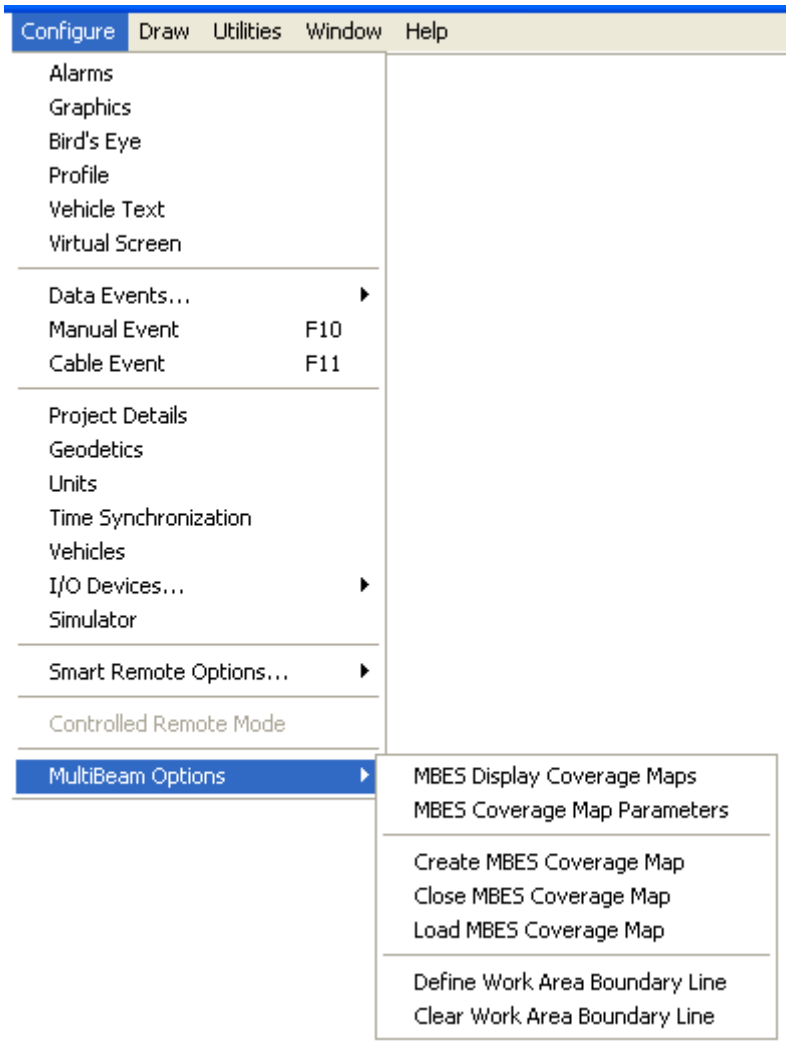
Chapter EM4: Multibeam Logging and Display

One of WinFrog's add-on modules is the **Multibeam Data Logging and Coverage Map Display Module (MBES Data Logging)**. Configured with this module, WinFrog is able to do the following:

- Interface with the following devices:
  - POS MV (UDP-Binary)
  - POS MV (TCP-Binary)
  - Reson SeaBat 81xx
  - Reson SeaBat 7125
- Log the data from the aforementioned devices to XTF or S7K files for post-processing with third party software.
- Create coverage maps for display in the Graphics windows to monitor operations.
- Display QC window showing beam pattern, sounding coverage, snippet coverage and sonar coverage.
- Perform a MBES calibration, a patch test.
- Display a profile generated from the coverage map in the Profile window.

If this module is available, the menu includes **Multibeam Options** under the **Configure** menu item.



Devices

The devices supported and required for this module are reviewed in this section. The POSMV and Reson SeaBat 81xx or 7125 units must be available and added to WinFrog. In the case of the SeaBat 81xx, this device is actually interfaced to WinFrog as three devices, depending upon the requirements. For details concerning the interface settings and configuration steps, refer to the respective device documentation.

POS MV (BINARY-UPD)

- Provides time-stamped position, heading, heave, attitude and position QA data via UDP broadcast.
- Supports POSITION, HEADING and ATTITUDE data items for use by WinFrog.

POS MV (BINARY-TCP)

- Provides time-stamped position, heading, heave, attitude and position QA data via TCP communication with the host.

- Supports POSITION, HEADING and ATTITUDE data items for use by WinFrog.
- Allows local logging of raw POS-MV data.

Reson SeaBat 81xx-BATHY

- Provides bathymetric data via UDP broadcast.
- Supports BOTTOMDEPTH data item for use by WinFrog.

Reson SeaBat 81xx-SNIPPET

- This provides snippet data via UDP broadcast.
- Does not support any data items for use by WinFrog.

Reson SeaBat 81xx-SONAR

- This provides sonar data via UDP broadcast.
- Does not support any data items for use by WinFrog.

Reson Seabat 7125

- This provides bathymetric, sonar and snippet data via UDP broadcast.
- Supports BOTTOMDEPTH data item for use in WinFrog.
- Supports CTD SVP data item for use in WinFrog.

Note: The Reson unit must be configured to do time-stamping and include this information in the output data. WinFrog does not do the precise time stamping required.

To Add and Configure POSMV (BINARY-UDP) Device

If interfacing with the POSMV via UDP, the following steps detail the interfacing setup.

1 From the GPS device list, select and add the POSMV (BINARY-UDP) device and configure the UDP broadcast address and port to match the POS MV configuration.

2 Configure the POS MV (BINARY-UDP) device.

a. Check the box to log when XTF data logging is active.This applies to the XTF data logging associated with the 81xx and the S7K data logging associated with the 7125.

b. Select the datum that corresponds to the datum that the POS MV is providing positions on.

3 Add the POSITION, HEADING and ATTITUDE data items to the respective vehicle and configure as required.

To Add and Configure POSMV (BINARY-TCP) Device

If interfacing with the POSMV via TCP, the following steps detail the interfacing setup.

1. From the GPS device list, select and add the POS MV (BINARY-TCP) device and configure the TCP interface. The Host Address will be the address of the local IP network adaptor connected to the Reson device. The IP Address will be the IP address of the Reson device. The port number will be 5603. Set the connection type as "Call".
2. Configure the POS MV (BINARY-TCP) device.
    a. If the POS MV is providing positions in NAD83 datum set the NAD83 radio button.
    b. If you are using a Reson MBES device set the XTF logging checkbox. This applies for XTF and S7K MBES logging.
    c. To log the raw POS MV data select a logging directory, base file name and select Start POS MV Raw logging.
3. Add the POSITION, HEADING and ATTITUDE data items to the respective vehicle and configure as required.

To Add and Configure Reson 81XX Device

If interfacing with a Reson SeaBat 81xx, the following steps detail the interfacing setup.

1. From the SOUNDER device list, select and add the Reson 81xx-BATHY device and configure the UDP broadcast address and port to match the Reson configuration.
2. Configure the Reson 81xx-BATHY device:
    a. To log when XTF data logging is active.
    b. Assign the correct head ID.
3. Repeat steps 4 and 5 for the Reson 81xx-SNIPPET and Reson 81xx-SONAR devices.
4. Add the Reson 81xx-BATHY BOTTOMDEPTH data item to the respective vehicle and configure as required.
5. Save the configuration.

To Add and Configure RESON 7125 Device

If interfacing with a Reson SeaBat 7125, the following steps detail the interfacing setup.

1. From the SOUNDER device list, select and add the Reson 7125-MBES device and configure the UDP broadcast address and port to match the Reson configuration.
2. Add the Reson 7125 MBES BOTTOMDEPTH data item to the respective vehicle and configure as required.
3. Configure the Reson 7125 MBES device:
    a. To log when XTF data logging is active.
    b. Assign the correct head ID. 0 for 1st head. 1 for 2nd head.

c. To use the nadir beam for water depth, ensure the Use N for Water Depth checkbox is cleared.

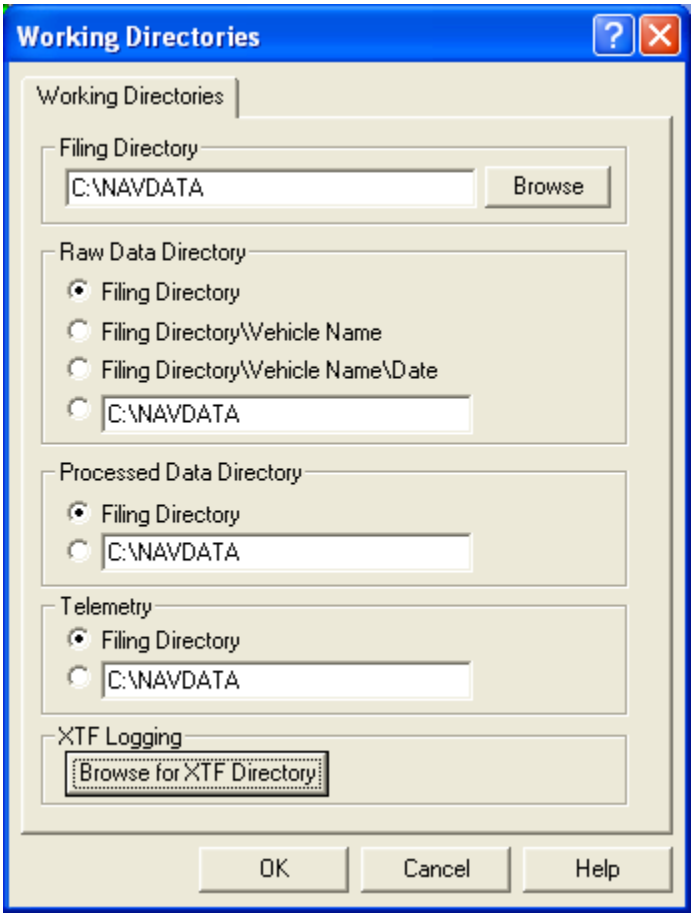
Working Directory

The directory to log the XTF or S7K files to must be specified. This is done the same way all Working Directories are setup.

To Configure the XTF Directory

1 Access the Working Directories dialog.

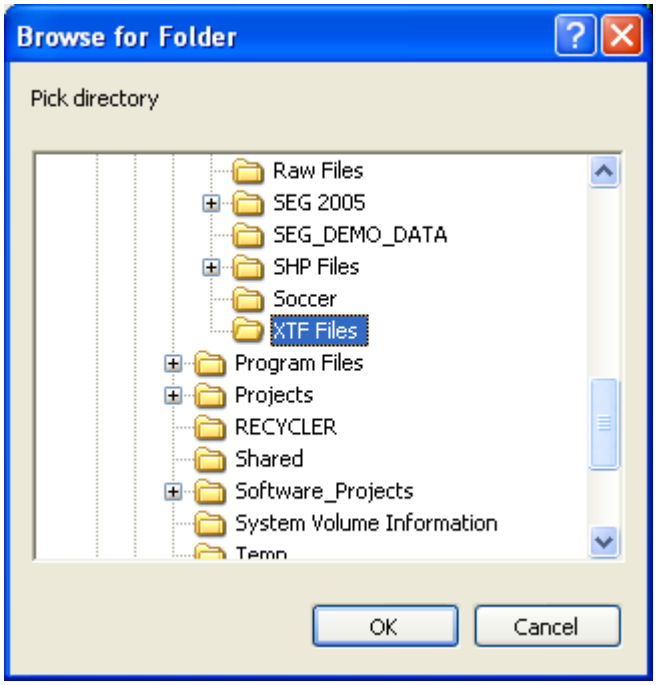
Note: If eventing is enabled or active or raw data logging is configured for Always, i.e. data logging of some form is enabled, a message box will appear alerting you to the fact that due to the potential impact of changing target directories while data logging is occurring the Working Directories cannot be edited. The dialog will appear so that the target directory selections can be reviewed, but they cannot be changed. The eventing and raw data logging must be stopped before the directories can be changed.



2 Click the Browse for XTF Directory button.

3 Navigate to and select the target directory; click OK.

Note: The S7K file will be logged to this directory if logging is enabled for the 7125.



4 Click OK in the Working Directories dialog.

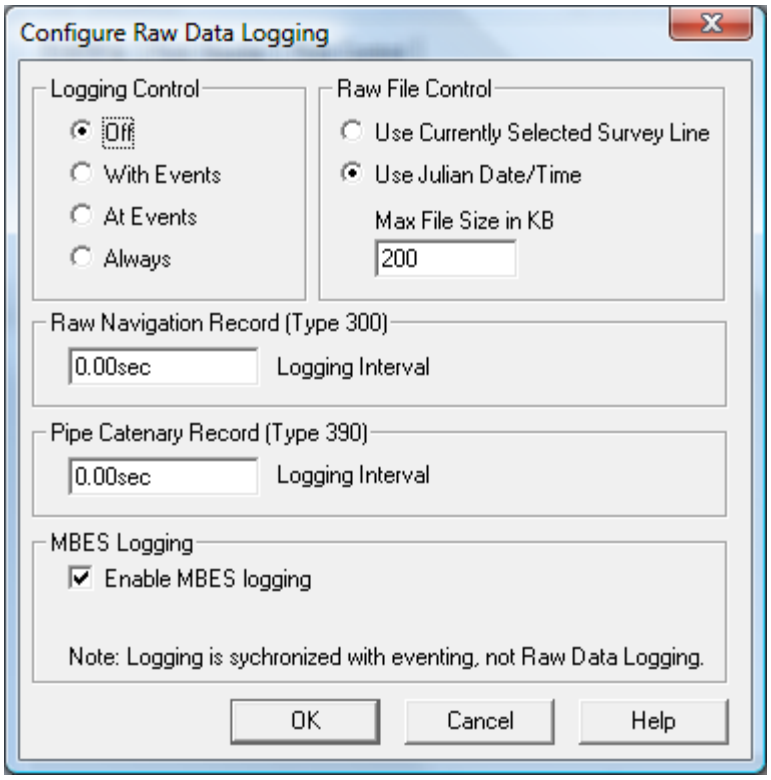
Note: The target folder must already exist. If it does not, use Windows Explorer® to browse to the desired folder and create the XTF/S7K target folder.

Data Logging

When enabled, the XTF or S7K files are logged when WinFrog is eventing. The enabling/disabling of the logging is configured with the standard Raw Data Logging.

To Configure XTF/S7K Logging

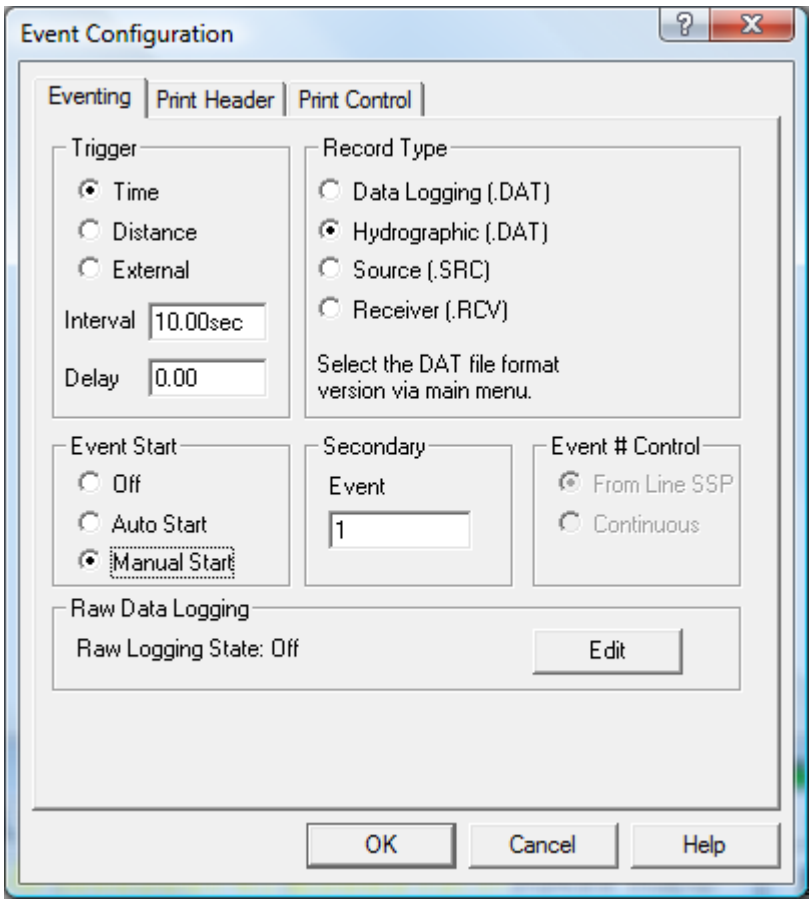
1 Access the **Configure Raw Data Logging** dialog by selecting **Configure > Raw Data Logging**.



2 Check **Enable MBES logging** to enable multibeam logging so that 81xx data will be logged to an XTF file and 7125 data will be logged to an S7K file.

3 Unless further configuration for eventing or raw data logging is required at this time, click OK.

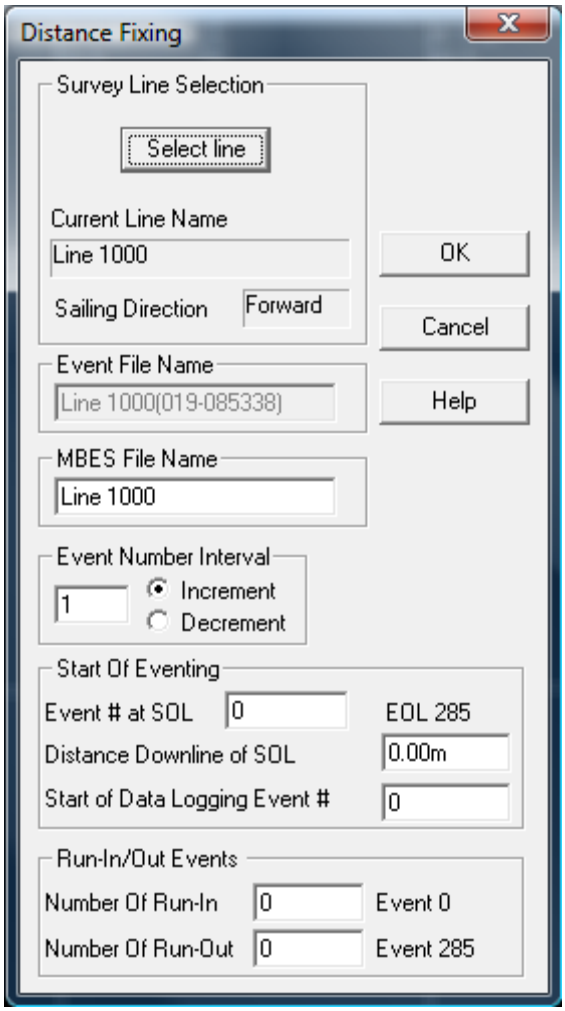
4. Access the **Event Configuration** dialog by selecting **Configure > Data Events > Setup**. Set the **Hydrographic** checkbox. Click **Manual Start** and click OK.



5. In the **Distance Fixing** dialog click the **Select Line** button to select the desired line to run. The default MBES file (XTF and S7K) is the selected line name. If you wish to modify this, edit the MBES File Name entry. The Event File Name (DAT file) will automatically be created from the MBES file name, but with the Julian day and time appended. This is to ensure a unique Event File Name is always created. Complete the rest of the configuration and click OK.

Note: If the MBES Data Logging module is present but MBES Data Logging is not enabled, the operation of the Distance Fixing dialog reverts to normal operation, i.e. the event file name is based on the selected line name with the entered prefix.

6 When ready to start logging data, click the start eventing button in the tool bar.



Coverage Map

The Coverage Map is used to display the area, coverage and quality of the multibeam data collected in the Graphics windows. The coverage map is created from the POS MV and Reson SeaBat data. New coverage maps can be created and existing maps loaded. The coverage maps can also be created directly from XTF and S7K files. In addition, multiple coverage maps can be displayed.

To Create a Coverage Map

1 Define a Working Area Boundary, option 1.

a. From the main menu, select **Configure > Multibeam Options > Define Work Area Boundary Line**.

b. Enter a line that defines the polygon that represents the outside boundaries of the multibeam work area. This can be facilitated by clicking in a Graphics window at the respective estimated line node locations and copying the resulting coordinates to the respective Node Data Position control in the Survey Line dialog.

Note: It is not necessary to repeat the starting node. WinFrog will automatically do this to create a polygon.

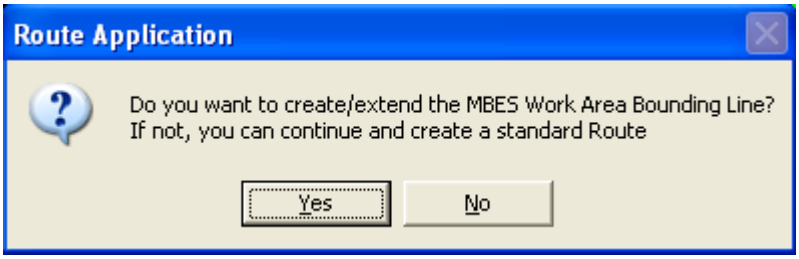
c. Click OK. If the Graphics window is configured to Draw Coverage Map Work Area bounds (default), this line will be displayed as a thick yellow line.

2 Define a Working Area Boundary, option 2.

a. Open a Graphics window, if not already open.

b. Click the Graphical Route Design button  in the Measurement Tools toolbar.

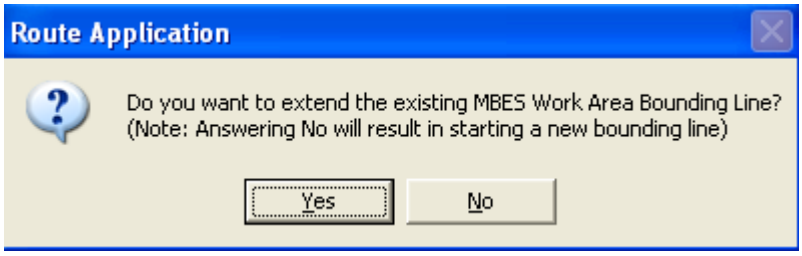
c. You will be asked to confirm that you wish to create a Work Area Boundary line.



Click No if you wish to create a standard Route for addition to the Working Survey Line and Waypoint files.

Click Yes to continue with the creation of a Work Area Boundary Line using this tool.

d. The next step requires selection of extending the existing boundary line or creating a new one.



Click No to delete the existing boundary line and prepare for the creation of a new line.

Click Yes to add nodes to the current boundary line.

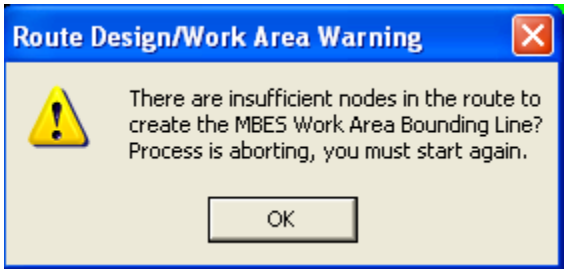
e. The standard route coordinate window will appear, displaying the information pertaining to the cursor position in the Graphics window.

f. Click in the Graphics window to locate the nodes that define the polygon that represents the work area boundaries. As these points are defined, the bounding line will be displayed in green.

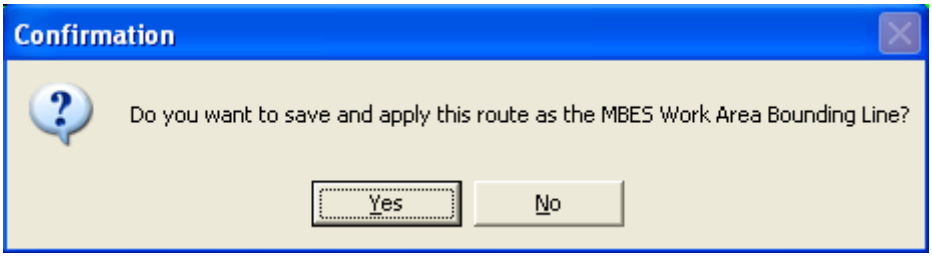
Note: It is not necessary to repeat the starting node. WinFrog will automatically do this to create a polygon.

g. When the boundary line is completed, click the Graphical Route Design button  in the Measurement Tools toolbar again.

i. If insufficient nodes have been defined, you will be warned and the line creation process will abort.



ii. If sufficient nodes have been defined, you will be prompted to save the line.



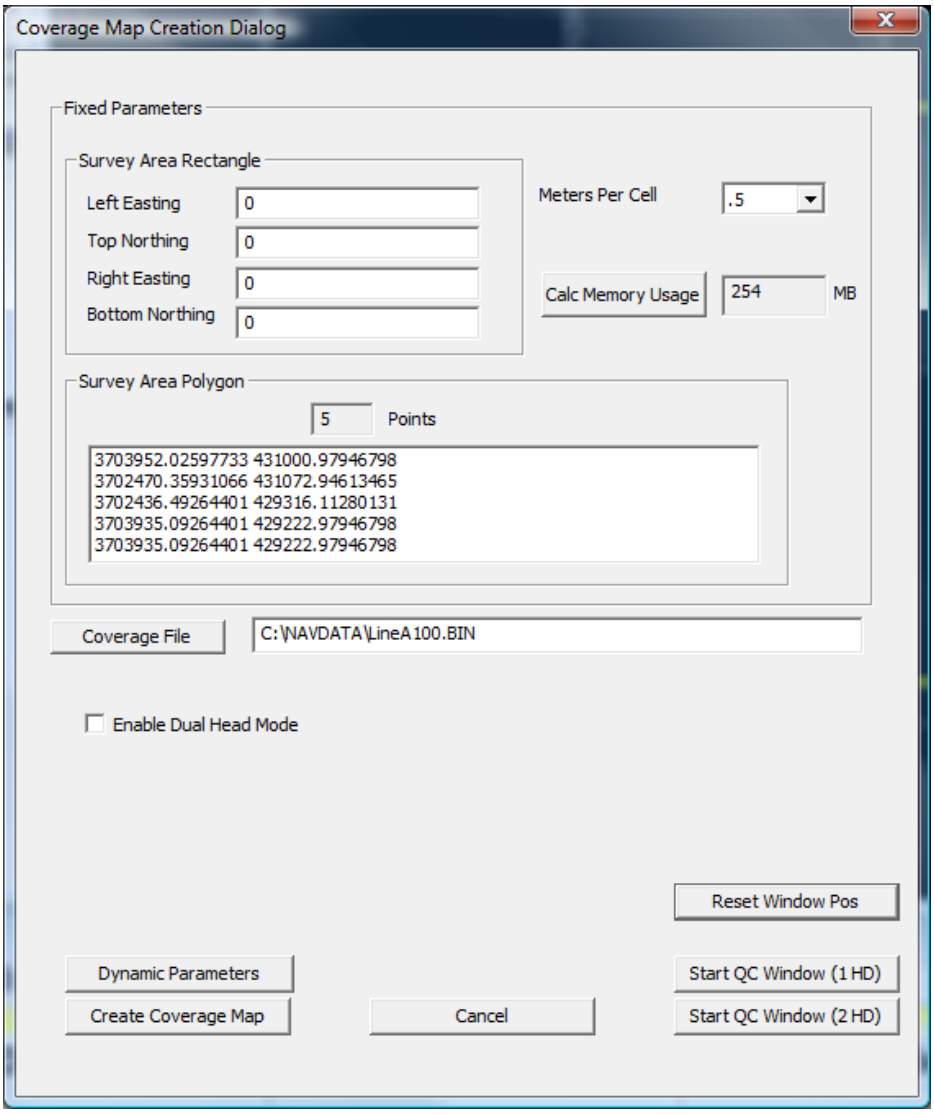
Click Yes to save this line as the Work Area Boundary Line. If the Graphics window is configured to Draw Coverage Map Work Area bounds (default), this line will be displayed as a thick yellow line.

Click No to abort the operation.

3 Go to the main menu **Configure > Multibeam Options > Create MBES Coverage Map**. The Coverage Map Creation Dialog will appear. The work area boundary polygon is displayed in the Survey Area Polygon panel.

Note: If a boundary has not been defined, the Survey Area Polygon panel will be blank.

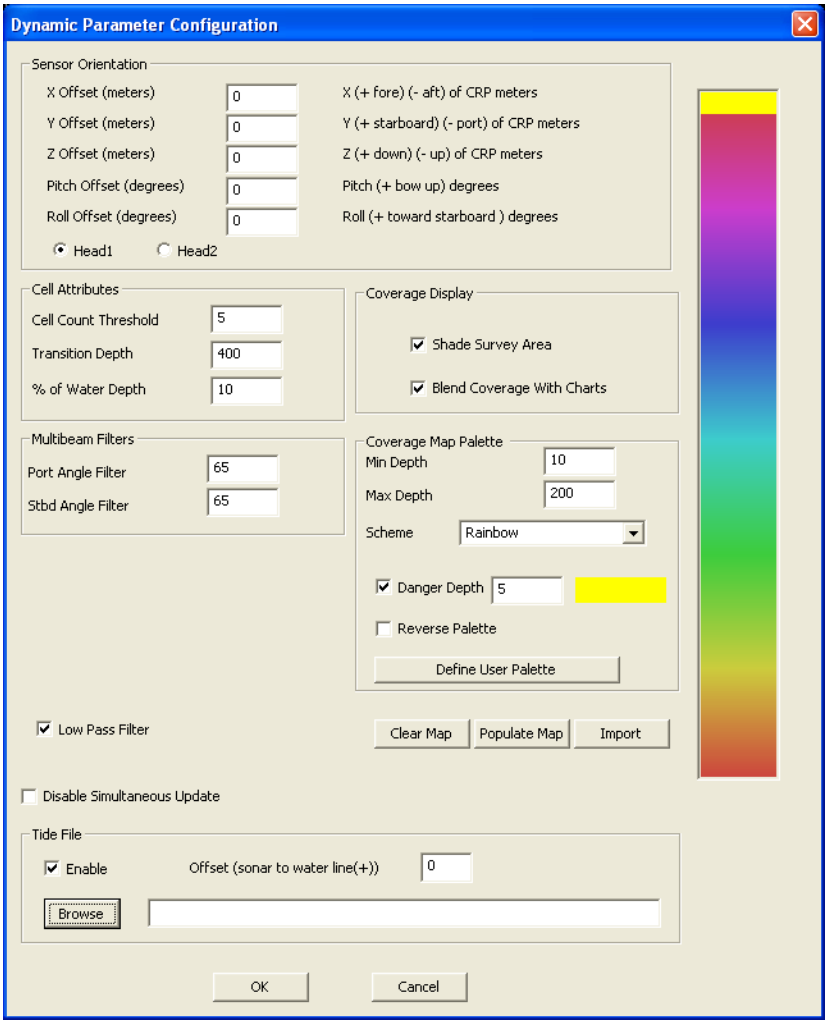
Alternatively, the coordinates defining the top left and bottom right corners of a rectangle can be entered to define the Work Area Boundary.



4 Select the desired grid resolution in **Meters Per Cell** control and click the **Calc Memory Usage** button to determine how much memory the coverage map will require.

5 Click the **Coverage File** button and select a path and file name to save the new coverage map to.

6 Click the **Dynamic Parameters** button to access the Dynamic Parameter Configuration dialog.



a. Configure the Sensor Orientation:

X Offset

Y Offset

Z Offset

Pitch Offset

Roll Offset

b. Configure the Cell Attributes:

Cell Count Threshold	Enter the required number of hits per cell.
Transition Depth	Enter the depth beyond which the size of the bin becomes a function of water depth.
% of water Depth	Enter the % of water depth used for cell size when the depth is greater than the transition depth.

c. Configure Multibeam Filters:

Port Angle Filter — Enter the angle from the nadir at which beams will be clipped. To include all beams this should be set to 90º.

Stbd Angle Filter — Enter the angle from the nadir at which beams will be clipped. To include all beams this should be set to 90º.

Note: Beams are also filtered by the Reson quality status. The beam is only added to the coverage map if the brightness and colinearity tests have passed for the beam.

d. Configure Coverage Map Palette:

This controls the color display used for the Coverage Map. The minimum and maximum depths are used to scale the Coverage Map palette correctly.

Min Depth — Enter an appropriate minimum depth.

Max Depth — Enter an appropriate maximum depth.

Scheme — Select the desired color scheme from the drop down list. The following palettes are available:

Name	**Description**
Log	Logarithmic color scale.
Step32	Constant step
Luminance	Color ordered by luminance.
Chrominance	Color ordered by chrominance.
BW	Grayscale.
Sine	Sine color scale.
Geof	RGB interpolated.
Sidescan	Inverted Grayscale.
Topo	Enhanced for topography.
GEBCO	GEBCO chart default.
Sealand	Enhanced for sea and land.
Haxby	Standard Haxby colors.
Rainbow	Red to Blue by hue in even increments.
Relief	Enhances relief.

Phi	Scaled by Phi ratio.
Bands	Repeating grey bands.
Cubic	Red to Blue scaled as the cube root. Provides greater color resolution for shallow depths.

Reverse Palette Reverses ordering of the palette. The maximum depth will map to the first color in the palette and the minimum depth will map to the last color in the palette.

Define User Palette Allows for the definition of a custom user palette based on depth range.

Danger Depth Allows you to set a minimum depth below which a single user-defined color is displayed. Click on the color box to the right of this control to edit the color.

e. Configure Coverage Display:

These settings affect the coverage map display in the Graphics windows.

Shade Survey Area Check this box to for the work area for a coverage map to be shaded.

Blend Coverage With Charts Check this box to blend the coverage map into the WinFrog background chart. This will result in a change in the colors of both the coverage map and the chart but it will allow both to be viewed simultaneously.

f. **Clear Map** – This will clear all data from the coverage map. This information cannot then be recovered.

g. **Populate Map** – This allows the coverage map to be populated with data from the existing XTF, S7K, or XYZ files. The data from these will be clipped to fall within the coverage area. The format of the XYZ file is as follows: Easting, Northing, Elevation. The Easting/Northing must be in the current WinFrog geodetics (datum and map projection), Elevation must be in the working vertical datum. Note elevation is positive above datum.

h. **Import** – Import data from one coverage map into another.

i. **Disable Simultaneous Update -** This forces the QC window to update on a single thread. This is primarily a diagnostic feature and the checkbox should be cleared for normal operation.

j. **Tide File –** These parameters control the use of a tide file (.TID) for correcting tide for the coverage map. The computer clock will be used for time matching tide values in the tide file. Typically this would involve synchronizing the computer clock to UTC.

Enable - Enable tide correction of the coverage map.

Offset - Offset from the sensor up to the water line (positive).

Browse – Select .TID file.

7 Click OK to save the Dynamic Parameters and return to the Coverage Map Creation Dialog. Note that the Dynamic Parameters can be edited after the Coverage Map is created.

8 Confirm that the work area and the resolution (meters per cell) configuration is correct. Once the Coverage Map is created, these cannot be changed.

9 Click the **Create** button to create the Coverage Map.

10 When the Coverage Map is created, the QC window will automatically open (see QC Window).

To Open a MBES QC Window

The QC display can be opened without a coverage map by clicking the Start QC Window button on the Coverage Map Creation dialog. When a coverage map is opened the QC display will automatically open.

To Load a Coverage Map

1 Go to the main menu **Configure > Multibeam Options > Load MBES Coverage Map**.

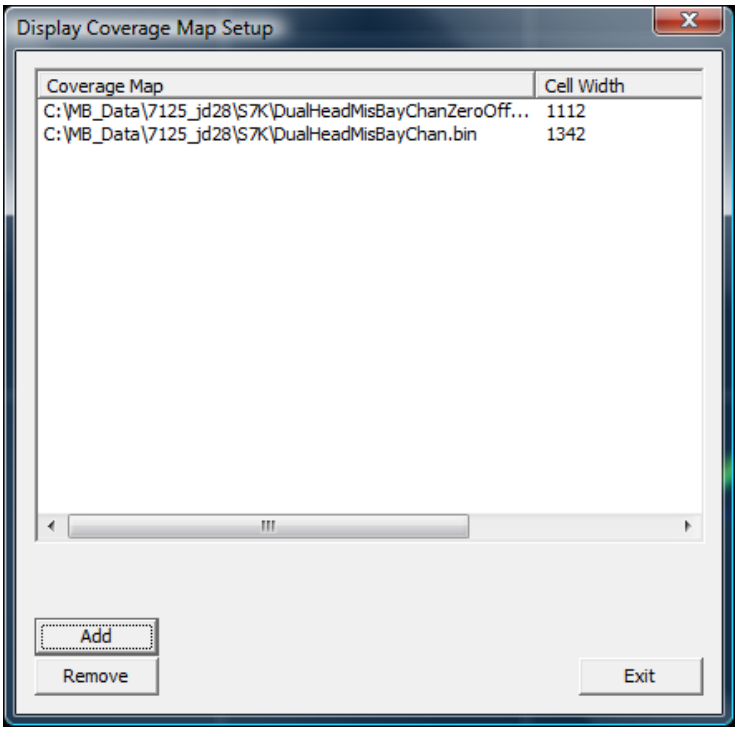
2 Navigate to the coverage map file (*.BIN) to load; select it and click OK.

3 When the Coverage Map is loaded, the QC window will automatically open (see QC Window).

Note: A loaded coverage map is updated with new multibeam data as if it was a newly created map.

To Load Additional Coverage Maps

1 Go to the main menu **Configure > Multibeam Options > MBES Display Coverage Maps**. The Display Coverage Map Setup dialog will appear.



a. Click the **Add** button to navigate to and select additional coverage maps (*.BIN) to display; select and click OK.

b. Click on a coverage map in the list and click the **Remove** button to remove coverage maps from being displayed.

c. Click **Exit** when completed.

Note: The additional coverage maps are used for display only and cannot be updated.

To Edit Coverage Map

1 Go to the main menu **Configure > Multibeam Options > MBES Coverage Map Parameters**. This will display the Dynamic Parameter Configuration dialog.

2 Edit parameters as required and click OK to save the parameters.

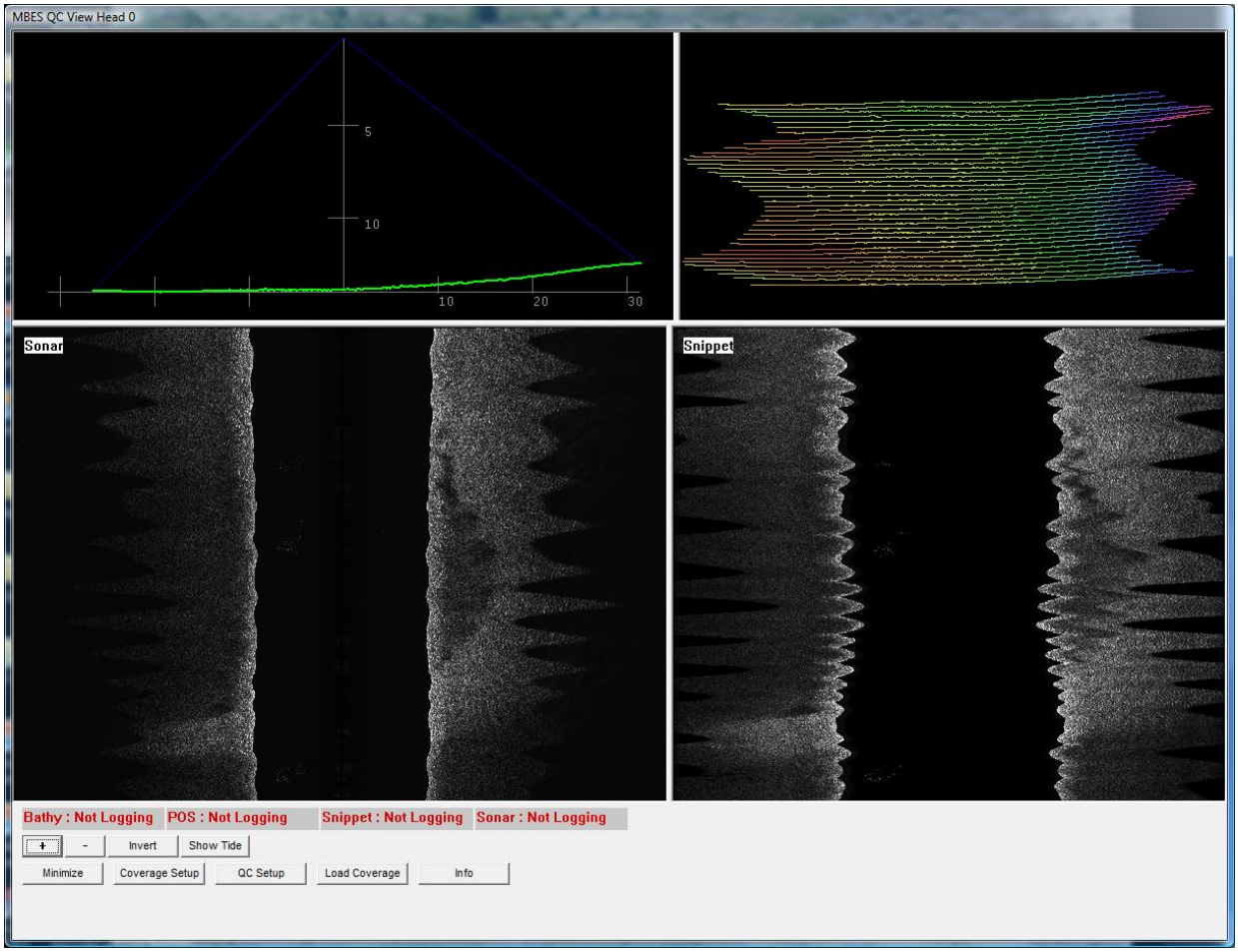
To Close Coverage Map

1 Go to the main menu **Configure > Multibeam Options > Close MBES Coverage Map**.

2 The coverage map will be closed and any additional coverage maps selected for display will also be closed.

3 The QC window will close.

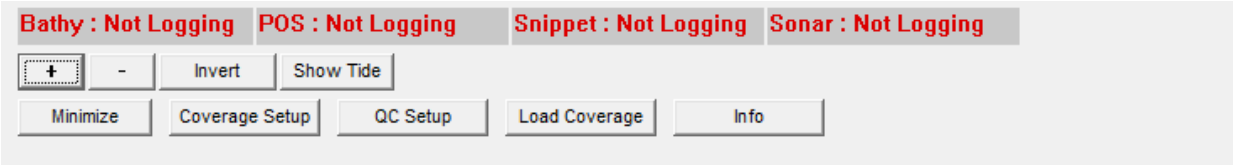
QC Window



The QC Window displays a graphical panel for the following:

- Top left: beam pattern from port to starboard
- Top right: sounding coverage from the last 20 pings rotated 45º about the across track axis
- Bottom left: sidescan sonar coverage
- Bottom right: snippet backscatter coverage

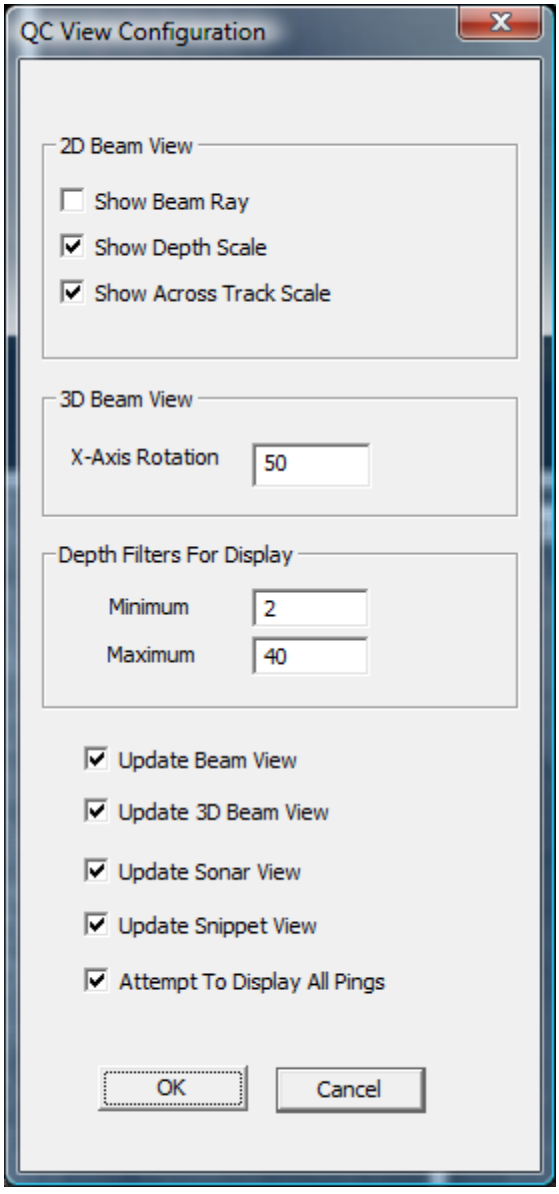
In addition, the tool bar provides the following:



- **Logging status** for bathymetry, sonar, snippet and attitude
- **+/-** scan gain adjustments
- **Invert** – click this to invert the displays
- **Show Tide** – Toggles display of a tide corrected coverage map.
- **Minimize** – click this to minimize the QC window
- **Coverage Setup** – displays the Dynamic Configuration dialog for the existing coverage map
- **QC Setup** – QC View Configuration
- **Load Coverage** – load coverage map; this will close the existing coverage map
- **Info** – view coverage map configuration information

QC Setup Dialog

This dialog provides for configuration of the QC display windows.

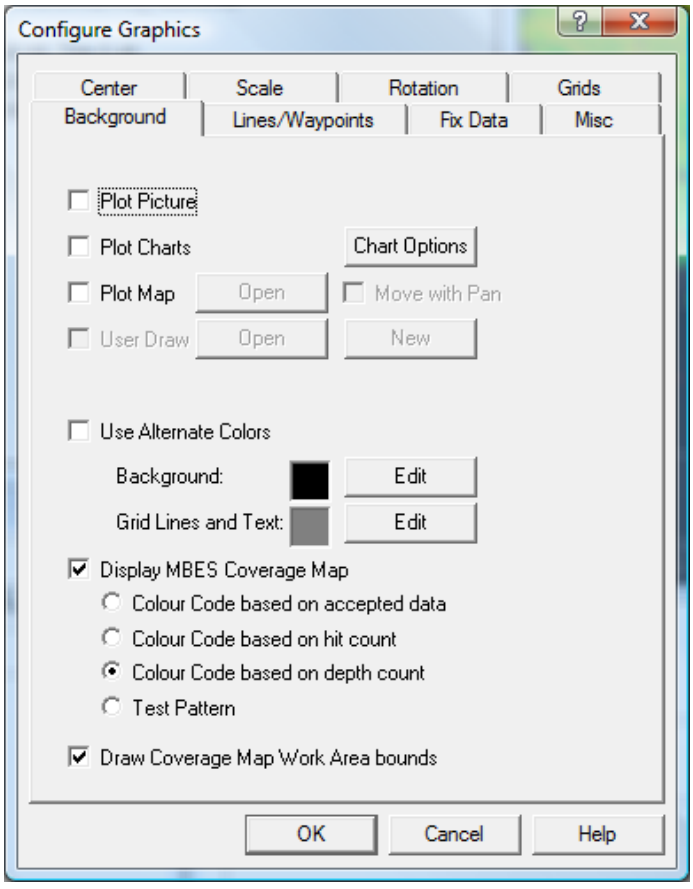


Show Beam Ray	Show the full ray for each beam in the 2D display. Note: The rays are drawn as simple straight lines and are not ray traced.
Show Depth Scale	Show vertical depth scale.
Show Across Track Scale	Show horizontal across track scale.
X-Axis Rotation	Rotate the 3D view about the X-Axis.
Depth Filter Minimum	Minimum depth to display.
Depth Filter Maximum	Maximum depth to display.

Update 2D Beam Display	Check this box to enable the Beam Pattern panel.
Update 3D Beam Display	Check this box to enable the Sounding Coverage panel.
Update Sidescan Display	Check this box to enable the Sidescan Sonar panel.
Update Snippet Display	Check this box to enable the Snippet Backscatter panel.
Invert Scan Display	Check this box to in invert sidescan sonar and snippet backscatter panel displays.
Display All Pings	Check this box to update the display for every ping received. If not checked, the update rate is 2Hz. This option is to enhance performance on slower computers.

Graphics Window Options

The Coverage Map can be displayed in the Graphics windows. This configuration is accessed via the Graphics Configuration – Background tab.



Display MBES Coverage Map

Check this box to enable the display of the loaded coverage map(s) in the Graphics window. Select the desired presentation mode.

Colour Code based on accepted data

Cell is displayed in green if it is within coverage specification; otherwise it is displayed in red. If there are no hits for a cell, that cell is not shown.

Colour Code based on hit count

Greyscale is used to display coverage map based on the number of hits per cell.

Colour Code based on depth count

Palette is used to display coverage map based on the average depth of each cell. Chose this option for simple display of a coverage area, i.e., say an XYZ file.

Test Pattern

For diagnostics only.

Draw Coverage Map Work Area bounds

Check this box to display the polygon defining the Work Area Boundary. The work area is shown shaded if so configured in the Dynamic Parameters.

Note: The Work Area for additional coverage maps is not shaded.

Multibeam Operation

Before installation of the equipment on the vessel, visually inspect the MBES, motion reference unit, position equipment and mounting hardware. After installation, confirm there is no independent motion among all the equipment and between the equipment and the vessel. Determination of offsets between all the equipment should be performed using well documented accurate land survey techniques.

Once the devices are added and configured and the Coverage Map is created/loaded, the actual multibeam operation is straightforward.

Eventing should be setup for Hydrographic (.DAT) Record Type.

When eventing goes Active, the associated multibeam data will be used to add to the coverage map. If the coverage map is being displayed in the Graphics window, it constantly updates to present the current situation. Operation can be monitored from this and the QC window.

As data is captured, the coverage map file (*.BIN) on disk is constantly updated ensuring that data is not lost if a problem is encountered.

If configured to log XTF or S7K files, these are logged while eventing is active. POS MV raw data is logged until the logging is manually stopped or the program is exited.

Patch Test

Note: WinFrog does not support multibeam data processing. Additional third party software is required to process the multibeam data.

The patch tests described below are for the equipment listed above. This equipment must be of recent version. This equipment offers much more accurate timing than older versions (before 2005). Because of the more accurate timing the navigation patch test (sailing fast then slow over the feature) as described in most other literature (including Engineering and Design, Hydrographic Surveying) will not work with this hardware. The timing error with this hardware is only a few milliseconds and the method using fast and slow runs over a target cannot detect this small of a latency; in fact pitch error is the prevalent detected value using fast-slow runs over a feature.

For further information see: Engineering and Design, Hydrographic Surveying Department of the Army USACE EM 1110-2-1003, Ch11

The procedures below describe the acquisition of the data for pitch, roll, and yaw misalignment generally as described in other literature. No additional technique is required to collect data for the navigation latency; some of the lines run for the pitch, roll, and yaw test can be used.

Processing of the data for the pitch, roll, and yaw test are as described in other literature and are not repeated here. However, processing for the navigation latency test is described below.

Note: since the POS M/V is the time source and provides position and attitude this data is of the same epoch and the navigation latency test actually determines any latency of the multibeam data and both the position and attitude.

Acquisition

Patch Test Procedure

1) Obtain adequate tide data for the patch test area.

2) Select a site to run the patch test. The site needs to have a flat area to test the roll calibration and have a distinct bottom feature to check for navigation latency and test the pitch and yaw calibrations. The bottom feature needs to be large enough to be visible in multiple pings and multiple beams. The feature should have enough definition that changes in depth can be recognized over the course of 4 to 8 pings. The feature selected will also depend upon the MBES frequency and water depth. Sand waves and sand dunes are good features to choose. Large boulders, bumps, and troughs are also acceptable. For deep water systems sea mounds or marine canyons can be used. A single slope is not an acceptable patch test feature.

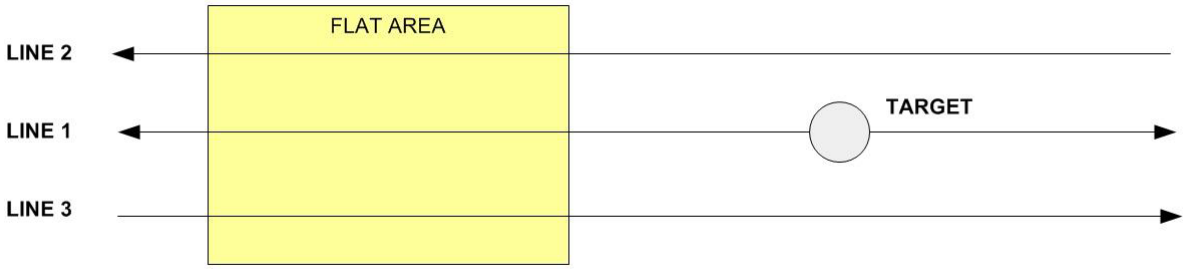
3) Complete a velocity cast for the entire water column or as near to it as practical.

4) Follow one of the three methods below.

A. Patch Test Method 1

Uses a Point Feature (target)

A patch test over a point feature can be completed by running as few as four lines. All of the lines should be run at a slow survey speed to increase the sounding density and reduce noise. They do of course need to be run fast enough to maintain good steerage. All the lines should be run along the same azimuth, perpendicular lines are not required.



There are three lines, the centre line runs directly over the feature and is sailed twice. The distance between the lines should be about equal to the water depth. If the survey vessel is crabbing the line width needs to be adjusted to ensure the swaths from lines 2 and 3 (runs 3 and 4) overlap at 45 degrees from nadir.

The lines should be run as follows:

Run	Line	Direction	Speed (RPM)
1	1	Right	Slow/Low
2	1	Left	Slow/Low
3	2	Left	Slow/Low
4	3	Right	Slow/Low

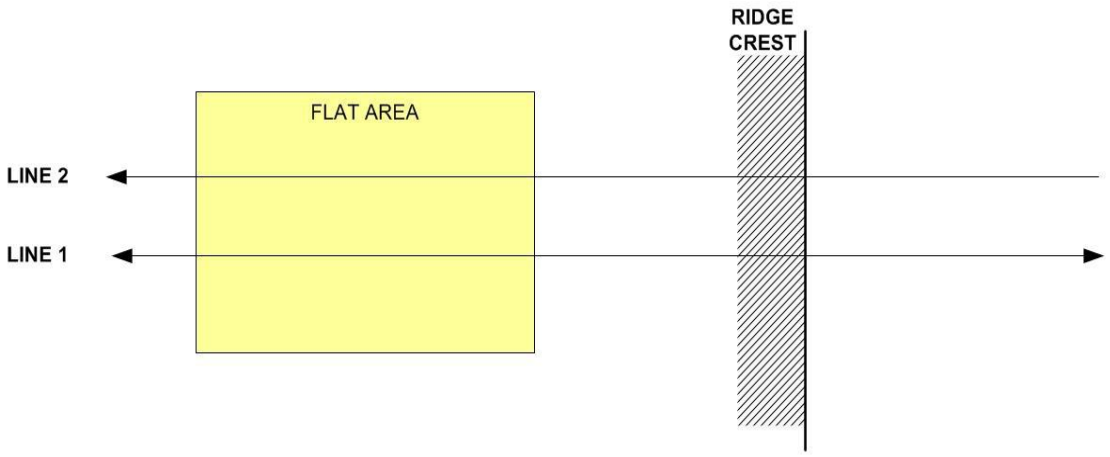
The runs will be processed as follows:

Calibration	Run	
Navigation	Any lines	
Pitch	1	2
Azimuth	4	3
Roll	1	2

B. Patch Test Method 2

Uses a ridge feature (target)

A linear feature such as a small ridge, dredge cut, or sand waves can be used in place of a point feature. In this case only three lines need to be run. They are all run perpendicular to the line of the linear feature.



There are two lines, line 1 is run twice. The distance between the lines should be about twice the water depth. If the survey vessel is crabbing, the line width needs to be adjusted to ensure the swaths from each line overlap at 45 degrees from nadir.

The lines should be run as follows:

Run	Line	Direction	Speed/RPM
1	1	Right	Slow/Low
2	1	Left	Slow/Low
3	2	Left	Slow/Low

The runs will be processed as follows:

Calibration	Run	
Navigation	Any lines	
Pitch	1	2
Azimuth	1	3
Roll	1	2

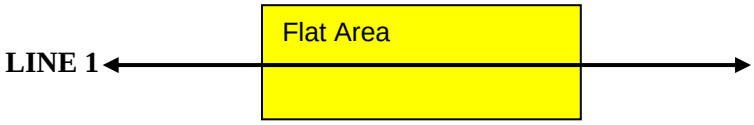
C. Patch Test Method 3

Individual line pairs

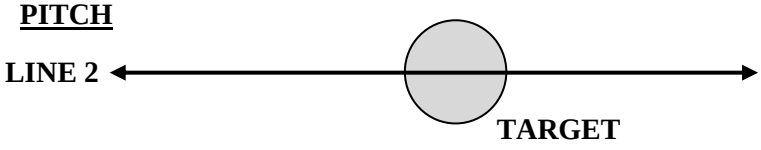
Most documents pertaining to multibeam patch tests suggest that a pair of lines be run for each of the four calibrations. We consider this unnecessary to obtain a quality calibration test. It also takes up additional boat time and takes longer to process. However, this method is described here.

Line patterns for each of the four calibrations are as follows:

1 NAVIGATION



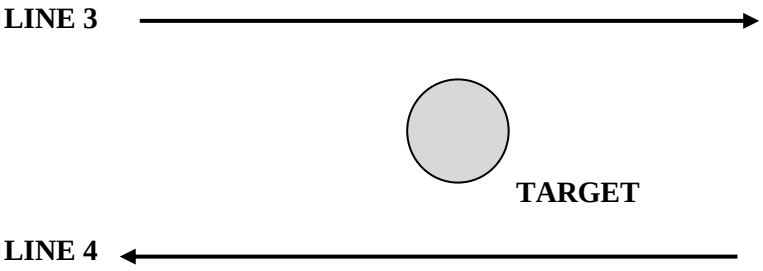
2 PITCH



3 AZIMUTH (YAW)

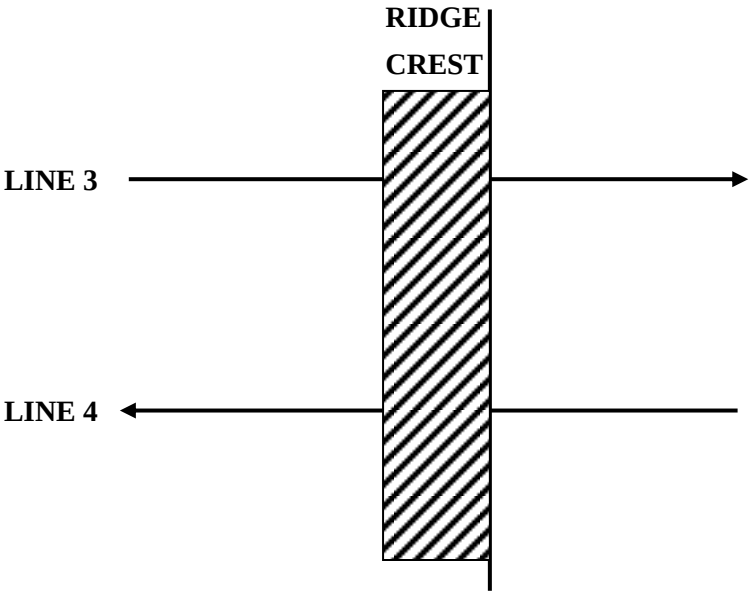
- POINT FEATURE (TARGET)

  The distance from each line to the feature should be about equal to the water depth. Thus the distance between the lines should be about twice the water depth.

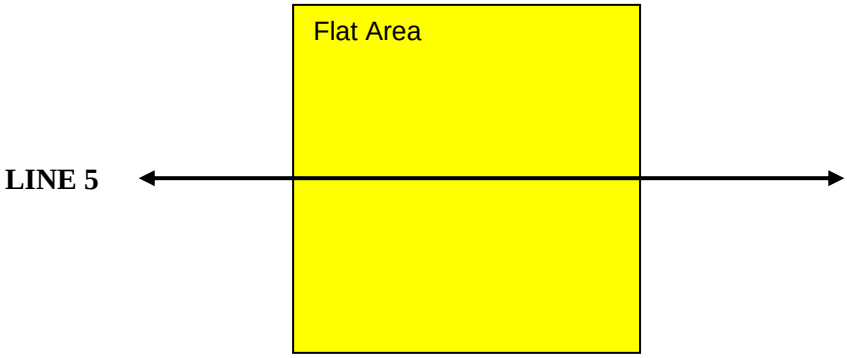


- LINEAR FEATURE (TARGET)

  The distance between the lines should be about twice the water depth.



4 ROLL



The lines should be run as follows:

Run	Line	Direction	Speed/RPM
1	1	Right	Slow/Low
2	1	Left	Slow/Low
3	2	Left	Slow/Low
4	2	Right	Slow/Low
5	3	Right	Slow/Low
6	4	Left	Slow/Low
7	5	Right	Slow/Low
8	5	Left	Slow/Low

The runs will be processed as follows:

Calibration	Run	
Navigation	1	2
Pitch	3	4
Azimuth	5	6
Roll	7	8

5) Complete a velocity cast for the entire water column or as near to it as practical.

Navigation Latency Processing Procedure

The POS M/V provides the time standard (UTC) plus position and attitude. Thus there is no latency between the position and attitude; they are of the same epoch. The Reson 81xx uses a time telegram from the POS M/V to synchronize its clock. The propagation delays of this time telegram is what this test will determine. Normally the propagation delay is about 3 milliseconds; however, if the POS M/V has been configured to output several additional telegrams, the propagation delay can increase to about 250 milliseconds. The Reson 7125 can synchronize to UTC using the 1PPS, which is the recommended configuration and no appreciable latency is expected. However, the test should still be performed.

A latency of only 3 milliseconds has minimal effect on the position however it does effect the application of roll. Thus we examine the data that is most effected by roll - the outer beams.

First apply the pitch, roll, and yaw corrections and process the data in the usual manner. Then examine the depths from the outer beam (or two) in profile. A roll timing error will appear as a high frequency sinusoid superimposed on the depth profile. Either adjust the ping time or the position/attitude time by say 3 milliseconds (advance the ping time or retard the position/attitude time) then reprocess all the data. Look at the same beam(s) in profile and compare the amplitude of sinusoid with that of the first. Iterate the application of a time correction until the amplitude reaches a minimum.

When adjusting the time and reprocessing the data ensure that the time is applied everywhere required.