Determining Timing Resolution of a Raspberry Pi

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Introduction

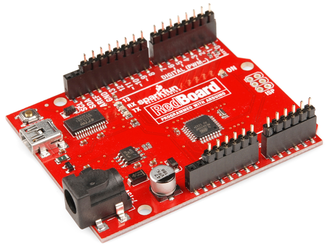
In order to design a low-cost muon detector that high school and college students could affordably build to study nuclear and particle physics, we needed to test suitable operating systems. Our first candidate was a Raspberry Pi.

To determine whether a Raspberry Pi would be a suitable operating system for the muon detector, we needed to test its timing resolution compared to the mean lifetime of a muon (2.1969811 microseconds).[1]

Material and Methods

We began by configuring the Raspberry Pi system settings so that it could properly communicate with our hardware, which consisted of a blinking LED circuit driven by an Arduino and coded in C++. After verifying that the internal timing system of the Pi corresponded to the known timing settings of the Arduino, we proceeded to drive the LED circuit by a function generator at progressively shorter periods to determine the resolution of the timing system.

Raspberry Pi



Arduino

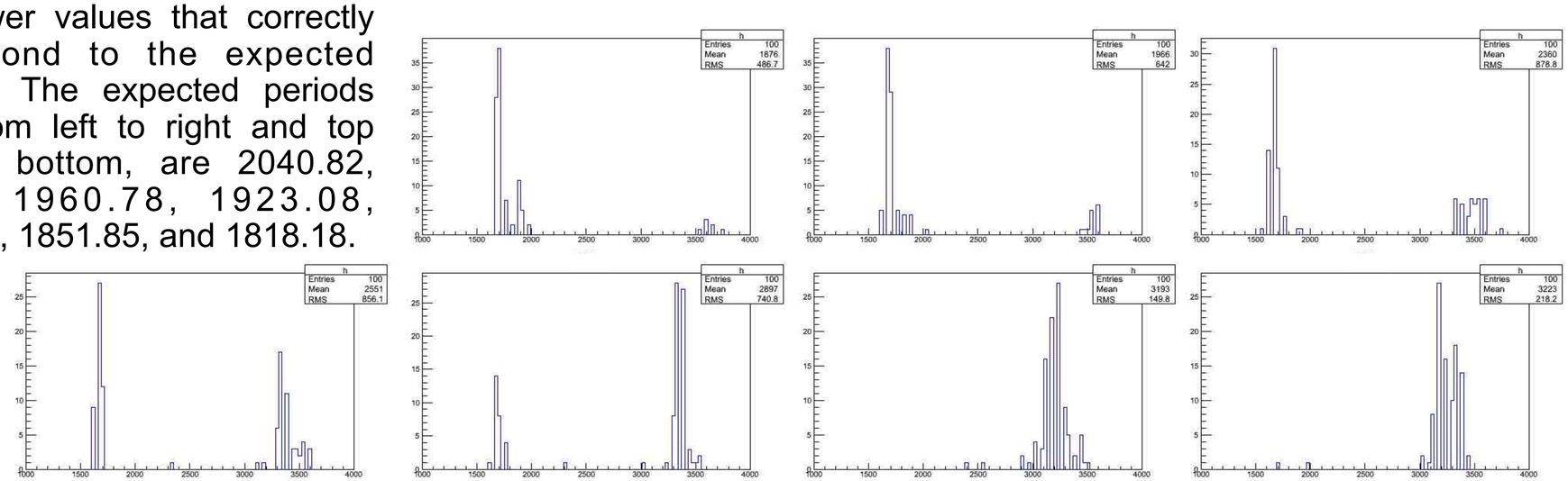
Function Generator

Conclusions

At approximately 2000 nanoseconds, the timing resolution of the Raspberry Pi reaches a limit. Due to the Raspberry Pi's timing resolution limit not being a significantly small fraction of the mean lifetime of a muon, we concluded that a Raspberry Pi is an insufficient operating system to use for a low-cost muon detector.

Results

These histograms show that at periods shorter than 2000 ns, the Raspberry Pi measures fewer and fewer values that correctly correspond to the expected periods. The expected periods (ns), from left to right and top row to bottom, are 2040.82, 2000, 1960.78, 1923.08, 1886.79, 1851.85, and 1818.18.



References

1. *Review of Particle Physics.* K. Olive et al. (PDG), Chin. Phys. C38, 090001 (2014).

Acknowledgments

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