Beam Test Analysis

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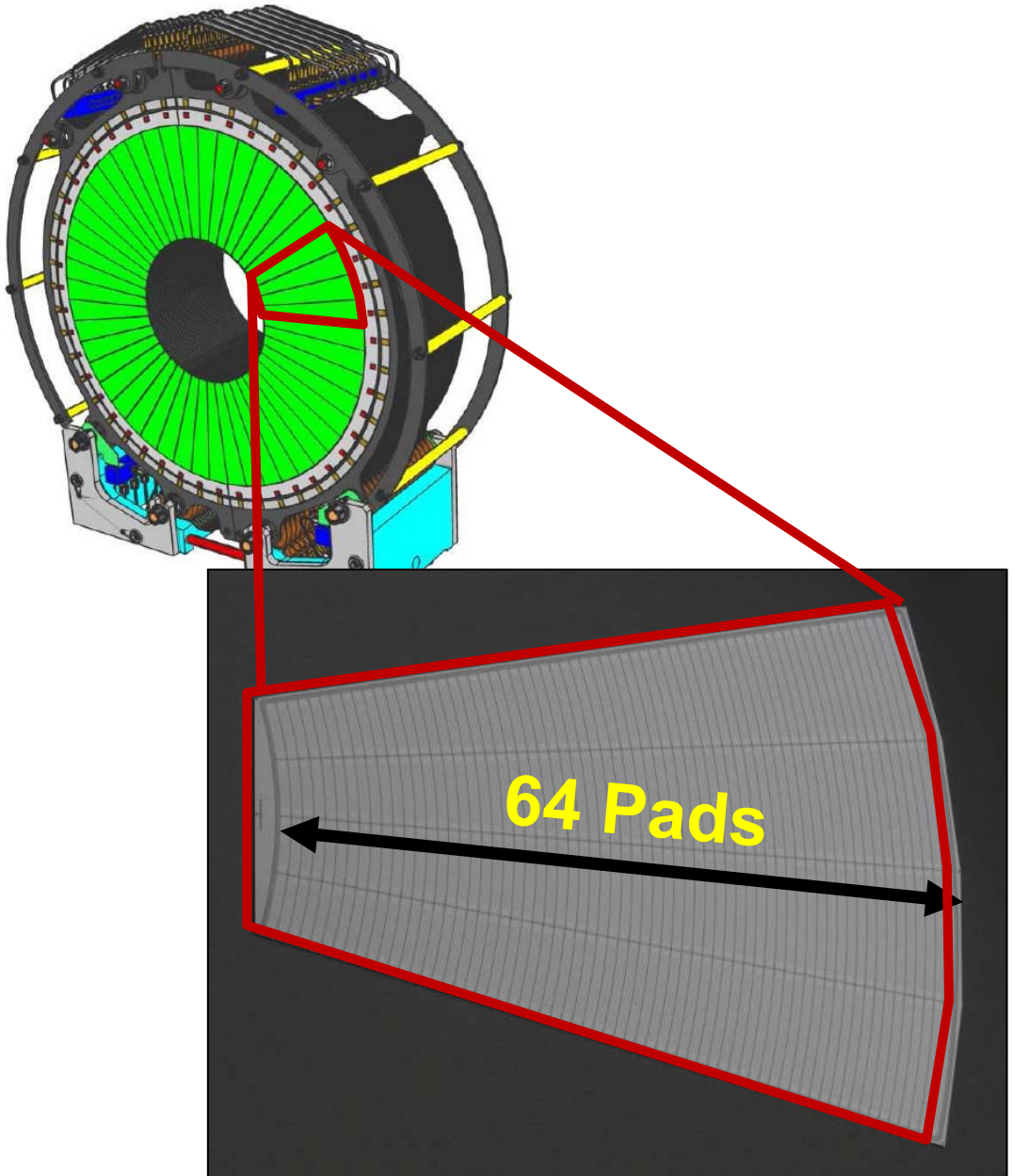
LumiCal sensor prototype

- Each layer has 48 sectors in the azimuth direction, and 64 pads (rings) in the radial one.
- A silicon-sensor prototype was produced by Hamamatsu from 320 μm thick 6” wafer, high resistivity n-type silicon
- The sensor prototype has 4 sectors (30° azimuthally) and 3 guard rings.



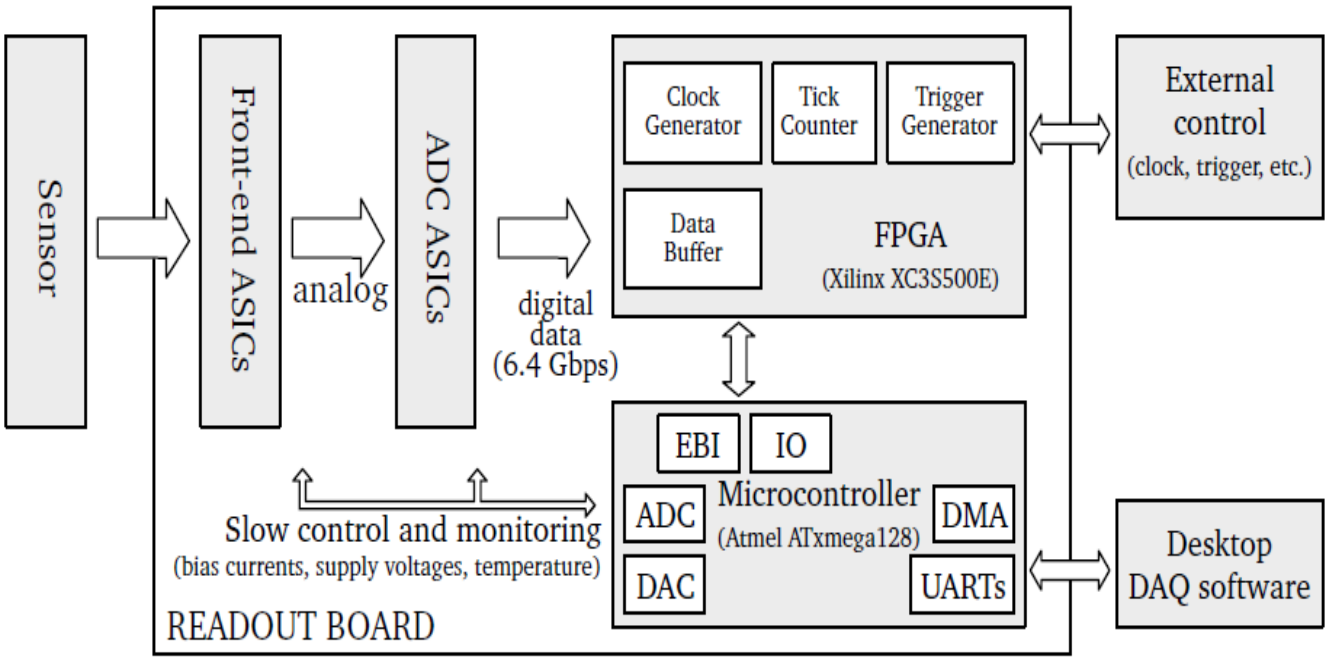
Test Beam objectives

The objective of this beam test is to demonstrate for the first time that the base-design for the forward calomiters is reasonable and well understood.

1. Tests and demonstration, for the first time, of multi-plane operation of the prototype forward detector system.
2. Study the development of the electromagnetic shower in a precise and well known structure and compare with MC simulations.
3. Try to apply a reconstruction algorithm on raw data and particle tagging (electron and hadrons).
4. Attempt to measure energy resolution and the precision of the polar angle reconstruction.

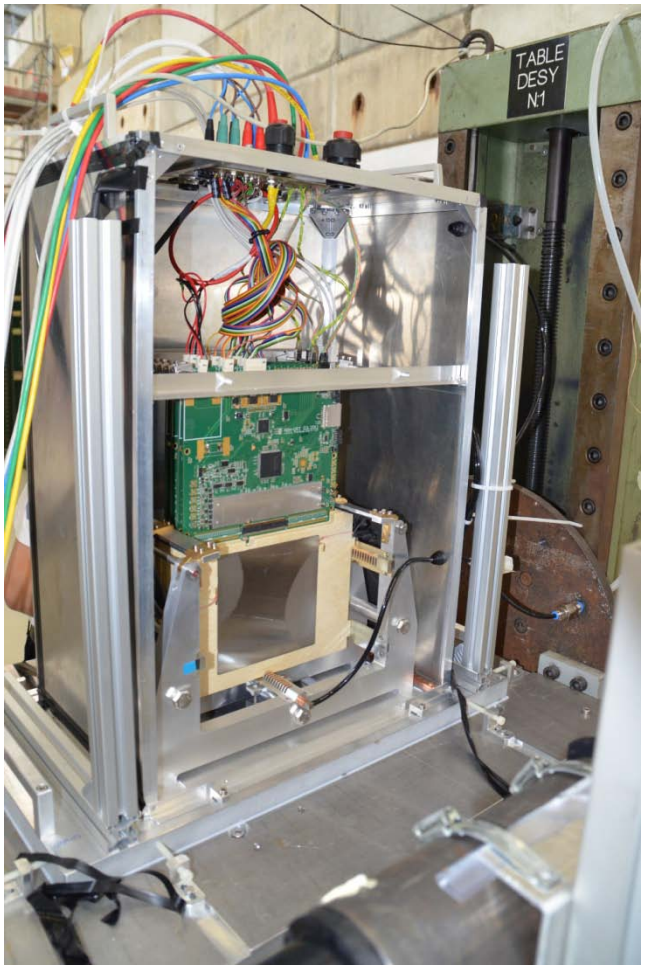
LumiCal Basic Plane

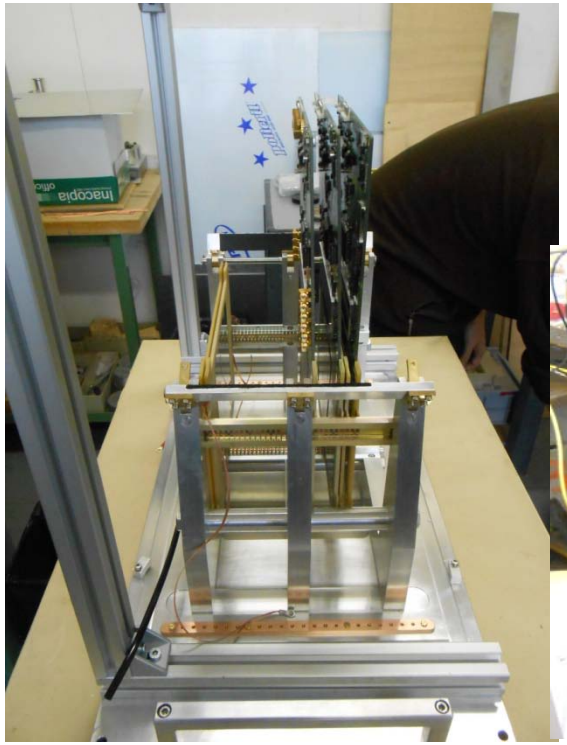
- The basic plane is a complete detector module equipped with first level DAQ.
- Its include the complete readout chain: Si-sensor, kapton fan-out, front-end electronic and multichannel 10-bit pipeline ADC ASIC
- ASIC is controlled by FPGA based data concentrator.
- The complete module has 4 multi channels chips with 8 channels each.



Multi - layer prototype

This test beam is based on the dedicated rigid structure for precise alignment of sensor and absorber planes, as a prototype calorimeter

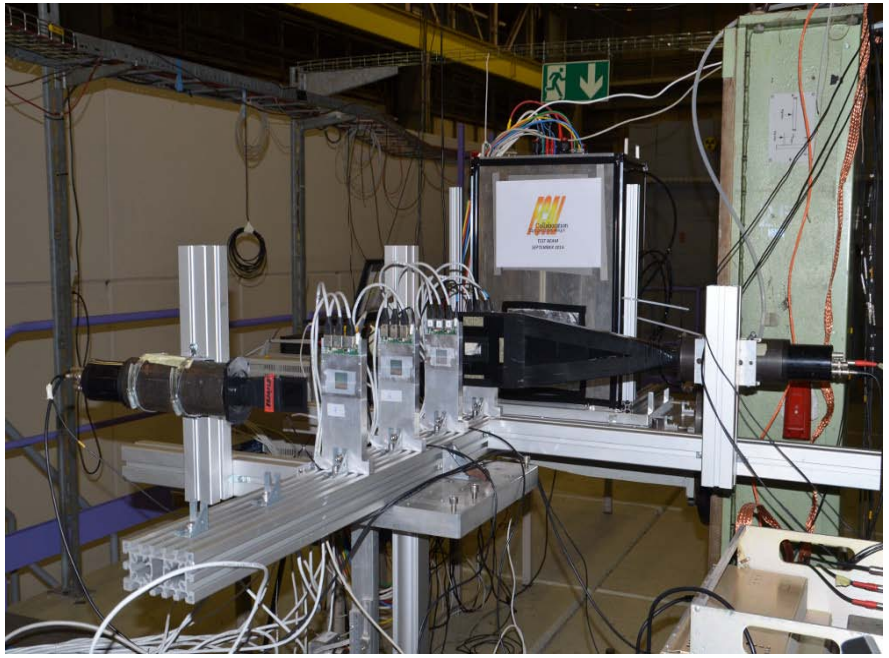




Set up

The Beam test was held In beam line T9 for 1 week between 22-29 of October.

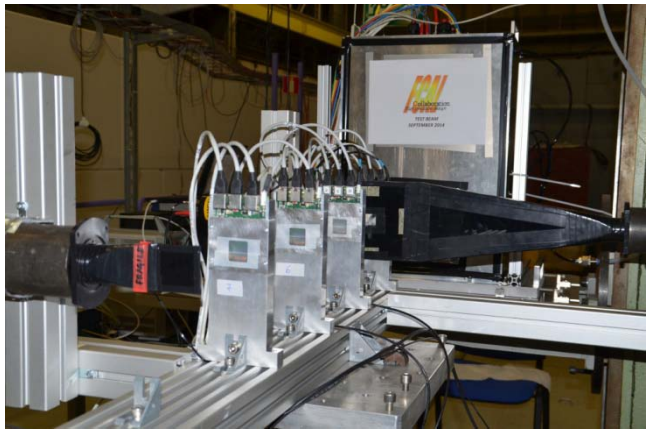
We used 4 LumiCal plane inside the rigid structure as the calorimeter prototype, with 4 MIMOSA sensor in front as beam Telescope for tracking.



Trigger and synchronization

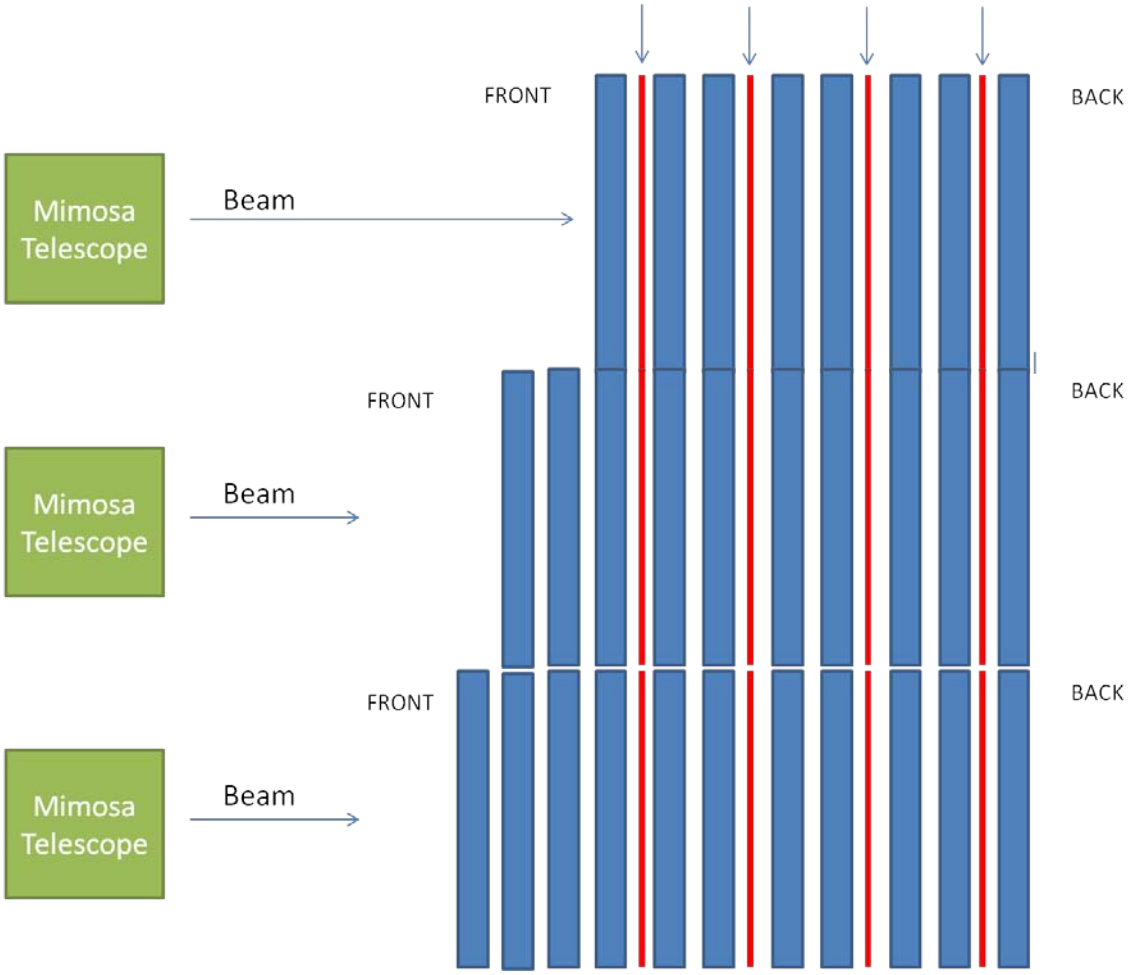
The main issue in DAQ for the beam test was the synchronization between the event in the FCAL DAQ to the event in the MIMOSA Telescope DAQ.

For that an AUX device was build, based on v1495 I/O module to much between TLU number (FCAL) to Frame counter (MIMOSA).



Configuration

During test beam we used 3 different configuration for the calorimeter :

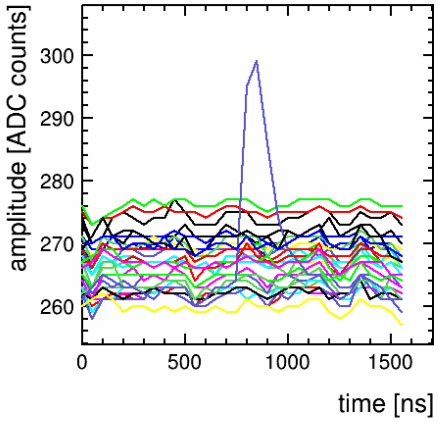


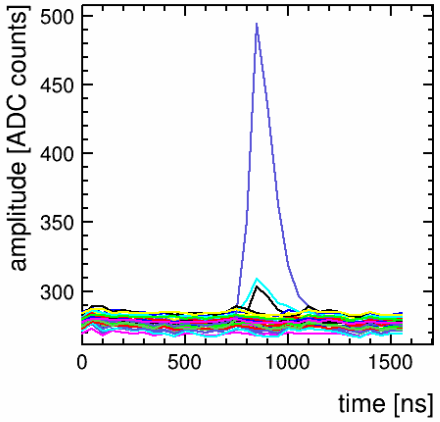
Beam conditions

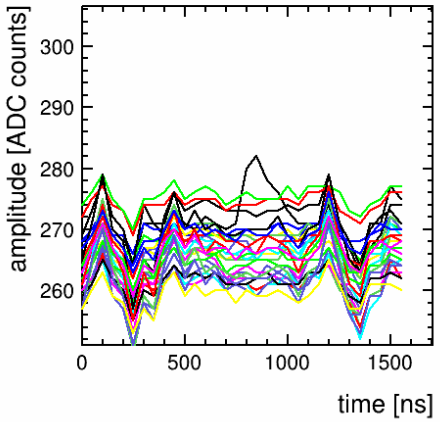
- For all configurations we use 5 GeV negative charged beam.
- For all configurations we toke 3 types of runs:
  1. Electron and Muons (with rate restrictions).
  2. Electron and Muons (no rate restrictions).
  3. Hadrons (anticoincidence of e- & μ-).

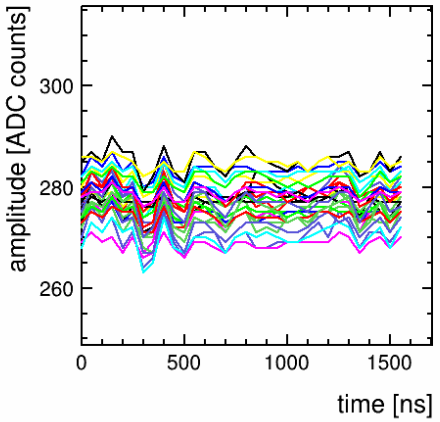
Runs/ events	e- & μ-	e- & μ- (no rate…)	Hadron
Configuration 1	75 / 30k	3/6k	4/20k
Configuration 2	60/36k	2/8.5	1/2k
Configuration 3	55/45k	7/15k	8/38k

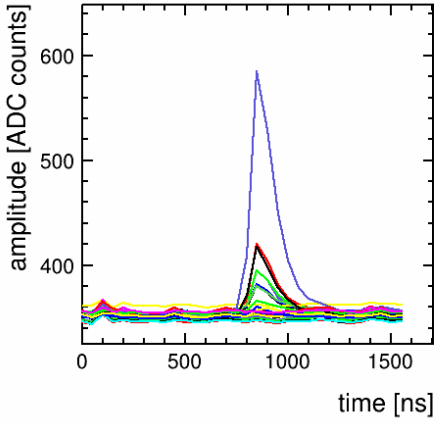
A single event

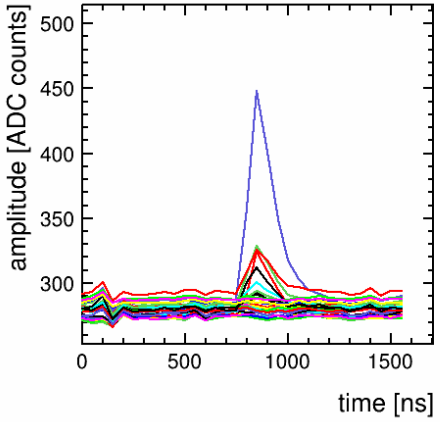


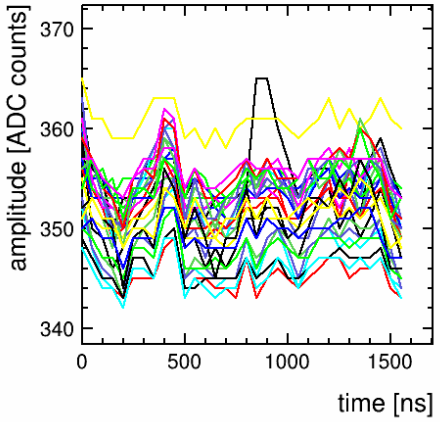


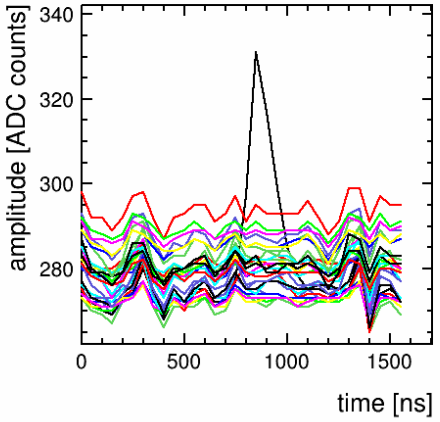




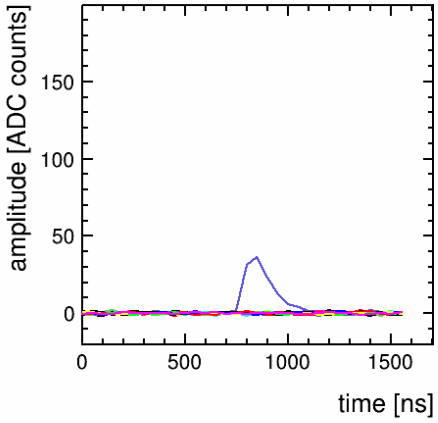


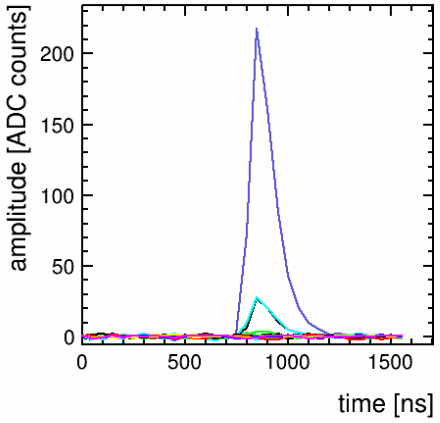


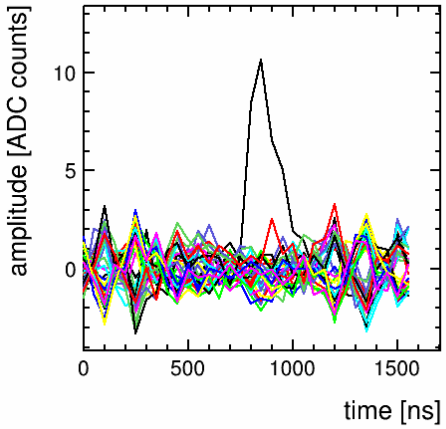


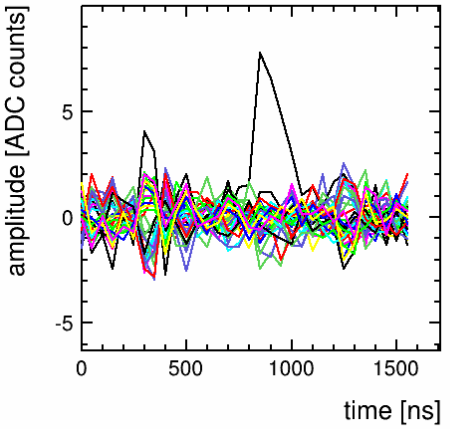


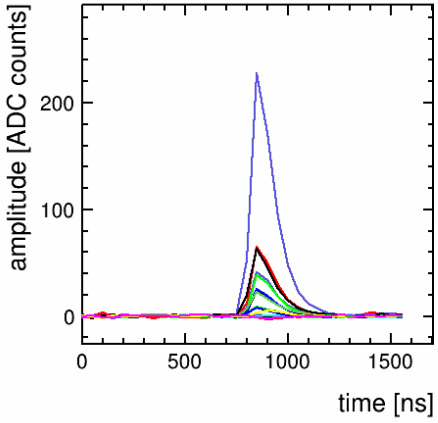
A single event

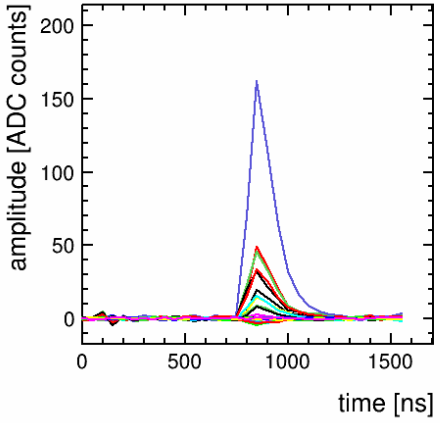


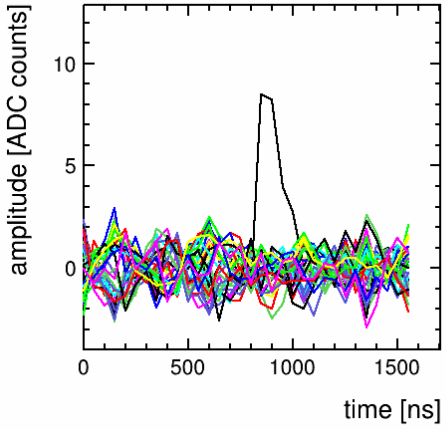


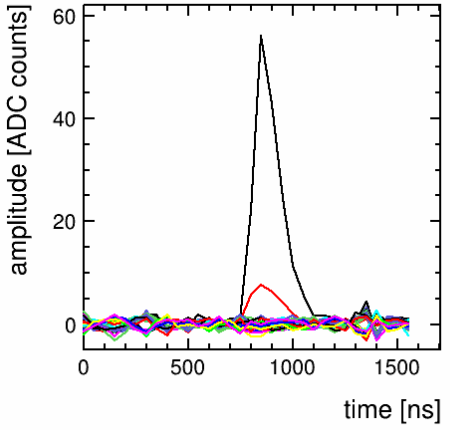




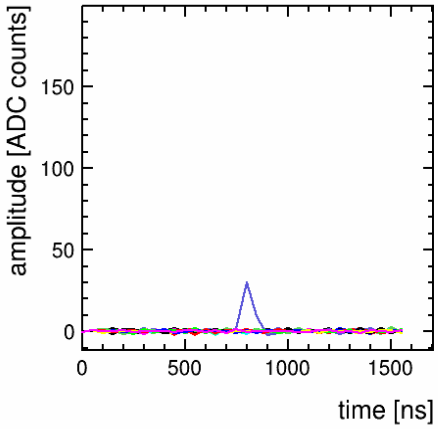


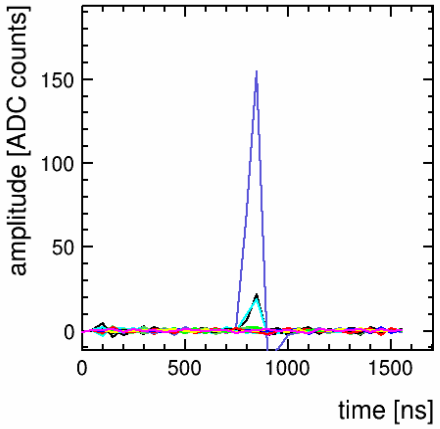


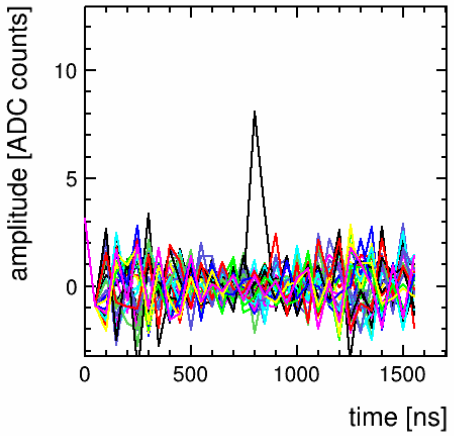


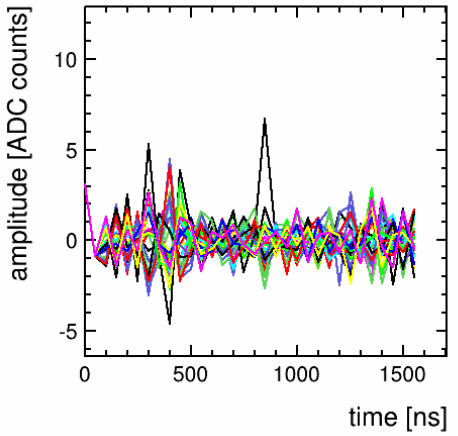


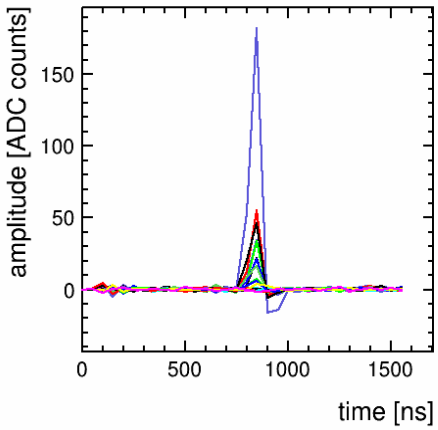
A single event

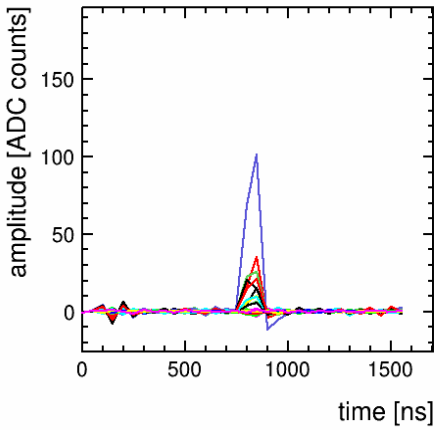


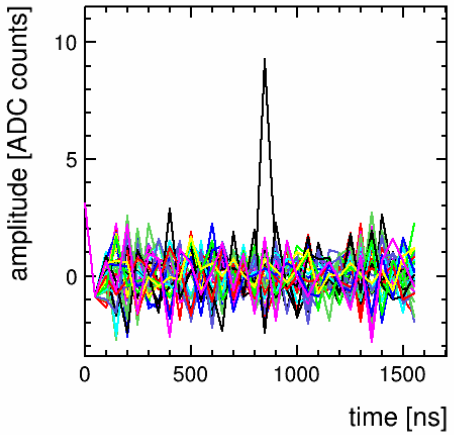


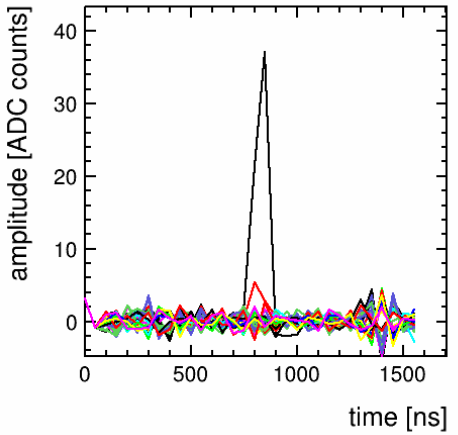










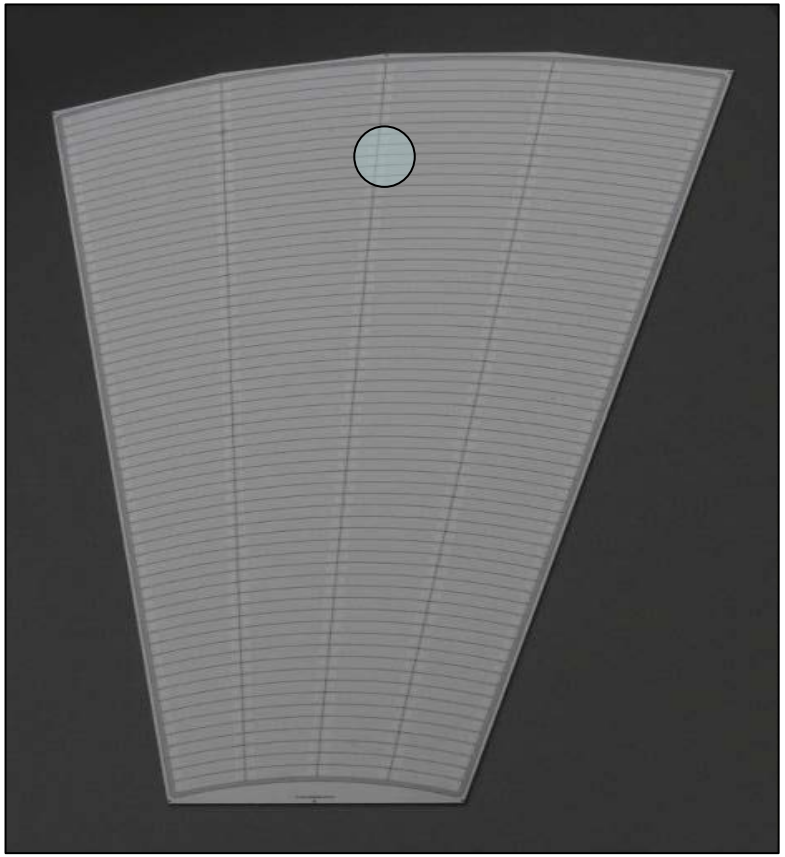


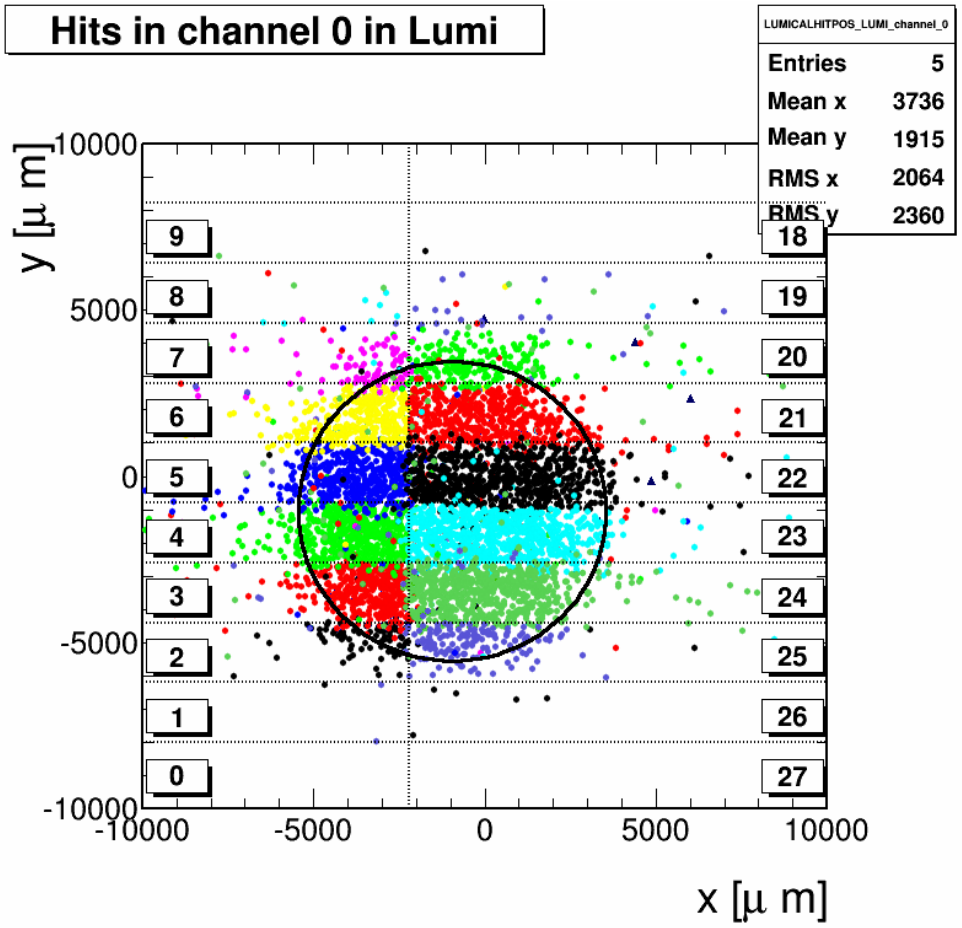
Synchronization example

FCAL FILE				Telescope FILE	
Event	FCAL-TLU	AUX-TLU	F-counter	Event	F-counter
1	1	1	10951	1	52130
2	2	2	10959	2	52138
3	4	3	10980	3	52149
4	5	4	10980	4	52159
5	6	5	12547	5	..
6	..	..	..	6	..

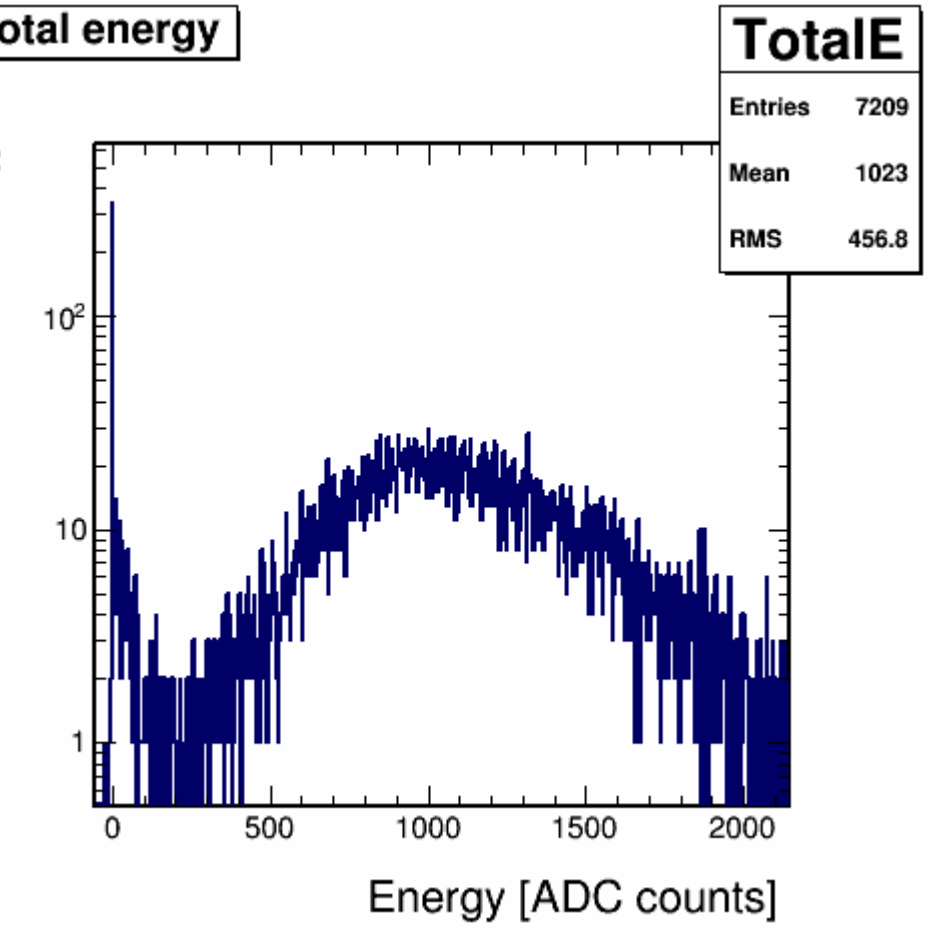
Event	FCAL-TLU	AUX-TLU	Diff- F-counter FCAL	Diff- F-counter Telescope
1	1	1	0	0
2	2	2	8	8
3	4	4	29	29

Synchronization results

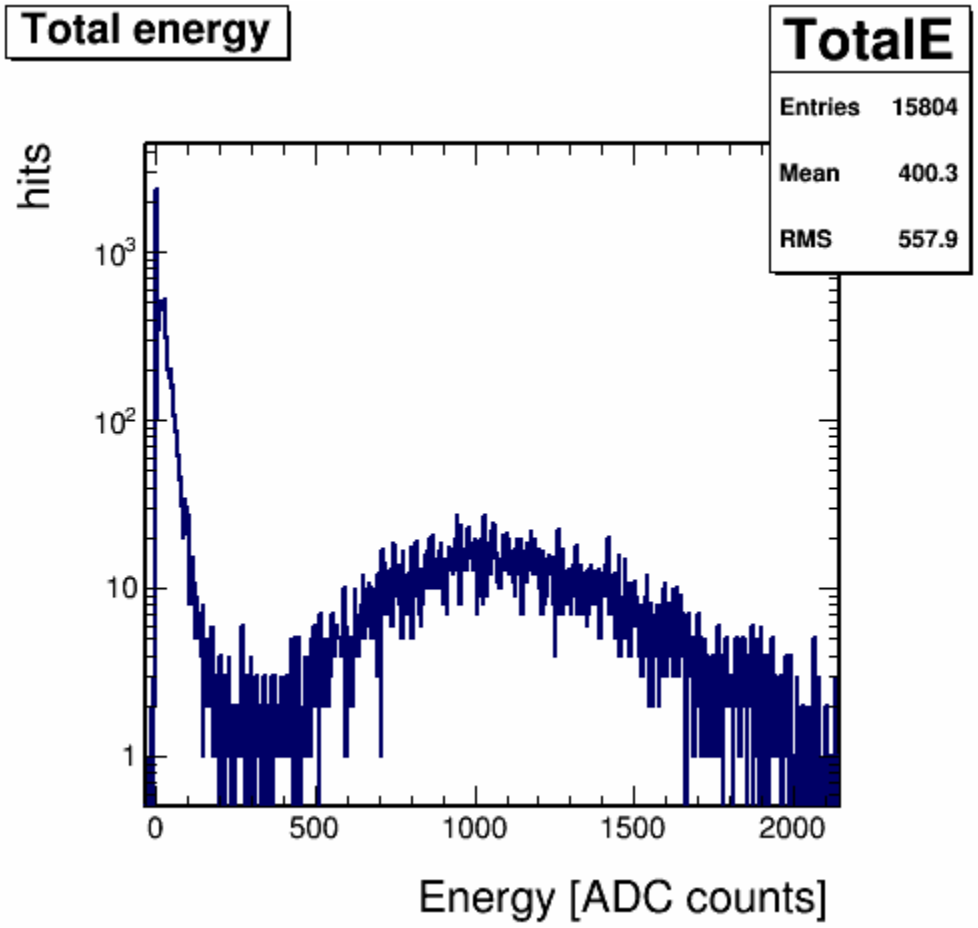




Total Energy

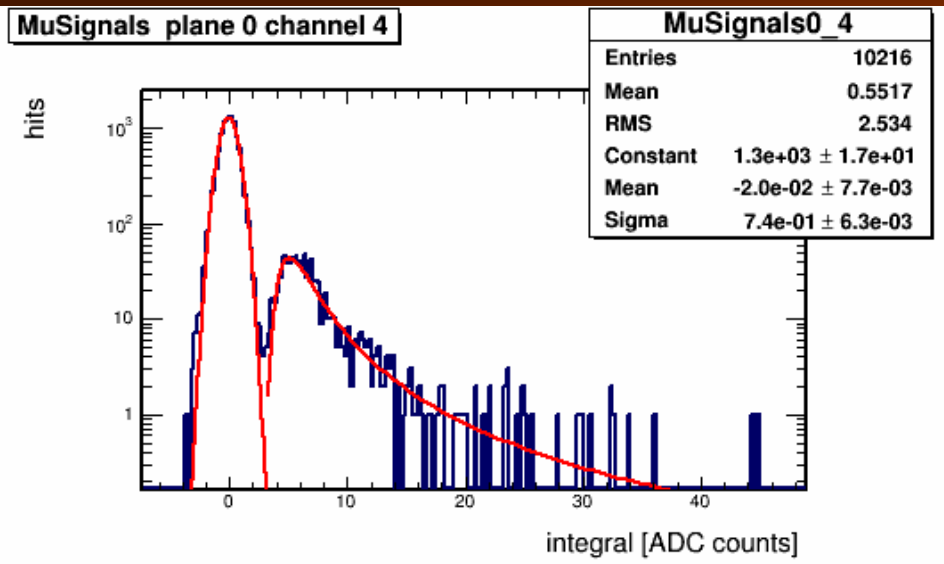


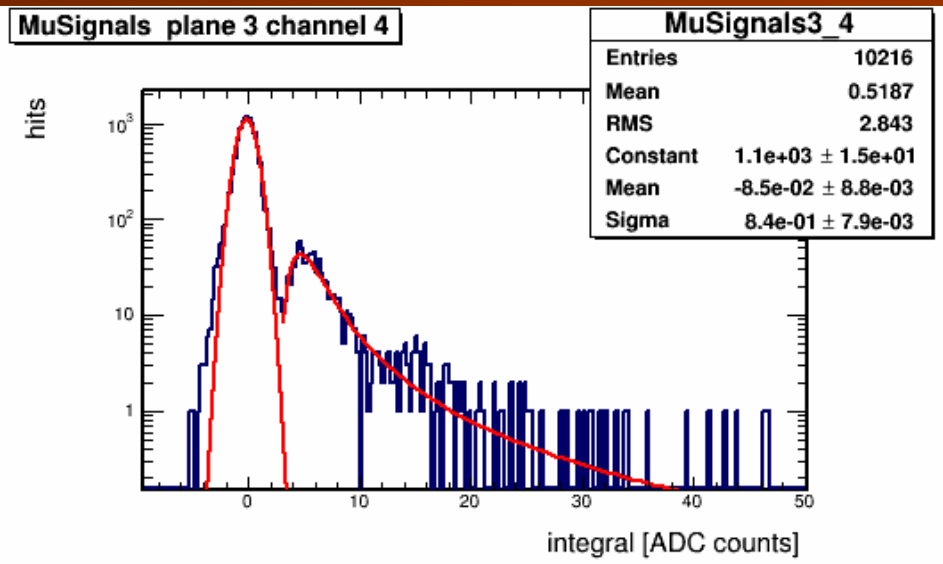
Just e-

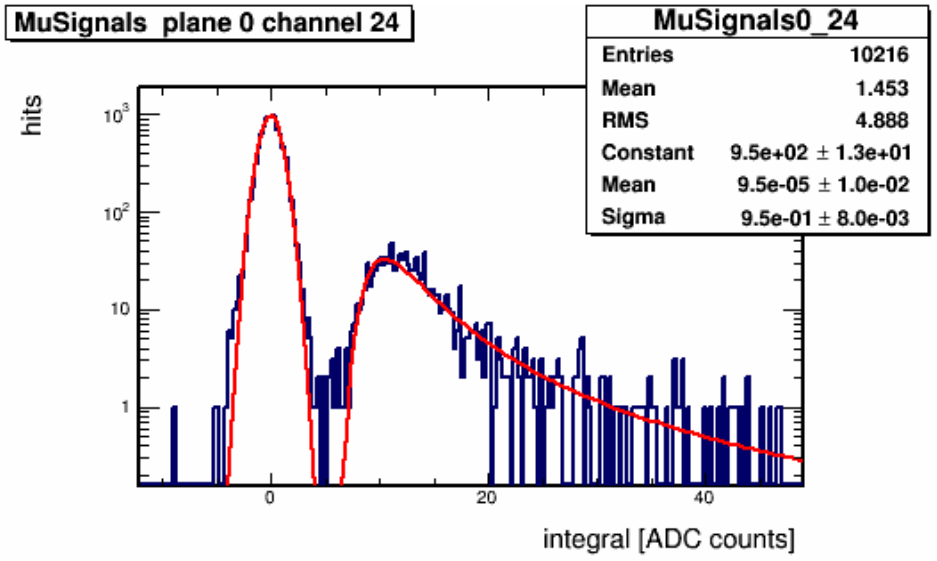


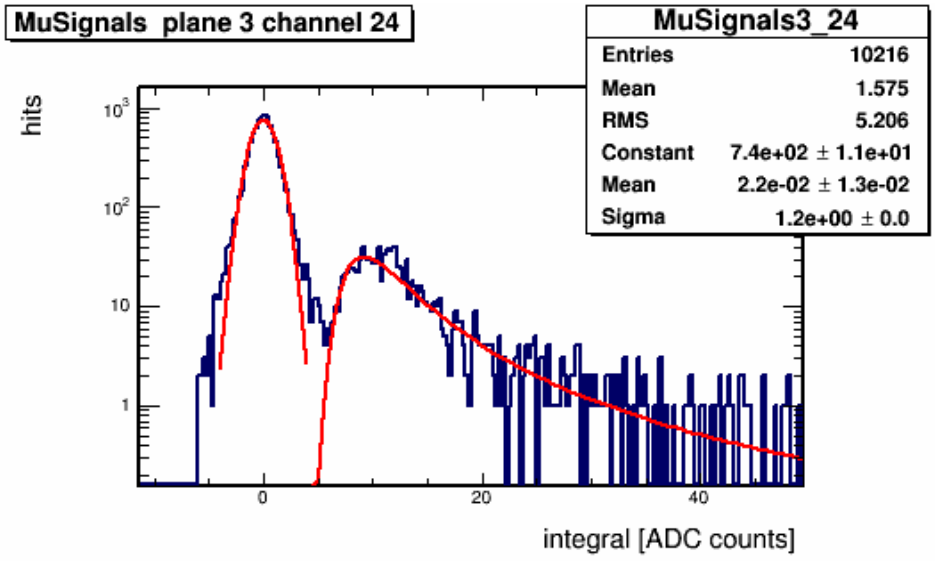
e- & μ-

Muon spectra

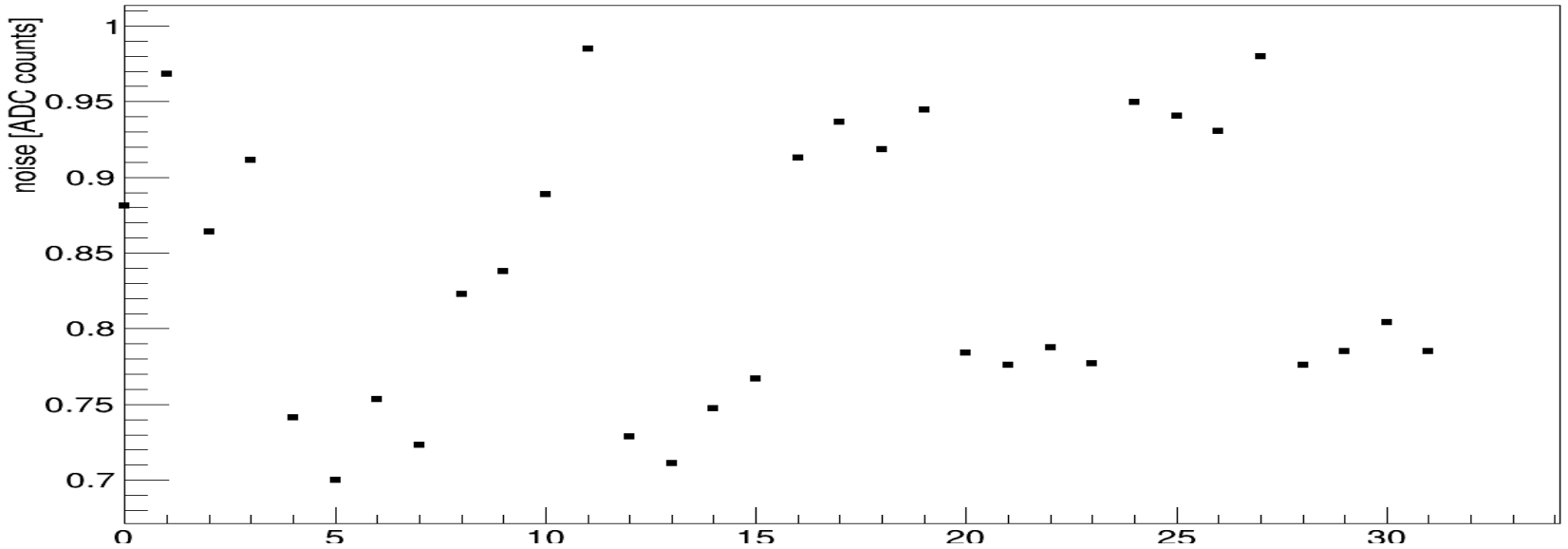


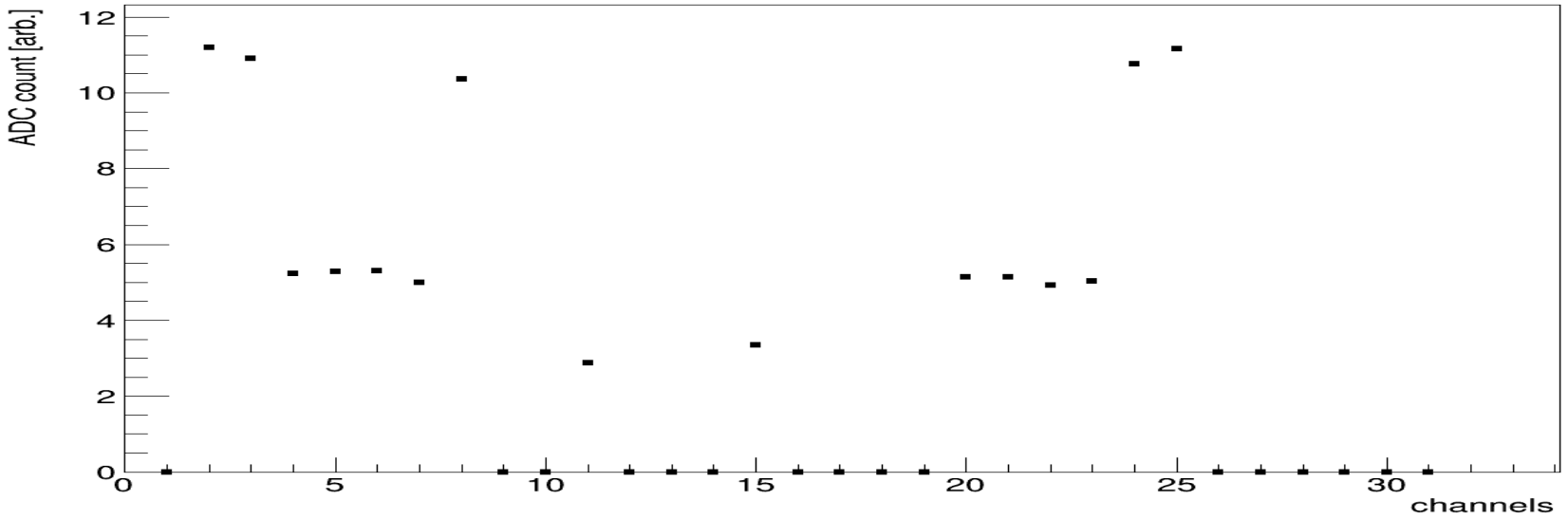




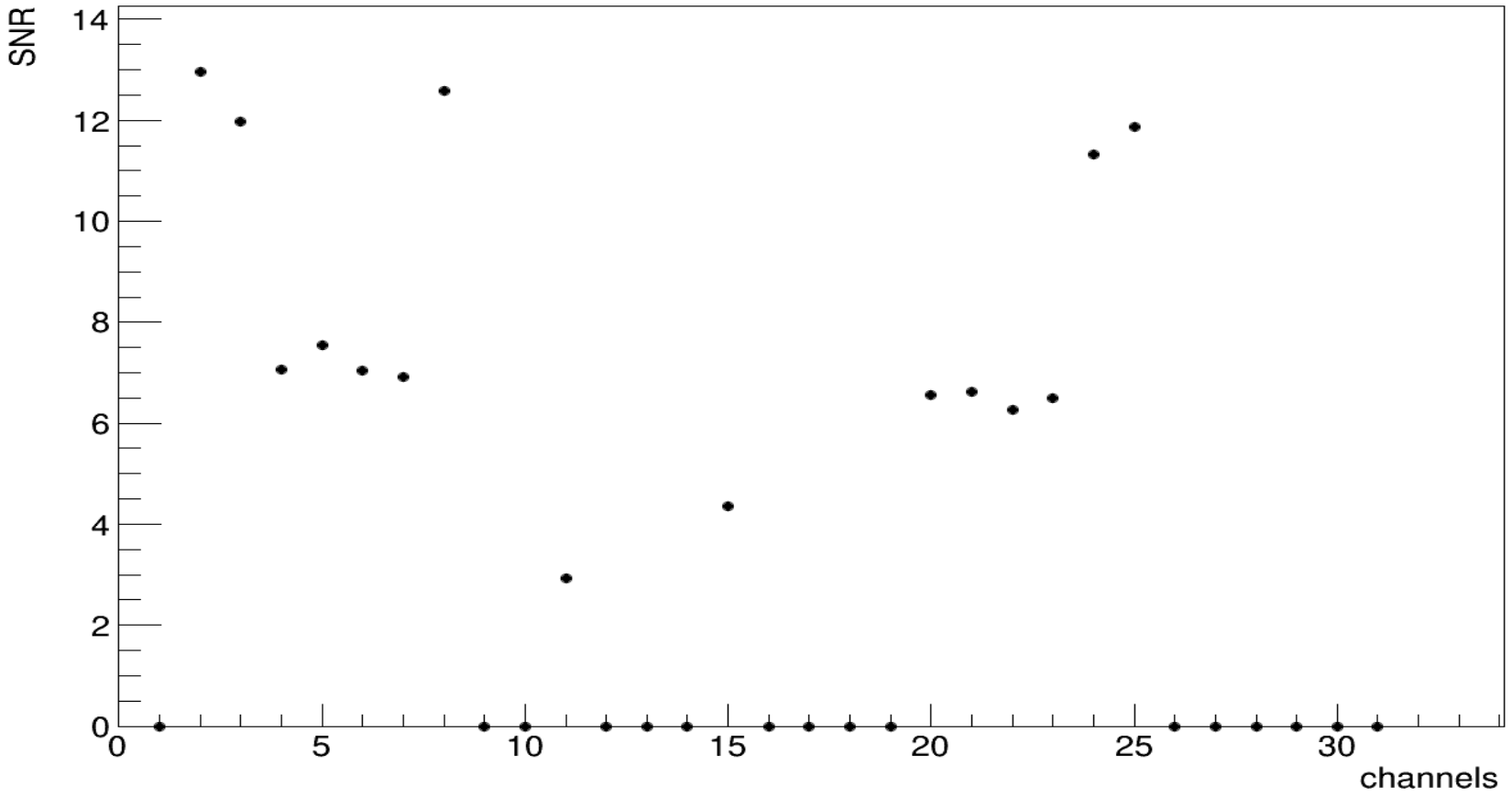


Muon results plane 0





Muon results plane 0



Analysis plan & summery

Most tools for analysis already exist.

Beam test analysis outlook (in my view) :

- Do off line calibration. √
- Show LumiCal basic signal processing. √
- Show the reconstruction of track and Telescope alignment. (~√)
- Show synchronization and LumiCal alignment. √
- Do on line (Muon) calibration. √
- Study E.M. showers development (compare with M.C – DD4HEP?).
- Compare hadrons muons and electrons runs.
- Study E.M. showers uniformity (X, Y plane).
- Apply clustering and reconstruct showers starting point and compared it to the Telescope extrapolation (for polar angle accuracy).

Thank you!