LABORATORY TO MEASURE DIRECTIVITY CHARACTERISTICS OF ARRAYS

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The paper presents the laboratory station to measure directivity characteristics of narrow beam sonar's and echo sounder's antennas. It will be describe method of collecting samples from surface, unit used to precise positioning receiving hydrophone, construction and use of rack to direct main beam in exact direction. Additionally we show station to measure drift of the sea bottom impedance.

INTRODUCTION

Usually new measuring units are delivered without indispensable set of exploitation characteristics. This problem touches our parametric echo sounder SES-2000. That's why we decided to make precise measurement of receive and transmit characteristics. Laboratory station was build on basin which dimension was 30 m x 3 m x 1.8 m. Because of parametric effect use in forming differential frequency main beam coming form echo sounder was pointed horizontally along longest dimension of basin. Principal purpose of delve was to point out real directivity characteristics both for primary waves and differential waves. Insomuch depth and width of tank was limited first important step was corrective direct main beam of unit transmitting waves. During measurement echo sounder's antenna was fixed to the stationary rack and one movable element was receiving hydrophone. Flat array was sampled with precise positioning device made by Iselautomative which gave opportunity to move with precise of 25 micrometers. Written computer code to steer motion of hydrophone allows to obtain precision characteristics. Next step of work was to find out acoustic impedance of materials being real drift of the sea bottom where we are going to make exploration.

1. STATION TO MEASURE CHARACTERISTICS

Figure 1 presents schema of placement elements during measurements on basin. Dimensions of tank are 30 m length 3 m width and 1.8 m depth. Material used to build it was beton.

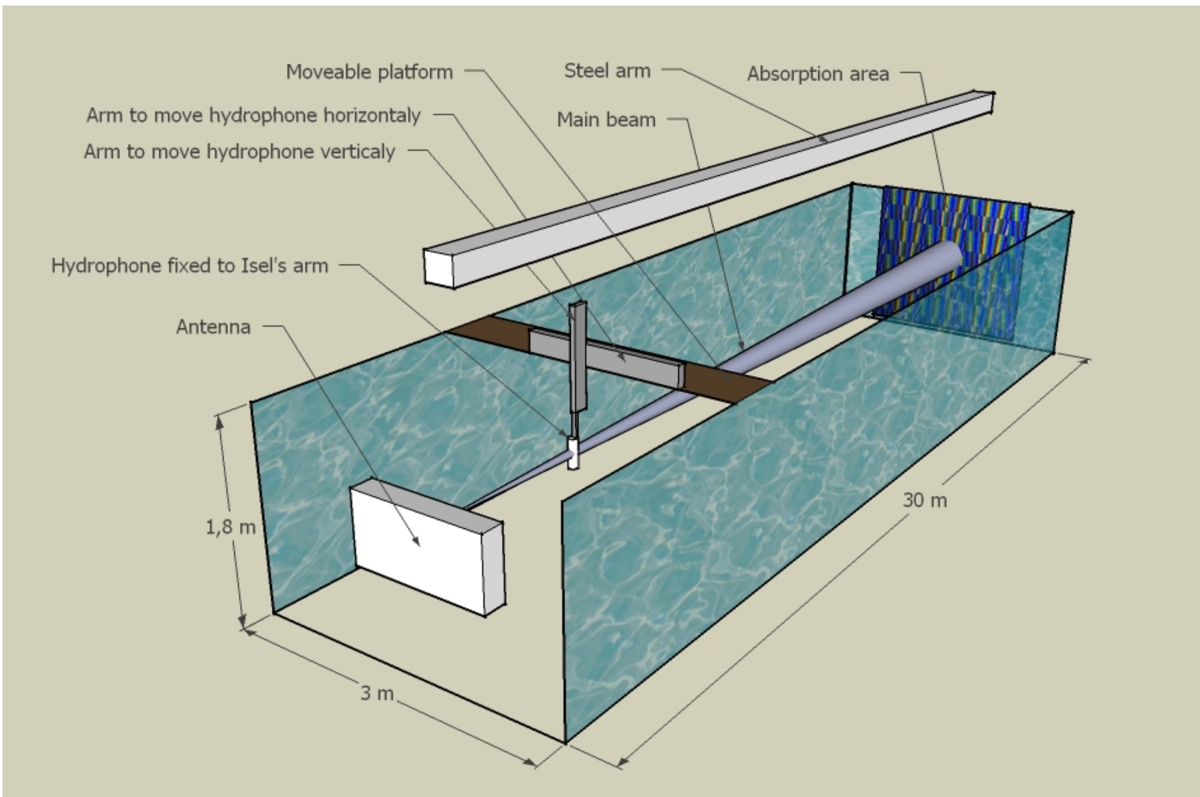

Fig.1 Station to measure antenna's directivity

Station to measure directivity characteristics can be divided to two main blocks:

a) rack for antenna
b) measurement section

Ad a) Mount for antenna assure:

- regulation depth of submersion antenna. Such facility allows eliminating reverberations coming from basin bottom and surface of water. Changing deepness was realized by blocking sliding element on correct level with precision to one millimeter.

- steer horizontally and vertically direction of transmitting sounding pulse. Because of small values of angels, which we set during rotating it was necessary to build accuracy positioning mechanism. In upper part of Figure 2 is array fixed to special rack made with two rectangular profile pipes with arms direct parallel to surface of water. Arms allow to use less power to turn aside transmitting element by using two rods with taped ends. Regulation can be done by screw or unscrew special positioning knobs. Element fixed in the middle of profile neutralized effect of deforming rods.

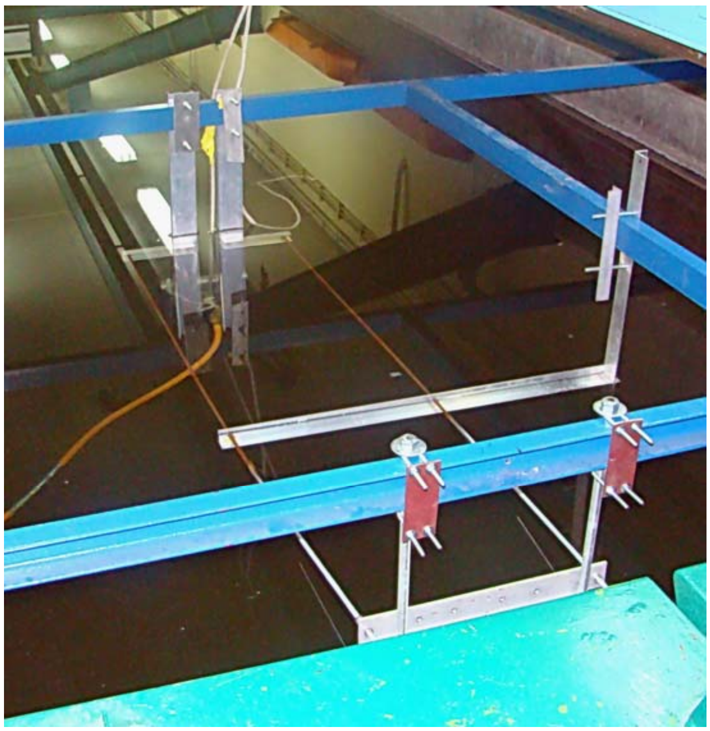

Fig.2 Rack to fix measured antenna

Ad b) Measure of characteristics was made using receiving hydrophone fasten to movable rack. Sampling space with precision to twenty five micro meters assure mechanism made in Germany concern: Iselautomative. Unit has got RS-232 standard junction which allows steering it from notebook with installed special program. Orders which are acceptable by Isel were described in delivered instruction. That’s why it was possible to write new program which takes maximum gantry outside position into account and protect for example hydrophone against being crush during probe of measuring amplitude under real basin bottom level. Additionally program gave user information about actual position of arms and number of sampling probe which is helpful during verification and eventual correcting values in tables.

Next facility of positioning system was its proof for high weight of fixed element to the machine arms. It gives opportunity to set station on which receiving hydrophone will be attach to immovable rack, while measured antenna (with weight up to 20 kg.) is fixed to movable Isel’s arms. Having such laboratory station it is necessary to comply vibrations of whole movable platform with array after moving it to new position. Our investigations demonstrate that proper results were made when speed of slide was low and time to stabilization was complying. Delay before reading amplitude of probe depended on weight of antenna and speed of its move. It should be select during testing measurement.

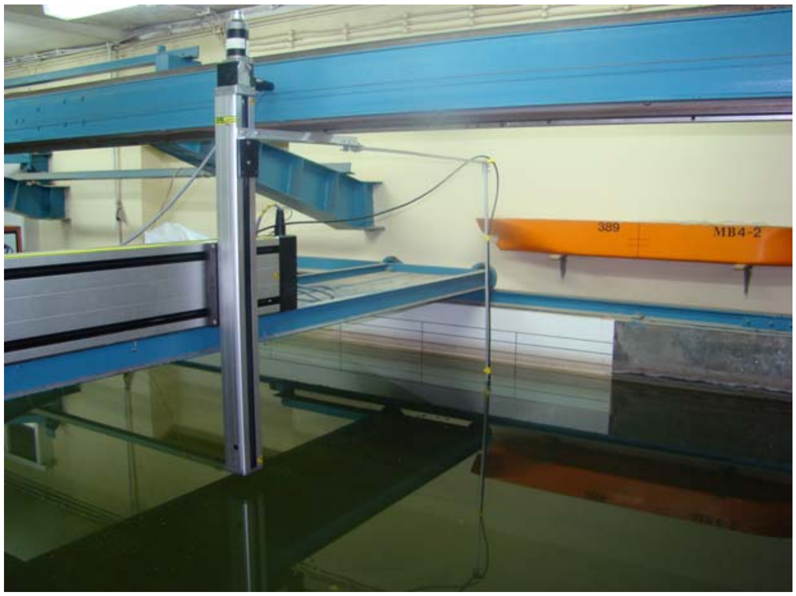

Fig.3 ISEL - unit to set hydrophone in precise position

Having in use three slides elements (in proper configuration) it was possible not only to sample flat surface but also sphere which center was measured element.

Results of investigation are shown below. Visualization of data was executed in Matlab. Special program in automatic mode imported sampling data from tables and generated three-dimensional pictures.

Figure 4 and 5 picture directivity characteristics measurement of primary frequency. Generated visualization thanks to 3D gave possibility to analyze all interested for user fragments of surface.

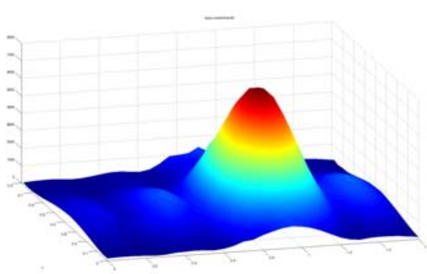

Fig.4 Characteristic for high frequency 3D

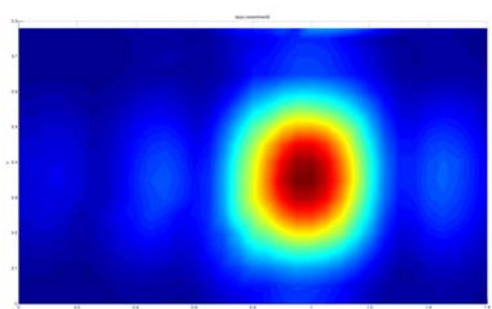

Fig.5 Characteristic of high frequency

Figure 6 and 7 showed characteristics of different frequency. Investigation confirmed agreement with specification delivered by producer, who in his documents among other things gave information about low level of side lobes in low frequency what can be notice on pictures below.

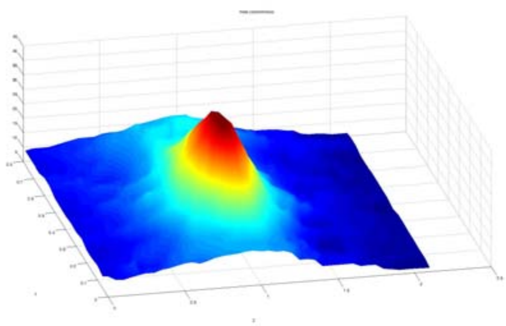

Fig. 6 Characteristic of low frequency in 3D

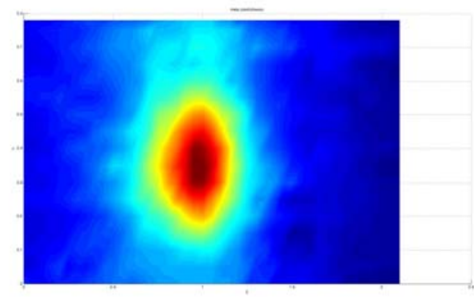

Fig. 7 Characteristic of low frequency

2. MEASURMENT DRIFT OF SEA BOTTOM IMPEDANCE

Laboratory station let users to measure mud's form sea bottom impedance. As receiving element was used, as in case of sampling characteristics, machine to precision positioning arms with fixed hydrophone.

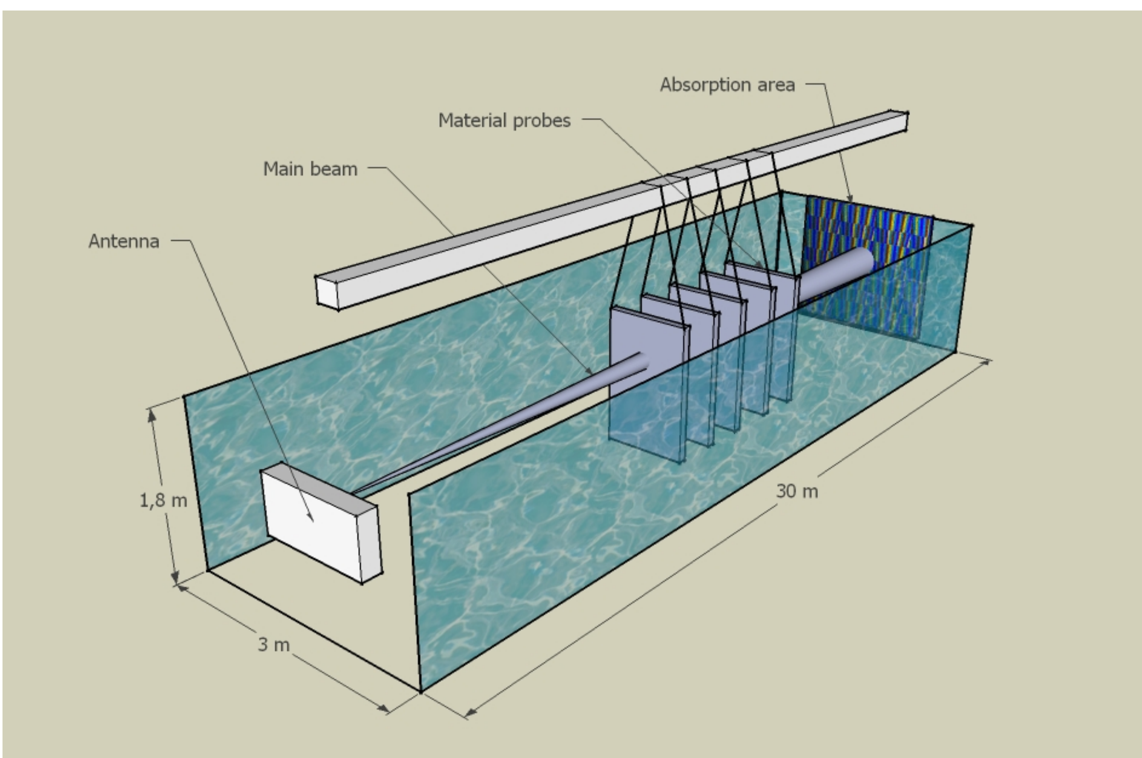

Fig.8 Station to measure impedance of different materials

Investigated materials which were real probes like for example mud took form sea bottom were placed in special prepared frames of dimensions 60 cm. width and 80 cm. high. First layer was plastic bag which isolate material from water environment. It has got high influence for measurement. Placed for example mud would not fill whole area in profile. Left spaces would be like small air bubbles. We took this effect into account and made small holes (in lower and upper part) in bag to let water fill whole space inside. Location of punctures neutralized probability of creation air bag form small air blisters.

Fig.9 Frame for natural probes

Precision measurement could be assured by similar distribution of material's depth on whole surface inside wooden frame. Such conditions were possible to be set by applying second layer which was polypropylene bag. It has got one very important property: it was not tractable for distension. Additionally frame was provided in system to strain membrane which gave opportunity to change thickens of material form 5 cm to 15 cm.

Fig.10 System to adjust frame's width

Figure 10 show measurement of five materials placed in boxes with distance form one to another oscillating near 30 cm. Frames has got one more advantage: it is possible to join them I one element with thickness up to 75 cm with the same or different materials inside. Such model is presented on Figure 11.

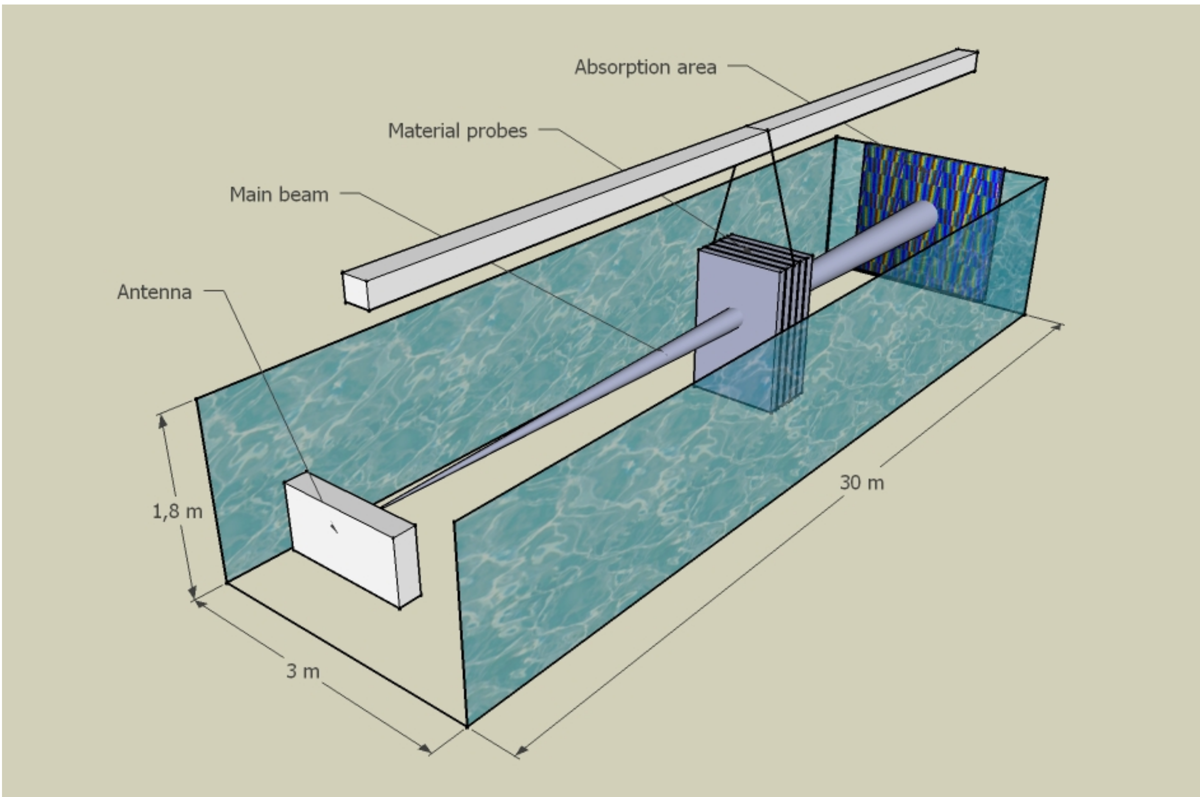

Fig.11 Station with one section of thick layer probe

Described laboratory station allowed measuring impedance and simulated exploration of sea bottom in one case: when it was flat and sounding pulse was direct at angle 90^o to the ground. Visualization of echoes can change diametrically when the same bottom would be drooping (for example it would be going deeper at angle 30^o). Set of elements on basin gave opportunity to make measurement including described above conditions. First it was necessary to decide how many frames and what kind of drift should be used. Next step was to rotate frame or frames and adjust correct angle between main beam and membrane. Such schema is show on figure 12. In this article no results will be placed, because of unsatisfactorily number of measurements which did not allow making logical discussion and drawing some conclusions.

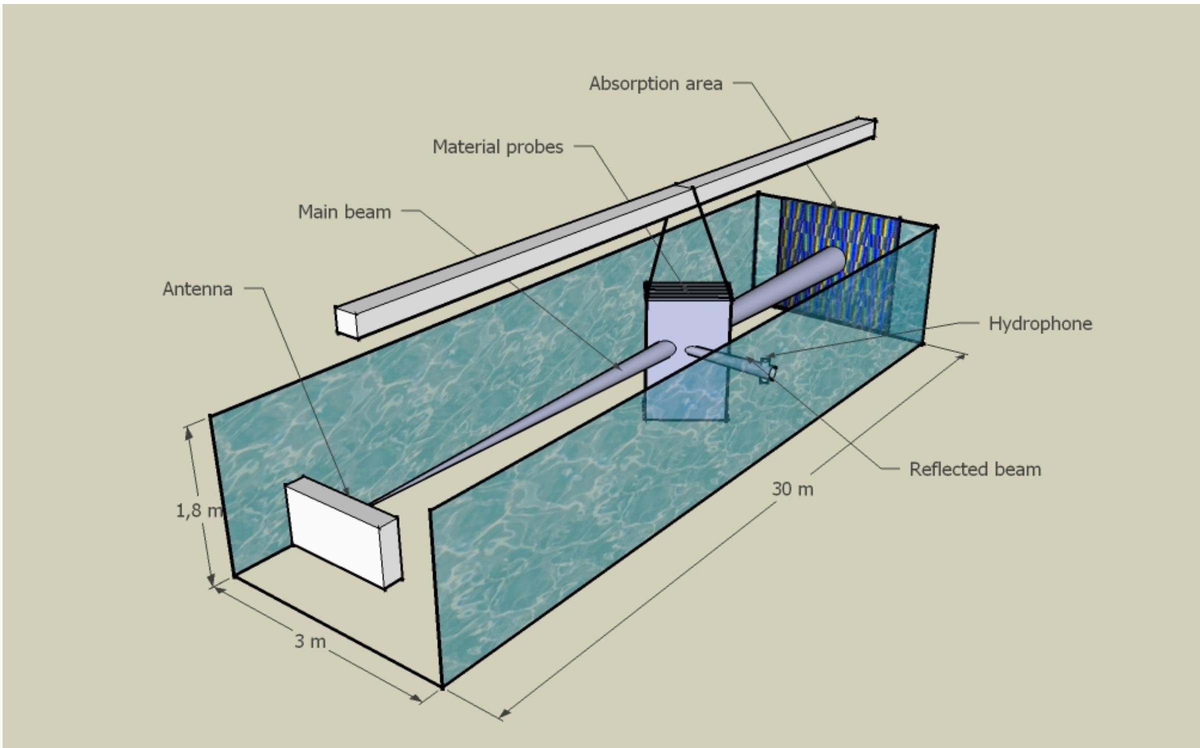

Fig.12 Station to measure impedance when material is rotated

3. CONCULUSION

Having data coming form sampling it was possible to picture directivity characteristics of SES-200 echo sounder. Results allows to find out conformation with information gave by producer. Visualization in three-dimension is better to use during analyzes and let us to draw a conclusion from measurements. What is more we ascertain that laboratory station and basin give opportunity to make searches both characteristics of high and middle frequencies and drift of the sea bottom acoustic parameters.

ACKNOWLEDGMENTS

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REFERENCES

1. Innomar's instruction to SES-2000
2. Innomar's article "High-resolution sub-bottom profiling using parametric acoustic"