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TECHNICAL PROGRESS REPORT #2

A compact programmable laser Doppler velocimeter for marine applications

Contract Number 90-C-0105

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Introduction

This second Progress Report covers the period of 30 June to 30 August 1990. During this period we have constructed the LDV breadboard and have commenced acquiring data. The breadboard, which is schematically shown on Figure 1, is capable of measuring two velocity components in a backscattering configuration. The primary components are a 40 mW diode laser which operates at 815 nm, three Bragg cells with respective frequencies of 75, 80, and 90 MHz, and an avalanche photodiode module developed at MetroLaser. In addition to the LDV breadboard, we also developed a test cell with a recirculating centrifugal pump which is capable of producing velocities of up to 8 m/s. The test cell is filled with water and polystyrene particles of 8 microns in diameter.

During the remaining two months of this program we expect to refine the performance of the breadboard, acquire data for a variety of flow conditions, and evaluate the performance of the system, especially as it relates to sensitivity and signal to noise ratio.

Discussion

The purpose of this SBIR program is to research and develop a new laser Doppler velocimeter for deployment in the ocean. The system must be programmable and autonomous, and must operate unattended over periods of about six months. The choice of hardware was suggested in the Phase I proposal and has been implemented into a breadboard as indicated on Figure 1. While the Phase I proposal only discussed a one velocity component breadboard, we built a breadboard capable of measuring the velocity and turbulence in two independent directions. The key elements of this breadboard are:

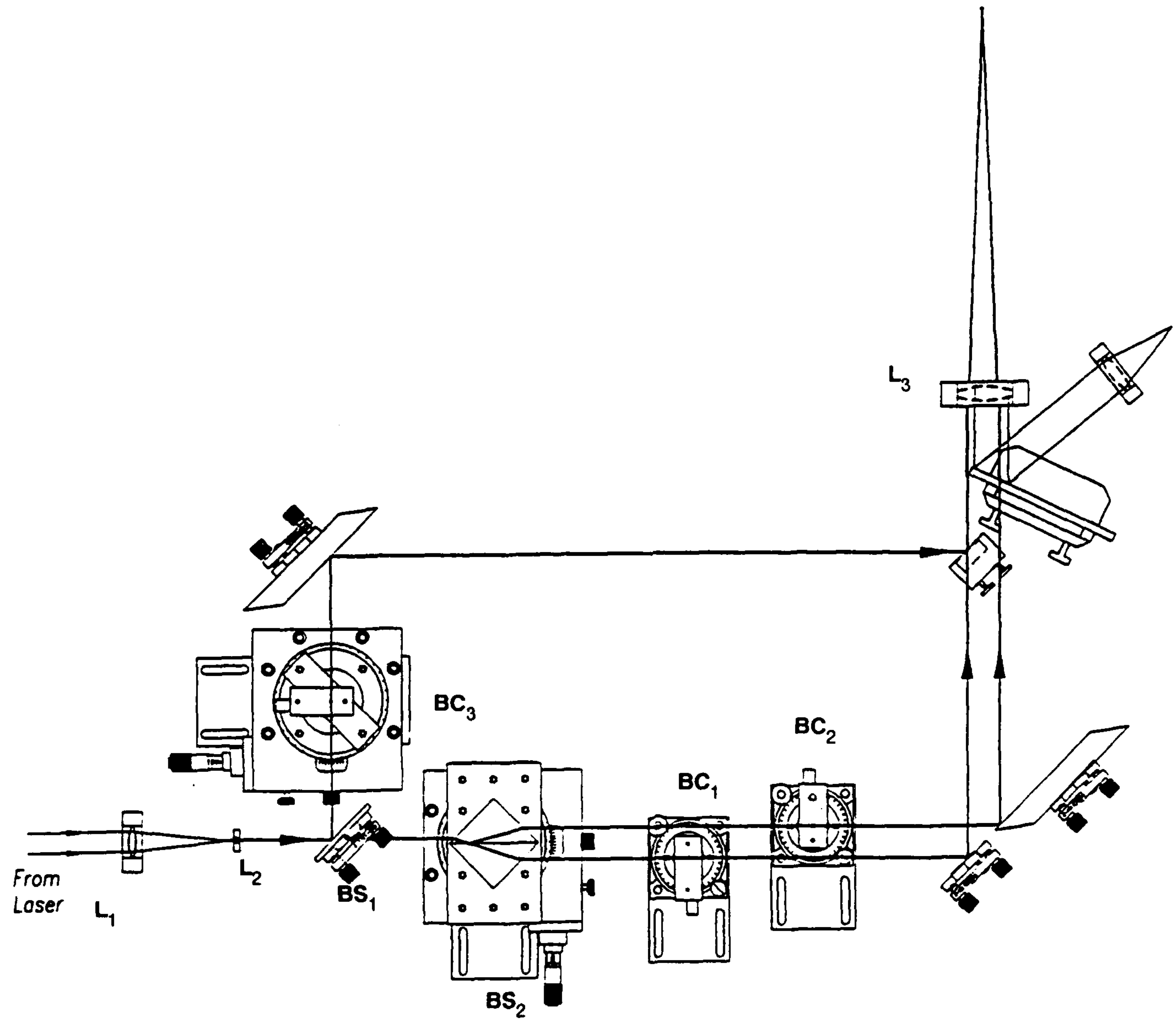
* Laser diode Melles Griot model 06DLL707 with temperature compensation and power control.
* Three Bragg cells Isomet model 1205C-1 specially coated to cover the laser diode wavelength of 815 nm. The Bragg cells are powered by three separate drivers with corresponding constant frequencies of 75, 80, and 90 MHz. This choice of frequencies allows for the spectral separation of the horizontal and vertical velocity components.
* Avalanche photodiode (APD) Texas Optoelectronics model TIED88 and custom made preamplifier board.
* Programmable digital signal processor (DSP).
* Optics to produce probe volume and collect the scattered light.

The laser, which is nominally 8 mm in diameter is minified to about 1 mm by a combination of two lenses (L_1 and L_2) with focal lengths of 200 and 25.4 mm. The beam splitter BS_1 separates the beam into two parts, a reflected part and a transmitted part. The transmitted portion of the beam is split again by BS_2. Each one of these three beams enters the respective Bragg cell. A combination of mirrors and lens L_3 is used to cross and focus the beams into a probe volume of about 70 μm in diameter and with fringe spacing of 10 μm. The light scattered by particles is collected and focused on the APD where an electronic signal is generated. This electronic signal has three carrier frequencies: 5, 10, and 15 MHz which correspond to the differences between the frequencies driving the Bragg cells.

Measurements have been made with static targets such as a flat piece of glass or a thin wire hung in the probe volume, and more recently with 10 micron polystyrene particles. The broadband signal to noise of the later is larger than 2 which should be more than adequate for FFT processing. At the present time we are evaluating the signal characteristics of the 10 micron particles in water contained in a small Plexiglass container.

Future Work

Two major tasks will be conducted in the last third of this program. First, the electronic processor will be tested, and second, the recirculating flow system will be made operational. Preliminary tests indicate that the measurement cell is small and a larger cell may have to be fabricated.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L_2
BS_1
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