

THE MASS MEDIAN AERODYNAMIC DIAMETER MEASUREMENTS  
FOR  
MICROSPACER USING AEROSIZER INSTRUMENTATION

Malvern Instruments, Inc.  
10 Southville Road  
Southboro, MA 01772  
August 23, 1990

COMPANY: Malvern Instruments, Inc.  
10 Southville Road, Southborough, MA 01772

Date: August 23, 1990

Product: Microspacer

Technician: Malcom Bailey

Geometry Use: Aerosizer Instrumentation

Purpose of Test: To demonstrate that when Microspacer is attached to a MDI (Metered-dose inhaler) the large aerosol drug particles that would normally deposit in the mouth and throat will be blocked, thus reducing unwanted side effects and allow the smaller treatment particles to pass through the Microspacer screen and into the lungs.

Definitions: 1. Aerosizer Instrumentation - Is a new particle size analyzer that uses the principle of aerodynamic separation of particles. The Aerosizer can analyze the aerosol produced by an MDI in less than one minute compared to hours using the cascade impactor. Moreover, it can disperse and measure the aerodynamic size distribution of a dry powder sample as utilized in MDI formulations that use only compressed air. The data can be used to determine mass median aerodynamic diameter (MMAD) or geometric mass median diameter (MMD).

2. Sum of Channels - Represents the total number of drug particles counted after spraying the aerosol medication from the metered-dose inhaler into the aerosizer machine.

3. With/Without - Three of the most widely used aerosol drugs were selected to be used both with the Microspacer device and without the Microspacer. (Albuterol, Beclomethasone Dipropionate, Cromolyn Sodium). All three MDI aerosol drugs were actuated into the Aerosizer machine in order to be evaluated.

4. % Under 95% - This data measures the mass median aerodynamic particle size diameter. This means 95% of the particle mass has been evaluated and the aerosol material is that particle size and under.

Test Results:

1. Beclomethasone Without

Sum of Channels - 25,665 - Total number of particles counted  
% under 95% - 9.62 This particle size and under

Beclomethasone with Microspacer

Sum of Channels - 21,762 - Total number of particles counted  
% under 95% - 6.95 - This particle size and under

2. Albuterol Without

Sum of Channels - 171,699 - Total number of particles counted  
% under 95% - 5.75 - This particle size and under

Albuterol with Microspacer

Sum of Channels - 81,023 - Total number of particles counted  
% under 95% - 3.66 - This particle size and under

3. Cromolyn Sodium Without

Sum of Channels - 290,527 - Total number of particles counted  
% under 95% - 6.46 - This particle size and under

Cromolyn Sodium with Microspacer

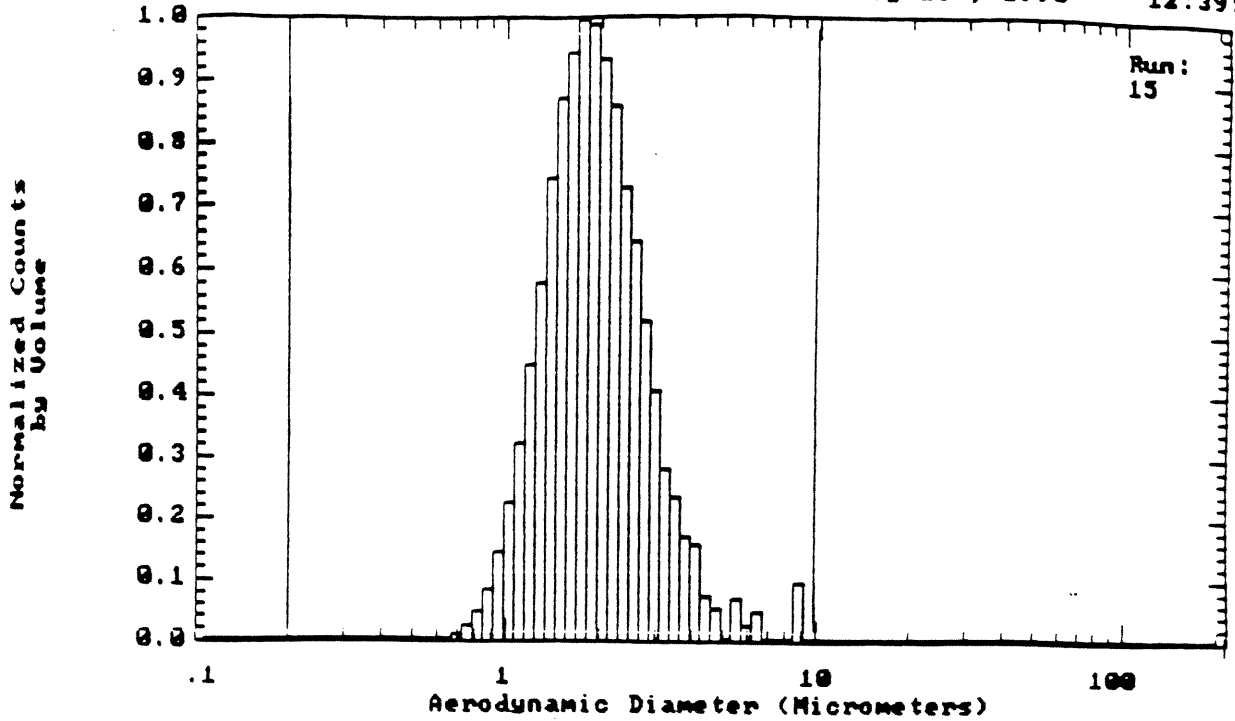
Sum of Channels - 185,403 - Total number of particles counted  
% under 95% - 5.47 - This particle size and under

## Discussions and Conclusions:

The total number of drug aerosol particles counted after using each of the three MDI drugs tested with Microspacer were all less, which means the larger drug aerosol particles were definitely blocked and not counted by the Aerosizer machine because they were blocked by the Microspacer screen.

The mass median aerodynamic diameter particle sizes at the important 95% evaluation point were all significantly smaller after using Microspacer with all three MDI drugs tested, which means Microspacer blocked the large drug particles and allowed the smaller particles to pass through the screen. Conversely, when evaluating the particle sizes at the 95% evaluation point without using Microspacer with the three MDI drugs tested, they were all significantly larger.

In conclusion, from the results using Microspacer with and without three MDI drugs Beclomethasone, Albuterol and Cromolyn Sodium via the Aerosizer Instrumentation, it was demonstrated that the Microspacer device significantly blocked the large aerosol particles while allowing the smaller aerosol particles to pass through the Microspacer screen system. This delivery system of blocking large aerosol drug particles and allowing the smaller aerosol drug particles to pass through the device and into the lungs is similar to the function one would expect from other spacer devices such as Aerochamber, Inspirease and Azmacort. The Microspacer device seemed much smaller in size compared to the other currently marketed spacer devices and also seemed to be light weight, portable and socially convenient to use in public.

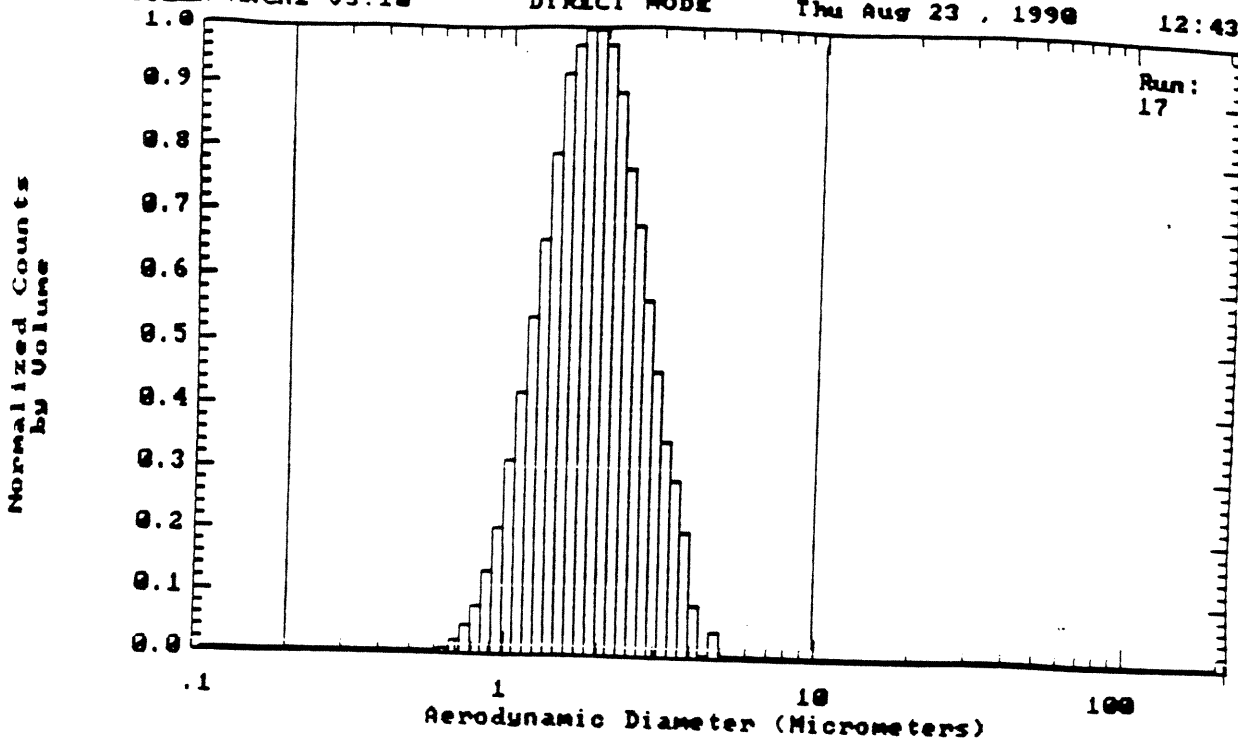


Run 15 — Thu Aug 23 12:39:13 1990  
ALBUTEROL DRUG  
W/O

VOLUME DISTRIBUTION

PARAMETERS		DISPENSER CONTROL		LOWER	SIZE	LOWER	SIZE
Material	: Water	Flow Pressure	: 0	5%	1.22	55%	2.30
Density	: 1.00	Flow Increment	: 0	10%	1.37	60%	2.42
Run Length (sec)	: 10.3	Pulse Pressure	: 0	15%	1.49	65%	2.56
PMT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	1.60	70%	2.72
Laser Intensity	: 50	Nebulizer Press	: 0	25%	1.69	75%	2.91
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	1.79	80%	3.16
Sum of channels	: 171699 X	Low Flow Limit	: 2000	35%	1.88	85%	3.53
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	1.98	90%	4.08
Upper Size Limit	: 9.98			45%	2.08	95%	5.75 X
Geometric Mean Size	: 2.34	SCANS 15 AND 16 COMBINED		50%	2.18		
Geometric Std Deviation	: 1.58						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				100.00	0.00	86.00	100.00	10.00	2.35	8.60	97.65	1.00	0.95	0.86	0.31
				86.00	0.00	74.00	100.00	8.60	0.93	7.40	96.72	0.86	0.25	0.74	0.05
				74.00	0.00	63.00	100.00	7.40	1.24	6.30	95.48	0.74	0.05	0.63	0.00
				63.00	0.00	54.00	100.00	6.30	1.99	5.40	93.49	0.63	0.00	0.54	0.00
				54.00	0.00	46.00	100.00	5.40	0.97	4.60	92.52	0.54	0.00	0.46	0.00
				46.00	0.00	40.00	100.00	4.60	3.30	4.00	89.22	0.46	0.00	0.40	0.00
				40.00	0.00	34.00	100.00	4.00	6.32	3.40	82.90	0.40	0.00	0.34	0.00
				34.00	0.00	29.00	100.00	3.40	8.57	2.90	74.34	0.34	0.00	0.29	0.00
				29.00	0.00	25.00	100.00	2.90	12.53	2.50	61.81	0.29	0.00	0.25	0.00
				25.00	0.00	22.00	100.00	2.50	11.65	2.20	50.16	0.25	0.00	0.22	0.00
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	20.03	1.80	30.13	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	10.69	1.60	19.44	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	9.17	1.40	10.27	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	6.04	1.20	4.23	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	0.00	10.00	100.00	1.20	2.97	1.00	1.25	0.12	0.00	0.10	0.00



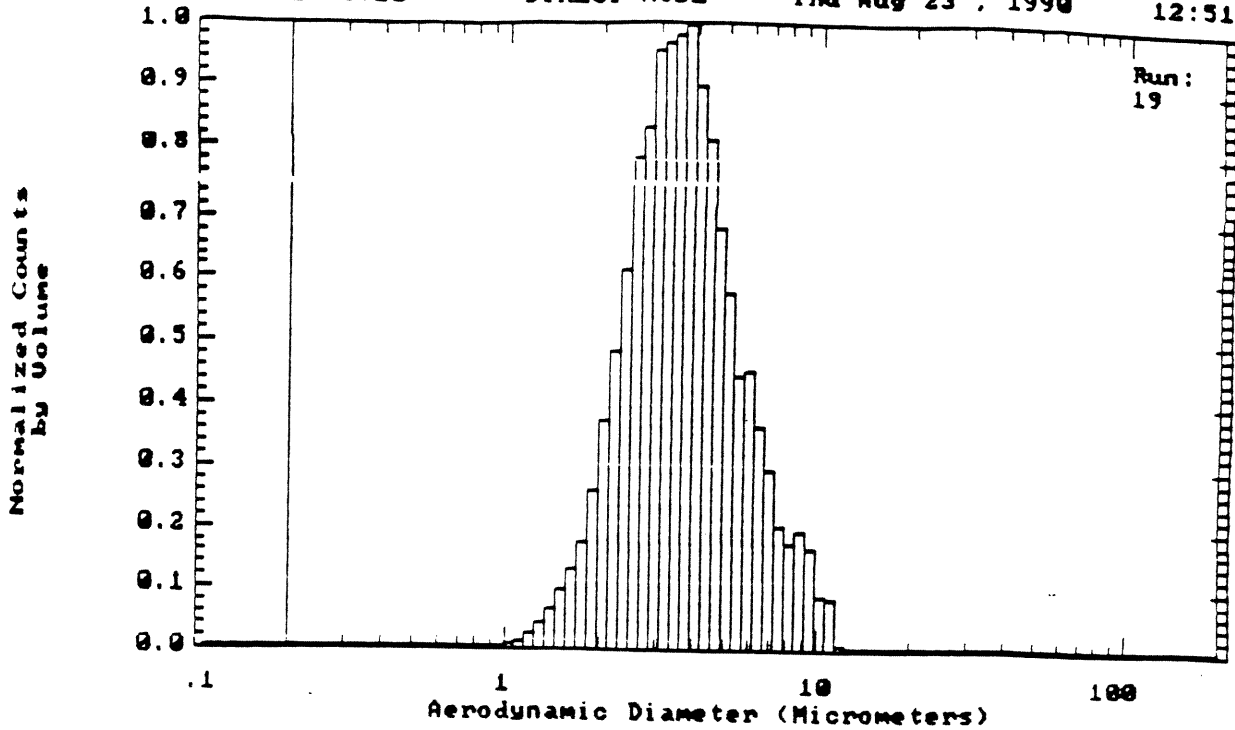
Run 17 — Thu Aug 23 12:43:16 1990  
 ALBUTEROL DRUG WITH MICROSPACER

VOLUME DISTRIBUTION



PARAMETERS		DISPENSER CONTROL		UNDER	SIZE	UNDER	SIZE
Material	: Water	Flow Pressure	: 0	5%	1.15	55%	2.20
Density	: 1.00	Flow Increment	: 0	10%	1.31	60%	2.31
Run Length (sec)	: 8.5	Pulse Pressure	: 0	15%	1.43	65%	2.43
PMT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	1.53	70%	2.56
Laser Intensity	: 49	Nebulizer Press	: 0	25%	1.63	75%	2.70
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	1.72	80%	2.87
Sus of channels	: 81023 X	Low Flow Limit	: 2000	35%	1.82	85%	3.06
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	1.91	90%	3.32
Upper Size Limit	: 9.98	SCANS 17 AND 18 COMBINED		45%	2.00	95%	3.66
Geometric Mean Size	: 2.12			50%	2.10		
Geometric Std Deviation	: 1.42						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
		100.00	0.00	86.00	100.00	10.00	0.00	8.60	100.00	1.00	1.41	0.86	0.54		
		86.00	0.00	74.00	100.00	8.60	0.00	7.40	100.00	0.86	0.44	0.74	0.10		
		74.00	0.00	63.00	100.00	7.40	0.00	6.30	100.00	0.74	0.09	0.63	0.01		
		63.00	0.00	54.00	100.00	6.30	0.00	5.40	100.00	0.63	0.01	0.54	0.00		
		54.00	0.00	46.00	100.00	5.40	0.72	4.60	99.28	0.54	0.00	0.46	0.00		
		46.00	0.00	40.00	100.00	4.60	0.72	4.00	98.56	0.46	0.00	0.40	0.00		
		40.00	0.00	34.00	100.00	4.00	7.82	3.40	90.74	0.40	0.00	0.34	0.00		
		34.00	0.00	29.00	100.00	3.40	10.21	2.90	80.53	0.34	0.00	0.29	0.00		
		29.00	0.00	25.00	100.00	2.90	13.67	2.50	66.86	0.29	0.00	0.25	0.00		
		25.00	0.00	22.00	100.00	2.50	12.46	2.20	54.40	0.25	0.00	0.22	0.00		
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	20.73	1.80	33.67	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	10.88	1.60	22.79	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	9.91	1.40	12.88	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	6.96	1.20	5.93	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	0.00	10.00	100.00	1.20	3.98	1.00	1.95	0.12	0.00	0.10	0.00



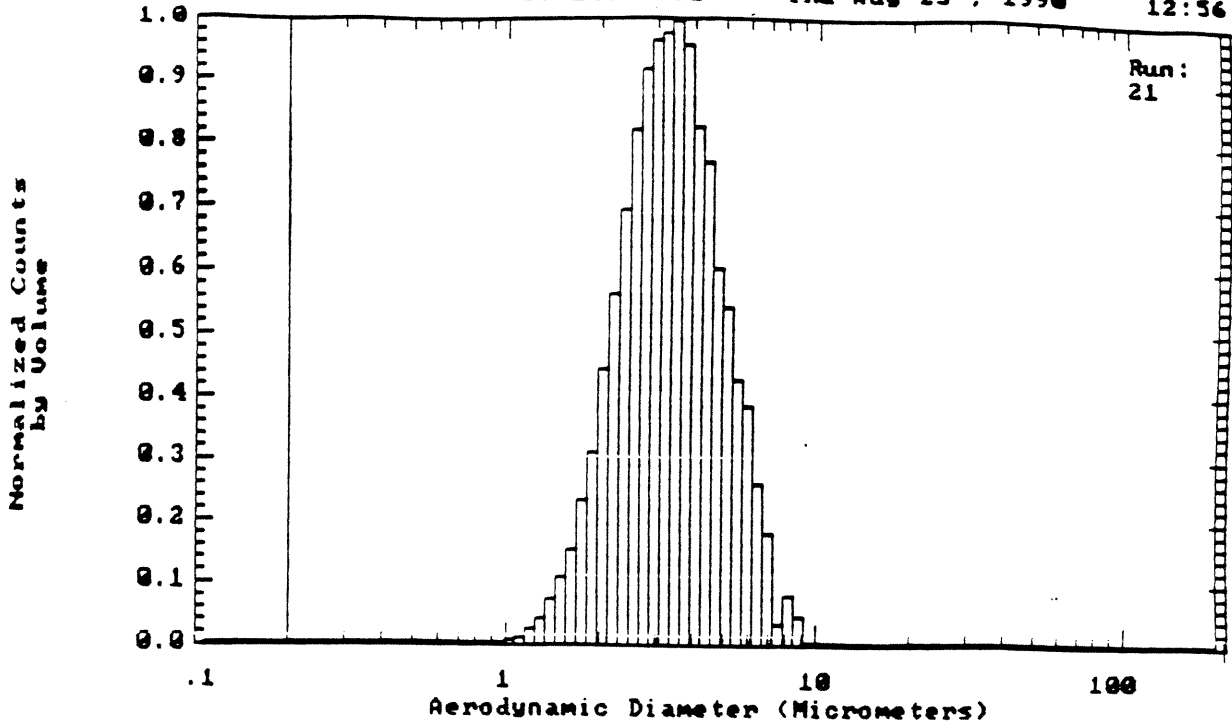
Run 19 — Thu Aug 23 12:51:32 1990  
 BECLMETHASONE WITHOUT

VOLUME DISTRIBUTION

X

PARAMETERS		DISPENSER CONTROL		UNDER	SIZE	UNDER	SIZE
Material	: Water	Flow Pressure	: 0	5%	2.22	55%	4.55
Density	: 1.00	Flow Increment	: 0	10%	2.55	60%	4.86
Run Length (sec)	: 8.1	Pulse Pressure	: 0	15%	2.80	65%	5.18
PMT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	3.02	70%	5.61
Laser Intensity	: 50	Nebulizer Press	: 0	25%	3.23	75%	6.07
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	3.44	80%	6.57
Sum of channels	: 25665 X	Low Flow Limit	: 2000	35%	3.65	85%	7.25
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	3.86	90%	8.37
Upper Size Limit	: 199.60			45%	4.06	95%	9.62 X
Geometric Mean Size	: 4.49	SCANS 19 AND 20 COMBINED		50%	4.29		
Geometric Std Deviation	: 1.55						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
		100.00	0.00	86.00	100.00	10.00	4.85	8.60	91.72	1.00	0.01	0.86	0.01		
		86.00	0.00	74.00	100.00	8.60	6.35	7.40	85.37	0.86	0.01	0.74	0.00		
		74.00	0.00	63.00	100.00	7.40	8.66	6.30	76.71	0.74	0.00	0.63	0.00		
		63.00	0.00	54.00	100.00	6.30	9.71	5.40	66.99	0.63	0.00	0.54	0.00		
		54.00	0.00	46.00	100.00	5.40	11.69	4.60	55.31	0.54	0.00	0.46	0.00		
		46.00	0.00	40.00	100.00	4.60	12.13	4.00	43.18	0.46	0.00	0.40	0.00		
		40.00	0.00	34.00	100.00	4.00	15.05	3.40	28.12	0.40	0.00	0.34	0.00		
		34.00	0.00	29.00	100.00	3.40	11.32	2.90	16.81	0.34	0.00	0.29	0.00		
		29.00	0.00	25.00	100.00	2.90	8.17	2.50	8.64	0.29	0.00	0.25	0.00		
		25.00	0.00	22.00	100.00	2.50	3.99	2.20	4.65	0.25	0.00	0.22	0.00		
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	3.22	1.80	1.43	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	0.75	1.60	0.68	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	0.44	1.40	0.24	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	0.18	1.20	0.07	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	3.43	10.00	96.57	1.20	0.05	1.00	0.02	0.12	0.00	0.10	0.00



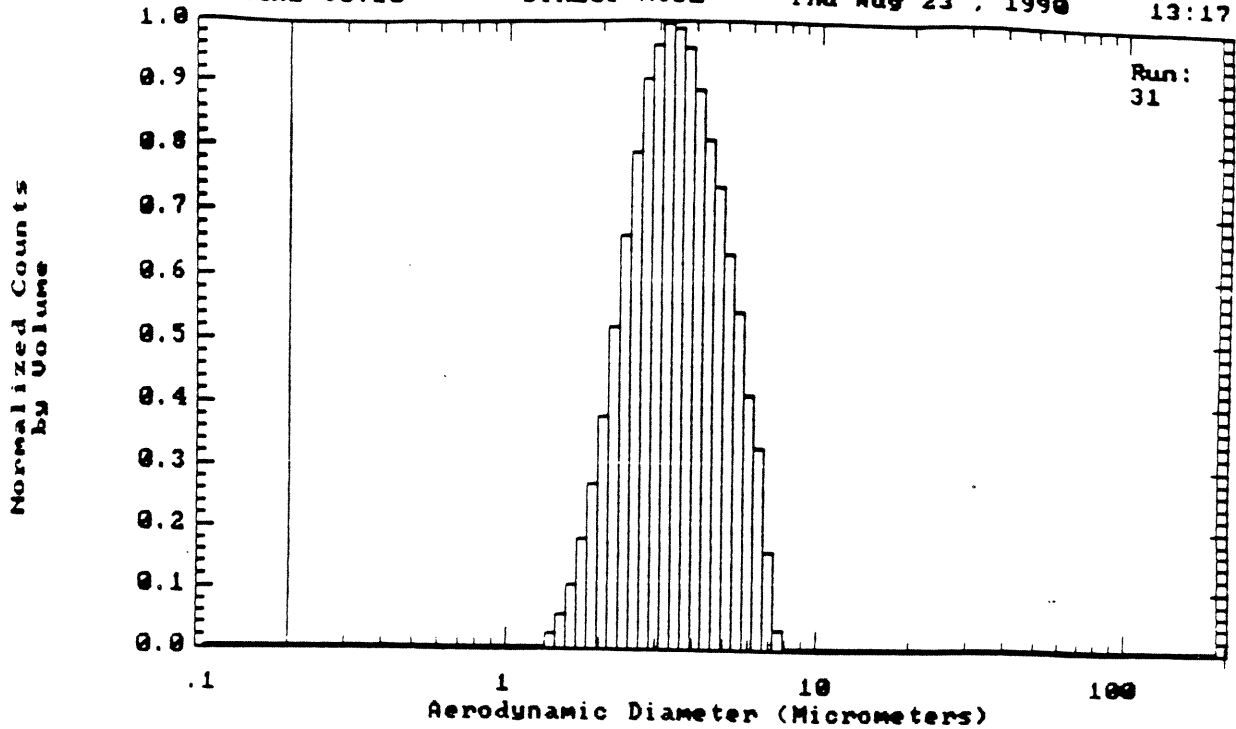
Run 21 — Thu Aug 23 12:56:00 1990  
 BECLONETHASONE WITH MICROSPACER

VOLUME DISTRIBUTION

PARAMETERS		DISPENSER CONTROL		LOWER	SIZE	LOWER	SIZE
Material	: Water	Flow Pressure	: 0	5%	2.08	55%	4.03
Density	: 1.00	Flow Increment	: 0	10%	2.38	60%	4.24
Run Length (sec)	: 7.9	Pulse Pressure	: 0	15%	2.59	65%	4.46
PWT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	2.79	70%	4.71
Laser Intensity	: 50	Nebulizer Press	: 0	25%	2.97	75%	4.99
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	3.14	80%	5.32
Sum of channels	: 21762 X	Low Flow Limit	: 2000	35%	3.31	85%	5.71
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	3.48	90%	6.15
Upper Size Limit	: 199.60			45%	3.66	95%	6.95 X
Geometric Mean Size	: 3.88	SCANS 21 AND 22 COMBINED		50%	3.84		
Geometric Std Deviation	: 1.44						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
		100.00	0.00	86.00	100.00	10.00	0.81	8.60	99.19	1.00	0.01	0.86	0.00		
		86.00	0.00	74.00	100.00	8.60	1.43	7.40	97.76	0.86	0.00	0.74	0.00		
		74.00	0.00	63.00	100.00	7.40	7.11	6.30	90.65	0.74	0.00	0.63	0.00		
		63.00	0.00	54.00	100.00	6.30	10.46	5.40	80.20	0.63	0.00	0.54	0.00		
		54.00	0.00	46.00	100.00	5.40	12.67	4.60	67.53	0.54	0.00	0.46	0.00		
		46.00	0.00	40.00	100.00	4.60	13.64	4.00	53.89	0.46	0.00	0.40	0.00		
		40.00	0.00	34.00	100.00	4.00	17.59	3.40	36.30	0.40	0.00	0.34	0.00		
		34.00	0.00	29.00	100.00	3.40	13.67	2.90	22.63	0.34	0.00	0.29	0.00		
		29.00	0.00	25.00	100.00	2.90	10.52	2.50	12.11	0.29	0.00	0.25	0.00		
		25.00	0.00	22.00	100.00	2.50	5.46	2.20	6.66	0.25	0.00	0.22	0.00		
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	4.59	1.80	2.07	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	1.17	1.60	0.90	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	0.60	1.40	0.30	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	0.24	1.20	0.06	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	0.00	10.00	100.00	1.20	0.05	1.00	0.01	0.12	0.00	0.10	0.00



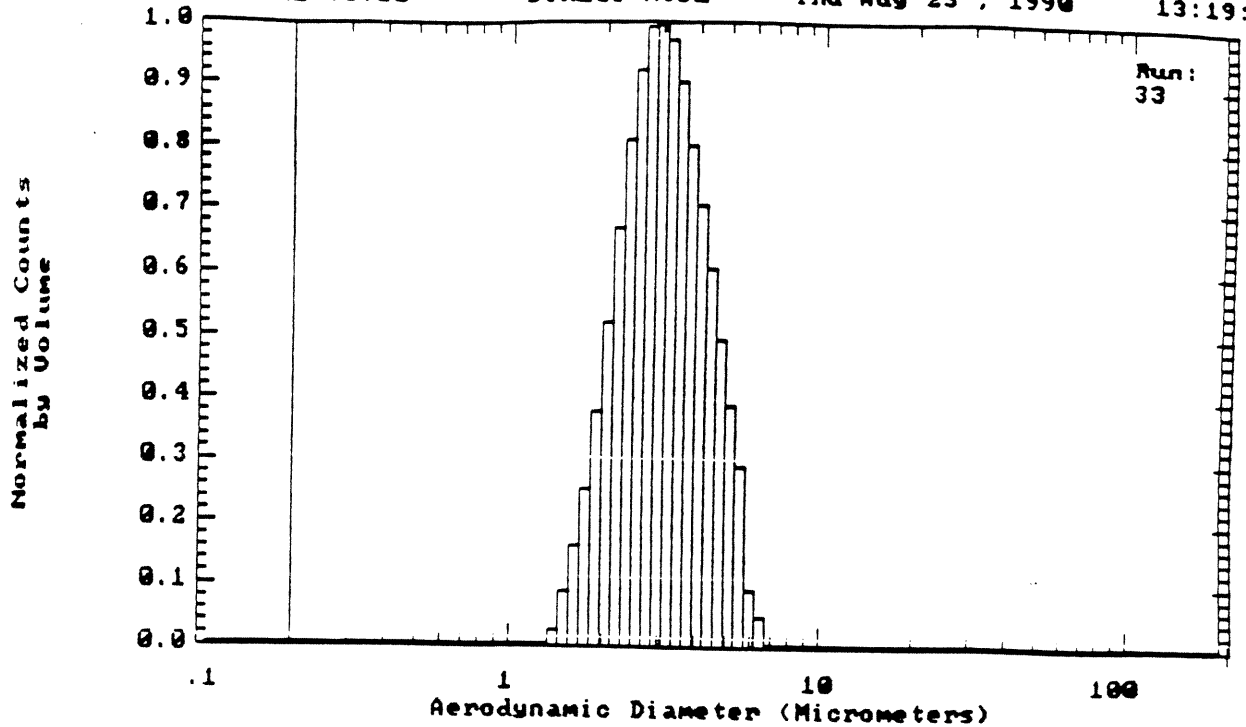


Run 31 — Thu Aug 23 13:17:22 1990  
 CROMOLYN SODIUM WITHOUT

VOLUME DISTRIBUTION

PARAMETERS		DISPENSER CONTROL		UNDER	SIZE	UNDER	SIZE
Material	: Water	Flow Pressure	: 0	5%	2.18	55%	4.13
Density	: 1.00	Flow Increment	: 0	10%	2.47	60%	4.34
Run Length (sec)	: 8.5	Pulse Pressure	: 0	15%	2.69	65%	4.55
PWT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	2.88	70%	4.78
Laser Intensity	: 49	Nebulizer Press	: 0	25%	3.06	75%	5.04
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	3.23	80%	5.31
Sum of channels	: 290527 X	Low Flow Limit	: 2000	35%	3.41	85%	5.62
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	3.58	90%	6.01
Upper Size Limit	: 199.60			45%	3.76	95%	6.46 X
Geometric Mean Size	: 3.94	SCANS 31 AND 32 COMBINED		50%	3.94		
Geometric Std Deviation	: 1.40						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
		100.00	0.00	86.00	100.00	10.00	0.00	8.60	100.00	1.00	0.00	0.86	0.00	0.00	0.00
		86.00	0.00	74.00	100.00	8.60	0.52	7.40	99.48	0.86	0.00	0.74	0.00	0.74	0.00
		74.00	0.00	63.00	100.00	7.40	7.11	6.30	92.37	0.74	0.00	0.63	0.00	0.63	0.00
		63.00	0.00	54.00	100.00	6.30	12.08	5.40	80.28	0.63	0.00	0.54	0.00	0.54	0.00
		54.00	0.00	46.00	100.00	5.40	14.91	4.60	65.37	0.54	0.00	0.46	0.00	0.46	0.00
		46.00	0.00	40.00	100.00	4.60	14.26	4.00	51.11	0.46	0.00	0.40	0.00	0.40	0.00
		40.00	0.00	34.00	100.00	4.00	17.33	3.40	33.79	0.40	0.00	0.34	0.00	0.34	0.00
		34.00	0.00	29.00	100.00	3.40	13.58	2.90	20.21	0.34	0.00	0.29	0.00	0.29	0.00
		29.00	0.00	25.00	100.00	2.90	10.06	2.50	10.14	0.29	0.00	0.25	0.00	0.25	0.00
		25.00	0.00	22.00	100.00	2.50	5.10	2.20	5.05	0.25	0.00	0.22	0.00	0.22	0.00
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	3.90	1.80	1.15	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	0.83	1.60	0.32	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	0.30	1.40	0.02	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	0.02	1.20	0.00	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	0.00	10.00	100.00	1.20	0.00	1.00	0.00	0.12	0.00	0.10	0.00



Run 33 — Thu Aug 23 13:19:06 1990  
 CROMOLYN SODIUM WITH MICROSPACER

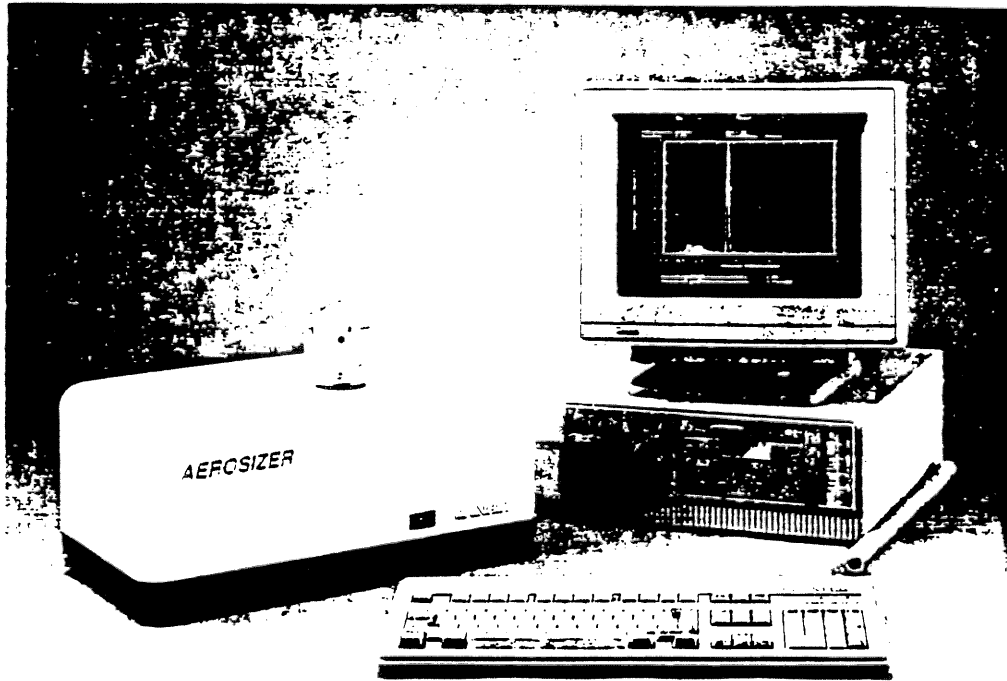
VOLUME DISTRIBUTION

PARAMETERS		DISPENSER CONTROL		UNDER	SIZE	UNDER	SIZE
Material	: Water	Flow Pressure	: 0	5%	2.00	55%	3.56
Density	: 1.00	Flow Increment	: 0	10%	2.23	60%	3.72
Run Length (sec)	: 9.7	Pulse Pressure	: 0	15%	2.41	65%	3.89
PMT Voltage (volts)	: 1100.0	Pulse Increment	: 0	20%	2.57	70%	4.08
Laser Intensity	: 49	Nebulizer Press	: 0	25%	2.71	75%	4.29
Clock Freq (MHz)	: 20.0	Nebulizer Inc	: 0	30%	2.85	80%	4.51
Sum of channels	: 185403 X	Low Flow Limit	: 2000	35%	2.99	85%	4.77
Lower Size Limit	: 0.20	High Flow Limit	: 99999	40%	3.12	90%	5.10
Upper Size Limit	: 199.60			45%	3.26	95%	5.47 X
Geometric Mean Size	: 3.44	SCANS 33 AND 34 COMBINED		50%	3.41		
Geometric Std Deviation	: 1.36						

UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER	UPPER SIZE	% IN	LOWER SIZE	% UNDER
				100.00	0.00	86.00	100.00	10.00	0.00	8.60	100.00	1.00	0.00	0.86	0.00
				86.00	0.00	74.00	100.00	8.60	0.00	7.40	100.00	0.86	0.00	0.74	0.00
				74.00	0.00	63.00	100.00	7.40	0.83	6.30	99.17	0.74	0.00	0.63	0.00
				63.00	0.00	54.00	100.00	6.30	5.96	5.40	93.21	0.63	0.00	0.54	0.00
				54.00	0.00	46.00	100.00	5.40	12.06	4.60	81.15	0.54	0.00	0.46	0.00
				46.00	0.00	40.00	100.00	4.60	13.80	4.00	67.36	0.46	0.00	0.40	0.00
				40.00	0.00	34.00	100.00	4.00	18.91	3.40	48.45	0.40	0.00	0.34	0.00
				34.00	0.00	29.00	100.00	3.40	17.22	2.90	31.23	0.34	0.00	0.29	0.00
				29.00	0.00	25.00	100.00	2.90	14.34	2.50	16.90	0.29	0.00	0.25	0.00
				25.00	0.00	22.00	100.00	2.50	8.02	2.20	8.88	0.25	0.00	0.22	0.00
220.00	0.00	180.00	100.00	22.00	0.00	18.00	100.00	2.20	6.78	1.80	2.09	0.22	0.00	0.18	0.00
180.00	0.00	160.00	100.00	18.00	0.00	16.00	100.00	1.80	1.54	1.60	0.56	0.18	0.00	0.16	0.00
160.00	0.00	140.00	100.00	16.00	0.00	14.00	100.00	1.60	0.56	1.40	0.00	0.16	0.00	0.14	0.00
140.00	0.00	120.00	100.00	14.00	0.00	12.00	100.00	1.40	0.00	1.20	0.00	0.14	0.00	0.12	0.00
120.00	0.00	100.00	100.00	12.00	0.00	10.00	100.00	1.20	0.00	1.00	0.00	0.12	0.00	0.10	0.00

# **malvern**

**API AeroSizer**



*High resolution particle size analyser*

# Aerosizer



When resolution is the key factor in particle size analysis, the Malvern API AeroSizer is the number one choice.

Ideal for all types of powder as well as suspensions and aerosols, the AeroSizer is especially suited to the detailed analysis of narrow or multimodal size distributions.

Another special feature is a facility to 'search out' small numbers of large particles in the presence of many small ones.

AeroSizer's simple, rugged design and high speed operation make it fast and easy to use. Samples can be analysed with little or no

preparation and the AeroSizer itself requires no calibration by the user.

Straightforward, menu-driven software operation and a wide choice of graphical and tabular results formats are provided by the fast 80286-based computer which comes complete with printer.

Built to the highest standards, the Malvern API AeroSizer has been designed to deal with the most demanding particle sizing applications encountered in today's research and quality control laboratories.

## Aerodynamic resolution plus laser accuracy

The striking performance of the Malvern API AeroSizer is based on two important factors – the aerodynamic separation of particles according to their size and the ability to measure particle velocities with very high precision.

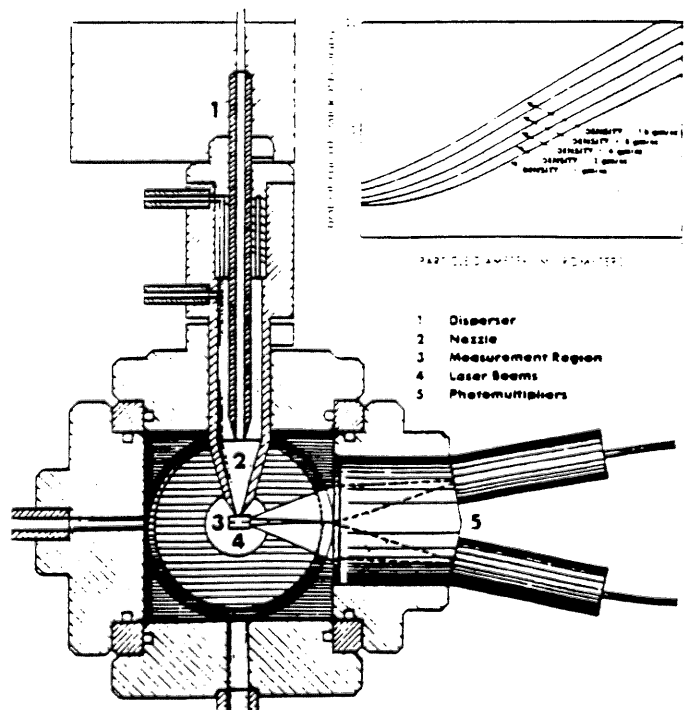
The particulate sample is first dispersed in air using either the dry powder feeder or, for suspensions, the specially designed nebulizer. The air-particle suspension is then passed through a nozzle and allowed to expand in a partial vacuum.

The air leaves the nozzle at near-sonic velocity and small particles are accelerated rapidly with the flow. Larger particles, due to their greater inertia, are accelerated more slowly. At a point downstream from the nozzle, the velocities of the individual particles are measured to determine their sizes.

In the measurement zone, the particles pass through two laser beams. As they do so, the light which they scatter is detected by two photomultipliers, one for each beam. The signals from the two detectors are analysed using correlation techniques to give each particle's time of flight between the two beams. This is achieved with an accuracy of better than one per cent.

In operation, the AeroSizer can measure up to 100,000 particles per second and determine times of flight with a precision of 0.025 microseconds. Particles differing in size by as little as 10% can be resolved, giving a number-based particle size distribution of great detail in the shortest possible time.

All this is achieved without the need for any sample specific information other than the particle density.

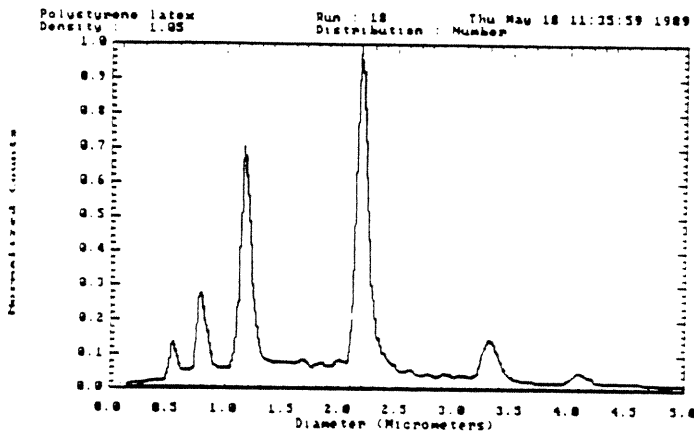


# Versatile AeroSizer

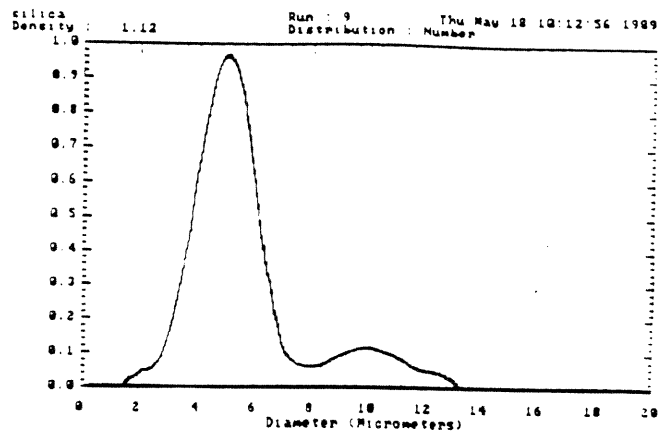


The AeroSizer has been designed with a wide range of samples in mind. Particles from below half a micron to over 200µm can be analysed and the examples shown here have been chosen both to demonstrate the AeroSizer's versatility and to illustrate some of the display and report options.

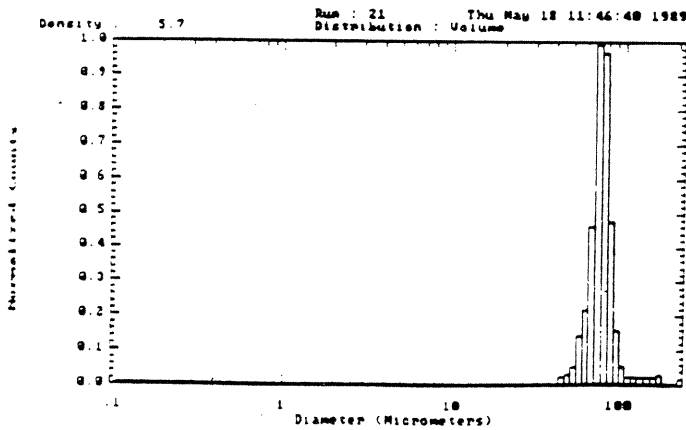
The excellent resolution of the AeroSizer is clear from this number distribution obtained for a mixed sample of six polystyrene latices which range in diameter from just over 0.5µm to about 4 microns. Results are presented as normalised counts against a linear 0-5µm size axis. The sample was dispersed using the suspension nebulizer.



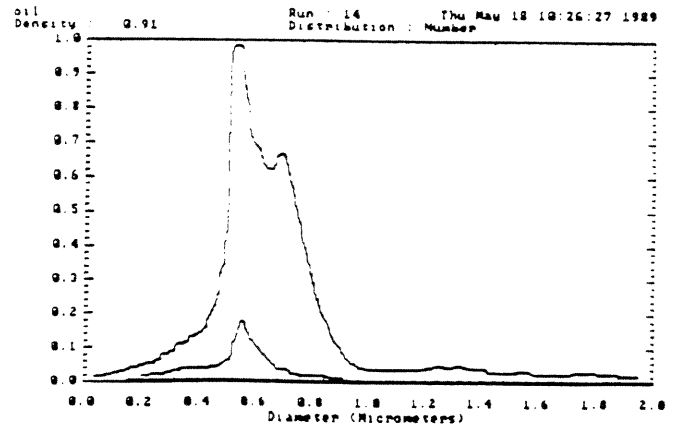
AeroSizer's ability to detect small quantities of larger particles in the presence of a predominance of smaller ones is illustrated by this example of 5 micron silica microspheres into which a small proportion of 10µm particles has been introduced. These silica particles are typical of the materials used as high performance chromatography adsorbents and particle size is a crucial factor in their specification. With the AeroSizer and its dry powder feeder, analysis of similar alumina or polymeric materials would be just as simple and effective.



Glass spheres of the type used in reflective paints are shown below in histogram form against a logarithmic particle size axis. The sample was introduced directly by means of the dry powder feeder attachment and the result is presented as a volume distribution.



Two oil mist samples analysed by direct injection into the unit show not only the effect of a filter but also the way the AeroSizer copes with complex distributions. The results are presented against a linear 0-2µm size axis and illustrate the effectiveness of being able to overlay different results for direct visual comparison.



# High resolution

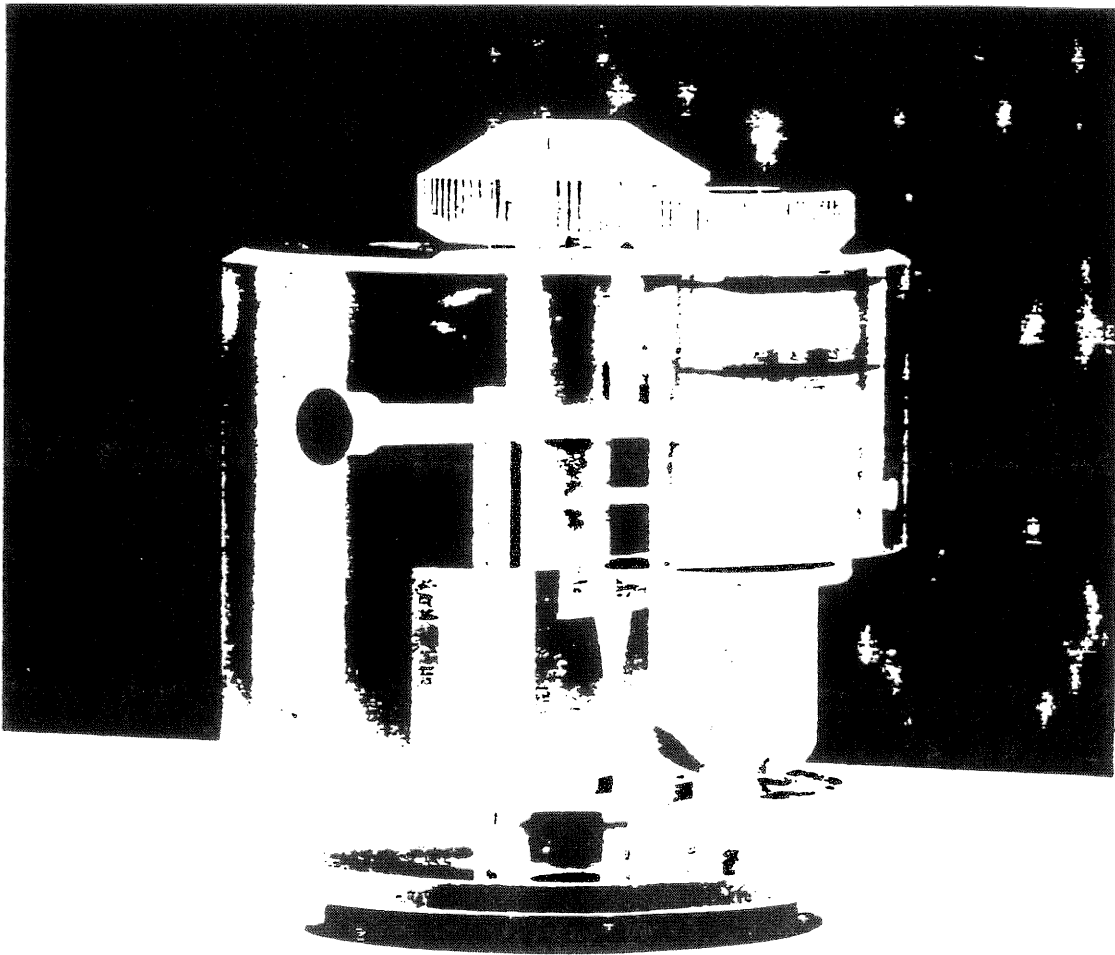
## Modular system design

The compact sensor module of the Malvern API AeroSizer houses the aerodynamic separation unit and the detector system with its low power helium-neon laser and associated optics, the two photomultipliers and their electronics.

Interchangeable sample dispersion units connect directly to the top of this module. No recalibration or realignment is required when changing from one sample type to another.

Six litres of air per minute (STP) is drawn in at a pressure of 0.1 bar and pressure is monitored at several points to ensure reliable operation.

The computer is a powerful IBM-compatible unit with fast 80286 processor and an integral coprocessor for even greater speed. It provides high resolution graphics – in colour or monochrome – and can be connected to a dot matrix, ink jet or laser printer for permanent hard copy results.



# and easy to use

## Flexible results formats

**T**he specially designed software of the Malvern API AeroSizer gives a wide range of options when it comes to results presentation.

In tabular form, every result can be presented in full detail with percentages of particles falling within or below each size band. A brief summary of instrument parameters and sample details is printed at the beginning of each report.

Being essentially a particle counter, the AeroSizer produces its primary data in the form of a number distribution. It is a simple software operation to convert this to any other form such as surface, weight or volume distribution.

For graphical results, the AeroSizer presents frequency distributions, histograms and cumulative undersize or oversize curves all with the clarity of high, 640 x 480, resolution.

```
Material      : Polystyrene latex
Density      : 1.05
Run Length sec : 13.670
PMT Voltage (volts) : 1000.00
Laser Intensity : 22
Clock Freq (MHz) : 40.00
Sum of channels : 3391
```

Upper Size	% in	Lower Size	% under	Upper Size	% in	Lower Size	% under	Upper Size	% in	Lower Size	% under	Upper Size	% in	Lower Size	% under
				100.00	0.32	86.00	98.91	10.00	1.59	8.60	90.52	1.00	2.19	0.86	67.15
				86.00	0.31	74.00	98.60	8.60	1.37	7.40	88.94	0.86	4.32	0.74	54.35
				74.00	0.28	63.00	98.28	7.40	1.33	6.30	87.57	0.74	9.39	0.63	60.13
				63.00	0.29	54.00	98.00	6.30	1.21	5.40	86.24	0.63	5.44	0.54	50.74
				54.00	0.33	46.00	97.72	5.40	1.02	4.60	85.03	0.54	4.84	0.46	45.30
				46.00	0.35	40.00	97.38	4.60	1.11	4.00	84.01	0.46	2.53	0.40	40.45
				40.00	0.38	34.00	97.04	4.00	1.36	3.40	82.39	0.40	3.06	0.34	37.32
				34.00	0.57	29.00	96.66	3.40	1.87	2.90	81.53	0.34	4.79	0.29	34.36
				29.00	0.52	25.00	96.09	2.90	1.82	2.50	79.66	0.29	2.10	0.25	30.07
				25.00	0.60	22.00	95.57	2.50	1.49	2.20	77.33	0.25	5.24	0.22	27.97
220.00	0.18	180.00	100.00	22.00	0.82	18.00	94.97	2.20	1.58	1.90	76.34	0.22	6.02	0.18	22.73
180.00	0.19	160.00	99.32	18.00	0.55	16.00	94.15	1.80	1.24	1.60	74.76	0.18	2.53	0.16	16.71
160.00	0.21	140.00	99.63	16.00	0.92	14.00	93.60	1.60	1.59	1.40	73.52	0.16	0.00	0.14	14.18
140.00	0.26	120.00	99.42	14.00	0.76	12.00	92.68	1.40	2.85	1.20	71.93	0.14	13.14	0.12	14.18
120.00	0.25	100.00	99.16	12.00	1.40	10.00	91.92	1.20	1.94	1.00	69.08	0.12	1.04	0.10	1.04

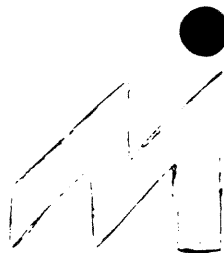
# Specification

<b>Model:</b>	API AeroSizer high resolution particle size analyser
<b>Applications:</b>	Powders, suspensions, aerosols
<b>Size range:</b>	Approximately 0.5 to 200 microns
<b>Principle of operation:</b>	Aerodynamic separation with laser time-of-flight velocity measurement
<b>Count rate:</b>	10 <sup>7</sup> particles per second (typical)
<b>Sample size:</b>	0mg to 1g depending upon particle size
<b>Sample dispersion accessories:</b>	Dry powder feeder, nebulizer for particles in suspension
<b>Sensor unit</b>	
<b>Description:</b>	Compact unit incorporating aerodynamic particle separation system, laser detector provision for attachment of interchangeable sample dispersion units
<b>Laser:</b>	5mW 632.8nm Helium-Neon
<b>Detector system:</b>	Dual photomultiplier
<b>Vacuum air requirements:</b>	5 l/min at 0.1 bar
<b>Computer:</b>	
<b>Description:</b>	16-bit IBM-compatible computer with 80286 33MHz processor and 80287 coprocessor
<b>Storage memory:</b>	640 KB RAM, 20 MB hard disk, 12 MB 3.5" floppy disk drive
<b>Display:</b>	High resolution (640 x 480) 14" colour VGA compatible
<b>Keyboard:</b>	102 key
<b>Interfaces:</b>	Malvern API AeroSizer interface, RS232C and parallel printer interfaces
<b>Printer:</b>	IBM graphics compatible 30 column dot matrix ink jet or laser printer optional
<b>Software:</b>	
<b>Description:</b>	Proprietary Malvern API AeroSizer software: menu driven operation, wide range of results formats
<b>Results presentations:</b>	Diagram and tabular formats including tabular results giving percentage in and percentage below 50 size classes, cumulative undersize and oversize distributions, frequency histogram, variable load, linear and logarithmic size ranges, normalised counts, number distributions transformable to surface, weight or volume distributions, difference plots, sample details and parameters recorded.
<b>General:</b>	
<b>Dimensions/weights:</b>	Sensor 460 x 265 x 225 mm, 10kg Pump 440 x 180 x 215 mm, 20kg Computer 410 x 393 x 424 mm, 24kg
<b>Power requirements:</b>	110, 24V, 50/60Hz, including dry powder feeder

In accordance with our policy of continual product development, specifications may be altered without notice.

## Ordering information

Model number	Description
AE1003	AeroSizer system complete. Consists of sensor unit, dry powder feeder, computer with high resolution colour display, coprocessor, AeroSizer software, dot matrix printer, vacuum pump with oil mist trap and filter. For aerosols and dry powder samples.
AE1005	AeroSizer system complete. As AE1003 but excluding dry powder feeder.
<b>Options and Accessories</b>	
AE5	Nebulizer. For dispersing samples in liquid suspension
AE64	Dry Powder Feeder.
PR002	Ink Jet Printer. Supplied in place of standard dot matrix printer when ordered with either AE1003 or AE1005.
PR003	Ink Jet Printer. Supplied separately or in addition to AE1003 or AE1005.
PR004	Laser Printer. 300 x 300 dots per inch, 8 pages per minute laser printer supplied with AE1003 or AE1005 in place of standard dot matrix printer.
PR005	As PR004 but supplied separately or in addition to AE1003 or AE1005.



**Malvern**

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