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Synopsis of Survey Data Collected During the Joint Canada-France Remote Minehunting System Demonstration and Trial, Brest, France, June 2003

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Defence R&D Canada – Atlantic

Technical Memorandum
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Canada

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Abstract

In May–June 2003, DCNinternational contracted DRDC to run the Remote Minehunting System (RMS) for the purpose of demonstration of the system to potential customers in Brest Harbour, France. DRDC took this opportunity to also carry out a week–long collaborative scientific trial with French researchers from le Groupe dÉtudes Sous–Marines de lAtlantique (GESMA), fulfilling a requirement of the Joint CA/FR Specific Agreement #21 on Minehunting.

Through the course of the scientific trial and demonstration, several areas in and around Brest Harbour were surveyed using sidescan and bathymetric sonars, some areas with both. This report includes an overview of operations, but is mainly a synopsis of the various survey and supporting sensor data that was collected.

Résumé

En mai-juin 2003, DCNinternational a fait appel à RDDC pour faire la démonstration du Système télécommandé de chasse aux mines devant des clients potentiels dans le port de Brest (France). RDDC a profité de l’occasion pour procéder également à un essai scientifique d’une semaine avec des chercheurs franais du Groupe d’études sous–marines de l’Atlantique (GESMA), répondant ainsi à une des exigences de l’Accord spécifique Canada–France no 21 sur la chasse aux mines.

Dans le cadre de cet essai scientifique et de cette démonstration, plusieurs secteurs du port de Brest et des environs ont été sondés avec des sonars latéraux ou des sonars bathymétriques, et parfois avec les deux. Le rapport contient un aperu des opérations, mais c’est surtout un synopsis des divers relevés qui ont été effectués et des données qui ont été recueillies.

Executive summary

Introduction

This report documents the various data that were collected during the joint CA/FR Minehunting trial and demonstration held in Brest, France, in May–June 2003. DCNinternational contracted DRDC to run the Remote Minehunting System (RMS) for the purpose of demonstration of the system to potential customers. DRDC took this opportunity to also carry out a week–long collaborative scientific trial with French researchers from le Groupe d'Études Sous–Marines de l'Atlantique (GESMA), fulfilling a requirement of the Joint CA/FR Specific Agreement #21 on Minehunting.

Sidescan and bathymetric surveys were conducted over areas in and around Brest Harbour, including a shipwreck, and deployed mine–shaped targets. Supporting data such as sound velocity profiles were also collected.

Significance

The collaboration between Canada and France was proved valuable during this trial and in the follow–on scientific work based on the data that was collected, and will continue to be fruitful with plans for more joint work together with NURC in the fall of 2005.

The data collected during the trial will support various research activities, such as Computer Aided Detection and Classification (CAD/CAC) of mine targets, integration of bathymetric data into Route Survey operation and development of operating procedures for the Remote Minehunting System.

Crawford, Anna M., John Fawcett, David Hopkin, Terry Miller, Richard Pederson, Mark Rowsome, and Mark Trevorrow. 2004. Synopsis of Survey Data Collected During the Joint Canada-France Remote Minehunting System Demonstration and Trial, Brest, France, June 2003. TM2004–258. DRDC Atlantic.

Sommaire

Introduction

Le rapport présente les données qui ont été recueillies pendant la démonstration et l'essai du Système télécommandé de chasse aux mines dans le cadre de l'Accord Canada–France, à Brest (France), en mai–juin 2003. DCNinternational a fait appel à RDDC pour faire la démonstration du Système télécommandé de chasse aux mines devant des clients potentiels. RDDC a profité de l'occasion pour procéder également à un essai scientifique d'une semaine avec des chercheurs franais du Groupe d'études sous–marines de l'Atlantique (GESMA), répondant ainsi à une des exigences de l'Accord spécifique Canada–France no 21 sur la chasse aux mines.

Des relevés ont été effectués, avec des sonars latéraux et des sonars bathymétriques, dans plusieurs secteurs du port de Brest et des environs, y compris au–dessus d'une épave, et des cibles en forme de mines ont été déployées. Des données complémentaires – par exemple des profils célérimétriques – ont été recueillies.

Signification

La collaboration entre le Canada et la France s'est avérée fructueuse pendant cet essai et lors des travaux scientifiques fondés sur les données recueillies, et elle se poursuivra : d'autres travaux sont prévus avec le Centre de recherche sous–marine de l'OTAN (NURC) à l'automne 2005.

Les données collectées pendant l'essai serviront à appuyer diverses activités de recherche telles que la détection et la classification assistées par ordinateur (DAA / CAA) de cibles pour les mines, l'intégration de données bathymétriques dans l'opération de levés de fonds marins et l'élaboration de modes demploi pour le Système de déminage télécommandé.

Crawford, Anna M., John Fawcett, David Hopkin, Terry Miller, Richard Pederson, Mark Rowsome, and Mark Trevorrow. 2004. Synopsis des données recueillies pendant la démonstration et l'essai du Système télécommandé de chasse aux mines dans le cadre de l'Accord Canada–France, à Brest (France), en juin 2003. TM2004–258. RDDC Atlantique.

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Acknowledgements

Team members from DRDC Atlantic involved in the trial were (alphabetically): Anna Crawford, John Fawcett, David Hopkin, Terry Miller, Richard Pederson, Mark Rowsome and Mark Trevorrow. In France, from GESMA, Benoit Zerr was instrumental in its success. The scientific portion of this trial supported the Canada/France Specific Agreement #21 on Minehunting. The demonstration portion of the trail was sponsored by DCN France and special acknowledgement is extended to Phillipe Waquet.

1 Introduction

In the spring of 2003, DCNinternational contracted DRDC to run the Remote Minehunting System (RMS) for the purpose of demonstration of the system to potential customers in Brest Harbour, France. The Dorado vehicle, Aurora Variable Depth Towfish and some other system components were shipped to France by DCNi, who supplied their own containerized command–and–control centre. The RMS was renamed Seakeeper for the demonstration. DRDC took this opportunity to also carry out a week–long collaborative scientific trial with French researchers from le Groupe dÉtudes Sous–Marines de lAtlantique (GESMA), fulfilling a requirement of the Joint Canada–France Specific Agreement #21 on Minehunting. The RMS carries a Klein 5500 sidescan sonar and a Reson 8125 bathymetric sonar, and the French researchers have an interferometric Klein 5500 sidescan/bathymetric sonar. Due to system incompatibilities, the French Klein sonar was not run from the RMS, but independently from another vessel.

Through the course of the scientific trial and demonstration, several areas in and around Brest Harbour were surveyed using sidescan and bathymetric sonars, some areas with both. This report is a synopsis of the survey data collected and brief summary of operations during the trial and demonstration.

2 Calendar and Map

Operations were carried out in late May–early June, as listed in Table 1. Harbour restrictions due to submarine traffic, holidays and labor disruptions resulted in many lost days. The work–up for the trial was during the last week of May, the scientific trial was the week of June 2–6, and the demonstration started on the 11th and finished on the 19th of June.

The surveys were performed mainly over four areas: a shipwreck just inside the mouth of the harbour, the area where mine–shaped targets were deployed, the transit through the harbour entrance (Le Goulet), and along a line joining the end of the harbour transit route and the area where the targets were deployed (referred to as “bathy” in Table 1). Figure 1 shows a chart of Brest Harbour with the locations of the survey areas and the jetty where operations were staged in the inner harbour indicated. Most of the bathymetric and sidescan sonar surveys were focussed on the area where mine–shaped targets were deployed. The surveys of Le Goulet referred to in the Table were conducted with the bathymetric sonar. Sidescan sonar surveys over that area were performed on June 11 and 16 during the demonstration, but are not listed and will not be discussed in this document as this data was retained by the French due to its sensitive nature.

Table 1: *Survey schedule for May–June 2003, Brest Harbour, France. “B” and “SS” denote bathymetric and sidescan surveys in the areas indicated (see the chart, Figure 1), and “Fr” denotes surveys by the French with their bathymetric sidescan sonar.*

May 2003						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
25 -	26 -	27 -	28 B wreck	29 -	30 -	31 -
June 2003						
1 -	2 B Le Goulet	3 -	4 B, SS Le Goulet targets	5 B, SS Le Goulet targets	6 B, SS Le Goulet targets	7 -
8 -	9 -	10 -	11 B Le Goulet (demo→)	12 SS wreck	13 SS targets	14 -
15 -	16 B targets	17 -	18 Fr targets	19 Fr bathy	20 -	21 -

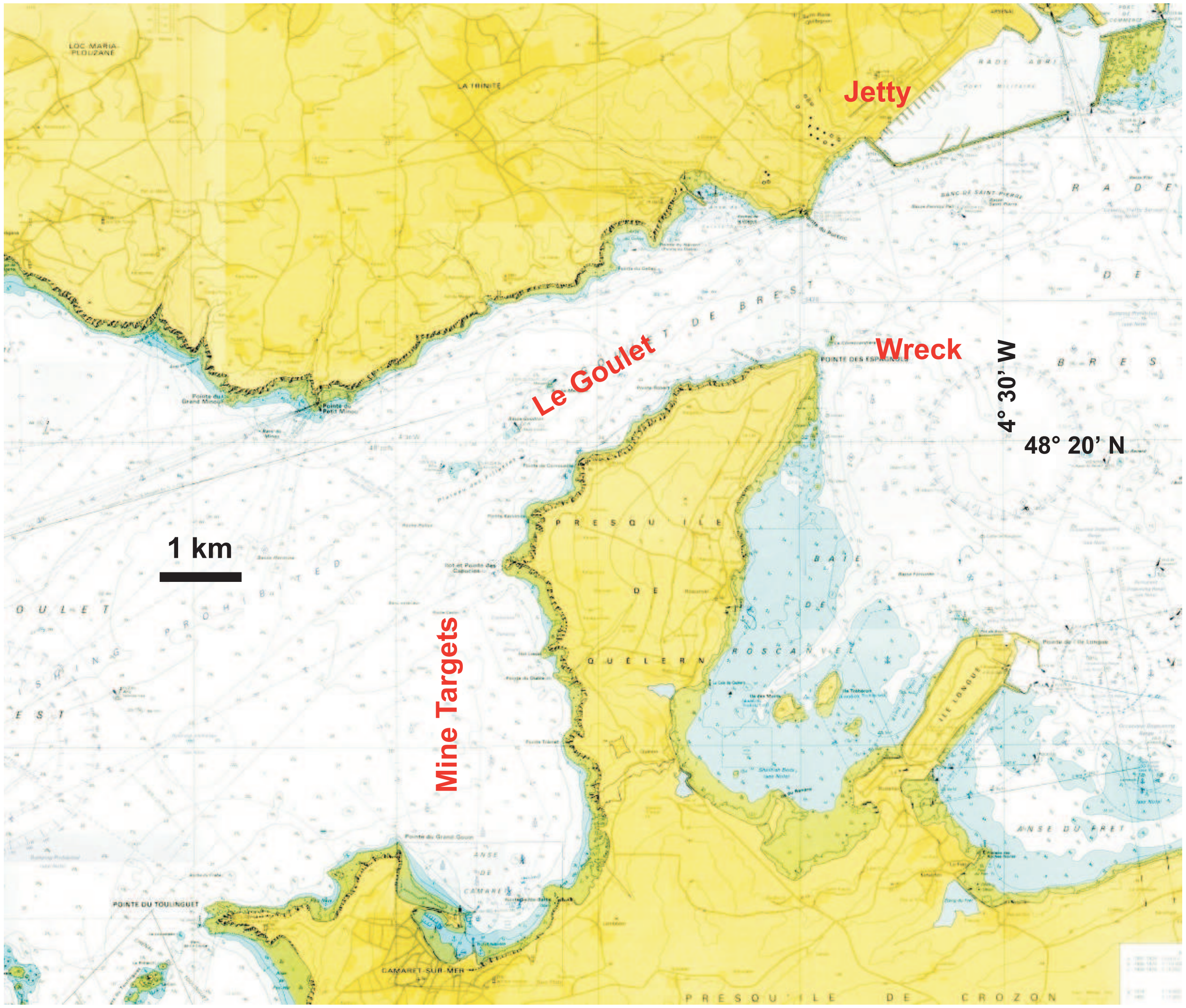

__Figure 1:__ Chart of Brest Harbour showing the locations of the surveyed areas and the jetty.

3 Research Vessel

The Dorado was deployed from the deck of the 47.5 m long buoy tender Armorique, shown in Figure 2. This vessel was an ideal platform for these operations due to its maneuverability, spacious back deck with no side rails and crane capable of lifting the vehicle. Visibility from the bridge in all directions was excellent and the RMS data radio communication antennas were unobstructed on the deck above the bridge.

Figure 2: *Vessel Armorique with Dorado (Seakeeper) onboard. The gray command–and–control container is located behind the vehicle below the arm of the crane. (Photo c/o DCN.)*

4 Deployed Targets

Mine–shaped targets supplied by GESMA were deployed for the trial in an area outside the harbour and away from traffic lanes (see Figure 1). A sphere (about 1 m in diameter), Rockan, Manta, and cylinder (2.3 m in length, 0.5 m in diameter) were deployed along a North–South line separated by roughly 200 m, ending with a float on an acoustic release for recovery. Photos of the four targets are shown in Figure 3. The sphere was deployed on the seabed, not in mid–water. Also surveyed with the RMS sidescan sonar was a resolution target, referred to as the “wedding cake”, located to the North–West of the mine targets. Table 2 lists the positions of the four targets and the wedding cake determined using a GPS Intelligent Buoy (GIBS) acoustic positioning system and diver–deployed transponders, along with positions determined from post–processed sidescan survey mosaics. A target positioning accuracy analysis study based on the sidescan and bathymetric survey data collected has been completed [1].

Figure 3: *Deployed mine–shaped targets: clockwise from upper left are the Manta, Rockan, sphere and cylinder. (Manta and Rockan photos c/o GESMA.)*

Table 2: *Target positions from GIBS survey and from post–processed sidescan survey data. Positions in degrees and minutes, or meters (UTM co–ordinates).*

	GIBS				Sidescan	
Target	East	North	Latitude	Longitude	East	North
Cylinder	381799	5351034	-4° 35.6333’	48° 18.0868’	381802	5351032
Manta	381804	5351196	-4° 35.6321’	48° 18.1743’	381808	5351193
Rockan	381805	5351367	-4° 35.6346’	48° 18.2672’	381809	5351366
Sphere	381801	5351534	-4° 35.6343’	48° 18.3569’	381802	5351541
Wedding Cake	381447	5351705	-4° 35.930’	48° 18.443’	381447	5351705

5 Bathymetric Sonar Surveys

The vehicle tracks for all bathymetric sonar surveys conducted during the trial and demonstration are shown in Figure 4. Vessel tracks on individual days are shown in Figure 5, including the surveys by the French with the interferometric Klein on the 18th and 19th of June. Vessel survey tracks for both the French and RMS bathymetric sonars over the “bathy” line are shown in Figure 6. The locations of the four mine–shaped targets and the resolution target are indicated in the Figures.

The bathymetric surveys conducted by the RMS are listed in Table 3. The survey of the wreck on May 28 was both a test of the bathymetric sonar installation during the work–up and to aid in planning a subsequent sidescan sonar survey of that area (June 12). On this day only, the navigation data has a 0.6 s latency. The route through Le Goulet was surveyed while transiting in and out on several days, June 2, 4, 5, and over a more northerly route on June 6 and 11 to extend the coverage (shown in Figure 4). Due to the sensitivity of this area, the French requested that the sonar ping rate be kept low at a maximum of 1 Hz during the transits. The transit was broken into 6 lines at way points along the route. Bathymetry data collected on June 2 is not viable because the vehicle navigation data was not synchronized properly. Several surveys were conducted over the area of the mine–shaped targets with both RMS and GESMA bathymetric sonars. Not all lines in these surveys covered the targets and on June 4, coverage was incomplete due to gaps caused by radio communication problems with the vehicle. The “bathy” route joined the west end of the transit route and the target deployment area, crossing a steep escarpment. Parallel tracks were followed by the French and by the RMS, but these do not quite overlap in coverage except at the west end, as shown in Figure 6.

The approximate along track spacing of the swaths in the bathymetric surveys is listed in Table 3. This is determined by the survey speed and ping rate, which is limited by the water depth or the user in the case of the surveys of Le Goulet. The water depth in the area where the targets were deployed was 21–22 m and surrounding the shipwreck, 20–23 m. The across track separation between soundings in a swath depends on the water depth and distance from nadir — less than 0.2 m at nadir in 20 m water depth to 1.75 m at the outer beams in 50 m water depth. Smaller along and across track sounding separation makes for higher resolution processed bathymetry data products, and greater likelihood of sampling a seabed target with a sufficient number of individual soundings to resolve it. The Rockan target, for example, was only resolved once in 5 passes over its location during the pass when survey speed was purposefully reduced.

Bathymetry data were recorded using the Reson–supplied software 6042, and then exported to xtf format. Subsequent processing was done using CARIS HIPS software to clean and condition the data and produce gridded bathymetry data products.

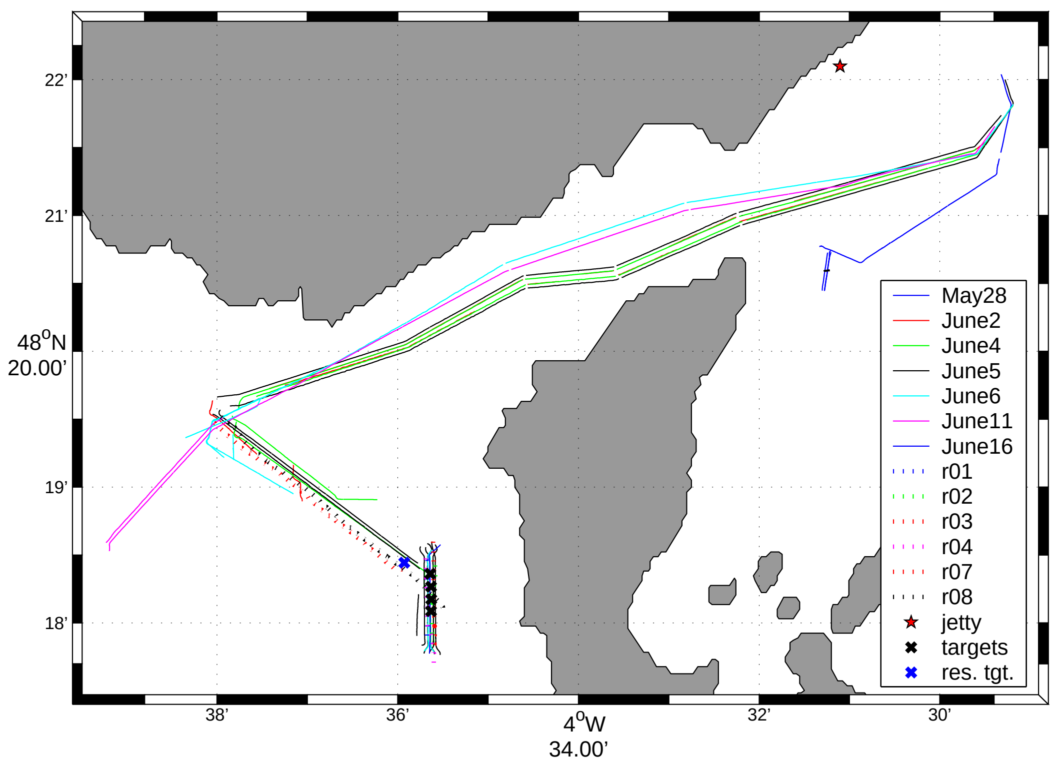

Figure 4: *Vehicle tracks for all bathymetric surveys. Target locations are marked by the x's (the mine–shaped targets in black and the resolution target in blue) and the jetty is marked with a red star. The breakwater enclosing the inner harbour is not shown. The dotted lines indicate the surveys performed with the French bathymetric Klein sonar.*

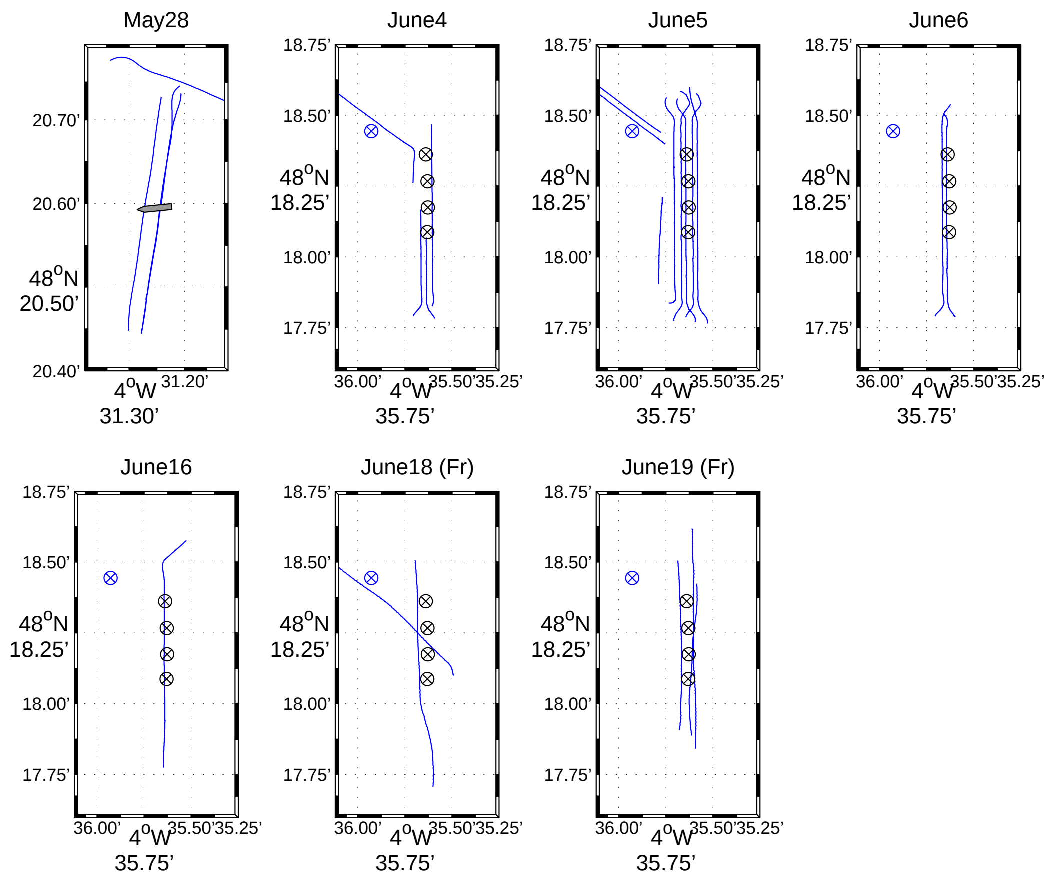

Figure 5: *Vehicle tracks for 7 days of bathymetric surveys over the wreck and targets. Target locations are marked by the circled x's and the outline of the shipwreck is shown for the May 28 survey. The surveys on June 18 and 19 were conducted by the French with their bathymetric Klein sonar.*

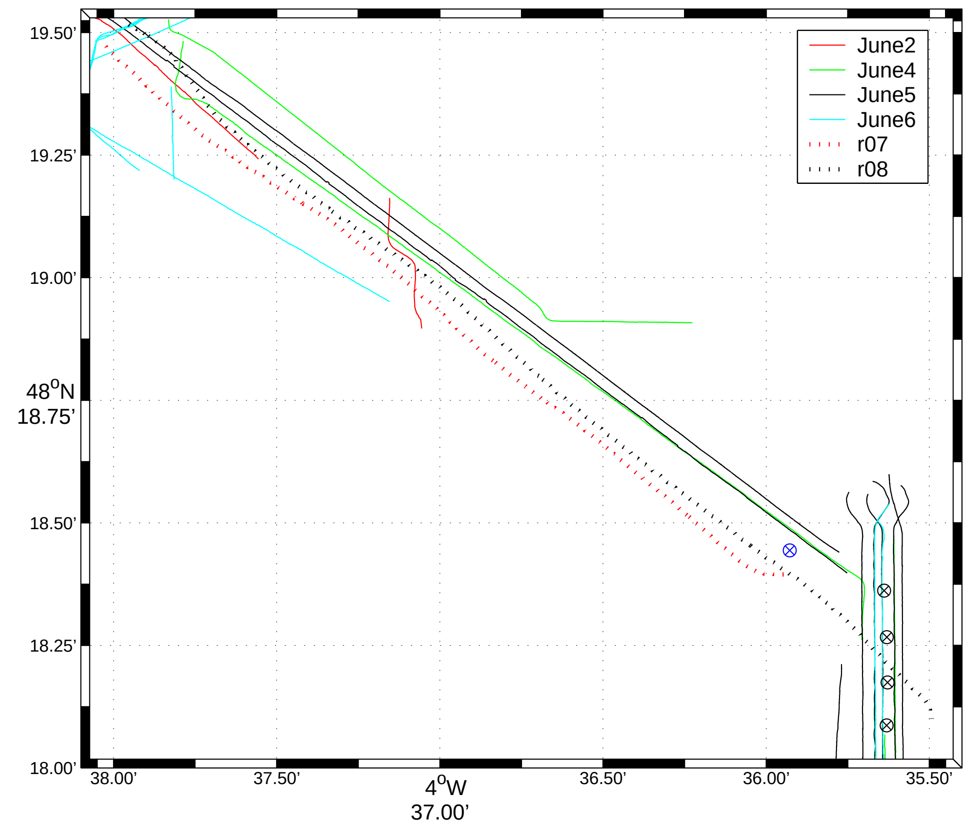

Figure 6: *Vehicle tracks for the RMS and French bathymetric surveys over the "bathy" line. Dotted lines show the routes followed by the French.*

Table 3: *Summary of RMS bathymetric surveys. "lines" is the number of survey lines at a location on that day. "ping sep." is the approximate along track separation between consecutive pings.*

date	location	lines	ping sep.	comments
May 28	wreck	3	0.6–0.8 m	system test, 0.6 s nav. latency
	transit	2	0.8–1 m	return to jetty
June 2	LeGoulet	6	bathymetry data collected this day not usable	
	bathy	2	because navigation data was not synchronized	
June 4	LeGoulet	6	5 m	ping rate always set < 1 Hz in this area
	bathy	2	1–2 m	many gaps in 2nd line, radio problems
	mines	3	1 m	poor coverage with gaps, missed targets
June 5	LeGoulet	6	5 m	
	bathy	2	1–2, 0.7–1 m	2nd line at slower speed
	mines	5	1–1.5 m	targets in 2 lines, except Rockan
June 6	mines	2	1 m	1^{st} line: 3 tgts, no Rockan. 2^{nd}: only sphere
	LeGoulet	8	5 m	route to the north of previous routes
June 11	LeGoulet	5	4.5–5 m	also on more northerly route
June 16	mines	1	0.8 m	best quality data over targets, all visible

5.1 Samples of Processed Bathymetry Data

Following are three samples of post–processed bathymetric survey data. The first, Figure 7, shows the survey of the shipwreck that was used to plan a subsequent sidescan sonar survey. The planned sidescan survey route is shown in black, oriented to pass side–on to the wreck at optimum range, with sonar altitude higher than normal (20 m) to better image the upper deck surface.

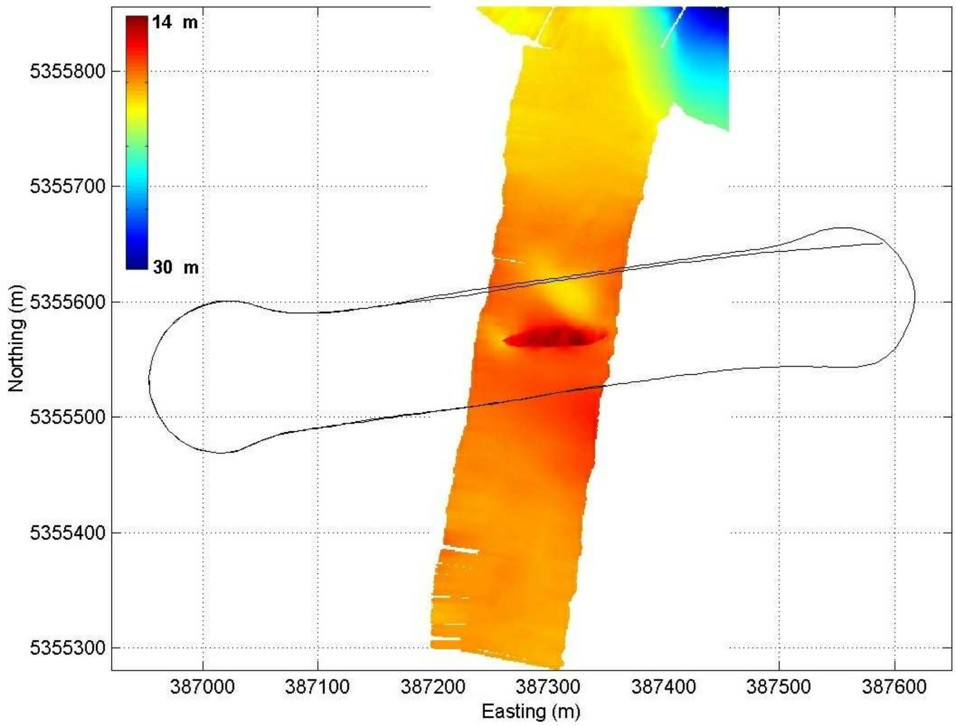

Figure 7: *Colour–coded bathymetric survey data used in planning subsequent sidescan sonar survey of shipwreck. Water depth ranges from 30 m (blue) to 14 m (red) over the wreck. The planned sidescan survey route followed later is shown in black.*

The second example, Figure 8, is bathymetric survey data of Le Goulet, showing a sharply incised channel, in places dropping to 50 m depth from 20 m in the surrounding area. This data was also collected for route planning purposes, as the sides of the channel are too steep to be followed by the Aurora in terrain–following mode.

The final example shows the cylinder target resting on a field of ripple bedforms. The cylinder is above and to the right of the center of the image, with its long axis (2.3 m in length) lying along a heading of about 10 degrees. The surface has been illuminated from the left to emphasis the relief of the target and ripples.

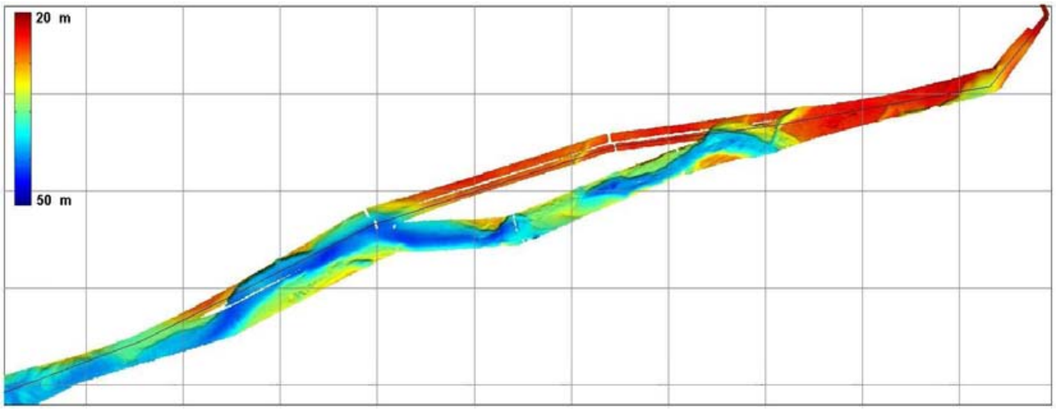

Figure 8: *Colour–coded and illuminated bathymetric survey data from Le Goulet. Each grid square is 1 km by 1 km.*

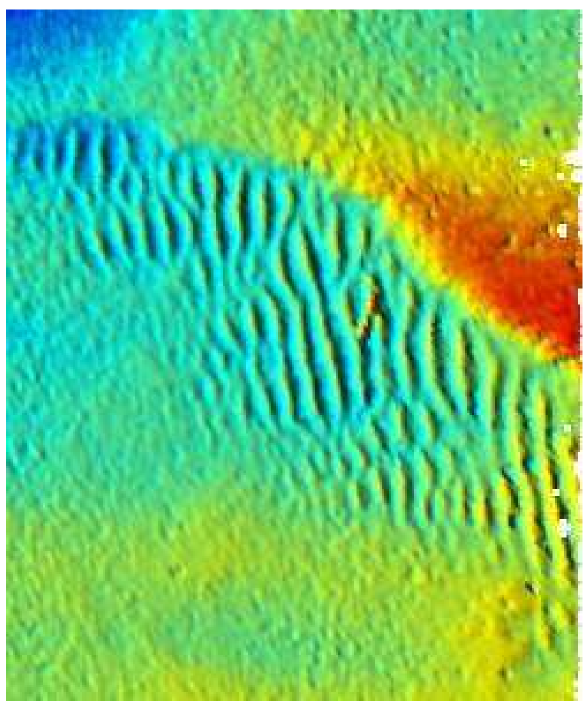

Figure 9: *Bathymetric data of the cylinder target. Relative elevation varies over 1 m from lowest in blue to highest in red.*

6 Sidescan Sonar Surveys

The sidescan sonar surveys conducted during the trial and demonstration are listed in Table 4 and the vehicle tracks for all days are shown in Figure 10, excluding the transits through Le Goulet, as mentioned earlier (Section 2). The survey tracks over the targets and shipwreck on each day are shown in Figure 11. The sonar settings are listed as “HiRes” or “LoRes” in Table 4. This refers to the nominal along track resolution of 10 cm for HiRes and 20 cm for LoRes, which is maintained by the sonar processor by varying the ping rate according to the towing speed.

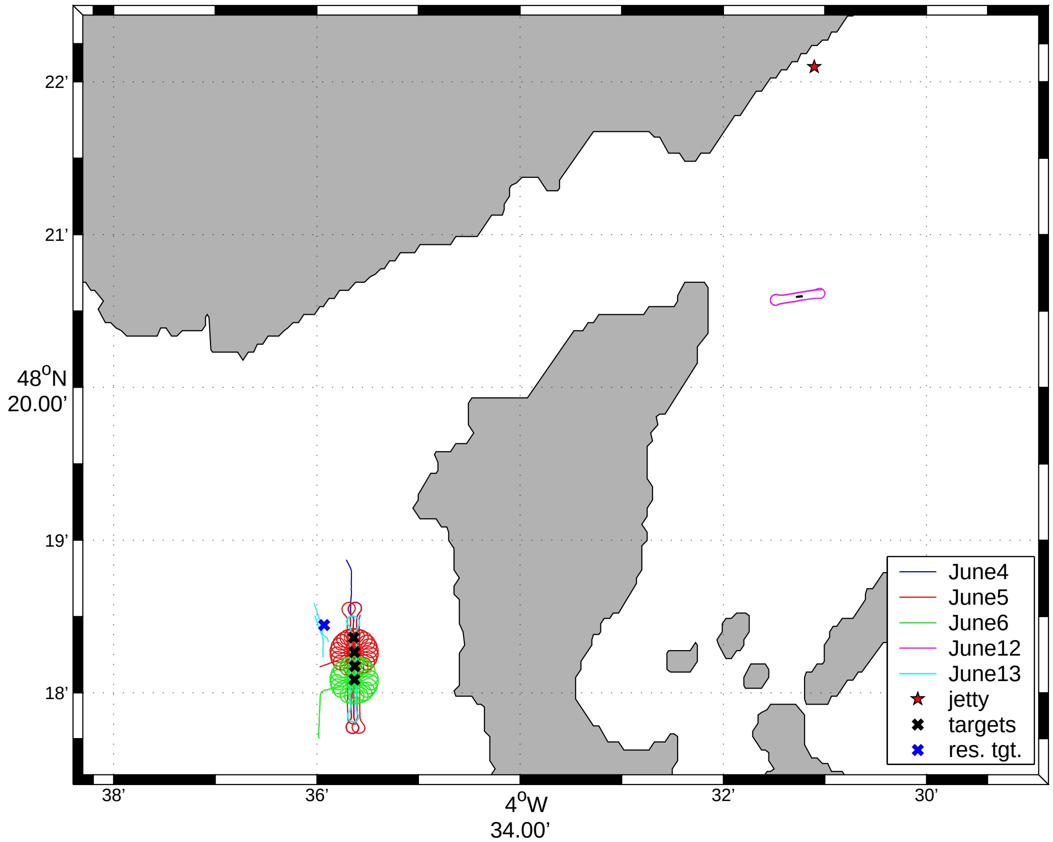

***Figure 10:** Vehicle tracks for all sidescan surveys, with the locations of the targets (x’s), and the jetty (red star) indicated.*

The mine–shaped targets were the focus of the sidescan sonar survey coverage. In particular, multi–aspect surveys were centered on the Rockan (June 5) and cylinder (June 6) targets. The multi–aspect survey route was designed to pass the target at a range of 35 m to the starboard side at headings distributed over 360° in 15° increments. This was accomplished by following a looping route with short straight segments by the target joined by turns with a small radius, as shown in more detail in Figure 12. The outer diameter of the pattern is about 600 m. Each of these surveys was completed in just over an hour. A more conventional survey pattern with straight legs oriented North–South and separated by 75 m

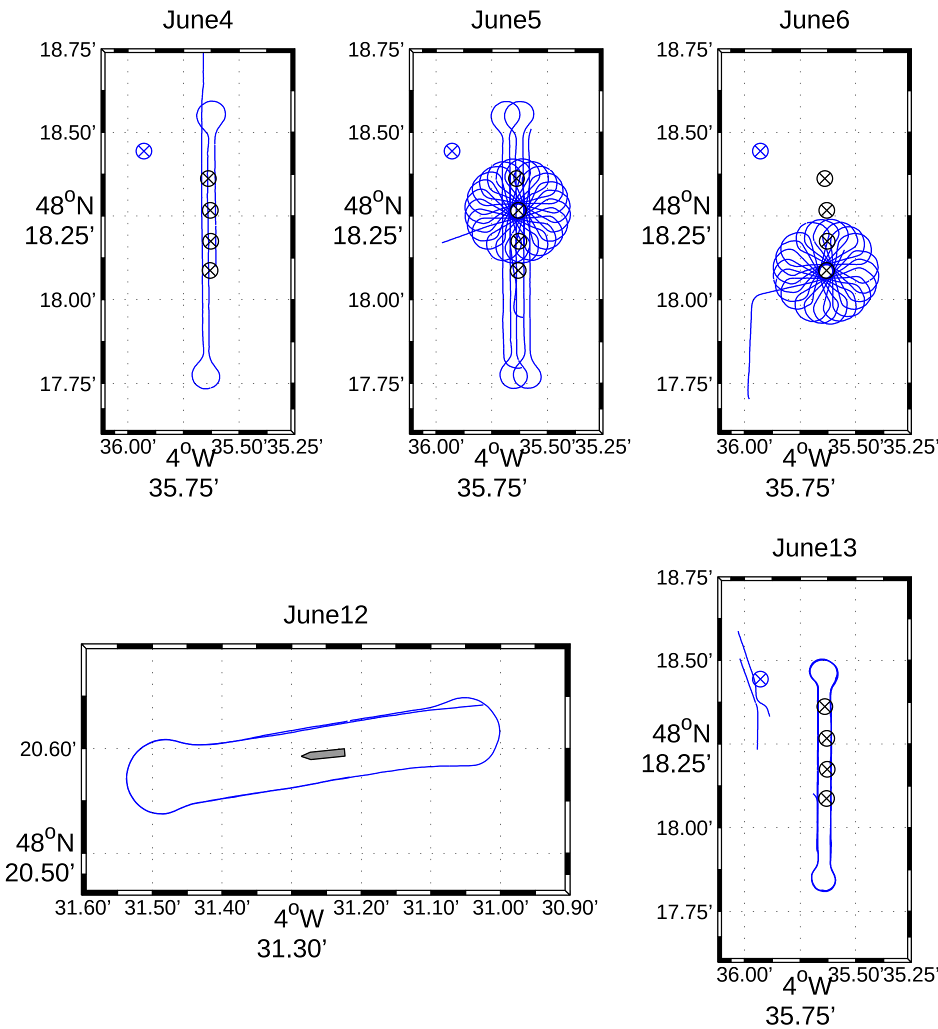

Figure 11: *Vehicle tracks for the 5 days of sidescan surveys. Target locations are marked by the circled x's and the outline of the shipwreck is shown for the June 12 survey.*

Table 4: *Summary of sidescan surveys. The sonar settings listed refer to the sonar resolution (HiRes or LoRes) and the range setting.*

day	location	sonar settings	comments
June 4	targets	LoRes, 75 m	preliminary survey
June 5	targets	HiRes, 75 m	multi–aspect survey of Rockan
		HiRes, 75 m	conventional pattern over all targets
June 6	targets	LoRes, 75 m	multi–aspect survey of cylinder
June 12	wreck	HiRes, 75 m	planned using bathy survey results
June 13	targets	HiRes, 75 m	conventional pattern over all targets
	res. tgt.	HiRes, 75 m	passed while transiting to and from targets

was also completed once with a low sonar resolution setting (June 4) and twice more at high resolution (June 5 and 13).

The RMS records sidescan sonar data in Klein sdf format, compiled from the navigation and other supporting attitude data, together with the ping data from the sonar. This data has been post–processed using DRDC Atlantic in–house Sonar Image Processing Software (SIPS).

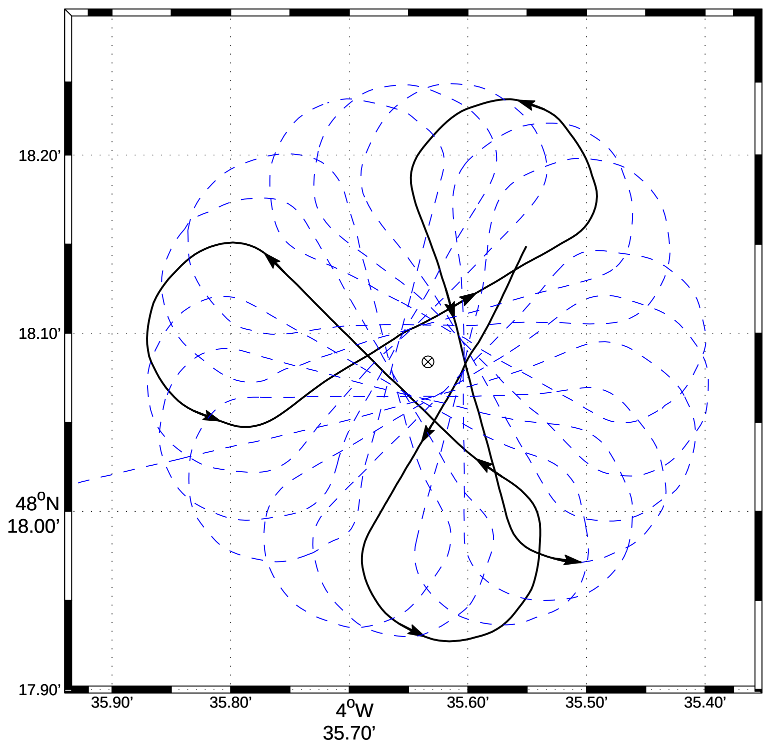

Figure 12: *Multi–aspect survey route centered on a target (the cylinder), with four passes shown in black to illustrate the pattern.*

6.1 Samples of Processed Sidescan Sonar Survey Data

Following are several samples of processed (georeferenced) sidescan sonar data. Figure 13 shows the cylinder from two directions of the multi–aspect survey (compare with the bathymetry data shown in Figure 9) and the resolution target, and Figure 14 shows the wreck.

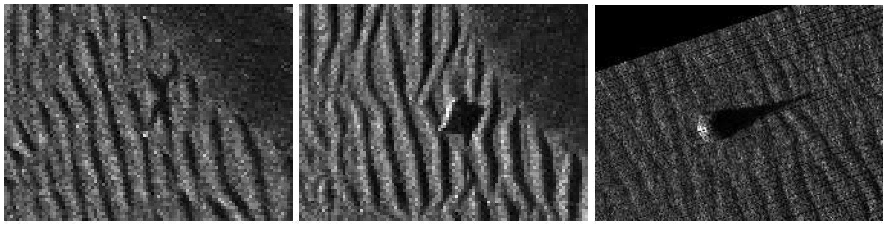

Figure 13: *From left to right: end–on and side–on views of the cylinder target from the multi–aspect survey at low sonar resolution, and the resolution target at high resolution.*

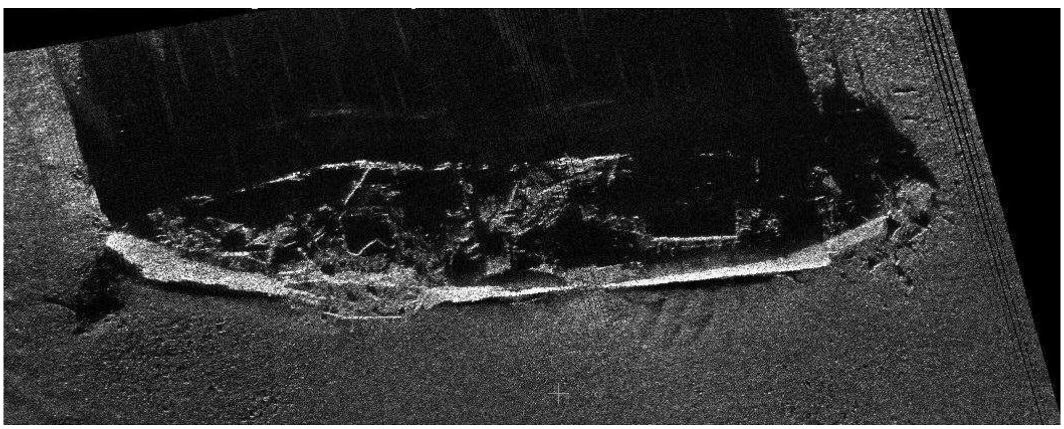

Figure 14: *Sidescan survey data of the wreck*

7 Supporting Sensor Data

7.1 Sound Velocity Profiles and Tides

Knowledge of the local sound propagation characteristics can be very important for post–processing of bathymetric data, particularly in an estuarine environment such as Brest Harbour where there can be significant fresh water input from rivers. Sound velocity profiles were collected at several locations, shown in Figure 15, and show typical variation in the sound speed profile between the inner and outer harbour (Figure 16). The profile at the location of the wreck (May 28) shows the influence of fresh water in having the lowest sound speed. The surface layer here extends to below the depth of the bathymetric sonar (usually about 3 m), so refraction may affect the bathymetric measurements in this location. The profiles nearest to the location of the targets (June 4 and 6) do not show a significant surface layer.

Tidal elevation predictions for Brest Harbour were downloaded prior to the trial from an Institut français de recherche pour l'exploitation de la mer (IFREMER) website. The time series of tidal elevation through the trial and demonstration is shown in Figure 17. In practice, tidal correction was not uniformly applied to the bathymetric data since there is no requirement for absolute water depths. Data from particular survey lines were tidally corrected only if being processed with other overlapping lines collected at different times in the tidal cycle. The tides in Brest Harbour are considerable with up to 4 m difference between low and high tide.

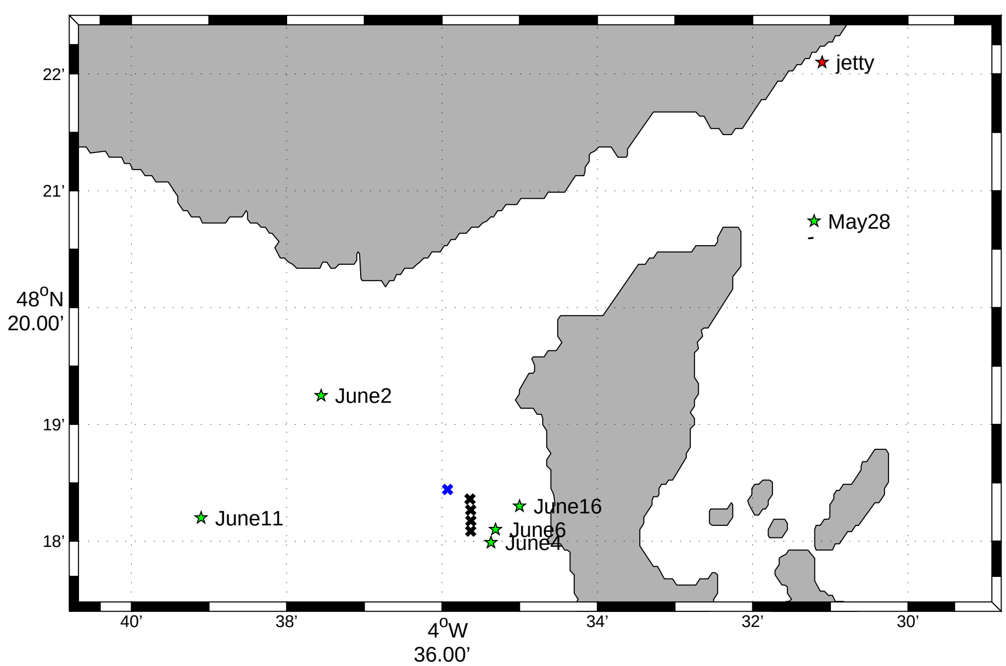

Figure 15: *Locations of sound velocity profile measurements.*

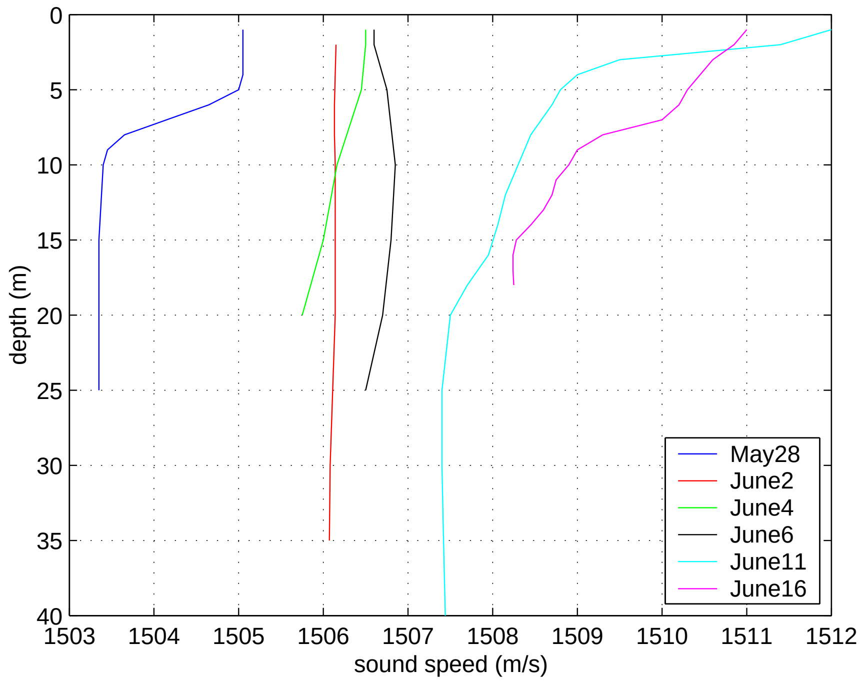

Figure 16: *Sound velocity profile measurements during the trial and demonstration.*

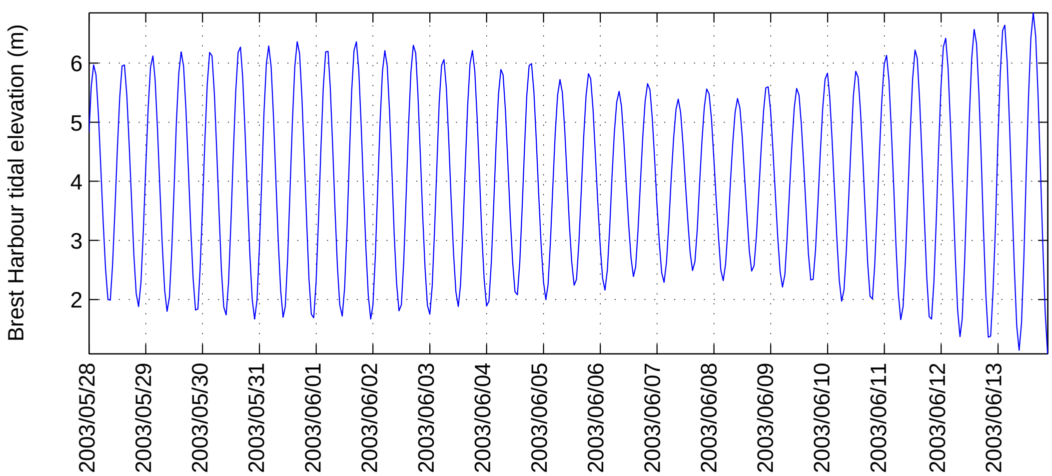

Figure 17: *Tidal elevation for Brest Harbour, May–June 2003.*

7.2 Vehicle Logs

Data from many of the sensors in the Dorado vehicle and Aurora towfish are stored in a series of time–stamped vehicle logs. Data logged at ∼5 Hz are stored in "fast" logs onboard the Dorado and "towfish_fast" logs onboard the Aurora. Slower data streams on the vehicle are logged in "slow" logs at ∼1 Hz and "v_slow" logs at ∼0.1 Hz. Figure 18 lists the variable fields stored in the four types of log files, all in ASCII comma–separated–

variable format. The field names are for the most part self explanatory. Variables with names starting with “vcc” originate from the Vehicle Control Computer, while “tcc” denotes the Towfish Control Computer. “fb” denotes feedback, and “sp” set–point. Several fields labelled “vcc_tfpe...” refer to “towfish position estimation” which are output from a cable layback model calculation for towfish position. These were not recorded on all days.

Information stored in these logs can be critical for post–processing sidescan or bathymetric sonar data and for system trouble–shooting and diagnosis. Sidescan sonar data is sometimes recorded without accompanying navigation or attitude data which is later inserted from the logs.

Fast log variable fields:

Seconds_since_Jan_1_1970
Time_in_English
tcc_dvl_altitude_fb_m
tcc_dvl_bottom_vel_valid
tcc_dvl_bottom_vel_z_fb_mps
tcc_dvl_heading_fb_deg
tcc_dvl_pitch_fb_deg
tcc_dvl_roll_fb_deg
tcc_dvl_temperature_fb_c
tcc_dvl_water_vel_x_fb_mps
tcc_inu_pos_latitude_fb
tcc_inu_pos_longitude_fb
tcc_man_altitude_sp_actual
tcc_man_depth_sp
tcc_man_heading_sp
tcc_man_pitch_sp
tcc_man_roll_sp
tcc_pos_depth_fb_m
tcc_pos_heading_fb_deg
tcc_pos_latitude_fb
tcc_pos_longitude_fb
tcc_pos_pitch_fb_deg
tcc_pos_pitch_rate_fb_dps
tcc_pos_roll_fb_deg
tcc_pos_roll_rate_fb_dps
tcc_pos_speed_fwd_fb_mps
tcc_pos_speed_lat_fb_mps
tcc_pos_yaw_rate_fb_dps
vcc_ballast_aft_level_fb_volts
vcc_ballast_fwd_level_fb_volts
vcc_cable_scope_fb_m
vcc_cable_scope_sp_echo
vcc_cable_tension_fb_lb
vcc_compass_fb_deg
vcc_dgps_course_true_fb
vcc_dgps_latitude_fb
vcc_dgps_longitude_fb
vcc_dgps_quality_fb
vcc_dgps_speed_fb_mps
vcc_engine_rpm_cmd
vcc_engine_rpm_fb
vcc_engine_rpm_fb_est
vcc_engine_rpm_fb_modelled
vcc_engine_rpm_fb_smith
vcc_engine_rpm_fb_smith_linear
vcc_engine_rpm_sp
vcc_keel_hyd_press_fb_psi
vcc_man_depth_sp
vcc_man_heading_sp
vcc_man_pitch_sp
vcc_man_roll_sp
vcc_octans_heading_fb_deg
vcc_octans_motion_status
vcc_octans_motion_x1
vcc_octans_motion_x1_speed
vcc_octans_motion_x2
vcc_octans_motion_x2_speed
vcc_octans_motion_x3
vcc_octans_motion_x3_speed
vcc_octans_pitch_fb
vcc_octans_pitch_rate_fb
vcc_octans_roll_fb
vcc_octans_roll_rate_fb
vcc_octans_speed_kn
vcc_octans_yaw_rate_fb
vcc_phins_depth_fb_m
vcc_phins_latitude
vcc_phins_longitude
vcc_plane_port_aft_fb_deg
vcc_plane_port_aft_sp_clip_deg
vcc_plane_port_fore_fb_deg
vcc_plane_port_fore_sp_clip_deg
vcc_plane_rudder_fb_deg
vcc_plane_rudder_sp_clip_deg
vcc_plane_stbd_aft_fb_deg
vcc_plane_stbd_aft_sp_clip_deg
vcc_plane_stbd_fore_fb_deg
vcc_plane_stbd_fore_sp_clip_deg
vcc_pos_altitude_fb_m
vcc_pos_depth_fb_m
vcc_pos_yaw_rate_calc
vcc_speed_fb_selected_mps
vcc_speed_mode_engine_rpm_sp
vcc_speed_sp_clipped
vcc_tfpe_scope_h
vcc_tfpe_scope_lat_deg
vcc_tfpe_scope_long_deg
vcc_winch_speed_sp_actual

Towfish−fast log variable fields:

Seconds_since_Jan_1_1970
Time_in_English
tcc_aft_plane_lift_bending_inlb
tcc_aft_plane_lift_bending_volt
tcc_aft_plane_shaft_torque_inlb
tcc_aft_plane_shaft_torque_volt
tcc_dvl_bottom_range_avg_fb_m
tcc_dvl_bottom_range_b1_fb_m
tcc_dvl_bottom_range_b2_fb_m
tcc_dvl_bottom_range_b3_fb_m
tcc_dvl_bottom_range_b4_fb_m
tcc_dvl_bottom_vel_valid
tcc_dvl_bottom_vel_x_fb_mps
tcc_dvl_bottom_vel_y_fb_mps
tcc_dvl_bottom_vel_z_fb_mps
tcc_dvl_coordinate
tcc_dvl_fb_sample_rate
tcc_dvl_heading_fb_deg
tcc_dvl_pitch_fb_deg
tcc_dvl_roll_fb_deg
tcc_dvl_temperature_fb_c
tcc_dvl_water_vel_valid
tcc_dvl_water_vel_x_fb_mps
tcc_dvl_water_vel_y_fb_mps
tcc_dvl_water_vel_z_fb_mps
tcc_inu_update_speed_fwd_mps
tcc_inu_update_speed_lat_mps
tcc_man_altitude_depth_sp
tcc_man_depth_sp
tcc_man_pitch_sp
tcc_man_roll_sp
tcc_phins_depth_fb_m
tcc_phins_heading_fb_deg
tcc_phins_heading_rate_fb_dps
tcc_phins_input_age
tcc_phins_input_depth
tcc_phins_input_latitude
tcc_phins_input_longitude
tcc_phins_input_pos_valid
tcc_phins_input_speed_valid
tcc_phins_input_speed_x
tcc_phins_input_speed_y
tcc_phins_latitude
tcc_phins_log_misalignment
tcc_phins_longitude
tcc_phins_output_status
tcc_phins_output_valid
tcc_phins_pitch_fb_deg
tcc_phins_pitch_rate_fb_dps
tcc_phins_roll_fb_deg
tcc_phins_roll_rate_fb_dps
tcc_phins_x1_speed_fb_mps
tcc_phins_x2_speed_fb_mps
tcc_phins_x3_speed_fb_mps
tcc_plane_1_fb_deg
tcc_plane_1_sp_deg
tcc_plane_1_volts_cmd
tcc_plane_3_fb_deg
tcc_plane_3_sp_deg
tcc_plane_3_volts_cmd
tcc_plane_4_fb_deg
tcc_plane_4_sp_deg
tcc_plane_4_volts_cmd
tcc_plane_5_fb_deg
tcc_plane_5_sp_deg
tcc_plane_5_volts_cmd
tcc_plane_6_fb_deg
tcc_plane_6_sp_deg
tcc_plane_6_volts_cmd
tcc_pos_depth_fb_m
tcc_pos_fb_sample_rate
tcc_pos_heading_fb_deg
tcc_pos_pitch_fb_deg
tcc_pos_pitch_rate_fb_dps
tcc_pos_roll_fb_deg
tcc_pos_roll_rate_fb_dps
tcc_pos_yaw_rate_fb_dps
tcc_watson_degraded
tcc_watson_heading_fb_deg
tcc_watson_heading_rate_fb_dps
tcc_watson_pitch_fb_deg
tcc_watson_pitch_rate_fb_dps
tcc_watson_roll_fb_deg
tcc_watson_roll_rate_fb_dps
tcc_watson_status

Slow log variable fields:

Seconds_since_Jan_1_1970
Time_in_English
tcc_battery_fb_volts
tcc_dvl_bit_result
tcc_dvl_coordinate
tcc_dvl_field_error
tcc_dvl_status
tcc_plane_1_sp_follow_fault
tcc_plane_3_sp_follow_fault
tcc_plane_4_sp_follow_fault
tcc_plane_5_sp_follow_fault
tcc_plane_6_sp_follow_fault
vcc_aft_jbox_flood_fault
vcc_ballast_aft_blow_fb
vcc_ballast_aft_flood_fb
vcc_ballast_aft_vent_fb
vcc_ballast_fwd_blow_fb
vcc_ballast_fwd_flood_fb
vcc_ballast_fwd_vent_fb
vcc_bilge_pump_current_fb_amps
vcc_charge_current_fb_amps
vcc_dgps_age_fb
vcc_dgps_num_sat_in_use_fb
vcc_elec_battery_fb_volts
vcc_elec_flood_1_fault
vcc_elec_flood_2_fault
vcc_elec_wet_fault
vcc_engine_battery_fb_volts
vcc_engine_box_cr_float_fb
vcc_engine_box_cr_pump_fb
vcc_engine_box_temp_fb_c
vcc_engine_exhaust_press_fb_psi
vcc_engine_oil_press_fb_psi
vcc_engine_room_flood_fault
vcc_engine_room_temp_fb_c
vcc_engine_temp_fb_c
vcc_fuel_fb
vcc_fuel_flow_fb_gph
vcc_fuel_inlet_temp_fb_c
vcc_fuel_total_gallons_fb
vcc_gearbox_temp_fb_c
vcc_ground_fault_1
vcc_ground_fault_2
vcc_guid_line_offline_distance
vcc_hyd_oil_temp_fb_c
vcc_hyd_press_fb_psi
vcc_pdu_ground_fault_fb_volts
vcc_phins_algsts_word_high
vcc_phins_algsts_word_low
vcc_phins_status_word_high
vcc_phins_status_word_low
vcc_pos_overdepth_fault
vcc_towfish_ground_fault
vcc_trans_fwd_fb
vcc_trans_oil_temp_fb_c
vcc_trans_rev_fb
vcc_vccbox_bottom_temp_fb_c
vcc_vccbox_bottom_temp_fb_volts
vcc_vccbox_top_temp_fb_c
vcc_vccbox_top_temp_fb_volts
vcc_water_in_fuel_fault

V−slow log variable fields:

Seconds_since_Jan_1_1970
Time_in_English
vcc_engine_rpm_ff_gain
vcc_engine_rpm_integral_gain_se
vcc_engine_rpm_prop_gain
vcc_engine_rpm_rate_gain
vcc_man_depth_ff_gain
vcc_man_depth_integral_gain
vcc_man_depth_prop_gain
vcc_man_depth_rate_gain
vcc_man_heading_prop_gain
vcc_man_heading_rate_gain
vcc_man_pitch_prop_gain
vcc_man_pitch_rate_gain
vcc_man_roll_prop_gain
vcc_man_roll_rate_gain
vcc_man_roll_yaw_rate_gain
vcc_pos_attitude_source
vcc_pos_heading_source
vcc_speed_integral_gain
vcc_speed_offset
vcc_speed_prop_ff_gain
vcc_speed_prop_gain
vcc_speed_rate_ff_gain
vcc_speed_rate_gain

Figure 18: *Variables stored in the vehicle logs.*

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1. Crawford, A. M. *et al.*, 2005, Target Positioning Accuracy Analysis Using Sidescan and Bathymetry Data Collected During the Joint Canada–France Minehunting Trial. DRDC Atlantic TM 2004–257, Defence R&D Canada – Atlantic.

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(U) In May-June 2003, DCNinternational contracted DRDC to run the Remote Minehunting System (RMS) for the purpose of demonstration of the system to potential customers in Brest Harbour, France. DRDC took this opportunity to also carry out a week-long collaborative scientific trial with French researchers from le Groupe d'Études Sous-Marines de l'Atlantique (GESMA), fulfilling a requirement of the Joint CA/FR Specific Agreement #21 on Minehunting.

(U) Through the course of the scientific trial and demonstration, several areas in and around Brest Harbour were surveyed using sidescan and bathymetric sonars, some areas with both. This report includes an overview of operations, but is mainly a synopsis of the various survey and supporting sensor data that was collected.

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