Staggered Calorimeter Analysis

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Preliminary Results

The Staggered module

9x9x250 cm^3 lead calorimeter:
4 Towers
Half fibers (scintillating and Cherenkov) starting at the front face
Half fibers (scintillating and Cherenkov) starting 25 cm after the front face
Each tower readout by 4 PMTs
16 PMTs (channels) as total readout

Main goal: study the behavior of short/long fibers in electromagnetic and hadronic environments. Understand possible particle identification capability in multi particle environment.

Standalone module:
PMTs
Ancillaries
DRS (for timing information)
Analysis completely decoupled from other subsystems.

Good runs

List of runs with Staggered module:

Run Number	Energy (GeV)	Particles	Num. Evt	Tower	X (cm)	Y (cm)	Note
12914	20	e-	15k	1	26.1	27.8	Equalization long fibres
12915	20	e-	15k	2	30.7	27.8	Equalization long fibres
12916	20	e-	15k	3	30.7	23.2	Equalization long fibres
12917	20	e-	15k	4	26.1	23.2	Equalization long fibres
12918	20	e-	15k	Center	28.4	25.5	Calibration long
12919	60	π-	15k	Center	28.4	25.5	Calibration short
12920	60	π-	15k	1	26.1	27.8	Equalization short fibres
12921	60	π-	50k	1	26.1	27.8	Equalization short fibres
12922	60	π-	50k	2	30.7	27.8	Equalization short fibres
12923	60	π-	50k	3	30.7	23.2	Equalization short fibres, Eliminate last spill of 1700 evts
12924	60	π-	25k	4	26.1	23.2	Equalization short fibres
12926	60	π-	10k	4	26.1	23.2	Equalization short fibres
12927	60	π-	25k	4	26.1	23.2	Equalization short fibres
12928	60	π-	50k	Center	28.4	25.5	Equalization short fibres

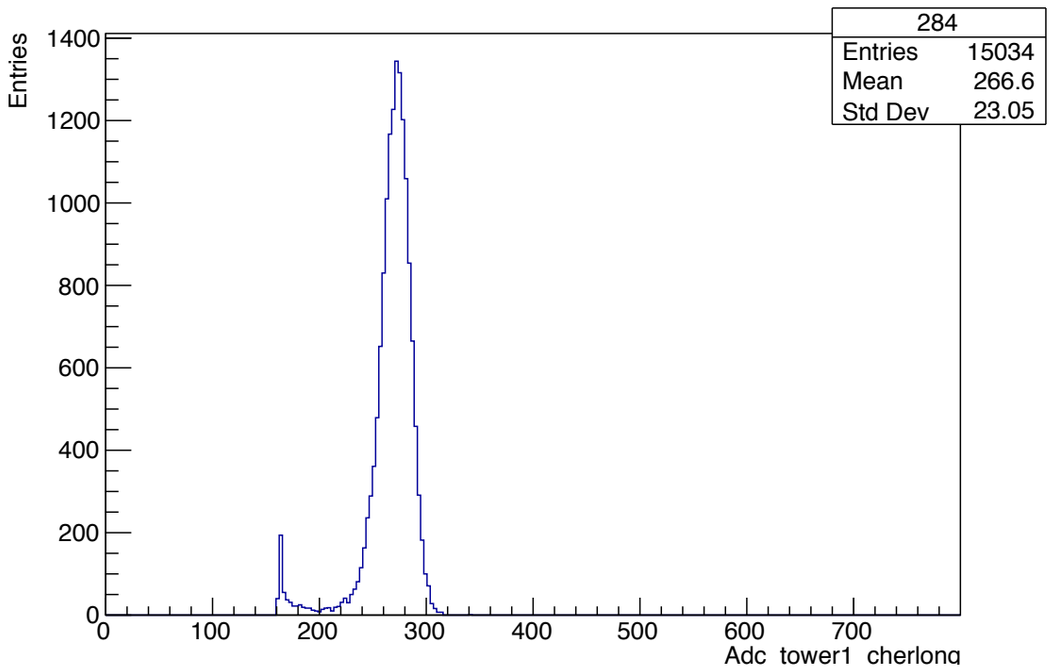
We managed to collect good runs with only 20 GeV electrons
60 GeV pions.

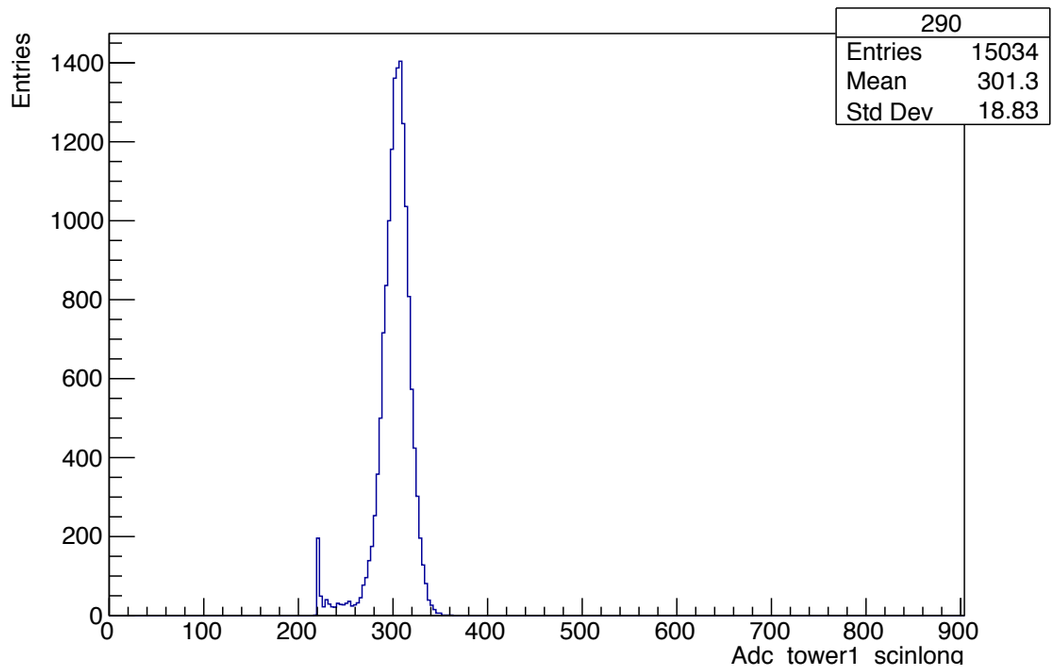
Analysis - Preliminary

Raw signals: 20 GeV electrons in tower 1, signals from long and short fibers.

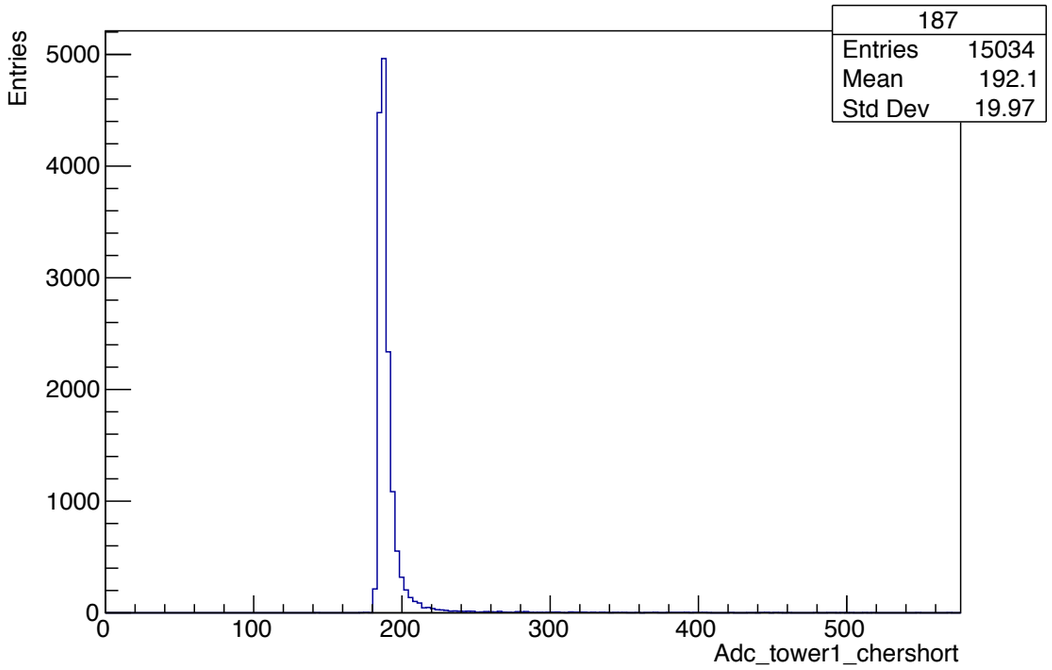
Cherenkov

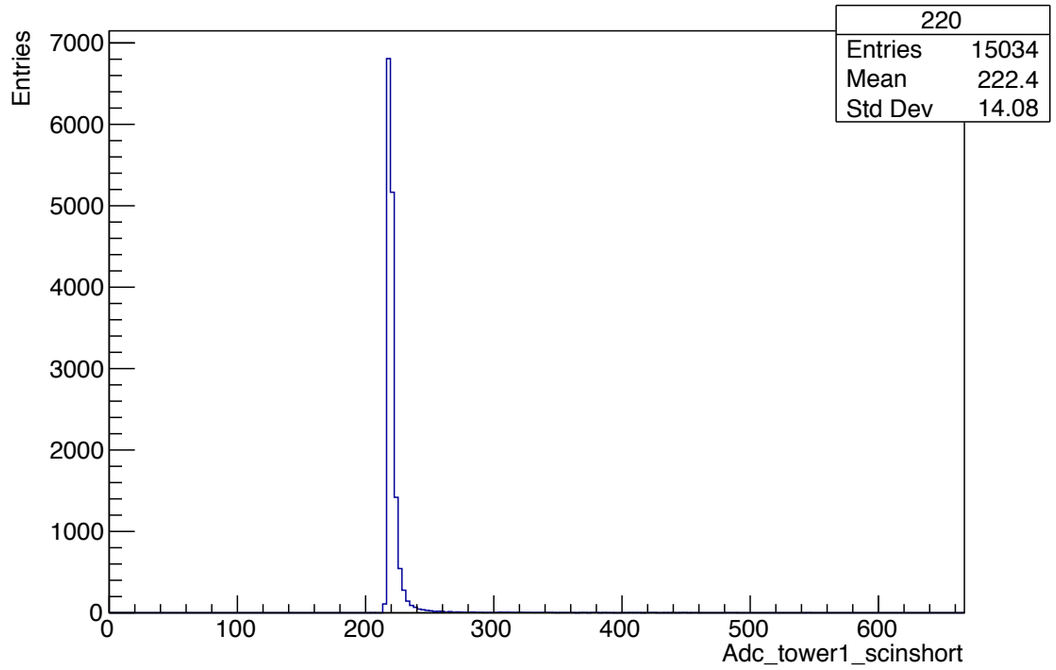
Scintillation





Long Fibers





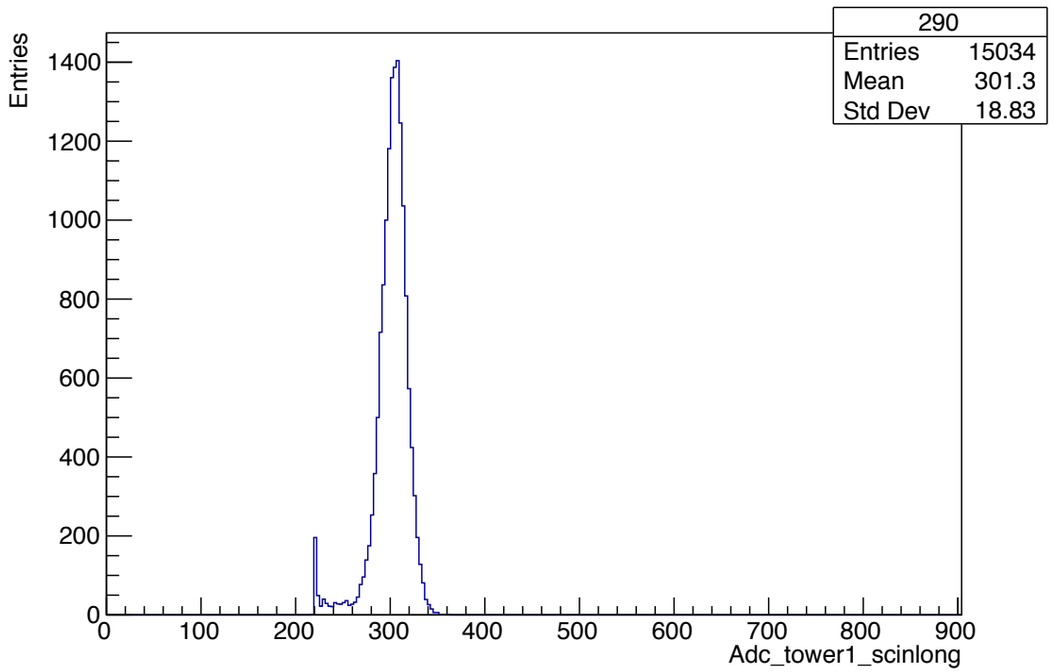
Short Fibers

Signal Processing

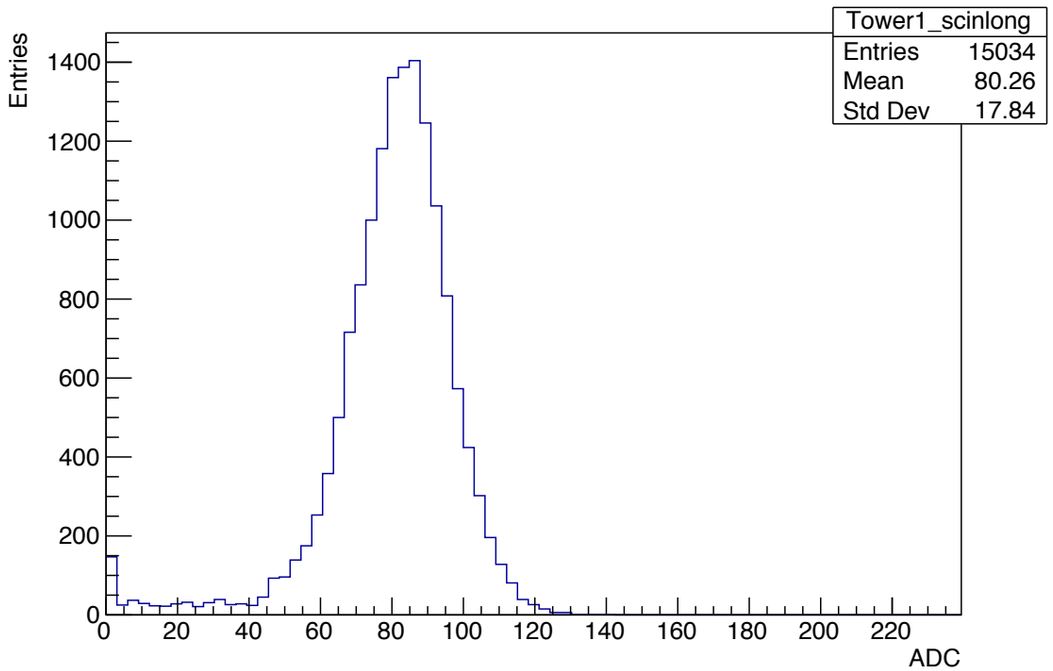
All towers (1-4) shows the same behavior when stimulated with electrons: signal compatible with pedestal in short fibers (scintillating and Cherenkov) and an actual signal in long fibers (scintillating and Cherenkov).

Pedestal subtraction with pedestal estimated every run. One every 10 events is a pedestal event.

raw_signal
20 GeV electron in tower 1



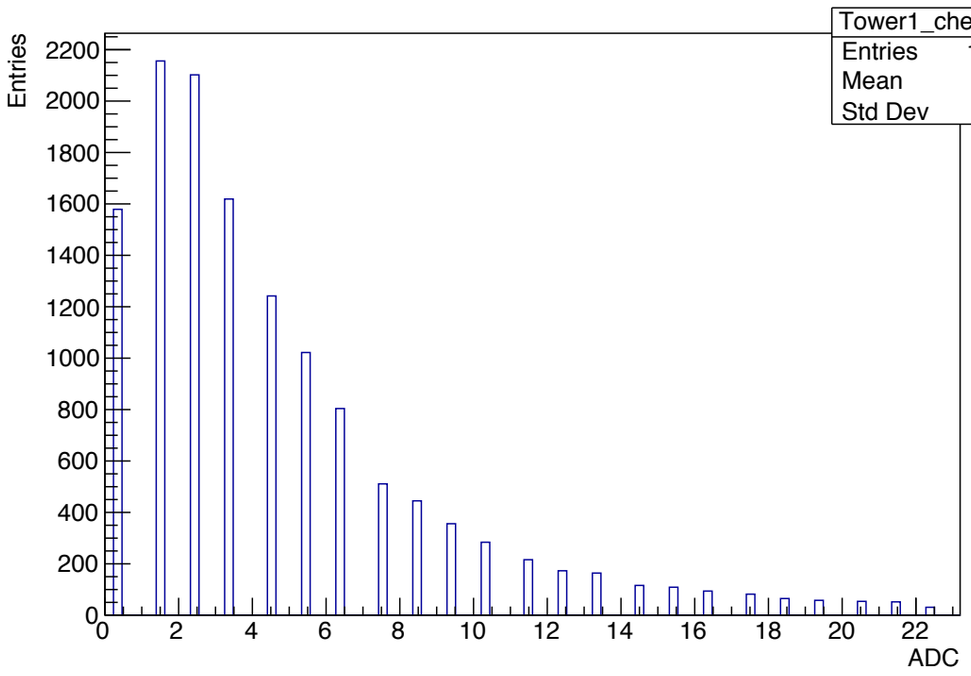
pedestal sub
20 GeV electron in tower 1



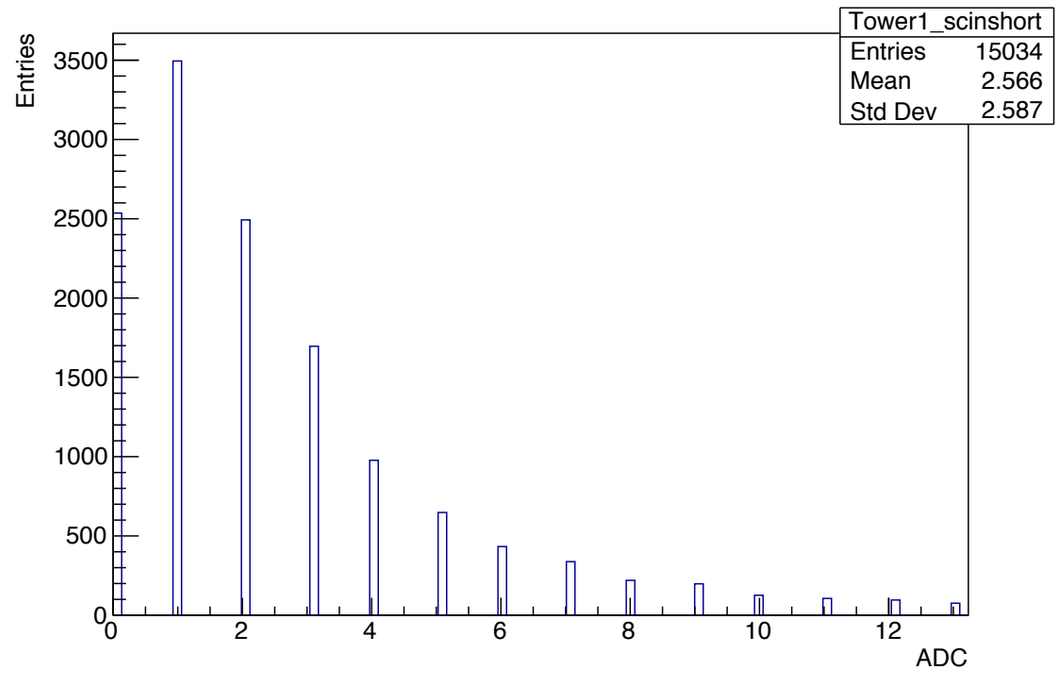
Do not correct signal with zero suppression.

Short fibers and electrons

Cherenkov



Scintillation

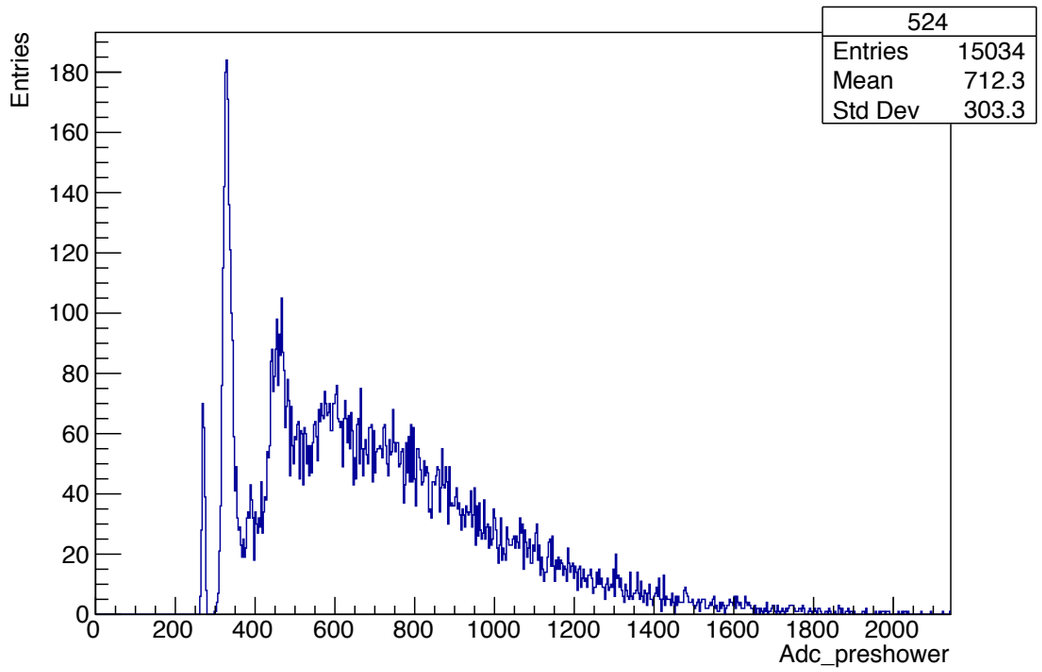


After the pedestal subtraction.

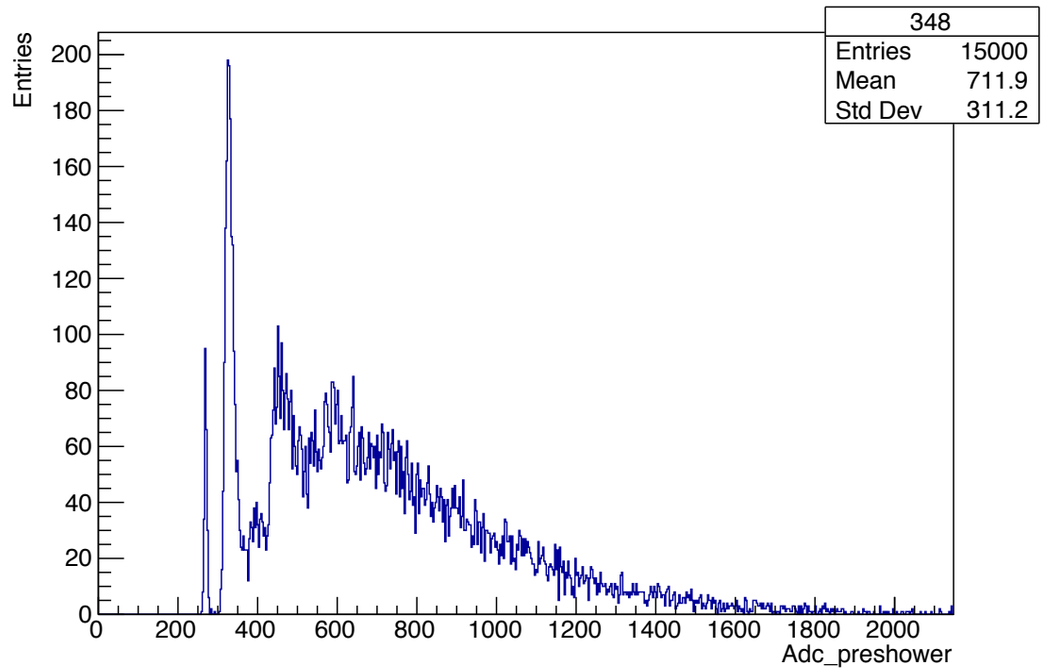
Particle selection

Ancillaries responses were very stable along the whole data taking.

First run with electrons



Last run with electrons

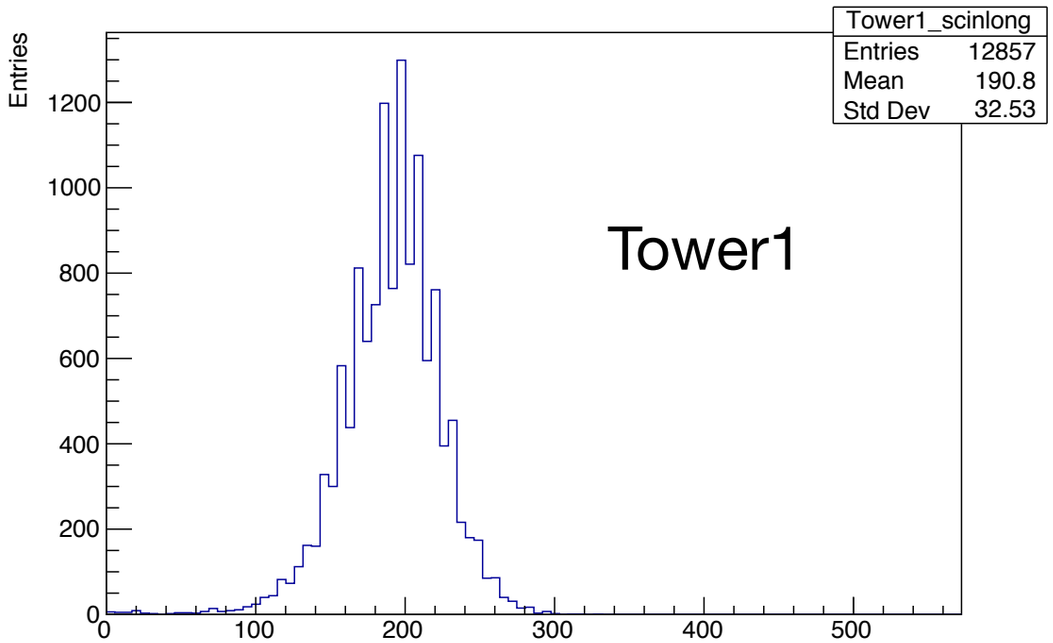


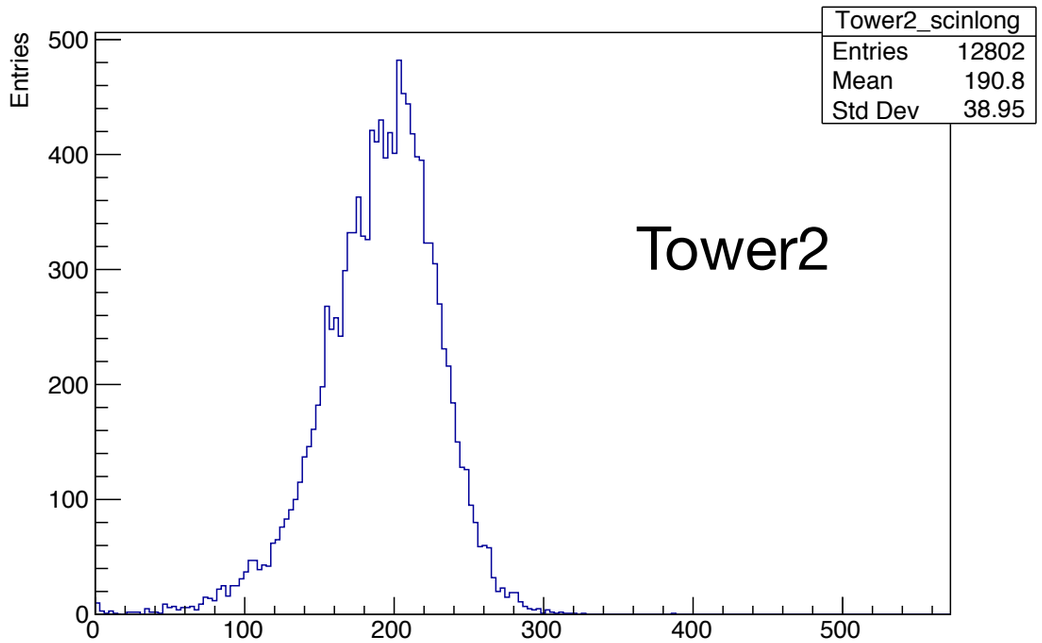
Electrons are identified as a signal in the preshower > 400 ADC and a negligible signal in the muon counter.

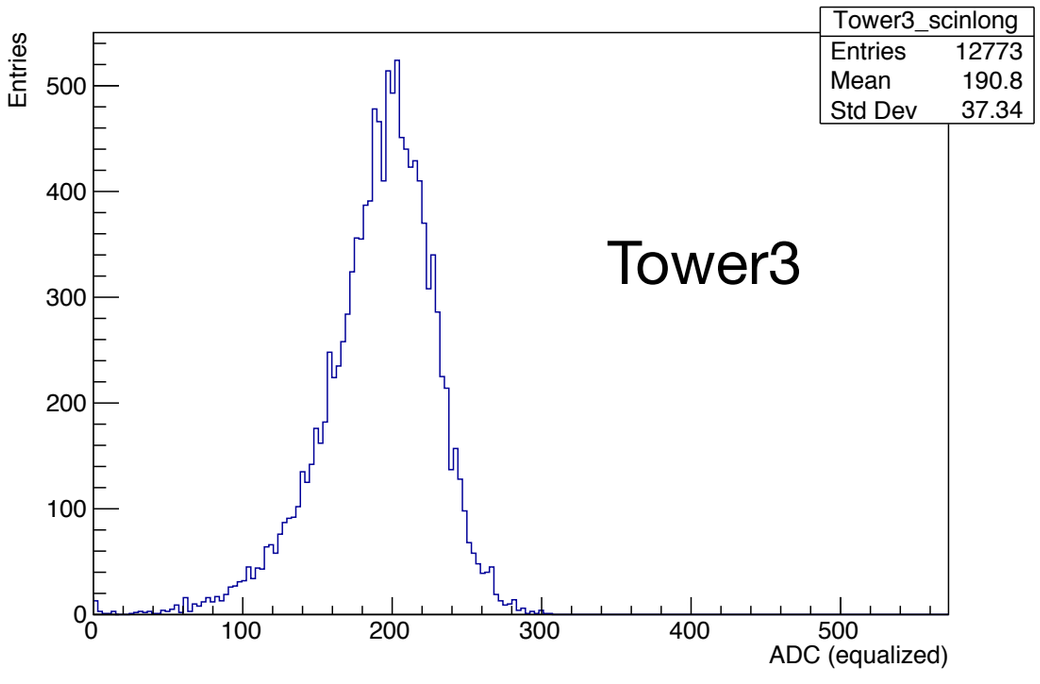
Hadrons are identified as a signal in the 3 sigma above mean pedestal value and a negligible signal in the muon counter.

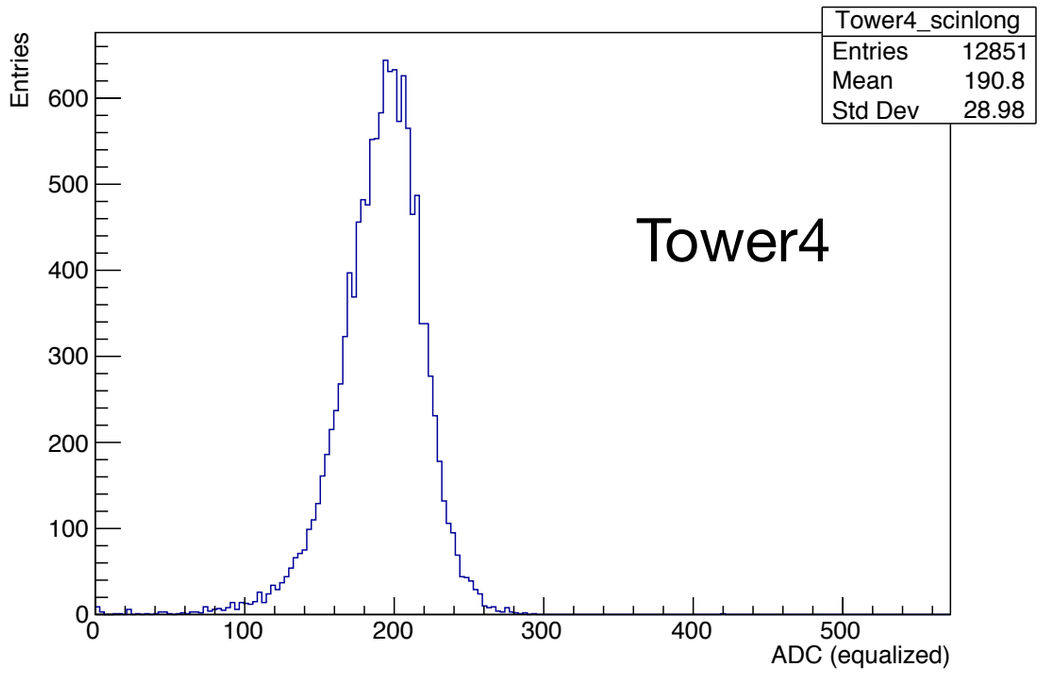
By taking the mean value in events in which 20 GeV electrons where sent in each tower, it is possible to equalize the response of long fibers (tower 1-4, scintillating and Cherenkov).

Scintillating long fibers 20 GeV electrons





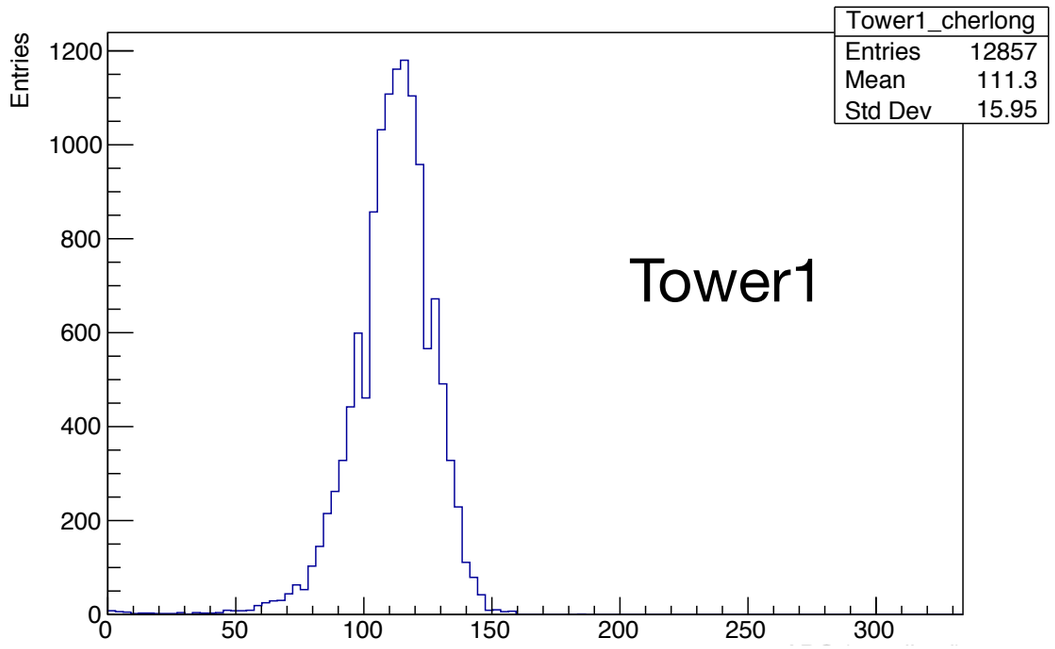


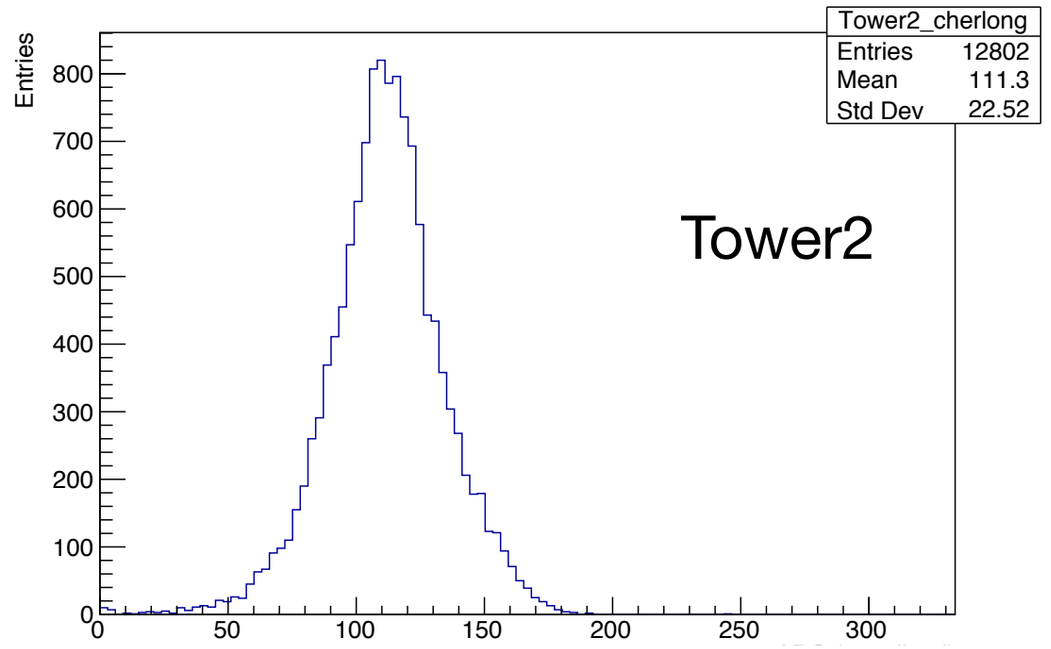


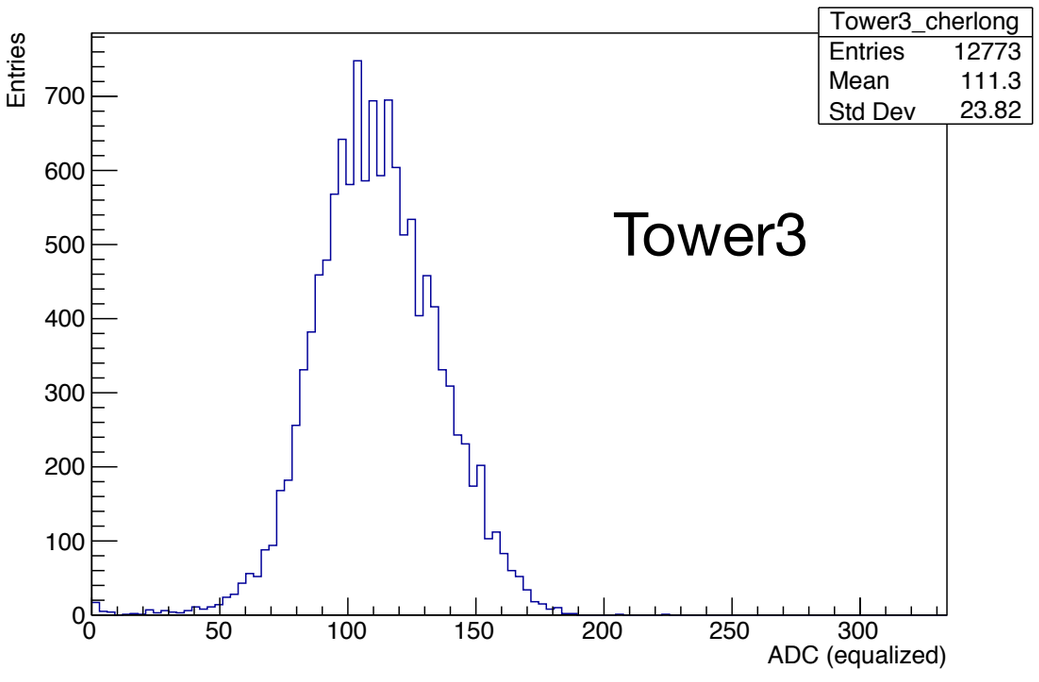
Mean value can be used for calibration

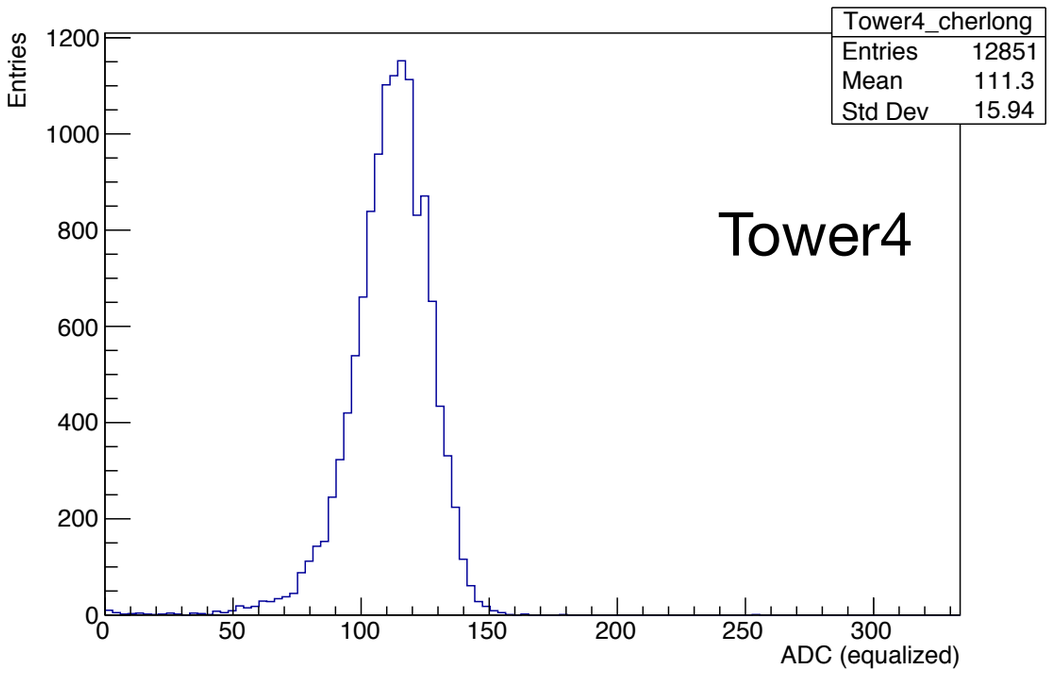
By taking the mean value in events in which 20 GeV electrons where sent in each tower, it is possible to equalize the response of long fibers (tower 1-4, scintillating and Cherenkov).

Cherenkov long fibers 20 GeV electrons









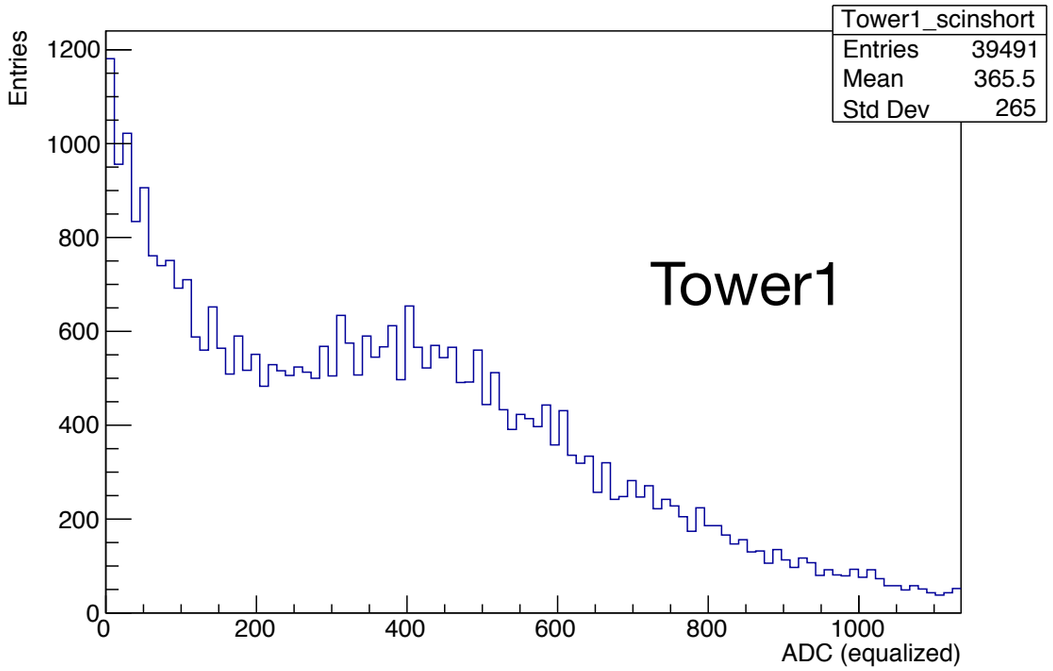
Mean value can be used for calibration

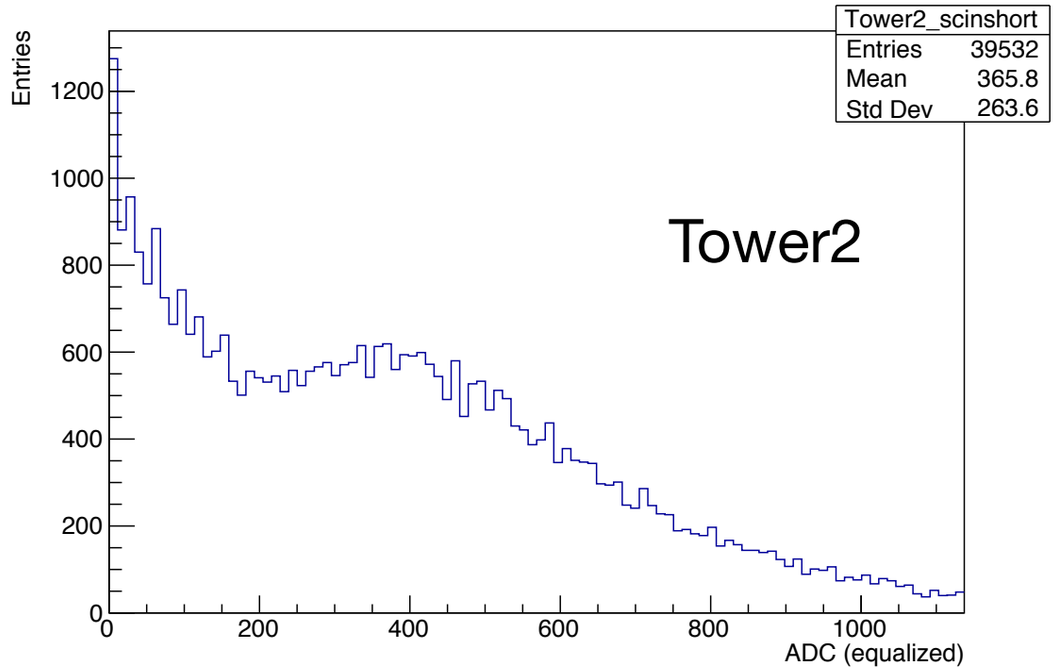
The short fibers world

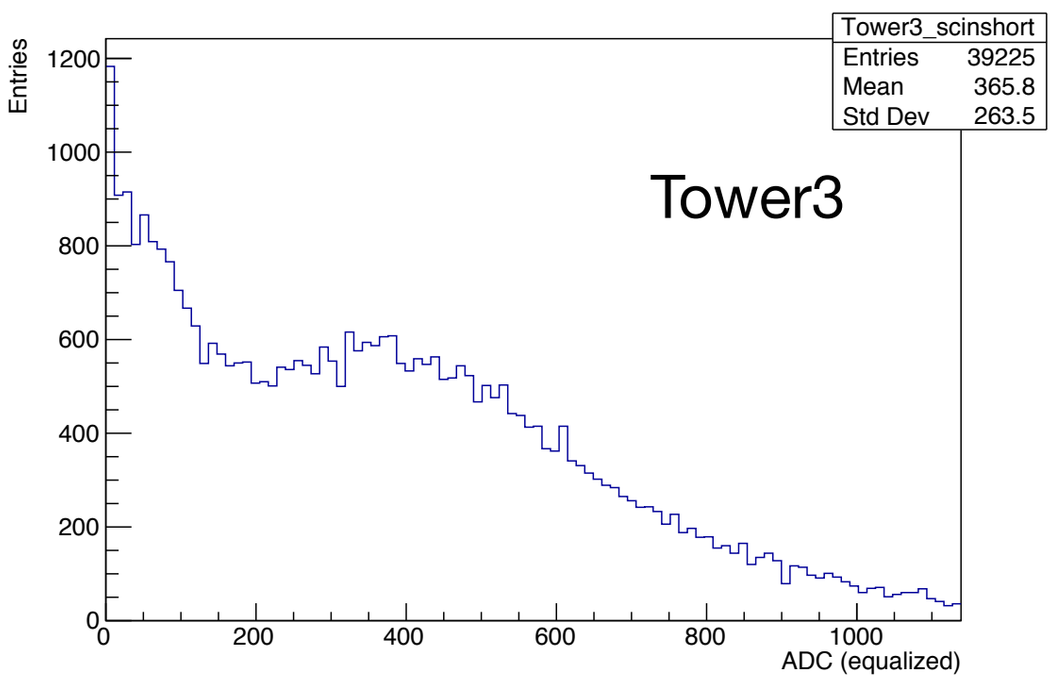
The response of short fibers can be studied only with pions (60GeV)

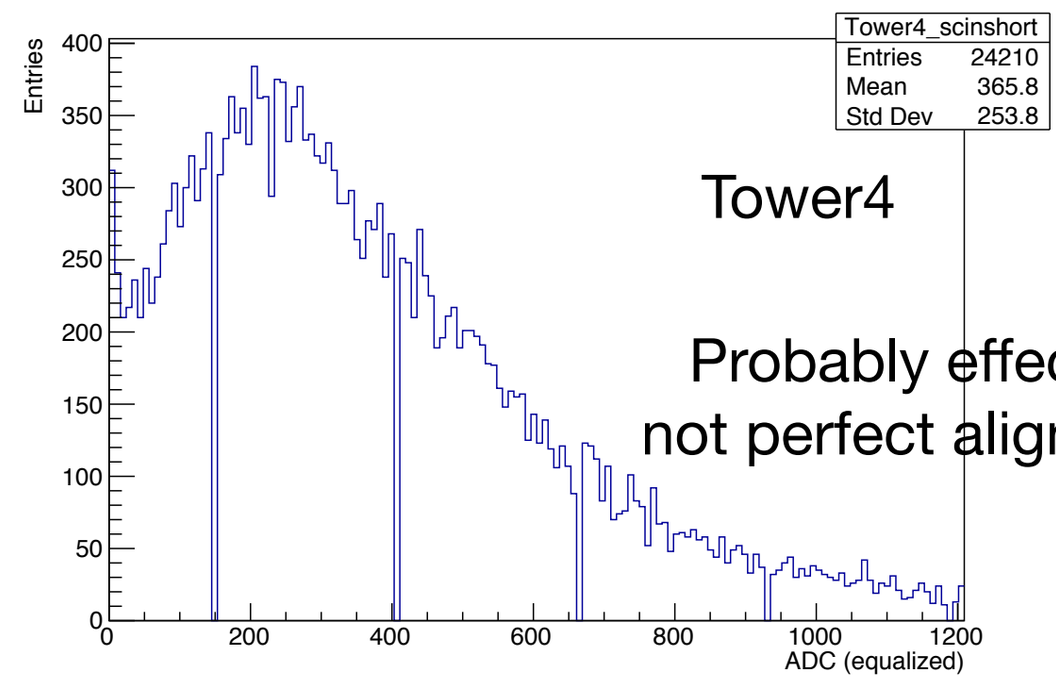
Scintillating short fibers with 60 GeV pions

After signal processing also response of short fibers is equalized.









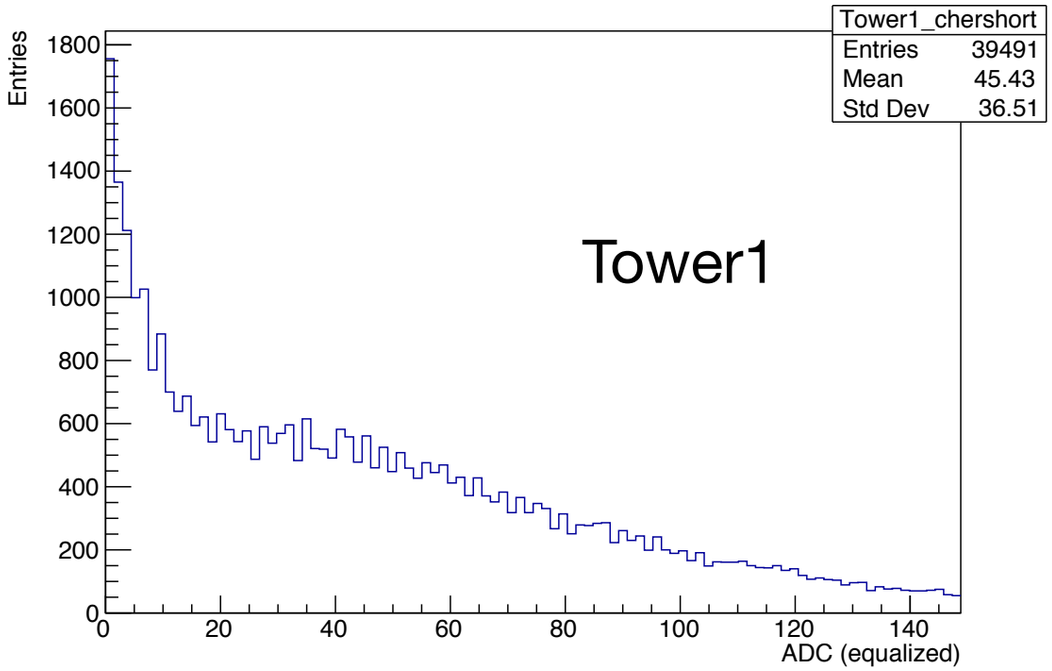
Probably effect of not perfect alignment

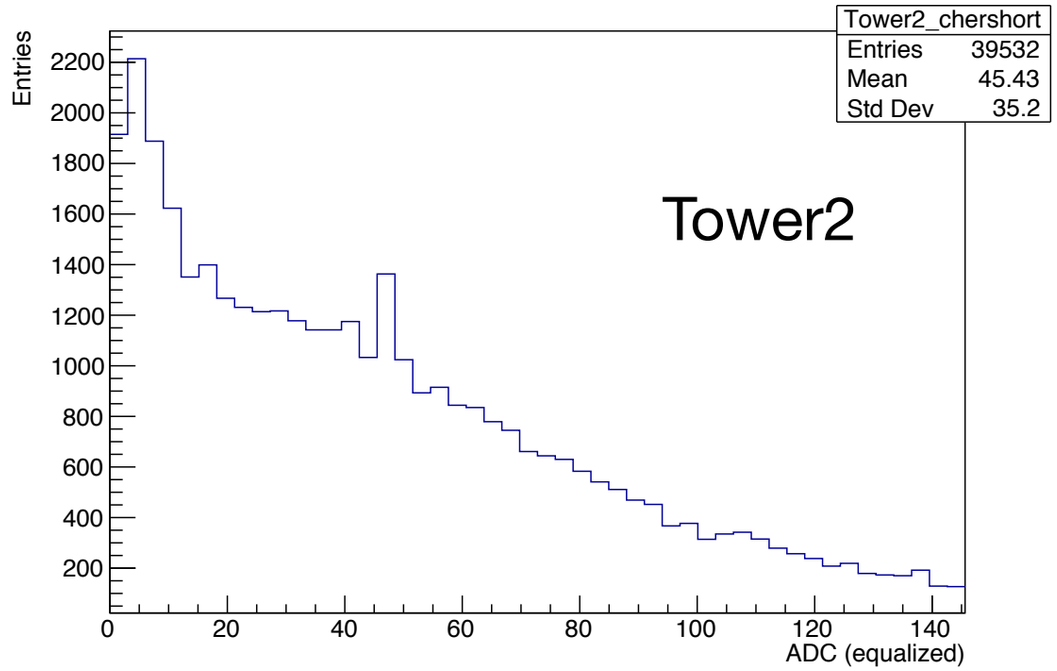
The short fibers world

The response of short fibers can be studied only with pions (60GeV)

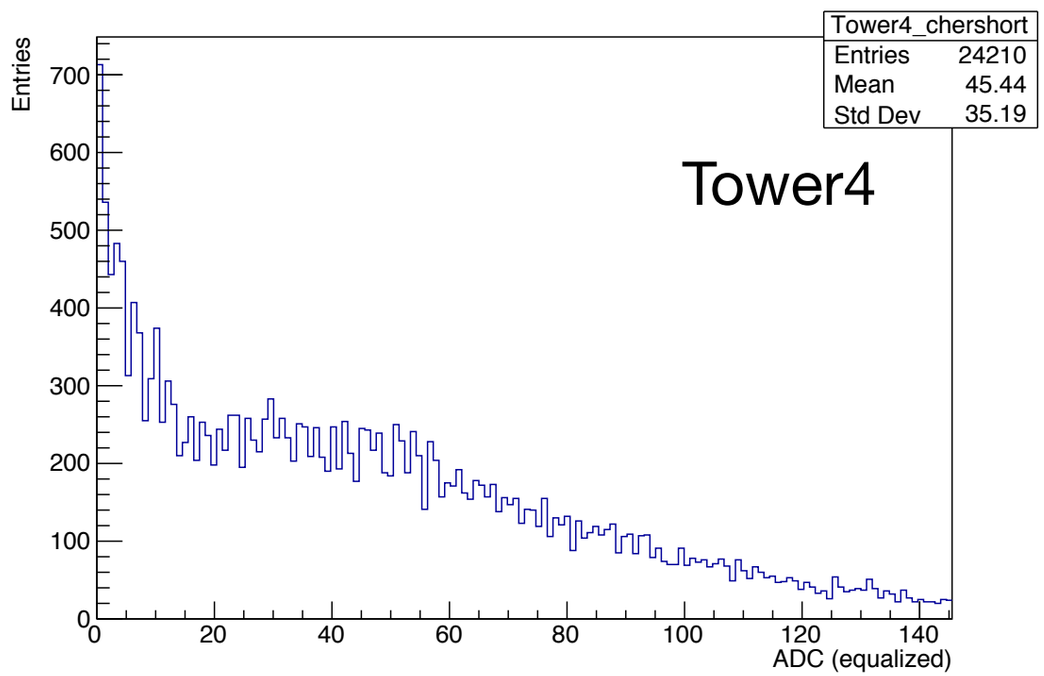
Cherenkov short fibers with 60 GeV pions.

After signal processing also response of short fibers is normalized.





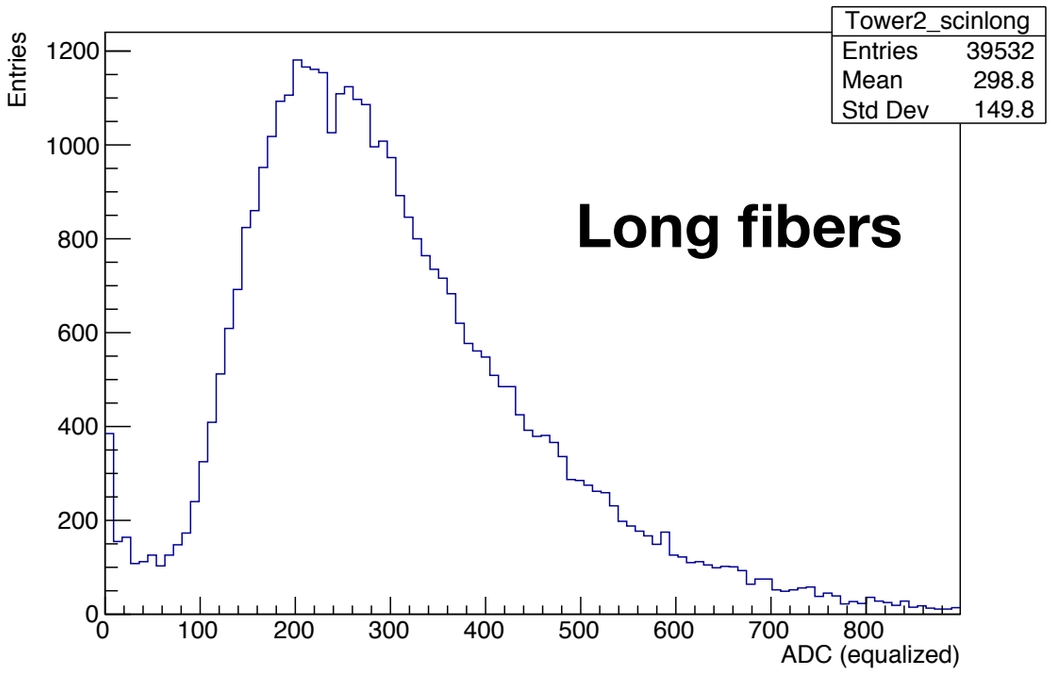
Tower 3 ADC Cherenkov short not working

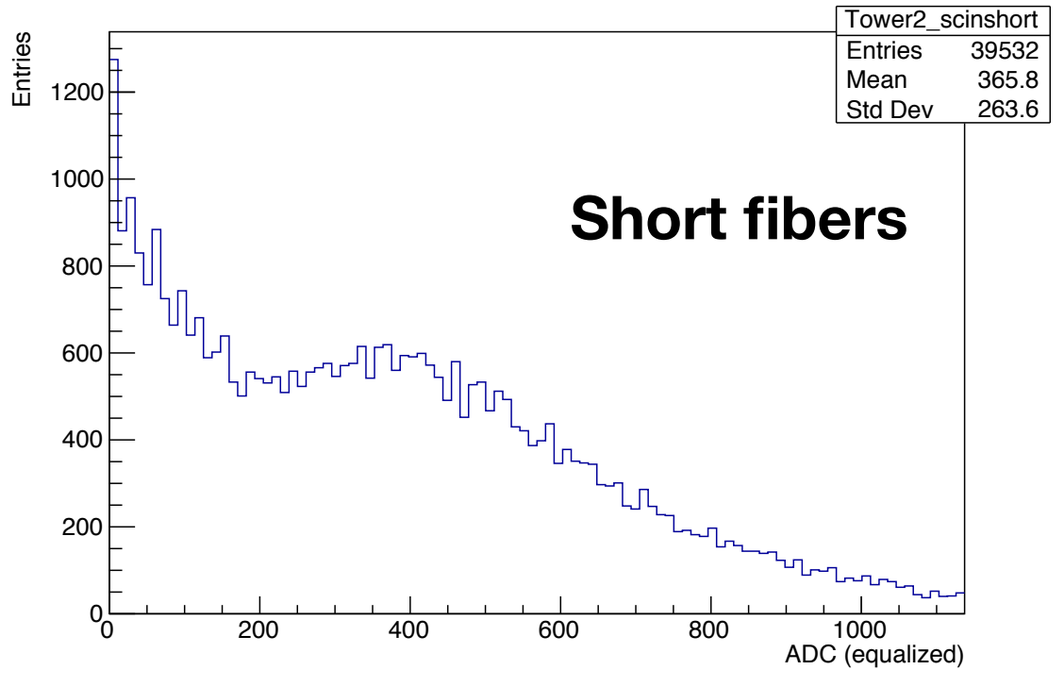


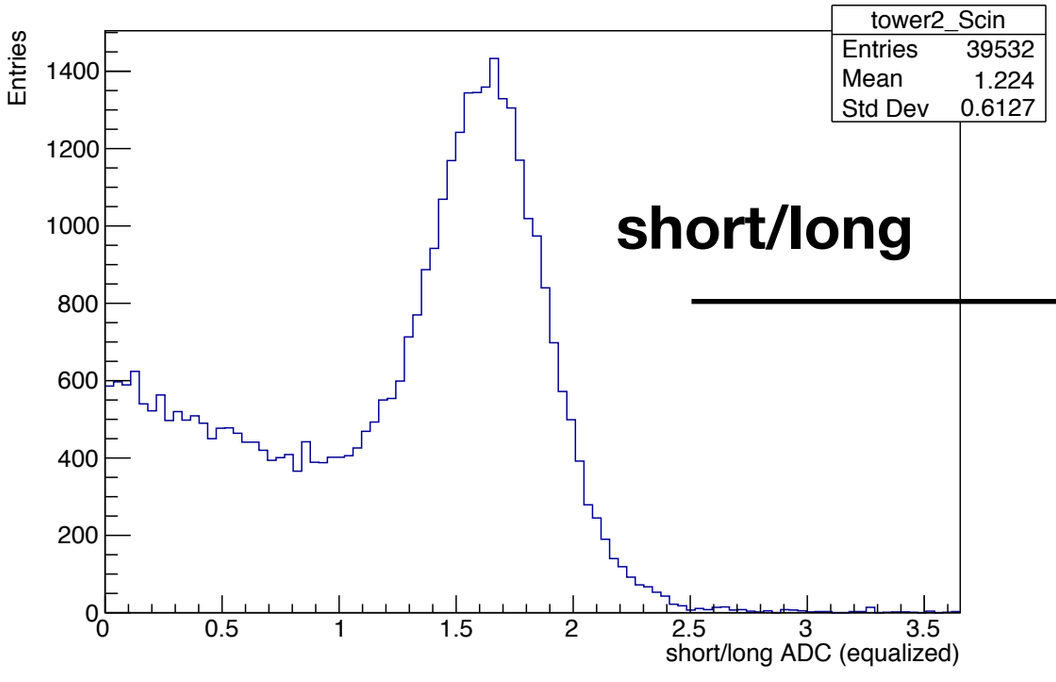
Calibrating short towers

Scintillating short fibers with 60 GeV pions

example: Tower 2







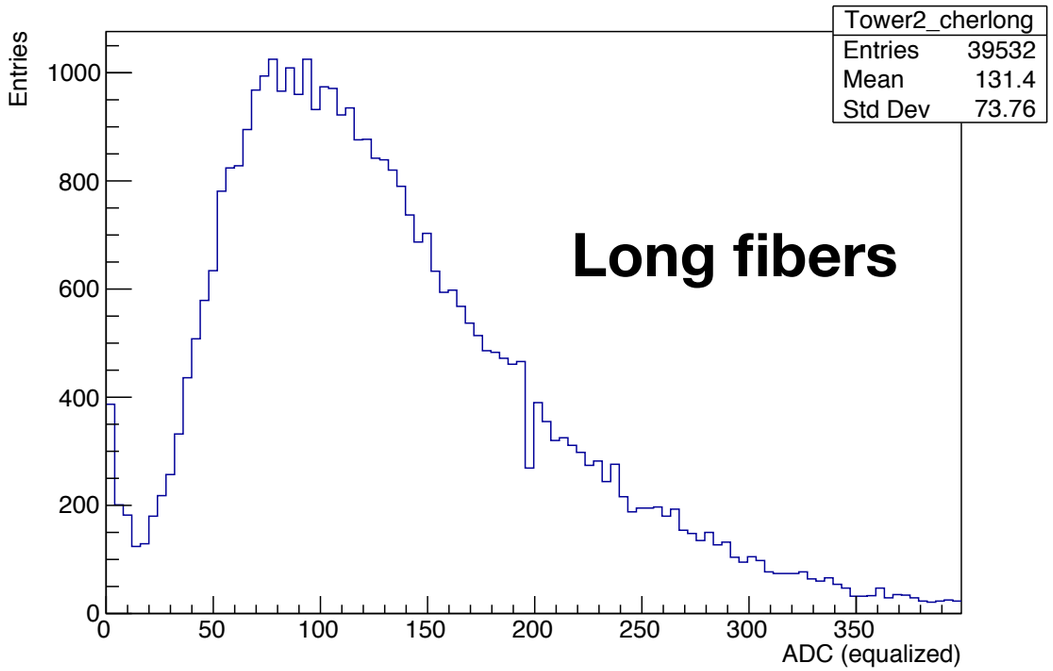
short/long

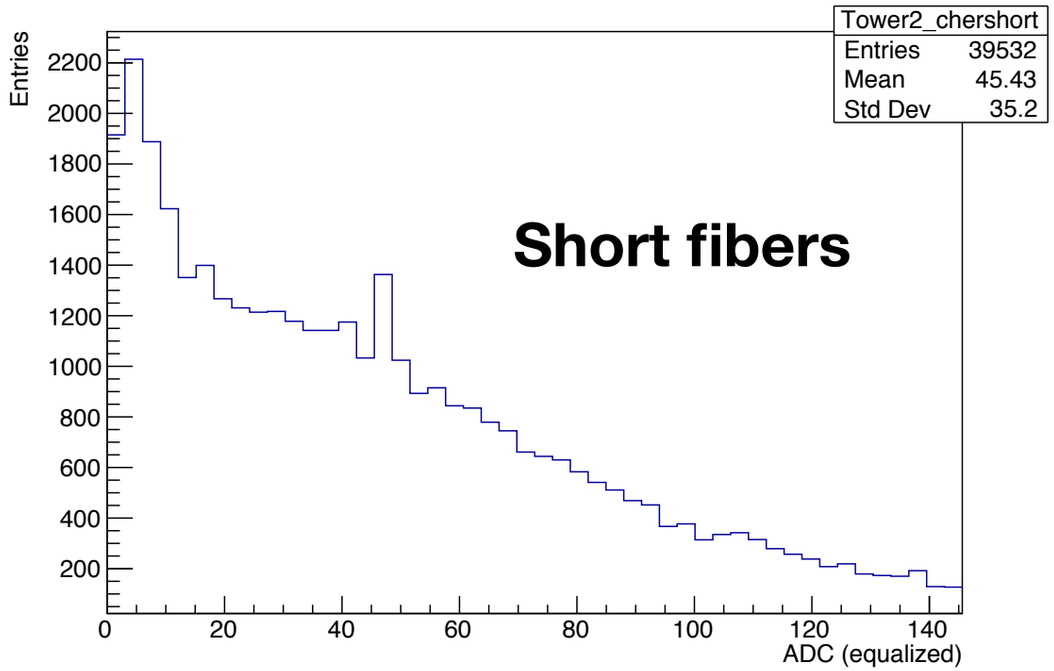
Well identified peak:
Can be used to calibrate scintillating short fibers of tower 2.

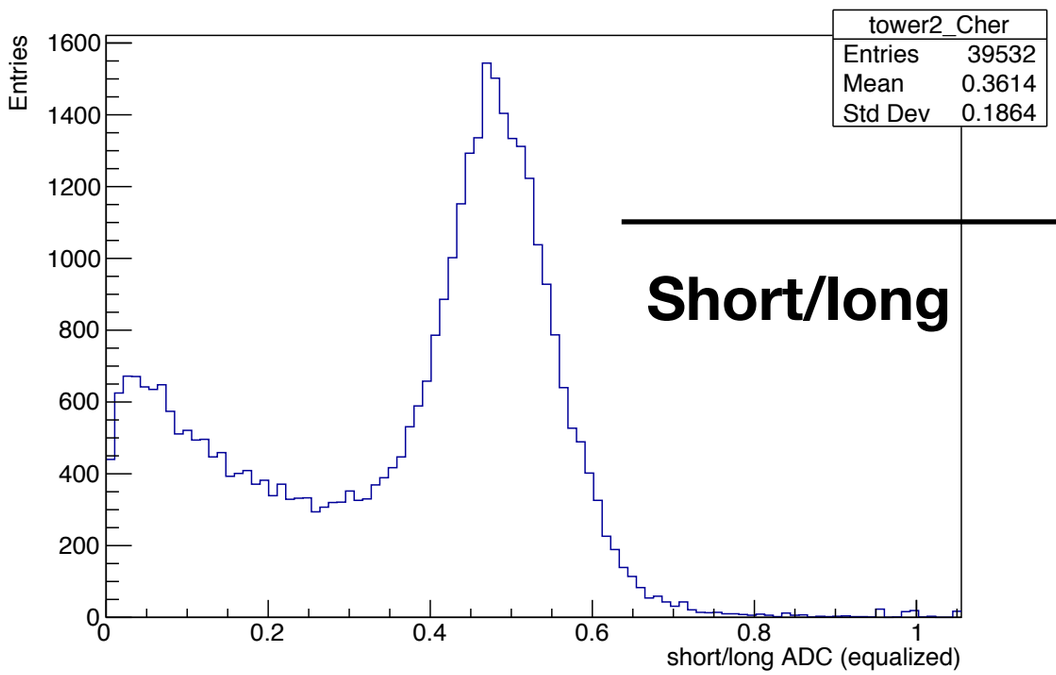
Calibrating short towers

Cherenkov short fibers with 60 GeV pions

example: Tower 2



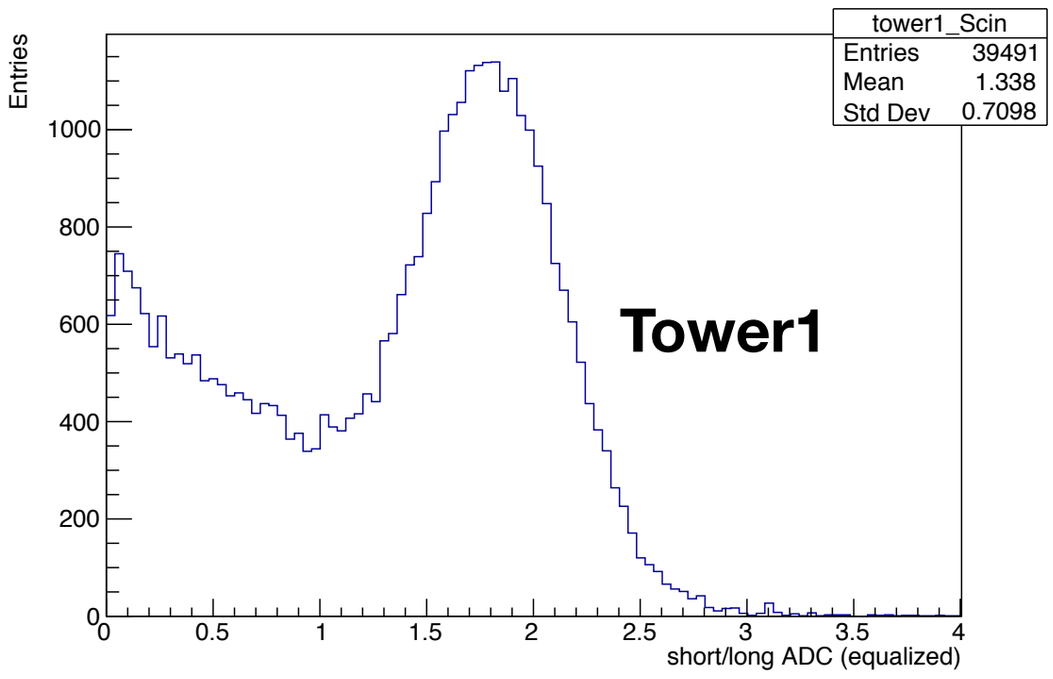


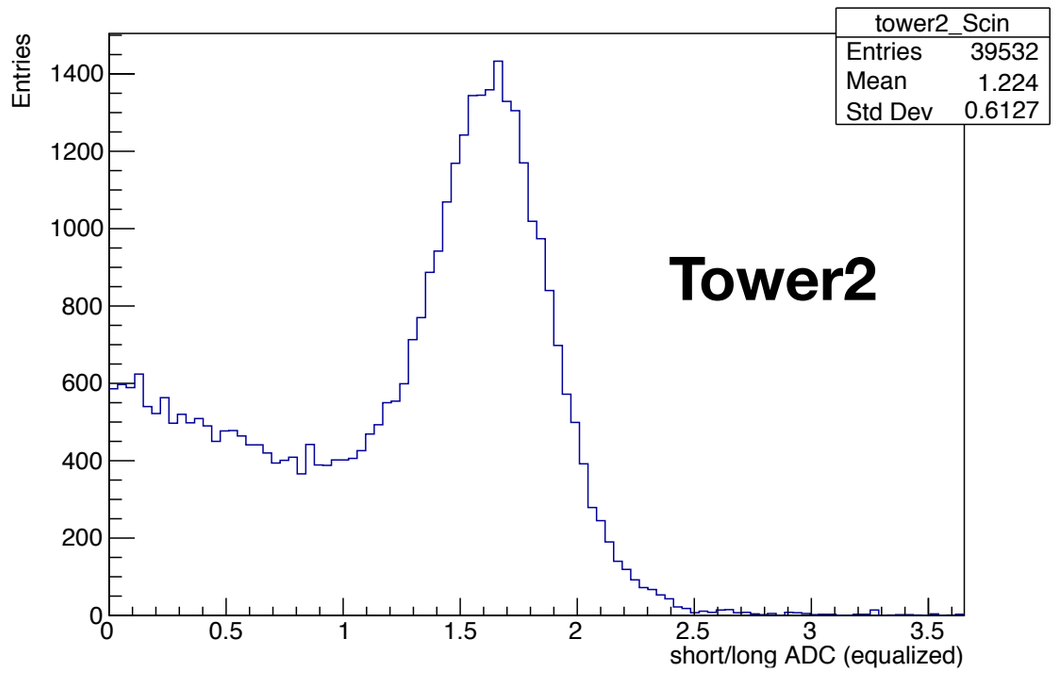


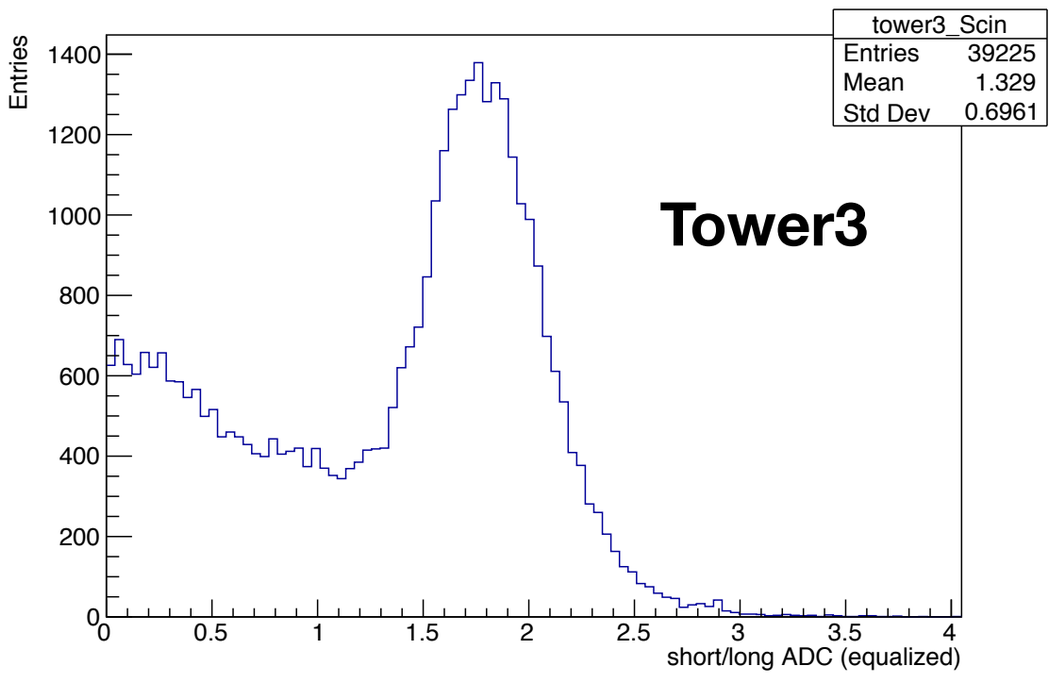
Even with Cherenkov fibers we have a well identified peak:
Can be used to calibrate Cherenkov short fibers of tower 2.

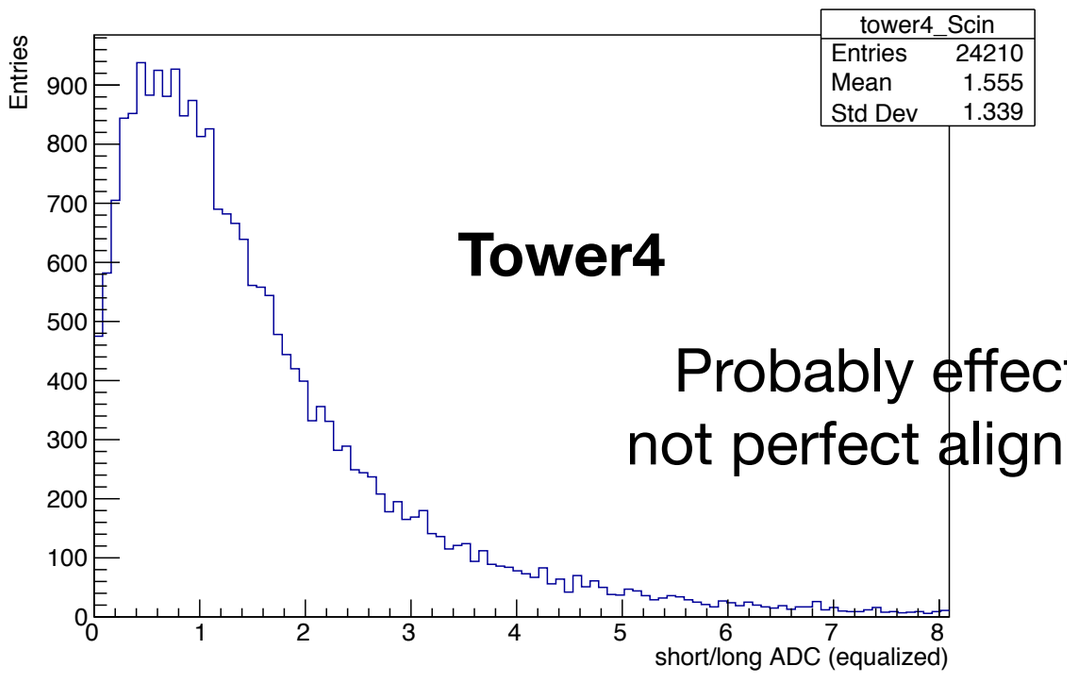
Summary of calibrating short fibers

Scintillating fibers





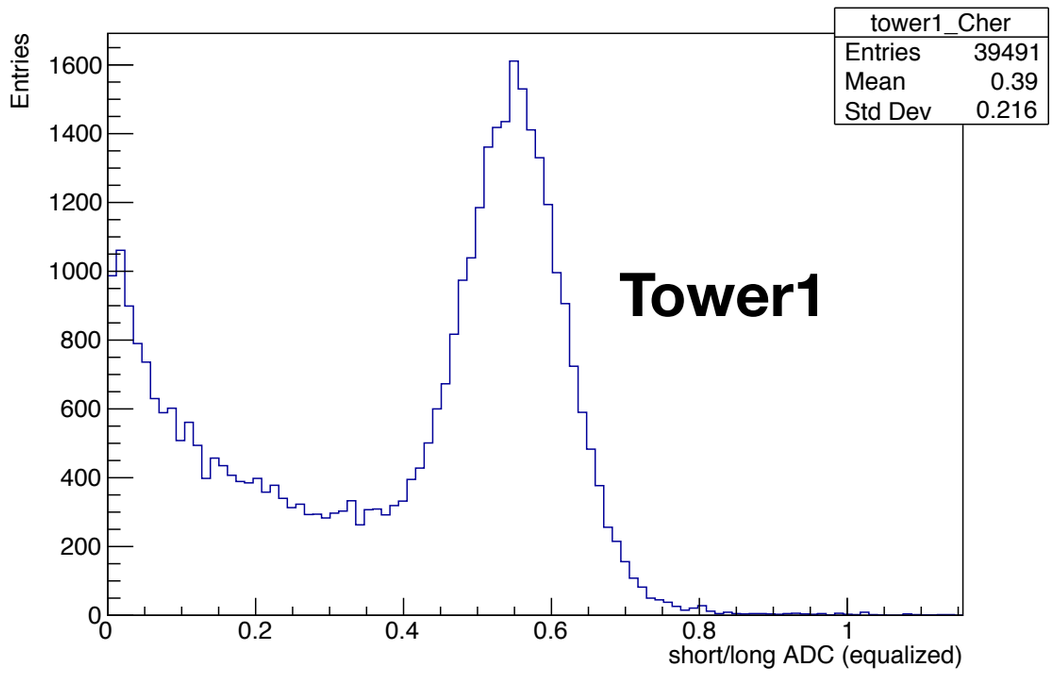


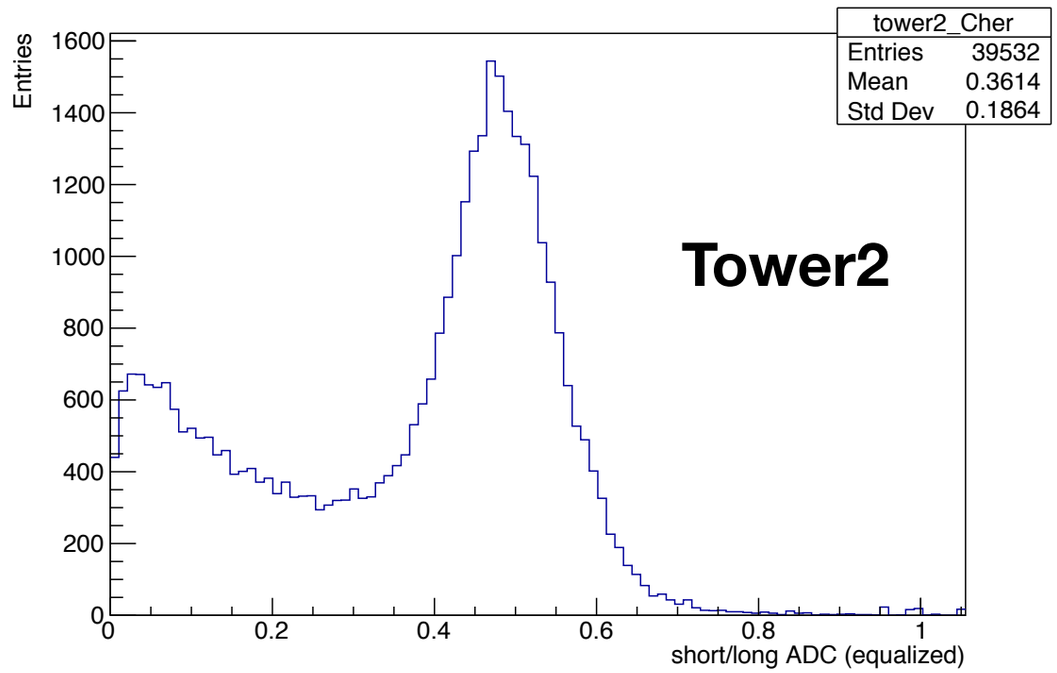


Probably effect of not perfect alignment

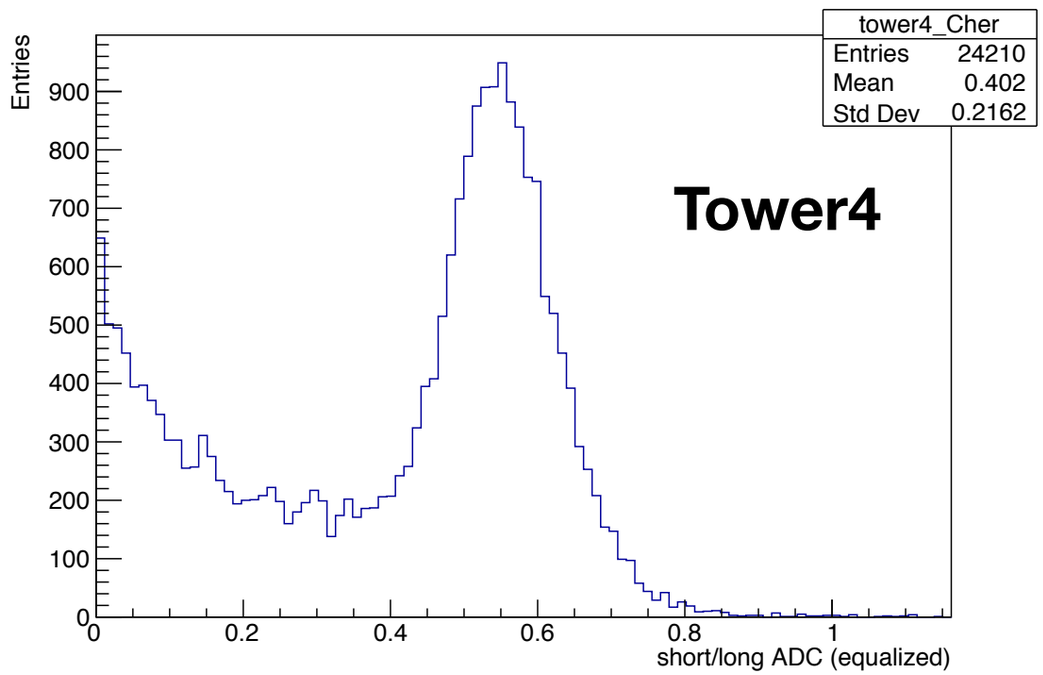
Summary of calibrating short fibers

Cherenkov fibers



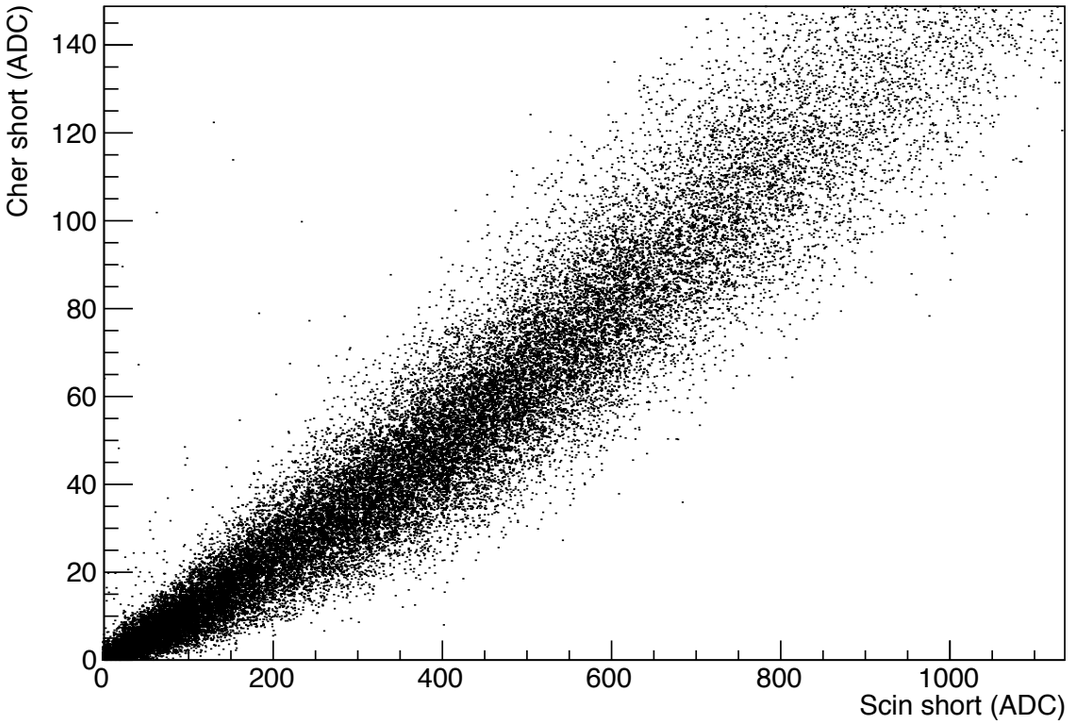


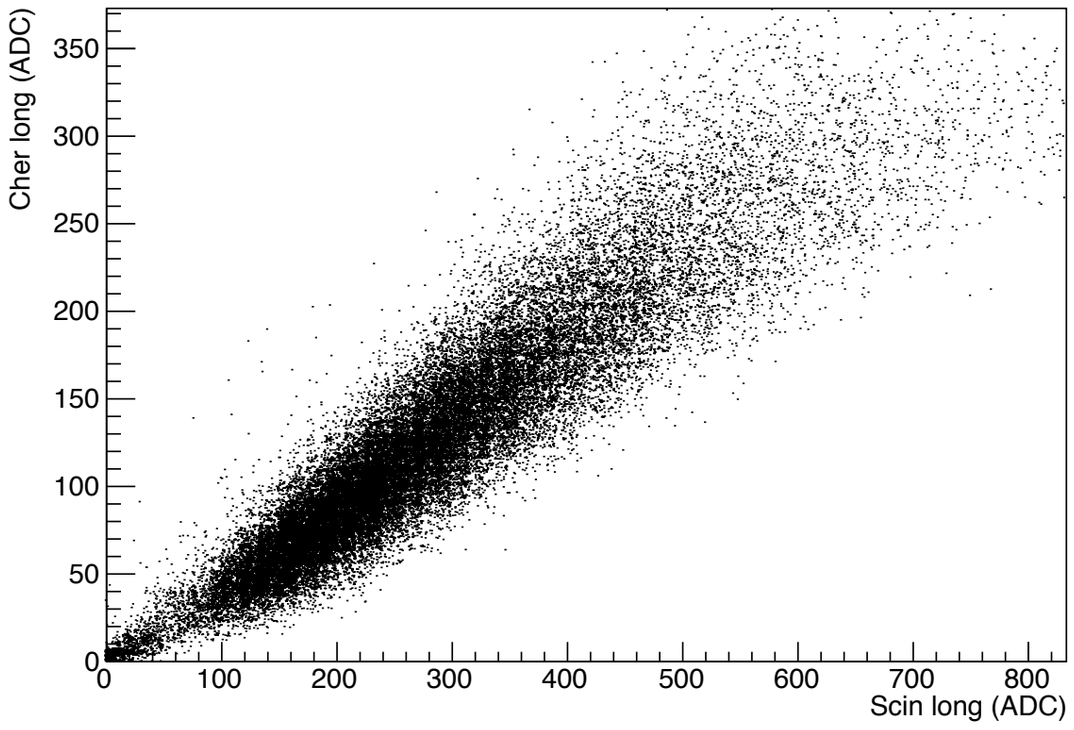
ADC tower 3 Cherenkov short not working



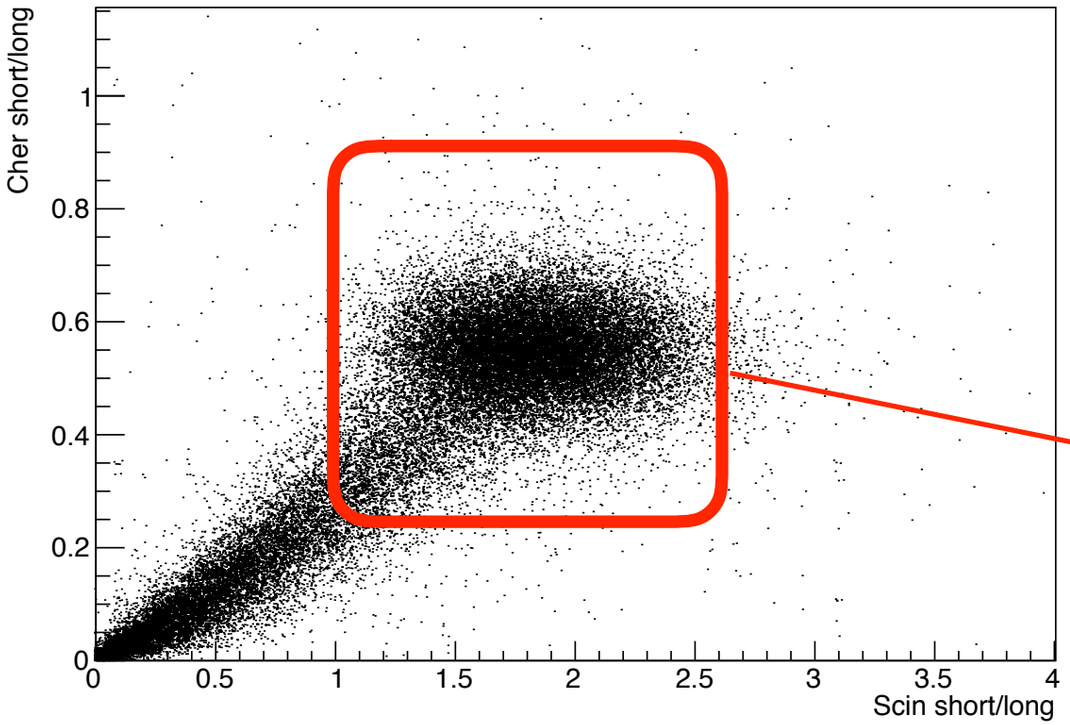
Correlation plots

Good correlation for 60 GeV π^- between
Scin / Cher short fibers
And
Scin / Cher long fibers



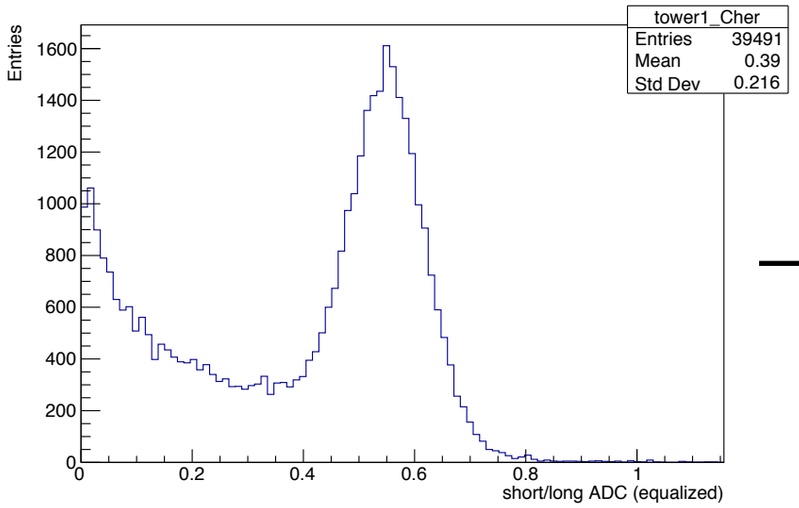


Further indications

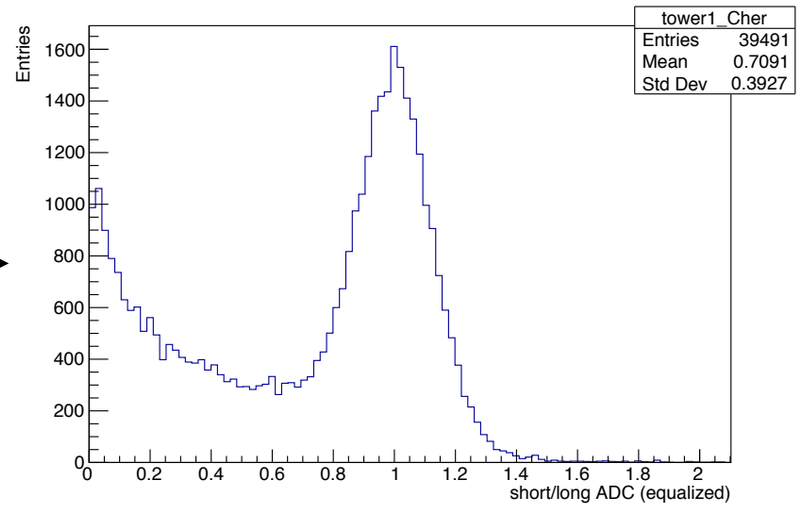


Clear evidence of two "populations" for 60 GeV π^- showering in the calorimeter

Pions that start showering inside the "hadronic" section



After calibration of short section peak is centered on 1



Next step

- From what showed above, is it possible to extract calibration constants for the whole detector with electrons and hadrons fired in the center of the calorimeter?

Conclusion

- The general behavior of the module is as expected. With good channels, the feasibility of calibrating short fiber sections is demonstrated both for the scintillation and Cherenkov signals.
- I will reorganize the analysis to reach conclusive results and summarize them in a separate document.
- The full study of a staggered dual-readout calorimeter needs more statistics, more energy points and an excellent capability of aligning the calorimeter respect to beams.

BACKUP

Tools to create ntuples

On dreamtest@pcdreamdaq2:
export DATADIR=/home/dreamtest/storage
myDaq2Ntu [runnumber] pedestal (data)
To create ntuples from .dat files in ntuple folder
pedestal_ntup_runxxxxx.root
datafile_ntup_runxxxxx.root

(see talks from Giuseppe)

On dreamtest@pcdreamdaq2:
in dir /home/dreamtest/storage/STAGGERED_Analysis (New folder by me)
merge2018.cpp runnumber (ped)
To create ntuples from ancillaries and ADC from calorimeter (16 channels)
In staggered folder:
staggered_runnumber.root and staggered_ped_runnumber.root

Created all the ntuples ready for analysis: run from 12914 to 12928.
ADC info from calorimeter channels and ancillaries included,
DRS info not included in ntuples yet.