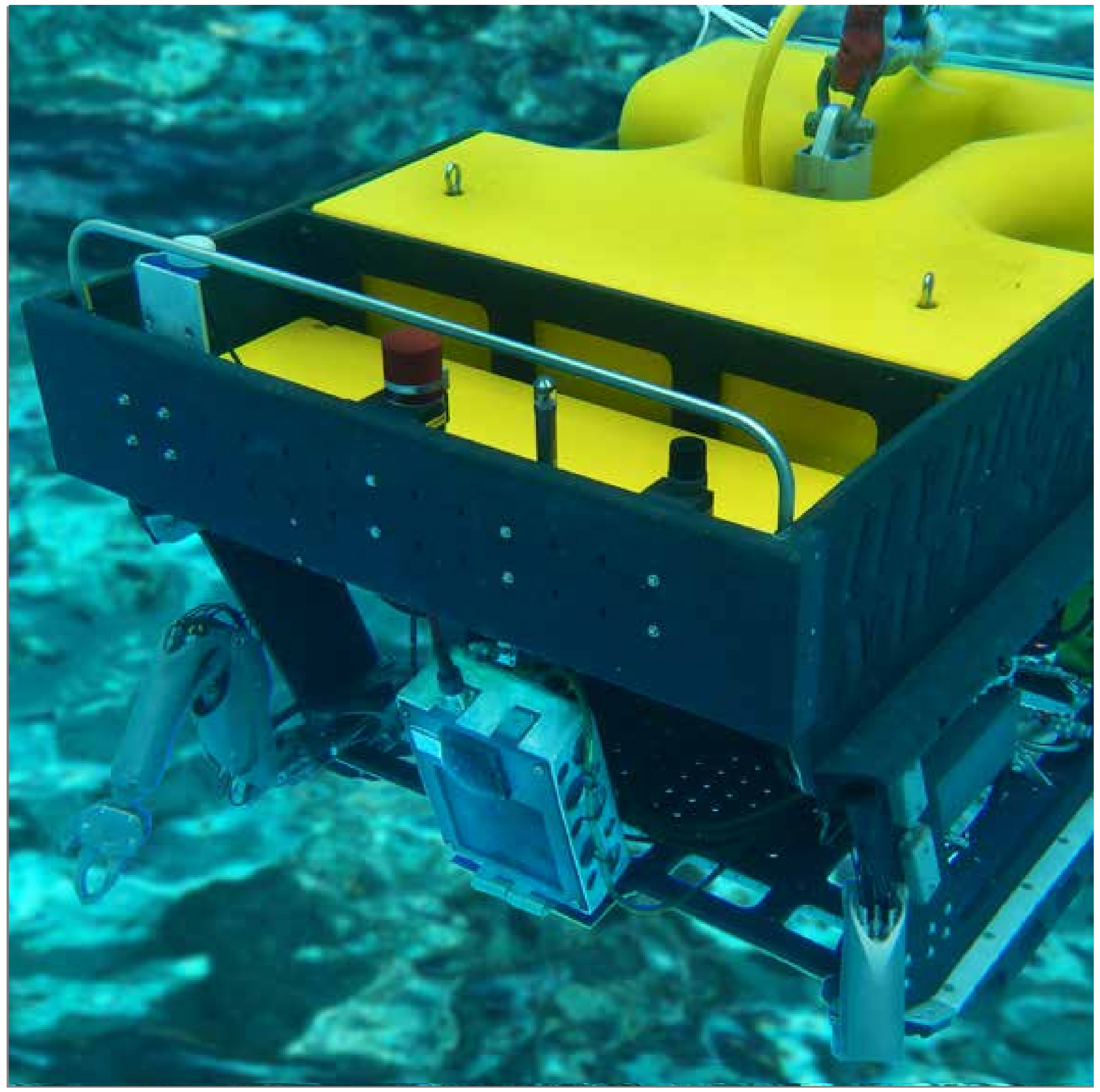
UT THREE

UNDERWATER TECHNOLOGY

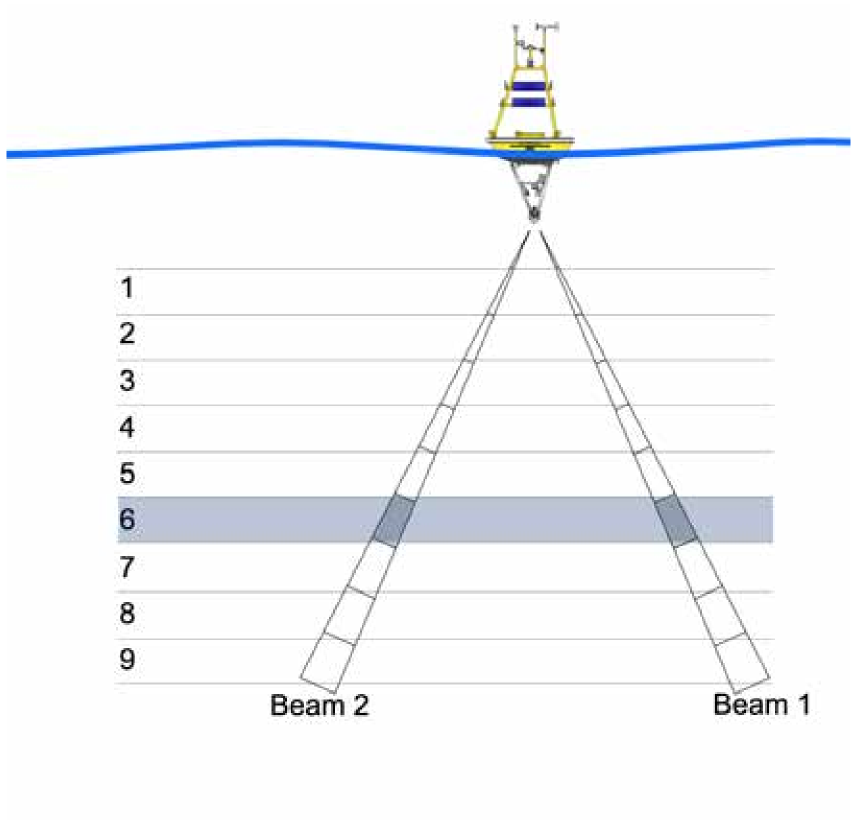


Issue Two 2019

VEHICLES X-PRIZE SONAR

CURRENT PROFILING

In collaboration with key technical specialists, Nortek has undertaken studies to improve the quality of current measurements collected from moving platforms.



Measuring water flow can be achieved by using sensors such as Acoustic Doppler Current Profilers (ADCPs), which are frequently deployed on the seabed looking upwards to scan a 2D profile of the water column.

Whilst this is a common method of deployment, there are often advantages to deploying the ADCPs downward-looking on surface buoys or sub-surface buoys. For example, this type of deployment supports easy access to the ADCPs for maintenance, real-time data transmission to a land base, or use with combined sensor packages such as offshore met stations.

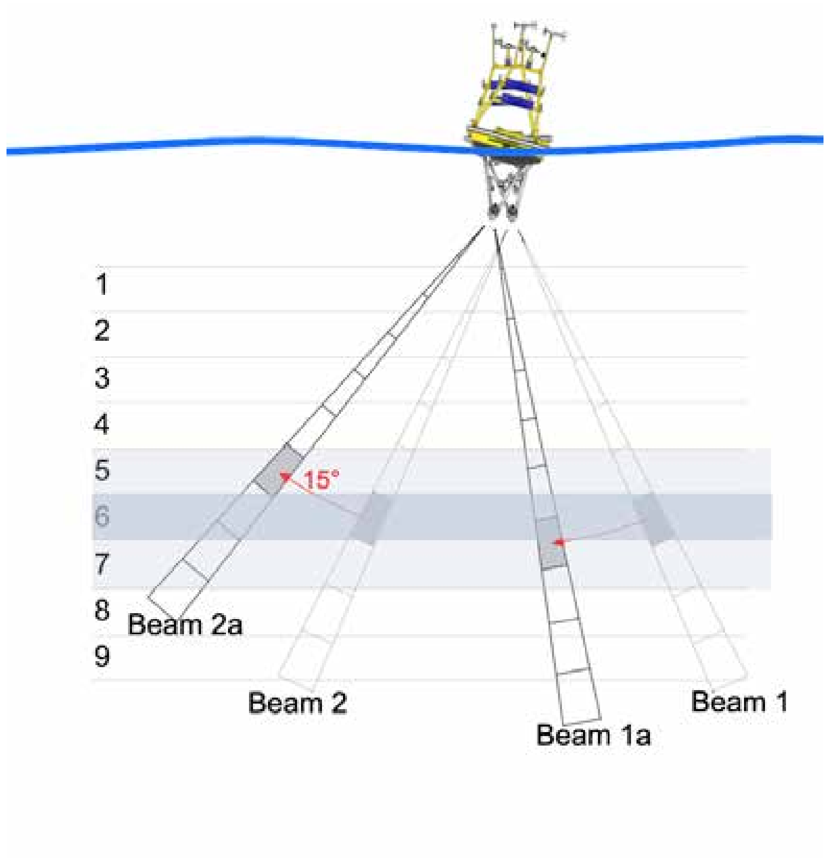
Deploying ADCPs in this way can often be challenging due to the destabilizing dynamic motion induced from waves, winds and even the currents themselves.

"Our collaborative team of experienced oceanographers and engineers realized that more can be done with our ADCPs to mitigate these effects and improve the quality of current measurements collected in this way," says Claire Cardy, Director, Nortek UK. "The data collected from a surface buoy can be compared with data collected from a seabed-mounted ADCP to check for consistency in the current measurements. We used our most advanced ADCP to examine the effects of motion at the surface on the quality of the current measurements."

An Acoustic Doppler Current Profiler

TECHNICAL CONSIDERATIONS
"If an ADCP is deployed straight, the distance along each beam will be exactly the same; therefore, the measurement depth will also be the same," explains Cardy. "A small change in the attitude of the ADCP, however, can cause a significant shift in the measurement depth of each beam. This is more noticeable at depth: the more the beams are spread out, the more we see a bias towards exaggerated current velocity measurements resulting from the vertical offset."

There are two ways in which to alleviate this bias. One is to increase the number of current measurement samples by sampling for longer periods, and average them together to smooth out the oscillations. However, in certain applications such as turbulence studies, the individual current measurement is of utmost importance, and therefore averaging loses the fine-scale detail of the current flow.



When measuring currents, instead of looking at one solid block of water, the column is divided into slices, called cells or bins. This enables the scientist to understand how the currents vary from the surface to the seabed in finer detail. In this diagram there are nine bins. If the instrument is exactly vertical at the surface, the distance along the beam is the same for each beam and therefore the depth is the same.

If an instrument is tilted, however, this means that at the same distance along the beam, the depths at which they are measuring are now different. In this case for the same distance along the beam, the measurement volume for beam 2 moves from bin 6 to bin 5, and for beam 1, it moves to cover half of bin 6 and half of bin 7.

Without bin mapping, the ADCP will put these tilted measurements in bin 6, but with bin mapping, the ADCP will adjust the offset and put the measurements into the correct bin. For example, in this second image the beam 2 measurements will be put in bin 5 not bin 6, but beam 1's measurements will be split between bins 6 and 7.

The alternative option is to negate the movement of the surface buoy and remap the current measurements. This requires the addition of a gyroscope-enabled tilt sensor and precise ping synchronization, which was previously unavailable in an ADCP until Nortek's Signature series arrived.

"This necessitated integrating an Attitude and Heading Reference Sensor (AHRS) output into our Signature ADCP, effectively enabling

ACDP

Large bodies of moving water often contain entrained particles. Piezoelectric transducers within the ADCP send out acoustic waves which bounce off these particles. By measuring the doppler frequency shift from the echo, this can be translated into water velocity values.

One application is to mount the ADCP sideways across a river bank to measure the water discharge.

Alternatively, securely mounting the profiler on the seabed, pointing upwards, allows it to measure the water currents up through the water column although in order to achieve a three dimensional image, a typical system will require three or more acoustic beams.

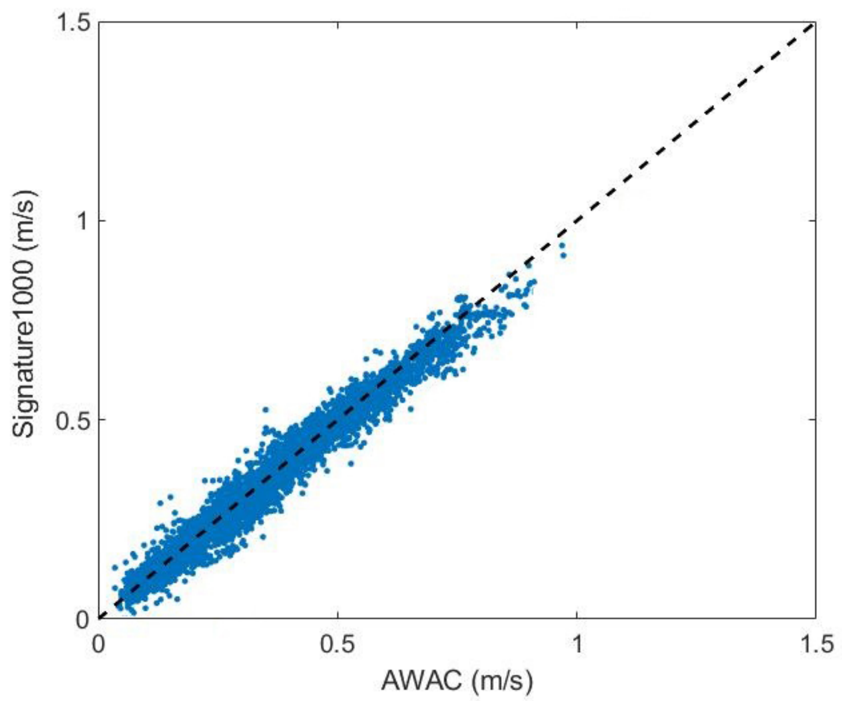
Conversely, locating the unit at the surface and pointing it downwards to the seabed allows 'bottom tracking' with the aim of looking along survey lines.

While there is a demand for systems to be installed on surface platforms the measurements are quite complex and this can be seen in the general lack of industry development. Nortek, however, are one of the companies that have been looking at this area.

us to incorporate readings from the accelerometer, magnetometer and gyroscope,” says Cardy. “The AHRS has a very high response rate of 100 Hz, which supports high-resolution real-time mapping on a ping-by-ping basis. Each individual ping from the ADCP beam has its own precise timing, which is matched with the AHRS on the receipt of the return signal.”

To validate this, Nortek placed an Acoustic Wave and Current Profiler (AWAC) on the seabed and looked for a comparison with the downward-looking Signature ADCP unit. The figure shows a linear regression between the depth-averaged velocity measured by the bottom-mounted AWAC (reference) and the buoy-mounted Signature1000.

As can be seen, there is a very strong agreement between the two datasets, showing how the quality of the buoy-mounted measurement matches that of the reference system on the bottom.



Correlation between bottom mounted AWAC and buoy mounted Signature ADCP current measurements

SURFACE VESSELS
Taking current measurements from an ADCP on a surface buoy presents similar challenges to using autonomous surface vehicles (ASVs), which are becoming more important with the rise of unmanned survey applications.

Not only is the ASV subject to pitch and roll like a surface buoy, it has the added challenge of transiting like a traditional survey vessel. Measuring currents in this way requires several pieces of instrumentation that previously have been complex to set up and configure for standard vessel-mounted applications.

For autonomous applications, this large equipment is highly impractical and an alternative solution is required.

“On a moving vessel, it is not only necessary to correct for the pitch, roll and heading, but also for the difference in position during the vessel transit, which is achieved by combining the Signature ADCP with a GNSS,” says Cardy.

“The benefit of the Signature series is that sampling up to 14 Hz provides much better vertical resolution throughout the water column.

Combined with an improved bottom-track algorithm, the result is fewer data dropouts, particularly when changing course quickly.”

Nortek is working on the practical aspects of adapting this system for autonomous platforms where the space on board is very limited.

“There are a number of practical issues in incorporating these systems into autonomous vehicles: space is at a premium for the various sensor packages, payload sensors need to be optimized to reduce interference, and, most importantly, each autonomous vehicle is different, which means a ‘one-solution-fits-all’ system isn’t yet feasible,” says Cardy.

A TITANIC CONTRIBUTION

Teledyne Marine has made a signficant contrubtion to OceanGate’s Titan Manned Submersible project which recently reached a major milestone by successfully completing a 4000m validation dive off the Bahamas coast.

This dive makes Titan the only commercially operated manned submersible capable of reaching this depth. With the completion of this dive, Titan is now poised to usher in a new era of increased access to the deep ocean for commercial exploration and research ventures, allowing up to five crew members to dive to the ocean depths for a myriad of tasks and operations.

Teledyne Marine, with its wide breadth of sensors and technology, has become a key partner and extensive technology provider to OceanGate for this innovative project.

Teledyne Benthos acoustic modems have been designed into this vehicle to provide real-time “text” communications up to 6km, allowing for the critical exchange of information between the vehicle’s pilot and the surface throughout the dive.

More recently, OceanGate has also enabled the modem’s positioning capability through the use of Benthos DAT, allowing them to capture the position of the vehicle relative to the ship’s surface.

A 6000m Teledyne RDI phased array Pioneer DVL, with XRT extended tracking has also been installed to provide critical precision vehicle navigation capability at full depth, complimented by a Teledyne RDI Citadel CTD. Teledyne BlueView’s 2D and 3D high-resolution imaging sonar systems are also installed.

The 2D system is used to support navigation and obstacle avoidance while the 3D sonar provides detailed 3D point clouds of areas/objects of interest.

”We could not have completed this project without the products and customer support of the Teledyne Marine team”, said Stockton Rush CEO of OceanGate.

With the completion of the recent validations dive, Titan is now preparing for its first major expedition, which will explore the Titanic in June 2019.

Saab Seaeye Tiger

WASTE DISPOSAL

After breaking all records for transferring waste material stored in spent fuel ponds, Sellafield has selected the Saab Seaeye Tiger robotic vehicle to work in one of the most hazardous environments on the planet.

The announcement came after the Tiger had worked consistently in the highly-corrosive conditions for nine months, during which time it only needed to pause for routine maintenance. Sellafield has now ordered four Tigers for this extremely challenging role.

Specially adapted for the role by Saab Seaeye engineers in collaboration with Sellafield engineers, the Tiger was chosen for its long-proven reputation for reliability when working in demanding conditions in the offshore energy industry. When applied to nuclear waste, the Tiger’s durability means that there is limited need for intervention by operators for maintenance purposes, considerably reducing their exposure in this hazardous environment.

Exposure to radiation for operators is carefully limited, and unplanned downtime will quickly exhaust their safe working period in any one year.

The nuclear-enabled version of the Tiger, called Tiger-N, gathers and sorts metre-long, 15kg radioactive fuel bars for removal to long-term storage. This work can involve removing buried radioactive material from 30cm of sludge.