The new Vertex project

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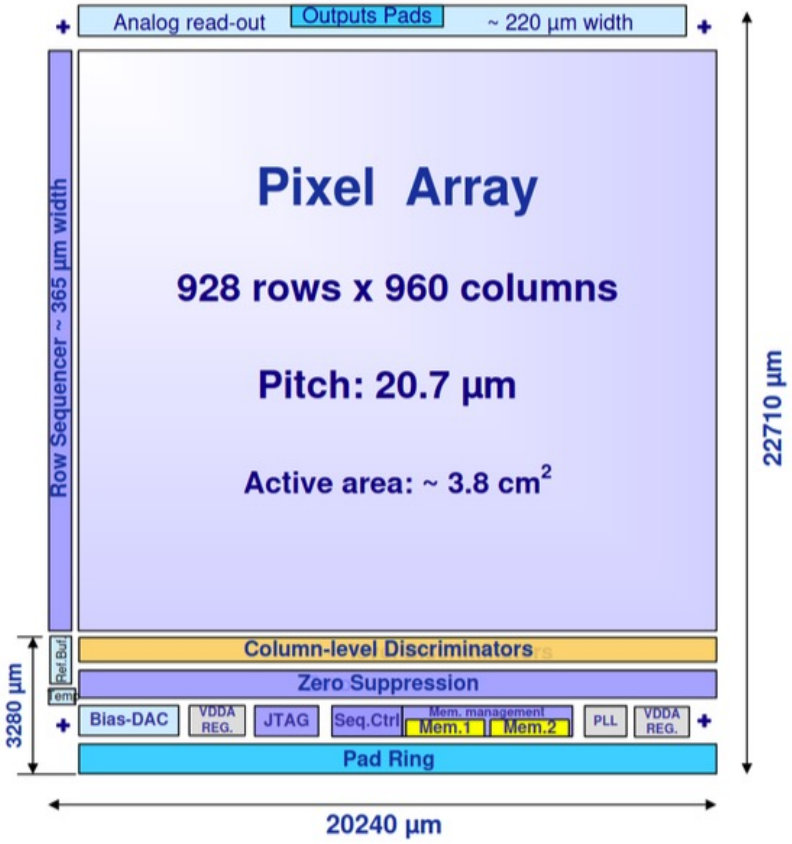
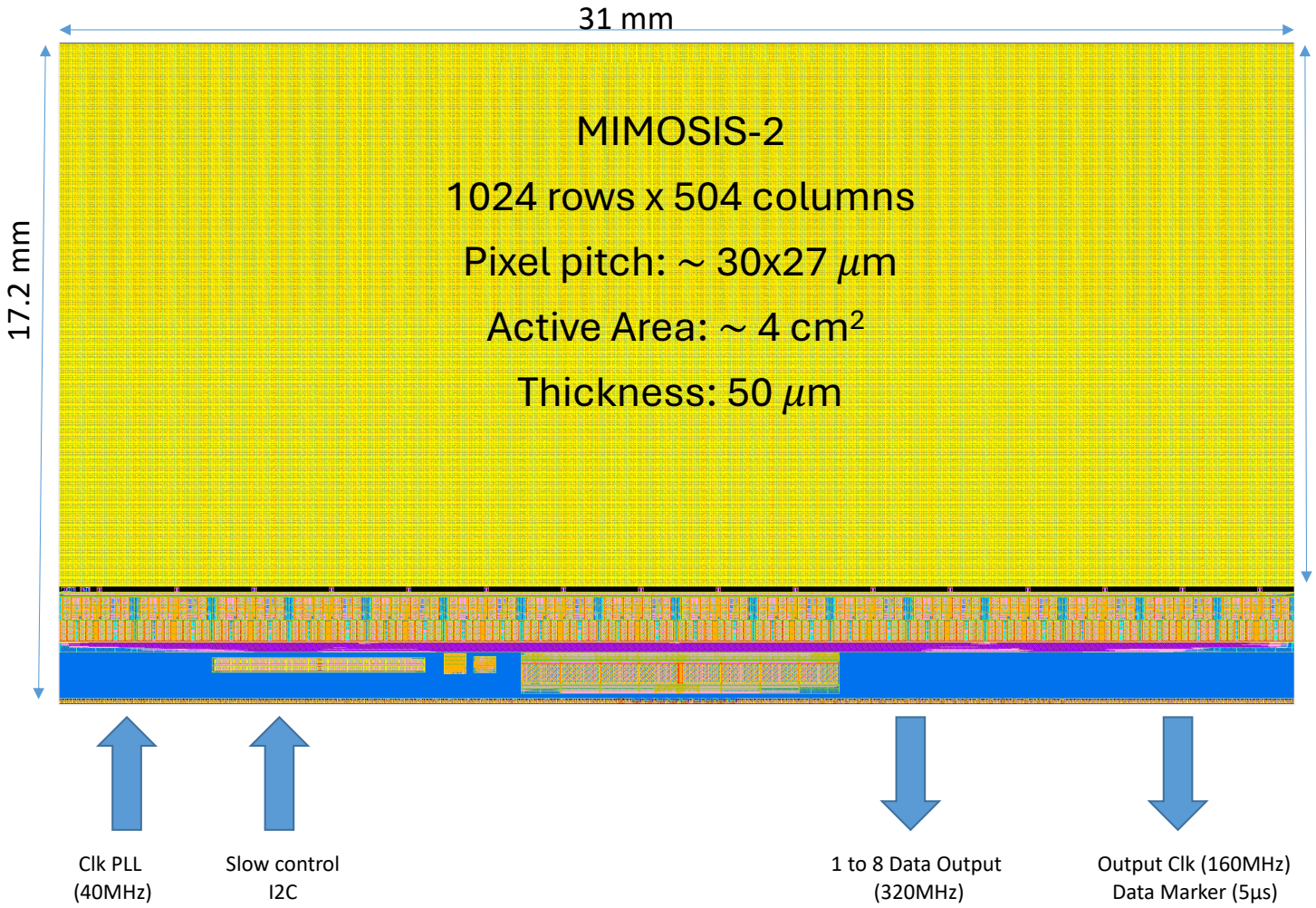
MAECI-MOFFIITS Meeting – 26-28 May 2025

Summary

- Overview of MIMOSIS-2 characteristics
- Tests on communication with the chip (I^2C and register settings)
- Tests on the data read-out and deserialization
- Tests with the full set-up and the radioactive source
- New Vertex design

MIMOSIS-28 VS MIMOSIS-2





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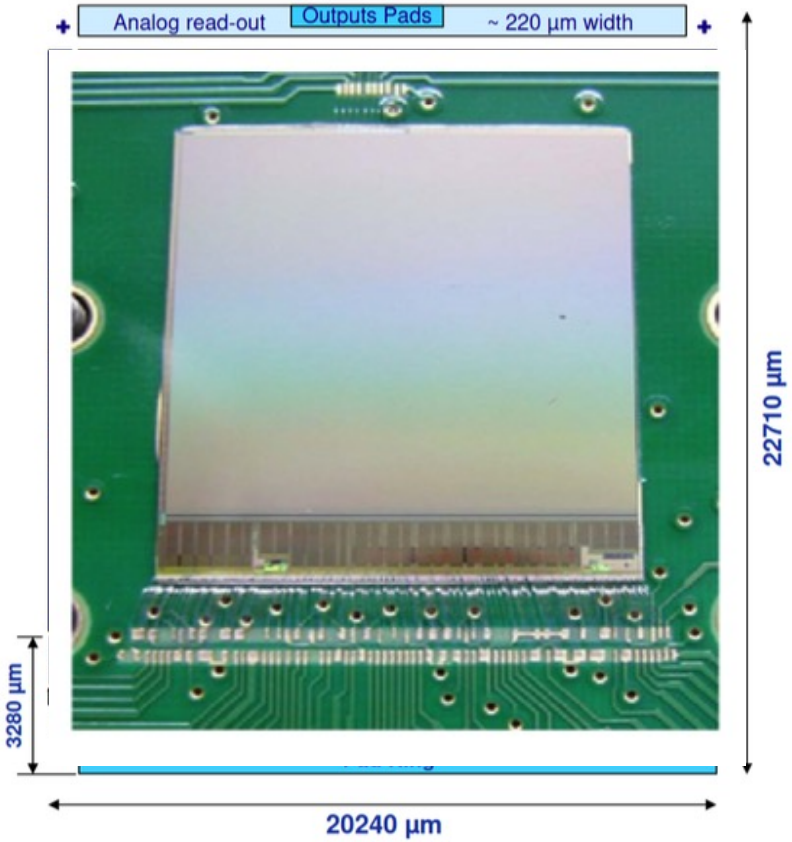
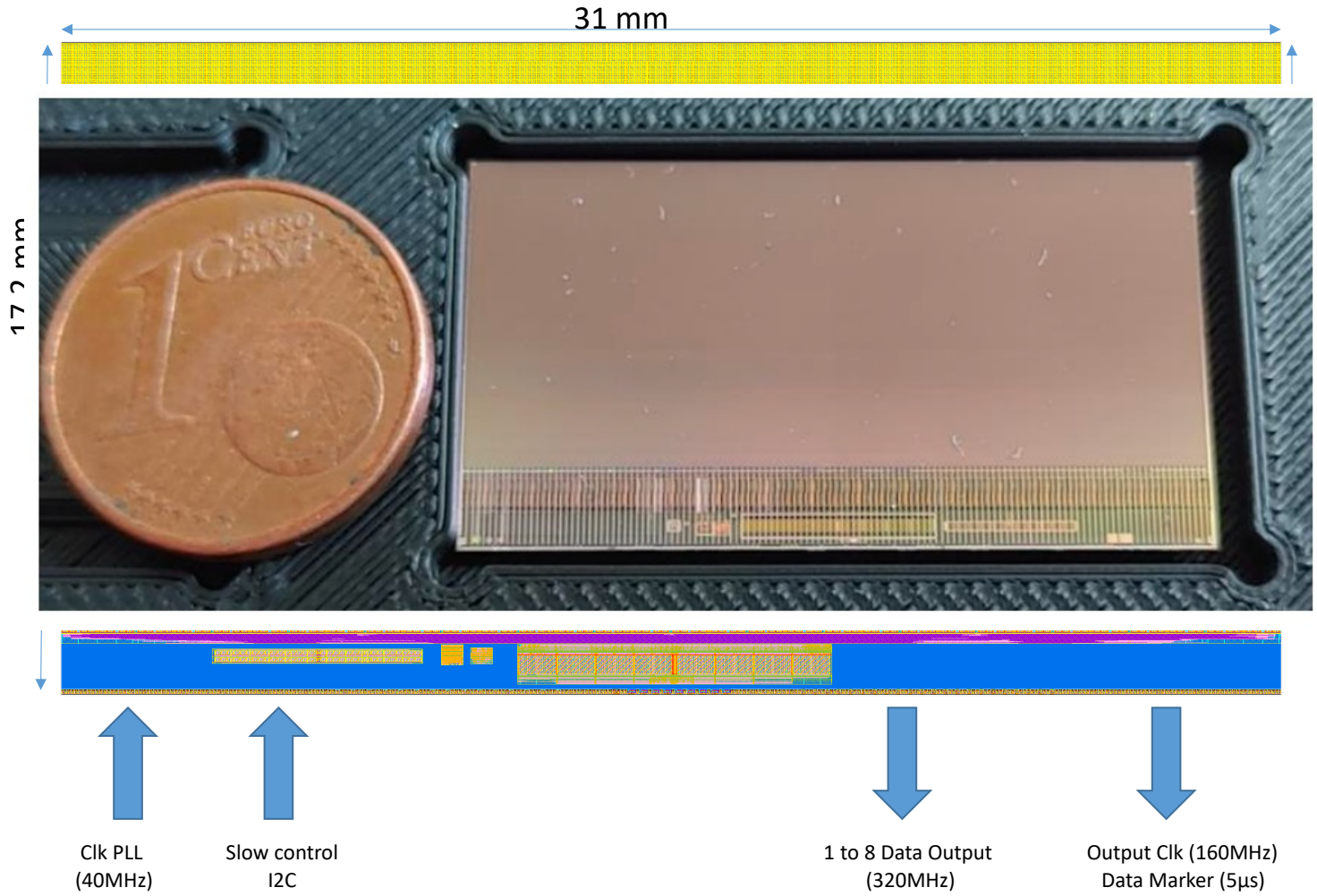
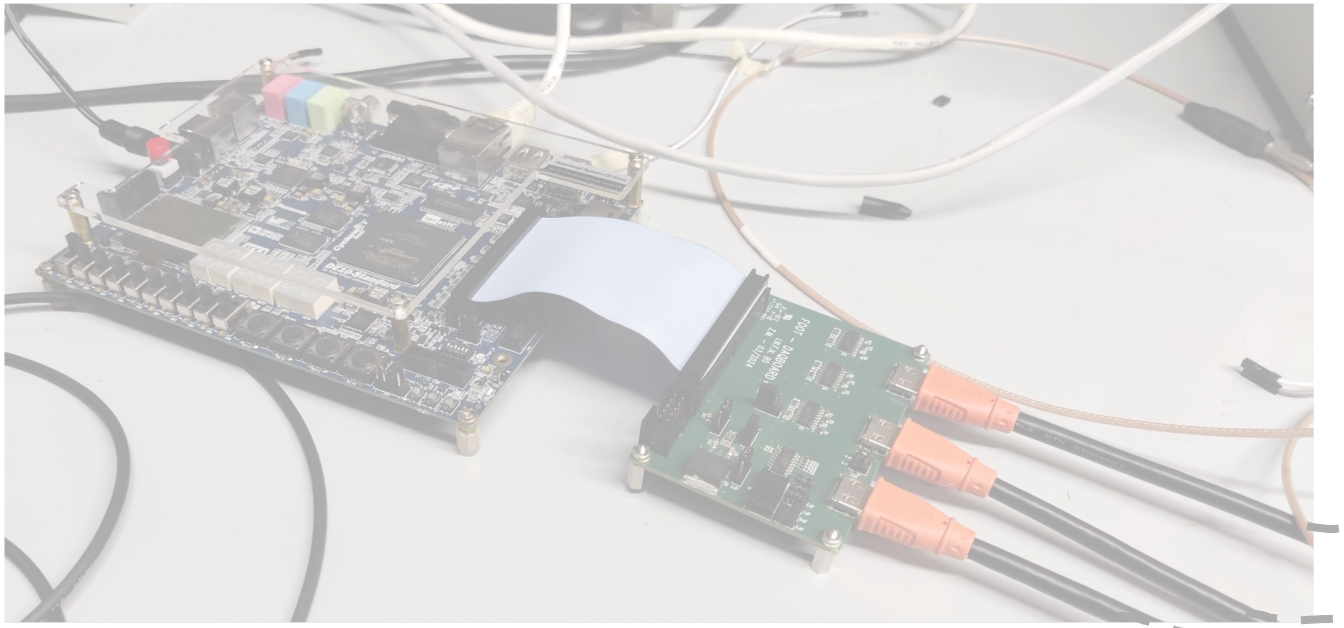


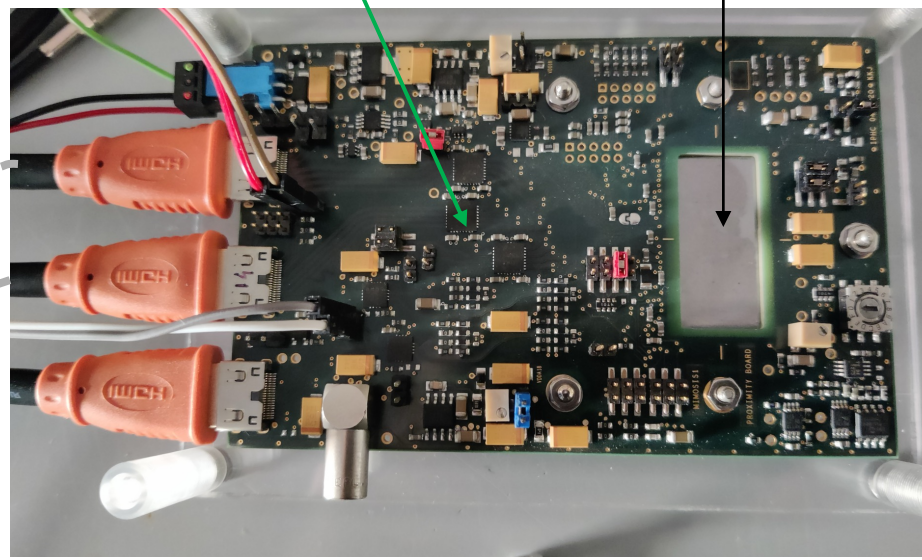


Time resolution:
185.6 μs ⟶ 5 μs

I^2C protocol

Experimental Setup

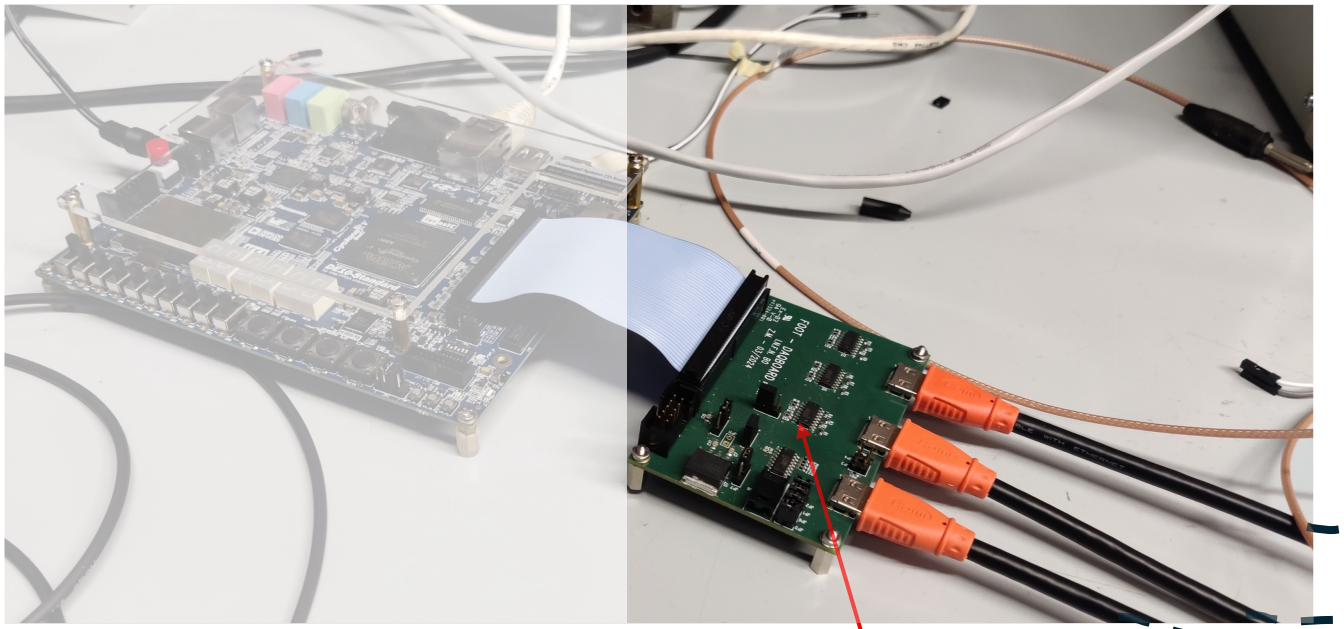




Power Supply:

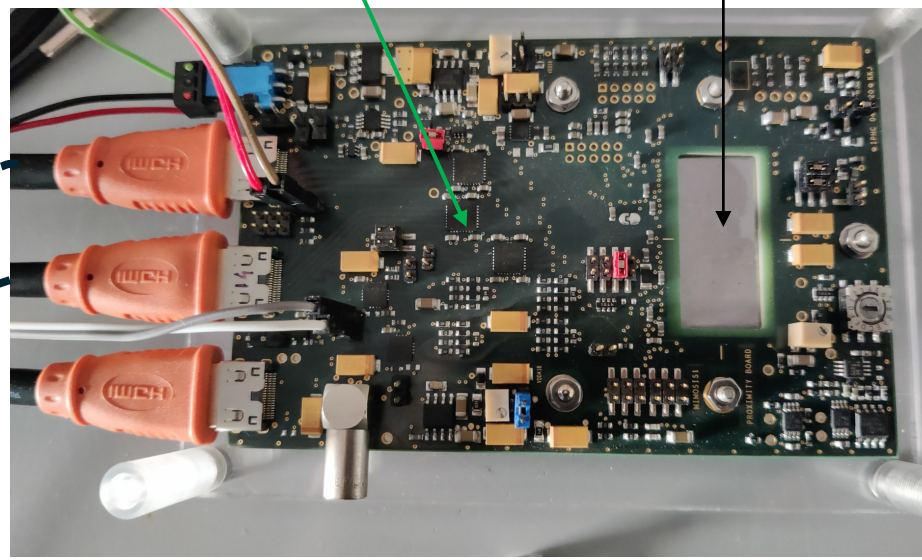
- Positive pin: +5 V
- Negative pin: 0 V (ground)

Experimental Setup



Proximity Board

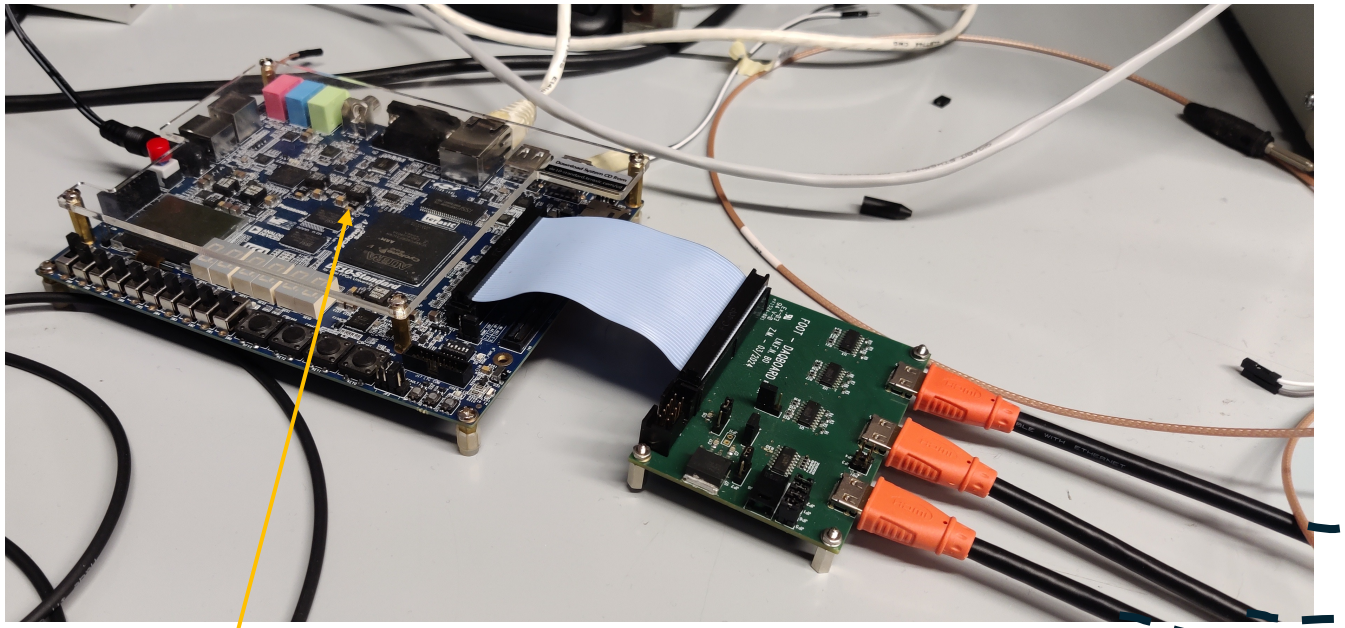
MIMOSIS



Conversion of LVDS signals to single-ended signals

DAQ Board ⟹ NEW version soon

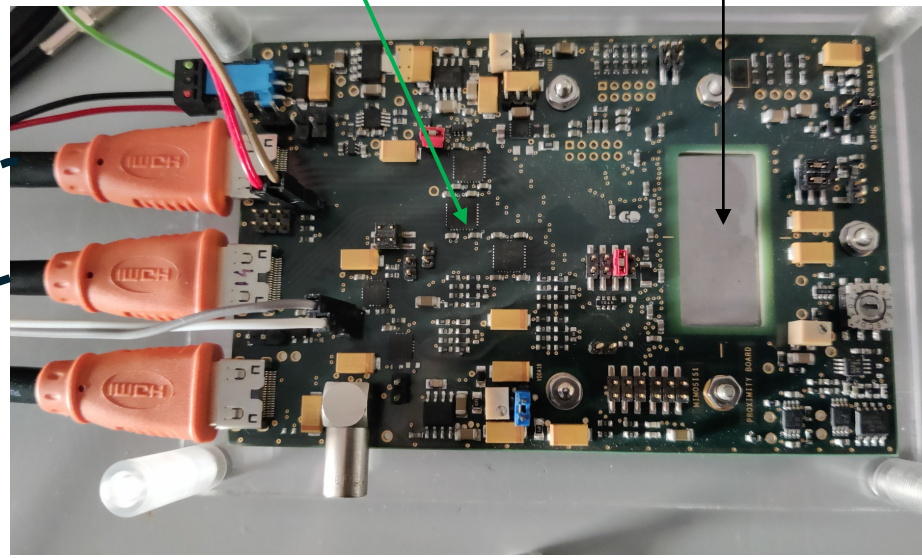
Experimental Setup



FPGA
(DE10STD)

Proximity Board

MIMOSIS

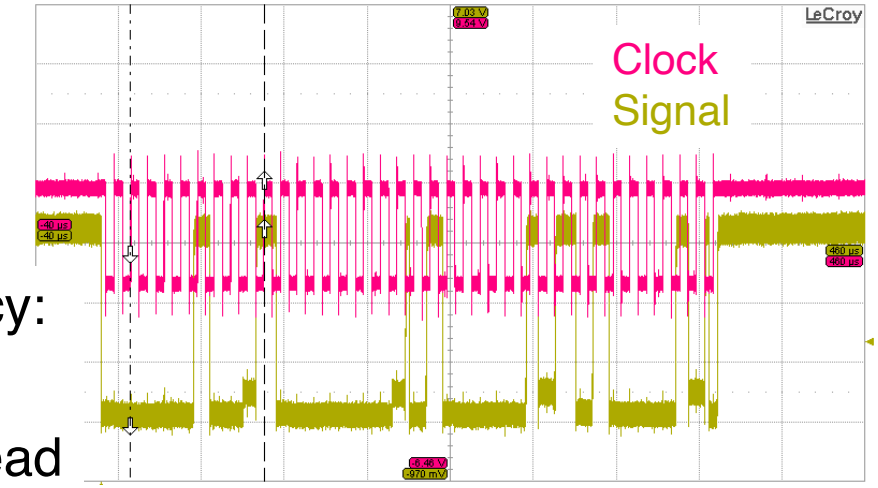


⟹ Final setup includes a DE10-Nano

Working Configuration

Registers to configure the chip are set through the **I²C** communication **protocol**

- Communication frequency: 400 kHz
- Many tests of register Read and Write operations.



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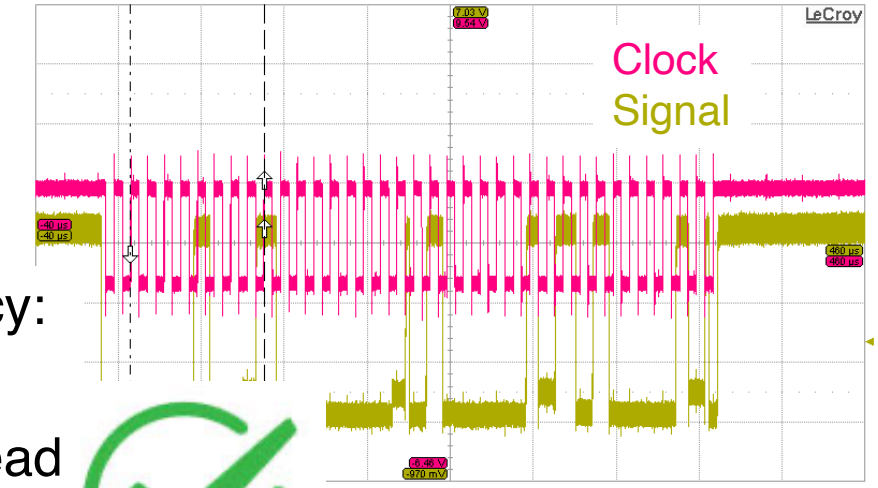

Working Configuration

2 Working **Configurations**

PLL mode	**Rescue Clock mode**
Clock @40 MHz given by the FPGA	Clock @40 MHz given by the FPGA
Clock @320 MHz (for data read out) generated by the internal PLL	Clock @320 MHz given by an external generator (injected through a jumper on the proximity board)
Default Configuration	Configurable through register 27
Configurable Gain and Threshold to lock the PLL (implemented an automatic scan)	
Clock generated by the PLL very noisy	

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Data Read-Out

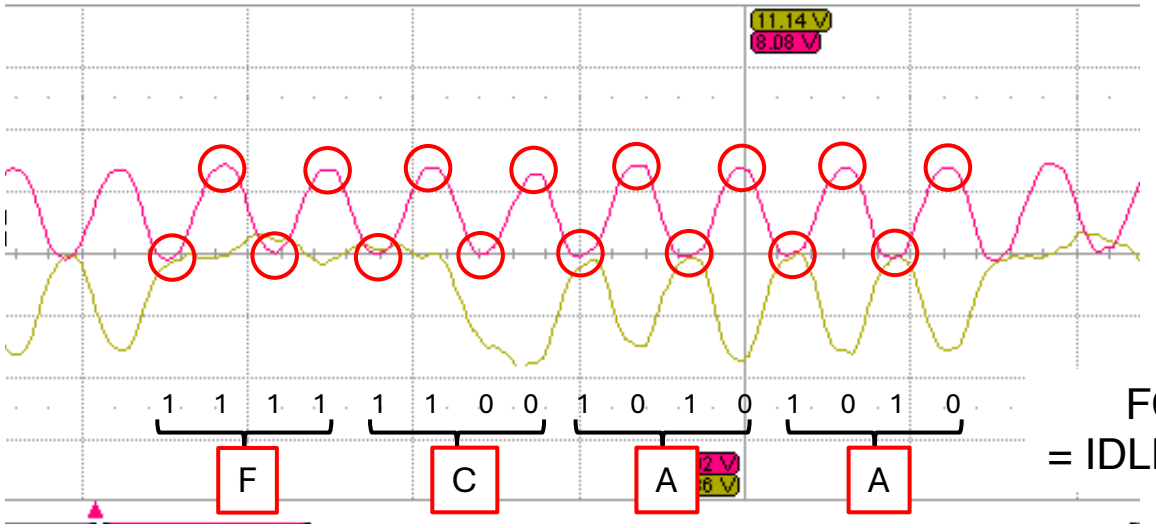
Data read-out

- Clock-out @160 MHz
  - ⟶ Data on the rising and falling edge
    - ⟶Data read-out @320 MHz
- 8 Data read out lines (DOUT)
- **128 bits words**
  - ⟶ 1 word/400 ns [1 lines]
  - ⟶ 1 word/100 ns [4 lines]
- Trigger ⟶ saved the frames arrived in the settable window [-Δt, +Δt']

1, 2, 4, 8 DOUTs:

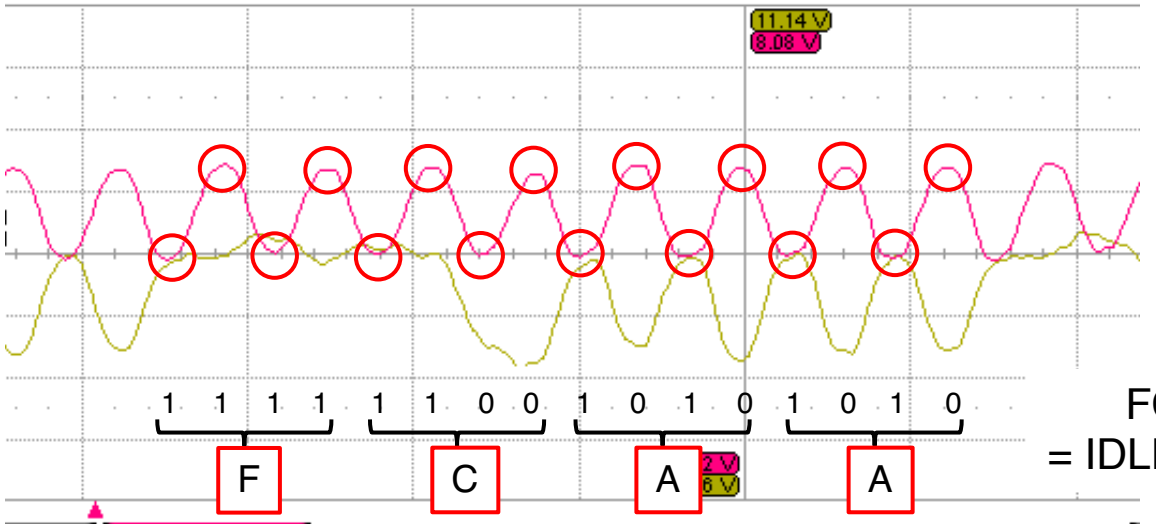
- 1 and 2 lines: widely tested 
- 4 lines: tested, but output signals become very noisy
- 8 lines: never tested, odd lines seem broken

Deserializer



FCAA
= IDLE WORD

Deserializer



FCAA
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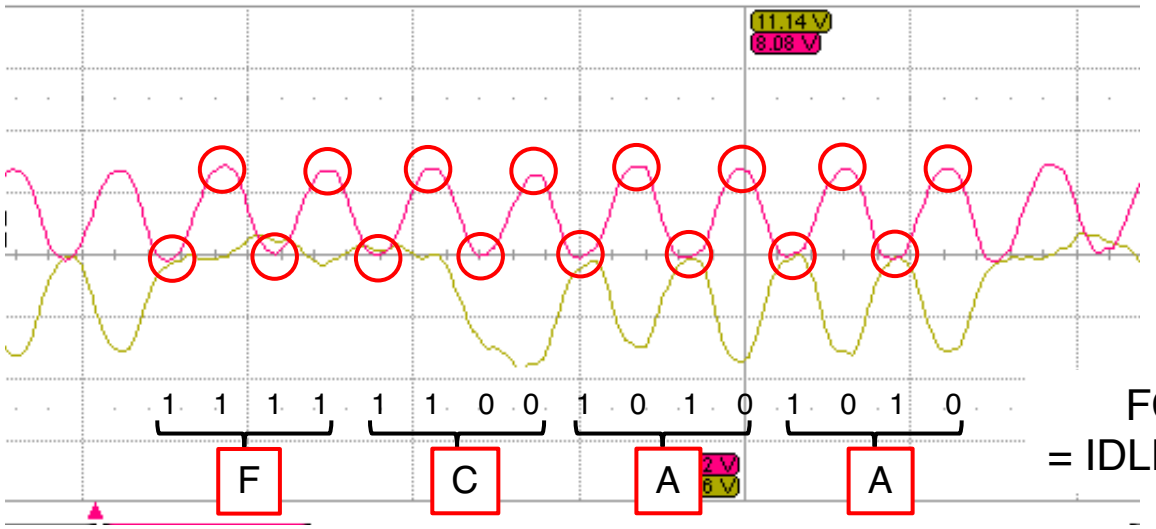
- Alignment between the clock and the data
  ⟶ PHASE
- (more than 1 DOUT) Build the word correctly

Deserializer



FCAA
= IDLE WORD

```
122    fcaafcaafcaafcaafcaafcaafcaafcaa
123    fcaafcaafcaafcaafcaafcaafcaafcaa
124    fe00fe00fe00fe00fe00fe9ffe7efee0
125    fcaafcaafcaafcaafcaafcaa7075ff00
126    fcaafcaafcaafcaafcaafcaafcaafcaa
```

```
134    fcaafcaafcaafcaafcaafcaafcaafcaa
135    fcaafcaafcaafcaafcaafcaafcaafcaa
136    fe00fe00fe00fe00fe00fe9ffe7efee1
137    fcaafcaafcaafcaafcaafcaa7070ff00
138    fcaafcaafcaafcaafcaafcaafcaafcaa
139    fcaafcaafcaafcaafcaafcaafcaafcaa
140    fcaafcaafcaafcaafcaafcaafcaafcaa
```

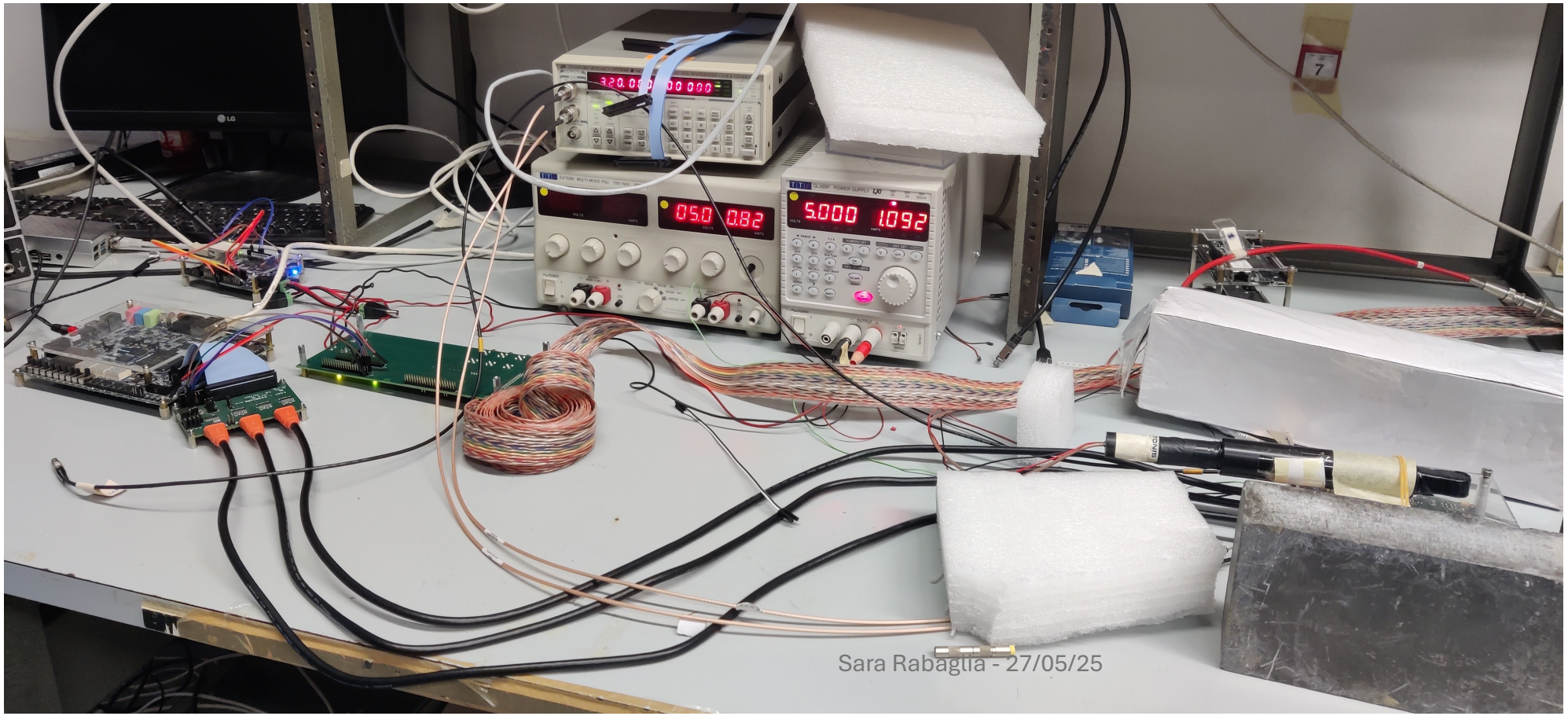
Data stream:

- Idle words
- Frames:
  - Header (yellow)
  - Frame counter (green)
  - Trail (pink)
  - Hits (FDXX)

NEW Experimental Setup

Radioactive Source: ^{207}Bi [105 kBq, β-]

External Trigger: scintillator + PMT



Threshold Scan

- Random Trigger
- NO radioactive source
- Possible value for the threshold: 0 – 1.5 V, step 6 mV (0 to 255)
- ~2000 events (arrived trigger) per threshold value
- 4 sub-matrices

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- Fit with a Sigmoid function to find the Pedestal (P) and the Sigma (σ):

$$S = 0.5 \cdot (\tanh\left(\frac{(x-P)}{\sigma}\right) + 1)$$

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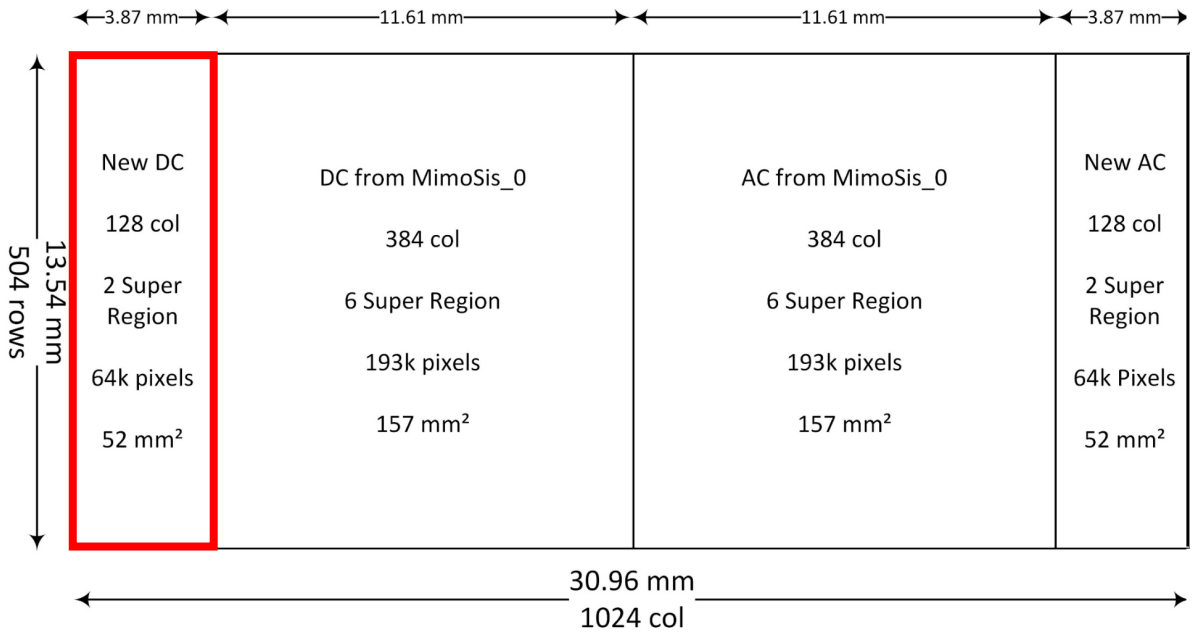

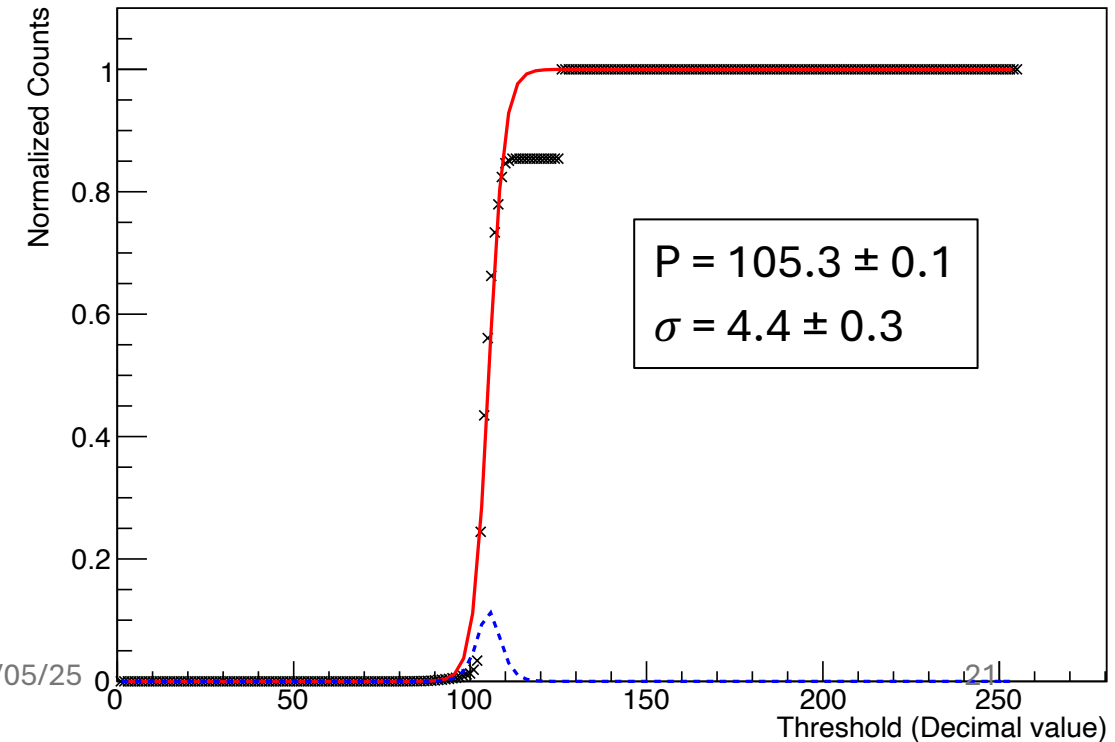

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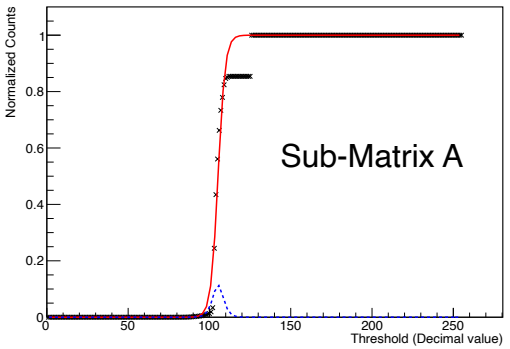

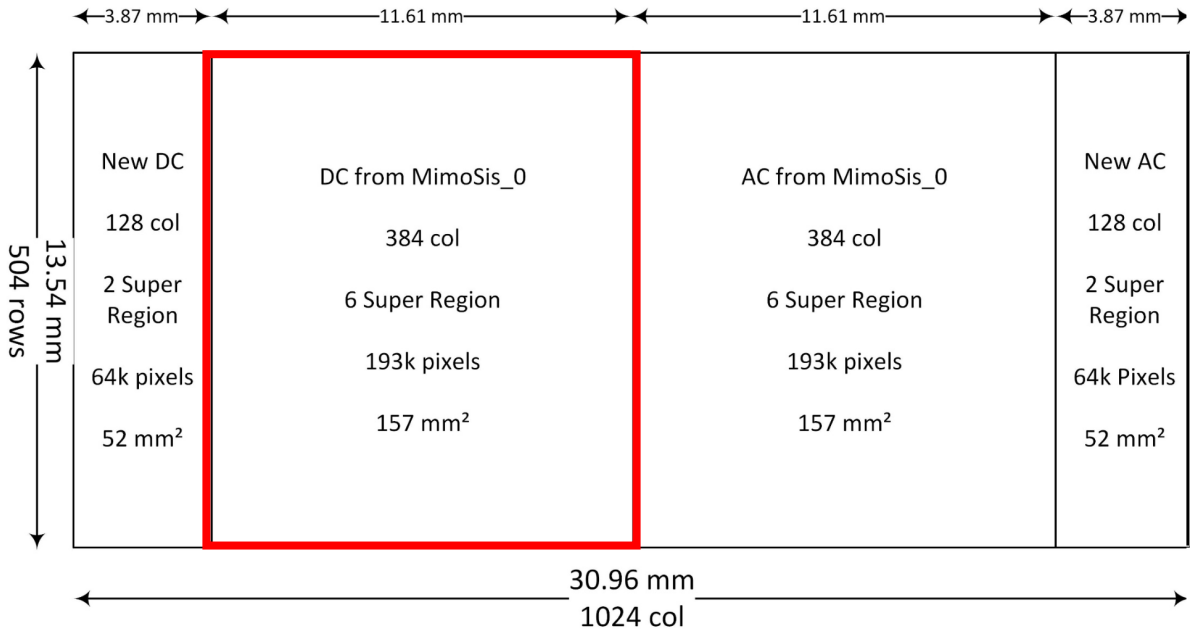

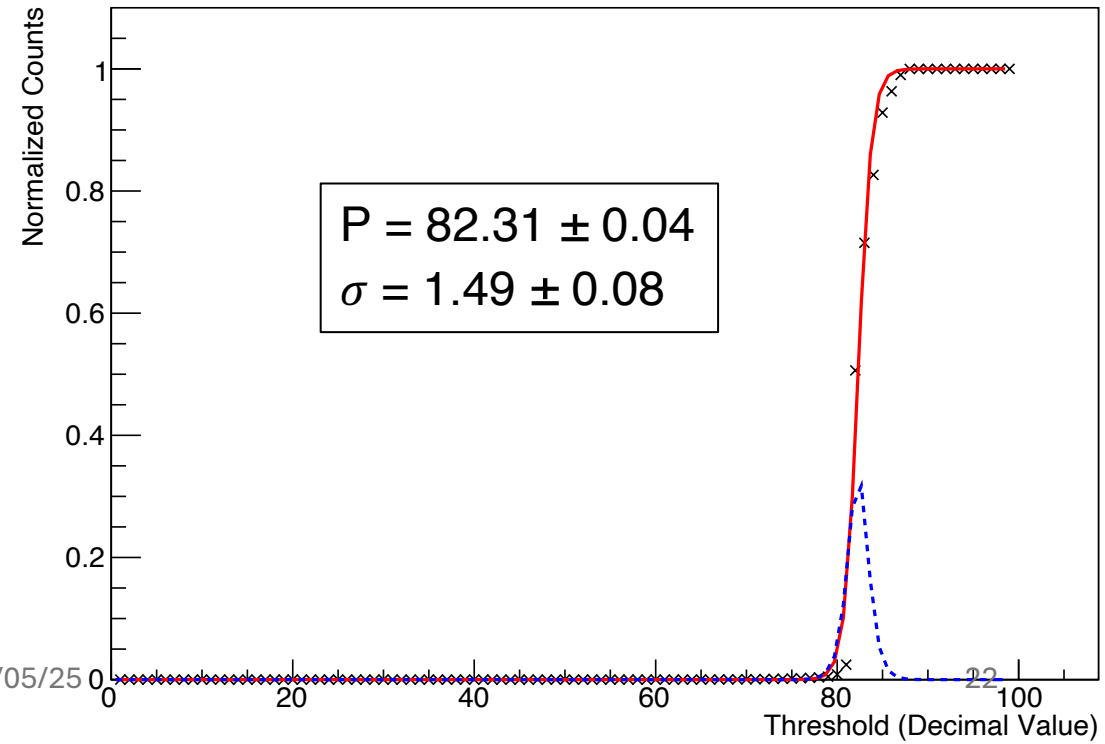

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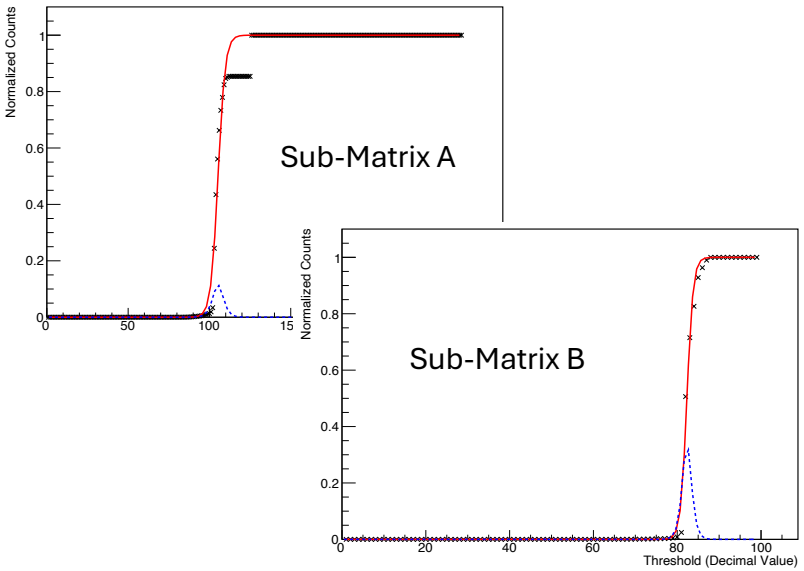

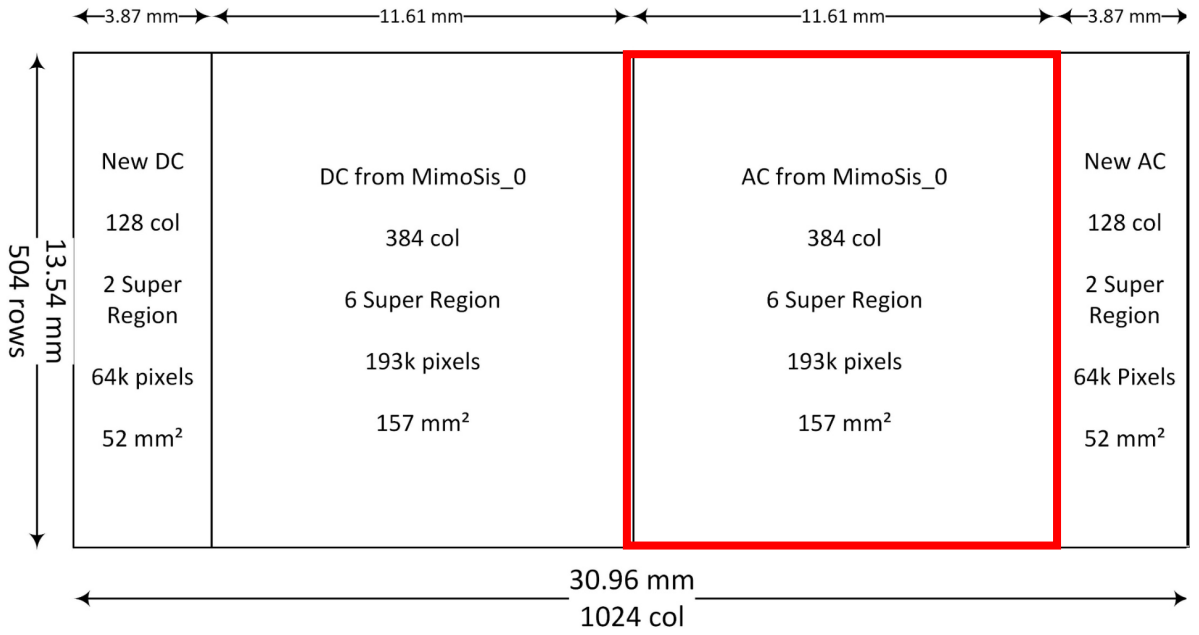

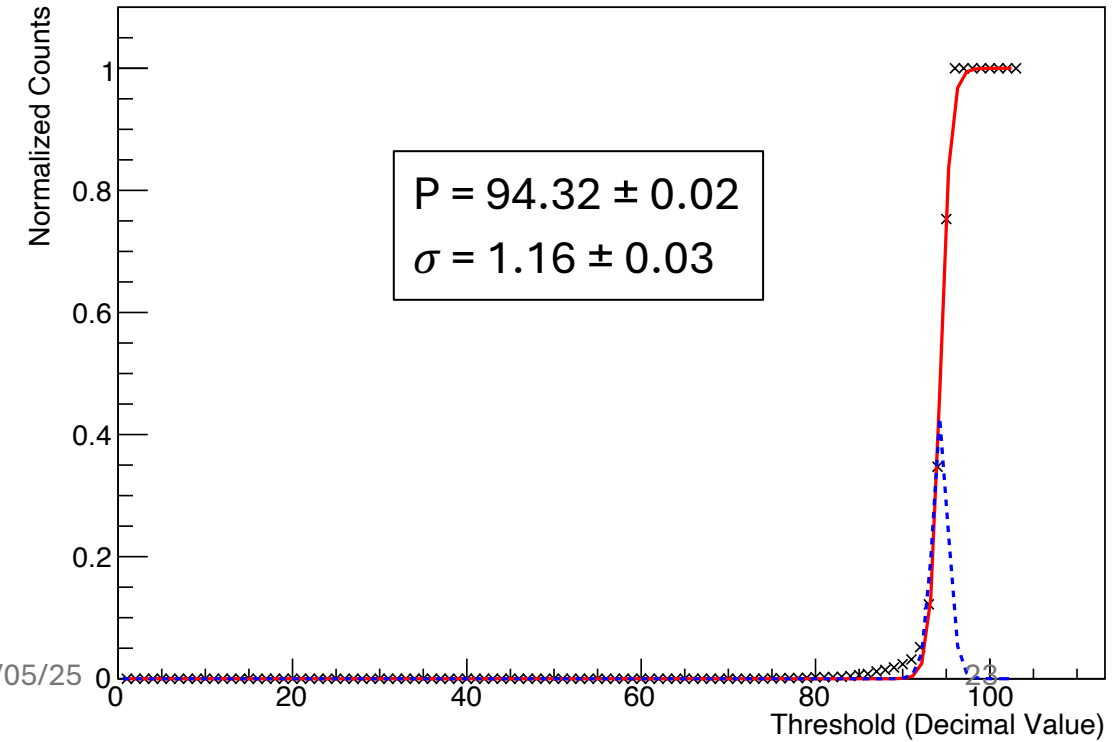

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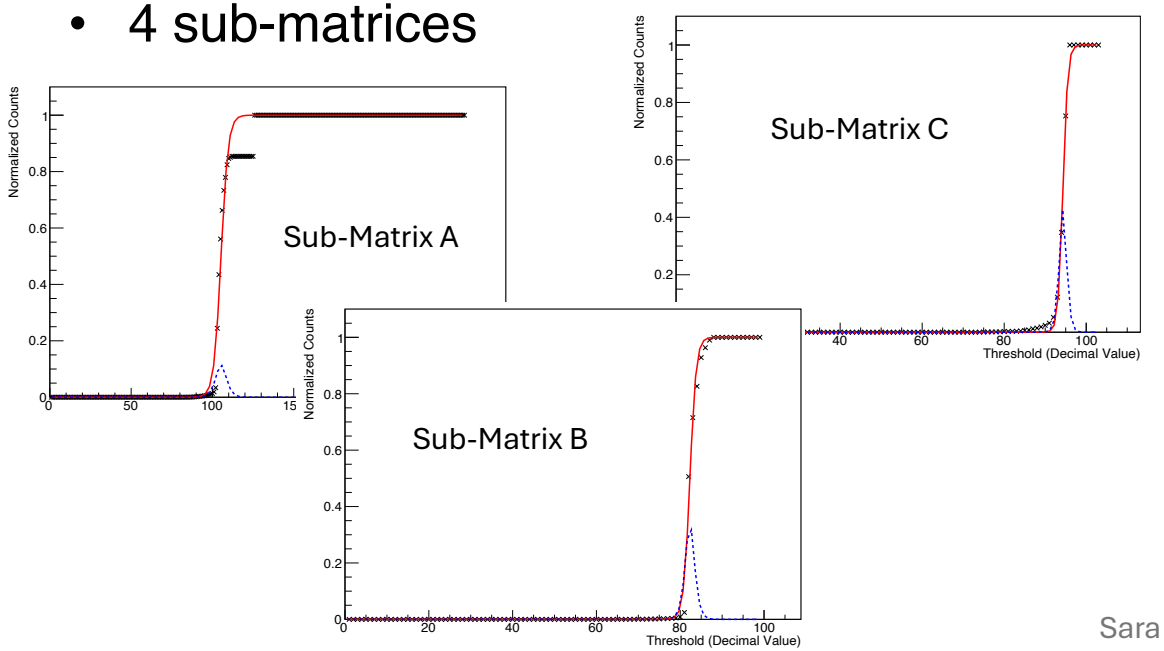
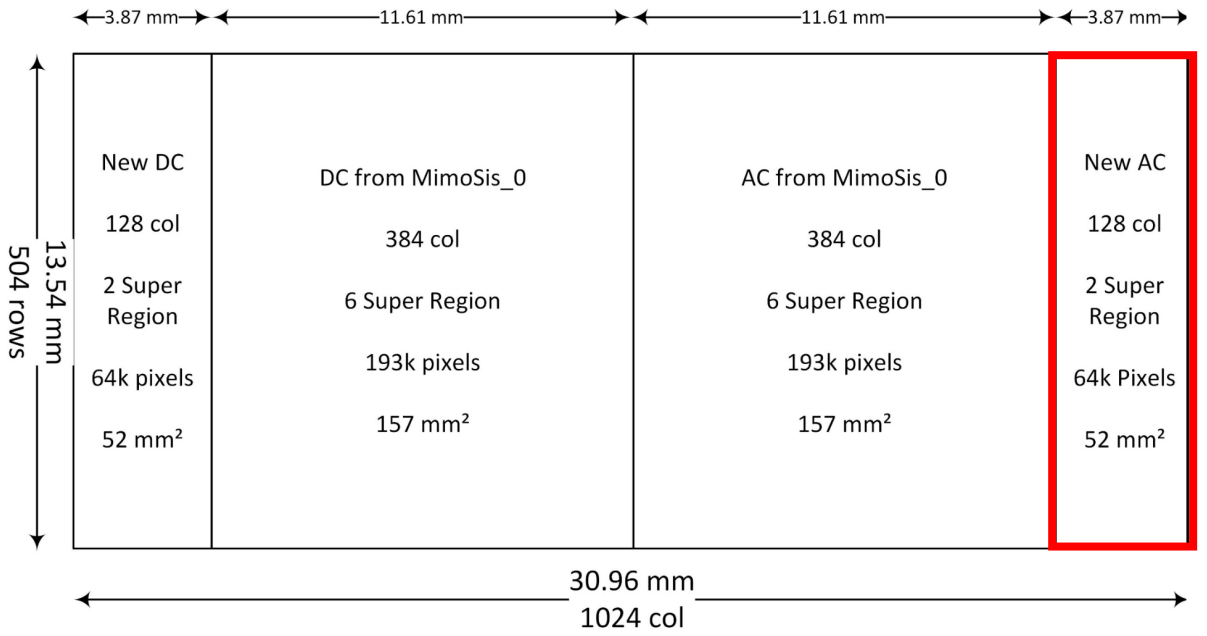
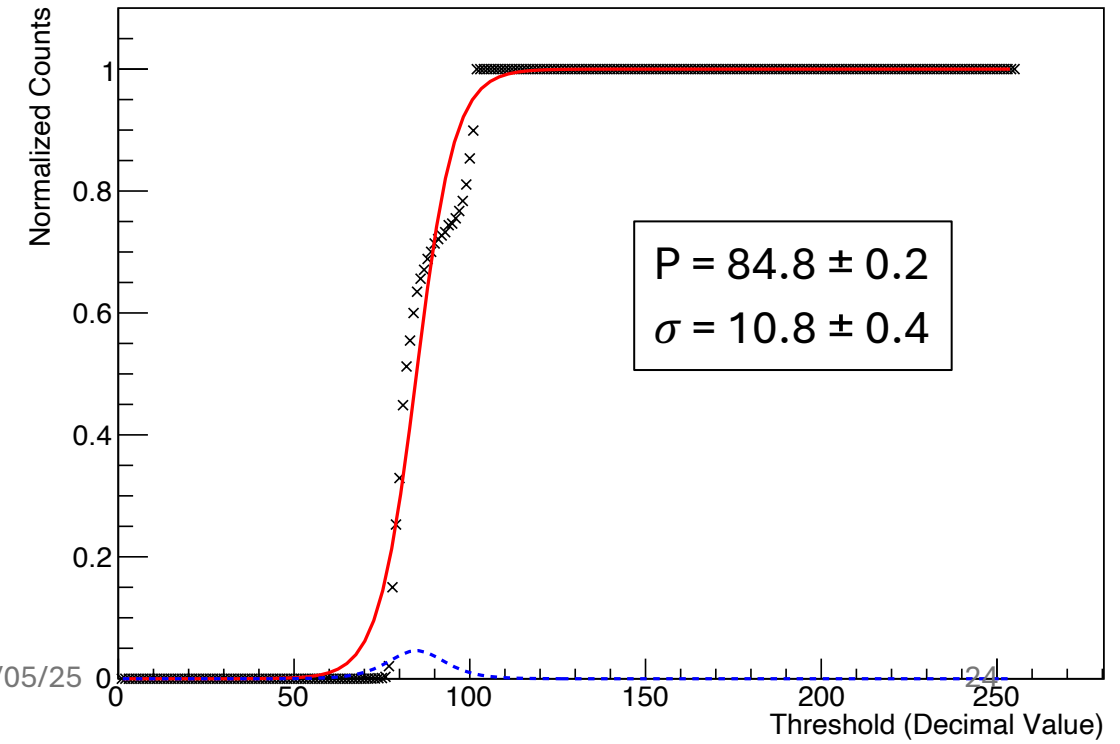
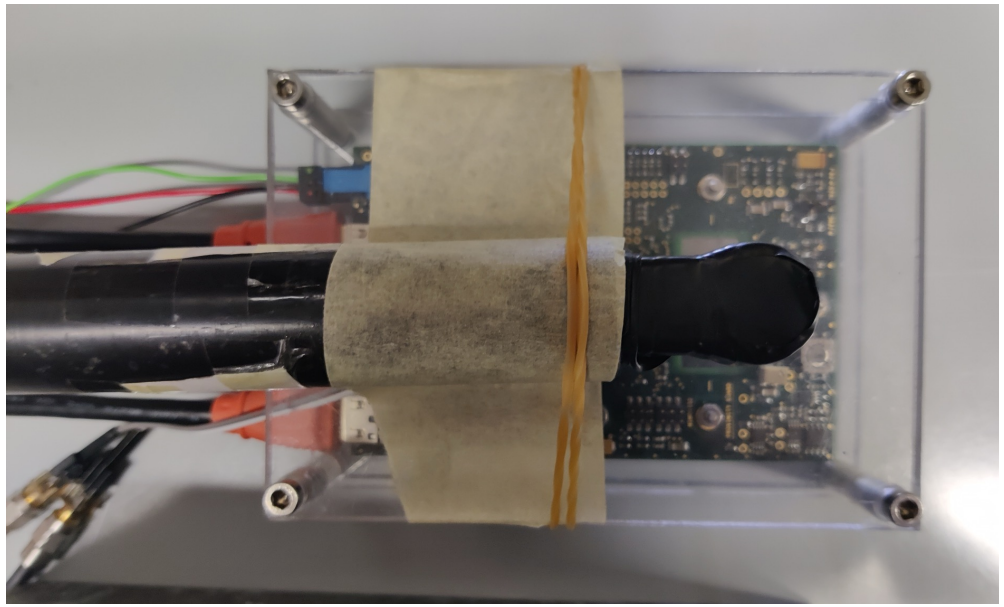


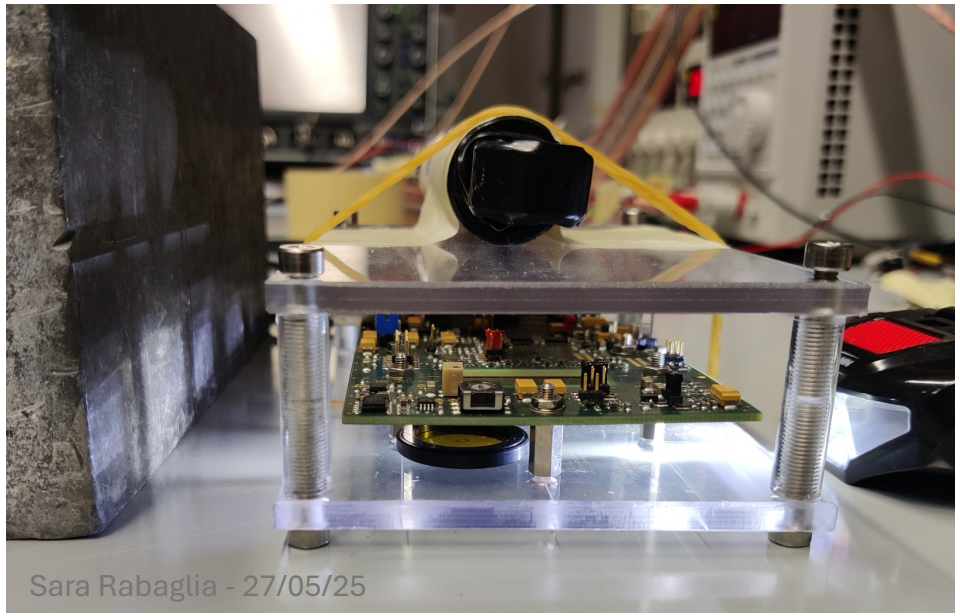




Data collection with radioactive Source

Few runs over the night:





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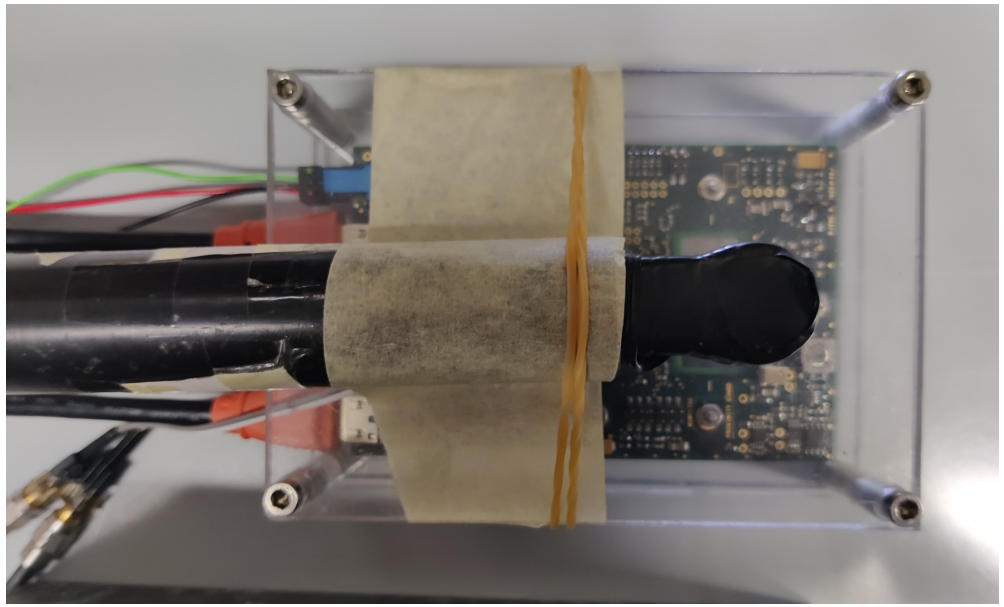
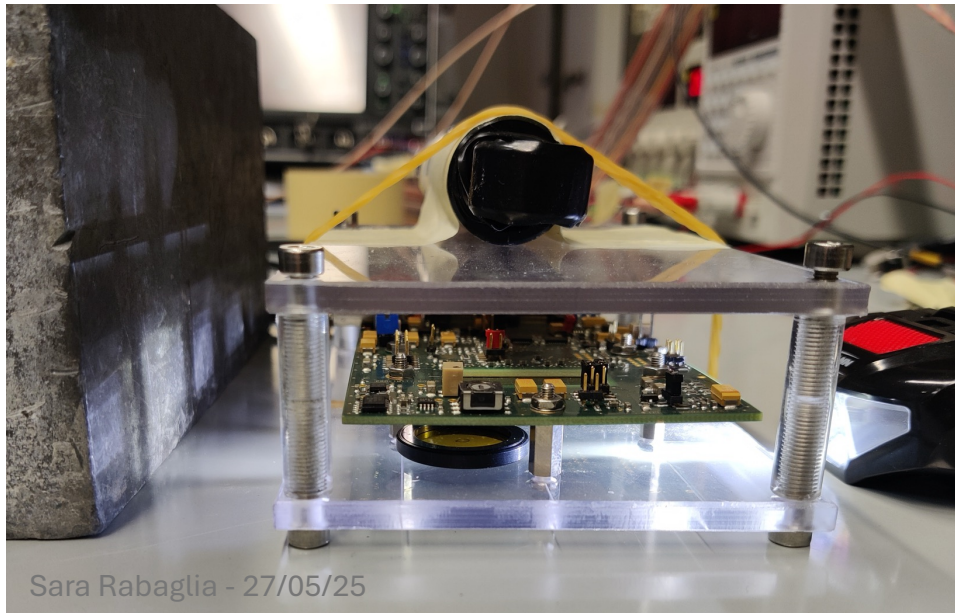
Few runs over the night:

⟶ Good stability (no errors occur)





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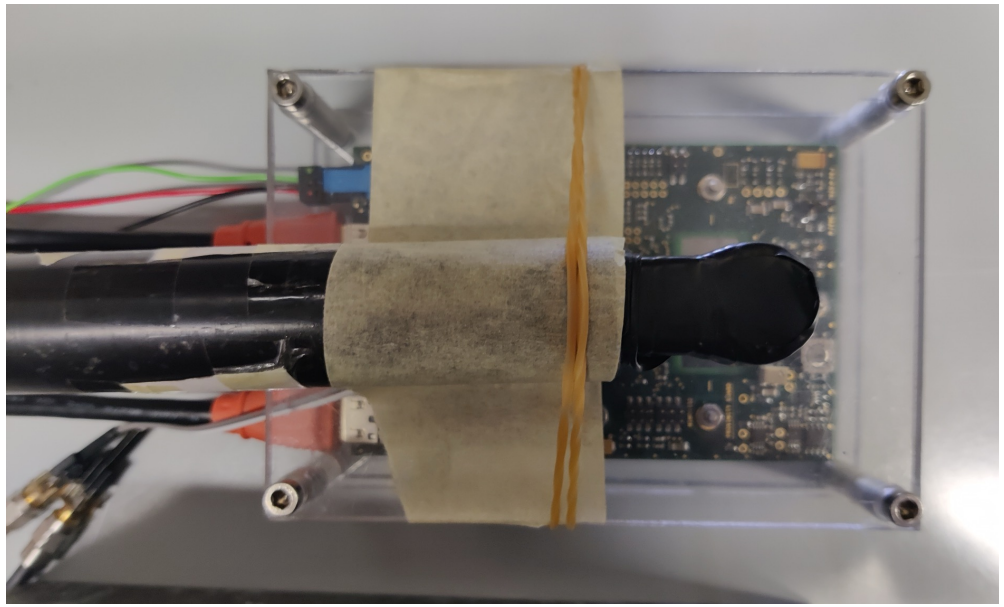

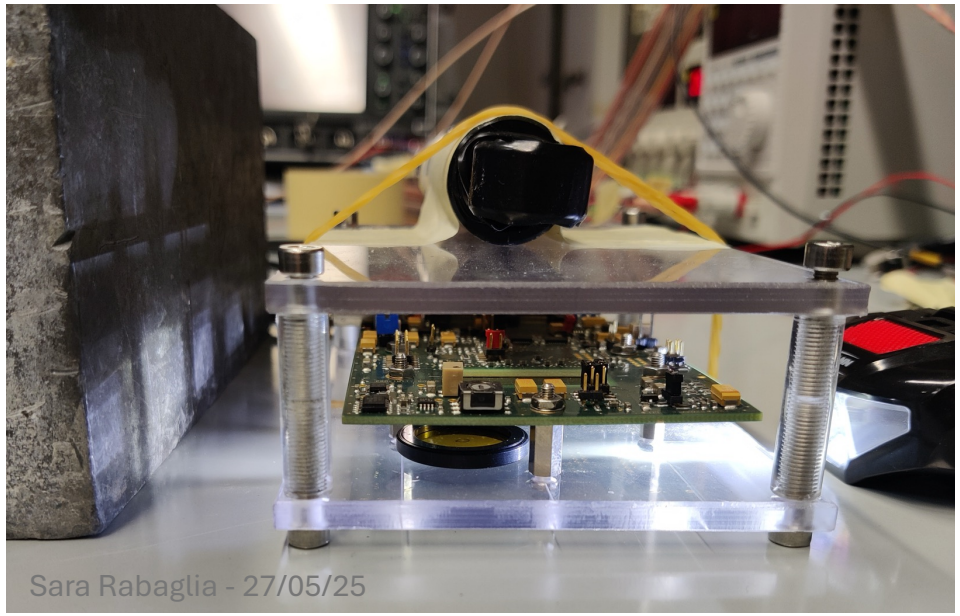

Data collection with radioactive Source

Few runs over the night:

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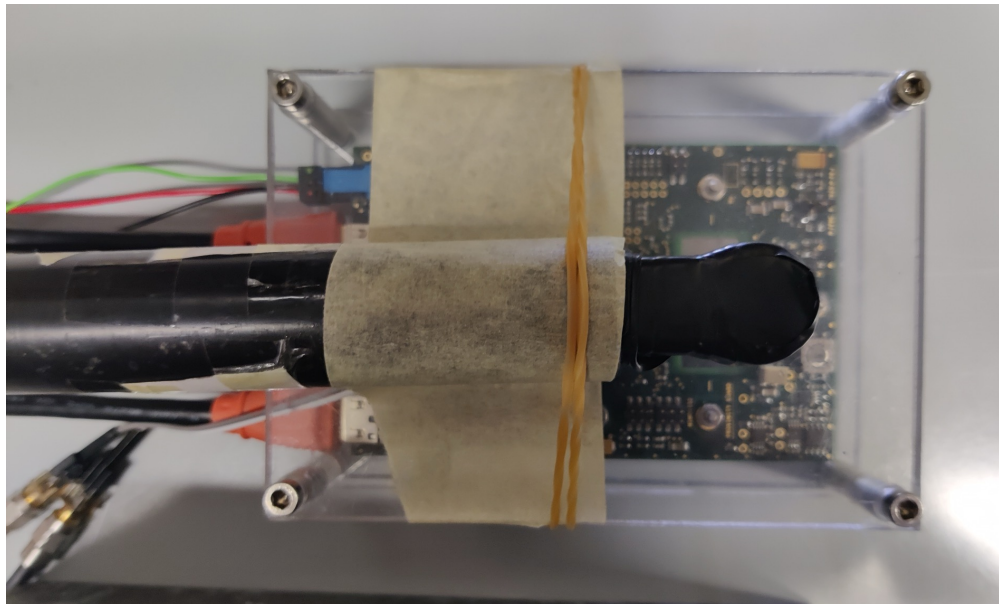
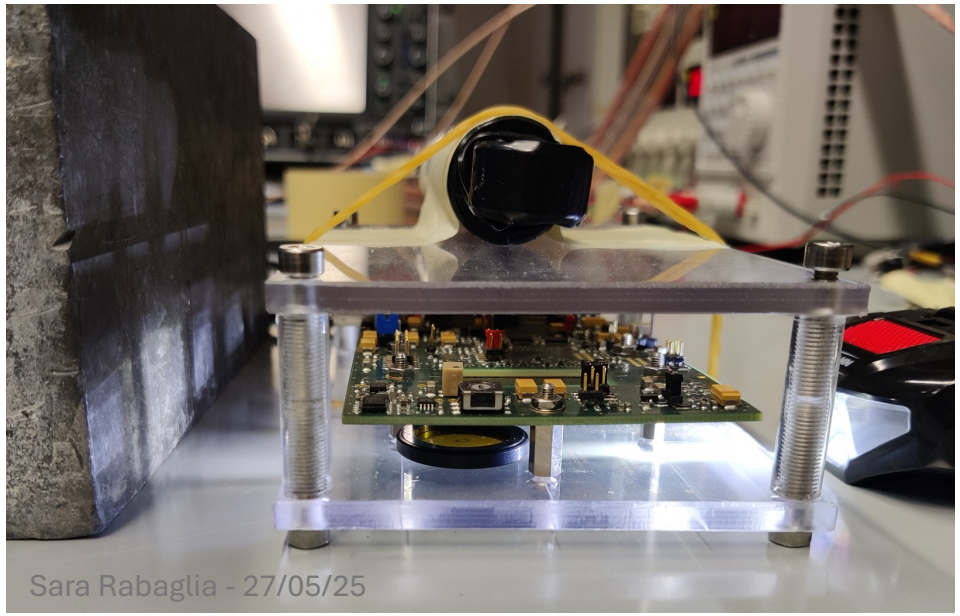
⟶ Analysis of the results: COMING SOON!





New Vertex

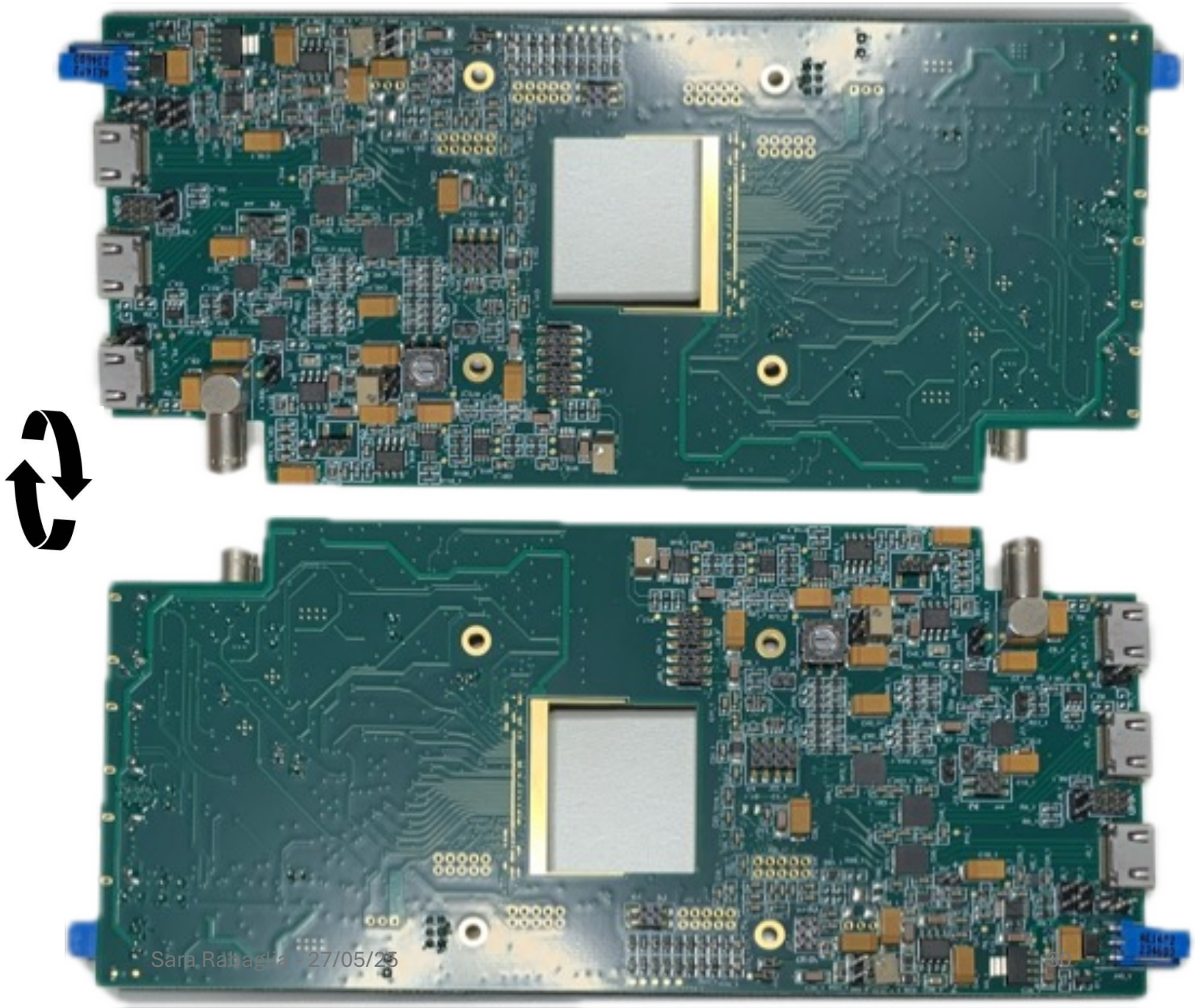
Proximity Board

2 MIMOSIS-2 chips per each proximity board

4 Proximity boards

2 DAQ board per proximity board (tot = 8)

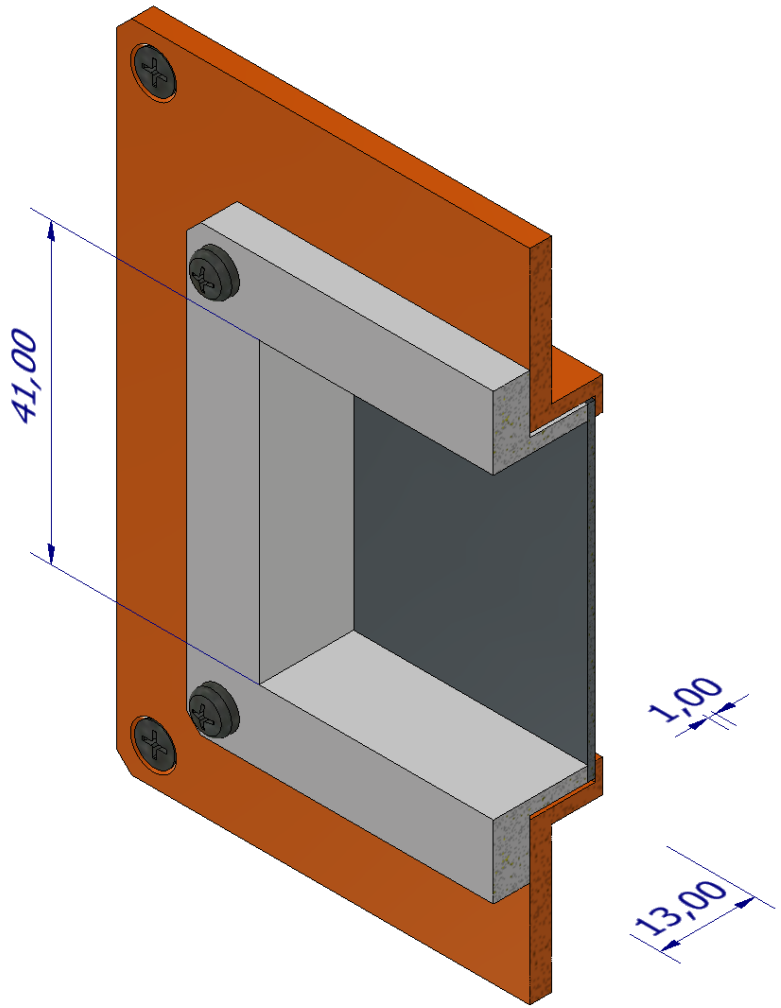
1 DE10-nano per proximity board (tot = 4)

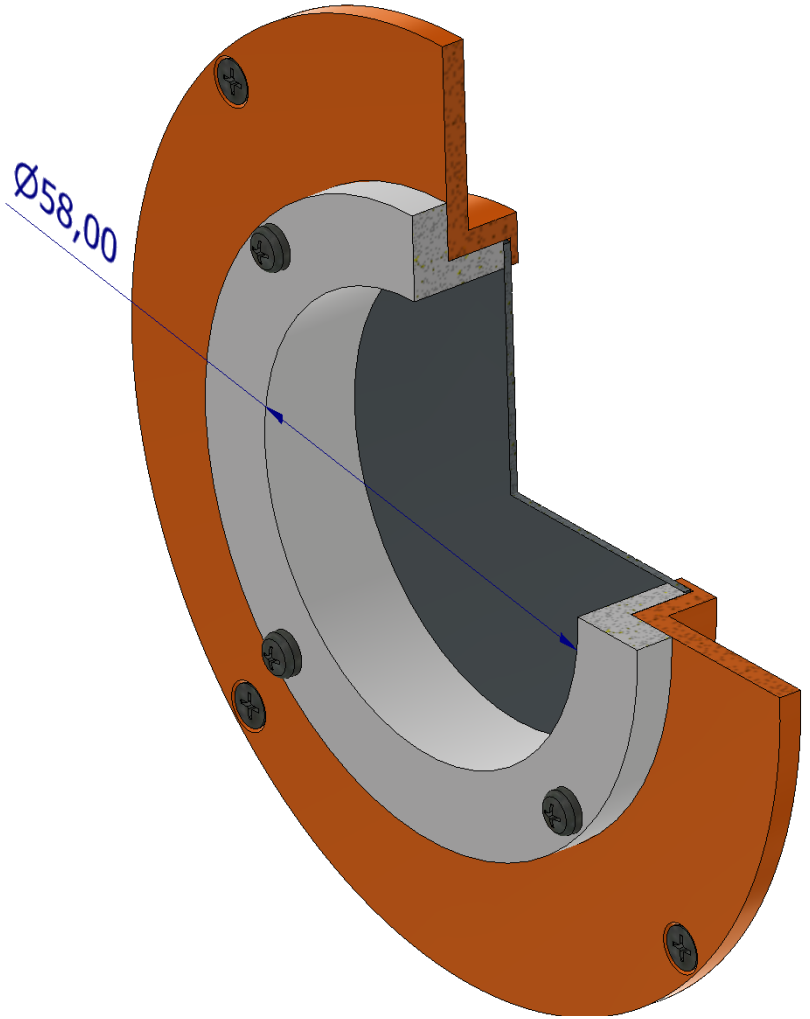


Target Holder: Conceptual Design

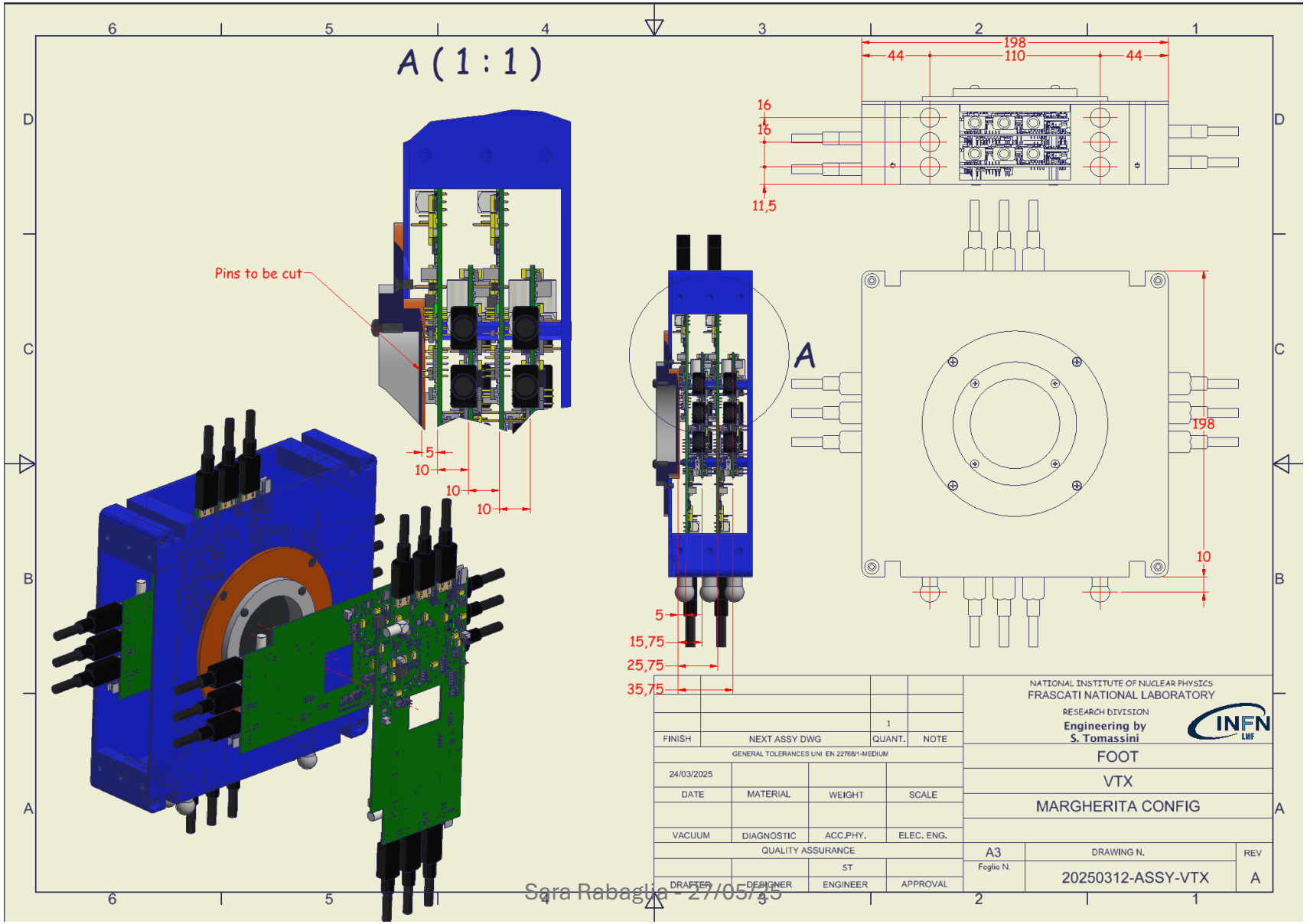
Conceptual target holder can be especially designed for specific target

⟹ 3D printer

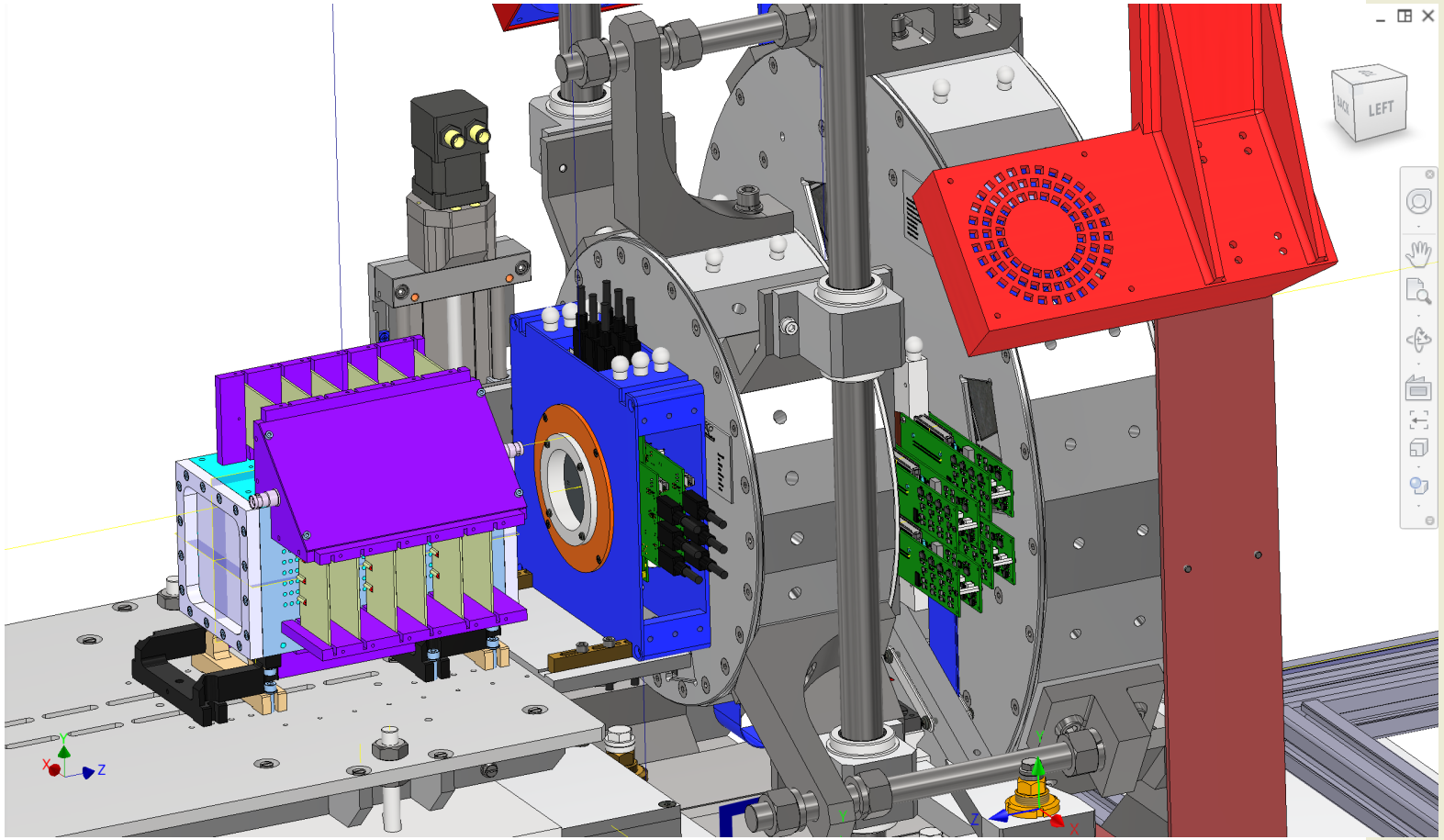


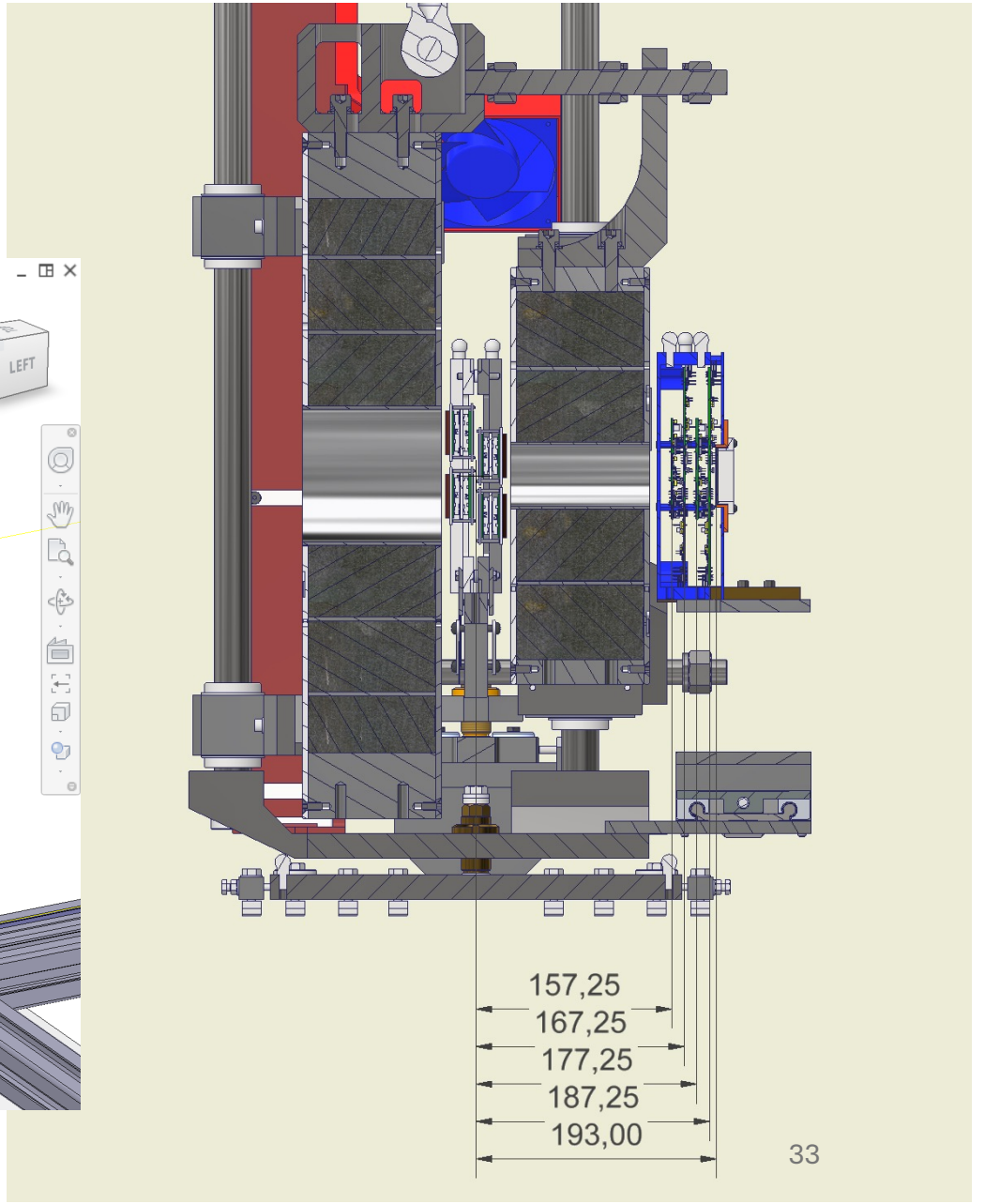


Target Holder: Board disposition



New Vertex details





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- Tests with the full set-up and the radioactive source → Automatic threshold scan and run over the night
- New Vertex design → Sketch of the future design

Thank for the attention

Bologna FOOT Group