



# ICPT 2019

International Conference on Planarization/CMP Technology

Ambassador Hotel, Hsinchu, Taiwan

September 15 (SUN)– September 18 (WED), 2019

## Post CMP Clean Effluent Endpointing and Monitoring with the LNS System

**Siqin He, Derek Oberreit, and Steve Kosier**

Kanomax FMT, Inc., White Bear Lake, Minnesota, United States



**NANOPARTICLE MEASUREMENT SOLUTIONS**

# CMP and Post CMP Clean

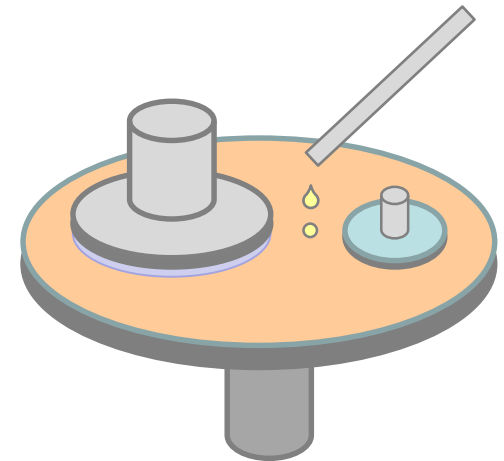
## Chemical Mechanical Planarization (CMP)

- Widely used and accepted planarization method
- Consumes large quantity of slurry
- Introduces defects and contaminations that must be removed

## Post CMP Cleaning

- Megasonic cleaning
- Brush scrubbing
- Fluid jet
- Spin rinse dry

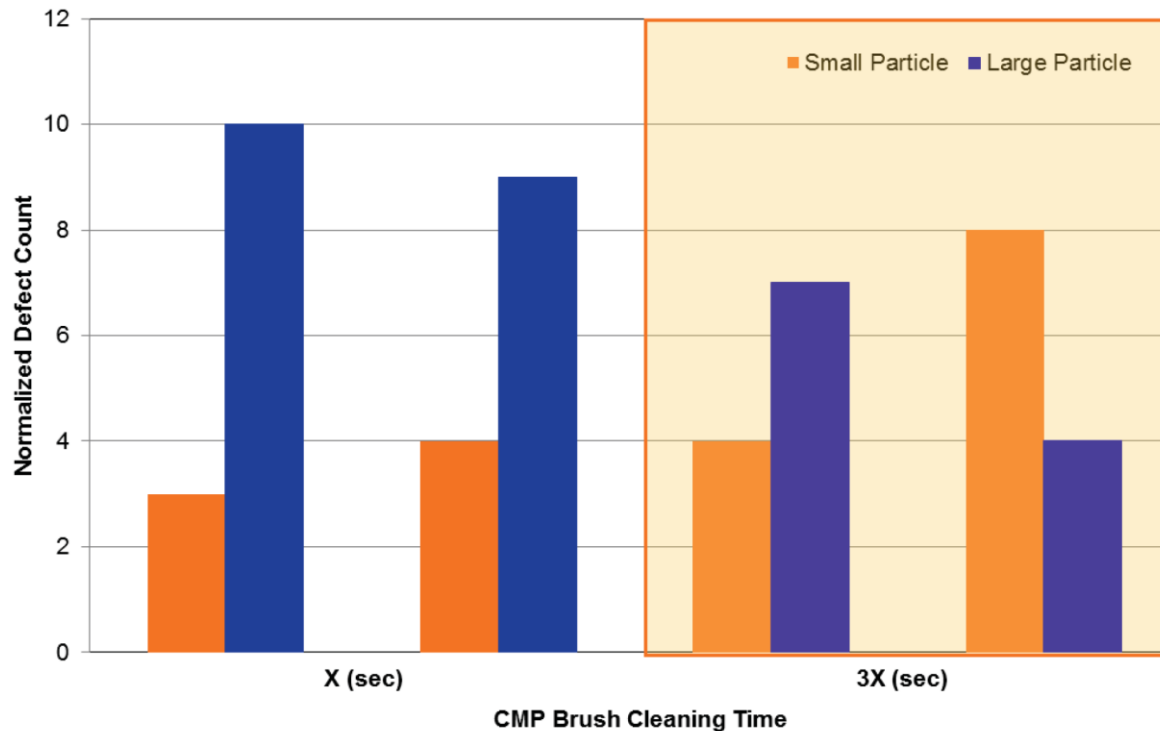
**Most widely used**



# Post CMP Clean – Brush Scrubbing

## Abrasive Particles

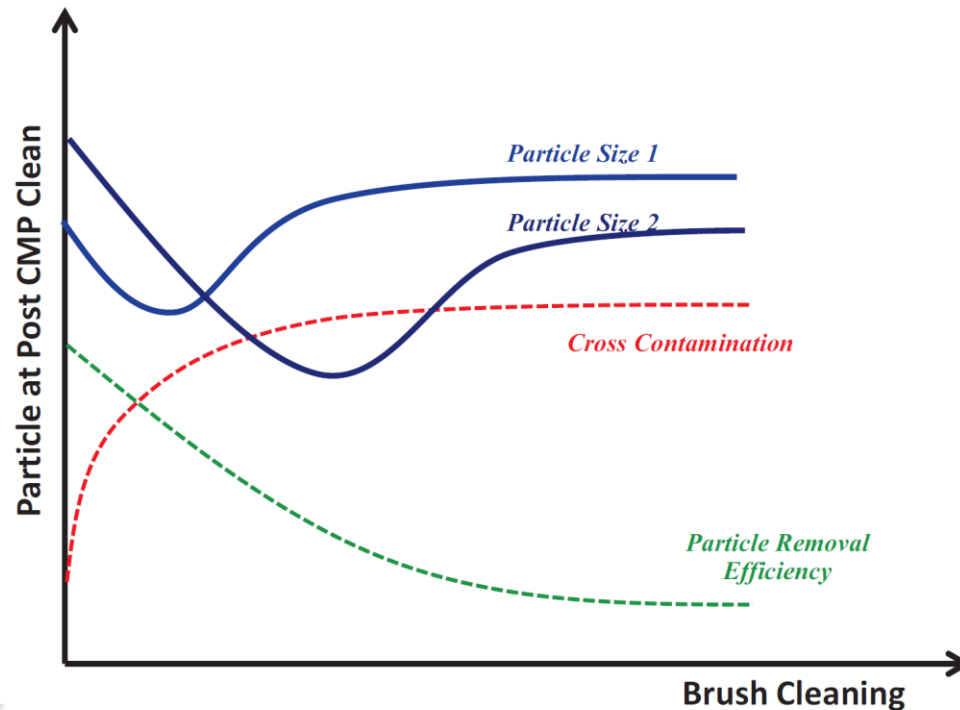
- Removal efficiency not linear with cleaning time
- Removal rate is **size dependent**



(Kim, H.J., Defects and Post CMP Cleaning, ICPT 2018)

# Post CMP Clean – Endpointing

- Combined removal of chemical and physical cleaning
- Mixed effect of particle removal and cross contamination
- **Size dependent** removal characteristics
- Complex behavior that needs a better monitoring method



(Kim, H.J., Defects and Post CMP Cleaning, ICPT 2018)

## Particle Characterization – Size and Concentration

### Dynamic light scattering

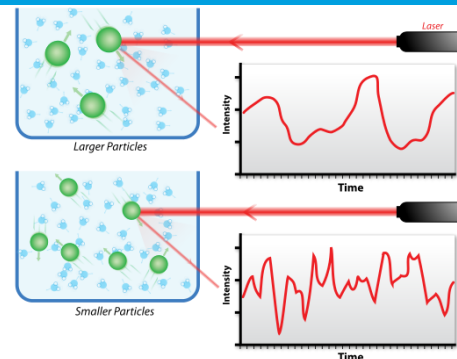
- Requires high concentrations
- Dependent on sample temperature and viscosity
- No concentration information
- Inconsistent multimodal performance

### Nanoparticle Tracking Analysis

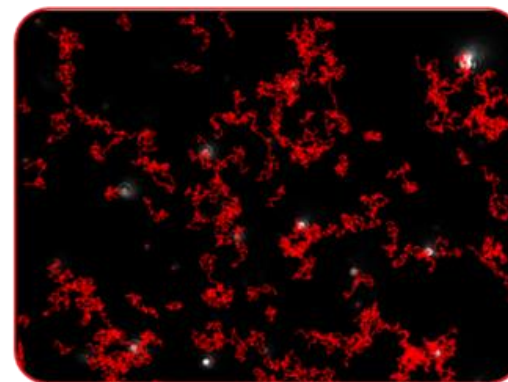
- Functional down to 20 nm
- Dependent on sample temperature and viscosity

### Liquid Nanoparticle Sizing System (LNS)

- Application to measurements at previously unattainable size thresholds



Dynamic Light Scattering Theory  
 By Mike Jones - Own work, CC BY-SA 3.0,  
<https://commons.wikimedia.org/w/index.php?curid=10502233>

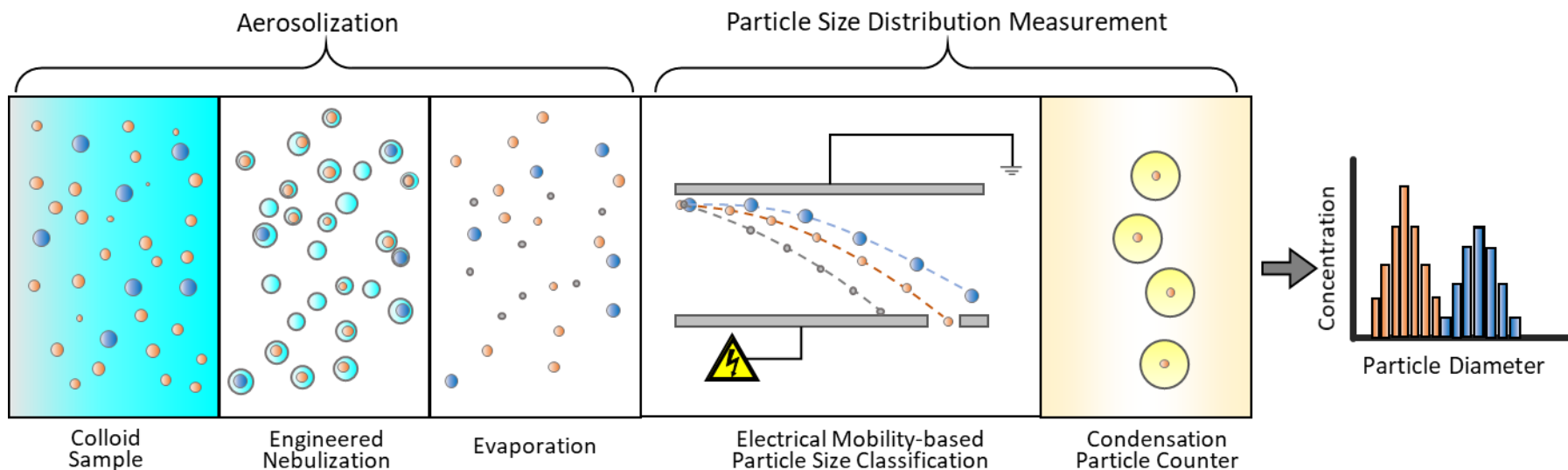


Nanoparticle Tracking Analysis image  
 By Thegnarlypanda - Own work, CC BY-SA 3.0,  
<https://commons.wikimedia.org/w/index.php?curid=11621345>

# Quantifying Particle Size Distribution in Liquid

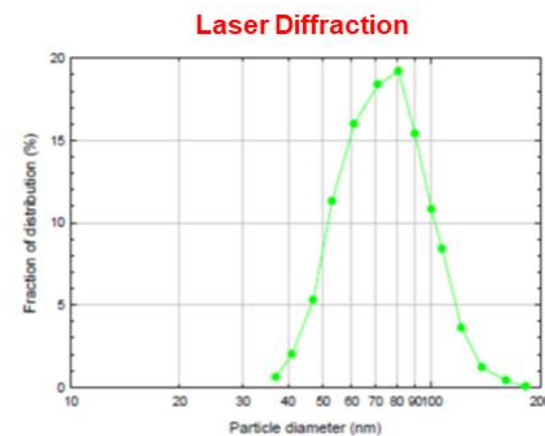
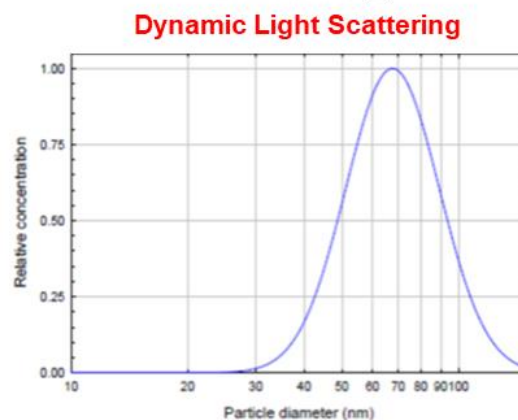
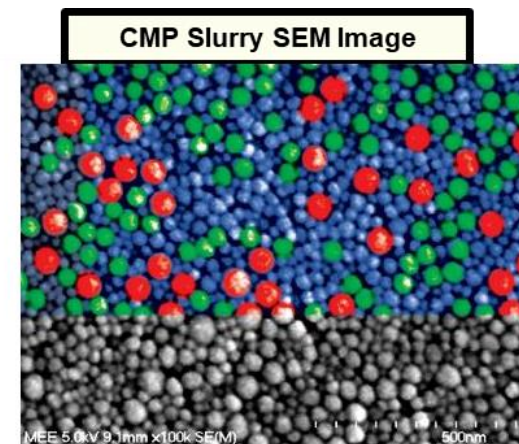
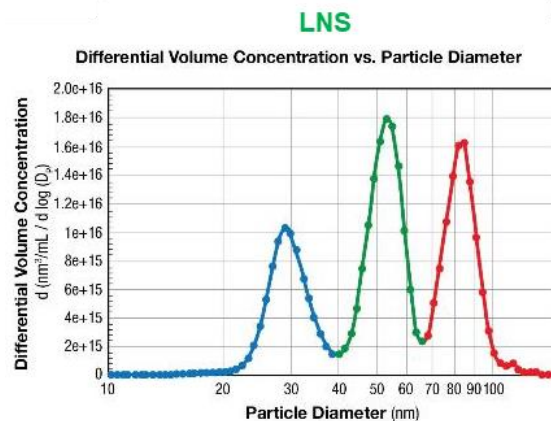
- In situ optical techniques do not provide concentration information
- Microscopy methods are costly and time consuming
- Volume concentration standards provide method to calibrate the true aerosolization rate,  $R_{Aerosol}$

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



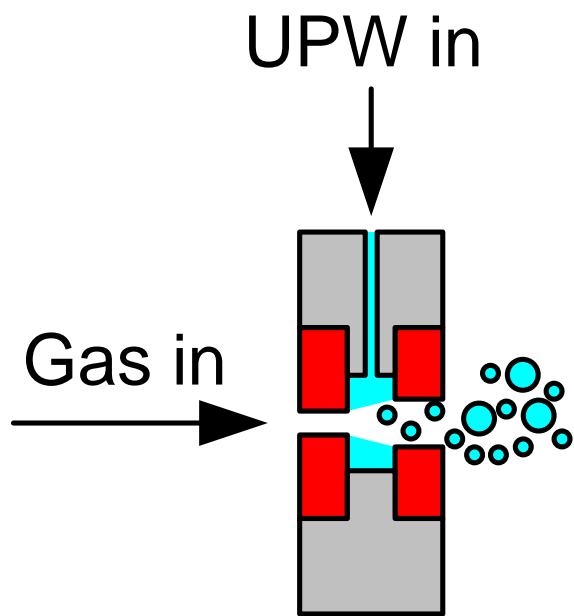
## Liquid Nanoparticle Sizer (LNS) Advantages

- High sizing resolution comparing to other in-situ particle size distribution measurement techniques
- Reports absolute particle concentration information instead of relative signal intensity



Reference: Litchy, M. et.al.: Pittcon 2012

# LNS System with Patented Nebulizer Design



Patent granted

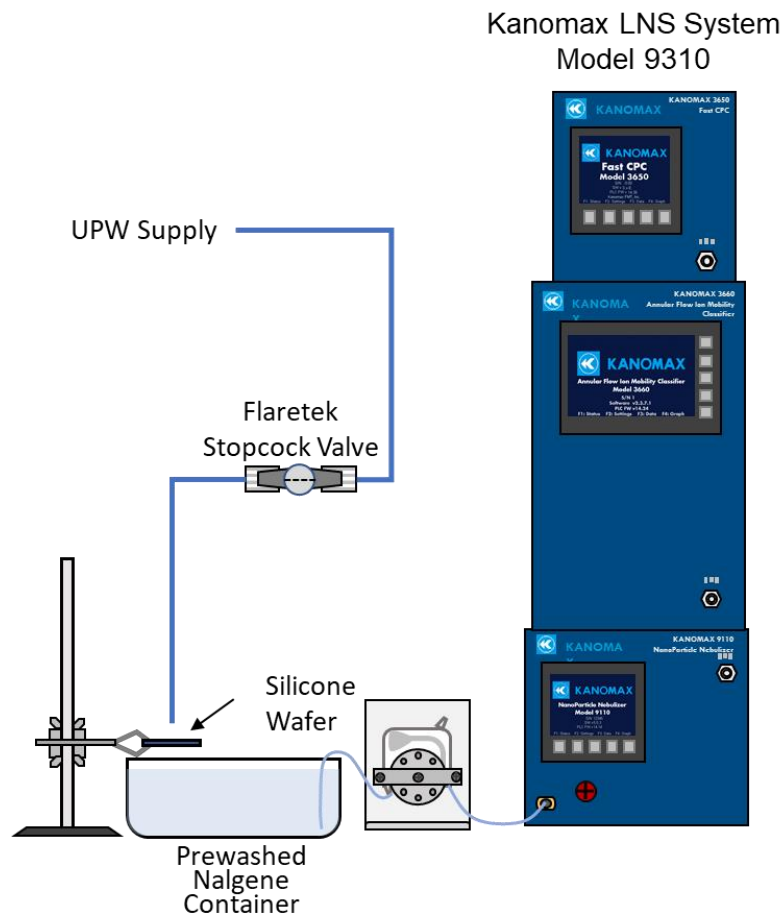




# Post CMP Clean Effluent Monitoring with LNS

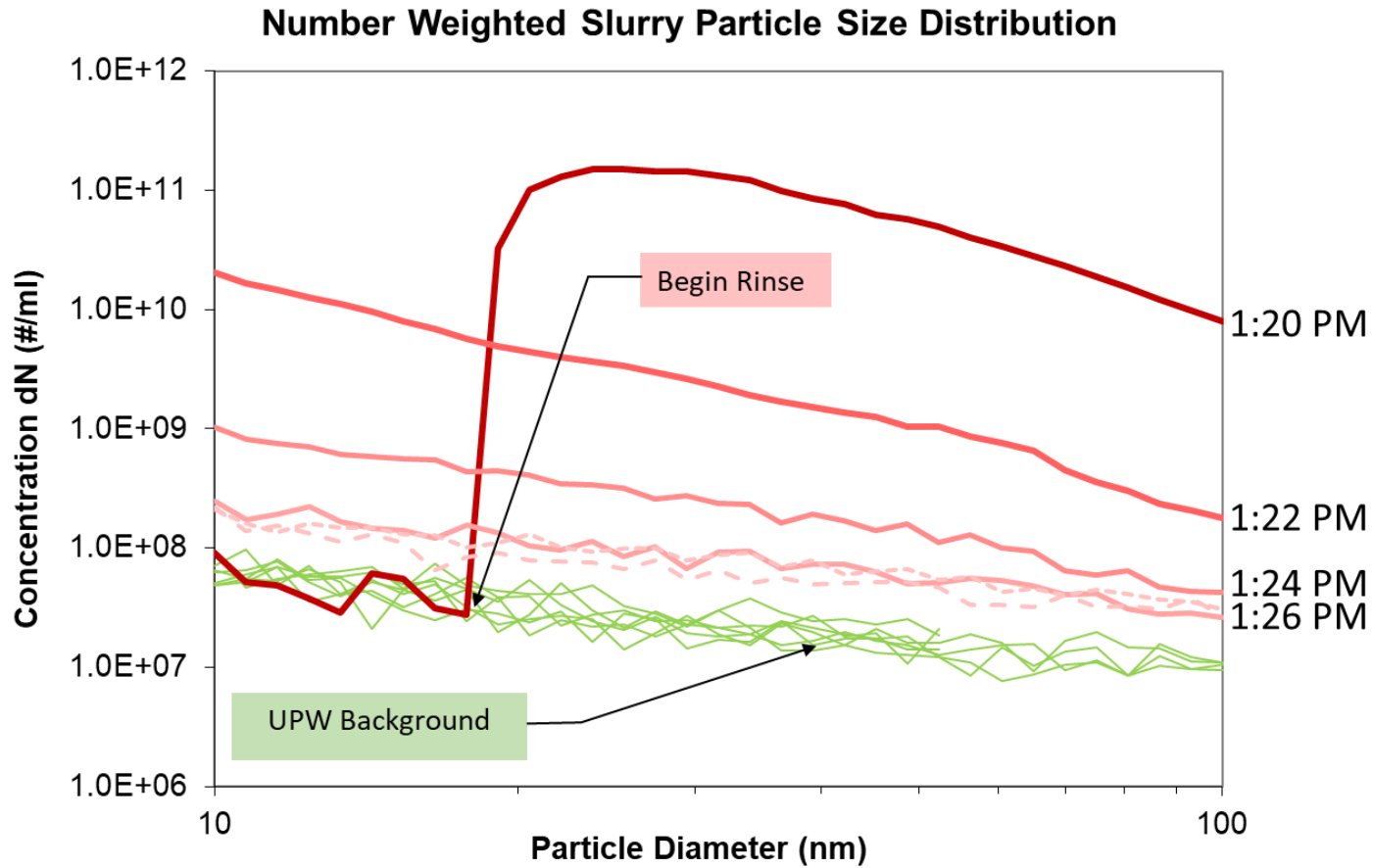
## Experimental Setup

- Silicon wafer loaded with CMP slurry
- UPW flows toward the wafer surface to mimic a simplified post CMP clean process
- **Real-time** monitoring of the effluent by the LNS system using direct injection mode



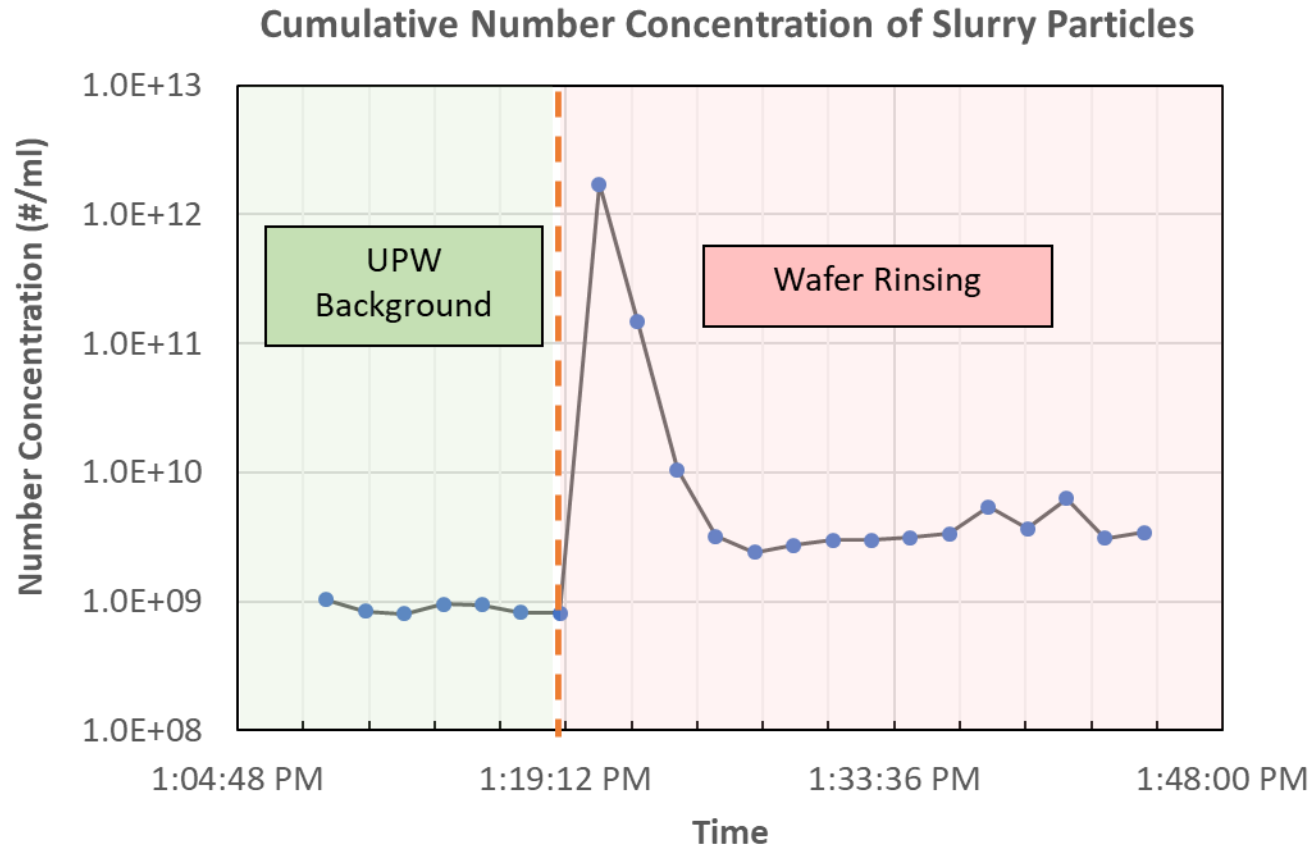
# Post CMP Clean Effluent Monitoring with LNS

- Particle Size Distribution Mode



# Post CMP Clean Effluent Monitoring with LNS

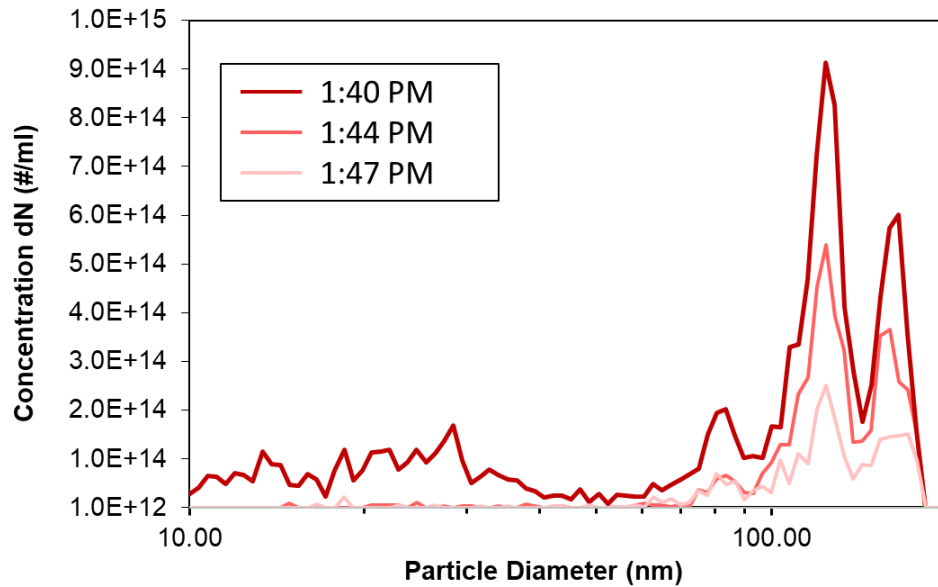
- Cumulative Particle Number Concentration



# LNS Results with Different Slurries

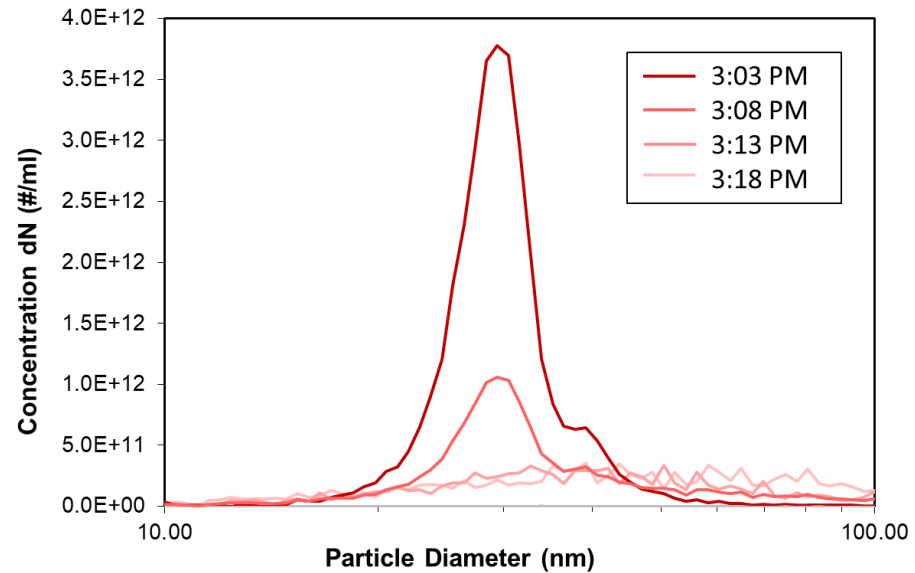
- Cleaning rate varies with particle size

Number Weighted Colloid Particle Size Distribution



Ceria

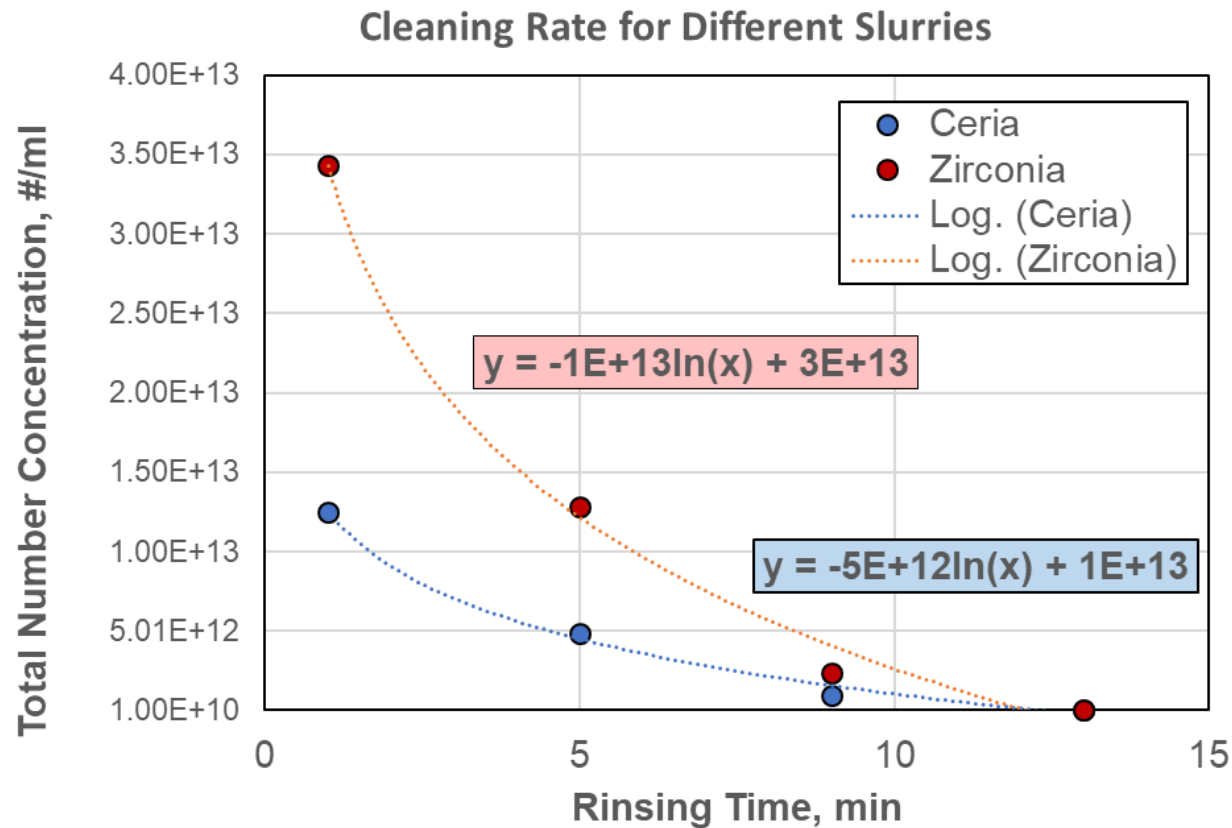
Number Weighted Colloid Particle Size Distribution



Zirconia

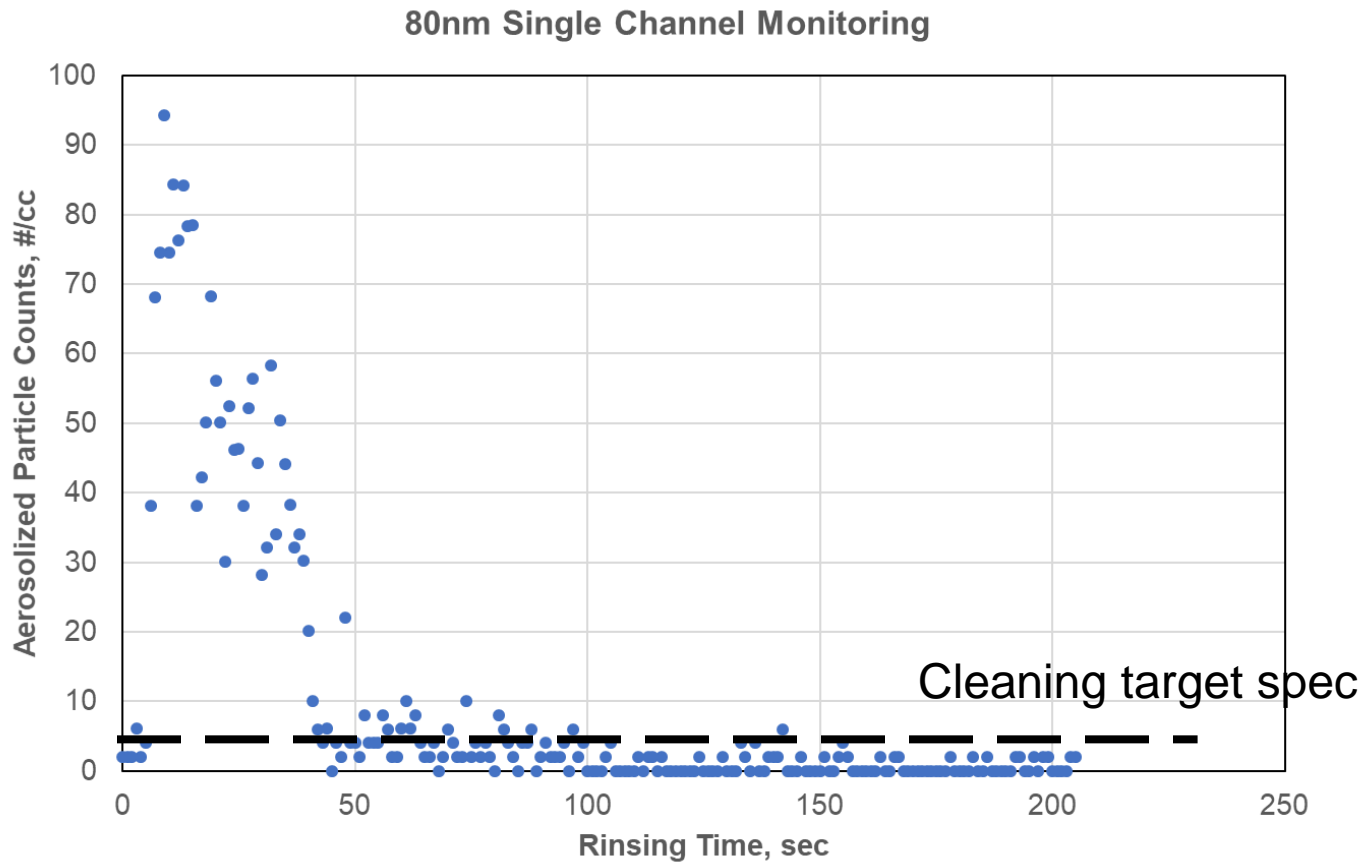
# LNS Results with Different Slurries

- Cleaning rate varies with slurry type



# LNS Single Channel Monitoring Mode

- Particle count data reported at 1 Hz rate for the selected size channel



Alumina

# Summary

- The LNS system is a perfect fit for characterizing size distribution of particles in post CMP cleaning effluent with its **high sizing resolution, absolute concentration measurement, fast-response, and online, real-time monitoring** capability.
- The LNS system can be operated in:
  - 1) **Size distribution mode**
  - 2) **Single channel mode**
- Cleaning rate of slurry particles varies with particle size and slurry type.
- Complex CMP particle cleaning behavior can be understood and monitored using the LNS System.





# ICPT 2019

International Conference on Planarization/CMP Technology

Ambassador Hotel, Hsinchu, Taiwan

September 15 (SUN)– September 18 (WED), 2019

# THANK YOU

For more technical details, please visit us at

[www.KanomaxFMT.com](http://www.KanomaxFMT.com)

ContactUs@KanomaxFMT.com



**KANOMAX** FMT

A Kanomax Company

**NANOPARTICLE MEASUREMENT SOLUTIONS**