PHASE SEPARATED VELOCITY MEASUREMENT

APPLICATION NOTE LDV-008

Velocity measurement by Laser Doppler Velocimetry (LDV) typically involves seeding the flow with tracer particles and measuring their velocity, with the assumption that the tracers will faithfully follow the fluid motion. In certain cases, however, the flow is seeded with tracers as usual, but it also contains objects that we would like to know the velocity of. The challenge then is to distinguish the *source* of Doppler signals: Did it originate from a tracer particle or an object in the flow? In the past, various techniques have been attempted to make this distinction, such as fluorescence tagging, photomultiplier tube current measurement, and velocity binning. All these methods suffer from various shortcomings and are not reliable. Fluorescence tagging results in weak signals with poor SNR, photomultiplier tube current measurement is inconclusive since a **small** slow moving tracer particle will have similar tube current as a **large** higher speed object in the flow. Velocity binning is also inconclusive since some tracer particles having low or negative velocities would be indistinguishable from objects in the flow. Intensity

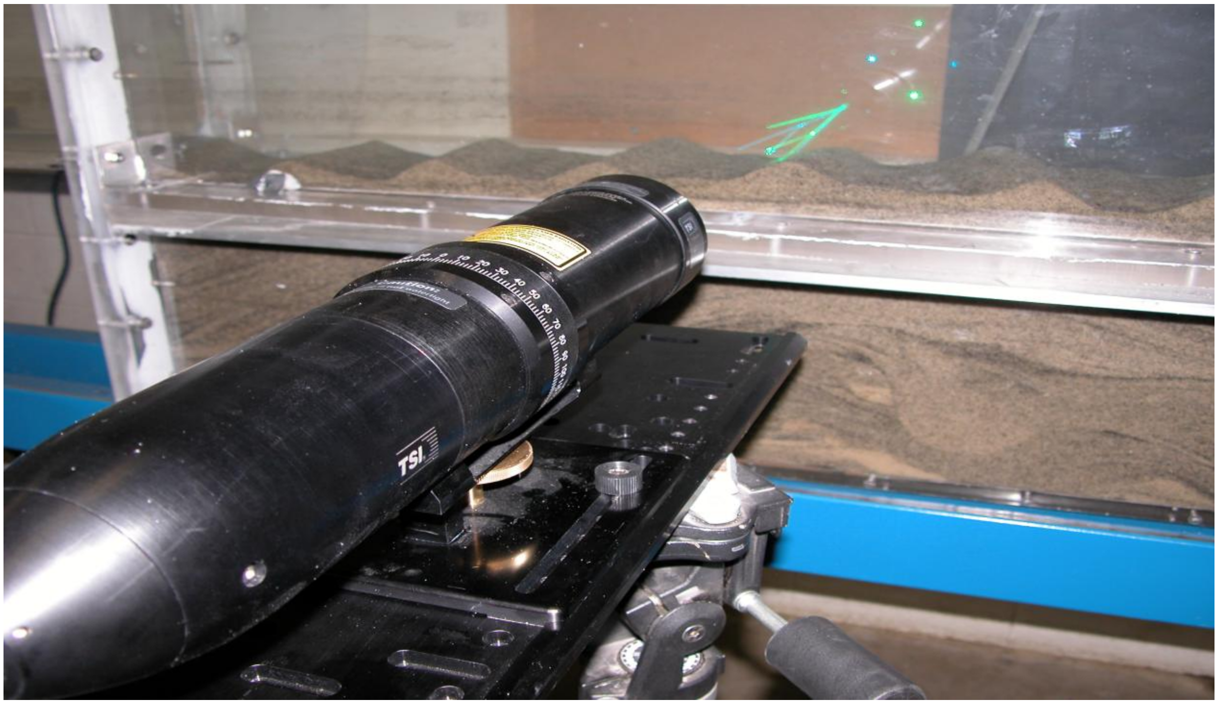

Figure 1: TR260 transceiver probe being used to measure phase-resolved velocities in a water channel flow. *(water channel courtesy of the Ven Te Chow Hydrosystems Laboratory at the University of Illinois – Urbana Champaign)*

* Intensity Measurement is covered by US Patent 4986659

measurement* and tagging is clearly the best alternative because tracer particles will always produce a characteristically lower scattered intensity than the larger objects in the flow, no matter what the velocity. In addition, no expensive dyes or special particles need to be used.

A two-component LDV system was used to perform a series of measurements in a water channel flow containing a sand bed, and seeded with ~10 µm glass spheres. The LDV system was composed of a model LA6000 5W Ar-ion laser for maximum data rate in water channel flows, FBL-2 fiberlight™ beam generator, and TR260 transceiver probe. Signals were captured by the transceiver probe and sent to a PDM1000-2 detector module and an FSA 3500-2 signal processor with FLOWSIZER™ software were used to acquire & analyze the data. The probe was set outside the water channel and adjusted vertically to allow measurement at various heights above the sand bed, as shown in Fig. 1. A full description of these components can be found in the Size and Velocity Measurement Systems brochure, available on www.tsi.com. Note that sealed stainless steel transceiver probes are also available from TSI for underwater flow measurements.

Figure 2 shows an example of the burst intensity histogram for a water channel flow containing sand particles as the sediment phase. Each and every Doppler burst is analyzed by the FSA signal processor, and tagged with its intensity (or amplitude). A sub-range can then be applied to separate the data originating from each phase. Analysis of the data shown here indicated a 13% higher velocity for the freestream, and uniquely different power spectrum.

In this application we have focused on phase separated measurements of a water channel flow, with TSI patented intensity tagging providing a robust parameter to enable analysis of both phases.

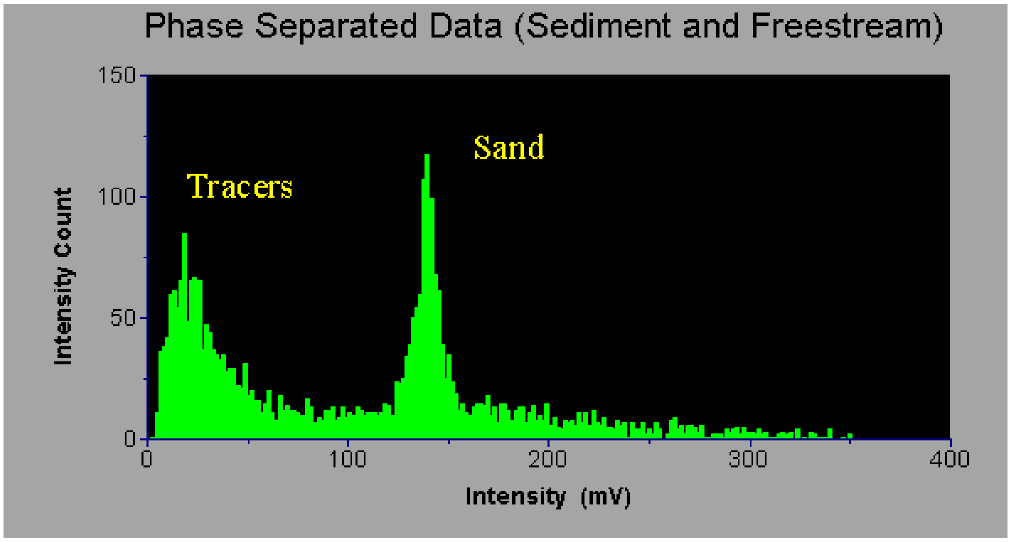

Figure 2: Measured intensity histogram of water channel flow, showing the clear distinction between sediment (sand) and freestream (tracers) Doppler signals.

UNDERSTANDING, ACCELERATED

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