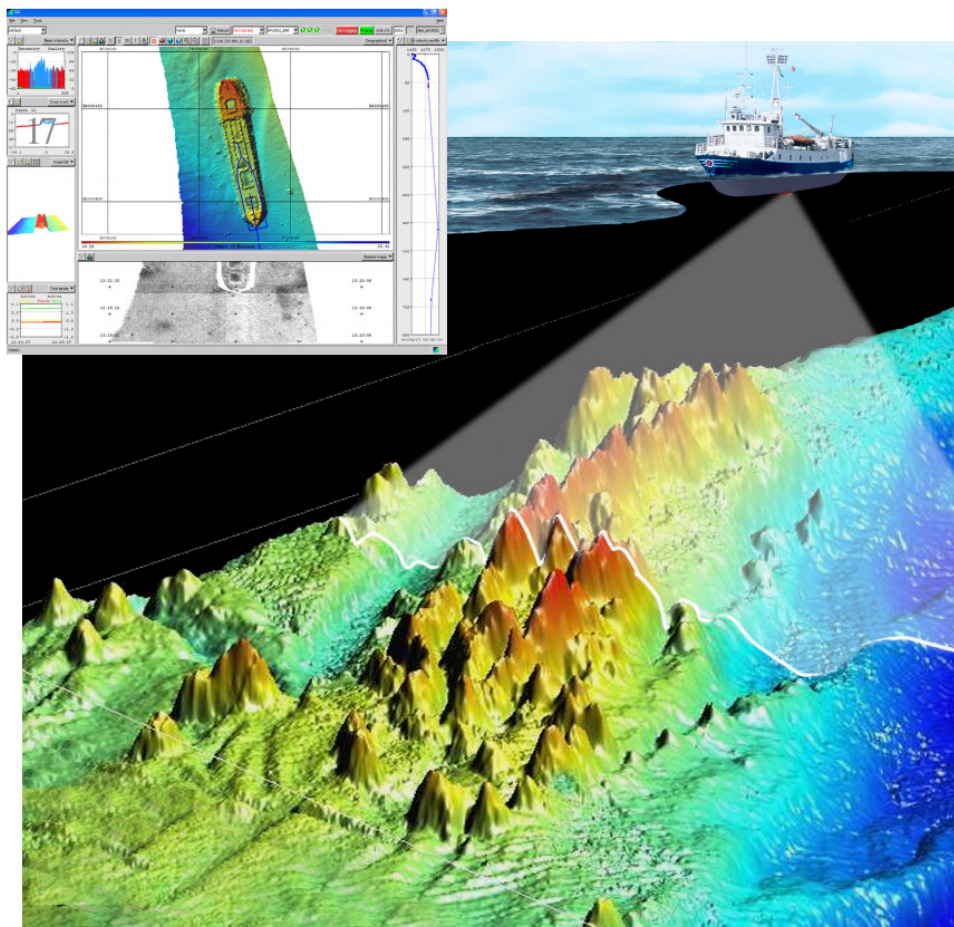


## Multibeam EM 710 on RV “Heincke”



Quelle: Kongsberg SIS Operator Manual

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## Contents

1	Hardware configuration .....	3
1.1	Sensor equipment .....	3
1.2	Sensor structure .....	3
1.3	Sensor layout / alignment.....	4
2	SIS – Kongsbergs Acquisition Software.....	5
2.1	Start SIS (SIS Operator Manual - page 94) .....	5
2.2	Start a new survey (SIS Operator Manual - page 95).....	6
2.3	Check runtime parameters (SIS Operator Manual - page 103) .....	8
2.4	Start the echo sounder (SIS Operator Manual - page 126) .....	9
2.5	Start and stop pinging (SIS Operator Manual - page 128) .....	9
2.6	Start and stop logging (SIS Operator Manual - page 133) .....	9
2.7	Plan a new job (SIS Operator Manual - page 156) .....	9
2.8	Run the survey (SIS Operator Manual - page 159) .....	11
2.9	External Triggering .....	11
2.10	Exit SIS (SIS Operator Manual - page 164).....	12
3	Sound velocity measurements .....	13
3.1	Operate Valeport MIDAS SVP .....	13
3.2	SVP editor (SIS Operator Manual - page 123) .....	14
4	CARIS HIPS – Post Processing Software.....	16
4.1	Create a new project (HIPS and SIPS User’s Guide – page 125) .....	16
4.2	Convert raw data (HIPS and SIPS User’s Guide – page 170) .....	17
4.3	Save session (HIPS and SIPS User’s Guide – page 159) .....	17
4.4	Clean auxiliary sensor data (HIPS and SIPS User’s Guide – page 261) .....	18
4.5	Sound velocity correction (Optional) .....	18
4.6	Load Tide (HIPS and SIPS User’s Guide – page 215).....	18
4.7	Merge (HIPS and SIPS User’s Guide – page 253) .....	18
4.8	Process swath data (HIPS and SIPS User’s Guide – page 299) .....	18
4.9	Define new field sheets (HIPS and SIPS User’s Guide – page 349) .....	19
4.10	Generate BASE surface (HIPS and SIPS User’s Guide – page 408) .....	19
4.11	Export data (HIPS and SIPS User’s Guide – page 585) .....	19
5	Tips and tricks .....	20
5.1	Planning survey lines in SIS.....	20
5.2	Line spacing .....	21

## History

Version / Date	Description
1.0 / 03.03.2010	First version
1.1 / 15.02.2013	Chapter 1.3 Sensor layout / alignment: Update of location offsets
1.2 / 15.04.2013	Added Chapter 2.9 , External Triggering



# 1 Hardware configuration

## 1.1 Sensor equipment

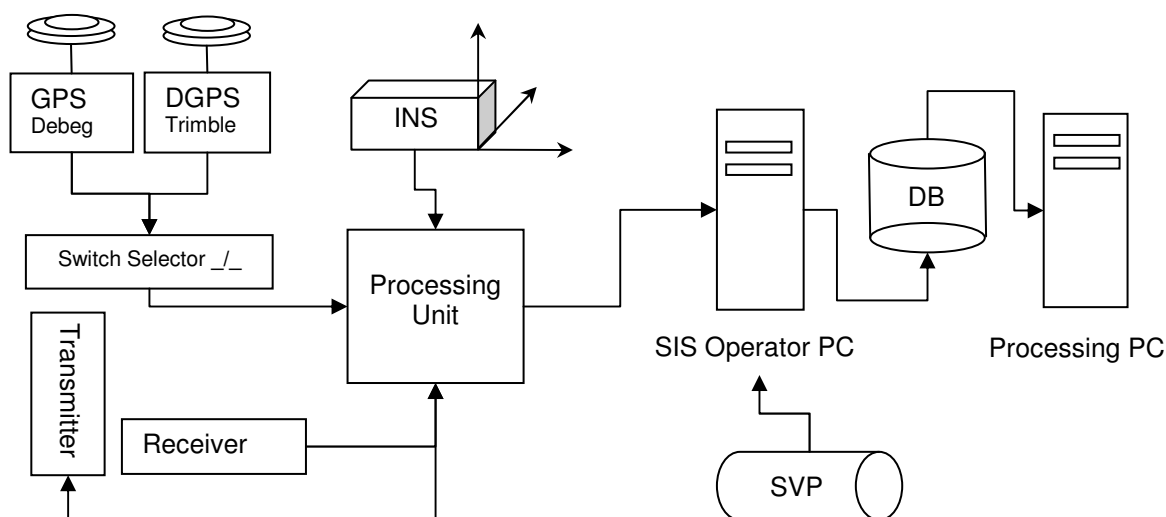
The following sensors are installed on the FS “Heincke”:

**Table 1: Sensor specifications**

Sensor	Model	Details from Manufacturer
Inertial Navigation System (INS)	IXSea PHINS III	Heading accuracy: 0.05 deg (without aiding) Roll, Pitch accuracy: 0.01 deg Heave accuracy: 5 cm or 5%
Primary Positioning Unit	Trimble SP461	Primary Positioning system DGPS 0.5 – 3 m accuracy
Secondary Positioning Unit	DEBEG/Leica	Secondary Positioning system GPS 5 – 15 m accuracy
Sound Velocity Probe (SVP)	Valeport MIDAS	Range: 1375 – 1900 m/s Resolution: 0.001 m/s, Accuracy: $\pm 0.02$ m/s

## 1.2 Sensor structure

Figure 1 shows the sensor structure of the multibeam echosounder hardware. The processing unit is the main unit which controls the transmitter, gets the sounding data from the receiver, and receives position information from the GPS Debeg receiver OR the Trimble DGPS receiver as well as attitude data (heading, roll, pitch, heave) from the Ixsea PHINS III Inertial navigation system (INS). Only one of the two GPS receivers can be selected as the echosounder positioning input. This can be done by a switch selector which is installed on the bridge. Before every survey make sure that the Trimble GPS is activated by the switch to receive a more accurate position than the Debeg GPS.



**Figure 1: Sensor dependencies**

### 1.3 Sensor layout / alignment

The sensor layout and alignment has been measured by the survey company Overath & Sand Ship Surveyors. The results are published in the survey report from 5<sup>th</sup> December 2009 (Revision 1) and an update from 12<sup>th</sup> May 2012 after movement of the primary GPS antenna. The Inertial Navigation System (INS) is located in the coordinate origin. All offsets of the transmitting transducer (TX), the receiving transducer (RX) and the GPS-Antennas refer to the INS position:

**Table 2: Sensor alignment**

	X (+forward in m)	Y (+starboard in m)	Z (+downward in m)
INS	0	0	0
TX	17.709	1.037	4.961
RX	16.987	1.156	4.963
Trimble GPS	5.042	6.787	-11.489
Debeg GPS	12.99	2.96	-11.24
Waterline	-	-	1.18

The angular misalignment of the transducer and transmitters with respect to the INS:

**Table 3: Angular transducer alignments**

	Roll (in deg)	Pitch (in deg)	Heading (in deg)
TX	-0.02	0.21	0
RX	0.04	0.28	0.54
Attitude COM1	0.07	0	0



## 2 SIS – Kongsbergs Acquisition Software

Figure 2 shows the normal sequence of operations required for survey runs using SIS.

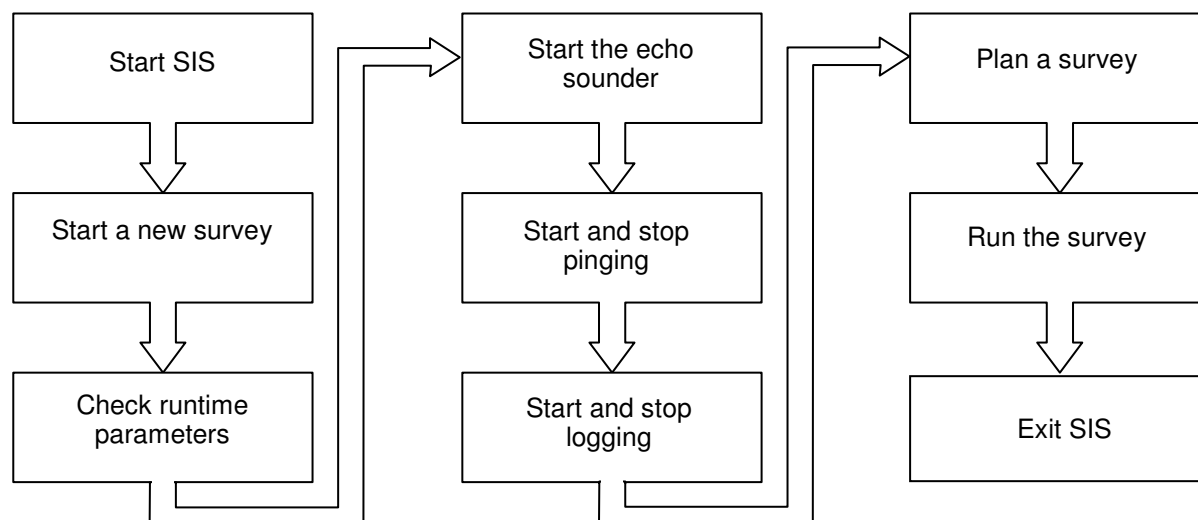


Figure 2: Workflow diagram for survey runs with SIS

### 2.1 Start SIS (SIS Operator Manual - page 94)

- Power up the echo sounder units (**by captain**)
- Power up the Operator Station peripherals (**by captain**)
- Power up the SIS Operator Station
  - (**for the SIS dongle, username and password please ask the captain**)
    - The operating system on the SIS Operator Station loads automatically. When the boot process is finished, the SIS program can be opened
- Click on the SIS icon on the desktop or select SIS from the Windows start menu



## 2.2 Start a new survey (SIS Operator Manual - page 95)

To create a new survey project at the beginning of a new expedition open the **New survey** frame (Figure 3).

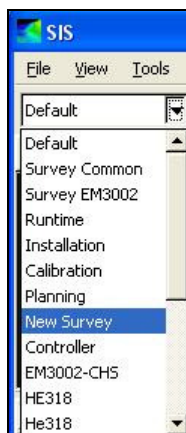


Figure 3: Open the New Survey frame

Important **New Survey** parameters to set are:

- **New survey name:** Select **Basic parameters** and enter a unique new survey name descriptive to the survey (Figure 4).

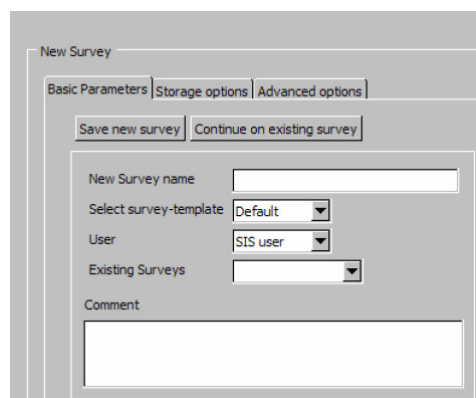


Figure 4: Basic parameters display

- **Map projection:** Select **Advanced options/Projection** (Figure 5, left). Select the applicable projection from the drop-down list. For the North Sea the map projection should be either **UTM31N\_WGS84** or **UTM32N\_WGS84** depending on the working area (Figure 5, right).

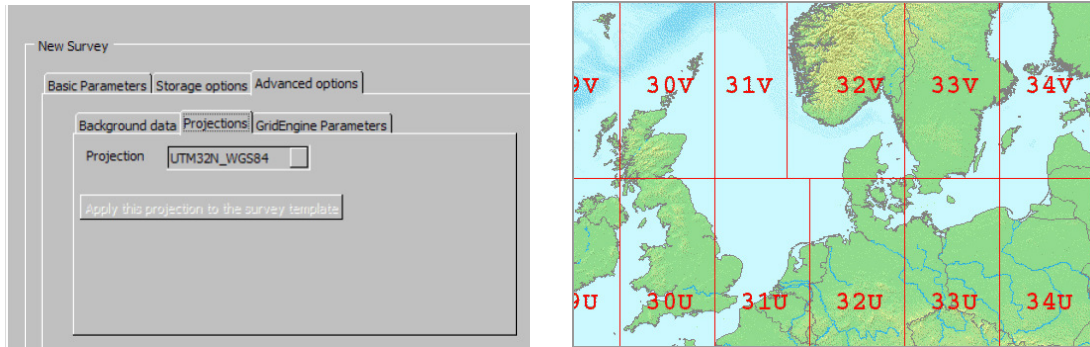


Figure 5: (left) Projections display - (right) UTM cells in the North Sea

- **Cell size:** Select **Advanced options/GridEngine parameters**. Select what depth to display and resolution of the grid, i.e. number of cells and cell size, suitable for the depth and expected coverage. The grid cell size is determined by the average swath width.

Normal resolution:                      Cell size = average\_swath\_width / 100

Number of cells = 64 x 64

High resolution:                        Cell size = average\_swath\_width / 200

Number of cells = 128x128

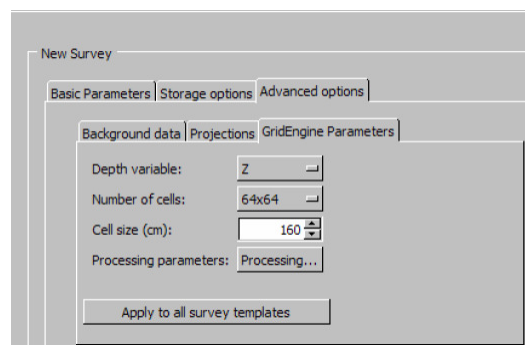


Figure 6: GridEngine Parameters display

When finished press **Save new survey** (Figure 4).



## 2.3 Check runtime parameters (SIS Operator Manual - page 103)

The runtime parameters are associated with the echo sounder and not with the survey (Figure 7).

Important Runtime parameters to set are:

- **Maximum angle:** Select **Sounder Main**. Under **Sector Coverage/ Max. Angle** the maximum swath width can be defined by setting the maximum port and starboard angles. The maximum angle possible is 65°. Recommend is an angle between 45° and 55°.
- **Depth settings:** Select **Sounder Main**. Make sure that the **Minimum Depth** and **Maximum Depth** settings are appropriate limits for the survey area or at least for the current location where the echosounder is planned to start. If the real depth is beyond these limits, the echosounder will not find the seafloor!
- **Ping Mode:** Select **Sounder Main**. Under **Depth settings/Ping Mode** the operational mode of the EM710 is defined. The Ping Mode should be set to **AUTO**.
- **Select SVP profile:** Select **Sound Speed**. The sound speed profile parameter allows to select the sound speed profile to be used in the echo sounder's depth calculations (See also Chapter 4.2.).

Runtime parameters

Sounder Main | Sound Speed | Filter and Gains | Data Cleaning | Javad and Trimble | ATH logging | Simulator | Survey Information

**Sector Coverage**

	Port	Starboard
Max. angle (deg.):	65	65
Max. Coverage (m):	2000	2000

Angular Coverage mode: AUTO

Beam Spacing: HIDENS EQDIST

**Depth Settings**

Force Depth (m): 0

Min. Depth (m): 2

Max. Depth (m): 150

Dual swath mode: OFF

Ping Mode: AUTO

Max. Ping Freq. (Hz): 40.000

FM enable

**Stabilization**

Pitch stabilization

Along Direction (deg.): 0.0

Yaw Stabilization

Mode: REL. MEAN HEADING

Heading: 0.0

Heading filter: MEDIUM

Figure 7: Runtime parameters display





## 2.4 Start the echo sounder (SIS Operator Manual - page 126)

Before starting pinging, the echo sounder must be turned on. Select the echo sounder from the **Echo sounder - not started** combo box (Figure 8). The **Logging** and **Pinging** buttons will all be disabled until the echo sounder is ready. When the echo sounder is ready, pinging can be started.

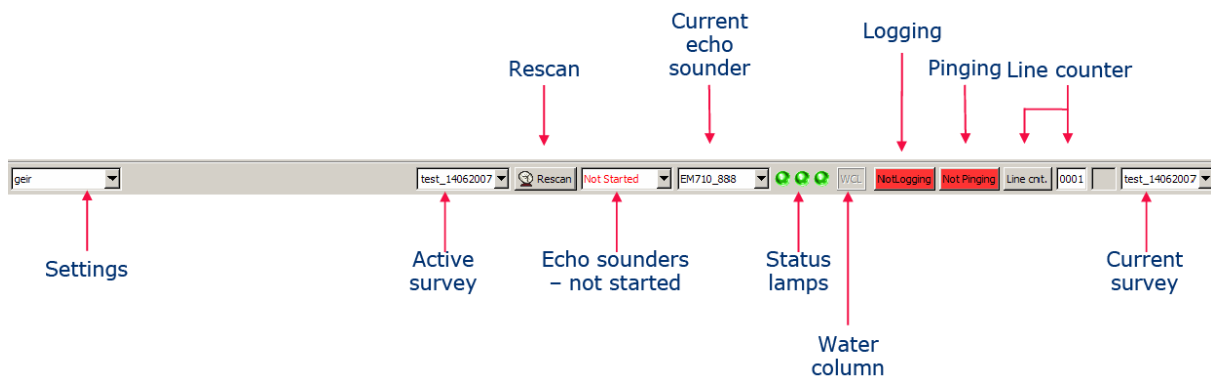


Figure 8: The main frame

## 2.5 Start and stop pinging (SIS Operator Manual - page 128)

Pinging must be started manually after the echo sounder is ready. Press the **Pinging** button on the toolbar. The button is red when **Off** and green when **On** (Figure 8).

## 2.6 Start and stop logging (SIS Operator Manual - page 133)

**Logging** must be started manually after the echo sounder is ready. When the echo sounder has started logging, data is automatically saved to disk in \*.all file format (Figure 8).

Note that if pinging is **Off** when logging is turned **On**, pinging will automatically be turned **On**. If logging is **On** and pinging is turned **Off**, logging will automatically be turned **Off**.

For logging the water column data from the water column view select the Water Column frame. Select its Show/Hide toolbar button and toggle the Logging option in the popup window. The water column symbol (Figure 8, WCD) will be green during logging. This data will be logged to \*.wcd files in your selected folder, separately from the \*.all files.

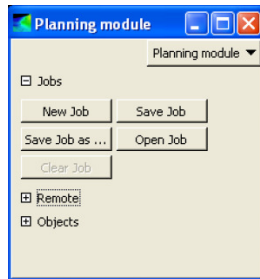
**Warning:** Water column data will be much larger than the default multibeam data (1 to 2 GB per hour extra). Please make sure to move these files regularly from the acquisition PC.

## 2.7 Plan a new job (SIS Operator Manual - page 156)

The planning module allows creating survey lines in the area to be surveyed. The planning module can be activated by clicking **P** in the toolbar at the top of the screen. With this tool survey lines can be created which the vessel must sail.



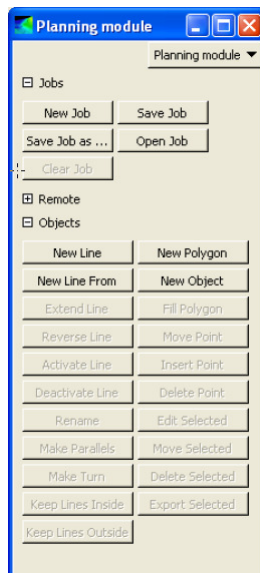
Please note, that all drawing and selecting commands are performed by pressing **CTRL & left mouse button**. To end all kind of drawings, confirm the changes by clicking **CTRL & right mouse button** and accept.



Expand **Jobs** (Figure 9):

- Press **New job** and enter a descriptive name of the job
- Select the preferred coordinate format

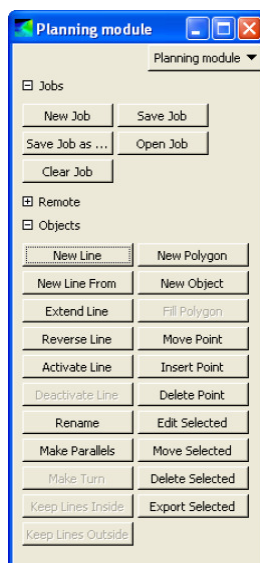
Figure 9: Planning module to start a new job



Expand **Objects** (Figure 10):

- Select **New line, New polygon, New line** from or **New object** depending on the survey plan
- Select the end points of the object by pointing the mouse in the geographical view, hold the Ctrl button while clicking on the left mouse button
- Hold the Ctrl button while clicking on right mouse button to bring up the confirm changes menu
- Press **Accept** to finish the object
- Press the **New line, New polygon, New line** from or **New object** again to finish the process

Figure 10: Before any object is created and selected, these are the possible options



Select one of the planned lines or objects by **ctrl + left mouse** button:

- *Edit, move, extend, reverse, make parallel lines*, etc. according to the survey plan (
- Figure 11)

Press **Save Job** or **Save Job as**.

**See also 4.3 Planning survey lines in SIS**

Figure 11: When an object is created and selected these are the new possible options



## 2.8 Run the survey (SIS Operator Manual - page 159)

On board of RV “Heincke” the raw multibeam data will be stored under **E:\sisdata\raw\...\\*all**.

### Load Job:

- Open the **Planning module** frame
- Expand **Jobs**
- Press the **Open job** button
- Select the file where the planned survey lines are stored
- Expand **Remote**
- Press **Transfer plan** so send the planned lines and objects to the remote helmsman display

### During the survey:

- Observe the **Geographical window** which gives an overall control of the performance of SIS and the multibeam echo sounder.
- Observe logging, pinging and line number status on the right hand side of the toolbar.
- Observe the **Numerical display**, where the sensor data values can be monitored.
- Observe the three status lamps on the main toolbar which give status of hardware units (applies to multibeam echo sounders only) (Figure 8).
- Observe the **Cross track** display. The **cross track** window shows the measured depths in all beams from the last ping. If it forms a smiley or a frown the sound velocity profile is not suitable anymore and as a result wrong depths are calculated.

## 2.9 External Triggering

To avoid sounding interferences with the Sub Bottom Profiler SES2000 it is possible to use an external trigger (Figure 12). The external trigger signal is configured in the SES2000 software (compare FIELAX Manual RV Heincke\_SubBottomProfiler\_Support.pdf, Chapter 3 Synchronisation with Multibeam Echosounder EM710). Caution: If this checkbox is checked without running SES2000 and its activated trigger, no pinging with EM710 will be possible!

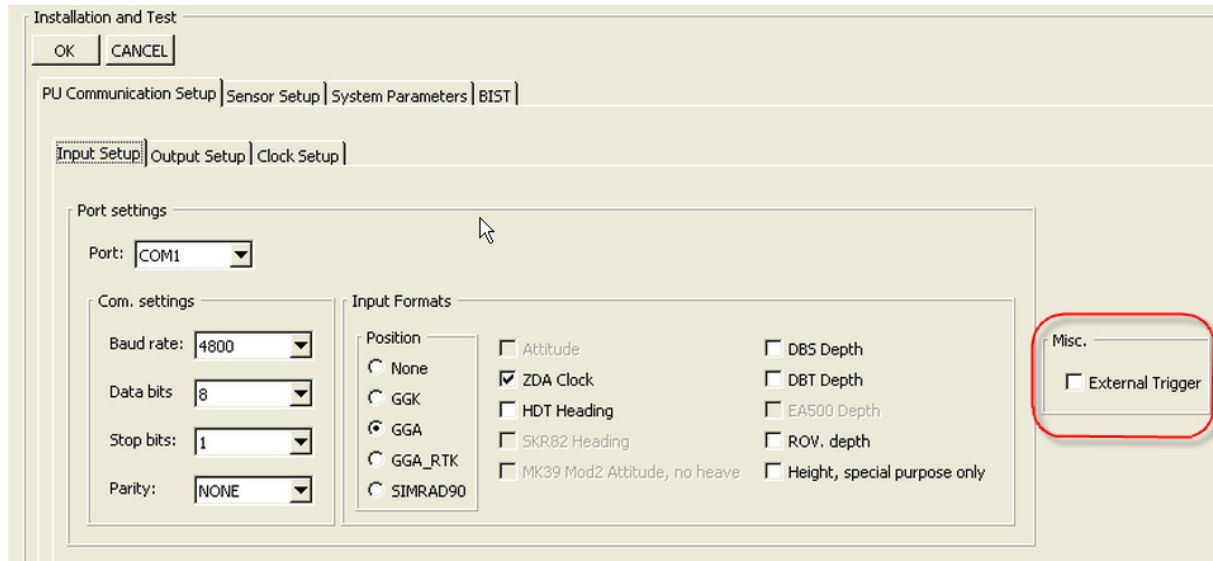


Figure 12 - External Trigger

## 2.10 Exit SIS (SIS Operator Manual - page 164)

Stop logging and pinging. Select **File/Quit** or press the **Close** button in upper right corner of the SIS window.



### 3 Sound velocity measurements

On board of RV “Heincke” sound velocity profiles can be measured using the Valeport MIDAS SVP probe, which is stored in the dry lab.

**We strongly recommend measuring a sound velocity profile before starting a new survey. Depending on the survey area, duration and purpose this should be repeated regularly.**

#### 3.1 Operate Valeport MIDAS SVP

The Valeport program **Data Log Express** is installed on the computer **xpc3** in the dry lab (**username: mbesadmin, password: please ask the captain**).

##### **Preparation of the probe in the lab:**

- Connect the SV probe with the computer (xpc3) on the serial COM port
- Start **Data Log Express**
- Connect to the probe
- Check the settings
- Select **OFFLINE** acquisition mode
- Start the acquisition with **RUN**
- Remove the serial cable and put on the dummy plug

**!!!! With the dummy plug on the probe is online and uses up the batteries !!!!**

##### **Measurement in the water:**

- Lower the SV probe to the desired depth
- Heave it back on deck
- Rinse the probe with clear water
- Dry the probe

##### **Data export:**

- Dry the connectors and remove the dummy plug
- Connect the serial cable again to the computer’s serial COM port
- Start **Data Log Express**
- **Upload** the data file (\*.000) to the computer. This is a plain text ASCII file that contains the measured sound velocity values over depth. This file can be imported to the SVP Editor in SIS (see next chapter)
- Disconnect the SV Probe from the PC and secure safely in the case. **DO NOT PUT ON THE DUMMY PLUG.**



### 3.2 SVP editor (SIS Operator Manual - page 123)

By using the SVP editor any column based ASCII format file can be converted to the \*.asvp format read by SIS.

Open the **SVP Editor** from the SIS menu (**Tools/Custom/SVP Editor**):

- Expand the view by dragging the boundaries of the window

Open the SVP file (**File/Open in editor**):

- Browse for the SVP input file and press **Open**. The **Raw file editor** opens
- Select the delimiter from the drop down list
- Press **Split** to apply the delimiter. A new window will appear
- Delete the header and mark the columns not needed. Position the mouse in the first data row to mark that column
- Press **Delete selected columns** to remove the marked columns
- Move the columns by position the mouse pointer on the column header row and drag the column to right position (Figure 13)
- Press **OK** when selected columns are in right place
- Back in the **Raw file editor** remove all header rows by marking them and press **Delete**
- Select **Save as** - the file extension is automatically set to \*.asvp

Reset selections		Redraw	
Depth		Speed	
0.12		1479.41	
0.26		1479.58	
0.63		1479.52	
1.02		1479.94	
1.27		1480.0	
1.65		1480.17	
1.91		1480.28	
2.03		1480.43	

Figure 13: Sound velocity profile

**Now the sound velocity profile can be loaded into SIS and checked for errors.**

Open the **SVP Editor** from the SIS menu (**Tools/Custom/SVP Editor**):

- Expand the view by dragging the boundaries of the window



Open the \*.asvp (**File/Open**) menu:

- Check the observations for double entries or upward depths by choosing **Tools/Check profile**
- Observations that are suggested removed are highlighted (Figure 14)
- Press **Delete row** to delete highlighted entries
- Repeat until the profile is acceptable

Save the file from the **File/Save as** menu. It is recommended to use a filename that identifies date and time.

Reset selections		Redraw	
Depth		Speed	
0.12	.	1479.41	.
0.25	.	1479.58	.
0.25	.	1470.05	.
0.25	.	1479.34	.
0.63	.	1479.52	.
0.63	.	1479.56	.
1.02	.	1479.94	.
1.27	.	1480.0	.
1.65	.	1480.17	.
1.91	.	1480.28	.
2.03	.	1480.43	.
2.16	.	1480.74	.

Figure 14: Double entries suggested to be removed

Select **Runtime parameters/Sound speed**:

- Use the browse button to open the correct \*.asvp file
- Press **Use Sound Speed Profile** to apply the selected sound speed profile

Runtime parameters

Sounder Main | Sound Speed | Filter and Gains | Data Cleaning | Javad and Trimble | ATH logging | Simulator | Survey Information

Sound Speed Profile

Use Sound Speed Profile: 20112302\_SWP.asvp

Abs. coeff. files, salinity: H:\Scientists\20112302\_SWP\_salinity\_03100

Abs. coeff. files, CTD: E:\sisdata\default

Sound Speed at Transducer

Source: PROFILE

Sound Speed (m/sec.): 1448

Sensor Offset (m/sec.): 0.0

Filter (sec.): 1

Figure 15: Select sound speed profile



## 4 CARIS HIPS – Post Processing Software

The processing software Caris HIPS is installed on the computers *xpc3* and *xpc4* (*username: mbesadmin*). For the *dongle* and the *password* please ask the captain.

Before processing the data copy the raw data from the SIS Operator station to the Data Processing Station via the Netstorage Server *xdc*. Figure 16 shows the most important steps for cleaning multibeam data. Also refer to *HIPS and SIPS 6.1 SP2 - Quick Reference for Multibeam data* and *HIPS and SIPS User's Guide*.

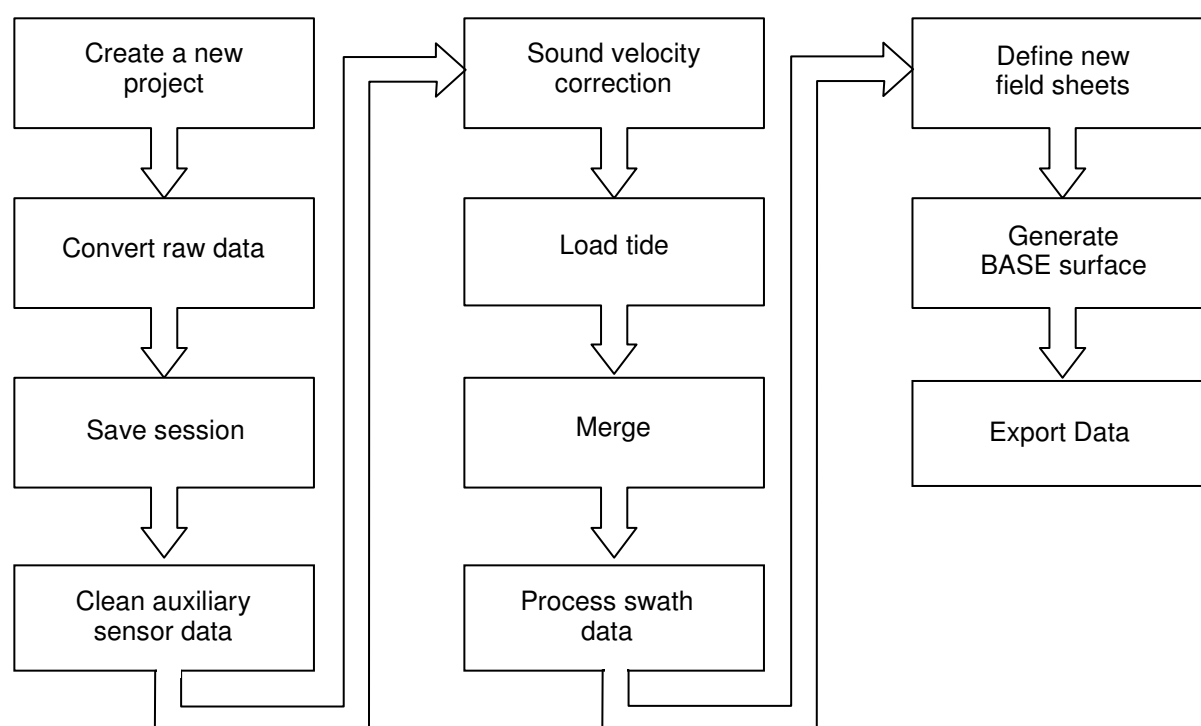


Figure 16: Workflow diagram for processing multibeam data

### 4.1 Create a new project (*HIPS and SIPS User's Guide – page 125*)

To create a new project-Vessel-Day directory tree structure to store data go to **File/Project/New** and enter a new project name, the vessel and the first day of the survey in Julian Day (number of day in a year, 001-365).





## 4.2 Convert raw data (HIPS and SIPS User's Guide – page 170)



Copy the raw-data of SIS (*E:\sisdata\raw\...\\*.all*) to the CARIS-PC. HIPS and SIPS files are created from survey data using the Conversion Wizard. To start the conversion process, activate the HIPS **Conversion Wizard**.

1. Select the survey data format "**Simrad**" - Click **Next**
2. Pick the files to be converted - Click **Next**
3. Select the Project/Vessel/Day or raw data files and click **Open** - Click **Next**
4. Select the coordinate system - Click **Next**
5. Enter range of extents. Automatically set to maximum range - Click **Next**
6. Start conversion by clicking **Next** (Figure 17)

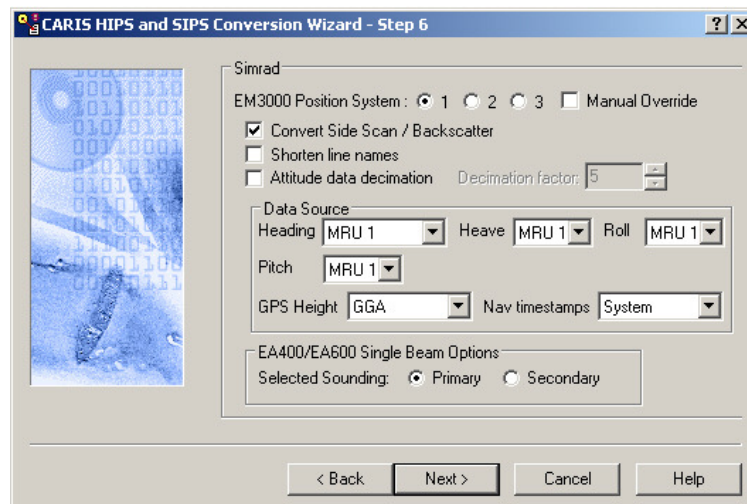


Figure 17: Step 6 of the Conversion Wizard

## 4.3 Save session (HIPS and SIPS User's Guide – page 159)

Save the currently open data as a session file (**File/Save Session As**).



#### 4.4 Clean auxiliary sensor data (HIPS and SIPS User's Guide – page 261)



Open the **Navigation Editor** to view and clean the vessel's navigation data. Take a look at the navigation for each survey line to make sure, that no error in the GPS will affect the measured data. When detecting GPS errors mark them with the left mouse button and press either



**Reject-With Interpolation** or



**Reject-Break Interpolation** to remove outlier data.

When finished, save and close the navigation editor.

#### 4.5 Sound velocity correction (Optional)



**Only relevant if not already applied in SIS.** Select the survey lines the sound velocity data shall be applied to and click **Sound Velocity Correction**. Select the respective \*.asvp file and press **OK**.

#### 4.6 Load Tide (HIPS and SIPS User's Guide – page 215)



Select the survey lines and press **Load Tide**. Select the respective \*.tid file and press **OK**.

**NOTE:** The tide file should have the following format:

Date (YYYY/DD/MM) Time (00:00:00) Tide (0.00) >> (2010/09/02 02:50:00 1.50)

#### 4.7 Merge (HIPS and SIPS User's Guide – page 253)



To create a position/depth value for each sounding select a line or group of lines and press **Merge**. Lines must have tide loaded before they can be merged.

#### 4.8 Process swath data (HIPS and SIPS User's Guide – page 299)



Open the **swath editor** to examine and clean soundings recorded by the multibeam system. With this tool it is possible to reject wrong bottom detection beams. It is possible to flag false beams and accept beams.



#### 4.9 Define new field sheets (HIPS and SIPS User's Guide – page 349)



To define a new field sheet select **New Field Sheet**.

1. Type a name for the field sheet in the **Name** text box – Click **Next**
2. Select a map projection (**UTM-WGS84**) and zone for the field sheet - Click **Next**
3. Press the cross line button and define the field sheet extents by using the mouse to create a rectangle defining the extents– Press **Finish**

#### 4.10 Generate BASE surface (HIPS and SIPS User's Guide – page 408)

To create a BASE surface (bathymetric grid), click on the field sheet – right mouse click – create BASE surface. Enter the desired resolution and foot print in pixel. Common settings are 2 m single resolution, surface type swath angle and a foot print of 9 pixels.

#### 4.11 Export data (HIPS and SIPS User's Guide – page 585)

To export data go to **File/Export**. All possible export options are listed. For external use only, the exports *HIPS to ASCII*, *BASE Surface To ASCII* and *BASE Surface To Image* are recommended. Please note that an export can last several hours, in particular HIPS to ASCII, depending on data size.

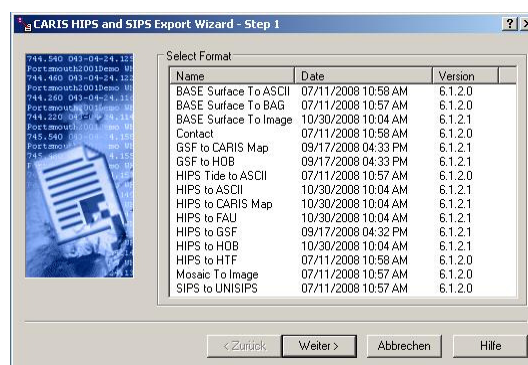


Figure 18: CARIS HIPS and SIPS Export options



## 5 Tips and tricks

### 5.1 Planning survey lines in SIS

A survey is normally planned taking the following into account:

- Echo sounder coverage
- Seafloor topography
- Sound speed variations
- Weather conditions

**Please note, that all drawing and selecting commands are performed by pressing CTRL & left mouse button. To end all kind of drawings, the changes must be confirmed by clicking CTRL & right mouse button and accept.**

To create a new job click **New Job**, enter a descriptive name of the job and select the preferred coordinate format. Then a new line or polygon can be created – depending on the survey plan - by activating the corresponding button (**New Line/New Polygon**). The respective mode is active until another option is selected or the button is pressed once more. Create a new line or polygon by holding the CTRL key while clicking the left mouse button for each new point of the line or for each node in the polygon respectively. At the end click CTRL and the right mouse button to accept the operation. Lines/Polygons can be edited using **Edit selected**. Note that the object has to be selected first. Now it is possible to insert for example the exact coordinates of the line/polygon.

#### **Fill Polygon**

A polygon can be filled with lines with specific line spacing. Therefore a new line just outside but near the polygon has to be created. The length of the line should be related to the maximum extent of the polygon in this orientation. For filling the polygon select both the polygon and the line and press **Fill Polygon**. Now the distance and spacing between the parallel lines can be defined (both port and starboard directions). How to determine the line spacing is explained in the following chapter. Every line has a defined direction, marked with a square at the start of the line. To reflect the sailing, select every second line and press **Reverse Line**. When finished save the job (**Save Job**). The coordinates of the start- and endpoints of the new survey lines will be saved as a ASCII file under E:\sisdata\common\planning.



## 5.2 Line spacing

To determine the line spacing the achievable coverage of the multibeam echo sounder and the overlap required between neighbouring lines is required. The echo sounder coverage depends on the opening angle ( $\alpha$ ) of the multibeam and the water depth ( $h$ ) (Figure 19).

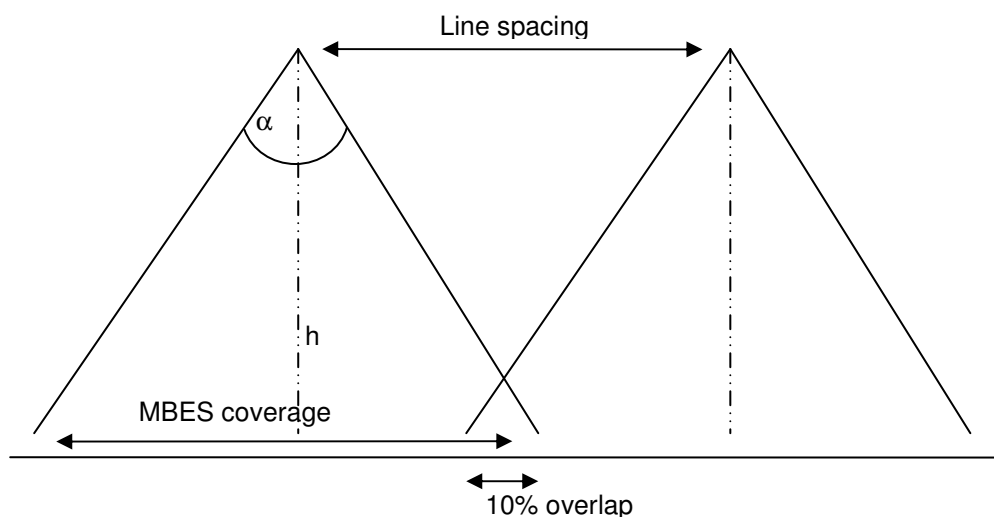


Figure 19: Important parameters for determining the line spacing

For a full coverage survey, including 10 % overlap, the line spacing can be calculated as follows:

$\alpha$	=	$55^\circ$	
$h$	=	30 m	
MBES coverage	=	$\tan(55) \cdot 30 \cdot 2$	= 85.7 m
Overlap (10%)	=	$0.1 \cdot (\tan(55) \cdot 30)$	= 4.3 m
Line spacing:	=	MBES coverage – Overlap	= 85.7 m – 4.3 m = 81.4 m

The vessel speed depends on the desired resolution and on the weather condition while acquiring the data. Typically a speed of 6 knots is appropriate.