SiPM Characterization

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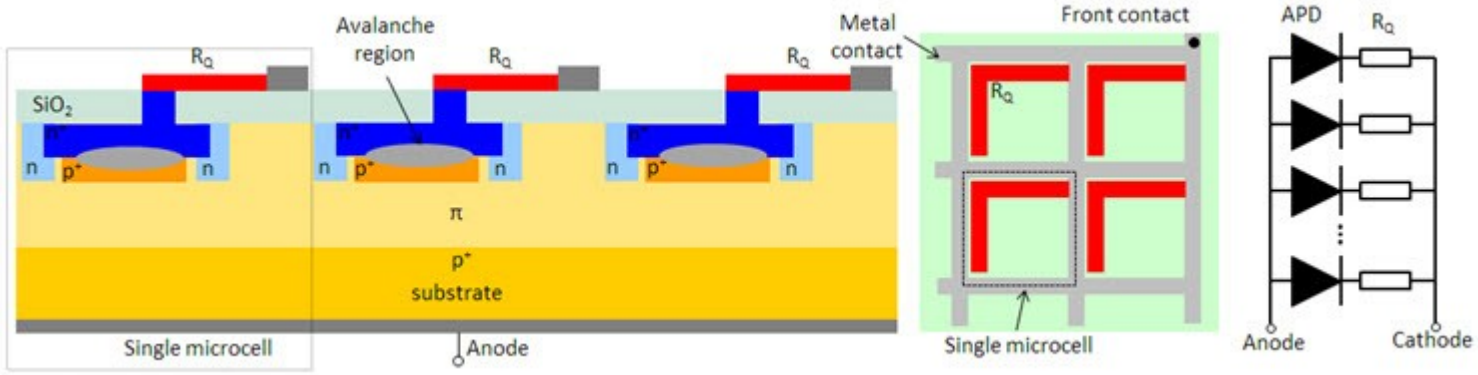
Outline

- Basic theory
- Experiment goal
- Methods and results
  - Breaking voltage
  - Gain measurements
  - Spectroscopy
- Conclusion

What are SiPMs

- Silicon Photomultipliers
- Extremely sensitive photon detectors
  - Composed of a large amount of APDs
- Used more and more in high energy gamma spectroscopy and cosmic particle detection
- Array of cells can be combined to produce large detection areas

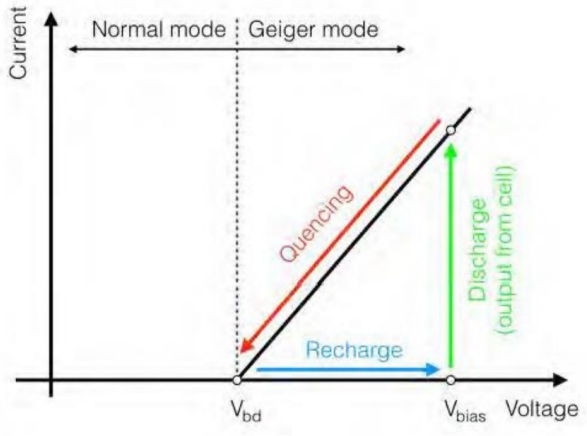


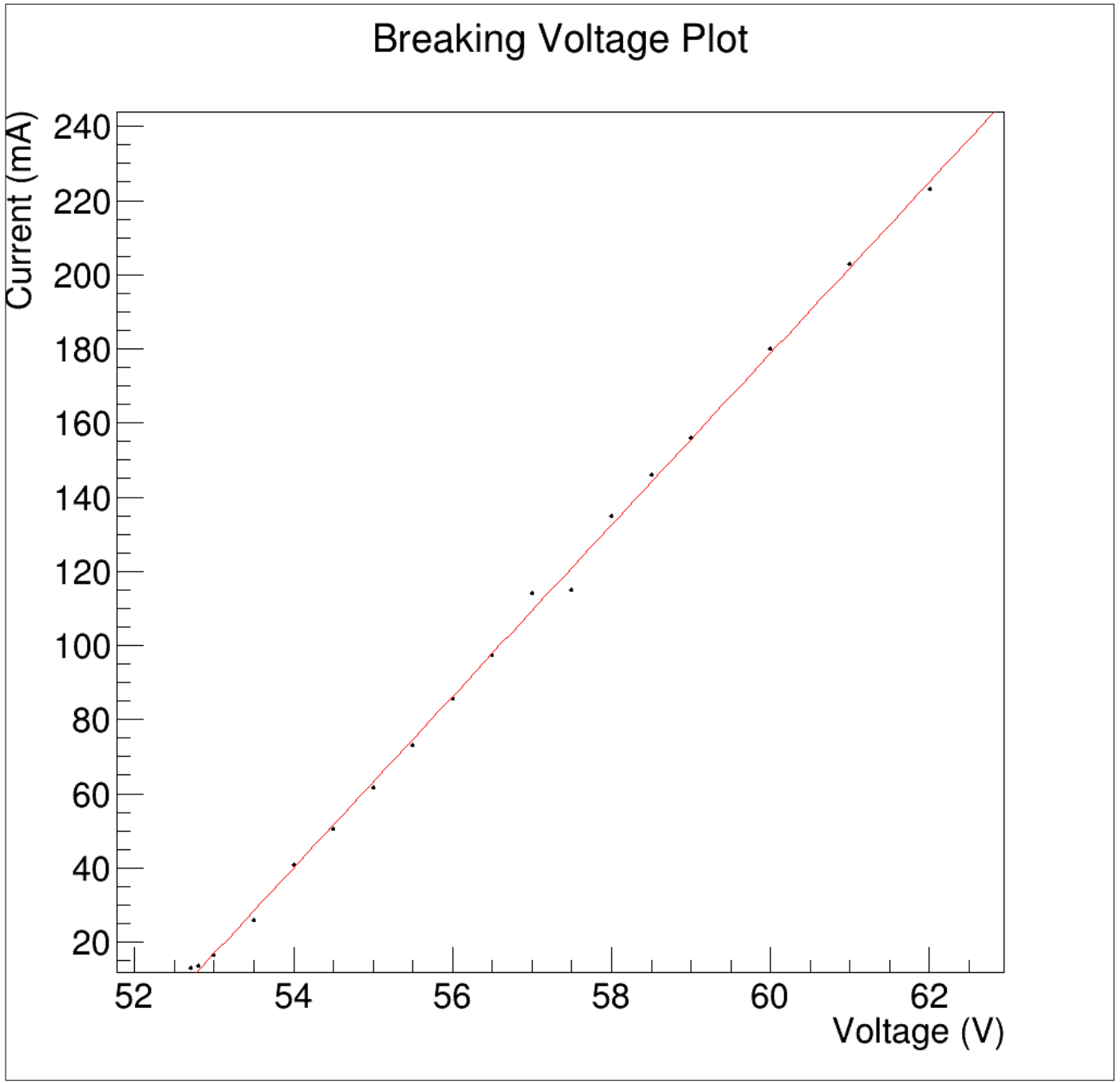
Characterization

- Breaking & bias voltage
- Gain of the SiPM
- Spectroscopy

Bias Voltage Measurements

- Measure the voltage output from the SiPM for bias voltages set on the power supply for 51 to 62 volts
- Linear fit will provide the breaking voltage and the bias voltage used will be breaking +3V



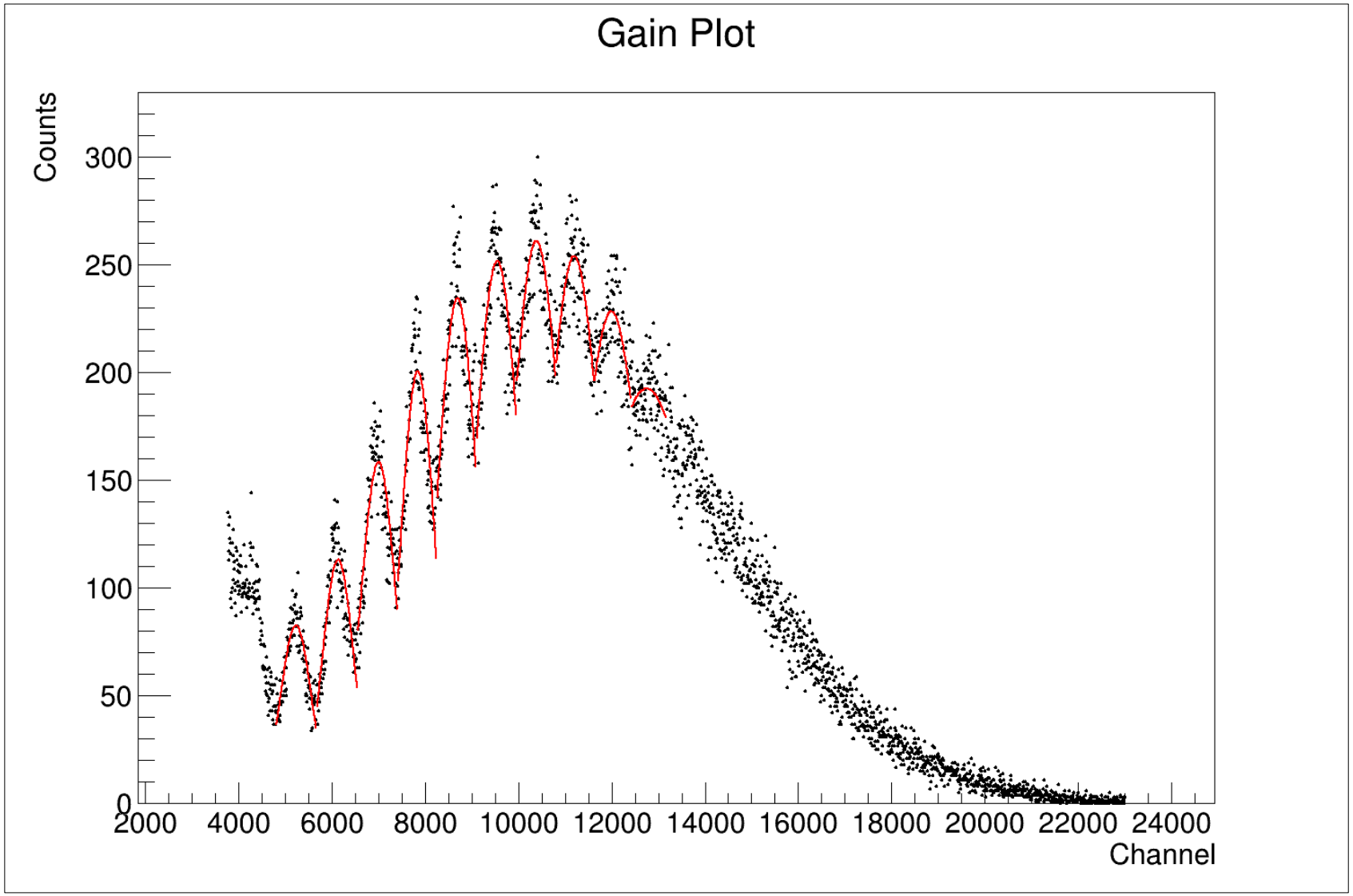


V_br = 52.268 +/- 0.699
V_p = 55.268 +/- 0.699

T-Test = 1.09

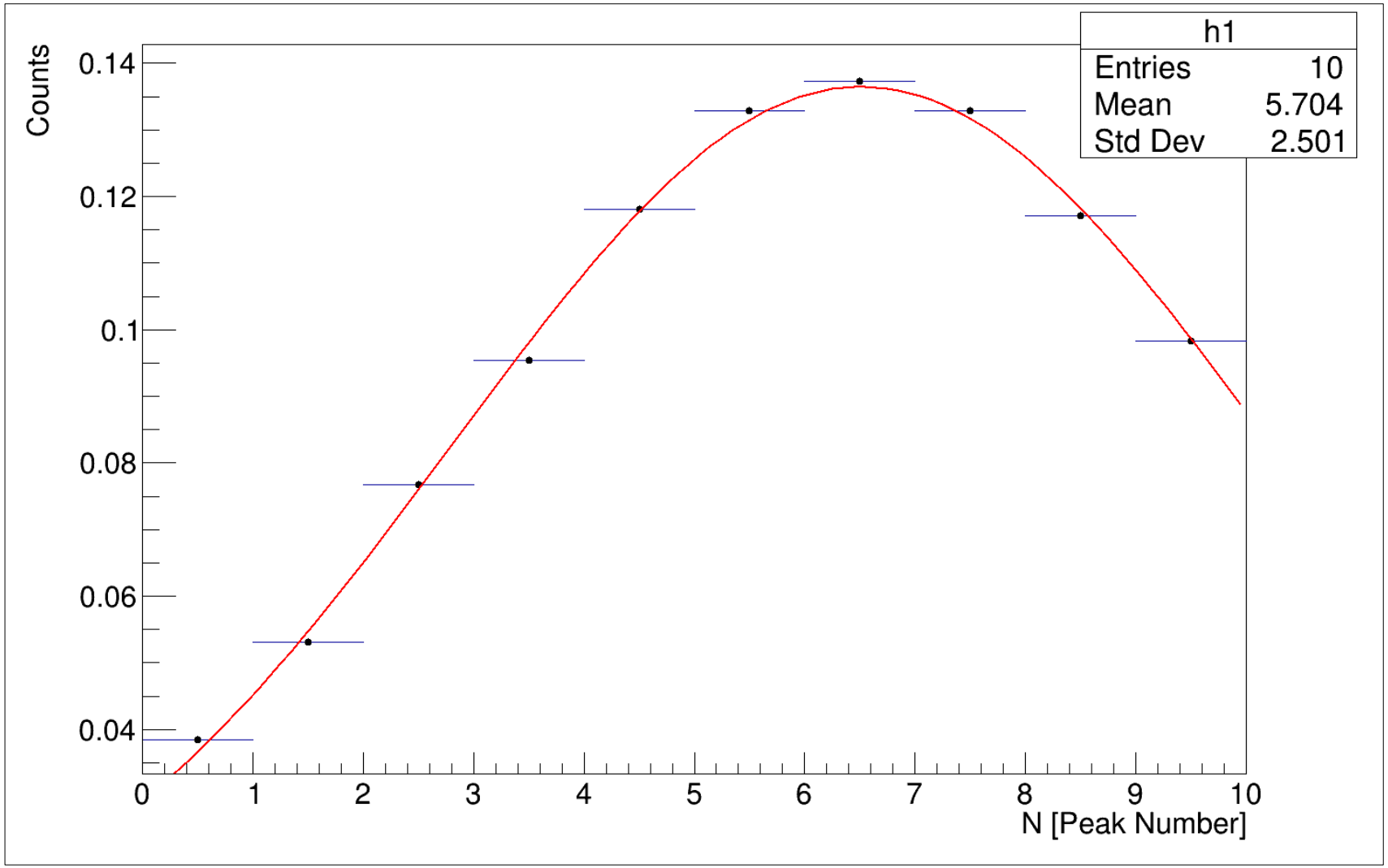
Gain measurement

- Photon pulses were emitted and measured by the SiPM to different channels
- Each is a plotted peak allowing for gain calculation
- Calculated by multiplying constant by distance between peaks over charge
- The overall spectrum can be Poisson fitted
- The gain for each individual set of peaks can be fit linearly against its channel
- This was done twice with the gain set to 32dB and 38dB respectively

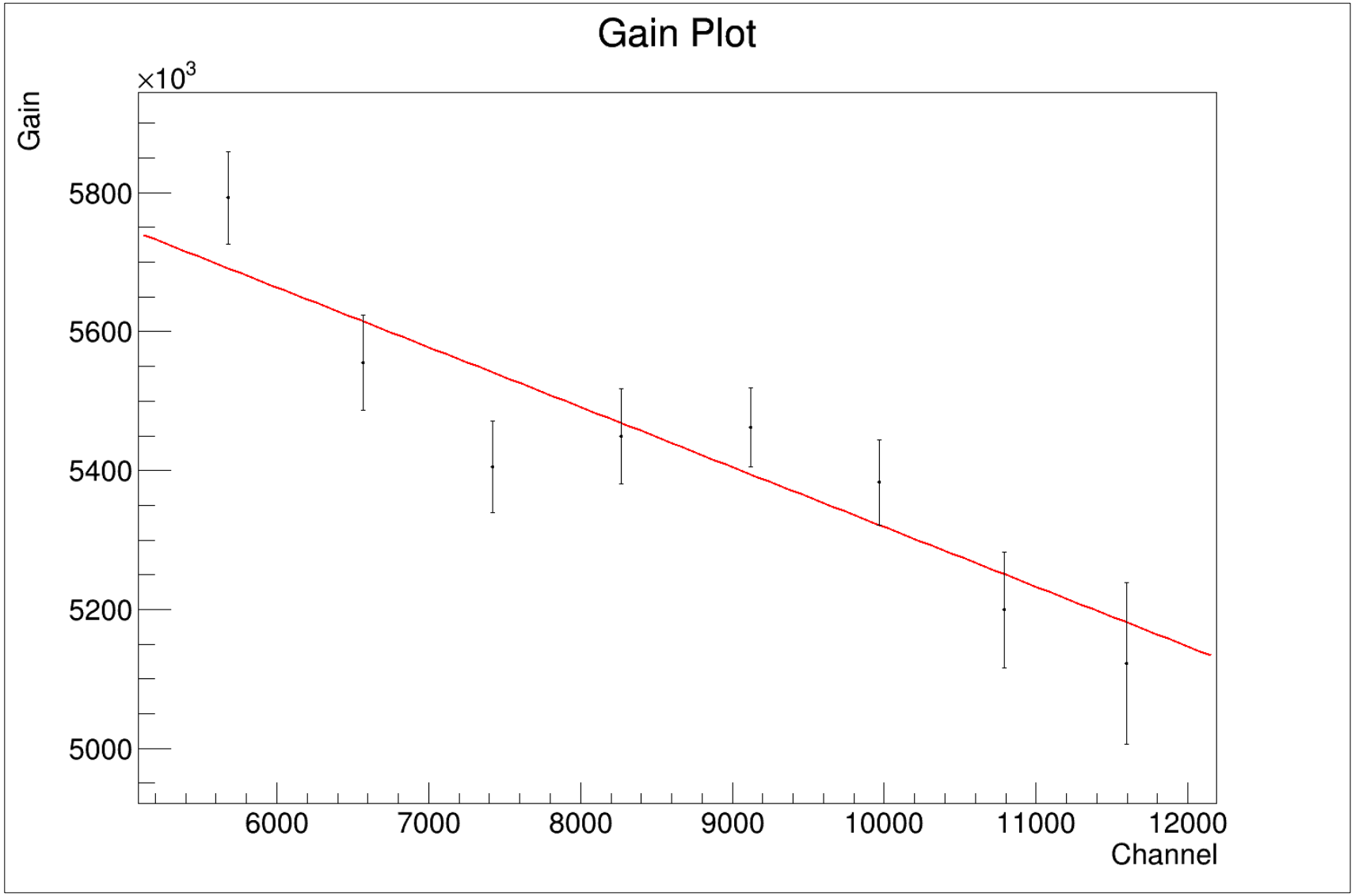


Gain 32dB = 2.634e6

Gain 38dB = 5.353e6



Mean +/- std dev 32dB = 7.897 +/- 3.888
Mean +/- std dev 38dB = 6.513 +/- 3.708

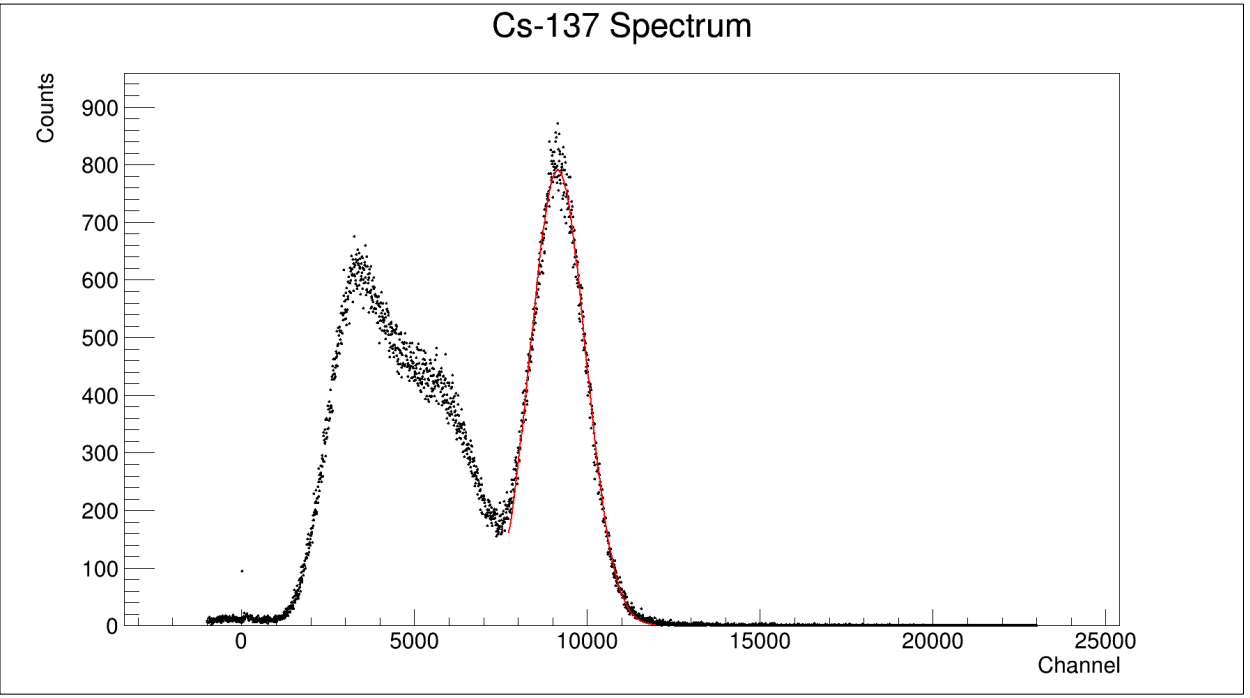


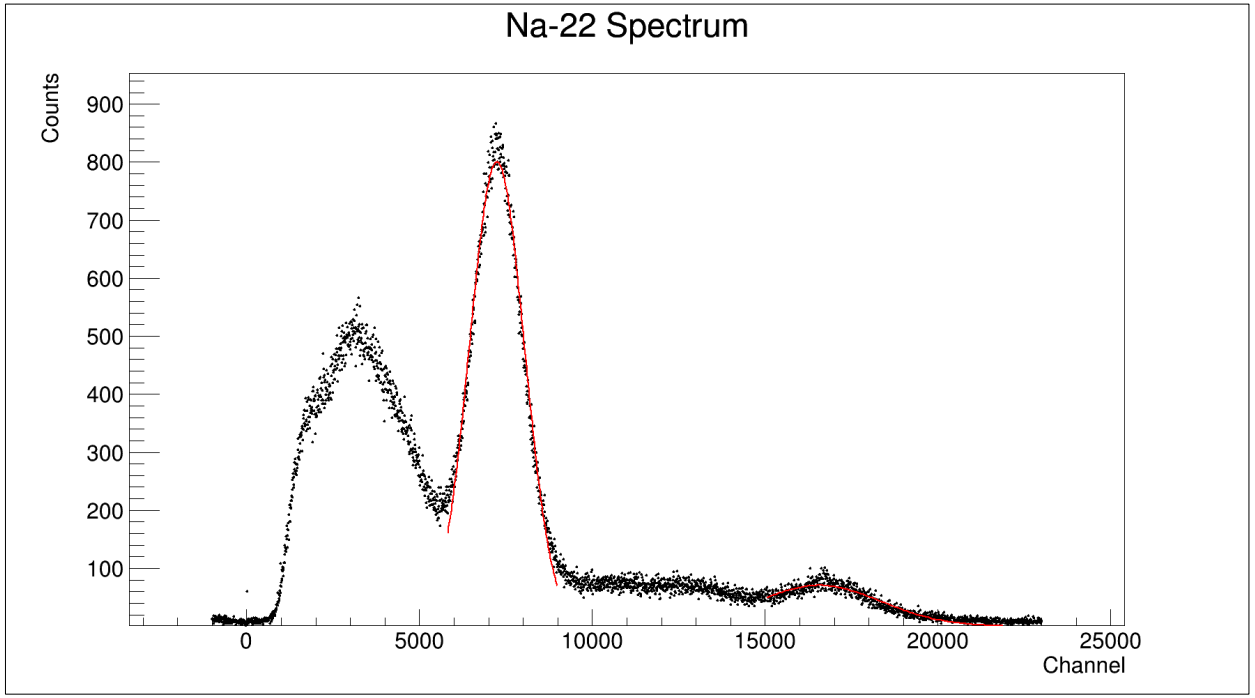
R^2 32dB = 0.882

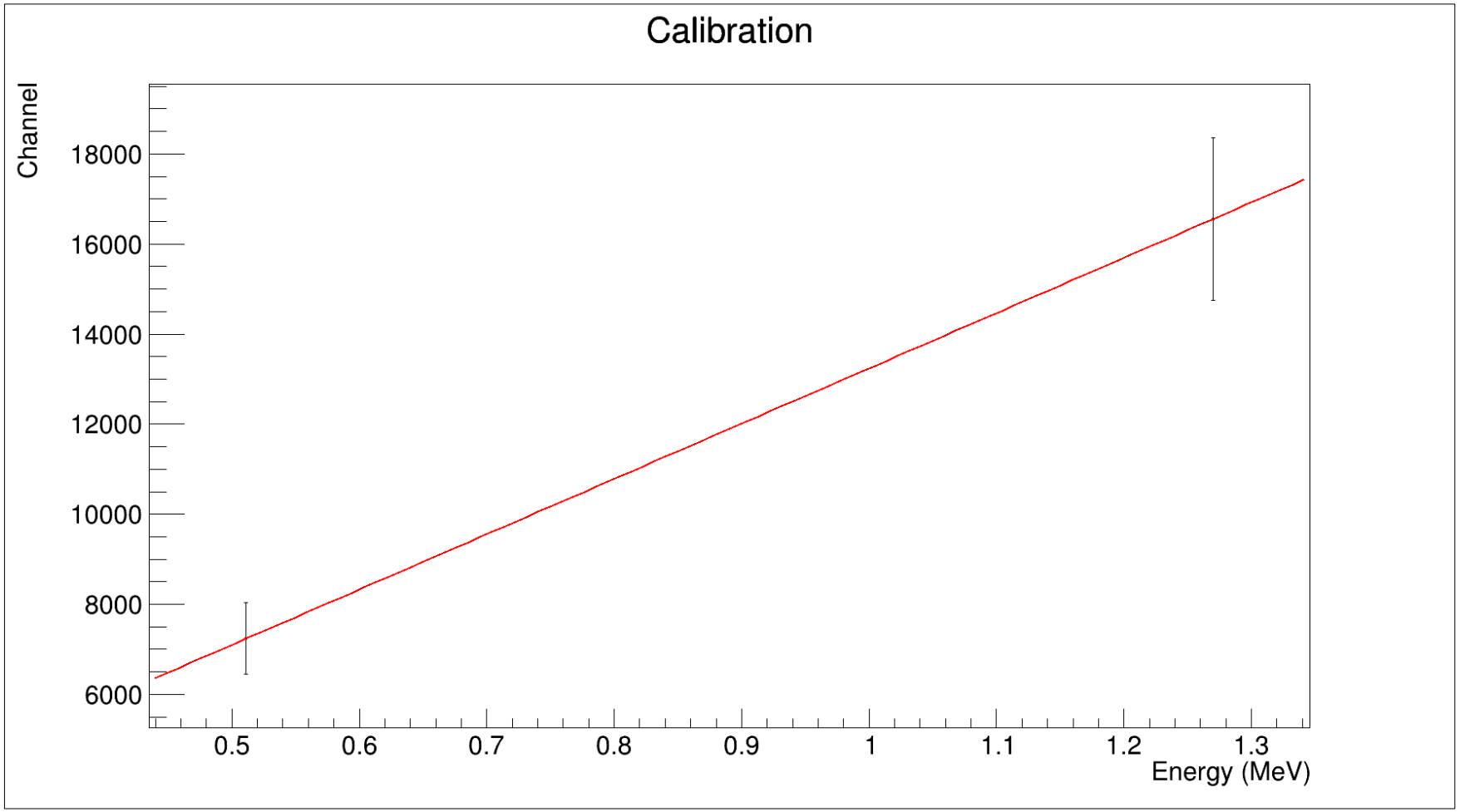
R^2 38dB = 0.922

Spectroscopy

- Scintillators and NaI crystal detectors used with SiPMs to measure annihilation peaks and calibrate the channels to energy


Cs-137 Spectrum
Counts
900
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
25000
Channel


Na-22 Spectrum
Counts
900
800
700
600
500
400
300
200
100
0
5000
10000
15000
20000
25000
Channel



Cs-137 Energy = 0.665 +/1
0.2138

Conclusion

- Overall went well, got values in the range of what was expected
- Spectroscopy for the crystal detector went very well
- Organic visibly had much poorer resolution as expected
  - Would need another sample to be able to do any estimation