Module X

ND-LAr L3 meeting

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October 4th 2023

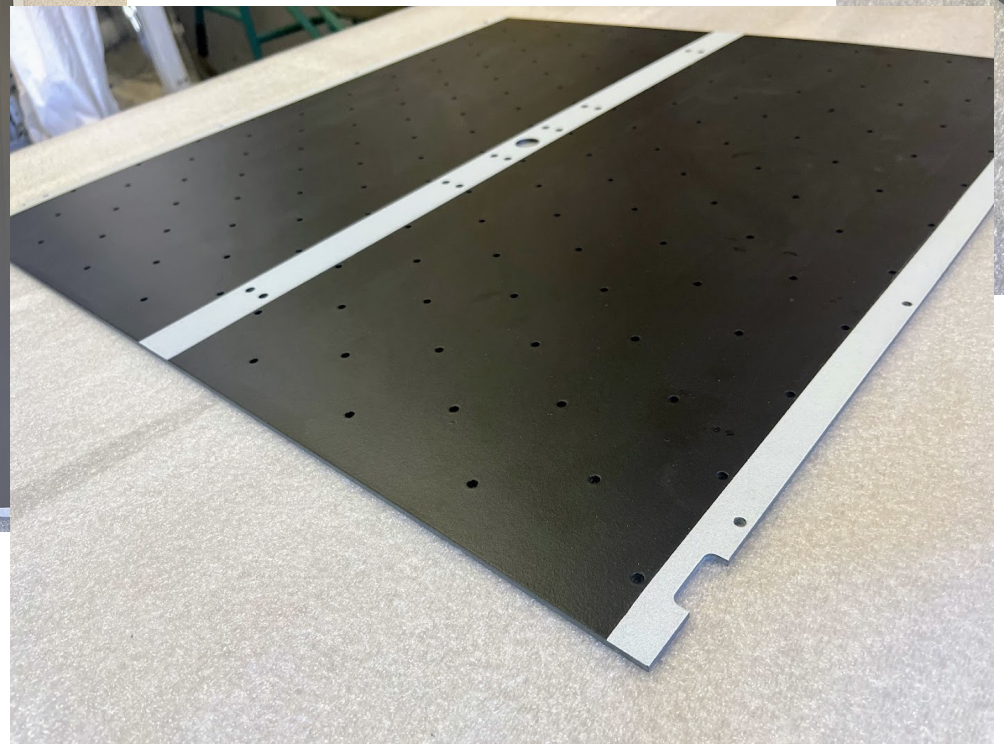
SLAC NATIONAL ACCELERATOR LABORATORY

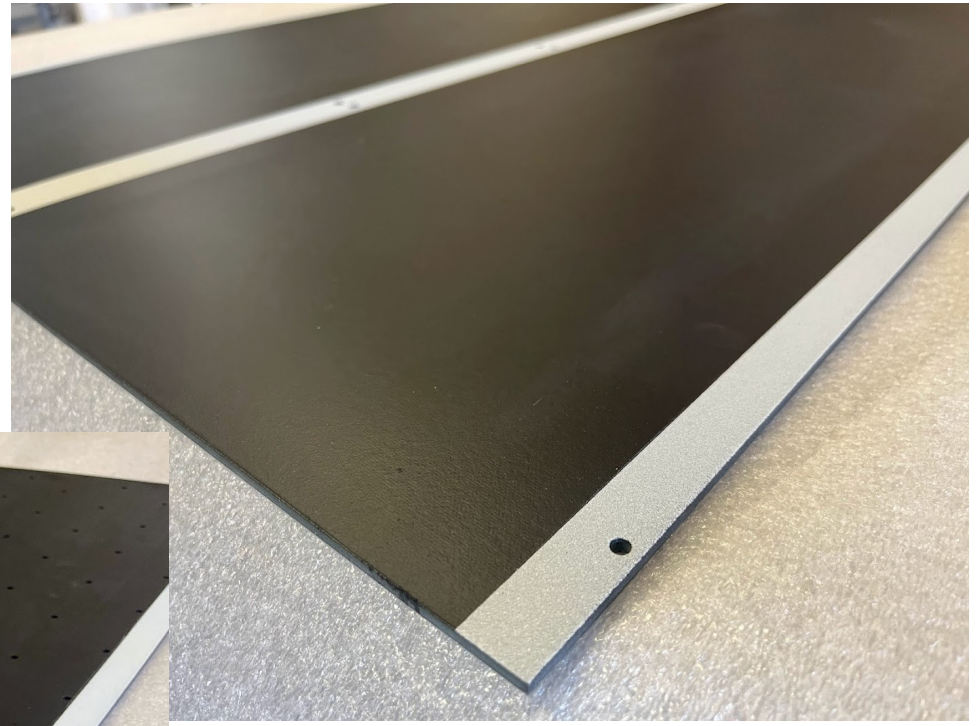
HOCHENERGIE LABORATORIUM FÜR PHYSIK HELP UNIVERSITÄT BERN

ArgonCube

Mod X Panels

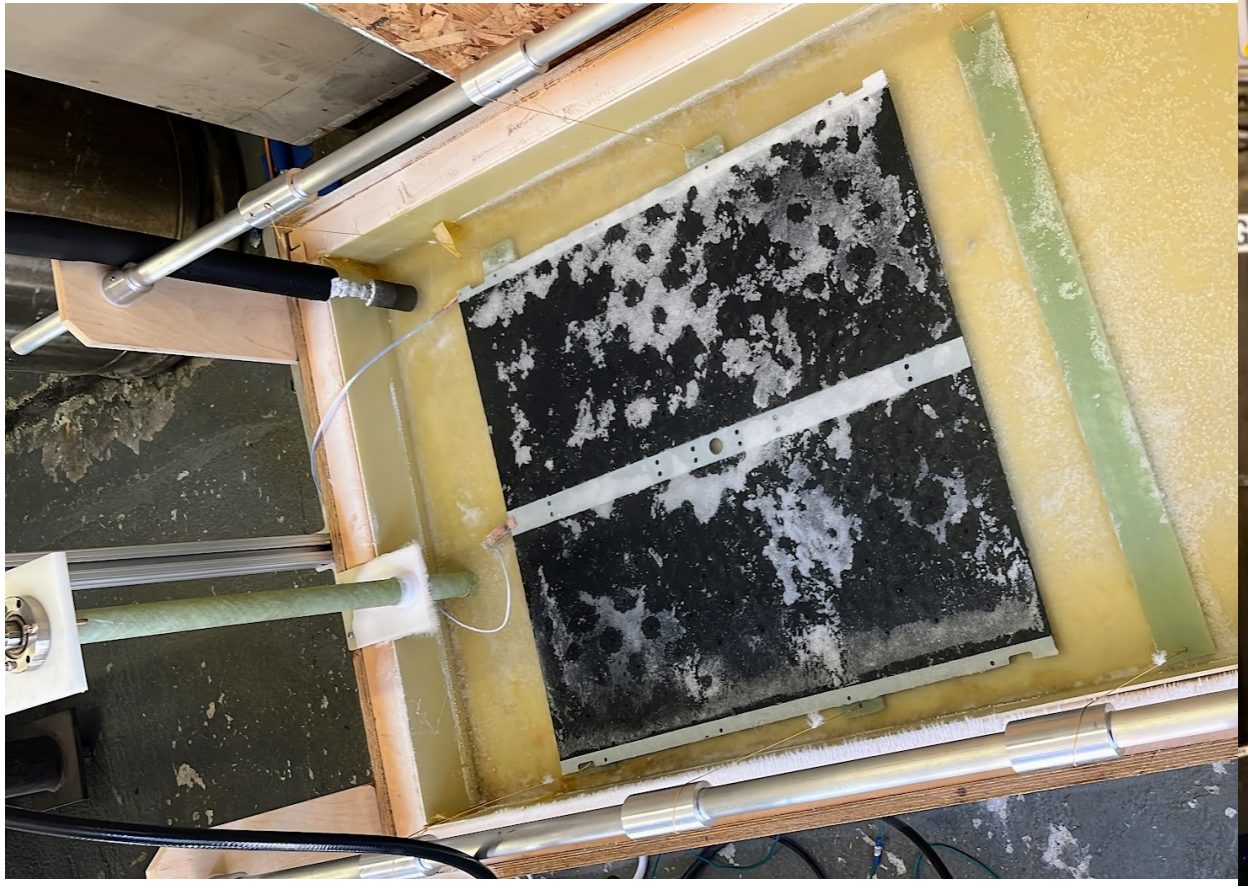
Friday Sep 8th all panels received, inspected, & tested.





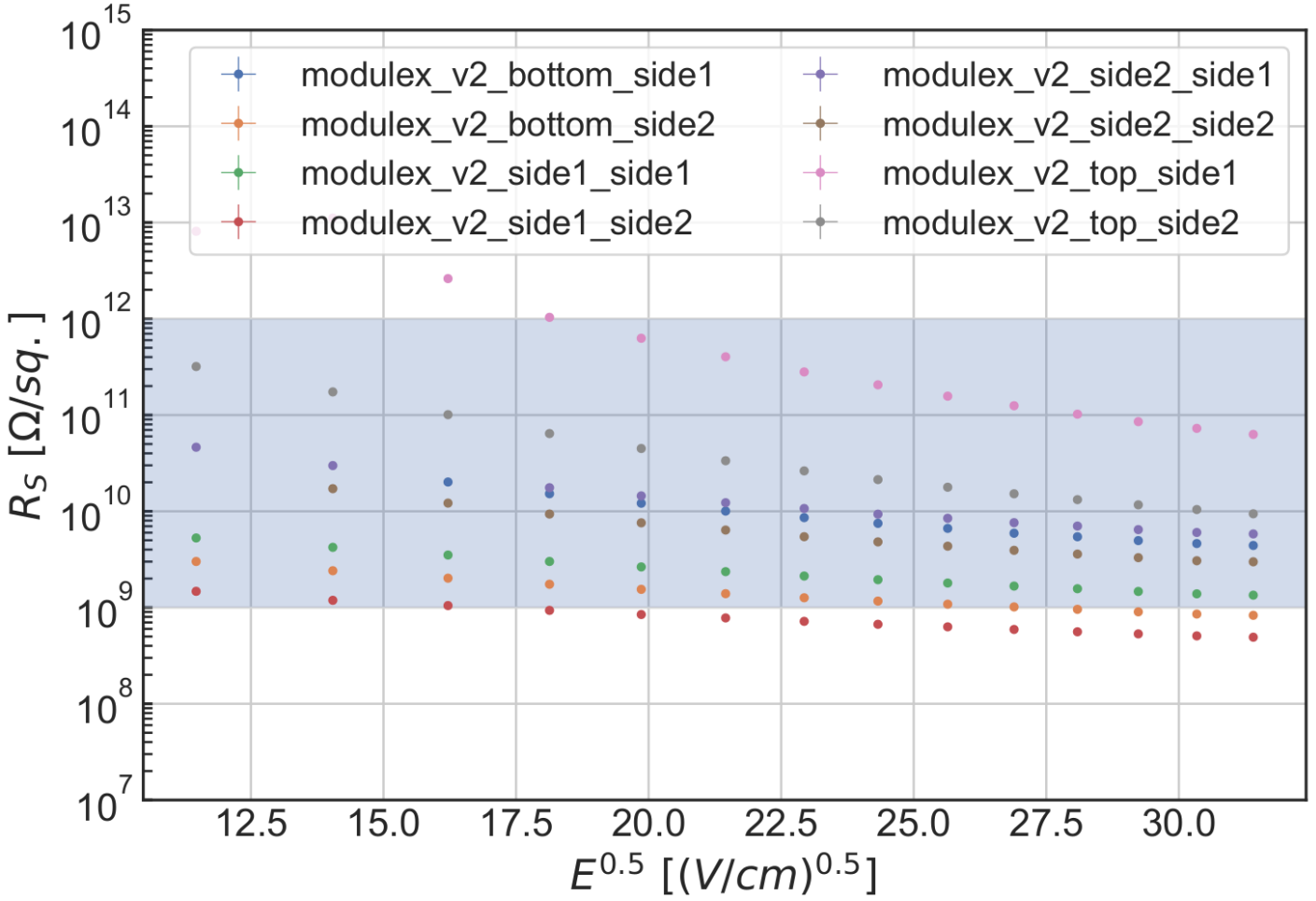
Mod X Panel Testing

For testing, all panels were submerged in LN2 and pushed to twice nominal voltage (30 kV)



Mod X Panel Resistances

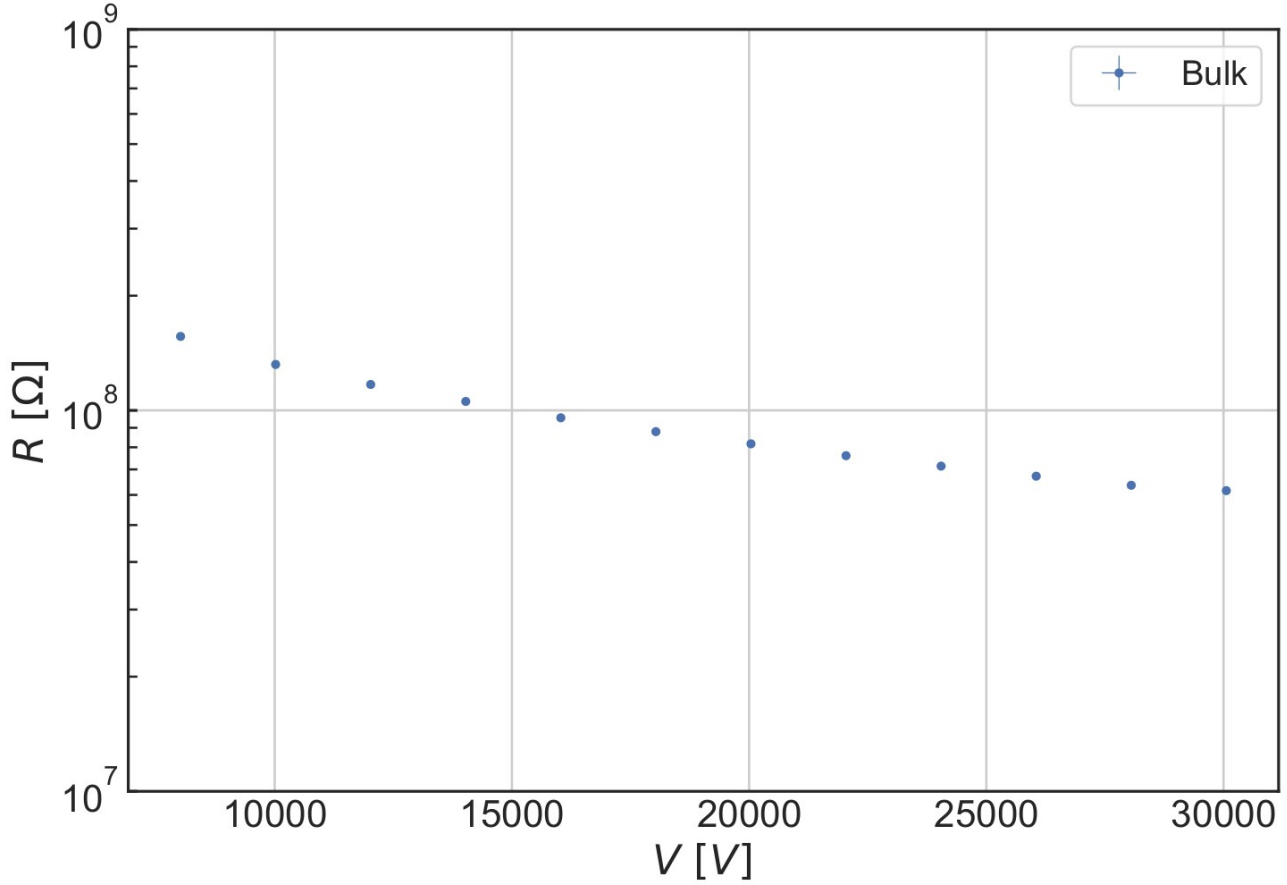
There was still a significant spread* on resistance, but all were within the target range.

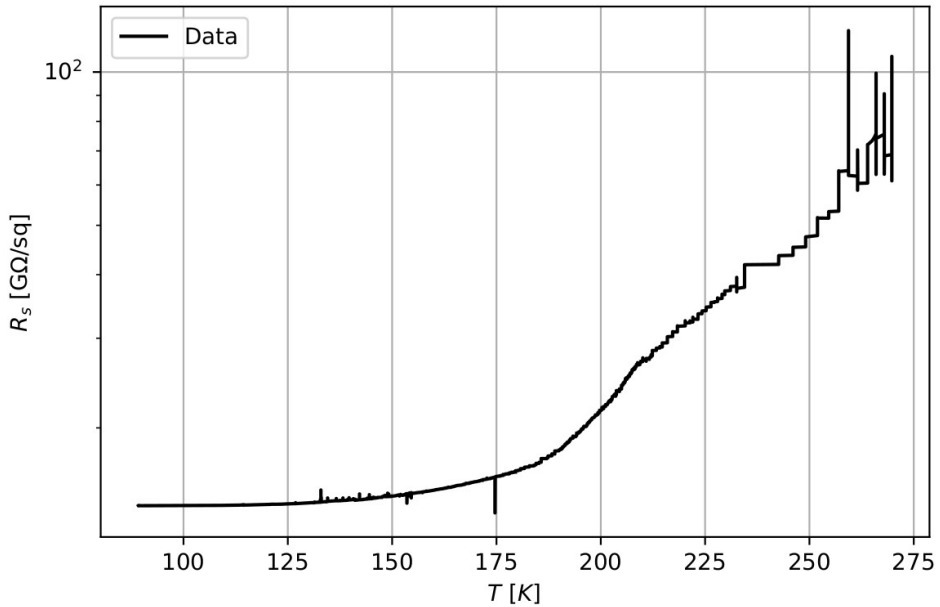


*work is underway to reduce spread, suspected environment variables (local temp) & spray method

Mod X expected performance

Bulk resistance is inline with Module 3; O(100) MΩ @ 15 kV.





Older carbon-epoxy sample (thicker with different loading ratio & metalization)

N.B. at 77 K, 90 K should slightly higher. Needs to be characterized for this particular coating.

Mod X to Bern

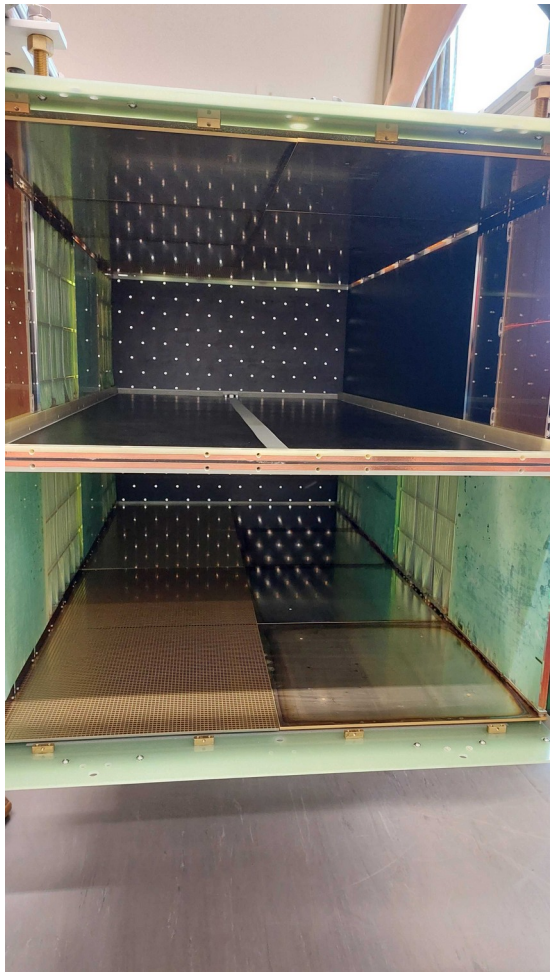
Mod X was shipped to Bern on Sep 15th (delayed by property control)

Mod X Construction

Sep 20th, the TPC was assembled, with all metal components provided by Bern

Mod X Instrumentation

Sep 22nd, instrumentation installed, thanks Bern, JINR, & LBNL.

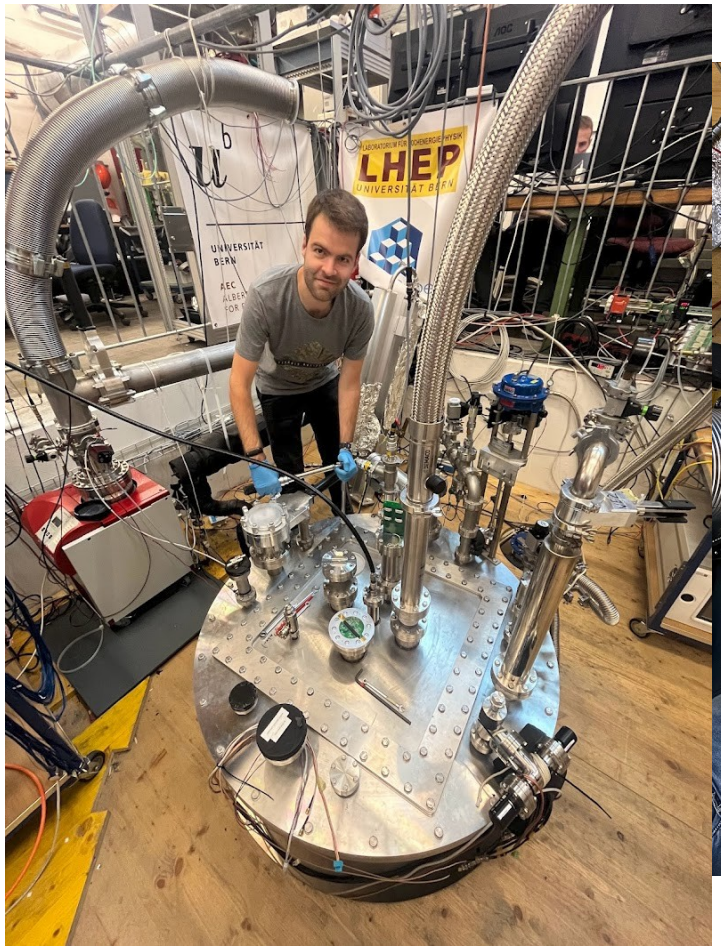


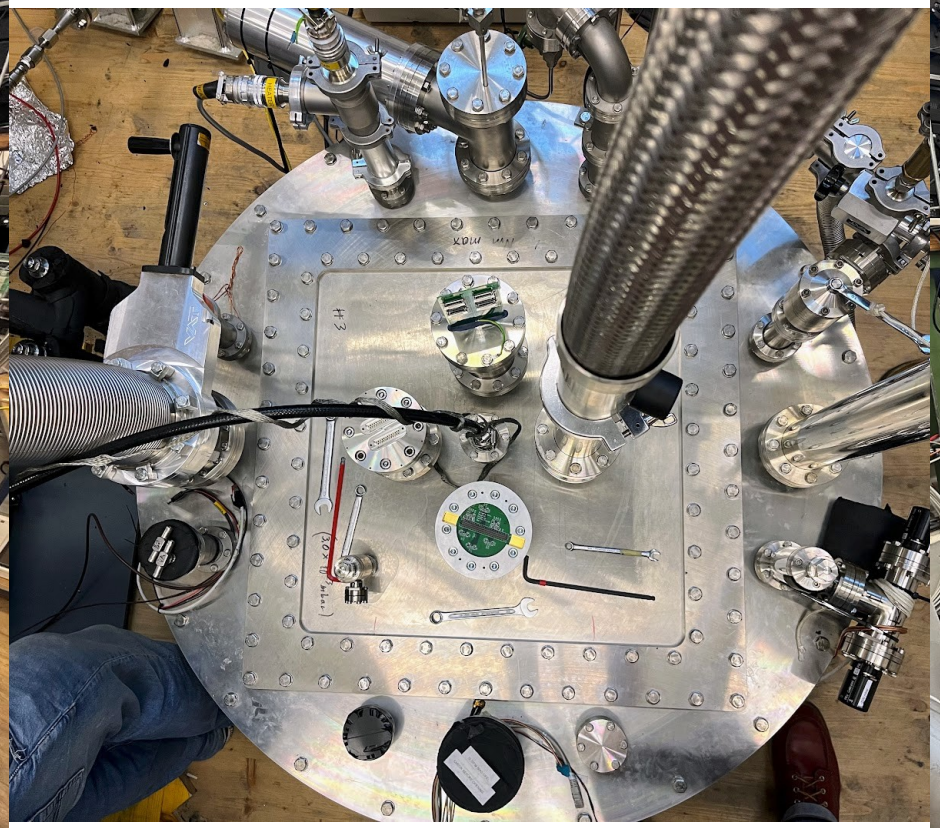
Mod X Final checkout

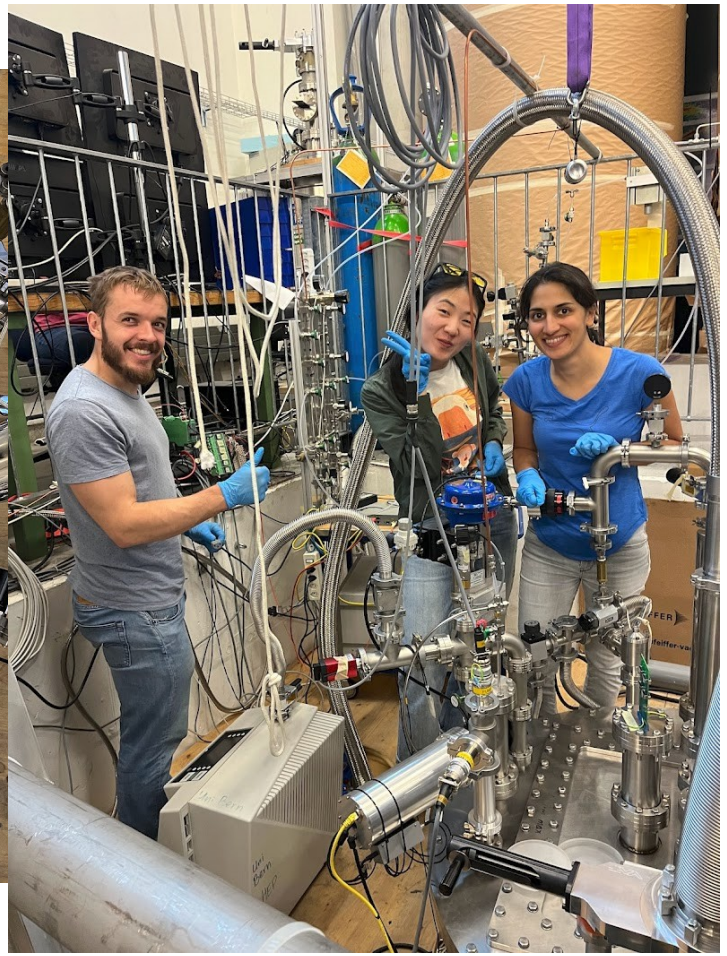
Sep 27th, minor grounding improvements made, all grounds (LRO, CRO & HV) now isolated

Sealing Cryostat

Sep 28th cryostat was sealed, leak checked, and left to pump out over the weekend.





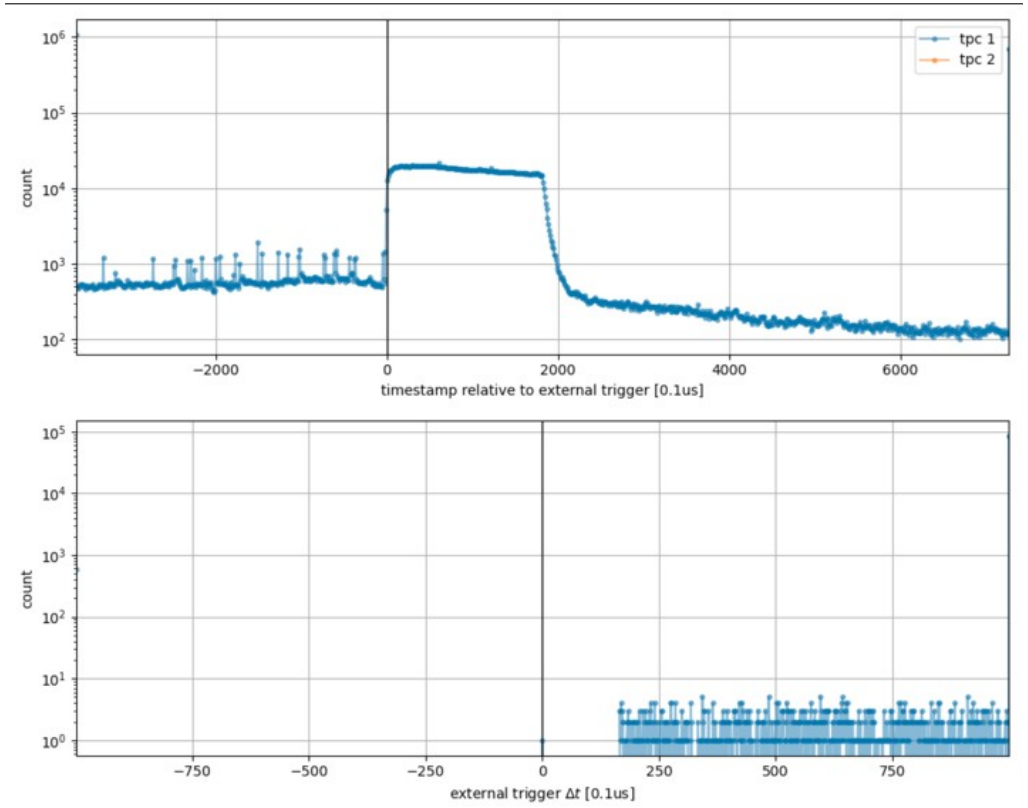


Cool down, Filling, & start of operations

Cool down started Oct 2nd, filling completed Oct 3rd, LRO calibrations complete early evening. Stephen worked tirelessly to bring CRO online in the night.

HV Ramp

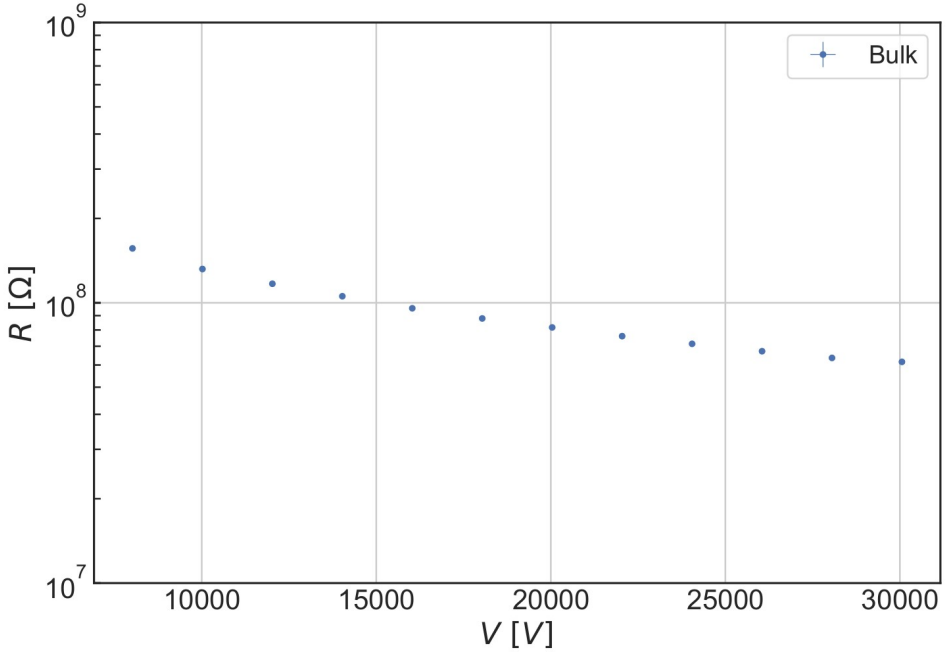
HV ramp started Oct 4th 07:36, reaching nominal at 07:53, where it has remained stable since.

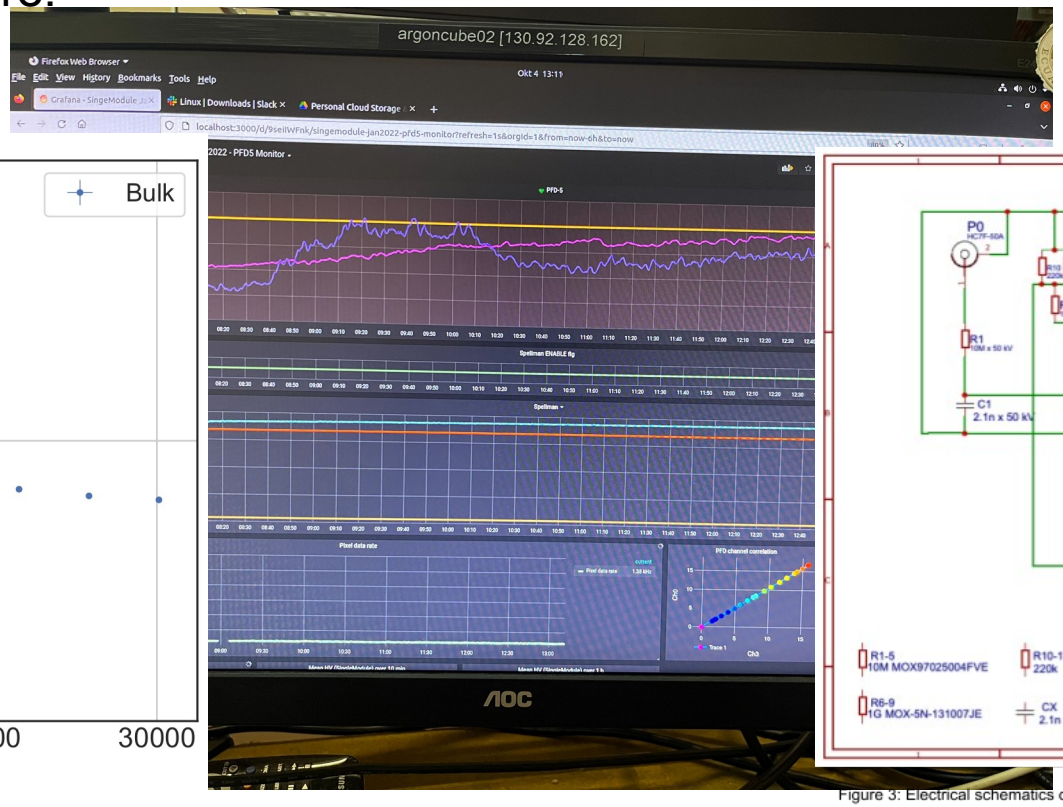


Shell Resistance

The TPC bulk resistance measured at SLAC in LN2 was 100 MΩ.

In Bern, the resistance seen by at the PSU is 80 MΩ. Each RC of the filter has 10 MΩ (input & output). Each output has a 1 GΩ voltage divider as a probe. Corresponding to 112 MΩ at the TPC, which fits with the increased temperature.





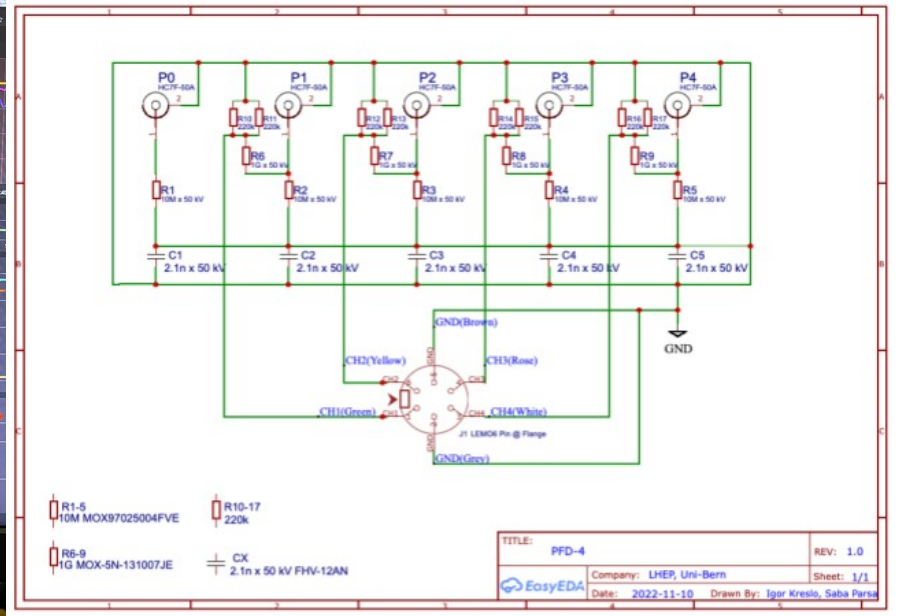
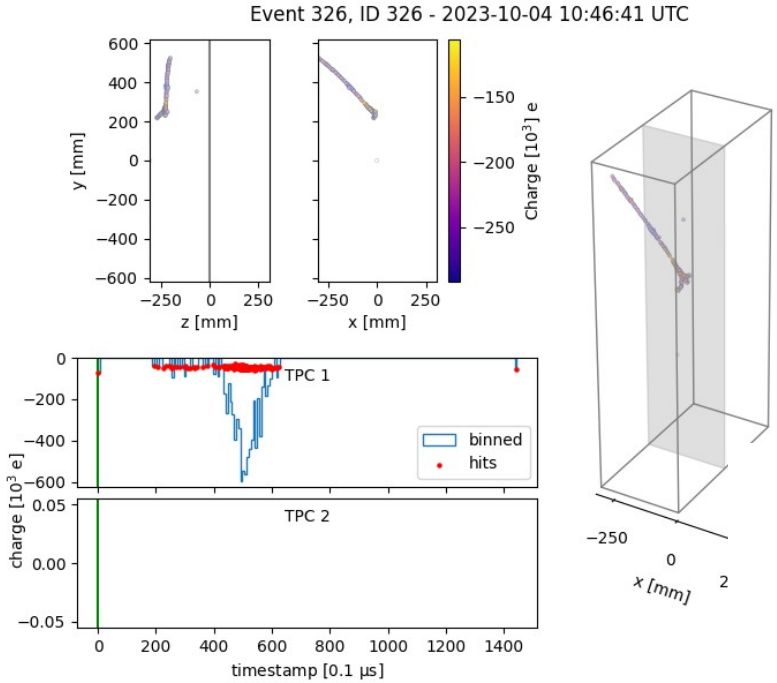
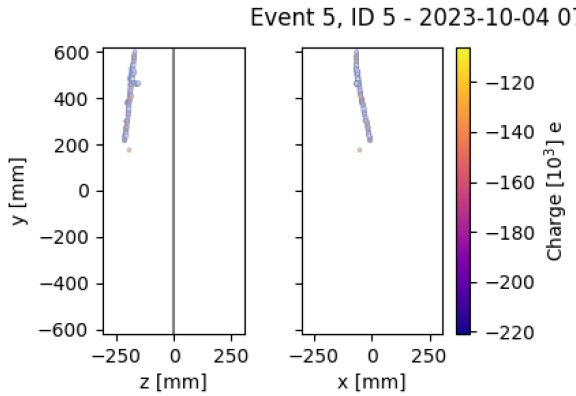


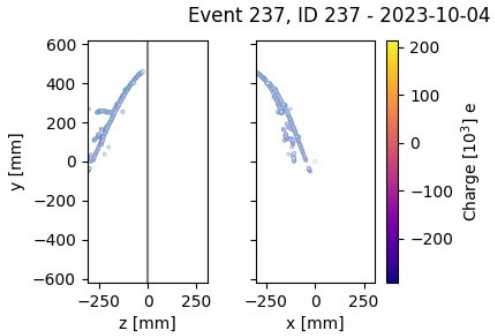
Figure 3: Electrical schematics of the HV filter, PFD-4

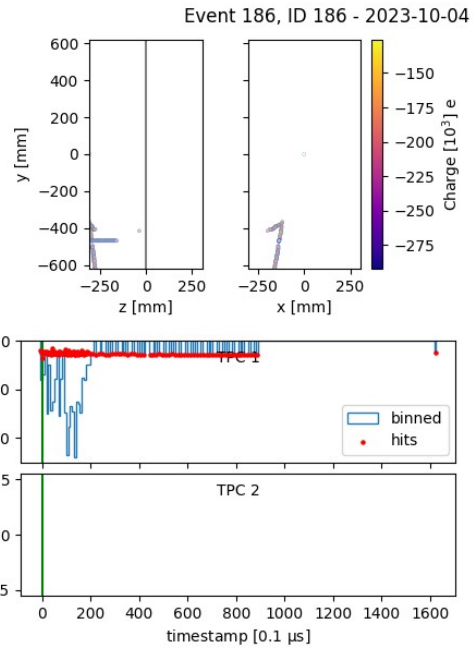
Initial results

Thanks to Stephen for the event displays



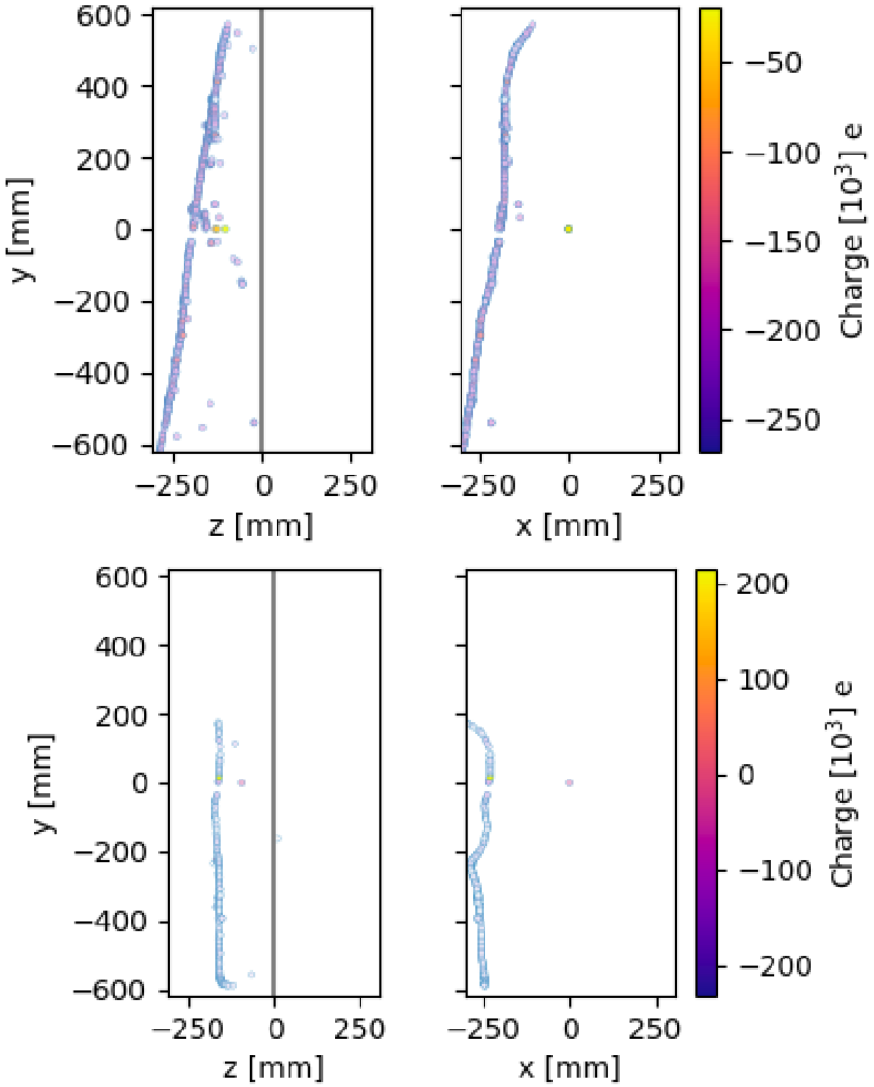






Initial results

Appear as though charge is pushed away from LCM - charging? (more data needed)



Run Outlook

1 – continue running at nominal voltage for total of ~12h (until 8pm) to maximize data for E-field reconstruction, and understand aging (reduction in resistance).

2 – increase E-field to twice nominal, if stable, to study aging of material for at least 4h (8pm to 12am), preferably longer. **STOP if 1 mA is reached.**

3 – return to nominal E-field for remainder of run to demonstrate stability after curing at high E-field.

Summary

In under a month we have gone from bare panels to an operating TPC - Huge thanks everyone involved.

Results so far are promising. Resistance is inline with expected at 112 MΩ.

Need more time to characterize E-field – can we see the affect of resistance variation between panels?

What is the aging of the material, and can it be cured at higher E-field (demonstrated at small scale, never in a TPC).