Characterization of a NTD Double-Sided Silicon Strip Detector using a Pulsed Ion Beam

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Characterization of a NTD Double-Sided Silicon Strip Detector using a Pulsed Ion Beam

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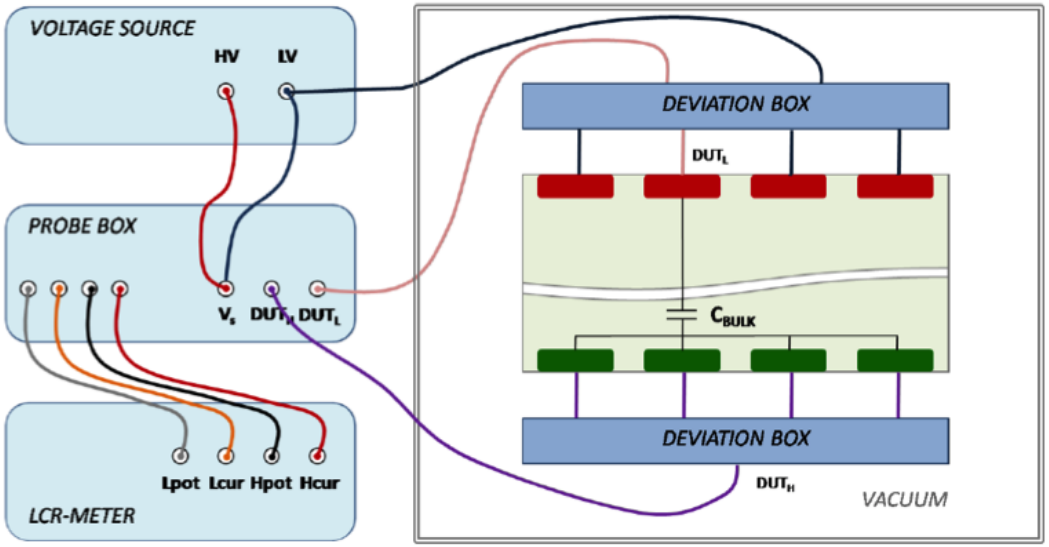
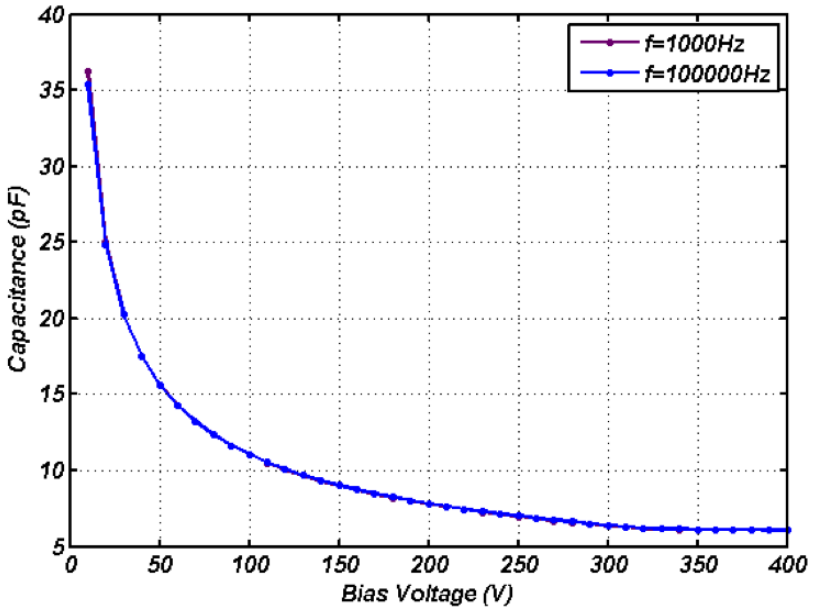
- Proceedings for the IEEE Nuclear Science Symposium Conference Records.
- Presented at Seattle conference, November 2014.

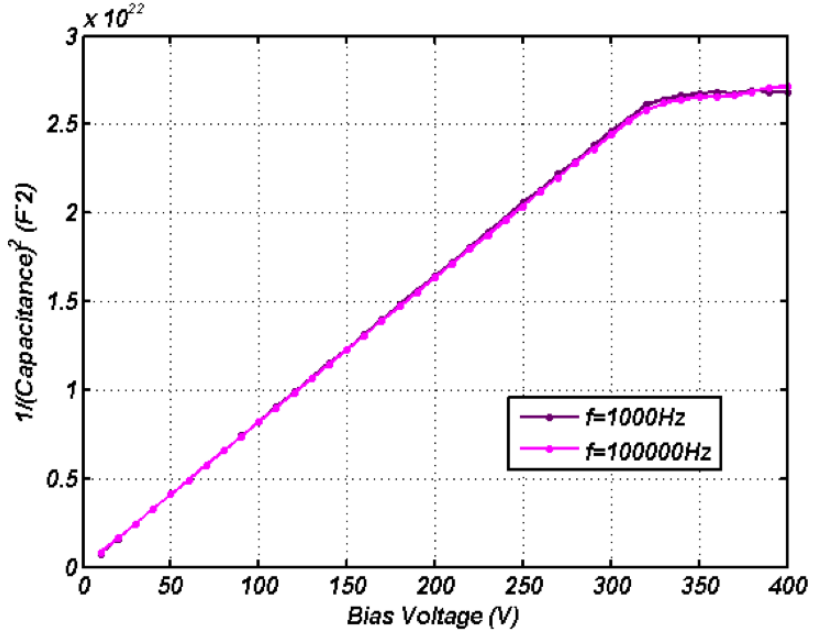
Laboratorio di Tecniche Nucleari per i **Be**ni **C**ulturali

- DEFEL beamline.
- Monoenergetic pulsed beam:
  - **1 & 3 MeV** protons.
  - 13 MeV carbon.
- Variable and finely controllable number of particles in each pulse.
- X-Y stages that can be moved orthogonal to the beam axis.
- Beam area arriving:
  - $105\mu m \times 108\mu m$, protons.
  - $205\mu m \times 208\mu m$, carbon.

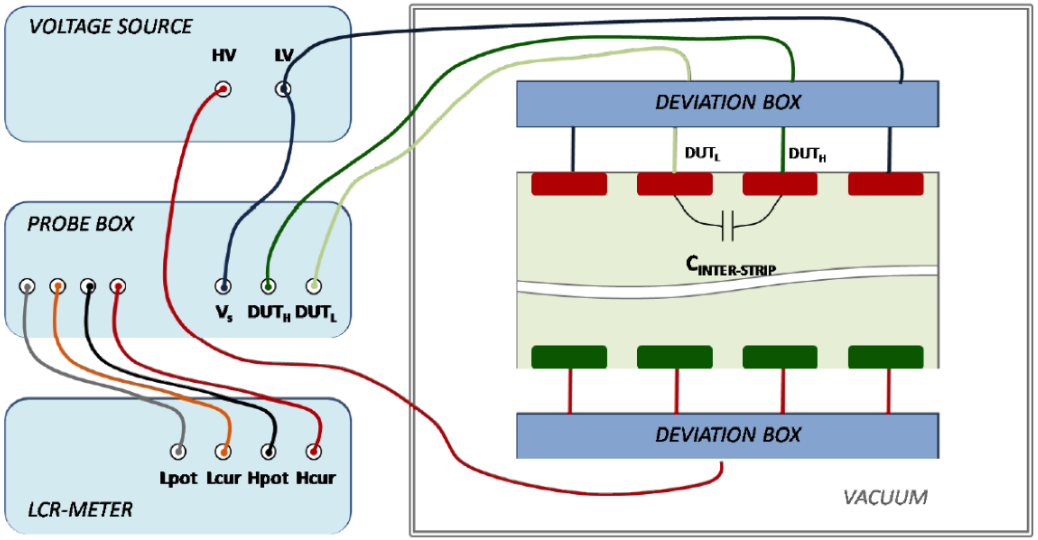
Photo from the web of LaBeC (http://labec.fi.infn.it)

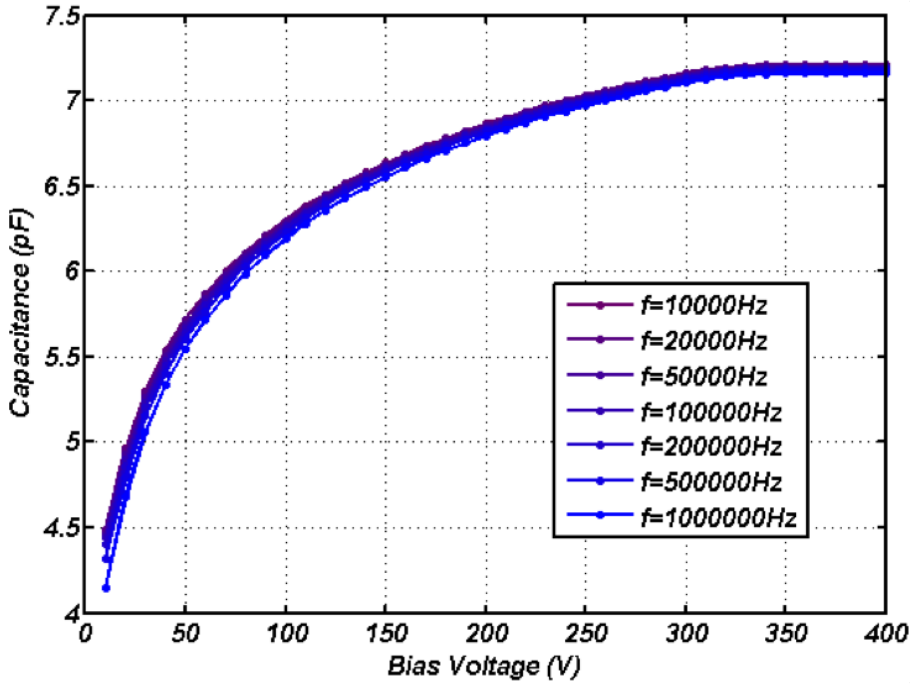




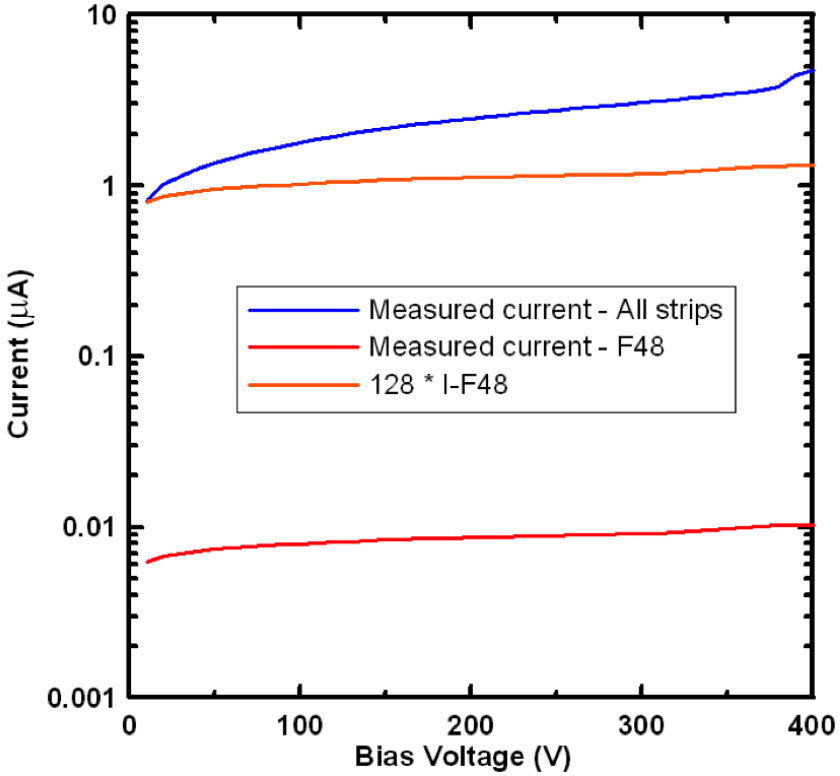


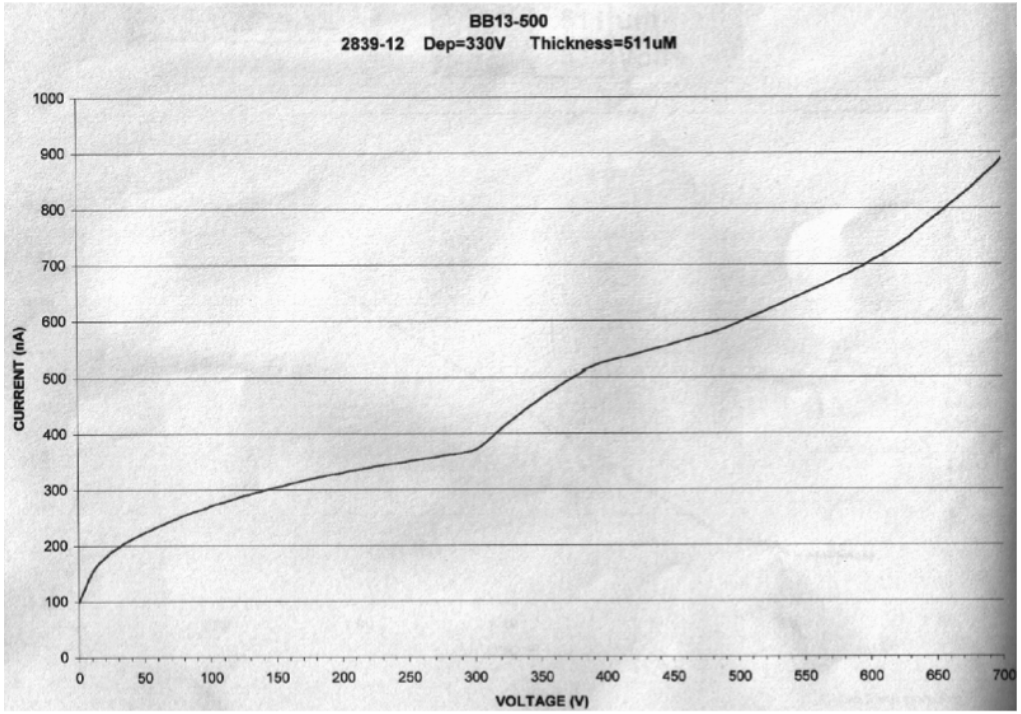
- Agilent E4980A LCR meter.
- Frequencies range 1 kHz - 1 MHz.
- Extracted bulk resistivity 2.3 kΩcm.
- Full depletion $\geq$ 350 V.
- Bulk capacitance 6 pF.



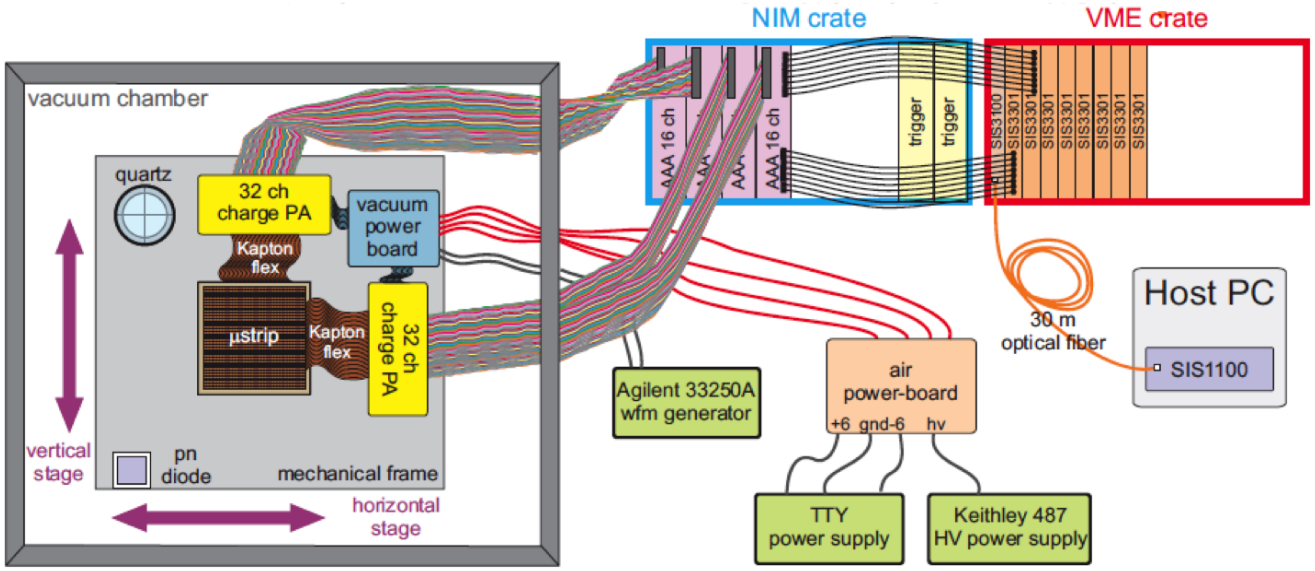


- Interstrip capacitance.
- Single-side contribution.
- On the junction side.
- 7 pF at full depletion.

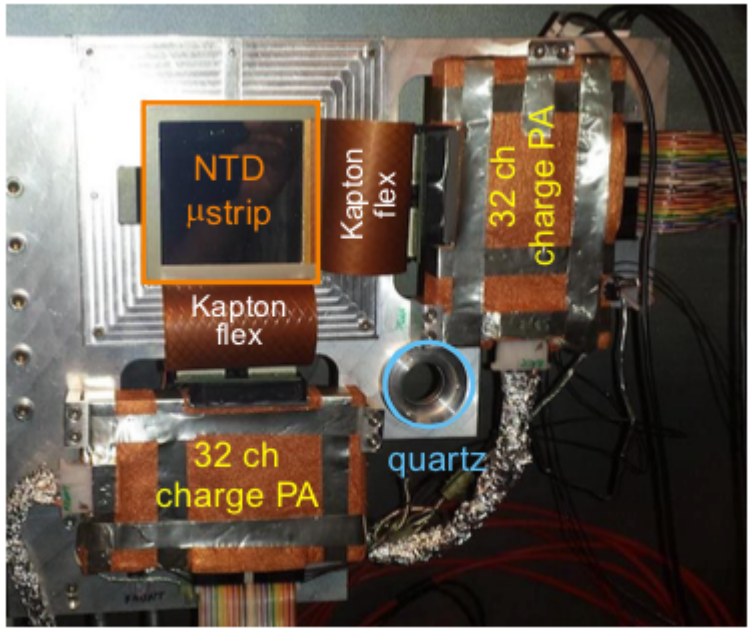


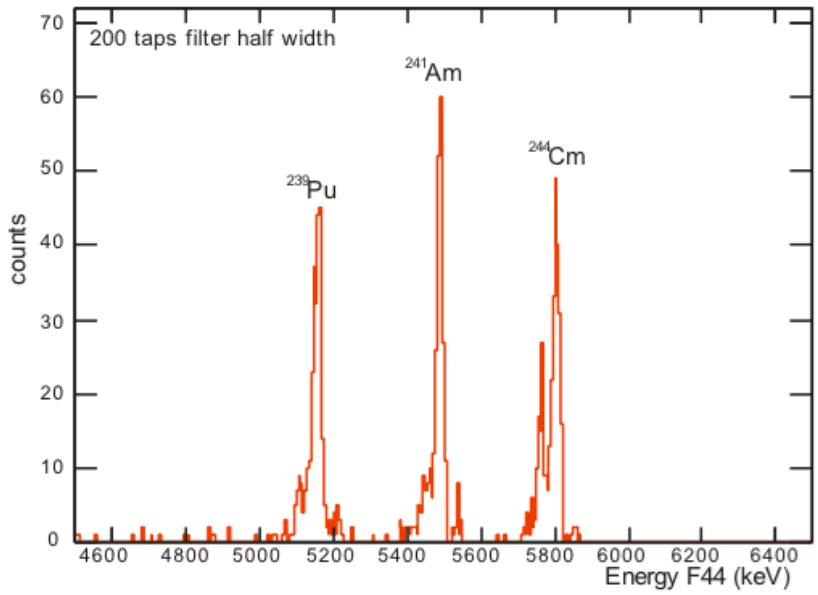


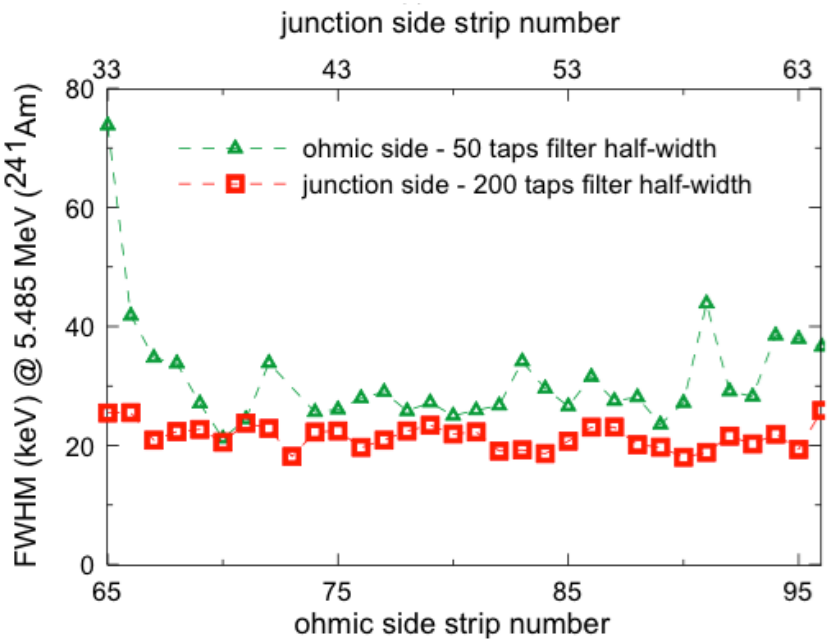
- Total current, all the strips (blue line).
- Single strip (F48, a central strip, red line).
- Orange, the contribution of 128 of such strip.
- MicronSemiconductors given IV curve.



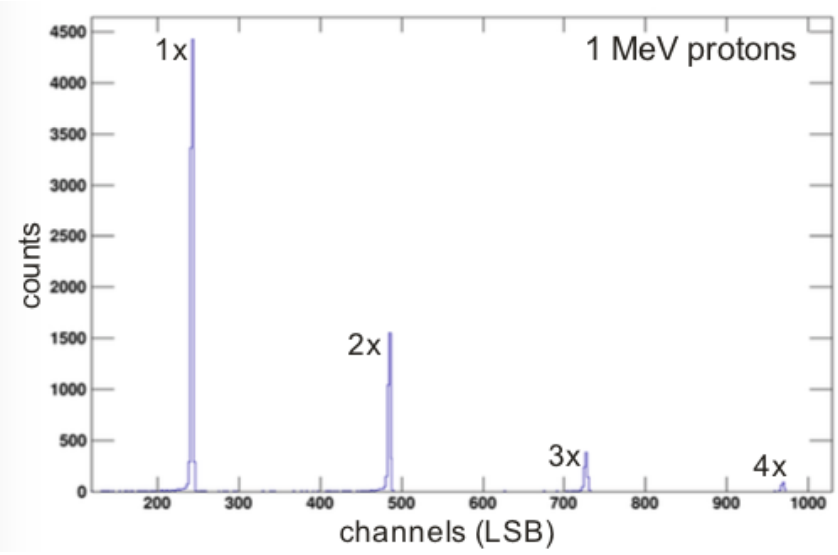
Scheme of principle of the experimental setup. The host PC is located outside the radiation controlled area.

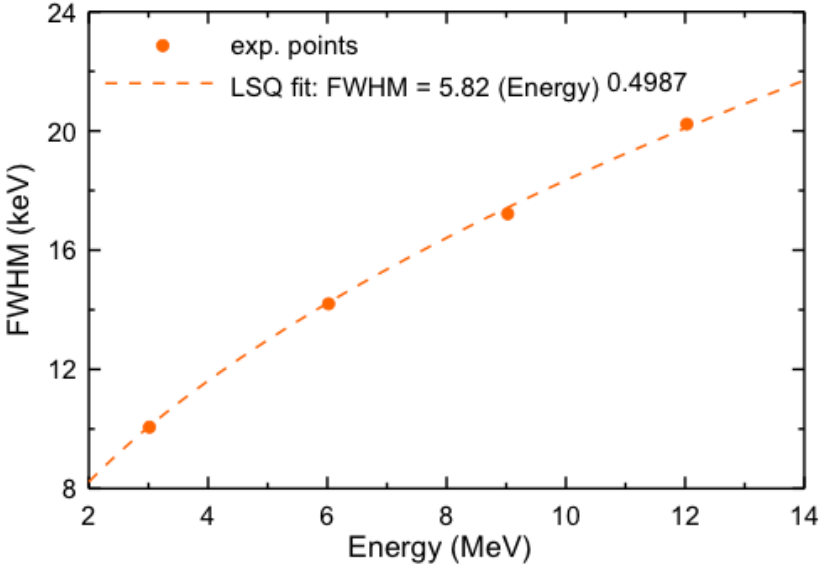




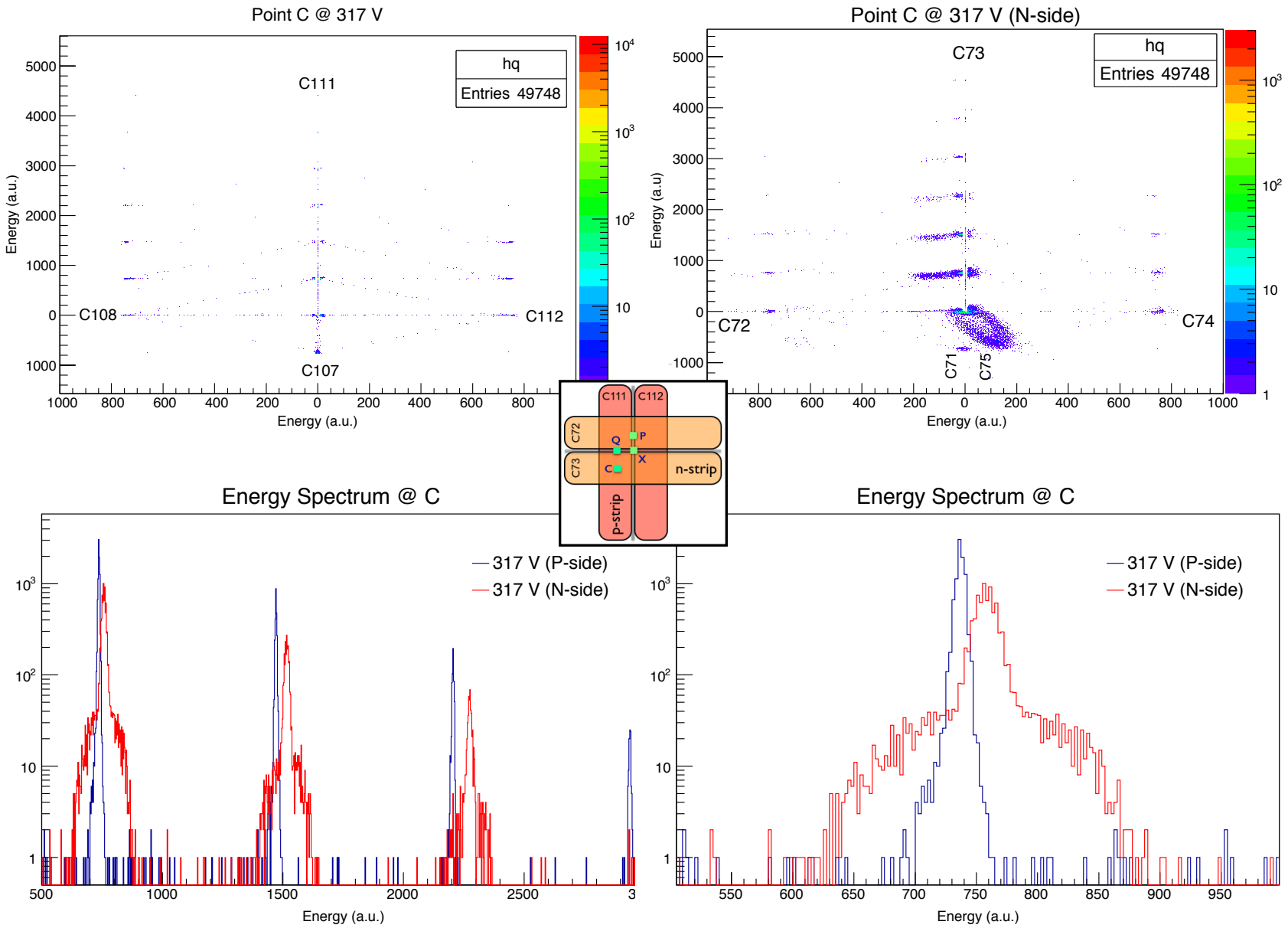


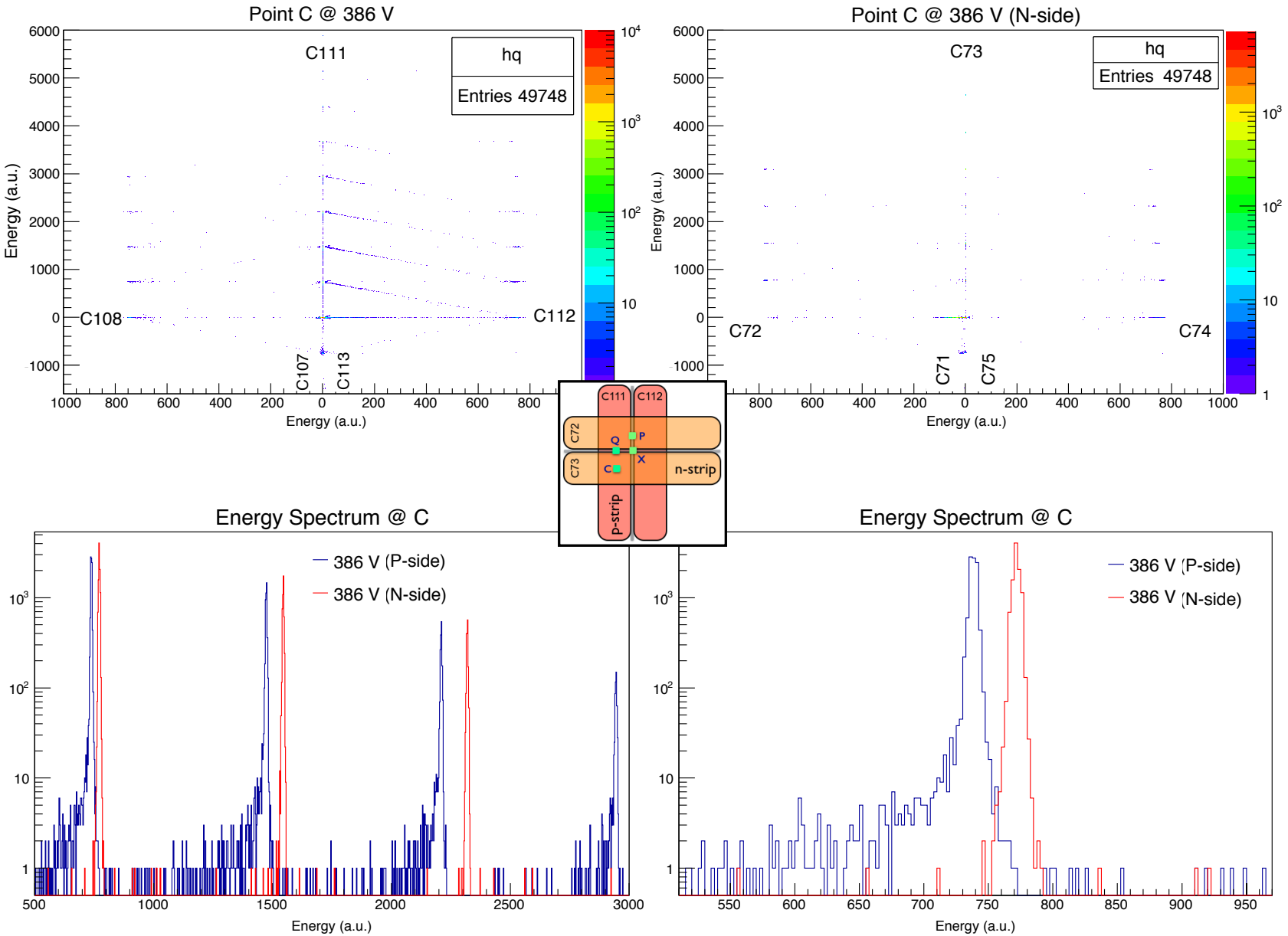
- Off-line with different digital filters.
- Triple alpha yielded 20 keV resolution.
- Best resolution on P-side (junction) rather N-side (ohmic)
- due to a larger parallel noise, mainly arising from the interstrip resistance.

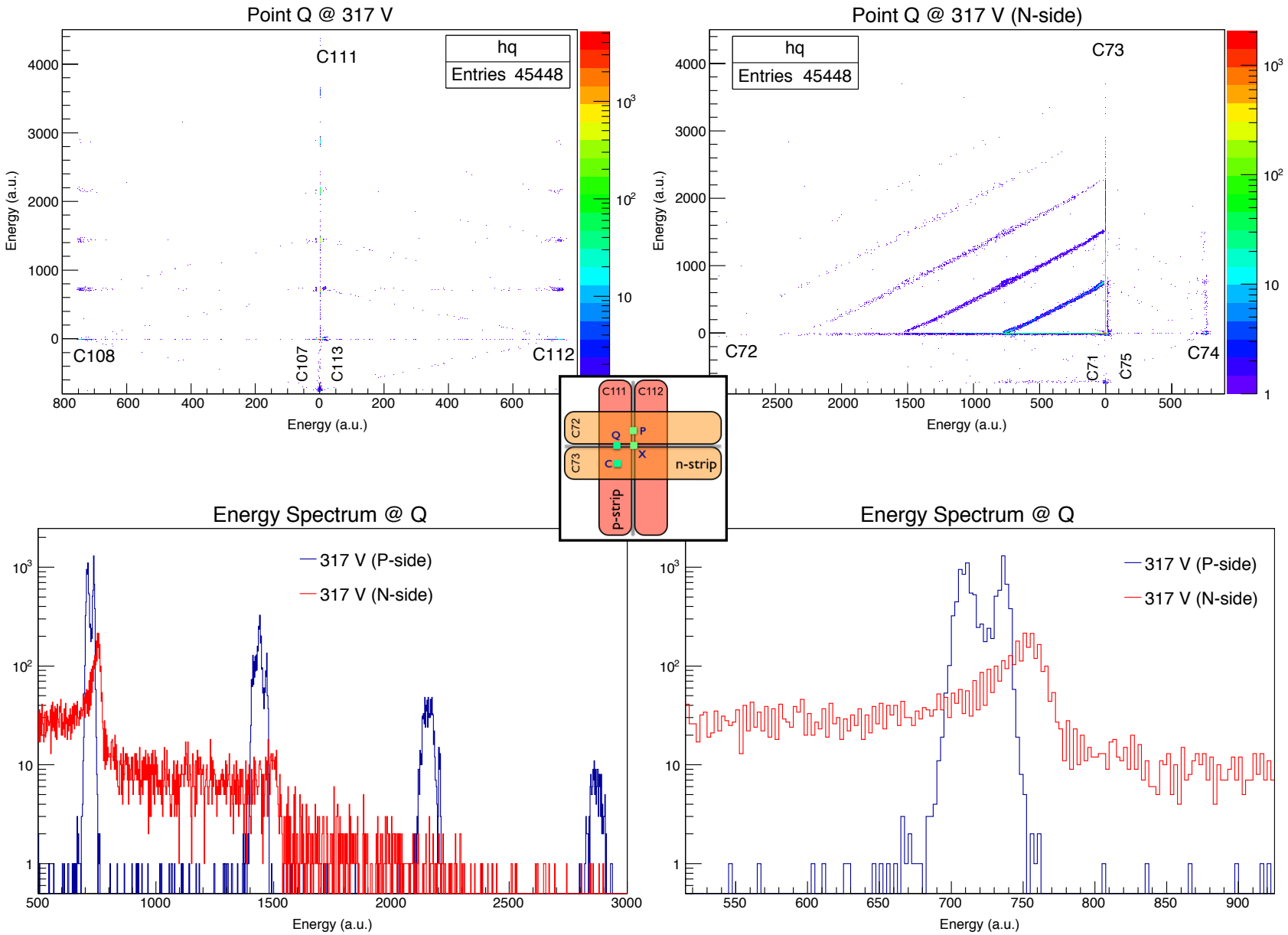


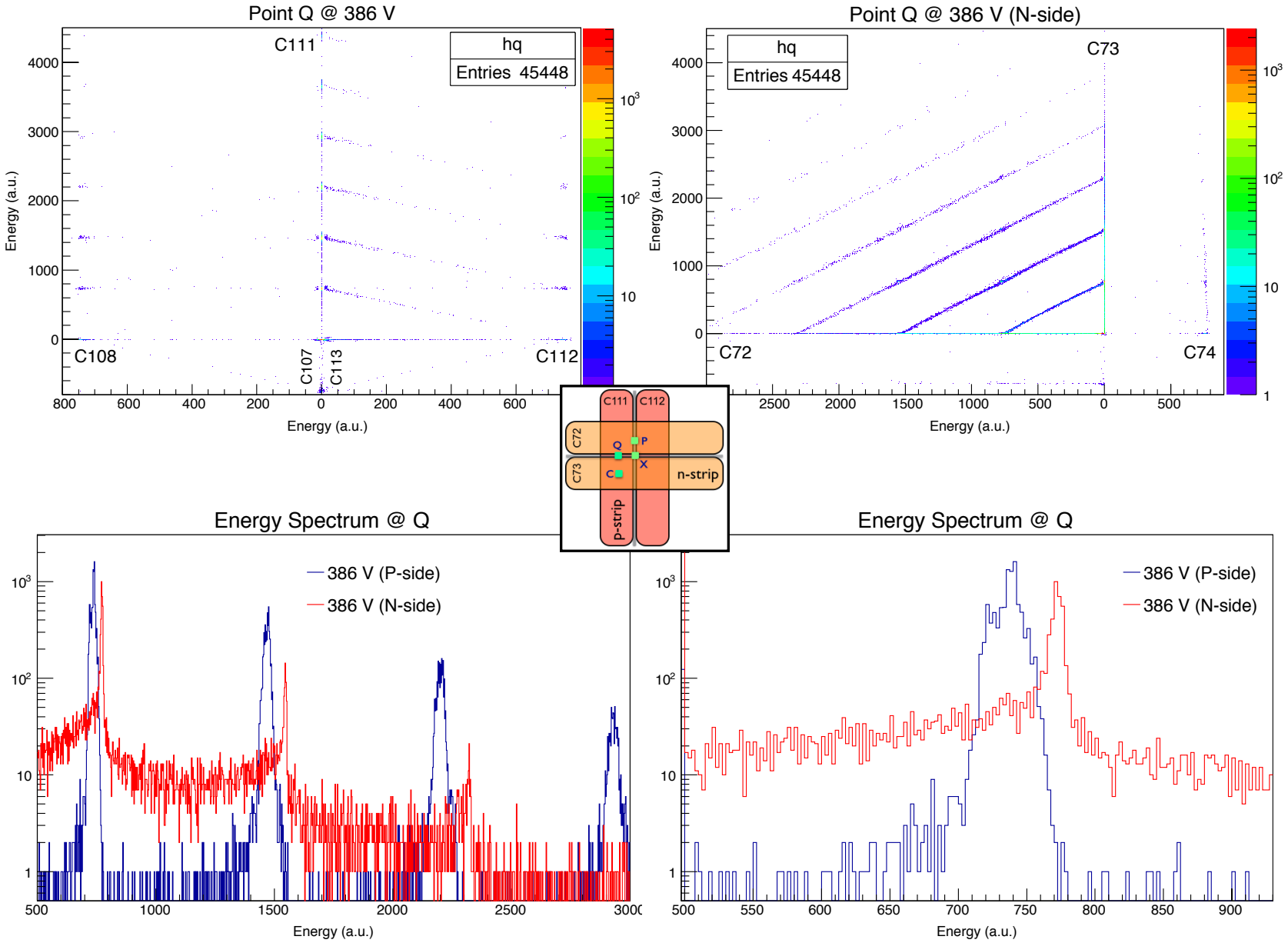


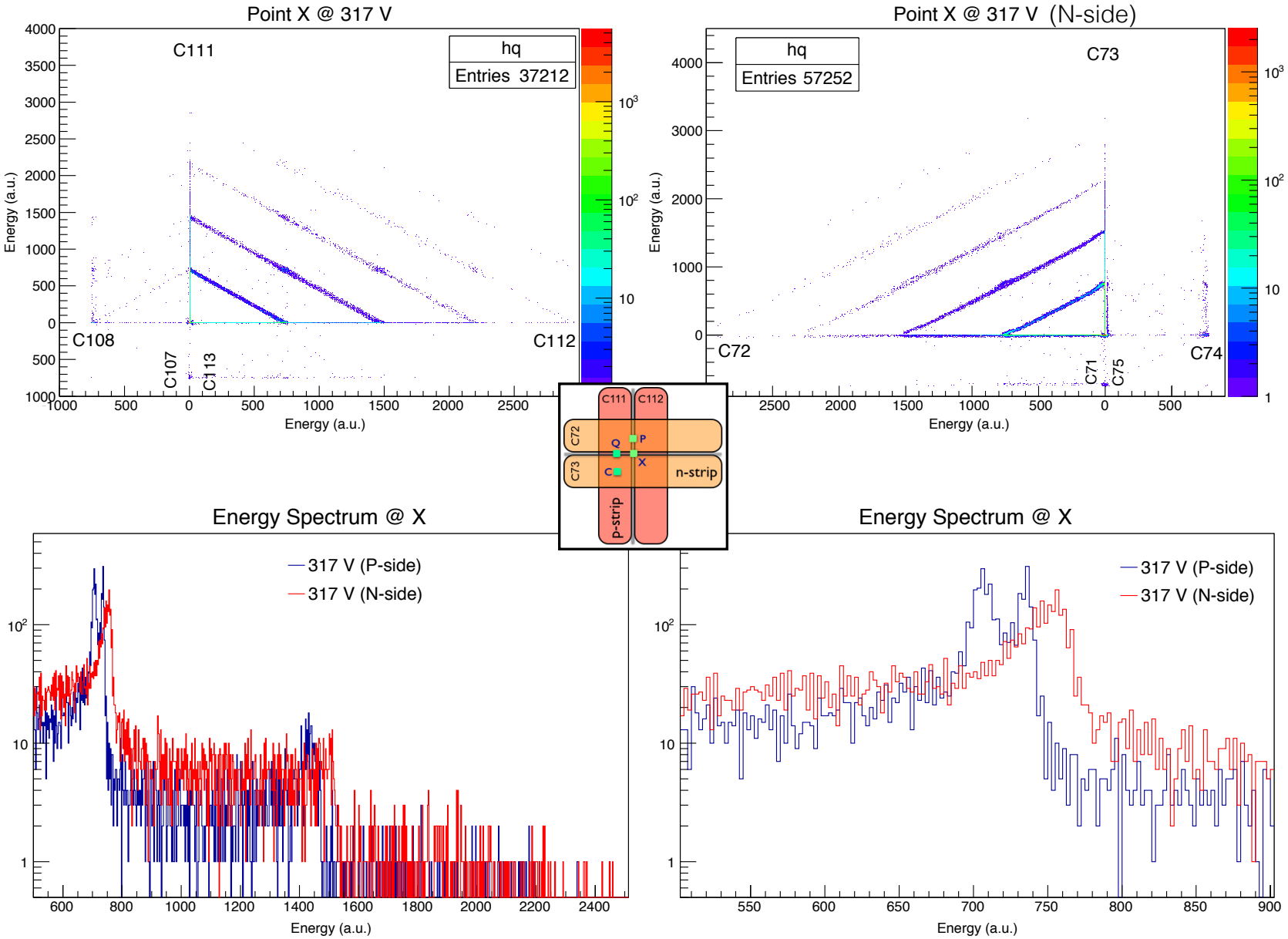
- Off-line with different digital filters.
- Different bunch multiplicity (1, 2, 3 and 4 protons per bunch).
- 10 keV energy resolution at 1 MeV protons.

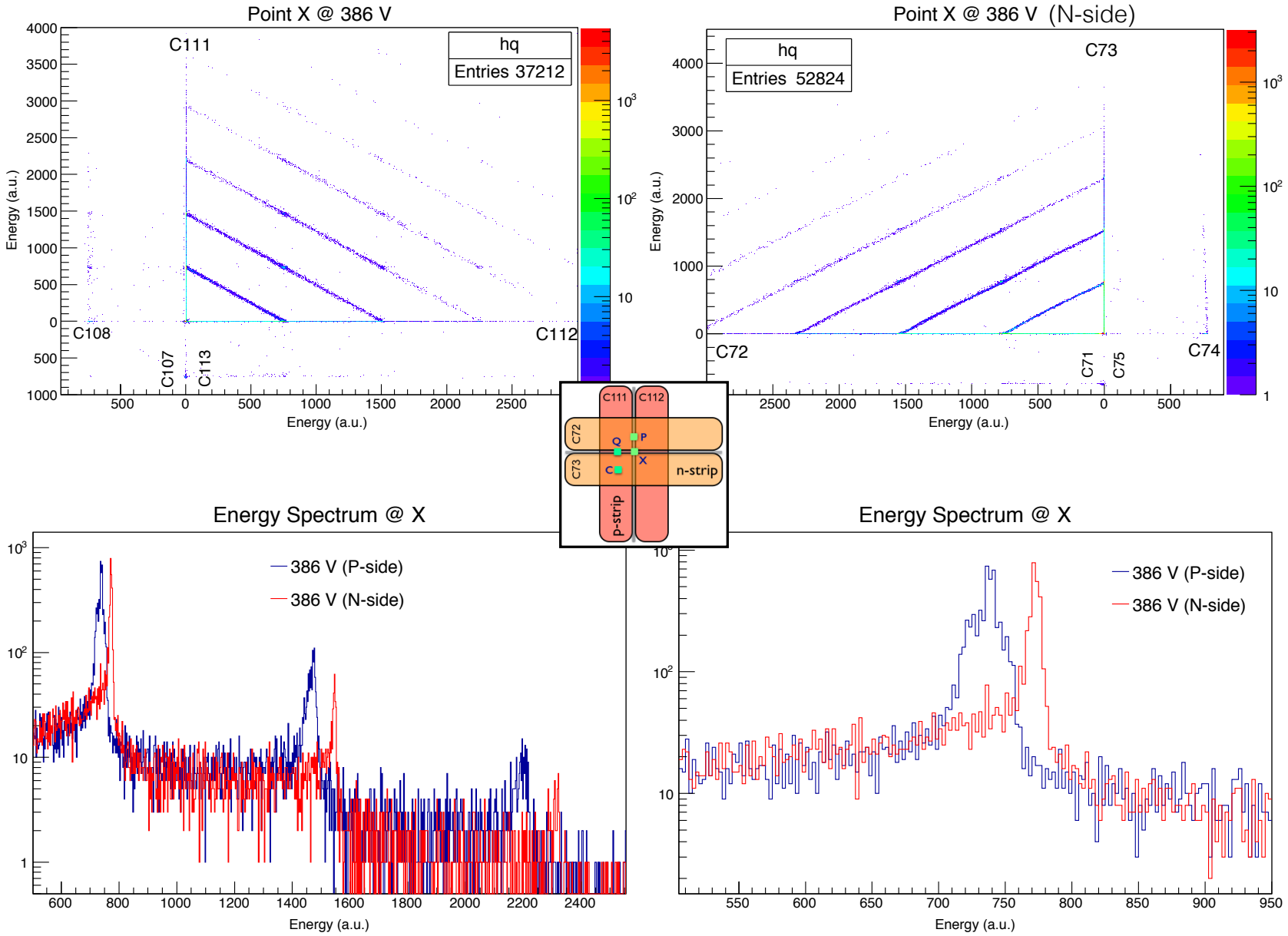

Point C @ 317 V
hq
Entries 49748
C111
C108
C112
C107
Energy (a.u.)
Point C @ 317 V (N-side)
C73
C72
C74
C71
C75
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ C
317 V (P-side)
317 V (N-side)
Energy (a.u.)


Point C @ 386 V
hq
Entries 49748
C111
C108
C112
C107
C113
Energy (a.u.)
Point C @ 386 V (N-side)
C73
C72
C74
C71
C75
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ C
386 V (P-side)
386 V (N-side)


Point Q @ 317 V
hq
Entries 45448
C111
C108
C107
C113
C112
Energy (a.u.)
Point Q @ 317 V (N-side)
C73
C72
C71
C75
C74
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ Q
317 V (P-side)
317 V (N-side)


Point Q @ 386 V
hq
Entries 45448
C111
C108
C107
C113
C112
Energy (a.u.)
Point Q @ 386 V (N-side)
hq
Entries 45448
C73
C72
C74
Energy (a.u.)
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ Q
386 V (P-side)
386 V (N-side)
Energy (a.u.)
Energy Spectrum @ Q
386 V (P-side)
386 V (N-side)
Energy (a.u.)


Point X @ 317 V
hq
Entries 37212
C111
C108
C107
C113
C112
Energy (a.u.)
Point X @ 317 V (N-side)
hq
Entries 57252
C73
C72
C71
C75
C74
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ X
317 V (P-side)
317 V (N-side)
Energy (a.u.)


Point X @ 386 V
hq
Entries 37212
C111
C108
C107
C113
C112
Energy (a.u.)
Point X @ 386 V (N-side)
hq
Entries 52824
C73
C72
C71
C75
C74
Energy (a.u.)
C111
C112
C72
C73
Q
P
X
C
n-strip
p-strip
Energy Spectrum @ X
386 V (P-side)
386 V (N-side)
Energy (a.u.)
Energy Spectrum @ X
386 V (P-side)
386 V (N-side)
Energy (a.u.)

Preliminary conclusions

- Good general performance of both detector + preamps.
- Capacitance with reasonable values, but not total leakage.
- Energy resolution down to 10 KeV for single proton particle.

Recommended future work

- Establish a protocol for detector characterisation.
- Study how to improve the Si manufacturing process to improve side assymetry.
- Perform a test with beam size smaller that interstrip gap.