Stray Field Measurements for CLEO Low Power Test

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2022-10

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During the planned lower current (100 amp) test for the CLEO solenoid in the High Bay of Test Lab facility the issue of possibility magnetizing the steel in the structure (rebar in flooring, crane girders, support beams, etc) around the magnet was raised as a possible issue due to the proximity to the SRF (Superconducting Radio Frequency) lab. In order to facilitate measuring the field at several locations during the ramping porition of the test a sensor assembly has been designed, tested and is in the process of being fabricated.

In order to quickly have a device up and running it was decided to try and pre-assembled components as much as possible, to that end the main board is an Adafruit ESP32-S3 TFT Feather which contains a ESP32-S3 Dual Core 240MHz Tensilica processor, a 1.14” TFT display, along with connectors for a LiPoly battery and STEMMA QT sensors. The main sensor in the device is one based on a ST Microelectronics LIS2MDL magnetometer (with a ±50 gauss range) on a breakout board, also with a STEMMA QT connector. This allows the sensor to be directly connected to the main board with no additional fabrication. Aside from the display itself data will be saved to a microSD card, also via a breakout board.

- **Components selected and ordered**
  - **Some required alternatives due to stock issues, initially selected battery and main board were OOS**
- **Prototype assembled to verify functionality**
  - **All needed functionality is present**
- **Waiting on final enclosure to deliver all units (8 in total)**

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It was initially planned to use the Adafruit provided CircuitPython libraries to have a fully functional system in the shortest time, unfortunately due to issues with the battery monitor chip not being able to be read out switching to the Arduino compatible mode was needed. This was mostly straightforward with each individual component (display, SD card, magnetometer, battery sensor) working fine in isolation with their various libraries. Once integration began it was found that there was a conflict with the SD card and the display, such that once the SD card was initialized commands to the display no longer responded. Switching to a different SD card library solved that issue.

Another issue was trying to use as little power as possible in an attempt to have the longest runtime, this meant using deep sleep as much as possible. Deep sleep shuts down nearly all the CPU and peripherals and has the lowest current draw. After additional discussions on the testing it was found that such low power requirements wouldn't be needed and light or even no sleep would be possible as the tests themselves would only be measured in hours and not the days. With light sleep and the TFT backlight turned off except when manually enabled the battery lasted over 5 days before the testing was halted. Another test will be done with the TFT always on to see the effect on battery runtime.

Currently the Arduino code to measure the field in X, Y, Z, display it to screen, and save to SD card has been developed and tested. The only remaining part is the development of an enclosure to house all the components.