SEMICON CHINA | FPDCHINA

CSTIC 2019

A New Nanoparticle Characterization Technology for CMP Slurries

Siqin He[1], Derek Oberreit[1], Gary Van Schooneveld[2], David Blackford[1]

[1]Kanomax FMT, Inc., White Bear Lake, Minnesota, United States

[2]CT Associates, Inc., Eden Prairie, Minnesota, United States

KANOMAX The Ultimate Measurements

KANOMAX FMT A Kanomax Company

Challenges in Colloid Sizing Technologies

Dynamic light scattering

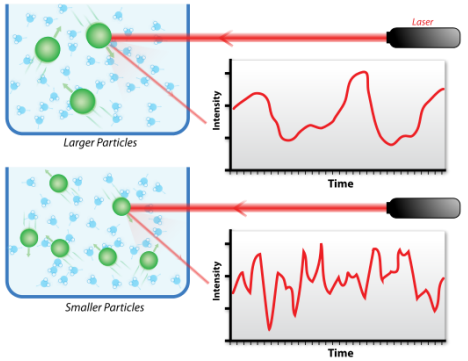
- Requires high concentrations
- Dependent on sample temperature and viscosity
- No concentration information
- Inconsistent multimodal performance

Nanoparticle Tracking Analysis

- Functional down to 20 nm
- Dependent on sample temperature and viscosity

Liquid Nanoparticle Sizing System

- Application to measurements at previously unattainable size thresholds



Dynamic Light Scattering Theory
By Mike Jones - Own work, CC BY-SA 3.0,
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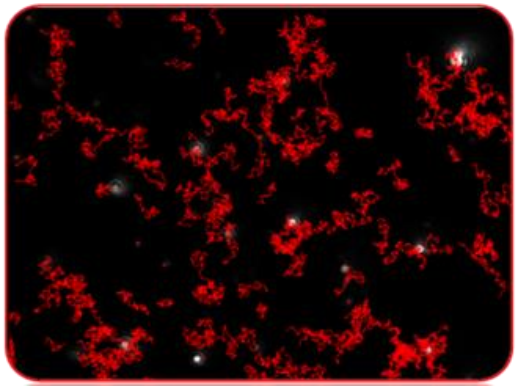

Nanoparticle Tracking Analysis image
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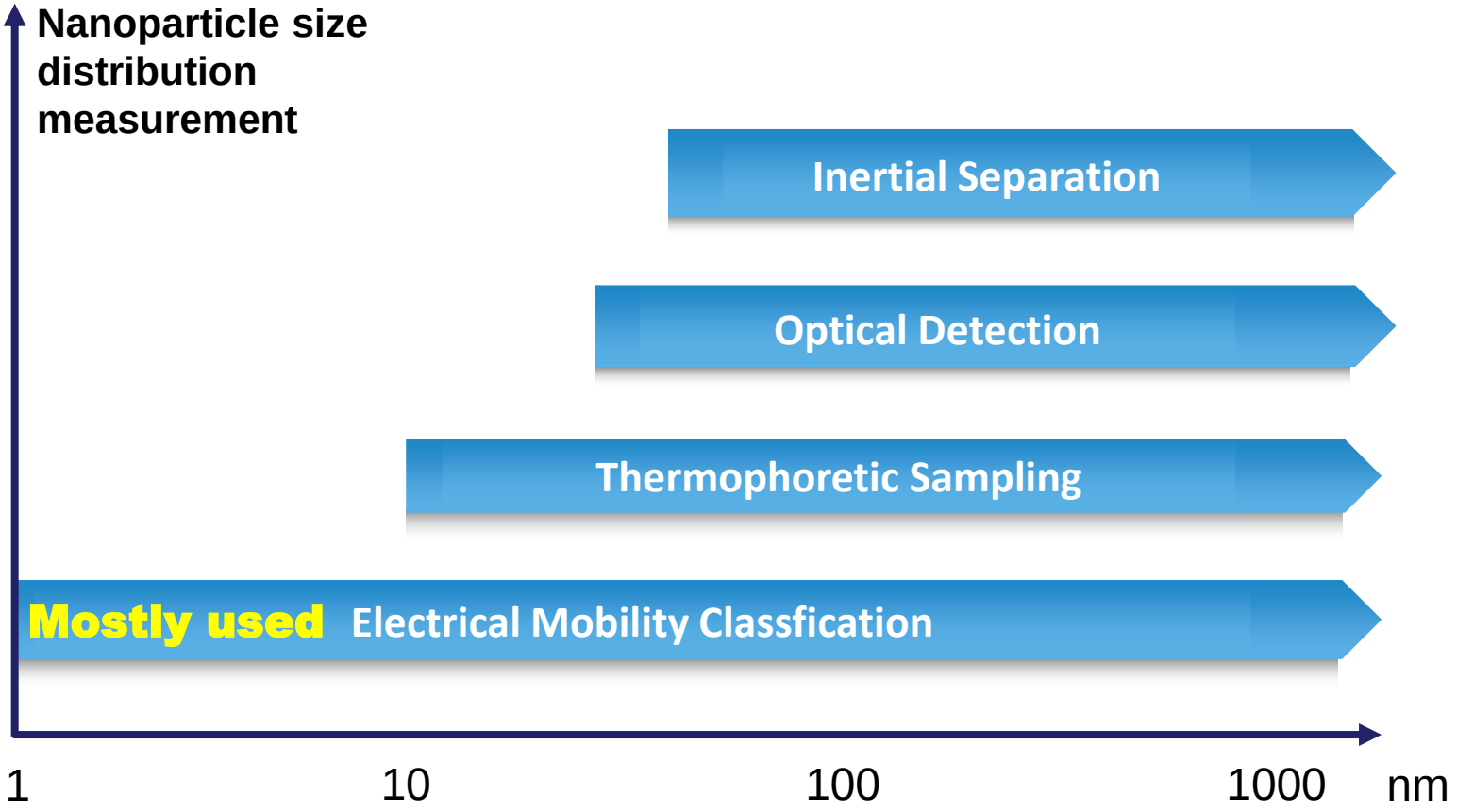
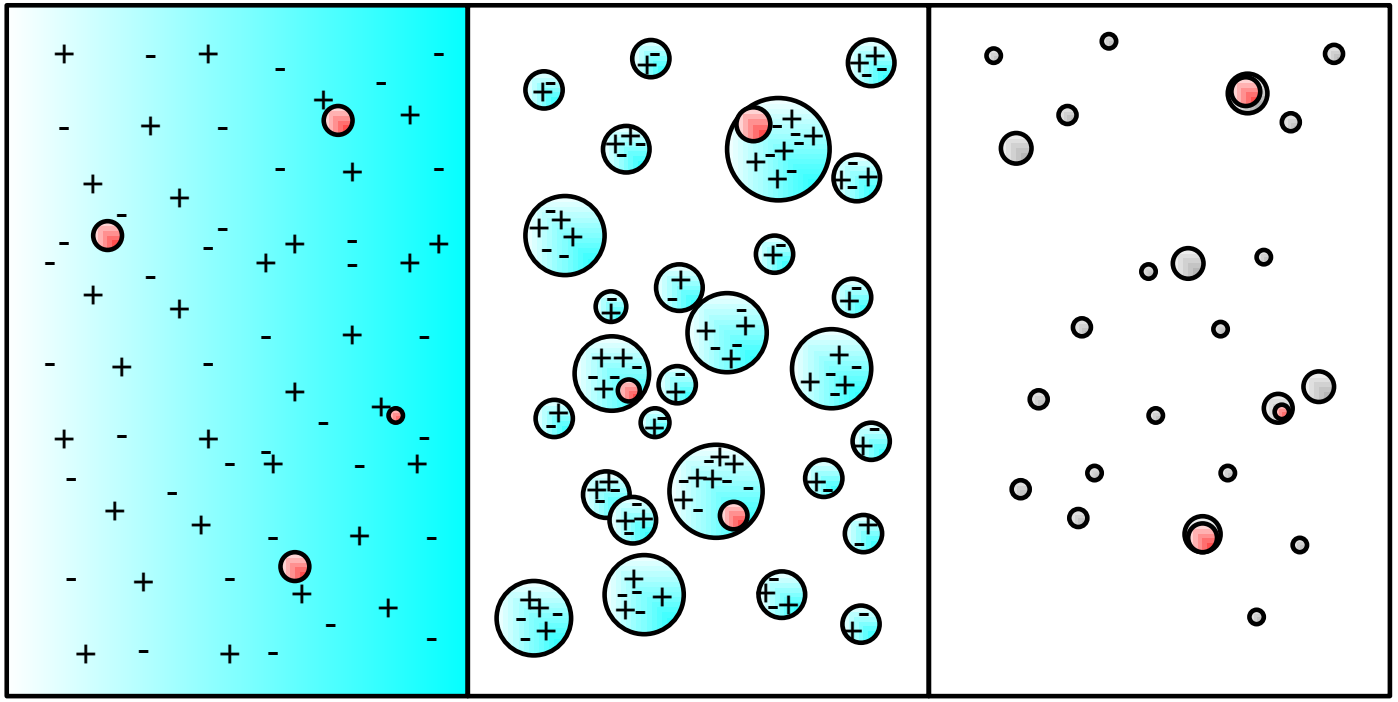
Established Aerosol Sizing Technologies

Aerosol Technologies for Sizing **Nanoparticles**



Aerosolization

Definition



Liquid Sample With NVR

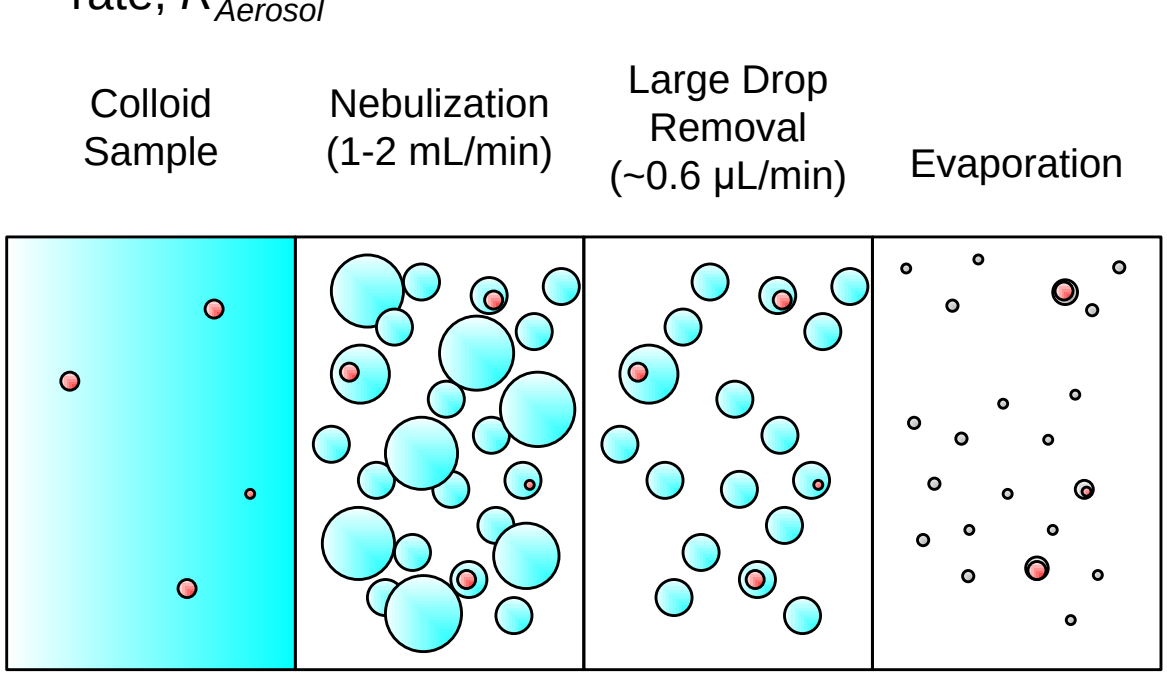
Nebulized Sample

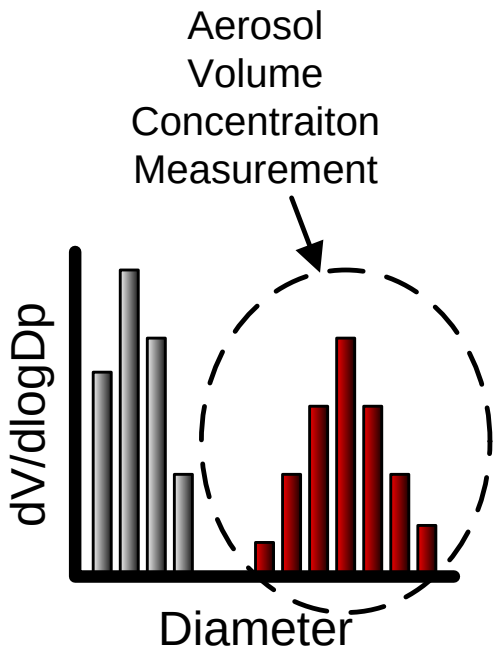
Aerosolized Sample

Quantifying Colloid Concentration

- In situ optical techniques do not provide concentration information
- Microscopy methods are costly and time consuming
- Volume concentration standards provide method to calibrate the true aerosolization rate, $R_{Aerosol}$

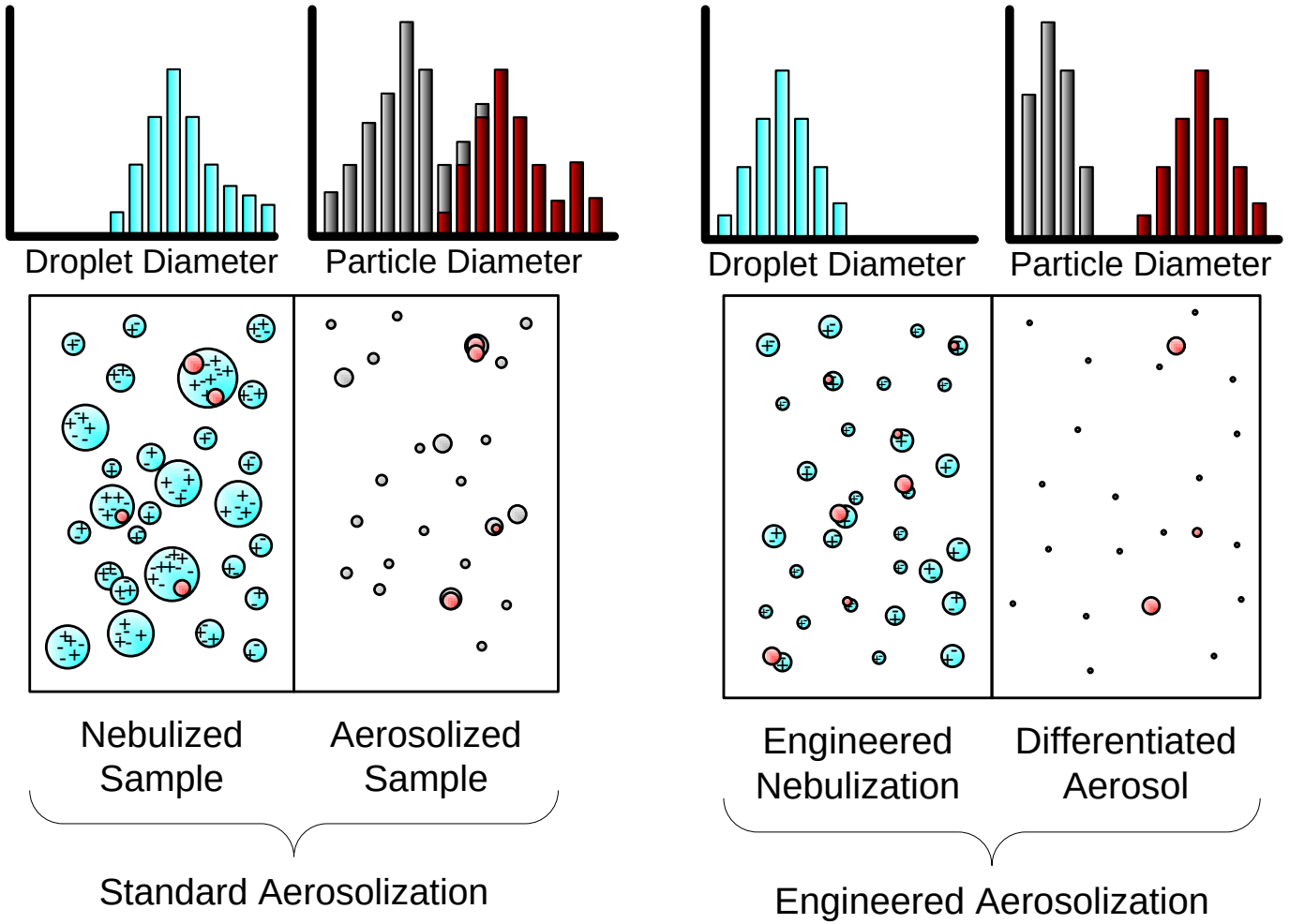
$$R_{Aerosol} = \frac{C_{Vol,Aerosol} Q_{Aerosol}}{C_{Vol,Hydrosol}}$$



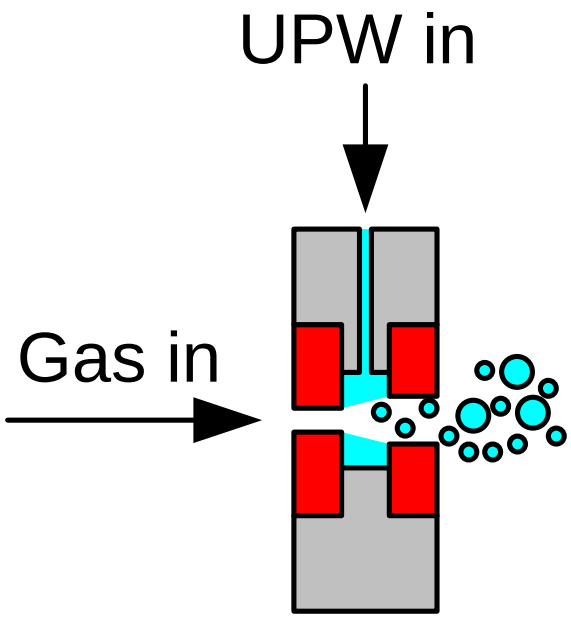


Differentiating DNVR and Liquid-Borne Particles

Engineered Aerosolization



Unique Kanomax Nebulizer Design

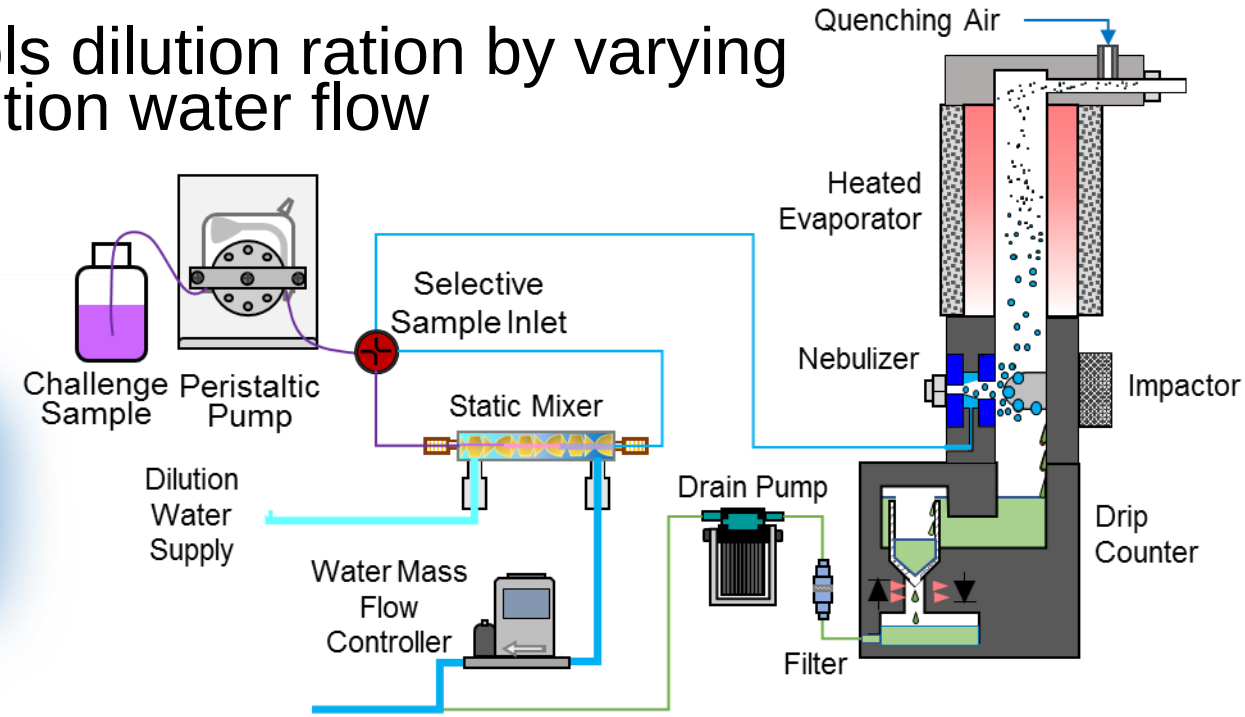


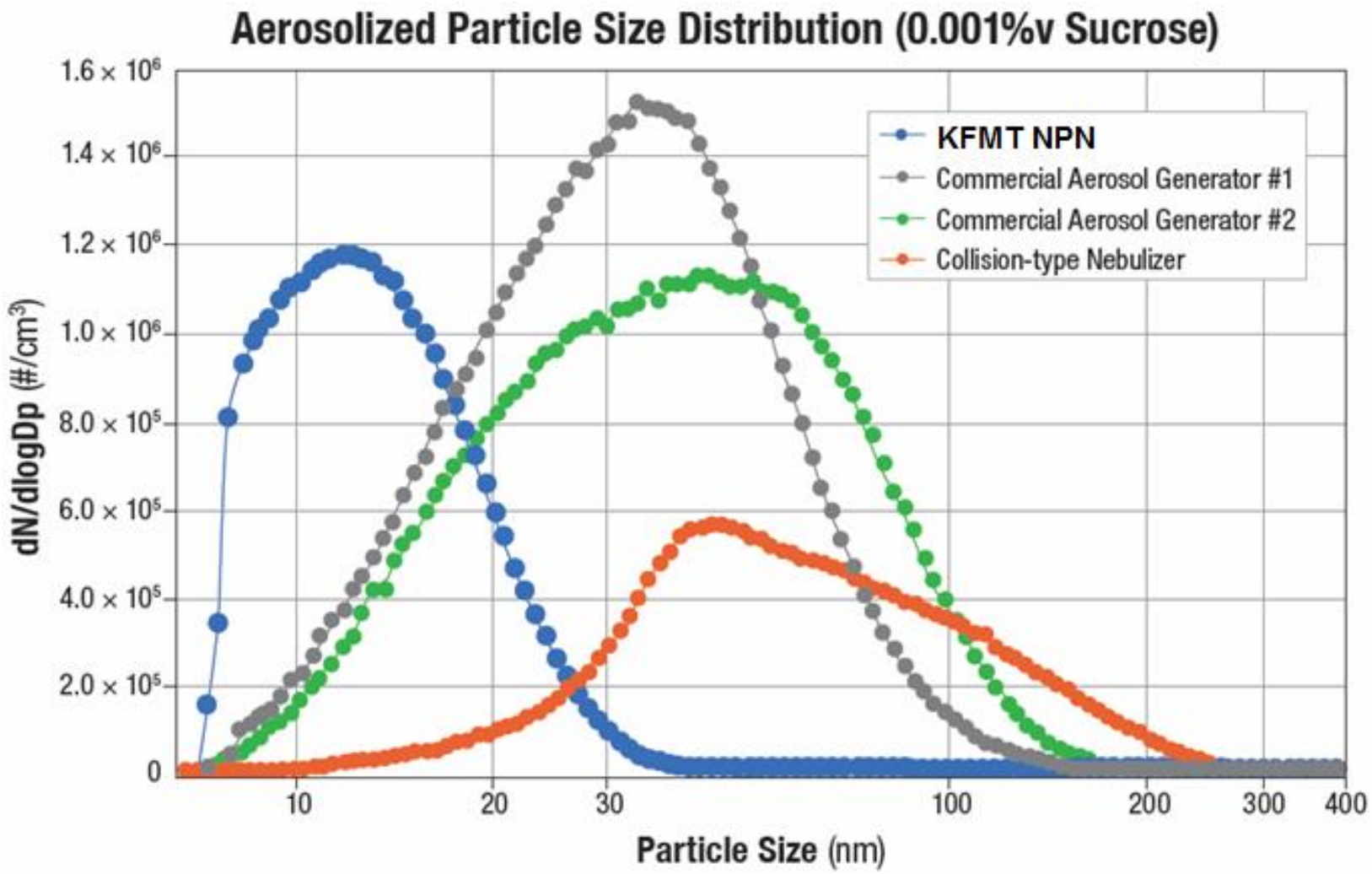
Patent granted

Unique Kanomax Nebulizer Design

Nanopartricle Nebulizer (NPN, Kanomax 9110)

- Nanoparticle Nebulizer provides online dilution and sample aerosolization
- Designed to nebulize droplets with a small peak diameter and reduced concentration of large droplets
- Software controls dilution ration by varying sample and dilution water flow

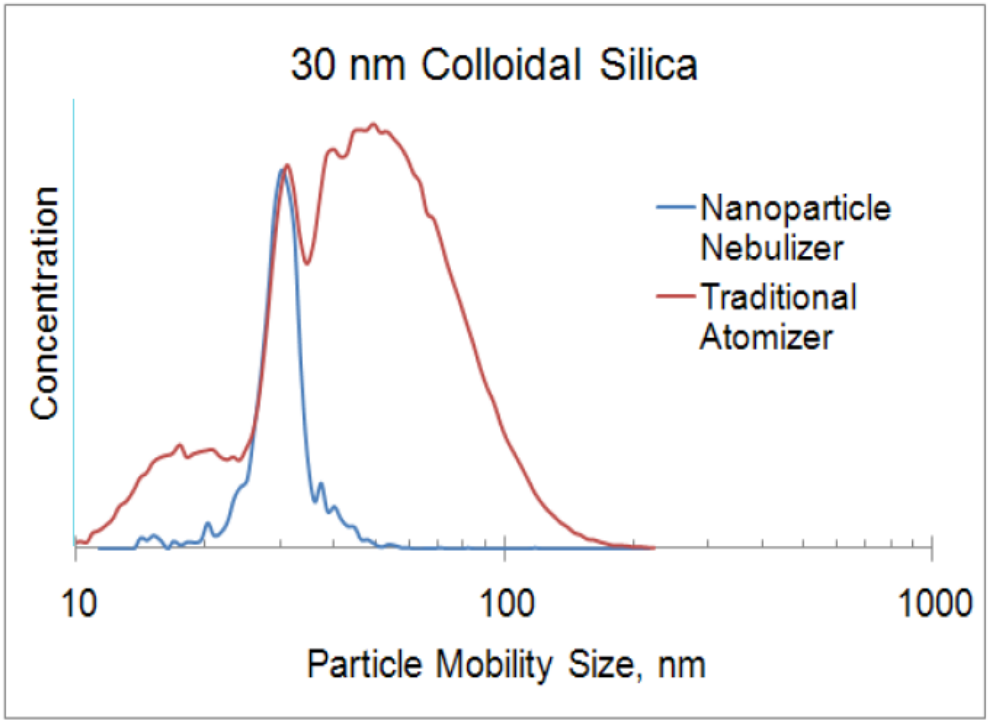



Aerosolized Particle Size Distribution (0.001%v Sucrose)
KFMT NPN
Commercial Aerosol Generator #1
Commercial Aerosol Generator #2
Collision-type Nebulizer
dN/dlogDp (#/cm3)
1.6 × 10^6
1.4 × 10^6
1.2 × 10^6
1.0 × 10^6
8.0 × 10^5
6.0 × 10^5
4.0 × 10^5
2.0 × 10^5
0
10
20
30
100
200
300
400
Particle Size (nm)

Nanoparticle Nebulizer Applications

30 nm Colloidal Silica Standard Particles

- Kanomax NanoParticle Nebulizer reduces interference from Precipitated Non-Volatile Residue
  - Overlapping peaks
  - Errors in particle diameter due to PNVR coating
- Allows for particle size distribution measurements at smaller particle diameters and at higher dissolved residue levels than traditional systems



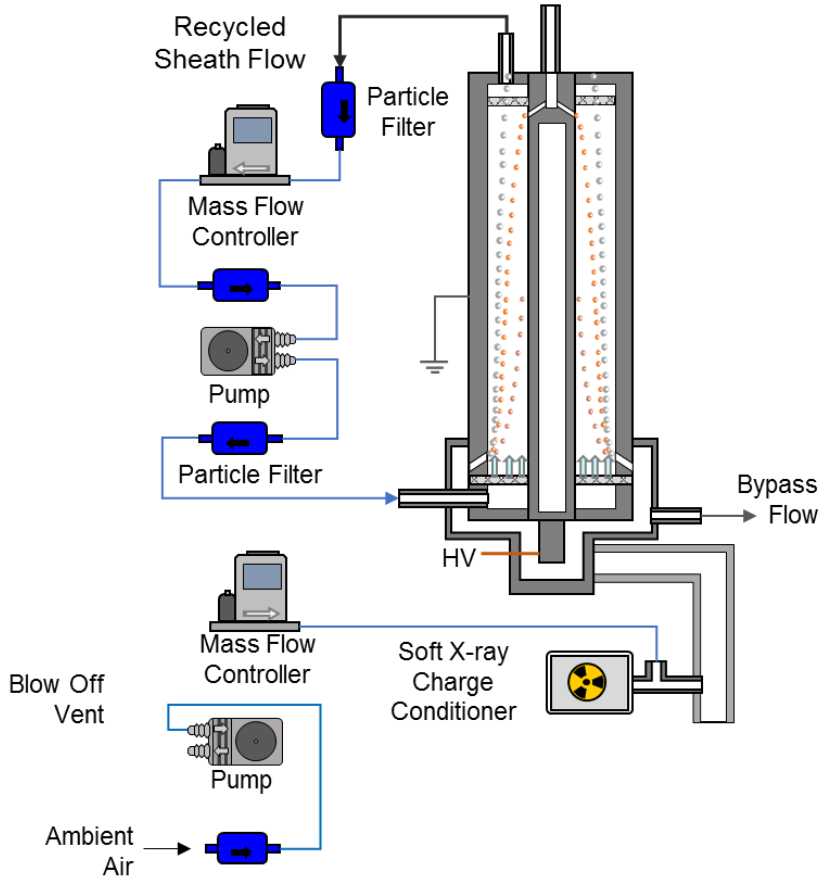
Litchy, M. et.al.: Pittcon 2012

Aerosolized Particle Size Characterization

Annular Flow Ion Mobility Spectrometer (AFIMS, Kanomax 3660)

Principle of Operation – Electrical Mobility Classification

- Annular Flow Ion Mobility Classifier (AFIMC) acts as a “bandpass” filter based on particle size
- Measurement of particle concentrations over a range of selected sizes provides particle size distribution information
- Data inverted to account for charging and detection efficiency of the aerosol particle counter

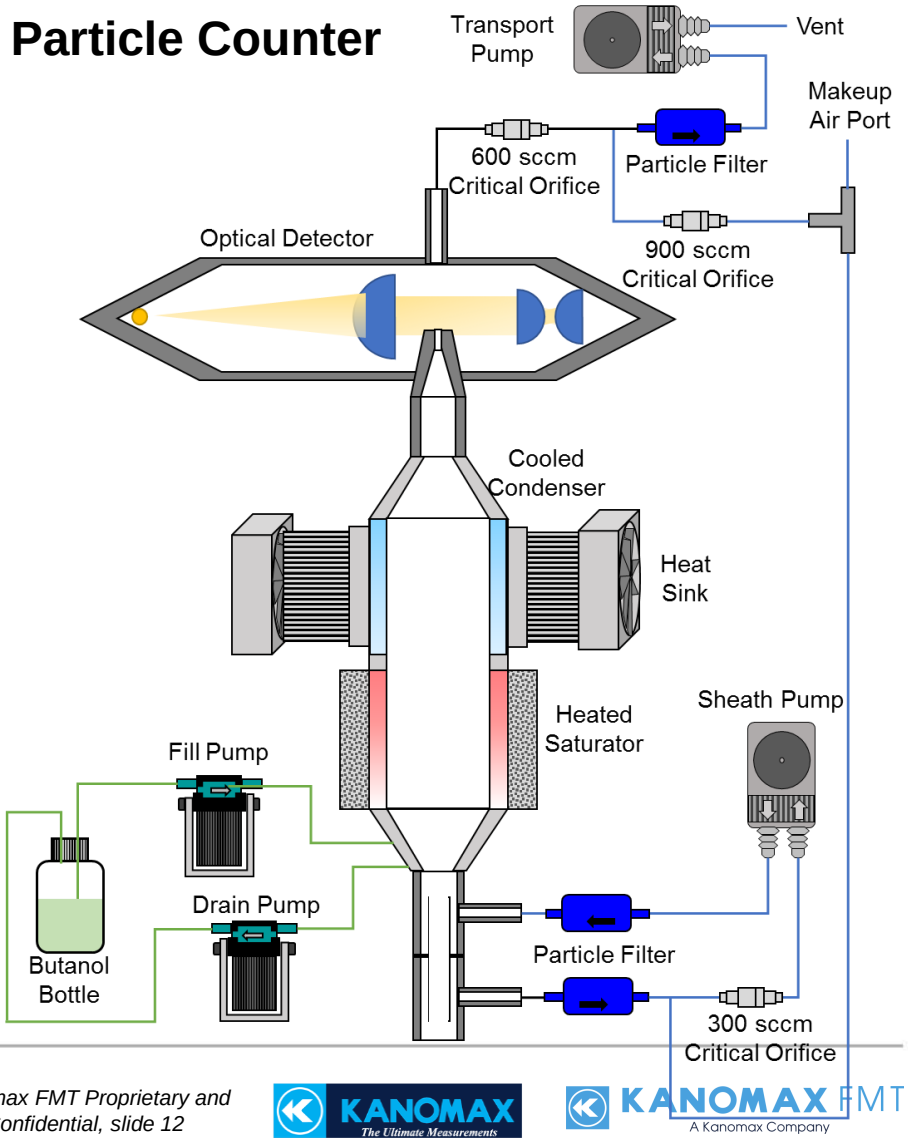


Aerosolized Particle Concentration Measurement

Annular Flow Ion Mobility Spectrometer (AFIMS, Kanomax 3660)

Principle of Operation – Condensation Particle Counter

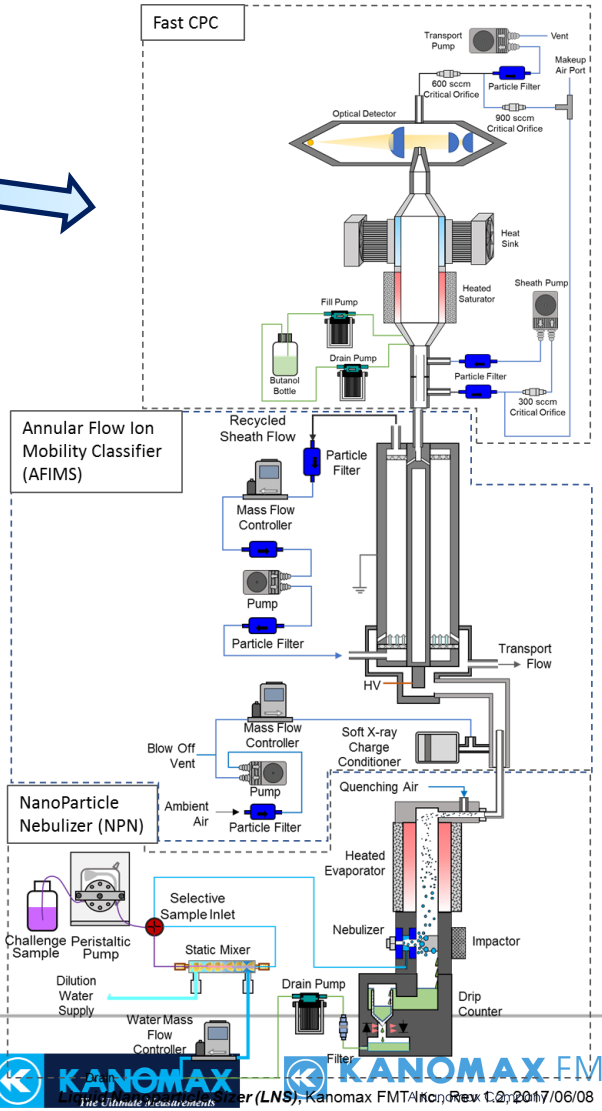
- Heated Saturator adds butyl alcohol vapor to the aerosol
- Cooled Condenser causes the butyl alcohol vapor to become supersaturated
- Supersaturated butanol vapor condenses onto particles in the aerosol making large droplets
- Droplets counted optically using light scattering ("Dry" particles are not detected)



Liquid Nanoparticle Sizer System

System Schematic

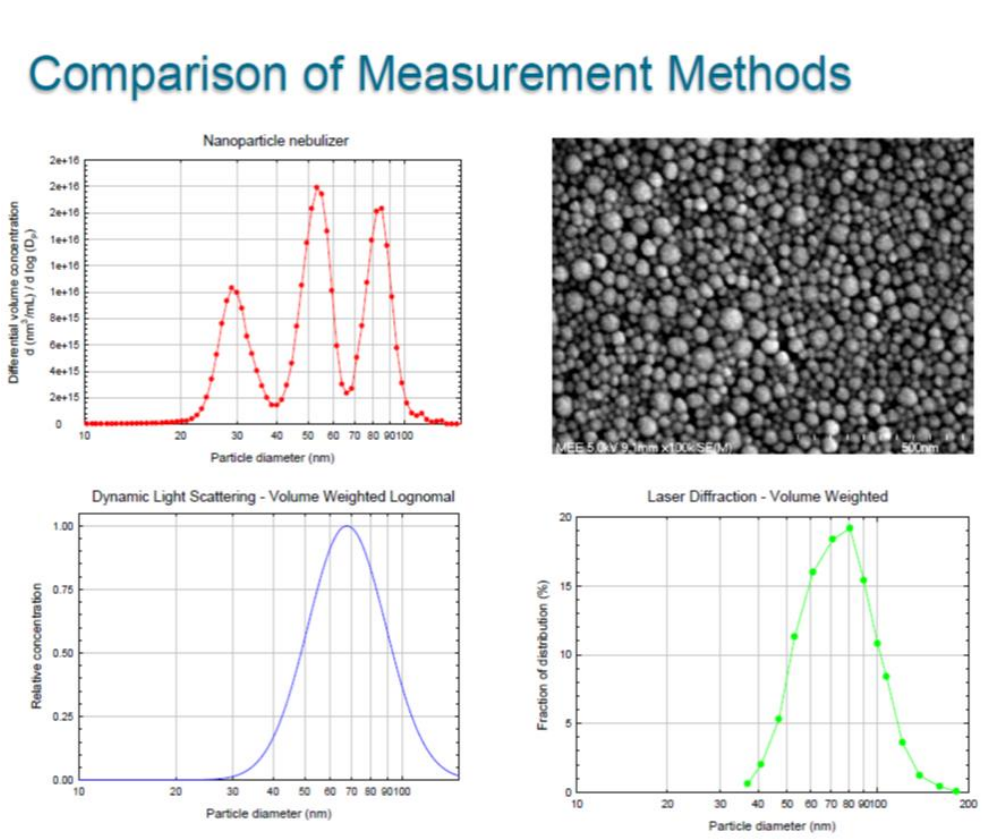
LNS, Kanomax 9310



Liquid Nanoparticle Sizer (LNS)

Competitive Methods

- Current in-situ methods are often unable to resolve multimodal distributions
- Concentration information is not provided

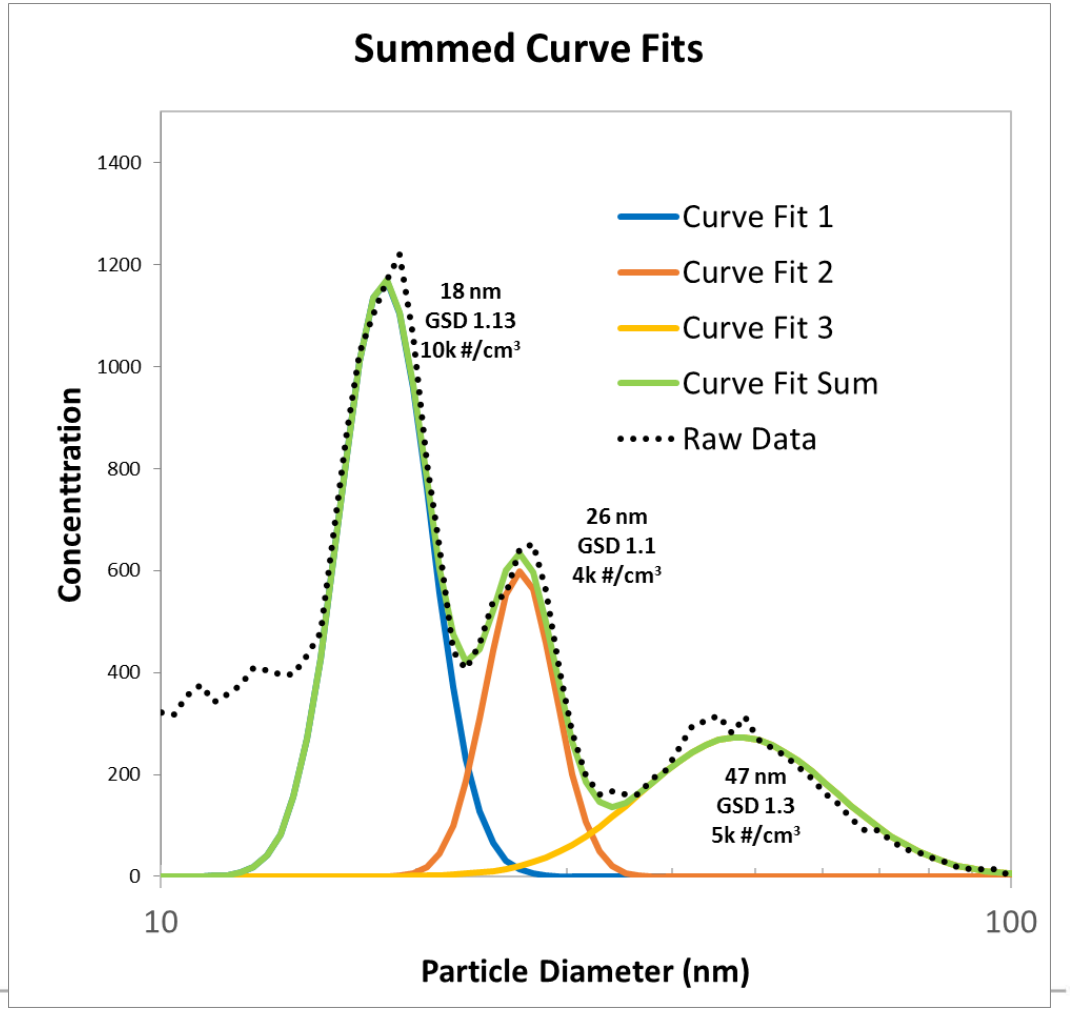


Litchy, M. et.al.. Pittcon 2012

Liquid Nanoparticle Sizer (LNS)

High Resolution – Multimodal Measurement

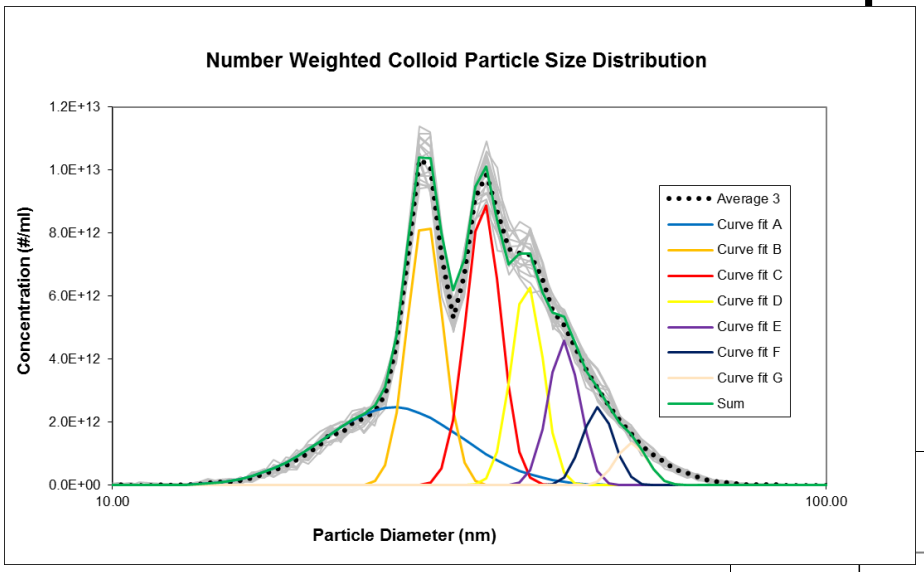
- Individual modes may be defined by separate log-normal distributions
- Sum of single distributions fit to raw data
- Automation for process coming for Kanolysis®

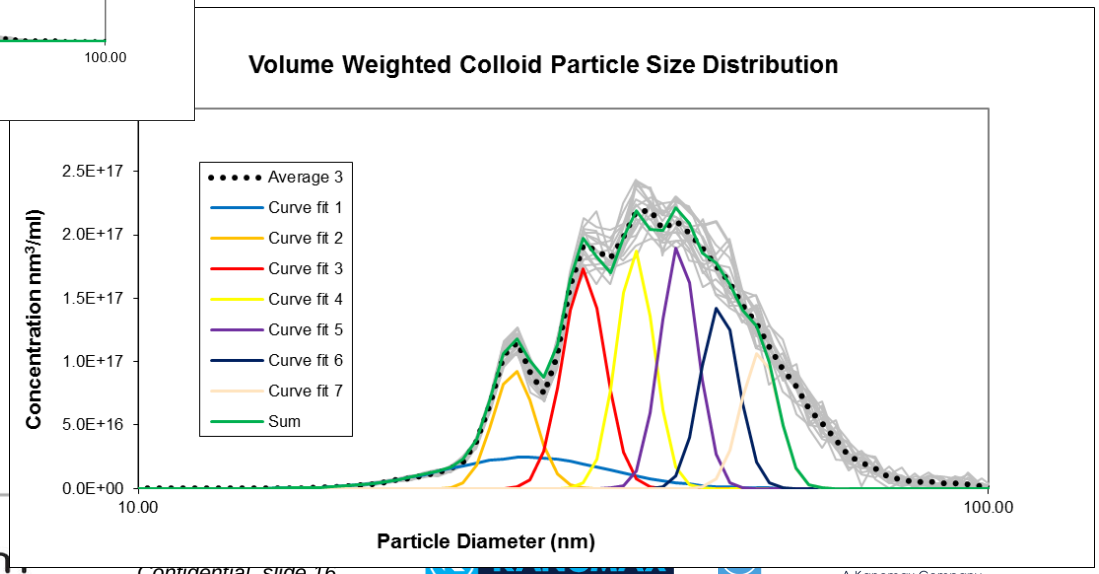


Liquid Nanoparticle Sizer (LNS)

Data Samples – Multimodel Distributions

- Able to resolve multiple overlapping modes

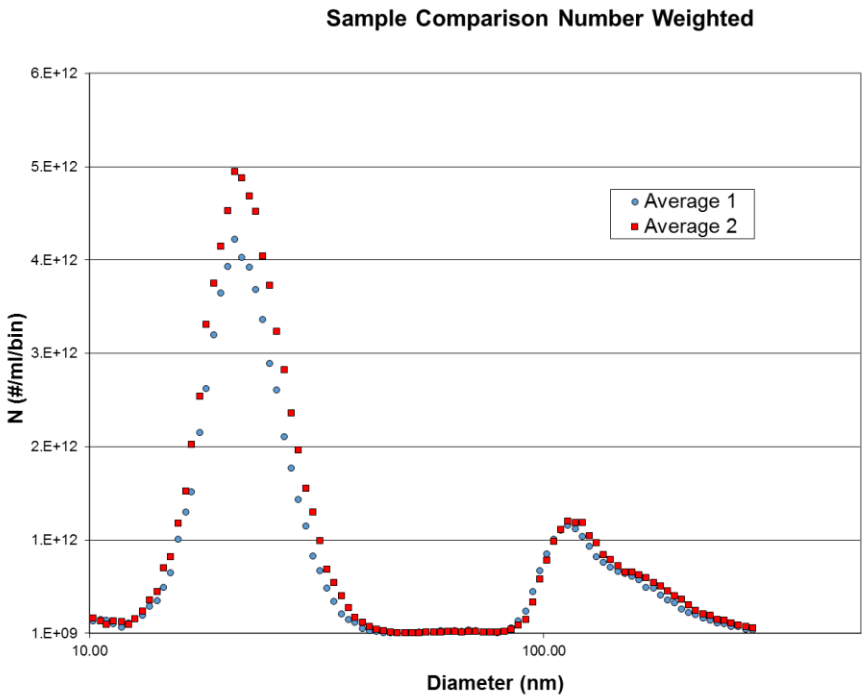


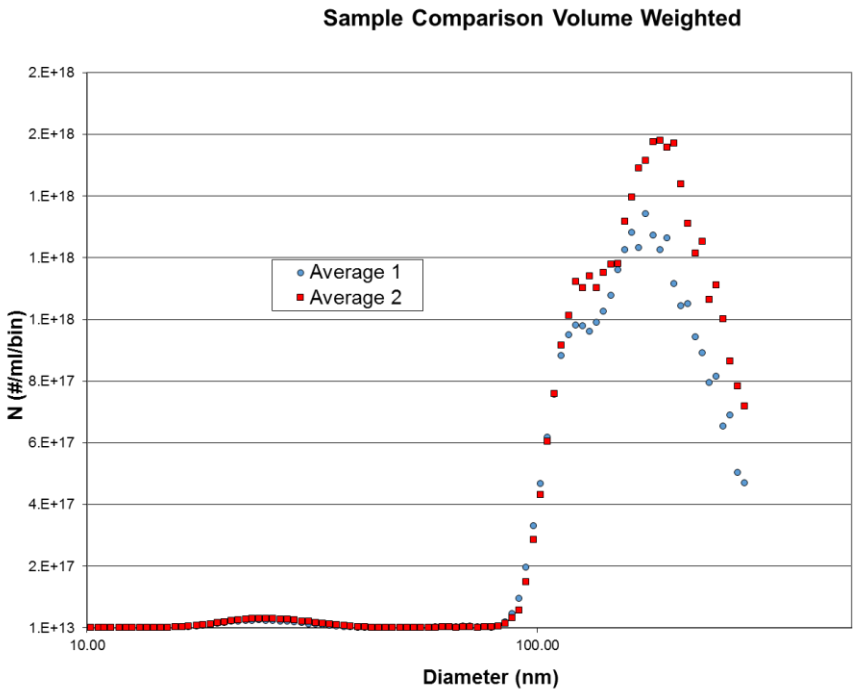


Liquid Nanoparticle Sizer (LNS)

High Sensitivity – Alarm Criteria

- Detect small shifts in individual modes
- Detect changes in ratios of mode concentrations
- Detect changes in mode shape (e.g. increased dimers)





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