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# TECHNICAL PROGRESS REPORT #3

## A compact programmable laser Doppler velocimeter for marine applications

**Contract Number 90-C-0105**



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*Introduction*

The three major tasks conducted during this period are the completion of the construction of a small water test section, the testing of the electronic processor, and the successful acquisition of single and two-velocity component LDV data. The test section consists of a rectangular Plexiglass section with a nozzle on one end and an extraction orifice on the other. A recirculating pump and flexible tubing are used to draw water from a reservoir, flow it though the test section and return it to the reservoir. Polystyrene particles of 10 $\mu$m in diameter were seeded into the flow. The laser beams were oriented to measure both the horizontal and vertical velocity components. The test section could be oriented at arbitrary angles to the incoming laser beams to produce flows at arbitrary directions.

*Discussion*

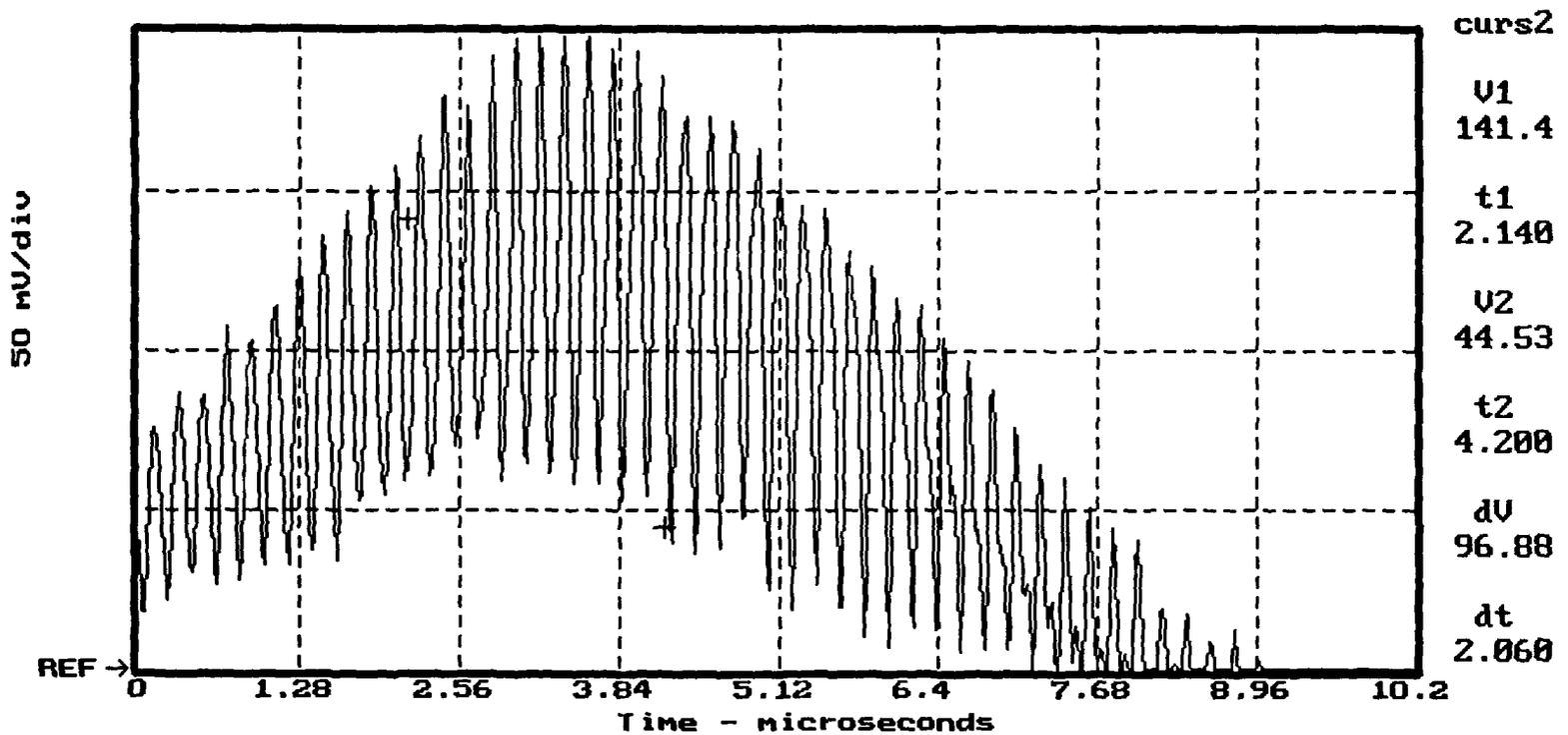
The system uses a 40 mW diode laser operating at 805 nm, three Bragg cells which provide frequency shifting, and a programmable digital signal processor (DSP) which will lead to a autonomous system capable of intelligent decisions. For stationary particles, the horizontal velocity component has a frequency shift ($fs_1$) of 5 MHz and the vertical velocity component has a frequency shift ($fs_2$) of 10 MHz. Thus, when the particles move due to flow velocity, the processed frequencies would be:

$$f_1 = fs_1 \pm U/\delta_1, \quad (1)$$

$$f_2 = fs_2 \pm V/\delta_2, \quad (2)$$

where $f_1$ and $f_2$ are the processed frequencies, $\delta_1$ and $\delta_2$ are the fringe spacings, and U and V are the velocity components in the horizontal and vertical directions. The values of $\delta_1$ and $\delta_2$ are 28 $\mu$m and 25 $\mu$m respectively.

The two enclosed graphs show the processed frequency both in the time domain and the frequency domain. The frequency spectrum was obtained by performing an FFT on the collected data. Notice the values of $f_1$ = 5.225 MHz and $f_2$ = 10.25 MHz. Substituting these values into equations (1) and (2), we arrive with velocity values of U = V = 6.2 m/s. In this particular example the U and V components are equal and correspond to flow moving at 45 degrees. In general, U and V can have arbitrary values. This arrangement permits the measurement of flow velocity and turbulence at arbitrary directions; including recirculating flows.

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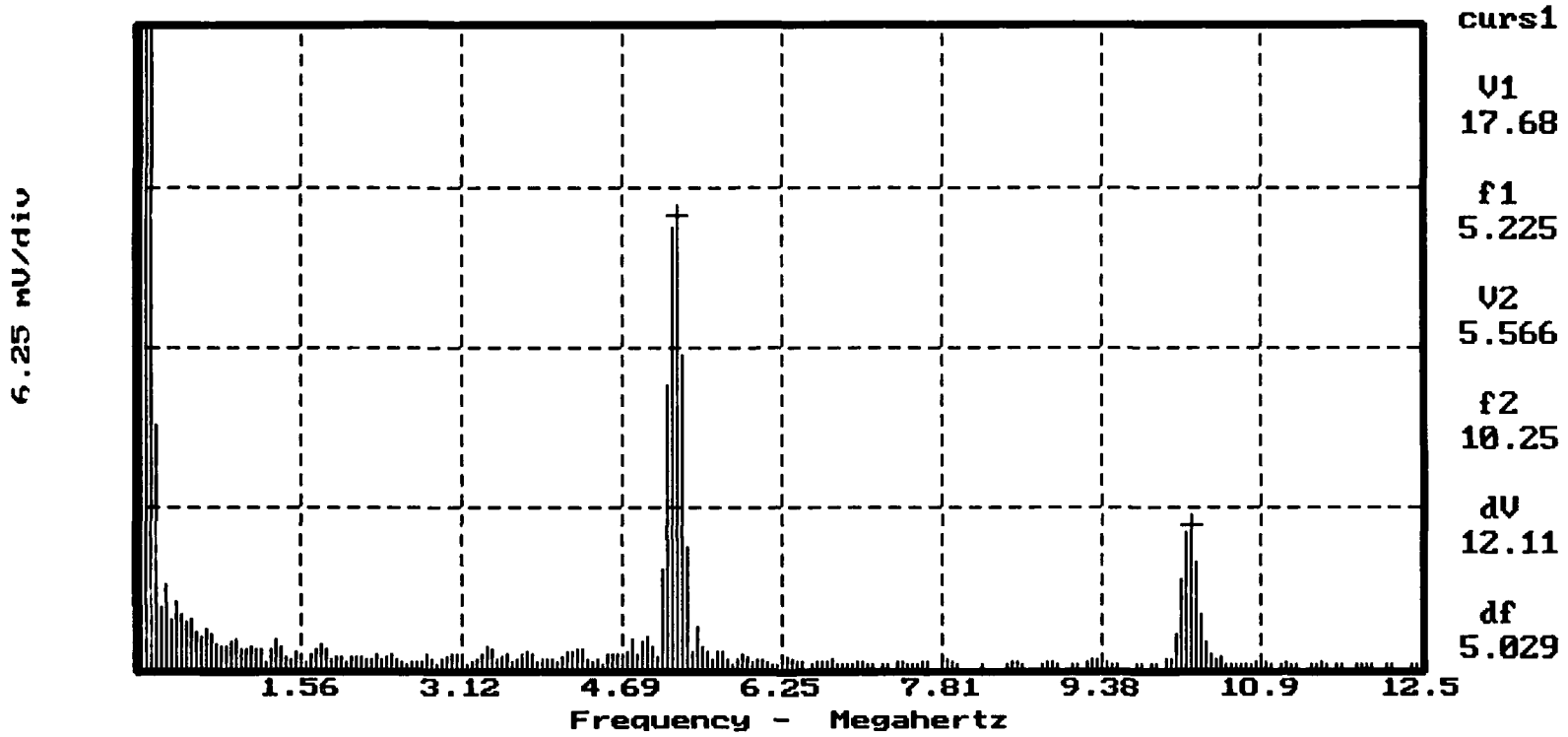


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