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A COMPARISON OF TWO METHODS FOR MEASURING THE EQUIVALENT BEAM ANGLES OF HULL MOUNTED TRANSDUCERS (preliminary)

by

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ABSTRACT

A first attempt to measure the conventional directivity of split beam transducers, using the information available on the parallel interface of the ES400 split-beam echo sounder, is described.

Measurements on two transducers are presented and compared to those obtained by a method described in an earlier paper (Reynisson, 1985), were the displacement of a standard target in the sound beam is calculated from the geometric configuration of the set-up. The difference in equivalent beam angles as estimated by these two methods are 2 dB. Measurements of the compensated sensitivity throughout the beam are presented. Variations over a 9 dB range were observed. Possible reasons are discussed.

INTRODUCTION

A method for measuring the equivalent beam angles of hull mounted transducers has been developed at the Marine Research Institute in Iceland. This method relies on the possibility of estimating the displacement of a reference target, suspended on three lines below the transducer, by geometrical considerations when the length of one of the lines is changed by a certain amount.

It was stated that a more direct way of measuring the position of the sphere was needed in order to test further the accuracy of this method, and that the use of a split beam echo sounder could provide the means for this (Reynisson, 1985).

The principle of the ES400 split-beam echo-sounder and some of it features have been described by Foote et.al. (1984).

The information available on the parallel computer interface of this instrument makes it possible to sample miscellanous data for every transmission, such as the position of the target in the beam and target strength, compensated for the transducers directivity. In this way the directivity of the conventional beam as well as the sensitivity changes of the compensated signal can be measured in considerable detail, fairly quickly.

Measurements of this kind were undertaken this year, as ES400 echo sounders are now installed on two Icelandic research vessels.

The directivites of the split beam transducers as measured by the two methods mentioned are presented, as well as the sensitivity of the compensated beams.

MATERIALS AND METHODS

The equipment and set-up for measuring the directivities of the transducers is the same as described by Reynisson (1985) which is very similar as is used in a standard target calibration of ordinary echo sounders (Foote et.al. 1981).

The parallel interface of the ES400 was connected to a Hewlett Packard 9816 personal computer. For every ten centimeters of the depth column, a read pulse is sent from this interface, and by giving a three bit control code, different information is available on the eight data lines. Further details are given in the manufactures instruction manual (SIMRAD ES400, P2092E, 1985).

To handle this amount of data, either a very fast computer is needed or some preselection is neccessary. In this case the data sampling was limited to one reading for every transmission. This was done by using a presettable counter with comparator to give a read pulse to the computer at the desired depth. The counter was then reset by the next trigger from the echo sounder. A scematic diagram of this is shown in figure 1. The reflected pulse and read pulse were monitored on a digital oscilloscope and made to coincide in time as in figure 2.

The angle information was sampled in the first two transmissions and the compensated target strength on the third by sending the neccessary control codes to the ES400 interface. The oscilloscope which was also connected to the computer, sampled and stored the peak voltage of the reflected pulse in every transmission. The average peak voltage was then stored with the corresponding angle - and target strength information for later analysis.

When measuring the directivity by the "geometric" method, the length of one of the suspension lines was changed by 10 centimeters at a time, and ten sets of ES400 data obtained for each new position of the sphere. At other times the lengths of the suspension lines were changed continuously, but very slowly, such that more detailed information could be gained.

RESULTS

The equivalent beam angles were calculated for each transect, as well as for the whole beam according to both methods, and are given in table 1. The average deviation of the compensated target strength measured throughout each transect relative to the targe strength measured on the acoustic axis are also given in this table. The conventional two way directivities of the transducers in the seperate planes and the resulting energy contours are shown in figures 3-6. The sensitivity changes of the compensated signal are shown in figure 7 and 8. The transects made by the sphere as measured by the ES400 are shown in figure 9.

DISCUSSION

When looking at table 1. there are several striking differences in the equivalent beam angles and the directivites in the seperate transects as measured by the two methods:

1) For both transducers the split beam measurements give 2 dB higher equivalent beam angles than the geometric method. When comparing the seperate transects these differences range from 0.3 to 3.8 dB.

2) On transects where the geometric method gives the smallest beam with, the split-beam measurements give the widest. It should also be noted that according to the ES400 measurements, the beams are more deformed from the circular than might be expected. According to the geometric method the beams are fairly circular, and although some bias in the estimated angles is possible, it is very unlikely that this bias would differ much from one transect to the other, unless very strong tidal currents were present.

3) When monitoring the movements of the sphere through the beam, the angle information on the port/stb transects did not change although the sphere was moving. This can clearly be seen on the directivity diagrams in figures 3 and 5, as well as on the transect-diagrams in figure 9. These "gaps" are on the starboard and port side of transducer I and II respectively.

Possible explanations for these differences on the seperate transects as well as the jump of the observed angles are that either some misalignment was present in the phase relationship of the echo sounders four receivers, or that the mounting arrangements of the transducers have changed the beam pattern or influenced in some way the phase relationship of the echoes. Wether it has any bearing on the matter or not, it is interesting to note that transducer I is mounted on the port side of R/V Arni Friðriksson and transducer II on the starboard side of R/V Bjarni Sæmundsson.

Anomalies in the phase relationship will of course affect the compensation of the received signal. In figures 7 and 8 where these compensation errors are shown, the units of the abscissas are chosen in such a way that the areas limited by the measured points are representative of the average error, as the area weighted intergral of the compensation must be estimated. This has been further adressed by MacLennan et.al. (1986). The diagrams in figure 7 show that the compensation for transducer I is fairly good except in the aft/stb direction. For this transducer a new memory microcircuit (PROM) had been installed, containing a new set of lobe correction factors. For transducer II the original PROM was used. In this case the average compensation error is about 1 dB, which if taken by itself is acceptable. But the diagrams in figure 8 show that the errors are much more severe in this case. Estimating roughly the extremes, shows that variations in measured target strength of -4 to +5 dB are to be expected from a uniform target, depending on its position in the beam. When measuring the target strength of live fish this might not affect the mean more than the stated average deviation of 1 dB, but it would deform the true distribution of target strength. This will also in effect shorten the usable dynamic range of the scale chosen.

REFERENCES

Foote, K.G., H.P. Knudsen, G. Vestnes, R. Brede and R.L. Nielsen, 1981. "Improved calibration of hydroacoustic equipment with copper spheres." ICES, C.M. 1981/B:20

Foote, K.G., F.H. Kristensen and H. Solli, 1984. "Trials of a new split-beam echo sounder." ICES, C.M. 1984/B:21.

MacLennan, D.N. and I. Svellingen, 1986. "Simple calibration of a split-beam echo sounder." ICES, C.M. 1986/B:8.

Reynisson, P., 1985. "A method for measuring the equivalent beam angles of hull mounted transducers." ICES, C.M. 1985/B:4.

Table 1. Equivalent beam angles as calculated for each transect as well as the whole beam. Also given is the average deviation of the compensated signal relative to the on-axis sensitivity. Units are in decibels.

Transducer	Transect	Equivalent Beam angles "geometric"	split beam	Average deviation of on-axis sensitivity
I	Aft/port-fore/Stb	-21.2	-17.5	-0.5
"	Fore/Port-Aft/Stb	-20.5	-18.9	-1.2
"	Port/Stb	-20.3	-18.8	-0.2
"	Whole beam	-20.6	-18.5	-0.7
II	Aft/Port-Fore/Stb	-20.6	-19.6	-0.3
"	Fore/Port-Aft/Stb	-20.9	-17.1	2.1
"	Port/Stb	-19.5	-19.2	0.8
"	Whole beam	-20.5	-18.5	1.0

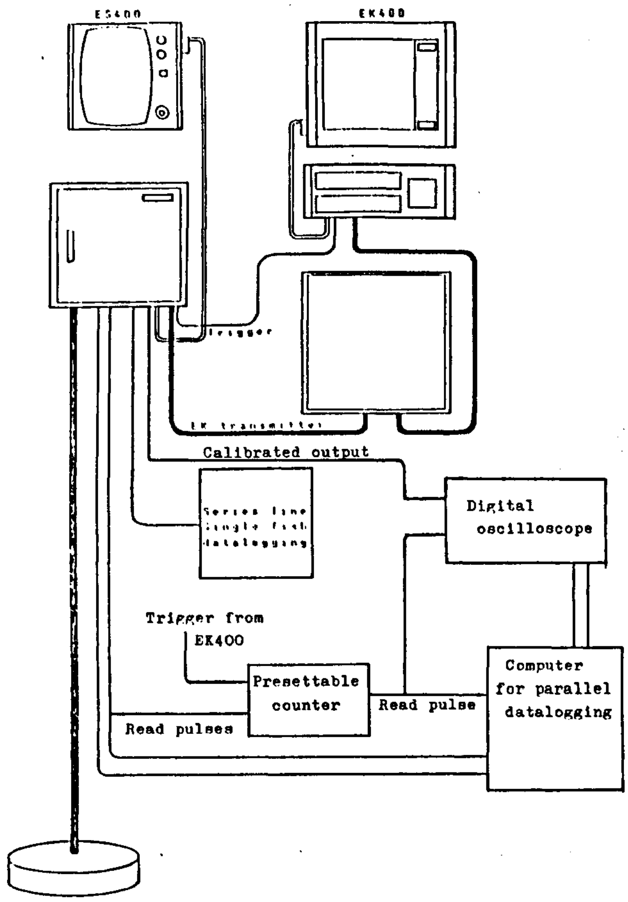


Figure 1. A scematic set-up of the electronic equipment used for the measurements(adapted from SIMRAD ES400 instruction manual, P2092E).

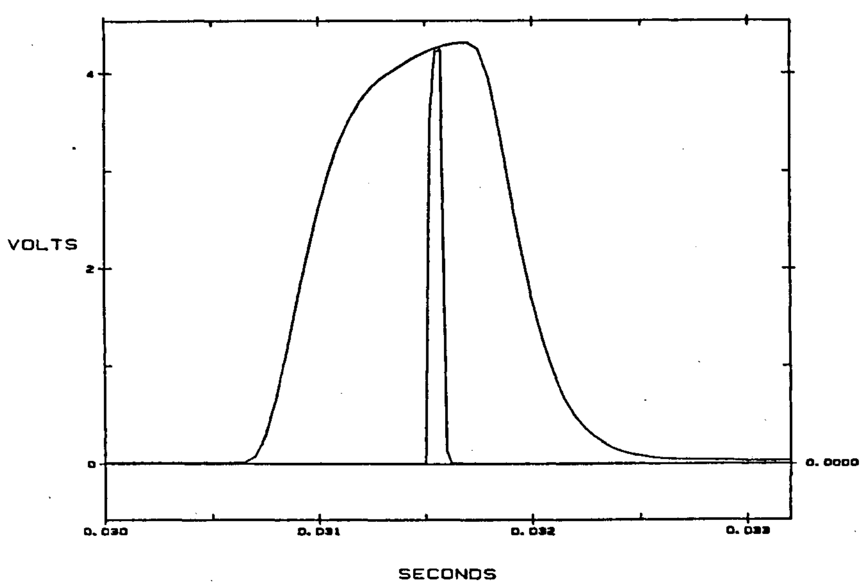


Figure 2. The envelope detected echo signal and the read pulse from the presettable counter.

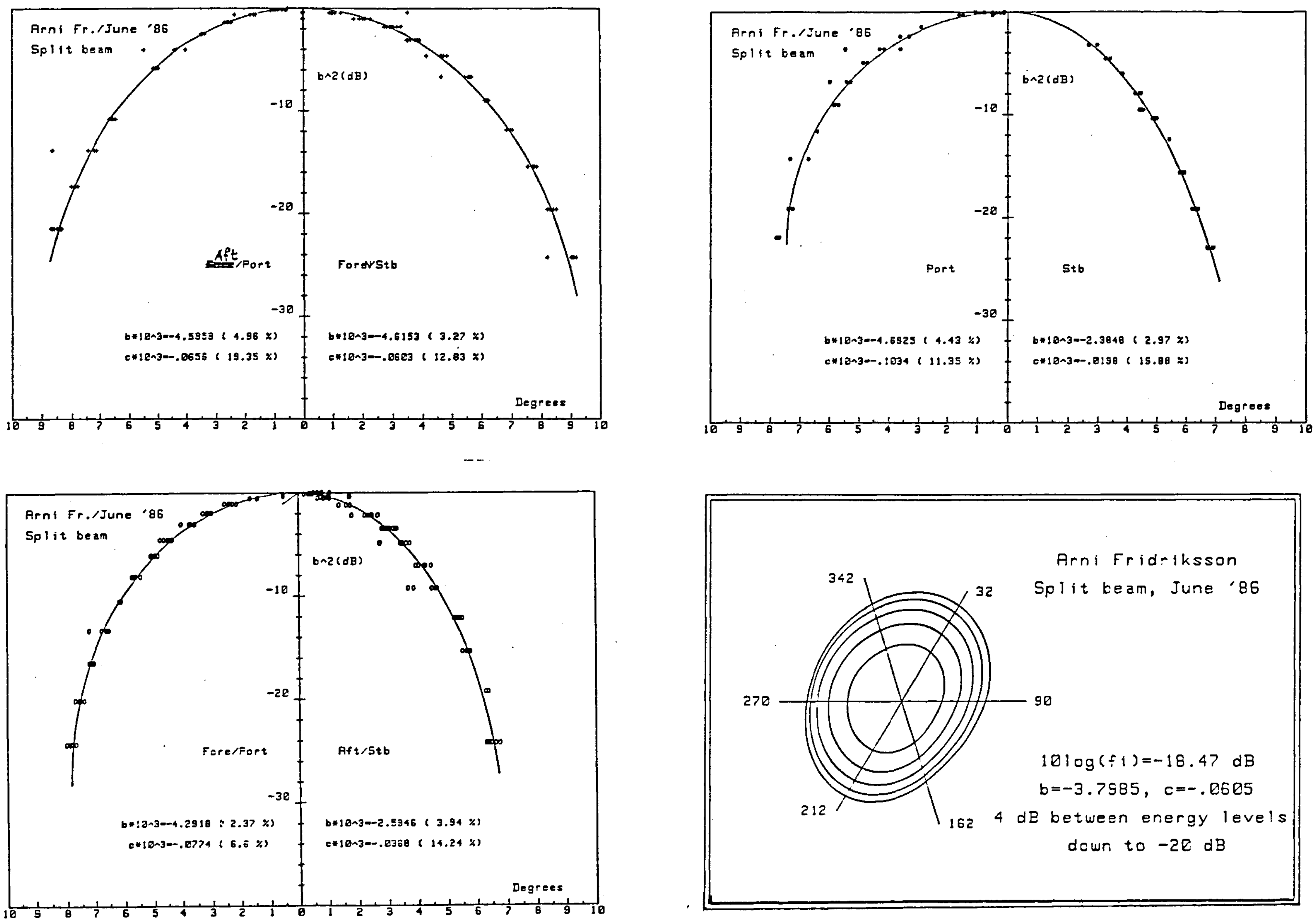


Figure 3. Two way directivity diagrams for transducer I, as measured by the ES400 and the resulting energy contours.

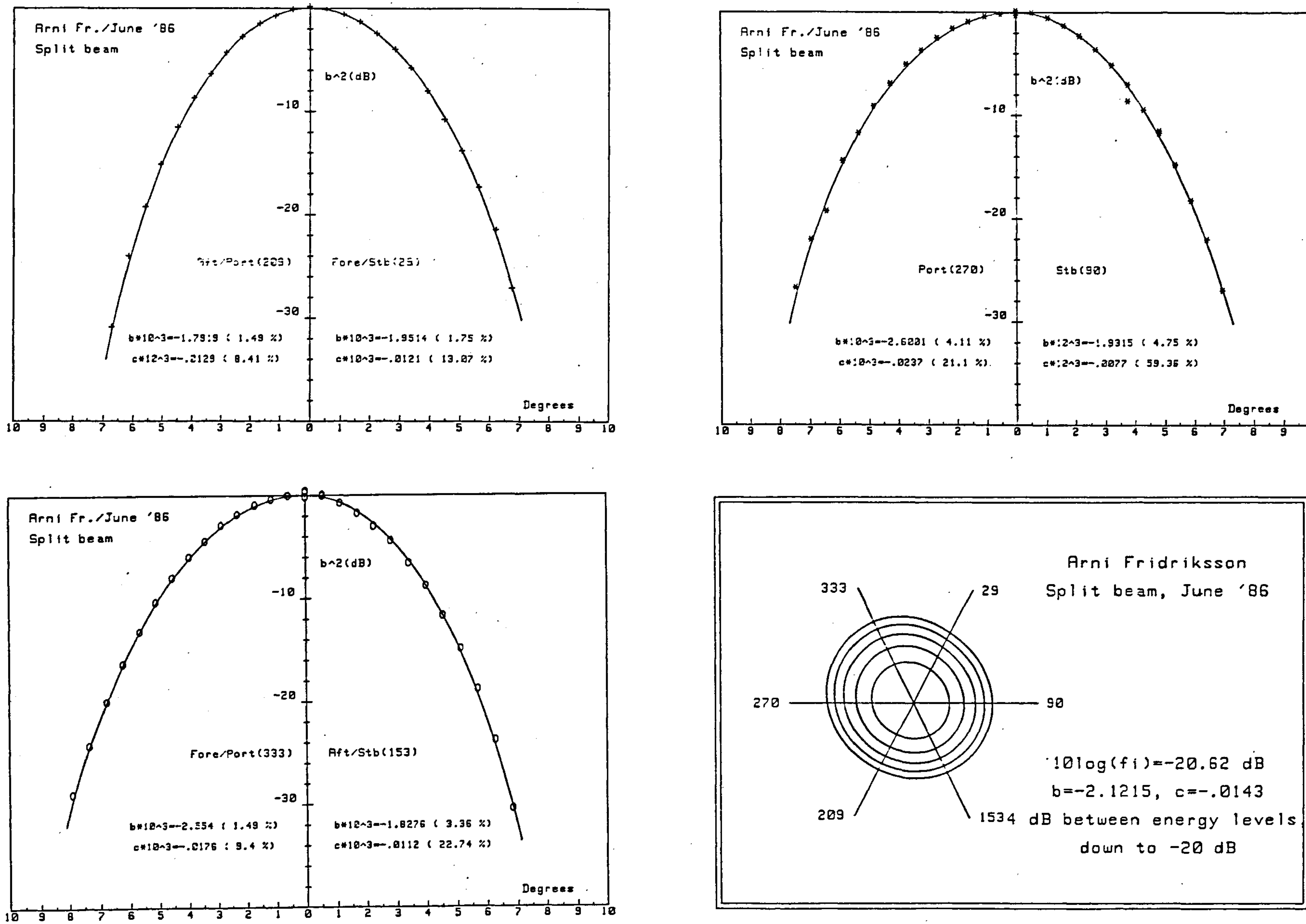


Figure 4. Two way directivity diagrams for transducer I as measured by the geometric method, and the resulting energy contours.

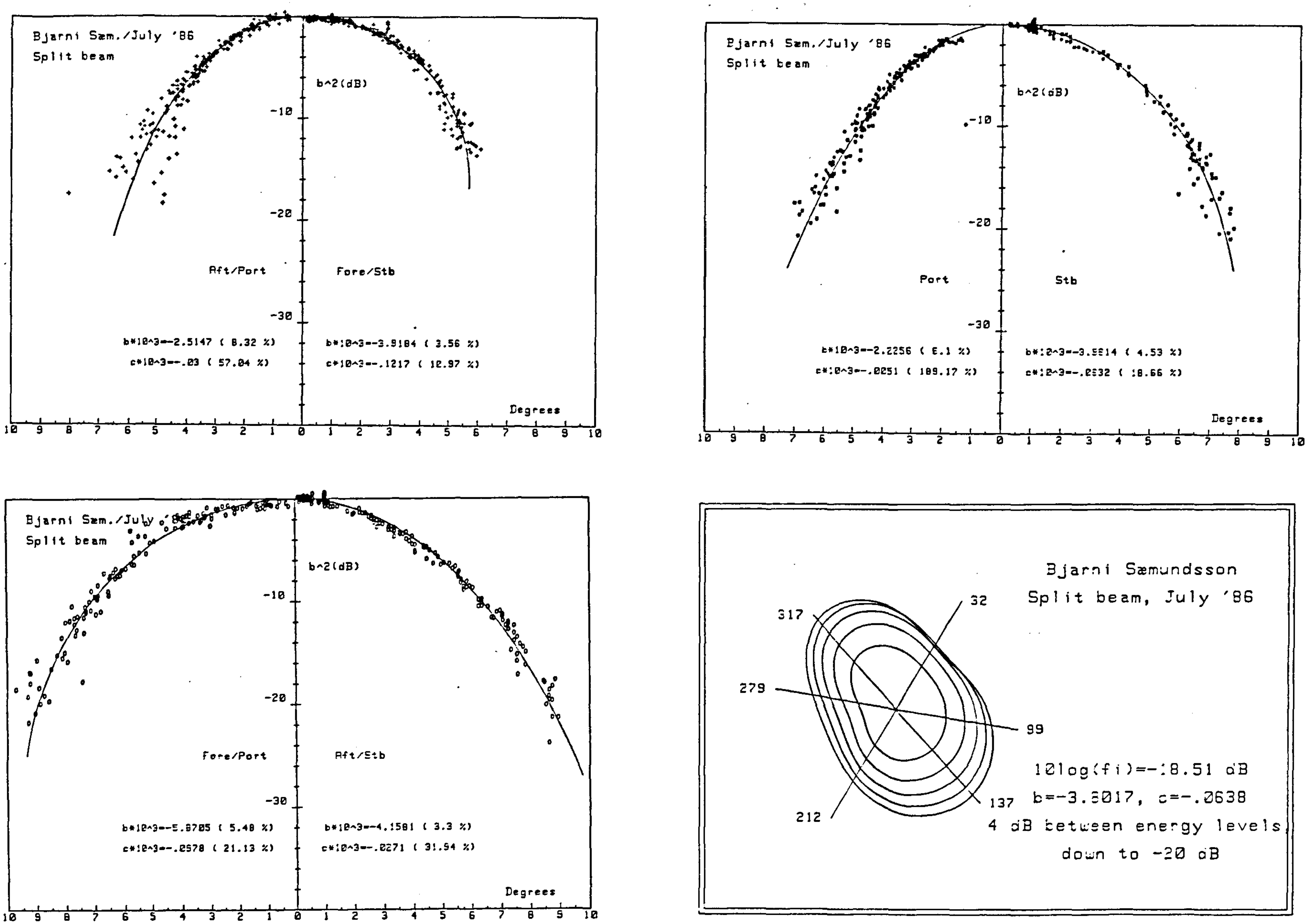


Figure 5. Two way directivity diagrams for transducer II, as measured by the ES400 and the resulting energy contours.

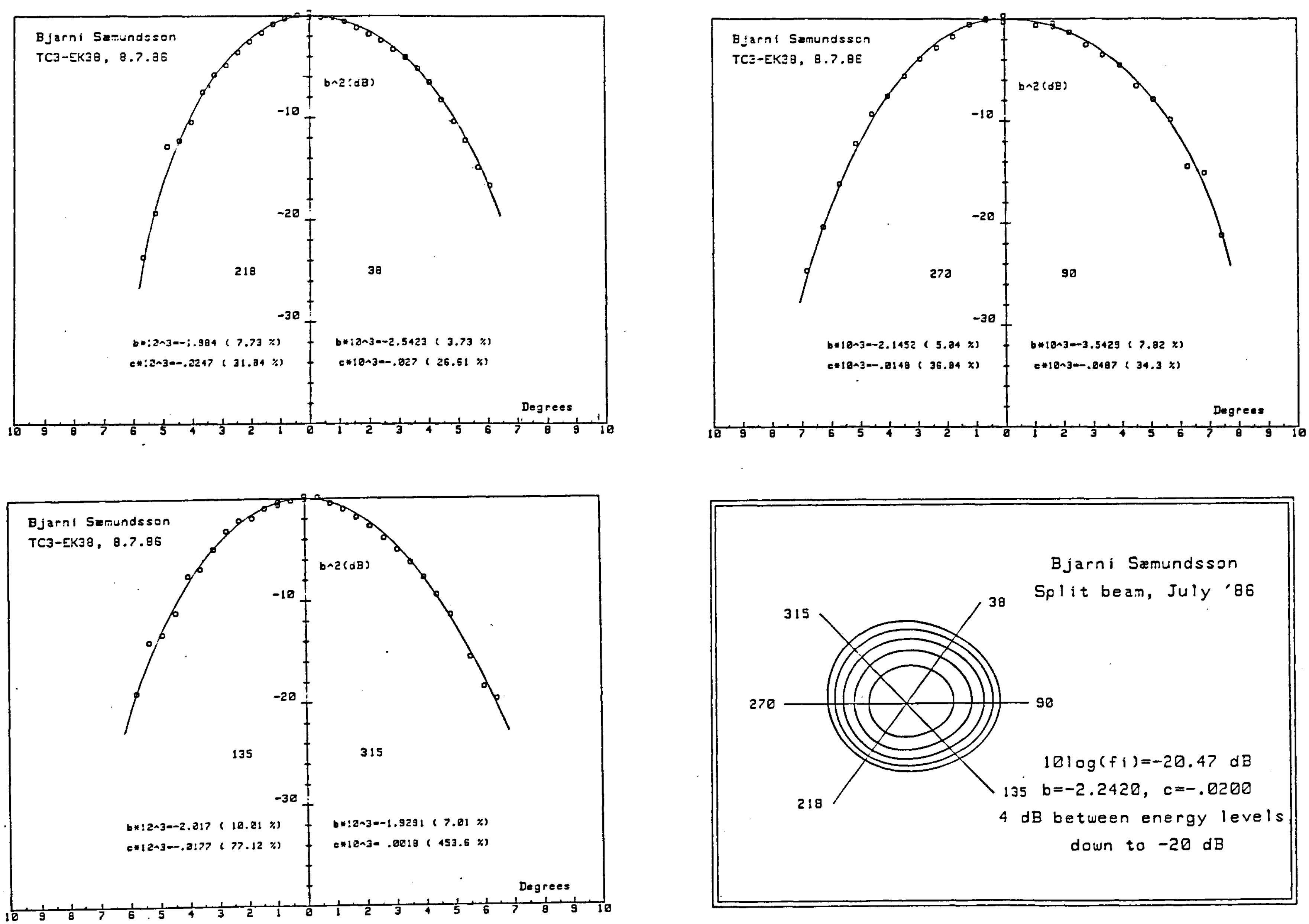


Figure 6. Two way directivity diagrams for transducer II as measured by the geometric method, and the resulting energy contours.

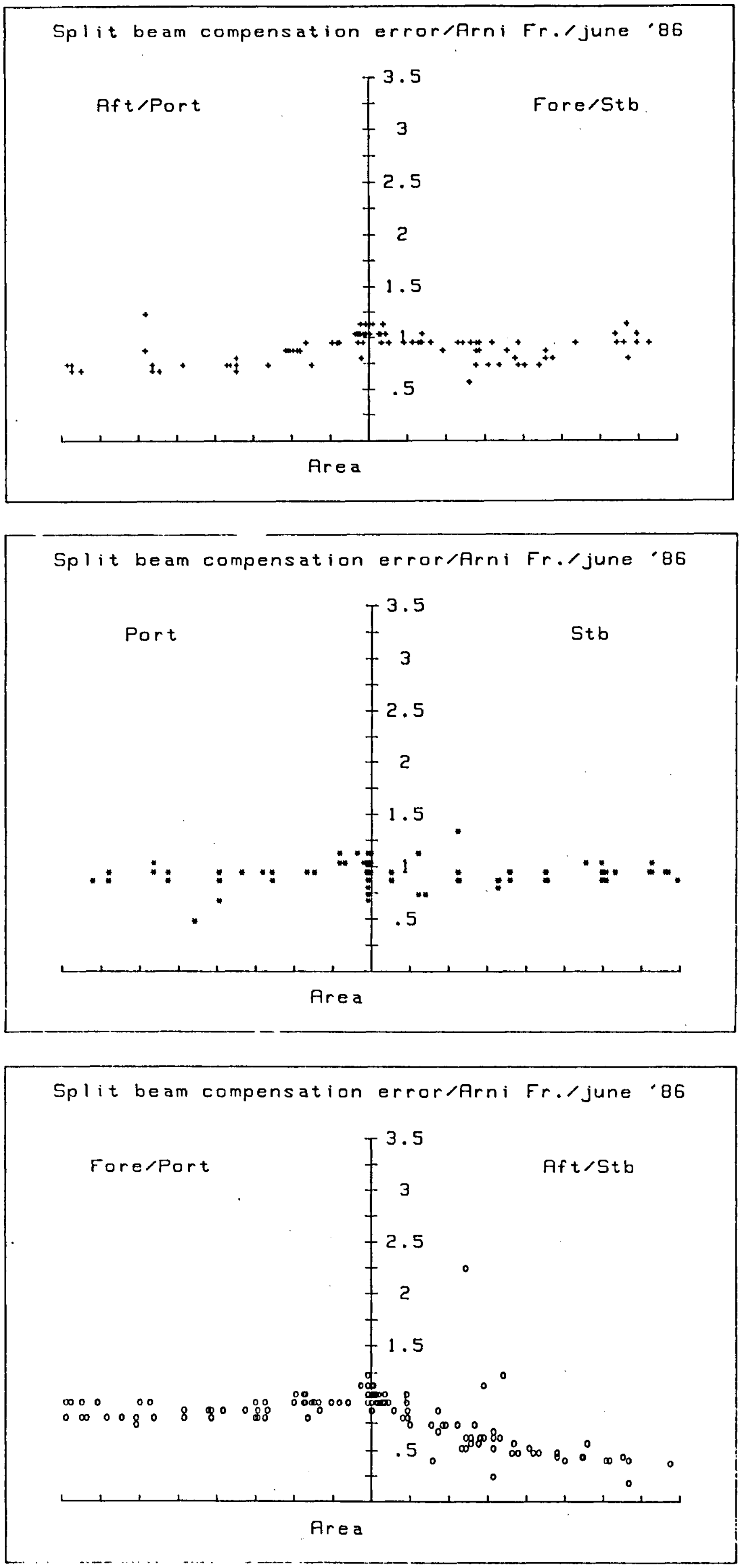
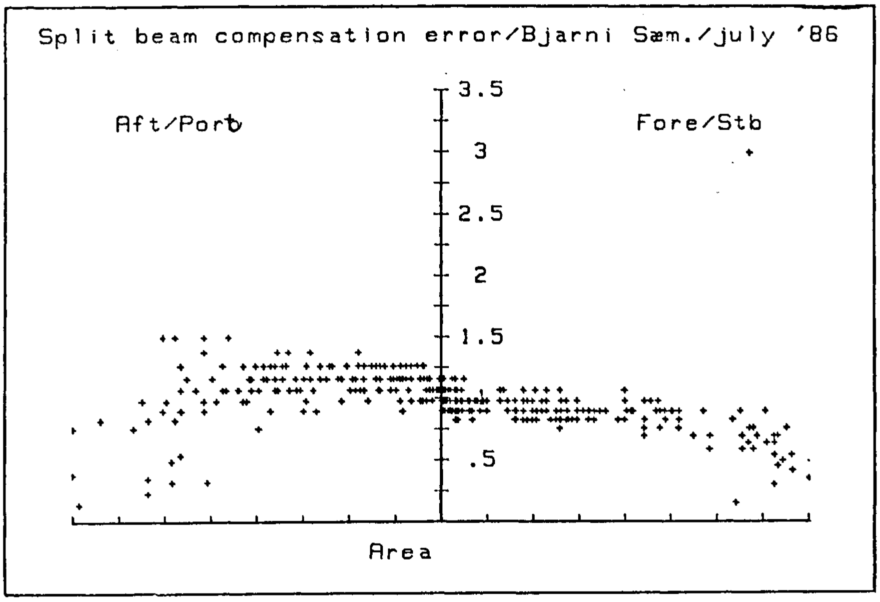
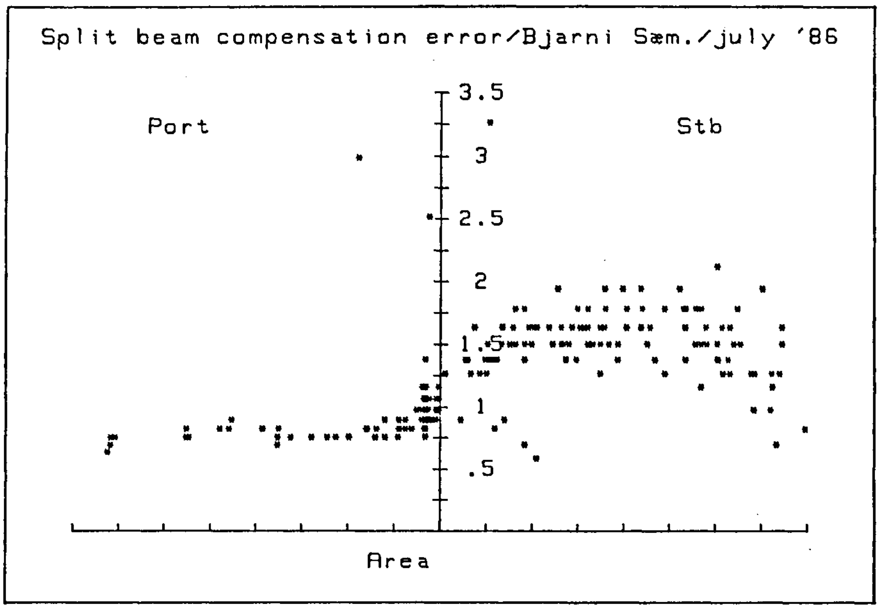


Figure 7. The normalized compensated sensitivity of transducer I for the seperate transects. The sensitivity is on a linear scale against an arbitrary area abscissa, out to 5 degrees.





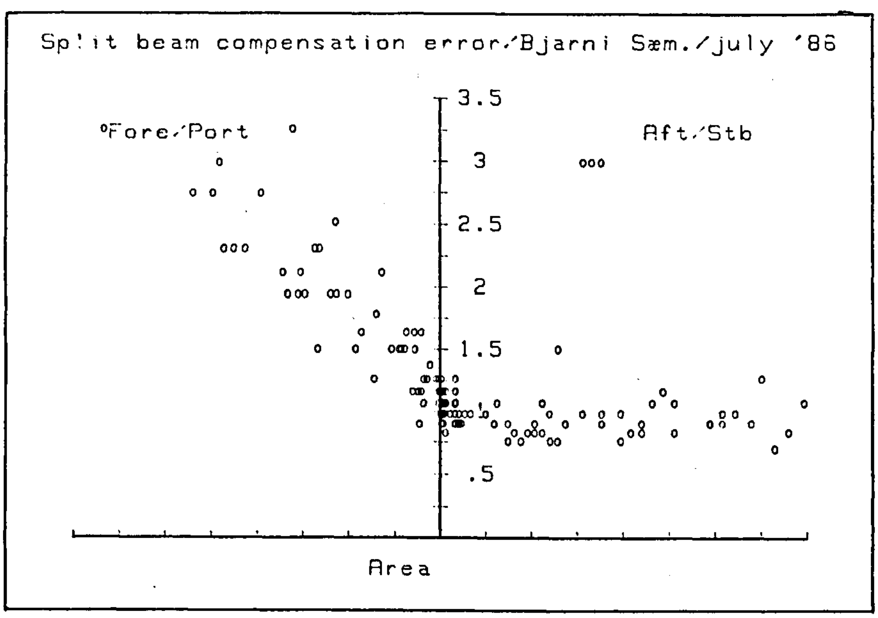
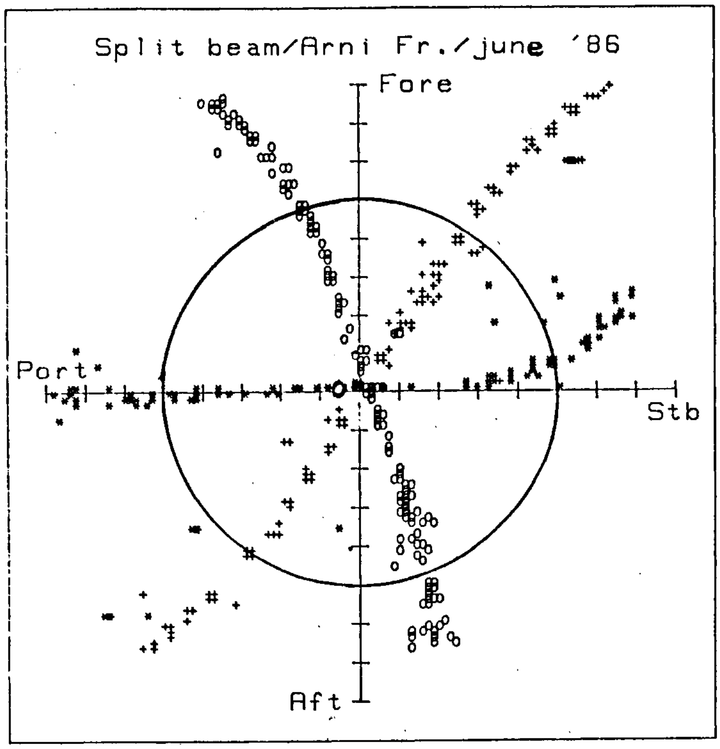


Figure 8. The normalized compensated sensitivity of transducer II for the sperate transects. The sensitivity is on a linear scale against an arbitrary area abscissa, out to 5 degrees.



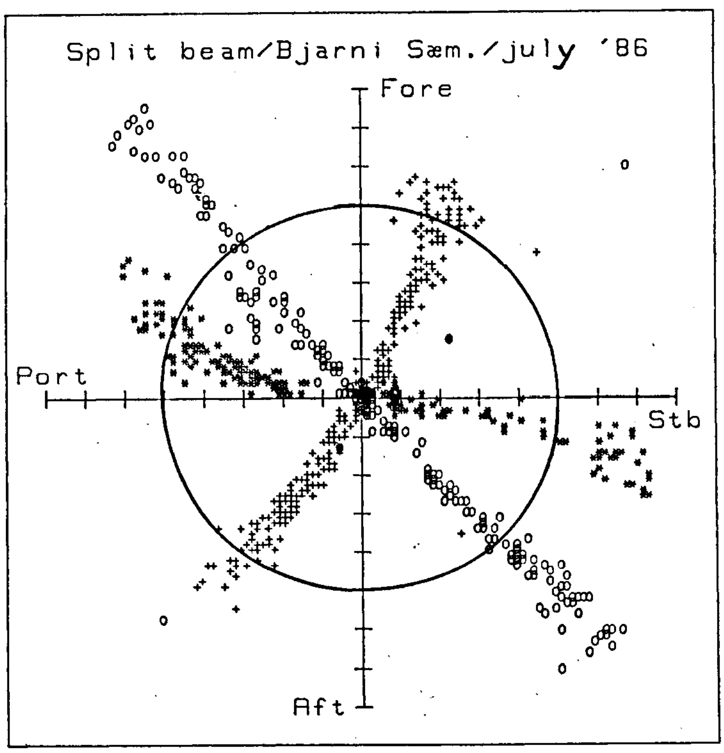


Figure 9. The movements of the reference target through the beams of transducer I and II, as measured by the ES400. A circle is drawn through the 5 degrees limit.