

# Automated for the PyPL: Using Bare-Metal Python to Build Robust Sample Preparation Lines and Much More

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Software excels at manipulating data, but is also a very useful tool to affect many aspects of the physical world. To give but one example, PID controllers are based on a very simple mathematical algorithm but are capable of regulating processes orders of magnitude more precisely than human beings are able to. In many cases where we wish to interact with the physical world through software, the difficult part is neither to formulate an algorithm nor its code implementation, but rather how to bridge the gap between data and the material world. This has become increasingly straightforward in recent years, with the advent of cheap yet capable computers such as the Raspberry Pi and of the Arduino ecosystem which offers access to microcontrollers once reserved for industrial processes.

Here I describe a free, open-source, open-hardware, fully automated preparation line for geochemical samples using MicroPython, (<https://micropython.org>) a lean and efficient “bare-metal” implementation of Python optimised to run on microcontrollers. This approach offers many advantages, namely that (1) it is cheaper than commercial solutions and avoids vendor lock-in; (2) it requires very little electronic knowledge due to the use of breakout boards for most components; (3) it is quite robust due to separation of process control (what happens to the samples) and the much more demanding interaction with a GUI (what human user see); (4) the exclusive use of (Micro)Python allows very quick/efficient development, testing and debugging, even with minimal prior knowledge.

The Python Preparation Line (PyPL) system is currently capable of interacting with electrical relays, valves, heating elements, thermocouple or PT-100(0) temperature sensors, PIDs, pressure gauges, stepper motors. It can communicate with an (optional) full-fledged computer through a single USB cable. All of its core software and hardware is open-sourced under a permissive license. Although originally designed for processing CO<sub>2</sub> samples, its extremely flexible design makes it straightforward to quickly create new automated systems.

