

BabyMOSS characterisation activities in Catania and Messina

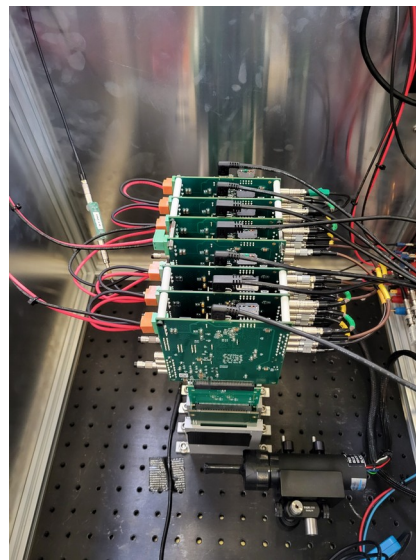
Alessandro Sturniolo

Università di Messina and INFN Sezione di Catania

on behalf of the Messina-Catania team:

Paola La Rocca, Antonio Trifirò, Alessandro Sturniolo, Giuseppe Mandaglio

First measurements with babyMOSS



- **Messina/Catania group has participated** to a training for babyMOSS chip in-lab characterisation and to **September 2024 test beam** measurements @CERN-PS (parasitic mode)
- **Performed analysis** of data @7 GeV/c π^+ beam from babyMOSS Sep 2024 test beam (presented at WP3 meeting on 14th Jan 2025)
- Catania's INFN-LNS laboratories received babyMOSS-5_2_W20E1 device mid Nov 2024, first functionality scans run mid Dec 2024

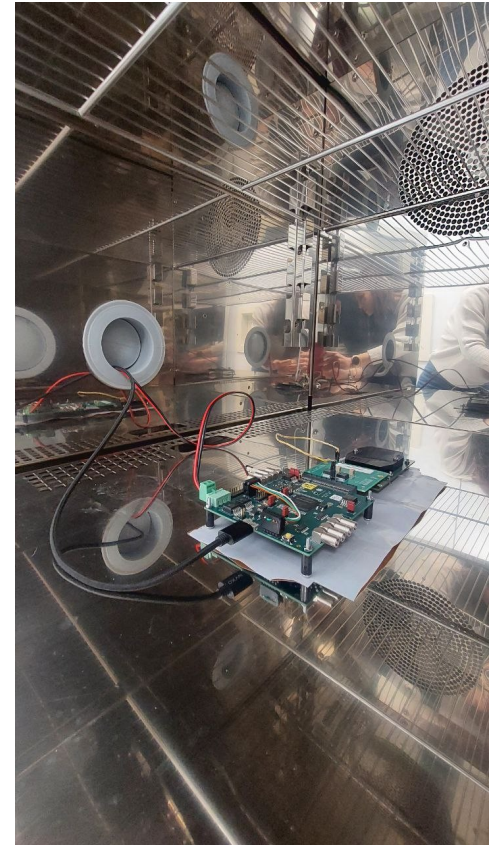
Present and future measurement plan

Setup:

- babyMOSS-5_2_W20E1
- DAQ-Raiser system
 - 2042 Raiser Board (v2)
 - MLR1-045 DAQ Board (rev4)
- Climate chamber for temperature control

Goals:

- ^{55}Fe spectrum acquisition and pixel-to-pixel calibration
- FHR and threshold characterisation at different temperatures



Initial functionality checks

BabyMOSS - 5_2_W20E1		
Functional testing	Power On Scan	Ok
	Register Scan	Ok
	Shift Register Scan	Ok
	DAC Scan	Ok
Readout and pixel matrix testing	Digital Scan	Ok
	Analogue Scan	Ok
	FHR Scan	Ok
	Threshold Scan	Ok

- **Threshold scan:** bottom region 1 shows double threshold peak
- **Confirmed chip functionality,** as obtained @CERN in June 2024

ToT vs V_{pulseH} calibration

Pulse length scan: overview

PSUB = 0.0 V

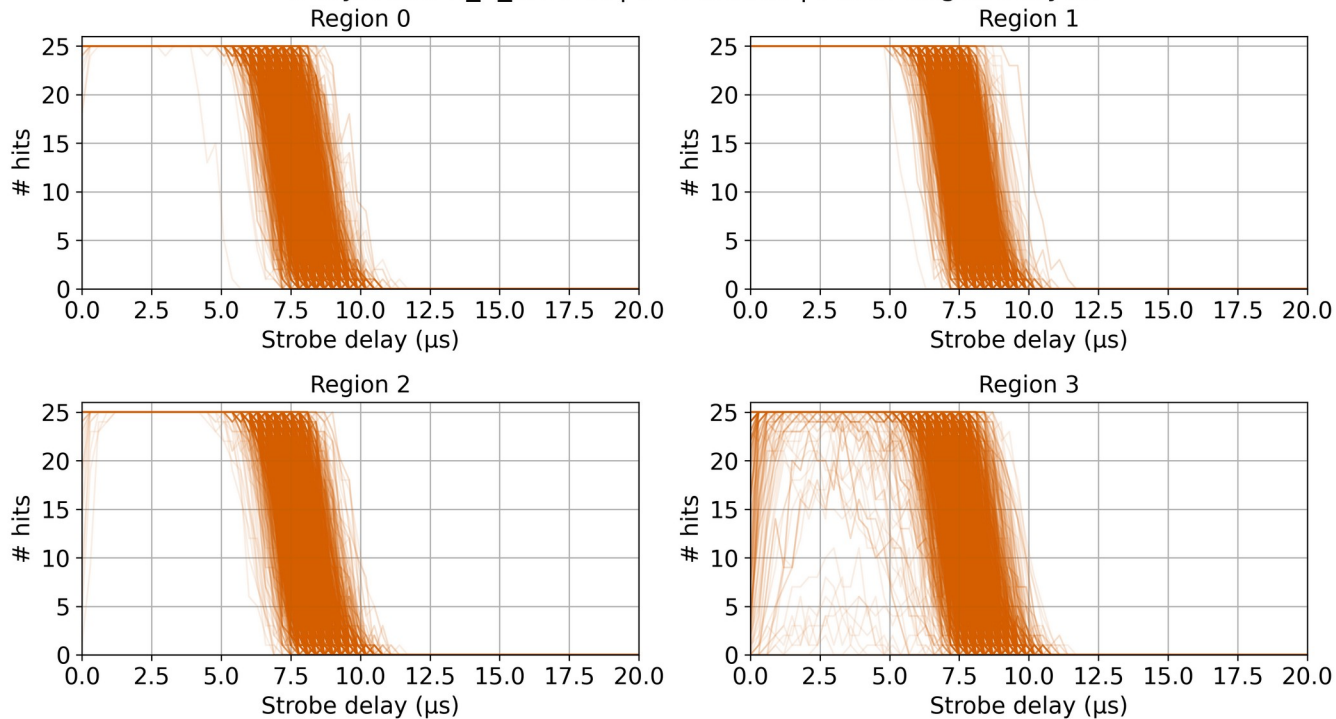
IBIAS	62
IBIASN	100
IDB	50
IRESET	10
VCASB	15
VCASN	64
VSHIFT	192

- **Iterated Pulse Length Scans** at varying VPULSEH, from 10 to 255 DAC
- Strobe signal length was 5 cc = 150 ns, pulse length was 5000 cc = 150 μ s (1 cc = 30 ns)
- Sending n_{strokes} strobe signals with a **varying delay** between them, ranging from 0 to 3000 cc at a step = 10 cc
- Recording hits vs strobe delay (inverted sigmoid curve)
- **Sigmoid μ is defined as ToT**

Pulse length scan: an overview

VPULSEH = 70 DAC

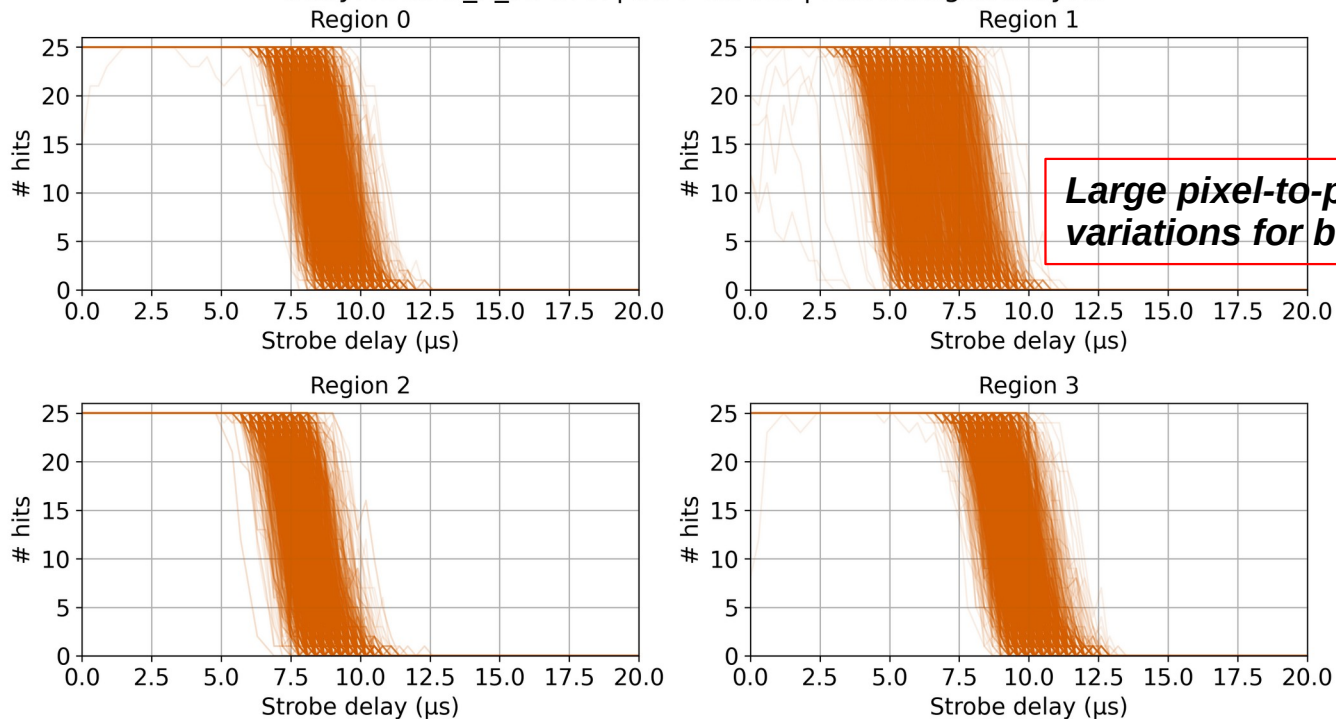
babyMOSS-5_2_W20E1 | tb s-curves | PulseLengthAnalysis



Pulse length scan: an overview

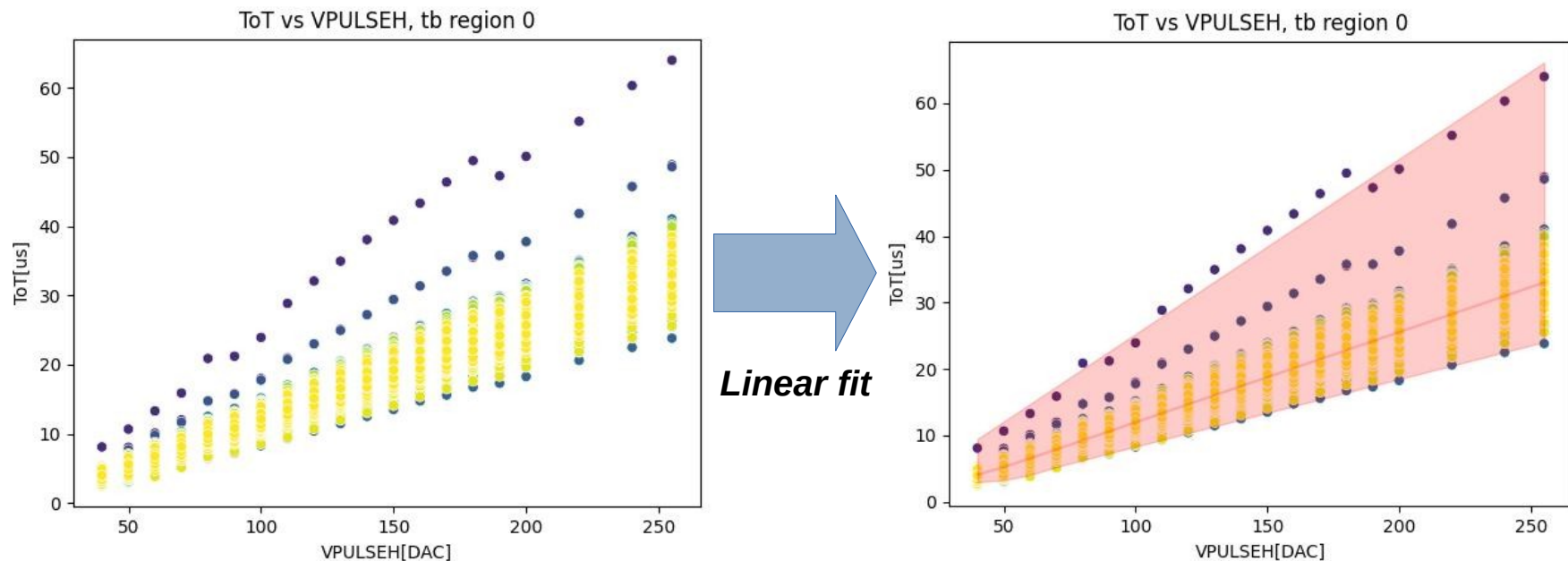
VPULSEH = 70 DAC

babyMOSS-5_2_W20E1 | bb s-curves | PulseLengthAnalysis





ToT vs VPULSEH calibration

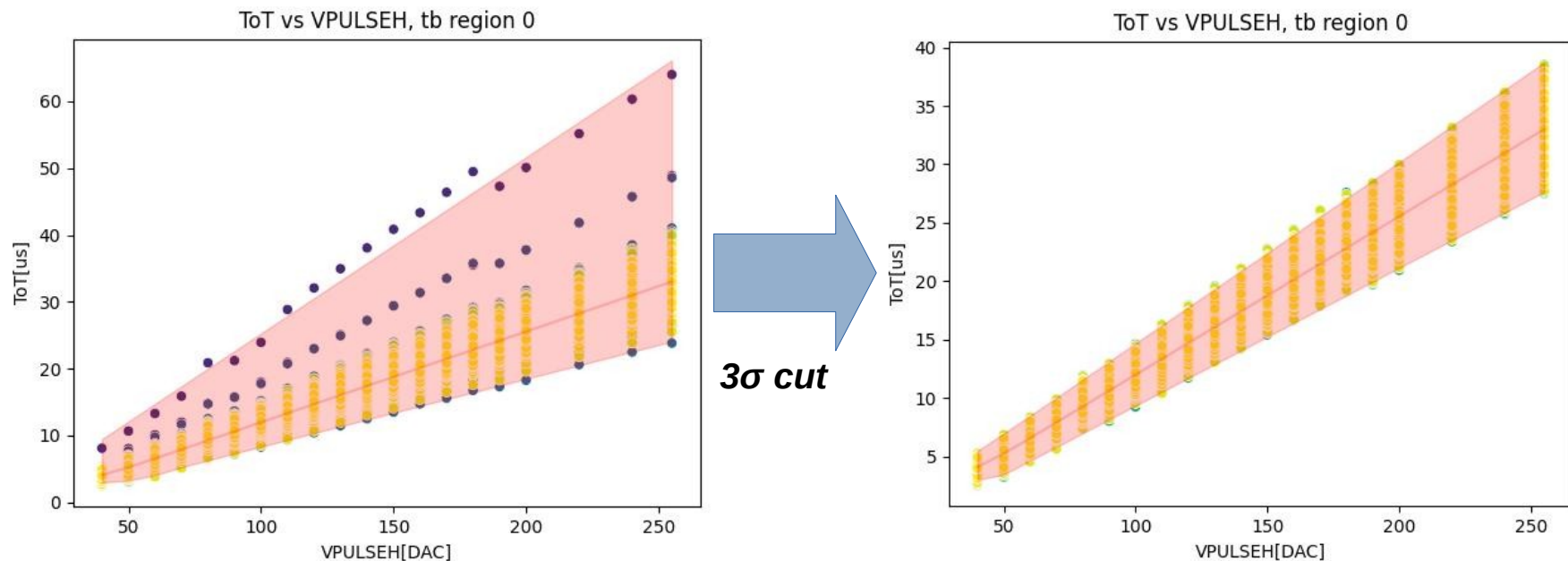


- Coloured area highlights minimum to maximum fit line
- ToT increases linearly with VPULSEH, with average slopes ranging 0.13 to 0.15 μ s/DAC and offsets from -1.2 to -3.0 μ s



ALICE

ToT vs VPULSEH calibration: data cuts

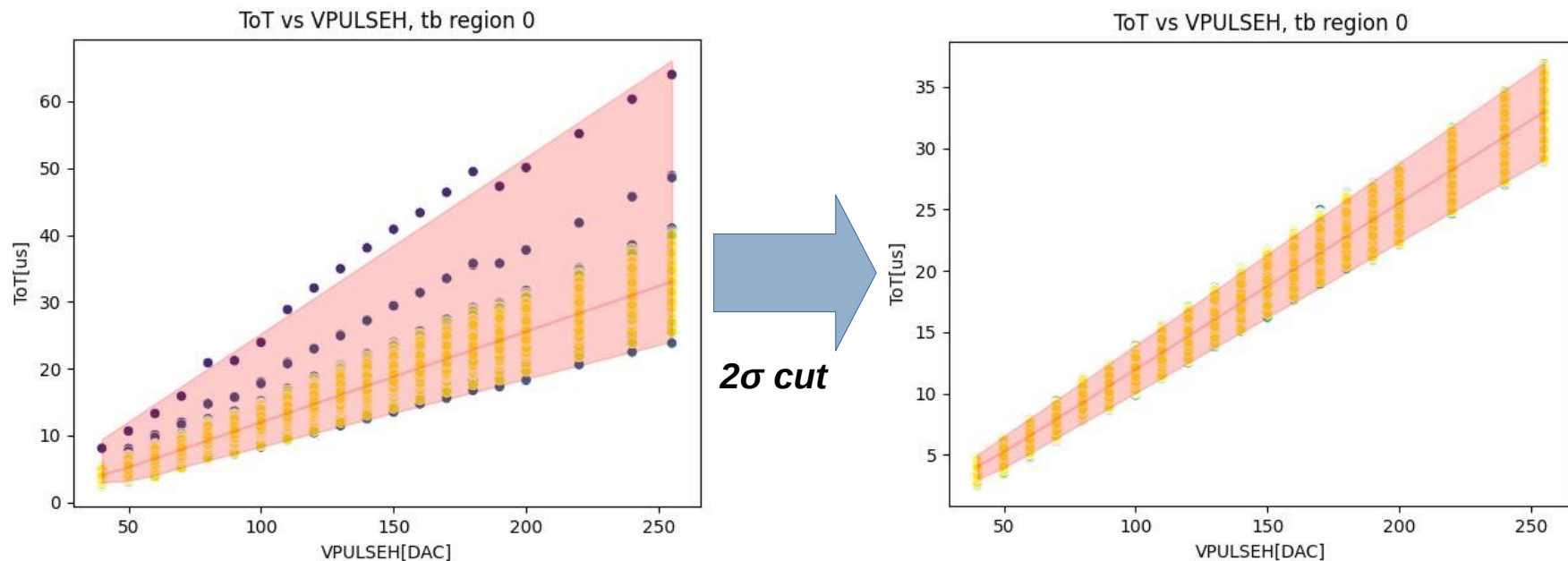


Pixels with line slope and offset outside $n\sigma$ from average excluded



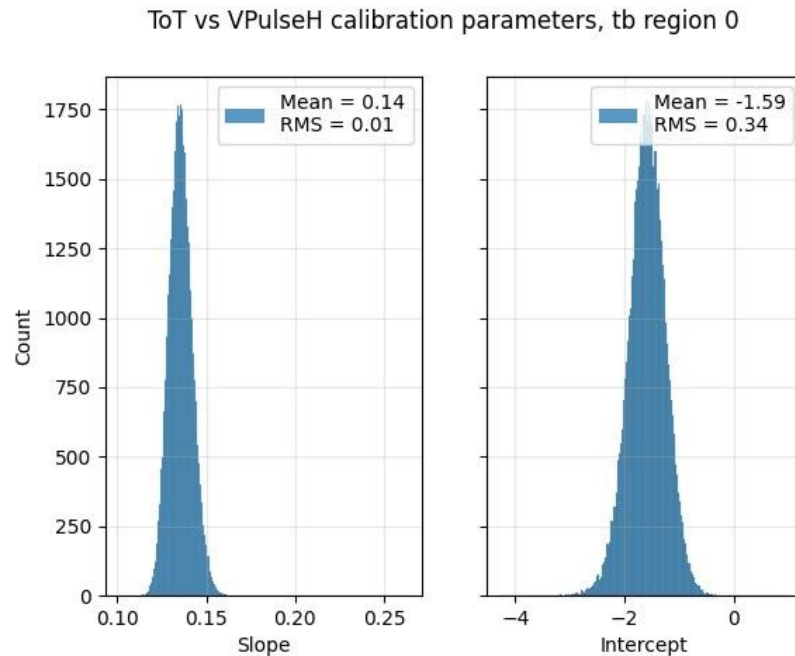
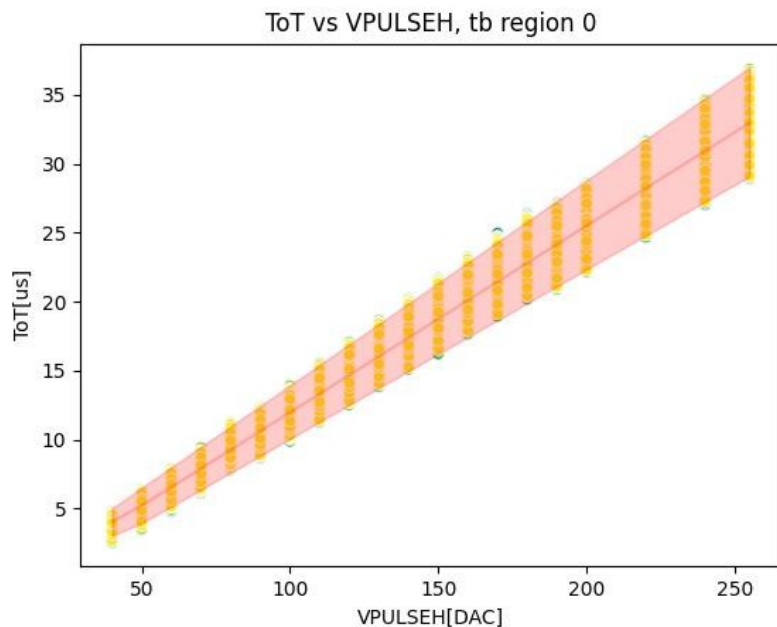
ALICE

ToT vs VPULSEH calibration: data cuts

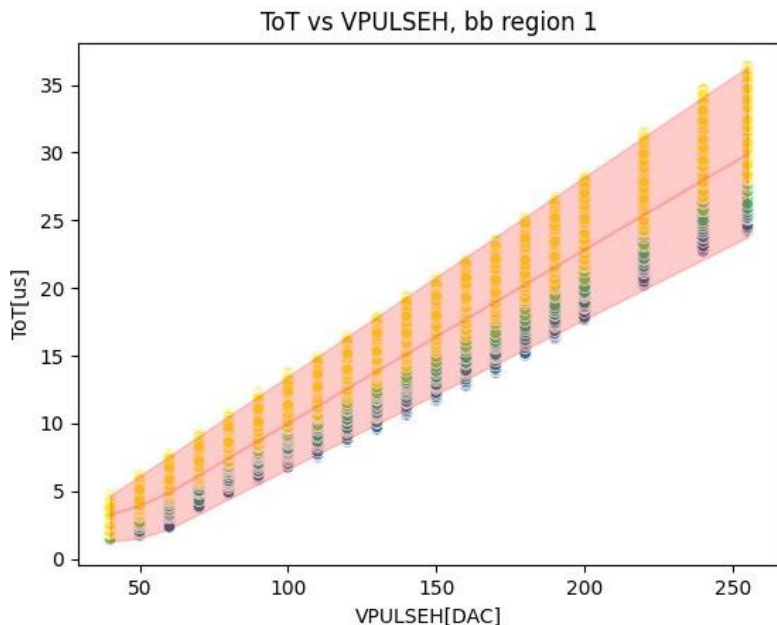


Pixels with line slope and offset outside 2σ from average excluded

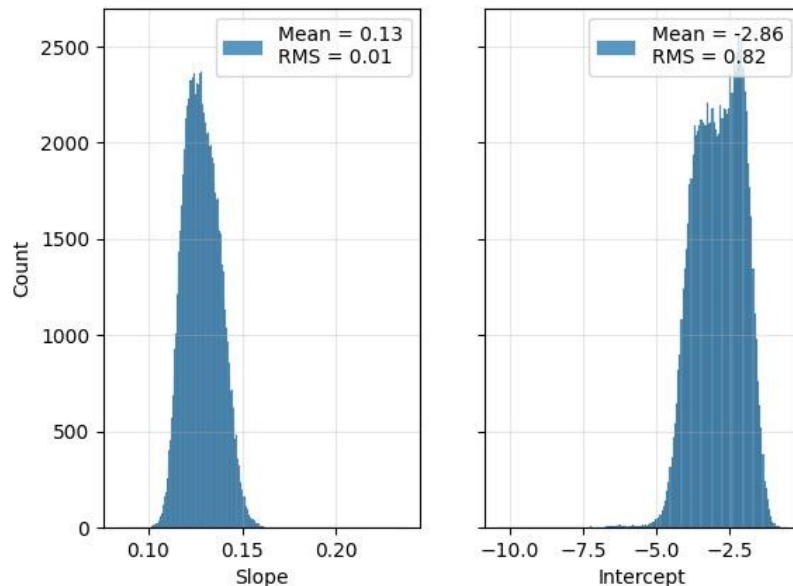
ToT vs VPULSEH calibration, 2σ cut



ToT vs VPULSEH calibration, 2σ cut



ToT vs VPulseH calibration parameters, bb region 1

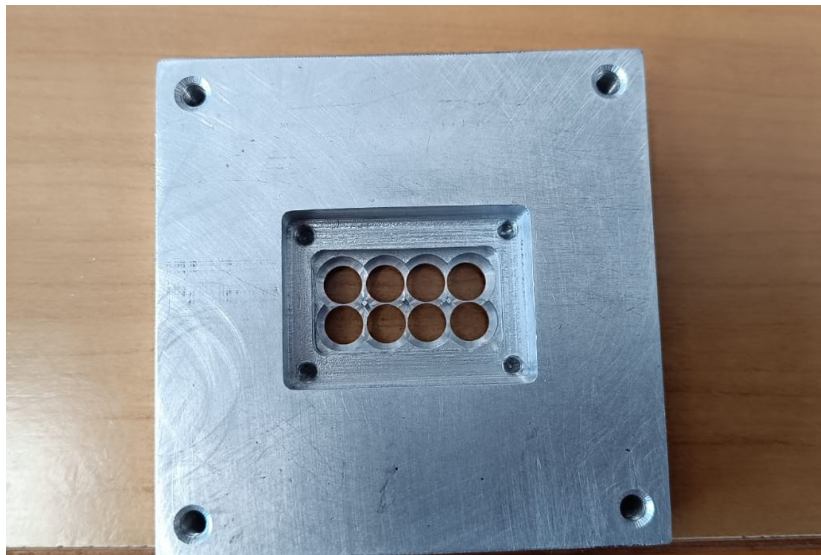


- Bottom region 1 shows double line slope peak, pointing out that 2 separate groups of pixels have different calibrations (threshold scan issues already known from scans @CERN)



Preparing for measurements with source

- With calibration complete, we open the possibility to acquire and calibrate ^{55}Fe spectra
- **Next steps:** acquisition of spectra with source. Considering to apply Marius Menzel's stuck-RO method (<https://indico.cern.ch/event/1479059/>)
- **Source holder designed** in Catania, **produced** in Messina and **ready for delivery!**



FHR/Threshold characterisation vs temperature



FHR & threshold vs temperature: overview

PSUB = 0.0 V

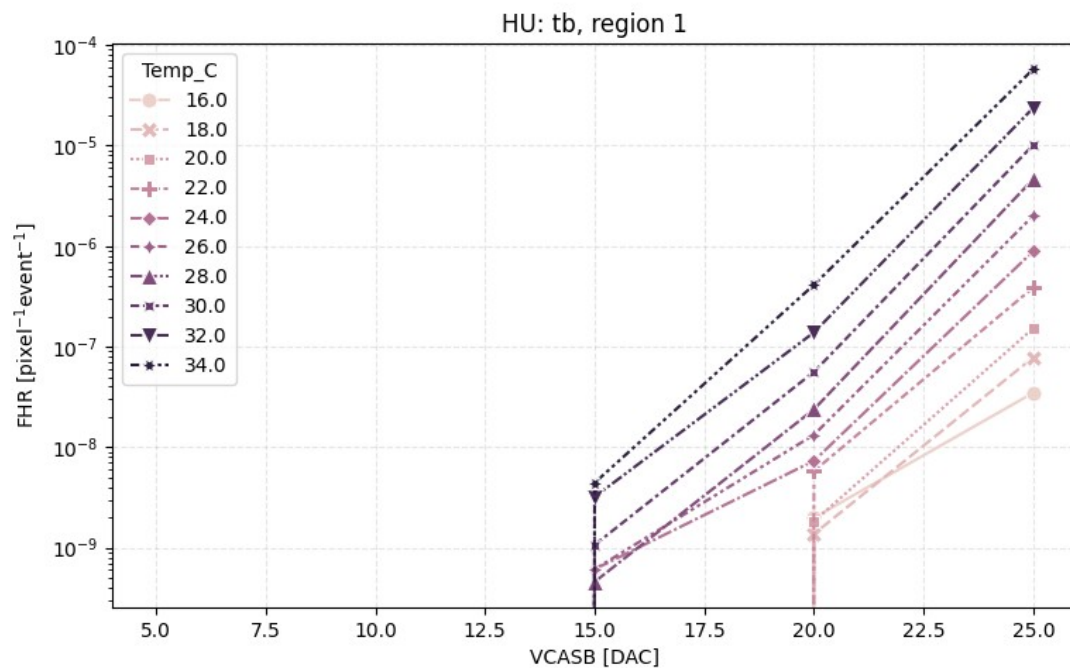
IBIAS	62
IBIASN	100
IDB	50
IRESET	10
VPULSEH	42
VCASN	64
VSHIFT	192

- **BabyMOSS + Raiser** set inside a **climate chamber** (@INFN Sezione di Catania)
- **Temperature was varied** from 16 to 34 °C with a step = 2 °C
- **For each temperature, a sequence of FHR and Threshold Scans** was performed at VCASB from 5 to 25 DAC with a step = 5 DAC, strobe signal length = 200 cc = 6 μ s
- **FHR Scan:** reading hits on babyMOSS regions, normalised by #triggers and #pixels per region
- **Threshold Scan:** sending pulses with varying amplitude (VPULSEH = 0 to 70 DAC) and length = 400 cc = 12 μ s



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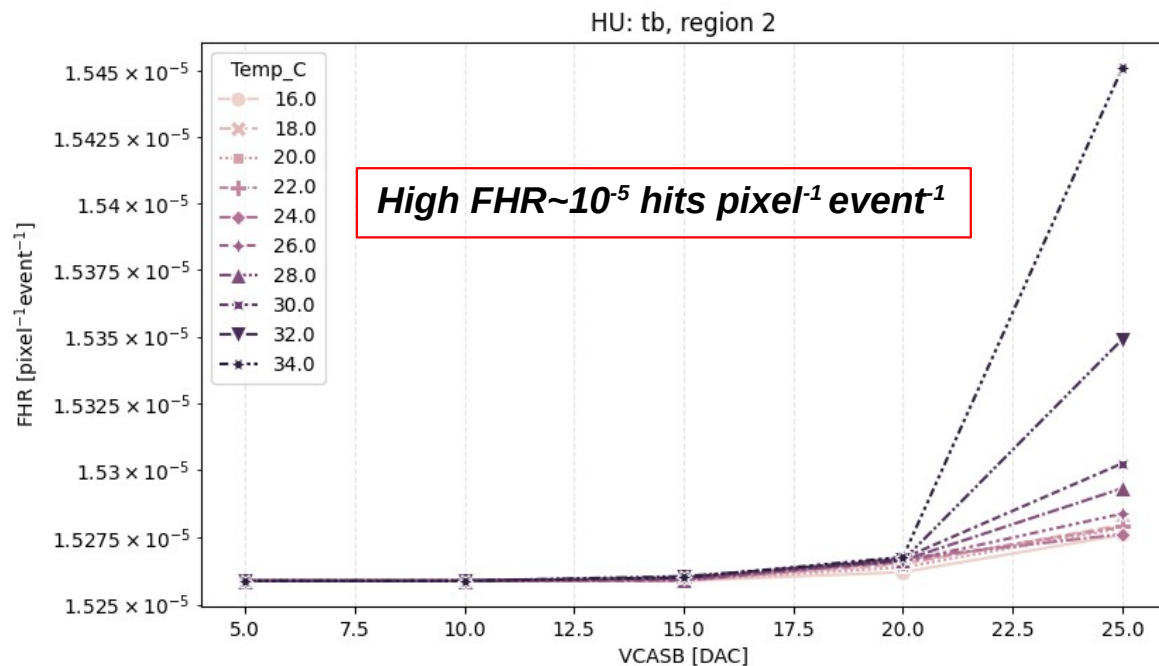
FHR scans



FHR increases with increasing temperature

ITS3WIP
babyMOSS – 5_2_W20E1
non irradiated
Pitch: 22.5 μm
Split 2
 $I_{bias} = 62$ DAC
 $I_{biasn} = 100$ DAC
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 $I_{db} = 50$ DAC
 $V_{shift} = 192$ DAC
 $V_{casn} = 64$ DAC
 $V_{psub} = 0.0$ V
Strobe length = 6 μs

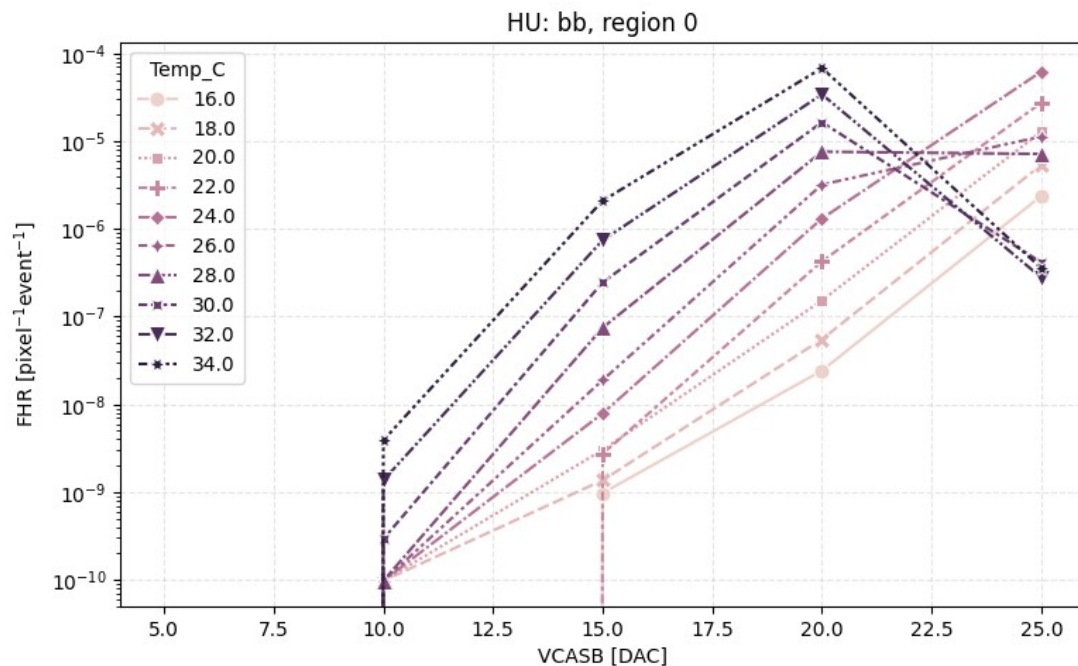
FHR scans



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 $V_{psub} = 0.0$ V
 Strobe length = 6 μs



FHR scans



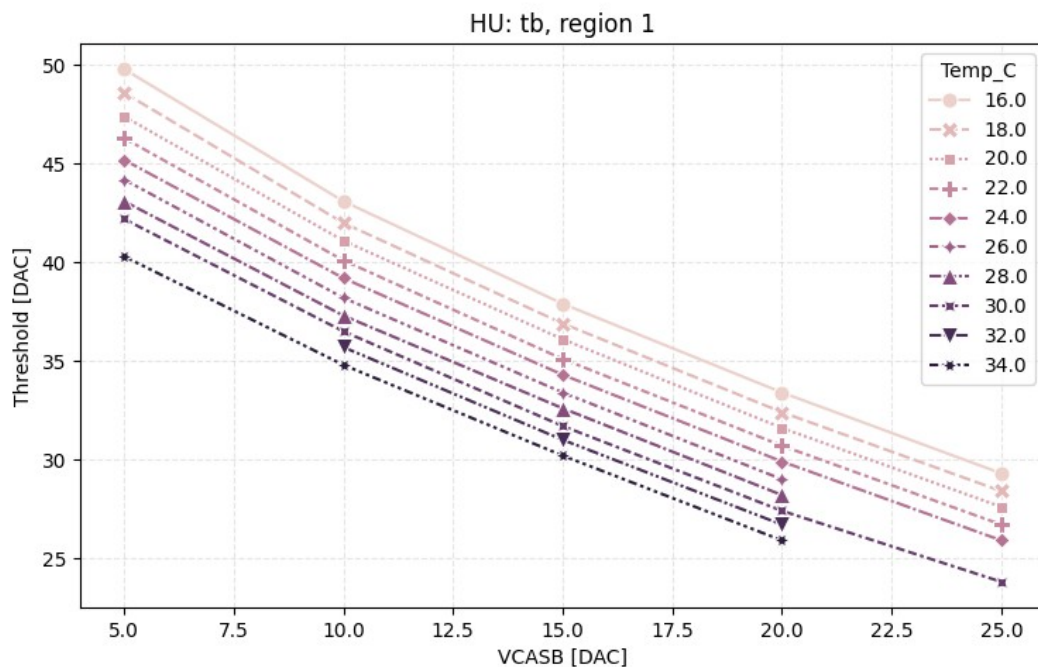
ITS3WIP
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Pitch: 18.0 μm
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 $V_{casn} = 64$ DAC
 $V_{psub} = 0.0$ V
Strobe length = 6 μs

Bottom HU: FHR at VCASB = 25 DAC grows slower than expected or falls for $T > 24$ °C



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Threshold scans

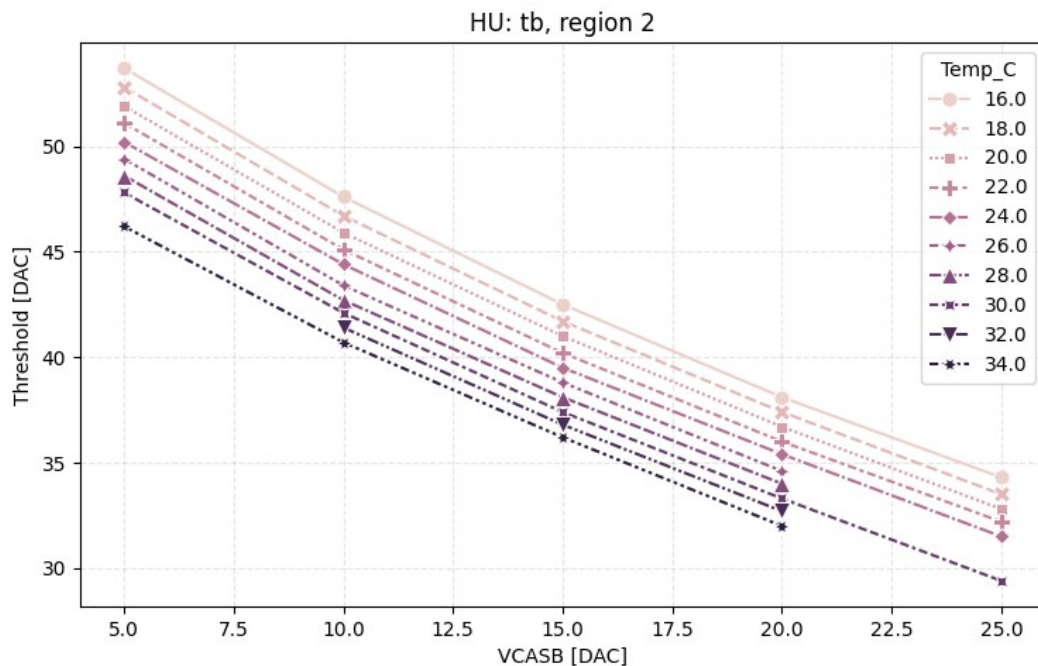


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 $I_{db} = 50$ DAC
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 $V_{psub} = 0.0$ V
Strobe length = 6 μs



ALICE

Threshold scans



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non irradiated

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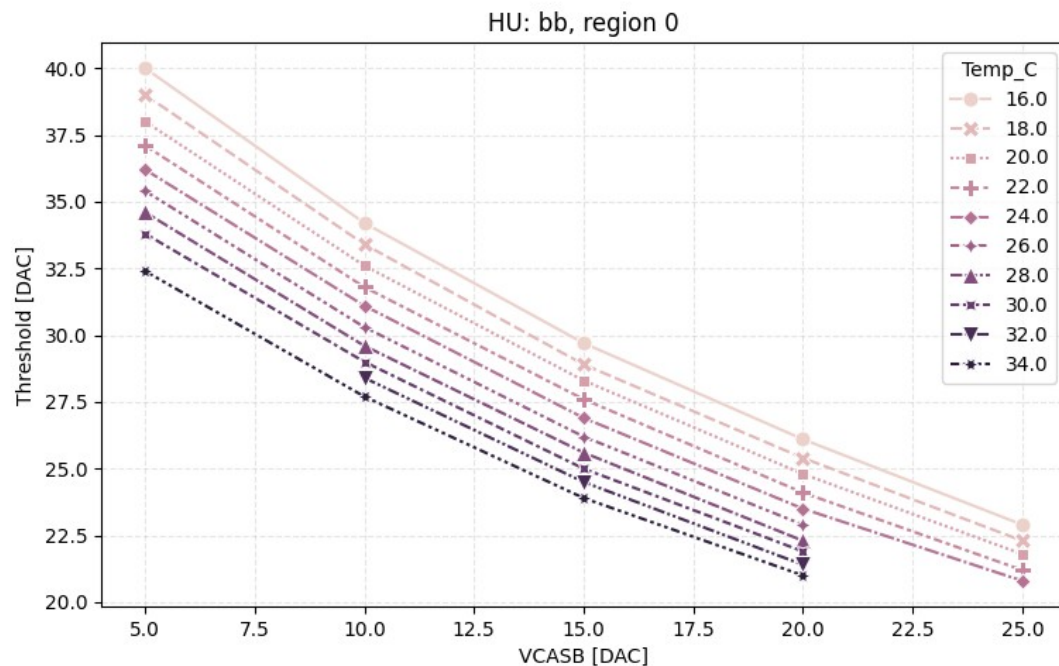
$V_{psub} = 0.0$ V

Strobe length = 6 μs



ALICE

Threshold scans



ITS3WIP

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non irradiated

Pitch: 18.0 μm

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$V_{casn} = 64$ DAC

$V_{psub} = 0.0$ V

Strobe length = 6 μs

Equipments and Facilities in Catania/Messina

Facilities:

- Clean Room
- Equipped laboratory (previously used to test Alptide structures)
- Singletron: light ions beam (H^+ , He^+ , He^{++}) with 0.5-3.5 MeV

Instrumentations:

- Chiller (Temperature range $-35 \div 200$ °C, ± 0.01 °C stability)
- Picoammeter/Voltage sources (Keithley 2400 and 6487)
- Digital Oscilloscope (2.5 GHz and 40 GS/s)
- Radioactivity sources ($^{90}\text{Sr}/^{90}\text{Y}$ 23 MBq, ^{55}Fe 9 MBq)
- Laser setup: Large Scanning TCT (660 nm and 1064 nm), beam spot ~ 10 μm , position resolution < 1 μm over 10 cm excursion
- Bonding tools: Hybrid Wedge Bonder (Kulicke and Soffa Asterion), Auto-Stepback Wedge Bonder (Kulicke and Soffa 4526)
- Climate chamber: volume 337 L, temperature range $[-75^\circ\text{C}; +180^\circ\text{C}]$, temperature stability $[\pm 0,5^\circ\text{C} \dots \pm 1^\circ\text{C}]$, speed: 8 °C/min from -70°C to $+180^\circ\text{C}$ and 5.5°C/min from $+180^\circ\text{C}$ to -70°C

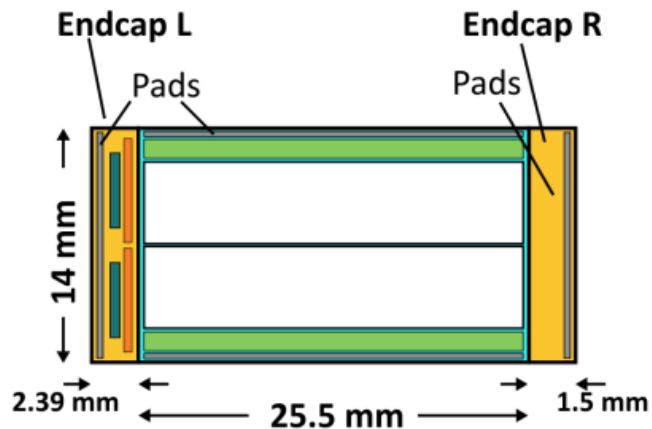


Thank you!

Backup slides



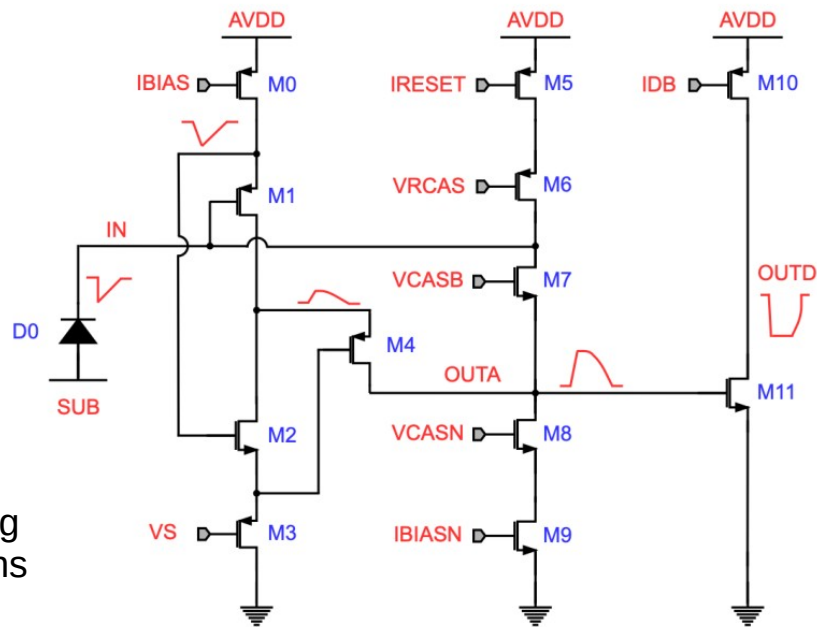
BabyMOSS architecture & front-end



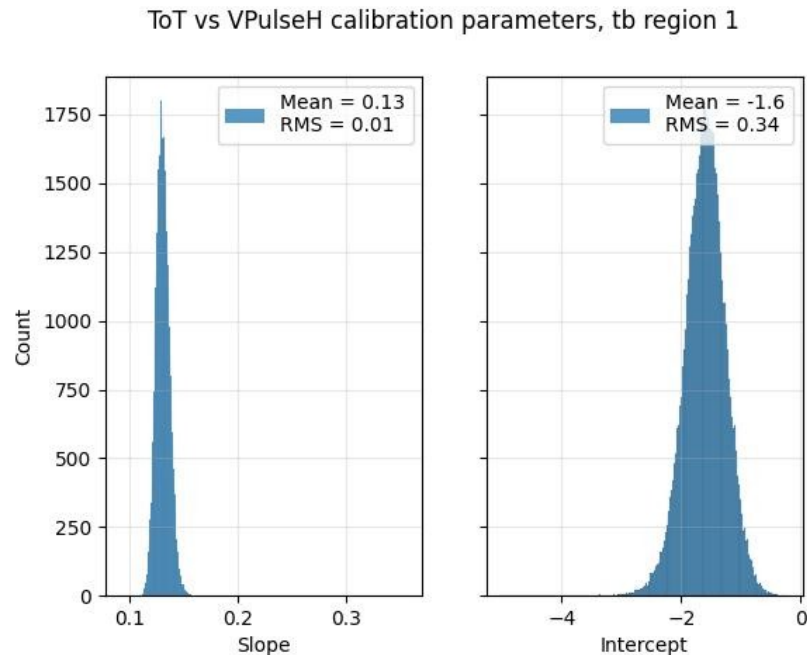
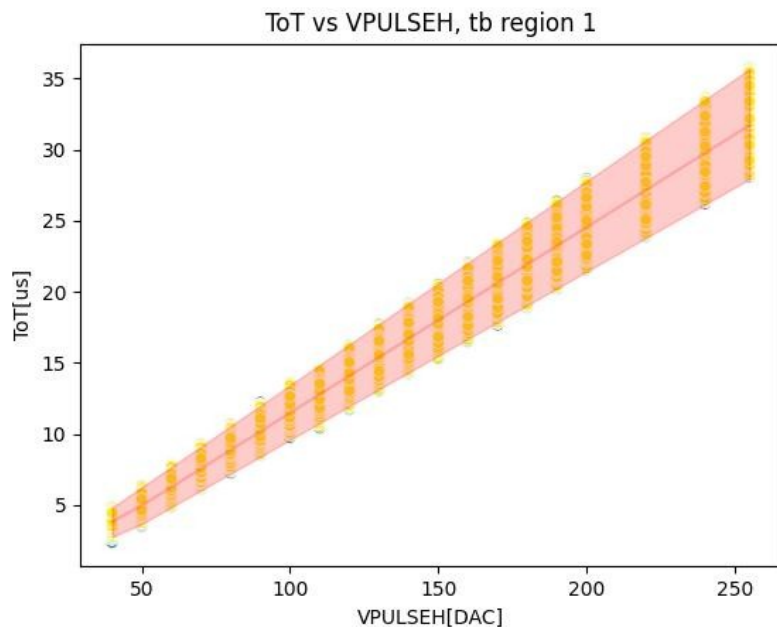
BabyMOSS chip architecture

- Digital read-out + pulsing circuit for testing
- Single RSU from MOSS (8 regions arranged in top & bottom half-unit)

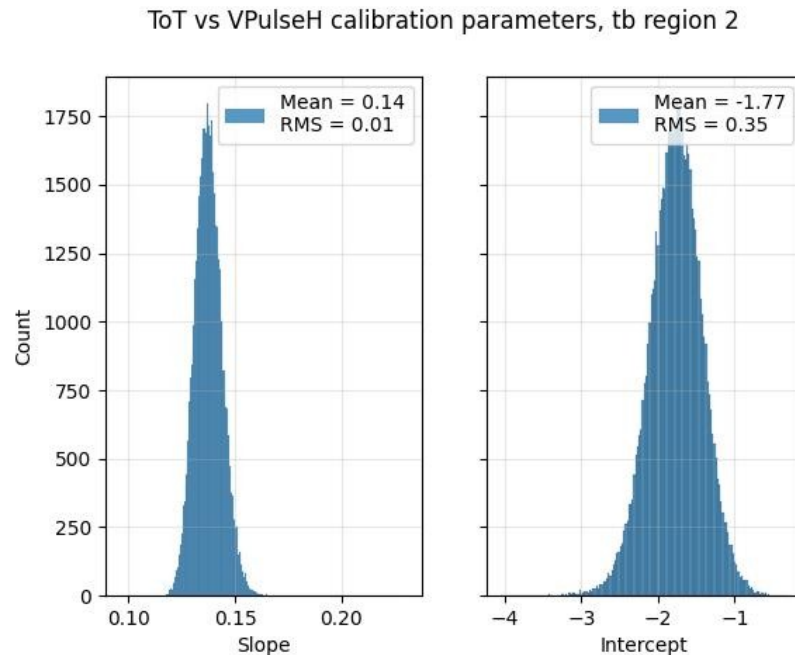
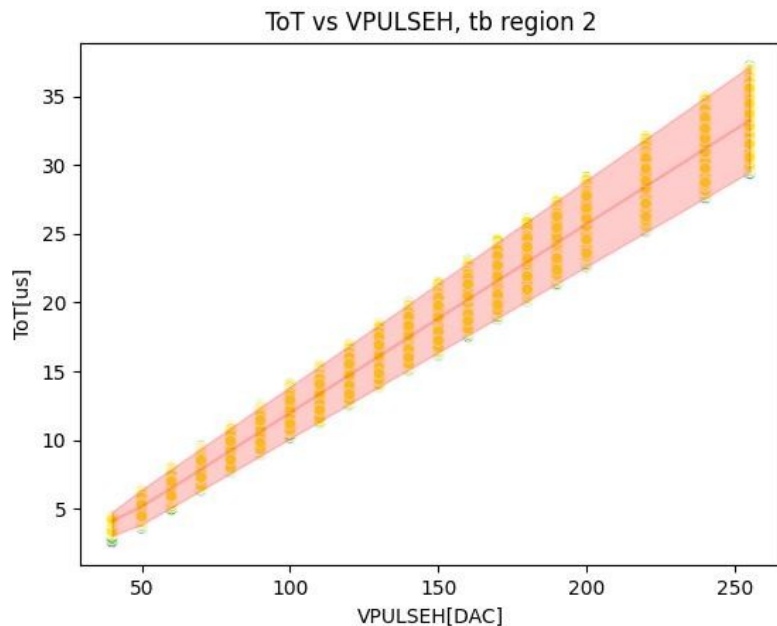
Front-end circuitry



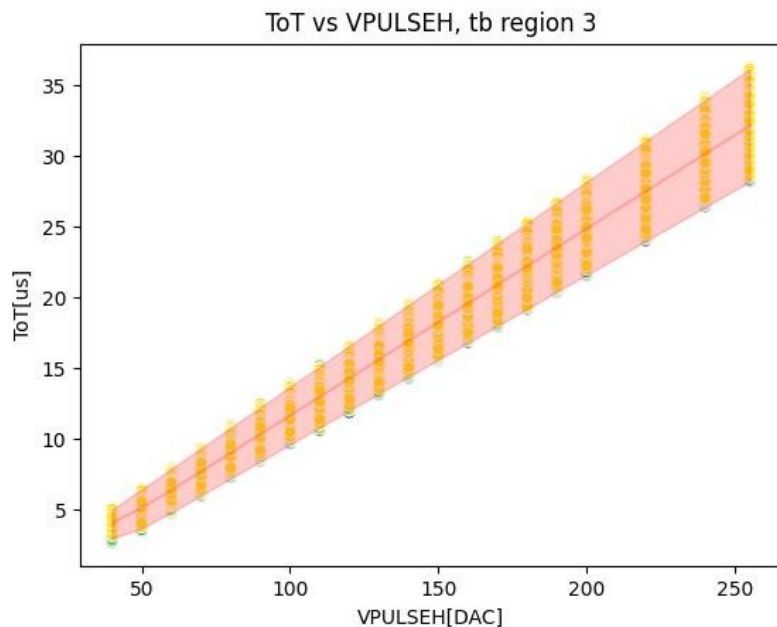
ToT vs VPULSEH calibration, 2σ cut



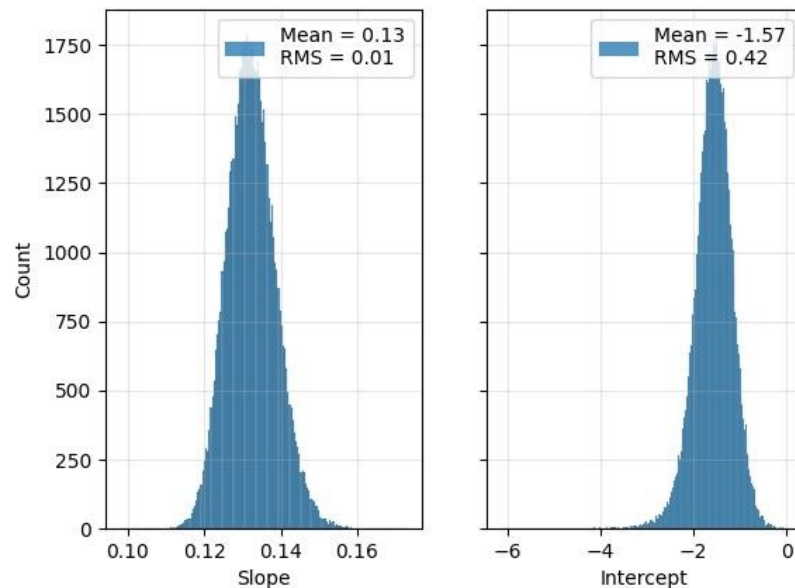
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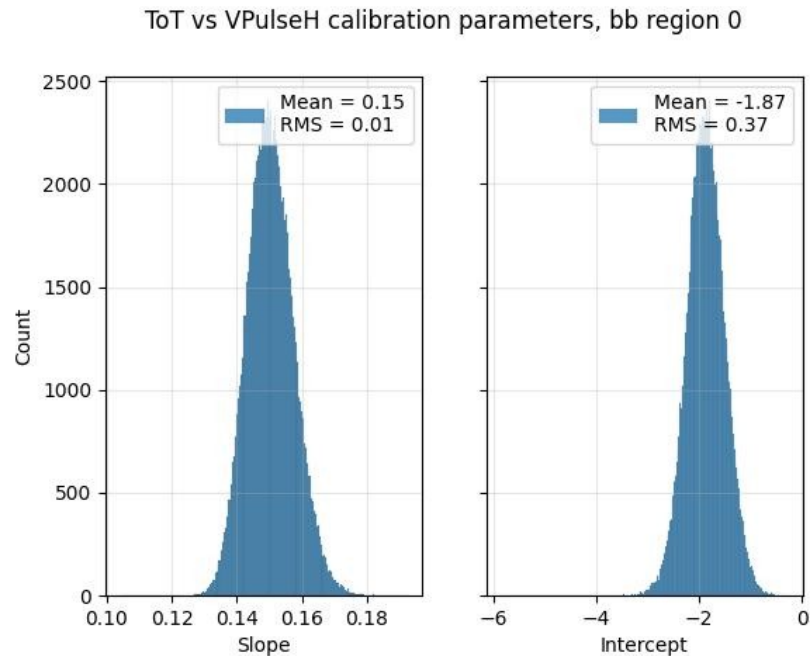
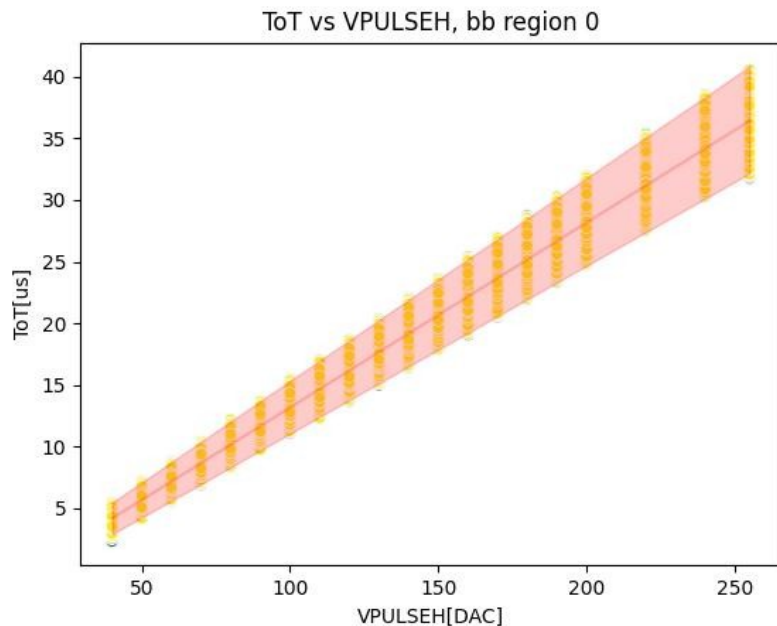
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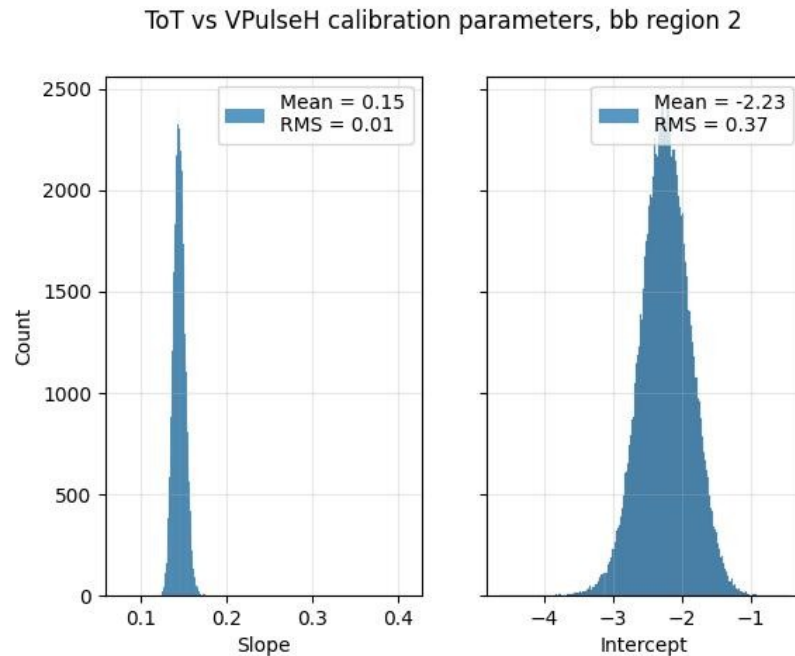
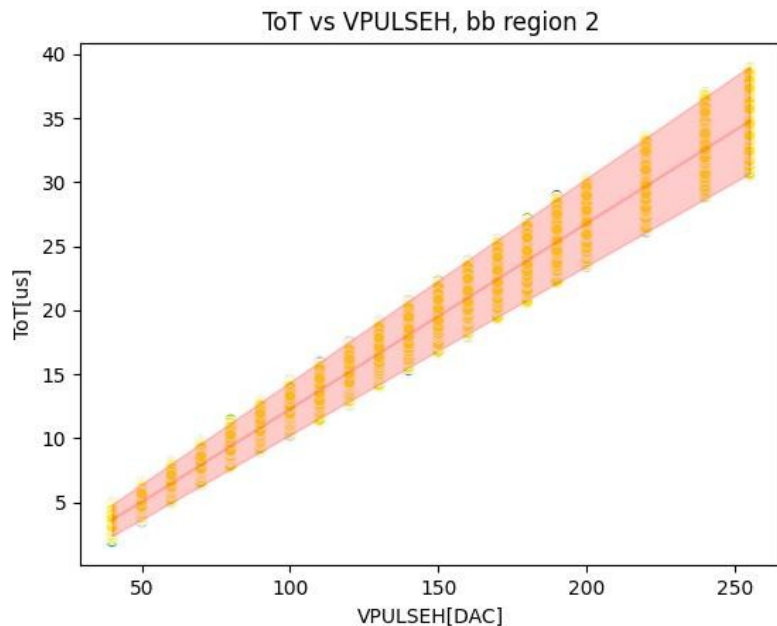
ToT vs VPulseH calibration parameters, tb region 3



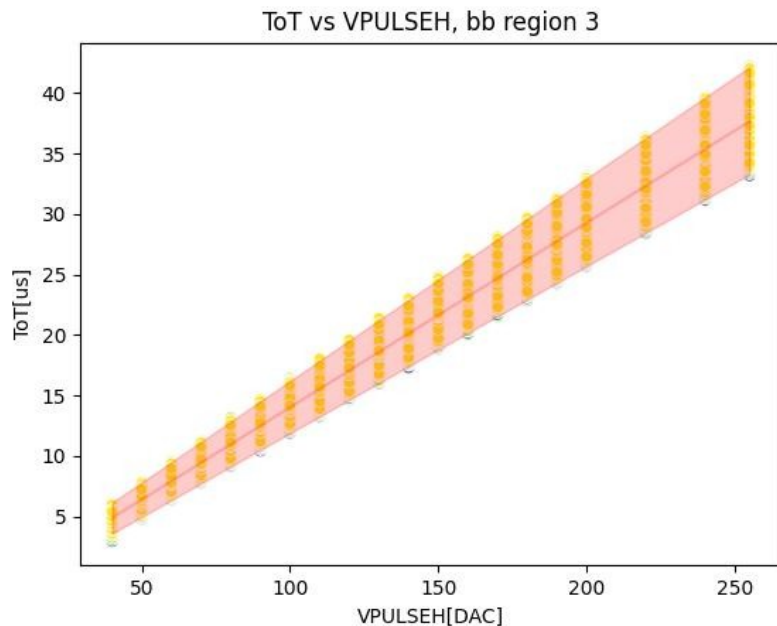
ToT vs VPULSEH calibration, 2σ cut



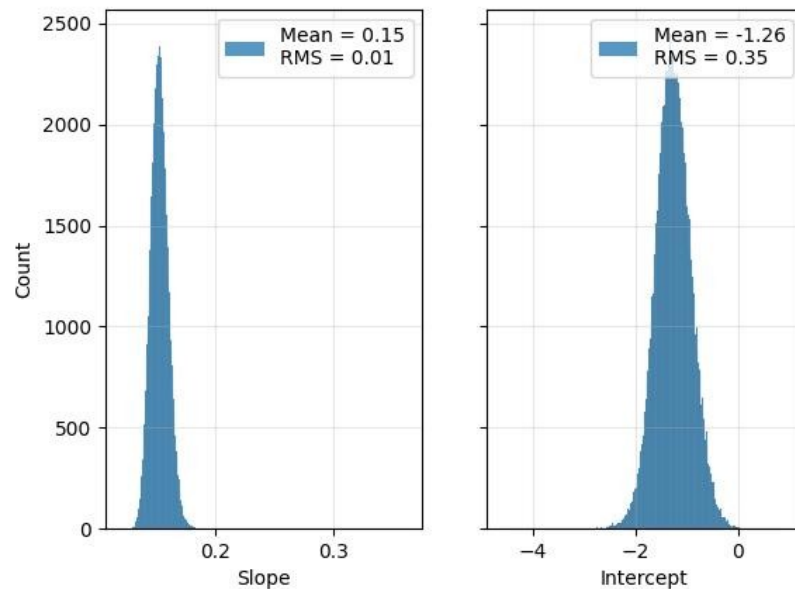
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ToT vs VPULSEH calibration, 2σ cut



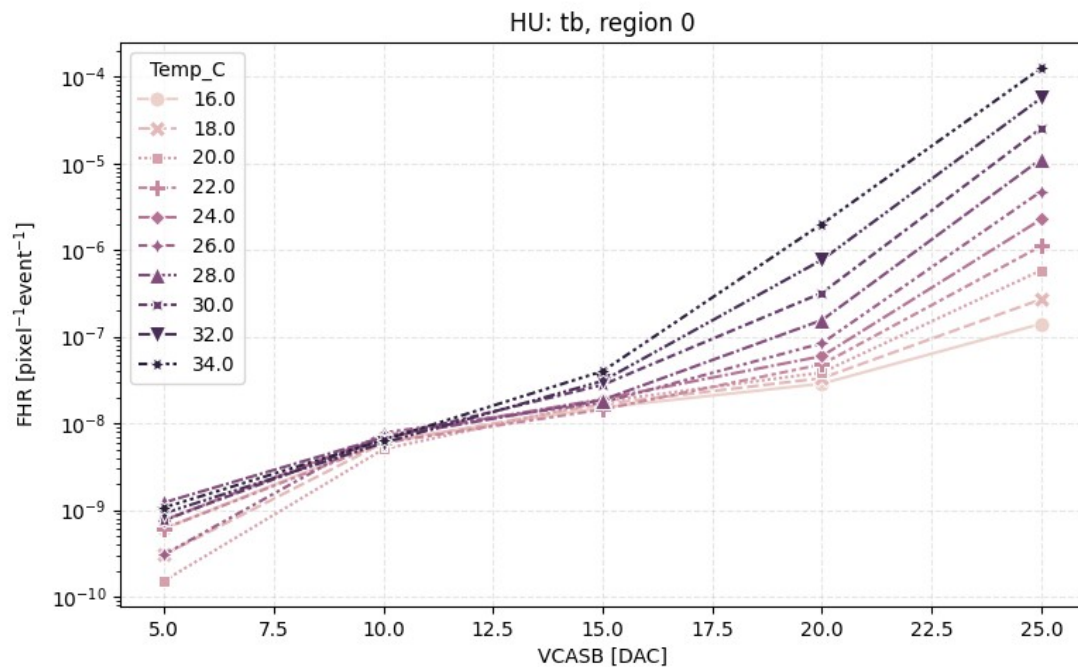
ToT vs VPulseH calibration parameters, bb region 3





ALICE

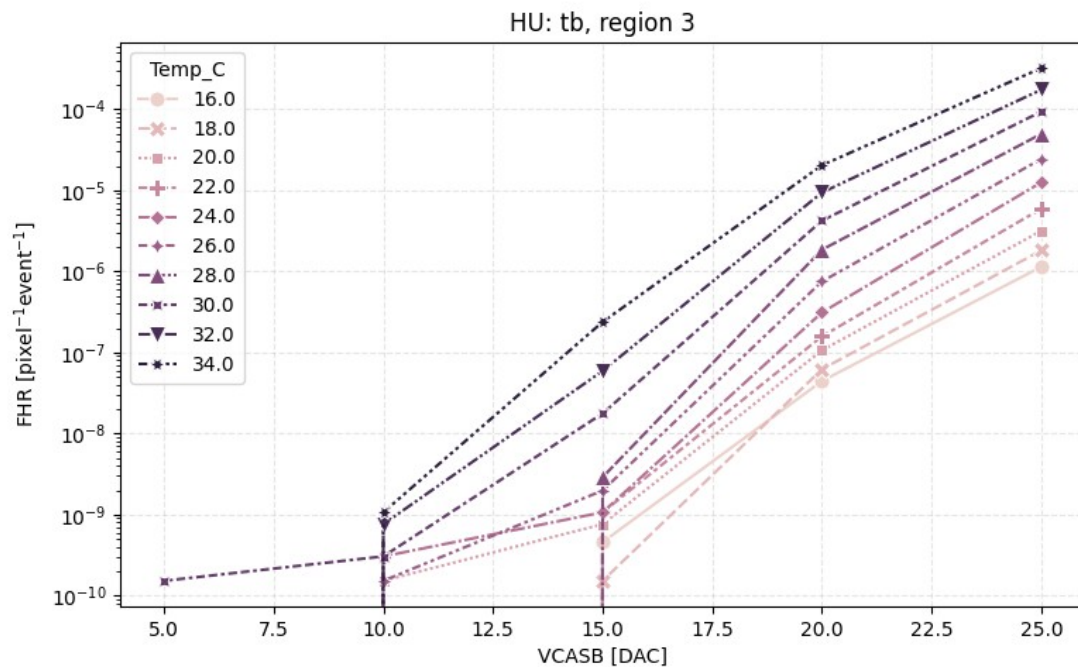
FHR scans



ITS3WIP
babyMOSS – 5_2_W20E1
non irradiated
Pitch: 22.5 μm
Split 2
 $I_{bias} = 62$ DAC
 $I_{biasn} = 100$ DAC
 $I_{reset} = 10$ DAC
 $I_{db} = 50$ DAC
 $V_{shift} = 192$ DAC
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 $V_{psub} = 0.0$ V
Strobe length = 6 μs



FHR scans



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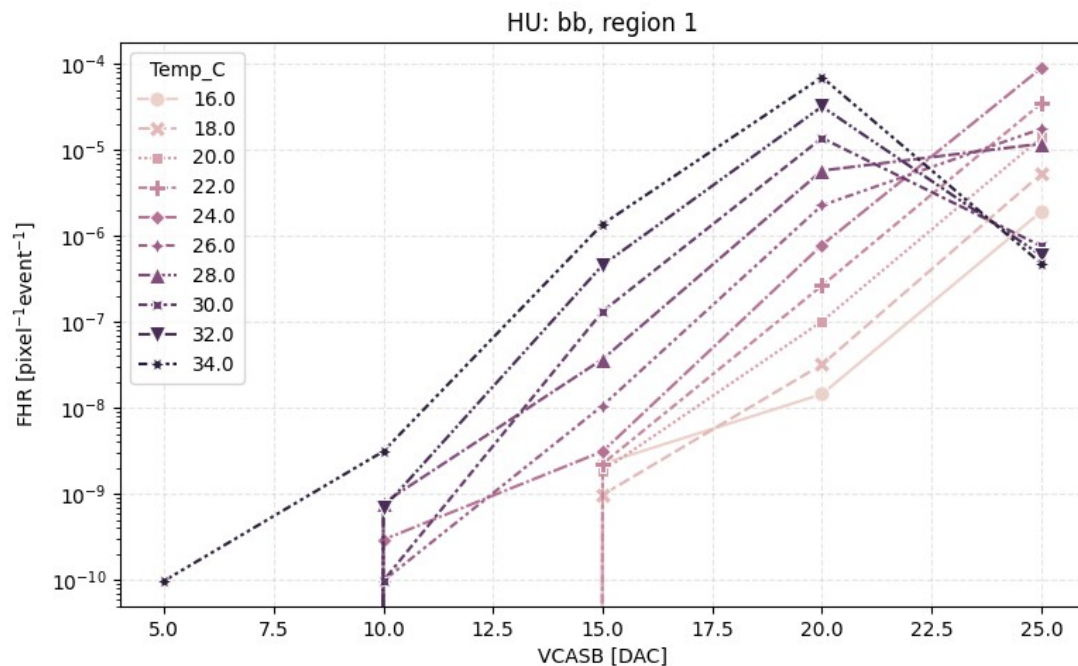
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ALICE

FHR scans



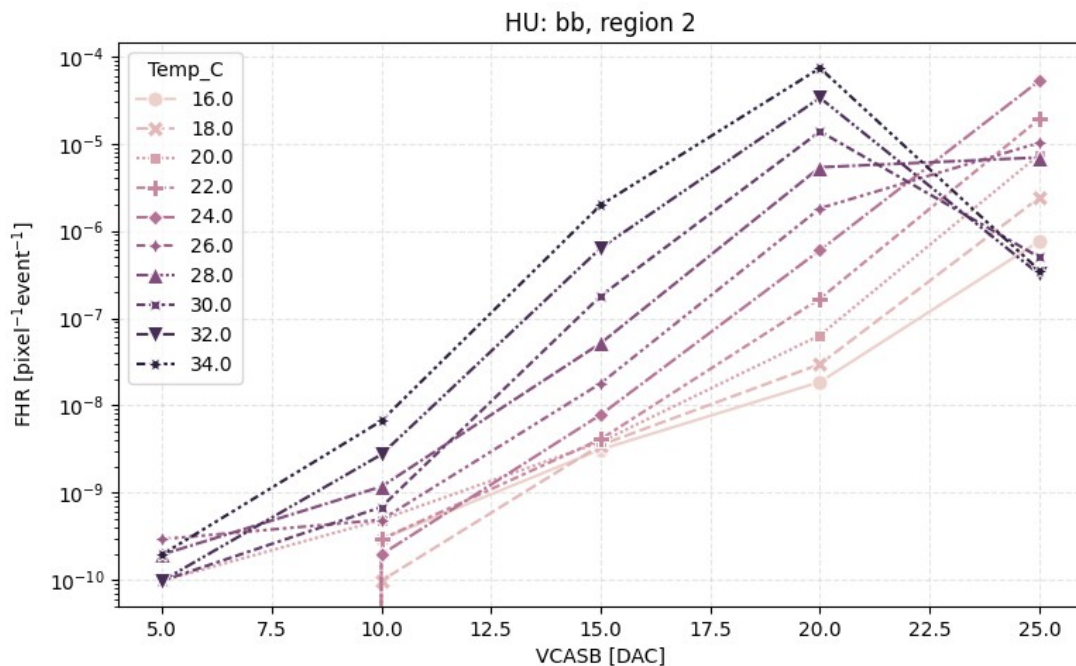
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Bottom HU: FHR at VCASB = 25 DAC falls for $T > 24$ °C



ALICE

FHR scans



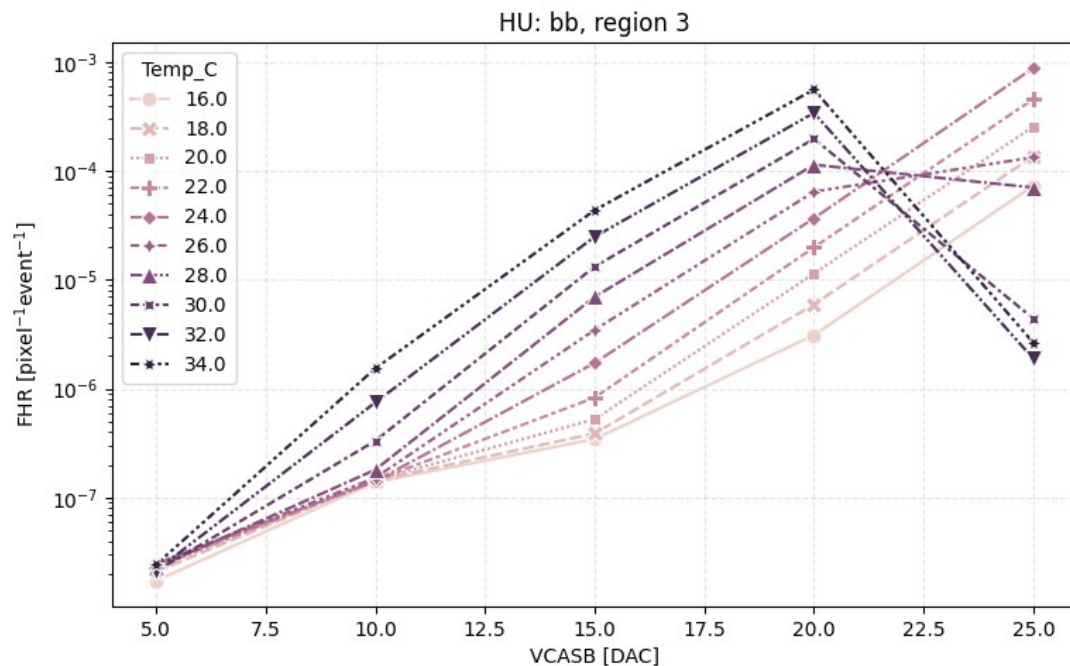
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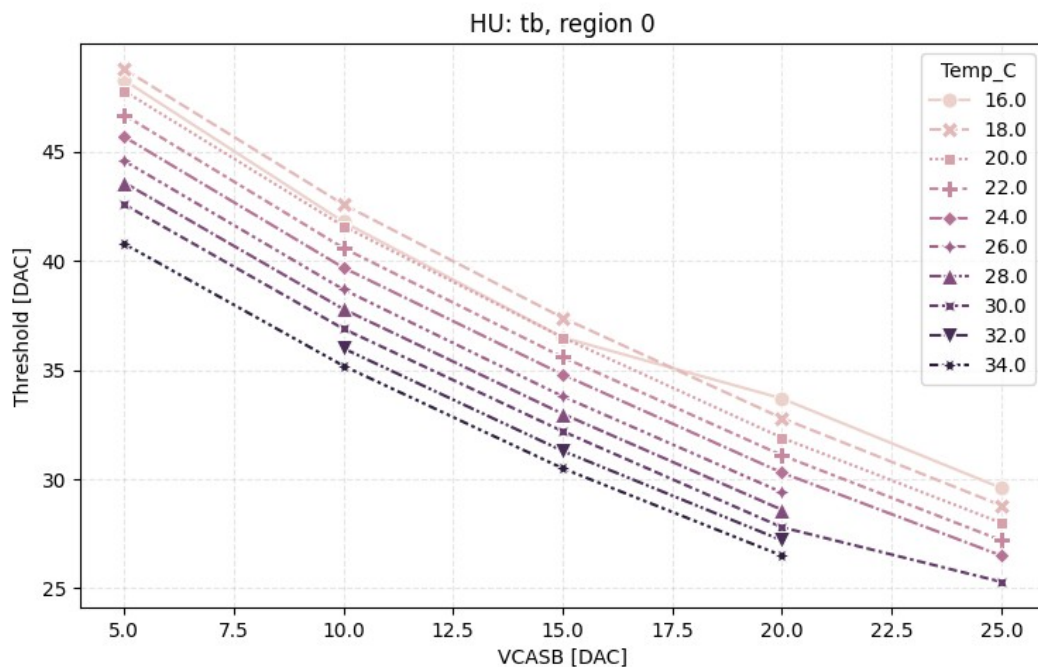
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ALICE

Threshold scans



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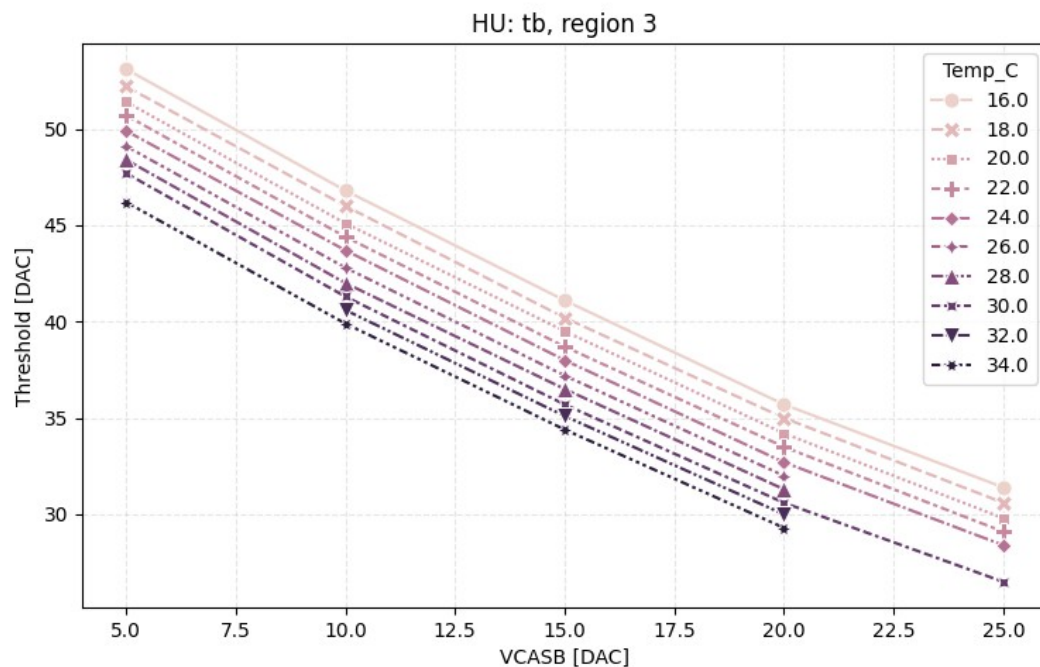
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ALICE

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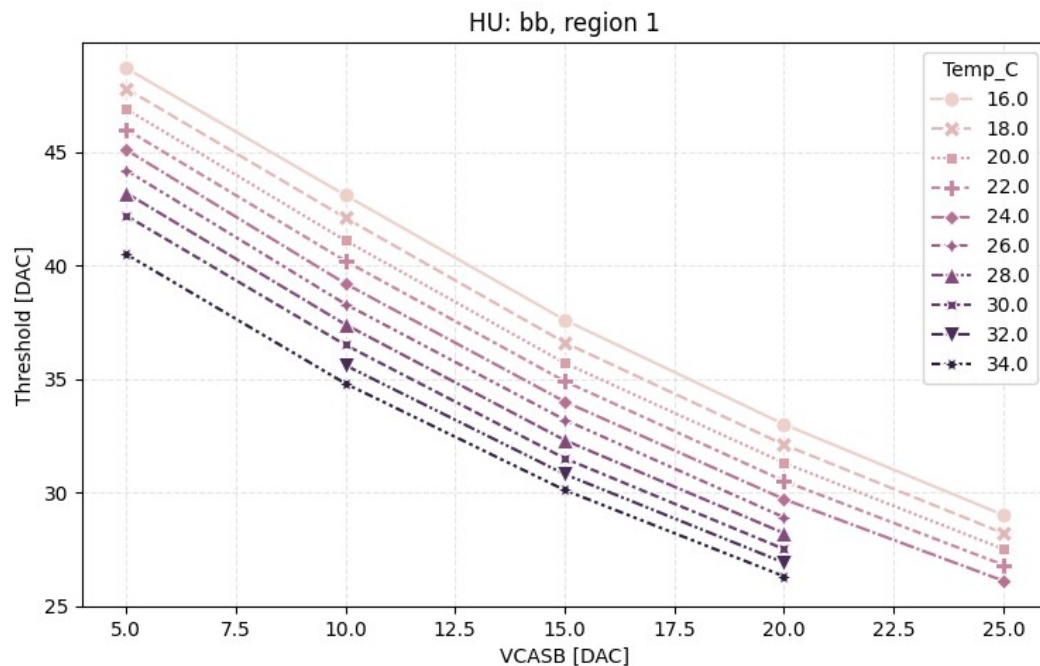
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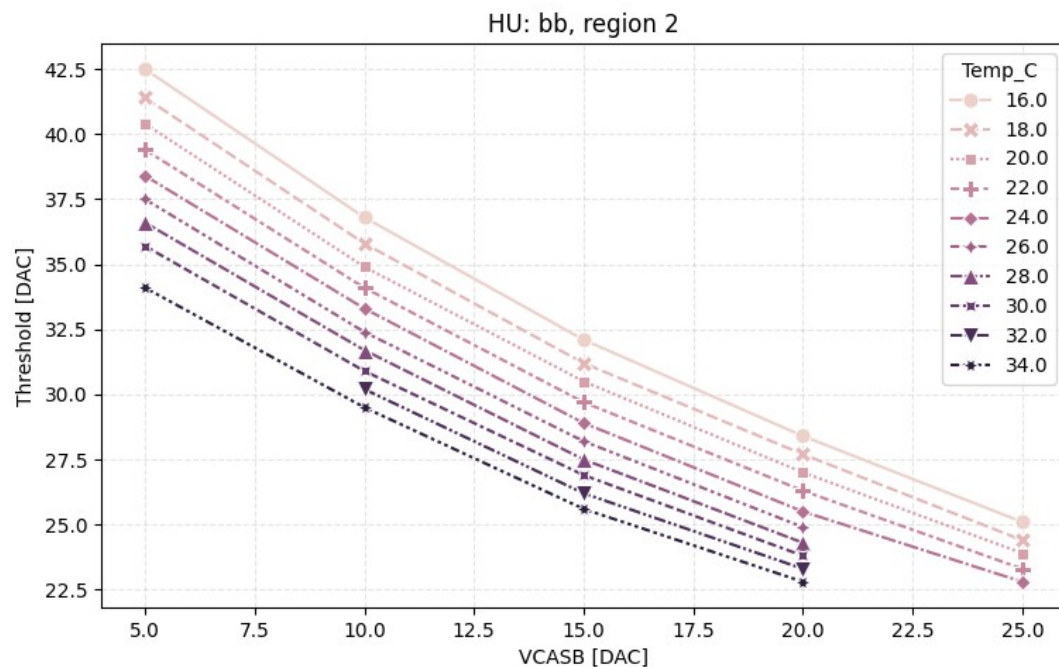
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Threshold scans

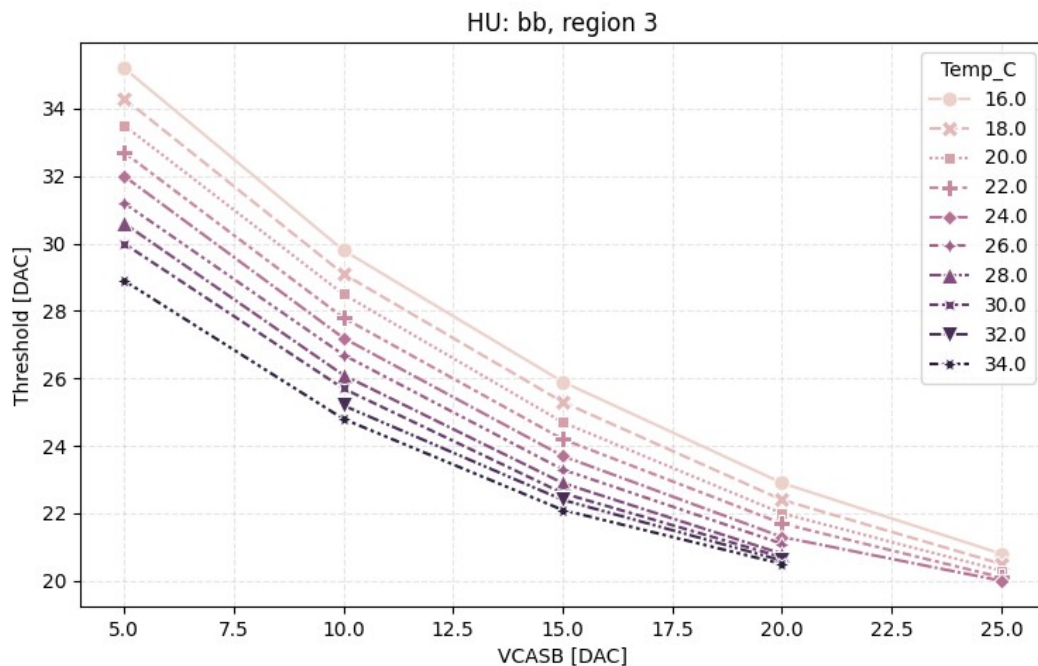


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Strobe length = 6 μs