ECAL read-out with SiPM
Status of the test

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Test setup (I)

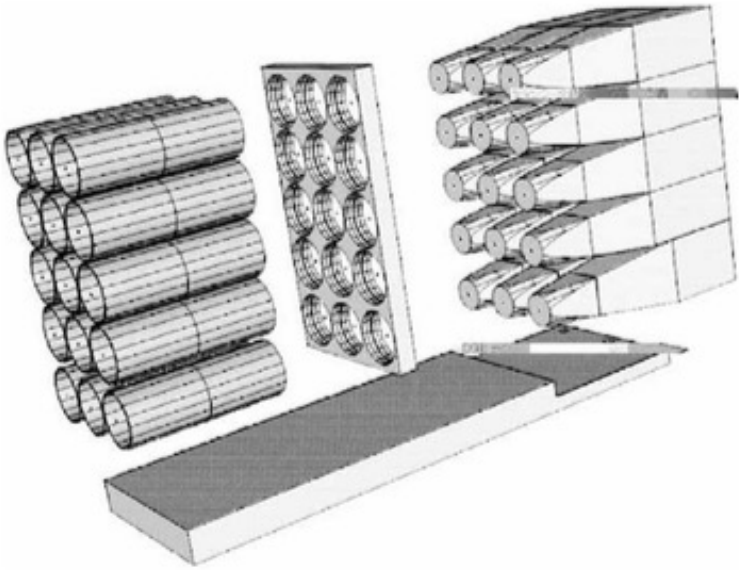
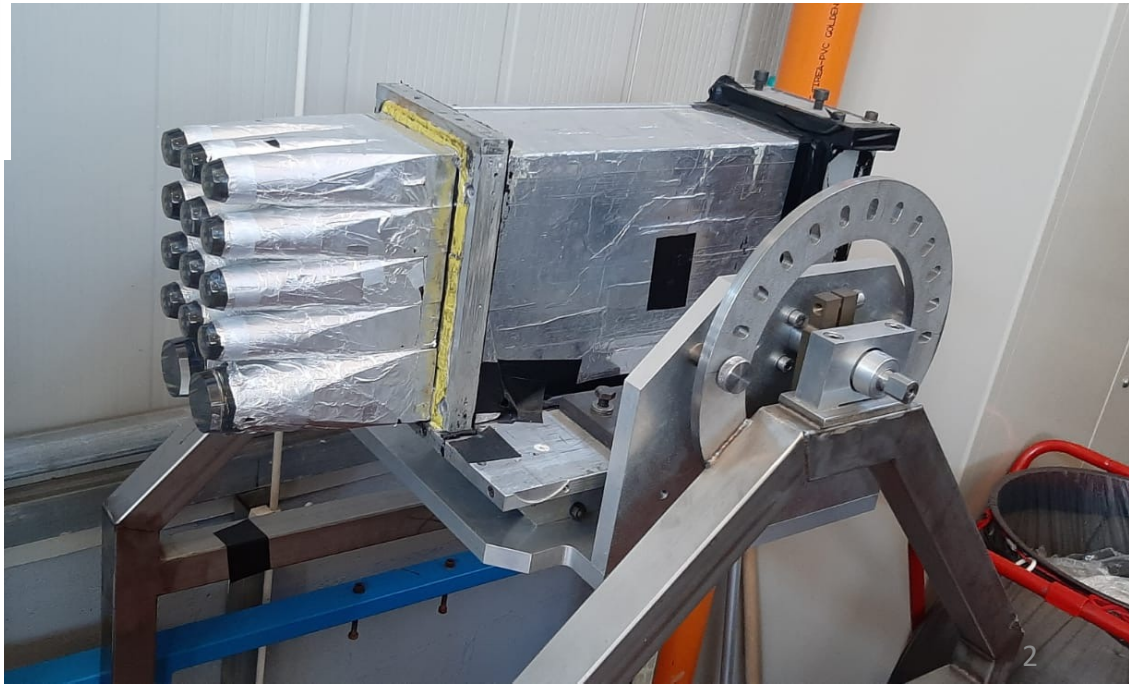


Fig. 4. Exploded view of the PM box.

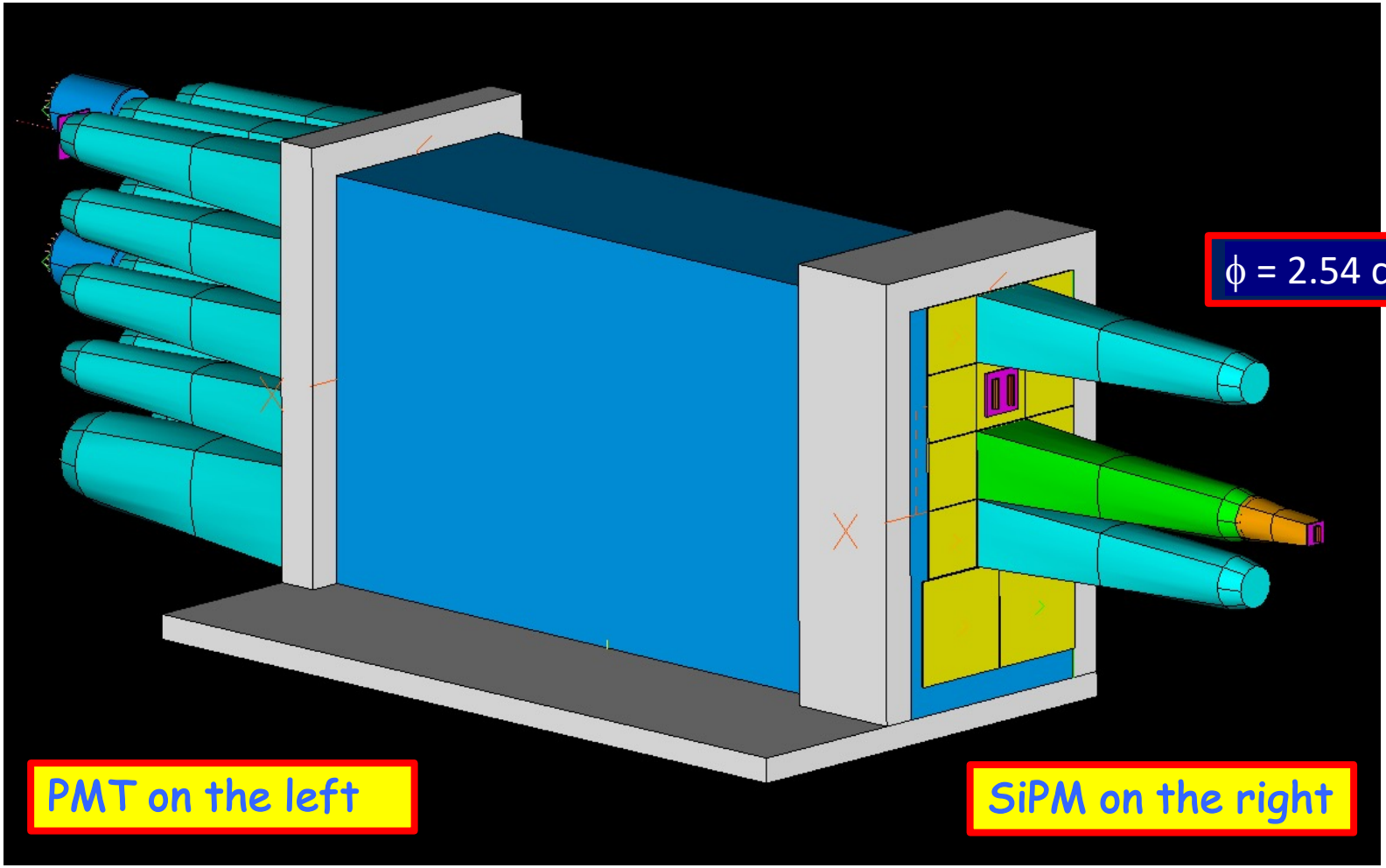
ECal in SAND is a lead-scintillating fiber sampling calorimeter

PMTs (Hamamatsu R5946/01) were used for the readout in KLOE

A slice of ECAL
(with Hamamatsu PMT)
is available in Lecce
for test and measurements

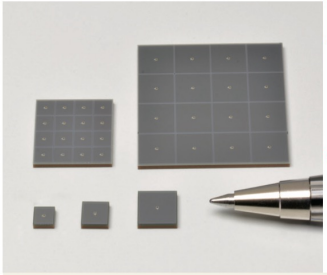


Test setup (II)



HAMAMATSU
PHOTON IS OUR BUSINESS

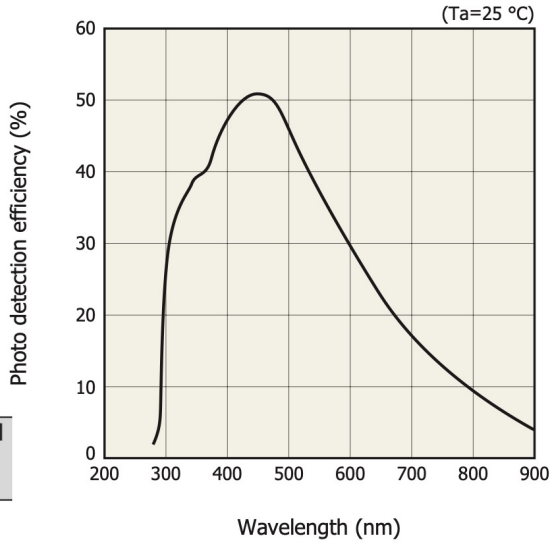
MPPC® (Multi-Pixel Photon Counter)



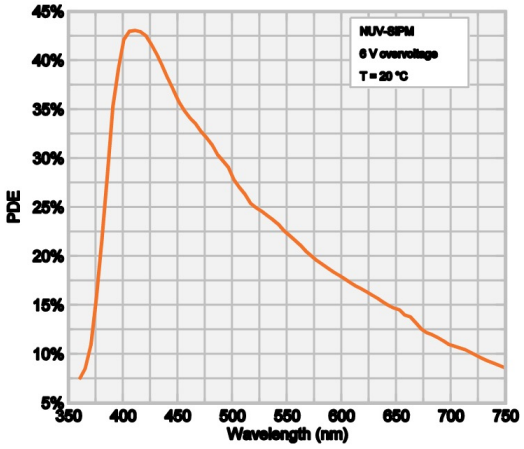
S14160/S14161 series

Low breakdown voltage type MPPC for scintillation detector

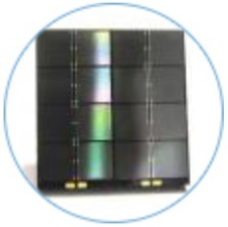
Typ. no.	Number of channels (ch)	Effective photosensitive area/channel (mm^2)	Pixel pitch (μm)	Number of pixels/channel	Package	Window	Window refractive index	Geometrical fill factor (%)
S14160-3050HS	1	3.0 × 3.0	50	3531	Surface mount type	Silicone	1.57	74
S14160-4050HS		4.0 × 4.0		6331				
S14160-6050HS		6.0 × 6.0		14331				
S14161-3050HS-04	16 (4 × 4)	3.0 × 3.0		3531				
S14161-3050HS-08	64 (8 × 8)	3.0 × 3.0		3531				
S14161-4050HS-06	36 (6 × 6)	4.0 × 4.0		6331				
S14161-6050HS-04	16 (4 × 4)	6.0 × 6.0		14331				



λ_{MAX} = 450 nm
PDE_{MAX} = 50 %



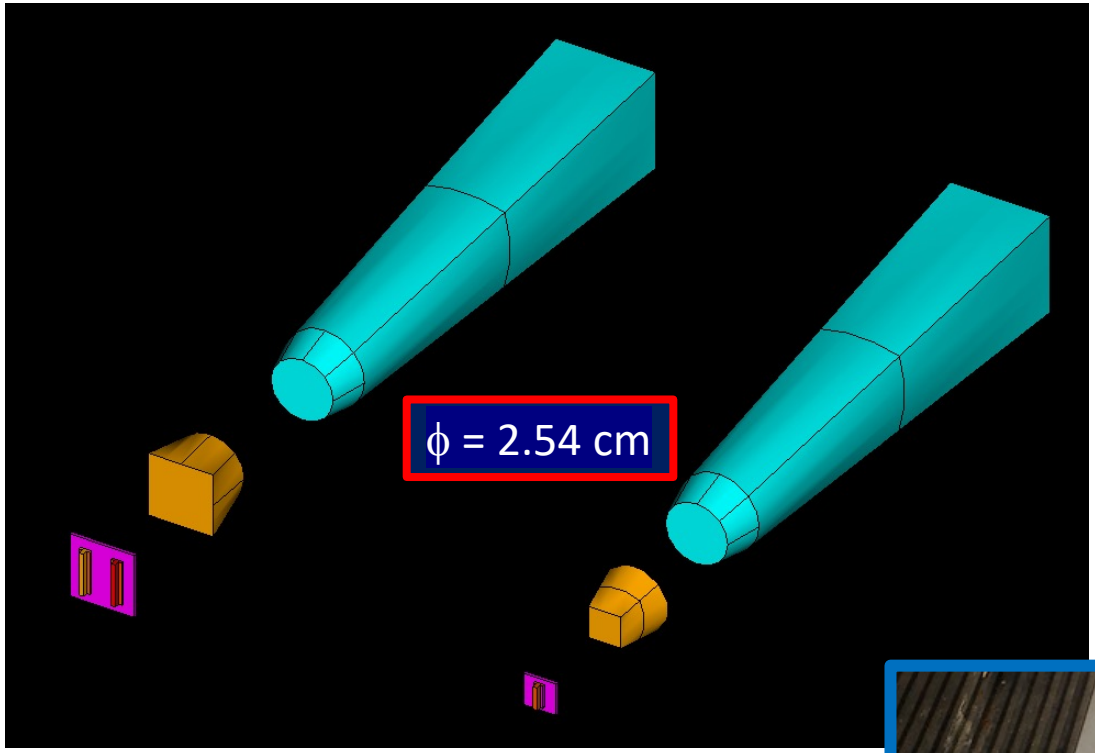
λ_{MAX} = 420 nm
PDE_{MAX} = 43 %



AdvanSiD
Advanced Silicon Detectors

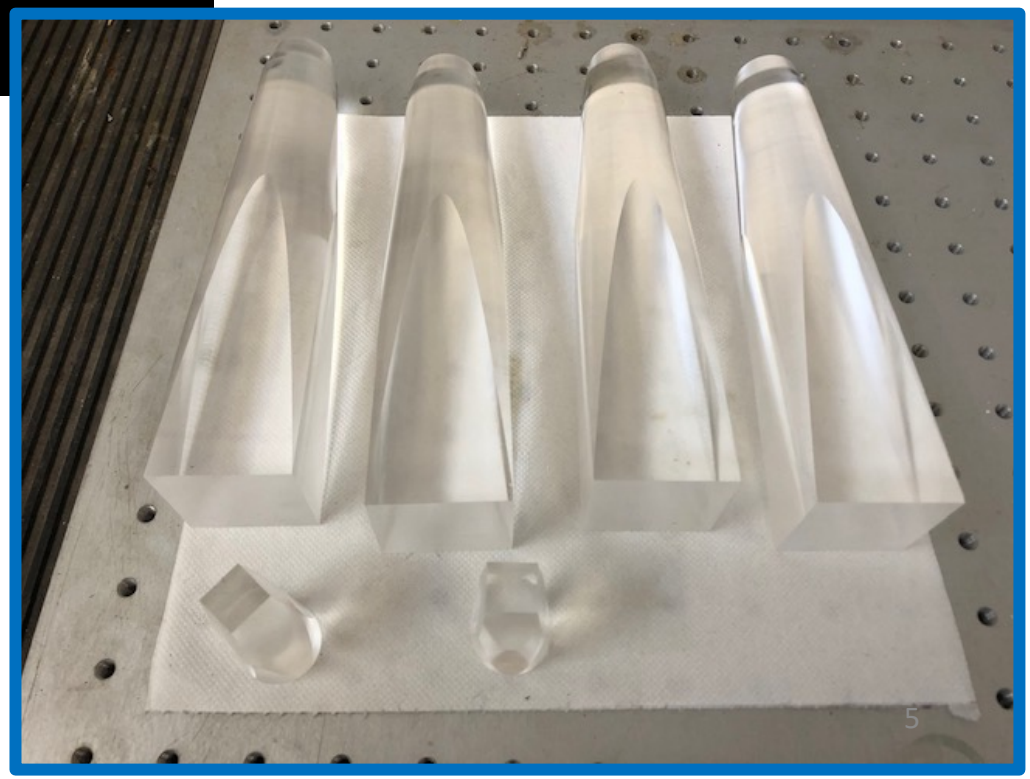
ASD-RGB4S-P-4x4TD, ASD-NUV4S-P-4x4TD

4x4 Hybrid Array of 4x4 mm^2 SiPMs in plastic chip scale package. The detector is completely covered with transparent epoxy layer.

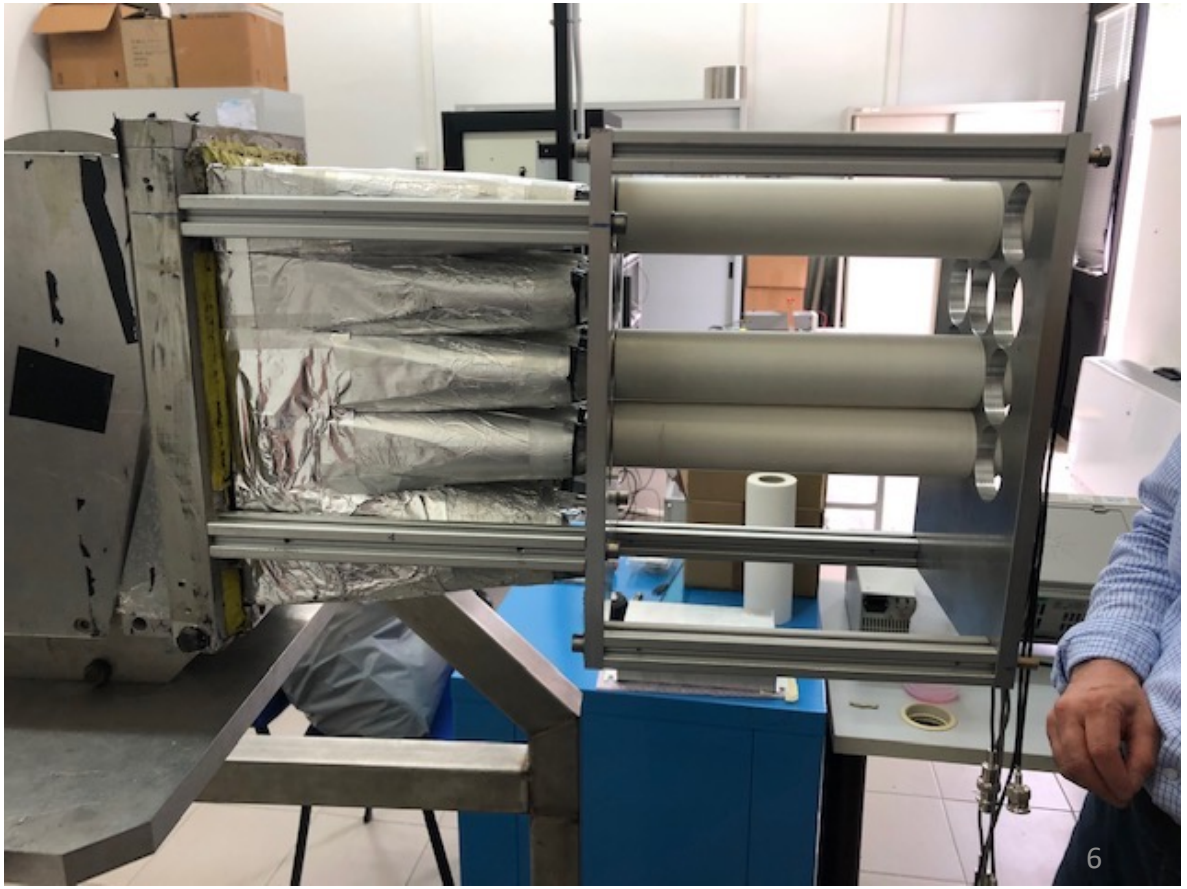


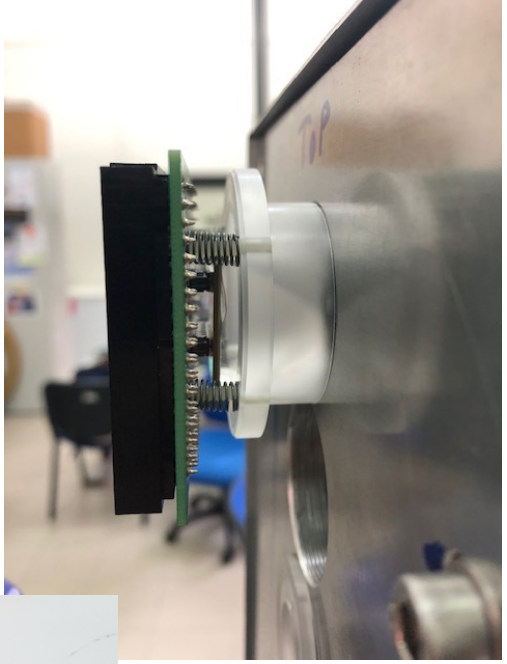
Coupling surfaces

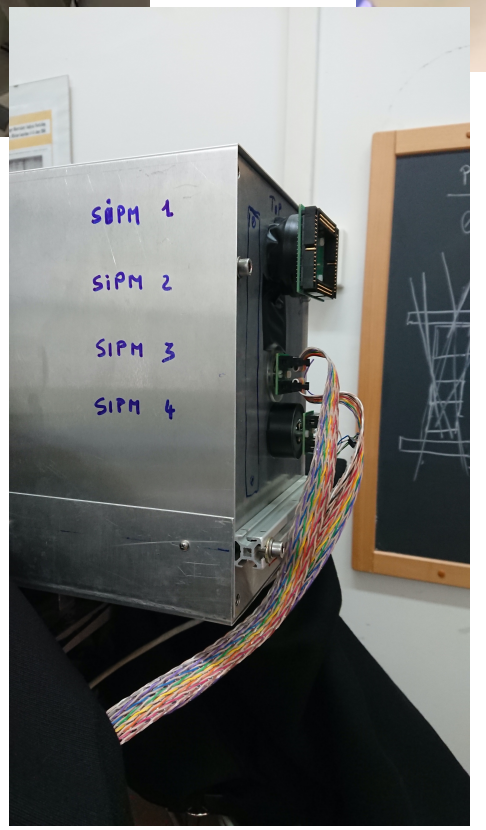
Light guide	490 mm²
4x4 SiPM	169 mm²
8x8 SiPM	666 mm²

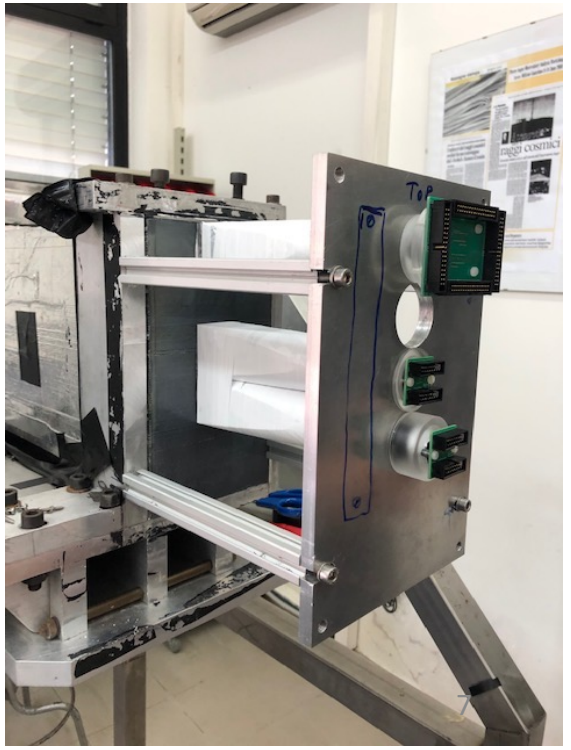


PMT coupling





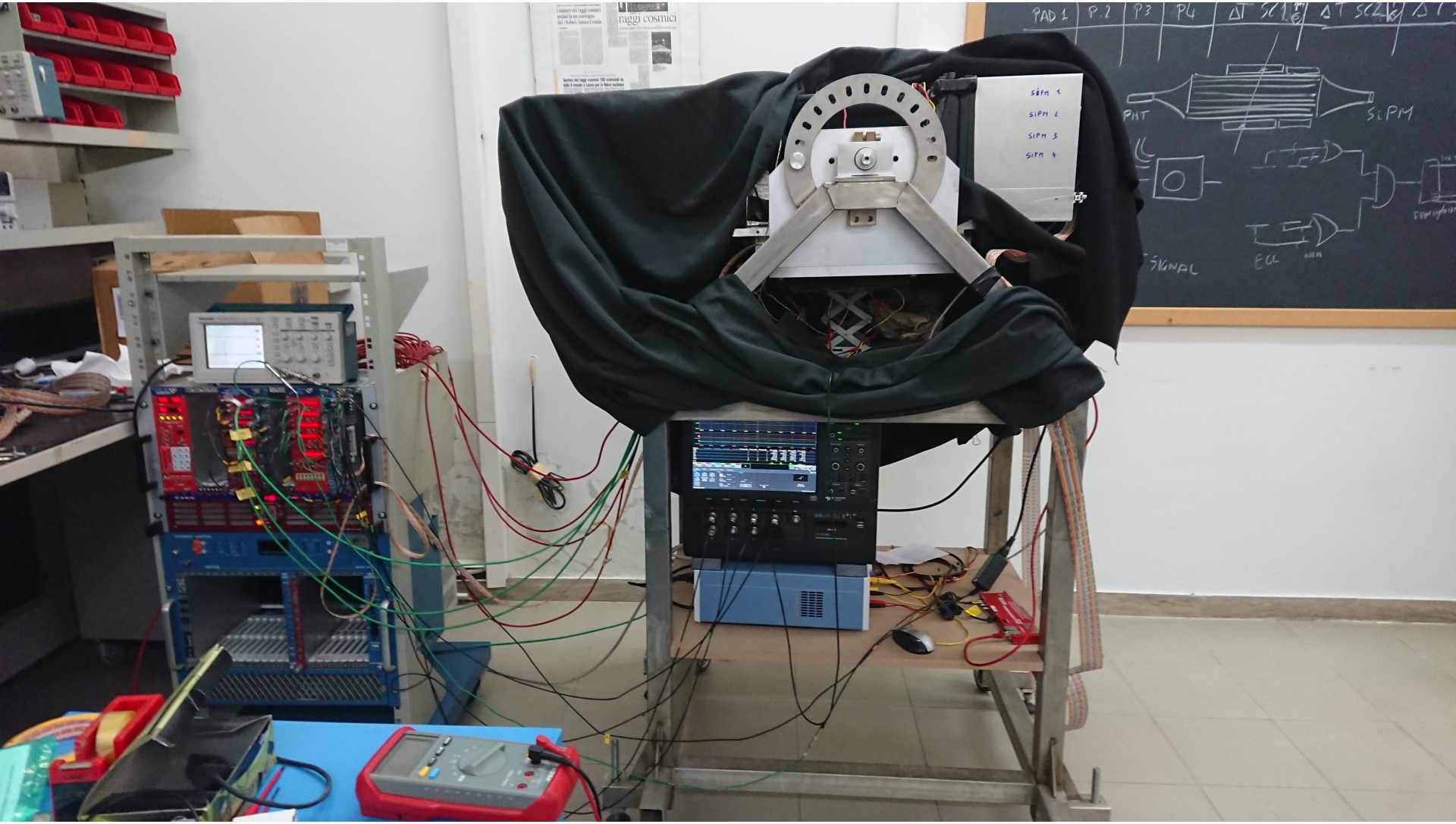




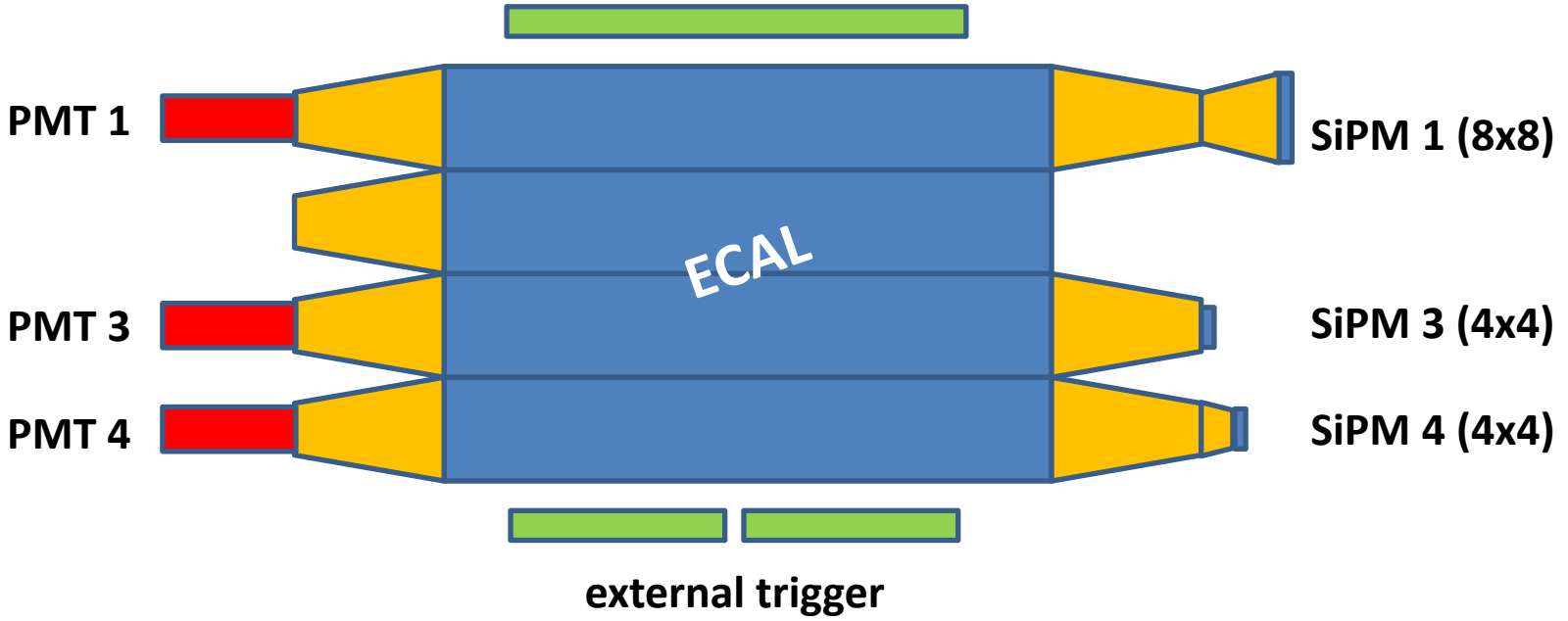
SiPM coupling

Twisted cables substituted with coaxial cables

the LAB



EXPERIMENTAL SETUP



Present

"internal" trigger PMT 1 && PMT 4

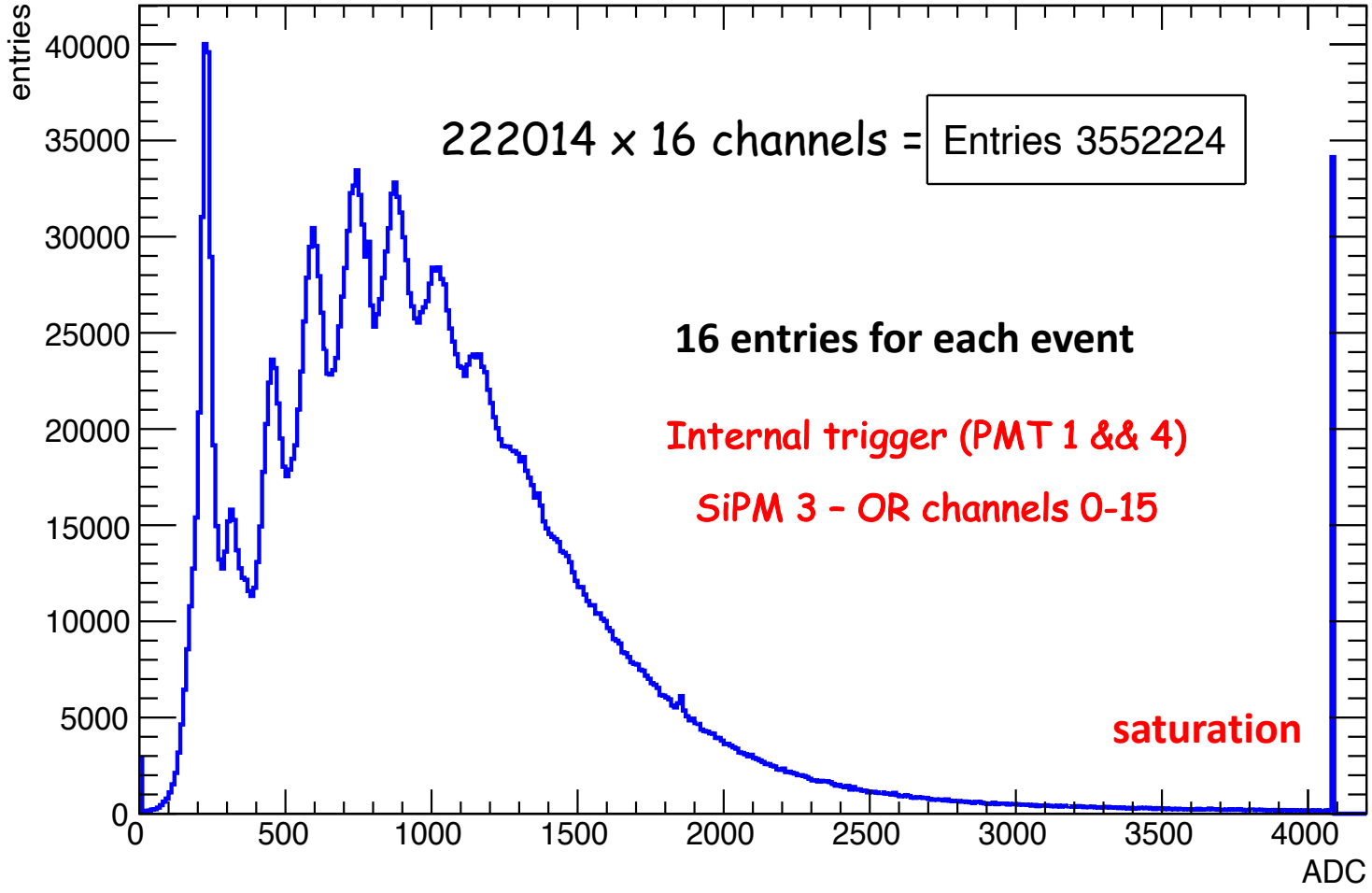
readout of all (16) channels of SiPM 3
readout of half (8) channels of SiPM 4

SiPM threshold and gain to be tuned

rate ~ 0.8 Hz with cosmic rays

Bias due to "internal" trigger

single SiPM spectrum



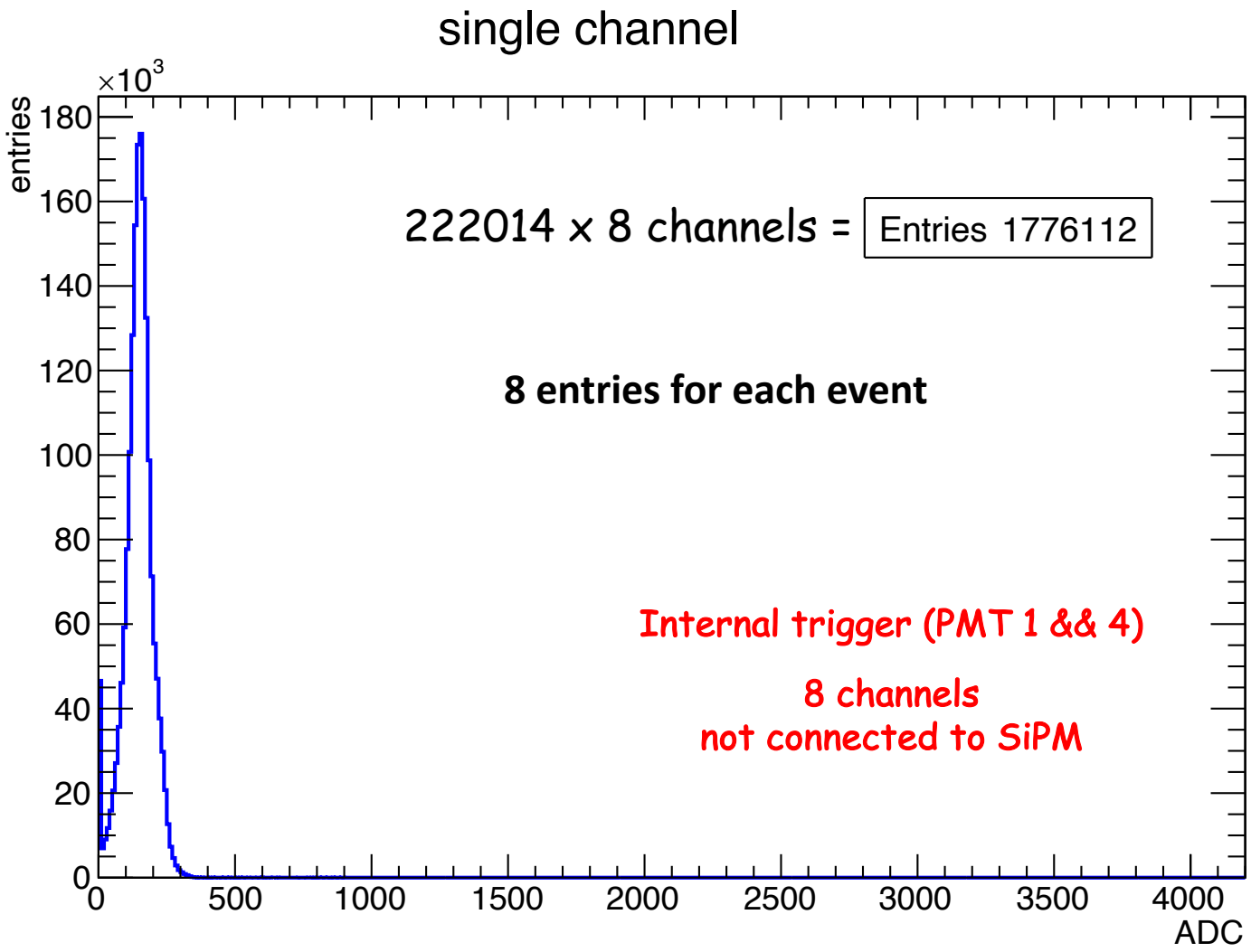
peak	Center (ADC)	Sigma (ADC)
1	228	42
2	317	53
3	461	53
4	596	62
5	744	80
6	876	96
7	1010	132
8	1145	129
9	1254	198

Channel-by-channel calibration is feasible by means of V_{BIAS} tuning

An improvement of the spectrum is expected, but …

… the SiPM stability must be checked

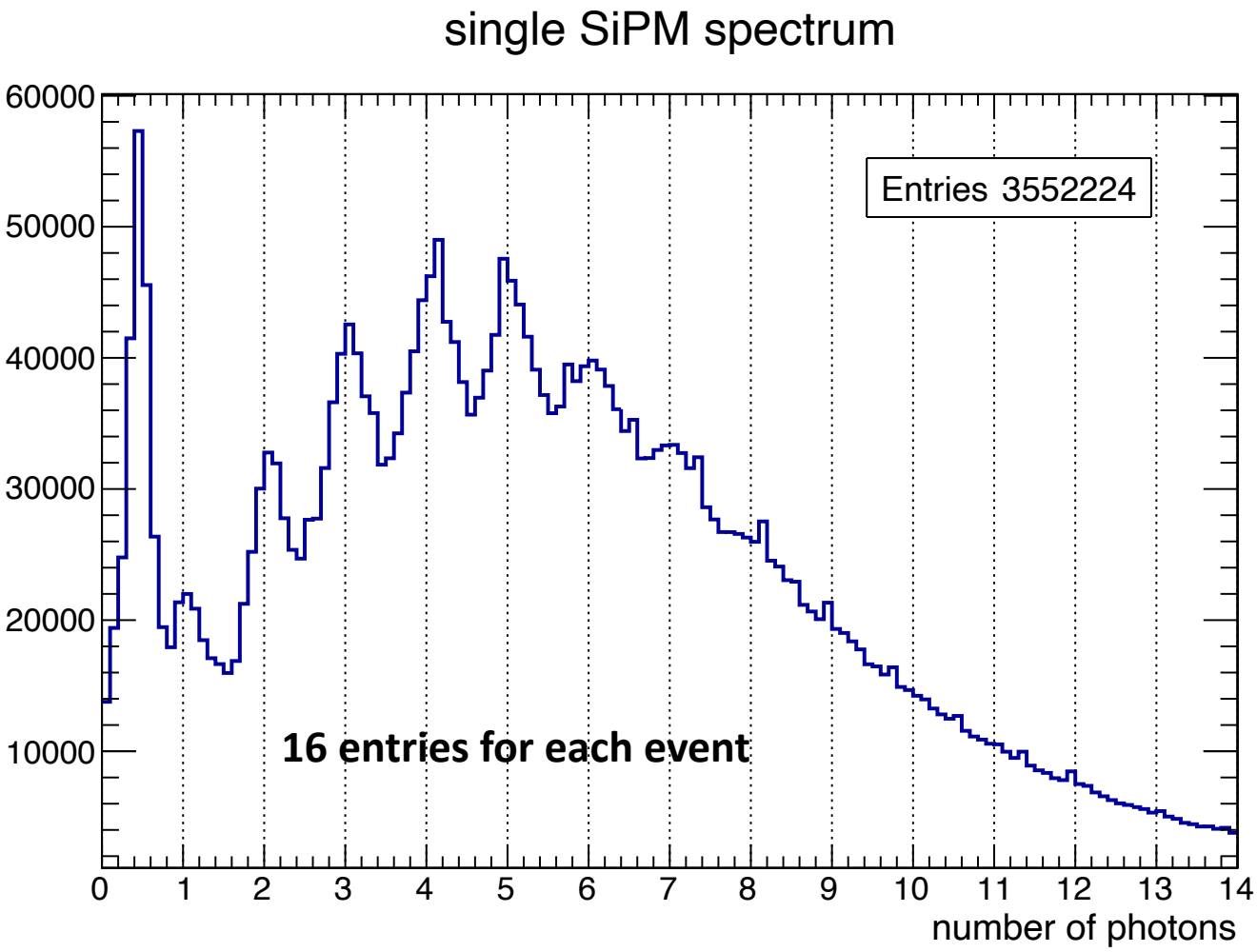
Only electronics noise (CAEN DT5702)



Peak 149
Sigma 46

Formula from the fit of ADC spectrum

Number of photons = 0.00708 ADC - 1.16

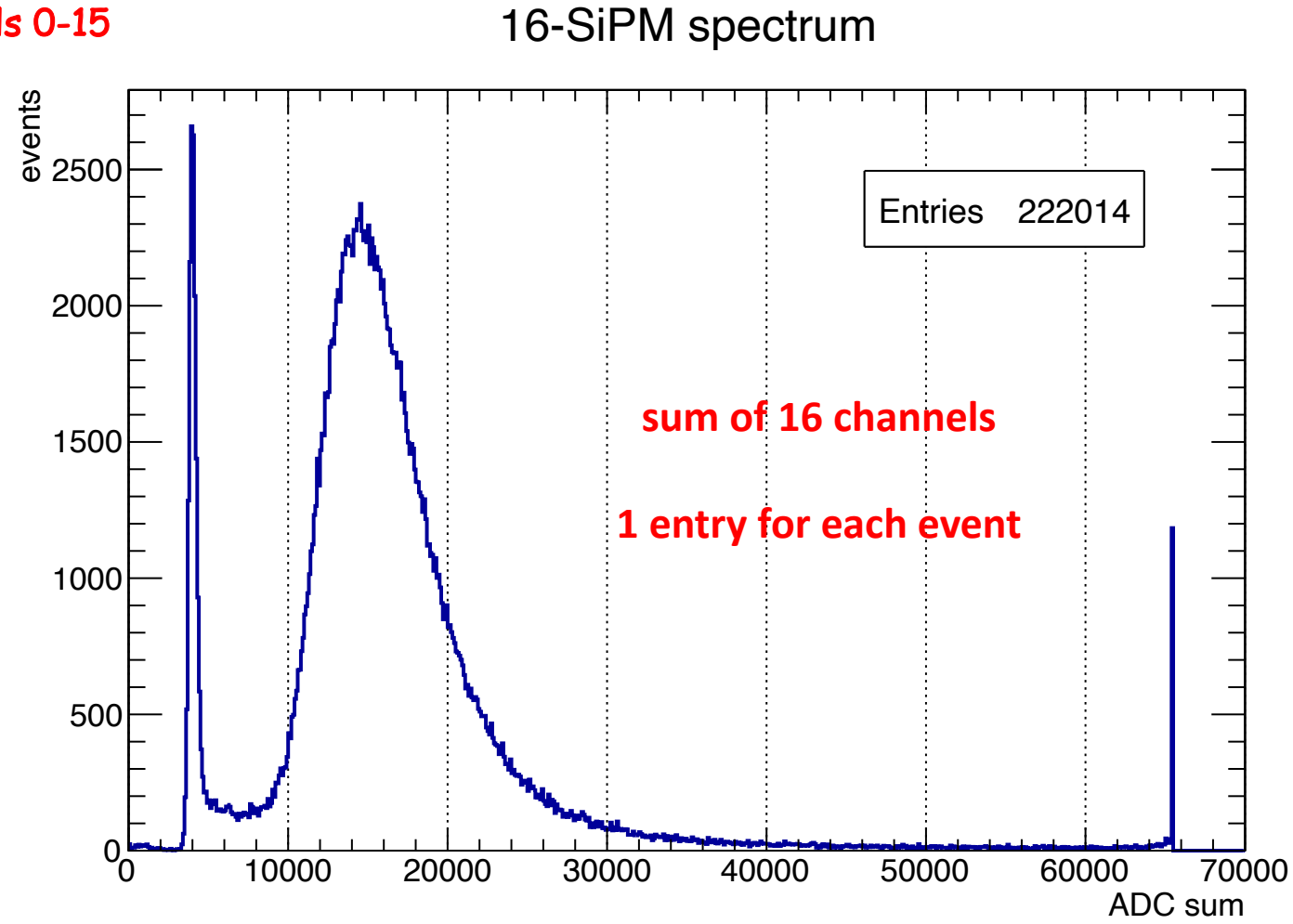


Internal trigger (PMT 1 && 4)

SiPM 3 – OR channels 0-15

Internal trigger (PMT 1 && 4)

SiPM 3 – OR channels 0-15

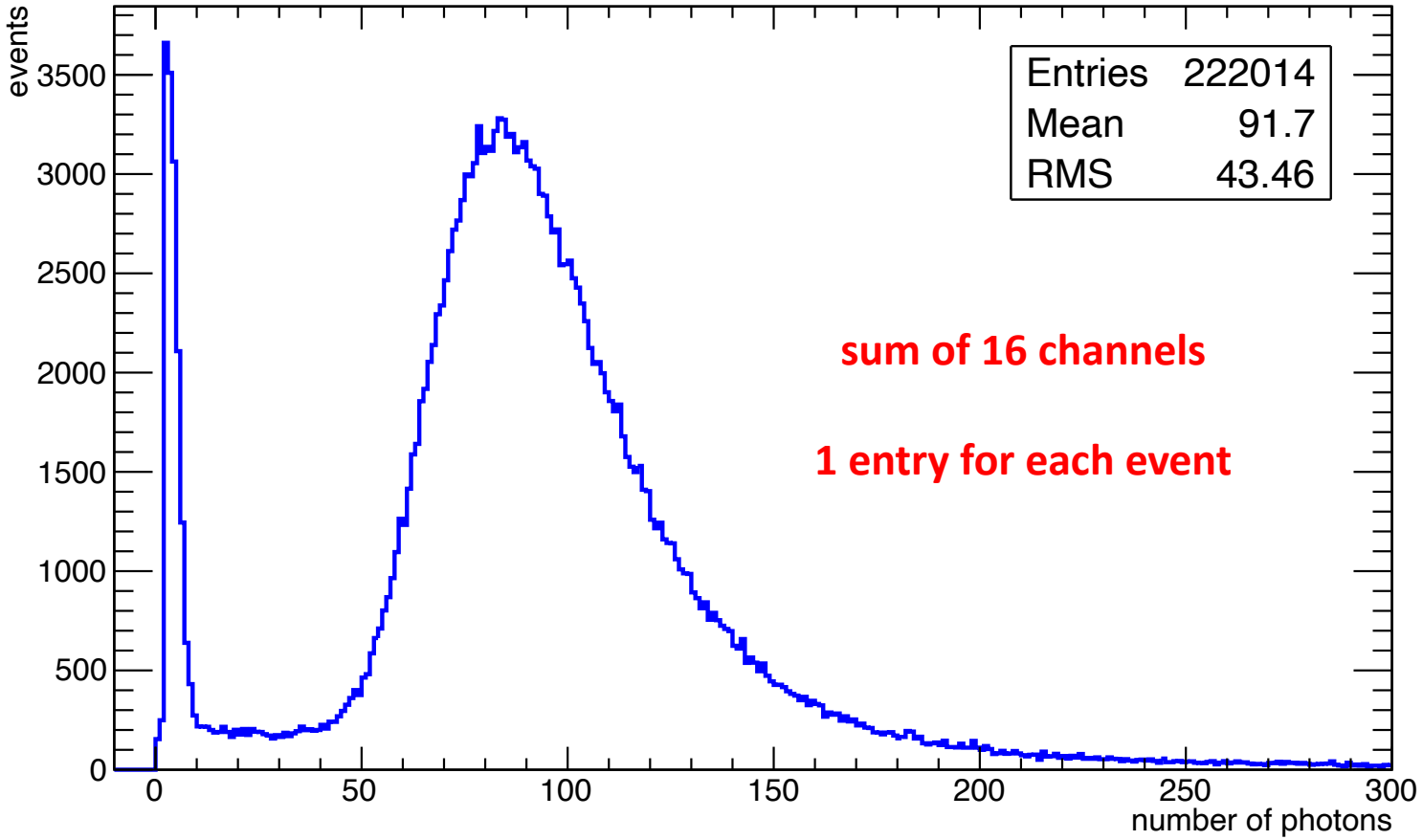


Cut effects

Σ ADC $\geq$ 5000	92.7 % surviving
Σ ADC $\geq$ 9000	90.0 % surviving

The ADC-photon formula is used channel-by-channel

16-SiPM spectrum



Cut effects

$n_\gamma \geq 3$ 98.3 % surviving

$n_\gamma \geq 10$ 93.1 % surviving

Preliminary efficiency estimate (SiPM 3)

	entries	efficiency (%)	Σ ADC ≥ 5000	Σ ADC ≥ 9000	$n_\gamma \geq 3$	$n_\gamma \geq 10$
PMT 1 && 4	6780					
PMT 3	6487	95.7 ± 1.2				
SiPM 3	6221	91.8 ± 1.2	85.1 ± 1.1	82.6 ± 1.1	90.2 ± 1.2	85.5 ± 1.1

Bias due to "internal" trigger

Threshold to be tuned

First test on SiPM 4

Very similar results

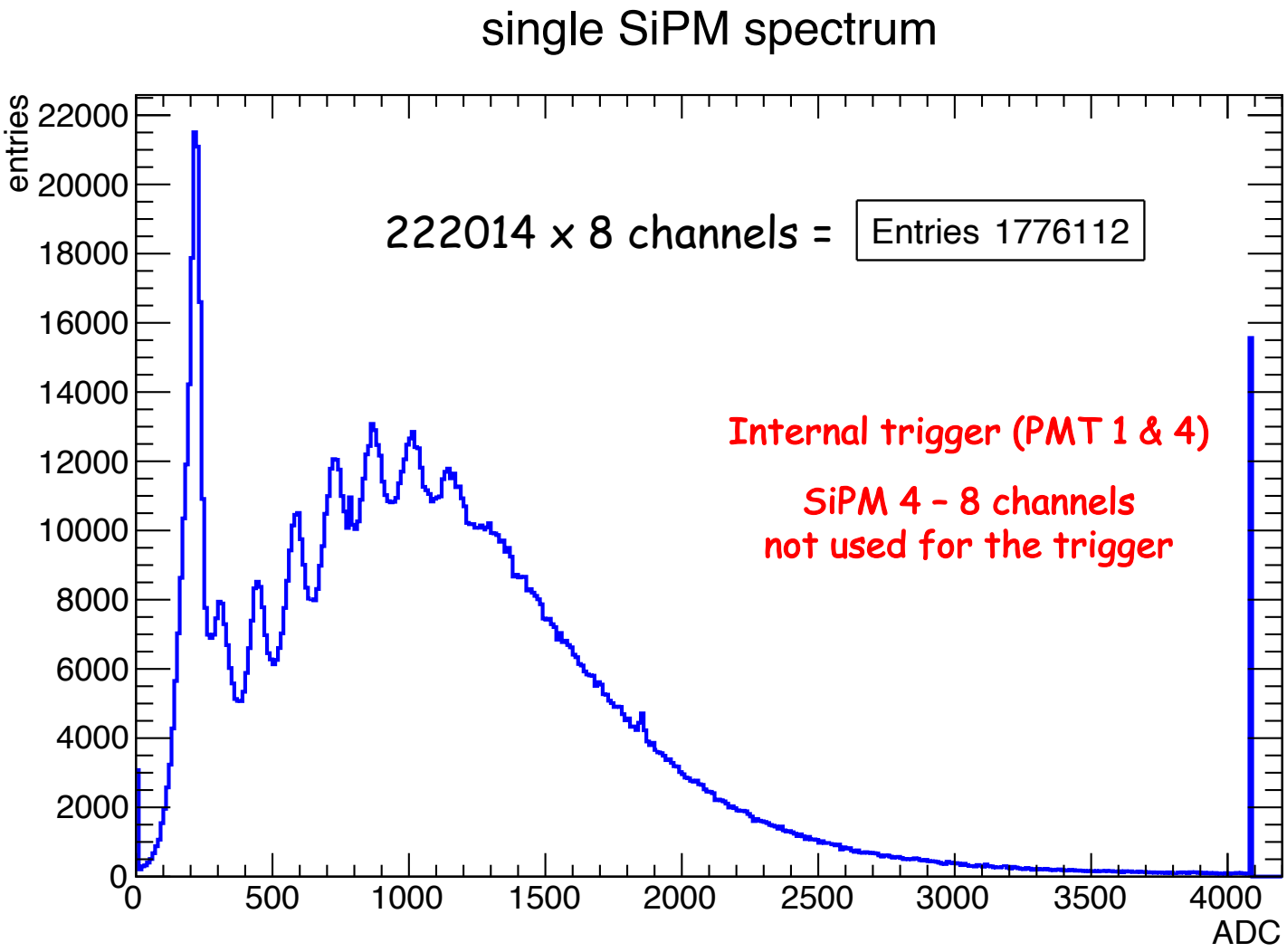
Plots in the buffer

Next steps

- To implement the external trigger
- Tuning of SiPM threshold and gain
- Efficiency measurement in different setups
- Test on the temperature effect
- … time resolution
- … energy calibration
- … dynamics (up to 1500 p.e./PMT in KLOE)

Suggestions are welcome !!! Beam test ?

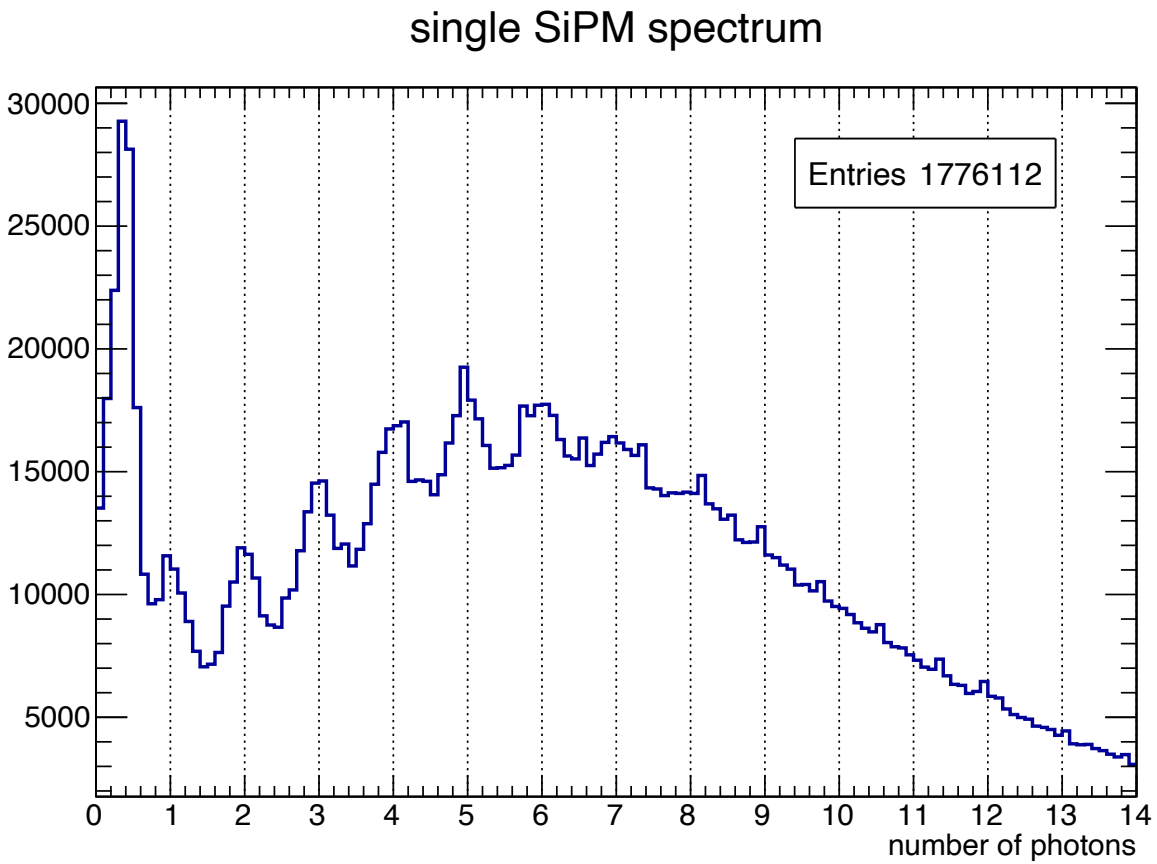
BUFFER



peak	Center (ADC)	Sigma (ADC)
1	216	27
2	306	55
3	447	57
4	587	57
5	729	64
6	871	90
7	1012	116
8	1151	116
9	1265	260

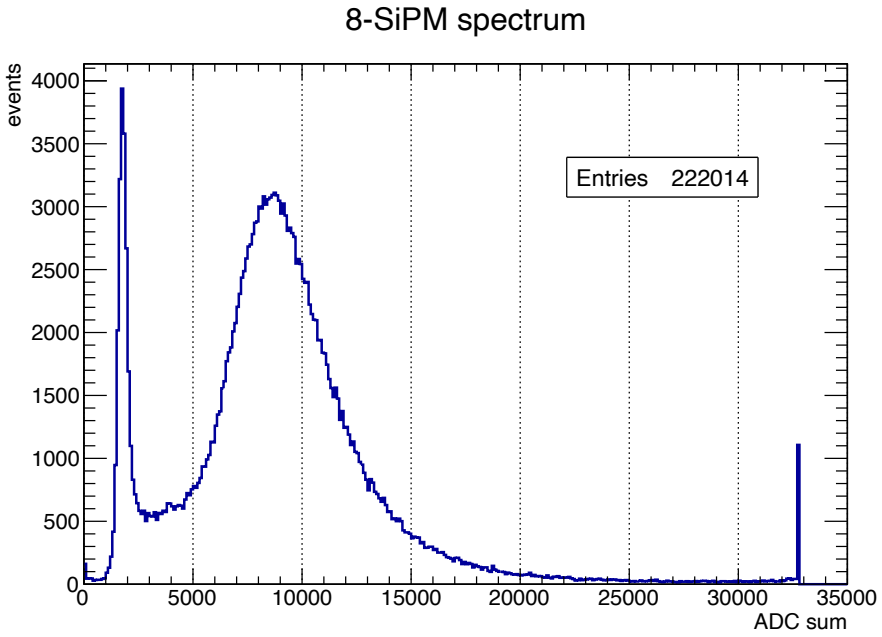
Formula from spectrum of SiPM 3

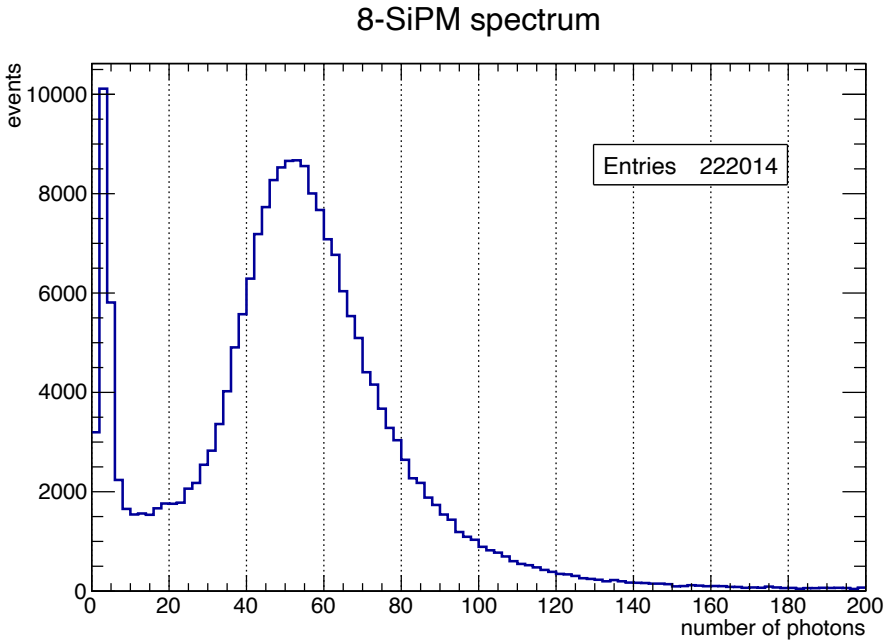
Number of photons = 0.00708 ADC - 1.16



Internal trigger (PMT 1 && 4)

SiPM 4 – 8 channels
not used for the trigger





Internal trigger (PMT 1 & 4)

SiPM 4 – 8 channels
not used for the trigger