I.O.S.

MOORED CURRENT METER RECORDS

by

M J HOWARTH AND S G LOCH

DATA REPORT 4

1974

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

MOORED CURRENT METER RECORDS

Morecambe Bay 11 Oct - 1 Nov 1972
St. George's Channel 1 Feb - 5 Mar 1973
ICOT Moorings 25-29

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DATA REPORT ~~2~~ 4

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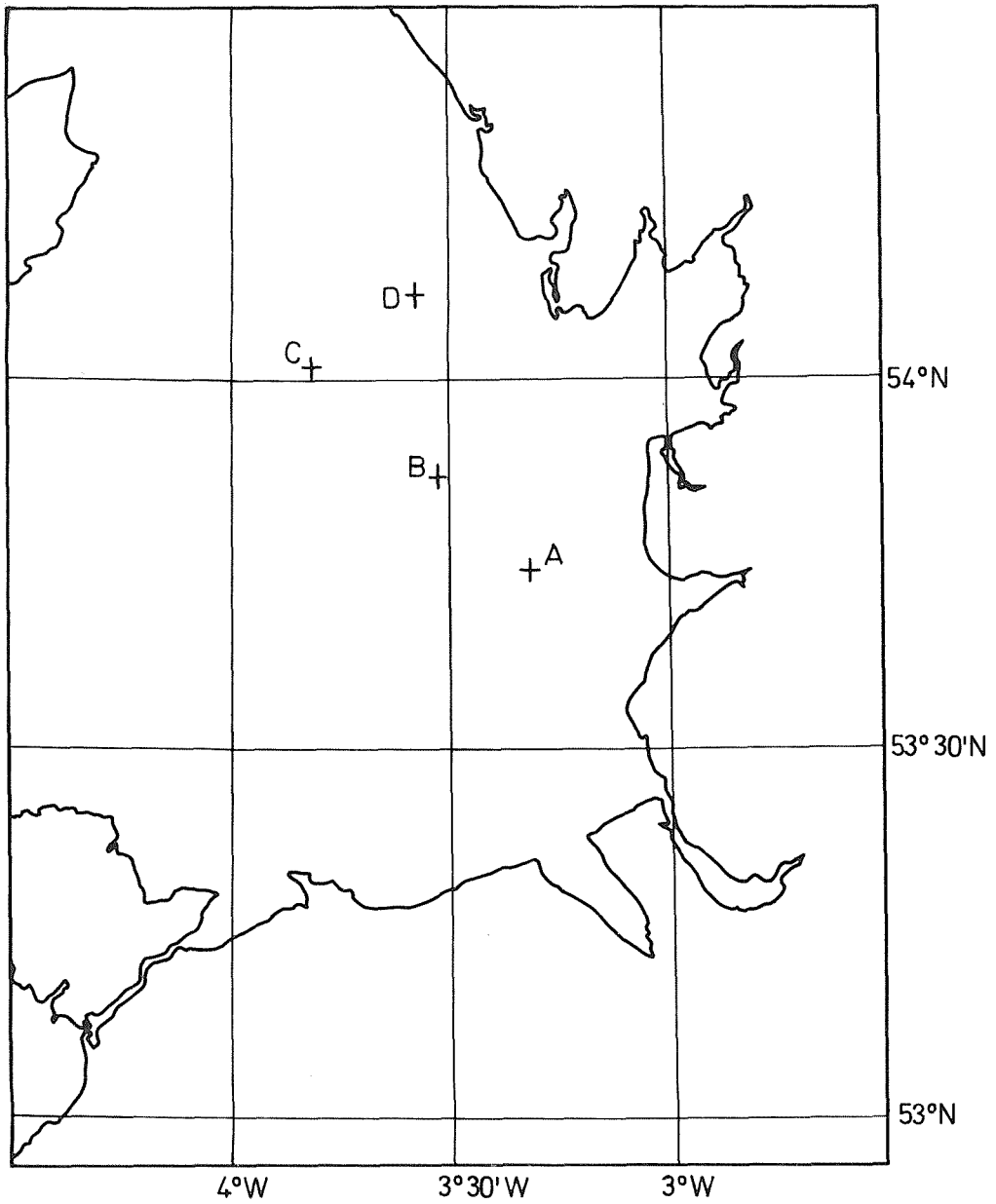
Introduction

This report describes the results from ICOT moorings 25-29 which were deployed in two separate exercises, one in Morecambe Bay and the other in St. George's Channel. In October, 1972, four rigs containing eight current meters were moored on the seaward boundary of Morecambe Bay (see map A and table 1) to provide tidal current data for input into a numerical model of the area (R. A. Flather and N. S. Heaps, in press). For February, 1973, an experiment was planned to investigate the tides and residual current patterns in the Celtic Sea in which an array of seven current meter rigs would be deployed. However, because of rough weather and an unsuitable ship, only one rig was moored (mooring 29) which consisted of three meters (see map B and table 1).

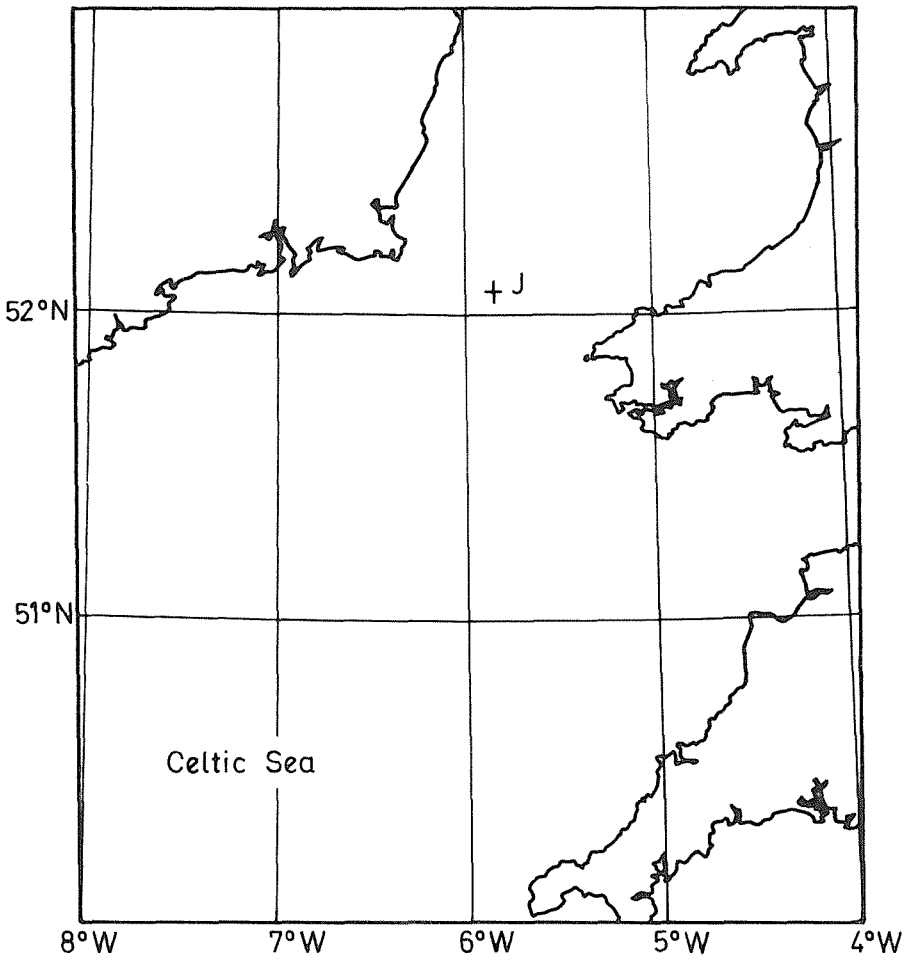
Hence eleven current meters were deployed on the five rigs, all Bergen meters (Aanderaa, 1964). The resulting data was of good quality and 100% of maximum possible data was returned.

Mooring	Rig	Latitude	Longitude	Water depth below chart datum (m)	Day Launched	Day Recovered	Height of meter above sea floor(m)	Tape No.
25	A	53°44.7'N	3°19.2'W	15	11 Oct 72	31 Oct 72	7	531/2
26	B	53°52.7'N	3°31.9'W	22	11 Oct 72	1 Nov 72	13	213/6
							5	530/2
27	C	54°00.8'N	3°44.4'W	33	11 Oct 72	31 Oct 72	25	417/4
							15	532/2
							5	212/7
28	D	54°06.8'N	3°33.4'W	22	11 Oct 72	32 Oct 72	13	533/2
							5	415/4
29	J	52°04.1'N	5°47.0'W	91	1 Feb 73	5 Mar 73	71	563/1
							56	564/1
							15	565/1

Table 1 : Summary of current meter deployment, times and positions



MAP A



MAP B

POSITION OF CURRENT METER RIGS

Current meter moorings

A schematic diagram of the mooring arrangement is shown in figure 1. The Bergen meter spindles were spliced into a taut line supported by a sub-surface buoy, of which there were three different types.

A) A bullet shaped buoy about 1.1 m long and 0.65 m in diameter made from high density polyurethane foam in a fibreglass shell approx. 1 cm thick. It has a buoyancy of 160 kg and is manufactured by Cosalt Ltd.

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

C) A free-flooding spheroid about 1 m in diameter made from a hollow fibreglass shell containing 38 mm 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 was marked by a toroidal surface buoy supporting a radar reflector and a flashing light. Two scrap chain anchors were used, one of 700 kg under the surface buoy and one of 450 kg below the sub-surface buoy. In four of the rigs wire rope of 8 mm diameter galvanised, flexible steel was used for the line supporting the meters, 12 or 16 mm wire for the ground line (approx. 200 m long) and the line to the surface toroid. However, on the fifth, rig B in Morecambe Bay, Nilspin jacketed wire was used throughout. The wire had a core of $\frac{1}{4}$ in diameter galvanized basic grade steel which was coated with polypropolene so that the overall diameter was 5/16 in. A 2 m 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 subsurface float, then the meters and the meter anchor, paying out the ground line, the anchor under the surface buoy, the surface

Current meters

Bergen current meters record onto magnetic tape, at a fixed sampling interval, temperature, current direction and integrated rotor count, and the top meter each at rigs B and C in Morecambe Bay also recorded pressure. The sampling interval for each of the meters was 10 min and was controlled by a quartz-crystal clock rated at $\pm$ 2 secs/day in nine of the meters and by an electro-mechanical clock in the remaining two. In fact, ten out of the eleven meters kept to within 3 secs/day - timing errors being determined by comparing the number of samples recorded with 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.

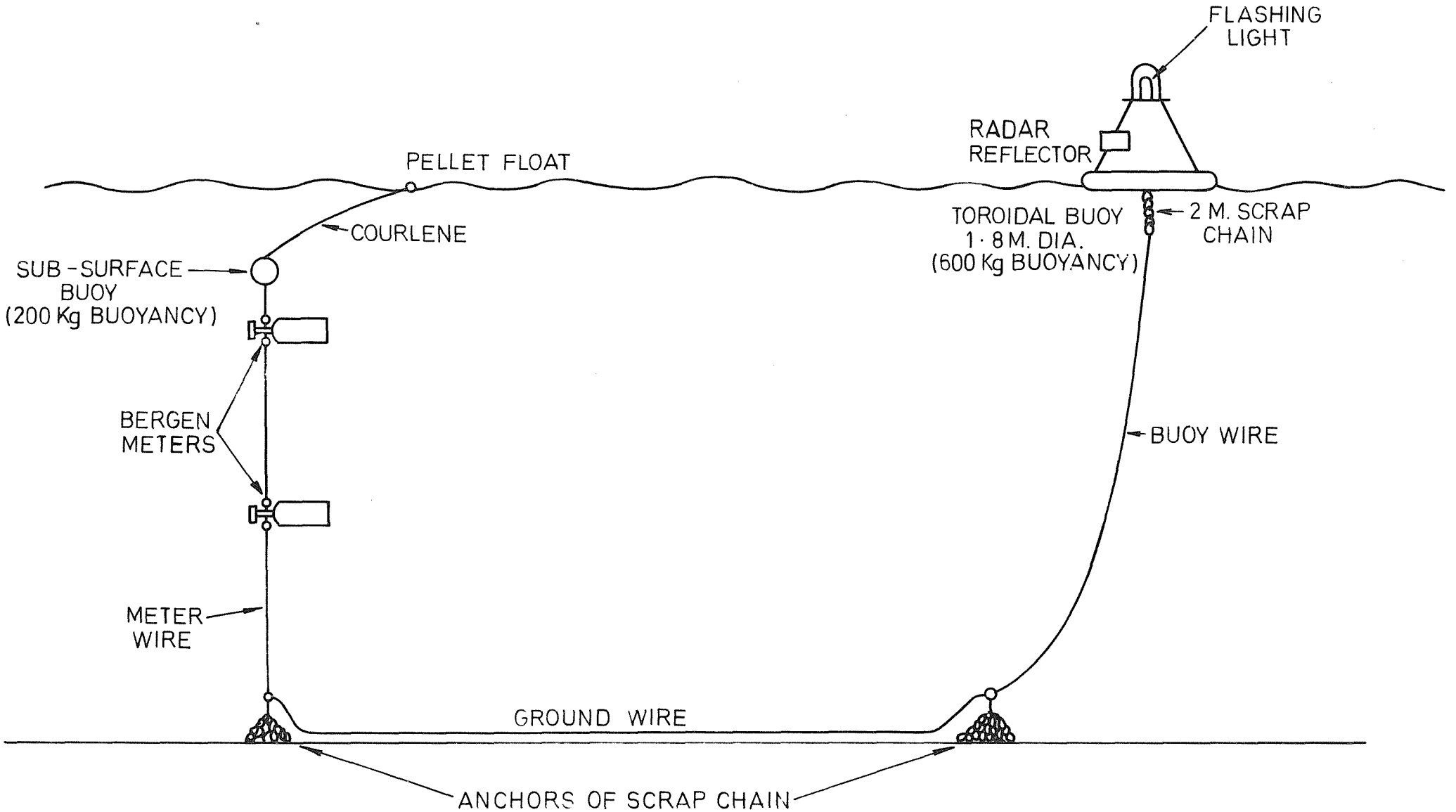
All meters were calibrated after their recovery and, in addition, the three meters of mooring 29 were calibrated before their launch. The compasses were calibrated every 10^{o} with particular attention to the dead-space and the rotors were tested over the range 0 - 150 cm/sec in the wave tank at Wormley. The thermistors were calibrated over the range -2^{o}C to 20^{o}C and the pressure sensors, bourdon tubes, over the range 0 to 13.5 bars above atmospheric pressure.

In all, eleven records were obtained, since all the meters were recovered and all appeared to have functioned satisfactorily.

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.

During the two exercises three ships were used - r.r.s. John Murray for the launch of the first, r.v. Edward Forbes for its recovery and r.v. Researcher for the launch and recovery of the second. The first two vessels were each equipped with an 'A' frame so that launch and recovery were conducted over the stern whilst on the third operations were conducted over the side. The skill and experience of their masters and crew contributed greatly to the success of the programme.

FIGURE 1. MOORING SYSTEM (SCHEMATIC)



Data processing

The data on the magnetic tapes from the Bergen meters was translated at Bergen onto 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 ($>$ 25 cm/sec). 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 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	:	ICOT 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 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/sec, 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 averaged 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/day is equivalent to a residual speed of 1.16 cm/sec. The crosses mark mid-day (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, the marine operations section for the help they have given in launching and recovering the instruments and the computer operators for their patience and help in running our programs.

References

Aanderaa, I. 1964 — A recording and telemetering instrument. Nato subcommittee on oceanographic research. Tech. report 16 - fixed buoys project.

Flather, R.A. and Heaps, N.S. — In Press. Tidal computations for Morecambe Bay. Geophys. J.R. astr. Soc.

Mooring number : 25

Position of rig : Lat $53^{o}44.7'$N Long $3^{o}19.2'$W (rig A)

Depth of water : 15 m below chart datum

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

MHWS	MHWN	MLWN	MLWS
8.8	6.9	2.4	0.5

Meter	Type	Height above sea floor (m)	Recording interval (min)
531	Bergen	7	10

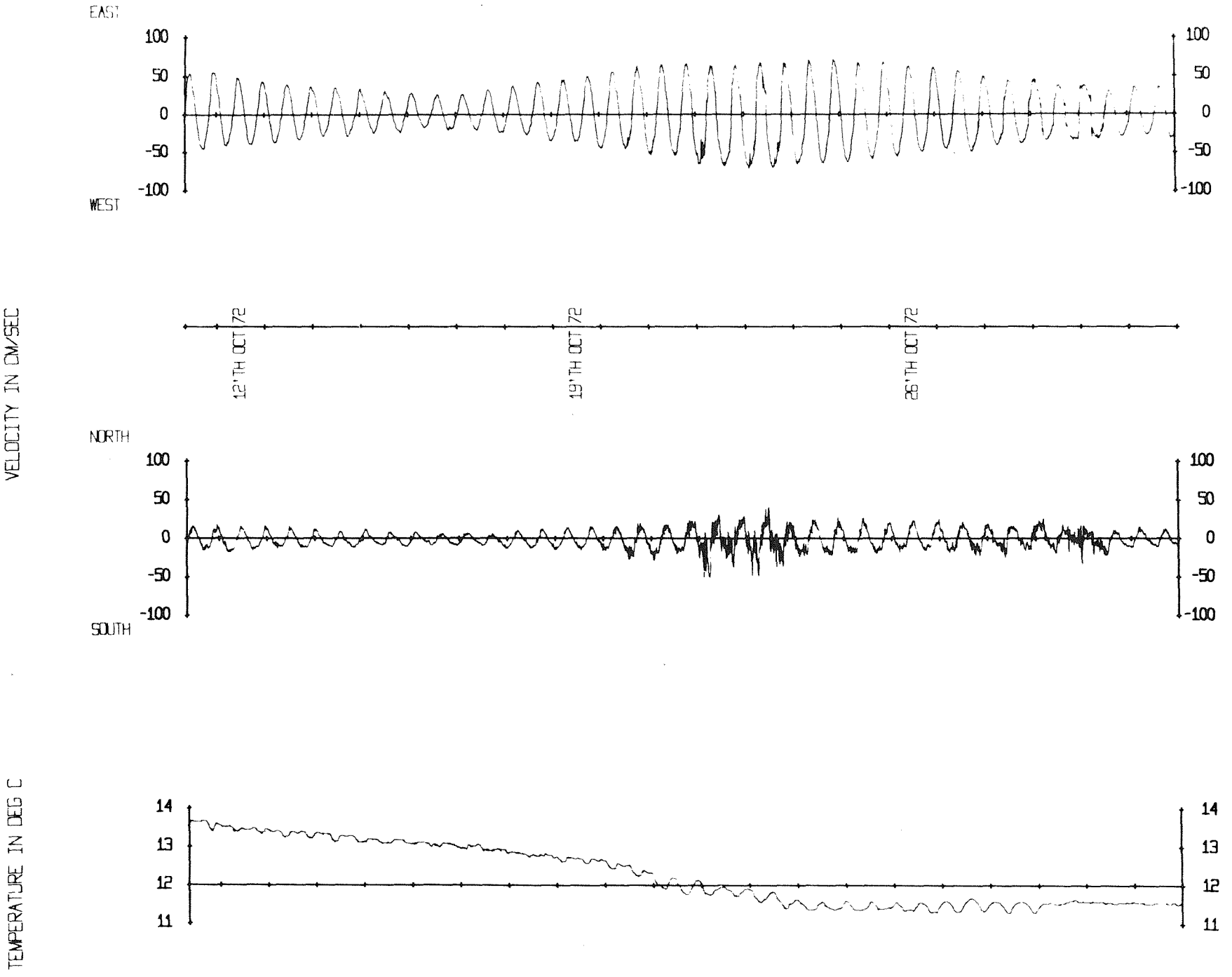
Rig set : 07.49 GMT 11 Oct 1972
from r.r.s. John Murray

Rig recovered : 23.55 GMT 31 Oct 1972
from r.v. Edward Forbes

Mooring : Standard with a Cosalt sub-surface buoy

Comments : Launch and recovery were successfully accomplished at the first attempt

Meter	:	Bergen 531
Tape number	:	531/2
Meter started	:	17.59.07 GMT 10 Oct 1972
Meter stopped	:	10.08.33 GMT 8 Nov 1972
Total number of readings	:	4130
Timing error	:	34 s fast
Start of useful record	:	07.59 GMT 11 Oct 1972
End of useful record	:	23.39 GMT 31 Oct 1972
Length of useful record	:	495 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock.


EAST
WEST
100
50
0
-50
-100
12'TH OCT 72
19'TH OCT 72
26'TH OCT 72
NORTH
SOUTH
VELOCITY IN CM/SEC
TEMPERATURE IN DEG C
14
13
12
11

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

PER CENT
0
10
20
30
40
50
60
SPEED IN KNOTS
0
15
30
45
60
DIRECTION
0
90
180
270
360

Mooring number : 26

Position of rig : Lat 53°52.7'N Long 3°31.9'W (rig B)

Depth of water : 22 m below chart datum

Tidal heights, in metres above chart datum, at Liverpool : MHWS 8.8 MHWN 6.9 HLWN 2.4 MLWS 0.5

Meter	Type	Height above sea floor (m)	Recording interval (min)
213	Bergen	13	10
530	Bergen	5	10

Rig set : 09.44 GMT 11 Oct 1972
from r.r.s. John Murray

Rig recovered : 09.30 GMT 1 Nov 1972
from r.v. Edward Forbes

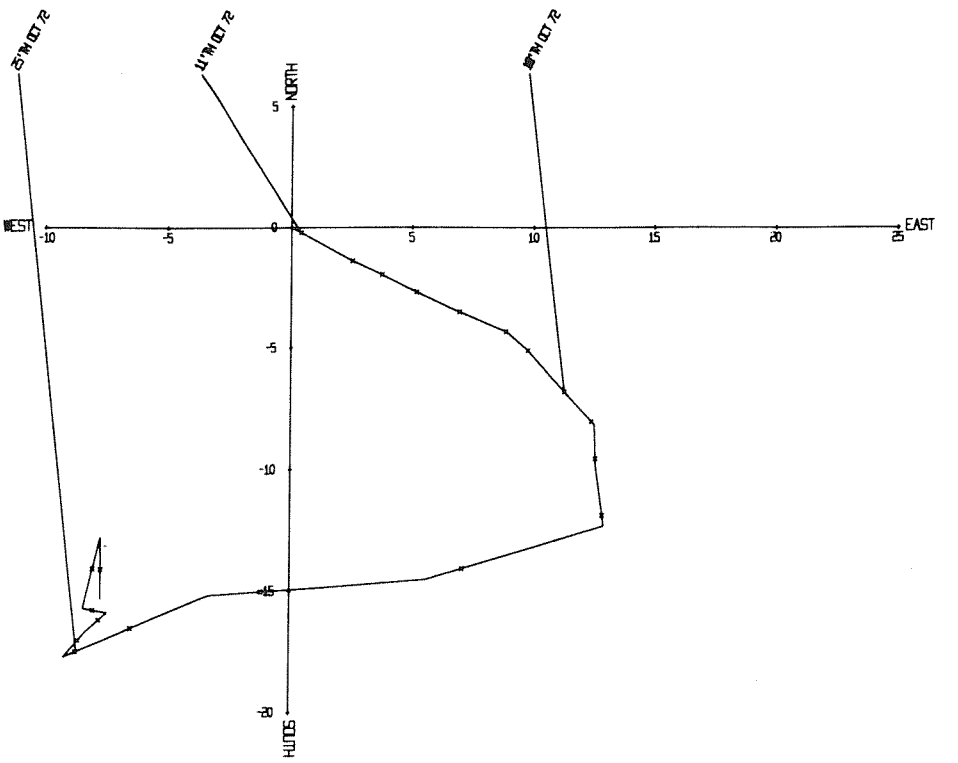
Mooring : Standard, with free-flooding Slingsby sub-surface buoy. Nilspin used for all wire.

Comments : The launch was successfully accomplished at first attempt.

On 25 Oct the toroid was washed ashore on Blackpool beach. A storm had occurred during the previous few days and the buoy appeared to have broken free since beneath the buoy there was about 3 m of Nilspin whose free end showed signs of corrosion and whose cover was torn.

On arrival at the station for the recovery the pellets were sighted and the rig dragged for. The ground line was successfully snagged on the fifth pass and the rig recovered.

Meter	:	Bergen 213
Tape number	:	213/6
Meter started	:	20.40.20 GMT 10 Oct 1972
Meter stopped	:	14.19.46 GMT 7 Nov 1972
Total number of readings	:	3995
Timing error	:	34 s fast
Start of useful record	:	10.01 GMT 11 Oct 1972
End of useful record	:	09.20 GMT 1 Nov 1972
Length of useful record	:	503 h
Comments	:	Good record. The meter was fitted with a pressure transducer and quartz-crystal clock.


25 PM OCT 72
11 PM OCT 72
4 PM OCT 72
NORTH
SOUTH
WEST
EAST
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-10
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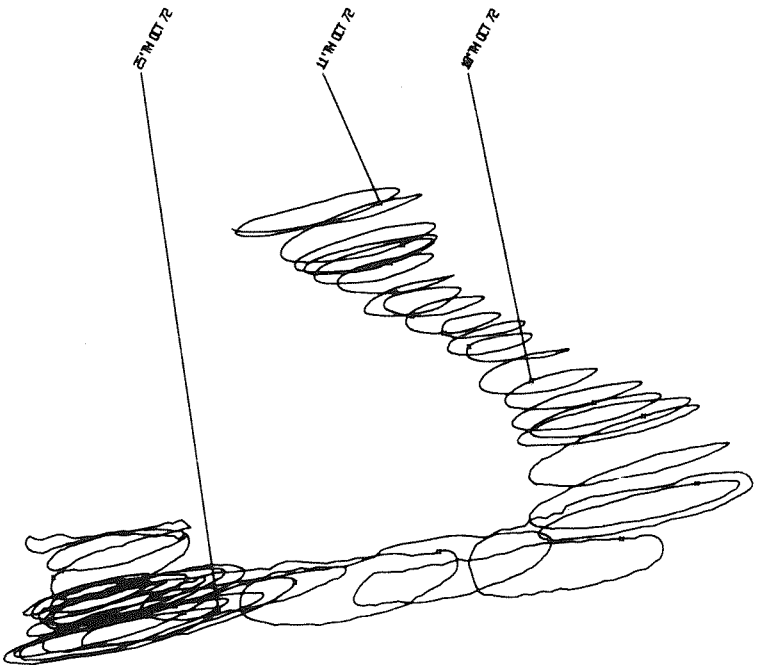
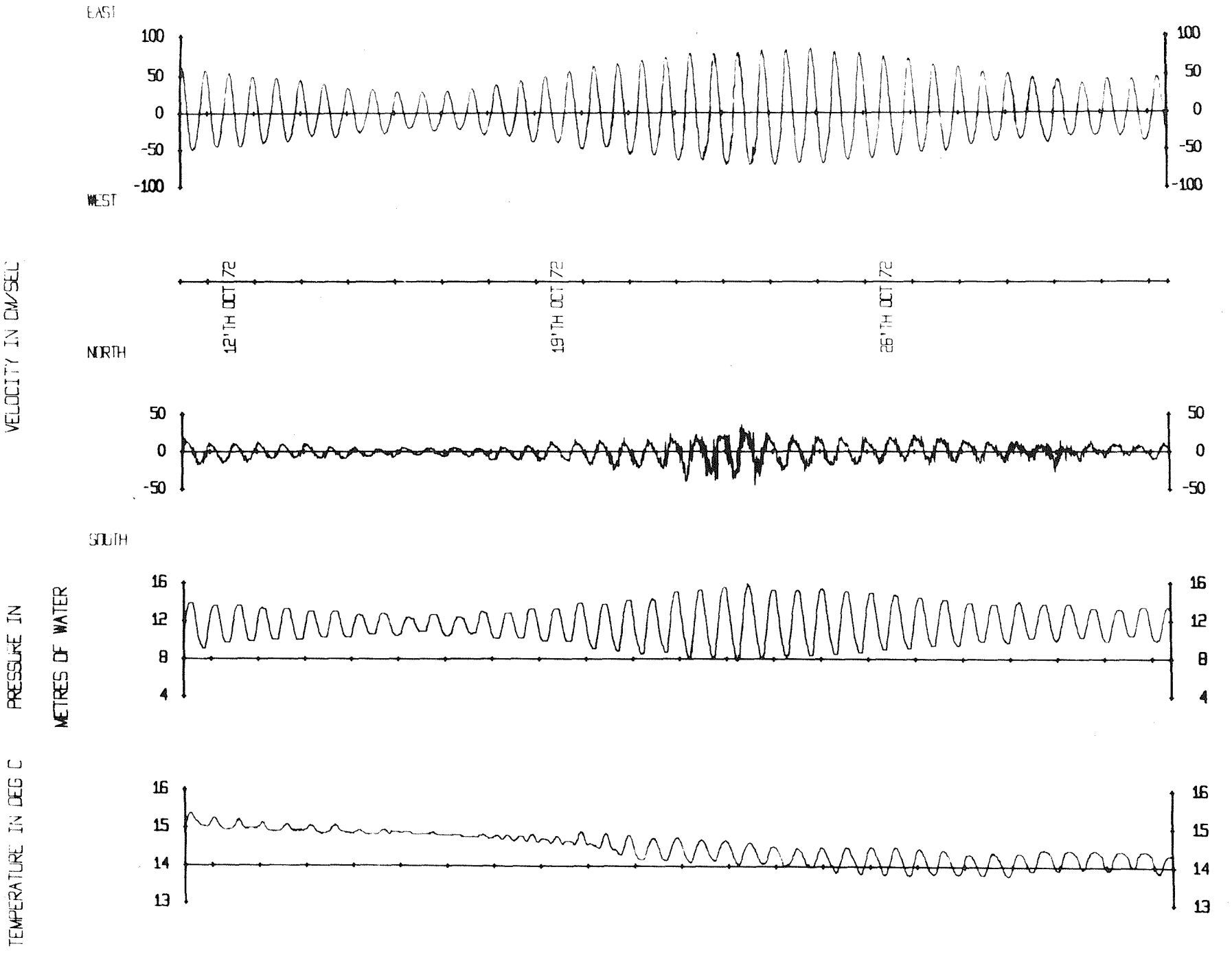
-20
-10
-5
5
10
15
20
25


25 PM OCT 72
11 PM OCT 72
4 PM OCT 72


EAST
100
50
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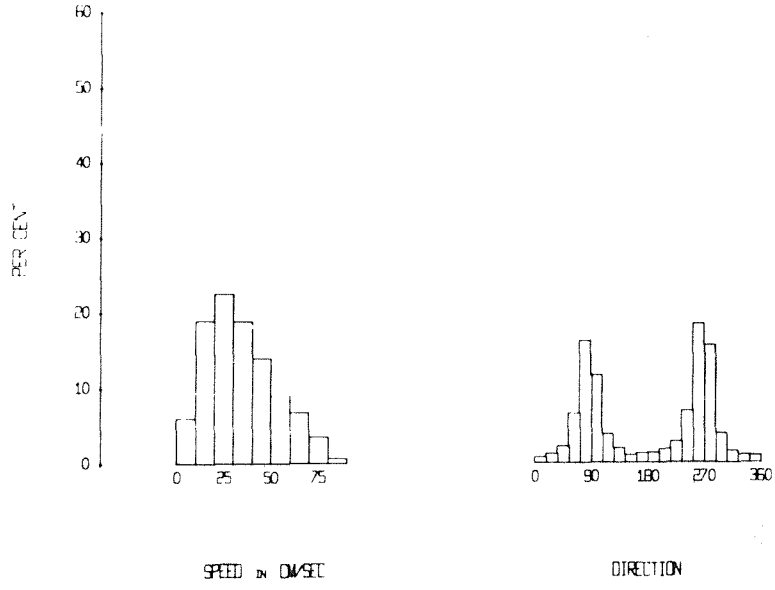
-100
WEST
12'TH OCT 72
19'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
16
12
8
4
16
15
14
13
VELOCITY IN CM/SEC
PRESSURE IN
METRES OF WATER
TEMPERATURE IN DEG C


60
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10
0
PER CENT
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25
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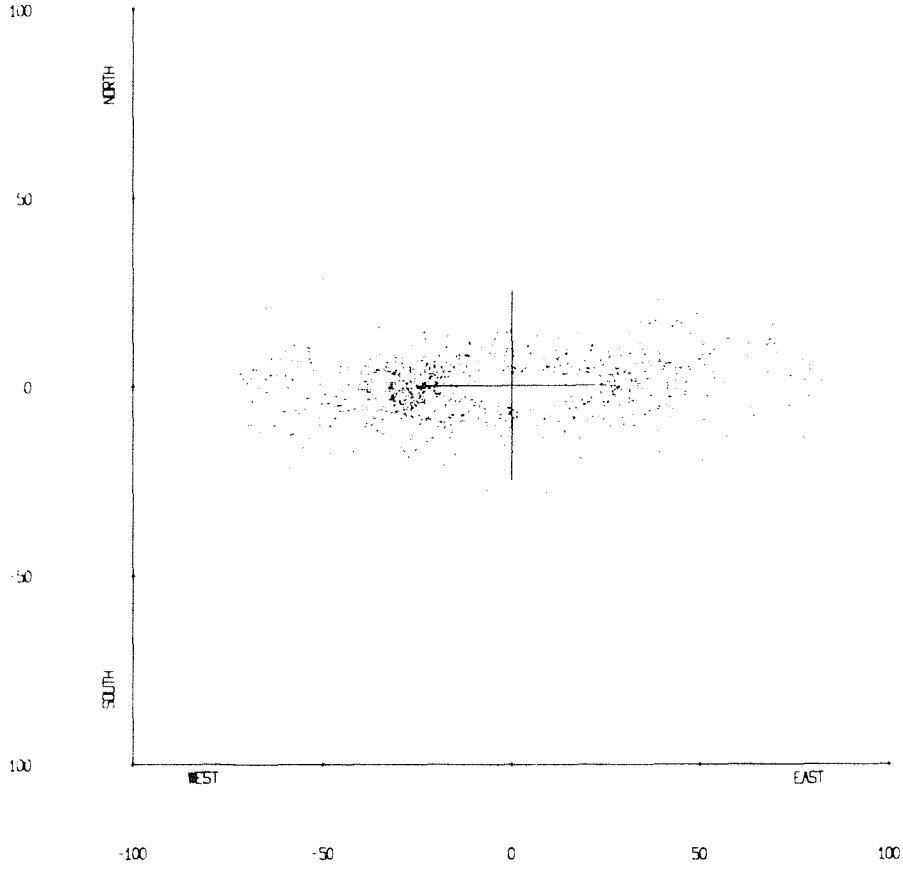
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION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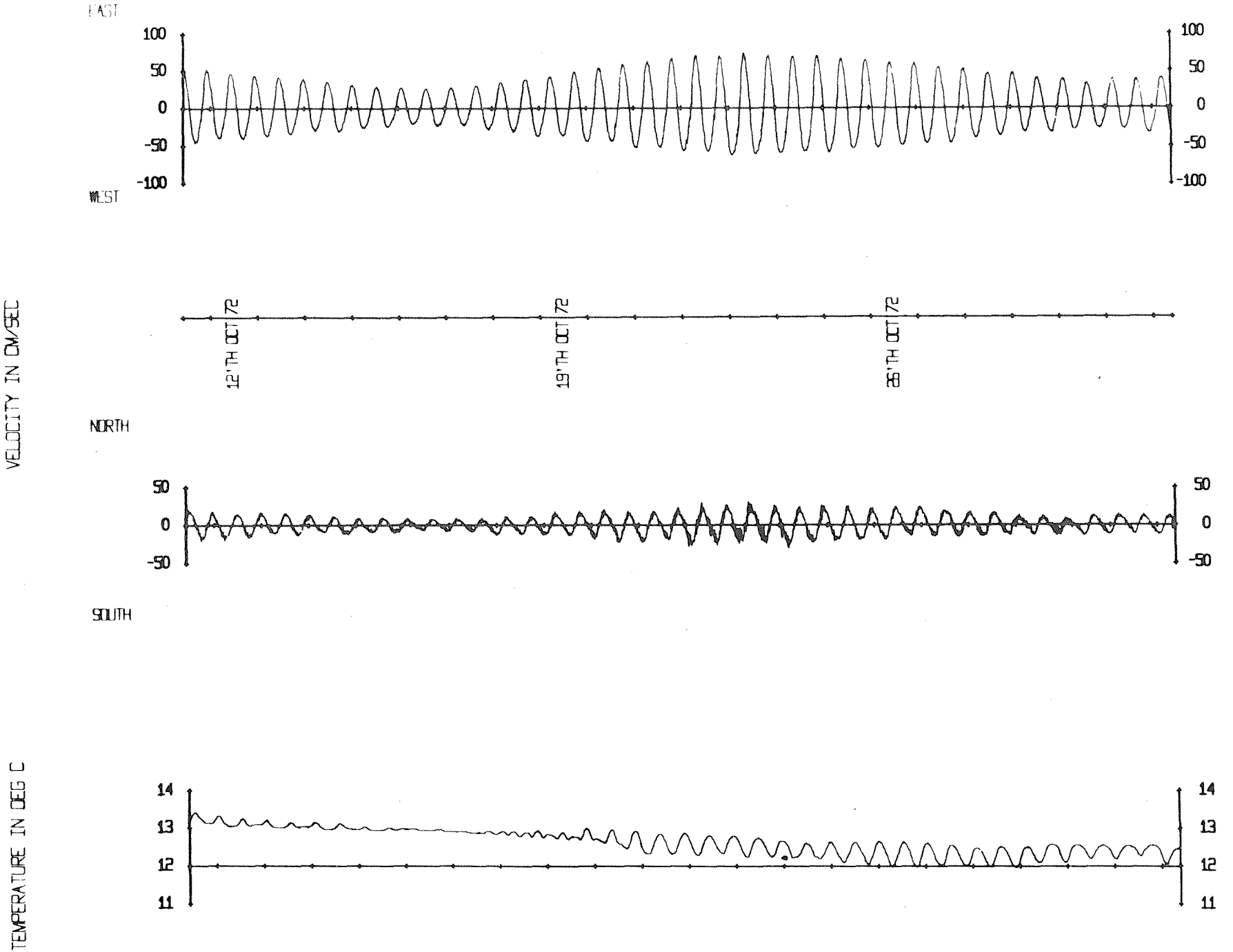
SOUTH
WEST
EAST
-100
-50
0
50
100

WEST
-20
-15
-10
-5
5
EAST
SOUTH
NORTH
24 OCT 72, 08:39
24 OCT 72, 08:49
24 OCT 72, 08:42

24 OCT 72, 08:52
24 OCT 72, 08:08
24 OCT 72, 08:11

Meter	:	Bergen 530
Tape number	:	530/2
Meter started	:	16.30.00 GMT 10 Oct 1972
Meter stopped	:	09.18.44 GMT 8 Nov 1972
Total number of readings	:	4134
Timing error	:	1 min 16 s fast
Start of useful record	:	10.00 GMT 11 Oct 1972
End of useful record	:	09.19 GMT 1 Nov 1972
Length of useful record	:	503 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock.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0
-50
-100
WEST
VELOCITY IN CM/SEC
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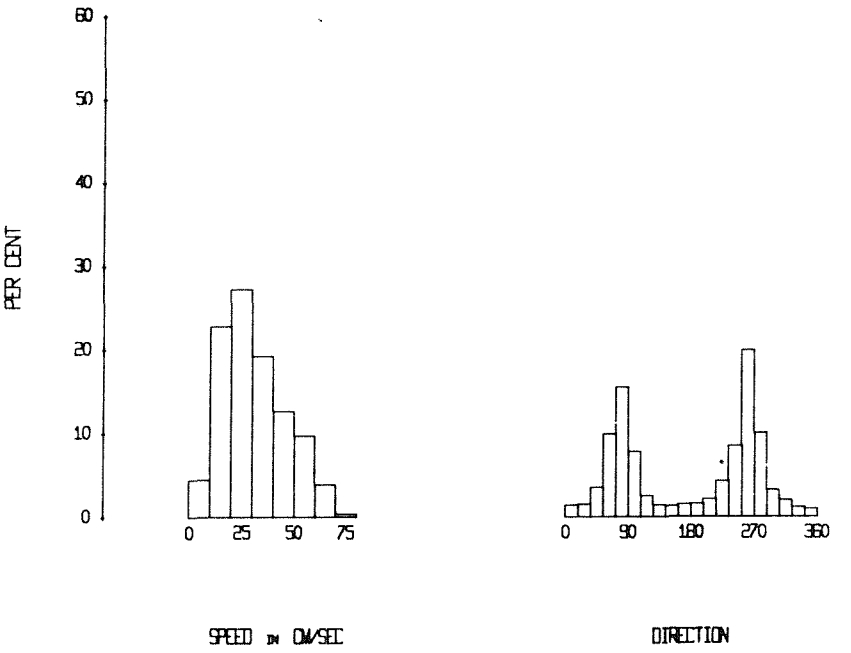
19'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
TEMPERATURE IN DEG C
14
13
12
11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75
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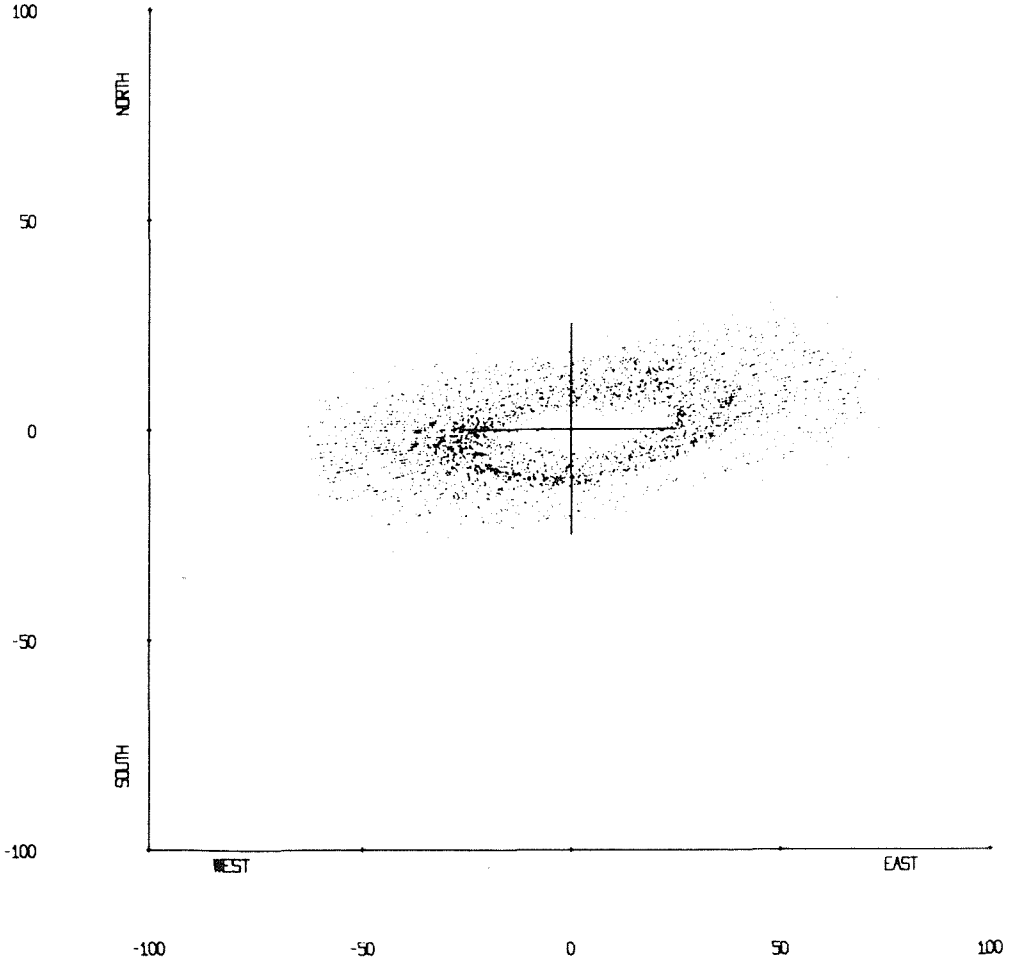
180
270
360
SPEED IN CM/SEC
DIRECTION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-100
NORTH
SOUTH
WEST
EAST
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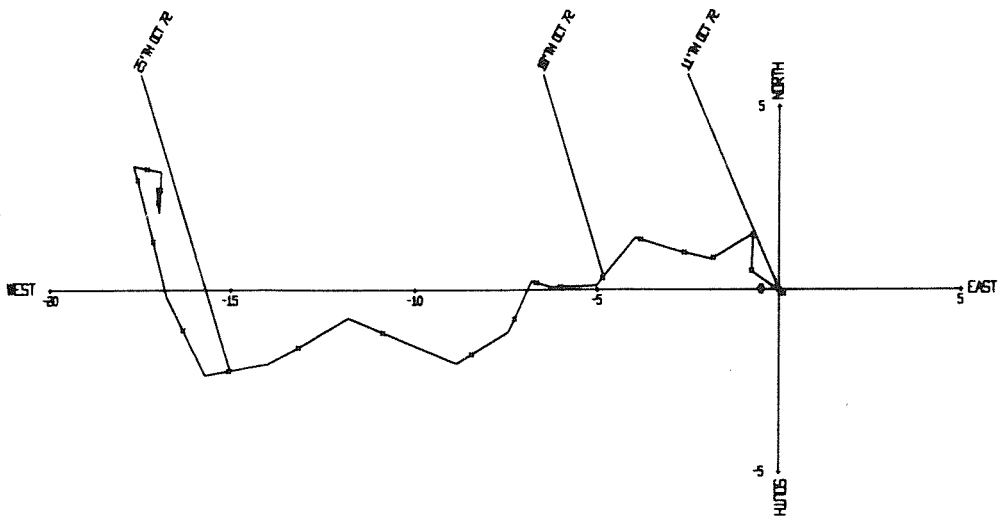
-50
0
50
100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30TH OCT 72
31TH OCT 72
NORTH
5
WEST
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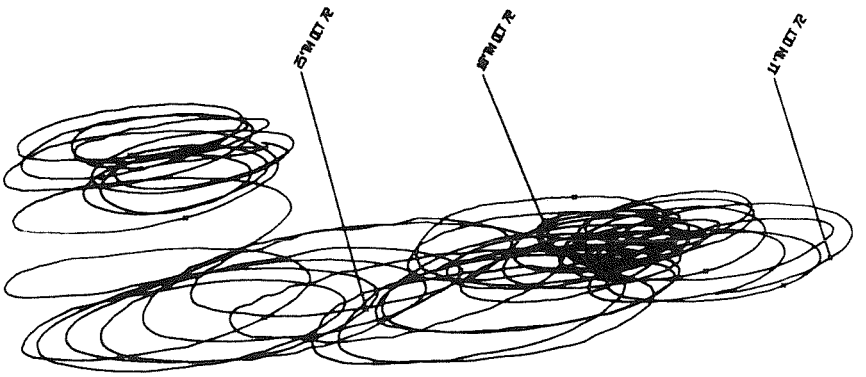
-10
-5
EAST
5
-5
SOUTH


25TH OCT 72
30TH OCT 72
31TH OCT 72

Mooring number : 27

Position of rig : Lat 54°00.8'N Long 3°44.4'N (rig C)

Depth of water : 33 m below chart datum

Tidal heights, in metres above chart datum, at Liverpool : MHWS 8.8 MHWN 6.9 MLWN 2.4 MLWS 0.5

Meter	Type	Height above sea floor (m)	Recording interval (min)
417	Bergen	25	10
432	Bergen	15	10
212	Bergen	5	10

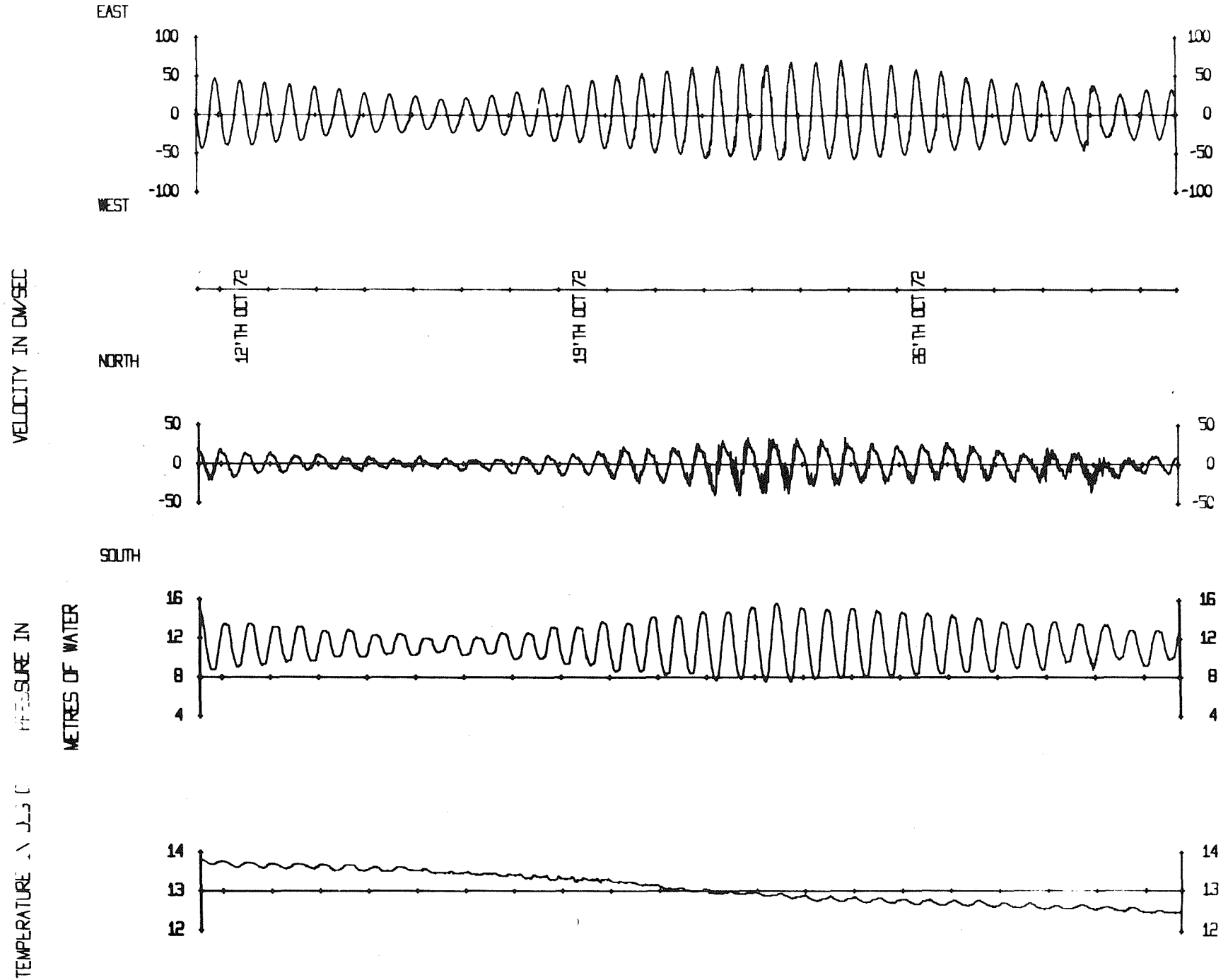
Rig set : 12.45 GMT 11 Oct 1972 from r.r.s. John Murray

Rig recovered : 17.52 GMT 31 Oct 1972 from r.v. Edward Forbes

Mooring : Standard with a solid Slingsby sub-surface buoy

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

Meter	:	Bergen 417
Tape number	:	417/4
Meter started	:	08.49.21 GMT 11 Oct 1972
Meter stopped	:	16.28.46 GMT 7 Nov 1972
Total number of readings	:	3935
Timing error	:	35 s fast
Start of useful record	:	13.00 GMT 11 Oct 1972
End of useful record	:	17.39 GMT 31 Oct 1972
Length of useful record	:	484 h
Comments	:	Good record. The meter was fitted with a pressure transducer and quartz-crystal clock. Its spindle was designed and made at Bidston.


EAST
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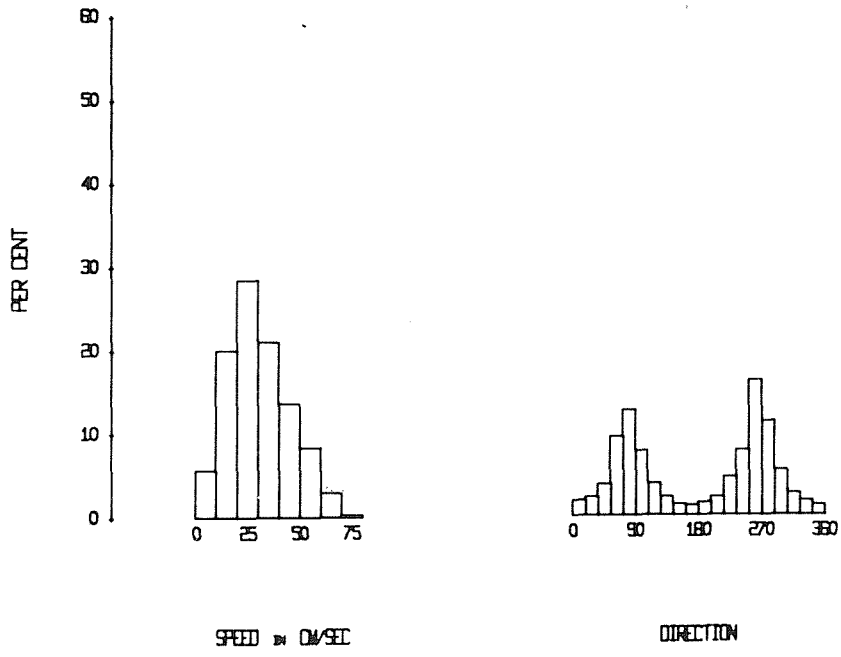
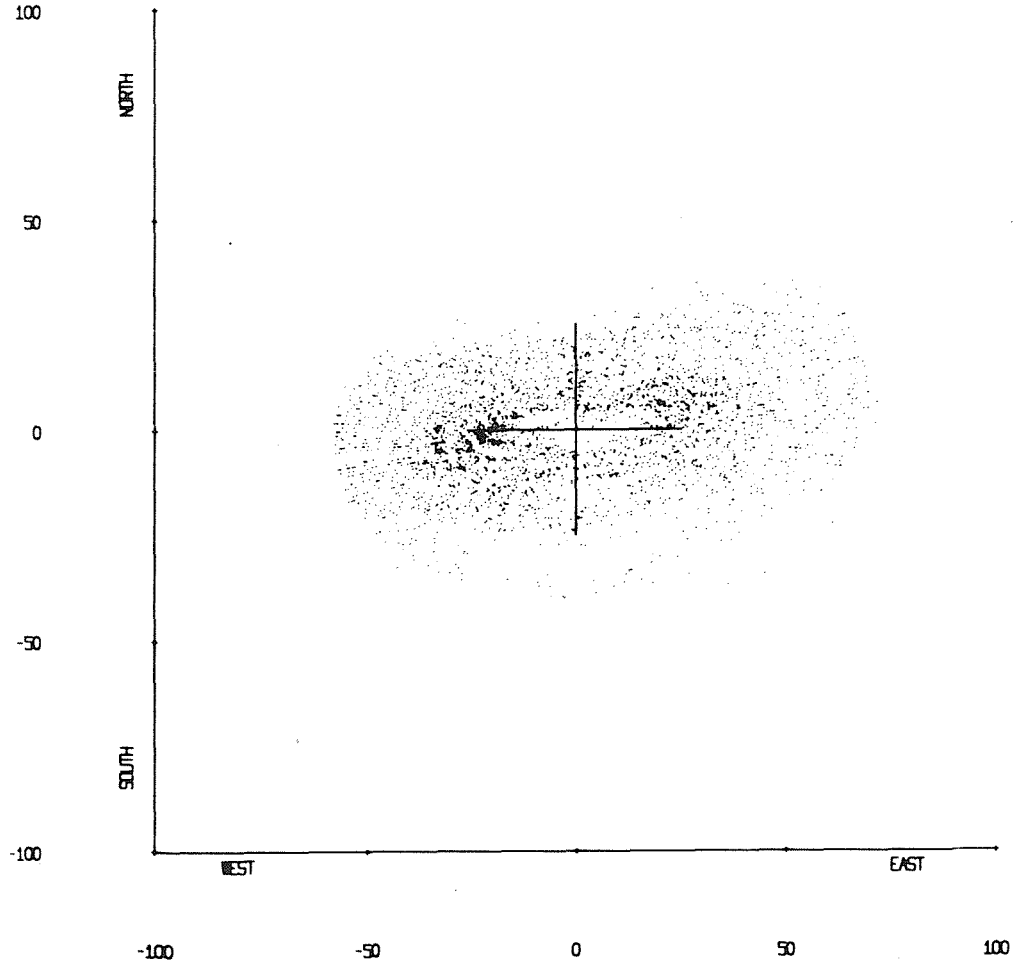
50
0
-50
-100
WEST
VELOCITY IN CM/SEC
12'TH OCT 72
19'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
METRES OF WATER
16
12
8
4
14
13
12

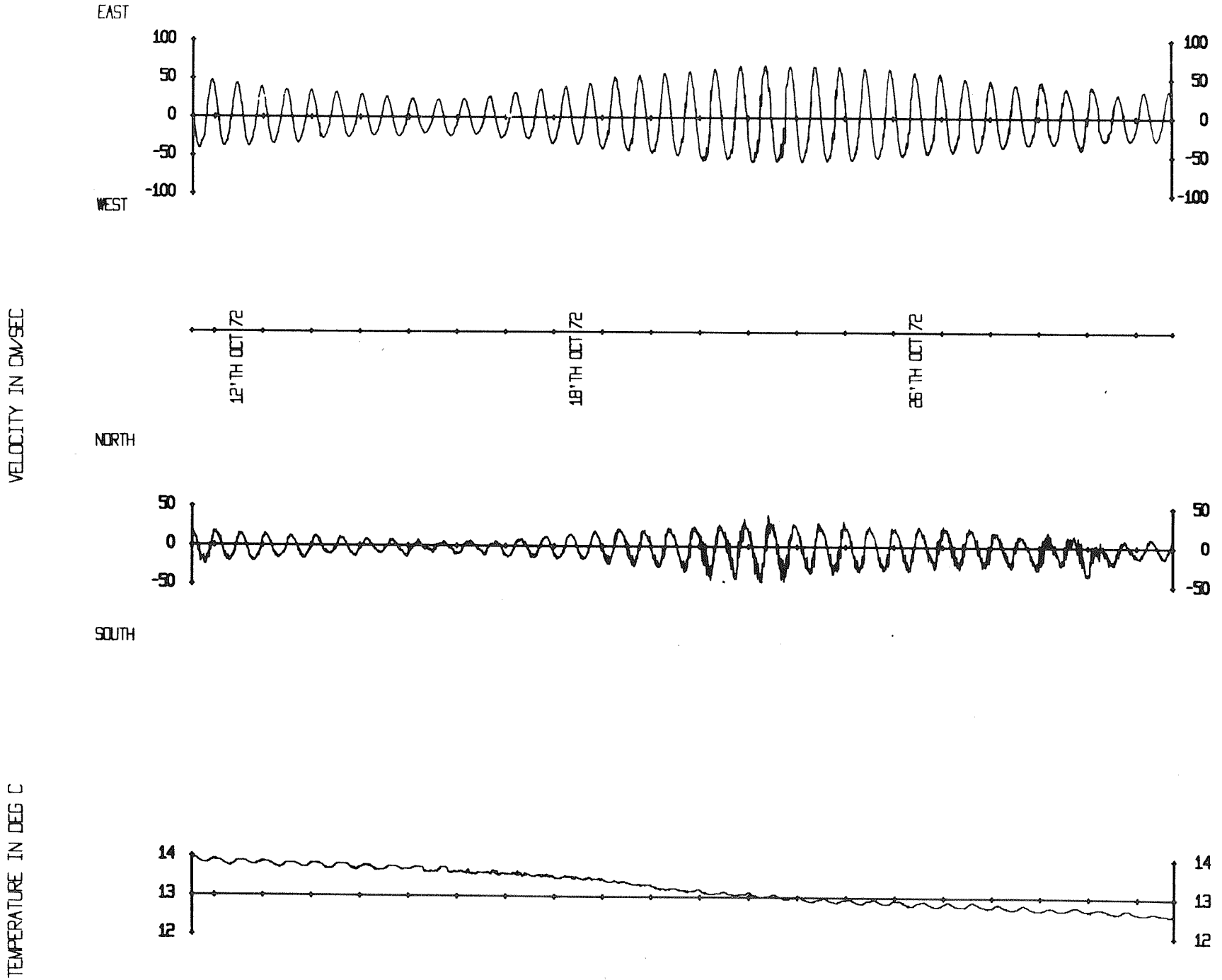

PER CENT
60
50
40
30
20
10
0
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

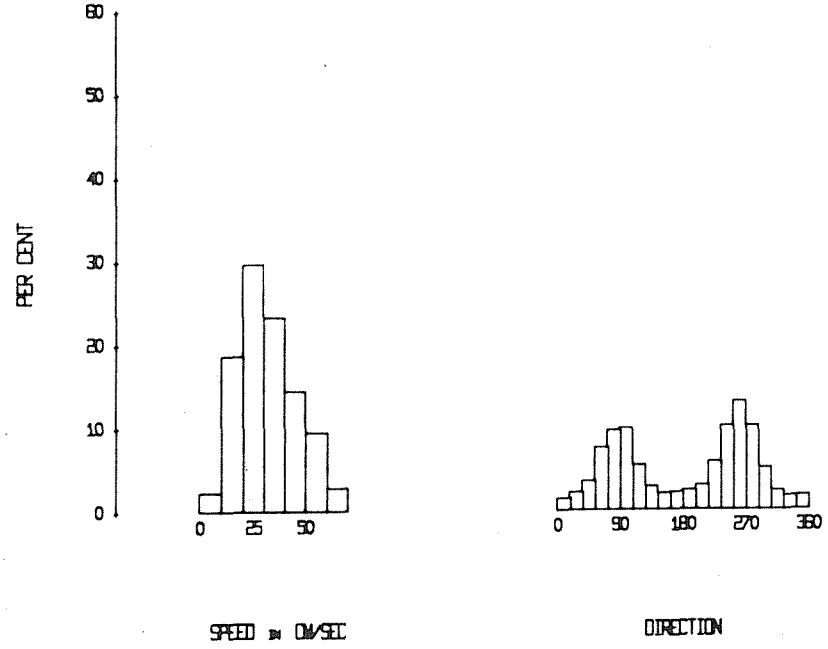

100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

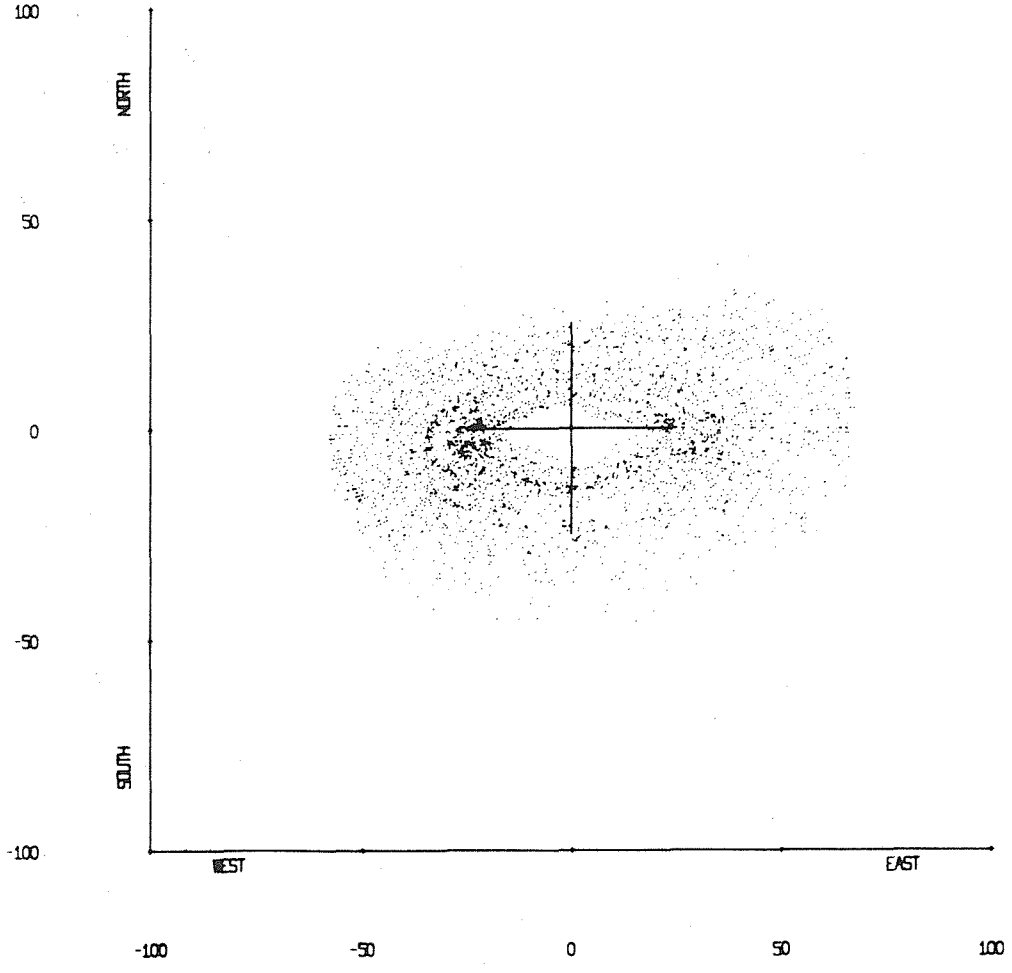
WEST
EAST
SOUTH
NORTH
25 OCT 72
25 OCT 72
25 OCT 72

25 OCT 72
25 OCT 72
25 OCT 72

Meter	:	Bergen 532
Tape number	:	532/2
Meter started	:	18.47.43 GMT 10 Oct 1972
Meter stopped	:	10.59.10 GMT 8 Nov 1972
Total number of readings	:	4130
Timing error	:	1 min 27 s slow
Start of useful record	:	12.58 GMT 11 Oct 1972
End of useful record	:	17.39 GMT 31 Oct 1972
Length of useful record	:	484 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock.

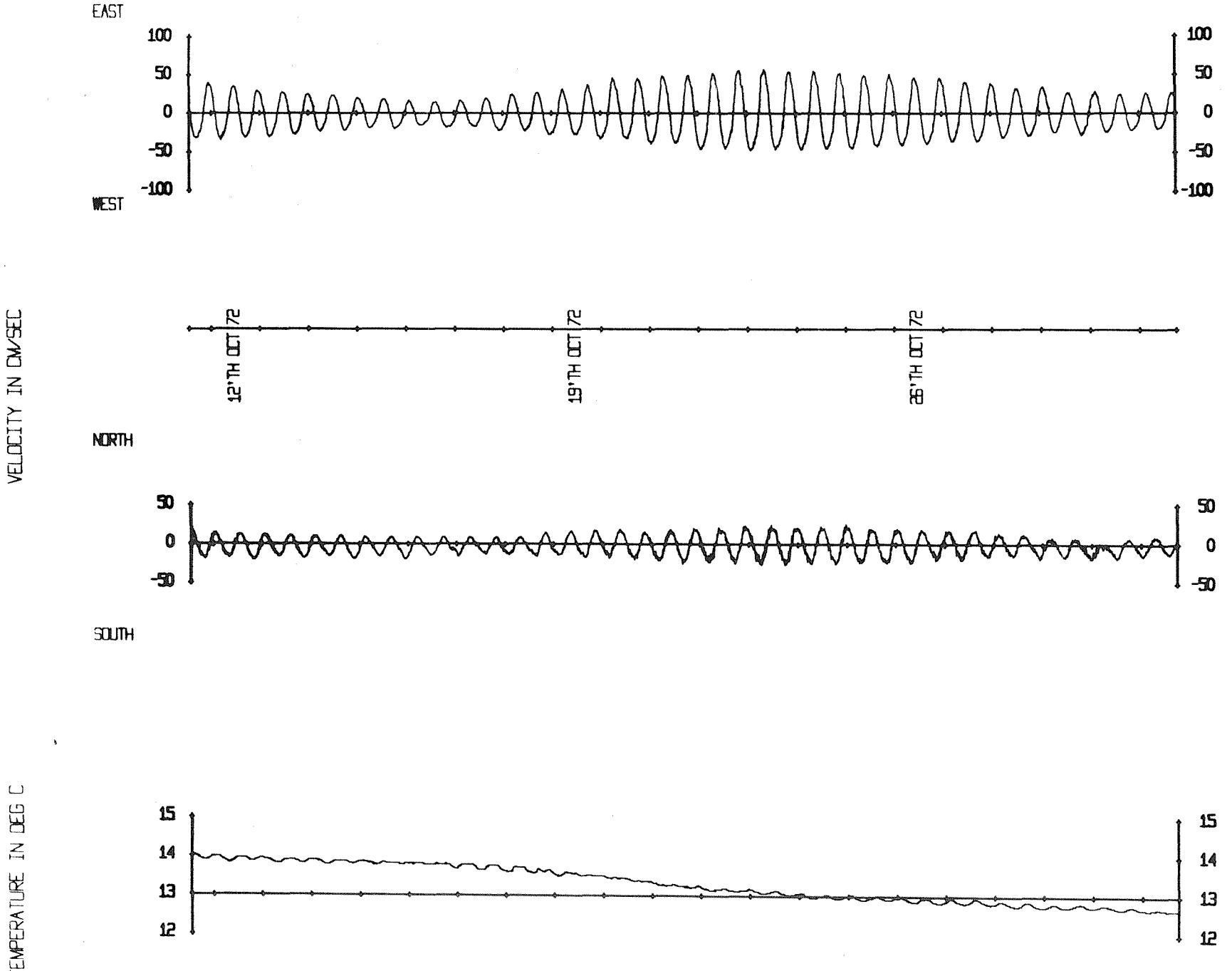

EAST
100
50
0
-50
-100
WEST
VELOCITY IN CM/SEC
12'TH OCT 72
18'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
TEMPERATURE IN DEG C
14
13
12

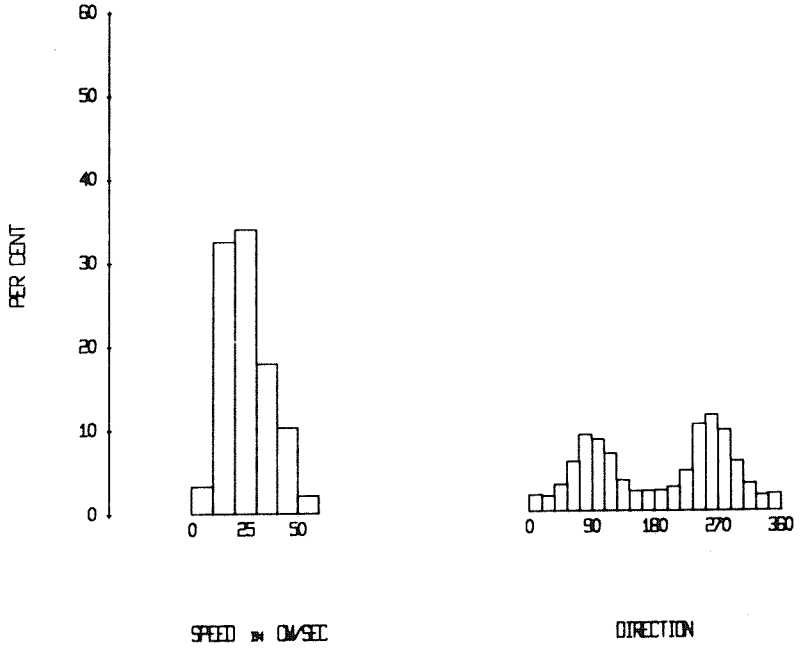

PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

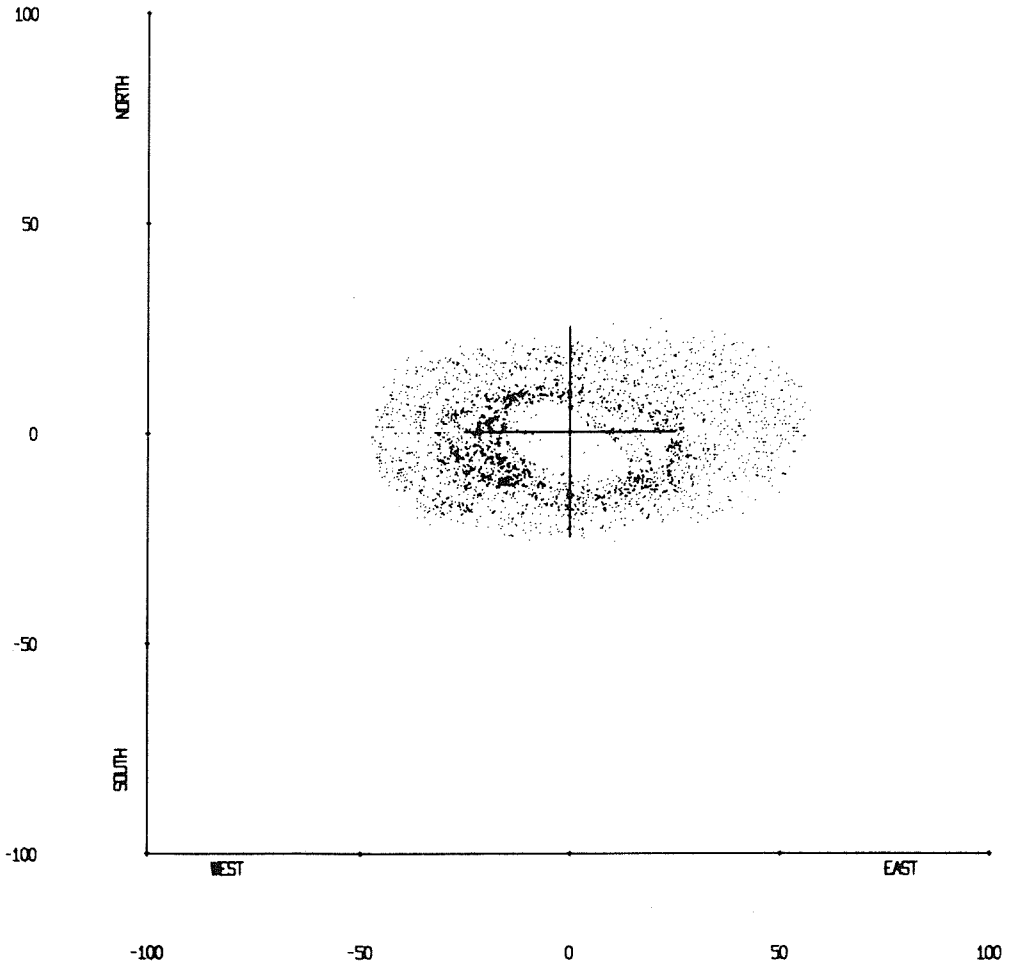

100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

SOUTH
NORTH
EAST
WEST

Meter	:	Bergen 212
Tape number	:	212/7
Meter started	:	10.46.11 GMT 11 Oct 1972
Meter stopped	:	12.57.39 GMT 7 Nov 1972
Total number of readings	:	3902
Timing error	:	1 min 28 s slow
Start of useful record	:	12.56 GMT 11 Oct 1972
End of useful record	:	17.38 GMT 31 Oct 1972
Length of useful record	:	484 h
Comments	:	Good record


EAST
100
50
0
-50
-100
WEST
VELOCITY IN CM/SEC
12'TH OCT 72
19'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
TEMPERATURE IN DEG C
15
14
13
12


60
50
40
30
20
10
0
PER CENT
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

42'N 107 7E
39'N 107 7E
38'N 107 7E

EAST
WEST
NORTH
SOUTH
42'N 107 7E
39'N 107 7E
38'N 107 7E

Mooring number : 28

Position of rig : Lat 54°06.8'N Long 3°33.4'W (rig D)

Depth of water : 22 m below chart datum

Tidal heights, in metres above chart datum, at Liverpool : MHWS 8.8 MHWN 6.9 MLWN 2.4 MLWS 0.5

Meter	Type	Height above sea floor (metres)	Recording interval (min)
533	Bergen	13	10
415	Bergen	5	10

Rig set : 14.17 GMT 11 Oct 1972 from r.r.s. John Murray

Rig recovered : 20.00 GMT 31 Oct 1972 from r.v. Edward Forbes

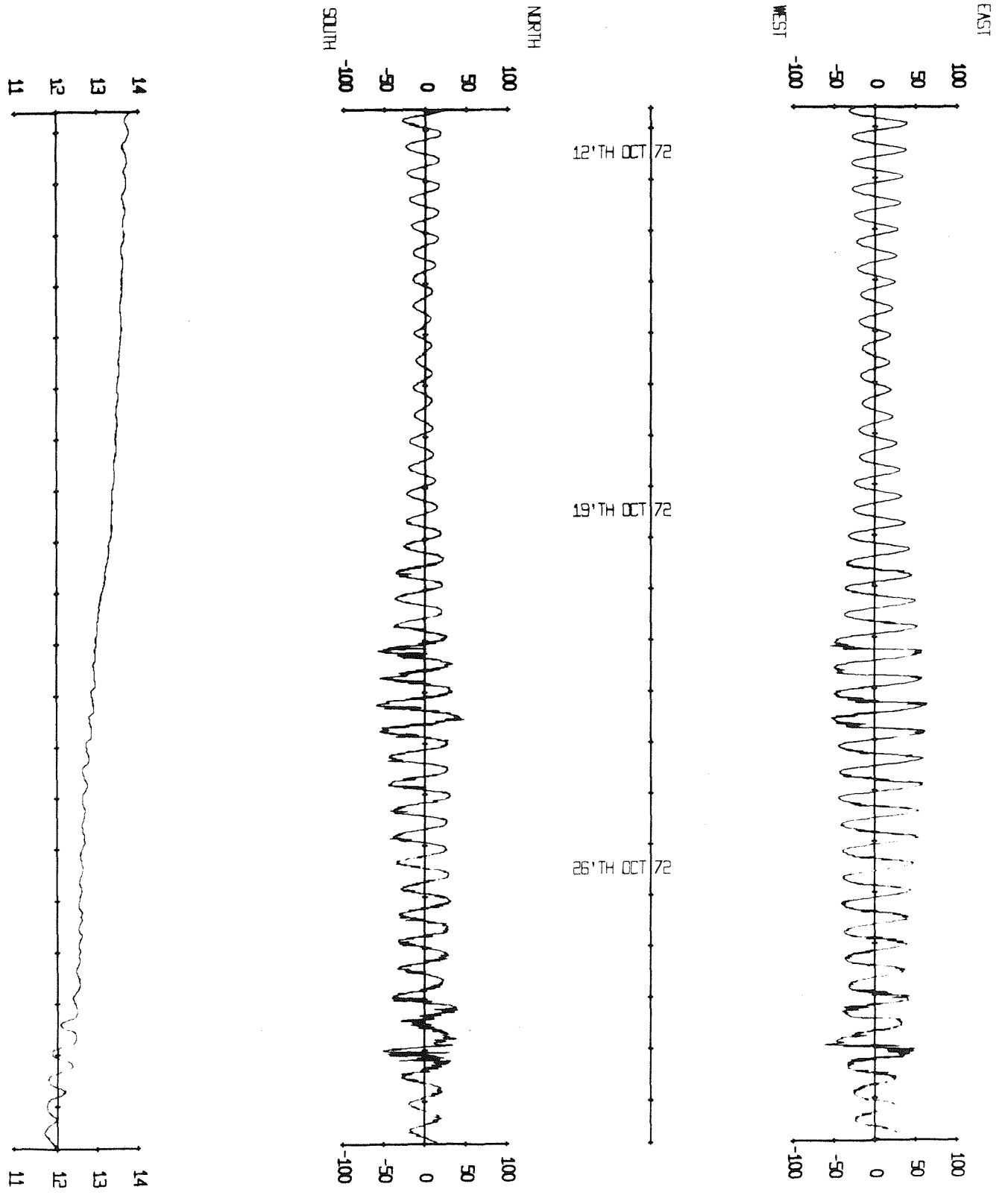
Mooring : Standard with Cosalt sub-surface buoy.

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

Meter	:	Bergen 533
Tape number	:	533/2
Meter started	:	19.40.36 GMT 10 Oct 1972
Meter stopped	:	16.01.10 GMT 8 Nov 1972
Total number of readings	:	4155
Timing error	:	34 s slow
Start of useful record	:	14.31 GMT 11 Oct 1972
End of useful record	:	19.51 GMT 31 Oct 1972
Length of useful record	:	485 h
Comments	:	Good record. Some marine growth was noticed on the meter when it was recovered. The meter was fitted with a quartz-crystal clock.

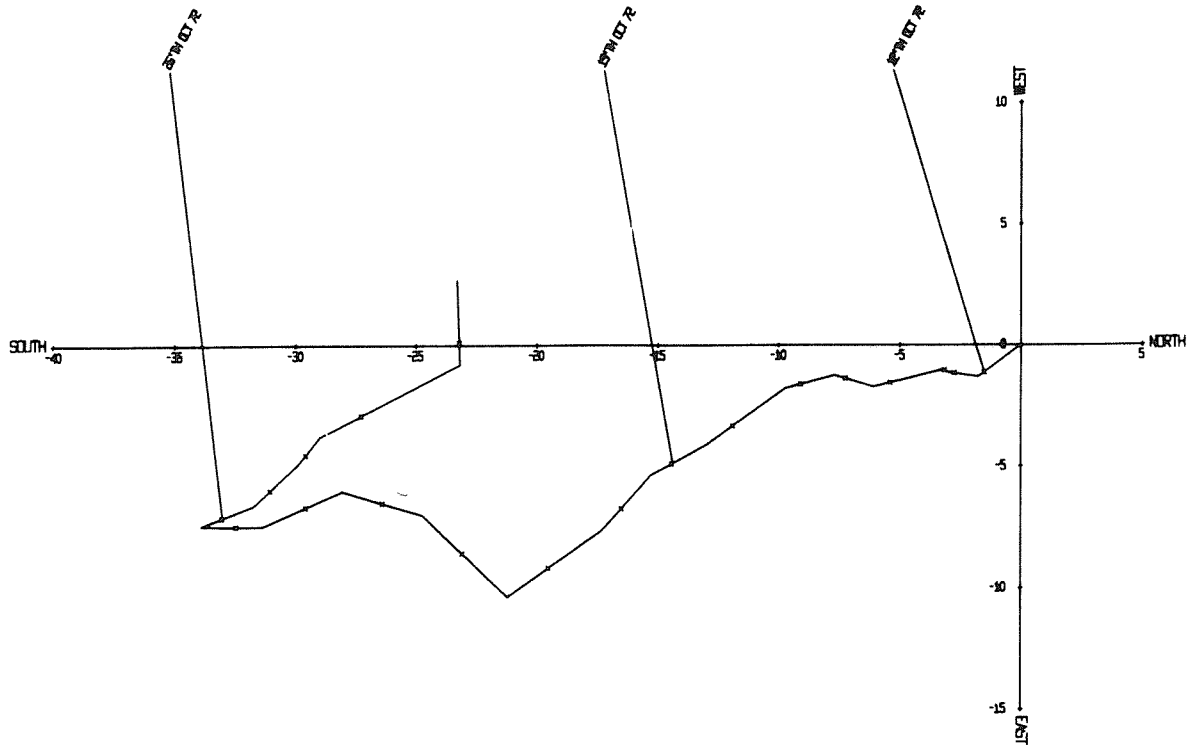
TEMPERATURE IN DEG C

VELOCITY IN CM/SEC



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

PER CENT
0
10
20
30
40
50
60
SPEED IN KNOTS
0
15
30
45
60
DIRECTION
0
60
120
180
240
300
360


SOUTH
NORTH
WEST
EAST
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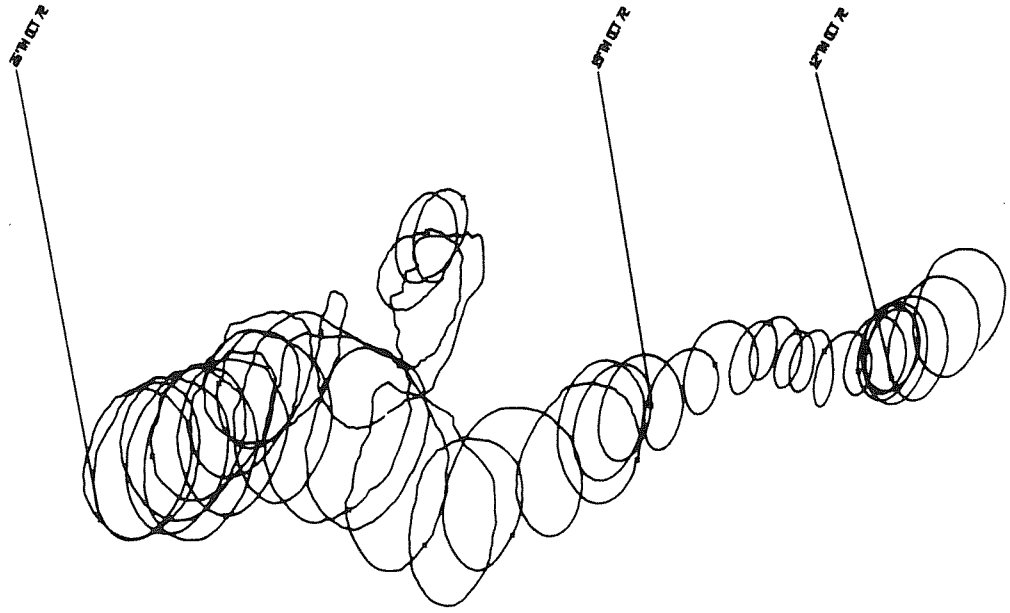
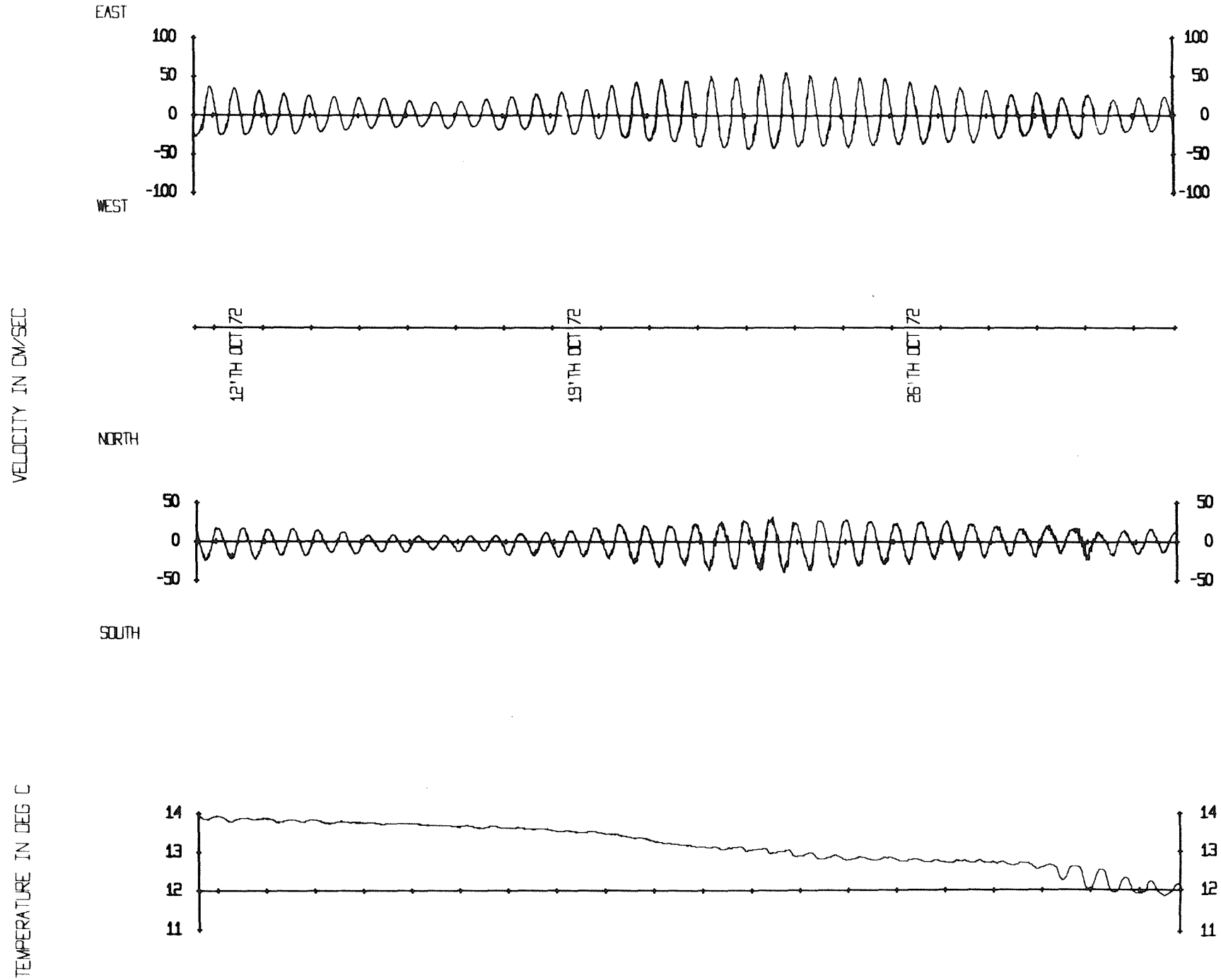
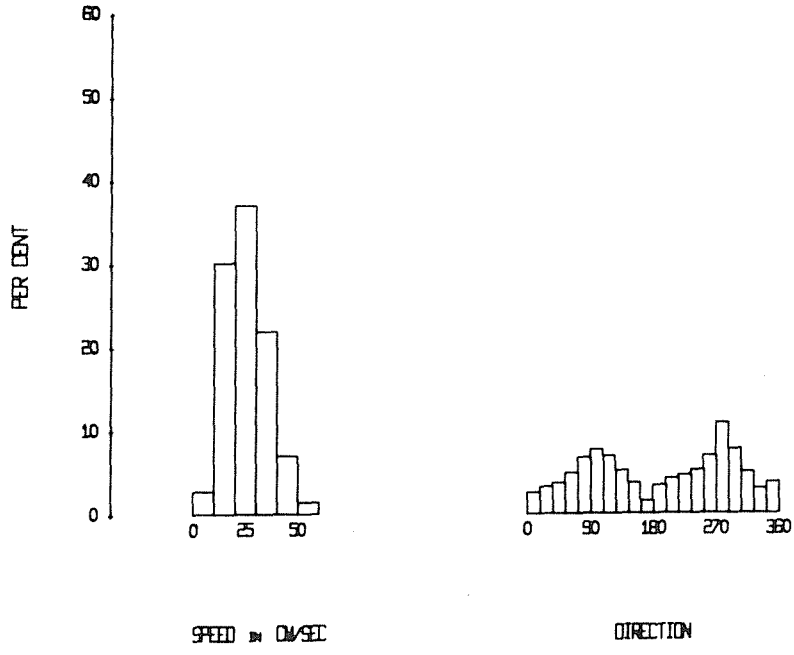
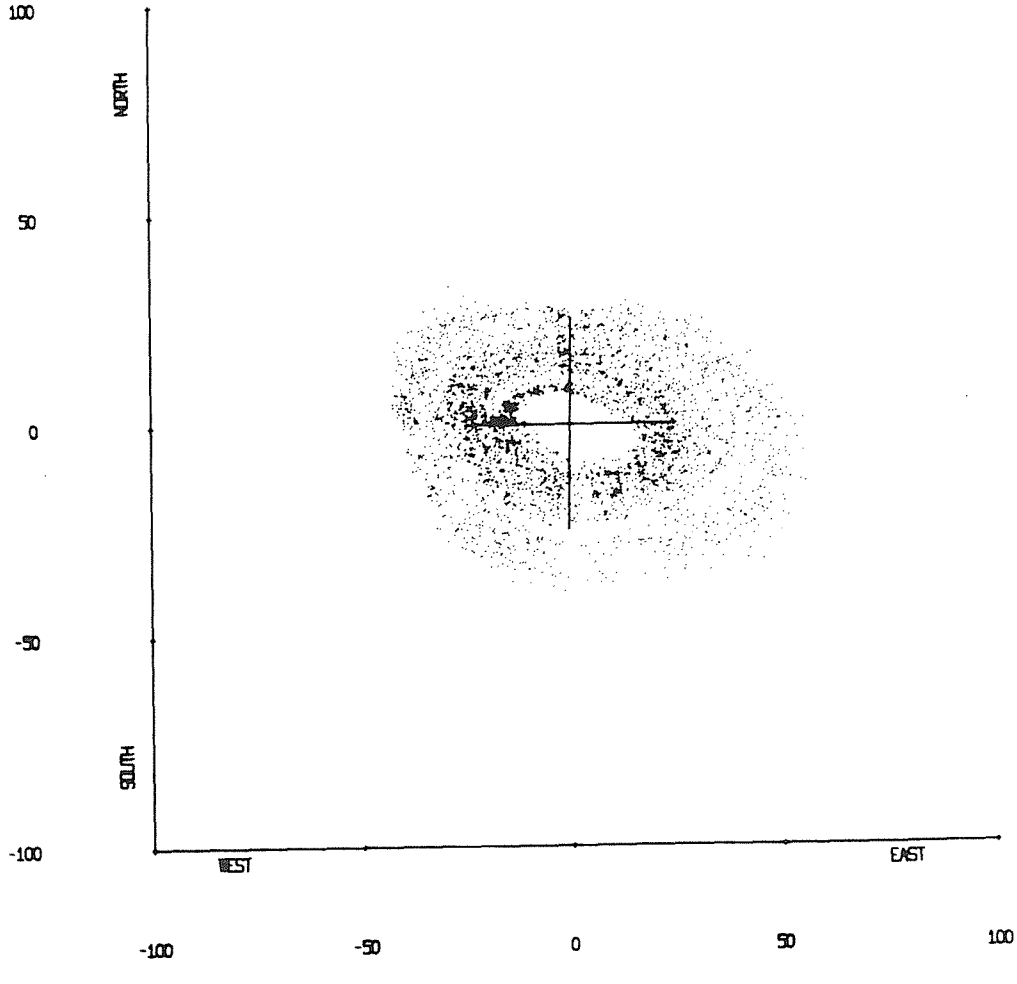
-35
-30
-25
-20
-15
-10
-5
0
5
10
-5
-10
-15



Meter	:	Bergen 415
Tape number	:	415/4
Meter started	:	13.35.28 GMT 11 Oct 1972
Meter stopped	:	15.17.34 GMT 7 Nov 1972
Total number of readings	:	3900
Timing error	:	7 min 54 s fast
Start of useful record	:	14.26 GMT 11 Oct 1972
End of useful record	:	19.50 GMT 31 Oct 1972
Length of useful record	:	485 h
Comments	:	Good record. Some marine growth was noticed on the meter when it was recovered.


EAST
100
50
0
-50
-100
WEST
VELOCITY IN CM/SEC
12'TH OCT 72
19'TH OCT 72
26'TH OCT 72
NORTH
50
0
-50
SOUTH
TEMPERATURE IN DEG C
14
13
12
11


60
50
40
30
20
10
0
PER CENT
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

25TH OCT 72
25TH OCT 72
25TH OCT 72
WEST
10
5
SOUTH
-25
-20
-15
-10
-5
0
NORTH
5
-5
-10
EAST

25TH OCT 72
25TH OCT 72
25TH OCT 72

Mooring number : 29

Position of rig : Lat 52°04.1'N Long 5°47.0'W (rig J)

Depth of water : 91 m below chart datum

Tidal heights, in metres above chart datum, at Fishguard	MHWS	MHWN	MLWN	MLWS
	4.7	3.4	1.9	0.8

Meter	Type	Height above sea floor (metres)	Recording interval (min)
563	Bergen	71	10
564	Bergen	56	10
565	Bergen	15	10

Rig set : 12.43 GMT 1 Feb 1973
from r.v. Researcher

Rig recovered : 10.22 GMT 5 Mar 1973
from r.v. Researcher

Mooring : Standard with solid Slingsby sub-surface buoy.

Comments : The launch and recovery were successfully accomplished at the first attempt with some difficulty - both taking over 2 hours. During the recovery the bottom meter was trapped between the side of the ship and the meter anchor.

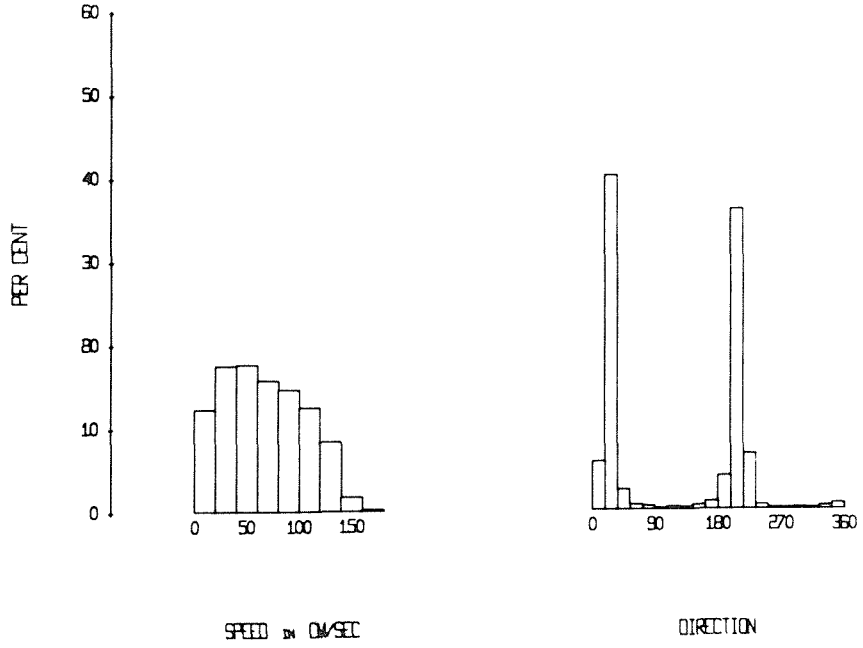
Meter	:	Bergen 563
Tape number	:	563/1
Meter started	:	10.40.00 GMT 31 Jan 1973
Meter stopped	:	17.10.38 GMT 9 Mar 1973
Total number of readings	:	5368
Timing error	:	38 s slow
Start of useful record	:	13.00 GMT 1 Feb 1973
End of useful record	:	10.10 GMT 5 Mar 1973
Length of useful record	:	765 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock and its spindle had nylon gimbals.

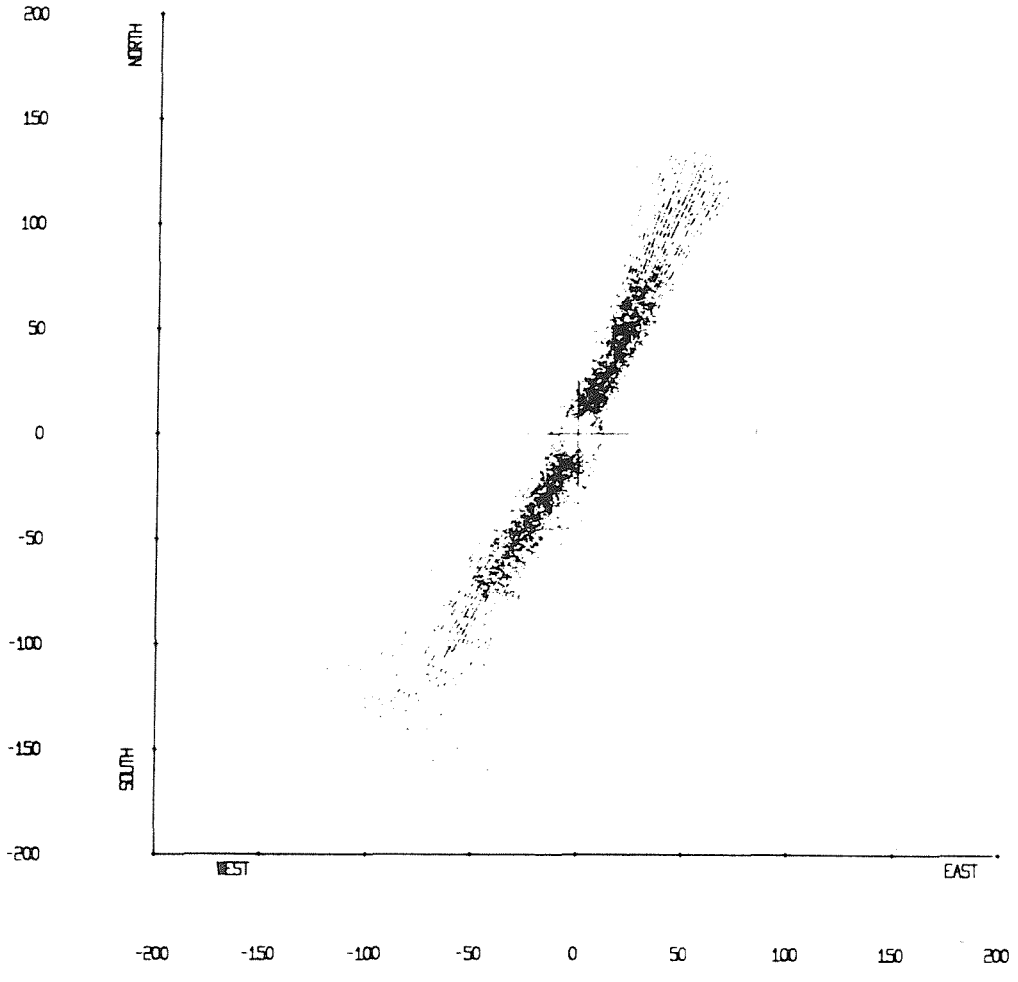
TEMPERATURE IN DEG C

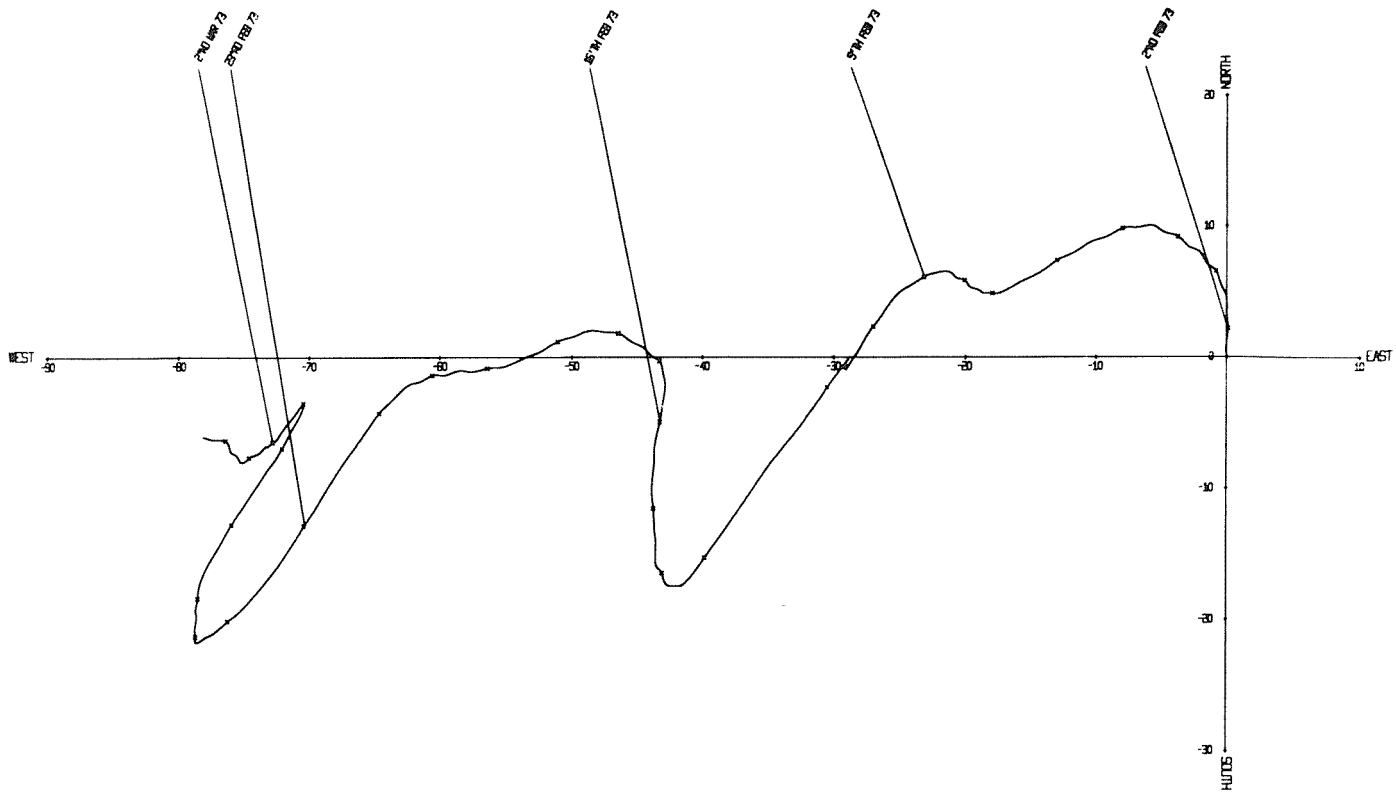
VELOCITY IN CM/SEC

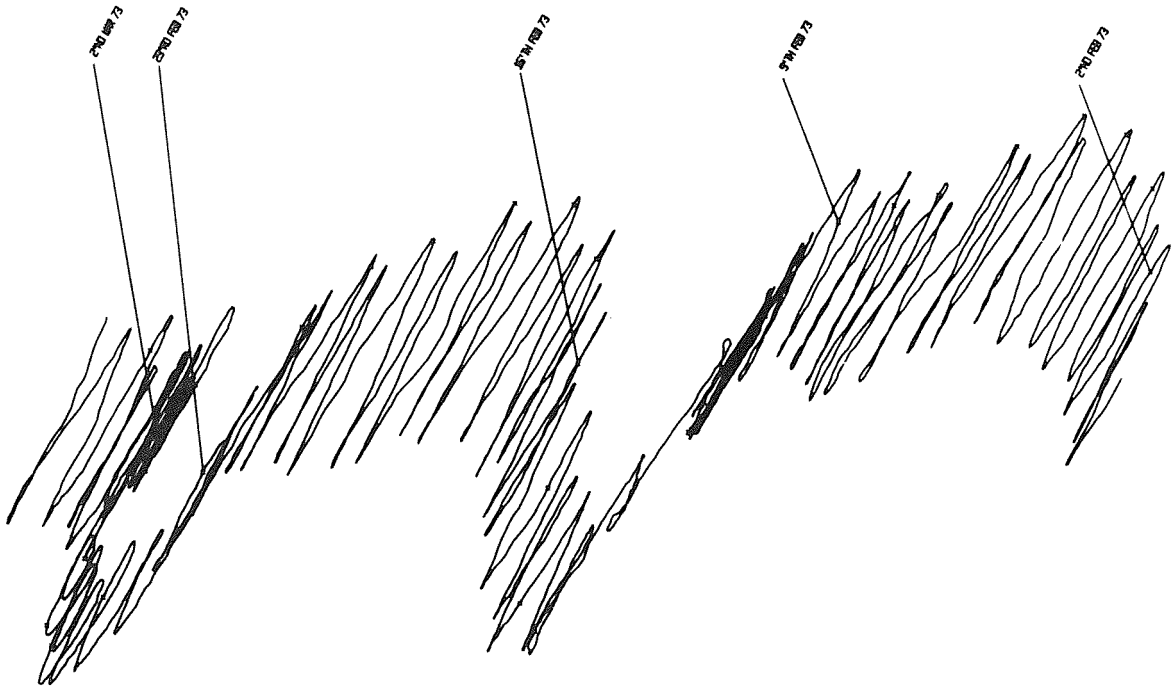
TEMPERATURE IN DEG C

VELOCITY IN CM/SEC

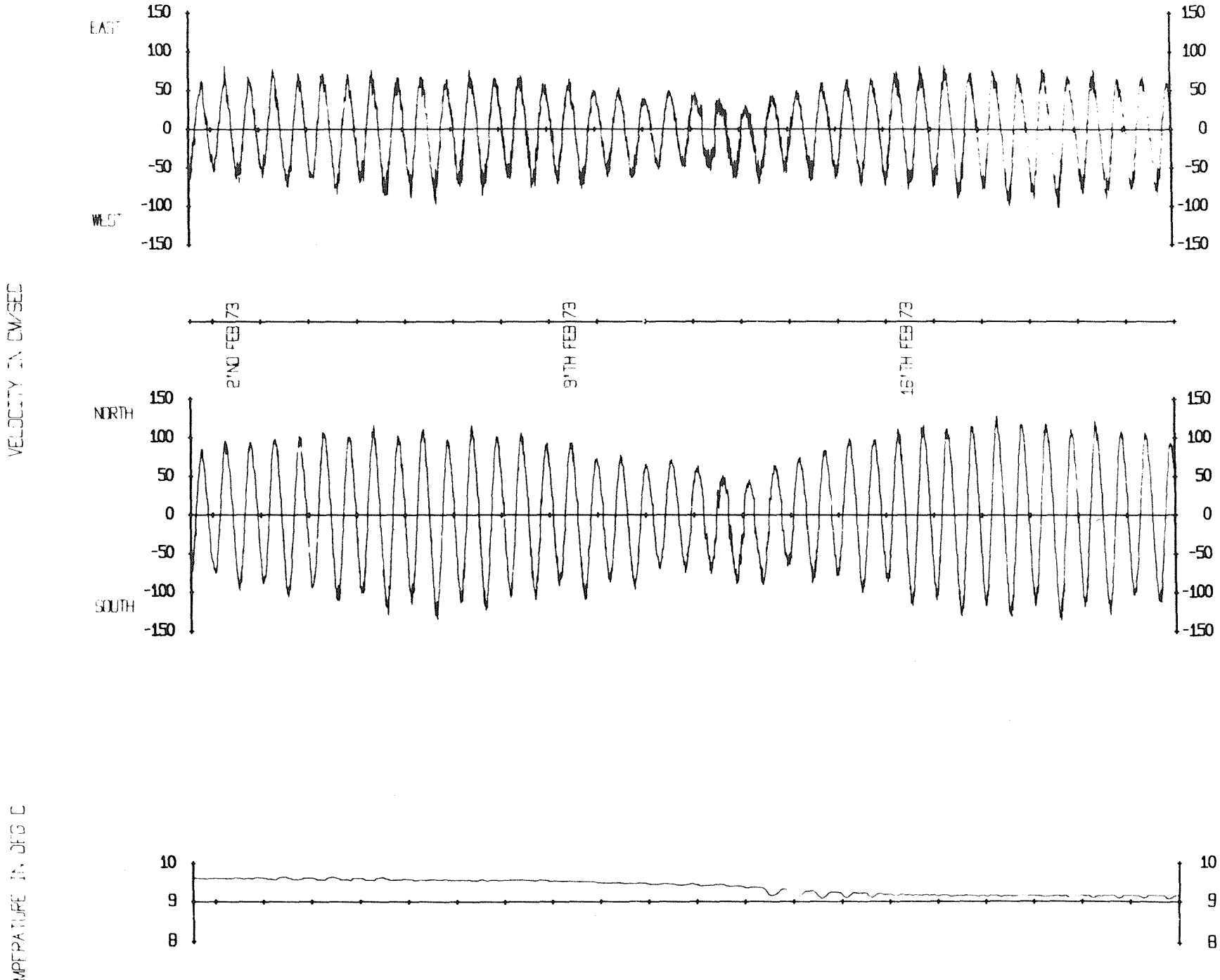

PER CENT
60
50
40
30
20
10
0
0
50
100
150
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION

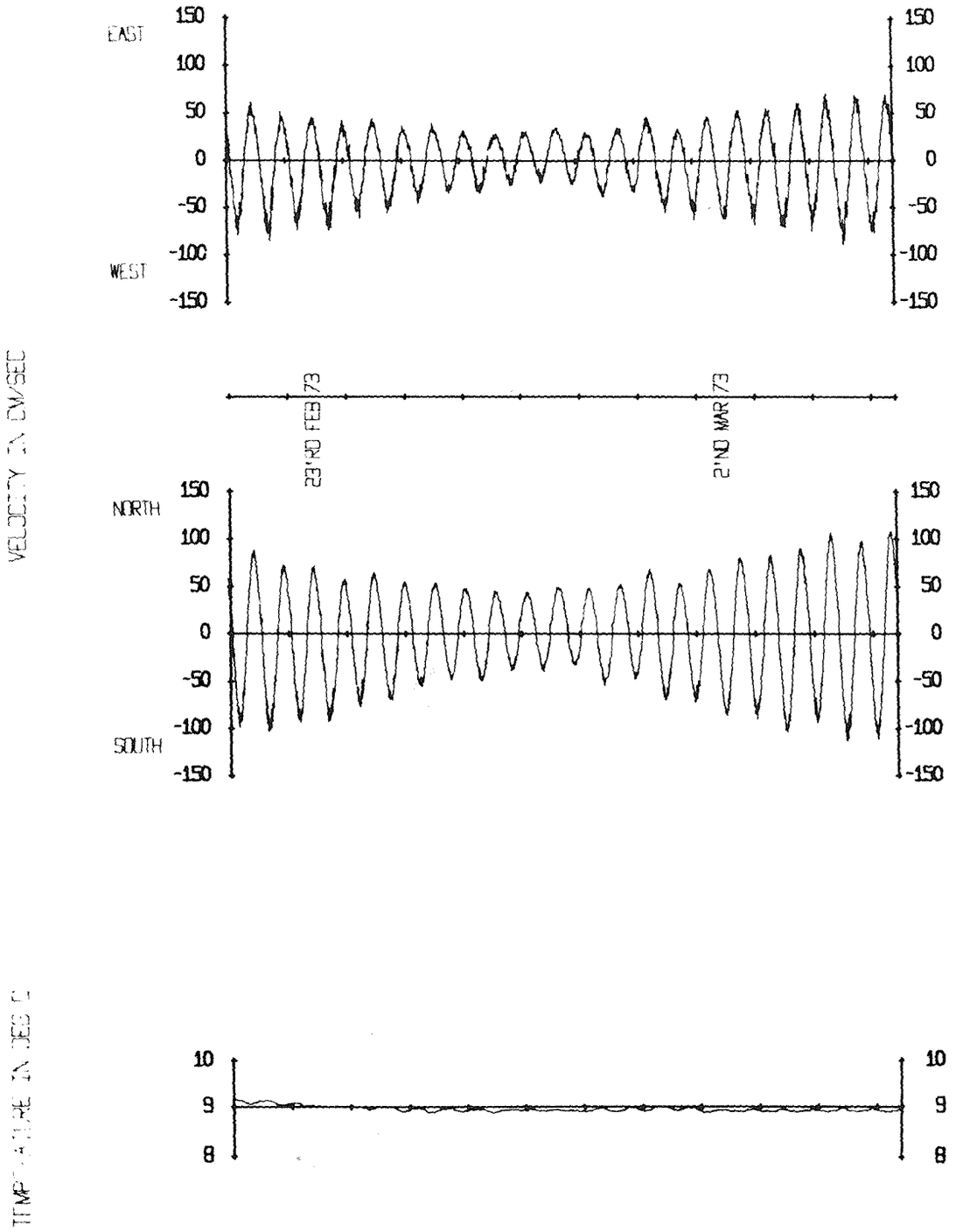

NORTH
SOUTH
WEST
EAST
200
150
100
50
0
-50
-100
-150
-200
-200
-150
-100
-50
0
50
100
150
200

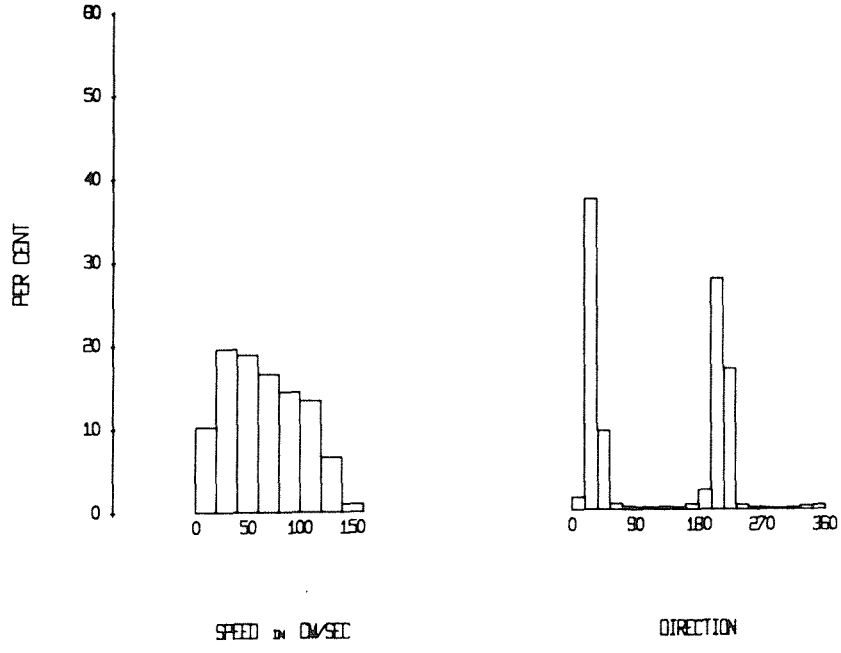

2140 MAR 73
2340 FEB 73
1545 FEB 73
0744 FEB 73
2140 FEB 73
WEST
EAST
NORTH
SOUTH
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
-30
-20
-10

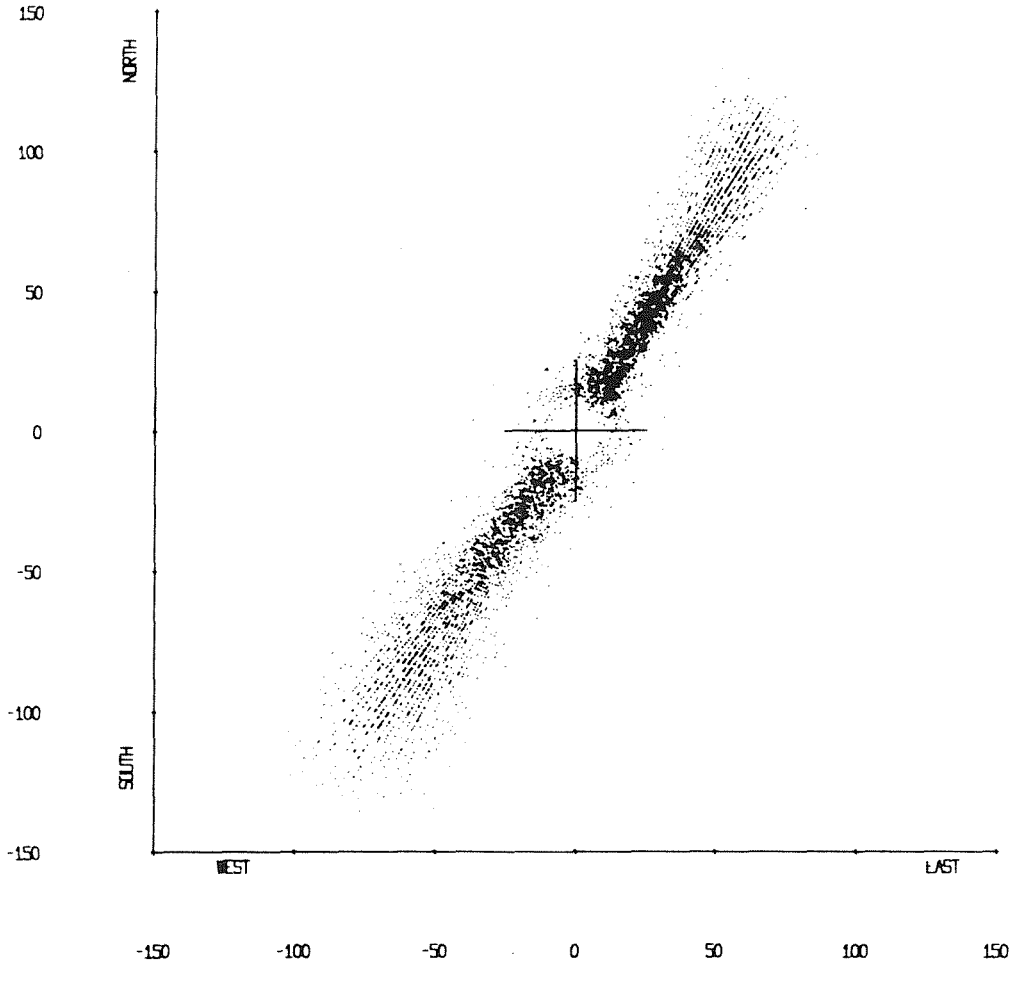

2140 MAR 73
2340 FEB 73
1545 FEB 73
0744 FEB 73
2140 FEB 73

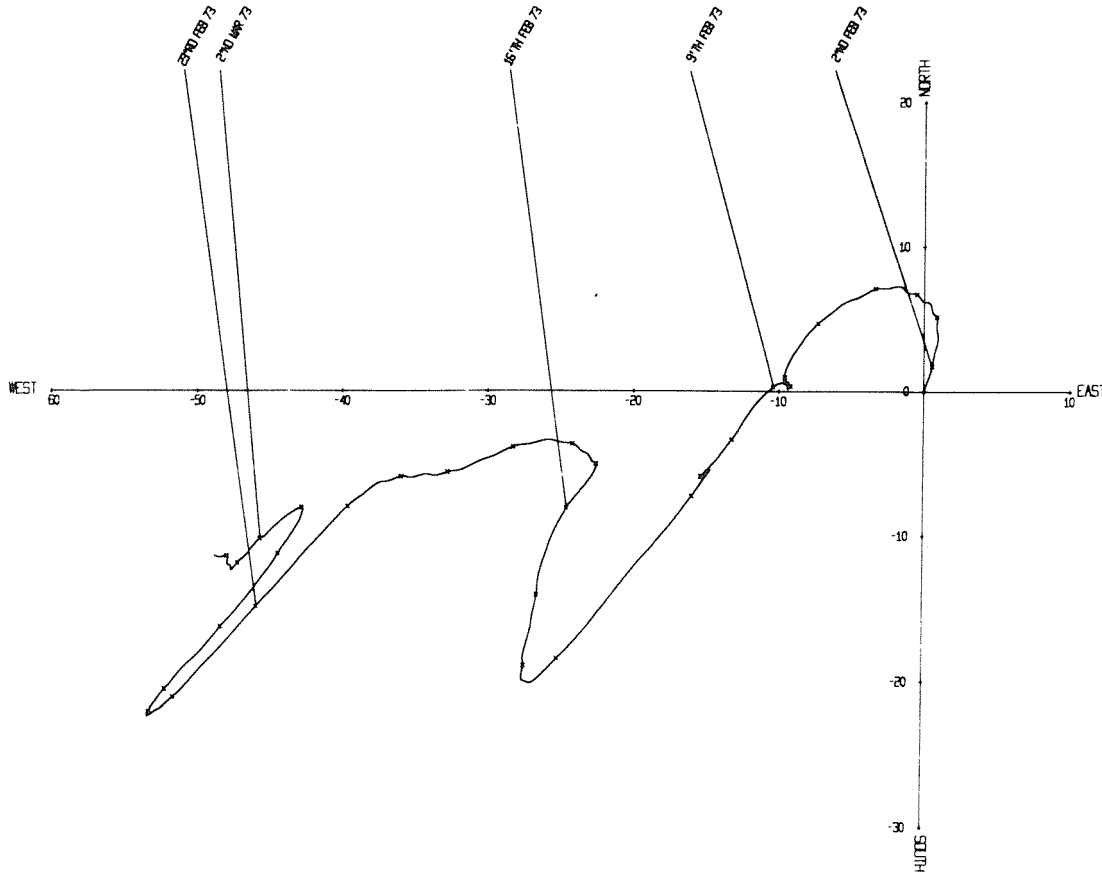
Meter	:	Bergen 564
Tape number	:	564/1
Meter started	:	14.40.00 GMT 30 Jan 1973
Meter stopped	:	17.20.18 GMT 9 Mar 1973
Total number of readings	:	5489
Timing error	:	18 s slow
Start of useful record	:	13.00 GMT 1 Feb 1973
End of useful record	:	10.10 GMT 5 Mar 1973
Length of useful record	:	765 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock.

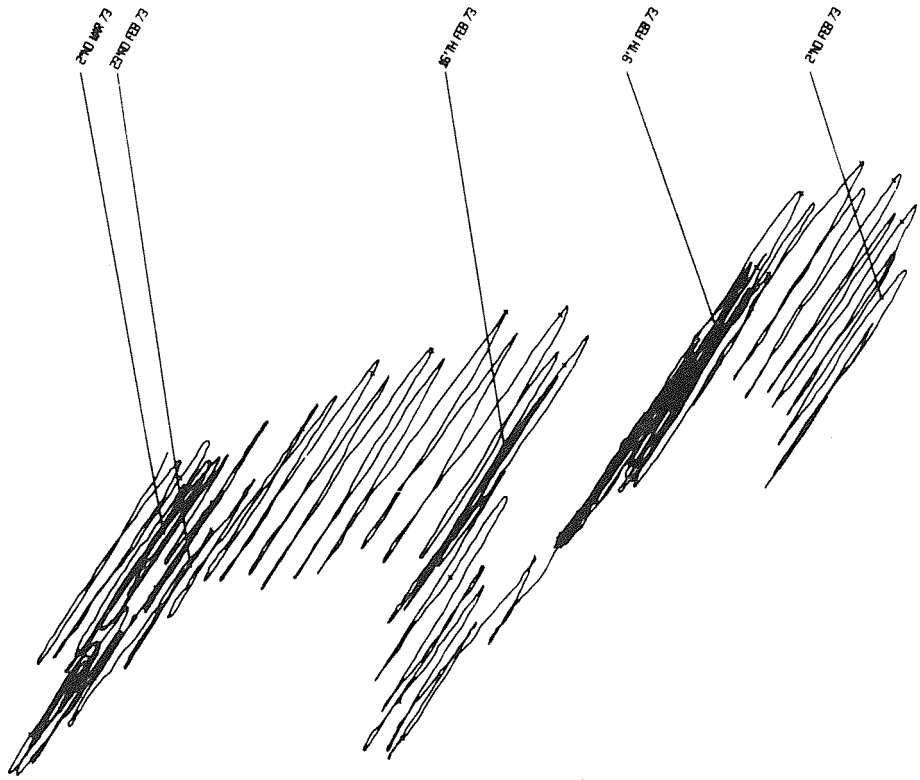

EAST
WEST
NORTH
SOUTH
150
100
50
0
-50
-100
-150
2'ND FEB 73
9'TH FEB 73
16'TH FEB 73
VELOCITY IN CM/SEC
10
9
8
TEMPERATURE IN DEG C


EAST
WEST
NORTH
SOUTH
150
100
50
0
-50
-100
-150
23'RD FEB/73
2'ND MAR/73
VELOCITY IN CM/SEC
10
9
8

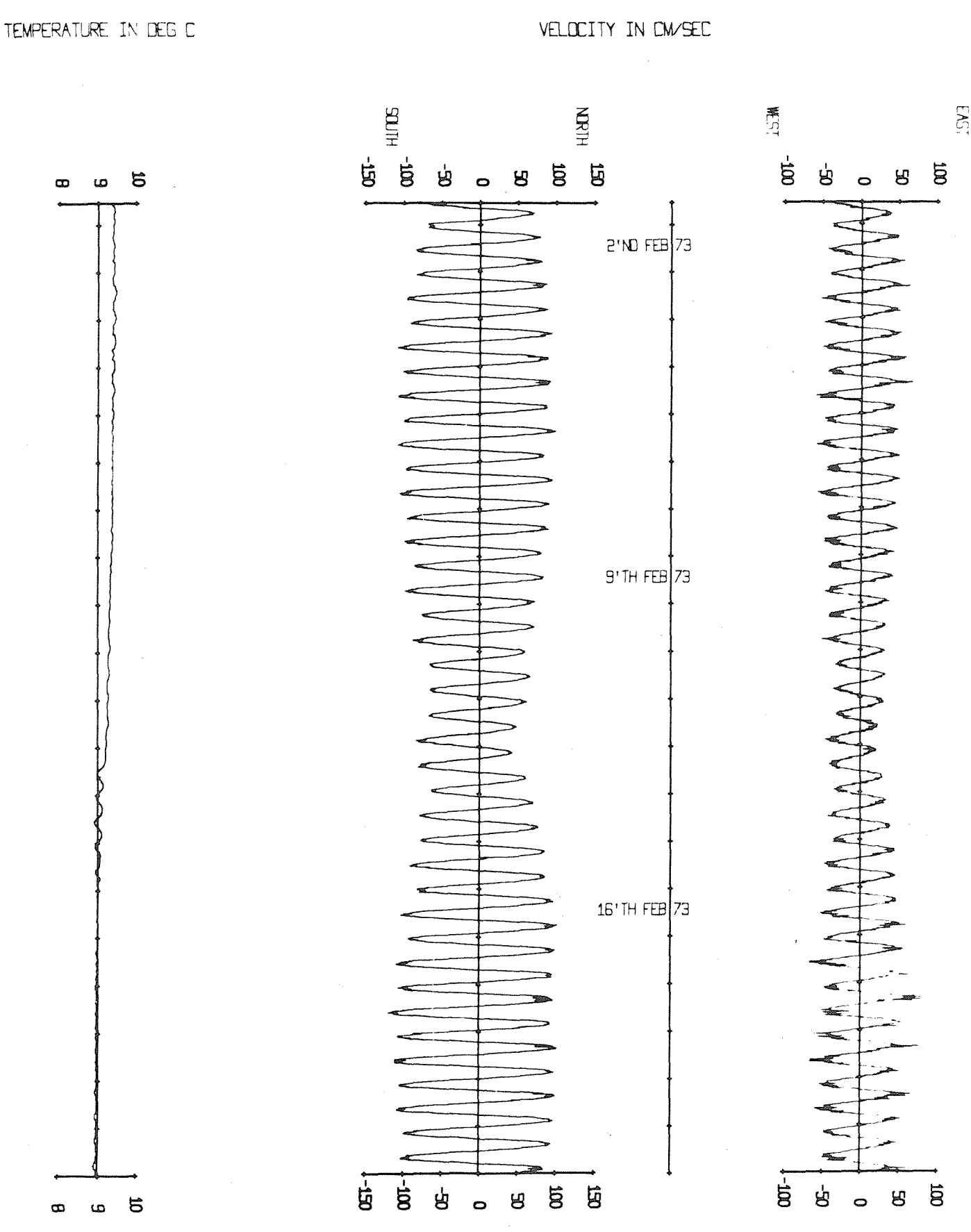

PER CENT
80
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


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


23RD FEB 73
2ND MAR 73
15'M FEB 73
9'M FEB 73
2ND FEB 73
NORTH
SOUTH
WEST
EAST
60
50
40
30
20
10
0
-10
-20
-30

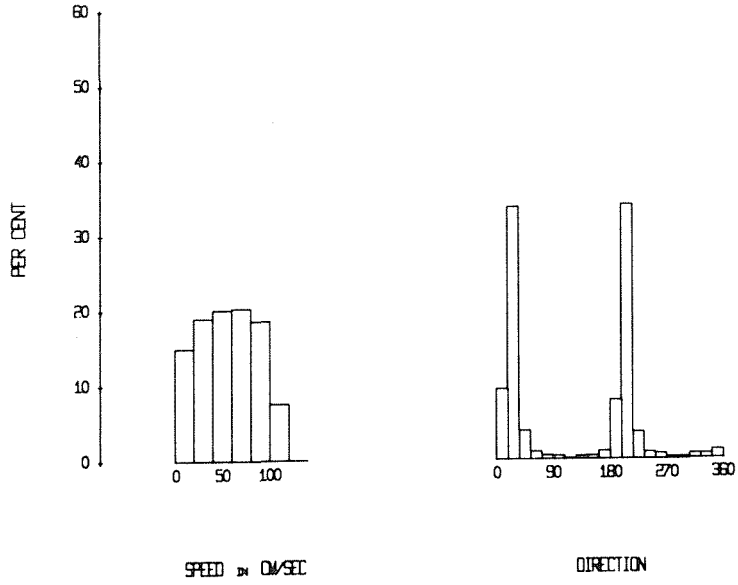

2ND MAR 73
23RD FEB 73
15'M FEB 73
9'M FEB 73
2ND FEB 73

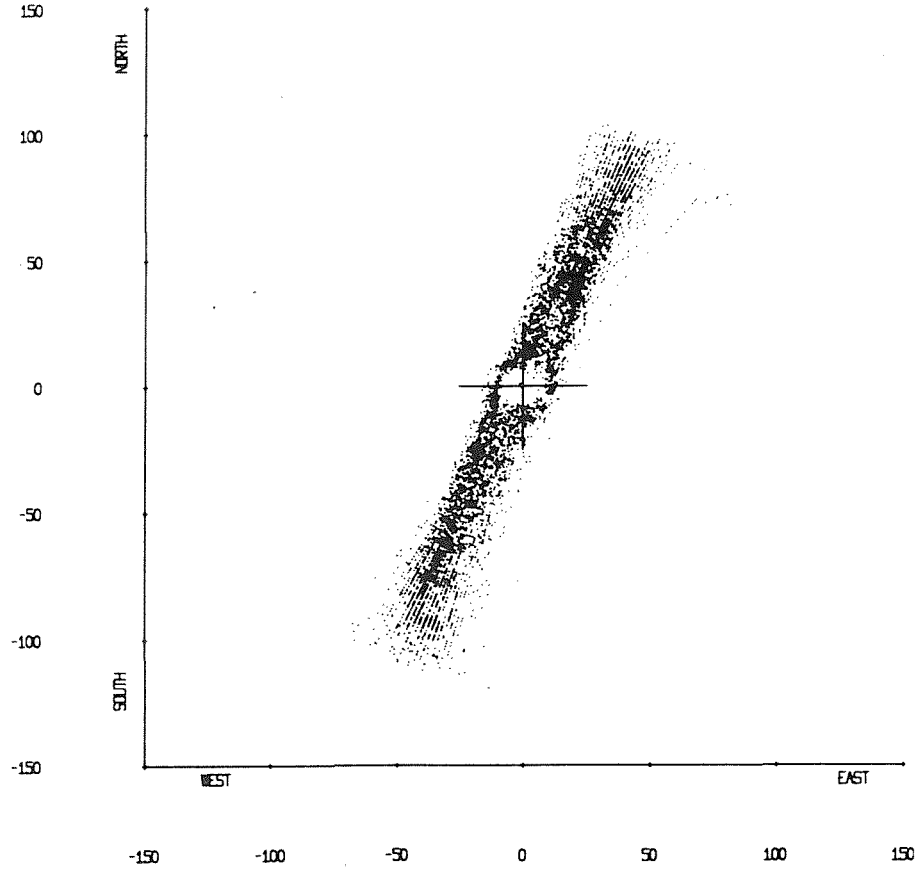
Meter	:	Bergen 565
Tape number	:	565/1
Meter started	:	16.20.00 GMT 30 Jan 1973
Meter stopped	:	17.22.56 GMT 9 Mar 1973
Total number of readings	:	5479
Timing error	:	2 min 56 s slow
Start of useful record	:	13.00 GMT 1 Feb 1973
End of useful record	:	10.13 GMT 5 Mar 1973
Length of useful record	:	765 h
Comments	:	Good record. The meter was fitted with a quartz-crystal clock and a spindle designed and made by the Institute. During the recovery the meter was trapped between the side of the ship and the meter anchor and its rotor was knocked out.


TEMPERATURE IN DEG C
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
2'ND FEB 73
9'TH FEB 73
16'TH FEB 73
8
9
10
-150
-100
-50
0
50
100
150

TEMPERATURE IN DEG C

VELOCITY IN CM/SEC


PER CENT
60
50
40
30
20
10
0
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

25TH FEB 73
2ND MAR 73
15TH FEB 73
9TH FEB 73
2ND FEB 73
WEST
EAST
SOUTH
NORTH
20
15
10
5
0
-5
-10
-15
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10

25TH FEB 73
2ND MAR 73
15TH FEB 73
9TH FEB 73
2ND FEB 73

```
PAGE    1

// JOB

LOG DRIVE    CART SPEC    CART AVAIL   PHY DRIVE
  0000         0001         0001         0000

V2 M09    ACTUAL 32K  CONFIG 32K

// FOR
*EXTENDED PRECISION
*IOCS(CARD,TYPEWRITER,1403 PRINTER)
*ONE WORD INTEGERS
*NAME POLRG

UNREFERENCED STATEMENTS
 100      110      150      220

FEATURES SUPPORTED
 ONE WORD INTEGERS
 EXTENDED PRECISION
 IOCS

CORE REQUIREMENTS FOR POLRG
 COMMON       2  VARIABLES  15476  PROGRAM    1108

END OF COMPILATION

// XEQ
```