End-of-Sector Boxes Update

ePIC/Barrel Imaging Calorimeter

Z. Papandreou

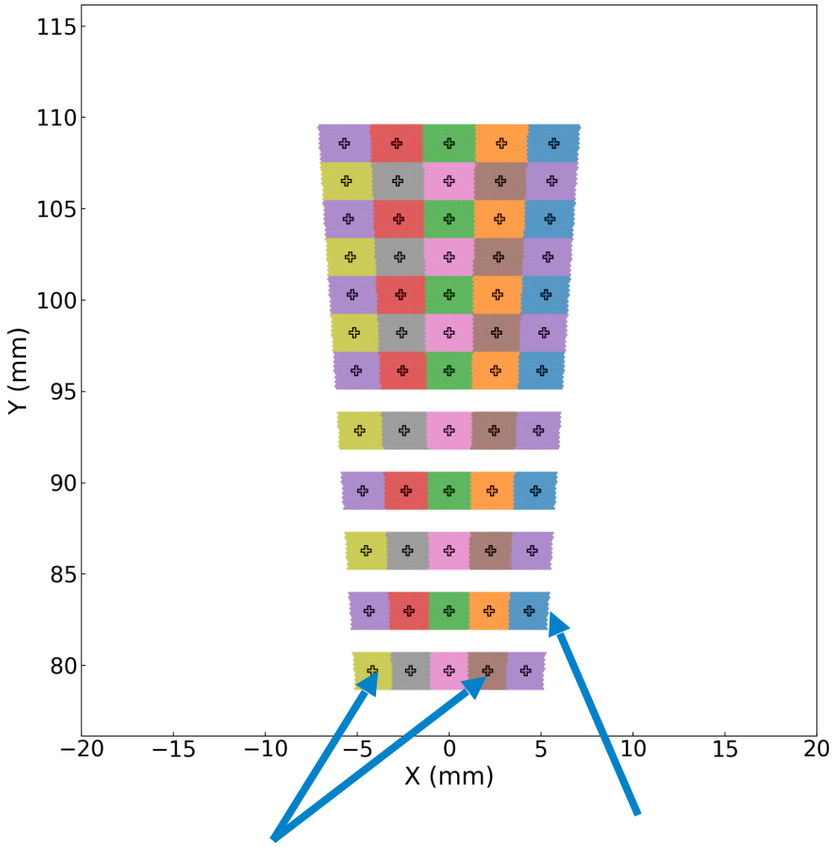
BIC General Meeting

March 1, 2024

SiPM Readout

- **2-sided SiPM readout**
- **Lightguides** on sector sides
  - inner surface ~2×2 cm²
  - output face 1.3×1.3 cm²
- SiPMs that meet our requirements:
  - 4 x 6×6 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**

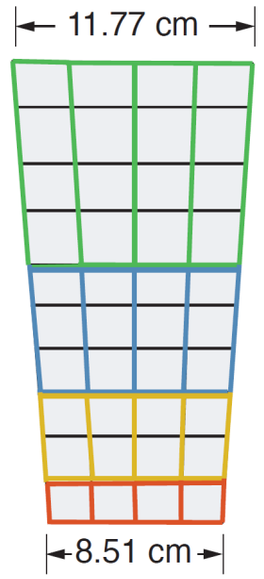
ePIC Sector End View (x-y plane view), 17.1 X0



Readout **Cell**
Has lightguide
Layer = 5 cells

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

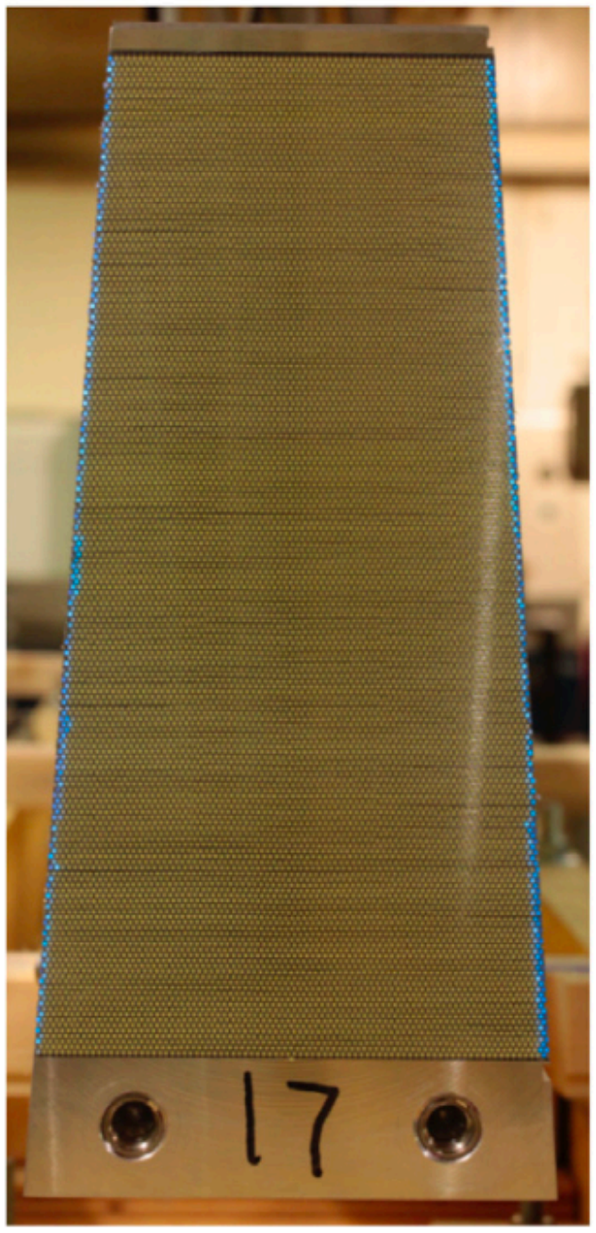
GlueX Sector End View, 15.5 X0

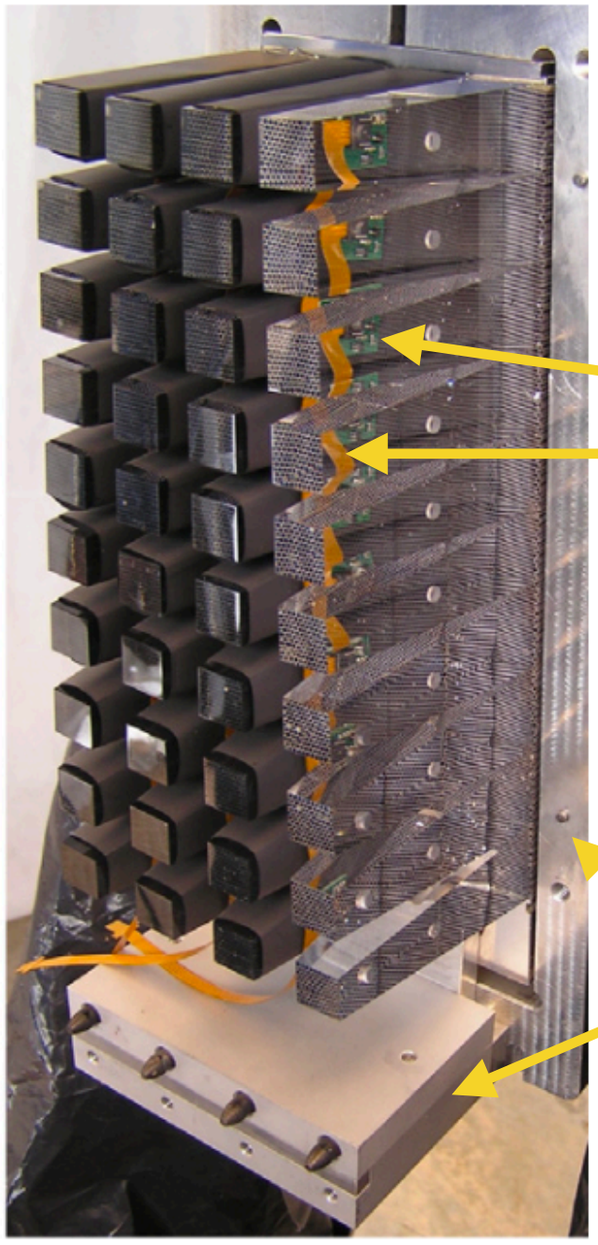


Hamamatsu S12045(X)
4×4 array of 3×3 mm²
50×50μm² pixels

16 FADC per side
12 TDC per side

BCAL Light Guides





BCAL Light Guides

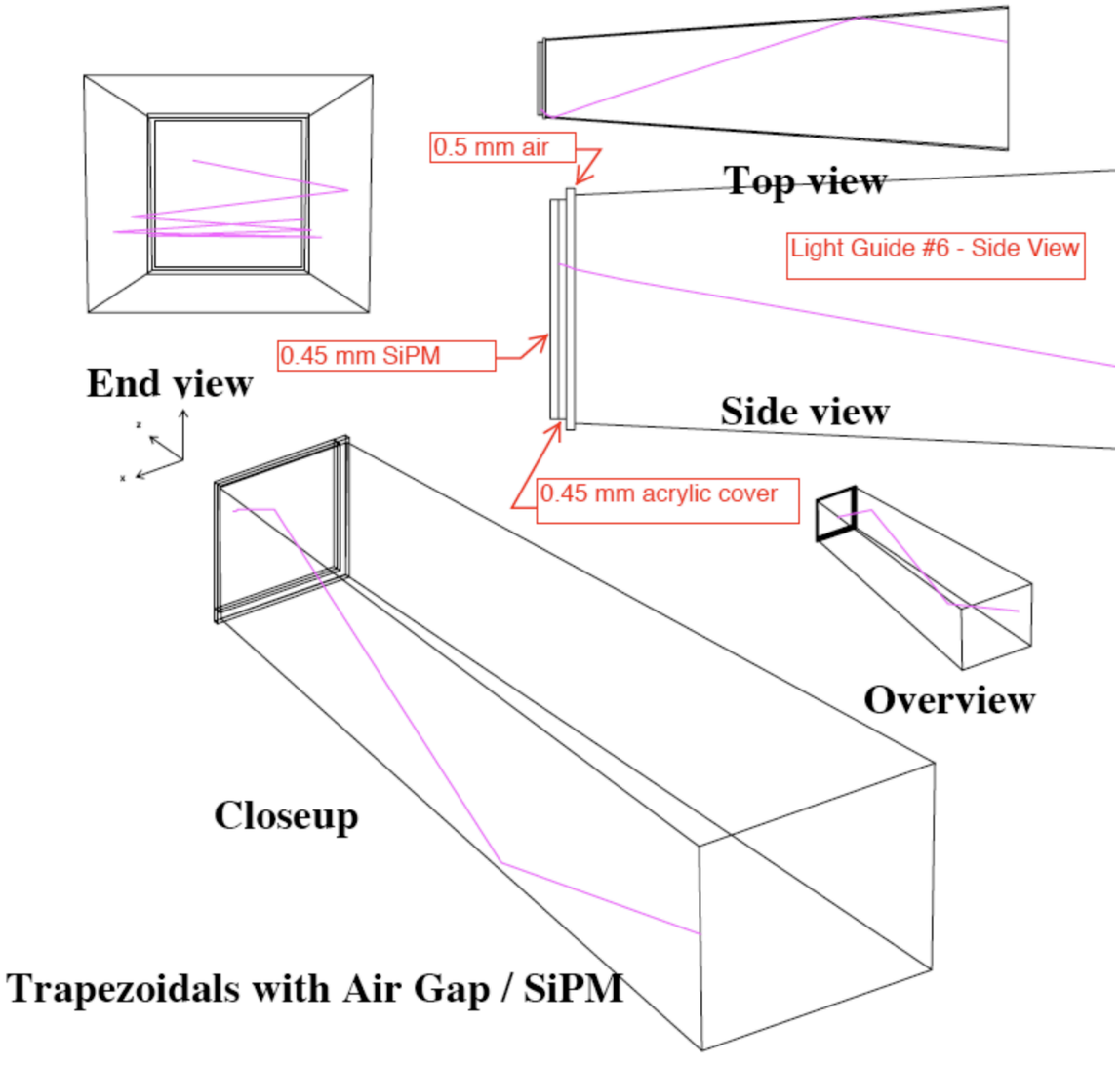
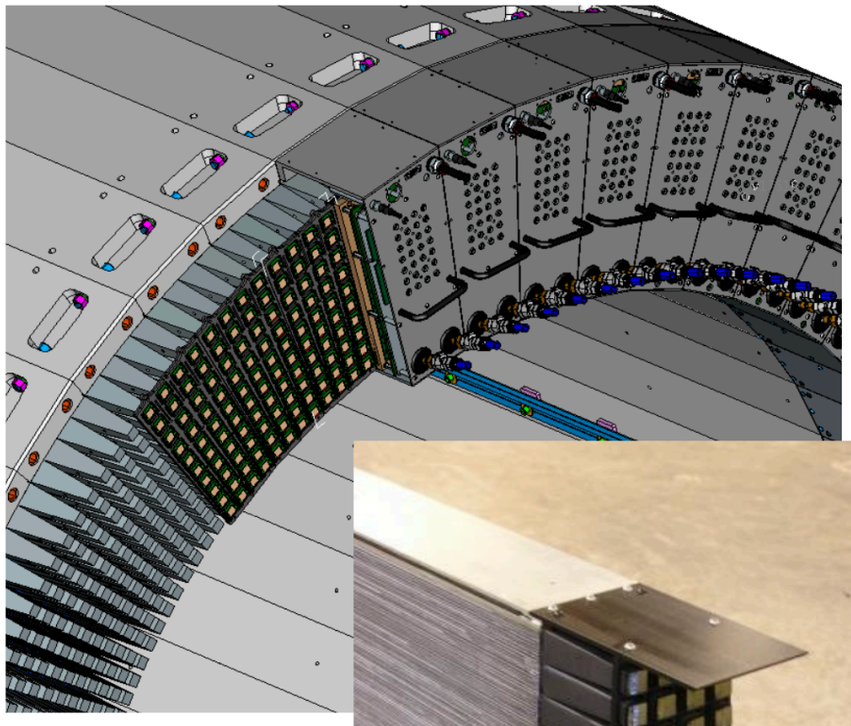


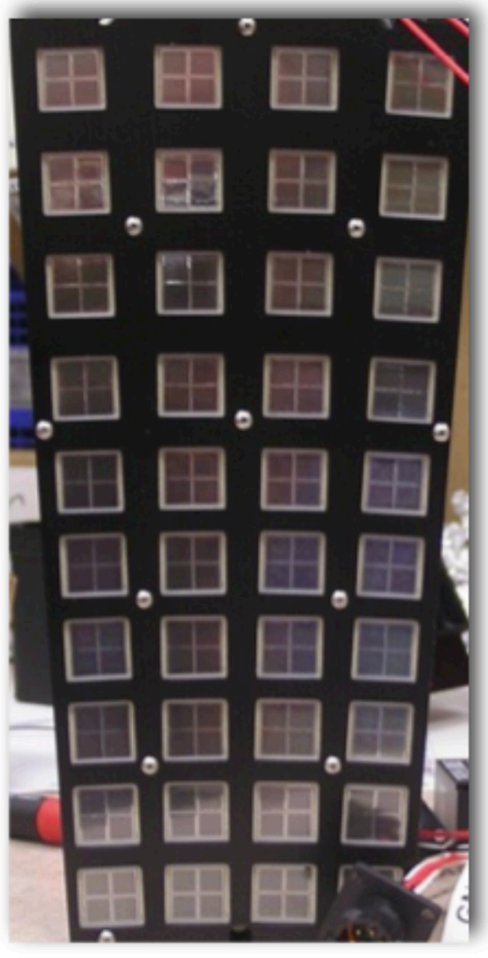
Table 1: Sizes of the ten production light guides for the Bcal. The trapezoid dimensions are denoted using the notation (bottom-top × height).

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

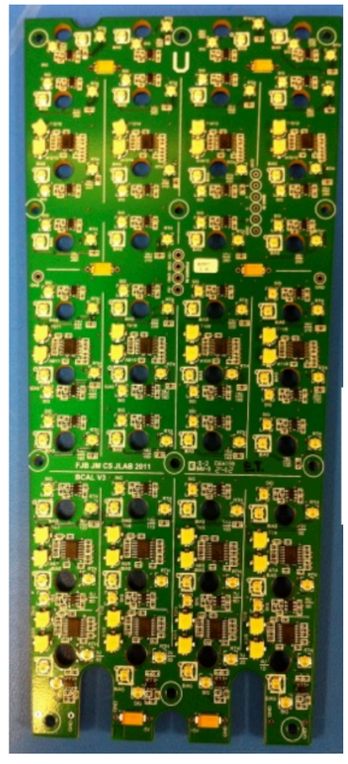
BCAL SiPMs



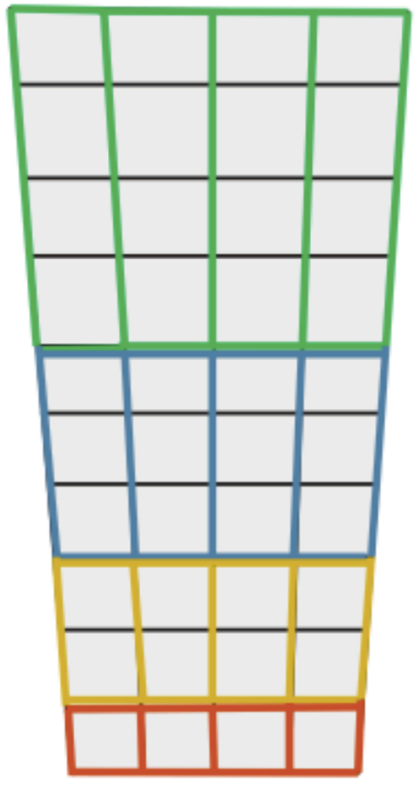
Light guides



Assembly



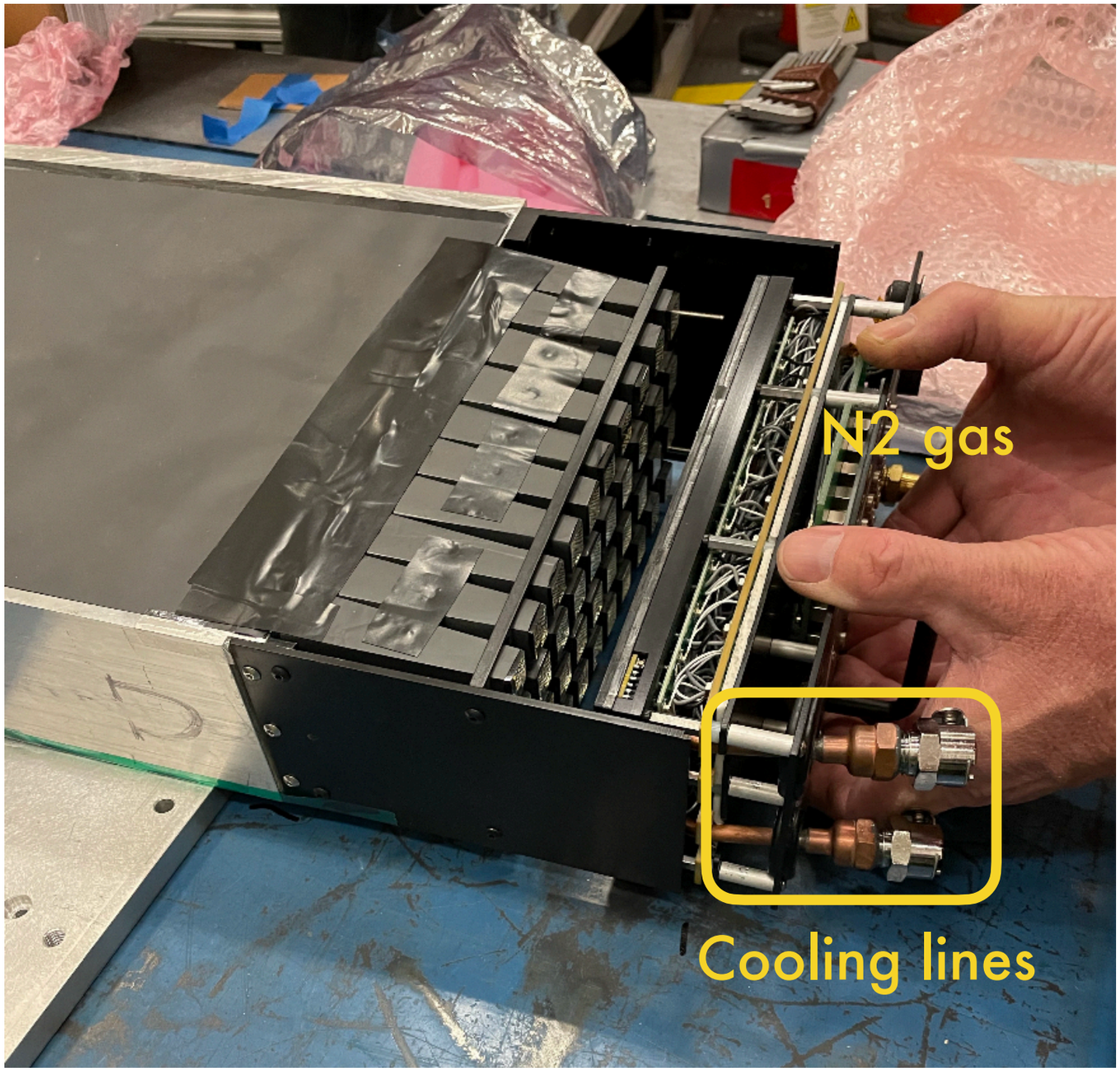
Electronics



Summing Scheme

GlueX: discrete electronics; Norbert's HGCROC for BIC modern approach

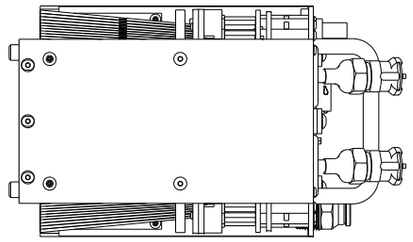
BCAL "Wedges"

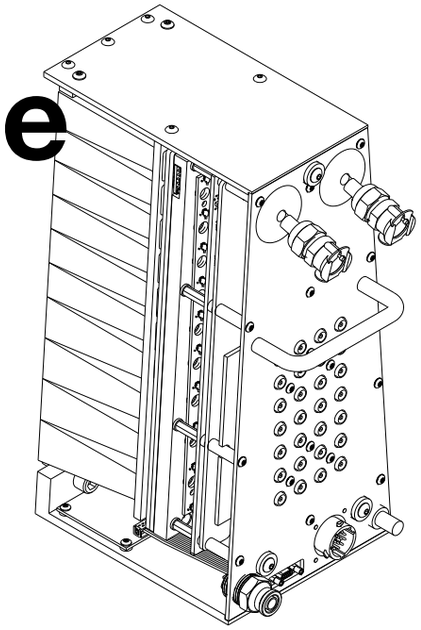


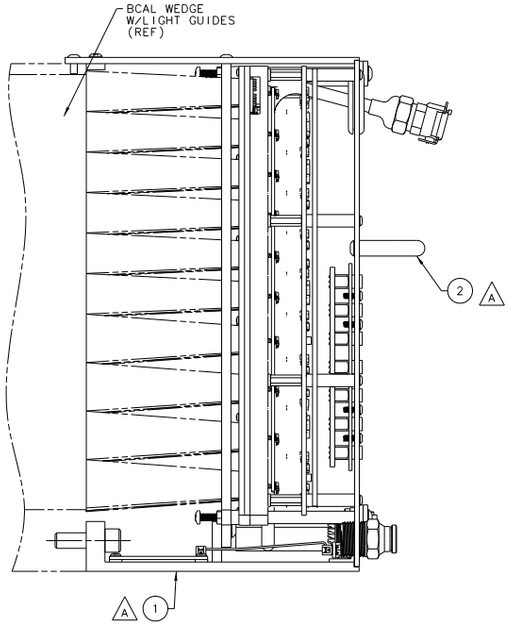
- Contiguous LG stacking
- LG-SiPM air gap
- BIC: Si cookie
- Spring loading
- Integrated ESB for installation ease

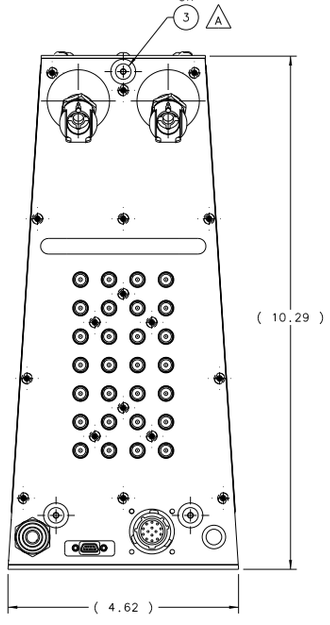
REVISION HISTORY				
ZONE	REV	DESCRIPTION	DATE	APPROVED
6C, 7B 3E, 3B	A	UPDATED ITEMS 1 & 2. ITEM 3 WAS SPACER. DELETED ITEMS 4-6 & NOTE 1. DRAWING NAME WAS READOUT MODULE - O GROOVE	04AUG14 04AUG14	R GETZ WHITLATCH

GlueX-BCAL Wedge









A

A

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

EACH SHEET OF MULTI-SHEET DRAWINGS SHALL ALWAYS HAVE THE SAME REVISION LEVEL.

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	01NOV10
CHECKED J FOCHTMAN	25MAR11
APPROVED J FOCHTMAN	25MAR11
APPROVED T WHITLATCH	28MAR11

United States Department of Energy — Jefferson Lab — Newport News Virginia

HALL D - GLUEX DETECTOR BARREL CALORIMETER READOUT MODULE ASSY

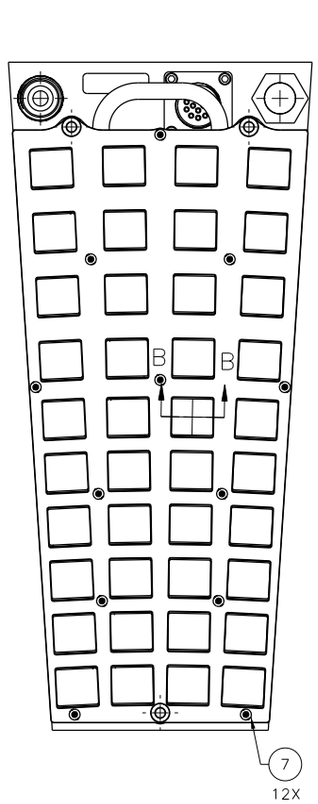
A

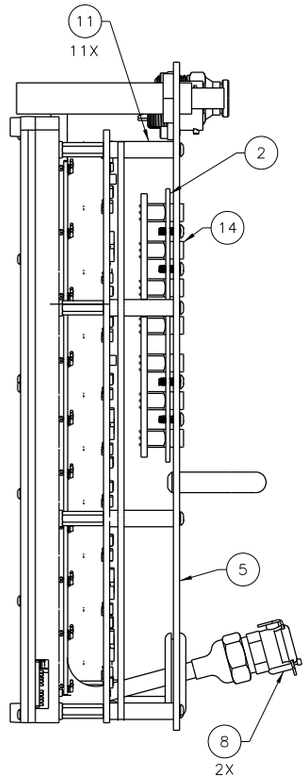
SIZE E | DWG. NO. D00000-01-07-1011 | REV. A

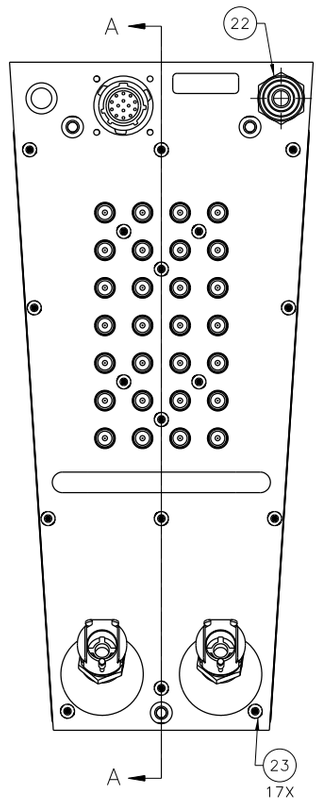
SCALE 1 : 1 | USED ON ASSY NO. D00000-01-07-1010 | SHEET 1 OF 1

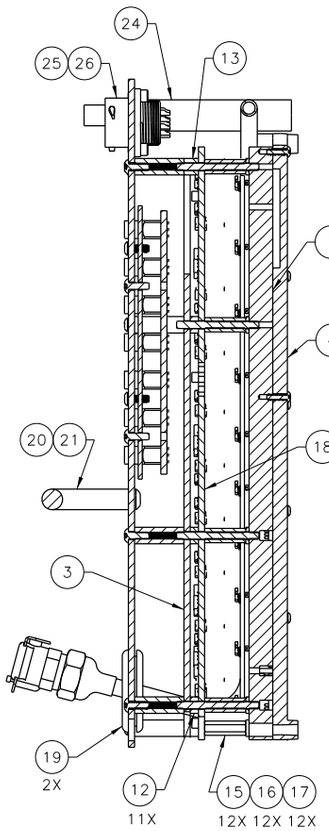
Approved: 08/06/2014; E-Sign ID: 280054; Signed By: Approver 1: T. Whitlatch; Checker: R. Getz; DCO: T. Fust

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









SECTION A-A

NOTES:

1. SUGGESTED SOURCE OR JLAB APPROVED ALTERNATE

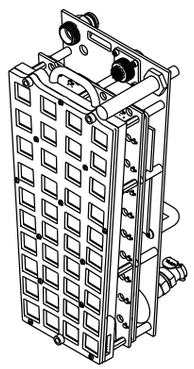
DIGI-KEY CORPORATION 1-800-344-4539 www.digikey.com	ALLIED ELECTRONICS (866) 433-5722 WWW.ALLIEDELEC.COM
MCMASTER-CARR 1-630-833-0300 www.mcmaster.com	MICHELL INSTUMENTS UK (44) 01353 658000 www.michell.com

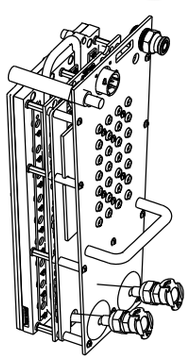
2. ITEMS 22 AND 24 ONLY USED AS NEEDED. WHEN NOT USED, HOLES IN COVER WILL BE PLUGGED.

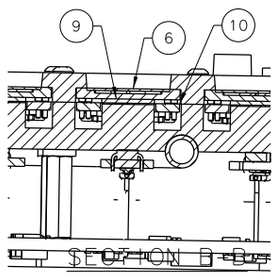
QTY REQD	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	NOTES
4	26	MCMASTER-CARR #92196A105	HEX HD CAP SCREW #4-40 X .18 LG	18-8 SS	1
1	25	ALLIED ELECTRONICS 70129601	SQ FLANGE RECEPTACLE W/14 PIN CONTACTS (SOURIAU #UTS012E14P)		1
1	24	MICHELL INSTRUMENTS PCMINI-52	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 SCREWMMET #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" MALENPT 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		

PARTS LIST

GlueX-BCAL Wedge





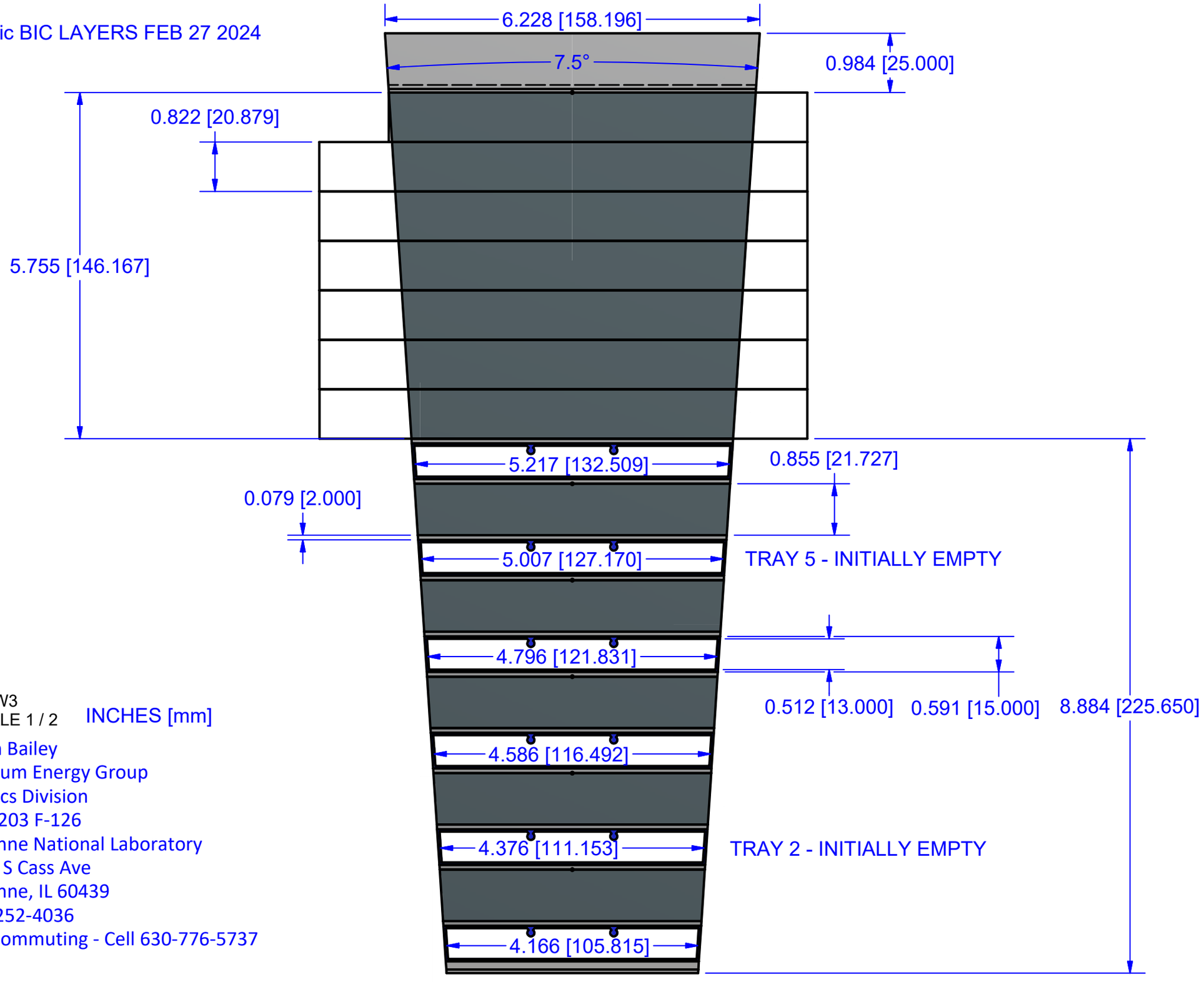


SECTION B-B

DOCUMENT CONTROL STAMP	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	United States Department of Energy — Jefferson Lab — Newport News Virginia
MATERIAL SEE PARTS LIST		APPROVALS / DATE DRAWN C L HUTTON 21MAR11 CHECKED J FOCHTMAN 25MAR11 APPROVED J FOCHTMAN 25MAR11 APPROVED T WHITLATCH 28MAR11	HALL D - GLUEX DETECTOR BARREL CALORIMETER COOLING/ELEC MODULE
FINISH MACHINED SURFACES 125 UNLESS OTHERWISE NOTED DEBURR & BREAK ALL SHARP EDGES			SIZE D — DWG. NO. D00000-01-07-1023 — REV. A
DO NOT SCALE DRAWING			SCALE 1:1 — USED ON ASSY NO. D00000-01-07-1011 — SHEET 1 OF 1

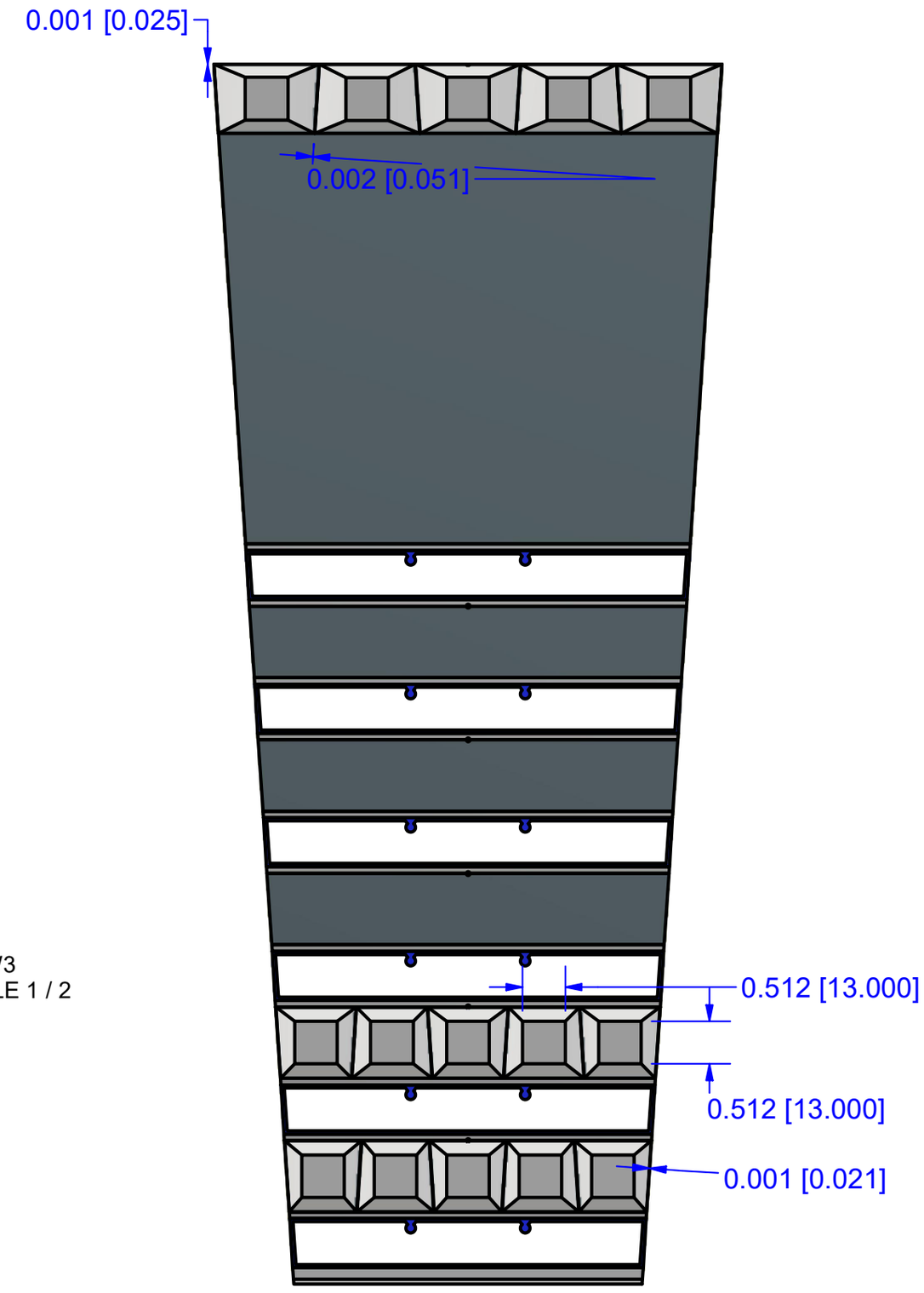
Approved: 01/23/2013; E-Sign ID: 225000; Signed By: Approver 1: T. Whitlatch; Checker: J. Fochtman; DCG: T. Fuesl

Epic BIC LAYERS FEB 27 2024



VIEW3
SCALE 1 / 2 INCHES [mm]

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



VIEW3
SCALE 1 / 2

INCHES [mm]

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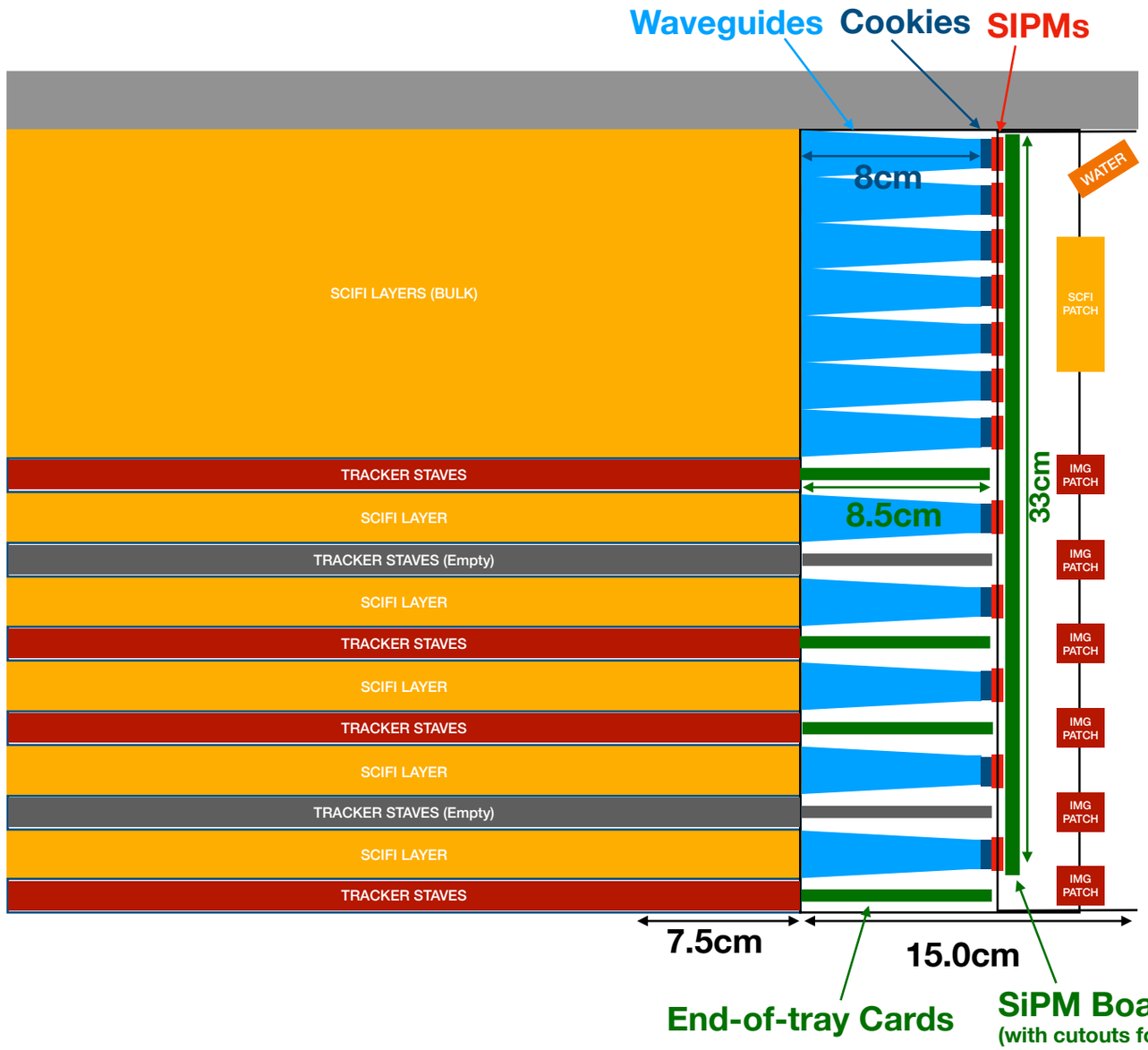
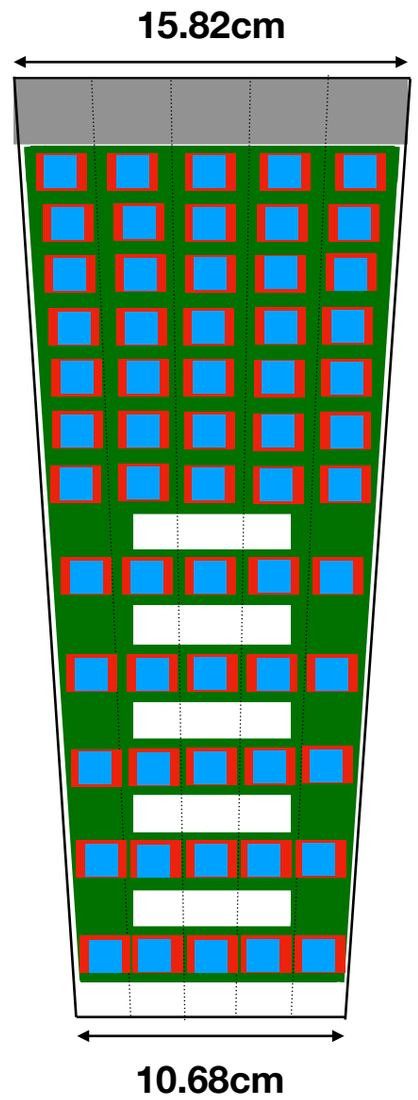
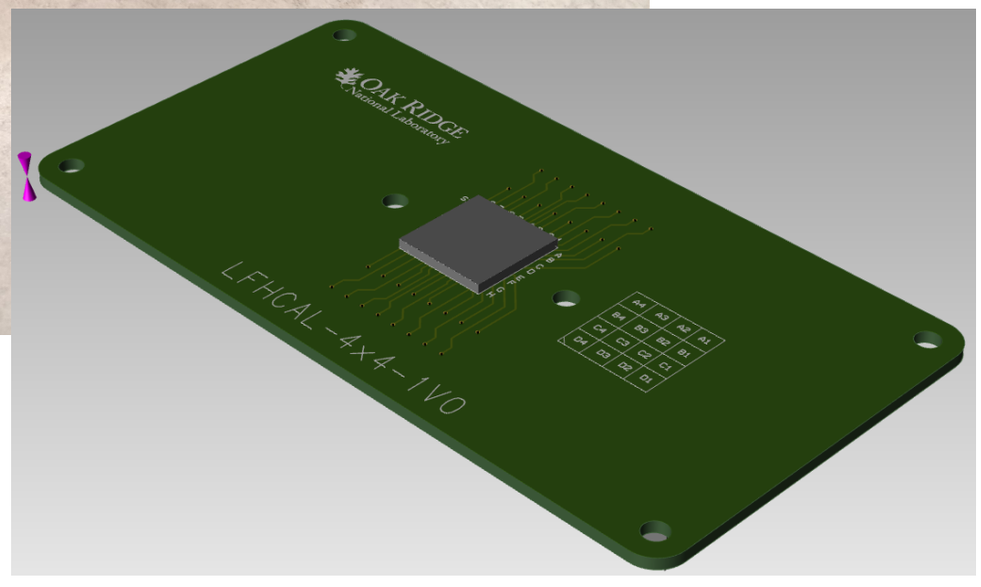
Side View for EOSB
(12 modules/9 chips scenario)



Cross section at SiPM Board





Testing soon at ORNL!

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).

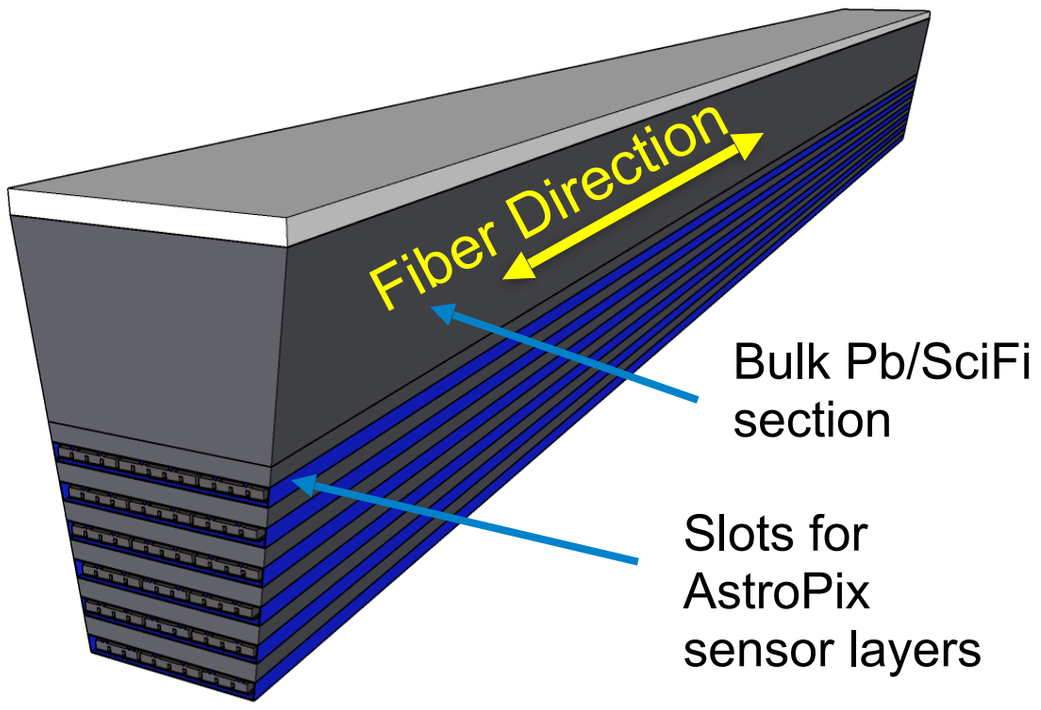
Summary

- **BIC baseline comparison is to GlueX/BCAL**
  - BIC is longer (435 cm vs 390 cm)
- Design, R&D, First Article
  - PbSciFi @ ANL & Manitoba
  - **ESB @ Regina** (UofA-MRS, ANL, ORNL)
    - PED Funds: Mech Eng/Elec Eng, Postdoc, M&S
    - Timeline: ~ 15 mo for test article (June 2025).

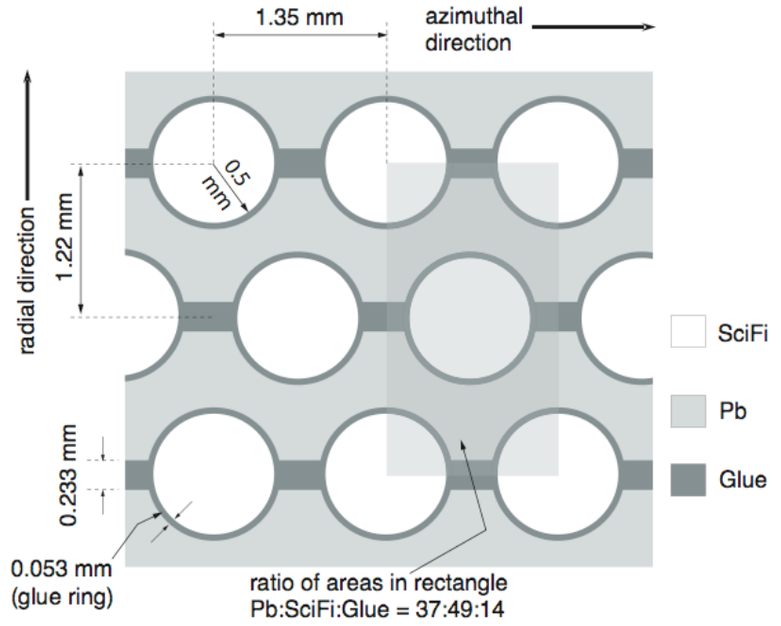
Backup slides

bECAL Sector

Calorimeter Sector



- 48 sectors:
  - Bulk
  - SFIL & ESB



- Inner: interleaved layers of imaging Si sensors with PbSciFi (SFIL- SciFi Imaging Layers)
- Outer: bulk Pb/SciFi section
- Light guides; optical cookie
- SiPMs as sensors

GlueX/BIC SiPMs

HAMAMATSU

PHOTON IS OUR BUSINESS

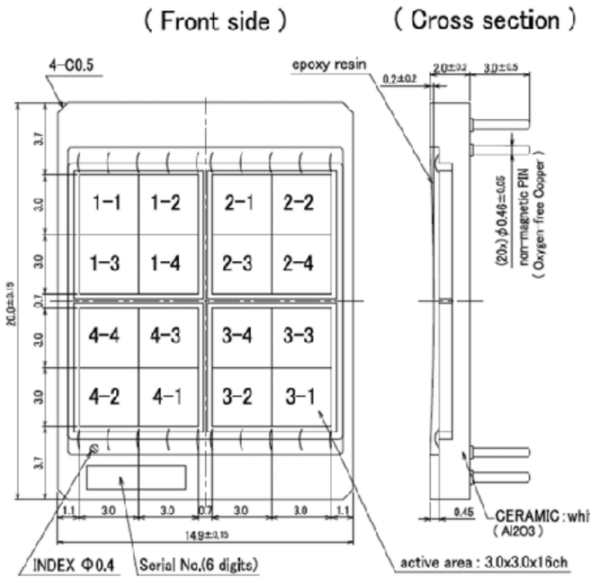
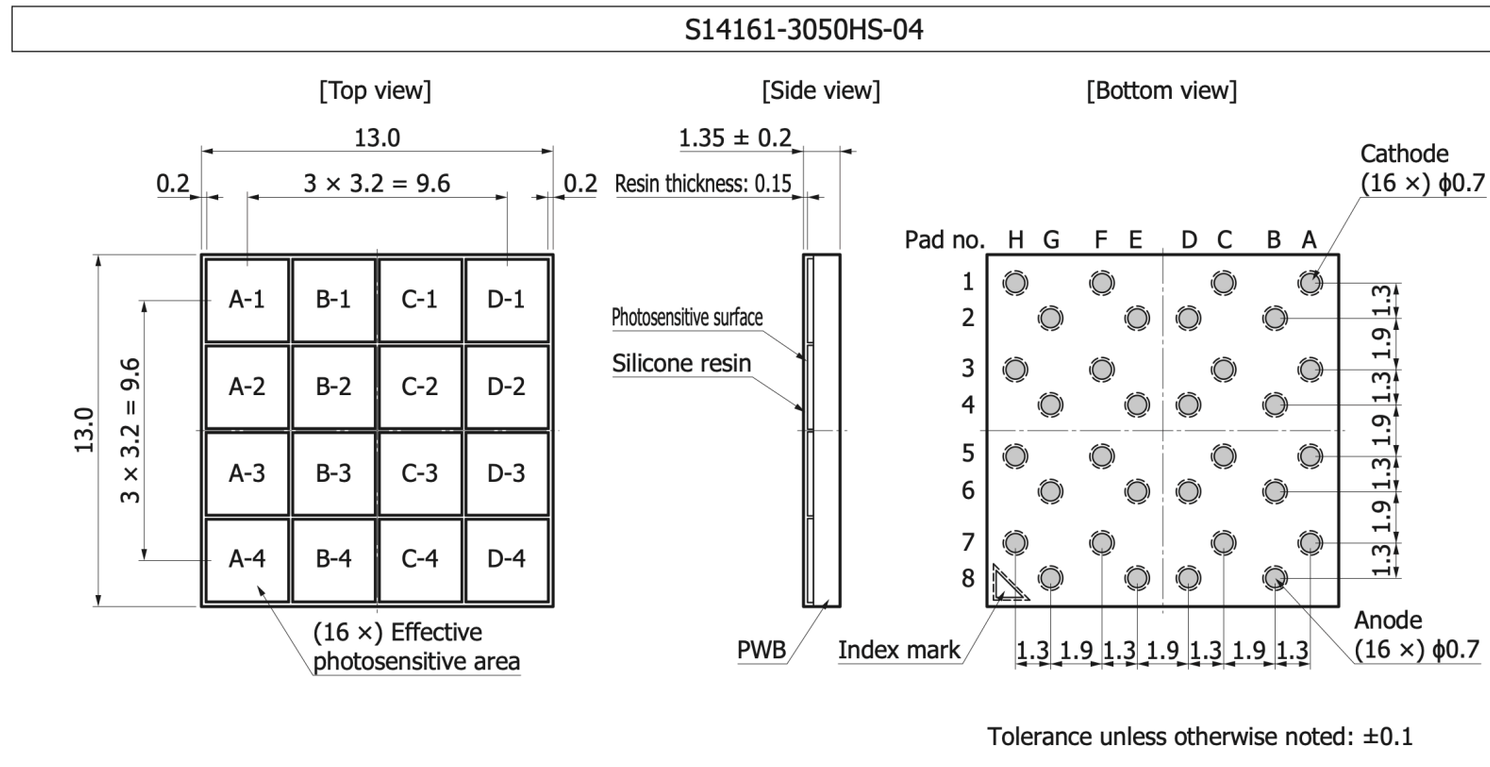


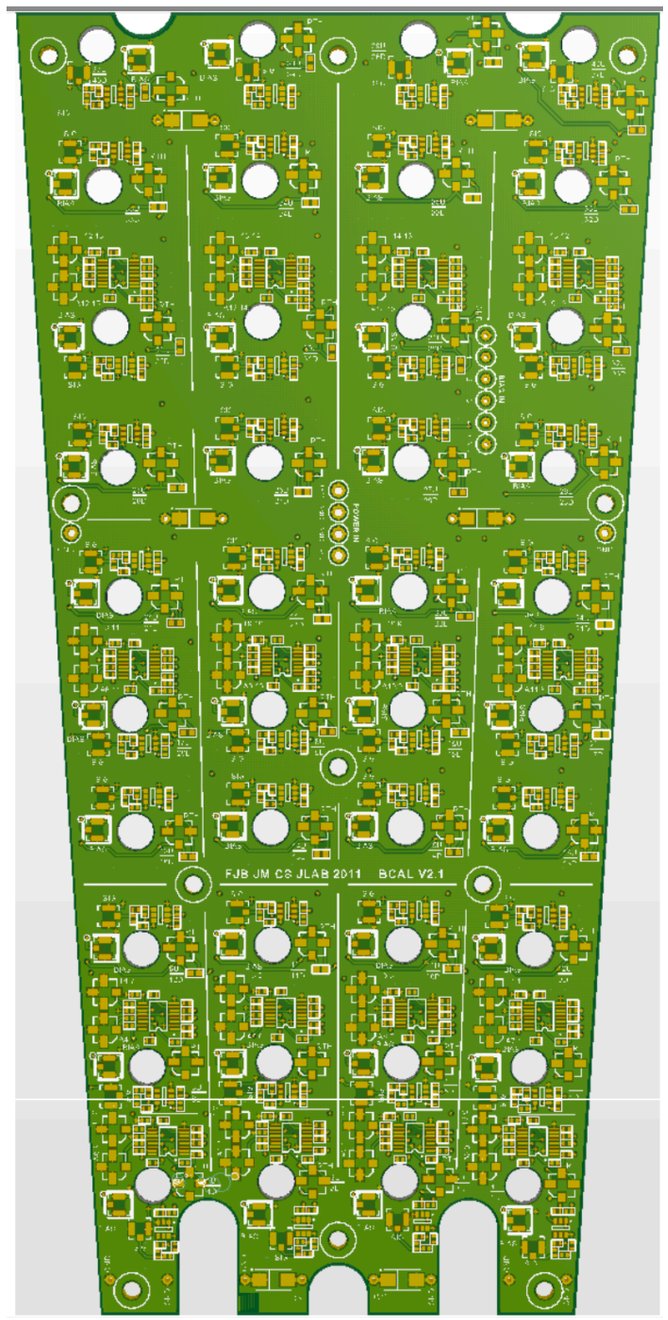
Fig. 1. A schematic drawing of the front and side views for the Hamamatsu MPPCs for the GlueX experiment is shown, detailing the tiling of the 3×3 mm^2 cells into a 4×4 configuration. The numbered cells are active; all other areas and spacings are inactive. (Courtesy of Hamamatsu).

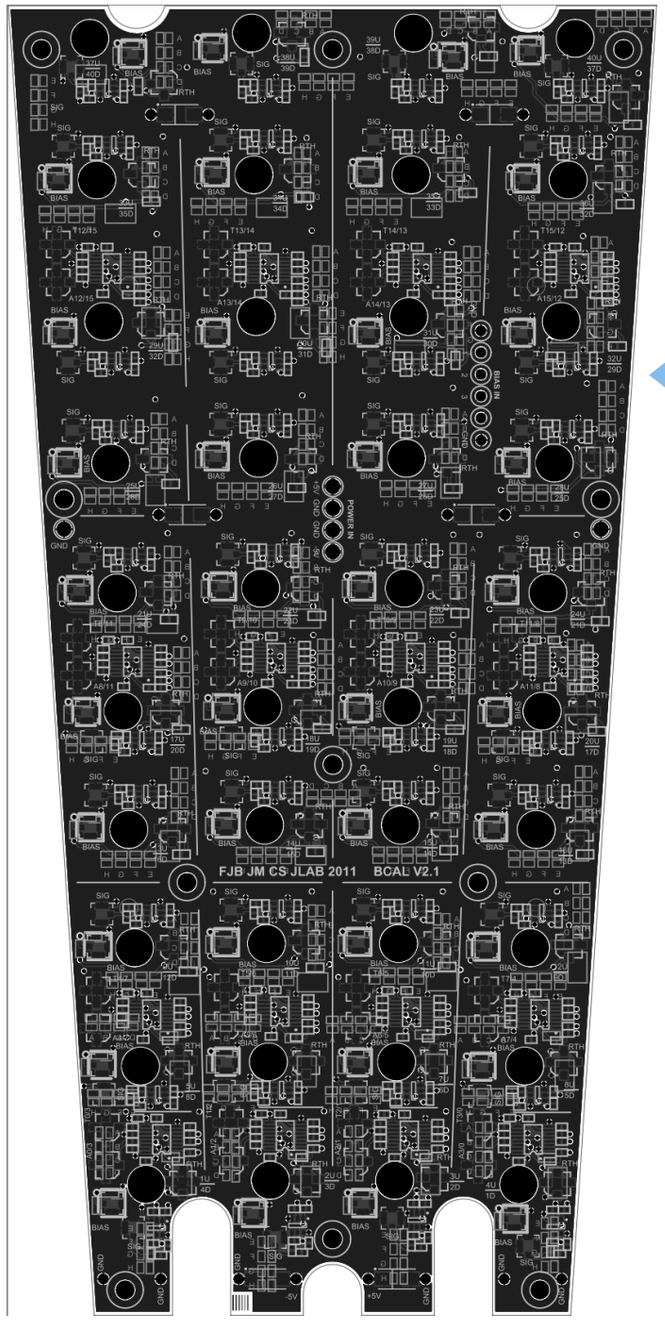
GlueX



BIC

GlueX-BCAL Boards



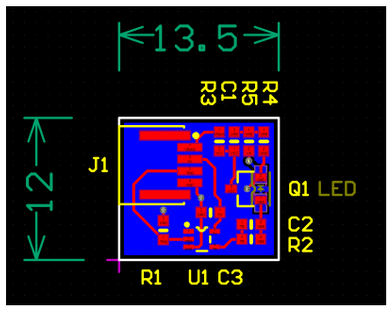


Analog/
Discrete

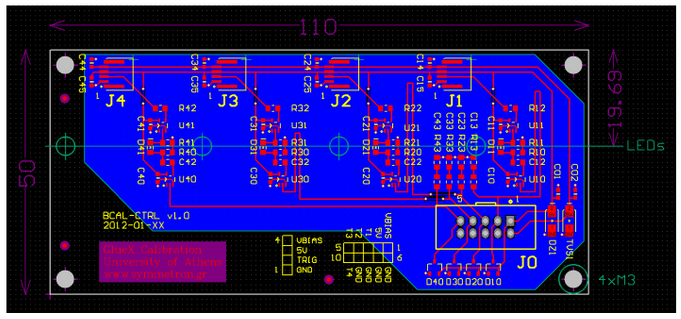
See Norbert's talk on how this will be done for BIC/EIC

GlueX LMS

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



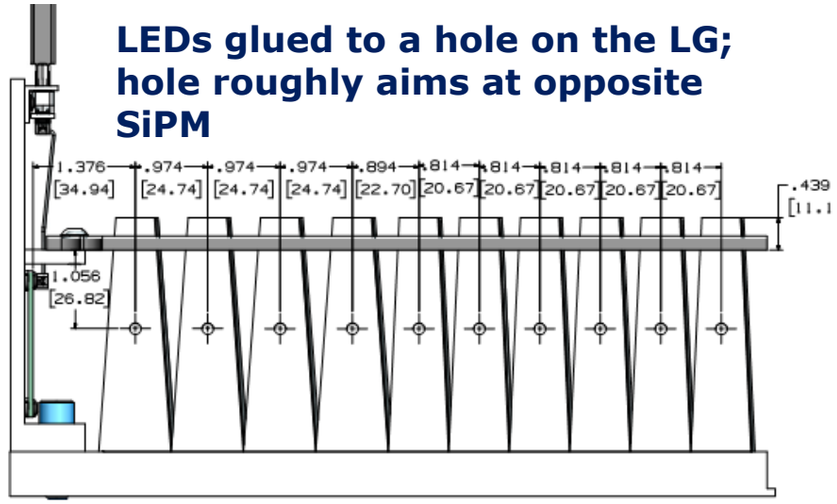
BCAL Controller layout



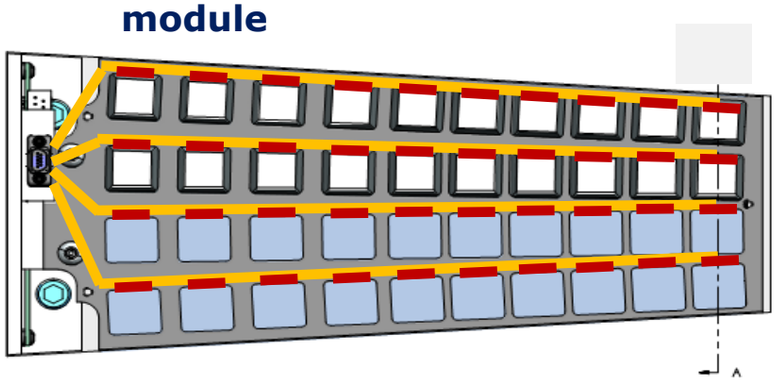
innermost LG 21x21 mm², outermost 27x25 mm²; output faces are 13x13 mm² to match SiPM window

LEDs: Bivar, Blue, 465 nm

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



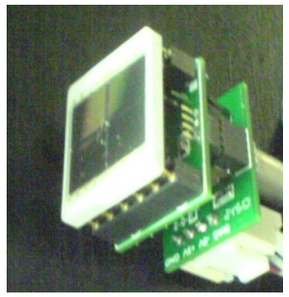
4 flexible strips per side per module



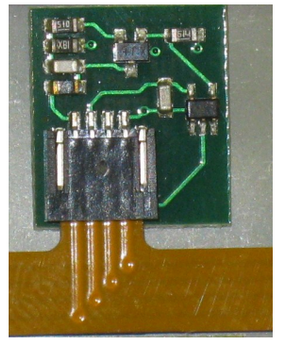
- 1 flex cable per row, connecting 10 mini boards; 384 flex cables
- 4 flex cables connected **to** 1 BCAL controller**; 96 BCAL controllers**
- **1 BCAL controller per half module;** light each row independently
- System typically pulsed at 50-100 Hz

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

Hamamatsu S12045X



BCAL miniboard on flex cable



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