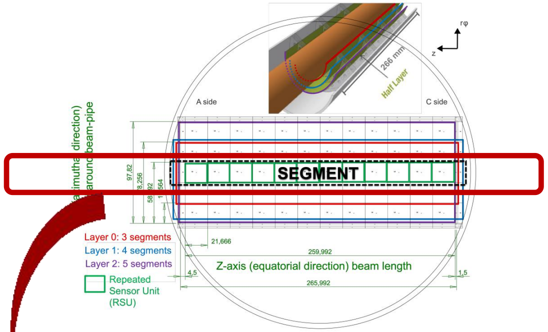
BERKELEY LAB

Study of the baby-moss @ L268

Zhenyu Ye, and Yu Hu (胡 昱) for LBL group

Babymoss - from ALICE ITS report



CMOS wafer

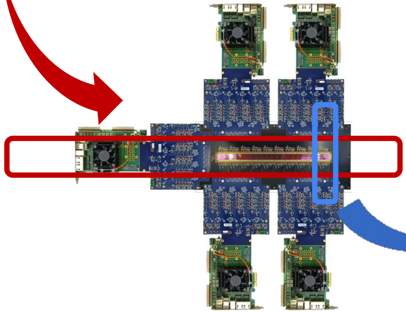
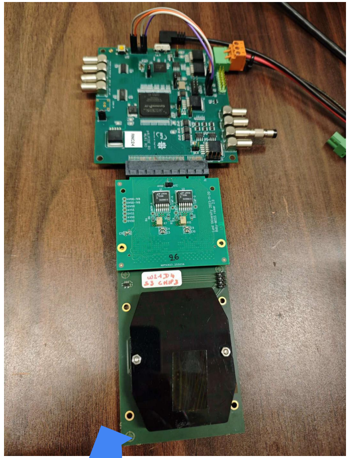
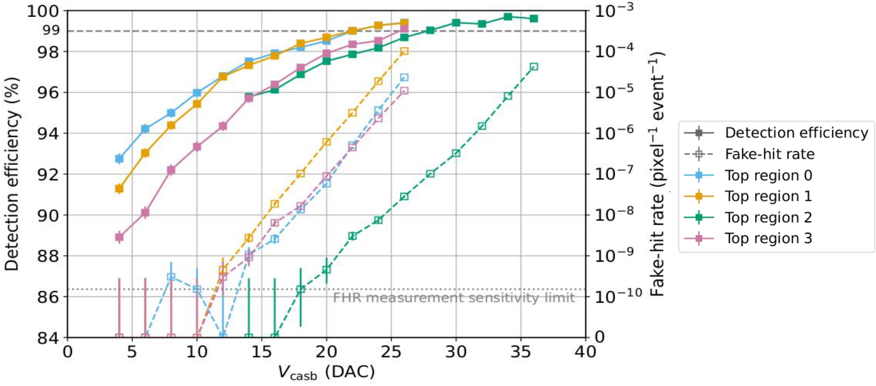


Figure 3.27: Photograph of the MOSS test system.

MOSS



Babymoss



small design differences in each region

	Region 0	Region 1	Region 2	Region 3
TOP	Standard	Larger input transistor (M1)	Larger discriminator input transistor (M11)	Larger common-source transistor (M2)
BOTTOM	Standard	Standard	Standard	Slightly different layout

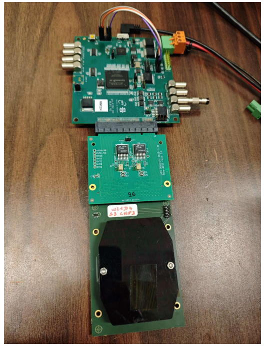
ALICE, Technical Design Report of the ITS Upgrade, page 40, Fig. 3.30; page 46, Fig. 3.33

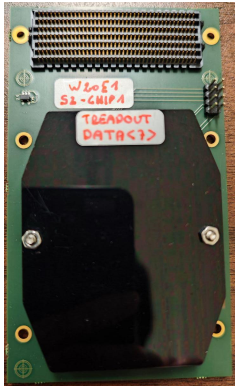
Default setups

DAC units:

IBIAS = 62
IBIASN = 100
IDB = 50
IRESET = 10
VCASB = 15
VCASN = 64
VSHIFT = 192

A. W21D4 S3 CHIP3
B. W20E1 S2 CHIP1
C. W20E1 S2 CHIP3





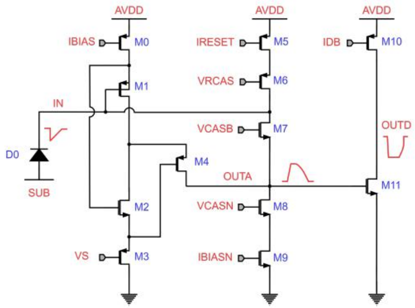
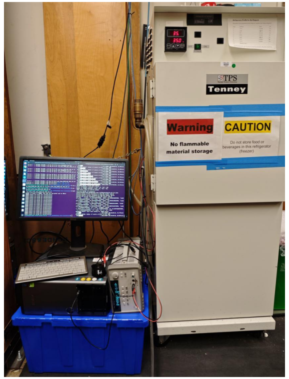


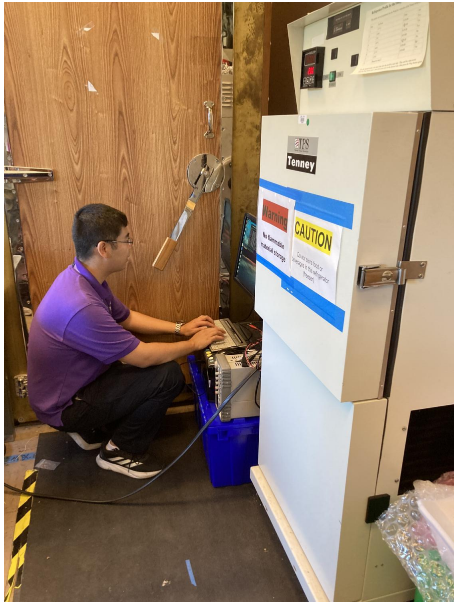
Figure 3.40: Simplified schematic of the pixel front-end amplifier and discrimination sections.

Short term target:

- Understand the performance of the baby-moss under different configures (Vcasb dependence..)
- The temperature dependence of the noise level
- The performance after the radiation expose

Temperature test with climatic chamber

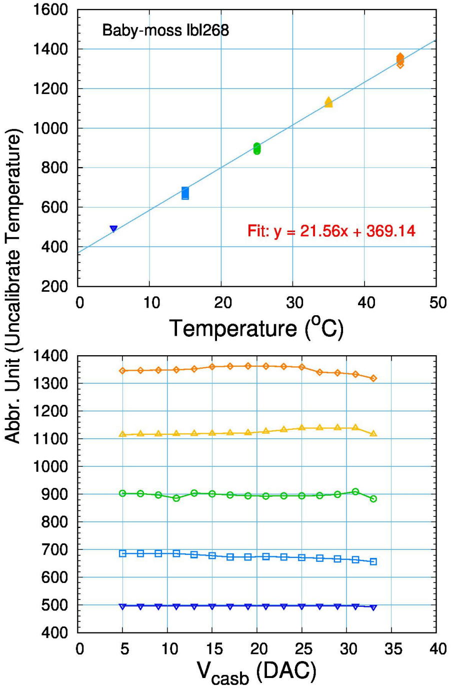




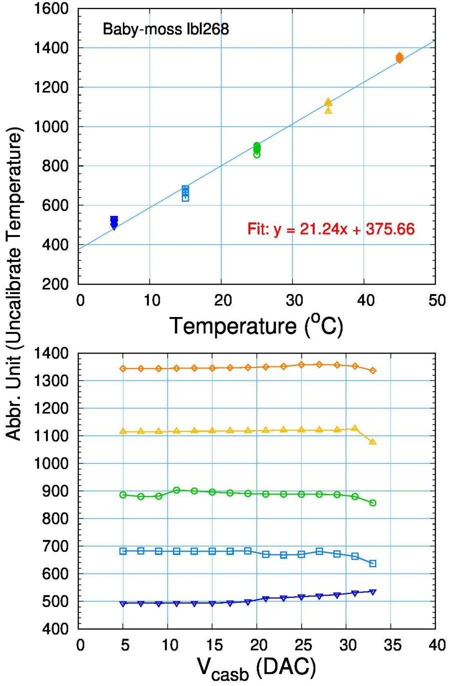
- We scaned 5°C, 15°C, 25°C, 35°C, 45°C with different V_{casb} using the climatic chamber
- As a calibration to the on-board thermistor

Temperature calibration

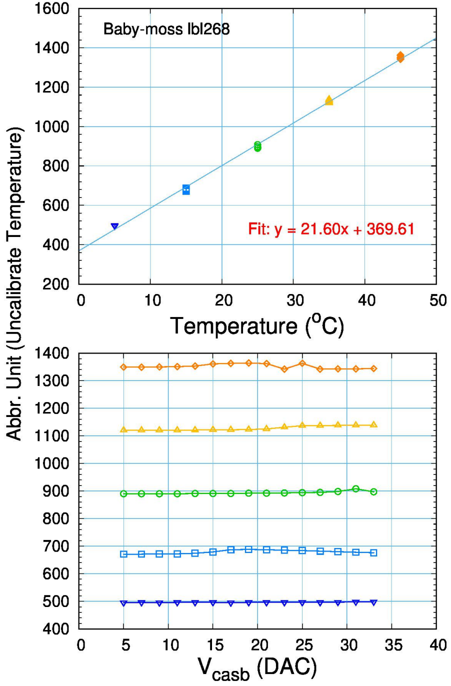
Board-A



Board-B

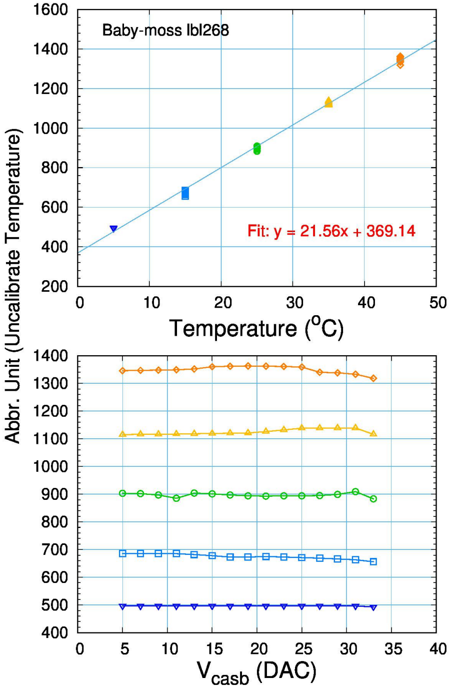


Board-C

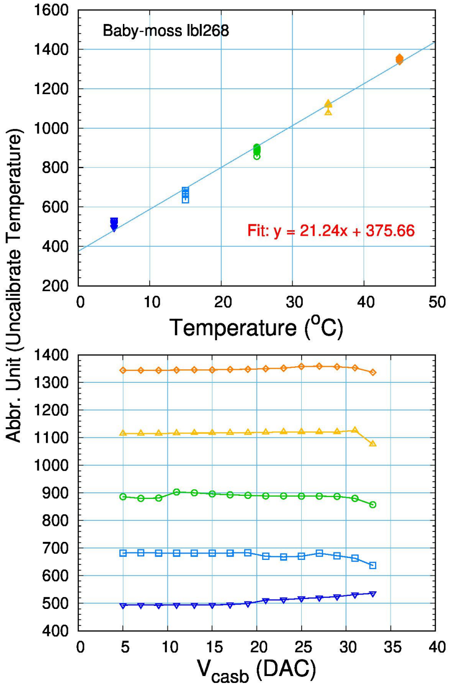


Temperature calibration

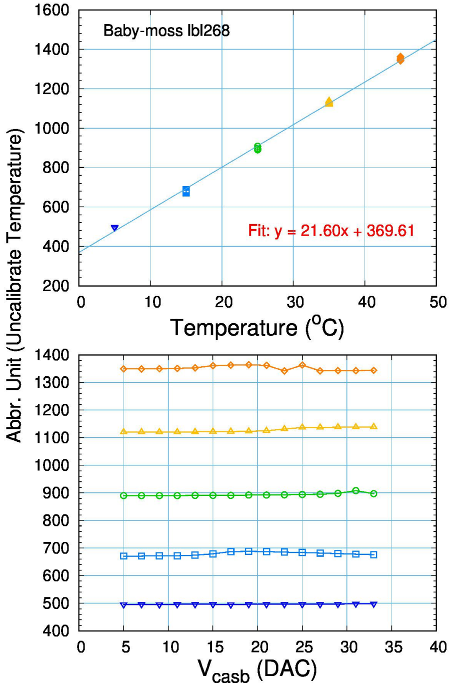
Board-A



Board-B



Board-C



Cooling loop layout

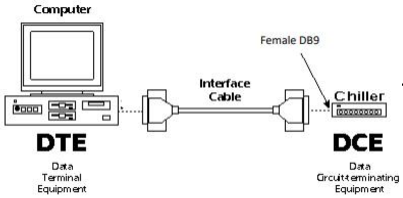
Remote control with 8bit Hexadecimal command

RS-232 Communication Protocol

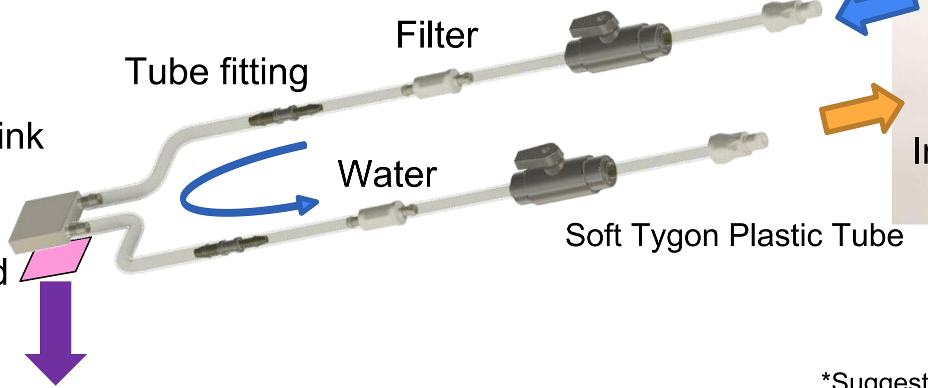
Table 2: Command and Data Bytes

	Bit Position	Description	Bit =1	Bit = 0
Command Byte	Bit 7 (MSB)	Set Remote Control	remote control	local control (chiller)
	Bit 6	Remote On/Off	chiller On	chiller in standby
	Bit 5	Communication Direction	remote to chiller (command from master)	chiller to remote (status from chiller)
	Bits 4 – 0	Parameters being communicated (see table 2)		
Data Bytes	1 or 2 bytes depending on parameter (see tables 3 and 4)			

Timing: ThermoCube 200/300/400 can accept a maximum of three commands per second



RS-232



valve

Out

Filter

Tube fitting

Heat Sink

Water

In

Therm Pad

Soft Tygon Plastic Tube

Attach to the Aluminum board holder

Standard: 5 ~ 50 °C

LT-HT Module: -5 ~ 65 °C

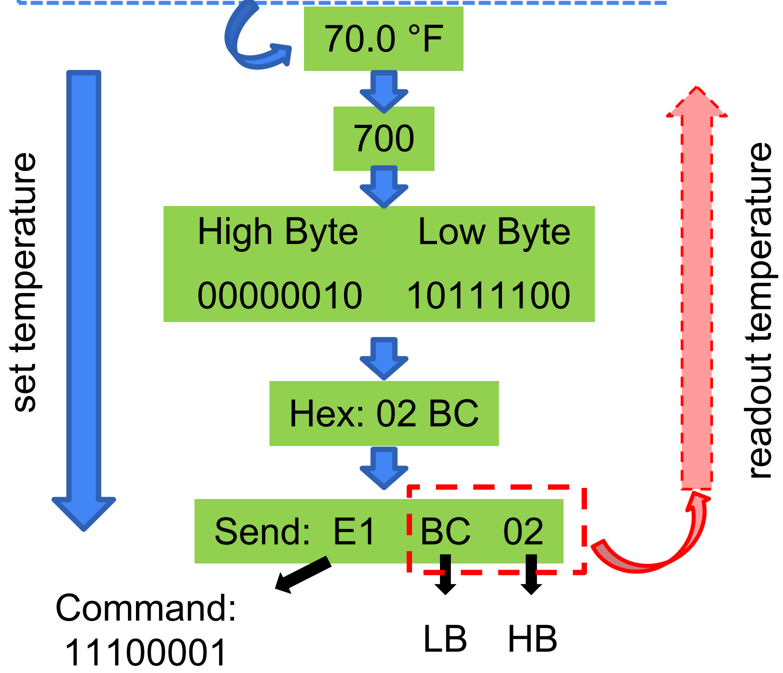
*Suggest to use Koolance (27% propylene glycol / water mix) or 27-50% ethylene glycol / water mix

Slow control for the cooling unit

	Bit Position	Description	Bit =1	Bit = 0
Command Byte	Bit 7 (MSB)	Set Remote Control	remote control	local control (chiller)
	Bit 6	Remote On/Off	chiller On	chiller in standby
	Bit 5	Communication Direction	remote to chiller (command from master)	chiller to remote (status from chiller)
	Bits 4 – 0	Parameters being communicated (see table 2)		
Data Bytes	1 or 2 bytes depending on parameter (see tables 3 and 4)			

Table 3: Control Parameter

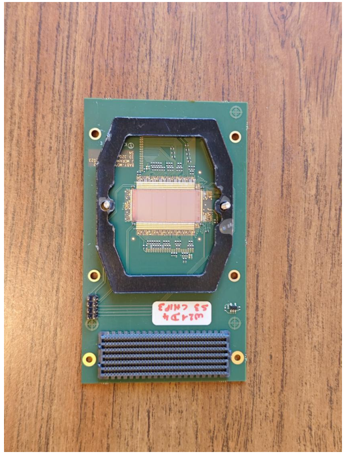
Bits 4 – 0	Parameter	No of Data Bytes
00001	Chiller set point 1 temperature	2
01001	Current fluid temperature at chiller coolant output	2
01000	Faults from chiller (fan, pump, RTD failure, etc.)	1

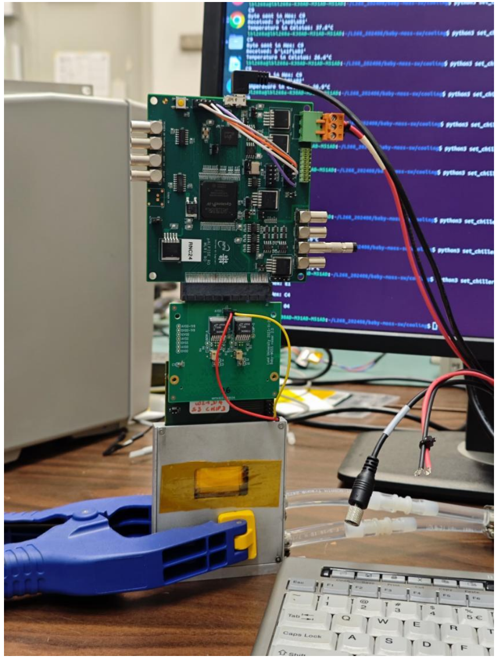


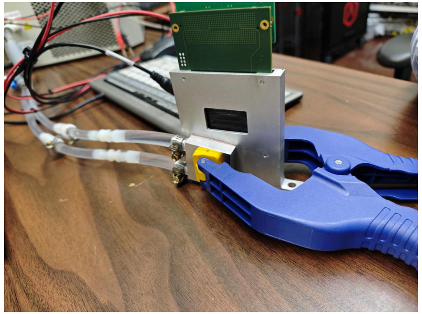

```
import serial
import sys

# Configure the serial port
port = '/dev/ttyUSB0'   # Replace with your port
baud_rate = 9600        # Replace with your device's baud rate
ser = serial.Serial(port, baud_rate, timeout=1)

def send_to_rs232(hex_string):
    try:
        # Hex data to send
        hex_bytes = hex_string.split()

        for hex_byte in hex_bytes:
            byte = bytes.fromhex(hex_byte)
            print(f"Byte sent in Hex: {byte.hex().upper()}")

            # Send data
            ser.write(byte)
            # print("Hex data sent:", byte)

            # Optionally, read response
            response = ser.read(100)  # Adjust the number of bytes to read
            print("Received:", response)
            if hex_string.lower() in ['c1', 'c9']:
                if response:
                    process_received_data(response)
    except Exception as e:
        print("Error:", e)
    finally:
        ser.close()
```

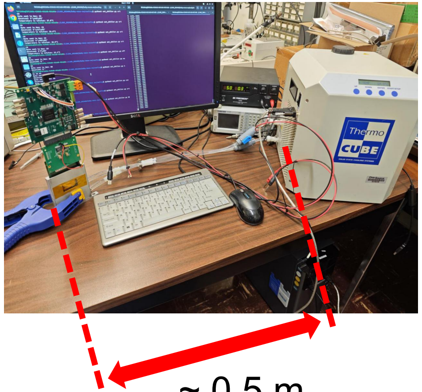
Testing system @ L268

Board-A







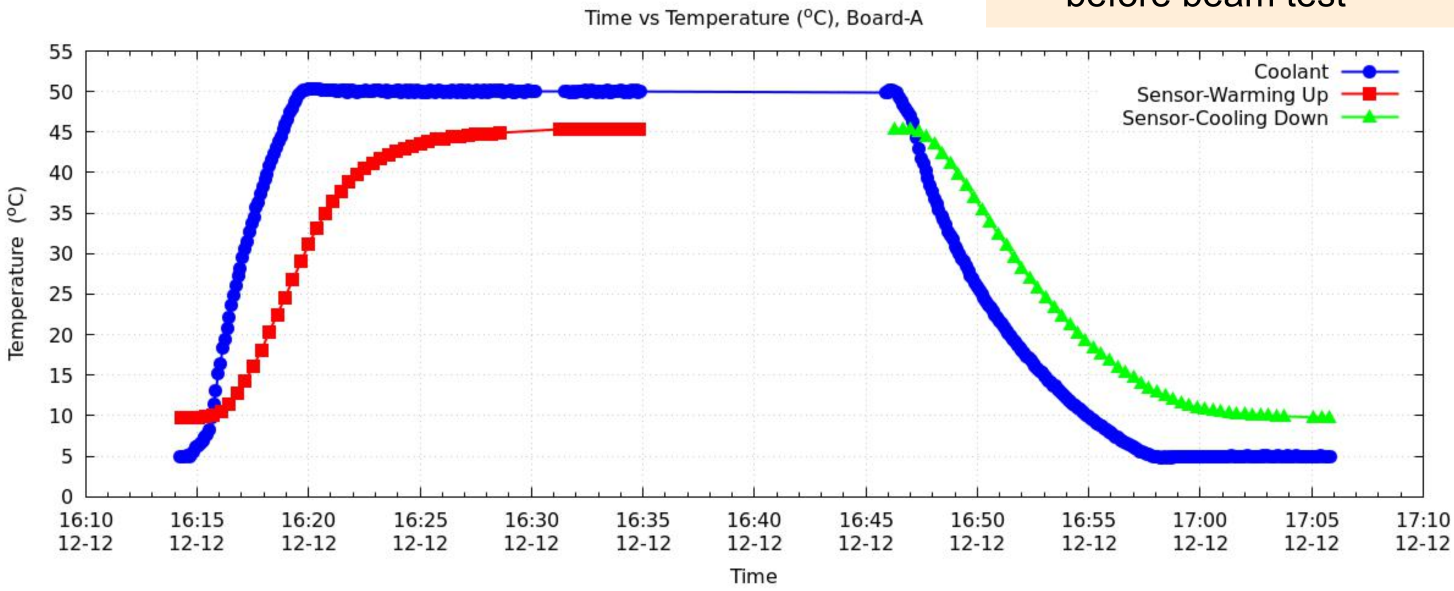


~ 0.5 m

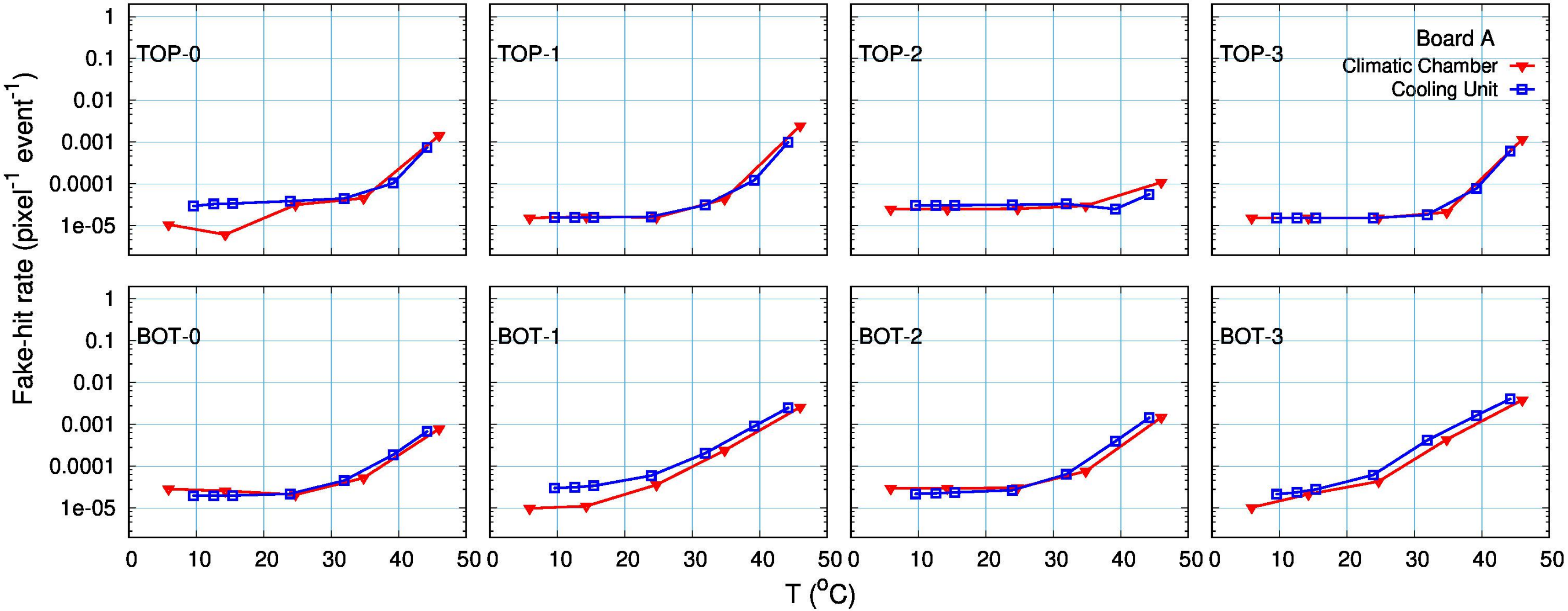
Heating/Cooling efficiency

Chiller Temp (°C)	Thermistor Readout (Arb.)	Thermistor Readout (°C)
5	576	9.6
50	1344	45.2

- Under the current configuration, we could reach 10~45 °C within 10 mins.
- We expect a longer time & narrower range once using a longer tube - will test before beam test



Compare with the tests using climatic chamber



- FHR are consistent with the tests using climatic chamber
- Slightly higher FHR for TOP-0 and BOT-1 with our cooling unit
  - Light? Will check with a dark tape covered

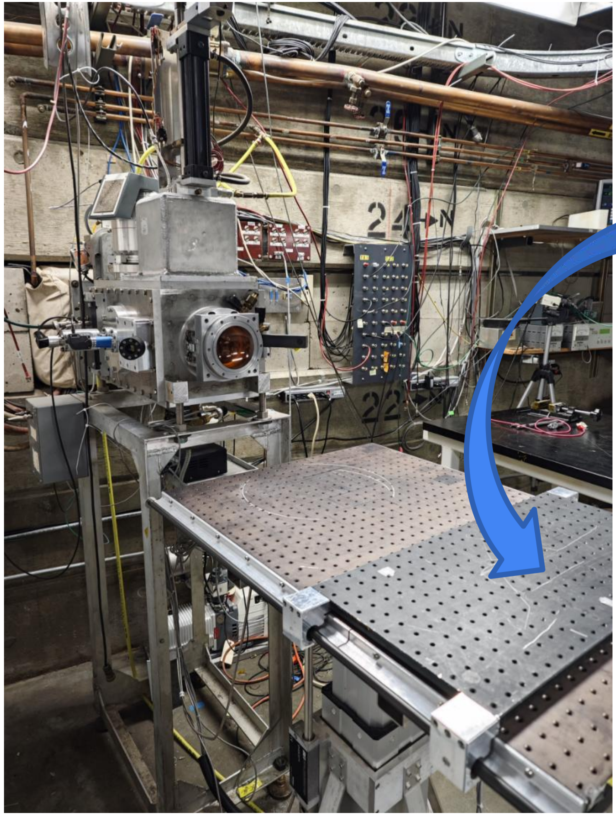
Summary & Outlook

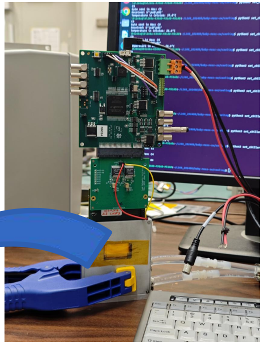
- We successfully built an efficient cooling loop for the babyMOSS test
- Under the current configuration, we could reach 10~45 °C within 10 mins.

- Threshold scan - on-going
- Heating/Cooling efficiency test with longer cooling loop
- Test with Board A,B,C - prepare for the beam test @ UC Davis
- Test configurations @ UC Davis

Cyclotron @ UC Davis

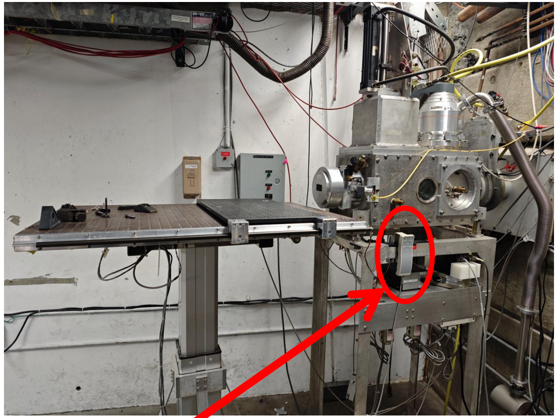
Produce high-intensity, external beams of light ions that can be tuned to energies between 4 MeV and 67.5 MeV. The primary particles accelerated are protons, deuterons, helions and alphas.

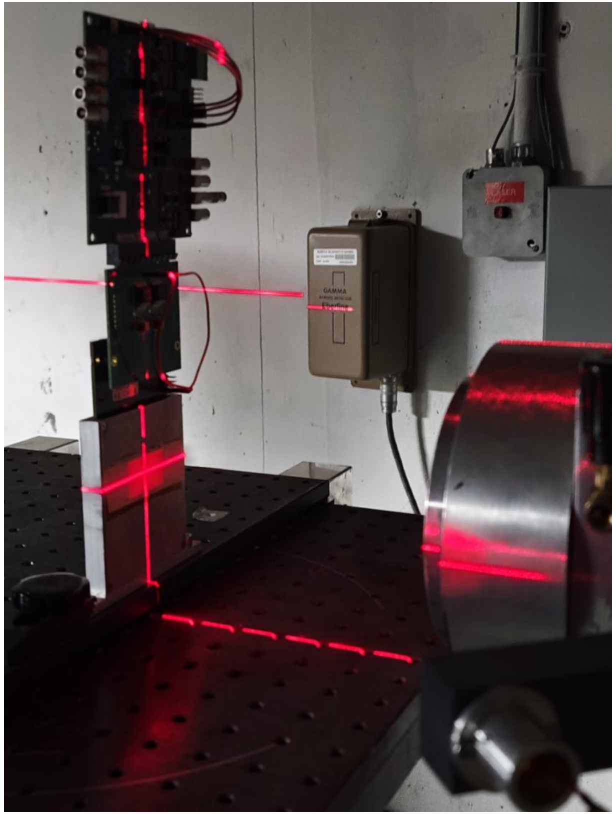


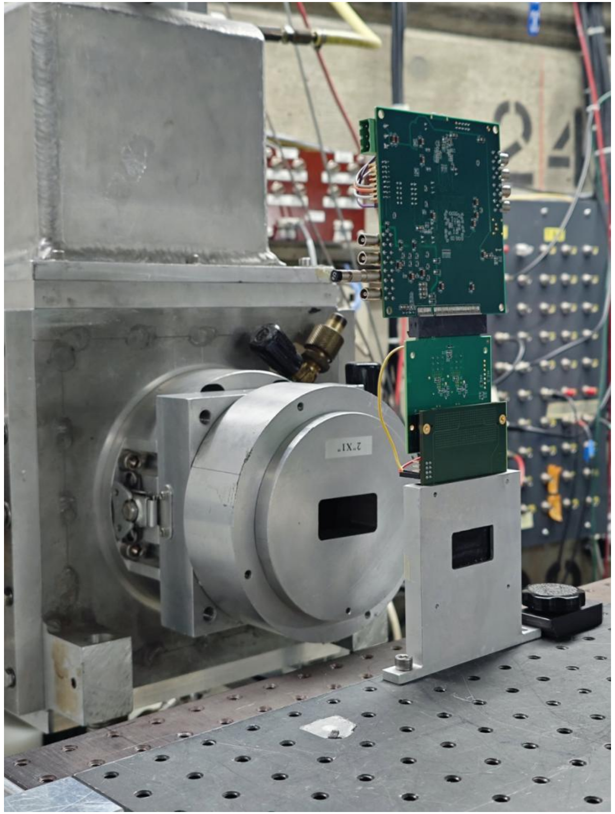


- Scheduled time: 2025.01.21
- Will not take the cooling unit consider the following beam test @JLab

Plans for the beam test @ UC Davis

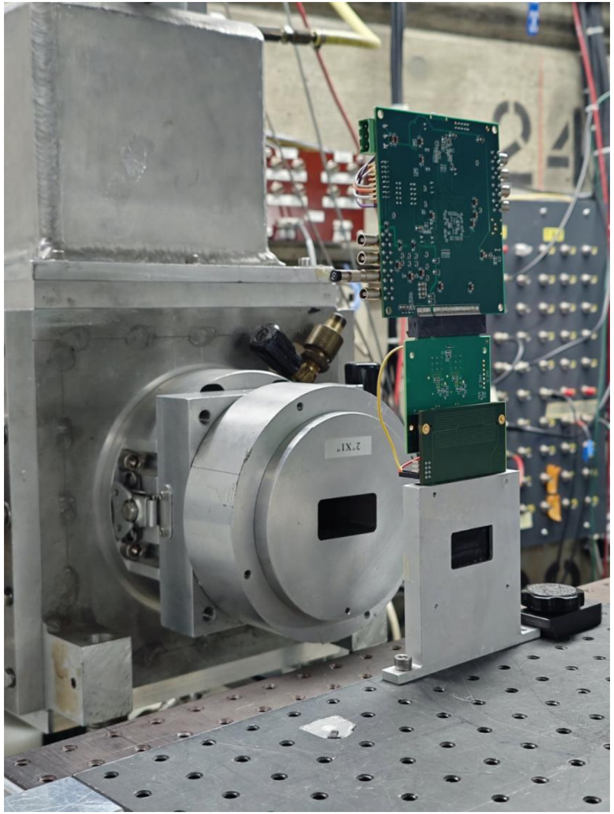






- Controller to adjust the XY position with remote control available
- Two real-time cameras to monitor
- Beam dose monitor/counter
- Different shapes of beam filter/cover, size/shape adjustable

Plans for the beam test @ UC Davis



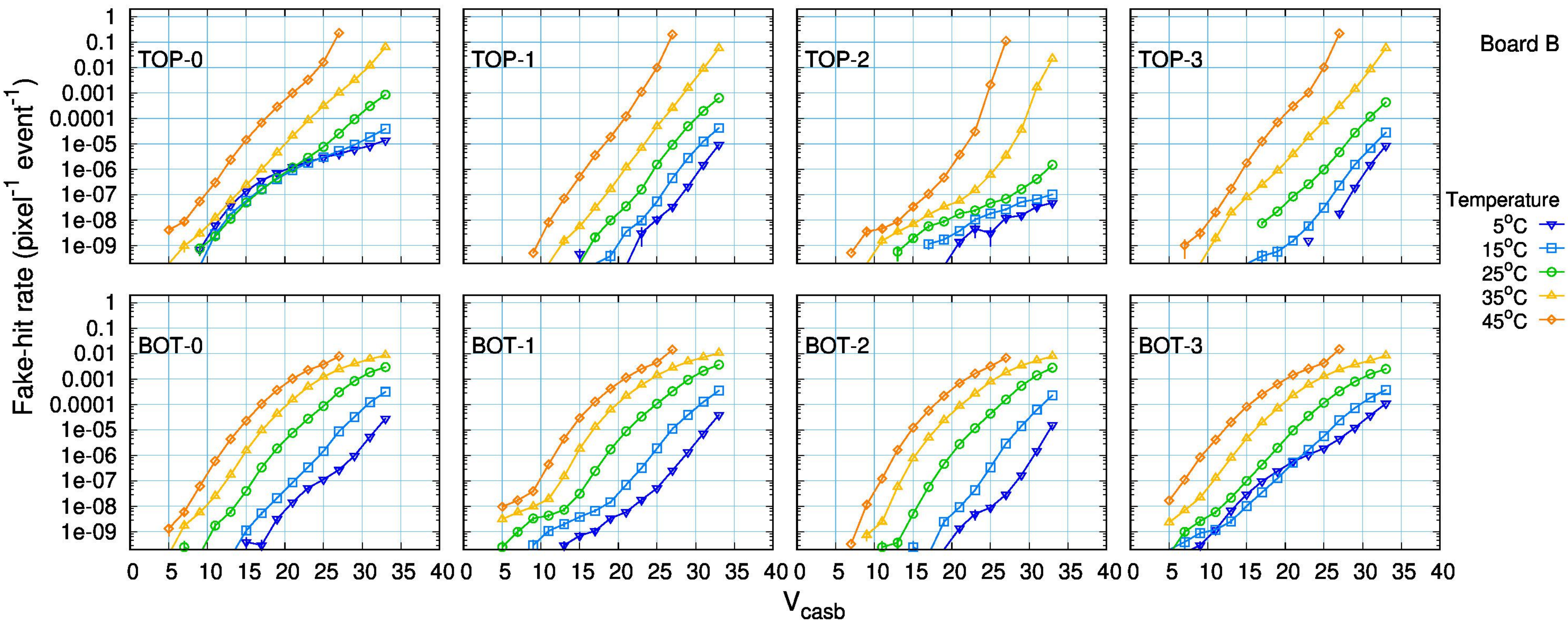
8 hours testing:

- **Goal:** Chip expose test under different times/dose
- **Plans:**
  - 3 babyMOSS (expose) + 1set of readout board (shielded);
  - Expose 3 babyMOSS with different doses (time) - change the chips in the middle (~ 5 mins to restore beam);
  - Constantly running FHR tests all the time in the background
- **Before the beam tests:**
  - Threshold scan under different temperature;
  - Comunicate to the desktop with UC Davis local network/internet

BERKELEY LAB

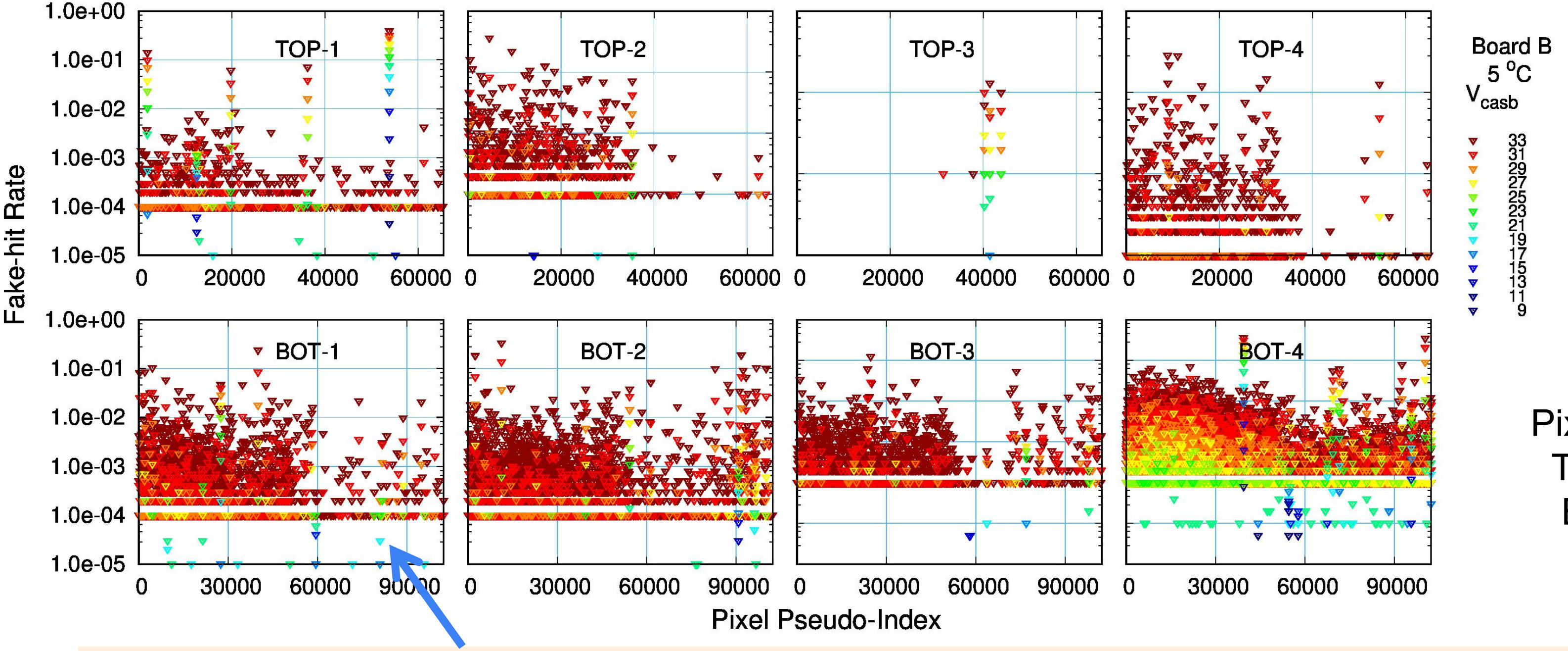
Materials from the last presentation

FHR vs V_{casb} @ different T



- lower temperature gives the lower Fake-Hit Rate (FHR)

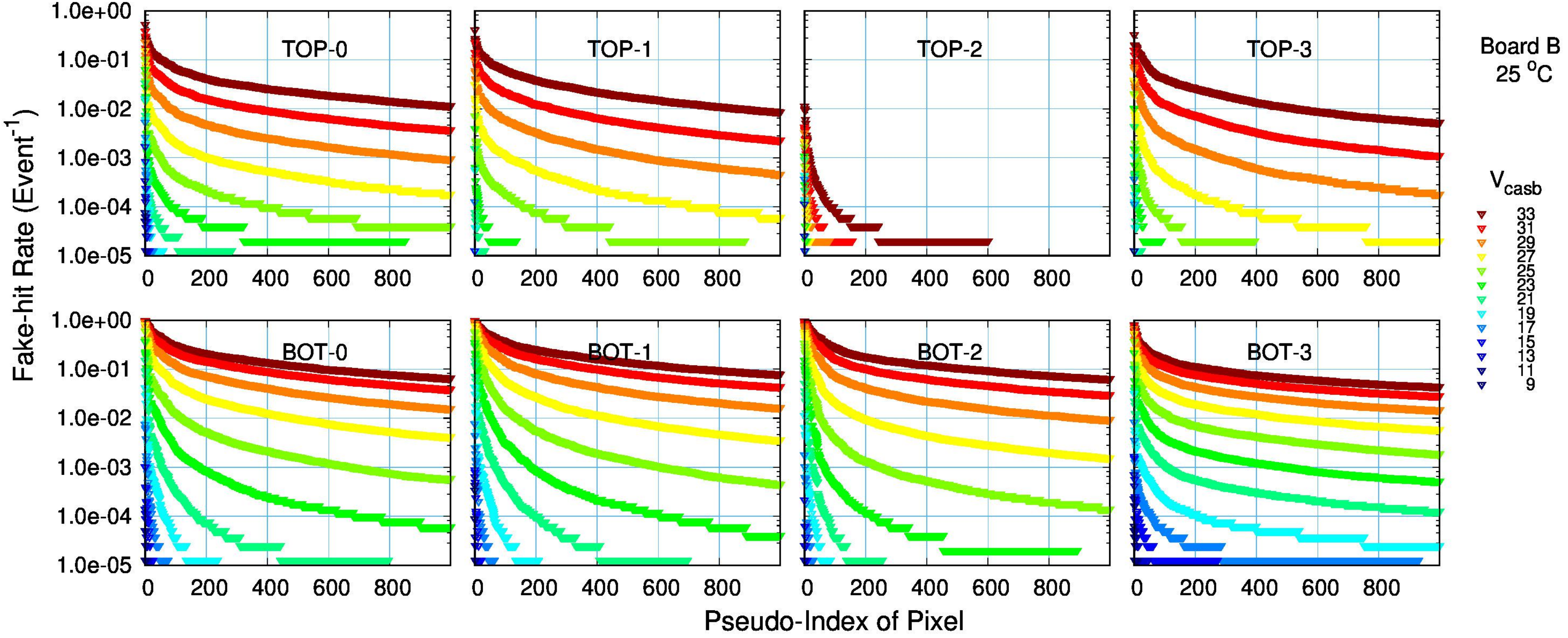
Where are the hot pixels?



Pixels:
Top: 256x256
Bot: 320x320

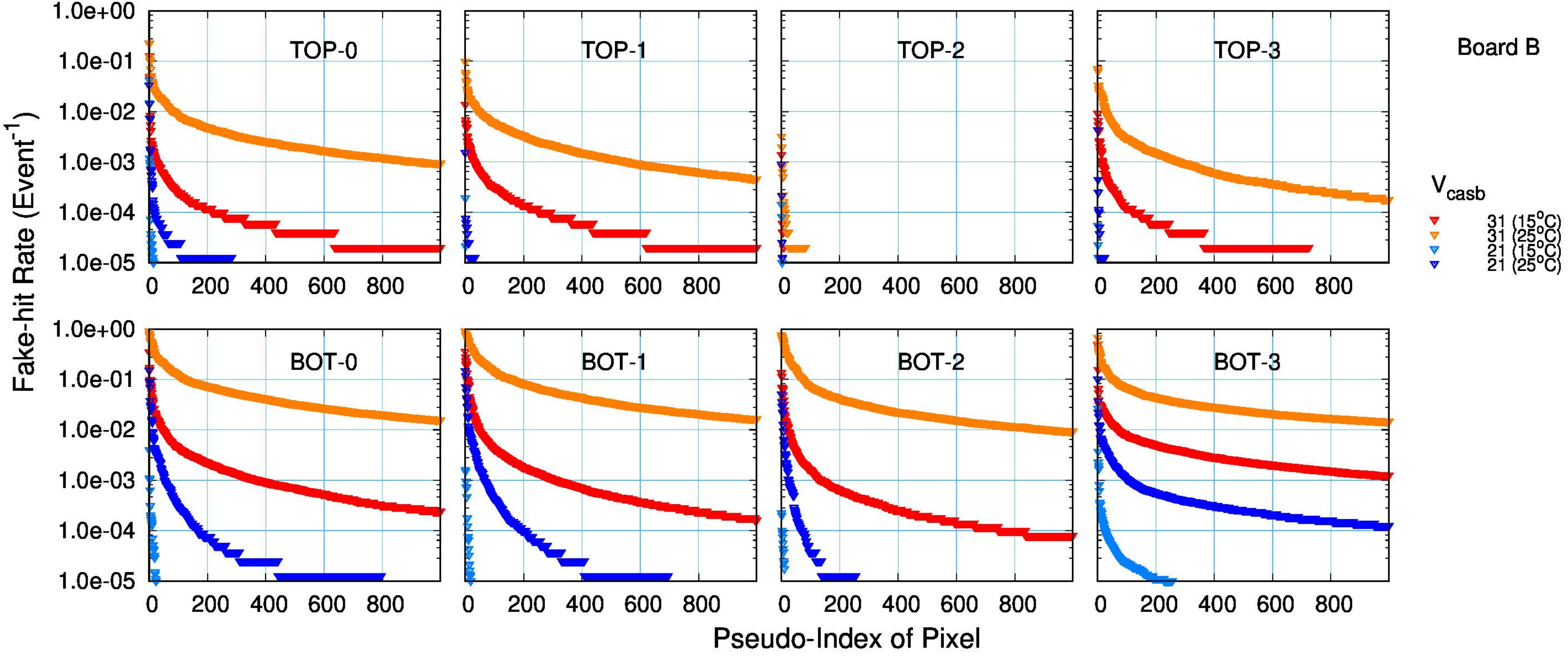
- 2D hit map are very random, so shown a Psedo-index vs FHR (eg. Index = X*256+Y)
- Some of the pixels are fired every time, which should be masked out
- Most of the pixels are random fired

FHR vs Pixel Index @ 25 C

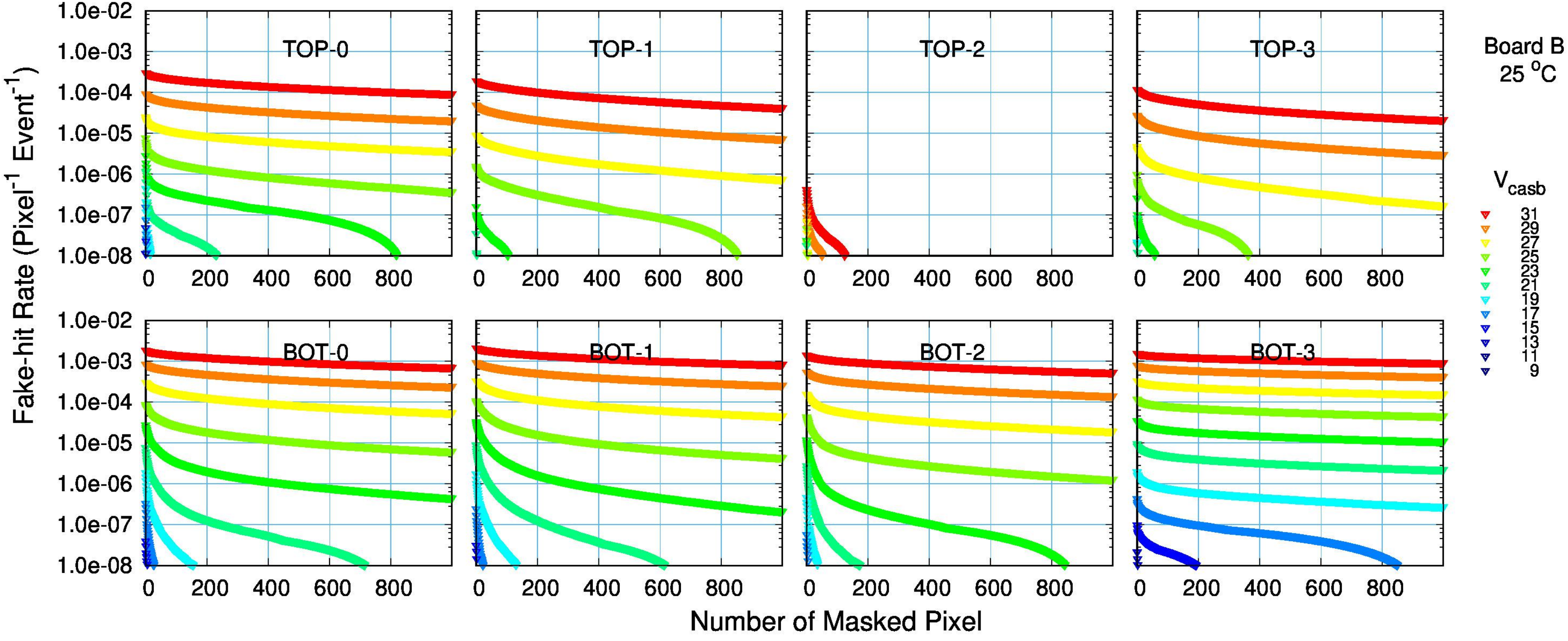


- In total: TOP: 256x256=65536 Pixels; BOT: 320x320=102400 Pixels
- Reorder all the Psedo-index form high to low, and plot it vs FHR

FHR vs Pixel Index @ different T



FHR vs Number of Masked Pixels

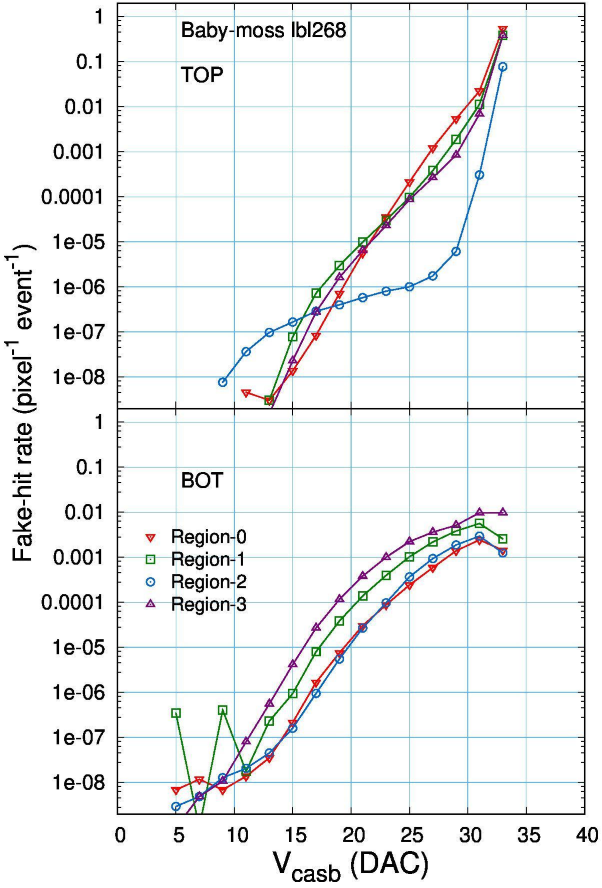


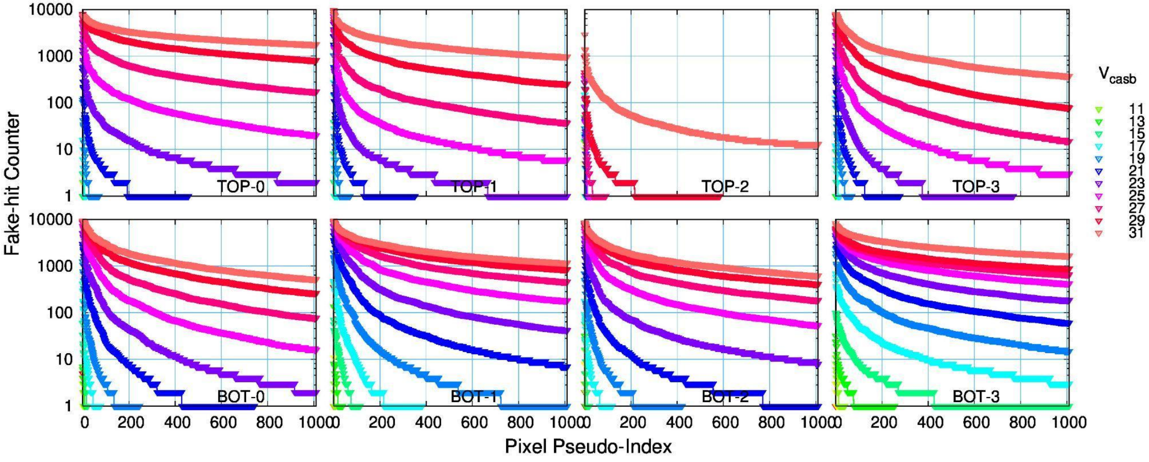
- FHR as a function of number of masked Pixels

Summary and Outlook

- We studied the FHR at different temperatures with different Vcasb
- Calibrated the on board thermistor (- last presentation)
- We will build the cooling loop by ourselves for the future beam test, study the performance of the cooling loop

Board A - **W21D4 S3 CHIP3** (20240906) - 10k events



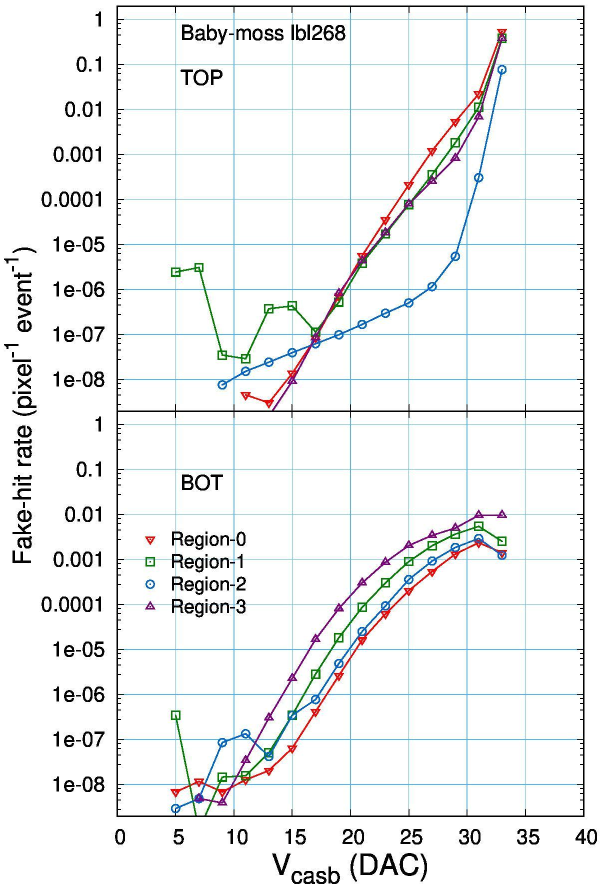


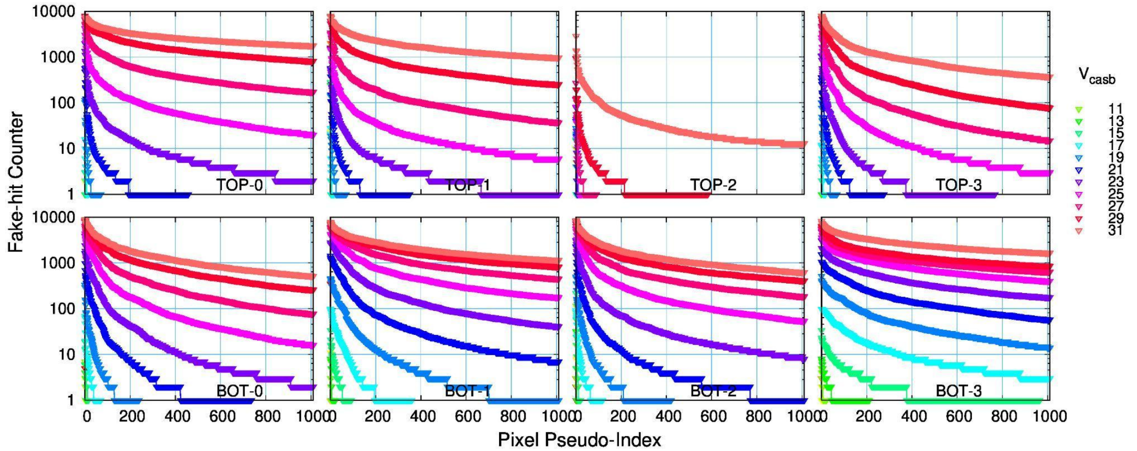
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=15

Masked pixels

	R-0	R-1	R-2	R-3
TOP	5	6	4	0
BOT	3	12	6	20

Board A - W21D4 S3 CHIP3 (20240906) - 10k events





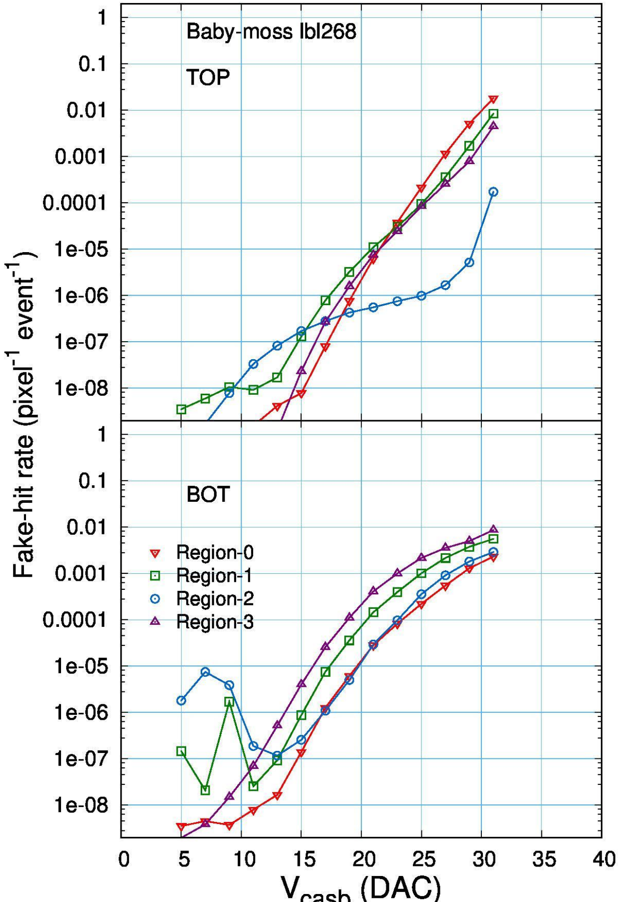
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=17

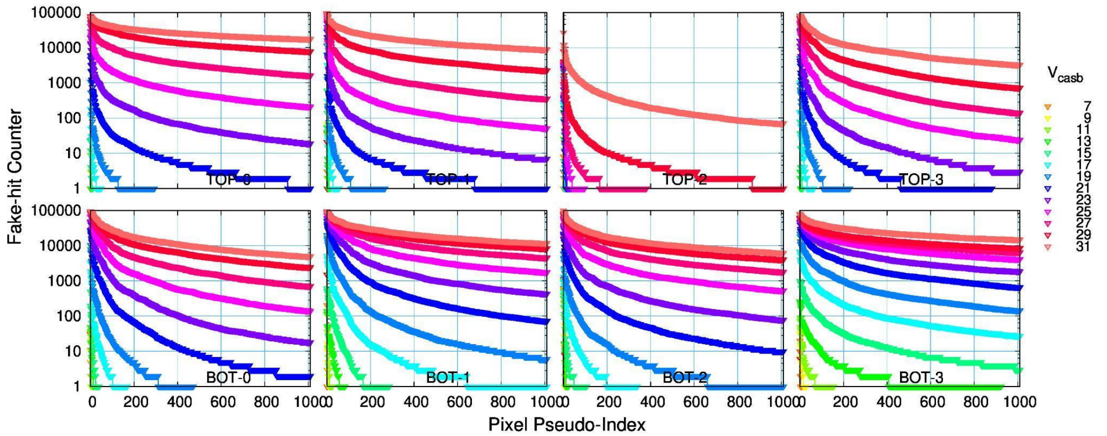
Masked pixels

	R-0	R-1	R-2	R-3
TOP	5	7	5	1
BOT	9	34	6	69

No significant different with mask @ V_{casb}=15 and V_{casb}=17

Board A - W21D4 S3 CHIP3 (20240918) - 100k events



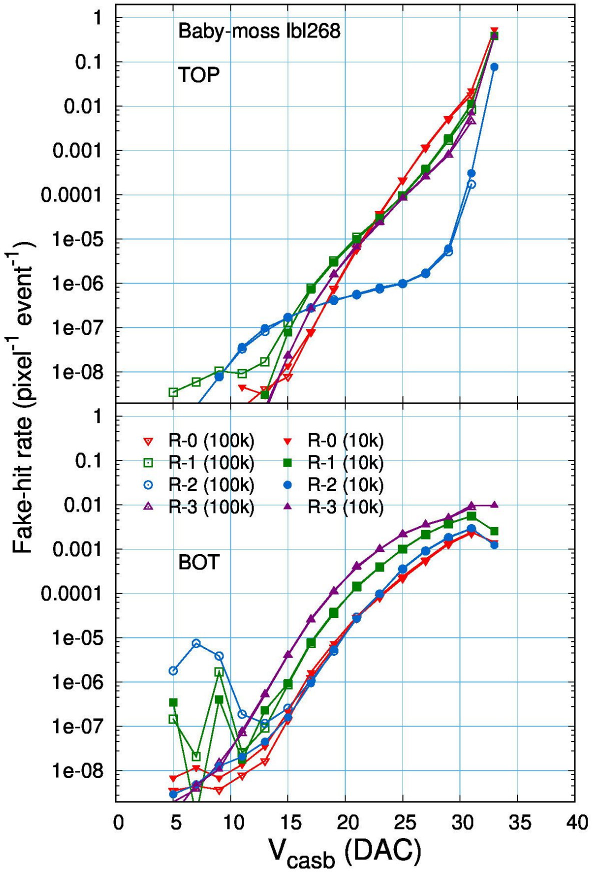


Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=15

Masked pixels

	R-0	R-1	R-2	R-3
TOP	4	5	3	0
BOT	6	13	6	18

10k vs 100k



10k

Masked pixels

	R-0	R-1	R-2	R-3
TOP	5	6	4	0
BOT	3	12	6	20

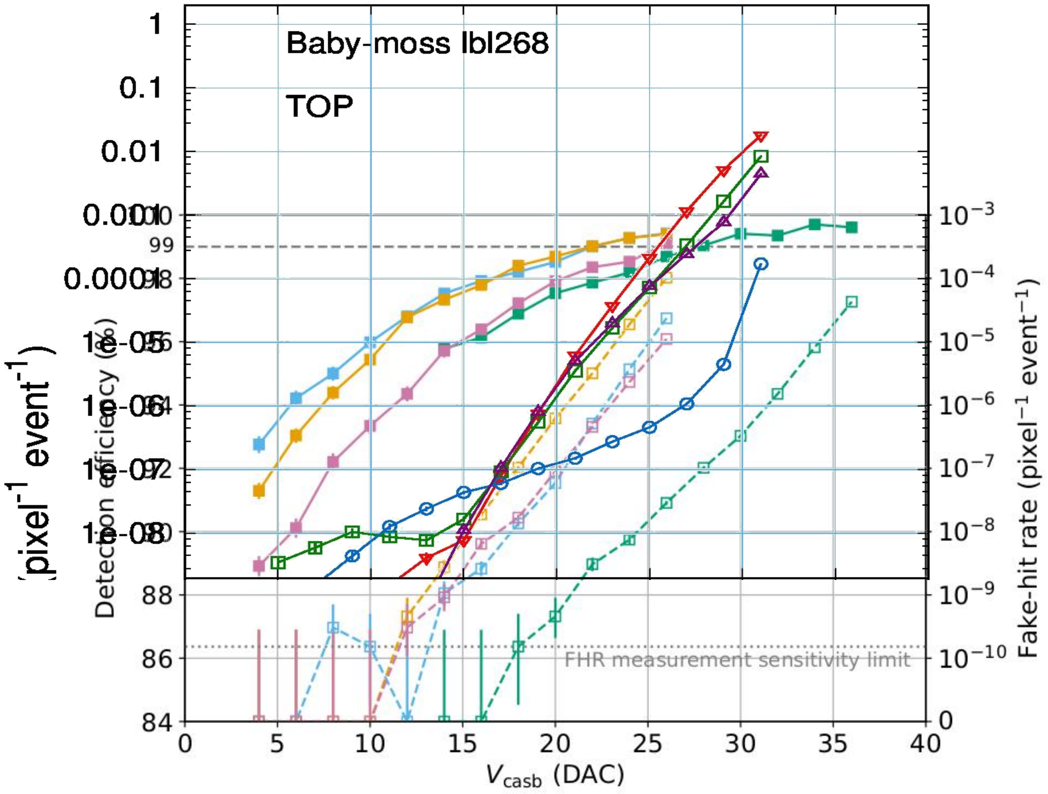
100k

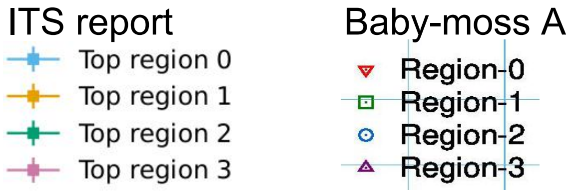
Masked pixels

	R-0	R-1	R-2	R-3
TOP	4	5	3	0
BOT	6	13	6	18

- No significant difference with 10k or 100k events
- 10k should be sufficient enough for this test

Layer-over comparison with ALICE tests





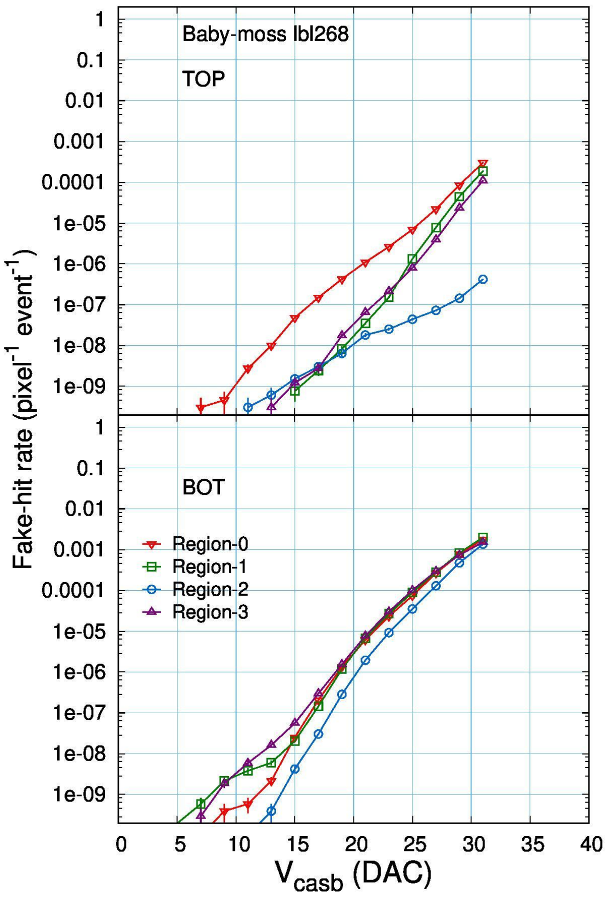
small design differences in each region

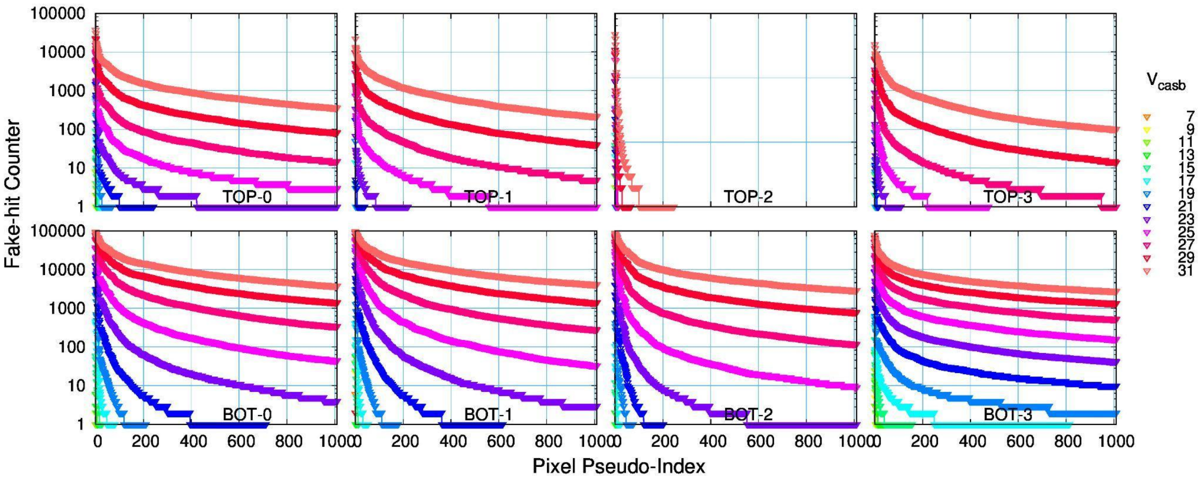
	Region 0	Region 1	Region 2	Region 3
TOP	Standard	Larger input transistor (M1)	Larger discriminator input transistor (M11)	Larger common-source transistor (M2)
BOTTOM	Standard	Standard	Standard	Slightly different layout

- Good consistence for Region-0,1,3
- Some differences for Region-2

Individual differences?

Board B - W20E1 S2 CHIP1 (20240918) - 100k events



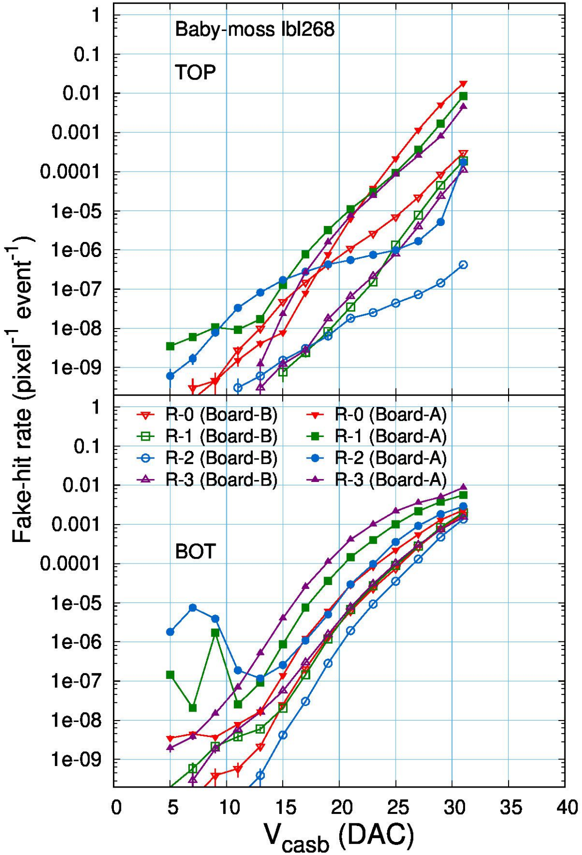


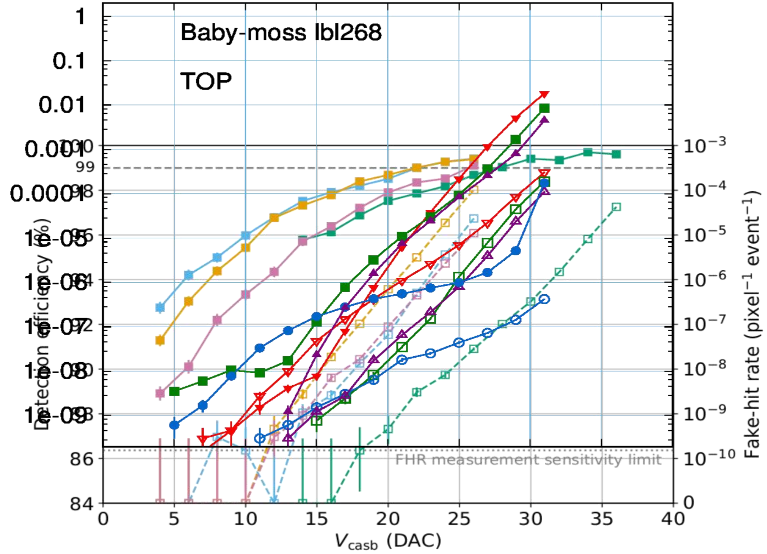
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=15

Masked pixels

	R-0	R-1	R-2	R-3
TOP	0	0	0	0
BOT	0	0	0	2

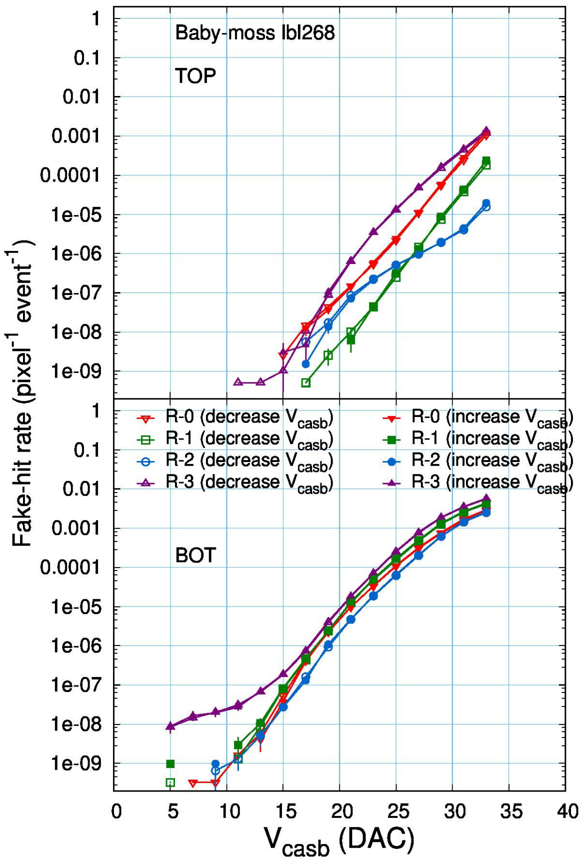
Board-A vs Board-B



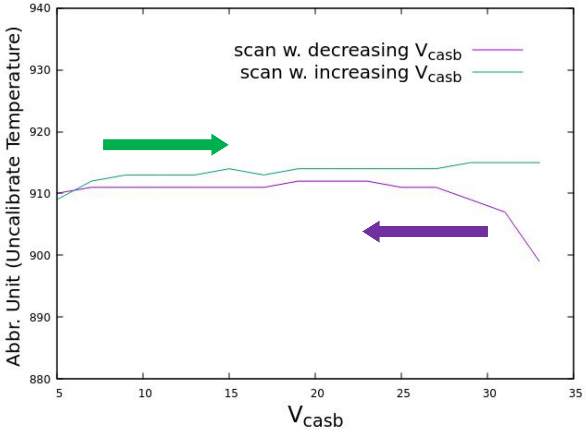


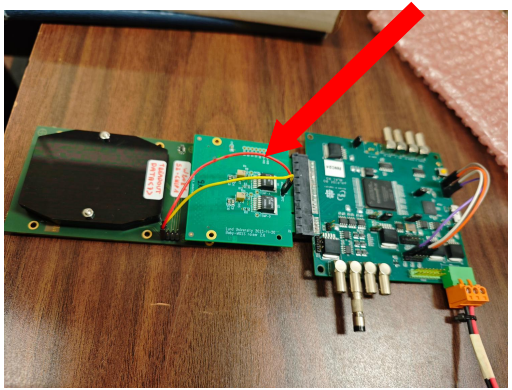
- The performance of individual chips has noticeable differences
- The trend of the Fake-hit rate (also checked Board-C) is consistent with the example in the ALICE ITS report

Order of scaning - w. Board-C



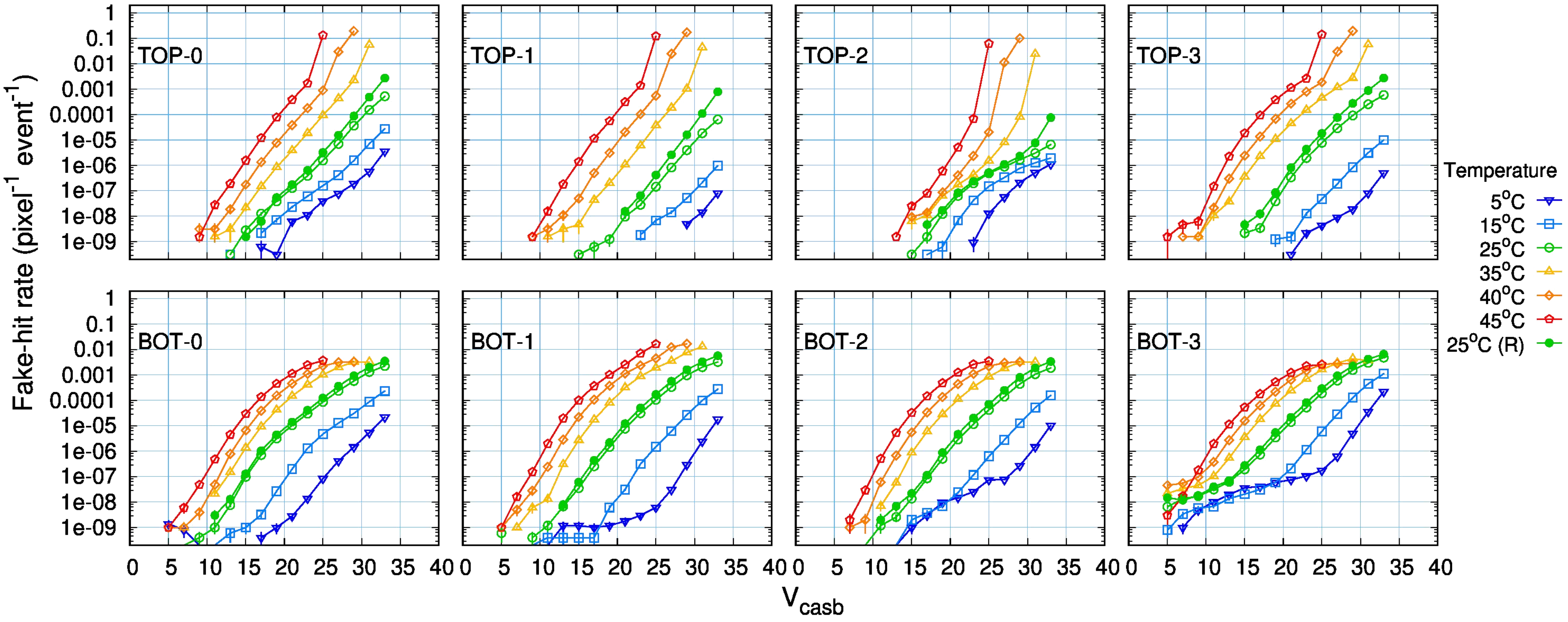
Will the order of scaning affect the results?





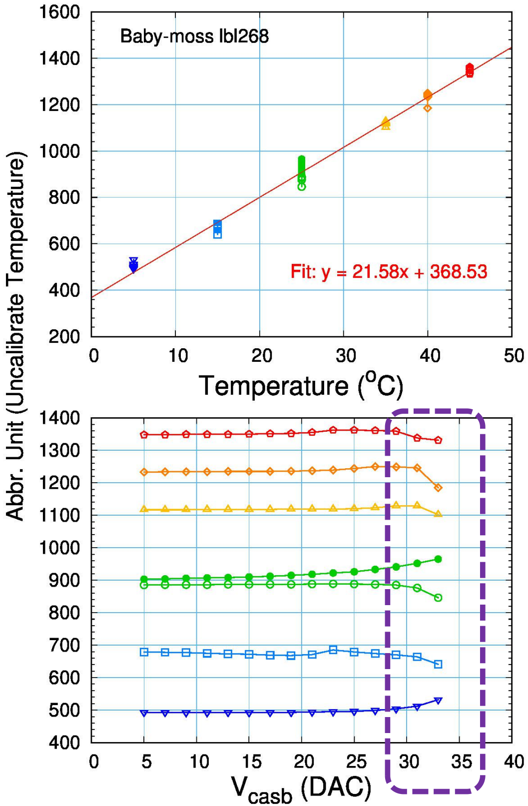
- The temperature read by thermistor resistance shows some difference (electronic warming up) - the scale is unknown
- No significant difference in Fake-hit Rate no matter scanning from large or small Vcasb in the current scale

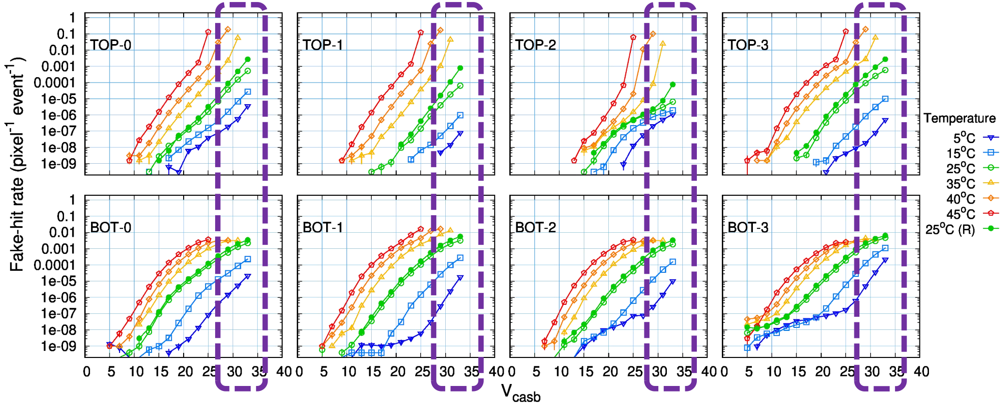
Fake-hit Rate vs Temperature (Board-C)

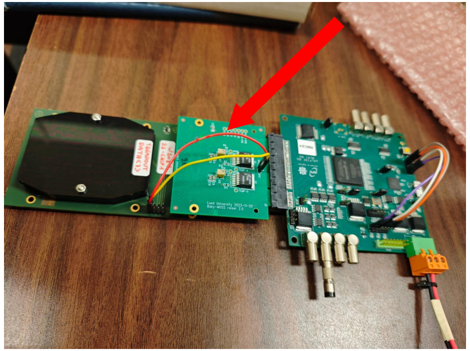


- High Temperature → High noise, as expected
- Noise levels are consistent at the same temperature after a run in a hot temperature (45°C)

Temperature sensor (thermistor resistance)







- There are some small variation at the beginning of the test
- The thermistor resistance follows the linear relation to the set temperature

Summary & **Outlook**

For Fake Rate Test:

- No significant different with masking @ Vcasb=15 and Vcasb=17
- No significant difference with 10k or 100k events - 10k should be sufficient enough
- Good consistence for Region-0,1,3, some differences for Region-2 compare with ALICE report
- The performance of individual board has noticeable differences, the trend of the Fake-hit rate are consistent
- No significant difference in Fake-hit Rate no matter scanning from large or small Vcasb in the current scale

Test with Climatic Chamber:

- High Temperature → High noise, as expected
- Noise levels are consistent at the same temperature after a run in a hot temperature (45°C)
- The thermistor resistance follows the linear relation to the set temperature

To to next:

- Temperature test with other boards
- Noise test after radiation exposure

Amplifier setups

DAC units:

IBIAS = 62
IBIASN = 100
IDB = 50
IRESET = 10
VCASB = 15
VCASN = 64
VSHIFT = 192

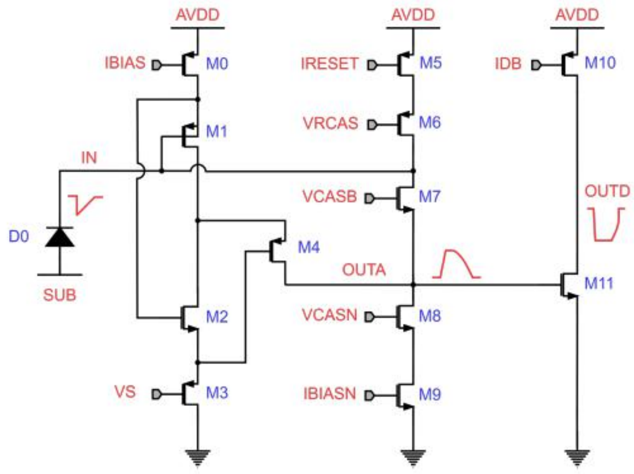
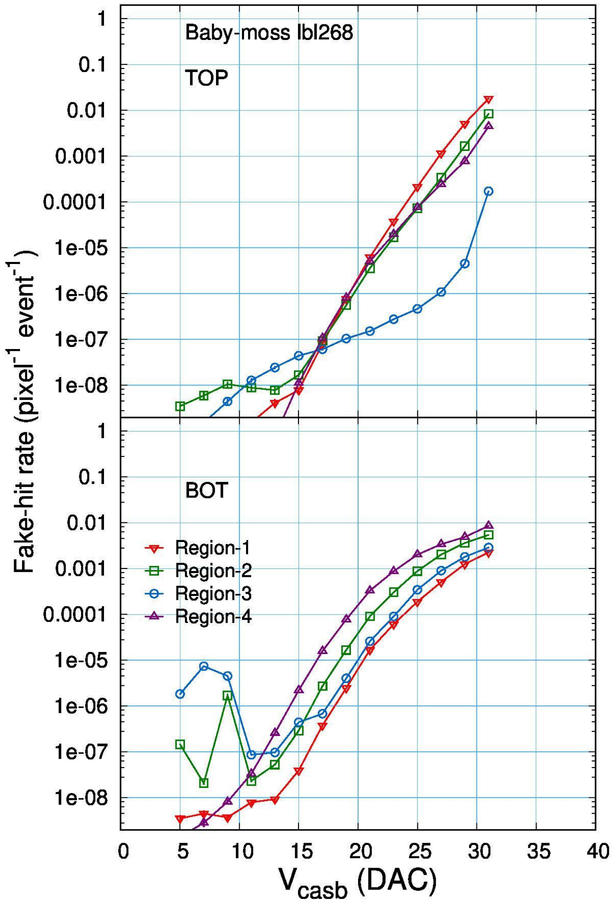
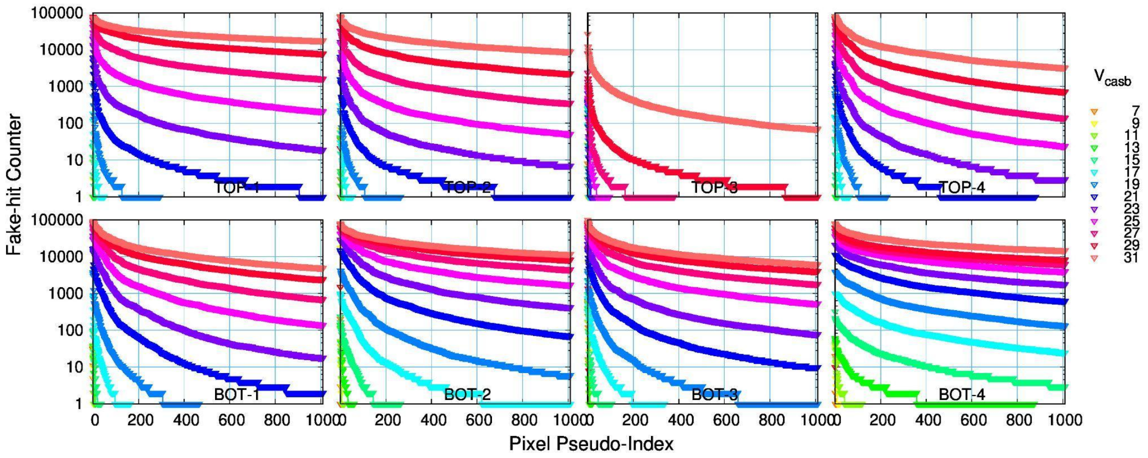


Figure 3.40: Simplified schematic of the pixel front-end amplifier and discrimination sections.

Board A - W21D4 S3 CHIP3 (20240918) - 100k events



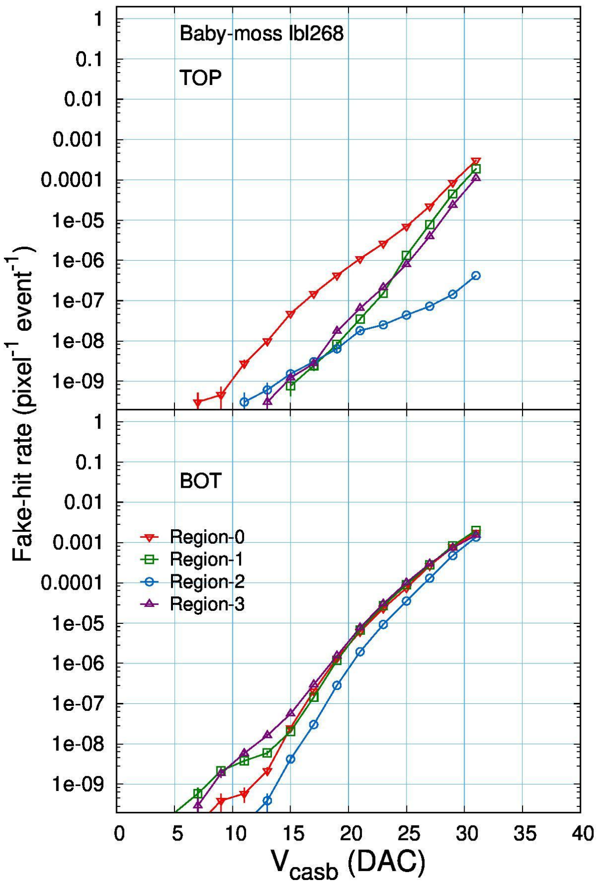


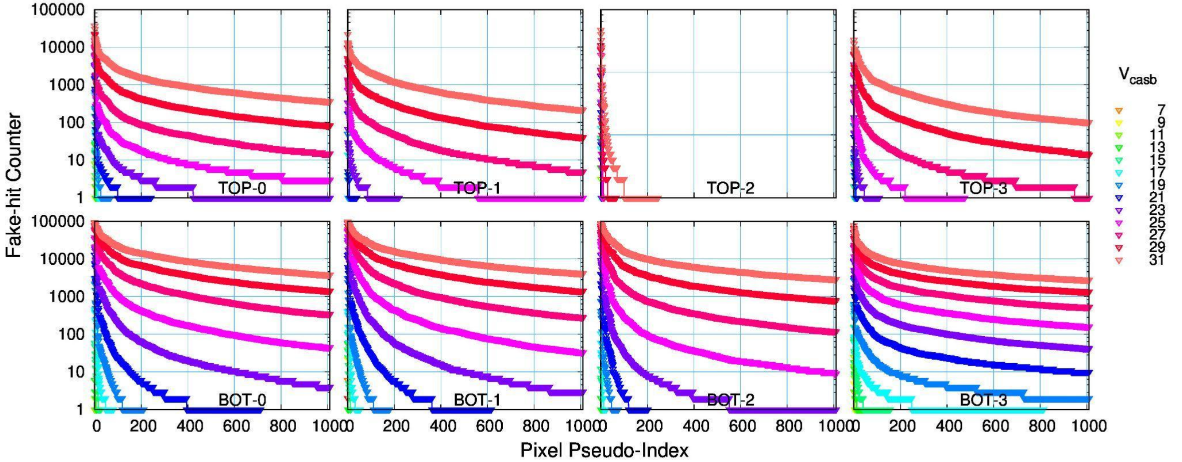
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=17

Masked pixels

	R-0	R-1	R-2	R-3
TOP	4	7	4	1
BOT	11	35	8	67

Board B - **W20E1 S2 CHIP1** (20240918) - 100k events



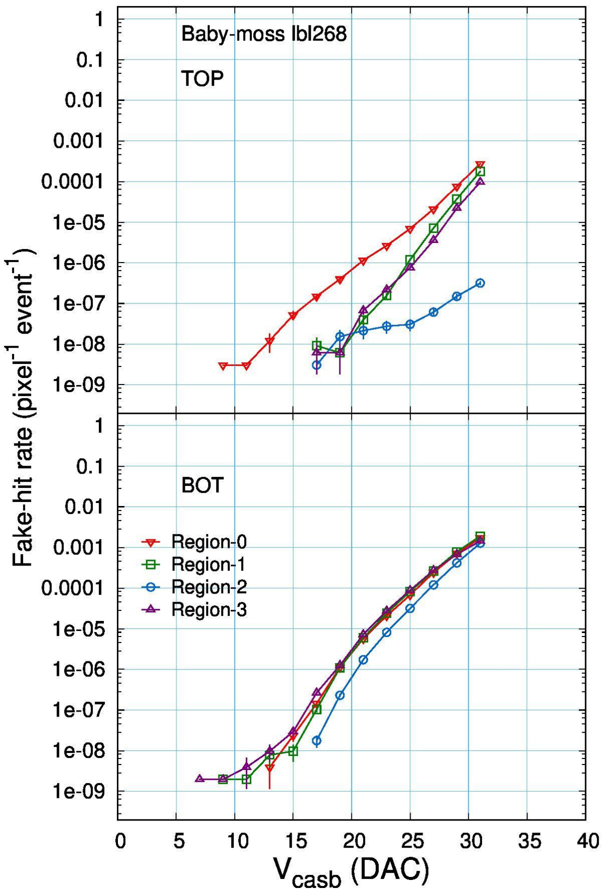


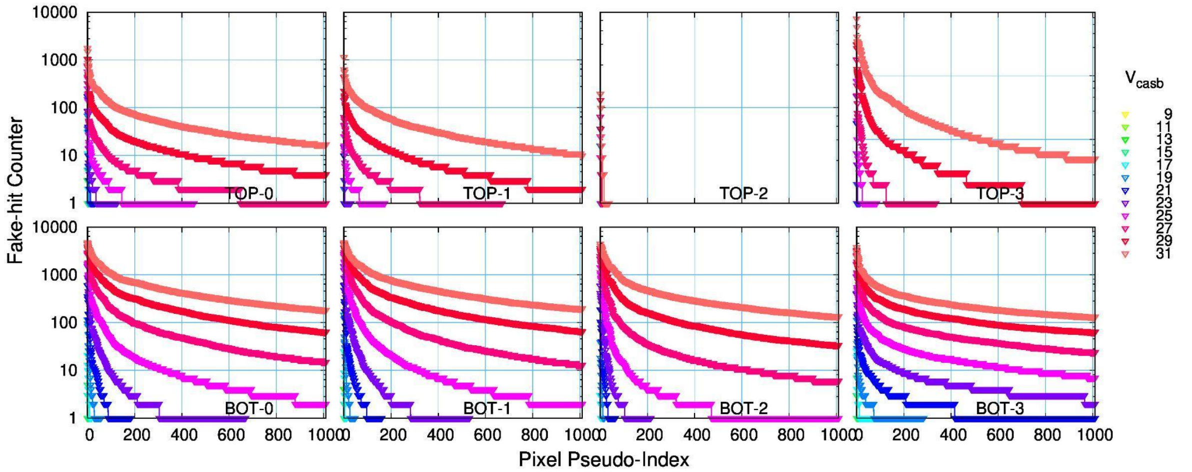
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=17

Masked pixels

	R-0	R-1	R-2	R-3
TOP	0	0	0	0
BOT	0	0	0	2

Board B - **W20E1 S2 CHIP1** (20240918) - 5k events



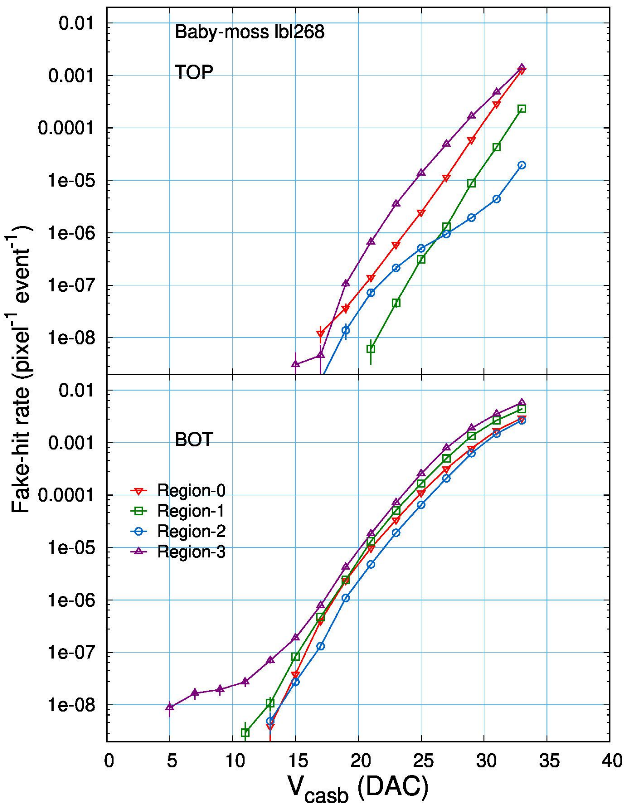


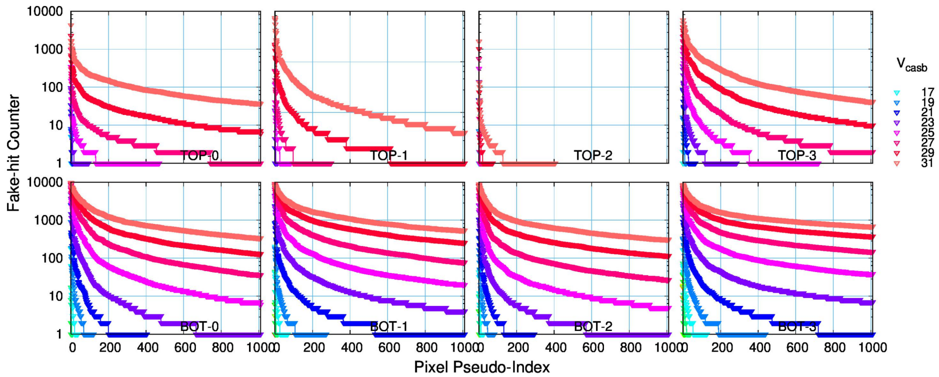
Hot Pixel mask: Hit-Rate > 1% events @ **V_{casb}=15**

Masked pixels

	R-0	R-1	R-2	R-3
TOP	0	0	0	0
BOT	0	0	0	2

Board C - **W20E1 S2 CHIP3** (20240924) - 10k events



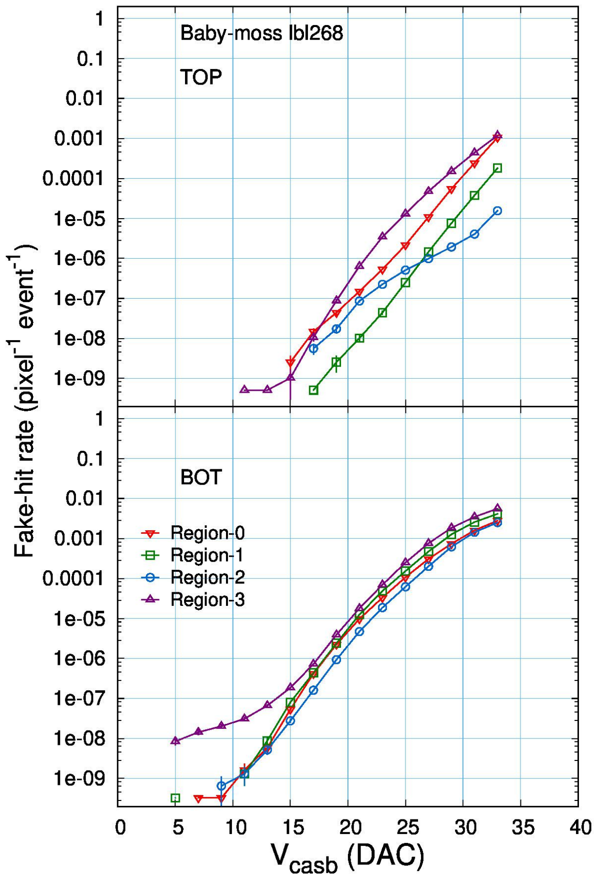


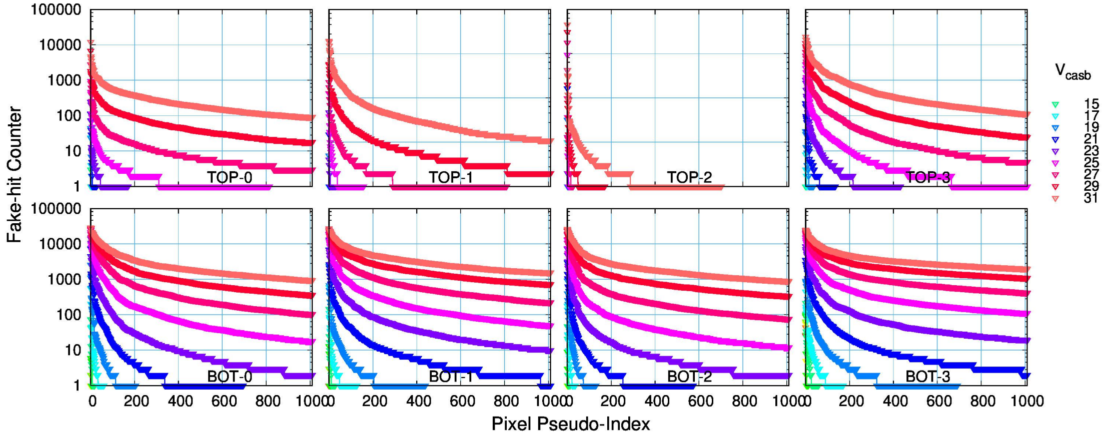
Hot Pixel mask: Hit-Rate > 1% events @ V_{casb}=15

Masked pixels

	R-0	R-1	R-2	R-3
TOP	0	0	0	0
BOT	1	0	0	2

Board C - **W20E1 S2 CHIP3** (20240924) - 30k events





Hot Pixel mask: Hit-Rate > 1% events @ **V_{casb}=15**

Masked pixels

	R-0	R-1	R-2	R-3
TOP	0	0	0	0
BOT	1	0	0	2