PHASE SEPARATED VELOCITY MEASUREMENT

APPLICATION NOTE LDV-008 (A4)

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 additional objects, such as bubbles or solids, that we would like to know the velocity of. The challenge then is to distinguish the *source* of the Doppler signals: Did the signal 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. While offering some benefit, all of 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 measurement* and tagging is clearly the best alternative because smaller tracer particles will always produce a characteristically lower scattered light intensity than the larger objects in the flow, no matter what the velocity. In addition, no expensive dyes or special particles are required.

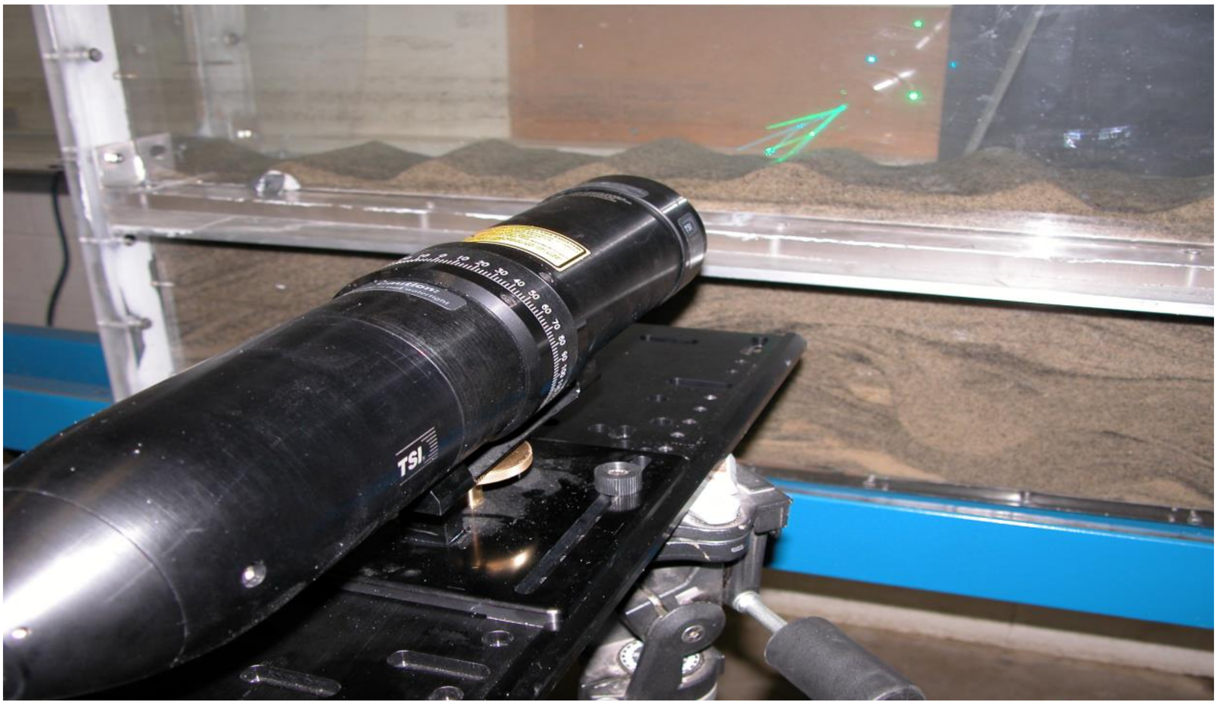

Figure 1: TR260 transceiver probe being used to measure phase-resolved velocities in a water channel flow. *(water channel courtesy of the Ven Te Chow Hydrosystems Laboratory at the University of Illinois – Urbana Champaign)*

* Intensity Measurement is covered by US Patent 4986659

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 sphere tracers. The LDV system was composed of a 5W Ar-ion laser, 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. FlowSizer™ software was used to acquire and analyze the data. The probe was set outside the water channel and adjusted vertically to allow measurements at various heights above the sand bed, as shown in Figure 1.

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 between the two phases.

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

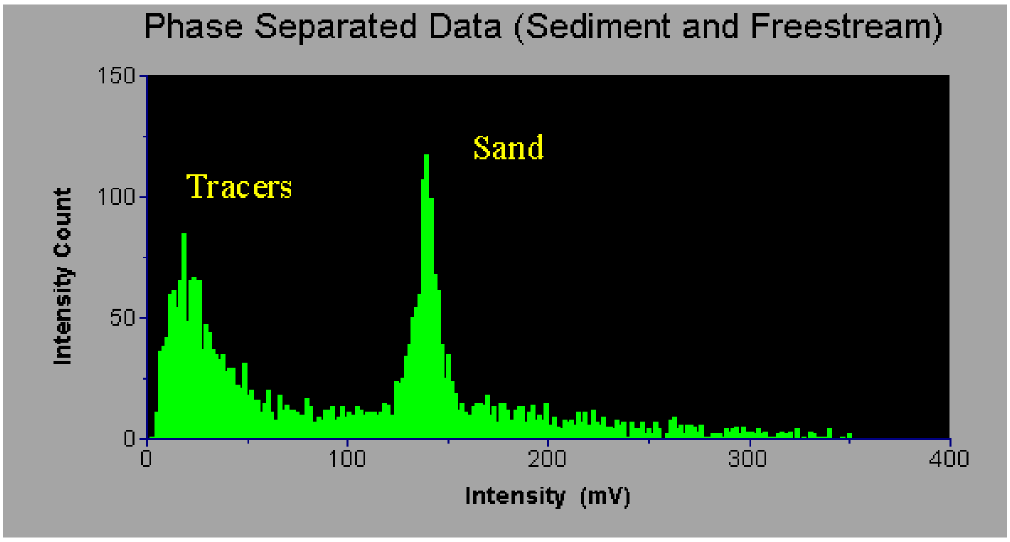

Figure 2: Measured intensity histogram of water channel flow, showing the clear distinction between sediment (sand) and freestream (tracers) Doppler signals.

UNDERSTANDING, ACCELERATED

TSI Incorporated – Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 680 1220	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 1 41 19 21 99	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

  Printed in U.S.A.