PHASE-DOPPLER MEASUREMENT OF KNOWN DROPLET SIZE USING THE TSI MDG-100

APPLICATION NOTE POWERSIGHT-003

PDPA Measurements of a Monodisperse Droplet Generator (MDG-100)

A TSI one-dimensional (1D) PowerSight system was used to take phase Doppler particle analysis (PDPA) measurements. The purpose of the investigation was to determine the accuracy and repeatability of using the PowerSight system for droplet size measurements. In order to obtain data on a known flow, a Monodisperse Droplet Generator (TSI Model# MDG-100) was used to generate a continuous stream of distilled water droplets of known diameter. A photograph showing the MDG-100 can be seen in fig. 1. Further details on the setup, operation and configuration of the MDG-100 droplet generation system can be found in the MDG-100 Operation and Service Manual (TSI P/N 1990870).

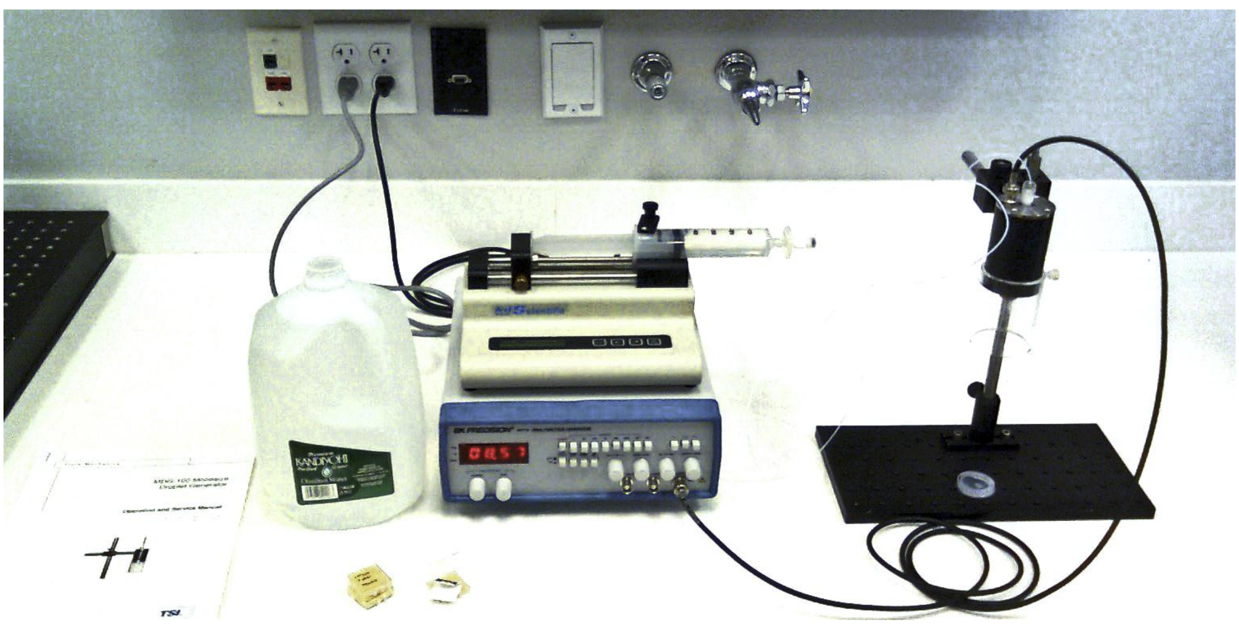


Fig. 1. The MDG-100 setup for measurements with the 50 micron orifice. Distilled water was used as the droplet media.

Procedure

The principle of the MDG-100 is that liquid is forced through a vibrating orifice at a specified flow rate and known vibrational frequency. As the liquid exits the orifice, the vibration causes the steady stream to be broken up into individual droplets of identical size. A schematic representation of the MDG-100 operation can be seen in fig. 2.

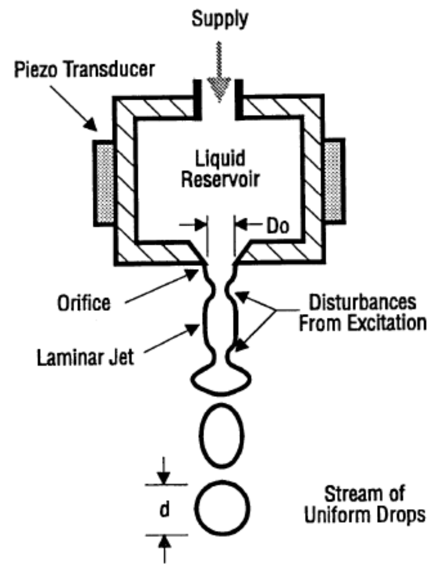


Fig. 2. A schematic of the MDG-100 showing the component parts and principle of operation.

After the droplets are formed, the stream passes downward protected by a shroud of approximately 60 mm in length to allow sufficient time for the droplets to stabilize. The shroud limits evaporation and deflection of the droplet stream. The PowerSight system was aligned so that the beams intersected at the location where the stream of uniform droplets passed below the shroud. A photograph of the PowerSight during data collection can be seen in fig. 3.

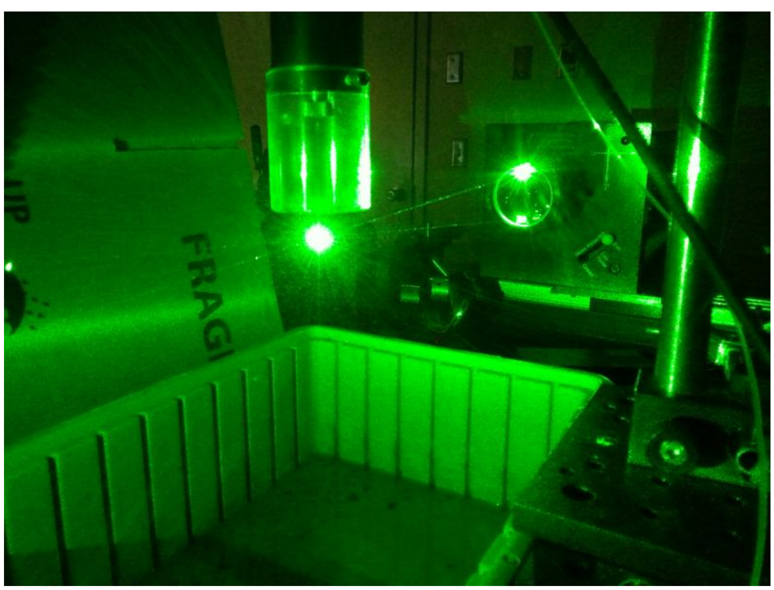


Fig. 3. Photograph of the PowerSight System and MDG-100 during data collection.

In the current experiment, the orifice of the MDG-100 was set to a vibrational frequency of 19.50 kHz with an orifice size of 50 microns and a flow rate of 66.6 ml/hr. The following relationship was used, where Q is the liquid flow rate and f is the excitation frequency:

$$D^{3} = \left[\frac{6Q}{\pi f}\right]$$

This corresponds to a droplet size of 121.912 microns. The output of the FSA signal processor was attached to an oscilloscope so that the raw signals could be viewed (fig. 4).

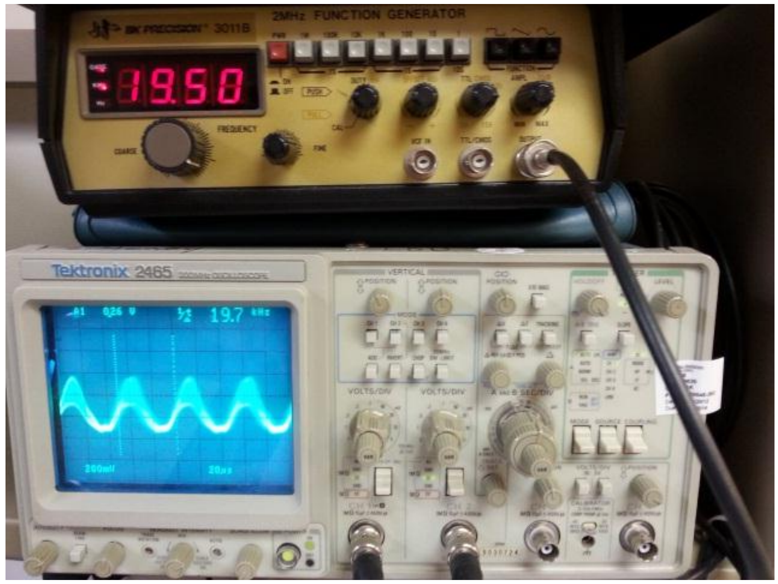


Fig. 4. The function generator giving an output of 19.50 kHz and the oscilloscope showing the output of the raw signal from the FSA signal processor.

TSI's Flowsizer64 software was used to collect the data. For the measurement tests, 100,000 measurement samples were acquired. A screenshot of the data collected by the software can be seen in fig. 5.

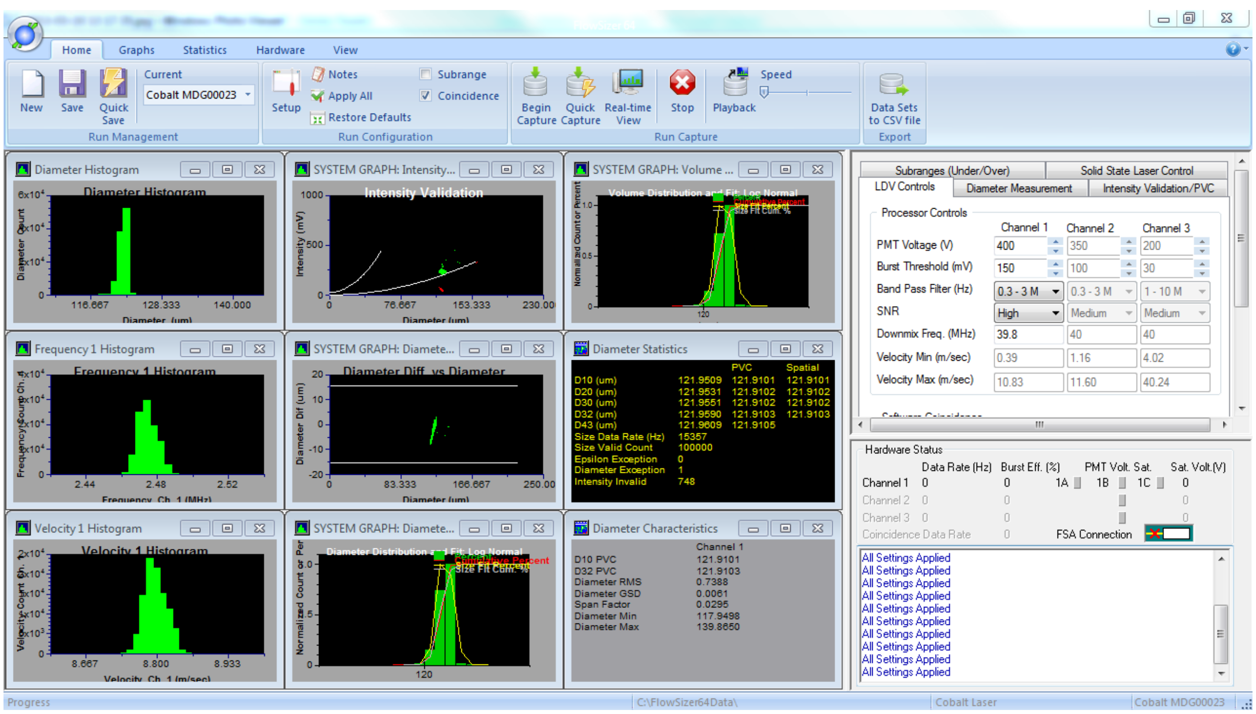
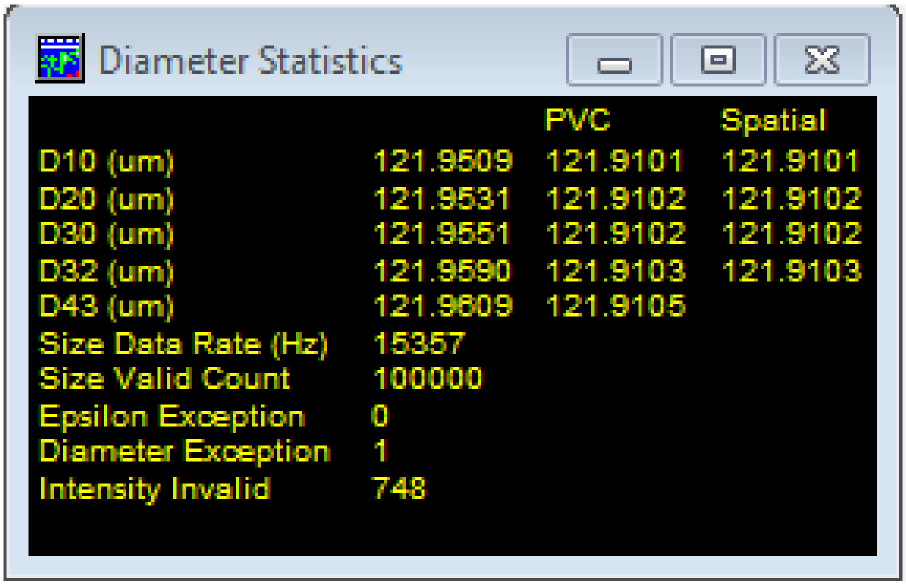


Fig. 5. Screenshot of the Flowsizer64 software after data collection.

Results and Conclusion

The data statistics can be seen in fig. 6. The PowerSight system gave a mean droplet diameter of 121.9101 microns, which compared quite well with the calculated diameter of 121.9120 microns, giving an accuracy of 0.002%. In terms of repeatability, the root mean squared (RMS) in diameter was 0.7388 microns, or 0.6%, this corresponds to a geometric standard deviation (GSD) of 0.0061.



		PVC	Spatial
D10 (um)	121.9509	121.9101	121.9101
D20 (um)	121.9531	121.9102	121.9102
D30 (um)	121.9551	121.9102	121.9102
D32 (um)	121.9590	121.9103	121.9103
D43 (um)	121.9609	121.9105	
Size Data Rate (Hz)	15357		
Size Valid Count	100000		
Epsilon Exception	0		
Diameter Exception	1		
Intensity Invalid	748		

Fig. 6. Screenshot of the Diameter Statistics screen from Flowsizer64.

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

USA	**Tel:** +1 800 874 2811	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 4 91 11 87 64	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

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