



“KAIYO” Cruise Report

KY13-04

Experiments of underwater acoustic technology,

Izu-Ogasawara area and Suruga-Bay

27/Feb./2013 – 11/March/2013

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

●Contents

1. Cruise Information

2. Researchers

3. Purpose

4. Experiments

4.1. Overview

4.2. Experimental setup and results

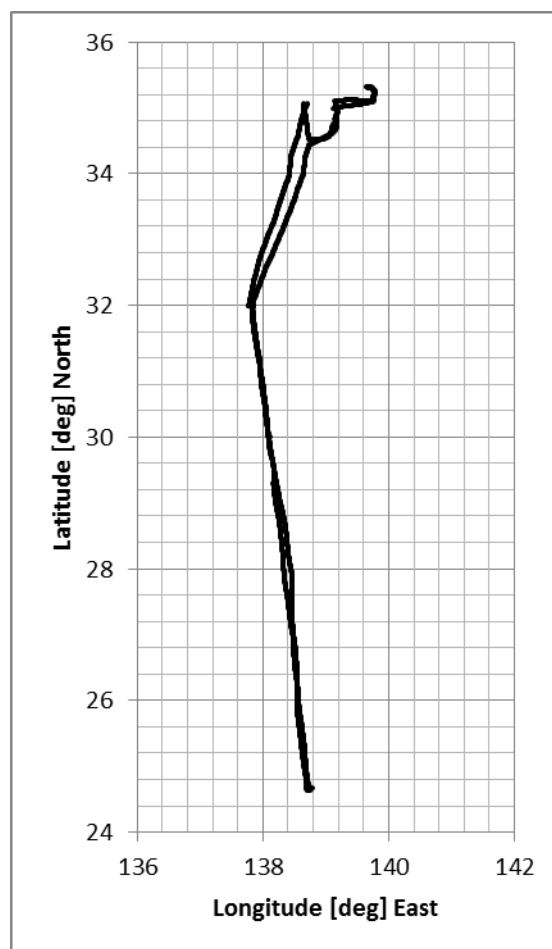
4.3. Research Information

- Deployment and recovery information
- XBT list

5. Notice on Using

1. Cruise Information

- Cruise ID: KY13-04
- Name of vessel R/V KAIYO
- Title of the cruise Experiments of underwater acoustic technology
- Title of proposal Experiment of long-range communication using time reversal in deep ocean.
Experiment of short-range high-speed acoustic communication.
- Cruise period 27/Feb./2013 – 11/March/2013
- Ports of call Yokosuka
- Research area Izu-Ogasawara area and Suruga-Bay
- Research Map



2. Researchers

- Chief scientist [Affiliation] Hiroshi OCHI [JAMSTEC]
- Representative of the science party [Affiliation] Hiroshi OCHI [JAMSTEC]
Takuya SHIMURA [JAMSTEC]
- Science party [Affiliation, assignment etc.]
Takuya SHIMURA, Tomohiko SUGIYAMA [JAMSTEC]

Tomoyuki TAKAMORI, Takami MORI, Kentaro SHIRAISHI, Tamami UENO [Marine Works Japan. LTD]

3. Purpose

Our group is researching and developing long-range acoustic communication using time-reversal wave and short-range high-speed acoustic communication. In this cruise, our purposes are

1. To obtain data of long-range acoustic communication in single user and multi user.
 2. To obtain data of short-range acoustic communication in horizontal direction.
- And to get XBT and sound speed profile data are also the purposes of this cruise.

4. Experiments

4.1. Overview

- a. Experiment of long-range communication using time reversal in deep ocean.

In JAMSTEC, there are plans to develop an autonomous underwater vehicle (AUV) which will have the capability to cruise long distances over several hundred kilometers and relatively smaller multiple AUVs to explore ocean floor resources. Achieving acoustic communication with such AUVs, even at a low data transmission rate, will be important.

We have researched time-reversal communication to solve this problem. By time reversal, multipath waves converged in time and space and then inter-symbol interferences (ISI) are removed. Additionally, time reversal can be applied to multiuser communication. By its spatial focusing, signals from sources at different positions can be separated each other by the same processing in the single user case without sacrificing throughput, and more complex multipath arrivals give better crosstalk cancellation.

In KY13-04, experiment of communication from two sources was demonstrated in deep ocean.

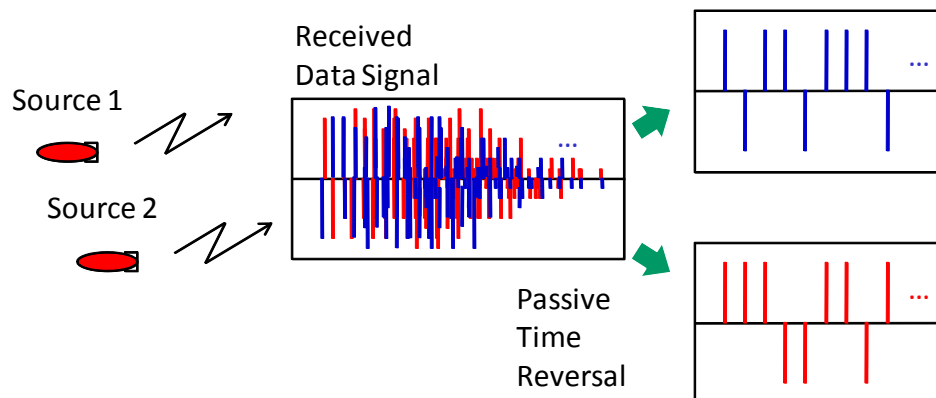


Fig.1 Schematic of crosstalk mitigation by passive time reversal.

b. Experiment of short-range high-speed acoustic communication.

The other experiment is for short-range high-speed acoustic communication. In JAMSTEC, there is a plan of working type AUV. This type of AUV has a purpose of making a precise map by mosaicking of color still images. For checking images by an operator, high-speed data transmission system is required. When the transmission system constructed by using acoustic signal, quite high data rate transmission system should be developed. In this experiment, 80 kHz of carrier frequency, and 40 kHz of band width are applied. And aim of this system is to transmit colour still image less than 1 second.

4.2. Experimental setup and results

a. Experiment of long-range communication using time reversal in deep ocean.

In this experiment, two sources, whose source level is 197 dB re 1 μ Pa and bandwidth is from 450 to 550 Hz, were used. One of them was moored and the other one was suspended from R/V Kaiyo at the depth of around 1200 m, that is, around the axis of SOFAR channel. In the meantime, a 37-channels vertical receiver array with element spacing around 6 m was moored similarly at the depth of around 1200 m. The distance between the sources and the receiver array was around 800 km. In this measurement, a 5-sec long linear frequency modulation (LFM) chirp signal from 450 to 550 Hz as a probe for passive time reversal and subsequently a data signal of 2000 symbols modulated with BPSK were transmitted at the same time from the two sources. As mentioned above, the received signals were processed with passive time reversal.

Figure 2 shows one of demodulation results. This shows that it is possible to achieve communication from two users by mitigating crosstalk using time reversal in deep ocean.

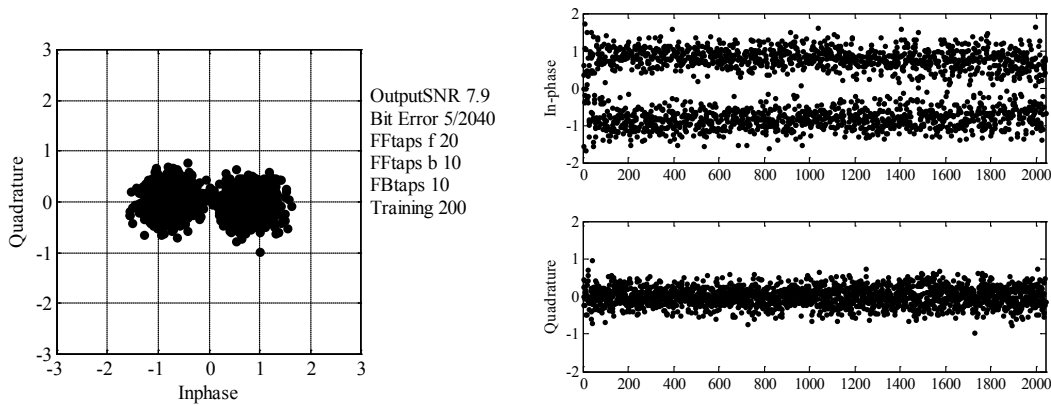


Fig.2 An example of demodulation results.

b. Experiment of short-range high-speed acoustic communication.

Before communication experiment, directivity pattern of the transducer of acoustic navigation system (ANS) was measured for general use (2013/March/08). That transducer has been replaced in last

February. In this experiment, sound pressure level (SPL) has been measured by changing the depth of hydrophone, which was suspended by coaxial cable from R/V KAIYO. Figure 3 shows the results of measurement. 0 degree is for the direction of the right under the KAIYO. Inward of ± 45 degrees, the SPL is almost 190 dB re μPa at 1m at full power of ANS transmission power.

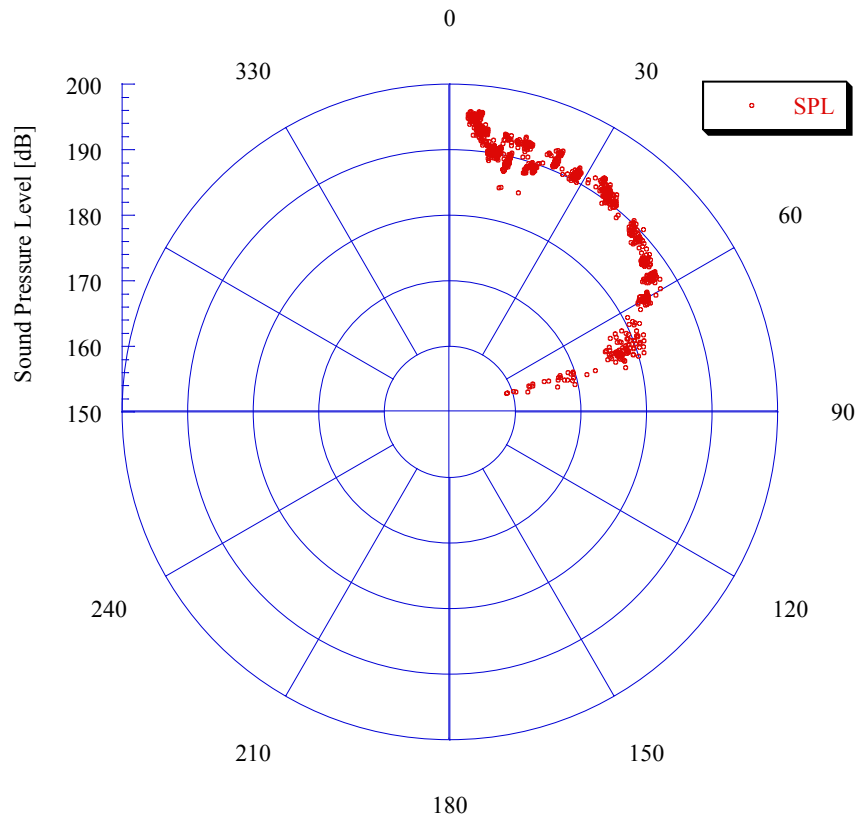


Fig.3 Beam pattern of the transducer of ANS.

Acoustic communication test has been executed for vertical direction at 2013/March/09. A transmitter was suspended by wire rope from R/V KAIYO, and a receiver is connected to the hydrophone array of ship's ANS system. Data transmission has been repeatedly between them and has been recorded by AD converter at the receiver. Example of received signal is shown in Figure 4, and signal configuration is shown in Table I. Weaving the received signal level is observed in 10 seconds. Demodulation is under processing now.

Table.I Signal configuration of Figure 4.

Carrier frequency	80 kHz
Band width	40 kHz
Bit rate	120 kbps (40 ksps)
Data length	22,560 symbols (0.564 s)
Sampling rate	800 kHz
Modulation method	8-PSK

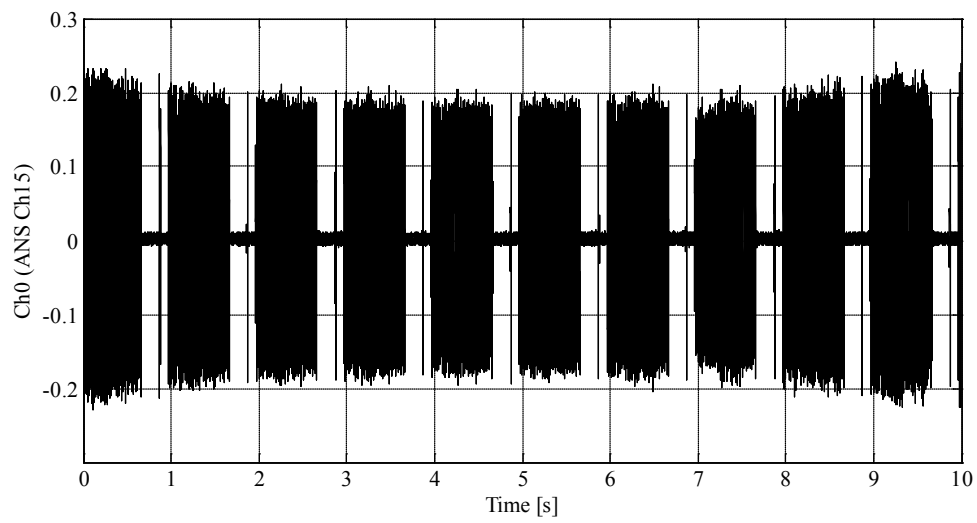


Fig.4 Example of received signal. (8PSK, 40ksps)

4.3. Research Information

● Deployment and recovery information

Moored number	Moored date	Moored point		Depth	Recovery date
		Latitude	Longitude		
#01	2013/03/01	31-59.6476N	137-49.7572E	4,010m	2013/03/07
#02	2013/03/03	24-39.1041N	137-43.7484E	4,820m	2012/03/04

● XBT

Cast number	Cast date [JST]	Cast time [JST]	Cast point	
			Latitude	Longitude
225	2013/02/28	22:30	32-05.9742N	137-51.5457E
226	2013/03/03	04:10	24-43.0907N	138-42.2317E
227	2013/03/05	10:21	27-48.3882N	138-20.9458E
228	2013/03/06	05:37	30-00.3258N	138-05.3654E
229	2013/03/08	08:08	35-02.5480N	138-39.7433E

Cast number 229: Suruga Bay

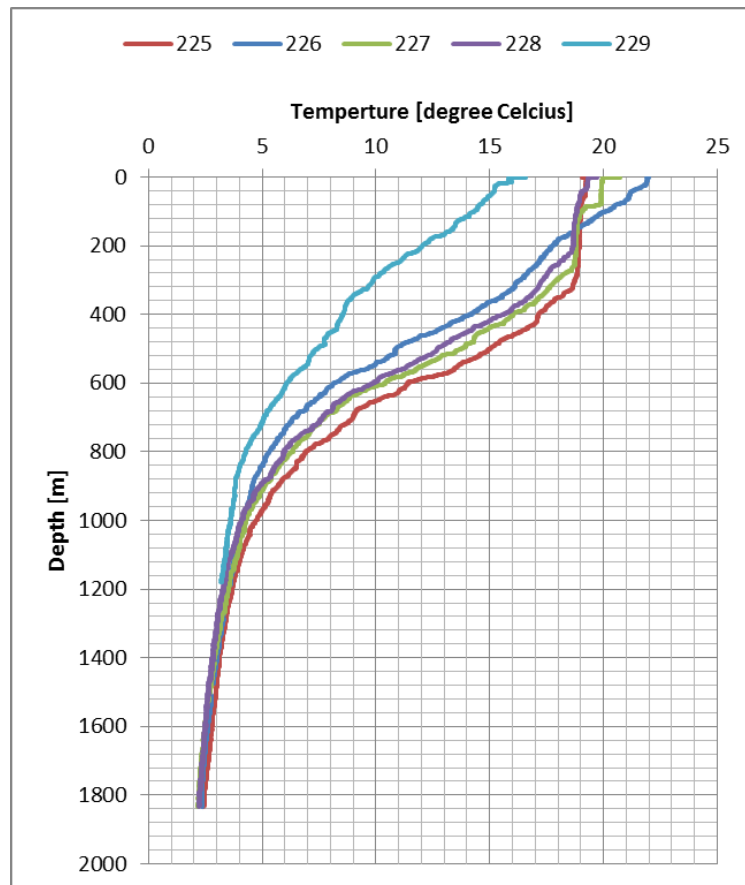


Fig.5 XBT profile.

5. Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.