Patch Test Calibration

with NaviModel

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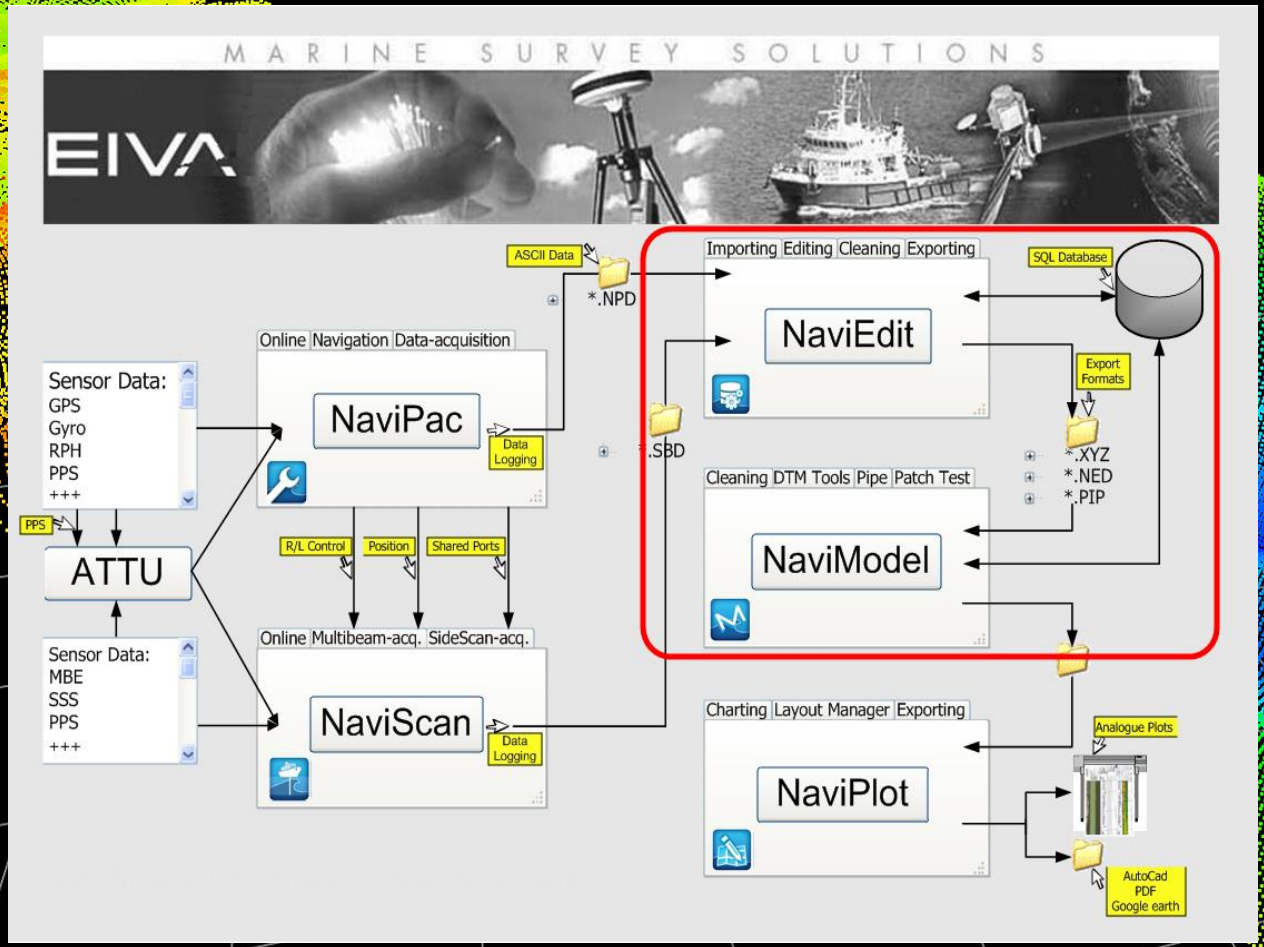

MARINE SURVEY SOLUTIONS
EIVA
ASCII Data
*.NPD
Importing Editing Cleaning Exporting
SQL Database
NaviEdit
Export Formats
Online Navigation Data-acquisition
Sensor Data:
GPS
Gyro
RPH
PPS
+++
NaviPac
Data Logging
*.SBD
*.XYZ
*.NED
*.PIP
Cleaning DTM Tools Pipe Patch Test
NaviModel
PPS
ATTU
R/L Control
Position
Shared Ports
Online Multibeam-acq. SideScan-acq.
Sensor Data:
MBE
SSS
PPS
+++
NaviScan
Data Logging
Charting Layout Manager Exporting
Analogue Plots
NaviPlot
AutoCad
PDF
Google earth

Patch Test – Purpose of the Calibration

A multibeam Patch Test calibration serves a dual purpose:

a. To determine the mount angles of the multibeam transducer relative to the three axes of the local coordinate system of the vessel/ROV. These three figures are often referred to as the roll-, pitch- and heading mount angles.

b. To confirm the relationship between the time-tagging on the multibeam data and the time-tagging on the position data. This figure is often referred to as the latency or as the time value.

Patch Test – Prior to the Calibration

Bearing in mind the purpose of a Patch Test, it is necessary, prior to the calibration, to:

a. Calibrate relevant sensors (gyro, motion) relative to the local coordinate system of the vessel/gyro.

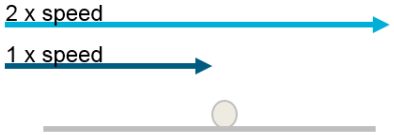
b. Configure NaviPac/NaviScan as well as the multibeam echo-sounder to correctly utilize the same, accurate time reference for the time-tagging of the various sensor data.

Patch Test – Sequence in Processing

To enable the values to be isolated and quantified, some pre-defined datasets in specific patterns must first be collected and then processed in a given sequence. The recommended sequence of Patch Test processing is:

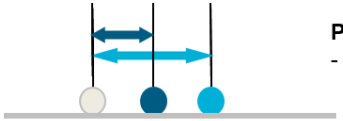
- Time.
- Pitch.
- Roll.
- Heading.

1. Time Calibration



Seabed with well defined target/edge

Result of **Time/Latency** error:



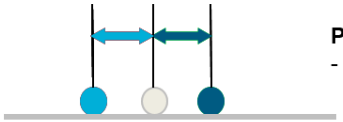
Longitudinal profiles view

Position error, function of:
- speed and latency

2. Pitch Calibration

Seabed with well defined target/edge

Result of **Pitch** mount angle error:



Longitudinal profiles view

Position error, function of:
- mount error and depth

3. Roll Calibration

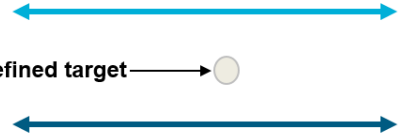
Flat seabed

Result of **Roll** mount angle error:

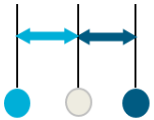
Cross profiles view

Depth error, function of:
- mount error, beam angle and depth

4. Heading Calibration



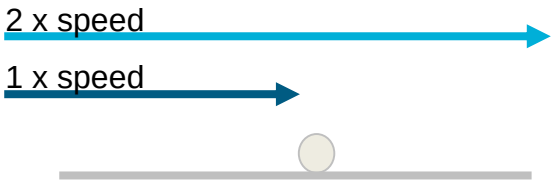
Result of **Heading/Yaw** mount angle error:



XY-view

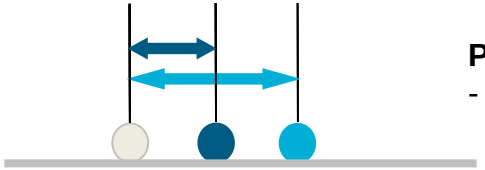
Position error, function of:
- mount error, beam angle and depth

Patch Test – 1. Time Calibration



Seabed with well defined target/edge

Result of **Time/Latency** error:



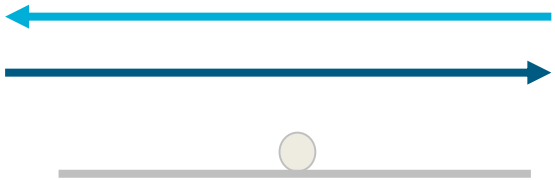
Position error, function of:
- speed and latency

Conditions for the time calibration:

1) The same runline, over a well defined target, must be sailed twice, in the same direction but with a significantly different, constant speed and with a constant heading.
2) Determination of the latency is done in a longitudinal profile underneath the transducer.

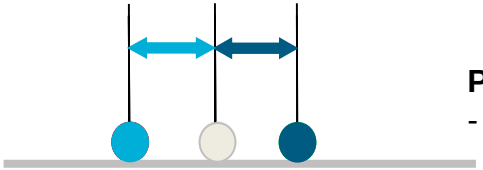
- Influences from a pitch mount error can thus be ignored – these will be identical when sailing in the same direction.
- Influences from roll and heading mount errors can also be ignored, since these are both a function of the beam angle.

Patch Test – 2. Pitch Calibration



Seabed with well defined target/edge

Result of **Pitch** mount angle error:



Position error, function of:
- mount error and depth

Conditions for the pitch calibration:

1) The same runline, over a well defined target, must be sailed twice, in opposite directions, with the same, constant speed and with a constant heading.
2) Determination of the pitch mount angle is done in a longitudinal profile directly underneath the transducer.
3) Result from the latency determination is used in the calculations.

- Influences from roll and heading mount errors can be ignored, since these are both a function of the beam angle.

Patch Test – 3. Roll Calibration

Flat seabed

Result of **Roll** mount angle error:

Cross profiles view

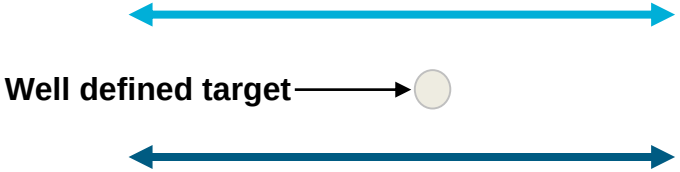
Depth error, function of:
- mount error, beam angle and depth

Conditions for the roll calibration:

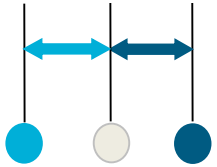
1) The same runline, above a flat seabed, must be sailed twice, in opposite directions, with the same, constant speed and with a constant heading.
2) Determination is done using the entire model/swathe area.
3) Result from the latency and pitch mount angle determinations are used in the calculations.

- Influences from a heading mount error can be ignored, since it is associated with position (not depth).

Patch Test – 4. Heading Calibration



Result of **Heading/Yaw** mount angle error:



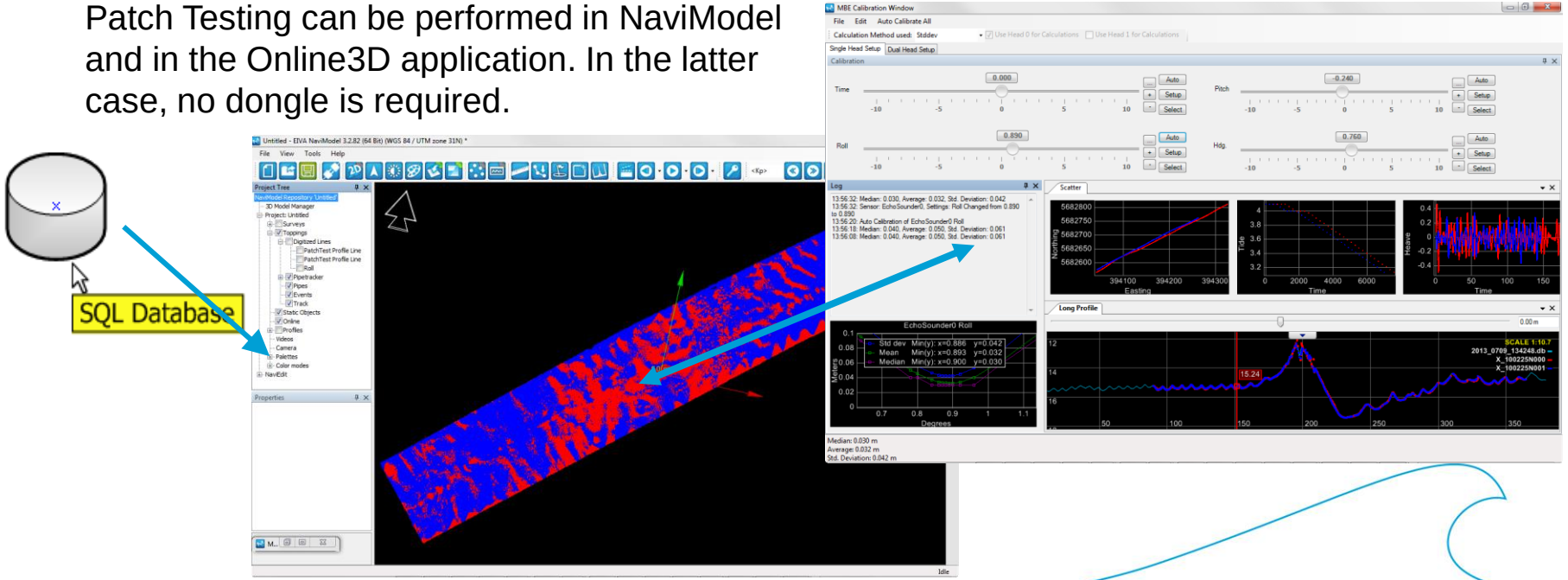
Position error, function of:
- mount error, beam angle and depth

Conditions for the heading calibration:

1) Two different runlines, with a well defined target between them, must be sailed, in the same (or opposite) direction, with the same, constant speed and with a constant heading.
2) Determination of the heading mount error is done in a longitudinal profile that goes through the target.
3) Result from the latency and from pitch- and roll mount angles determinations are used in the calculations.

Patch Testing – in NaviModel/Online3D

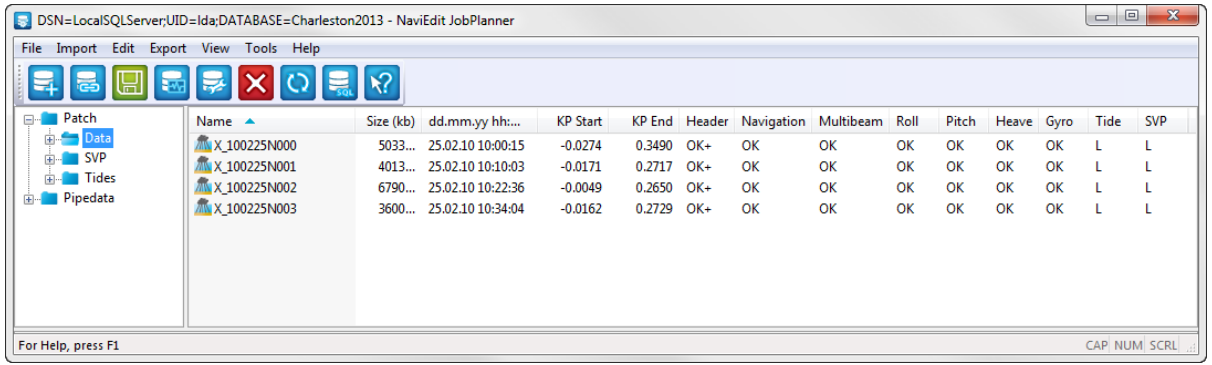
Patch Testing can be performed in NaviModel and in the Online3D application. In the latter case, no dongle is required.



Patch Test Preparation I

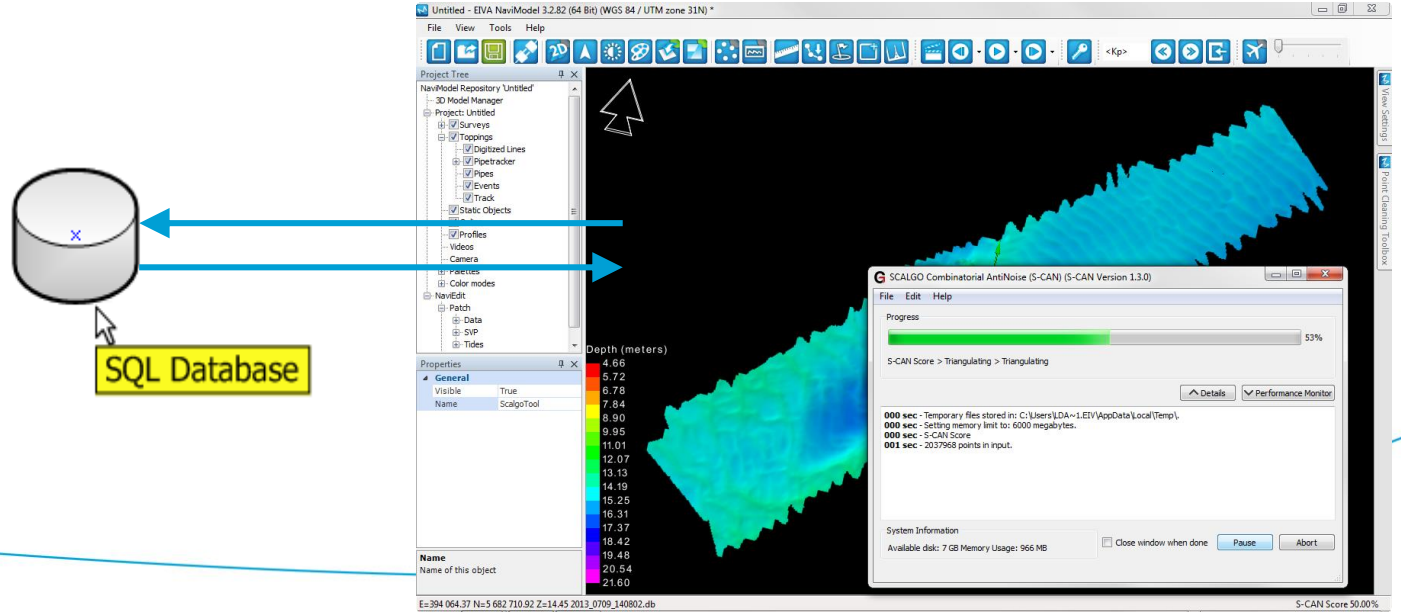
The first step in the patch test preparation is to read the files acquired for the Patch Test into NaviEdit. Here the data must be edited and checked for gross errors (offsets, C-O values, latencies etc.). The data must also be corrected for tidal- and for sound-velocity variations. The user can also choose to use PointEdit to manually clean the data.

Once this has been done, the NaviEdit JobPlanner can be closed.



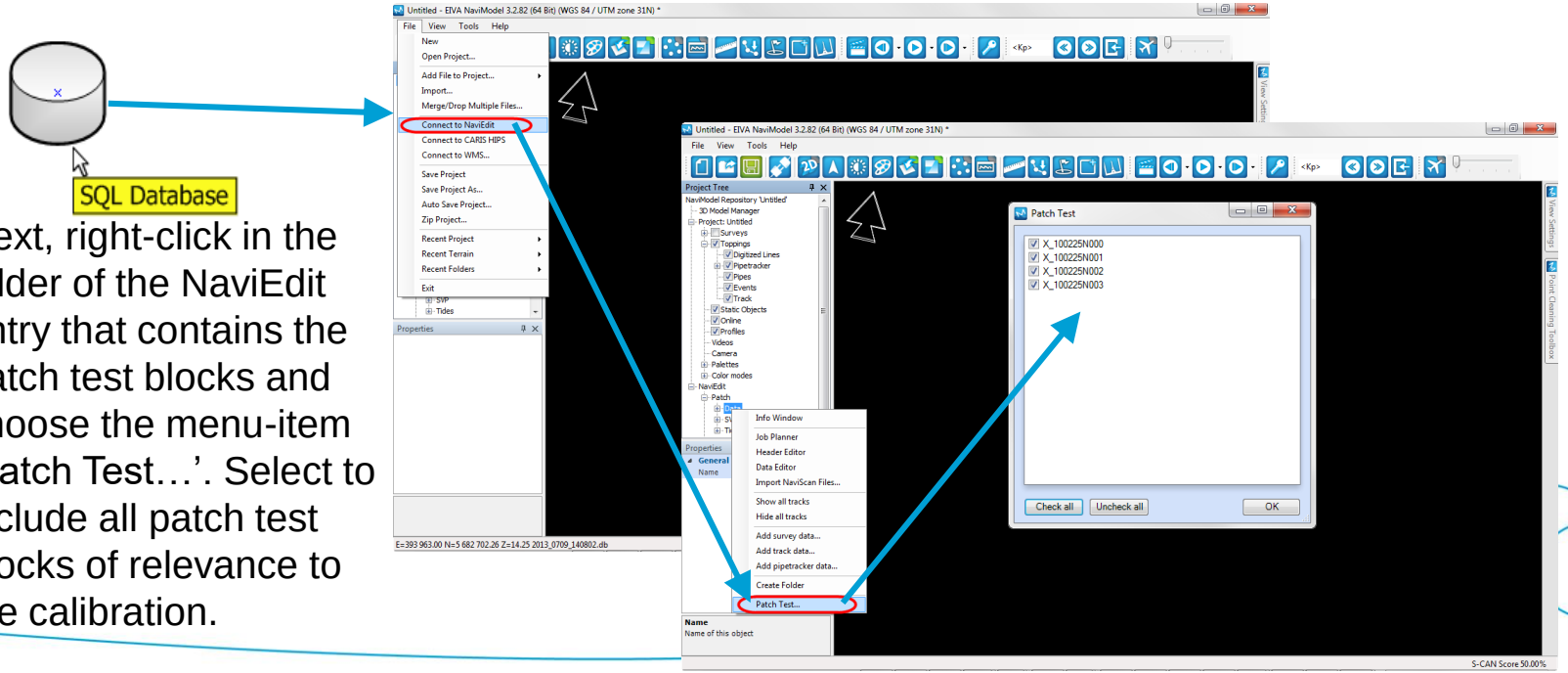
Patch Test Preparation II

The second step is to perform automatic cleaning of the patch test data blocks in NaviModel, using the S-CAN automatic cleaning tool. Once cleaning is performed, data must be returned to the NaviEdit database.



Patch Test Preparation III

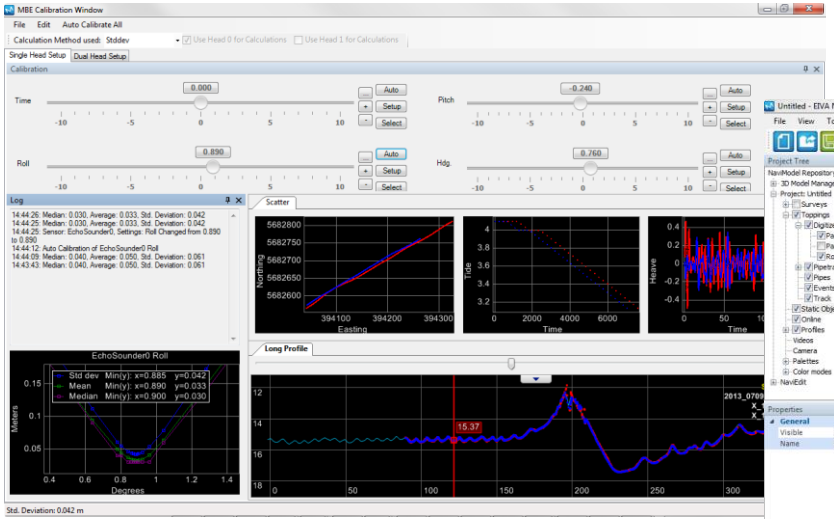
On a new NaviModel project, a connection to NaviEdit must now be established.



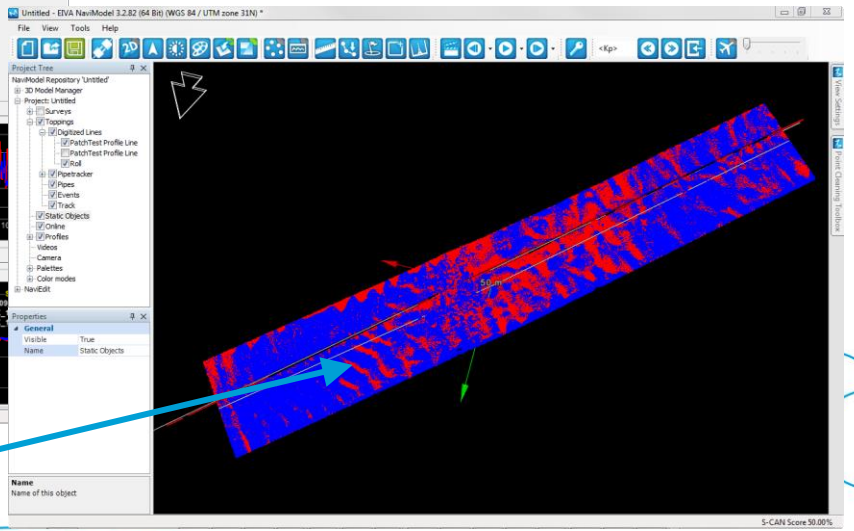
Next, right-click in the folder of the NaviEdit entry that contains the patch test blocks and choose the menu-item ‘Patch Test…’. Select to include all patch test blocks of relevance to the calibration.

Patch Test Preparation IV

The MBE Calibration Window will now open with the default layout. For each of the four calibration types, a slider bar shows the values entered into the NE database.

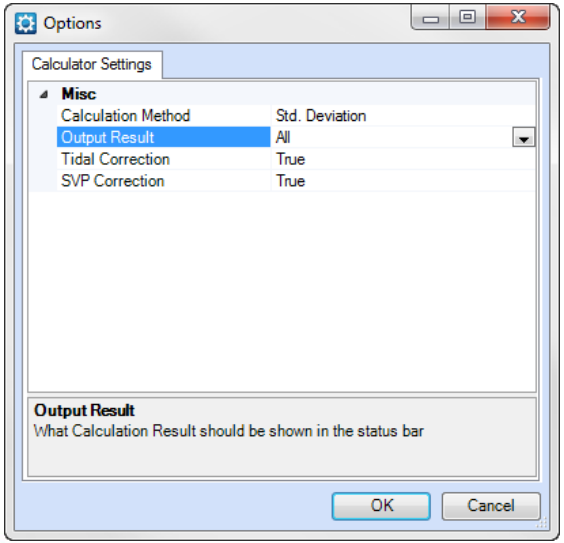


At the same time, a representation of the blocks is shown in the DTM window.



Patch Test Preparation V

The last thing to do before the actual Patch Test Calibration can take place, is to define the ‘Calculator Settings’. This is done via the menu item ‘Edit – Calculation Setup’. The dialogue below will appear, in which the following can be defined:



Calculation method: defines the method for auto calibration (recommendation: St. Deviation).

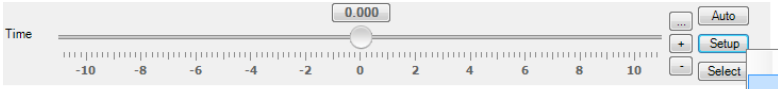
Output Results: defines the calibration results to be shown in the status bar (recommendation: All).

Tidal Correction: the user can define whether tidal correction should be applied to the data (recommendation: True).

SVP Correction: the user can define whether SVP correction should be applied to the data (recommendation: True).

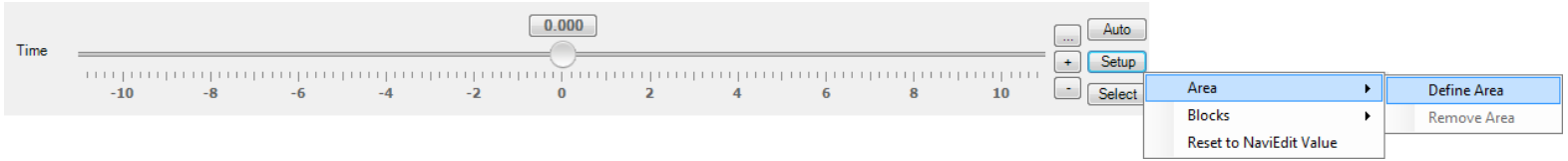
Time Calibration I

To perform a time-calibration, the same runline, over a well defined target, must be sailed twice, in the same direction but with a significantly different, constant speed. The two relevant blocks must be selected for the time calibration (Setup – Blocks). They will, as a consequence, be shown as active in the DTM window. NM will remember the selection for future reference.

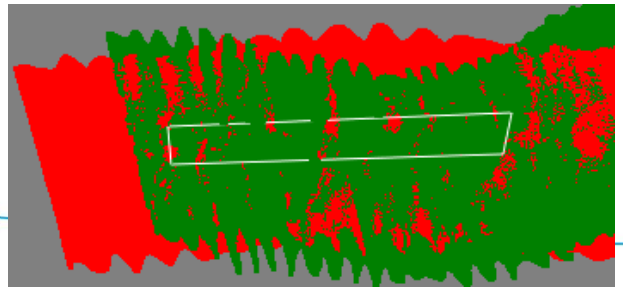


Time Calibration II

Now activate selection of an area for the time calibration, using the ‘Setup – Area – Define Area’ menu-item:

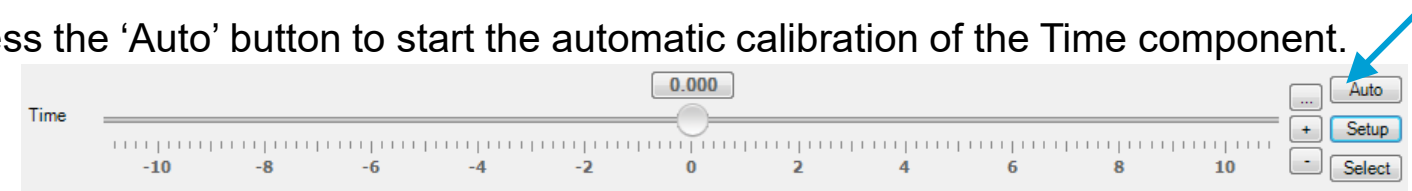


The area can be defined using the mouse. For time calibrations, the CL must be directly underneath the transducer for both blocks. The width of the area must also be sufficiently small to avoid potential influences from un-modeled heading mount errors. Alternatively a digitized line can be used to define the area (below middle and right).



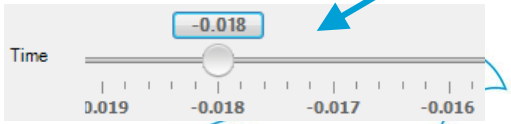
Time Calibration III

Press the ‘Auto’ button to start the automatic calibration of the Time component.



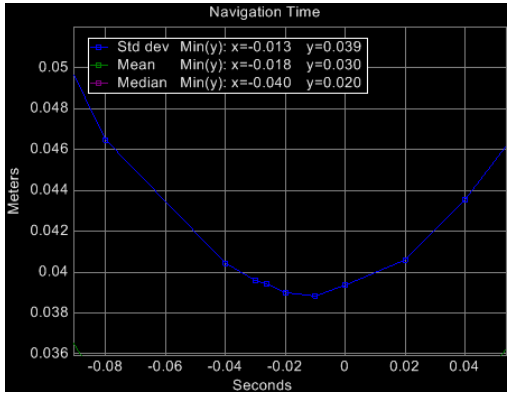
NaviModel will calculate the optimum solution for the Time component, based on a comparison between the two pseudo surfaces, that in turn are based on the two blocks. The optimization is based on the method selected for auto calibration. The recommended method is std., which basically means that NaviModel will find the Time value for the selected area, that yields the smallest average standard deviation of the difference between the two pseudo surfaces. NaviModel will show the best automatic result in the slider label.

The resolution of the slider and of the label can be changed by clicking on the time axis and then rotating the mouse wheel. This can also be accomplished by pressing the +/- buttons to the right of the axis.



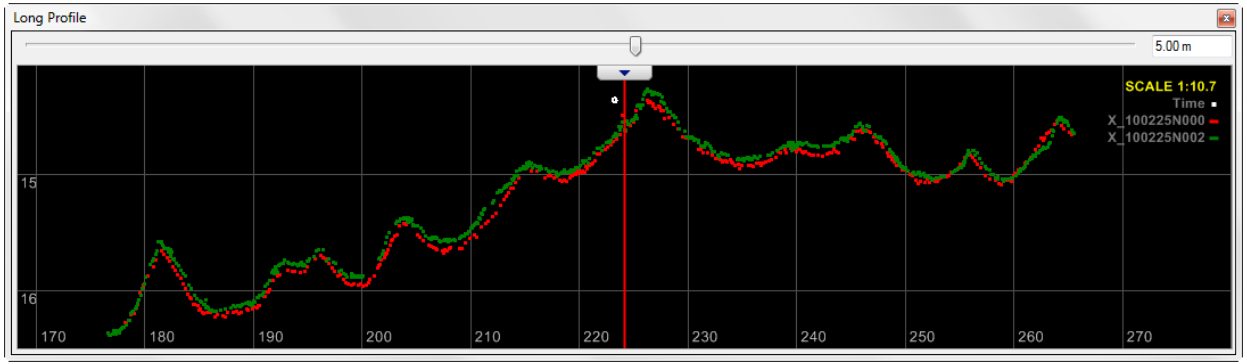
Time Calibration IV

NaviModel offers a series of tools that can be used to optimize the decision making:



The graph shows the relationship between different time values (x-axis) and std., mean and median on the y-axis. In the graph above only the std. is shown graphically. Note that the results for the std., mean and median calculations are also given alphanumerically.
The results must be significant: changes in x-axis direction, relative to the best fit result should result in significant and unambiguous changes in y-values. To assist the decision making, zooming and panning can be performed on the graph, using the mouse wheel.

Time Calibration V

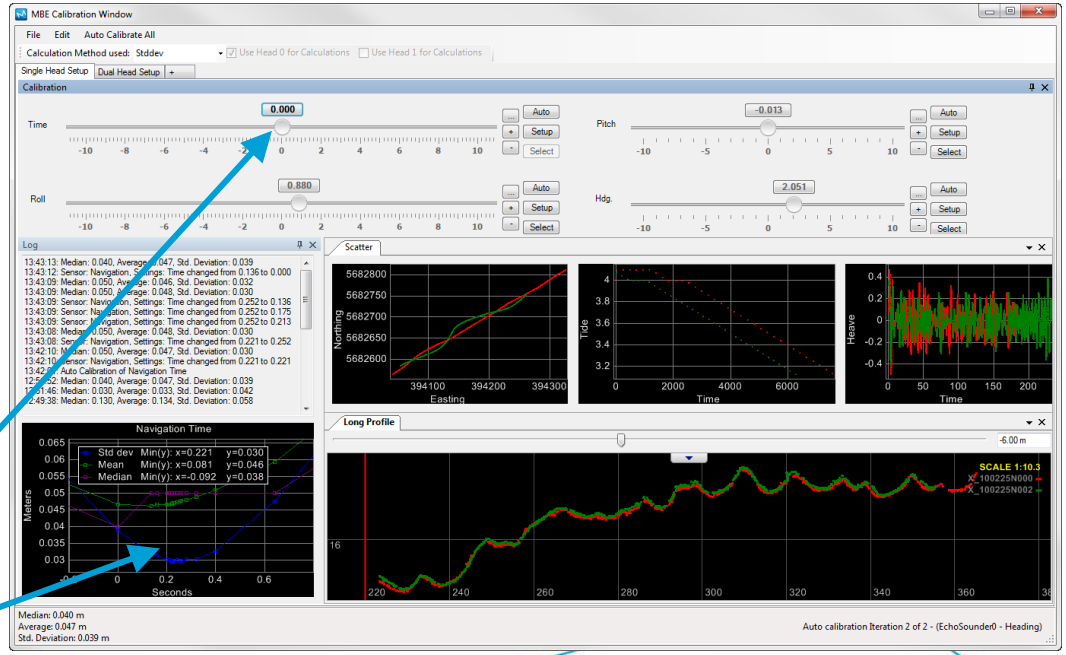


The longitudinal profile shows the relationship between the two blocks in a profile along the CL. For time calibration, the two profiles must match with respect to position in the significant locations (the well defined target(s)). It is up to the user to ensure this. The automatic results can be used as an indication only. The assessment of the final result must be made, based on a visual evaluation of all results, with focus on the longitudinal profile. To improve the quality of this assessment, zoom in and pan onto the relevant data. Depress the mouse wheel to pan, use wheel for zoom, shift+wheel for vertical zoom only and ctrl+wheel for horizontal zoom only.

Time Calibration VI

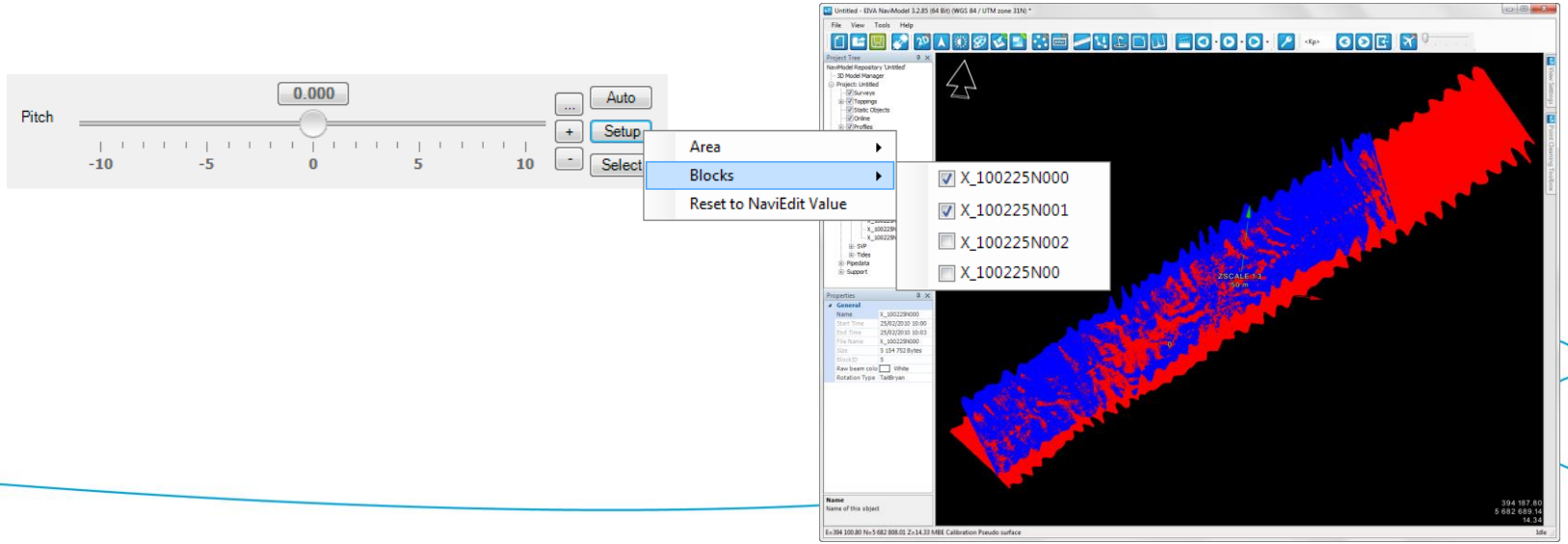
Theoretically the final result of a time calibration must be 0 ms, since NaviPac/NaviScan and the multibeam echo-sounder has been configured to utilize the same, accurate time reference for the time-tagging of the sensor data. The time-calibration must therefore primarily be regarded a check of the configuration.

Choose the optimum result in the slider (0 ms) and see the result visualised in the different windows.



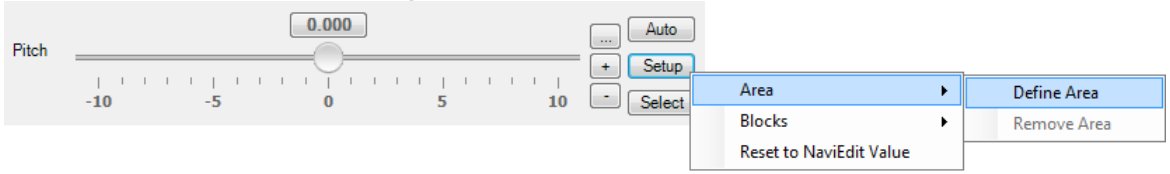
Pitch Calibration I

To perform a pitch calibration, the same runline, on top of a well defined target, must be sailed twice, in opposite directions, with the same, constant speed and with a constant heading. The two resulting blocks must be selected in the MBE Calibration Window. As a consequence they will be shown as active in the DTM window.

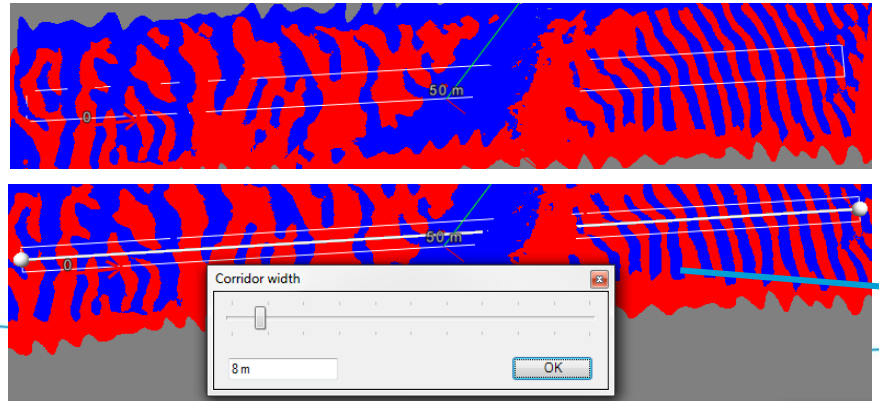


Pitch Calibration II

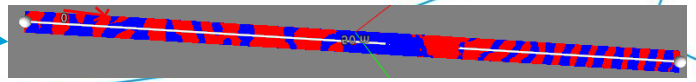
Activate selection of an area for the pitch calibration:



The area can be created using the mouse. The CL of the area must be directly underneath the transducer for both blocks. Furthermore the width of the area must be sufficiently small to avoid potential influences from un-modeled heading mount errors.

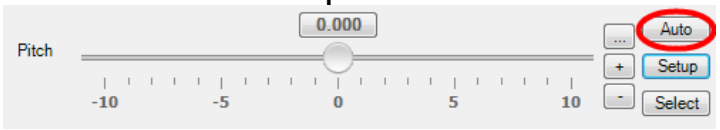


Alternatively a digitized line can be used to define the area with a constant width, as shown below.



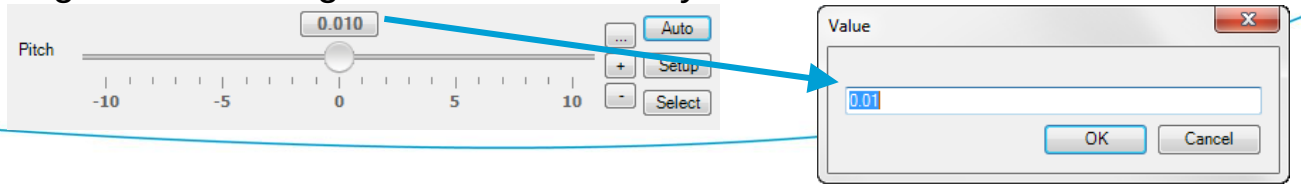
Pitch Calibration III

Now press the ‘Auto’ button next to the pitch slider to start the automatic calibration of pitch.

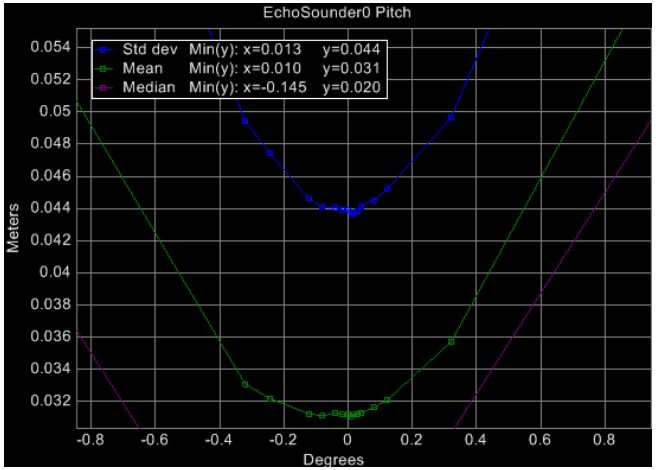


NaviModel will calculate the optimum solution for the pitch, based on a comparison between the two pseudo surfaces, that in turn are based on the two blocks. With std. selected as the method for auto calibration, NaviModel will try to find the pitch value for the selected area, that yields the smallest average standard deviation of the difference between the two pseudo surfaces.

Upon completion of the auto calculation, NaviModel will show the best automatic result for pitch in the slider label. The value can be changed manually by double-clicking on the label or by using the left and right arrows on the keyboard.

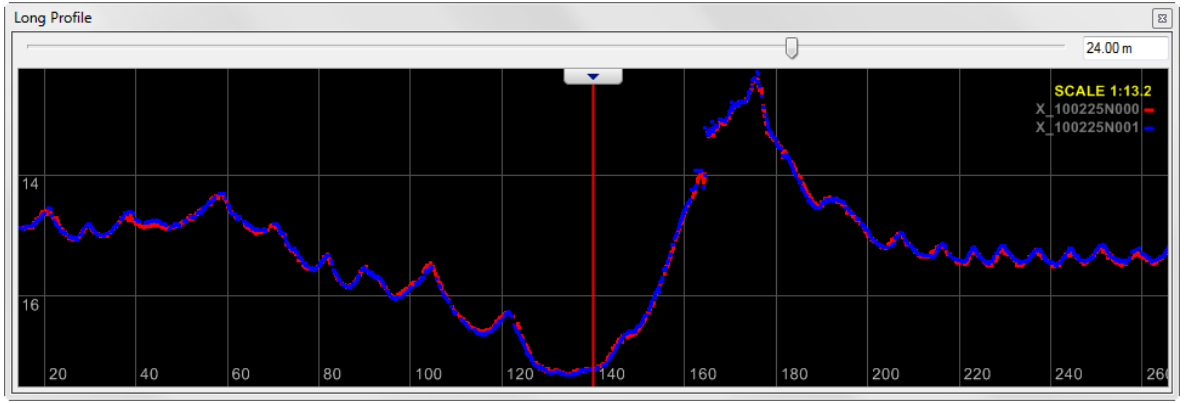


Pitch Calibration IV



The graph, that visualizes the relationship between different pitch values (x-axis) and std., mean and median, respectively on the y-axis is given above. In this case all results, originating from std., mean as well as median are shown graphically and alphanumarically.

Pitch Calibration V

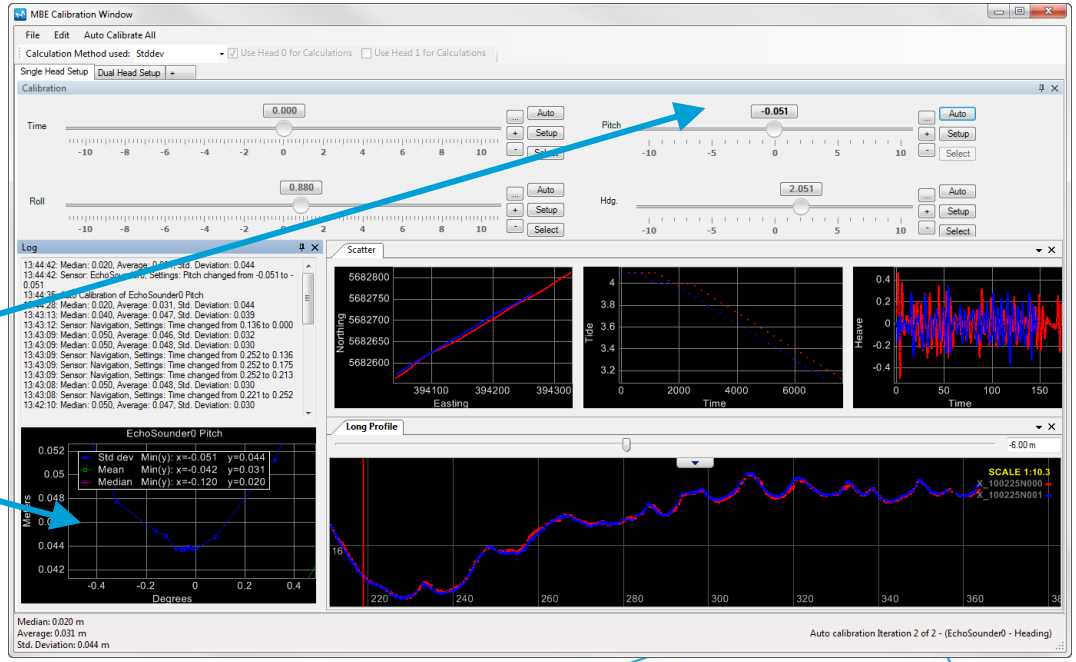


The longitudinal profile shows the relationship between the current blocks in a profile along the CL. For a pitch calibration, the two blocks must match with respect to position in the significant locations (the well defined target(s)). It is up to the user to ensure this. The automatic results can be used as an indication only. The assessment of the final result must be made, based on a visual evaluation of all results, with focus on the longitudinal profile.

To improve the quality of this assessment, zoom in and pan onto the relevant data.

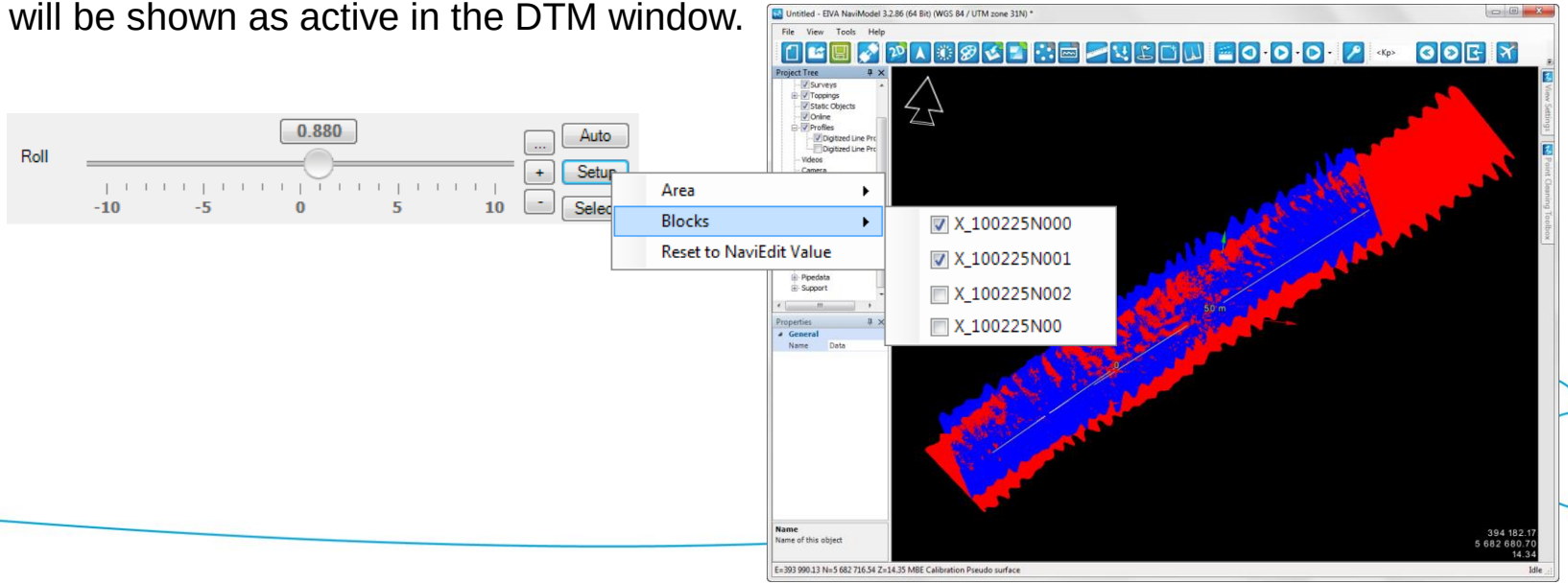
Pitch Calibration VI

The assessment of the final result must be made by the user, based on a visual evaluation of the results. To improve the quality of this assessment, zoom in on the relevant data. When finished, select the desired result in the pitch slider and see the result visualised in the other windows.



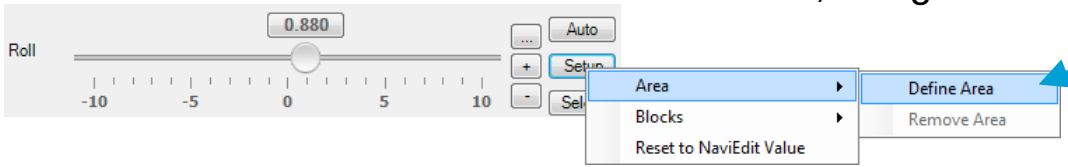
Roll Calibration I

To perform a roll calibration, the same runline, above a flat seabed, must be sailed twice, in opposite directions, with the same, constant speed and with a constant heading. The two resulting blocks must be selected in the MBE Calibration Window. As a consequence they will be shown as active in the DTM window.

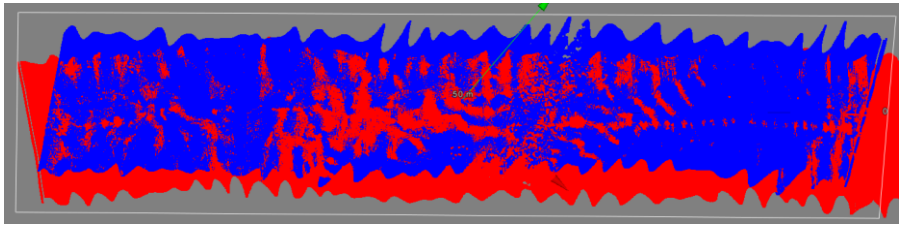


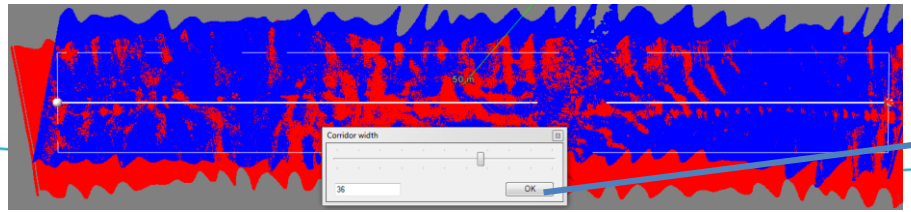
Roll Calibration II

Now activate selection of an area for the roll calibration, using the browse button:



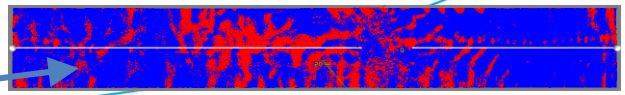
The area can be created using the mouse. For the roll calibration, the user can even choose to use the entire area for the calibration, as shown below.





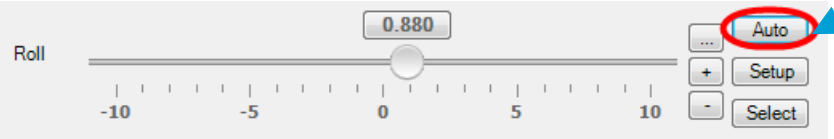
Alternatively a digitized line can be used to define the area.

Either way however, the width of the area must be selected to include the outer beams of the survey.



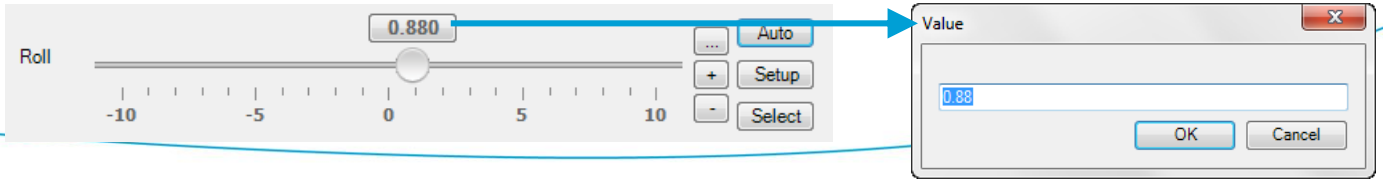
Roll Calibration III

Press the ‘Auto’ button in the to start the automatic calibration of roll.

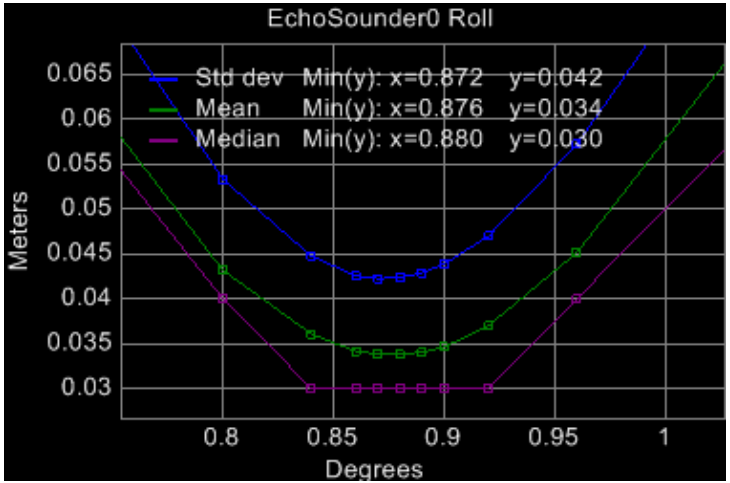


NaviModel will calculate the optimum solution for the roll, based on a comparison between the two pseudo surfaces, that in turn are based on the two blocks. With std. selected as the method for auto calculation, NaviModel will try find the roll value for the selected area, that yields the smallest average standard deviation of the difference between the two pseudo surfaces.

NaviModel will show the best automatic result for roll in the slider label. This value can be changed manually by clicking on the label or by using the left/ right arrows on the keyboard.



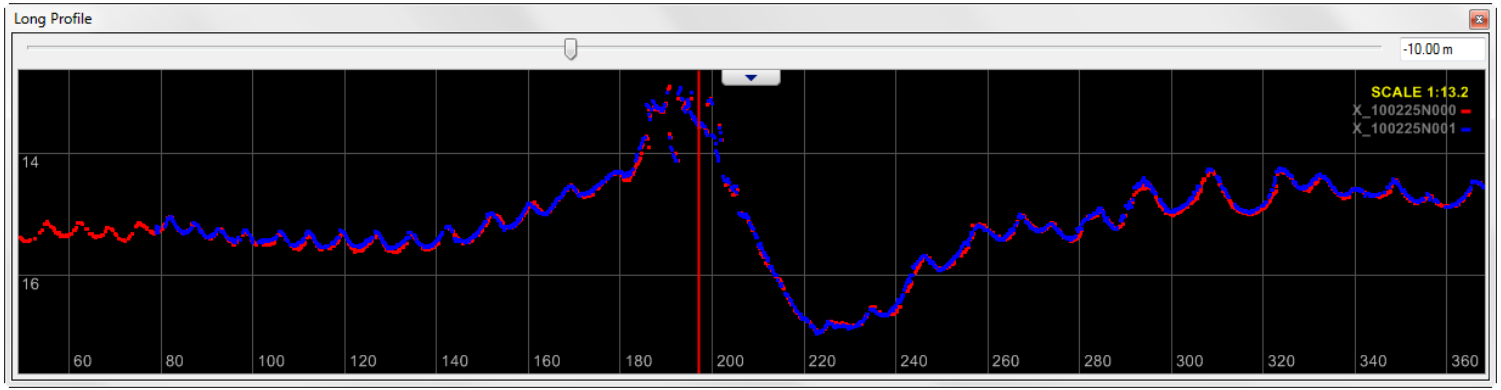
Roll Calibration IV



The graph, that visualizes the relationship between different Roll values (x-axis) and std., mean and median, respectively on the y-axis is given above.

The results for the std., mean and median calculations are also given alpha-numerically. Note how similar these are (between 0.87 and 0.88 degrees in all cases).

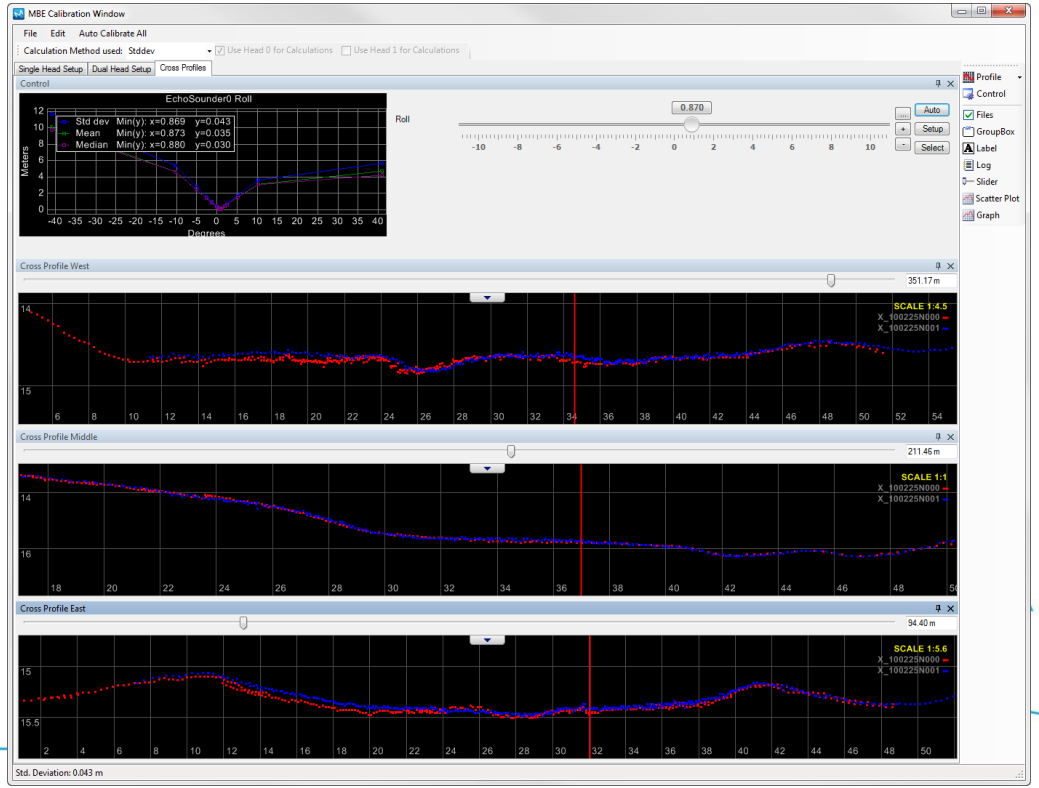
Roll Calibration V



The longitudinal profile shows the relationship between the current blocks in a profile along a line defined in NM. For a roll calibration, the two blocks must match with respect to depth throughout the profile. Note that the profile evaluation for the roll component should be made in different locations, as a minimum on outer beams at both sides of the area. The automatic results can normally be used as final results for the roll calibration. Having said this, it is still recommended that the user makes his own visual evaluation of the results, primarily based on the longitudinal profile(s).

Roll Calibration VI

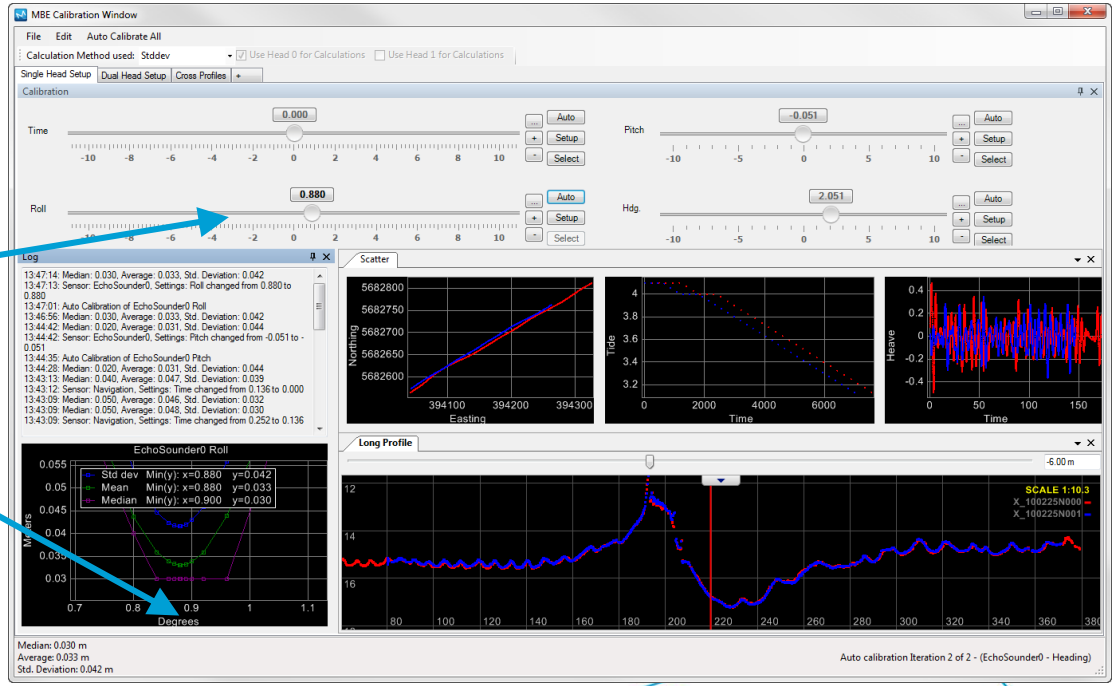
In addition to using the longitudinal profile, the user is encouraged to evaluate the roll results using cross profiles. These can be generated in the user defined layouts. An example is shown here where three different cross profiles (in different locations) have been added together with the roll slider and a graph window.
The user defined layouts work in parallel with the standard layout(s), and it is therefore possible to perform (part of) the roll calibration from here.



Roll Calibration VII

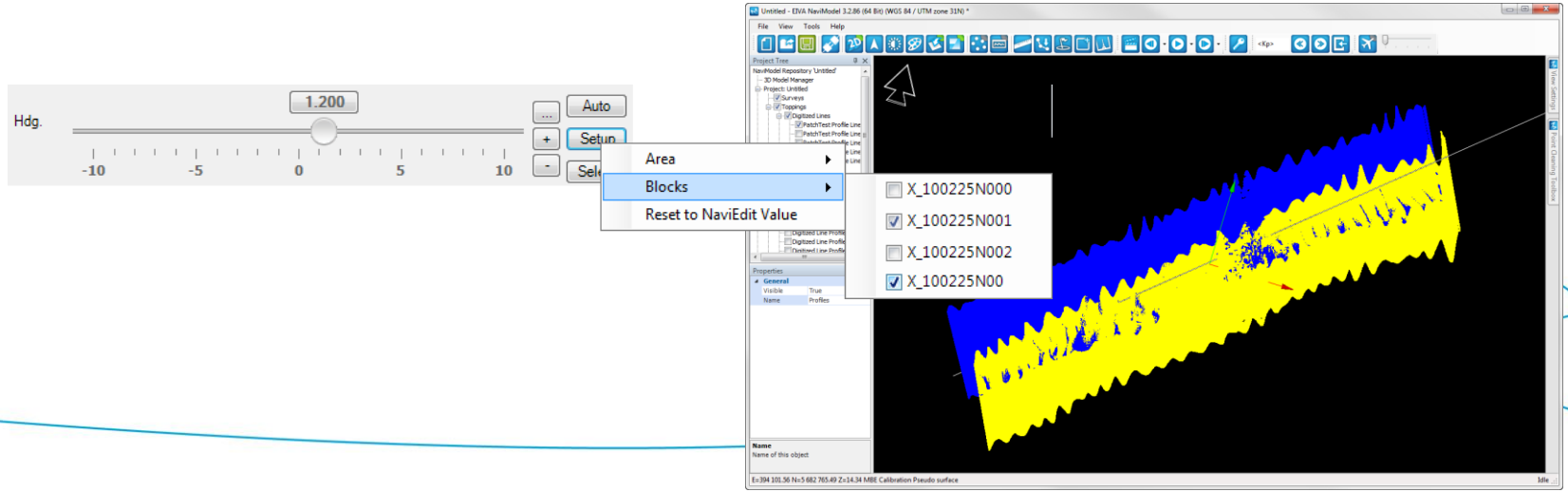
The assessment of the final result must be made by the user, based on a visual evaluation of the calculation results. When finished, select the desired result in the roll slider and see an immediate visualization in the other windows.

The highlighted result will be used as entry when creating the subsequent patch test report.



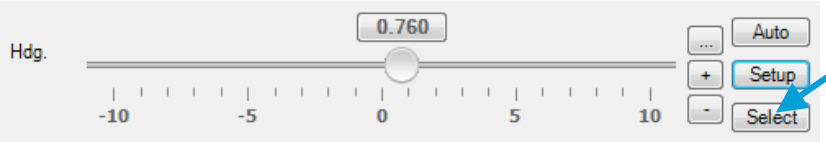
Heading Calibration I

To perform a heading-calibration, two different runlines must be sailed, in the same (or opposite) direction, with the same, constant speed and with a constant heading. Determination of the heading mount error must be done in a longitudinal profile that goes through the target(s). The two blocks must be selected in the MBE Calibration Window. As a consequence they will be shown as active in the DTM window.

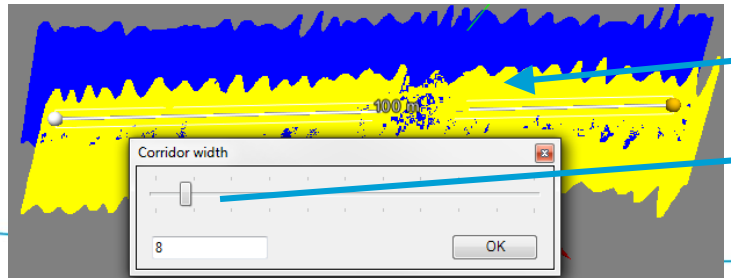


Heading Calibration II

Activate selection of an area for the heading calibration, using the browse button:



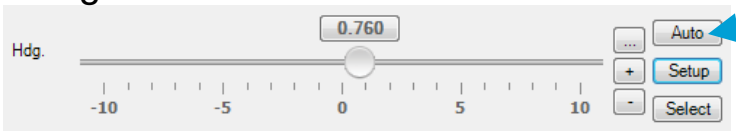
For a heading calibration, the CL of the area must be in the middle between the two blocks. The width of the area must furthermore be sufficiently small to avoid potential influences from un-modeled time and heading mount errors.



The area can be defined using the cursor or via a digitized line.

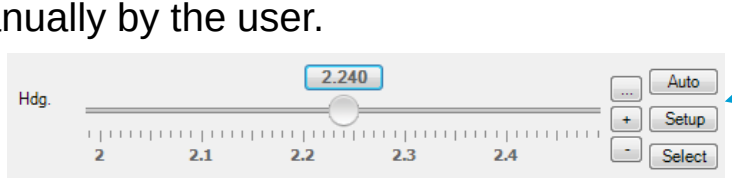
Heading Calibration III

Press the ‘Auto’ button in the ‘Hdg.’ slider to start the automatic calibration of heading.

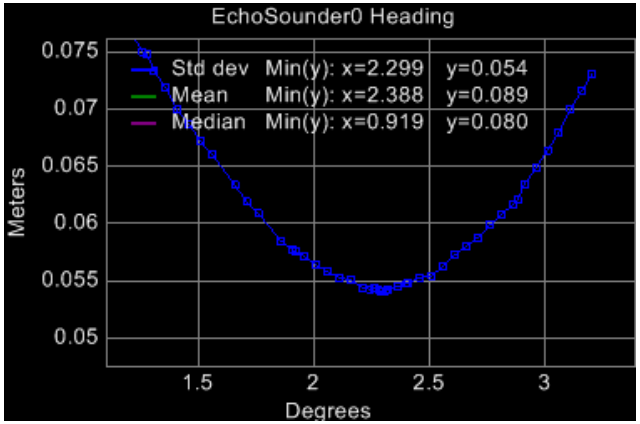


NaviModel will calculate the optimum solution for the heading, based on a comparison between the two pseudo surfaces. With std. selected as method selected for auto calibration, NaviModel will try to find the heading value for the selected area, that yields the smallest average standard deviation of the difference between the two pseudo surfaces.

NaviModel will show the best automatic result for heading in the slider label. This result can be changed manually by the user.



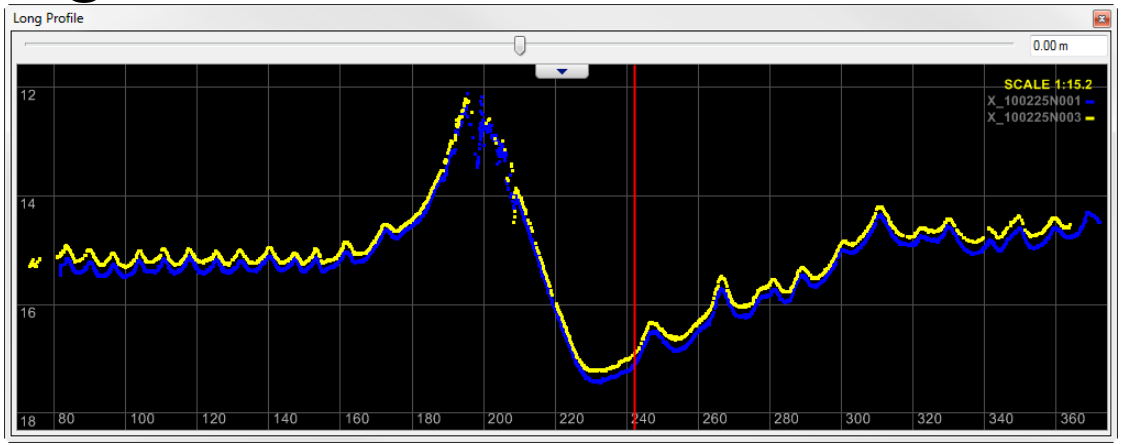
Heading Calibration IV



The graph, that visualizes the relationship between different Heading values (x-axis) and std., mean and median, respectively on the y-axis is shown above. The result must be significant: changes in the x-axis direction, relative to the selected result should result in significant and unambiguous changes in the y-values.

Note that, whenever the user manually moves away from the automatic results, using the arrows on the keyboard, new entries will appear in the graph as can be seen above.

Heading Calibration V

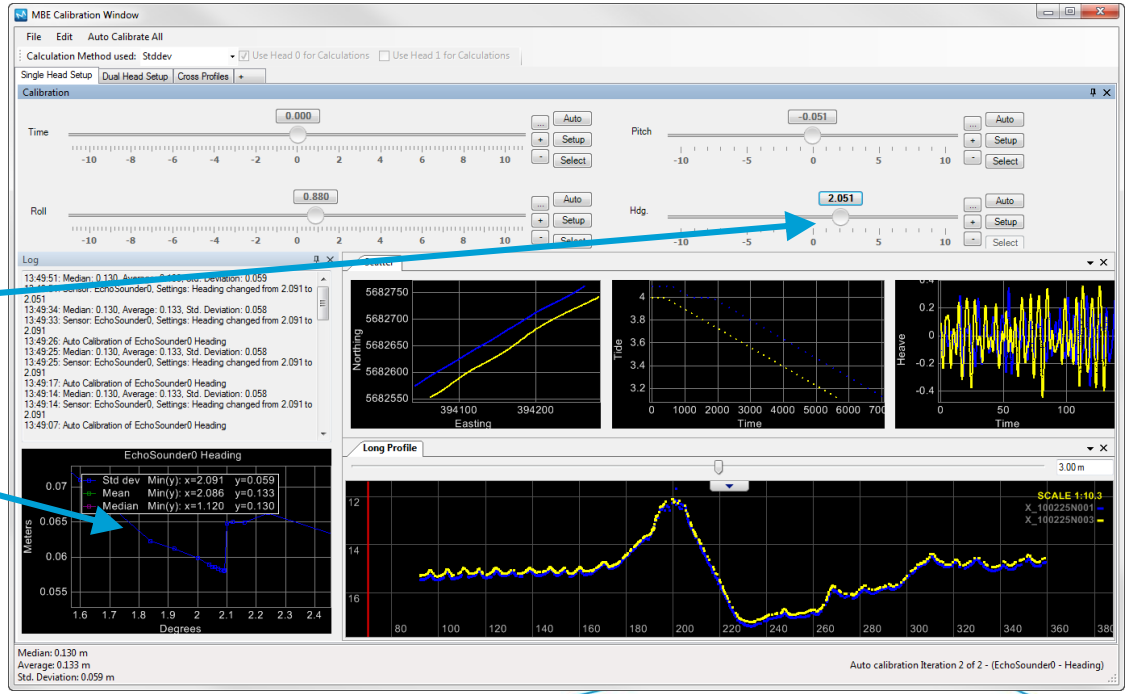


The longitudinal profile shows the relationship between the current blocks in a profile along a line defined in NM. For a heading calibration, the two blocks must match with respect to position throughout the profile. The profile assessment for the heading component should be made in a line parallel to the sailing direction, between the two blocks. The evaluation of the final result must be made by the user, based on a visual evaluation of all results, but primarily based on the longitudinal profile.

Heading Calibration VI

The assessment of the final result must be made by the user, based on a visual evaluation of the calculations. When a final result has been found, select the desired result in the heading slider and see an immediate visualization in the other windows.

The highlighted result will be used as entry when creating the subsequent patch test report.



Iterations I

It is often difficult to totally isolate influences from other sources (not constant speed, varying heading, noisy positioning etc.) when conducting a calculation. So therefore it is recommended to re-iterate the calibration calculations, with the obtained mount angles and the latency value from the first iteration, in order to investigate whether an additional fine-tuning is required.

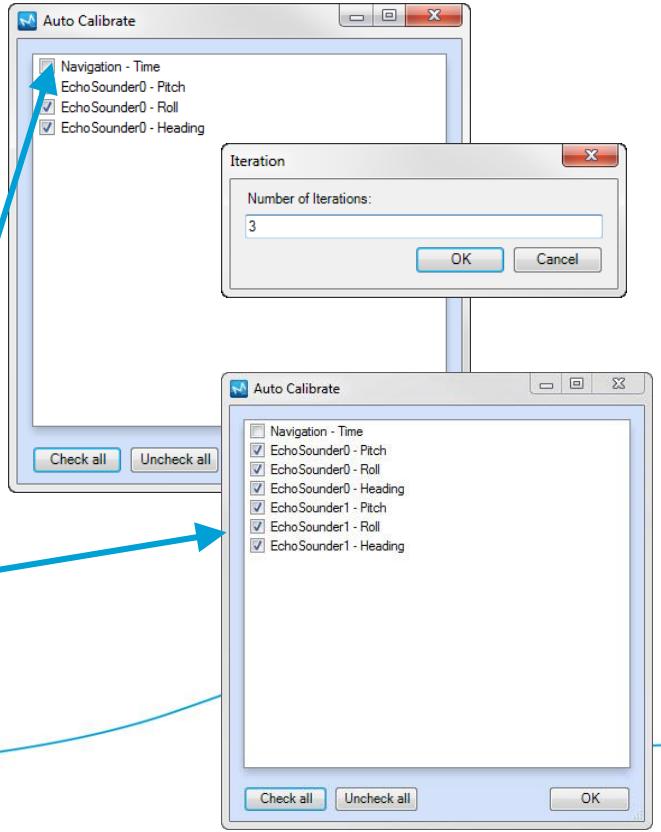
This is easily accomplished in NaviModel. The Patch Test tool facilitates a function to perform auto calibration in a number of iterations, the ‘Auto Calibrate All’ function. ‘Auto Calibrate All’ takes advantage of the fact that once the blocks and areas have been defined, they will be remembered by the Patch Test tool.

Iterations II

Automatic iterations can take place, without any user intervention. Through these iterations, it is consequently possible to compensate for the fact that in practice it is impossible to acquire the data for the calibration in the ideal patterns to ensure that influences from unmodelled mountings can be ignored. Typically three iterations is recommended.

Note that normally no iterations are conducted on the time component.

For dual head systems, both heads can be ‘Auto Calibrated’ concurrently.

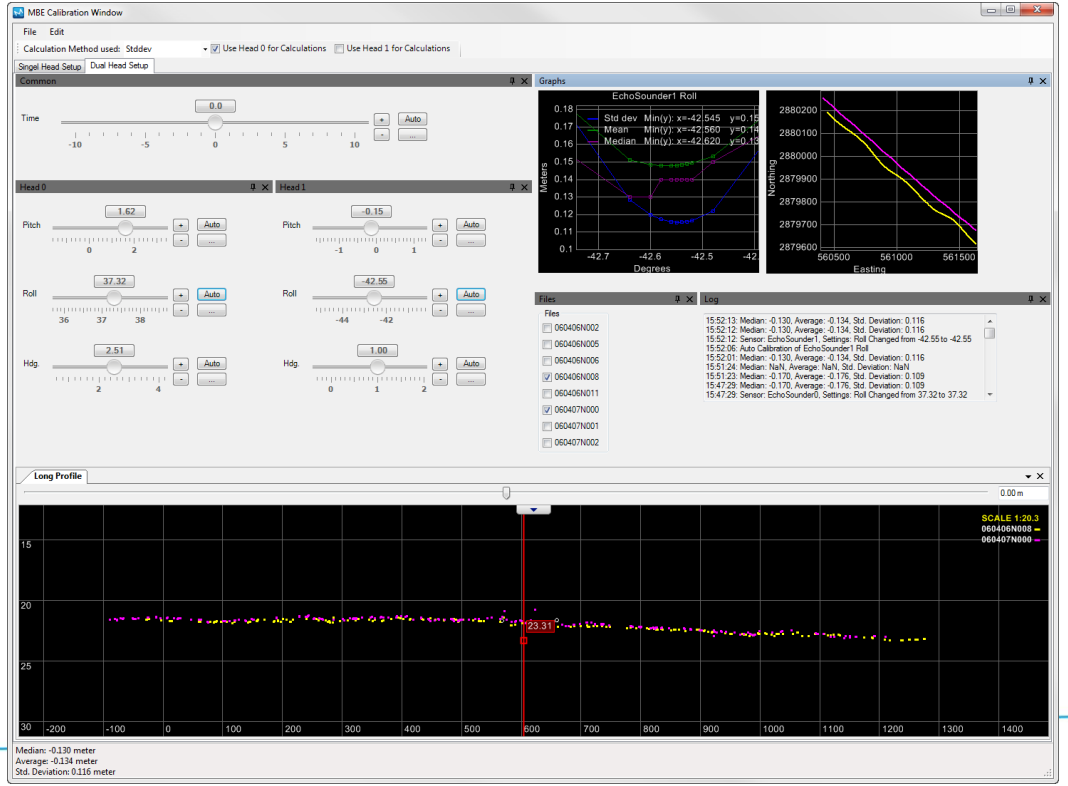


Dual Head Patch Test Calibration

Calibration of dual head systems is facilitated on the dedicated tab, as shown here.

Prior to the actual calibration, the user must determine which of the two heads is the subject of the calculations.

For each of the two heads, a possibility to perform pitch, roll and heading calibration is facilitated. At the same time, time can be determined. The latter is shared for the two heads, by definition.

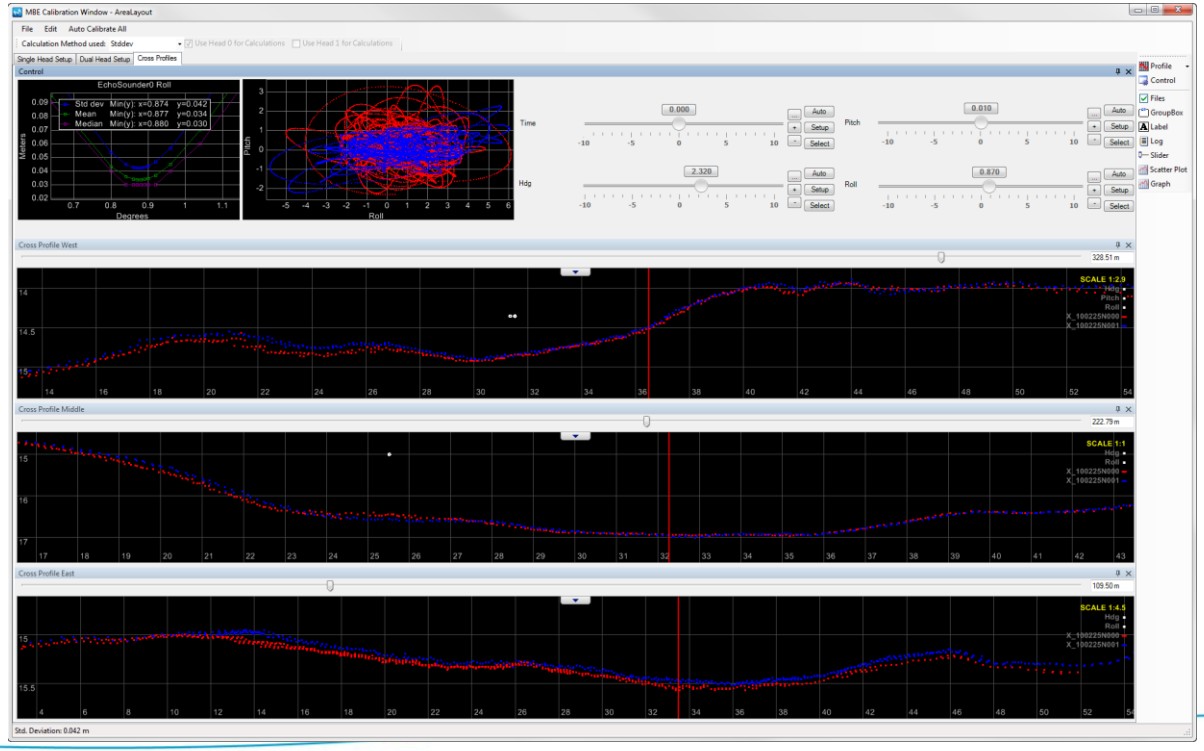


User Defined Layout I

The Patch Test functionality introduces a feature that allows the user to define his own layout.

First a new tab must be added. Once this is done, a toolbar will appear that allows inclusion of a variety of applicable components, as seen to the far right.

For most users however, the facilities contained in the two predefined tabs will suffice.



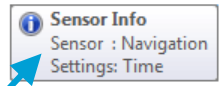
User Defined Layout II

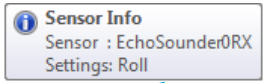
Remarks to the user defined layout components:

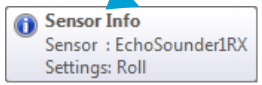
- For the Time component, the slider must enclose ‘Navigation’ with setting ‘Time’

  (Hoover over the Auto button to see the appropriate tolltip)

- For conventional echosounder arrays, the following definition must be used:
  - Single head: Pitch, Roll and Heading must all be related to Echosounder0
  - Dual head: Pitch, Roll and Heading are related to the Echosounder 0 and 1 heads
- For transducer arrays with separated RX and TX arrays:
  - Single head: Pitch and Heading are related to the TX transducer (Echosounder0), Roll is related to the RX transducer (Echosounder0RX)
  - Dual head: Pitch and Heading are related to the TX transducers (Echosounder0 and 1), Roll is related to the RX transducers (Echosounder0RX and Echosounder1RX)







Save and Load Layout

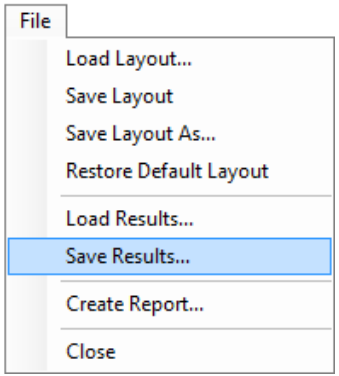
The Layouts can be saved using the ‘File – Save Layout’ menu item. The saved layouts can be used again thorugh the use of the ‘Load Layout’ menu option.

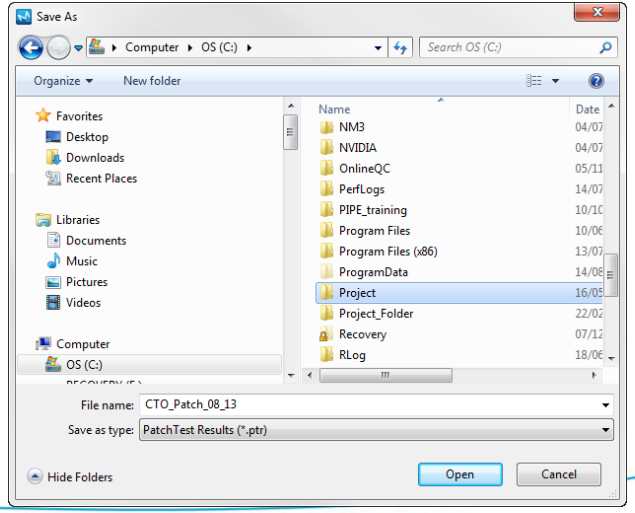
The saved layout will contain configuration information related to all tabs that were created at the time of saving.

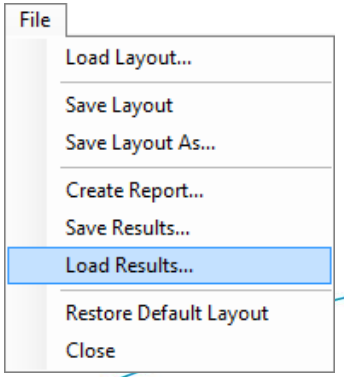
The ‘Restore Default Layout’ functionality will restore to factory defaults with respect to layout. As a consequense of this action, any present customer layout tabs will be removed.

Save Results

The user is given the possibility to save the Patch Test results. Apart from the results of the calibration, this functionality will also save the areas and blocks associated with each calibration component. By reloading the results and by relinking to NaviEdit, it is thereby possible to reestablish the Patch Test scenario in exactly the way it was at the time of saving.







Using the Patch Test results in NaviScan

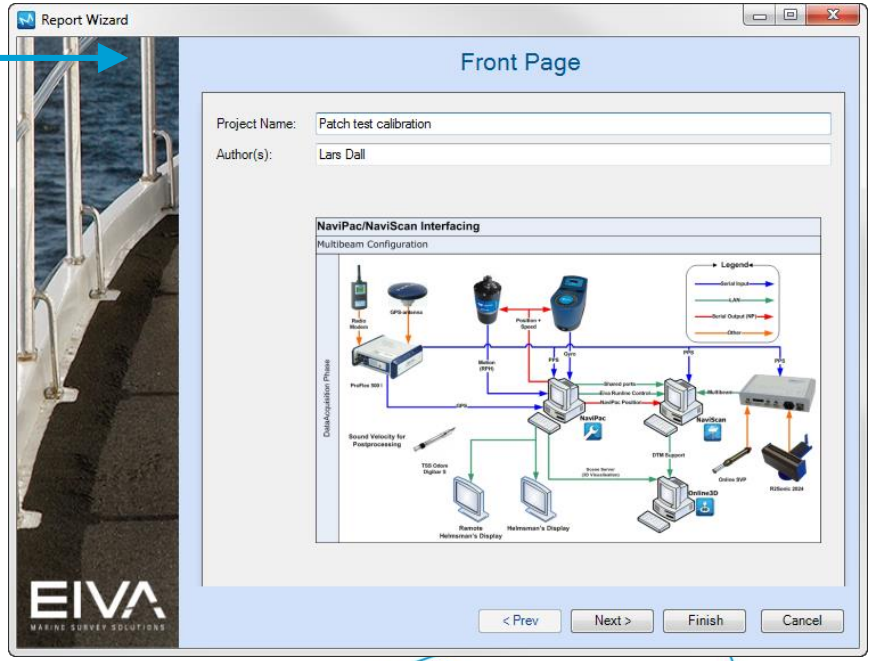
The saved Patch Test results file can be loaded into the NaviScan Config program. The parameters will subsequently be used in NaviScan online acquisition and visualization and consequently saved with the raw SBD-files.

When loading the parameters, the user is instructed that NaviScan will not apply the time value, even if it differs from 0 in the result file, since it is recommended to use 0 as time value. If the desire is to use a value that differs from 0, the value must be entered manually.

Reporting

Reporting of the Patch Test calibration is conducted via the Report wizard, that is invoked from the ‘File – Create Report’ menu item.

The user is guided through different dialogues and finally, a report is generated, with contents listed below.



Contents

Create Report I

The ‘Create Report’ wizard comprises the following steps:

- Front page (mandatory): Project name, report author and picture.
- Project info. (mandatory): Project ID, client, company, area, comments and second picture.
- Calibration results (mandatory): time, pitch, roll & heading (files and area used, result, std. and median value. The user can choose to include calibration graphs (timeconsuming but useful).
- Sensor info. (mandatory): Sensor type and driver for instruments available (roll, pitch, gyro, heave, bathy, position, echosounder).
- Sound velocity info. (mandatory): Listing of sound velocity blocks.
- Tide correction info. (mandatory): Listing of tide correction blocks.
- Cross profiles (optional): All cross profiles can be included in the report with comments.
- Long profiles (optional): All longitudinal profiles can be included in the report with comments.

Create Report II

The ‘Create Report’ functionality, continued:

- Screenshots (optional): The user can choose to include various screenshots with comments.
- Geodesy settings (optional): Information about the map projection and datum shift parameters.
- Survey info. (optional): Min. and max. Easting, Northing and depth values for related blocks.
- Change log (optional): Log information given in sequence relative to the actions performed.

2 Results

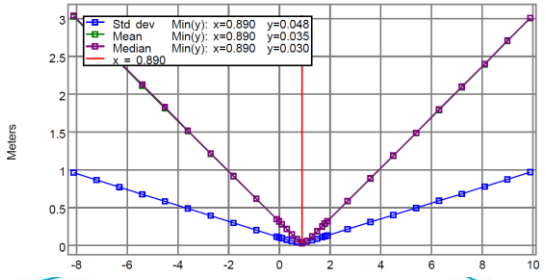
2.1 Mounting Results

Calibration Type	Blocks Used	Area Used	Result
Time	X_100225N000 X_100225N002	1134.41 m²	0.000 s
Pitch	X_100225N000 X_100225N001	2198.53 m²	-0.360 °
Roll	X_100225N000 X_100225N001	9625.34 m²	0.890 °
Heading	X_100225N001 X_100225N003	2135.43 m²	2.300 °

2.2 Calculation Results

Calibration Type	Std. Dev.	Median	Average
Time Loaded Results	0.062 m	0.060 m	0.075 m
Pitch Loaded Results	0.048 m	0.030 m	0.035 m
Roll Std. Deviation Calculation Basis	0.048 m	0.030 m	0.035 m
Heading Loaded Results	0.058 m	0.130 m	0.132 m

2.3.3 EchoSounder0-Roll

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