LArLArPD

Large Area Pico-second Photodetector (LAPPD) in Liquid Argon (LAr)

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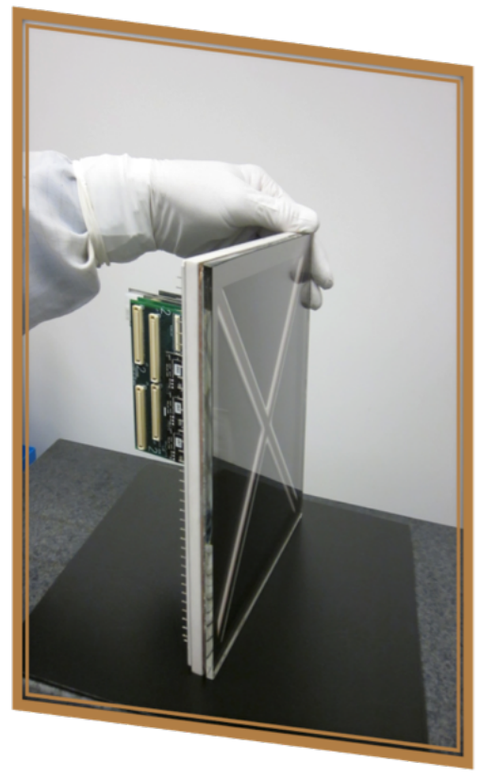
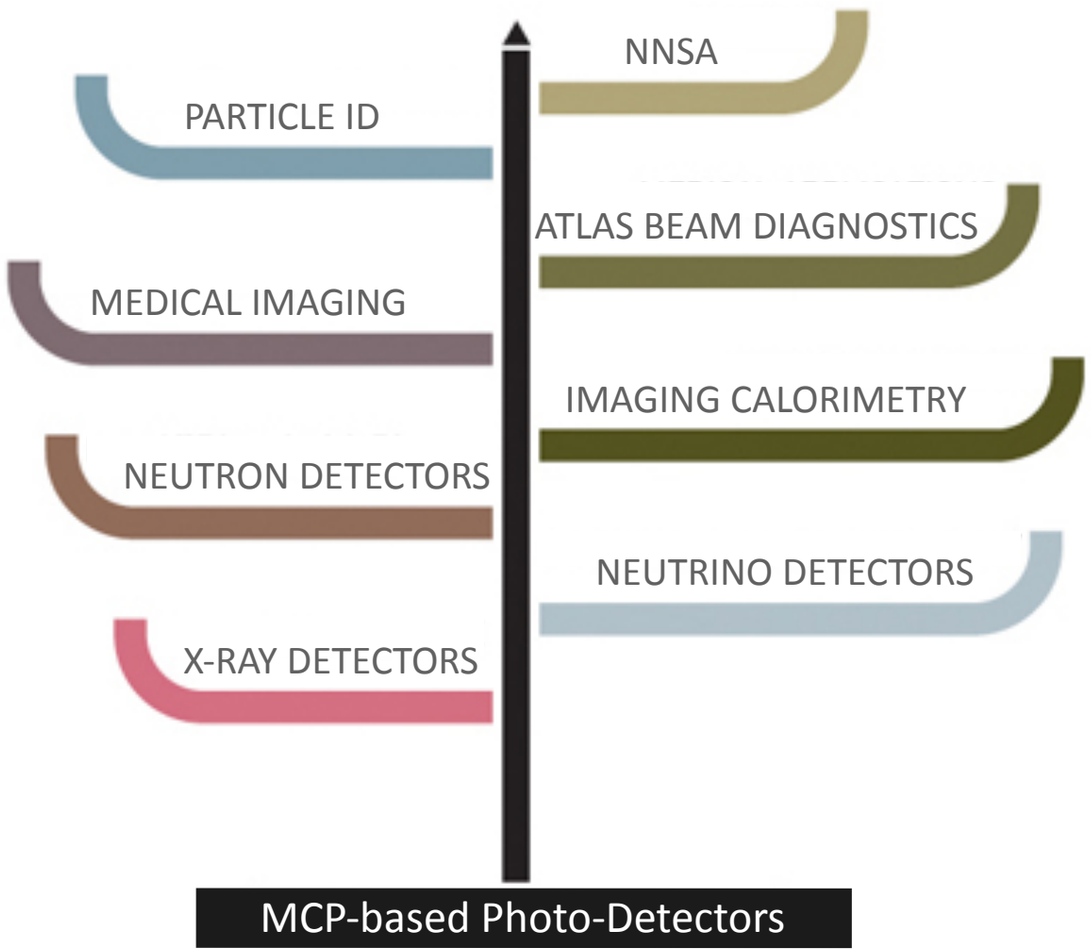
LAPPD

- LAPPD (Large Area Picosecond Photodetector) is a micro-channel plate (MCP) based photodetector, capable of imaging, and having high spatial and temporal resolution.



LAPPD Applications



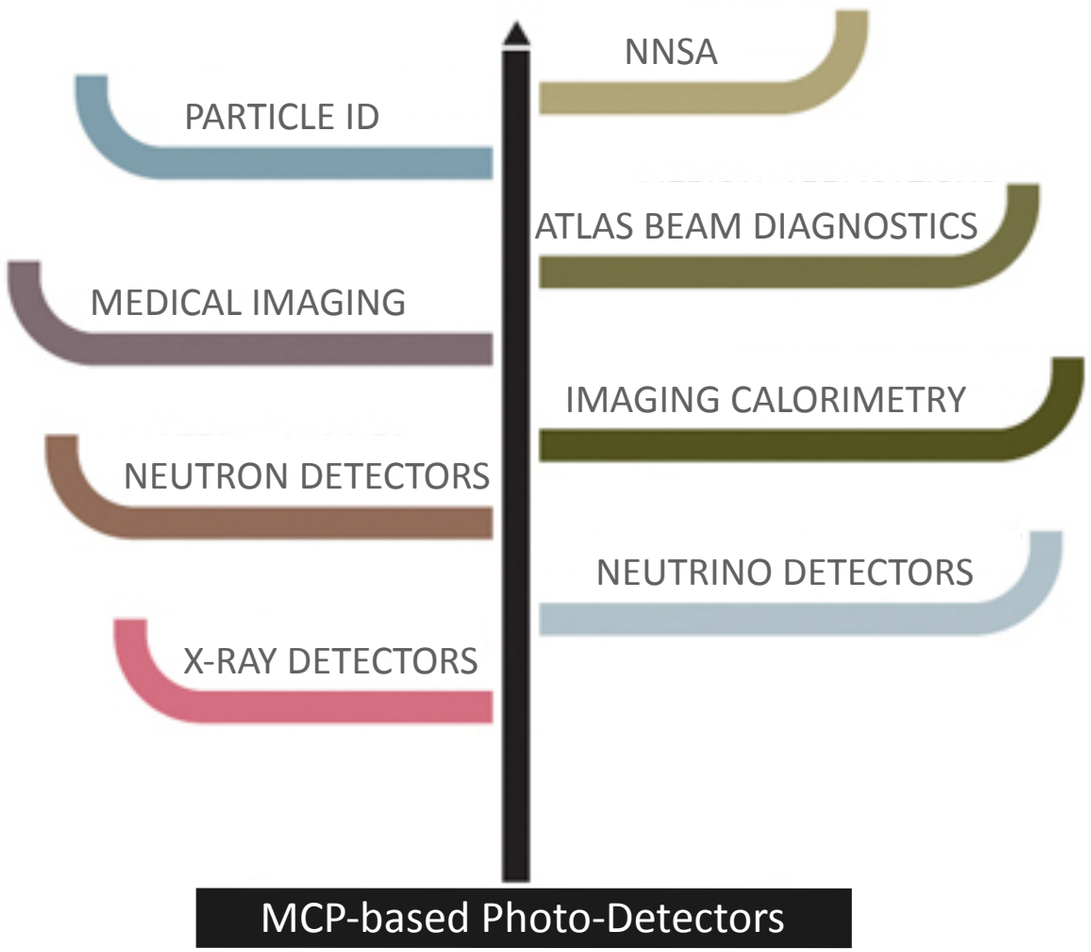
For HEP:

- Increased coverage
- high granularity
- increased timing resolution
- high QE
- at low cost

Implications:

- better background rejection
- vertex resolution
- plus more…

LAPPD Applications



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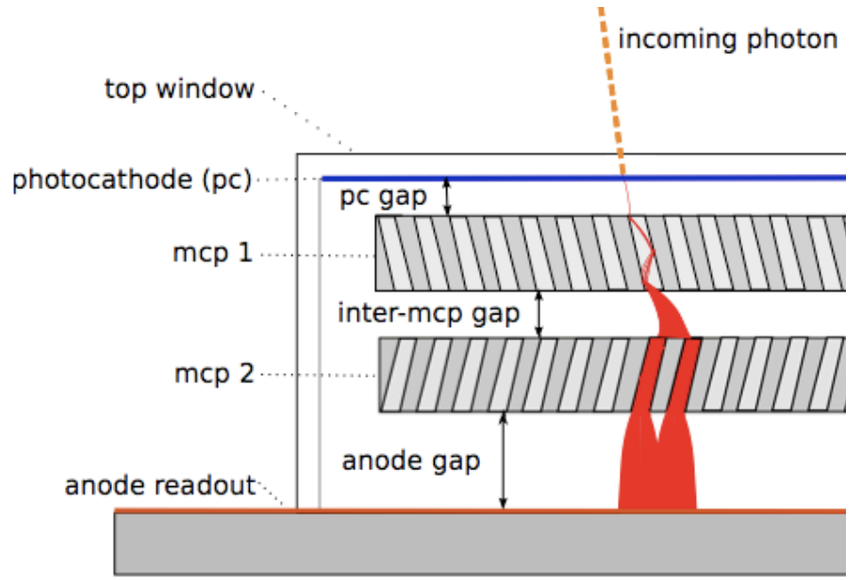
<u>For LAr TPC:</u> Photon detection

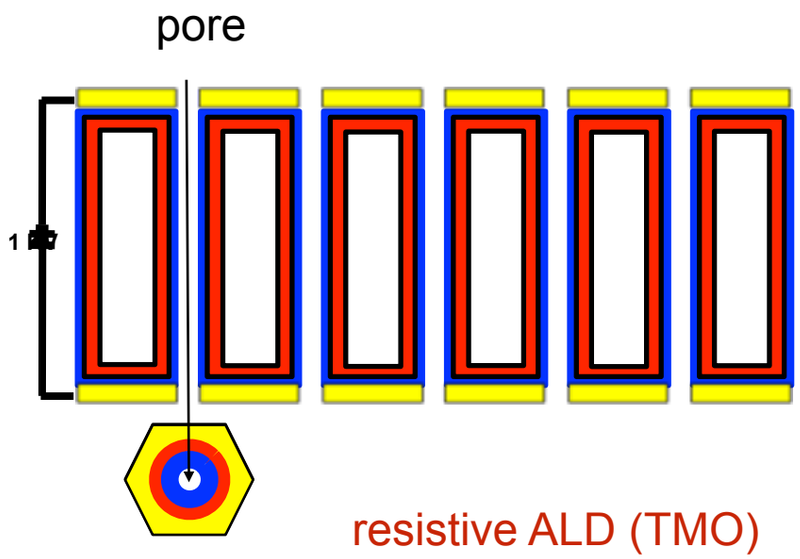
- **Thin form factor**
- **Increased coverage**
- **Low cost**

LAPPDs at Argonne

New generation of Micro Channel Plates (MCPs)

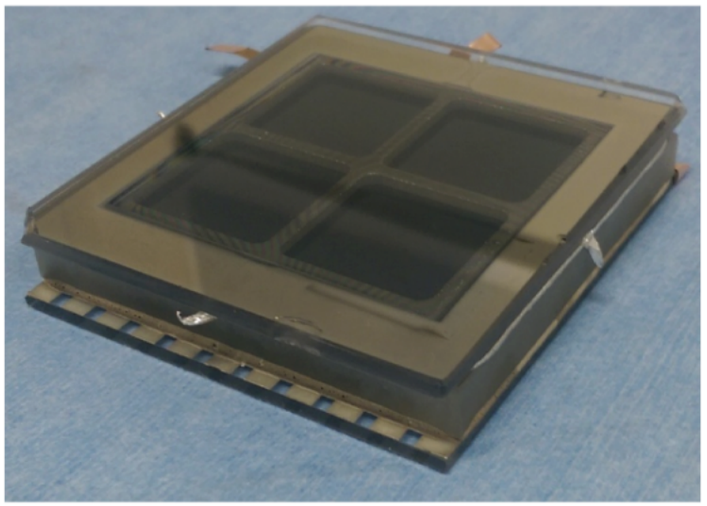
- Borosilicate glass capillary arrays (GCPs) made by Incom Inc.
  - Novel, inexpensive manufacture, large formats possible(>20cm^2).
  - 20um pore size, 60%–80% open area ratio(OAR).
- Functionalized using Atomic Layer Deposition (ALD)
  - ALD–industrial batch method.
  - Separate and tunable: resistive, emissive and conductive coatings (Ω tunable over many orders).



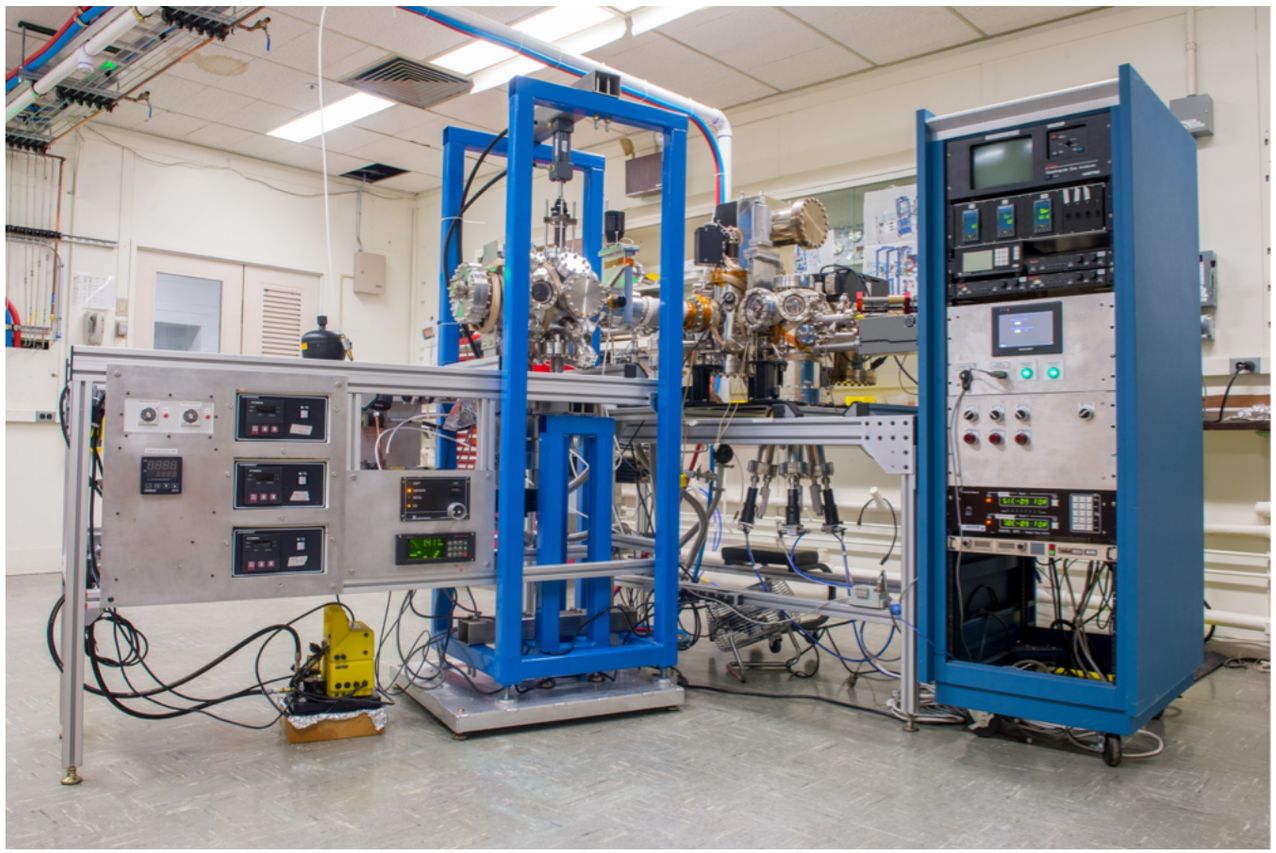


LAPPDs at Argonne

- Argonne is focussed on producing 6x6 cm^2 small form-factor detectors, as a way to optimize the manufacturing process, for testing and getting devices out to the community.



Argonne 6x6 cm^2 'small tile'



Argonne Small Single Tile Processing System

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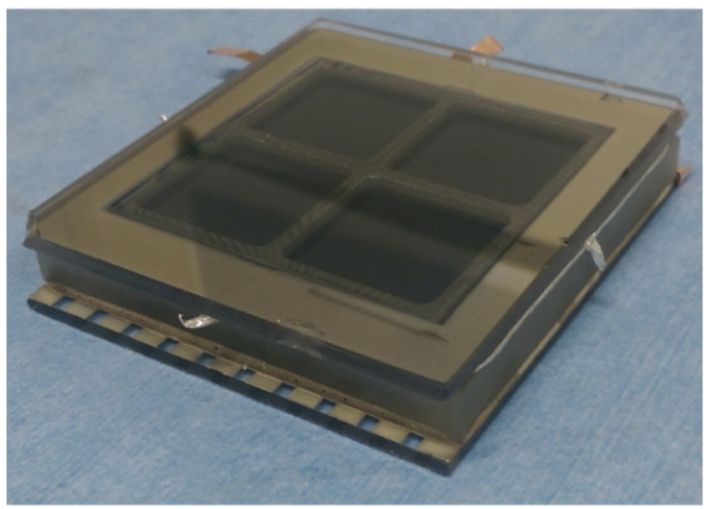
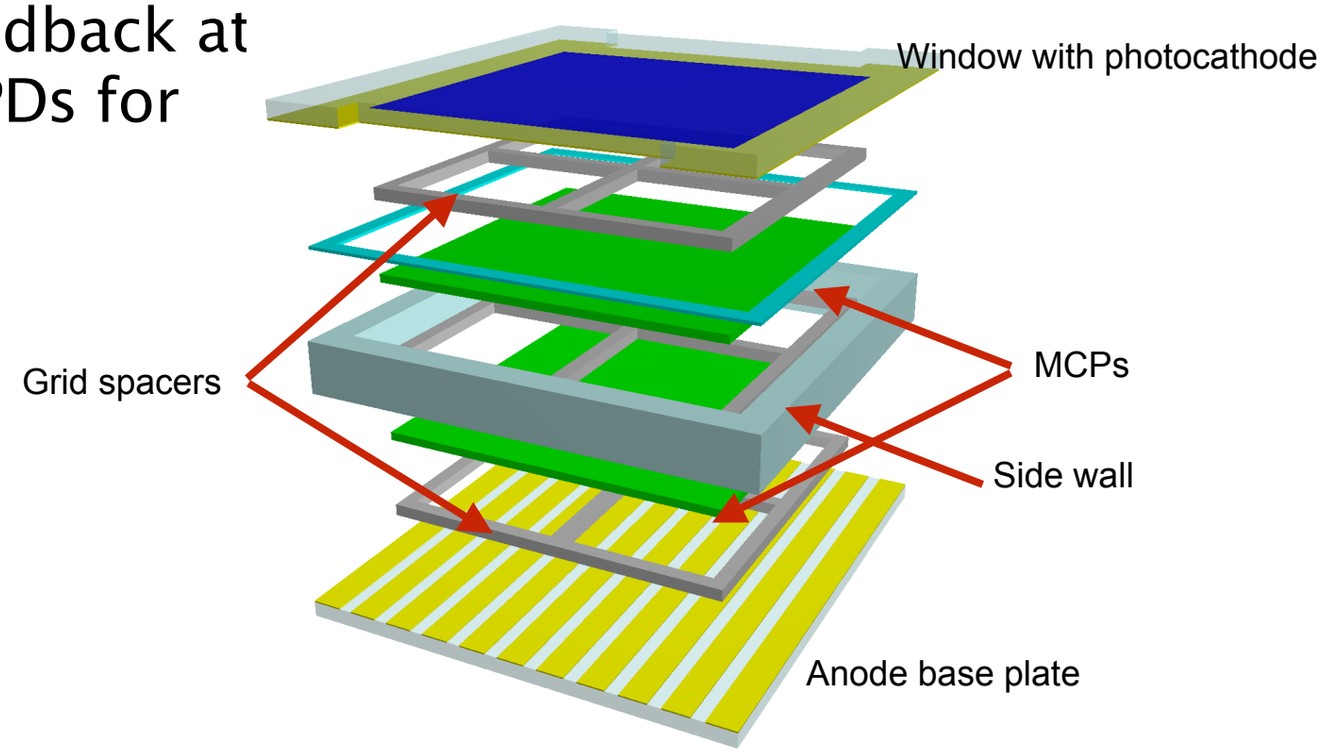


Argonne 6x6 cm^2 'small tile'

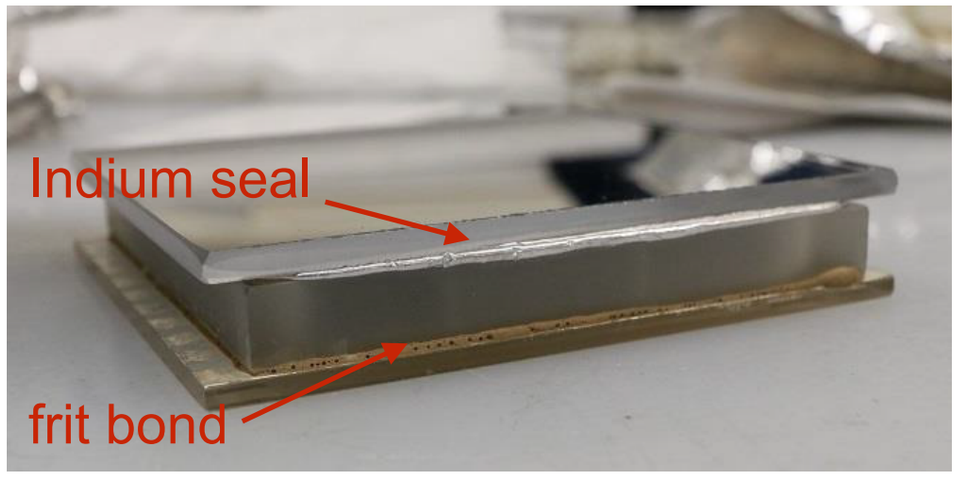
- Opportunity to test and provide feedback at the design stage to customize LAPPDs for cryogenic applications.



6x6 cm^2 'small tile' blowout

1. Testing the mechanical prototype

- Structural integrity in cryogenic environment:
  - Indium seal (cathode side)
  - Glass frit bond (anode side)



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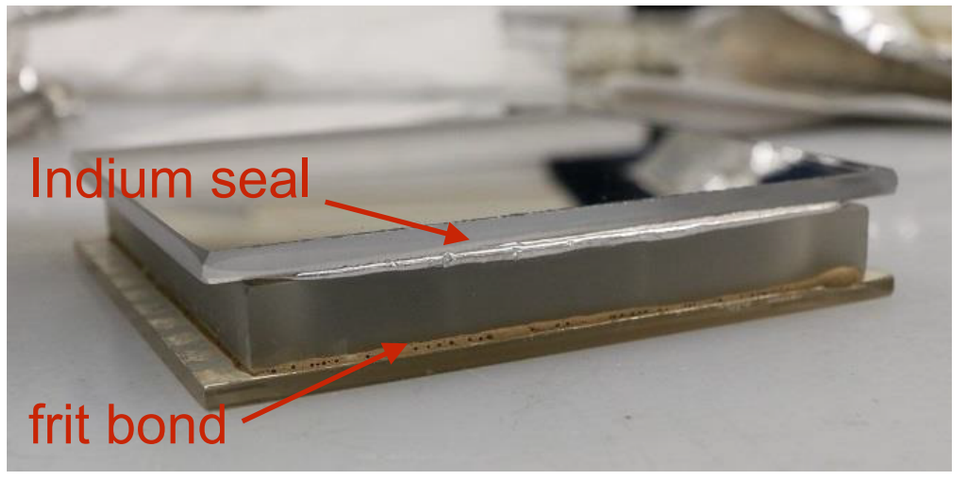
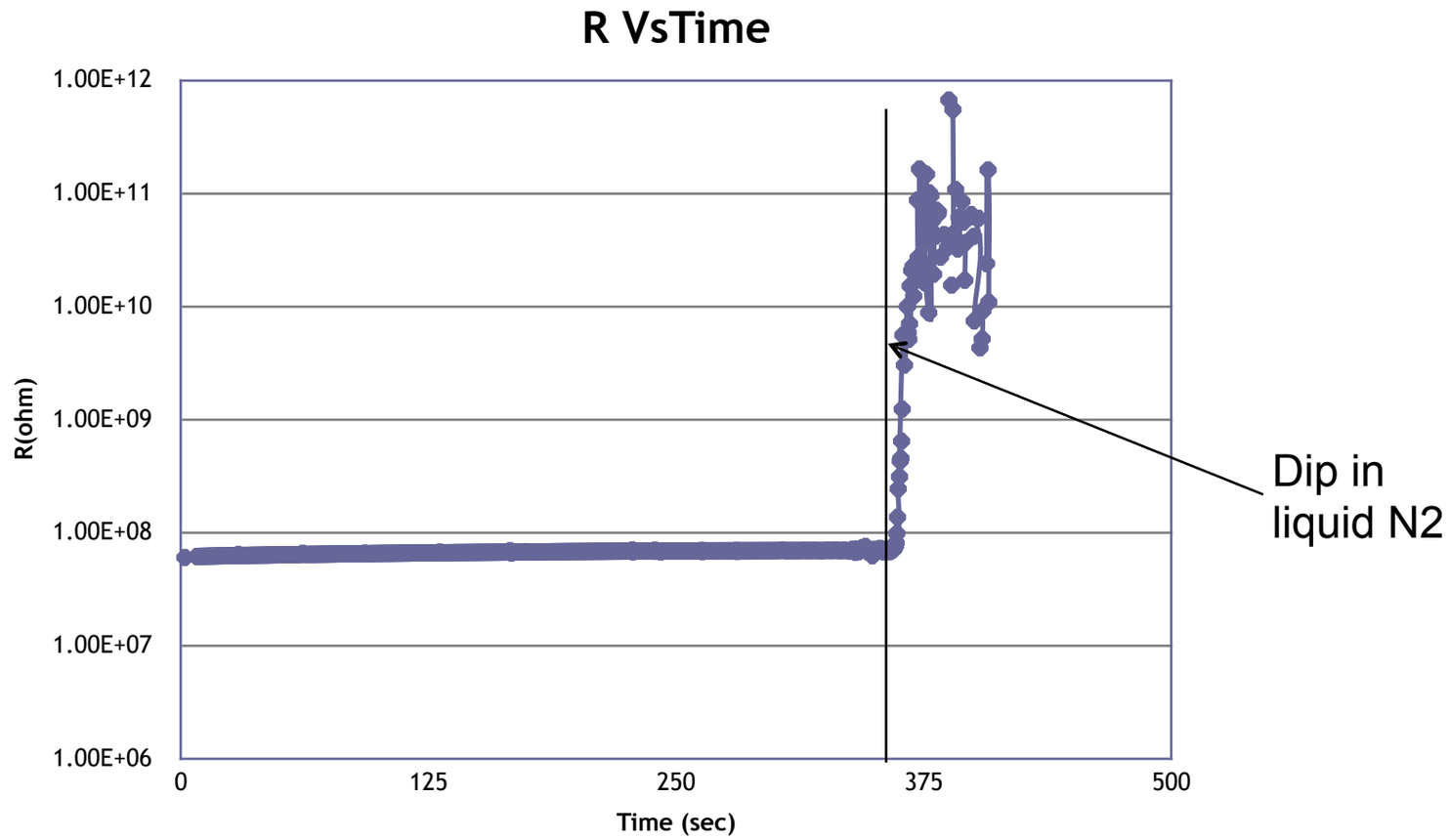


Success!

- Dunked device in liquid N_2. Vacuum 10^{-5} Pa, held for 15 mins.
- Performed both a ‘slow’ dunk and ‘fast’ dunk.
- Device intact, the seals work

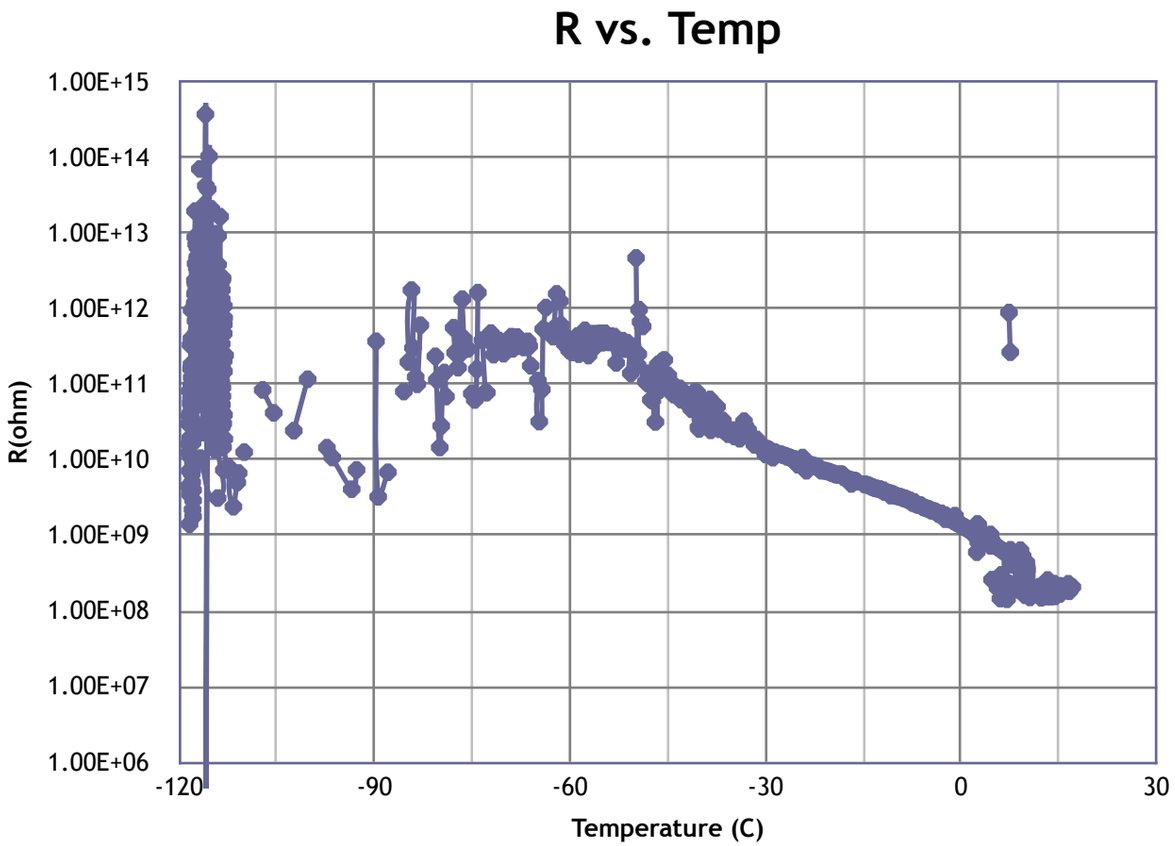
2. Functionalize MCP for Liq. Ar

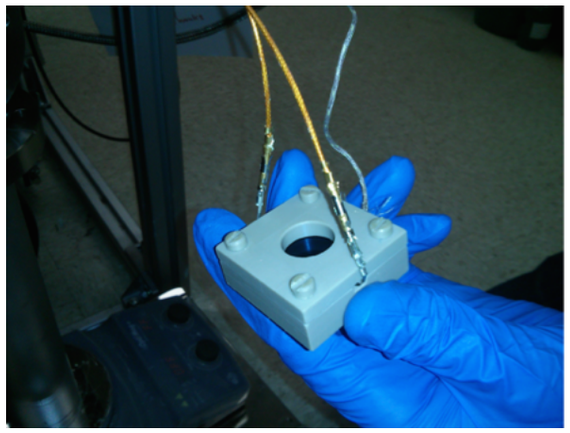
- Semiconductor ALD layer, MCP resistance goes up as temperature decreases.



2. Functionalize MCP for Liq. Ar

- Study the R change w.r.t. T and find the ALD recipe for optimum resistance in cryogenic temperature.





33 mm MCP inside a PEEK holder

33 mm MCP R vs T test

Next steps

- Test the photocathode for cryogenic application
  - Argonne LAPPD group has a systematic program of photocathode development and analysis. We will use the expertise and setups to optimize photocathode for cryogenic application.

- "Detector in a box":
  - 6x6 cm^2 LAPPD (functionalized for cryogenic temperatures)+read out electronics.
  - Enclosed in a box painted with wavelength shifting TPB coating.
  - Helpful discussions with Dave Schmitz, UChicago who have a similar setup for SiPMs.

LArLArPD at Fermilab

- After preliminary testing at Argonne, use the liquid argon test facility at Fermilab.
- Test at Tall Bo. Physics analysis at a test beam experiment.
- Looking at geometries and beginning MC simulation work.

Summary

- The LAPPD group at Argonne is on track to produce small form factor detectors for evaluation by the physics community.

- We are making progress on customizing the LAPPDs for operation in liquid argon.