ESB Updates & Path Forward

Progress Report

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BIC General Meeting

April 24, 2026

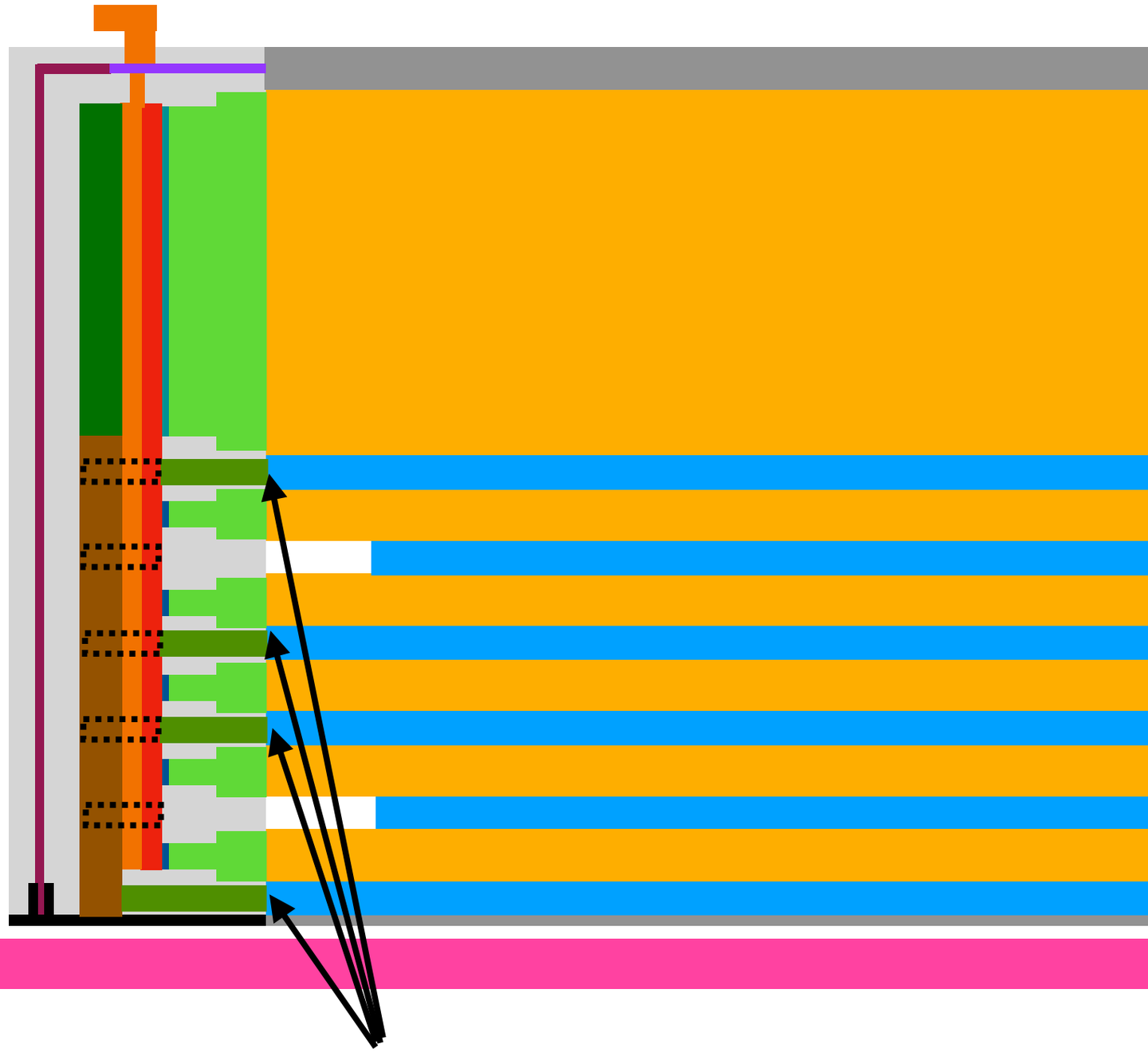
ESB Napkin Sketch - Electron End

Challenge in servicing

Legend:

PbScFi	CALOROC
Astropix	ETC
Light Guides	ETC cable
Cookies	Top plate
SiPMs	Bottom plate
Cooling	End plate

(Nasty)
DIRC

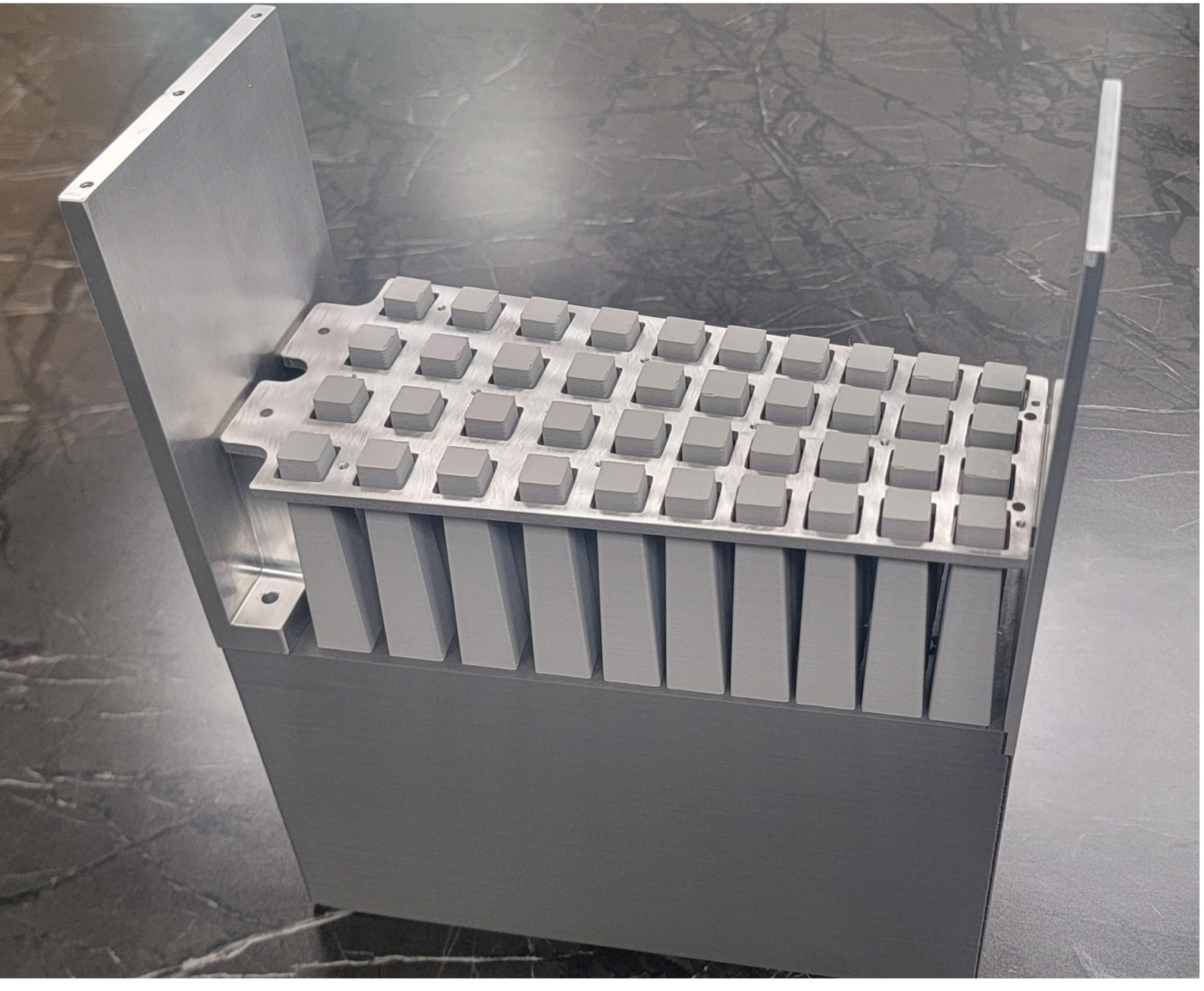


ETC to Astropix connector

ETC window thru SiPM/Cooling layers

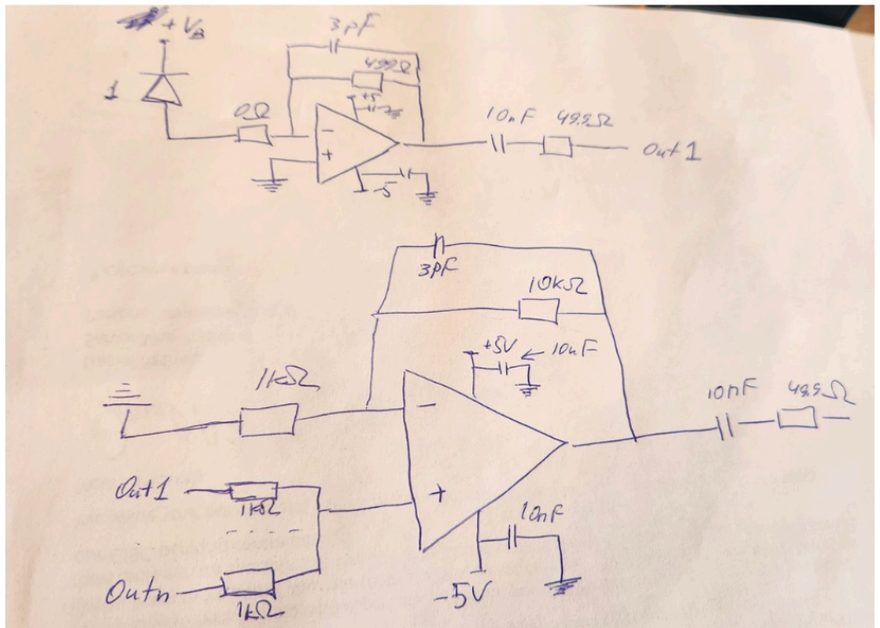
Sylvester & Zisis, March 4, 2025

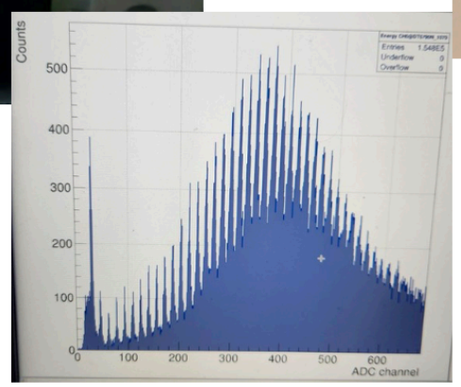
Baby BCAL Box - Design & 3D-print mockup



Inner plate "cancelled"?

SiPM readout basic design



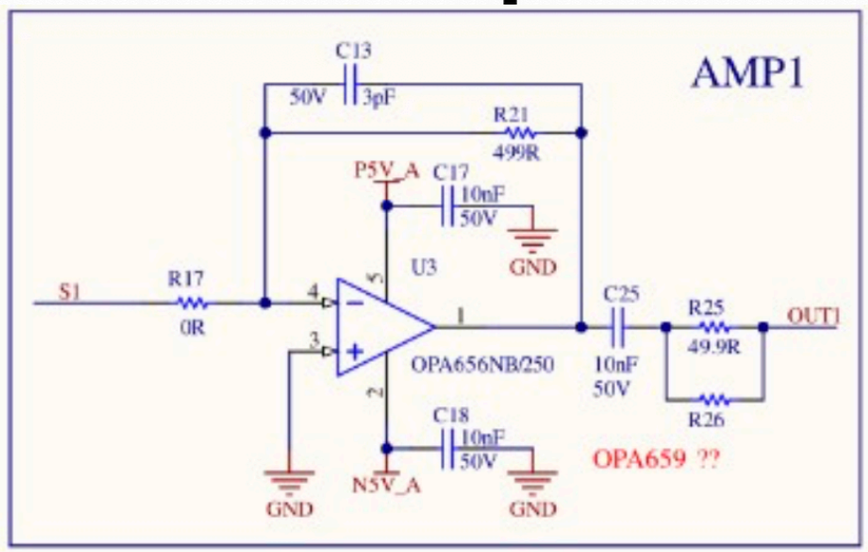


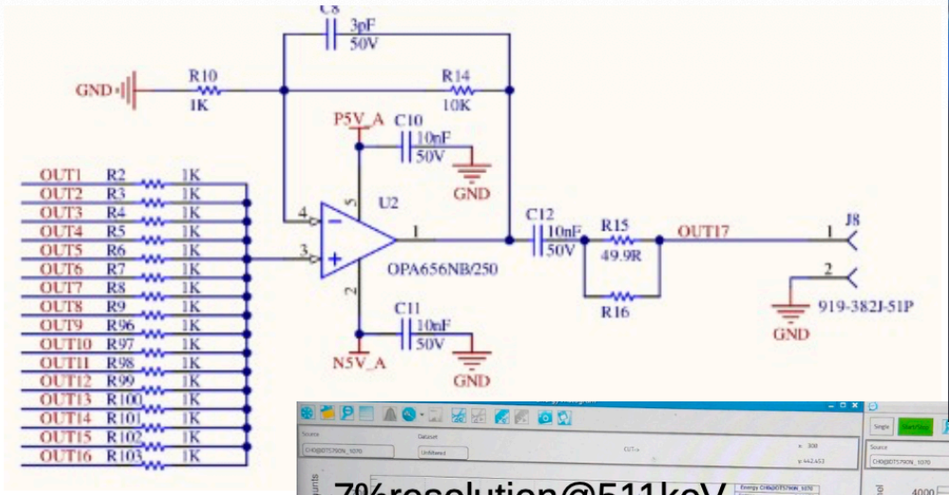
Signals clean enough to see up to 30+ single photons! Readout with CAEN DT5790

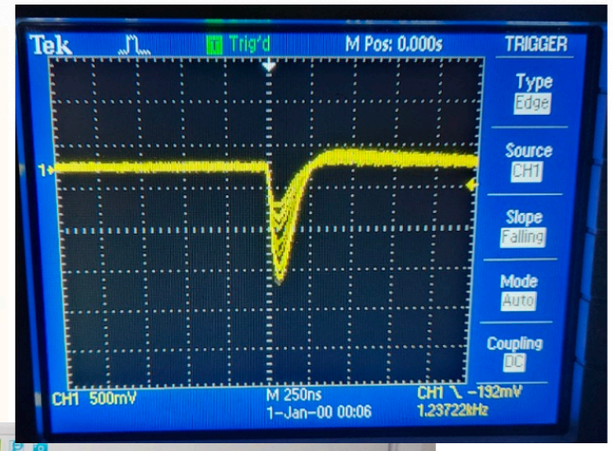
Tested with single 3x3 mm² SensL C-series sipm .. mid 2023?

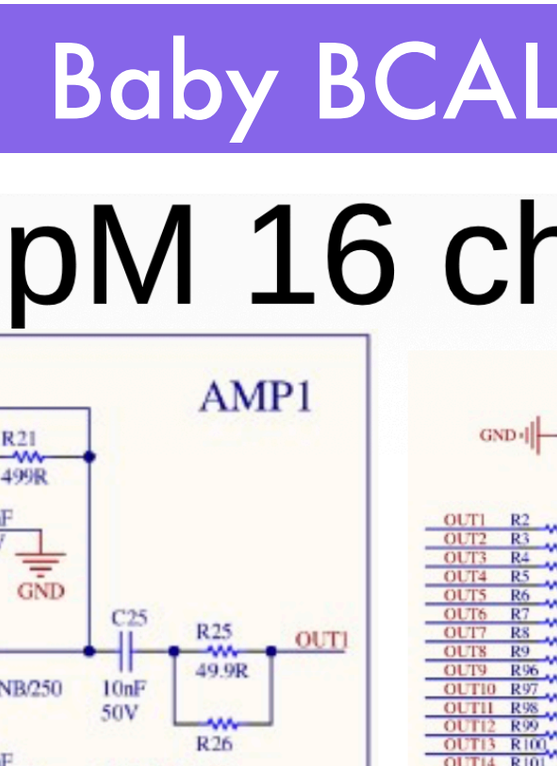
Disipated power ~0.3W per sipm

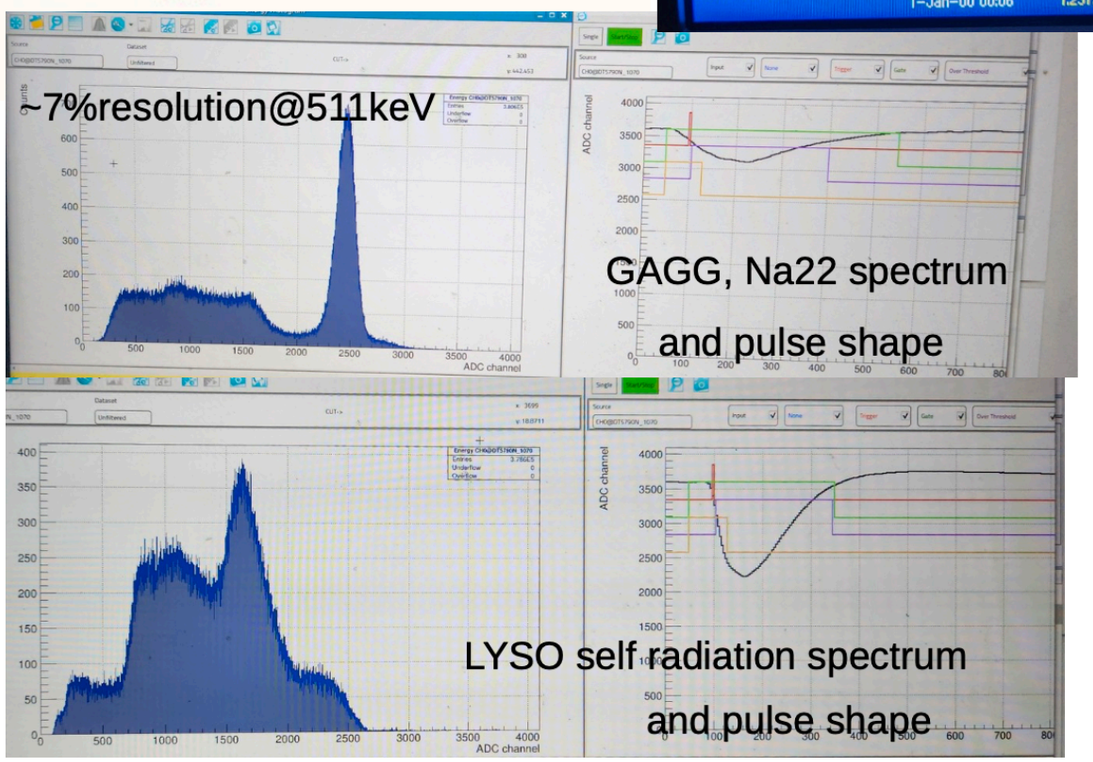
SipM 16 channel readout





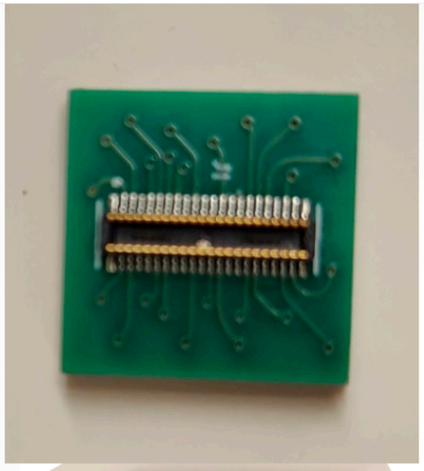


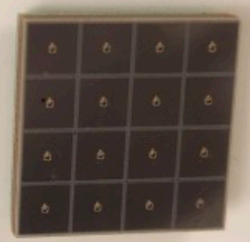




Good resolution but a **power hog ~2.5W per 4x4 sipm array!!**

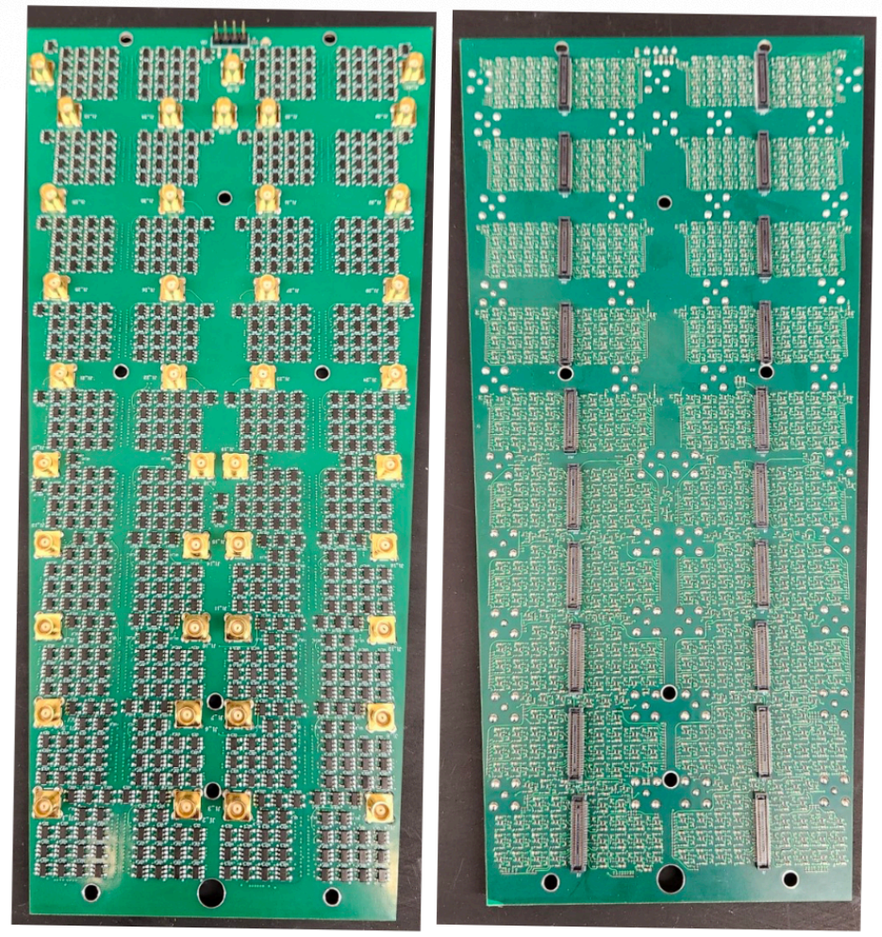
Baby BCAL Amp/Sum - Aram 2026

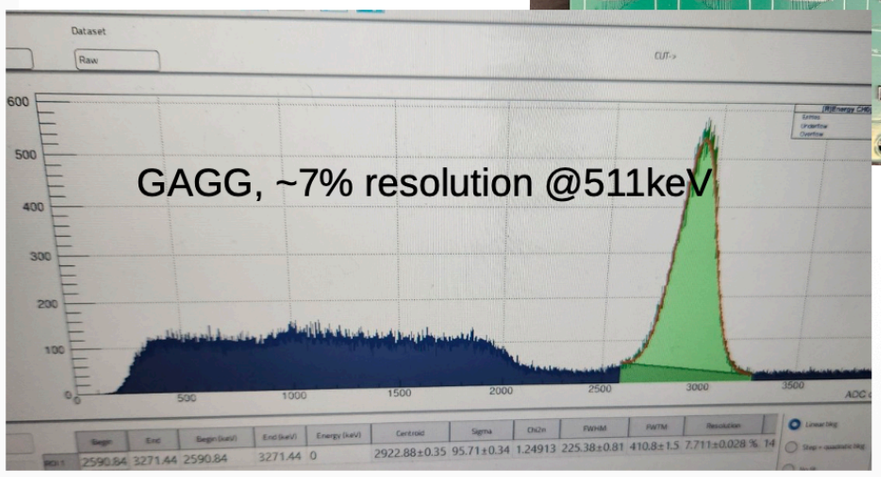




Mini-board

Baby BCAL readout based on 16 channel readout



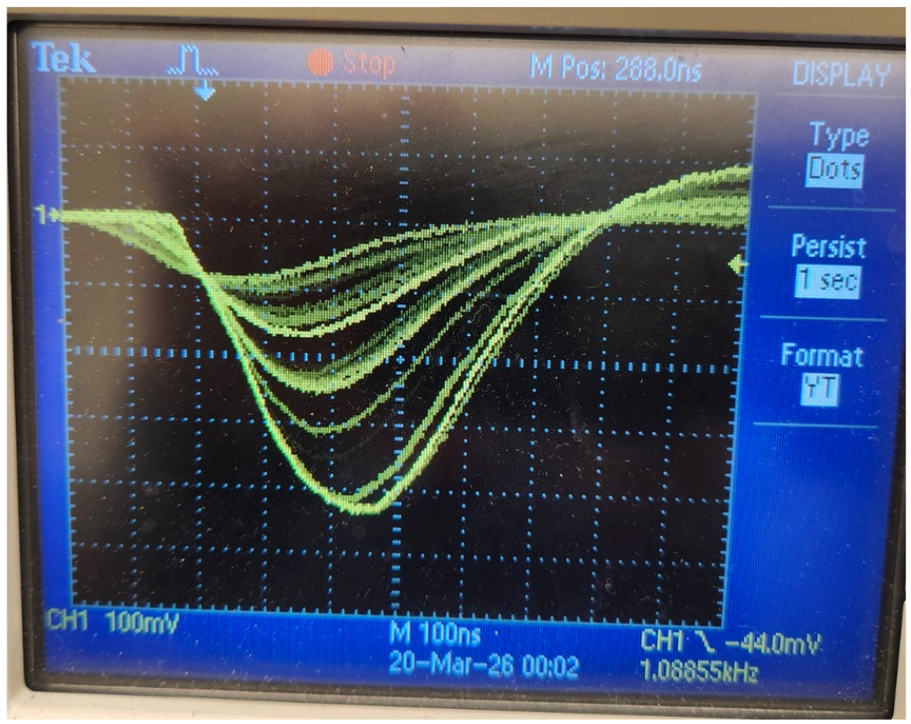


Amplifier board for 40 sipm arrays
16 channels each.
Only ~8W! For entire board

Baby BCAL Amp/Sum - Aram 2026

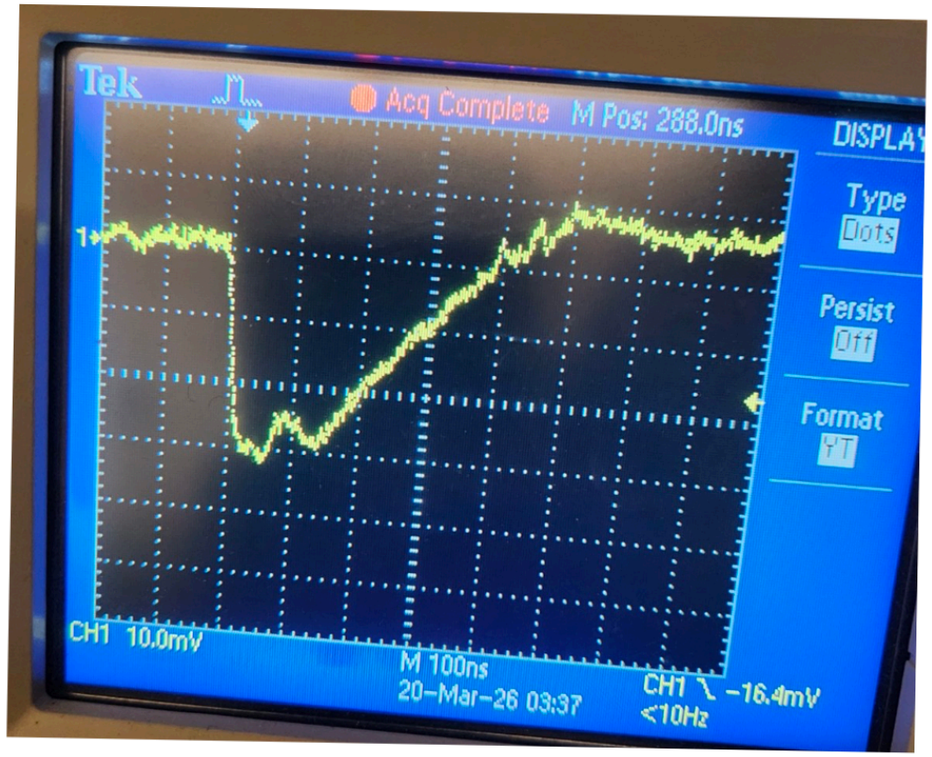
Boards to be tested at JLab

Baby BCAL readout based on 16 channel readout



GAGG, pulse shape of 16 sipm SUM with ^{22}Na source

- Pulses are ~500-600ns at the base
- Rise time ~130ns (88ns is the scintillator)



Pulse shape of a scintillating fiber matrix in LEAD (small piece of a GlueX detector prototype)-- poor optical contact

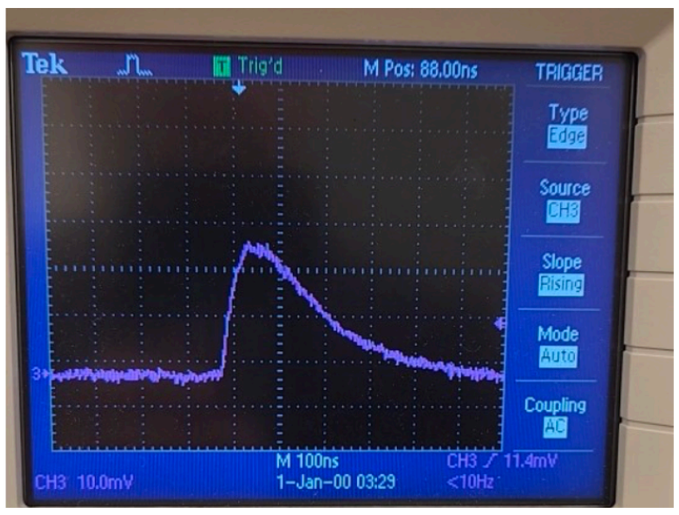
- Very fast rise time!
- Pulses are <400ns at the base

Baby BCAL Amp/Sum - Aram 2026

Currently aim is to further reduce the power consumption

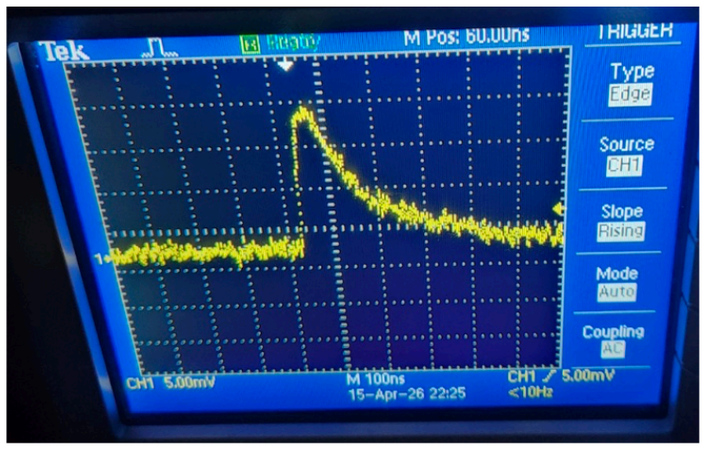
1- Resisitive /passive first stage per SiPM pixel followed by a summing/amplification stage

- Low power consumption
- Decent timing properties
- Potentially prone to crosstalk between pixels



2 - Diode coupled first stage per SiPM pixel followed by a summing/amplification stage

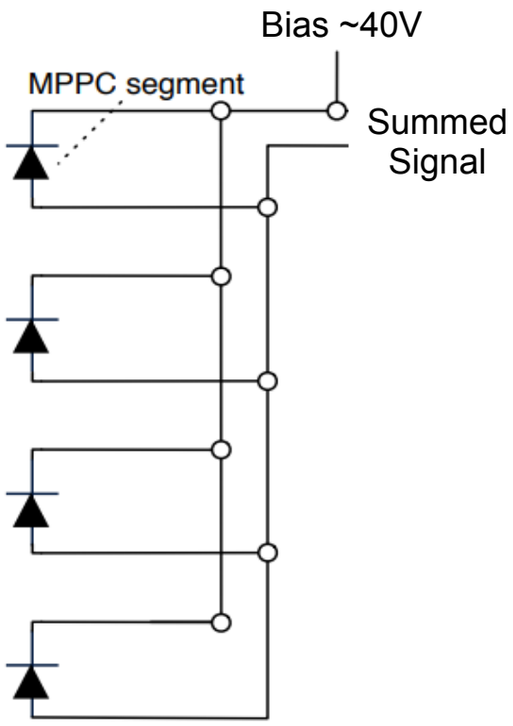
- Low power consumption
- Decent timing properties
- Almost completely eliminates crosstalk between pixels

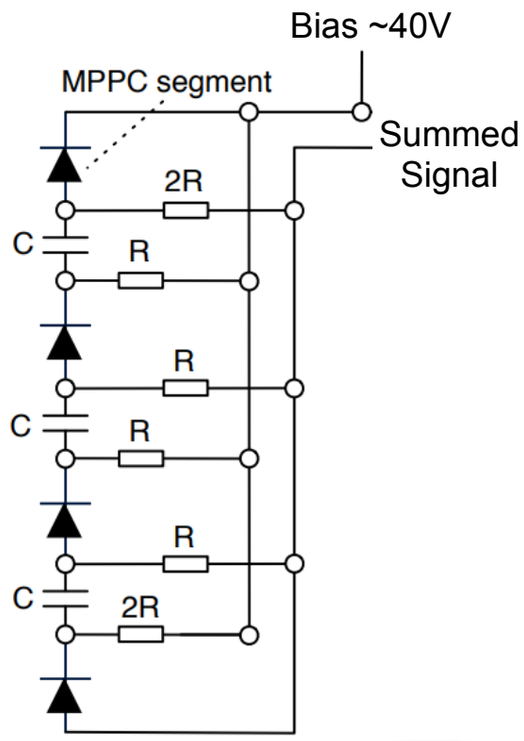


KNU

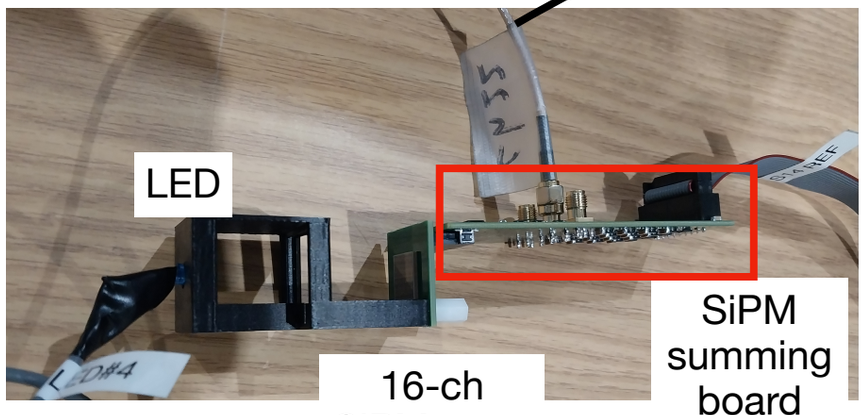
H2GCROC SiPM summing board

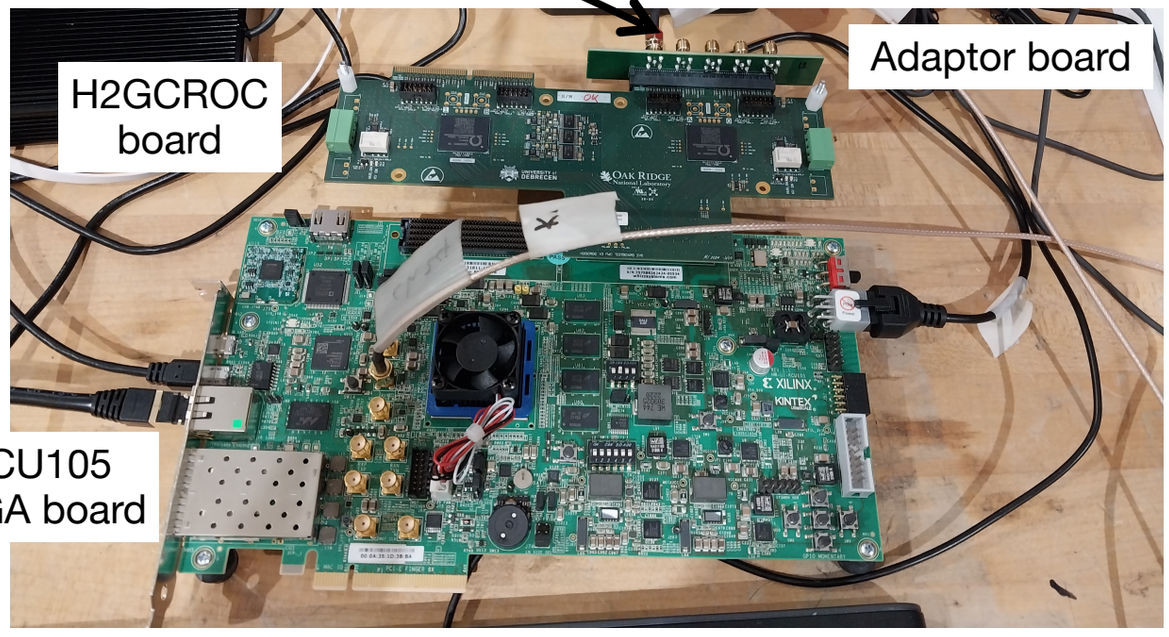
- 16-ch parallel sum
- 16-ch hybrid sum
- 1-ch Individual





- Test setup





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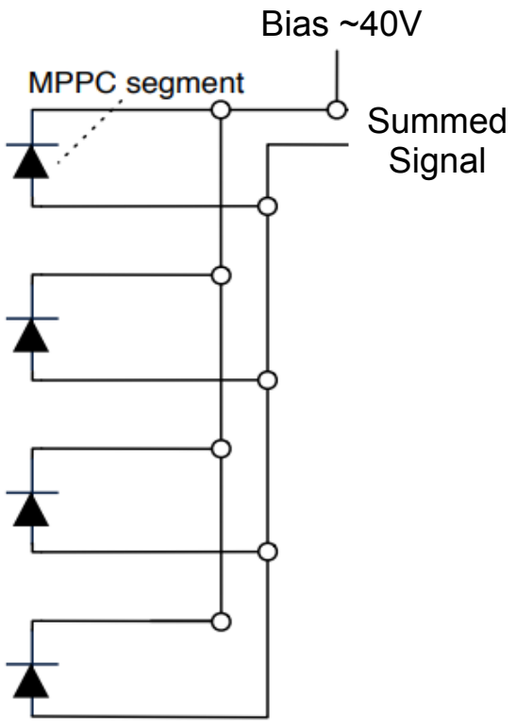
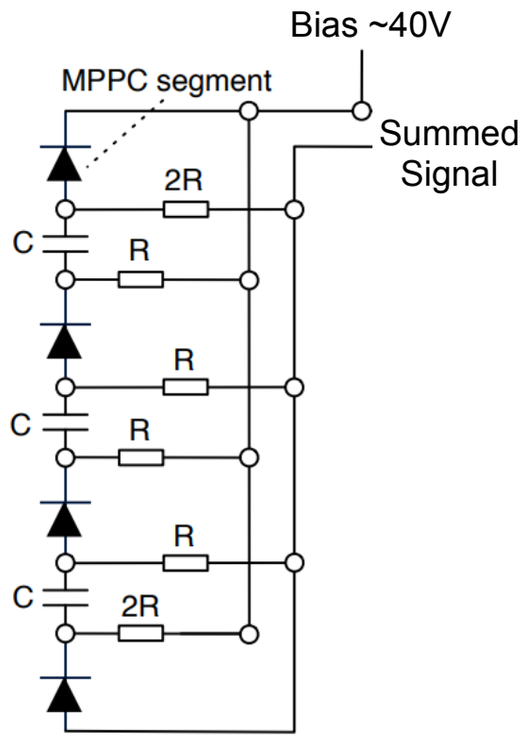
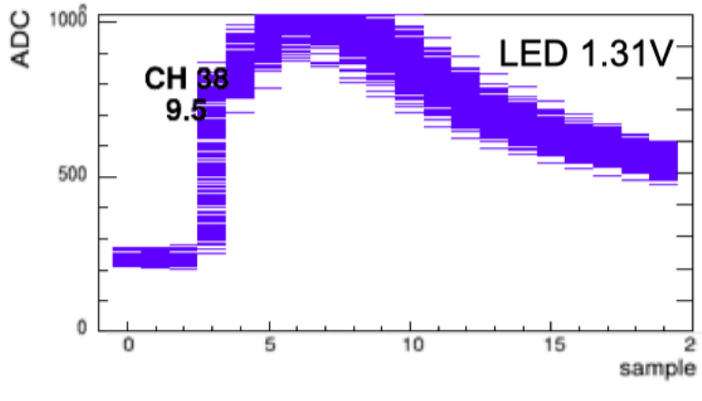
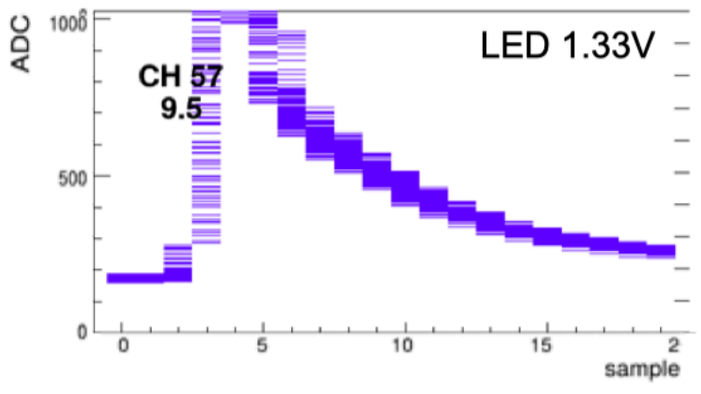




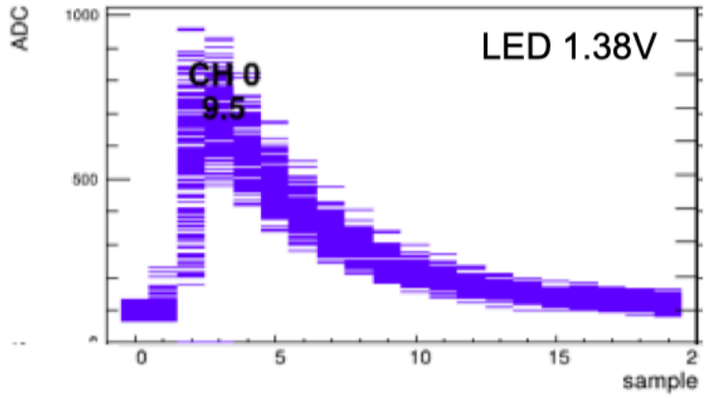
- Results



- rising time: 75 ns
- falling time: ~1 μs



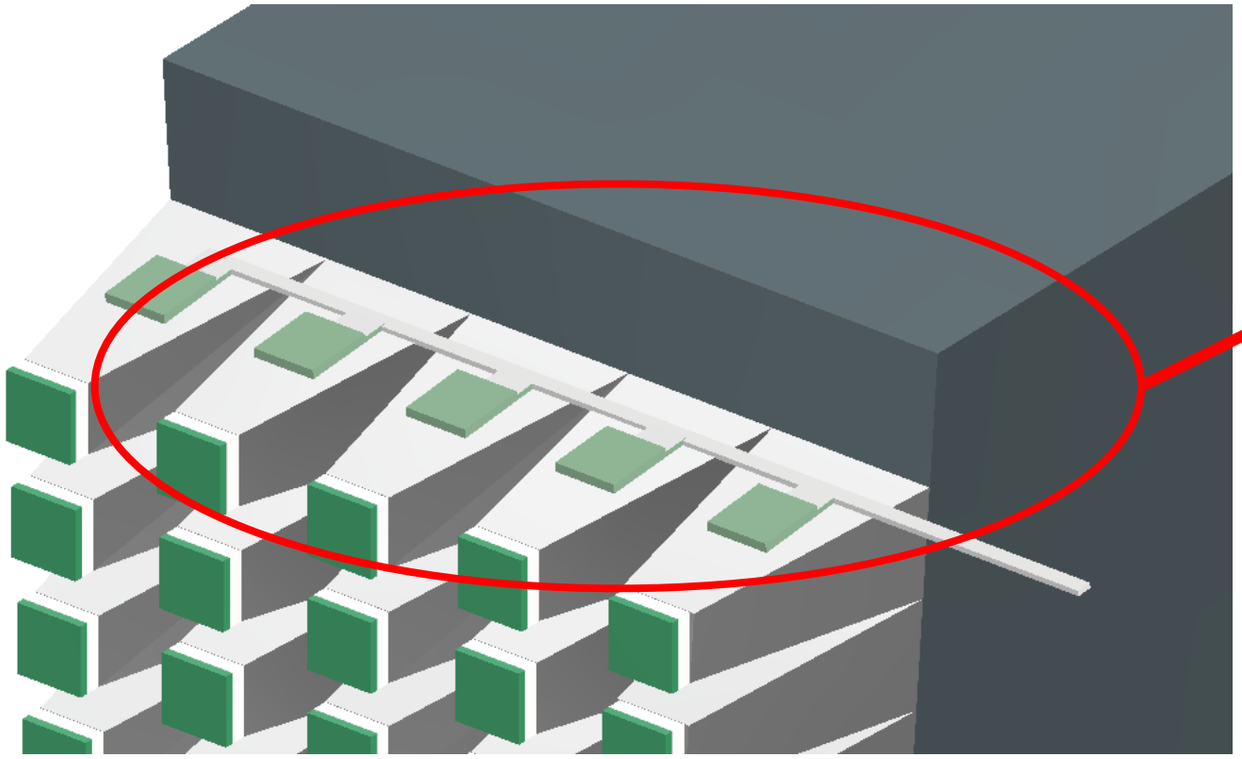
- rising time: 25 ns
- falling time: ~300 ns

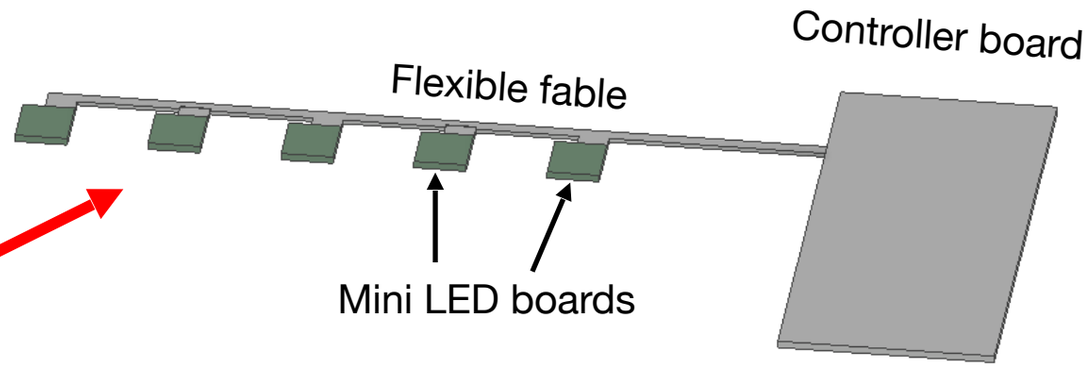


- rising time: 25 ns
- falling time: ~250 ns

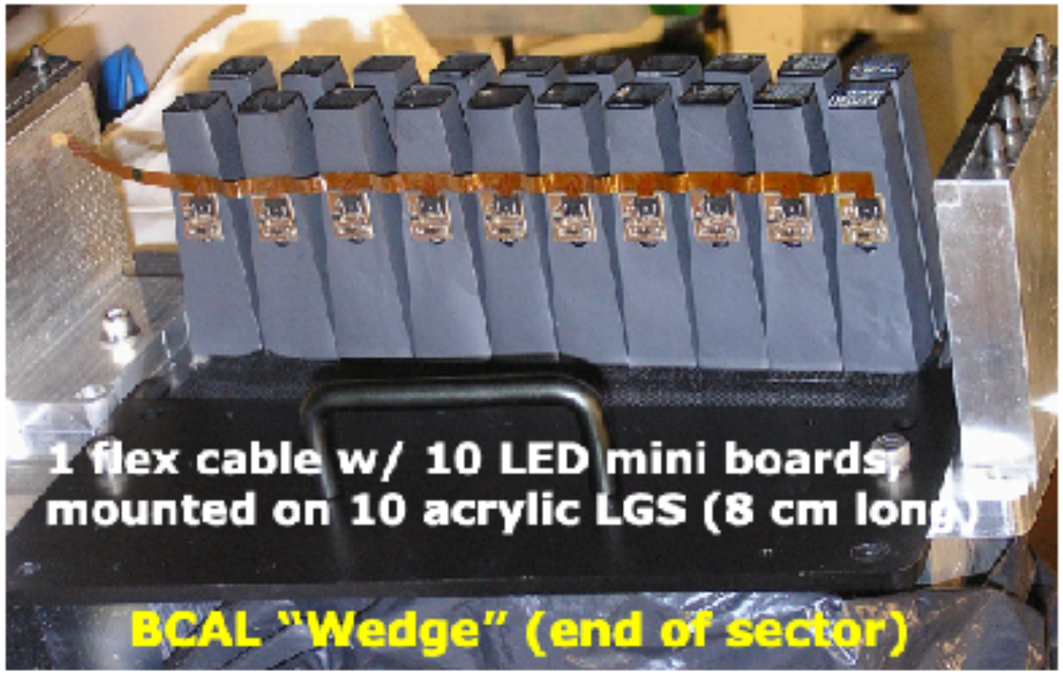
KNU

LMS system

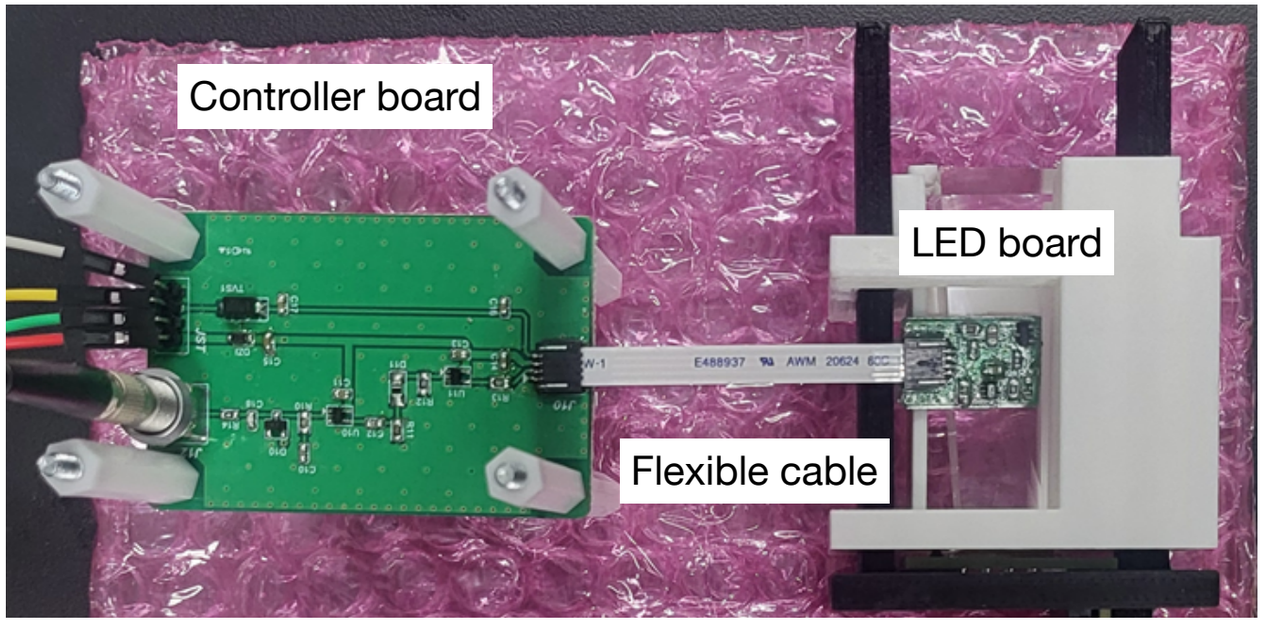




- glueX LMS system



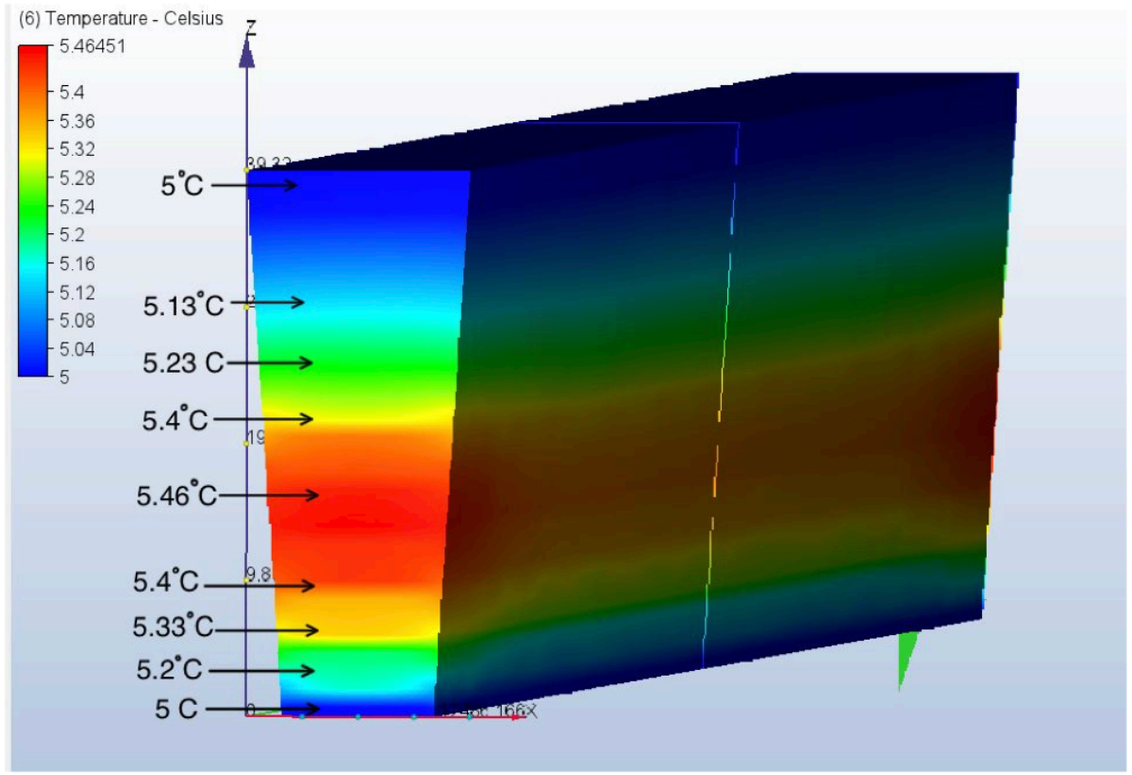
- 1-ch prototype board at KNU



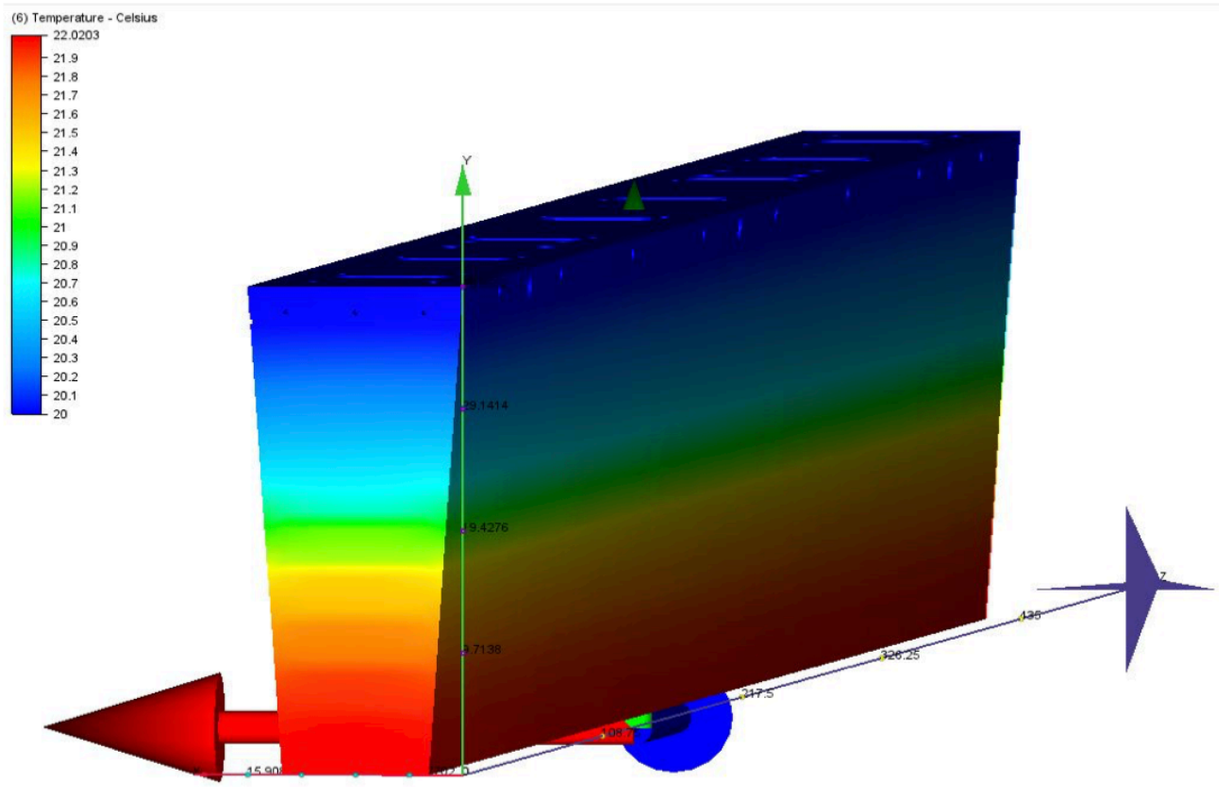
- Test on-going

BIC - Cooling Simulations (Manitoba)

Simulation Results (1 Sector)



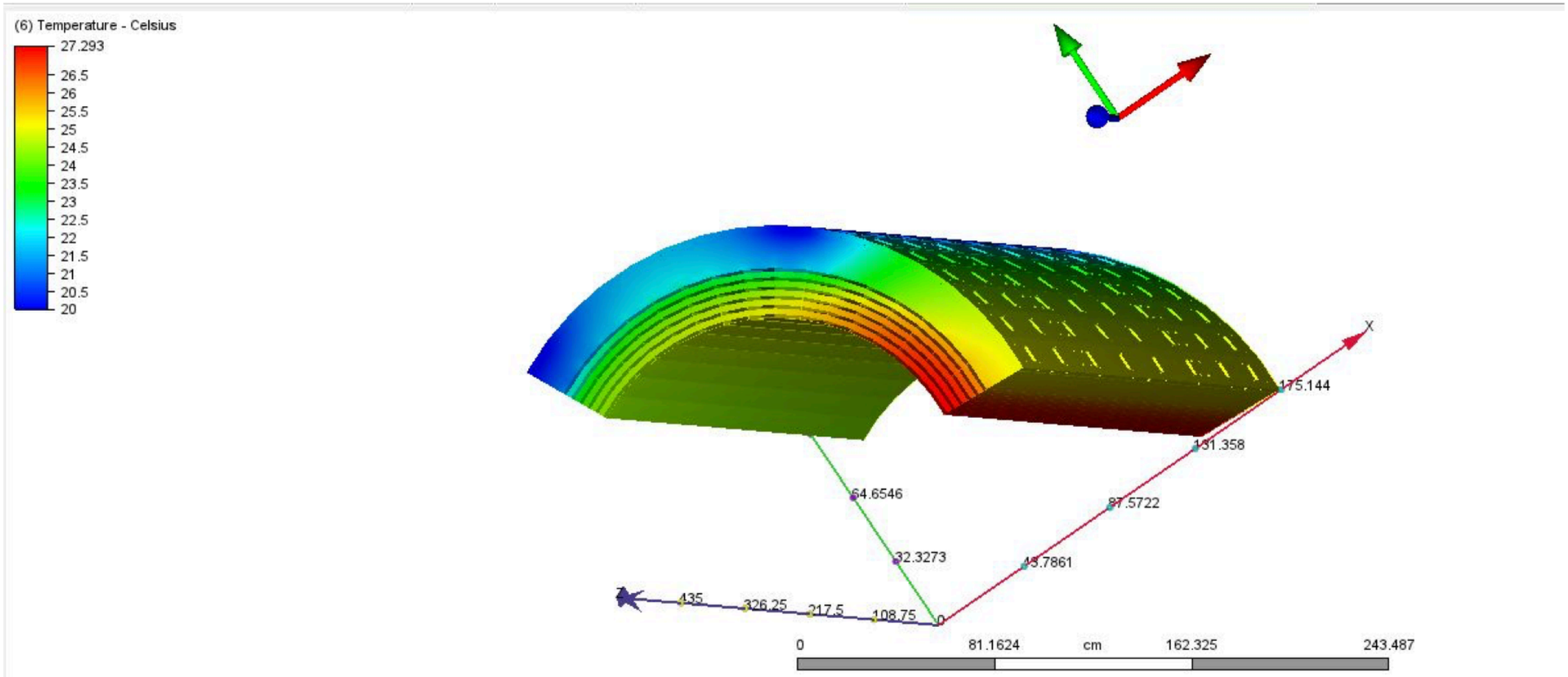
Old simulation results



New simulation results

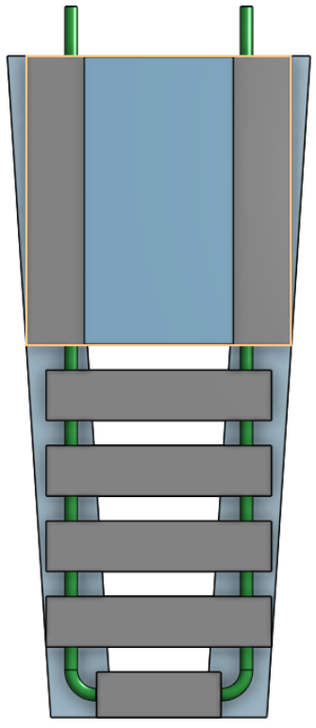
BIC - Cooling Simulations (Manitoba)

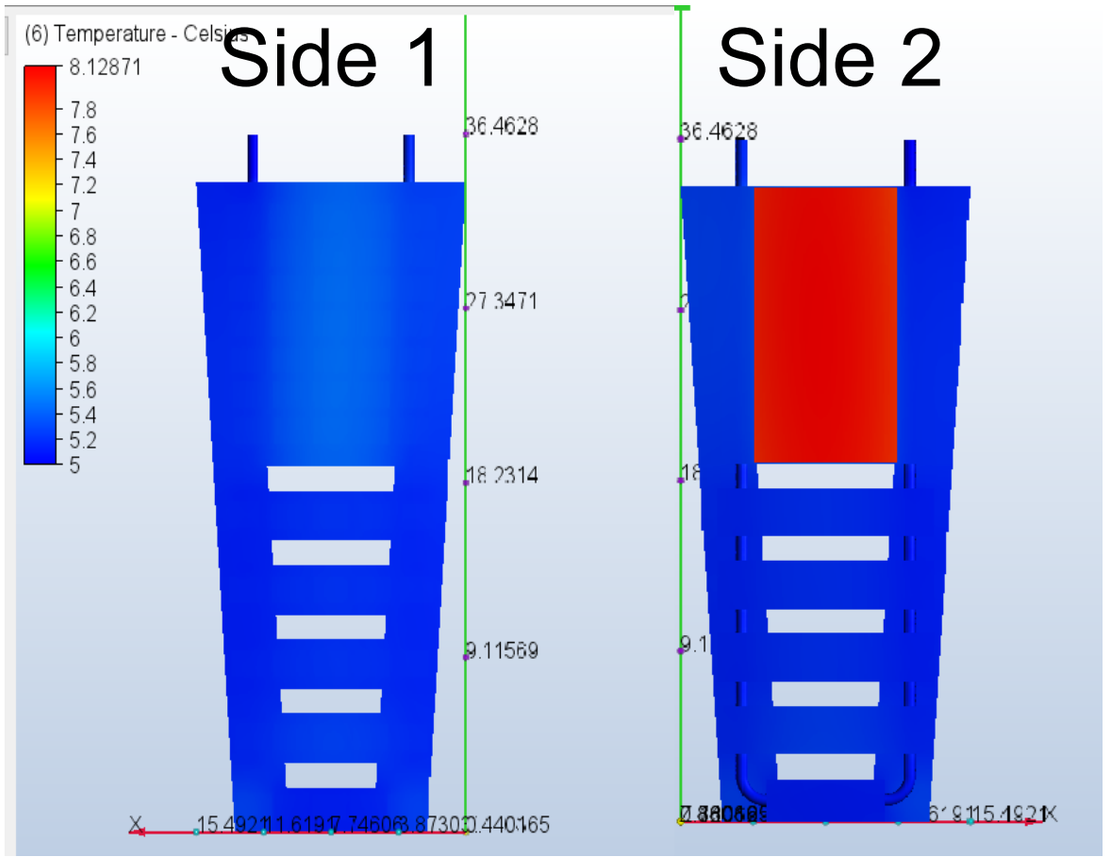
Simulation Results (16 Sector)



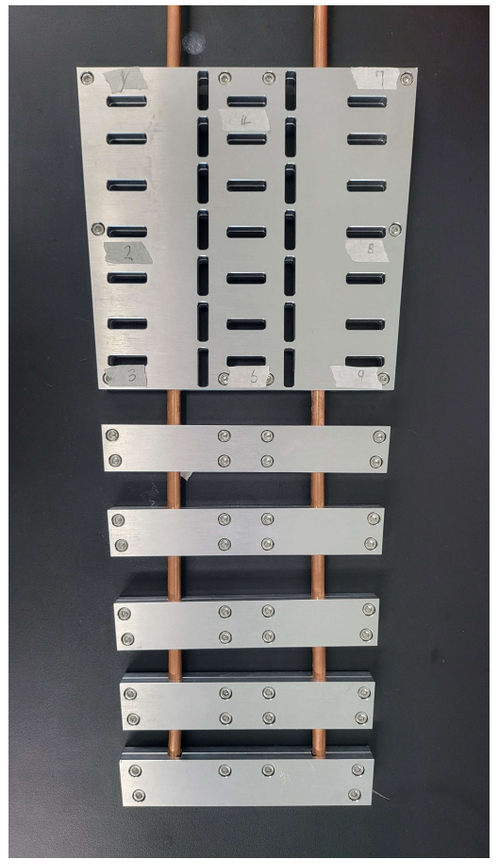
Cooling R&D

- Thermal simulation at Manitoba Univ.





- Prototype at KNU



Aluminum cold plate, PCBs on both sides:

- Side 1: ESB PCB with SiPMs
- Side 2: CALOROC and AstroPix ETC

Design dimensions:

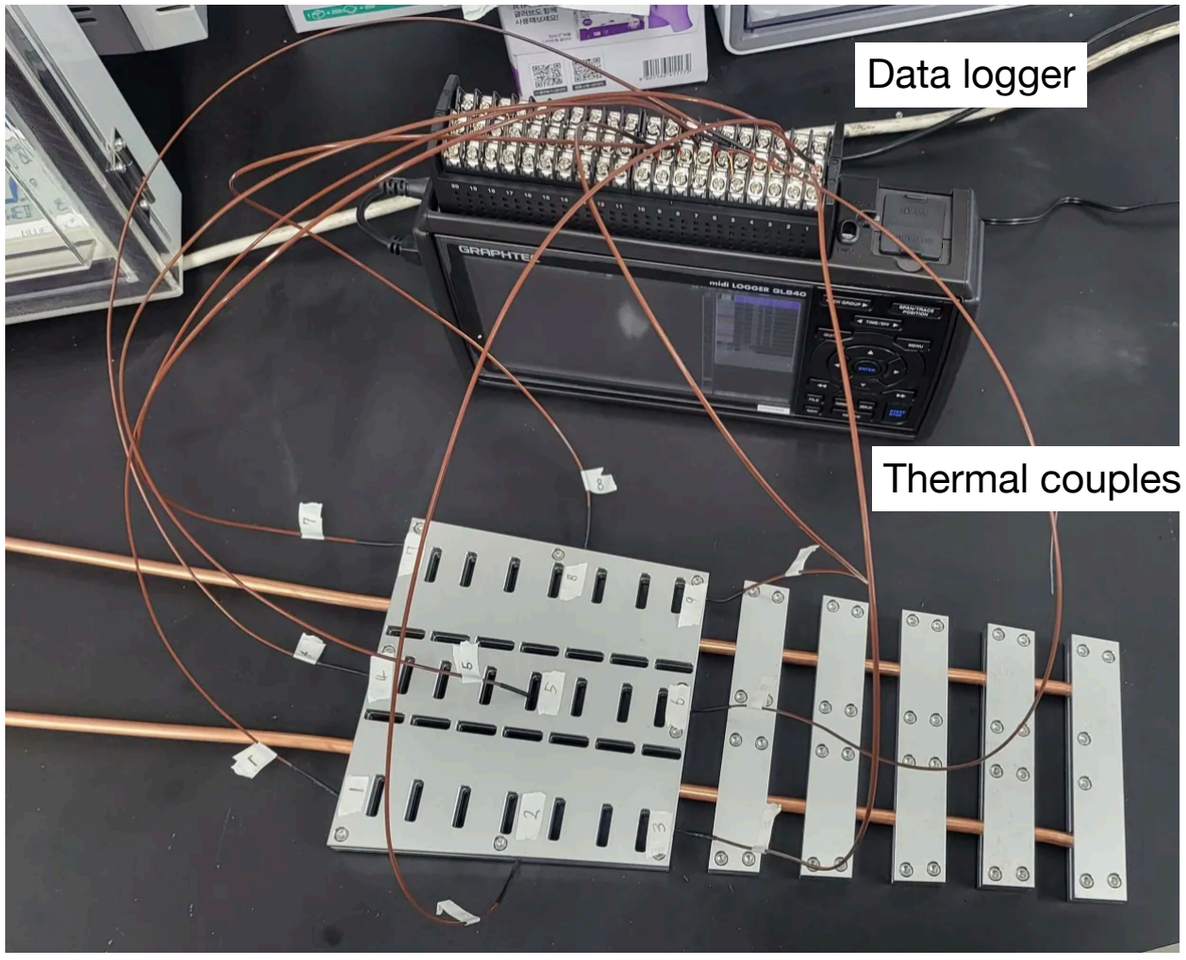
- Cu cooling lines ¼” OD
- Aluminum cold plate thickness ½”

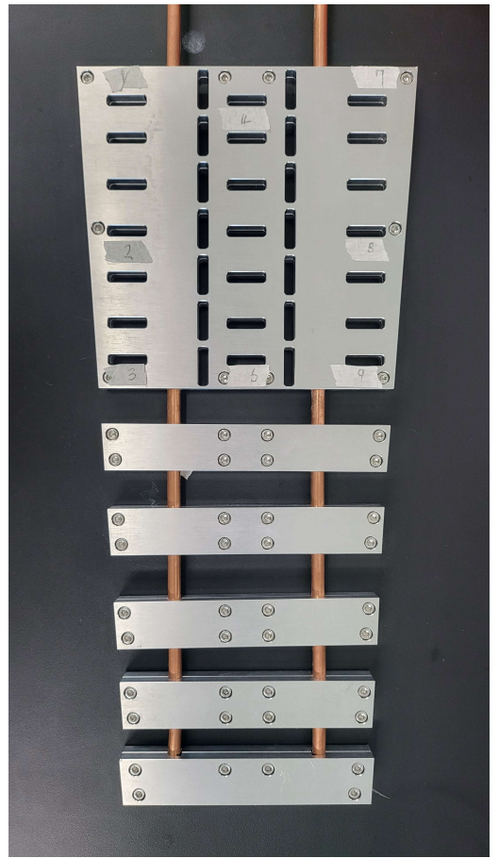
KNU

Cooling R&D

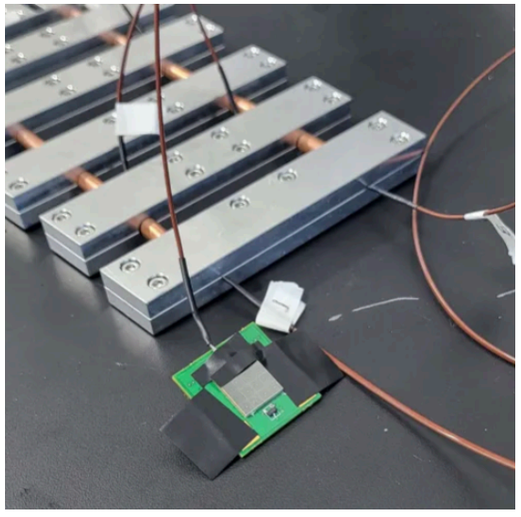
Goal: Temp/Gain Stabilize SiPMs;
Use passive circuit (copy BCAL)

- Water cooling
- Temperature monitoring
- Prototype at KNU





- Water temperature: -25 ~ 150 °C
- flow rate: 0.006 ~ 3400 mL/min

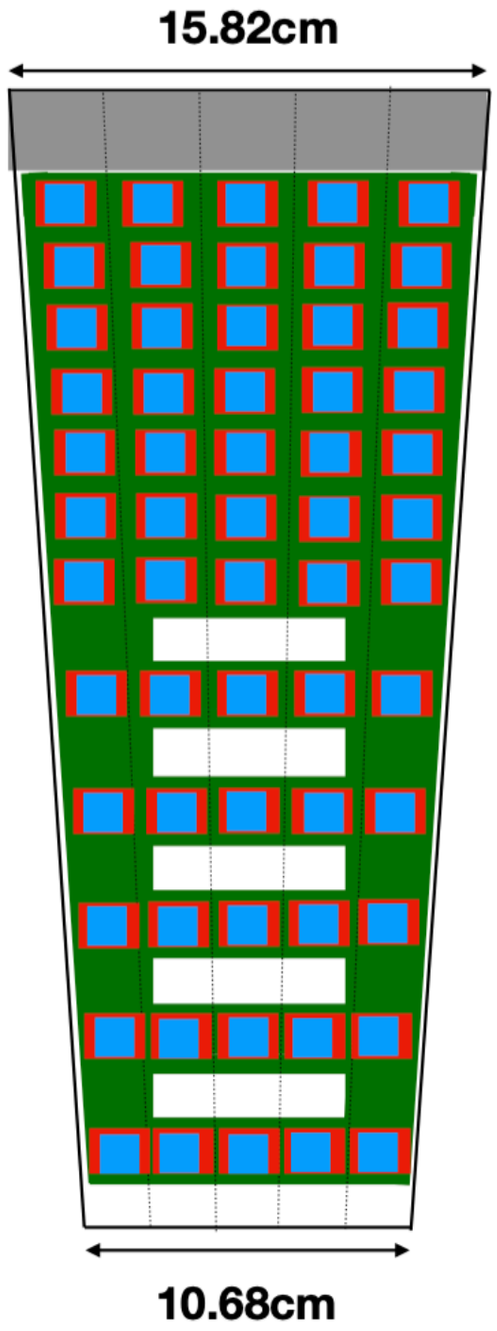


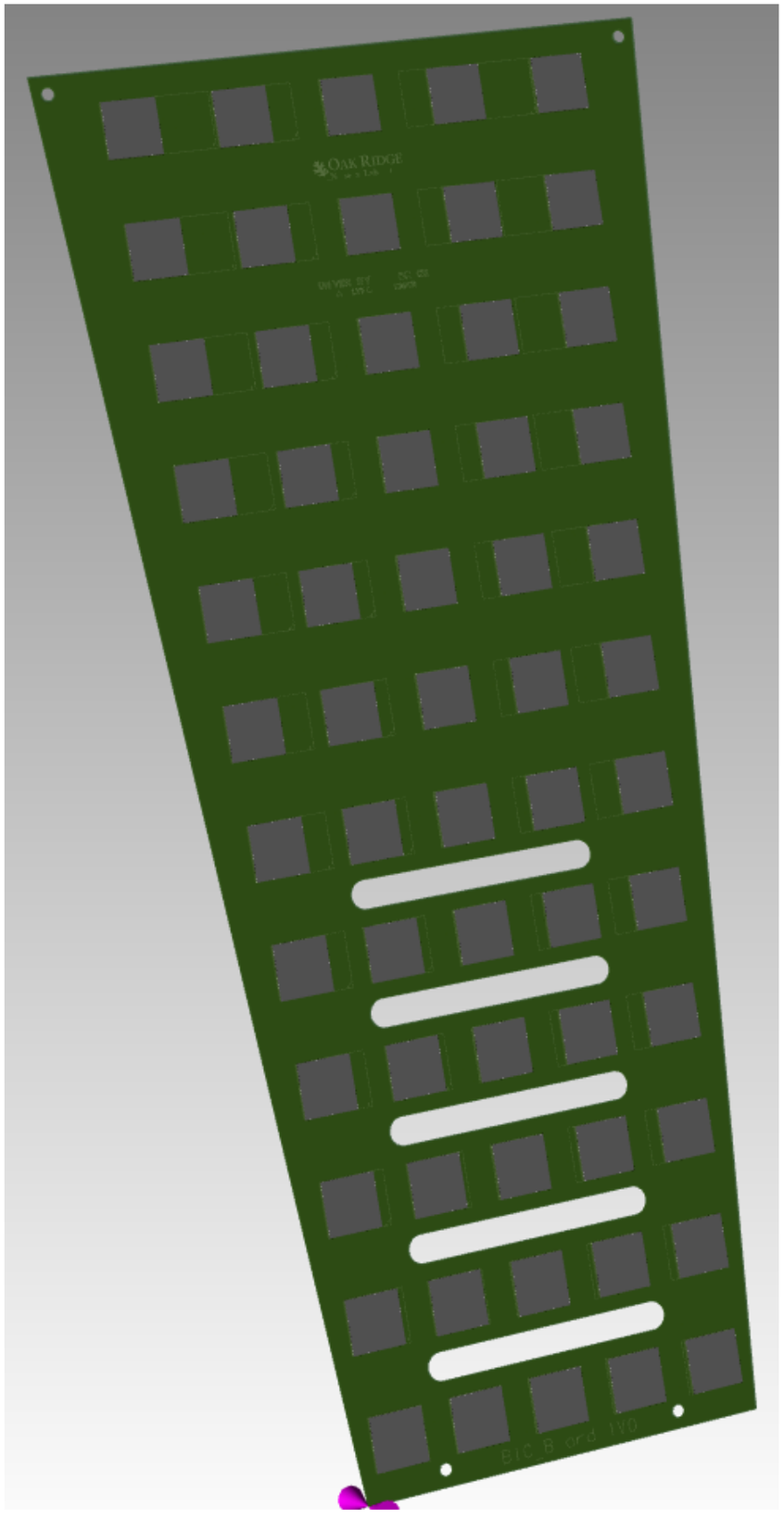
- Ongoing: development and construction of PCB (thermal) test articles for validation of CFD calculations
  - resistive element array distributed at locations of SiPMs

Summary & Looking Ahead

- Mechanical:
  - Baby BCAL - design advanced; **August 2026 (include cooling)**
  - BIC - design over the summer
  - LGs settled; need to make more
- Electronics:
  - HGCROC/readout: JLab beam test
  - Streams at Regina, ORNL, KNU: merge by June BIC workshop at ANL
  - Cooling design advanced

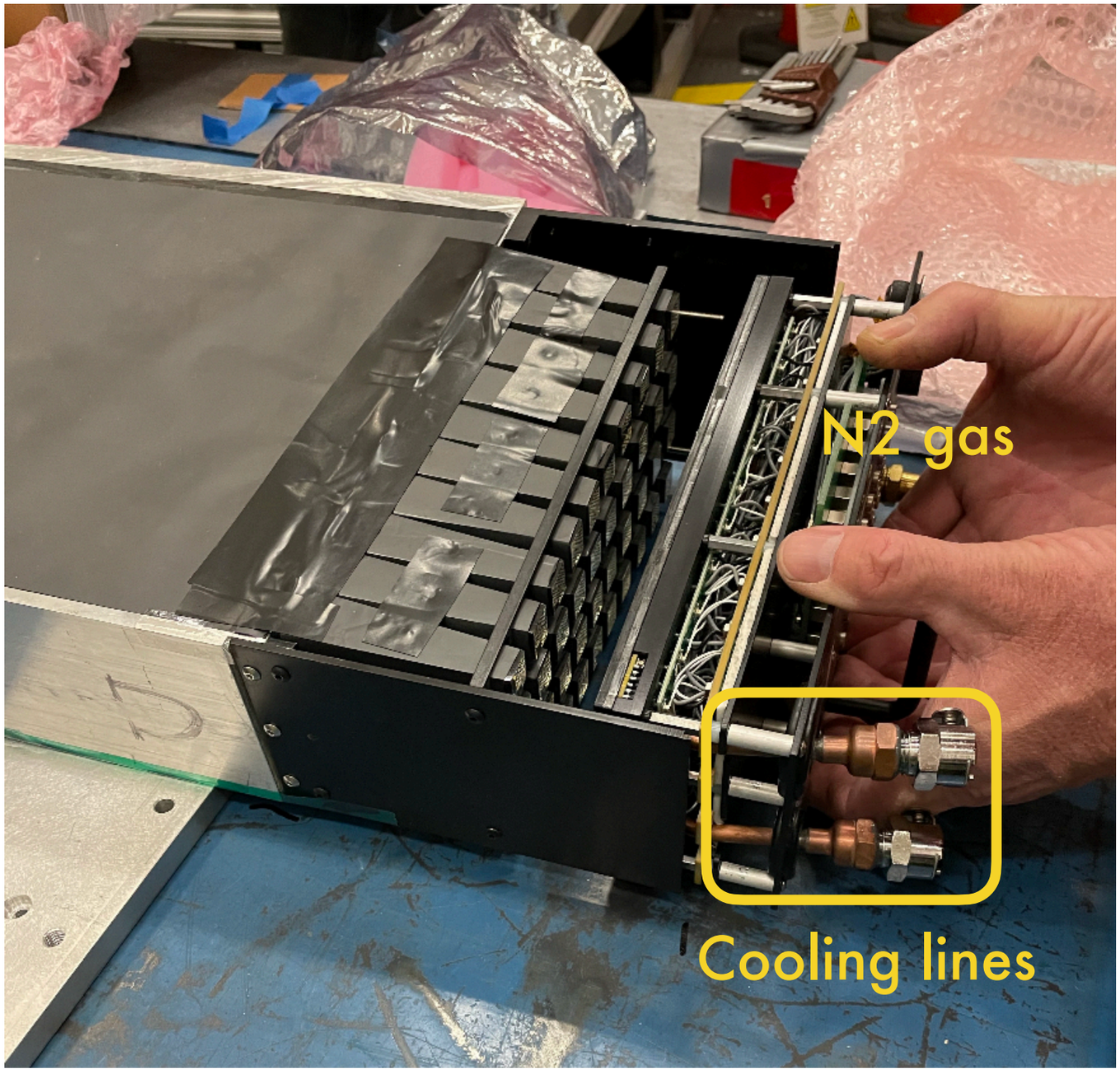
Backup slides





Testing at ORNL

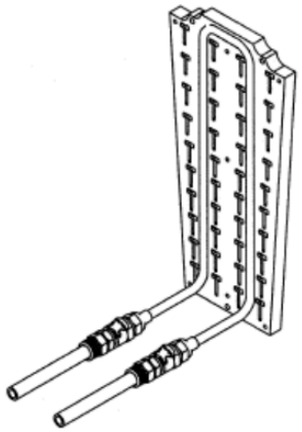
BCAL "Wedges"

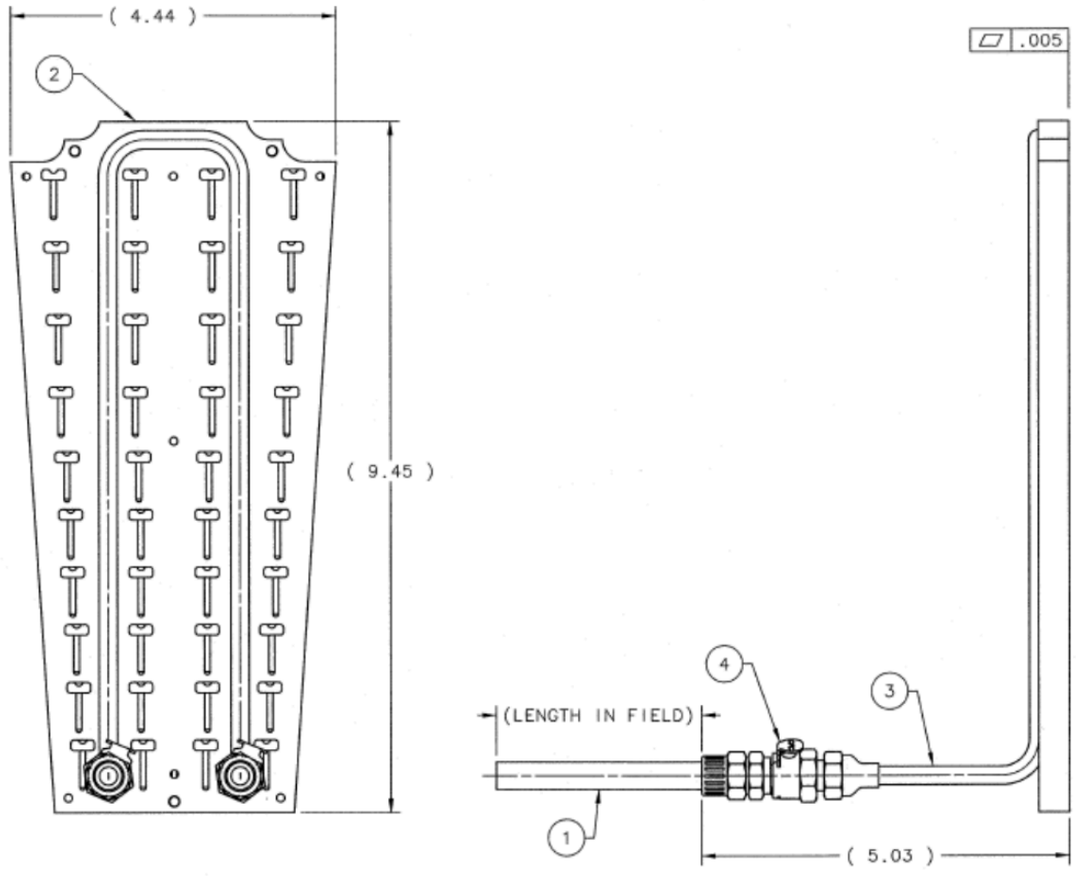


- Contiguous LG stacking
- LG-SiPM air gap
- BIC: Si cookie
- Spring loading
- Integrated ESB for installation ease

Cooling Assembly

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED





NOTES:

1. SUGGESTED SOURCES OR JLAB APPROVED ALTERNATE:

   COLDER PRODUCTS COMPANY
   1-800-444-2474
   www.colder.com

2. SOLDER ITEM 2 TO ITEM 3 IN SUCH A WAY TO ENSURE GOOD THERMAL AND MECHANICAL CONTACT.

4. SOLDERING ITEMS 2 & 3 TOGETHER USING 50/50 TIN-LEAD SOLDER WITH GENERAL PURPOSE FLUX USING ANY STANDARD SOLDERING PROCESS.

5. PROCESS SHOULD ENSURE COMPONENT TEMPERATURES ARE MAINTAINED BELOW 800°F.

6. THOROUGHLY CLEAN ALL FLUXES WITH APPROPRIATE METHODS TO ENSURE REMAINING FLUX IS COMPLETELY REMOVED OR RENDERED NON-CORROSIVE

7. LENGHT OF ITEM 1 TO BE DECIDED IN FIELD TO ALLOW FOR APPROPRIATE LENGTH AND THEN INSTALLED AS SHOWN.

QTY REQD	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	NOTES
2	4	COLDER PRODUCTS MCD1002	1/8 NPT VALVED COUPLING BODY	BRASS	1
1	3	D00000-01-07-2041	COOLING TUBE W/FITTINGS		
1	2	D00000-01-07-2040	COOLING PLATE		
2	1	D00000-01-07-1022	HOSE ASSY		

PARTS LIST

DOCUMENT CONTROL STAMP

MATERIAL: SEE PARTS LIST

FINISH: MACHINED SURFACES 125 UNLESS OTHERWISE NOTED. DEBURR & BREAK ALL SHARP EDGES

DO NOT SCALE DRAWING

DIM & TOL PER ASME Y14.5. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± N/A; DECIMAL .X ± .1, .XX ± .01, .XXX ± .005; ANGLES ± .50°

THIRD ANGLE PROJECTION

TRACKING NO. N/A

APPROVALS	DATE
DRAWN C L HUTTON	01MAR11
CHECKED	21 MAR 11
APPROVED	21 MAR 11
APPROVED	21 MAR 11

United States Department of Energy — Jefferson Lab, Thomas Jefferson National Accelerator Facility — Newport News Virginia

HALL D - GLUEX DETECTOR BARREL CALORIMETER COOLING PLATE ASSY

SIZE D | DWG. NO. D00000-01-07-1021 | REV. –

SCALE 1:1 | USED ON ASSY NO. D00000-01-07-1011 | SHEET 1 OF 1