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Transducer and LBL calibration - Integrated functions in HiPAP systems

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Marine Technology Society

Calibration of transducer alignment and of LBL array

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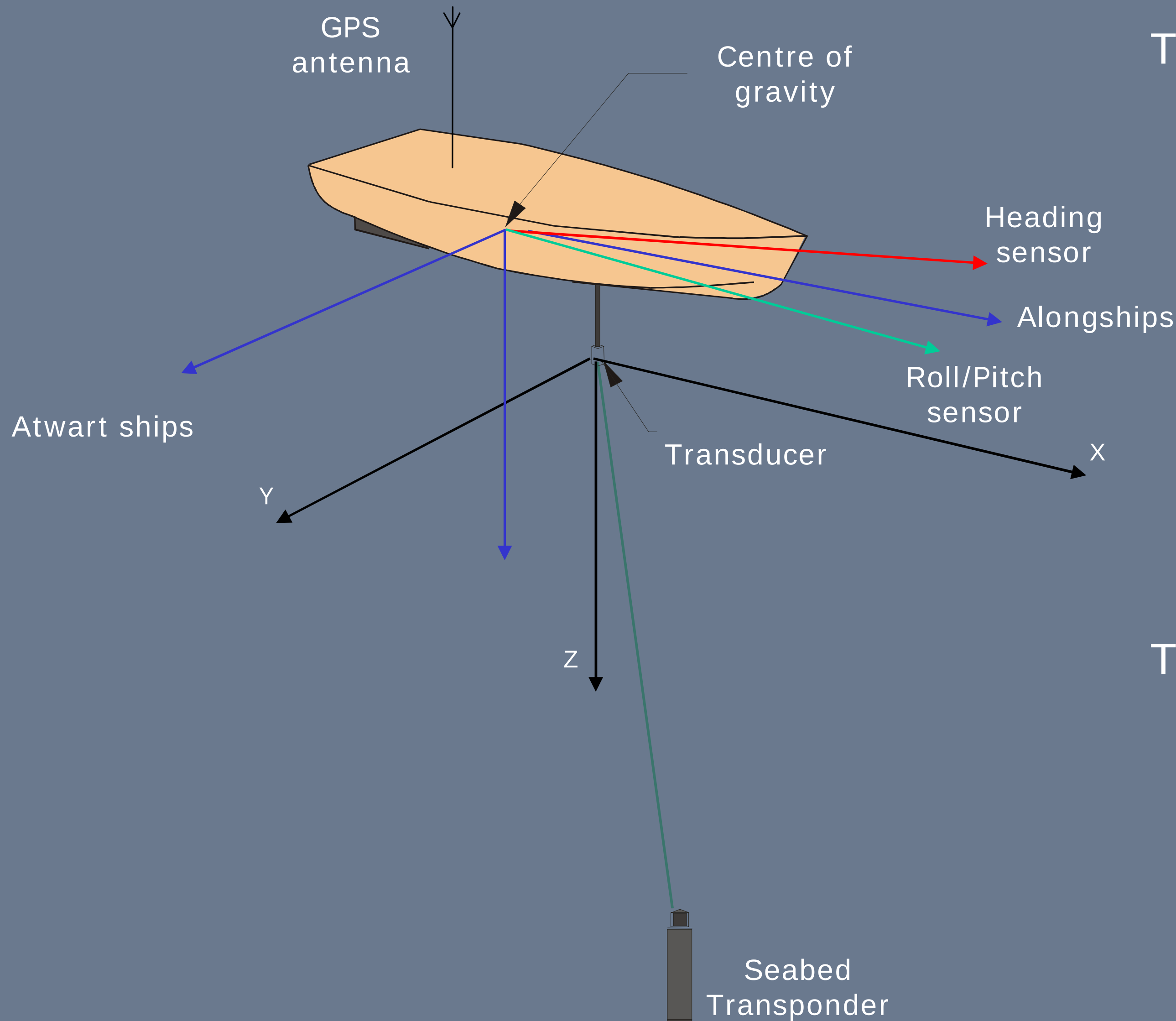
This presentation illustrates and stresses out the importance in acoustic positioning of:

- Transducer alignment calibration.
  The objective is to calculate the offset and the inclination of the transducer(s).

- LBL transponder array calibration.
  The objective is to calculate the positions of the LBL transponders in a North East local co-ordinate system.

All results presented are based on Kongsberg Simrad's HiPAP system.

Calibration of transducer alignment



The transponder position is measured in the transducer XYZ co-ordinate system. It is presented and sent to the DP in the vessel co-ordinate system with the origin in the centre of gravity (CG).

These two co-ordinate systems differ with an offset and an inclination, which both must be known.

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Effect of alignment error for the DP

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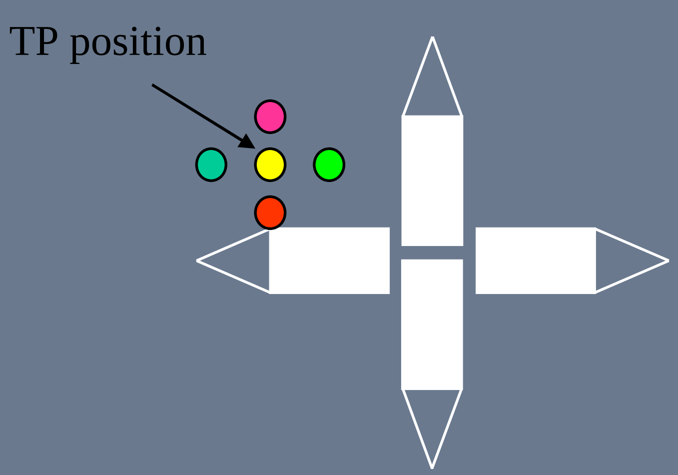
Transducer roll and pitch inclination error will cause error in transponder position as shown below.
Transducer offset error will cause similar errors.



GPS antenna offset error will cause similar errors for the DP.

Measurements

Measurements for transducer alignment are done from several locations and with different headings. The measurements of interest are:

- The position of the vessel in latitude and longitude (dGPS)
- The position of a transponder relative to the vessel (SSBL)

For each measurement, the transponder position in latitude, longitude and depth is calculated.

The transponder position in latitude, longitude and depth shall not move when the vessel moves and rotates. The function calculates the transducer offsets and inclinations that makes the spreading of the transponder position as small as possible.

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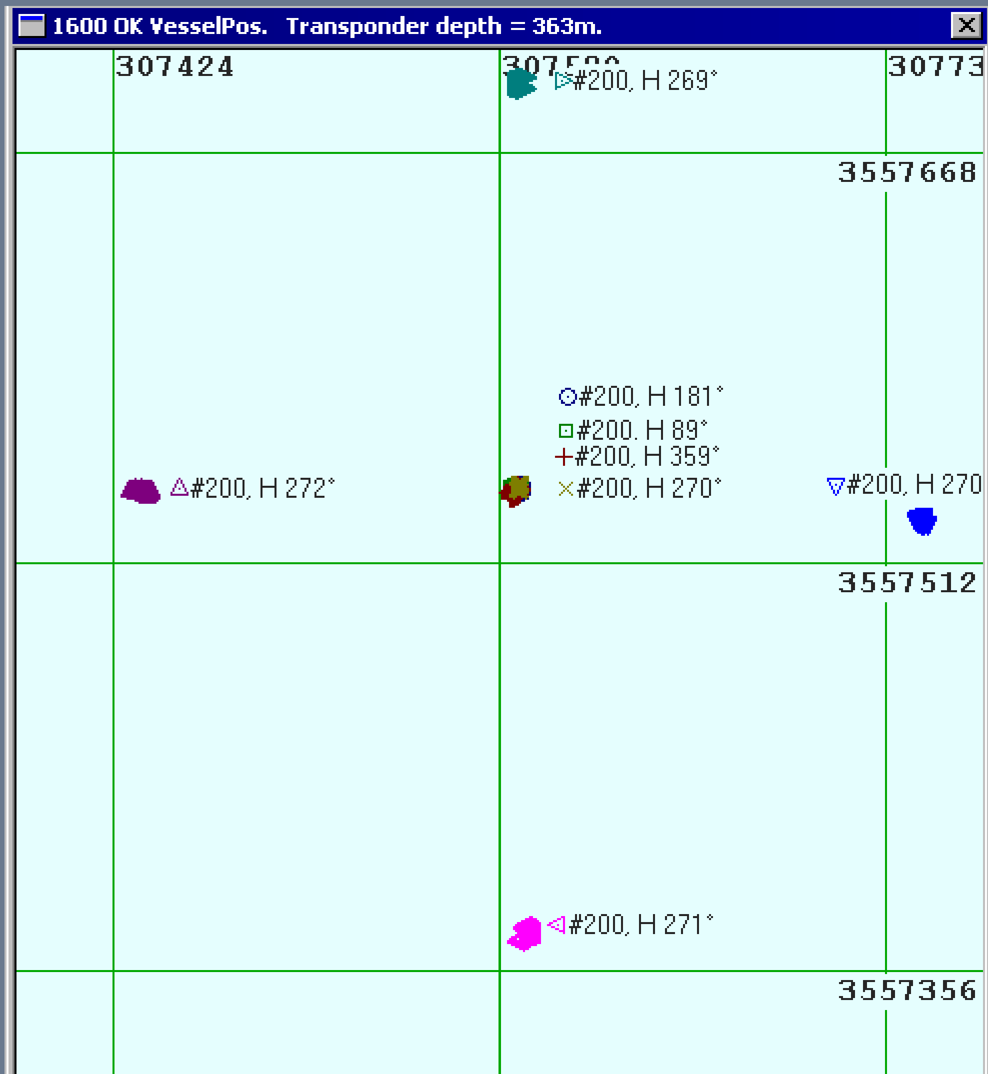
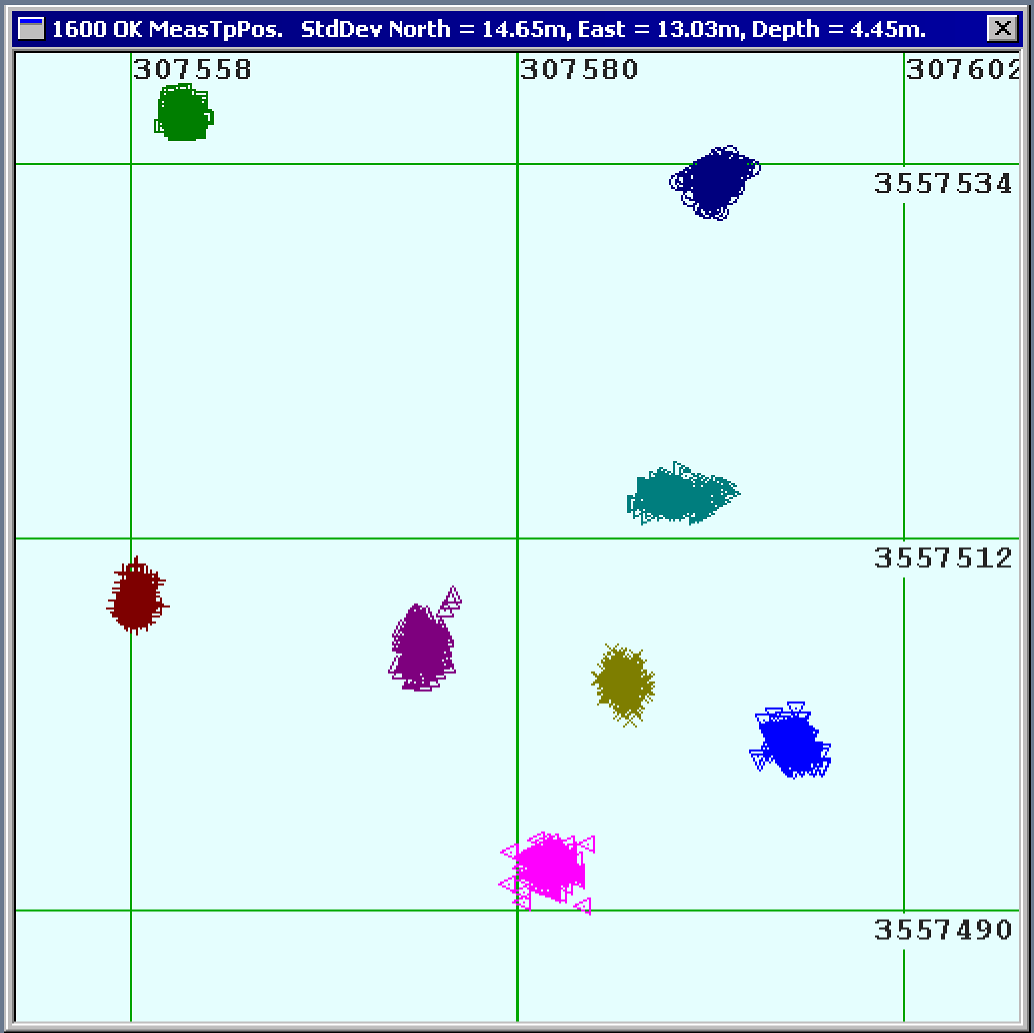
Vessel position



The vessel position when doing the measurements for calibration of the transducer alignment.

Grid distance 156 m.

The transponder position as measured



The position of the transponder as measured with the installation parameters.

There is obviously something wrong.

Grid distance 22 m.

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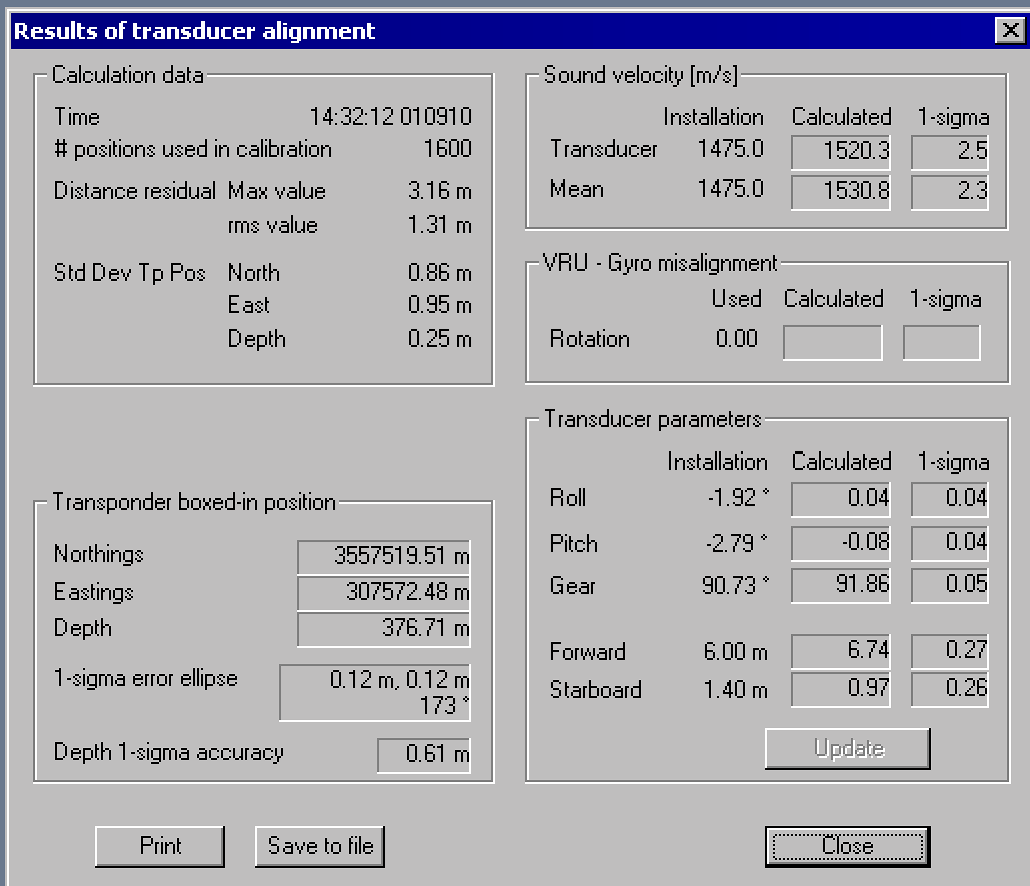
Result of the calculation

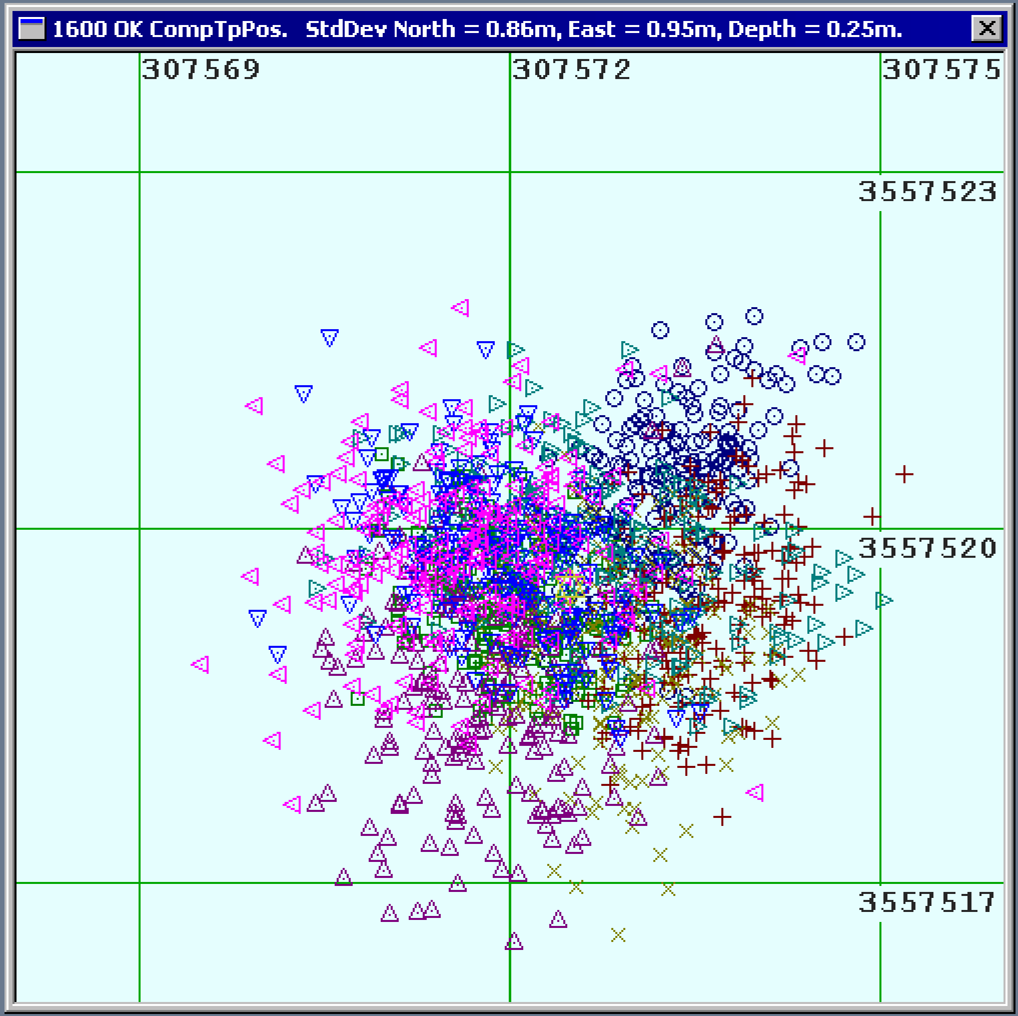


The HiPAP system calculates new values for the sound velocity and the transducer inclination.

The transducer and GPS antenna offset seems to be OK.

Insert the new transducer parameters by ticking the Update button.

The transponder position as compensated



The transponder position when compensated with the newly calculated parameters.

Grid distance 3 m.

It is NOT necessary to repeat the measurements.

History and summary

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The function for calibration of the transducer alignment was added in the HiPAP system in the spring of 2000.

- All done on the already existing operator station, only dGPS required as external input.
- The process can be done by the either the vessel personnel or by a Kongsberg Simrad engineer.
- The function checks the GPS antenna offset, which has been a major error contributor.
- If you are not satisfied with the result, send the logged file to us on e-mail and we will evaluate it.

The experience with the new function is very good, both in shallow and deep waters.

Transducer alignment time and evaluation

When to do transducer alignment?

- After installation
- After any changes in gyro or VRU.
- A given periodic time depending on vessel type (each year for shuttle tanker as example)

When is the transducer alignment calibration done successfully?

- The variation on the transponders lat/lon position is inside the expected accuracy on the actual depth.

New topic

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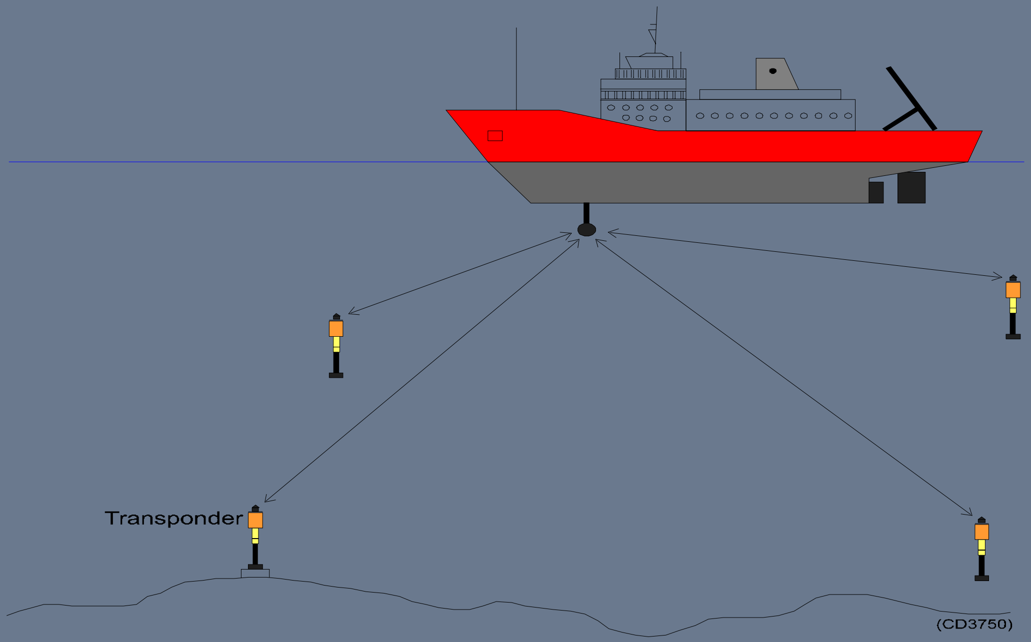
End of transducer alignment

Start of LBL array calibration

LBL positioning principle



LBL Principle: Measuring distance and direction to known transponder co-ordinates in a North East local co-ordinate system.

The objective of the LBL calibration is to decide these co-ordinates.

Baseline measurements

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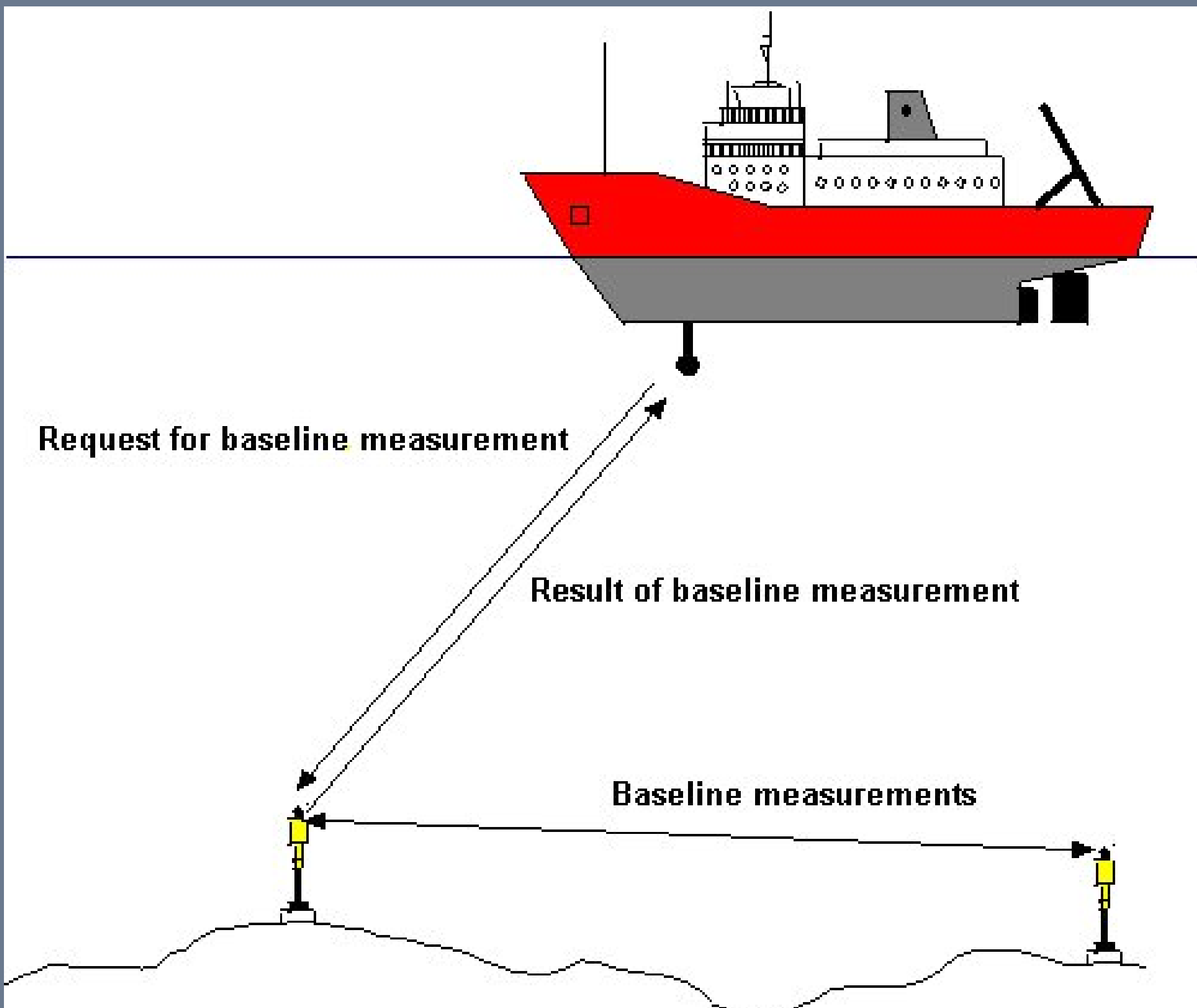

Baseline measurements require:

- Telemetry communication with long messages between vessel and transponder.
- Free line of sight between the transponders.

When to do the baseline measurements

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The baseline measurements give the most accurate relative positions of the transponders in a local co-ordinate system. This accuracy may be necessary when the LBL positioning is used for:

- Survey operations
- ROV operations
- Multiuser transponder arrays

The new LBL Run Time calibration functionality makes the baseline measurements needless for DP LBL positioning.

LBL calibration when using the new functionality

The following steps are required:

- Deploy the transponders on the seabed.
- Position the transponders in SSBL.
- Use the SSBL positions as the positions for the array.
- Command the transponders to switch to LBL mode.
- Position the vessel in LBL.
- Log the LBL measurements. It lasts for 10 to 15 minutes.
- Use the LBL measurements to calculate accurate co-ordinates for the transponders.

The last two topics are explained in more detail on the next slide.

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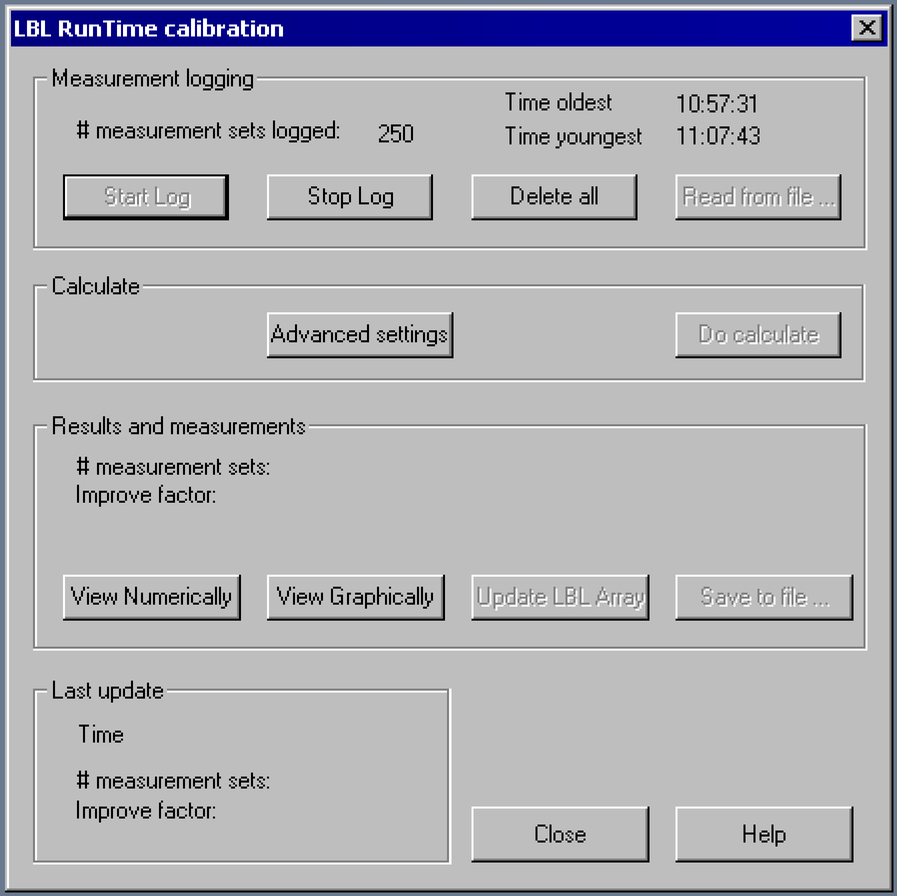
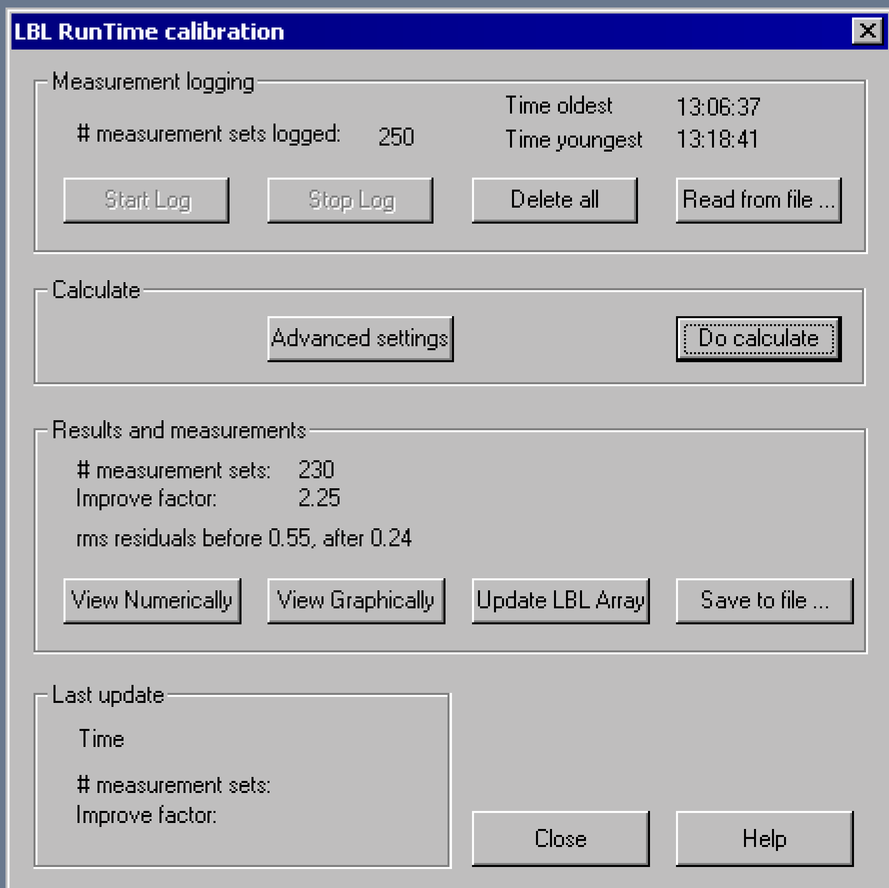
Steps in LBL run time calibration



Steps when doing an LBL run time calibration:

- Select the LBL RunTime calibration command from the main menu
- Start to log measurements by ticking the "Start log" button.
- Stop logging by ticking the "Stop Log" button.
- Calculate by ticking the "Do Calculate" button.

Use the calculated co-ordinates



When the calculation is finished, a summary of the results is displayed. When the improve factor is significantly greater than 1, we recommend to use the results.

Examine the results by ticking the “View ...” buttons.

Use the results by ticking the “Update LBL Array “button. It can be done without stopping the LBL positioning of the vessel.

Numerical presentation of the results.

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LBL RunTime calibration result

☐ Show the 1-Sigma of the positions

Location	Existing position North	Existing position East	Existing position Depth	New suggested position North	New suggested position East	New suggested position Depth
1	70.67	132.53	1068.00	75.07	134.90	1066.08
2	-34.85	-28.14	1068.00	-34.30	-23.96	1066.08
3	242.95	-182.50	1068.00	239.00	-185.47	1066.66
4	345.89	-38.54	1068.00	346.28	-44.10	1066.80
5	58.45	-187.53	1068.00	53.74	-185.01	1066.23
6	247.59	126.89	1068.39	251.68	124.24	1066.72

Weight on existing pos

Horizontal 1.00

Depth 1.00

Average RMS residuals before calculation: 0.55

Average RMS residuals after calculation: 0.24

Close

The figure is displayed when the operator presses the “View numerically” button.

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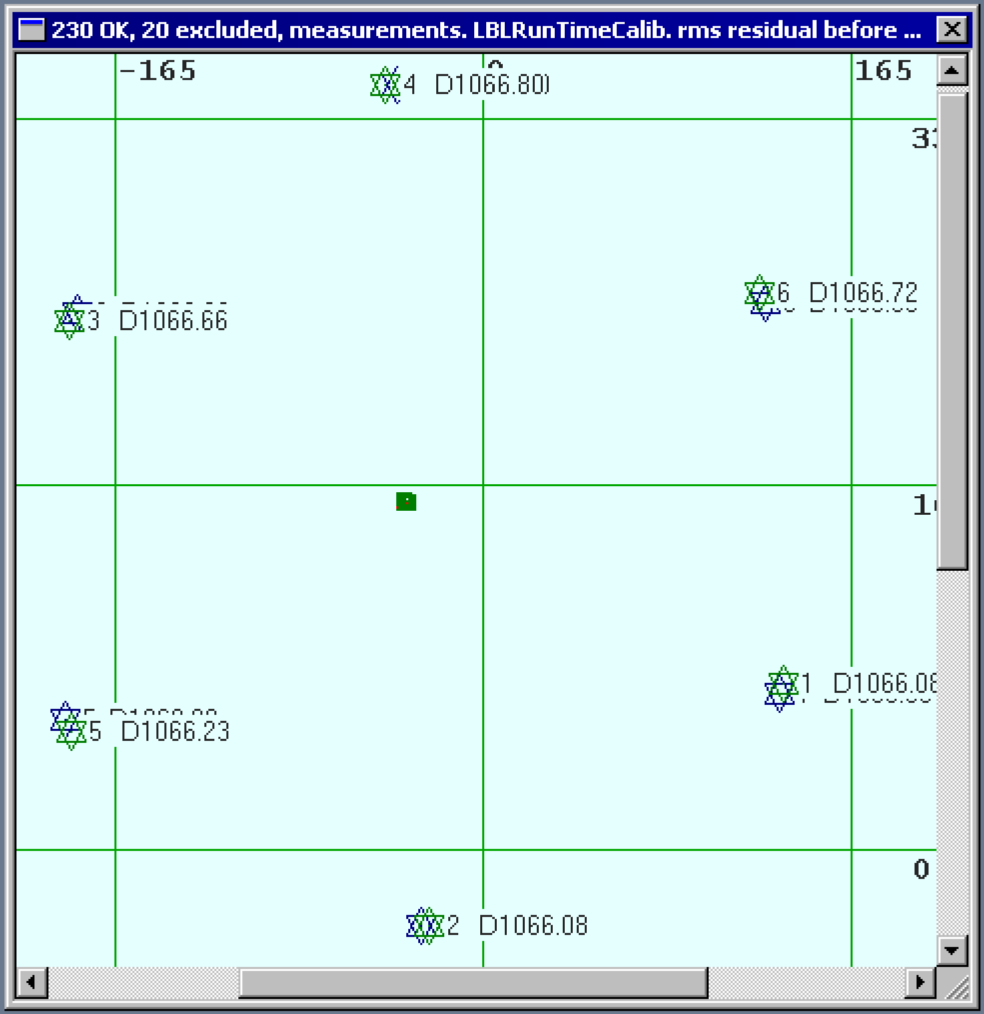
Graphical presentation of the results



The figure is displayed when the operator ticks the “View graphically” button. The blue stars are the existing transponder positions. The green stars are the new calculated positions. The numbers are the depth.

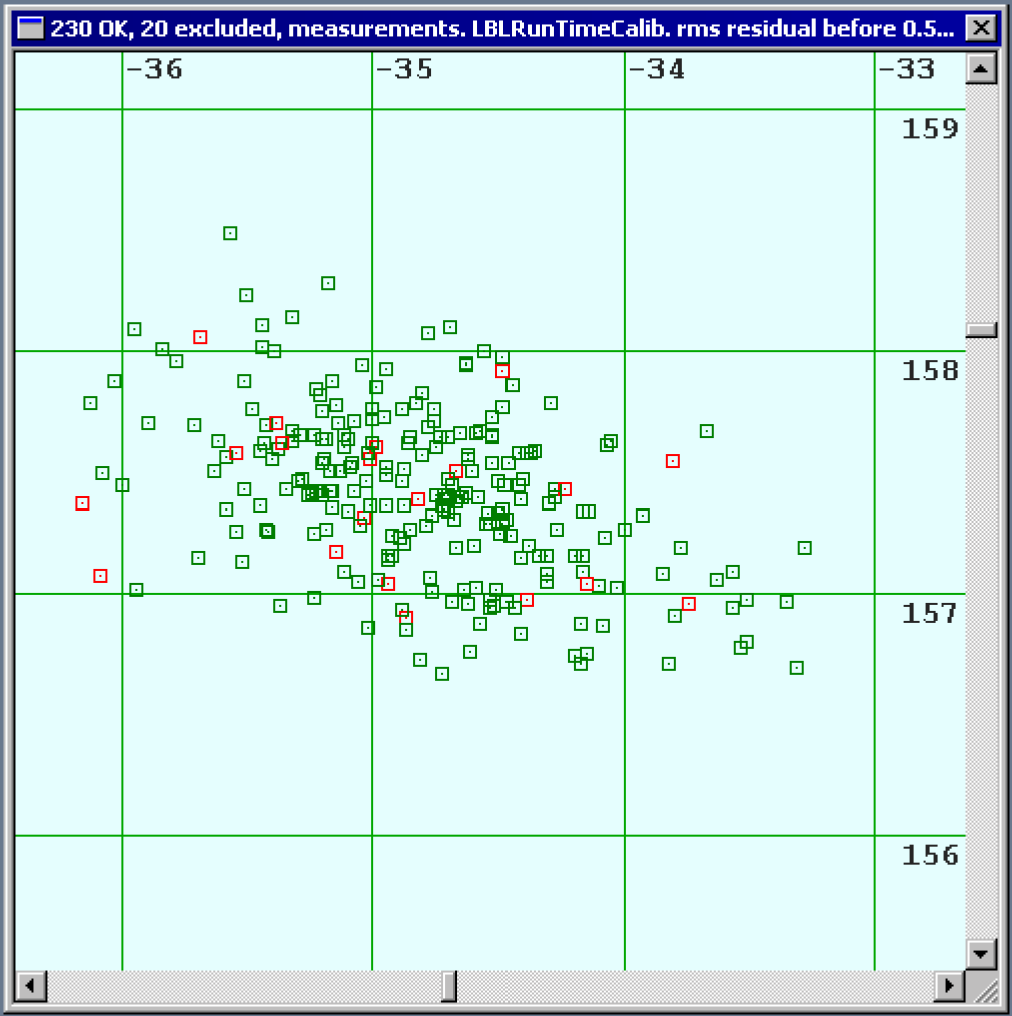
The vessel was in the centre of the array when logging the measurements.

Graphical presentation zoomed in at transponder 2

Transponder 2 is south of the array centre. The figure illustrates that the new position is a rotation of the existing position around the centre of the array.

The depth is calculated more accurately.

Graphical presentation zoomed in at vessel position



Each square is the position of the vessel when doing a set of measurements towards the transponders.

20 measurement sets are excluded from the calculation. They are shown in red. The exclusions are done automatically without operator intervention.

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Experience with LBL run time calibration.

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The LBL run time calibration with HiPAP systems were tested outside Horten (190 m depth), in the North Sea (330 m depth), in the Norwegian sea (1060 m depth) and in the gulf of Mexico (2000 m depth) before introduction 1 year ago.

Later it has been used by customers with good results, normally without the need for assistance from Kongsberg Simrad.

We obtain stable LBL positioning, mainly due to:

- The orientation of the LBL array with respect to geographical north is accurate, especially when an HiPAP system is used for the logging.
- The depths of the transponders are accurate.

Advantages with LBL run time calibration.

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- Short calibration time
- Easier to use
- Improved depth calibration
- Improved rotation of the array.
- Not necessary with “free sight” between transponders.
- Less depended on correct sound velocity.

Both transducer alignment and LBL runtime calibration are standard functions in HiPAP system with operator stations based on windows NT.