

AHCAL Time Response Analysis 3



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IPP / McGill University
Supported by DAAD and MPP

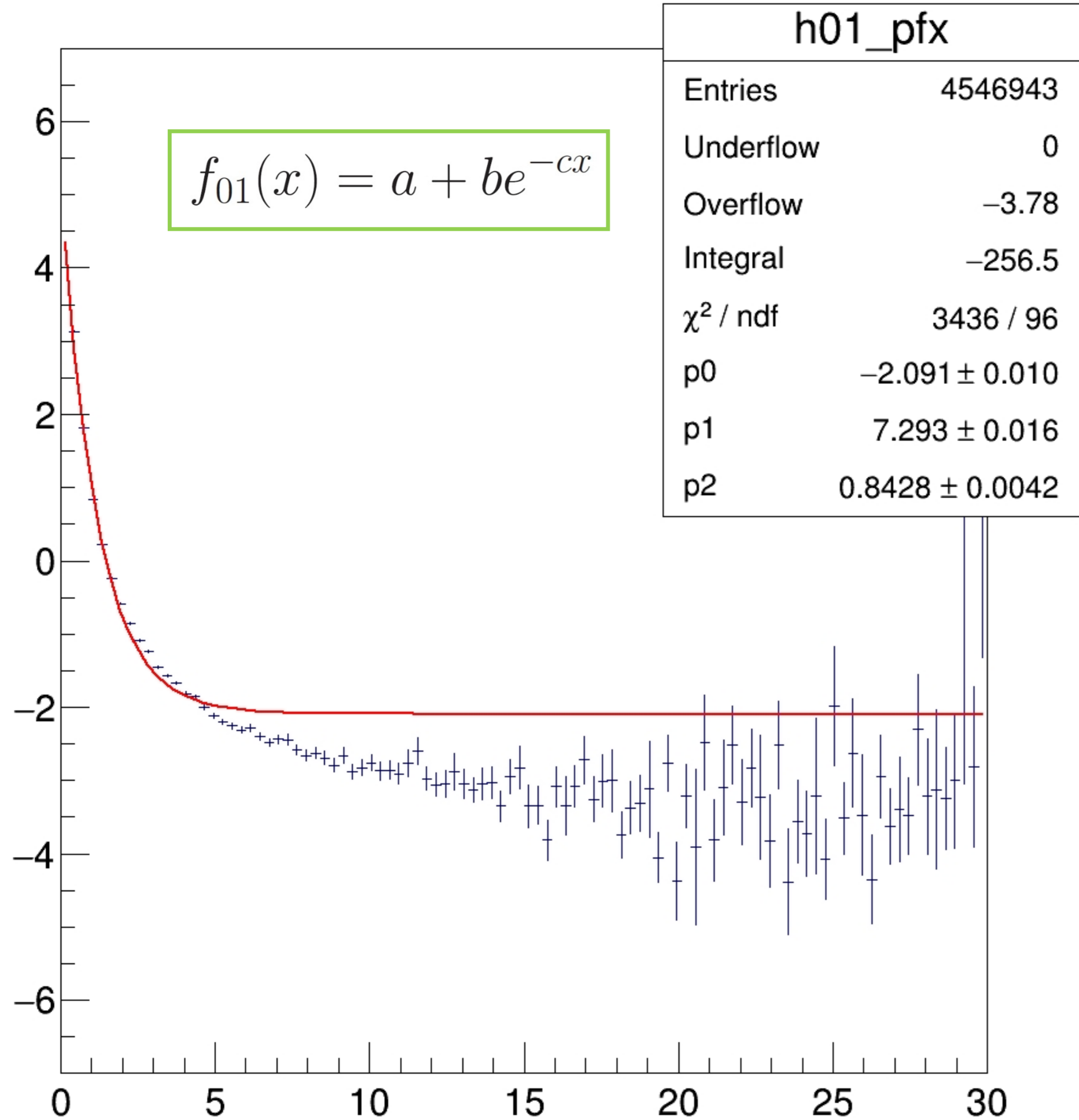
DAAD

2019.07.29

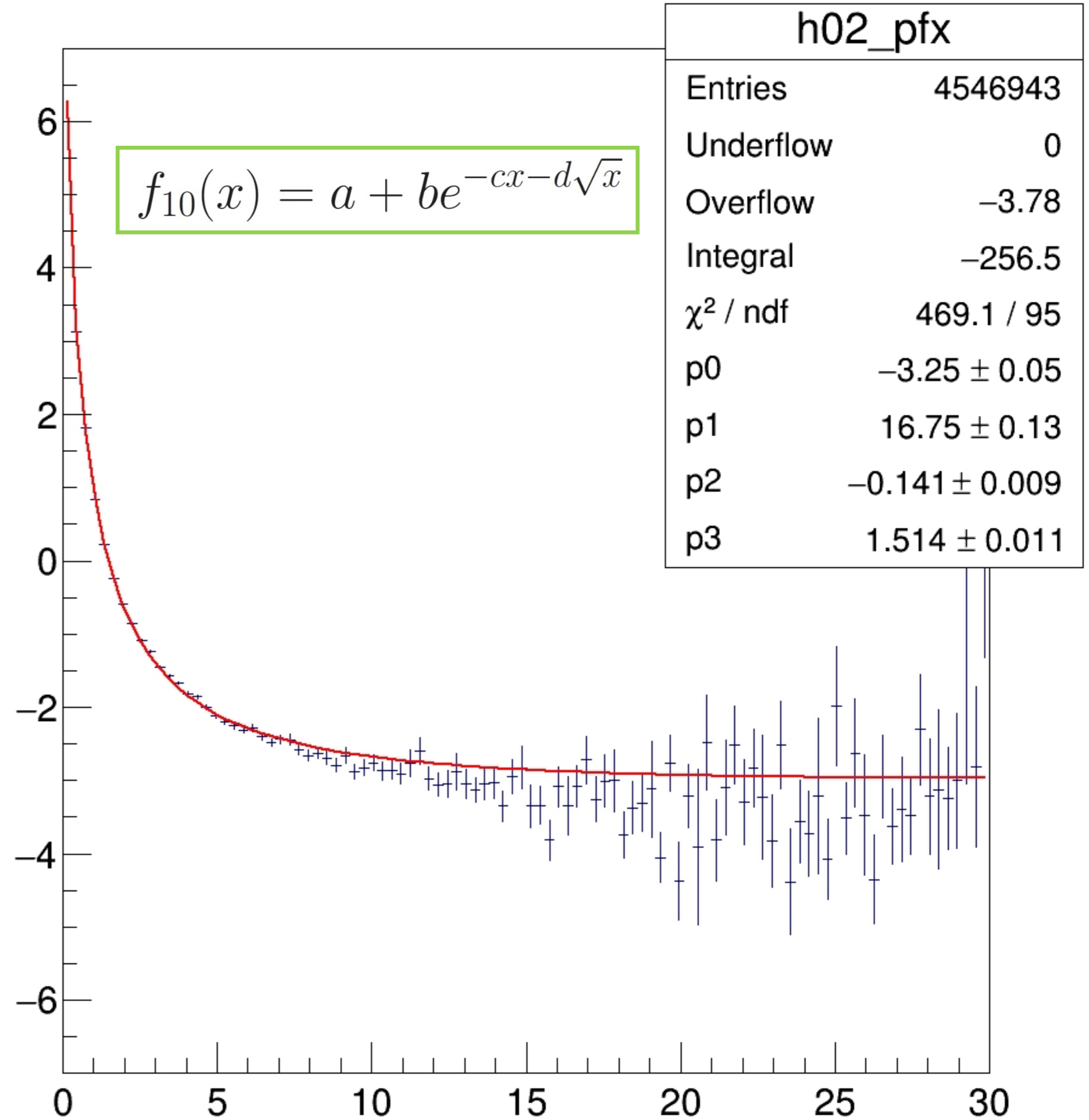


Time Walk Functions

ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}



ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}

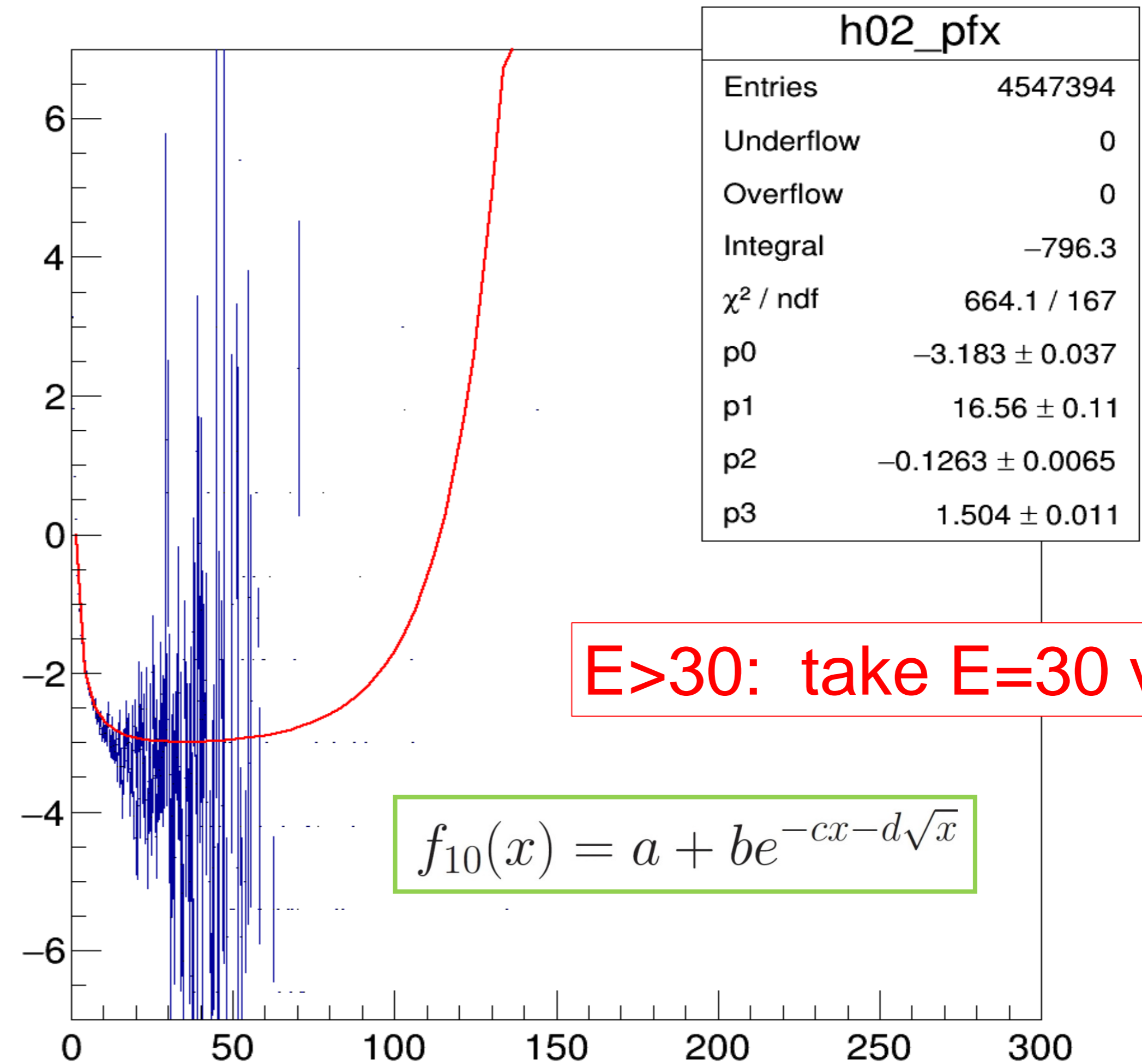
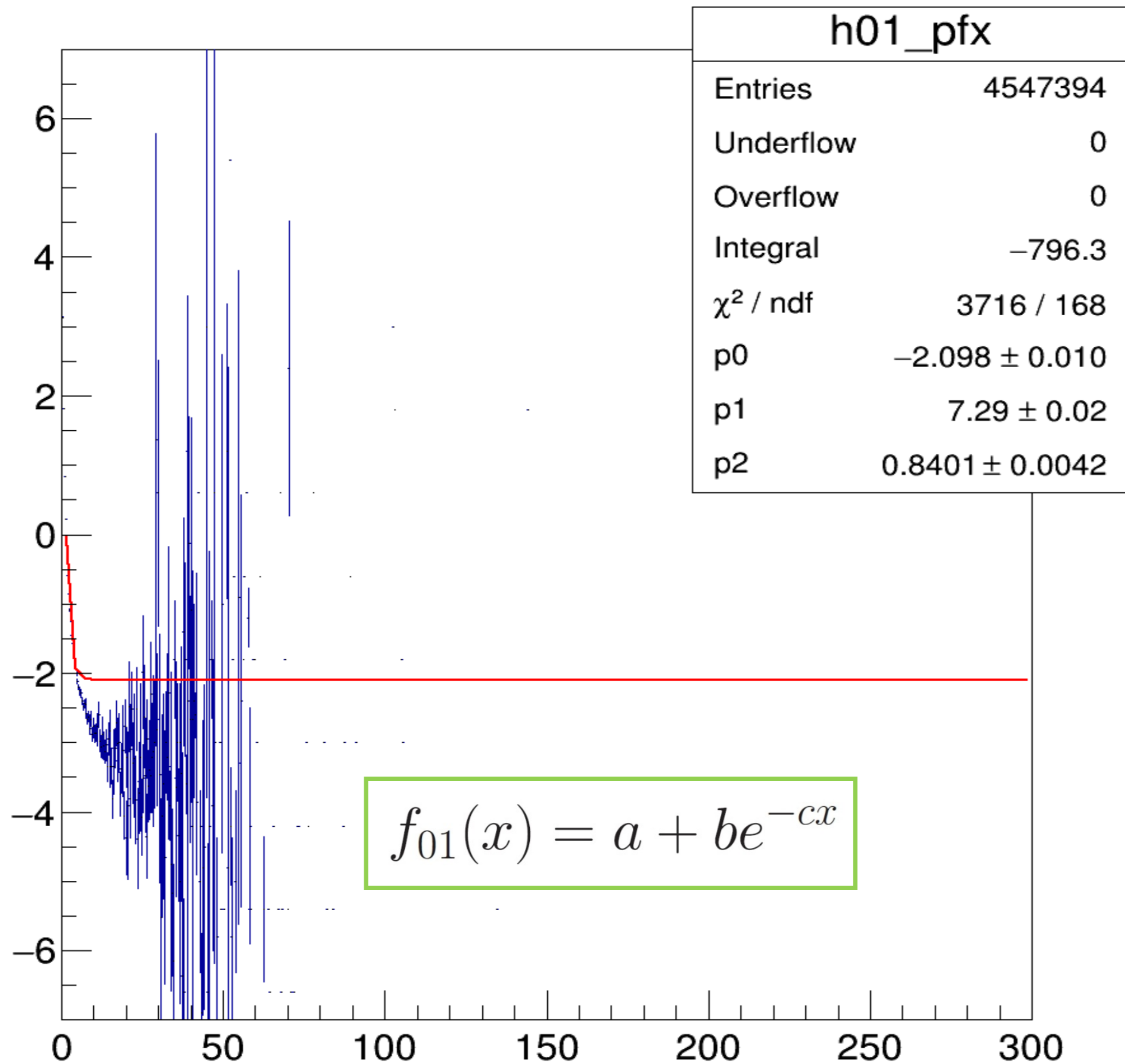


Wider Range

vsenergy_20190709r_hitTimevsEne reco_run60382_testNewConstants.rc

ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}

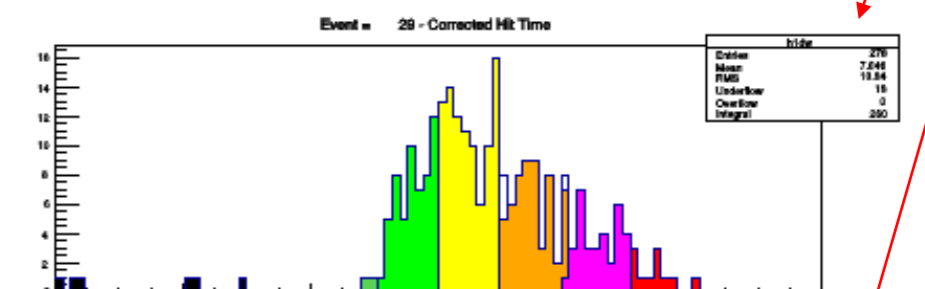
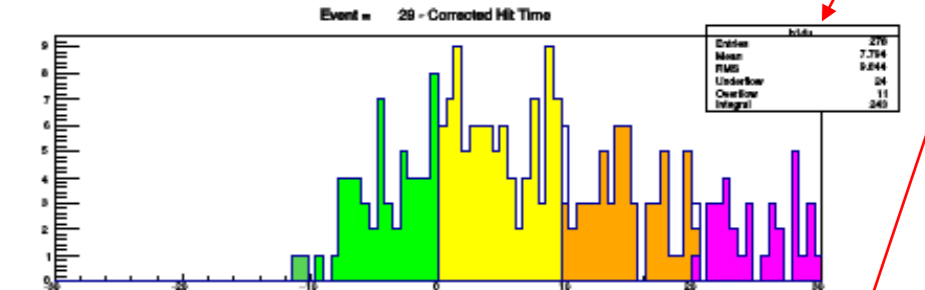
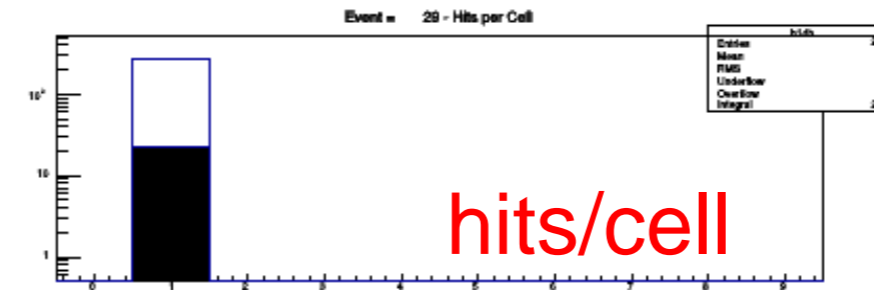
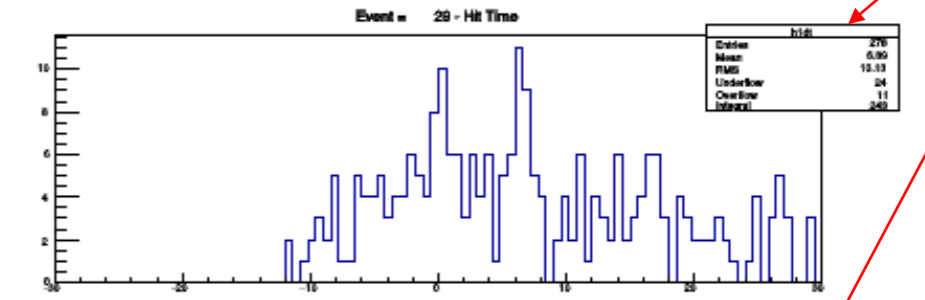
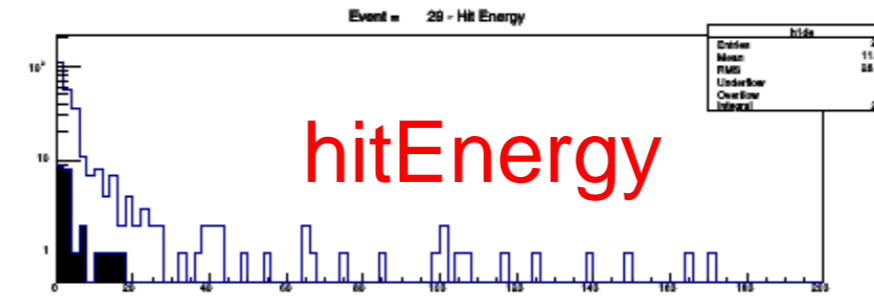
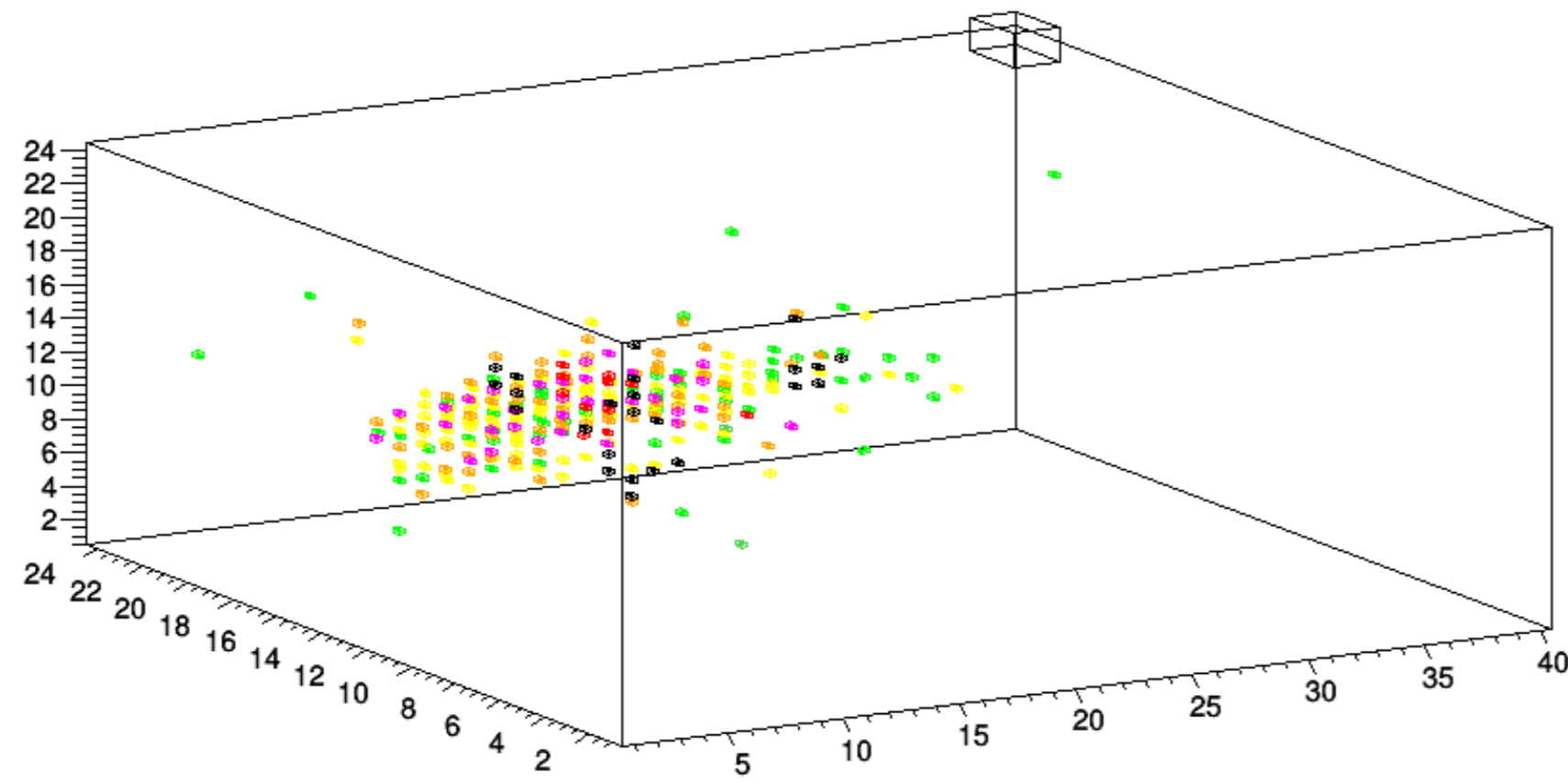
ahc_hitTime:ahc_hitEnergy {ahc_nHits>21&&ahc_nHits<53}



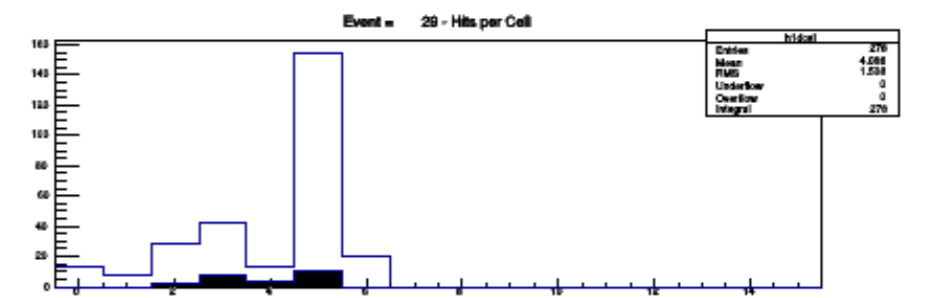
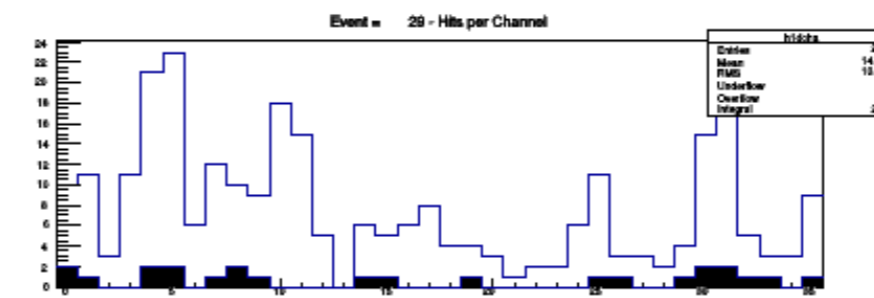
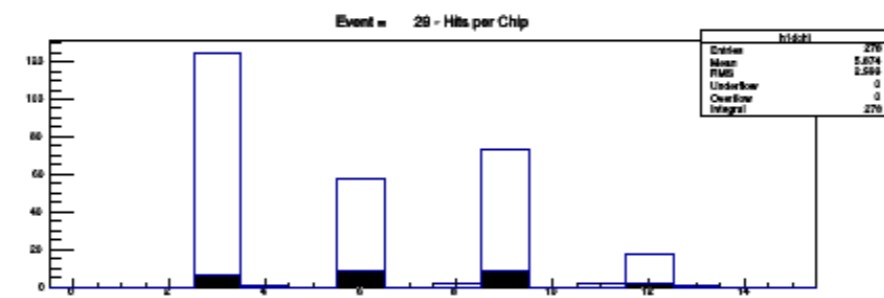
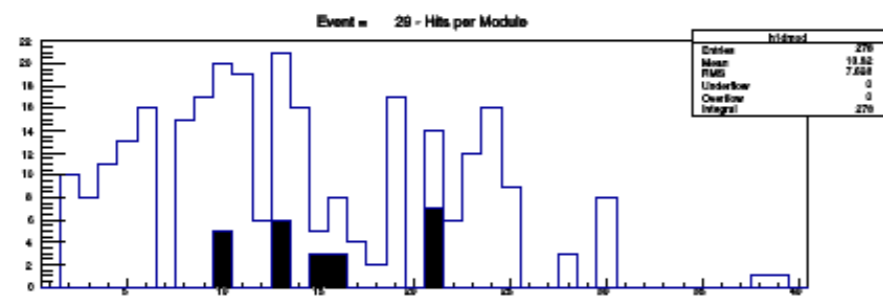
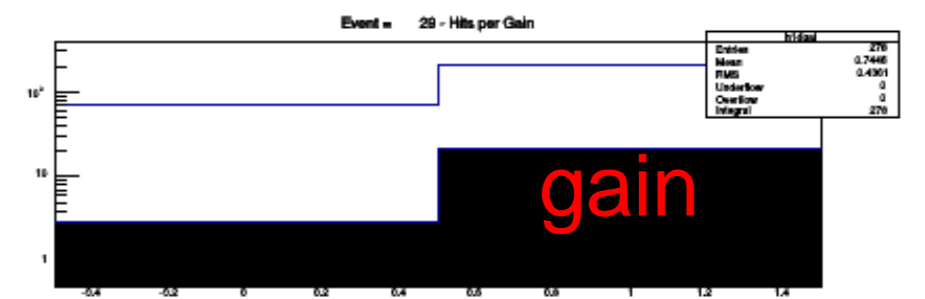
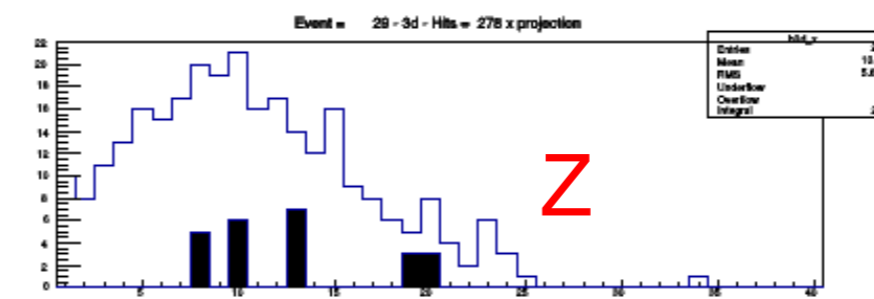
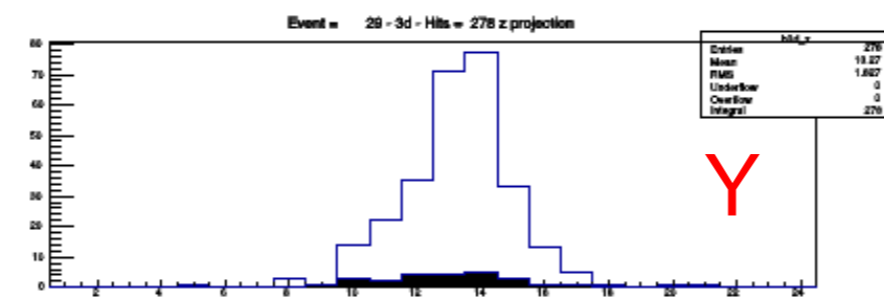
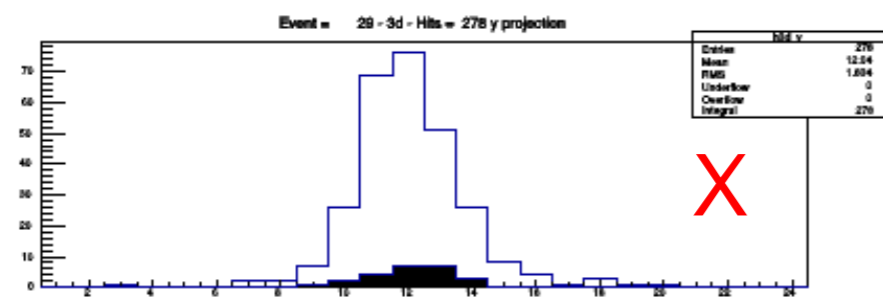
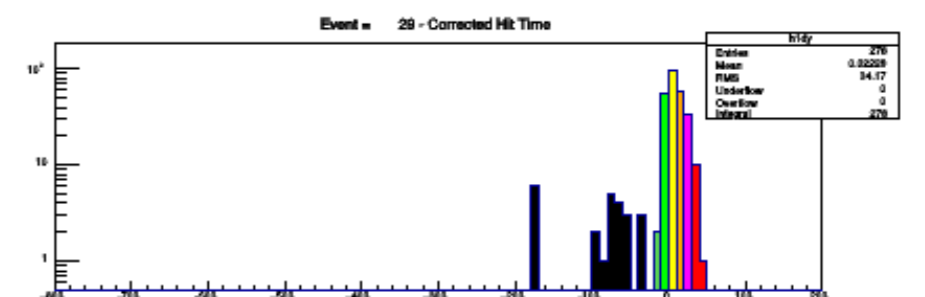
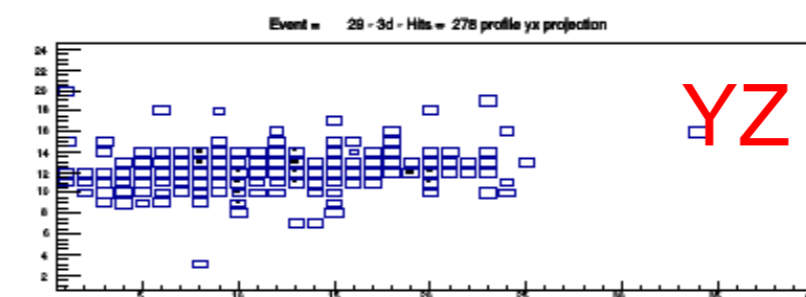
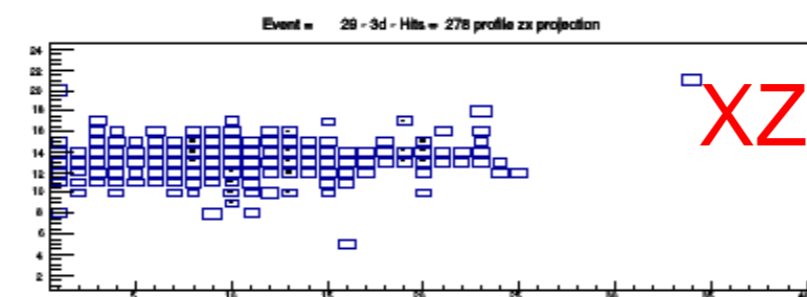
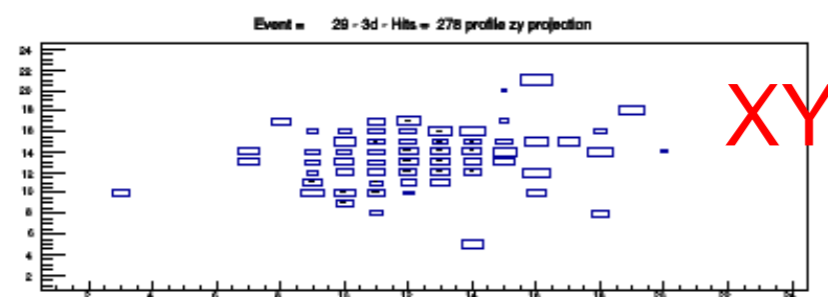
Event Display: Electron

display_20190717s reco_run60512_testNewConstants.root

Event = 29 - 3d - Hits = 278



black: t<-30nsec



module#

chip#

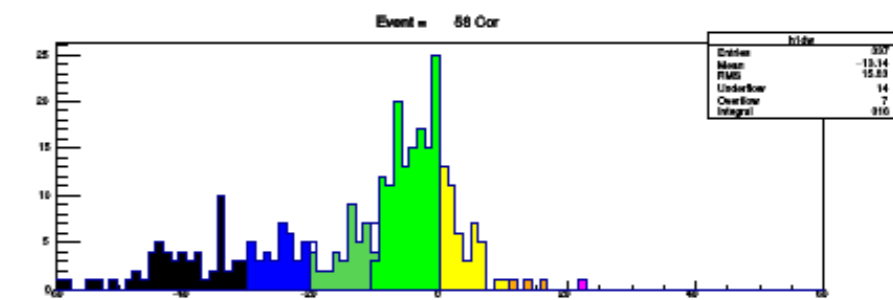
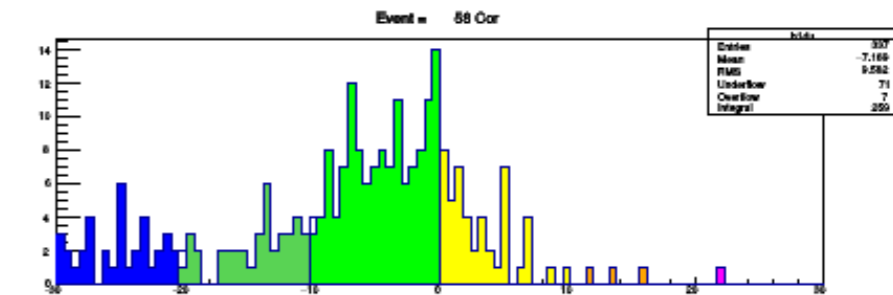
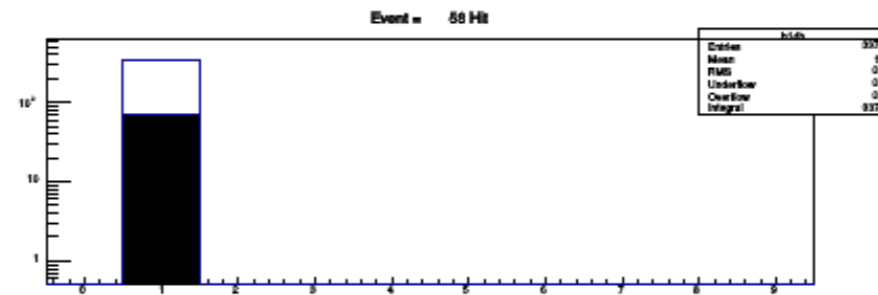
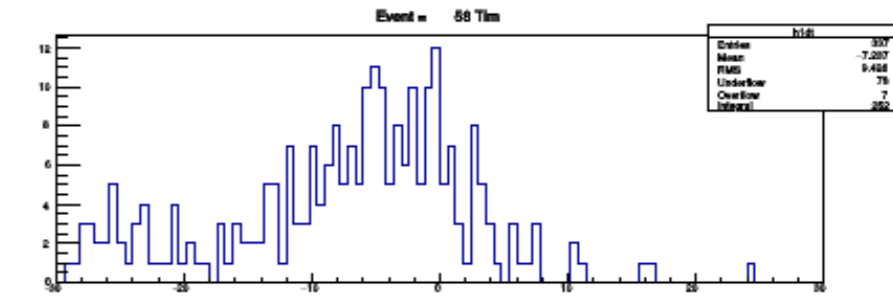
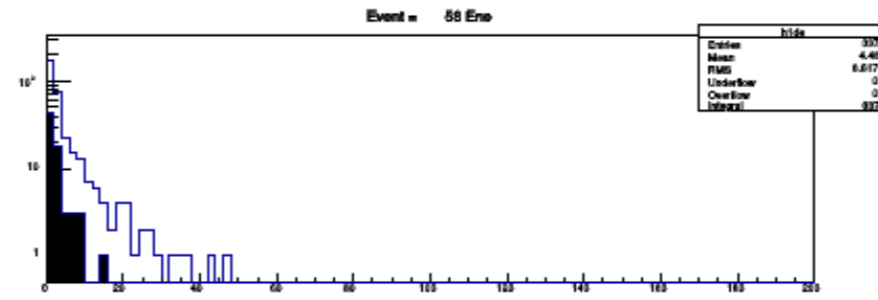
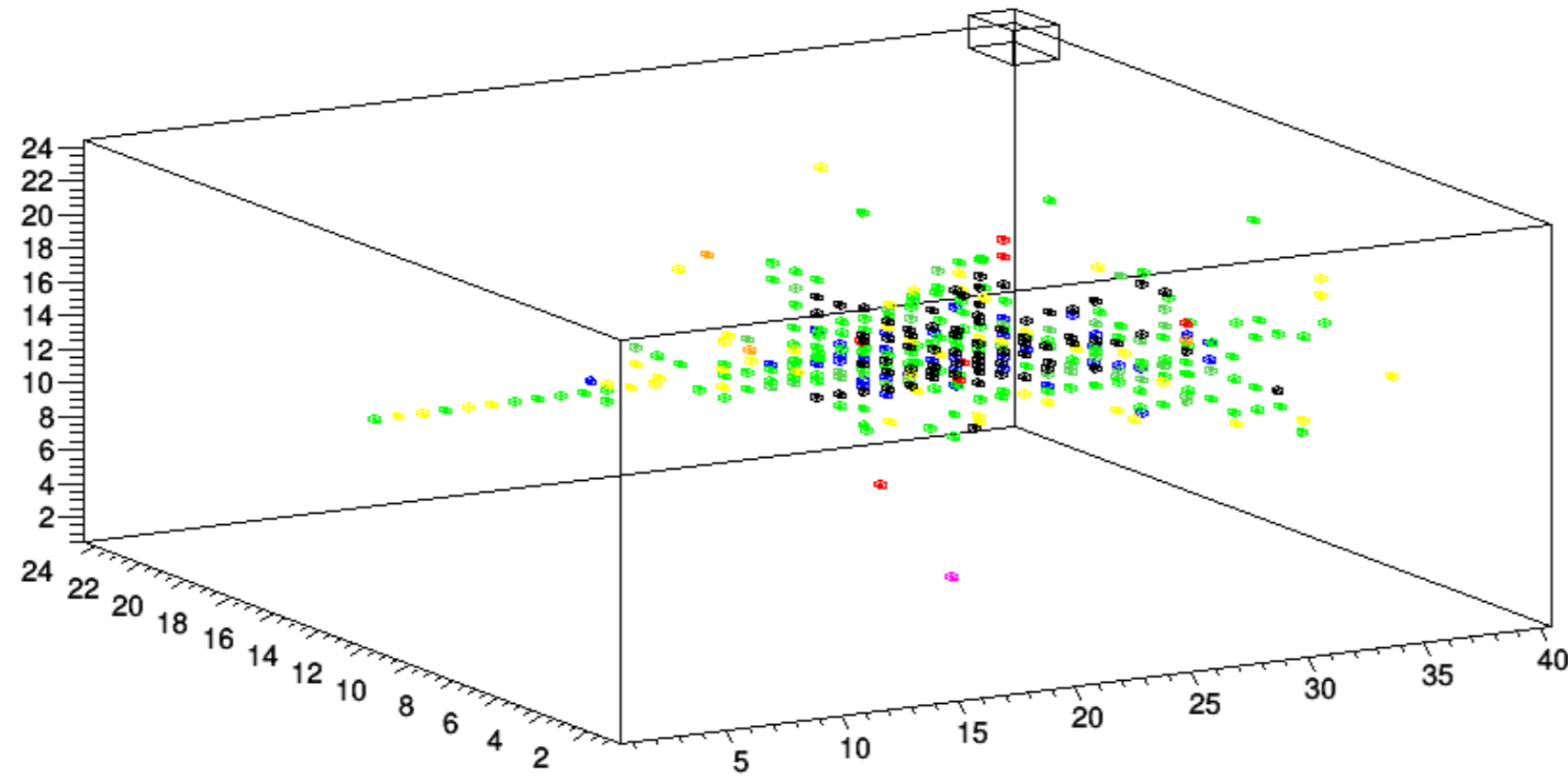
channel#

cell#

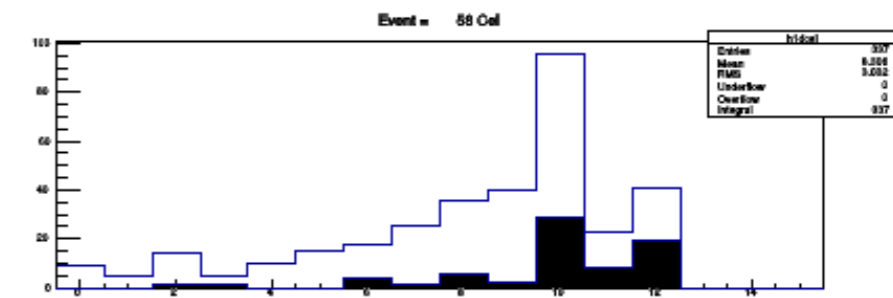
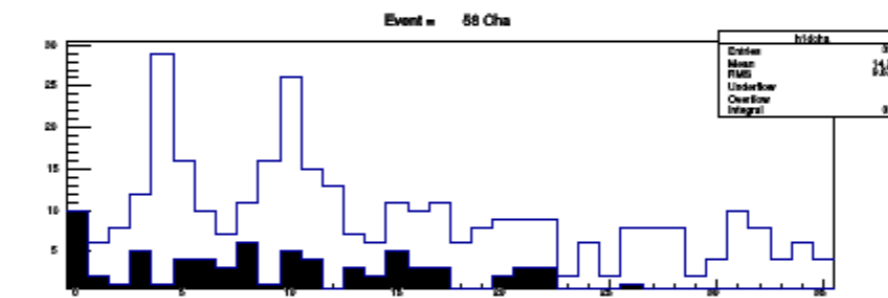
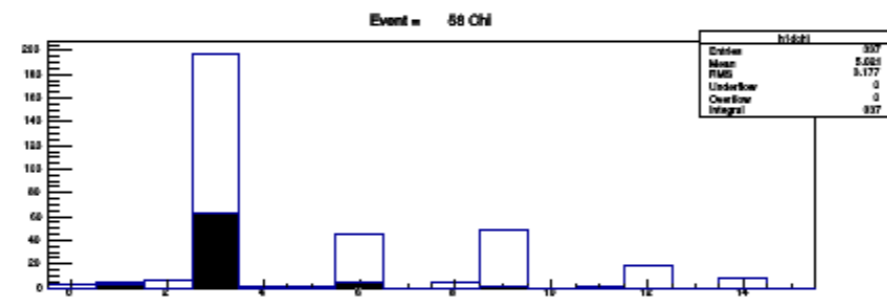
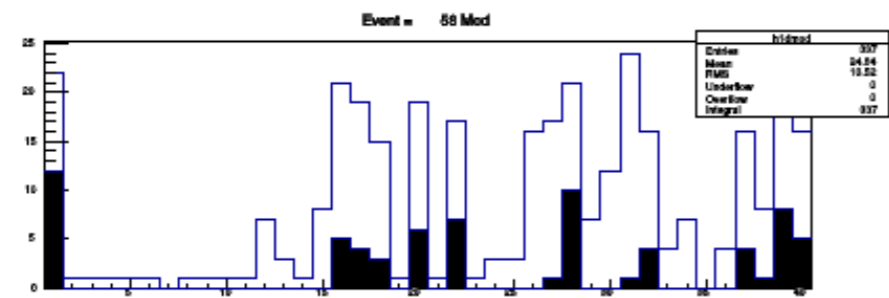
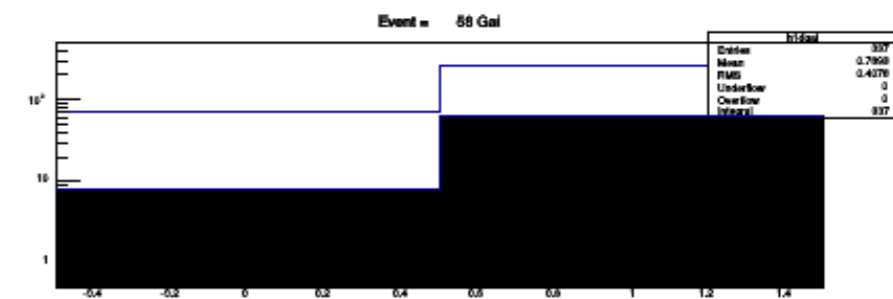
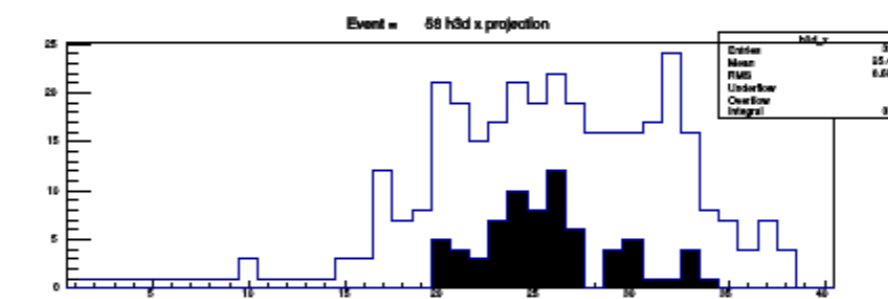
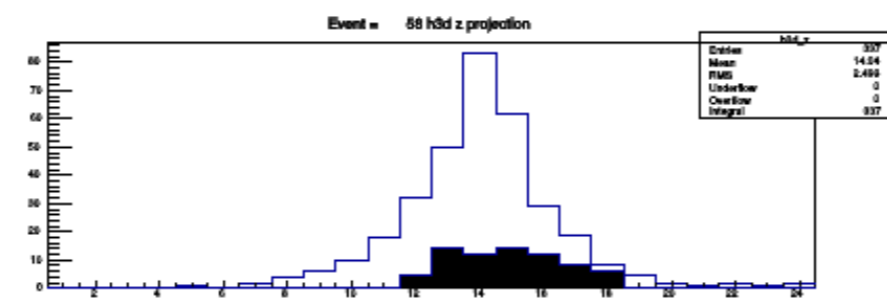
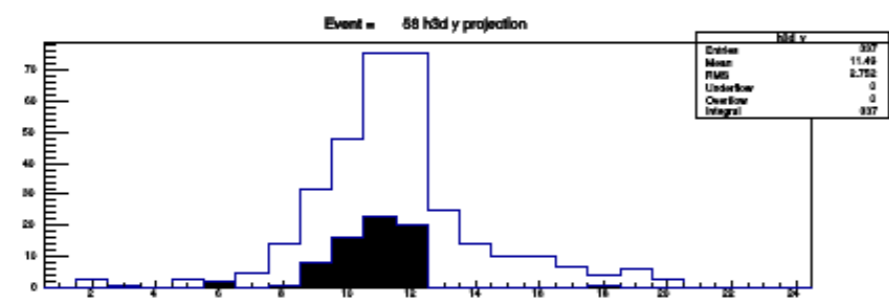
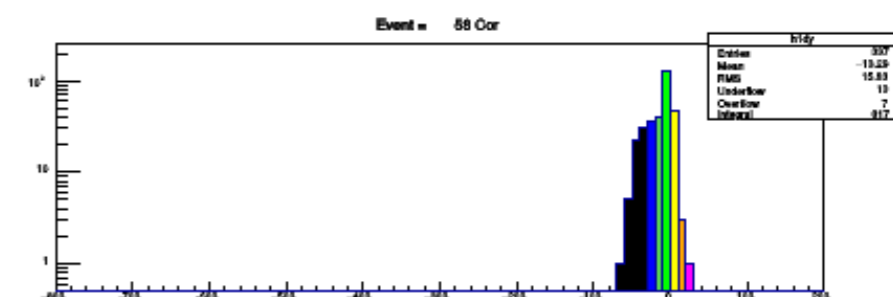
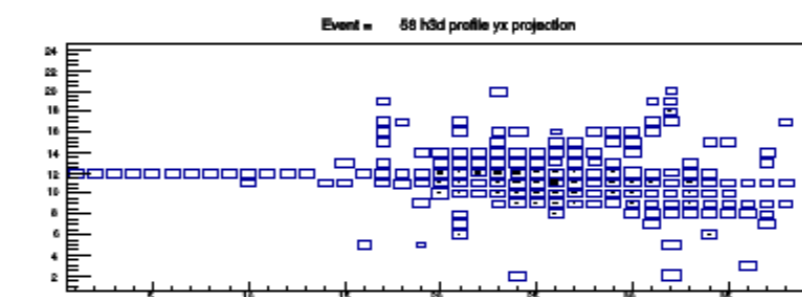
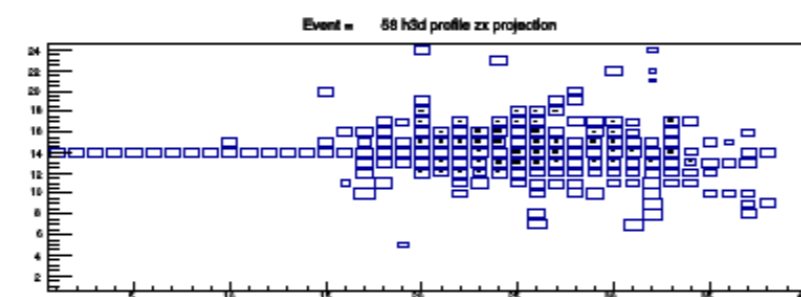
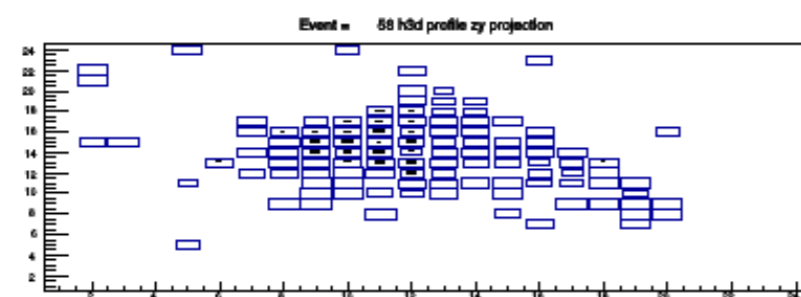
Event Display: Pion

display_20190710r reco_pion_n40GeV.root

Event = 58 h3d

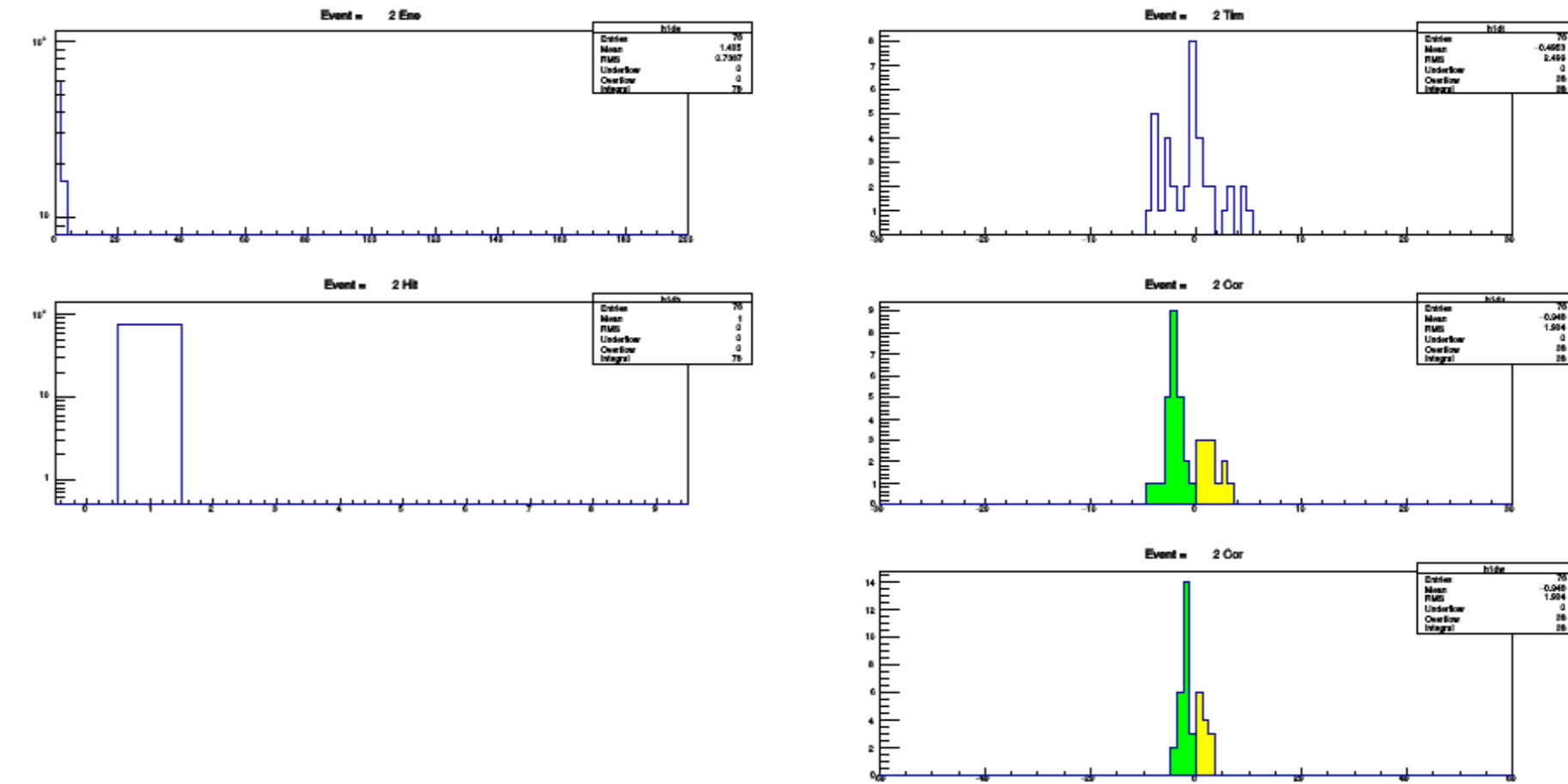
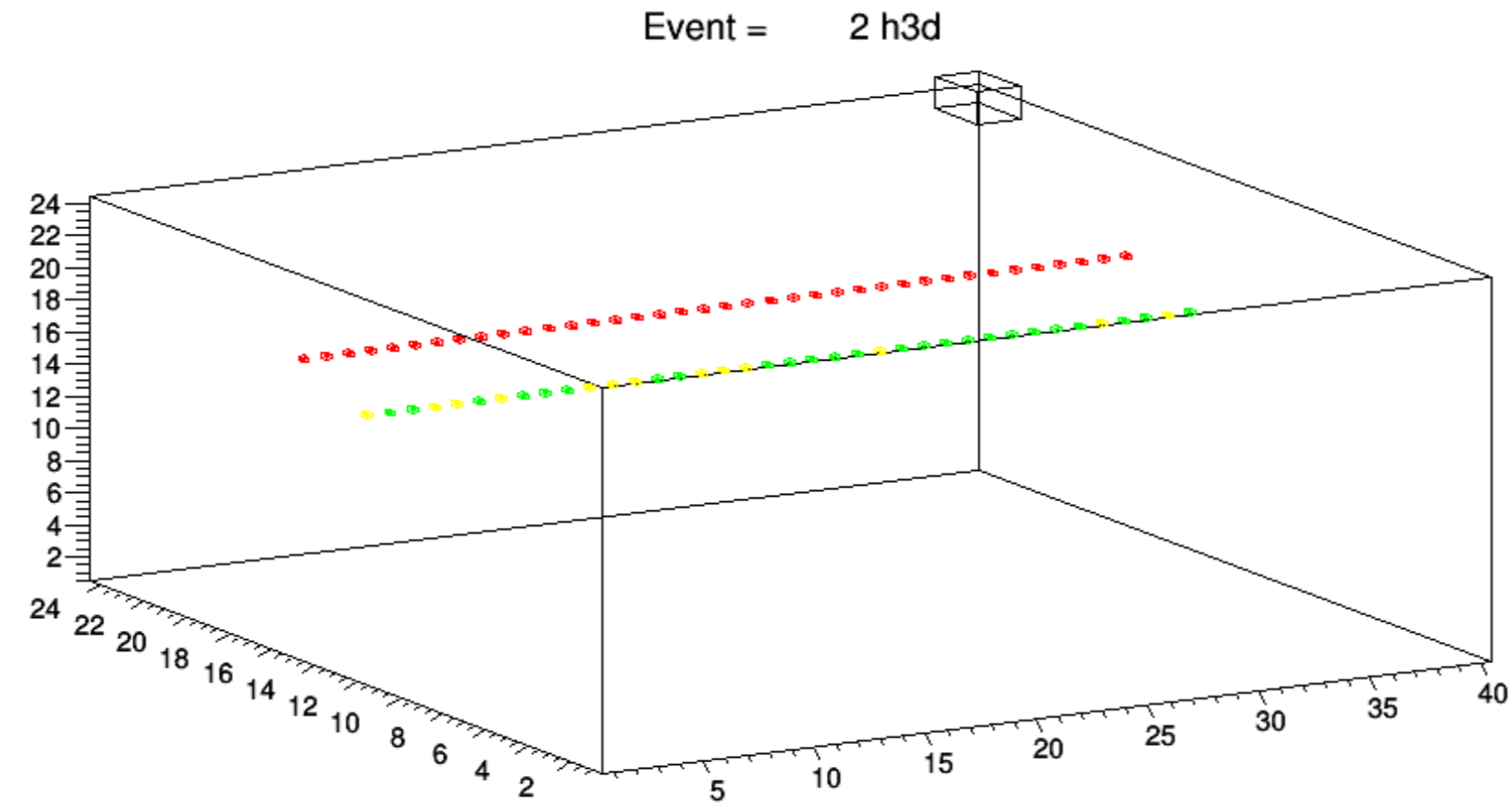


hit time tags not as expected

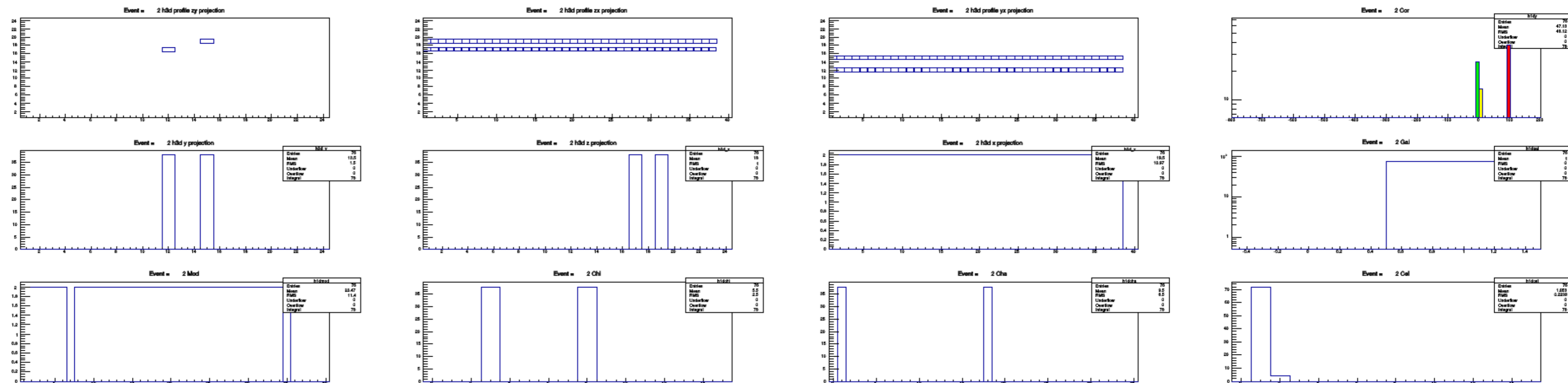


Event Display: Muon

display_20190710q reco_run60382_testNewConstants.root



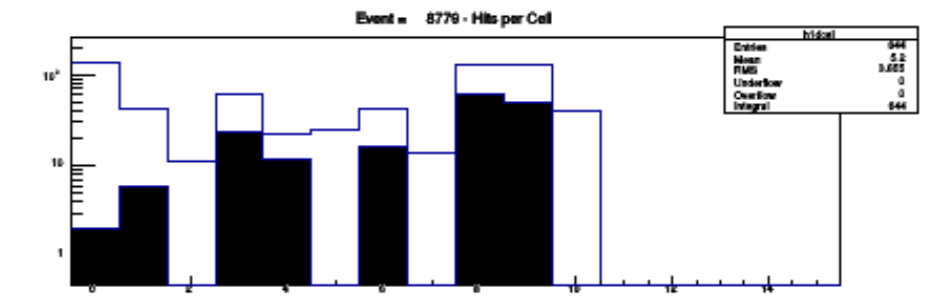
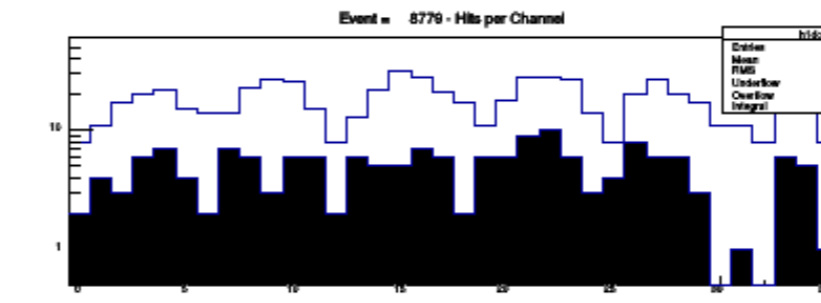
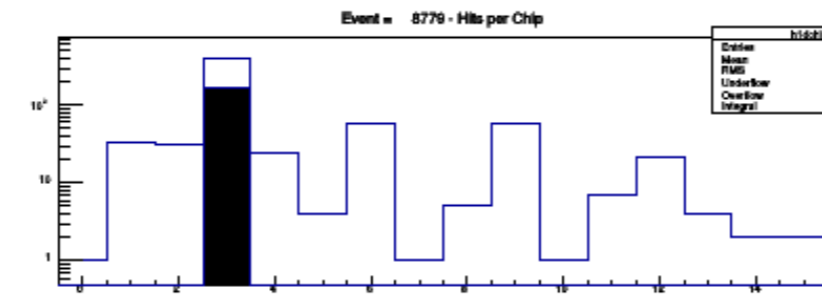
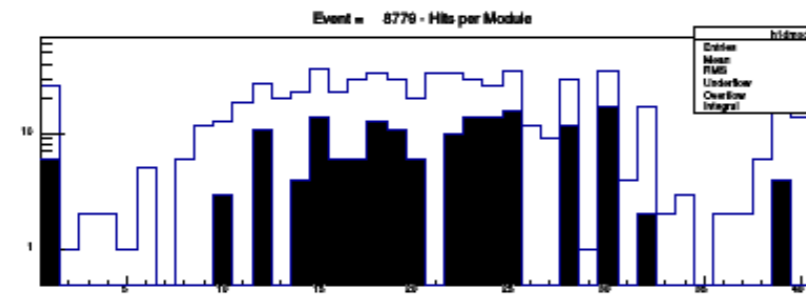
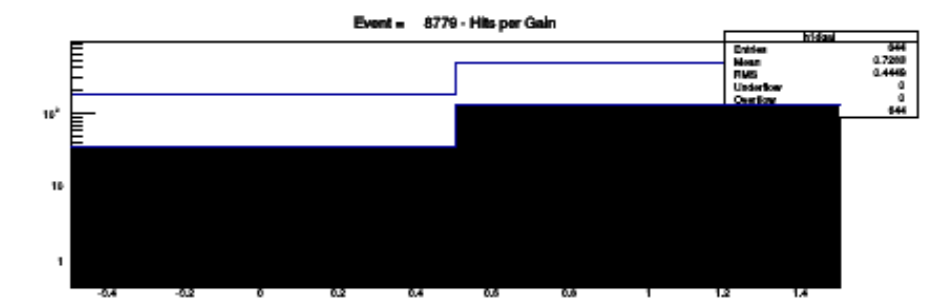
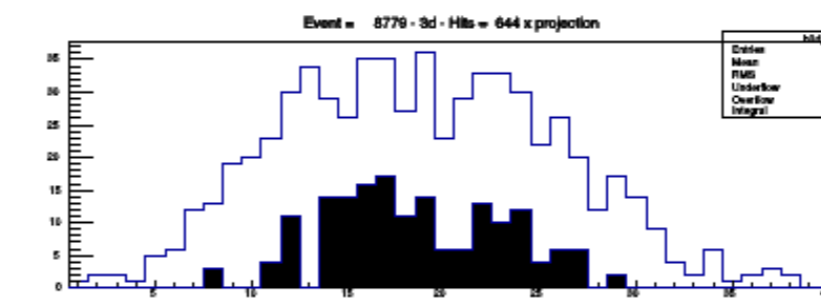
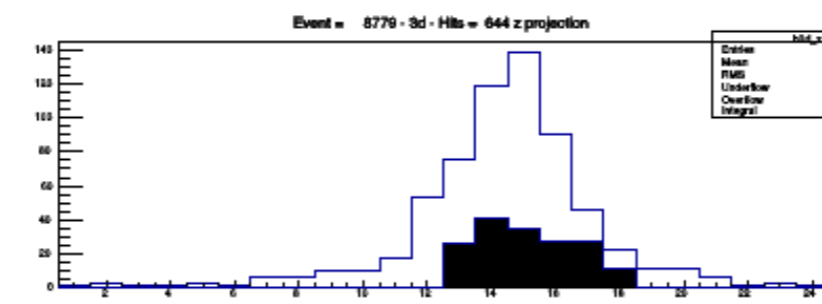
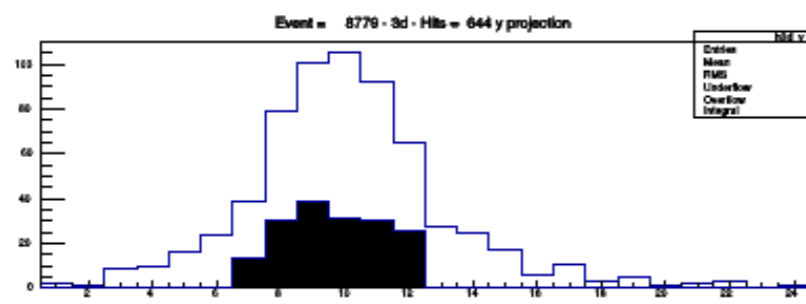
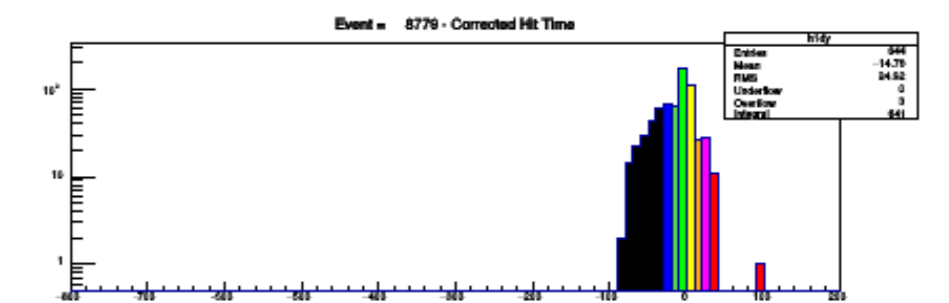
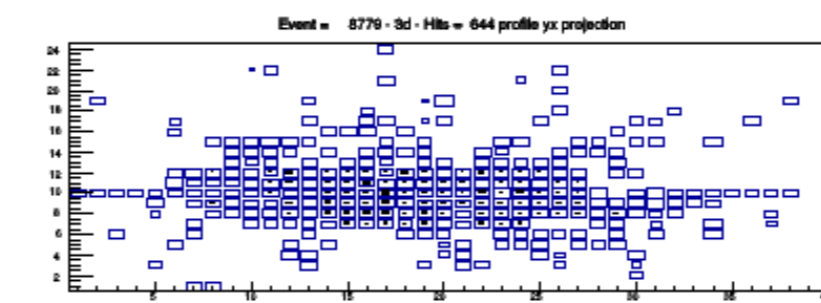
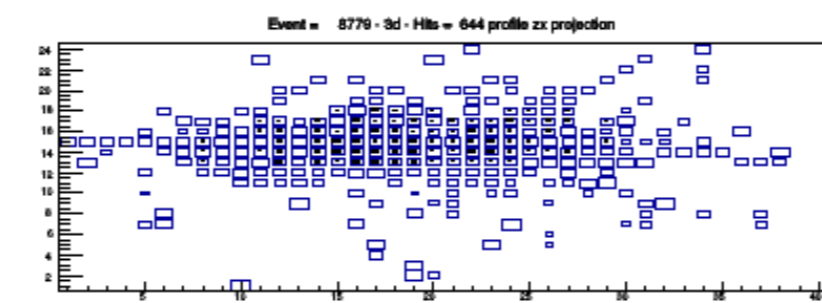
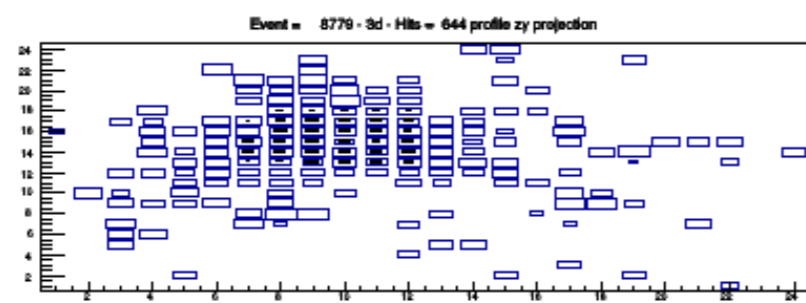
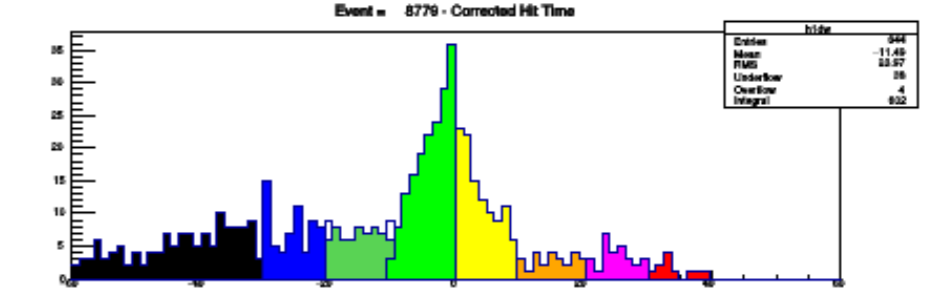
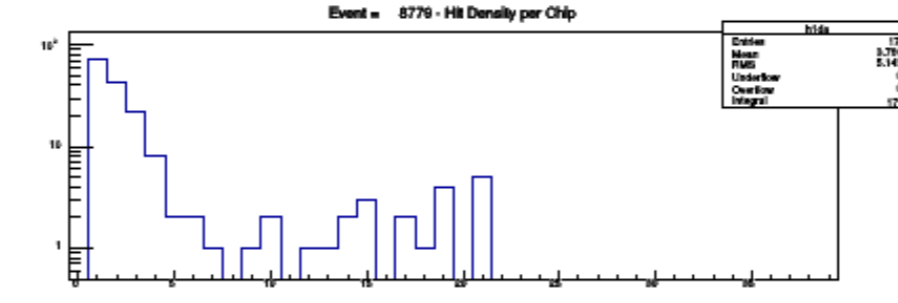
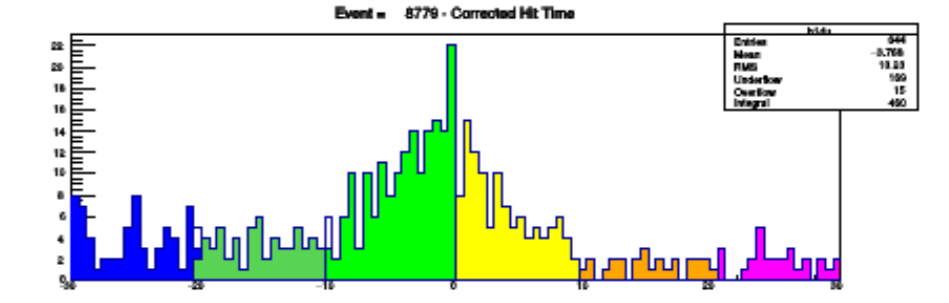
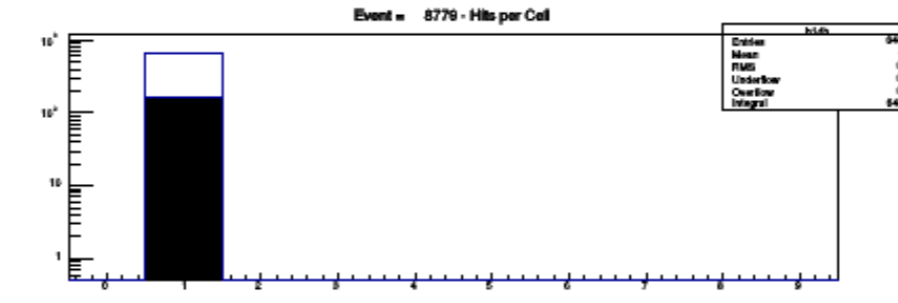
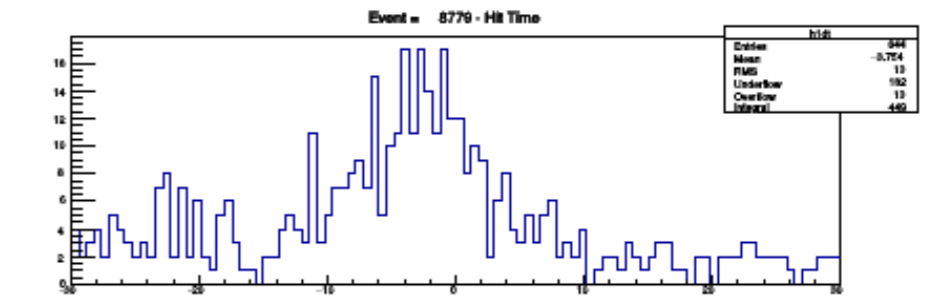
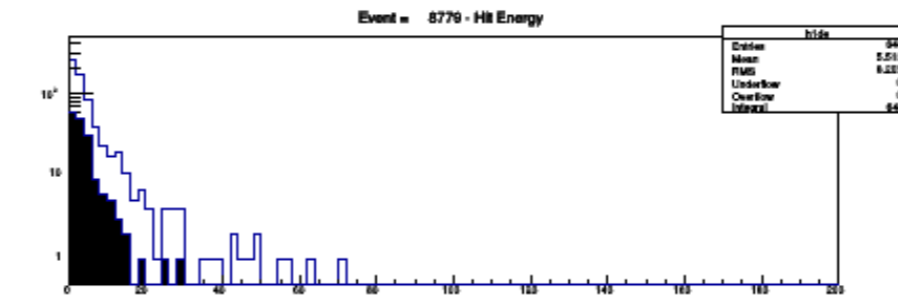
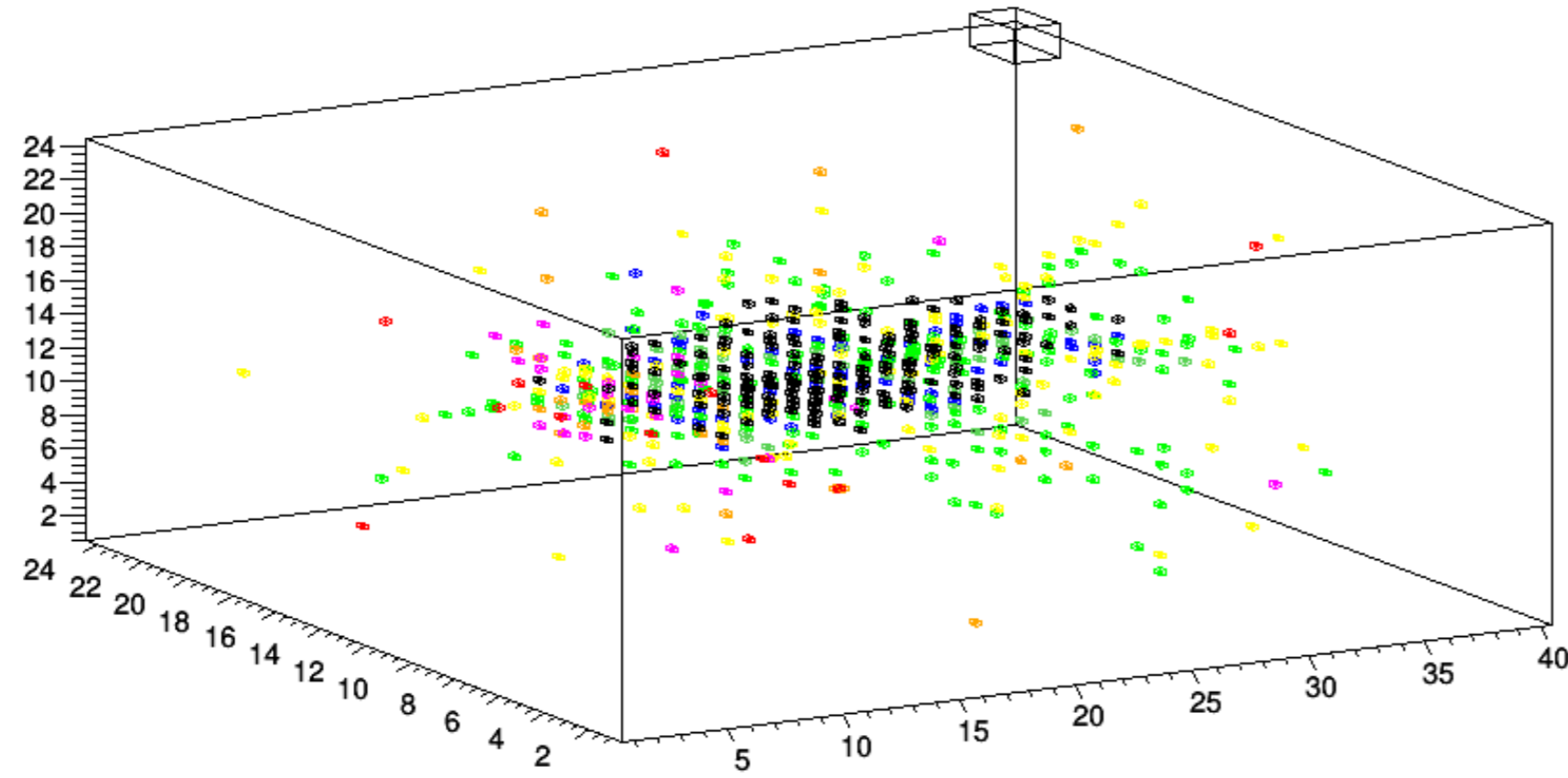
double event



Electron: Double Event

display_20190717t reco_run60512_testNewConstants.root

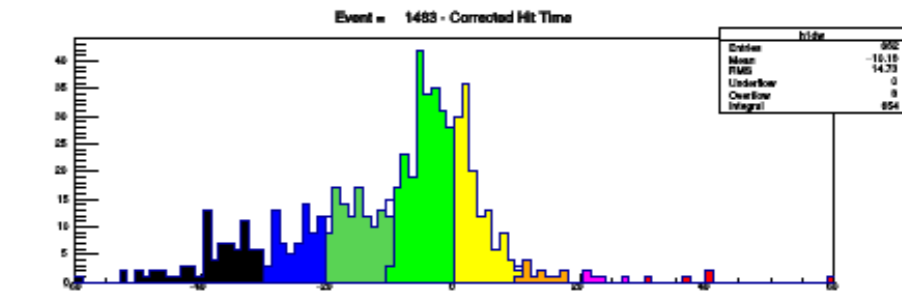
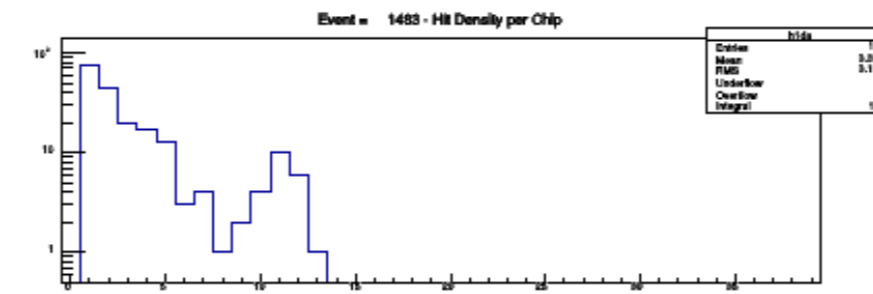
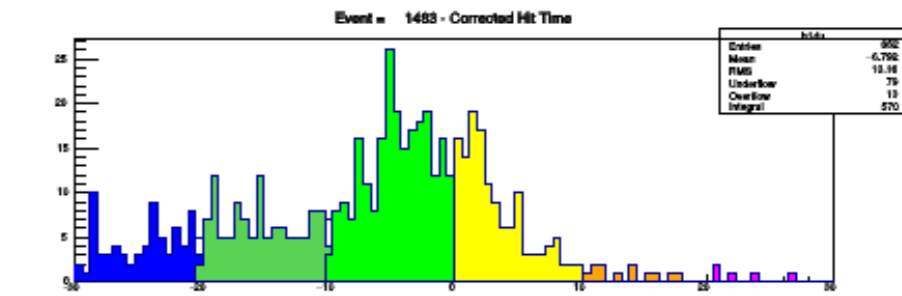
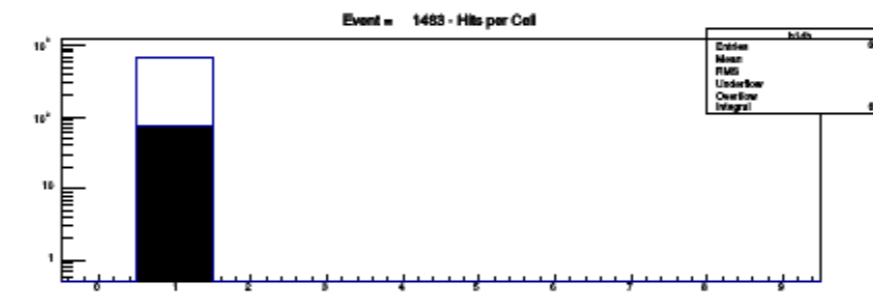
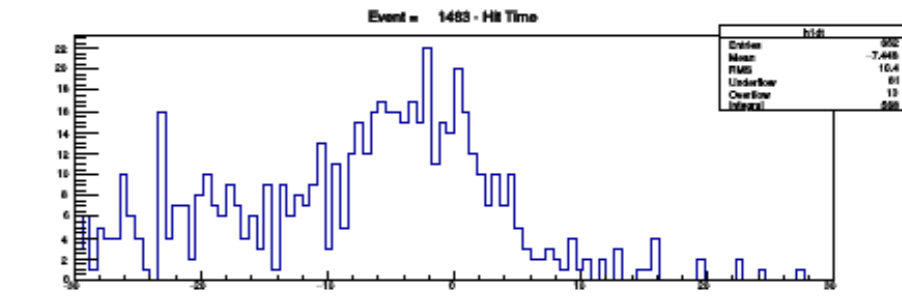
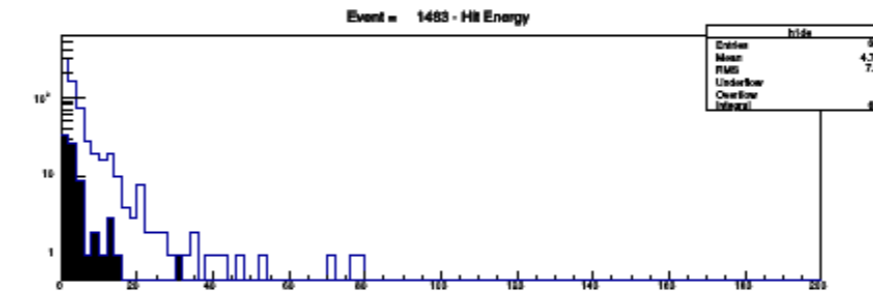
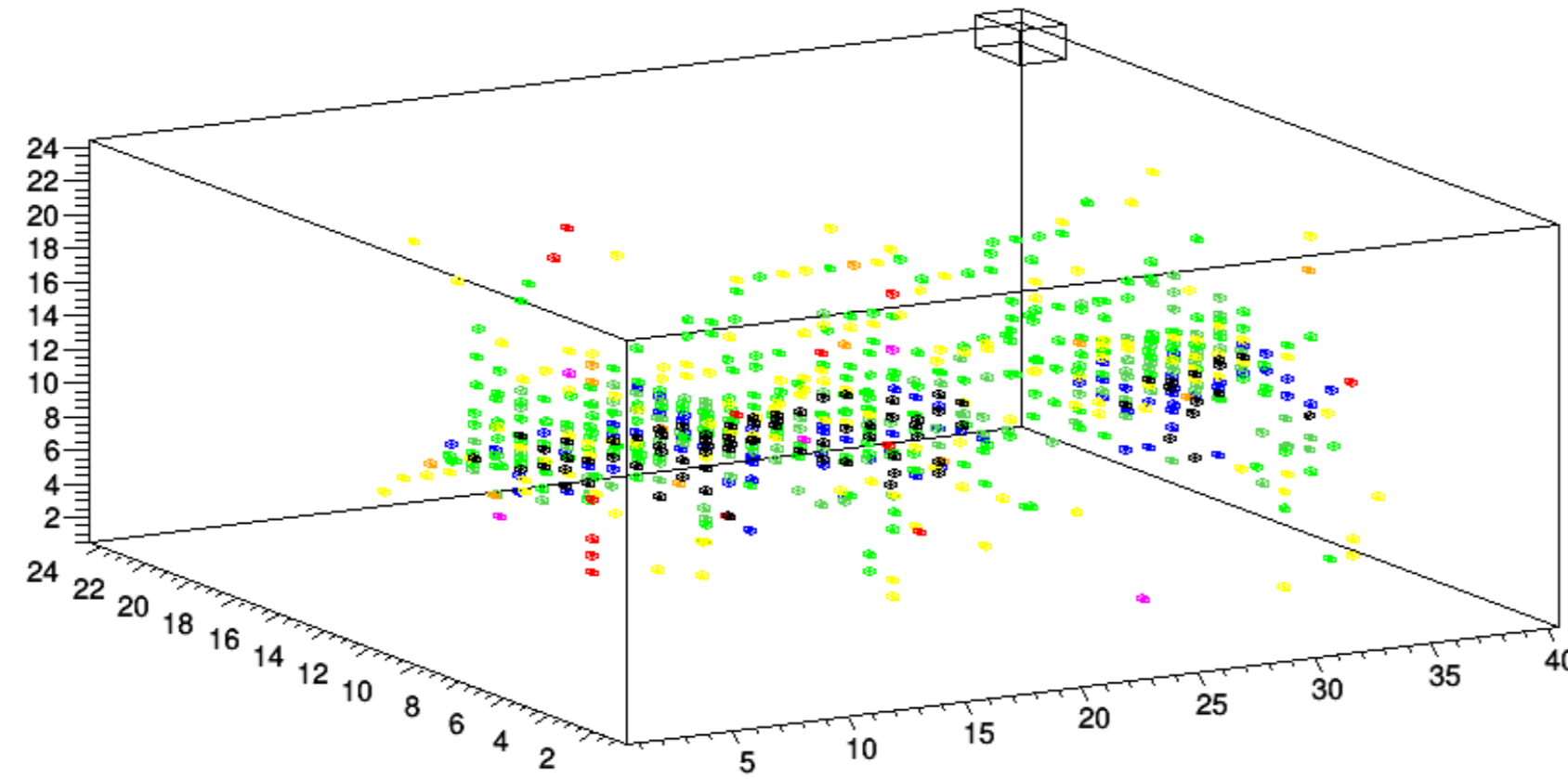
Event = 8779 - 3d - Hits = 644



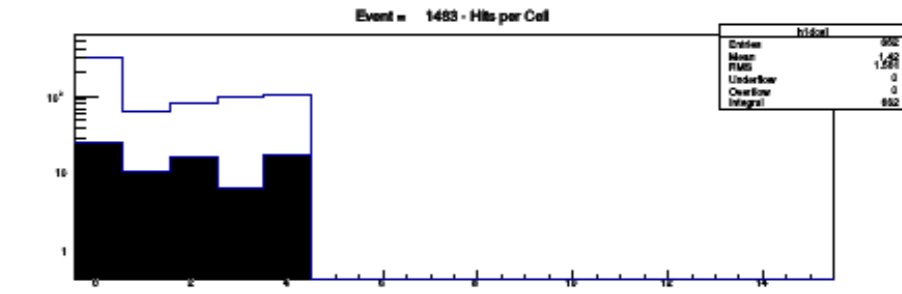
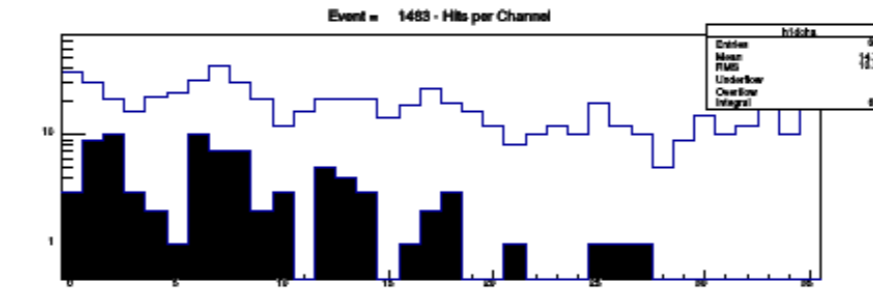
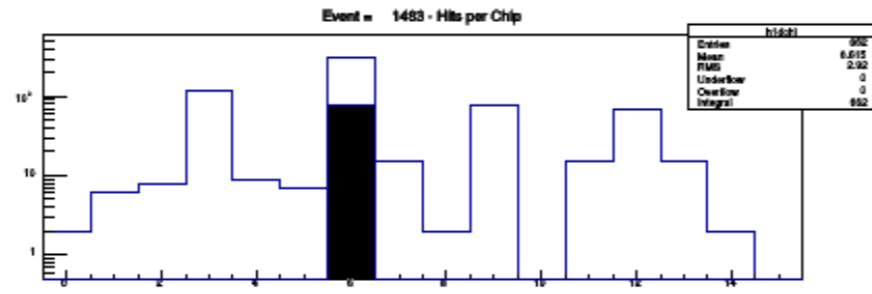
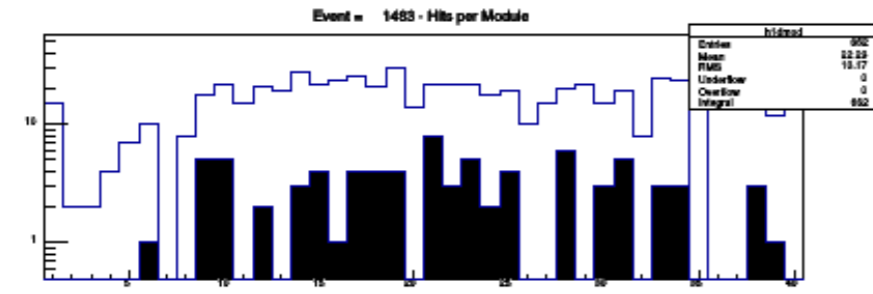
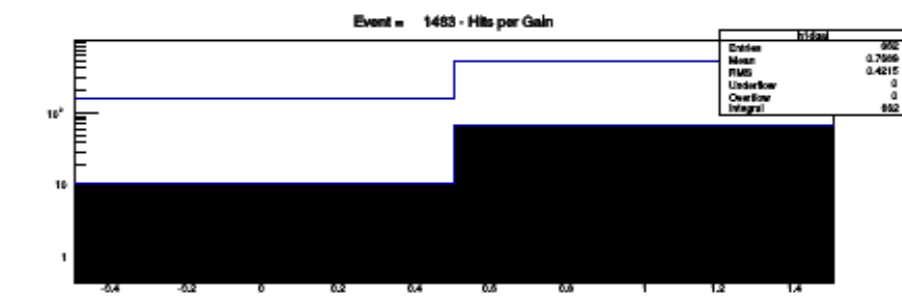
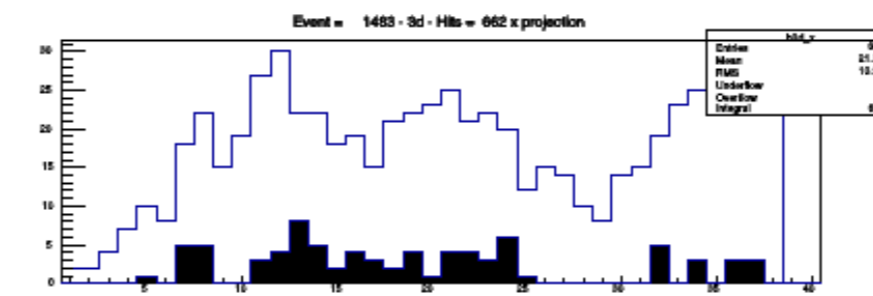
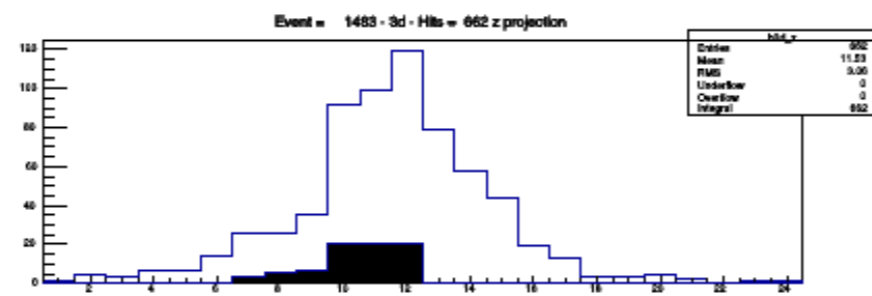
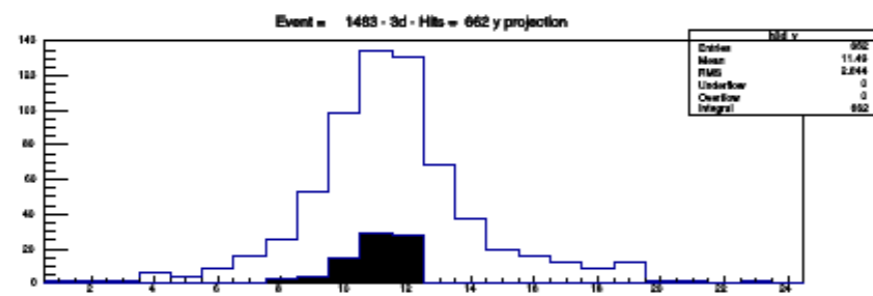
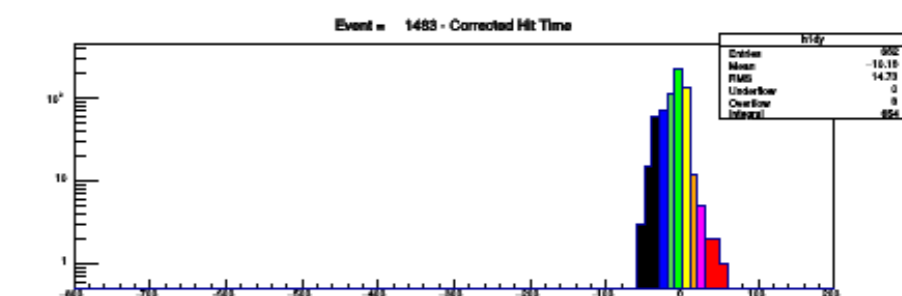
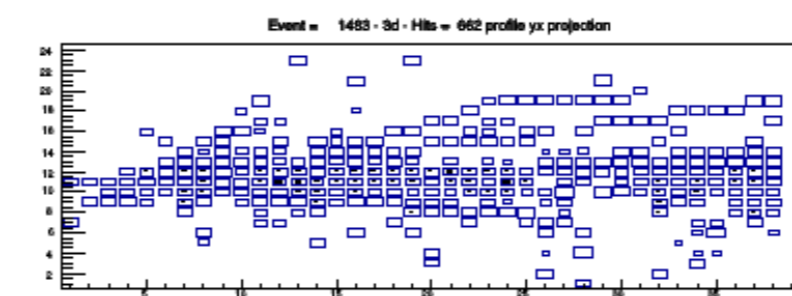
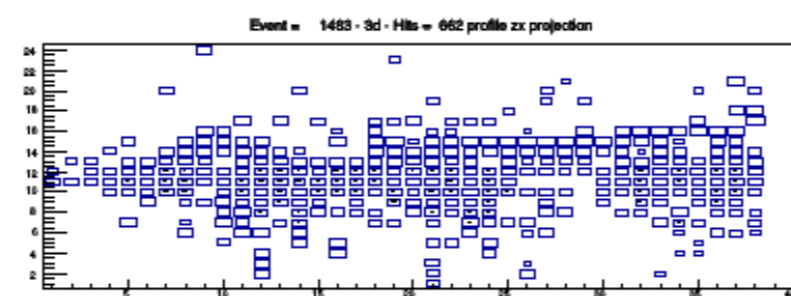
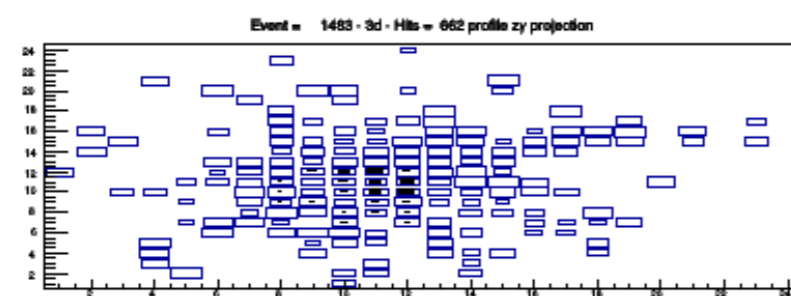
Electron: high occupancy event

display_20190724u reco_run60512_testNewConstants.root

Event = 1483 - 3d - Hits = 662



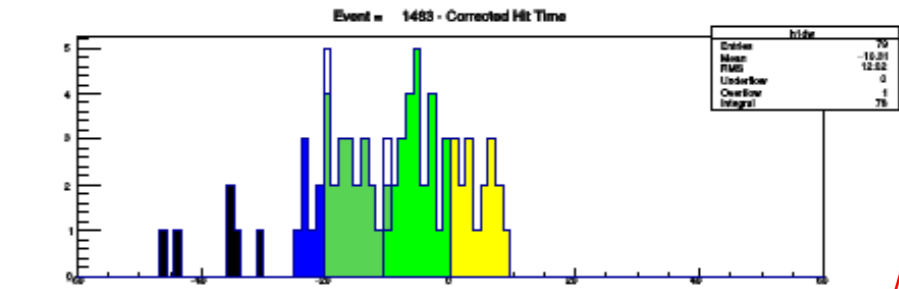
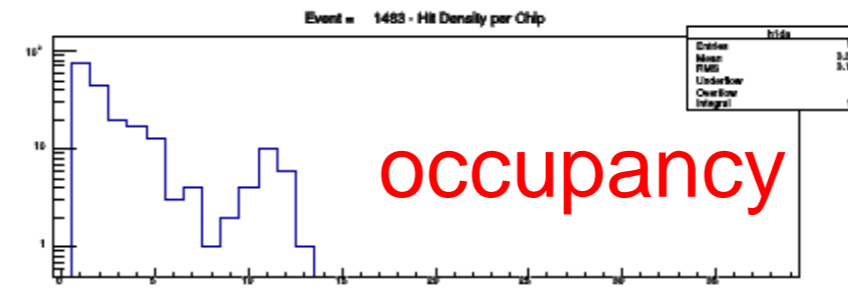
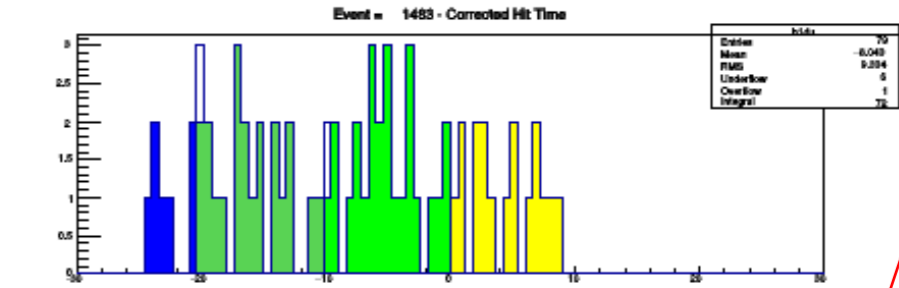
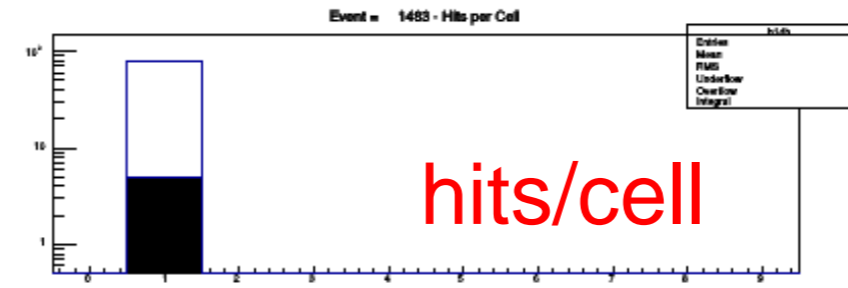
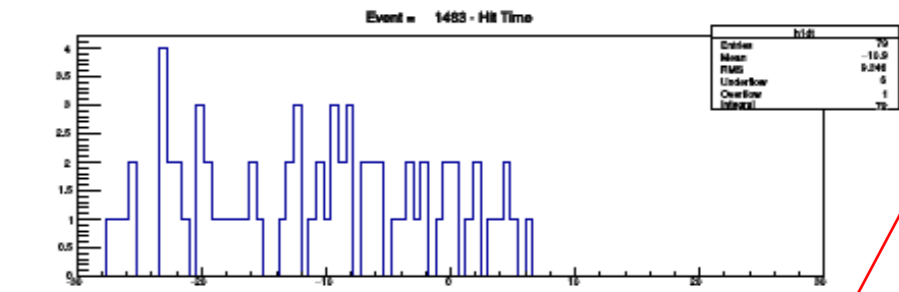
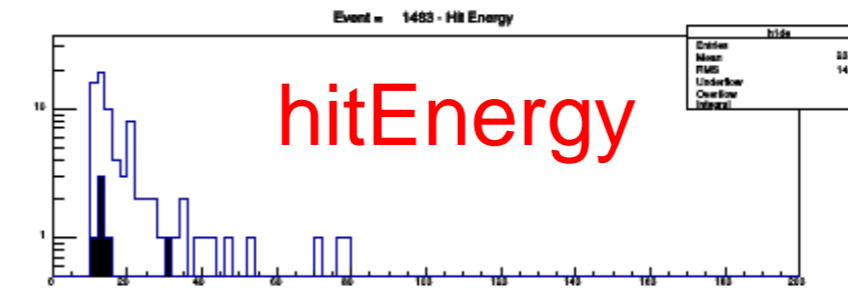
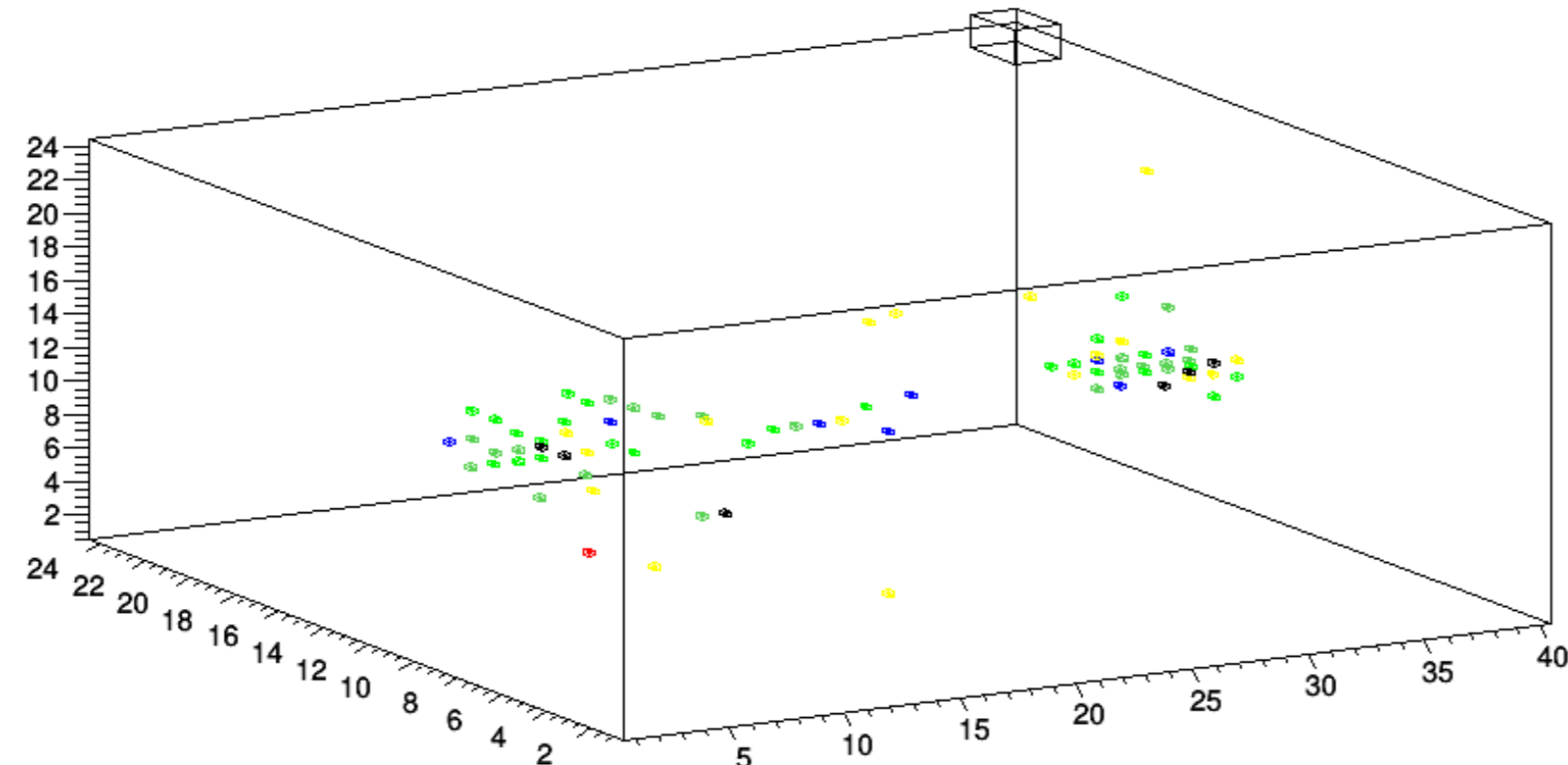
hitden>20, hits>600



Electron: high occupancy event

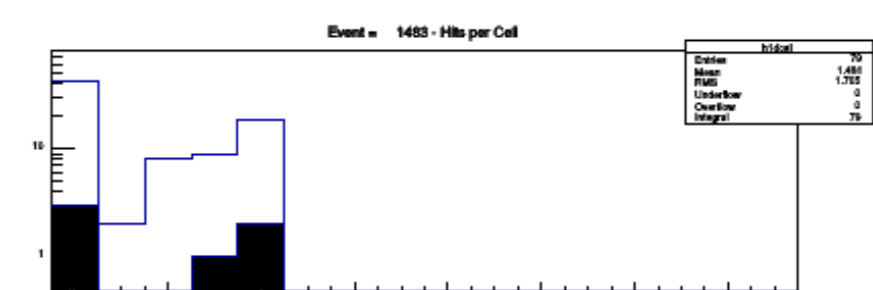
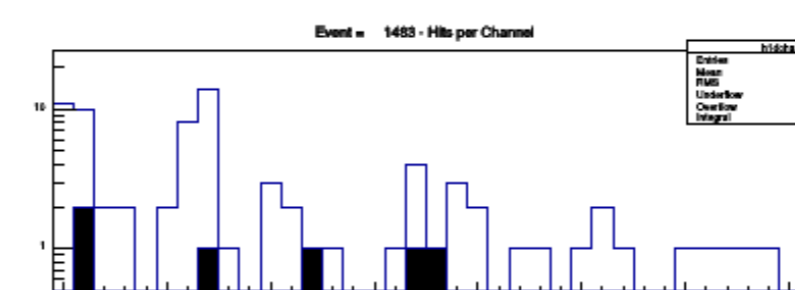
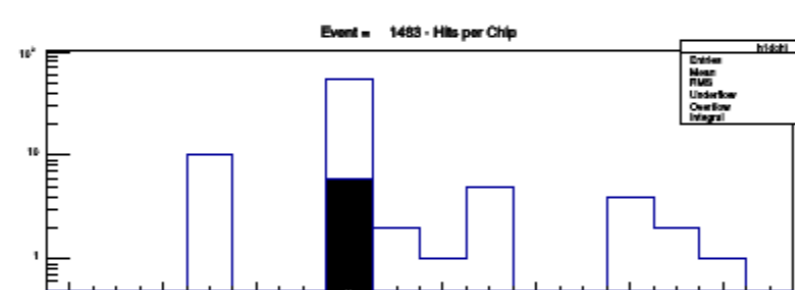
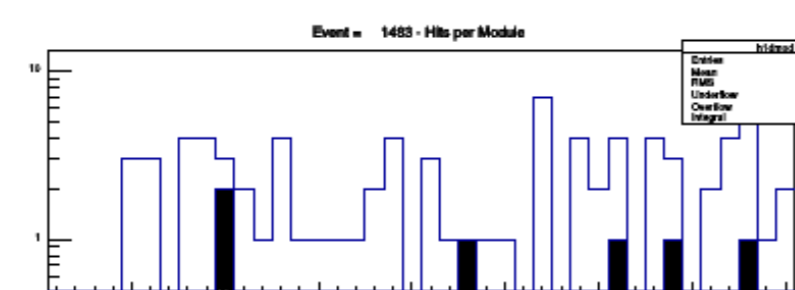
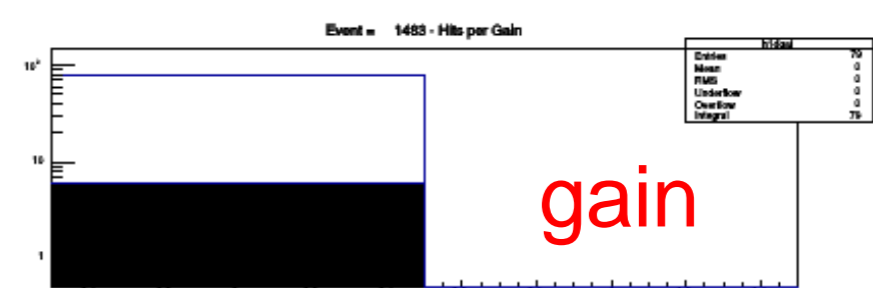
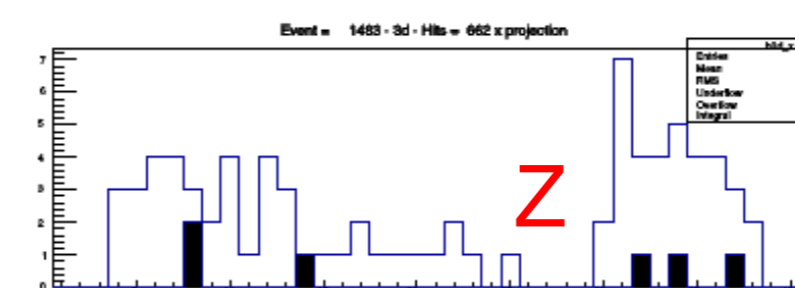
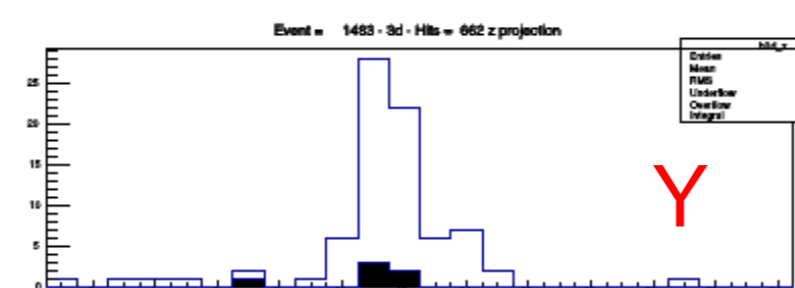
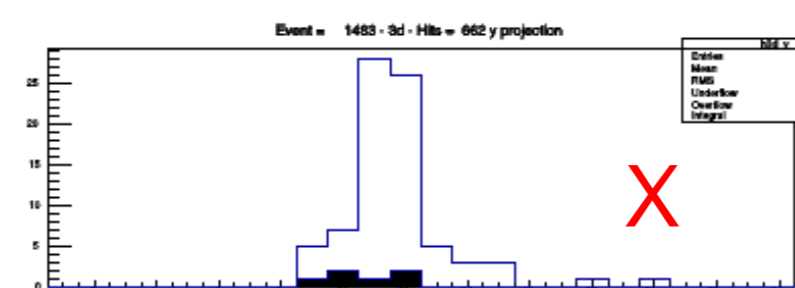
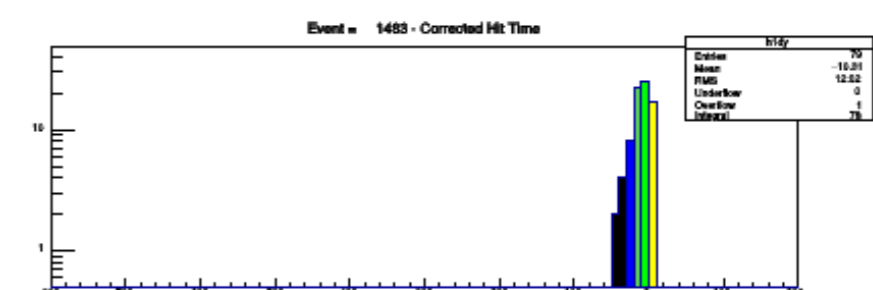
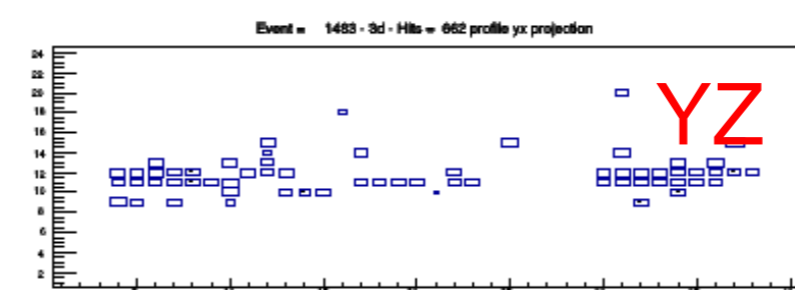
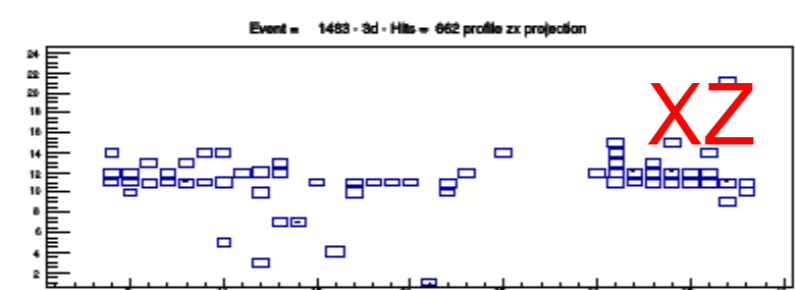
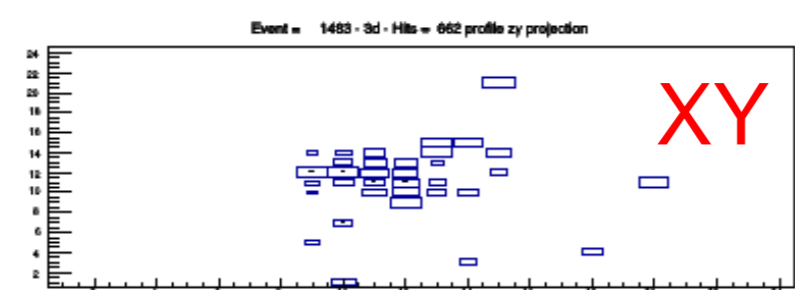
display_20190724u reco_run60512_testNewConstants.root

Event = 1483 - 3d - Hits = 662



de>20, hi>600, **en>10** hitEnergy>10 MIP

black: t<-30nsec



module#

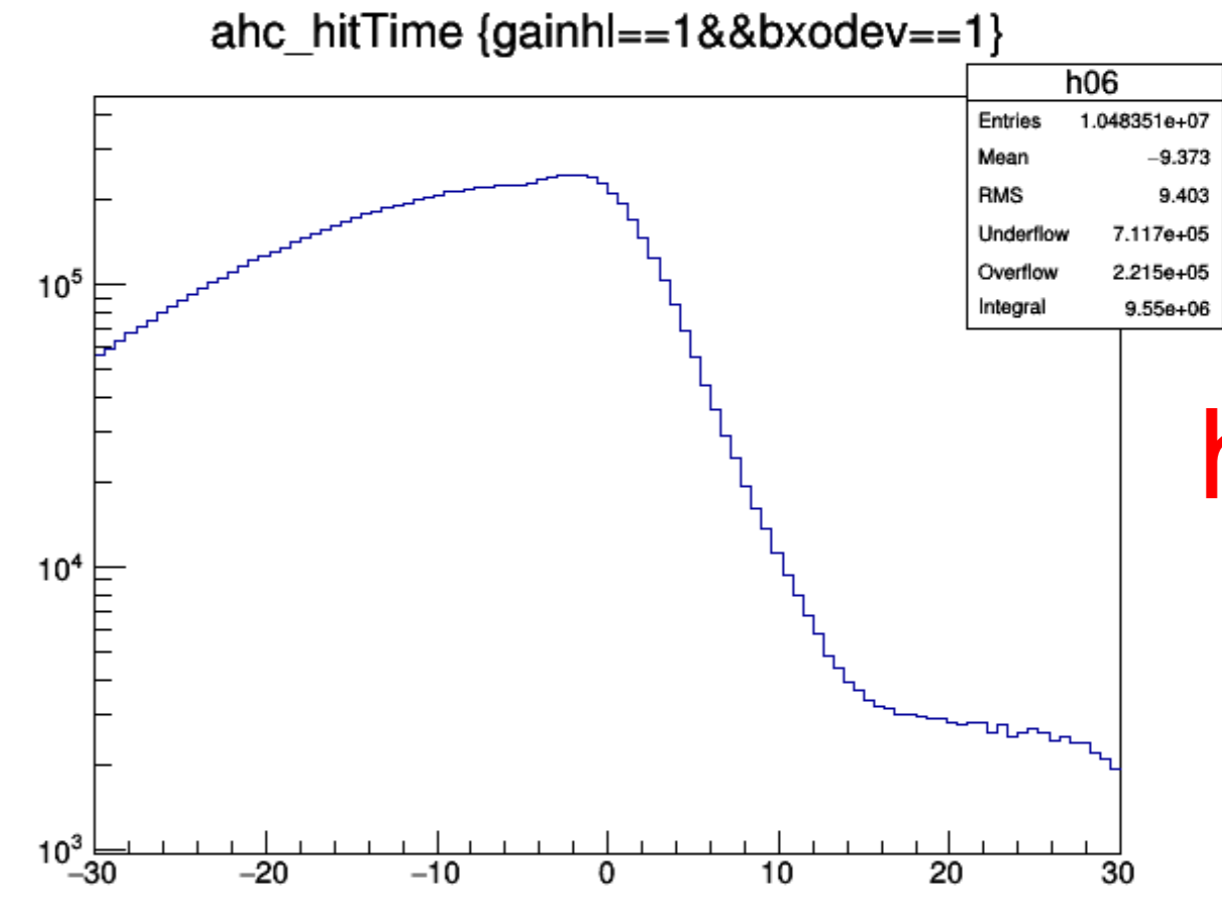
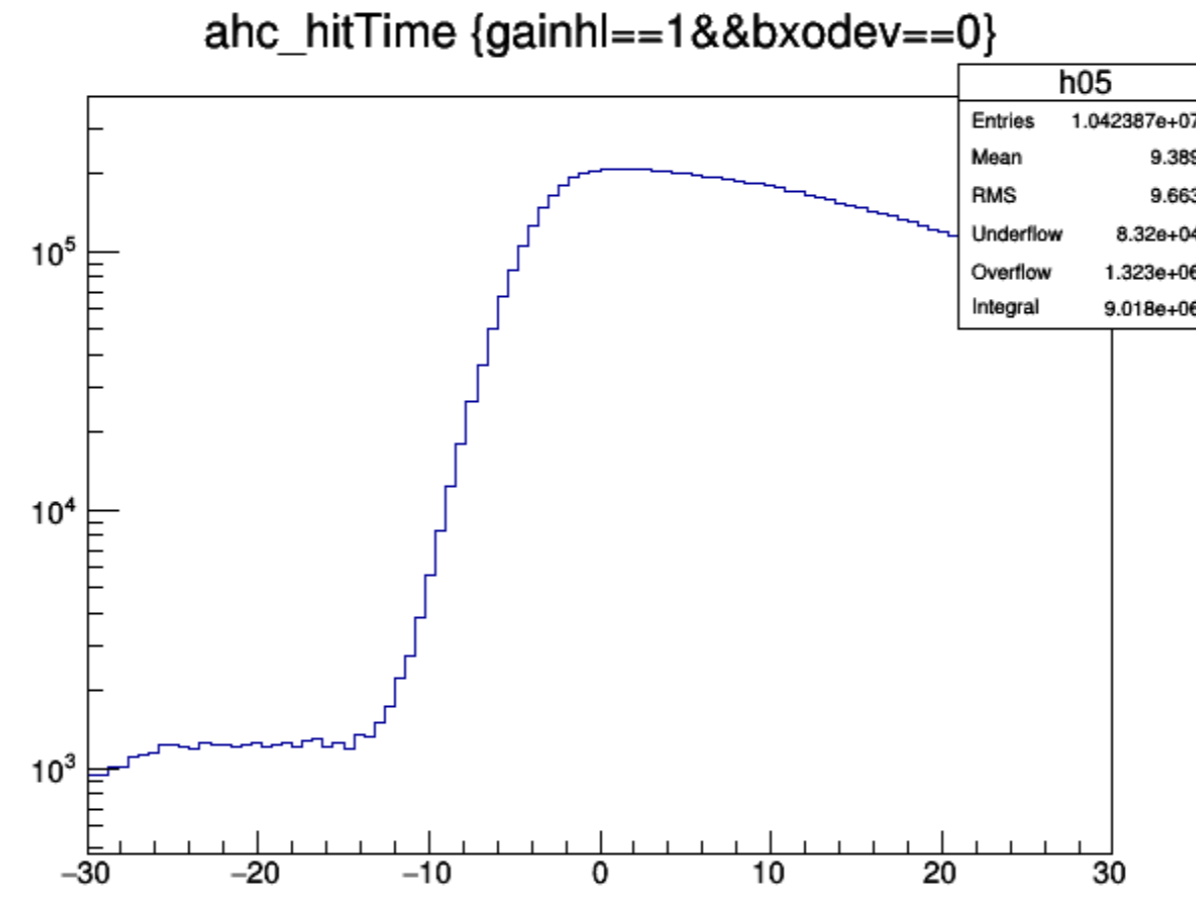
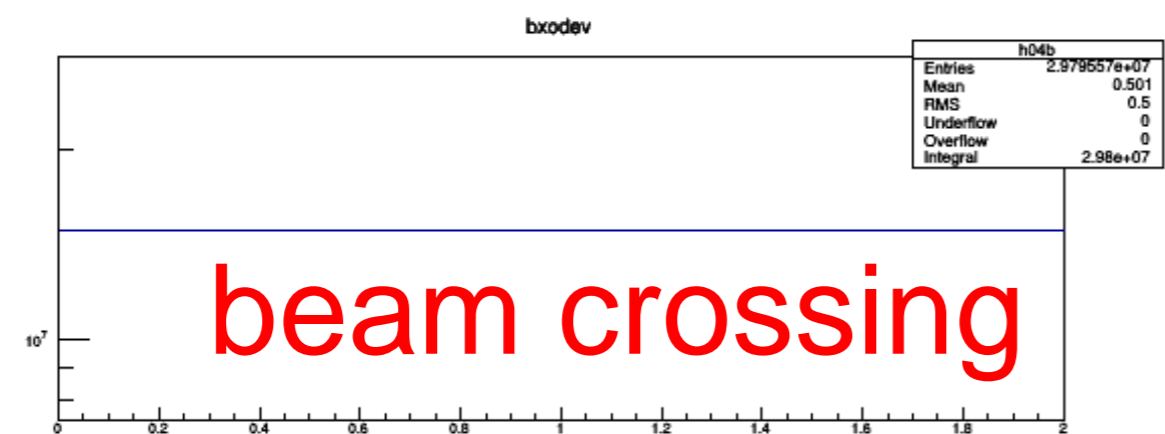
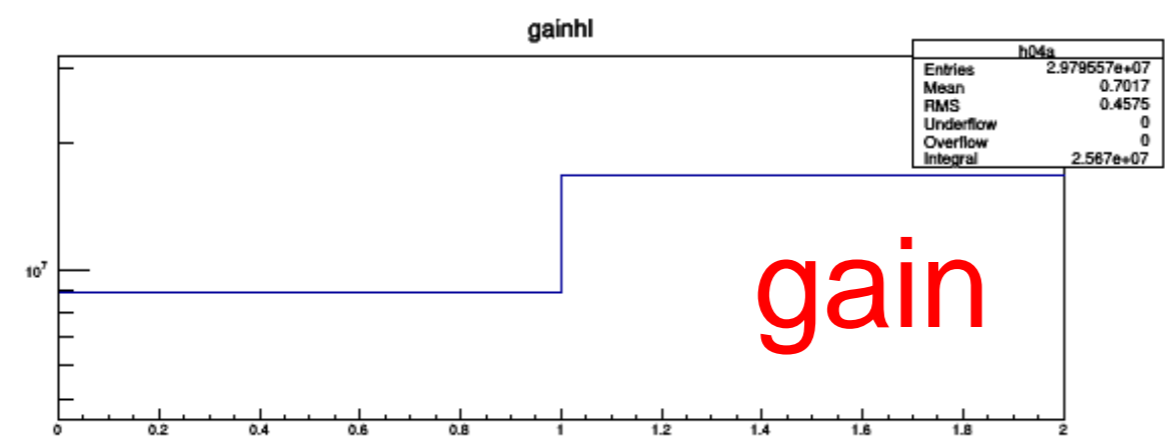
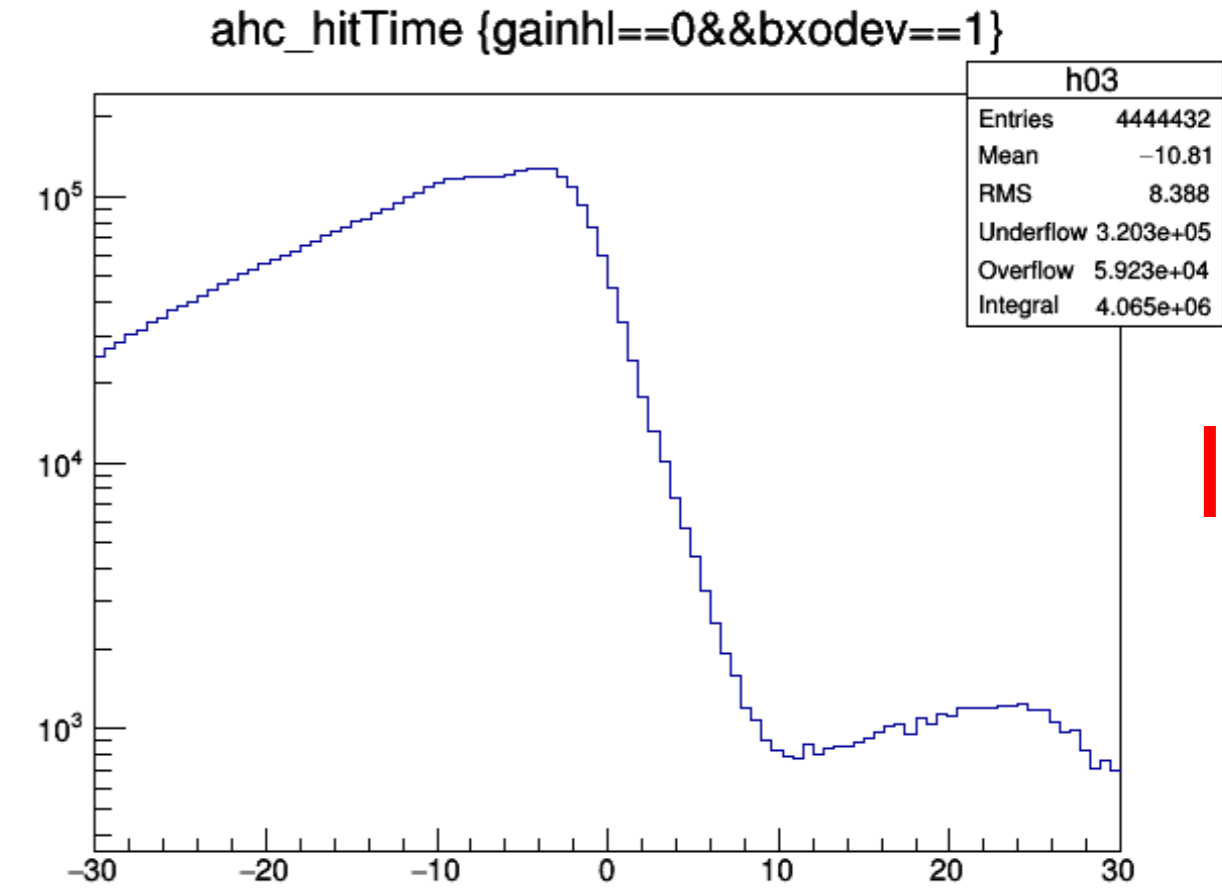
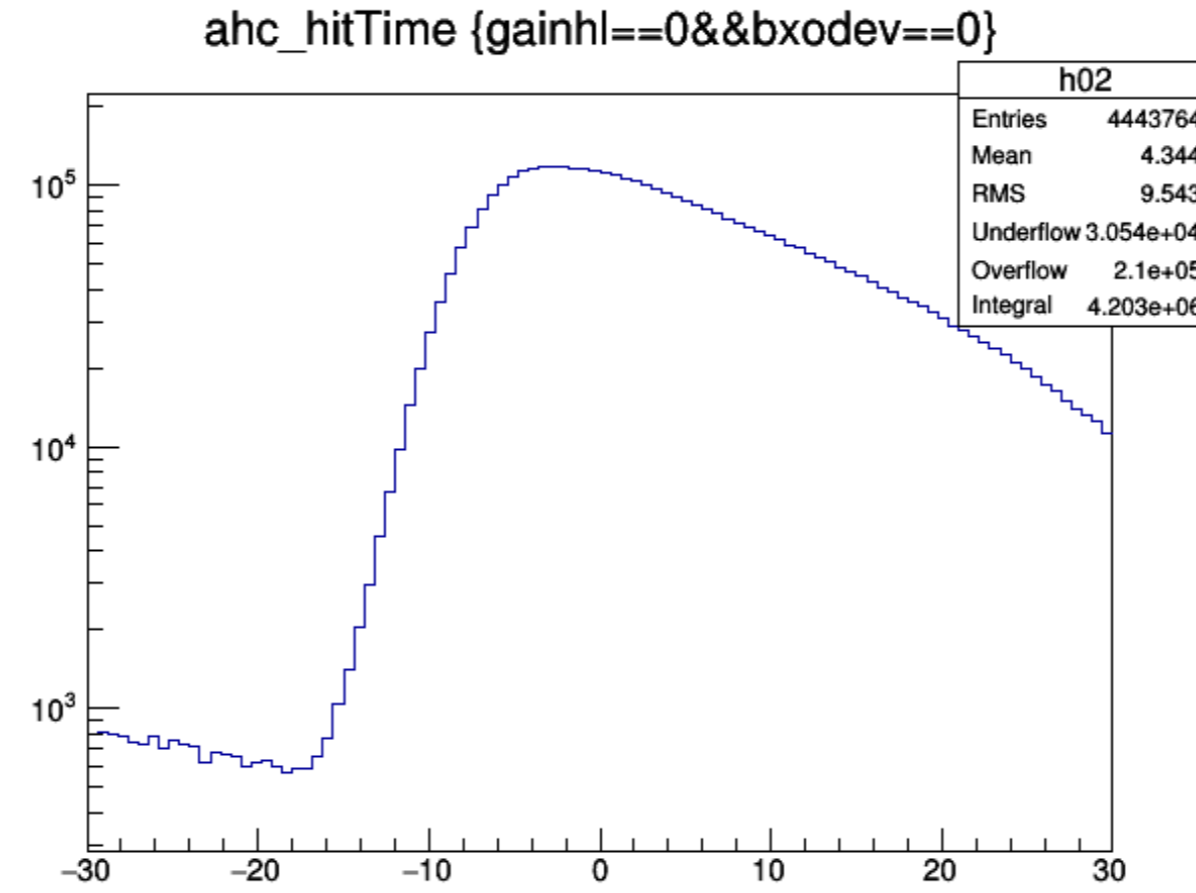
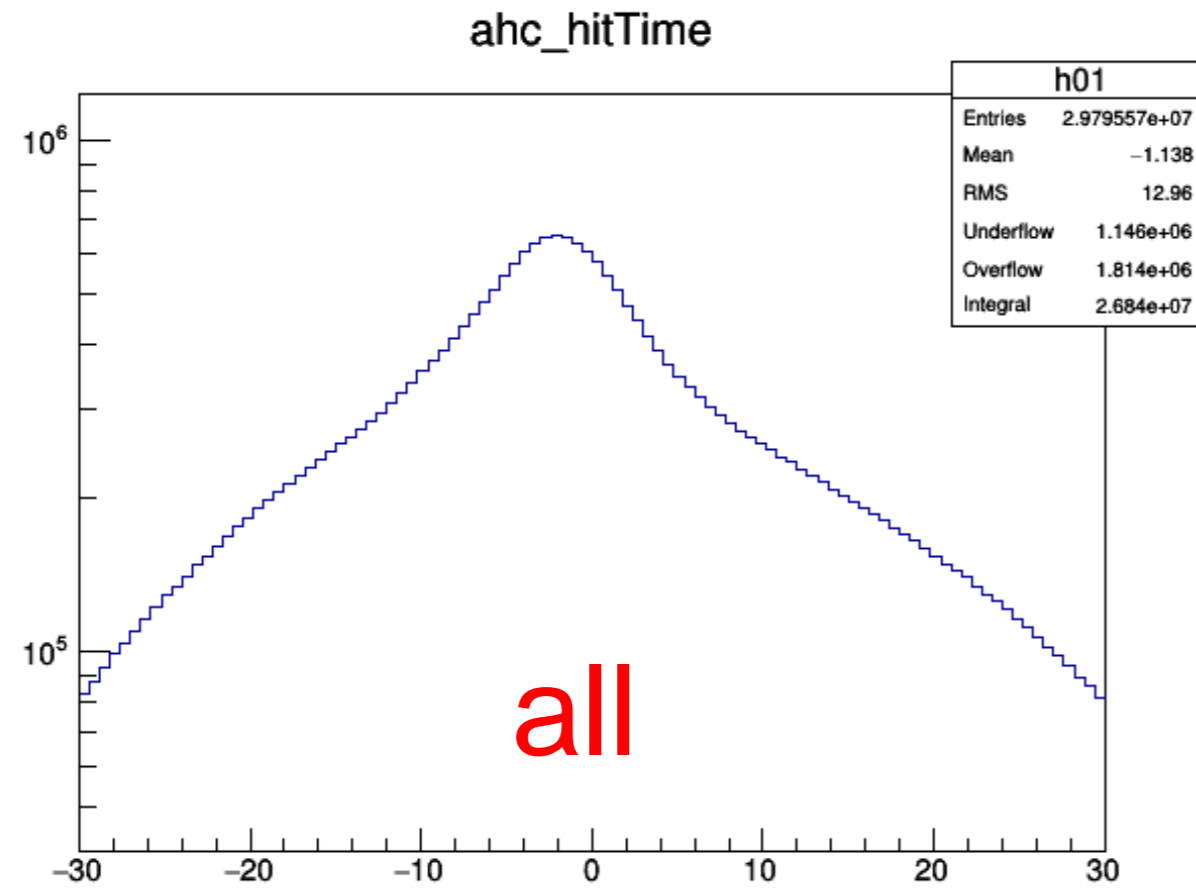
chip#

channel#

cell#

Electrons: hitTime vs Gain/BeamCrossing

vsbx_20190719b reco_run60512_testNewConstants.root

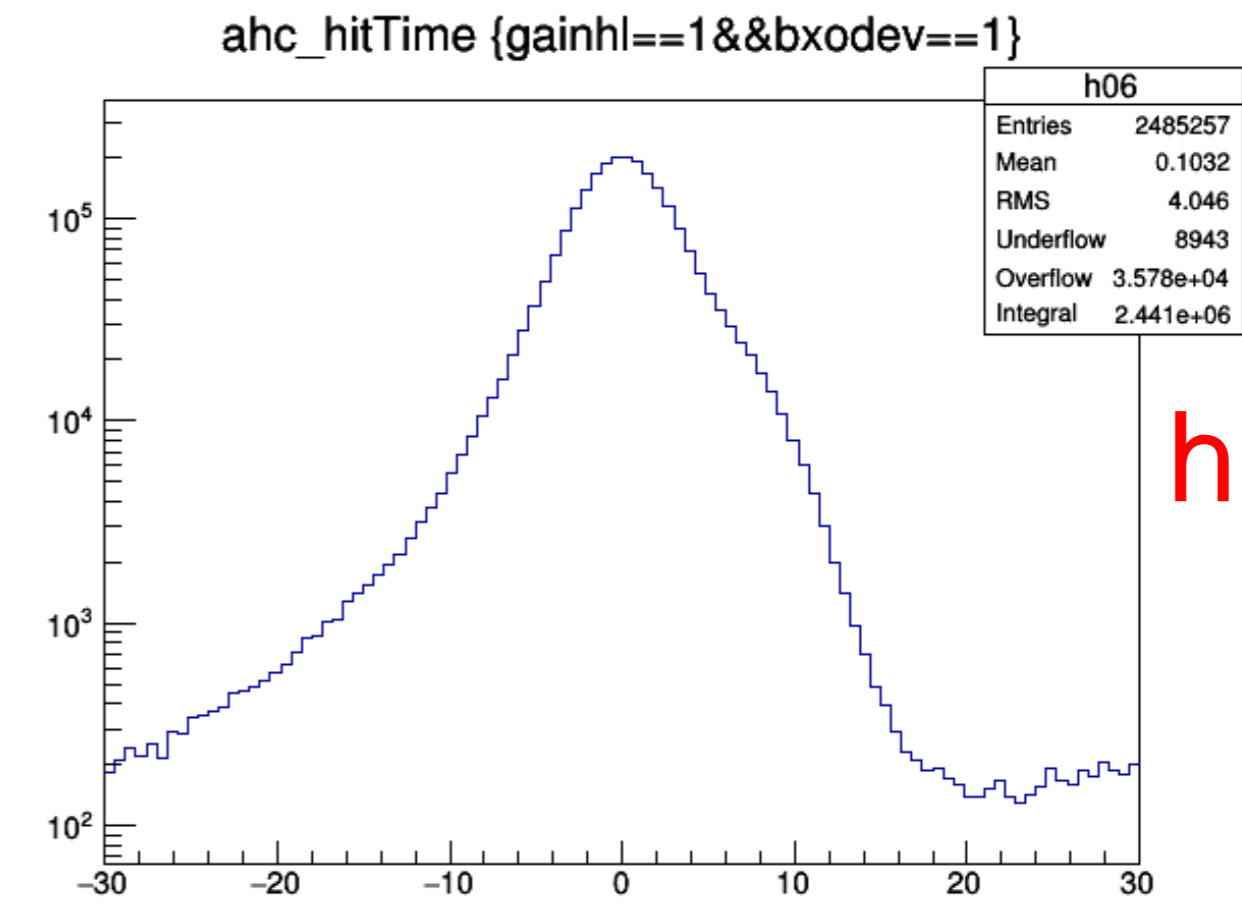
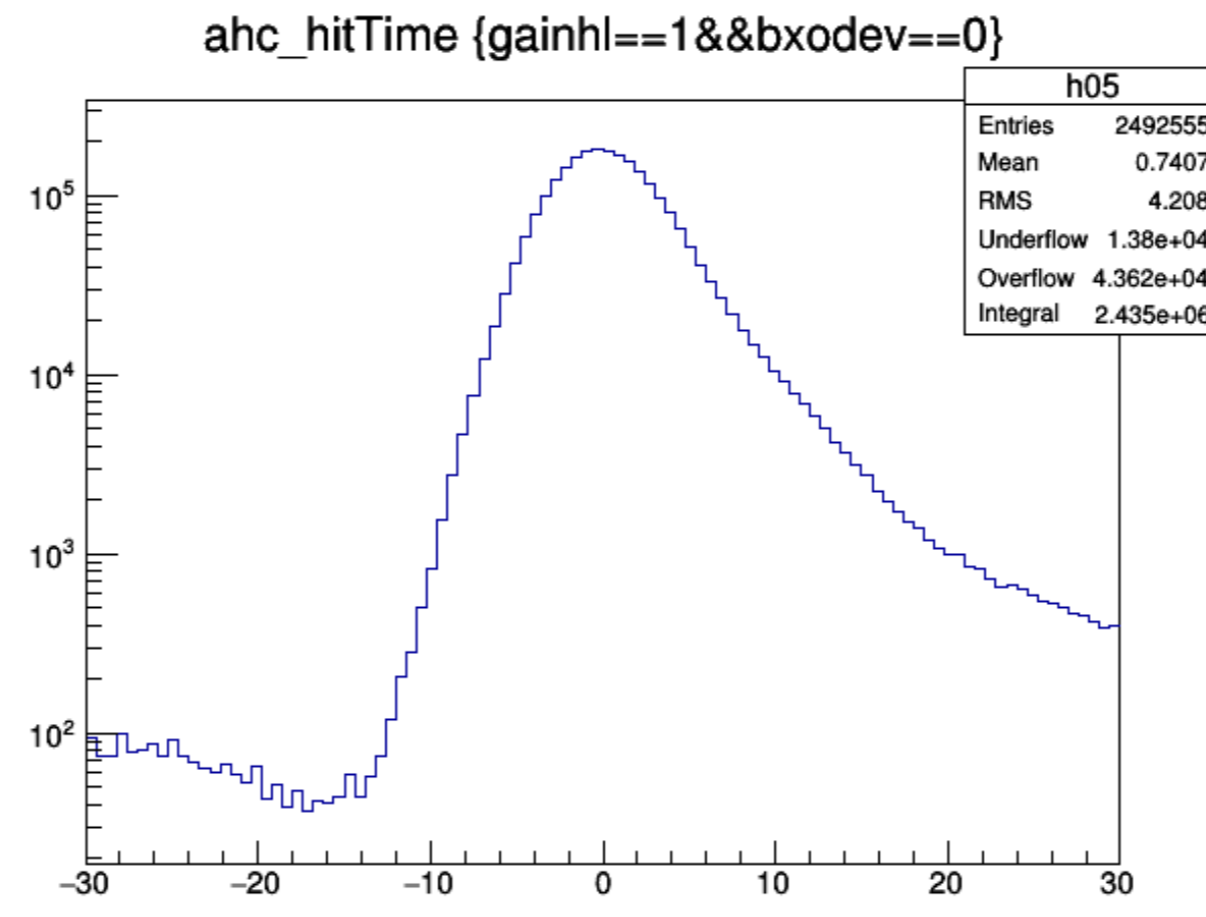
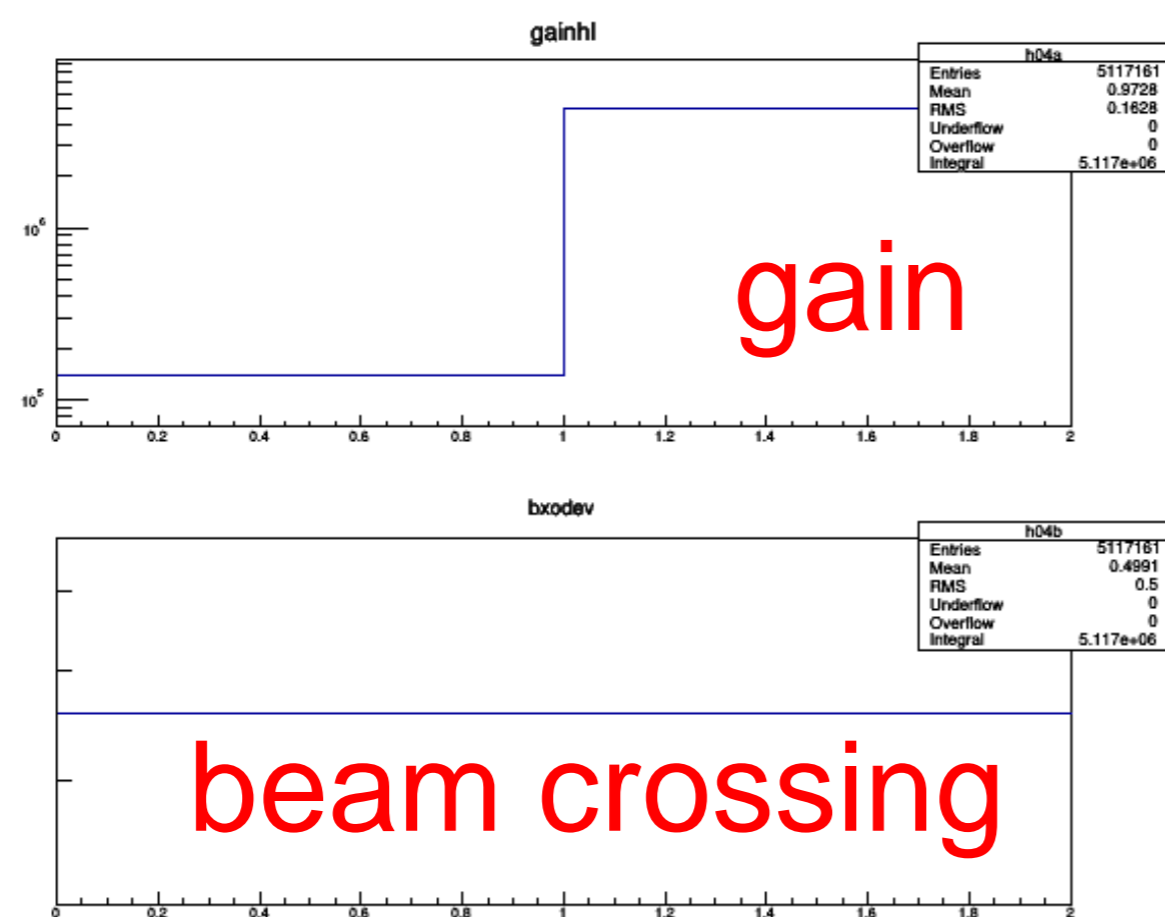
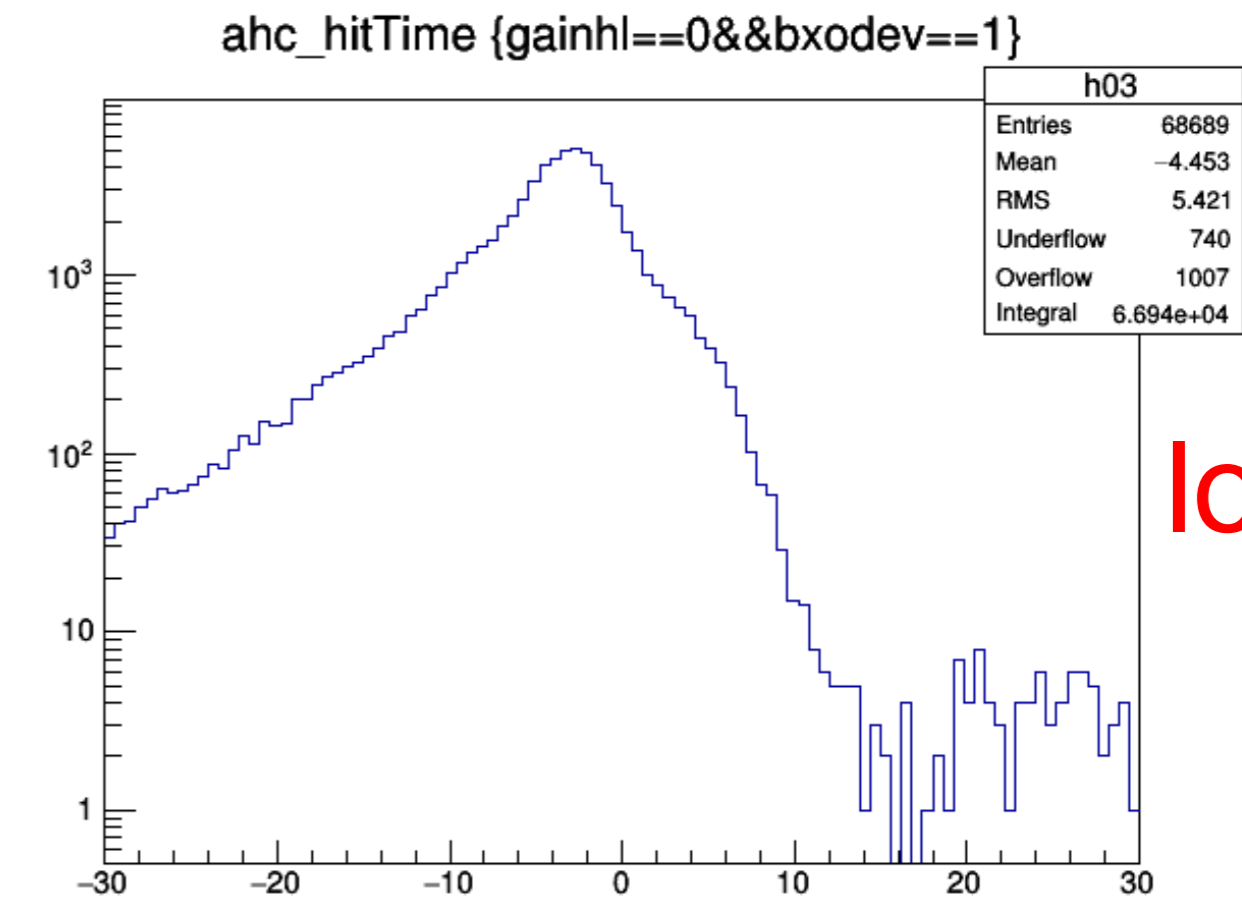
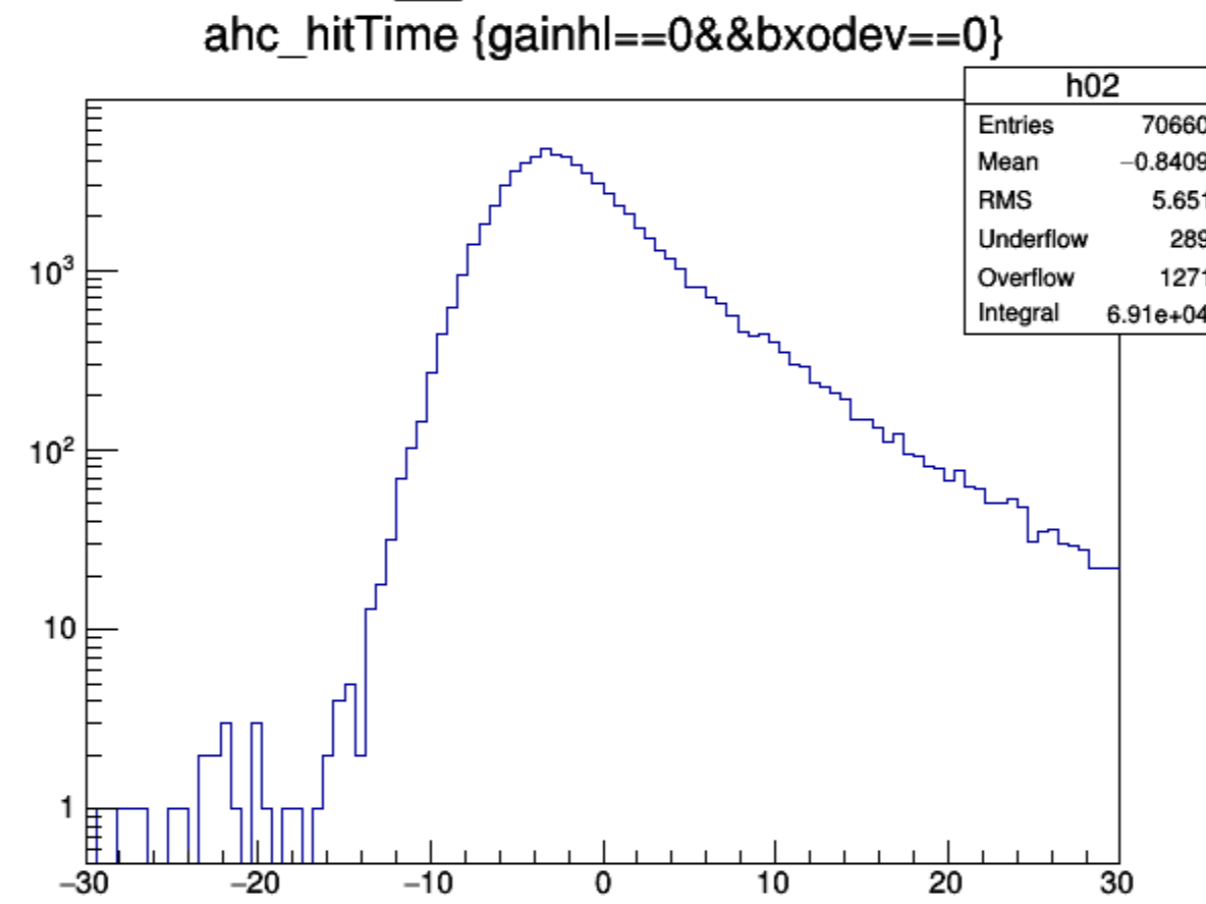
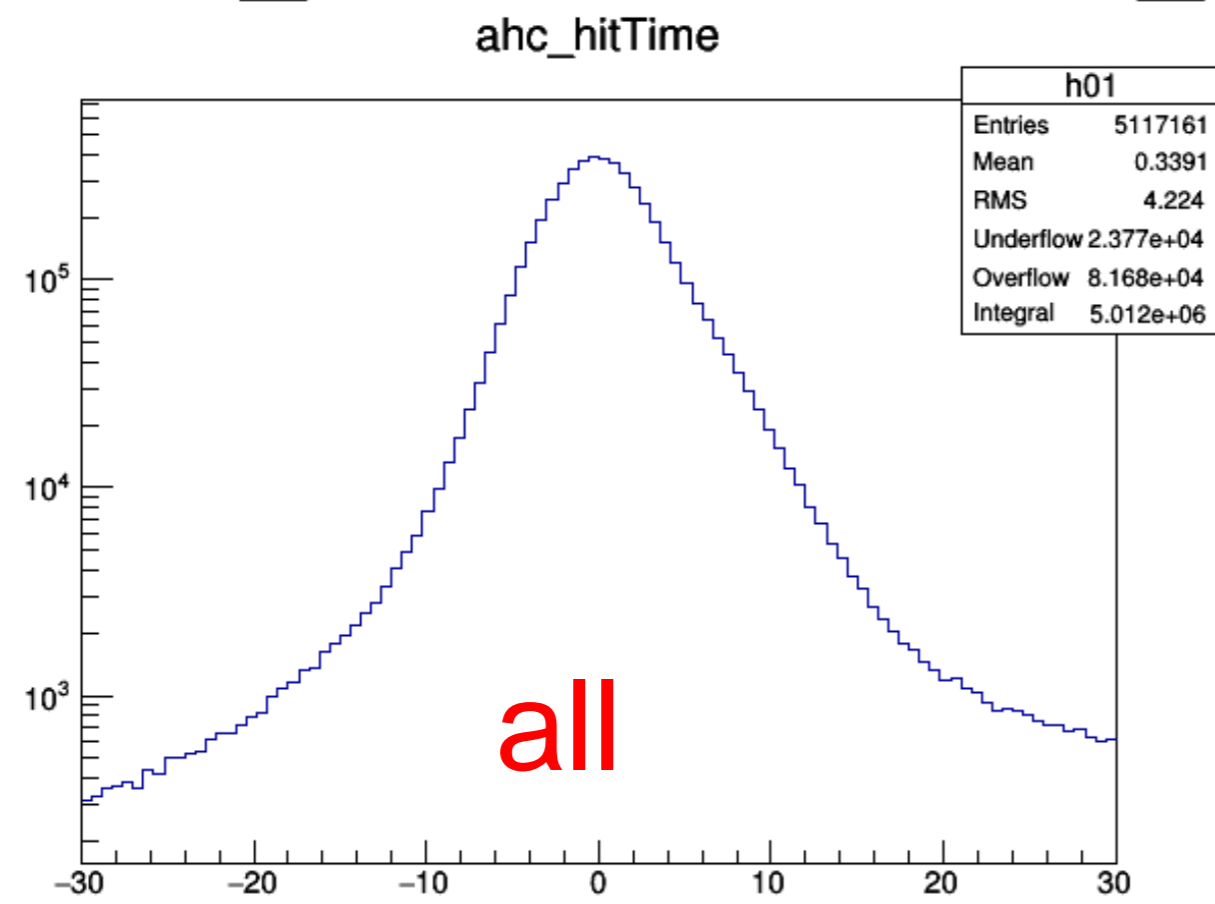


even BX

odd BX

Muons: hitTime vs Gain/BeamCrossing

vsbx_20190719b reco_run60382_testNewConstants.root



even BX

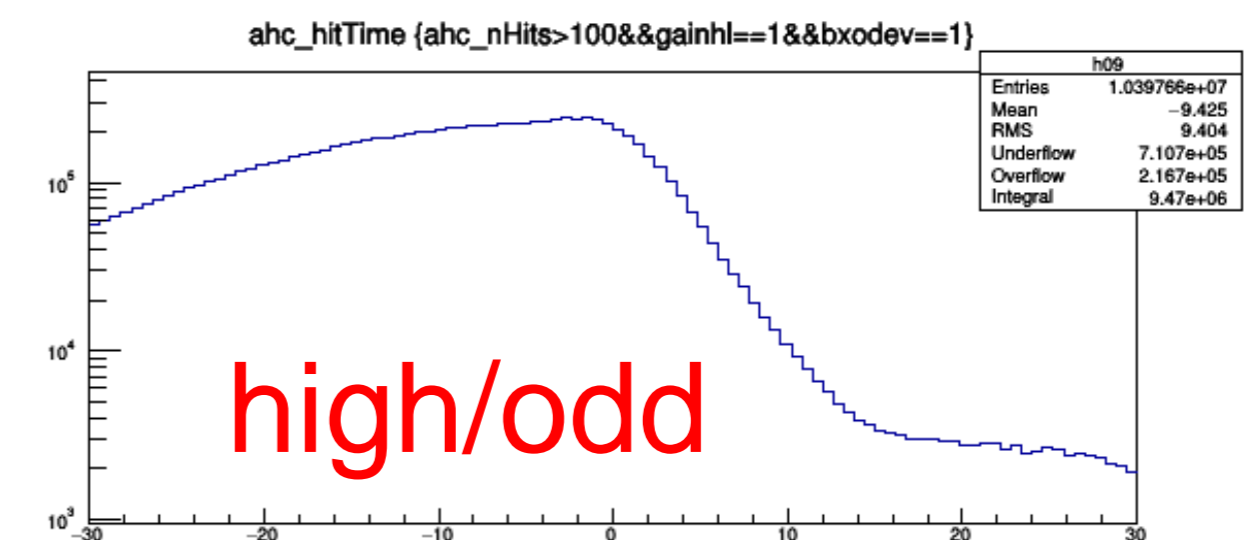
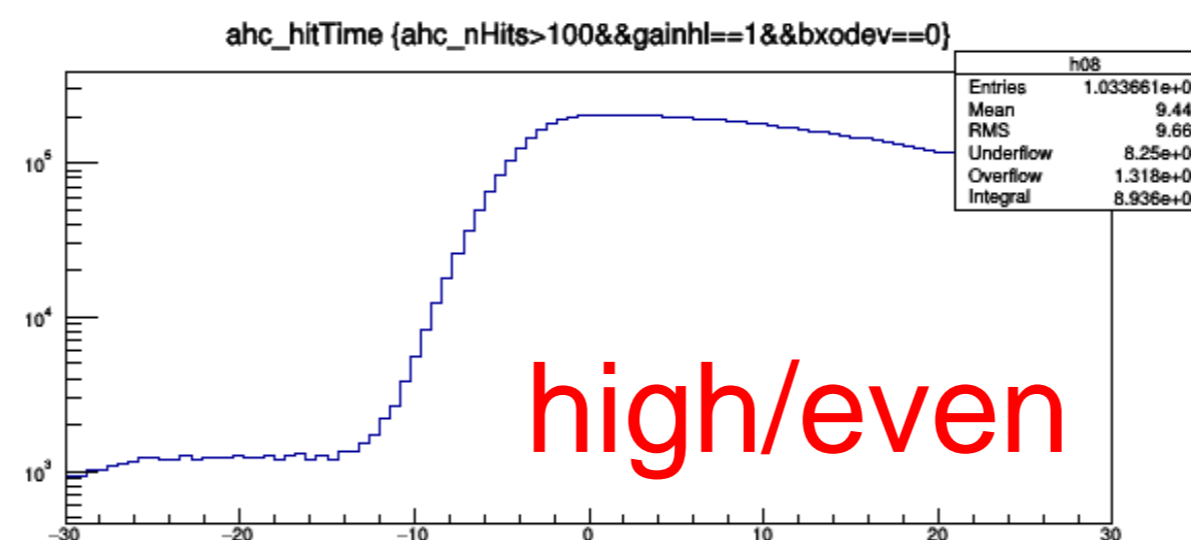
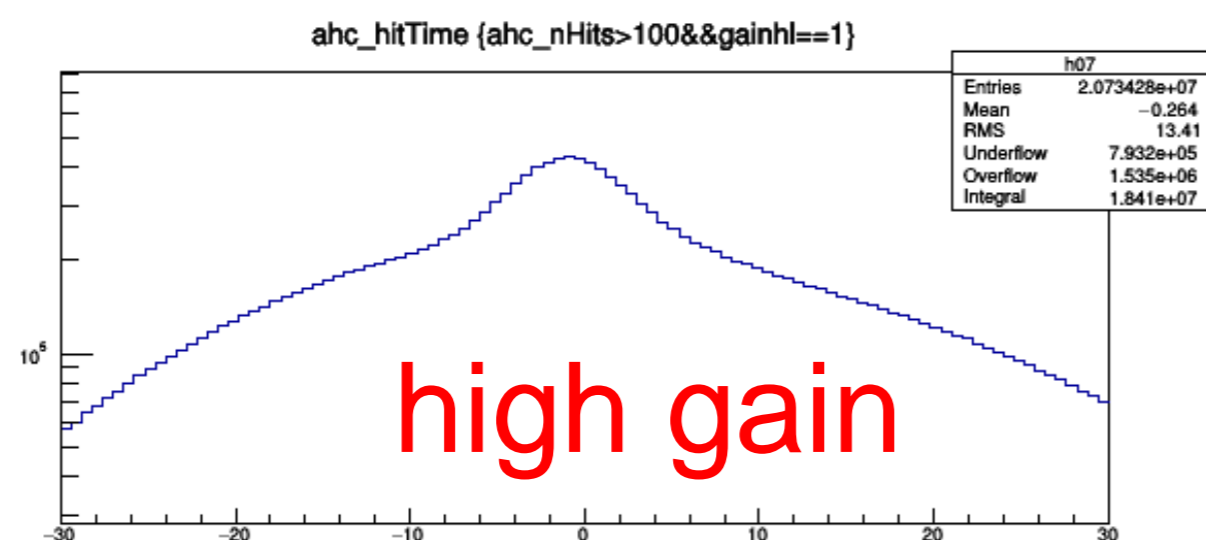
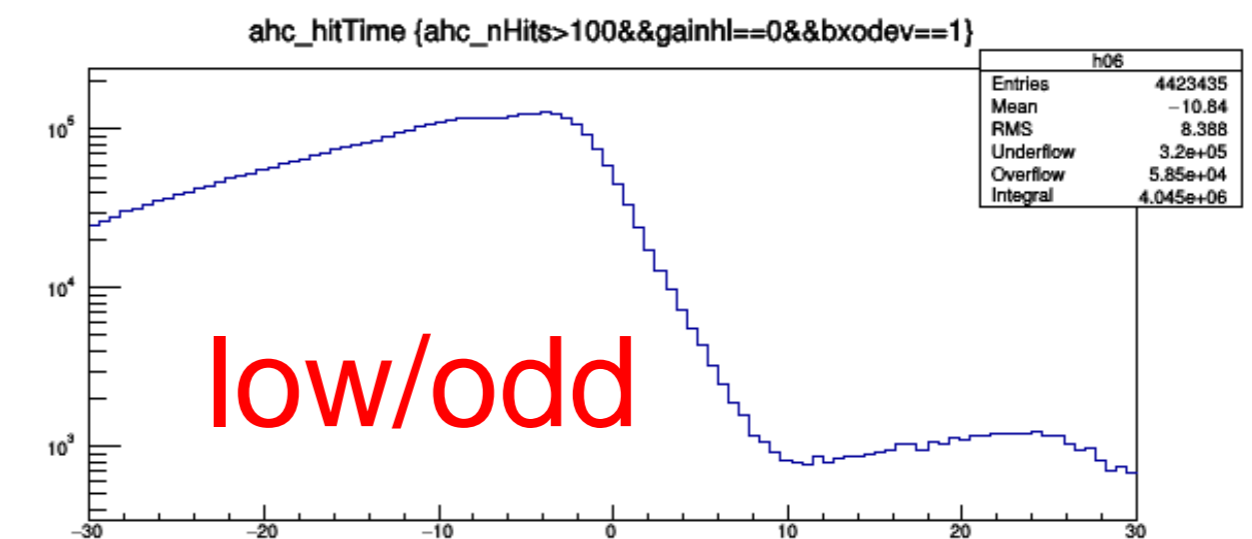
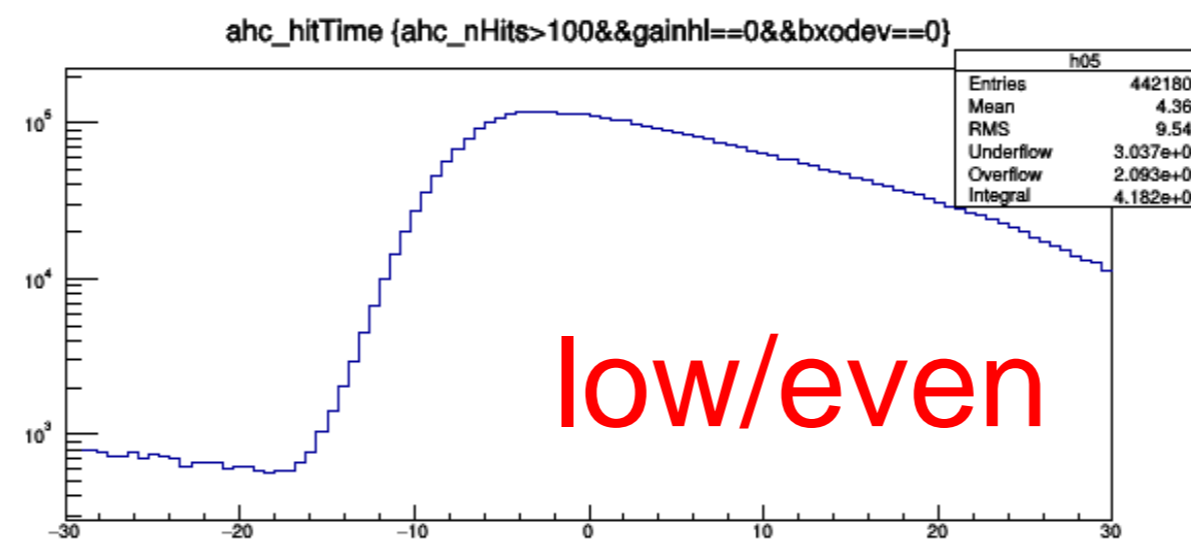
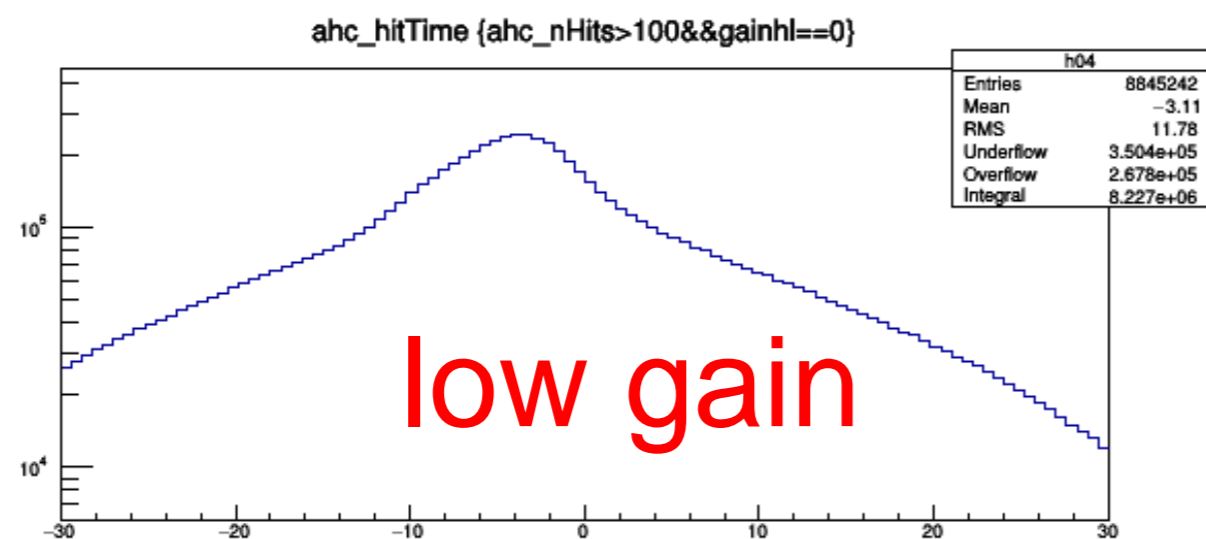
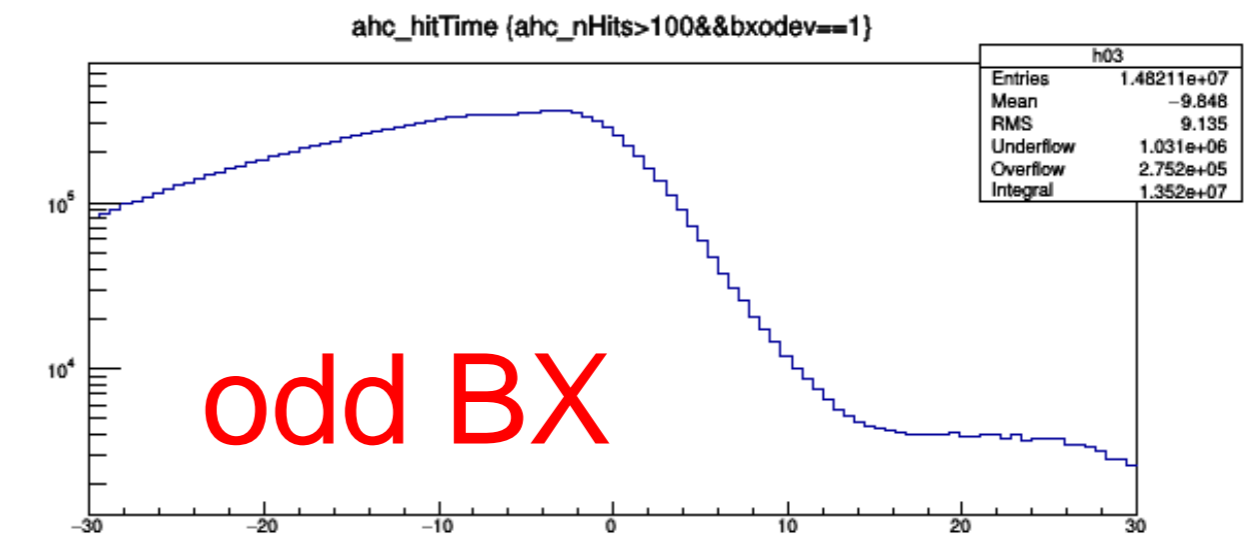
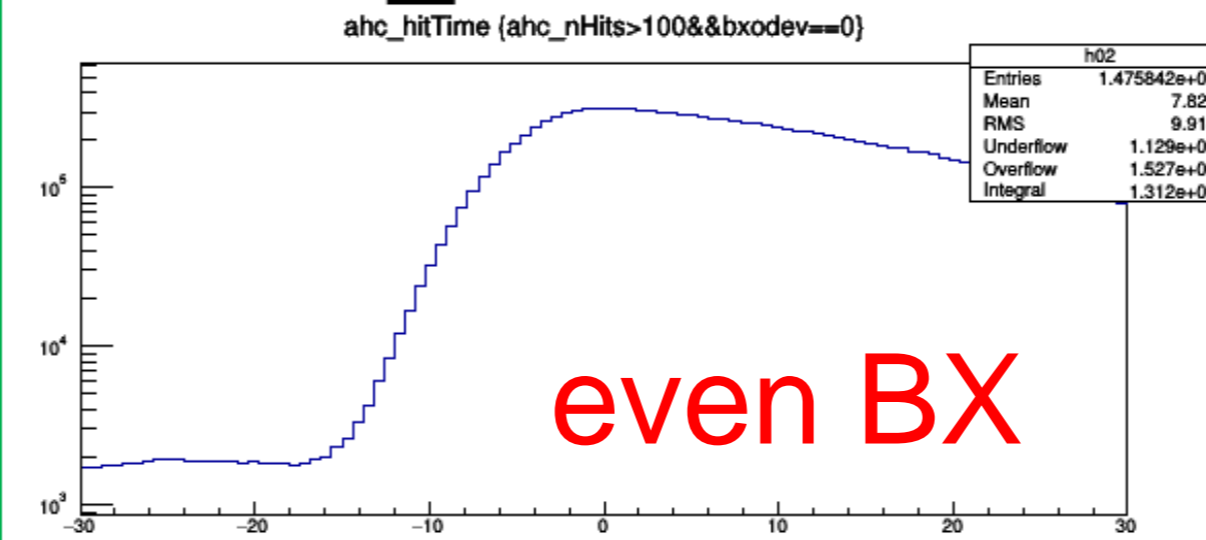
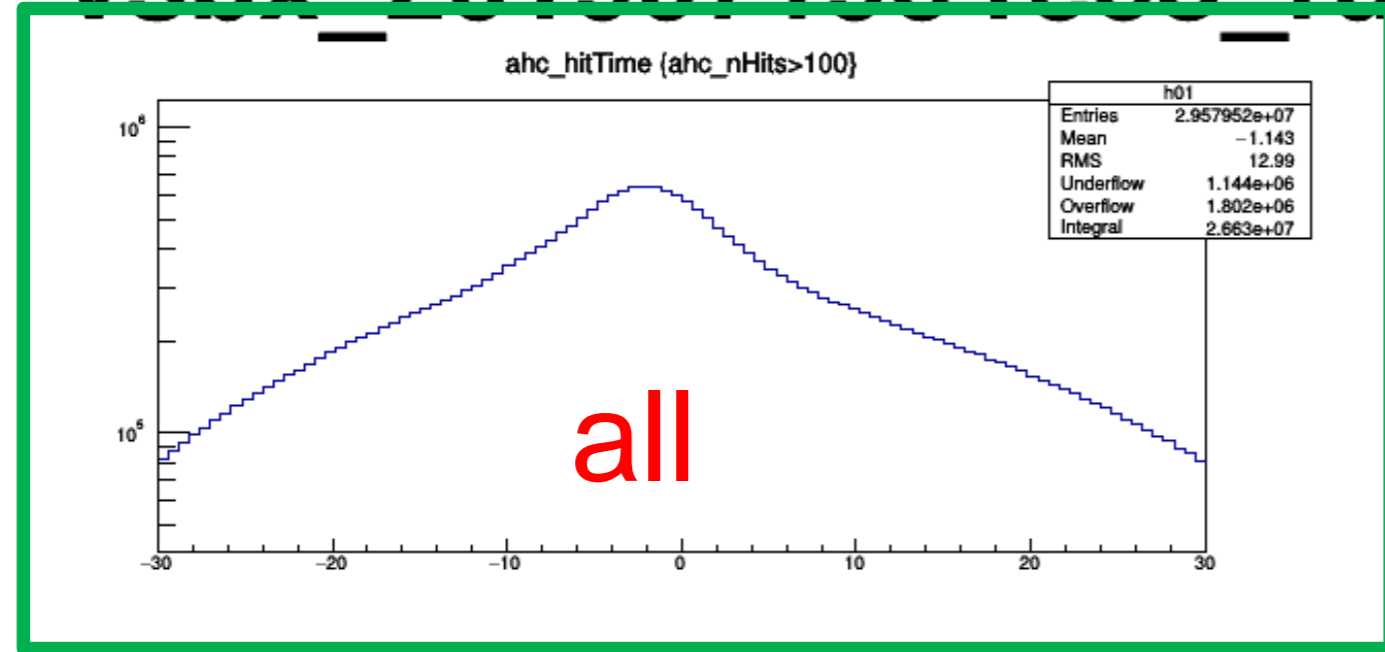
odd BX

low gain

high gain

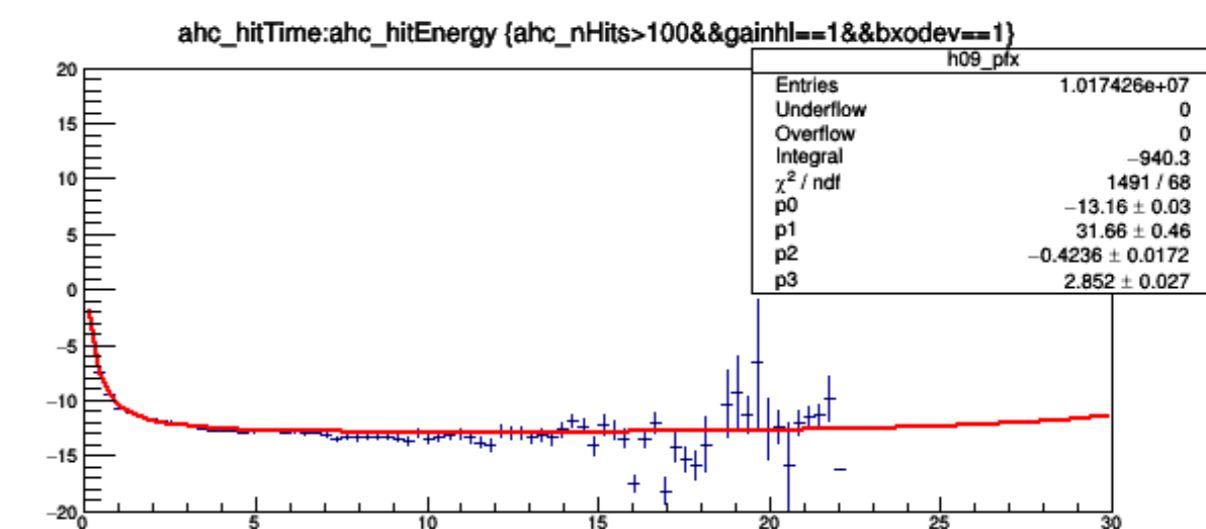
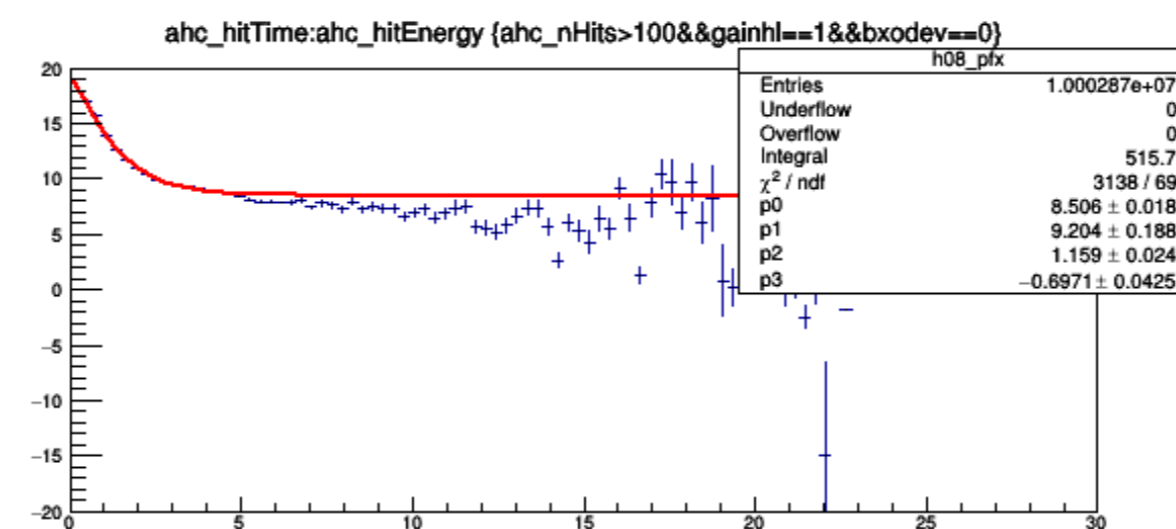
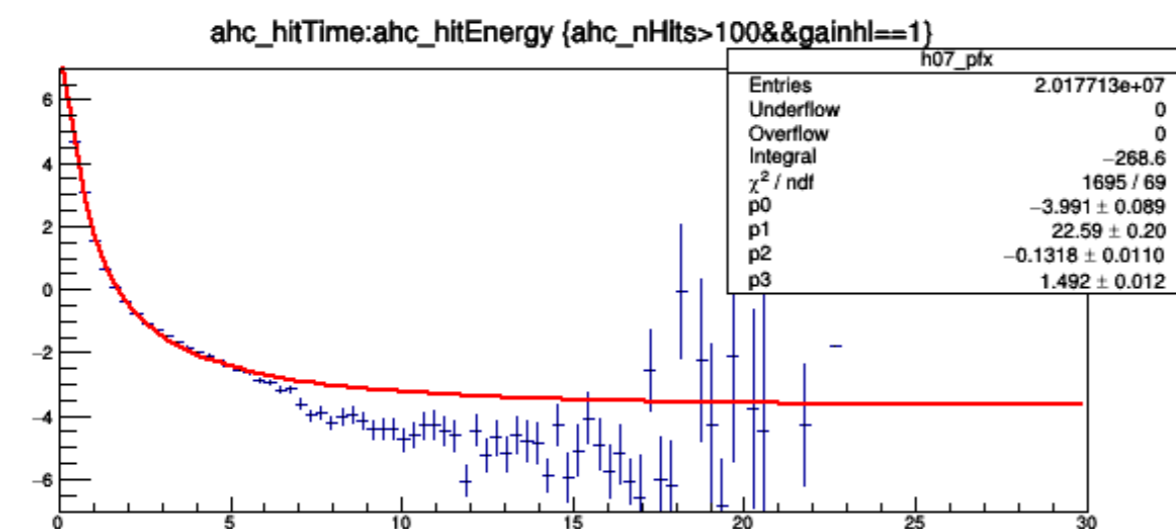
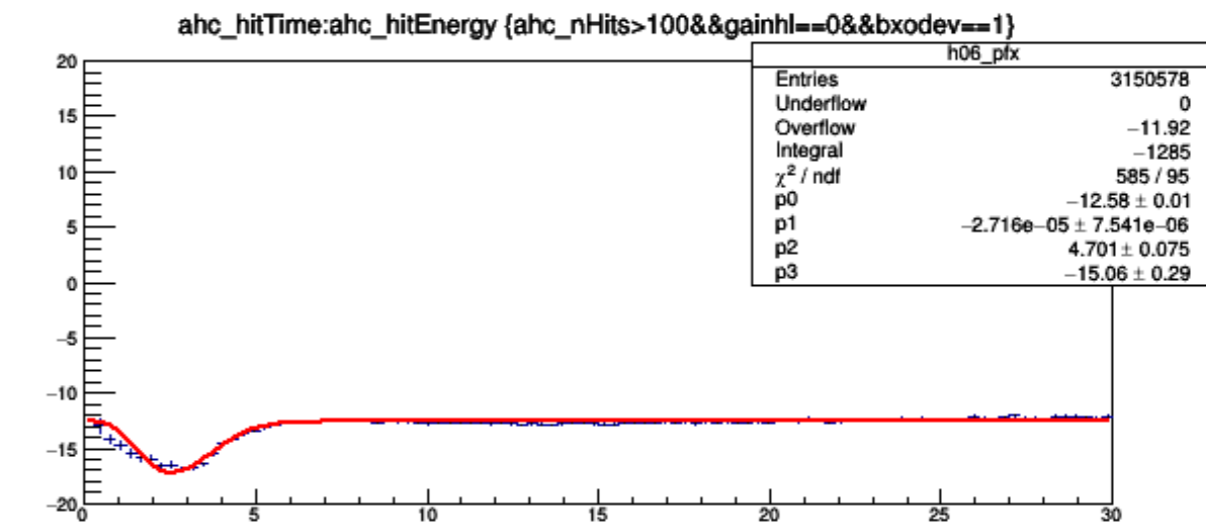
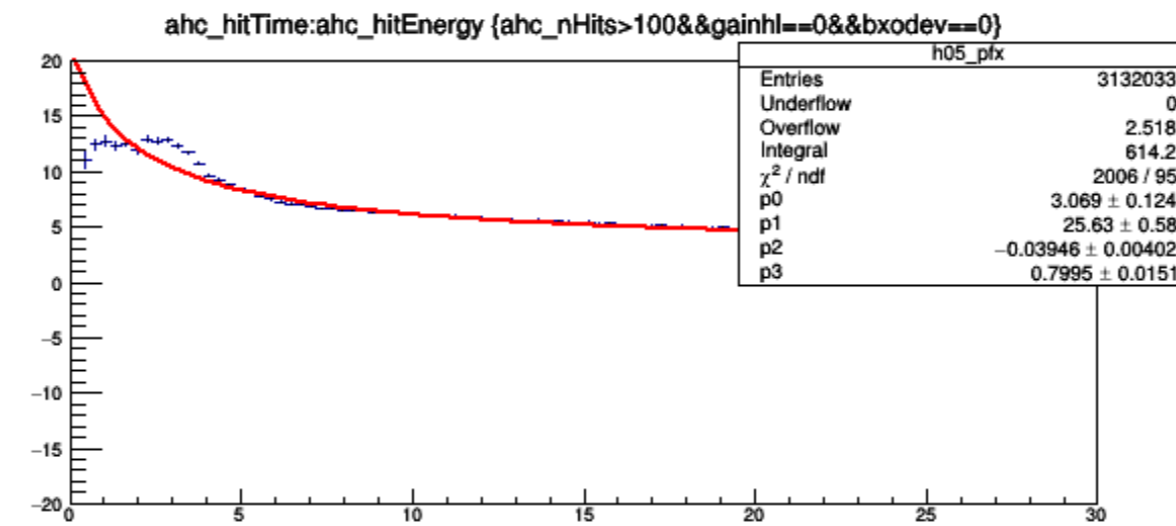
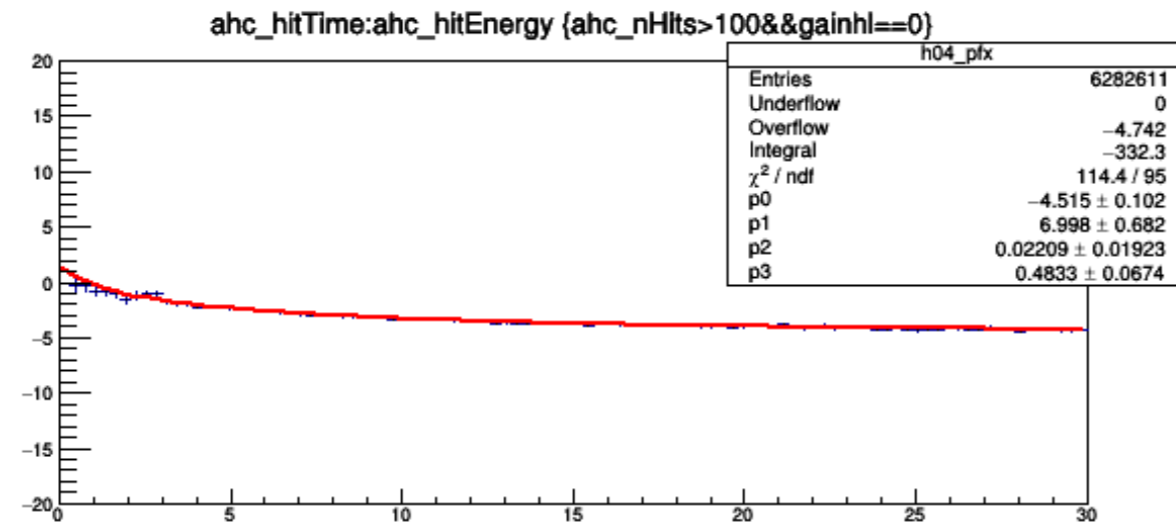
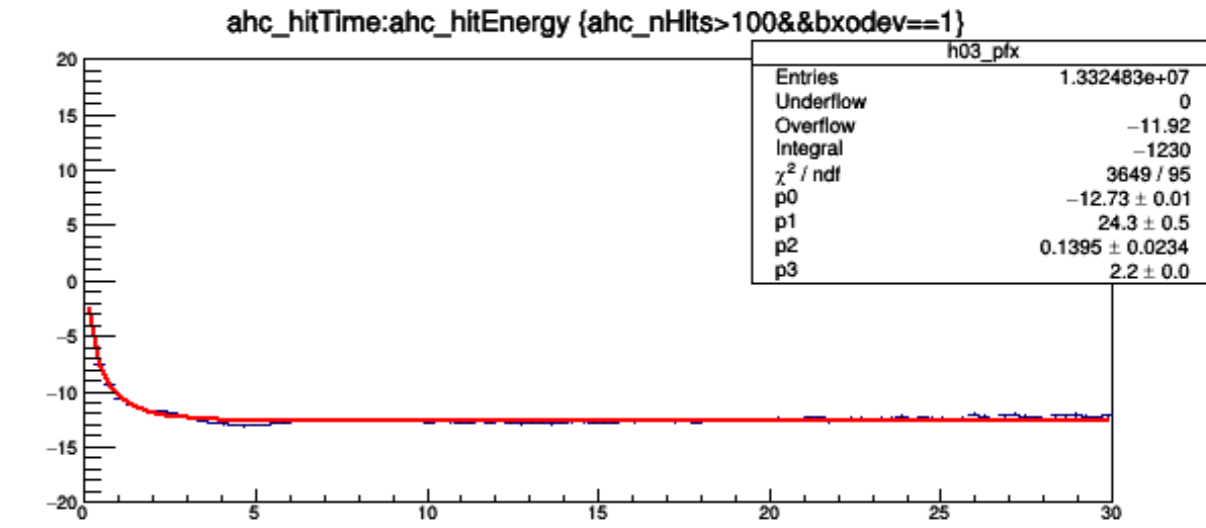
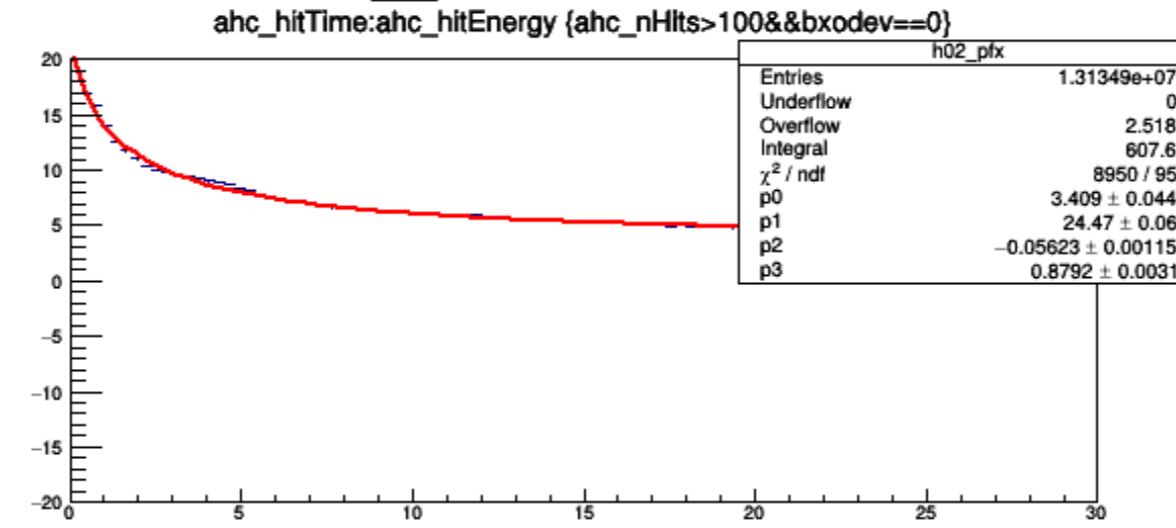
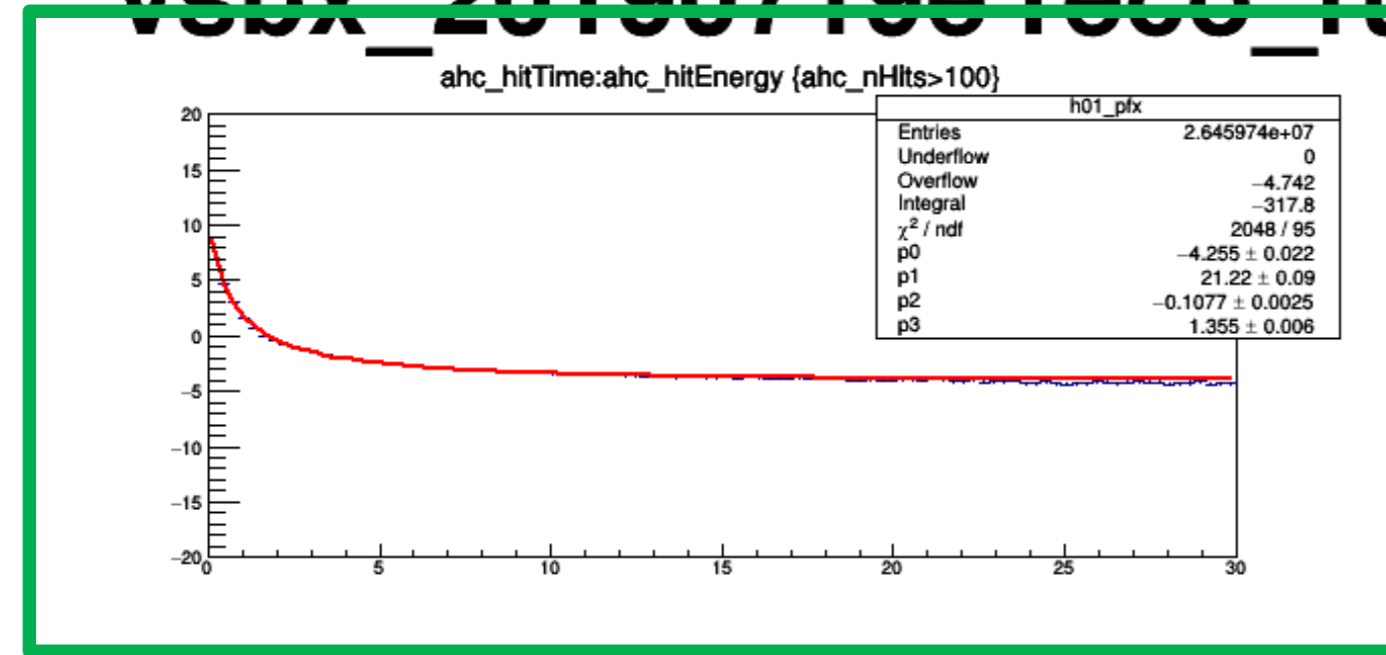
Electrons: hitTime vs Gain/BeamCrossing

vsbx_20190719c reco_run60512_testNewConstants.root



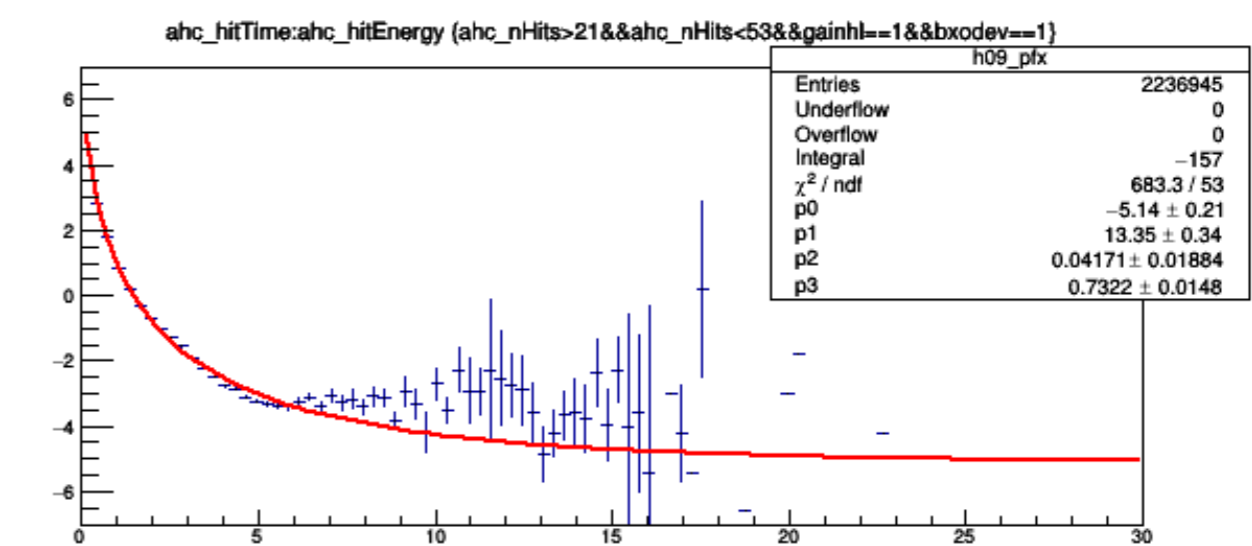
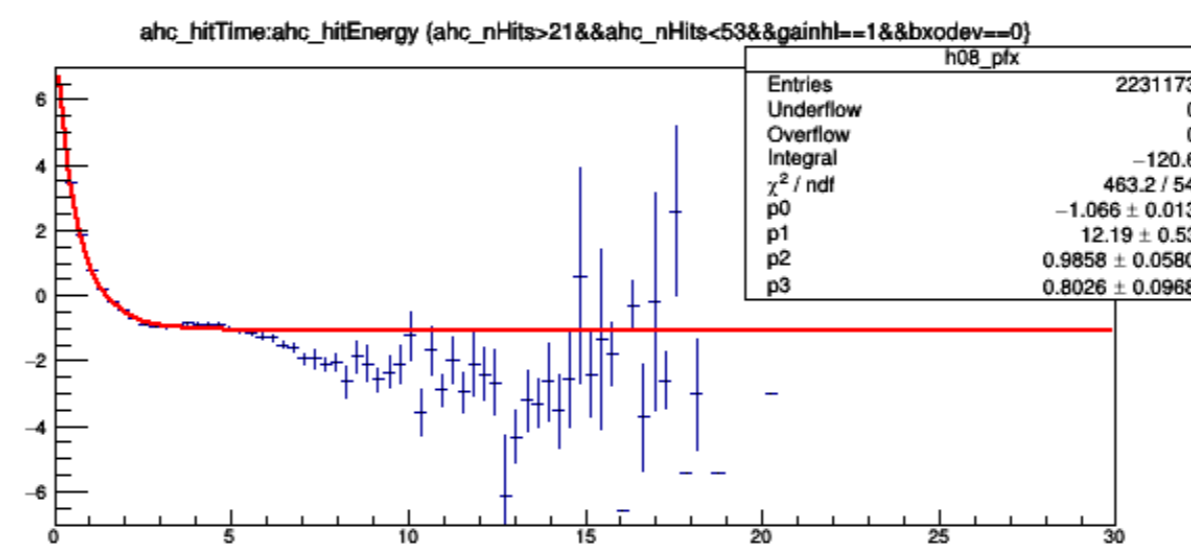
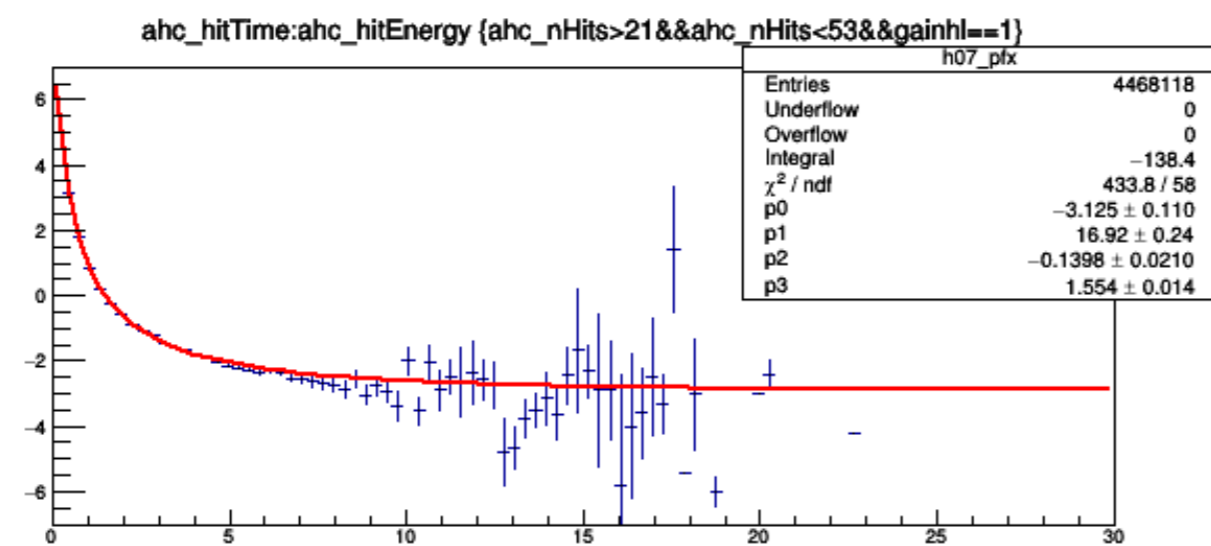
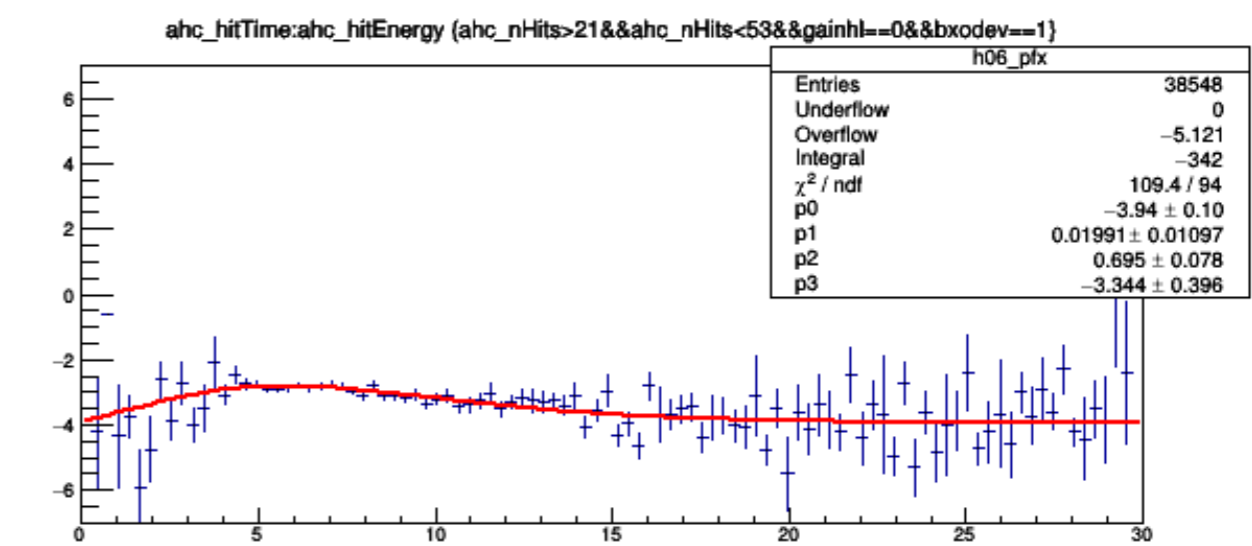
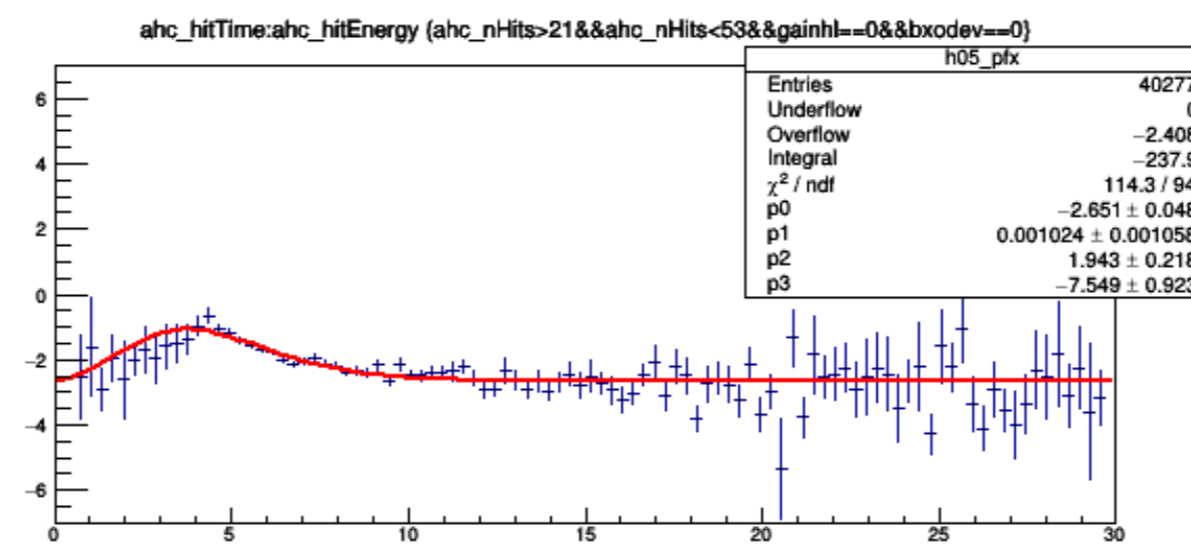
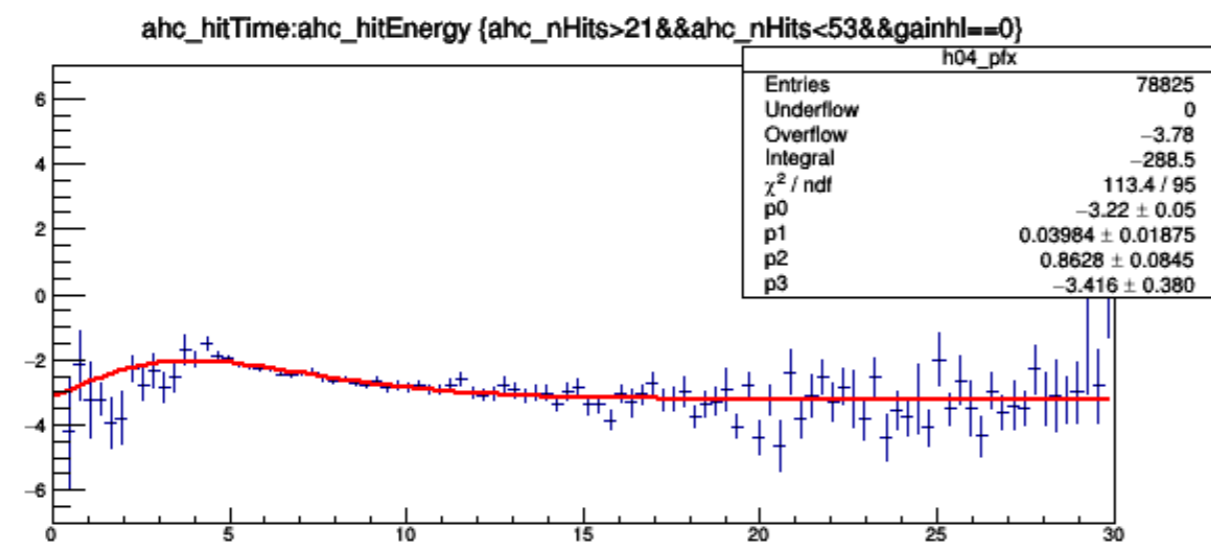
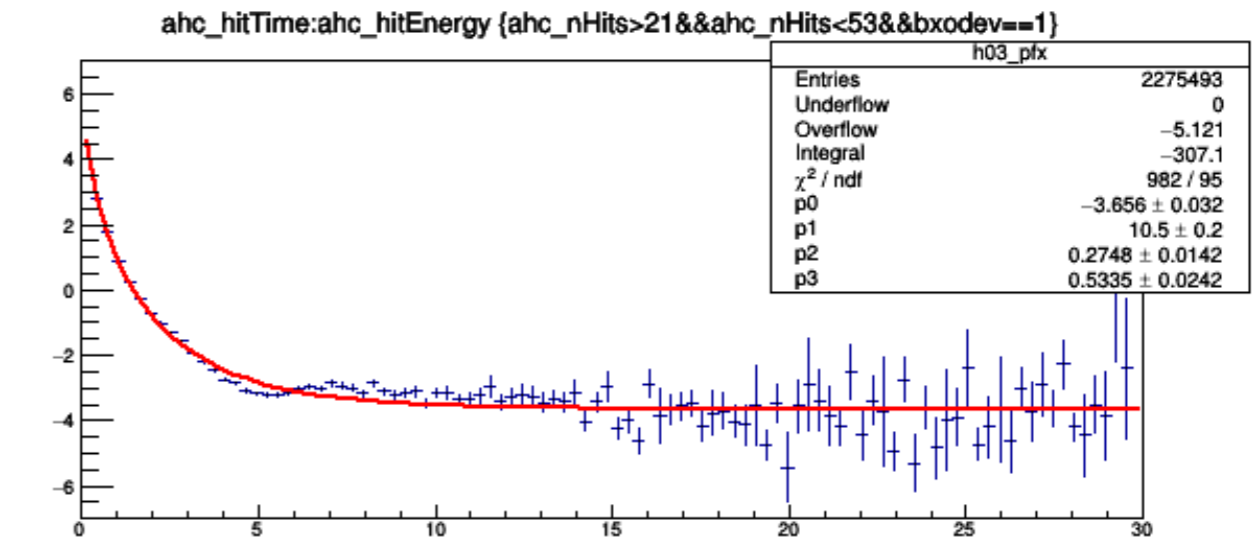
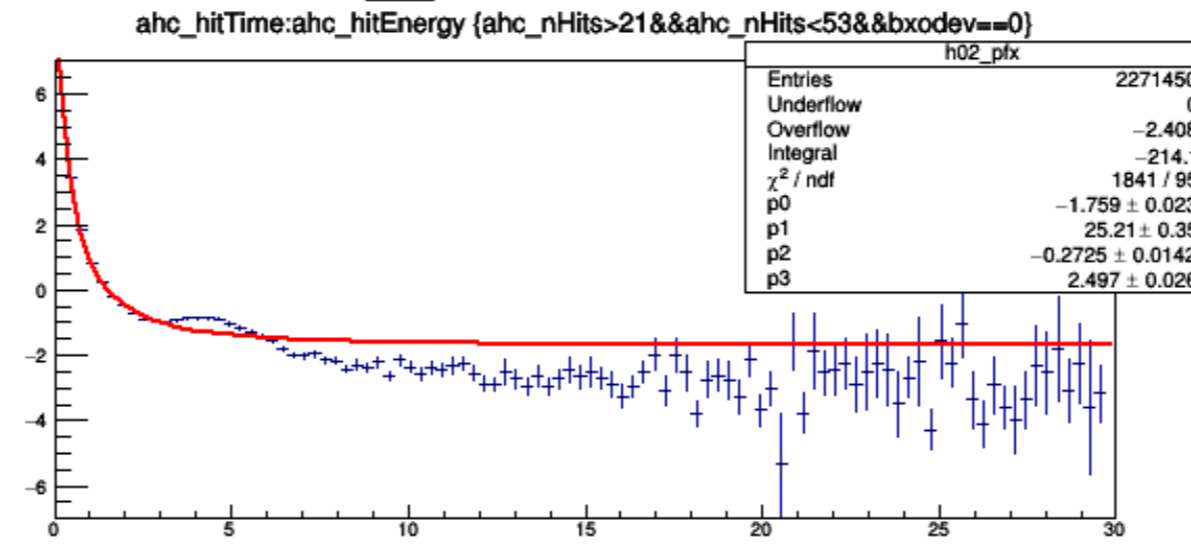
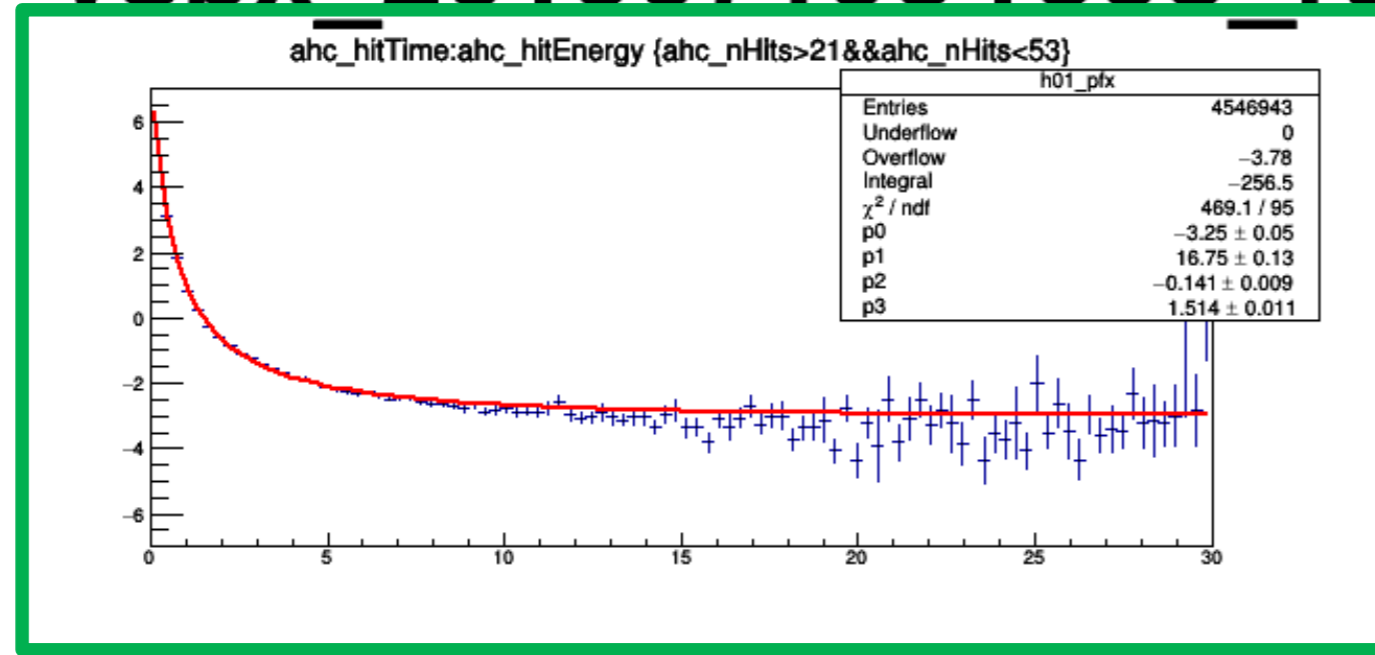
.. Hit Time vs Hit Energy

vsbx_20190719e_reco_run60512_testNewConstants.root



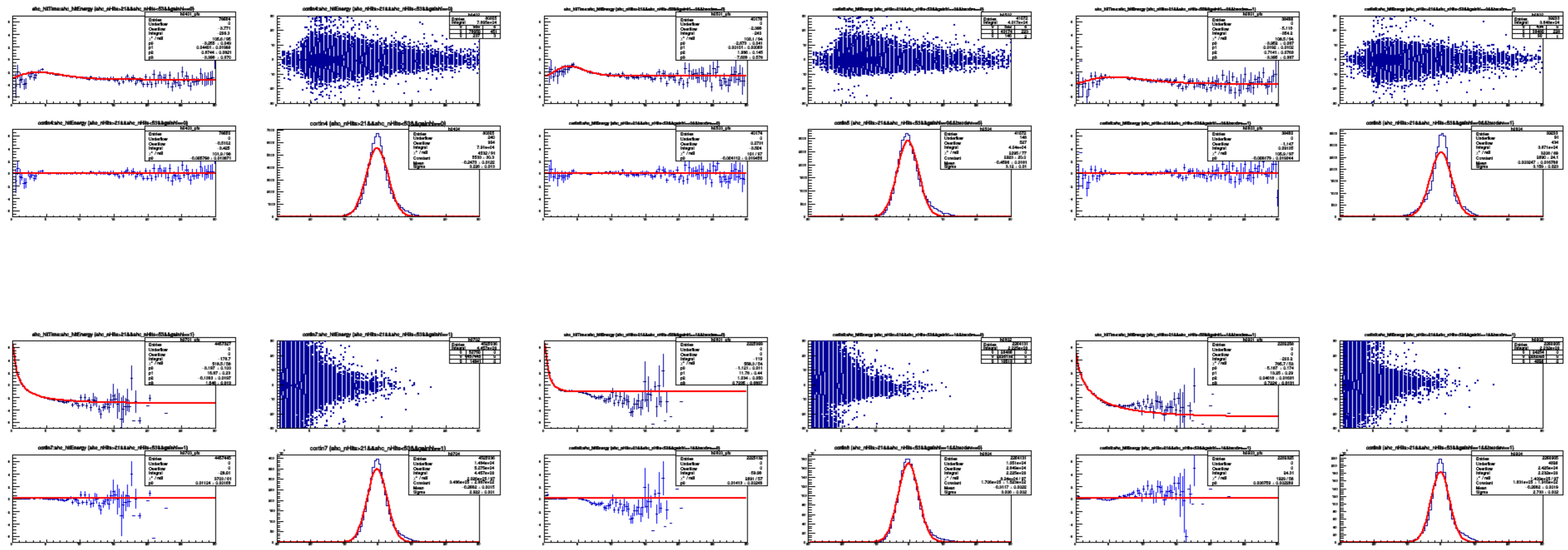
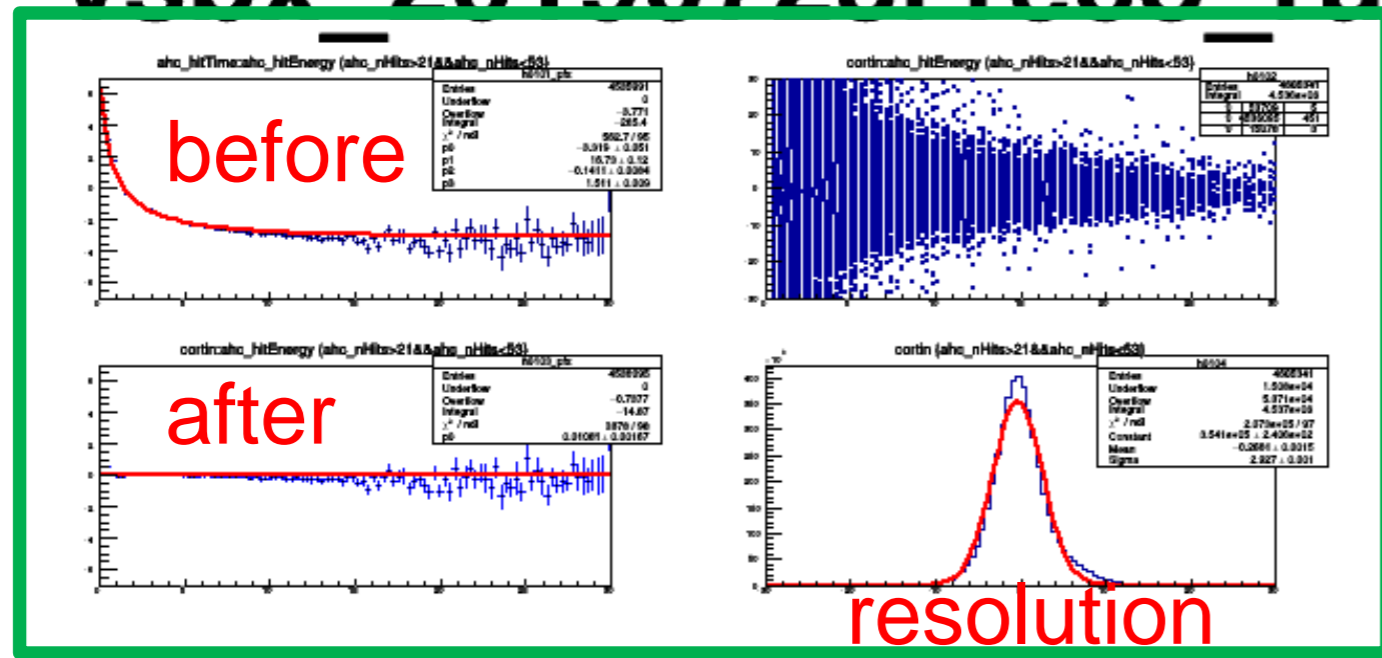
.. same for Muons

vsbx_20190719e_reco_run60382_testNewConstants.root



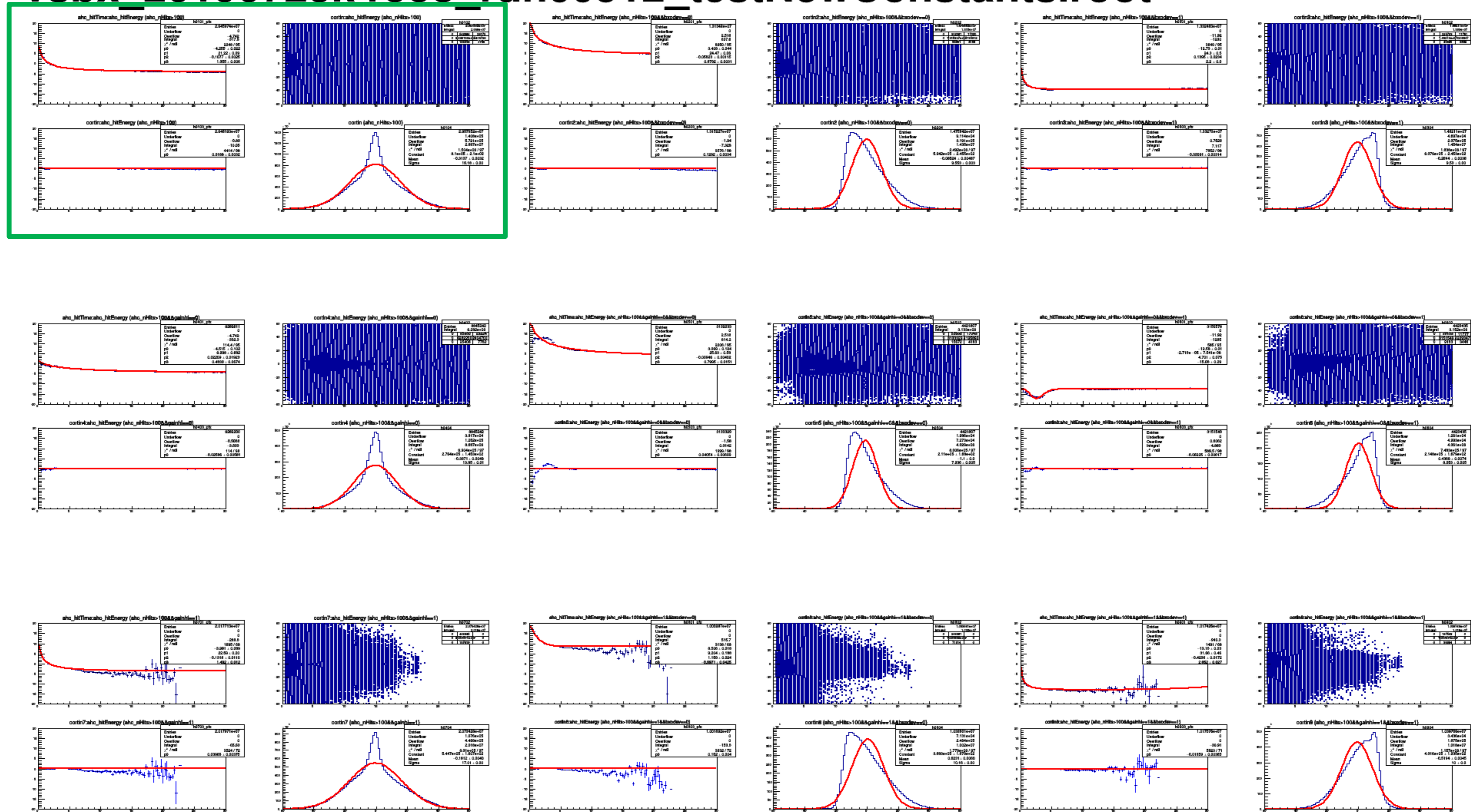
Muons: Time Walk Correction + Resolution

vsbx_20190723I_reco_run60382_testNewConstants.root



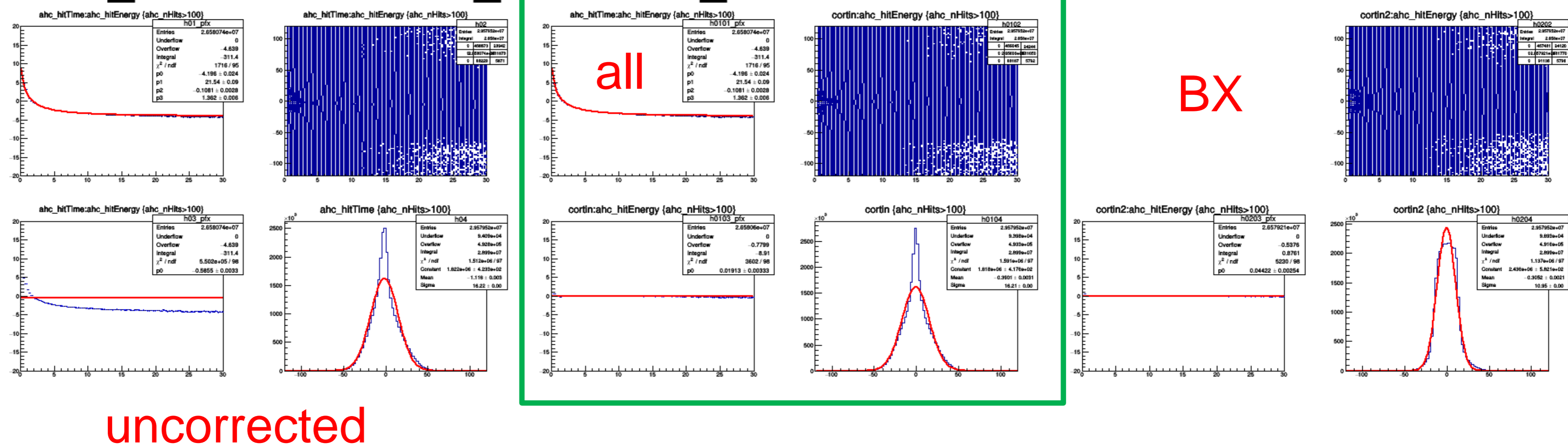
Electrons: Time Walk Correction + Resolution

vsbx_20190723k reco run60512_testNewConstants.root



Electrons: Global Correction + Resolution

vsbx_20190723n reco_run60512_testNewConstants.root



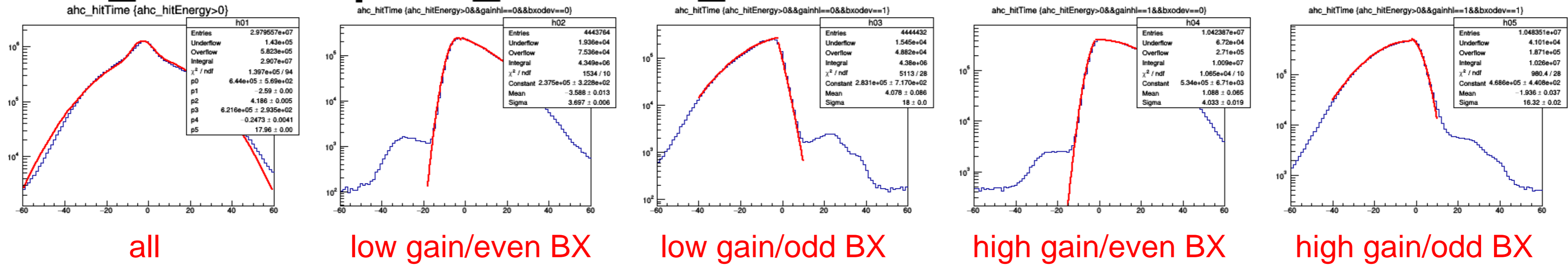
Muons: 10% improvement to ~2.9 ns

Electrons: from 16 to 10 ns?

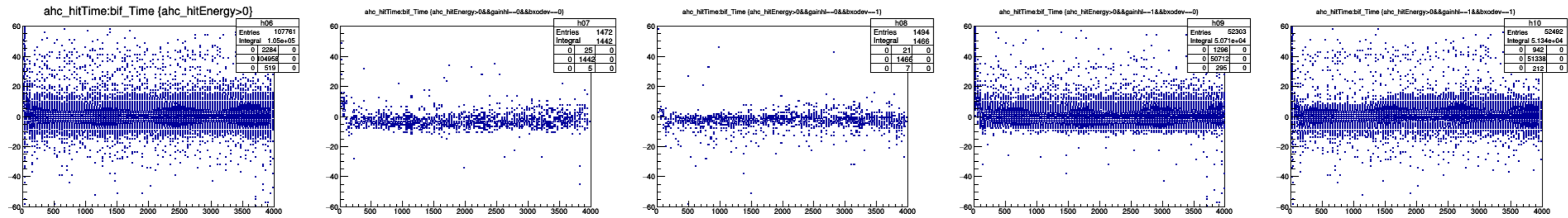
Electrons: hitTime vs Gain/BeamCrossing

vsbx_20190724q reco_run60512_testNewConstants.root

hit times

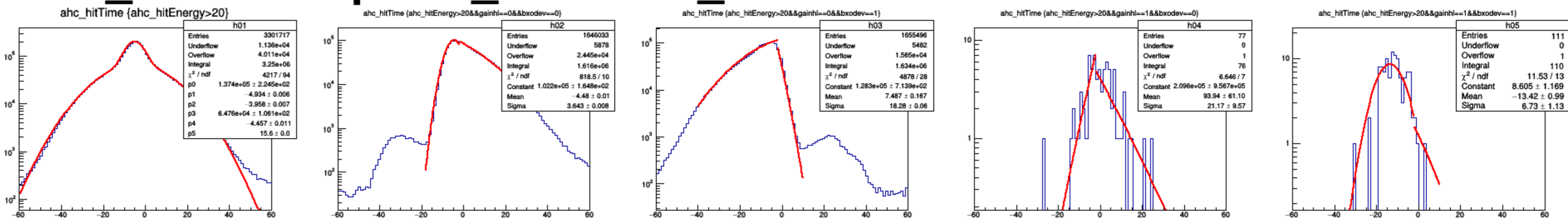


hit times vs bif time



vsbx_20190724q reco_run60512_testNewConstants.root

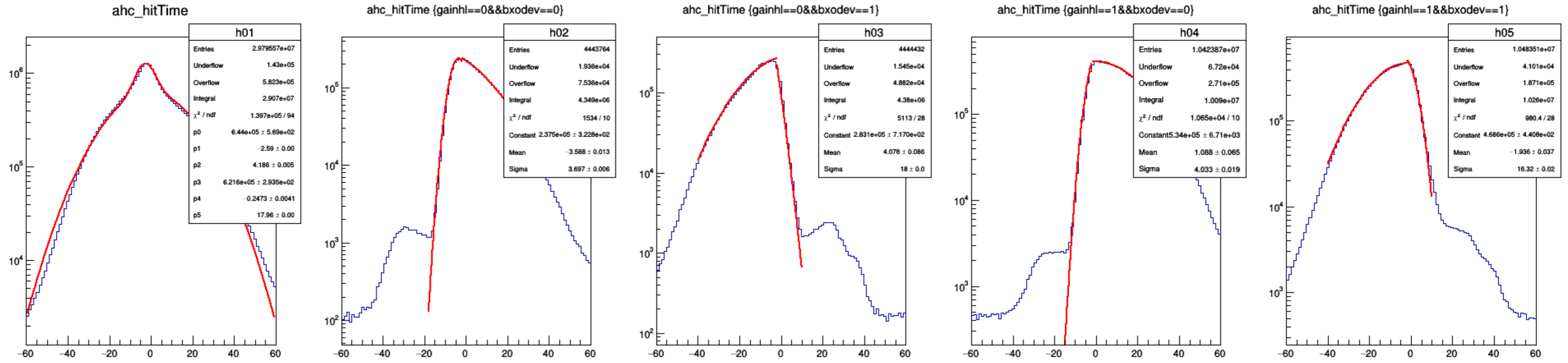
hit times with hit energy > 20 MIP



.. idem, vs hit Energy

vsbx_20190726u reco_run60512_testNewConstants.root

hit times



all

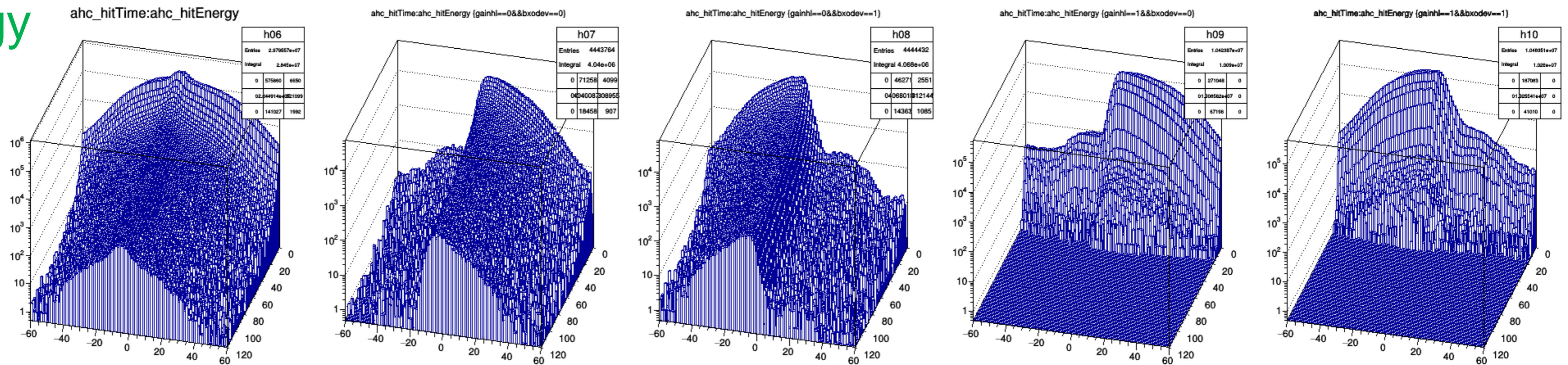
low gain/even BX

low gain/odd BX

high gain/even BX

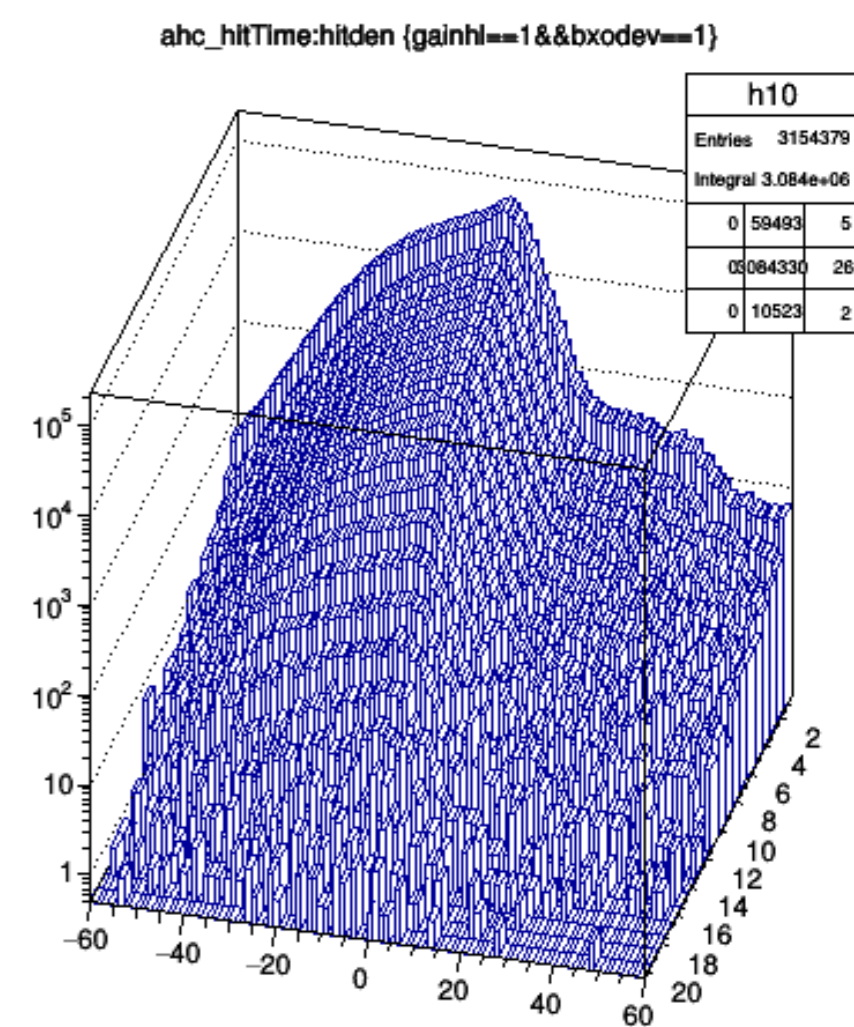
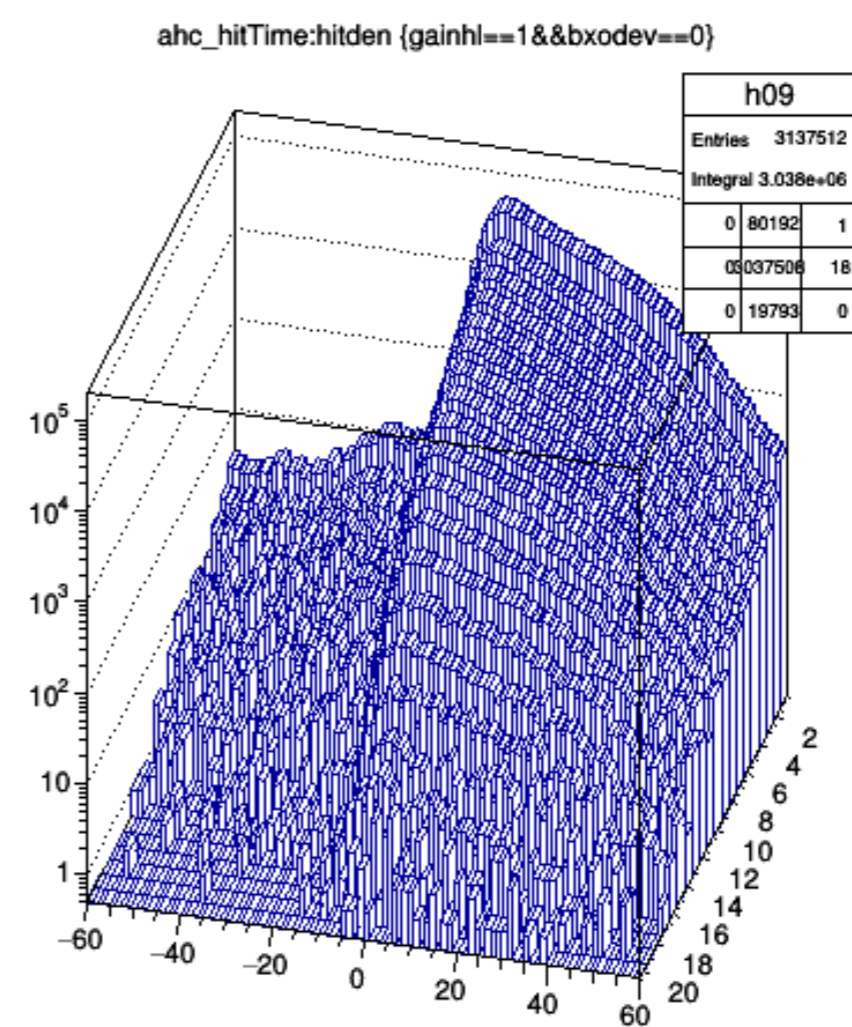
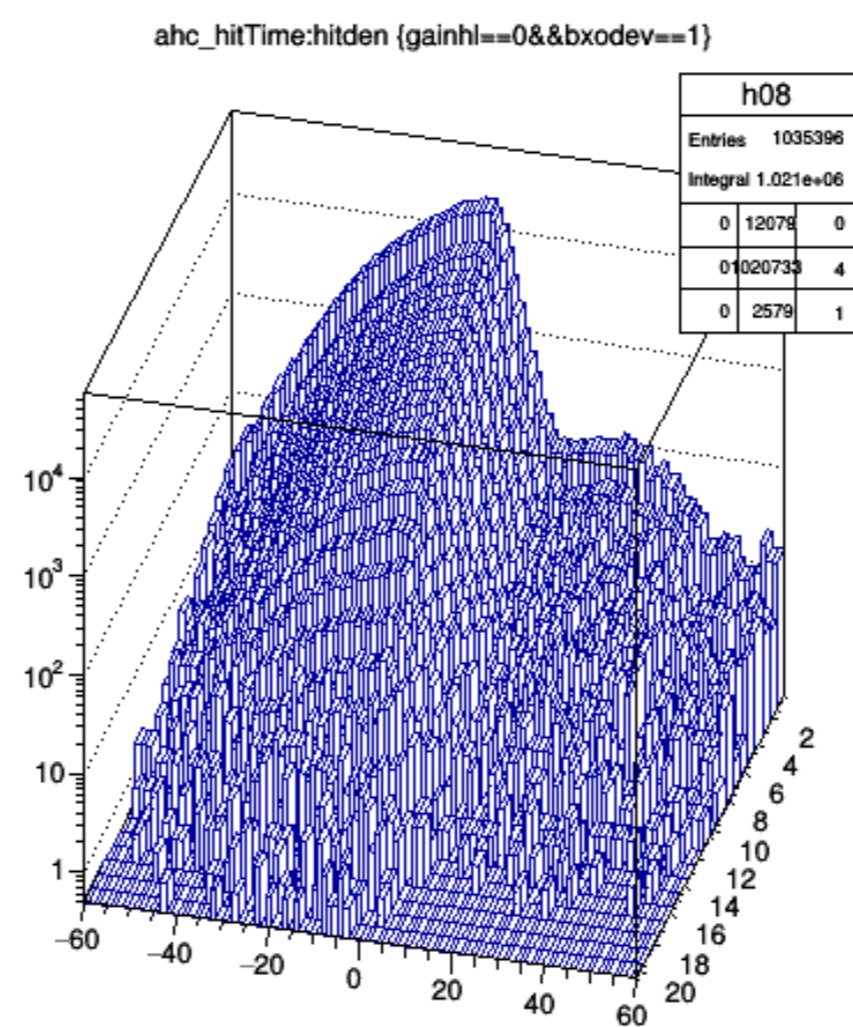
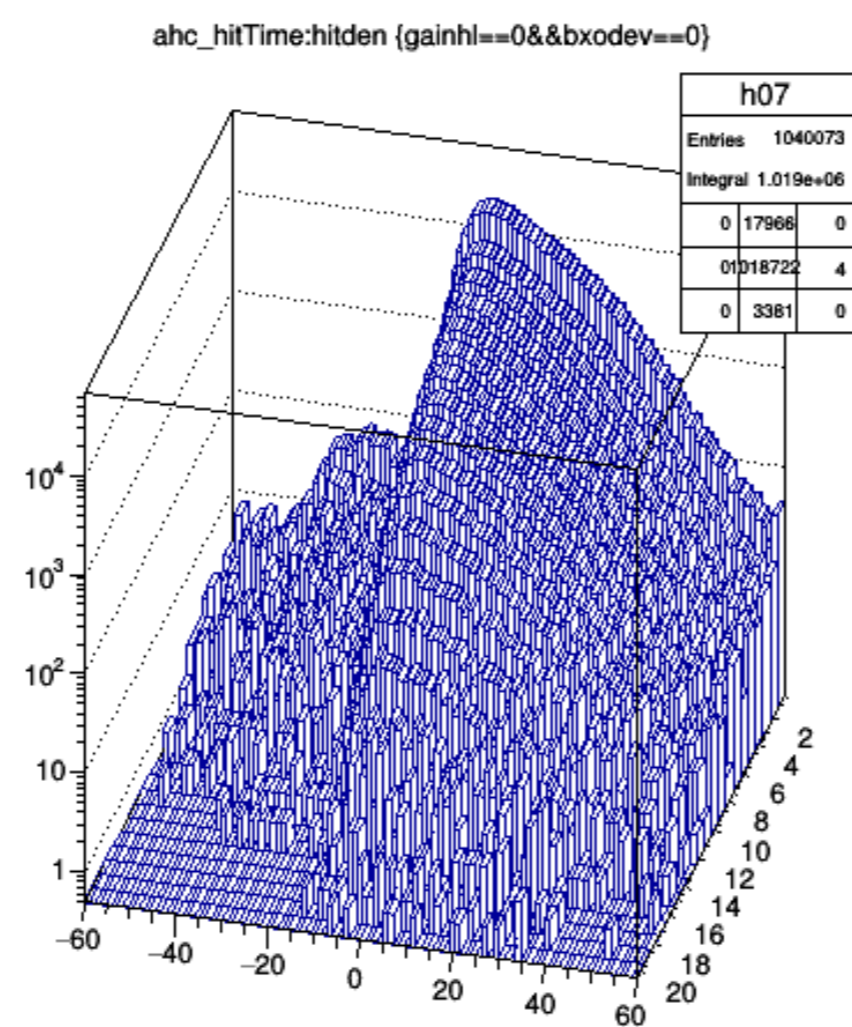
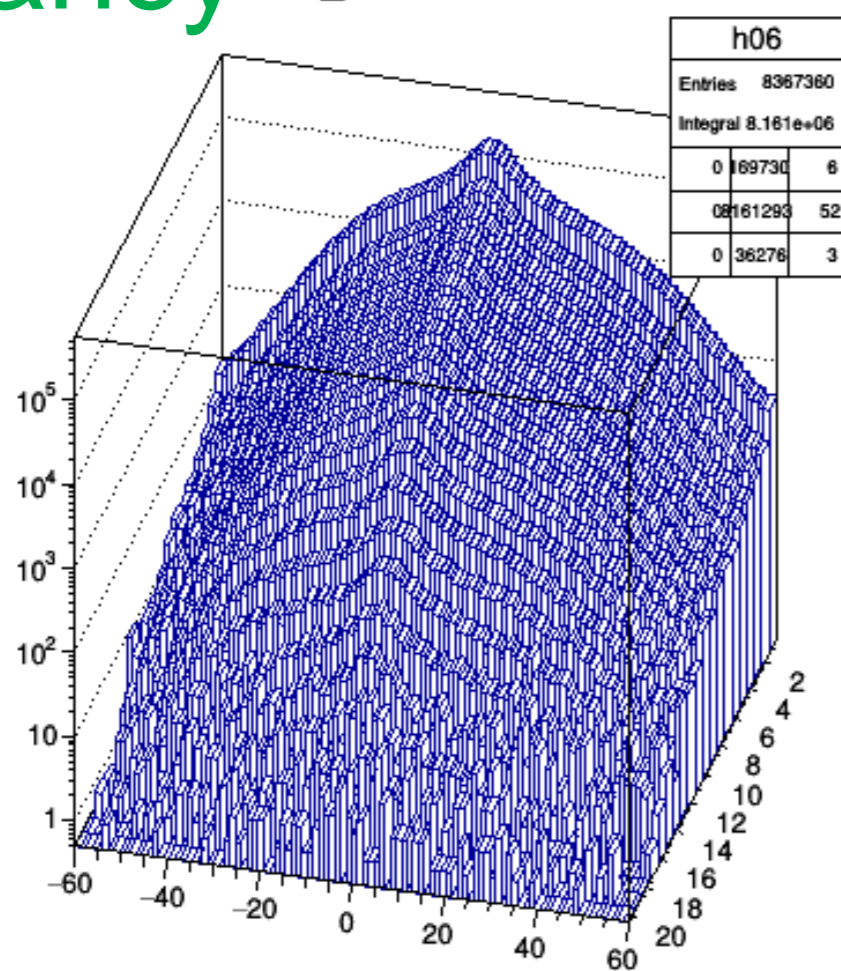
high gain/odd BX

.. vs hit energy



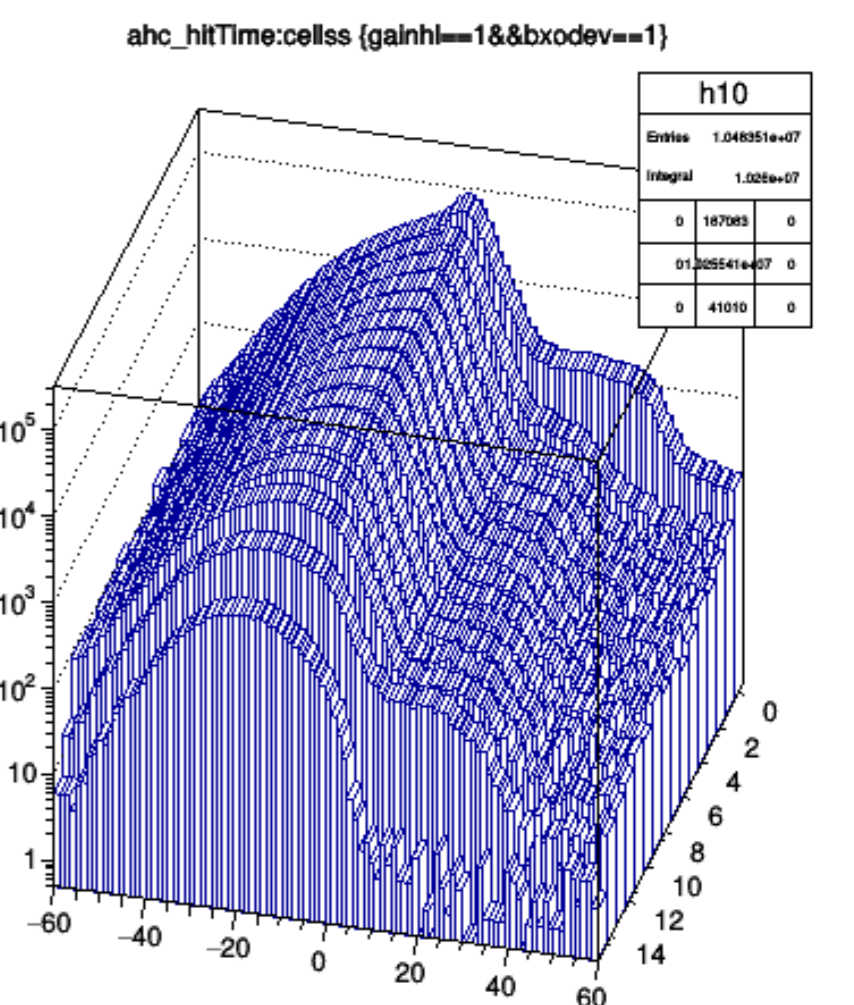
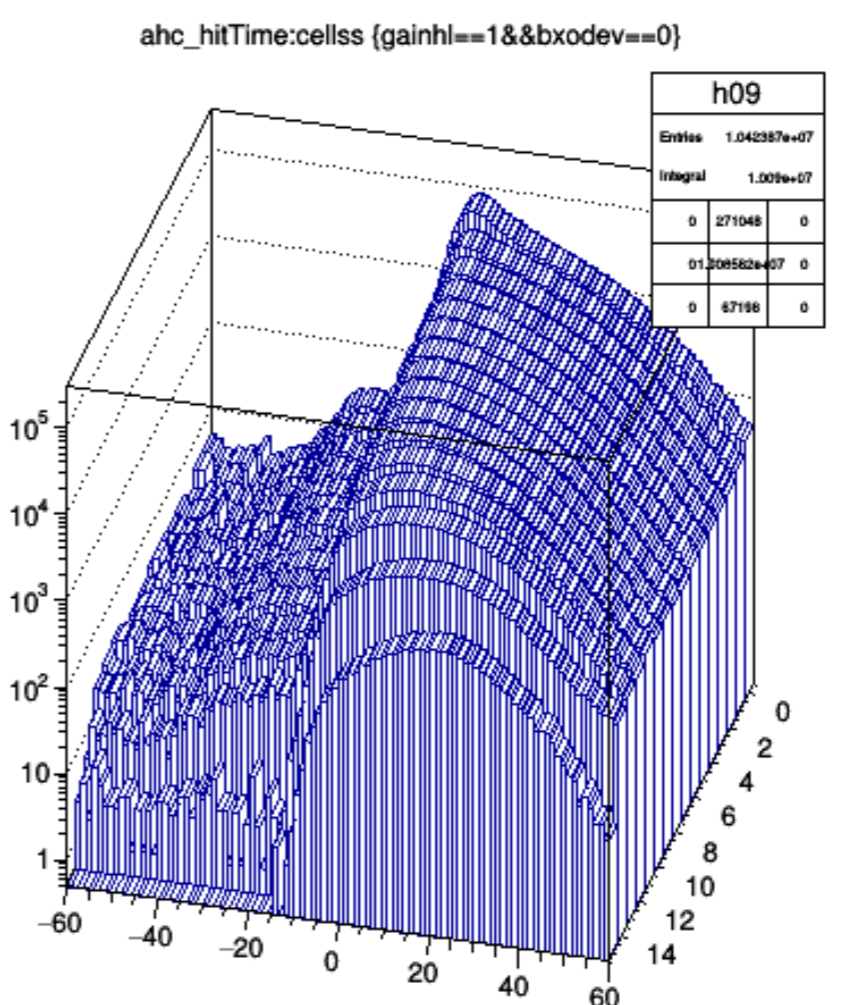
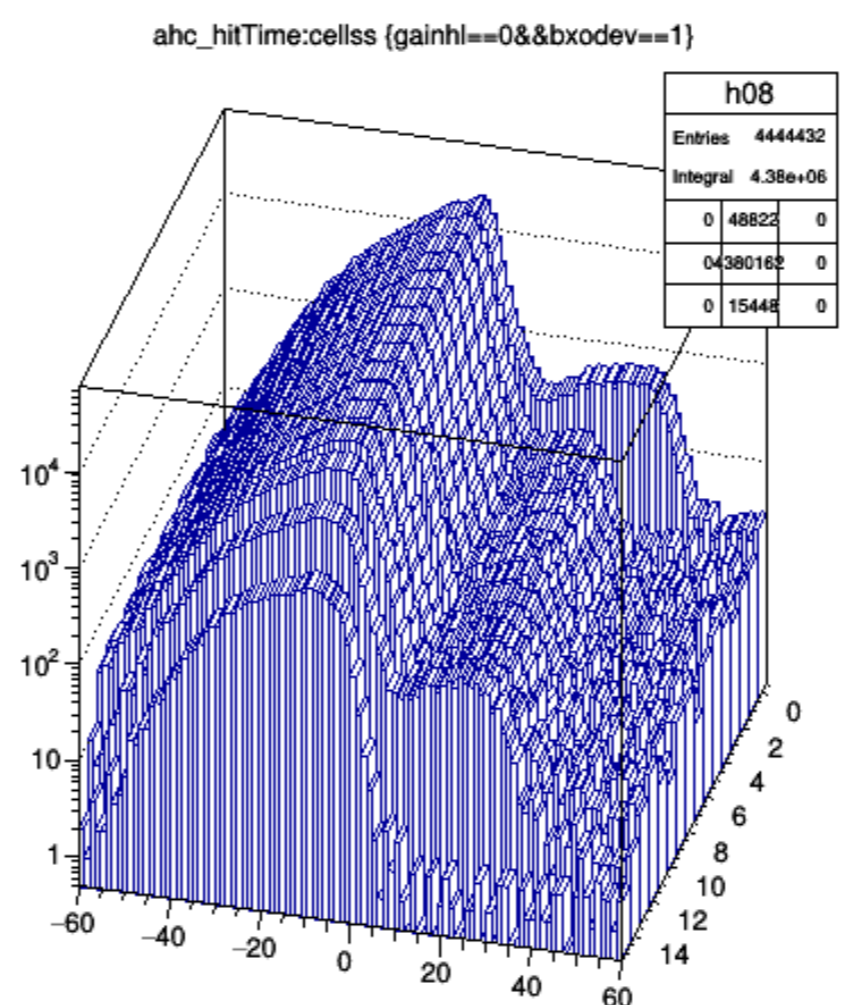
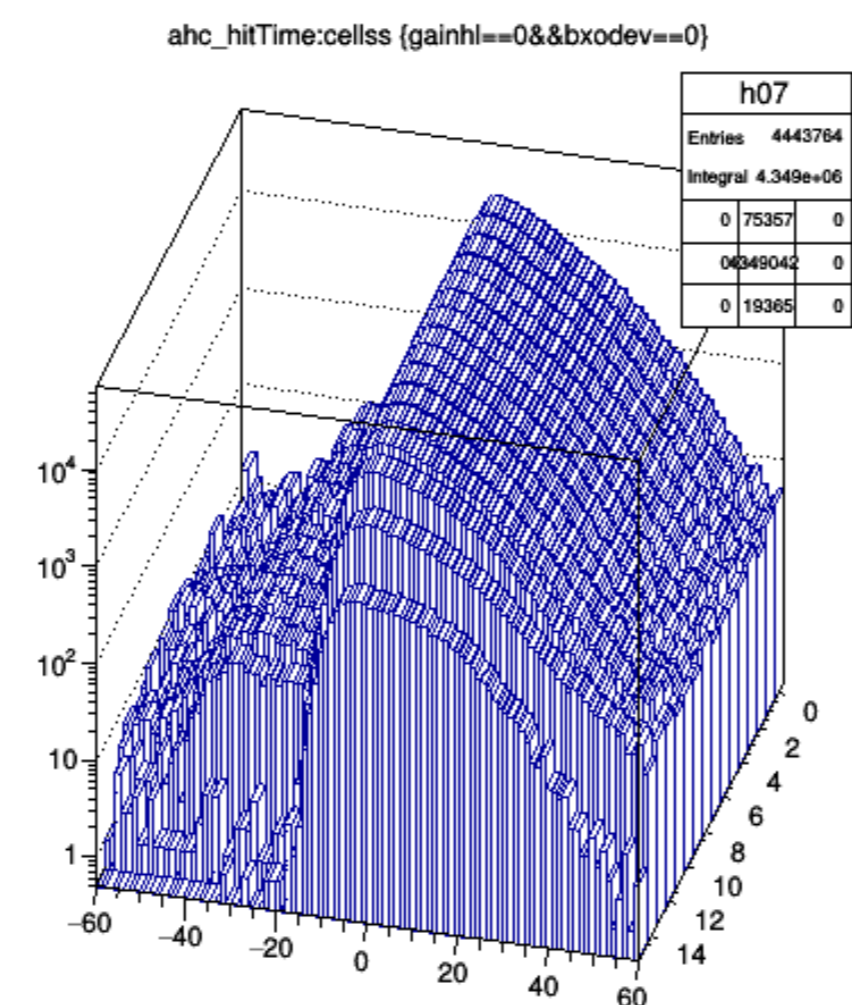
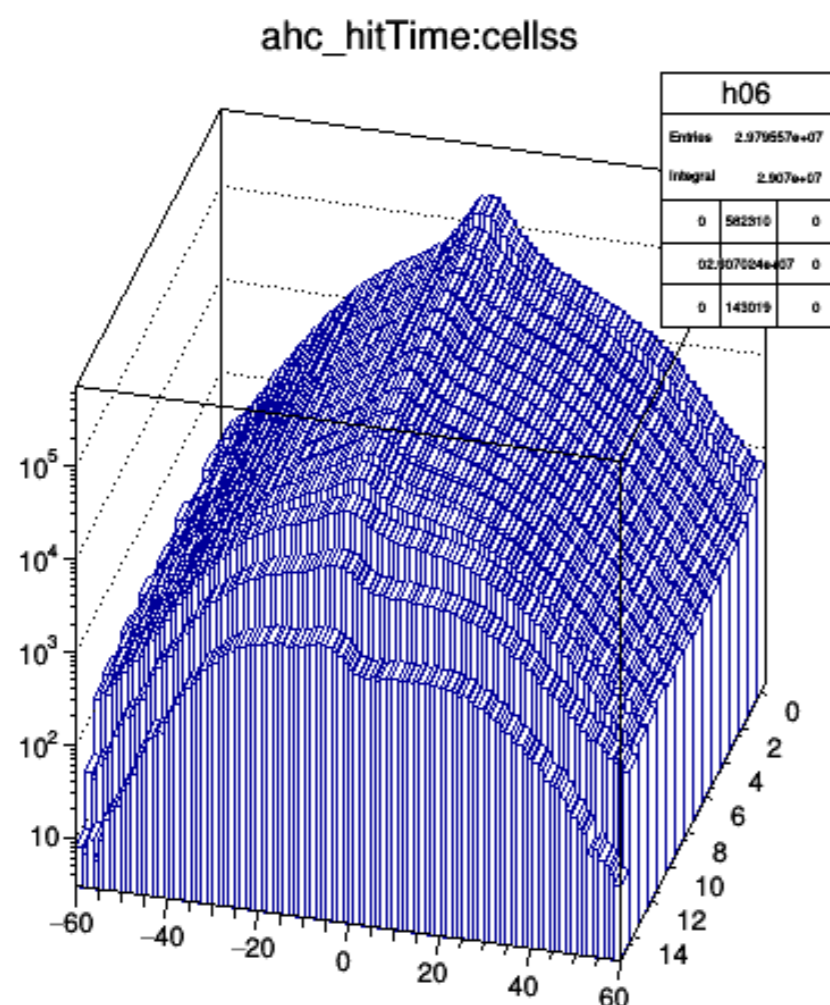
no pattern

.. vs occupancy `ahc_hitTime:hitden`



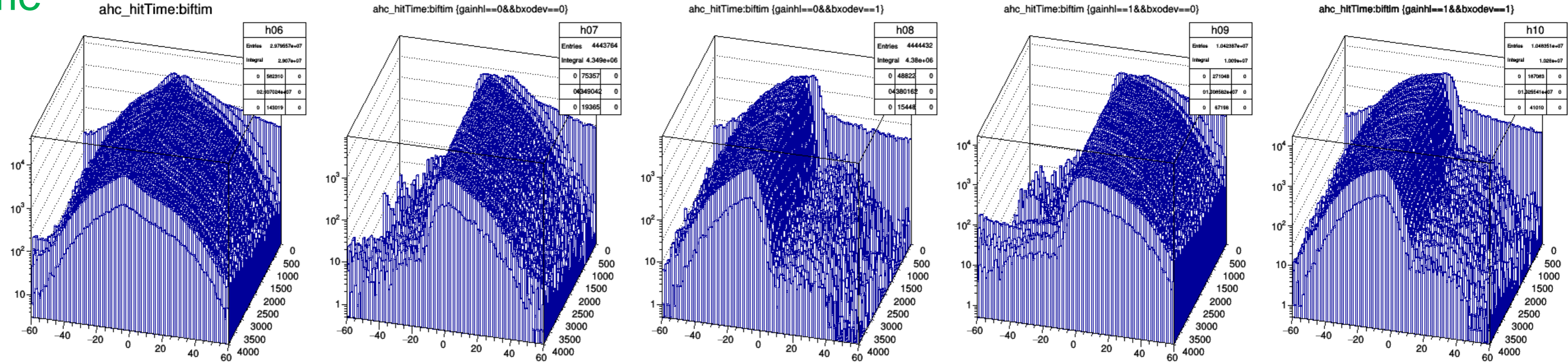
no pattern

.. vs cell#



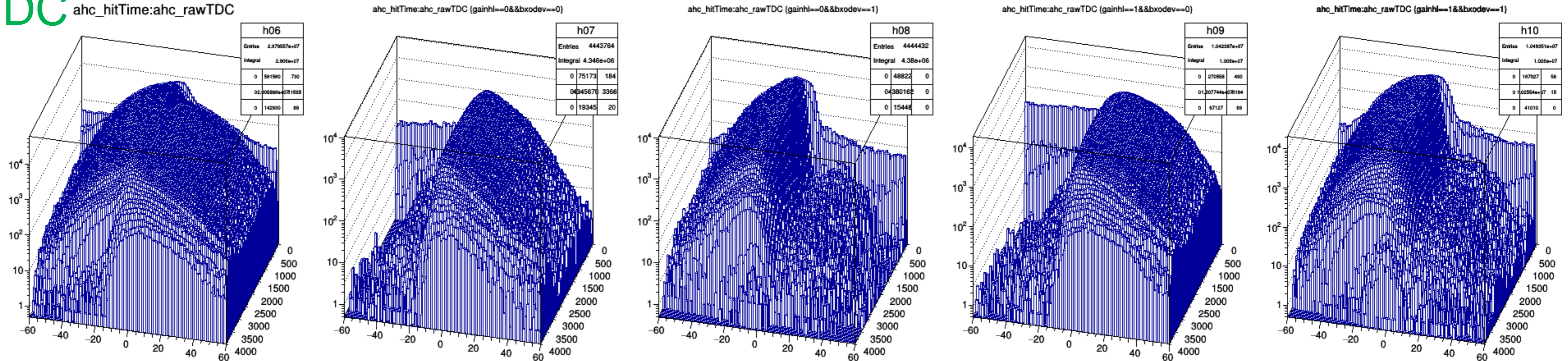
?

.. vs bif time



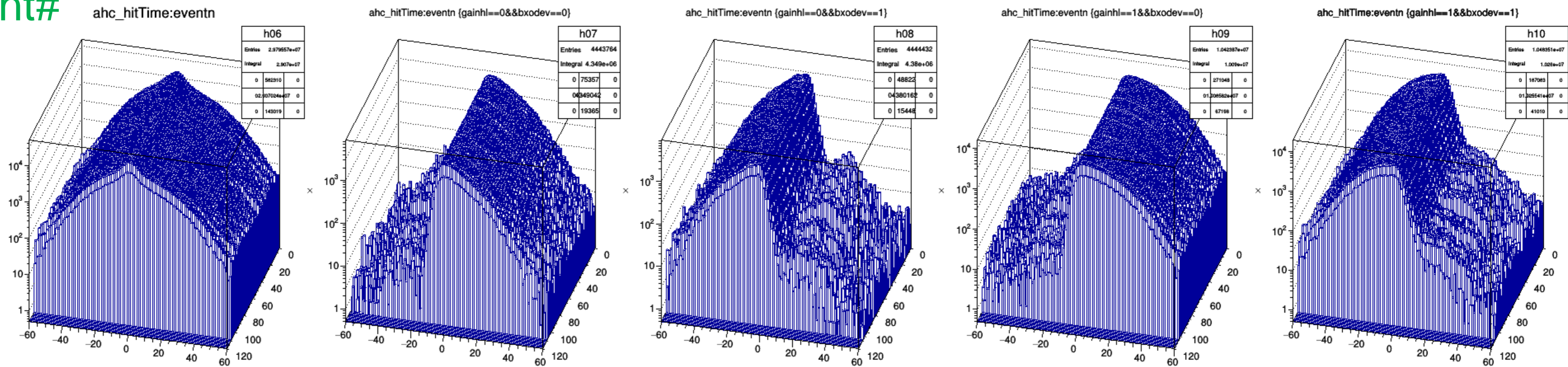
no pattern

.. vs raw TDC



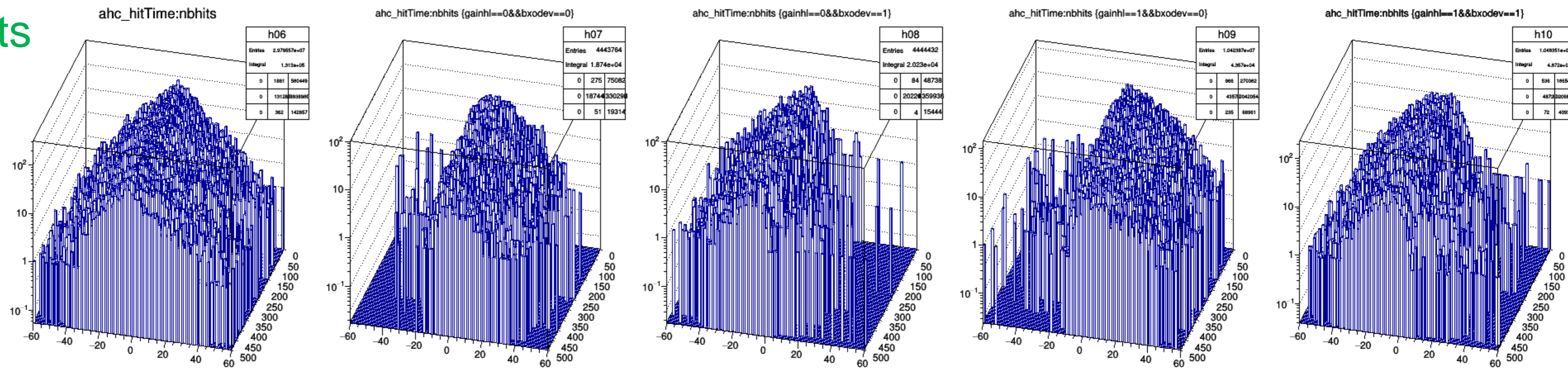
?

.. vs event#



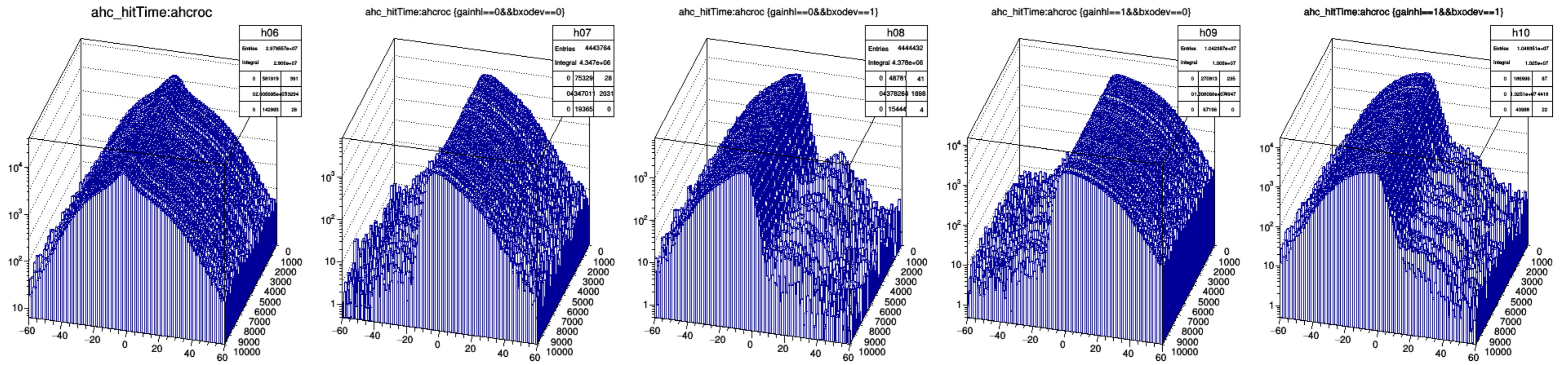
no pattern

.. vs #hits



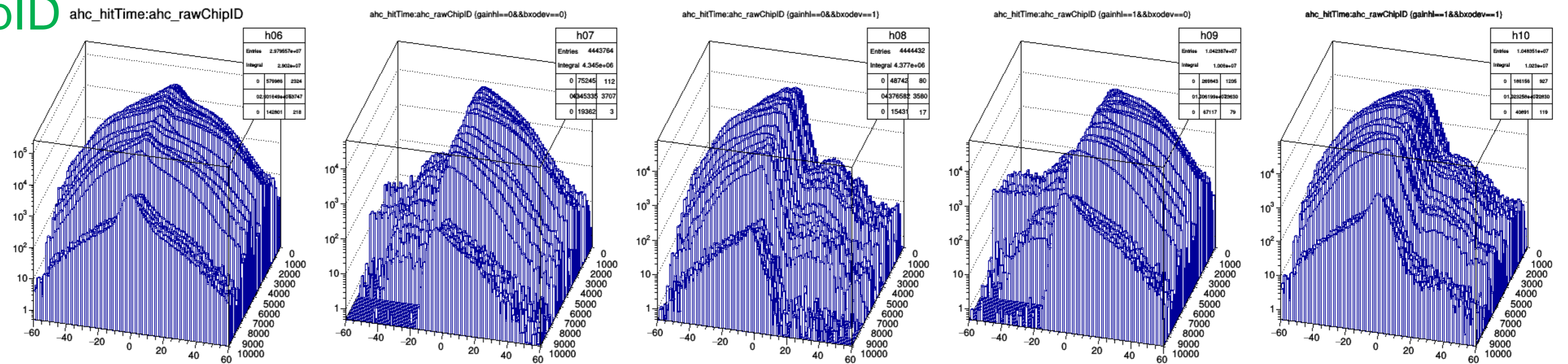
no pattern

.. vs "roc"



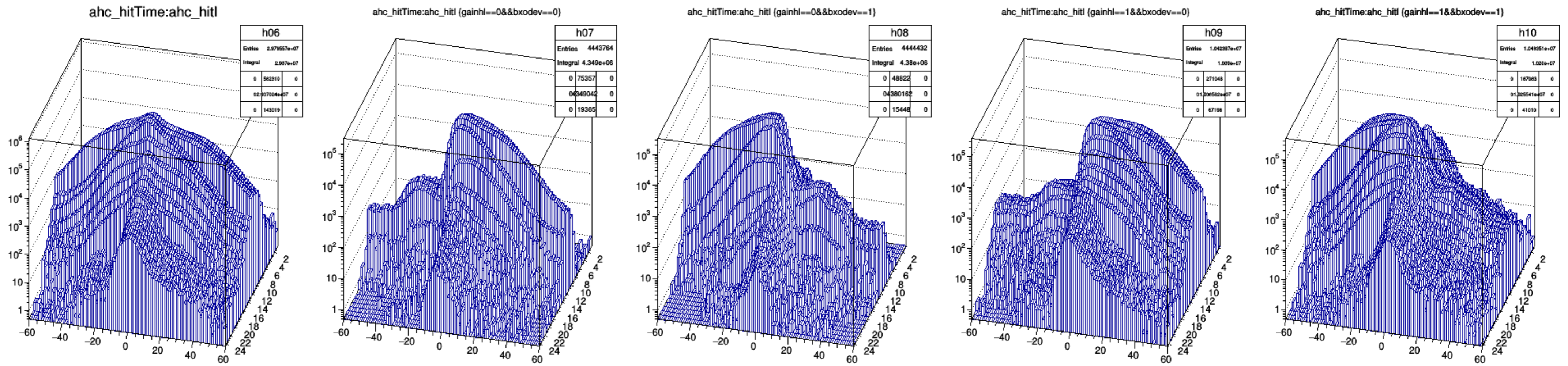
no pattern

.. vs rawChipID



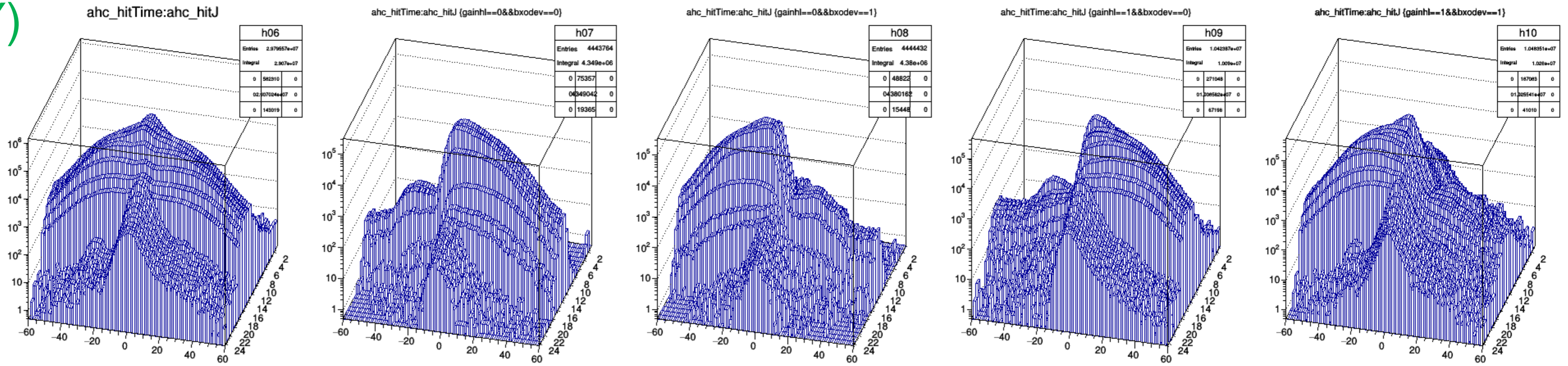
??

.. vs hit I (X)



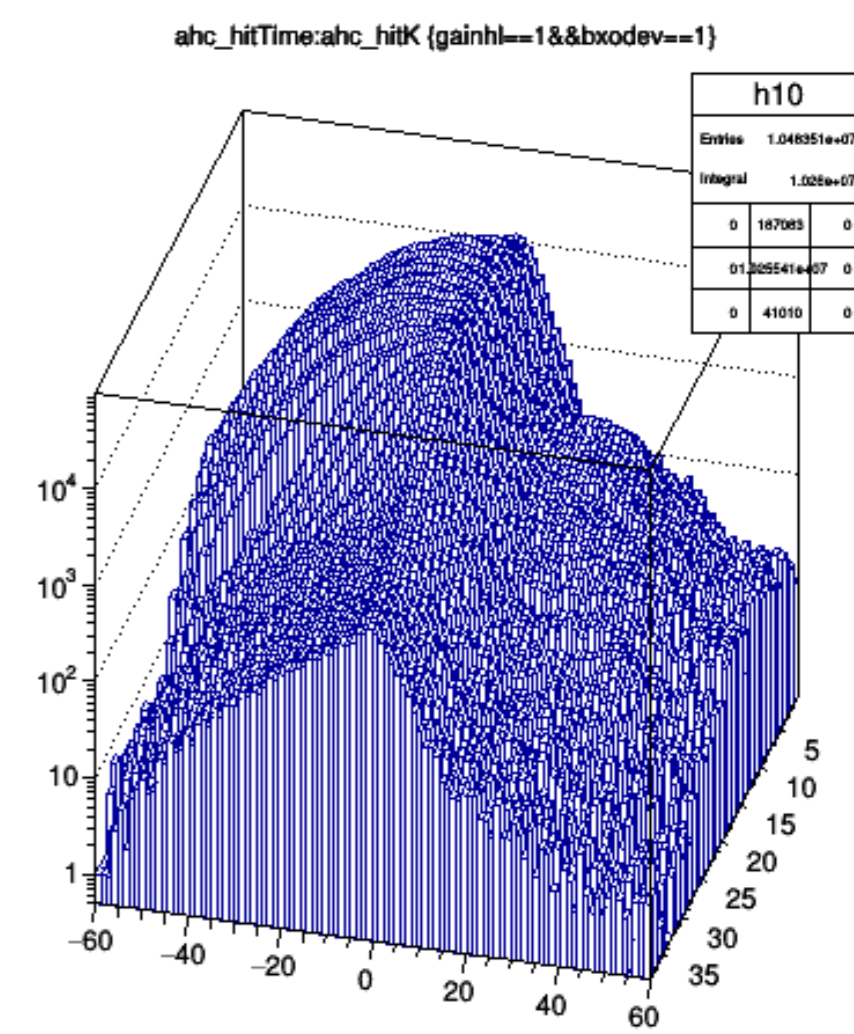
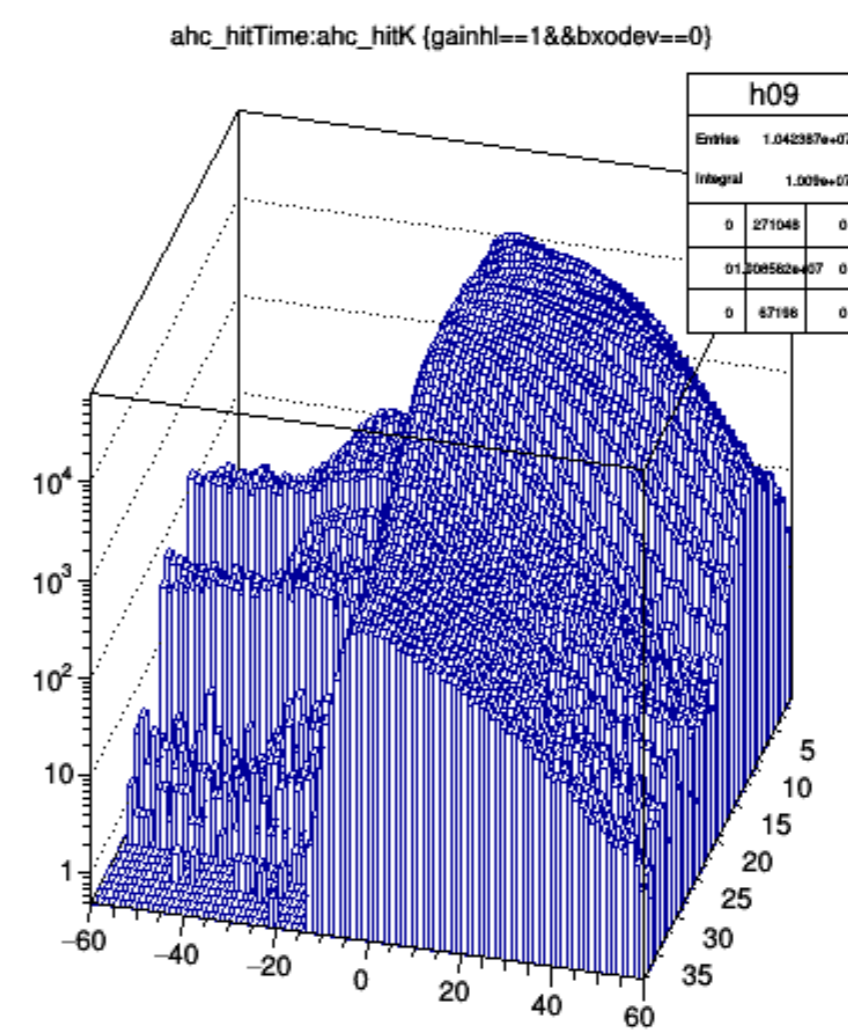
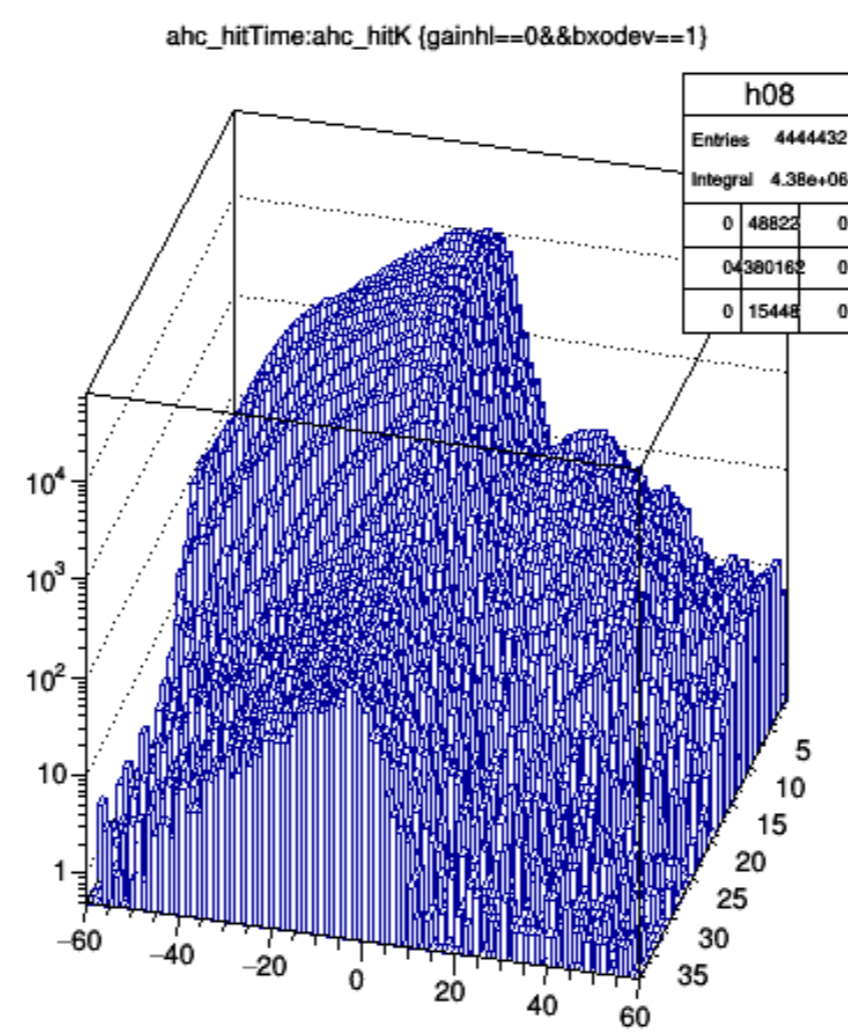
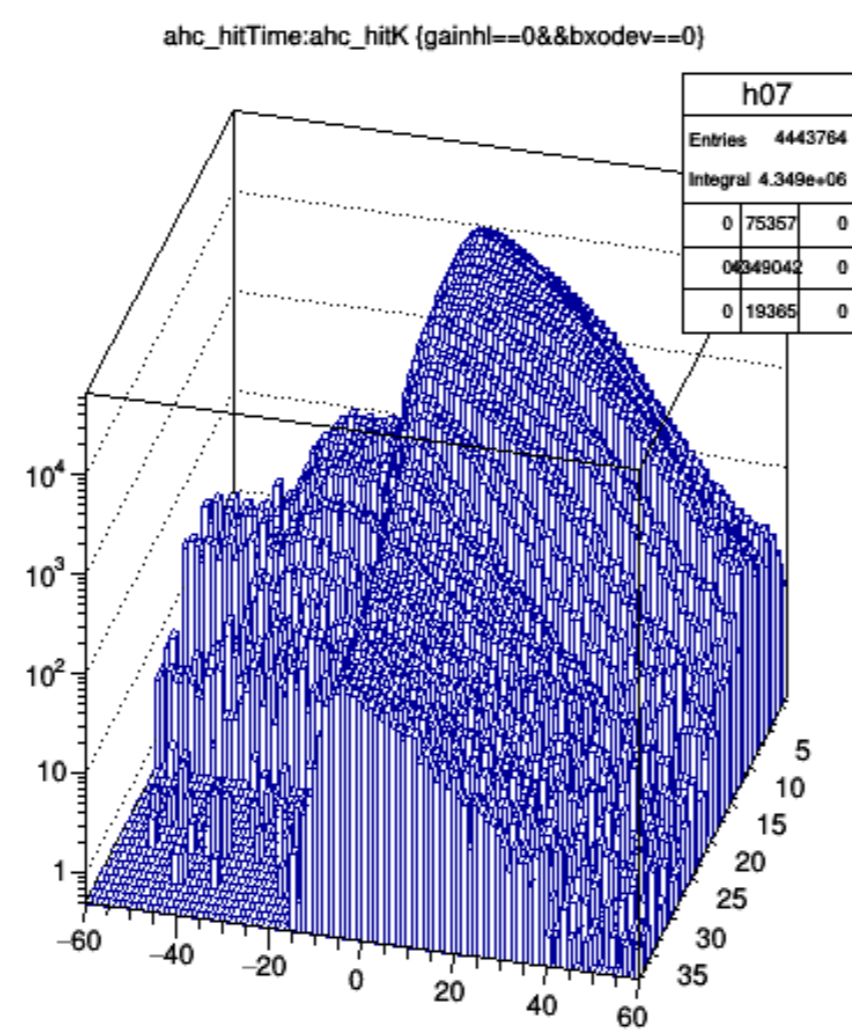
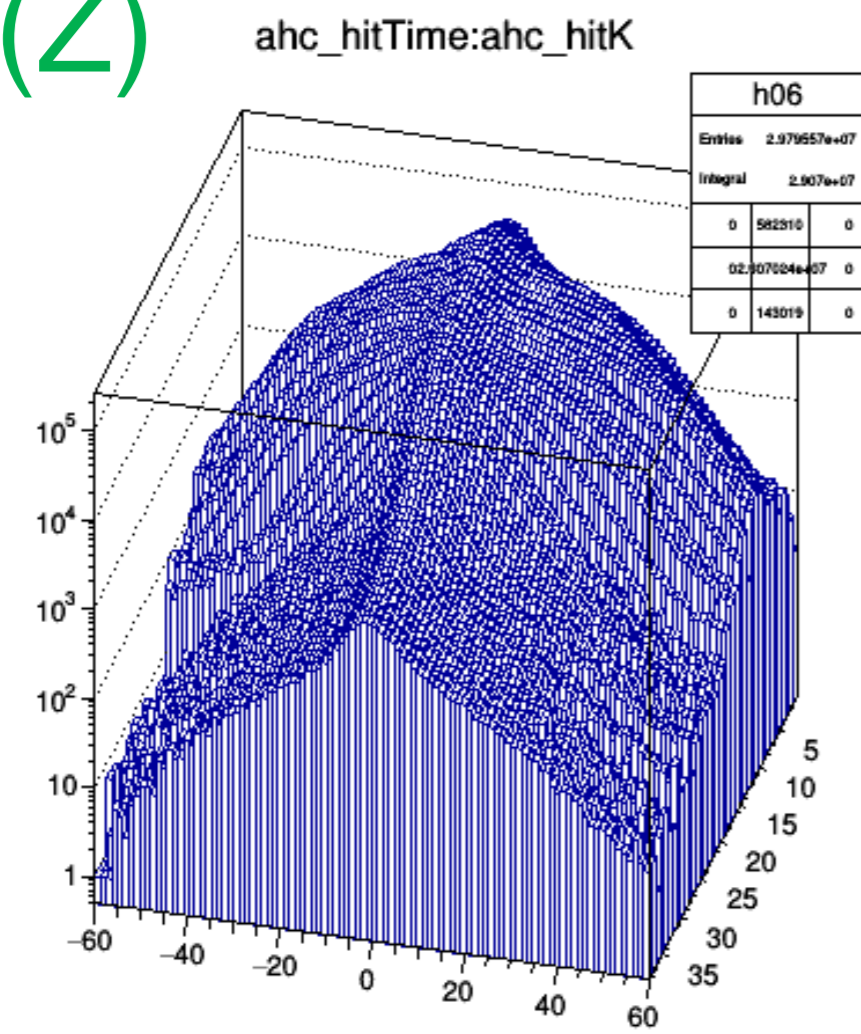
??

.. vs hit J (Y)



??

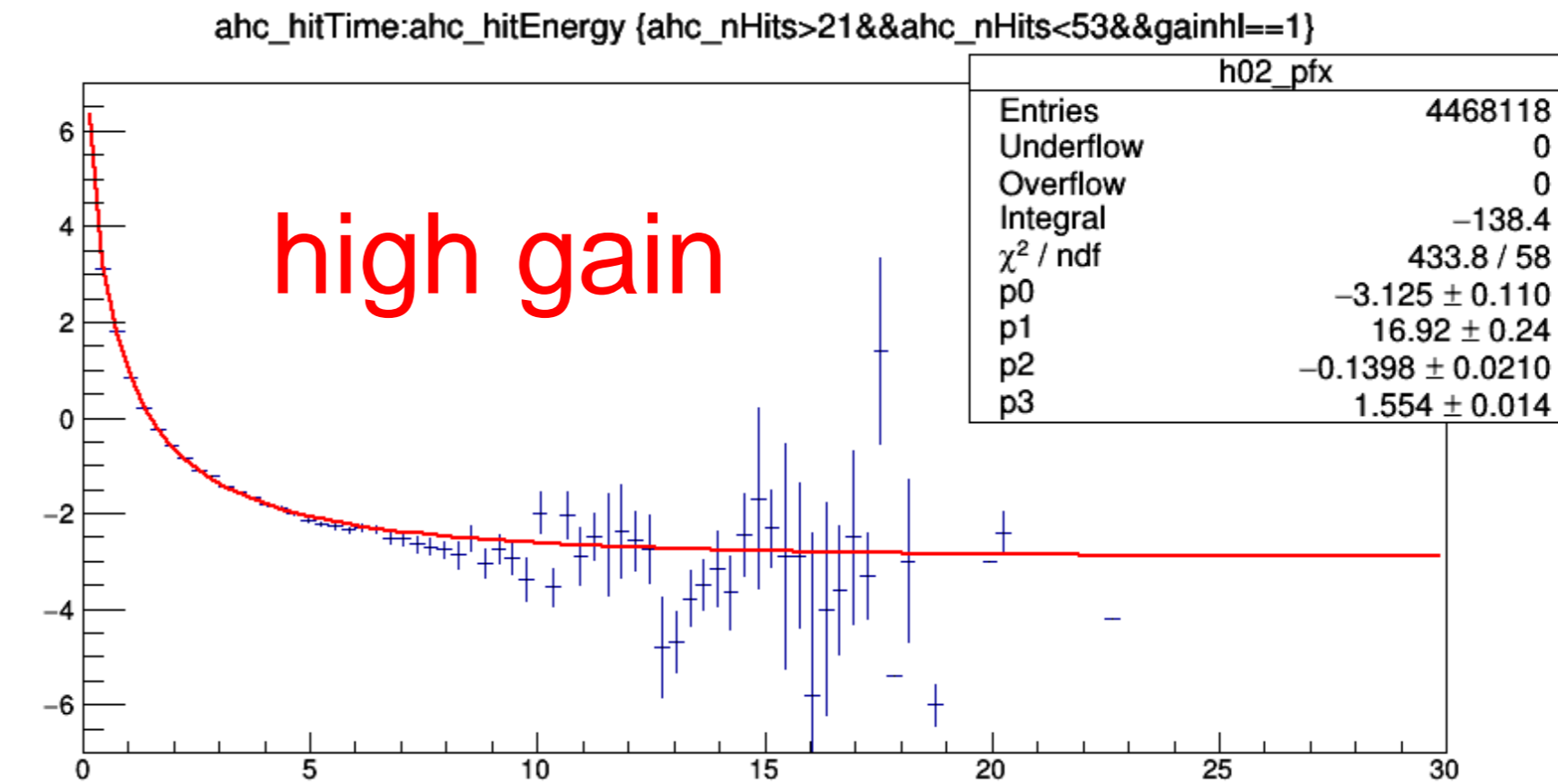
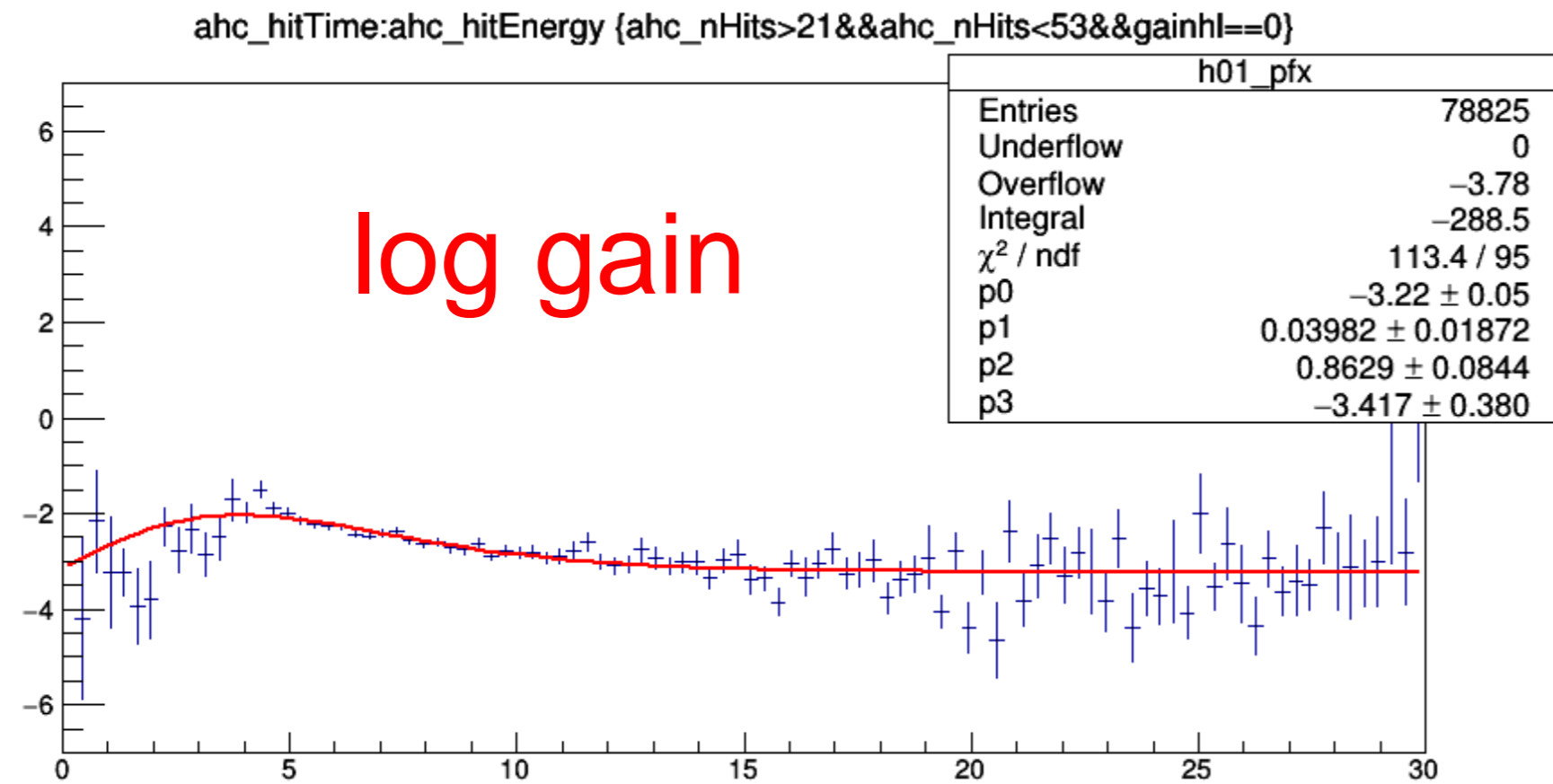
.. vs hit K (Z)



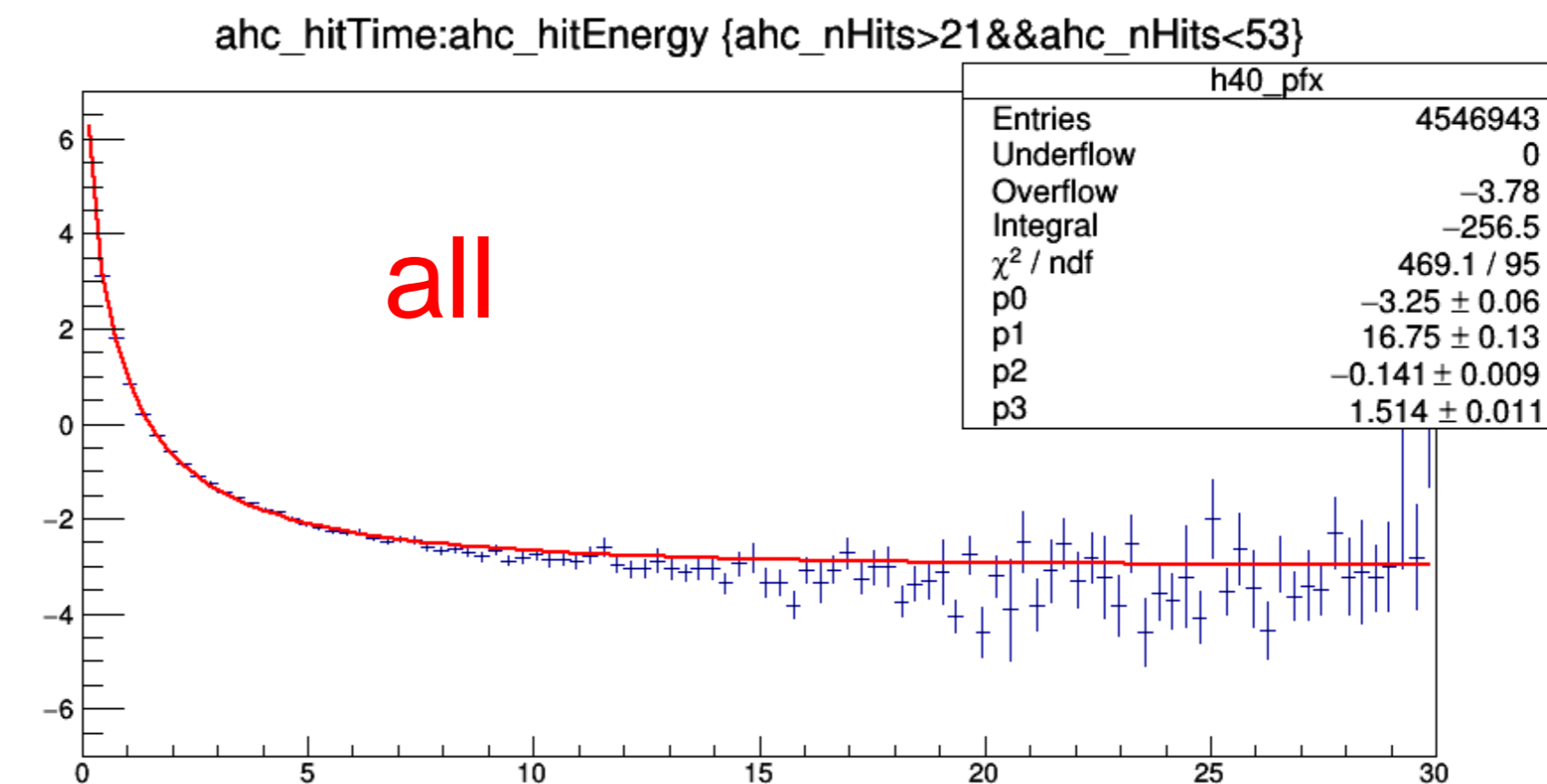
no pattern

Time Walk: low/high gain

vsenergy_20190712r_hitTimevsEne reco_run60382_testNewConstants.rc



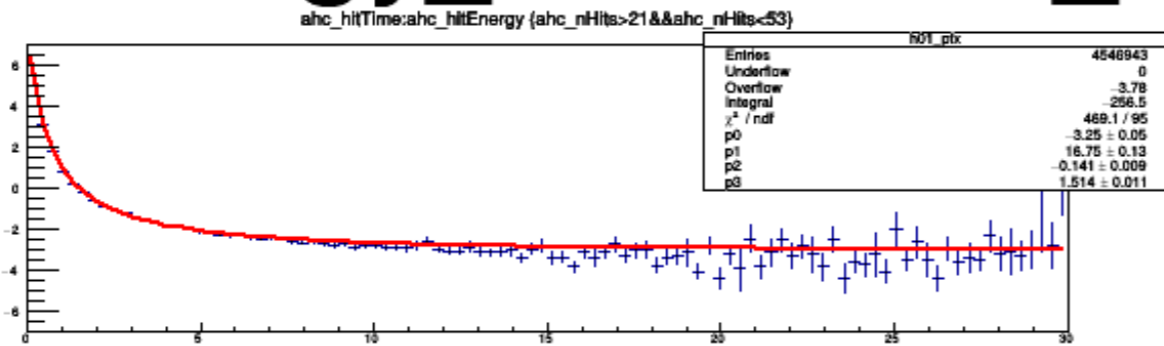
very different responses



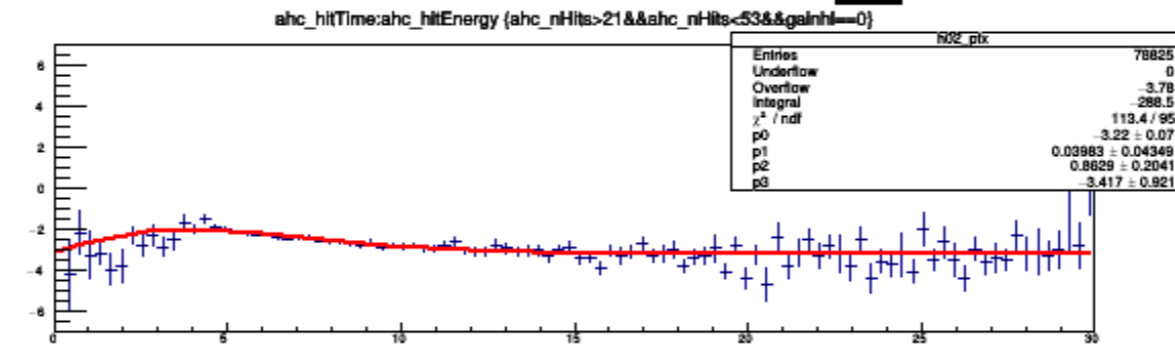
Muons: Low vs High Gain

vsenergy_20190716x_hitTimevsEne reco_run60382_testNewConstants.ro

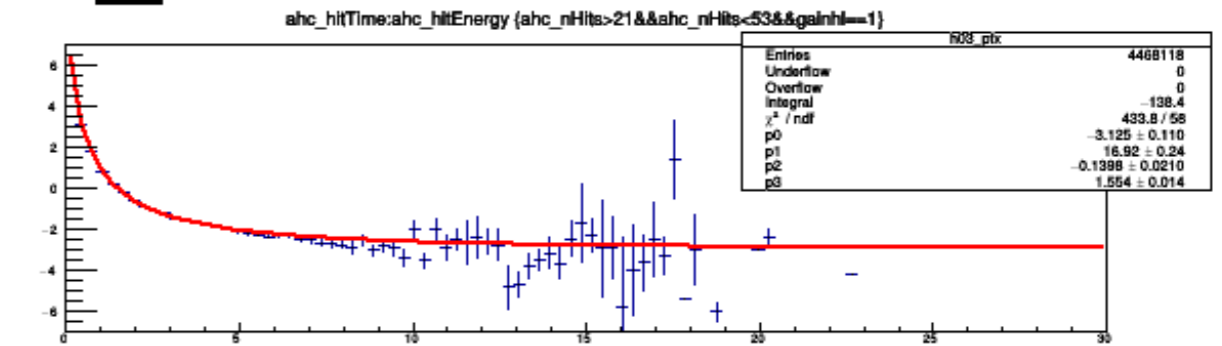
time vs energy



all

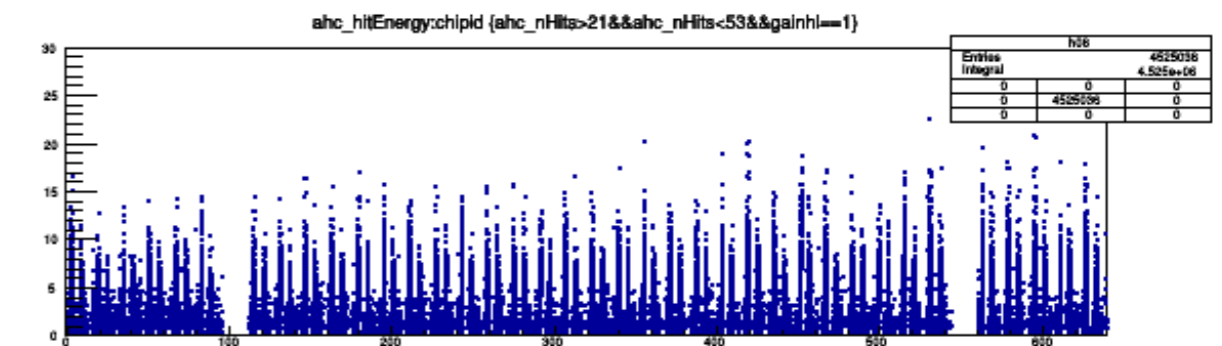
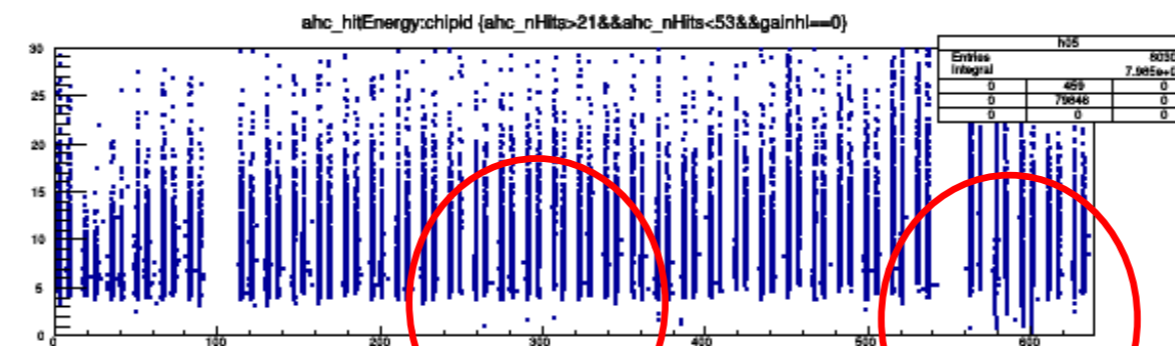
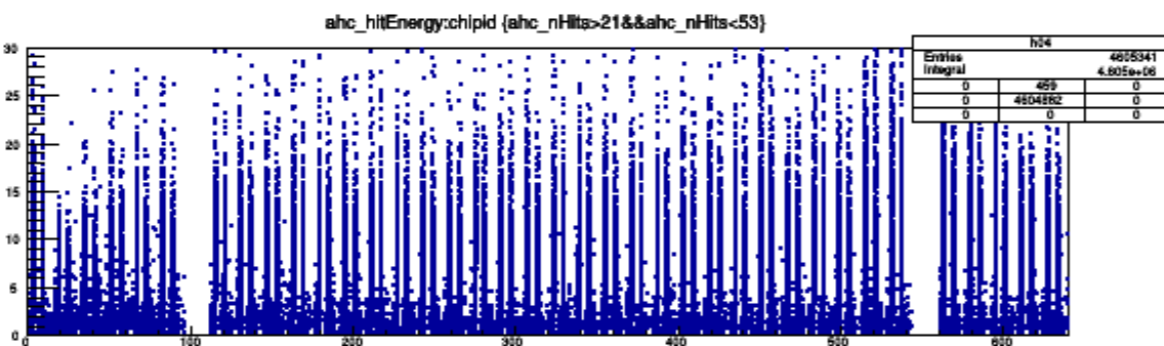


low gain



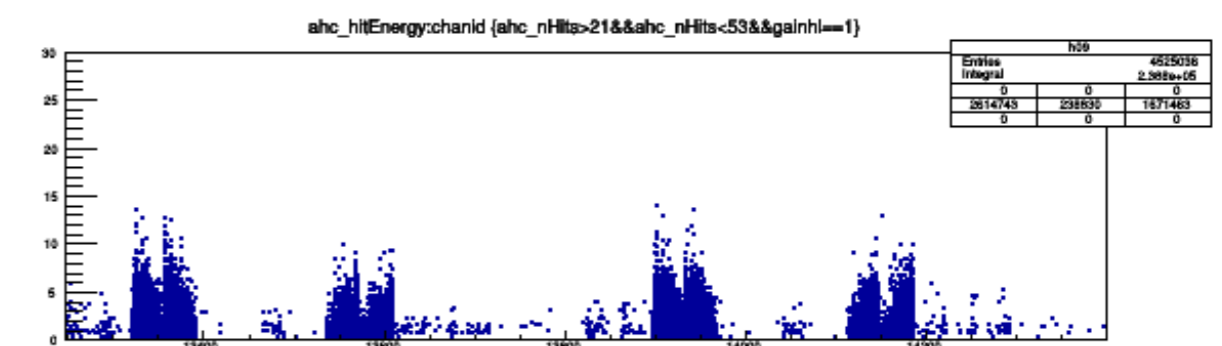
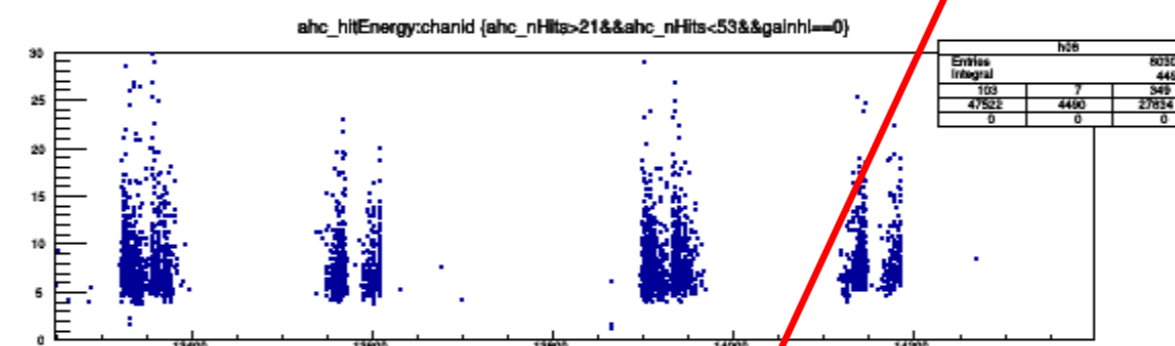
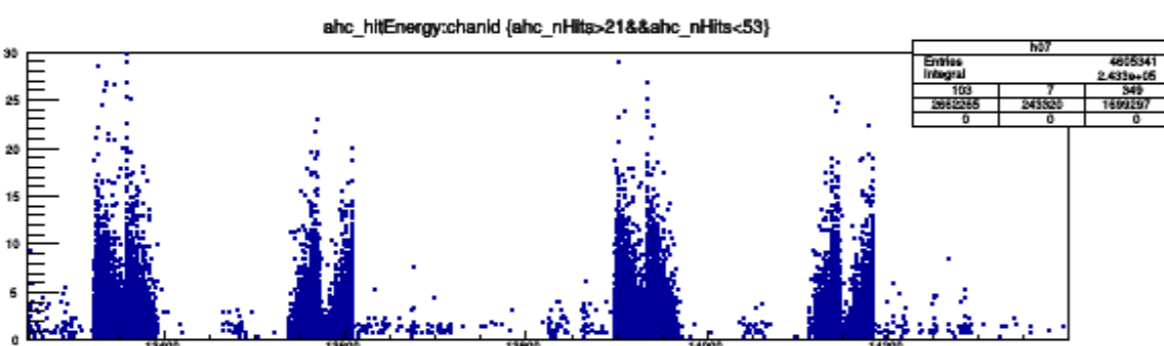
high gain

time vs chipID

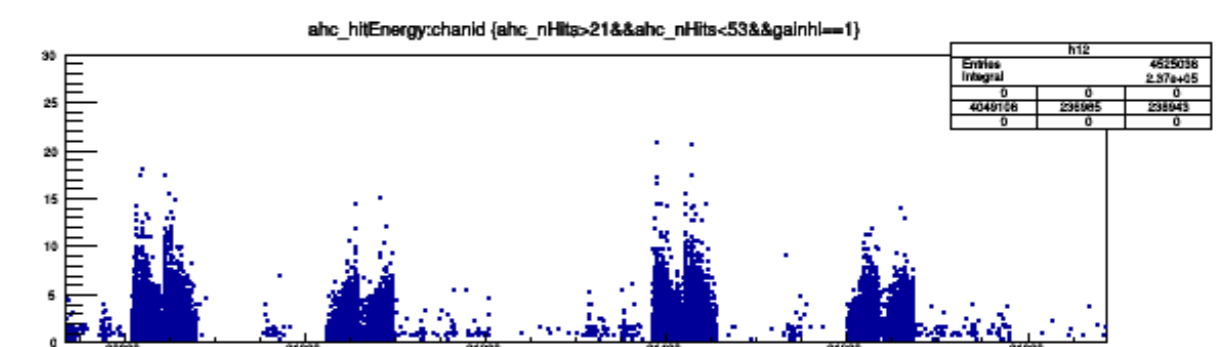
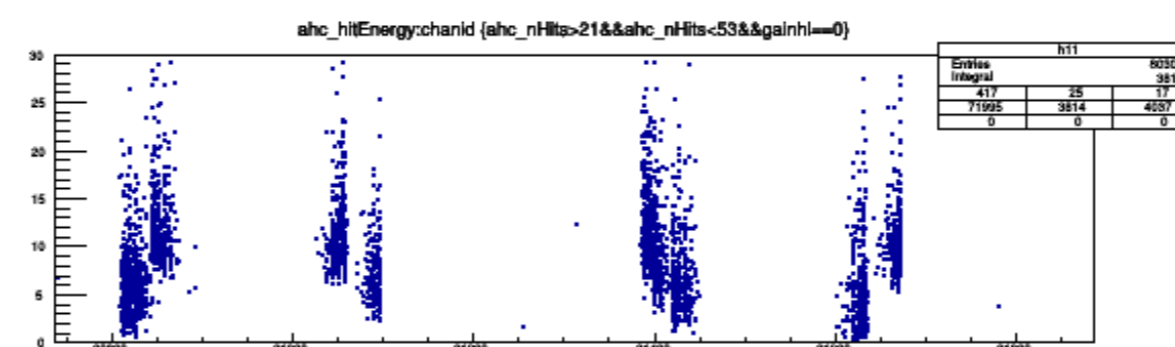
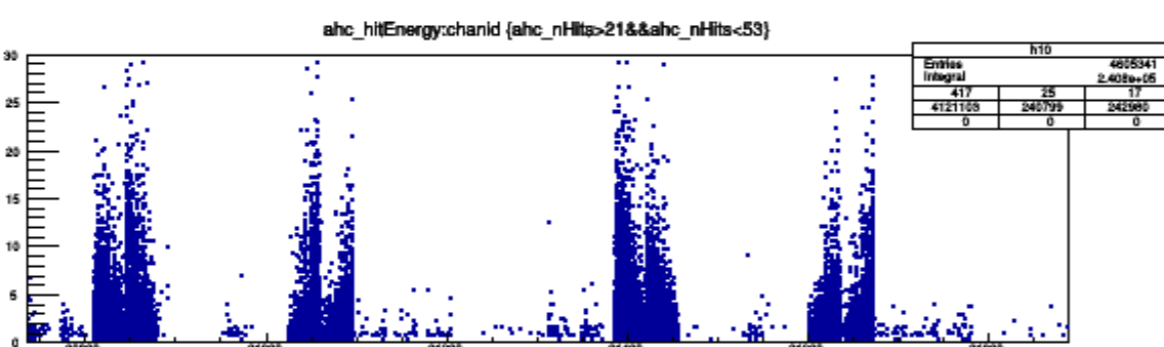


problem chips?

time vs channelID



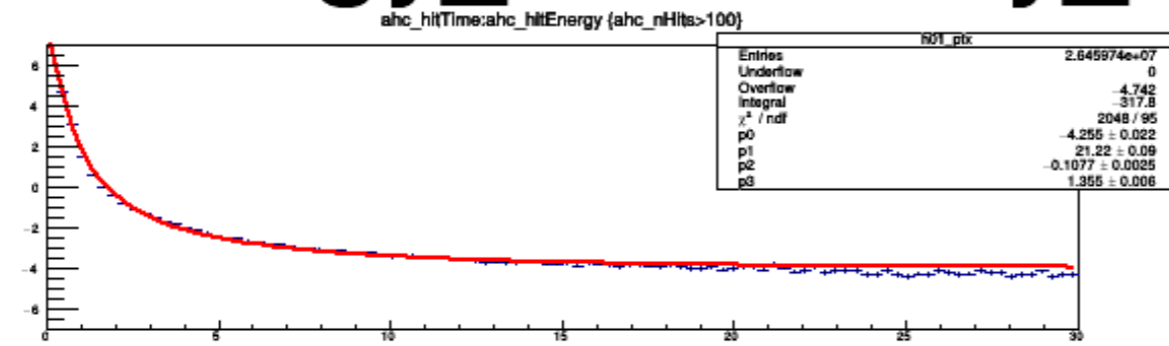
time vs channelID



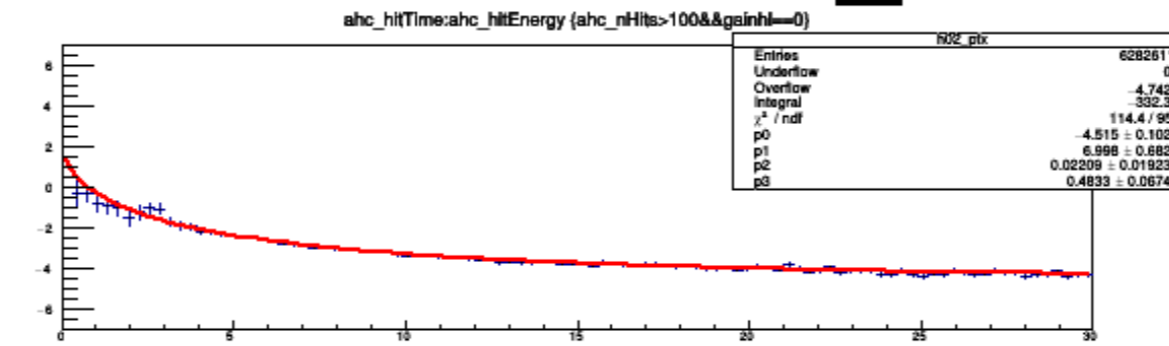
Electrons: Low vs High Gain

vsenergy_20190716y_hitTimevsEne reco_run60512_testNewConstants.ro

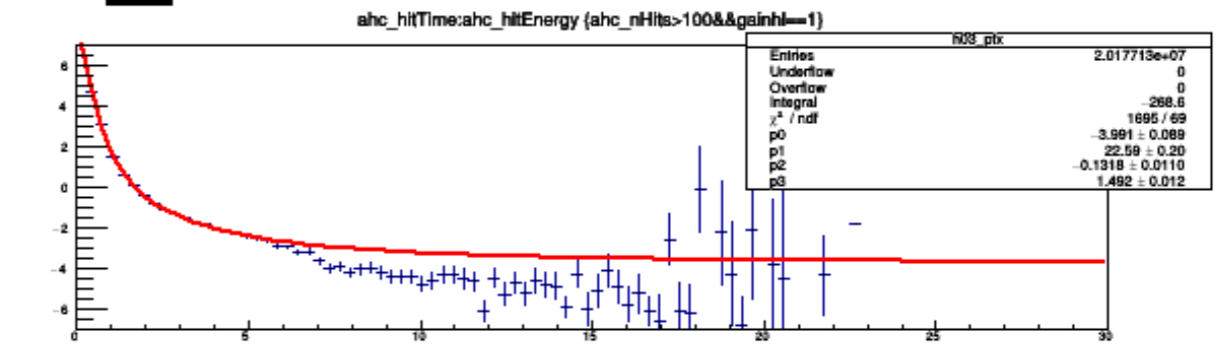
time vs energy



all

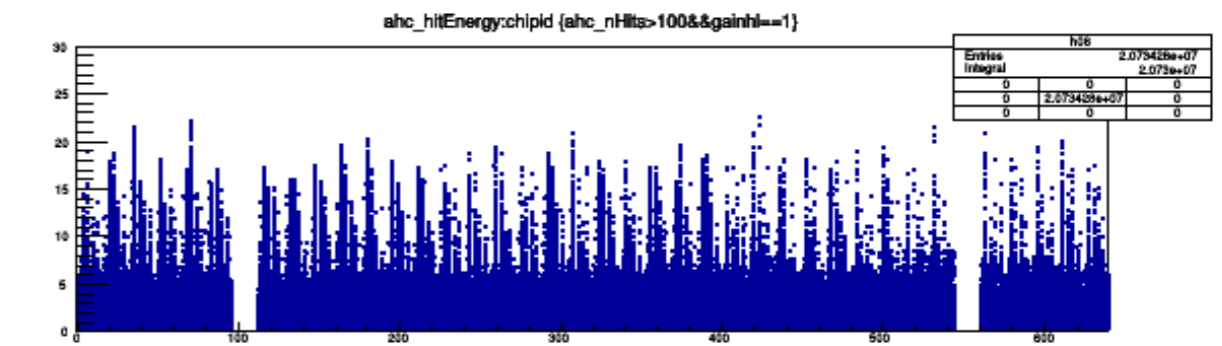
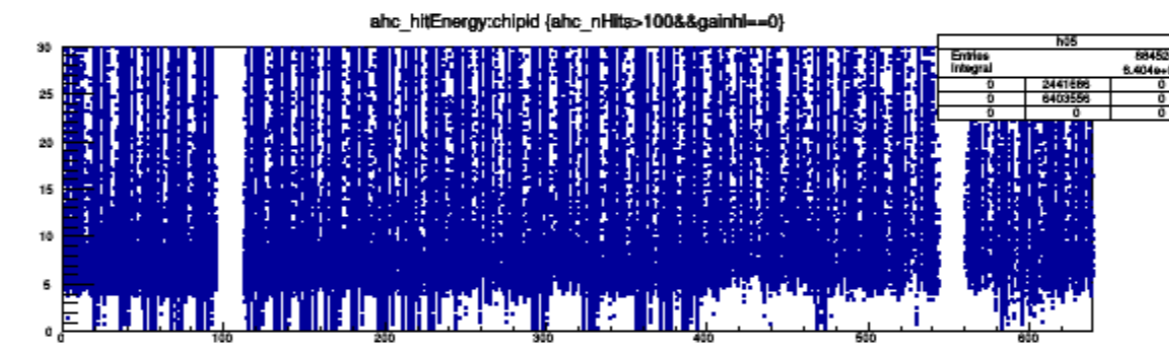
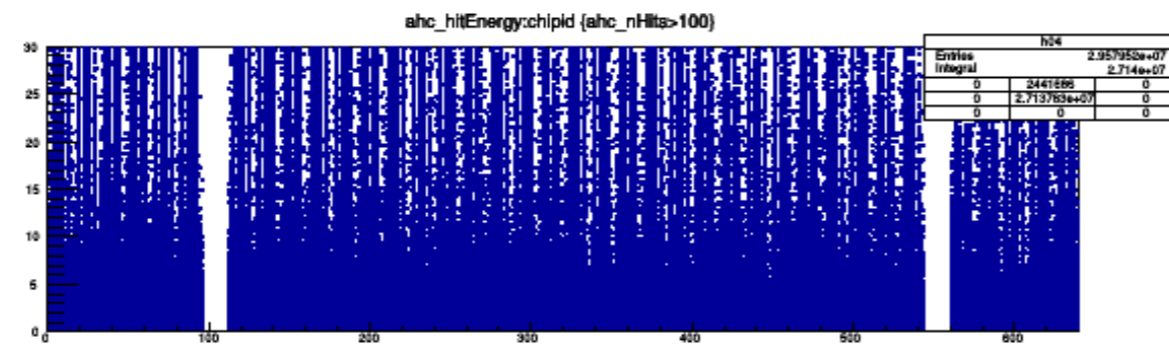


low gain



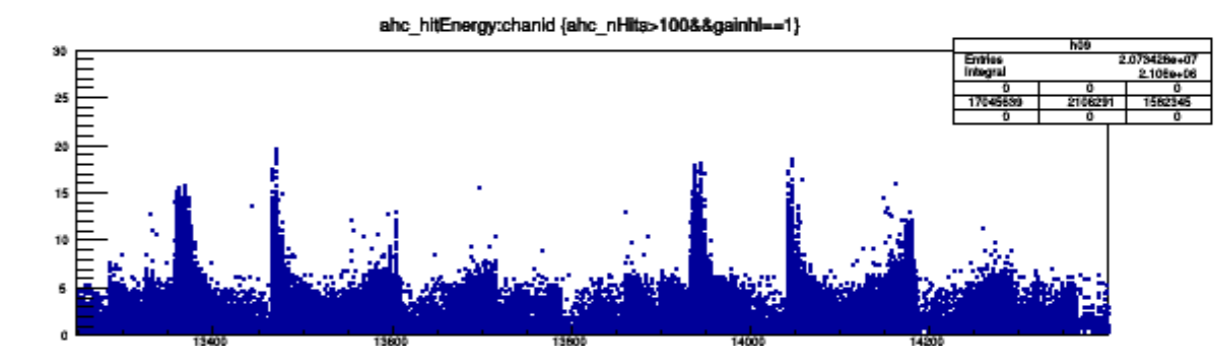
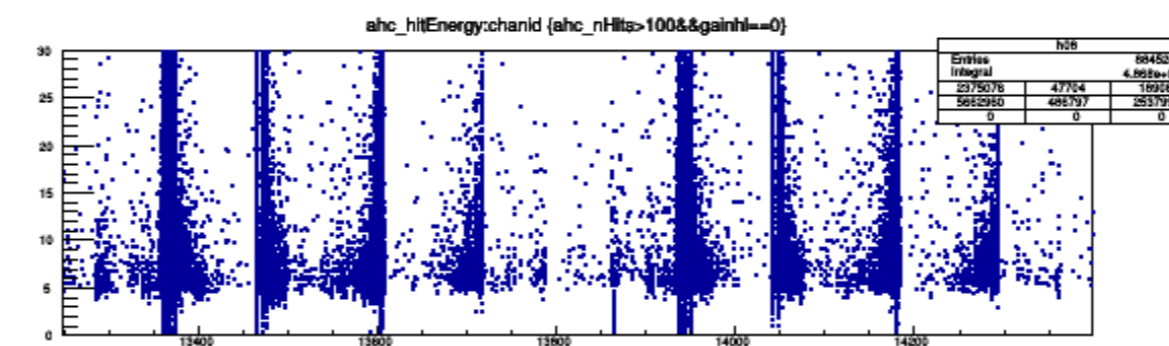
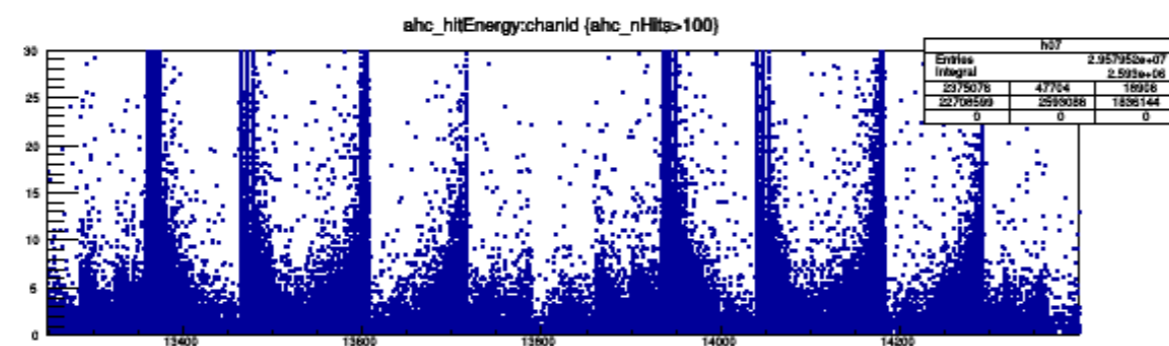
high gain

time vs chipID

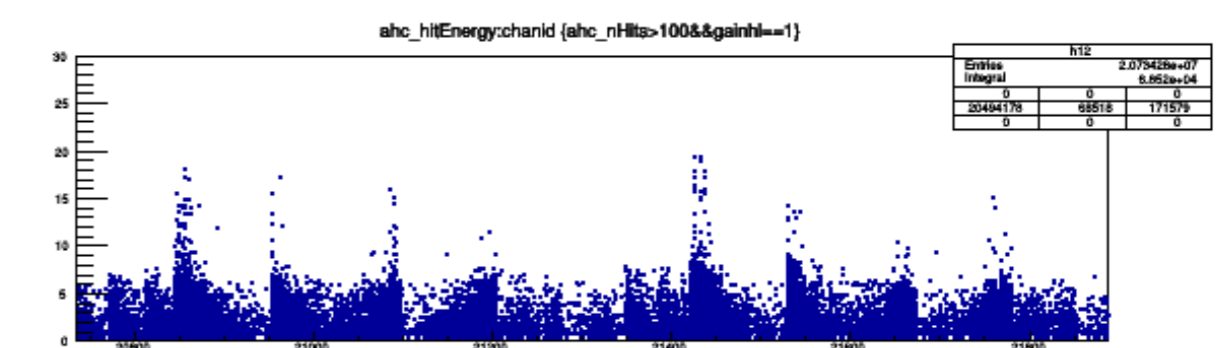
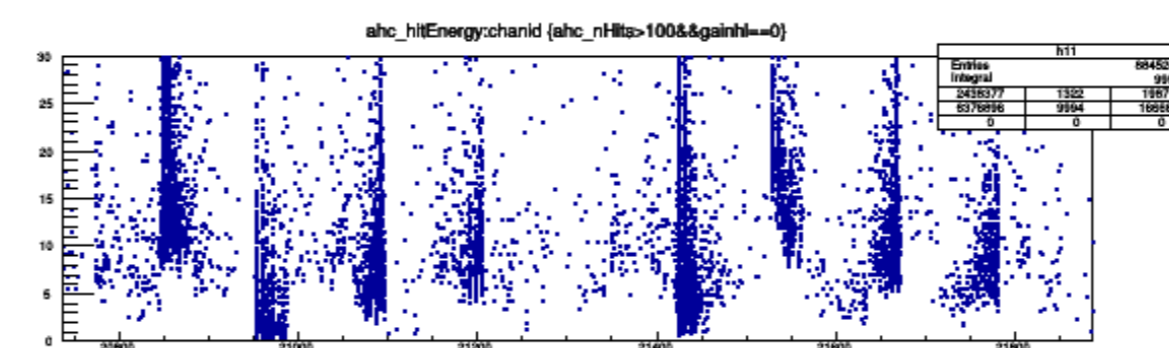
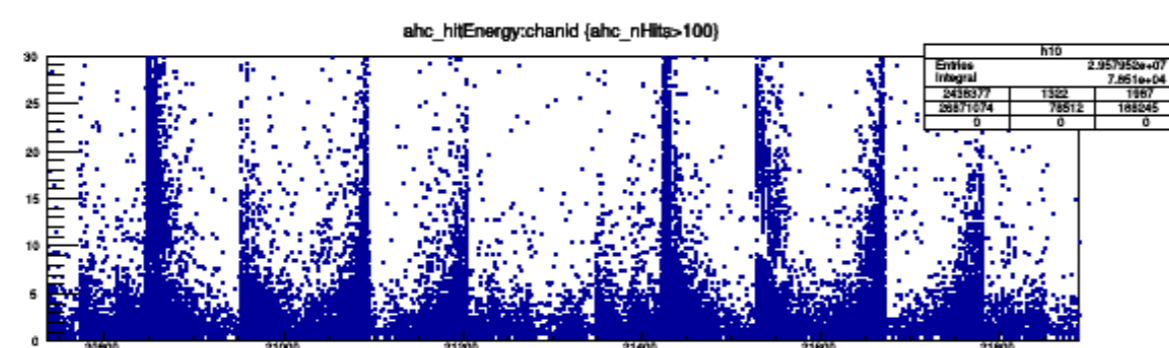


much more often the case

time vs channelID



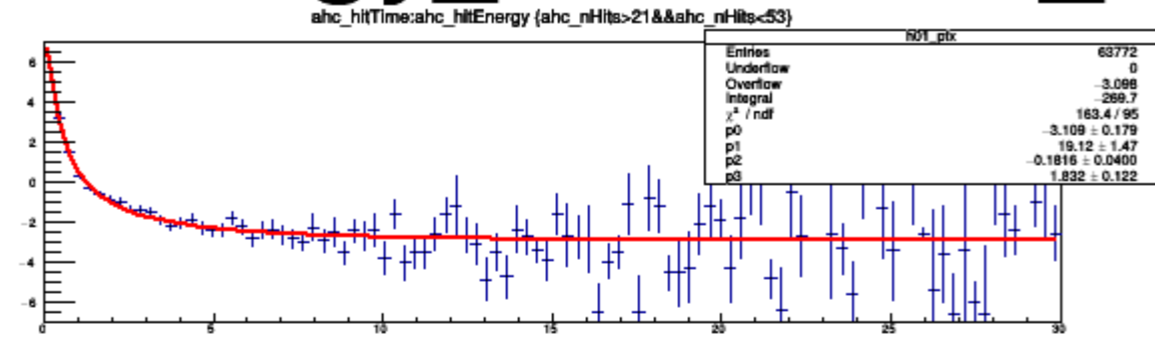
time vs channelID



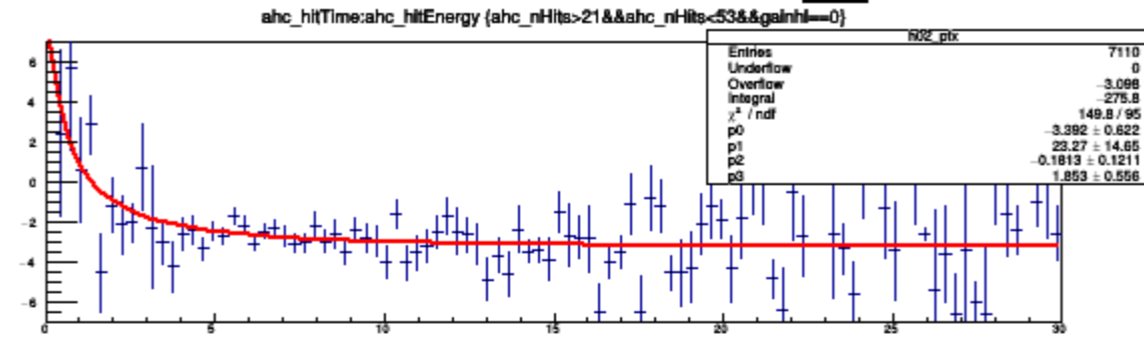
Electrons: Low vs High Gain

vsenergy_20190716z_hitTimevsEne reco_run60512_testNewConstants.rc

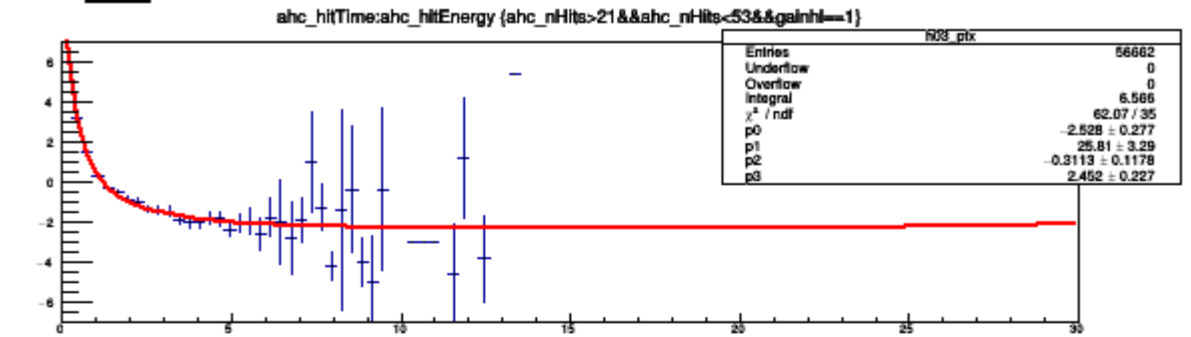
time vs energy



all

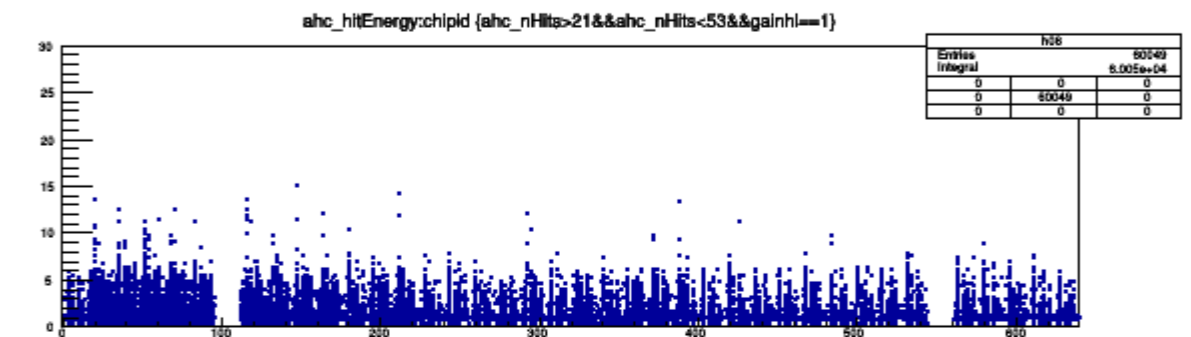
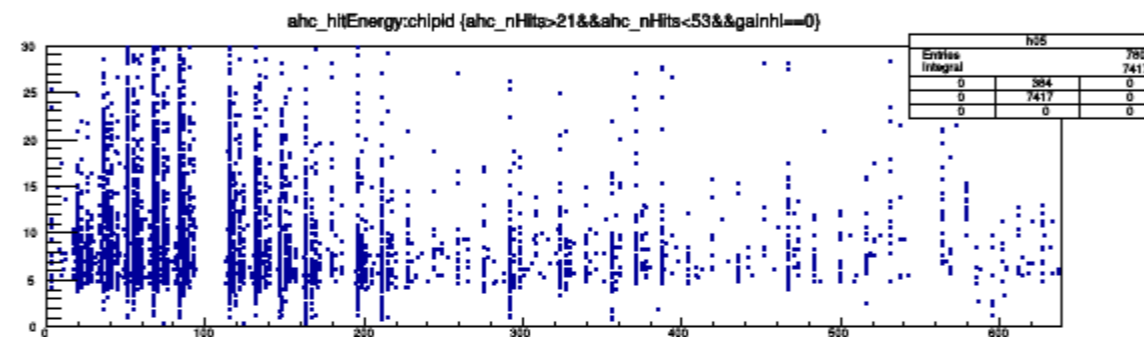
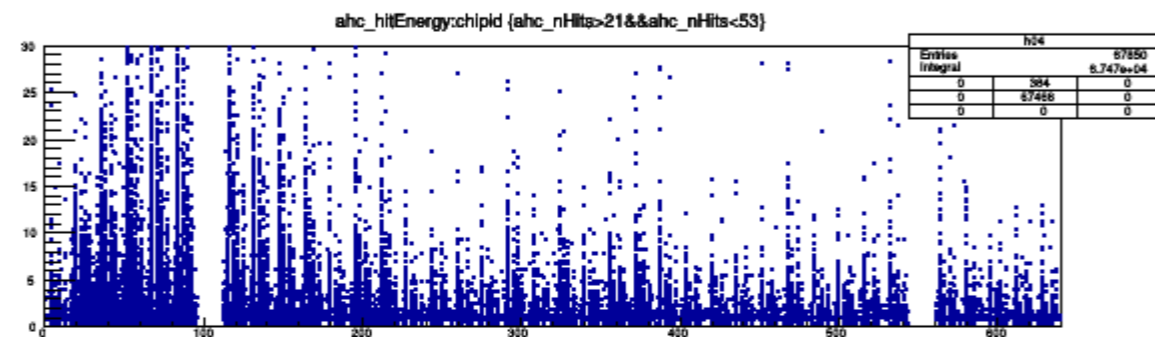


low gain



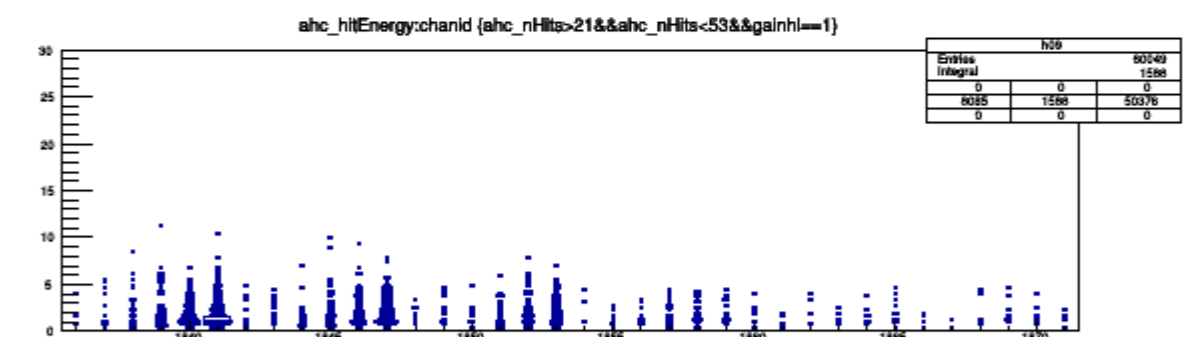
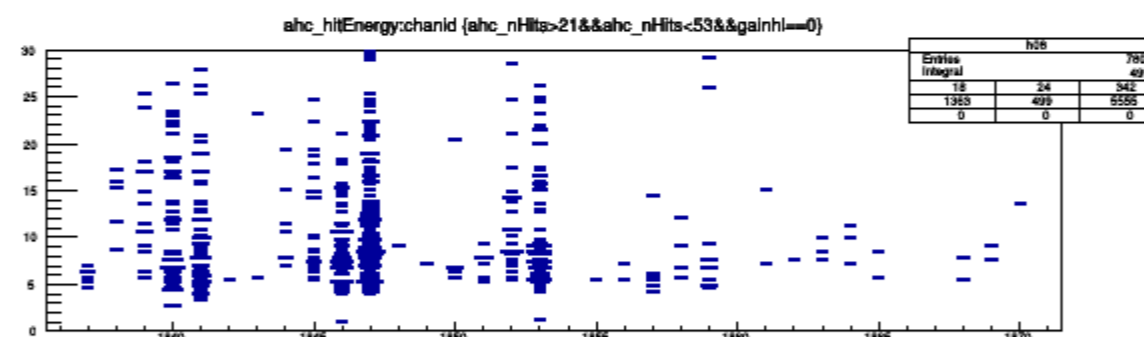
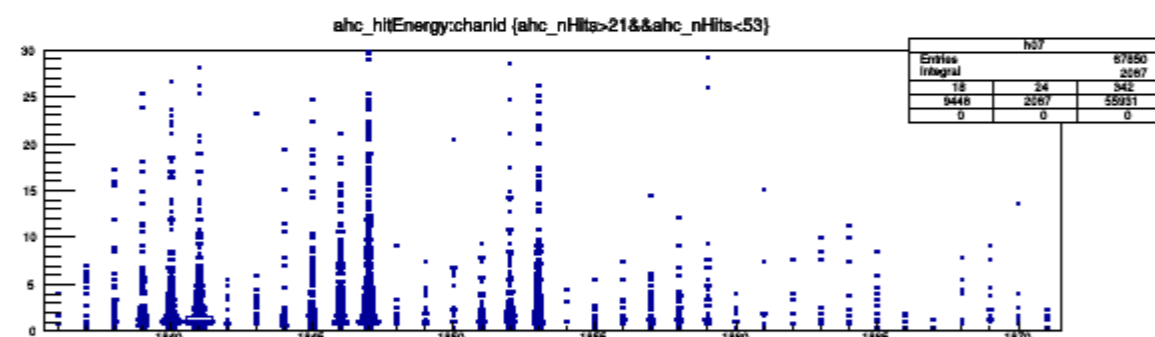
high gain

time vs chipID

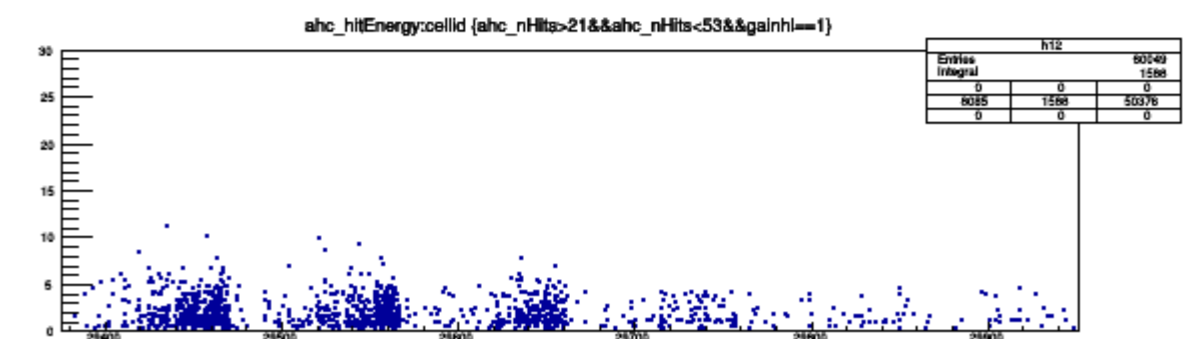
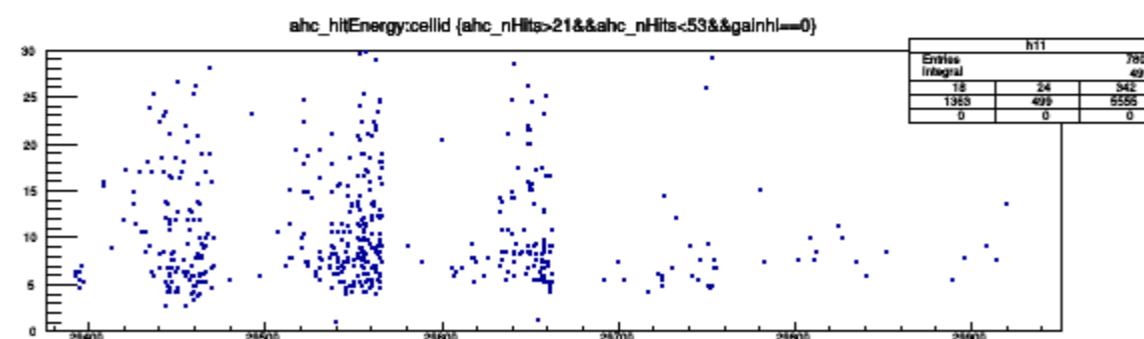
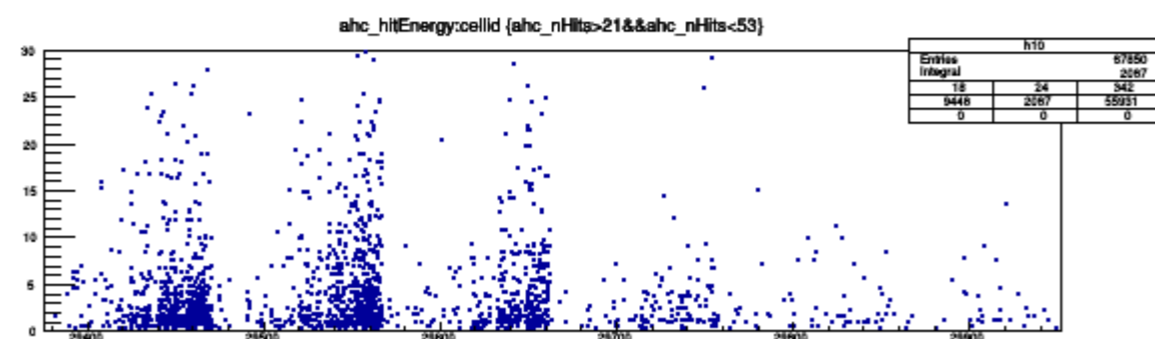


no clear pattern?

time vs channelID



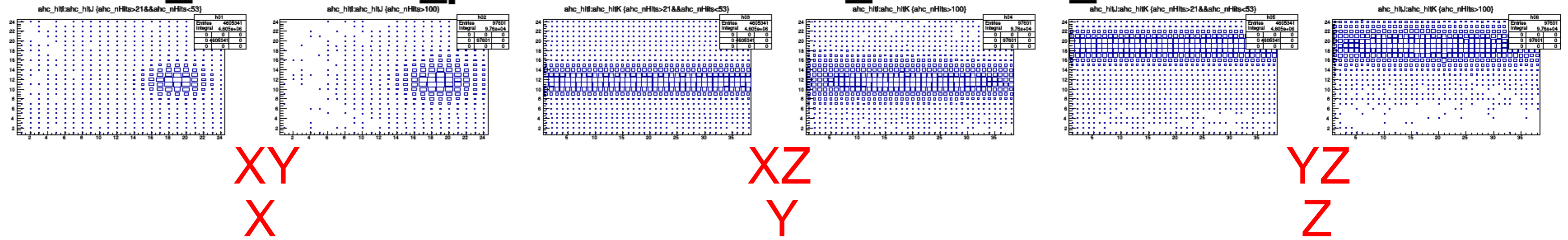
time vs cellID



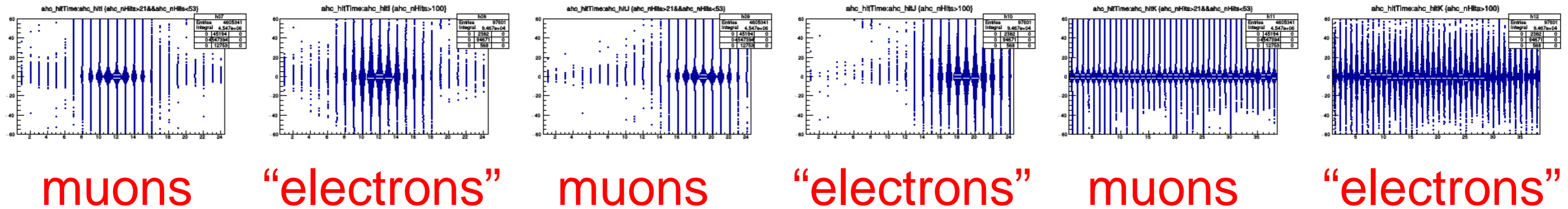
Muon Data: hit time vs position

versust_20190725b_posvshitTime reco_run60382_testNewConstants.roc

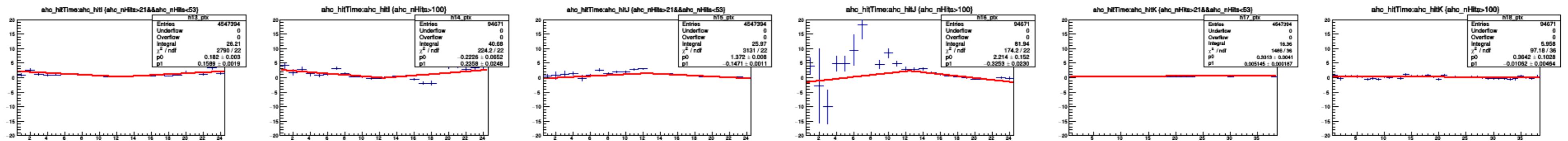
2d distributions



time vs X/Y/Z

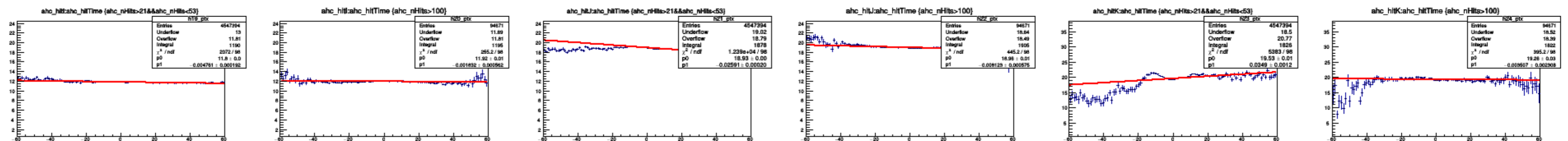


time vs X/Y/Z (projections)



~flat distributions X/Y/Z

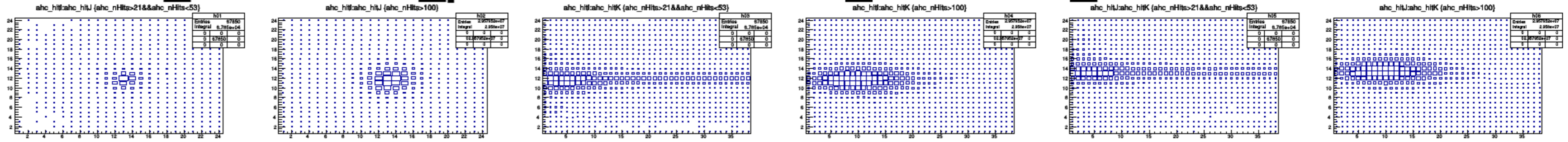
X/Y/Z vs time (projections)



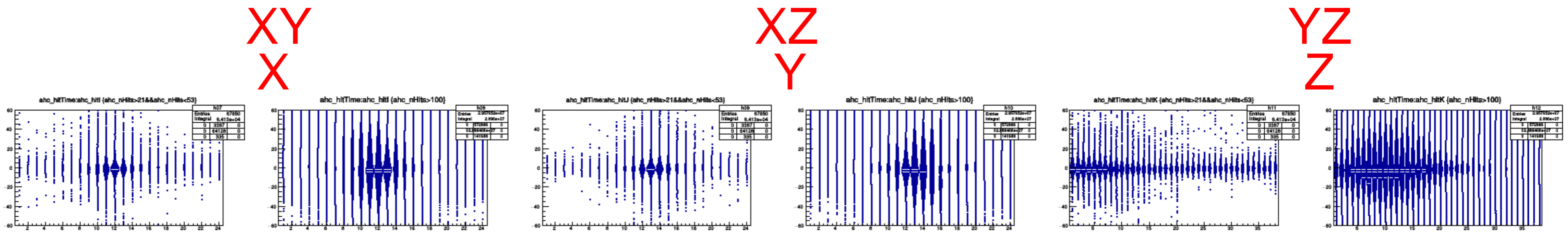
Electrons: hit time vs position

versust_20190725b_posvshitTime reco_run60512_testNewConstants.roc

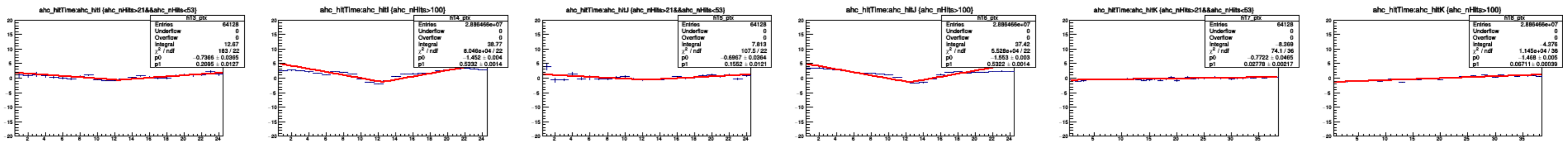
2d distributions



time vs X/Y/Z

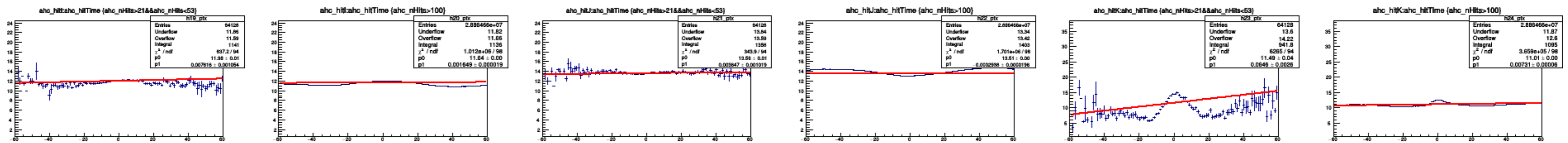


time vs X/Y/Z (projections)



~sides later X/Y, slope in Z

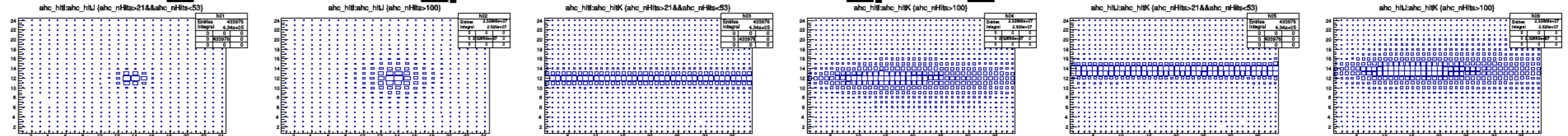
X/Y/Z vs time (projections)



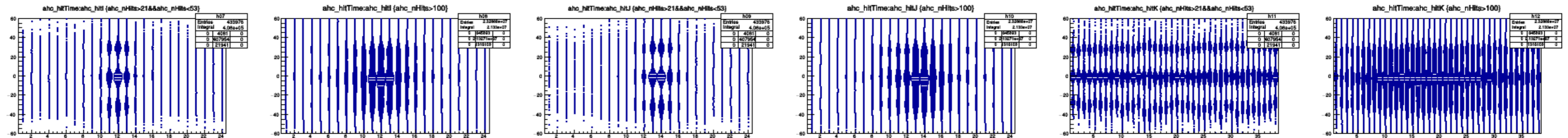
Pions: hit time vs position

versust_20190725b_posvshitTime reco_pion_n40GeV.root

2d distributions



time vs X/Y/Z



“muons”

pions

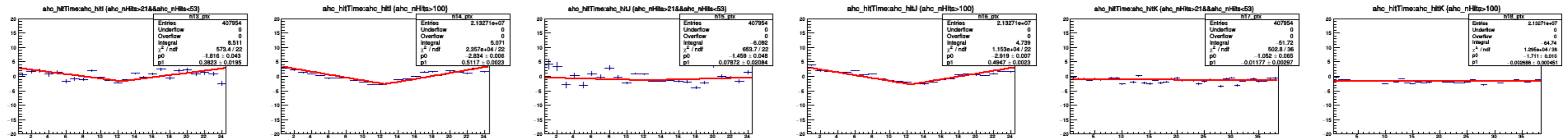
“muons”

pions

“muons”

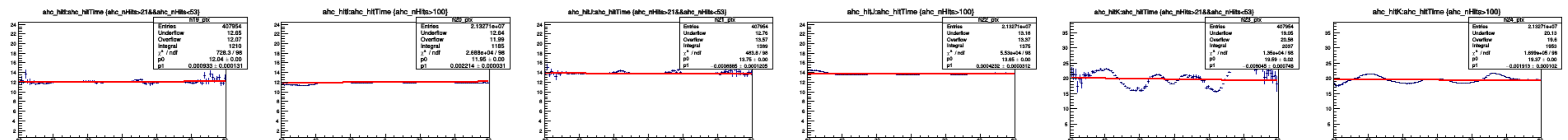
pions

time vs X/Y/Z (projections)



~sides later X/Y, no slope in Z?

X/Y/Z vs time (projections)



Summary

Hit time response is:

- very strongly dependent on hit energy (due to time walk / threshold), but similar for all types of particles, modules, chips, channels.
- 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 ?
- very dependent on beam crossing (odd or even), especially for electrons, which leads to low time resolution.

Correlations with other event info were investigated, no clear pattern emerges. Electronics effect? Time walk corrections improve resolution.

Study of events show limited usability of current time information/resolution.