

Measurements with 1.5m bar+AdvanSiD SiPMs

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for the GSSI Group

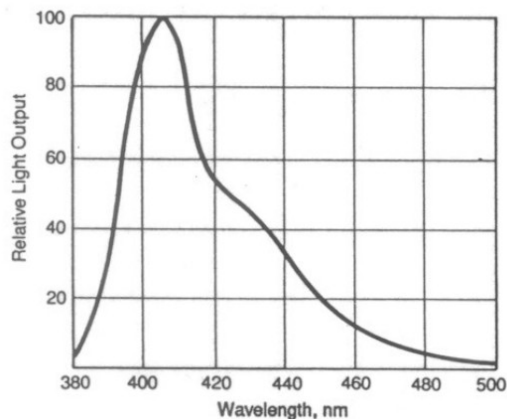
Gran Sasso Science Institute (GSSI) & INFN-LNGS

Saint-Gobain (BC-404) [150 x 5 x 1 cm³] scintillator bar coupled with 2 SiPMs/side [AdvanSiD NUV3S]

BC-404

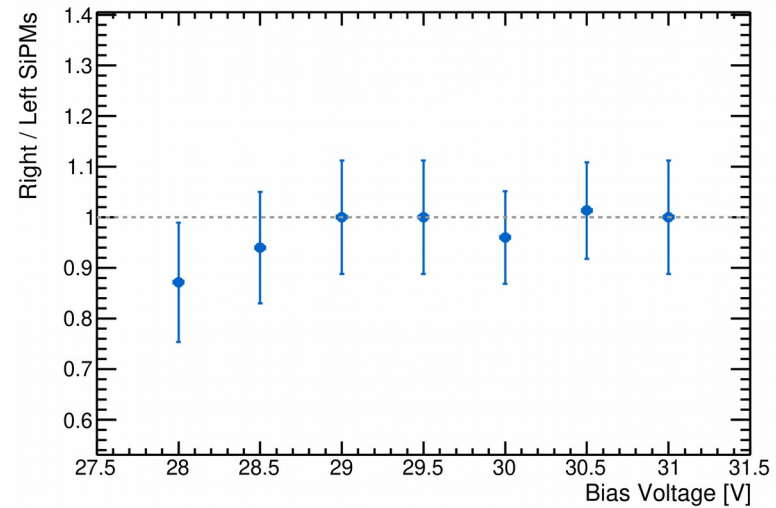
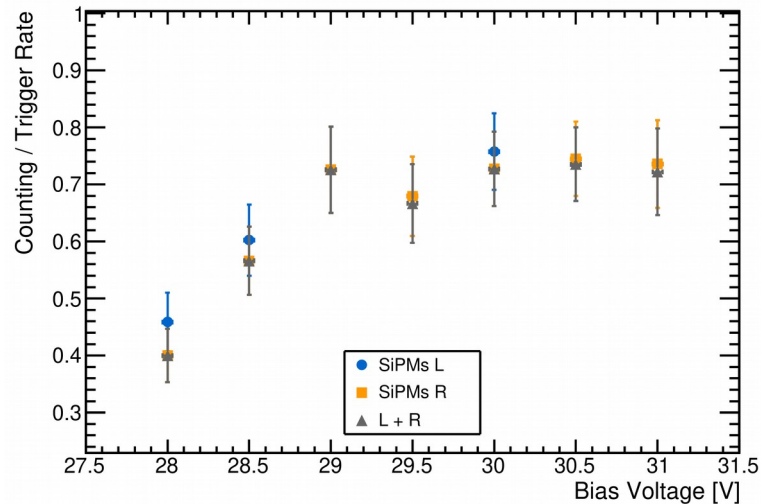
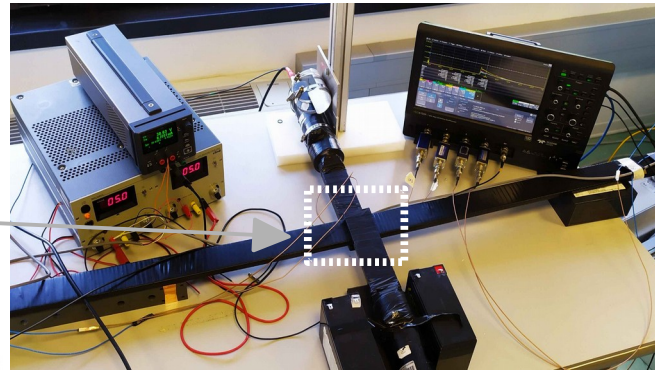
Radiation Detected	
<100keV X-rays	
100keV to 5MeV gamma rays	
>5MeV gamma rays	
Fast neutrons	
Alphas, betas	X
Charged particles, cosmic rays, muons, protons, etc.	
Principal Uses/Applications	fast counting
Scintillation Properties	
Light Output, %Anthracene	68
Rise Time, ns	0.7
Decay Time (ns)	1.8
Pulse Width, FWHM, ns	2.2
Wavelength of Max. Emission, nm	408
Light Attenuation Length, cm*	140
Bulk Light Attenuation Length, cm	160

BC-404



SiPM model	ASD – NUV3S
Effective area (mm)	3 x 3
Cell count	5520
Cell size (μm)	40
Cell fill factor (%)	60
Response range (nm)	350 – 900
Peak sensitivity (nm)	420
PDE (%)	43
Breakdown voltage (V)	24 – 28
Overvoltage (V)	2 – 6
Dark count rate	50 – 100 (kHz/mm ²)
Gain	3.6 x 10 ⁶

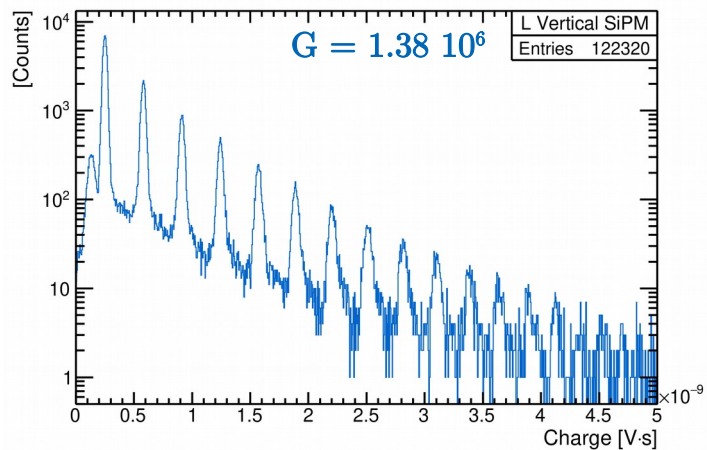
Trigger imposed by 2 scint+PMTs in
“sandwich” configuration
and placed towards the bar center



$V_{\text{BIAS}} = 30 \text{ V}$ is selected collectively for all 4 SiPMs

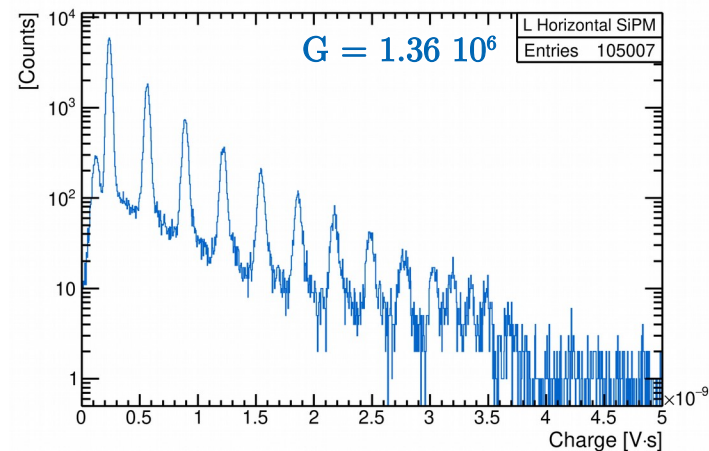
Dark Count Rate (DCR) charge spectra

Extraction of DCR spectra for all 4 SiPMs at $V_B = 30$ V and calculation of Gain



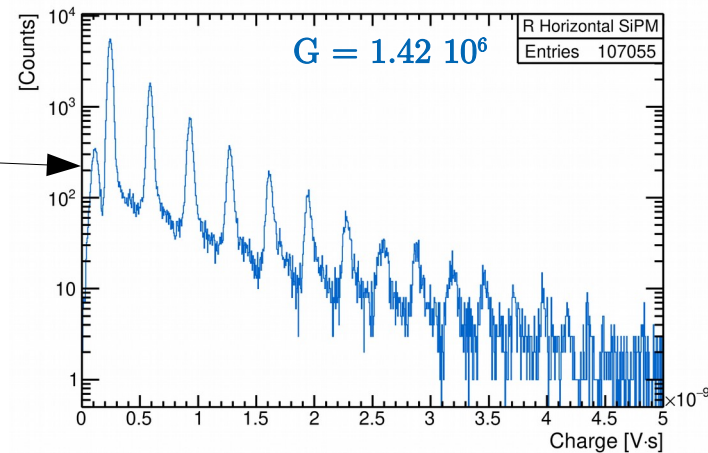
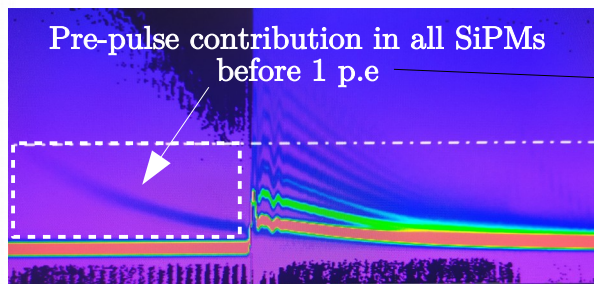
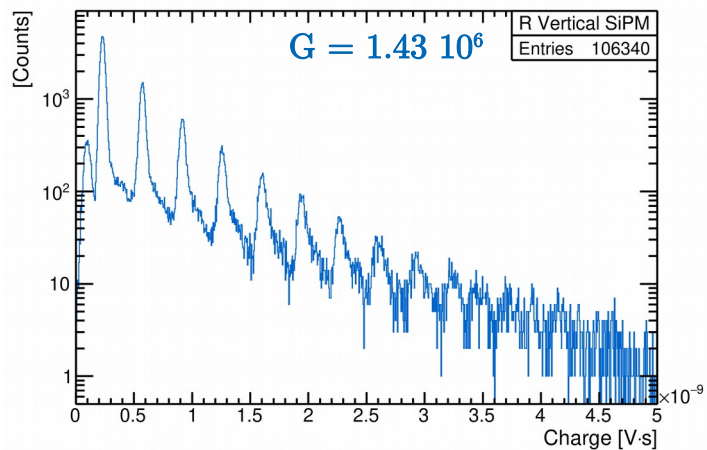
Gain Calculation:

Average distance between
Gaussian mean of first
4 p.e. peaks



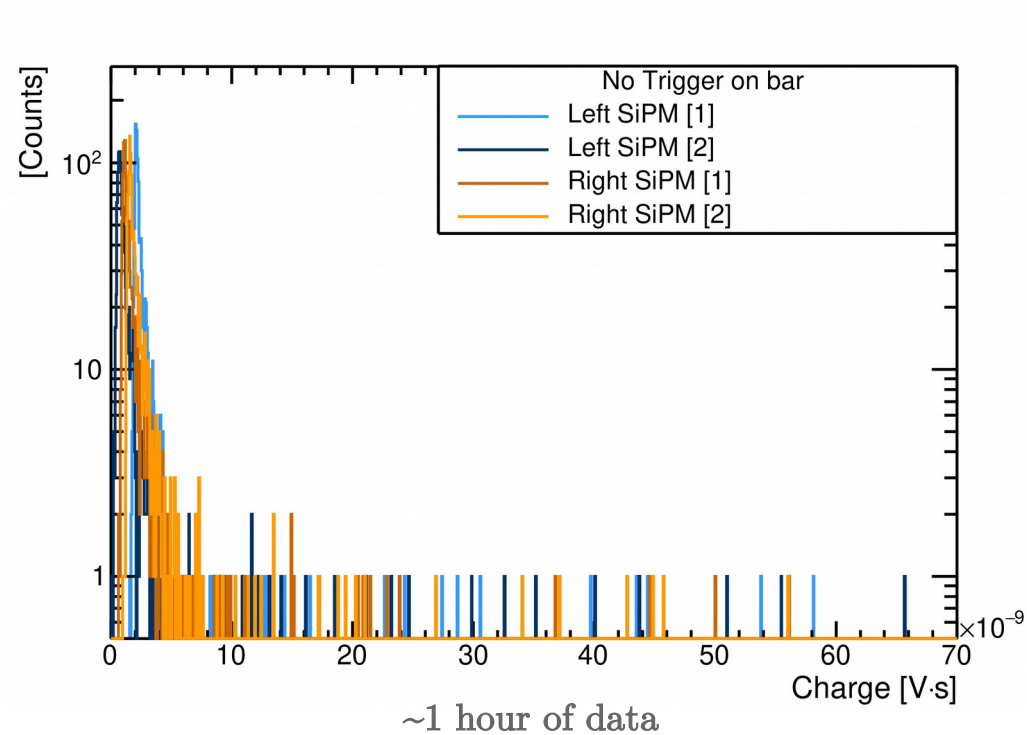
Left Side

Right Side

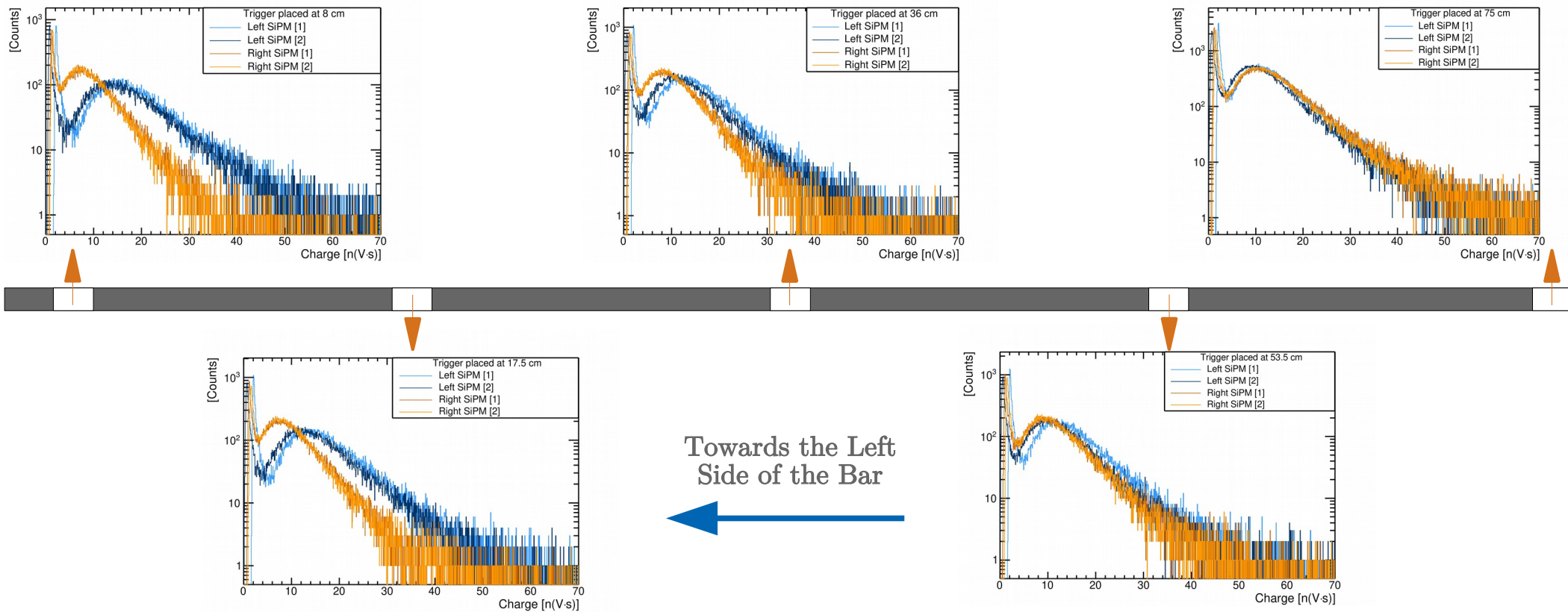


Long Bar Measurements

“Sandwich” trigger placed away from the scintillator bar under test



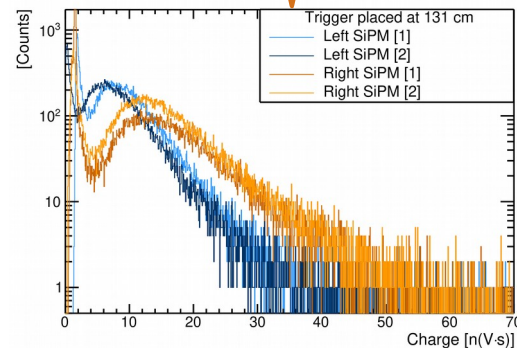
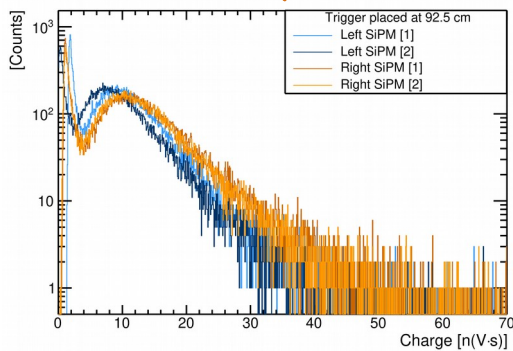
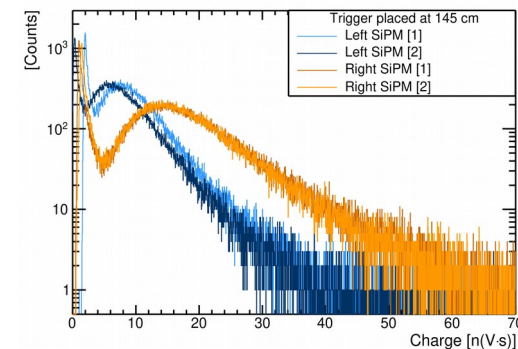
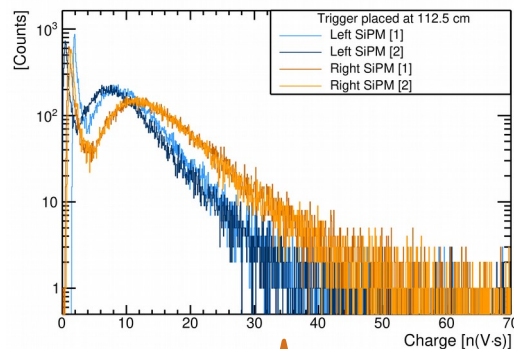
“Sandwich” trigger placed in various positions along the [Left Half] bar



Only the LEFT half of the 1.5m bar is graphically illustrated

“Sandwich” trigger placed in various positions along the [Right Half] bar

Towards the Right Side of the Bar



Only the RIGHT half of the 1.5m bar is graphically illustrated

X – plot from 14 days of total data acquisition

At 1 n(Vs):

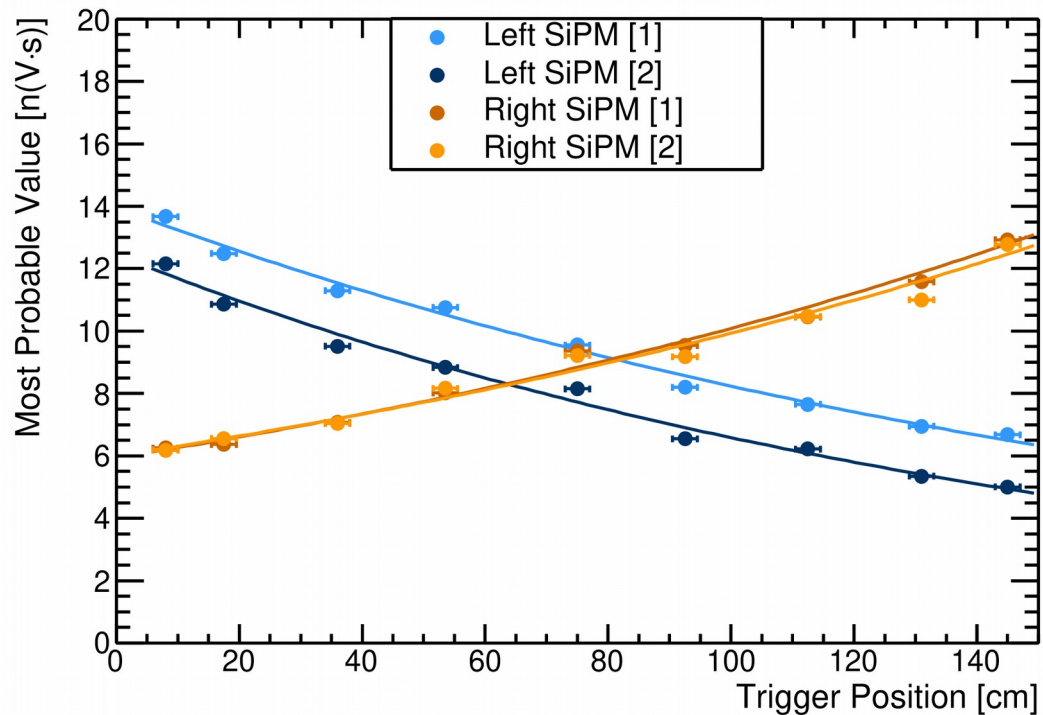
L1 : 4 p.e.

L2: 4.22 p.e

R1: 4.34 p.e.

R2: 4.1 p.e.

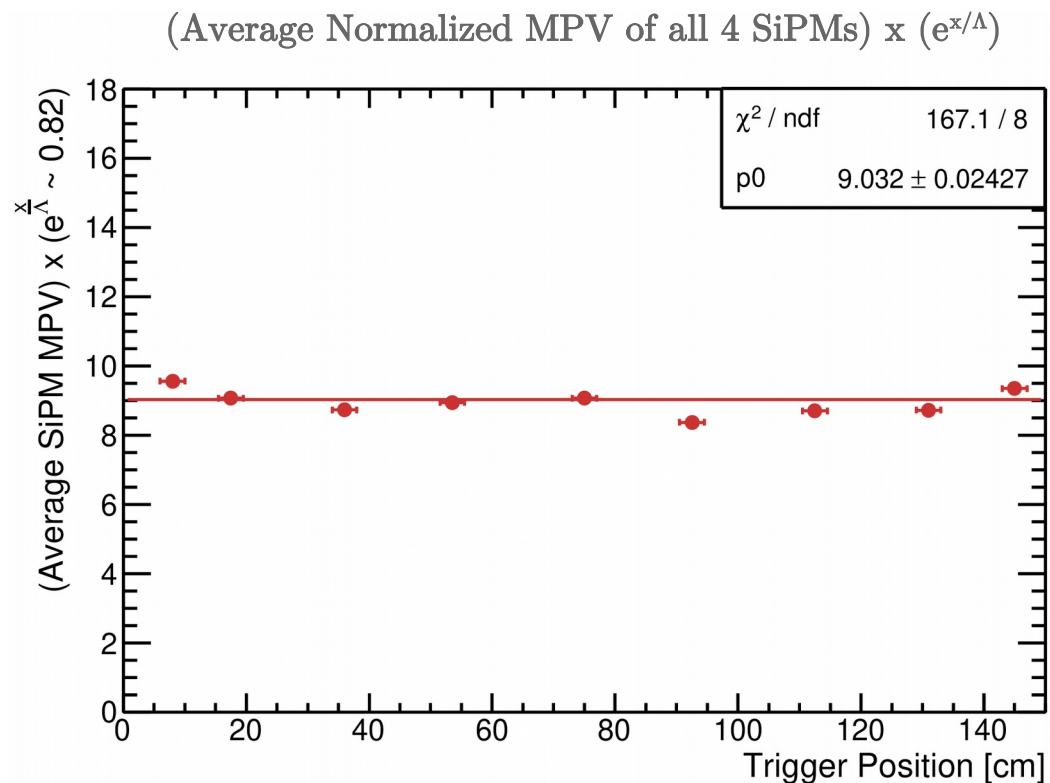
On average: 4.17 p.e



All four SiPM contributions
from the 9 spectra
were fitted with a LanGaus

Each Landau MPV is plotted
wrt to the trigger position

Each resulting curve is fitted
with an exponential

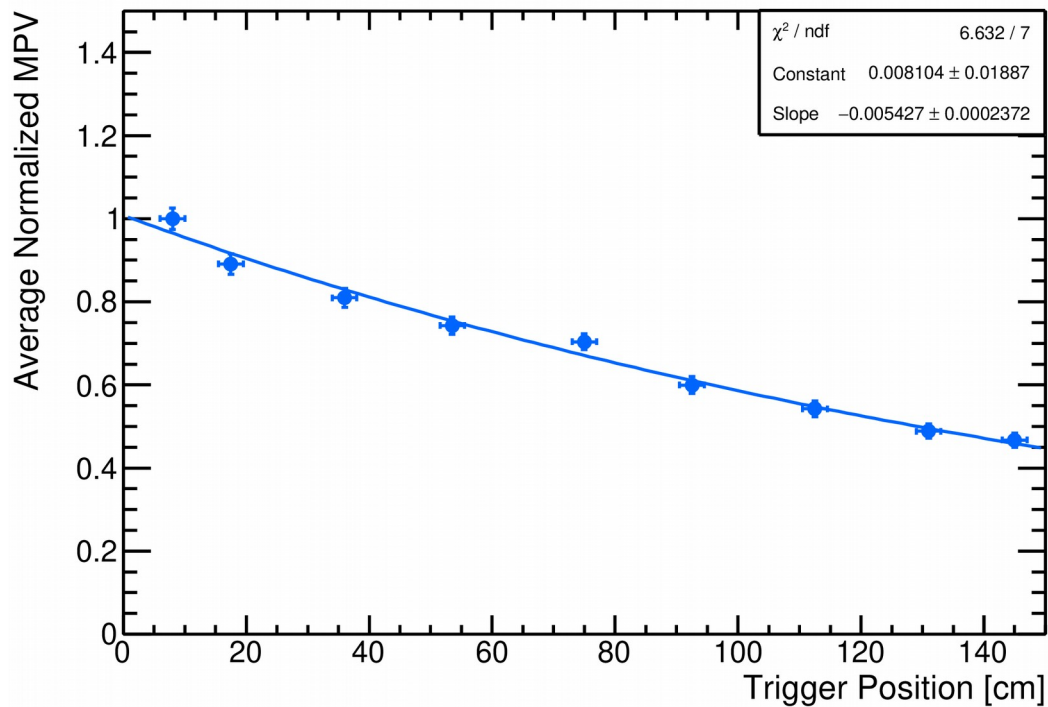


Combining the average photon count with
the average MPV extracted from the fit:

~ 46 p.e

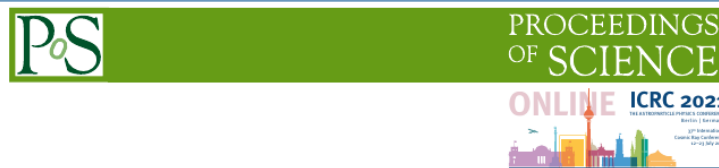
Muon Spectral Measurements

Average Normalized MPV of all 4 SiPMs w/ expo fit



Attenuation length:

$$\Lambda = 184 \pm 13 \text{ cm}$$



The Plastic Scintillator Detector of the HERD space mission

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The High Energy cosmic-Radiation (HERD) detector is one of the prominent space-borne instruments to be installed on-board the upcoming Chinese Space Station (CSS), around 2026. Primary scientific goals regarding this initiative include: precise measurements of cosmic ray (CR) energy spectra and mass composition, at energies up to the PeV range; contributions to high energy gamma-ray astronomy and transient studies; as well as indirect searches for Dark Matter (DM) particles via their annihilation/decay to detectable products. HERD is configured to accept incident particles from both its top and four lateral sides. Owing to its pioneering design, an order of magnitude increase in acceptance is foreseen, with respect to previous and ongoing experiments.

The Plastic Scintillator Detector (PSD) constitutes an important sub-detector of HERD, particularly aimed towards anti-coincidence (discriminating incident photons from charged particles), while providing precise charge measurement of incoming cosmic-ray nuclei in a range of $Z = 1 - 26$. Main requirements concerning its design, include: high detection efficiency, broad dynamic range and good energy resolution. In order to select the optimal layout, two geometries are currently under investigation: one based on long scintillator bars and the other on square tiles, with both layouts being readout by Silicon Photomultipliers (SiPMs). Ongoing activities and future plans regarding the HERD PSD will be presented in this work.

Poster & Paper in preparation

Representative plots and pics
from the tile layout regarding
ongoing lab tests will be useful

Construction, calibration and test of 1.5m BC-404 w/ AdvanSiD SiPMs

Working point selection w/ muon triggers

Gain calculation from exported charge spectra

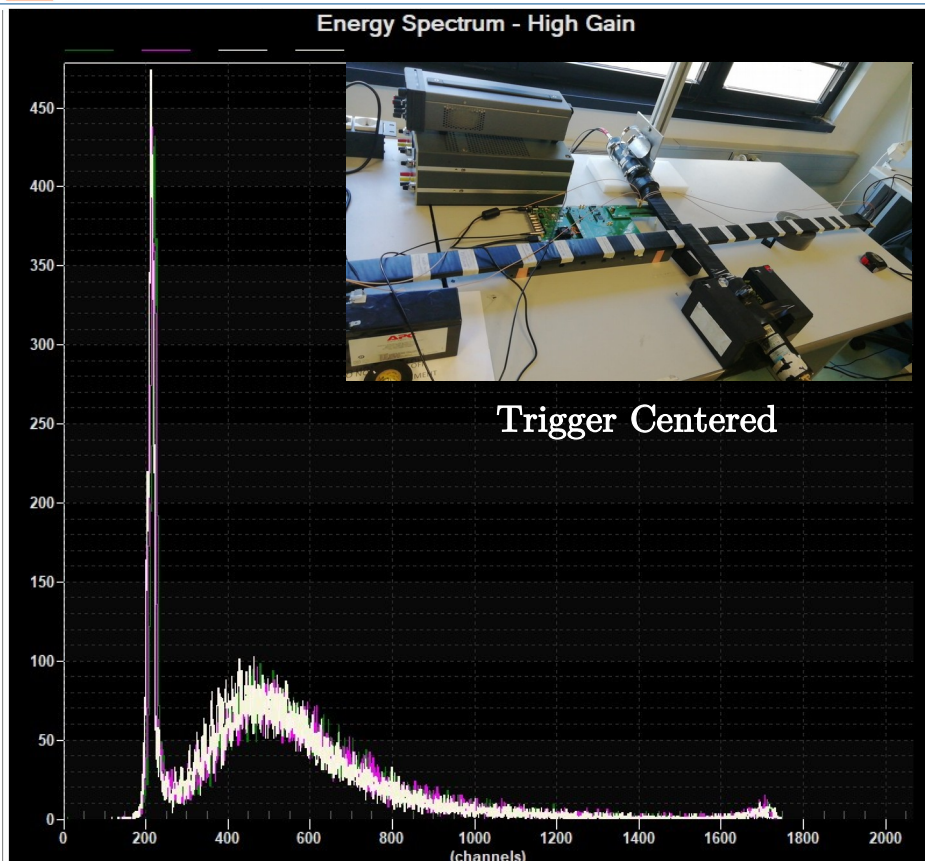
Background estimation w/ muon trigger placed away from the bar

Muon data acquired in 9 trigger positions

LanGaus fits on all exported charge distributions

X – plot derived from all MPVs

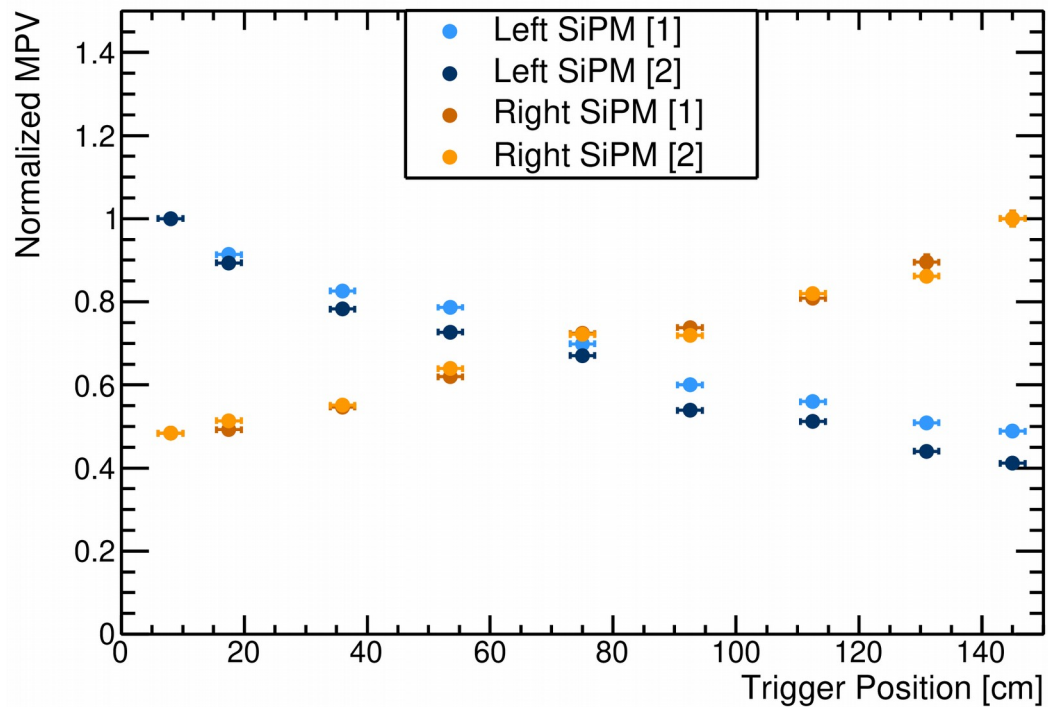
Calculation of light attenuation length & average p.e in each trigger position

ONGOING
WORK

Reproduction of aforementioned measurements with the CAEN DAQ
under the same configuration.

Additional Info

X – plot normalized to 1 (according to the each SiPM side)



X – plot with logY

