Report on 50l Setup

Different tests - PDS

Renan de Aguiar[1], Manuel Arroyave[2], and Federico Galizzi[3]

[1]Unicamp Br, [2]Fermilab, [3]Milano - Bicocca

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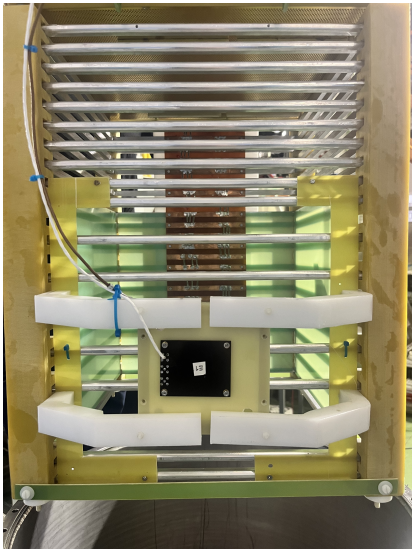
What is the 50l setup?

This is a 50-liter Liquid Argon Time Projection Chamber (LAr TPC) that employs the same VD charge readout technology concept. The configuration allows for incorporating various systems, such as a CRP readout, a high electric field setup, and a PDS readout.



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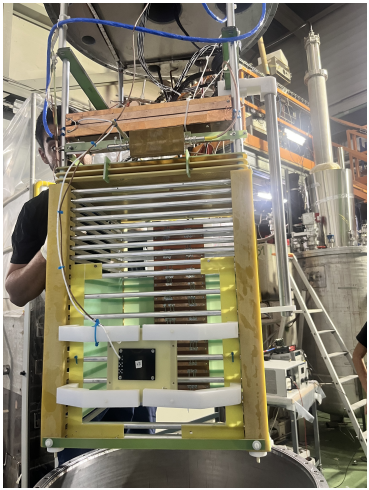


Studies conducted with this setup include several aspects, including monitoring the purity of LAr using radioactive sources (Bi 207), investigating low-energy deposition and detection, assessing the stability of different electric field configurations, examining noise levels associated with various grounding schemes, and integrating Data Acquisition (DAQ) systems, like the 10Gb ETH.

What is the system provided by the PD

The PDS group allocated one mini Arapuca for the 50l setup. The device doesn't have WLS, the dichroic filter is not in good condition, and the CE is not optimized for this specific SiPM ganging.

We use an HD-style CE with the DAPHNE emulator on the warm side. The reason for choosing this Electronics was to provide a system with integration capabilities to the DAQ system (using DAPHNE).

Measurements @182 building

- @182 building we cooled down on October the 13th.
- We took data and optimized noise and grounding for ten days.
- During this time, the LAr system @182 is connected to the recirculation system to preserve LAr purity.
- The team and most of the equipment, oscilloscope, signal generator, digitizer, and power supplies, were present in 182 during these days to provide PDS support.

Measurements @EHN1 - NP

We haven't performed the PoF and the DVDC tests because the procurement of LAr is not trivial:

- We need at least three people to fill the large white ranger 500kg, And three days at NP + time for the testing.
- The ranger does not preserve the LAr for over a few days.
- For this reason, we have to be careful not to expend LAr unnecessarily.
- The amount of LAr needed for the tests is around 150lt. Nevertheless, filling the ranger implies expending 1 ton of LAr, 500lt for cooling down the ranger + filling.

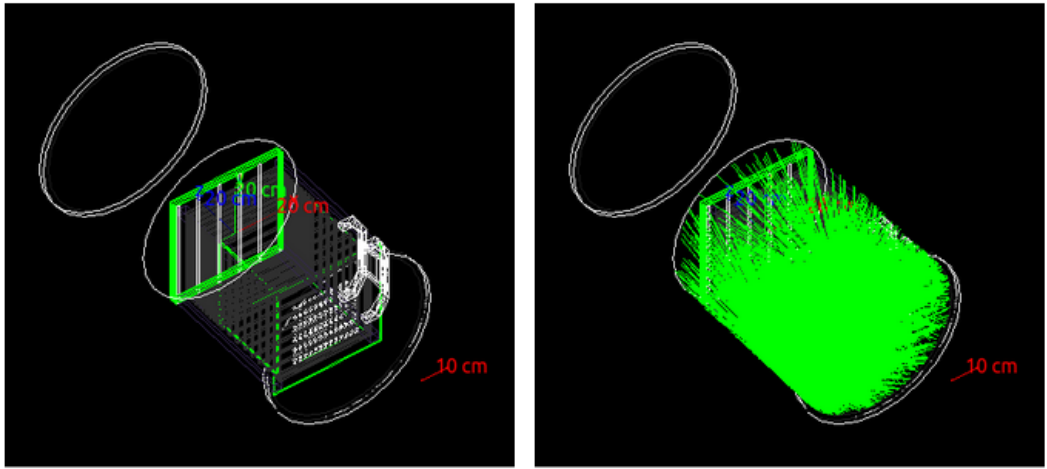
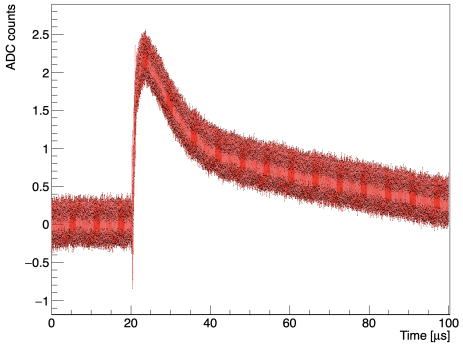


Figure: Left, geometry. Right, scattering. A simulation in GEANT4 estimated around 130 photons reaching the ARAPUCA's window per Bi 207 decay.

What are the results from PDS in the 50l setup?



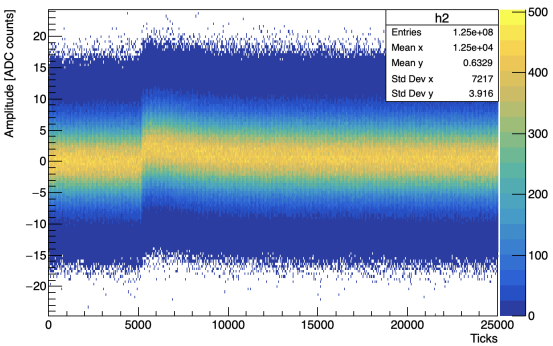
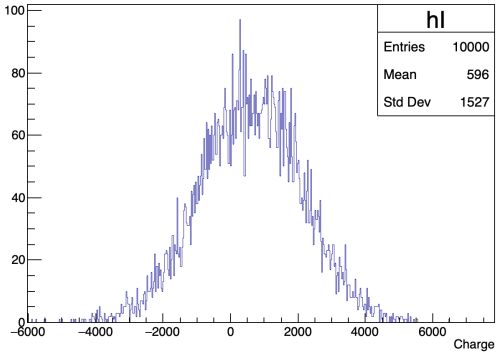


Figure: Average and Persistence plot -LED data, 47V- Waveforms: very large fall time (>80 μs), baseline fluctuation $\sim$ (usual) amplitude of the single p.e., large oscillation on the rising edge.

Charge histogram



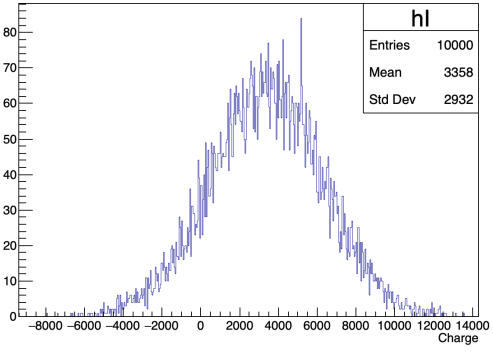


Figure: 47V (left) and 48V (right) charge histograms. The LED light intensity was properly set to have good statistics for the "zeros" (0 p.e.), but we cannot see any multi-peaks.

PE from Cosmic Rays

Using 49 V bias and an internal trigger of 40 ADC, we acquired events in a 280 µs window. We then look for signals associated with muon decay electrons in the tail of the CR signal. We apply a matching filter to select the signals and calculate the charge.

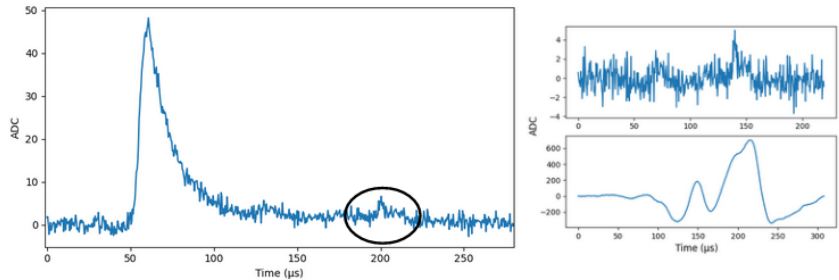


Figure: CR signal (left) tail signal and filtered signal (right)

Charge histogram from CR tail

The charge histogram doesn't have multiple peaks, as observed in the LED data.

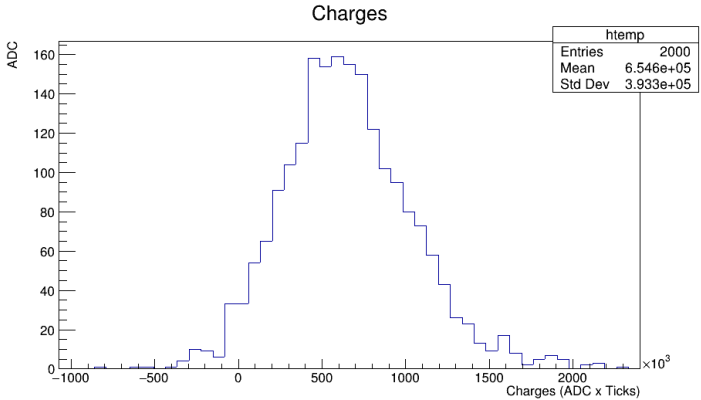


Figure: Charge histogram

Particle ID attempt

We also tried to do particle ID with the F prompt criterium, but no blobs are visible. Our guess is that we are sensitive only to large amount of light, so only the one coming from high-energy cosmic muons.

F Prompt ≡ Integral rising edge / Integral pulse

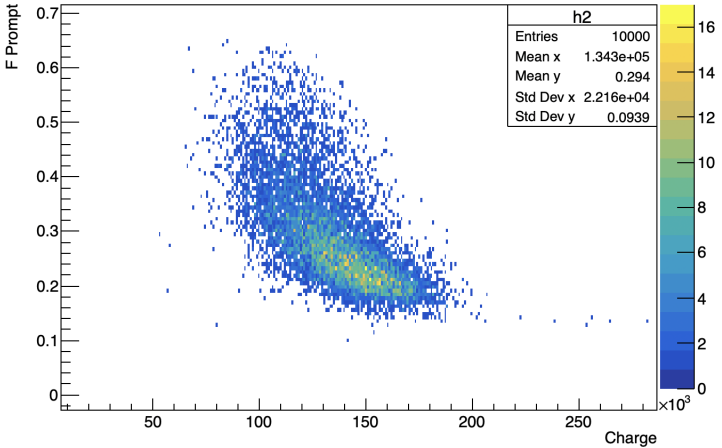


Figure: F Prompt vs Charge

Power Spectral Density of the noise

We can confirm that there is no interference between the CRP electronic and the PDS.
The yellow slope on the left is due to the LED signal; it should not be considered noise.

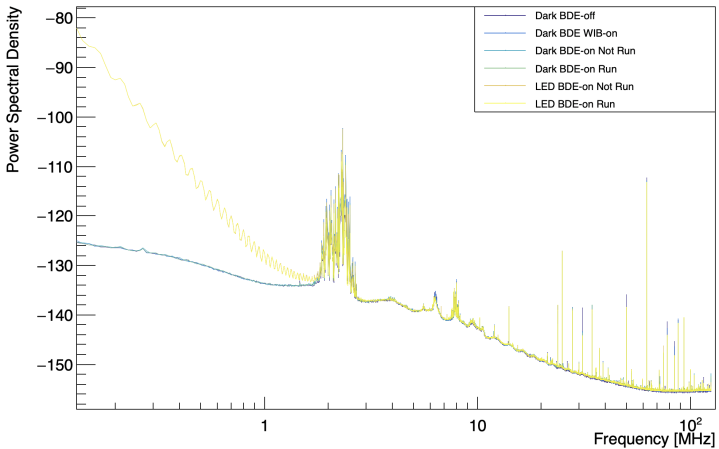


Figure: PSD of the noise

Not SPe recognition under current circumstances

We have to discard multiple factors to understand the behavior of the mini Arapuca under the current conditions:

- We might have a large capacitance in the white cable because it's not referenced on either side, and it's relatively close to the EF.
- HD CE might not be optimized for this ganging.
- We are not sure this device demonstrated single PE recognition. (We took the one that was not used in the ColdBox for a long time)
- We can test one of the other devices in a standalone manner with the VD CE to check this capability.

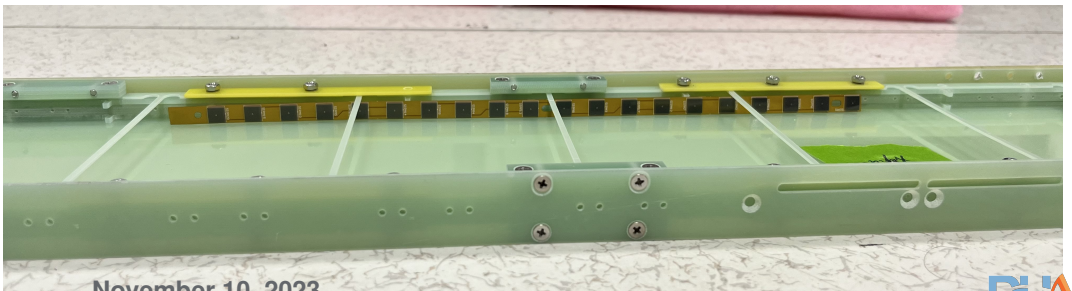
Why are we suggesting to build a new device?

If the previous test with a different mini Arapuca and VD CE is positive, SPe recognition, we can install it in the 50l setup.
We want to note the following:

- The mini Arapuca does not have WLS or the same model of SiPMs present in more modern devices.
- We have tested both electronics with the 20 SiPM flexes from the VD technology, and stability and S/N have been widely demonstrated.
- Including the WLS permits us to increase the efficiency of the device and gives us the possibility to perform efficiency tests.

material required

- 1 supercell body for mechanical support.
- 2 ELJEN WLS spares from previous HD PD modules assembly.
- 4 spares dichroic filters from previous HD PD modules assembly.
- 2 20 SiPM Flexes VD technology from previous Coldbox, V5 module.




DEEP UNDERGROUND
NEUTRINO EXPERIMENT