Determining Optimal Running Conditions for TinyTPC Detector

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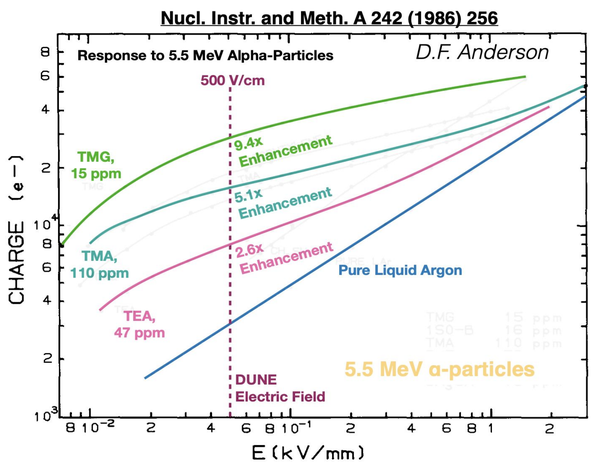
FERMILAB-POSTER-24-0180-STUDENT

Introduction/Background:

Liquid argon time projection chambers are particle detectors used to measure charge and light from particle interactions. The Deep Underground Neutrino Experiment (DUNE) will utilize such detector to study neutrino interactions. Currently, LArTPCs effectively collect ionization charge, but not scintillation light; converting light to charge with the addition of dopants would enhance scintillation signal.

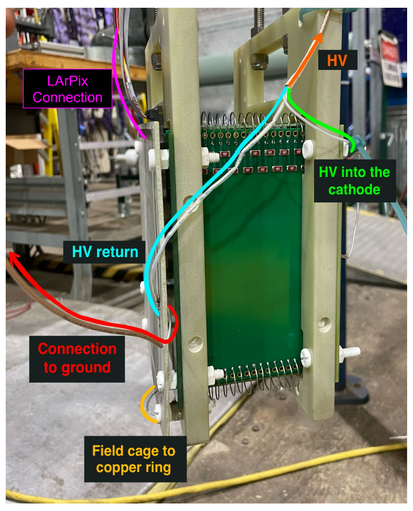


Past Demonstration of Charge Enhancement with dopants

Experimental Overview:

TinyTPC is LArTPC with a pixelated readout (LArPix) that we will use to demonstrate the effects of photosensitive dopants for improved energy resolution at lower MeV scale.

TinyTPC consists of a HV and LV system. Initially tested in a test vessel and then moved into a cryostat, Blanche, for data taking at the Proton Assembly Building (PAB).



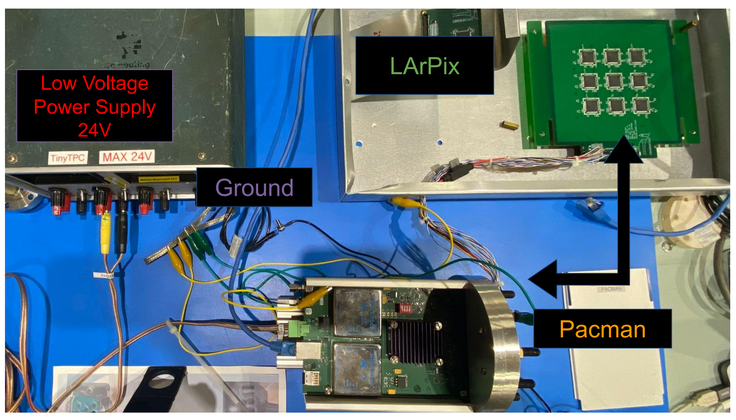
TinyTPC system

Blanche Deployment

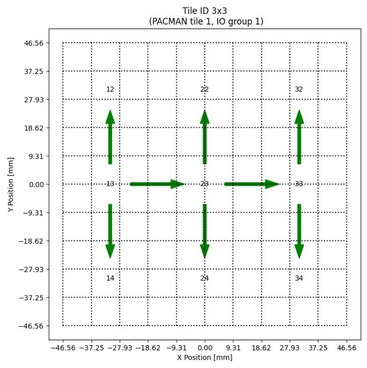
Once placed in blanche, the tinyTPC is running for 3 weeks with radioactive source Th-228 and:

- LAr
- LAr + isobutylene
- LAr + Xe
- LAr + isobutylene + Xe

Low Voltage System:



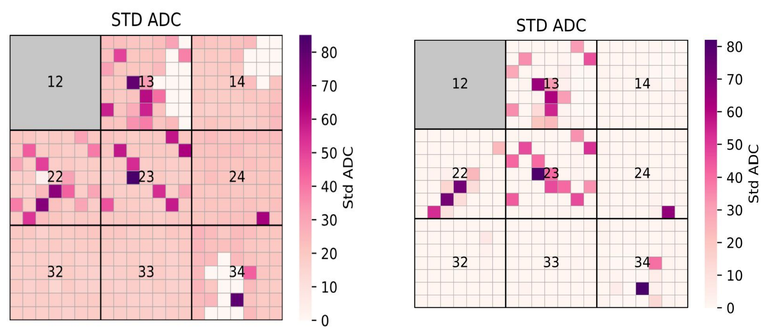
TinyTPC Low Voltage System



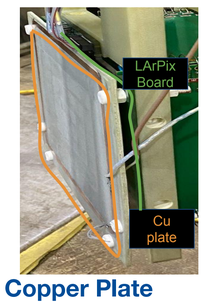
Optimal Hydra Configuration

Hydra configurations describe the connection path between chips on the LArpix board. Not all chip connections operate stably. We performed bench tests and found an optimally stable hydra configuration to run all the chips simultaneously.

Pedestal data provides noise levels which are used to set threshold values for noise reduction in the data.



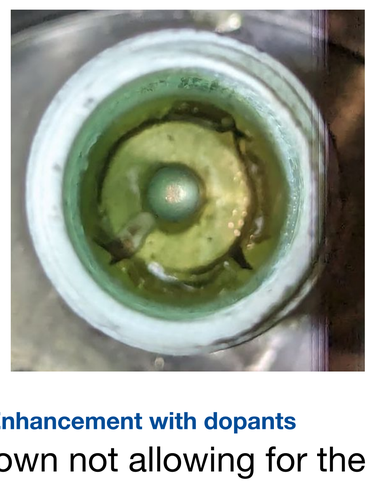
Pedestal scan with floating grounds shows more noise (left).
Pedestal scan with uniform grounding of all components (right).



Copper Plate

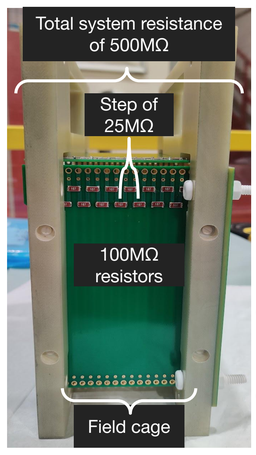
A copper plate was added alongside the LArPix board for improvement in noise shielding. We found that uniform grounding of all components optimizes LArPix chip connection.

High Voltage System:



Past Demonstration of Charge Enhancement with dopants

There was a HV breakdown not allowing for the sustaining of 5kV. Various tests were performed on the HV system in a dewar simulating cryostat condition to identify its source. The breakdown was found to be caused by the cracked epoxy in the HV flange.

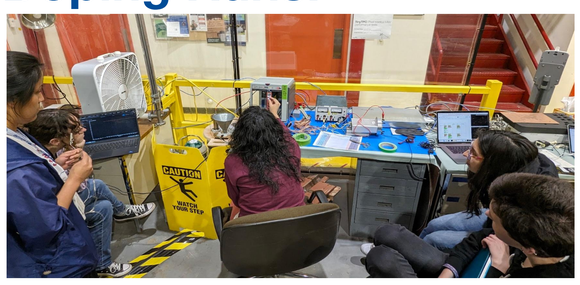


Test Performed on HV:

- Verified system's resistance of 500MΩ
- Measured step resistances of 25MΩ
- Probed the field cage for continuity
- LN2 fill with N2 flush ramping voltage to 5kV
- LAr fill with N2 flush ramping voltage to 5kV

The new flange is able to hold 5kV in the test set up although not yet when in the cryostat.

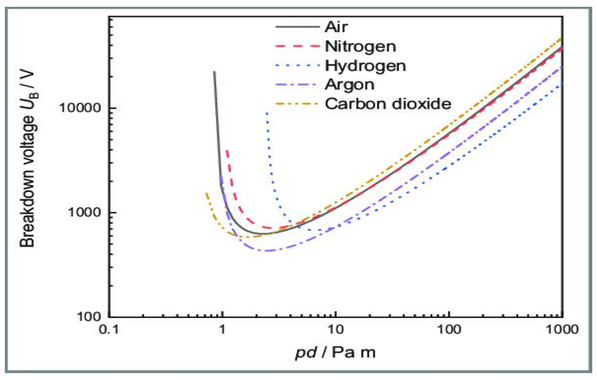
Doping Runs:



TinyTPC team

We are currently taking data using the optimal configuration and new HV flange. Our preliminary analysis shows an increase in charge collected.

Next Steps:



Paschen curve describes the breakdown voltage of various gases including argon.

HV flanges

Argon purity played a large role with the continued HV break down. While we were able to hold 5KV in bench testing, only 2KV were able to be held in blanche due to Ar low breakdown V. I am currently simulating HV breakdown in a new HV test stand to further test the flange, HV and Ar breakdown in order to increase HV held.

Acknowledgements:

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics. I would also like to thank the URA-UWIS internship program. A huge thank you to my advisors Joseph Zennamo and Fernanda Psihas, and to all the TinyTPC team.