Open-source hardware and software for measurement, logging, and monitoring of cryogenic temperatures: a flexible, light-weight option
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— Although plasma physics is more commonly known for high temperatures, many plasma experiments involve various cryogenic systems. Measurement and logging of temperatures in these systems may be fairly mundane (e.g., an indication that a cryopump needs to be serviced) or may be an essential element of experimental success/reproducibility. As an alternative to pricey commercial options, one can assemble from only a handful of low-cost electronics an open-source, flexible, modular solution for the read-out, logging, and monitoring of, e.g., standard silicon cryo-diodes. In our example system, a multi-channel Arduino-based controller unit uses a three-component current source to excite each diode; the resulting voltage is read via a differential-mode 16-bit ADC and converted to a real-time temperature output. A Linux-based single-board computer (SBC) running a pair of Python scripts records long-term temperature data (SQLite) as well as recent data at higher time resolution (Redis) and makes the data available via a unified web API for simple integration with other services, such as browser-based monitoring or cloud storage. Together with the Arduino and SBC, the open-source microcontroller firmware, Python scripts, and circuit designs constitute a fully open hardware/software stack.

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