Tow fish tracking

KONGSBERG

HiPAP® and HPR used in plough and tow fish tracking

Introduction

The HiPAP® system may work down to 4000 meters. The HPR Super-Short Base Line (SSBL) systems (HPR 309, HPR 310 and HPR 410) may work down to 2000 meters using high power, deep-water transponders. These figures are based on a “normal” noise level in the surroundings of the vessel and sufficient source level from the transponder. “Looking” through the propeller water and having to “look” through the water column at a slanted angle, will often create limitations to the actual range performance.

In general, the most important factors for getting successful positioning results in underwater navigation are:

- No ray-bending or deflection, due to different temperatures in the water column.
- The best possible Signal-to-Noise ratio (S/N).
- No obstructions or aerated water between the seabed transponder and the hull mounted transducer.

Ray-bending

Kongsberg Maritime has many years of experience in handling these factors. In plough and tow fish tracking applications, the point about deflection is unique, as the positioning will be relatively more horizontal than in other applications. Please note that there is no ray-bending effect when the acoustic signal communication is vertical through the layers.

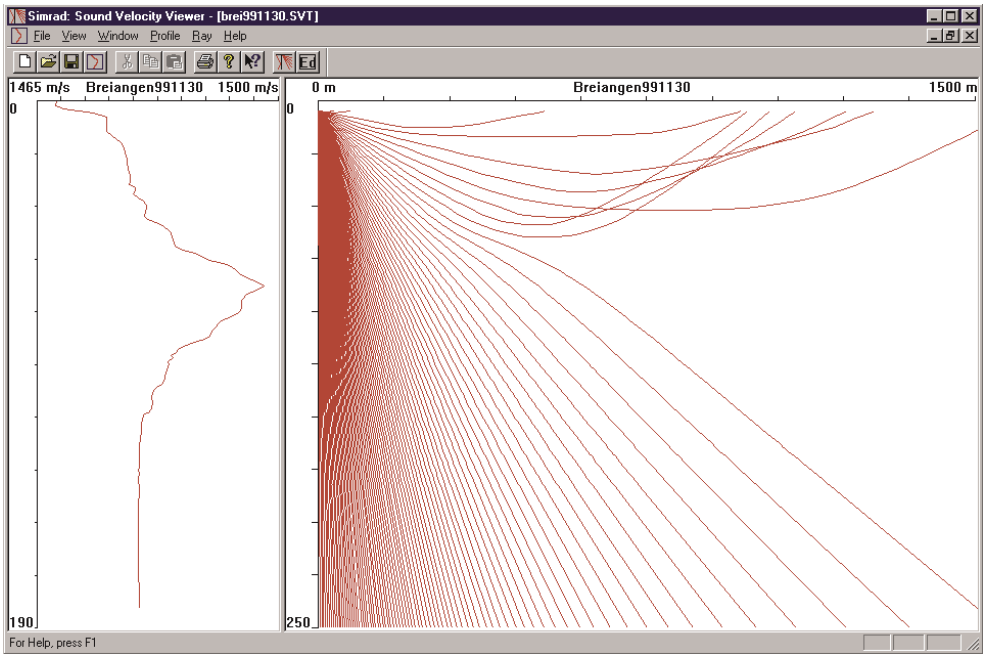
The ray-bending effect will start influencing the accuracy of the positioning when the angle to the transponder is 15-20 degrees (relative to vertical), and will normally increase with increasing angles.

Kongsberg Maritime has developed different solutions to minimize the ray-bending effect.

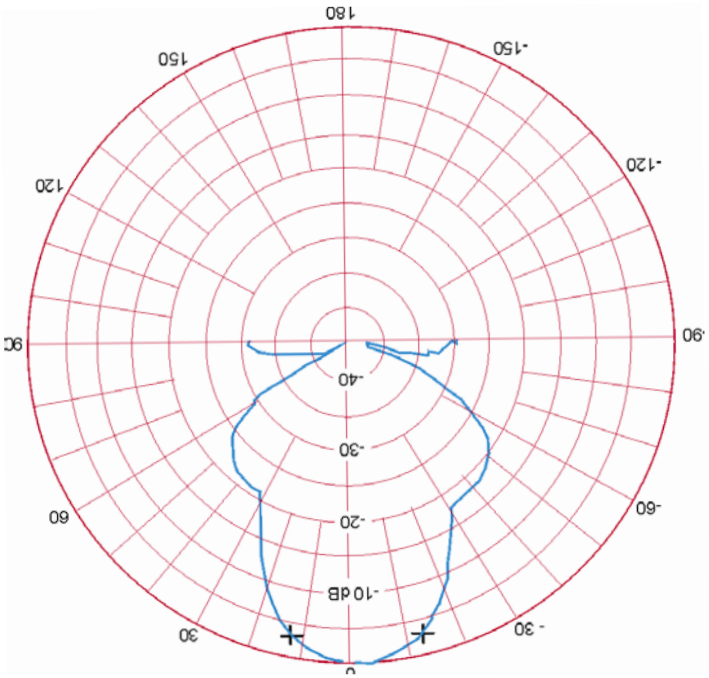
The HiPAP / HPR system has:

- Functions to calculate the sound deflection through water, and software to compensate the error caused by this effect. Both range and angle detection are compensated.
- Possibilities for taking input from a sound velocity meter, and a dedicated program will calculate and display the ray-bending graphically on the display.

An example of operator presentation of the sound velocity profile of the whole water column, and the presentation of ray-bending diagram calculated by the HPR, is presented in the figure below.



The function is not only error correcting, it also gives the operator a tool to see the limitations of the nature, as well as it can give the answer to a range problem.
Wrong sound velocity input gives error in absolute accuracy, but influences very little in relative position changes and stability.
At some stage, the ray-bending will cause the ray to deflect upwards (see figure). In such conditions the interrogation pulse from the transducer will never reach the seabed transponder, and thereby no positioning can take place.
An alternative tool for handling the ray-bending effect, is to use depth sensing transponders, or entering operator set transponder depth into the HiPAP / HPR system. Then the system will use this depth instead of calculating it.



Signal-to-Noise ratio

The next important factor is the Signal-to-Noise ratio at the receiving transducer onboard the vessel. This is often the most noisy place, as it is close to propellers and thrusters. There are two ways of getting the highest possible Signal-to-Noise ratio:
1. Suppress the noise as much as possible
2. Increase the transponder source level

Kongsberg Maritime extensively uses beam forming transducers to obtain maximum sensitivity towards the seabed transponder. This gives less sensitivity towards the noise sources (thrusters and propellers) and suppresses the influence from noise. A sensitivity diagram of a 30 degree transducer beam is shown in the figure to the right. As you can see, the horizontal sensitivity (towards the thrusters) is some 30 decibel (dB) lower than maximum sensitivity vertically!

- The HiPAP system can steer a narrow beam of only 10 degrees to any direction.
- The HPR 400 series of systems has different transducers - all with directive beams.

Transponder source level

Kongsberg Maritime manufactures many different types of transponders. It is always important to select the right transponder for the specific application. Transponders vary in size, battery lifetime, transmitter source level and beam pattern. If success is difficult in for example a noisy environment, you should always see to that you have a transponder with high source level to obtain the best Signal-to-Noise ratio. These transponders are often large due to narrow beamwith which concentrates the energy in the right direction.
A high power transponder typically has a source level of 205 dB. A transponder rated for less than 1000 meter typically has 190 dB. A high power transponder has approximately 32 times higher source level.
To handle possible noise problems on a plough / tow fish we suggest to use a responder instead of a transponder. The responder is triggered and controlled from the onboard HiPAP / HPR system through an umbilical.

Aerated water

The hull units are designed to allow the transducer to work some 3,5 meters below the hull. The main reason to have the transducer at this depth is to get the transducer down below the “natural” aerated waters surrounding the hull.
The transducer location in the hull is also important. Kongsberg Maritime will assist to recommend this location, based on a General Arrangement drawing showing the entire hull with all propellers and thrusters.
If a Dynamic Positioning (DP) system controls the engines, it is important that any azimuth thrusters have “abandoned zones”, to avoid water flushing towards the transducer(s).

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