The Bethel University undergraduate Atomic, Molecular, & Optical Physics Lab used the qNimble Quarto to lock a laser to an atomic transition, developing a robust optical frequency standard. The 778 nm laser drove a two-photon transition in rubidium-85, with 420 nm fluorescence detected by a photomultiplier tube. The role of the Quarto was threefold: it simultaneously generated a modulation signal at 94 kHz that was summed with the laser current; it served as a lock-in amplifier to demodulate the photomultiplier tube signal; and it performed proportional-integral feedback to steer the laser onto the peak of the fluorescence signal. qNimble provided some example code for this work, as well as excellent technical support as we worked out the challenges and made the system function well. Figure 1 shows the photomultiplier tube signal (yellow) and demodulated error signal (blue) on an oscilloscope, as the laser is swept by a triangle wave across the set of Doppler-free hyperfine spectra on the $^2S_{1/2}$ (F = 3) − $^5D_{5/2}$ transition.
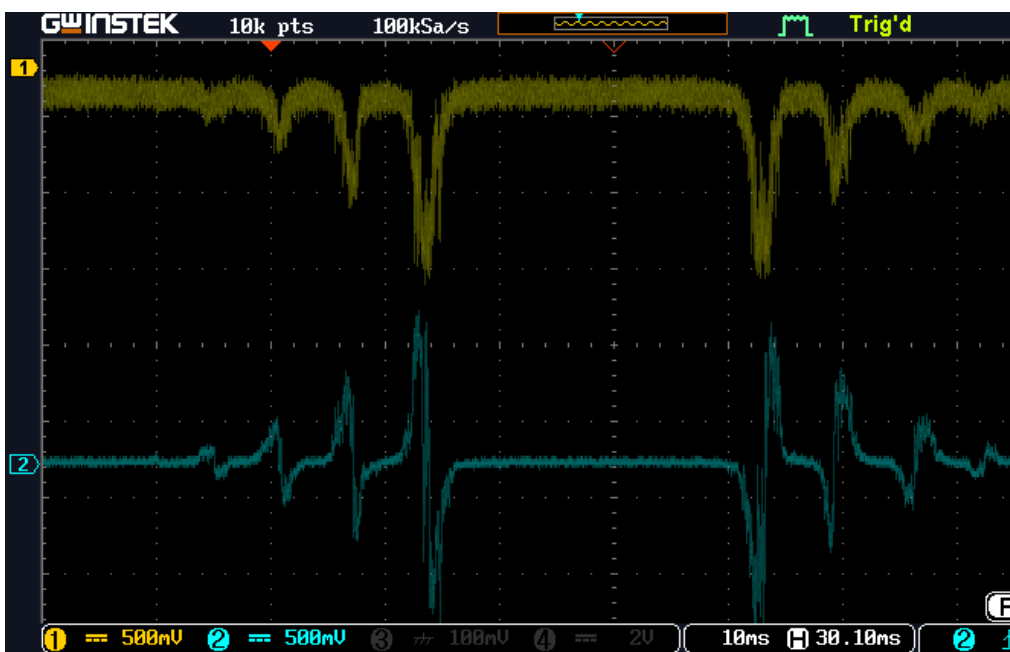

Figure 1. Doppler-free two-photon spectrum of rubidium-85 using the qNimble Quarto as a modulation source and as a lock-in amplifier to generate a steep zero crossing at the peak of each transition (blue trace). X-axis ~7 MHz/div.

After sweeping to locate the resonances, the sweep was turned off and the lock enabled. Figure 2 shows the same signals after the lock has been acquired by providing feedback to the laser current. The non-zero mean value of the fluorescence (yellow) indicates the laser is locked on resonance.
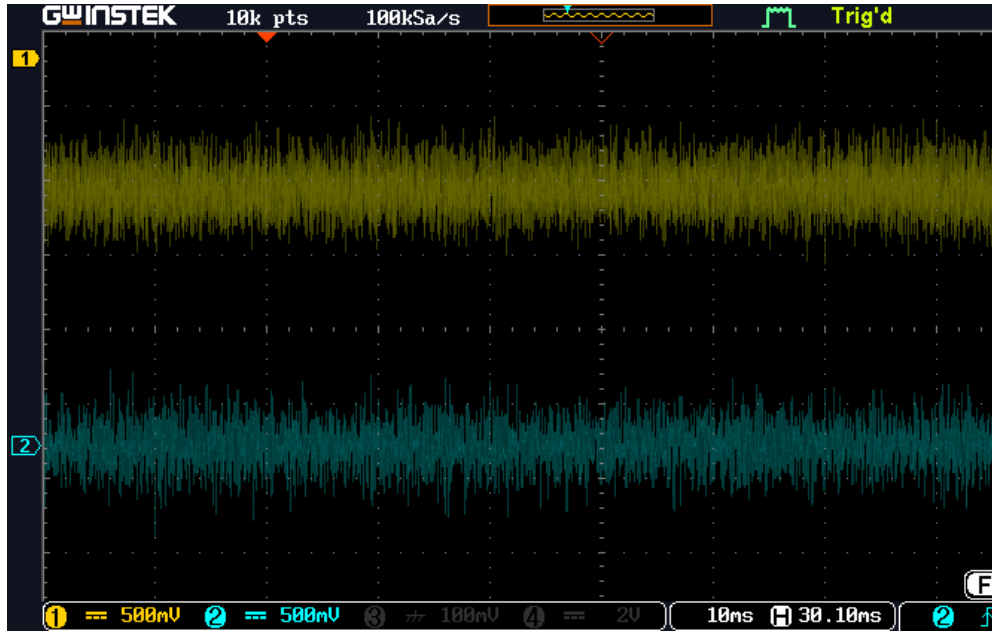
Figure 2. Photomultiplier and error signal when locked by a PI servo signal generated by the qNimble Quarto.

Overall, our lab has had a very positive experience using the qNimble Quarto. The Arduino code was easy to learn, and the ability to send serial commands to the Quarto provided a seamless interface with the experiment. The technical support offered by qNimble was invaluable, including answering emails with questions and tips and pointing us to helpful online forums. We are very grateful for their assistance and are benefitting from adding the Quarto to our laboratory apparatus.

The qNimble Quarto is a flexible data acquisition and experiment control device. Low latency & jitter, high-resolution A2Ds & D2As, a high sampling rate, and a facile user interface make the Quarto a high-performance tool for any laboratory.