TinyTPC: A Test Stand for LAr Doping

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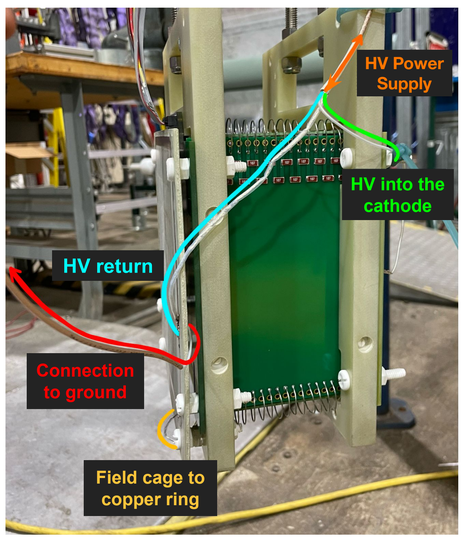
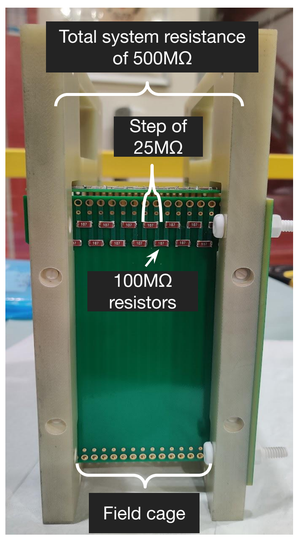
TinyTPC and Dopants

LArTPCs measure the charge and light produced by interactions between charged particles and argon atoms. While charge is collected efficiently, light is not. TinyTPC is a small scale LArTPC with a pixelated readout for R&D with photosensitive dopants, which convert light into charge. **TinyTPC studies the effects of adding photosensitive dopants and xenon to LAr to enhance charge signals of events in the MeV scale.**

High Voltage System



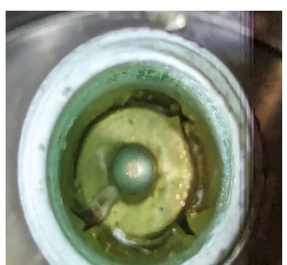


TinyTPC high voltage system (left). Field cage (right).

The HV system is designed to hold up to 5kV, but it was experiencing breakdowns at 3.5kV. We verified field cage resistances and continuity, and **confirmed the HV issue was not in TinyTPC. To identify the breakdown location, we ran tests in a dewar**, filling with LN2 and LAr on different runs.

Fixing TPC resistors (left). Testing TinyTPC in dewar (right)

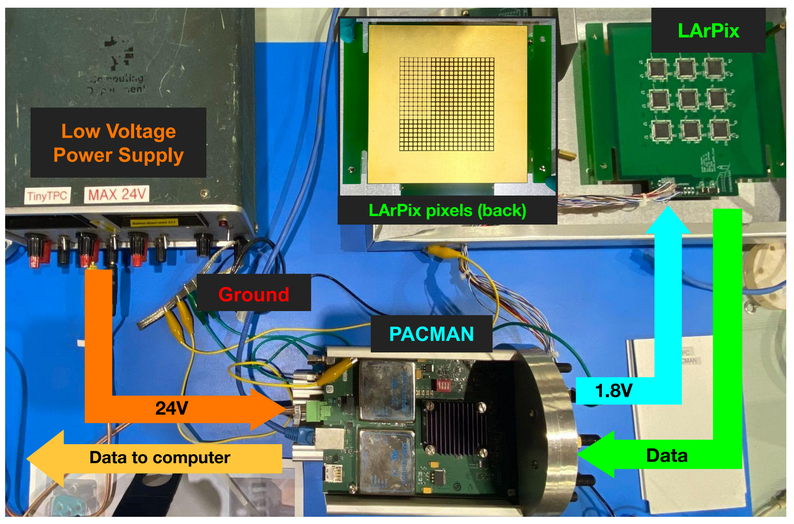
The ‘crackling’ sounds coming from the HV flange indicated a voltage breakdown. We found cracks in the epoxy of the feedthrough. After modifying a new feedthrough, **TinyTPC was able to hold 5kV in the dewar, but not yet in the cryostat.**



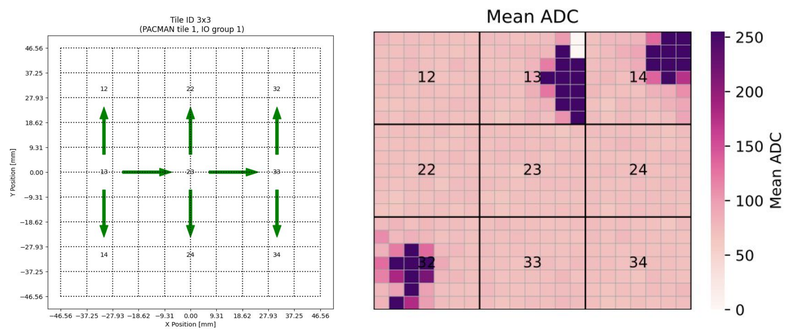
Cracks in feedthrough epoxy (left). Team testing HV (right).

The argon in the cryostat is more pure, so the system **could only hold 2kV, sufficient for data taking.** We are **currently testing a feedthrough with baked epoxy** as a solution.

Low Voltage System



Tiny TPC low voltage system

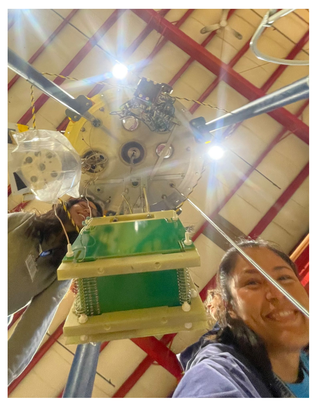


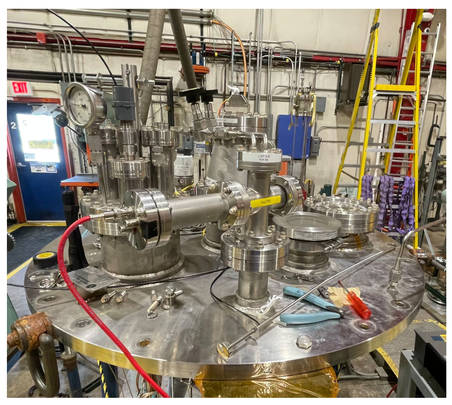
Hydra configurations describe the LArPix chip-to-chip connection (left). Pedestal data provides noise levels used to set threshold values for noise reduction in the charge collection data (right).

We **identified a stable combination of hydra configuration and grounding** of the LV system by comparing pedestal data taken on the bench.

Testing LV system on the bench and on the cryostat lid..

Run Plan



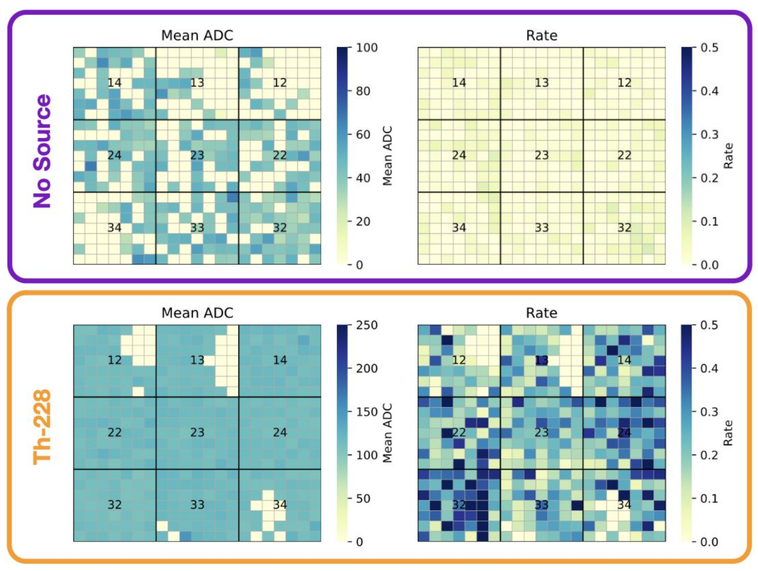


Mounting TinyTPC on cryostat lid.

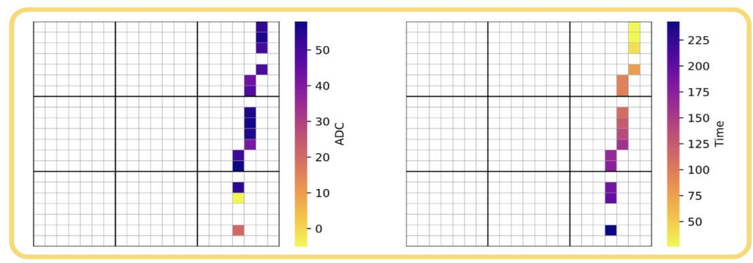
1. Take **minimum bias data** of noise and cosmic ray muons for calibration and background subtraction
2. Add a **Th-228 radioactive source**, which emits gamma rays (photons), to characterize TinyTPC’s energy resolution
3. Introduce **isobutylene** (photosensitive dopant), measure TinyTPC’s energy resolution, and search for charge enhancement
4. Test the addition of **xenon** (wavelength shifter) to LAr and isobutylene

Preliminary Results

We detected an **increase in mean and rate of ADC charge collected after adding the Th-228 source**, as we expected.

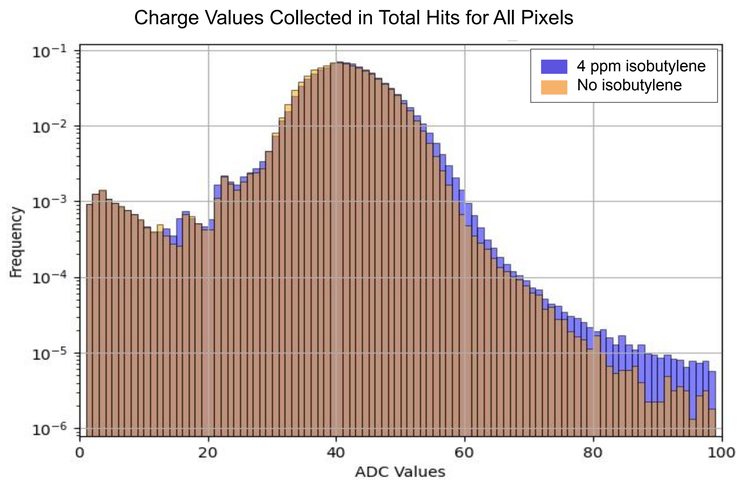


Before and after introducing Th-228 source



Cosmic ray track, ADC and time

We injected 4 ppm of isobutylene in total. So far, we have confirmed a **charge yield drop through time due to electron lifetime decreasing**. We have also observed a **charge increase in the total hits on the pixels when isobutylene is present**.



Ongoing analysis of the total pixel hits ADC charge values with and without isobutylene.

Next Steps

We will add xenon, which could induce a wavelength shift of the Th-228 ejected photons. **We will test if charge is still enhanced by dopants after the Xe shift in wavelength** and find if any light still remains. We are also **testing a new HV feedthrough**.

Acknowledgements

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