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Commissiong the TinyTPC: A Test Stand for Liquid Argon Doping

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Undergraduate Women in STEM Final Presentation

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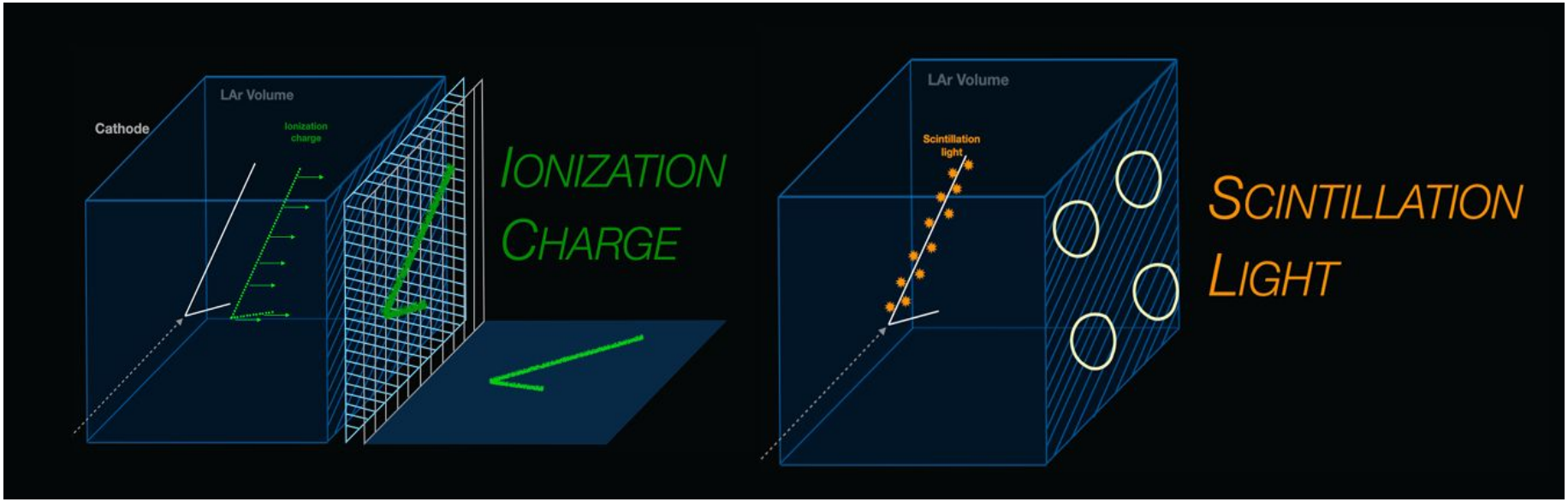
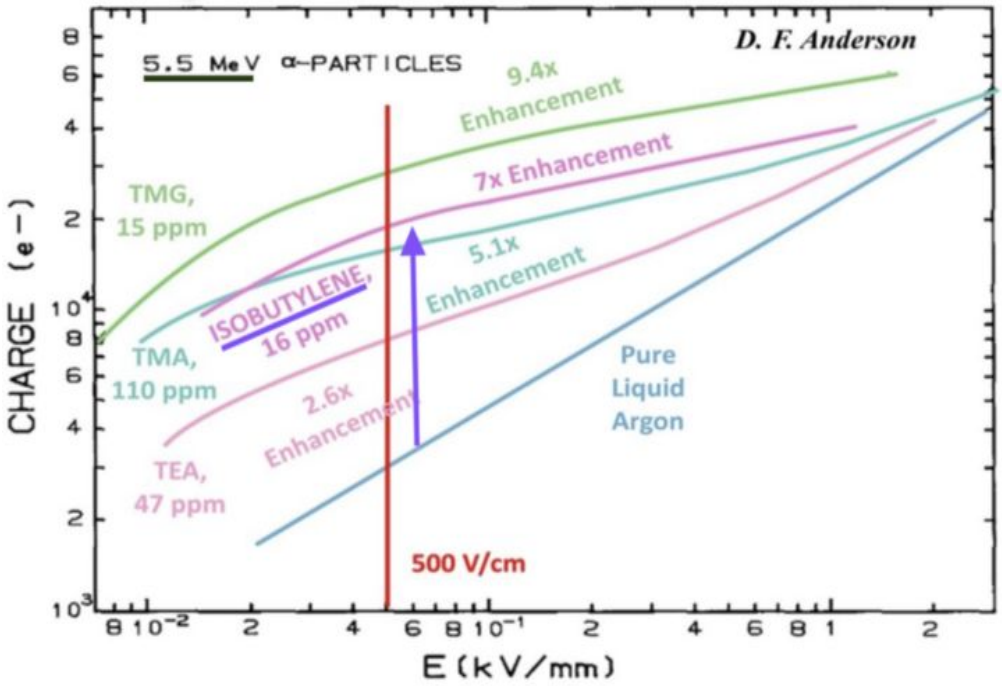
LArTPCs



Liquid argon time projection chambers (LArTPC) are particle detectors used to measure charge and light from particle interactions.

While the TPCs are efficient in the collection of ionization charge (100%), they aren't as efficient with the collection of scintillation light (50%)

How to Change the Light-to-Charge Ratio

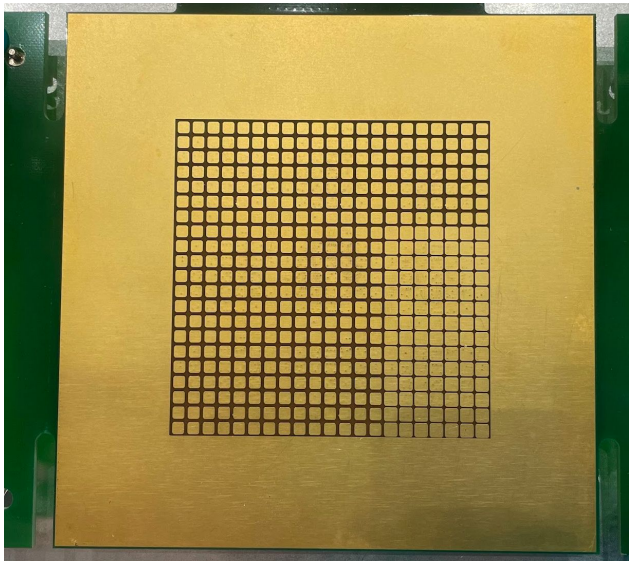


Photosensitive dopants increase the amount of charge produced in LAr

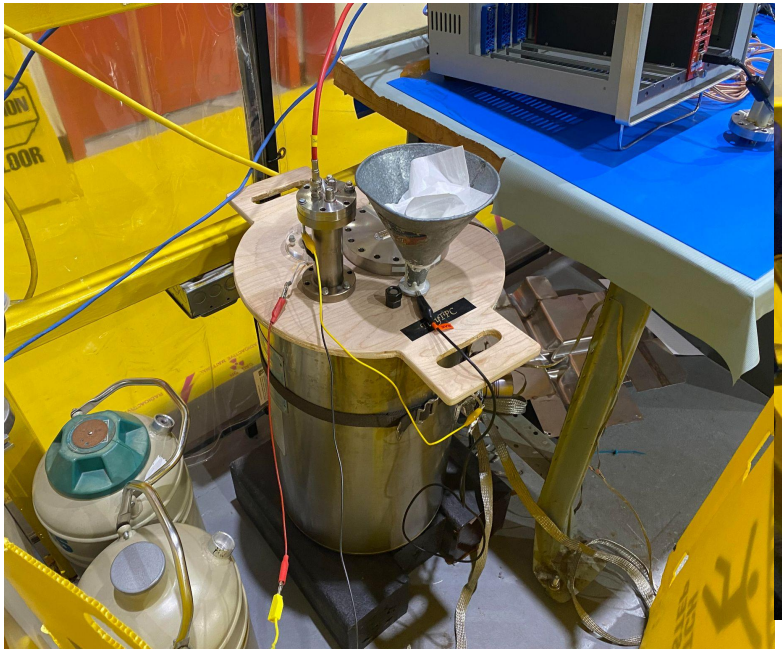
- Converting light to charge with the addition of dopants would enhance ionization signal
- Photosensitive dopants have been shown to increase the ionization charge
- They do this by turning the light into charge
- This has only been demonstrated with alpha particles at given energy level

TinyTPC

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 energies.**



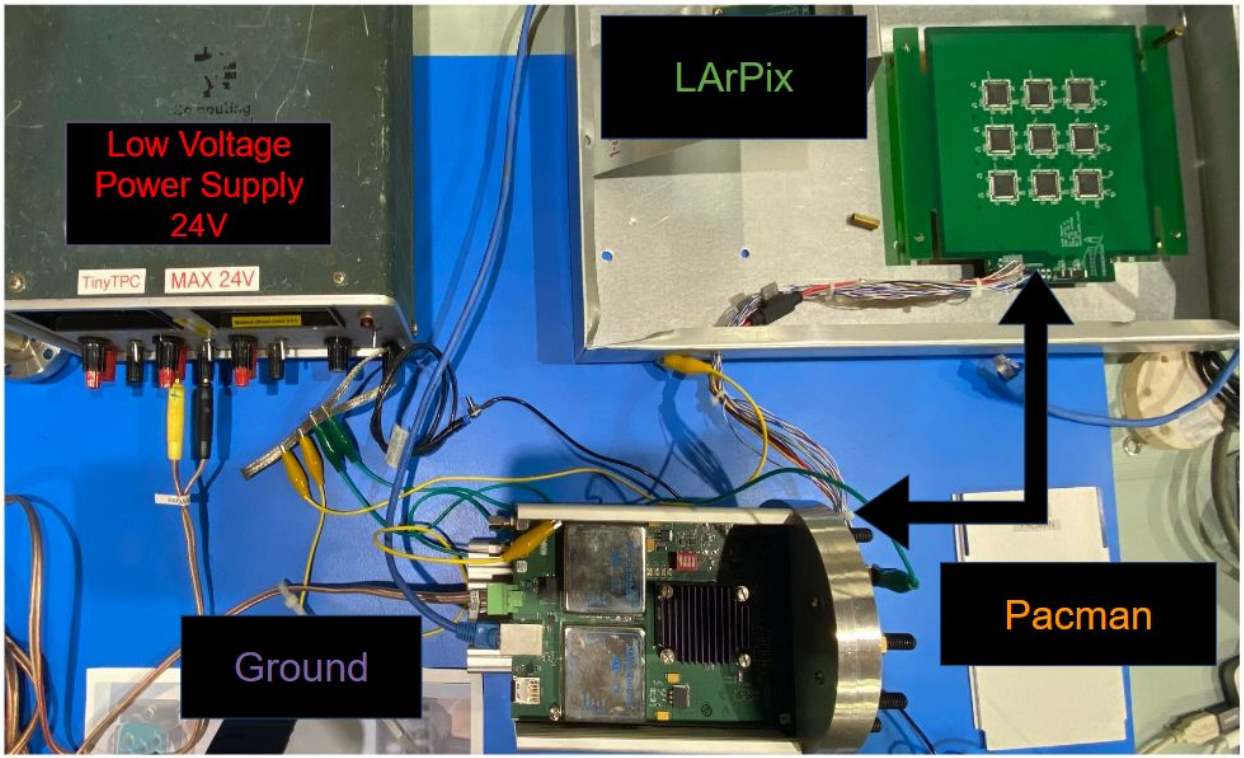
Bench Top Setup



Dewar

Before deployment in the cryostat, we ran a number of tests in a dewar to simulate cryostat conditions to ensure full funcionaltity of the TinyTPC

Low Voltage System :



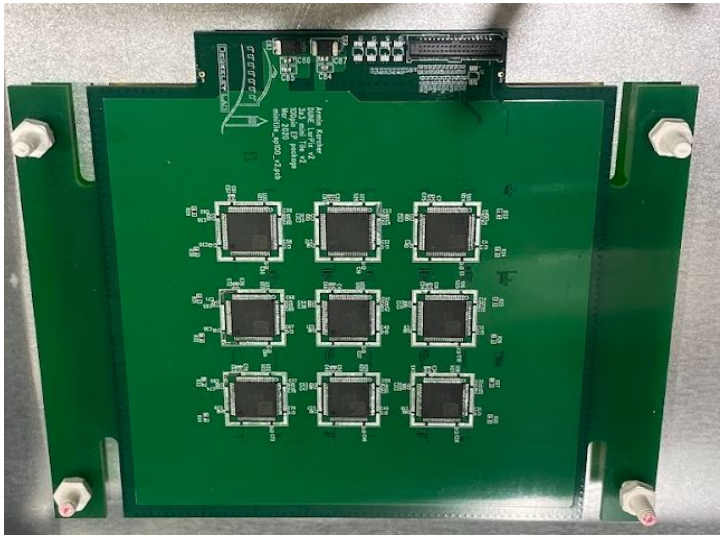
Low Voltage System on Bench Top

Components of the LV system:

- LV power supply
- Pacman
- LArPix Board

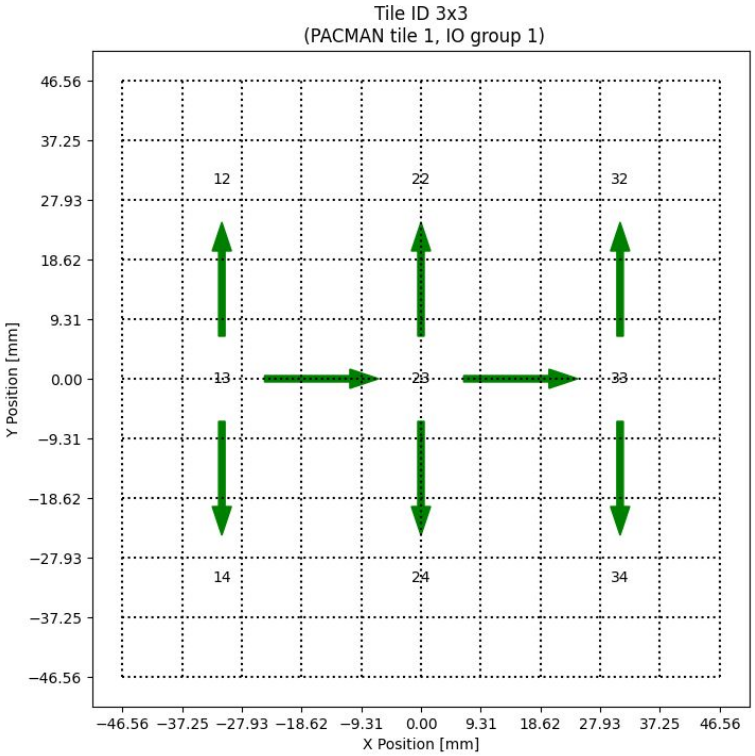
LArPic Board

- The LarPix board is composed of 9 chips
- Each chip holds a number of pixels for data collection
- We found that the grounding of the system as well as the noise present in the system affect functionality of the chips



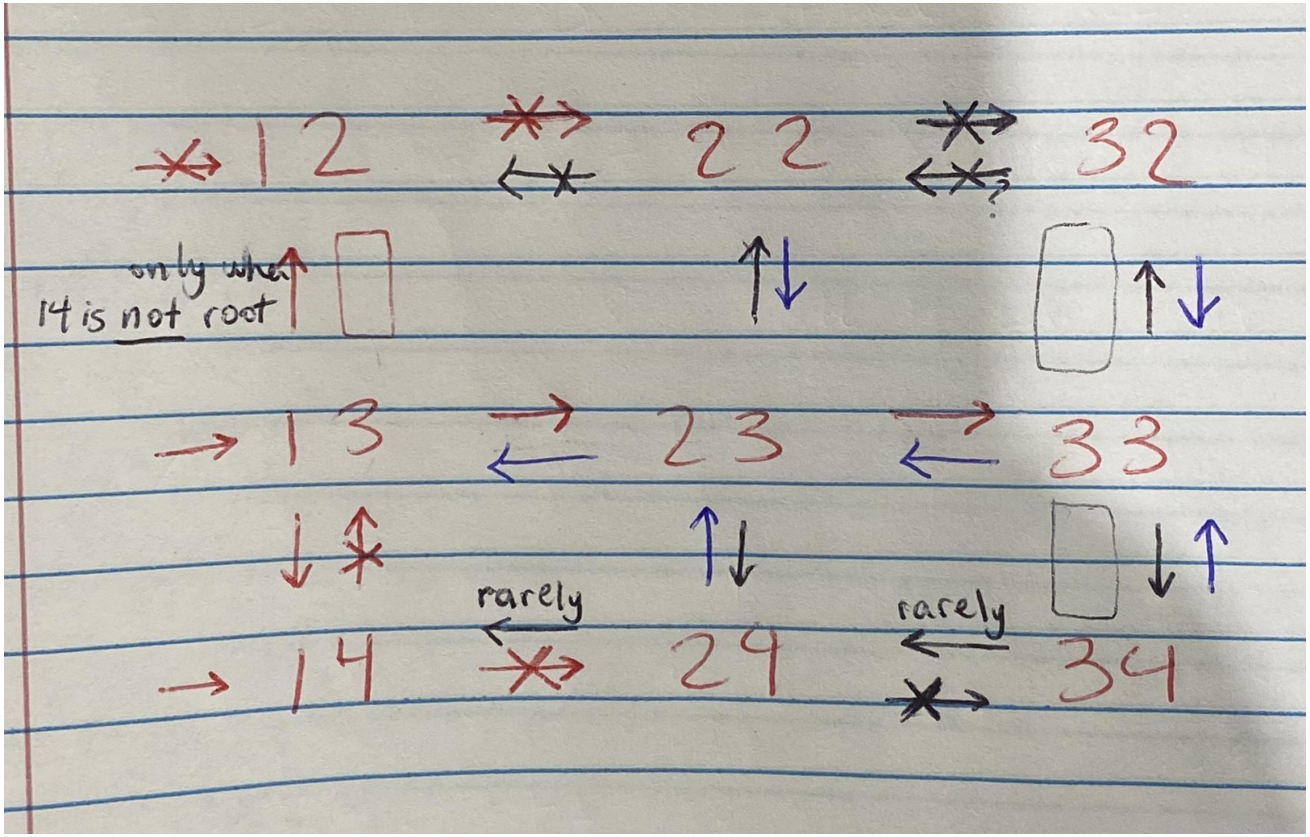
Hydra Configurations

Ideal Configuration



- The hydra configuration dictates the path in which data is transmitted between each chip on the LArPix
- Not all chip connections operate stably
- We performed bench tests and found an optimally stable hydra configuration to run all the chips simultaneously.

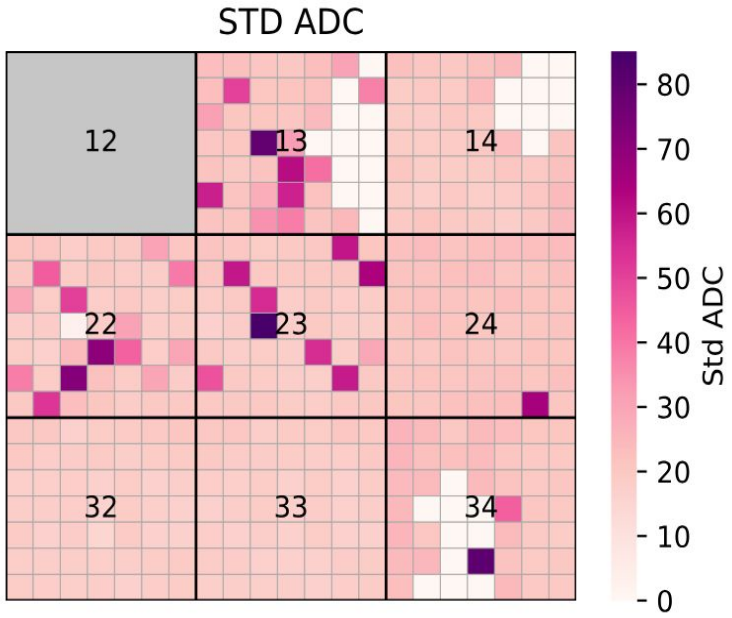
Hydra Configurations Tested



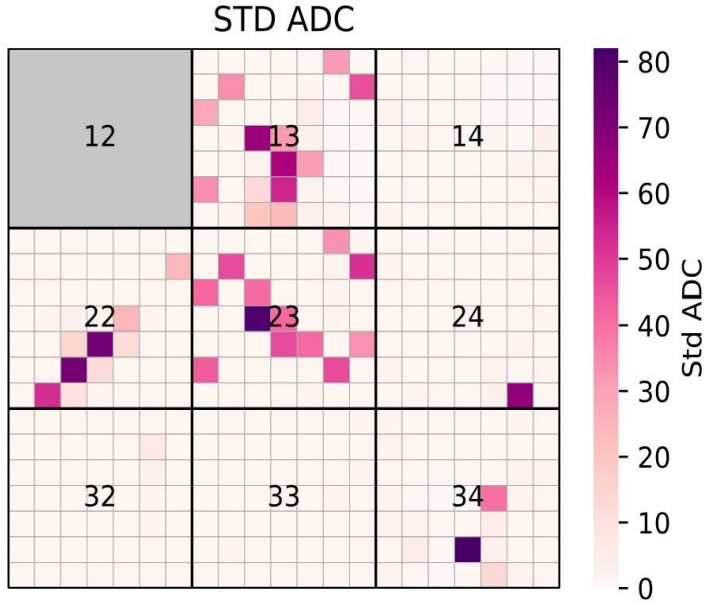
Various possible paths for each chip connection

Pedestal Scans

Floating grounds

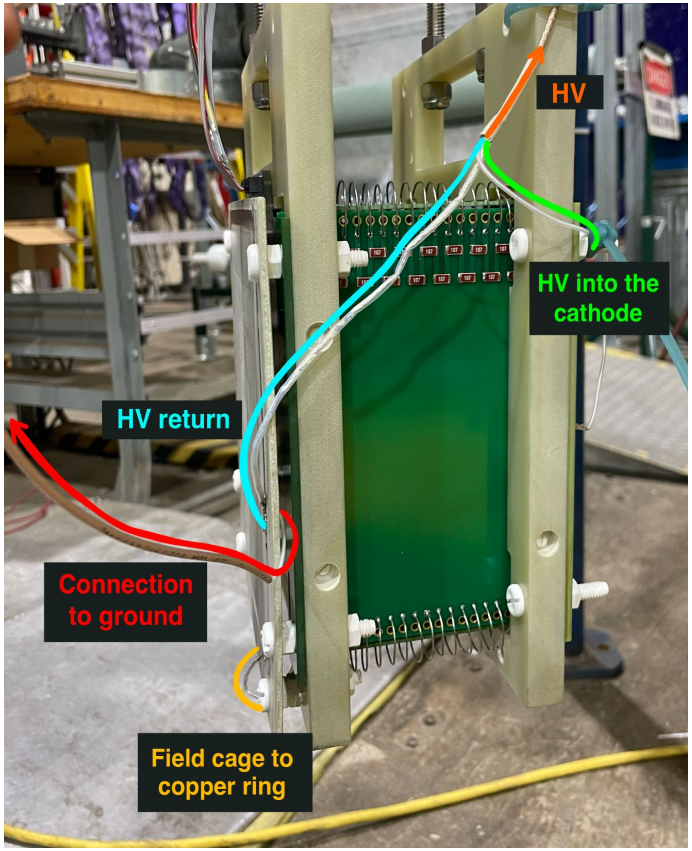


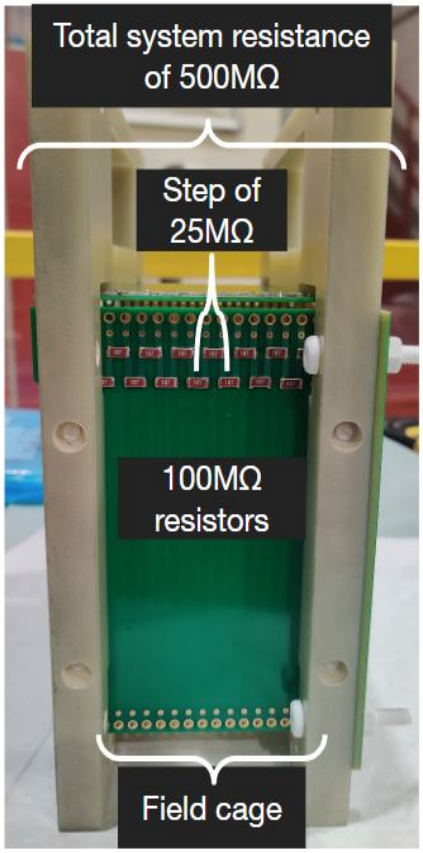
Uniform grounding



Pedestal scans determine the amount of noise seen by each pixel
We tested different grounding configurations by comparing pedestal scans

High Voltage System:





The TinyTPC is meant to operate at 5kV, This voltage goes through the field cage, creating the field that drifts ionoization electrons towards the pixel plane where it gets collected.

We observe voltage breakdown starting at 3kV and performed studies to resolve this.

We measured resistance of the TPC and each field cage ring to confirm that the circuit had no physical damage.

HV Flange

HV flange; cracked epoxy shown in a connection pin

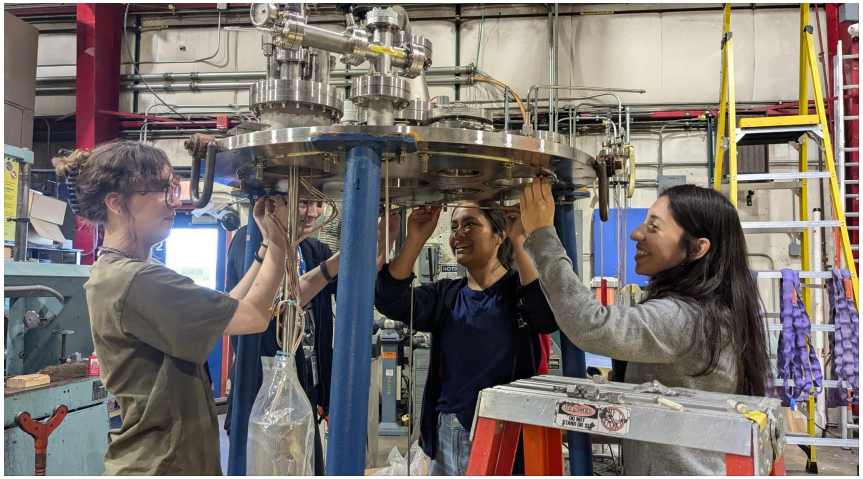
- With continued testing of the individual resistors on the tpc as well as probing the field cage, the HV flange was ultimately found to be cause of the HV breakdown.
- There was an unusual noise produced, prompting examination of the flange itself that showed cracked epoxy
- We successfully replaced the new flange and were able to hold 5kV on the bench top setup

Deployment and Run Plan

- In preparation for deployment a number of tests were ran in stimulated cryostat conditions to ensure TinyTPC optimal functionality.

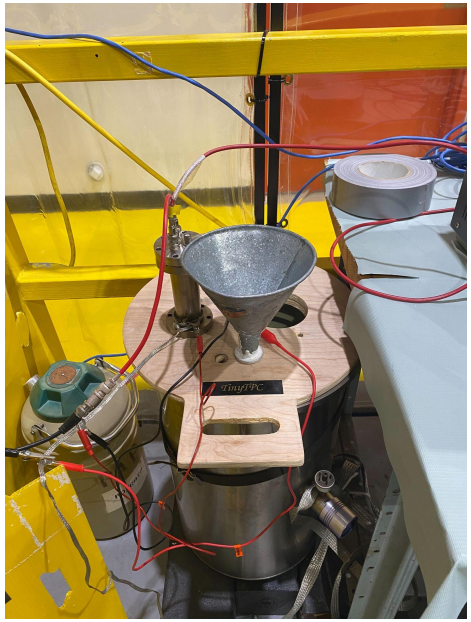
- Once placed in blanche, the TinyTPC has been running ~ 3 weeks with radioactive source Th-228 and:

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



TinyTPC Installation

Next Steps



We will continue to utilize the HV test stand

- We found that the high purity argon in the cryostat led to electrical breakdown
- Replicate cryostat conditions by introducing a very pure Ar flush

Thank You!

TinyTPC Team