I.O.S.

MOORED CURRENT METER RECORDS
CELTIC SEA 2 JUNE – 7 JULY 1973
IOS BIDSTON MOORINGS 30–36

M. J. HOWARTH
S. G. LOCH

1976

DATA REPORT NO. 6

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Bidston Observatory
Birkenhead
Merseyside L43 7RA

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Introduction

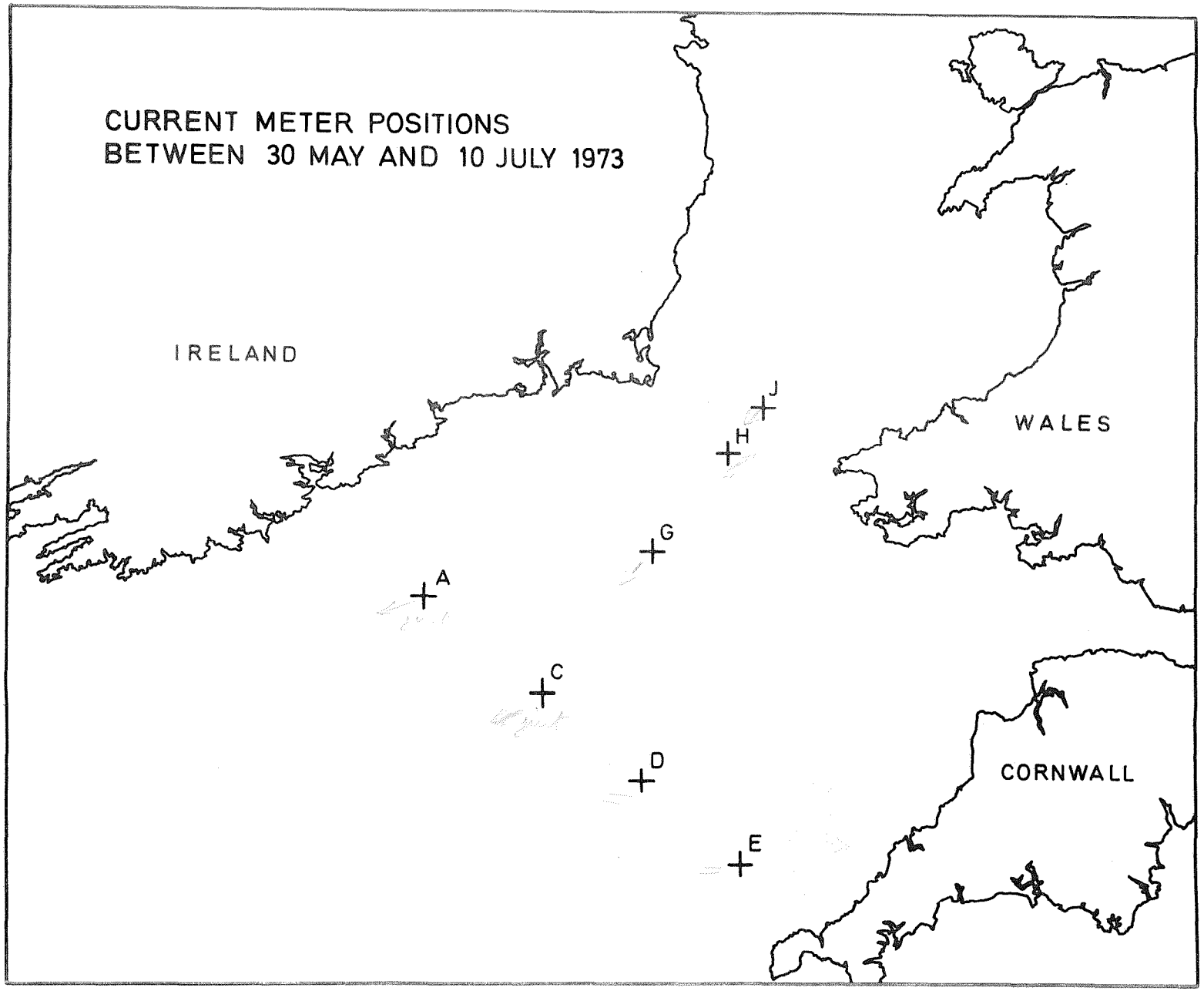
This report describes the results from I.O.S. Bidston moorings 30-36 which formed part of a general investigation into the physical oceanography of the Celtic Sea (to south of Eire and west of the Bristol Channel). Seven rigs were deployed containing a total of nineteen Bergen recording current meters, AANDERAA (1964). Four of the rigs were on the line between St. Ives and Cork and the remaining three on a perpendicular to this line towards the St. George's Channel (see map and Table 1). Station J had been occupied twice before by I.O.S. Bidston, HOWARTH et al. (1974a) and (1974b), and once by MAFF, Lowestoft, HOWARTH (1974). The investigation also included extensive surveys of salinity and temperature with a CTD profiler, an off-shore tide gauge deployed at station C, ALCOCK et al. (IN PRESS), as well as several shore based tide gauges, and a short drogue tracking exercise.

Six of the seven rigs were recovered without damage to their meters but of rig E, containing two meters, there was no sign when the time came for its recovery. The remaining seventeen meters all returned data of good quality without gaps or omissions.

Table 1

Summary of current meter deployment, times and positions

Mooring No.	Rig	Latitude	Longitude	Water depth below chart datum (m)	Day Launched	Day Recovered	Height of meter above sea floor (m)	Tape No.
30	E	50°27'N	5°54'W	73	2 June 1973	-	55	213/7
							15	530/3
31	D	50°45'N	6°27'W	96	2 June 1973	6 July 1973	75	563/2
							60	569/1
							15	570/1
32	C	51°03'N	7°00'W	91	2 June 1973	6 July 1973	73	415/5
							58	416/4
							15	417/5
33	A	51°24'N	7°40'W	85	3 June 1973	6 July 1973	64	160/6
							15	531/3
34	G	51°34'N	6°23'W	80	3 June 1973	18 June 1973	70	565/2
							55	566/1
							15	567/1
35	H	51°55'N	5°58'W	106	3 June 1973	7 July 1973	80	564/2
							65	568/1
							15	532/3
36	J	52°05'N	5°46'W	92	3 June 1973	7 July 1973	71	214/7
							56	212/8
							15	533/3


CURRENT METER POSITIONS
BETWEEN 30 MAY AND 10 JULY 1973
IRELAND
WALES
CORNWALL
A
C
D
E
G
H
J

Current Meter

A Bergen current meter is a self-contained instrument for measuring water temperature, integrated rotor count and direction. It consists of a recording unit, spindle and vane. The recording unit houses a rotor, thermistor, compass, quartz-crystal clock, tape deck for $\frac{1}{4}$" magnetic tape and encoder - a self-balancing bridge which converts the output from the sensors into a ten bit binary number. The spindle is spliced into the mooring wire and has a gimbal mounting which allows $\pm 27^{o}$ tilt between the spindle and the meter. The vane aligns the meter with the flow and is a 1.00m x 0.37m PVC sheet to which is fitted a pair of small horizontal stabilizer fins and a weight to balance the meter.

In the past, the spindles had often been recovered damaged or corroded and so a better quality spindle has been designed at Bidston, CHIVERS (IN PRESS). This was fitted to five of the meters. A pressure sensor, a bourdon tube driving a potentiometer with a range 0-13.8 bar, is also available. It was fitted to all three meters on one rig, C, and to the top meters of five other rigs (all except A). The sampling interval for each of the meters was 10 minutes and was controlled by a clock rated at ± 2 seconds/day but four of the meters had errors greater than this. Timing errors were determined by comparing the number of samples recorded with the difference between the times of starting and stopping the meters. The meters were started on board ship but were stopped and had pre- and post-cruise checks performed on them in the laboratory.

All meters were calibrated before their launch and after their recovery. The thermistors were calibrated over the range $-2^{o}K$ to $20^{o}K$ in an environmental chamber before the launch and

in a water bath after recovery. A straight line was fitted to the results of each calibration. The compasses were calibrated every 10^{o} from 0 to 360^{o} and every degree through its dead-space. This calibration was performed on Bidston Hill with the meters in a special jig. The results were used to create a table which contained the direction (to the nearest degree) corresponding to each meter reading. The pressure sensors were calibrated over the range 0 to 13.5 bars above atmospheric pressure using a dead weight tester and a straight line fitted to the results. The rotors were not calibrated but the manufacturer's formula was used since experience had shown this to be sufficiently accurate.

Seventeen records were obtained because two meters were lost. Despite three meters being recovered accidentally by a trawler, none of the meters malfunctioned and all returned good records.

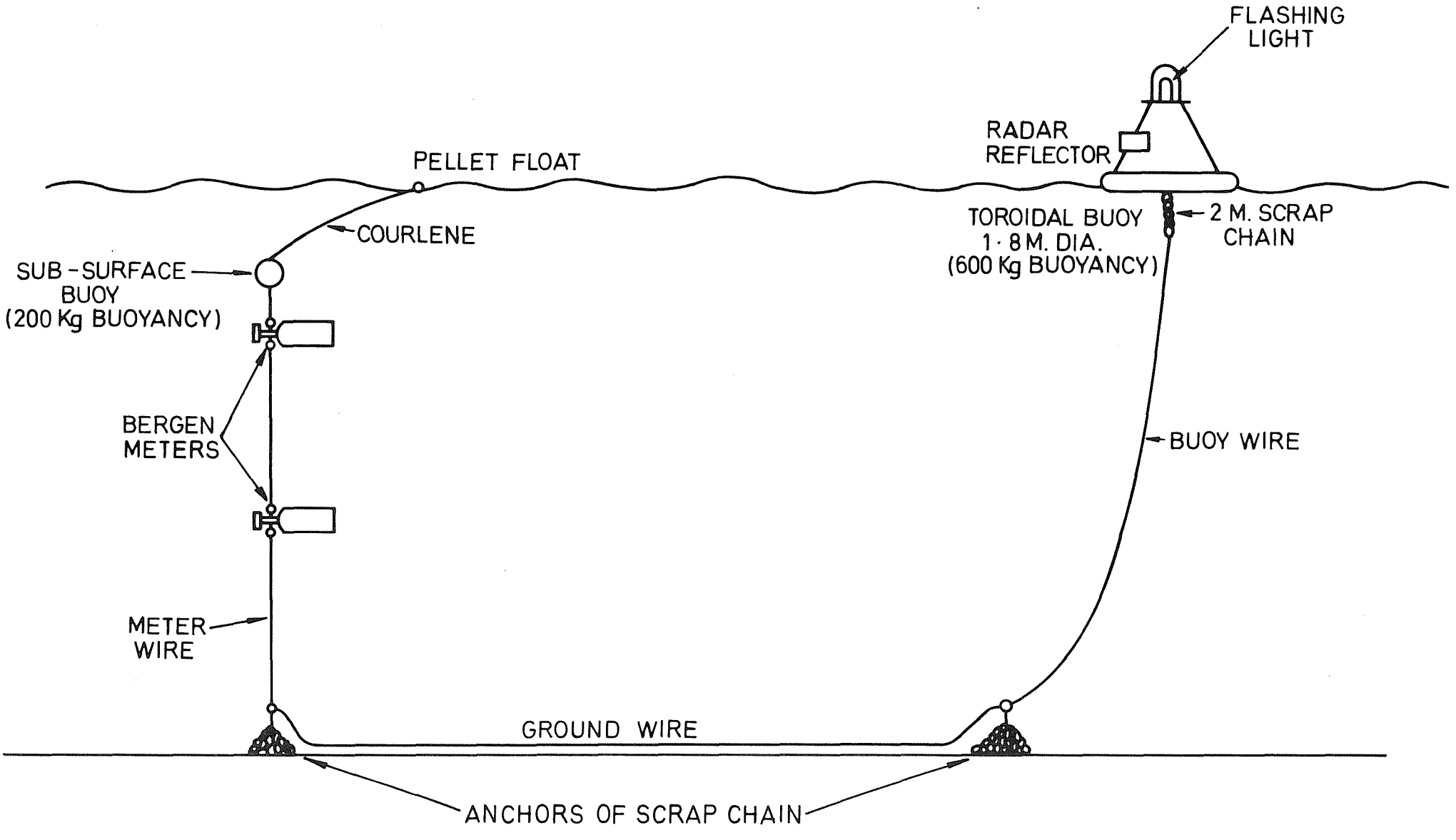
Current meter moorings.

A schematic diagram of the mooring arrangement is shown in figure 1. It is a standard shelf seas rig designed to reduce the effects of surface waves on the meters. The Bergen meter spindles were spliced into a taut line supported by a sub-surface buoy. In this experiment three different types of sub-surface buoy were used :-

(A) A bullet shaped buoy about 1.1m long and 0.65m in diameter made from high density polyurethane foam in a fibreglass shell approx. 1 cm thick. It has a buoyancy of 180 kg and is manufactured by Cosalt Ltd.

(B) A solid spheroid about 1m in diameter made from a heterogeneous mix of syntactic foam and 38mm diameter pressure resistant spheres all inside a fibreglass casing. It has a buoyancy of 225 kg and is manufactured by Slingsby Sailplanes Ltd.

FIGURE 1. MOORING SYSTEM (SCHEMATIC)



(C) A free-flooding spheroid about 1m in diameter made from a hollow fibreglass shell containing 38mm diameter pressure resistant spheres encased in a net. The shell is perforated to render the buoy free-flooding. It has a buoyancy of 225 kg and is manufactured by Slingsby Sailplanes Ltd.

The position of the rig is marked by a toroidal surface buoy supporting a radar reflector and a flashing light. Two scrap chain anchors were used, one of 700 kgs under the surface buoy and one of 450 kgs below the sub-surface buoy. A wire rope of 8mm diameter galvanised, flexible steel was used for the line supporting the meters, 12mm wire for the ground line (approx. 200m long) and the line to the surface toroid. A 2m length of scrap chain was attached to the bottom of the surface buoy to give it some form of stability, but despite this the buoys overturned several times.

The rigs were deployed by first launching the sub-surface float, then the meters and the meter anchor, paying out the ground line, the anchor under the surface buoy, the surface buoy line and finally launching the surface buoy. This procedure was reversed for recovery. Snap shackles were used, where possible, to minimise handling problems and generally to speed up both launch and recovery. Where snap shackles were not used connections were made by $\frac{5}{8}$ in D shackles with $\frac{3}{4}$ in pins and reciprous bearing swivels.

The R.R.S. John Murray was used for all operations and the skill and experience of her master and crew contributed greatly to the success of the programme.

Data processing

The data on the magnetic tapes from the Bergen meters was translated at Bidston on to punched paper tape which was input

into the Institute's IBM 1130 computer. Errors in the data were discovered by noting either discontinuities in the records or consecutive readings with the same value; the most common errors being :-

(a) A large change in direction between adjacent readings at times of reasonable speed - $> 0.25\text{m s}^{-1}$. This is probably caused by the meter's encoder misreading the compass.

(b) The rotor count going backwards. This often occurs when the rotor potentiometer is in its dead-space.

Errors of type (b) were corrected and the meter calibrations were then used to calculate the temperature, pressure and the North (true) and East components of velocity. Because the meter integrates the rotor count but records instantaneous directions, some further averaging was necessary to derive a simultaneous reading of speed and direction. Consider three adjacent readings of rotor count and direction at times t1, t2, t3. The value for speed and direction at t2 was derived by associating the speed given by the rotor count at t3 minus that at t1 with the instantaneous measurement of direction at time t2.

After the components of velocity had been calculated errors of type (a), which were more common than those of type (b), were corrected using a cubic spline routine on each velocity component.

Format

The report is split into sections, one for each mooring, each section beginning with a page of mooring details showing :-

Mooring number	:	IOS Bidston reference number.
Position of rig	:	Station identification letter, latitude and longitude.
Depth of water	:	from the appropriate Admiralty Chart.

Tidal heights : from the tidal predictions for the nearest port giving the heights above chart datum of the

mean high water springs	MHWS
mean high water neaps	MHWN
mean low water springs	MLWS
mean low water neaps	MLWN

Meter information : the meter number, the type of meter, the height of the meter's rotor above the anchor.

Time of set : the time that the surface buoy was released from the ship.

Time of recovery : the time that the surface buoy was brought on board the ship.

Mooring : any additional information on the mooring.

Another page of information is included before the results from each meter. This contains :-

Meter information : manufacturer and meter identification number.

Tape number : identification of the record.

Times : the times when the meter was started and stopped together with the calculated timing error and the total number of readings.

Length of useful record : times of start and end of velocity time series, total length of useful data.

Comments : comments on the meter, its behaviour and the quality of the record.

The results are displayed in five graphs produced on a Computer Instrumentation Limited 6011 plotter linked to the Institute's IBM 1130 computer. The diagrams are :-

(1) A plot of the temperature, pressure (if appropriate) and the North and East components of velocity against time. The whole data series obtained (10 minute values in this case) is used as the input for this graph. The lines on the time axis indicate midnight (0000 GMT).

(2) Histograms of speed and direction. Plots of the percentage of the data which lie within a certain

interval of speed or direction. The direction histogram is split into intervals of 18^{o}, the speed range is flexible depending on the maximum speed recorded.

(3) A scatter diagram of the North component of velocity against the East component. The scale is in cm s^{-1}, each dot representing a reading of the meter. The eccentricity of the tidal ellipse is clearly indicated, showing the contrast between the almost rectilinear tidal stream in the upper layers and the noticeably elliptical motion nearer the bed. This diagram is particularly useful in revealing malfunctions in the meter's compass or in the rig itself.

(4) Two progressive vector diagrams. One uses the same data as diagram 1; the other uses the data filtered by applying a running average over a period of 24 hrs 50 mins (two tidal cycles) to remove most of the tidal signal and hence show the residual movement more clearly. For any record, the scale (in kms) and orientation are the same for both graphs. A drift of 1 km d^{-1} is equivalent to a residual speed of 1.16 cm s^{-1}. The crosses mark midday (1200 GMT) each day. Care is needed in interpreting these graphs, they indicate the time variation of the current vector at the meter and not the path of a particle.

Acknowledgements

The authors would like to thank Mr. A. J. Harrison for the care he has taken in looking after the instruments, Mr. D. L. Leighton for launching and recovering the rigs and the computer operators for their patience and help in running our programs.

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Mooring number	:	30
Position of rig	:	Lat $50^{o}27'$N Long $5^{o}54'$W (rig E)
Depth of water	:	73m below chart datum

Tidal heights, in metres above chart datum, at St. Ives	:	MHWS	MHWN	MLWN	MLWS
		6.6	4.9	2.4	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
213	Bergen	55	10
530	Bergen	15	10

Rig set	:	09.31 GMT 2 June 1973 from r.r.s. John Murray
Rig recovered	:	-
Mooring	:	Standard, with cosalt sub-surface buoy.
Comments	:	The launch was successfully accomplished at the first attempt. The surface buoy was found floating free on 6 June and the pellet floats attached to the sub-surface buoy were observed in position on 15 June. However, the rig was dragged for on 5, 8 and 9 July, without success.

Mooring number : 31

Position of rig : Lat 50°45'N Long 6°27'W (rig D)

Depth of water : 96m below chart datum

Tidal heights, in metres above chart datum, at St. Ives	MHWS	MHWN	MLWN	MLWS
	6.6	4.9	2.4	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
563	Bergen	75	10
569	Bergen	60	10
570	Bergen	15	10

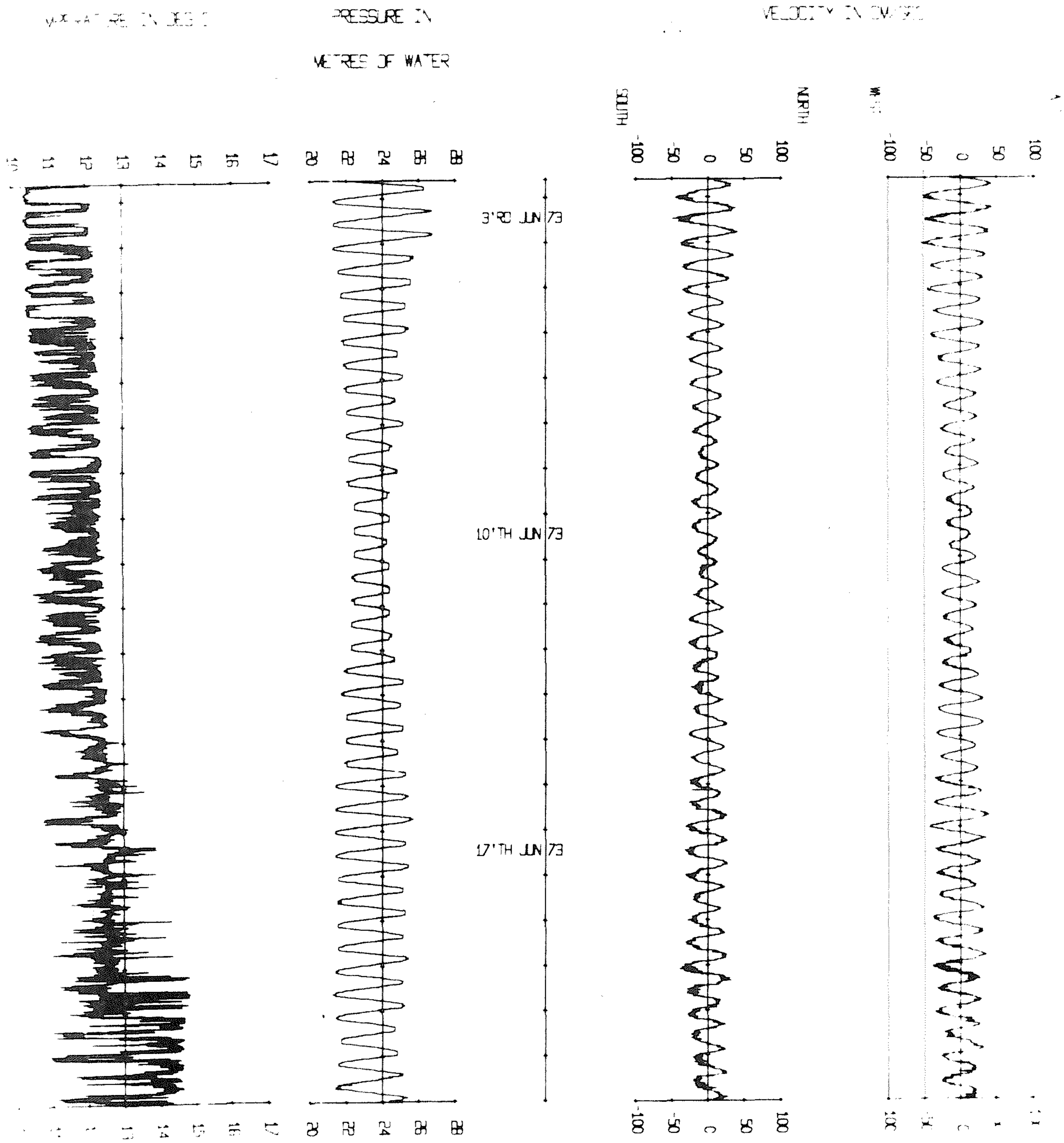
Rig set : 13.22 GMT 2 June 1973
from r.r.s. John Murray

Rig recovered : 05.09 GMT 6 July 1973
from r.r.s. John Murray

Mooring : Standard, with free-flooding Slingsby sub-surface buoy.

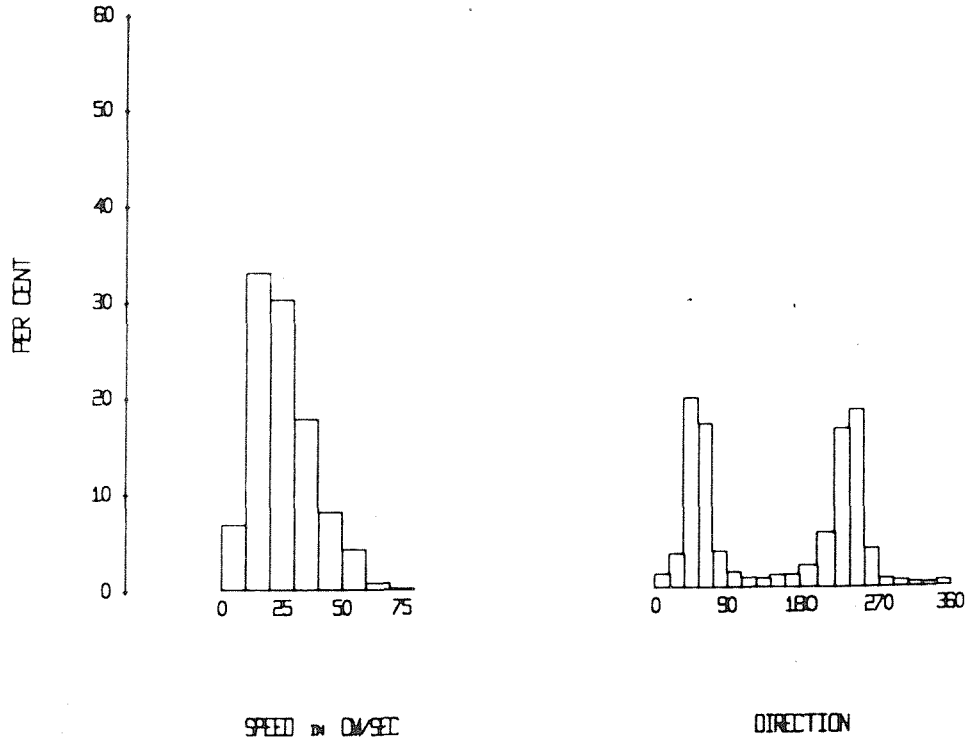
Comments : The launch and recovery were successfully accomplished at the first attempt.

Meter	:	Bergen 563
Tape number	:	563/2
Meter started	:	18.30.00 GMT 1 June 1973
Meter stopped	:	09.40.16 GMT 16 July 1973
Total number of readings	:	6428
Timing error	:	16 s slow
Start of useful record	:	13.40 GMT 2 June 1973
End of useful record	:	04.50 GMT 6 July 1973
Length of useful record	:	807 h
Comments	:	Good record. The meter was fitted with a pressure sensor. It was situated near the top of the thermocline - a $5^{o}K$ change with an average gradient of $0.2^{o}K\ m^{-1}$.



PRESSURE IN
METRES OF WATER
VELOCITY IN
SOUTH
NORTH
3'RD JUN 73
10'TH JUN 73
17'TH JUN 73
11
12
13
14
15
16
17
20
22
24
26
28
-100
-50
0
50
100

TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
24'TH JUN 73
1'ST JUL 73


PER CENT
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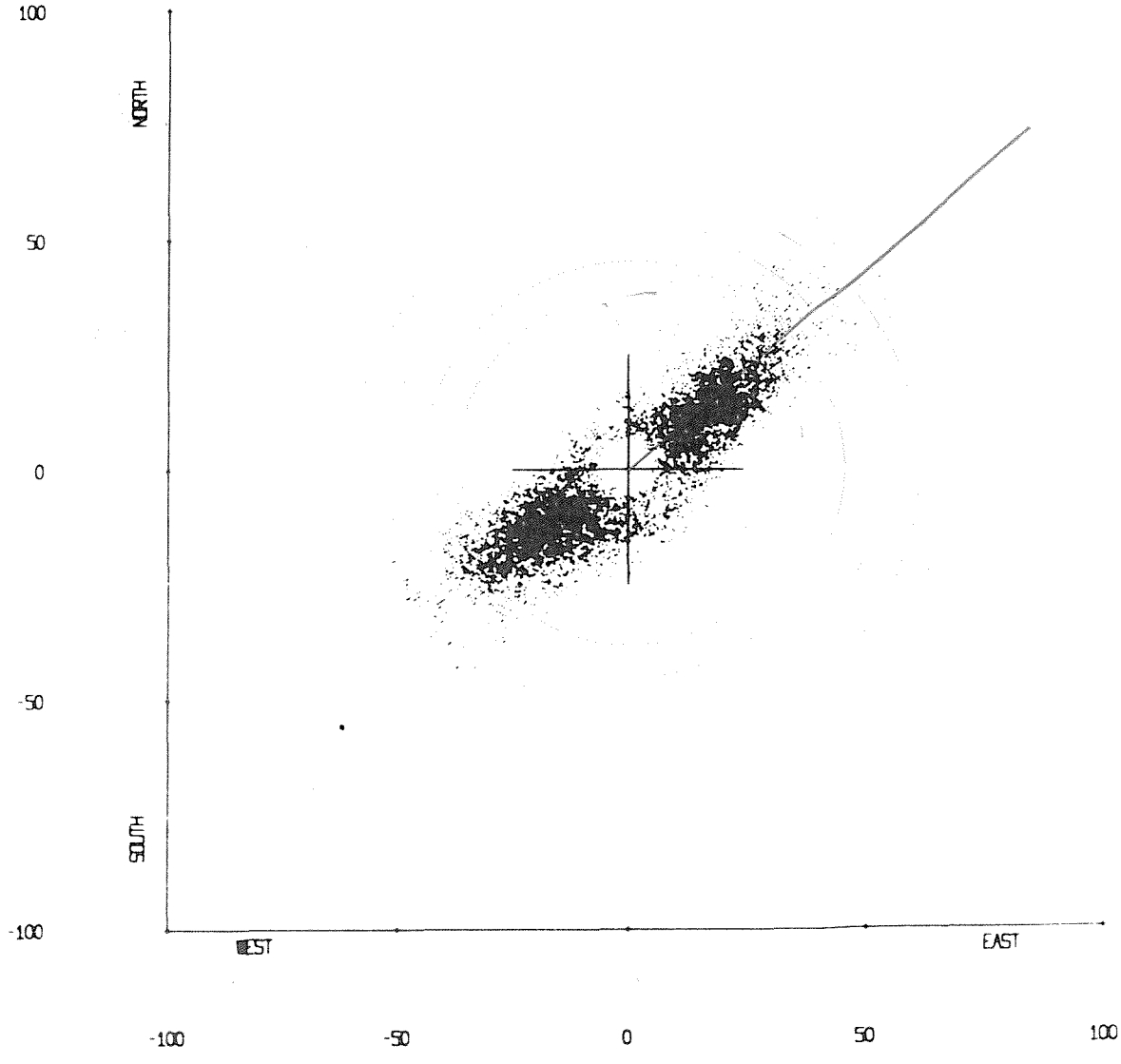
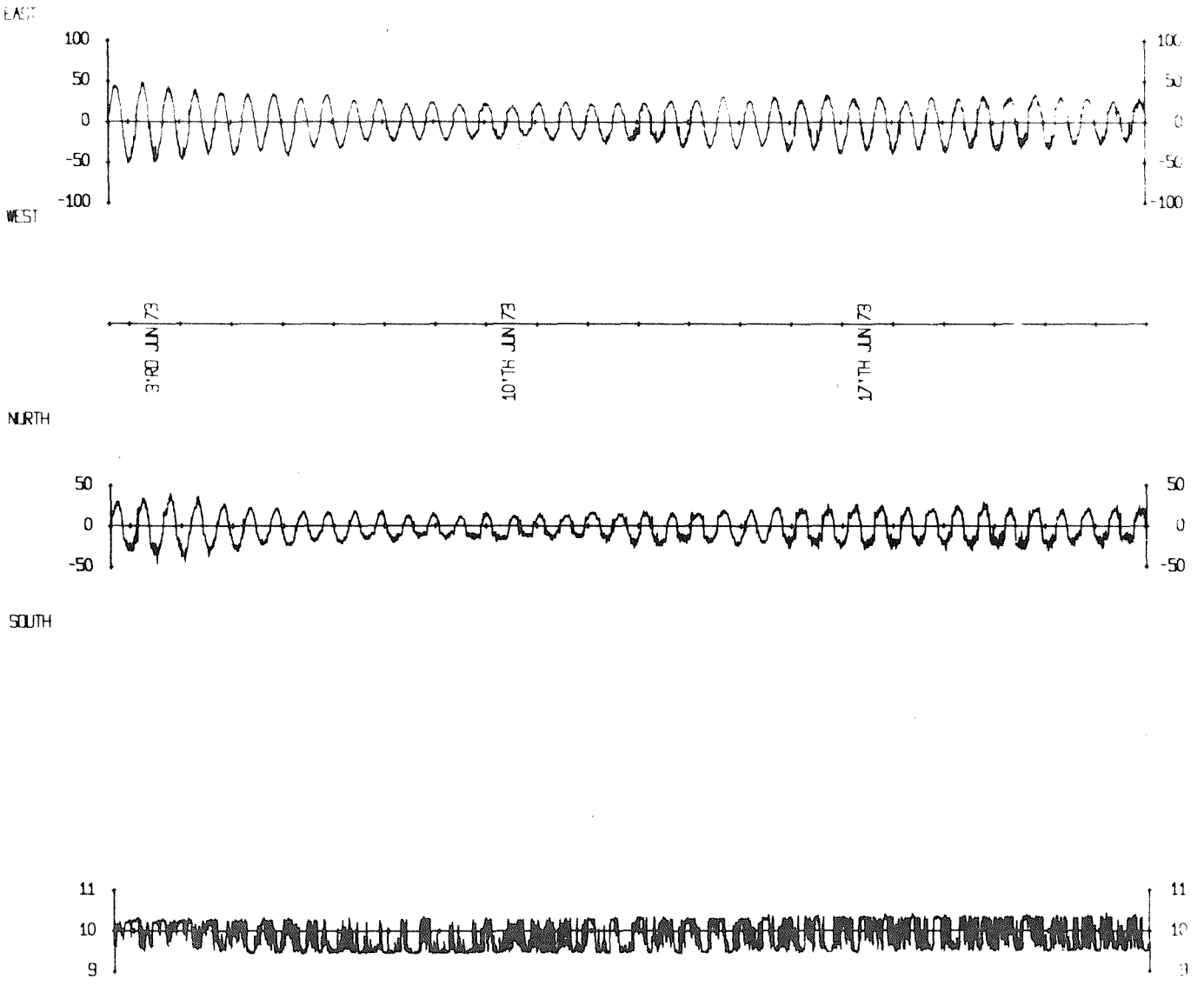
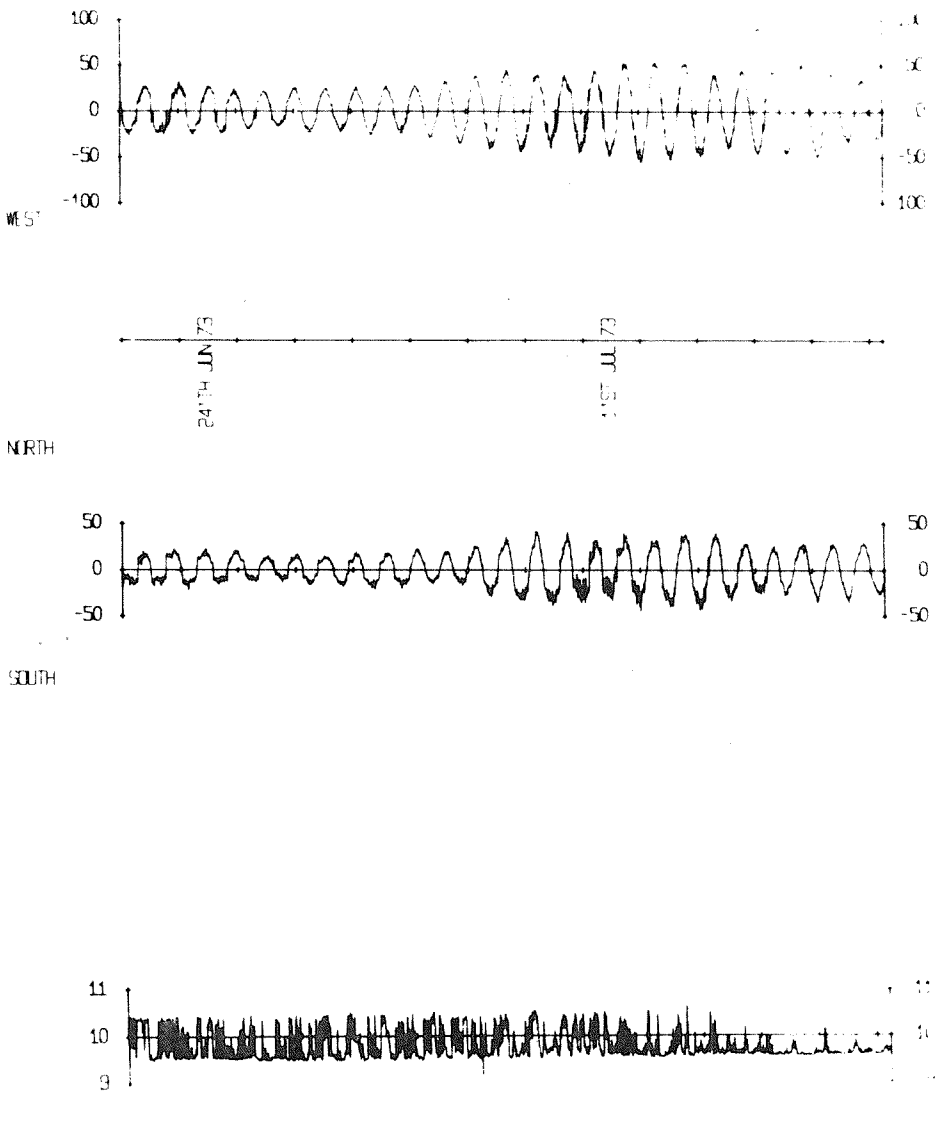
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

SOUTH
25
20
15
10
5
-10
-5
0
5
10
15
EAST
WEST
5
NORTH

Meter	:	Bergen 569
Tape number	:	569/1
Meter started	:	18.40.00 GMT 1 June 1973
Meter stopped	:	10.59.17 GMT 16 July 1973
Total number of readings	:	6435
Timing error	:	43 s fast
Start of useful record	:	13.40 GMT 2 June 1973
End of useful record	:	04.50 GMT 6 July 1973
Length of useful record	:	807 h
Comments	:	Good record. The meter was equipped with a spindle designed by Bidston and was situated near the bottom of the thermocline.


EAST
100
50
0
-50
-100
WEST
3'RD JUN 73
10'TH JUN 73
17'TH JUN 73
NORTH
50
0
-50
SOUTH
11
10
9


100
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WEST
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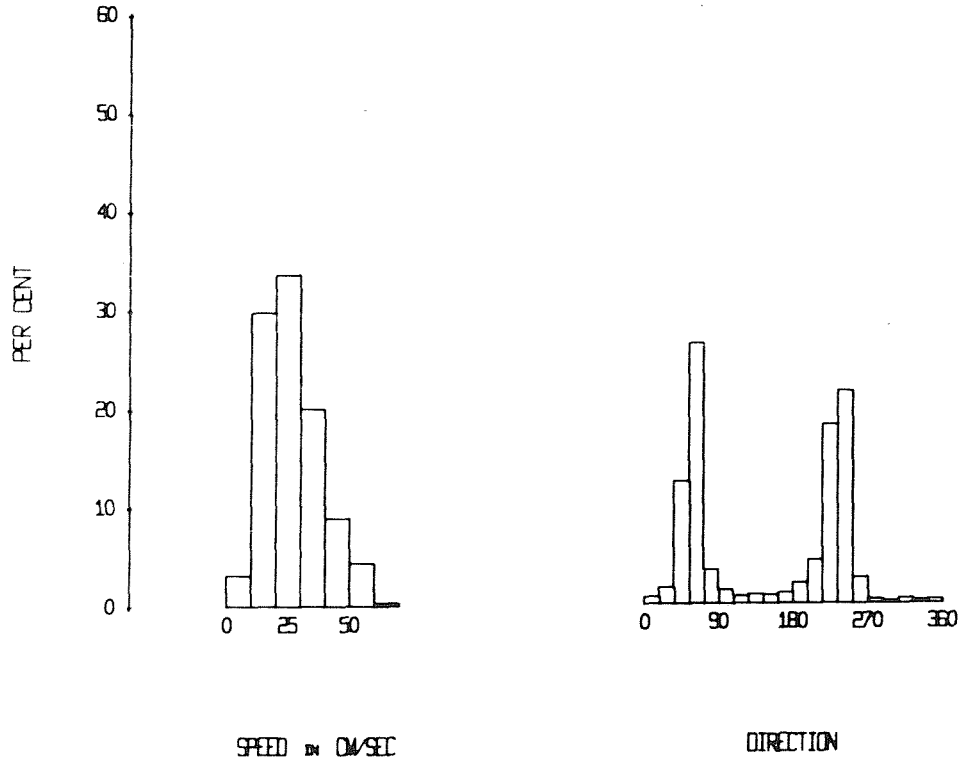
SOUTH
11
10
9


PER CENT
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0
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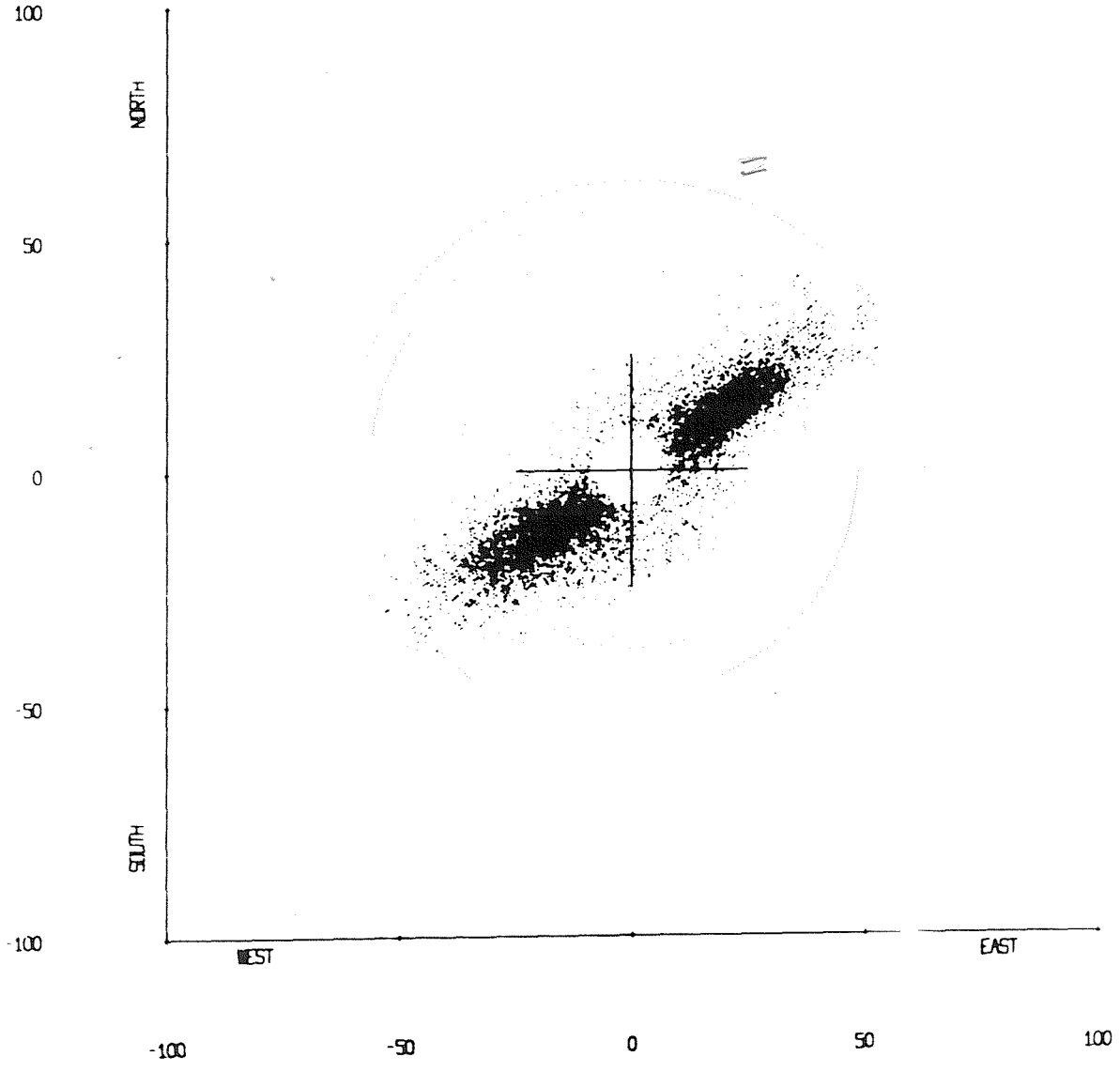
180
270
360
SPEED IN CM/SEC
DIRECTION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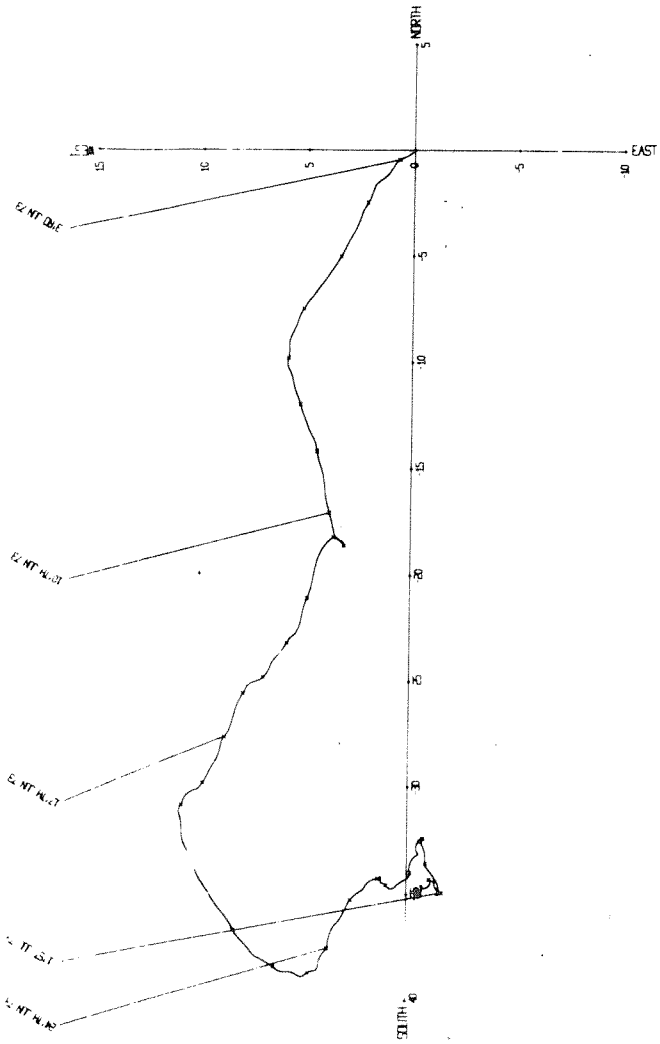
NORTH
EAST
SOUTH
EL MT OLIVE
EL MT HAZEL
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EL MT HAZEL


EL MT OLIVE
EL MT HAZEL
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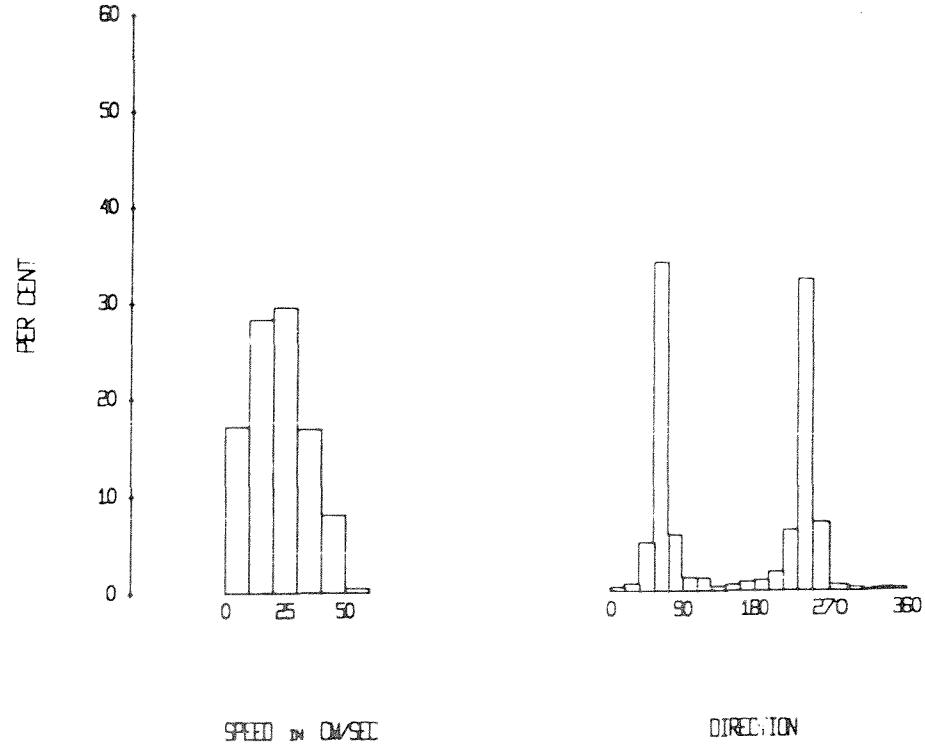
EL TT ISLE
EL MT HAZEL

Meter	:	Bergen 570
Tape number	:	570/1
Meter started	:	18.50.00 GMT 1 June 1973
Meter stopped	:	11.17.37 GMT 16 July 1973
Total number of readings	:	6436
Timing error	:	2 min 23 s fast
Start of useful record	:	13.40 GMT 2 June 1973
End of useful record	:	04.48 GMT 6 July 1973
Length of useful record	:	807 h
Comments	:	Good record. On recovery it was noted that the bottom rotor bearing was worn, but this does not seem to have affected the speed record.

TEMPERATURE IN DEG C

VELOCITY IN CM/SEC

VELOCITY IN CM/SEC
SOUTH
-50
0
50
NORTH
24'TH JUN 73
1'ST JUL 73
WEST
EAST
TEMPERATURE IN DEG C
9
10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20
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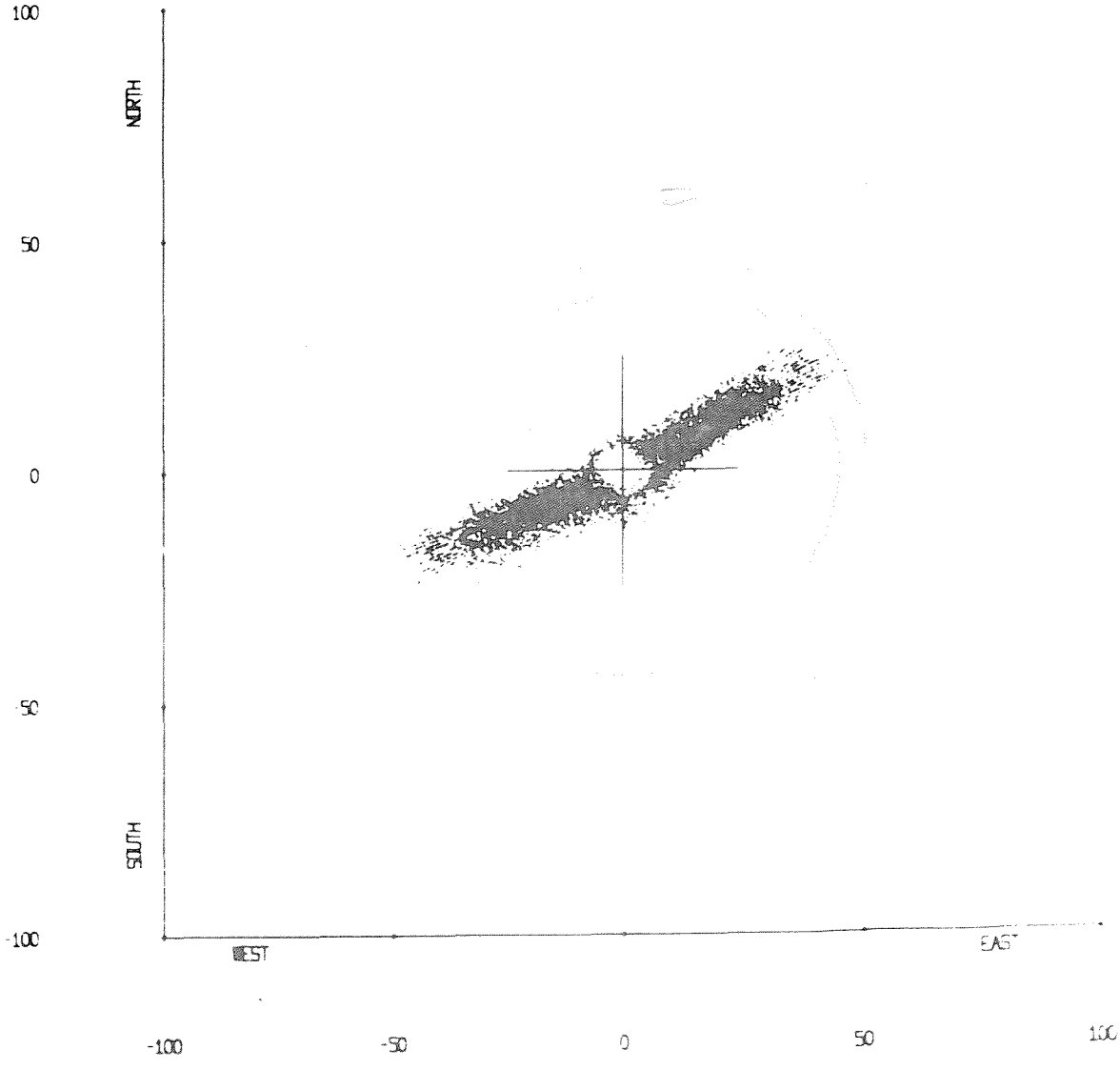
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

WEST
10
5
17'TH JN 73
10'TH JN 73
1'ST JL 73
1'ST JL 73
3'RD JN 73
5
10
NORTH
5
SOUTH
5
10
EAST

17'TH JN 73
10'TH JN 73
1'ST JL 73
3'RD JN 73
24'TH JN 73

Mooring number : 32

Position of rig : Lat 51°03'N Long 7°00'W (rig C)

Depth of water : 91m below chart datum

Tidal heights, in metres above chart datum, at Cobh	MHWS	MHWN	MLWN	MLWS
	3.7	2.8	0.8	0.0

Meter	Type	Height above sea floor (m)	Recording interval (min)
415	Bergen	73	10
416	Bergen	58	10
417	Bergen	15	10

Rig set : 17.09 GMT 2 June 1973
from r.r.s. John Murray

Rig recovered : 10.03 GMT 6 July 1973
from r.r.s. John Murray

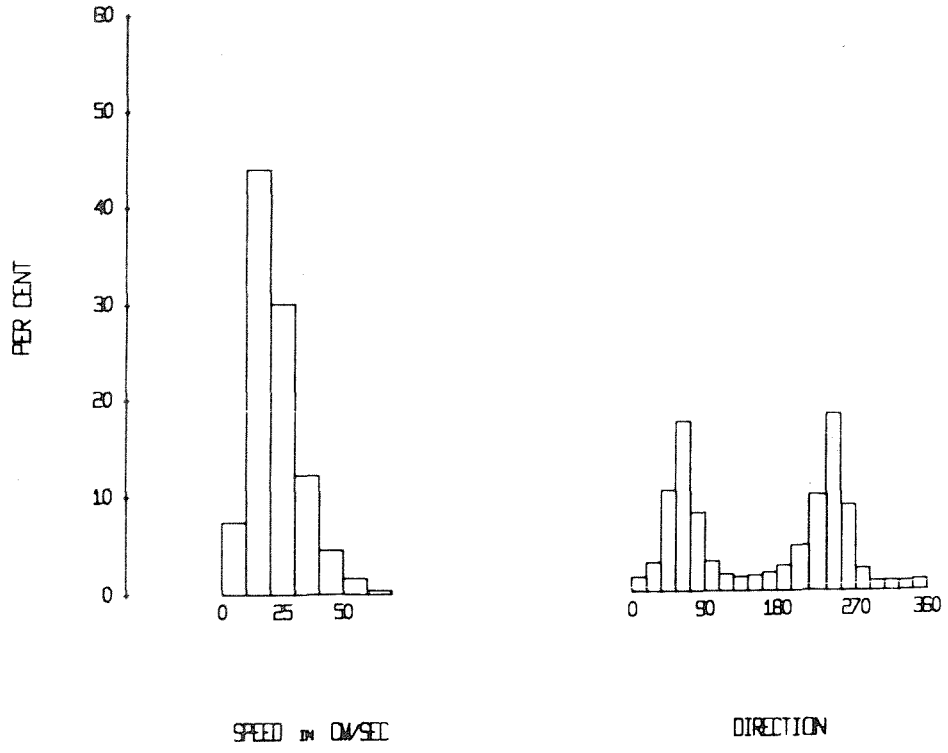
Mooring : Standard, with free-flooding Slingsby sub-surface buoy.

Comments : The launch and recovery were successfully accomplished at the first attempt. A Wormley type off-shore tide gauge was also deployed at this station.

Meter	:	Bergen 415
Tape number	:	415/5
Meter started	:	19.00.00 GMT 1 June 1973
Meter stopped	:	08.38.40 GMT 16 July 1973
Total number of readings	:	6419
Timing error	:	1 min 20 s fast
Start of useful record	:	17.20 GMT 2 June 1973
End of useful record	:	09.49 GMT 6 July 1973
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a pressure sensor and was situated near the top of the thermocline.

100
50
0
-50
-100
NORTH
SOUTH
3 AUG JUN 73
10 TH JUN 73
17 TH JUN 73
24
22
20
18
16
15
14
13
12
11
10

TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
24'TH JUN 73
1'ST JUL 73


PER CENT
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25
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SPEED IN CM/SEC
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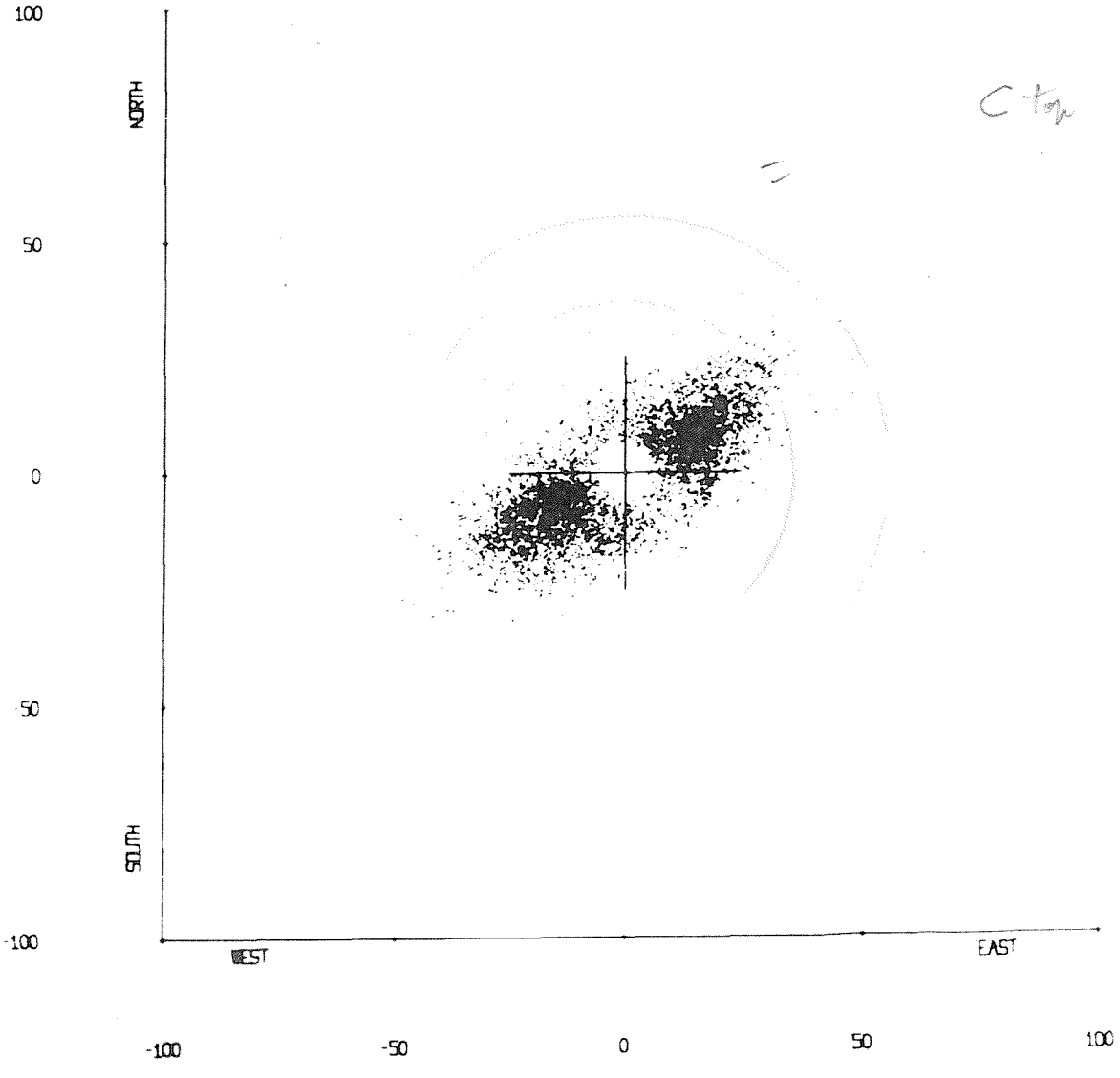
90
180
270
360
DIRECTION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SOUTH
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0
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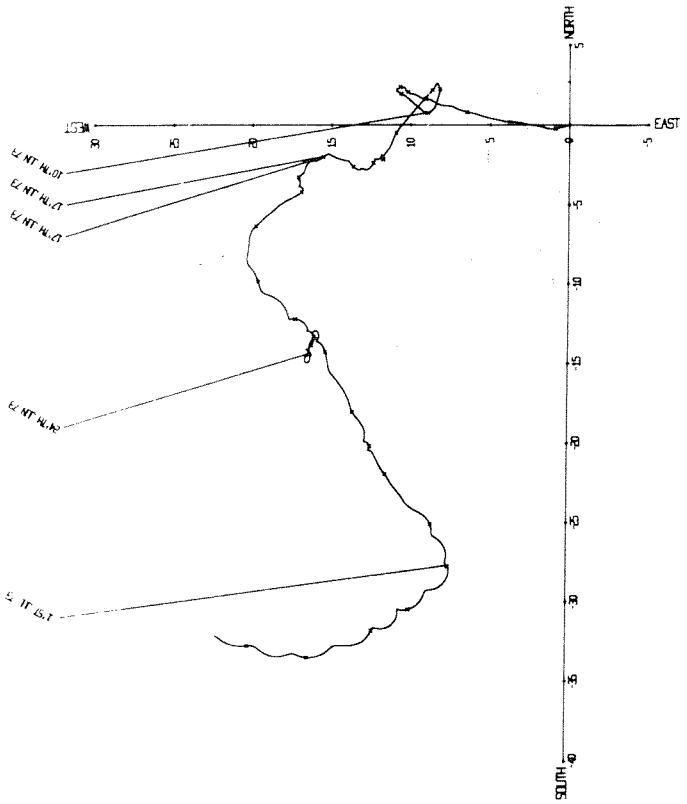
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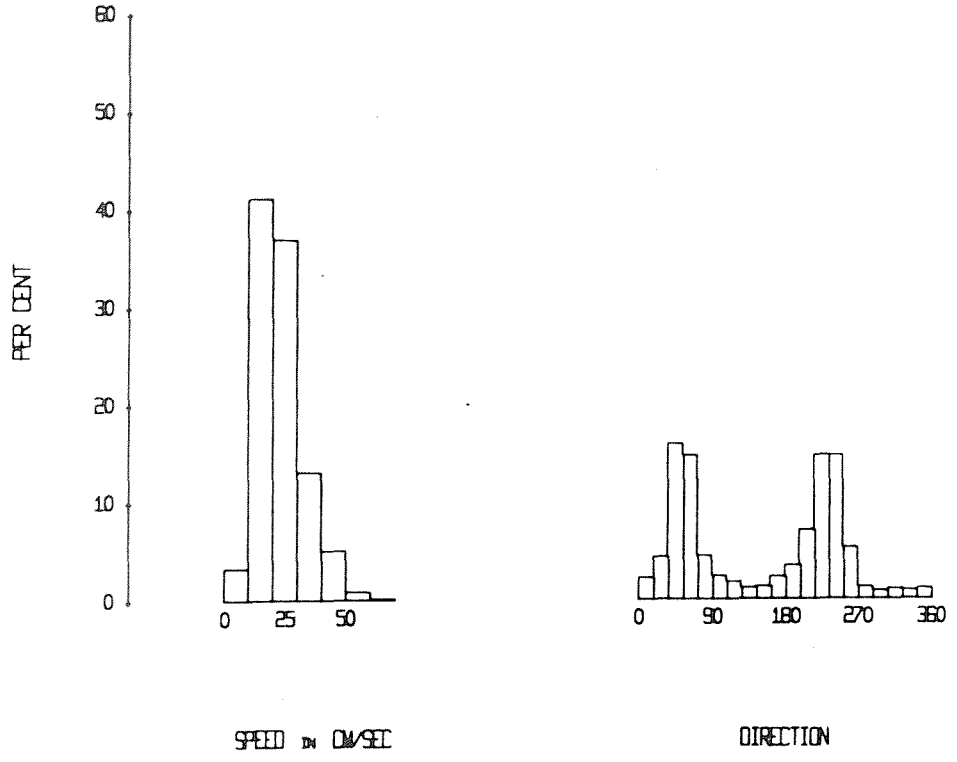
SOUTH
EAST
WEST
5
0
-5
10
15
20
25
30
35
40

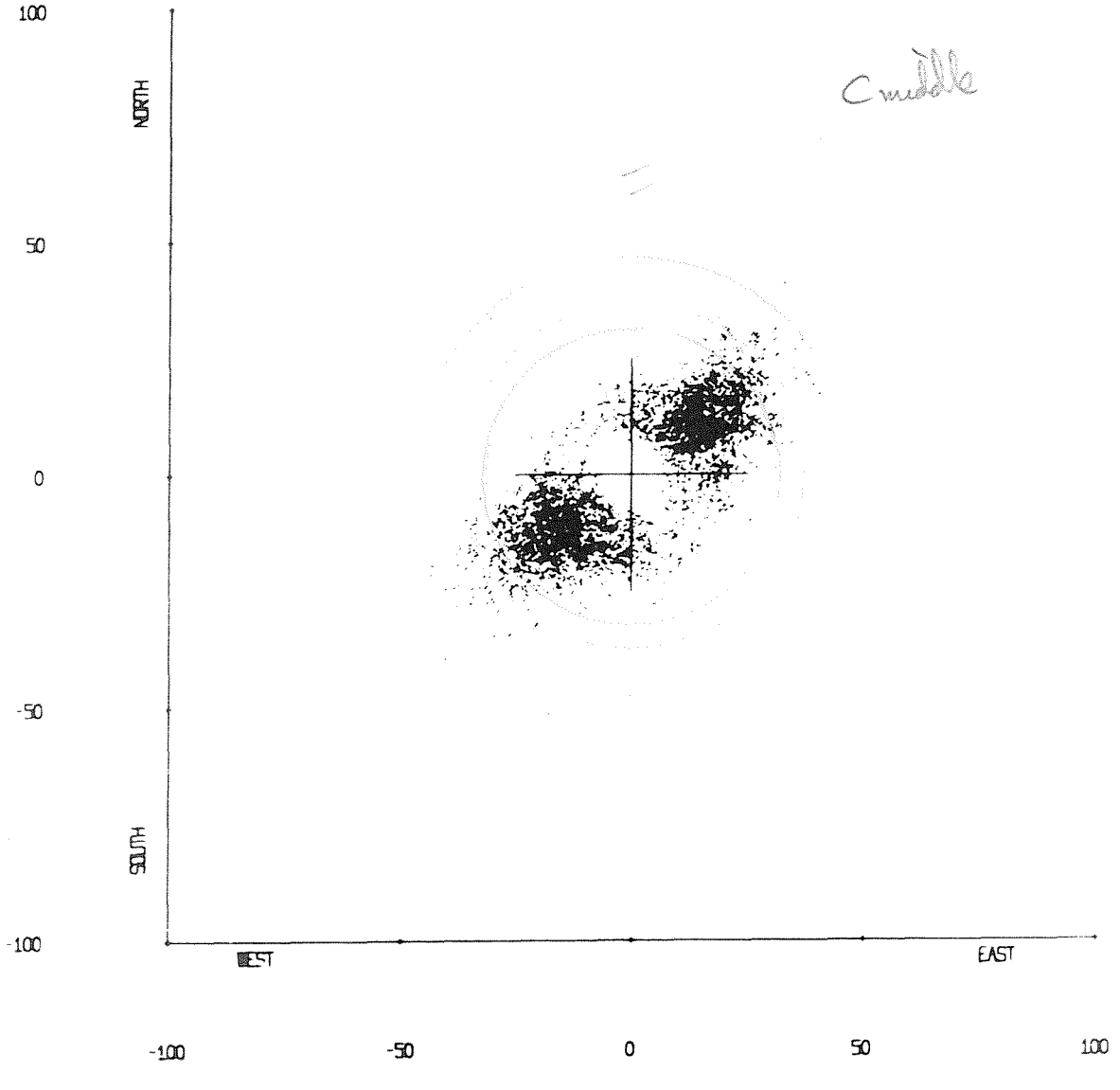
Meter	:	Bergen 416
Tape number	:	416/4
Meter started	:	19.10.00 GMT 1 June 1973
Meter stopped	:	08.53.06 GMT 16 July 1973
Total number of readings	:	6418
Timing error	:	13 min 6 s slow
Start of useful record	:	17.20 GMT 2 June 1973
End of useful record	:	09.53 GMT 6 July 1973
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a pressure sensor but not with stabilizer fins and was situated in the middle of the thermocline. The record tallies well with 415/5 whilst the meters were in the water so it would appear that the meter failed to record one scan sometime after its recovery and hence the timing error should be 3 min 6 s slow.

TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
3'RD JUN 73
10'TH JUN 73
17'TH JUN 73
9
10
11
12
30
32
34
36
-50
0
50

TEMPERATURE IN DEG C PRESSURE IN METRES OF WATER

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

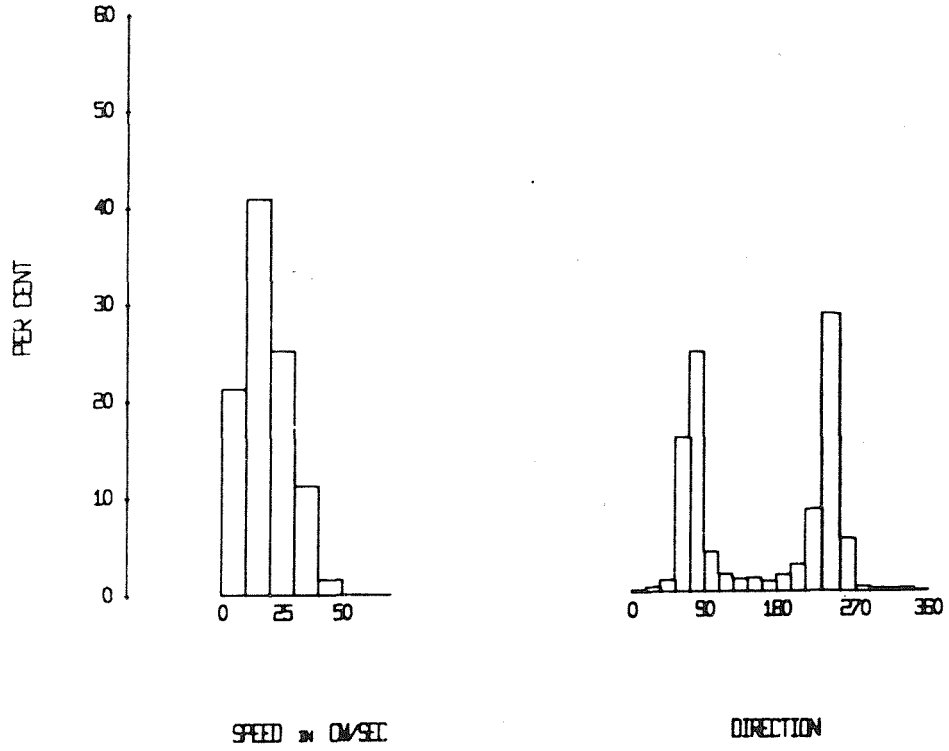
NORTH
EAST
SOUTH
5
10
15
20
25
30

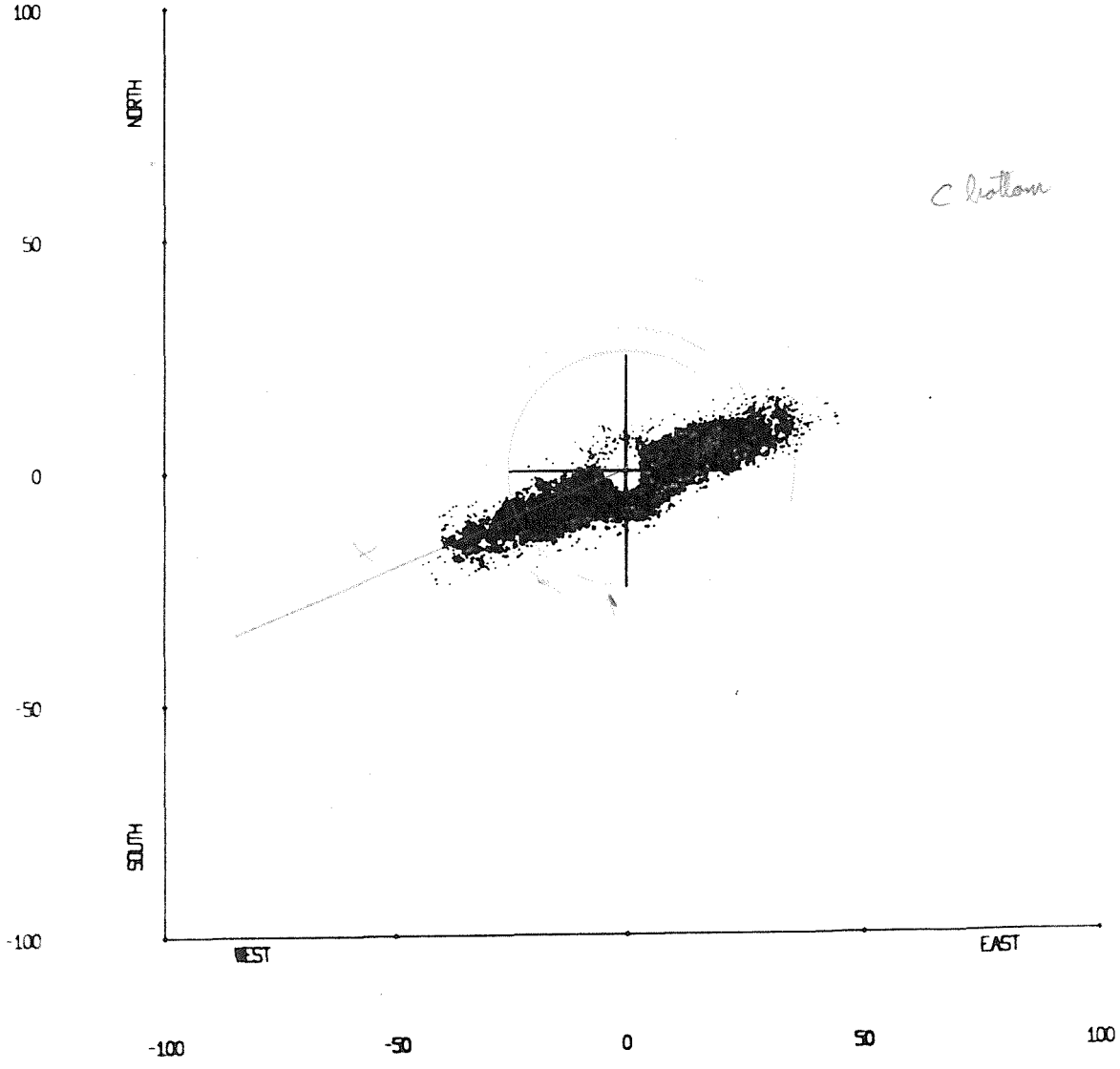
Meter	:	Bergen 417
Tape number	:	417/5
Meter started	:	19.20.00 GMT 1 June 1973
Meter stopped	:	09.09.27 GMT 16 July 1973
Total number of readings	:	6419
Timing error	:	9 min 27 s slow
Start of useful record	:	17.20 GMT 2 June 1973
End of useful record	:	09.50 GMT 6 July 1973
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a pressure sensor but not with stabilizer fins. The record tallies well with 415/5 so it would appear that the meter failed to record one scan sometime after its recovery. Hence the timing error should be 33 s fast. Subsequent tests at laboratory temperatures showed it gained 5 s d^{-1}.

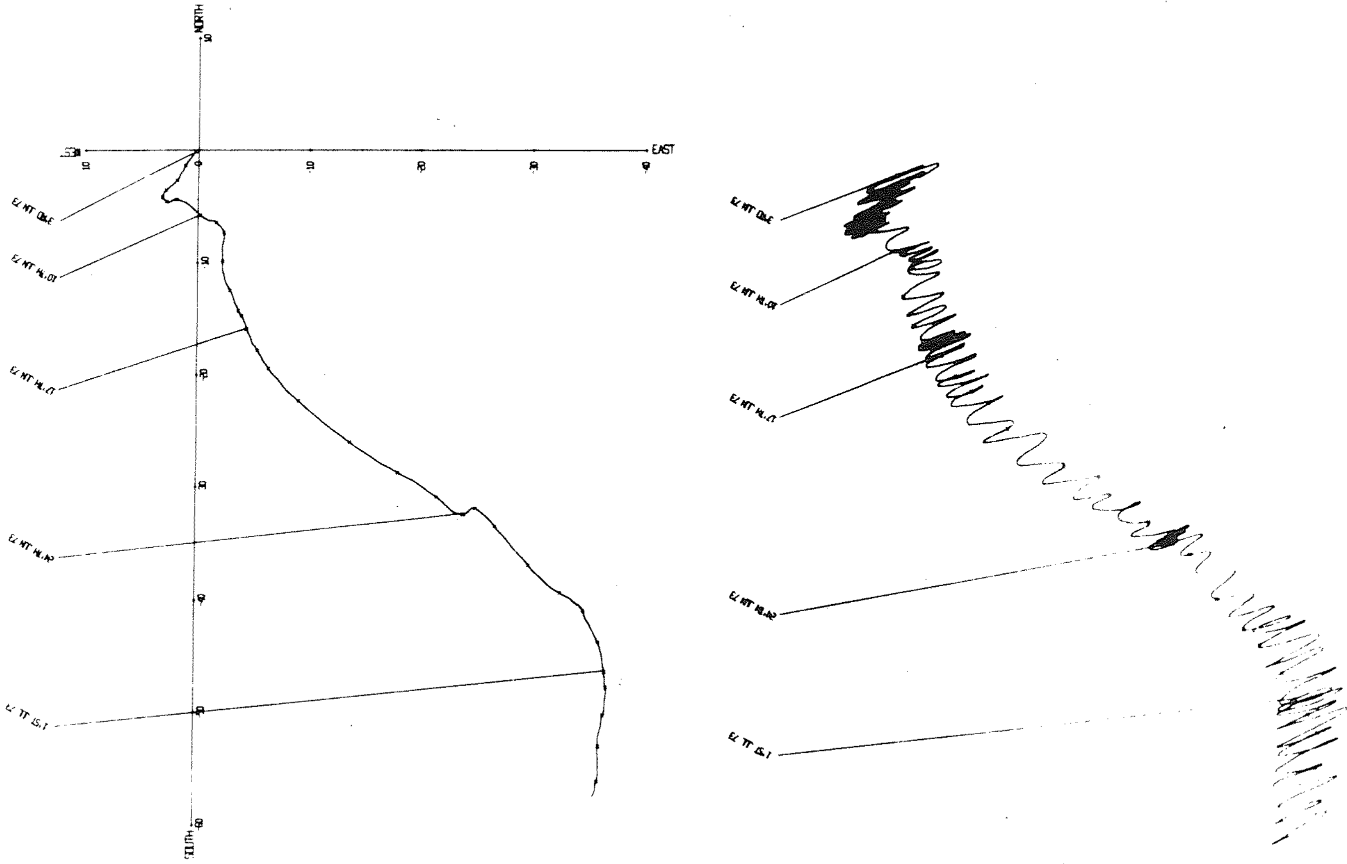
100
50
0
-50
100
50
0
-50
-100
EAST
WEST
50
0
-50
50
0
-50
NORTH
SOUTH
3'RD JUN 73
10'TH JUN 73
17'TH JUN 73
82
80
78
76
82
80
78
76
10
5
10
5
METRES OF WATER
TEMPERATURE IN DEG C PRESSURE IN
VELOCITY IN CM/SEC

TEMPERATURE IN DEG C PRESSURE IN METRES OF WATER

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


NORTH
EAST
SOUTH

Mooring number : 33

Position of rig : Lat 51°24'N Long 7°40'W (rig A)

Depth of water : 85 m below chart datum

Tidal heights, in metres above chart datum, at Cobh :

MHWS	MHWN	MLWN	MLWS
3.7	2.8	0.8	0.0

Meter	Type	Height above sea floor (m)	Recording interval (min)
160	Bergen	64	10
531	Bergen	15	10

Rig set : 08.15 GMT 3 June 1973
from r.r.s. John Murray

Rig recovered : 14.47 GMT 6 July 1973
from r.r.s. John Murray

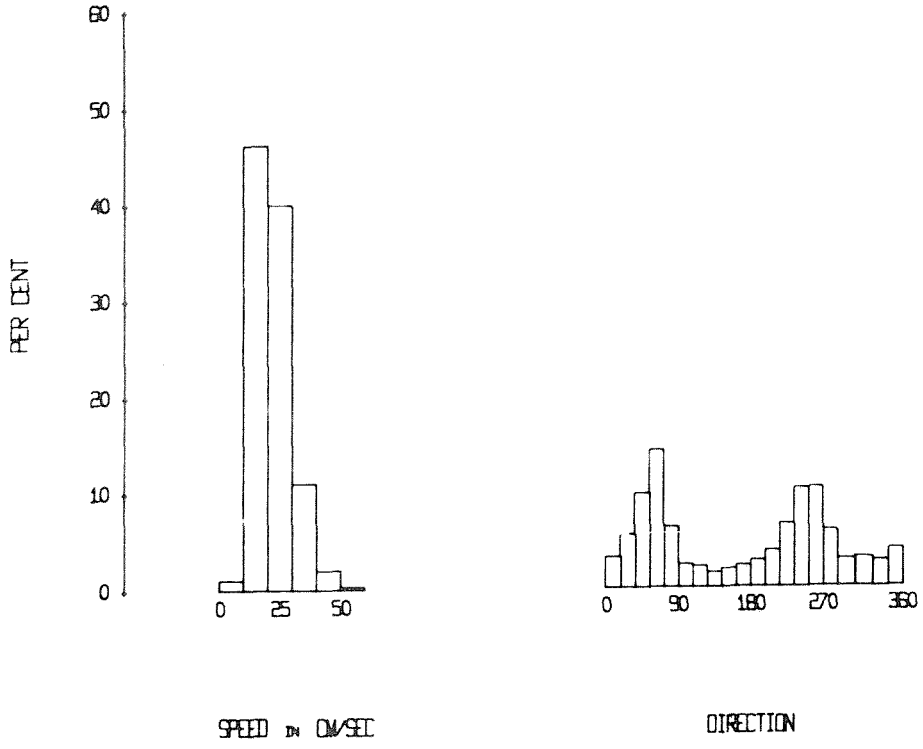
Mooring : Standard, with cosalt sub-surface buoy.

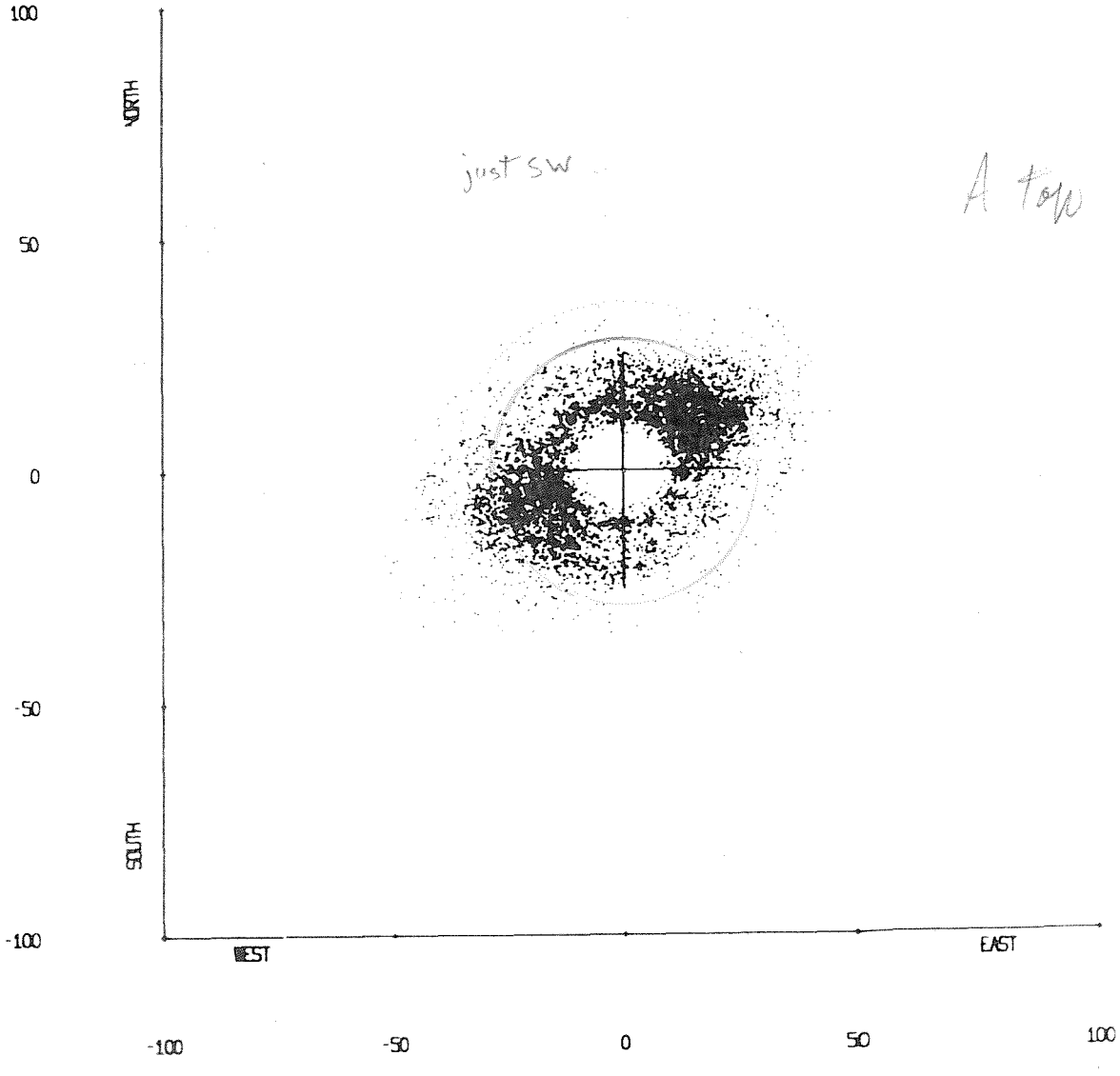
Comments : The launch and recovery were successfully accomplished at the first attempt.

Meter	:	Bergen 160
Tape number	:	160/6
Meter started	:	19.50.00 GMT 1 June 1973
Meter stopped	:	15.09.49 GMT 13 July 1973
Total number of readings	:	6021
Timing error	:	11 s fast
Start of useful record	:	08.30 GMT 3 June 1973
End of useful record	:	14.30 GMT 6 July 1973
Length of useful record	:	798 h
Comments	:	Good record. The meter was situated near the top of the thermocline. Several direction readings have been edited.

VELOCITY IN CM/SEC

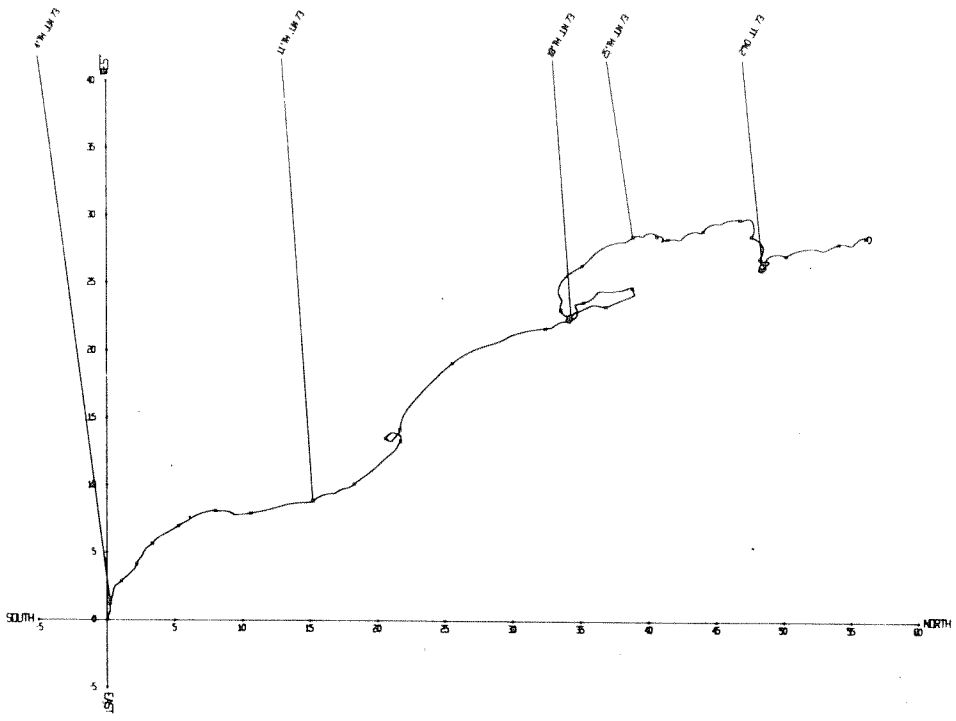
TEMPERATURE IN DEG C
11
12
13
14
15
16
VELOCITY IN CM/SEC
SOUTH
-50
0
50
NORTH
25'TH JUN 73
2'ND JUL 73
WEST
-100
-50
0
50
100
EAST

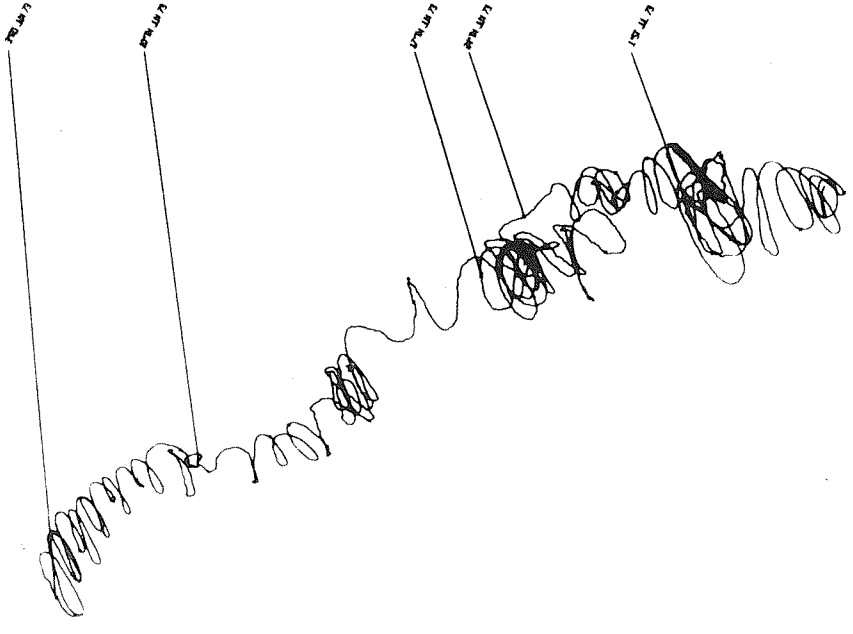

PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

just SW

A tow


SOUTH
NORTH
EAST
WEST



Meter	:	Bergen 531
Tape number	:	531/3
Meter started	:	19.40.00 GMT 1 June 1973
Meter stopped	:	09.19.30 GMT 13 July 1973
Total number of readings	:	5987
Timing error	:	30 s fast
Start of useful record	:	08.30 GMT 3 June 1973
End of useful record	:	14.30 GMT 6 July 1973
Length of useful record	:	798 h
Comments	:	Good record. Several rotor count readings have been edited.

TEMPERATURE IN DEG C

VELOCITY IN CM/SEC

SOUTH

NORTH

WEST

EAST

9 10

-50 0 50

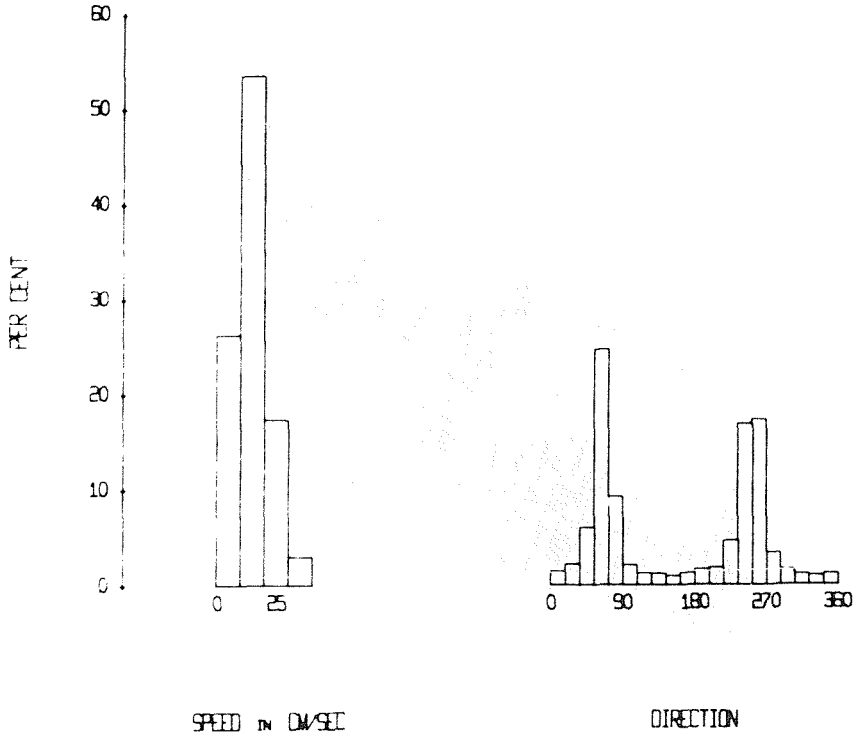
4'TH JUN 73

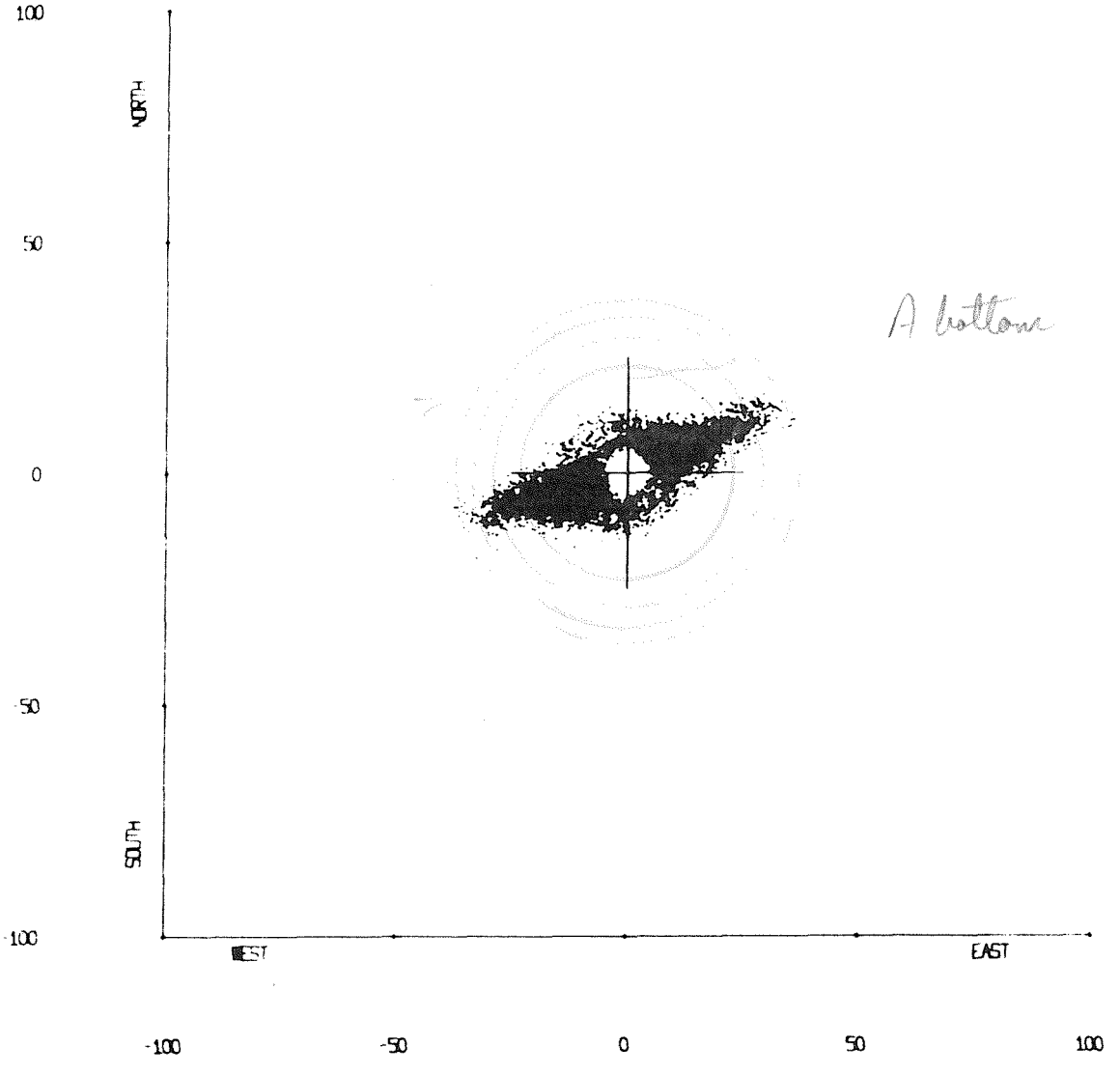
11'TH JUN 73

18'TH JUN 73

TEMPERATURE IN DEG C

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
0
25
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

WEST
-20
-15
-10
-5
0
5
10
15
20
NORTH
-5
SOUTH
5
EAST
2'ND JN 73
18'TH JN 73
25'TH JN 73
11'TH JN 73
4'TH JN 73

1'ST JN 73
17'TH JN 73
24'TH JN 73
10'TH JN 73
3'RD JN 73

Mooring number : 34

Position of rig : Lat 51°34'N Long 6°23'W (rig G)

Depth of water : 80m below chart datum

Tidal heights, in metres above chart datum, at Fishguard	MHWS	MHWN	MLWN	MLWS
	4.7	3.4	1.9	0.6

Meter	Type	Height above sea floor (m)	Recording interval (min)
565	Bergen	70	10
566	Bergen	55	10
567	Bergen	15	10

Rig set : 13.47 GMT 3 June 1973
from r.r.s. John Murray

Rig recovered : 11.00 GMT 18 June 1973
by trawler Malagi

Mooring : Standard, with solid Slingsby sub-surface buoy.

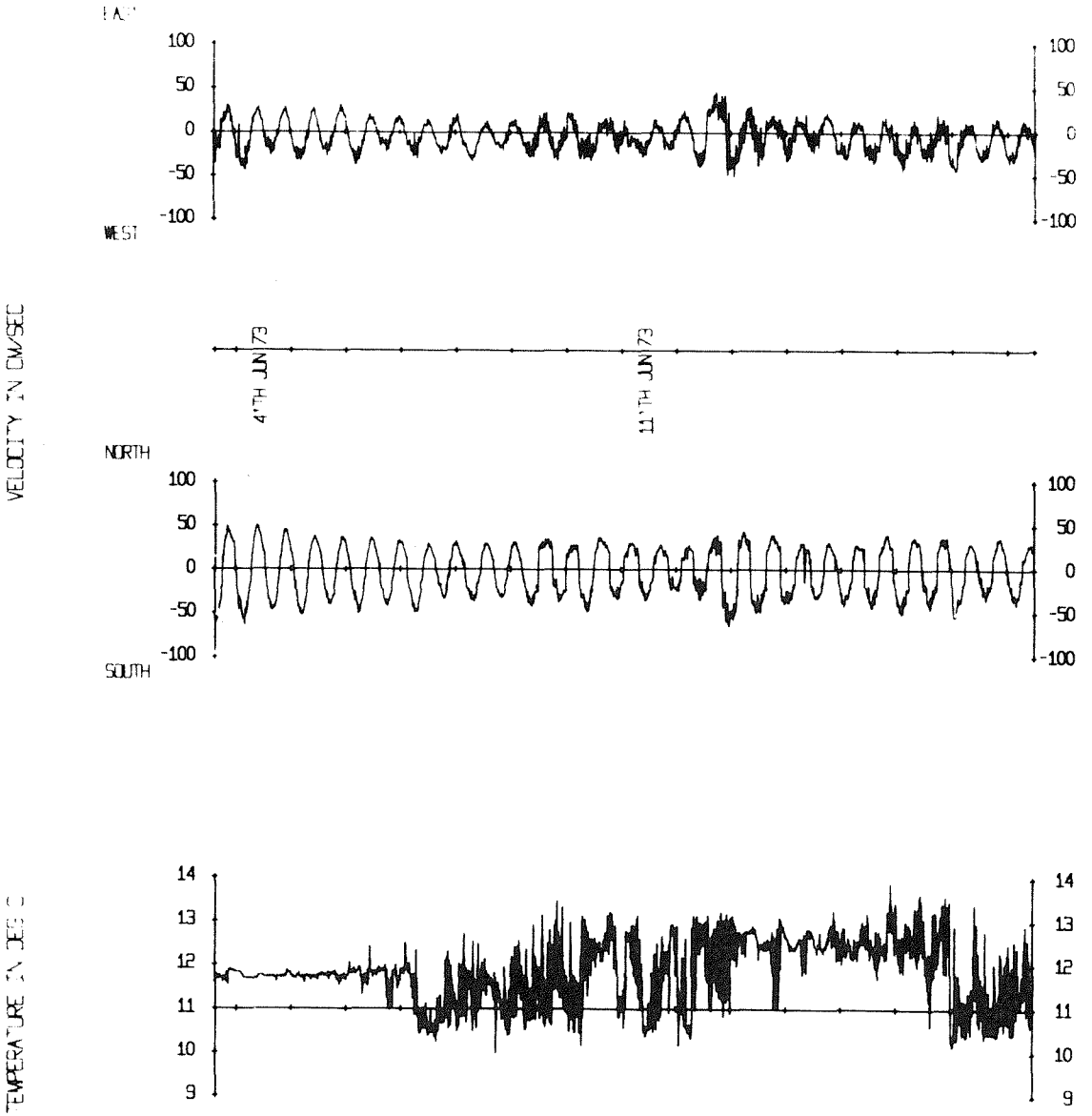
Comments : The launch was successfully accomplished at the first attempt. The rig was accidentally recovered by the French trawler Malagi during foggy conditions in which the Captain did not see the surface buoy. All the equipment was landed at Milford Haven with no major items missing and having sustained very little damage. The pressure record from the top meter shows the rig was also disturbed on 17 June.

Meter	:	Bergen 565
Tape number	:	565/2
Meter started	:	16.00.00 GMT 1 June 1973
Meter stopped	:	14.34.26 GMT 16 July 1973
Total number of readings	:	6476
Timing error	:	35 min 34 s fast
Start of useful record	:	14.00 GMT 3 June 1973
End of useful record	:	10.52 GMT 18 June 1973
Length of useful record	:	357 h
Comments	:	Good record. The meter was equipped with a spindle designed at Bidston and a pressure sensor whose record, displayed separately, indicates that the rig was also disturbed on 17 June. The meter was situated in the middle of a 3K thermocline. When it was returned to Bidston the rotor shaft was broken and there were cable marks on the pressure case. Several direction readings have been edited. By comparing with records 566/1 and 567/1 it would appear that the timing of this meter was correct whilst it was in the water. Hence a better estimate of the timing error for the record would seem to be 4 min 26 s slow - an error of 5.8 s d^{-1}. This loss rate was confirmed by tests in the laboratory.

Meter	:	Bergen 566
Tape number	:	566/1
Meter started	:	18.00.00 GMT 1 June 1973
Meter stopped	:	14.48.59 GMT 16 July 1973
Total number of readings	:	6462
Timing error	:	1 min 1 s fast
Start of useful record	:	14.00 GMT 3 June 1973
End of useful record	:	10.49 GMT 18 June 1973
Length of useful record	:	357 h
Comments	:	Good record. The meter was fitted with a spindle designed at Bidston and was returned in good condition apart from cable marks on its spindle and pressure case. The meter was deployed just below the thermocline. Several direction readings have been edited.

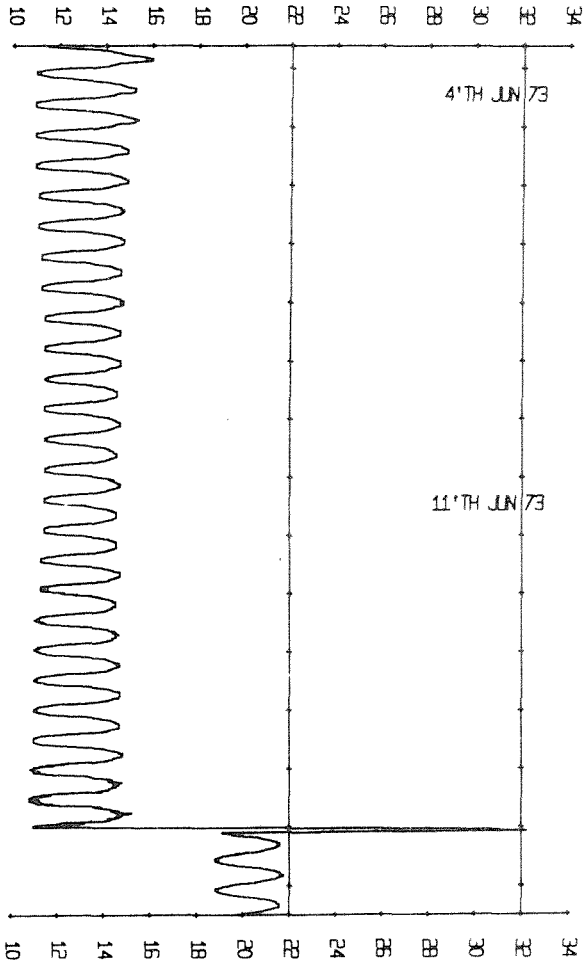
TEMPERATURE IN DEG C

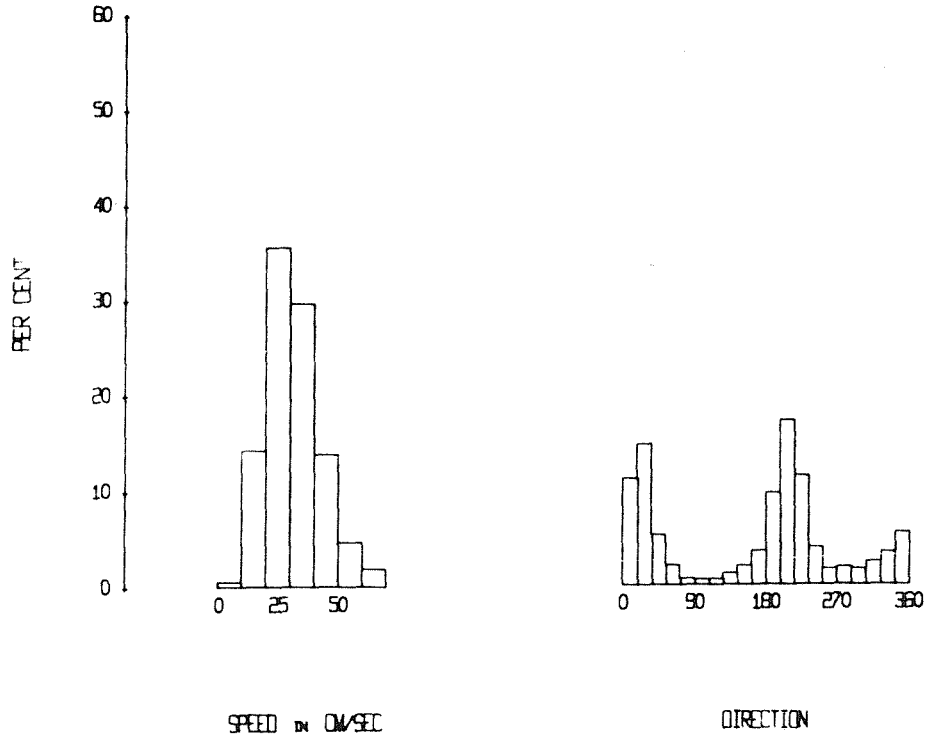
VELOCITY IN CM/SEC

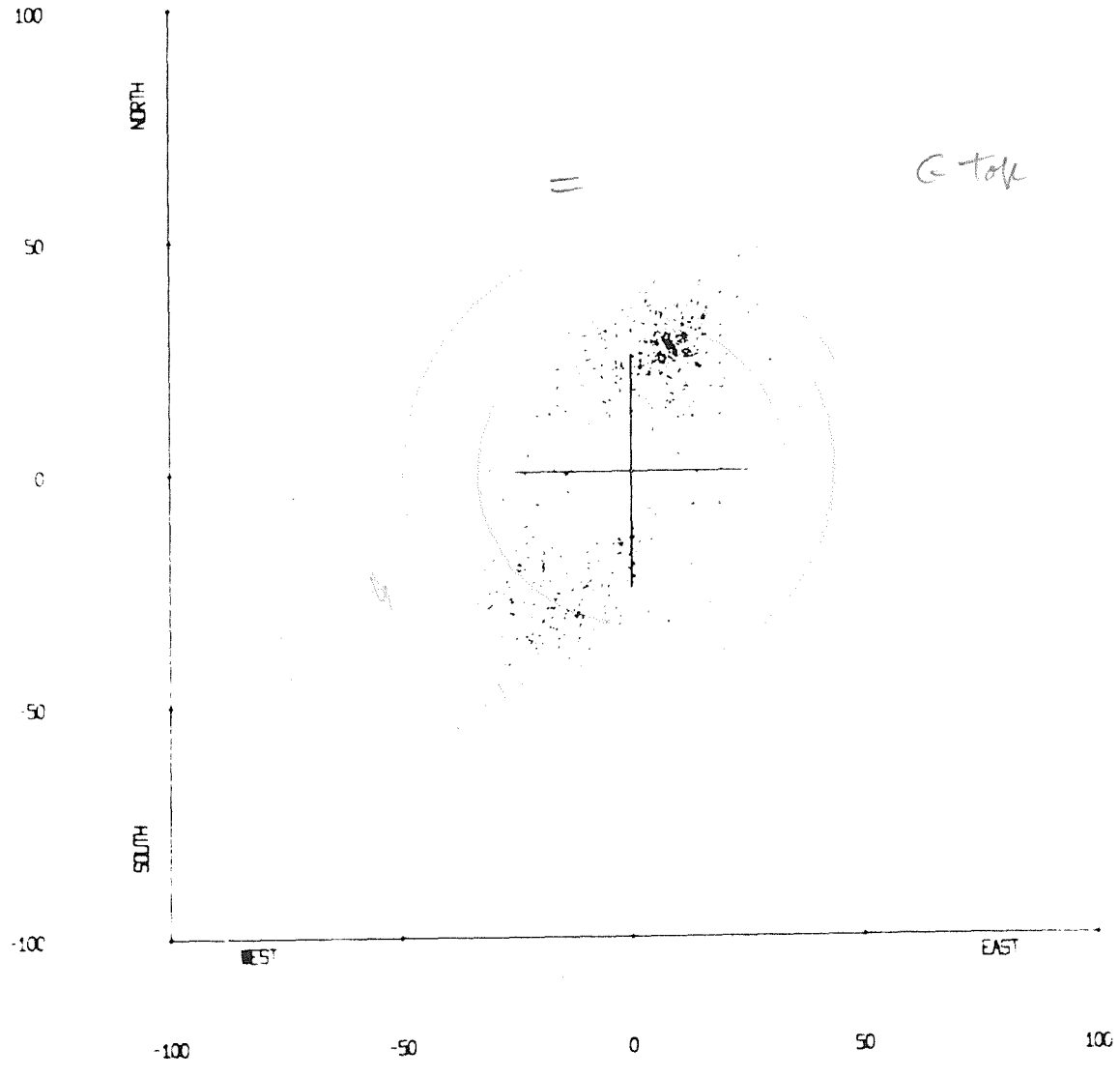

VELOCITY IN CM/SEC
EAST
100
50
0
-50
-100
WEST
4'TH JUN 73
11'TH JUN 73
NORTH
SOUTH
TEMPERATURE IN DEG C
14
13
12
11
10
9

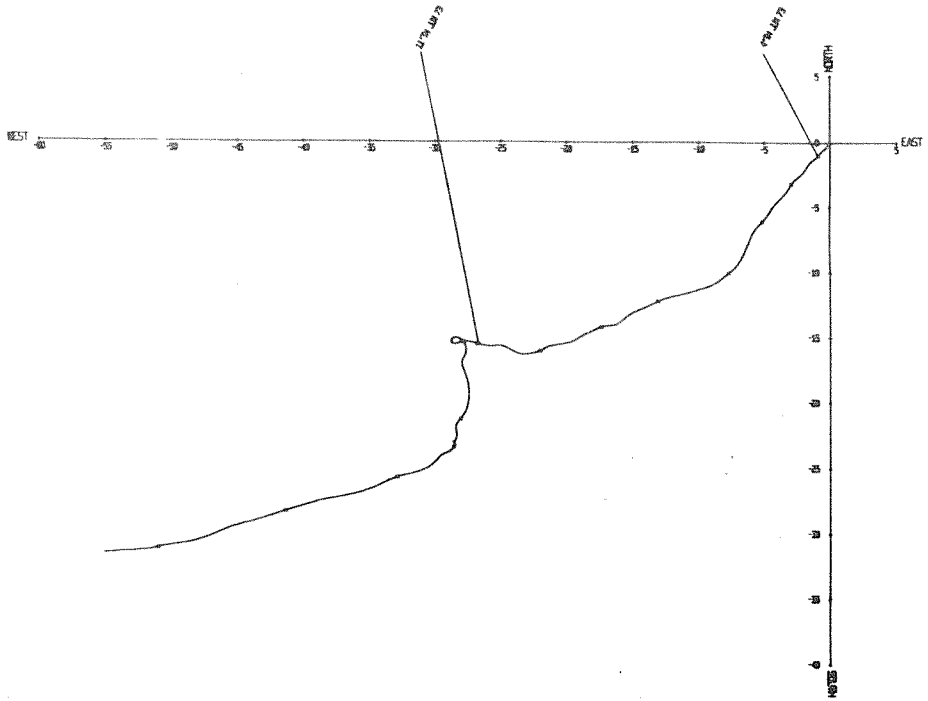
PRESSURE IN

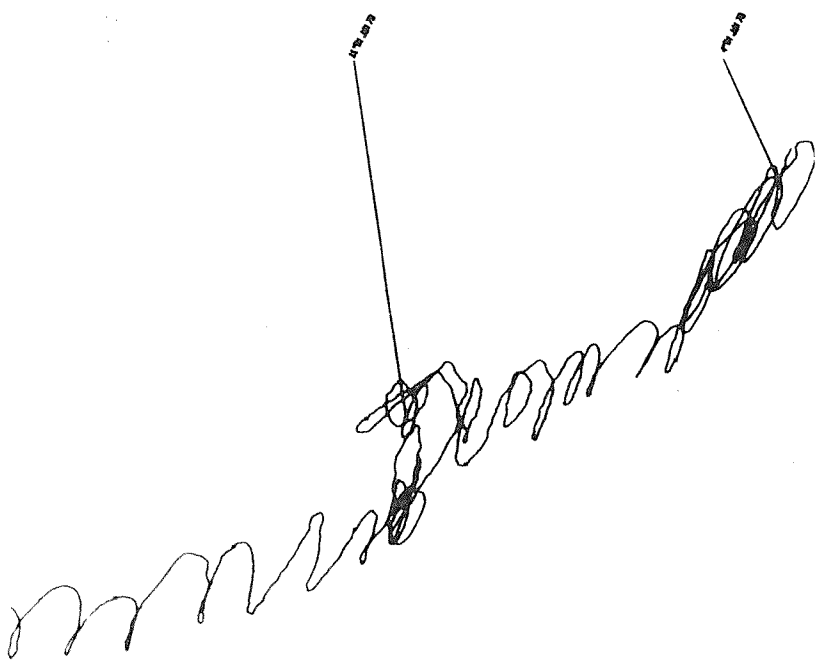
METRES OF WATER

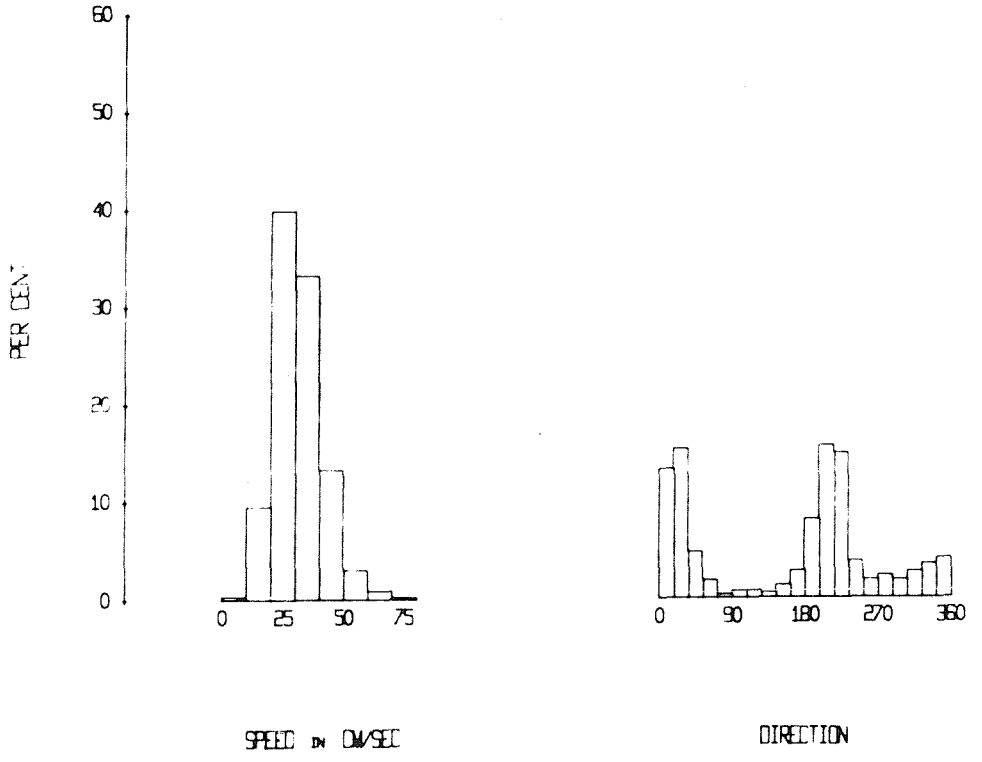


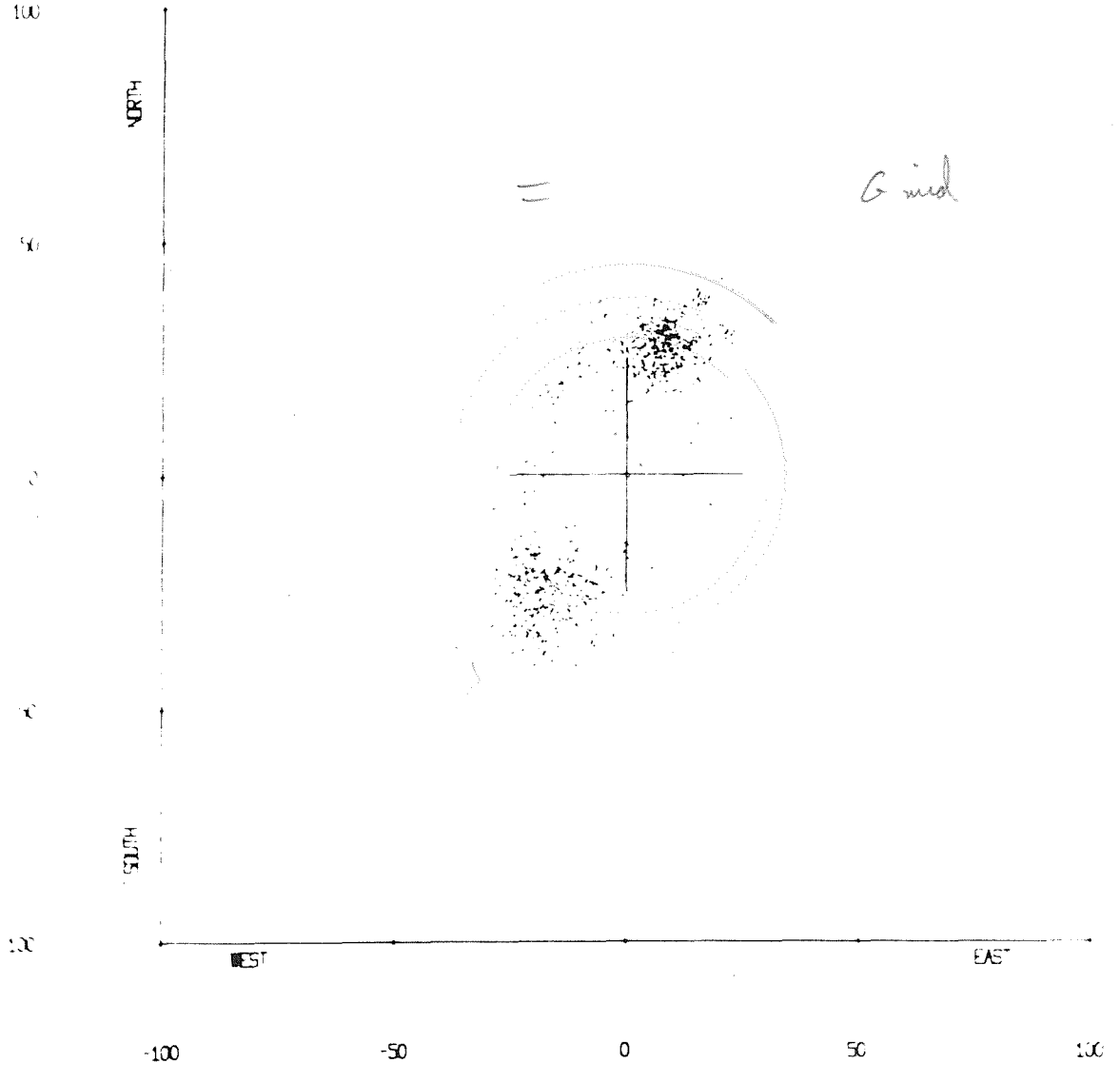

PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

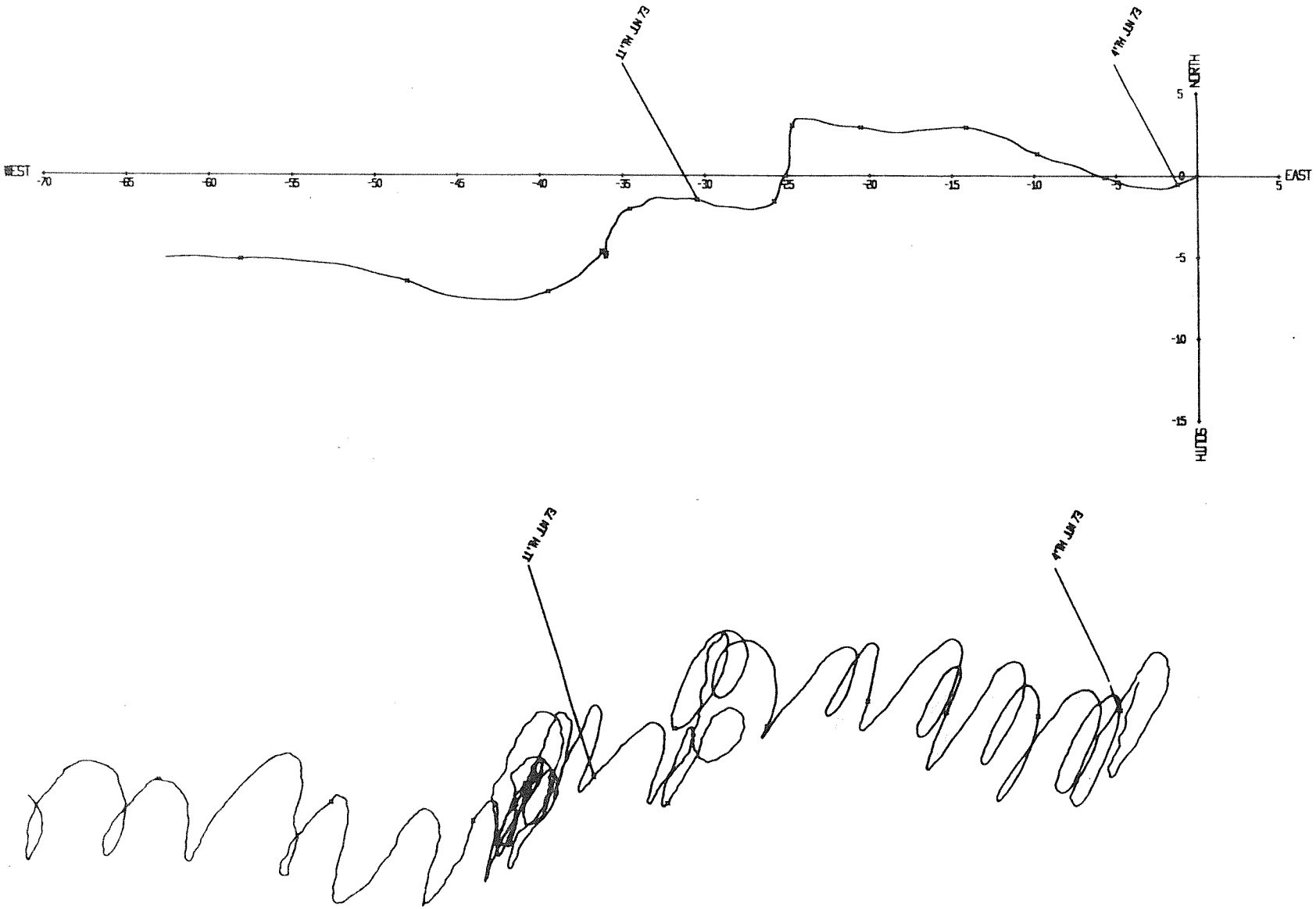

100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


WEST
EAST
NORTH
SOUTH




60
50
40
30
20
10
0
PER CENT
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

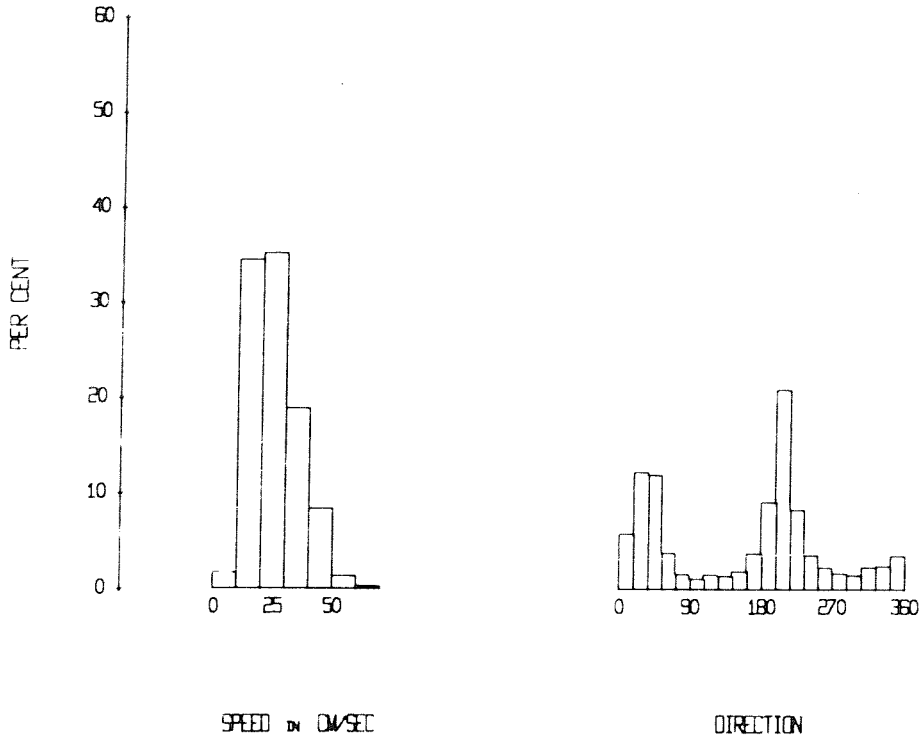

100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

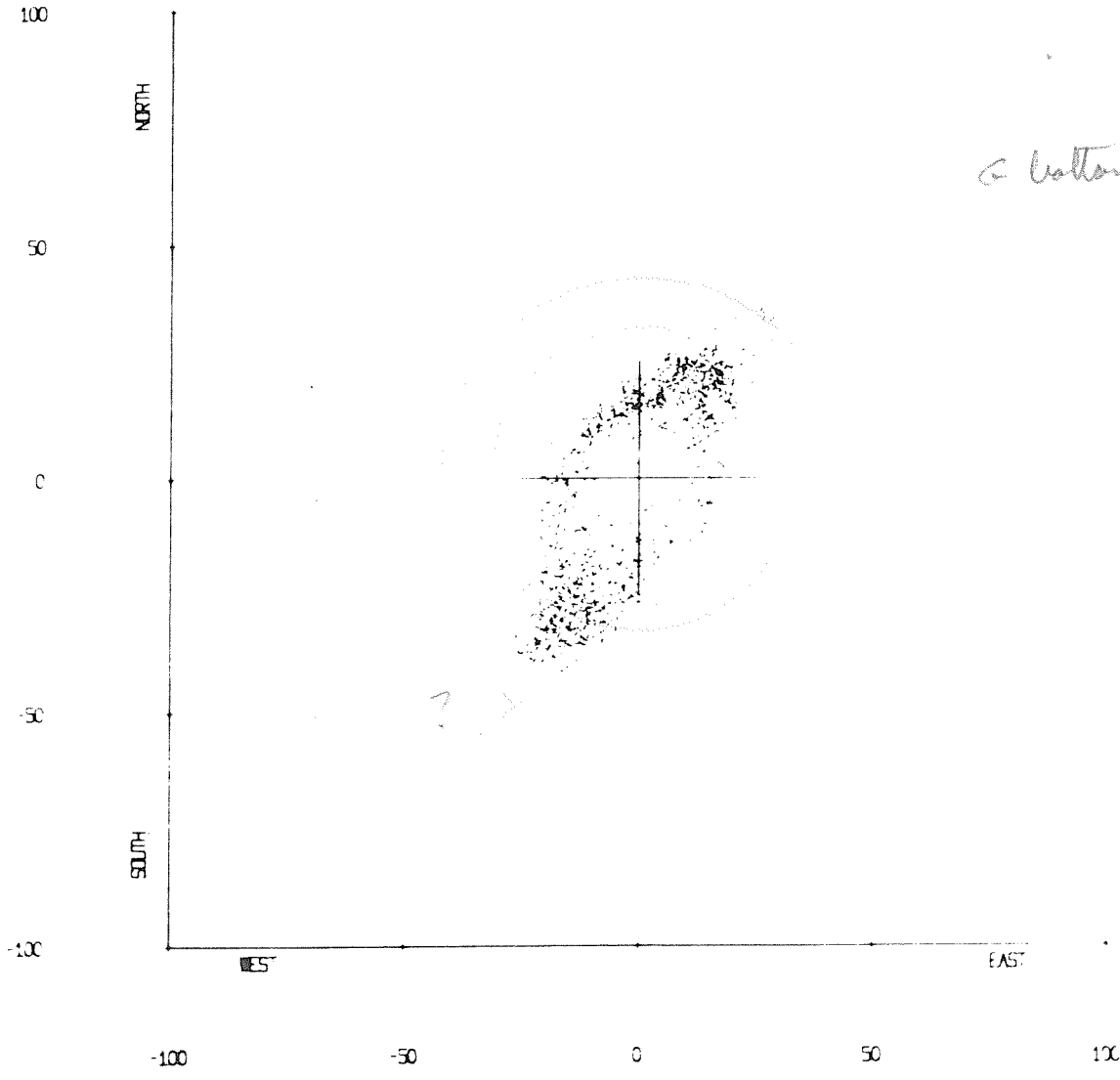

11 AM JAN 73
4 PM JAN 73
NORTH
5
0
-5
-10
-15
WEST
-70
-65
-60
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
EAST
HUNDS
11 AM JAN 73
4 PM JAN 73

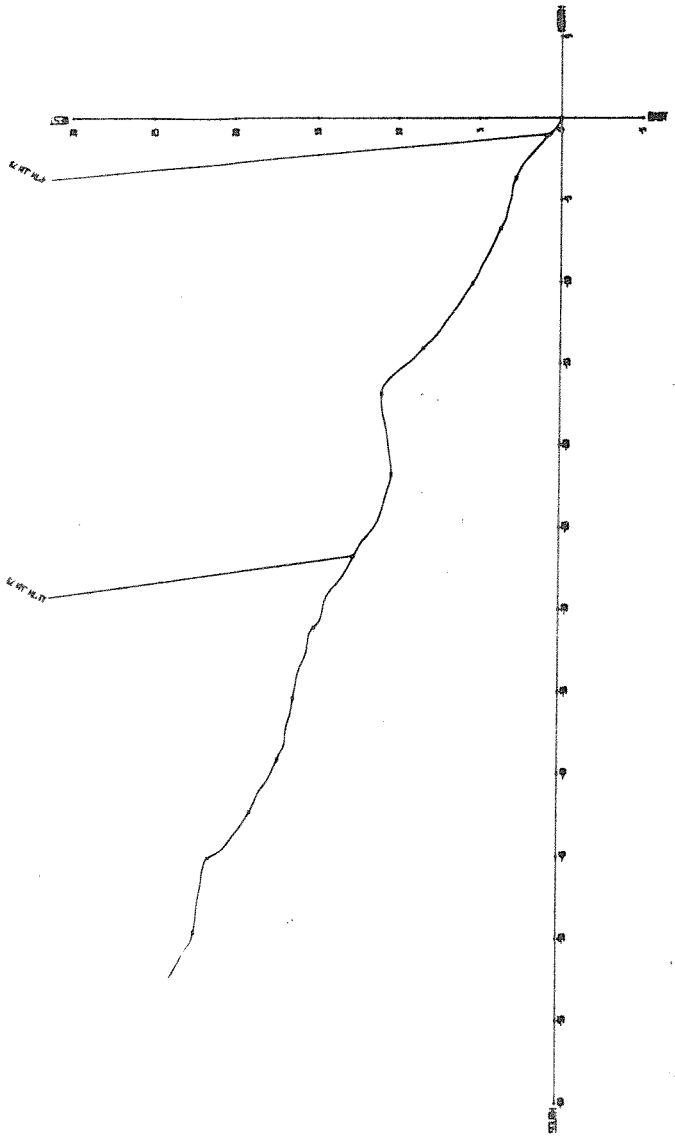
Meter	:	Bergen 567
Tape number	:	567/1
Meter started	:	18.20.00 GMT 1 June 1973
Meter stopped	:	15.39.20 GMT 16 July 1973
Total number of readings	:	6465
Timing error	:	40 s fast
Start of useful record	:	14.00 GMT 3 June 1973
End of useful record	:	10.50 GMT 18 June 1973
Length of useful record	:	357 h
Comments	:	Good record. The meter was fitted with a spindle designed at Bidston and when it was returned to Bidston its spindle was damaged, its rotor shaft broken and its pressure case plating scratched. The spike on the scatter plot going south-east occurred when the rig was disturbed on 17 June.

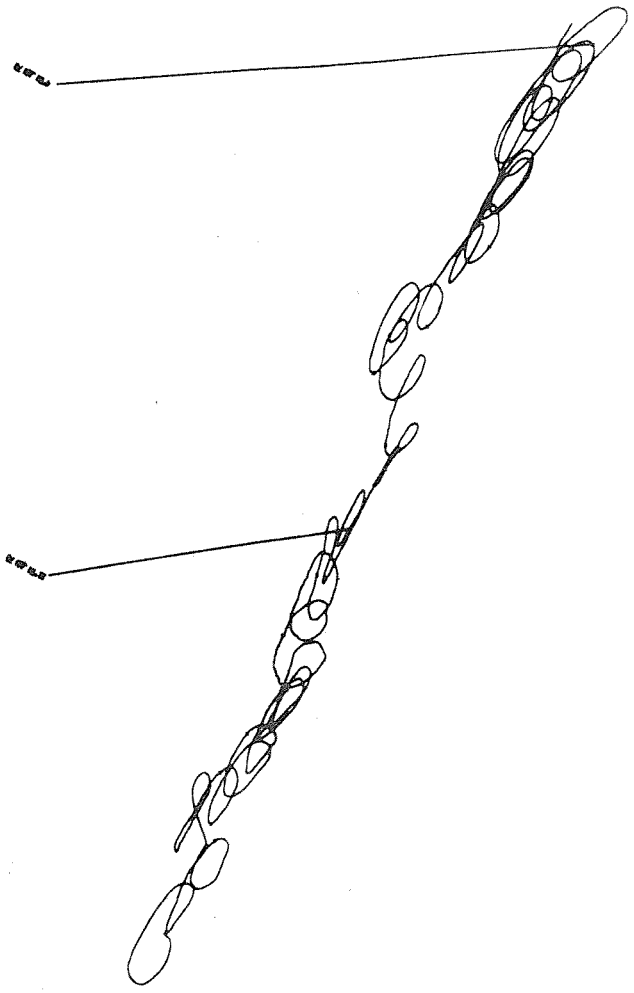
TEMPERATURE IN DEG C

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100





Mooring number : 35

Position of rig : Lat 51°55'N Long 5°58'W (rig H)

Depth of water : 106m below chart datum

Tidal heights, in metres above chart datum, at Fishguard :	MHWS	MHWN	MLWN	MLWS
	4.7	3.4	1.9	0.6

Meter	Type	Height above sea floor (m)	Recording interval (min)
564	Bergen	80	10
568	Bergen	65	10
532	Bergen	15	10

Rig set : 17.38 GMT 3 June 1973
from r.r.s. John Murray

Rig recovered : 09.50 GMT 7 July 1973
from r.r.s. John Murray

Mooring : Standard, with free-flooding Slingsby sub-surface buoy.

Comments : The launch was successfully accomplished at the first attempt. At the recovery the pellet floats and surface buoy were not visible, so dragging commenced at 09.50 and the ground line was snagged at 10.40. The meters were recovered without damage. The surface buoy was last seen on station on 25 June but was missing on 29 June.

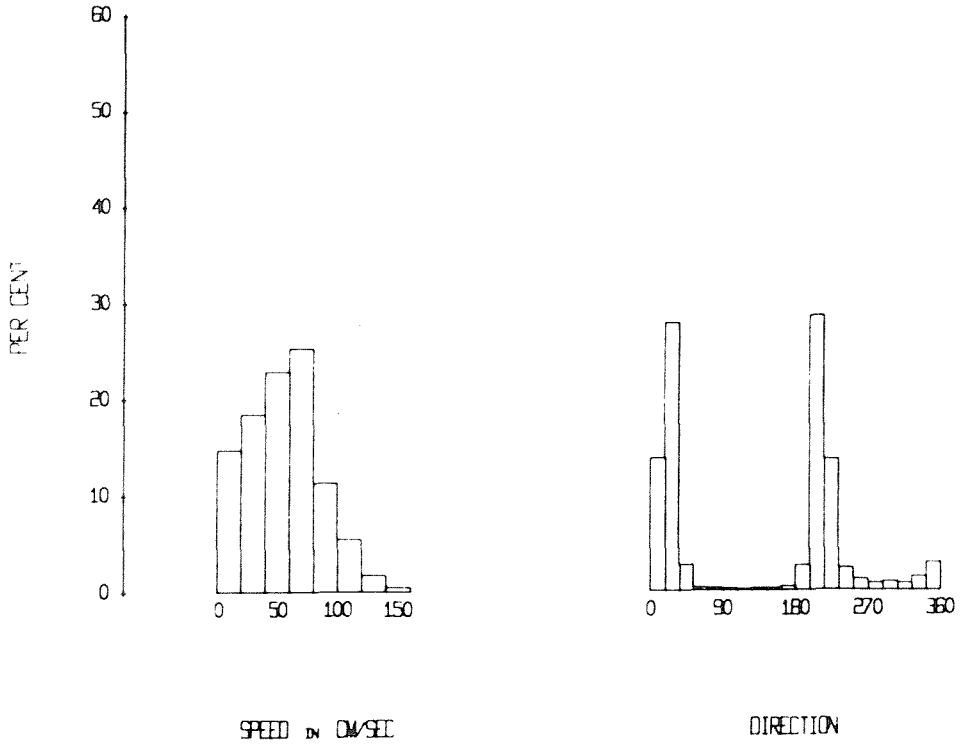
Meter	:	Bergen 564
Tape number	:	564/2
Meter started	:	20.10.00 GMT 1 June 1973
Meter stopped	:	08.09.58 GMT 17 July 1973
Total number of readings	:	6553
Timing error	:	2 s fast
Start of useful record	:	17.50 GMT 3 June 1973
End of useful record	:	09.40 GMT 7 July 1973
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a pressure sensor. It indicates a maximum knockdown of 12m occurring in a 1.75m s^{-1} current. There is no sign of this affecting the records of any of the meters on the rig.

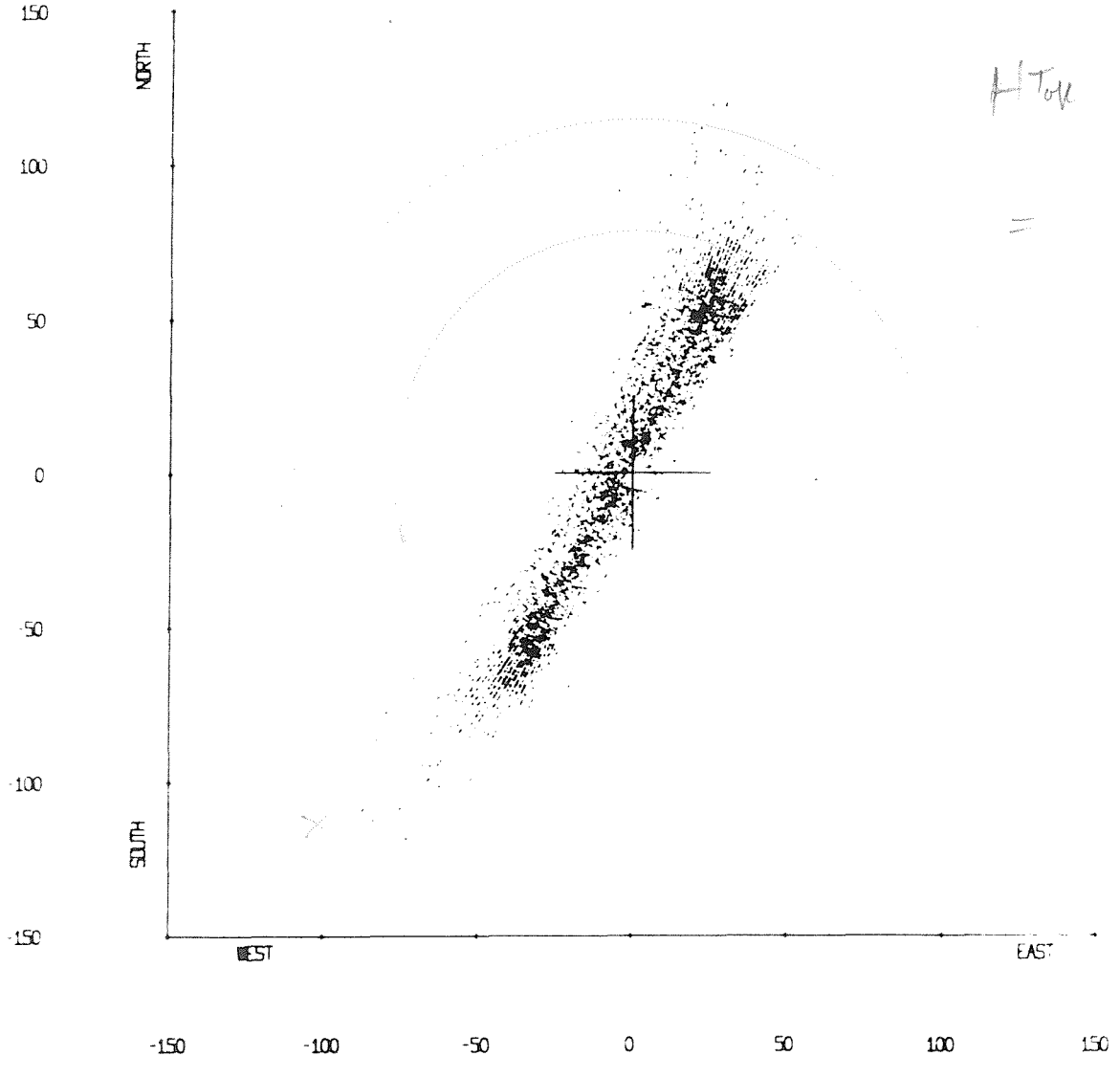
TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
4'TH JUN 73
11'TH JUN 73
18'TH JUN 73

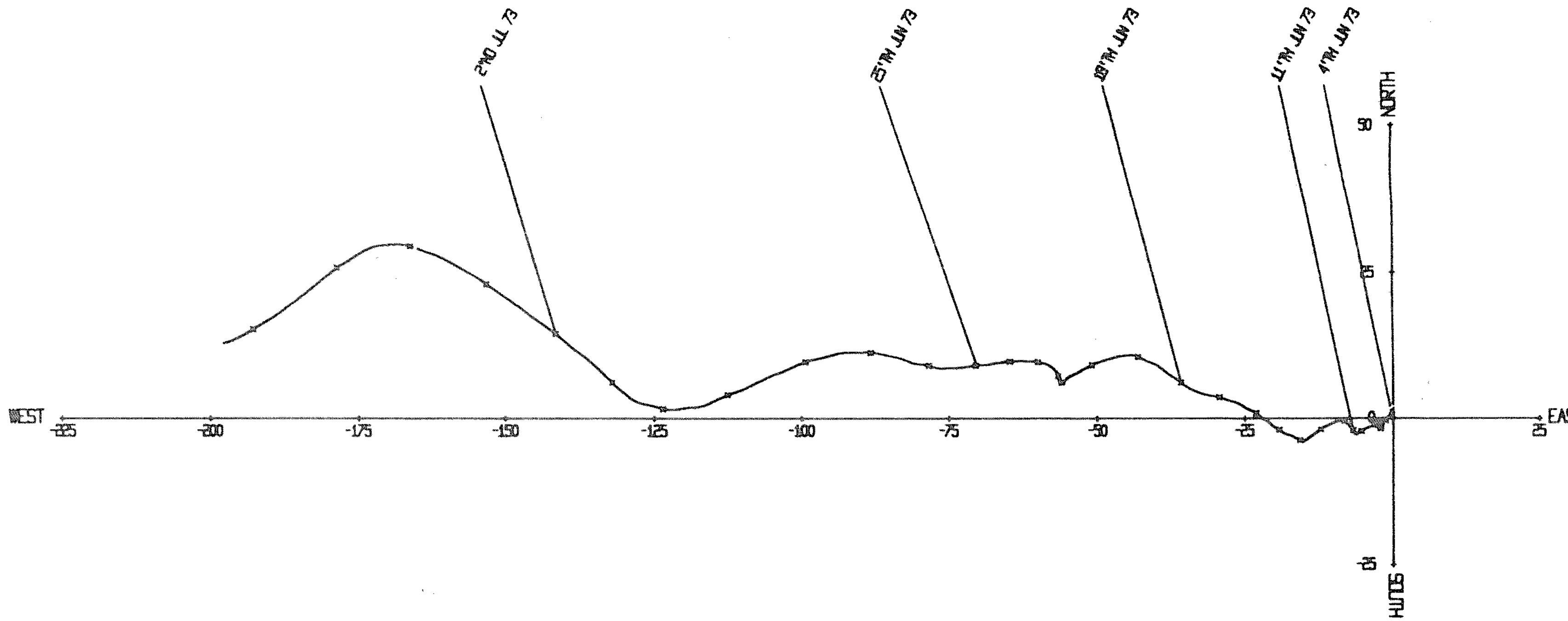
VELOCITY IN CM/SEC

PRESSURE IN METRES OF WATER

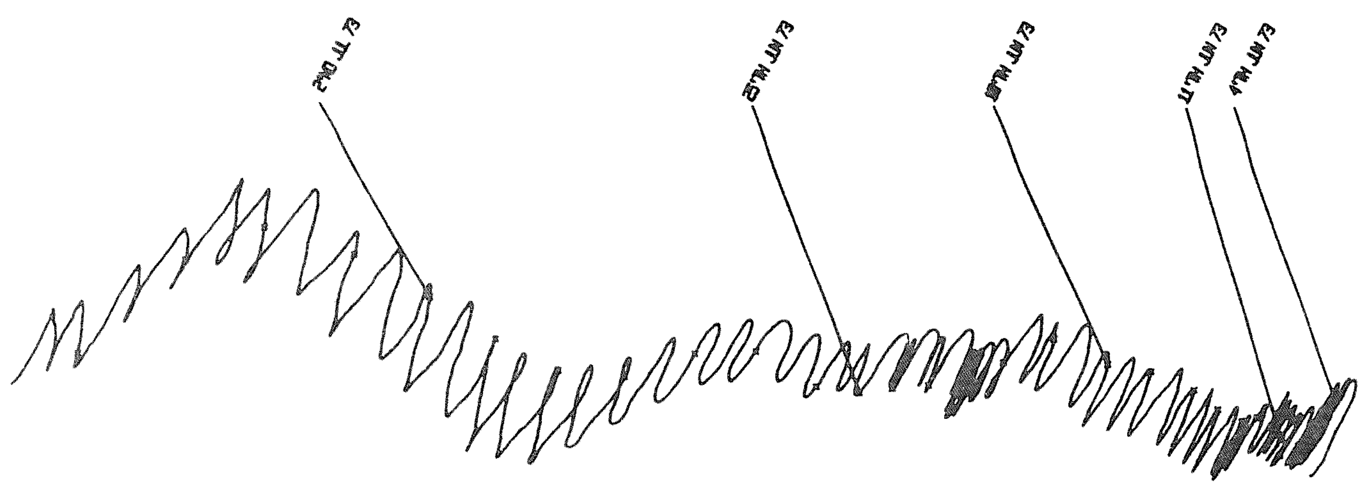
TEMPERATURE IN DEG C


PER CENT
60
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150



2ND JUL 73
25TH JUN 73
18TH JUN 73
11TH JUN 73
4TH JUN 73
NORTH
50
25
0
-25
SOUTH
WEST
-225
-200
-175
-150
-125
-100
-75
-50
-25
25
EAST



2ND JUL 73
25TH JUN 73
18TH JUN 73
11TH JUN 73
4TH JUN 73

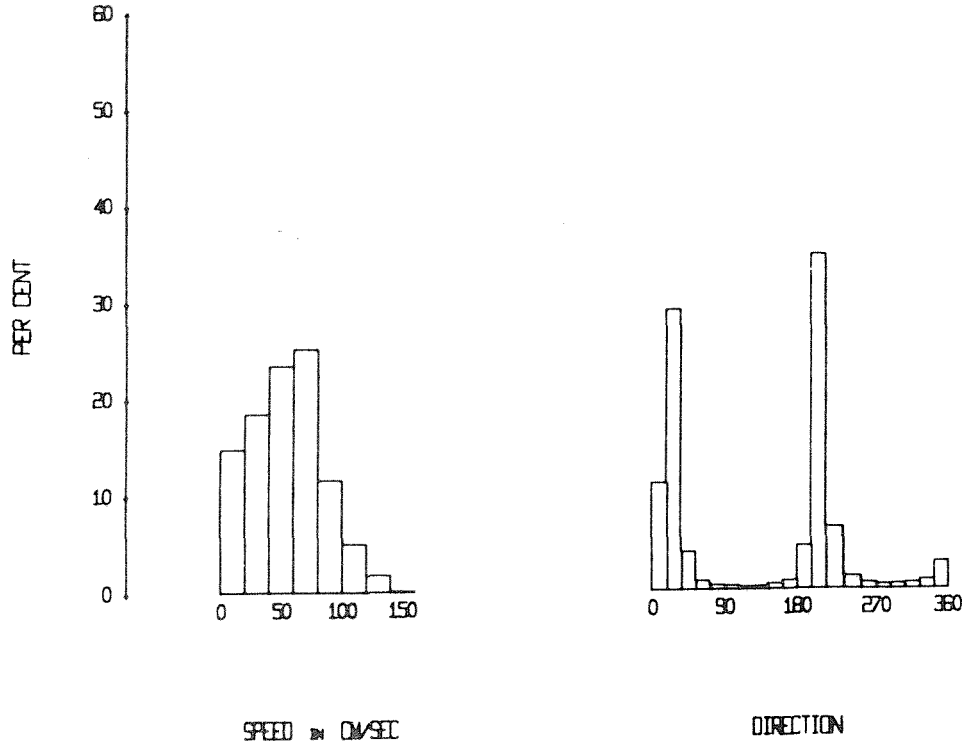
Meter	:	Bergen 568
Tape number	:	568/1
Meter started	:	20.20.00 GMT 1 June 1973
Meter stopped	:	08.50.01 GMT 17 July 1973
Total number of readings	:	6556
Timing error	:	1 s slow
Start of useful record	:	17.50 GMT 3 June 1973
End of useful record	:	09.40 GMT 7 July 1973
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a spindle designed at Bidston. There was slight marine growth on meter when it was recovered.

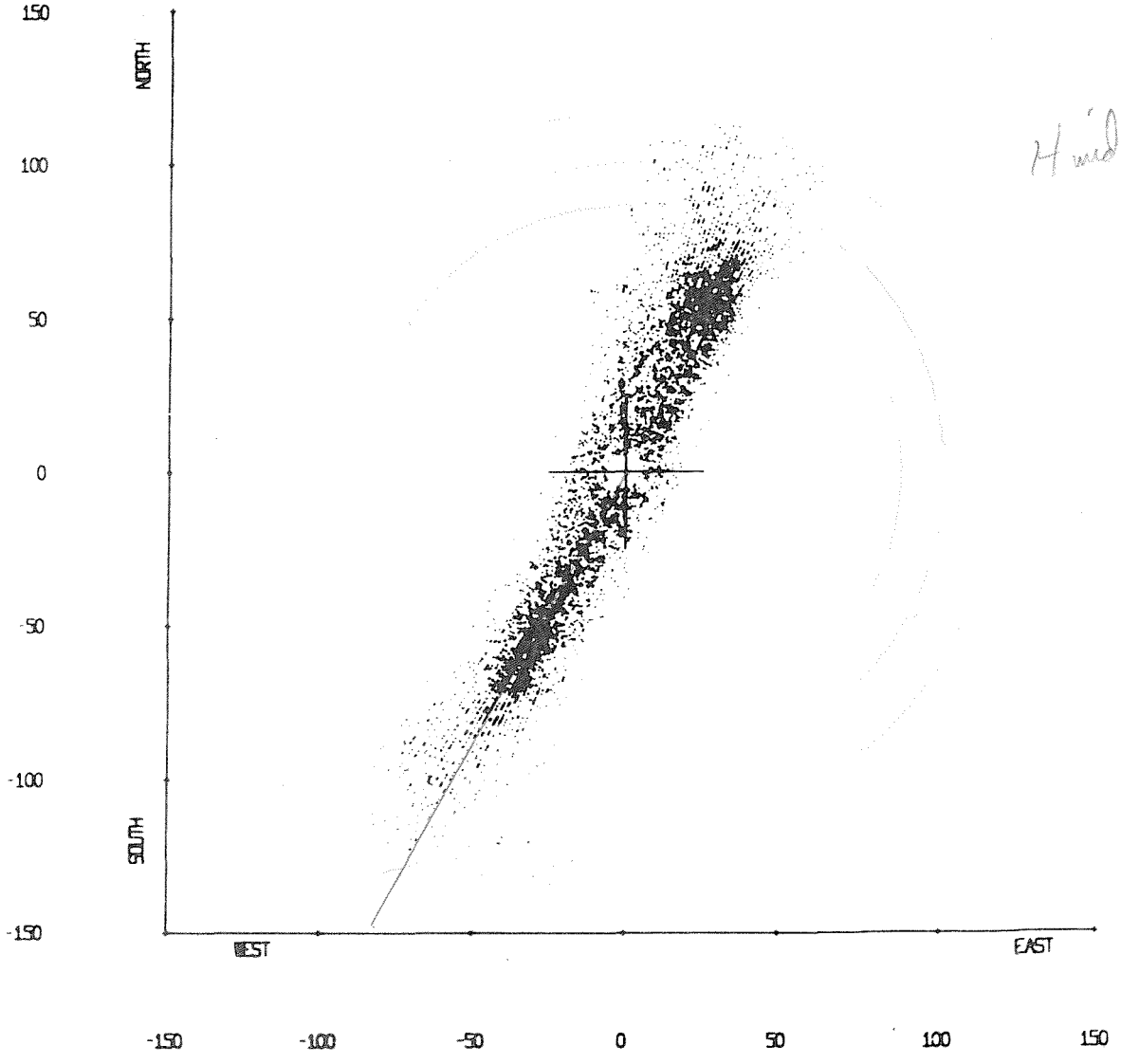
TEMPERATURE IN DEG C

VELOCITY IN CM/SEC

TEMPERATURE IN DEG C

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

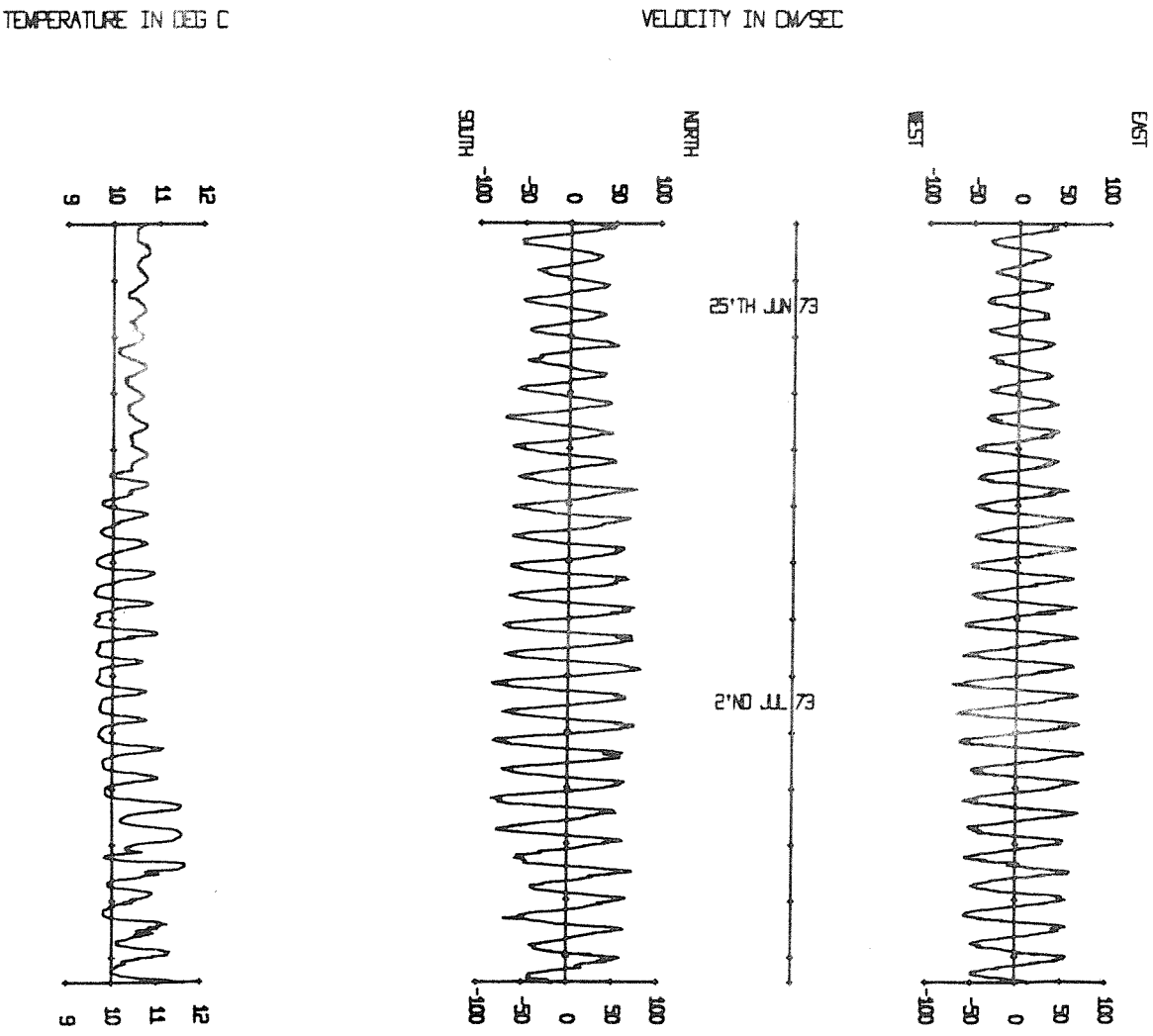
EAST
WEST
NORTH
SOUTH
EZ NT HL.4
EZ NT HL.IT
EZ NT HL.BT
EZ NT HL.S2
EZ TT DM.2

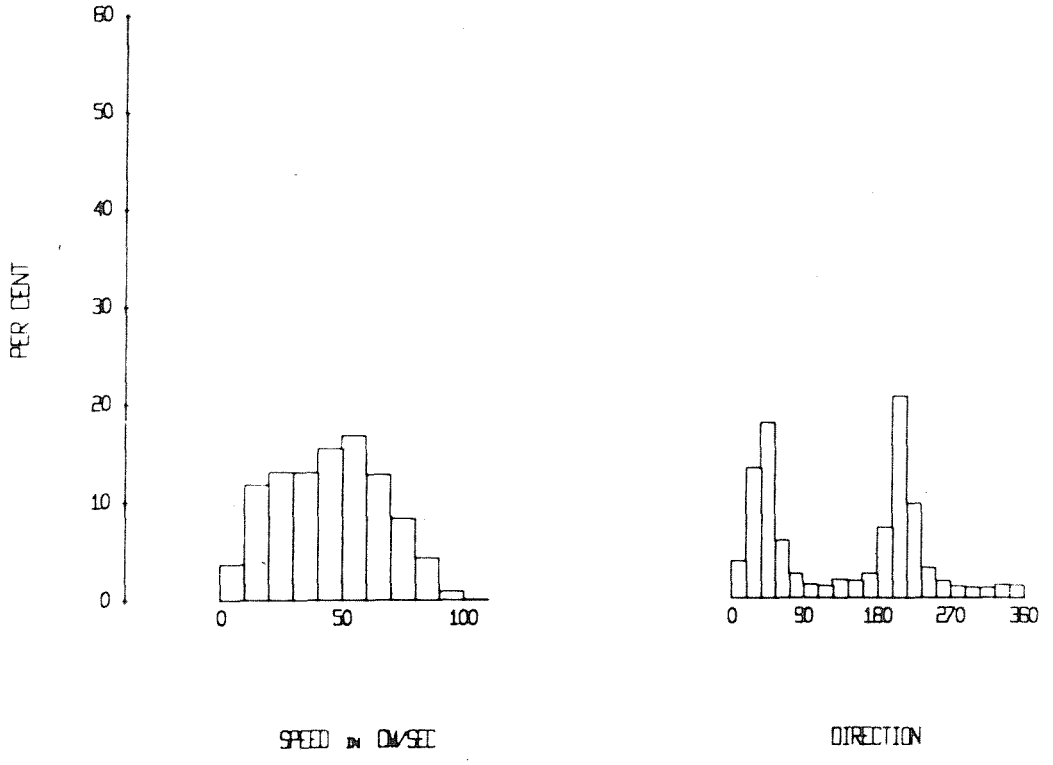
EZ NT HL.4
EZ NT HL.IT
EZ NT HL.BT
EZ NT HL.S2
EZ TT DM.2

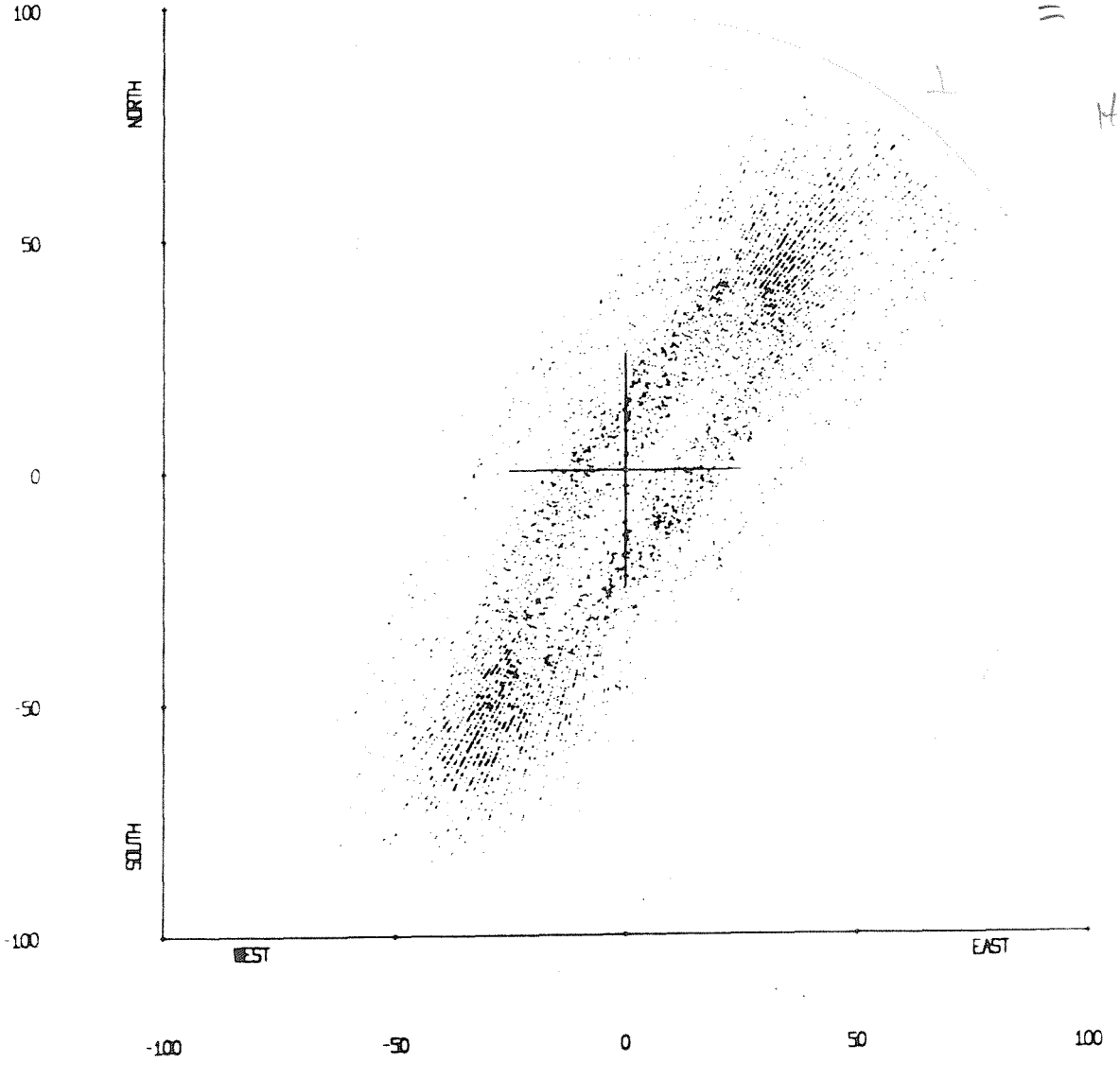
Meter	:	Bergen 532
Tape number	:	532/3
Meter started	:	20.30.00 GMT 1 June 1973
Meter stopped	:	09.09.24 GMT 17 July 1973
Total number of readings	:	6557
Timing error	:	36 s fast
Start of useful record	:	17.50 GMT 3 June 1973
End of useful record	:	09.40 GMT 7 July 1973
Length of useful record	:	808 h
Comments	:	Good record. There was slight marine growth on the meter when it was recovered. Several rotor count readings have been edited.

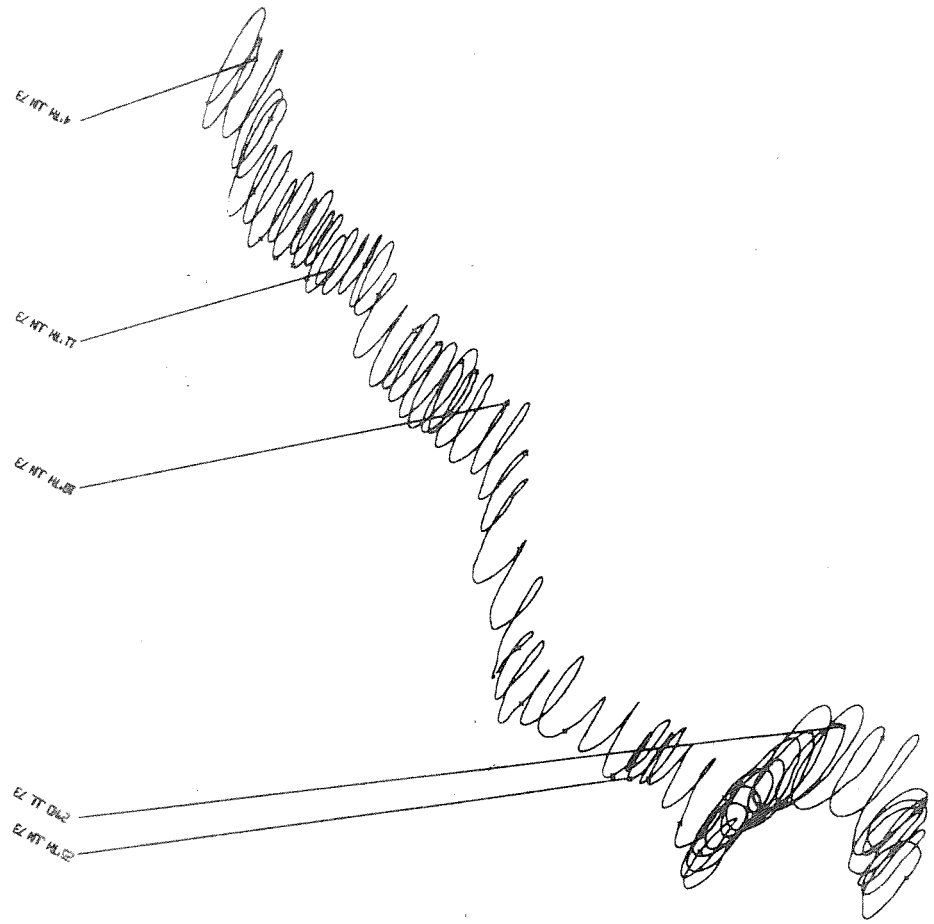
TEMPERATURE IN DEG C

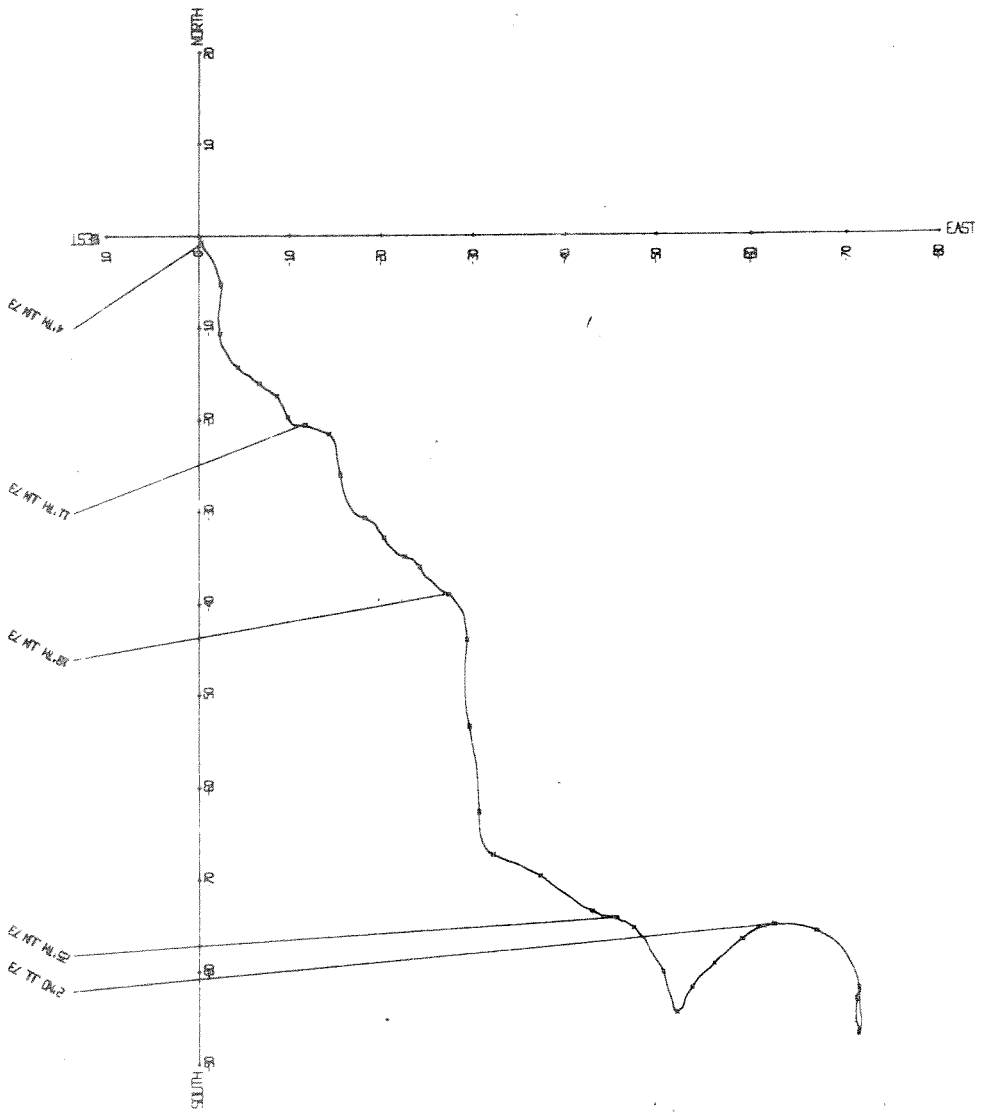
VELOCITY IN CM/SEC


TEMPERATURE IN DEG C
9
10
11
12
VELOCITY IN CM/SEC
SOUTH
NORTH
-100
-50
0
50
100
25'TH JUN 73
2'ND JUL 73
WEST
EAST


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100




NORTH
EAST
SOUTH

Mooring number : 36

Position of rig : Lat 52°05'N Long 5°46'W (rig J)

Depth of water : 92m below chart datum

Tidal heights, in metres above chart datum, at Fishguard : MHWS 4.7 MHWN 3.4 MLWN 1.9 MLWS 0.6

Meter	Type	Height above sea floor (m)	Recording interval (min)
214	Bergen	71	10
212	Bergen	56	10
533	Bergen	15	10

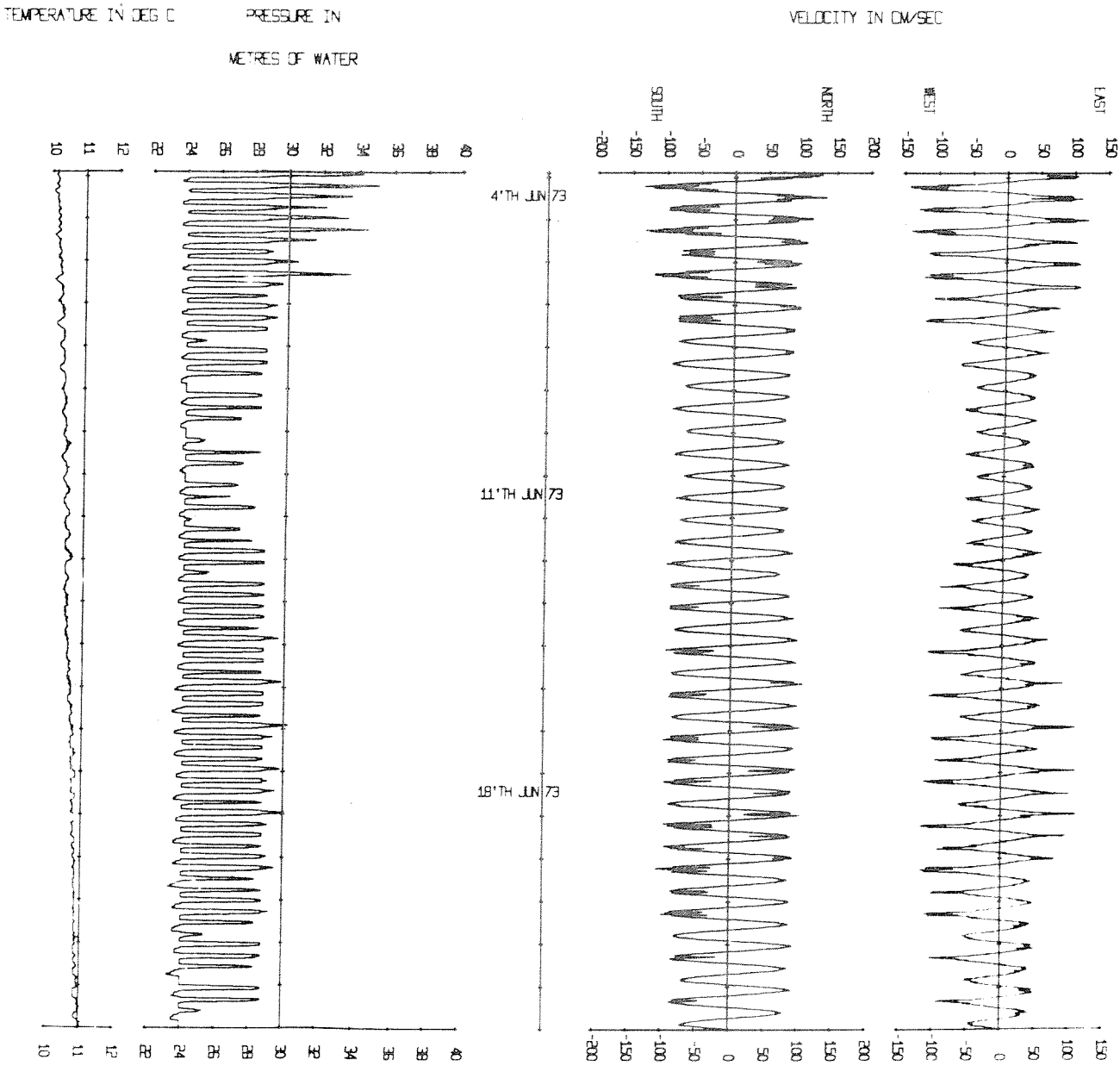
Rig set : 19.11 GMT 3 June 1973 from r.r.s. John Murray

Rig recovered : 08.00 GMT 7 July 1973 from r.r.s. John Murray

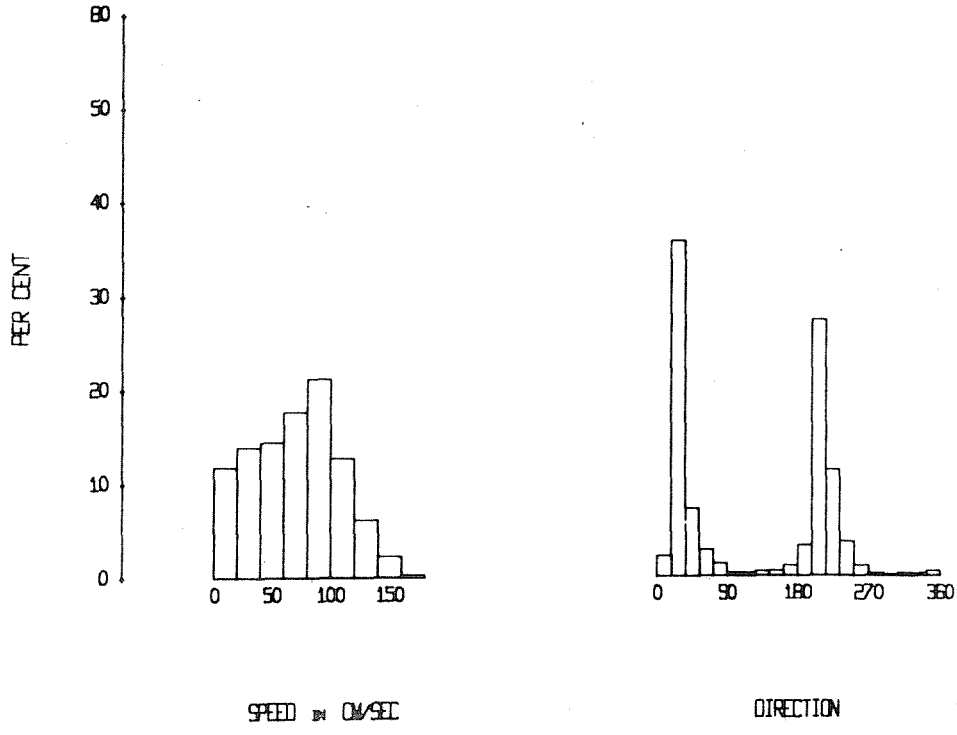
Mooring : Standard, with free-flooding Slingsby sub-surface buoy.

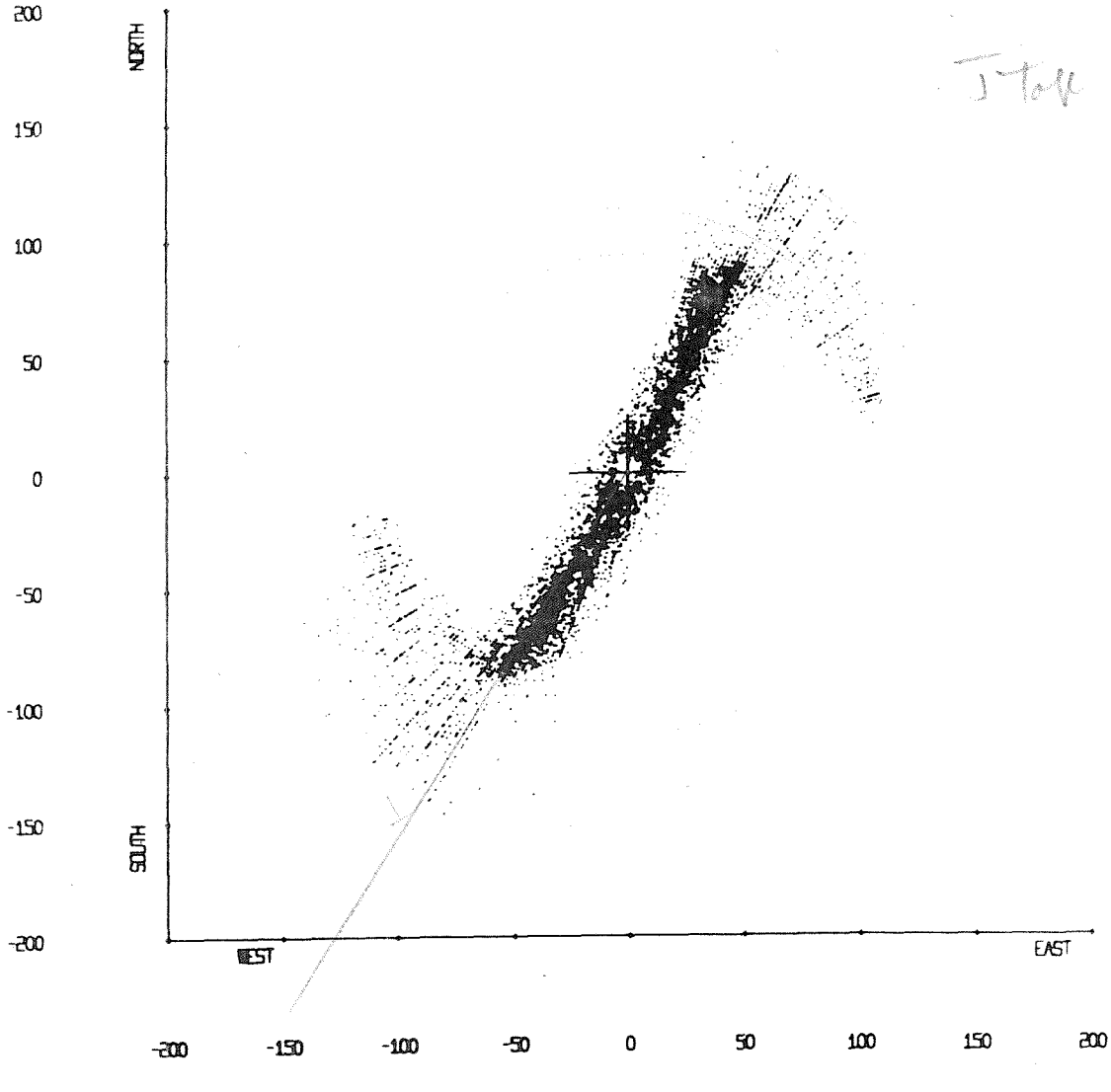
Comments : The launch was successfully accomplished at the first attempt. The surface buoy was seen on station on 25 June but was missing on 29 June and was later recovered floating free by a Trinity House vessel. Dragging was started at 08.00 on 7 July and was immediately successful. The meters were recovered undamaged.

Meter	:	Bergen 214
Tape number	:	214/7
Meter started	:	20.40.00 GMT 1 June 1973
Meter stopped	:	13.49.55 GMT 13 July 1973
Total number of readings	:	6008
Timing error	:	5 s fast
Start of useful record	:	19.20 GMT 3 June 1973
End of useful record	:	07.40 GMT 7 July 1973
Length of useful record	:	804 h
Comments	:	Good record. The meter was fitted with a pressure sensor. When it was recovered it was noted that one of its stabilizer fins was broken. The pressure record indicates that a maximum knockdown of 14m occurred in a 1.80m s^{-1} current. This appears to have affected slightly this meter and meter 212, as can be seen in their scatter plots.


TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
4'TH JUN 73
11'TH JUN 73
18'TH JUN 73

TEMPERATURE IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
25'TH JUN 73
2'ND JUL 73

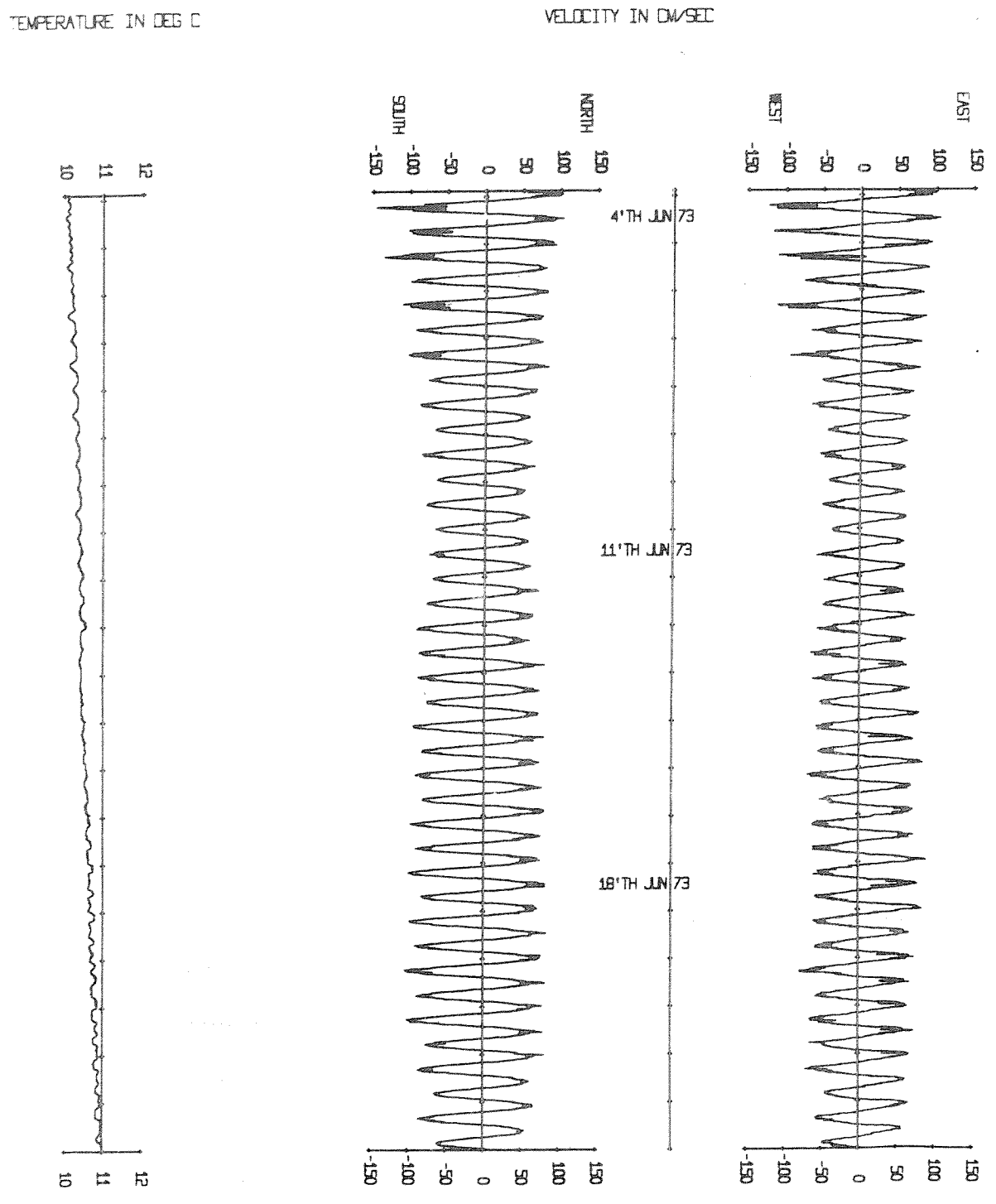

PER CENT
80
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

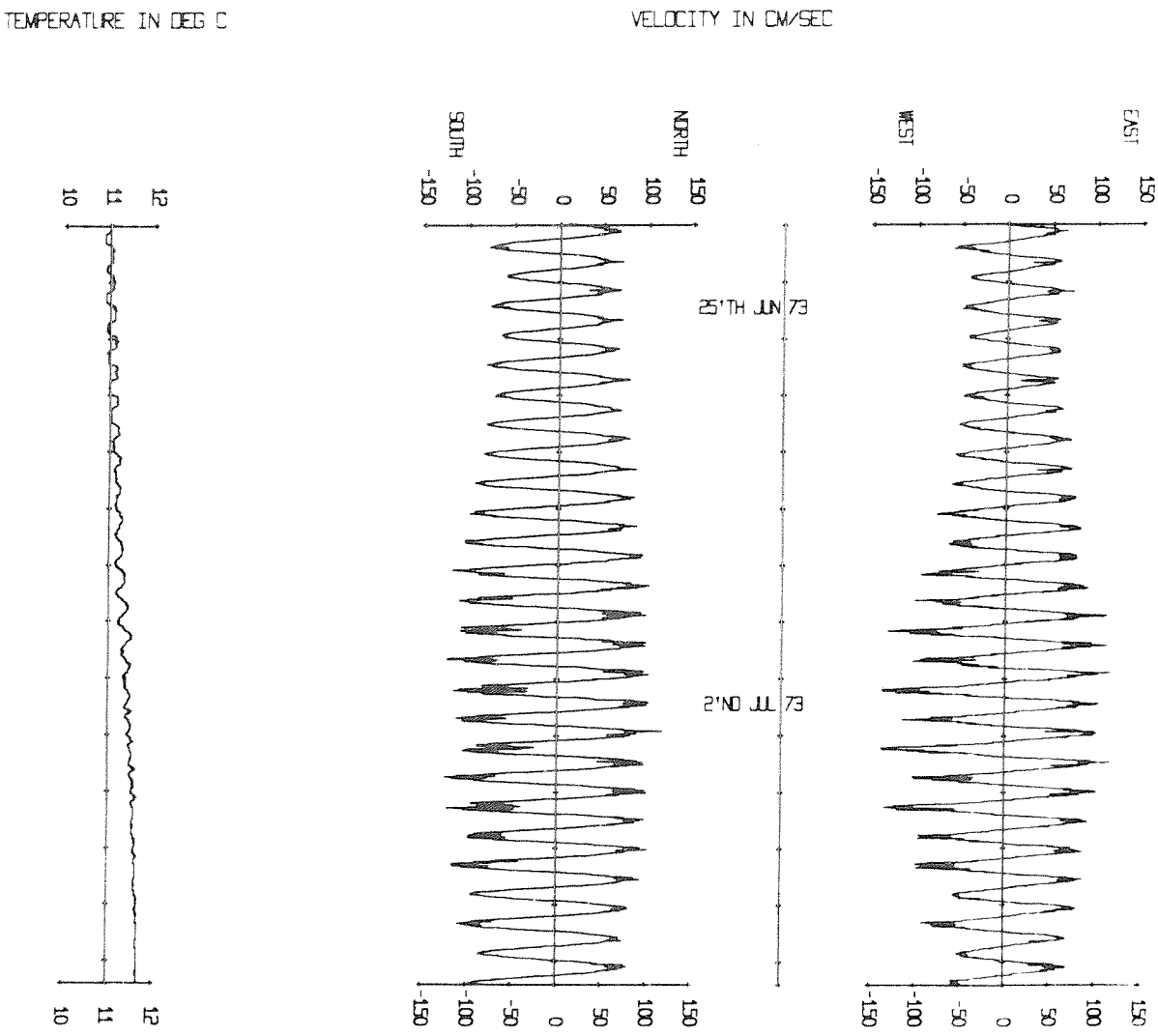

NORTH
SOUTH
WEST
EAST
200
150
100
50
0
-50
-100
-150
-200
-200
-150
-100
-50
0
50
100
150
200

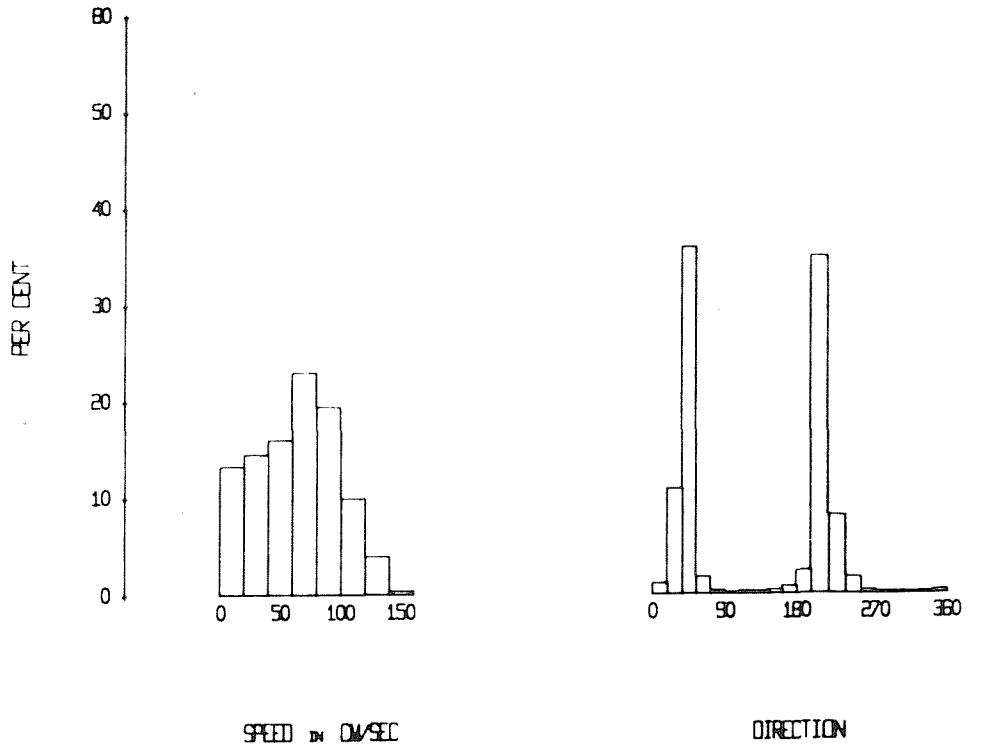
EZ NT HL.9
EZ NT HL.17
EZ NT HL.18T
EZ NT HL.25
EZ TT ON.2

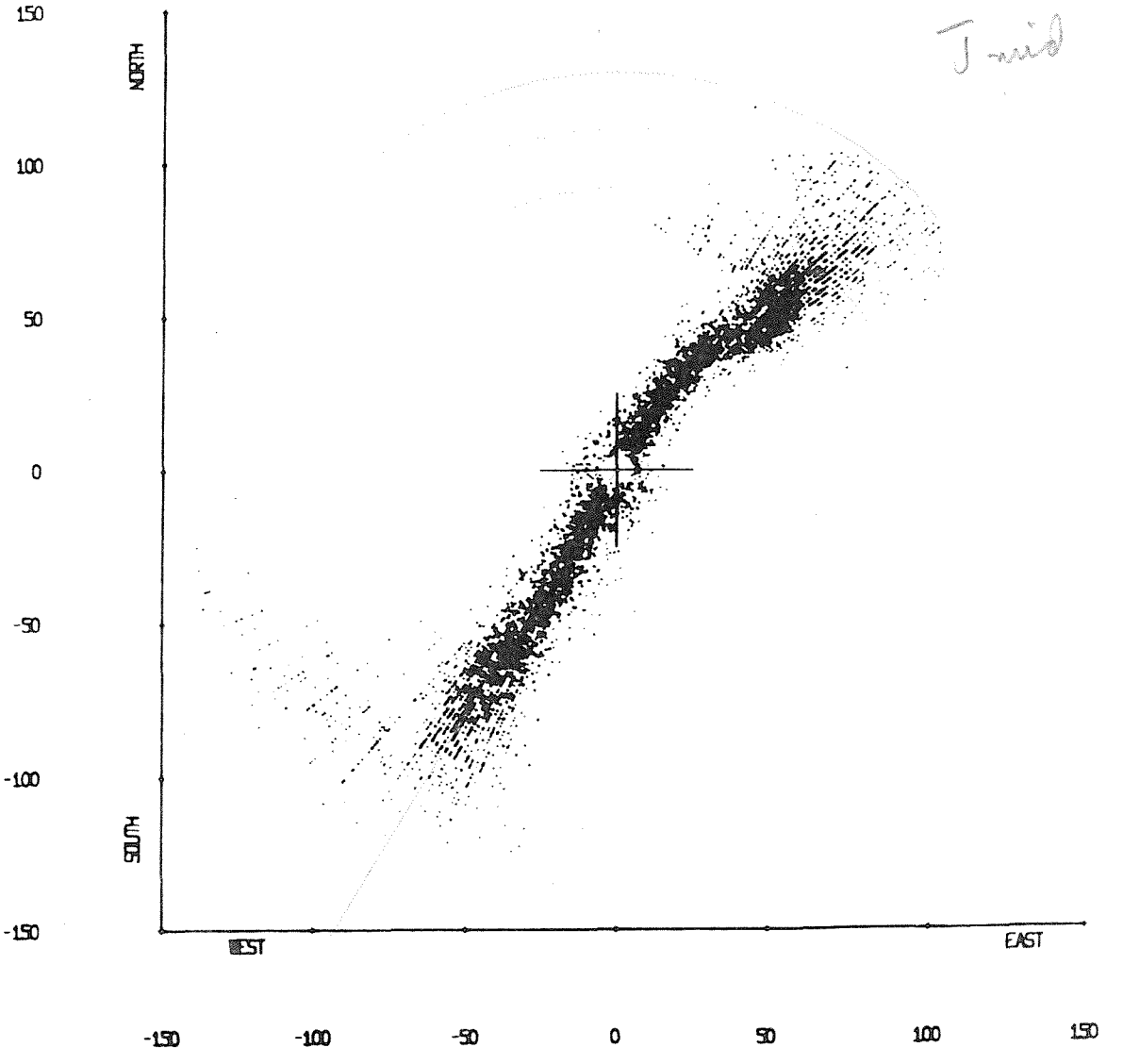
NORTH
SOUTH
EAST
WEST
EZ NT HL.9
EZ NT HL.17
EZ NT HL.18T
EZ NT HL.25
EZ TT ON.2

Meter	:	Bergen 212
Tape number	:	212/8
Meter started	:	20.50.00 GMT 1 June 1973
Meter stopped	:	14.31.02 GMT 7 July 1973
Total number of readings	:	6011
Timing error	:	1 min 2 s slow
Start of useful record	:	19.20 GMT 3 June 1973
End of useful record	:	07.41 GMT 7 July 1973
Length of useful record	:	804 h
Comments	:	Good record. The scatter plot shows some errors caused by meter knockdown.


TEMPERATURE IN DEG C
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
4'TH JUN 73
11'TH JUN 73
18'TH JUN 73
-150
-100
-50
0
50
100
150
10
11
12

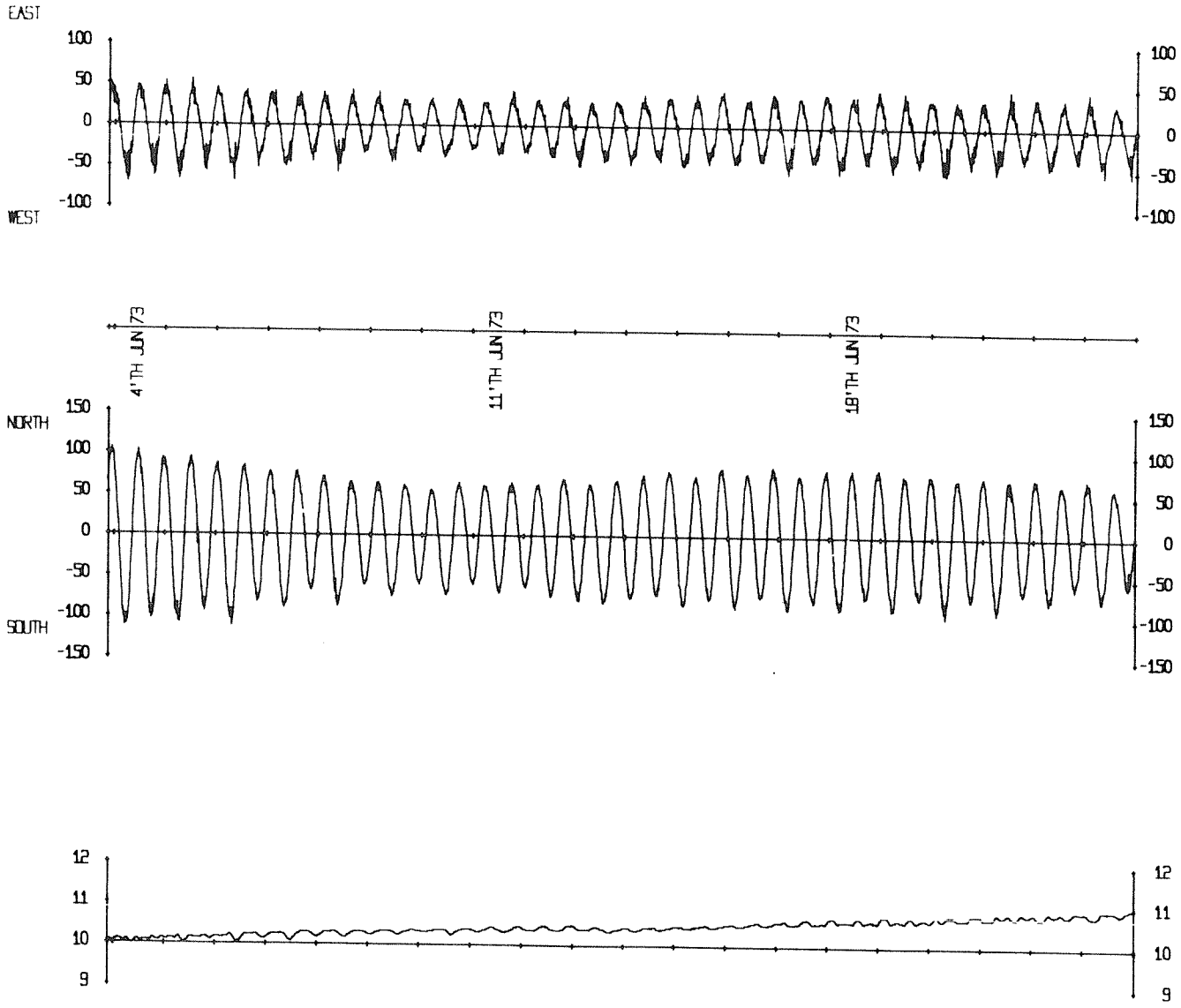

TEMPERATURE IN DEG C
VELOCITY IN CM/SEC
EAST
WEST
NORTH
SOUTH
25'TH JUN 73
2'ND JUL 73
10
11
12
-150
-100
-50
0
50
100
150


PER CENT
60
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

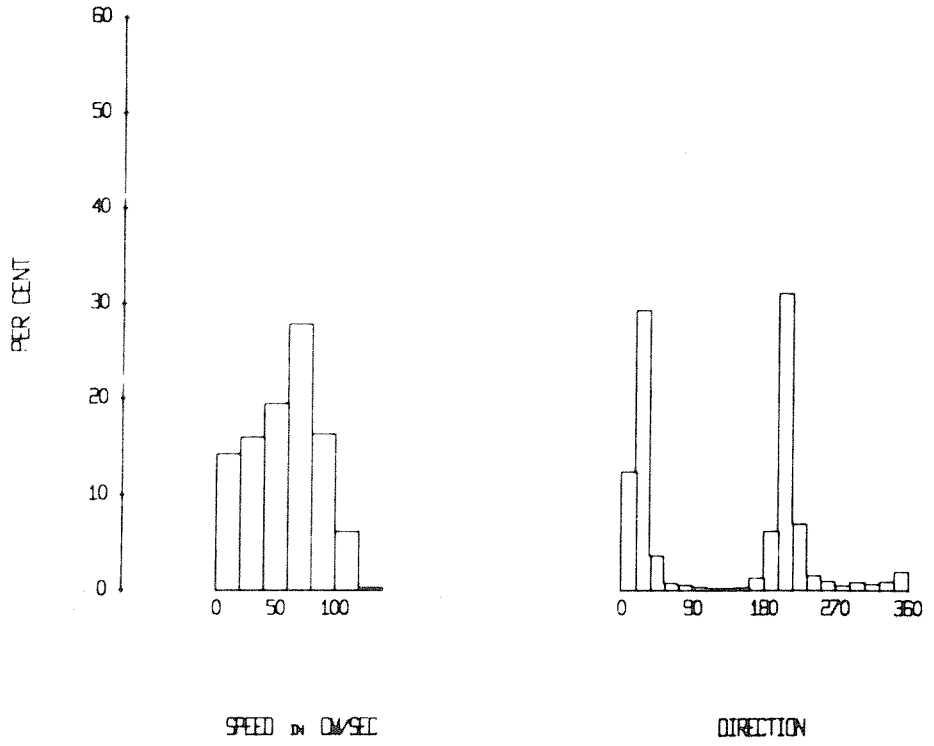
EAST
150
125
100
75
50
25
0
-25
WEST
NORTH
50
25
0
-25
-50
-75
-100
SOUTH

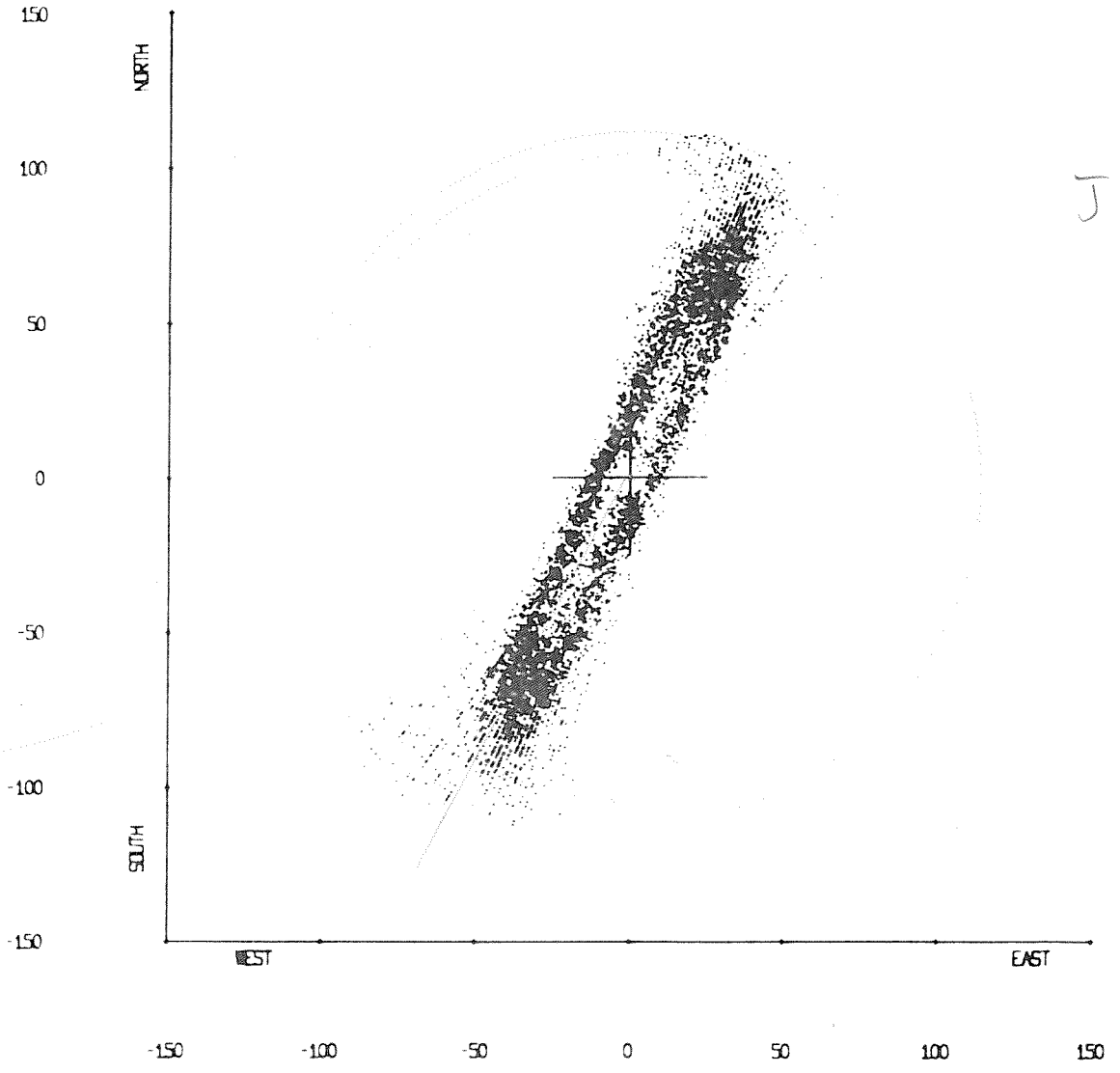
Meter	:	Bergen 533
Tape number	:	533/3
Meter started	:	21.00.00 GMT 1 June 1973
Meter stopped	:	14.51.20 GMT 13 July 1973
Total number of readings	:	6012
Timing error	:	1 min 20 s slow
Start of useful record	:	19.20 GMT 3 June 1973
End of useful record	:	08.41 GMT 7 July 1973
Length of useful record	:	804 h
Comments	:	Good record. Several rotor count and direction readings have been edited.


EAST
WEST
100
50
0
-50
-100
4'TH JUN 73
11'TH JUN 73
18'TH JUN 73
NORTH
SOUTH
150
100
50
0
-50
-100
-150
12
11
10
9

VELOCITY IN CM/SEC

TEMPERATURE IN DEG C


60
50
40
30
20
10
0
PER CENT
0
50
100
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


150
100
50
0
-50
-100
-150
NORTH
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150

J Walton