Project Proposal

Radiation Exposure by Location and Time

February 25, 2010

Contents

1 Project Abstract

The device will analyze a signal from a NaI(Tl) detector to determine and record radiation exposure. Achieving this will require the use of an analog to digital converter (ADC) before the resulting signal is interpreted by a microcontroller. Using a GPS receiver and an external precision oscillator, the device will be able to record its exposure by location and time. The device will use Bluetooth to transfer this information to a computer where long-term exposure records will be stored.

2 Strategy

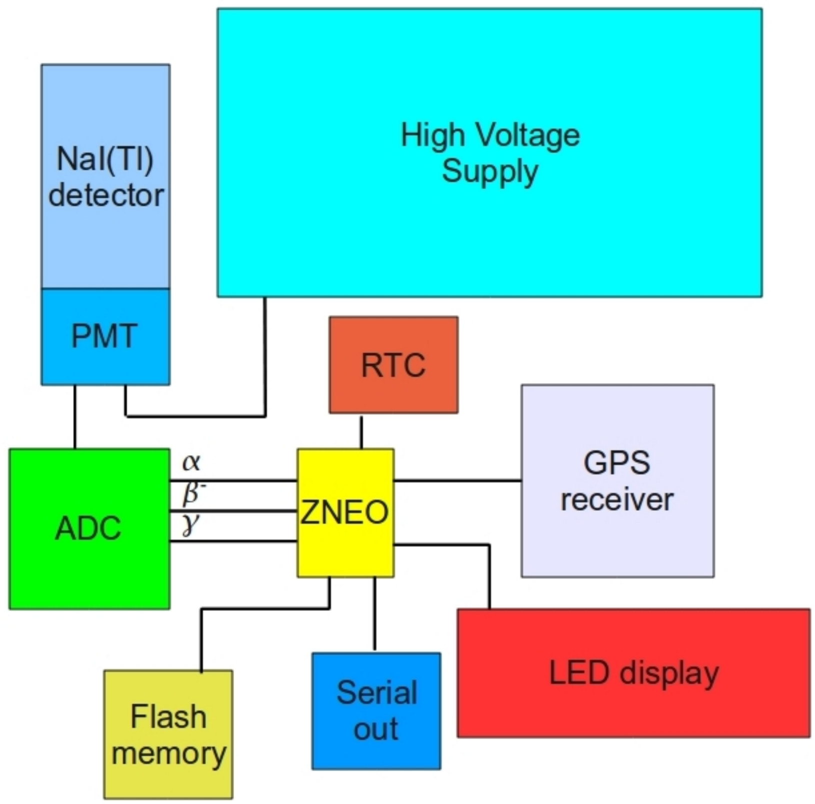

Figure 2.1: Hardware diagram

A NaI detector will be powered using a high voltage (HV) power supply. The detector produces an analog signal where the amplitude is proportional to the energy of a detected photon event. Thresholds will be set on this signal in an analog to digital converter so that peaks will be separated into channels representing various photon energy benchmarks.

These channels will carry digital signals to a ZNEO microcontroller. A channel's voltage will be set high when a photon in it's energy range is detected and will be low otherwise. Each digital signal will generate interrupts in the ZNEO which will increment a counter for its energy. After a period of time, to be determined, these counters will be used to determine the energy exposure per second in MeV/s, which will be printed out to an LED display for real time viewing of the measurements.

The main function of this device will come from its ability to combine these dose readings with location information obtained from a GPS receiver. Every time the ZNEO outputs the dose reading, it will also retrieve position information from the receiver. This information, along with current time information from a real time clock (RTC), will be stored on an external flash memory device for future reference.

The final component of this device will be the serial port which will be used to output the recorded information to a computer, where it can be stored for the long-term. As data accumulates in the computer, it can be viewed either by location, time or both to see where and when the device was exposed to the most dangerous radiation levels.

3 Unknowns

At this time, I do not know what form GPS signals come in, or how computationally intensive it is to determine a position based on the received information. I will need to learn more about this technology before proceeding.

Additionally, I do not yet have the ADC. I will need to build this circuit because of the specific voltage cut-offs I will require. Although this should not present a problem, it remains one of the greater sources of uncertainty.

4 Implementation Plan

Figure 4.1: Agilent 6516A, the HV source

The HV supply has not arrived yet, however its specification state that it is capable of producing the voltage and current needed to power the NaI's photomultiplier tube (PMT). Although the HV supply requires an outlet, the availability of wall outlets on campus allow it to be portable. The first step will be to calibrate the detector to determine the operational voltage. Known sources of electromagnetic radiation will then be used to determine the thresholds to be placed on the analog signal. It should be possible to complete this step by the first week in March.

Figure 4.2: NaI(Tl) detector and stand

Once these levels are known, an ADC capable of separating one analog signal into several digital signals based on signal amplitude will be built. If a signal's amplitude is greater than the voltage set for a given channel, then a logic high is sent on that channel. The highest channel which is high for a given event will be taken as that event's energy.

Figure 4.3: LED display on ZNEO contest kit

The output signals from the ADC will be connected to pins on the ZNEO. At this point the problem will be a software one. Code will need to be written to generate interrupts from the ADC's output which will increment detection counters, and to display the calculated MeV/s readings on the LED display. This step should be completed by the third week of March.

The GPS receiver will then be connected to the ZNEO. It is assumed that by this time, the technology will be understood by reading the receiver's spec sheets and by researching the required calculations. The ZNEO's code will be amended to receive and interpret these signals every time the LED display is updated, approximately once per second. This information will then be stored along with the current radiation readings and timing information from the RTC. This step will probably be completed by the end of March.

The final step of this project will be to output the stored information to a computer using a serial port. A small program will be written to receive the data on the computer and store it in an accessible location. This will be completed by mid-April, leaving time for improvements and debugging before the deadline.

5 Resources

- NaI(Tl) scintillation detector: currently available, borrowed from GWU's physics department
- HV source: currently available, borrowed from GWU's physics department
- Specialized ADC: this device will either be built
- ZNEO microcontroller: currently available, borrowed from GWU's computer science department
- GPS receiver: to be purchased from SparkFun.com
- Real time clock: currently available, borrowed from GWU's computer science department
- LED display: the display on the ZNEO contest kit is currently available, borrowed from GWU's computer science department