

MUON DETECTOR

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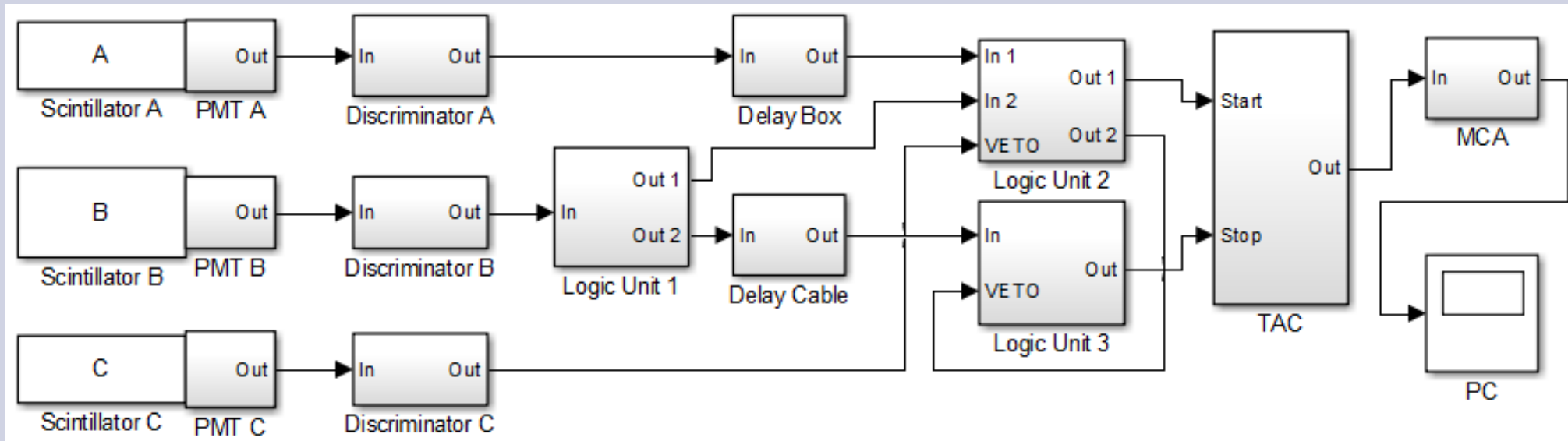
- Measuring Muon Lifetime
- Cosmic Watch 2.0

Measuring Muon Lifetime

Introduction

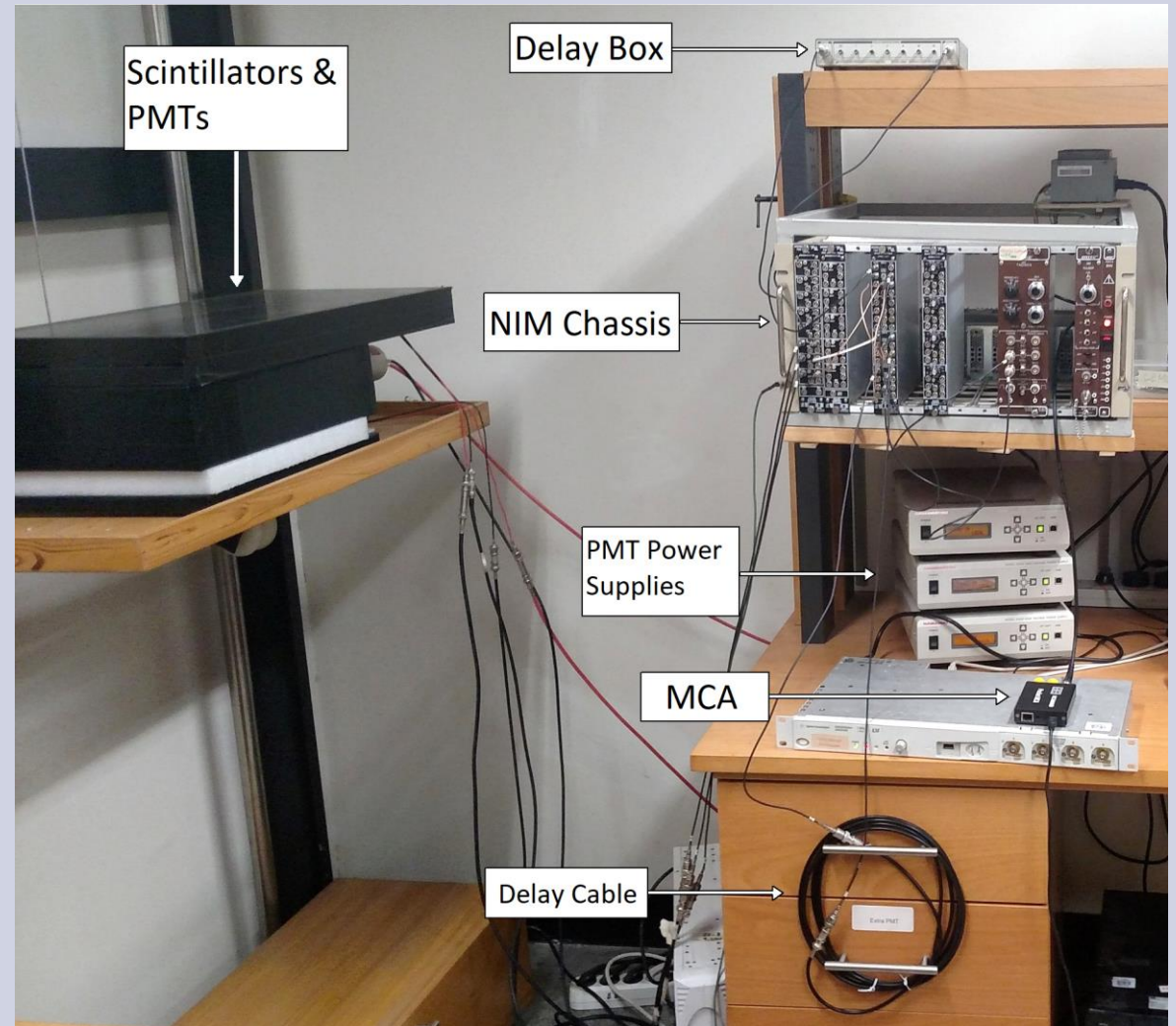
- Muons are product of interaction of cosmic rays and the atmosphere
- Two types -> positive muon, negative muon
- Electron like, except heavier, almost 200 times.
- Mean lifetime is $2.2\mu\text{s}$
- Travels at almost speed of light, $0.9997c$.
- Classically they can travel 660m
- Special Relativity
 - From Earth's perspective muon has lifetime of $89.8\mu\text{s}$ and so can travel 26,932m
 - From muon's perspective the effective length contracts

Schematic Diagram

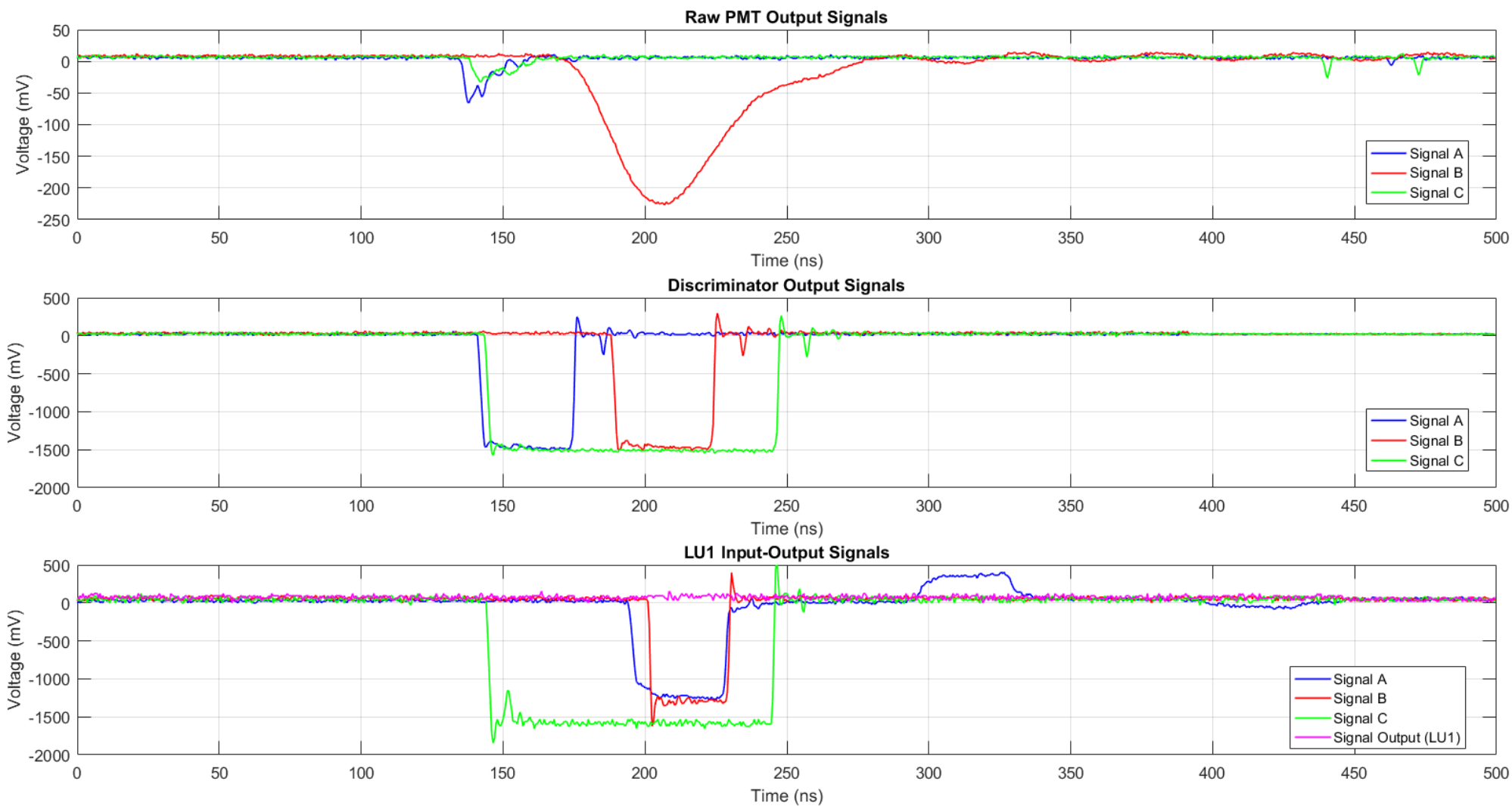


Experimental Setup

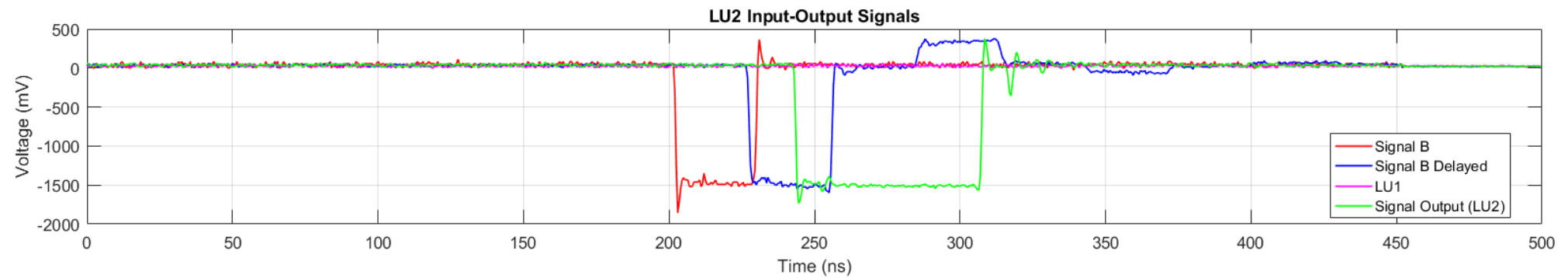
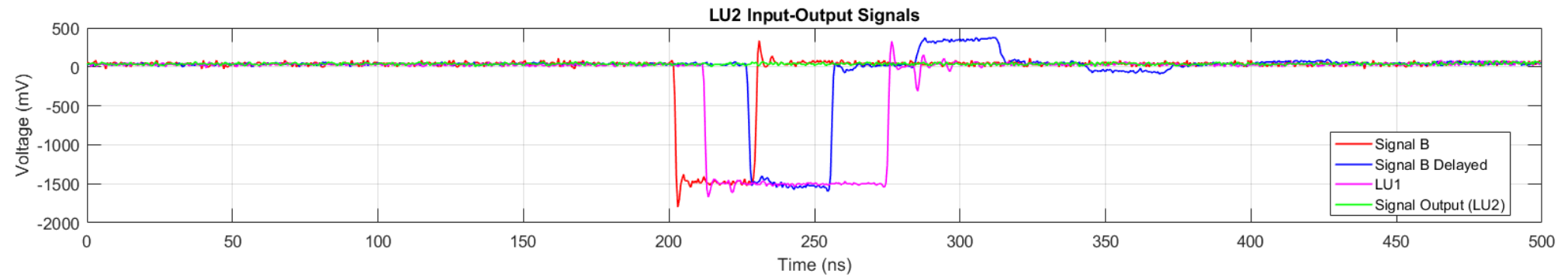
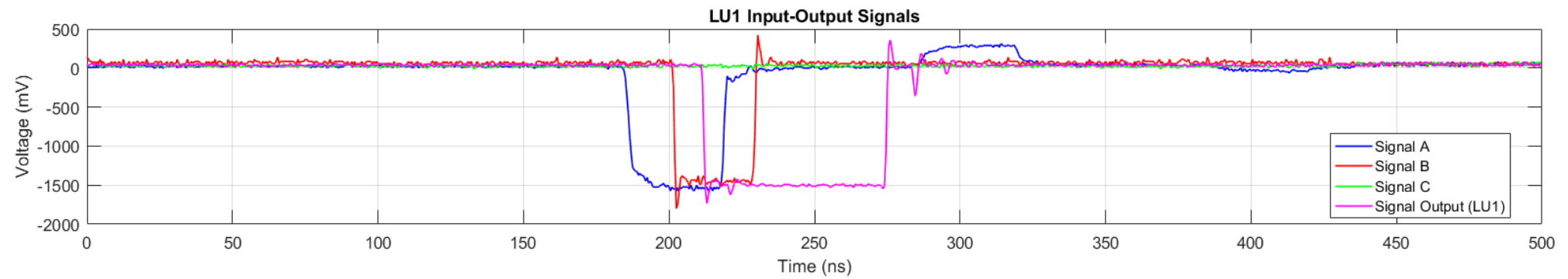
- PMT Power Supply = 1100V
- NIM Chassis
 - Octal Discriminator 705
 - Discriminator A = 32.7mV
 - Discriminator B = 95.4mV
 - Discriminator C = 20.6mV
 - Quad Four-Fold Logic Unit 755
 - Logic Unit 1 = Coincidence Level 1
 - Logic Unit 2 = Coincidence Level 2
 - Logic Unit 3 = Coincidence Level 1
 - TAC/SCA 567
 - Range = 100ns , Multiplier = 100
 - Start = Anti , Stop = Anti, TAC Out
- Delay box = 42ns
- Delay cable = 0.4m
- Pocket MCA8000D = 8192 Channels



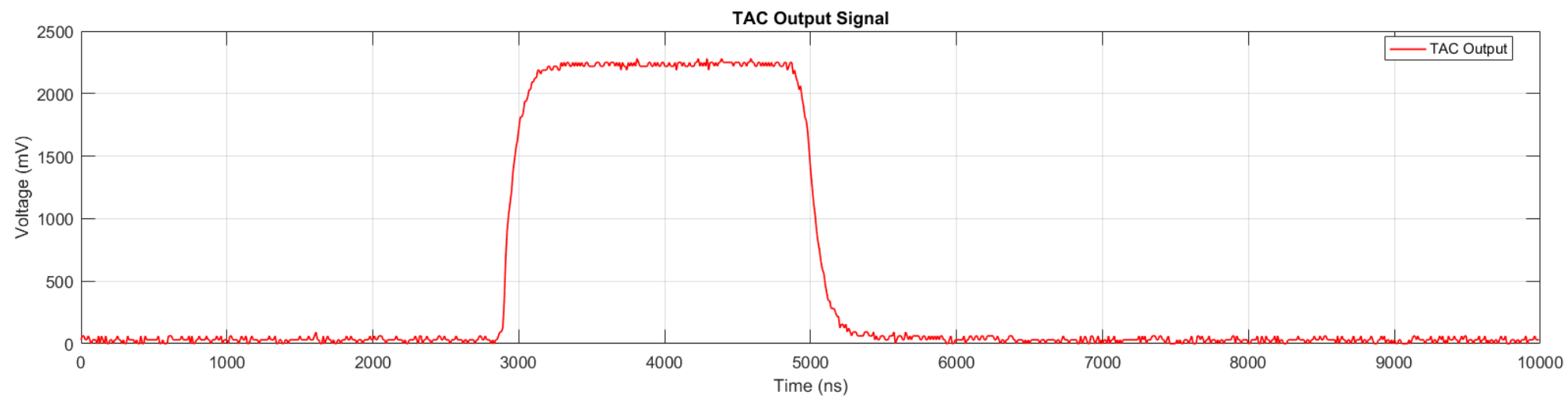
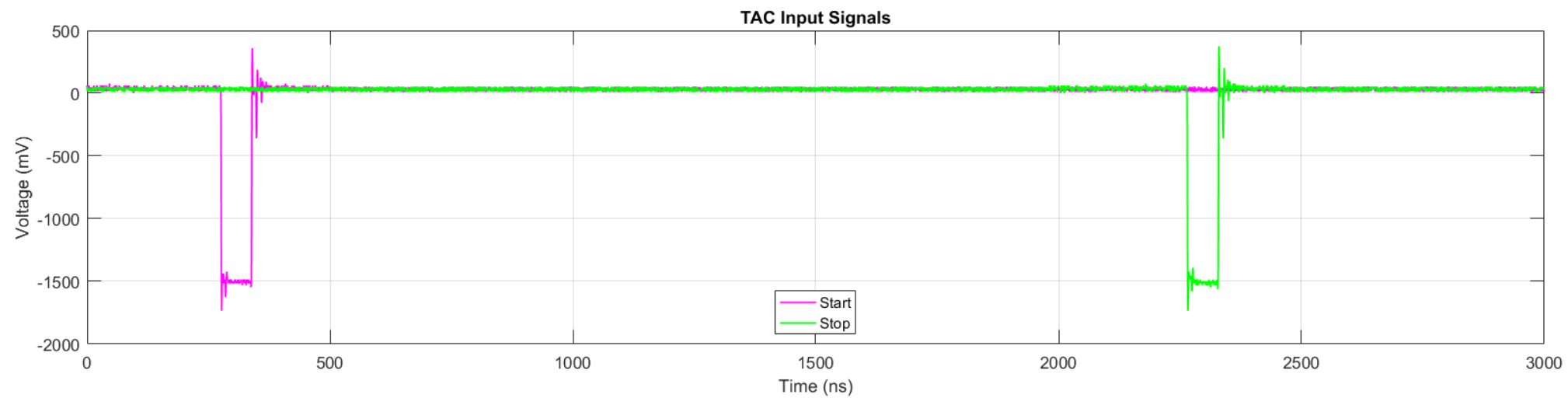
Signal Outputs



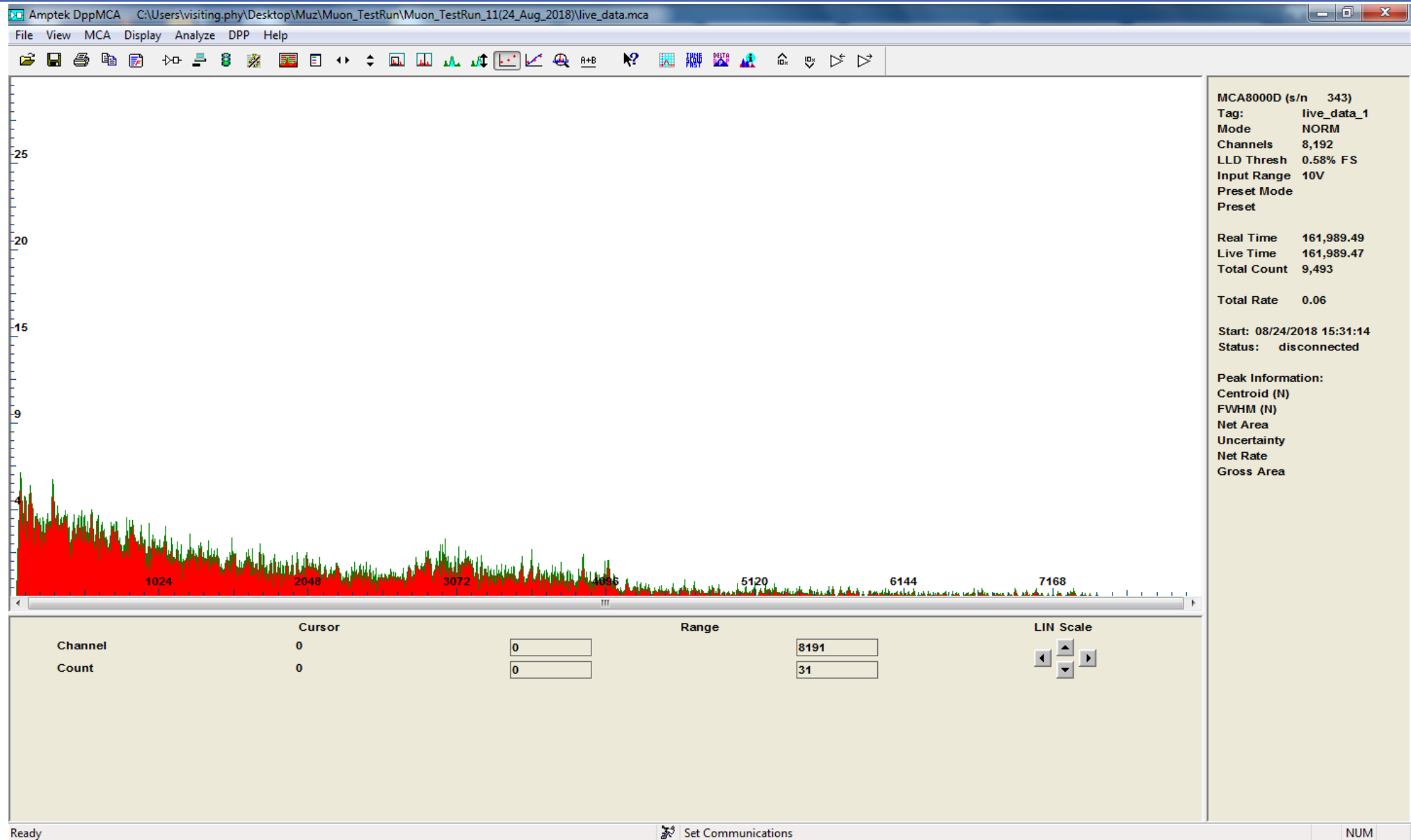
Signal Outputs



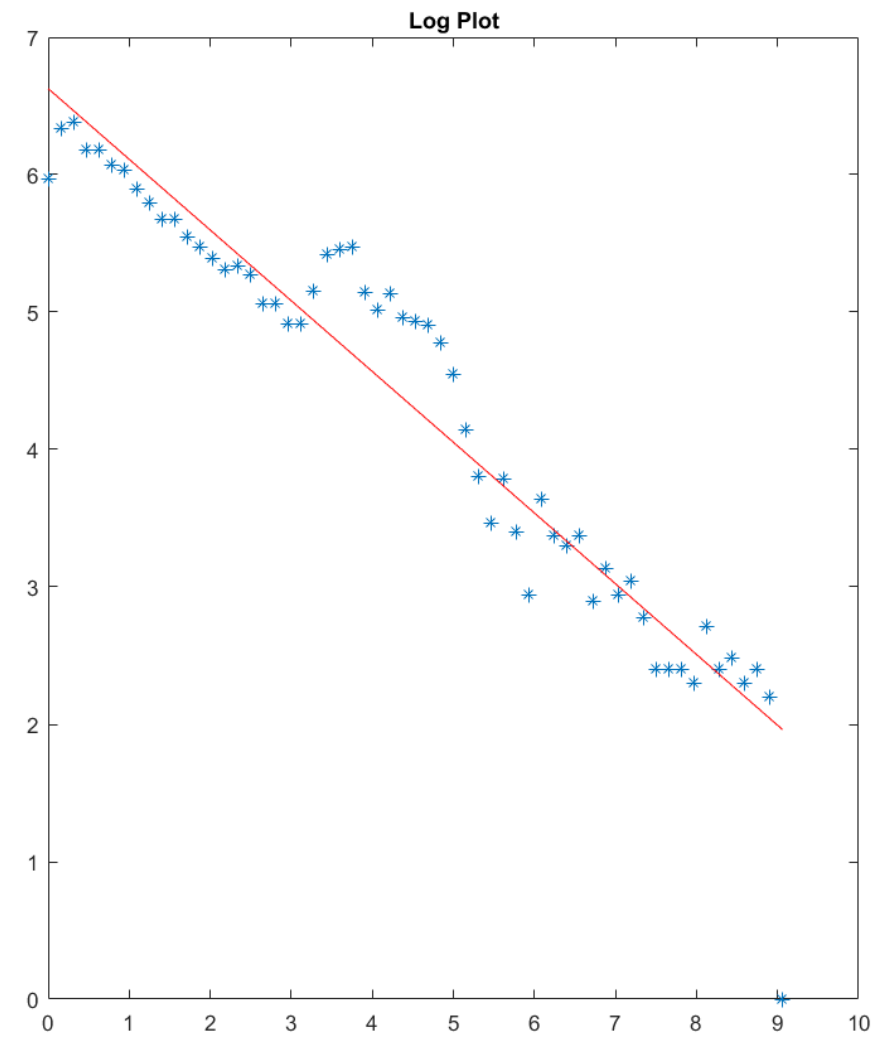
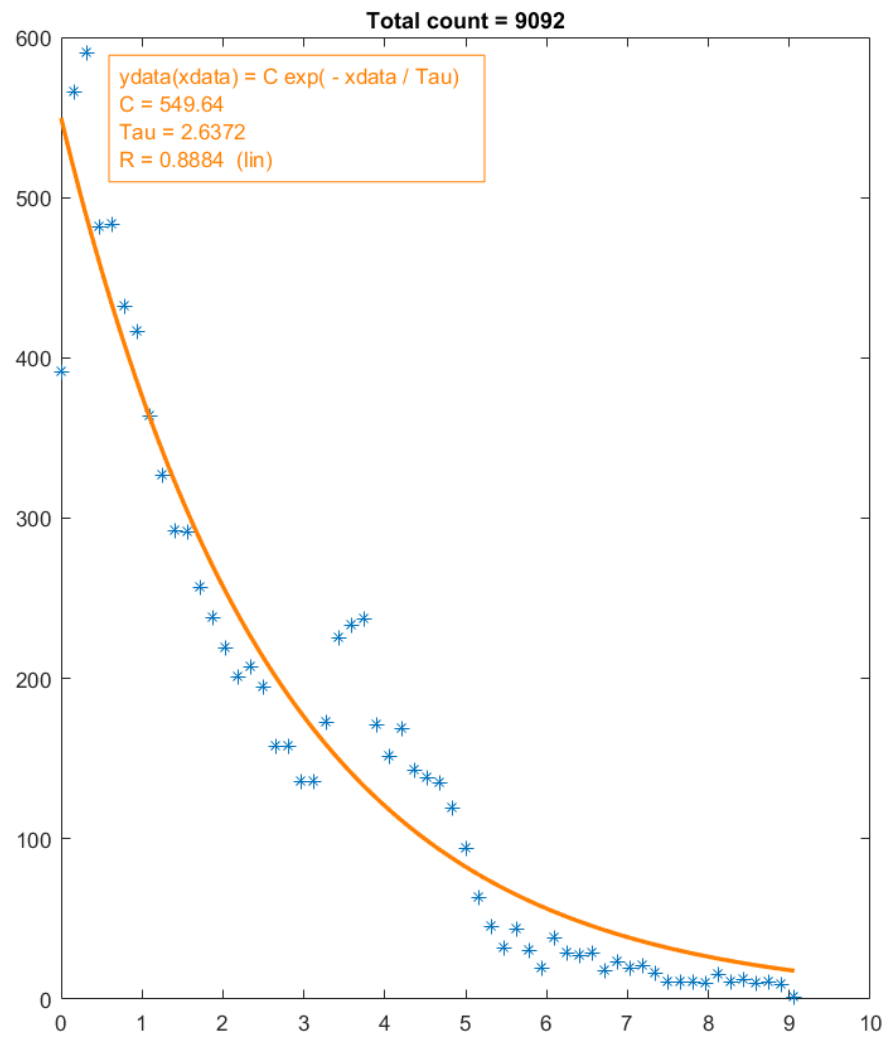
Signal Outputs



MCA

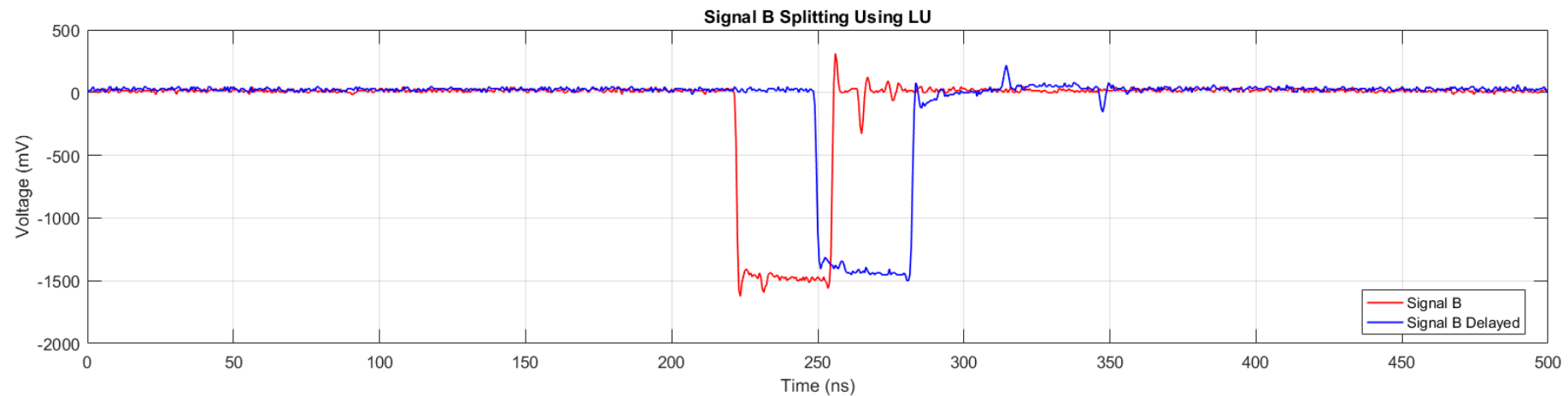
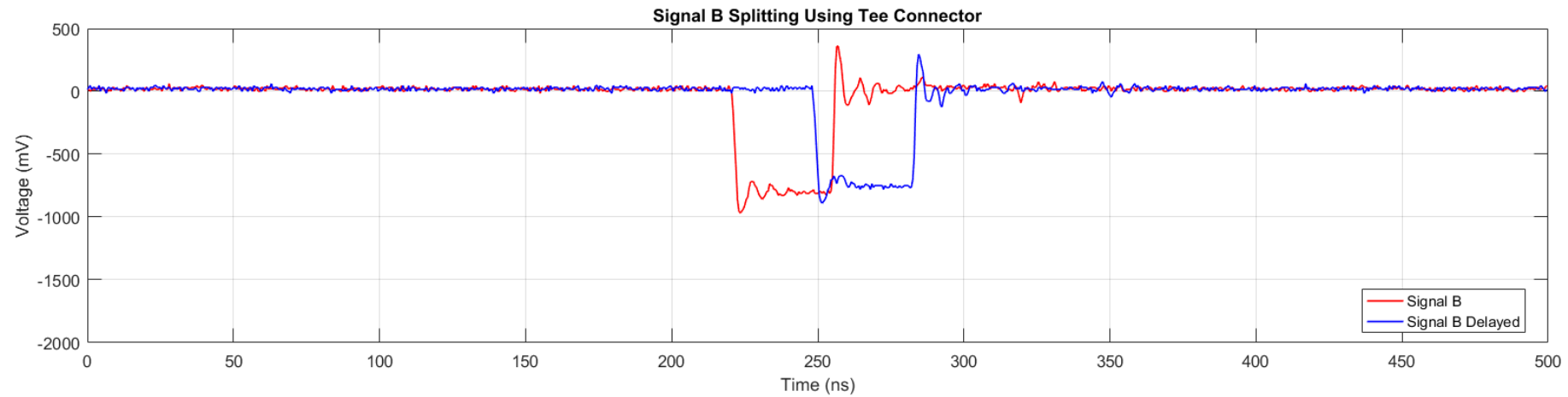


Result



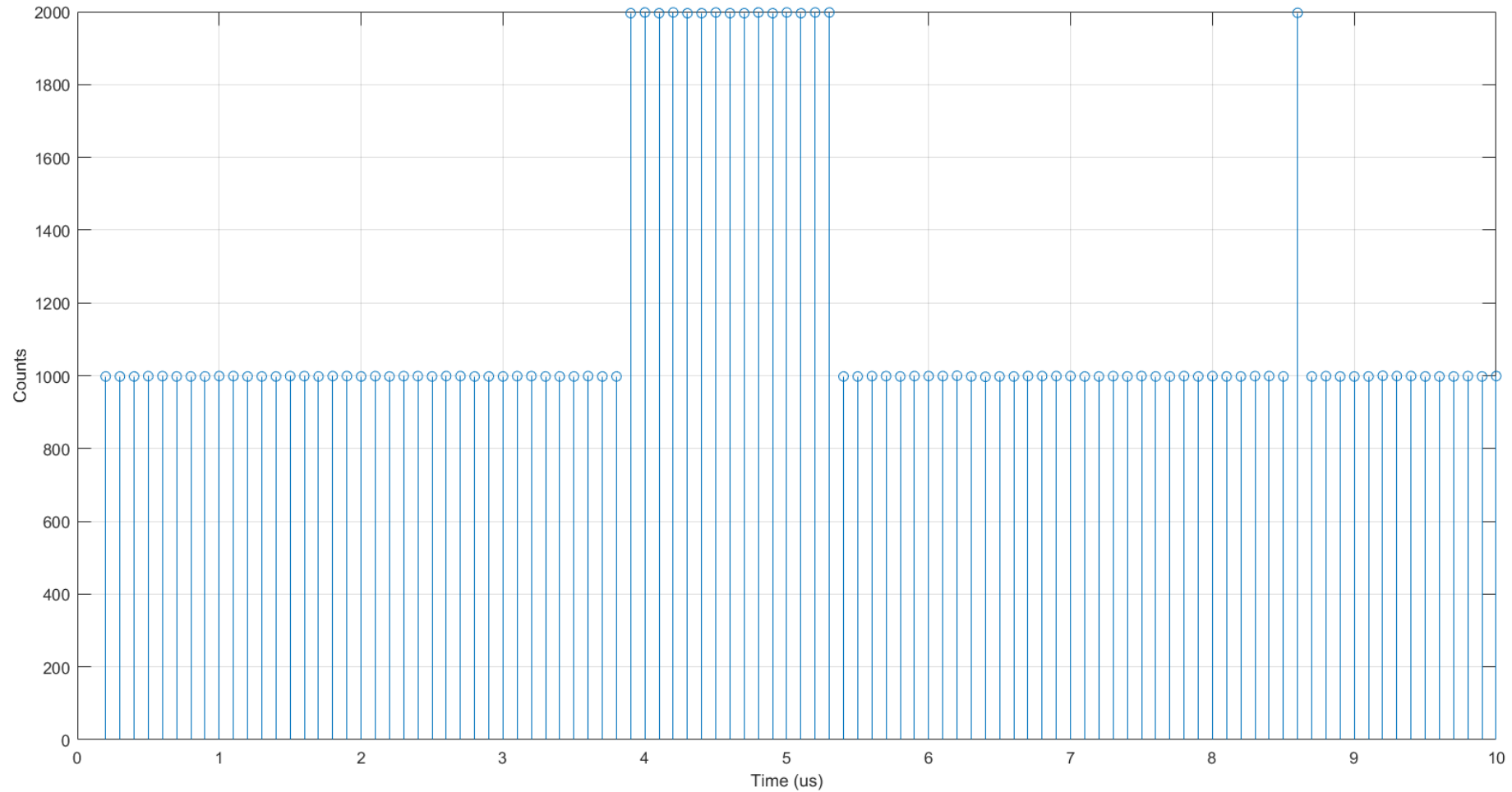
Signal Splitting

- With Tee connector there is net effect on all the connections with Tee of signal reflection or attenuation
- With Logic Unit, signal reflection or attenuation does not effect the other signal from the other connection



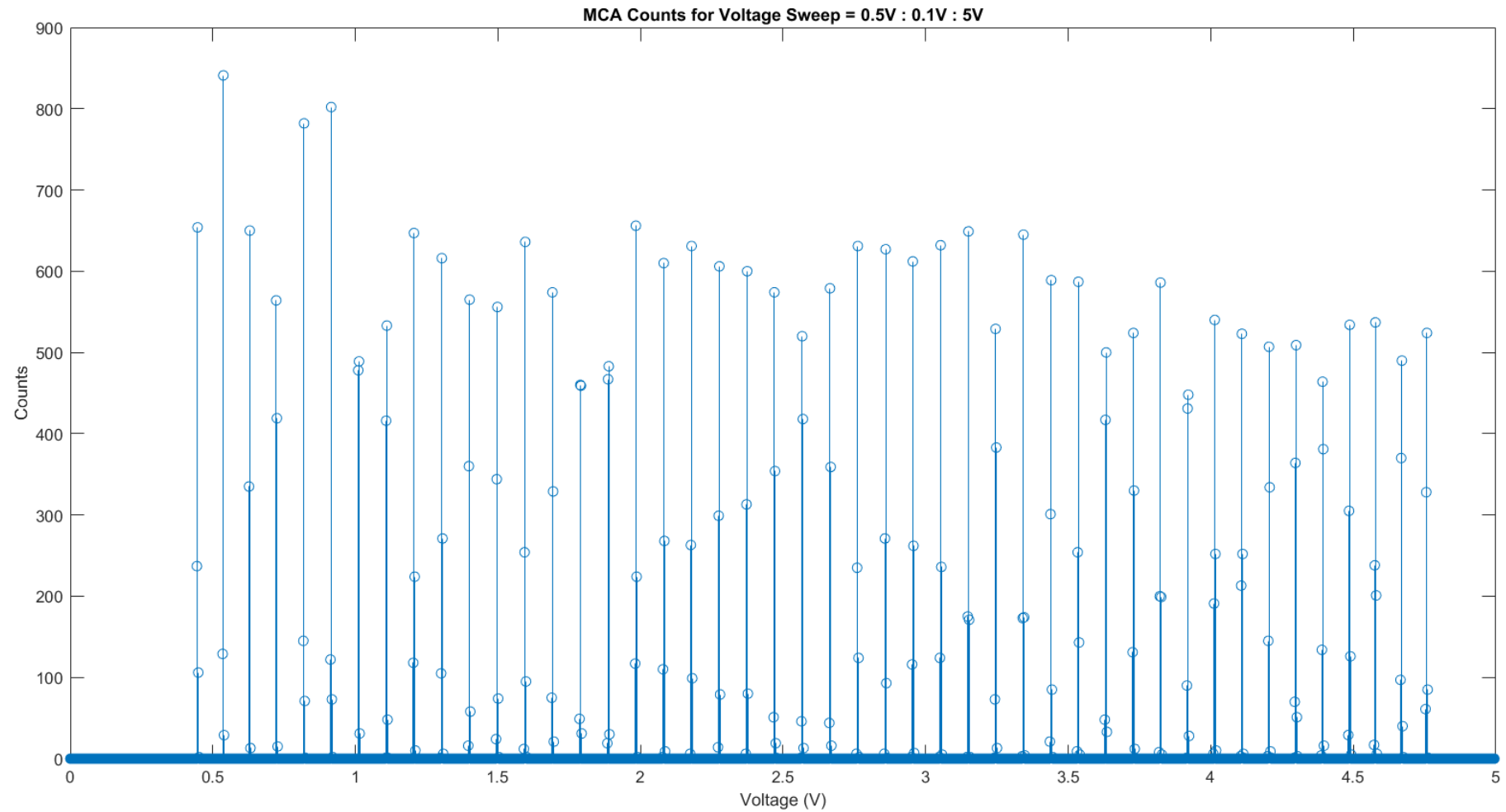
TAC – MCA pulse count using Signal generator

- Burst of thousand of two pulses with delay from $0.1\mu\text{s}$ to $10\mu\text{s}$ between them were input to TAC and MCA counts were recorded.

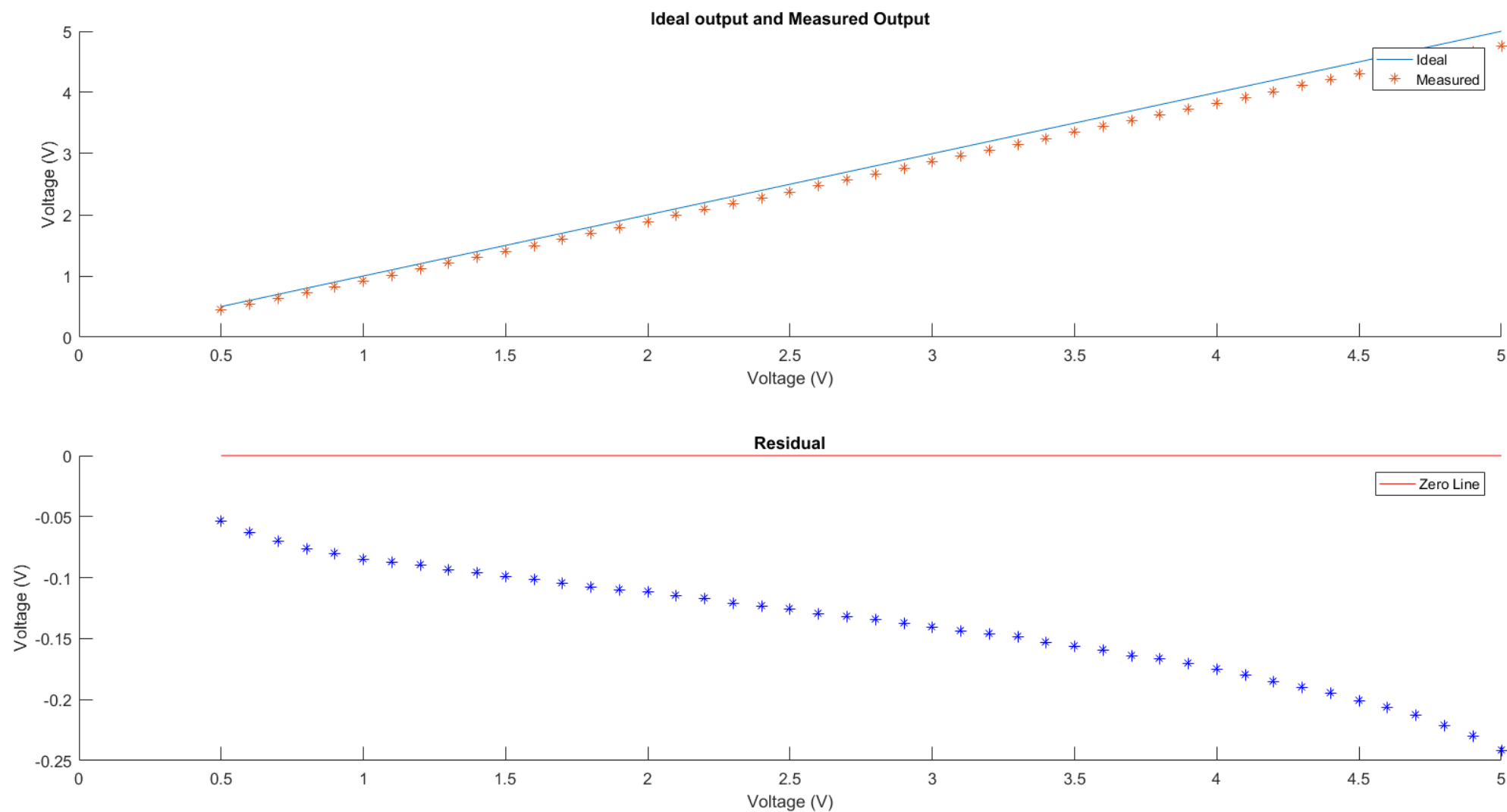


MCA Integral Non-Linearity Test

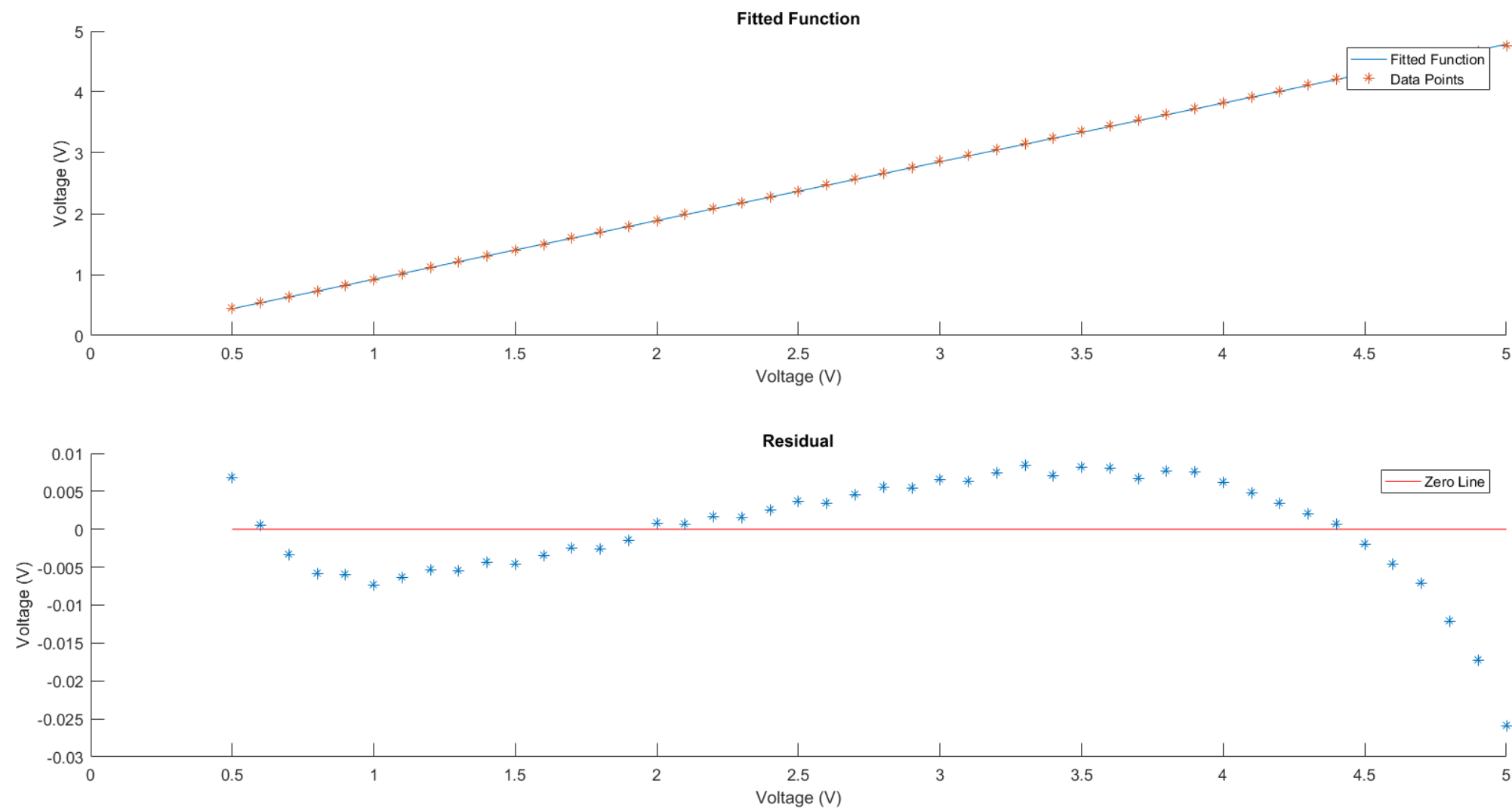
- Burst of thousand of pulses with voltage from 0.5V to 5V from Pulsar to MCA.



MCA Integral Non-Linearity Test

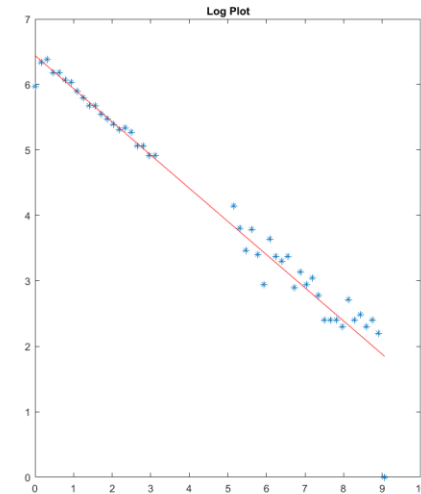
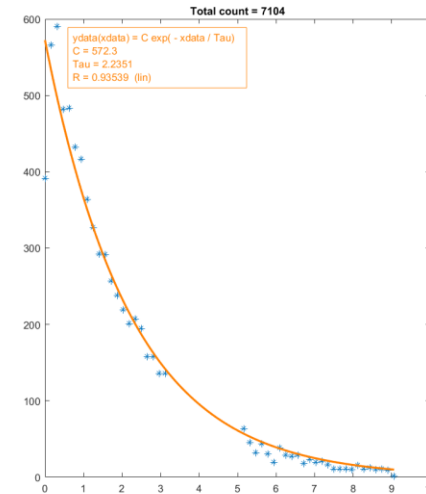
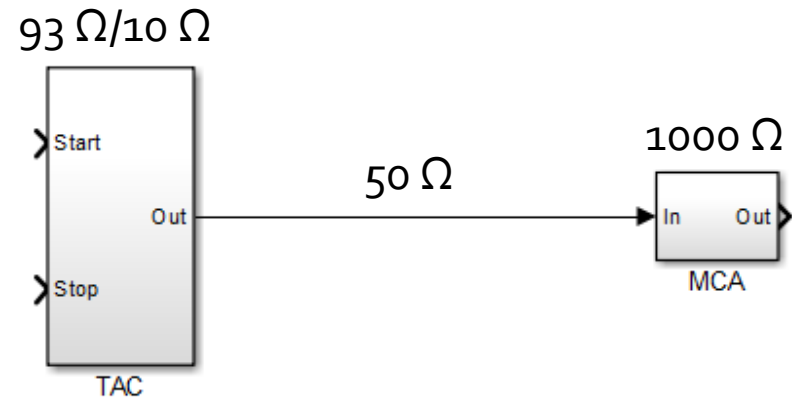


MCA Integral Non-Linearity Test



Conclusion

- If the faulty region is trimmed, the mean lifetime measured is 2.2351 μ s
- Avoid Tee connectors for signal splitting
- Apply calibration fit to suppress the effect of INL.
- Impedance Matching between each unit



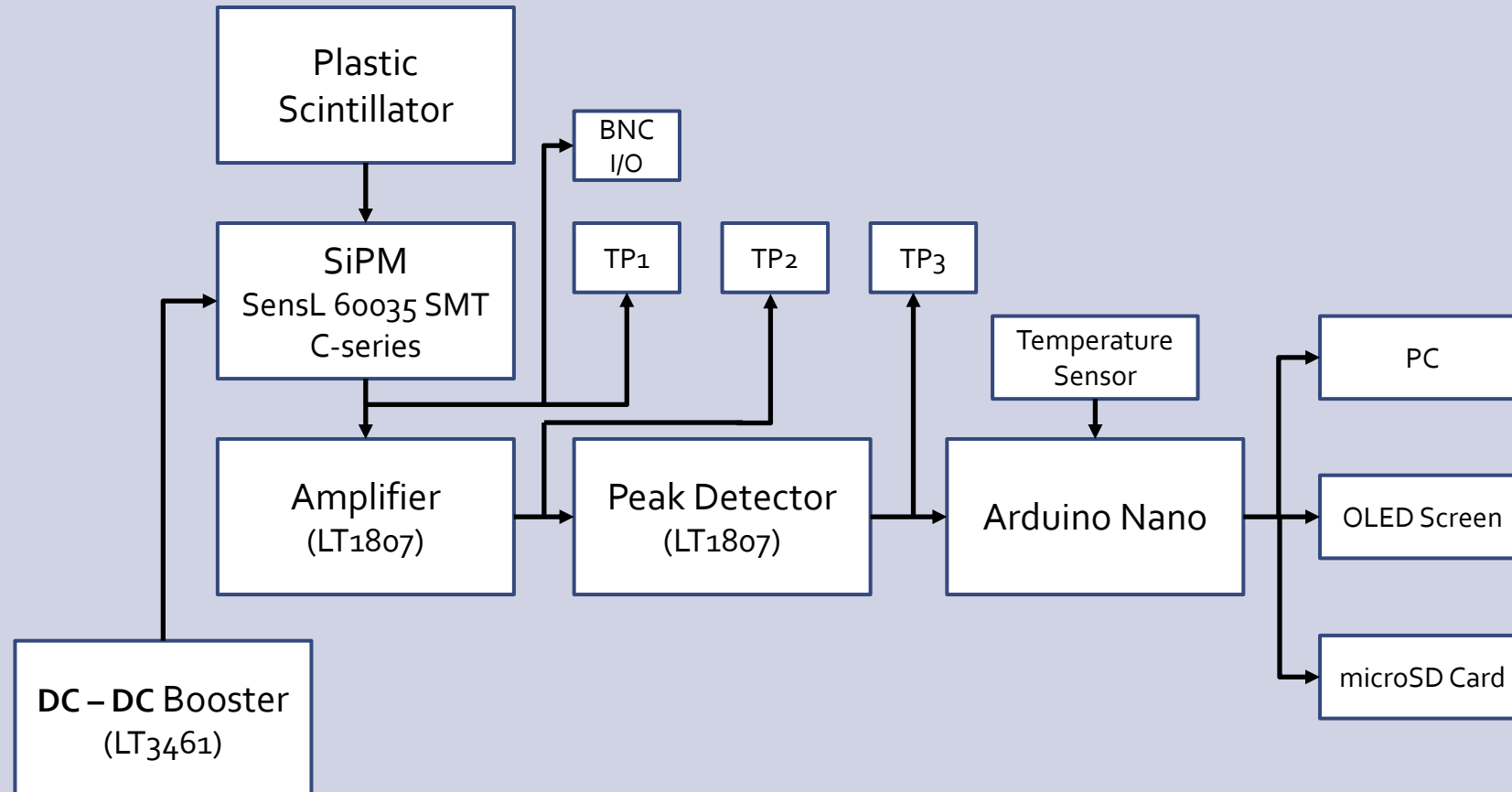
Cosmic Watch 2.0

Introduction

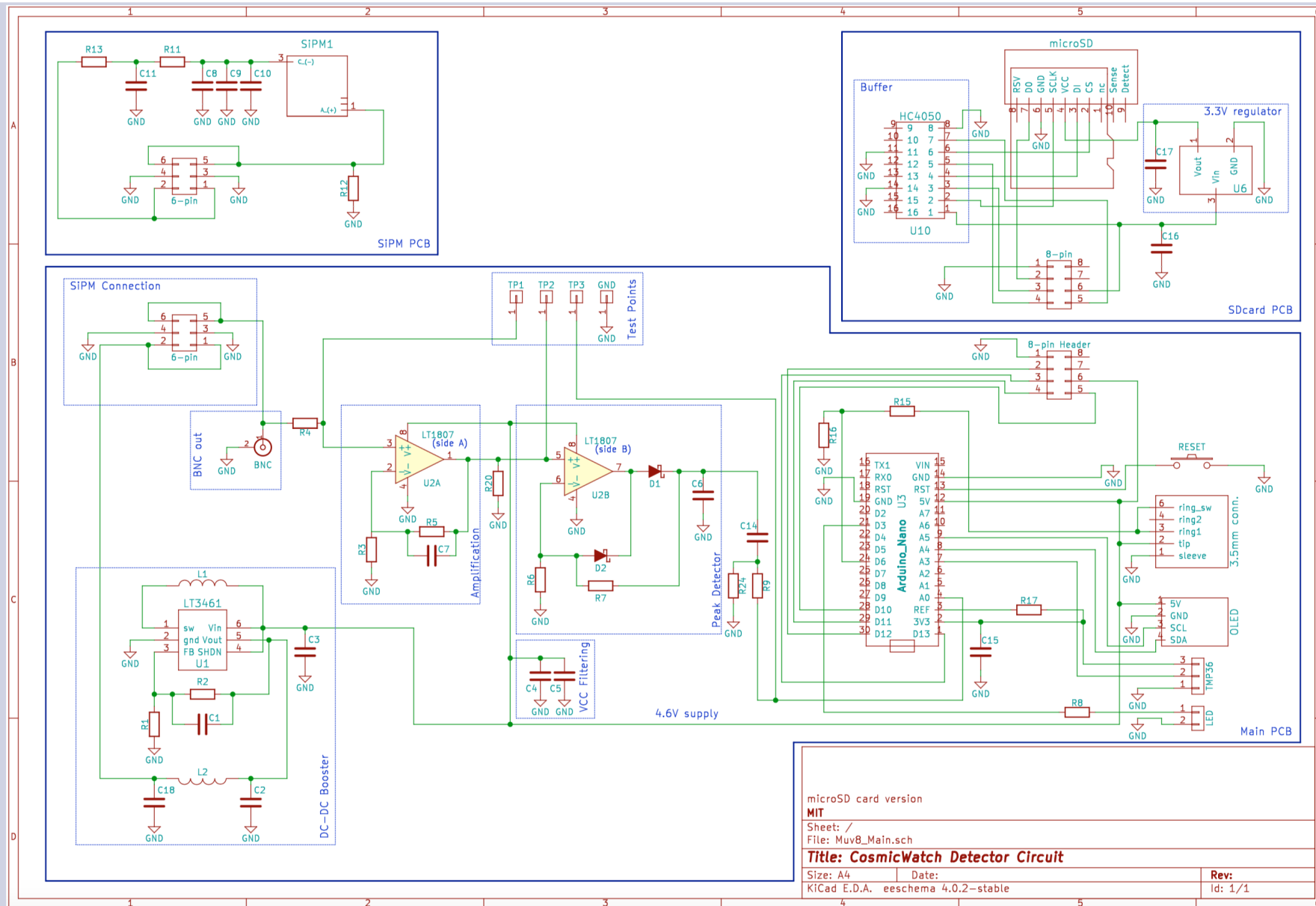
- It is a MIT and NCBJ based undergrad physics project.
- It consists of
 - Plastic Scintillator
 - Silicon Photomultiplier
 - Pulse Shaping Circuitry
 - Arduino
 - microSD Card
 - Coincidence Connection
- The instruction manual consists of part list, building steps, hardware/software and its potting, data acquisition methods and troubleshooting.



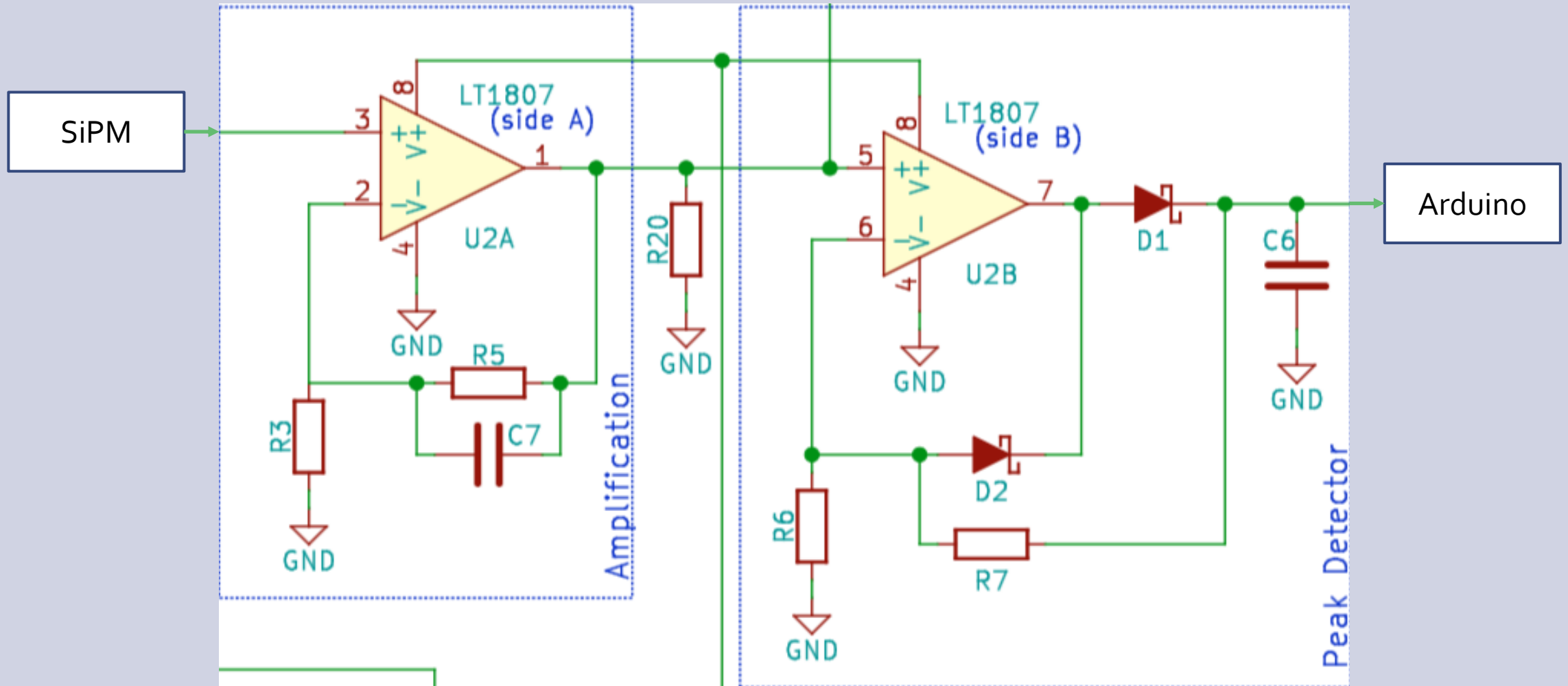
Flow Diagram



Circuit Diagram



Circuit Diagram



- Calibration
 - Input signal through BNC of know amplitude (mV) over the range of ADC 0 to 1023
 - Fit curve with minimum standard deviation
 - Add the fit to Calibration_fit function in Arduino code
- Setting up two detectors in coincidence
 - Connect through audio cable
 - Reset master first, and then slave within 10 to 2000 ms
 - 30 μ s Coincidence window
- Troubleshoot

Thank You!