



Aspects of
SiPM data
analysis

Théo Hugues

SiPM analysis
with ReD data

SiPM data
analysis work
plan

First example
- SPE
calibration
using
prominence

APC-AstroCeNT meeting

Aspects of SiPM data analysis

October 05, 2020

Théo Hugues, PhD student at APC and AstroCeNT

Laboratoire AstroParticule et Cosmologie – Particule Astrophysics Science
and Technology Centre – Nicolaus Copernicus Astronomical Center

October 05, 2020

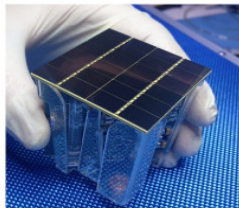


- 1 SiPM analysis with ReD data
- 2 SiPM data analysis work plan
- 3 First example - SPE calibration using prominence



Advantage :

- Higher photo-detection efficiency
- Better single photon resolution
- Lower background
- Larger optical coverage than PMTs



However certain issue still have to be addressed :

- after-pulses
- crosstalks
- slow components



ReD experiment

Aspects of
SiPM data
analysis

Théo Hugues

SiPM analysis
with ReD data

SiPM data
analysis work
plan

First example
- SPE
calibration
using
prominence

In January I spend 10 days in Catania, to contribute to data taking shift. ReD has been moved from Naples to Catania in December to study the recoil directionality under a beam from the cyclotron at LNS.

ReD

ReD is the first LAr TPC using SiPMs. The aim of the project is to assess and enhance the sensitivity to the direction of nuclear recoils (and WIMPs) of two-phase argon TPCs to eliminate sources of neutrino and other backgrounds or find techniques to distinguish background events from true signal.



ReD experiment in Catania

Comparison PyReD vs ReD-DAQ-Light



Aspects of
SiPM data
analysis

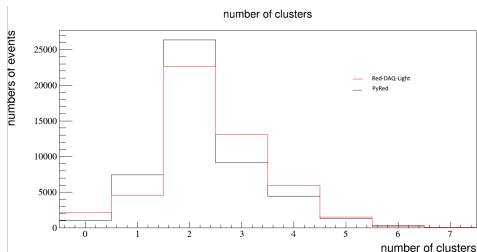
Théo Hugues

SiPM analysis
with ReD data

SiPM data
analysis work
plan

First example
- SPE
calibration
using
prominence

- first-pass analysis code based (C++) in place, without SiPM effect correction
- fast python-based tools correcting for SiPM response (filtering) under development
- started by comparing the result consistency and event reconstruction consistency





The project aims to study effects specific to silicon photomultipliers (SiPM), in particular characterize instrumental noise (afterpulsing and cross-talk) the tasks undertaken will be:

- * Optimization of the signal filtering and peak finding algorithms.
- * Identification and characterization of SiPM external cross-talk with noise data as a function of the SiPM voltage bias.
- * Identification of the optimal algorithm based on filtered photoelectrons, to fully exploit the pulse shape discrimination power.
- * Characterization of energy resolution loss due to instrumental noise factors in a wide dynamic range.



SPE calibration using prominence

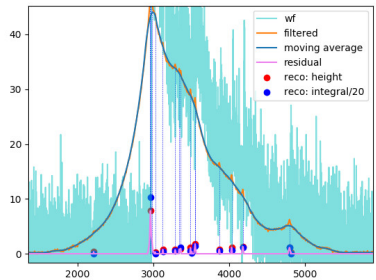
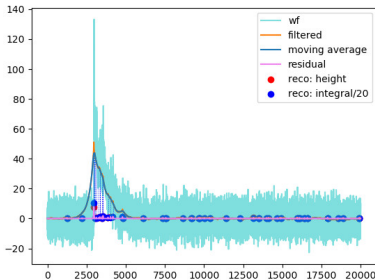
Aspects of
SiPM data
analysis

Théo Hugues

SiPM analysis
with ReD data

SiPM data
analysis work
plan

First example
- SPE
calibration
using
prominence



Convolution with the template from SiPM has been optimized, but the bottleneck comes from the hits identification in the filtered waveform. The idea is to subtract moving average to the filtered waveform and with find peak get the position, the height and the integral of each peak. Two question remains :

- How to combine height and integral to remove fluctuation?
- How to convert height/integral into photoelectrons?



Simulated charge and height distributions



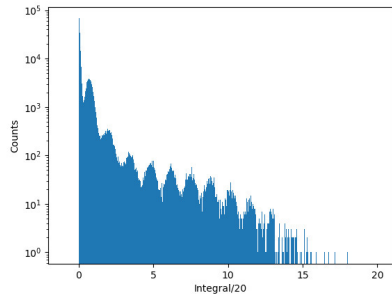
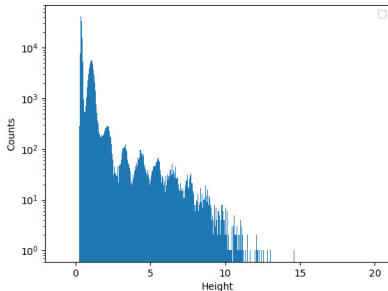
Aspects of
SiPM data
analysis

Théo Hugues

SiPM analysis
with ReD data

SiPM data
analysis work
plan

First example
- SPE
calibration
using
prominence





PE calibration

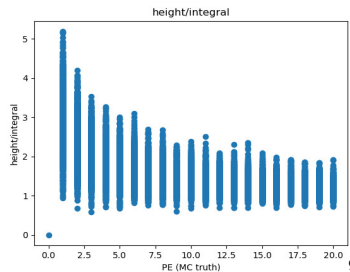
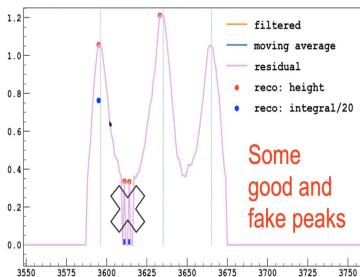
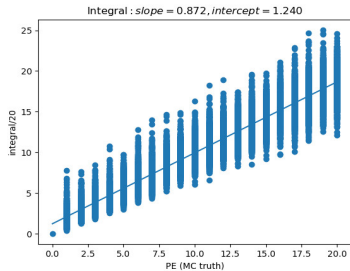
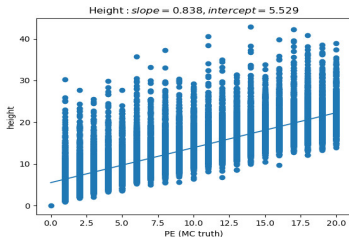
Aspects of SiPM data analysis

Théo Hugues

SiPM analysis with ReD data

SiPM data analysis work plan

First example - SPE calibration using prominence





Conclusion :

- On going analysis of the first TPC with SiPM (ReD)
- First-pass of peak finder and filtering algorithms calibration
- Better resolution using integral but more work needed to optimize boundaries cases

Thanks for your attention.

