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FIELD EXPERIENCES WITH A NEW MINIATURE VECTOR AVERAGING CURRENT METER

by

Trygve Gytre and Øivind Østensen
Inst. of Marine Research P.O. Box 1870 / 72
N- 5024 Bergen Norway

ABSTRACT

For several years Inst. of Marine Research Bergen has been developing miniaturized modular current meters. Thanks to major improvements in electronic component technology in recent years, a physically small current meter can now be designed with processing and recording capacity which is comparable to much larger instruments.
The paper describes the design and field performance of a new miniaturized vector averaging "Mini" current meter which can measure and record up to 6000 data sets.
Via a built in two way optical data communication system all recorded data in the instrument can be transferred to a PC in less than 30 s.
In an intercomparision experiment during May 1991 two "Mini" current meters were moored close to two Aanderaa RCM-7 current meters. The instruments were positioned 20 and 28 meters from the surface in a region where the current speed varied from 0 - 20 cm/s.
Technically the new instruments functioned well and in accordance with their design specifications.
The intercomparision showed that all of the RCM-7 and the "Mini" current meters - when compensated for a minor directional offset in one instrument - responded almost identically to current speeds between 4 - 14 cm/s. Beyond 14 cm/s the "Mini "current meters showed a slightly higher current speed.

INTRODUCTION

A modern oceanographic instrument is basically a mechanical housing filled with electronic components. If ruggedness and performance can be kept to a satisfactory level, a physical small instrument is advantageous compared to a large instrument mainly because a small instrument is less expensive to manufacture, to transport and to anchor than a large one.

For several years work has been done at the Inst. of Marine Research to exploit advances in electronic technology to design a miniaturized recording current meter with performance comparable to much larger instruments.

In order to follow the much faster changes in electronic technology than in mechanical technology, the designs have been based on a standardized mechanical unit and a updatable electronic unit which can be plugged into the mechanical unit.

The standardized mechanical unit is shown on fig. 1.

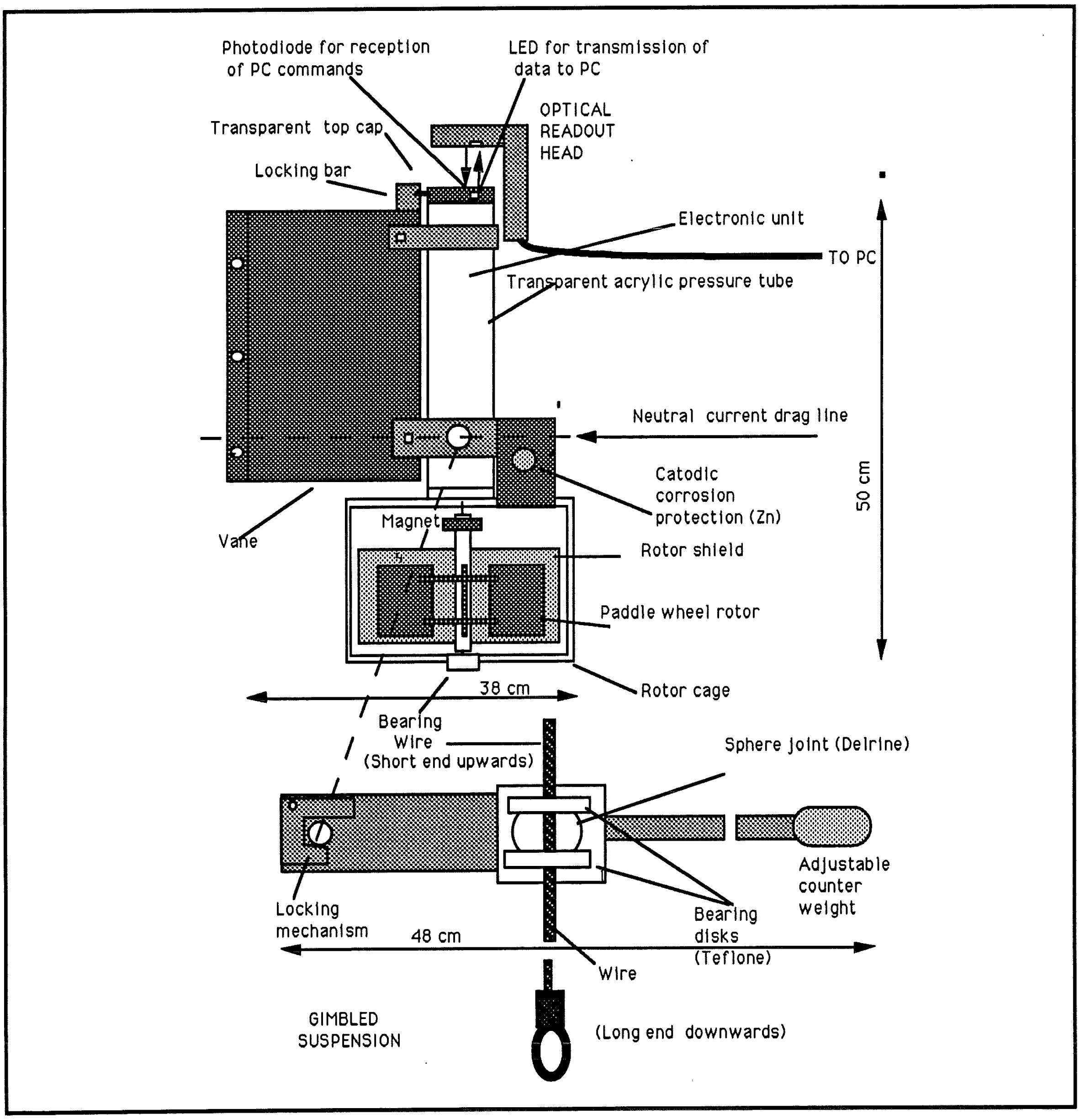

Fig. 1 Standardized mechanical unit

The mechanical unit is basically a transparent pressure tube with transparent top cap, vane and rotor cage which has been attached to a gimbled balance. The instrument transparency makes it possible for the instrument to give visible messages to the user. Transparency is also perfect for exchange of optically coded data .

The most wanted properties of the electronic unit are :

- Physical dimensions to fit into the standard mechanical unit shown on fig. 1
- Non galvanic communication between user and instrument to avoid connectors that may corrode and cause malfunctions.
- Performance equivivalent to the state of the art represented by "large" current meters.

In earlier Mini current meter designs unprocessed raw data from the sensors were recorded in a solid state RAM memory . Successive data processing was taken care of after the recorded data had been optically transferred to a PC. Although the results obtained with pre-1991 designs proved comparable to those obtained with an Aanderaa mod. RCM-7 current meter (Gytre and Østensen 1990), several design improvements were defined.

These are mainly:

- Increased data recording capacity.
- Non volatile memory (No data loss in case of power failure)
- In situ vector averaging capability
- Two way optical data transmission between instrument and readout PC
- Built in real time clock

In May 1991 a new electronic "mini" current meter with the mentioned improvements was field tested and intercompared with Aanderaa mod. RCM-7 current meter outside the Lofoten islands in Northern Norway.

BASIC INSTRUMENT DESIGN

The new instrument uses a non volatile EEPROM with recording capacity for 6000 complete current speed-direction-temperature + two other variable data sets.

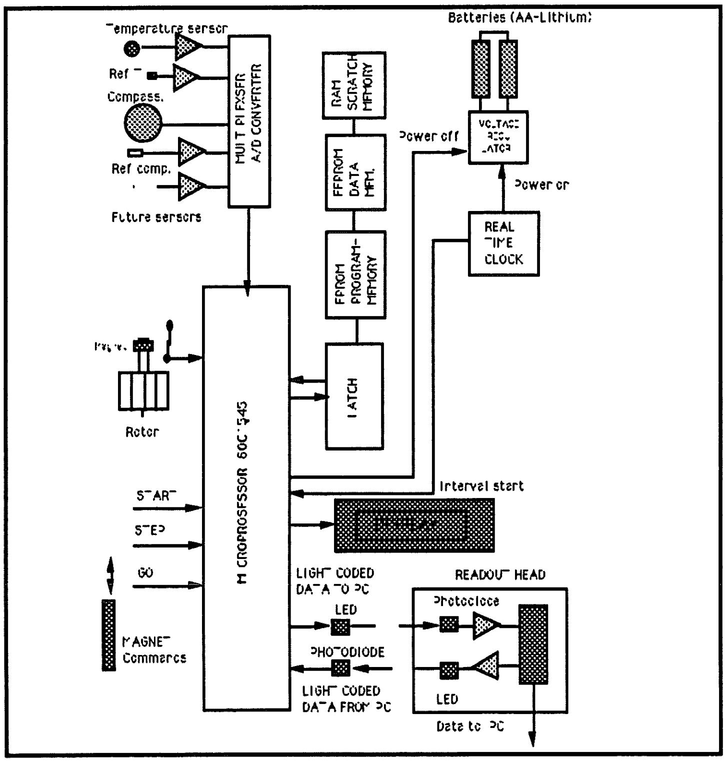

Fig 2 Electronic block diagram
Data from the sensors are processed and recorded in non volatile EEPROM memory. Recorded data are transferred to a PC via optics.

Fig 2 shows the electronic block diagram .
The instrument can be programmed to record data at six possible measuring intervals ranging from 5 minutes to 3 hours.
Data from the sensors and from fixed sensor references used for automatic calibration are multiplexed into the instrument microprocessor. Impulses from the current speed rotor are measured continuously. Five times during T the compass direction is sampled. The current speed is averagedand decomposed into a North and an East component for each T / 5. The components are preliminary stored stored in a "scratch" memory. At the end of each T the complete averaged vector is calculated and recorded. Then the signals from all additional sensors are recorded.
Fig. 3 shows the current vector averaging process. To save battery power, 5 compass samplings per recording period have been selected . If needed the sampling frequency can be increased.

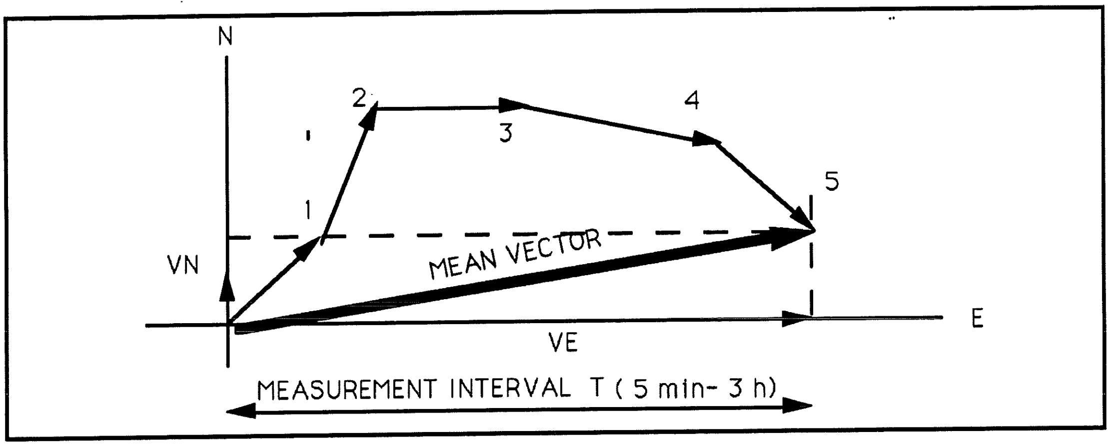

Fig. 3 Principle for vector averaging.
Current speed is measured continuously.The direction is sampled at 1 - 5

COMMANDS AND DATA COMMUNICATION.

"Field commands " represented by selecting an interval time and giving measurement start and stop orders are made by holding a magnet outside START-STEP and "GO" positions on the instrument in a dialogue with the display.
Service functions like data readout, erase memory, setting of clock and modification of calibration coefficients must be excecuted from a PC via an optical connector.
The optical "connector" is a light emitting diode (LED) / photodiode pair encapsulated inside the transparent instrument top cap. It communicates with a PC through a corresponding LED / photodiode pair inside an optical "readout head".
Data communication between PC and instrument is made at 9600 baud according to a handshake and error correcting protocol. Transfer of 6000 data sets takes appr. 30 seconds.

FIELD TESTS

A practical field test was made during a survey with F/F Johan Hjort during may 1991.
Two "Mini" current meters were anchored at 20 and 28 meter depths. The diatance to bottom was appr. 100 m.
A second mooring with two Aanderaa RCM- 7 current meters at identical depths was anchored 85 m away.
Fig. 4 shows the field situation.

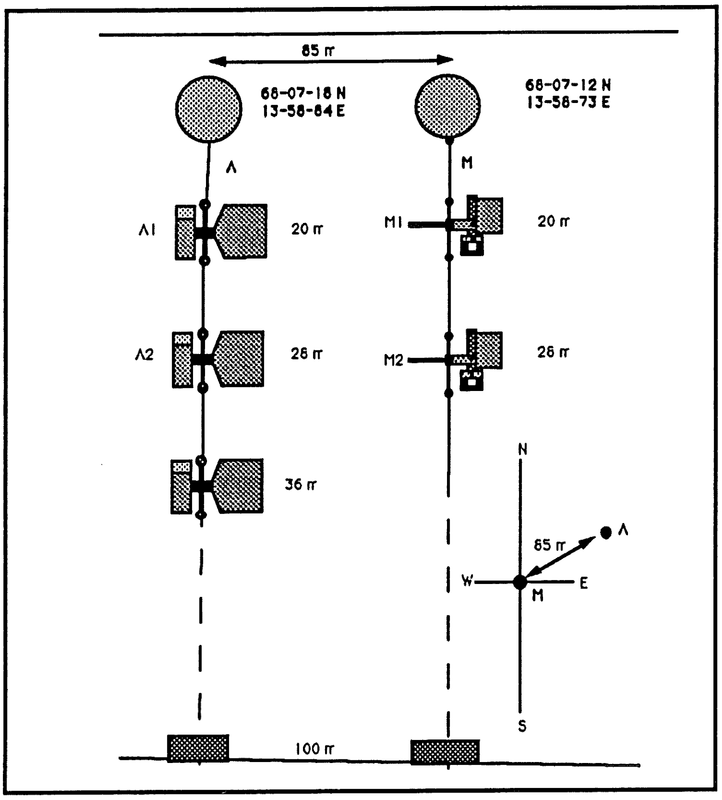

Fig. 4 Anchor station with two Aanderaa RCM-7 current meters (A1 and A2) and two "Mini" current meters (M1 and M2) moored in identical depths

The instruments were kept in position for a period of 5 days . Both instruments were programmed to record data each 10 minutes.

The current speed was basically dominated by tidal effects. During one gale period which lasted for appr. one day, wind effects became significant in the upper layer.

Fig 5 shows the current speed and direction measured by A1 and M1

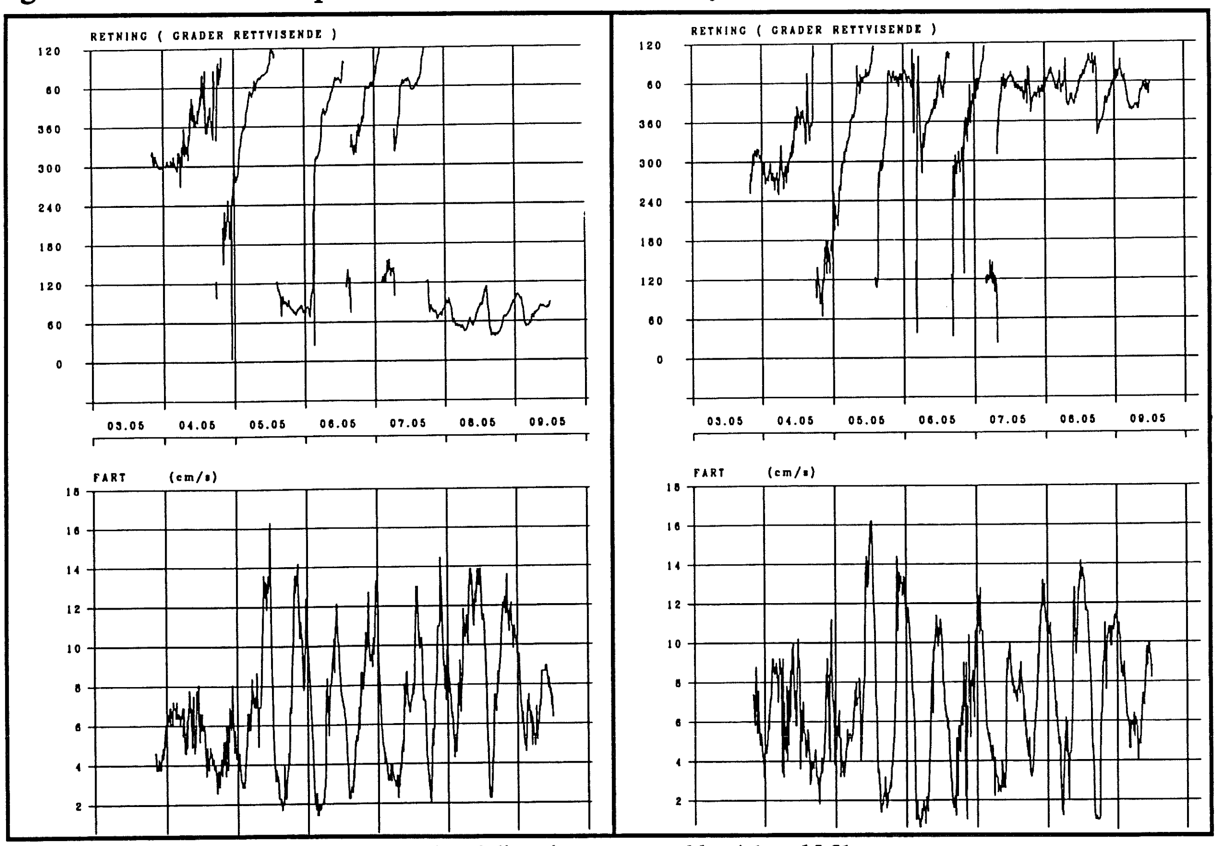

Fig. 5 Current speed and direction measured by A1 and M1.
The recorded direction show a permanent differance of 10- 15 degrees

Fig. 6 shows the current speed and direction recorded by instruments A2 and M2

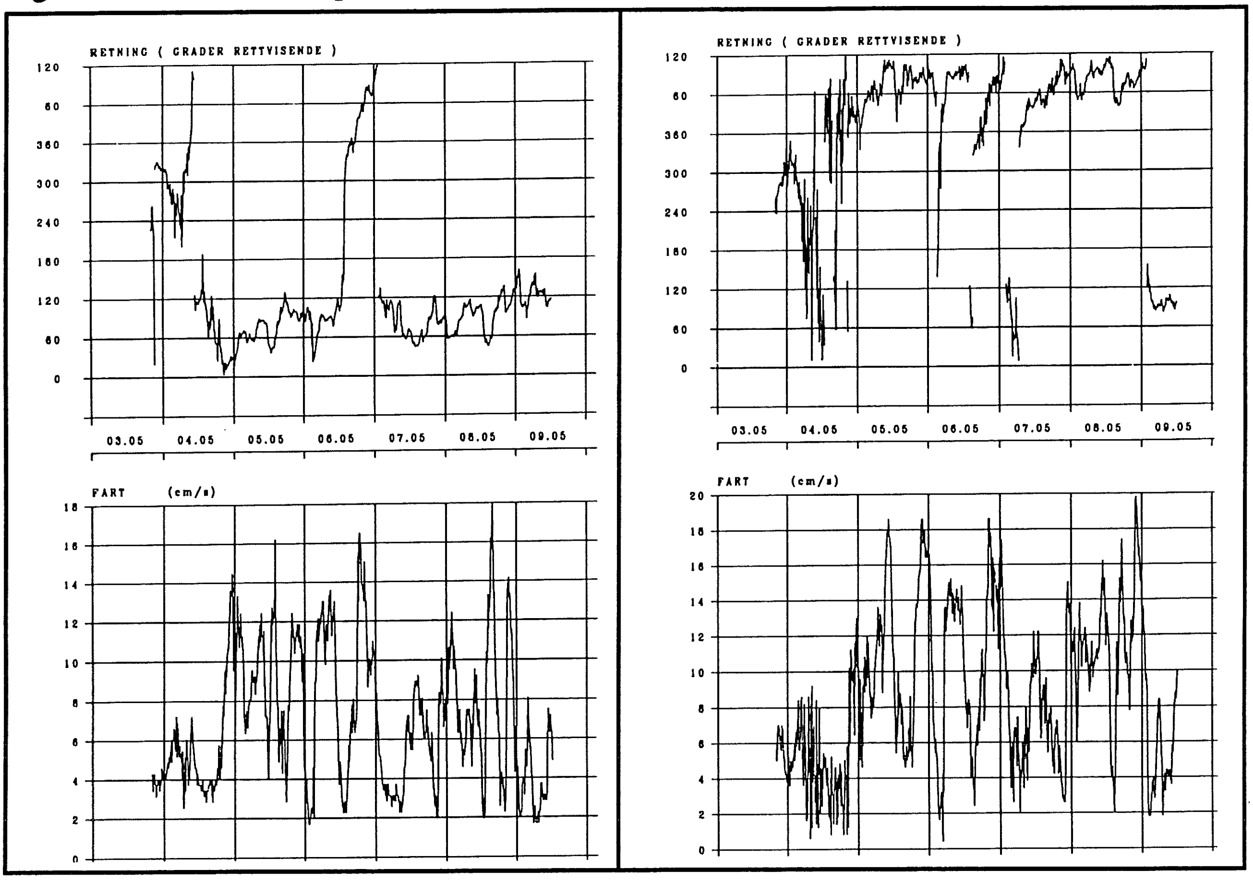

Fig. 6 Current speed and direction measured by A2 and M2 in deep 28 m

Fig. 7 shows the progressive current vector in 20 m

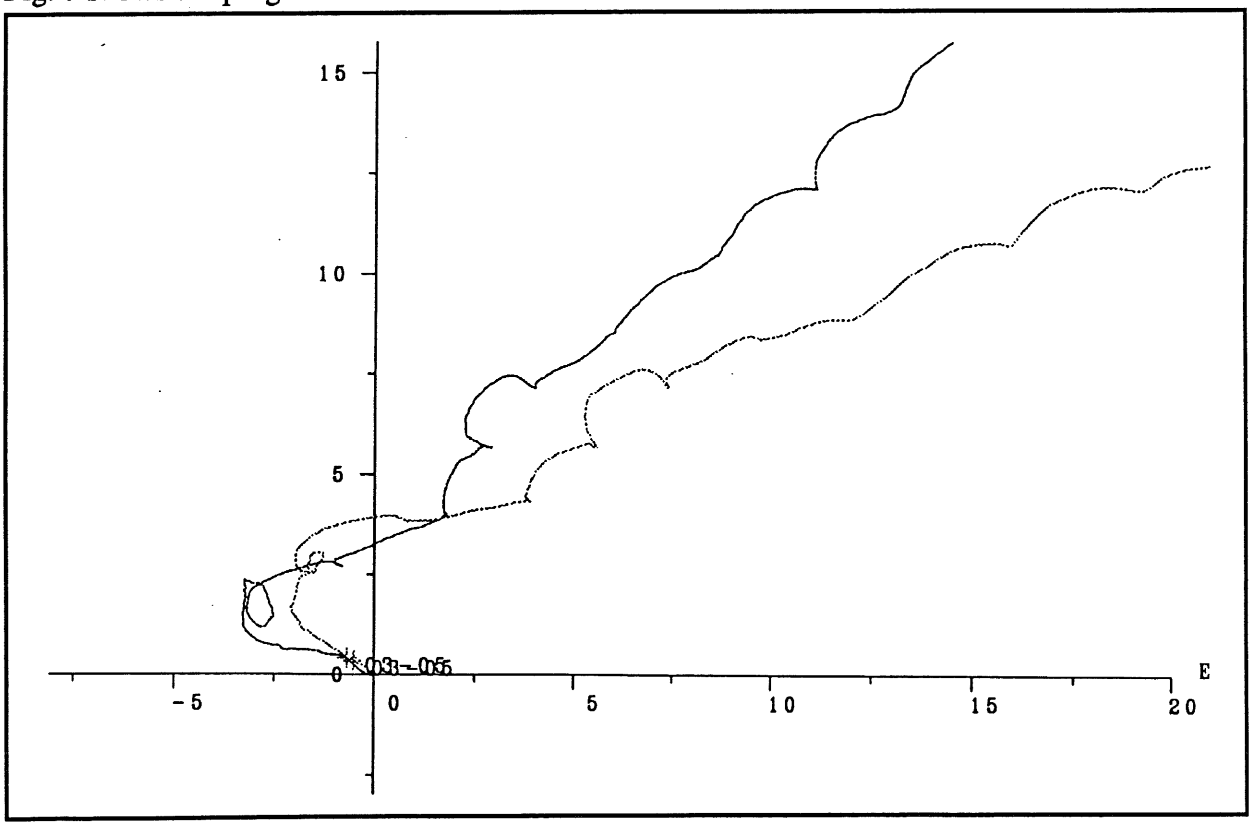

Fig.7 Progressive vectors calculated from A1 and M1
The difference in direction is basically caused by an offset in calibration.

Fig. 8 shows the progressive vector calculated from A2 and M2

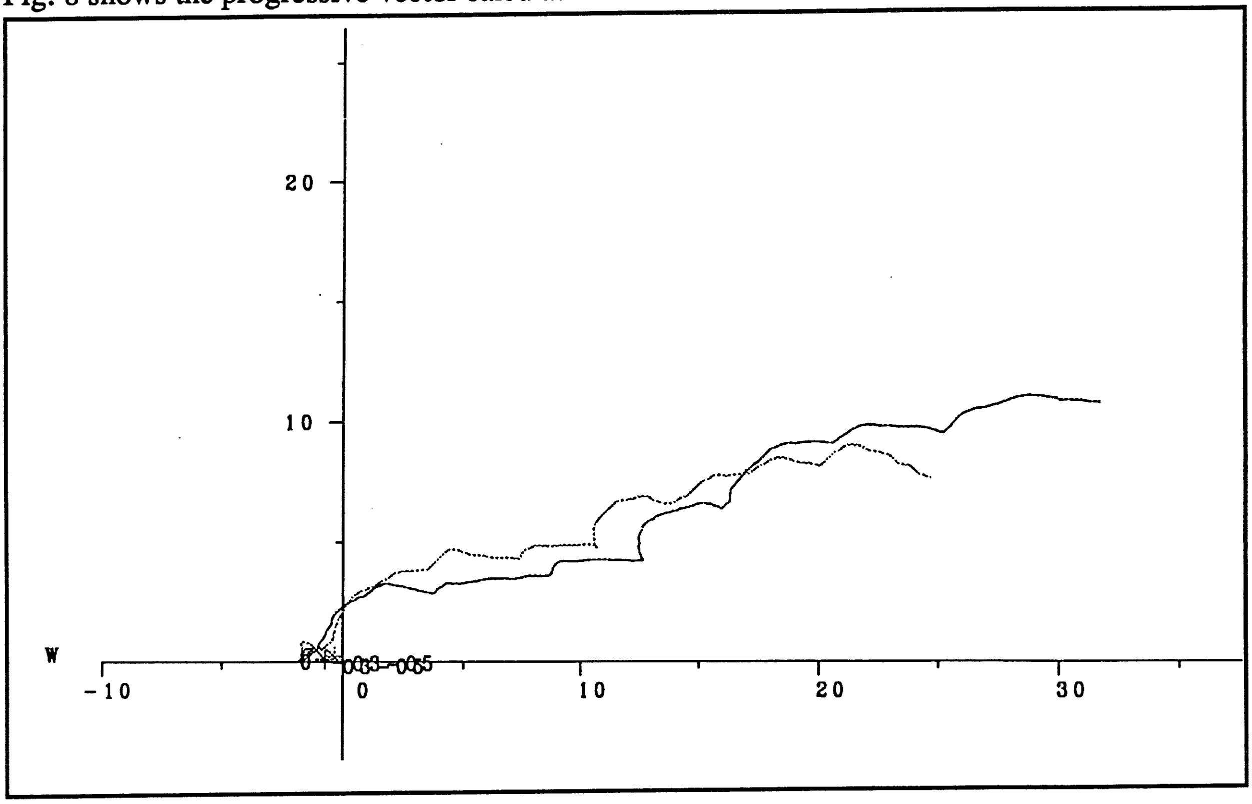

Fig. 8 Progressive vectors calculated from A2 and M2

In order to find any systematic differences in current speed sensitivity between the two current meters, the average difference in speed was plotted against the speed measured by the Mini current meter. (Fig. 9)
Fig 9 shows that the RCM-7 has a tendency to show a higher current speed than the Mini current at low velocities and a lower current speed at higher velocities.

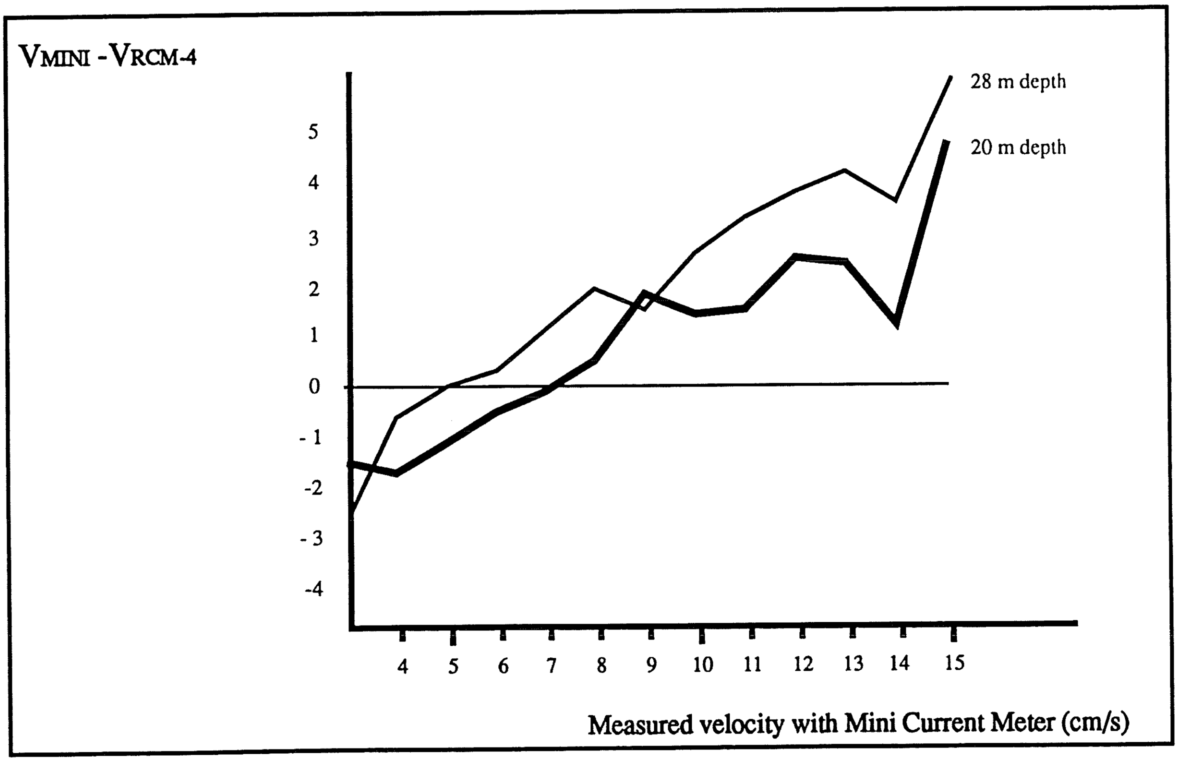

Fig. 9 Differences in current speed between RCM-7 and Mini Current meter.

DISCUSSION

Intercomparision results.

The data show that the Mini Current meter and the Aanderaa RCM-7 current meter have close to identical response to current speeds in the 4 - 14 cm/s range. When the current speed is higher than 14 cm/s , the Mini curent meter shows a significant tendency to show higher current speeds. The reason for the measured differences cannot be explained from this single experiment alone. In order to measure relative and absolute instrument responses below, under and over their specified ranges, a new intercomparing towing tank experiment with RCM-7 and the Mini current meter is planned later this year

GENERAL FIELD EXPERIENCE

The new Mini current meter was easy to operate in the field. The two way optical data transfer system proved to give a completely error free data communication with the PC.

The present design with a transparent pressure tube made from Acryle can only be used down to appr. 500 meter. Possible use of hardened glass instead of plastic is being evaluated. This may enable future designs to be operative down to 6-7000 m.

REFERENCES

(1) Gytre T and Østensen Ø. "A field intercomparision between an acoustic current meter and two Savonius type current meters"
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