First test measurements on the bar-shaped PSD with SiPM readout at GSSI-LNGS

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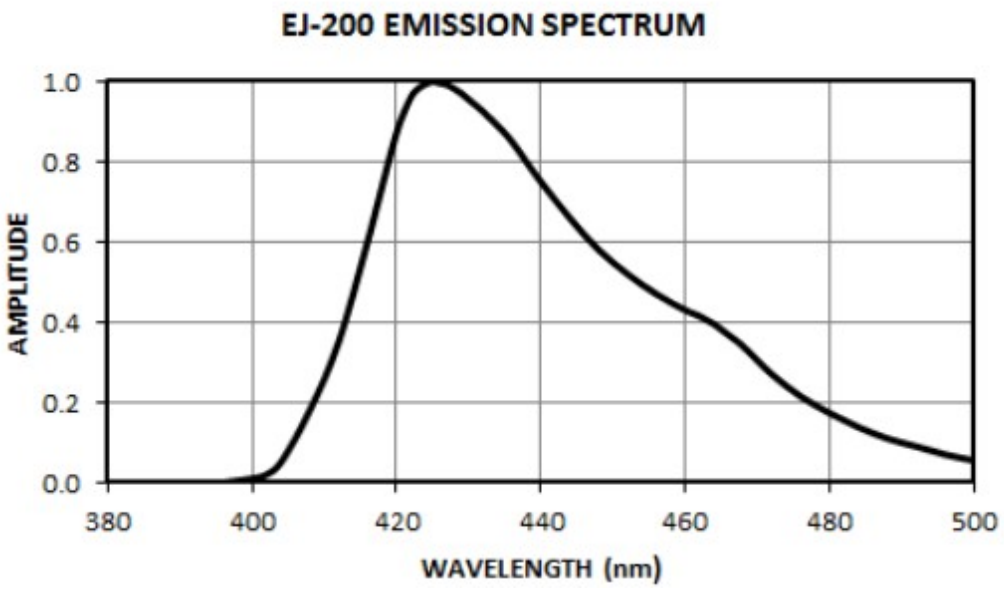
EJ200 Plastic Scintillator' Properties

PROPERTIES	EJ-200
Light Output (% Anthracene)	64
Scintillation Efficiency (photons/1 MeV e^-)	10,000
Wavelength of Maximum Emission (nm)	425
Light Attenuation Length (cm)	380
Rise Time (ns)	0.9
Decay Time (ns)	2.1
Pulse Width, FWHM (ns)	2.5
H Atoms per cm³ ($\times 10^{22}$)	5.17
C Atoms per cm³ ($\times 10^{22}$)	4.69
Electrons per cm³ ($\times 10^{23}$)	3.33
Density (g/cm³)	1.023

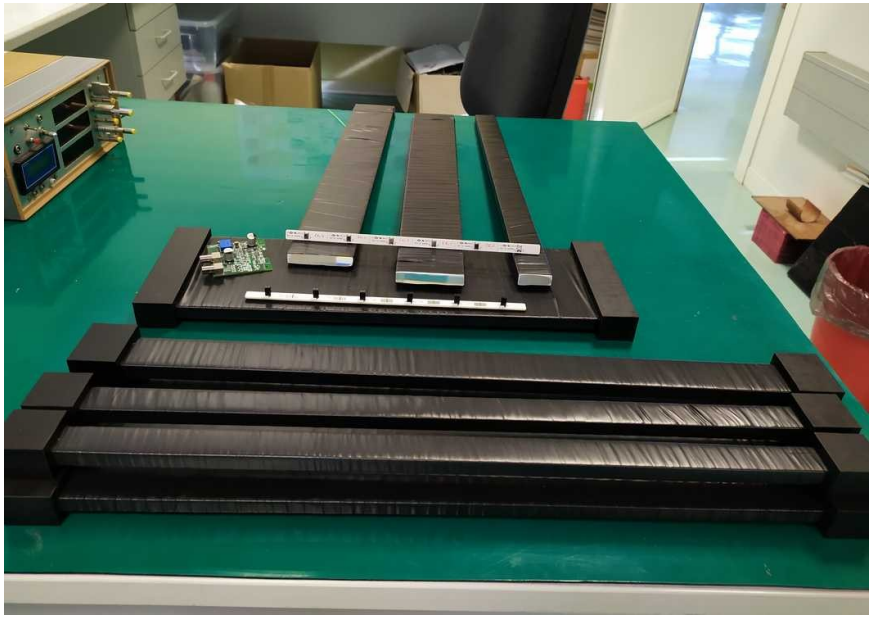


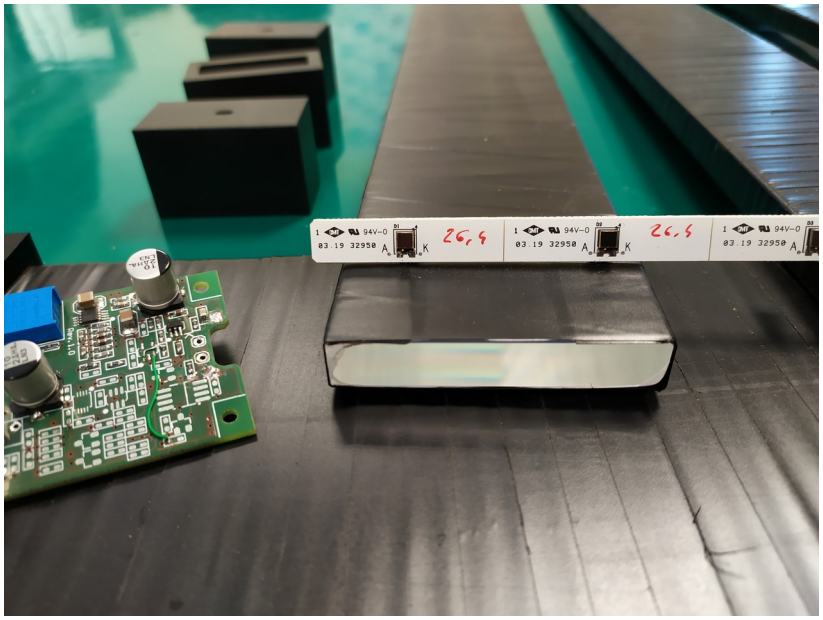
Scintillator' Preparatory Phase @ GSSI-LNGS

Scintillator' bar inventory:

1) 50 x 12 x 1 cm – 3 SiPMs/side
2) 40 x 12 x 1 cm – 3 SiPMs/side
3) [50 x 6 x 1 cm] x 2 – 2 SiPMs/side
4) [50 x 3 x 1 cm] x 2 – 1 SiPMs/side
5) [50 x 2 x 1 cm] x 2 – 1 SiPMs/side

New scintillator types are bought and will be added to the inventory





SiPM characteristics' overview

Hamamatsu

SiPM model	S12572 – 010C	S12572 – 015C	S13360 – 3025CS	S14160 – 1315PS/–3015PS
Effective area (mm)	3 x 3	3 x 3	3 x 3	3 x 3
Cell count	90000	40000	14400	7296/40000
Cell size (μm)	10	15	25	15
Cell fill factor (%)	33	53	47	49
Response range (nm)	320 – 900	320 – 900	270 – 900	290 – 900
Peak sensitivity (nm)	470	460	450	460
PDE (%)	10	25	25	32
Breakdown voltage (V)	65 ± 10	65 ± 10	65 ± 10	38 ± 3
Overvoltage (V)	4.5	4.0	5.0	4.0
Dark count rate	1000 – 2000 (kcps)	1000 – 2000 (kcps)	400 – 1200 (kcps)	120 – 360/700 – 2100 (kcps)
Gain	1.35 x 10^5	2.3 x 10^5	7 x 10^5	3.6 x 10^5

SiPM characteristics' overview

AdvanSiD

SiPM model	ASD – NUV1C	ASD – NUV3S	ASD – RGB3S – P
Effective area (mm)	1.13(circular)	3 x 3	3 x 3
Cell count	673	5520	5520
Cell size (μm)	40	40	40
Cell fill factor (%)	60	60	60
Response range (nm)	350 – 900	350 – 900	350 – 900
Peak sensitivity (nm)	420	420	550
PDE (%)	43	43	32.5
Breakdown voltage (V)	24 – 28	24 – 28	27 – 29
Overvoltage (V)	2.0 – 6.0	2 – 6	2 – 4
Dark count rate	50 – 100 (kHz/mm^2)	50 – 100 (kHz/mm^2)	100 – 200 (kHz/mm^2)
Gain	3.6 x 10^6	3.6 x 10^6	2.7 x 10^6

Detector setup

First tests involving AdvanSiD SiPMs, specifically: ASD - NUV3S

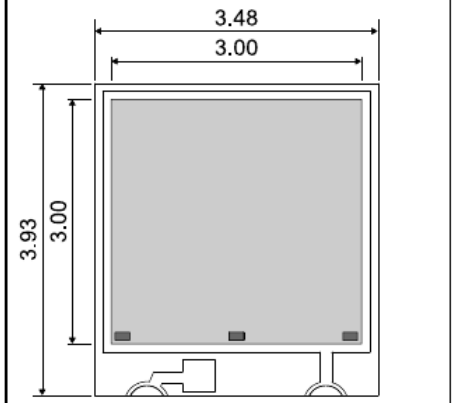
ASD-NUV3S-P

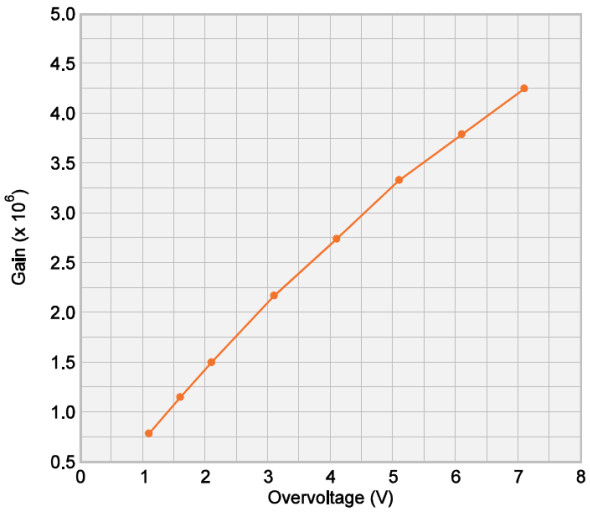
SMD package

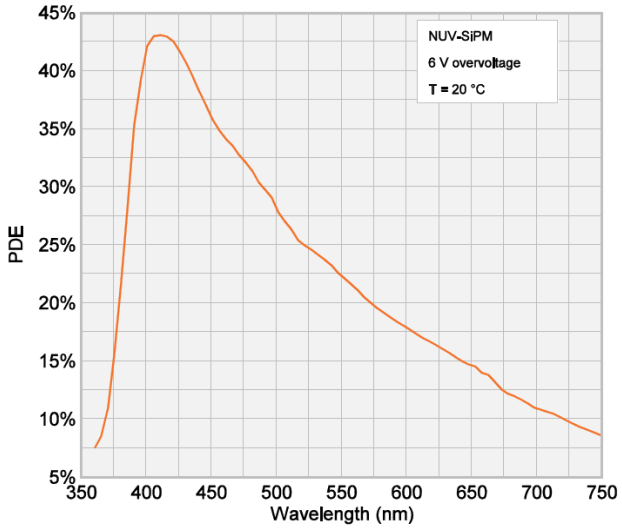
for SiPM 3x3 mm^2 active area size

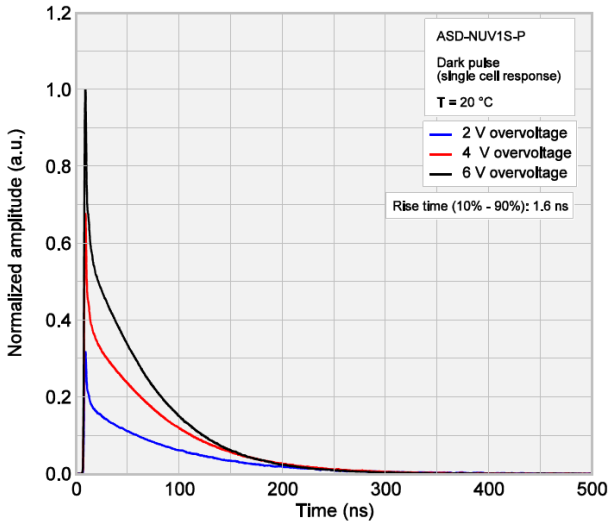
Material: Black FR4 + transparent epoxy layer

SLIM PACKAGE



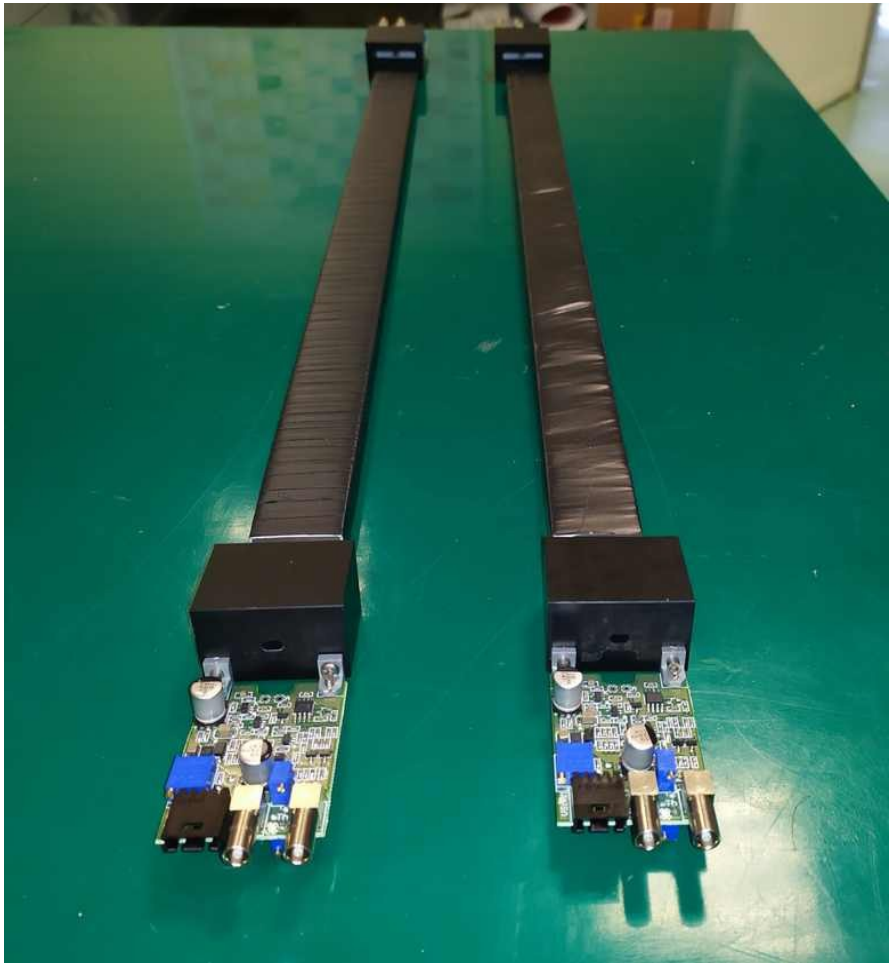






Detector setup

Utilization of 50 x 3 x 1 cm scintillator' bars with 1 SiPM readout on each side

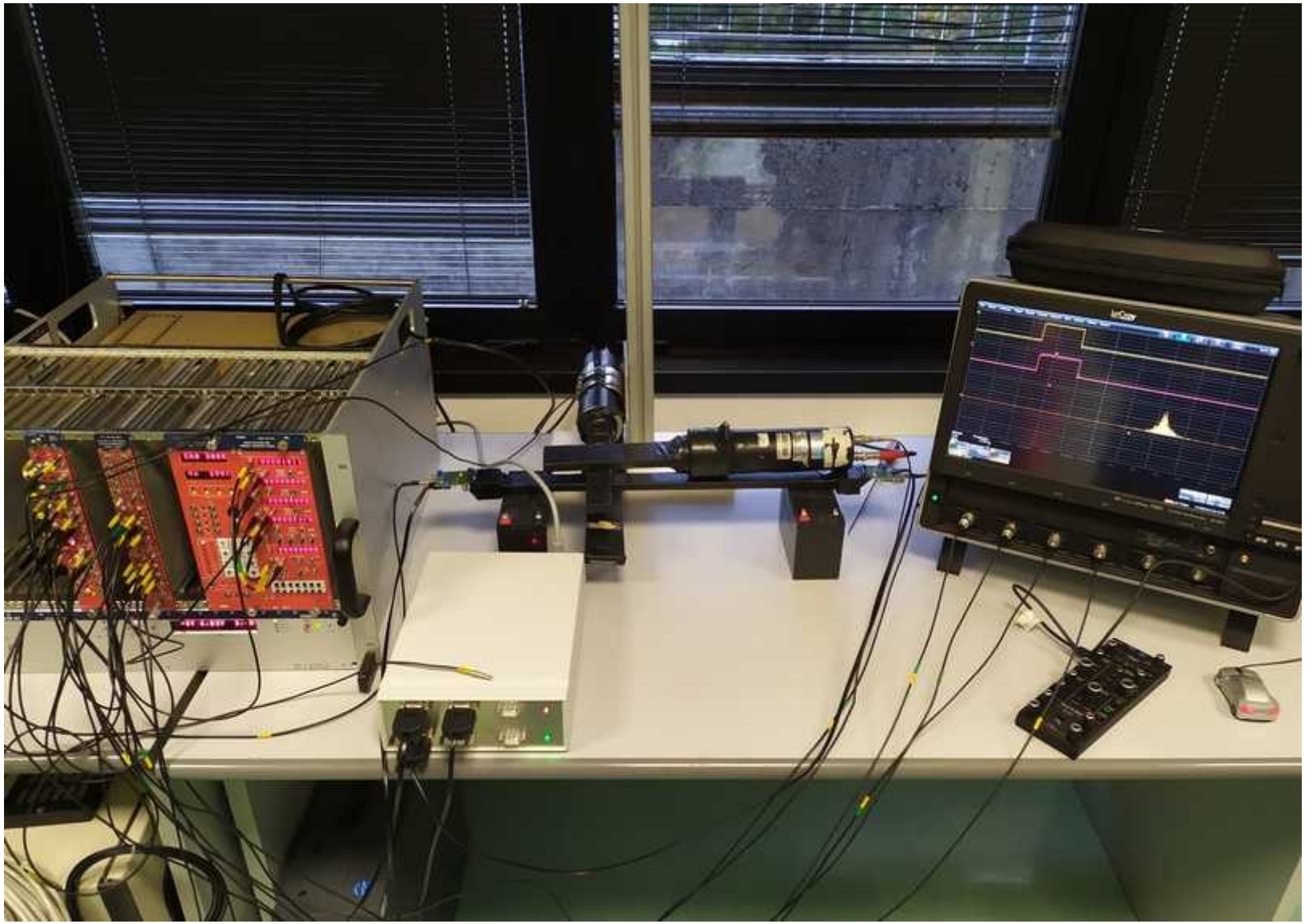


Successful tests considering the PS bar + SiPM configuration including:

- Counting rate' uniformity on both sides
- Light leakage prevention

Detector setup

Configuring a coincidence setup involving an ensemble of PS+PMT and PS+SiPM



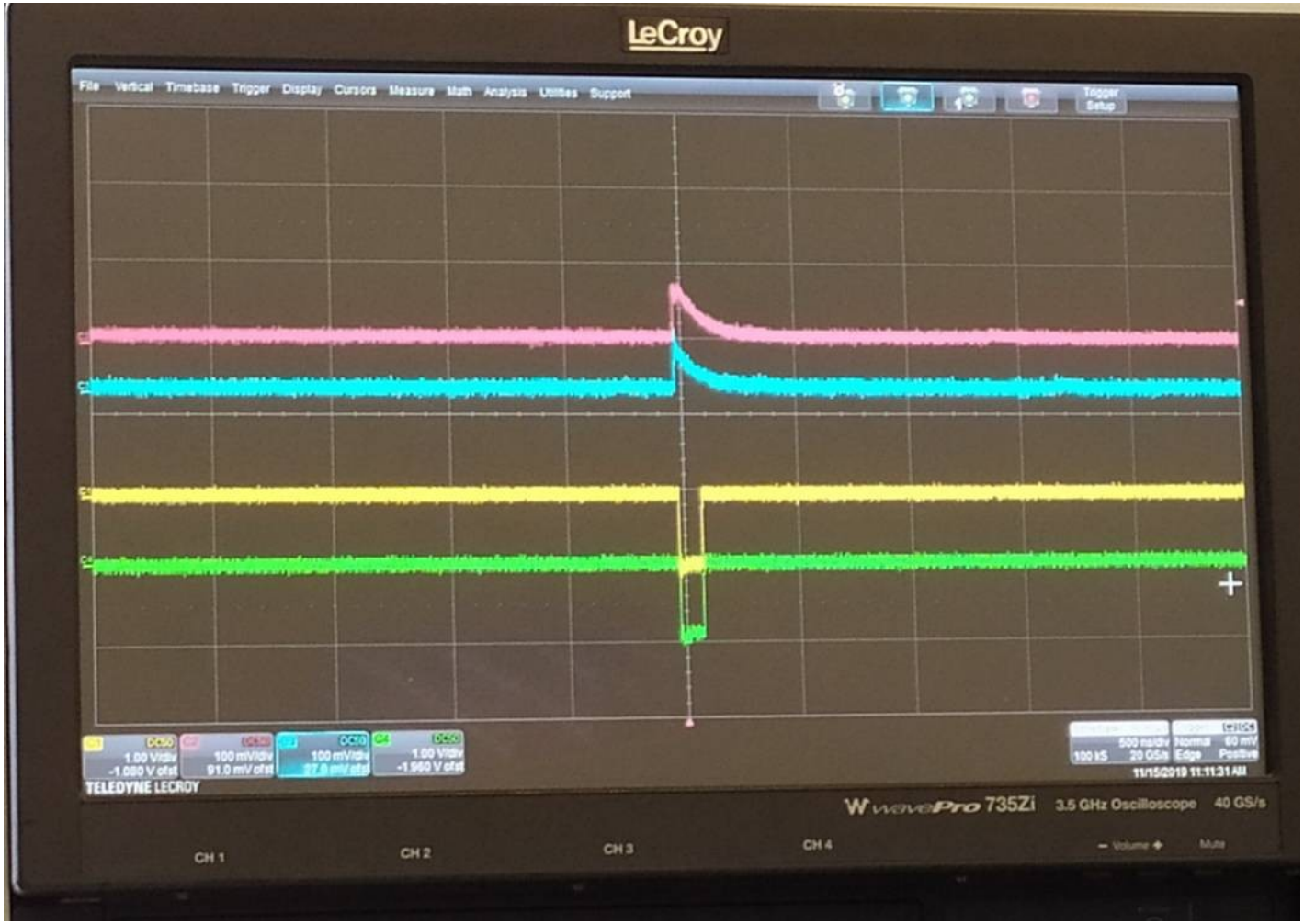
Detector setup

Coincidence setup for timing measurements (ongoing)

#1 – PS + PMT
#2 – PS + fast PMT ("finger")
#3 – PS + PMT
#4 – PS + SiPMs

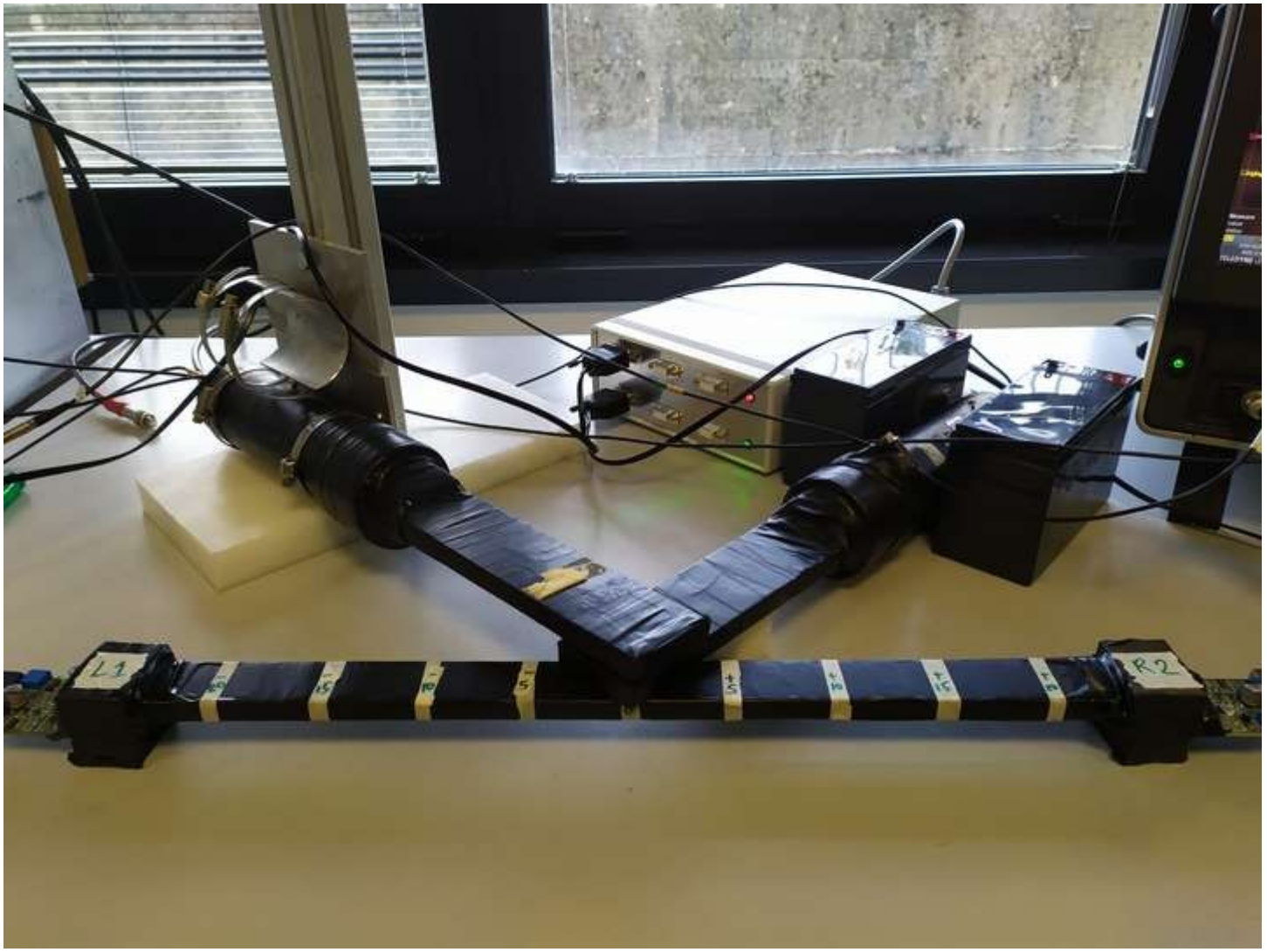
Detector setup

Checking the overlapping signals (both Analog and Digital) of the utilized SiPMs in order to maintain similar behavior on each side of the scintillator bar.
(V_{bias} = 30 V, V_{br} = 26.5 V)

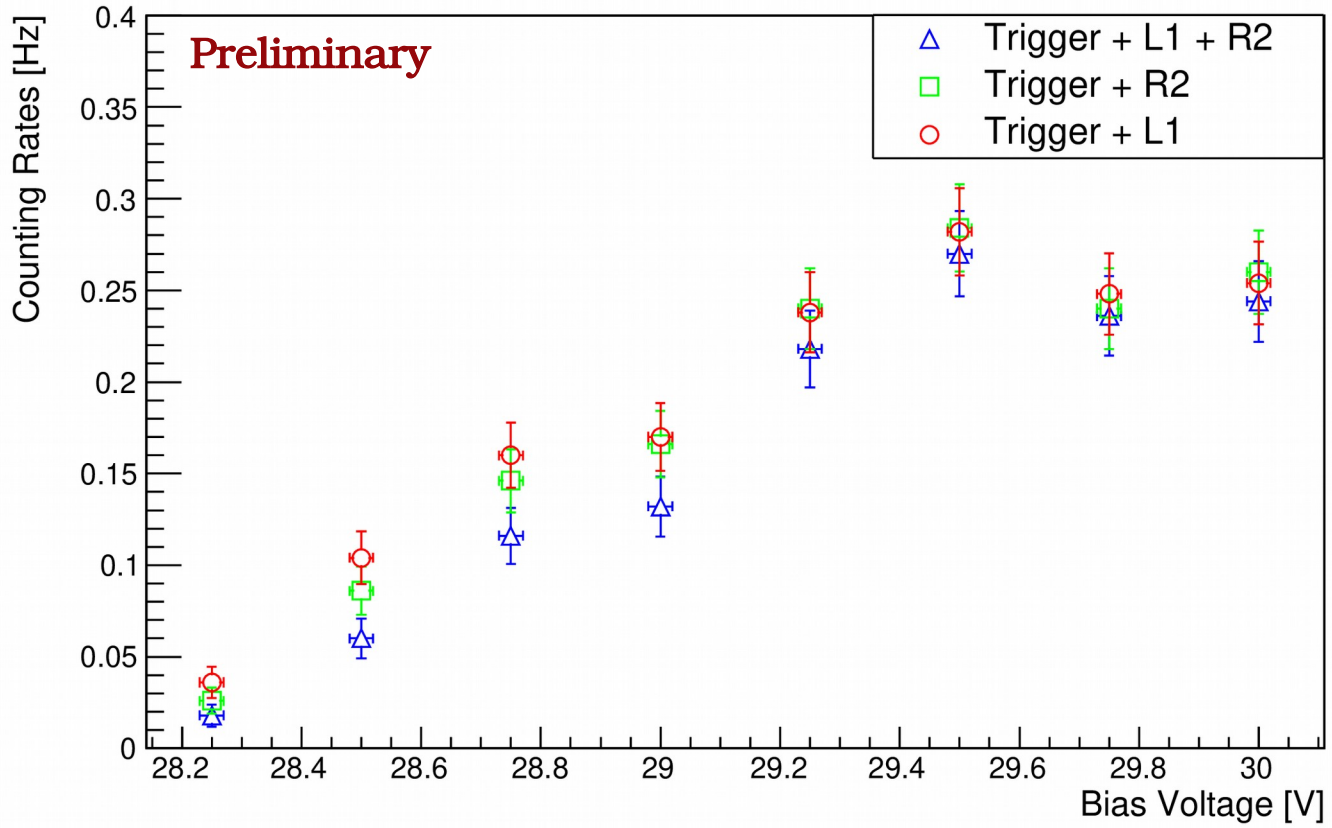


Detector setup

Configuring a coincidence setup involving an ensemble of PS+PMT and PS+SiPM



Counting Rates



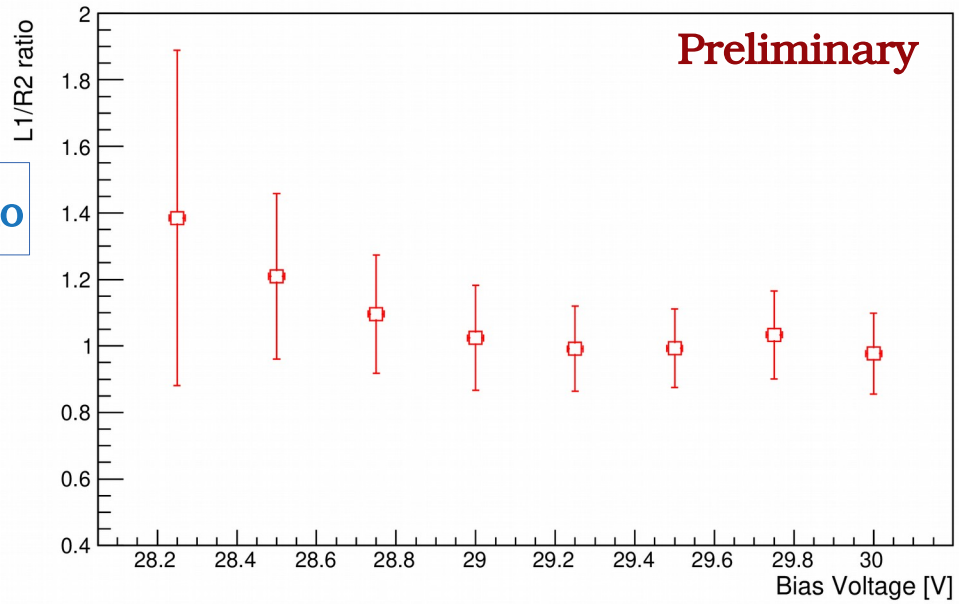
SiPM#1 [L1] + Trigger

[L1] + [R2] + Trigger

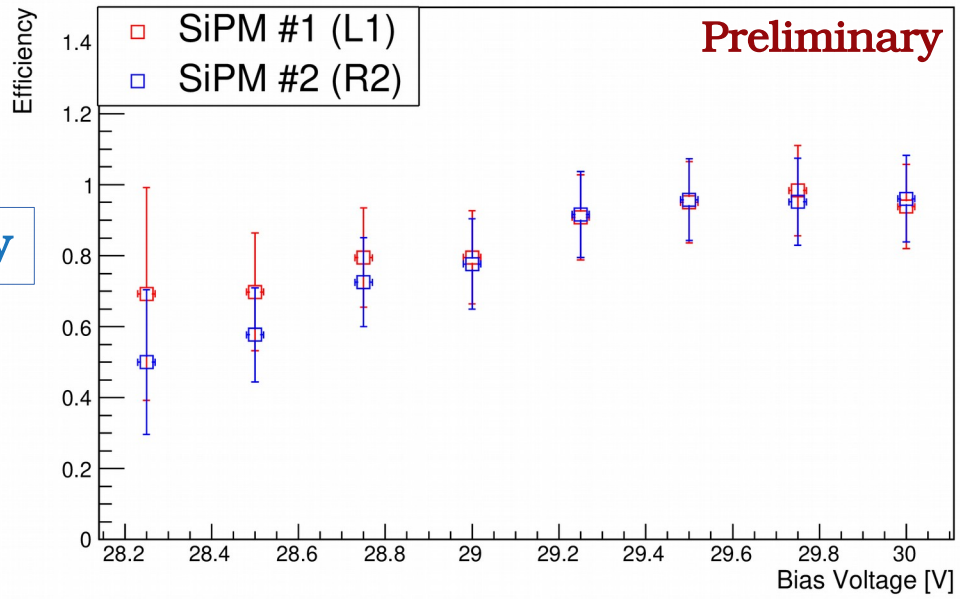
SiPM#2 [R2] + Trigger

First Results @ GSSI-LNGS

Left / Right SiPM ratio



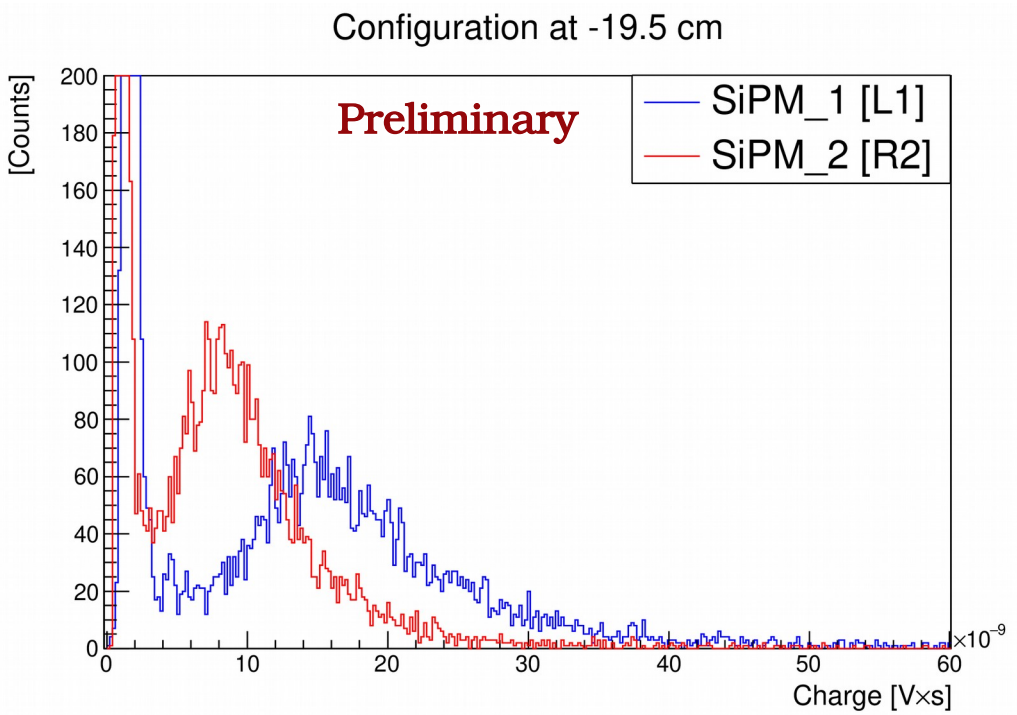
Detector efficiency



$$\frac{R_{Total}}{R_{L1+Trigger}} = \frac{R_{Trigger} * \varepsilon_{L1} * \varepsilon_{R2} * \varepsilon_{geom}}{R_{Trigger} * \varepsilon_{L1} * \varepsilon_{geom}} = \varepsilon_{R2}$$

First Results @ GSSI-LNGS

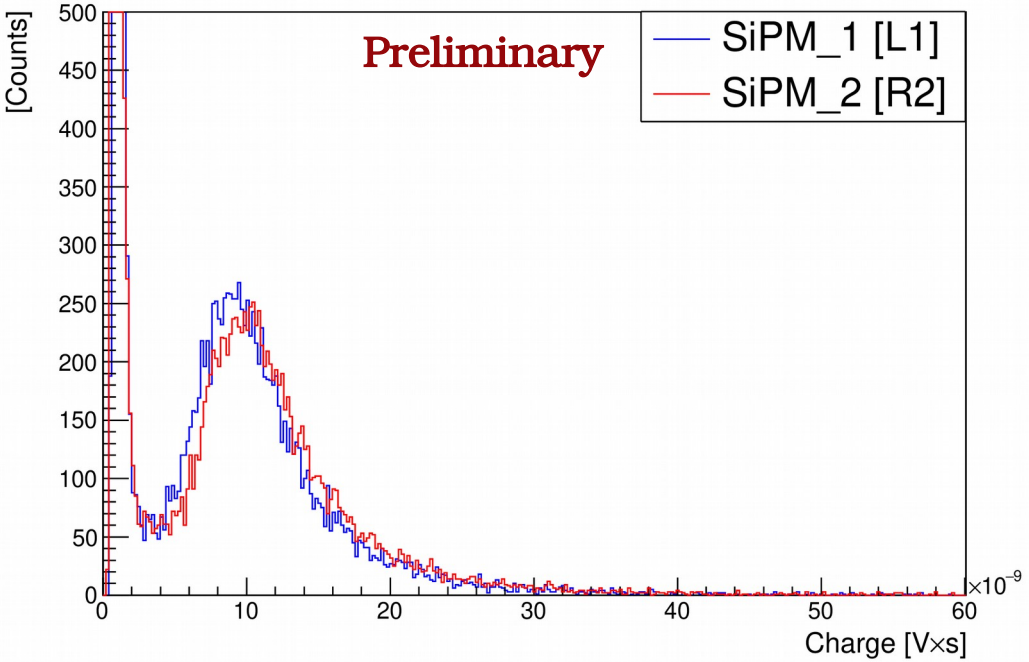
Charge histograms exported in varying positions with regard to the trigger placement.



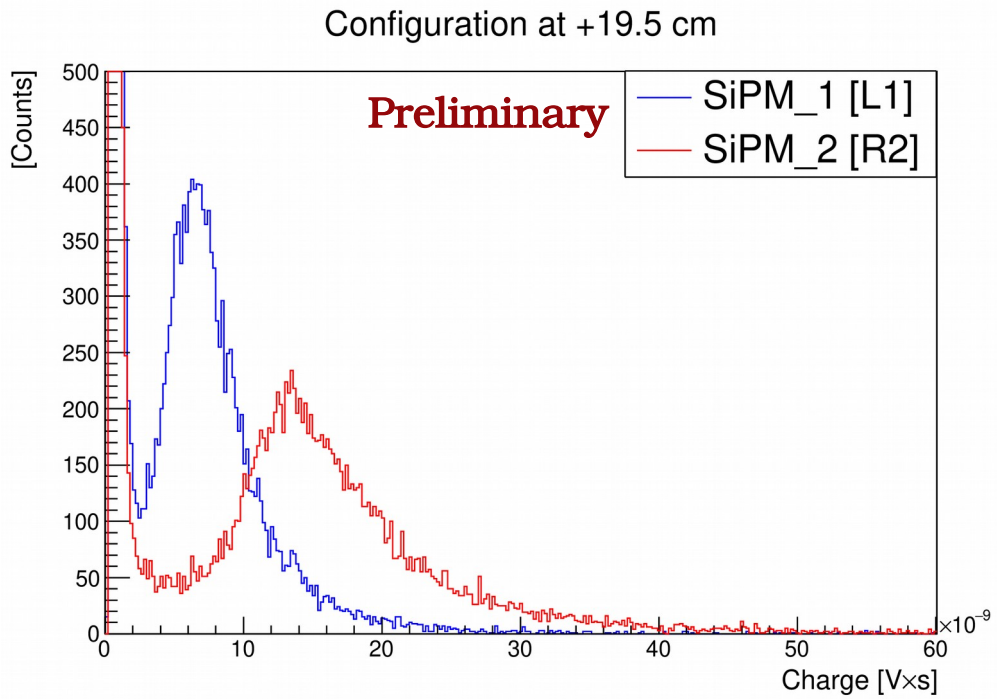
Trigger geometry is not yet optimized

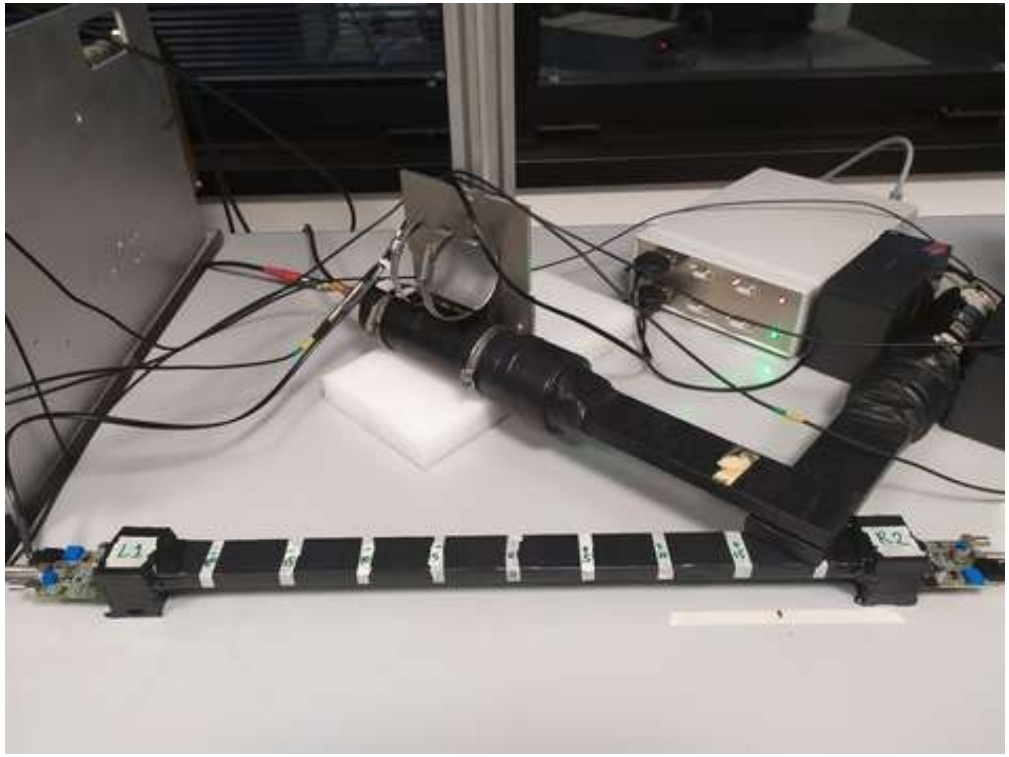
First Results @ GSSI-LNGS

Configuration centered



First Results @ GSSI-LNGS





Next steps

First PS + SiPM configuration successfully built:

- SiPM overlapping signals [done]
- Timing measurements [ongoing]
- Efficiency measurements [ongoing]
- Utilization of the DAQ system (provided by Lecce)
- Comparison between varying scintillator' sizes
- Utilization of Hamamatsu SiPMs and comparison with AdvanSiD.
- Acquiring new scintillators and SiPMs
- Beam test preparations for the upcoming year
- Optimizing the shape of both scintillator' ends