

## Phase Doppler Interferometer

### Modular

### Droplet Size and Velocity Measurements

*Advanced Signal Processing*

*Variable SW selectable aperture sizes*

*Variable SW selectable masks and beam separation for changing measurement range*

*Ability to tilt apertures to adapt to spray angles*

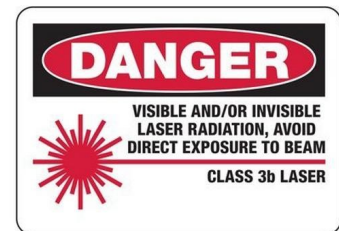
*Auto-setup*

## PDI-x00MD

Artium Technologies Inc. continues to advance the state-of-the-art in phase Doppler interferometer (PDI) instrumentation. The **modular phase Doppler systems** offer turnkey operation with a fully automated setup feature. The modular system can be used for the real-time, non-intrusive measurement of individual droplet size and 1, 2, or 3 velocity components in a variety of applications.

The complete instrument includes optical transmitters, optical receiver, ASA signal processors, data management computer and the AIMS system software. The high powered DPSS lasers built into the transmitter provide stability, compactness, ruggedness, and high reliability; eliminating the need for inefficient and unreliable fiber optics and bulky Arion lasers. The Fourier transform based **Advanced Signal Analyzer (ASA)** incorporates a proprietary digital signal burst detection technique and adaptive Doppler burst sampling approach to provide high accuracy in signal detection and measurement. The **Automated Instrument Management System (AIMS)** provides fully automatic setup and operation of the instrument. A variety of standard and user-configurable views are available to analyze the data. It also offers remote operation and monitoring via the Internet.

The new PDI design incorporates several features aimed at ease-of-use and data accuracy. A key feature is the ability to change the droplet size measurement range without requiring the user to change lenses or realign the optics. This can be accomplished by changing the laser beam separation and selecting different masks in the receiver via software. A software controlled aperture module also allows for the selection of a variety of apertures and tilts. A new version of the ASA is now available for improved data accuracy at high speeds in dense spray environments. The AIMS software includes an auto-setup feature that automatically selects the processor and optics settings for optimal performance in complex sprays.



## Technical Specifications

<b>PDI-x00MD</b>	
<b>Drop size measurement range</b>	0.3 to > 8000 $\mu\text{m}$ (spherical or near-spherical particles)
<b>Size dynamic range</b>	50:1
<b>Estimated size accuracy</b>	+/- 0.5 $\mu\text{m}$ or 0.5% of full size range
<b>Estimated size resolution</b>	+/- 0.5 $\mu\text{m}$ or 0.5% of full size range
<b>Velocity measurement range</b>	-600 to 1000 m/s
<b>Velocity accuracy</b>	+/- 0.1%
<b>Volume flux accuracy</b>	+/- 10%
<b>Available receiver focal lengths</b>	350 mm, 500 mm, 758mm, 1000 mm and 2000 mm
<b>Available transmitter focal lengths</b>	350 mm, 500 mm, 750mm, 1000 mm and 2000 mm
<b>Laser type</b>	Diode pumped solid state (DPSS)
<b>Wavelength</b>	491 nm, 532 nm, 561 nm, 660nm

<b>Signal Processing (ASA)</b>	
<b>Maximum Input Frequency</b>	200 MHz
<b>Processor bandwidth</b>	160 MHz
<b>Input voltage</b>	200 $\mu\text{V}$ to 1V
<b>Minimum transit time</b>	100ns
<b>Max sampling frequency</b>	Quadrature, 320 MHz
<b>Measurement resolution</b>	0.01% of the sampling frequency (frequency) 0.5 degree (phase)
<b>Minimum SNR</b>	-6 dB
<b>Maximum data rate</b>	>250,000 per second
<b>Number of samples per record</b>	Adaptive 16 to > 100,000 quadrature
<b>Burst detection</b>	Frequency domain burst detector Quadrature analog burst detector
<b>Run time</b>	64 bits, 0.5 $\mu\text{s}$ resolution
<b>Transit time</b>	32 bits, 0.1 $\mu\text{s}$ resolution
<b>Amplitude Sampling Resolution</b>	12 bits

## Typical Measurement Ranges

### 60 mm Beam Separation

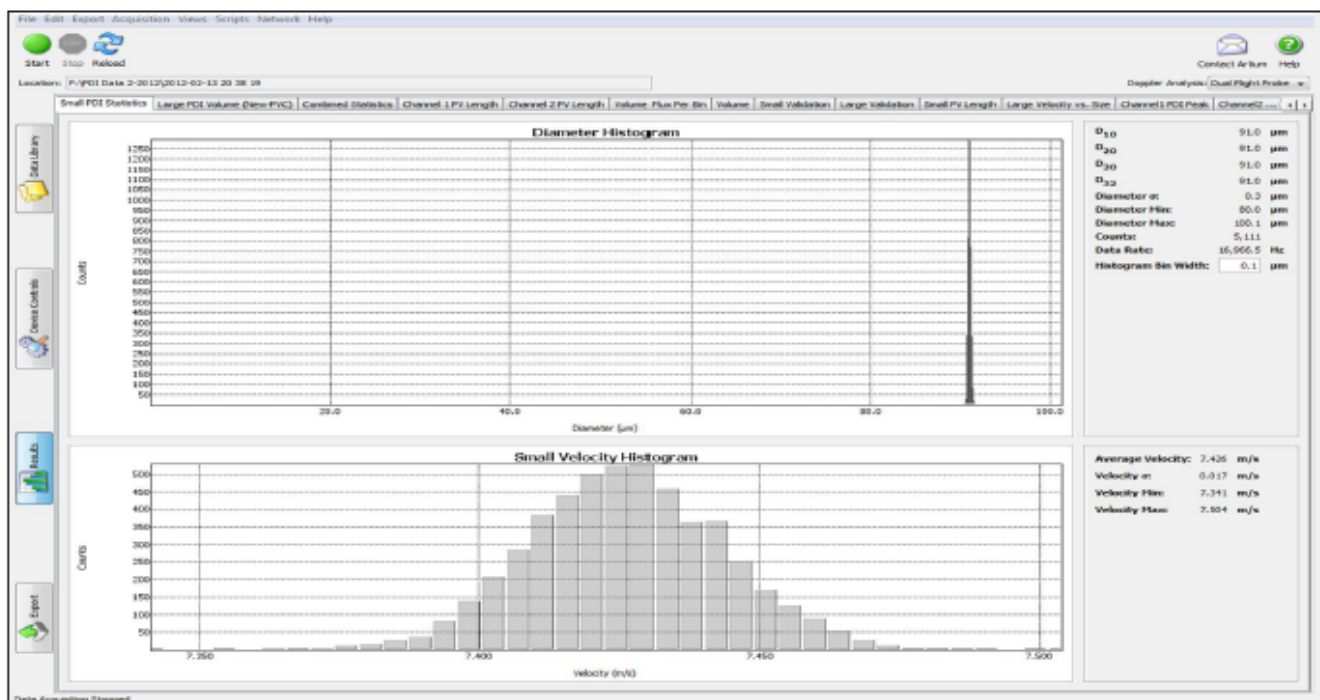
Optics		Velocity Range (m/s)		Diameter Range (microns)							
XMT Focal Length (mm)	RCV Focal Length (mm)	min	max	1X Mask		2X Mask		3X Mask		4X Mask	
				min	max	min	max	min	max	min	max
350	350	-100	350	0.4	80	1	230	2	330	2	400
500	500	-130	500	1	170	3	500	4	700	5	900
750	758	-200	700	2	400	5	1,100	8	1,600	10	2,100
1000	1000	-250	1,000	3	700	8	2,000	12	2,900	16	3,700

### 25 mm Beam Separation

Optics		Velocity Range (m/s)		Diameter Range (microns)							
XMT Focal Length (mm)	RCV Focal Length (mm)	min	max	1X Mask		2X Mask		3X Mask		4X Mask	
				min	max	min	max	min	max	min	max
350	350	-200	800	1	200	3	600	4	800	5	1,000
500	500	-300	1,100	2	400	6	1,100	8	1,600	10	2,100
750	758	-500	1,800	4	1,000	11	2,900	16	4,100	21	5,300
1000	1000	-600	2,300	8	1,600	23	4,600	33	6,600	42	8,500

## Measurement Precision

### Monodisperse Droplets



## Key Features:

### OPTICS

- Free-space optics; eliminates need for polarization preserving fiber optics and fiber coupler; more efficient power delivery
- High power (300 mW, 500 mW or 1W) diode pumped, solid state lasers packaged inside optical transmitter
- Automated beam separation for doubling the particle size measurement range
- Automated mask changer with five settings for doubling, tripling or even quadrupling the maximum size range
- Automated aperture selection with six apertures ranging from 15  $\mu\text{m}$  to 500  $\mu\text{m}$  or 50  $\mu\text{m}$  to 1600  $\mu\text{m}$  depending on application
- Ability to tilt the apertures (+/- 90 deg) to align it with the main component of flow velocity vector; maximizes droplet measurement time while minimizing the sample volume size

### SIGNAL PROCESSOR

- Digital frequency domain burst detection
- Variable down mixing
- Full complex Fourier Transform for measuring velocity (Doppler frequency) and size (phase)
- Complex quadrature sampling
- Sampling frequency as high as 320 MHz; option to go as high as 800 MHz

### SOFTWARE

- Auto setup of signal processor (sampling rate, analog filters, down mixing frequency, burst detection)
- Auto high voltage setting
- Auto probe volume setting (aperture selection)
- Software based Fourier transform processing and signal validation
- Configurable data views
- Remote control and data analysis

US Patents: 7, 126, 694 B1, 7, 564, 564 B2, 7, 788, 067 B2, 8, 525, 093 B2 EPO Patent: EP 1 855 081 B1

Our offices, research facilities, and manufacturing plant are located in Sunnyvale, California, where we serve our North American customers. Our distributor partners provide valuable services to our customers in other parts of the world.

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