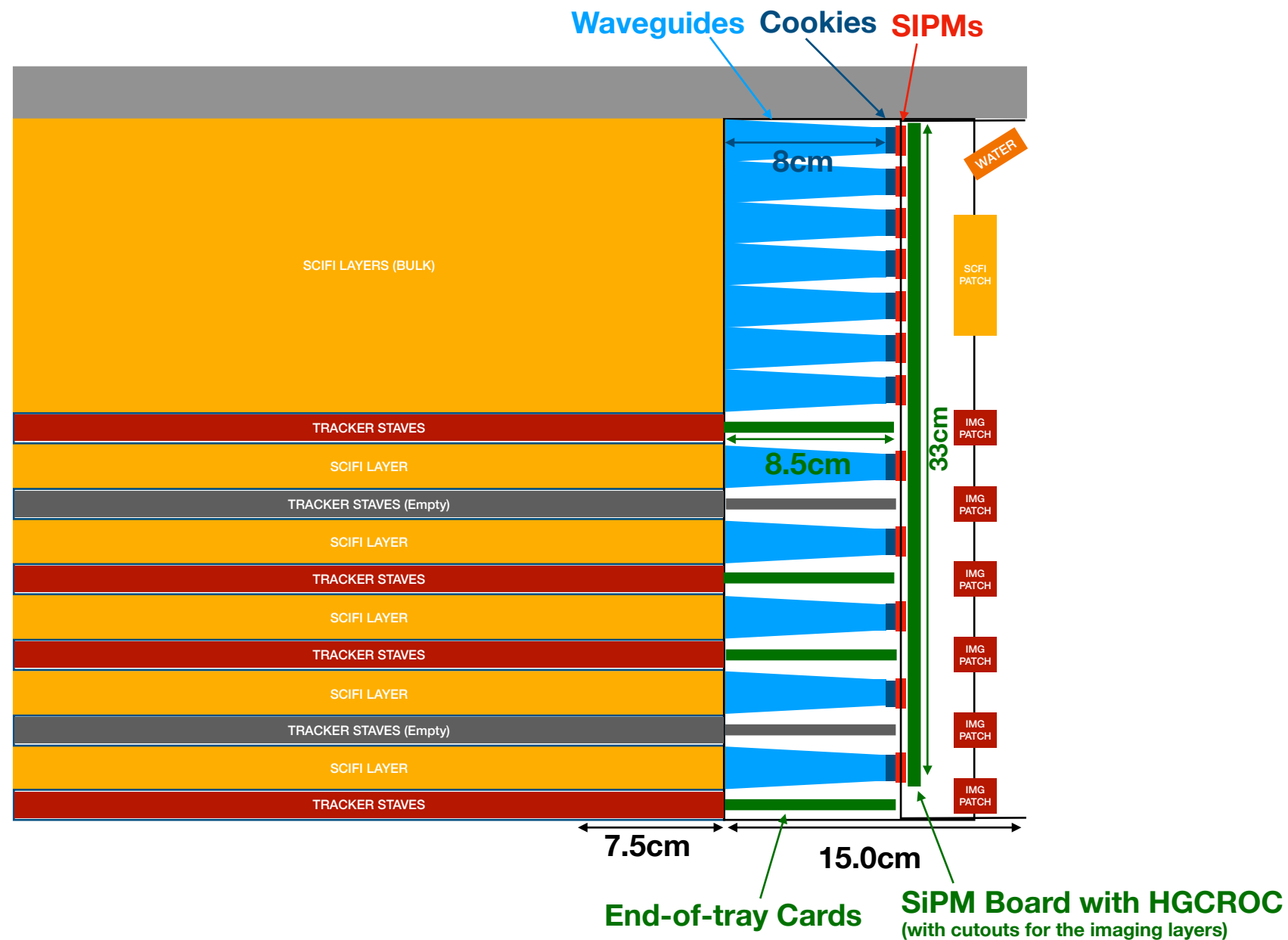


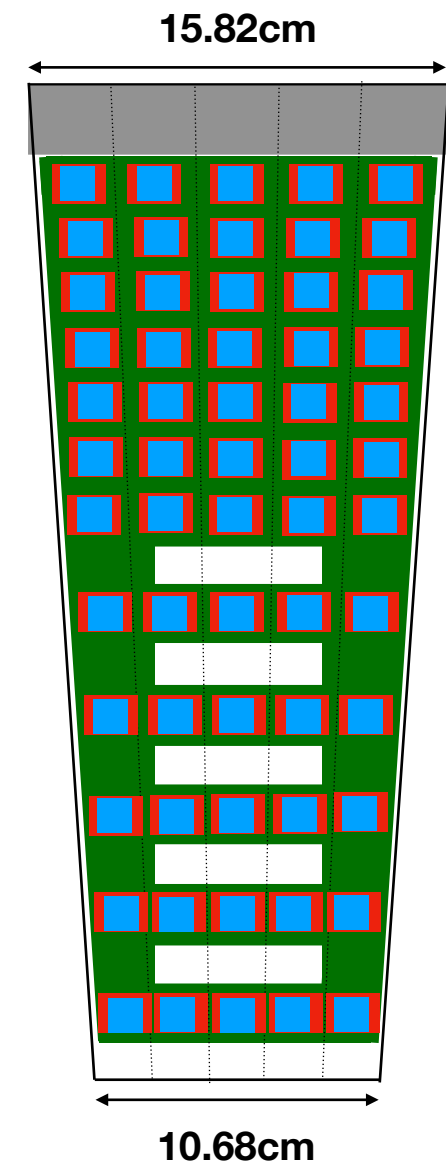
End-of-Sector Boxes Interfaces

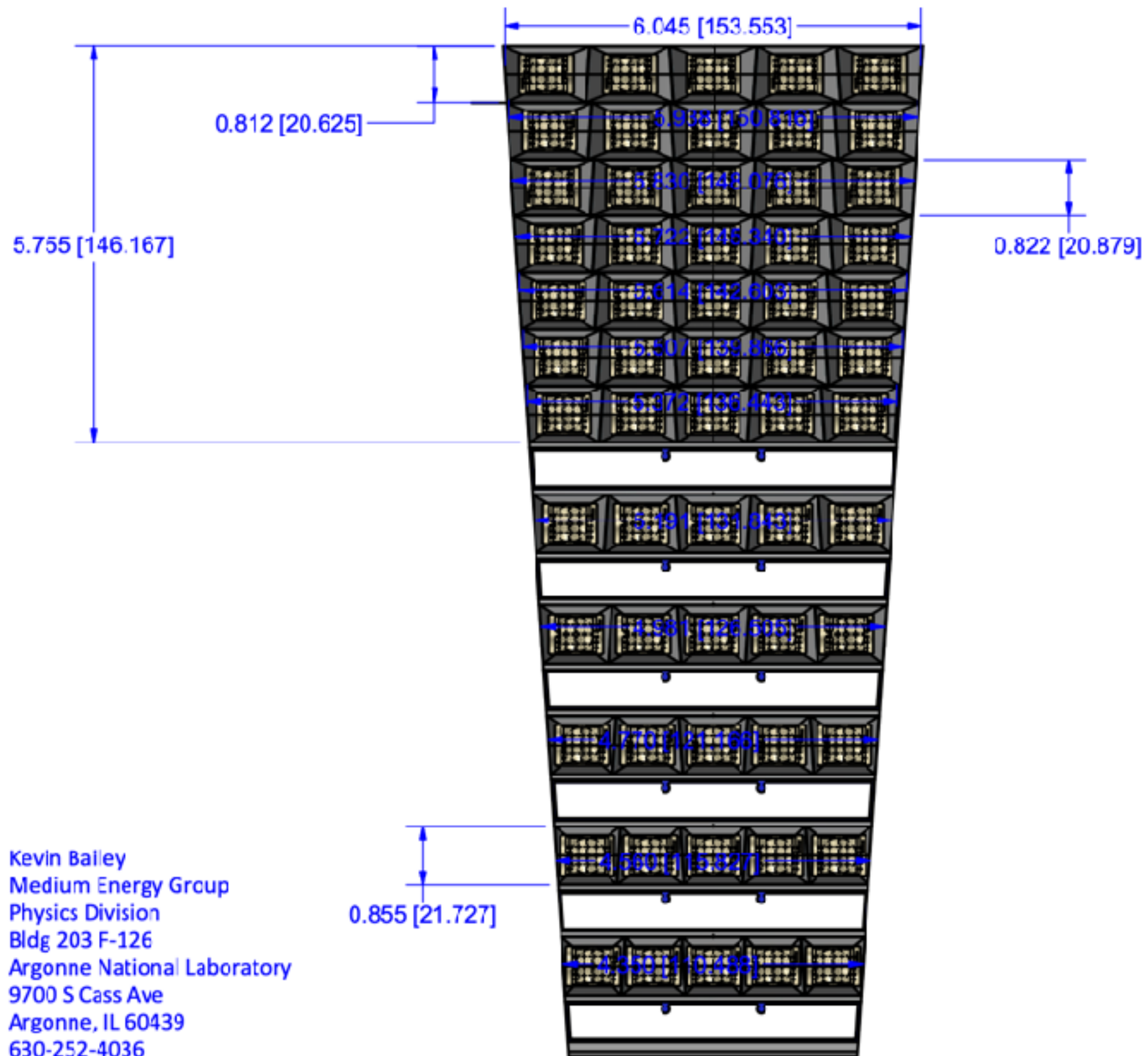
K. Bailey, Z. Papandreou
BIC Virtual Mini Workshop
April 12, 2024

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

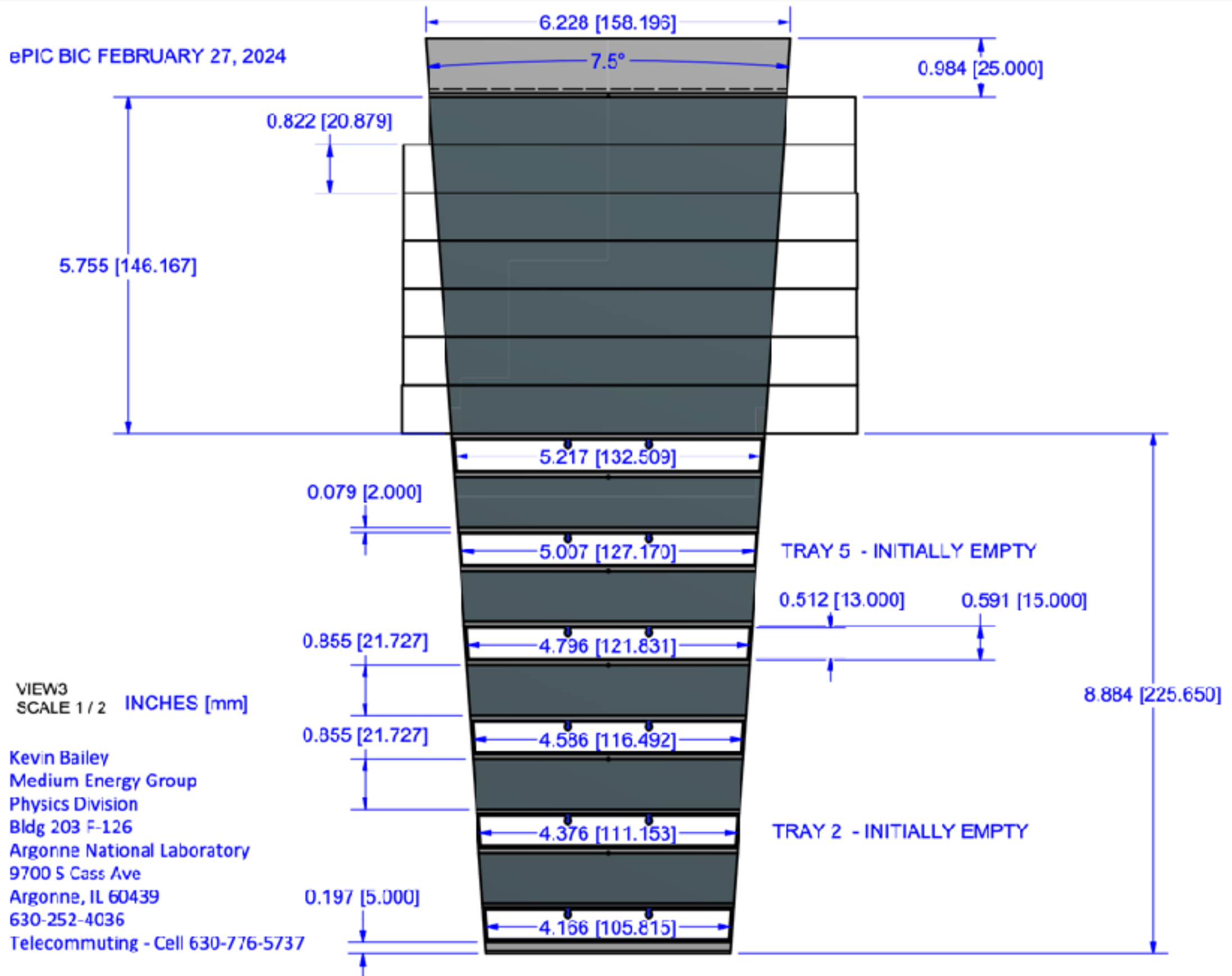


Cross section at SiPM Board





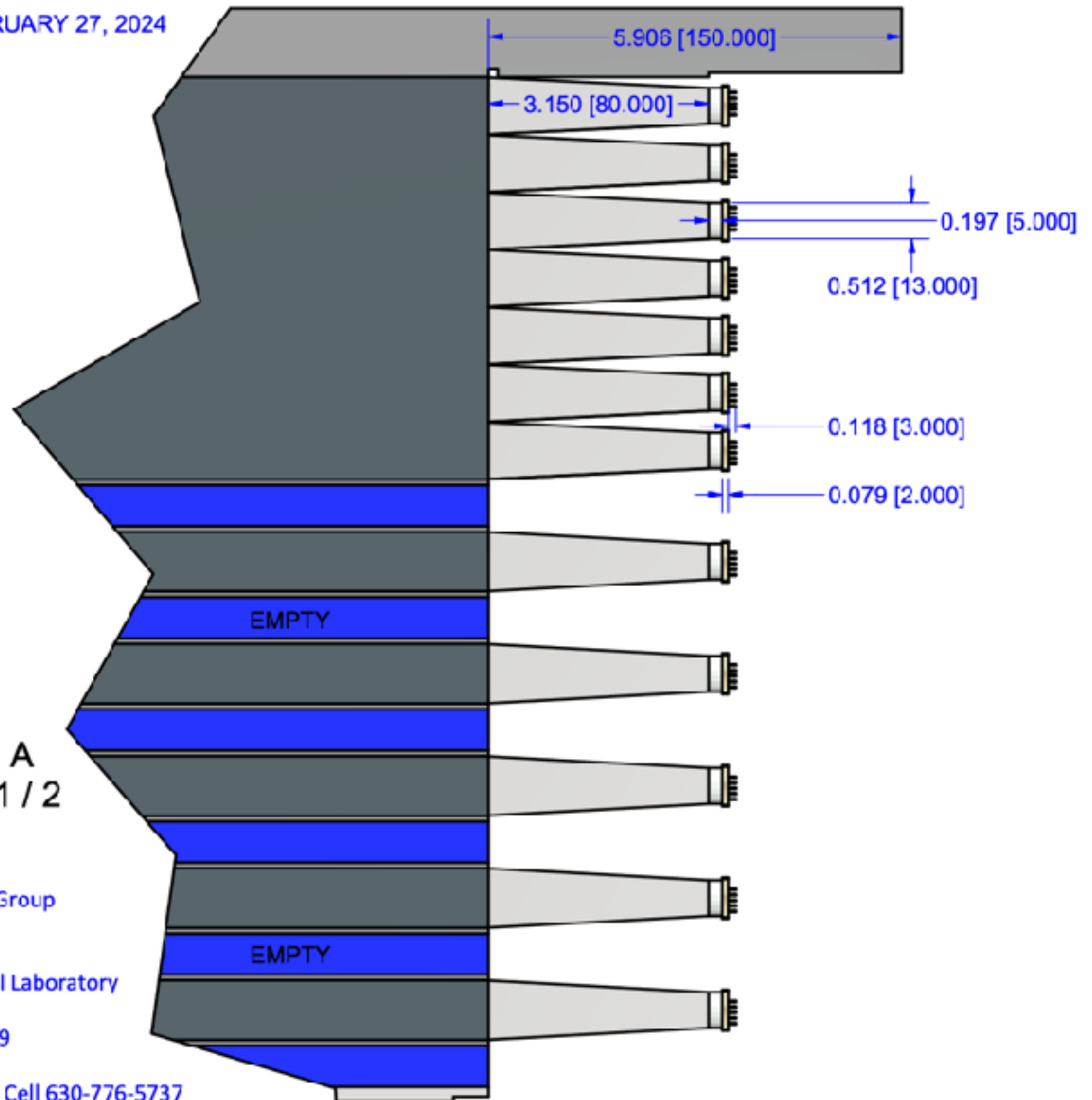
Kevin Bailey
 Medium Energy Group
 Physics Division
 Bldg 203 F-126
 Argonne National Laboratory
 9700 S Cass Ave
 Argonne, IL 60439
 630-252-4036
 Telecommuting - Cell 630-776-5737



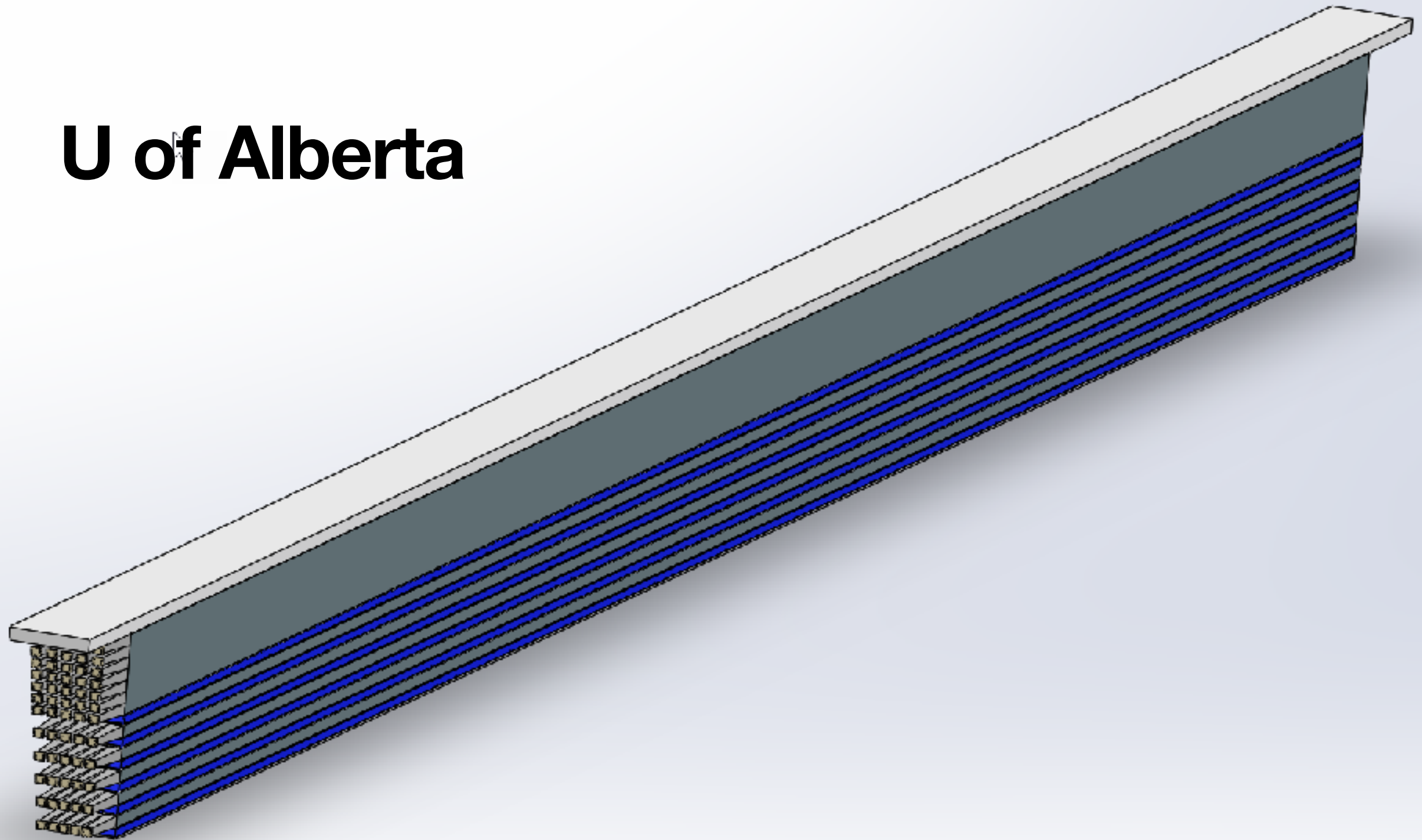
ePIC BIC FEBRUARY 27, 2024

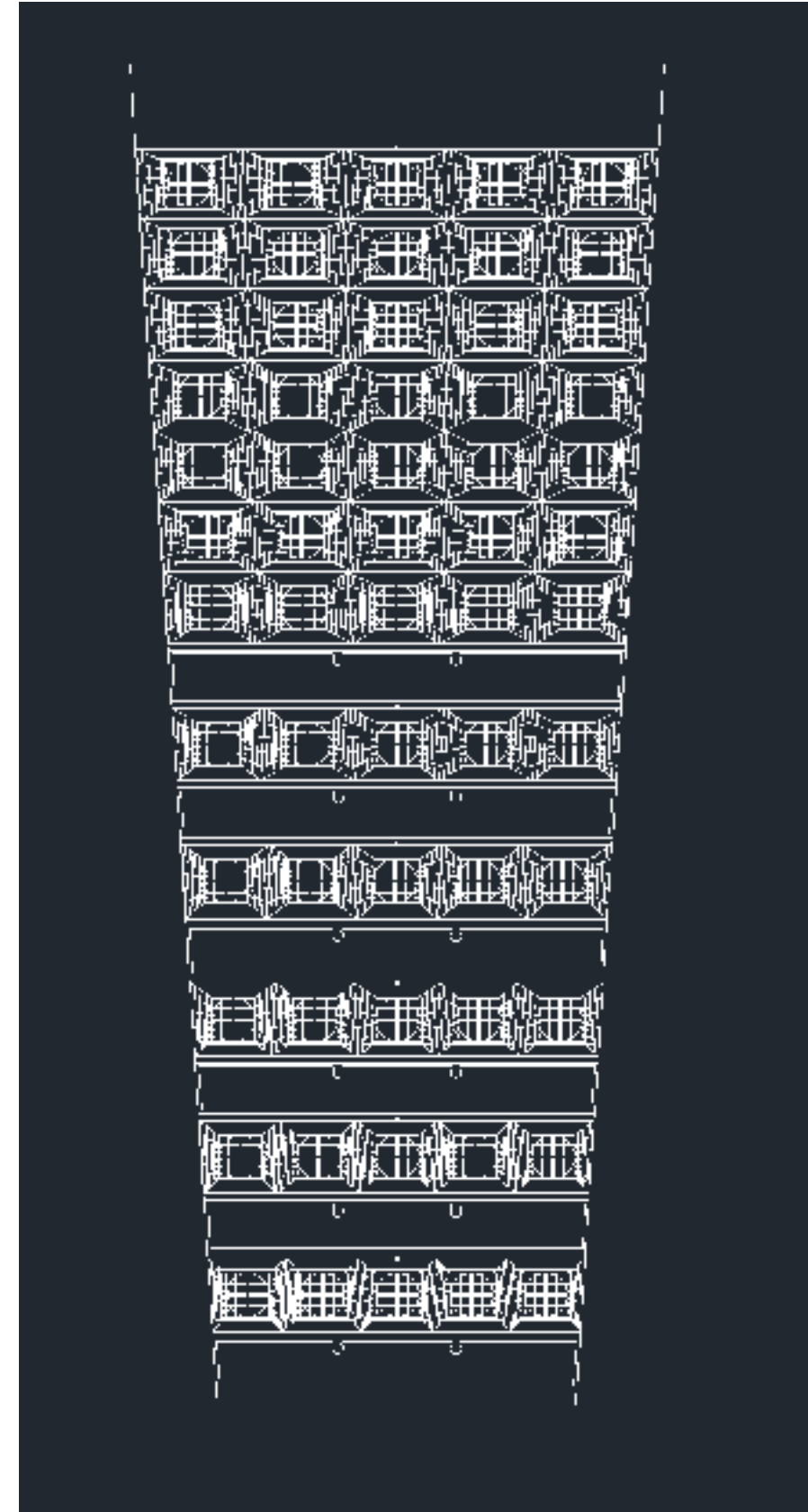
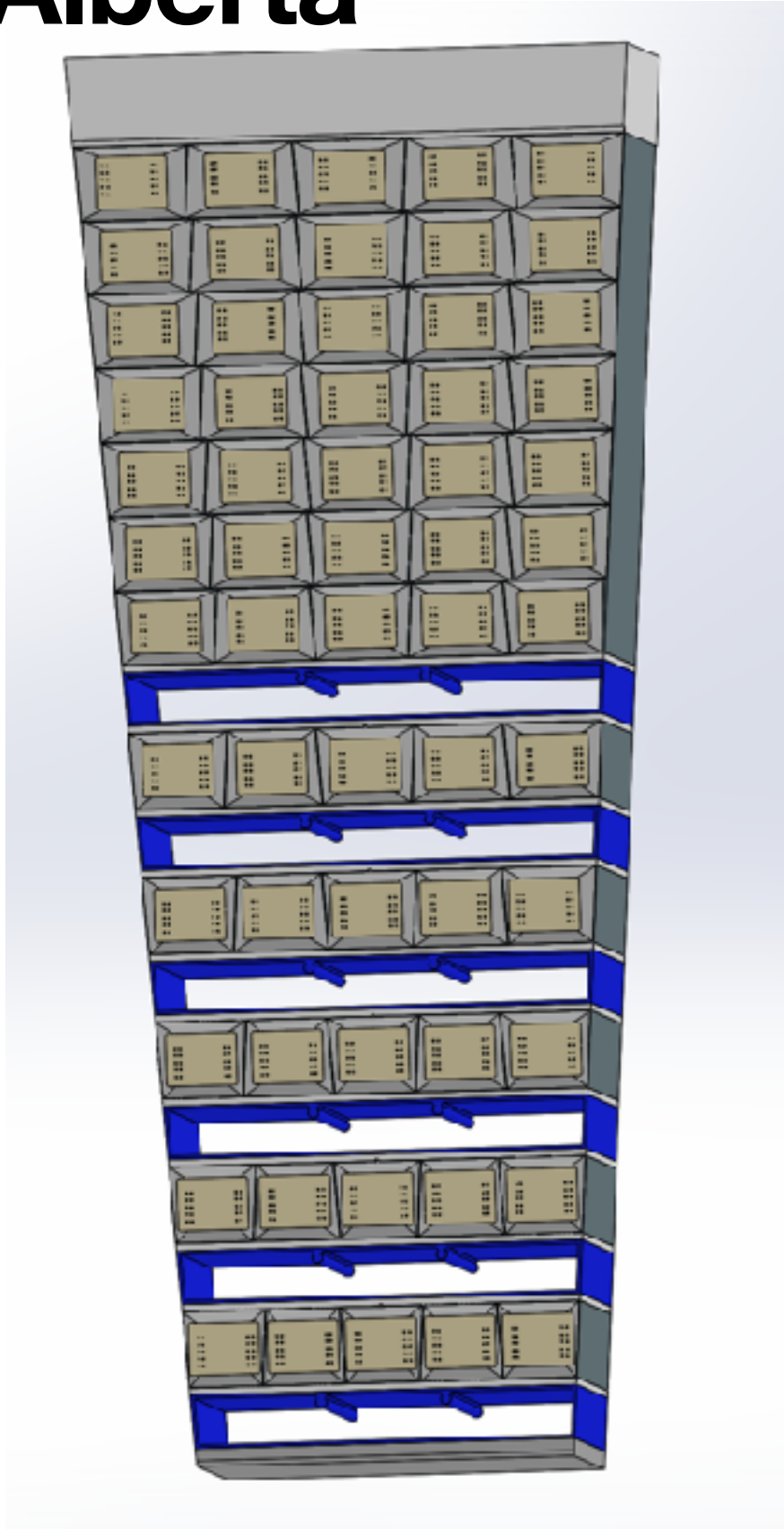
DETAIL A
SCALE 1 / 2

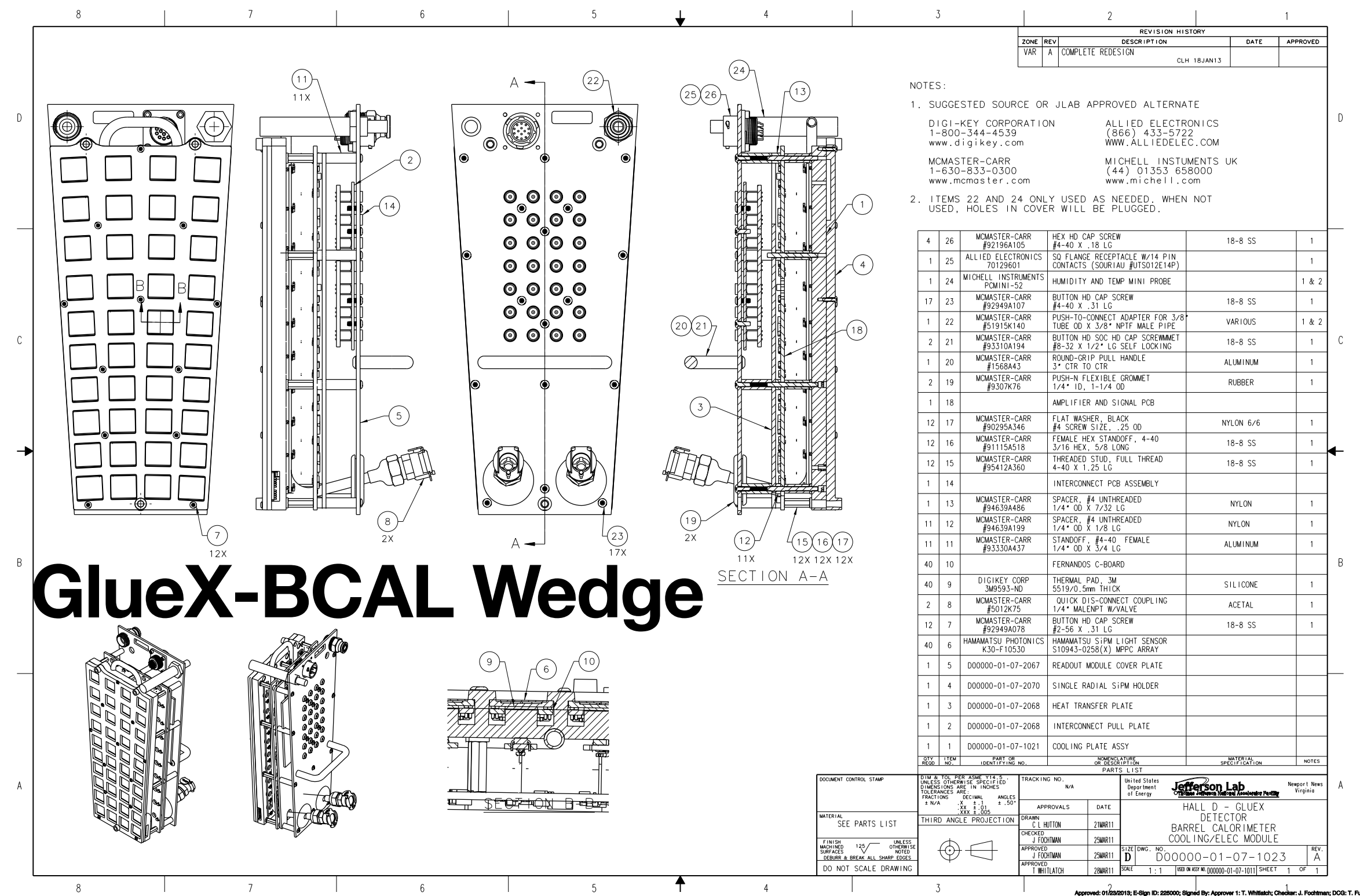
Kevin Bailey
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9700 S Cass Ave
Argonne, IL 60439
630-252-4036
Telecommuting - Cell 630-776-5737



U of Alberta







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

- NOTES:
- 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
 - 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		

DOCUMENT CONTROL STAMP

SEE PARTS LIST

FINISH 125 UNLESS OTHERWISE NOTED

DO NOT SCALE DRAWING

DTM & TOL PER ASME Y14.5 UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:

FRACTIONS DECIMAL ANGLES

THIRD ANGLE PROJECTION

TRACKING NO. N/A

APPROVALS DATE

CHECKED J FOCHTMAN 25MAR11

APPROVED J FOCHTMAN 25MAR11

APPROVED T WHITLATCH 28MAR11

United States Department of Energy

Jefferson Lab

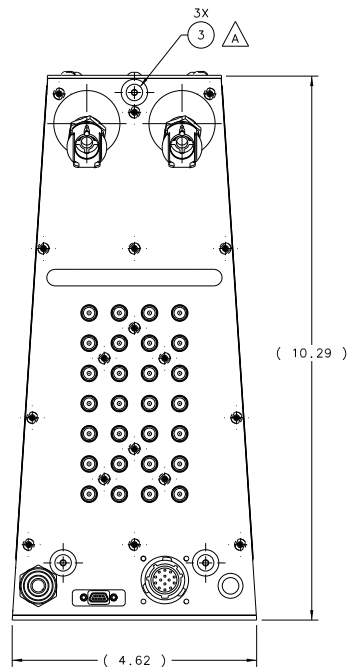
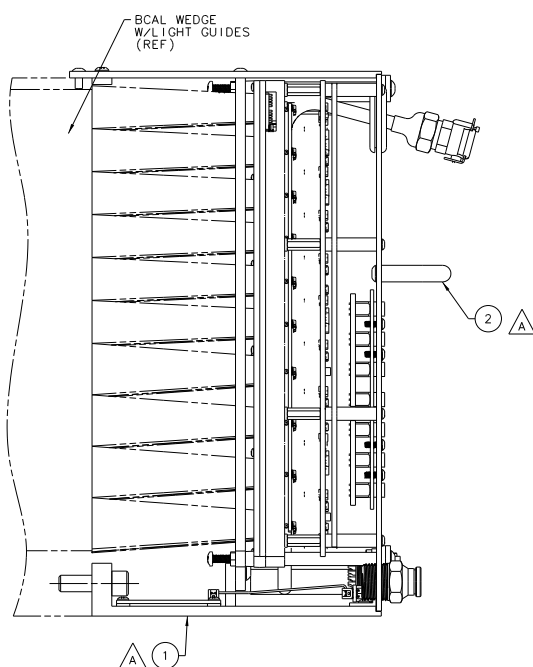
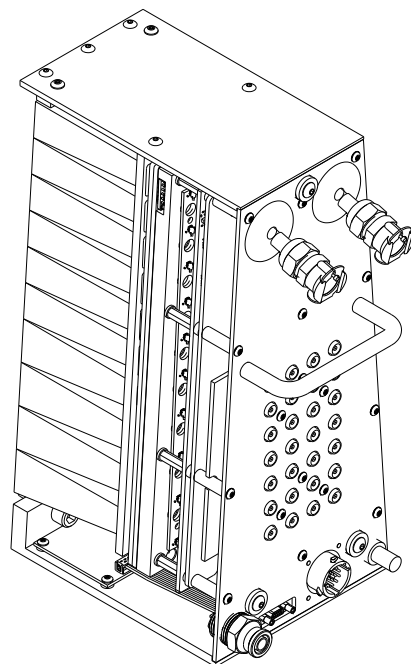
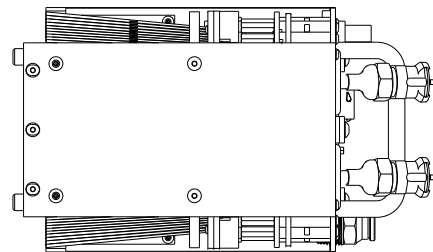
HALL D - GLUEX DETECTOR BARREL CALORIMETER COOLING/ELEC MODULE

SIZE DWG. NO. D00000-01-07-1023

SCALE 1:1

REV. A

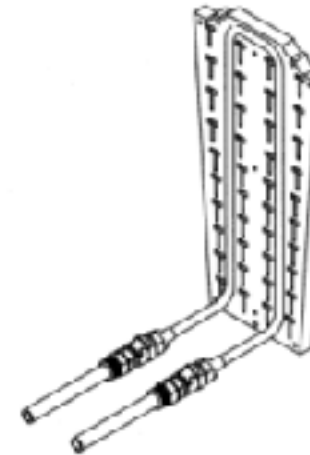
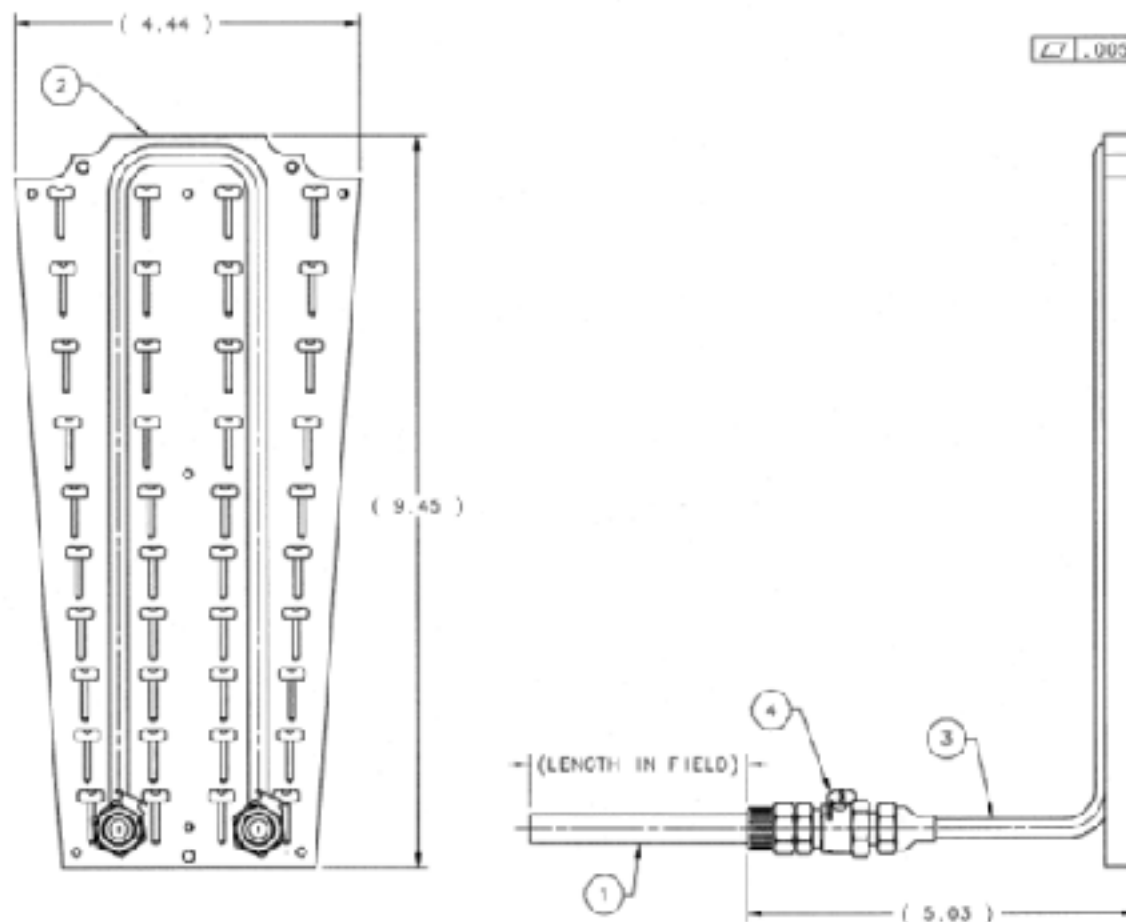
GlueX-BCAL Wedge



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

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
PARTS LIST					
EACH SHEET OF MULTI-SHEET DRAWINGS SHALL ALWAYS HAVE THE SAME REVISION LEVEL.					
UNIT & TOL PER THIS TITLE UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS ARE DECIMAL ANGLES ARE DEGREES		TRACKING NO. N/A		United States Department of Energy	
MATERIAL SEE PARTS LIST		THIRD ANGLE PROJECTION		Jefferson Lab HALL D - GLUEX DETECTOR BARREL CALORIMETER READOUT MODULE ASSY	
FINISH: UNLESS OTHERWISE NOTED, SURFACES ARE TO BE BREAK ALL SHARP EDGES. DO NOT SCALE DRAWING.		APPROVALS DRAWN: C. L. HUTTON CHECKED: J. FUCHSMAN APPROVED: J. FUCHSMAN APPROVED: T. WHITLATCH		DATE 01NOV10 25MAR11 25MAR11 20MAR11	
		SIZE (DWG. NO.) E D00000-01-07-1011		SHEET 1 OF 1	

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 MOD-000	1/8" NPT VALVED COUPLING BODY	BRASS	1
1	3	D00000-01-07-2041	COOLING TUBE W/ TITENGS		
1	2	D00000-01-07-2040	COOLING PLATE		
2	1	D00000-01-07-1022	HOSE ASSY		

DESIGNER: [Signature] CHECKED: [Signature] DATE: 07/07/01	TITLE: [Signature] DATE: 07/07/01	TRACKING NO.: [Blank]		JEFFERSON LAB Jefferson National Accelerator Facility Hall D - GLUEX DETECTOR BARREL CALORIMETER COOLING PLATE ASSY	REV: 1 DATE: 07/07/01
		APPROVALS: [Signature] DATE: 07/07/01			
MATERIAL: SEE PARTS LIST		THERMAL PROTECTION: [Blank]		D00000-01-07-1021	

Series "ARV" Thermoplastic Air Release Valve

Self-Guided Poppet Assures Dependable, Repetitive Operation

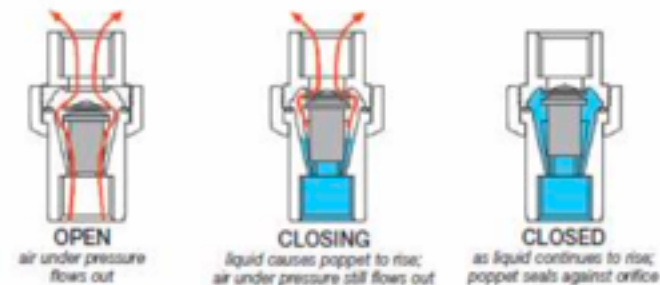


Features:

- **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

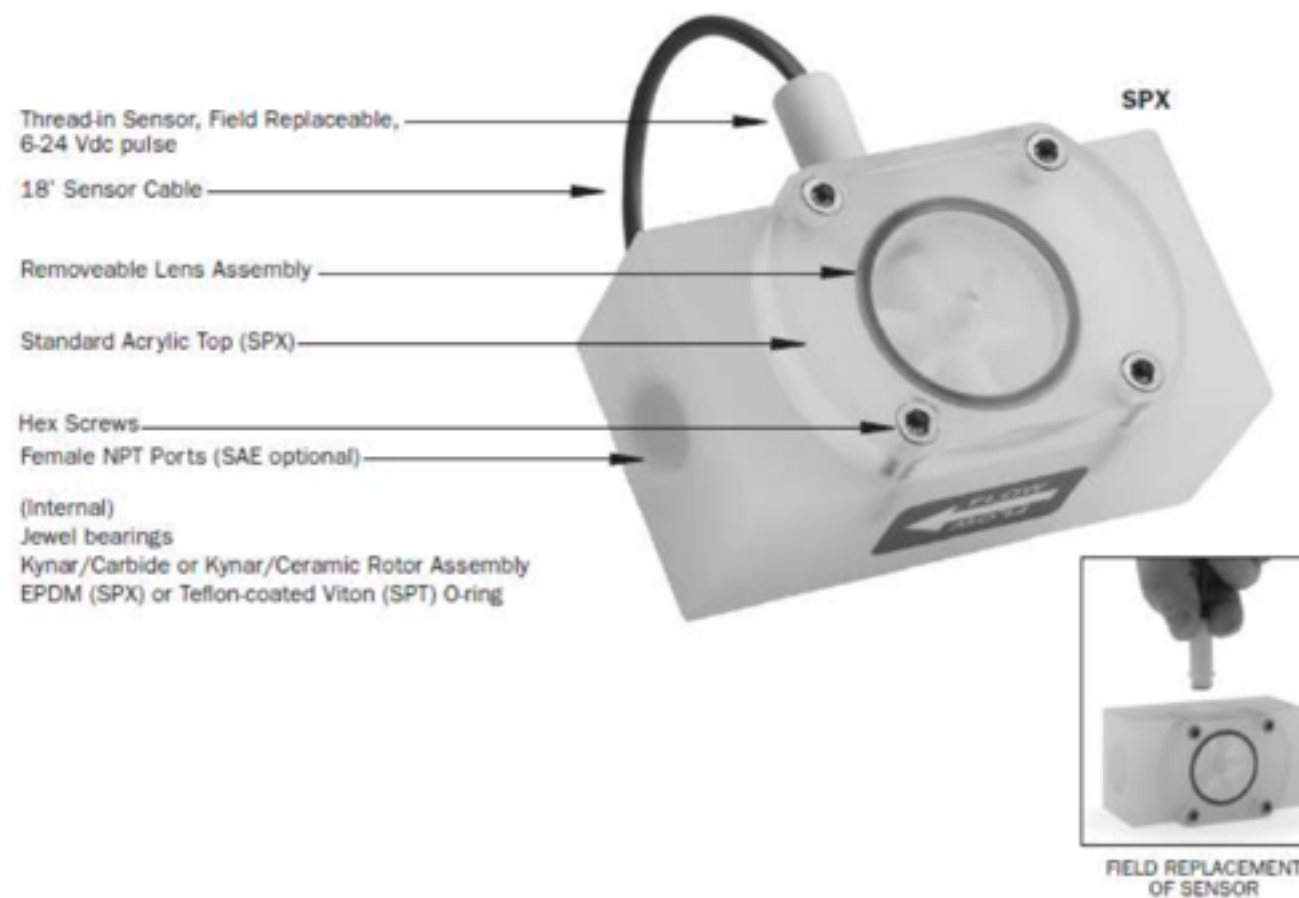
ADD TO ORDER

In stock
\$443.00 Each
5439K23

Seametrics

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

FEATURES



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).

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

GLUE X BCAL Light Guides

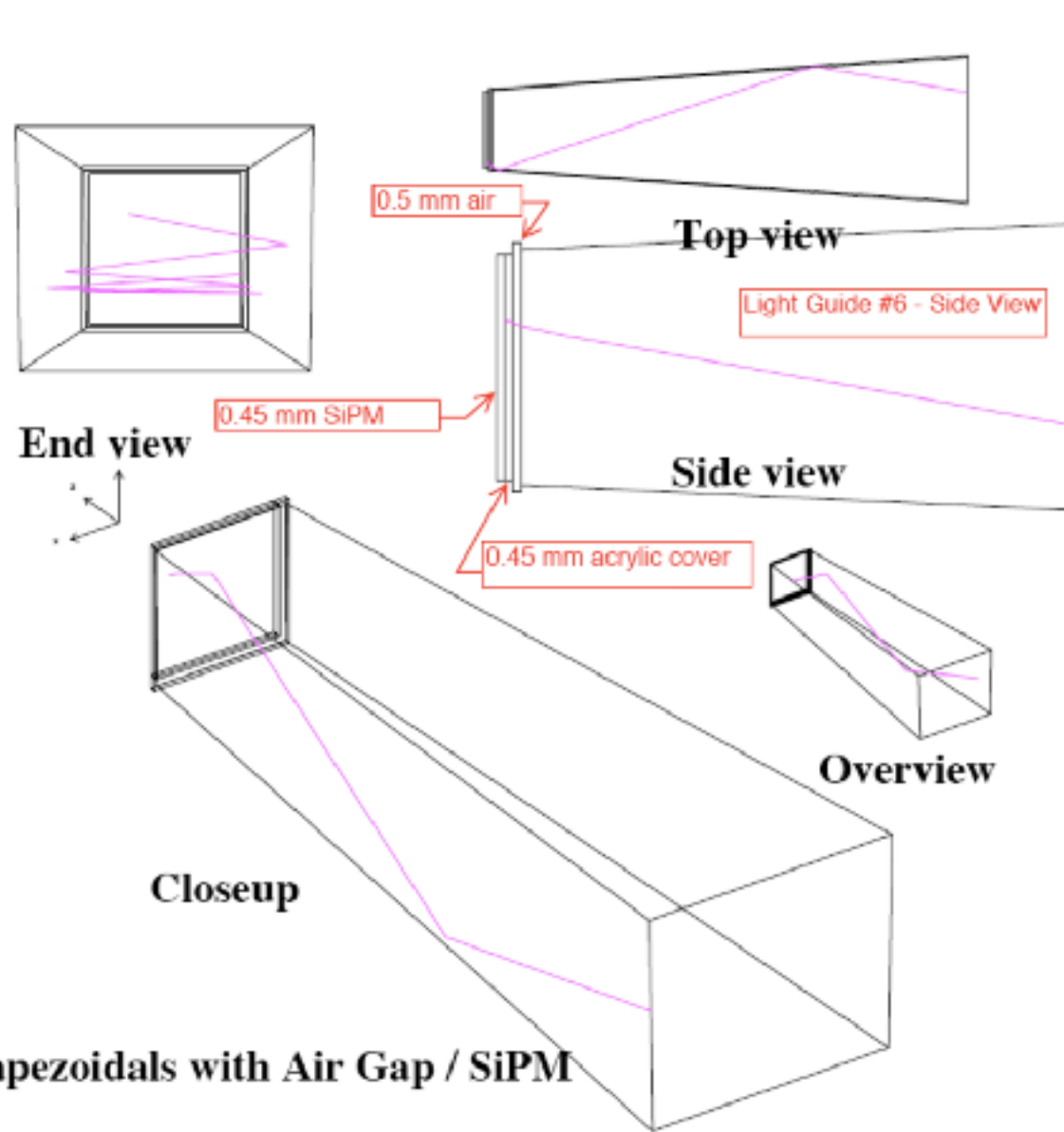
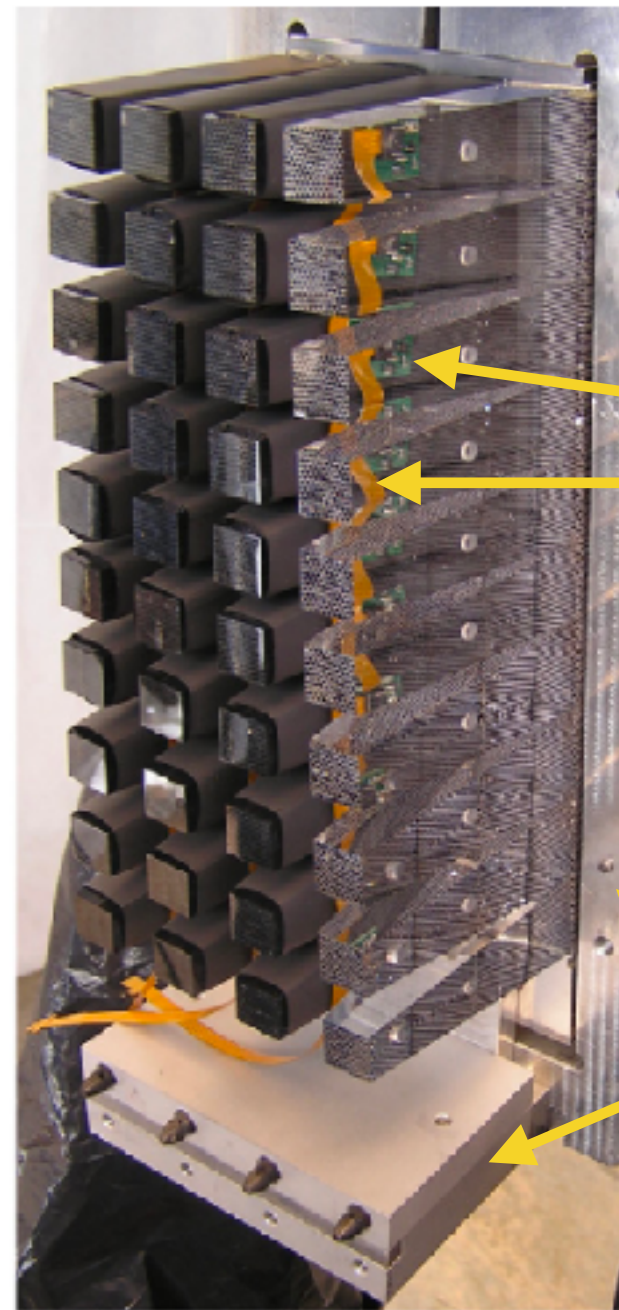


Table 1: Sizes of the ten production light guides for the Bcal. The trapezoid dimensions are denoted using the notation (bottom-top $\times$ height).

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

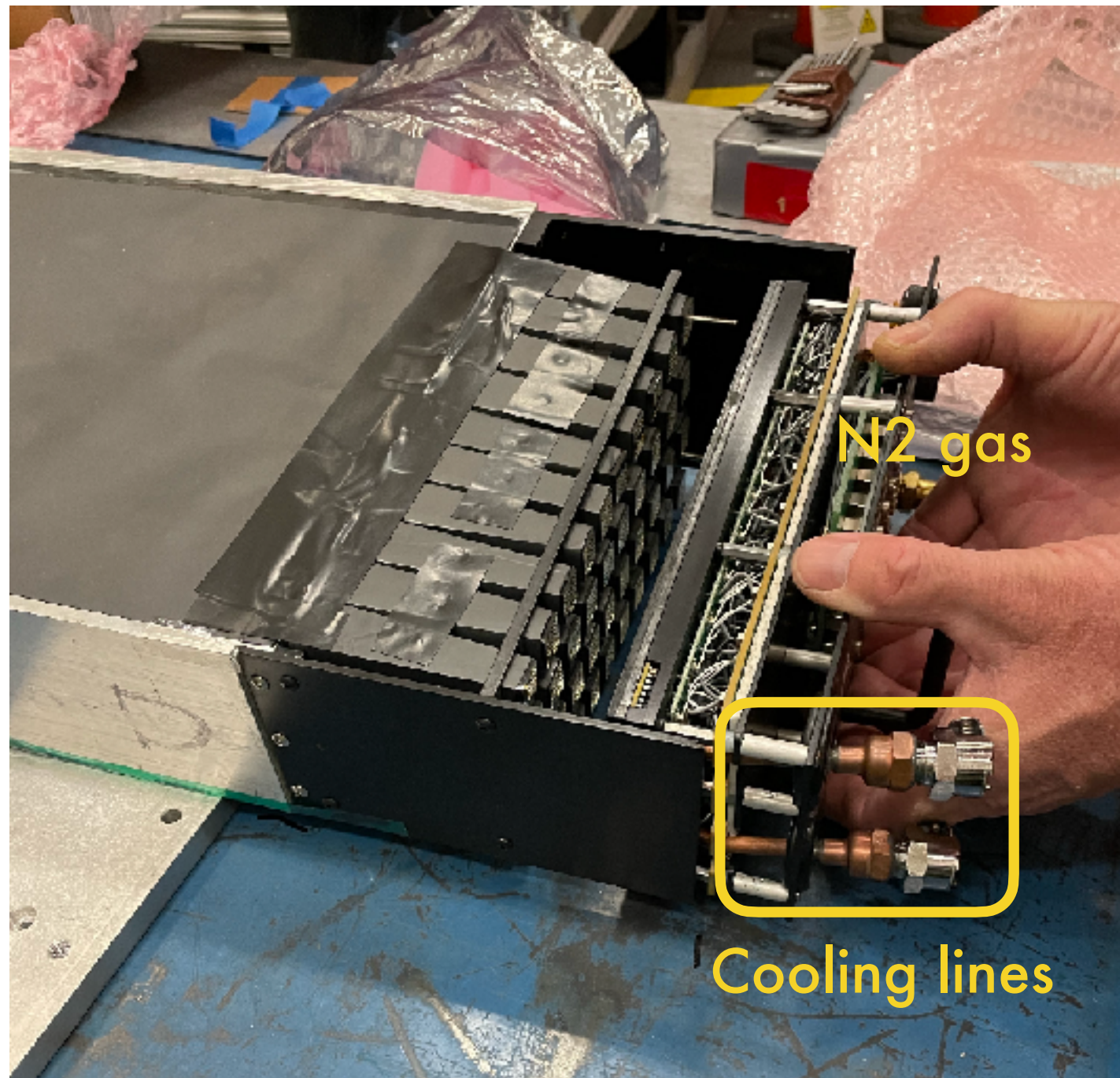
GLUE X BCAL Light Guides



LED mini boards;
Flex cable

LG mounting jig

BCAL "Wedges"

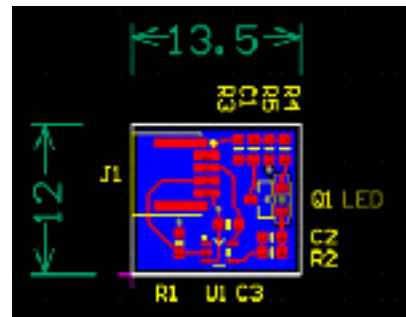


- Contiguous LG stacking
- LG-SiPM air gap
- BIC: Si cookie
- Spring loading
- Integrated ESB for installation ease

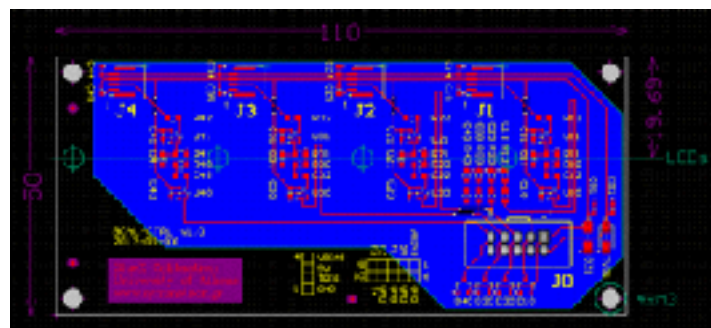
GlueX LMS



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



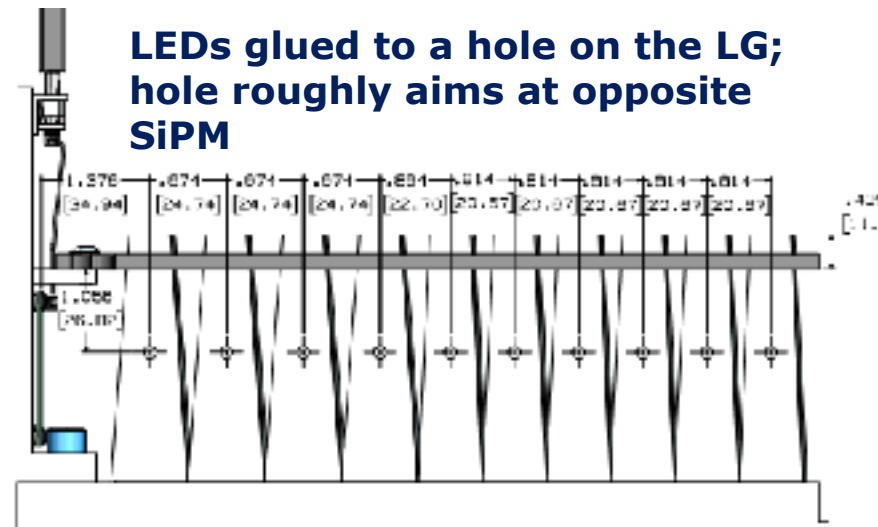
BCAL Controller layout



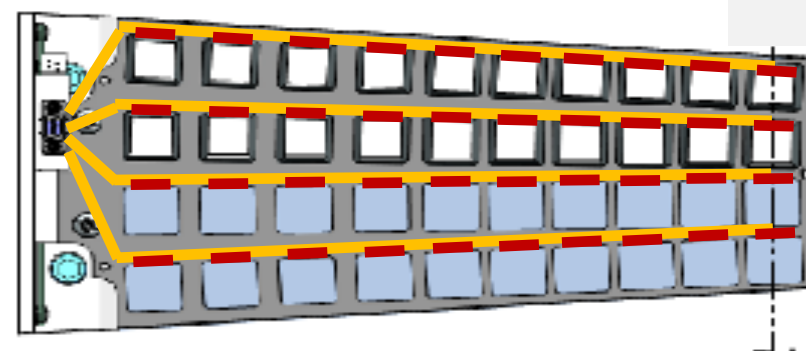
innermost LG 21x21 mm², outermost 27x25 mm²; output faces are 13x13 mm² to match SiPM window

LEDs: Bivar, Blue, 465 nm

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



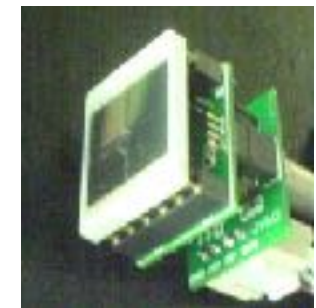
4 flexible strips per side per module



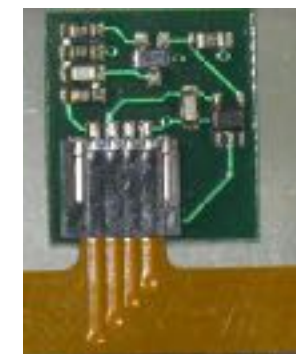
- 1 flex cable per row, connecting 10 mini boards; 384 flex cables
- 4 flex cables connected **to** 1 BCAL controller; **96 BCAL controllers**
- **1 BCAL controller per half module;** light each row independently
- System typically pulsed at 50-100 Hz

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

Hamamatsu S12045X



BCAL miniboard on flex cable

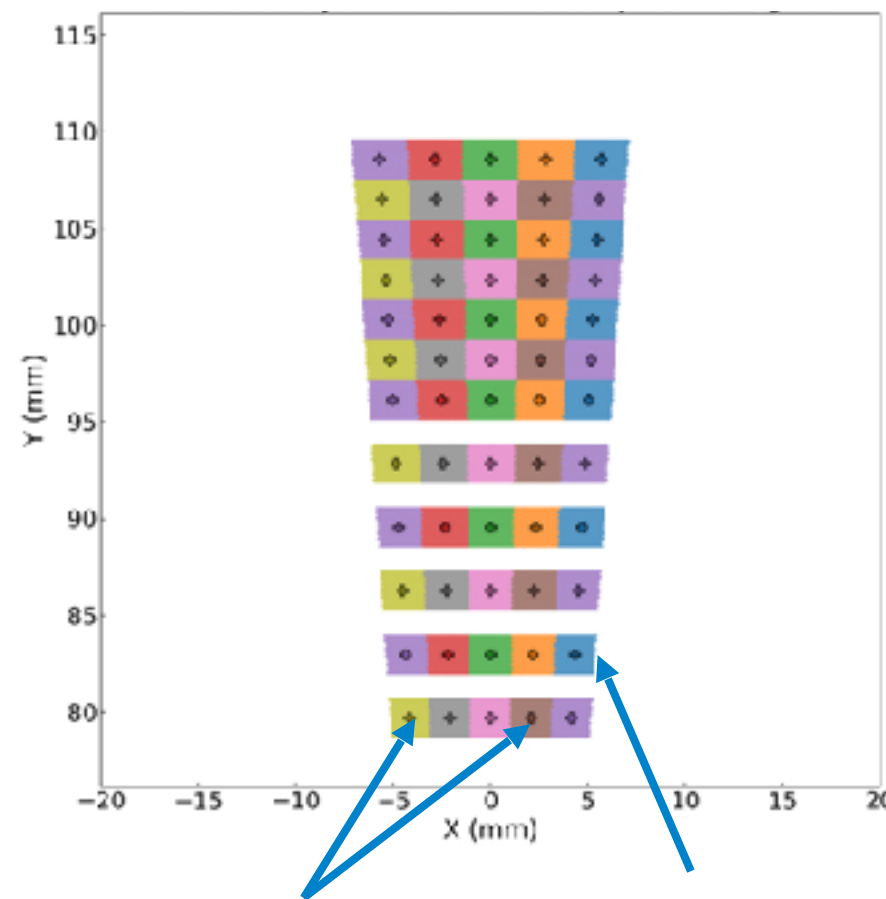


NIMA 738 (2014)
41-49

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 6x6 mm² SiPMs with 50 μm 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**

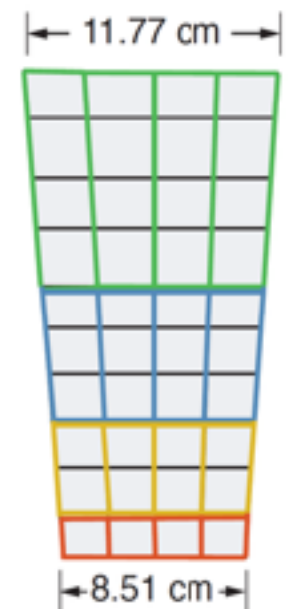
ePIC Sector End View
(x-y plane view), 17.1 X0



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 3x3 mm²
50x50 μm^2 pixels

16 FADC per side
12 TDC per side