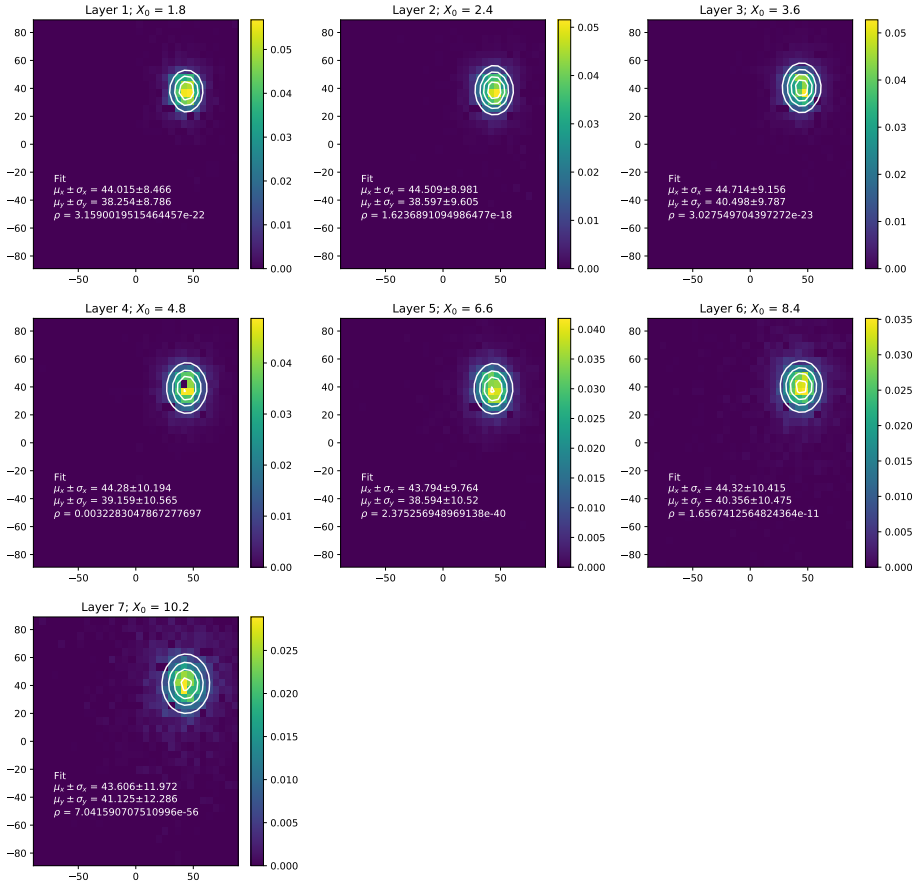


Selection

beam profile



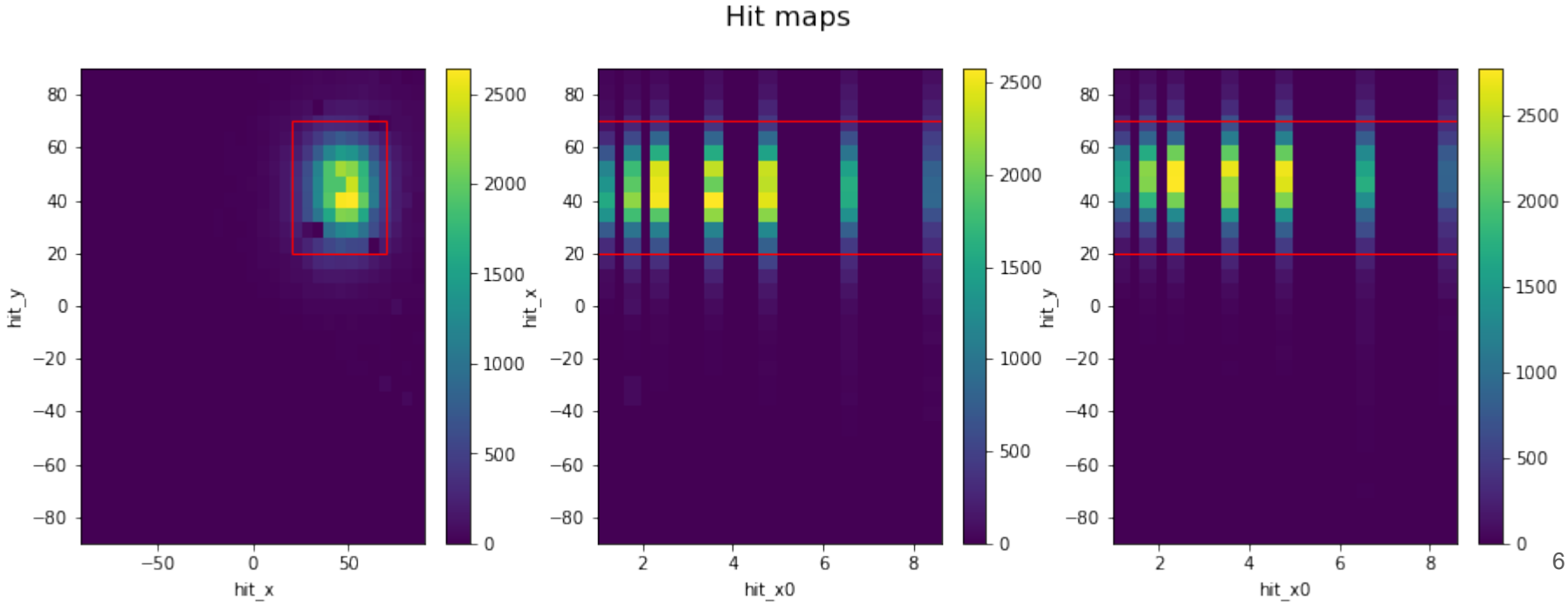




Selection

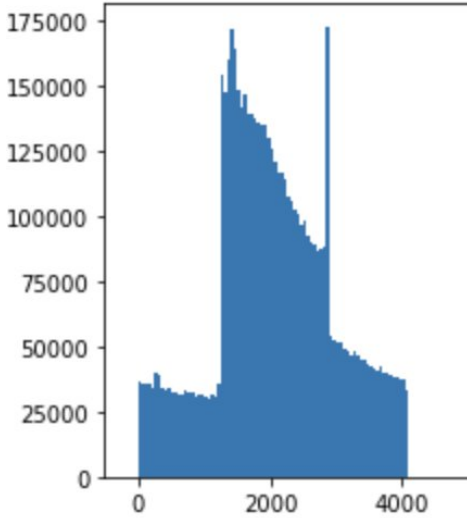
Hit maps for the sum of all showers (conf2, 1GeV):

→ At the moment: cut on [20, 70] in hit_{x,y}, but need to automate this

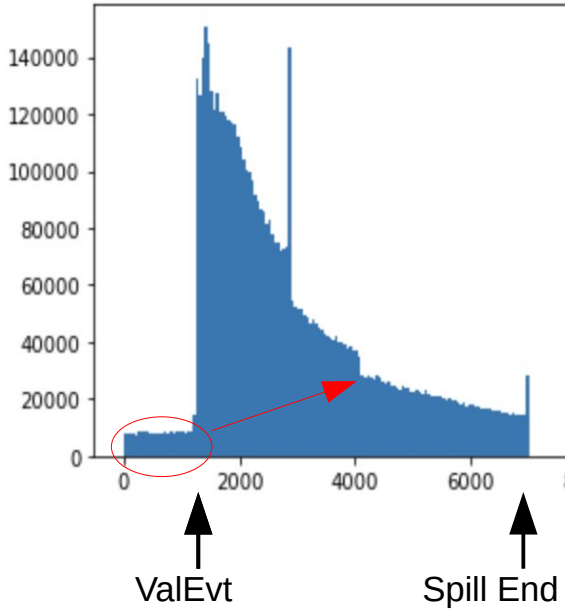


BCID reconstruction

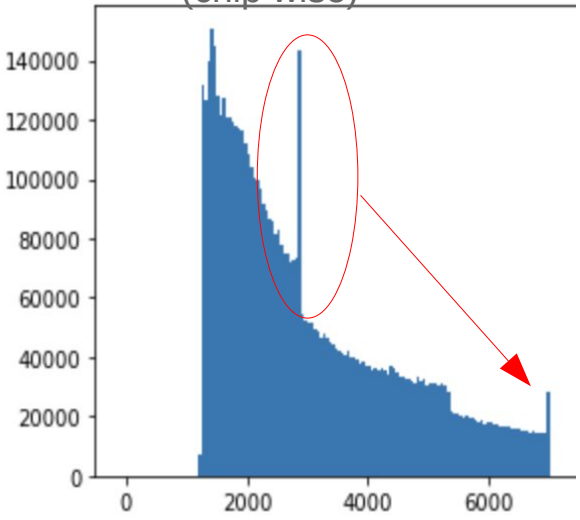
Looping BCID's at 4096



Corrected BCID
corr BCID = BCID +4096 if ≤ BCID in SCA-1
(chipwise)



Corrected BCID bis:
If BCID<(ValEvt) += 4096
(chip wise)



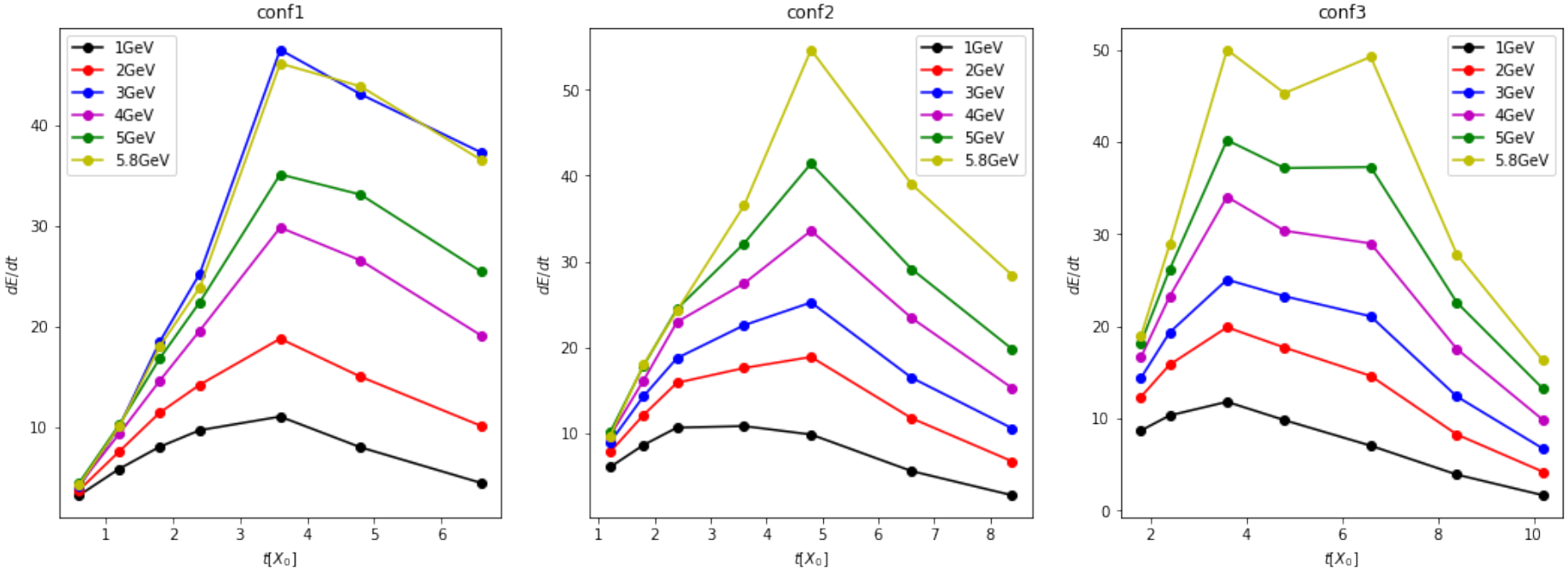
BCID Reconstruction

- 1 event = BCID±1 (to account for over-the-clock-boundary events)

- what is the effect of bad reconstruction ?
  - if corrected BCID wrong:
    - split events ⇒ worst case = Energy / 2 in 2 events (separated by 4096)
      - low tails in resolution or thrown-out events
  - if using uncorrected BCID (= true BCID%4096):
    - include ×2 the noise in the events
      - small correction

- Ideally, either
  - tag BCID crossing (force trigger @ BCID=4095 ?)
  - have spill length ≤ 4096×1/f ~ 0.8ms

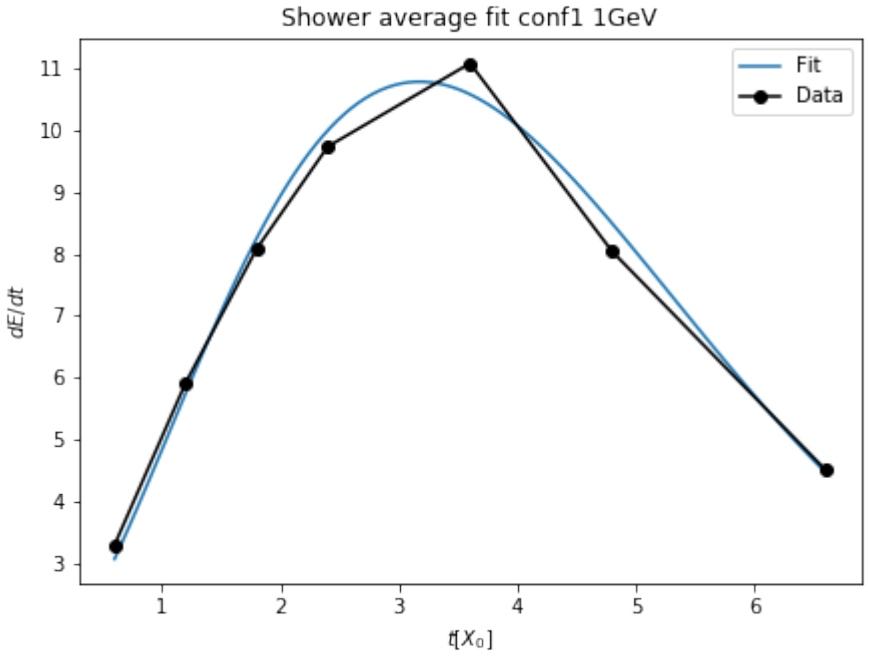
Average energy per layer

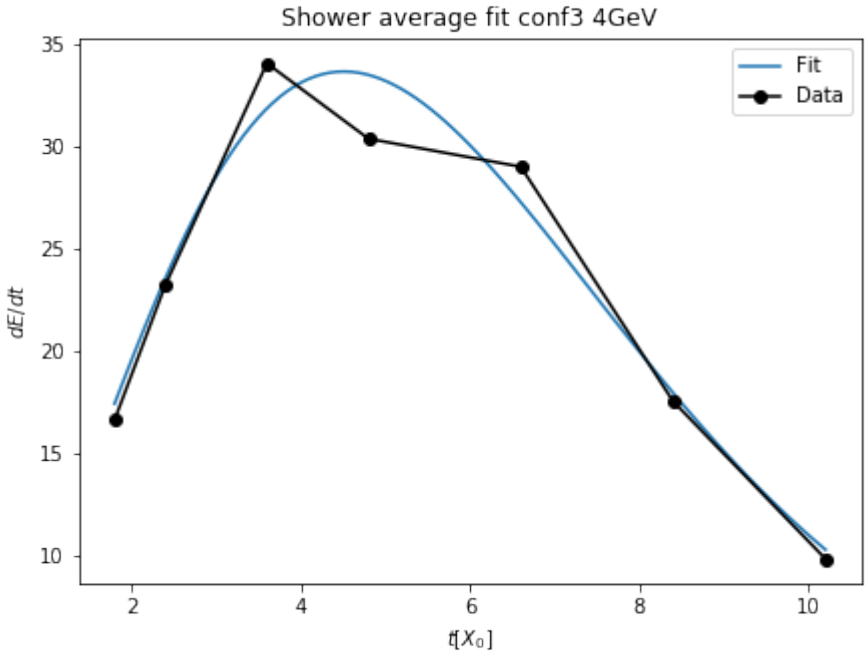


- No error bar yet (small)
- Some non-statistical deviations

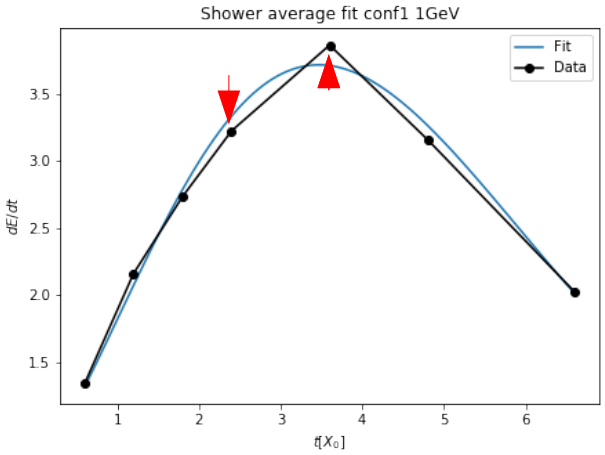
Fitting average energy

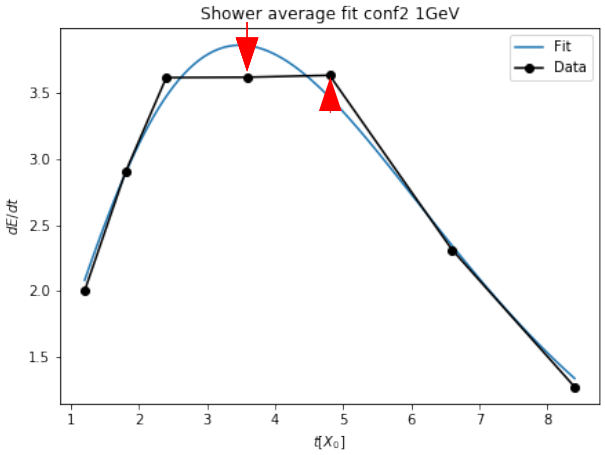
$$\frac{dE}{dt} = E_0\, b\, \frac{(bt)^{a-1} e^{-bt}}{\Gamma(a)}$$

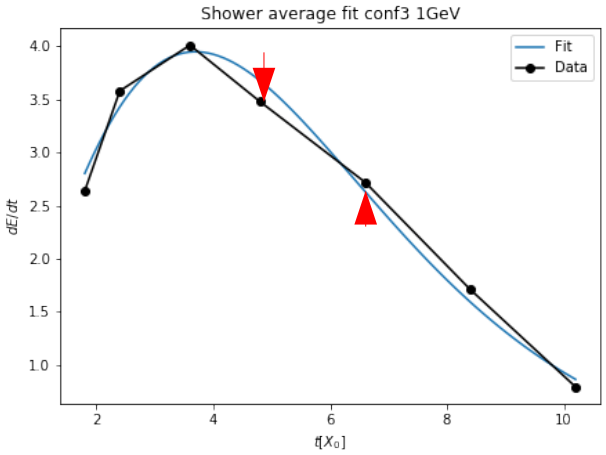




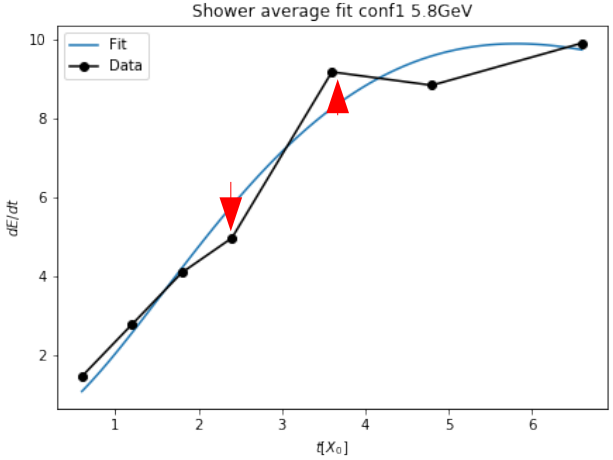
Fitting the sum of energy deposition (1 GeV)

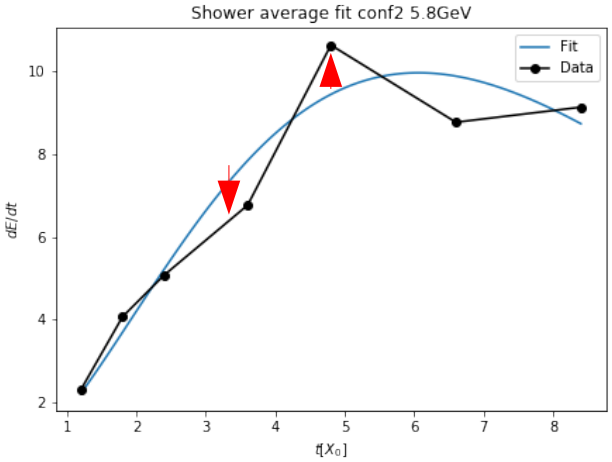


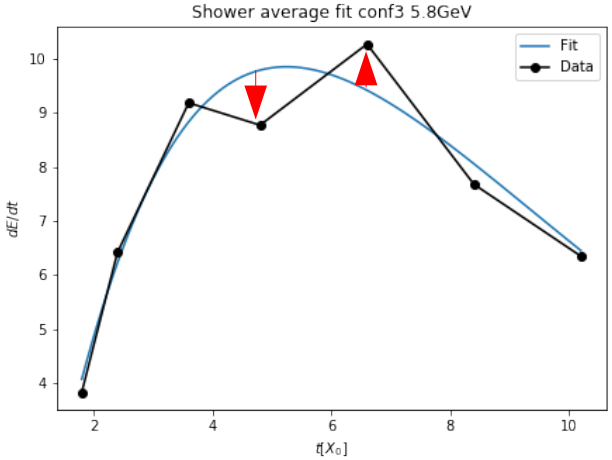




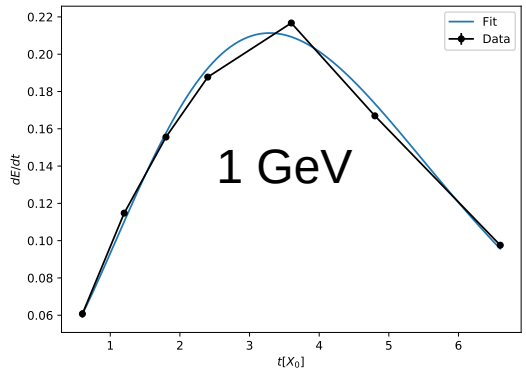
Fitting the sum of energy deposition (5.8 GeV)

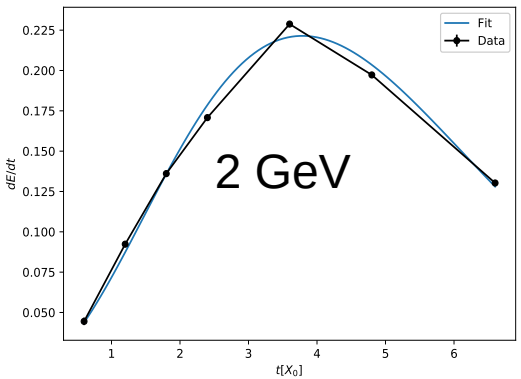


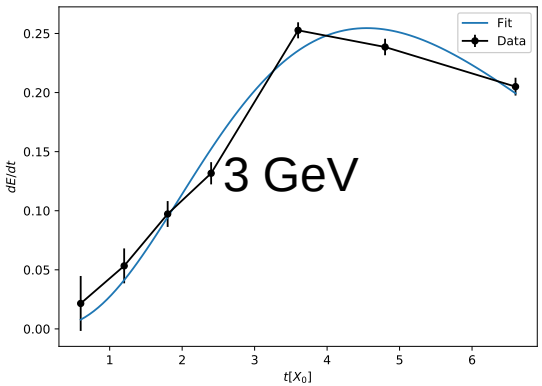


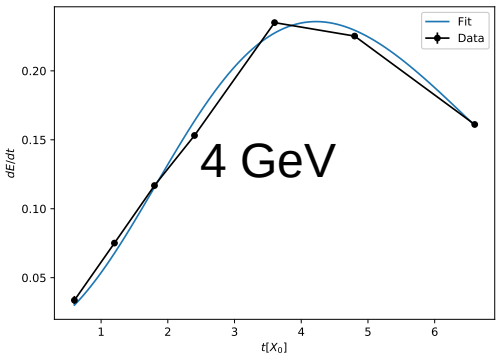


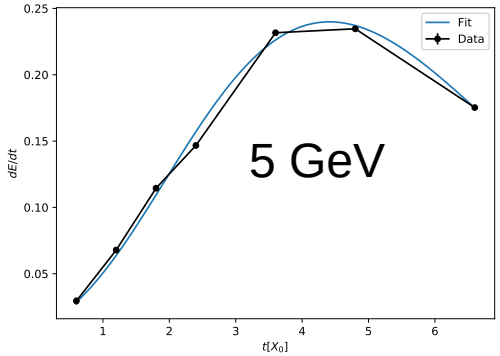
Config 1

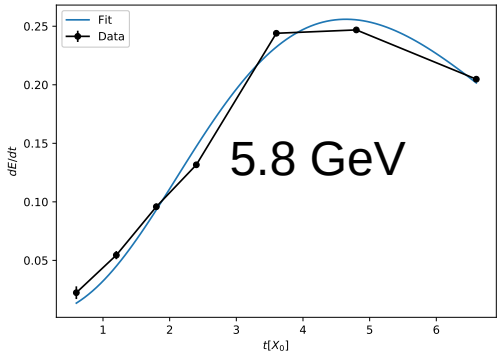

1 GeV
Fit
Data
dE/dt
t[X0]


2 GeV
Fit
Data
dE/dt
t[X0]

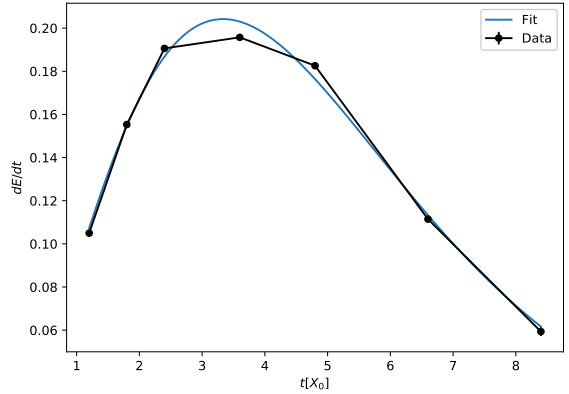

3 GeV
Fit
Data
dE/dt
t[X0]

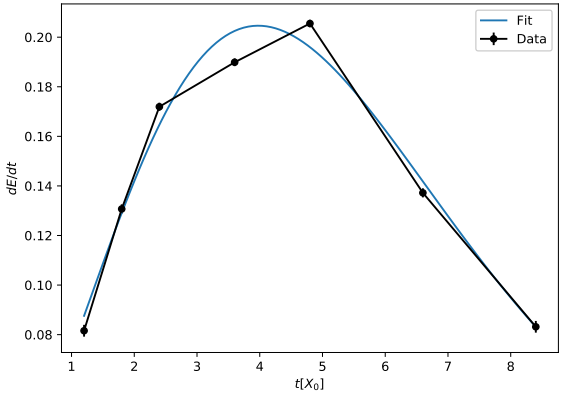

4 GeV
Fit
Data
dE/dt
t[X0]

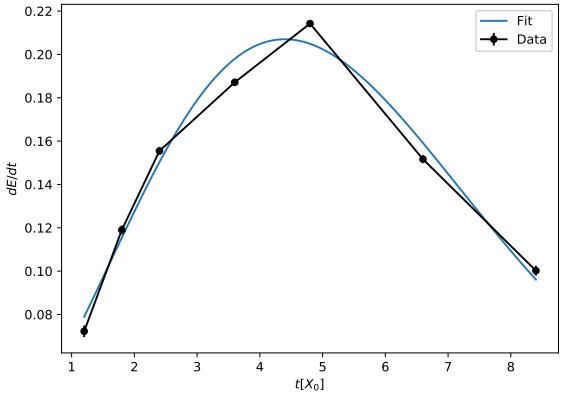

5 GeV
Fit
Data
dE/dt
t[X0]

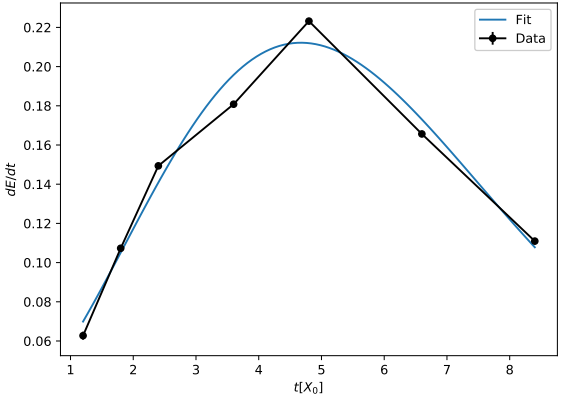

5.8 GeV
Fit
Data
dE/dt
t[X0]

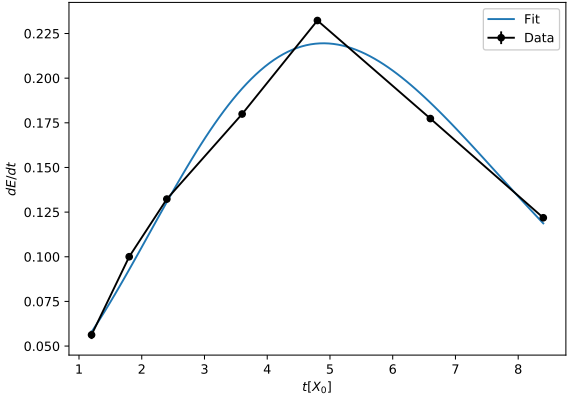
Config 2

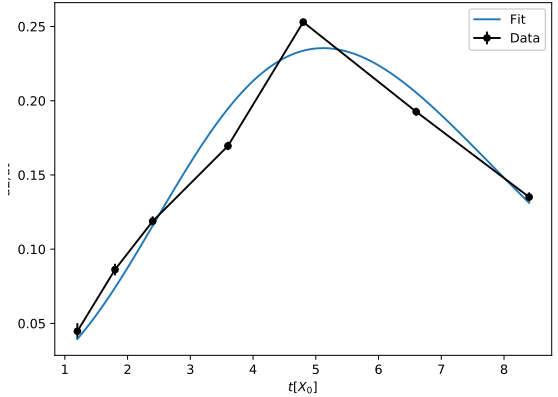

Fit
Data
dE/dt
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
1
2
3
4
5
6
7
8
$t[X_0]$


Fit
Data
dE/dt
0.20
0.18
0.16
0.14
0.12
0.10
0.08
1
2
3
4
5
6
7
8
$t[X_0]$

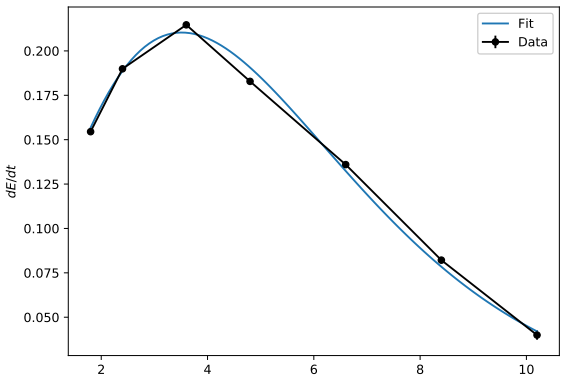

Fit
Data
dE/dt
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
1
2
3
4
5
6
7
8
$t[X_0]$

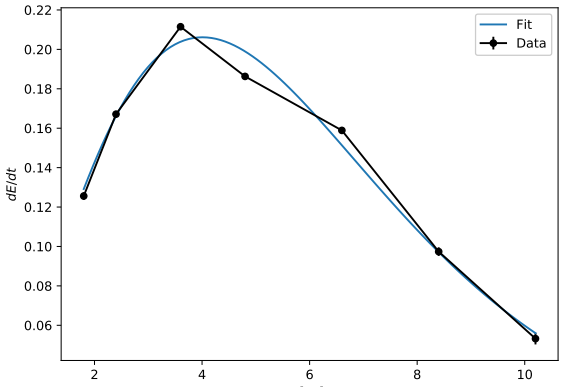

Fit
Data
dE/dt
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
1
2
3
4
5
6
7
8
$t[X_0]$

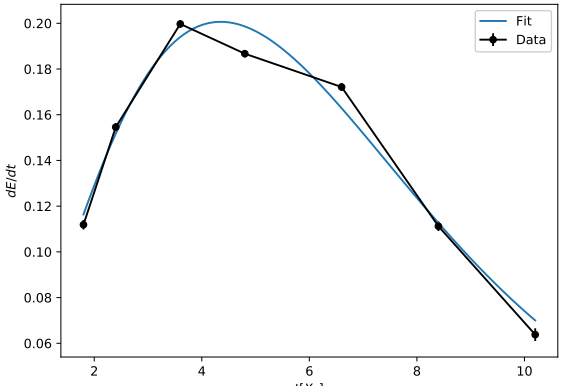

Fit
Data
dE/dt
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
1
2
3
4
5
6
7
8
$t[X_0]$

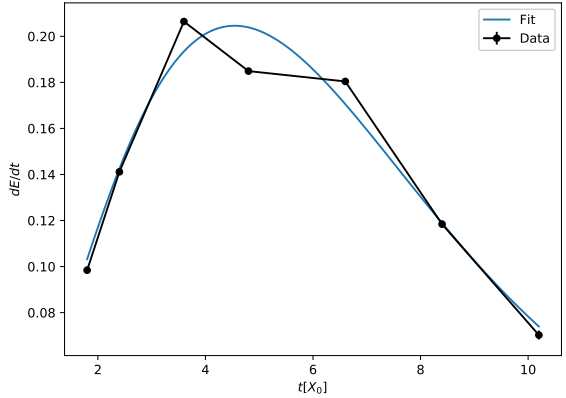

Fit
Data
0.25
0.20
0.15
0.10
0.05
1
2
3
4
5
6
7
8
$t[X_0]$

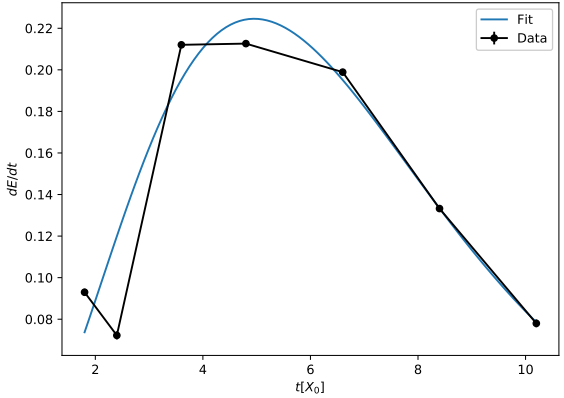
Config 3

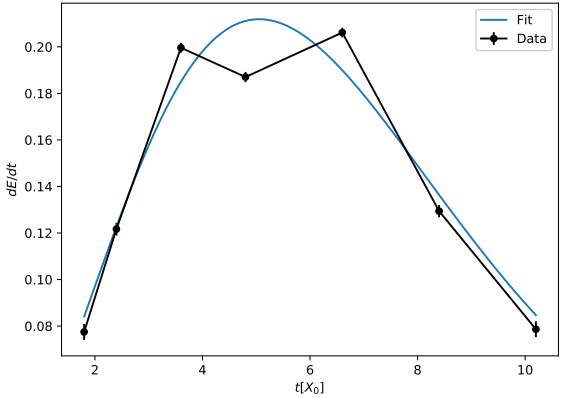

Fit
Data
dE/dt
0.200
0.175
0.150
0.125
0.100
0.075
0.050
2
4
6
8
10


Fit
Data
dE/dt
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
2
4
6
8
10


Fit
Data
dE/dt
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
2
4
6
8
10


Fit
Data
dE/dt
0.20
0.18
0.16
0.14
0.12
0.10
0.08
2
4
6
8
10
t[X0]


Fit
Data
dE/dt
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
2
4
6
8
10
t[X0]

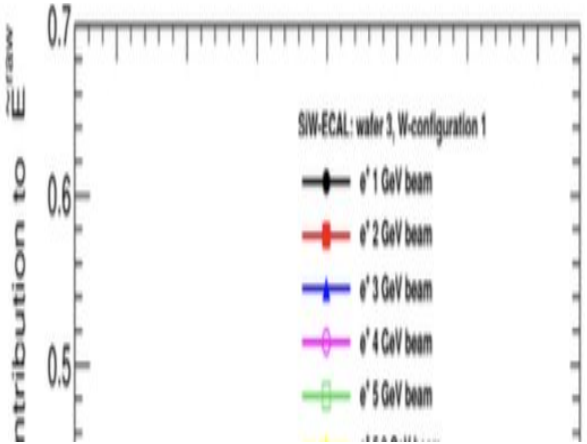

Fit
Data
dE/dt
0.20
0.18
0.16
0.14
0.12
0.10
0.08
2
4
6
8
10
t[X0]

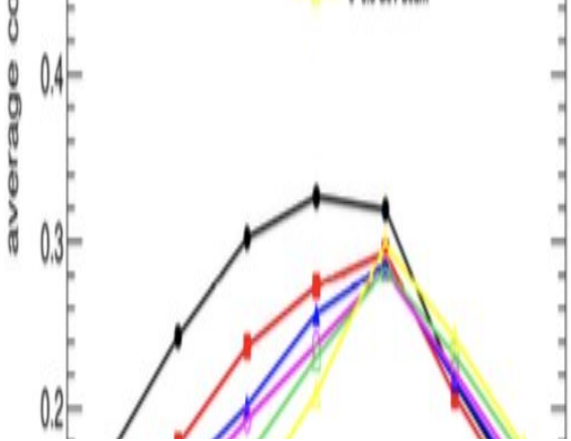
Follow-up

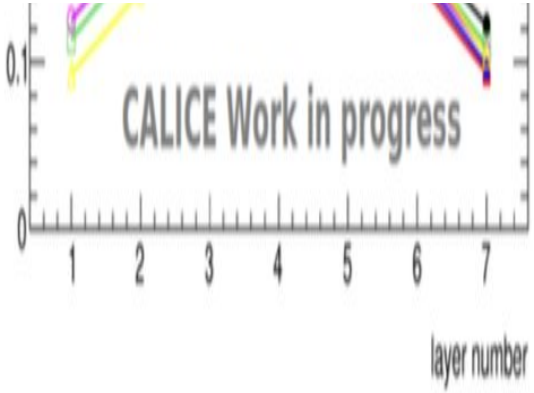
- Profile fitting started...
- Calibration of layers beyond mips

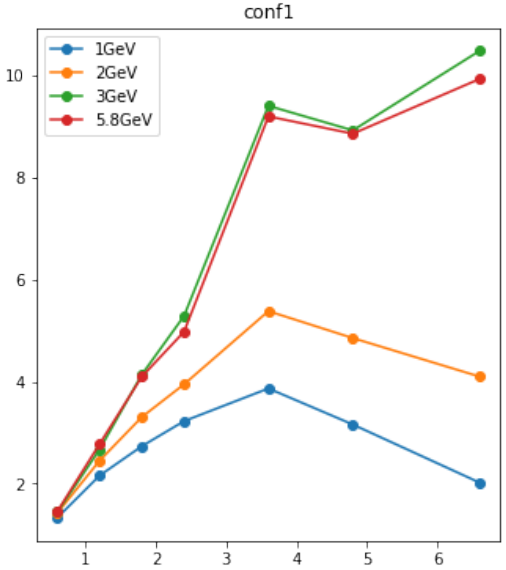
- Handling of missing cells at ≠ depth and different thicknesses
- ⇒ 3D shower reconstruction ?
  - Fit: $d^3E/dX_0 dx dy\ (z, x, y) \times \Delta x(\text{cell}) \times \Delta x\ (\text{cell}) \times \Delta z(\text{cell})$
    - Code is ready
    - include all distribution with long profile × ∑ (2 Gaussians) + tilt.
  - Started: Fit of Physics Prototype shower shapes
    - Tricky: handling of noise distributions in tails.

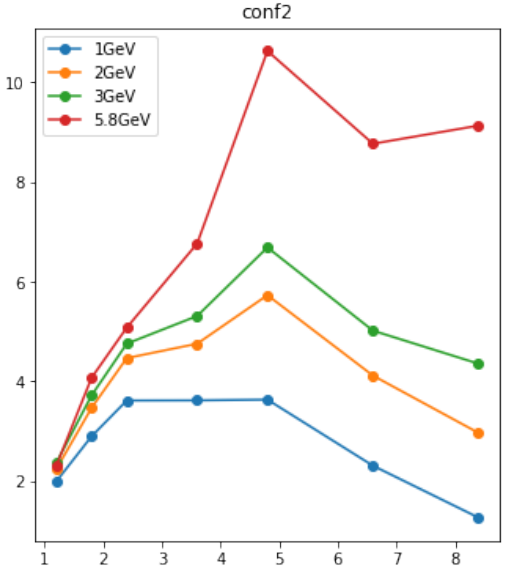
Backup

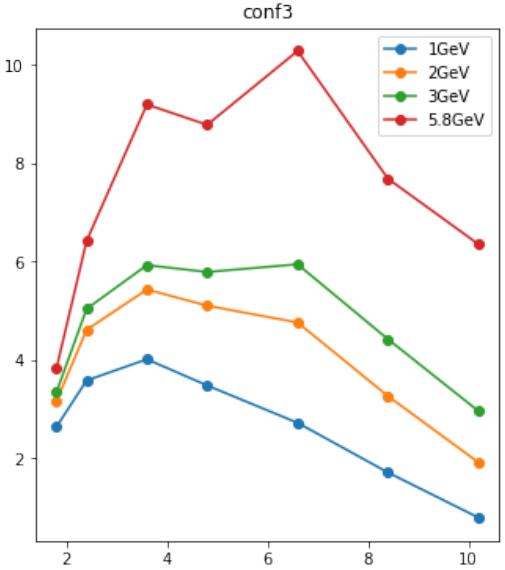

SiW-ECAL: wafer 3, W-configuration 1
e⁻ 1 GeV beam
e⁻ 2 GeV beam
e⁻ 3 GeV beam
e⁻ 4 GeV beam
e⁻ 5 GeV beam



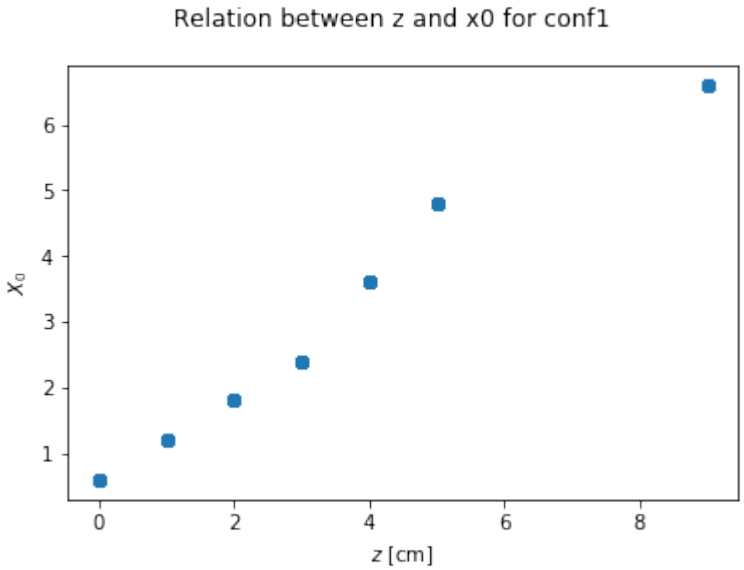

CALICE Work in progress
layer number

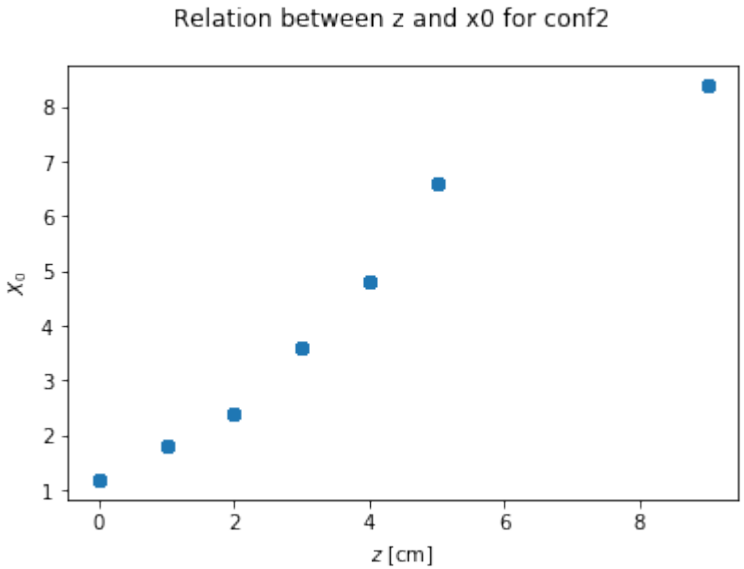

conf1
1GeV
2GeV
3GeV
5.8GeV

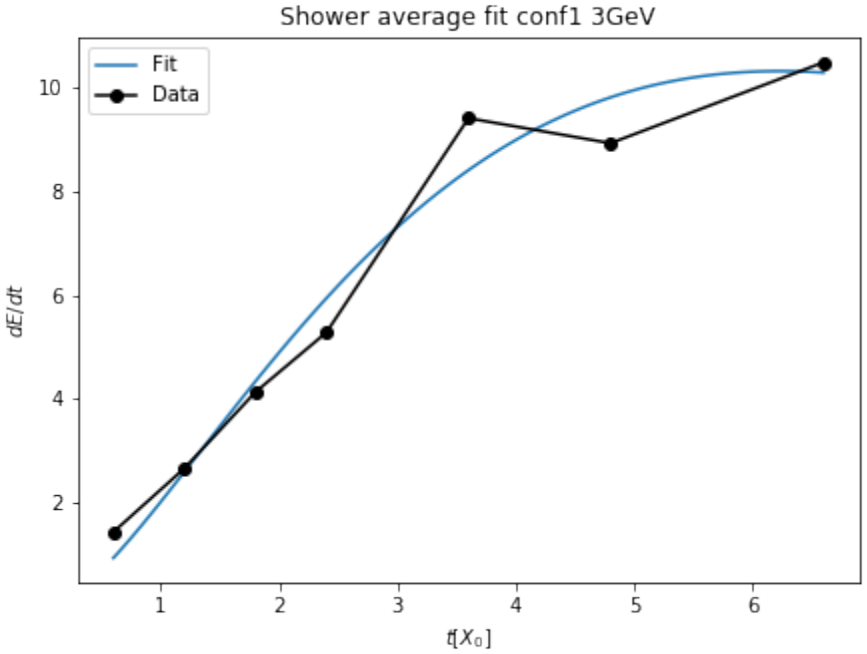

conf2
1GeV
2GeV
3GeV
5.8GeV

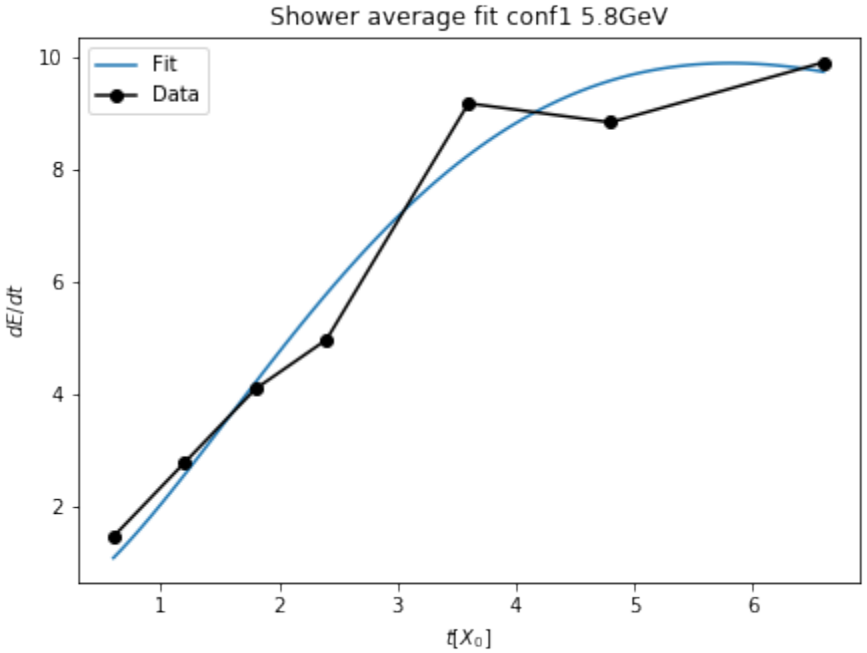

conf3
1GeV
2GeV
3GeV
5.8GeV

Z and X0 for configurations



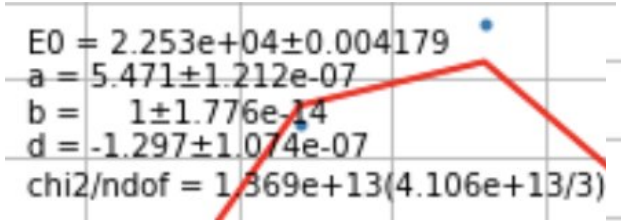


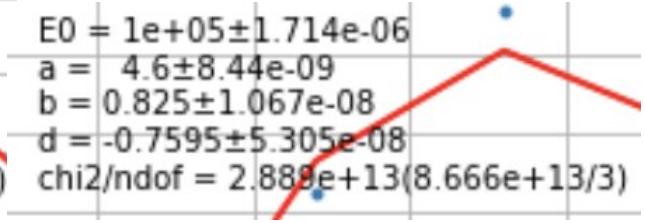

Shower average fit conf1 3GeV
Fit
Data
10
8
6
4
2
dE/dt
1
2
3
4
5
6
t[X₀]

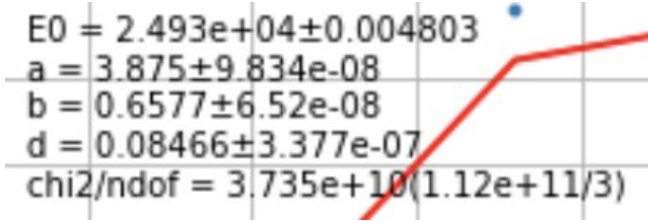

Shower average fit conf1 5.8GeV
Fit
Data
10
8
6
4
2
dE/dt
1
2
3
4
5
6
t[X₀]

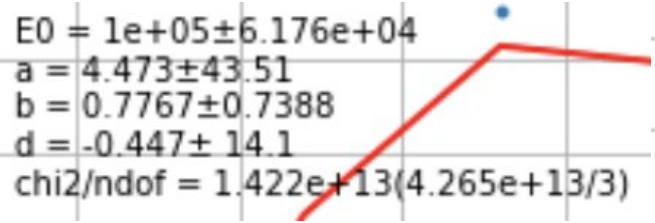
Fit results conf1 - 1, 2, 3 // 4, 5, 5.8 GeV

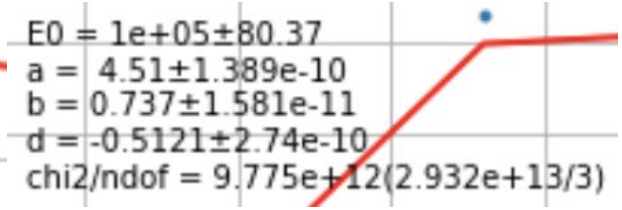
(E0 normalization to be fixed)

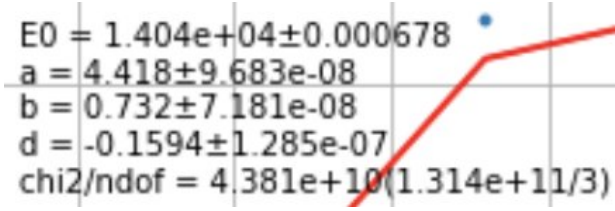






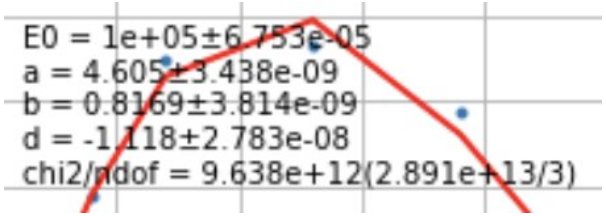


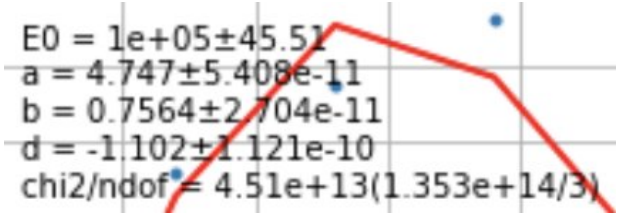


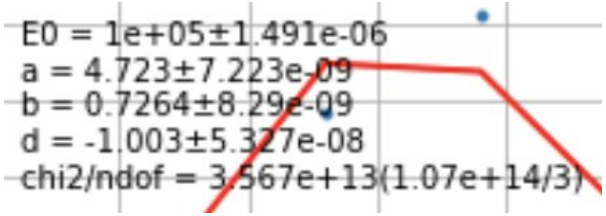


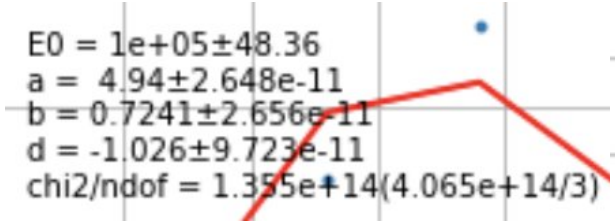
Fit results conf2 - 1, 2, 3 // 4, 5, 5.8 GeV

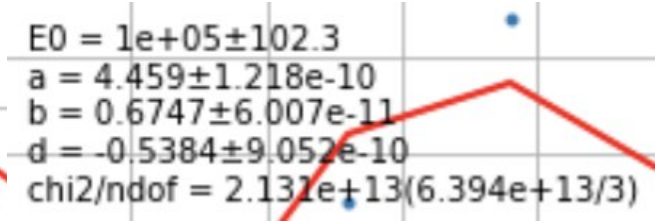
(E0 normalization to be fixed)

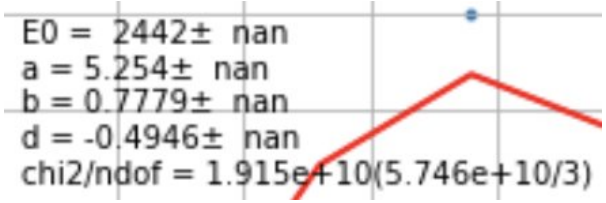












Fit results conf3 - 1, 2, 3 // 4, 5, 5.8 GeV

(E0 normalization to be fixed)