

# **HORIBA**

Explore the future

# **HORIBA Instruments Incorporated**

**Particle Characterization**

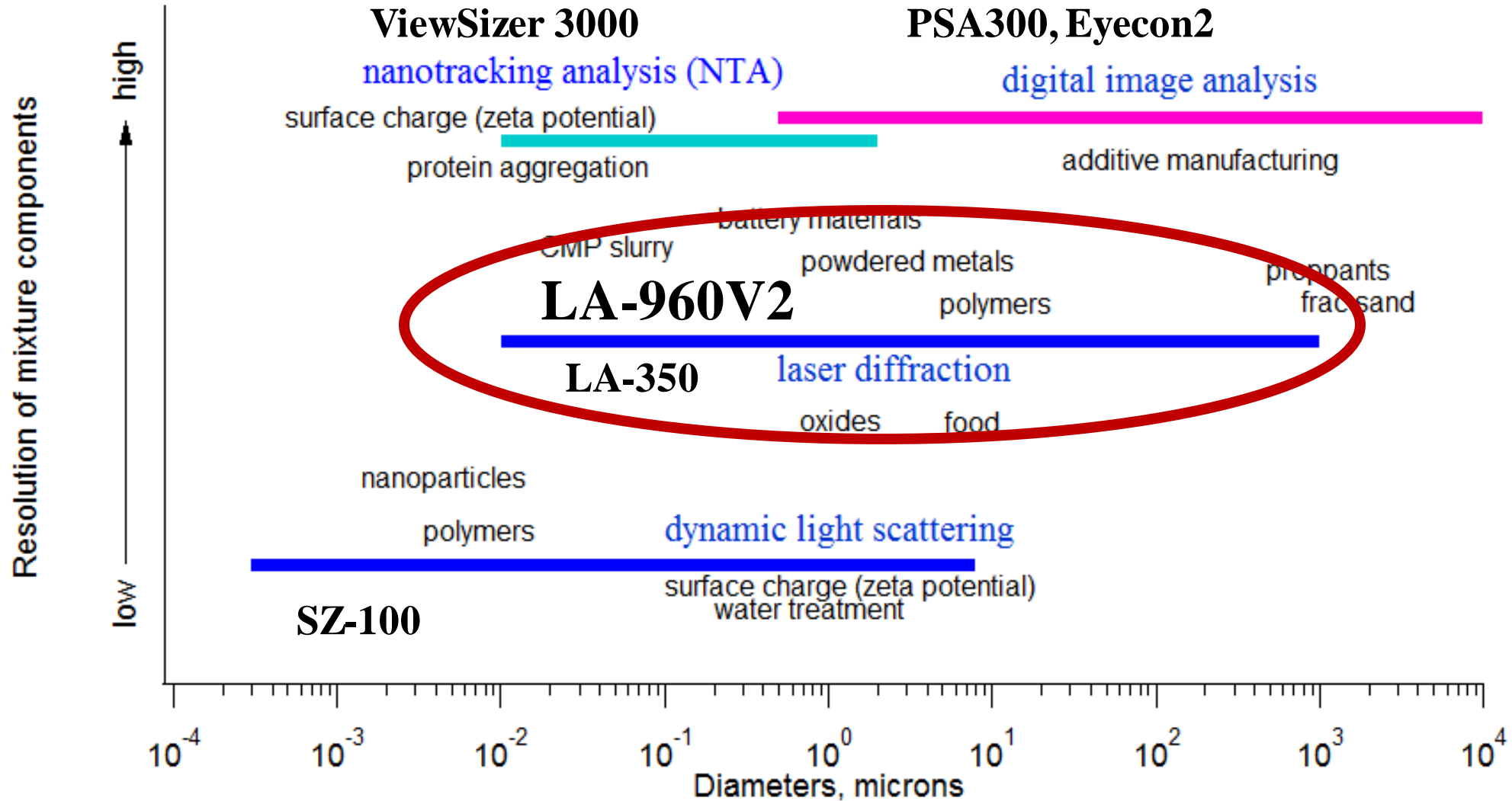
**Jeffrey Bodycomb, Ph.D.**

## **Unveiling the LA-960 V2**

**October 6, 2020**



# Perspective

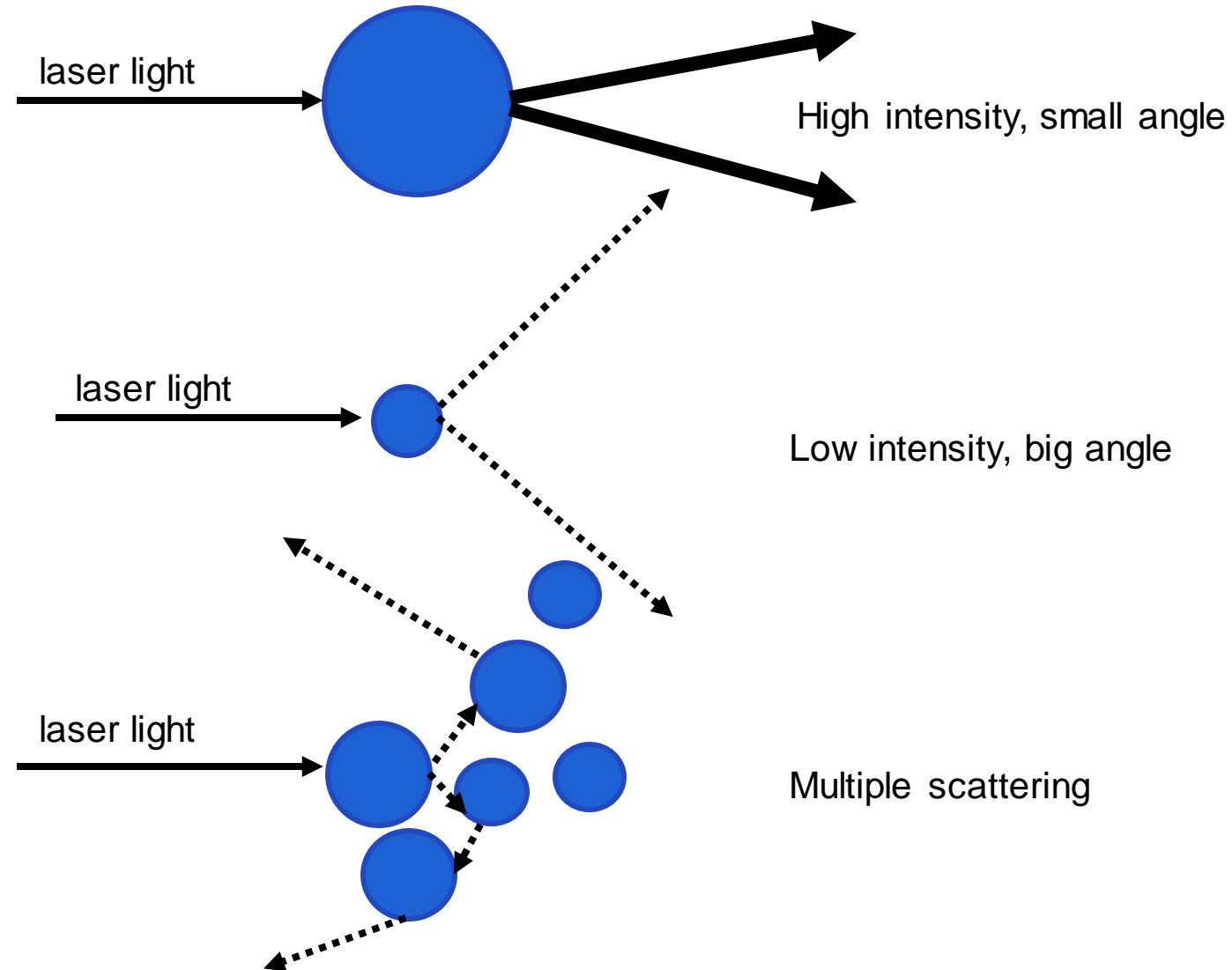


# History of successful innovation



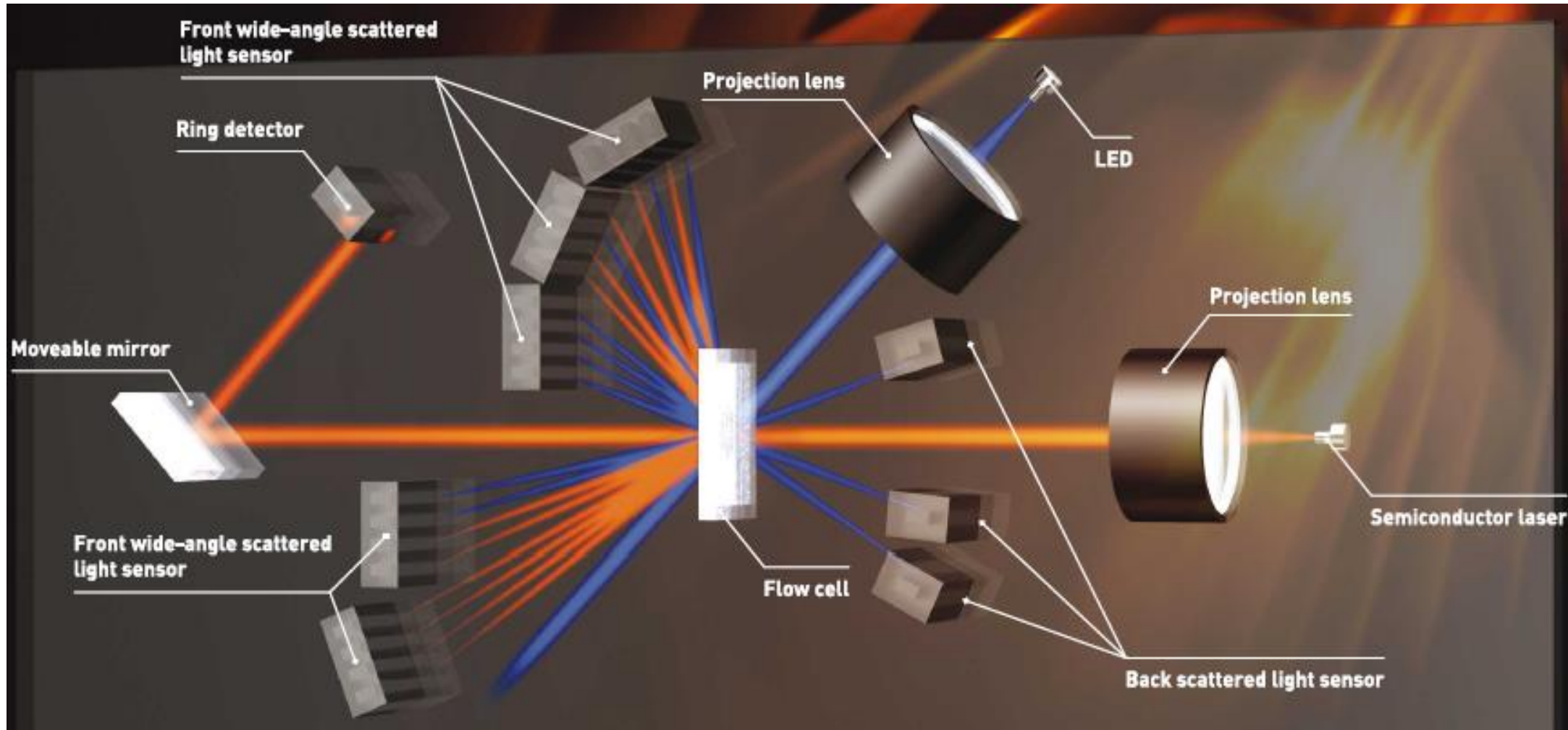
# Diffraction pattern

1. Intensity
2. Angle



**Detectors**

# The optics (LA-960V2)

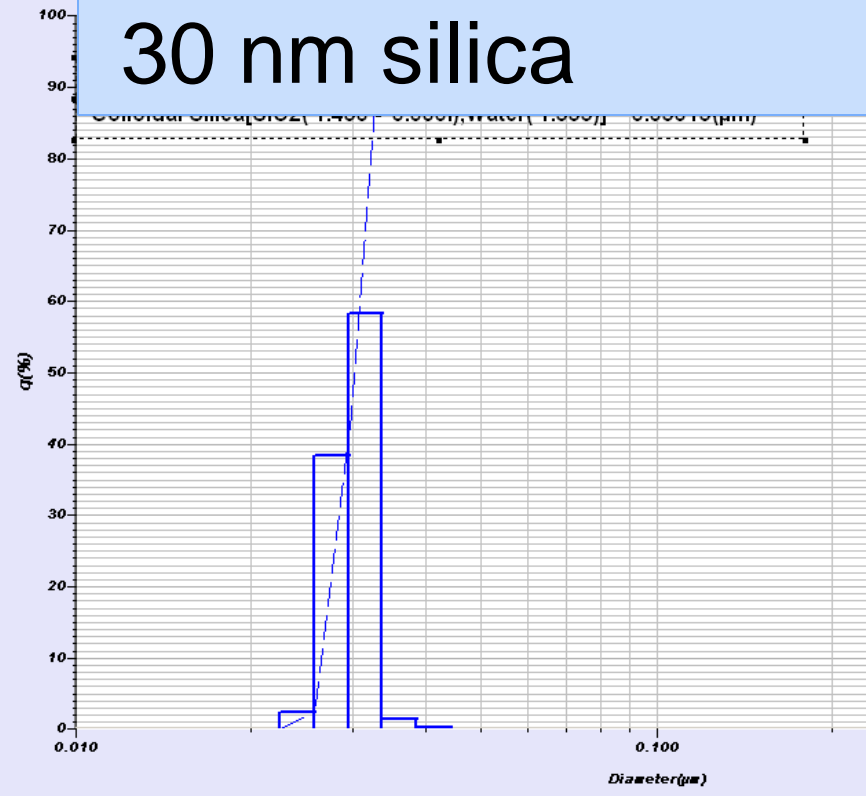


# Measurements from the very small

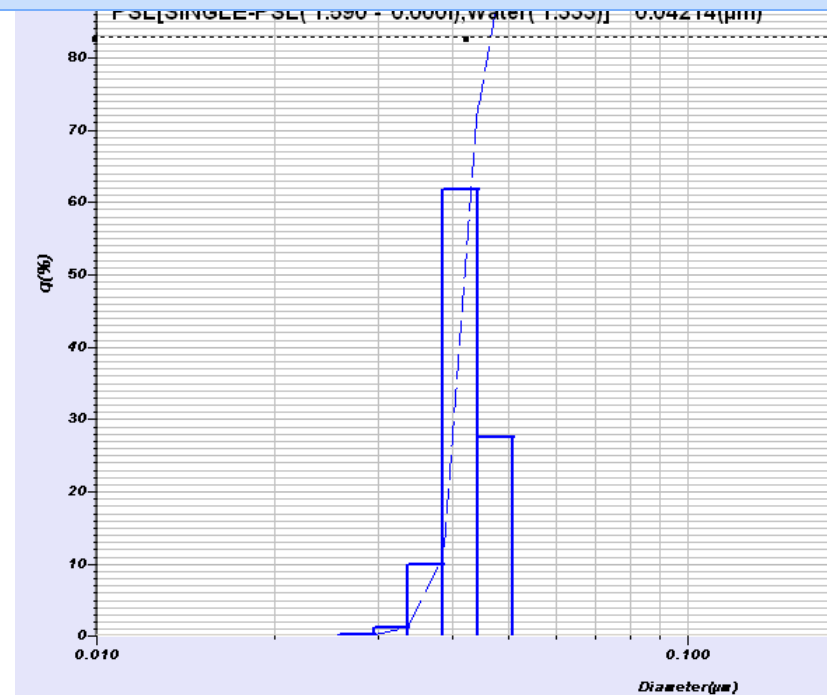
S.P.Area : 2.0183E+6(cm<sup>2</sup>/cm<sup>3</sup>)  
 Mean Size : 0.02990(μm)  
 Variance : 5.0313E-6(μm<sup>2</sup>)  
 Median Size : 0.03013(μm)  
 Mode Size : 0.0302(μm)  
 Skewness : -0.2901

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

## 30 nm silica

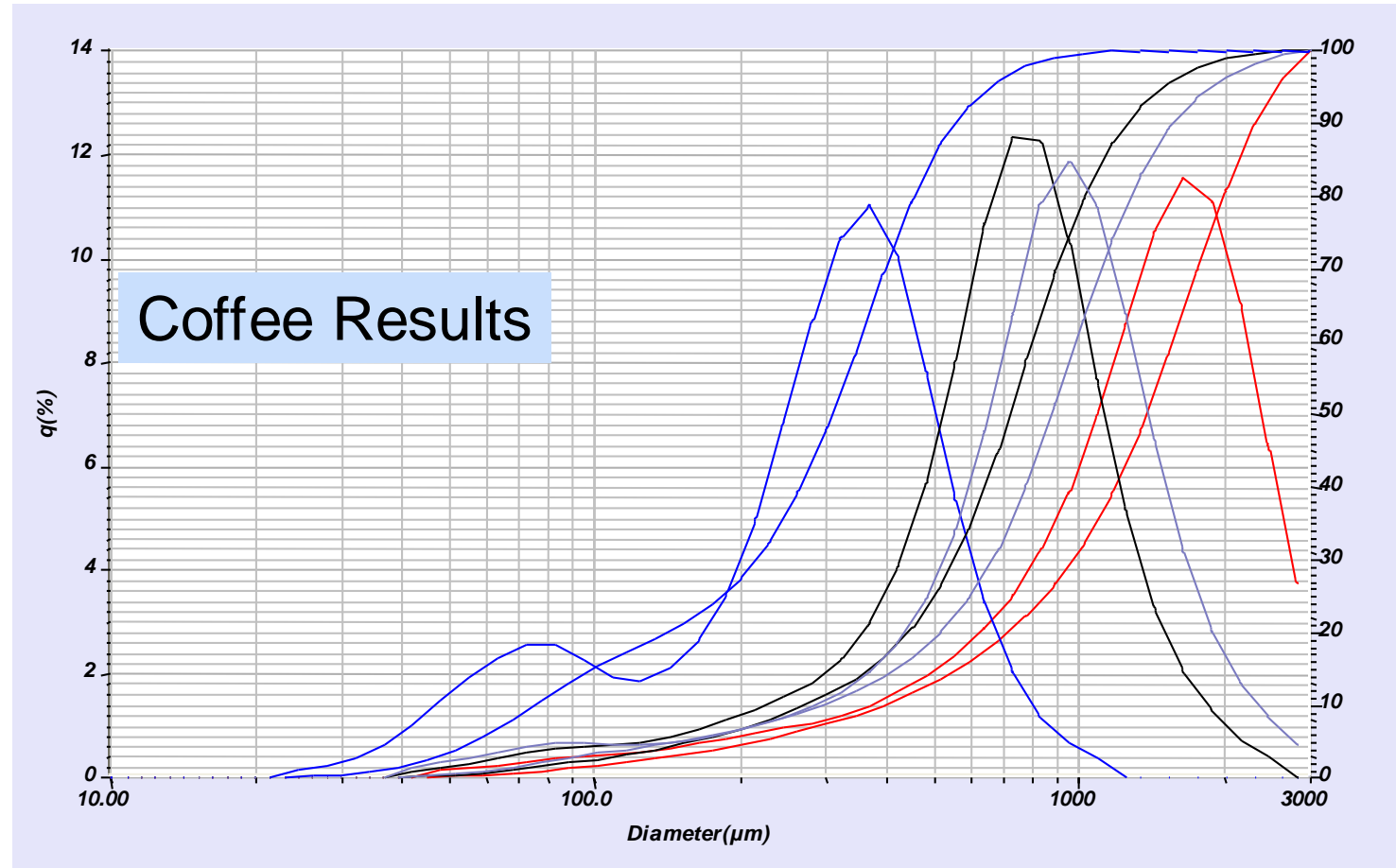


## 40 nm latex



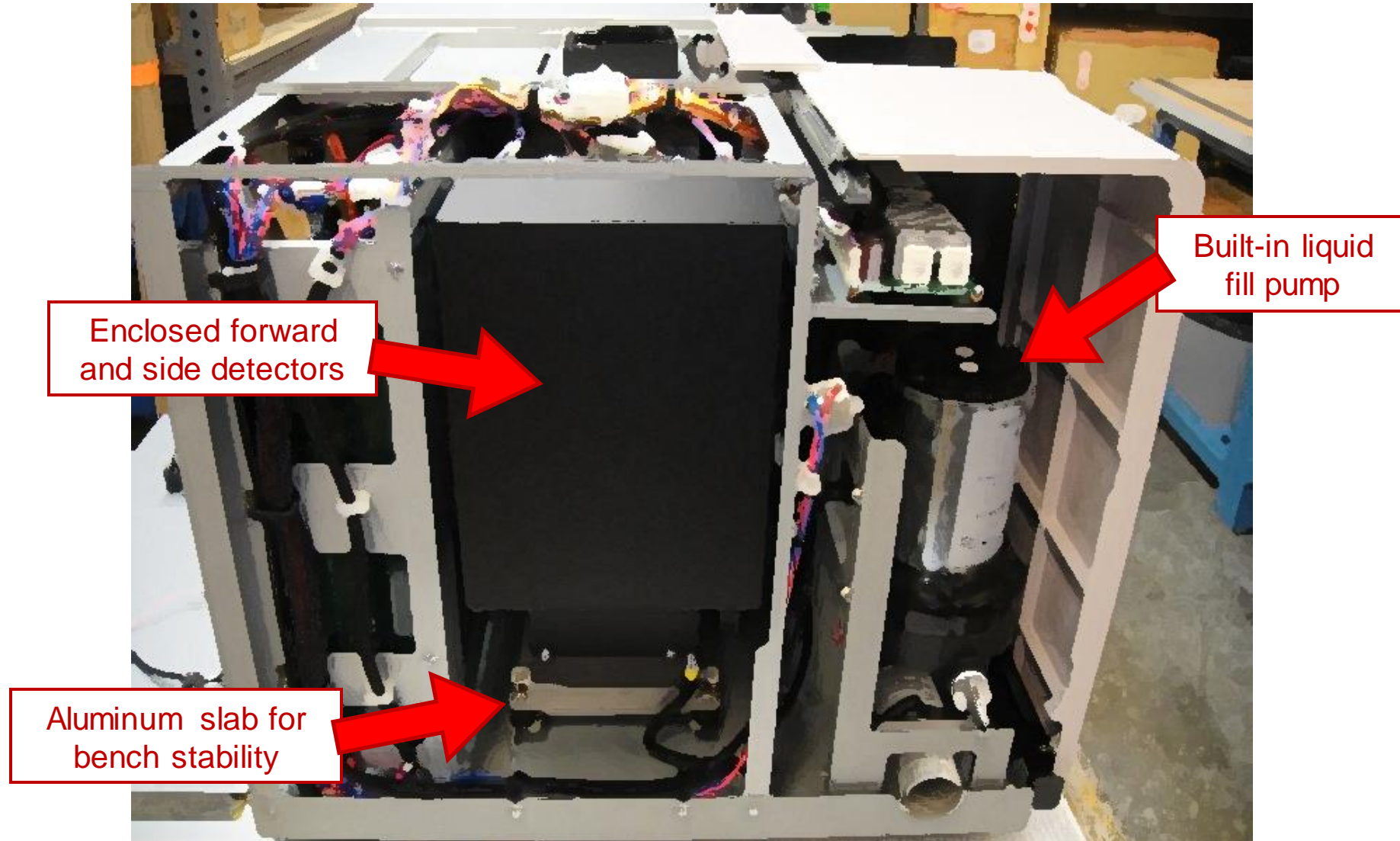


# To the very large ...





# Solid build!



# Analyzing your sample

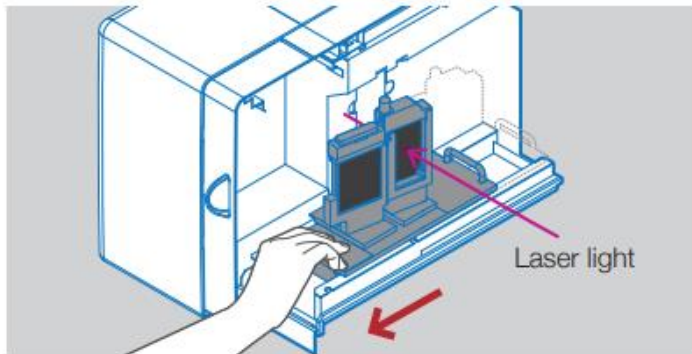
---

## **Optics are half the story...**

- **Also need to get sample in front of optics... and that depends on the sample.**
- **I cover wet (+high concentration) and dry...**

# Accessories for wet analysis

## ■ Easy cell switching.



Change cells just sliding changer table. No tools required.



Flow Cell

<b>Volume (mL)</b>	<b>180 – 250</b>
<b>Range (μm)</b>	<b>0.01 – 3000</b>



Mini flow

<b>Volume (mL)</b>	<b>35</b>
<b>Range (μm)</b>	<b>0.01 – 1,000</b>



Fraction Cell

<b>Volume (mL)</b>	<b>5 – 15</b>
<b>Range (μm)</b>	<b>0.01 – 3000</b>



Paste Cell

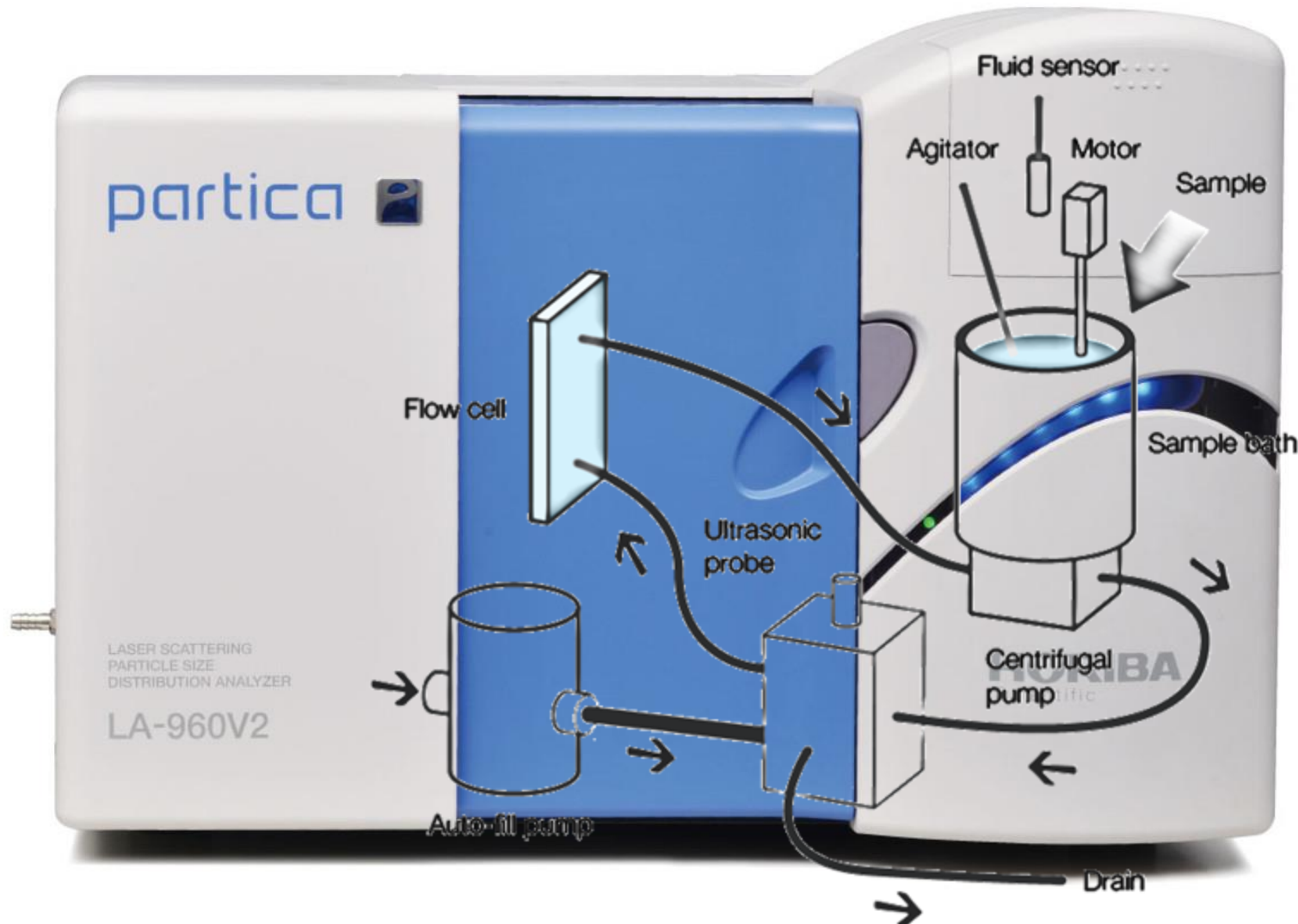
<b>Volume (mL)</b>	<b>~0.3</b>
<b>Range (μm)</b>	<b>0.01 – ~500</b>



HL Cell

<b>Volume (mL)</b>	<b>0.5 – 2 mL</b>
<b>Range (μm)</b>	<b>0.01 – 500</b>

# Standard circulation



Circulate dense 3 mm particles.

Why? Because we can...



※ Ceramic Zirconia  
3mmΦ

# Wet Operation Video

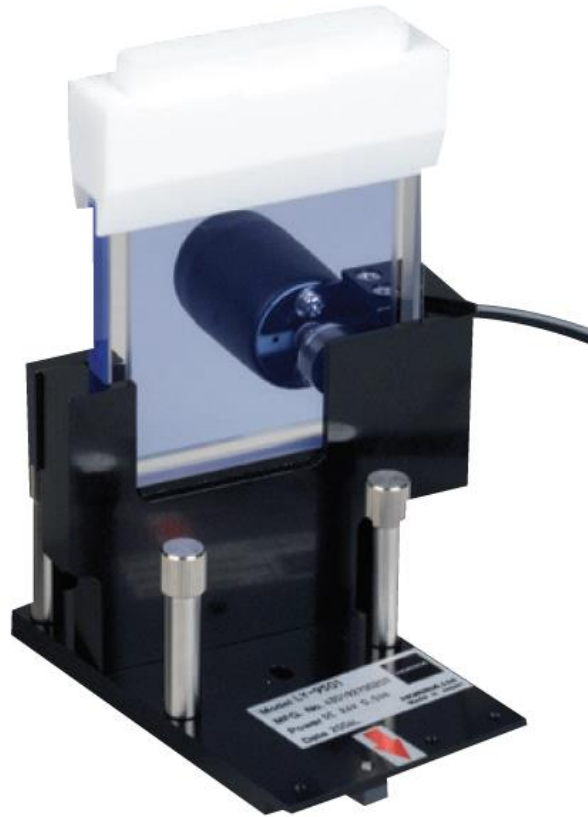
---

# Miniflow



On board ultrasound, circulation and only requires 35 mL.  
This is a great option for nonaqueous liquids such as organic solvents. Uses less solvent (less disposal) and slide module out for a fast switch to aqueous operation even from nonpolar solvents.

# Fraction cell



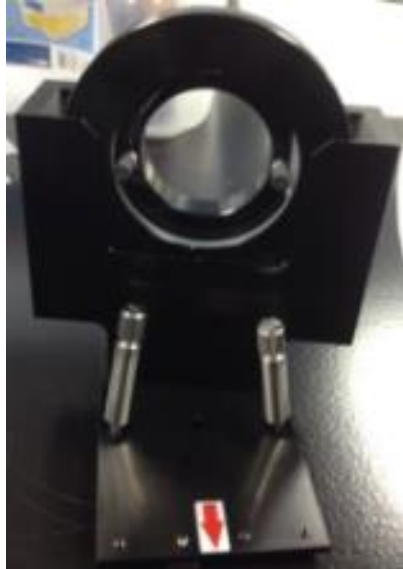
Precious Sample?

5, 10, 15 mL options

Also good for fast switches



# High concentration cells



HL Cell

<b>Volume (mL)</b>	<b>0.5 – 2 mL</b>
<b>Ranger (μm)</b>	<b>0.01 – 500</b>



Paste Cell

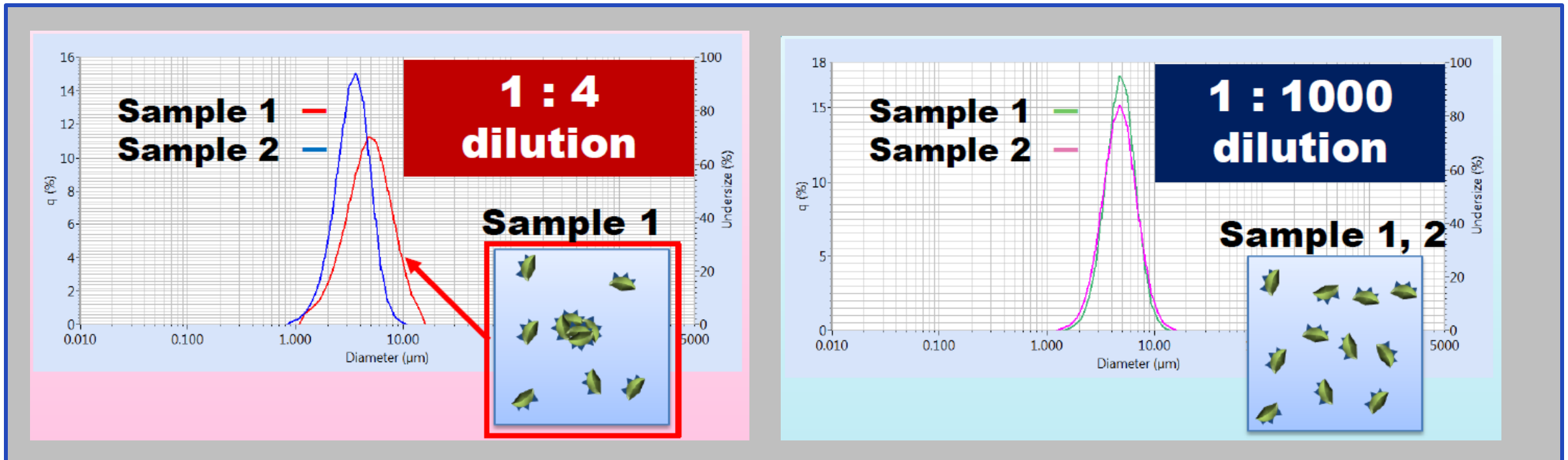
<b>Volume (mL)</b>	<b>~0.3</b>
<b>Ranger (μm)</b>	<b>0.01 - 100</b>

***Just a drop of sample is enough...***

# Why?

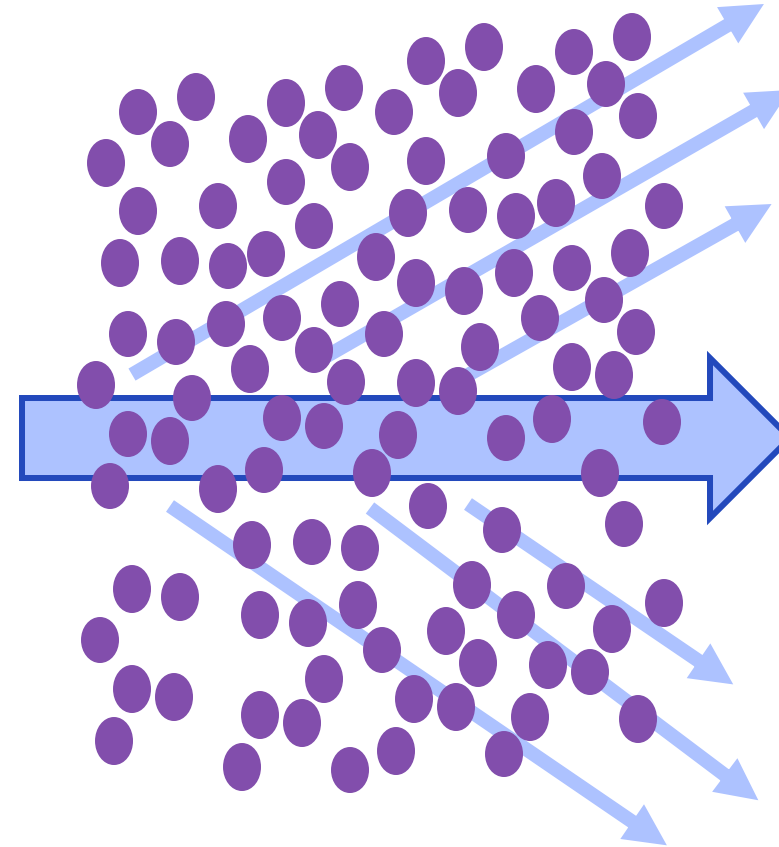
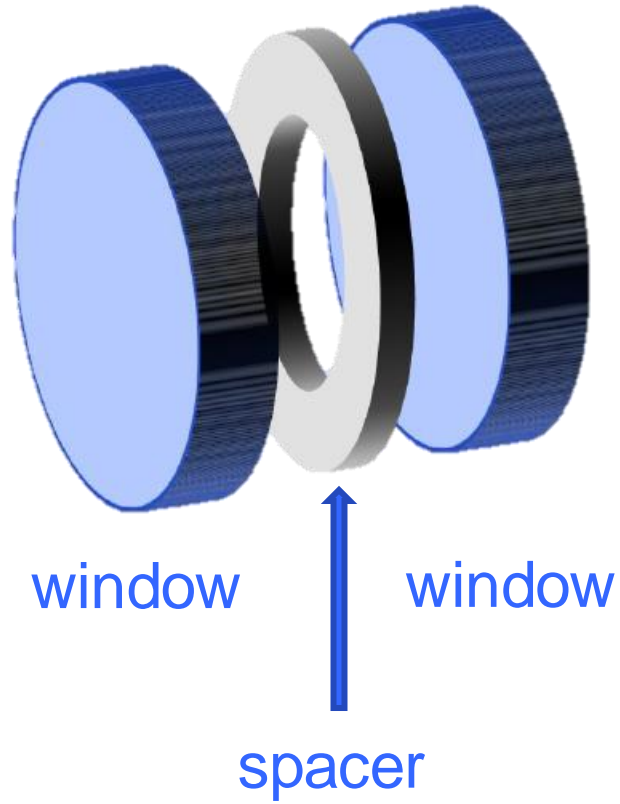
## Battery Electrode:

Sample 1 and 2 had different performance.

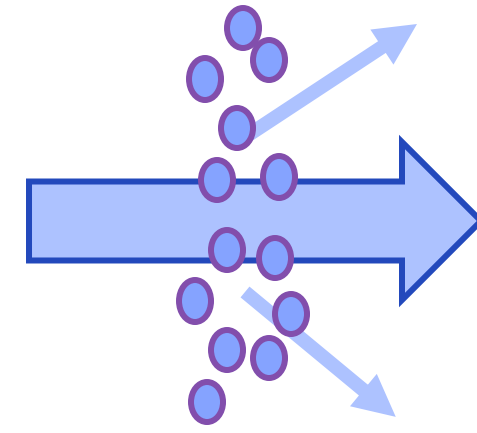


High dilution can suppress the interesting aggregation.

# How?



Long path

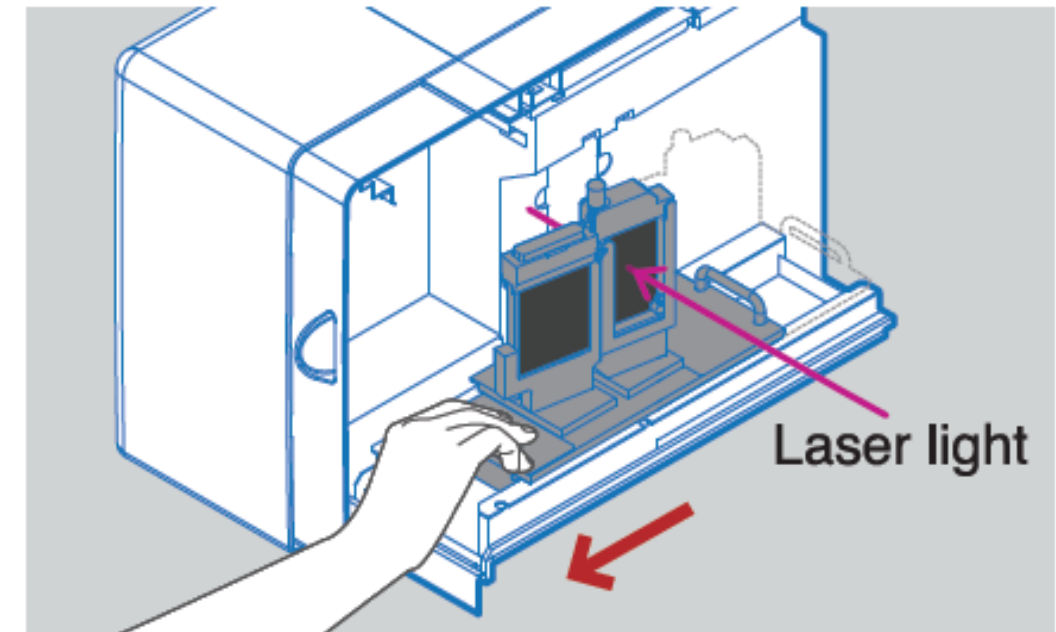


Short path

*Narrow spacer means short optical path length.*

# Switching cells

Flow cell	Nothing to do
Fraction cell	Minimum Steps! Remove tubes and just to slide the cell stage
High concentration cell	
Paste cell	
Dry cell	
Mini-flow unit	Remove imaging unit and pull out the stage, insert the Mini-flow unit.



Also works when switching to dry....

....minimum steps, less work, fewer mistakes

# Dry powder analysis

Powderjet Dry Powder Feeder



Dry Unit

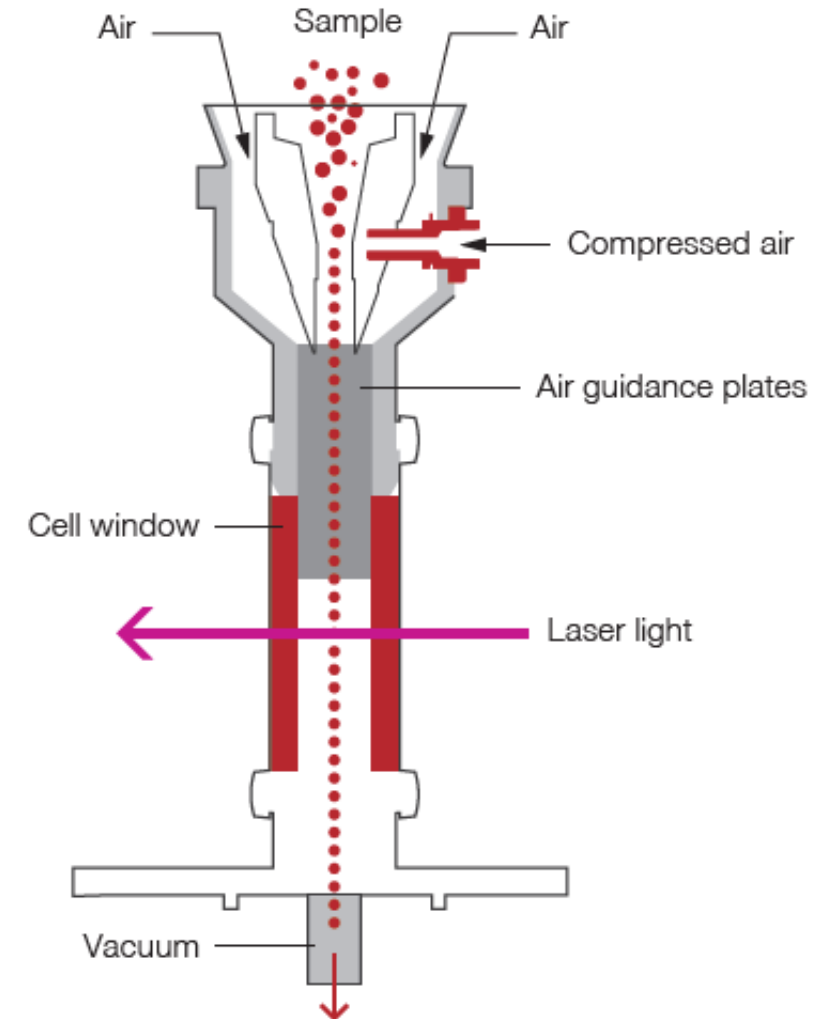
<b>Pressure (MPa)</b>	<b>0 – 0.4</b>
<b>Ranger (μm)</b>	<b>0.1 – 5,000</b>

# Dry Operation Video

---

# Dry powder feeder

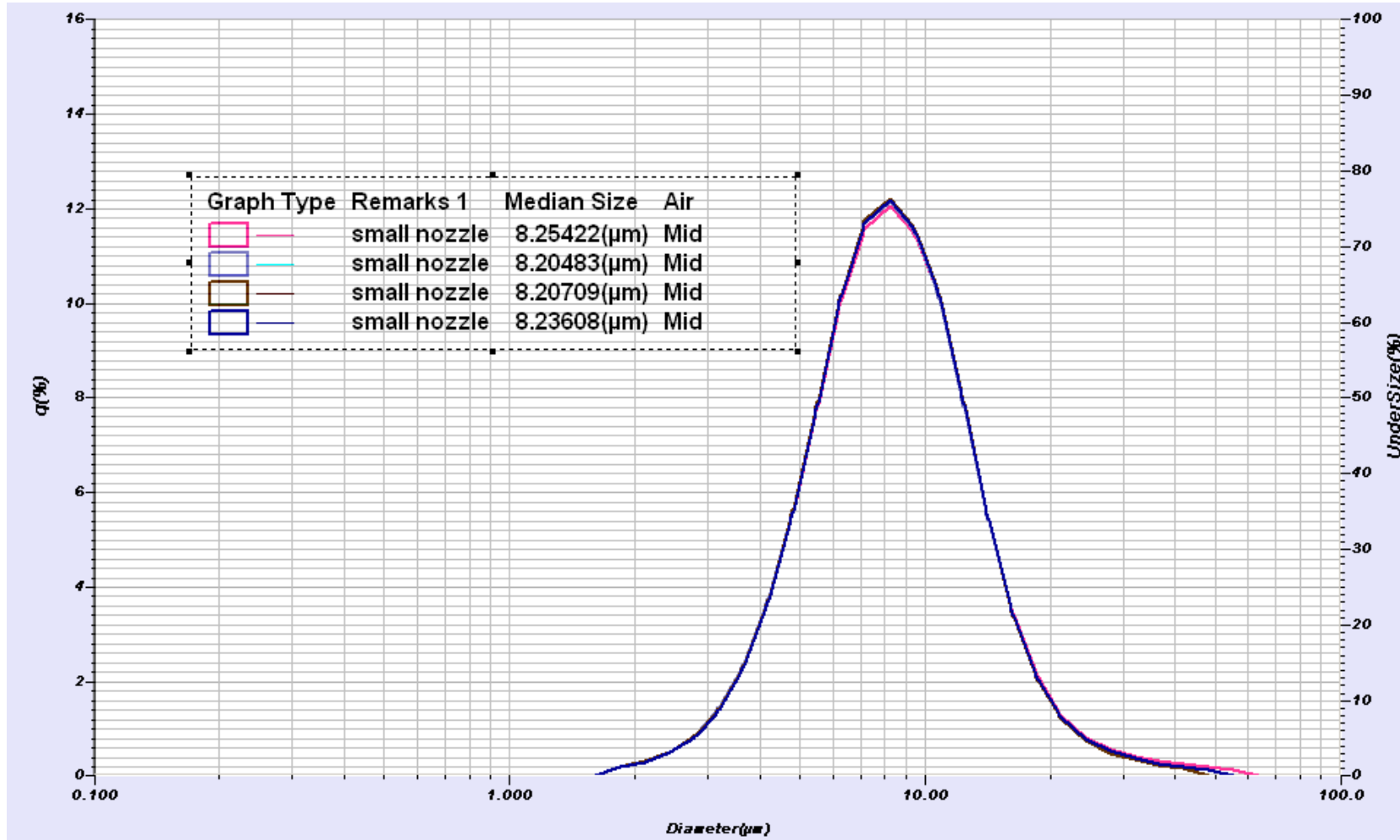
- Direct flow of powder straight down
- Adjustable air pressure for dispersion.
- No impact surfaces means good dispersion w/o comminution.
- Feedback control gives great reproducibility.
- As little as 5 mg of sample.



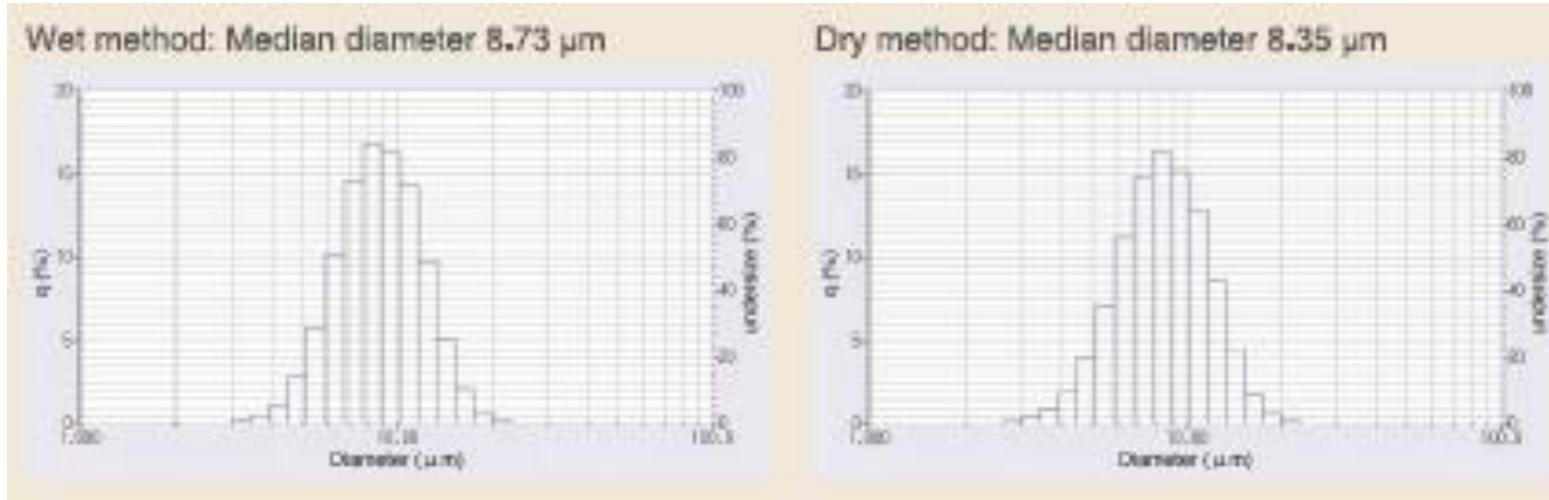


# Reproducibility

## Mg Stearate dry, 2 bar

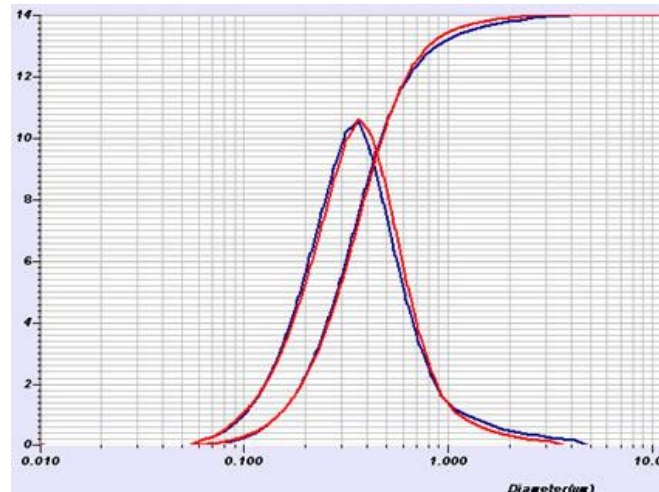


# Wet vs Dry



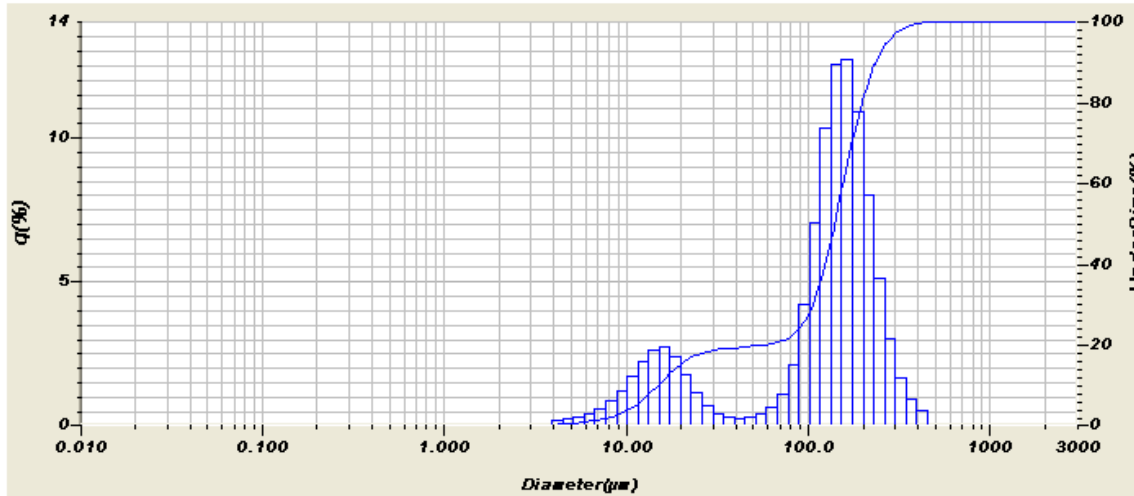
Abrasive

- **Red:** Wet measurement using ultrasonic dispersion
- **Blue:** Dry measurement using compressed air dispersion

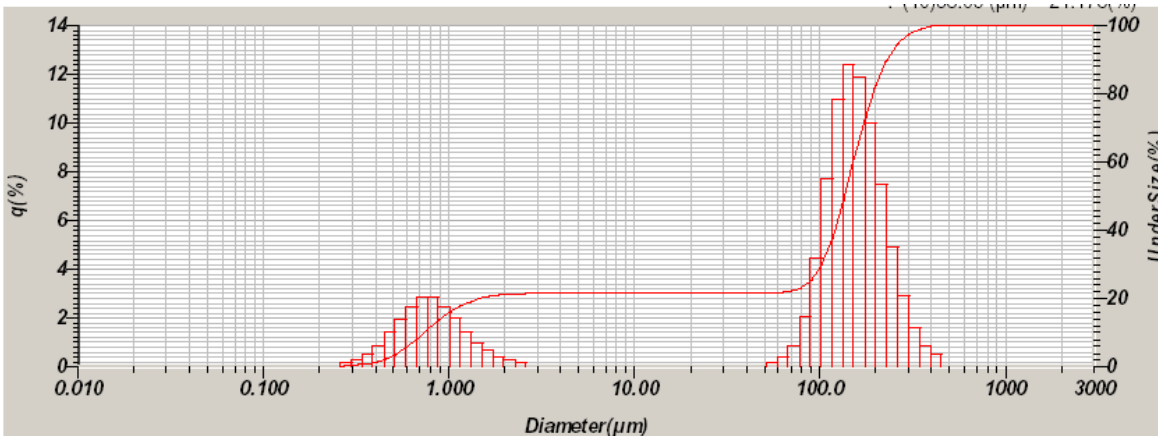


TiO<sub>2</sub> (anatase)

# Mixed glass bead standards

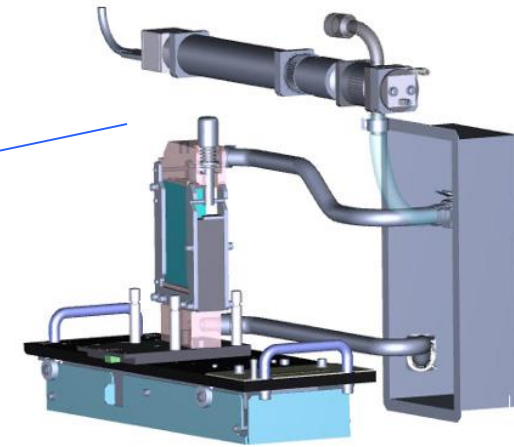


4 parts PS225 to  
1 part PS202



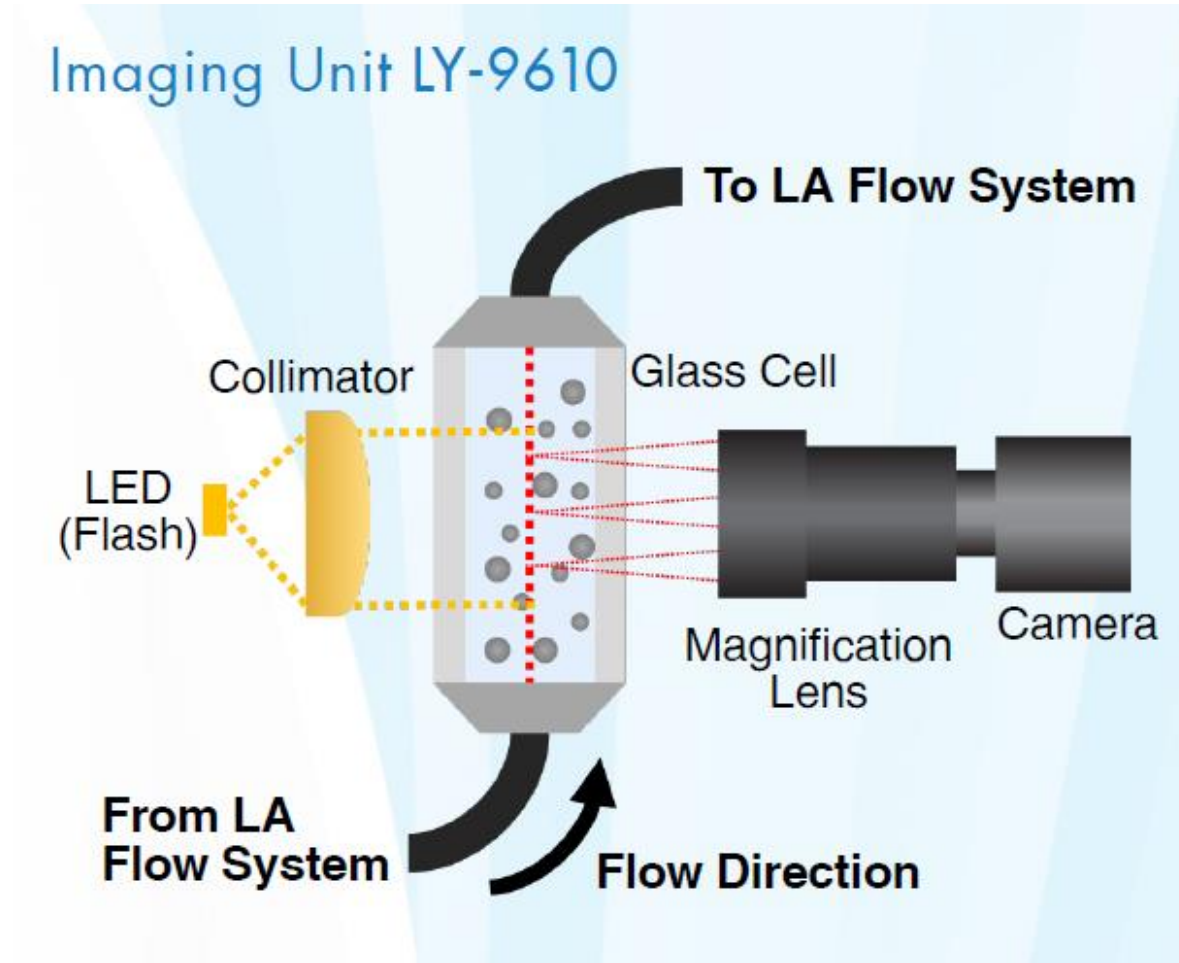
4 parts PS225 to  
1 part PS181

# Imaging option



**Integrated Module!**

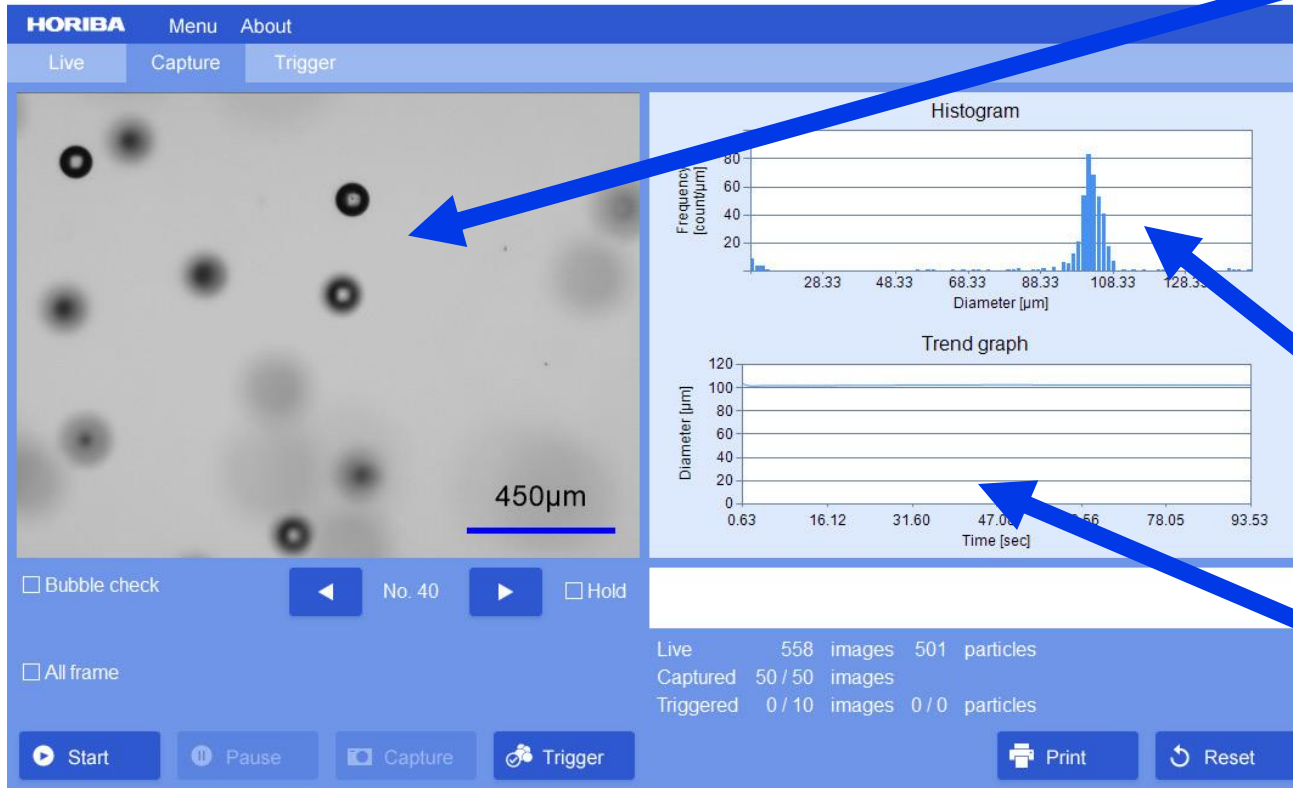
# Imaging



Size Range: 9-1000 microns

Pixel Size: 0.73 microns

# Image results benefits



Immediate Feedback:  
Real-time Images

Size and Shape from  
High Resolution Images

Live Histogram

Live Trend Graph

# Sampling systems

---

Options can be readily added later.

Initially buy the base unit.

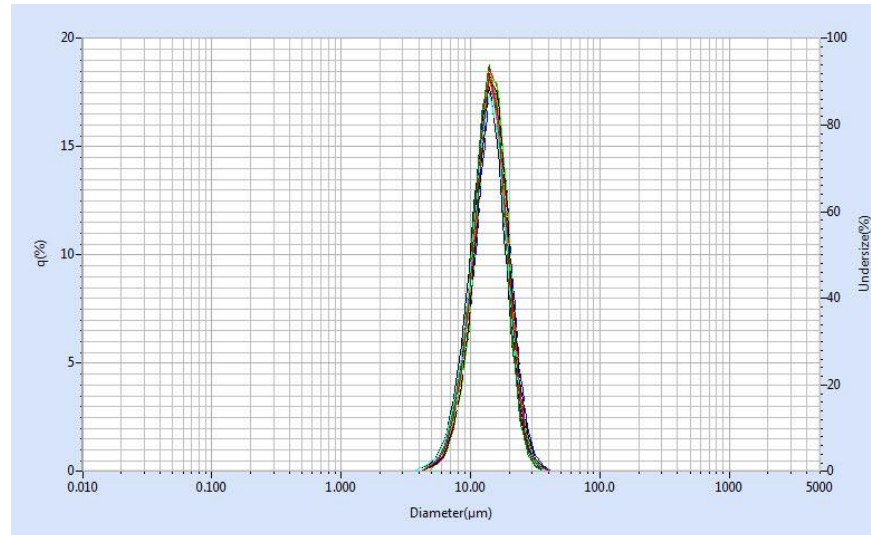
Add dry, fraction cell, imaging, high concentration cells as budget allows and requirements change.



# Repeatability & reproducibility

20 wet  
results

Flow  
system

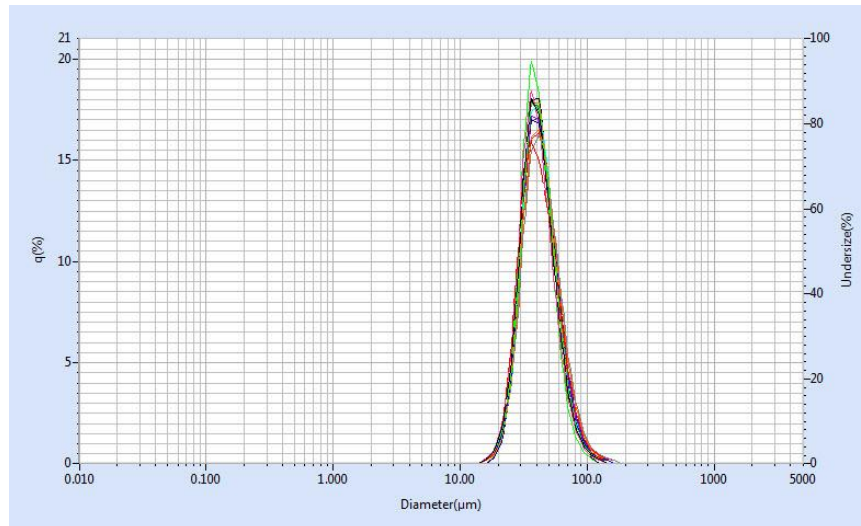


PS-202 (μm)			
	D10	D50	D90
PS202 (U2A).NGB	8.08	13.29	20.50
PS202 (W03).NGB	8.86	14.16	22.12
PS202 (CA2).NGB	8.39	13.75	21.39
PS202 (SY9).NGB	8.26	13.54	20.75
PS202 (U19).NGB	8.46	13.68	20.87
PS202 (DEE).NGB	9.09	13.82	21.83
PS202 (X4T).NGB	8.45	13.76	21.06
PS202 (V5T).NGB	8.77	14.08	21.30
PS202 (TWV).NGB	8.94	14.12	21.23
PS202 (RPR).NGB	8.91	14.14	21.48
PS202 (U9U).NGB	8.79	13.86	21.07
PS202 (XYN).NGB	8.98	14.07	21.48
PS202 (ABG).NGB	8.80	14.06	21.21
PS202 (67S).NGB	9.42	14.48	21.57
PS202 (YET).NGB	8.78	13.80	21.35
PS202 (SS7).NGB	9.04	14.41	21.34
PS202 (UDH).NGB	8.26	13.64	20.88
PS202 (WRT).NGB	9.05	14.15	21.48
PS202 (PLS).NGB	8.24	13.62	20.71
PS202 (NKU).NGB	8.72	13.24	19.25
<b>Average</b>	8.71	13.88	21.14
<b>Std. Dev.</b>	0.351	0.333	0.591
<b>CV (%)</b>	4.03	2.40	2.79

# Repeatability & reproducibility

20 dry results

*PowderJet*



PS215 (μm)			
	D10	D50	D90
PS215 (VGR).NGB	28.66	42.48	68.04
PS215 (XM3).NGB	27.20	40.34	65.68
PS215 (R8C).NGB	28.20	40.76	61.60
PS215 (U0A).NGB	28.66	41.53	65.52
PS215 (TGV).NGB	28.69	42.41	67.34
PS215 (TLB).NGB	27.98	40.70	62.85
PS215 (PGC).NGB	27.91	39.22	58.28
PS215 (W1X).NGB	27.15	39.12	60.51
PS215 (VRF).NGB	28.58	41.11	63.27
PS215 (PSA).NGB	28.79	41.80	65.29
PS215 (TBA).NGB	28.24	41.24	64.75
PS215 (RJC).NGB	28.51	41.15	63.72
PS215 (SV3).NGB	27.56	40.03	61.80
PS15 (AB6).NGB	26.45	37.99	57.87
PS215 (G07).NGB	27.81	40.80	62.96
POS215 (XES).NGB	28.23	40.82	63.64
PS215 (X1G).NGB	28.71	41.63	64.22
PS215 (CKS).NGB	27.61	40.21	61.45
PS215 (T9X).NGB	27.49	40.67	62.82
PS251 (Y4B).NGB	28.81	43.09	69.22
<b>Average</b>	28.06	40.85	63.54
<b>Std. Dev.</b>	0.658	1.21	2.92
<b>CV (%)</b>	2.35	2.95	4.60

# Software highlights

Summary Report

Export Summary   Print Summary   Best Fit Columns

Sample name	D(v,0.1)	D(v,0.5)	D(v,0.9)
19A	34.448	102.355	456.759
19A	32.105	96.580	544.156
19A	30.371	86.317	382.367
Average	32.308	95.084	461.094
Std. Dev.	2.046	8.123	80.982
CV (%)	6.333	8.543	17.563
Custom ( 5.0, 3.0, 5.0)	FAILED	FAILED	FAILED

- After a quick sampling adjustment, the user makes high precision measurements which easily pass

- Calculates COV and compares to ISO, USP, or custom standard
- Simple PASS/FAIL indicator notifies the user to check sampling and measurement conditions

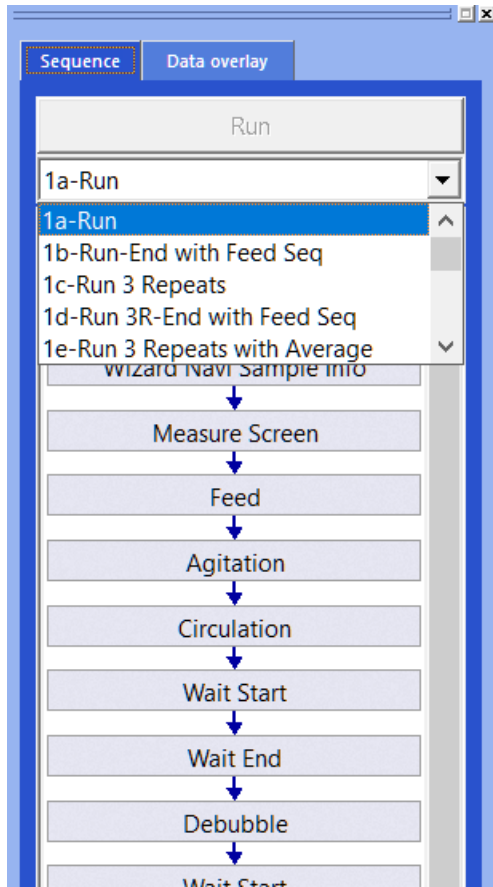
Summary Report

Export Summary   Print Summary   Best Fit Columns

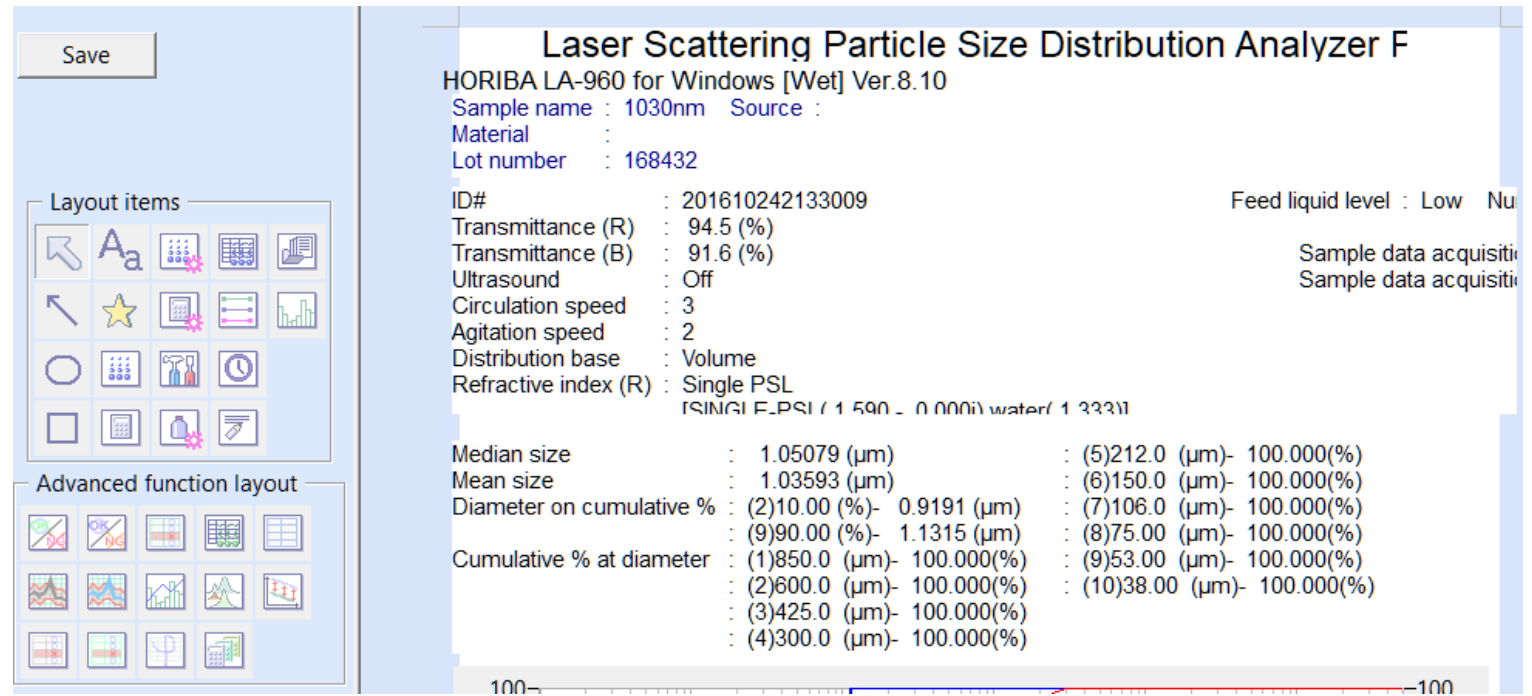
Sample name	D(v,0.1)	D(v,0.5)	D(v,0.9)
19A	18.315	61.758	337.027
19A	17.995	61.016	335.442
19A	17.946	61.326	364.517
Average	18.085	61.367	345.662
Std. Dev.	0.200	0.373	16.348
CV (%)	1.108	0.607	4.730
Custom ( 5.0, 3.0, 5.0)	PASSED	PASSED	PASSED

# Software highlights

## Sequences for One-button operation



## Customizable printouts





# Software highlights

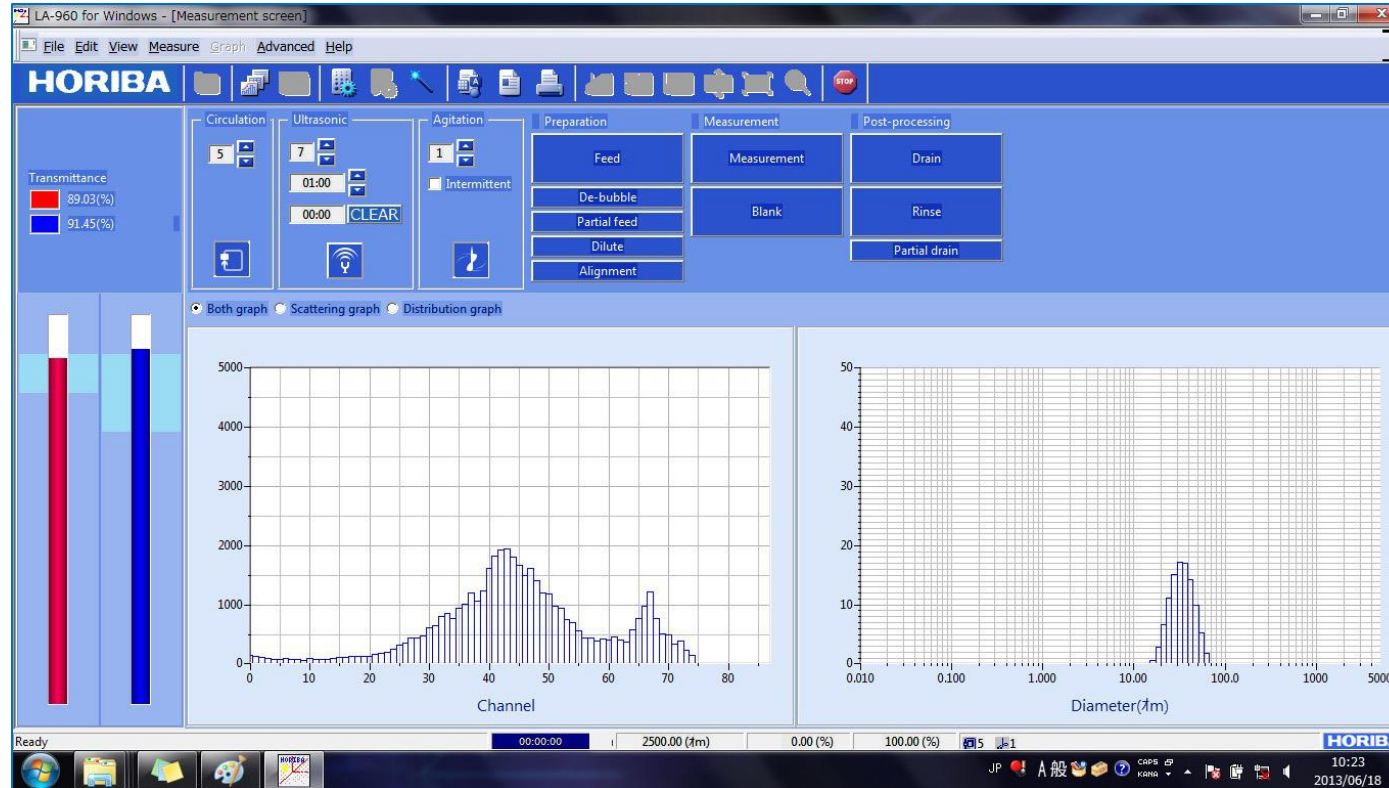
## Method Expert

- Unique guided method development
- Easily choose measurement and calculation conditions
- Choose the best refractive index
- Create “one button” SOPs



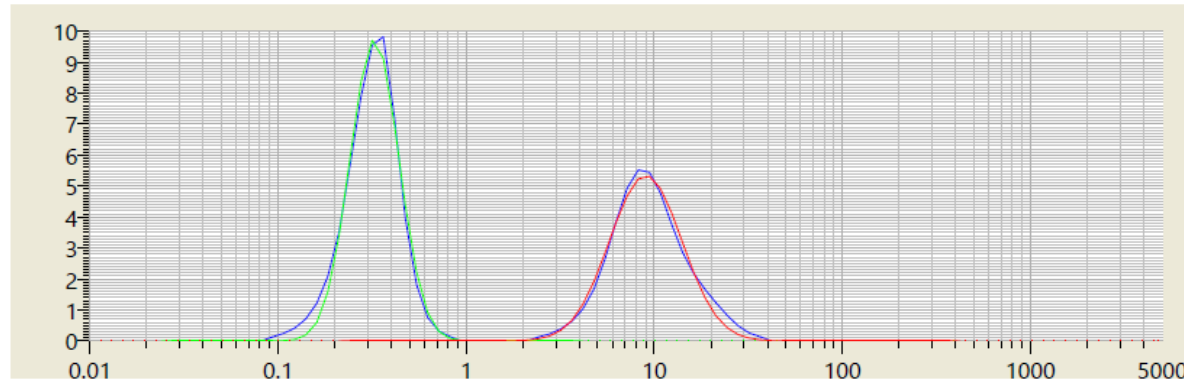
# Software highlights

LA-960V2 displays real-time particle size distribution to indicate when to start measuring.



# Software highlights

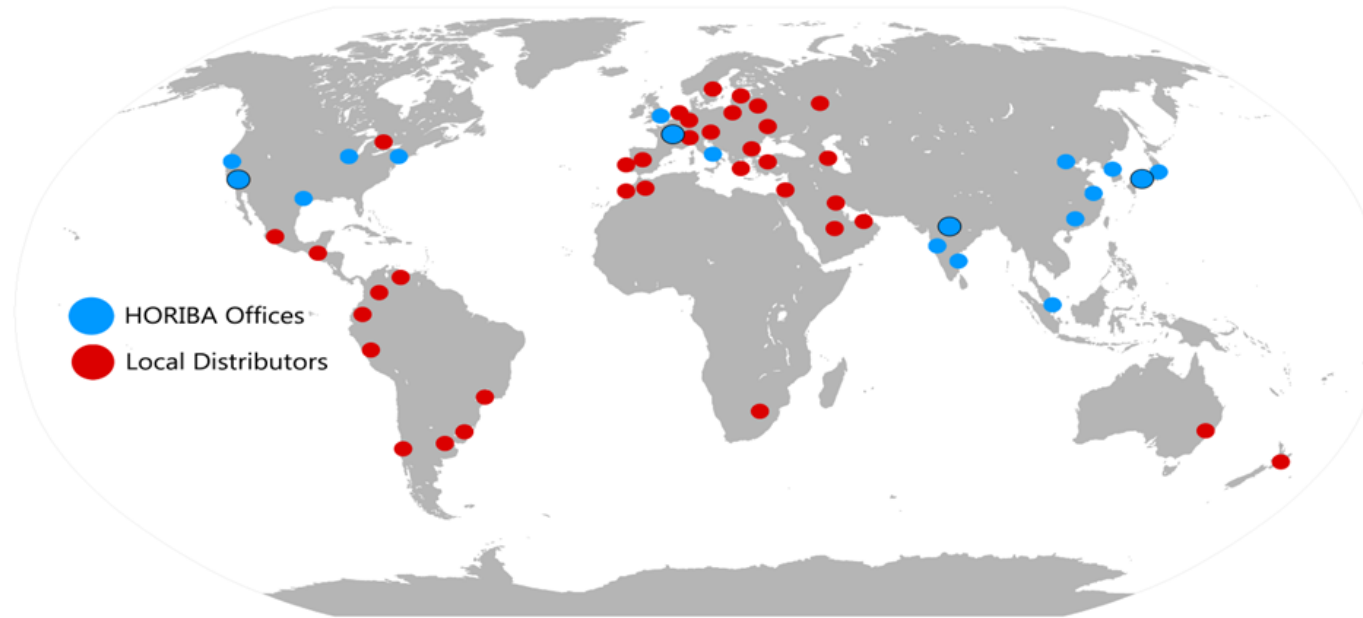
Multi-modal reports decompose results into separate populations



	Statistics	Sample	Dist1	Dist2	Dist3
1	D50 (μm)	0.469689	0.325754	9.01333	---
2	D10 (μm)	0.23525	0.221961	5.12116	---
3	D90 (μm)	13.0625	0.481231	15.9546	---
4	Average (μm)	4.8363	0.340791	9.93924	---
5	Mode (μm)	0.35731	0.318627	9.39585	---
6	St. Dev. (μm)	6.16748	0.104246	4.62451	---
7	Span (μm)	27.31	0.795905	1.20193	---
8	Area ratio (:Sample)	---	0.537717	0.436288	---
9	Area ratio (:Dist1)	1.85971	---	0.811371	---
10	Area ratio (:Dist2)	2.29206	1.23248	---	---
11	Area ratio (:Dist3)	---	---	---	---
12	Area ratio (:Residual)	10.6558	5.7298	4.64899	---
	Statistics	Sample	Dist1	Dist2	Dist3
23	PerOnCum 10.00 % (μm)	0.23525	0.221961	5.12116	---
24	PerOnCum 20.00 % (μm)	0.286918	0.253004	6.19174	---
25	PerOnCum 30.00 % (μm)	0.332582	0.277804	7.13218	---
26	PerOnCum 40.00 % (μm)	0.382121	0.302129	8.0508	---
27	PerOnCum 60.00 % (μm)	5.26369	0.351994	10.0771	---
28	PerOnCum 70.00 % (μm)	7.50732	0.381321	11.3681	---
29	PerOnCum 80.00 % (μm)	9.63757	0.420898	13.0794	---
30	PerOnCum 90.00 % (μm)	13.0625	0.481231	15.9546	---
31	PerOnCum 0.00 % (μm)	0.01	0.01	0.01	---



# Global support



- HORIBA's experienced staff of technical and applications specialists support the LA-960 in 54 offices across 45 countries
- We are committed to the satisfaction of our users and to the education of the greater industry and provide many channels of support including:
  - ❖ Sample analysis via the many Applications Lab around the world
  - ❖ Free software updates, webinars, technical notes, and much more on web site
  - ❖ Ongoing support via phone, e-mail, and online meeting
  - ❖ On-site and in-house user training courses
  - ❖ Service contracts, verifications, and validations to fit every requirement
  - ❖ Advanced software tools to correlate data from other particle size analyzers to maintain historic specifications

Thank you

Omoshiro-okashiku  
Joy and Fun



Danke  
 Grazie  
 Tack ska du ha  
 Gracias  
 Σας ευχαριστώ πάρα πολύ  
 Terima kasih  
 谢谢  
 धन्यवाद  
 شُكْرًا  
 ขอบคุณครับ  
 Большое спасибо  
 Obrigado  
 Cảm ơn  
 감사합니다  
 Merci  
 ありがとうございました  
 Dziękuję

**THANK YOU**