

Dynamic light scattering using 300 μ L volume samples:

Raw data:

Size	Size 1	Size 2	Size 3	Size Average	Size SD
Control	88.9	86.35	85.51	86.9	1.8
Dropped 130 cm	87.69	84.96	84.72	85.8	1.6
Shaken (mod.) 10s	96.8	93.15	92.44	94.1	2.3
Vortex 10s	148.2	151.9	153	151.0	2.5

Polydispersity Index	PD 1	PD 2	PD 3	PD Average	PD SD
Control	0.181	0.152	0.186	0.173	0.018
Dropped 130 cm	0.185	0.176	0.204	0.188	0.014
Shaken (mod.) 10s	0.213	0.232	0.211	0.219	0.012
Vortex 10s	0.522	0.446	0.453	0.474	0.042

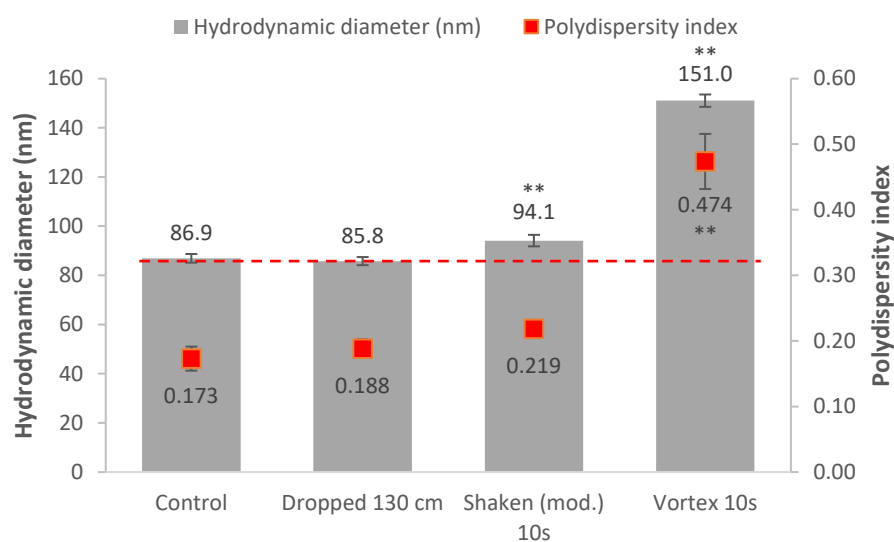


Figure S1: Hydrodynamic diameter (left axis) and polydispersity index (right axis) of COVID-19 Pfizer/BioNTech vaccine nanoparticles after dropping from 130 cm, shaking moderately for 10s, or vortexing for 10s. Sample size was 300 μ L. Numbers above bars are hydrodynamic diameter values (nm). Numbers below the scatter points are polydispersity indices. Each data point was an average of 3 measurements \pm standard deviation. (**) indicates a significant difference when compared to the control (ANOVA with Dunnett post-test; $p < 0.01$).

Raw data of size measurements by dynamic light scattering

Raw data for figure 1

Size	Size 1	Size 2	Size 3	Size average	Size SD
Control	91.34	90.01	89.64	90.3	0.89
Inverted gently 10x	90.17	90.51	90.31	90.3	0.17
Flicked 10x	96.39	93.47	93.5	94.5	1.68
Shaken (mod.) 10x	96.67	95.56	96.94	96.4	0.73
Shaken (vig.) 10s	130.5	126.1	126.7	127.8	2.39
Vortex 10s	161.9	153.5	148.4	154.6	6.82

Polydispersity Index	PD 1	PD 2	PD 3	PD average	PD SD
Control	0.184	0.21	0.212	0.202	0.016
Inverted gently 10x	0.187	0.202	0.205	0.198	0.010
Flicked 10x	0.223	0.236	0.21	0.223	0.013
Shaken (mod.) 10x	0.251	0.255	0.259	0.255	0.004
Shaken (vig.) 10s	0.416	0.416	0.429	0.420	0.008
Vortex 10s	0.36	0.395	0.383	0.379	0.018

Raw data for figure 2

Size	Size 1	Size 2	Size 3	Size average	Size SD
Control	86.87	86.09	84.28	85.7	1.33
Knocked over	89.69	85.69	84.53	86.6	2.71
Dropped 10 cm	92.12	88.11	85.54	88.6	3.32
Dropped 30 cm	89.83	87.25	86.08	87.7	1.92
Dropped 130 cm	92.14	87.2	86.93	88.8	2.93

Polydispersity	PD1	PD2	PD3	PD average	PD SD
Control	0.17	0.175	0.161	0.169	0.007
Knocked over	0.189	0.162	0.158	0.170	0.017
Dropped 10 cm	0.164	0.174	0.193	0.177	0.015
Dropped 30 cm	0.17	0.158	0.179	0.169	0.011
Dropped 130 cm	0.205	0.208	0.182	0.198	0.014

Raw data for figure 3

Size	Size 1	Size 2	Size 3	Size average	Size PD
Control	92.3	93.93	93.69	93.3	0.880
10s x1	95.43	92.82	91.58	93.3	1.965
10s x3	98.3	93.89	93.91	95.4	2.540
10s x5	96.97	95.62	92.84	95.1	2.106
3s x1	97.38	93.96	93.91	95.1	1.989
3s x3	98.74	94.44	94.25	95.8	2.539
3s x5	99.66	95.64	94.21	96.5	2.826
2s x1	98.68	94.08	92.96	95.2	3.031
2s x3	98.93	95.64	94.02	96.2	2.502
2s x5	99.02	95.94	95.97	97.0	1.770
1s x1	96.82	93.49	94.19	94.8	1.756
1s x3	99.96	95.77	95.27	97.0	2.576
1s x5	101.9	100	98.13	100.0	1.885

Polydispersity	PD1	PD2	PD3	PD average	PD SD
Control	0.178	0.177	0.18	0.178	0.002
10s x1	0.178	0.207	0.17	0.185	0.019
10s x3	0.187	0.189	0.179	0.185	0.005
10s x5	0.169	0.183	0.201	0.184	0.016
3s x1	0.172	0.191	0.198	0.187	0.013
3s x3	0.208	0.18	0.205	0.198	0.015
3s x5	0.211	0.192	0.203	0.202	0.010
2s x1	0.214	0.189	0.198	0.200	0.013
2s x3	0.195	0.191	0.188	0.191	0.004
2s x5	0.197	0.202	0.193	0.197	0.005
1s x1	0.202	0.204	0.188	0.198	0.009
1s x3	0.19	0.207	0.225	0.207	0.018
1s x5	0.211	0.209	0.222	0.214	0.007

Raw data for intensity curves

Figure 1c - raw data

Intensity	Control	Inverted gently 10x	Flicked 10x
0.4	0	0	0
0.463	0	0	0
0.536	0	0	0
0.621	0	0	0
0.719	0	0	0
0.833	0	0	0
0.965	0	0	0
1.12	0	0	0
1.29	0	0	0
1.5	0	0	0
1.74	0	0	0
2.01	0	0	0
2.33	0	0	0
2.7	0	0	0
3.12	0	0	0
3.62	0	0	0
4.19	0	0	0
4.85	0	0	0
5.61	0	0	0
6.5	0	0	0
7.53	0	0	0
8.72	0	0	0
10.1	0	0	0
11.7	0	0	0
13.5	0	0	0
15.7	0	0	0
18.2	0	0	0
21	0	0	0
24.4	0	0	0
28.2	0	0	0.030333
32.7	0	0	0.245333
37.8	0.563	0	0.945
43.8	2.26	1.31	2.6
50.7	4.93	4.17	4.996667
58.8	8.04	7.77	7.626667
68.1	10.9	11.1	9.94
78.8	13	13.4	11.56667
91.3	13.8	14.2	12.2
106	13.3	13.5	11.83333
122	11.6	11.5	10.57667
142	9.05	8.85	8.706667
164	6.15	5.96	6.536667

190	3.44	3.37	4.386667
220	1.4	1.45	2.553333
255	0.283	0.357	1.229333
295	0	0	0.460667
342	0	0	0.146667
396	0	0	0.030667
459	0	0	0
531	0	0	0
615	0	0	0
712	0	0	0
825	0	0	0
955	0	0	0
1.11E+03	0	0	0
1.28E+03	0	0	0
1.48E+03	0	0	0
1.72E+03	0	0	0.004
1.99E+03	0	0	0.0192
2.30E+03	0	0.0204	0.0615
2.67E+03	0	0.102	0.139333
3.09E+03	0	0.248	0.2678
3.58E+03	0	0.437	0.45
4.15E+03	0.131	0.629	0.656333
4.80E+03	0.393	0.784	0.841333
5.56E+03	0.697	0.861	0.954667
6.44E+03	0	0	0
7.46E+03	0	0	0
8.63E+03	0	0	0

Figure 1d –
raw data

X Intensity	Control	Shaken (mod.) 10x	Shaken (vig.) 10s	Vortexed 10s
0.4	0	0	0	0
0.463	0	0	0	0
0.536	0	0	0	0
0.621	0	0	0	0
0.719	0	0	0	0
0.833	0	0	0	0
0.965	0	0	0	0
1.12	0	0	0	0
1.29	0	0	0	0
1.5	0	0	0	0
1.74	0	0	0	0
2.01	0	0	0	0

2.33	0	0	0	0
2.7	0	0	0	0
3.12	0	0	0	0
3.62	0	0	0	0
4.19	0	0	0	0
4.85	0	0	0	0
5.61	0	0	0	0
6.5	0	0	0	0
7.53	0	0	0	0
8.72	0	0	0	0
10.1	0	0	0	0
11.7	0	0	0	0
13.5	0	0	0	0
15.7	0	0	0	0
18.2	0	0	0	0
21	0	0	0	0
24.4	0	0	0	0
28.2	0	0	0	0
32.7	0	0	0.119	0.05
37.8	0.563	0.488	0.443333	0.307667
43.8	2.26	2.34	1.470667	1.078
50.7	4.93	5.14	3.726667	2.2
58.8	8.04	8.09	6.356667	3.396667
68.1	10.9	10.5	8.36	4.463333
78.8	13	11.8	9.166667	5.336667
91.3	13.8	11.9	8.68	6.023333
106	13.3	11	7.296667	6.58
122	11.6	9.37	5.503333	7.046667
142	9.05	7.28	3.83	7.41
164	6.15	5.14	2.65	7.633333
190	3.44	3.21	2.12	7.643333
220	1.4	1.71	2.15	7.366667
255	0.283	0.704	2.470967	6.773333
295	0	0.172	3.012667	5.876667
342	0	0	3.623333	4.743333
396	0	0	4.146667	3.503333
459	0	0.0953	4.44	2.31
531	0	0.276	4.426667	1.317333
615	0	0.512	4.096667	0.641
712	0	0.764	3.493333	0.307633
825	0	0.994	2.713333	0.209
955	0	1.17	1.889	0.154333
1110	0	1.27	1.137333	0.118667
1280	0	1.28	0.5595	0.102
1480	0	1.21	0.202	0.103667
1720	0	1.08	0.027467	0.124333

1990	0	0.887	0	0.163667
2300	0	0.674	0.013067	0.219
2670	0	0.461	0.049667	0.332667
3090	0	0.273	0.121533	0.540433
3580	0	0.129	0.234	0.883
4150	0.131	0.0396	0.371333	1.311667
4800	0.393	0.0019	0.502	1.726667
5560	0.697	0	0.589667	2.003333
6440	0	0	0	0
7460	0	0	0	0
8630	0	0	0	0

Figure 3c -
raw data

X Intensity	Control	2s (x1)	2s (x3)	2s (x5)
0.4	0	0	0	0
0.463	0	0	0	0
0.536	0	0	0	0
0.621	0	0	0	0
0.719	0	0	0	0
0.833	0	0	0	0
0.965	0	0	0	0
1.12	0	0	0	0
1.29	0	0	0	0
1.5	0	0	0	0
1.74	0	0	0	0
2.01	0	0	0	0
2.33	0	0	0	0
2.7	0	0	0	0
3.12	0	0	0	0
3.62	0	0	0	0
4.19	0	0	0	0
4.85	0	0	0	0
5.61	0	0	0	0
6.5	0	0	0	0
7.53	0	0	0	0
8.72	0	0	0	0
10.1	0	0	0	0
11.7	0	0	0	0
13.5	0	0	0	0
15.7	0	0	0	0
18.2	0	0	0	0
21	0	0	0	0
24.4	0	0	0	0
28.2	0	0	0	0
32.7	0	0	0.138	0.109333

37.8	0.293667	0.252067	0.770333	0.504
43.8	1.88	1.803333	2.115333	1.88
50.7	4.67	4.493333	4.293333	4.343333
58.8	7.96	7.643333	6.9	7.27
68.1	10.96667	10.50667	9.4	9.906667
78.8	12.96667	12.5	11.25	11.73
91.3	13.7	13.3	12.21	12.43333
106	13.03333	12.86667	12.2	12.03333
122	11.23333	11.33333	11.18	10.76667
142	8.736667	9.113333	9.456667	8.896667
164	6.01	6.57	7.343333	6.806667
190	3.523333	4.126667	5.166667	4.8
220	1.639333	2.133333	3.243333	3.115667
255	0.519333	0.803667	1.797	1.86
295	0.094	0.156	0.877333	1.01
342	0	0	0.329667	0.423333
396	0	0	0.07	0.113897
459	0	0	0	0.018
531	0	0	0	0
615	0	0	0	0
712	0	0	0	0
825	0	0	0	0
955	0	0	0	0
1110	0	0	0	0
1280	0	0	0	0
1480	0	0	0	0
1720	0	0	0	0.00118
1990	0.0098	0	0	0.022933
2300	0.043333	0.016127	0	0.071
2670	0.102	0.079233	0	0.142333
3090	0.2068	0.191	0.023167	0.226
3580	0.365667	0.335	0.101033	0.309667
4150	0.552667	0.482333	0.231333	0.38
4800	0.724	0.601	0.382333	0.42
5560	0.834	0.661333	0.507667	0.423333
6440	0	0	0	0
7460	0	0	0	0
8630	0	0	0	0

Figure 3d –
raw data

X Intensity	Control	1s (x1)	1s (x3)	1s (x5)
0.4	0	0	0	0
0.463	0	0	0	0

0.536	0	0	0	0
0.621	0	0	0	0
0.719	0	0	0	0
0.833	0	0	0	0
0.965	0	0	0	0
1.12	0	0	0	0
1.29	0	0	0	0
1.5	0	0	0	0
1.74	0	0	0	0
2.01	0	0	0	0
2.33	0	0	0	0
2.7	0	0	0	0
3.12	0	0	0	0
3.62	0	0	0	0
4.19	0	0	0	0
4.85	0	0	0	0
5.61	0	0	0	0
6.5	0	0	0	0
7.53	0	0	0	0
8.72	0	0	0	0
10.1	0	0	0	0
11.7	0	0	0	0
13.5	0	0	0	0
15.7	0	0	0	0
18.2	0	0	0	0.0247
21	0	0	0	0.057
24.4	0	0	0	0.04955
28.2	0	0	0	0.04135
32.7	0	0.07	0	0.1465
37.8	0.293667	0.464367	0.245	0.9185
43.8	1.88	1.996667	1.61	2.41
50.7	4.67	4.53	3.92	4.375
58.8	7.96	7.496667	6.62	6.48
68.1	10.96667	10.22333	9.12	8.395
78.8	12.96667	12.16667	11	9.87
91.3	13.7	13.03333	11.9	10.69
106	13.03333	12.66667	11.9	10.805
122	11.23333	11.26667	11	10.265
142	8.736667	9.146667	9.55	9.165
164	6.01	6.68	7.69	7.675
190	3.523333	4.27	5.72	6.015
220	1.639333	2.276667	3.86	4.38
255	0.519333	0.913667	2.29	2.95
295	0.094	0.225	1.13	1.8555
342	0	0.021567	0.405	1.1359
396	0	0	0.0693	0.72

459	0	0	0	0.4185
531	0	0	0	0.2005
615	0	0	0	0.068
712	0	0	0	0.00895
825	0	0	0	0
955	0	0	0	0
1110	0	0	0	0
1280	0	0	0	0
1480	0	0	0	0
1720	0	0	0	0
1990	0.0098	0	0.0193	0
2300	0.043333	0.013933	0.0661	0
2670	0.102	0.058533	0.138	0
3090	0.2068	0.151893	0.225	0
3580	0.365667	0.307033	0.314	0.0499
4150	0.552667	0.499333	0.39	0.157
4800	0.724	0.683667	0.437	0.2955
5560	0.834	0.808333	0.444	0.422
6440	0	0	0	0
7460	0	0	0	0
8630	0	0	0	0

Statistical analysis for dynamic light scattering results:

Figure 1 Size

One-way Analysis of Variance (ANOVA)

The P value is < 0.0001, considered extremely significant.

Variation among column means is significantly greater than expected by chance.

Dunnett Multiple Comparisons Test

Control column: Control

If the value of q is greater than 2.900 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
Control vs Inv gently 10x	0.000	0.000	ns P>0.05
Control vs Flicked 10x	-4.123	1.648	ns P>0.05
Control vs Shaken (mod.)	-6.060	2.422	ns P>0.05
Control vs Shaken (vig.)	-37.437	14.963	** P<0.01
Control vs Vortex 10x	-64.270	25.687	** P<0.01

Difference	Mean Difference	Lower 95% CI	Upper 95% CI
Control - Inv gently 10x	0.000	-7.256	7.256
Control - Flicked 10x	-4.123	-11.379	3.132
Control - Shaken (mod.)	-6.060	-13.316	1.196
Control - Shaken (vig.)	-37.437	-44.692	-30.181
Control - Vortex 10x	-64.270	-71.526	-57.014

Figure 1 Polydispersity

One-way Analysis of Variance (ANOVA)

The P value is < 0.0001, considered extremely significant.

Variation among column means is significantly greater than expected by chance.

Dunnett Multiple Comparisons Test

Control column: Control

If the value of q is greater than 2.900 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
Control vs Inv gently 10x	0.004000	0.4012	ns P>0.05
Control vs Flicked 10x	-0.02100	2.106	ns P>0.05
Control vs Shaken (mod.)	-0.05300	5.316	** P<0.01
Control vs Shaken (vig.)	-0.2183	21.898	** P<0.01
Control vs Vortex 10x	-0.1773	17.786	** P<0.01

Difference	Mean Difference	Lower 95% CI	Upper 95% CI
Control - Inv gently 10x	0.004000	-0.02491	0.03291
Control - Flicked 10x	-0.02100	-0.04991	0.007914
Control - Shaken (mod.)	-0.05300	-0.08191	-0.02409
Control - Shaken (vig.)	-0.2183	-0.2472	-0.1894
Control - Vortex 10x	-0.1773	-0.2062	-0.1484

Figure 2 Size – Results not significant

Figure 2 Polydispersity – Results not significant

Figure 3 Size

One-way Analysis of Variance (ANOVA)

The P value is 0.1049, considered not significant.

Variation among column means is not significantly greater than expected by chance.

Dunnett Multiple Comparisons Test

Control column: Control

If the value of q is greater than 2.983 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
Control vs 10s x1	0.03000	0.01634	ns P>0.05
Control vs 10s x3	-2.060	1.122	ns P>0.05
Control vs 10s x5	-1.837	1.000	ns P>0.05
Control vs 3s x1	-1.777	0.9675	ns P>0.05
Control vs 3s x3	-2.503	1.363	ns P>0.05
Control vs 3s x5	-3.197	1.741	ns P>0.05
Control vs 2s x1	-1.933	1.053	ns P>0.05
Control vs 2s x3	-2.890	1.574	ns P>0.05
Control vs 2s x5	-3.670	1.998	ns P>0.05
Control vs 1s x1	-1.527	0.8313	ns P>0.05
Control vs 1s x3	-3.693	2.011	ns P>0.05
Control vs 1s x5	-6.703	3.650	* P<0.05

Difference	Mean Difference	Lower 95% CI	Upper 95% CI
Control - 10s x1	0.03000	-5.449	5.509
Control - 10s x3	-2.060	-7.539	3.419
Control - 10s x5	-1.837	-7.315	3.642
Control - 3s x1	-1.777	-7.255	3.702
Control - 3s x3	-2.503	-7.982	2.975
Control - 3s x5	-3.197	-8.675	2.282
Control - 2s x1	-1.933	-7.412	3.545
Control - 2s x3	-2.890	-8.369	2.589
Control - 2s x5	-3.670	-9.149	1.809
Control - 1s x1	-1.527	-7.005	3.952
Control - 1s x3	-3.693	-9.172	1.785
Control - 1s x5	-6.703	-12.182	-1.225

Figure 3 Polydispersity

One-way Analysis of Variance (ANOVA)

The P value is 0.0362, considered significant.

Variation among column means is significantly greater than expected by chance.

Dunnett Multiple Comparisons Test

Control column: Control

If the value of q is greater than 2.983 then the P value is less than 0.05.

Comparison	Mean Difference	q	P value
Control vs 10s x1	-0.006667	0.6940	ns P>0.05
Control vs 10s x3	-0.006667	0.6940	ns P>0.05
Control vs 10s x5	-0.006000	0.6246	ns P>0.05
Control vs 3s x1	-0.008667	0.9022	ns P>0.05
Control vs 3s x3	-0.01933	2.013	ns P>0.05
Control vs 3s x5	-0.02367	2.464	ns P>0.05
Control vs 2s x1	-0.02200	2.290	ns P>0.05
Control vs 2s x3	-0.01300	1.353	ns P>0.05
Control vs 2s x5	-0.01900	1.978	ns P>0.05
Control vs 1s x1	-0.01967	2.047	ns P>0.05
Control vs 1s x3	-0.02900	3.019	* P<0.05
Control vs 1s x 5	-0.03567	3.713	** P<0.01

Difference	Mean Difference	Lower 95% CI	Upper 95% CI
Control - 10s x1	-0.006667	-0.03532	0.02199
Control - 10s x3	-0.006667	-0.03532	0.02199
Control - 10s x5	-0.006000	-0.03466	0.02266
Control - 3s x1	-0.008667	-0.03732	0.01999
Control - 3s x3	-0.01933	-0.04799	0.009324
Control - 3s x5	-0.02367	-0.05232	0.004991
Control - 2s x1	-0.02200	-0.05066	0.006658
Control - 2s x3	-0.01300	-0.04166	0.01566
Control - 2s x5	-0.01900	-0.04766	0.009658
Control - 1s x1	-0.01967	-0.04832	0.008991
Control - 1s x3	-0.02900	-0.05766	-0.0003424
Control - 1s x 5	-0.03567	-0.06432	-0.007009