AHCAL Time Response Analysis 2

François Corriveau

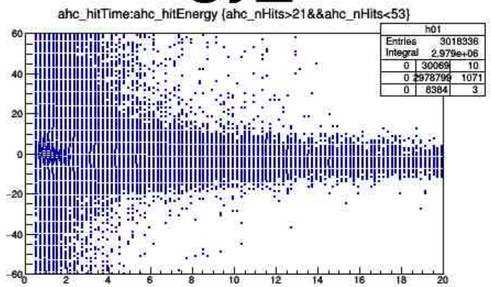
IPP / McGill University
Supported by DAAD and MPP

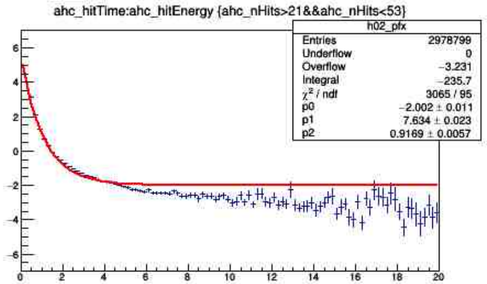
2019.07.10

Time walk vs hitEnergy [0-20 MIP]

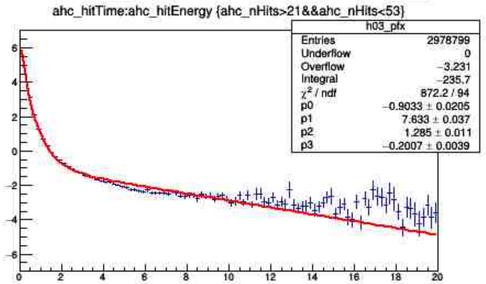
Functional Forms

vsenergy_20190617f_hitTimevsEne reco_run60382_testNewConstants.rc

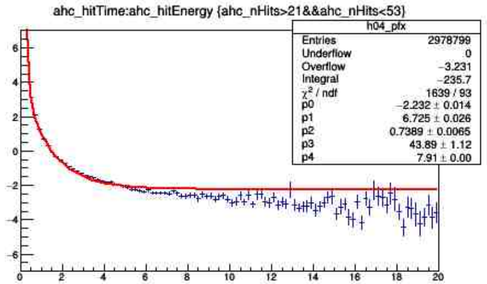




$f_{01}(x) = a + be^{-cx}$

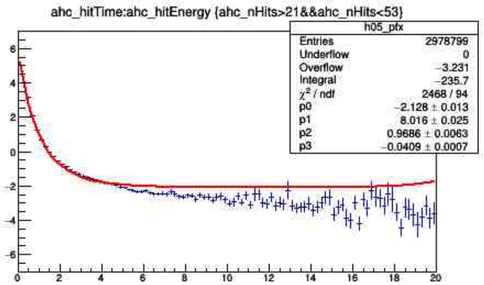


$f_{02}(x) = a + be^{-cx} + dx$

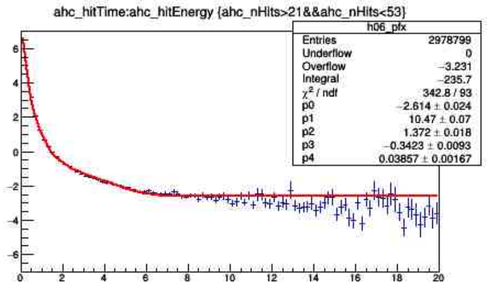


$f_{03}(x) = a + be^{-cx} + de^{-ex}$

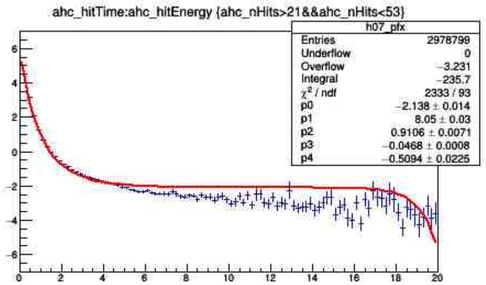
from last time (2019.06.19)



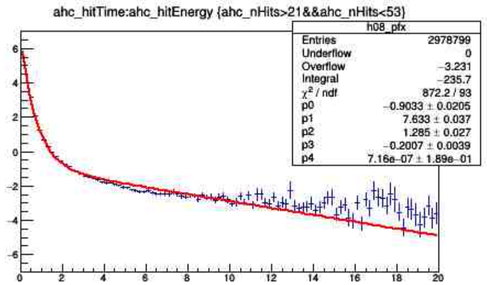
$f_{04}(x) = a + be^{-cx-dx^2}$



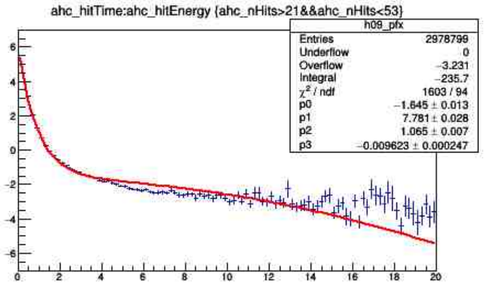
$f_{05}(x) = a + be^{-cx-dx^2-ex^3}$



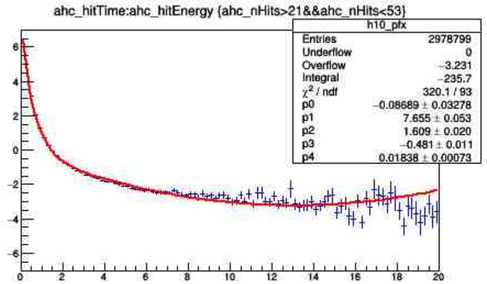
$f_{06}(x) = a + (b + dx)e^{-cx-ex^2}$



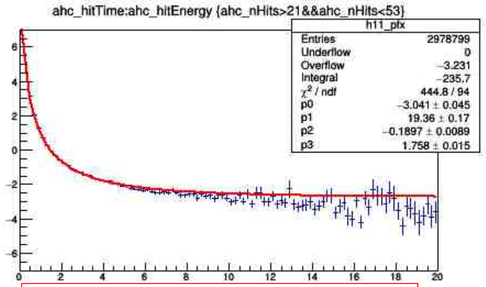
$f_{07}(x) = a + (b + dx)e^{-cx} + ex$



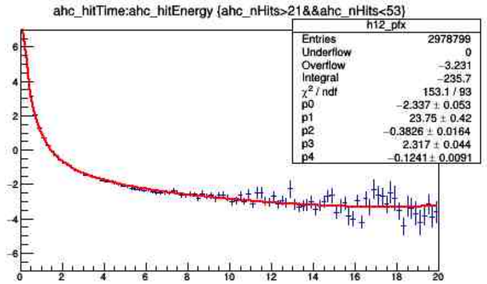
$f_{08}(x) = a + be^{-cx} + dx^2$



$f_{09}(x) = a + be^{-cx} + dx^2 + ex^3$



$f_{10}(x) = a + be^{-cx-d\sqrt{x}}$

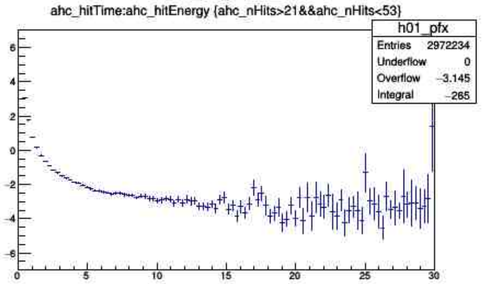


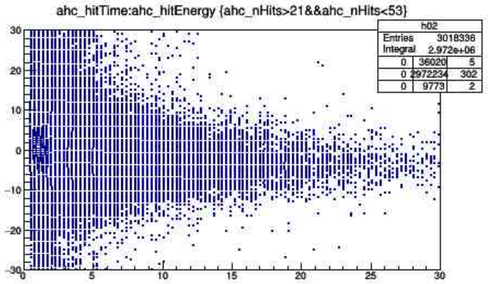
$f_{11}(x) = a + be^{-cx-d\sqrt{x}} + ex$

Form 1 ~ok until 8 MIPS.
Form 10 better behaved.

Muons – Time Correction

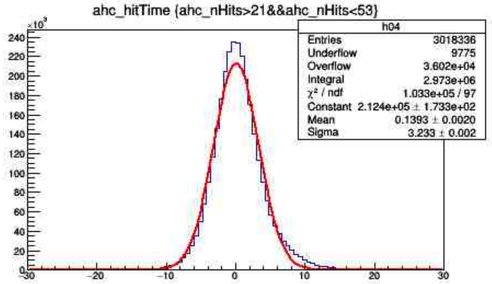
vsenergy_20190617h_hitTimevsEne reco_run60382_testNewConstants.r



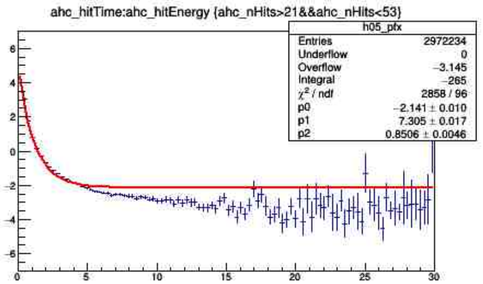


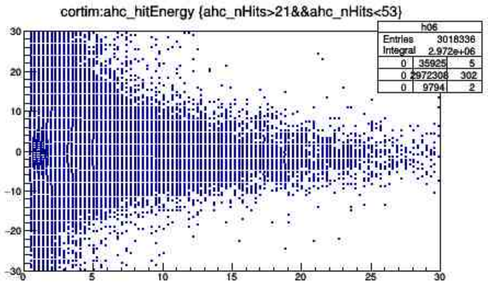
raw data

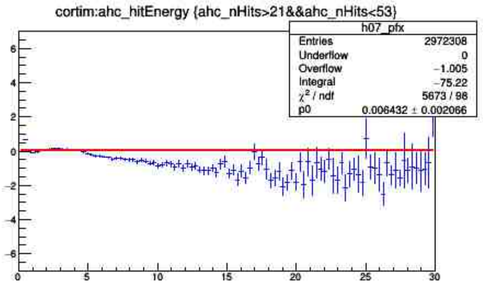
[0-30 MIP]

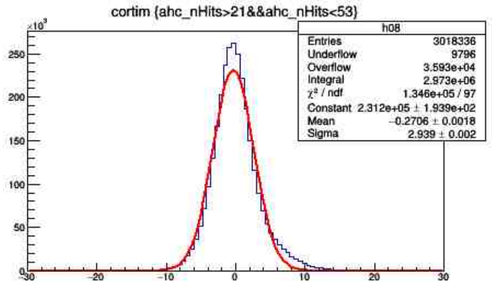


from last time (2019.06.19)

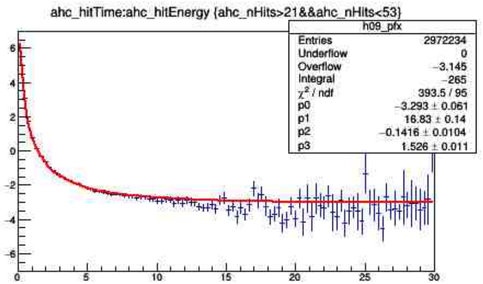


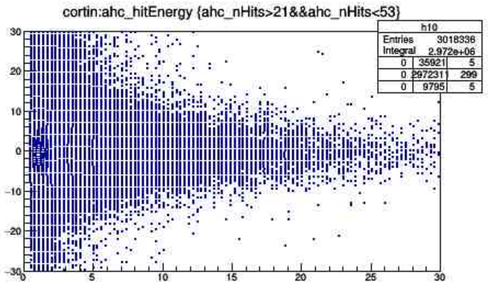


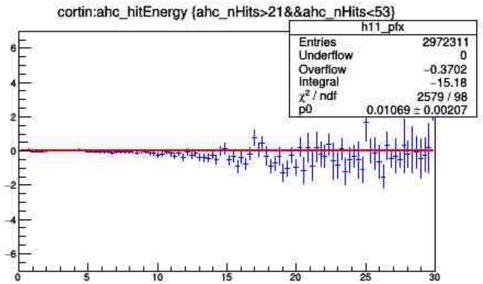


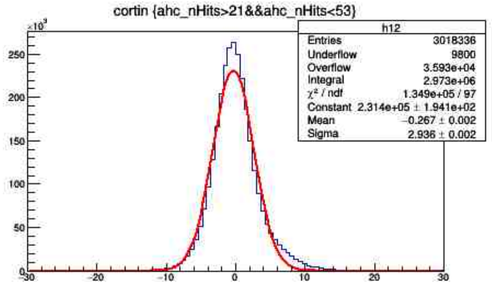


$$f_{01}(x) = a + be^{-cx}$$









$$f_{10}(x) = a + be^{-cx-d\sqrt{x}}$$

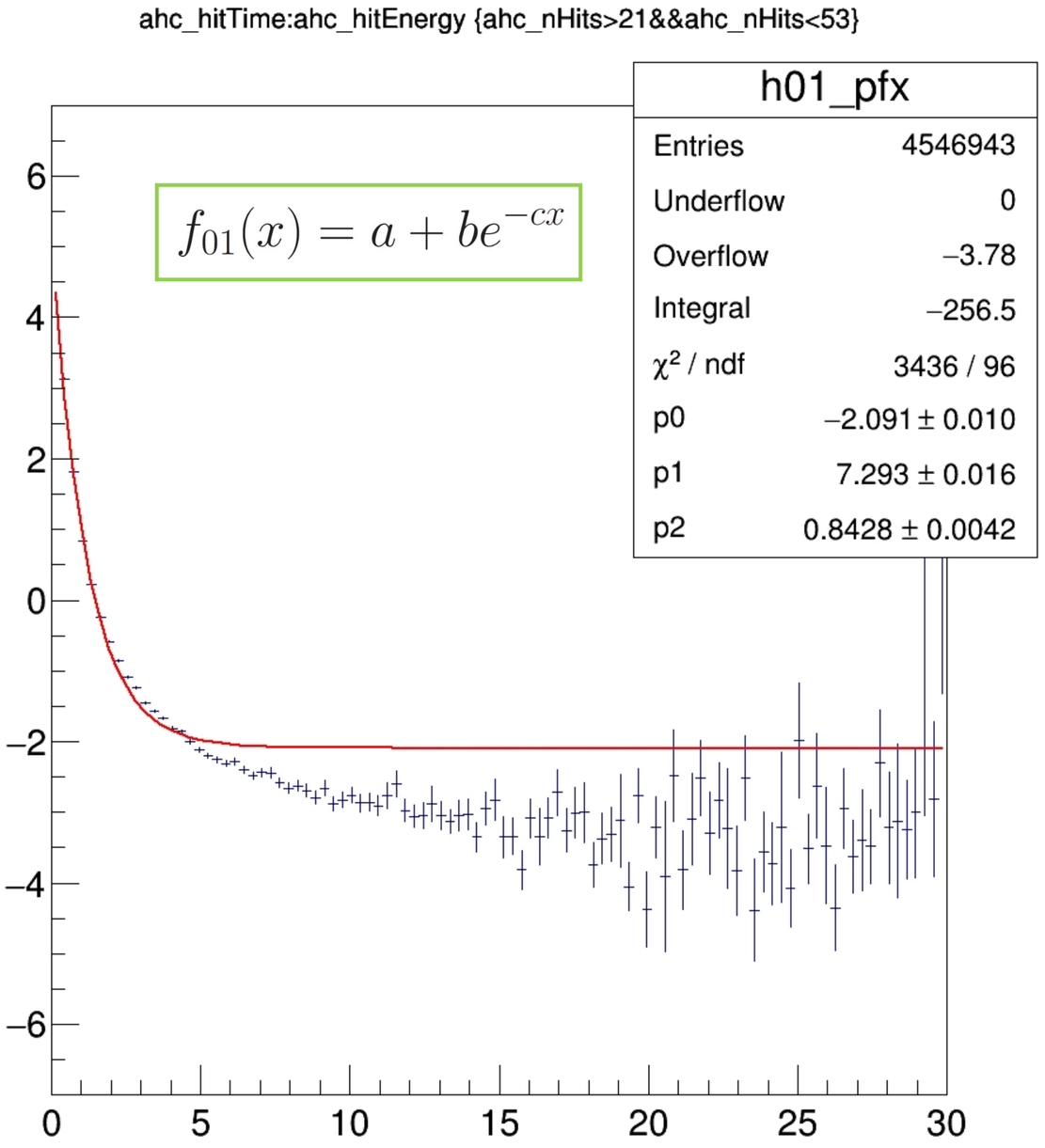
energy dependence

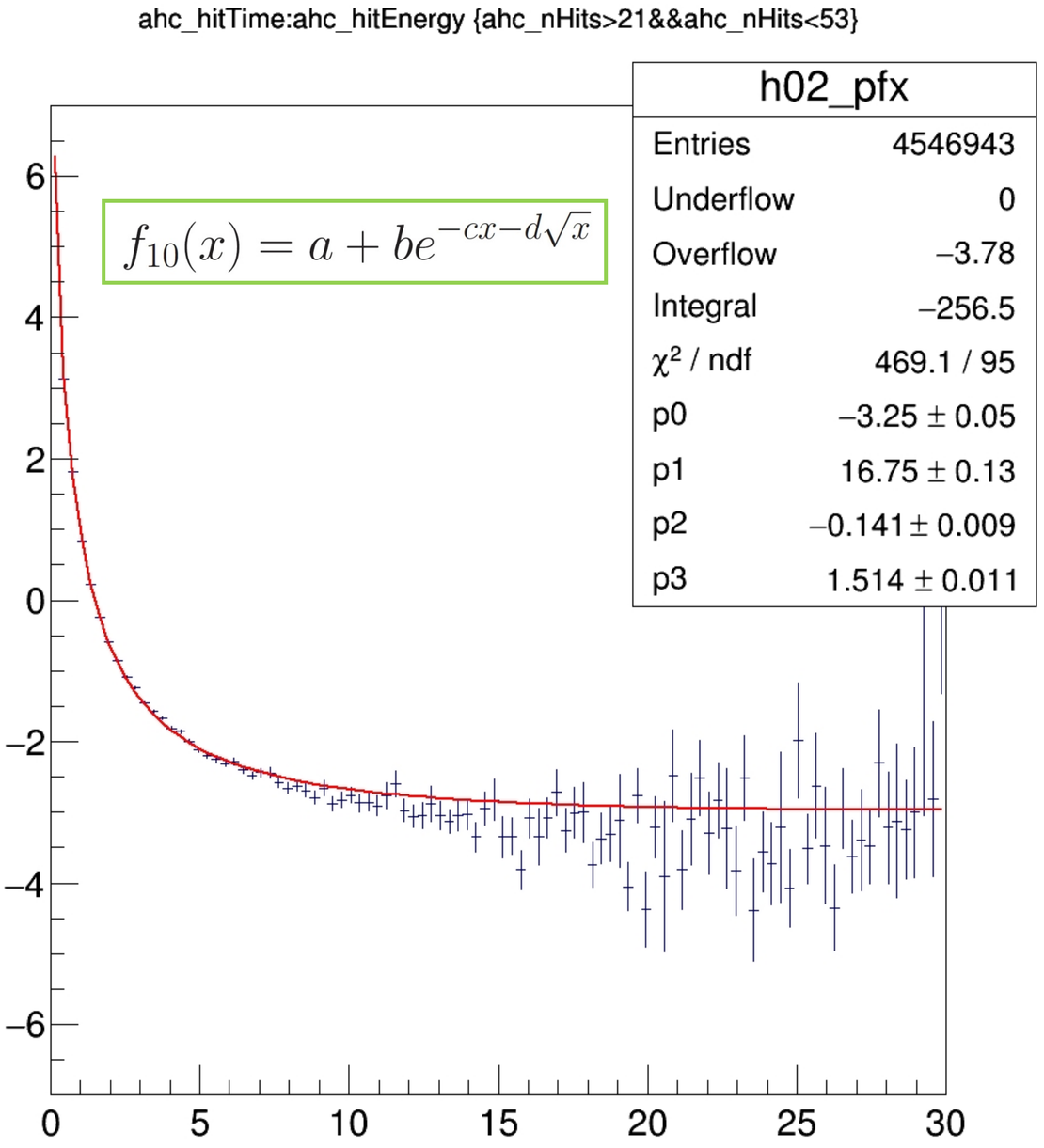
hit time vs energy

.. after correction

resolution ~10% better

Functions


ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}
$f_{01}(x) = a + be^{-cx}$
h01_pfx
Entries 4546943
Underflow 0
Overflow −3.78
Integral −256.5
χ² / ndf 3436 / 96
p0 −2.091 ± 0.010
p1 7.293 ± 0.016
p2 0.8428 ± 0.0042


ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}
$f_{10}(x) = a + be^{-cx-d\sqrt{x}}$
h02_pfx
Entries 4546943
Underflow 0
Overflow −3.78
Integral −256.5
χ² / ndf 469.1 / 95
p0 −3.25 ± 0.05
p1 16.75 ± 0.13
p2 −0.141 ± 0.009
p3 1.514 ± 0.011

Observations

The hit time response is strongly dependent on the hit energy.

It is ~ uniform across	modules,	38
	chips,	4 (out of 16 possible, more muon runs)
	channels,	36
	cells.	16

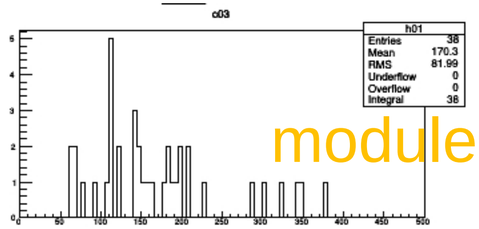
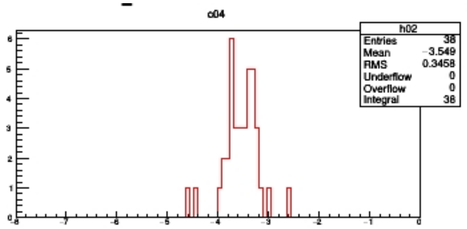
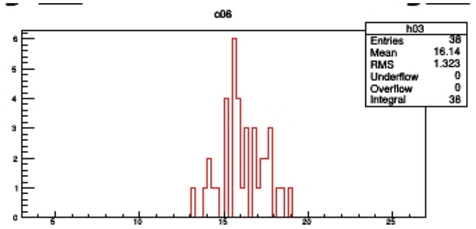
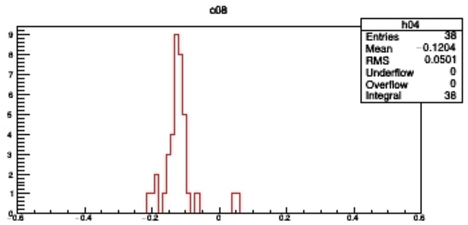
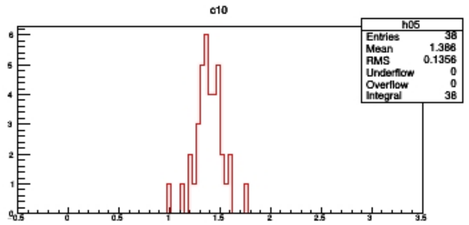
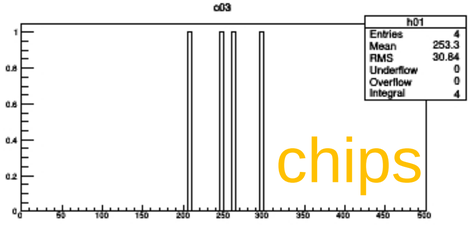
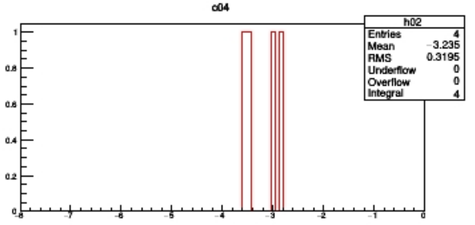
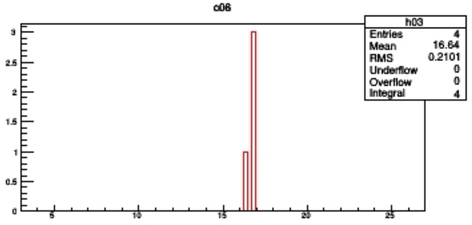
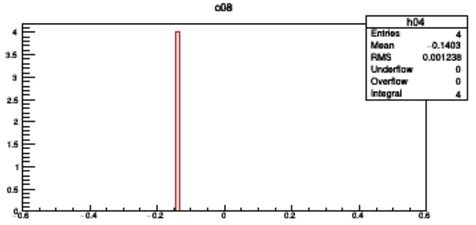
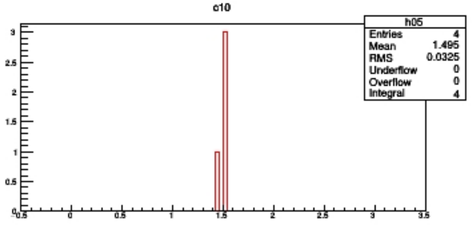
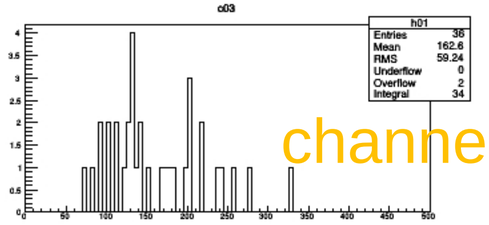
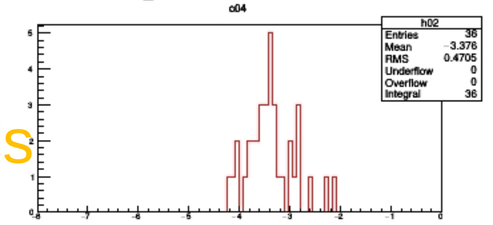
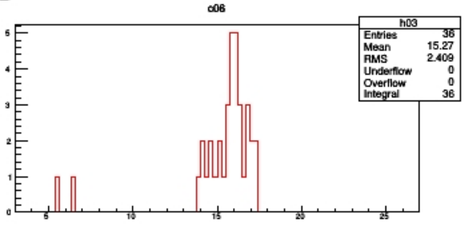
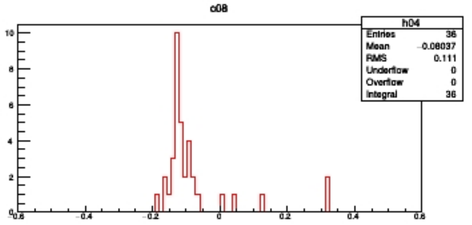
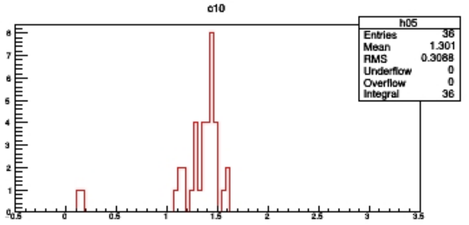
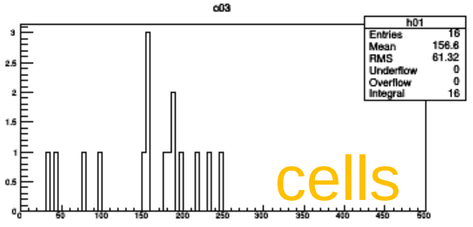
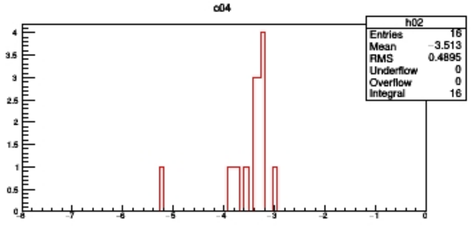
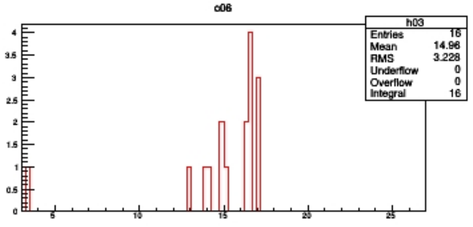
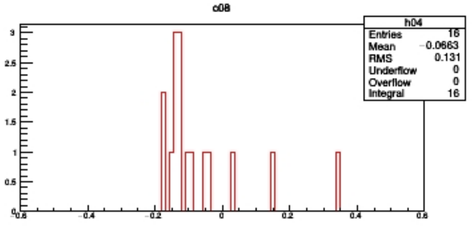
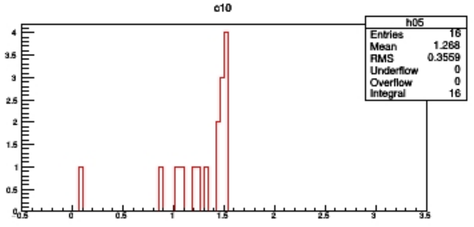
Not enough statistics for all 5472 combinations module x chip x channel.

See next 3 slides on how to ascertain the issue.

A functional form should be usable to correct the time: $f_{10}(x) = a + be^{-cx-d\sqrt{x}}$

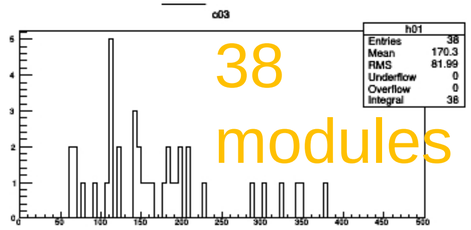
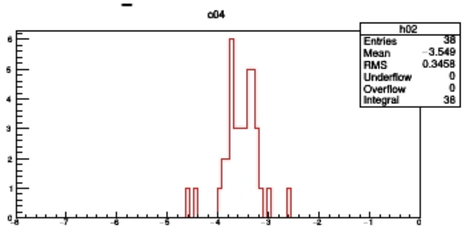
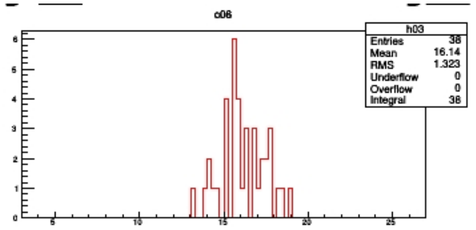
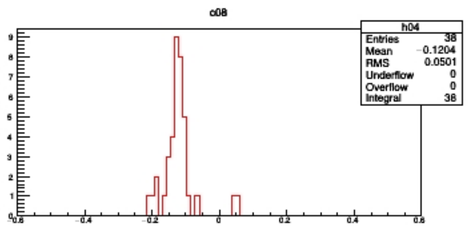
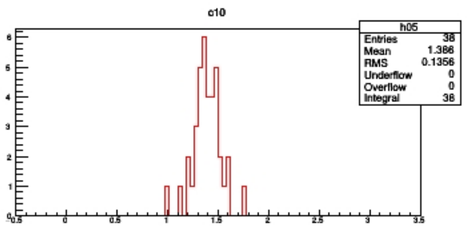
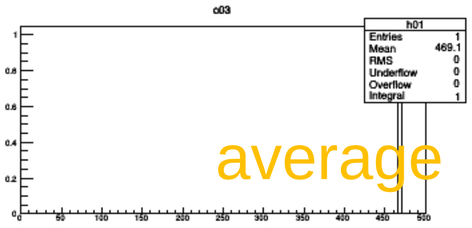
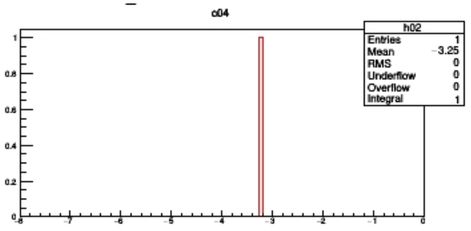
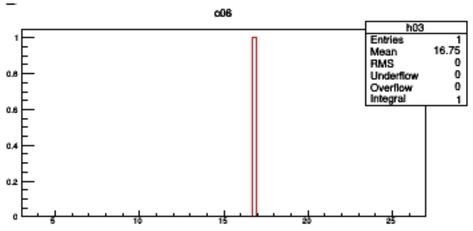
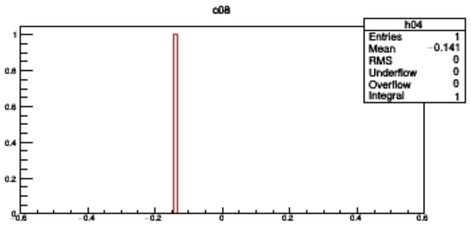
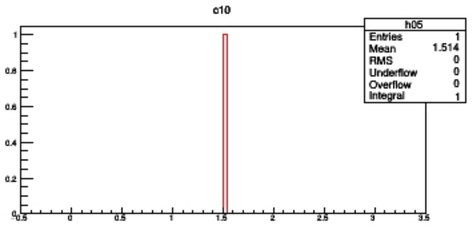
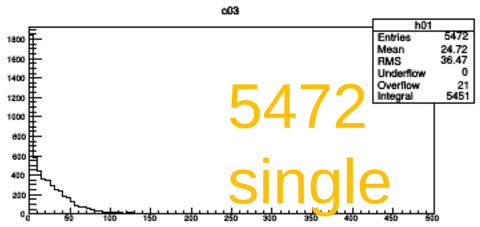
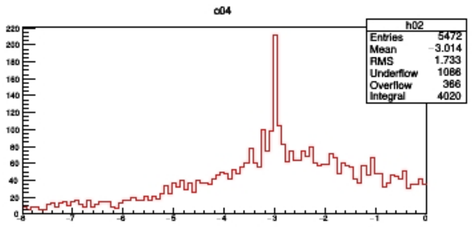
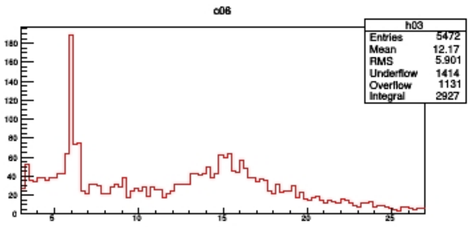
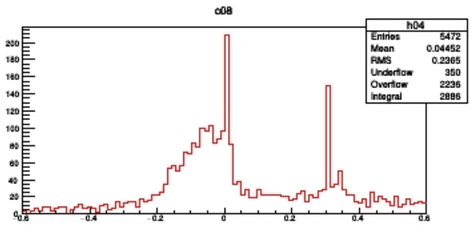
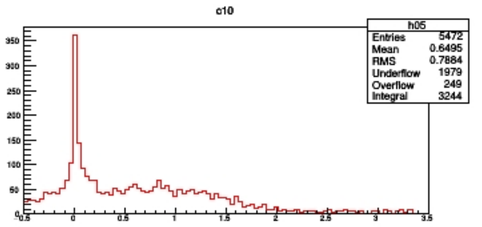
Fit Results

$$f_{10}(x) = a + be^{-cx-d\sqrt{x}}$$

χ^2	a	b	c	d
modules					
chips					
channels					
cells					

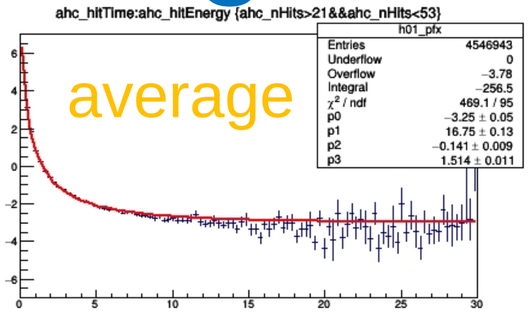
Fit Results

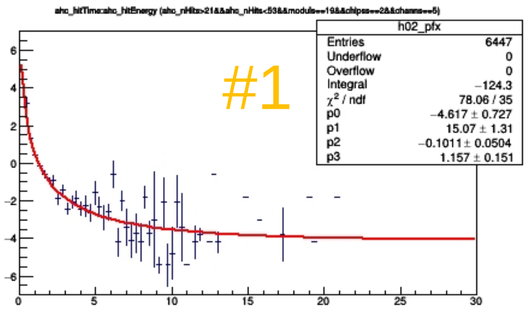
$$f_{10}(x) = a + be^{-cx-d\sqrt{x}}$$

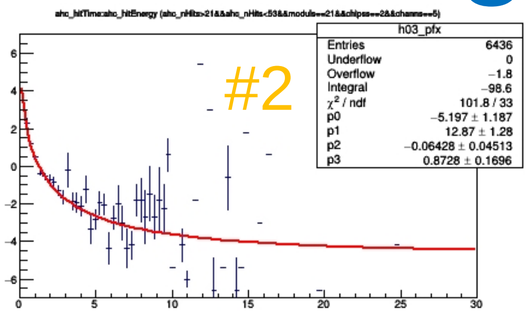
χ^2	a	b	c	d
38 modules					
average					
5472 single channels					

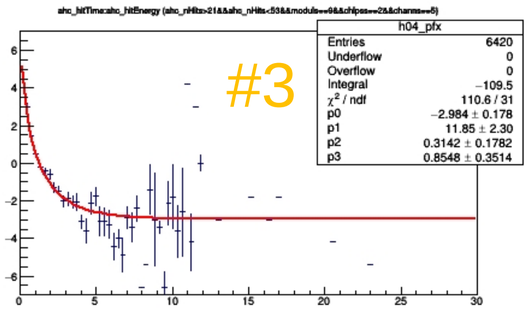
often very low statistics, see next slide

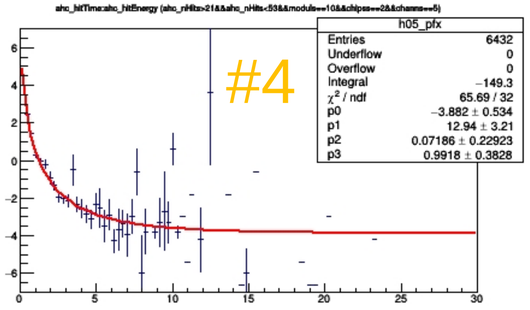
Single Channel Fits with Largest Statistics

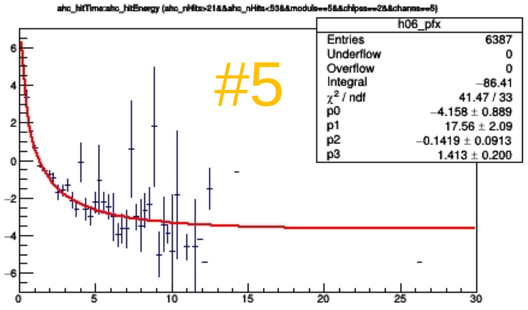


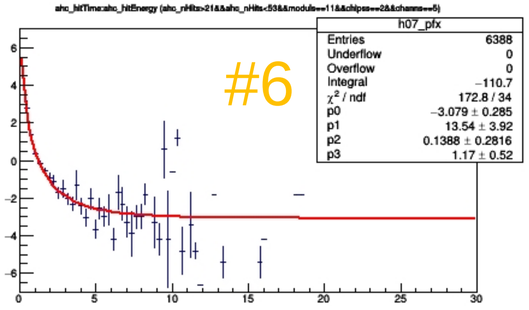


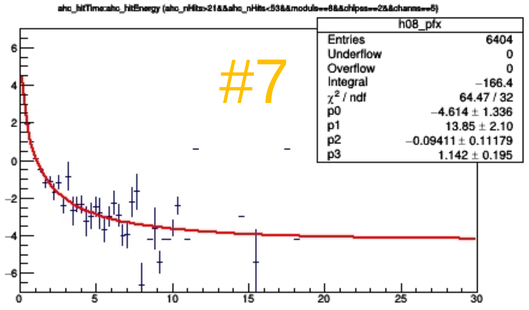


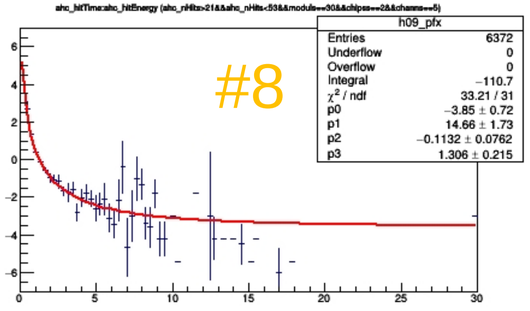


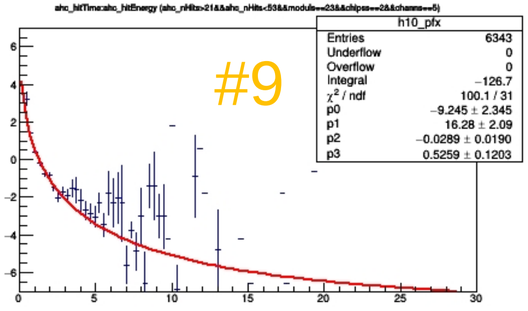


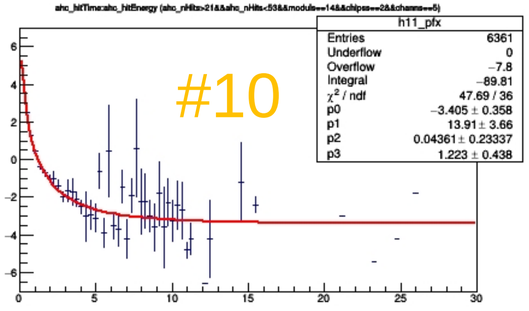


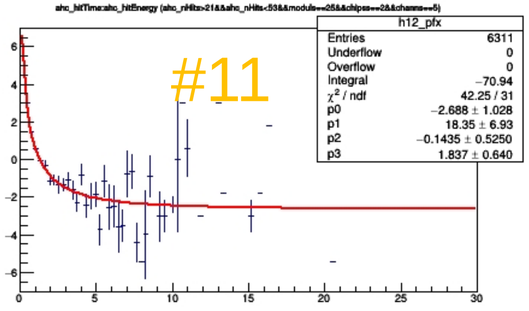








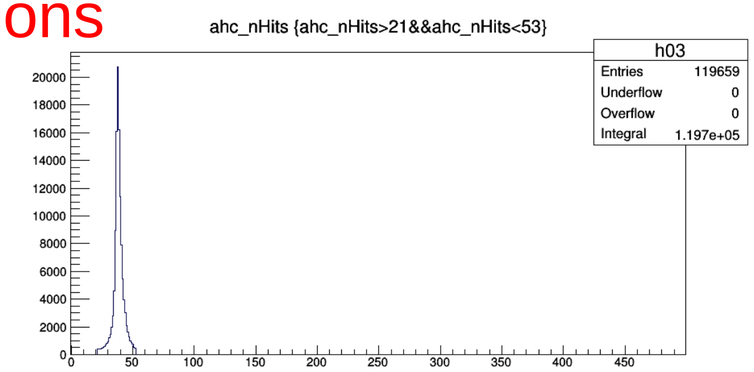


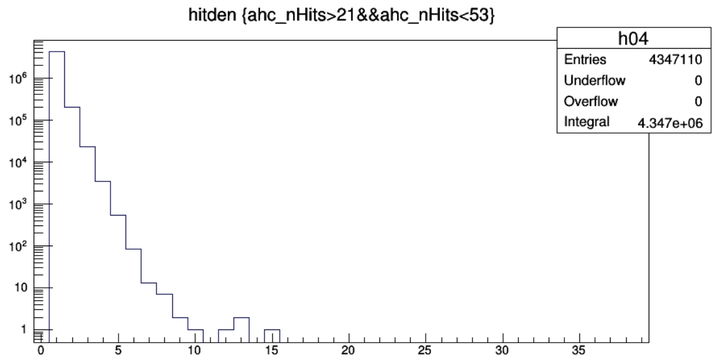


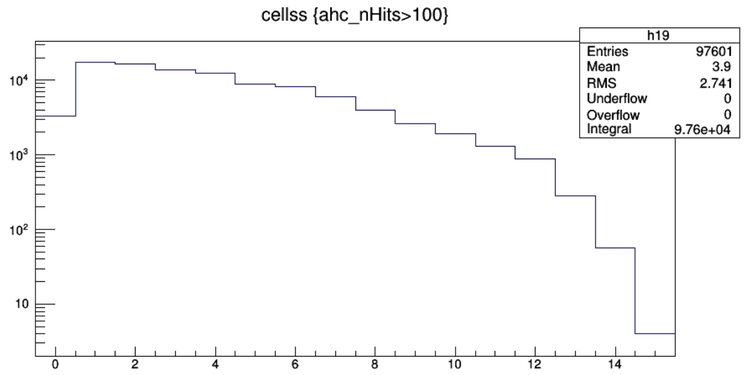
Occupancy and Cell Number

occupancy = hit density per single channel
cell number = position in channel at readout time

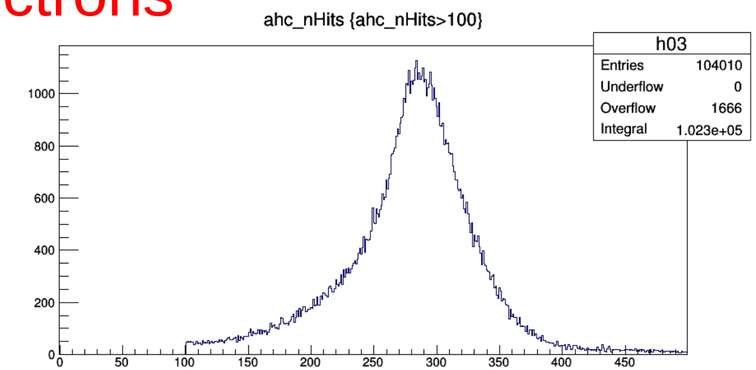
muons

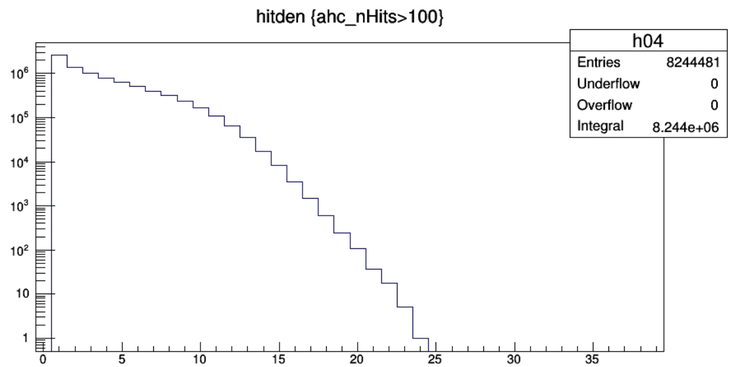


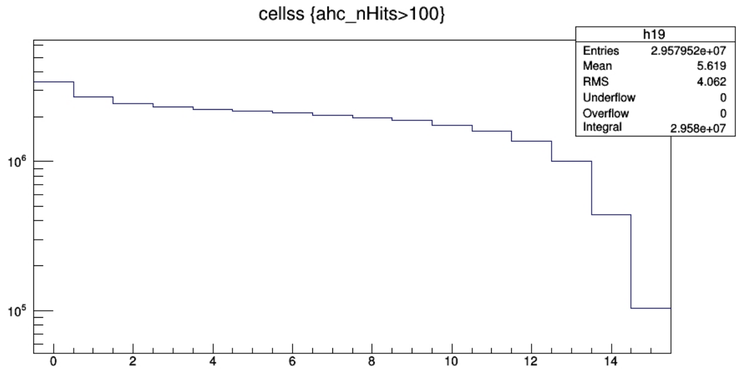




electrons





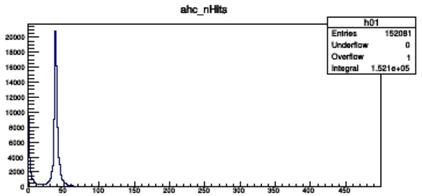


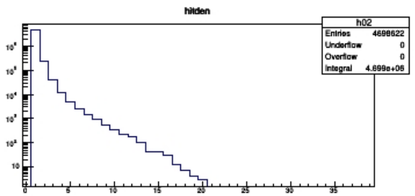
nHits

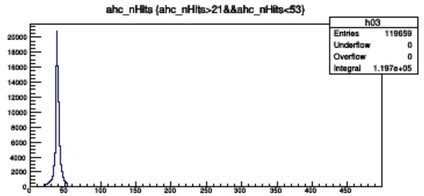
occupancy

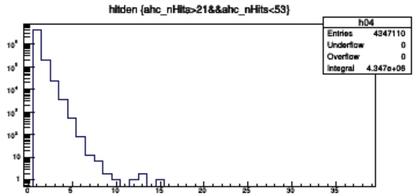
cell#

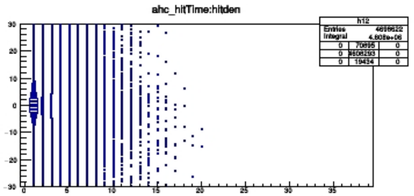
Muons - Occupancy

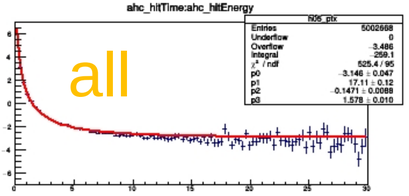




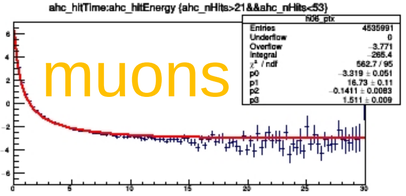




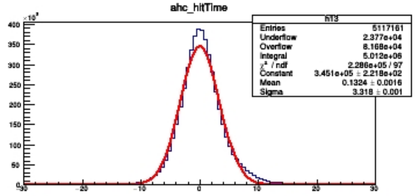


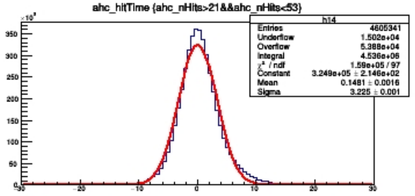


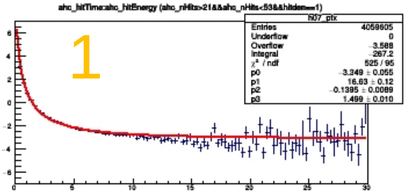
all



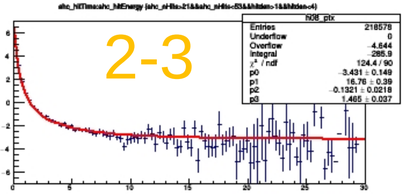
muons



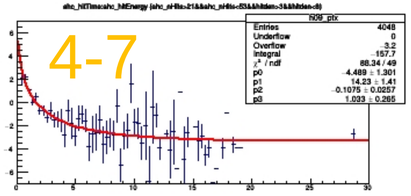




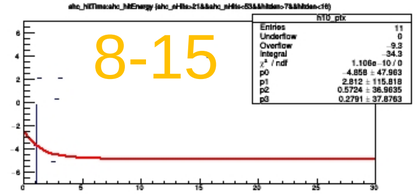
1



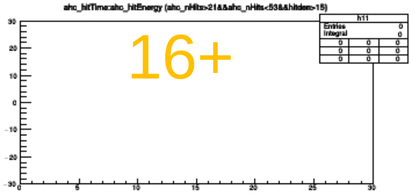
2-3



4-7

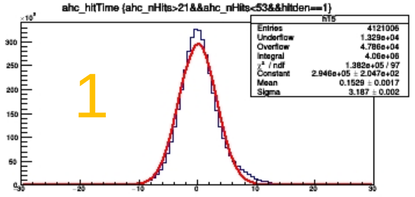


8-15

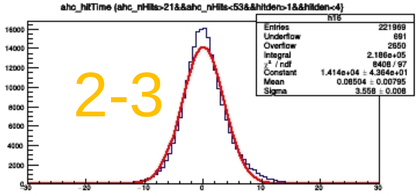


16+

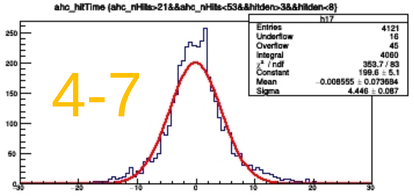
time vs E



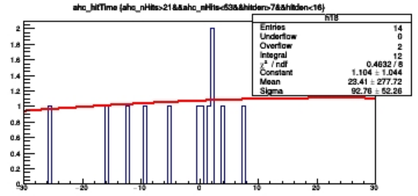
1

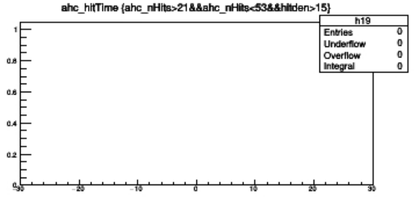


2-3



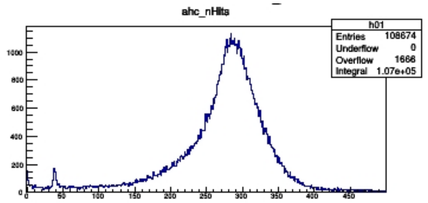
4-7

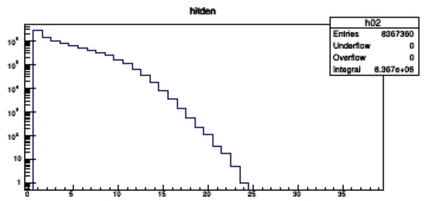


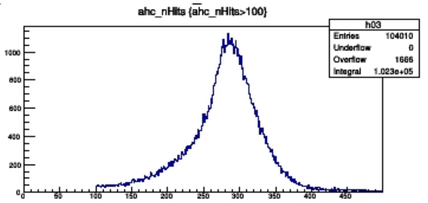


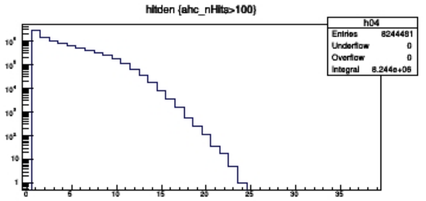
resolution

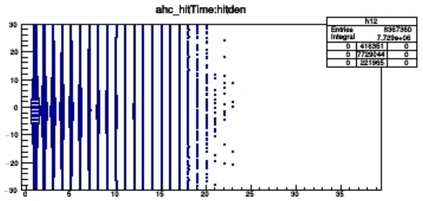
Electrons - Occupancy

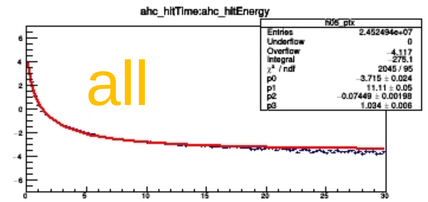




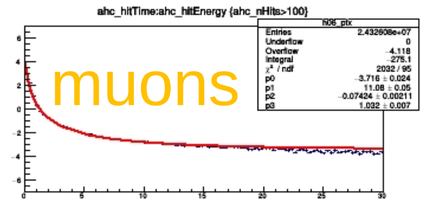




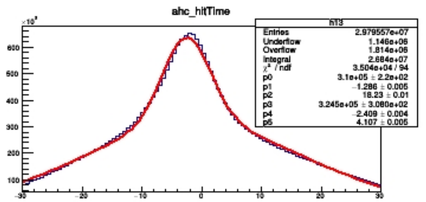


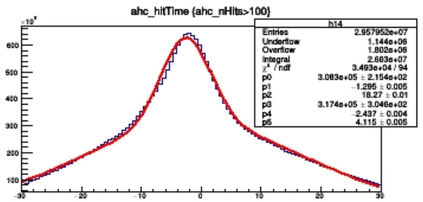


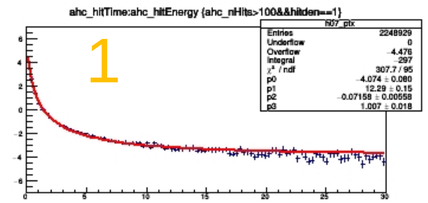
all



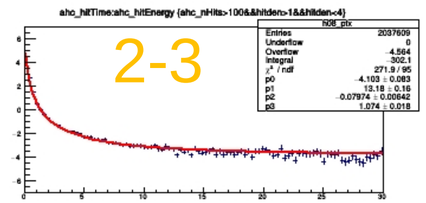
muons



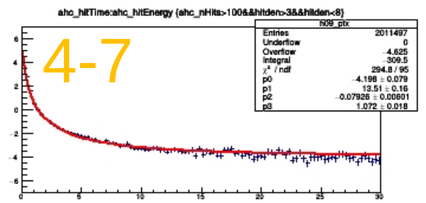




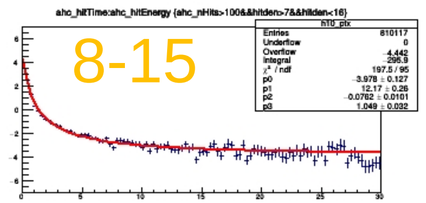
1



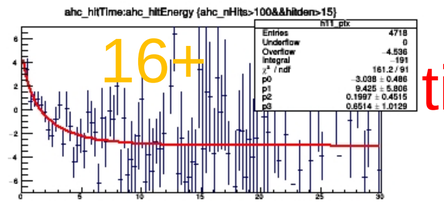
2-3



4-7

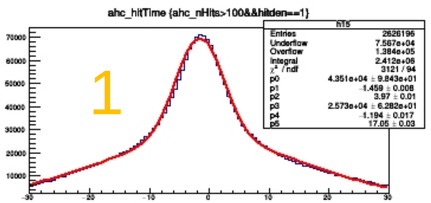


8-15

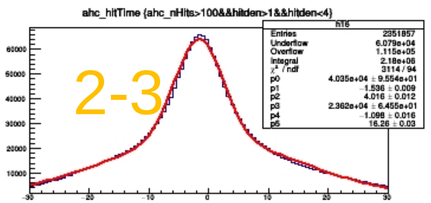


16+

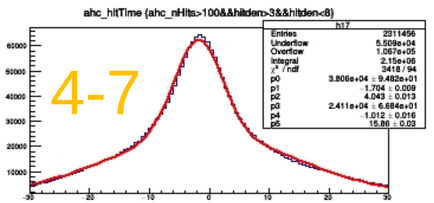
time vs E



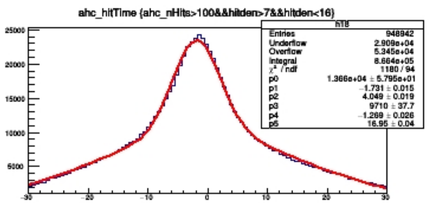
1

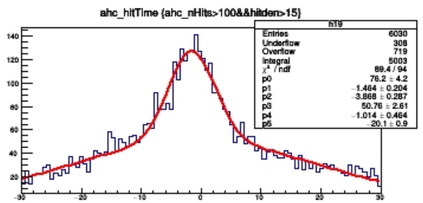


2-3



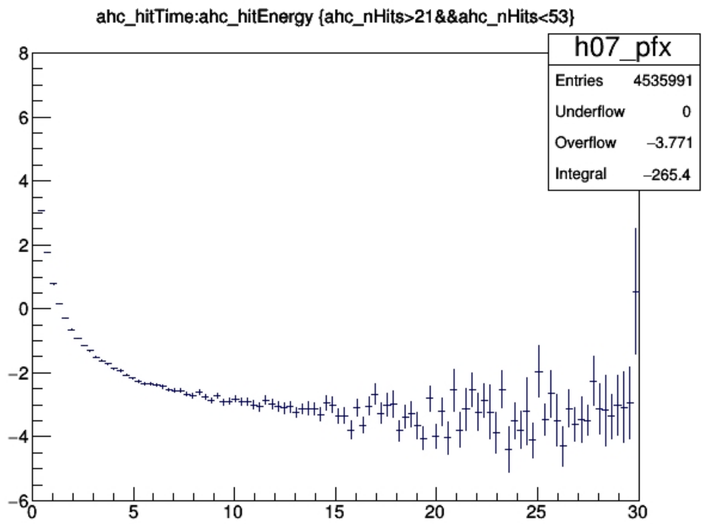
4-7

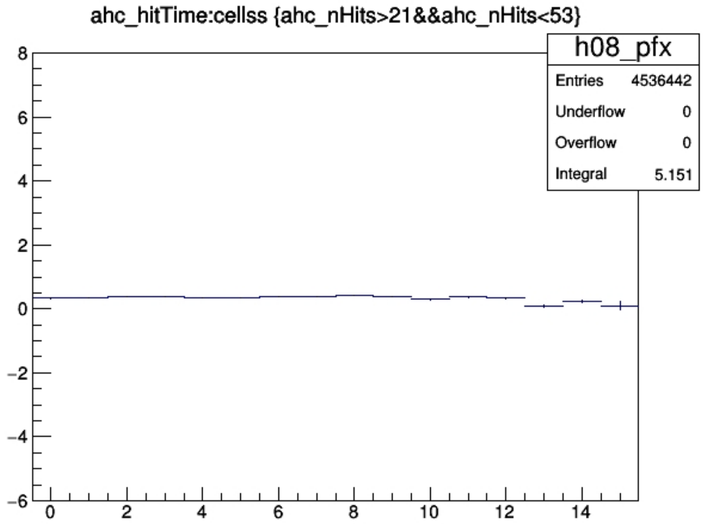


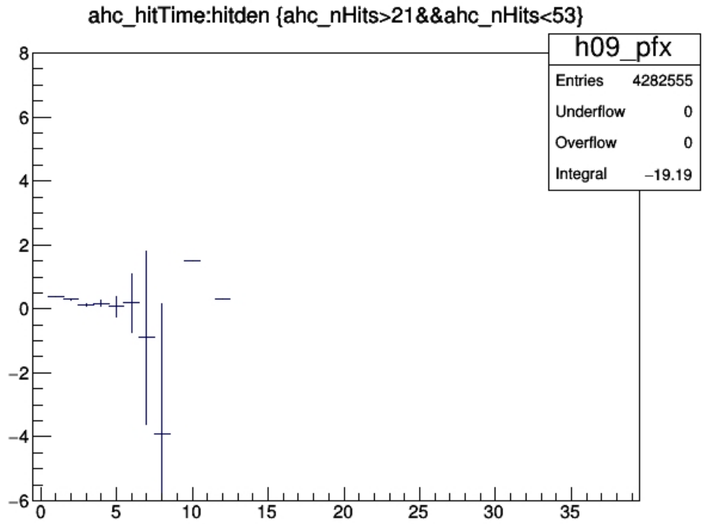


resolution

Time Dependencies - Muons

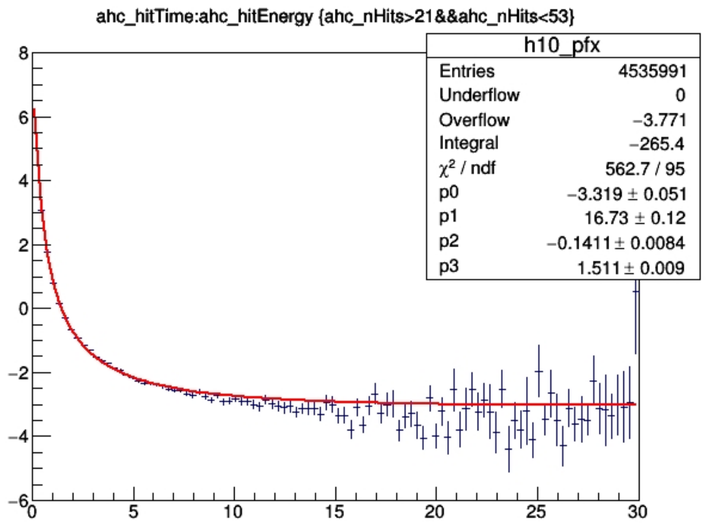


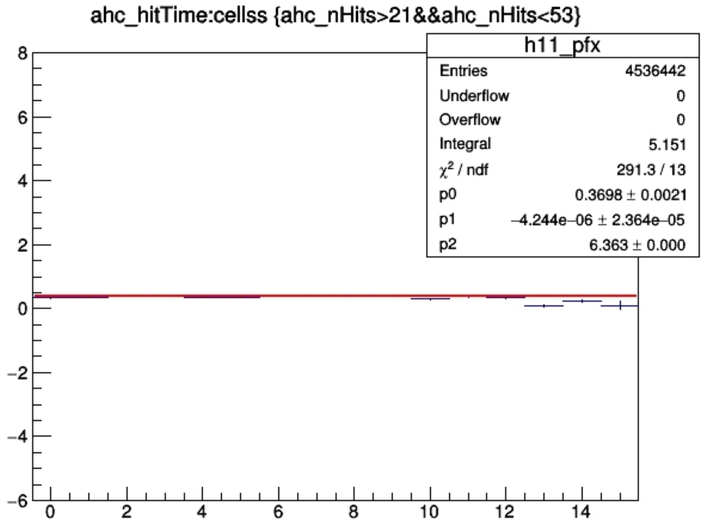


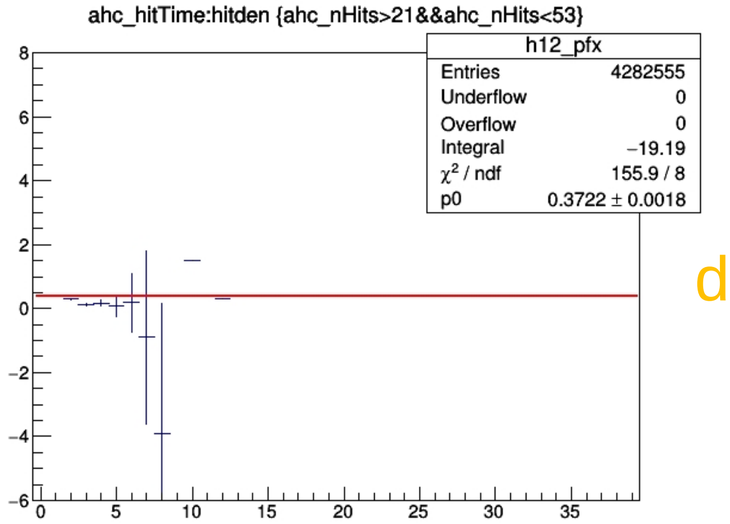


data

vs Energy **vs Cell#** **vs Occupancy**

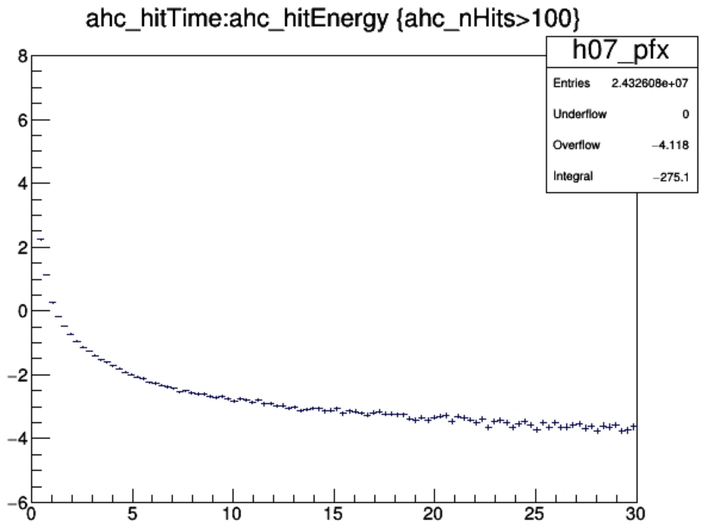


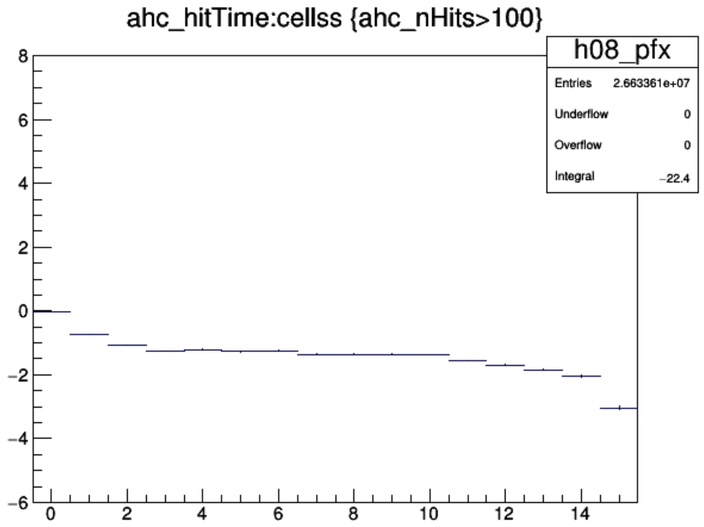


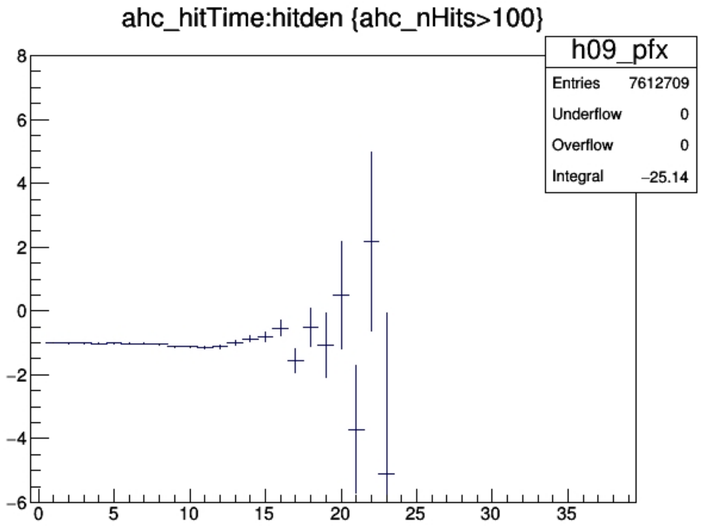


data+fit

Time Dependencies - Electrons

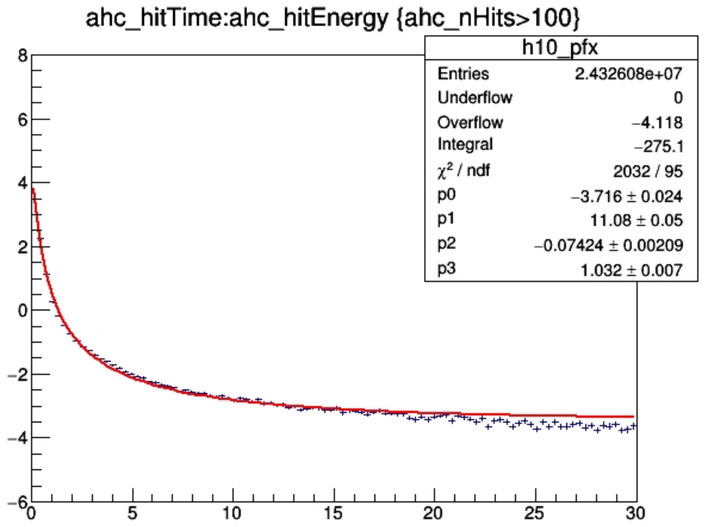


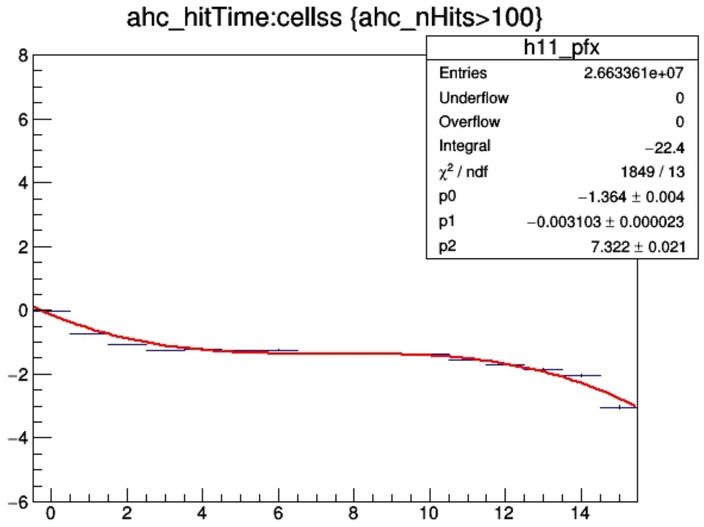


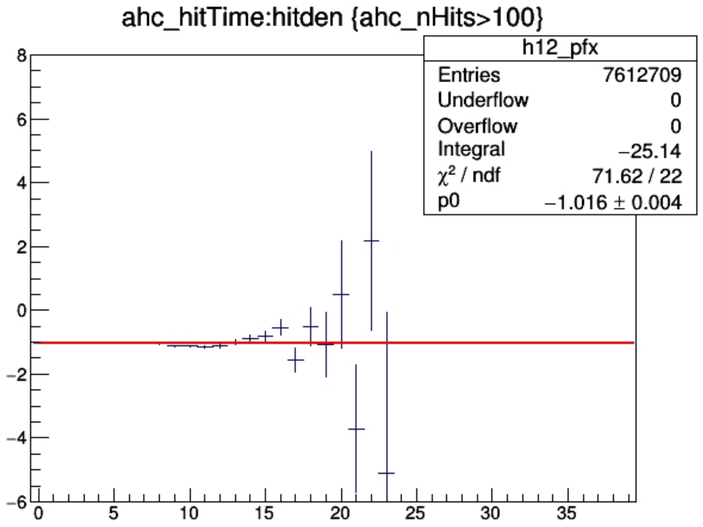


data

vs Energy **vs Cell#** **vs Occupancy**







data+fit

Summary

Hit time response seems to be:

- very strongly dependent on hit energy (due to time walk / threshold), but similar for all types of particles
- somewhat dependent on cell number within channel at readout, especially for busy events such as electron showers
- almost independent on occupancy/hit density within a single channel ?

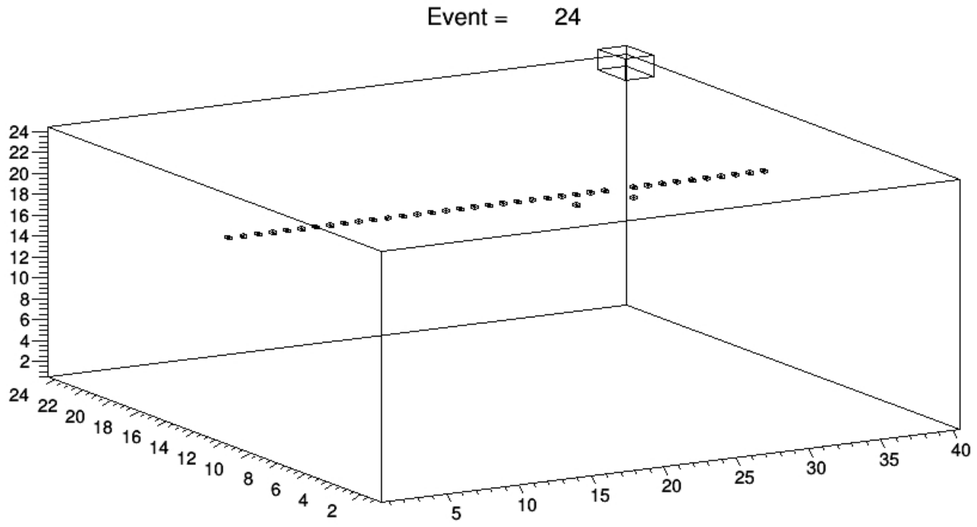
A robust functional form for the time walk is proposed.

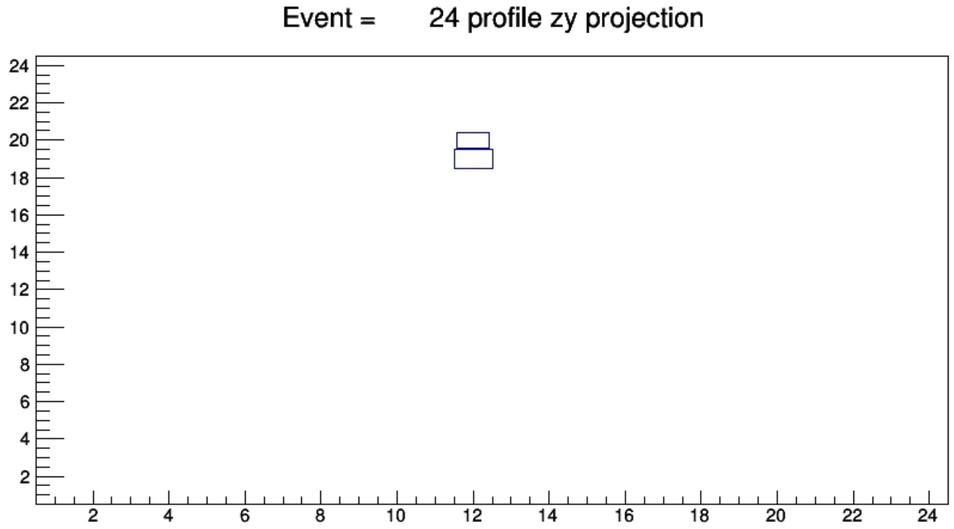
Other observations should be confirmed.

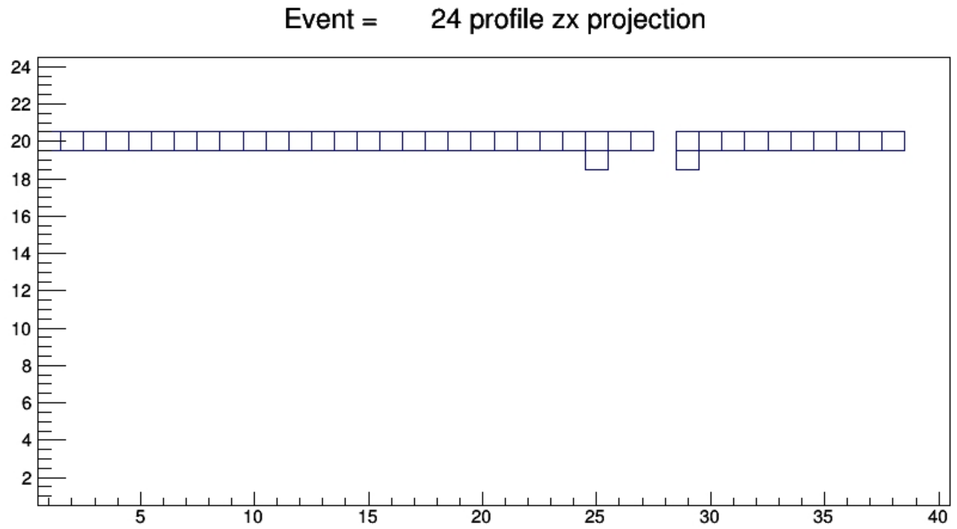
More reprocessed muon data available soon to cover all chips.

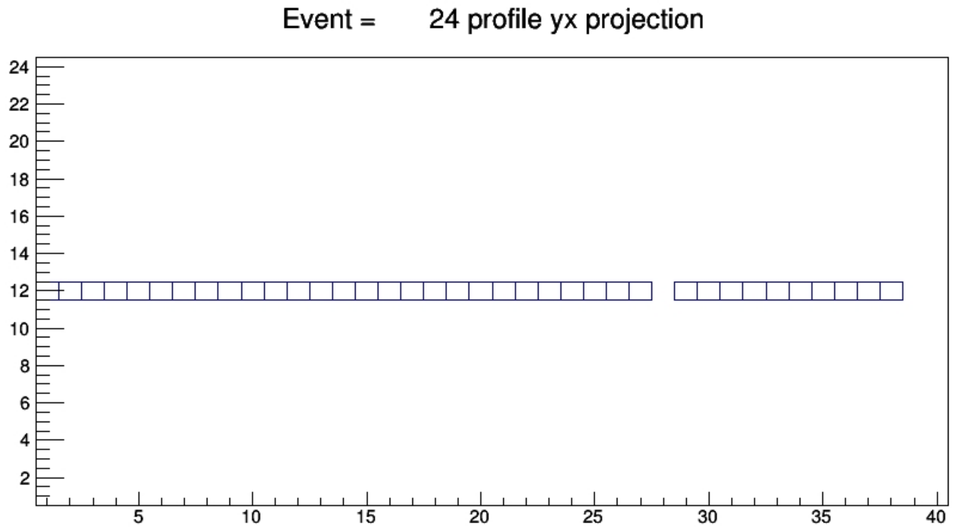
Backup

Muon Event

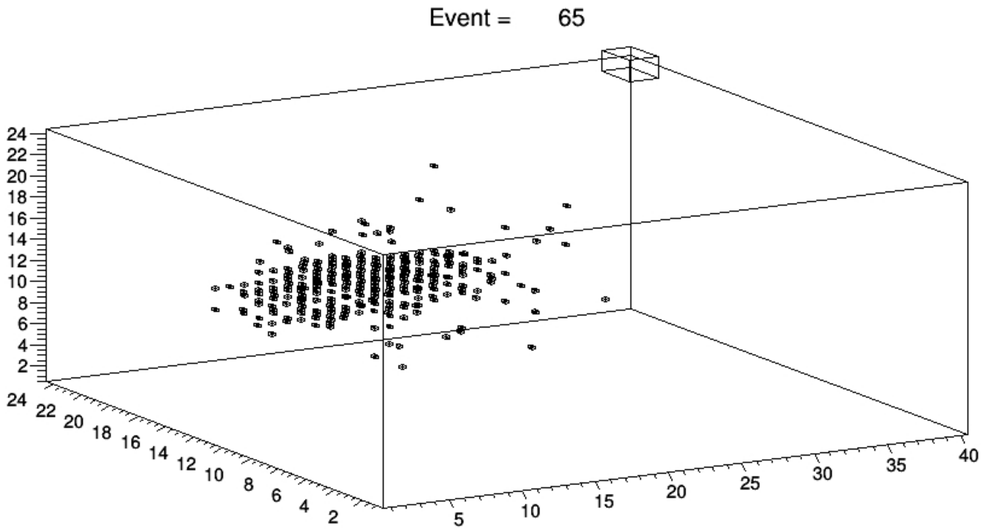

Event = 24

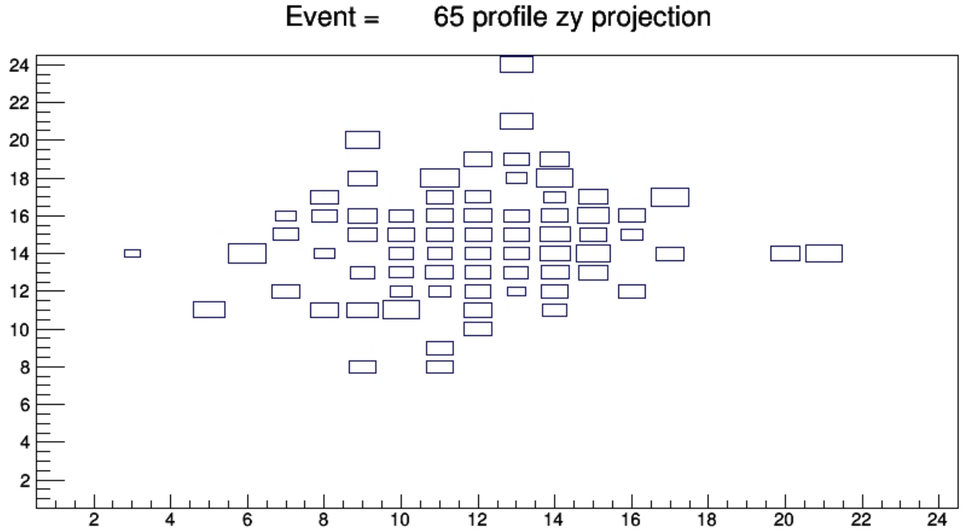

Event = 24 profile zy projection

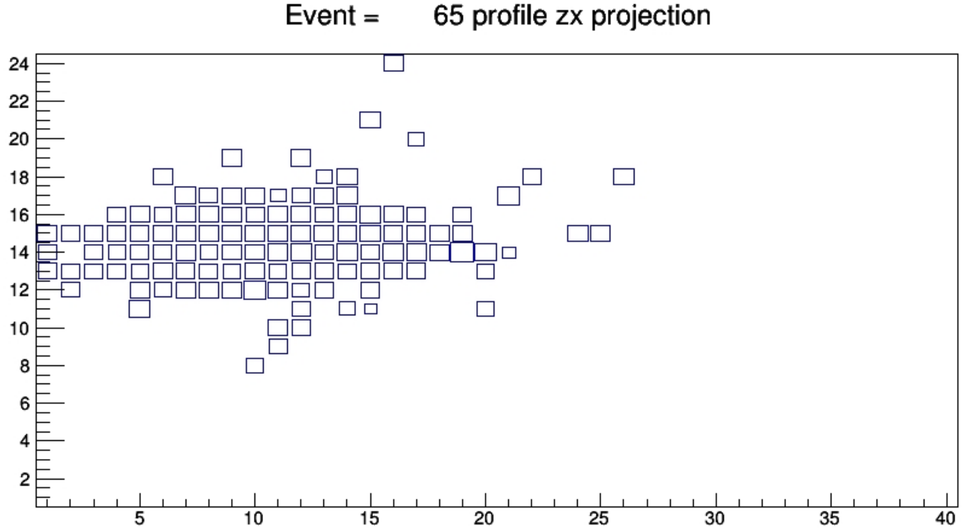

Event = 24 profile zx projection

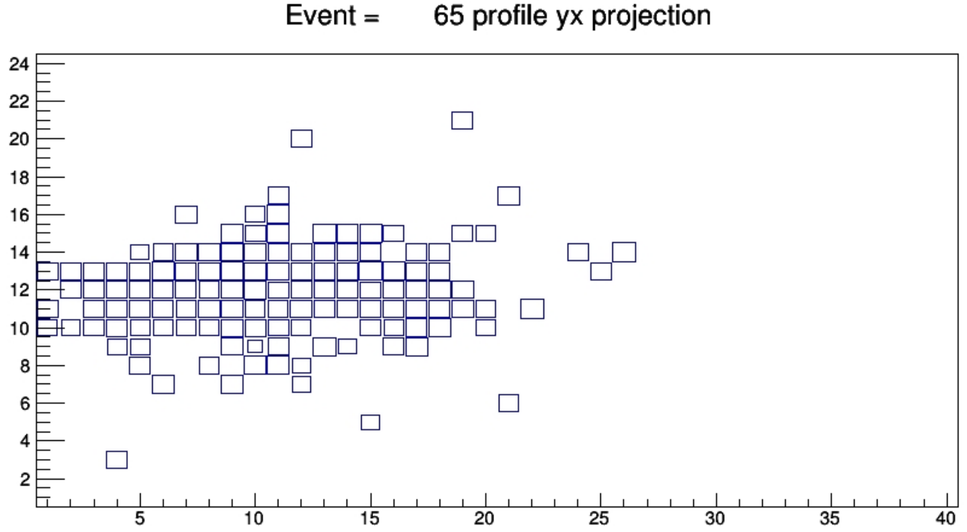

Event = 24 profile yx projection

Electron Event

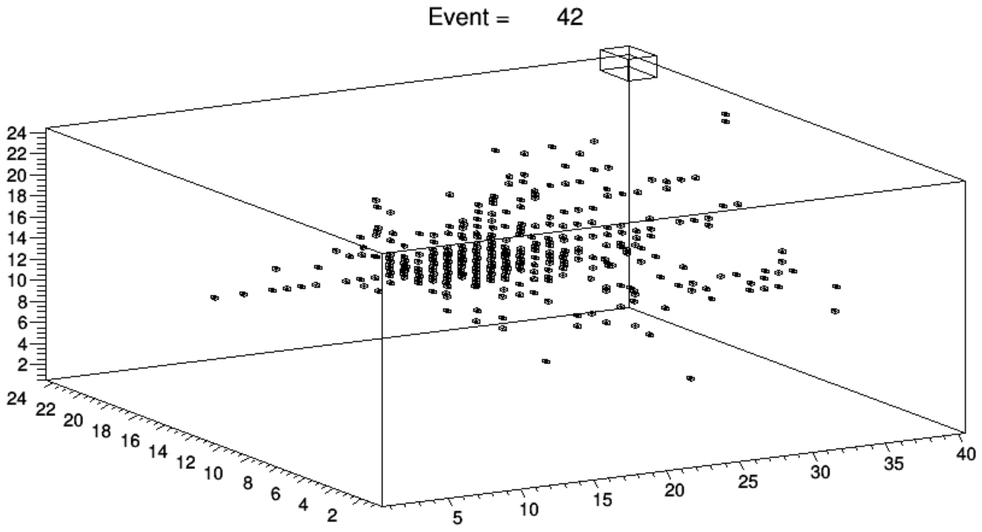


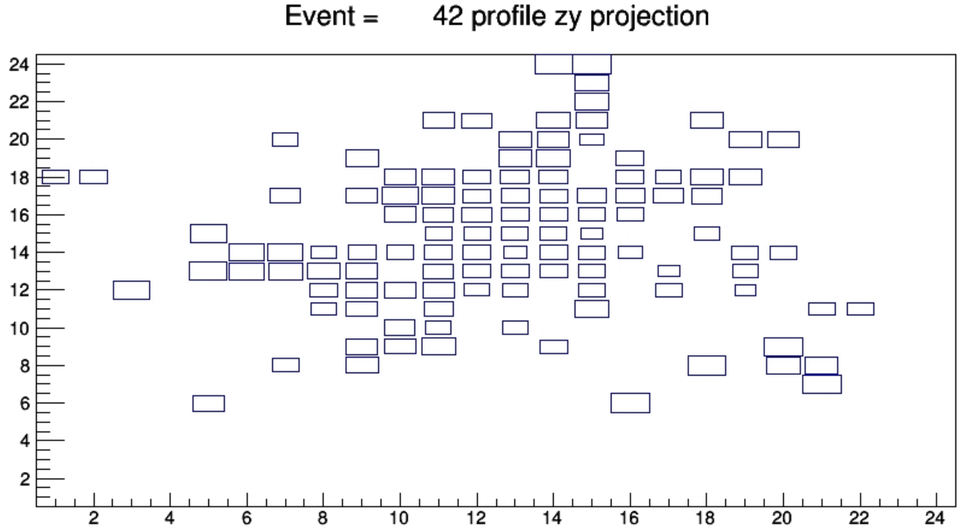


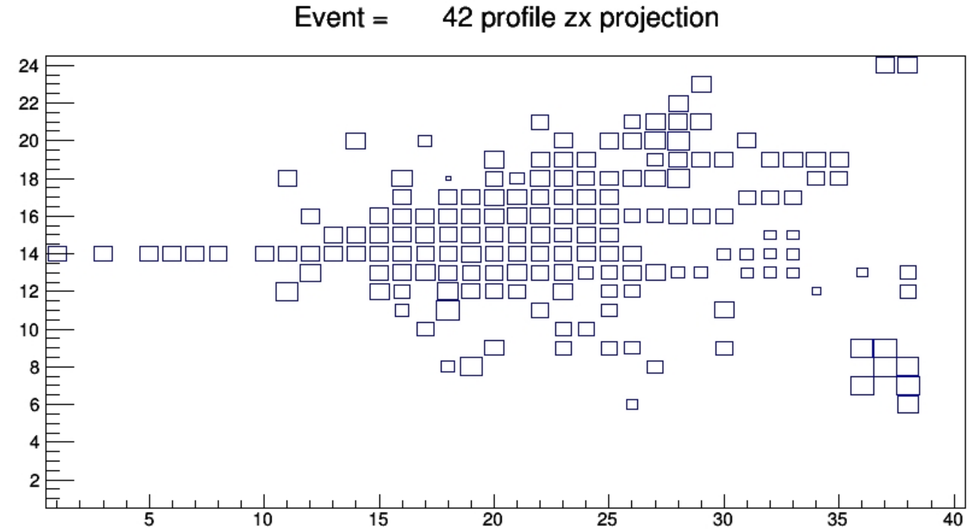


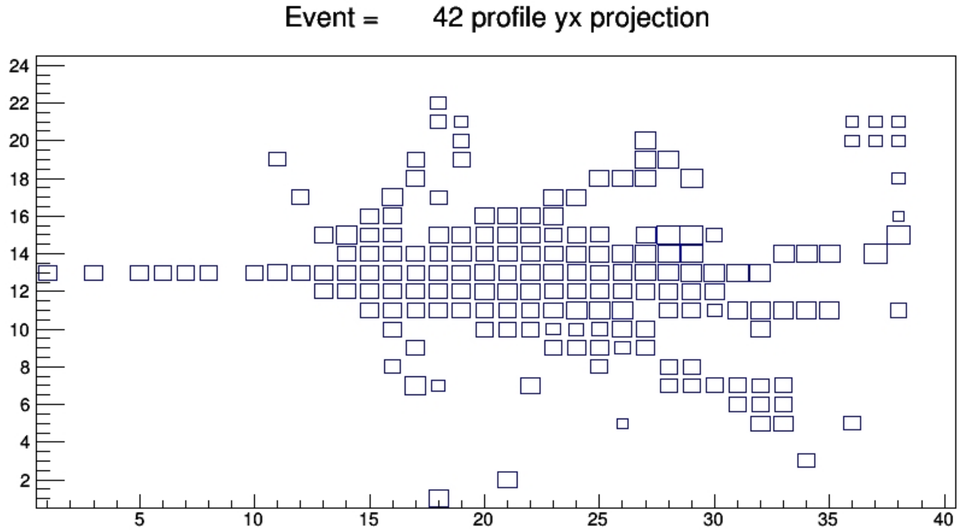


Pion Event


Event = 42


Event = 42 profile zy projection


Event = 42 profile zx projection


Event = 42 profile yx projection