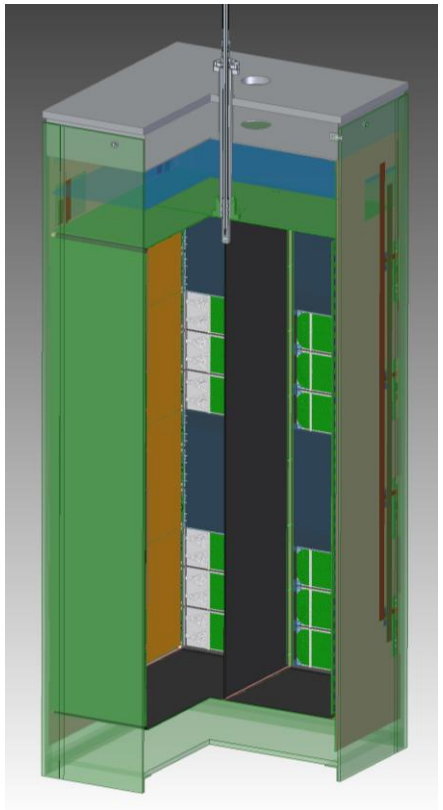
SLAC NATIONAL ACCELERATOR LABORATORY

ND TPC Design & High Voltage



ArgonCube

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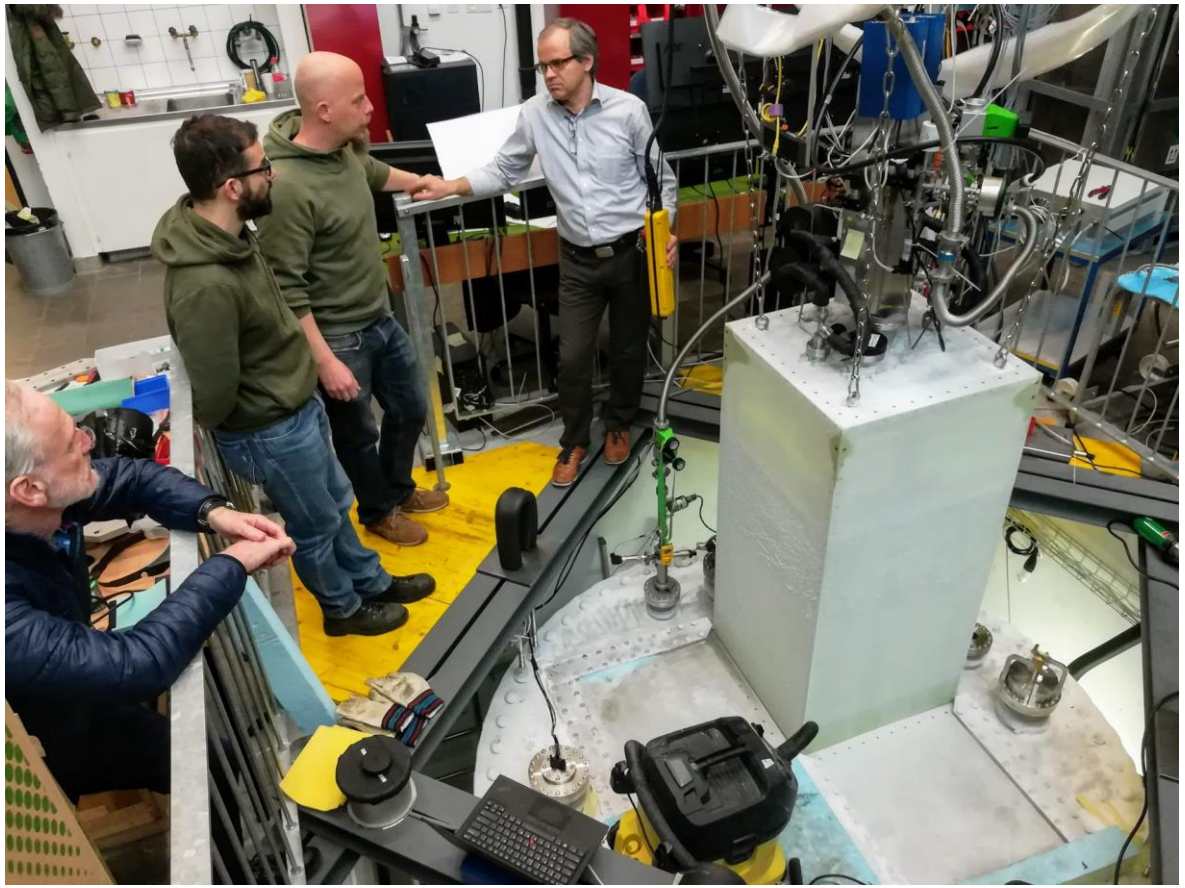
SLAC National Accelerator Laboratory

DUNE meeting

May 2019

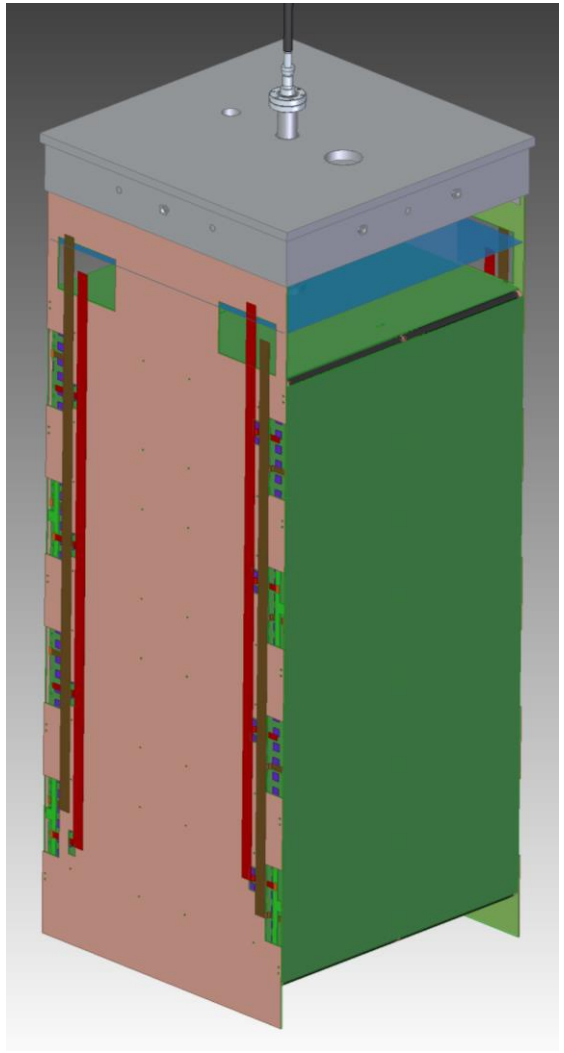
TPC Design

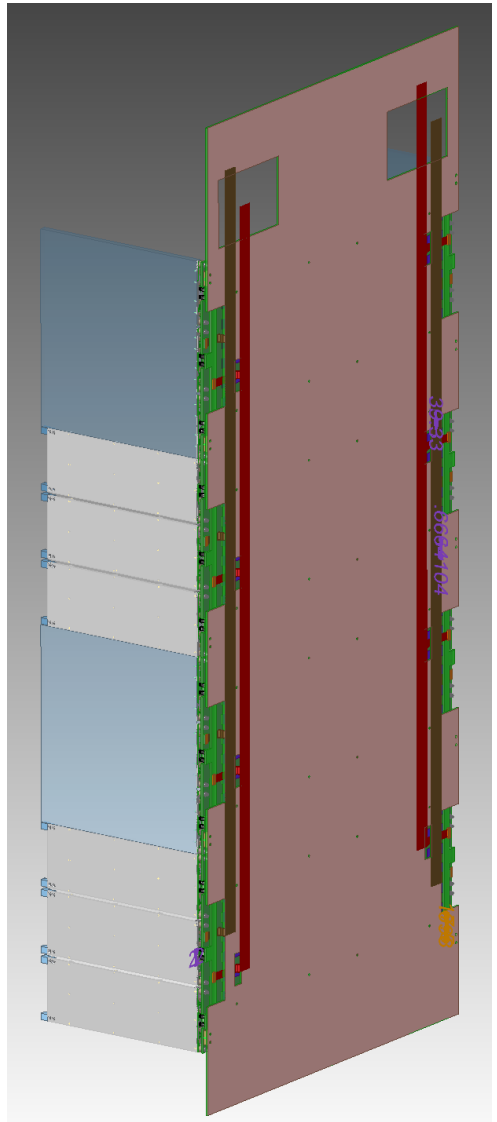
- Hermetic “bucket” sealing
- Add insulation
- Easier assembly



TPC Design

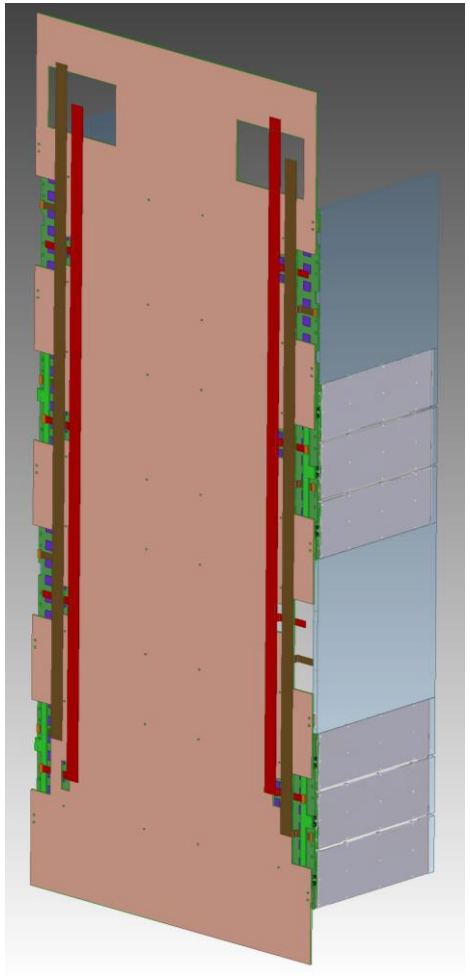
- Each module is made of two “half detectors” and a field cage which joins them into one unit which hangs from the insulating pillow
- Top flange has a “vacuum pillow”
- Structural planes attached to pillow on 2 sides (‖ anode plains)
- Everything mounted to these planes
- “Naked” module

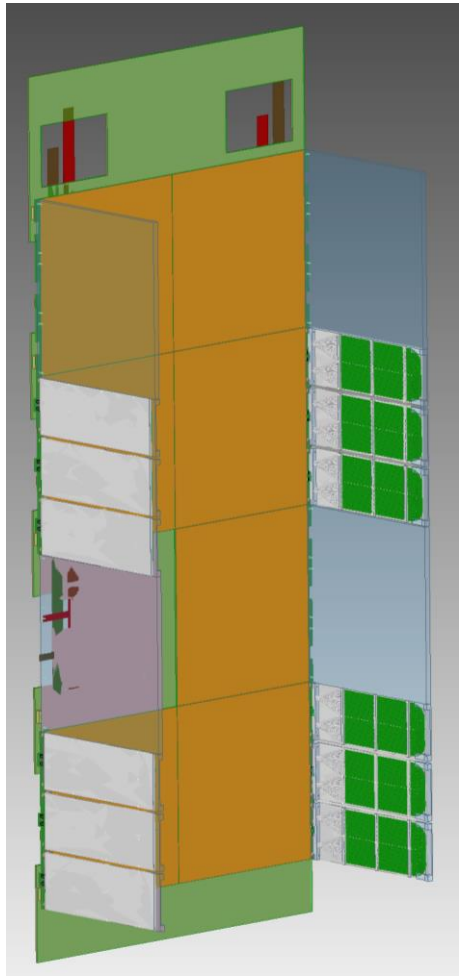




TPC Design

- Fiberglass stiffener with 8 LArPix modules attached (detector half)
- Flex Circuits to each tile and SiPM
- Light readout (ArcLight / Dubna) attached to LArPix

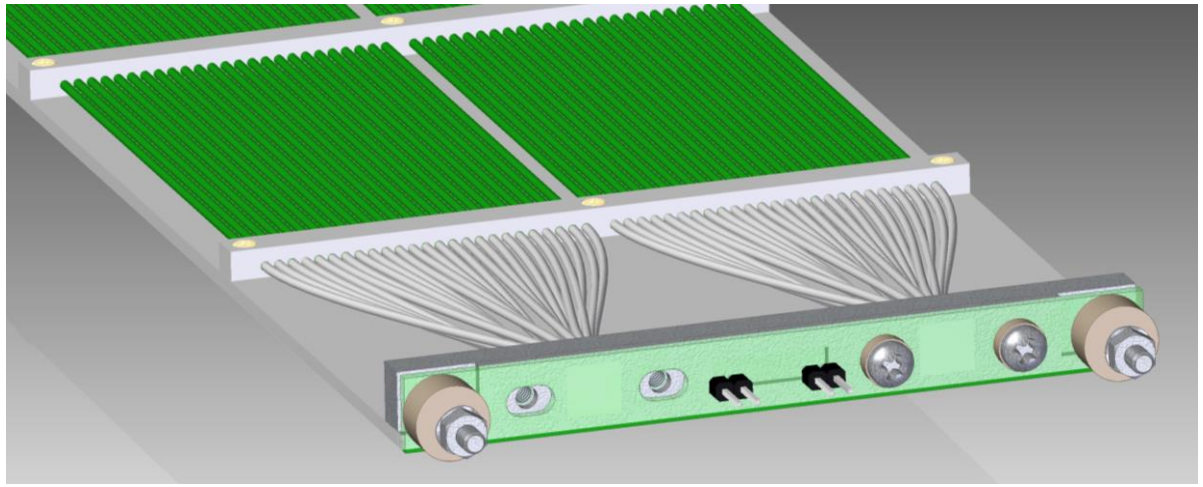


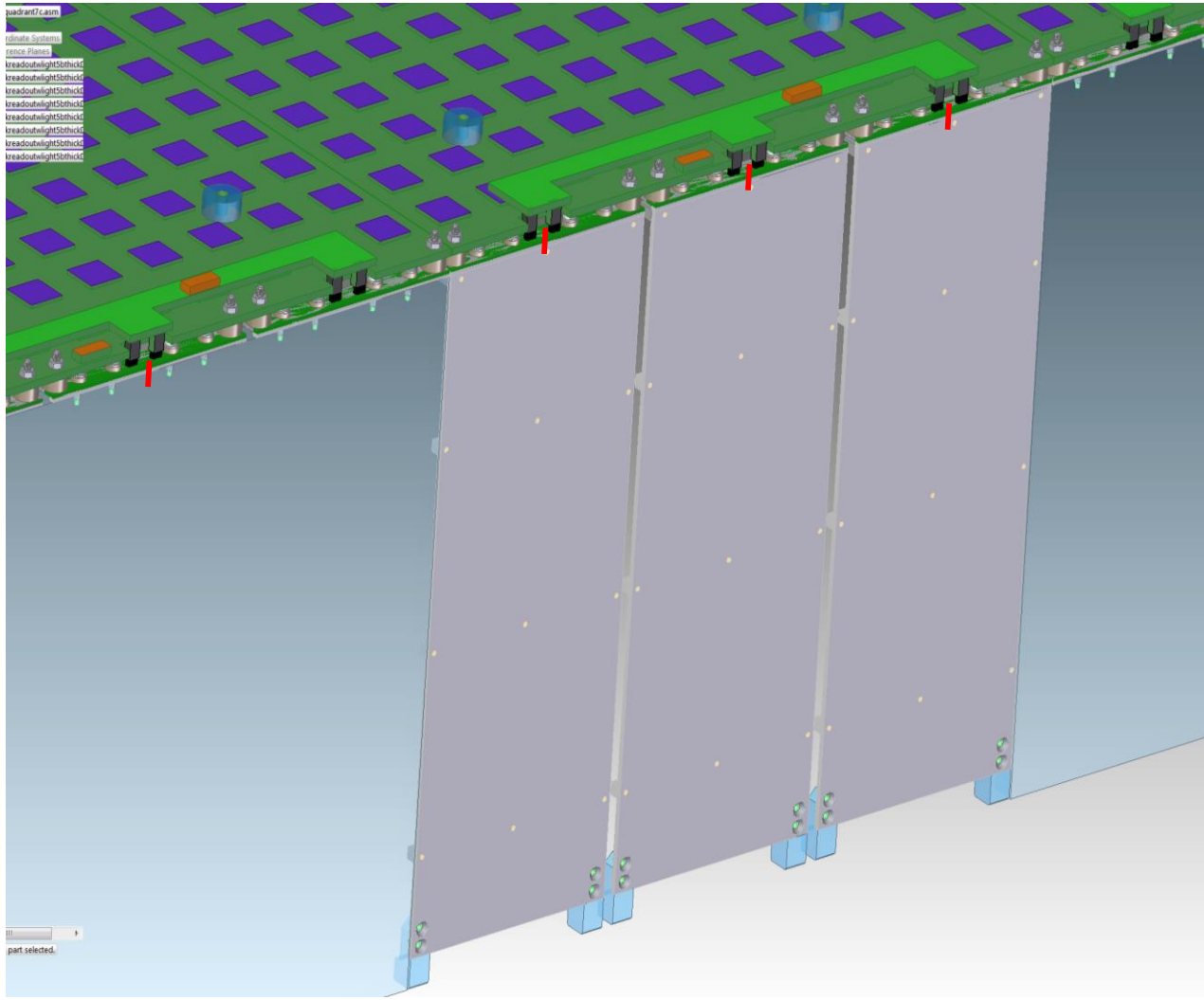


TPC Design

- Possible plastic pin locations at red lines to set thermal shrinkage locking points

- Slots permit slip

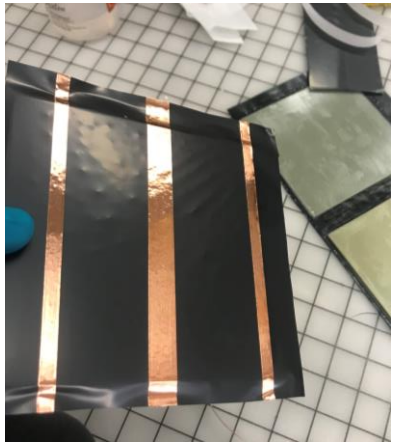


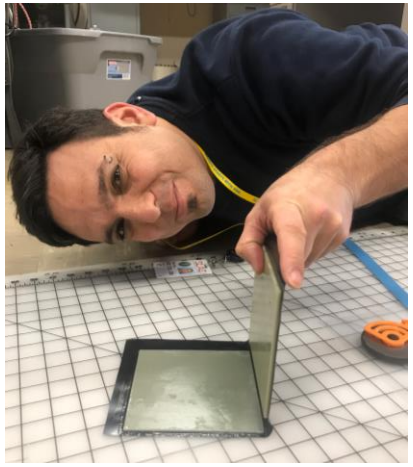


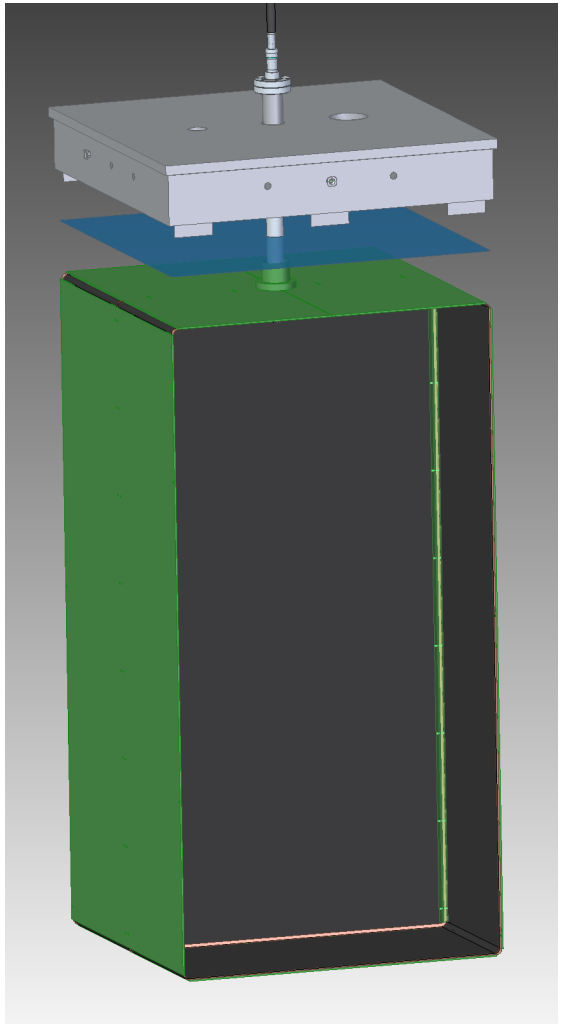
TPC Design

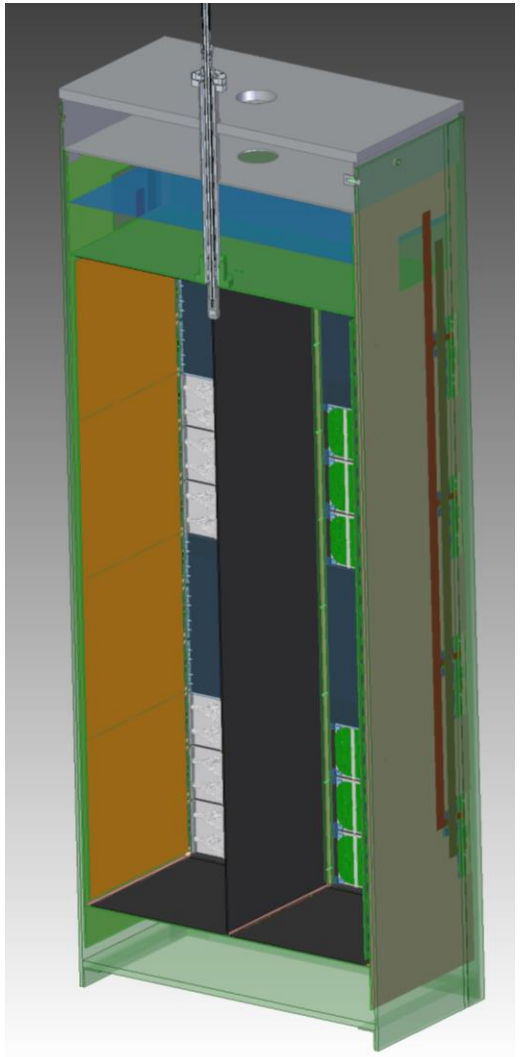
- Field cage (~1 GOhm/square) resistive polyimide (two 12” wide strips joined with a conductive strip) with G-10 stiffeners)

- Metalized edges at anodes and cathode planes



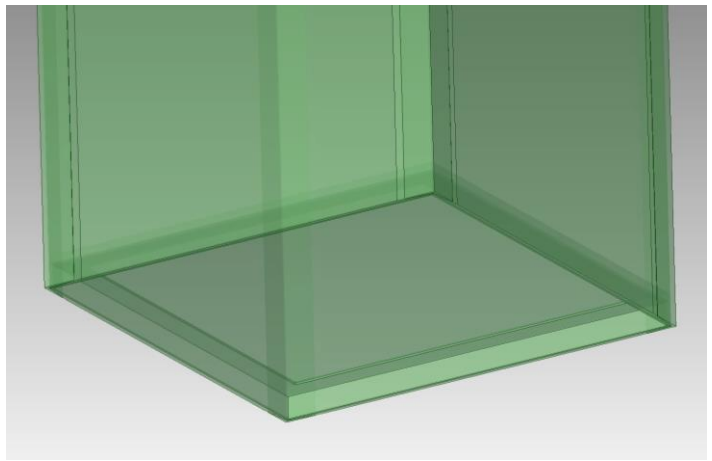


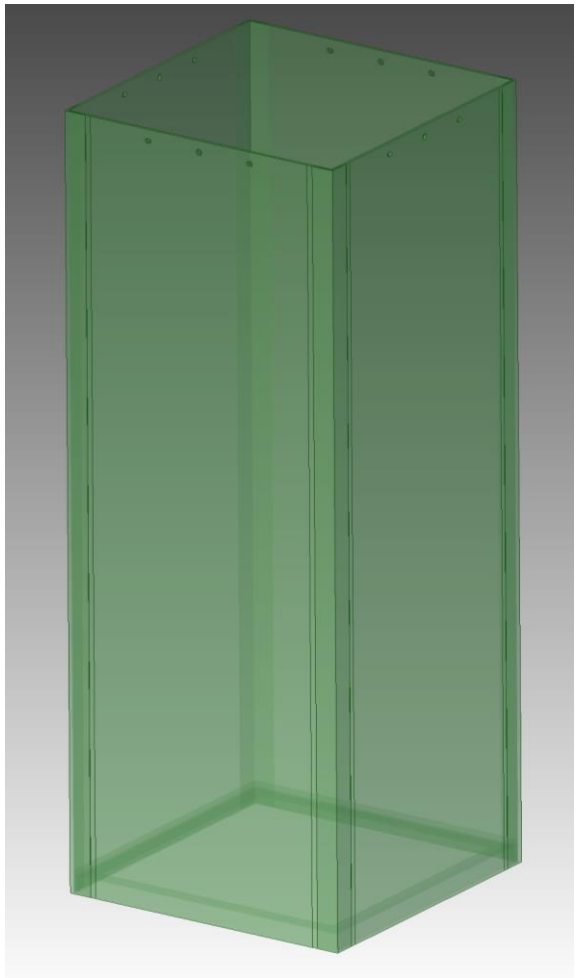




TPC Design

- Hermetic fiberglass “bucket” to isolate LAr in modules
- Sealed to “pillow” in warm area above liquid with special silicone which is good to 165K)





High Voltage

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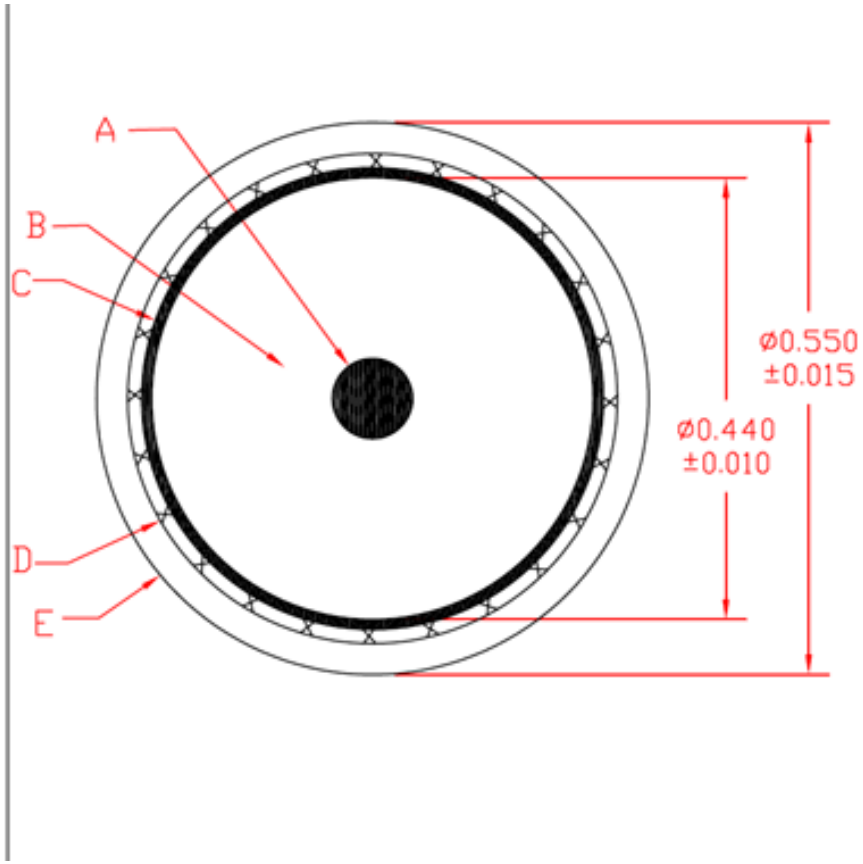

LEGEND

A. CORE CONDUCTOR: SEMI-COND POLYETHYLENE TO ø0.080 (~2800 Ω/FT)

B. LDHMW POLYETHYLENE TO ø0.44±0.010

C. SEMI-CONDUCTIVE POLYETHYLENE, 0.010 WALL TO ø0.46

D. BRADED SHIELD #34AWG TC, 95% COVERAGE

E. JACKET: POLYESTER-BASED POLYURETHANE
0.031 WALL, TO ø0.55±0.015
THE APPEARANCE OF THE JACKET TO BE OVER 30% SEMI GLOSS OR HIGHER AND SMOOTH TO THE TOUCH.
RIPPLES MAY BE SEEN BUT NO ALLIGATORING OR BRAID SHOWING THROUGH.

- Joint work of many people for nEXO (P. Rowson, R. DeVoe, and more) for 100KV
- Resistive layer below liquid level to prevent breakdowns.
- Polyethylene ring to reduce surface breakdown
- Teflon cover for guidance

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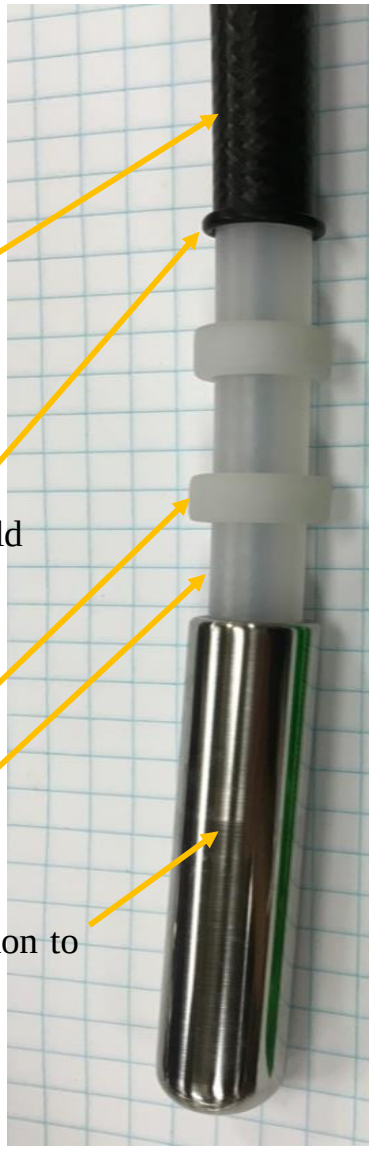
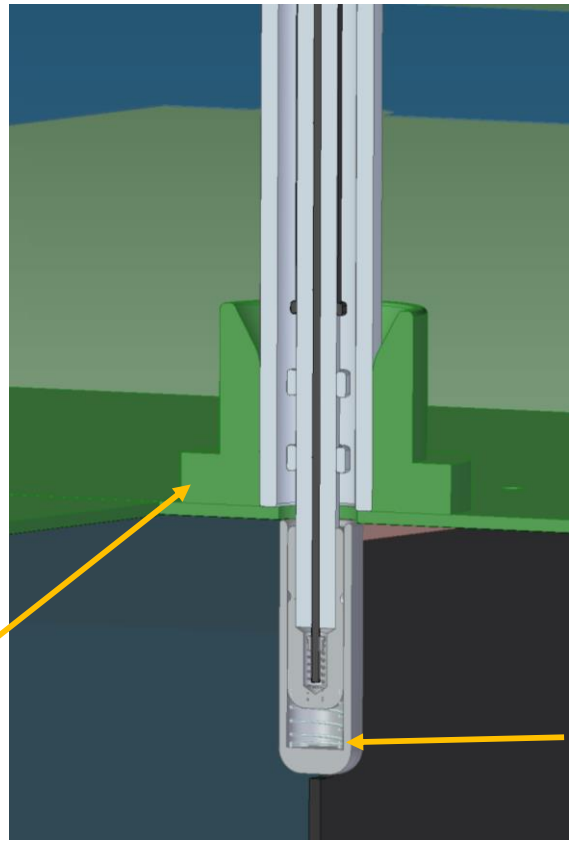


High Voltage

LAr level

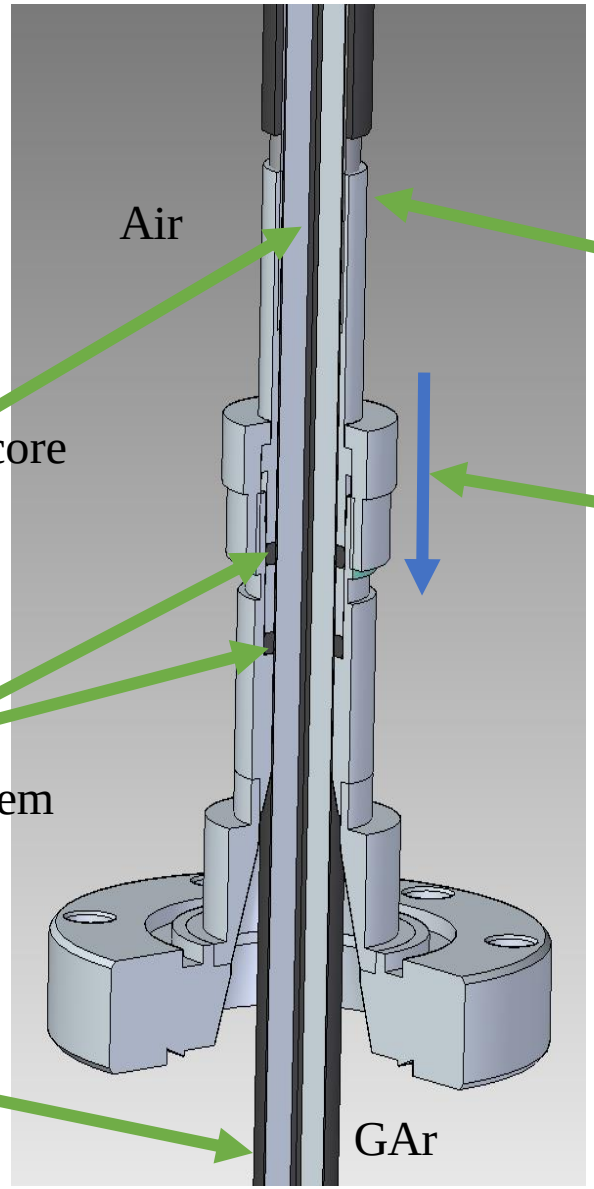


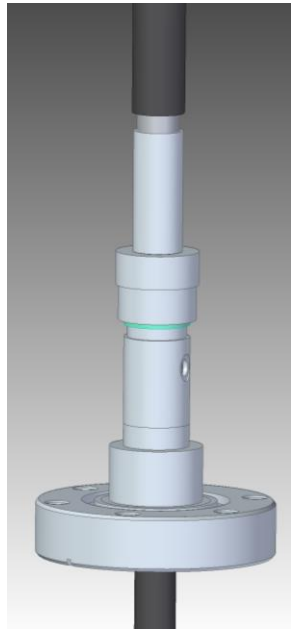
G-10 socket (holds top resistor plates together and guides guide tube)

Socket on cathode with soft spring

High Voltage

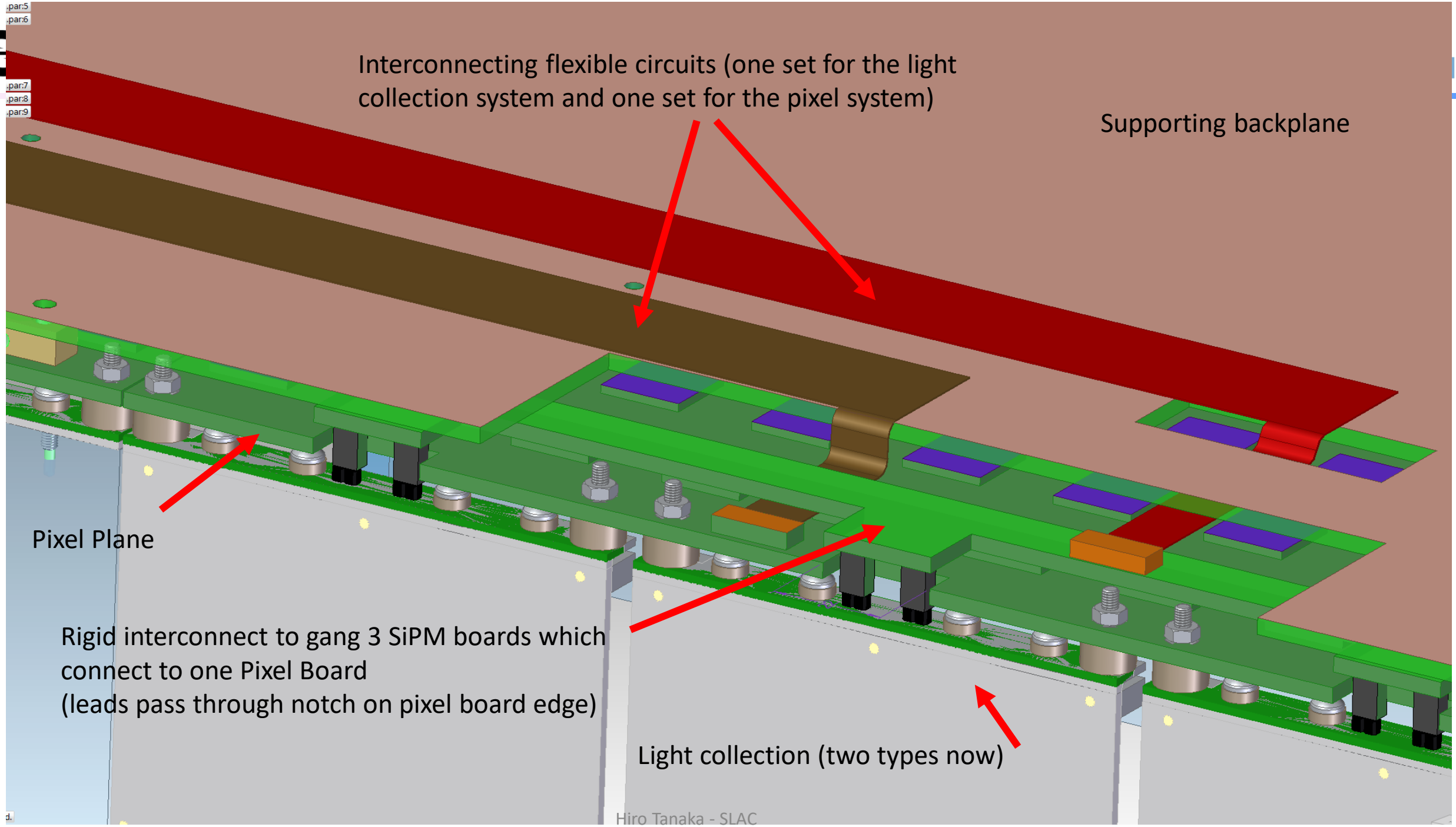
Air to argon HV feedthrough-
(EXO developed with resistive core)



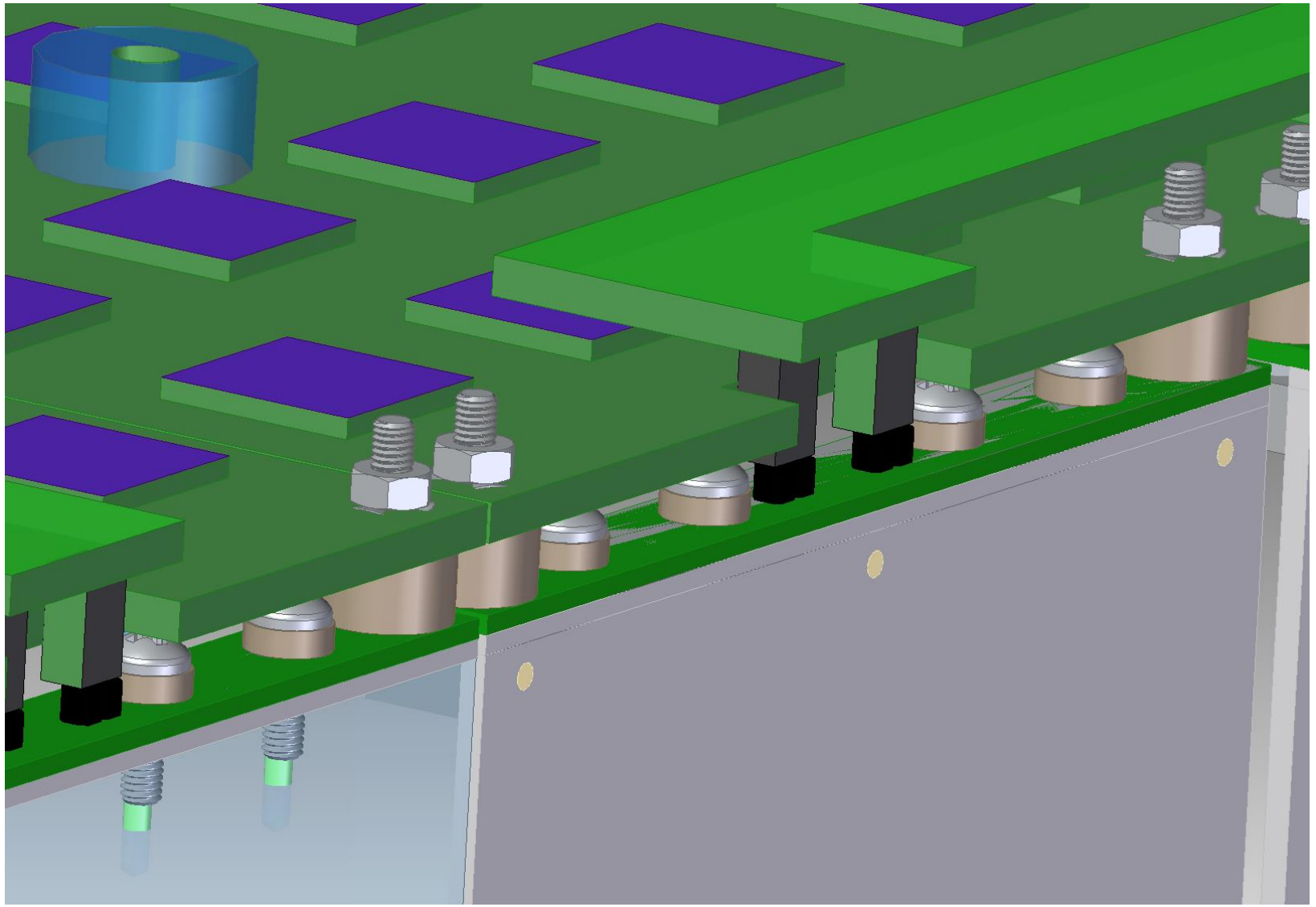


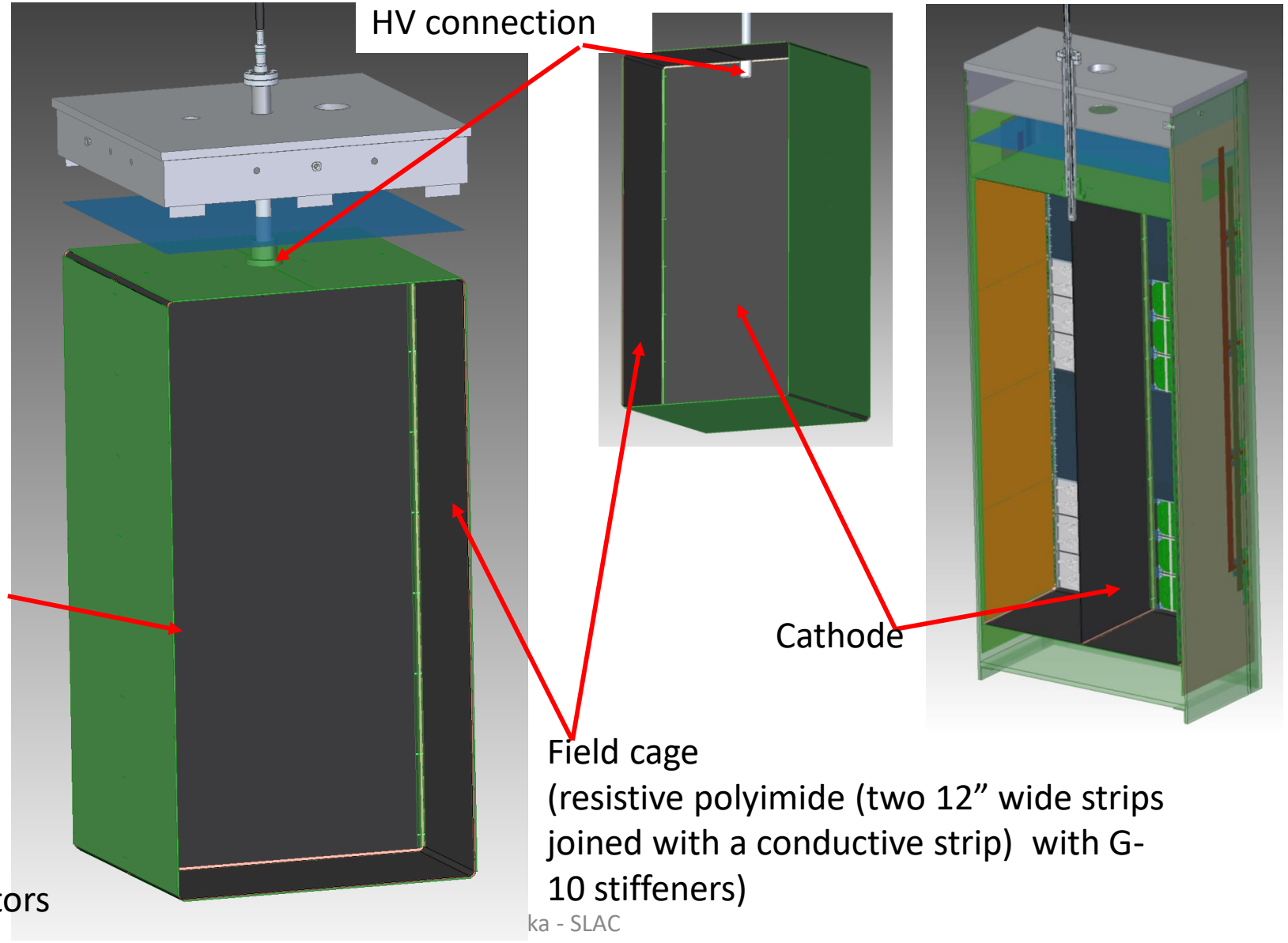
Questions

Backup Slides


Interconnecting flexible circuits (one set for the light collection system and one set for the pixel system)
Supporting backplane
Pixel Plane
Rigid interconnect to gang 3 SiPM boards which connect to one Pixel Board
(leads pass through notch on pixel board edge)
Light collection (two types now)

Plastic stand-offs mount light collection to pixel boards- slots in strategic locations permit thermal slip, spring washers provide flexibility

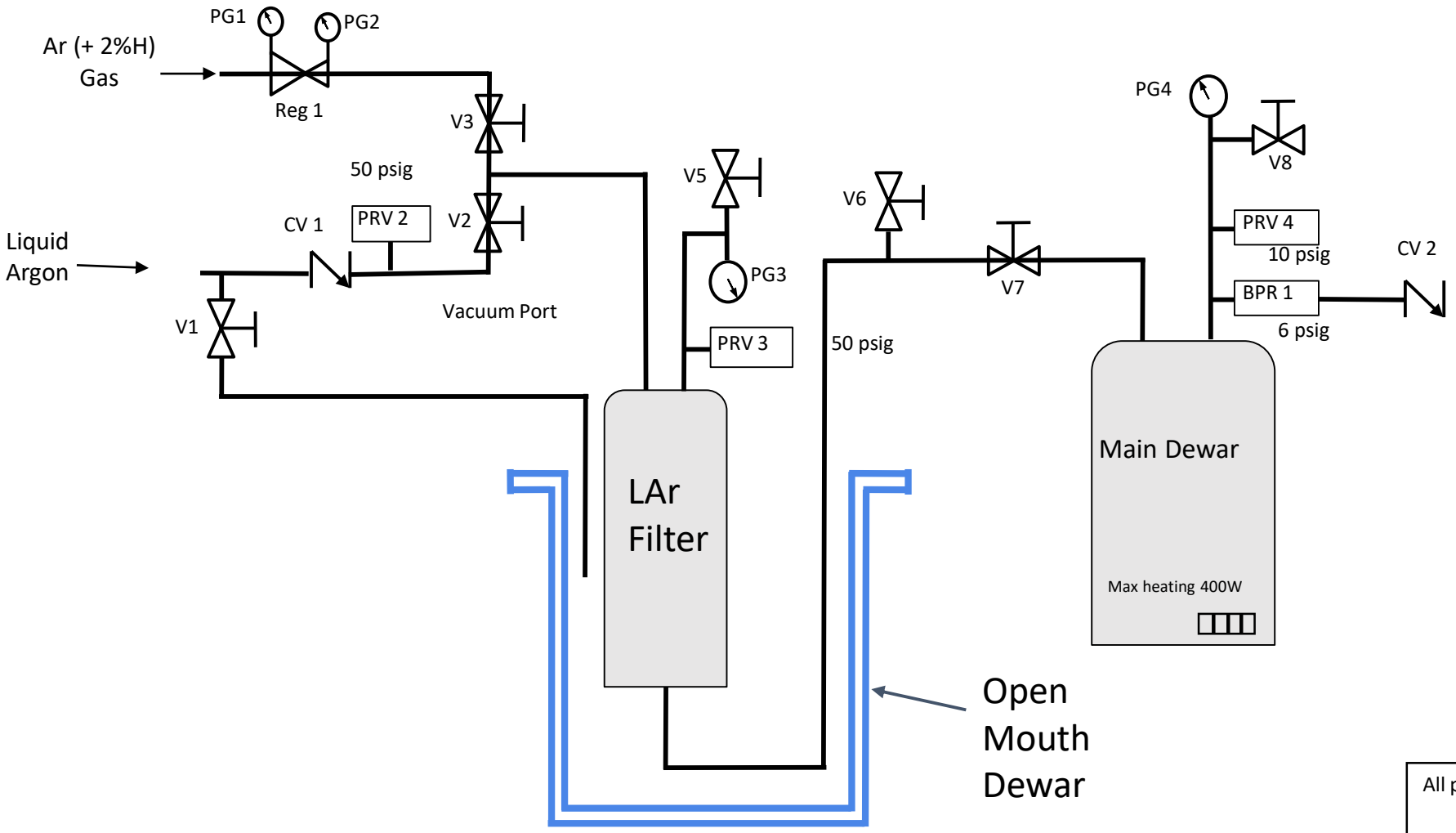



HV connection
Metalized edges at anodes
Cathode
Field cage
(resistive polyimide (two 12” wide strips joined with a conductive strip) with G-10 stiffeners)
Module with no half detectors

- DUNE Near Detector – 5X7 modules each (1 X 1 X 2)m
  - Dead space between one model to another needs to be minimized
  - Idea to replace field shaping rings to a field cage made of Carbon loaded Kapton thin sheets (<1mm)
- Prototype for these models is developed and would operate at FNAL (ArgonCube 2 X 2)

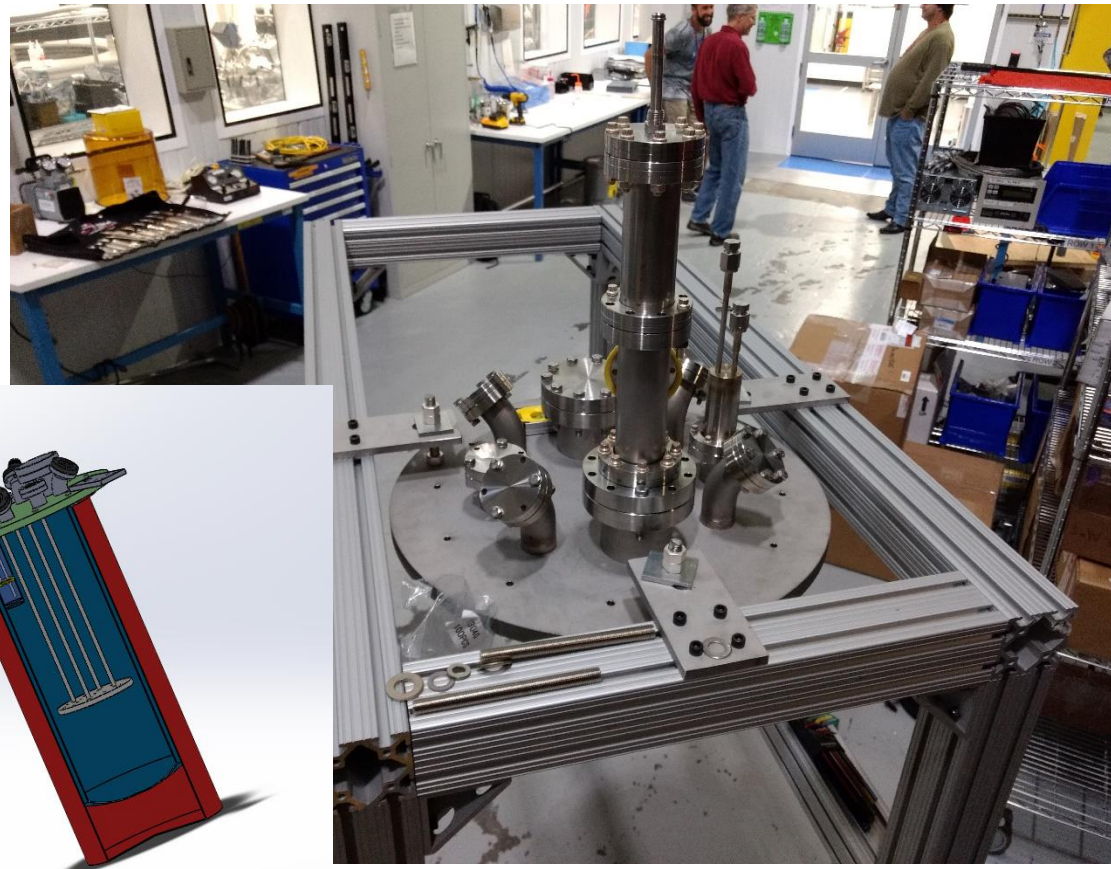
- We are planning on a multi-stage program developing this Carbon sheets TPC
  - Stage 1 – develop cryogenic capabilities on a small scale setup.
  - Stage 2 – deploy a prototype of this TPC (carbon field cage) into the small scale setup

P&ID

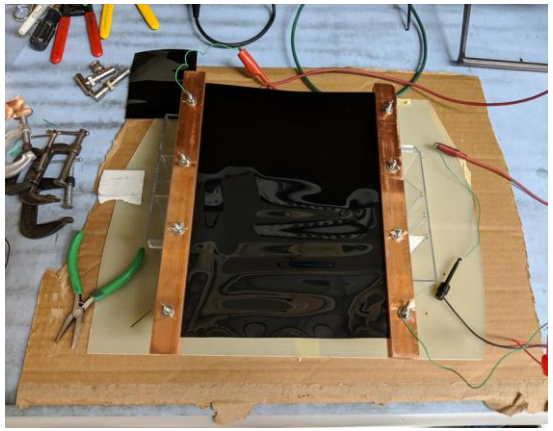

PG1
PG2
Ar (+ 2%H)
Gas
Reg 1
V3
50 psig
V5
V6
PG4
V8
Liquid
Argon
CV 1
PRV 2
V2
PRV 4
10 psig
CV 2
PG3
V7
V1
Vacuum Port
PRV 3
50 psig
BPR 1
6 psig
LAr
Filter
Main Dewar
Max heating 400W
Open
Mouth
Dewar
All pipes are 316 SS ¼" OD

The System

- Dewar cryogenic dewar V =51 L (13” ID, 30” height)
- Top Flange – 20” diameter 0.75” thick, contains
  - 6 X 2-3/4 CF
  - 2X 4-5/8 CF
- Occupied By:
  - Electrical FT
  - Argon FT (including safety mechanism, see P&ID)
  - Viewport
  - Evaporator (cooling power)
- Mounted using 3 mounting plates 0.5” thick attached using a ½” bolt

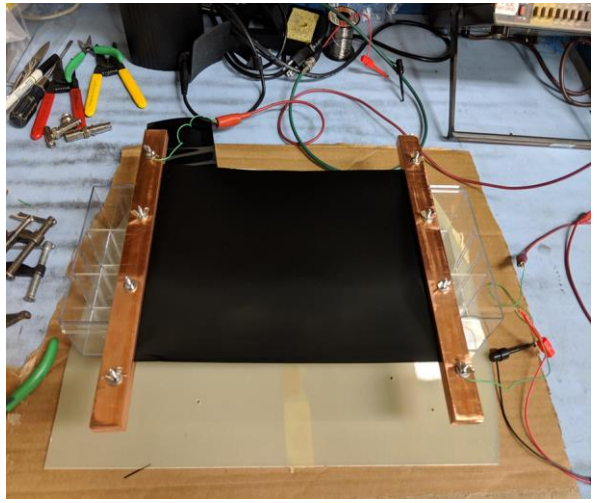


Room Temperature

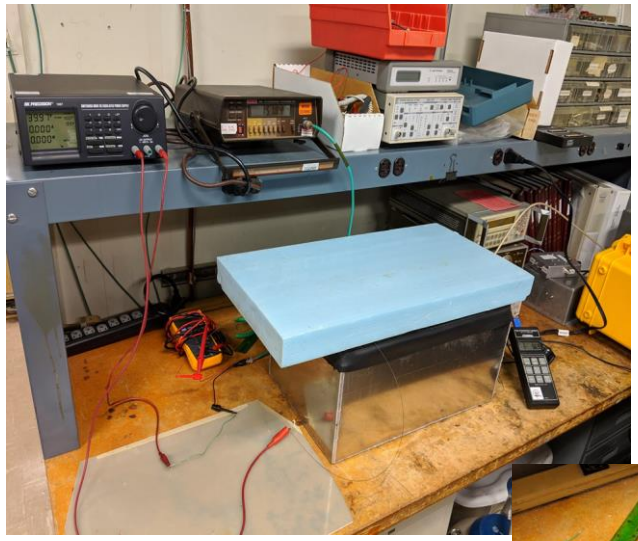


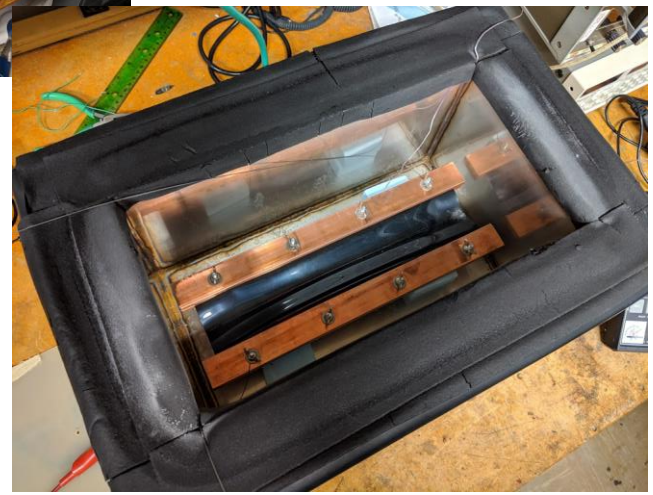
0°

90°



LN_2 Temperature





T= 293K	0 d. [Ω/sq]	90 d. [Ω/sq]	45 d. [Ω/sq]
Sheet C – DuPont	6.64 X 10^8	5.57 X10^8	6.01 X 10^8
Sheet D – DuPont	6.53 X 10^8	5.59 X10^8	x
Sheet E – DuPont	6.74 X 10^8	5.38X 10^8	x
Sheet F – FermiLab	1.08 X 10^5	6.47 X 10^4	x
T= -150C			
	8 X 10^9		