AccuSizer *FX*

Online Monitoring of Particle Size in CMP Slurries by SPOS, Requiring Little or No Dilution

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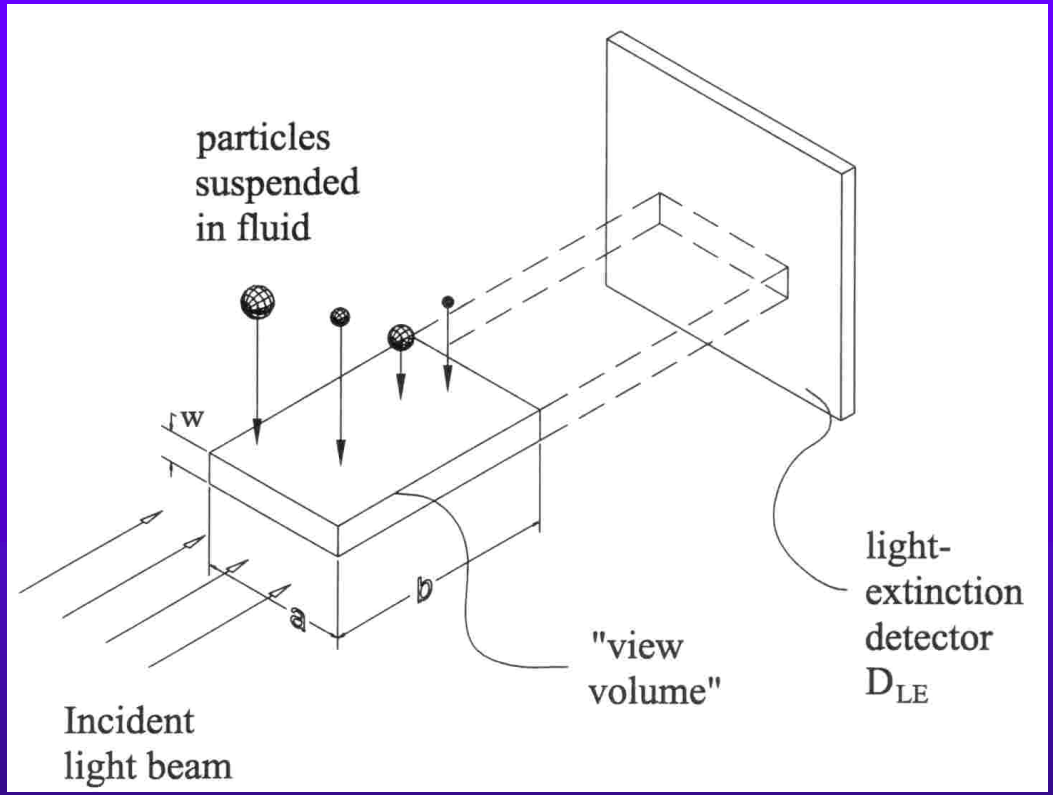
Features of AccuSizer$_{FX}$

- High Concentration
  - Little or NO Dilution
- High Resolution: Single-particle Optical Sensing
- High Accuracy
- High Reproducibility
- Sensitivity to outliers several standard deviations above the mean diameter
- Adjustable lower size threshold limit
- Fast, easy to use

Applications

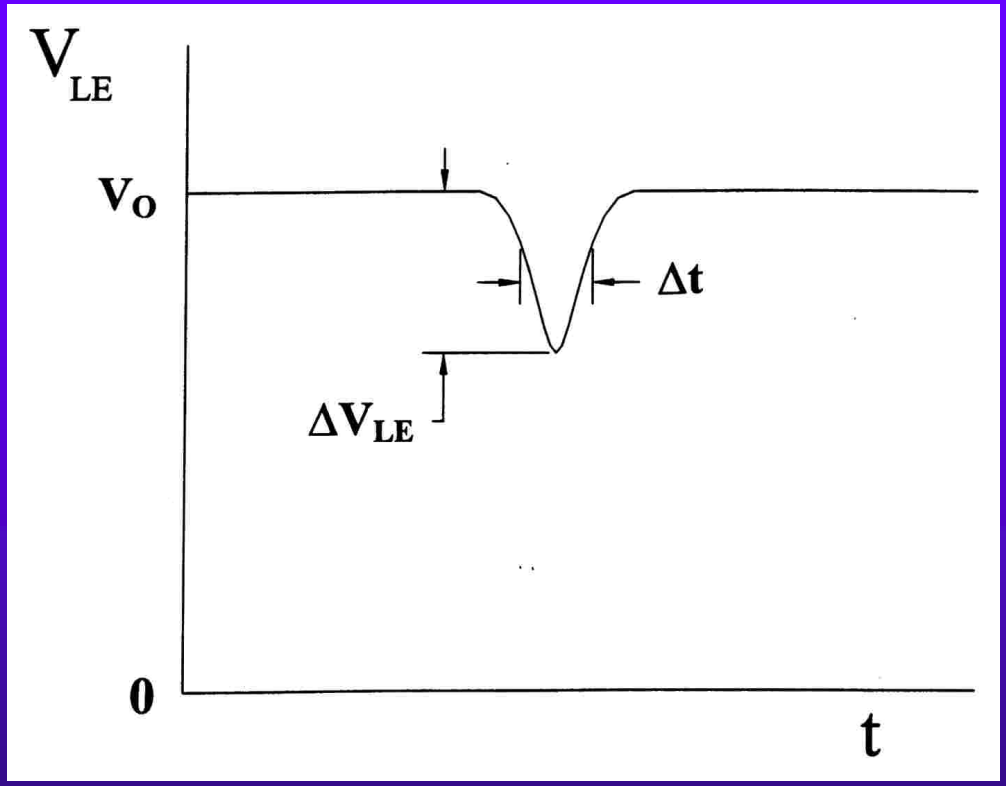
- CMP Slurries
- Emulsions (oil/water)
- Dispersions
- Paints
- Inks / Pigments
- Ceramics
- Filtration media
- Homogenized products
- Abrasives
- Protein aggregates
- Macromolecules

Single-Particle Optical Sensing ...
…*true* PSDs, of Highest Resolution



Light-Extinction (LE) -- Momentary decrease in light intensity transmitted across a flow channel, caused by the passage of a particle through a very small optical sensing zone (OSZ). Mechanisms: refraction and scattering

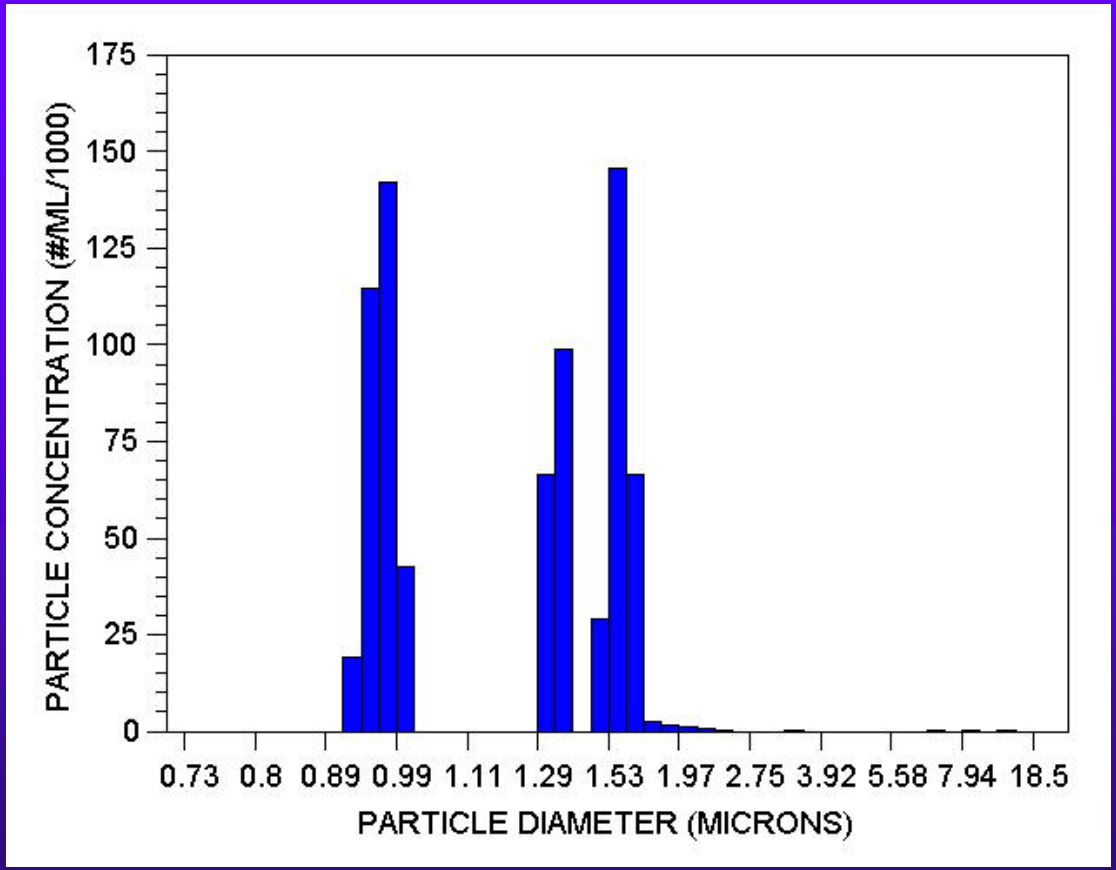
High Resolution … using SPOS
High Concentration … AccuSizer $_{FX}$



Light Extinction (LE) -- Stylized representation of signal pulse produced by a single particle passing through the OSZ.

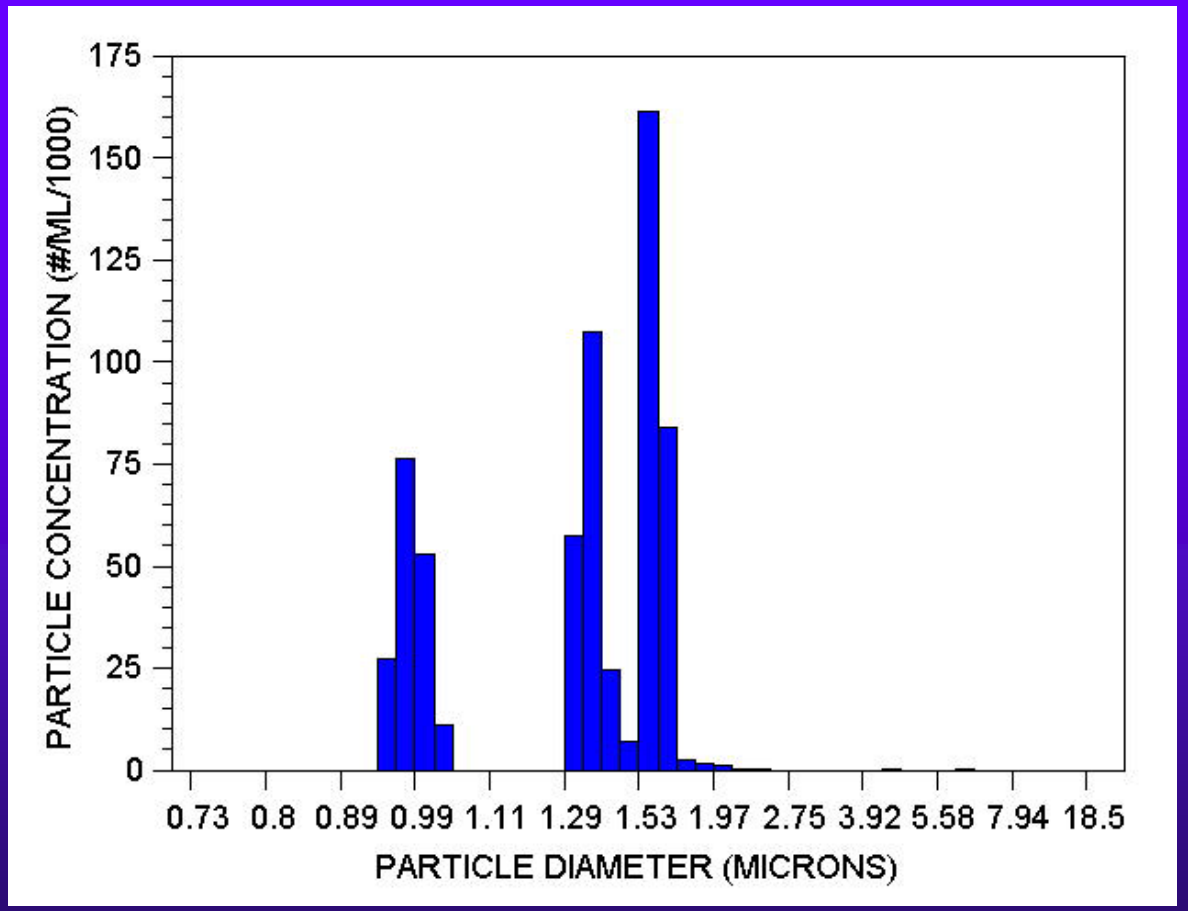
Useful size range of AccuSizer$_{FX}$: ≈ 0.6 to 25 μm

High Resolution (SPOS) and High Concentration (AccuSizer $_{FX}$)



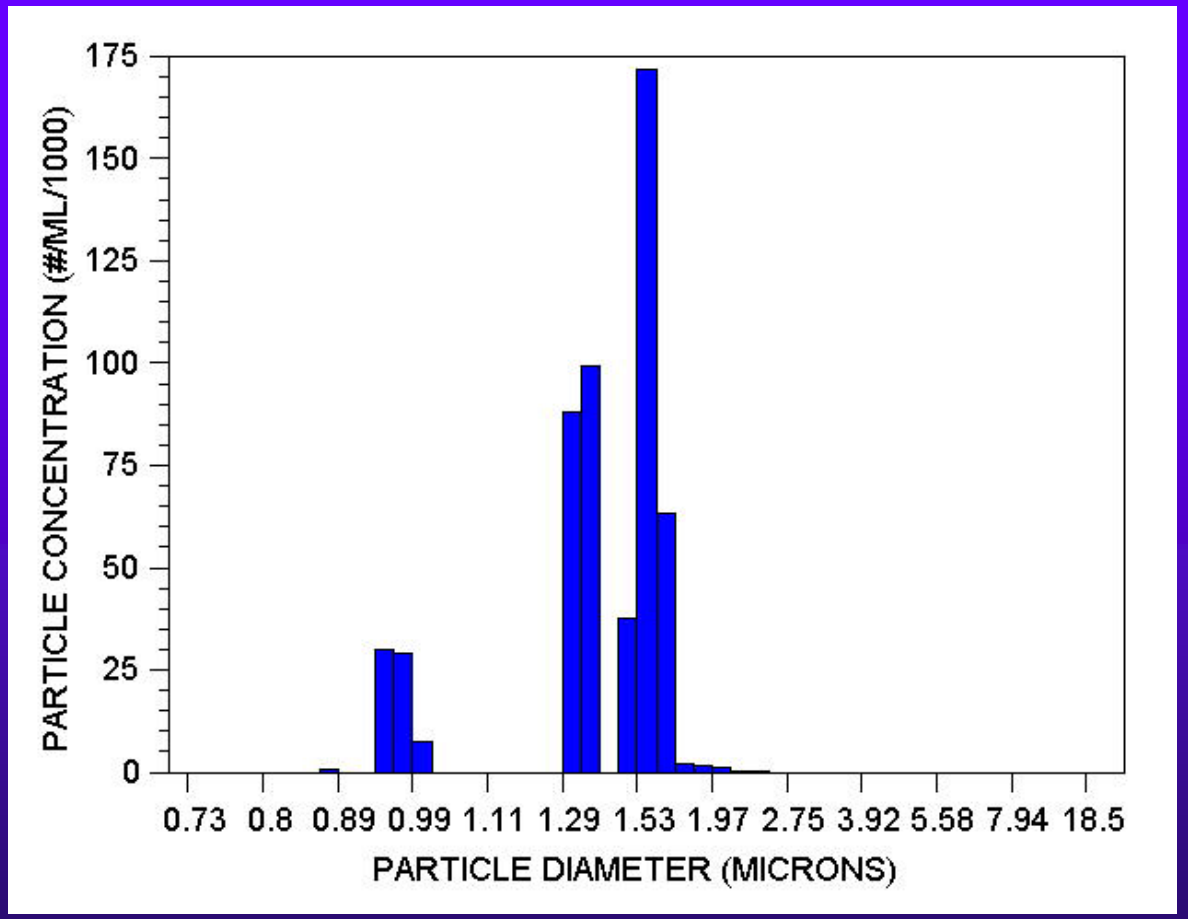
TRI-MODAL #1: 0.5-uL 1-µm + 1-uL 1.36-µm + 2-uL 1.59-µm uniform latex particles (1% w/w), added to 40-ml water. Measured volume: 16-ml

High Resolution (SPOS) and High Concentration (AccuSizer $_{FX}$)



TRI-MODAL #2: same as TRIMODAL #1, but only 1/2 the amount of 1-µm latex particles (0.25-µL added to 40-ml water).

High Resolution (SPOS) and High Concentration (AccuSizer $_{FX}$)



TRI-MODAL #3: same as TRI-MODAL #1, but only 1/4 the amount of 1-µm latex particles (0.125-µL added to 40-ml water)

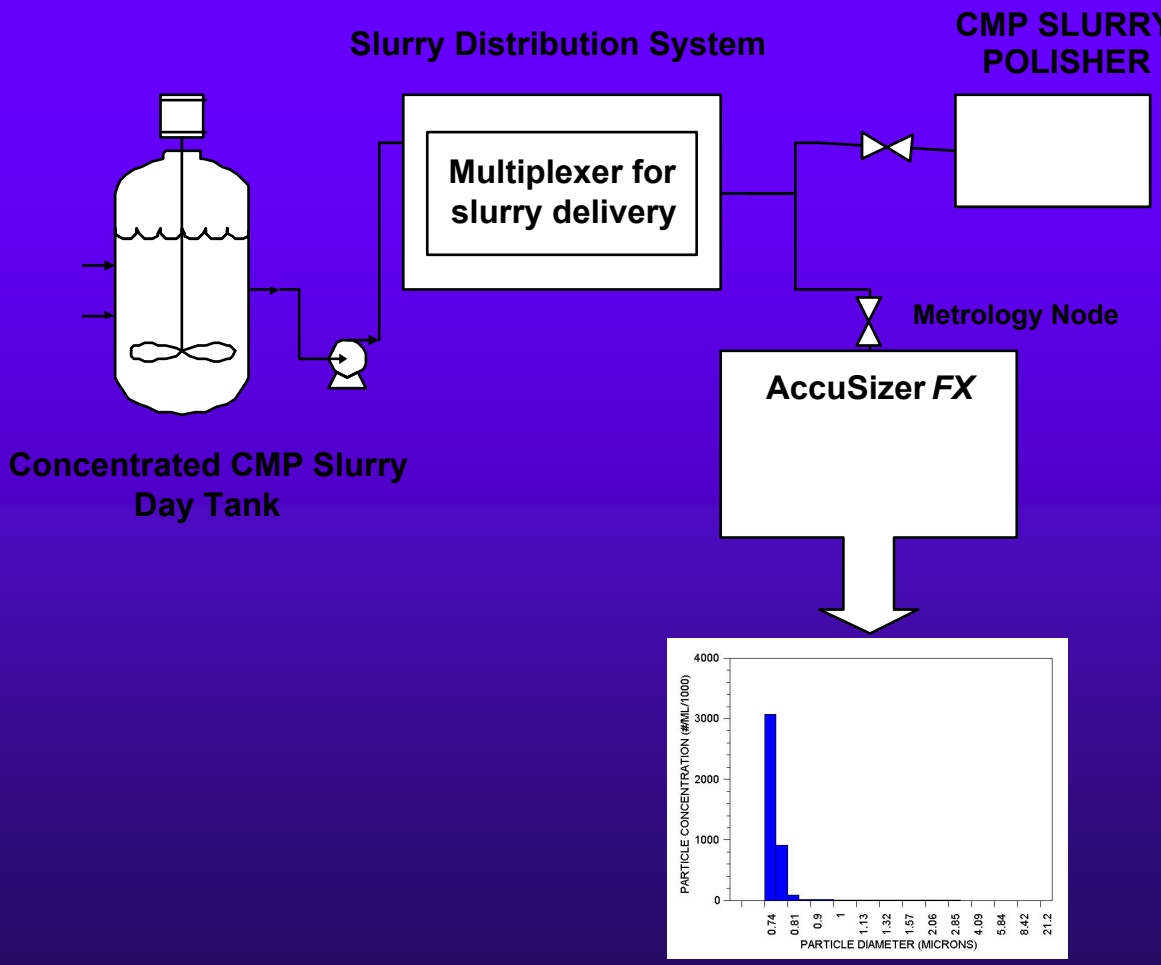
High Resolution and Accuracy

Summary of Latex Tri-modal Standard Results

Particles/ml/1000 -- Measured PSDs *vs* Expected Values

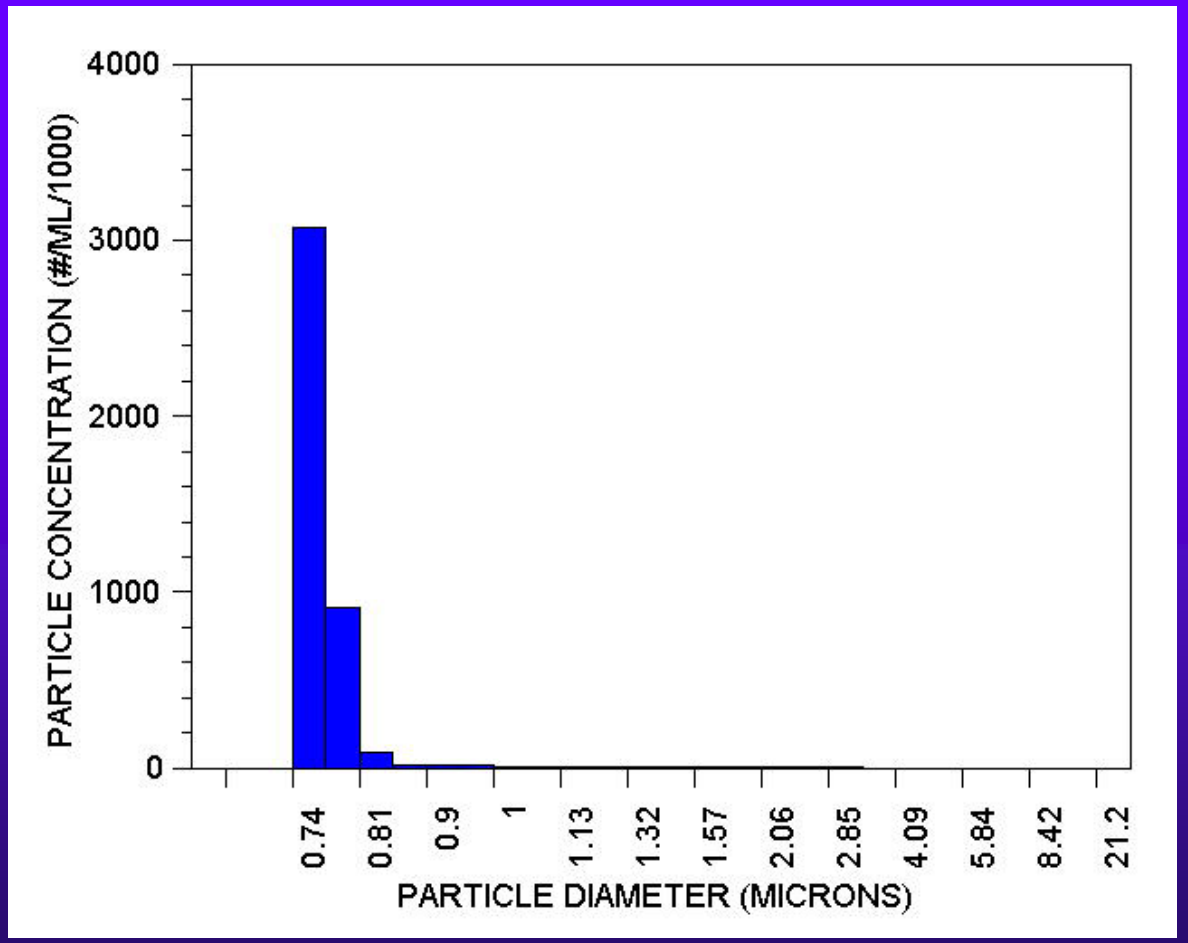
	1-µm Peak		1.36-µm Peak		1.59-µm Peak	
Tri-Modal	PSD	Expected	PSD	Expected	PSD	Expected
#1	318	325	165	177	242	272
#2	168	163	190	177	252	272
#3	67	81	187	177	272	272

Online Particle Size Monitoring of Concentrated CMP Slurries



High Sensitivity to Outliers ...

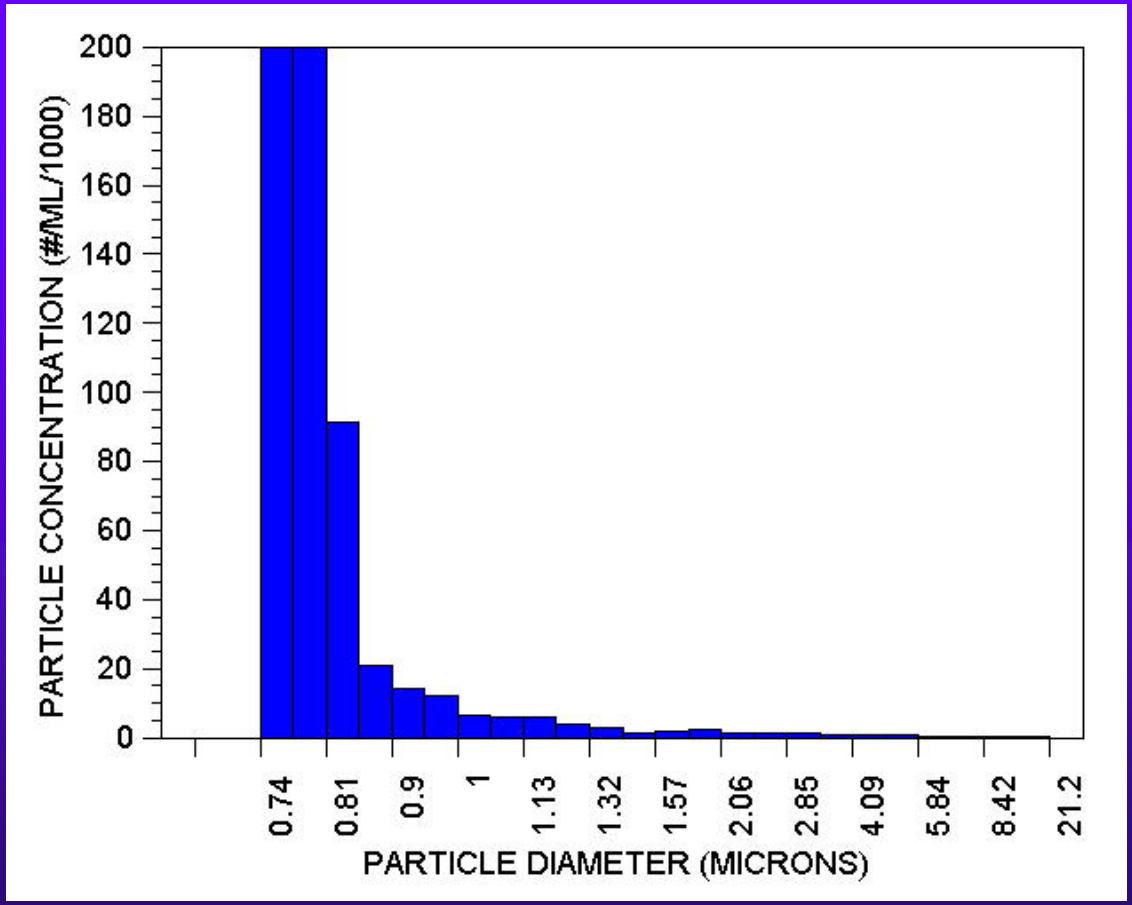
... the Key to Determining CMP Slurry Health



Silica CMP Slurry (SS25) -- *full working concentration*

High Sensitivity to Outliers ...

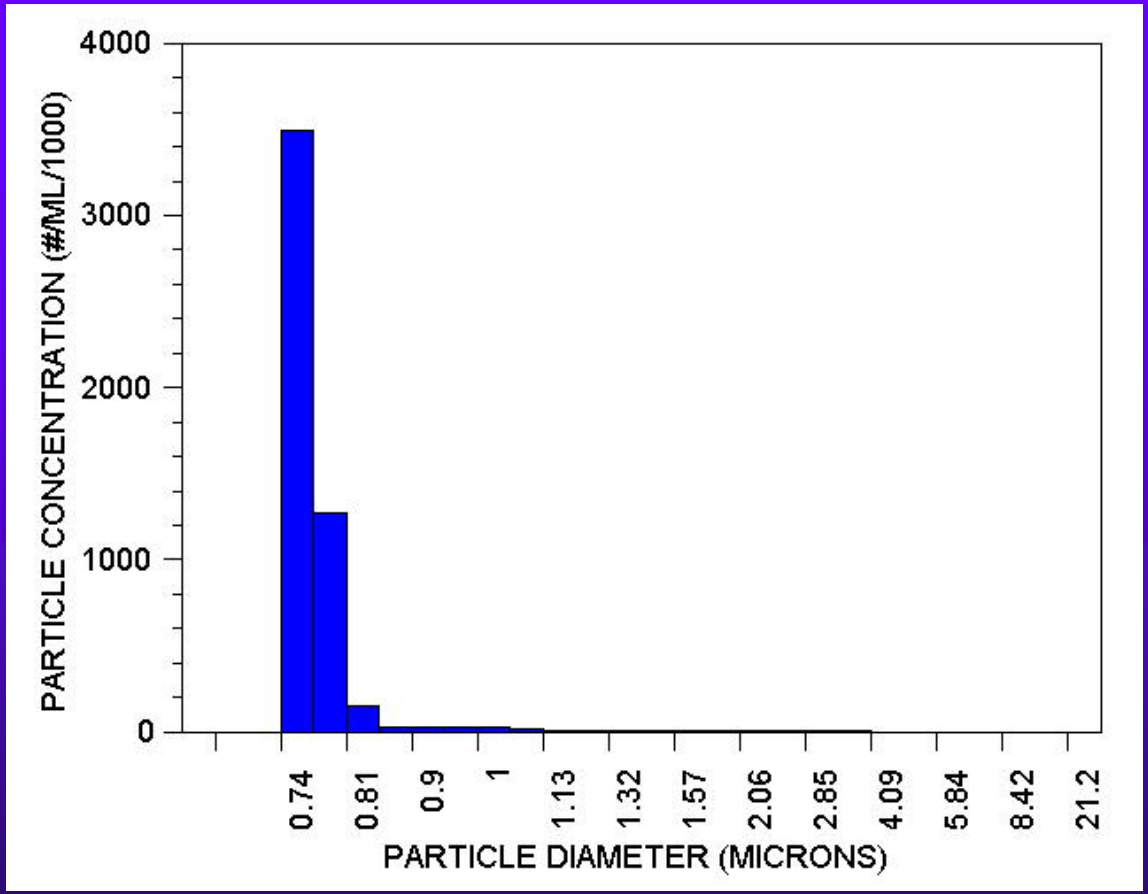
... the Key to Determining CMP Slurry Health



Silica CMP Slurry (SS25) -- *full working concentration*
Y-Axis expanded 20× to emphasize large-particle outliers

High Sensitivity to Outliers …

… the Key to Determining CMP Slurry Health

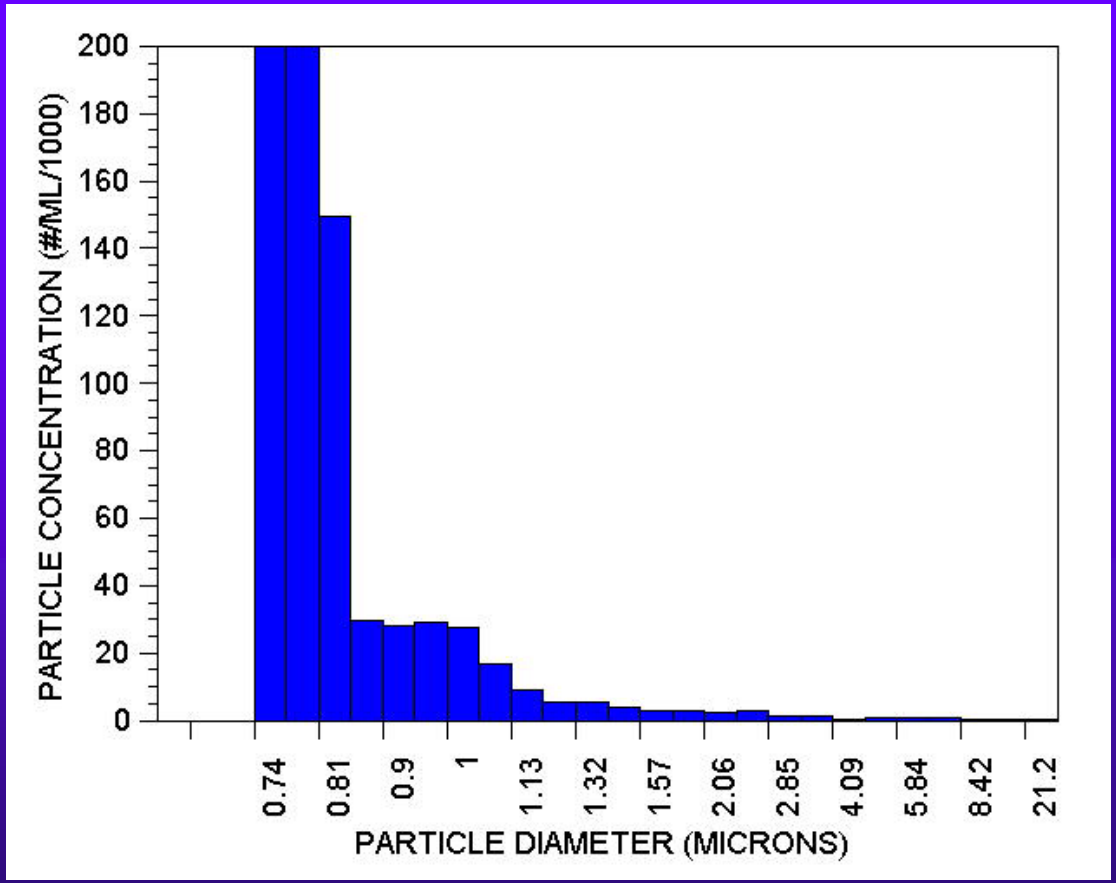


Silica CMP Slurry (SS25) -- *full working concentration*

"Spike" of 1-μm latex particles added to raw slurry ($\approx 1.3 \times 10^5$ /ml)

High Sensitivity to Outliers ...

… the Key to Determining CMP Slurry Health



Silica CMP Slurry (SS25) -- *full working concentration*

"Spike" of 1-μm latex particles (≈ 0.5 ppm) added to raw slurry

Y-Axis expanded 20× to emphasize the added latex spike

High Sensitivity to Outliers …

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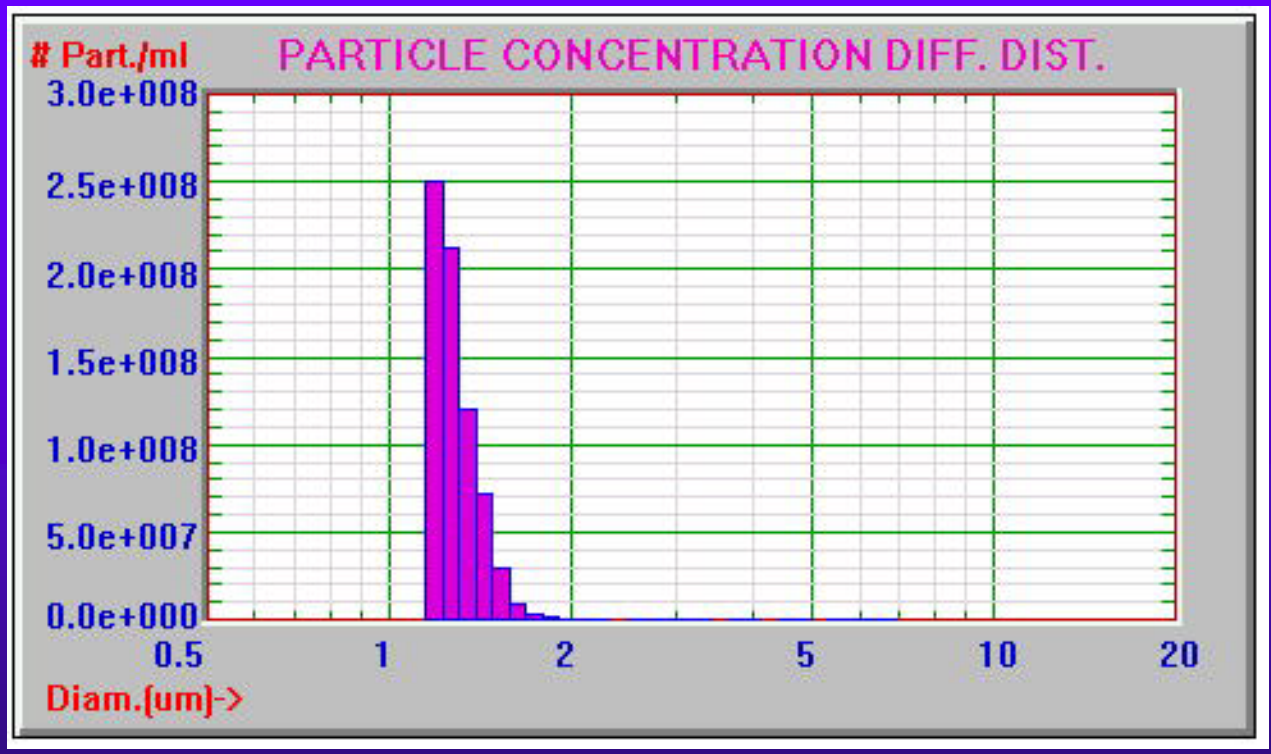
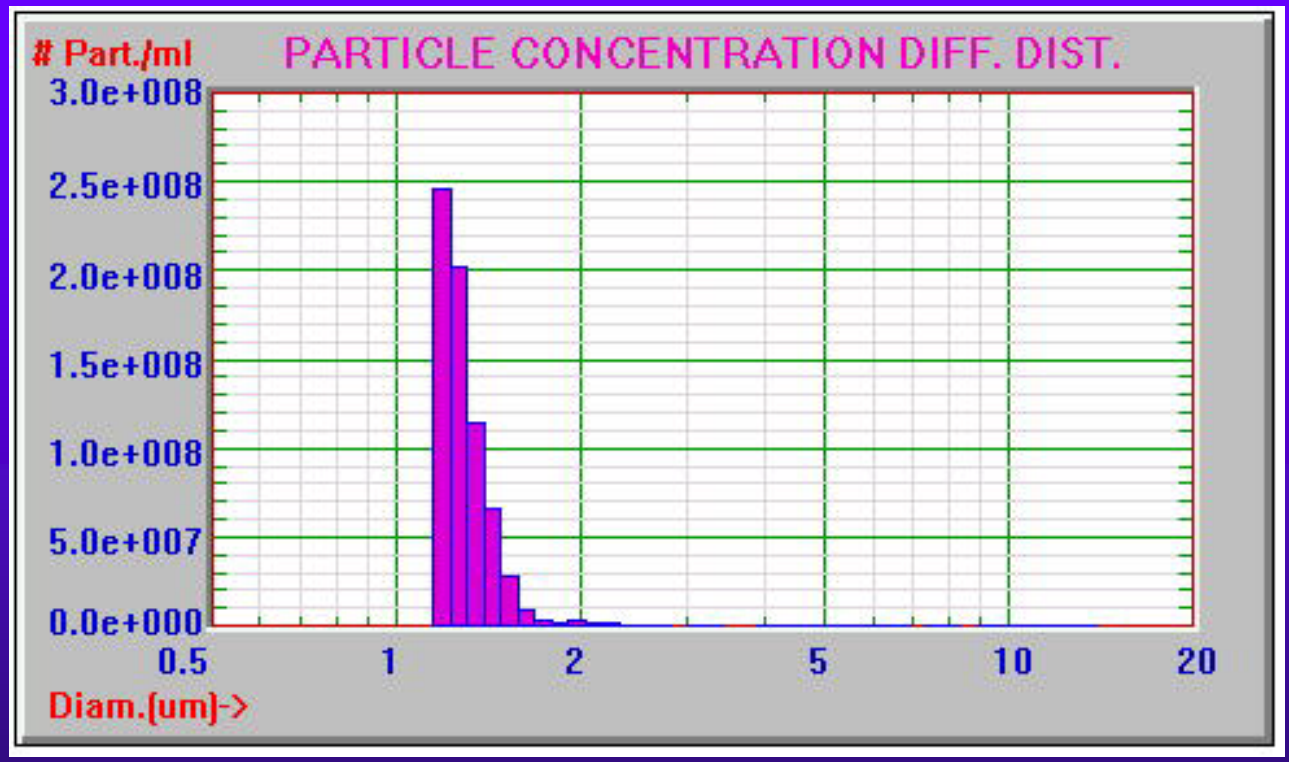


Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution

$\approx 7 \times 10^8$ particles/ml larger than 1.15-µm in starting slurry

High Sensitivity to Outliers …

… the key to Determining CMP Slurry Health

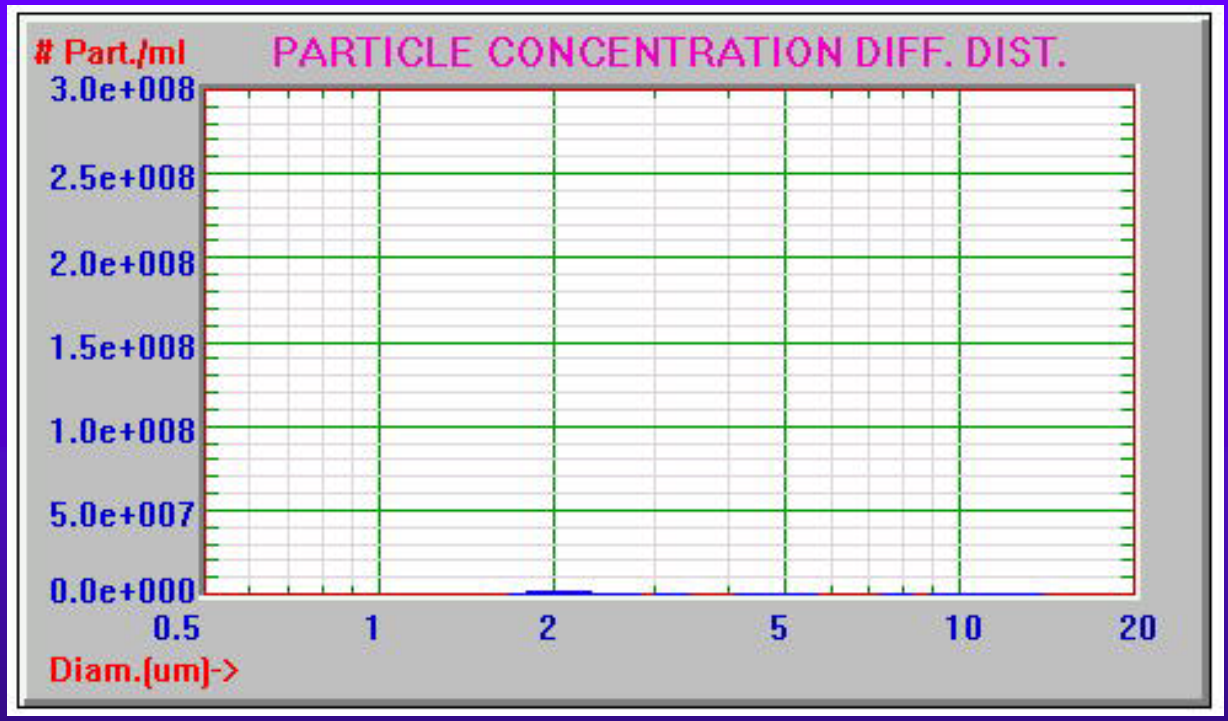


Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution

"Spike" of 2.013-µm latex particles added to slurry ($\approx 9 \times 10^6$ /ml)

High Sensitivity to Outliers …

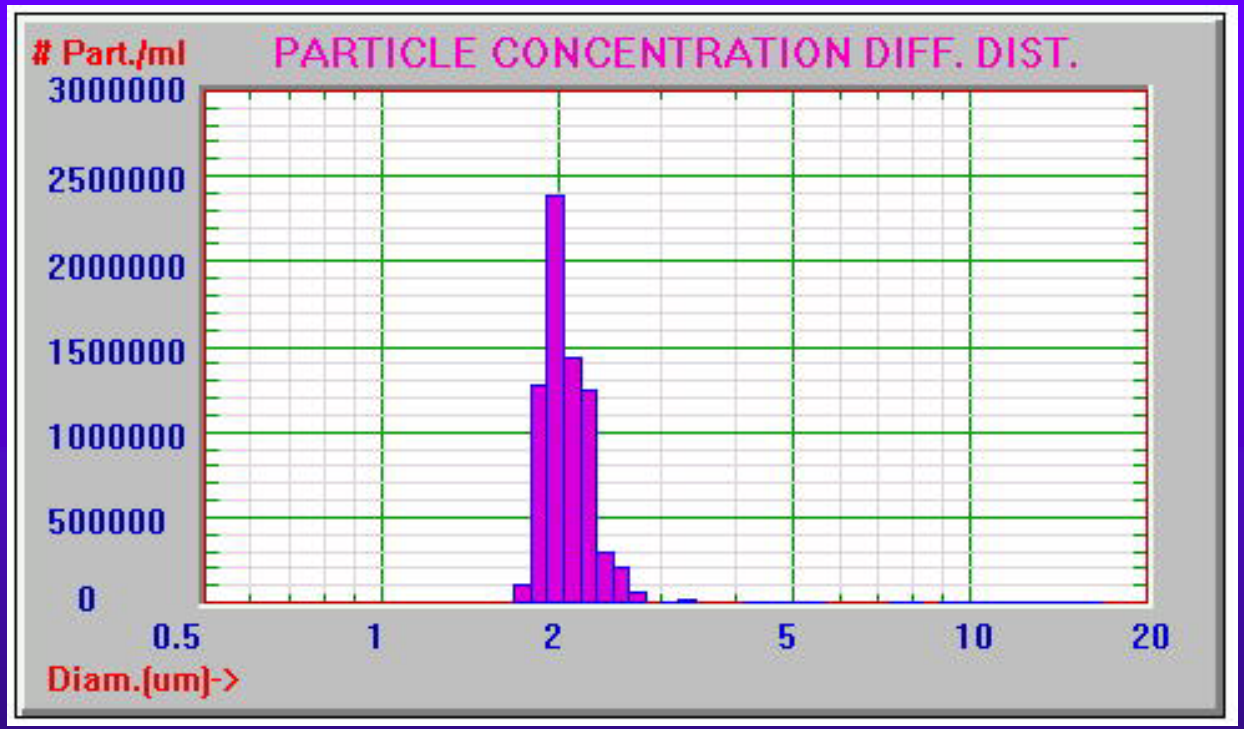
… the Key to Determining CMP Slurry Health



Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution
Result of subtracting plain-slurry PSD from spiked-slurry PSD

High Sensitivity to Outliers …

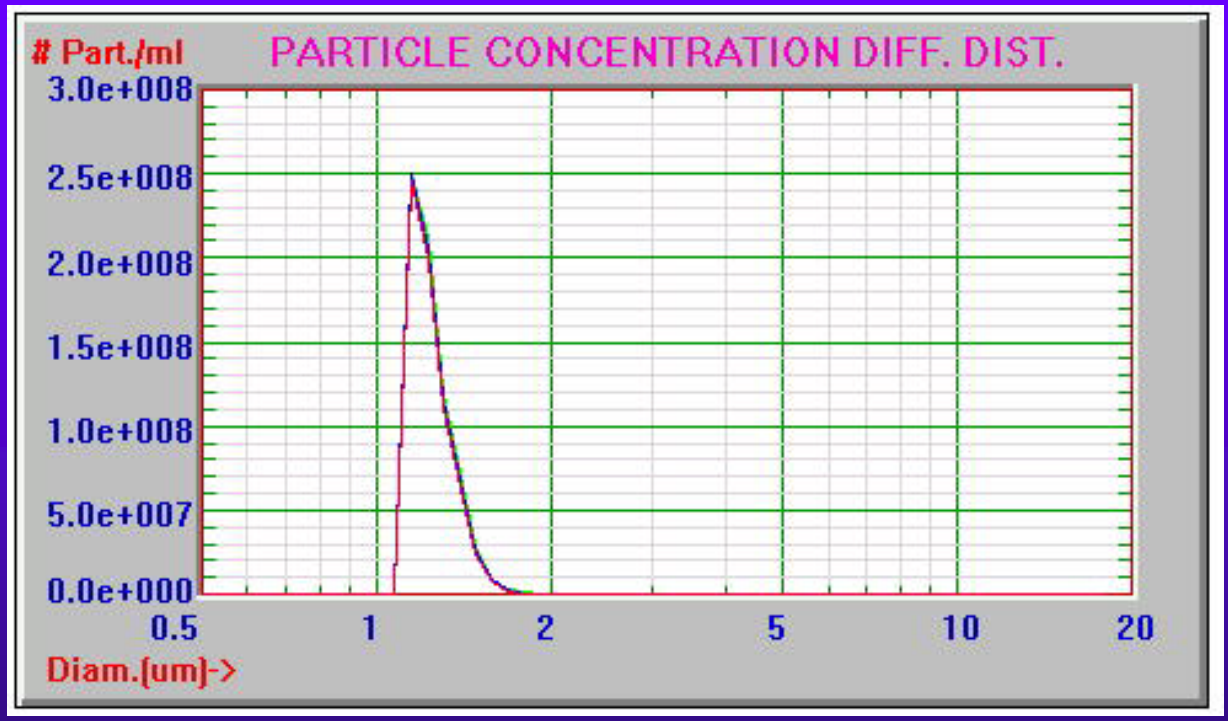
… the Key to Determining CMP Slurry Health



Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution
Result of subtracting plain-slurry PSD from spiked-slurry PSD
Y-Axis expanded 100× Spike conc. ≈ 7×10^6 /ml

High Reproducibility ...

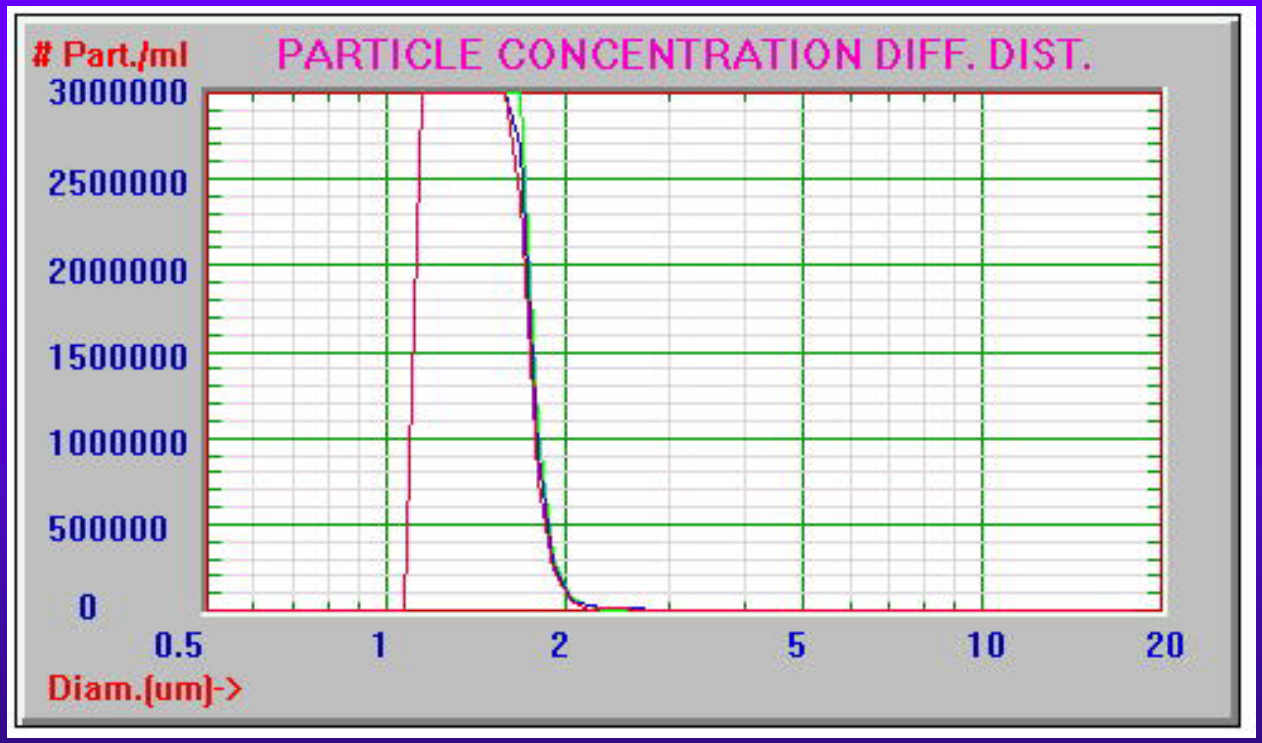
… the Key to Reliable AccuSizer $_{FX}$ Measurements



Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution
Overlay of four consecutive measurements (120-sec each)

High Reproducibility ...

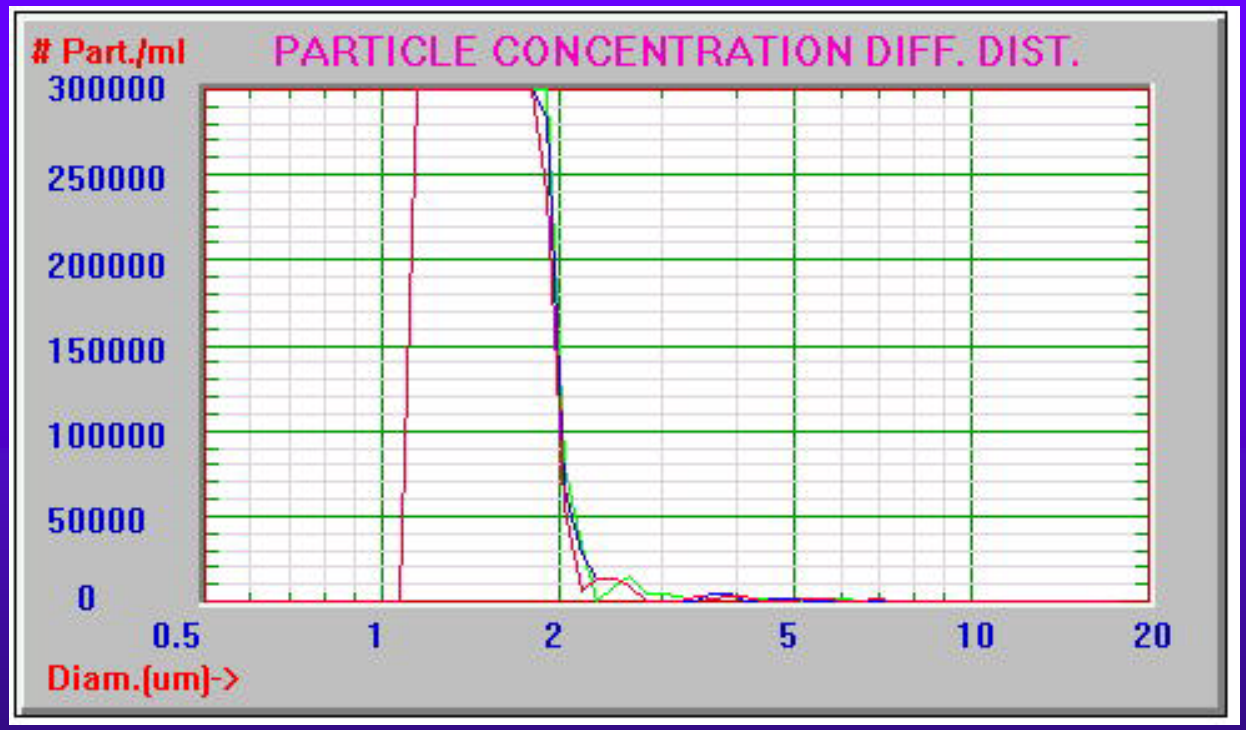
… the Key to Reliability of AccuSizer $_{FX}$ Results



Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution
Overlay of four consecutive measurements (120-sec each)
Y-Axis expanded 100×

High Reproducibility ...

… the Key to Reliability of AccuSizer $_{FX}$ Results



Cerium Oxide CMP Slurry (Hi8005) -- 160:1 dilution
Overlay of four consecutive measurements (120-sec each)
Y-Axis expanded an additional 10× (total: 1000×)

AccuSizer *FX*

High Sensitivity at High Concentration ...
... a powerful (and unique) combination!

- The AccuSizer$_{FX}$: **The KEY to QUALITY**
  - When particles several standard deviations away from the mean diameter of the distribution spell disaster (low yield) ... COUNT on the AccuSizer$_{FX}$ to detect and quantify them. The first step in solving a problem is identifying its root cause.

  - AccuSizer™ - Trademark of Particle Sizing Systems
  - *FX* Technology - Patents Pending