

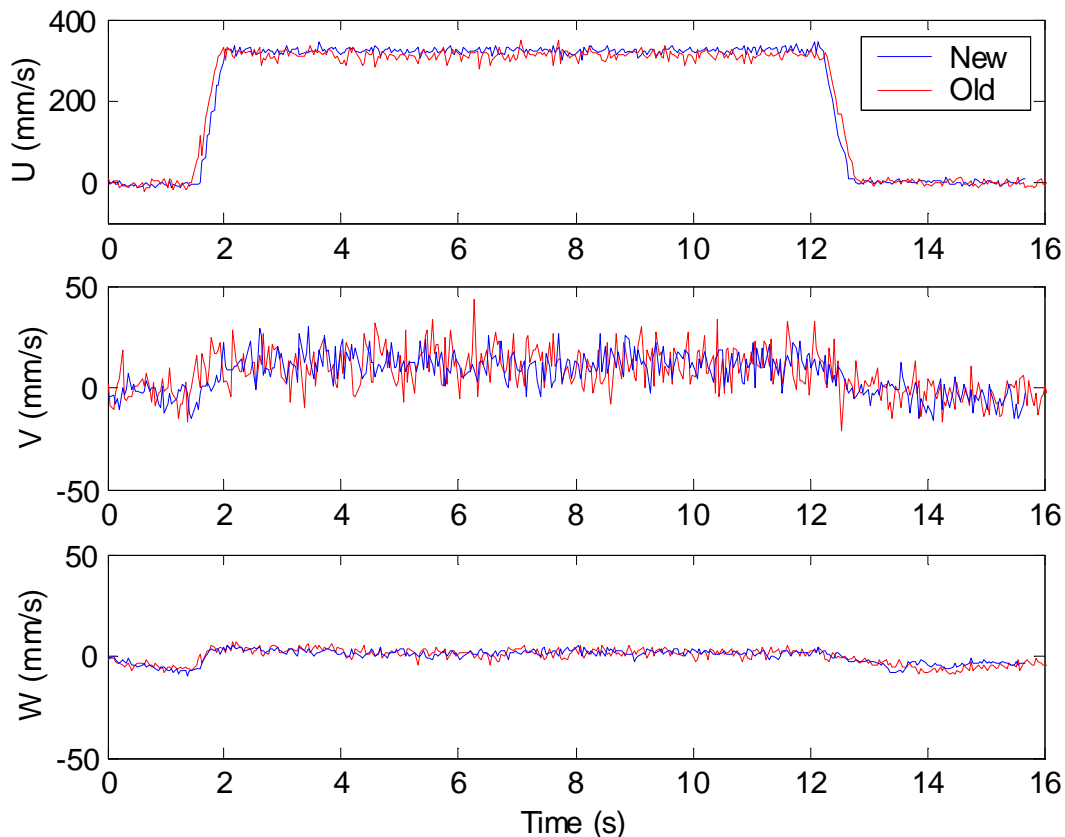
## New Velocimeter Processing Algorithms Reduce Variance

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December 8, 1999

Nortek has developed a new, improved velocimeter signal-processing algorithm, which cuts measurement variance in half. The new algorithm is the result of developments associated with our Vector Velocimeter, Nortek's integrated velocimeter designed for open water applications. The Vector has more powerful and flexible signal processing capability than standard velocimeters, in hardware, digital signal processing and algorithms. Standard lab and field velocimeters are unable to implement most of the improvements designed into Vectors, but we have retrofitted a new algorithm, developed for the Vector, into the older instruments. This document illustrates the differences in performance in a lab velocimeter, arising from this improved algorithm.

Figure 1 shows measured velocity from a test in which we used the same standard velocimeter, both with and without the improved algorithm. Data were sampled at 25 Hz in a tow tank with the velocimeter configured for a 1 m/s velocity range. Other than changes in firmware, conditions were identical for the two tests. Figure 2 shows a detail of the velocity measured at full tow speed. The variance of the velocity (while at tow speed) dropped by a factor of 2.6 as a result of the improved firmware.

Figure 3 shows the difference in spectra between the two measurements. The noise floors show a drop of about a factor of two as a result of the improved firmware.



*Figure 1. Velocity data collected using new and old velocimeter processing. The same velocimeter was used for both run, and its setup and tow velocities were identical. The only difference between the two runs was velocimeter firmware.*

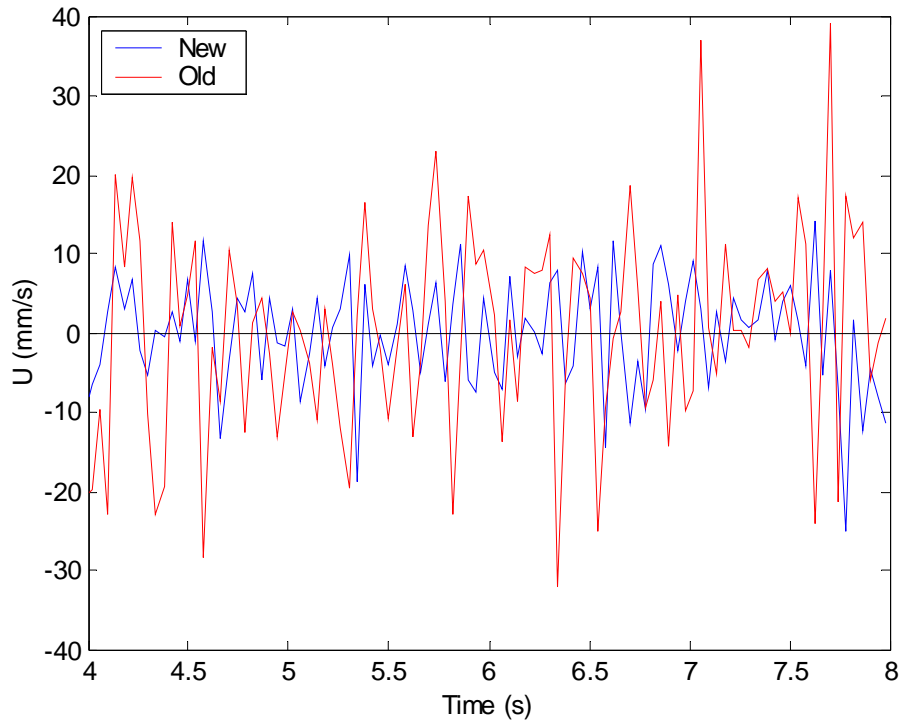


Figure 2. Detail showing velocities in the direction of the flow, with the mean removed. The corresponding measurement variances are  $50 \text{ mm}^2/\text{s}^2$  (new), and  $130 \text{ mm}^2/\text{s}^2$  (old), which differ by a factor of 2.6.

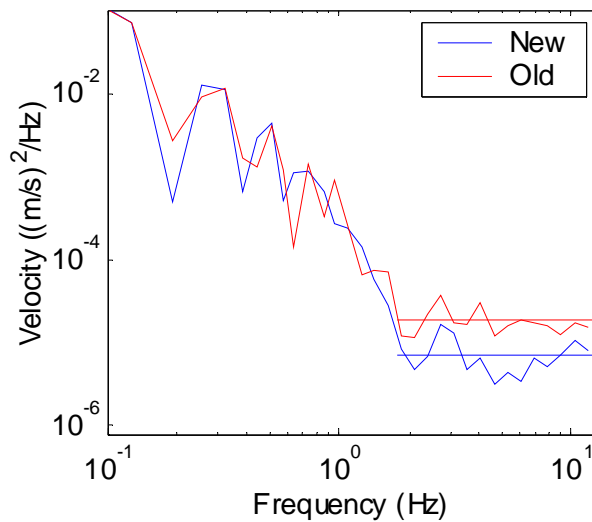


Figure 3. Velocity spectra using new and old processing. The flat horizontal lines indicate the noise floors of the spectra, and they differ by a factor of 2.6.

The spectra combine both x- and y- velocity components.

These and other measurements indicate that this new algorithm reduces instrumental noise (or measurement variance) by a factor of 1.5-3. In practice, the actual improvement depends on the details of how you collect data as well as on the environment, but a factor of 2 appears to be typical. Reducing noise a factor of 2 means you can collect data twice as fast. It gives you the equivalent of the improvement you would obtain by increasing the frequency by 50%, but without suffering the corresponding loss of signal sensitivity.