



# Development of low energy calorimeter modules

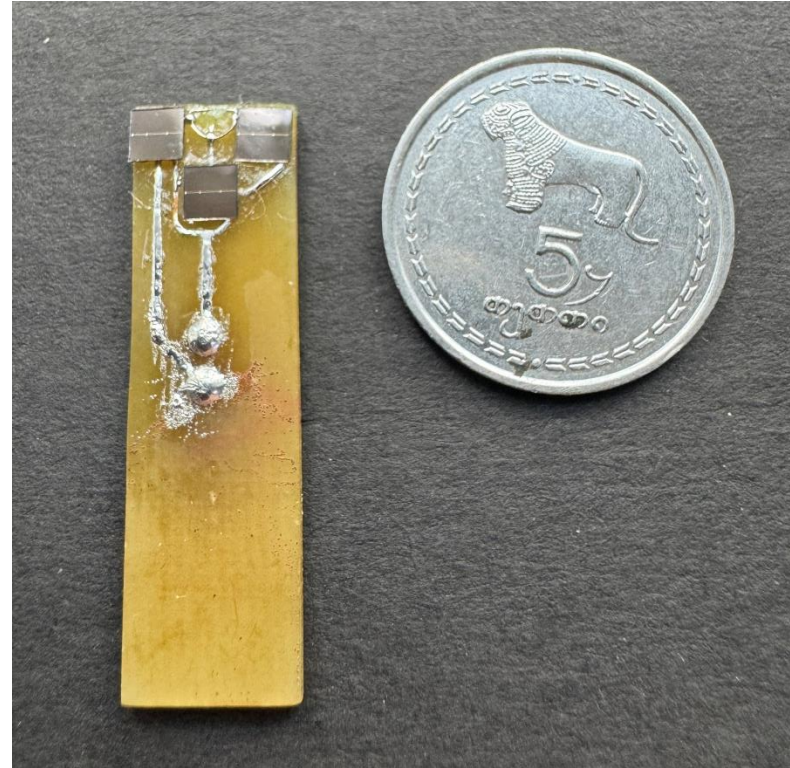
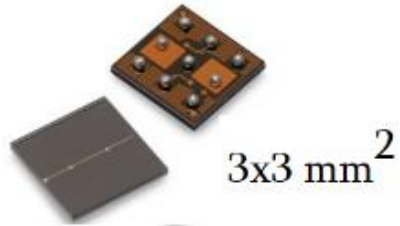
David Mchedlishvili

HEPI/SMART|EDM\_lab

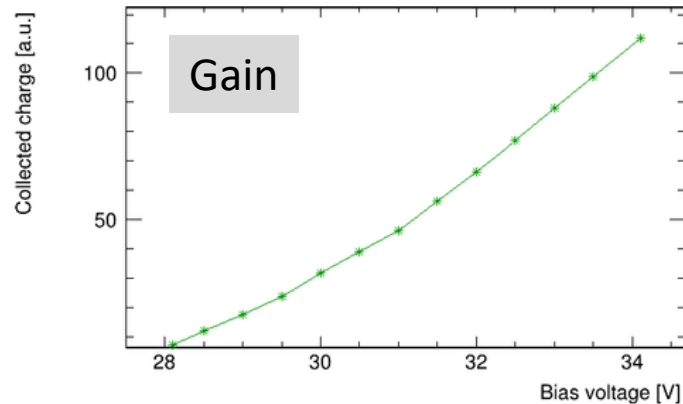
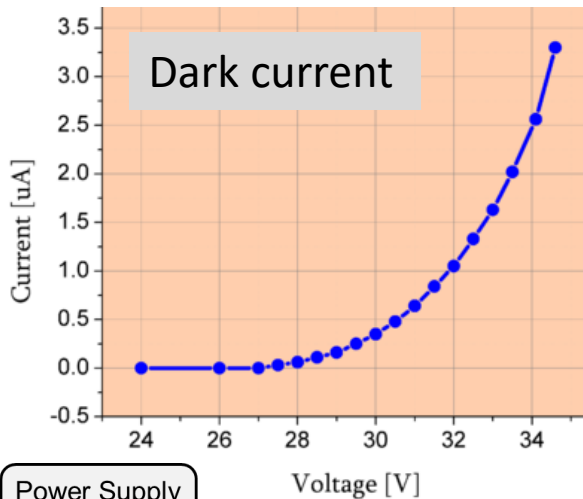
# SiPM/PCB assembly

SiPMs used:

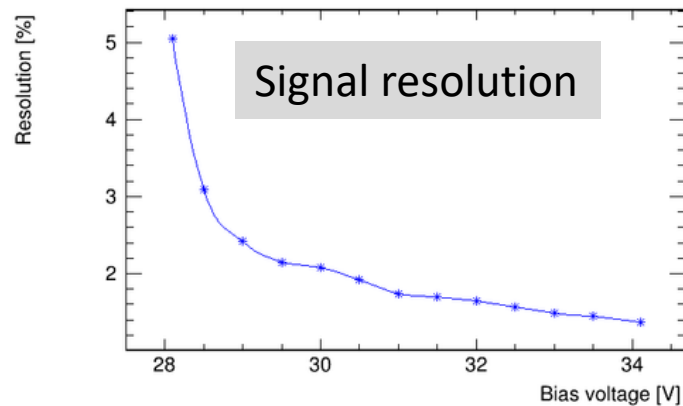
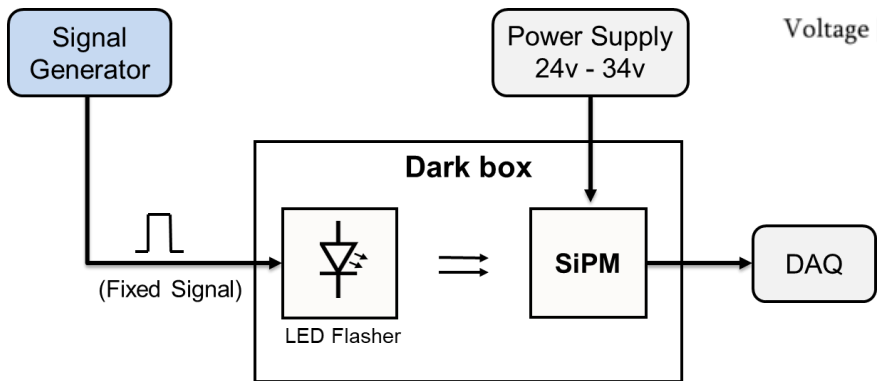
**AFBR-S4N33C013**  
NUV-HD Single Silicon  
Photo Multiplier



# SiPM lab tests

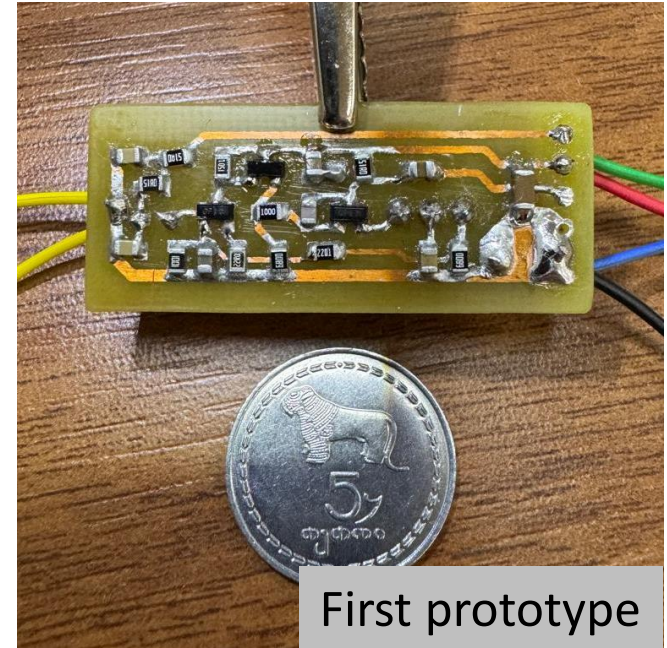
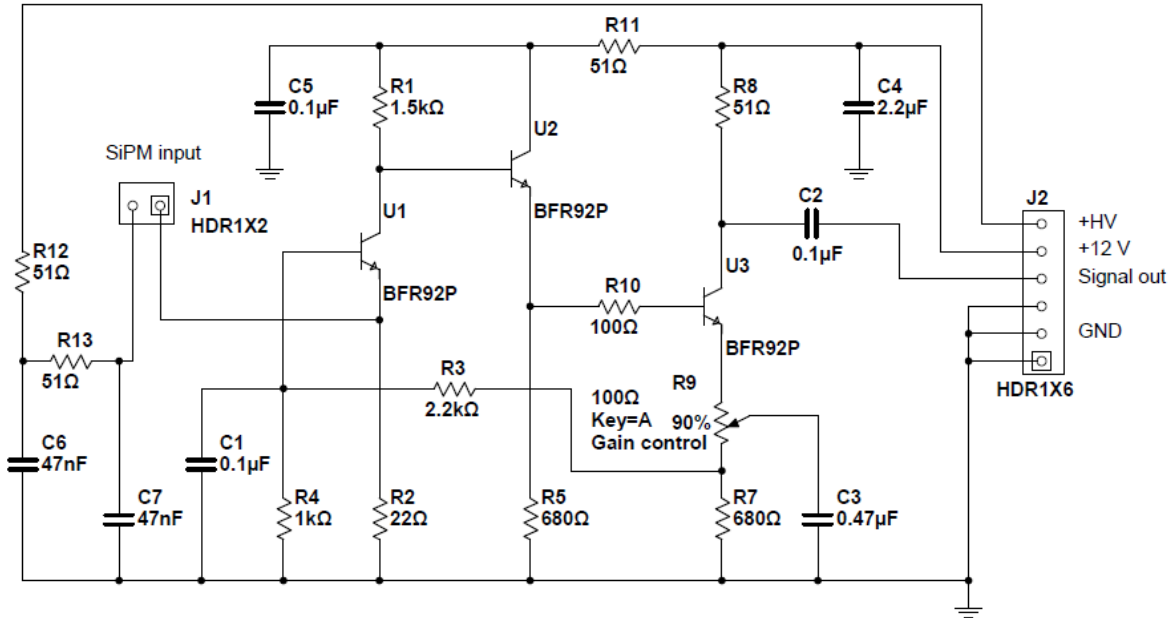


## Test setup:



# SiPM preamplifier

BJT-based trans impedance amplifier:



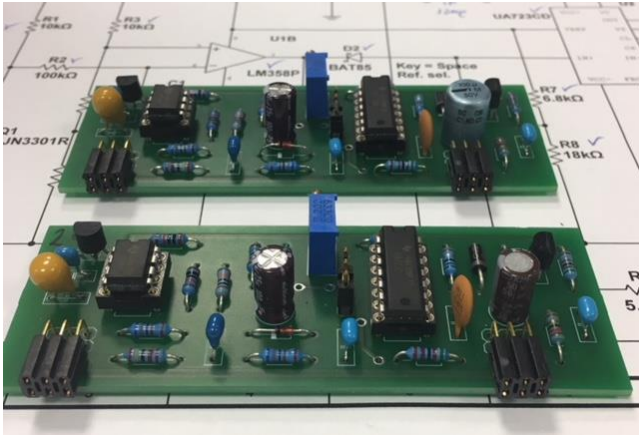
First prototype

Measured gain: 1.25 V/mA

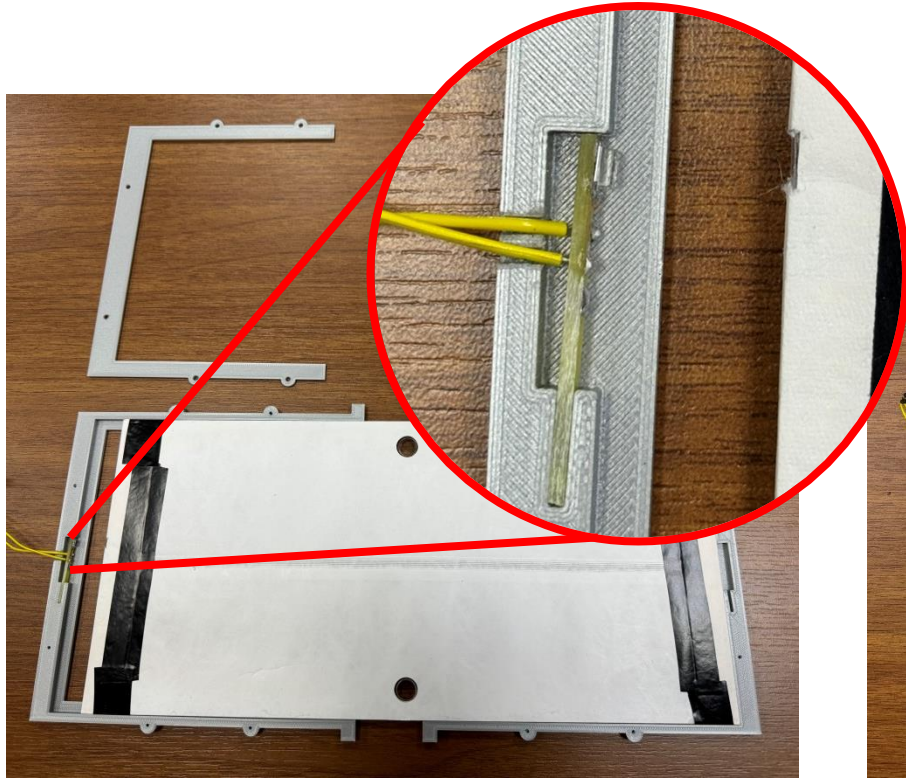
# SiPM power supply

Based on high precision supply modules from JePo

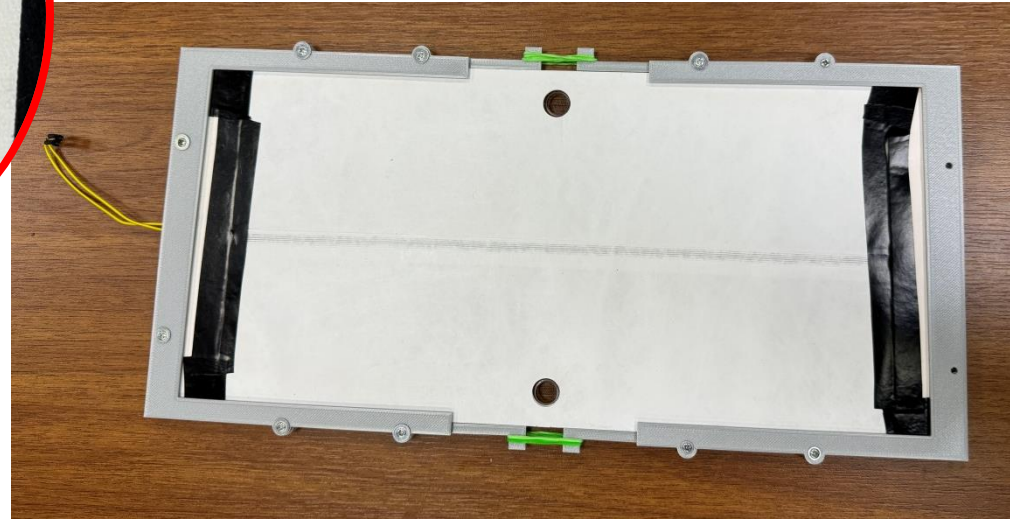
- Linearly regulated (low noise)
- High stability
- Slow ramp up/down
- $V_{\text{out}} = 24 - 34 \text{ V}$
- $I_{\text{out}} < 100 \text{ mA}$  (active current limiting)



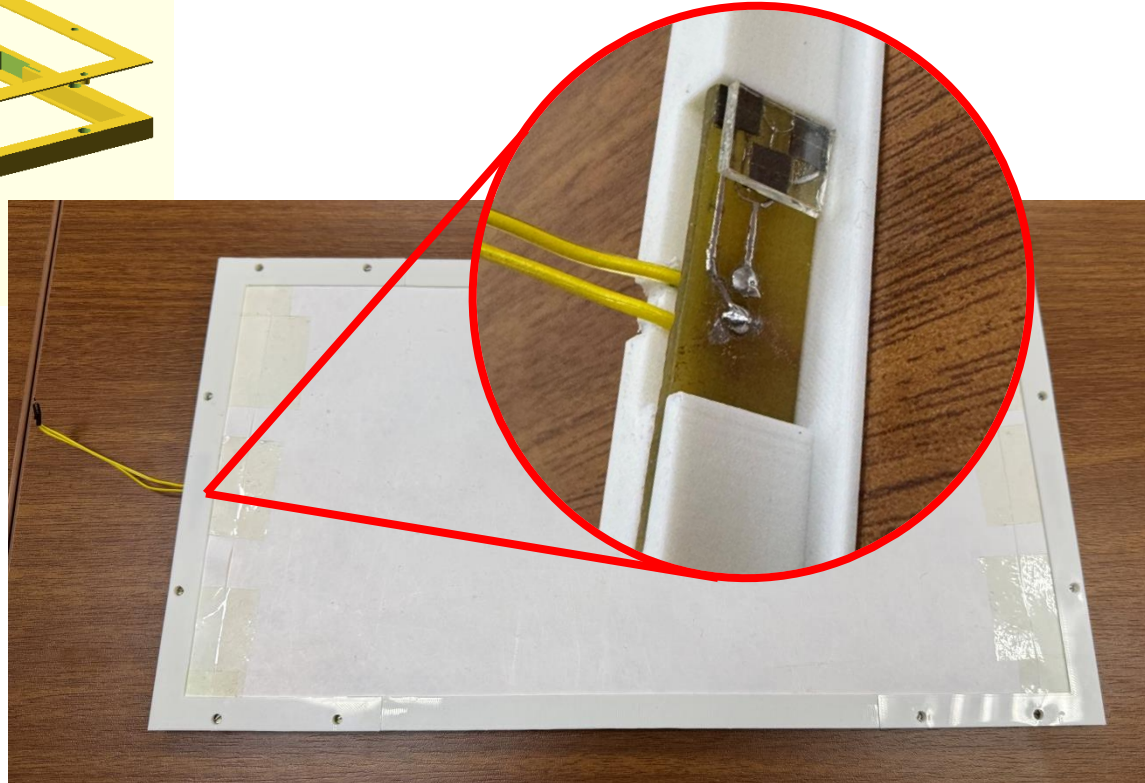
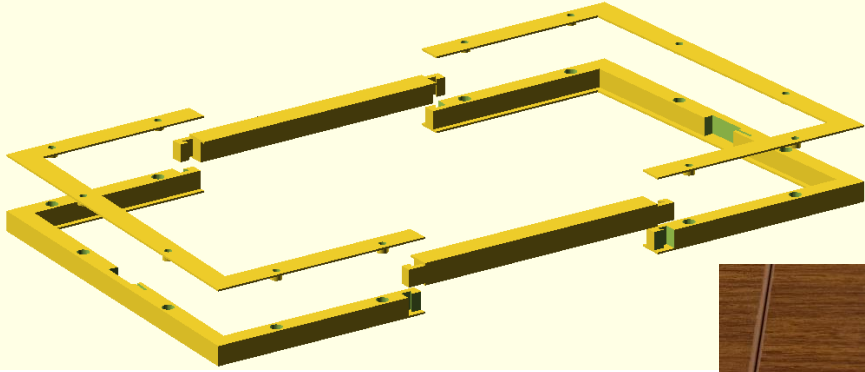
# Calorimeter module (1 layer)



**Frames are 3D-printed**



# Calorimeter module assembly (3 layer)

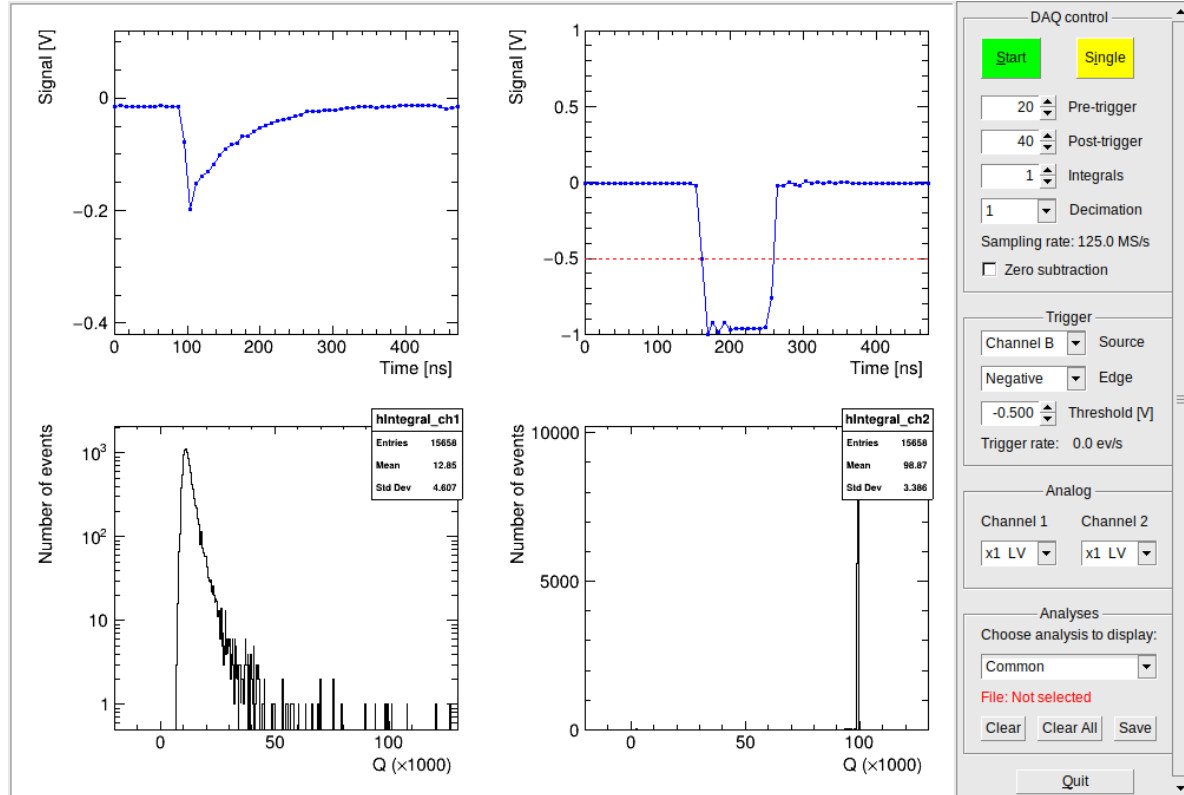


# DAQ - Based on Redpitaya + custom-developed software

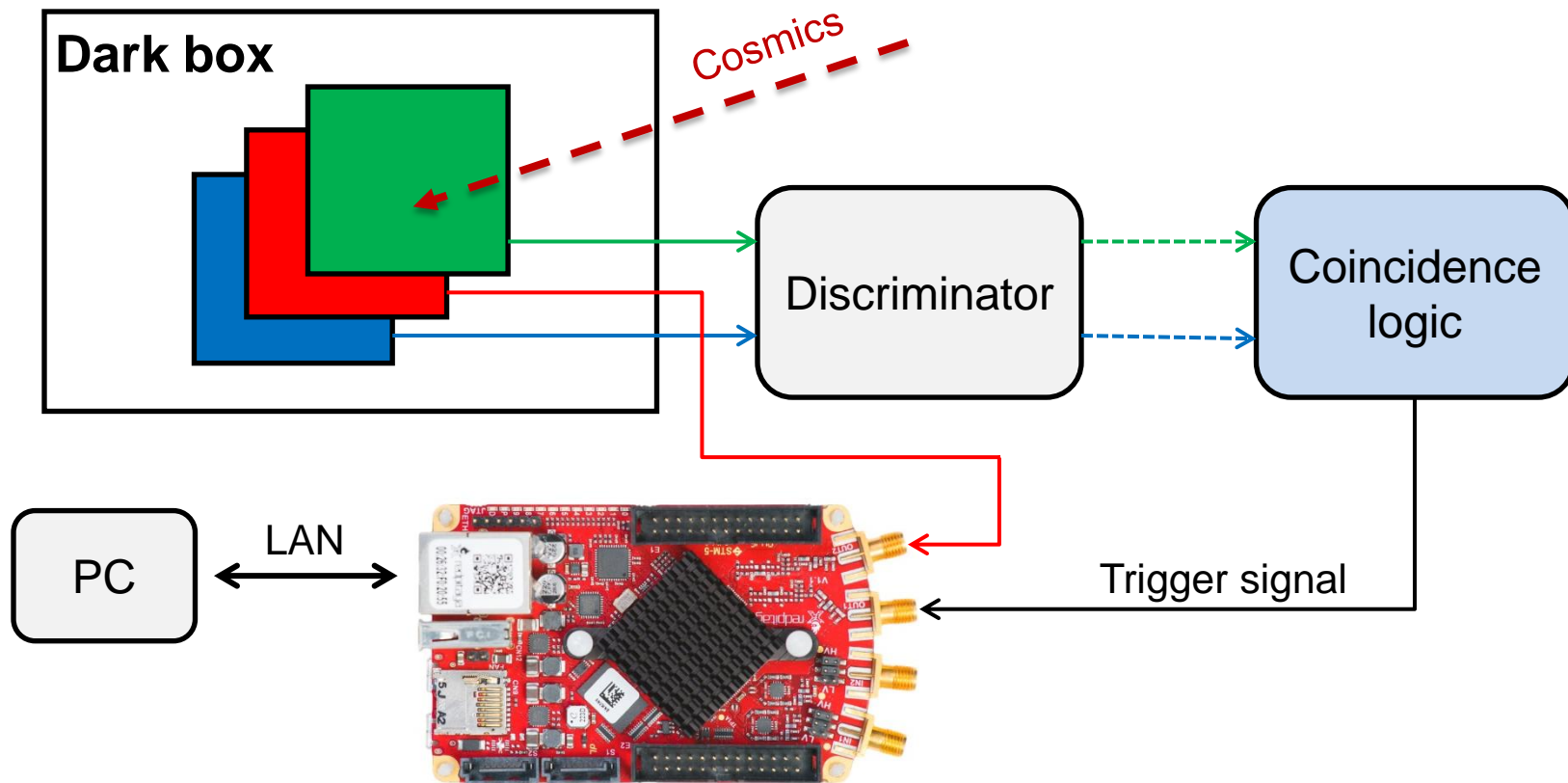


## STEM lab 125-14

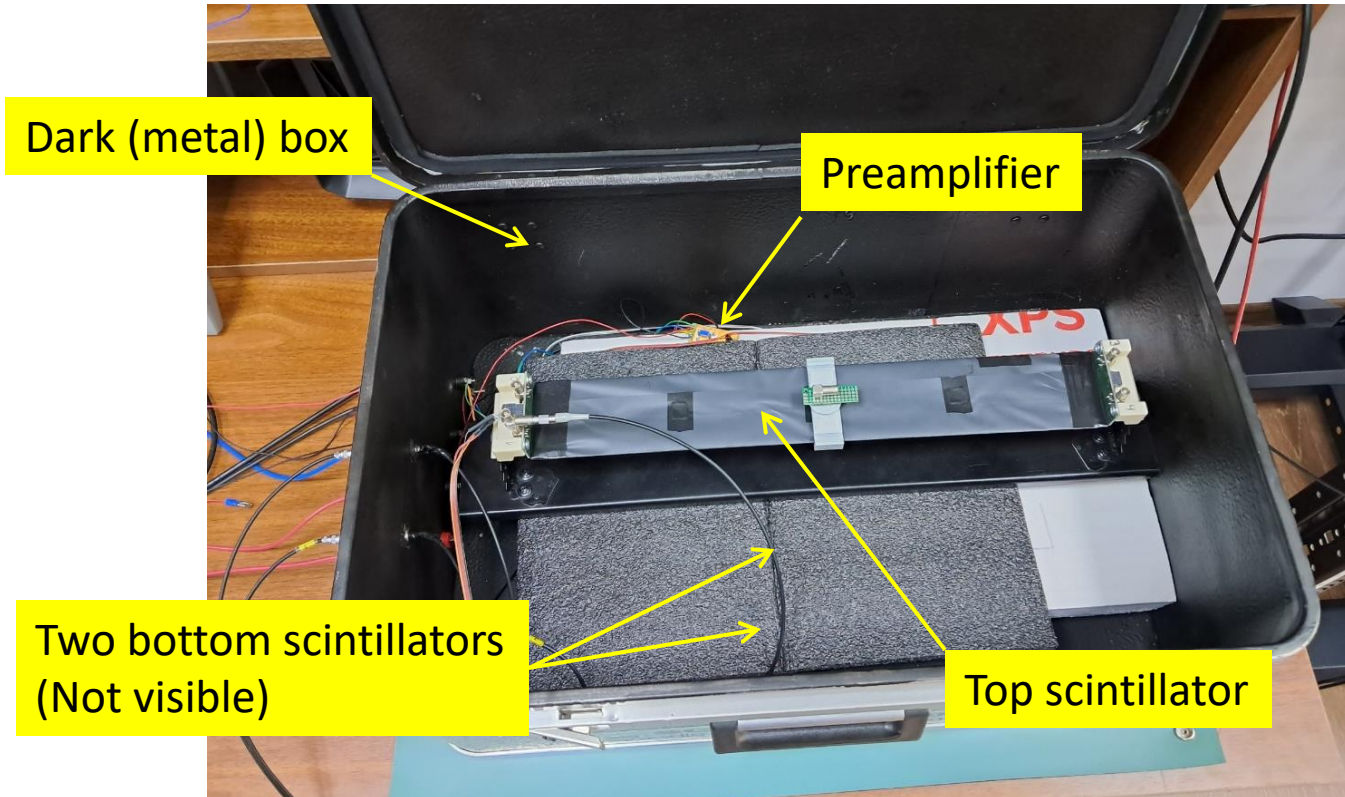
- DAC + ADC
- 125 MS/s – 14 bit
- Linux on board
- Access via LAN



# Efficiency test setup



# Efficiency test setup



# Efficiency tests

## Signal detection algorithm:

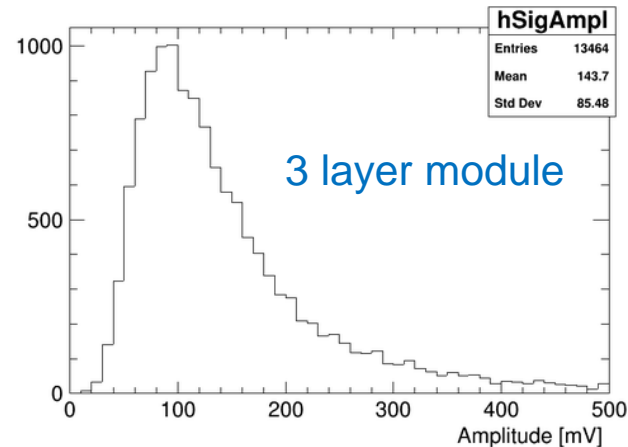
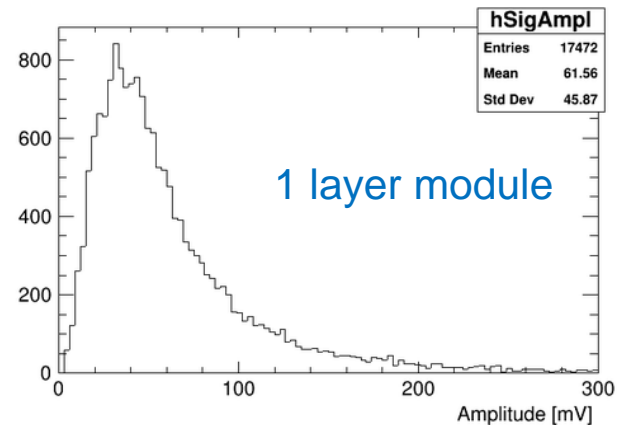
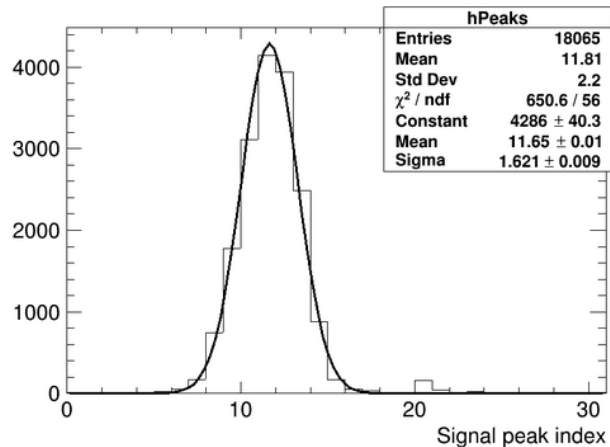
1. Search for the highest peaks within the written signal shapes;
2. Peak position distribution built;
3. Useful signals selected within  $\pm 3$  sigma;
4. Signal amplitude (in mV) distribution built for selected events.

## Measured efficiencies:

(at 20 mV threshold)

1 layer module: **0.95**

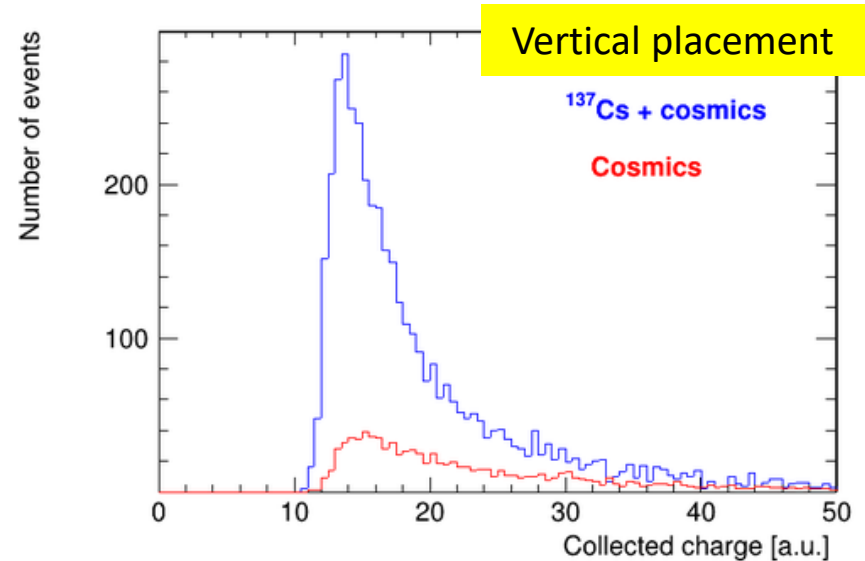
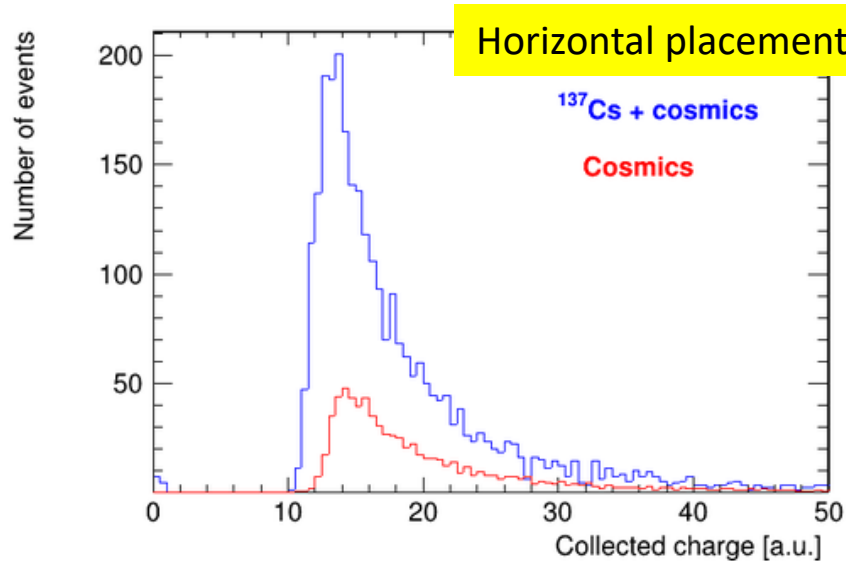
3 layer module: **0.99**



# Test with $^{137}\text{Cs}$ source

## Test and analysis procedures:

1. Calorimeter module placed in vertical/horizontal positions;
2.  $^{137}\text{Cs}$  radioactive source attached to the module;
3. Cosmic events recorded for the background subtraction (both positions independently);
4. Bg weight determined using event rates.



# Aging tests

- Scintillator tiles irradiated at Gamma Irradiation Facility (GIF++) at CERN
- Efficiency measurements for the tiles performed before and after irradiation

## Tile 1

	Initial	Irradiated
Efficiency (at 20 mV threshold)	0.95	0.93
Av. Rate [1/h]	1093	900
Amplitude mean [mV]	81	64

## Tile 2

	Initial	Irradiated
Efficiency (at 20 mV threshold)	0.94	0.92
Av. Rate [1/h]	930	834
Amplitude mean [mV]	68	64

Three more tiles will be irradiated