# VELOCITY MEASUREMENTS UNDER BROKEN WAVES AND BORES

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## 1. ABSTRACT

The dynamics of waves after breaking is widely investigated because it controls several phenomena in the surf zone and swash zone. Several numerical models based essentially on non-linear shallow water equations (NLSWE) have been developed, but all of them fail to model turbulence in the bore. Many authors have measured fluid velocity in bores using Laser Doppler Velocimetry (LDV), Hot Wire and Hot Film anemometry, and Particle Image Velocimetry (PIV) with good results, though such studies possess several limitations imposed mainly by the presence of air bubbles.

In order to overcome such limitations, a set of experiments was carried out in a flume using the Doppler Ultrasonic Technique for fluid velocity measurements. The instrument, a DOP1000, works essentially as a radar and utilizes ultrasound in the range 1 MHz-8 MHz as a carrier. This instrument is able to measure fluid velocity in several points along the US beam with negligible time delay. The maximum data rate obtained is ≈30 profiles per second for each probe, with three probes being employed and a maximum of 255 points per profile. The generated waves have a period of T=2.0, 2.5 and 3.0 s, and break as spilling on a 1:20 bottom. UDVP velocity profiles have been collected in three sections: one at the breaking point and two in the bore region after breaking.

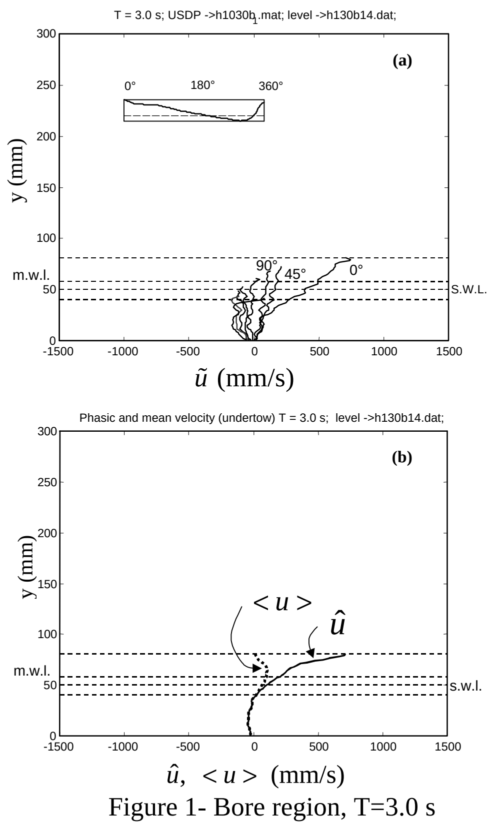


Figure 1- Bore region, T=3.0 s
a) Average phase velocity, and b) Mean phase and mean phasic velocity (undertow).

The data have been phase averaged to obtain estimates of fluid velocity (Fig.1a), and time averaged in order to obtain a measure of mean fluid velocity (Fig.1b).

The classical undertow is evident. The UDVP technique has several advantages when compared to other fluid velocity measurements: it can be used in opaque fluids, and the error in measurements is strictly related to the accuracy of the set-up and can be reduced to less than 5%. The present limits are essentially due to the low data rate, which at best allows the measurement of macro-turbulence. The low data rate is an intrinsic element of the carrier celerity, and is approximately 1000 m/s.

The main advantage of UDVP is that it can give information on spatio-temporal velocity, with a data rate that is virtually independent of seeding concentration.

The aim of the present work is to use UDVP data for the estimation of fluid velocity, bottom stress and macro turbulence in a breaking wave and in a bore. Measurements of turbulence are rarely available due to the difficulty in measuring fluid velocity in a strongly aerated flow field.

The results of this investigation will improve flow field modelling with respect to breaking waves and bores.

## 2. ACKNOWLEDGEMENTS

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