

PARTICLE SIZE ANALYSIS

Sample Description

Mono ammonium phosphate powder is submitted for image analysis.

Purpose of Analysis

Demonstrate the ability of Clemex Vision image analysis system can discriminate the particles and perform size measurements.

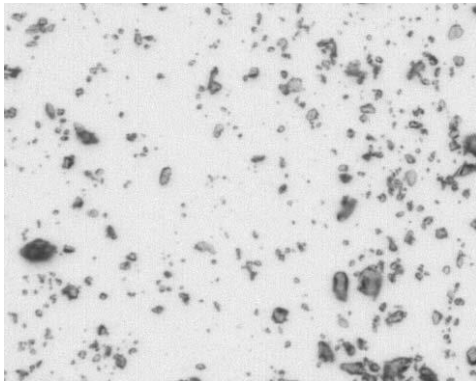


Figure 1: Part of the original image (0.6173 $\mu\text{m}/\text{pixel}$).

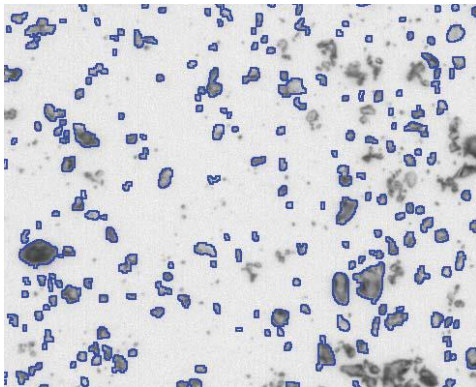


Figure 2: Outline of particles as measured in blue bitplane.

Procedure¹

A small part of the sample was dispersed on a slide for analysis. A Guard Frame was used to avoid measuring features sectioned by the field of view. Particles were binarized in blue using Contrast Thresholding.

Holes were filled and artifacts were removed during the analysis. Connected particles were eliminated prior to measurements.

Equipment

Image Analysis System: Clemex Vision PE
Microscope: Leica Z6 APOA with transmitted light
Camera: Clemex L 2.1M
Magnification: 72X
Stage: Marzhauser EK32IM 75x50mm

Results²

Length, Circular Diameter, Width and Ellipsoidal Volume measurements were performed on each feature. Automated statistics and graphs were generated. Final results can be printed directly from Clemex Vision. Raw data are linked to their respective objects for validation purpose. Raw data can also be exported in Excel format.

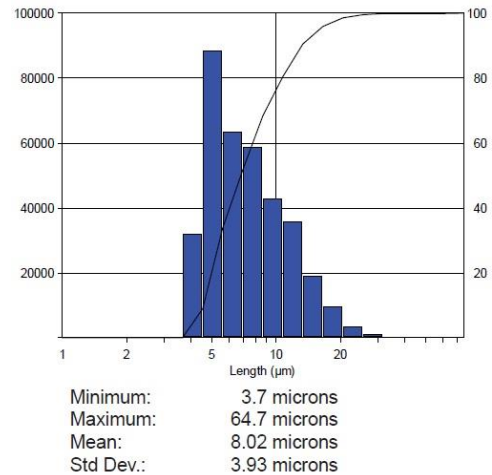


Figure 3: Particles' Length distribution and corresponding statistics.

¹ Images taken during the procedure are available in appendix A
² Complete results are available in appendix B

Appendix A: Image Analysis Steps

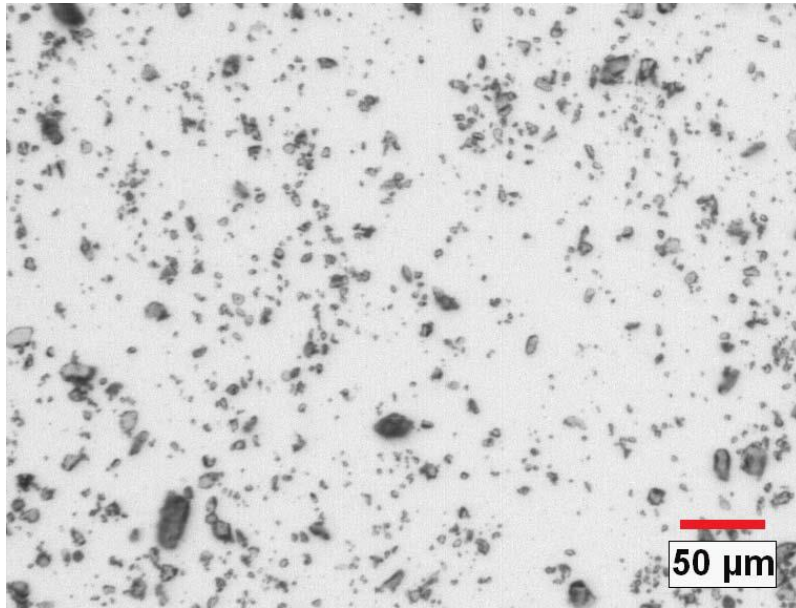


Image 1: Part of the original image at 72X magnification (0.6173 microns/pixel).

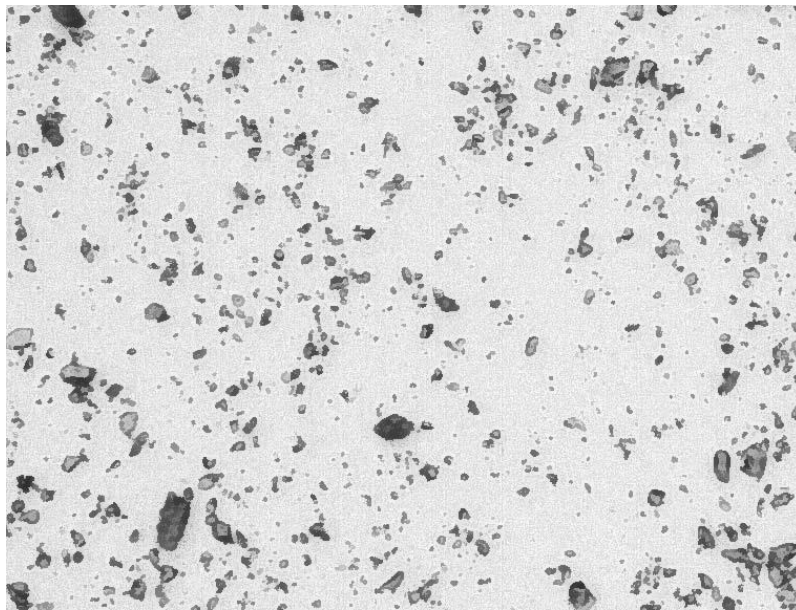


Image 2: Gray image enhanced by a delineate.

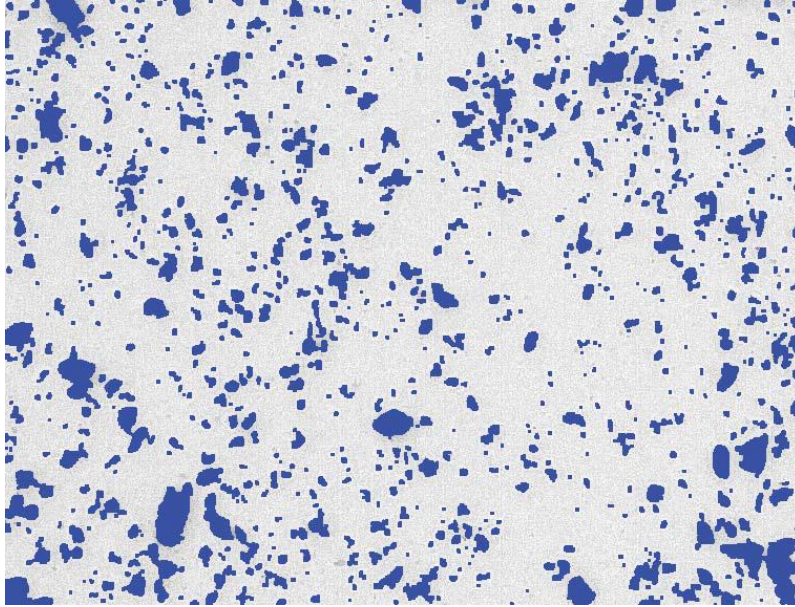


Image 3: Particles as binarized in blue using contrast thresholding.

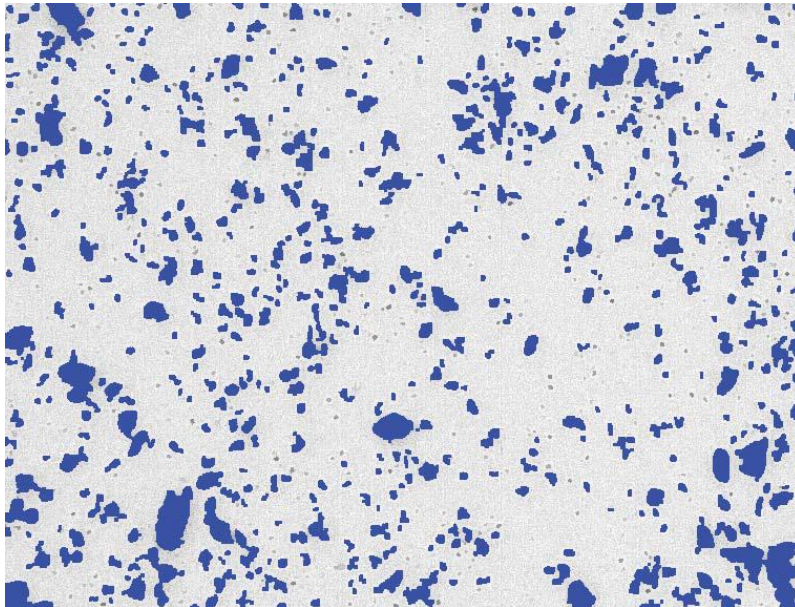


Image 4: Same view after filling holes and eliminating small artifacts.

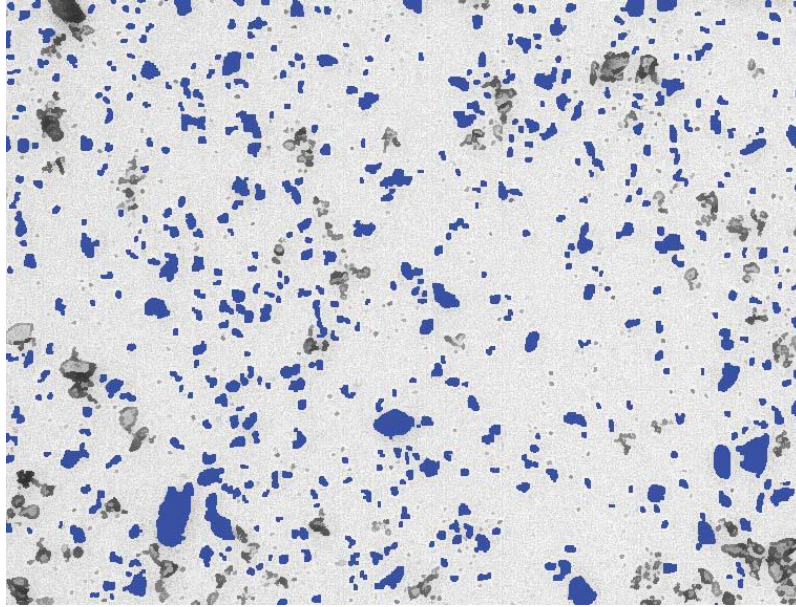


Image 5: Clusters were eliminated based on their roughness.

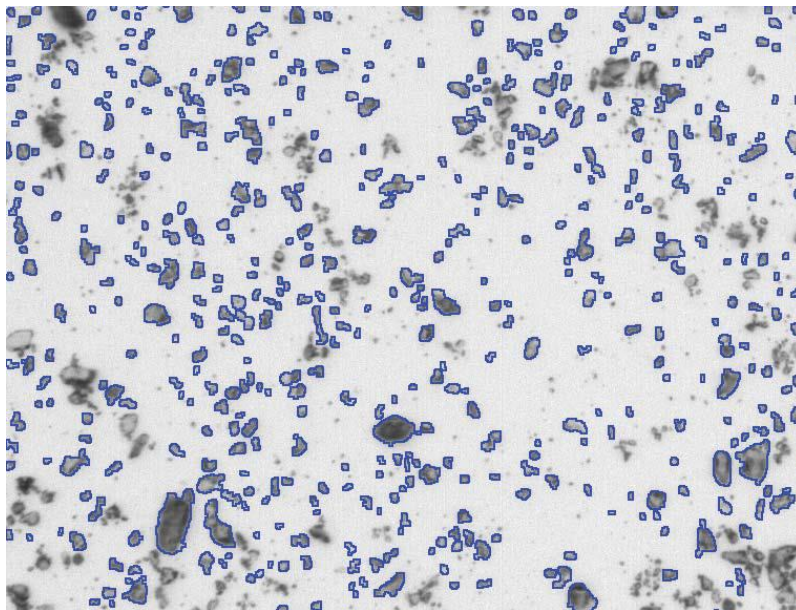
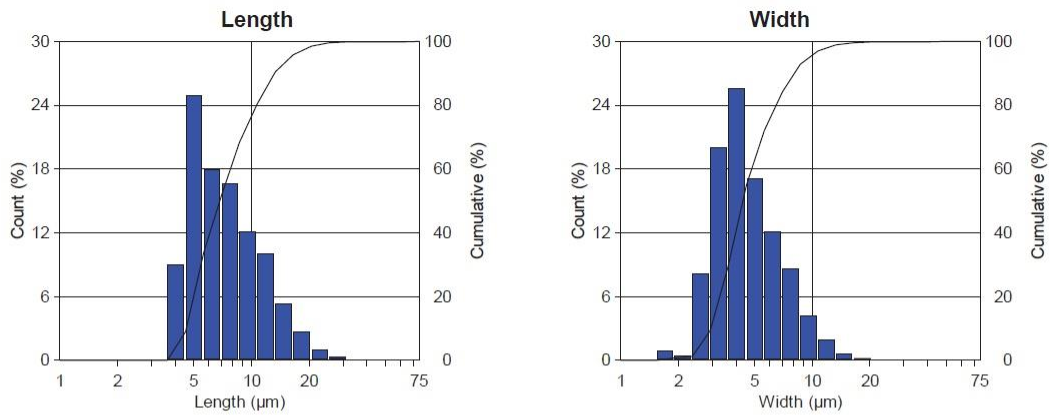


Image 6: Outline view of the particles as measured; on top of the original image.

Appendix B: Results
Sample #1

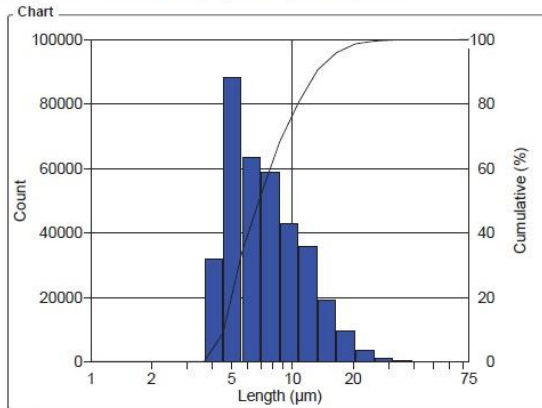

Figure 1. Field of view showing the longest particle found in the analysis.



Min:	3.70	microns	1.85	microns
Max.:	64.74	microns	42.05	microns
Mean:	8.02	microns	5.00	microns
Std. Dev.:	3.93	microns	2.36	microns
D10:	4.49	microns	3.01	microns
D50:	6.78	microns	4.29	microns
D90:	13.20	microns	7.98	microns

OBJM1 Count - Length

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1



Values

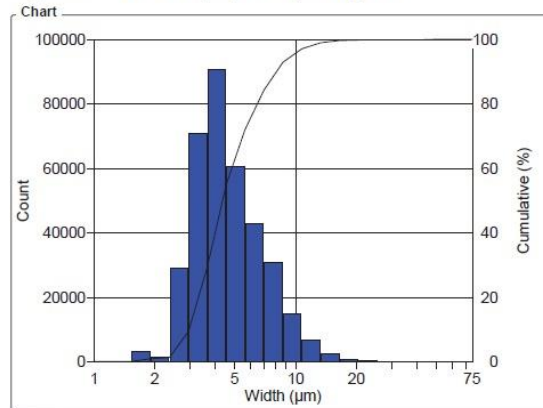
Length Intervals (µm)	Count	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	0	0	0
1.9 - 2.4	0	0	0
2.4 - 2.9	0	0	0
2.9 - 3.7	0	0	0
3.7 - 4.5	31804	8.97	8.97
4.5 - 5.6	88255	24.90	33.88
5.6 - 7	63464	17.91	51.78
7 - 8.7	58845	16.60	68.39
8.7 - 10.7	42907	12.11	80.49
10.7 - 13.3	35690	10.07	90.56
13.3 - 16.5	19056	5.38	95.94
16.5 - 20.5	9588	2.71	98.64
20.5 - 25.5	3468	0.98	99.62
25.5 - 31.6	990	0.28	99.90
31.6 - 39.2	274	0.08	99.98
39.2 - 49	60	0.02	100.00
49 - 60	8	2.26e-03	100.00
60 - 75	4	1.13e-03	100

Statistics

Minimum:	3.7	µm
Maximum:	64.7	µm
Mean:	8.02	µm
Std Dev.:	3.93	µm
Sum:	2841926.5	µm
Count:	354413	
Under:	0	
Over:	0	
Accepted:	100	%
Field Count:	310	
Field Area:	727331.2	µm ²
Total Area:	225.5e+06	µm ²
D10:	4.5	µm
D50:	6.8	µm
D90:	13.2	µm

OBJM1 Count - Width

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1



Values

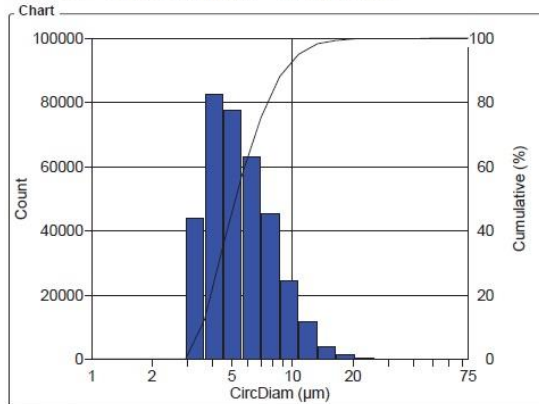
Width Intervals (µm)	Count	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	3153	0.89	0.89
1.9 - 2.4	1426	0.40	1.29
2.4 - 2.9	28991	8.18	9.47
2.9 - 3.7	70904	20.01	29.48
3.7 - 4.5	90620	25.57	55.05
4.5 - 5.6	60645	17.11	72.16
5.6 - 7	42998	12.13	84.29
7 - 8.7	30714	8.67	92.96
8.7 - 10.7	14816	4.18	97.14
10.7 - 13.3	6690	1.89	99.02
13.3 - 16.5	2355	0.66	99.69
16.5 - 20.5	786	0.22	99.91
20.5 - 25.5	239	0.07	99.98
25.5 - 31.6	65	0.02	100.00
31.6 - 39.2	10	2.83e-03	100.00
39.2 - 49	1	280.14e-06	100
49 - 60	0	0	100
60 - 75	0	0	100

Statistics

Minimum:	1.9	µm
Maximum:	42.1	µm
Mean:	5.00	µm
Std Dev.:	2.36	µm
Sum:	1770392.1	µm
Count:	354413	
Under:	0	
Over:	0	
Accepted:	100	%
Field Count:	310	
Field Area:	727331.2	µm ²
Total Area:	225.5e+06	µm ²
D10:	3.0	µm
D50:	4.3	µm
D90:	8.0	µm

OBJM1 Count - CircDiam

Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1

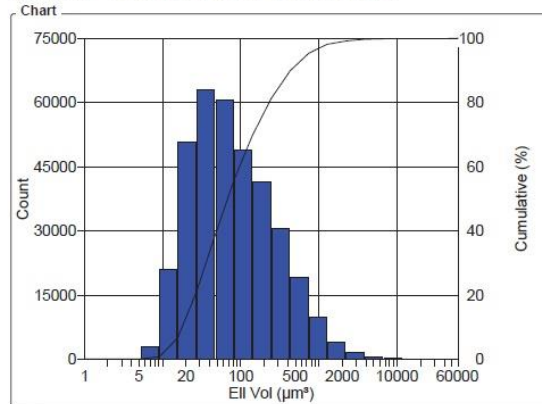


Values				
CircDiam Intervals (µm)	Count	%	Cumul%	
1 - 1.2	0	0	0	0
1.2 - 1.5	0	0	0	0
1.5 - 1.9	0	0	0	0
1.9 - 2.4	0	0	0	0
2.4 - 2.9	6	1.69e-03	1.69e-03	
2.9 - 3.7	43926	12.39	12.40	
3.7 - 4.5	82585	23.30	35.70	
4.5 - 5.6	77509	21.87	57.57	
5.6 - 7	62989	17.77	75.34	
7 - 8.7	45199	12.75	88.09	
8.7 - 10.7	24457	6.90	94.99	
10.7 - 13.3	11706	3.30	98.30	
13.3 - 16.5	4106	1.16	99.46	
16.5 - 20.5	1348	0.38	99.84	
20.5 - 25.5	429	0.12	99.96	
25.5 - 31.6	127	0.04	99.99	
31.6 - 39.2	22	6.21e-03	100.00	
39.2 - 49	4	1.13e-03	100	
49 - 60	0	0	100	
60 - 75	0	0	100	

Statistics	
Minimum:	2.4 µm
Maximum:	46.6 µm
Mean:	5.88 µm
Std Dev.:	2.53 µm
Sum:	2084275.5 µm
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm²
Total Area:	225.5e+06 µm²
D10:	3.6 µm
D50:	5.1 µm
D90:	9.1 µm

OBJM1 Count - Ell Vol

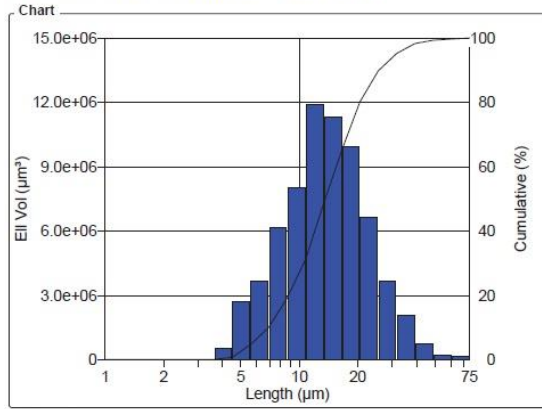
Magn.: 72x Calib.: 0.6173 µm/pixel Bitplane: Bitplane 1



Values				
Ell Vol Intervals (µm³)	Count	%	Cumul%	
1 - 1.7	0	0	0	0
1.7 - 3	0	0	0	0
3 - 5.2	0	0	0	0
5.2 - 9	2834	0.80	0.80	
9 - 16	20981	5.92	6.72	
16 - 27	50684	14.30	21.02	
27 - 47	62853	17.73	38.75	
47 - 82	60512	17.07	55.83	
82 - 141	49076	13.85	69.68	
141 - 245	41342	11.66	81.34	
245 - 425	30492	8.60	89.94	
425 - 736	19157	5.41	95.35	
736 - 1276	9879	2.79	98.14	
1276 - 2212	4103	1.16	99.29	
2212 - 3834	1611	0.45	99.75	
3834 - 6645	590	0.17	99.92	
6645 - 11519	213	0.06	99.98	
11519 - 19968	67	0.02	99.99	
19968 - 34613	16	4.51e-03	100.00	
34613 - 60000	3	846.39e-06	100	

Statistics	
Minimum:	6.7 µm³
Maximum:	58442.6 µm³
Mean:	191.1 µm³
Std Dev.:	514.8 µm³
Sum:	67.7e+06 µm³
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 µm²
Total Area:	225.5e+06 µm²
D10:	20.7 µm³
D50:	66.9 µm³
D90:	426.9 µm³

OBJM1 Ell Vol - Length

 Magn.: 72x Calib.: 0.6173 $\mu\text{m}/\text{pixel}$ Bitplane: Bitplane 1


Values

Length Intervals (μm)	Ell Vol (μm^3)	%	Cumul%
1 - 1.2	0	0	0
1.2 - 1.5	0	0	0
1.5 - 1.9	0	0	0
1.9 - 2.4	0	0	0
2.4 - 2.9	0	0	0
2.9 - 3.7	0	0	0
3.7 - 4.5	517374.4	0.76	0.76
4.5 - 5.6	2712060	4.01	4.77
5.6 - 7	3667514	5.42	10.19
7 - 8.7	6156431.5	9.09	19.28
8.7 - 10.7	8017631	11.84	31.12
10.7 - 13.3	11.9e+06	17.62	48.74
13.3 - 16.5	11.3e+06	16.74	65.48
16.5 - 20.5	9940544	14.68	80.16
20.5 - 25.5	6607099.5	9.76	89.92
25.5 - 31.6	3643118.3	5.38	95.30
31.6 - 39.2	2075493.5	3.07	98.36
39.2 - 49	744346.6	1.10	99.46
49 - 60	200417.8	0.30	99.76
60 - 75	165003.5	0.24	100

Statistics

Minimum:	3.7 μm
Maximum:	64.7 μm
Mean:	15.3 μm
Std Dev.:	8.12 μm
Sum:	1.0e+09 μm
Count:	354413
Under:	0
Over:	0
Accepted:	100 %
Field Count:	310
Field Area:	727331.2 μm^2
Total Area:	225.5e+06 μm^2
D10:	6.9 μm
D50:	13.6 μm
D90:	25.5 μm