A Rigging of a USBL Transceiver for Use on a Seismic Vessel

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***Abstract*—In this article we present an application of USBL for seismic acquisition. In order to measure the far field signature of a source, a hydrophone, on which a USBL transponder is installed, is towed below the source. The USBL transceiver is rigged on a float. The float, which is a headfloat or a tailbuoy, is deployed short behind the vessel. This rigging is easier to perform on seismic vessels than traditional mounting of the transceiver on a pole. As this creates a noisy environment for the USBL system, quality of acoustic communication is assessed. In particular, the number of hydrophones acoustically valid in the acoustic array of the transceiver provides interesting information, and shows that most of the time the USBL works properly despite the flow noise.**

I. Introduction

USBL (Ultra-Short BaseLine) technology allows positioning of underwater targets thanks to acoustic signals [1], [2]. USBL equipments are commonly used to track AUVs [6], ROVs [7], sonars or various kinds of towed fishes. A transponder is mounted on the target and exchanges acoustic signals with a transceiver generally set on-board the vessel, on a through-hull pole or on a side-pole.

USBLs can also have applications in marine seismic acquisition operations, for example when measuring the far-field signature of an air guns seismic source. When available, a through-hull pole is well suited for mounting of the USBL transceiver; this particular mounting has been used for sea trials on the CGG Symphony in August/September 2012.

However, mounting the transceiver on a vessel pole can be quite challenging to perform on a seismic vessel. In fact, few vessels are equipped with a large enough through-hull pole, or this pole is already used for acoustic positioning of various elements of the spread. Installing a side-pole requires welding it on the hull, which implies being alongside and recertifying the vessel.

Seismic vessels often stay months offshore, and immobilizing a vessel alongside is to be avoided as much as possible, for costs reasons. That is why an alternative rigging of the USBL transceiver on a float has been studied.

II. An application of USBL for measuring the far field signature of a source

A particular application of USBLs on a seismic vessel is for measuring the far field signature of a source. In fact, to measure this signature, one or several hydrophones are towed deep below the source. Depth of the hydrophones can range from 100 to 300m. By installing a transponder on the hydrophone and a USBL transceiver whether on-board the vessel or on a float, it is possible to get the position of the hydrophone. In absence of USBL, position is estimated by firing successively four guns at the four corners of the source arrays, and by measuring the arrival times. The main drawback of this method is that no continuous monitoring of the position can be done. Use of a USBL allows continuous recording of the hydrophones position, then this position can be used afterwards for data processing to take into account the position of the fish relative to the one of the source.

One or several transponders can also be installed on the gun arrays, in order to make direct comparison of the source and hydrophone positions.

When the guns are fired, by nature of the air-guns, high acoustic perturbations are generated, and could prevent proper functioning of the USBL. However, as it will be presented afterwards, it has no real incidence on the quality of communication between transceiver and transponder.

III. Rigging

We will now present how the USBL transceiver was rigged on a float for testing of this particular way of deployment.

Because of operational constraints, it was decided to use a standard seismic float, whether tailbuoy or headbuoy. In order to attach the USBL transceiver to the float, a protective stainless steel housing was designed and manufactured. The USBL transceiver was screwed to the top of the housing, and the housing whether welded on the metallic structure of the tailbuoy, whether screwed to the keel of the headbuoy.

One of the purposes of this housing is to avoid damaging the sensor during deployment and recovery operations of the float. A secondary purpose is to keep the USBL transceiver fixed respect to the float: no drift with the GPS position of the float, and limitation of motion of the transceiver.

A GPS antenna was attached to the float mast, so as to know the exact position of the transceiver.

To make accurate calculation of the position of the transponder, the USBL transceiver needs to be used in conjunction with an AHRS (Attitude and Heading Reference System). Transceiver and AHRS need to be fixed respect to each other: it is not possible to install the transceiver on the float and the

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Fig. 1. Tailbuoy with underneath protective housing for USBL transceiver

AHRS on-board. Therefore USBL models having integrated AHRS are to be preferred [3], [4], [5]. The test described hereafter was conducted with an AHRS integrated in the USBL transceiver. Precision of the internal AHRS is quite important in this configuration, because of the big movements the float is submitted to; tests have been carried with two USBL models, one being not robust enough for this kind of rigging.

The float was deployed in a different way of the way it is usually deployed in a seismic spread. It was towed with a rope, with no streamer connection, and was between the vessel and the source arrays. During the test it was 85m behind the vessel. Towpoint was on portside, at the extremity of the vessel. The RGPS pod of the buoy was powered with battery. The USBL transceiver was connected with a dedicated cable to a control box on-board the vessel, in order to power it and retrieve the data. A Y termination of this cable allows to power at the same time USBL transceiver and GPS antenna, and to retrieve data from both of them.

No depth sensor on the transponder was available.

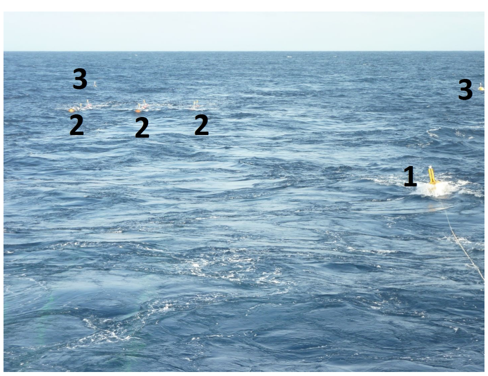

Fig. 3. Buoy with USBL transceiver when deployed. View from the stern of the vessel. 1: Float with USBL transceiver underneath; 2: Source arrays; 3: Headbuoys: heads of streamers

IV. Test procedure

Tests of this USBL rigging were performed on the CGG seismic vessel Oceanic Champion in February 2013. A USBL transceiver was installed as described before on a tailbuoy, and a beacon was attached to a towed fish. The fish was deployed at different depths and distances, in order to assess the tracking capabilities of the USBL rigged in this configuration.

V. Results

A. Distance between transceiver and transponder constant

The USBL transceiver has an acoustic array of four hydrophones. In order to assess the effect of a highly noisy environment on the USBL, it can be studied how many hydrophones were valid acoustically speaking. Table 1 shows the percentages of time 4,3 or less than 2 hydrophones were acoustically valid. At least three hydrophones are required to calculate a position. The test lasted in total 7h53min. During this phase of the test, the towed fish on which the transponder was installed was towed with constant length of cable (220m).

TABLE I
Hydrophones acoustic validity

Number of valid hydrophones	Percentage of the total time
4	78%
3	3%
less than 2	19%

The duration of the losses of communication between beacon and transceiver, that is less than two hydrophones acoustically valid, have been studied more in depth. Results are presented in table 2.

TABLE II
Hydrophones acoustic validity

Duration of communication loss	Percentage
≤ 2s	45%
$2s < d \leq 5s$	41%
$5s < d \leq 10s$	12%
> 10s	2%

B. Distance between transceiver and transponder varying

During this phase of the test, length of tow fish cable changed from 220 to 350m. As before, the acoustic validity of the USBL was studied. Tables 3 and 4 show the acoustic validity of the hydrophones array and the repartition of the duration of the communication losses. However, this test lasted only 32min, so any conclusion drawn from this phase of the test should be taken carefully.

TABLE III
Hydrophones acoustic validity

Number of valid hydrophones	Percentage of the total time
4	52%
3	4%
less than 2	44%

It is worth noting that the quality of acoustic communication is completely decorrelated with the guns shooting or not,

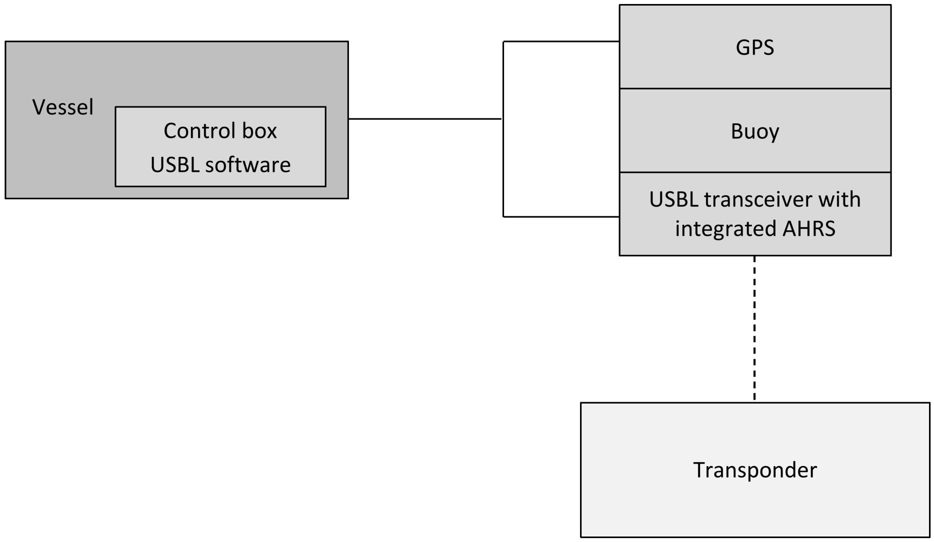

Fig. 2. Assembly of all elements. Float is deployed about 85m behind the vessel

TABLE IV
HYDROPHONES ACOUSTIC VALIDITY

Duration of communication loss	Percentage
≤ 2s	26%
2s $< d \leq$ 5s	36%
5s $< d \leq$ 10s	26%
$>$ 10s	12%

which shows that the air bubbles generated by the source have no incidence on the use of the USBL, whereas the flow noise generated by the float or the fish influences much the USBL tracking peformances.

VI. CONCLUSION

A new rigging of a USBL transceiver easier to perform on a seismic vessel was presented, and the tests that have been performed were detailed. The USBL system was used to track a tow fish, this tow fish being used for far field measurements. The quality of the acoustic communication between the transceiver and the transponder was assessed, and proved to be good, despite being something altered by modifying the length of the fish tow cable.

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