TinyTPC: A Test Stand for LAr Doping

Rebecca Gonzalez, Hannah McCright, Paloma Rodriguez Thorne
Advisors: Joseph Zennamo & Fernanda Psihas

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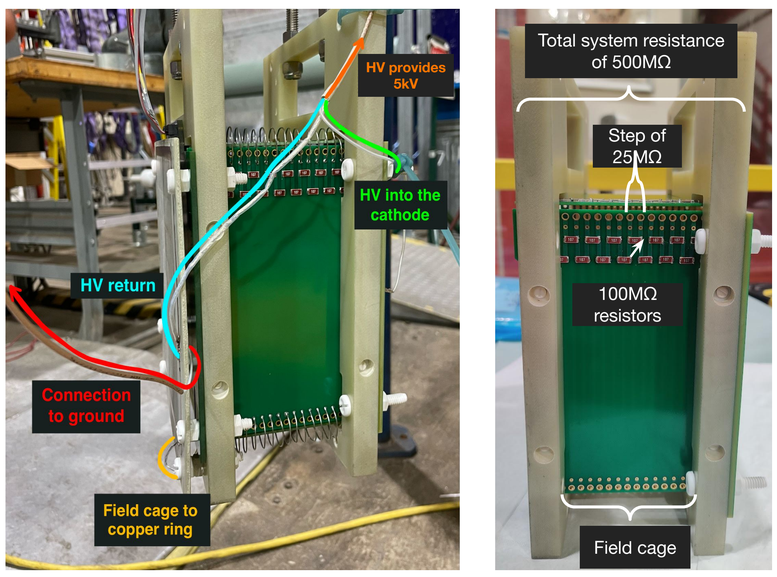
Introduction

LArTPCs measure charge and light from particle interactions. While ionization charge is efficiently collected, scintillation light is not. TinyTPC is a small scale LArTPC with a pixelated readout (LArPix) for R&D with photosensitive dopants. It aims to enhance ionization charge which would improve energy measurements of low energy events at the MeV scale. **TinyTPC will study the effects of adding photosensitive dopants and xenon to liquid-argon.**

For expected improvements with dopants, see poster #84

High Voltage System



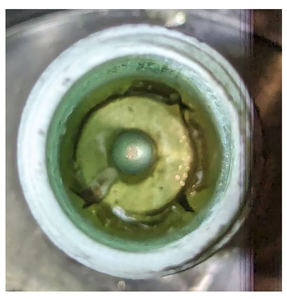
TinyTPC High Voltage System (left). Field Cage (right).

TinyTPC had only been able to hold up to 3kV before a voltage breakdown occurred. To identify the location of the HV system issue, we performed various tests with TinyTPC in a dewar simulating the cryostat testing conditions:

- 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

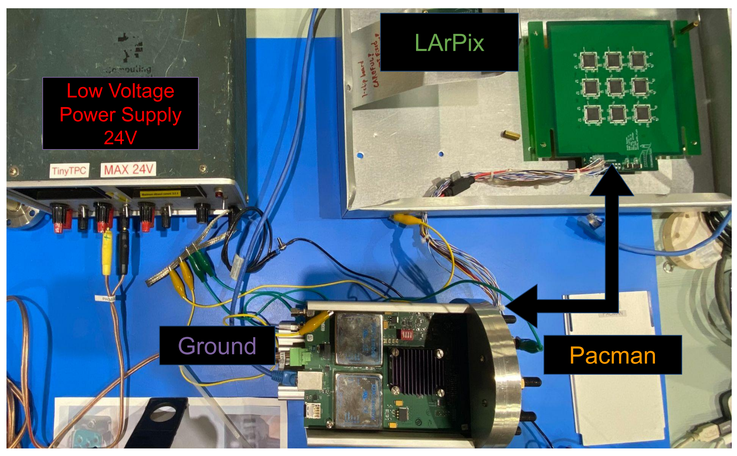
Testing TinyTPC in dewar

During the LAr fill, we heard a 'crackling' sound characteristic of a breakdown coming from the HV flange. We found cracks in the epoxy of the feedthrough allowing electrons to come in contact with Ar gas, which has a low breakdown voltage. After changing the HV feedthrough, the system was able to maintain 5kV.



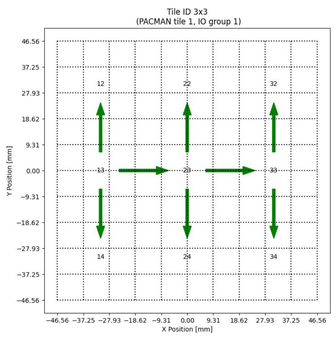
Cracks in Feedthrough Epoxy (left). Team testing HV (right).

Low Voltage System



Tiny TPC Low Voltage System

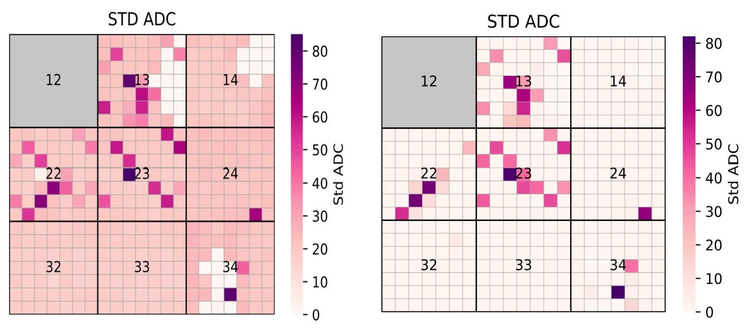
The low voltage power supply provides 24V to operate the Pacman, which is connected to the LArPix. The LArPix obtains the charge collection readout that is then transmitted to the Pacman, providing the data.



Hydra configurations describe the connection path between chips on the LArpix board. We found that uniform grounding of all components optimizes LArPix chip connection.

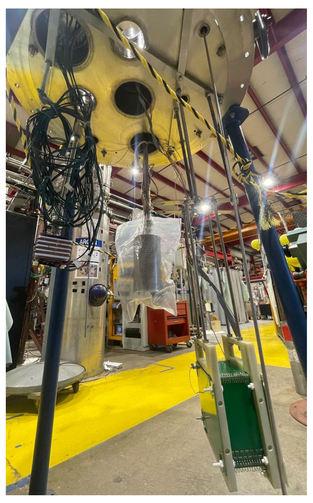
Optimal Hydra Configuration

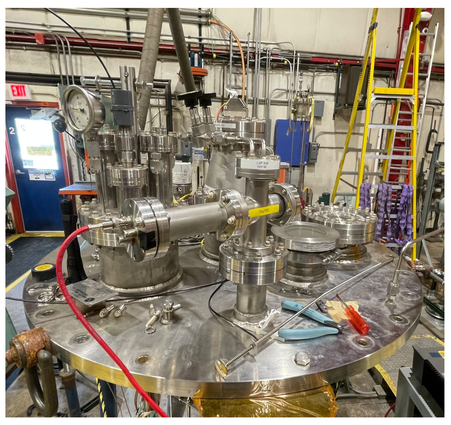
Pedestal data provides noise levels which are used to set threshold values for noise reduction in the data.



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

Experimental Overview



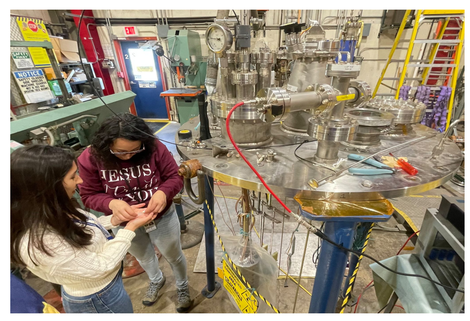


TinyTPC mounted on cryostat lid (left). Top of cryostat lid (right).

To deploy TinyTPC in the Blanche cryostat at the Proton Assembly Building (PAB), the detector has been mounted to the lid to collect data for a month. The HV and LV flanges, and the Pacman are located on top of the lid for access during data collection.

Accomplishments so far

- Tested TinyTPC HV system in dewar
- Identified HV issue and fixed feedthrough
- Ran different hydra networks and established optimal configuration
- Determined optimal grounding of copper plate to run pedestal scans
- Deployed system in Blanche cryostat

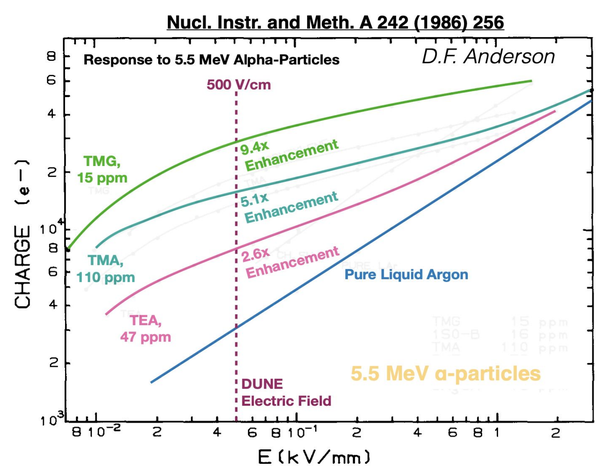


Filling Dewar with LAr (left). Testing on Cryostat Lid (right).

Next Steps

This week, we are restarting data runs in liquid-argon with radioactive sources to test the readout at low energies.

We will introduce isobutylene, a photosensitive dopant that converts light to charge. We aim to demonstrate how dopants improve energy resolution in LArTPCs at the MeV scale and explore optimal doping strategies.



Past Demonstration of Charge Enhancement with Dopants

Finally, we will add xenon which is known to produce light around 178 nm. We will test the addition of Xe to LAr and isobutylene to verify if the charge is still enhanced by the dopant and find if light of any wavelength still remains.

See poster #82 for info about LArPix calibration!

Acknowledgements

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