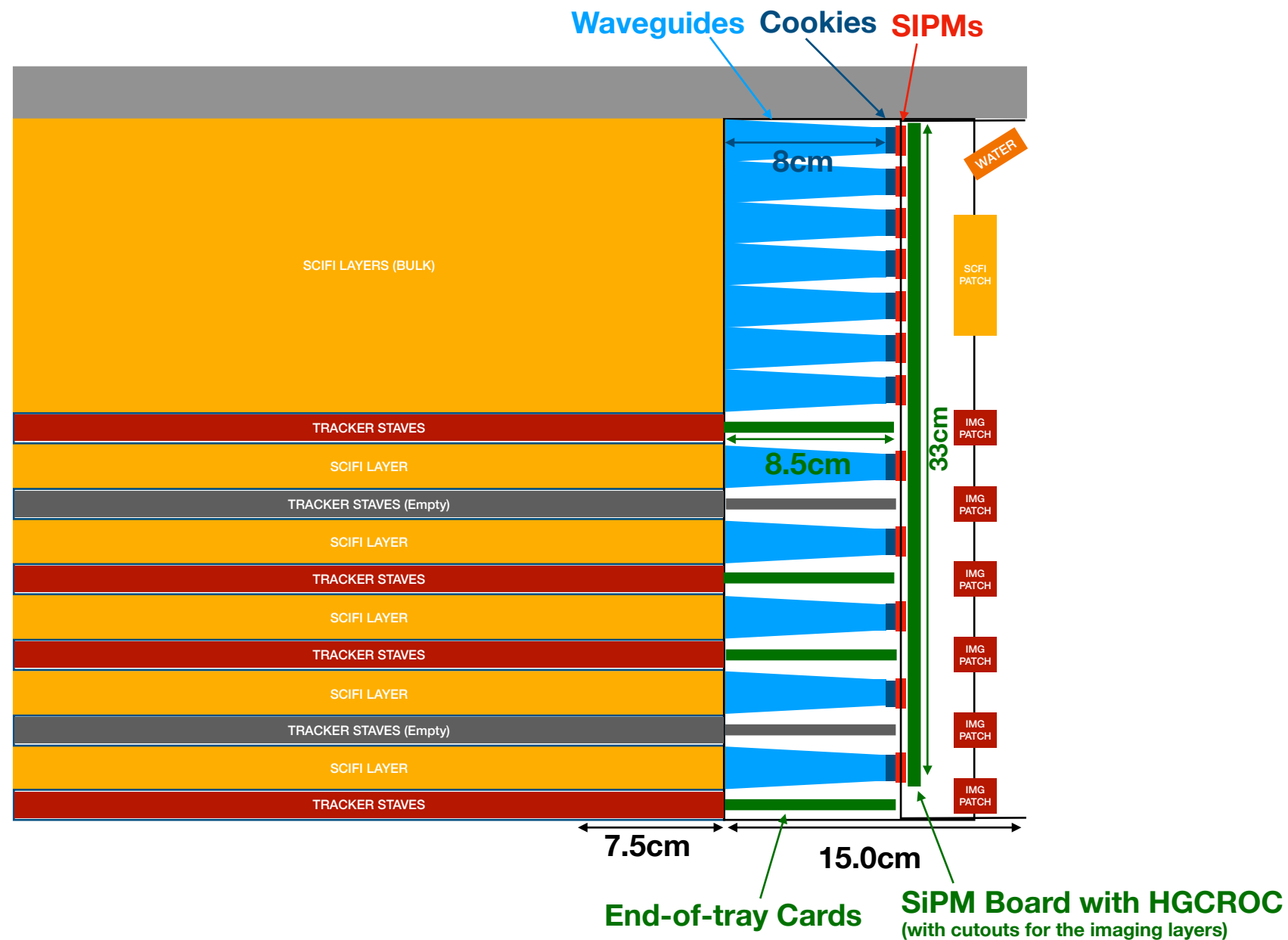


End-of-Sector Boxes Requirements

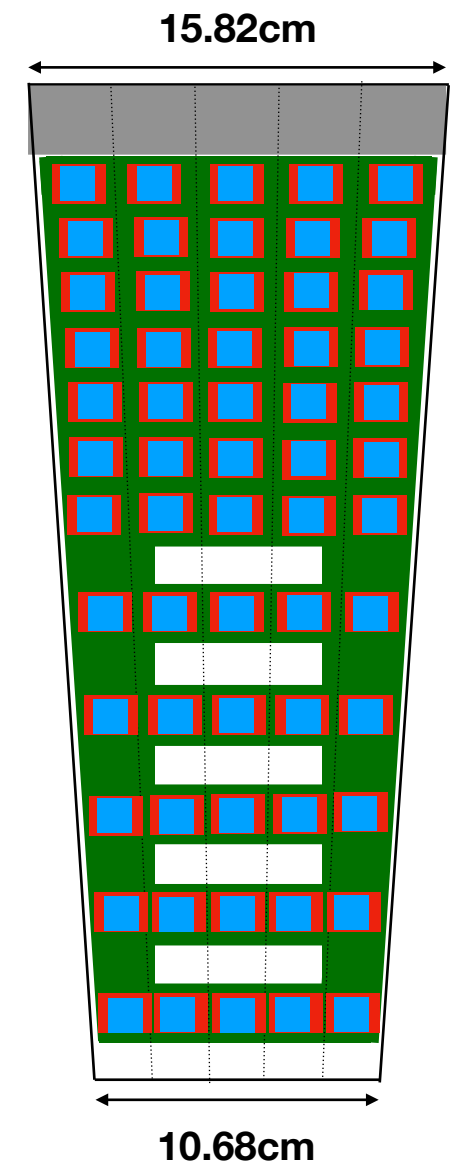
Follow-up & BCAL Electronics

K. Bailey, Z. Papandreou
BIC Meeting
April 26, 2024

Side View for EOSB (12 modules/9 chips scenario)



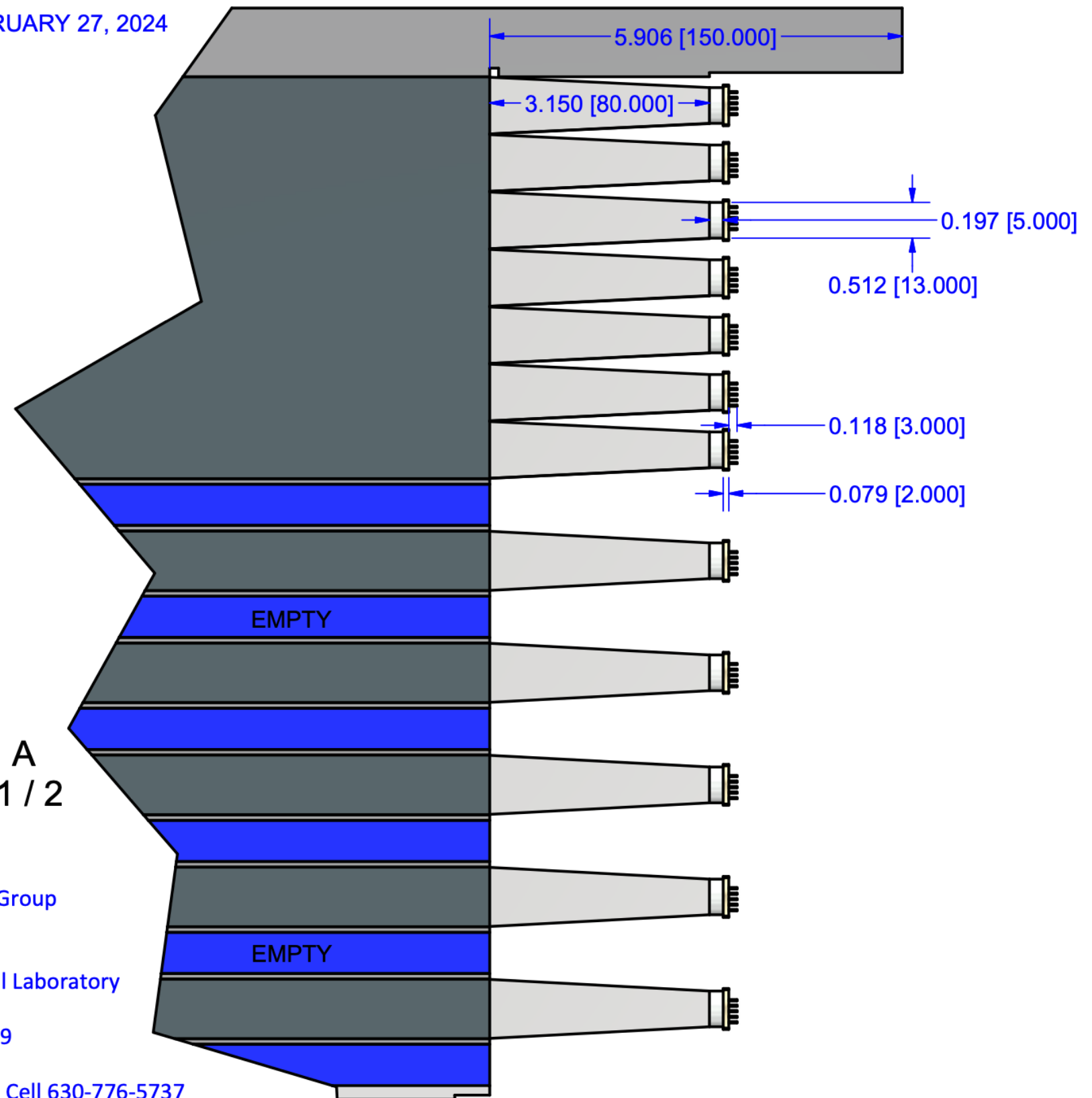
Cross section at SiPM Board



Feb 2024

DETAIL A
SCALE 1 / 2

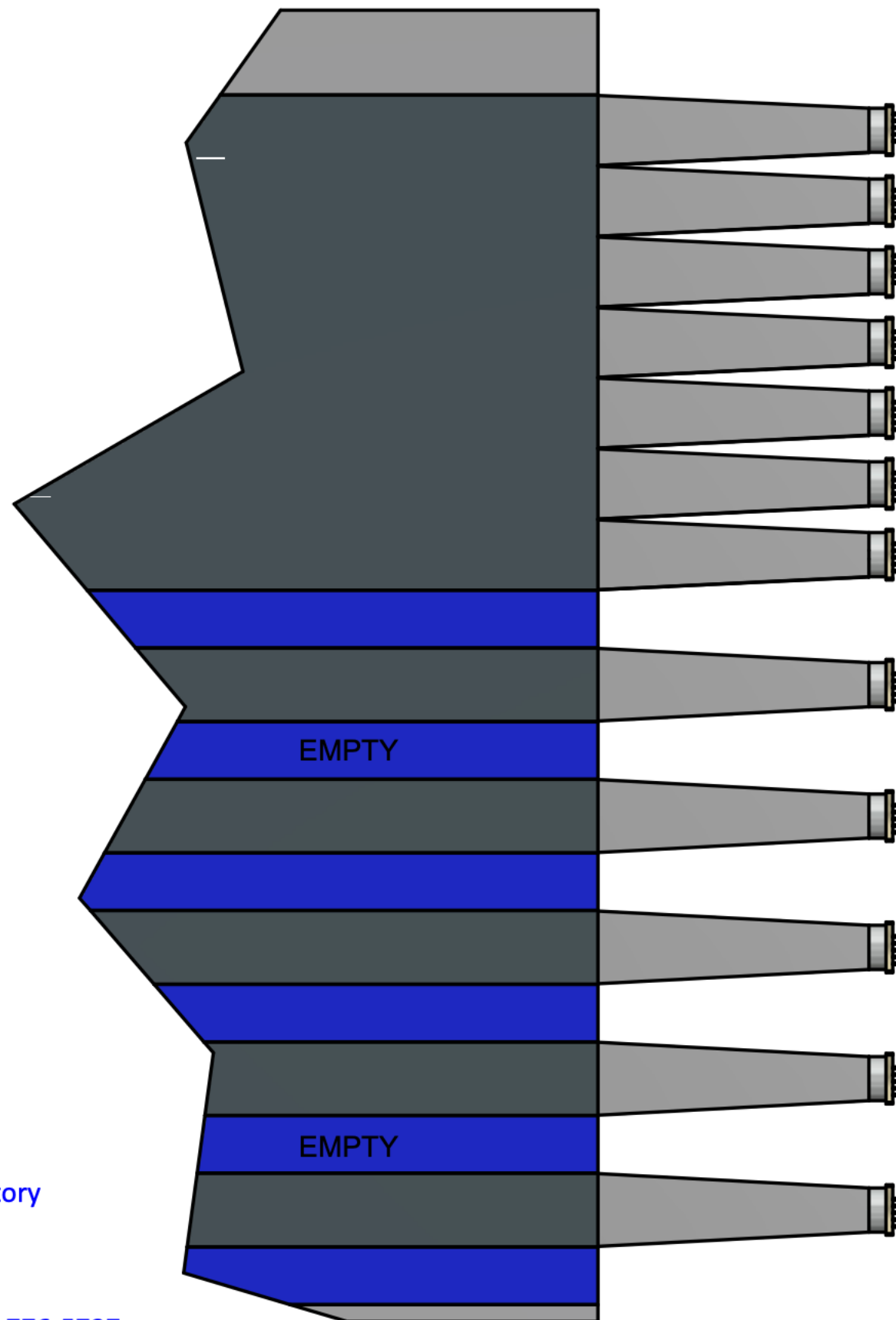
Kevin Bailey
Medium Energy Group
Physics Division
Bldg 203 F-126
Argonne National Laboratory
9700 S Cass Ave
Argonne, IL 60439
630-252-4036
Telecommuting - Cell 630-776-5737



Apr 2024

DETAIL C
SCALE 1 / 2

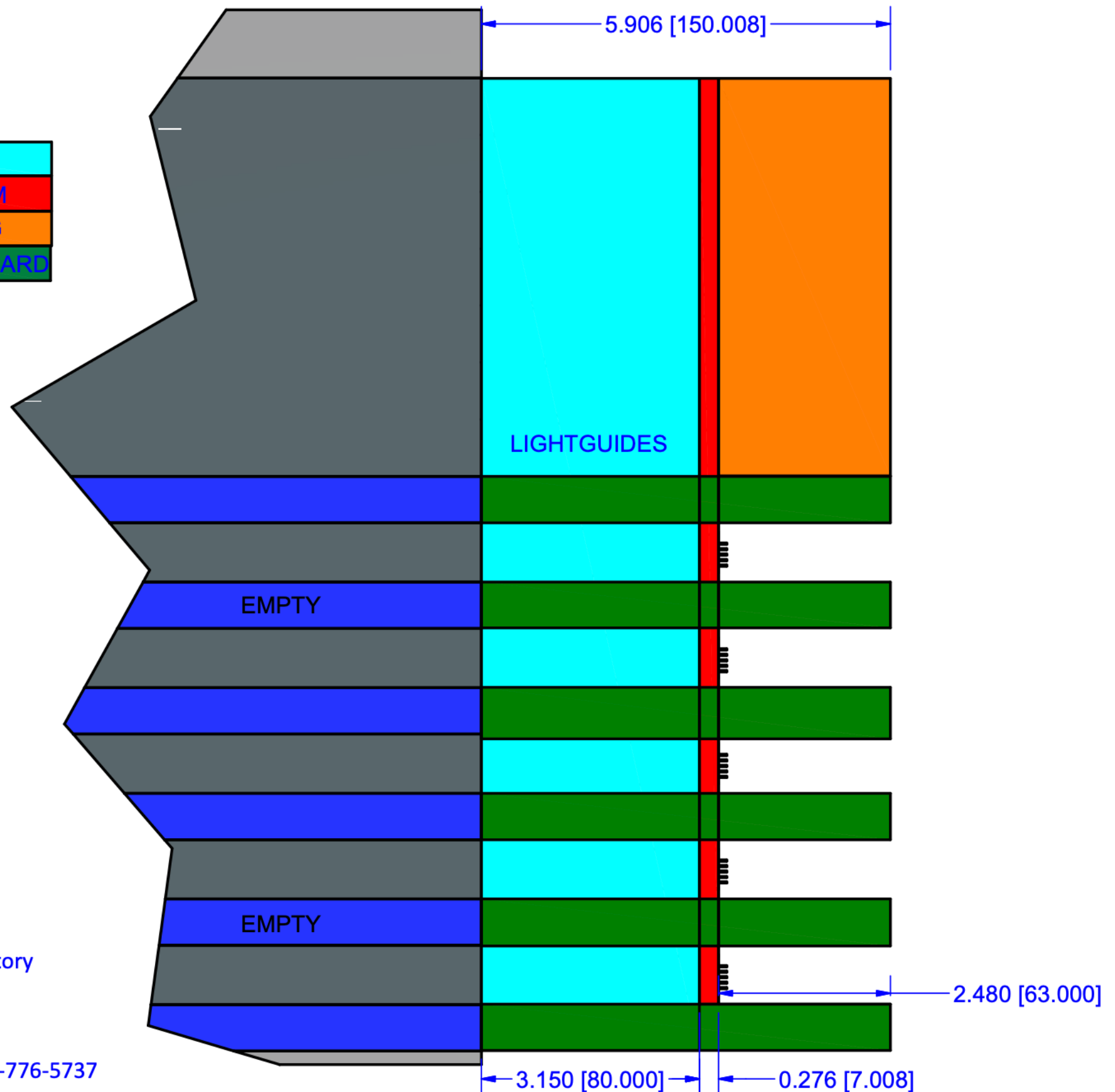
Kevin Bailey
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630-252-4036
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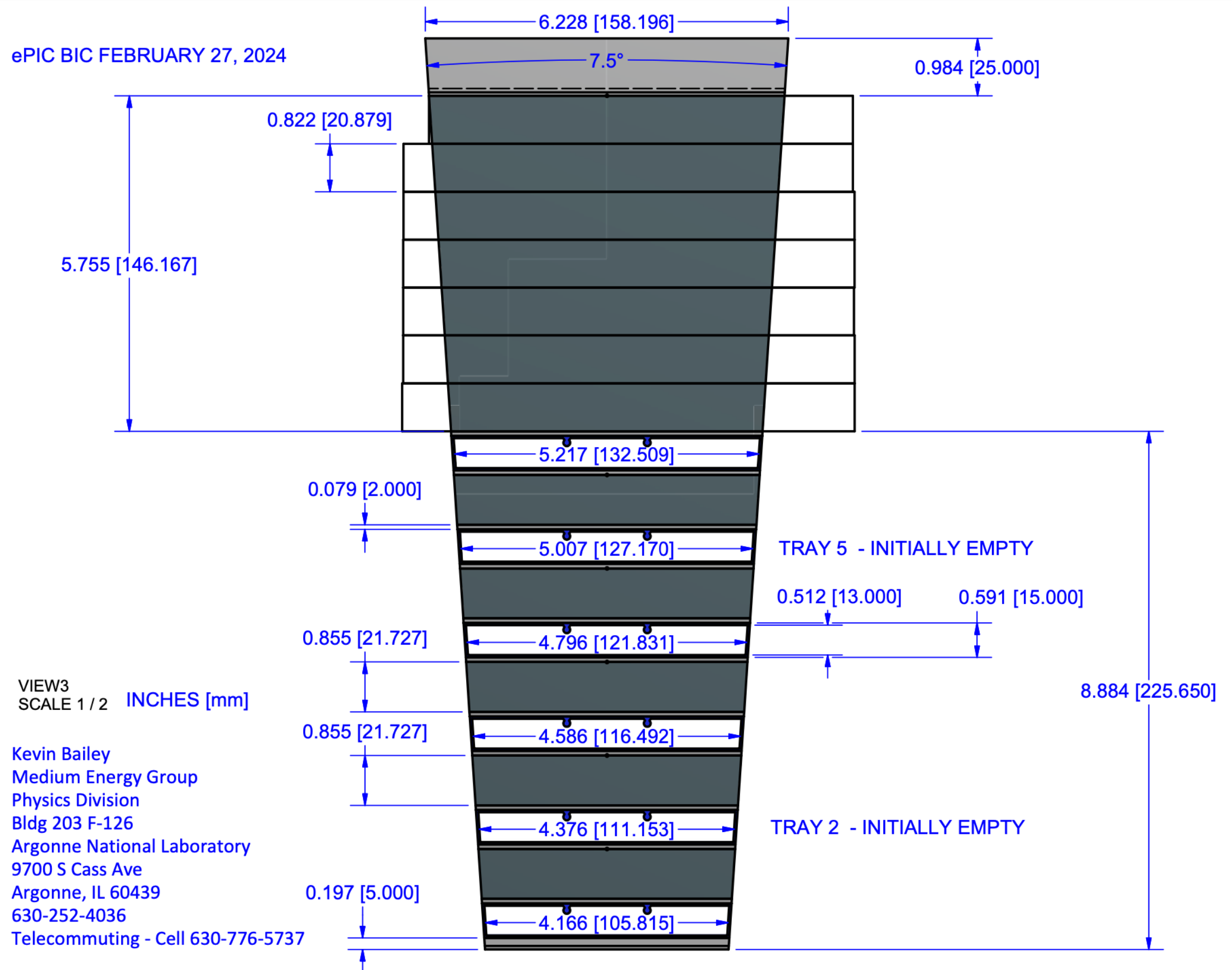
LIGHTGUIDES
COOKIE & SCIPM
PCB & COOLING
END OF TRAY CARD

DETAIL D
SCALE 1 / 2

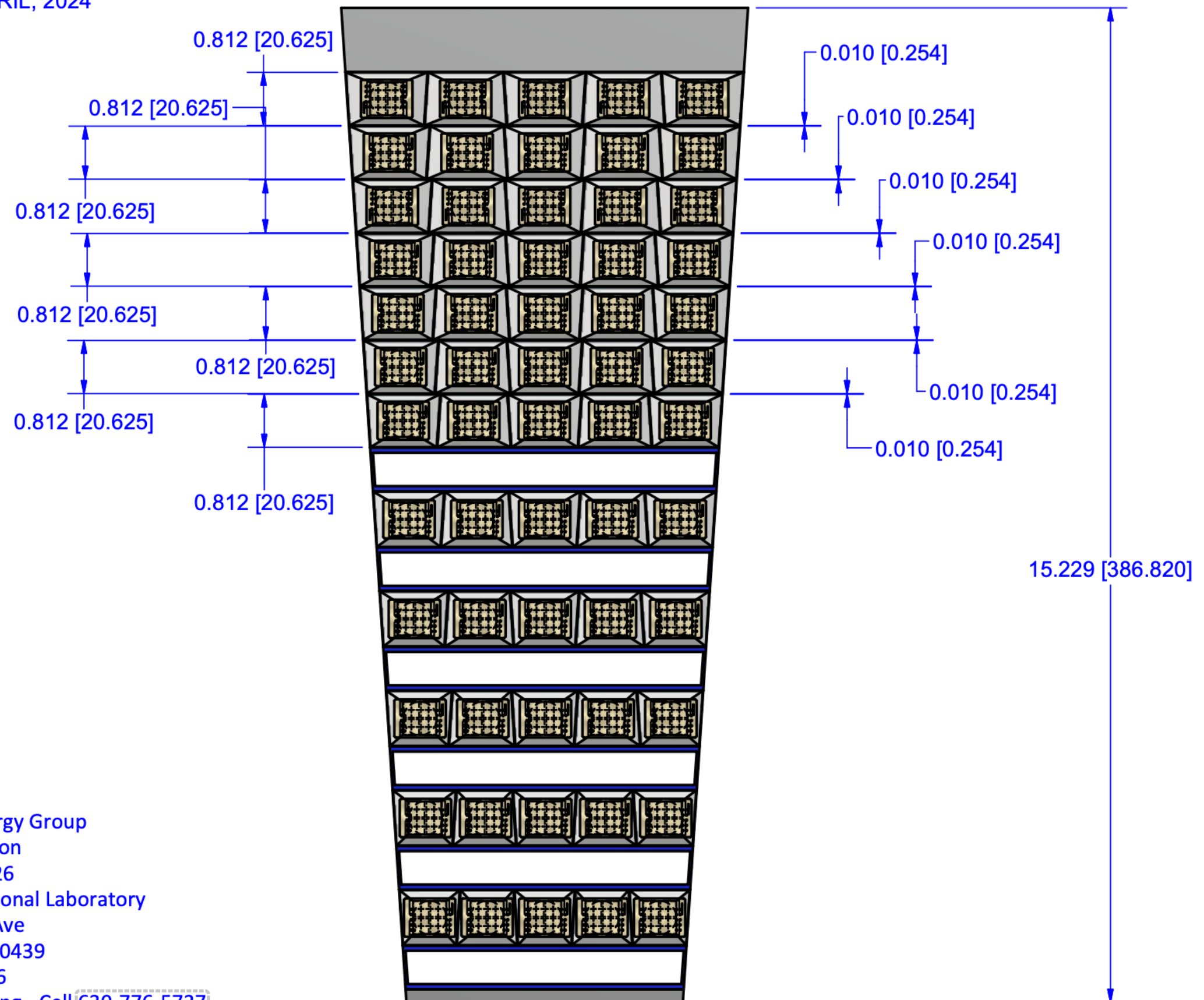
Kevin Bailey
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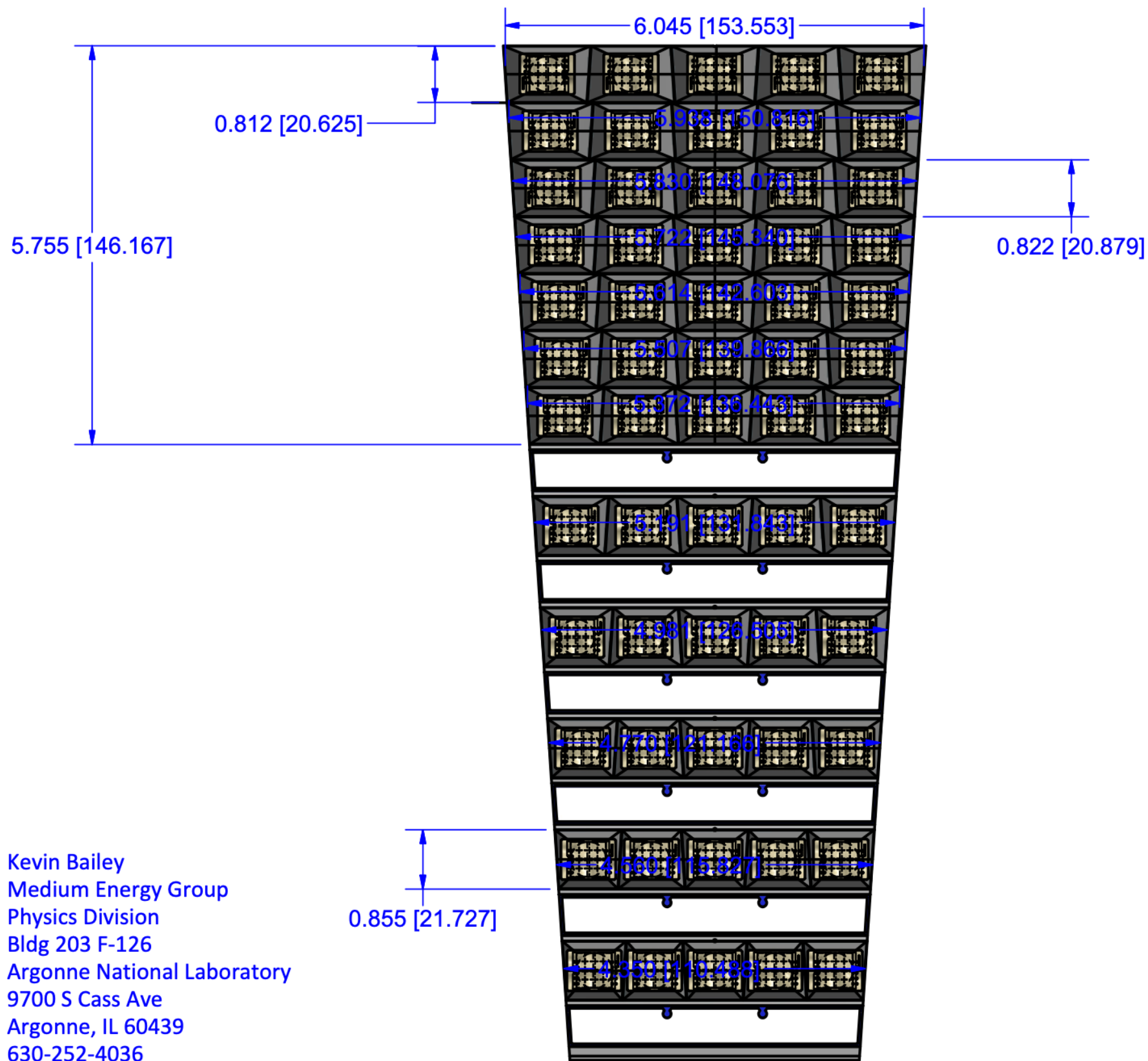
ePIC BIC FEBRUARY 27, 2024



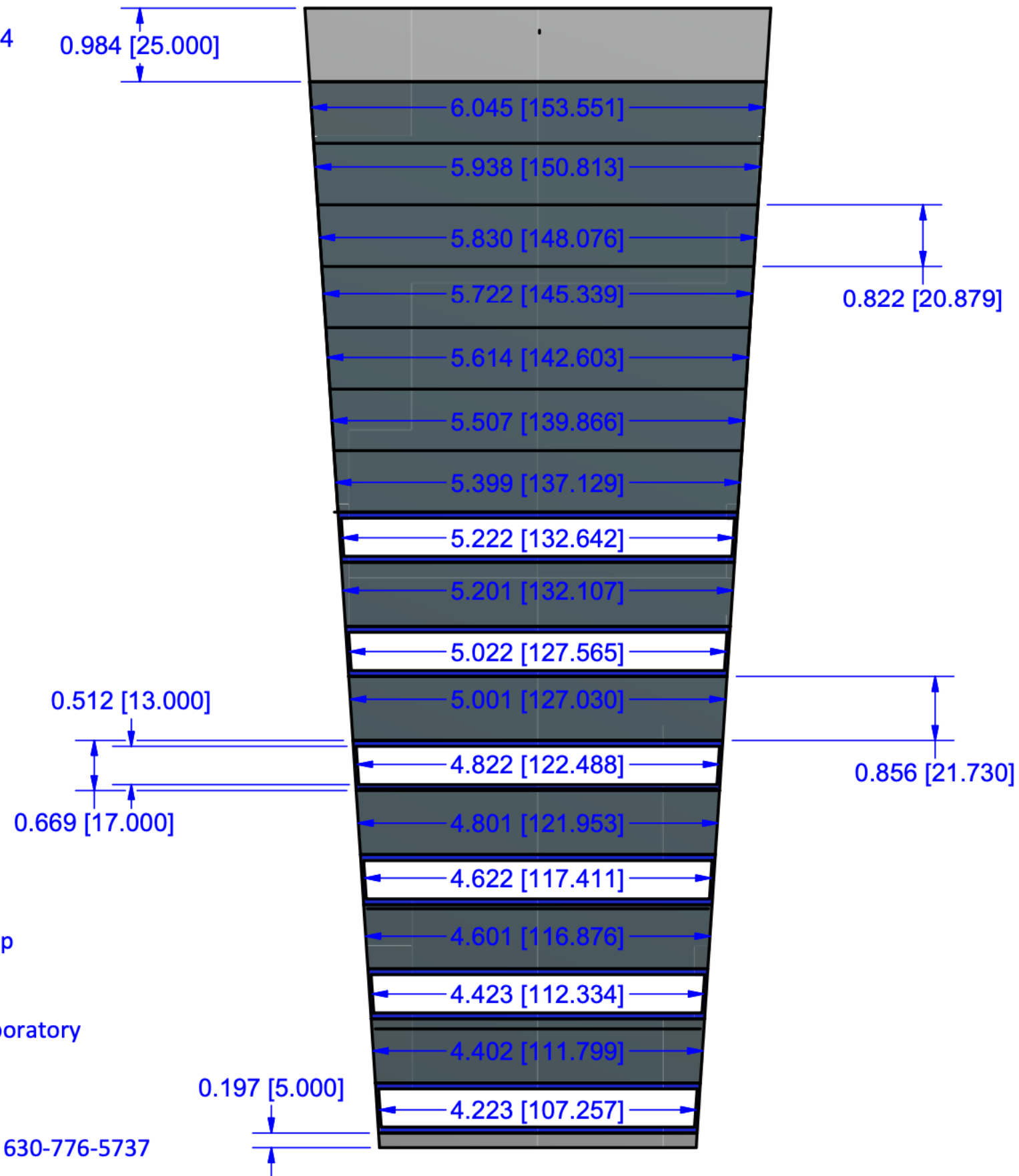
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BCAL Electronics

REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
VAR	A	COMPLETE REDESIGN	CLH 18JAN13	

NOTES:

1. SUGGESTED SOURCE OR JLAB APPROVED ALTERNATE

DIGI-KEY CORPORATION
1-800-344-4539
www.digikey.com

ALLIED ELECTRONICS
(866) 433-5722
WWW.ALLIEDELEC.COM

MCMASTER-CARR
1-630-833-0300
www.mcmaster.com

MICHELL INSTRUMENTS UK
(44) 01353 658000
www.michell.com

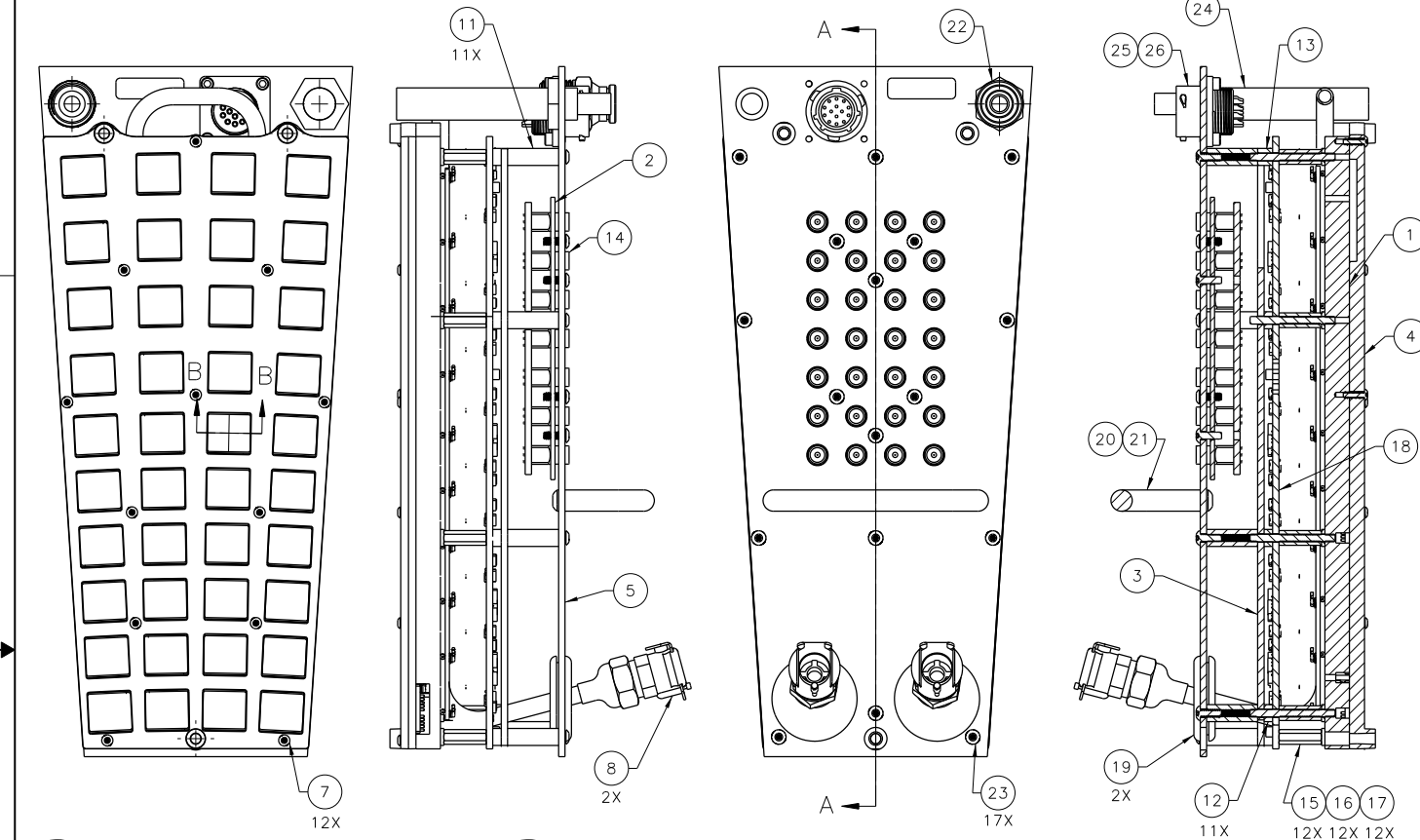
2. ITEMS 22 AND 24 ONLY USED AS NEEDED. WHEN NOT USED, HOLES IN COVER WILL BE PLUGGED.

4	26	MCMASTER-CARR #92196A105	HEX HD CAP SCREW #4-40 X .18 LG	18-8 SS	1
1	25	ALLIED ELECTRONICS 70129601	SO FLANGE RECEPTACLE W/14 PIN CONTACTS (SOURIAU #UTS012E14P)		1
1	24	MICHELL INSTRUMENTS PCMINI-52	HUMIDITY AND TEMP MINI PROBE		1 & 2
17	23	MCMASTER-CARR #92949A107	BUTTON HD CAP SCREW #4-40 X .31 LG	18-8 SS	1
1	22	MCMASTER-CARR #51915K140	PUSH-TO-CONNECT ADAPTER FOR 3/8" TUBE OD X 3/8" NPTF MALE PIPE	VARIOUS	1 & 2
2	21	MCMASTER-CARR #93310A194	BUTTON HD SOC HD CAP SCREWMET #8-32 X 1/2" LG SELF LOCKING	18-8 SS	1
1	20	MCMASTER-CARR #1568A43	ROUND-GRIP PULL HANDLE 3" CTR TO CTR	ALUMINUM	1
2	19	MCMASTER-CARR #9307K76	PUSH-N FLEXIBLE GROMMET 1/4" ID, 1-1/4" OD	RUBBER	1
1	18		AMPLIFIER AND SIGNAL PCB		
12	17	MCMASTER-CARR #90295A346	FLAT WASHER, BLACK #4 SCREW SIZE, .25 OD	NYLON 6/6	1
12	16	MCMASTER-CARR #91115A518	FEMALE HEX STANDOFF, 4-40 3/16 HEX, 5/8 LONG	18-8 SS	1
12	15	MCMASTER-CARR #95412A360	THREADED STUD, FULL THREAD 4-40 X 1.25 LG	18-8 SS	1
1	14		INTERCONNECT PCB ASSEMBLY		
1	13	MCMASTER-CARR #94639A486	SPACER, #4 UNTHREADED 1/4" OD X 7/32 LG	NYLON	1
11	12	MCMASTER-CARR #94639A199	SPACER, #4 UNTHREADED 1/4" OD X 1/8 LG	NYLON	1
11	11	MCMASTER-CARR #93330A437	STANDOFF, #4-40 FEMALE 1/4" OD X 3/4 LG	ALUMINUM	1
40	10		FERNANDOS C-BOARD		
40	9	DIGIKEY CORP 3M9593-ND	THERMAL PAD, 3M 5519/0.5mm THICK	SILICONE	1
2	8	MCMASTER-CARR #5012K75	QUICK DIS-CONNECT COUPLING 1/4" MALE NPT W/VALVE	ACETAL	1
12	7	MCMASTER-CARR #92949A078	BUTTON HD CAP SCREW #2-56 X .31 LG	18-8 SS	1
40	6	HAMAMATSU PHOTONICS K30-F10530	HAMAMATSU SiPM LIGHT SENSOR S10943-0258(X) MPPC ARRAY		
1	5	D00000-01-07-2067	READOUT MODULE COVER PLATE		
1	4	D00000-01-07-2070	SINGLE RADIAL SiPM HOLDER		
1	3	D00000-01-07-2068	HEAT TRANSFER PLATE		
1	2	D00000-01-07-2068	INTERCONNECT PULL PLATE		
1	1	D00000-01-07-1021	COOLING PLATE ASSY		

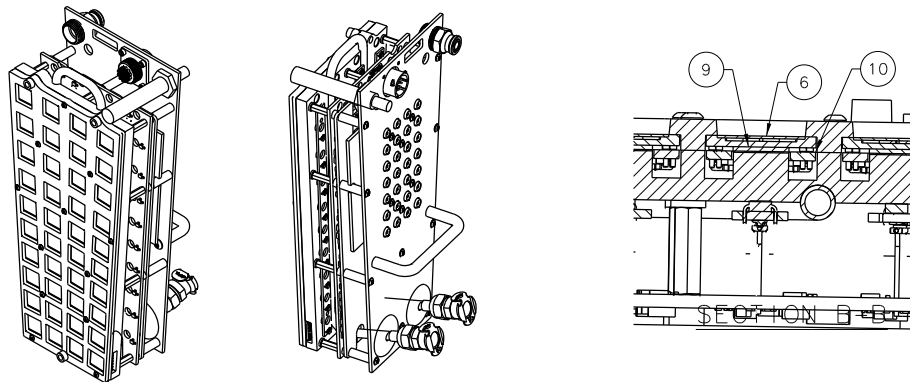
QTY	ITEM	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL SPECIFICATION	NOTES

DOCUMENT CONTROL STAMP		TRACKING NO.		PARTS LIST	
MATERIAL SEE PARTS LIST		APPROVALS DATE		DRAWN C L HUTTON 21MAR11	
FINISH 125 UNLESS OTHERWISE NOTED		CHECKED J FOCHTMAN 25MAR11		APPROVED J FOCHTMAN 25MAR11	
DO NOT SCALE DRAWING		APPROVED T WHITLATCH 28MAR11		SIZE DWG. NO. D00000-01-07-1023	

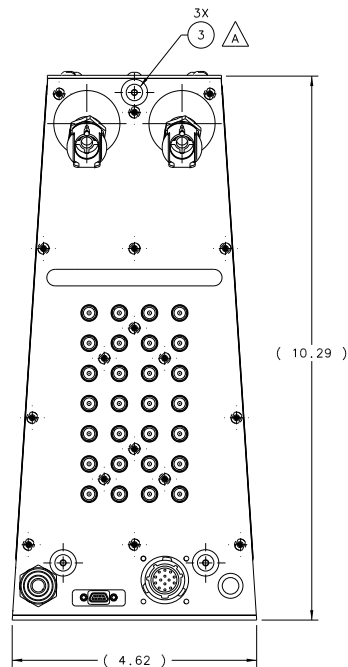
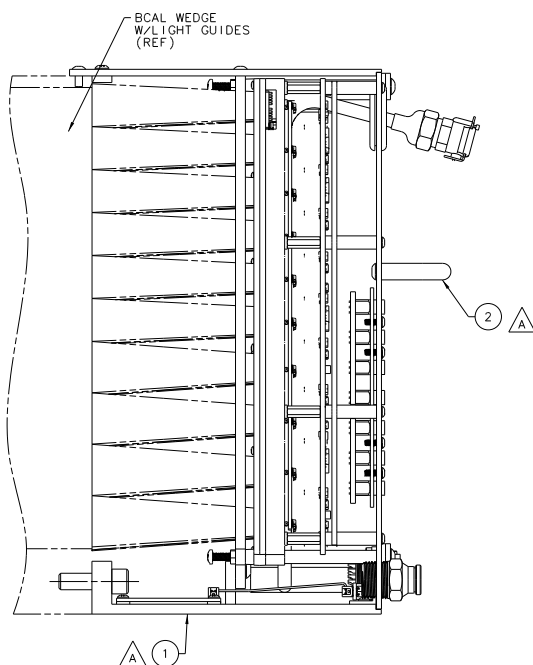
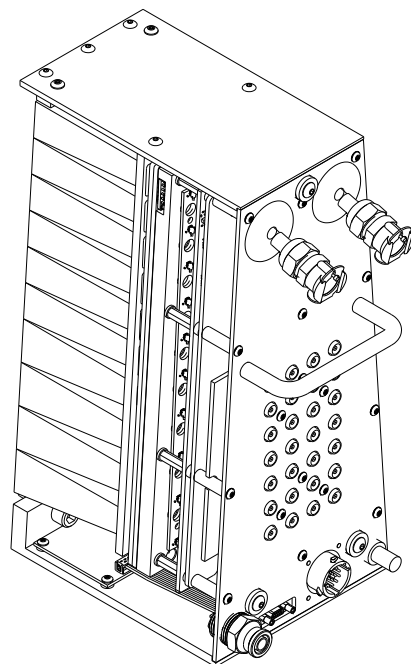
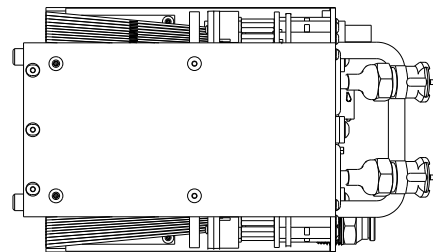
Approved: 01/23/2013; E-Sign ID: 225000; Signed By: Approver 1: T. Whitlatch; Checker: J. Fochtmann; DCG: T. Fuel



GlueX-BCAL Wedge



GlueX-BCAL Wedge



REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
6C, 7B, 3E, 3B	A	UPDATED ITEMS 1 & 2. ITEM 3 WAS SPACER. DELETED ITEMS 4-6 & NOTE 1. DRAWING NAME WAS READOUT MODULE - O GROOVE	04AUG14 04AUG14	R GETZ WHITLATCH

A	3	3	D00000-01-07-2097	BCAL STANDOFF ASSY					
	1	2	D00000-01-07-1023	COOLING/ELEC MODULE					
	1	1	D00000-01-07-1016	CAGE ASSY W/OUT GROOVE					
QTY		ITEM NO.	PART OR IDENTIFYING NO.		MANUFACTURE OR DESCRIPTION		MATERIAL SPECIFICATION	NOTES	
PARTS LIST									
EACH SHEET OF MULTI-SHEET DRAWINGS SHALL ALWAYS HAVE THE SAME REVISION LEVEL.									
DOCUMENT CONTROL STAMP				TRACKING NO. N/A	United States Department of Energy		Jefferson Lab HALL D - GLUEX DETECTOR BARREL CALORIMETER READOUT MODULE ASSY	Import / News Virginia	
IF FINISH UNLESS OTHERWISE NOTED DEBURR & BREAK ALL SHARP EDGES DO NOT SCALE DRAWING				THIRD ANGLE PROJECTION	APPROVALS		DATE		
				DRAWN	HUTTON		01NOV10	HALL D - GLUEX DETECTOR BARREL CALORIMETER READOUT MODULE ASSY	A
				CHECKED	FOOTMAN		25MAR11		
				APPROVED	FOOTMAN		25MAR11		
				APPROVED	WHITLATCH		20MAR11		
				SIZE (DWG. NO.)		E D00000-01-07-1011			
SCALE		1:1		SHEET 1 OF 1					

Wire Legends

ISEG to Chassis (50 ft) Bias

Cable (3M 3600B/36 300 [300]ft , 3600B/36 100 [100ft]) + 1 REDEL + 1 D-SUB 44 - X3

TOTAL = 3 x 4 x 2 = 24

44 Pin DSub	Redel	Wire Color	
		Solid	/ Band
1	HV0	Black	Red
2	HV1	Red	Black
3	HV2	Black	White
4	HV3	White	Black
5	HV4	Black	Green
6	HV5	Green	Black
7	HV6	Black	Blue
8	HV7	Blue	Black
9	HV8	Black	Yellow
10	HV9	Yellow	Black
11	HV10	Black	Brown
12	HV11	Brown	Black
13	HV12	Black	Orange
14	HV13	Orange	Black
15	HV14	Red	White
16	RTN0	White	Red
17	RTN1	Red	Green
18	RTN2	Green	Red
19	RTN3	Red	Blue
20	RTN4	Blue	Red
21	RTN5	Red	Yellow
22	RTN6	Yellow	Red
23	RTN7	Red	Brown
24	RTN8	Brown	Red
25	RTN9	Red	Orange
26	RTN10	Orange	Red
27	RTN11	Green	White
28	RTN12	White	Green
29	RTN13	Green	Blue
30	RTN14	Blue	Green
31	SL0	Green	Brown
32	SL1	Brown	Green
37	CABLE SHIELD	CABLE SHIELD	
43	RTN15	Green	Yellow
44	HV15	Yellow	Green

CONFIDENTIAL INFORMATION The information in this document shall not be disclosed, copied nor disseminated unless authorized by the authors.				
Drawn FJB	Date: 4/26/2024	Title BCAL LV Distribution Notes		
Checked	Date:			
Approved		Size: B	Drawing Number: 2	Revision:
Engineer FJ Barbosa		File: M:\hall-d-electronics\PCBs\LV DISTRIBUTION\BCAL\LV2_Dst_#BCAL_BCAL Bias V	Sheet of	

Wire Legends

Chassis to BCAL Wedge (12ft)

Cable (Alpha 6347 SL001) + 2 Trim-Trio -
X12-(UTS6JC12E14S-Sockets, UTS6JC12E14P-Pins)
TOTAL = 12 x 4 x 2 = 96

Trim Trio Designator(Both Ends)

A
B
C
D
E
F
H
J
K
L
M
N
P
R

Wire Color

Black
White
Red
Green
Orange
Blue
White/Black
Red/Black
Green/Black
Orange/Black
Blue/Black
Black/White
Red/White
Green/White

BCAL LV Distribution

One BCAL quadrant
12 BCAL Wedges per BCAL LV Distribution Chassis
U - 4 Chassis
D - 4 Chassis
TOTAL = 8 Chassis

BCAL LV Distribution Chassis:

Inputs Connectors:
Preamp Power - D-SUB 37 - To WIENER 8008 module (8 channels = 4 +5V, 4 -5V : one of each are spares)
1 WIENER 8008
2 D-SUB 37(FCI 10090096-P374VLF [Male])

Bias - D-SUB 44 - To ISEG module (16 channels [HV + RTN] plus 2 SL [Safety loop])
3 ISEG 100V
3 D-SUB 44 (FCI 10090928-P444XLF [Male], 10090770-S444ALF [Female], 8655MH2501BLF [Hood])

Output Connectors:
Preamp Power + Bias + RTD
1 Trim-Trio Connector per BCAL Wedge
12 (Souriau UTS012E14S [Panel], UTS6JC12E14P [Cable, Male], UTS6JC12E14S [Cable,Female])

1 D-SUB 50 - To RTD Readout
1 D-SUB 50 (Norcomp 171-050-113R911 [Male])

Cable Assemblies:
8008 to Chassis (50 ft) Power
Cable (Alpha 1299/37C SL001 [1000]ft) + 2 D-SUB 37 - X2
TOTAL = 2 x 4 x 2 = 16

ISEG to Chassis (50 ft) Bias
Cable (3M 3600B/36 300 [300]ft , 3600B/36 100 [100ft]) + 1 REDEL + 1 D-SUB 44 - X3
TOTAL = 3 x 4 x 2 = 24

Chassis to BCAL WEdge (12ft)
Cable (Alpha 6347 SL001) + 2 Trim-Trio - X12-(UTS6JC12E14S-Sockets, UTS6JC12E14P-Pins)
TOTAL = 12 x 4 x 2 = 96

Wire Legends

BCAL Power Wire (50ft)

Cable (Alpha 1299/37C SL001 [1000]ft) + 2 D-SUB 37 - X2

TOTAL = 2 x 4 x 2 = 16

37 pin DSub/Pins	37 pin DSub/Sockets	Wire Color
1	1	Black
20	20	Red
2	2	White
21	21	Green
3	3	Orange
22	22	Blue
4	4	Brown
23	23	Yellow
5	5	Violet
24	24	Slate
6	6	Pink
25	25	Tan
7	7	Red/Green
26	26	Red/Yellow
8	8	Red/Black
27	27	White/Black
9	9	White/Red
28	28	White/Green
10	10	White/Yellow
29	29	White/Blue
11	11	White/Brown
30	30	White/Orange
12	12	White/Slate
31	31	White/Violet
13	13	White/Black/Red
32	32	White/Black/Green
14	14	White/Black/Yellow
33	33	White/Black/Blue
15	15	White/Black/Brown
34	34	White/Black/Orange
16	16	White/Black/Slate
35	35	White/Black/Violet
17	17	White/Black/Black
36	36	White/Red/Black
18	18	
37	37	
19	19	

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Drawn FJB	Date: 4/26/2024	Title BCAL LV Distribution Notes		
Checked	Date:			
Approved		Size: B	Drawing Number: 2	Revision:
Engineer FJ Barbosa		File: M:\hald-electronics\PCBs\LV DISTRIBUTION\BCAL\LV2 Dist_BCAL_		Sheet of 2

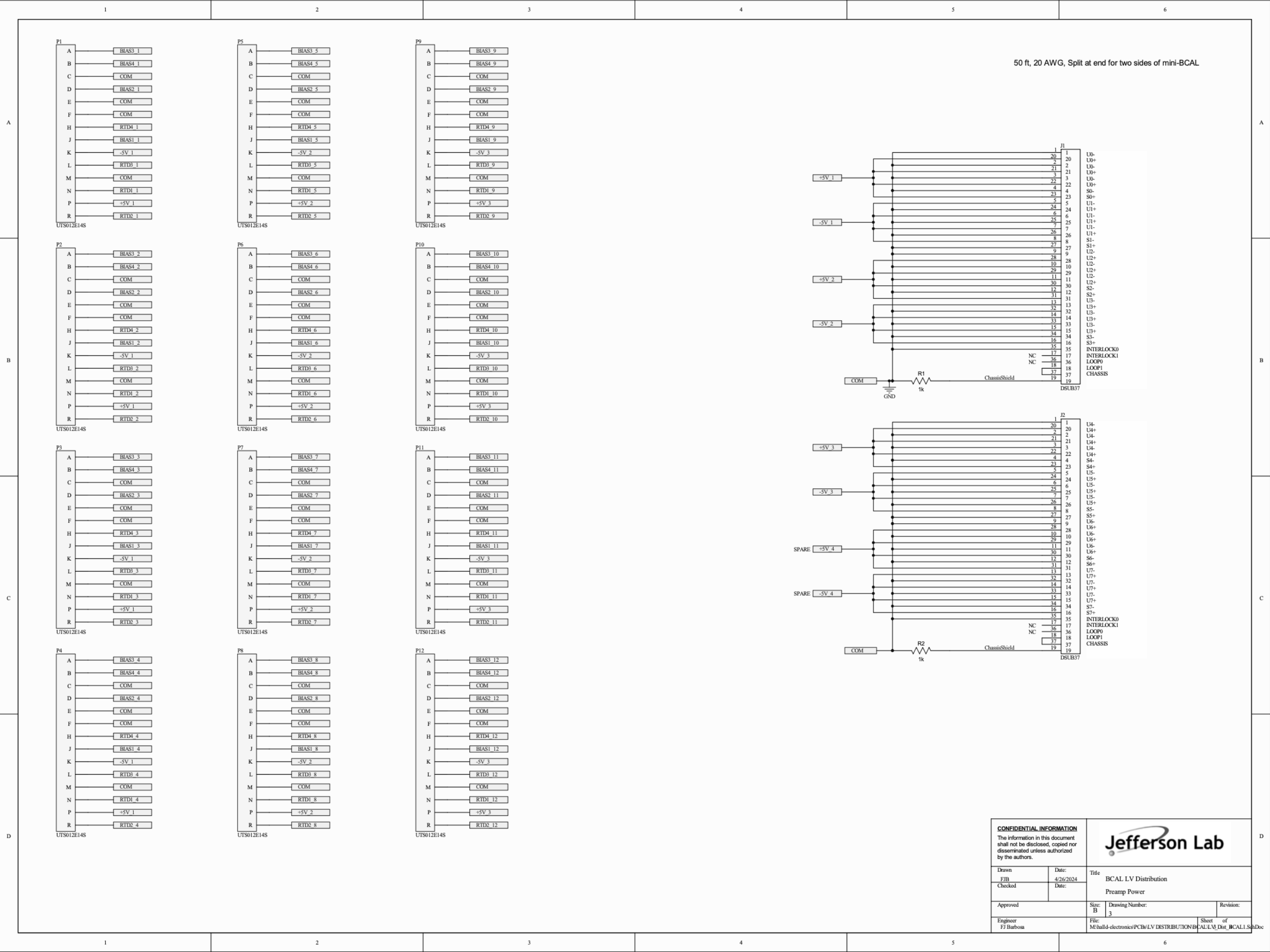
Wire Legends

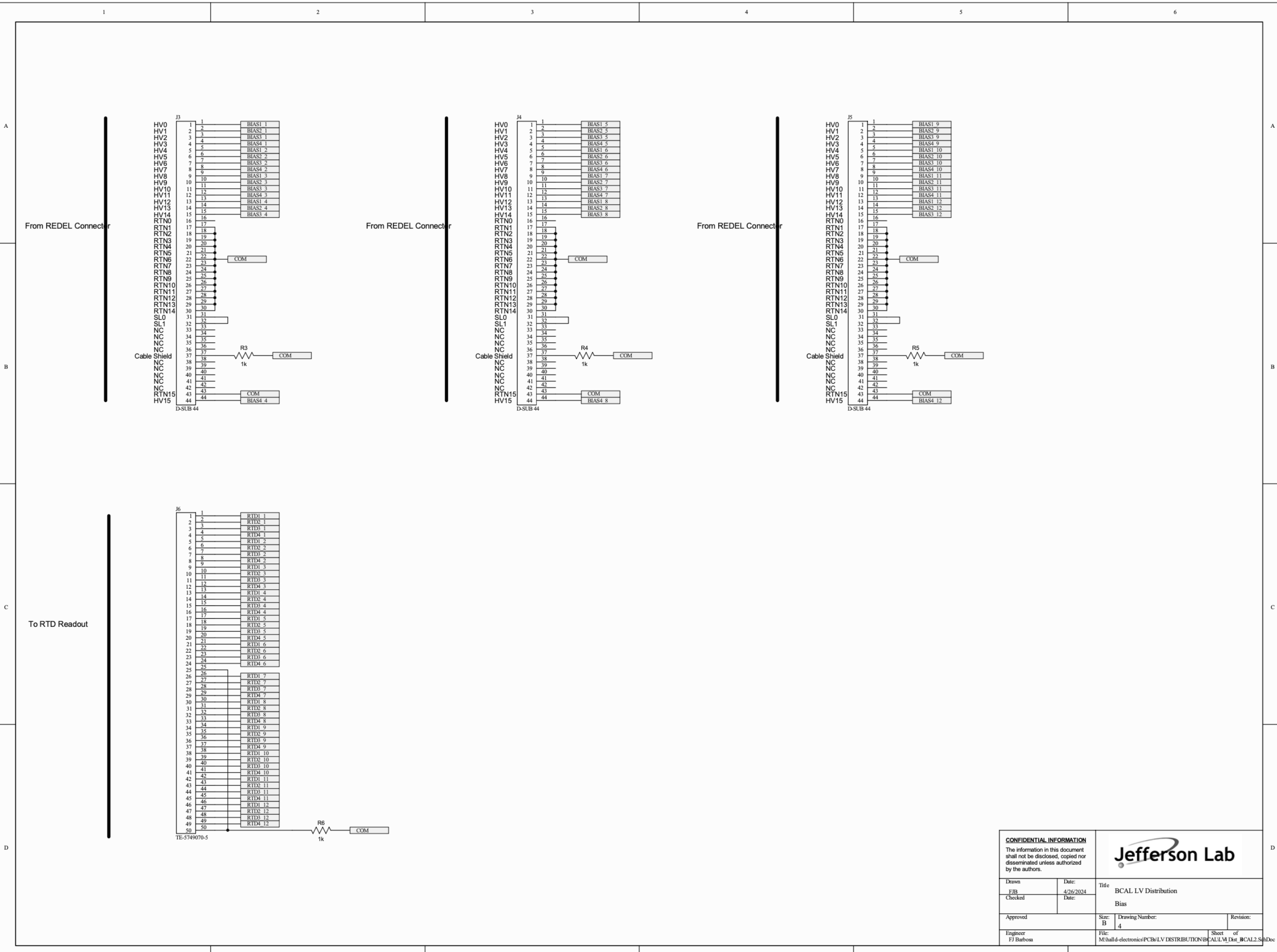
Trim Trio on BCAL Wedge to PCB-(UTS012E14P)

Trim Trio Designator	Wire Color	Part Number
A	Grey-(Bias)	5854/7 SL005
B	White-(Bias)	5854/7 WH005
C	Black-(Bias)	5854/7 BK005
D	Yellow-(Bias)	5854/7 YL005
E	Black-(Bias)	5854/7 BK005
F	Black-(Power)	5855 BK005
H	White	5852 WH005(White)
J	Red-(Bias)	5854/7 RD005
K	White-(Power)	5855 WH005
L	Black	5852 BK005(Black)
M	Black-(Power)	5855 BK005
N	Yellow	5852 YL005(Yellow)
P	Red-(Power)	5855 RD005
R	Red	5852 RD005(Red)

Bias Wires 5852 WH005(White), 5852 BK005(Black)
5852 RD005(Red), 5852 YL005(Yellow)

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Drawn FJB	Date: 4/26/2024	Title BCAL LV Distribution Notes		
Checked	Date:			
Approved		Size: B	Drawing Number: 2	Revision:
Engineer FJ Barbosa		File: M:\hall-d-electronics\PCBs\LV DISTRIBUTION\BCAL LV Dist	Sheet 2	of BCAL Trim Trio on





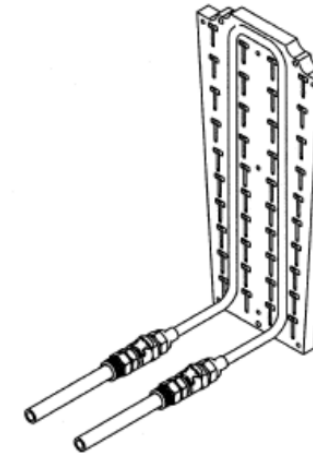
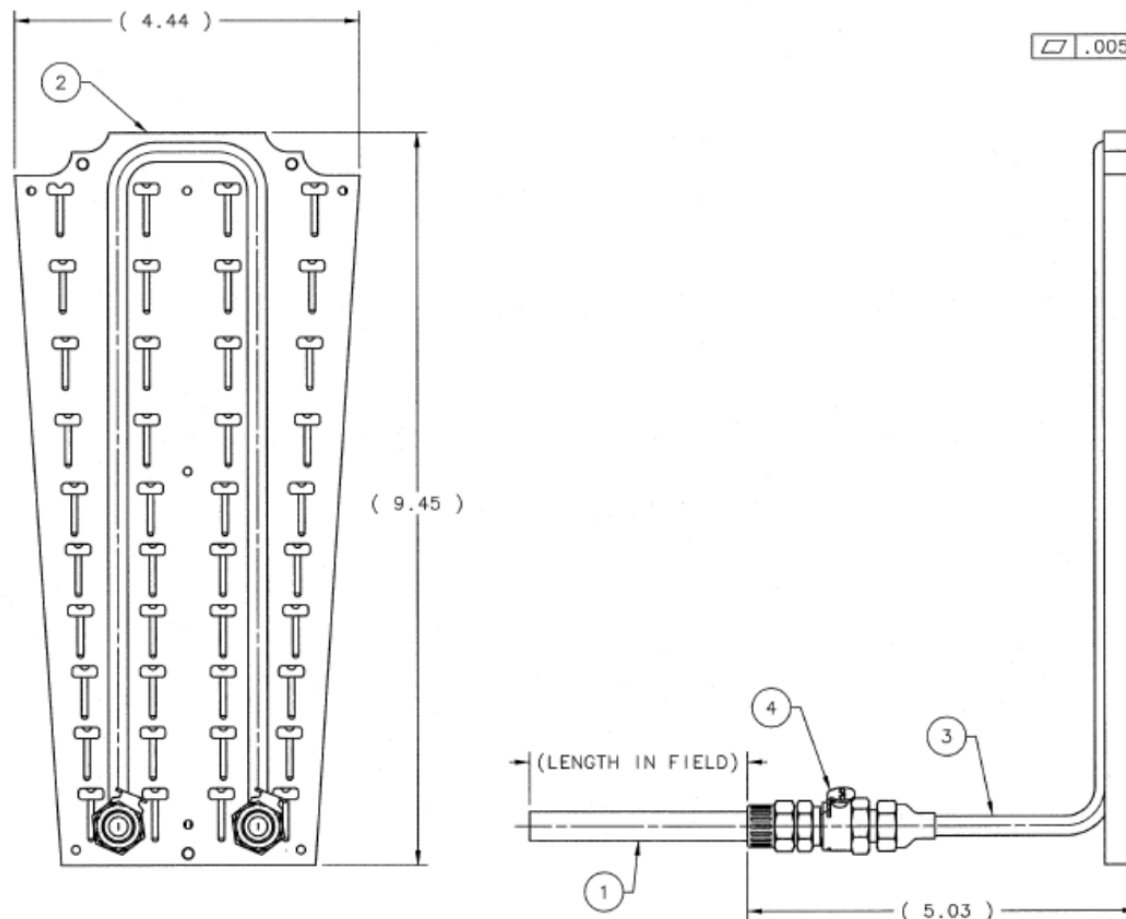
BCAL Cooling

GlueX-BCAL SiPM & Electronics

Heat output

- From Fernando (2/19/2024): “SiPMs produce negligible heat but the bias distribution network does, still not anything comparable to what the preamps produce. Power consumption per wedge is less than 8 W. 400 W at each BCAL end.”
- From Tim (2/19/2024): “Each chiller is 1KW (1 at each end). There are 2 wedges in series (24 parallel circuits) and the temperature rise of the water is about 0.5C from inlet to outlet. Bias is adjusted for this”.
- HGCROC and AstroPIX contributions to heat (not in this talk).

Cooling Assembly



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

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		
QTY REQD	ITEM NO.	PART OR IDENTIFYING NO.	DESCRIPTION OR DESCRIPTION	MATERIAL SPECIFICATION	NOTES

DOCUMENT CONTROL STAMP MATERIAL SEE PARTS LIST FINISH MACHINED SURFACES 125 UNLESS OTHERWISE NOTED DEBURR & BREAK ALL SHARP EDGES DO NOT SCALE DRAWING	UNIT & TOL PER ASME Y14.5 UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMAL ANGLES .X ±.1 .XX ±.01 .XXX ±.005 THIRD ANGLE PROJECTION 	TRACKING NO. N/A		United States Department of Energy Jefferson Lab Thomas Jefferson National Accelerator Facility Newport News Virginia HALL D - GLUEX DETECTOR BARREL CALORIMETER COOLING PLATE ASSY
		APPROVALS DRAWN: C. L. HUTTON CHECKED: [Signature] APPROVED: [Signature]	DATE 01/08/11 2/1/11	
SIZE Dwg. NO. D00000-01-07-1021 SCALE 1:1		SHEET 1 OF 1		

Series "ARV" Thermoplastic Air Release Valve

Self-Guided Poppet Assures Dependable, Repetitive Operation

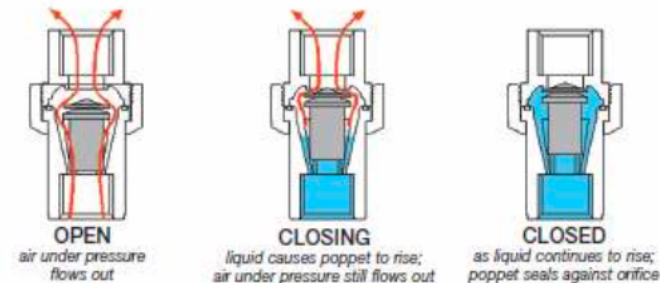


Features:

- **Safety:** Allows safe expulsion of unwanted air in piping system.
- **Dependability:** Unique self-guided poppet assures minimal emission of system liquid prior to sealing.
- **Convenience:** Union simplifies valve inspection/removal with minimum piping breakdown.
- **Minimum Closing Pressure:** Closes at 0 PSI, as long as liquid is present. Valve closes as liquid rises, after virtually all unwanted air is forced out. Seals bubble-tight at system pressures as low as 10 psi (EPDM seals).
- **Cost Efficient:** Designed to improve system performance and competitively priced.
- **Superior Design:** Poppet seals more reliably than ball design; does not deform under pressure like a hollow ball.
- **Corrosion Resistant:** Top quality thermoplastics and elastomers resist chemical attack and protect system purity. No metal components in Series ARV.

Description

Series ARV is a normally-open valve. Until your system is pressurized, the valve is simply open, and air is present. As pressure builds within the system, unwanted air is forced to the highest point in the system, i.e., the normally-open air release valve. When pressure within the system exceeds atmospheric pressure, air is expelled. As liquid rises, the poppet becomes buoyant and eventually closes. (Note, minimum specific gravity of liquid must be .9 or higher). It is possible that trace amounts of air will remain in the system, depending on the rapidity with which the valve closes. It is also likely that some trace amounts of process liquid will be emitted. At system pressure of 10 PSI (with EPDM elastomer), the poppet will seal bubble-tight against the orifice. When pressure and liquid level drop, the valve will automatically re-open.*



The poppet is guided by a series of thermoplastic ribs within the valve. The poppet is a unique design by Plast-O-Matic Valves, Inc. that is engineered to provide a balance of buoyancy and sealability. This balanced poppet is the key to the superior performance of this valve: it is dense enough to permit maximum emission of unwanted system air, yet buoyant enough to affect a

continued on back

PLAST-O-MATIC
VALVES, INC.

1384 Pompton Avenue, Cedar Grove, New Jersey 07009
(973) 256-3000 • Fax (973) 256-4745
www.plastomatic.com • info@plastomatic.com

NEW! Degassing Valve For Continuous Automatic Venting

All Plastic Design • United States Patent #7,481,238 B2



FEATURES:

- Reduces replacement costs – no internal or external metal components; ideal for aggressive environments.
- Placed at the high point of a piping system, this innovative valve will vent gas as it occurs. A unique float/actuating lever allows the vent orifice to open when gas is present. After gas vents, liquid forces the vent to close. Whenever gas accumulates, the valve will re-open until the gas is vented.
- All-plastic construction designed for sodium hypochlorite, ozone systems, or any liquids prone to outgassing.
- Series DGV is designed for systems that continuously generate trace amounts of gasses. For system start-up requiring rapid expulsion of larger volume of air or gasses, see Series ARV.

Installation Notes

Series DGV should be installed at the highest possible point in a piping system, and it must be oriented upright. In most cases, residual liquid and/or vapor in the valve may be expelled or "spit" from the outlet vent. Therefore, it is recommended to pipe the outlet port to a safe area for hazardous liquids, or use a standpipe for non-hazardous liquids.

Important Note on DGV use with Salt Solutions & Other Liquids that may Precipitate Solids:

Should the DGV be installed in liquids which have the possibility of precipitating solids out of solution, it is recommended to periodically clean the DGV in warm or cold water to remove debris and/or precipitated salts from the orifice and the seat. To disassemble use an appropriate spanner wrench inserted into the two 1/8" holes in the top of the valve, unscrew and remove the float/seat assembly. Then clean and re-assemble the DGV.

It is further recommended to keep a spare seal kit on hand. When the DGV is disassembled for cleaning, examine the spring o-ring (the o-ring retaining the seat and float arm) for elasticity and general overall condition. If lack of elasticity or general wear is evident, replace the seals.

SPECIFICATIONS AND DIMENSIONS:

Body Materials Available: PVC, CPVC, Polypro or PVDF
 Elastomers: FKM (Viton) or EPDM
 Additional Wetted Material: Natural Polypropylene
 Maximum Operating Pressure: 100 psi
 Minimum Specific Gravity: 0.9
 Dimensions: 4 1/4" high x 2 1/4" diameter
 Vent Port: 1/8" NPT
 System Connection: 1/4" NPT; valve must be oriented vertically as illustrated above.
 Specifications and Dimensions subject to change.

Series DGV Part Numbers Pipe Size (NPT)	PVC	CPVC	Polypro	PVDF
1/2"	DGV050V-PV	DGV050V-CP	DGV050V-PP	DGV050V-PF

DGV (series) 050 (size) V (seal material) - PV (body material)
 Part numbers shown are FKM seals. For EPDM seals, change "V" to "EP." For example, DGV050EP-PV.
 • Standard connections are threaded. For other connection types, consult factory.

APPENDIX 5: Tubing (Page 1 of 1)

Crack-Resistant Polyethylene Tubing

1/4" ID, 3/8" OD, 1/16" Wall Thickness, White



Semi-Clear White

Length, ft.
✓ 100

☐ Each

ADD TO ORDER

In stock
\$20.00 Each
5181K25

You'll get superior resistance to stress cracking along with flexibility at low temperatures. Made of linear low-density polyethylene (LLDPE), this tubing won't impart tastes or odors to the fluid passing through. Use with water, air, food and beverage, and ethylene glycol. Tubing is made from FDA-compliant resins.

View information about the [chemical compatibility of polyethylene tubing](#).

ID	1/4"
OD	3/8"
Wall	1/16"
Bend Radius	3"
Maximum psi @ 73° F	210
Length	100 ft.
Temperature Range	-100° to 175° F
Additional Specifications	Semi-Clear White—Inch Sizes Flexible Firm (Shore D44) Use with compression fittings Chemical Compatibility of Polyethylene Tubing

High-Pressure Tygothane Polyurethane Tubing

Clear, 1/2" ID, 3/4" OD, 1/8" Wall Thickness



Length, ft.
✓ 100

☐ Each

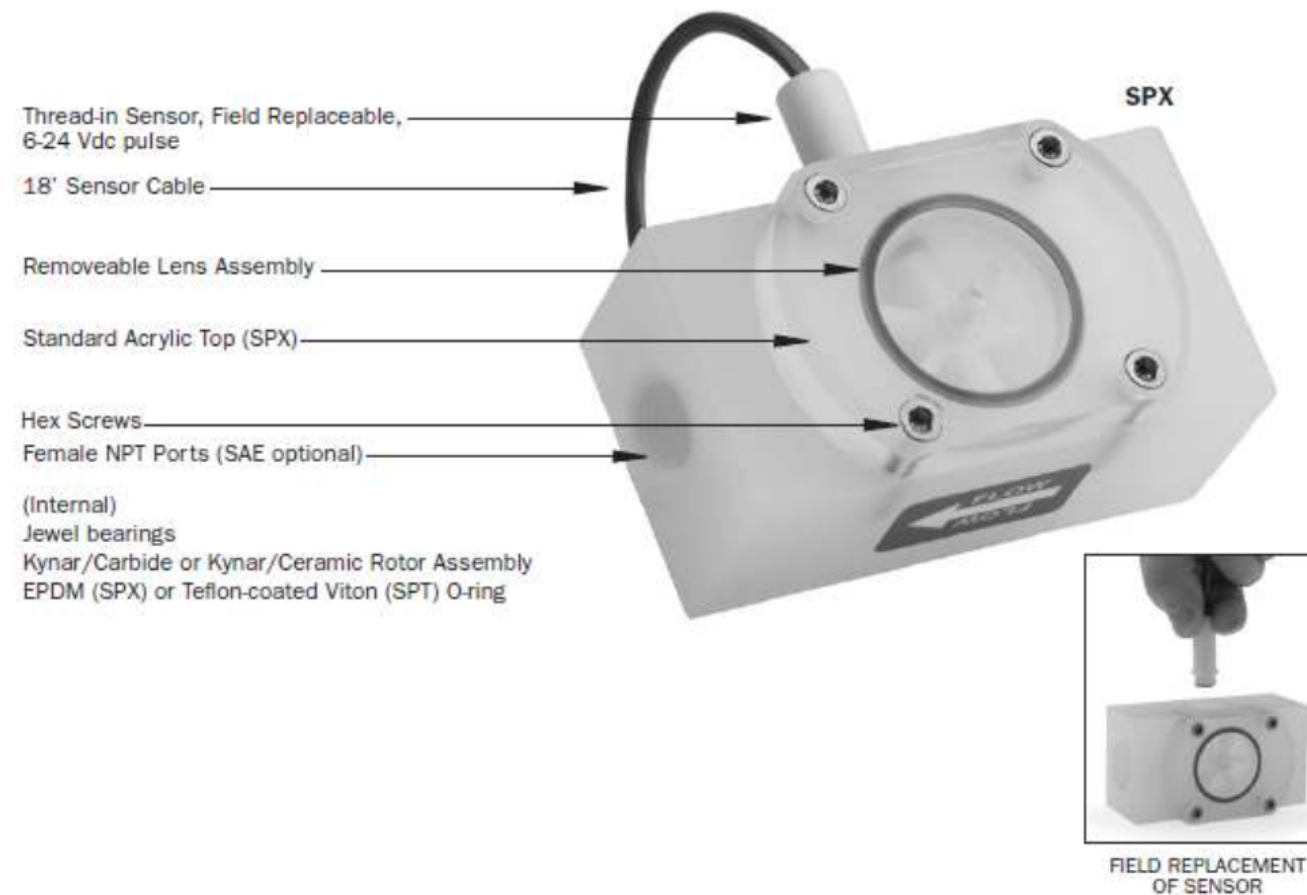
ADD TO ORDER

In stock
\$443.00 Each
5439K23

Seametrics

**S-SERIES
SPT, SPX Low Flow Meters**

FEATURES

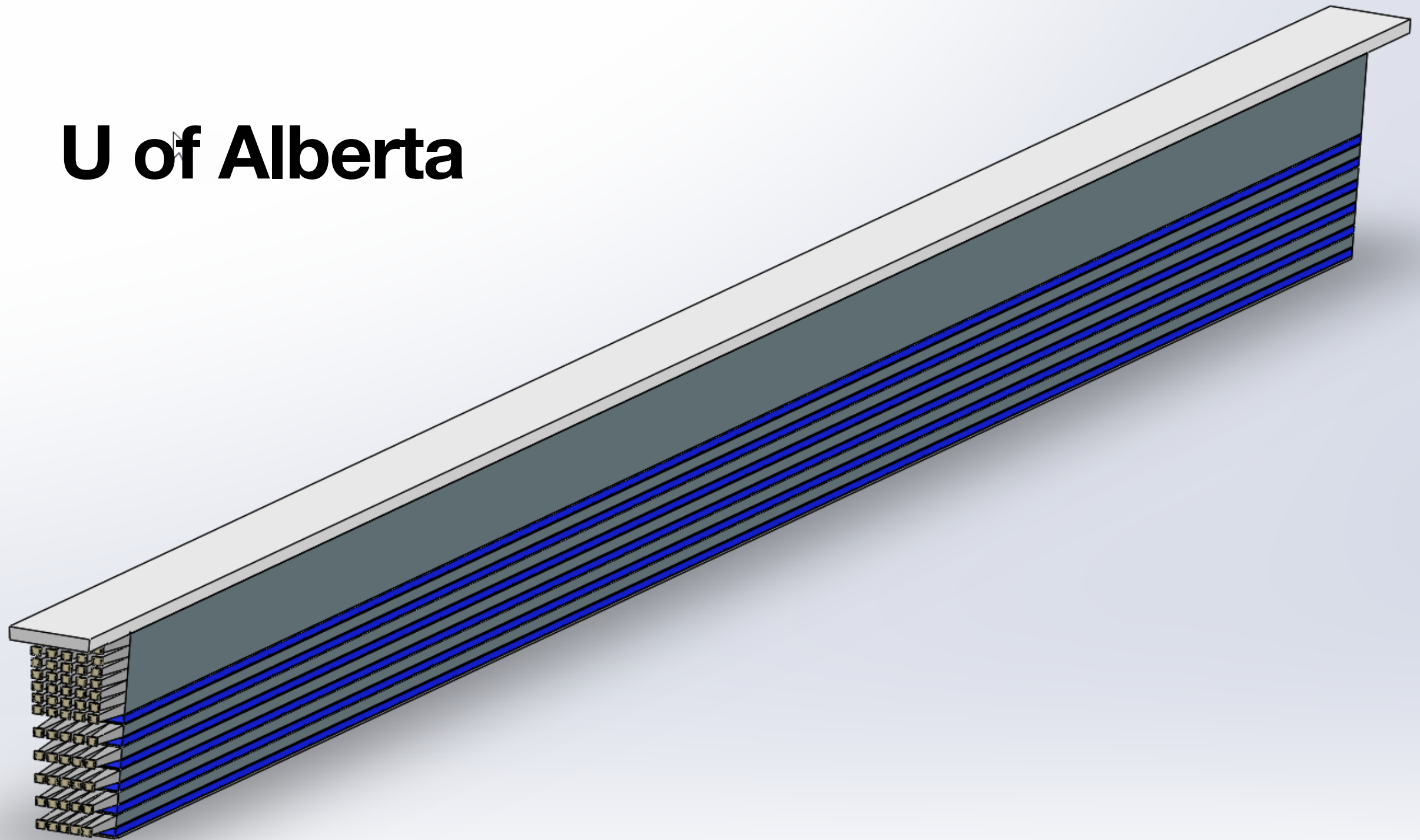


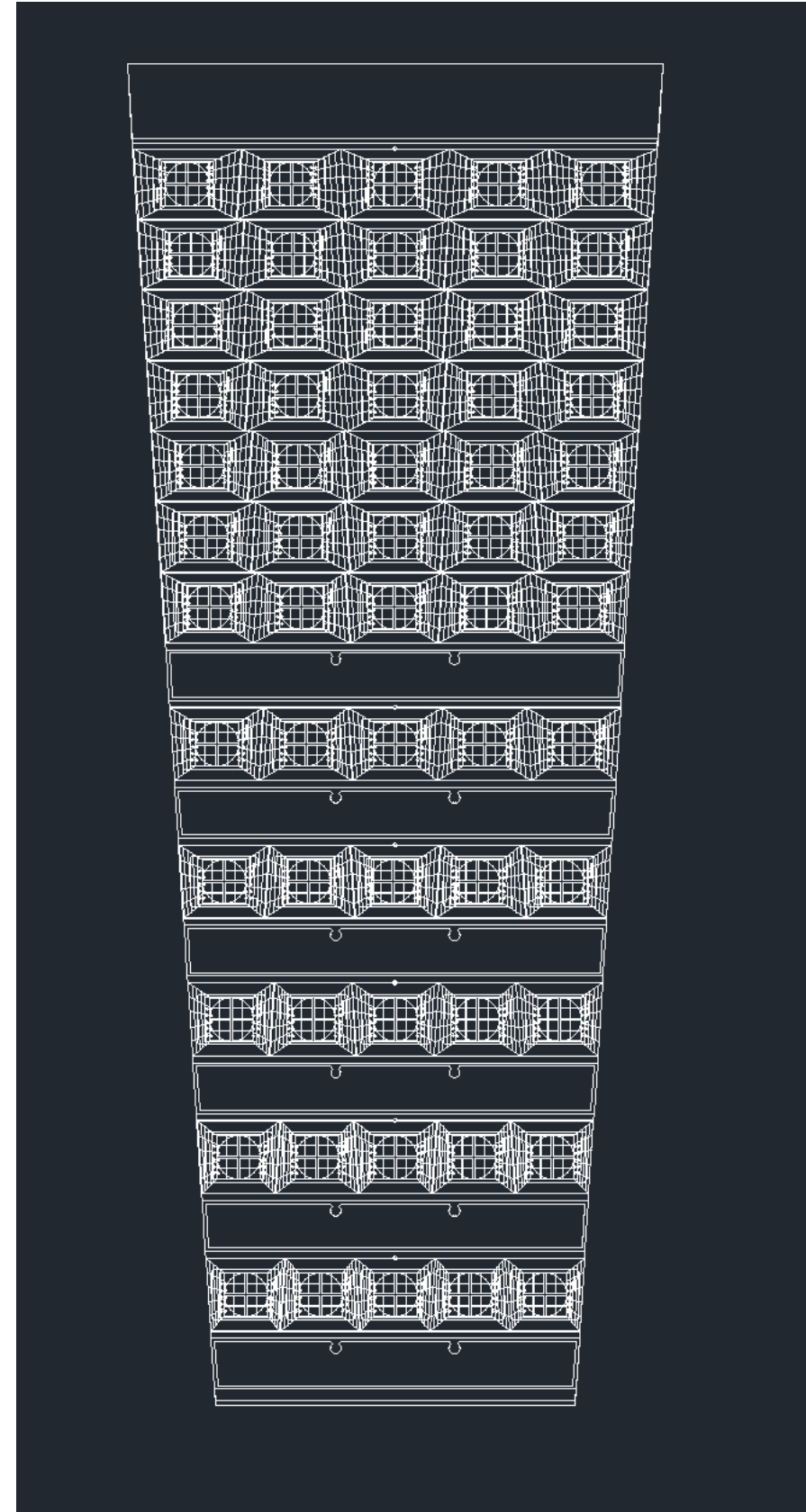
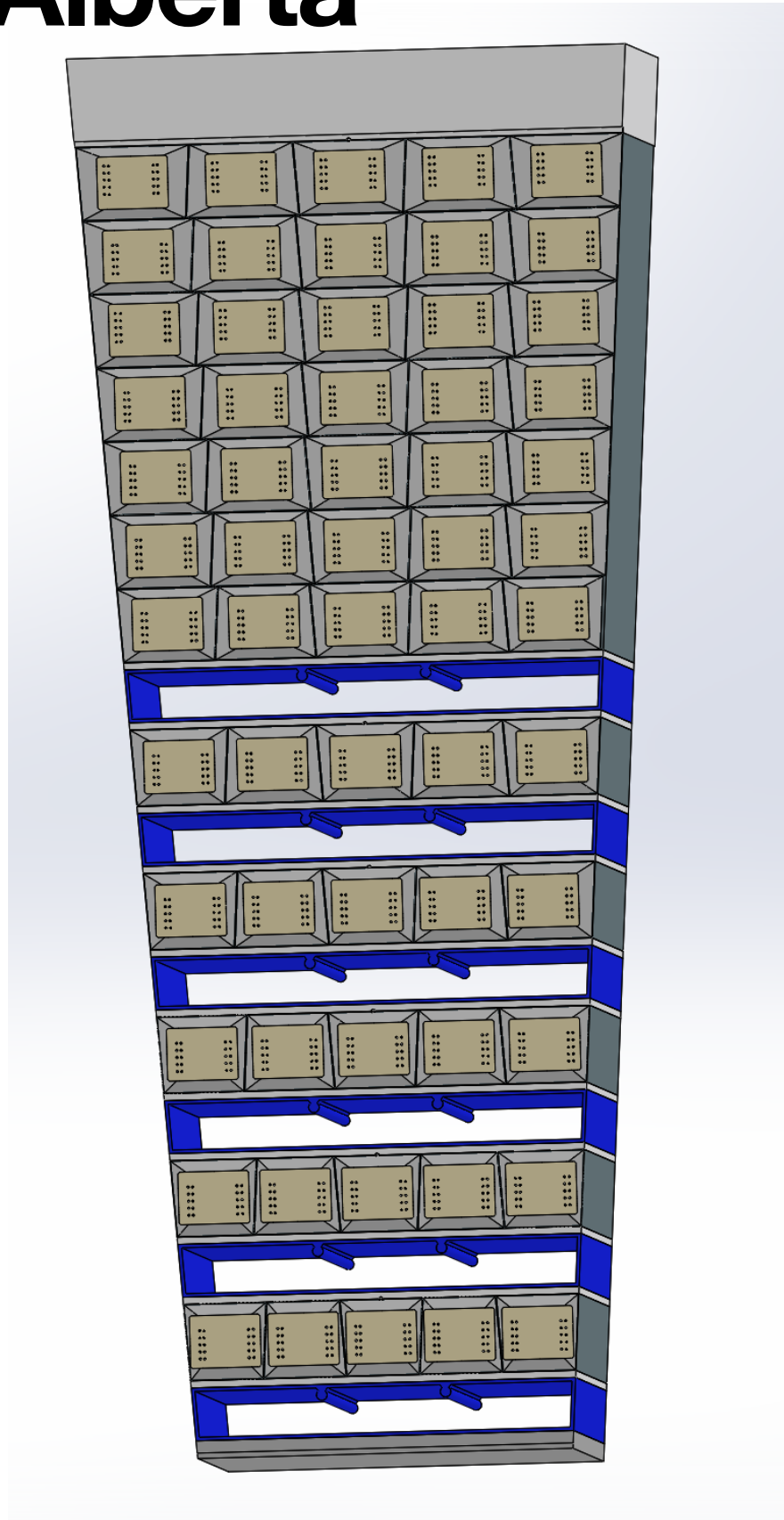
Summary

- Progress in drawings at ANL
 - U of Alberta making drawings
- PED, First Article
 - **ESB @ Regina** (UofA-MRS, ANL, ORNL)
 - PED Funds: Mech Eng / Elec Eng, Postdoc, M&S
 - Timeline: ~ 15 mo for test article (June 2025).

Backup slides

U of Alberta





GLUEX BCAL Light Guides

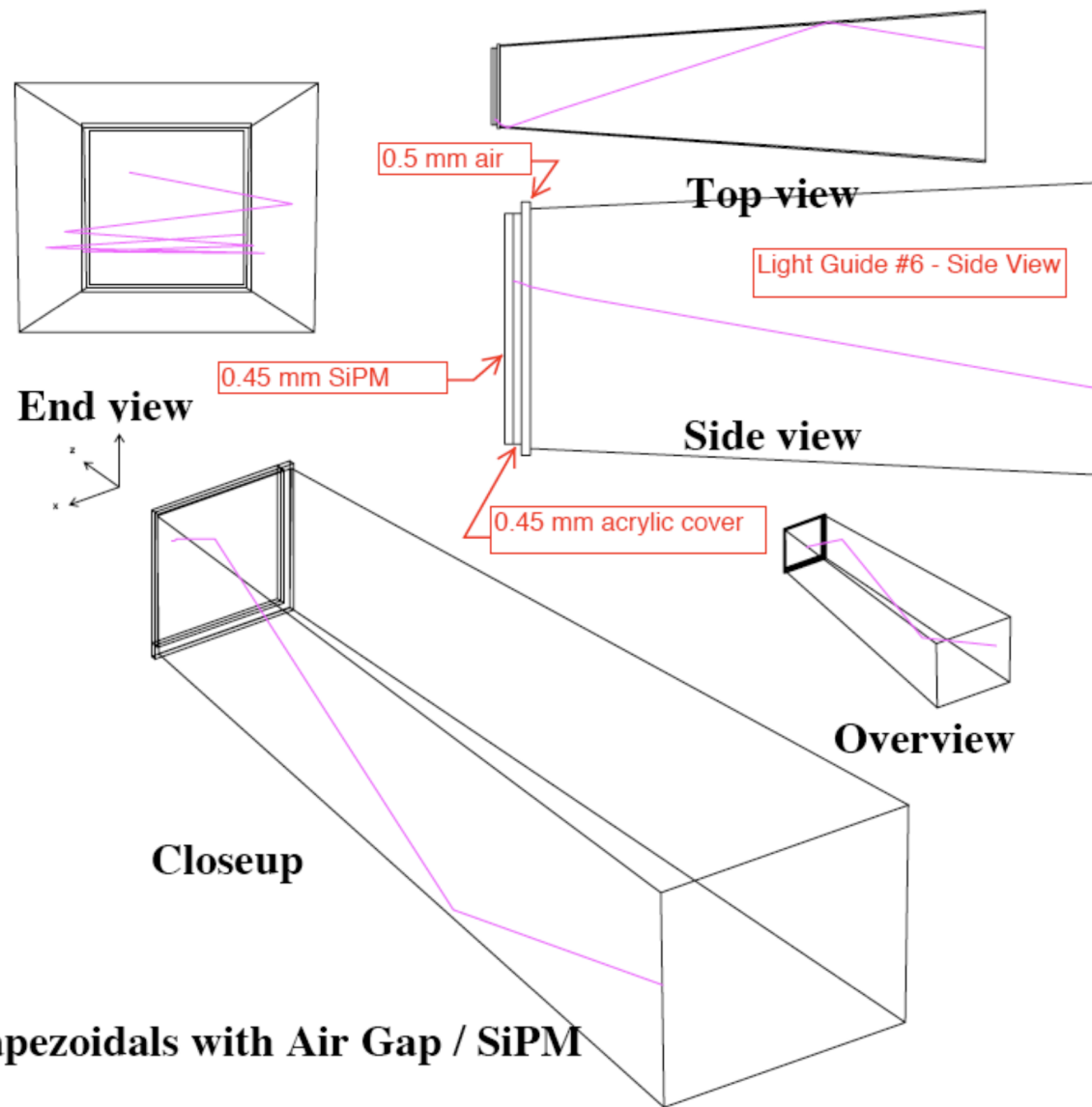
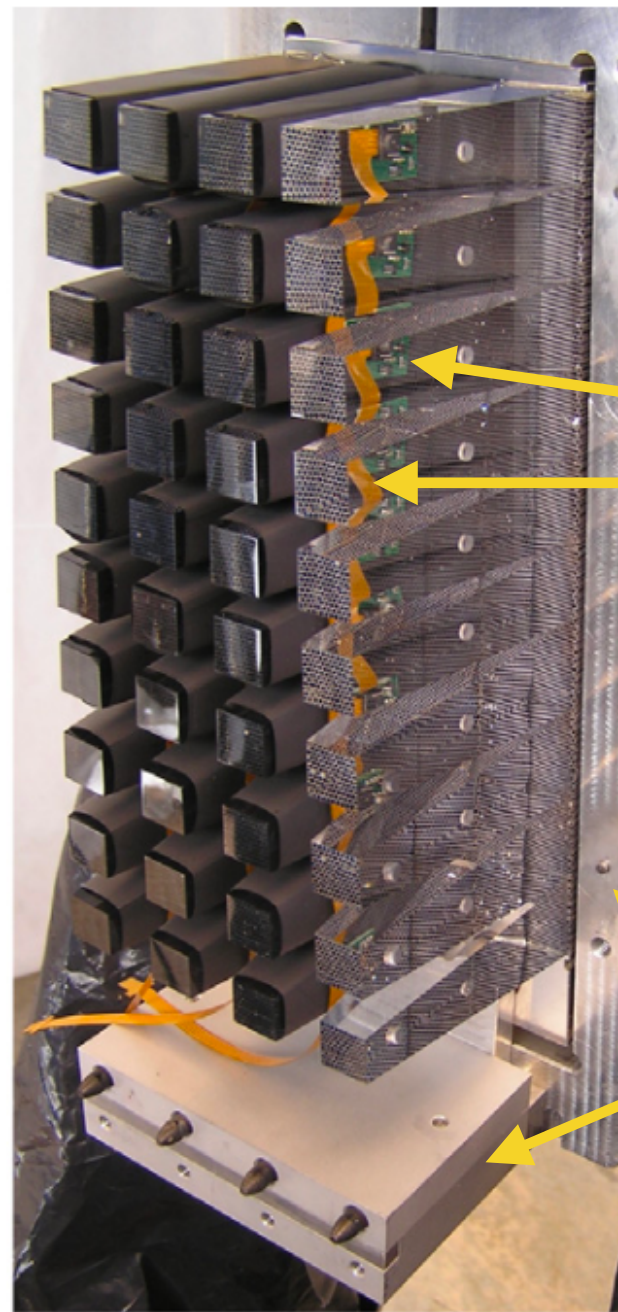
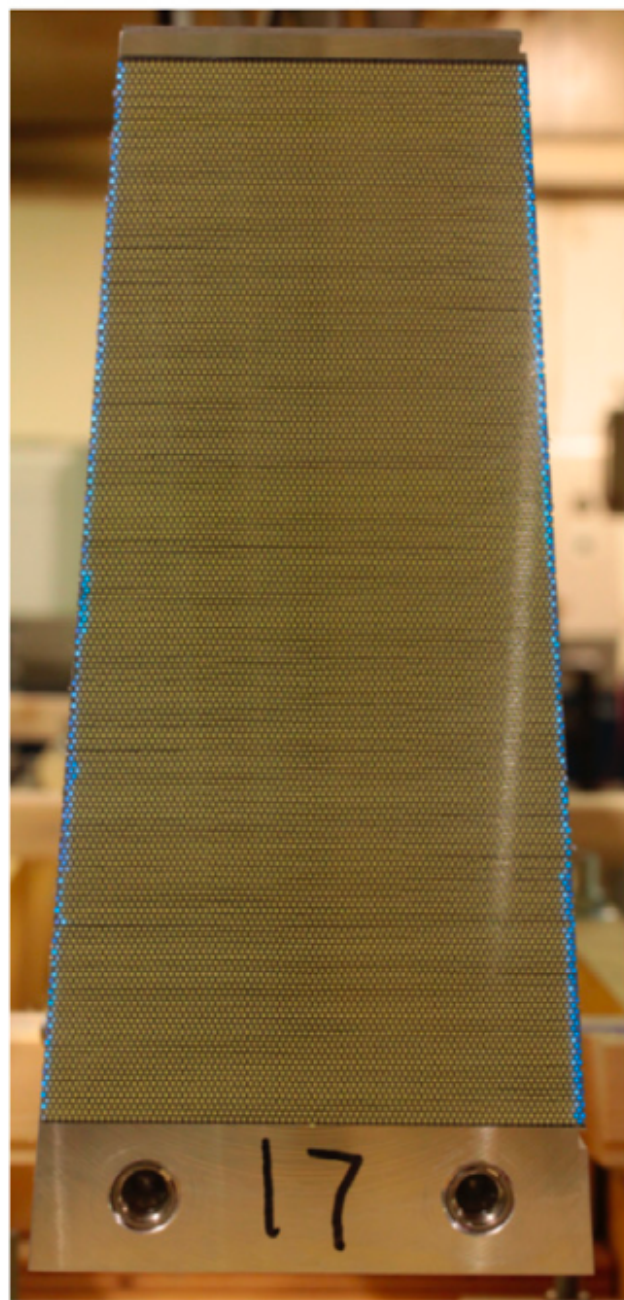


Table 1: Sizes of the ten production light guides for the Bcal. The trapezoid dimensions are denoted using the notation (bottom-top $\times$ height).

Configuration	Input Trapezoid (mm ²)	Length (cm)	Output Trapezoid (mm ²)	Eff (%)
g1	20.96-21.64 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.748
g2	21.64-22.30 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.723
g3	22.30-22.99 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.701
g4	22.99-23.65 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.683
g5	23.67-24.33 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.662
g6	24.33-25.02 $\times$ 20.57	8	13.19-13.61 $\times$ 13.19	0.643
g7	25.02-25.83 $\times$ 24.64	8	13.19-13.61 $\times$ 13.19	0.516
g8	25.83-26.62 $\times$ 24.64	8	13.19-13.61 $\times$ 13.19	0.503
g9	26.64-27.43 $\times$ 24.64	8	13.19-13.61 $\times$ 13.19	0.488
g10	27.46-27.84 $\times$ 24.64	8	13.19-13.61 $\times$ 13.19	0.477

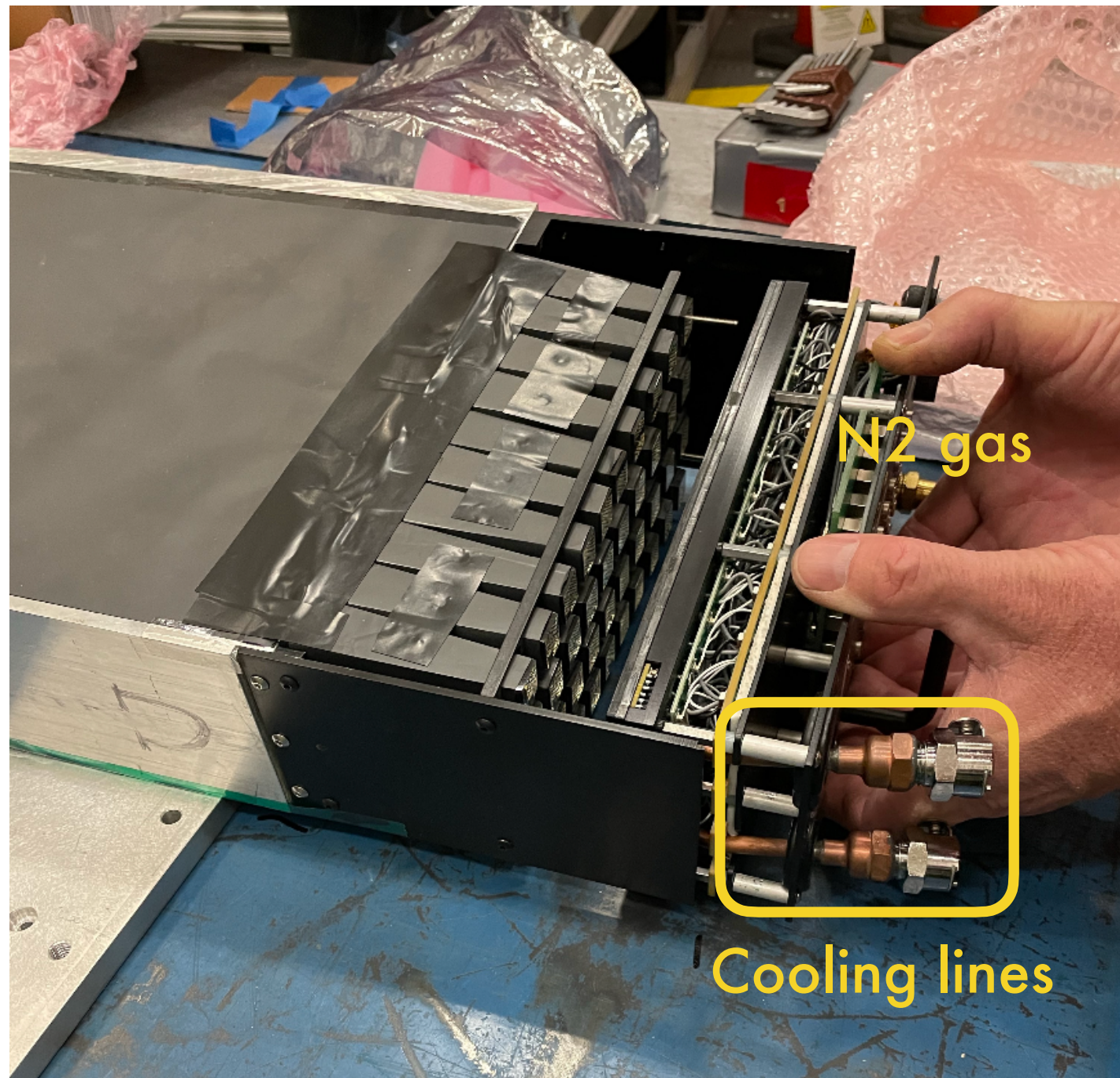
GLUEX BCAL Light Guides



LED mini boards;
Flex cable

LG mounting jig

BCAL "Wedges"



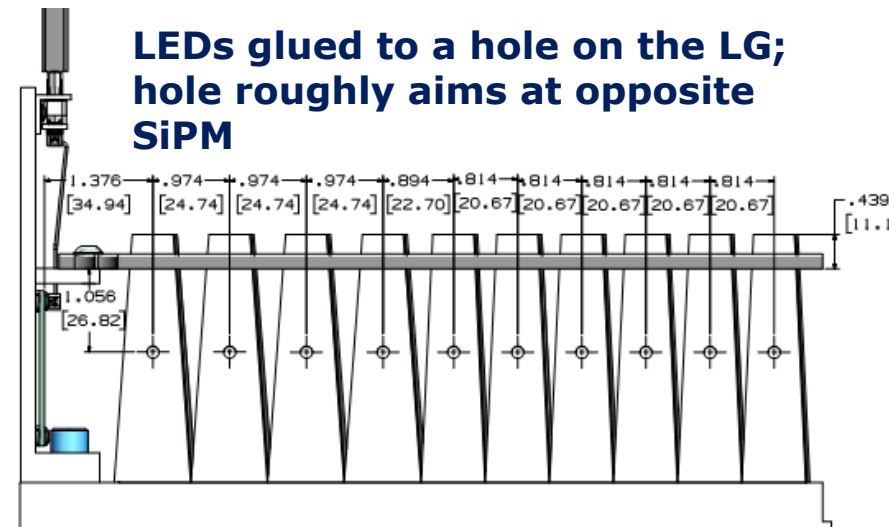
- Contiguous LG stacking
- LG-SiPM air gap
- BIC: Si cookie
- Spring loading
- Integrated ESB for installation ease

GlueX LMS

innermost LG 21x21 mm², outermost 27x25 mm²; output faces are 13x13 mm² to match SiPM window

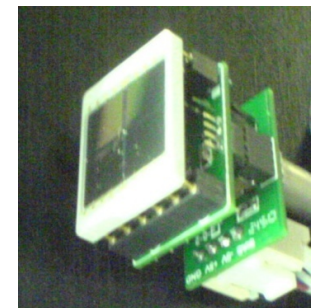
LEDs: Bivar, Blue, 465 nm

LEDs glued to a hole on the LG; hole roughly aims at opposite SiPM

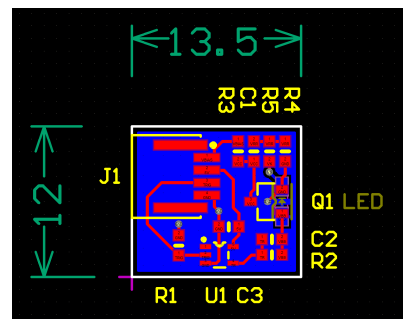


BCAL has 3840 SiPMs, and 3840 LEDs: pulsing both ends decouples SiPM from LED failure

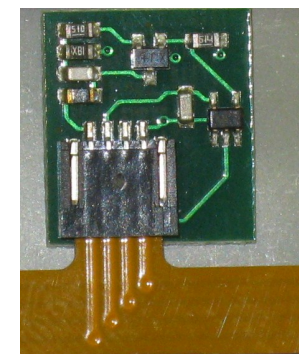
Hamamatsu S12045X



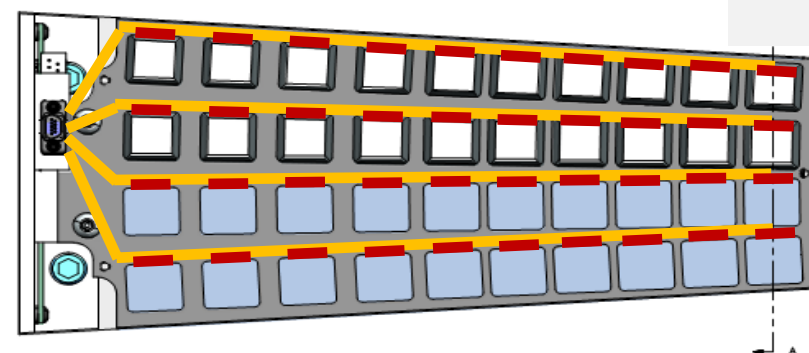
BCAL miniboard layout ("components" side, LED on the other side, shining parallel to the board towards the right)



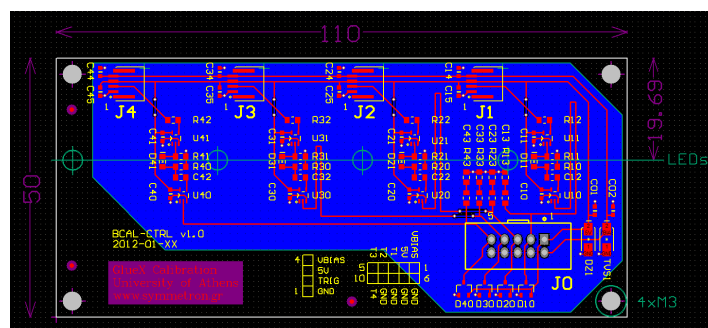
BCAL miniboard on flex cable



4 flexible strips per side per module



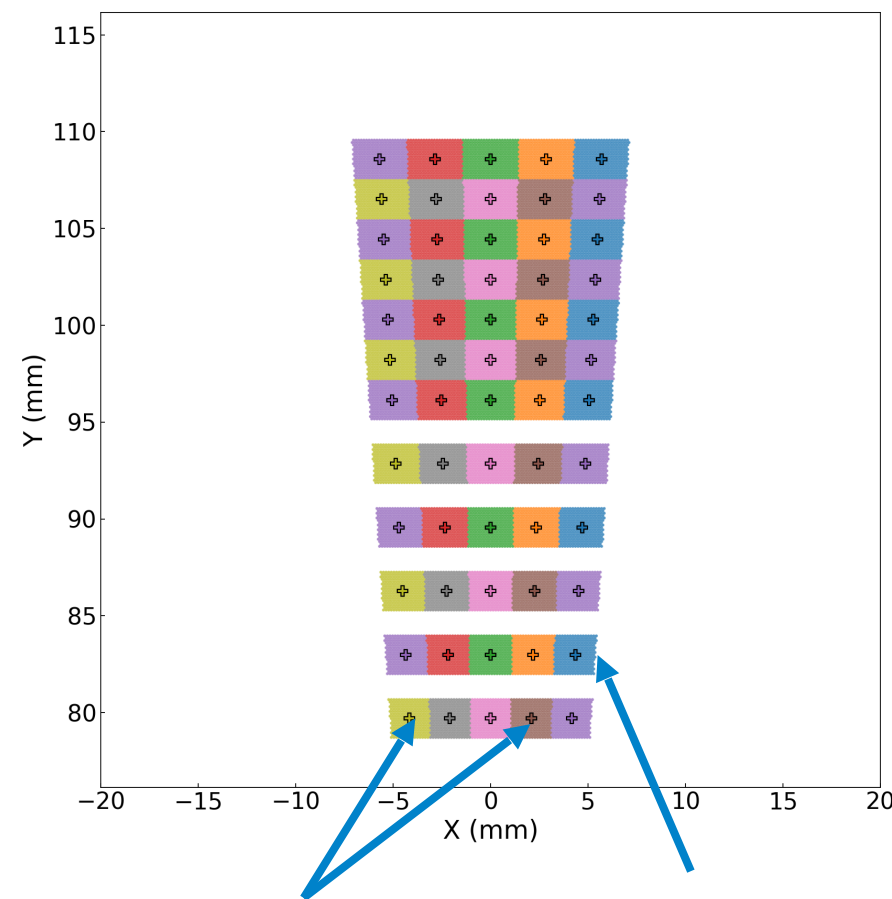
BCAL Controller layout



SiPM Readout

- **2-sided SiPM readout**
- **Lightguides** on sector sides
 - inner surface $\sim 2 \times 2 \text{ cm}^2$
 - output face $1.3 \times 1.3 \text{ cm}^2$
- SiPMs that meet our requirements:
 - 4 x $6 \times 6 \text{ mm}^2$ SiPMs with $50 \mu\text{m}$ pixels (e.g. 4 x S14160-6050, or a **pre-assembled S14161-3050-04 array**)
- 12 layers x 5 cells x 2 sides x 48 sectors = **5760 channels**

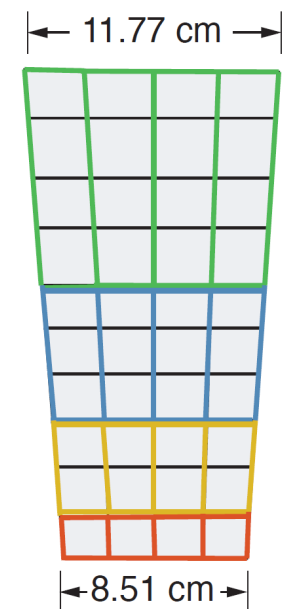
ePIC Sector End View
(x-y plane view), 17.1 X0



Readout Cell
Has lightguide
Layer = 5 cells

Pb/SciFi Layer
1 sector = 12 layers
1 layer = 17 fiber rows

GlueX Sector End View, 15.5 X0



Hamamatsu
S12045(X)
4x4 array of $3 \times 3 \text{ mm}^2$
 $50 \times 50 \mu\text{m}^2$ pixels

16 FADC per side
12 TDC per side