Improving time accuracy on Field Mapping Units

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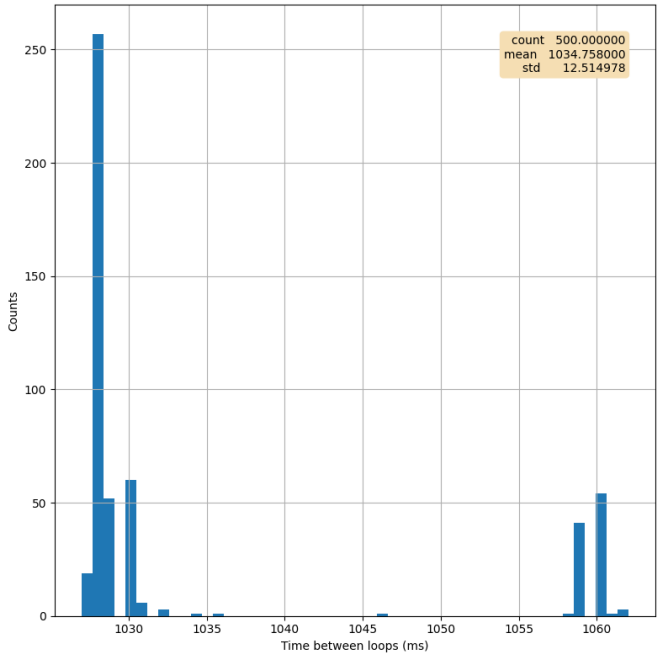
Refer to DSG Note 2023-07 for details on the hardware/software setup of the field mapping units and DSG Note 2023-19 for the analysis of the data from the CLEO Magnet during the initial low power test. The timestamp for the data is recorded as UNIX time, which is the number of seconds since 00:00:00 UTC on 1 January 1970, with an integer data type. While correlating data between sensor units it was found that there were what appeared to be gaps in time when performing an inner join, which is a form intersection on each unit's timestamp index. In an attempt to save power the units will enter light sleep mode at the end of each loop and are woken up by a timer.

Since the precision of the UNIX time is only one second an additional field was added to the data file, the number of milliseconds since the program was first started. This has a data type of unsigned long and will wrap back to zero after approximately 50 days. Figure 1 has a histogram of the number of milliseconds between each measurement in the data file. Of note are the two peaks at ~1028 and ~1060. The 1028 entries corresponds to the normal program sequence of sampling data 10x a second and writing the data to the SD card every second. The 1060 entries corresponds to the exact same sequence with the addition of updating the TFT display every five seconds.

From this analysis it can been seen that it takes approximately 30 milliseconds for the combination sensor acquisition and writing data to the SD card and a similar 30 milliseconds to update the TFT display. The effect of these additional times is that around every 30 data entries the integer timestamp is rounded over and appears as a two second gap rather than the expected one second.

- **Additional analysis done on timing of mapping unit data**
- **Improved delay code reduced frequency of timestamp rounding from 1/30 to 1/500**



Previous ms delay between loops

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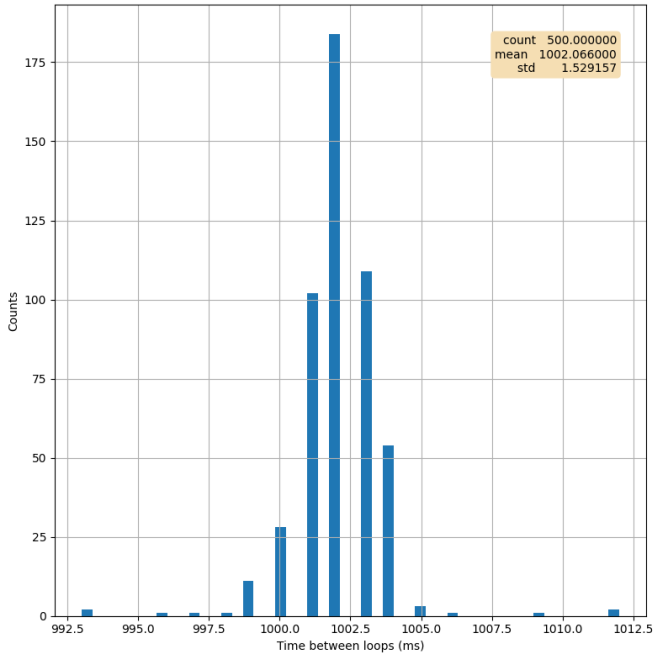
In order to remove this gap rather than the fixed 100 millisecond delay between each loop execution a variable delay was used. The number of milliseconds between the start and just prior to finishing the loop is calculated and subtracted from the desired delay of 100 milliseconds. This attempts to remove any extra time spent in the loop from writing to the SD card or updating the display. Figure 2 has a histogram of the number of milliseconds between each measurement in the data file with the variable delay.

With the variable delay added in the distribution of the time is much improved compared to the fixed delay as it much more gaussian in appearance. However, there is still an offset of approximately 2 milliseconds, which appears as a two second gap every 500 entries. While it is unclear if the timing can be improved further, additional work is ongoing.



Improved ms delay between loops