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Real-time Logging and Remote Monitoring of Key Parameters for Continuous Operation of Primary Atomic Frequency Standard

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The NPLI-CsF1 is an indigenously developed primary frequency standard for the realization of SI second [1]. The system comprises of various components that generate numerous parameters which require real-time as well as remote monitoring. To ensure the continuous and reliable operation of the CsF1, we need a system that can simultaneously log all these parameters and display them in a single window, allowing for remote access and comprehensive monitoring. This paper outlines the development of an 8-channel data logger system for logging and remote monitoring laser powers, as well as a separate logging system for temperature and humidity designed to ensure the reliable operation of the NPLI-CsF1.

Cs Fountain operates in a cyclic manner with a complete cycle lasting two seconds, during which cesium atoms are laser cooled, trapped, launched, interrogated, and detected. For seamless operation, it is essential to monitor the laser power of the six cooling and two detection beams. These 8 beams are coupled to single-mode polarization-maintaining (SM-PM) fibers on the optics table and then routed to the physics package, where the cooling, trapping, launch, interrogation and detection of cesium atoms take place. At this location, the beams are expanded using our indigenously developed beam expanders. A small fraction of this power is detected by a photodiode, generating an analog signal which is electronically amplified. To visualize this signal, we have developed a power monitor display utilizing an IC7107 with a 3.5-digit display. IC7107 receives the amplified analog voltage signal from the photodiode, converts it into a digital format suitable for display, and then shows the corresponding voltage on its 3.5-digit screen. To log these measurements, we've implemented an 8-channel datalogger system. Using the ADS1115 [2] for analog-to-digital conversion, controlled via I2C by an ESP8266 [3] chip programmed with Arduino IDE, it ensures synchronous observation of parameters with the fountain cycle. Data is transmitted over Wi-Fi to a remote PHP server, displayed in a single GUI window, and saved into a CSV file for further analysis.

Additionally, continuous monitoring of temperature and humidity is essential for uninterrupted operation. The data is recorded by temperature and humidity sensors and stored/retrieved via a microcontroller's data card. This data is retrieved live and recorded in a database and appended to a CSV file. Real-time plotting of this data is done on a web-based application, enabling remote monitoring from any system. This allows for analysis of trends and patterns in temperature and relative humidity behaviours. The work is in progress to scale-up the data logging system for logging additional parameters and to have one-window remote monitoring of all key parameters.

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