

ECAL Barrel Test Stand at LNF

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ECAL Barrel Test Stand at LNF



Goals:

- Characterize the performance of individual ECAL modules before shipment.
- Validate the response of the readout electronics under controlled conditions using Cosmic Rays

Work started in June → On going..

- First Test and Results on ECAL Barrel 5;

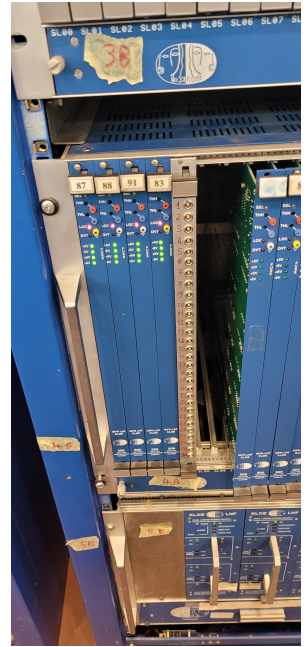
Black plastic cover to shield the fibers from external light

ECAL Barrel Test Stand at LNF



→ A CAEN SY527 universal multichannel power supply system provides high voltage to each barrel's PMT.

PMT Signals are discriminated by using custom SDS boards with constant fraction discriminators. ←

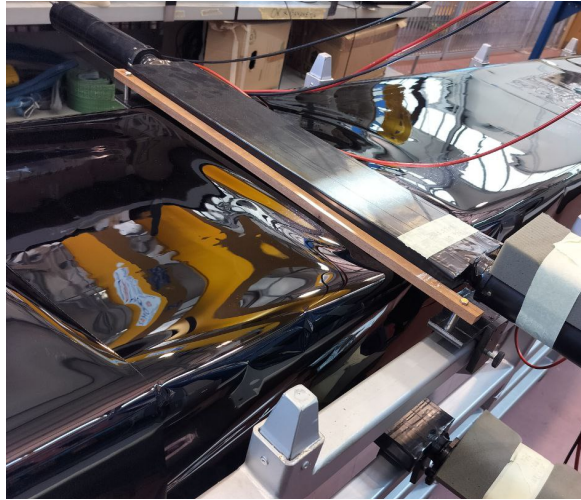


PMT Signals are sent to 4 ADC (CAEN Mod. VX559) and 4 TDC (CAEN Mod. VX569) 9U 400 mm deep VME boards of 30 channel each → Each board is identified by an unique address.

The TDCs work in common start mode and stop signals delayed by 220 ns with a mono-stable to accommodate the trigger formation time.

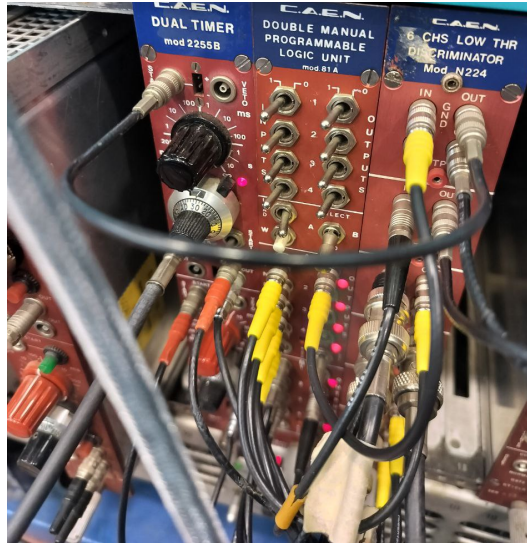


ECAL Barrel Test Stand at LNF: Trigger



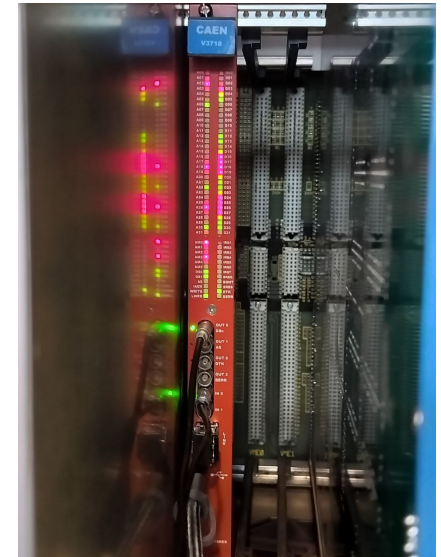
2- The coincidence is given by a programmable logic unit

1- The coincidence between 4 PMTs at the end of 2 scintillator bar provide a trigger signal to start the acquisition (Trigger and PMTs properly synchronised)



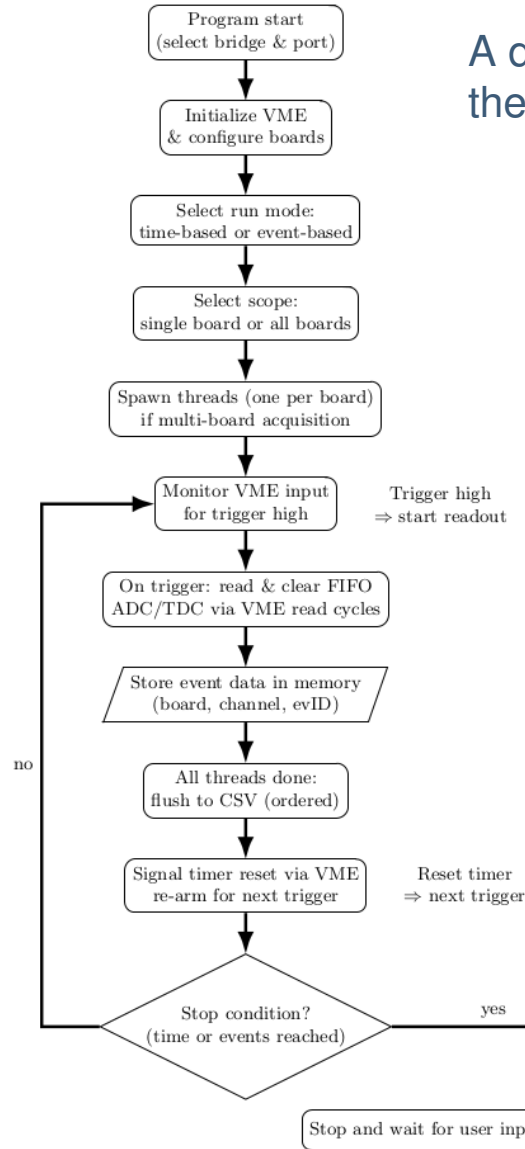
3- The trigger signal is passed to a dual timer that gives a continuous high signal to a VME Bridge

4- Upon receiving the trigger signal, a VME Bridge Starts the acquisition of the event and resets the dual timer waiting for a new signal.



ECAL Barrel Test Stand at LNF: DAQ Software

A dedicated DAQ program was developed in C for the operation of the ECAL Barrel Test stand, built upon the CAENVMELib framework.

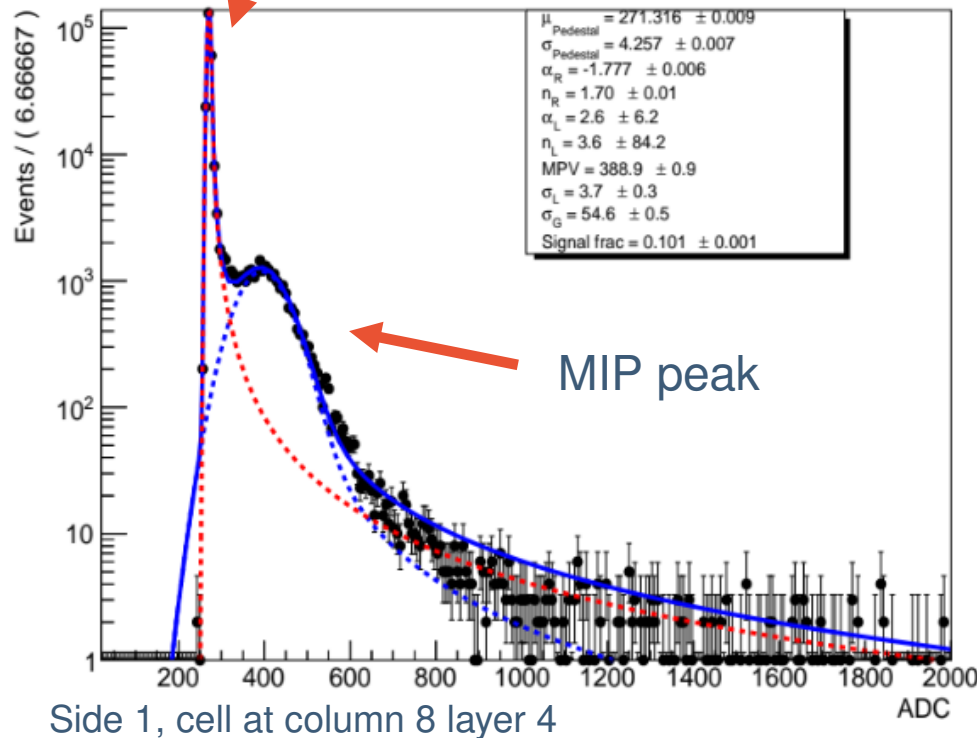


Primary Functions:

- Manual controller of the VME Bridge;
- Initialize and configure ADC and TDC boards via the VME interface;
- Monitor the trigger line and start readout upon coincidence detection;
- Perform parallel data acquisition through multithreaded FIFO access;
- Decode board outputs (channel,data) and store events in structured CSV files;
- Manage trigger reset and synchronization between events.

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

Pedestal + Background



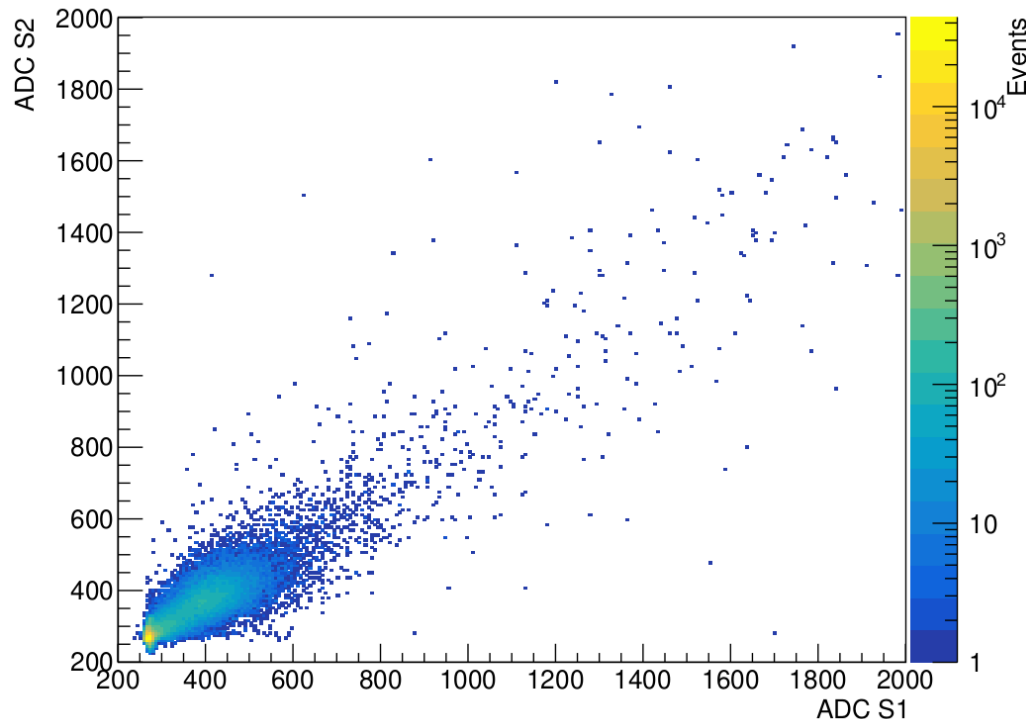
The Fit modelise the distribution with a **double sided CrystalBall** (to fit pedestal and background) and a Landau Convolved with a Gaussian for the MIP signal peak.

For each channel this fit evaluates the value of the pedestal.

~28h Data Taking on Barrel module 5

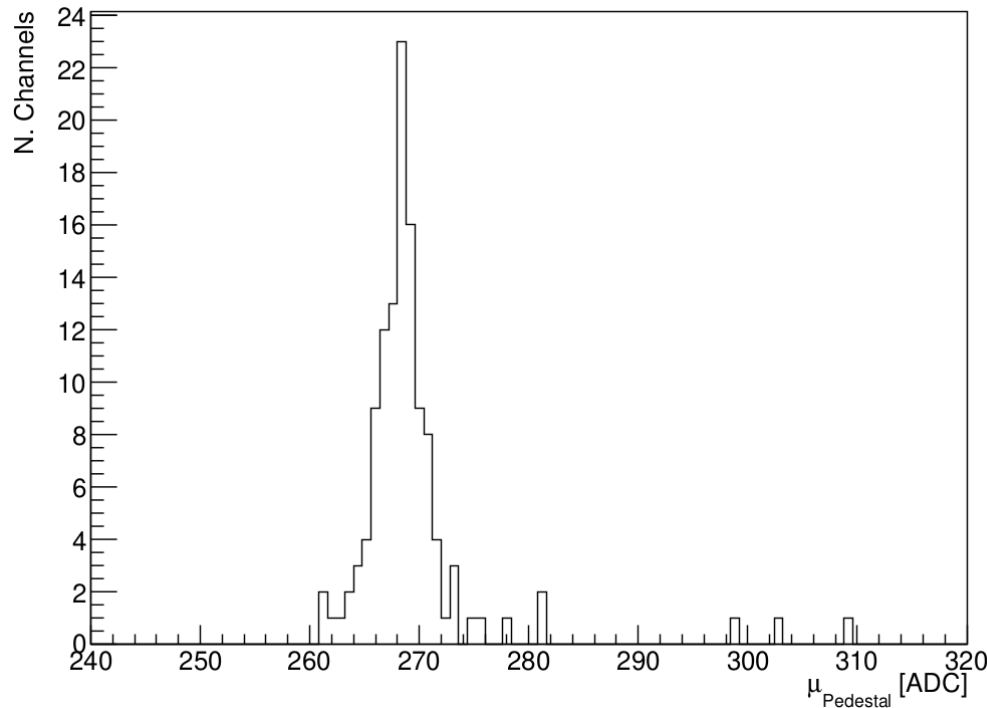
ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

PMT ADC signal correlation plot of cell at column 8 layer 4



~28h Data Taking on Barrel module 5

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

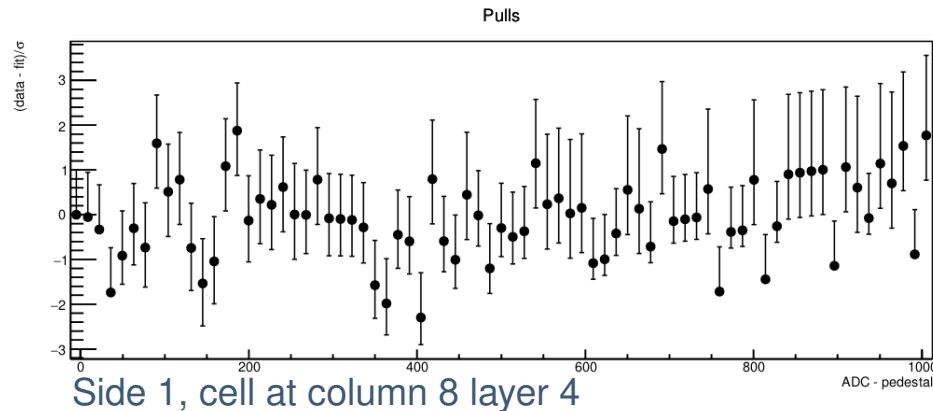
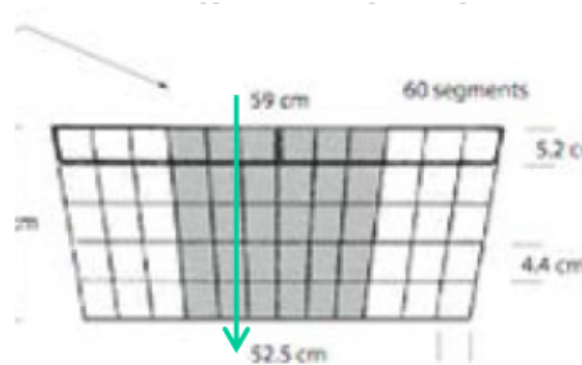
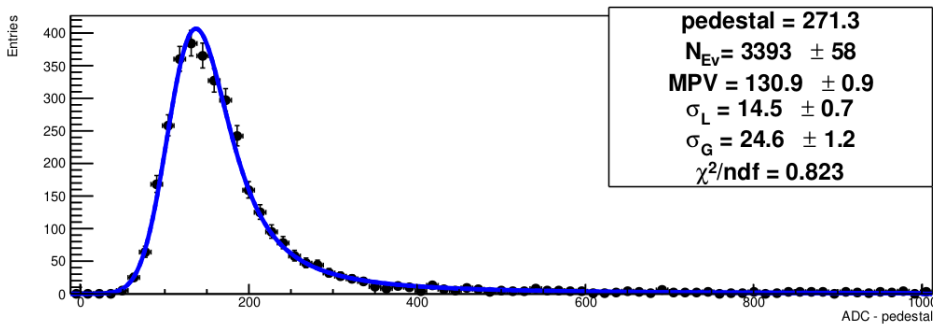


From the previous fit the value of the pedestal for each channel is obtained and it can be subtracted from the MIP signals.

~28h Data Taking on Barrel module 5

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

Golden MIP selection after pedestal subtraction

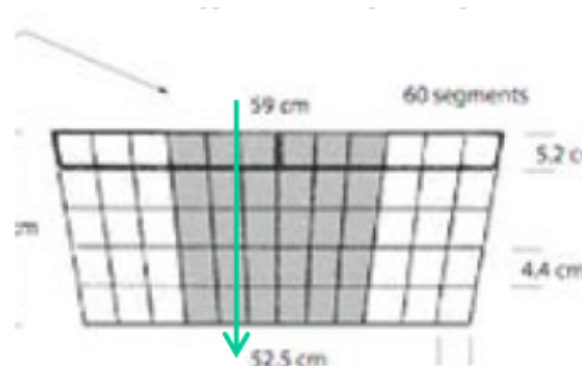
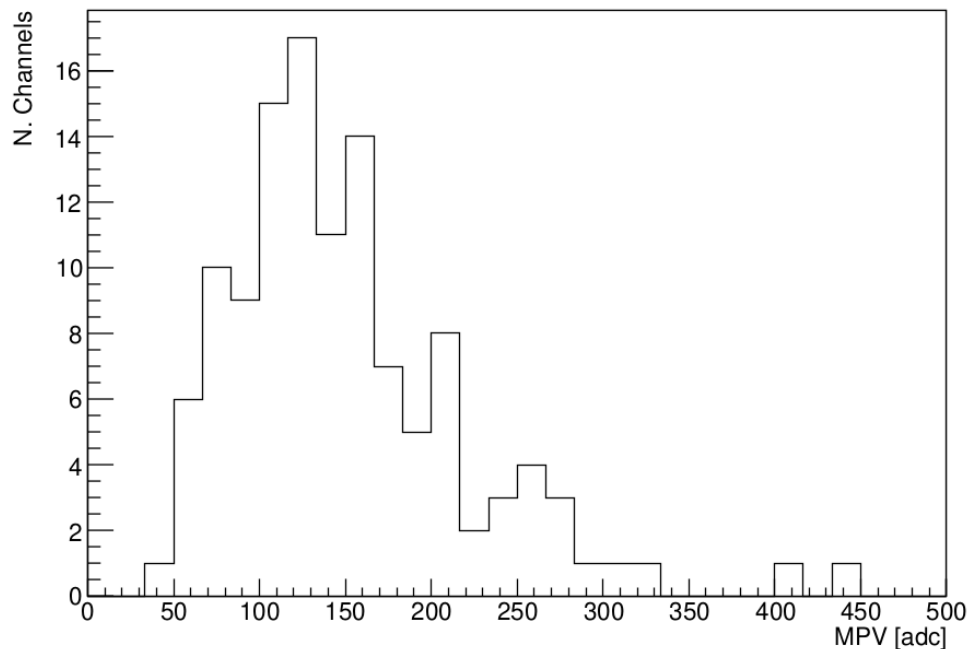


After the event selection the background from muons not crossing the full length of the cell disappears.

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

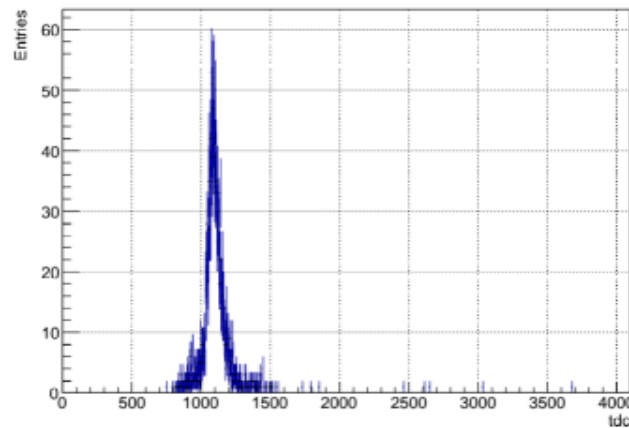
Golden MIP selection after pedestal subtraction

PMTs MPV Distribution

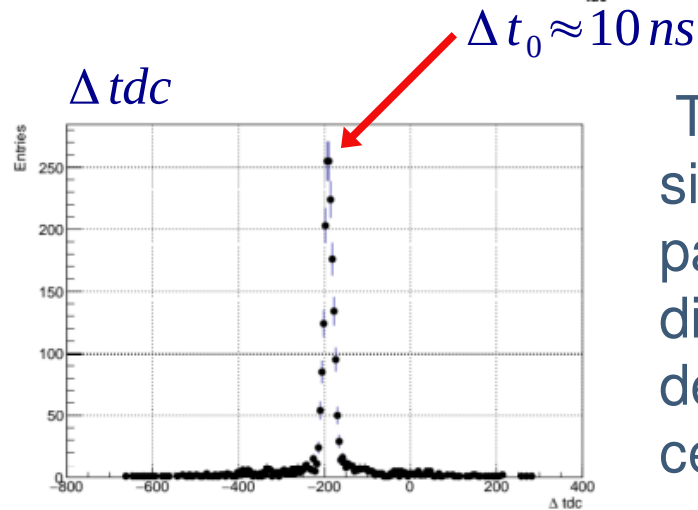
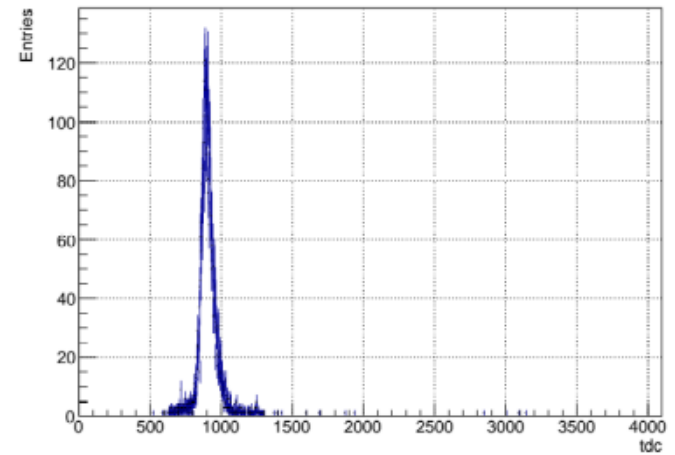


Equalisation on the PMTs for equal MIP response needed.

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - TDC

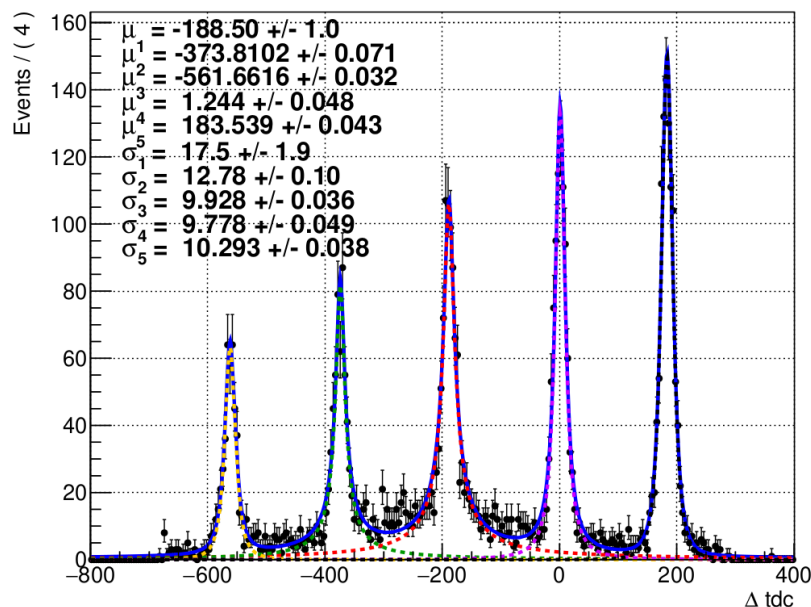


TDC spectra for both sides of cell in layer 2 column 9



The PMTs difference distribution is a peak since the trigger is given by the scintillator palettes. For the full module length (along the direction of the fibers) a new trigger has to be developed, for example with the logic sum of the cells in the last layer of the module.

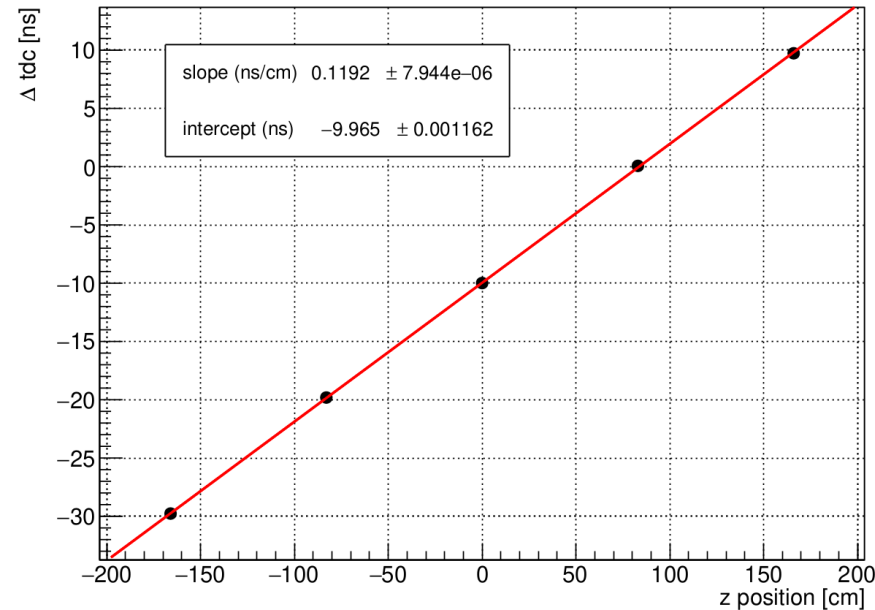
ECAL Barrel Test Stand at LNF: Preliminary Data and Results - TDC



Trigger position [cm]	μ_{peak} [TDC counts]
166	183.54 ± 0.03
83	1.24 ± 0.05
0	-188 ± 1
-83	-373.61 ± 0.07
-166	-561.66 ± 0.03

A preliminary investigation of the module time response was performed by varying the trigger scintillator position along the longitudinal axis of the barrel. **Negative displacements corresponds to shifts towards side 1.**

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - TDC

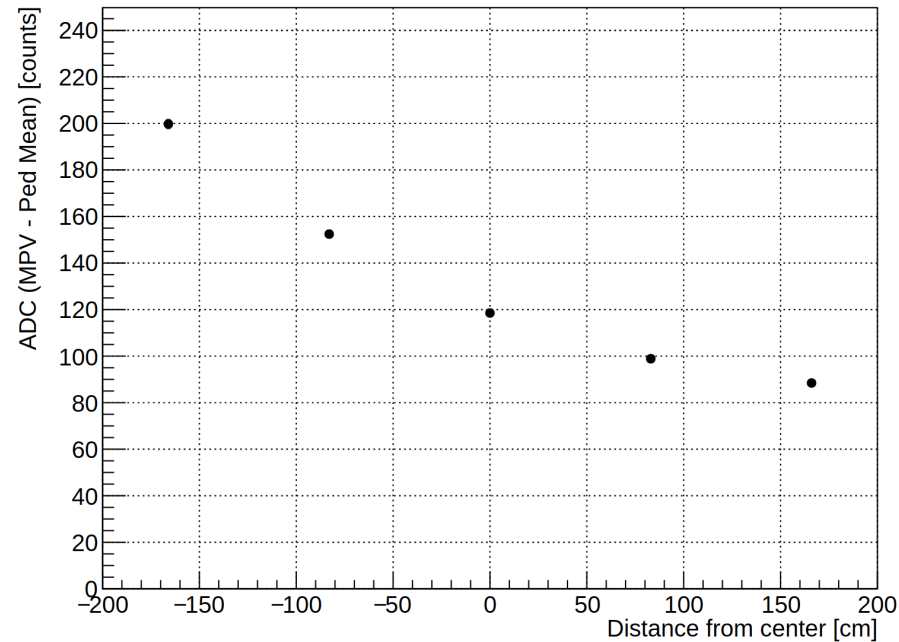


Trigger position [cm]	μ_{peak} [ns]
166	9.7276 ± 0.0016
83	0.0657 ± 0.0027
0	-9.964 ± 0.053
-83	-19.8013 ± 0.0037
-166	-29.7680 ± 0.0016

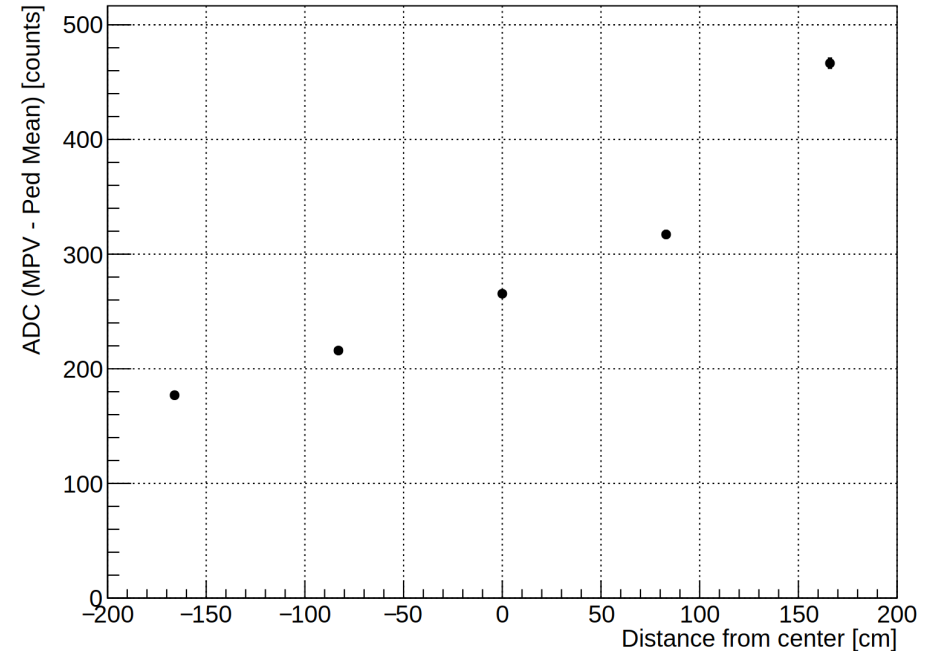
Converting the results from tdc counts in ns, a linear fit on $\Delta tdc [ns]$ vs $z [cm]$ yields the value of velocity in the fiber $v_{lf} = 2 / \text{slope} = (16.778 \pm 0.001) cm/ns$.

ECAL Barrel Test Stand at LNF: Preliminary Data and Results - ADC

Side 1 Cell at column 7 Layer 1



Side 2 Cell at column 7 Layer 2



The same dataset can be used to study the relation between the Peak of the MIP signal and the position along the longitudinal axis of the barrel, to evaluate the attenuation length of the scintillation light in the fibers.

Conclusions:

- ECAL Barrel Test Stand ready in early commissioning;
- Preliminary DAQ software;
- Preliminary results on cosmic ray data acquisition;

Next steps:

- Change trigger logic → Trigger on the logical sum of the signals of the PMTs in layer 5;
 - A custom connection cable is needed and in preparation
- Start the campaign to characterize Barrel modules.
 - To be repeated/replicated for EndCap modules

Thank you