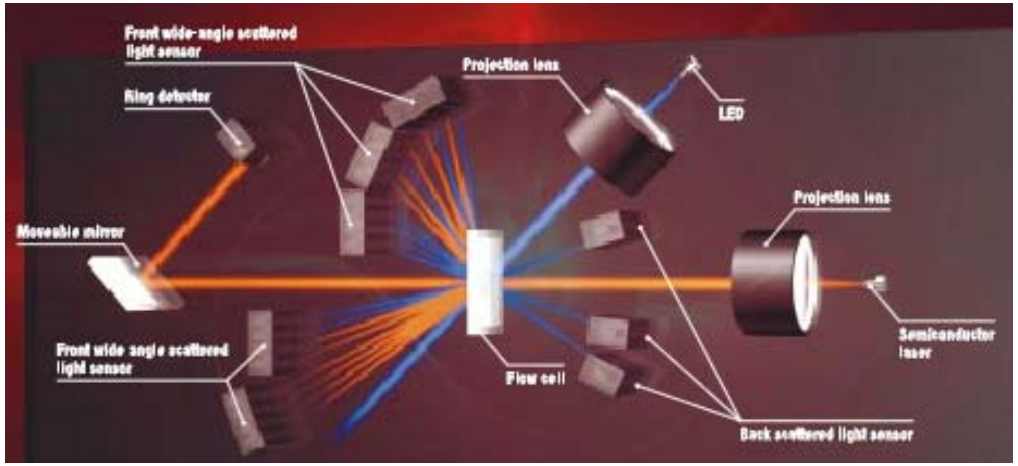
LA-950 Laser Diffraction Analyzer

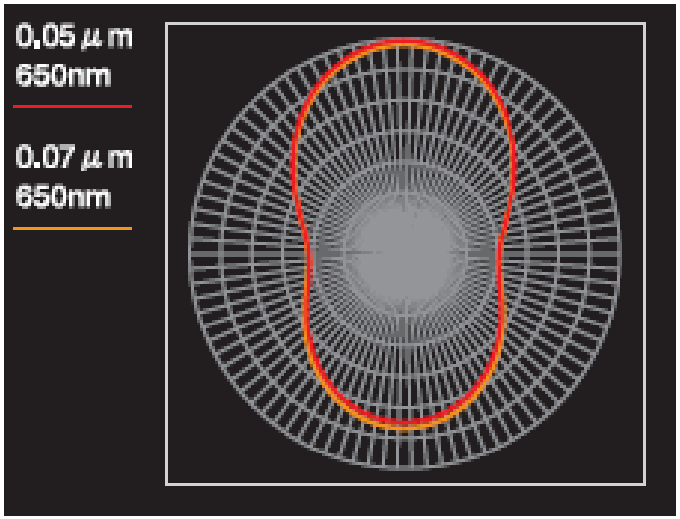
mark.bumiller@horiba.com

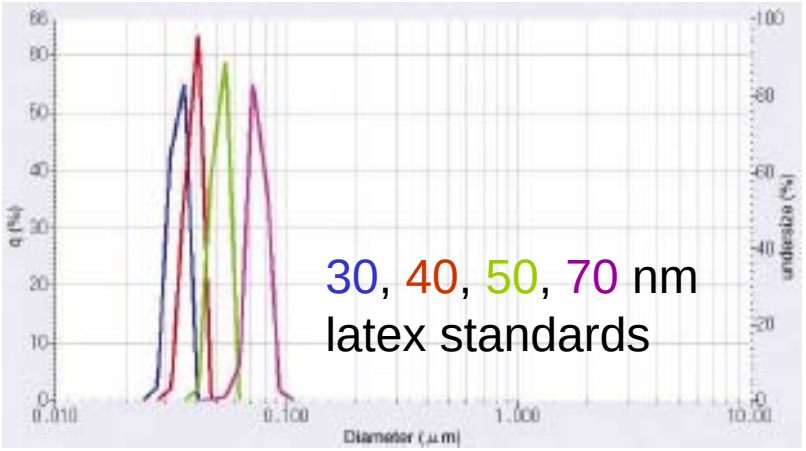
Laser Diffraction

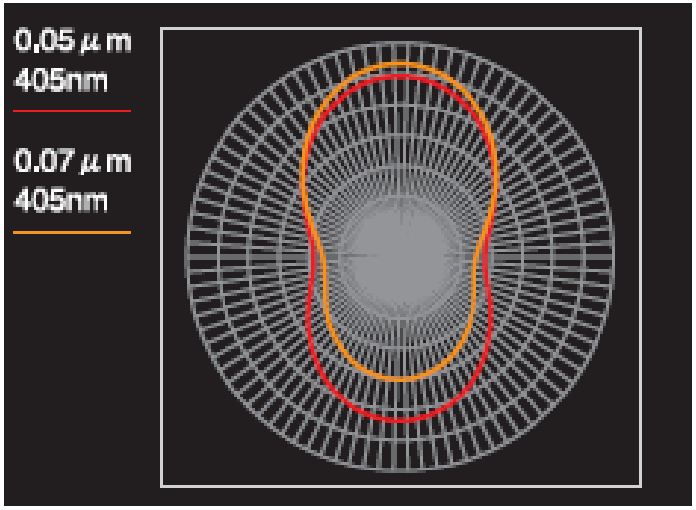
Particle size 0.01 – 3000 µm

Low End Sensitivity







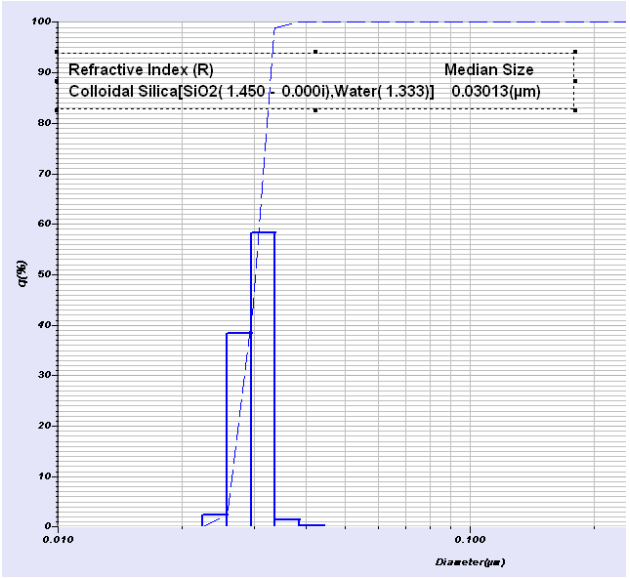


Low End Sensitivity

- Sensitivity: small particle detection

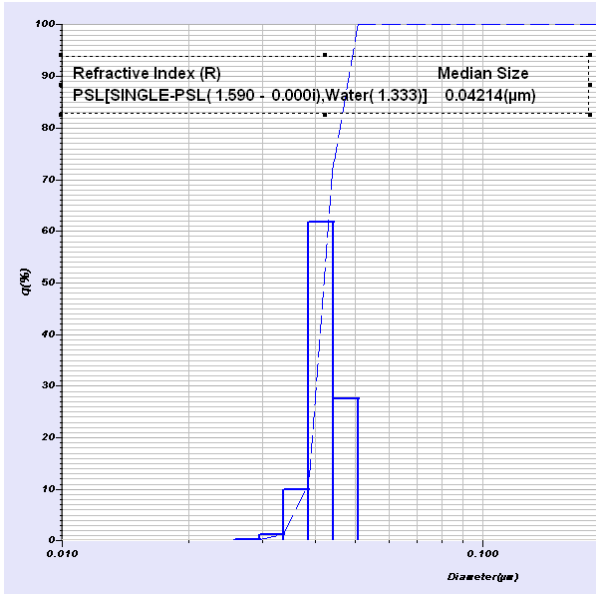
30 nm silica

S.P.Area	:	2.0183E+6(cm^2/cm^3)
Mean Size	:	0.02990(µm)
Variance	:	5.0313E-6($µm^2$)
Median Size	:	0.03013(µm)
Mode Size	:	0.0302(µm)
Skewness	:	-0.2901



40 nm latex

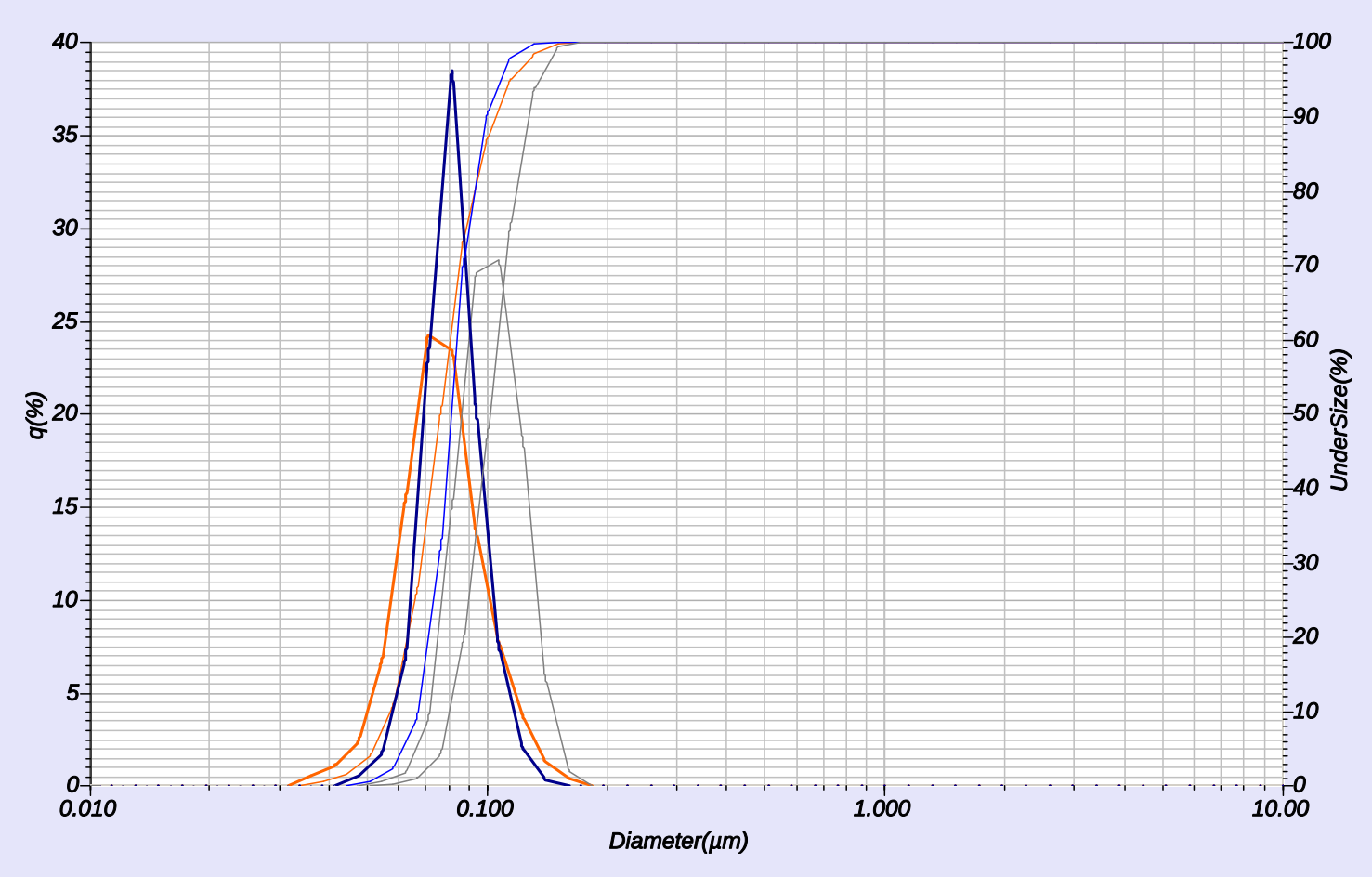
S.P.Area	:	1.4253E+6(cm^2/cm^3)
Mean Size	:	0.04241(µm)
Variance	:	1.2759E-5($µm^2$)
Median Size	:	0.04214(µm)
Mode Size	:	0.0422(µm)
Skewness	:	-0.1514



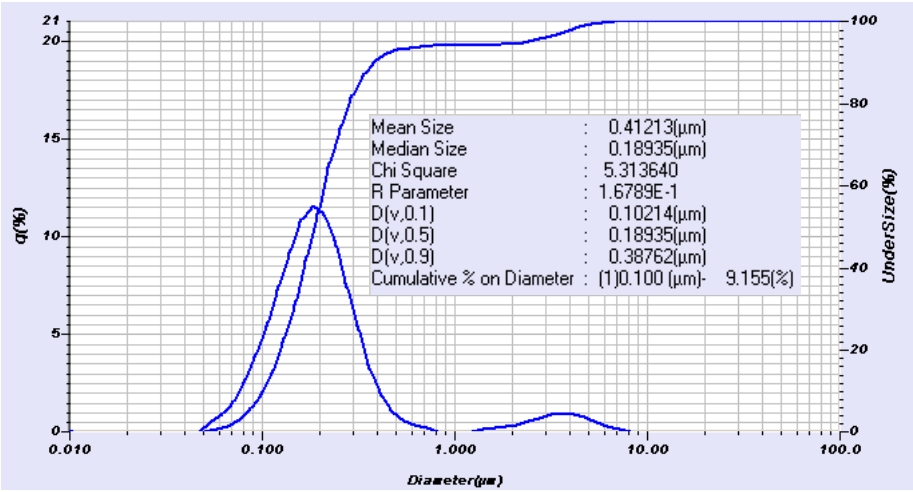
30 nm Colloidal Silica: DLS Data

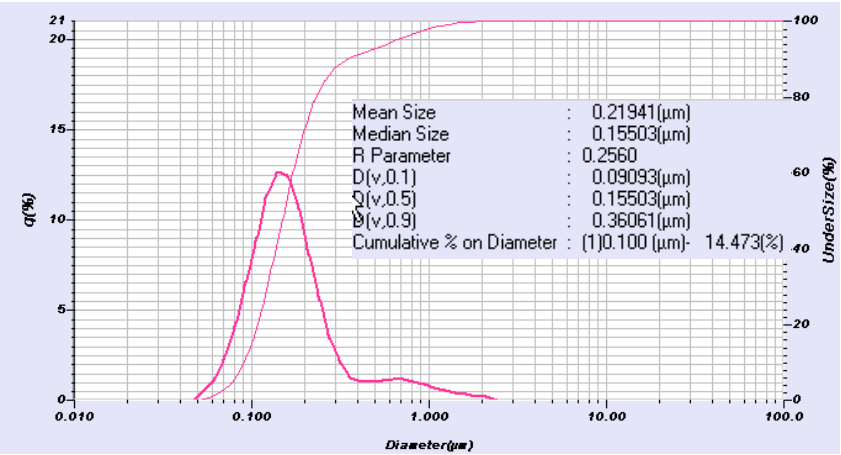
	Mean determined z-average size (nm)	COV (%)
Dynamic Light Scattering with SZ-100, laboratory 1	34.4	0.7
Dynamic Light Scattering with SZ-100, laboratory 2	34.6	0.3

Low End Sensitivity: Pigments



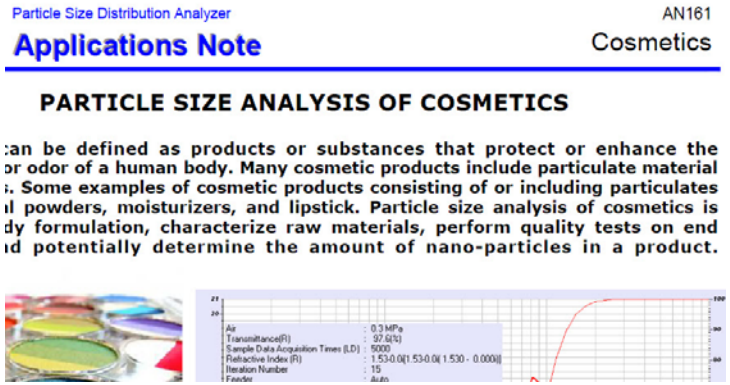
Low End Sensitivity: Cosmetics





- Some (unfounded?) concerns with particles <100nm
- LA-950 good at determining sub 100nm particles
- Software set to display % under any given size
- Data shown left is for skin cream and TiO2 suspension

See Cosmetics Application Note:



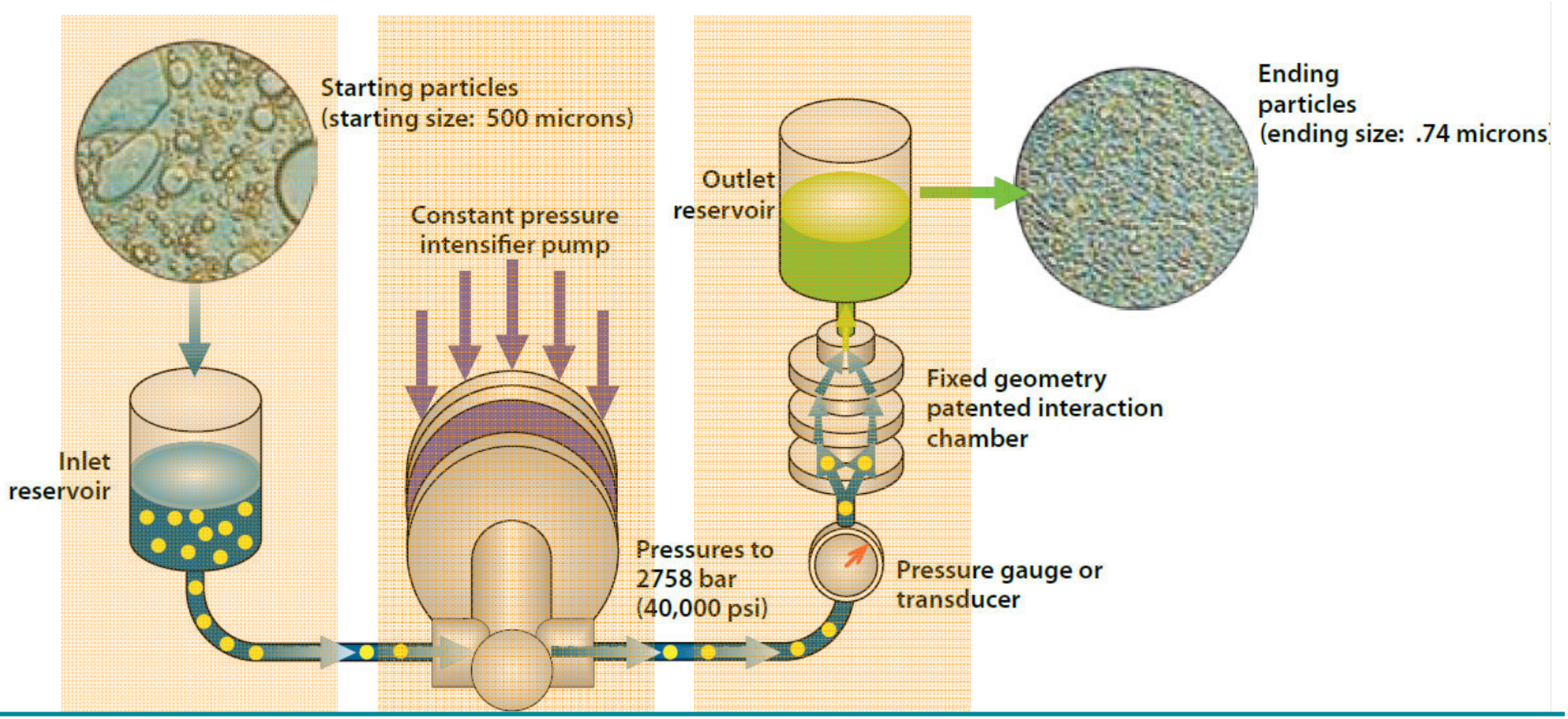
Particle Size Distribution Analyzer AN161

Applications Note Cosmetics

PARTICLE SIZE ANALYSIS OF COSMETICS

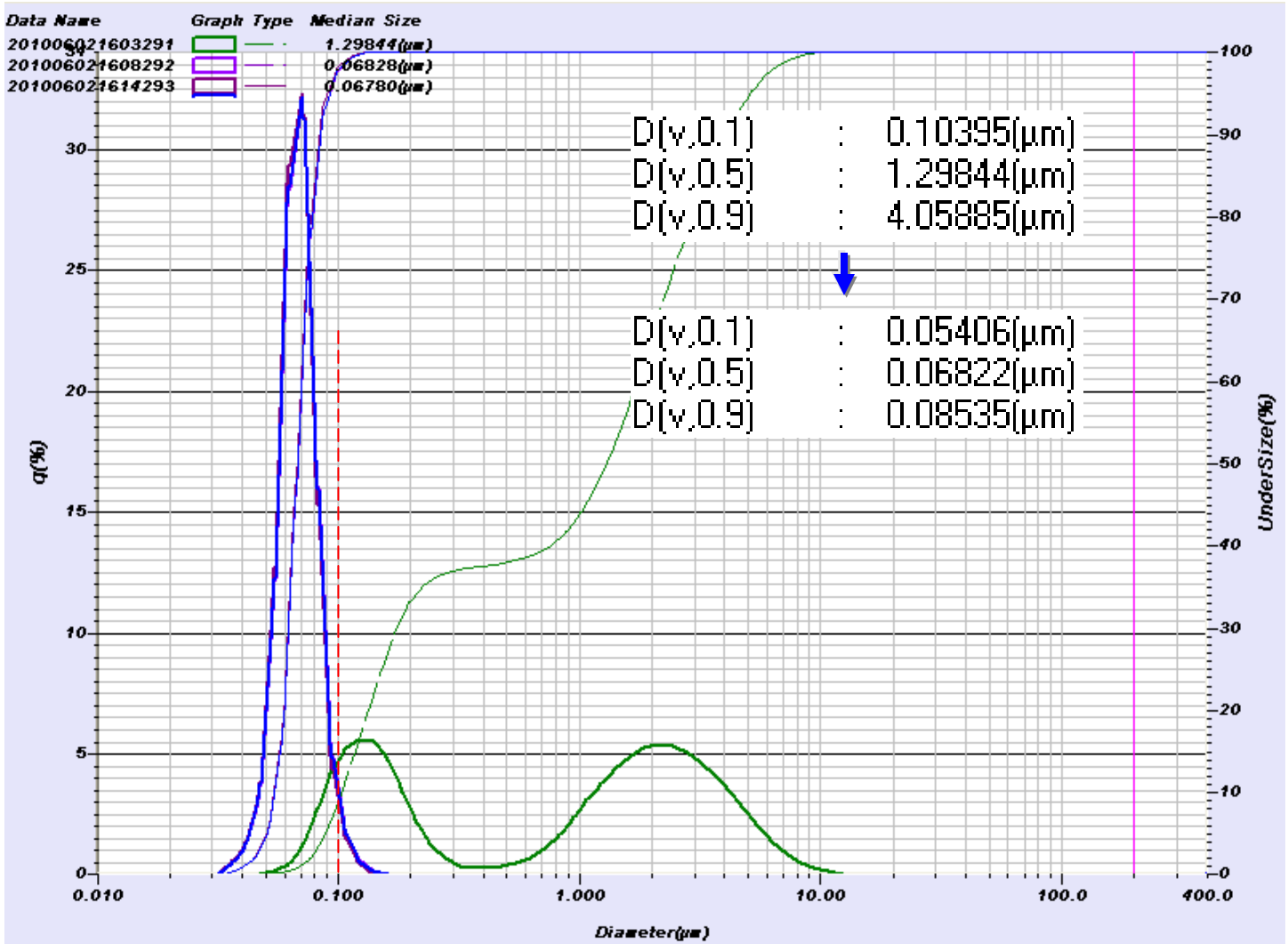
:an be defined as products or substances that protect or enhance the or odor of a human body. Many cosmetic products include particulate material . Some examples of cosmetic products consisting of or including particulates l powders, moisturizers, and lipstick. Particle size analysis of cosmetics is dy formulation, characterize raw materials, perform quality tests on end d potentially determine the amount of nano-particles in a product.

Monitoring Size Reduction



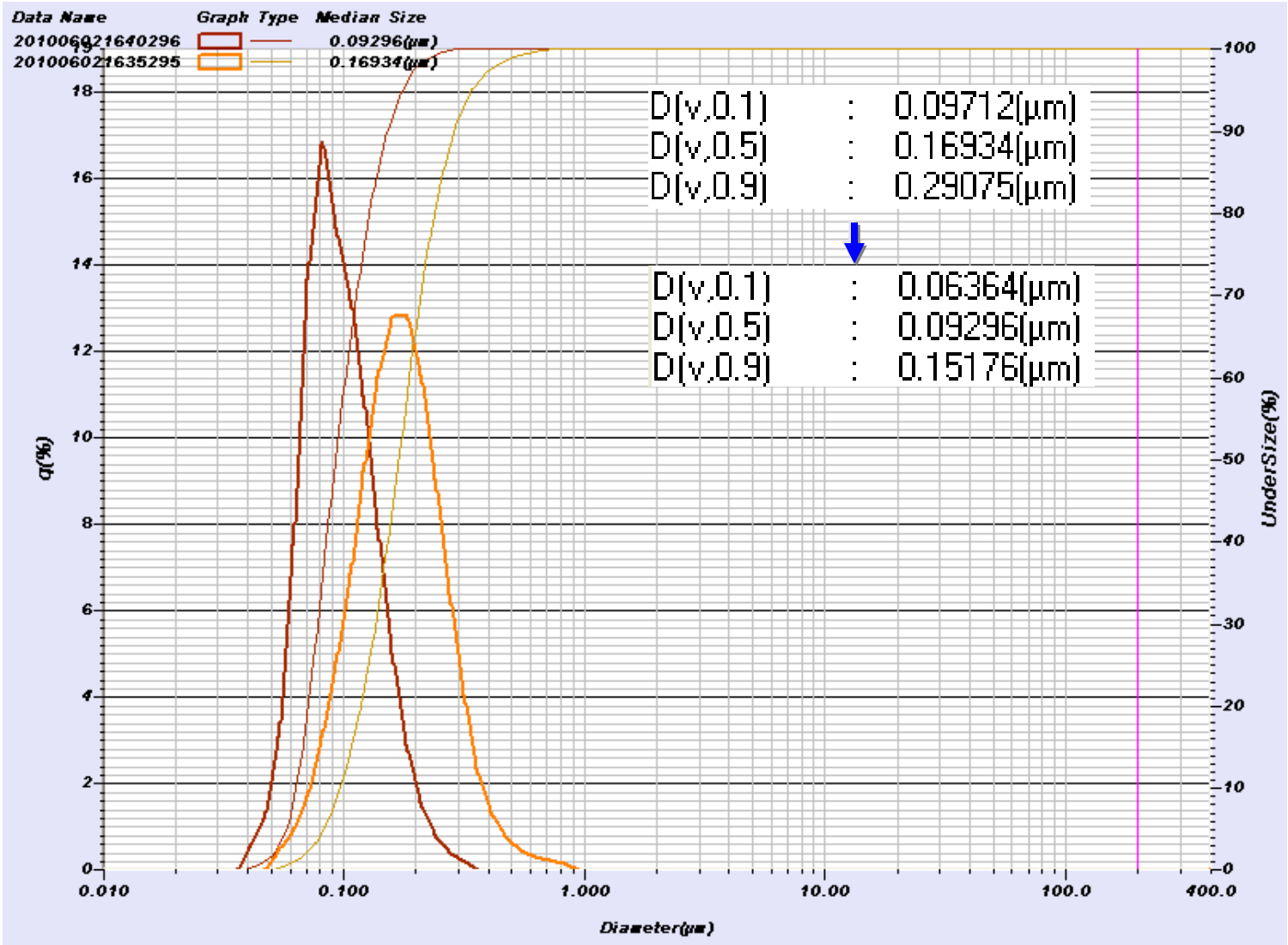
Microfluidics * See http://www.microfluidicscorp.com/

Ceria: Before, After Processing

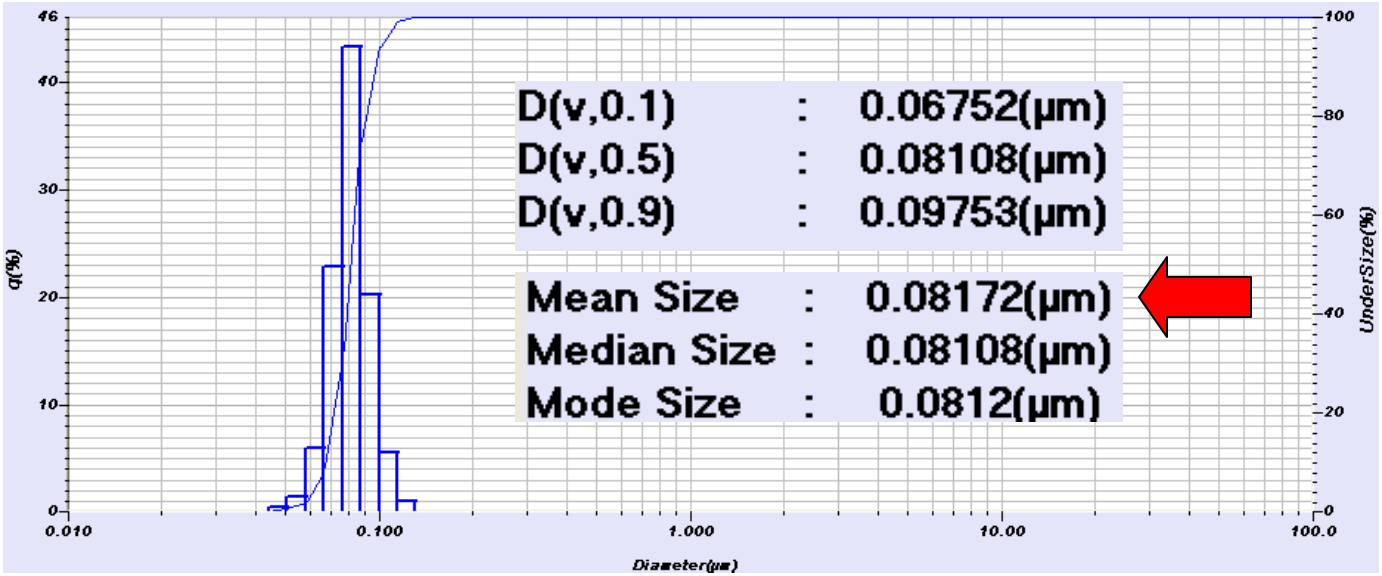


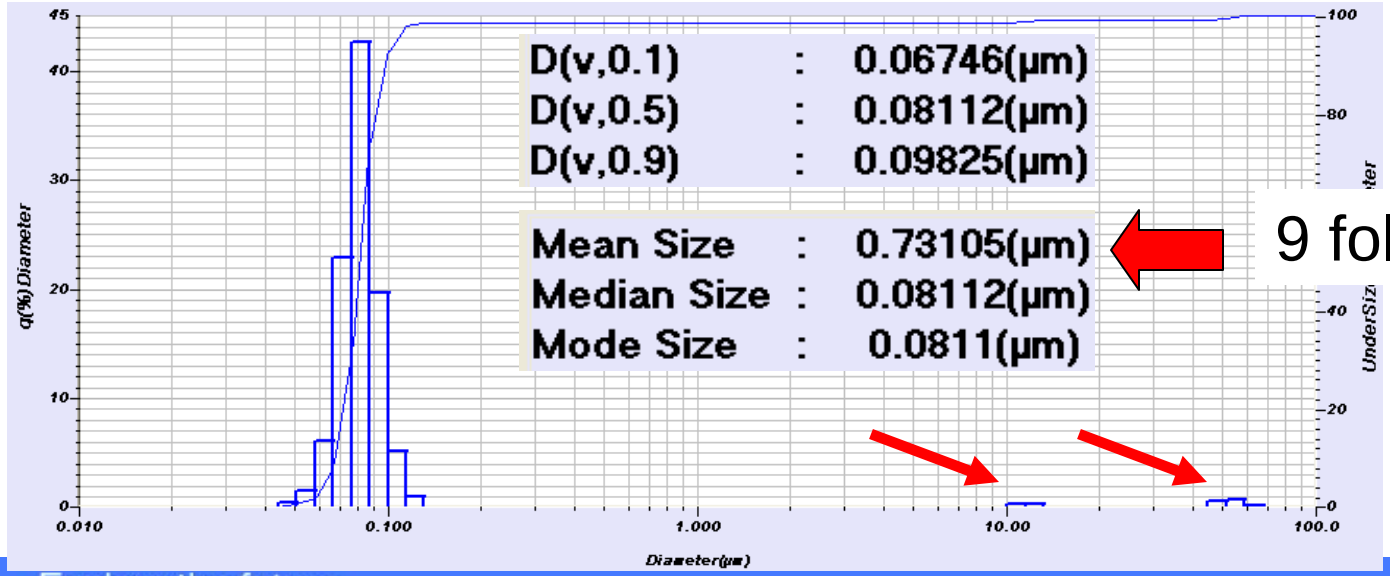
Laser diffraction required for before sample

Liposome: Before, After Processing



PLA Nanoparticles for Drug Delivery

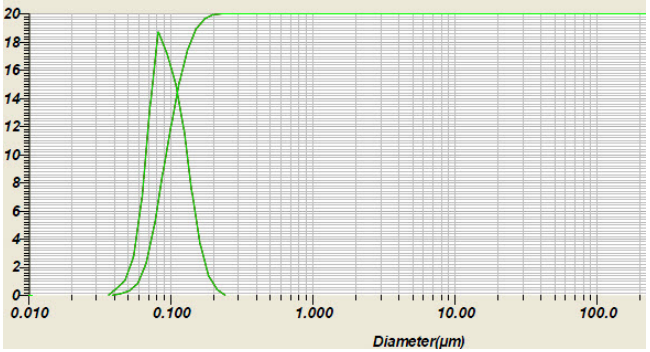




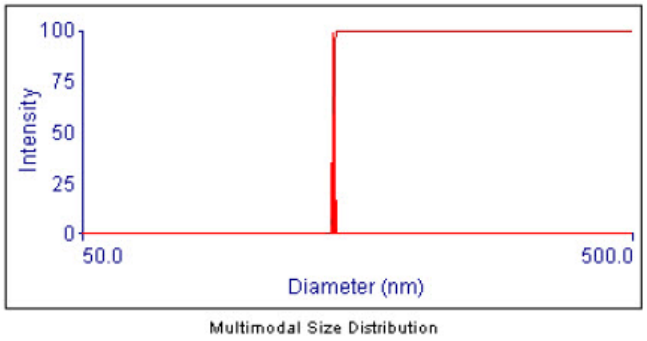
9 fold increase

PLA Nanoparticles for Drug Delivery

Pure

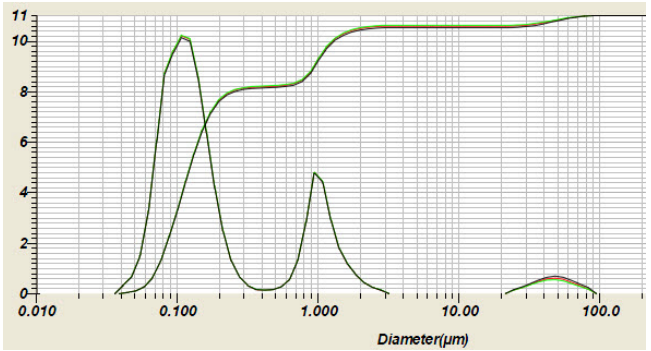


Sample Name	D(v,0.1)	D(v.0.5)	D(v.0.9)
50928-6-1	0.06541(µm)	0.09222(µm)	0.13789(µm)
50928-6-1	0.06541(µm)	0.09222(µm)	0.13788(µm)
50928-6-1	0.06540(µm)	0.09221(µm)	0.13787(µm)

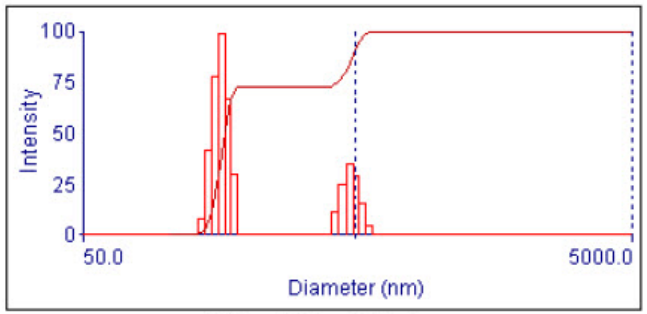


Multimodal Size Distribution

Spiked with 1 µm PSL

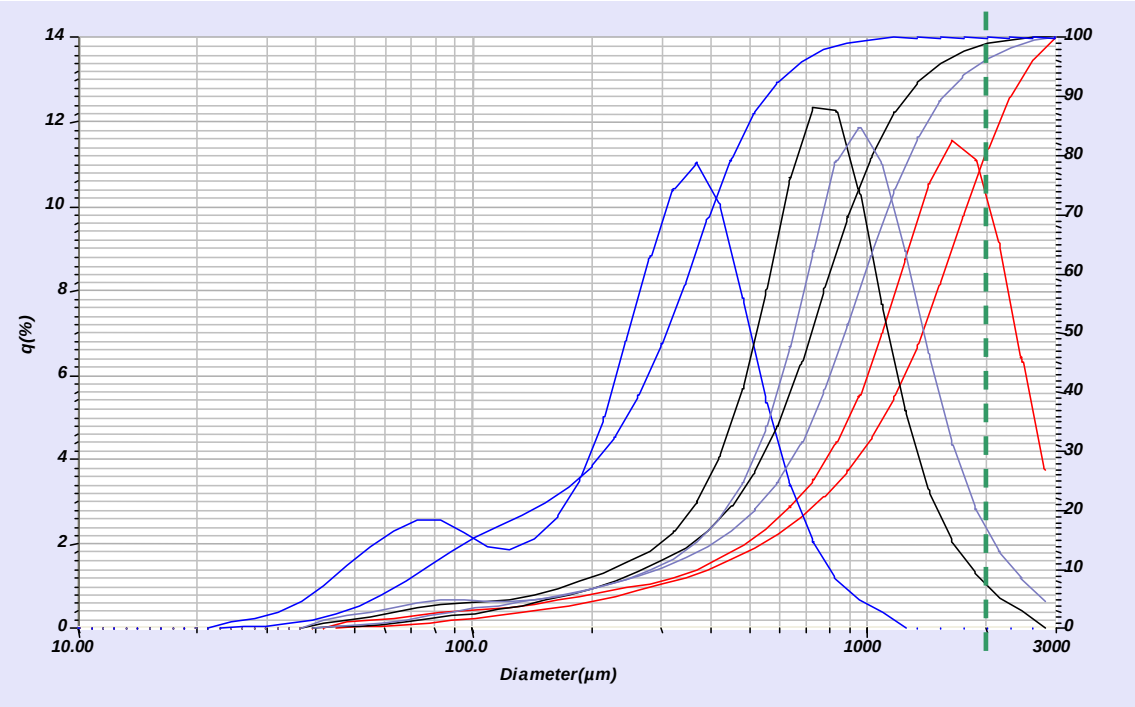


Sample Name	D(v,0.1)	D(v.0.5)	D(v.0.9)
50928-6-2	0.07348(µm)	0.13085(µm)	1.21951(µm)
50928-6-2	0.07345(µm)	0.13065(µm)	1.20702(µm)
50928-6-2	0.07360(µm)	0.13155(µm)	1.25225(µm)

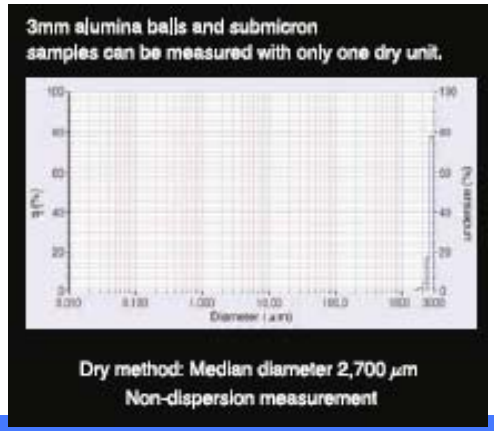


Multimodal Size Distribution

Dynamic Range: High end



Coffee Results



Dynamic Range: High end: Soils

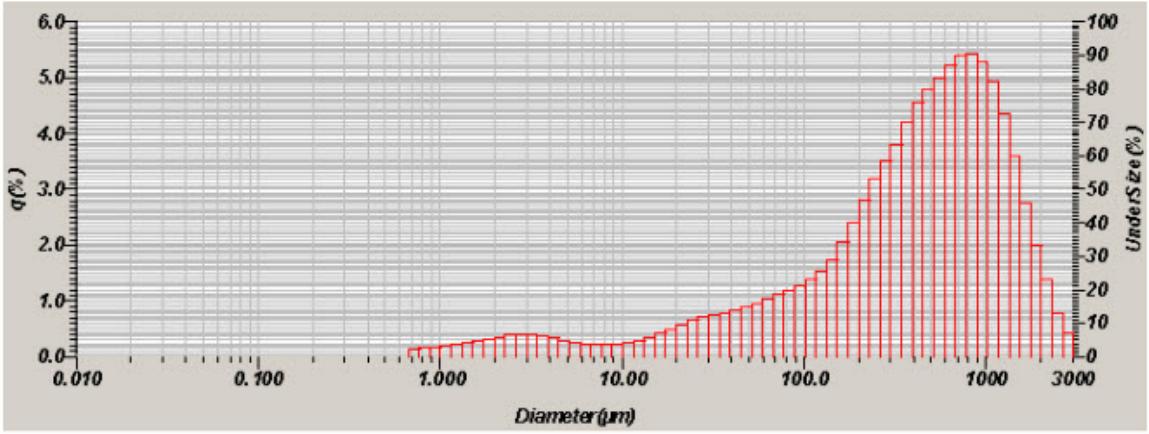
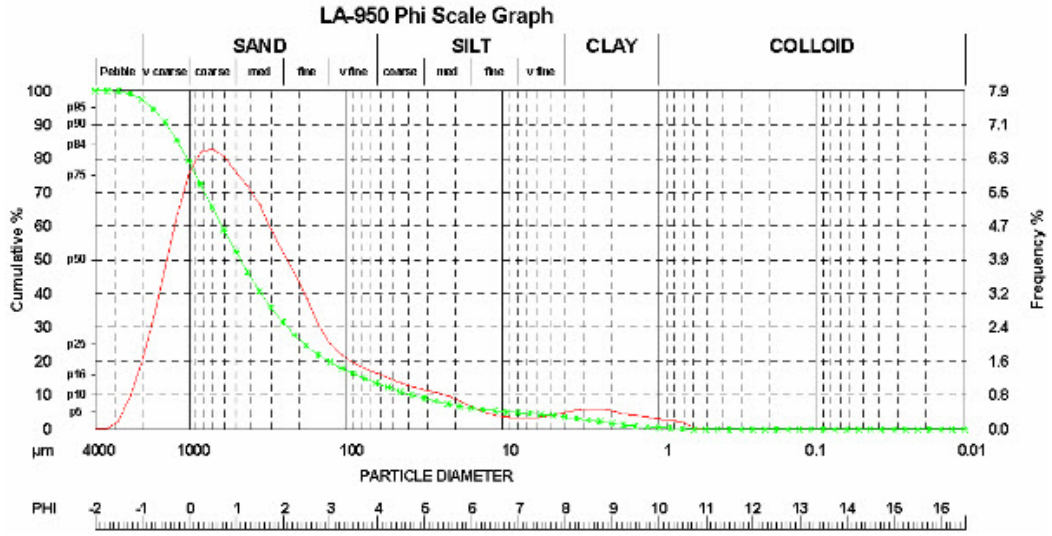


Fig. 3. Lake sediment sample measured on the LA-950



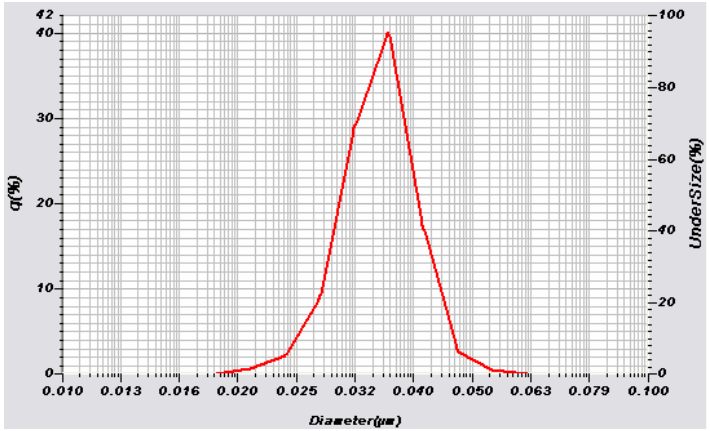
Soils Accessory: Slurry Sampler

- 15, 30, or 60 position auto sampling
- Optional magnetic stirrer base plate
- Sample mixed, removed from cup, delivered to LA-950 for analysis

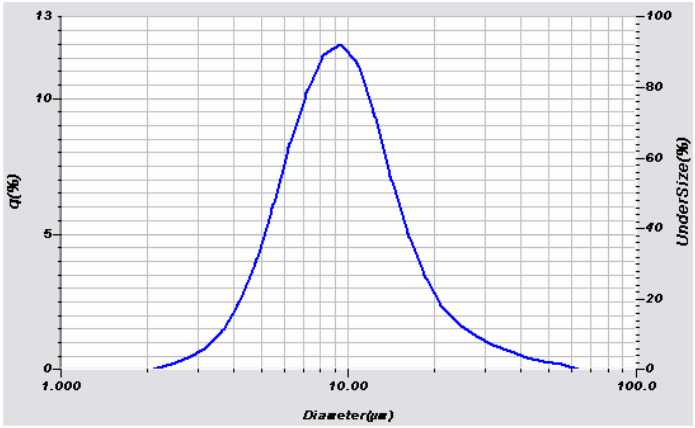
Other Liquid Accessories

- Miniflow
  - 35-55 mL liquid
  - W or w/o ultrasound
- Fraction Cell
  - 10 or 15 mL liquid
  - Magnetic stirrer
- Paste Cell
  - Sample pressed between two windows

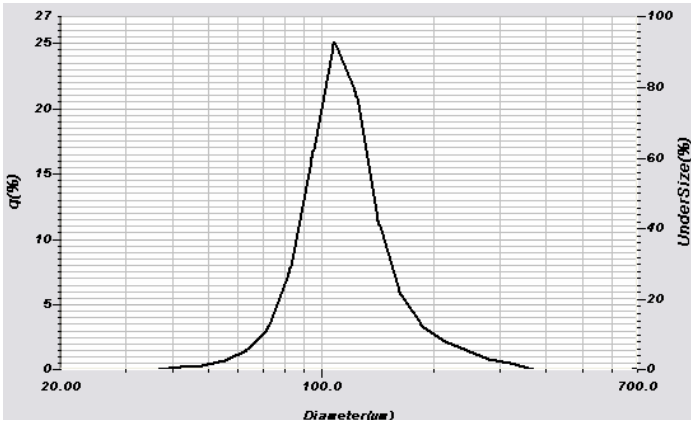
Small Sample Volume (MiniFlow)



Colloidal Silica (weak scatterer)
Median (D50): **35 nm**
Sample Amount: **132 mg**



Magnesium Stearate
Median (D50): **9.33 μm**
Sample Amount: **0.165 mg**



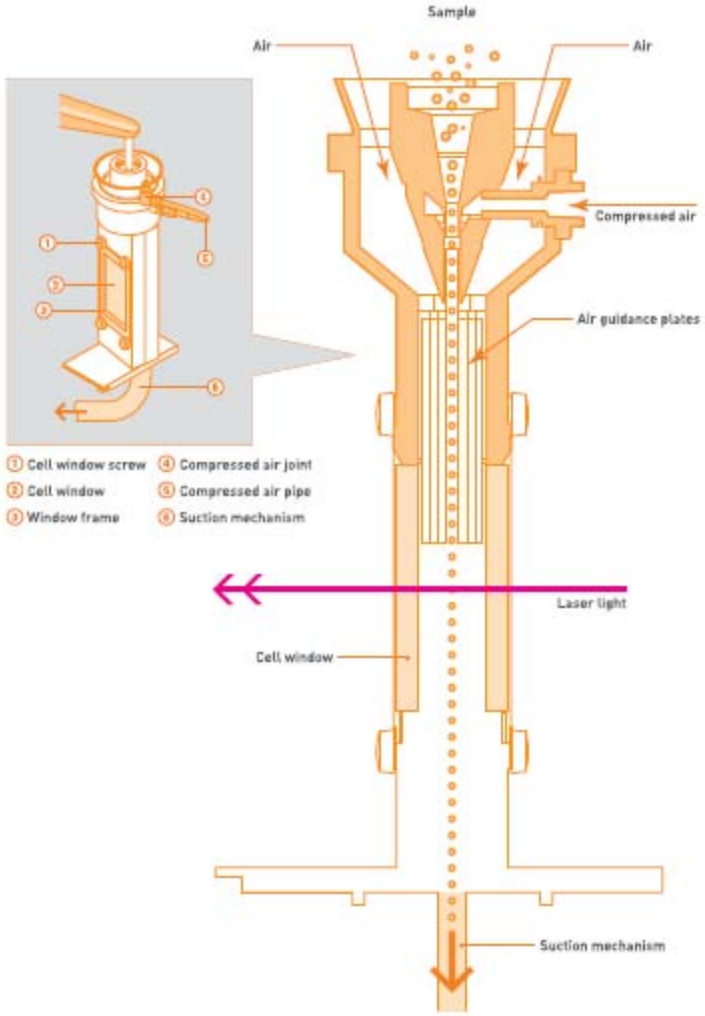
Bio-degradable Polymer
Median (D50): **114 μm**
Sample Amount: **1.29 mg**

Built in Ultrasonic Probe

Specifications

Ultrasonic Power	Output Power		Idling Power	Power Transmited to Water	
	Circulation Speed 3	Circulation Speed 15		Circulation Speed 3	Circulation Speed 15
1	3.8	4.4	1	2.8	3.4
2	6.8	8	1.8	5	6.2
3	9.8	11	2.9	6.9	8.1
4	12.8	14.6	4.5	8.3	10.1
5	16.2	18	5.8	10.4	12.2
6	19.8	22	7.1	12.7	14.9
7	23.2	26	8.6	14.6	17.4

Reproducibility: Dry Powder Feeder

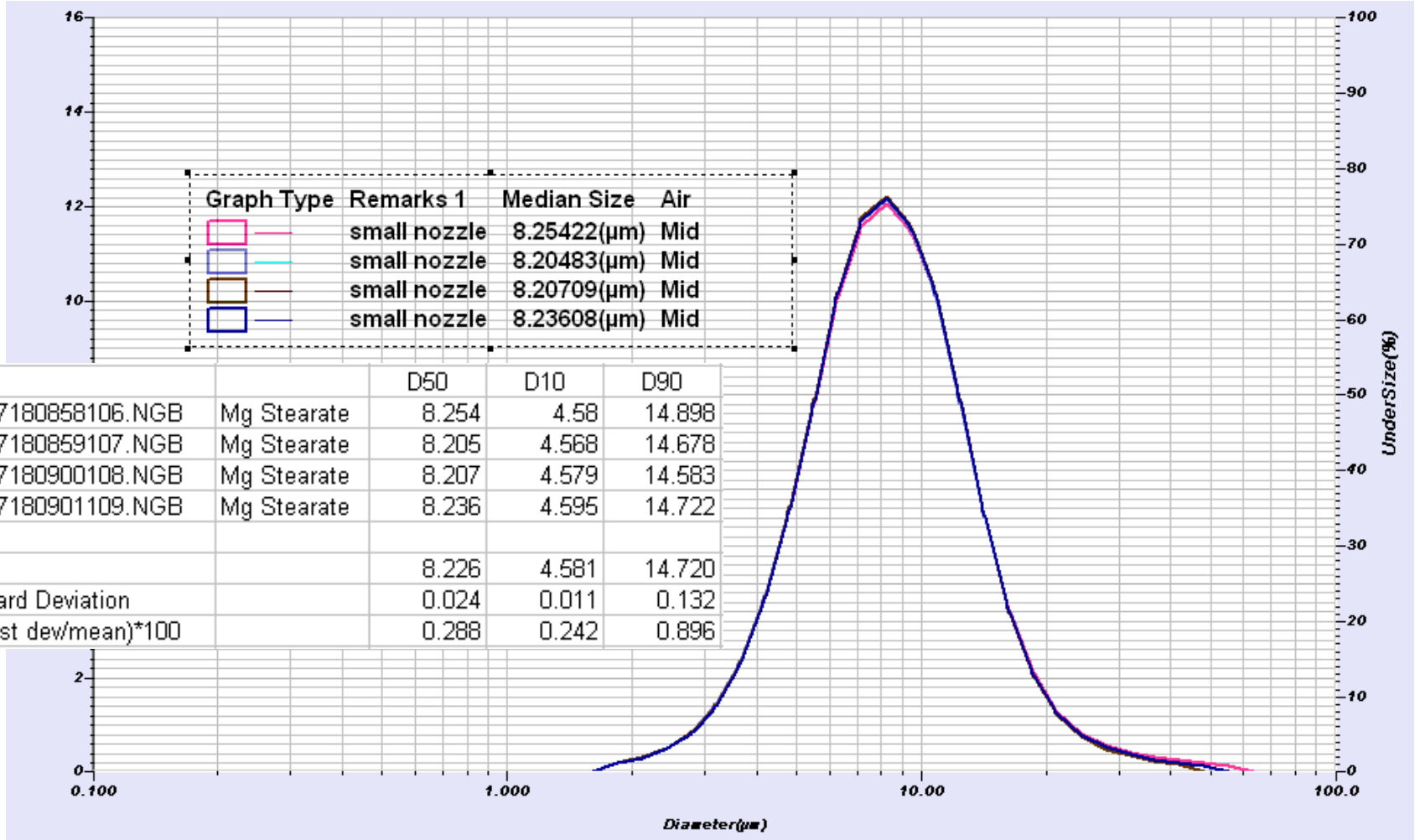


Direct flow of powder down to cell rather than turn 90º, then around plastic tube

Reproducibility: Dry Powder Feeder

- Automatic control of sample feed rate
  - LA-950 monitors amount of sample supplied by the vibratory feeder. Automatic feed back control keeps constant mass flow rate of powder during measurement
  - This is CRITICAL
    - More reproducible, robust
    - No ghost peaks
    - No cutting off results

Reproducibility – Mg Stearate Dry

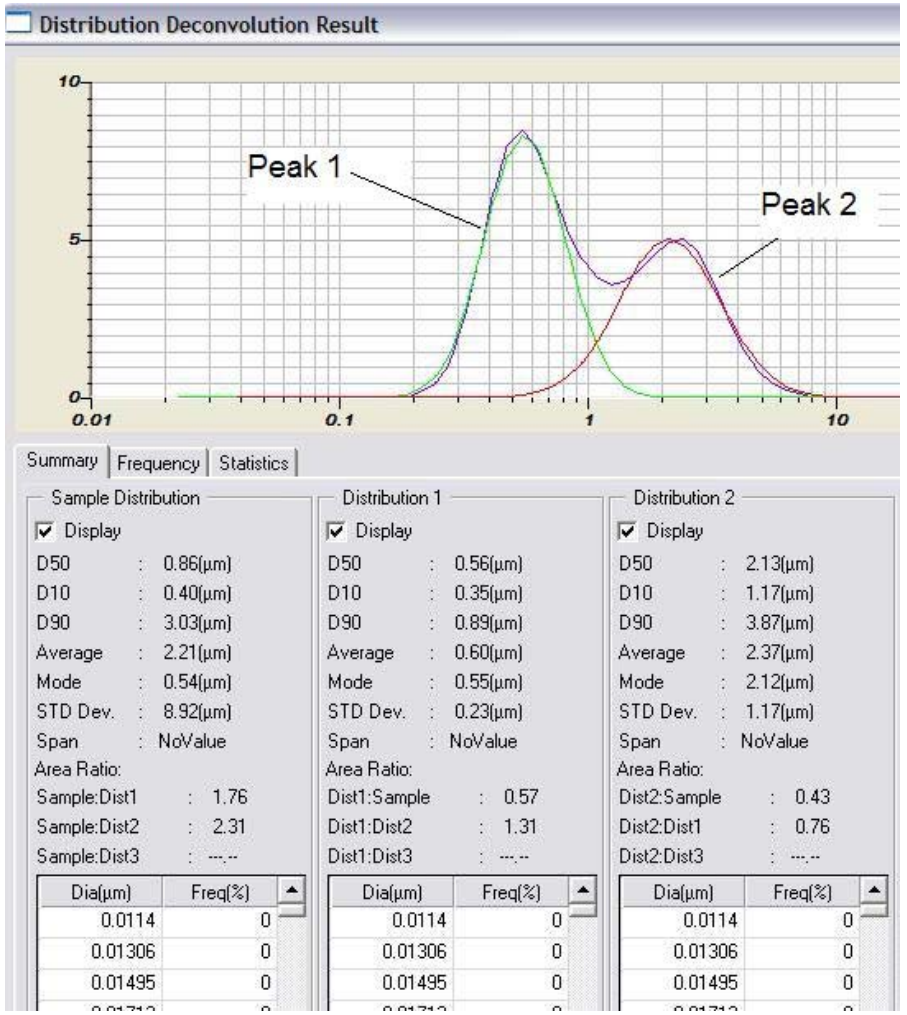


		D50	D10	D90
200707180858106.NGB	Mg Stearate	8.254	4.58	14.898
200707180859107.NGB	Mg Stearate	8.205	4.568	14.678
200707180900108.NGB	Mg Stearate	8.207	4.579	14.583
200707180901109.NGB	Mg Stearate	8.236	4.595	14.722
Mean		8.226	4.581	14.720
Standard Deviation		0.024	0.011	0.132
COV (st dev/mean)*100		0.288	0.242	0.896

Unique Software features

“Multifunctions”

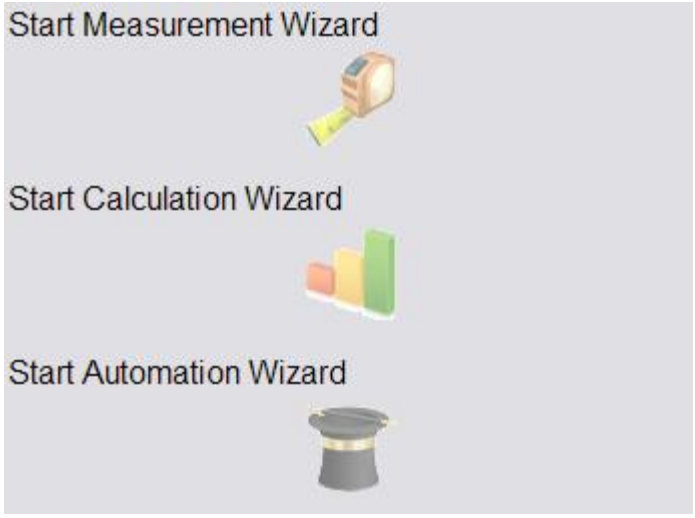
- To compute individual distribution size from multimodal sample distribution



Unique Software features

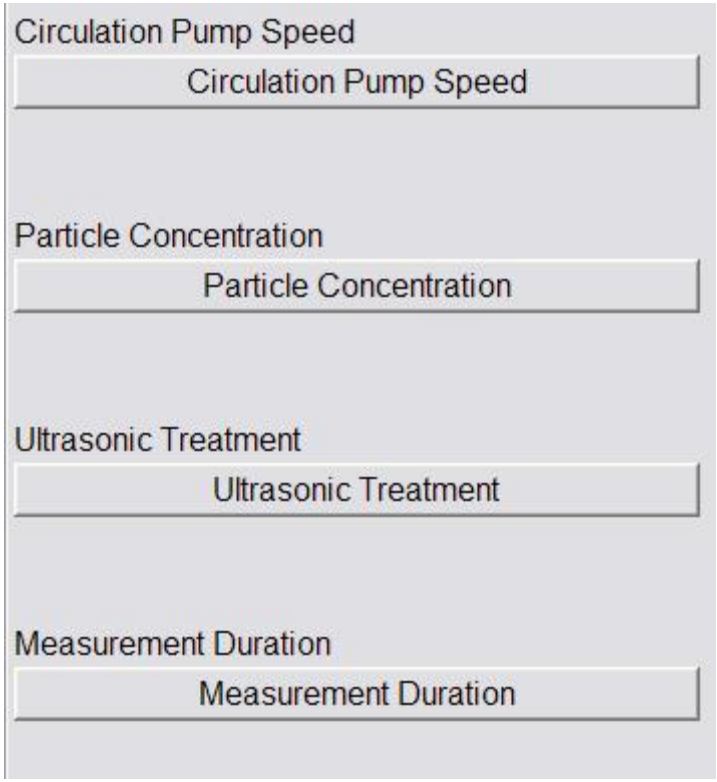
Method expert function

- To study and develop method conditions
- Search of best analytical conditions (pump speed, acquisition time, us time power….)
- Search of best calculation conditions (Refractive Indexes)
- Set a Navigation program including all improved parameters



Unique Software features

Analytical conditions



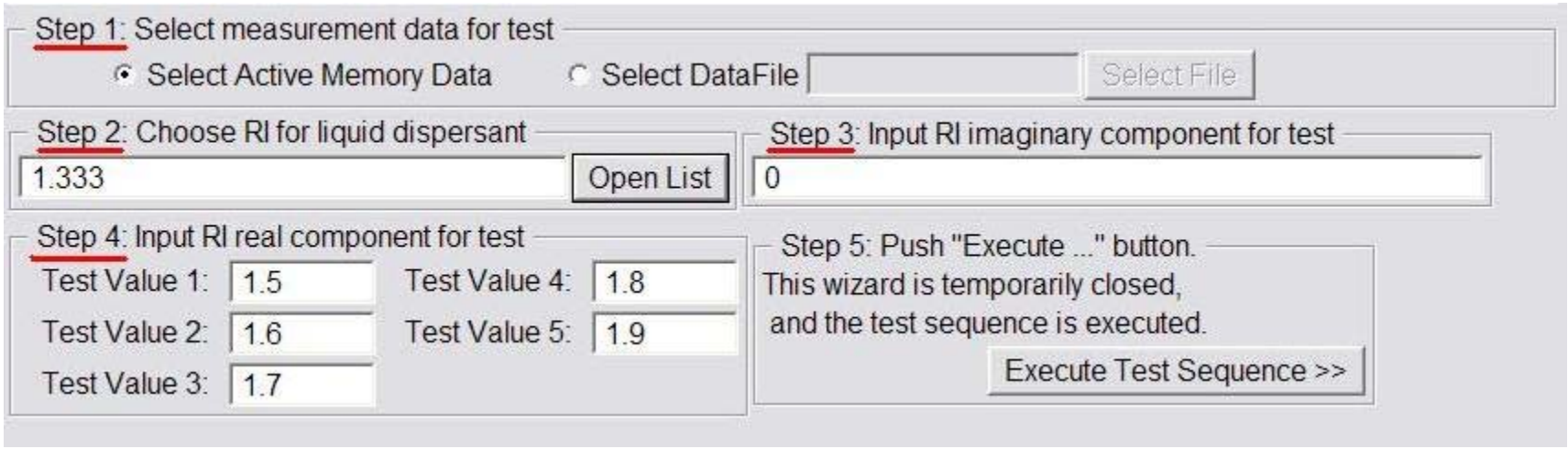
Calculation conditions

View Method Expert webinar on website (Download Center)

Automated RI computation

Real part study

- Need to fix imaginary part
- Set up to 5 real parts
- Software will compute all RI and display R parameter variation with RI selection



Automated RI computation

Imaginary part study

- Need to fix real part
- Set up to 5 imaginary parts
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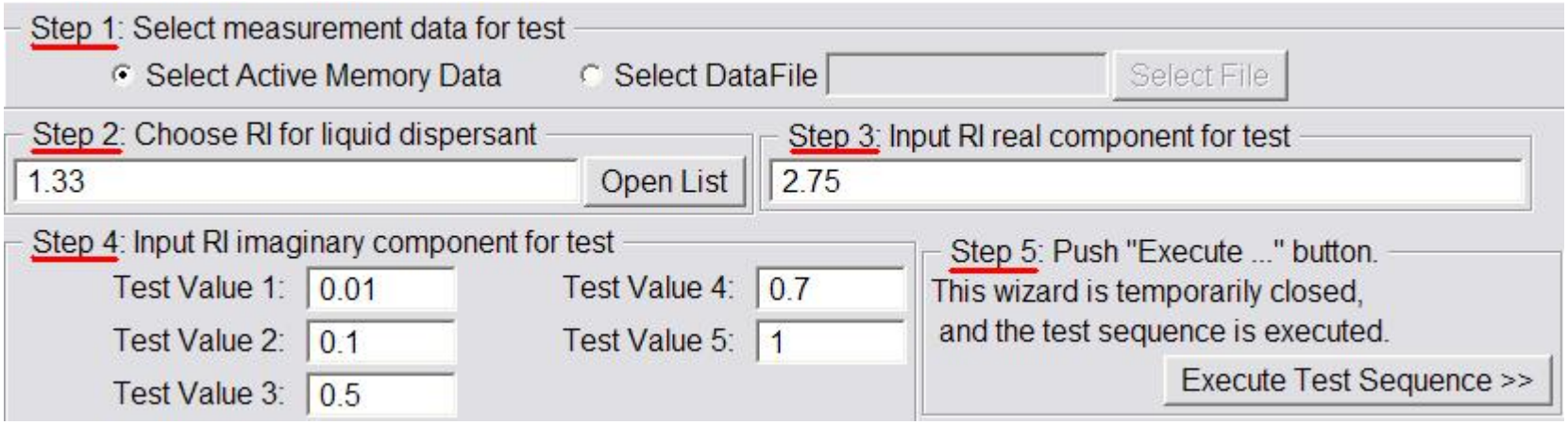
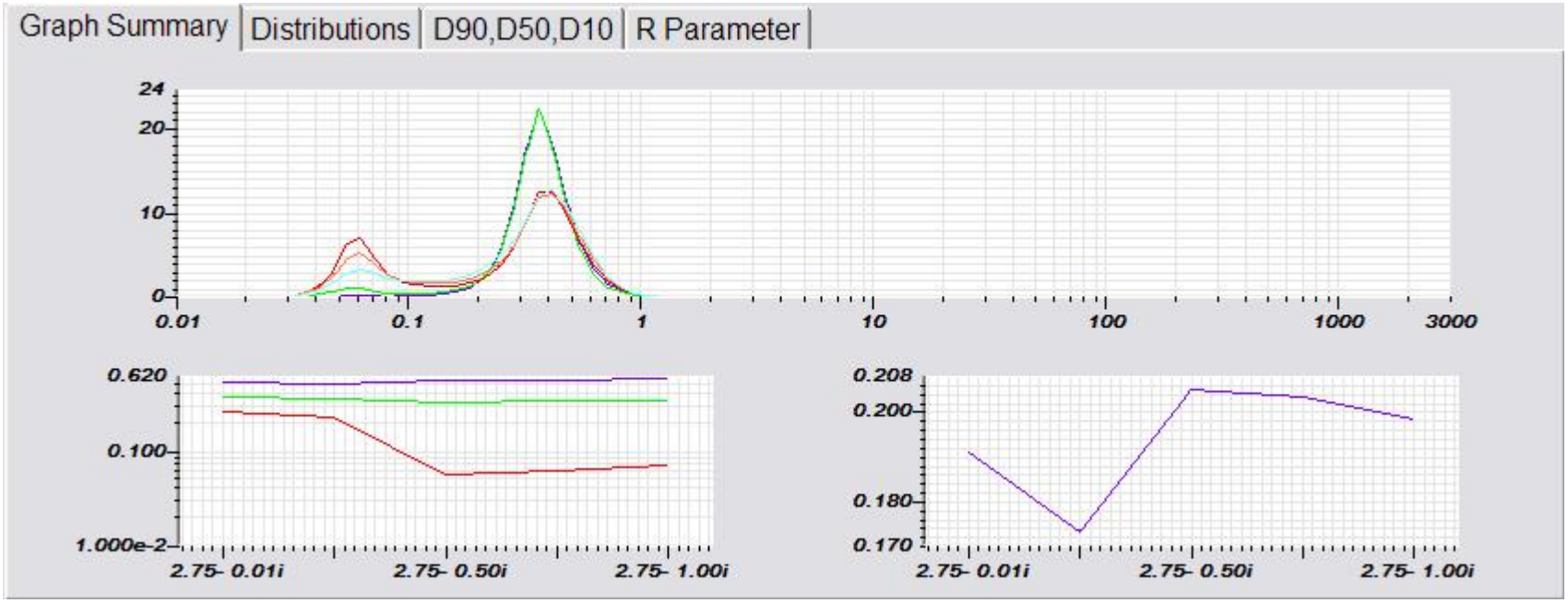
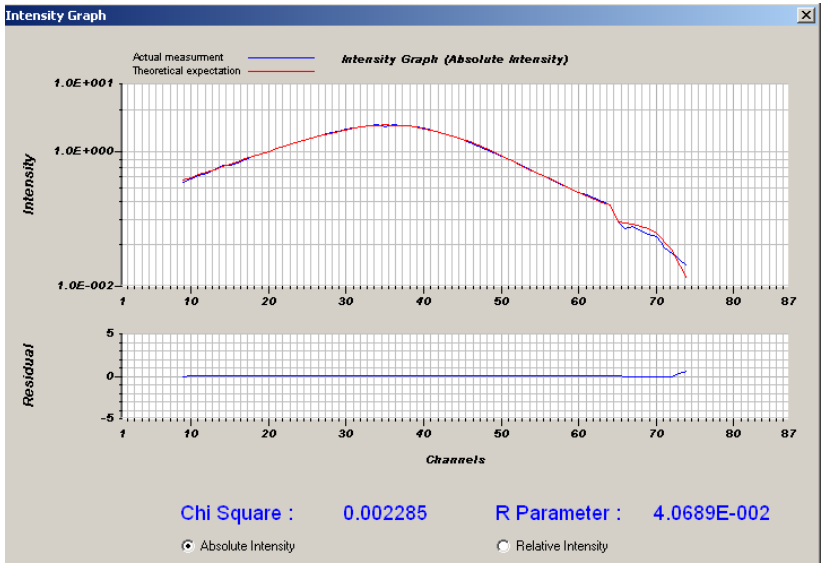


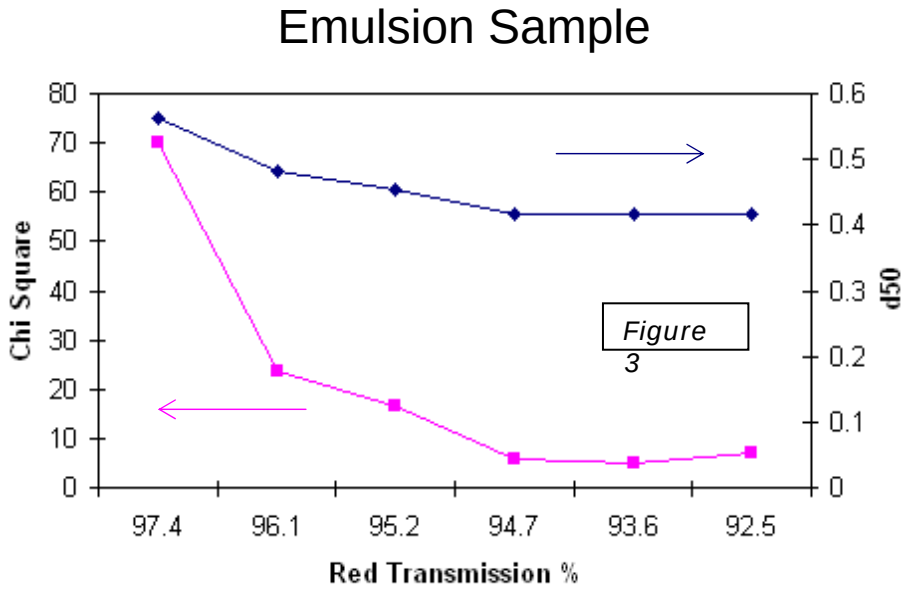
Automated RI computation

- **“Method Expert”- Final RI study**



Accuracy: Error Calculations

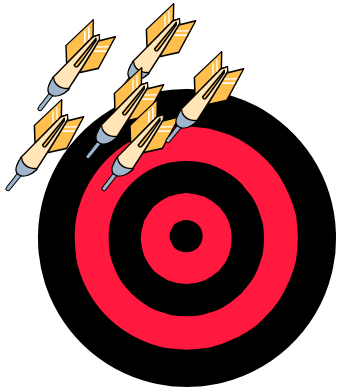




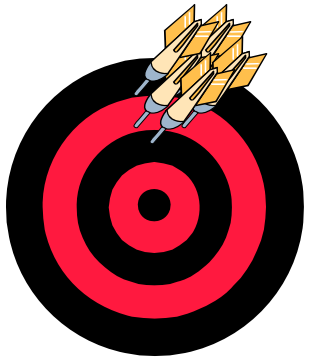
$$\chi^2 = \sum \left\{ \frac{1}{\sigma_i^2} [y_i - y(x_i)]^2 \right\} \qquad R = \frac{1}{N} \sum_{i=1}^{N} \left\{ \frac{1}{y_{(x_i)}} |y_i - y(x_i)| \right\}$$

yi	The measured scattered light at each channel (i) of the detector.
y (xi)	The calculated scattered light at each channel (i) of the detector based on the chosen refractive index kernel and reported particle size distribution.
σi	The standard deviation of the scattered light intensity at each channel (i) of the detector. A larger σi indicates lower reliability of the signal on a given detector.
N	The number of detectors used for the calculation

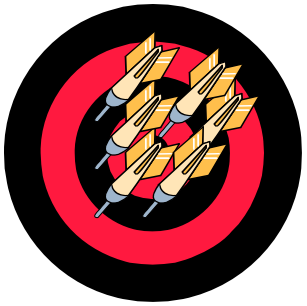
Specifications:Accuracy and Precision



LOW ACCURACY
LOW PRECISION



LOW ACCURACY
HIGH PRECISION



HIGH ACCURACY
LOW PRECISION

HIGH ACCURACY
HIGH PRECISION

■(A) Low accuracy, low precision measurements form a diffuse, off-center cluster; (B) Low accuracy, high precision measurements form a tight off-center cluster; (C) High accuracy, low precision measurements form a cluster that is evenly distributed but distant from the center of the target; (D) High Accuracy, high precision measurements are clustered in the center of the target.

Accuracy

- Comparison to referee technique
  - Microscope (image analysis) is referee technique for particle characterization
- Challenged with particle size standards
  - Monodisperse latex spheres
    - Verifies optics
    - May pass even if problems with sampler
  - Polydisperse glass spheres
    - Verifies complete system
    - Should find problems with samplers

Accuracy

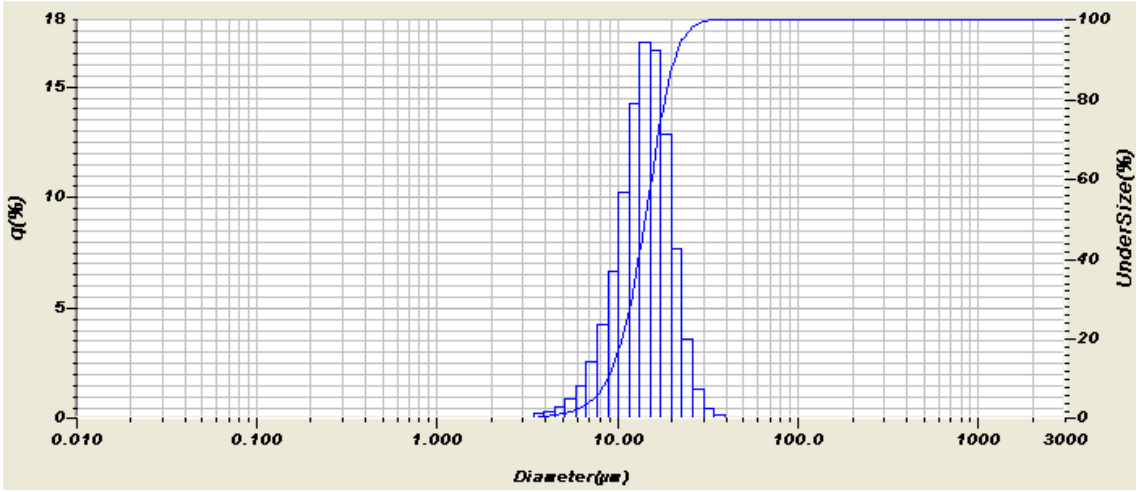
- Verification following accepted practices using polydisperse standards:
  - ISO13320 and USP <429>
    - D_{50} deviates < 3% from certified range
    - D_{10} & D_{90} deviate < 5%

    AND
    - COV D50 < 3%
    - COV D10 & D90 < 5%

Note: Coefficient of Variation = (standard deviation/mean)*100
also called RSD

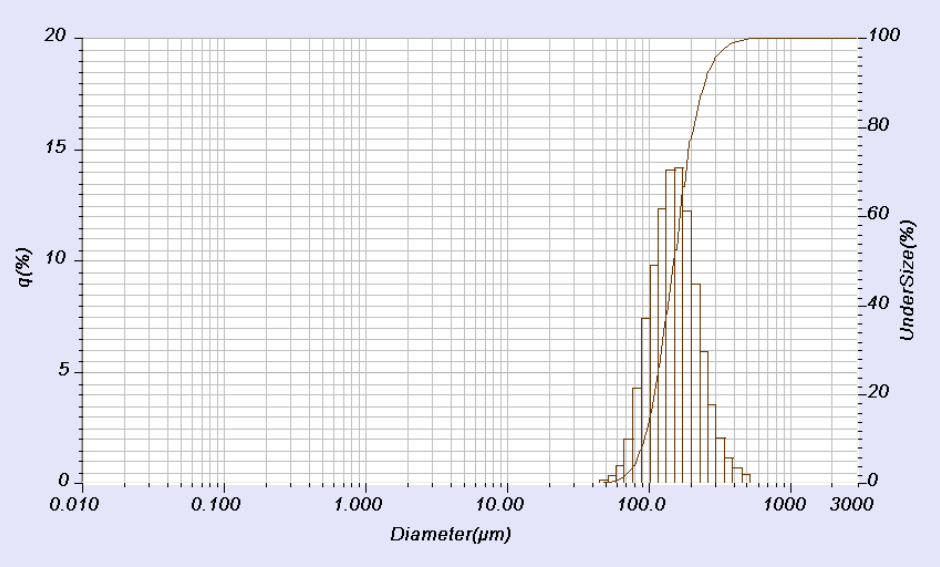
Accuracy Test: PS202

PS202 (3-30µm)	D10	D50	D90
Standard Value (µm)	9.14	13.43	20.34
Uncertainty (µm)	0.86	0.86	1.44
ISO standard error	5%	3%	5%
Lower limit (µm)	7.866	12.193	17.955
Measured Result (µm)	9.721	13.916	18.959
Upper Limit (µm)	10.500	14.719	22.869



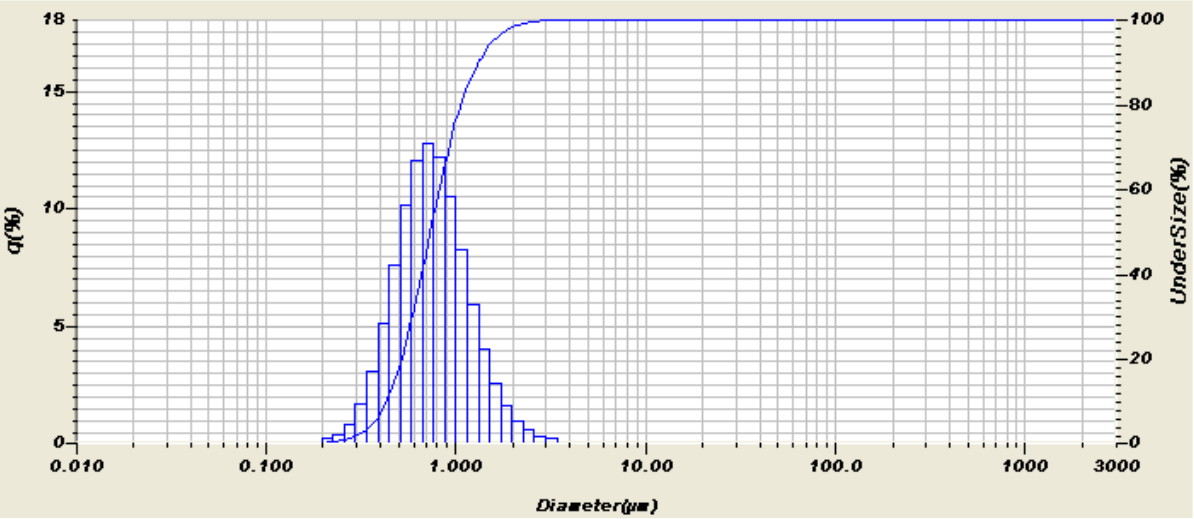
Accuracy Test: PS 225

PS225 (50-350µm)	D10	D50	D90
Standard Value (µm)	93.7	150.5	238.8
Uncertainty (µm)	3.54	2.52	6.02
ISO standard error	5%	3%	5%
Lower limit (µm)	85.652	143.541	221.141
Measured Result (µm)	94.217	153.815	252.542
Upper Limit (µm)	102.102	157.611	257.061

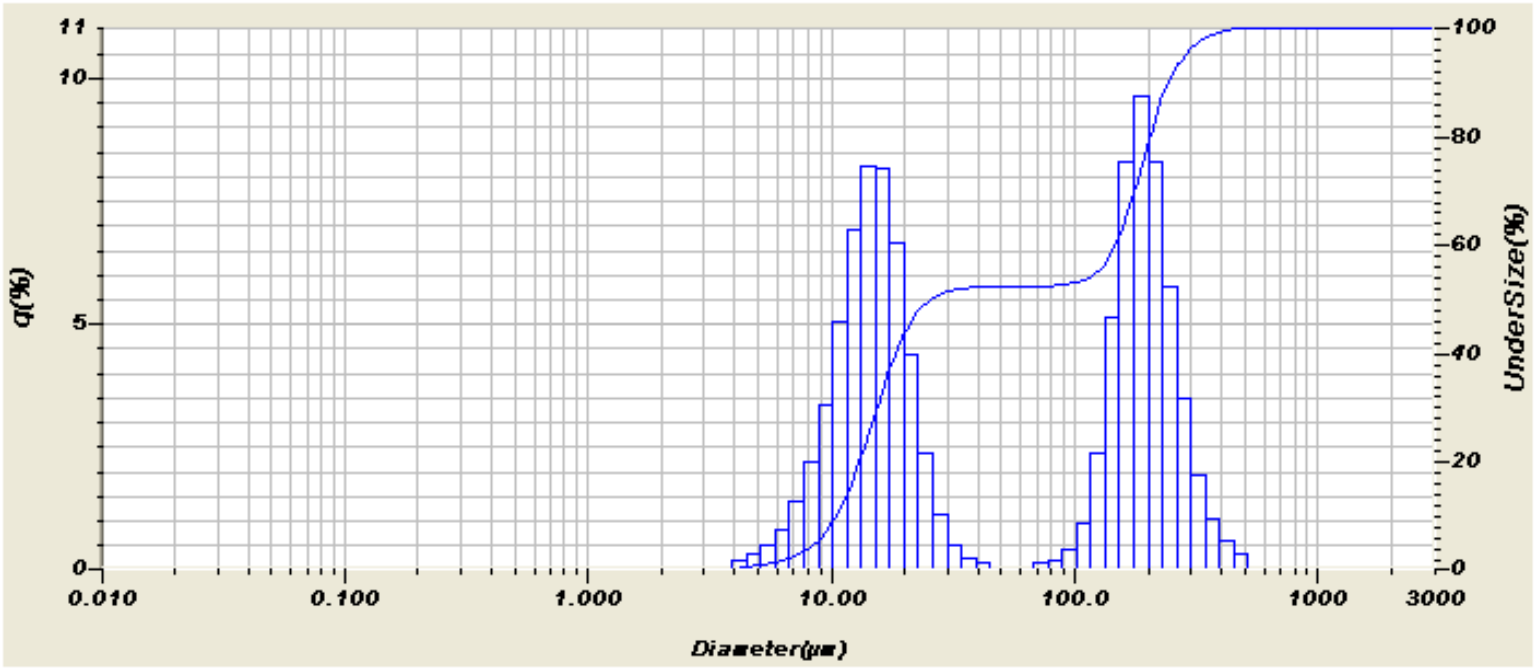


Accuracy Test: PS 181

PS181 (0.1-1µm)	D10	D50	D90
Standard Value (µm)	0.36	0.65	1.11
Uncertainty (µm)	0.06	0.06	0.13
ISO standard error	5%	3%	5%
Lower limit (µm)	0.285	0.5723	0.931
Measured Result (µm)	0.434	0.709	1.296
Upper Limit (µm)	0.441	0.7313	1.302

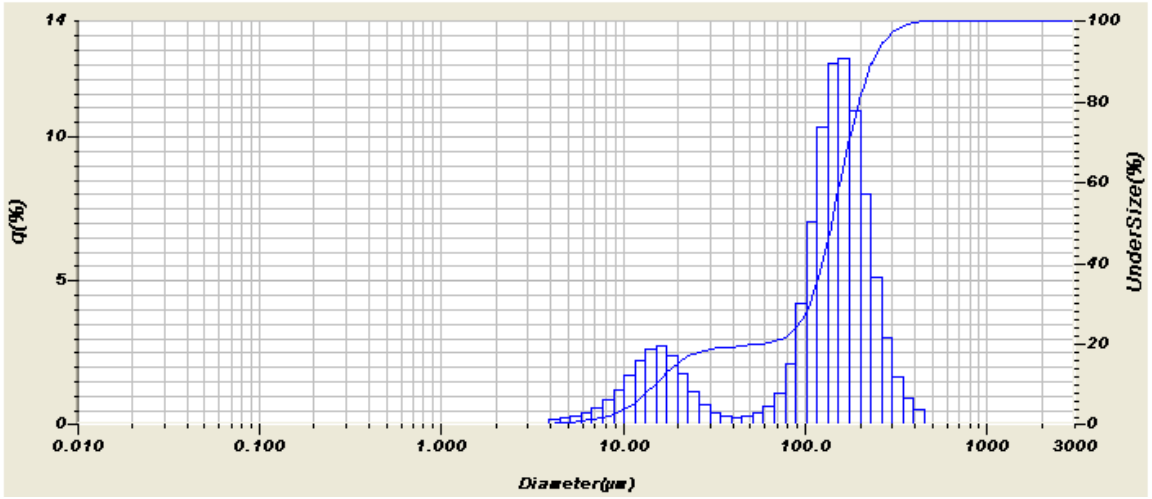


Mix of 50/50 PS202 & 225

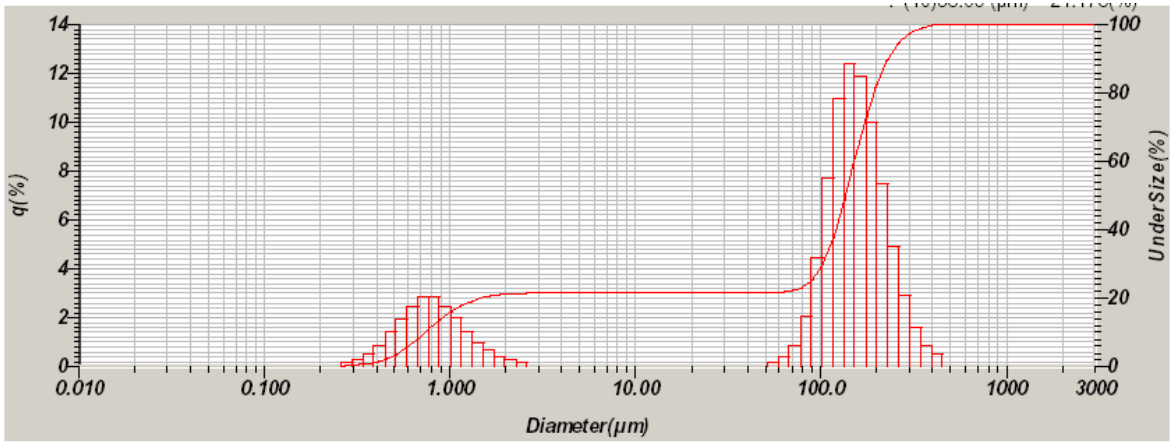


Excellent baseline resolution: 48/52 calculated proportions

Mixed Standards



5 parts PS225 to
1 part PS202

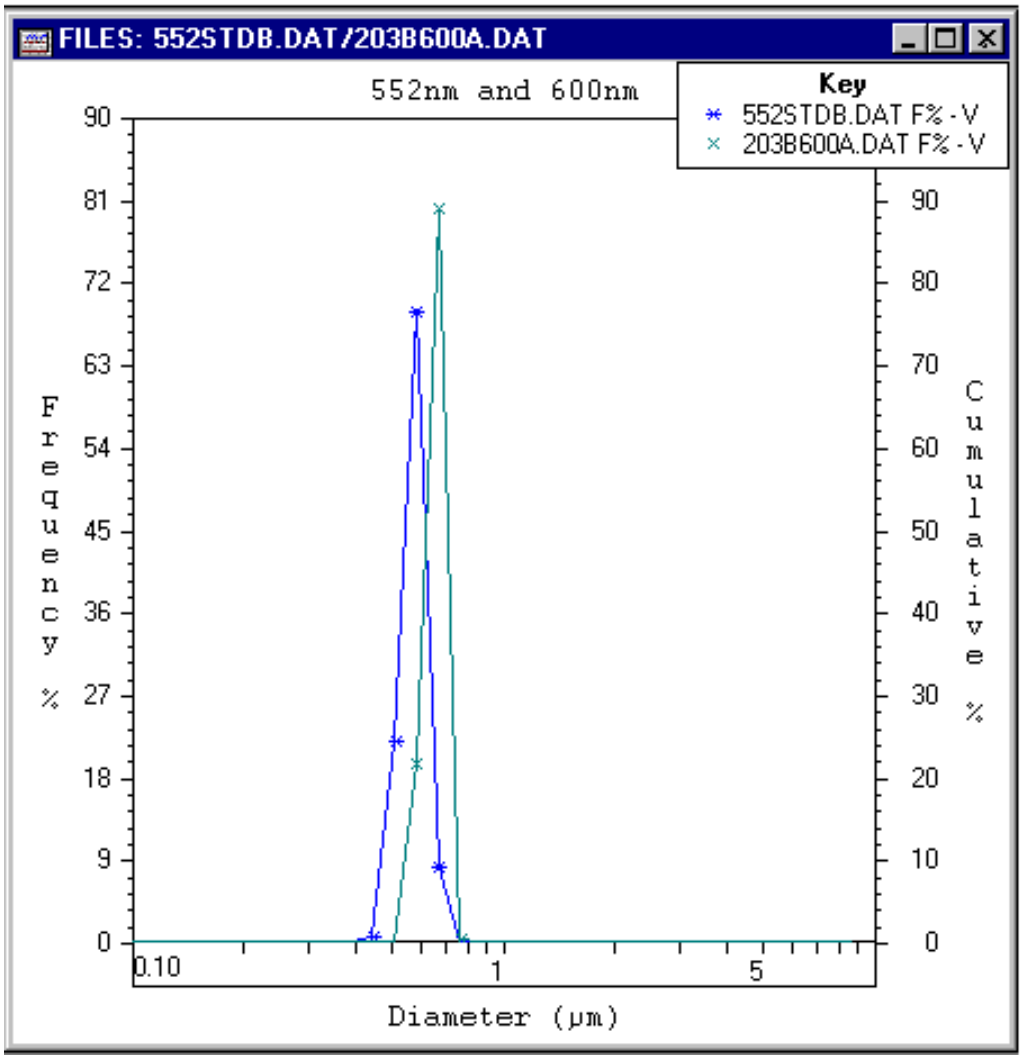


5 parts PS225 to
1 part PS181

Resolution

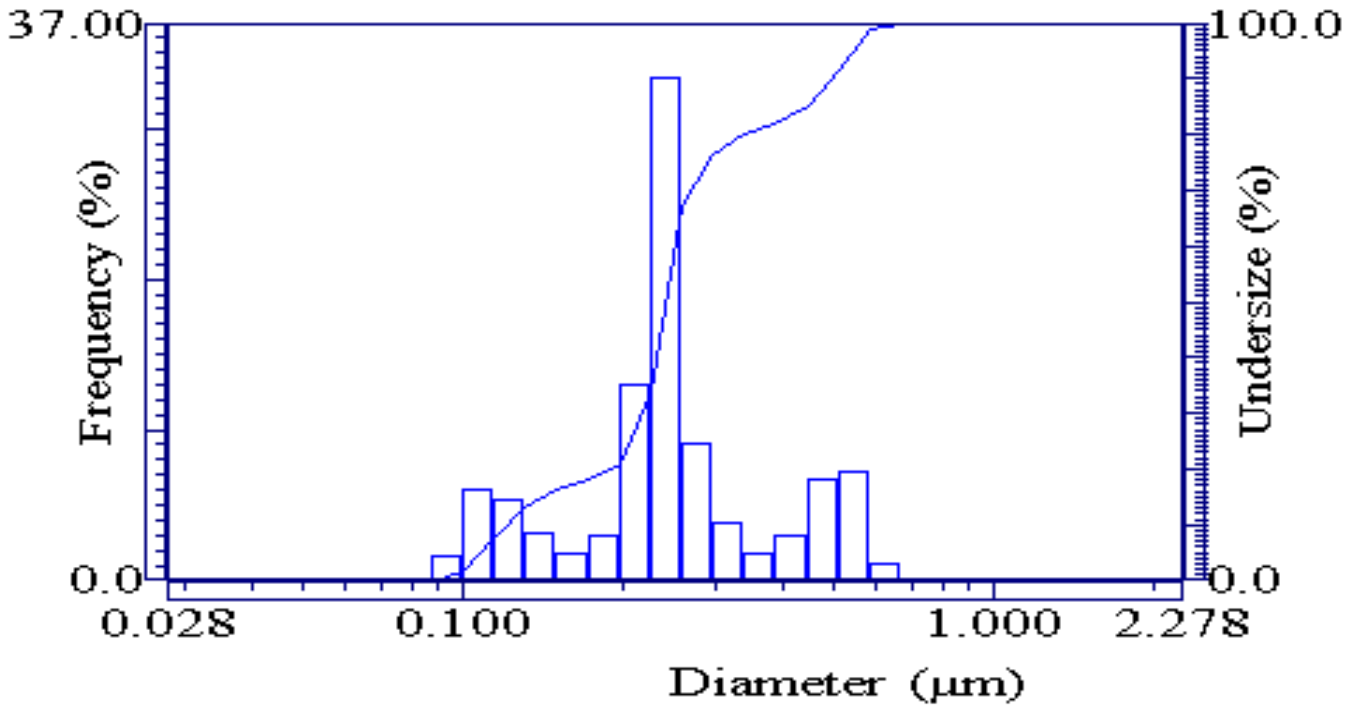
- Ability to measure small differences in particle size
- Small differences between successive samples (different production lots) are most important
- Detection limit of small amount of material outside of main size distribution
- Best defined by user's real-world requirements

Resolution



- Resolve size difference between two materials of similar size.
- 552nm and 600nm PSL
- Can separate peaks when measured separately
- Would merge into one peak if measured together

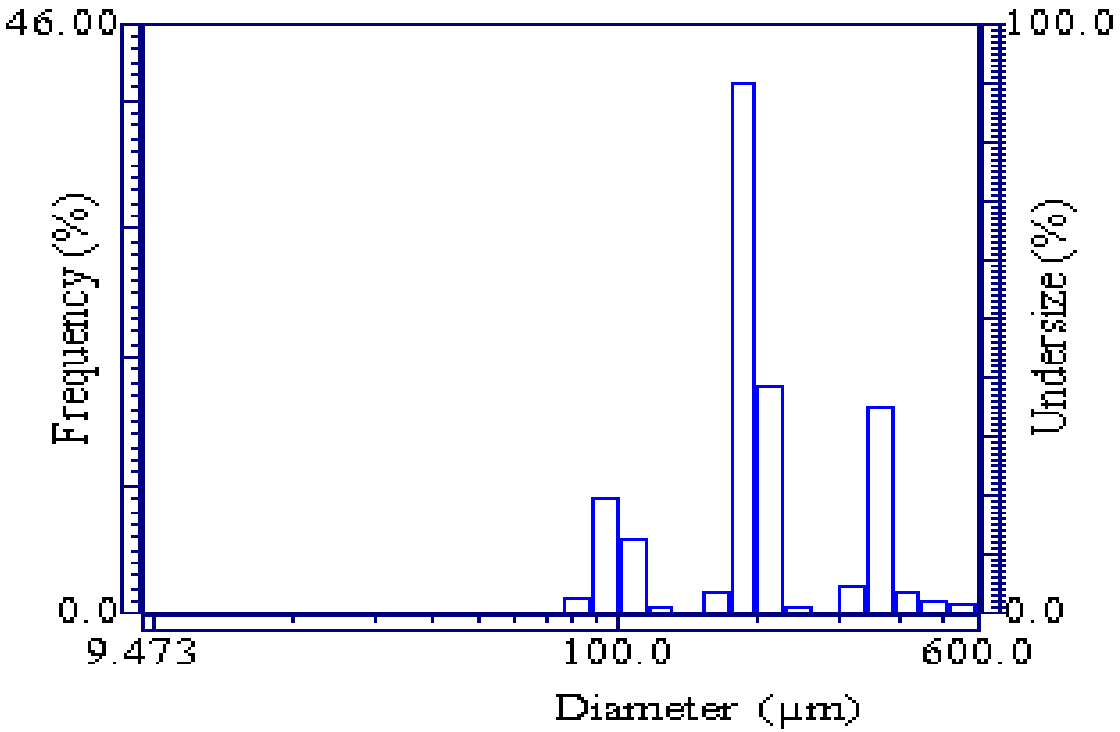
Resolution: Small Particles



83nm,
204nm,
503nm
PSL

Resolution of multiple modes in a single sample.

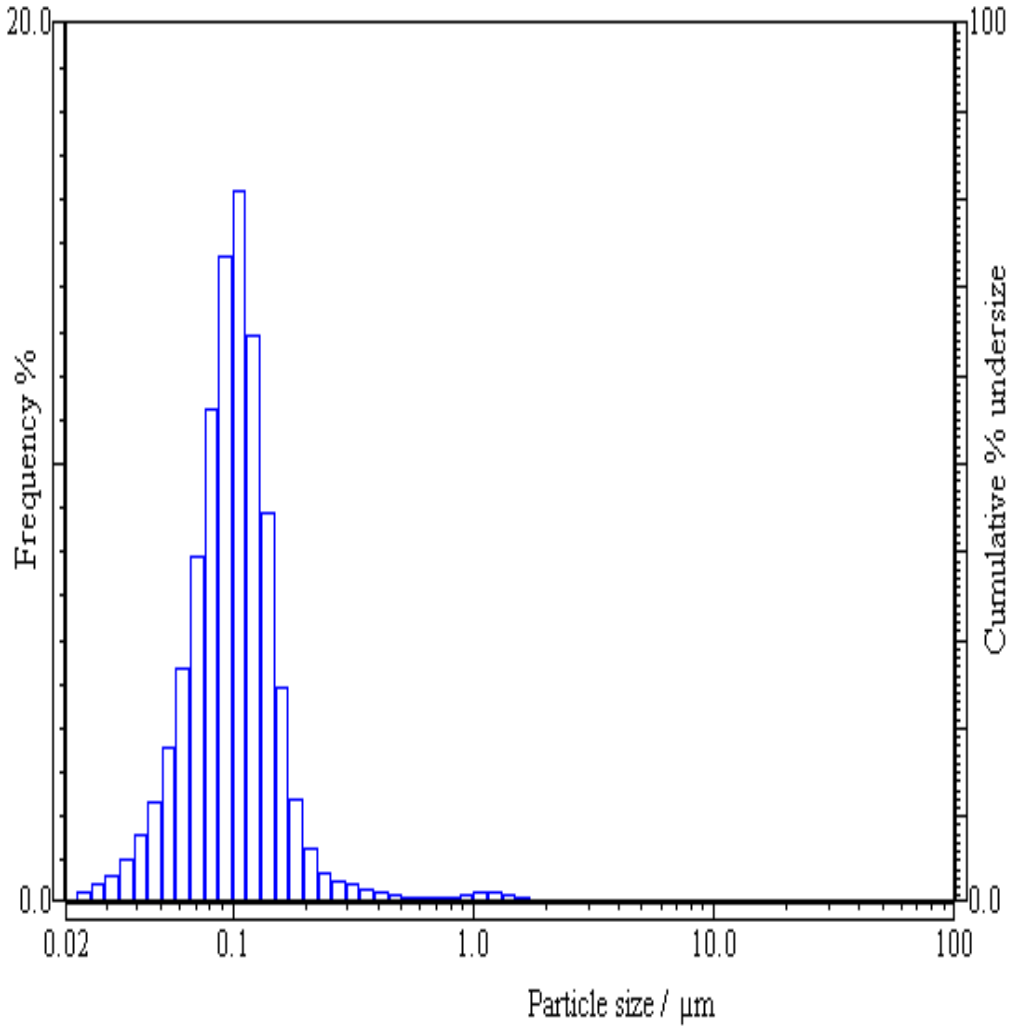
Resolution: Large Particles



100µm, 200µm, 400µm glass beads

Resolution of multiple modes in a single sample.

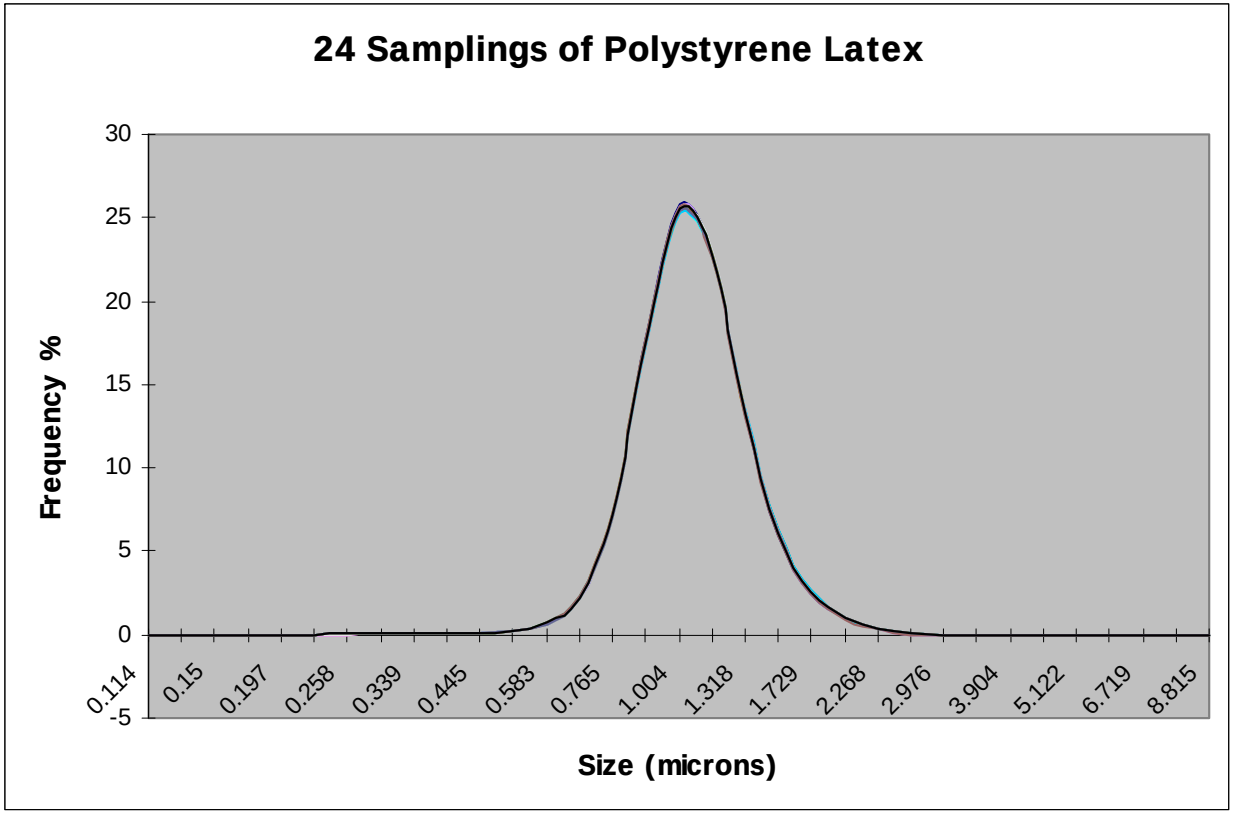
Resolution: Small Amount of Second Peak



- 0.1 micron silica material
- 2% by weight of ~1 micron quartz standard added

Precision (Repeatability)

- Repeatability: Measuring the same sample multiple times as it recirculates within the system

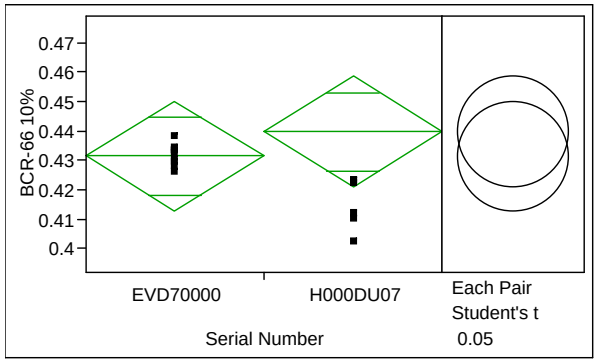


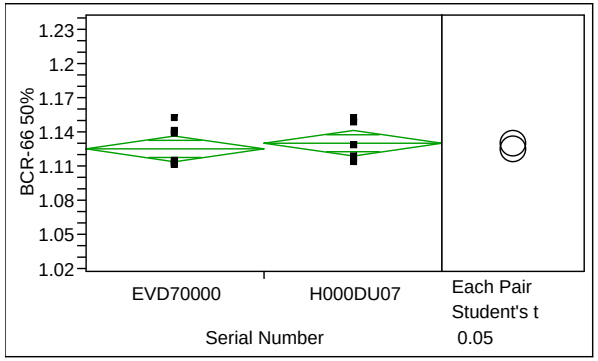
LA-950 Accuracy & Precision Data

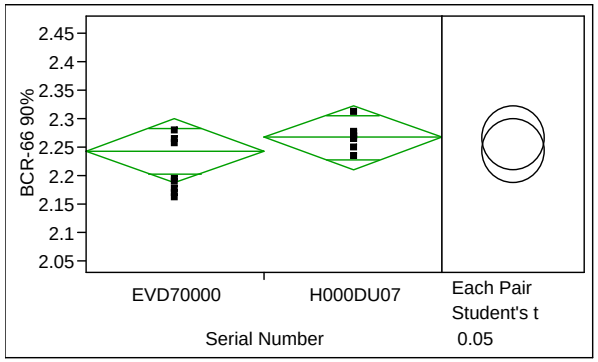
Accuracy and Precision for PSL Standards

Standard value	**102nm**	**491nm**	**1.02um**	**12.01um**	**102um**	**1004um**
Tolerance	**3nm**	**4nm**	**0.022um**	**0.07um**	**1.4um**	**14um**
1	104.41	489.41	1.021	11.97	102.64	1001.14
2	104.39	489.28	1.019	11.97	102.66	1000.20
3	104.39	490.24	1.019	11.97	102.73	1001.49
4	104.33	489.52	1.021	11.96	102.70	1001.28
5	104.38	489.55	1.019	11.97	102.73	1000.14
6	104.36	489.52	1.021	11.97	102.74	1000.27
7	104.36	489.50	1.019	11.97	102.76	1001.67
8	104.35	489.91	1.021	11.96	102.74	1001.22
9	104.37	488.99	1.021	11.97	102.74	1000.76
10	104.34	489.68	1.021	11.97	102.76	1000.45
Average	**104.37**	**489.56**	**1.020**	**11.97**	**102.72**	**1000.86**
Std. Dev.	**0.024**	**0.321**	**0.001**	**0.004**	**0.039**	**0.540**
CV	**0.02%**	**0.07%**	**0.10%**	**0.03%**	**0.04%**	**0.05%**

Analysis of Variance (ANOVA): BCR-66*







Summary of Fit	10%	50%	90%
Rsquare	0.02698	0.03032	0.02330
Adj Rsquare	-0.03384	-0.03029	-0.03775
Root Mean Square Error	0.02654	0.01566	0.07936
Mean of Response	0.4356	1.1276	2.2553
Observations	18	18	18

t Test	10%	50%	90%
Difference	0.00833	0.00522	0.02311
Std Err Dif	0.01251	0.00738	0.03741
Upper CL Dif	0.03486	0.02088	0.1024
Lower CL Dif	-0.01819	-0.01043	-0.05619
Confidence	0.95	0.95	0.95
t Ratio	0.6660	0.7072	0.6178
DF	16	16	16
Prob > |t|	0.5149	0.4896	0.5454

Tool Difference	10%	50%	90%
EVD70000	0.4314	1.1250	2.2438
H000DU07	0.4398	1.1302	2.2669
Grand Mean	0.4356	1.1276	2.2553
Difference of Tools	-0.00833	-0.00522	-0.02311
% Difference	-1.91%	-0.46%	-1.02%
Tolerance Level	±10%		

*see AN146 LA-950 Repeatability Study on www.horiba.com

Reproducibility

- Prepare sample, measure, drain, repeat
- What would be good reproducibility?
- Test COV according to ISO13320
  - CV < 3% at D_{50}
  - CV < 5% at D_{10} & D_{90}
  - Double values if D_{50} <10 μm
- Test COV according to USP<429>
  - CV < 10% at D_{50}
  - CV < 15% at D_{10} & D_{90}
  - Double values if D_{50} <10 μm

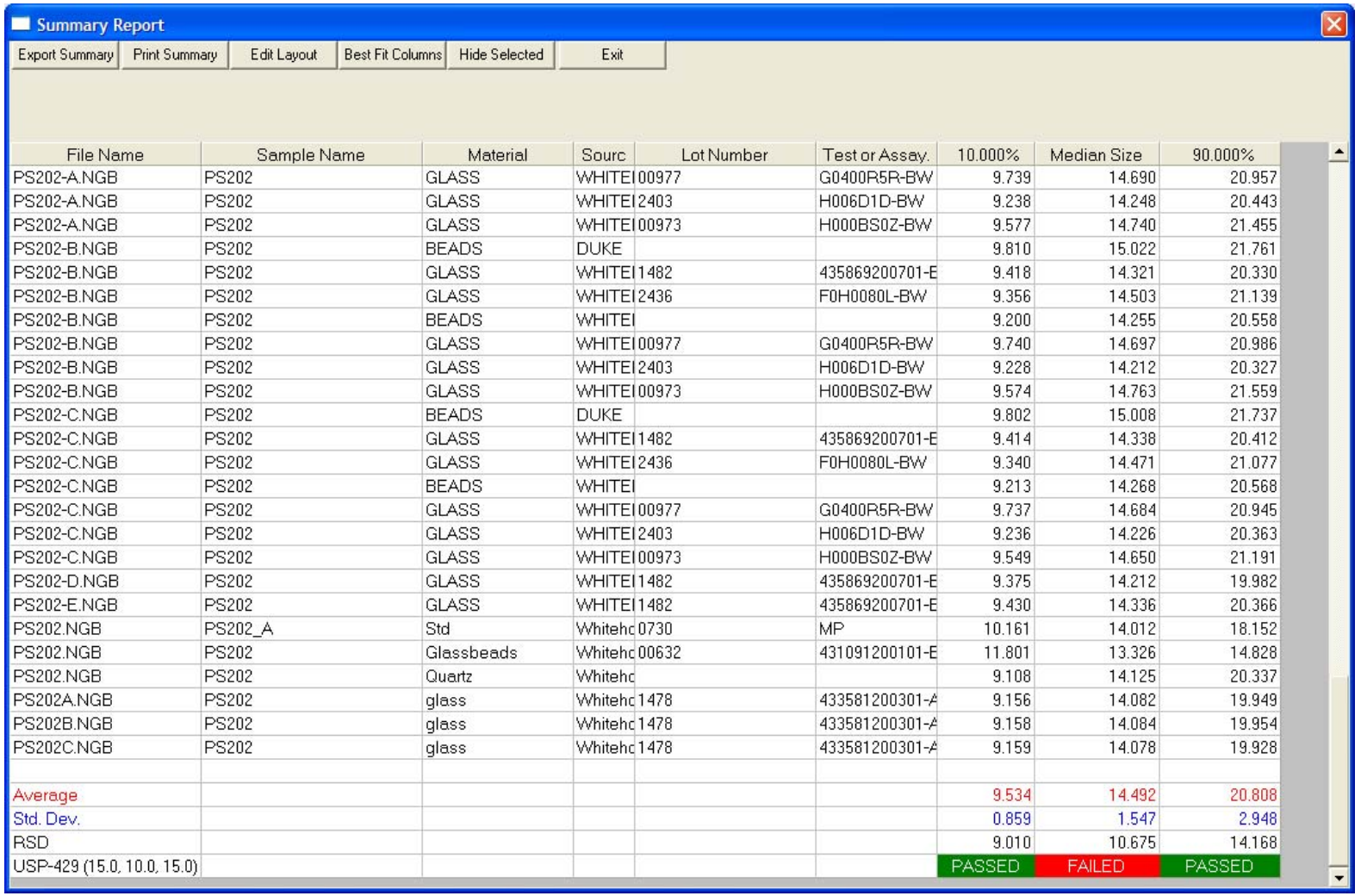
Automatic Reproducibility Calculations

- ISO13320-1-1999 “Particle size analysis — Laser diffraction methods — Part 1: General principles
- EP 2.9.31 “Laser Diffraction Measurement of Particle Size”; Lead for this monograph
- Appearance in Pharmacopeial Forum 28, Number 3 2002
- Now in USP 28, NF25
  - in Stage 4 of the harmonization process with the EP and the JP

General Chapters Status

Chapter Title	Summary Status	Most Recent/Proposed PF	Official/Proposed Official Date	Expert Committee
<429> LIGHT DIFFRACTION MEASUREMENT OF PARTICLE SIZE	Official in PF	31(4)	USP 27 1S	GC

Software Automation



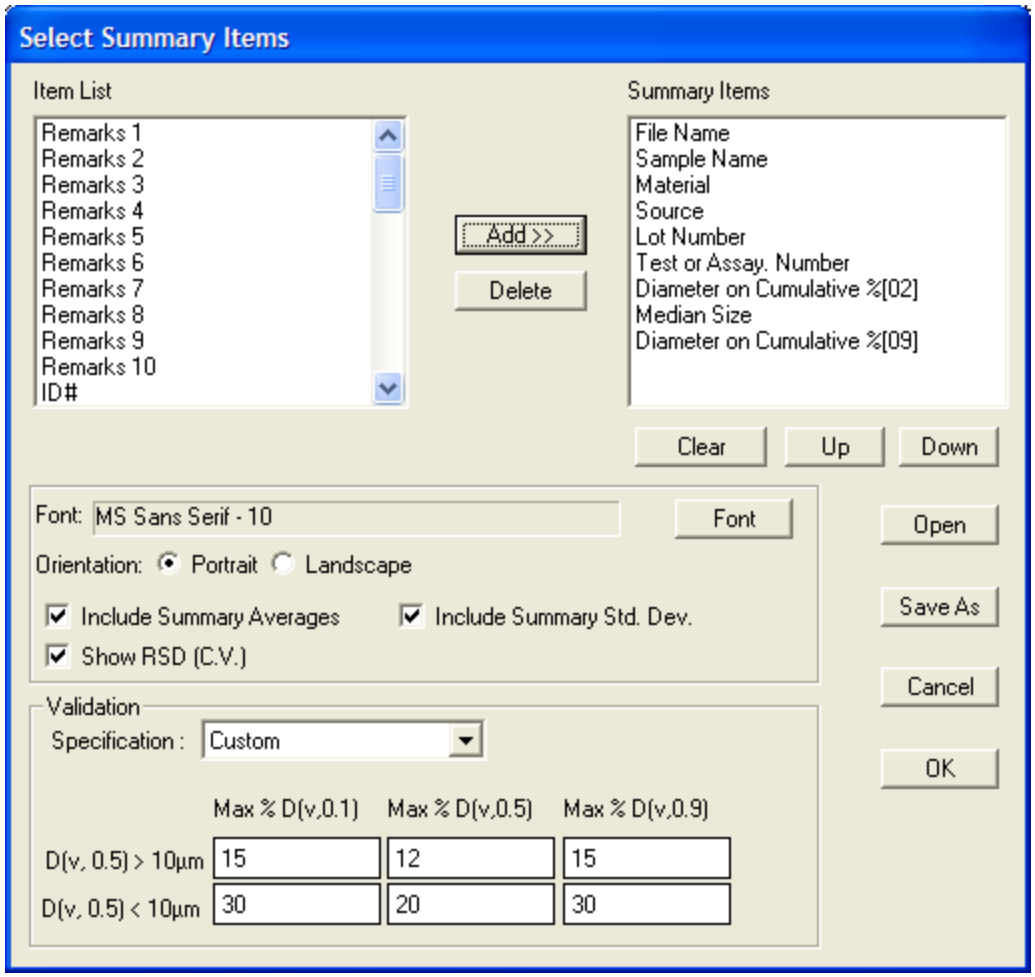
File Name	Sample Name	Material	Sourc	Lot Number	Test or Assay.	10.000%	Median Size	90.000%
PS202-A.NGB	PS202	GLASS	WHITEI	00977	G0400R5R-BW	9.739	14.690	20.957
PS202-A.NGB	PS202	GLASS	WHITEI	2403	H006D1D-BW	9.238	14.248	20.443
PS202-A.NGB	PS202	GLASS	WHITEI	00973	H000BS0Z-BW	9.577	14.740	21.455
PS202-B.NGB	PS202	BEADS	DUKE			9.810	15.022	21.761
PS202-B.NGB	PS202	GLASS	WHITEI	1482	435869200701-E	9.418	14.321	20.330
PS202-B.NGB	PS202	GLASS	WHITEI	2436	F0H0080L-BW	9.356	14.503	21.139
PS202-B.NGB	PS202	BEADS	WHITEI			9.200	14.255	20.558
PS202-B.NGB	PS202	GLASS	WHITEI	00977	G0400R5R-BW	9.740	14.697	20.986
PS202-B.NGB	PS202	GLASS	WHITEI	2403	H006D1D-BW	9.228	14.212	20.327
PS202-B.NGB	PS202	GLASS	WHITEI	00973	H000BS0Z-BW	9.574	14.763	21.559
PS202-C.NGB	PS202	BEADS	DUKE			9.802	15.008	21.737
PS202-C.NGB	PS202	GLASS	WHITEI	1482	435869200701-E	9.414	14.338	20.412
PS202-C.NGB	PS202	GLASS	WHITEI	2436	F0H0080L-BW	9.340	14.471	21.077
PS202-C.NGB	PS202	BEADS	WHITEI			9.213	14.268	20.568
PS202-C.NGB	PS202	GLASS	WHITEI	00977	G0400R5R-BW	9.737	14.684	20.945
PS202-C.NGB	PS202	GLASS	WHITEI	2403	H006D1D-BW	9.236	14.226	20.363
PS202-C.NGB	PS202	GLASS	WHITEI	00973	H000BS0Z-BW	9.549	14.650	21.191
PS202-D.NGB	PS202	GLASS	WHITEI	1482	435869200701-E	9.375	14.212	19.982
PS202-E.NGB	PS202	GLASS	WHITEI	1482	435869200701-E	9.430	14.336	20.366
PS202.NGB	PS202_A	Std	Whitehc	0730	MP	10.161	14.012	18.152
PS202.NGB	PS202	Glassbeads	Whitehc	00632	431091200101-E	11.801	13.326	14.828
PS202.NGB	PS202	Quartz	Whitehc			9.108	14.125	20.337
PS202A.NGB	PS202	glass	Whitehc	1478	433581200301-A	9.156	14.082	19.949
PS202B.NGB	PS202	glass	Whitehc	1478	433581200301-A	9.158	14.084	19.954
PS202C.NGB	PS202	glass	Whitehc	1478	433581200301-A	9.159	14.078	19.928
Average						9.534	14.492	20.808
Std. Dev.						0.859	1.547	2.948
RSD						9.010	10.675	14.168
USP-429 (15.0, 10.0, 15.0)						PASSED	FAILED	PASSED

Qualification: Accuracy and Repeatability

- Use polydisperse standard
- Three independent measurements, calculate mean
- X50 <3% “certified range of values”
- X10 & X90 < 5% “certified range of values”
- Also check repeatability
- COV X50 < 3%
- COV X10 & X90 < 5%

See Verification webinar on website

Software Automation



Qualification in Practice

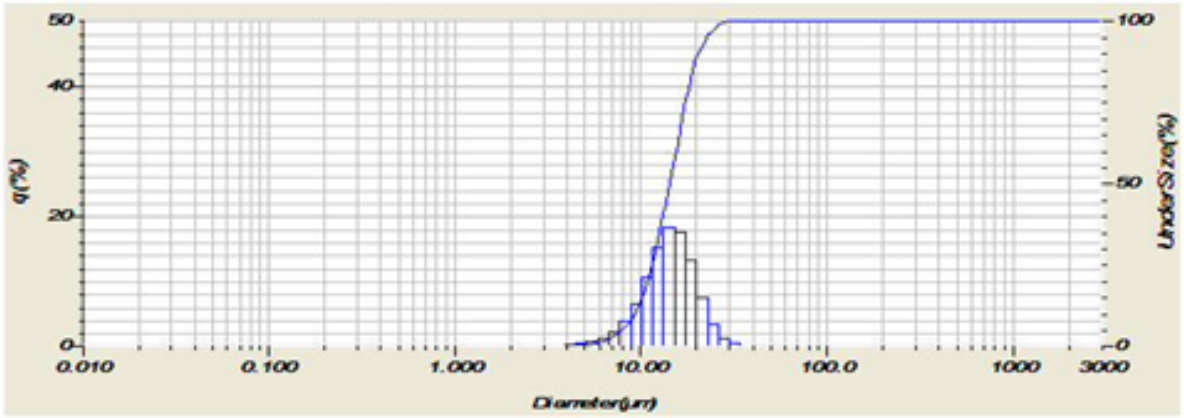
2007.04.18 13:58:26

HORIBA Laser Scattering Particle Size Distribution Analyzer LA-950

Sample Name	: HS 202	Median Size	: 14.33349(µm)
ID#	: 200702261526010	Mean Size	: 14.71330(µm)
Data Name	: 200702261526010	Std.Dev.	: 4.4439(µm)
Transmittance(R)	: 87.7(%)	Geo.Mean Size	: 14.0350(µm)
Transmittance(B)	: 89.8(%)	Geo.Std.Dev.	: 1.3688(µm)
Circulation Speed	: 4	Mode Size	: 14.3056(µm)
Agitation Speed	: 1	Span	: OFF
Ultra Sonic	: 05:00 (7)	Diameter on Cumulative %	: (2)10.00 (%)- 9
Form of Distribution	: Auto		: (9)90.00 (%)- 2
Distribution Base	: Volume		
Refractive Index (R)	: STD-GLASSBEADS[STD-GLASSBEADS(1.510 - 0.000i),Water(1.333)]		
Refractive Index (B)	: STD-GLASSBEADS[STD-GLASSBEADS(1.510 - 0.000i),Water(1.333)]		
Material	: BEADS		
Source	: DUKE		

Verification : OK 1.4% [Diameter on Cumulative %(2) 9.140 (µm)[± 5.000%]]
: NG 6.7% [Median Size 13.43 (µm)[± 5.000%]]
: OK 1.3% [Diameter on Cumulative %(9) 20.34 (µm)[± 5.000%]]

Verification Info



Accuracy & Precision Specifications

Accuracy – Guaranteed!

- +/- 0.6% on NIST-traceable polystyrene latex calibration standards
- 3% on d50 (median) for broad-distribution glass bead standards
- 5% on d10 and d90 for broad-distribution glass bead standards

Meets or exceeds all requirements of ISO 13320 and USP 429

Precision – 0.1%

The combination of a rigid optical bench, stable, high-intensity light sources, optimized detectors, and highly-refined electronics virtually eliminates variability in the background noise and fluctuations in the response of the instrument. The *Partica* LA-950 has a guaranteed precision of 0.1% on polystyrene latex calibration standards

Instrument to Instrument Variation

Minimized Instrument to Instrument Variation

As a result of each instrument being extremely accurate and precise, the variation in results from instrument to instrument is decreased. This is particularly important when multiple units are installed at different production facilities or when comparing data from supplier to customer.

Sample	CV D10	CV D50	CV D90
PS202 (3-30µm)	2%	1%	2%
PS213 (10-100µm)	2%	2%	2%
PS225 (50-350µm)	1%	1%	1%
PS235 (150-650µm)	1%	1%	2%
PS240 (500-2000µm)	3%	2%	2%
All samples measured on 20 different instruments			

Customer Data: Intermediate Precision

Design of Intermediate Precision Experiments				
1	N = 6 Assays	Day-1	Analyst-1	Instrument-1
2	N = 6 Assays	Day-1	Analyst-2	Instrument-1
3	N = 6 Assays	Day-1	Analyst-1	Instrument-2
4	N = 6 Assays	Day-1	Analyst-2	Instrument-2
5	N = 6 Assays	Day-2	Analyst-1	Instrument-1
6	N = 6 Assays	Day-2	Analyst-2	Instrument-1
7	N = 6 Assays	Day-2	Analyst-1	Instrument-2
8	N = 6 Assays	Day-2	Analyst-2	Instrument-2

Customer Data: LA-910 Intermediate Precision

				Grand RSD					
Analyst	Day	Instr.#	Replicate	Dmean (nm)	D5(nm)	D10(nm)	D50(nm)	D90(nm)	D95(nm)
1	1	1	1	107	45	56	95	171	211
1	1	1	2	107	45	56	95	171	210
1	1	1	3	106	45	56	94	168	206
1	1	1	4	107	45	56	95	170	209
1	1	1	5	106	45	55	94	169	208
1	1	1	6	103	45	55	93	163	195
1	1	2	1	102	44	53	88	165	200
1	1	2	2	101	44	53	87	163	206
1	1	2	3	101	44	53	87	162	202
1	1	2	4	100	44	53	87	161	201
1	1	2	5	101	44	53	87	161	202
1	1	2	6	98	44	53	87	152	188
1	2	1	1	108	45	56	96	172	212
1	2	1	2	108	45	56	96	171	210
1	2	1	3	106	45	56	95	168	205
1	2	1	4	107	45	56	95	169	208
1	2	1	5	107	45	56	95	169	208
1	2	1	6	106	45	56	95	168	206
1	2	2	1	103	44	53	89	166	211
1	2	2	2	103	44	53	88	167	210
1	2	2	3	102	44	53	89	165	207
1	2	2	4	102	44	53	88	164	206
1	2	2	5	102	44	53	88	164	206
1	2	2	6	101	44	53	88	163	205
2	1	1	1	107	45	55	94	172	214
2	1	1	2	107	45	55	94	173	216
2	1	1	3	105	45	55	93	168	207
2	1	1	4	106	45	55	93	170	212
2	1	1	5	106	45	55	93	171	213
2	1	1	6	106	45	55	93	169	208
2	1	2	1	102	44	53	88	164	209
2	1	2	2	100	44	53	87	161	202
2	1	2	3	100	44	53	87	158	198
2	1	2	4	100	44	53	86	158	199
2	1	2	5	100	44	53	87	159	200
2	1	2	6	99	44	53	87	157	197
2	2	1	1	109	45	56	97	176	216
2	2	1	2	108	45	56	96	174	214
2	2	1	3	107	45	56	95	170	208
2	2	1	4	106	45	55	94	169	208
2	2	1	5	106	45	55	94	170	209
2	2	1	6	106	45	56	94	169	207
2	2	2	1	103	44	54	89	165	209
2	2	2	2	104	44	53	89	169	217
2	2	2	3	103	44	53	88	167	212
2	2	2	4	102	44	53	88	165	210
2	2	2	5	101	44	54	88	162	203
2	2	2	6	101	44	54	89	161	200

	Grand RSD					
	Dmean (nm)	D5(nm)	D10(nm)	D50(nm)	D90(nm)	D95(nm)
Average	104	45	54	91	166	207
STDEV	3.0	0.5	1.3	3.5	5.0	5.8
% RSD	2.8	1.1	2.4	3.9	3.0	2.8
RSD limit	6%	10%	10%	6%	10%	10%

Instrument to instrument variability: LA-910

6-8 Instruments:

Formulation	Dmean	D10	D50	D90	Dmean	D10	D50	D90
	sd (nm)	sd (nm)	sd (nm)	sd (nm)	rsd (%)	rsd (%)	rsd (%)	rsd (%)
A	2.8	2.1	3.5	2.1	2.8	3.4	3.6	1.5
B	4.5	7.1	4.7	6.9	2.6	6.0	2.8	2.9
C	9.5	6.5	9.5	12.2	6.1	6.5	6.5	5.4
D	10.6	7.9	10.1	18.2	5.9	7.0	5.9	7.0
E	8.7	5.4	8.7	19.4	5.4	5.5	5.7	8.1
F	9.2	10.0	9.5	14.6	6.0	10.7	6.6	6.4

Customer Data: LA-950 Precision

LA-950 # 1:

Formulation 1	Dmean	D5	D10	D50	D90	D95
1	156	113	120	154	195	209
2	155	112	119	153	194	208
3	155	112	119	153	194	208
4	156	113	119	154	195	209
5	154	111	119	152	193	207
6	155	112	119	152	194	208
Average	155	112	119	153	194	208
Std Dev	0.8	0.8	0.5	1.0	0.8	0.7
RSD	0.5	0.7	0.4	0.6	0.4	0.4

LA-950 #2:

Formulation 1	Dmean	D5	D10	D50	D90	D95
1	154	112	119	152	192	208
2	154	112	119	152	192	208
3	155	113	119	152	192	208
4	155	113	119	152	193	208
5	154	112	119	152	193	207
6	155	112	119	153	193	208
Average	155	112	119	152	192	208
Std Dev	0.5	0.5	0.0	0.6	0.3	0.5
RSD	0.3	0.5	0.0	0.4	0.1	0.3

Instrument to instrument variability: LA-950

4 Instruments:

Formulation 1	Dmean	D5	D10	D50	D90	D95
Average (nm)	155	112	119	152	193	208
Std Dev (nm)	0.8	0.8	0.7	1.0	1.1	0.7
RSD (%)	0.5	0.7	0.6	0.6	0.6	0.3

Formulation 2	Dmean	D5	D10	D50	D90	D95
Average (nm)	193	136	147	187	247	264
Std Dev (nm)	1.5	0.5	0.4	0.6	0.4	1.1
RSD (%)	0.8	0.4	0.3	0.3	0.2	0.4

Reliability and Support

- LA-950 (V1) launched in 2004, hundreds of installations, not a single light source or detector failure yet
- Full applications support worldwide
  - Application labs in US (x2), France, Germany, Japan (x2), Singapore, China (x2), Korea
- Two day hands-on training course in NJ and CA
- Web based training – all lectures from 2 day diffraction training course
- HORIBA: a brand you can trust

Conclusions

- Most advanced laser diffraction analyzer available
- LA-950 publishes most detailed performance specifications
- Best small particle sensitivity
- High performance across entire dynamic range: wet and dry
- Most automated software to test both accuracy and reproducibility

Q&A

Ask a question at labinfo@horiba.com

Keep reading the monthly HORIBA Particle e-mail newsletter!

Visit the Download Center to find the video and slides from this webinar.

Thank-you