# ID18- COMBINED CURRENT PROFILING AND BIOLOGICAL ECHOSOUNDING RESULTS FROM A SINGLE ADCP

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## Abstract

The present work describes a newly-developed Acoustic Doppler Current Profiler (ADCP) that has a fully integrated single-beam wide-band biological echosounder, thus serving a dual purpose: current measurement and biomass assessment. The system comprises a traditional 4-beam Janus configuration head, which is responsible for profiling the currents, with a vertically oriented center beam for collecting high-resolution acoustic backscatter data for subsequent biomass analysis. The system belongs to the Signature Series family of ADCPs launched in 2013 by Norwegian scientific instrumentation company Nortek. Named Signature100, it is powered by the AD2CP electronics platform, described in United States Patent 7.911.880. The four slanted beams (current profiling beams) operate at a center frequency of 100 kHz and have a range of up to 400 m with 4 m spatial resolution and sampling rate up to 1 Hz. The center vertical beam (echosounding beam) has a wider frequency band of approximately 70-120 kHz with a high dynamic range (~130 dB), and presently operating in up to three discreet pulse characteristics from a single beam set: 1) 70 kHz monochromatic, 2) 120 kHz monochromatic, and 3) 91 kHz chirp with 50 percent bandwidth and pulse compression. Acoustic pulses from the echosounder beam are interweaved with pulses for the current profiling beam for synchronous data collection. In this work we describe the system's configuration, capabilities and results from initial trials.paper that is identical with the extended summaries format.

Keywords - echosounding, ADCP, currents, biomass.

## I. INTRODUCTION

The continual global increase in human population is prompting governments to assess protein sources with greater detail. Global demand for animal-derived protein is expected to double between now and 2050 [1], driven by increasing urbanization (especially in emerging economies), improved recognition of protein's role in a healthy diet, and increased need for protein in the elderly community. Fish stocks are one source of animal-derived protein which is receiving considerable attention due to their potentially vast contribution to addressing global protein requirements. In fact, global fish production far surpass the production of all other animal protein in the world, and fish also contain many essential micronutrients, minerals and essential amino acids [2].

## II. FIELD VALIDATION

Field trials have been done as part of the Signature100's development, and here we highlight one such deployment carried out in the Mediterranean Sea. The location was just south of Toulon, France, and the deployment lasted from the morning of 10/Nov/2017 until the afternoon of 15/Nov/2017. Water depth at the site was about 470 m and the instrument was mounted up-looking on a subsurface buoy at the top of a short mooring. Raw heading data from the Signature100 (not shown) indicates the buoy observed a strong spin moment on its 7 minute descent, rotating at about 3-4 revolutions per minute, which is not unreasonable during such deployments. For fixed installations (not this case), this spinning can be a source of raw magnetometer data allowing for compass calibration in post-processing. After about 3 hours on the bottom, the buoy stabilized and subsequent data shows the mooring was very stable throughout the rest of the deployment, with only a gentle rotation (less than one revolution every few hours) and a very minor variation in tilt (less than 1°).

### A. Current Data

The ADCP portion of the instrument was configured to transmit 60 pings at 0.25 Hz, repeating the sequence every 5 minutes, with single ping data being recorded for quality control purposes. Current profiling was set for 60 depth cells of 10 m each (15 ms pulse) with a blanking distance of 1 m. Variable particle distribution in the water column caused the maximum usable range to oscillate from about 230 m to 420 m (beyond the instrument's specifications), especially during the first half of the deployment, as evidenced by the SNR data of the four slanted beams shown in Fig. 2. As expected, times of reduced SNR coincide with lower along-beam signal correlation values, indicating limit of usable data which is taken at 50% correlation. But despite the variations in particle distribution, over 68% of the data is above this 50% correlation threshold.

### B. Echosounder Data

The echosounder portion of the Signature100 was configured to transmit all three pulse types supported, although only the 70 kHz monochromatic is presented here. Each pulse had a 1 ms transmit duration and were transmitted at 1 Hz. The echosounder pulses interweaved with the current profiling pulses at a ratio of 3:1 (i.e. every three echosounder pings to one current profiling ping). The echosounder pulses' return was recorded in 0.75 m depth cells.
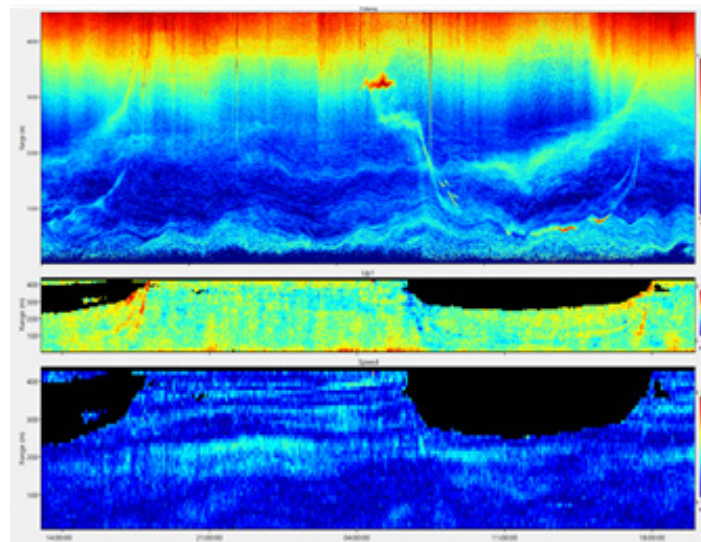


**Fig 1. 70 kHz Echogram (top), vertical velocity (middle), and horizontal current speed (bottom) for the first two days of the deployment.**

Four different features were selected from the echogram for presentation: plankton/krill diel migration, internal wave structures, passing surface vessels, and migration due to changes in current regime. The first type of feature is shown on Fig. 1. Although no trawling was conducted during the deployment to ground-truth the nature of the scatterers, it is reasonable to assume the features shown represent either plankton or krill (or both) migration, as the same patterns are widely observed in similar data [4]. The diel nature of the movement drives measurable vertical currents of approximately 5 cm/s upward during dusk hours, with the reverse pattern at dawn.

## III. CONCLUSIONS

A newly-developed Acoustic Doppler Current Profiler (ADCP) with a fully integrated single-beam wide-band biological echosounder has been developed and presented. The system belongs to the Signature Series family of ADCPs launched in 2013 by Norwegian scientific instrumentation company Nortek and is powered by the AD2CP electronics platform (US Patent 7.911.880). Named Signature100, it performs two key functions simultaneously over a maximum nominal range of 400 m: current profiling and biological echosounding. Some of its key features include a novel transducer design, three distinct echosounder pulse types, data processing with pulse compression, and the capability of recording the complex demodulated return signal. Details from a field validation deployment in the Mediterranean Sea were presented, with a focus on the 70 kHz echogram created by the instrument. Four main features of the echograms were discussed: plankton/krill diel migration, internal wave structures, passing surface vessels, and migration due to changes in current regime. The current profiling data complemented the echosounder data, providing greater insights into the distribution, structure and behavior of the marine life at the test site during the deployment.

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# ID19- EVALUATION OF SIGFOX LPWAN TECHNOLOGY FOR AUTONOMOUS SENSORS IN COASTAL APPLICATIONS

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**Abstract**

A low-power wide-area network (LPWAN) is a wireless communication network designed to send low bit rates in a long-range communication. SigFox is a LPWAN technology that uses Ultra Narrow Band to communicate packages of 12 bytes at a very low byte rate (<100 bits/s) and up to 140 messages/day per device. It is a payable service that includes the Base Stations and the Backend Services and works at 868 MHz (ISM band). These characteristics are attractive for IoT applications as it allows to send small packages at long distances at very low power range.
The TD1205P module features the SIGFOX Gateway and includes GNSS and Accelerometer sensors for tracking applications in 30x38x10.5 mm size. As a low power and compact solution that includes sensing, processing and transmitting units, it is suitable for Energy Harvesting Autonomous Sensor applications.

UPC is designing a drifter with a kinetic energy harvester, the electronics to adequate the power, the batteries to storage it and a TD1205P module as a tracker. It is going to be deployed at coastal areas to provide information of the surface currents for a long period hence, the power auntonomy has to be assured through the harvesting system. The aim of this study is to determinate the consumption of this module in his different modes of operation.
Two modules were set with different configuration and his power were compared, then in future studies, EH generation will be modelled in order to determine the autonomy of the buoy. The software is designed to minimize the consumption so it keeps the TD1205P sleeping during long periods, spending a few amount of energy. At some interval, the modules will wake up, fix the GPS position, take the measurements of battery voltage and temperature, send the
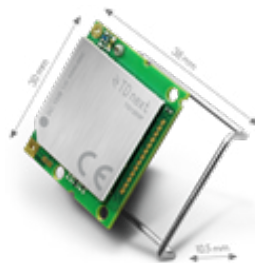


*Fig 1. At left, Sigfox technology scheme and at right, TD1205P module*