Università Degli Studi di Padova

Characterization of segmented detectors for nuclear structure's study

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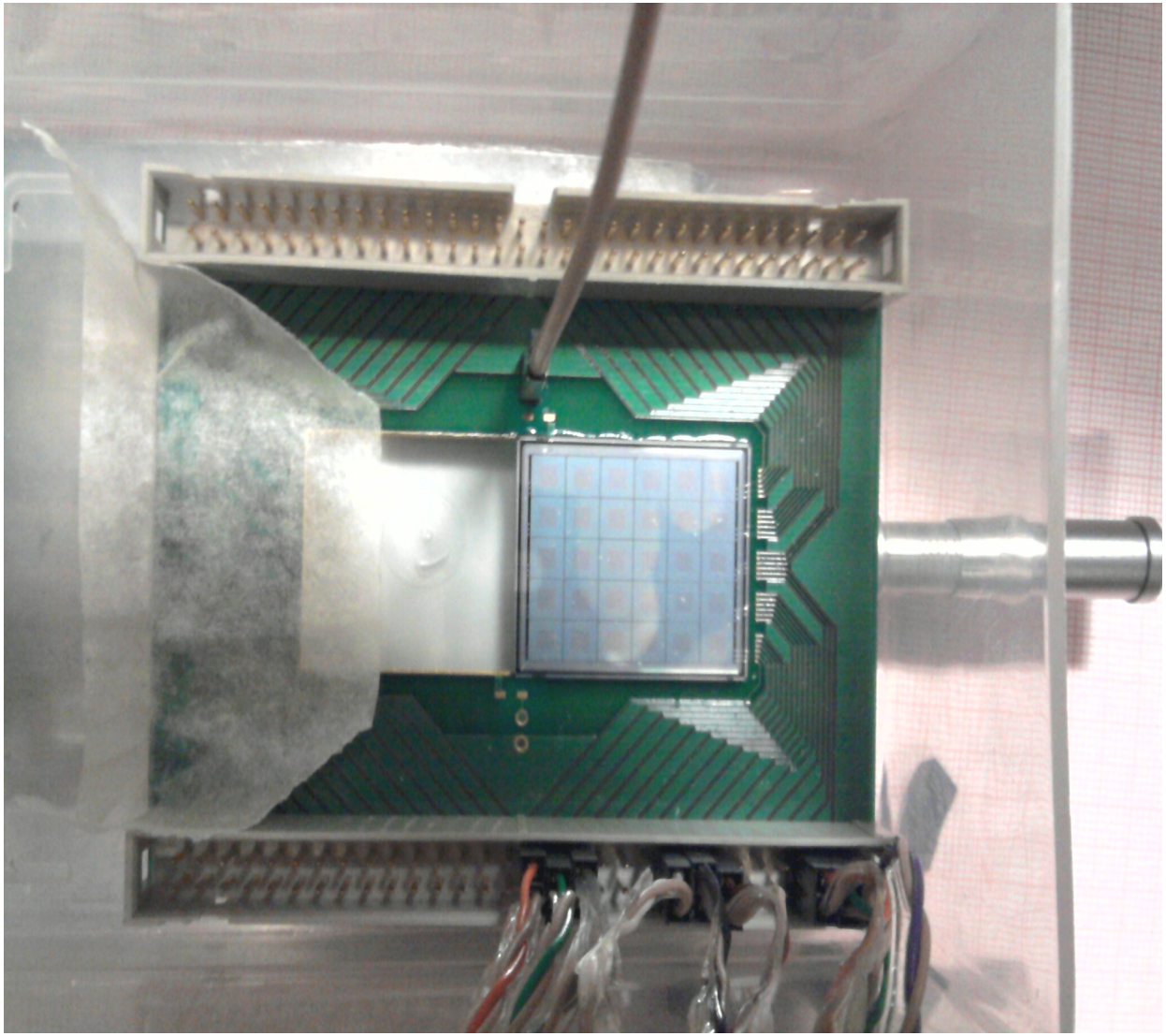
Outlook

- Estimated active area of the detector.

- Study of the detector's efficiency (interpad).

Experimental Set-Up

Early TRACE Prototype



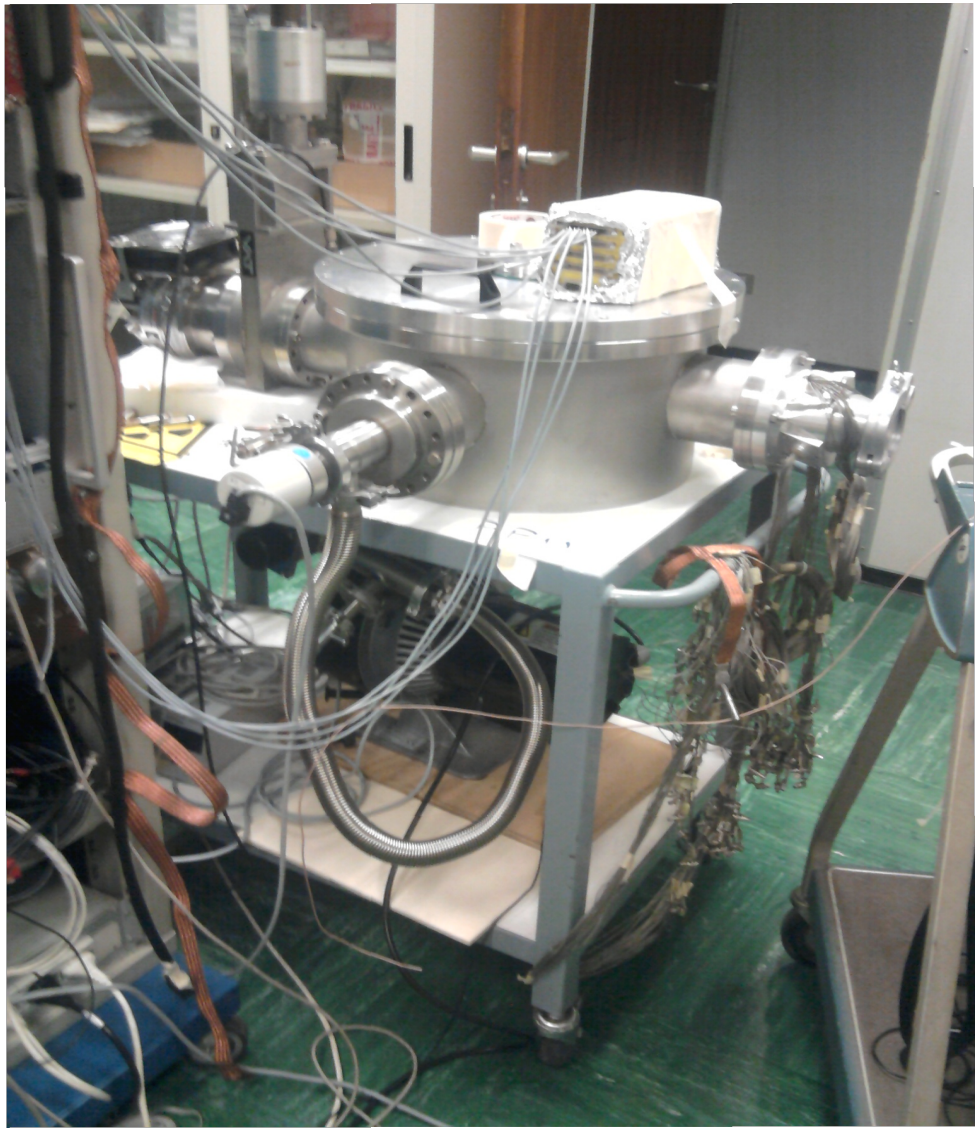
Segmentated detector (30 pads).

Thinkness: 1mm.

Dimensions provided by the builder: (2,5 x 2) cm.

N-p junction obtained by *diffusion doped.*

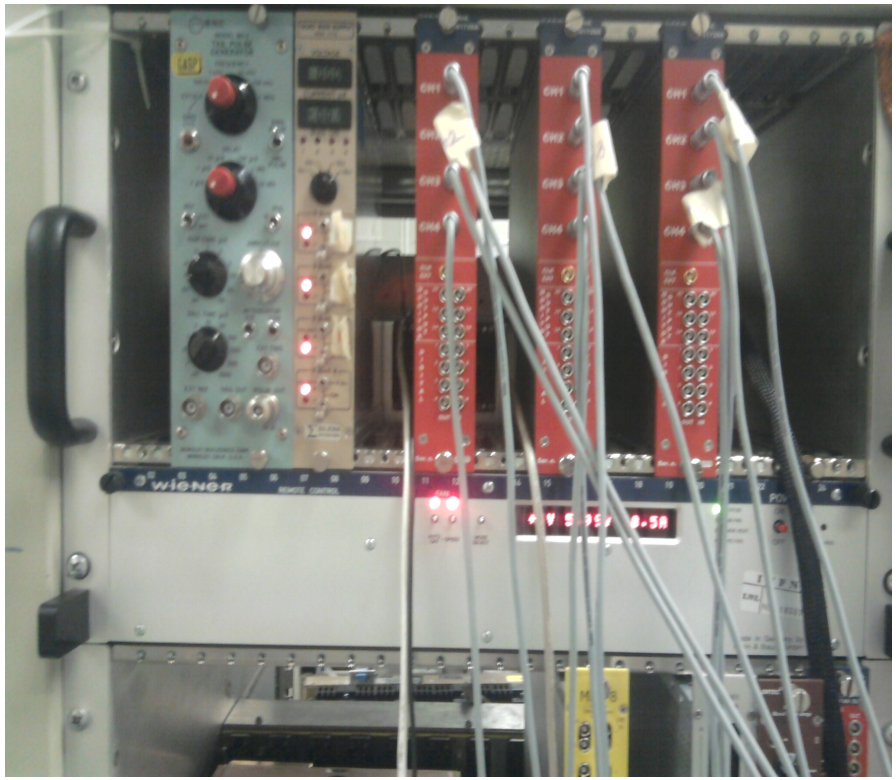
Vacuum system

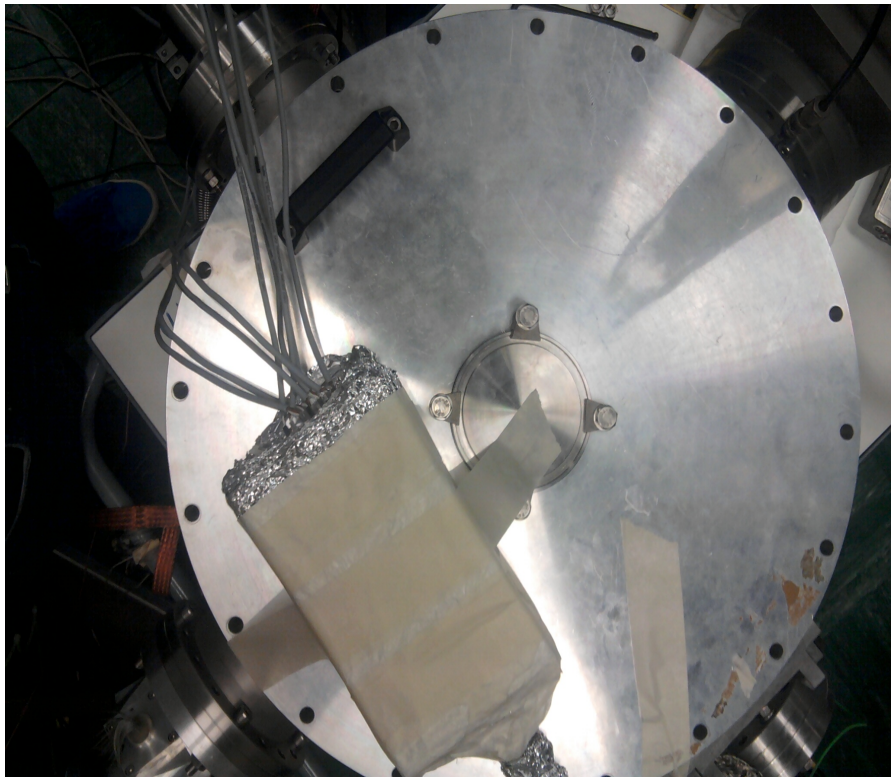


- Reaction chamber.
- Pomp: scroll (~10^{-2} mbar)
  turbo (~10^{-5} mbar)
- Gauge: Active Pirani Gauge X (range: 1000 mbar ÷ $5 \cdot 10^{-9}$ mbar)
- Vacuum : ~$6 \cdot 10^{-2}$ mbar.

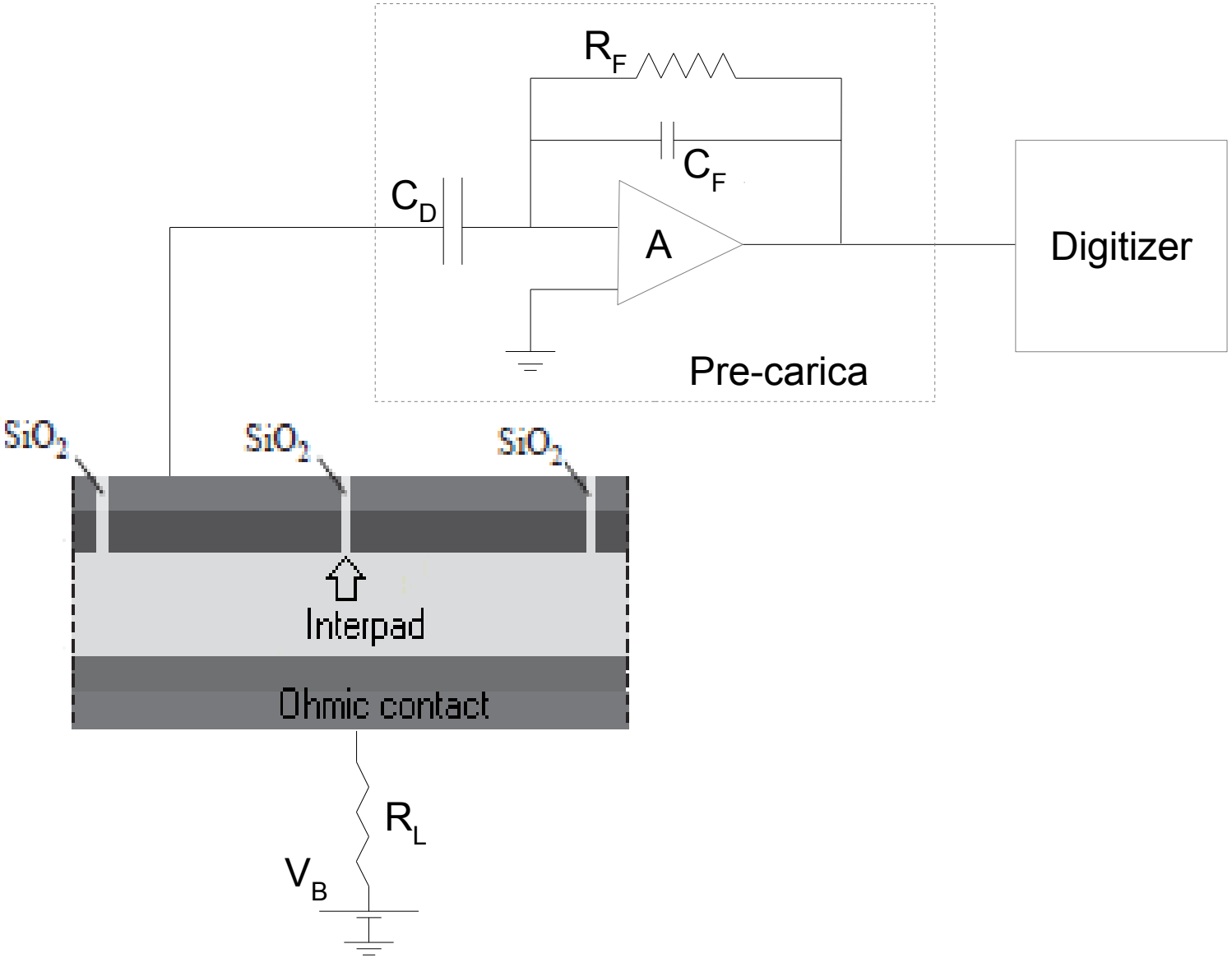
Electronic

- FEE: Commercial Preamplifier Mesytec (Amplification = 3 mV/fC, risetime$_{minimo}$ at 0 pF = 12ns and noise (KeV) = 3 ± 0.04/pF).
- BEE e DAQ: Three Commercial CAEN digitizers (14 bit, 100 MHz).





Electronic scheme

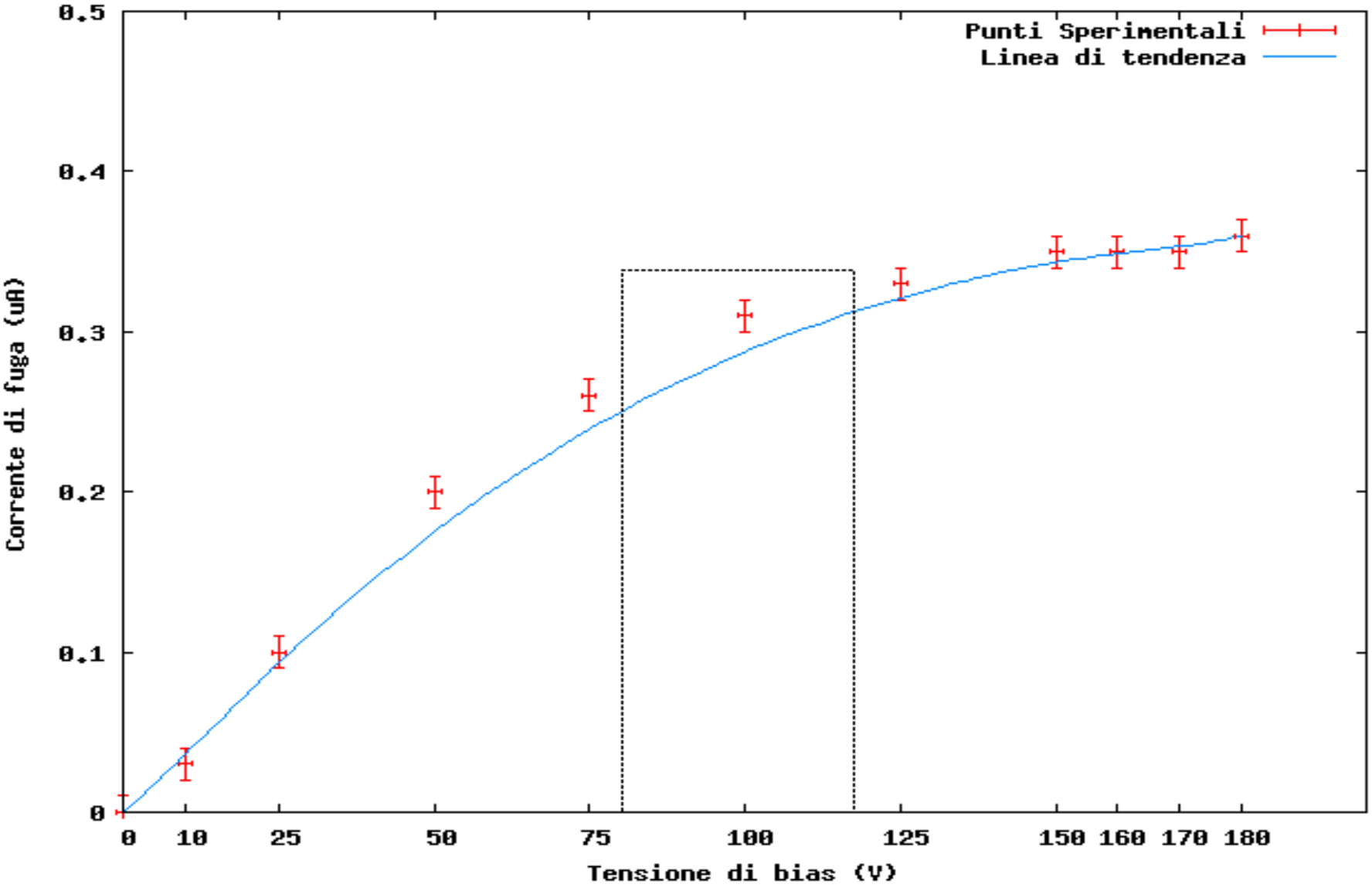


Experimental Measurements

1. Calibration

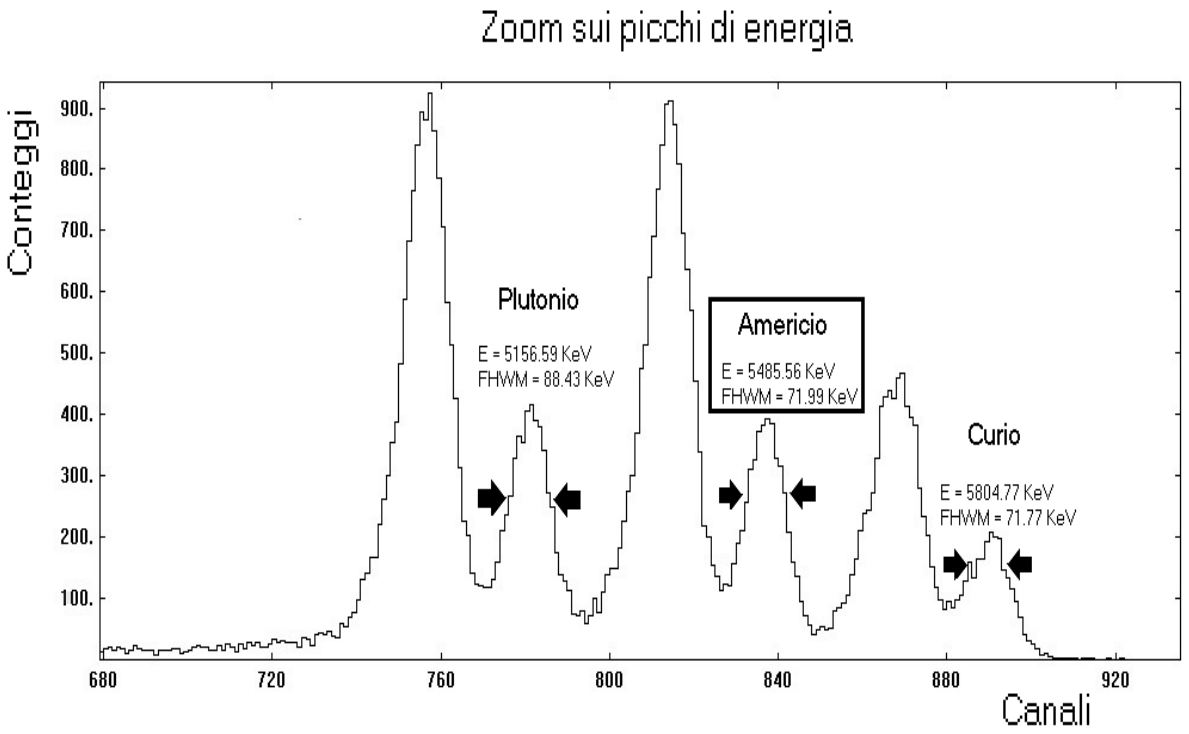
- Triple source ^{239}Pu, ^{241}Am e ^{244}Cm

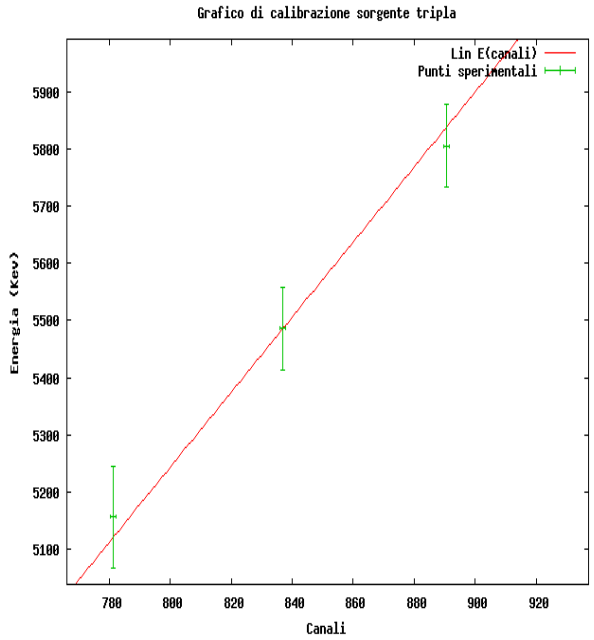
Depletion voltage



Energy resolution

- Finally, it was decided to set a bias voltage V=80.5 V. Leakage current I=0.28 μA.



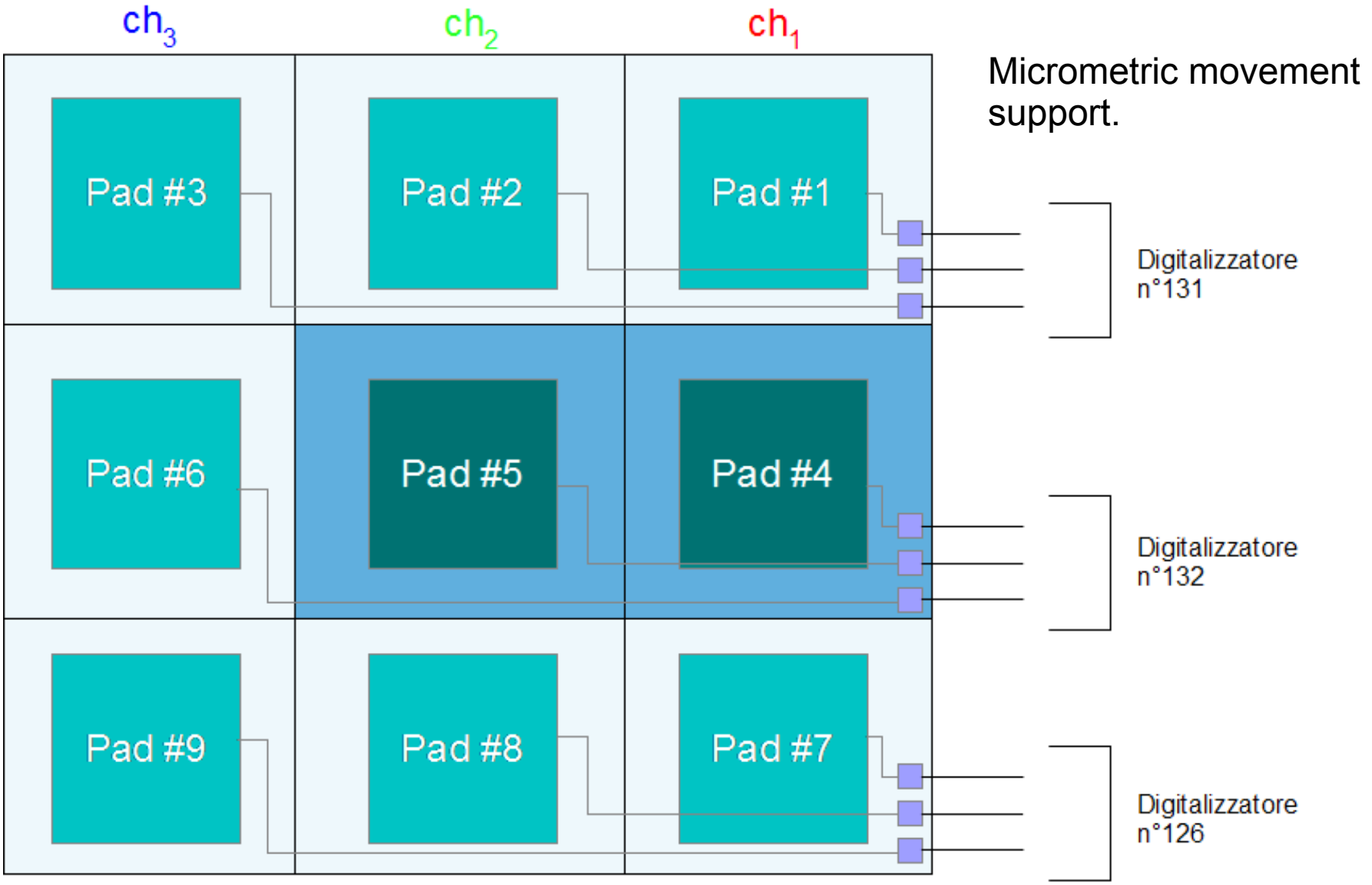


- So we obtain the parameters of the fit: m = (5.932±0.007) KeV/Chanels and c = (522 ± 6) KeV.

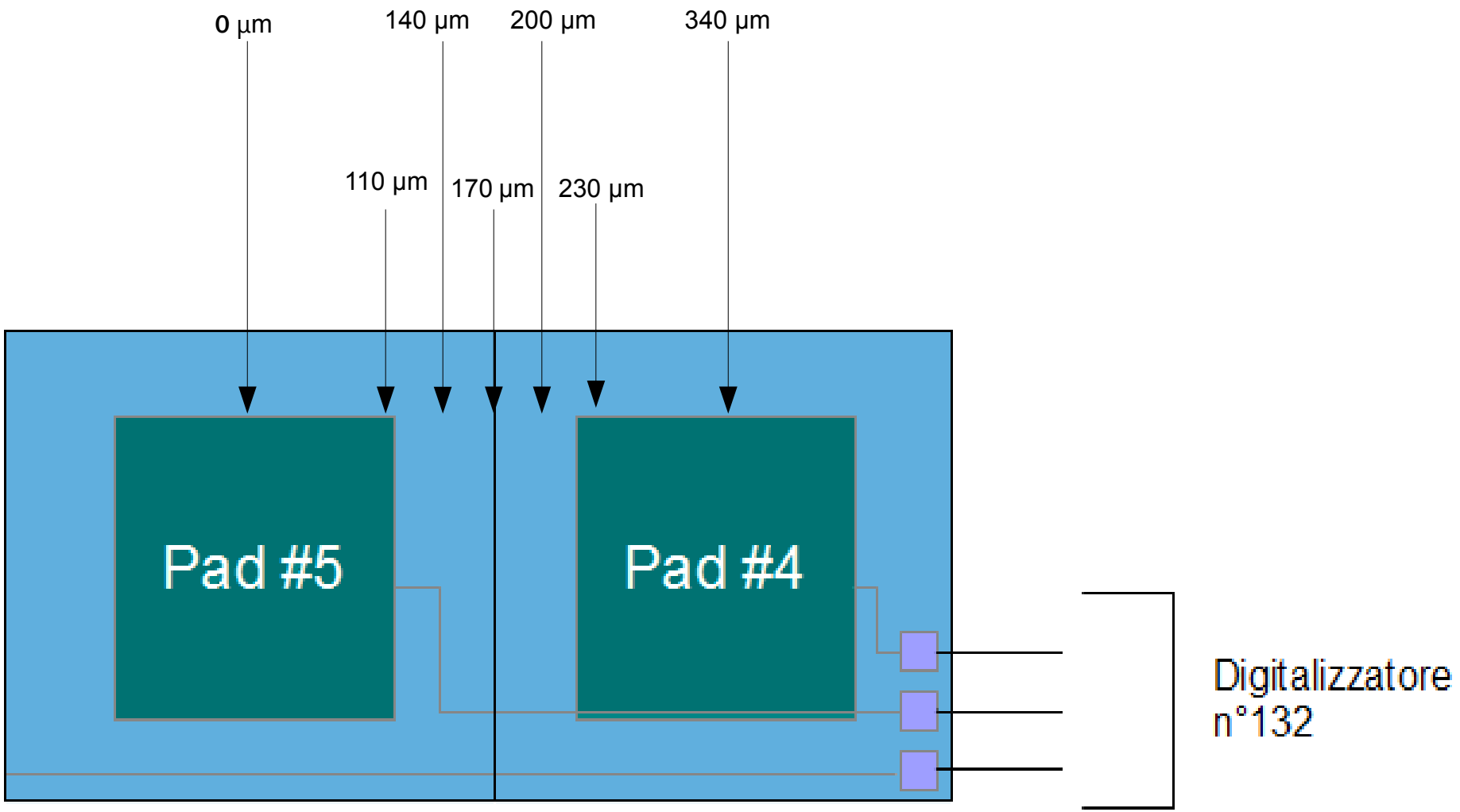
2. Active Area

- Single source ^{241}Am

Simplified diagram of the segmented detector



Working Area



Source and Collimator

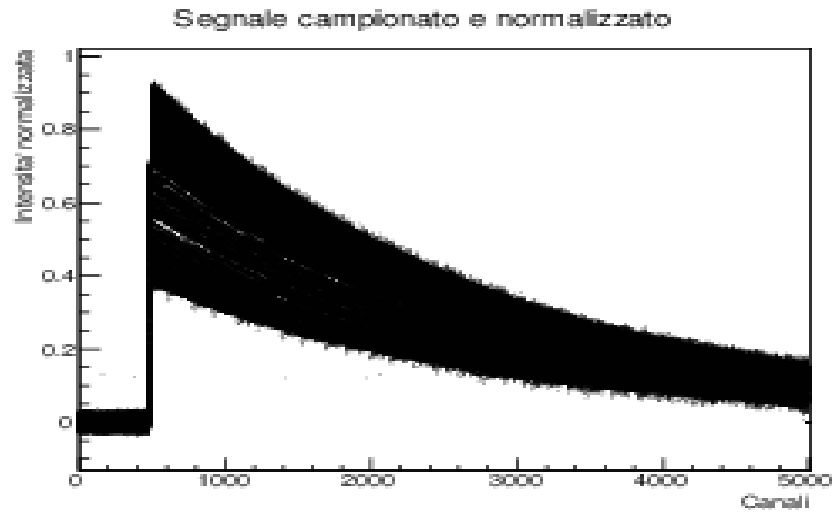
Steel collimator, three layers of ~50 µm each.

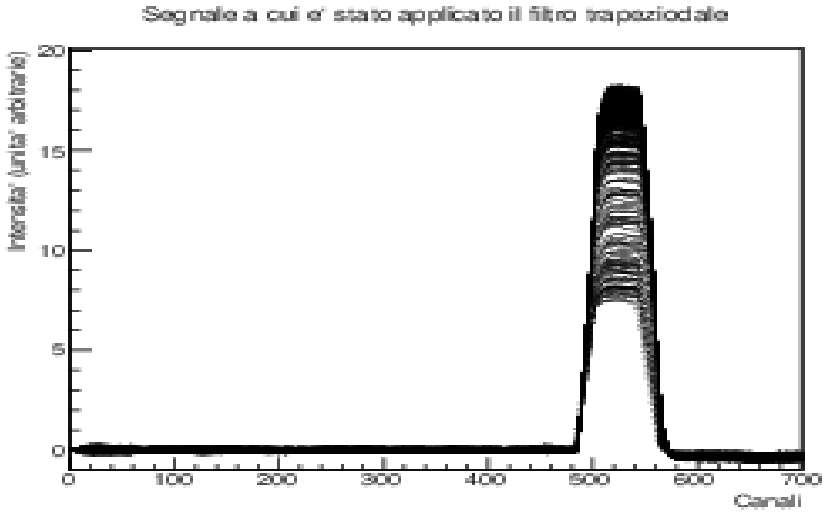
Range Al: ~12 µm.

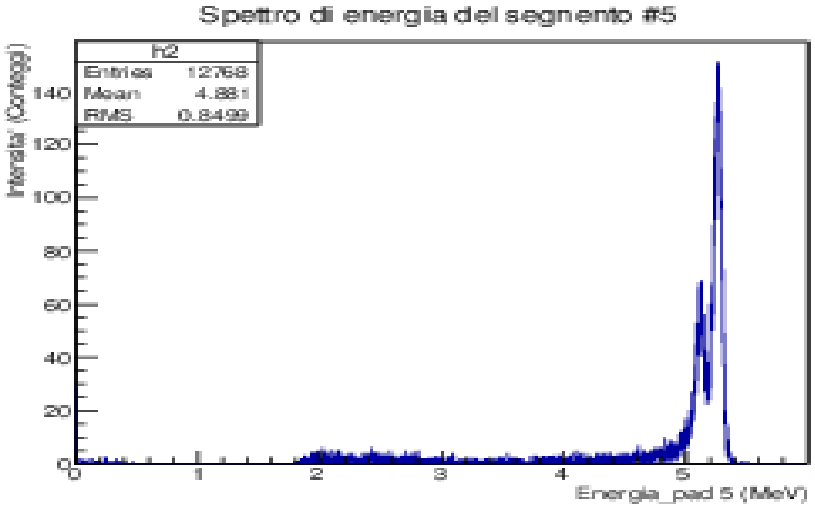
Range Steel: ~40 µm.

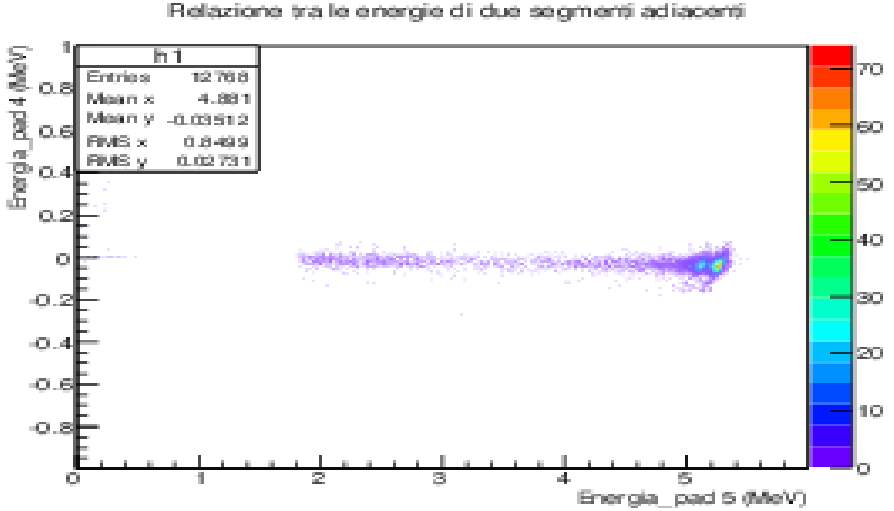
Range Si: ~30 µm.

Signals and Energy spectra; single pad

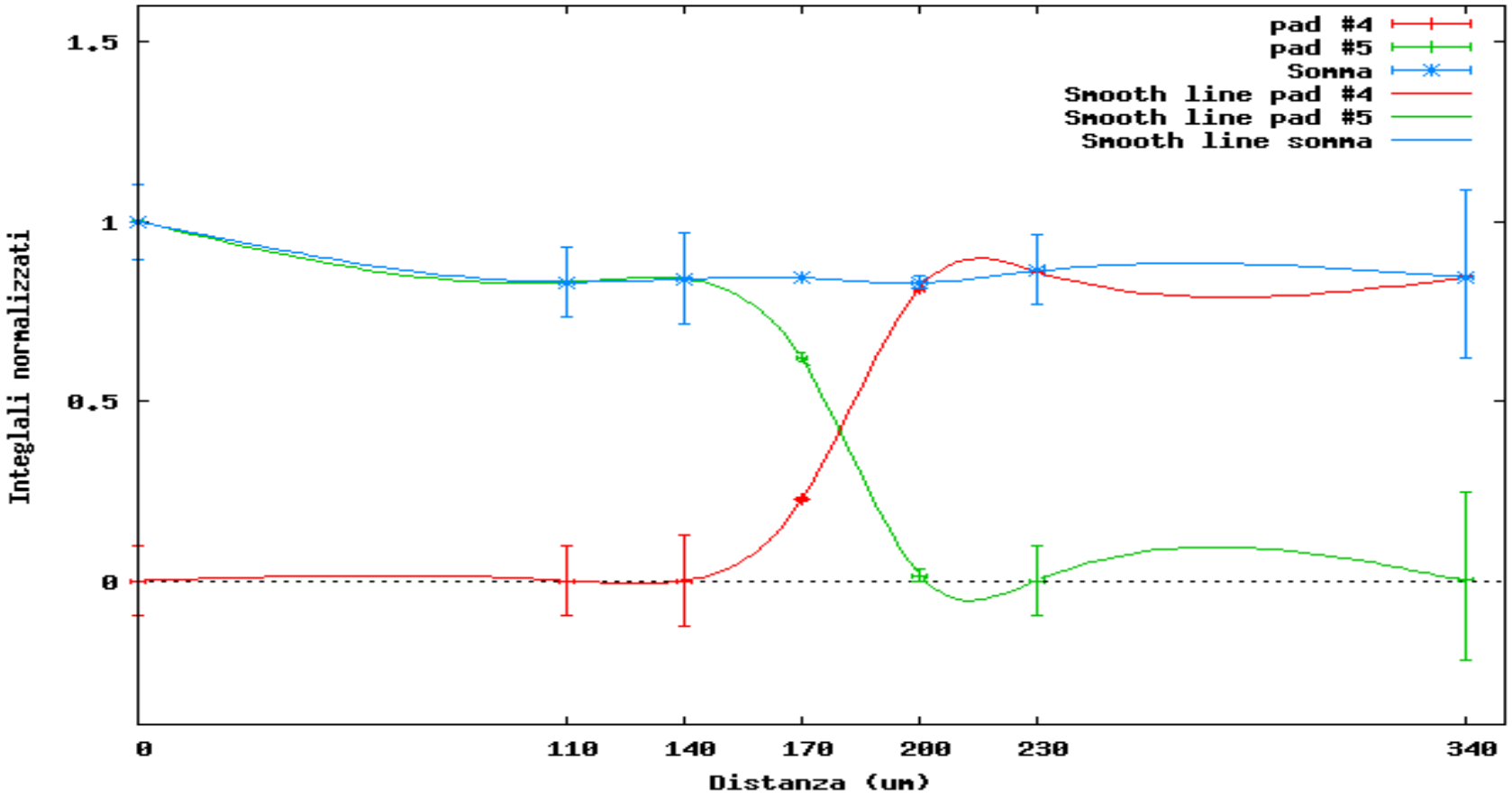








Determination of the active zone of the detector

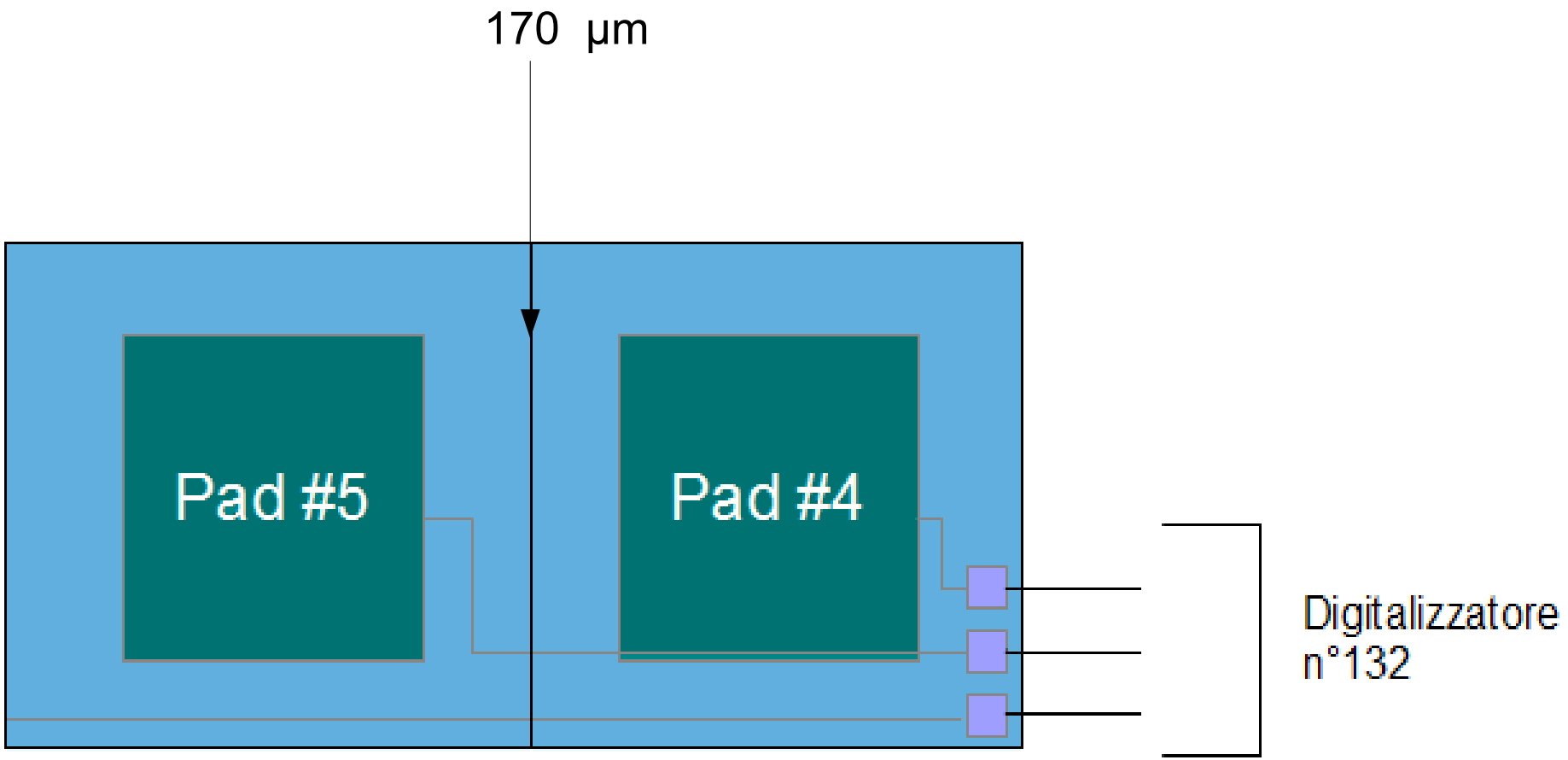


- Interpad scan, step 30 μm.
- Observable: Intensity normalized to the peak of maximum energy.
- The interpad's dimention is (60 ± 6) μm.
- Active area of one pad: linearly decreases by 1.5% neglecting the edges of the detector.

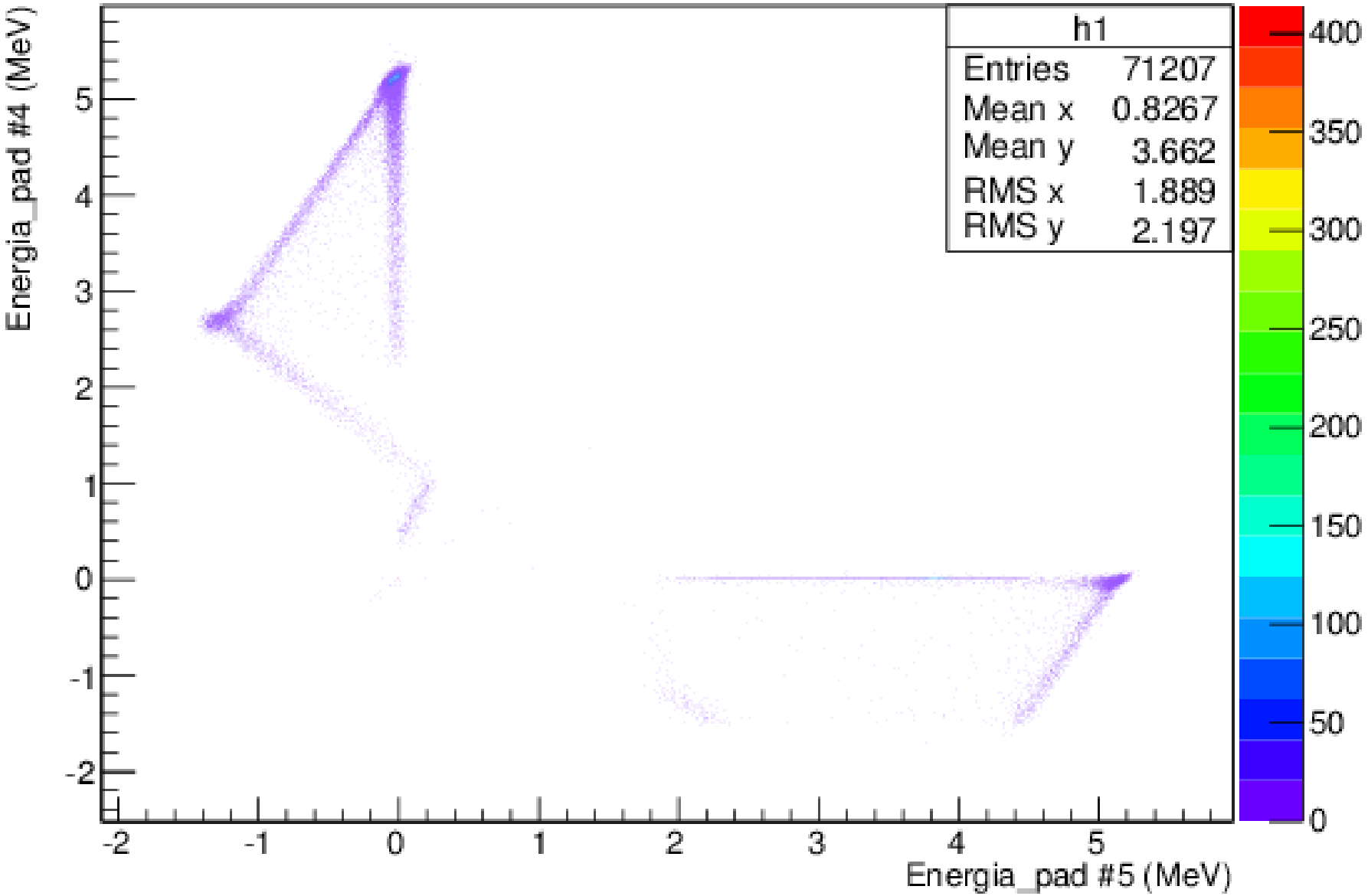
3. Response study at the interpad

- Single source ^{241}Am

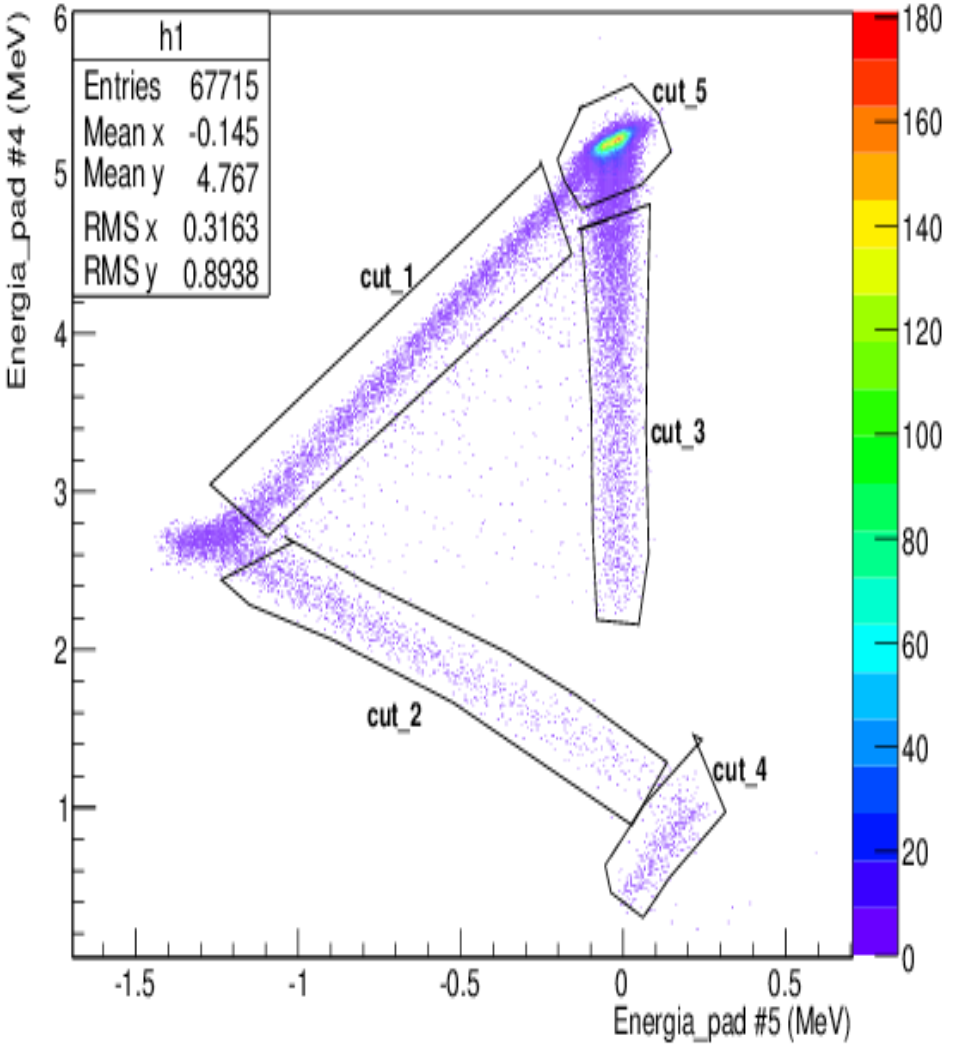
Working Area

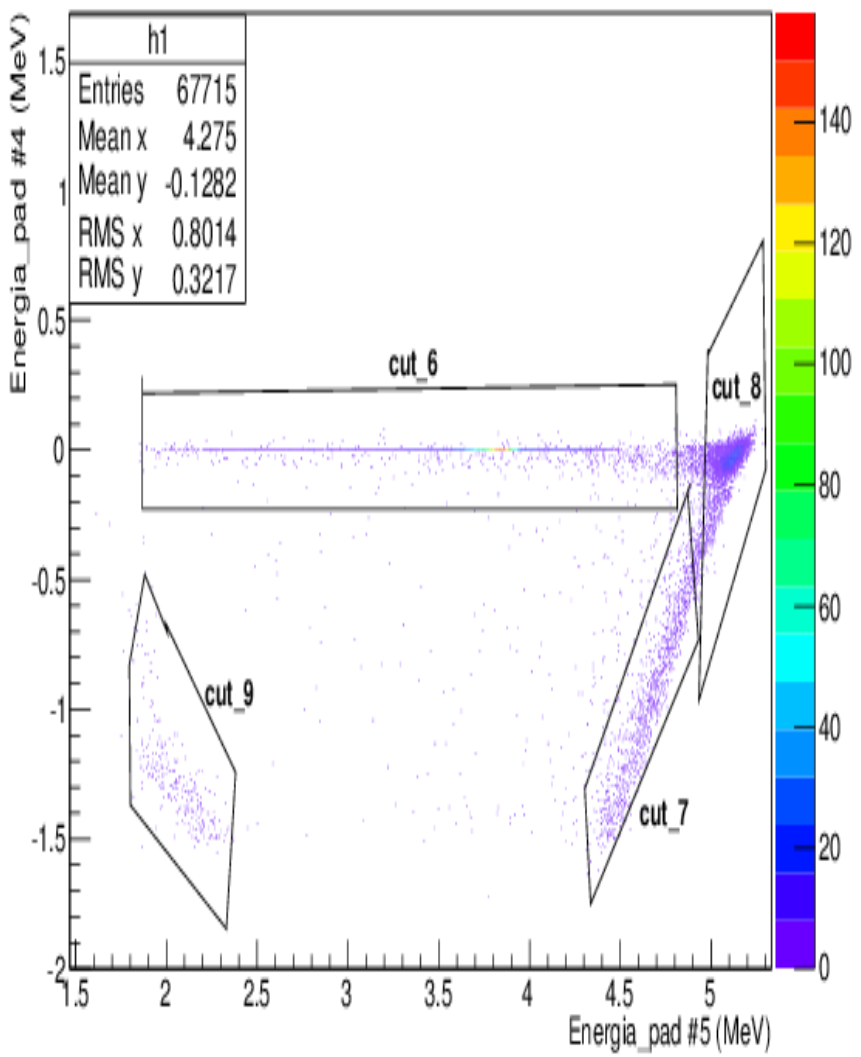


Correlation matrix (interpad)



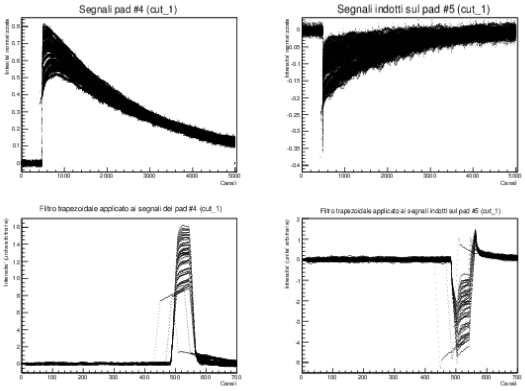
Energy spectra at the interpad



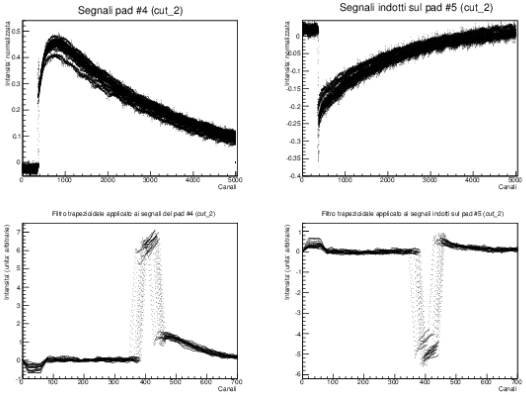


Signal and Energy cuts

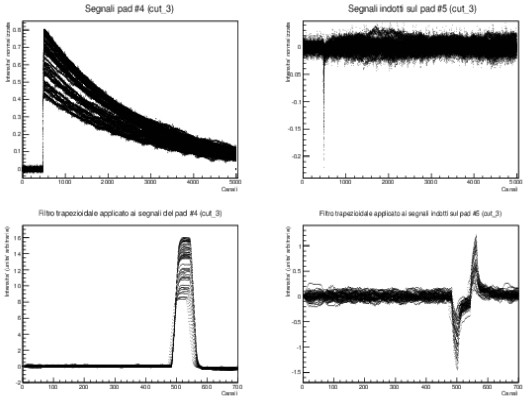
Cut_1



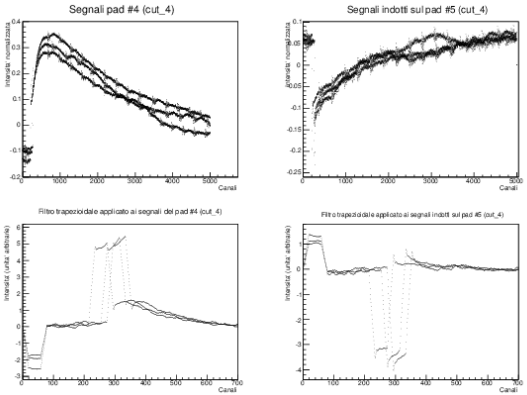
Cut_2



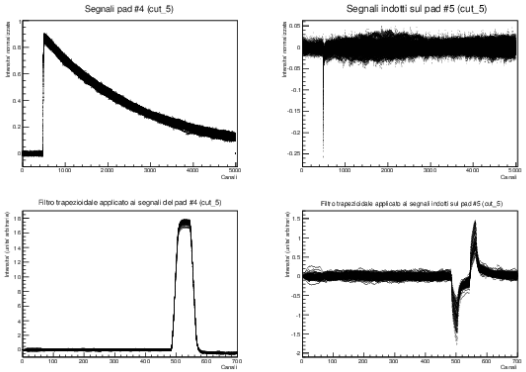
Cut_3



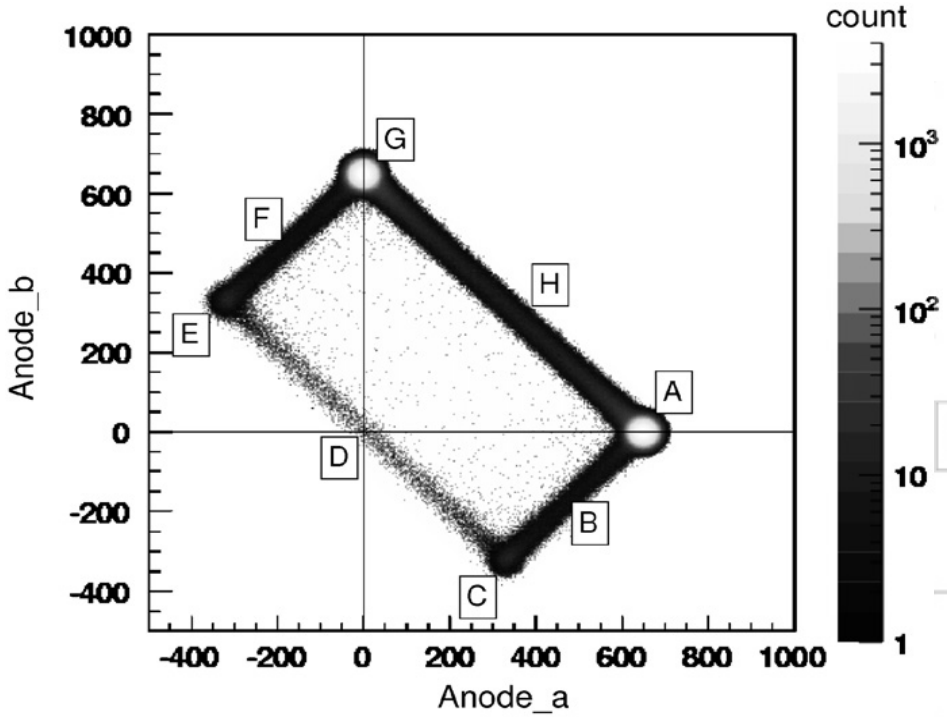
Cut_4

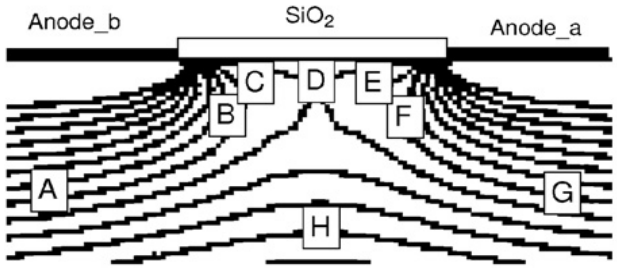


Cut_5

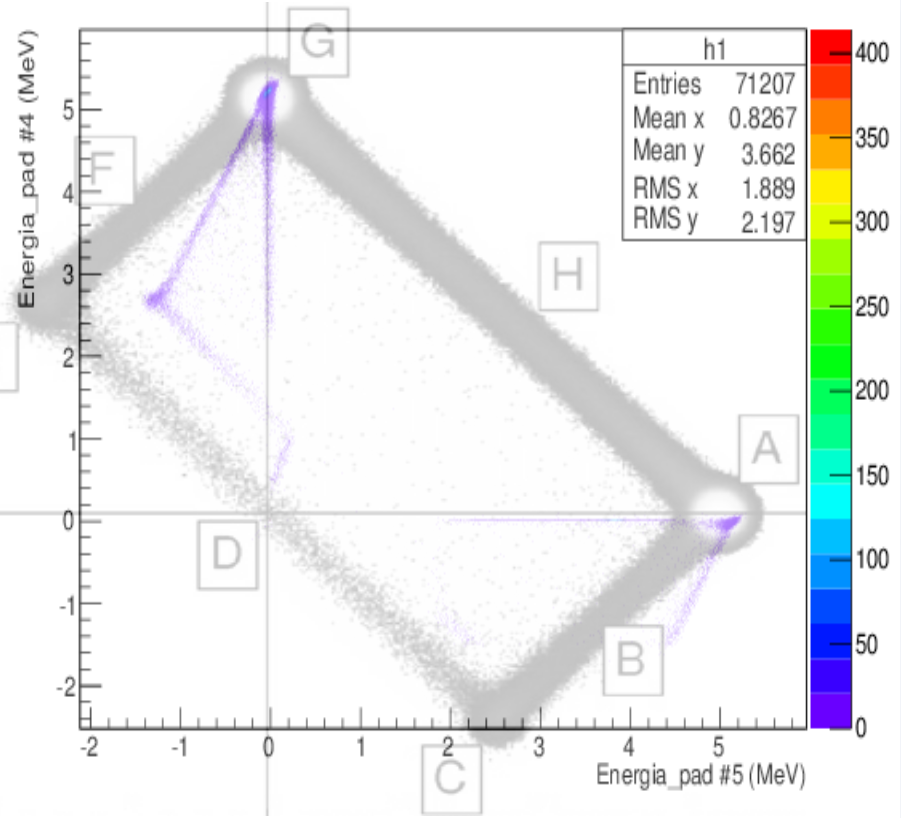


Comparison with the literature



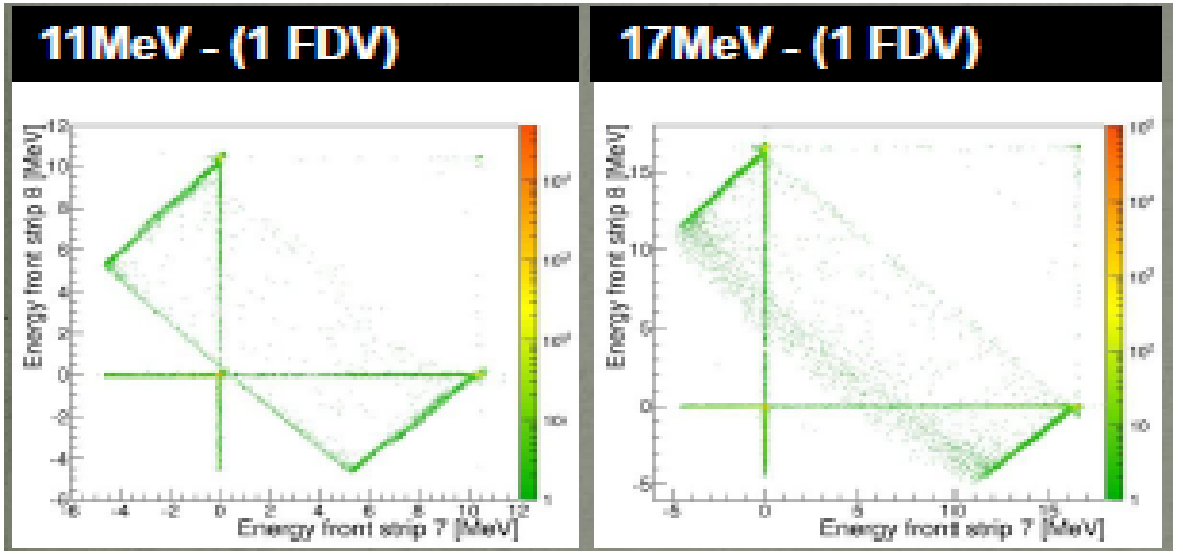


Single source ^{241}Am.



Shin'ichiro Takeda et al.
"Development of double-sided silicon strip detectors (DSSD) for a Compton telescope",
Nuclear Instruments and Methods in Physics Research A 579 (2007) 859–865

...and with recent experiments



^{7}Li Beam.
Experiment at the Tandem of Zagreb.

See talk of

D. Torresi

Conclusions

- At least 1.5% reduction in active zone (no board effects).
- Efficiency is recovered only under the conditions of known energy.

Perspectives

- Improvement of trapezoidal filter.
- Comparison with the simulations.
- Measurement of uniformity (resistivity).

References

[1] V. Eremin, J. Bohm, S. Roe, G. Ruggiero, P. Weilhammer
"The charge collection in single side silicon microstrip detectors",
Nuclear Instruments and Methods in Physics Research A 500 (2003) 121–132

[2] I.E. Anokhin, O.S. Zinets
"Distribution of electric field and charge collection in silicon strip detectors",
Nuclear Instruments and Methods in Physics Research A 477 (2002) 110–113

[3] Y. Blumenfeld, F. Auger, J.E. Sauvestre, F. Maréchal, S. Ottini, N. Alamanos, A. Barbier, D. Beaumel, B. Bonnereau, D. Charlet, J.F. Clavelin, P. Courtat, P. Delbourgo-Salvador, R. Douet, M. Engrand, T. Ethvignot, A. Gillibert, E. Khan, V. Lapoux, A. Lagoyannis, L. Lavergne, S. Lebon, P. Lelong, A. Lesage, V. Le Ven,I. Lhenry, J.M. Martin, A. Musumarra, S. Pita, L. Petizon, E. Pollacco, J. Pouthas,A. Richard, D. Rougier, D. Santonocito, J.A. Scarpaci, J.L. Sida, C. Soulet, J.S.Stutzmann, T. Suomijarvi, M. Szmigiel, P. Volkov, G. Voltolini
"MUST: A silicon strip detector array for radioactive beam experiments",
Nuclear Instruments and Methods in Physics Research A 421 (1999) 471-491

[4] Shin'ichiro Takeda, Shin Watanabe, Takaaki Tanaka, Kazuhiro Nakazawa, Tadayuki Takahashi, Yasushi Fukazawa, Hajimu Yasuda, Hiroyasu Tajima, Yoshikatsu Kuroda, Mitsunobu Onishi, Kei Genba
"Development of double-sided silicon strip detectors (DSSD) for a Compton telescope",
.Nuclear Instruments and Methods in Physics Research A 579 (2007) 859–865

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