# Meinberg Timing

## 1

Part of `mbggpscap` ouput at 5kHz internal trigger:

```
New capture: CH0: 2024-04-29 08:35:35.7975583 UTC
New capture: CH0: 2024-04-29 08:35:35.7977584 UTC
New capture: CH0: 2024-04-29 08:35:35.7979585 UTC
New capture: CH0: 2024-04-29 08:35:35.7981586 UTC
New capture: CH0: 2024-04-29 08:35:35.7983586 UTC
New capture: CH0: 2024-04-29 08:35:35.7987588 UTC
New capture: CH0: 2024-04-29 08:35:35.7989589 UTC
New capture: CH0: 2024-04-29 08:35:35.7991589 UTC
New capture: CH0: 2024-04-29 08:35:35.7993590 UTC
New capture: CH0: 2024-04-29 08:35:35.7995591 UTC
New capture: CH0: 2024-04-29 08:35:35.7997592 UTC
New capture: CH0: 2024-04-29 08:35:35.7999592 UTC
New capture: CH0: 2024-04-29 08:35:35.8003594 UTC
New capture: CH0: 2024-04-29 08:35:35.8005595 UTC
New capture: CH0: 2024-04-29 08:35:35.8007595 UTC
New capture: CH0: 2024-04-29 08:35:35.8009596 UTC
New capture: CH0: 2024-04-29 08:35:35.8011597 UTC
New capture: CH0: 2024-04-29 08:35:35.8013598 UTC
New capture: CH0: 2024-04-29 08:35:35.8015598 UTC
New capture: CH0: 2024-04-29 08:35:35.8019600 UTC
```

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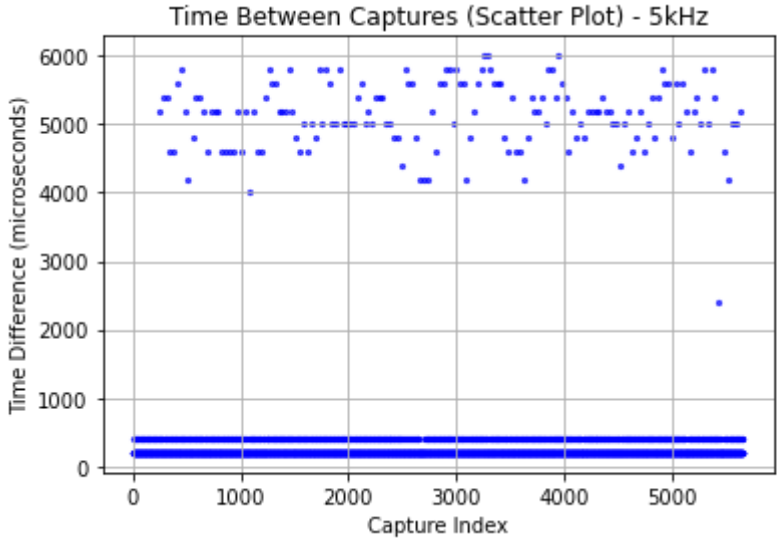
## 2

Some plots of timing data taken from `mbggpscap` as seen above running at an internal trigger rate of 5kHz. I only included data after lines like:

```
New capture: CH0: 2024-04-29 09:38:02.1233820 UTC << BUF OVR
```

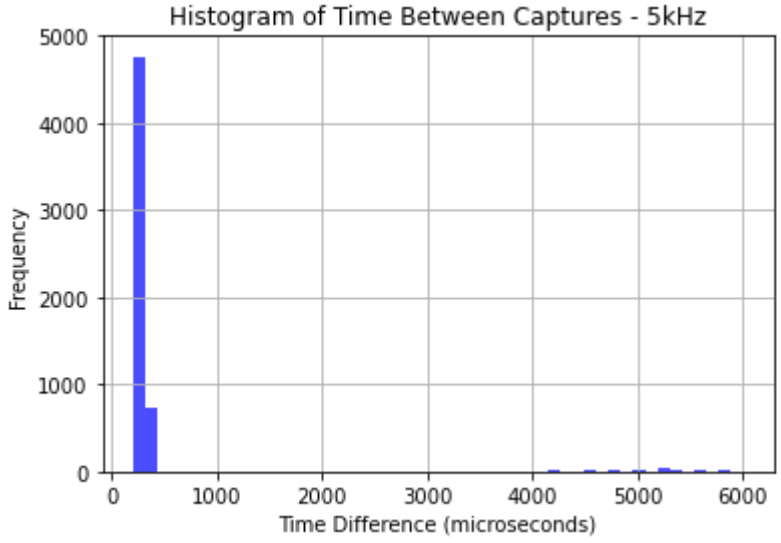
stopped occuring (so sort of a "steady state").

**All captures scatter**



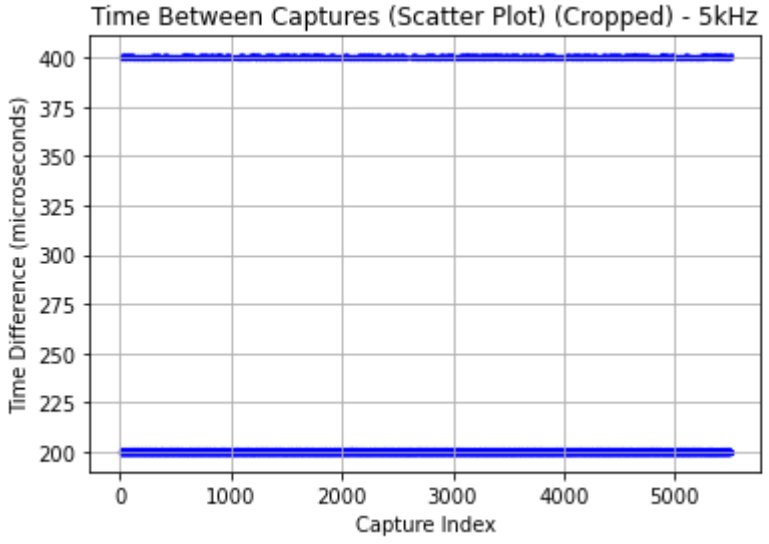

Average: 365.48 microseconds
Standard Deviation: 819.74 microseconds
Average (Hz): 2736.13 Hz

### All captures histogram



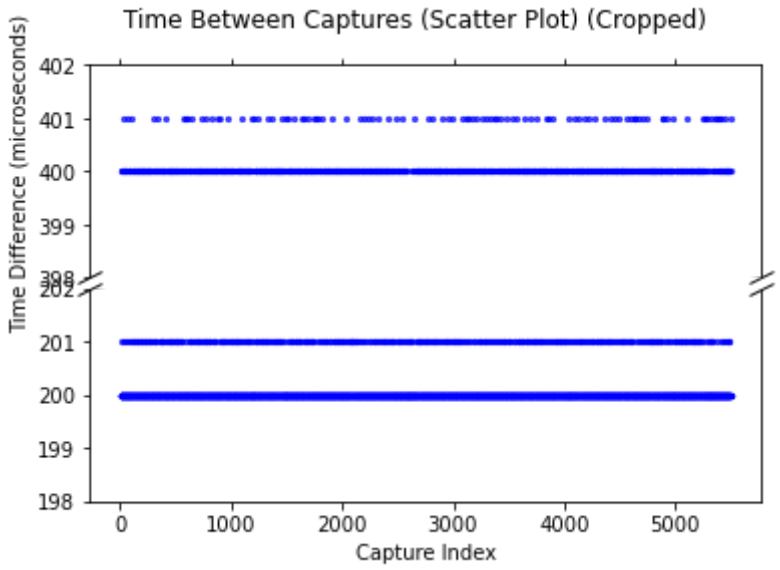

Average: 365.48 microseconds
Standard Deviation: 819.74 microseconds
Average (Hz): 2736.13 Hz

### "Normal" captures scatter

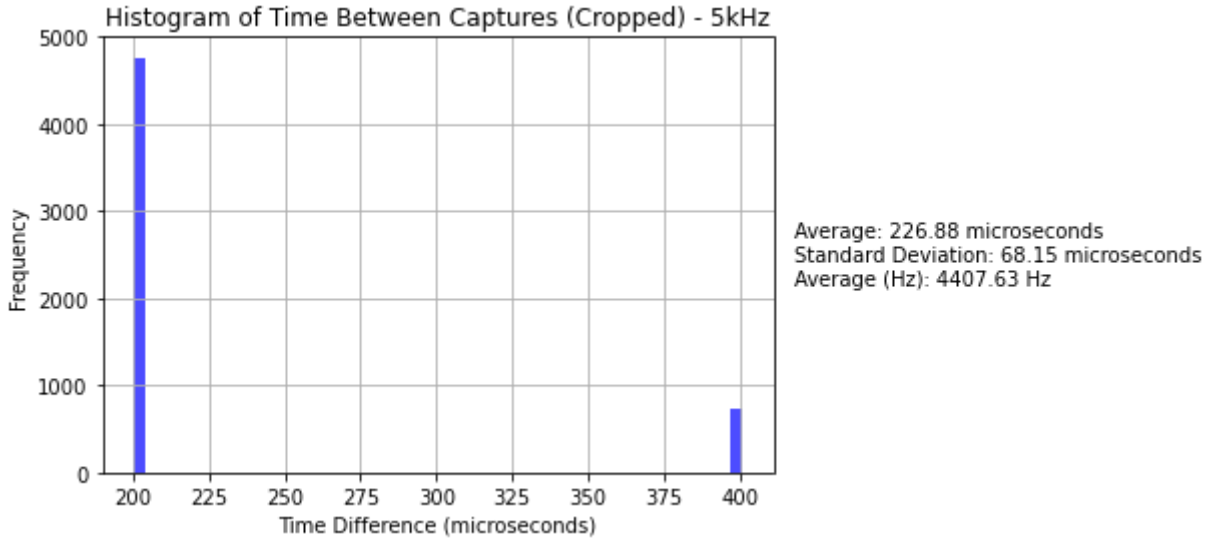



Average: 226.88 microseconds
Standard Deviation: 68.15 microseconds
Average (Hz): 4407.63 Hz

### "Normal" captures scatter with a break




**"Normal" captures histogram**

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## 3

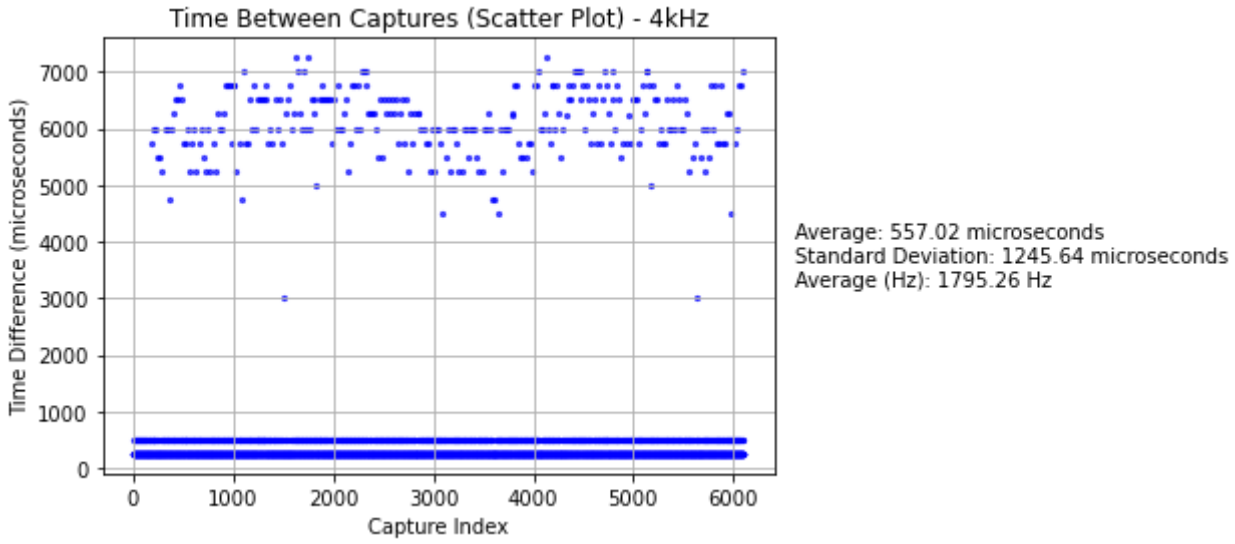
I repeated the "exercise" at 4kHz.

**Some output:**

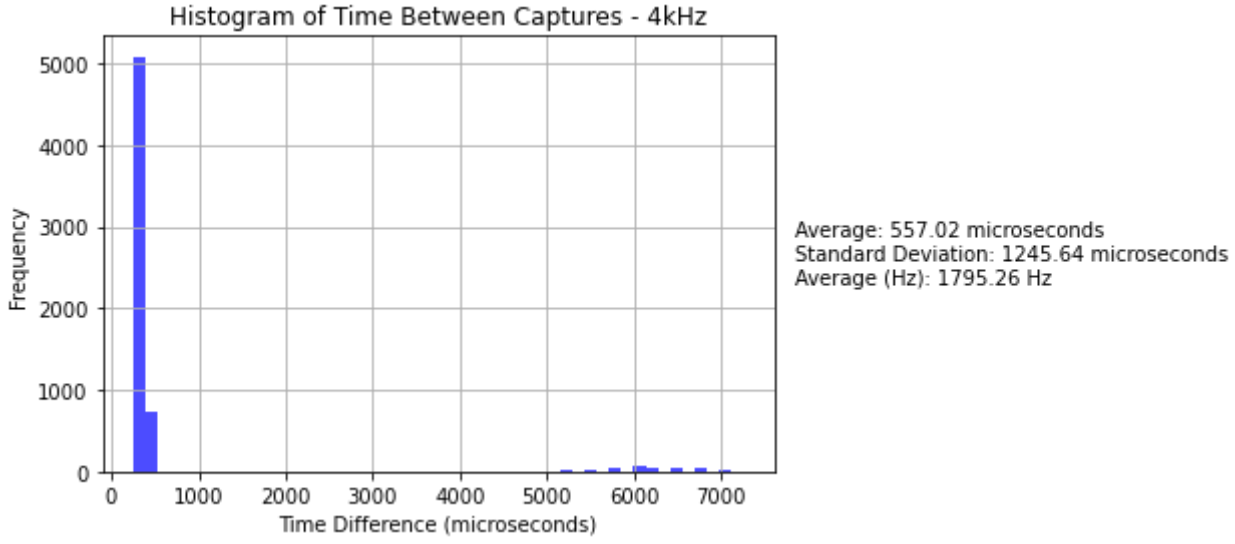
```
New capture: CH0: 2024-04-29 09:38:05.5506653 UTC
New capture: CH0: 2024-04-29 09:38:05.5509154 UTC
New capture: CH0: 2024-04-29 09:38:05.5511655 UTC
New capture: CH0: 2024-04-29 09:38:05.5581676 UTC
New capture: CH0: 2024-04-29 09:38:05.5584176 UTC
New capture: CH0: 2024-04-29 09:38:05.5586677 UTC
New capture: CH0: 2024-04-29 09:38:05.5589178 UTC
New capture: CH0: 2024-04-29 09:38:05.5591679 UTC
New capture: CH0: 2024-04-29 09:38:05.5594179 UTC
New capture: CH0: 2024-04-29 09:38:05.5599181 UTC
```

```
New capture: CH0: 2024-04-29 09:38:05.5601682 UTC
New capture: CH0: 2024-04-29 09:38:05.5604182 UTC
New capture: CH0: 2024-04-29 09:38:05.5606683 UTC
New capture: CH0: 2024-04-29 09:38:05.5609184 UTC
New capture: CH0: 2024-04-29 09:38:05.5611685 UTC
New capture: CH0: 2024-04-29 09:38:05.5614185 UTC
New capture: CH0: 2024-04-29 09:38:05.5619187 UTC
New capture: CH0: 2024-04-29 09:38:05.5621688 UTC
New capture: CH0: 2024-04-29 09:38:05.5624189 UTC
```

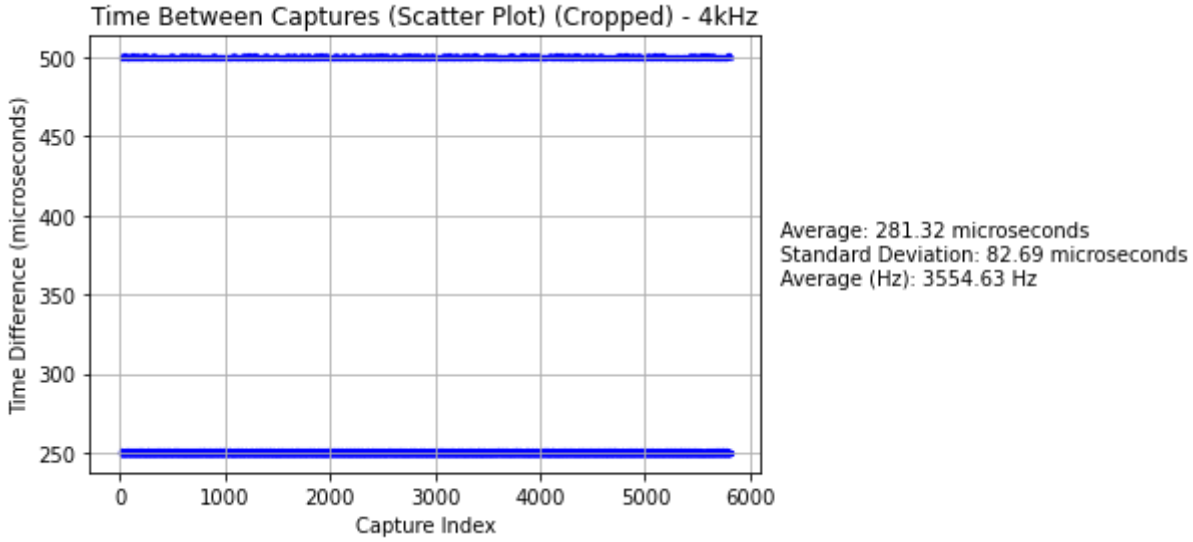
### All captures scatter



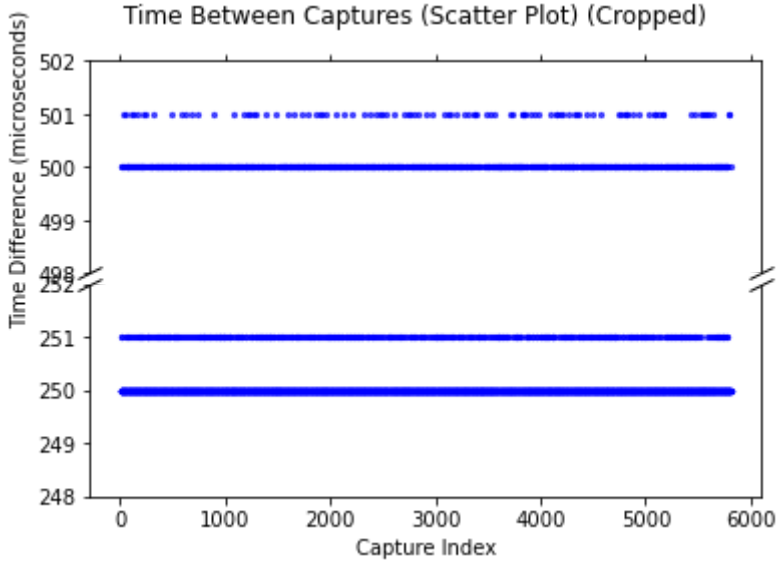

### All captures histogram



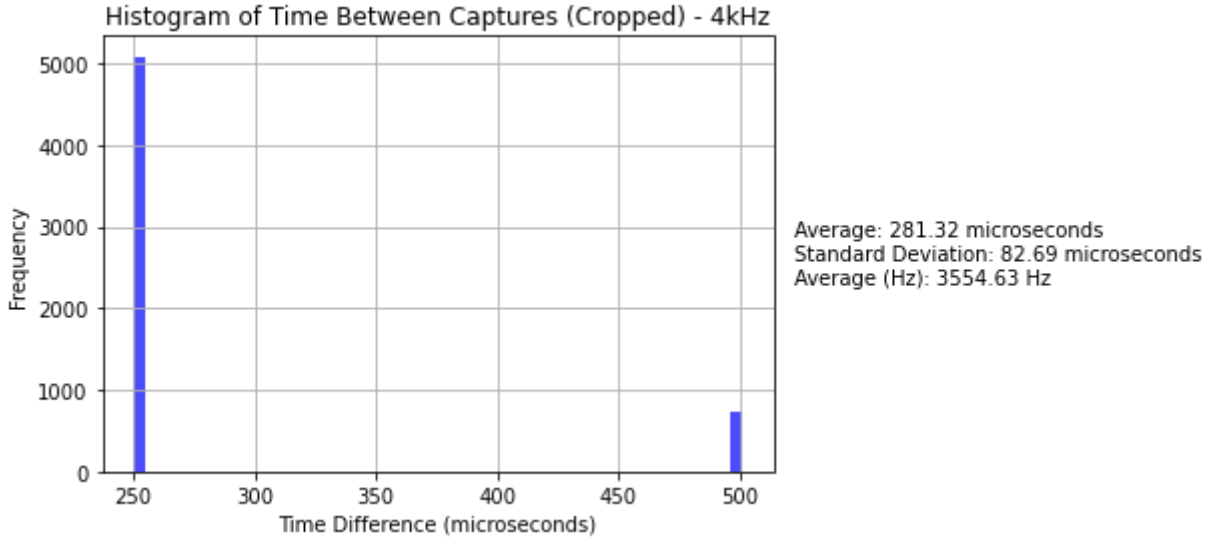

### "Normal" captures scatter




**"Normal" captures scatter with a break**




**"Normal" captures histogram**

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## 4

$$\delta(f(x)) \equiv \delta\left(\frac{k}{x}\right) = \frac{k\delta x}{x^2}$$

$$\implies \frac{\delta f}{f} = \frac{\delta x}{x}$$

Therefore the relative uncertainty of the average rate is the same as the relative uncerainty of the average time between captures.

**4kHz case:**

$$\delta x = \frac{\text{standard deviation}}{\sqrt{\text{counts}}} \approx \frac{1245.64}{\sqrt{6000}}$$

$$\frac{\delta x}{x} = \frac{\text{Average time between counts}}{\frac{\text{standard deviation}}{\sqrt{\text{counts}}}} \approx \frac{557.02}{\frac{1245.64}{\sqrt{6000}}} \approx 0.03$$

**5kHz case:**

$$\delta x = \frac{\text{standard deviation}}{\sqrt{\text{counts}}} \approx \frac{819.74}{\sqrt{6000}}$$

$$\frac{\delta x}{x} = \frac{\text{Average time between counts}}{\frac{\text{standard deviation}}{\sqrt{\text{counts}}}} \approx \frac{365.48}{\frac{819.74}{\sqrt{6000}}} \approx 0.03$$

So each case has a relative error of about 3%. This does not explain the discrepency between the average observed rate and the rate midas displays of 2.5kHz. For either internal trigger rate (4kHz or 5kHz).

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