

### DATA & 60 HZ PROBLEMS

Initially the data looked good. I took data with a source – detector distance about 2 mm.

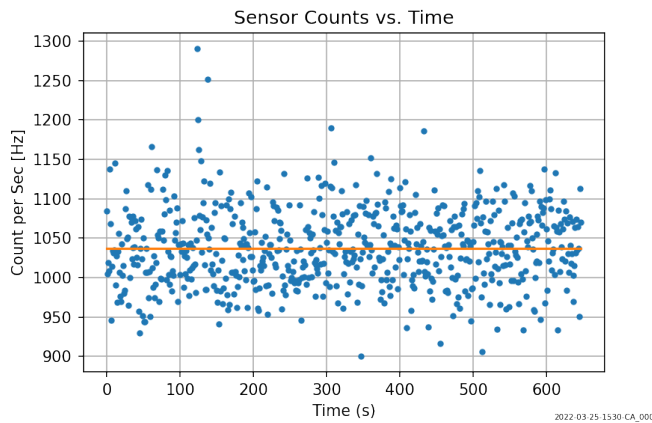


Figure 4: Counts versus time. Source-detector distance about 1 mm.

Afterwards I noticed the histogram has a width larger than the Poisson distribution, so something may be off.

Next I moved the source away from the sensor. I started picking up noise at 60 Hz. An example of the data is in the figures below.

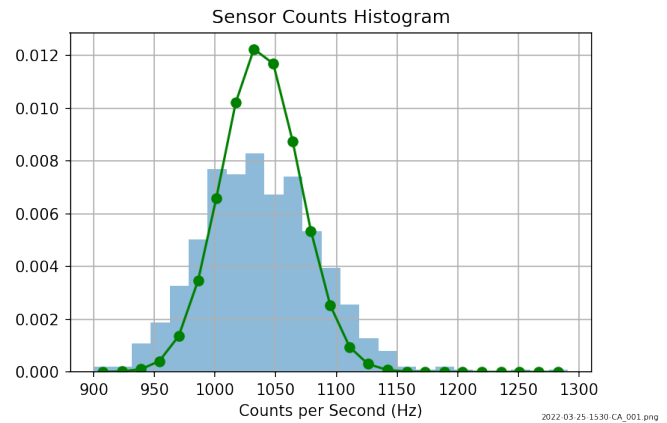


Figure 5: Histogram. The curve is a Poisson distribution using the average counts as the parameter.

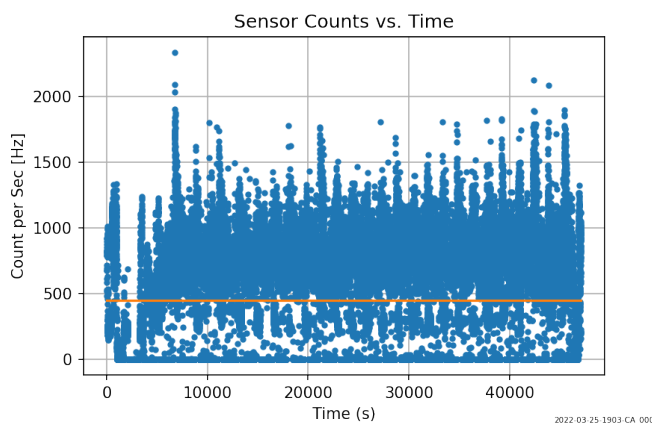


Figure 7: Source - sensor distance 8 mm.

There was a lot of sensitivity to 60 Hz noise. For example I would just move my hand near the circuit or the box with the sensor and source and it would pick up so much 60 Hz, the circuit was dominated by the 60 Hz.

When I put the scope on the +In of the transimpedance amp, there was about 1 Vpp of 60 Hz. About the same at the In, but way less on the output. About 1 mV after the passive highpass filter.

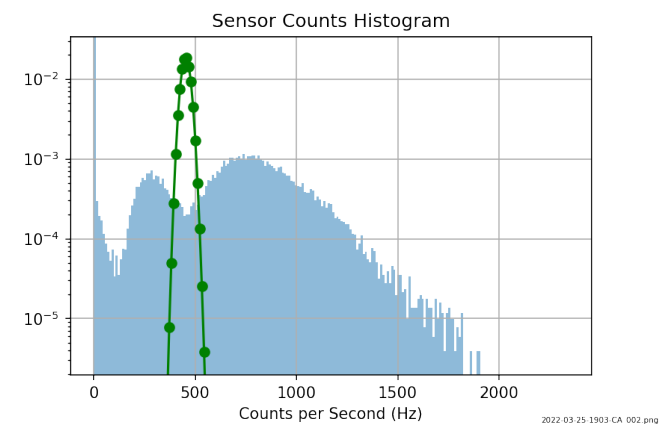


Figure 6: There is clearly a lot of noise in the data.

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I tied a couple of things.

- 1) Mount the sensor right to the op amp on the breadboard and move the sensor close. This cut down the 60 Hz on -In and +In.

- 2) Change the resistor on the passive high-pass to 10 k. This put the -3 dB frequency at 11 kHz.
- 3) Added 10 uF electrolytic capacitor to the breadboard supply rails next to op amp.
- 4) Change feedback resistor on op amp 2 to 66 k. This boosted the gain to about 66. The reason I changed the final gain was that I changed photodiodes and the signal pulses were smaller. This resulted in the final pulses into the microcontroller were not large enough to trigger the counting. It seems like the pulses have to cross  $\frac{1}{2} V_{DD}$ , about 1.7 V, to trigger the counting.

**Now:**

- There is about 50 mVpp 60 Hz on both +In and -In, about 30 mVpp on Out. After the passive high-pass filter the 60 Hz is gone!
- The data looks more Poisson-like.

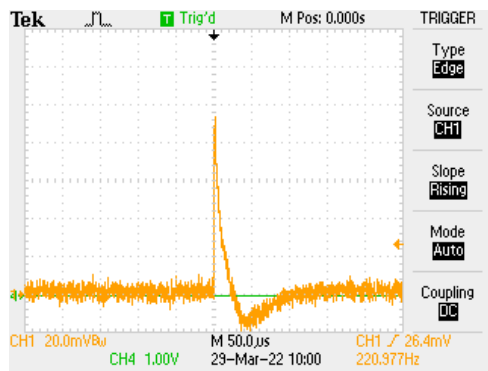


Figure 8: Alpha particle pulse after passive high pass filter.

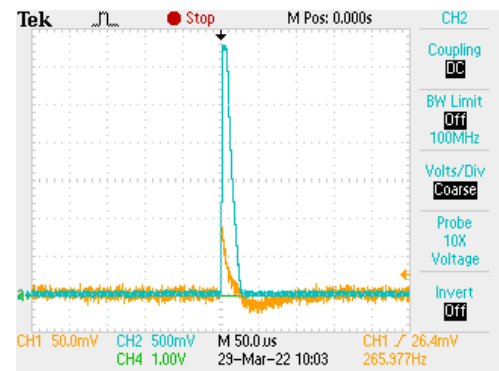


Figure 9: Alpha particle pulse. Blue is pulse going into the microcontroller.

Now the signal is very clean as seen in Figure 8. Figure 9 shows the pulse into the microcontroller is clean and easily triggers the counting.

Next I took data with the source about 5 mm from the detector.

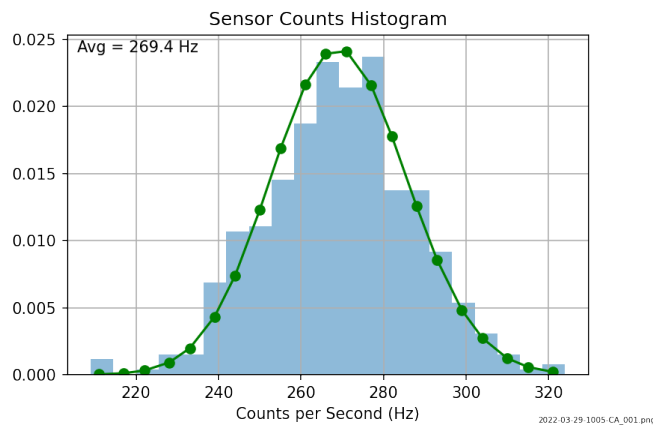


Figure 10: Histogram. Source - sensor distance about 5 mm. The green curve is a Poisson distribution.

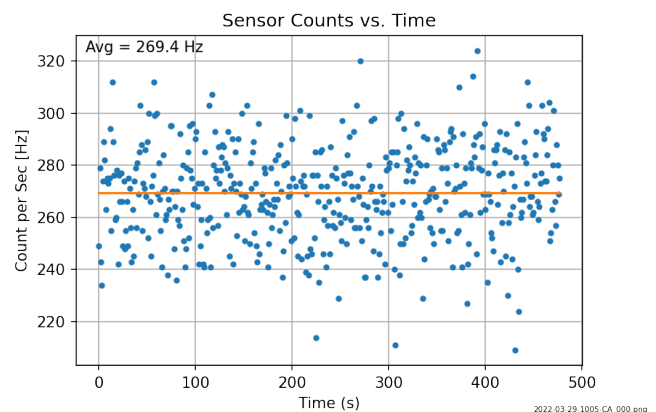


Figure 11: Time series of data. There are no outliers.

Next I moved the source farther from the detector.

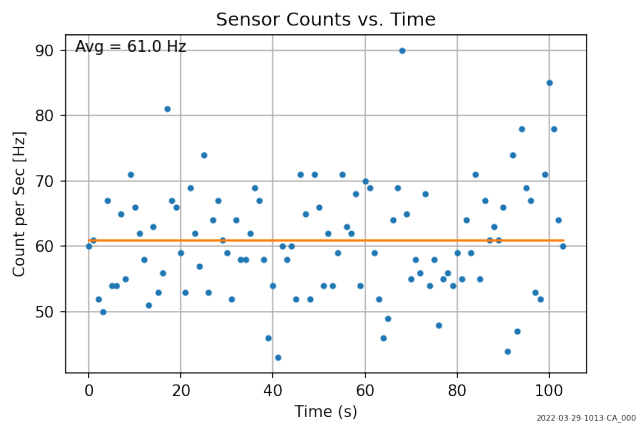


Figure 12: Source farther from the sensor.

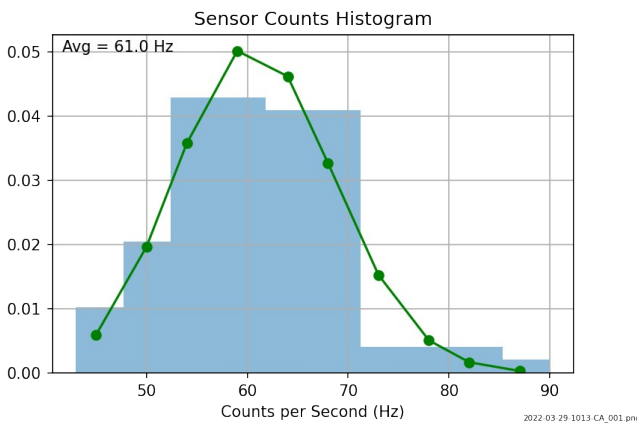


Figure 13: The histogram looks like a Poisson distribution.