Comparison of Three Acoustic Doppler Velocimeters

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This note presents results of two tests with Acoustic Doppler Velocimeters in a test tank at the University of Delaware's Ocean Engineering Laboratory. The purpose of the tests was to compare the performance of a 16 MHz velocimeter (DV16) versus a 10 MHz velocimeter made by Nortek (NDV). Since it was not possible to test both instruments at the same time, we ran two separate tests, comparing each with a tried-and-true standard. The comparison instrument was a 10 MHz velocimeter (DV10), manufactured around 1995.

Tests

Conditions during each test were held constant. The two tests were separated in time by a few weeks. We tried, to the extent possible, to make the two tests the same, but there may have been small differences in the conditions between the two tests. Test runs were collected in sequence. After the first instrument's run was competed, we replaced it with the second instrument, exactly where the first had been, and without changing the flow. All instruments were set up using standard factory-recommended settings.

Table 1. Test conditions and setup. All instruments were set for a maximum velocity of 1 m/s.

	Mean Speed (m/s)	SNR (dB)	Sample rate (Hz)
Test 1			
DV10	.389	40	25
DV16	.346	30	50
Test 2			
DV10	.336	34	25
NDV10	.333	42	25

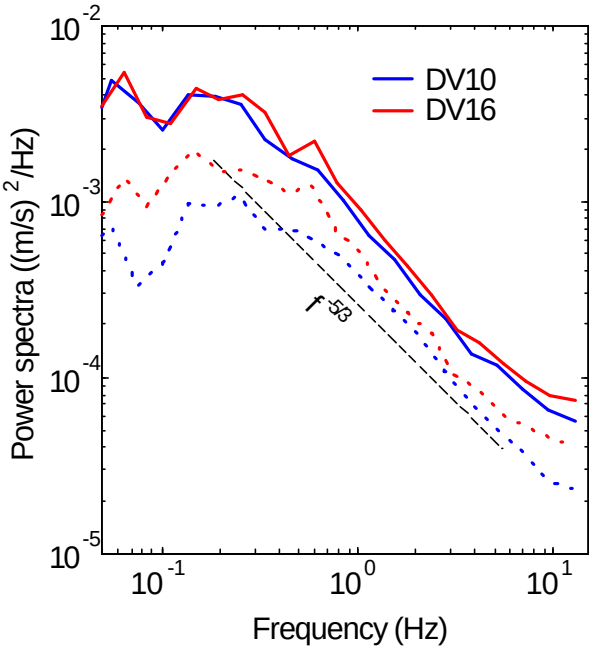
Table 1 compares the setup and conditions during the two tests. Data were collected in runs lasting 15-17 minutes each. In all cases, the signal strength was well above the level necessary to obtain good data.

Signal Strength

The DV16's acoustic signal strength (SNR) is about 10 dB lower than the DV10's SNR. This is consistent with the DV16's higher frequency [1]. Even so, a mean SNR of 30 dB is well above its threshold for good performance (which is somewhere below 10 dB).

Noise Level

Figures 1 and 2 present spectra, which illustrate differences in performance. The overall spectra are generally the same: the spectra peak around 0.1 Hz with levels around 0.005 $m^2s^{-2}Hz^{-1}$. At higher frequencies, they fall at a rate consistent with turbulence inside the inertial subrange (which falls typically at $f^{5/3}$). The differences of interest are at the high-frequency end of the spectra, where the spectra begin to flatten into their respective noise levels. Figures 1 and 2 also show spectra of the velocity component transverse to the mean flow. Because the transverse



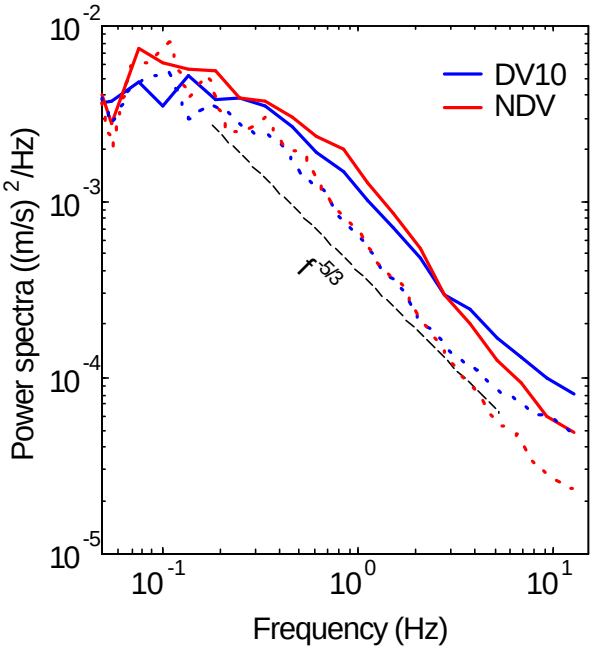


Figure 1 (left). Spectra from test comparison of DV10 and DV16. The DV10 data were smoothed to 25 Hz for the comparison.

Figure 2. Spectra from test comparison of DV10 and NDV.

Solid lines are spectra computed using combined x-and y-components (u+iv), and dotted lines use only the velocity component perpendicular to the mean flow.

component is weaker, the noise levels are easier to see and the differences are more pronounced. The DV16's noise spectrum is higher than the noise spectrum of the DV10, and the NDV's noise spectrum is about a factor of two lower than for the DV10.

Because of the DV16's higher frequency and faster ping rate (compared with the DV10), we expected its noise level to be about a factor of 2 lower than for the DV10 [1], so its higher noise level was unexpected. Because the NDV incorporates an improved signal processing algorithm [2], we expected its noise level to be about a factor of 2 lower, which is consistent with what we observed.

Given the way that velocimeters process data internally, the differing sample rates should have no effect on their noise levels (see for example, data in [3]).

References

[1] *Principles of Operation, Acoustic Doppler Velocimeters* (NortekUSA web site: www.nortekusa.com/prin-vel.html).

[2] Gordon, L., *New Velocimeter Processing Algorithms Variance*, December 8, 1999 (report available at www.nortekusa.com/PDF/VelocimeterProcessing.pdf).

[3] Gordon, L. and J. Cox, *Acoustic Doppler Velocimeter Performance in a Laboratory Flume*, September 24, 2000 (report available at www.nortekusa.com/PDF/NSL-NDV.pdf).