Pile-up pulse analysis with fast sampling ADC techniques

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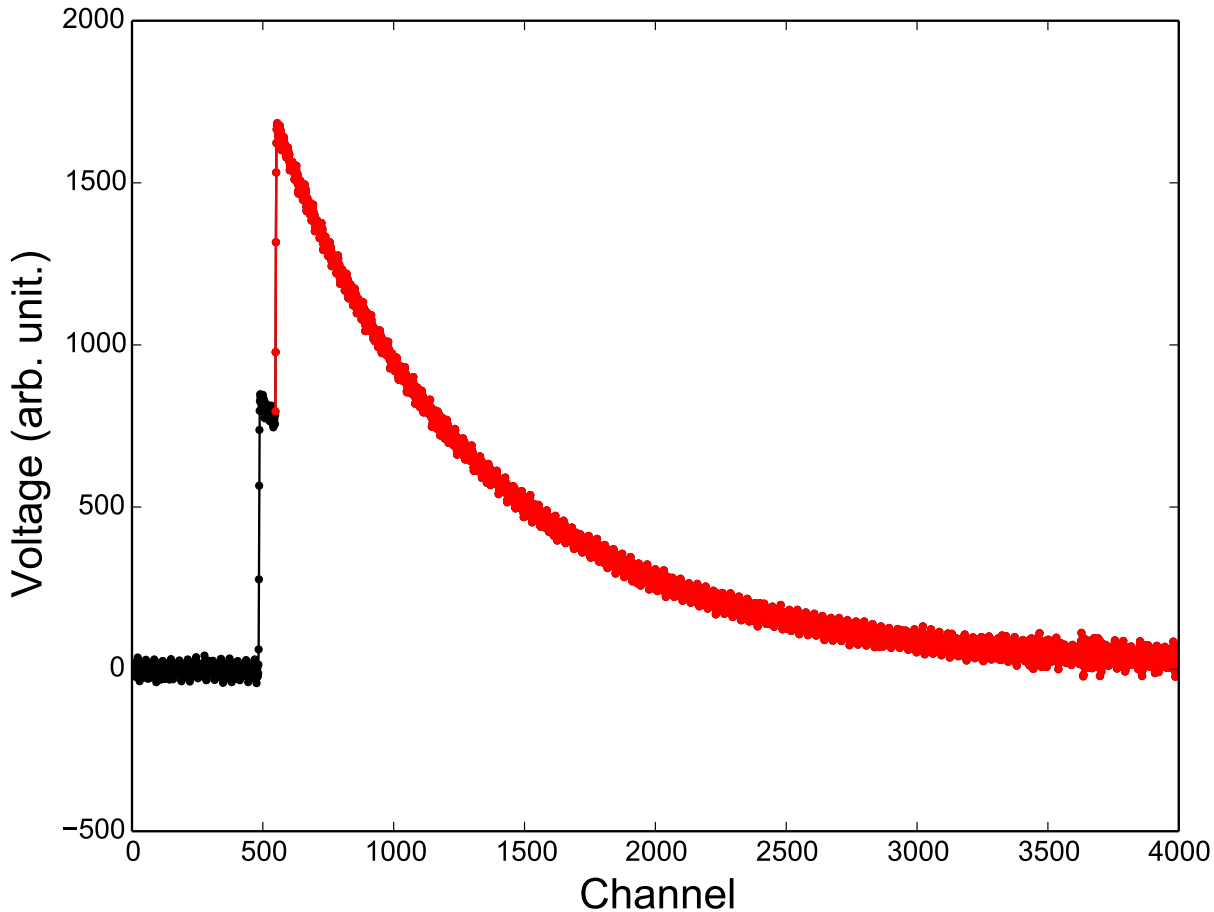
I have developed a method, and it works.

Outline

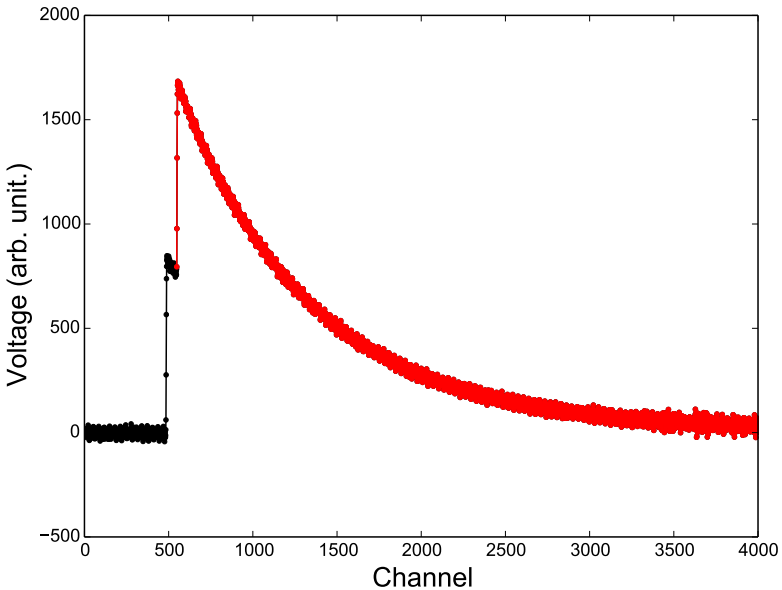
Pile-ups

A digitised preamplifier pile-up signal with a fast sampling ADC.

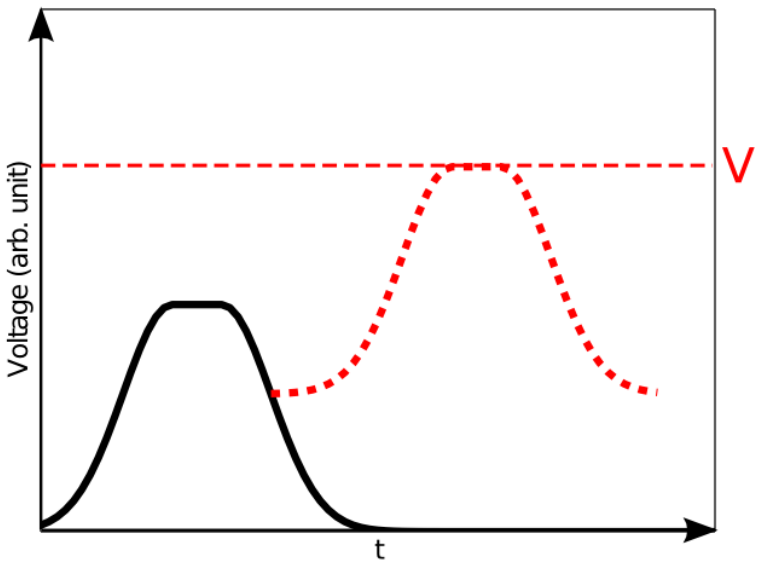


Pile-ups

Digital



Analogue



Why has the method been developed?

Possibilities with a digital electronics system:

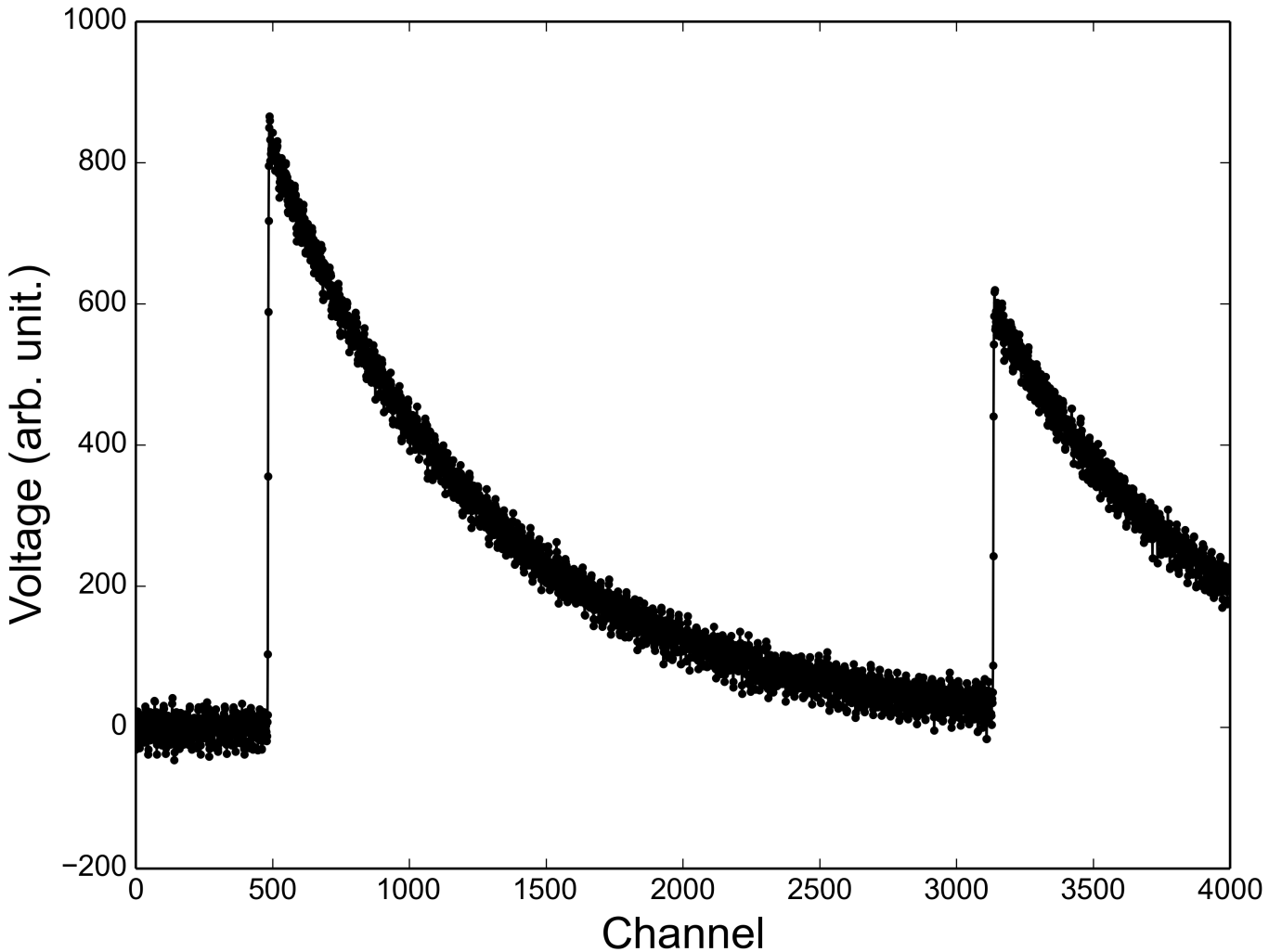
- The amplitudes in pile-ups can be resolved
- Short-lived nuclei can be studied

And:

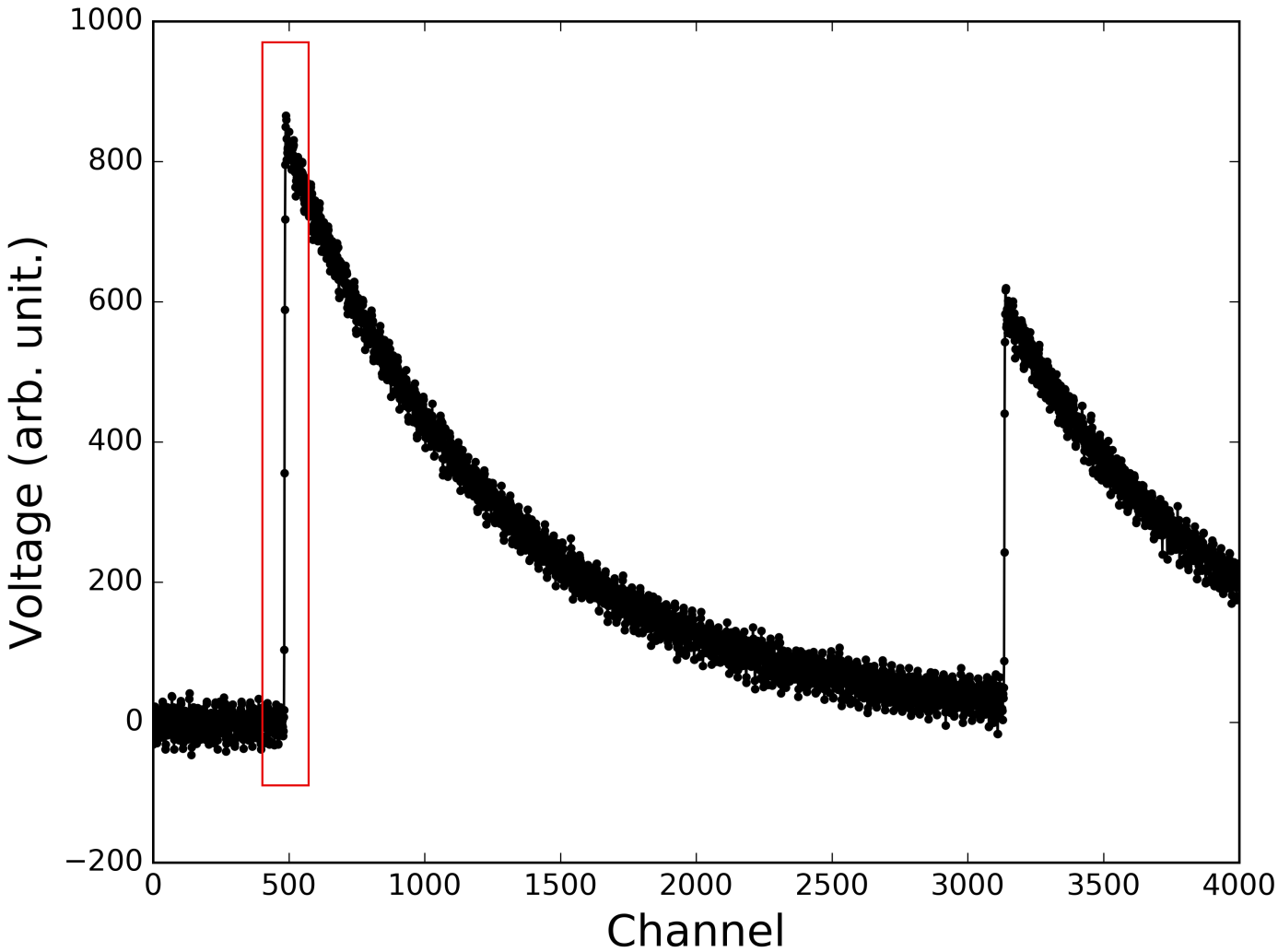
- Experimental data is available

How does the method work?

Filter and Time Extraction

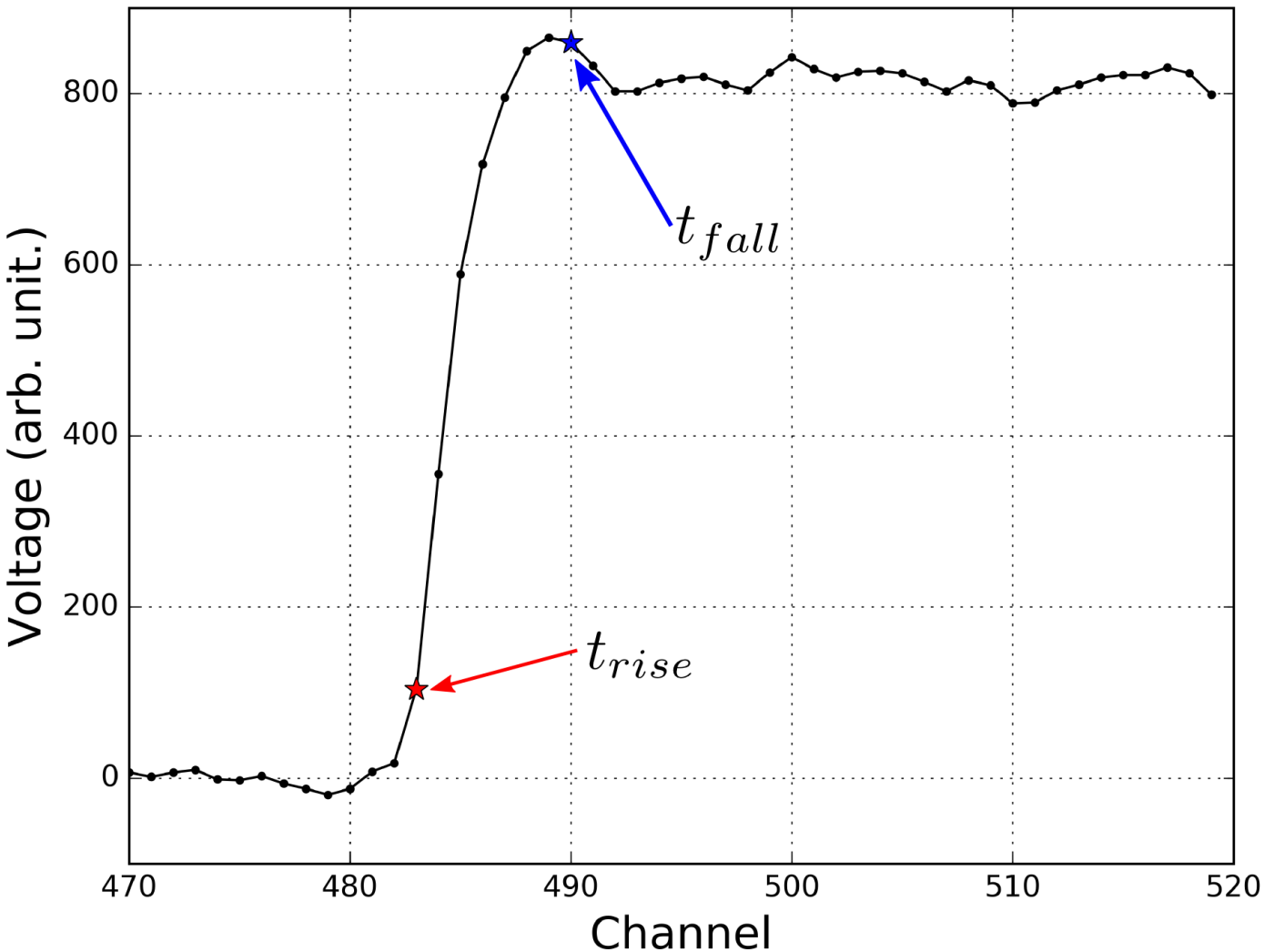


Filter and Time Extraction



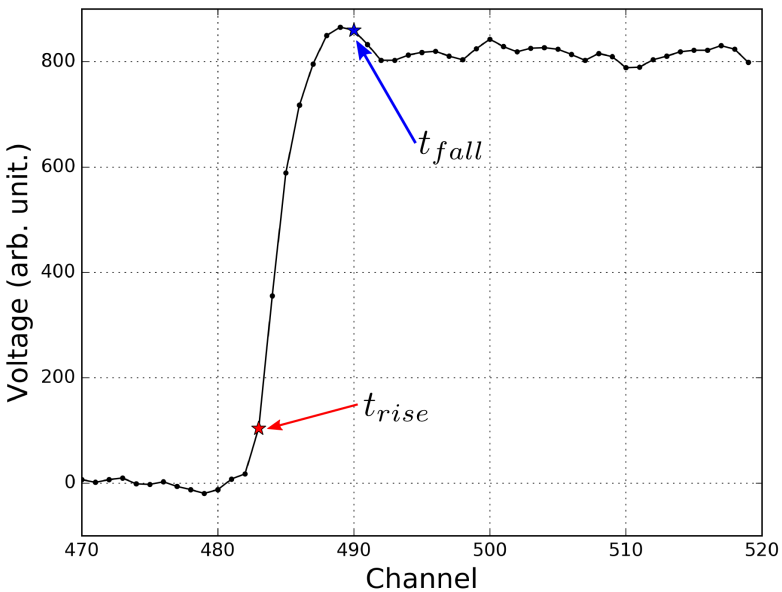
Filter and Time Extraction

Zoomed in

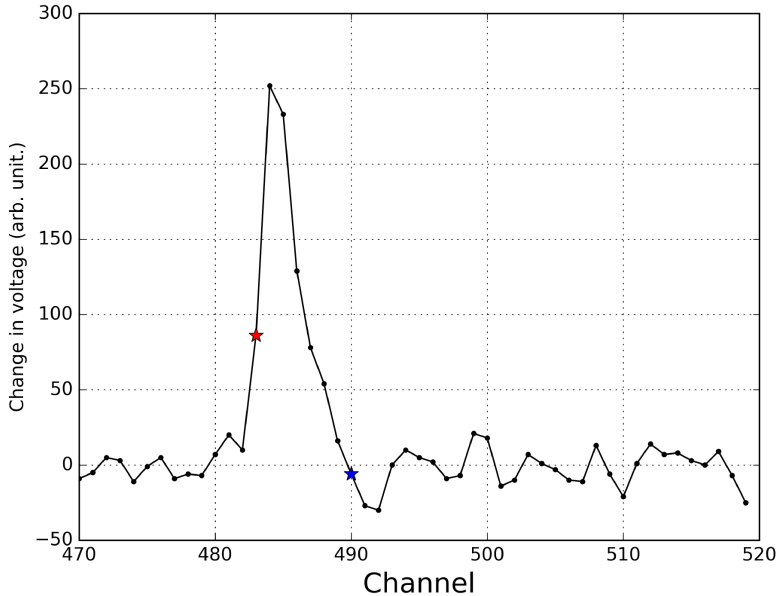


Filter and Time Extraction

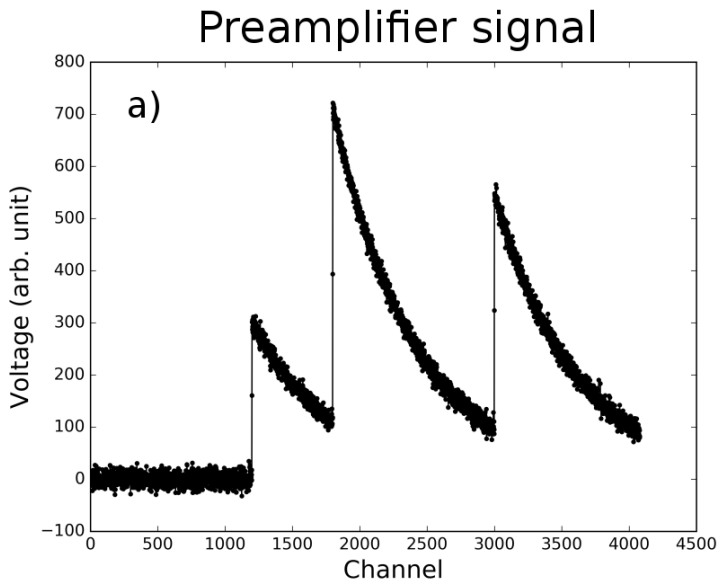
Zoomed in



First derivative



Moving Window Deconvolution



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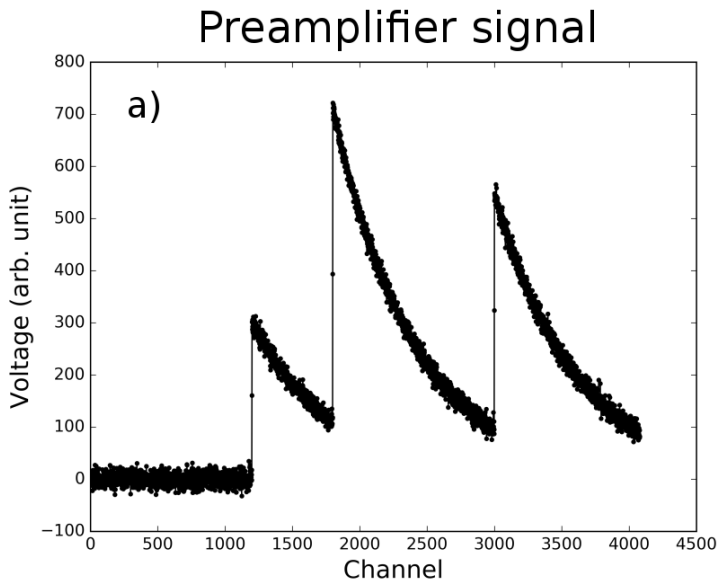
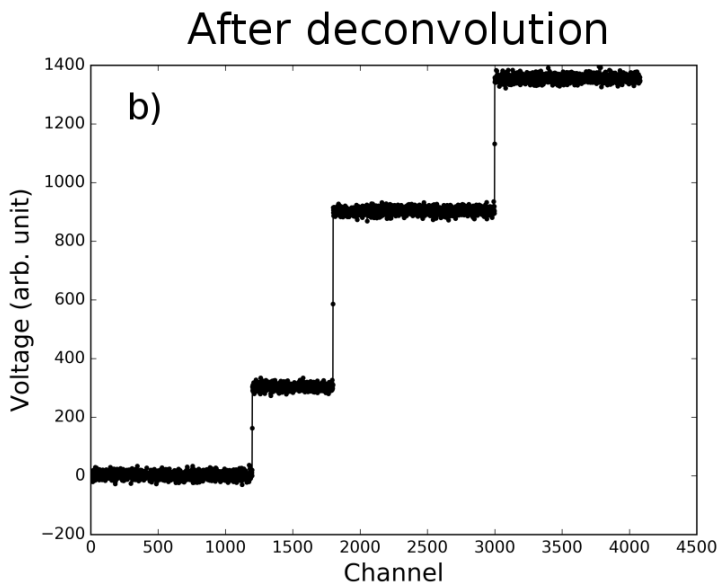
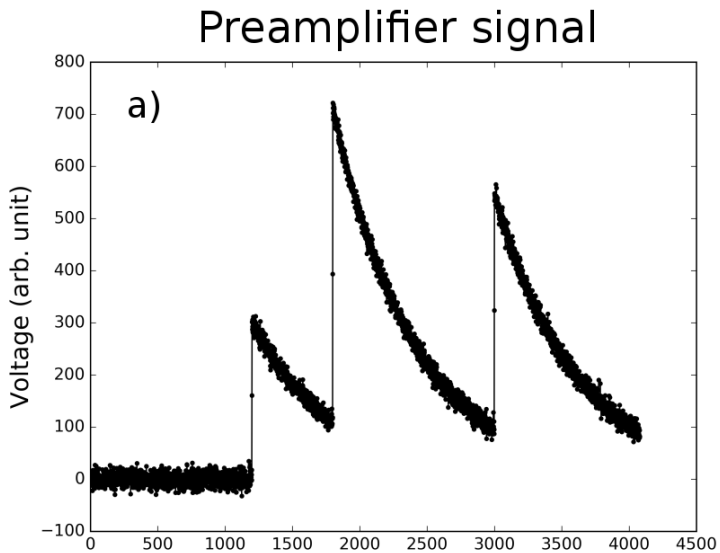
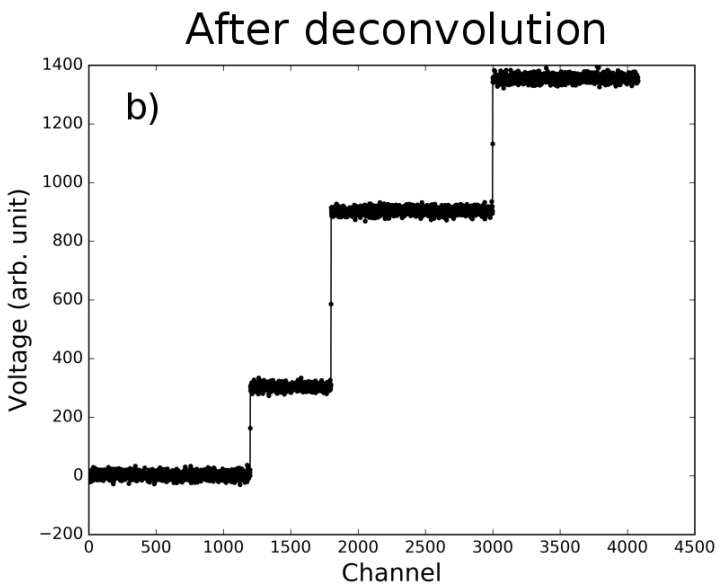
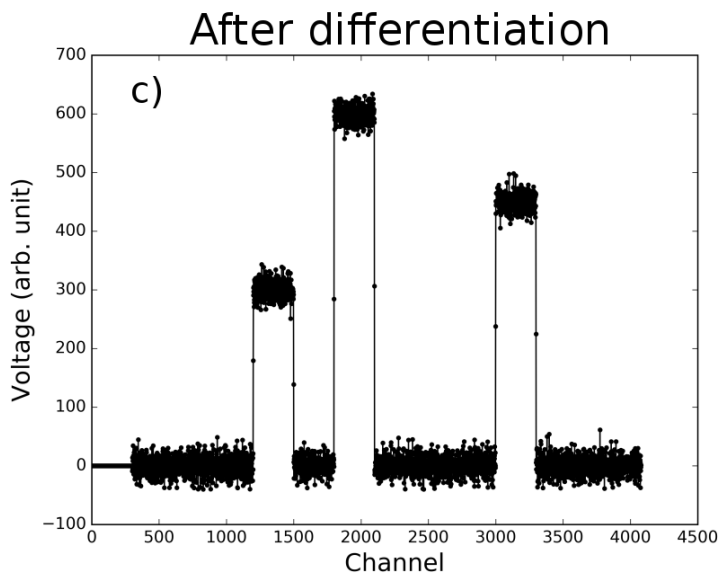




Moving Window Deconvolution







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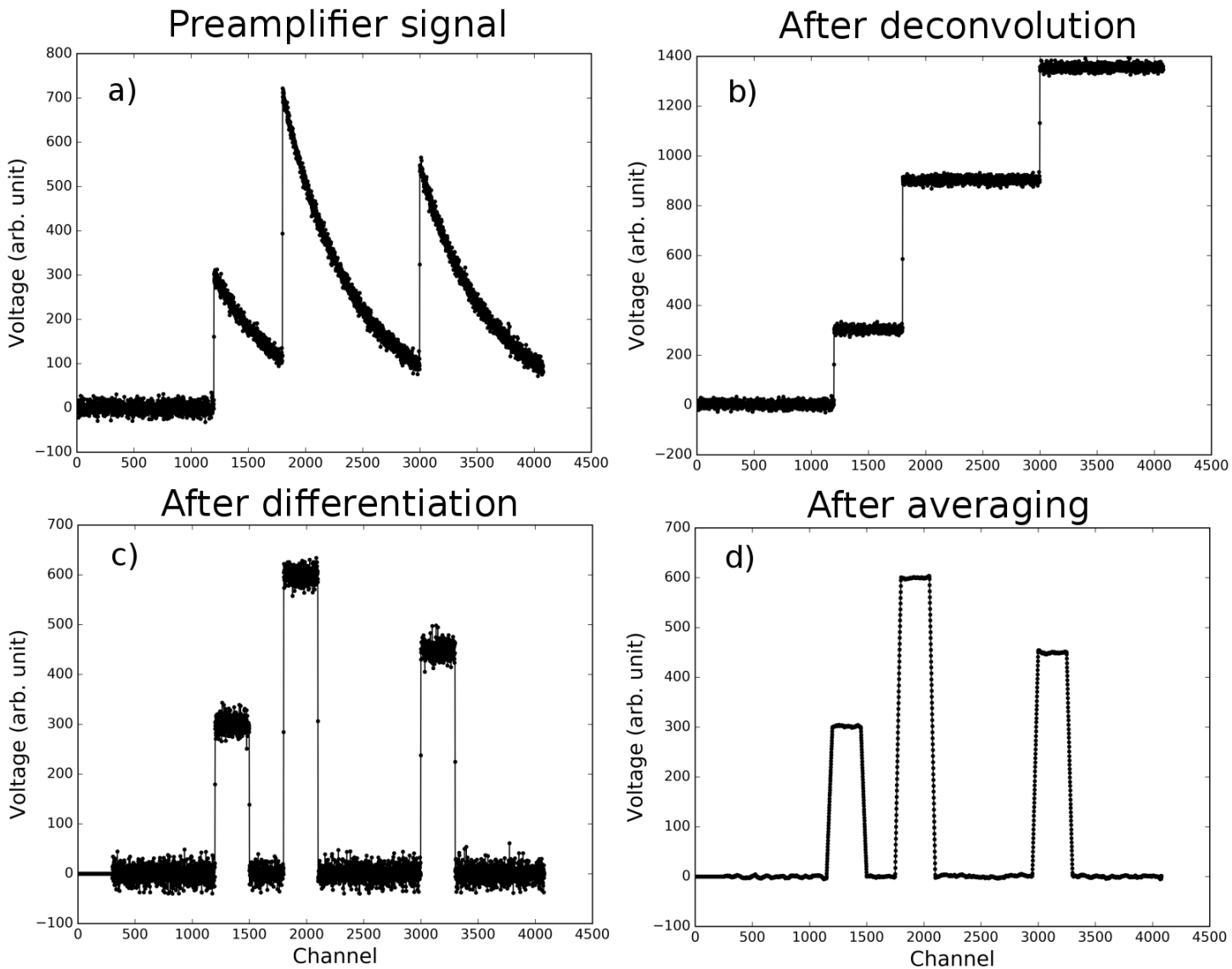
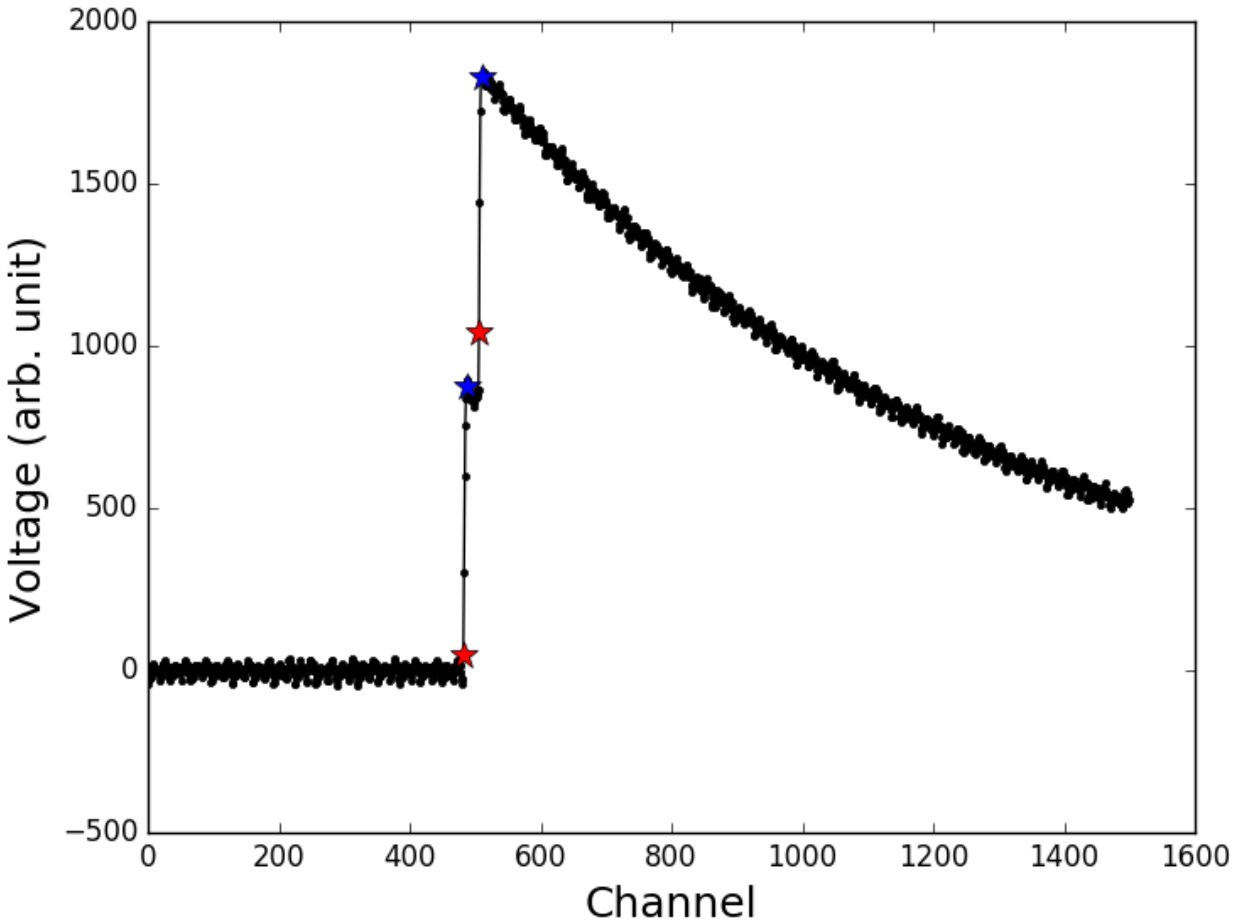


Amplitude Extraction

An example

Digitised signal



Amplitude Extraction
An example

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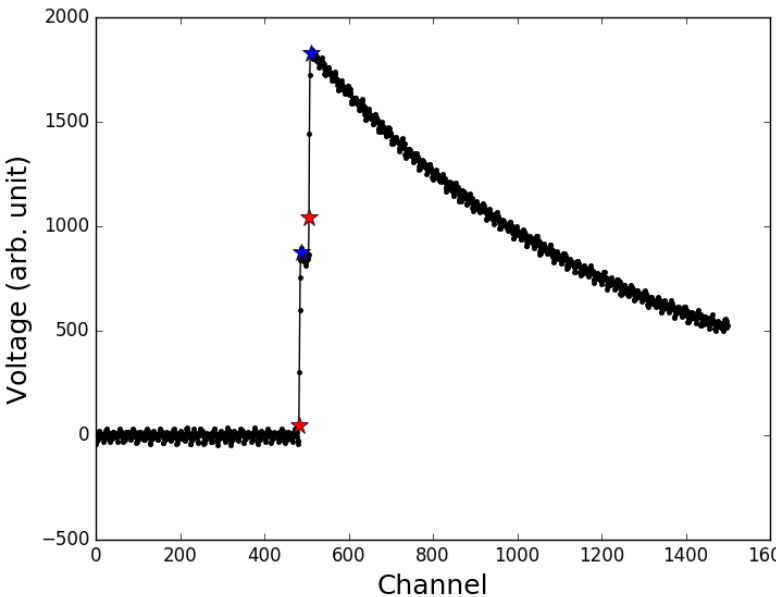
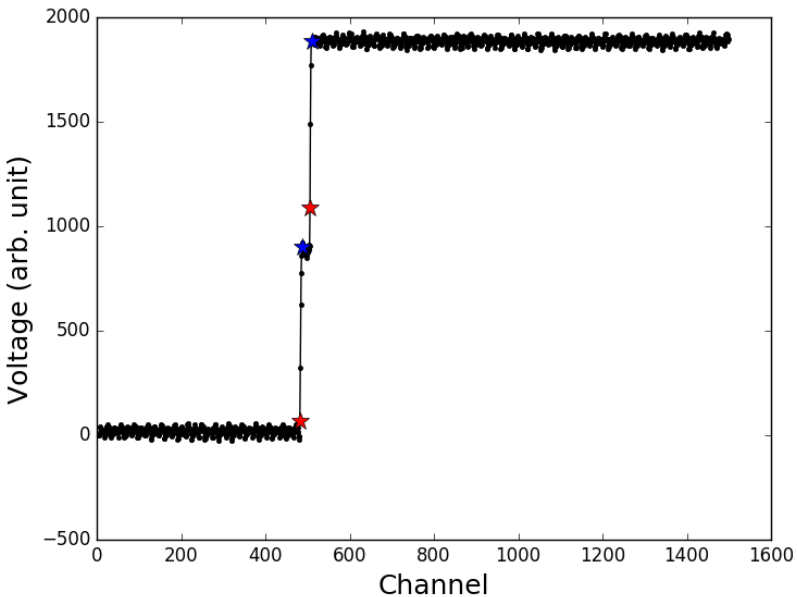
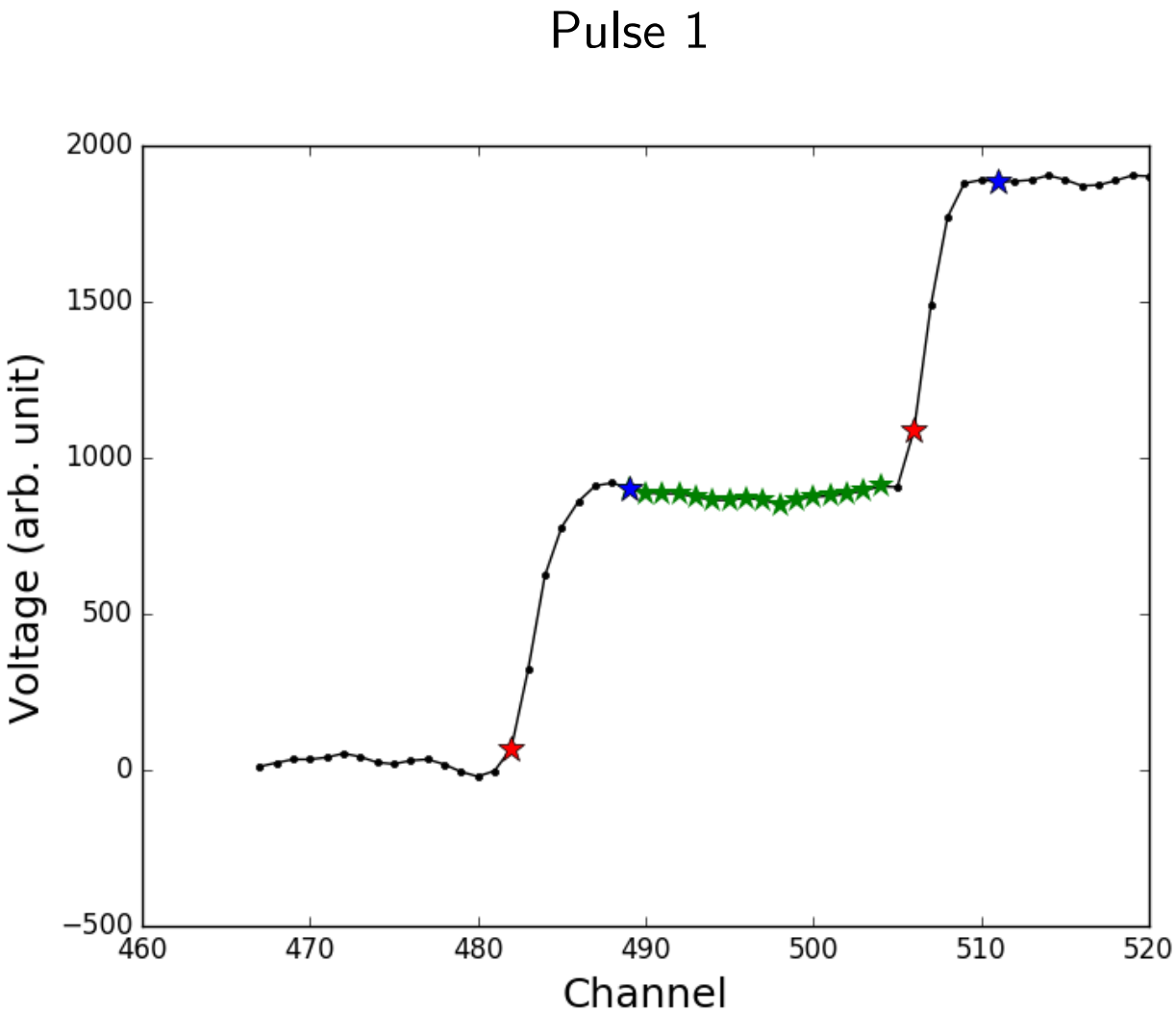


Deconvolved signal



Amplitude Extraction

An example



Amplitude Extraction

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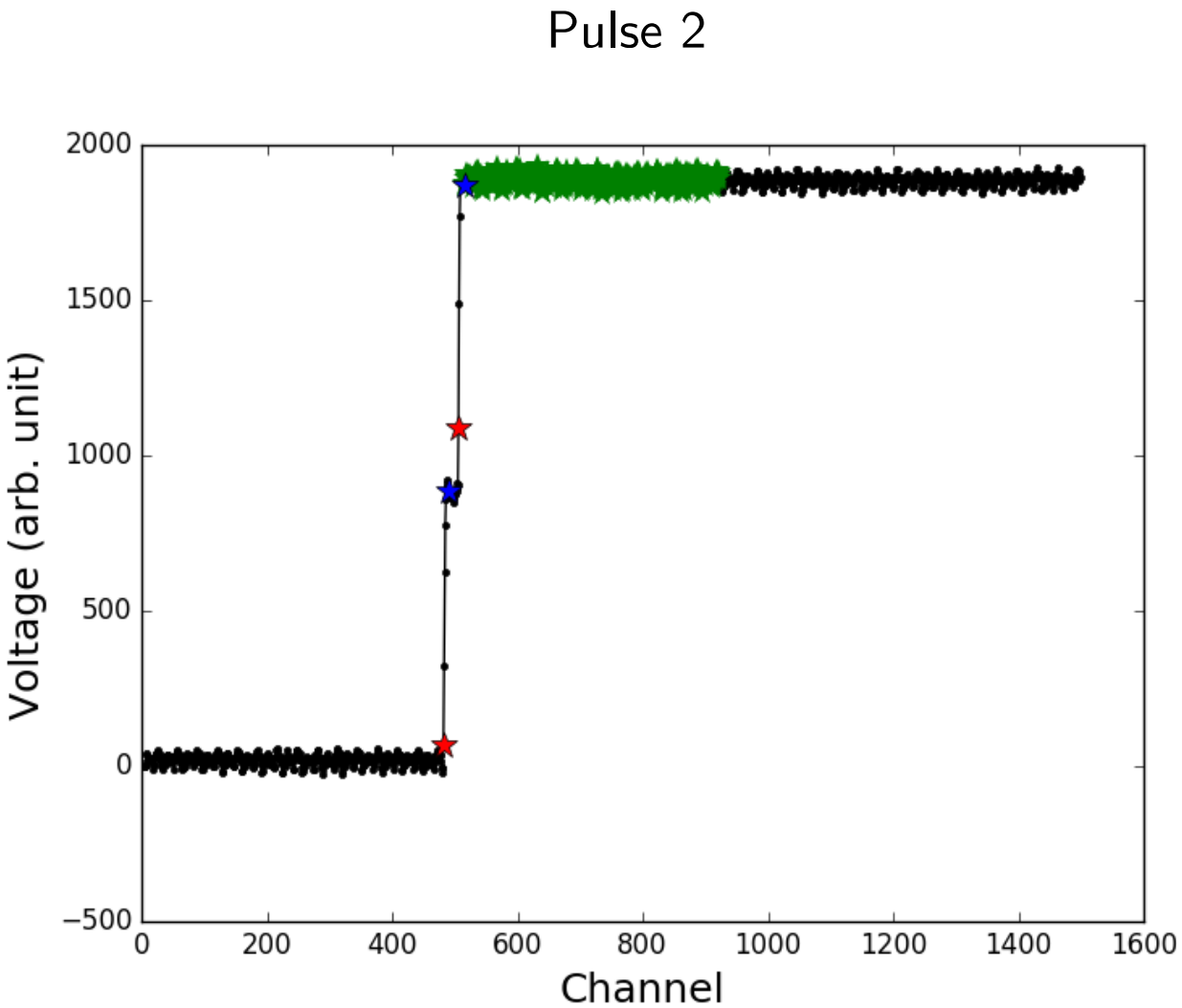
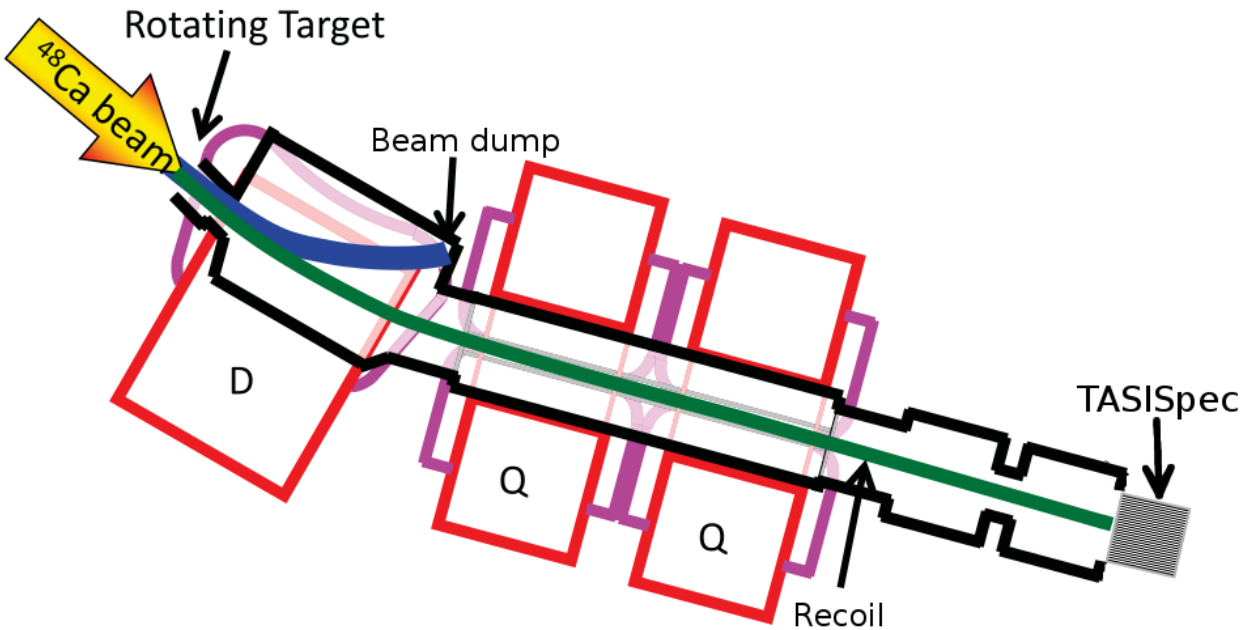


How do we know it works?

The 2012 E115-experiment

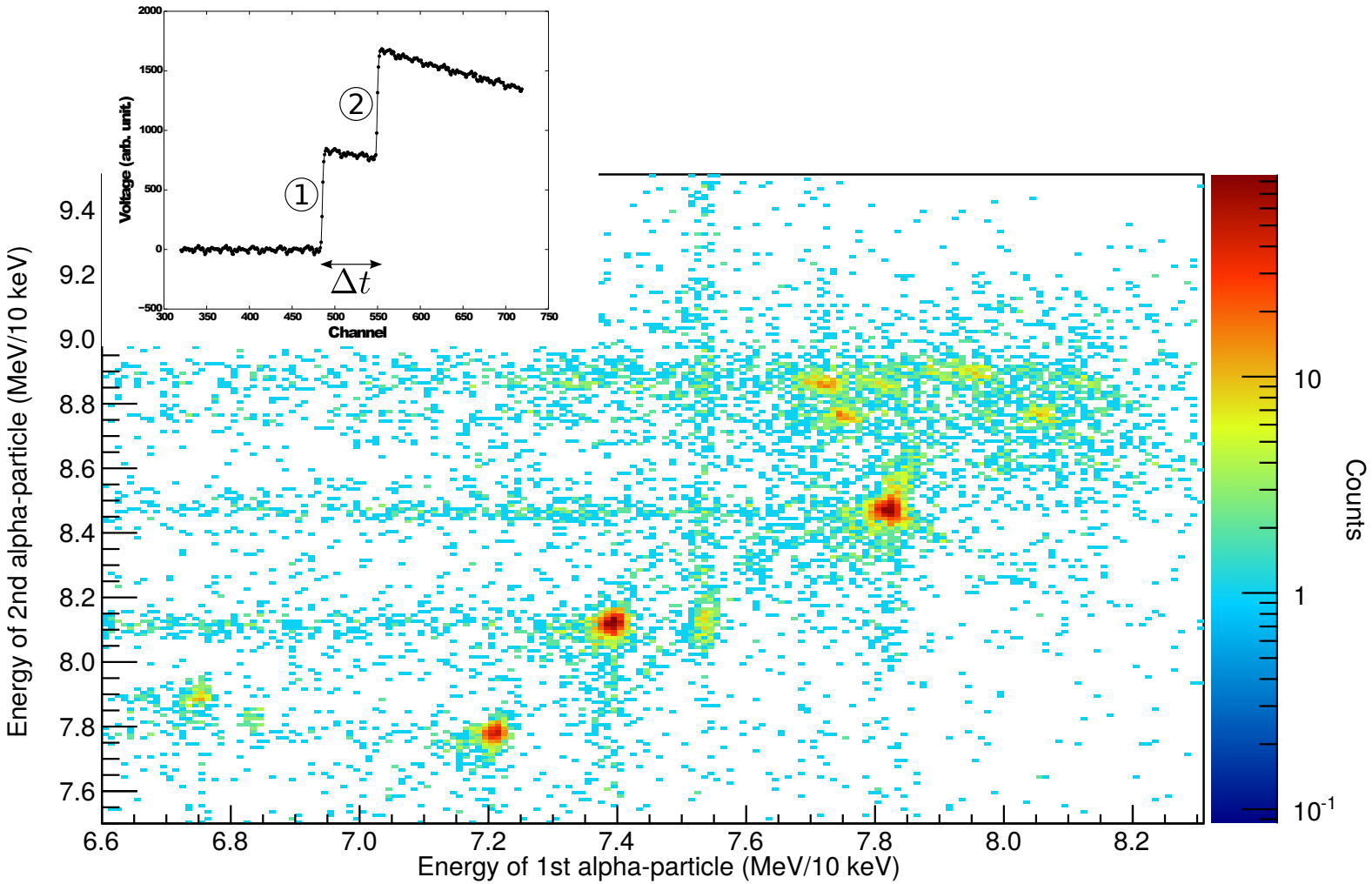
The reaction: $^{48}\mathrm{Ca} + ^{243}\mathrm{Am} = ^{291}115^{*}$



TASCA-separator. Source: Phys. Rev. C, **83**:054618.

Results

α_1-α_2-correlation spectra



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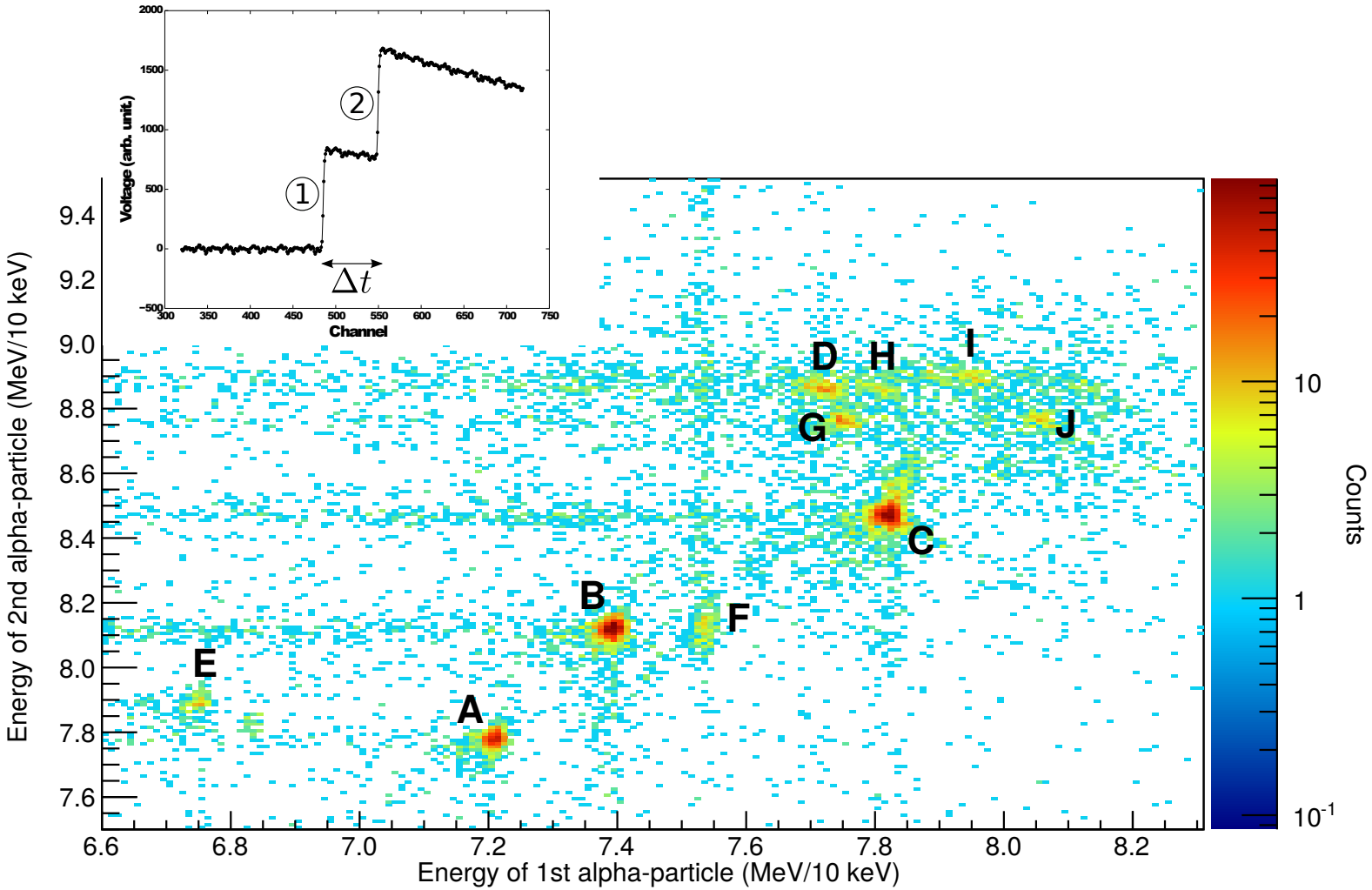

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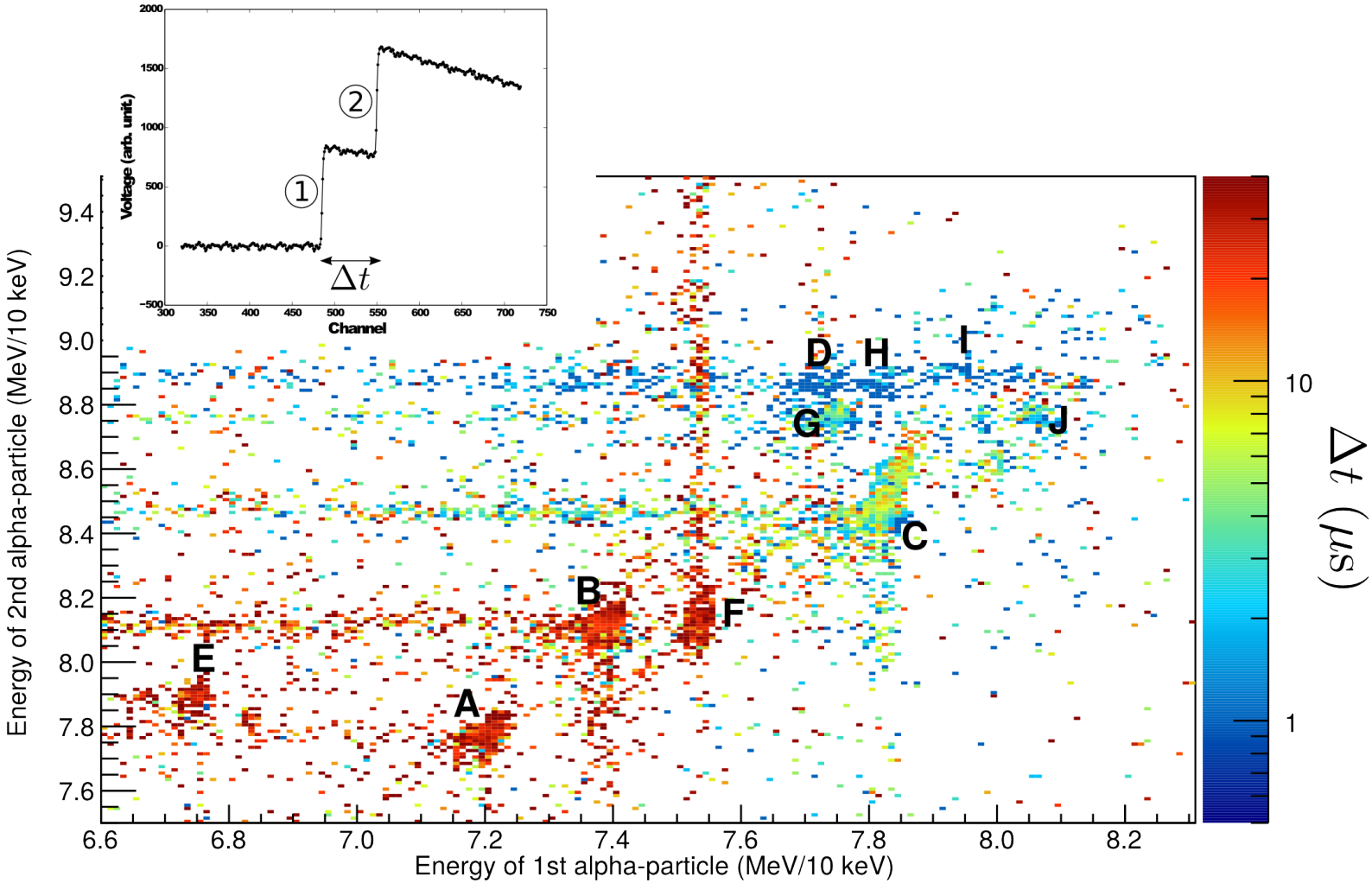

Results
Compiled results

Region	E_{α_1} (MeV)	E_{α_2} (MeV)	$T_{1/2}$ (μs)	E_{α_3} (MeV)
A	7.15(1)	7.72(1)	85(22)	-
B	7.33(2)	8.06(2)	32(2)	6.62(1)
C	7.76(2)	8.41(3)	3.6(1)	-
D	7.67(3)	8.80(2)	0.90(5)	-
E	6.69(2)	7.84(1)	44(12)	-
F	7.48(1)	8.07(3)	62(26)	-
G	7.68(5)	8.70(3)	2.1(1)	7.45(2)
H	7.75(3)	8.80(3)	0.7(1)	-
I	7.88(4)	8.83(3)	0.72(7)	-
J	8.00(3)	8.69(3)	1.9(2)	7.45(1)

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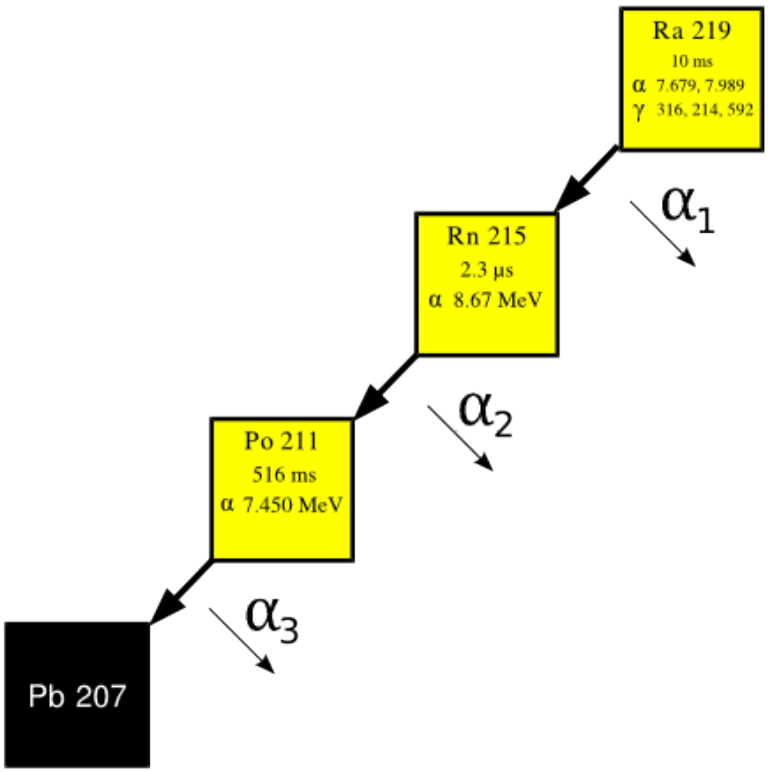
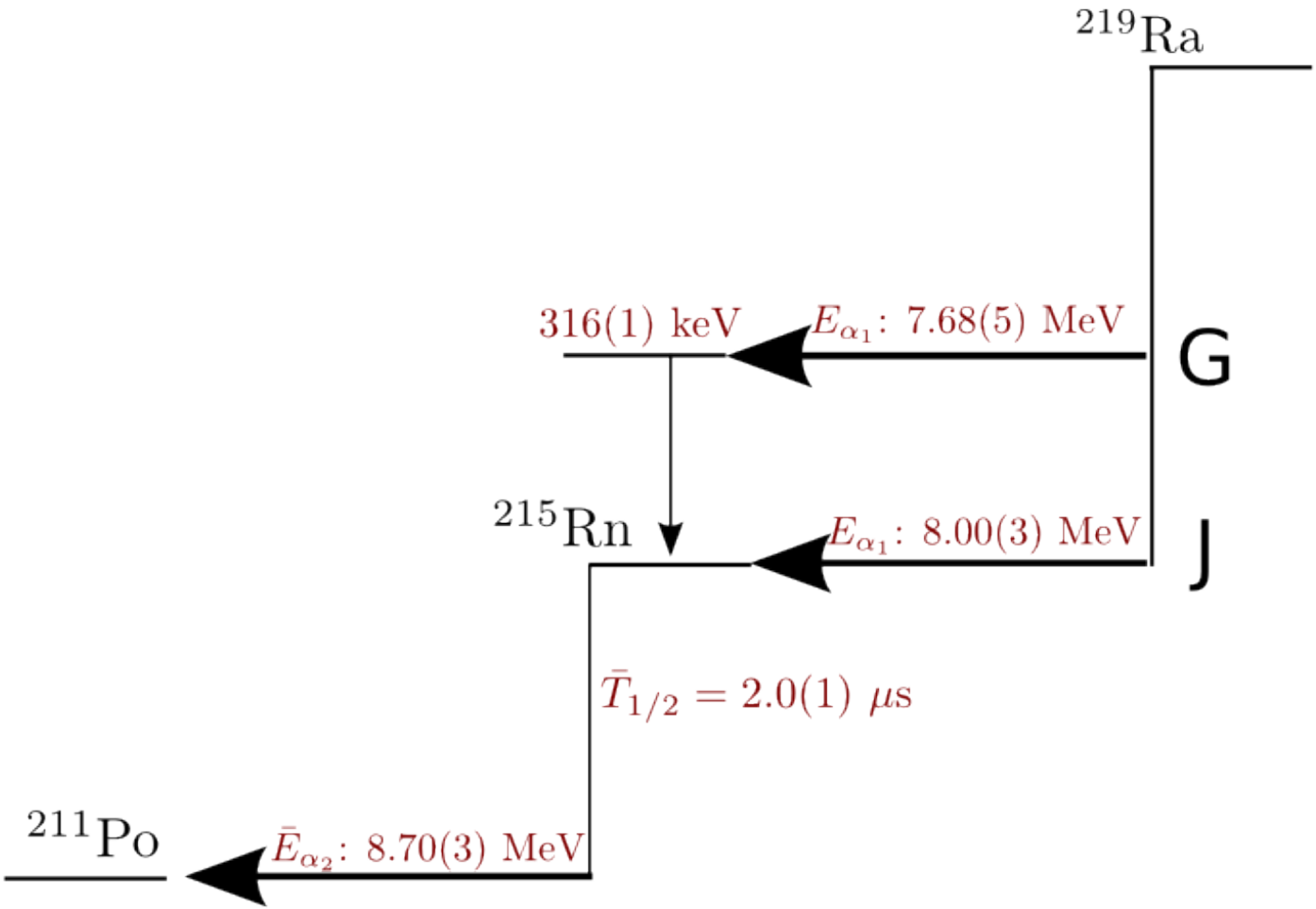
Results
Connection to decay paths

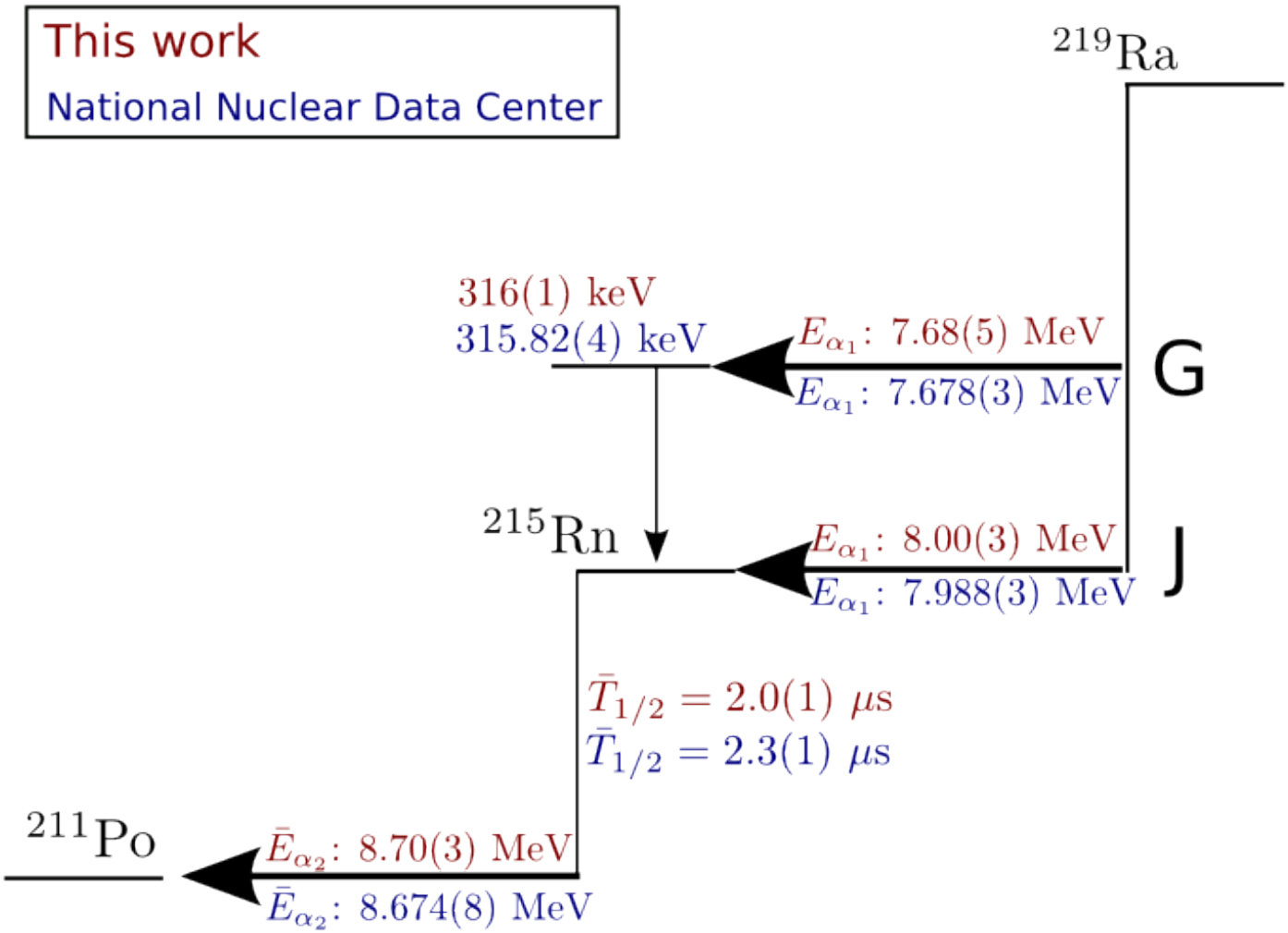


Source: Karlsruhe Nuclide Chart.

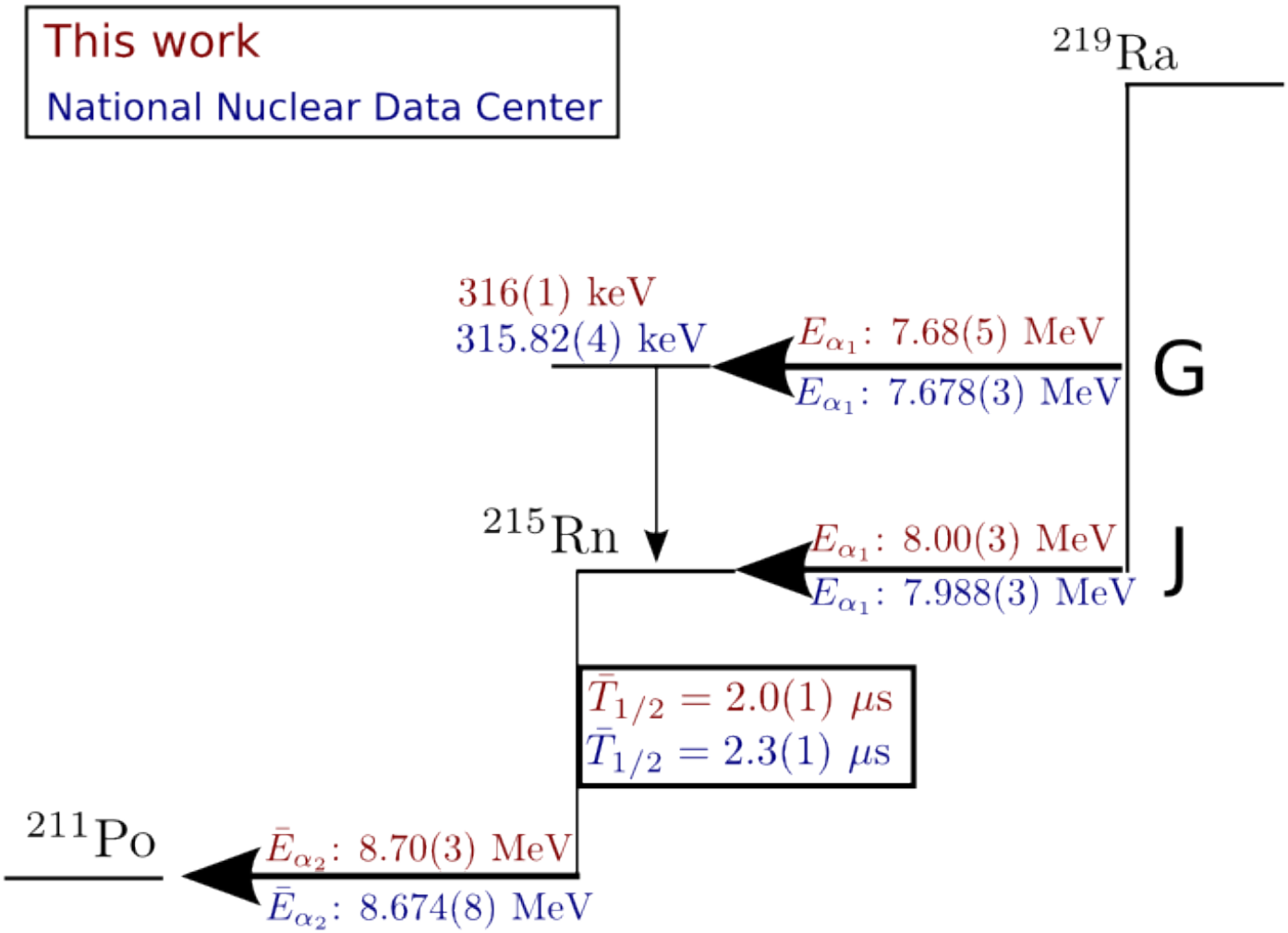
Results
Decay Level Scheme



Results
Decay Level Scheme



Results
Decay Level Scheme

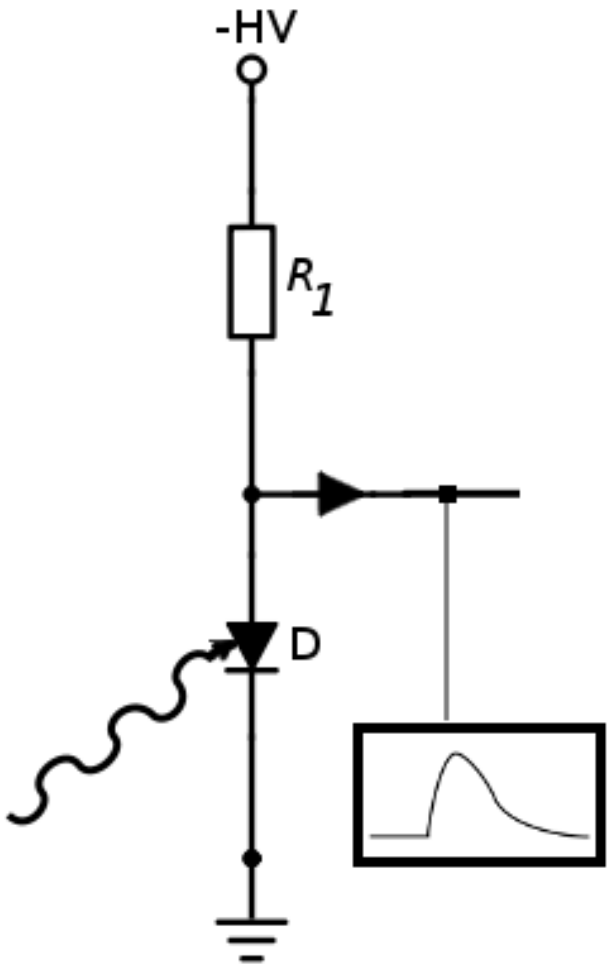


Outlook

- Study the remaining eight (and possibly more) blobs for:
  - Better half-life measurements
  - New decay modes
  - Improved branching ratios

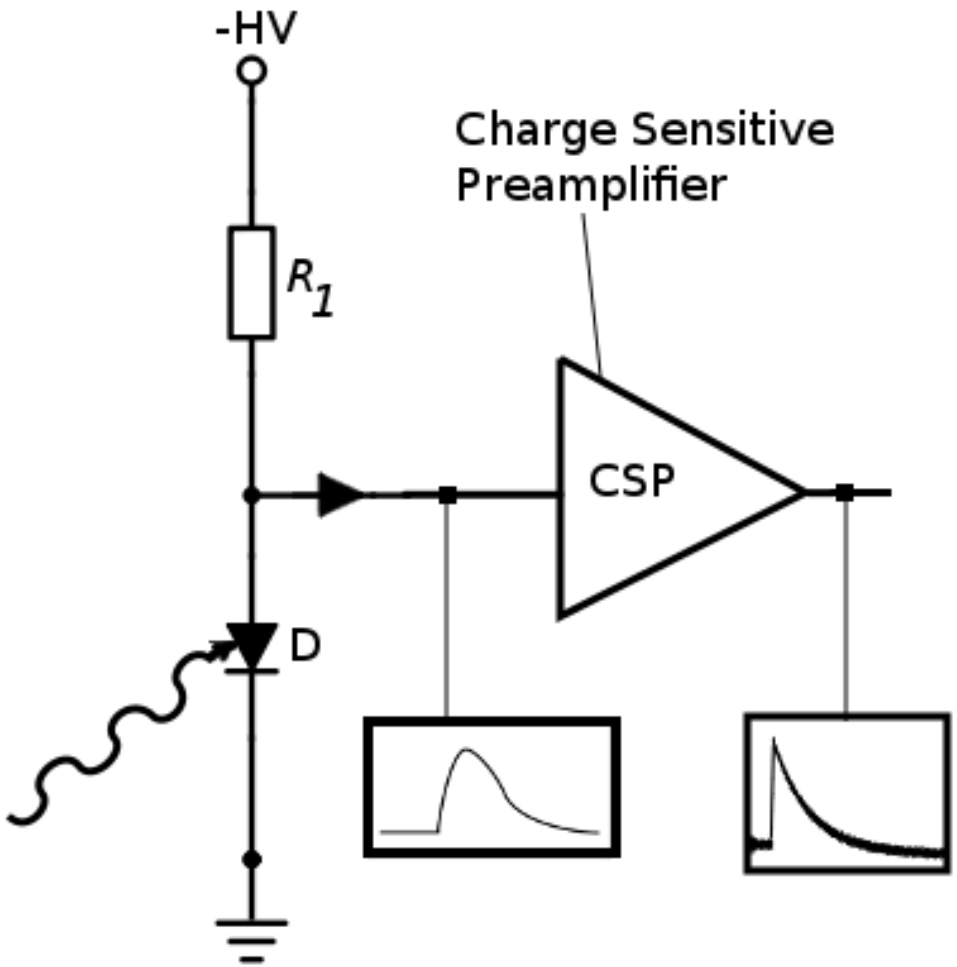
Experimental Techniques

Readout chain



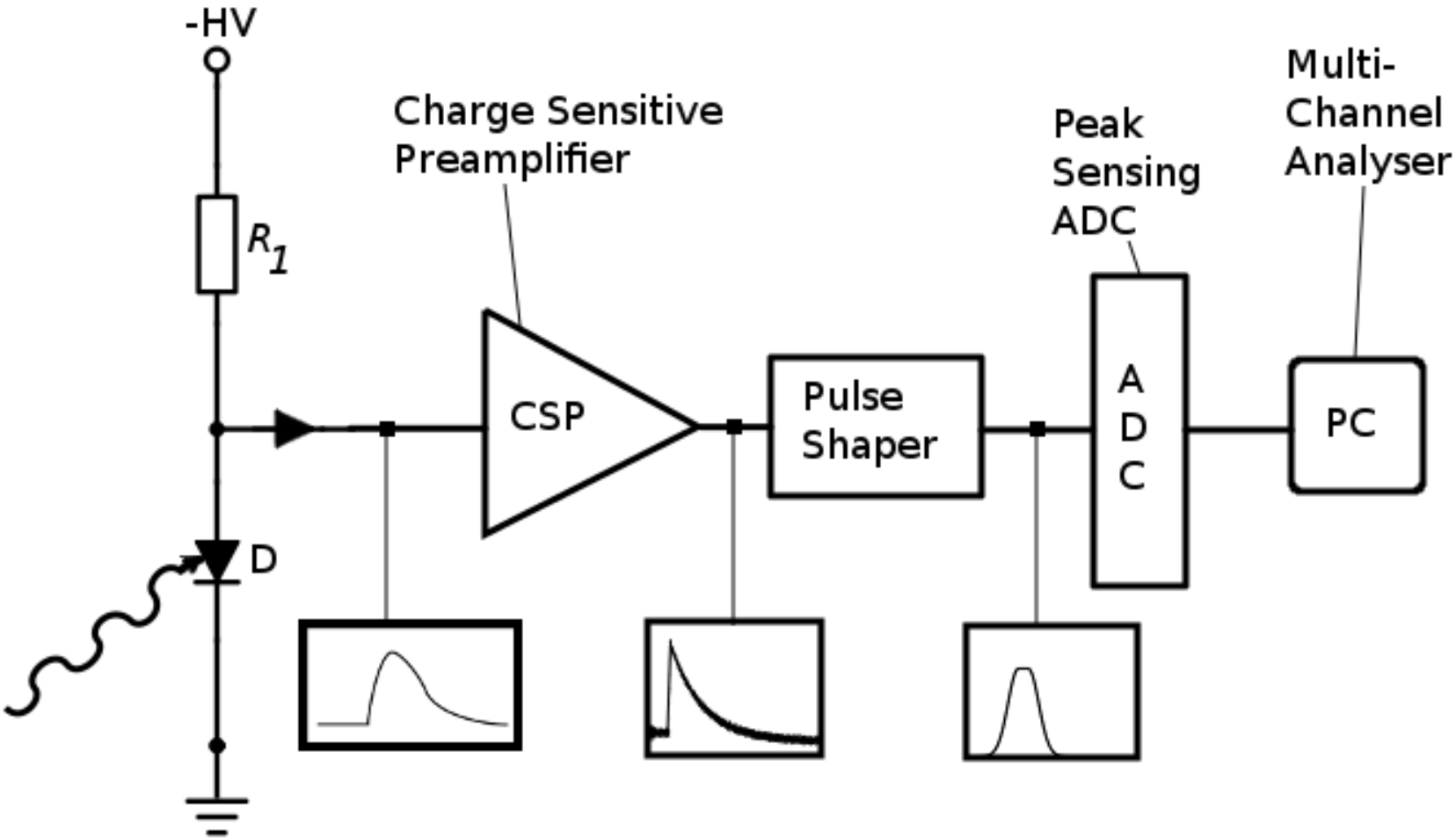
Experimental Techniques

Readout chain

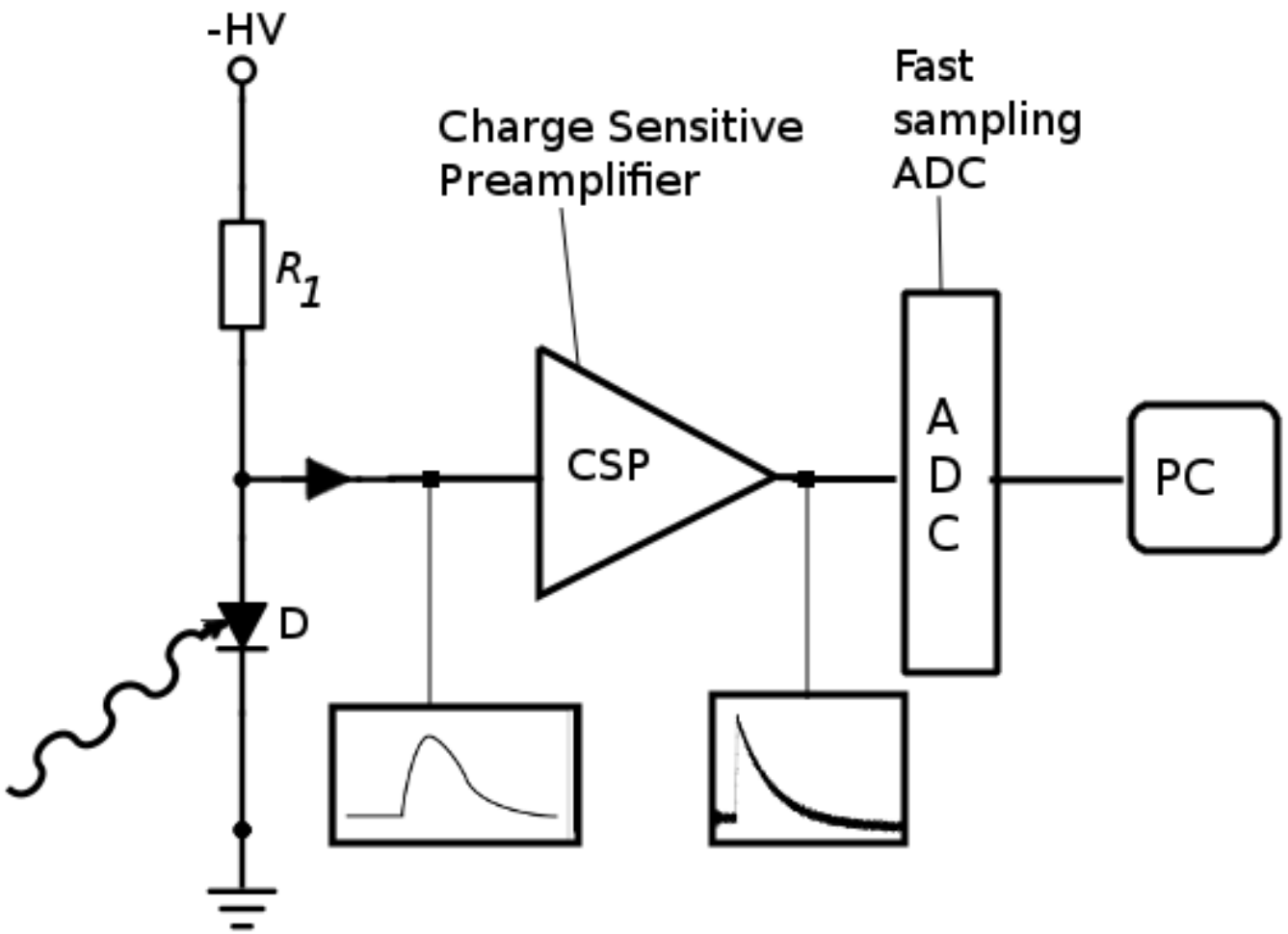


Experimental Techniques

Analogue Pulse Processing

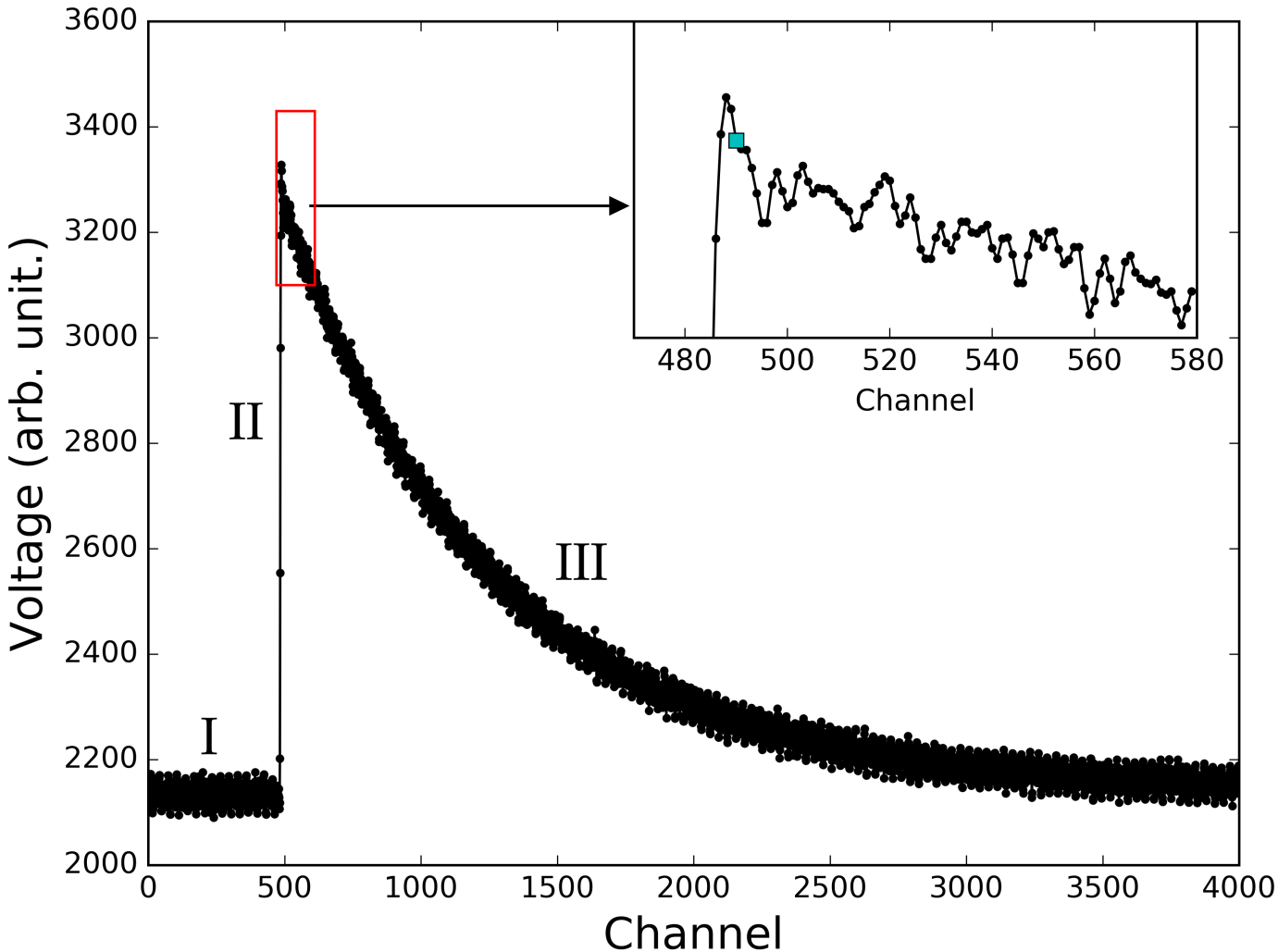


Experimental Techniques
Digital Pulse Processing

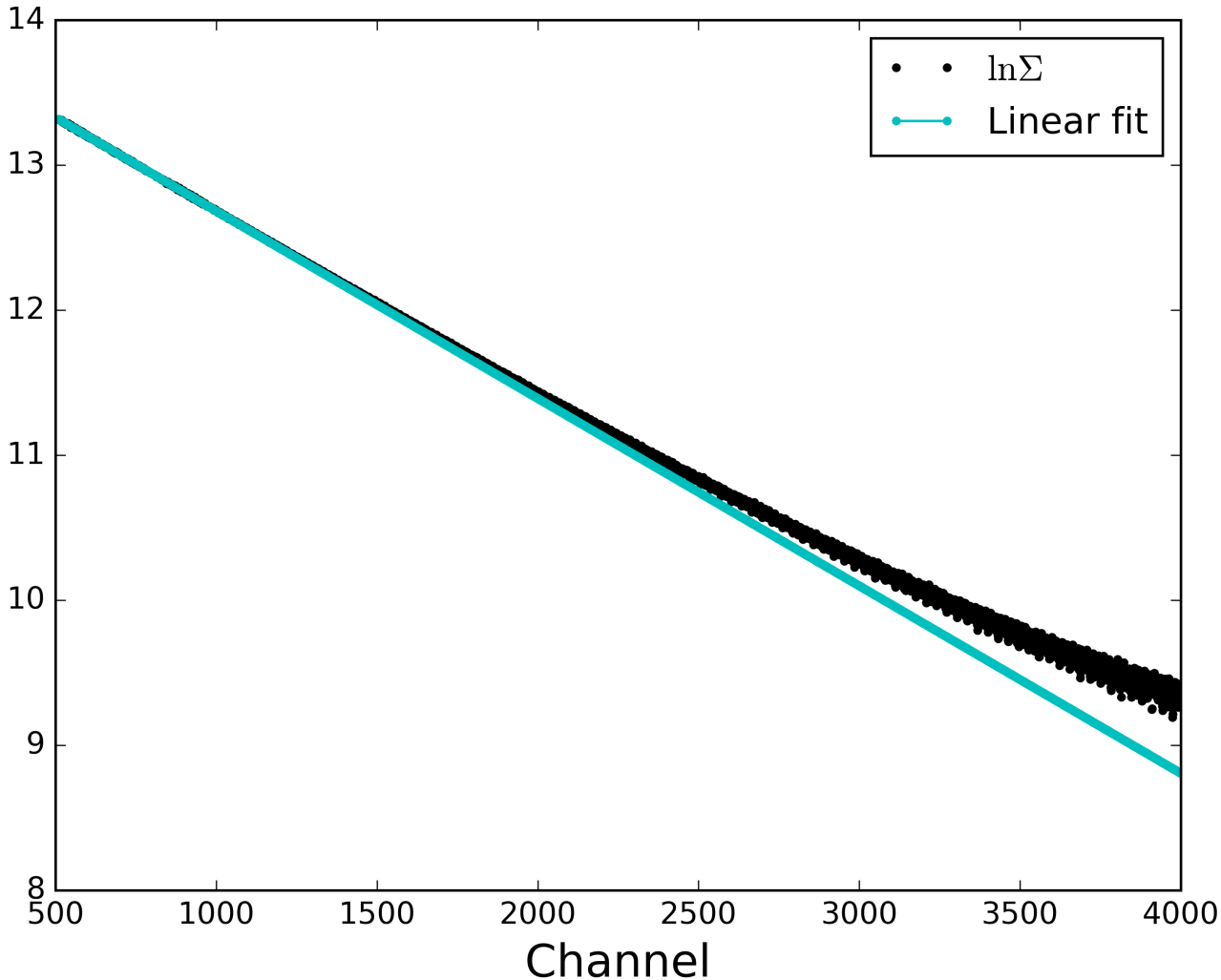


Experimental Techniques

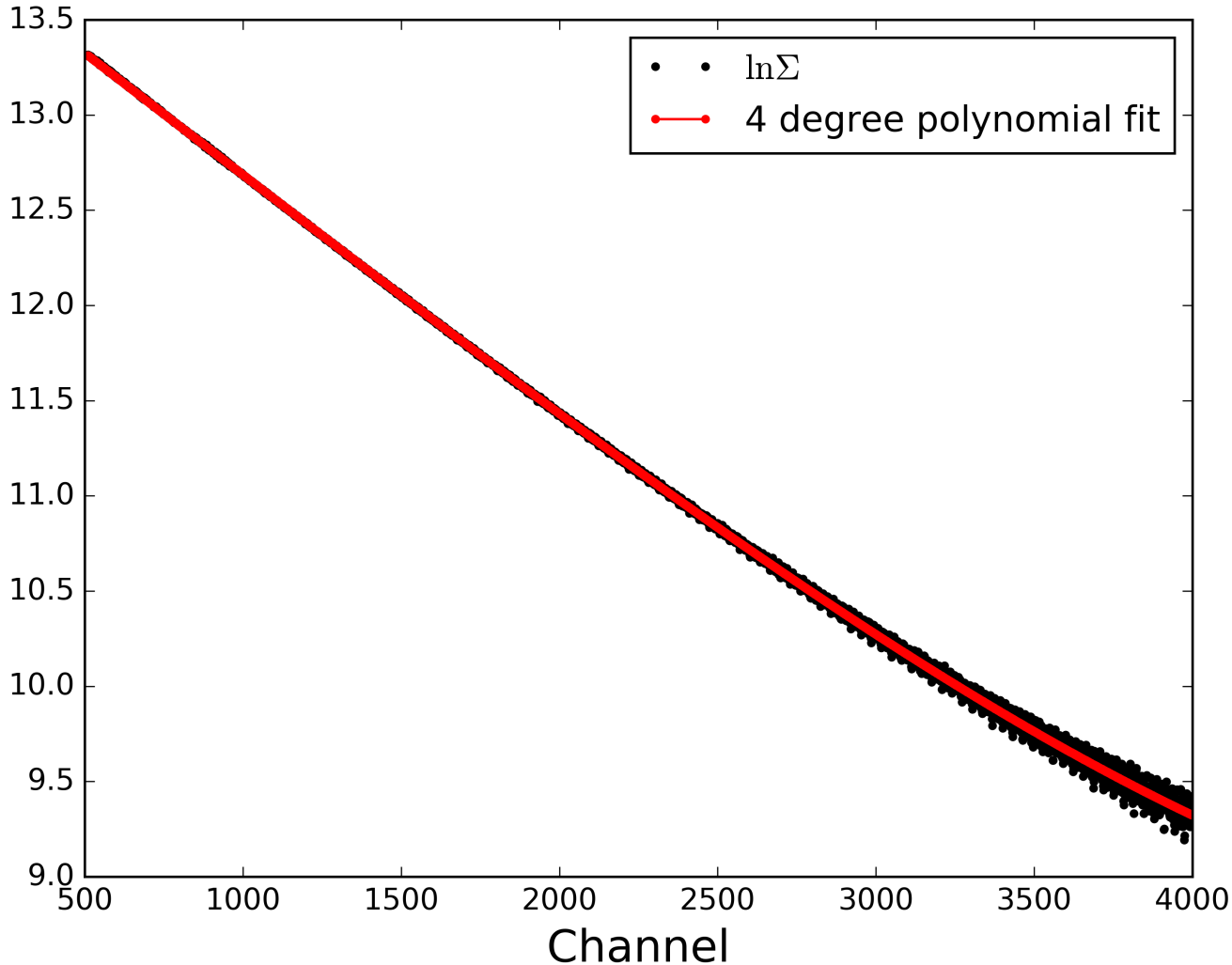
Preamplifier trace



Amplitude Extraction
Deconvolution

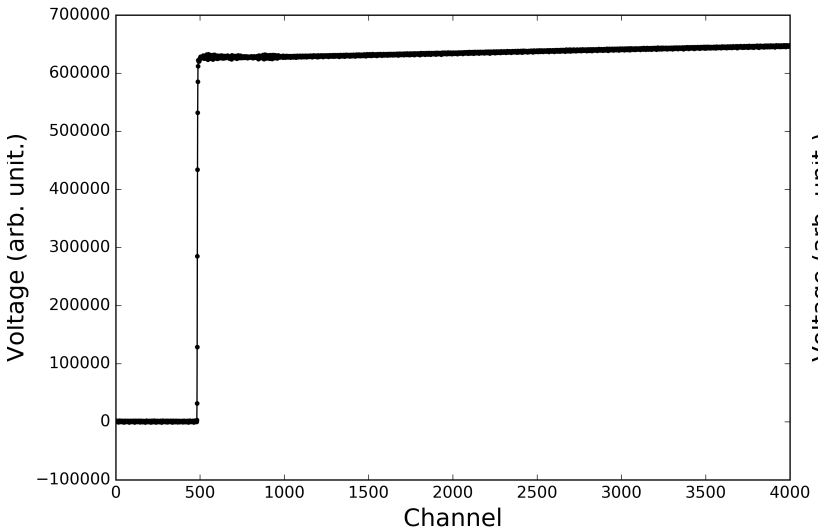


Amplitude Extraction
Deconvolution



Amplitude Extraction
Deconvolution

Deconvolution - before



Deconvolution - new