LAPPD R&D at JLab

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LDRD Funding in FY22 for LAPPD studies:

→ A new LAPPD with good quantum efficiency, uniform gain across the MCP area and optimized distance between MCP2-anode (3 mm instead of 6.6) would be fabricated by Incom Inc. specifically for this test

→ The smaller MCP2-anode gap is needed to reduce the spread of the charge cloud at the anode. This will minimize the possible active gain variations due to pore sharing.

→ The smaller distance between the second MCP and anode would also hopefully improve the resistance of the LAPPD to magnetic field

→ Once delivered the LAPPD would be characterized in terms of gain vs voltage curves and dark rates

→ An attempt at measuring the charge cloud radius would be made

→ Potential gain variation due to pore sharing would also be investigated

→ A test setup to use cosmic rays and a tank with C_4F_8 gas would be assembled to test the new LAPPD with Cherenkov light from cosmic rays using a scintillator and calorimeter as trigger

Status:

→ Several attempts at preparing the new LAPPD failed so far because of leaks, or excessive dark noise that reduced the operating range

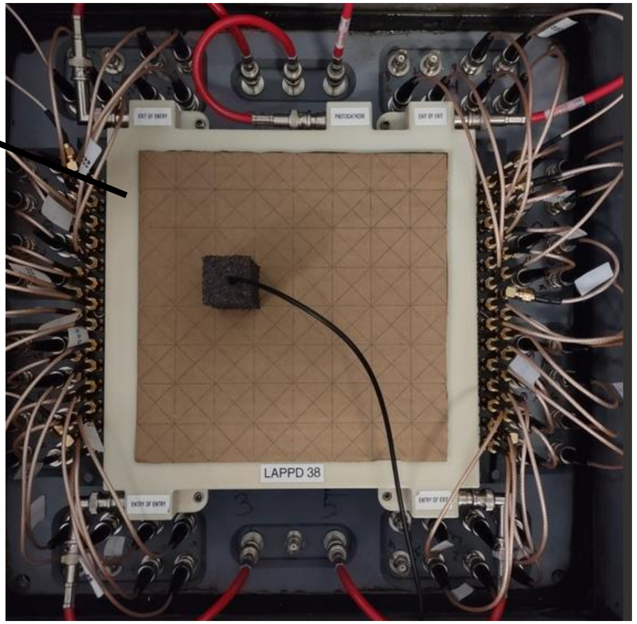
→ Incom is still working to fabricate the new LAPPD

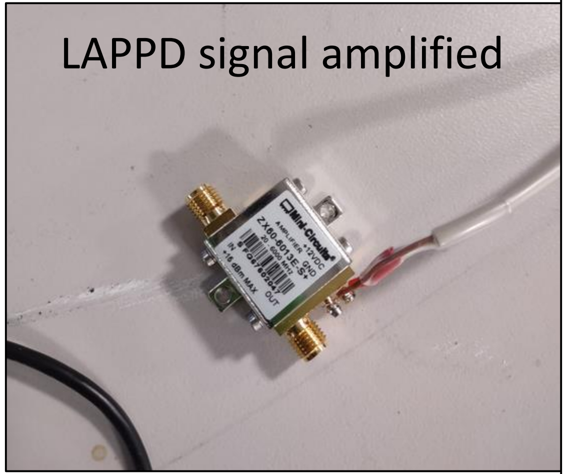
→ Meanwhile I am proceeding with tests using LAPPD 38

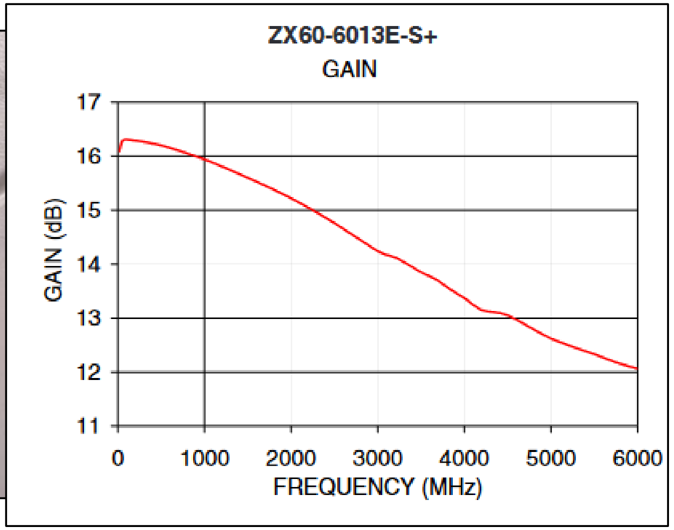
→ Bench tests are ongoing and the setup for tests with cosmic rays is ready and on standby

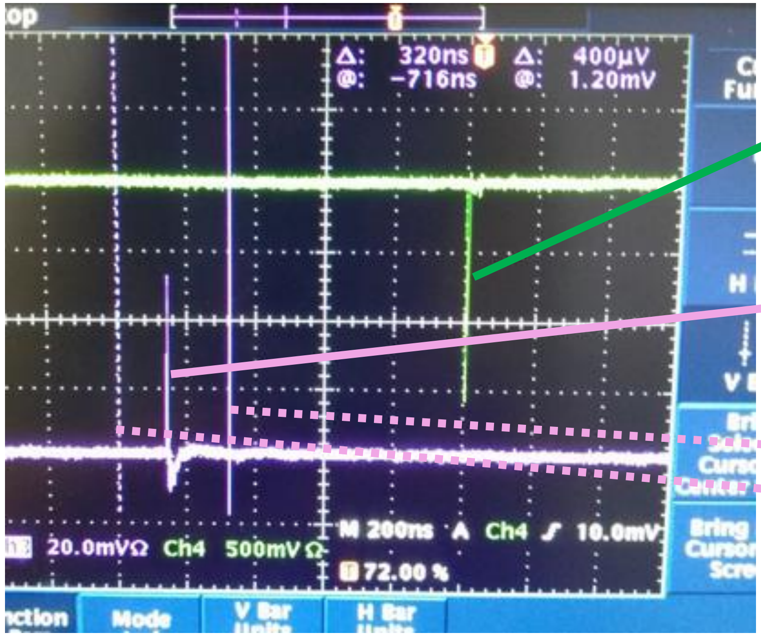
Setup for bench test characterization of the LAPPD

LAPPD 38 with a mask that allows LED light on photocathode through a 2 mm hole




LAPPD signal amplified





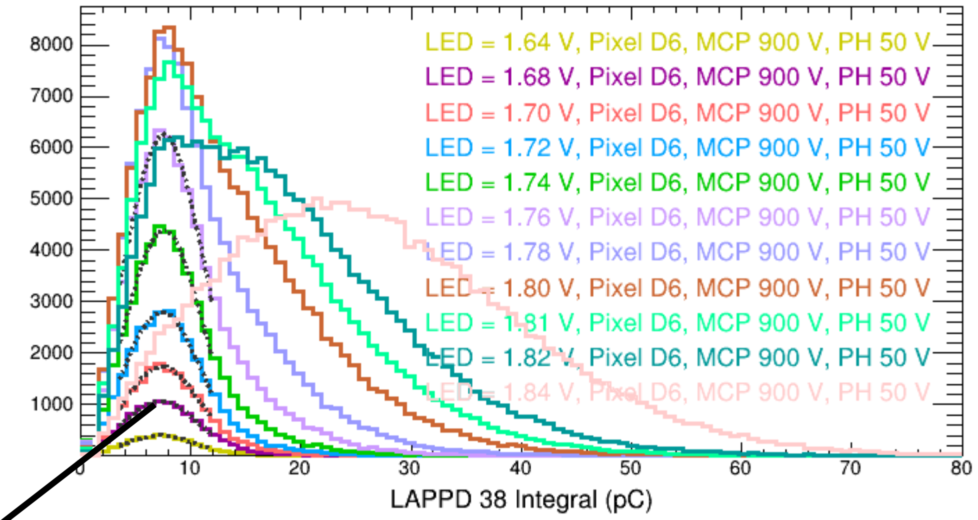
Trigger: pulse that drives LED

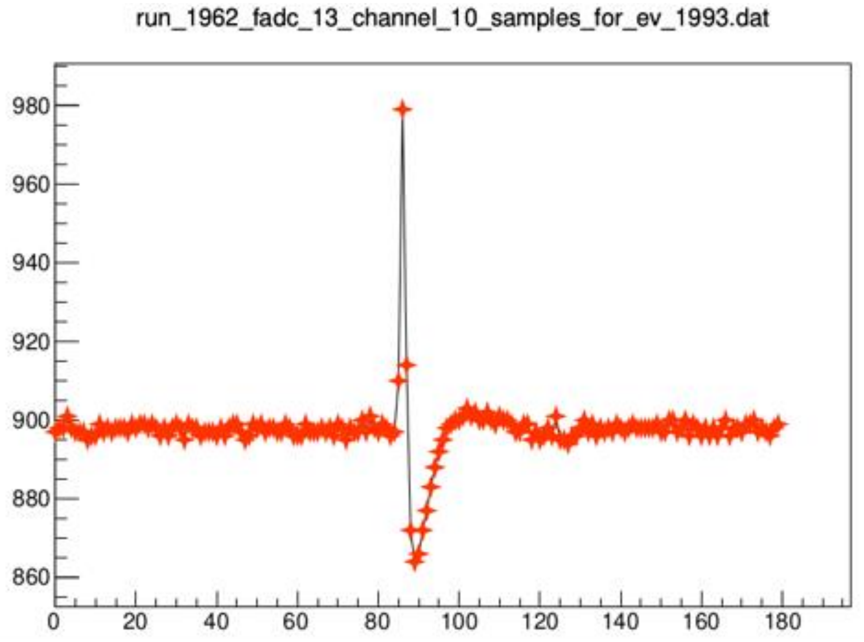
LAPPD pulse (unamplified)

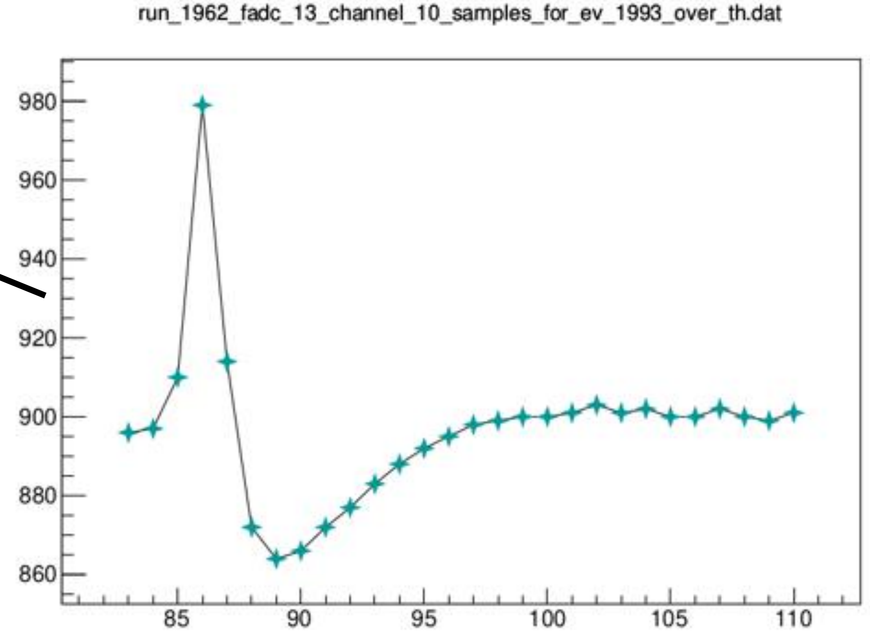
FADC250 sampling window (samples every 4 ns)


DAQ crates with FADC250 digitizers

Setup for bench test characterization of the LAPPD



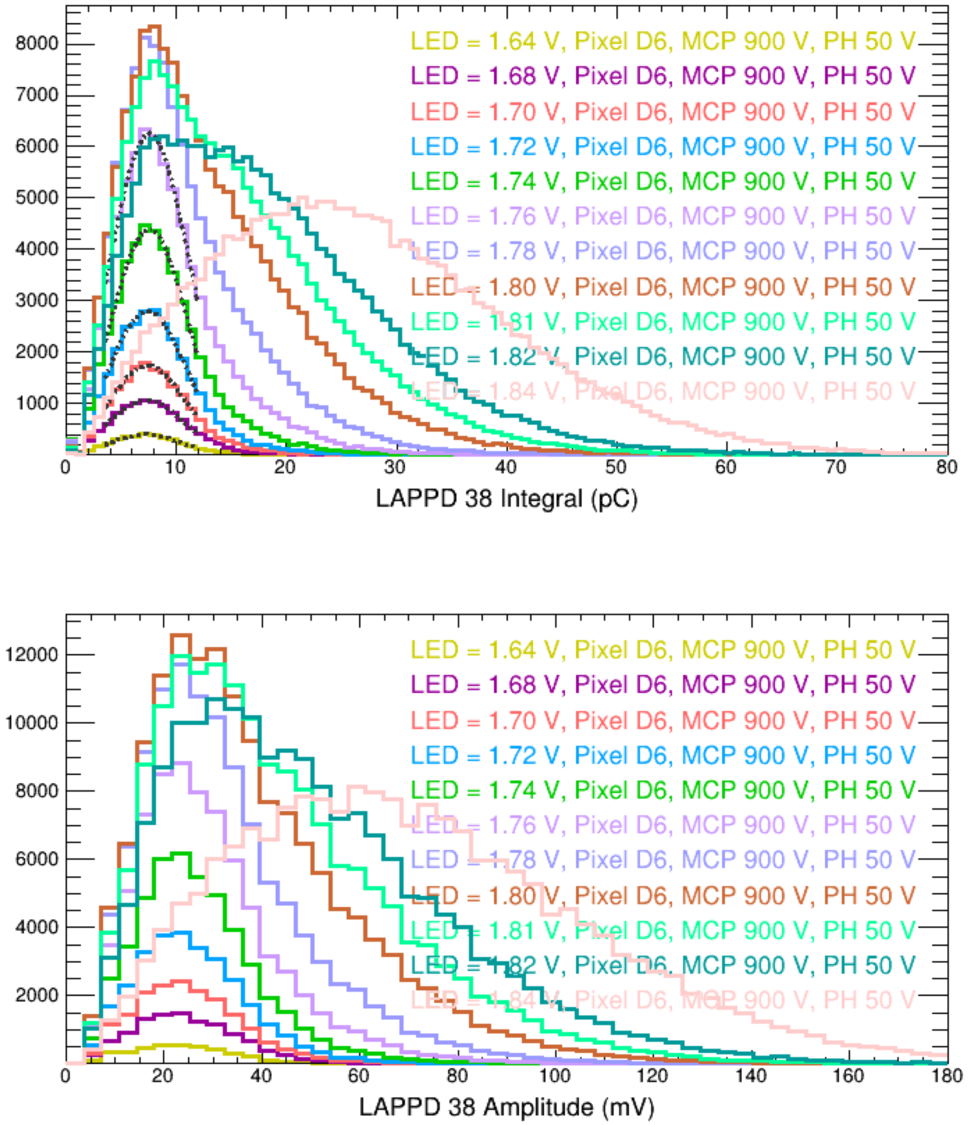




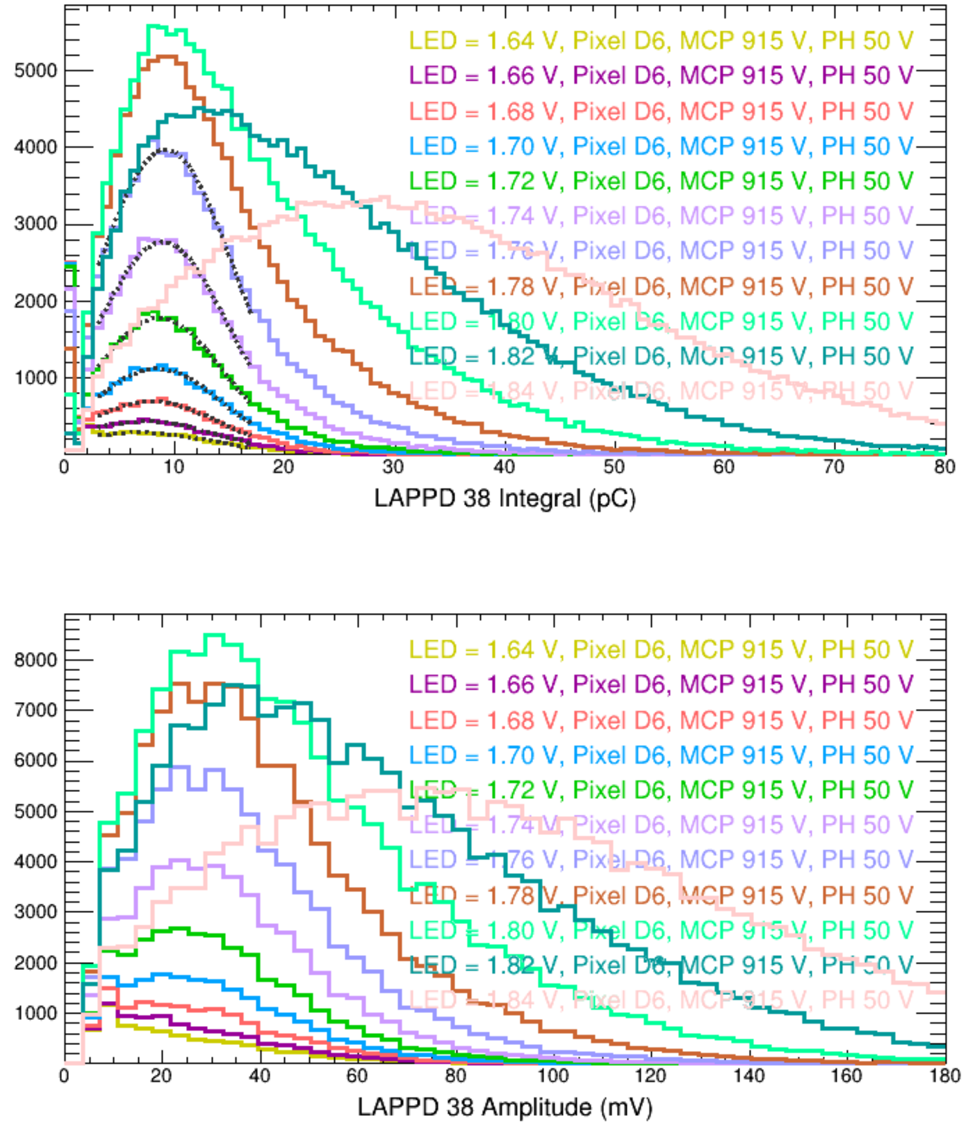
→ Each distribution of charge integral corresponds to a fixed LED voltage and a fixed number of triggers
→ Therefore comparing distributions means comparing probabilities for producing a certain number of photoelectrons

Definition of pulse integral from the FADC250 samples per trigger (or event)
→ The FADC is sampling every 4 ns, the dynamical range is set to 1 V
→ The FADC thresholds are set to 20 channels above pedestal
→ The pedestal is calculated as the average of the previous 4 samples once a sample registers above threshold
→ The pulse is defined as the first 28 samples above threshold once a sample registers above threshold

High voltage scan

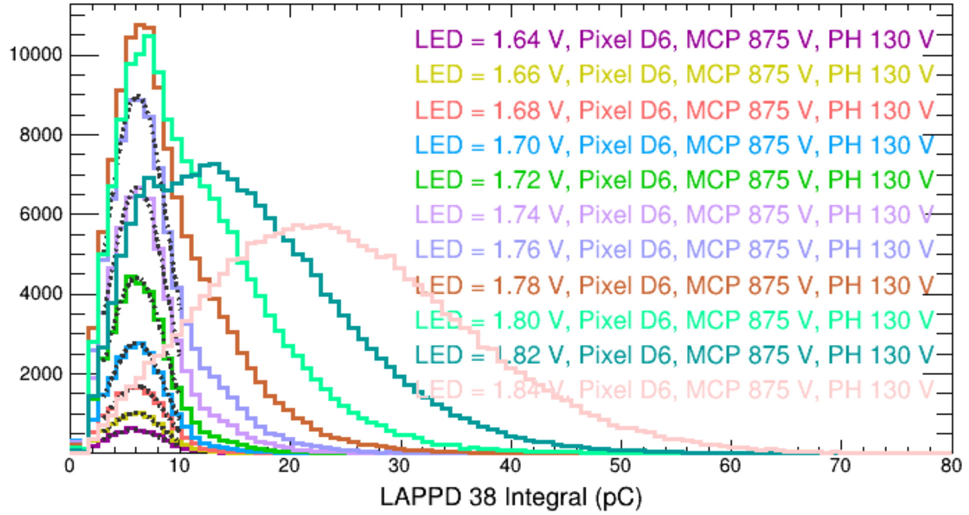


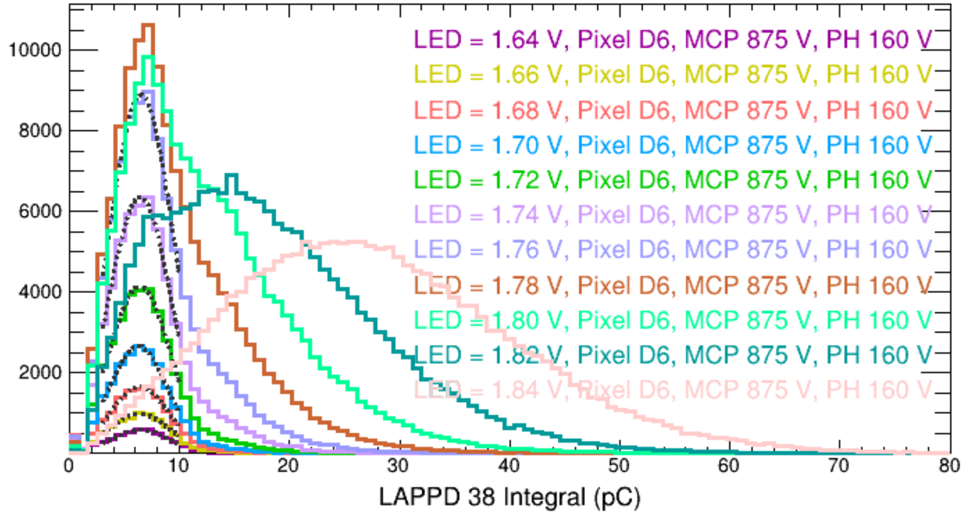
Single and multi photoelectron distributions obtained from LAPPD 38 at a **MCP voltage of 900 V and a photocathode voltage of 50 V**.

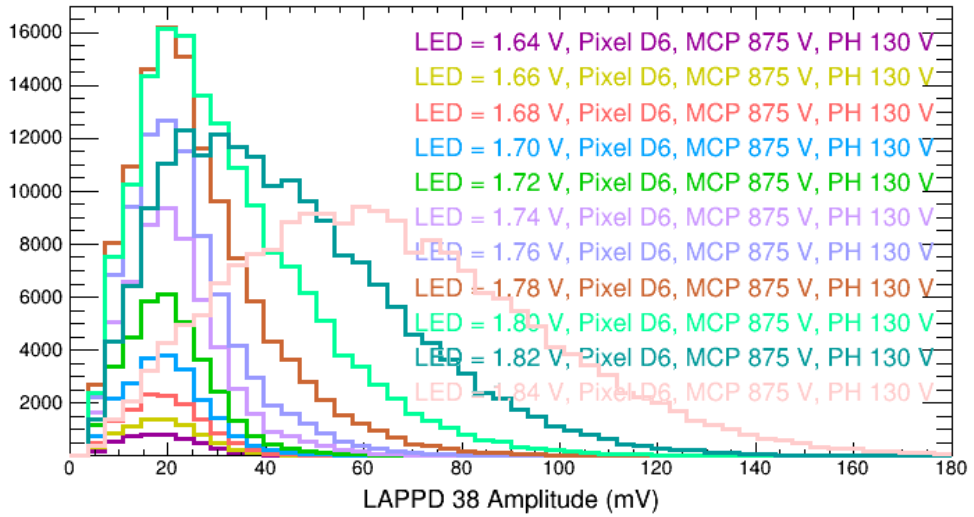


Single and multi photoelectron distributions obtained from LAPPD 38 at a **MCP voltage of 915 V and a photocathode voltage of 50 V**.

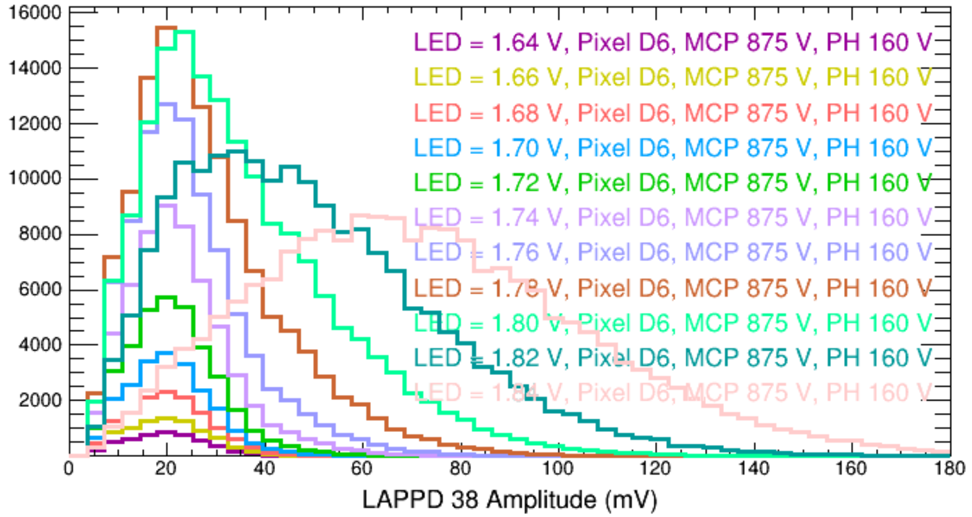
High voltage scan





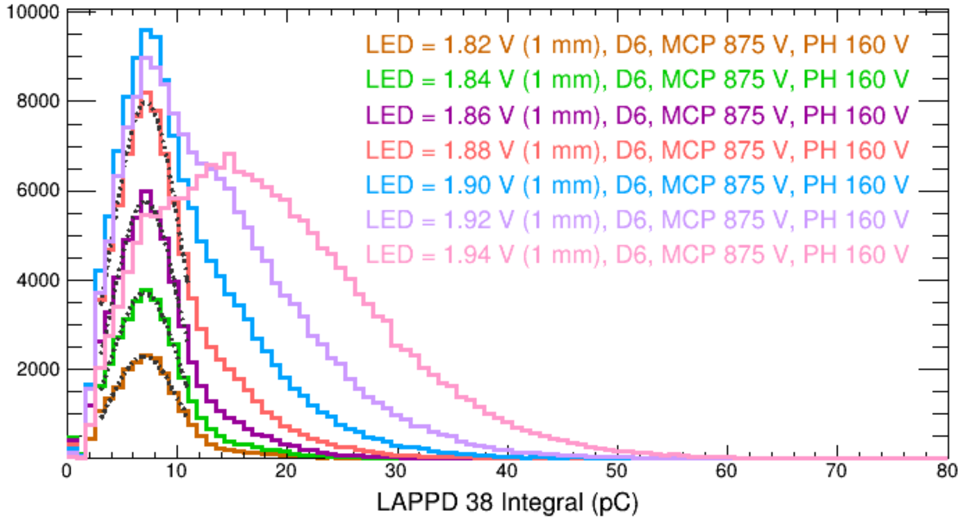


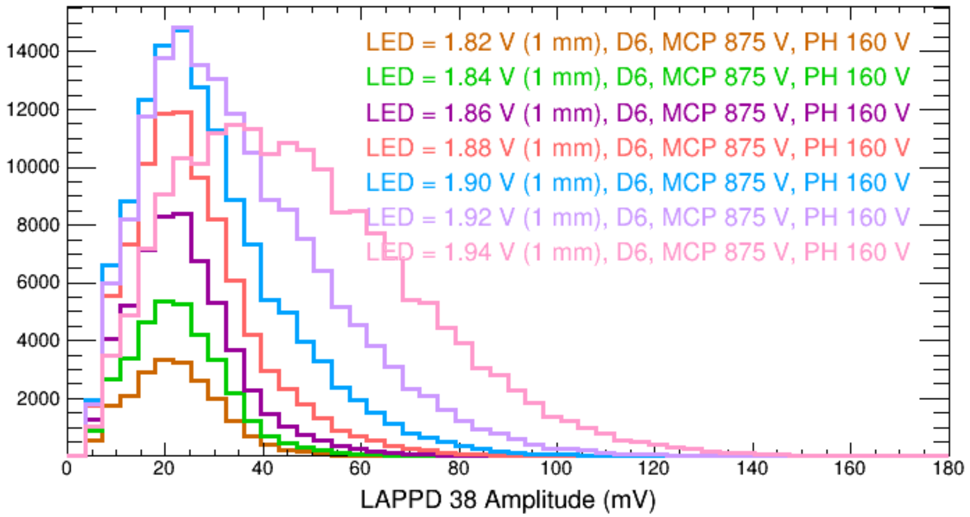
Single and multi photoelectron distributions obtained from LAPPD 38 at a **MCP voltage of 875 V and a photocathode voltage of 130 V**.



Single and multi photoelectron distributions obtained from LAPPD 38 at a **MCP voltage of 875 V and a photocathode voltage of 160 V**.

1mm hole collimation to attempt the measurement of the charge could radius





Single photoelectron distributions obtained from LAPPD 38 at a MCP voltage of 875 V and a photocathode voltage of 160 V with LED photons collimated through a 1 mm hole

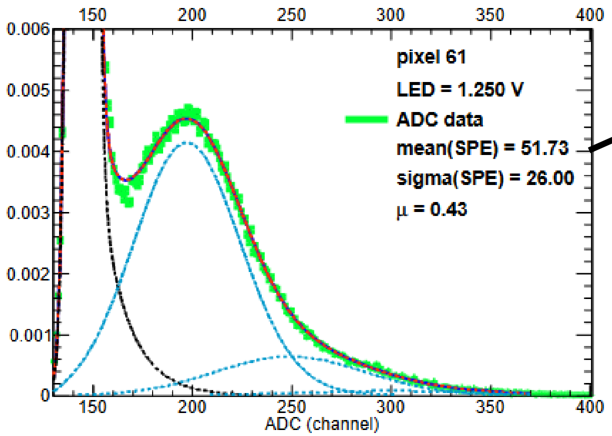
- → Here the 1 mm hole is placed at the center of a "pixel"
- → No significant charge is registered on adjacent pixels meaning that the charge cloud is confined to the illuminated pixel
- → The idea is to "move" the 1mm hole towards the edge of the illuminated pixel and determine when the adjacent pixel registeres ~30% of the charge
- → Then the distance between the location of the collimation hole and the edge of the pixel ~ the radius of the charge cloud

The size of the collimation hole was chosen to maximize the probability of going through 1 single amplification pore in the first MCP

This work is ongoing, I don't have yet a number for the radius of the charge cloud

Coming up

- → Optimize the setup for measurements of the charge cloud radius
- → Attempt to overlap 2 charge clouds and check for gain variation due to pore sharing
- → Switch to a faster digitizer (CAEN V1742) and eliminate the usage of 100 m long RG-58 cables with FADC250 (bench tests only)
- → Perform fitting with a LAPPD response function to extract single photoelectron characteristics
- → Do it allover again with the new LAPPD
- → Attempt to take data with cosmic rays
- → Eventually install in beam at JLab once the LAPPD is fully characterized and understood on the bench
- → Investigate the possibility of performing magnetic field measurements with CLEO-II (up to 1.48 T)



Example of fitting Hamamatsu maPMT (H8500C-03) to extract SPE characteristics; I will try it on the LAPPD distributions