

*n*PCD

NanoParticle Collection Device for Ultra-Pure Water

*New Analytical tool for Rapid Identification of
Sub-50 Nanometer Elemental Contamination*

David Blackford, PhD, Fluid Measurement Technologies Inc

Art Ackermann, PE, Microfier, Inc.

Glen Wildermuth, PE, Microfier, Inc.

Sarah Schoen, PhD, Balazs NanoAnalysis

Acknowledgements

- ITRS Committee
- Participating Fabs
- Balazs NanoAnalysis
- Lighthouse Worldwide Solutions
(Nanocount 50)

Existing Particle Metrology Limits Front End Process Defect Reduction

"The UPW section of Table YE9 highlights the inability of particle metrology in UPW to support the targets established by the Front End Process defect targets. Further work is needed to understand particle deposition from UPW and to speciate organics in UPW."

—ITRS 2008 Update

nPCD is Designed to Address ITRS Particle Metrology Needs by:

- Capturing Particles in UPW
- Retaining and Agglomerating Particles
- Releasing Particles to SEM Membranes for Analysis

*n*PCD is Based on Fundamental Physics

- **Ultra-Pure Water is relatively non-conductive so we can establish an electric field in it**
- **Majority of particles in ultra-pure water have electrical charge**
- **Using proper electrical and hydraulic design, *n*PCD removes particles from ultra-pure water**

Electrical Design of the *n*PCD

Electromagnetic Field moves charged particles through UPW

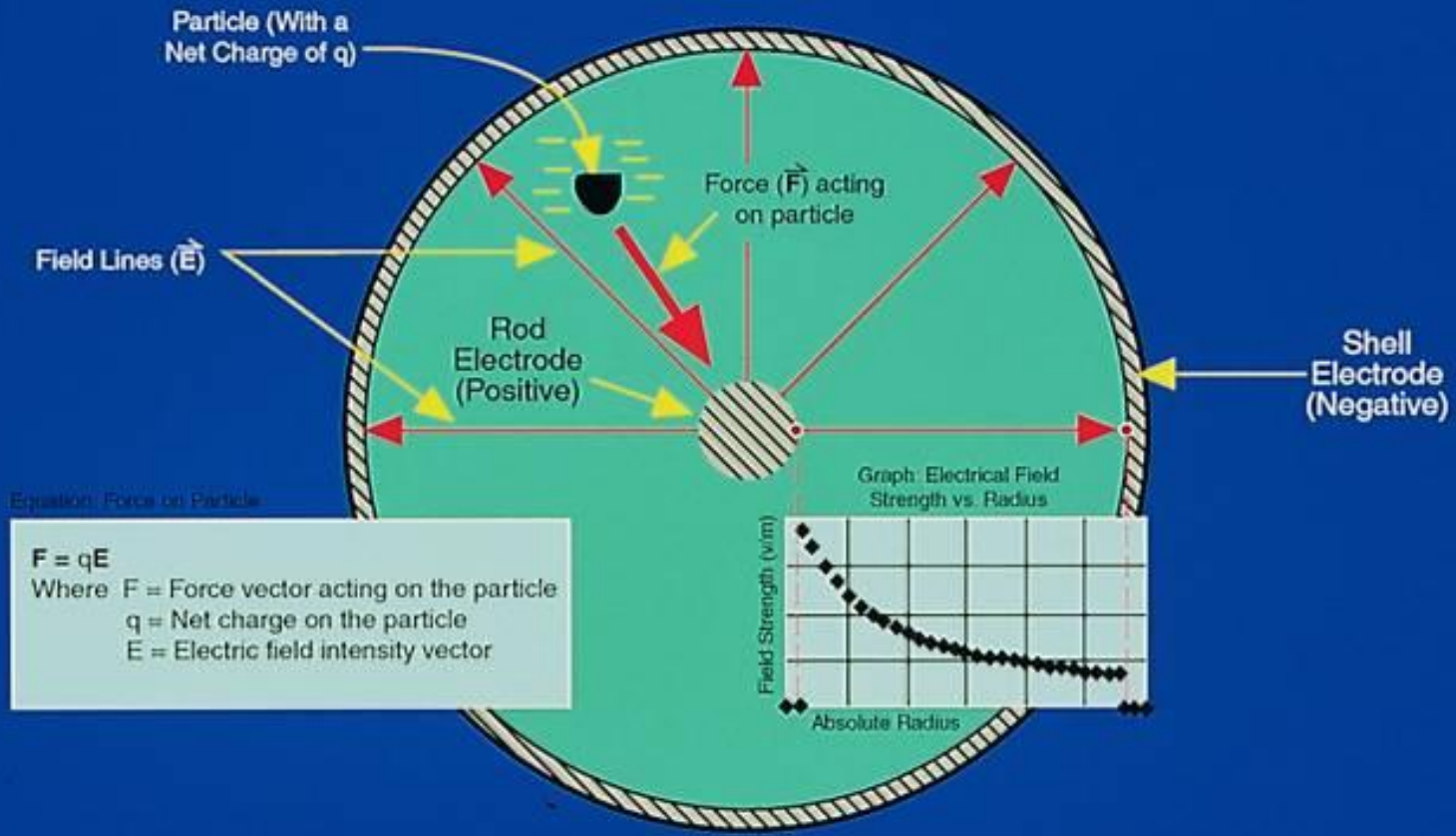


Figure 1

Hydraulic Design of the *n*PCD

Laminar Flow and Radial Separation Efficiently Capture Particles

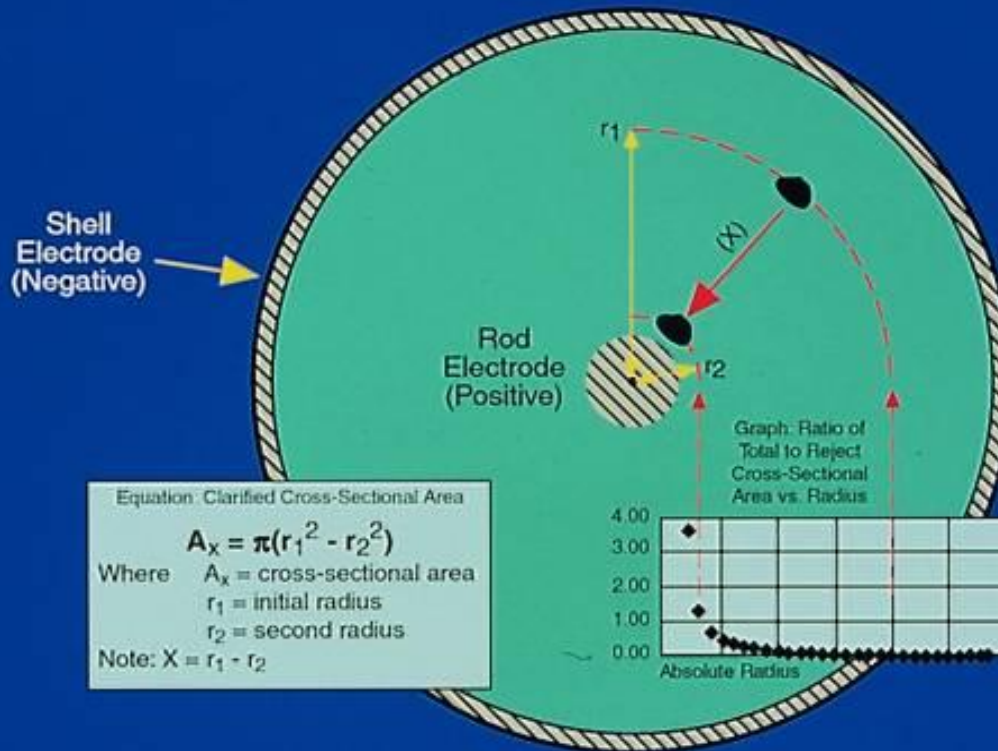
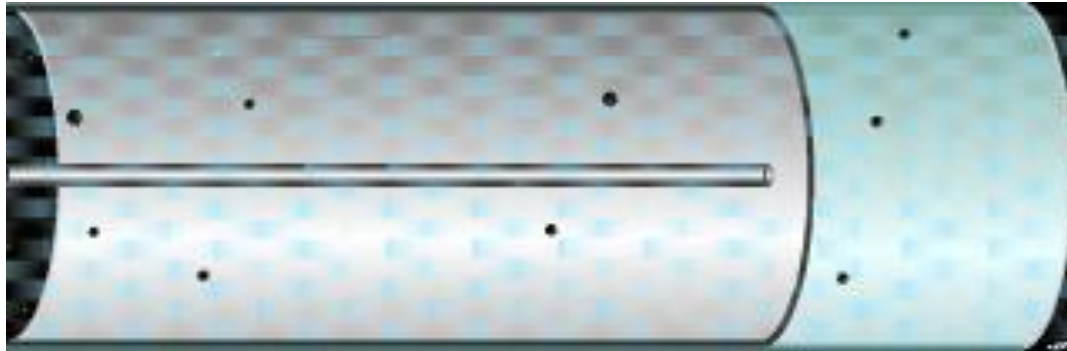


Figure 2

11-9068-Q34.13

The rod captures nanoparticles, then ejects them as larger agglomerates for collection on a membrane.



Traditional 0.1 Micron Sample Membranes Collect Concentrated Contamination for SEM/EDS Analysis

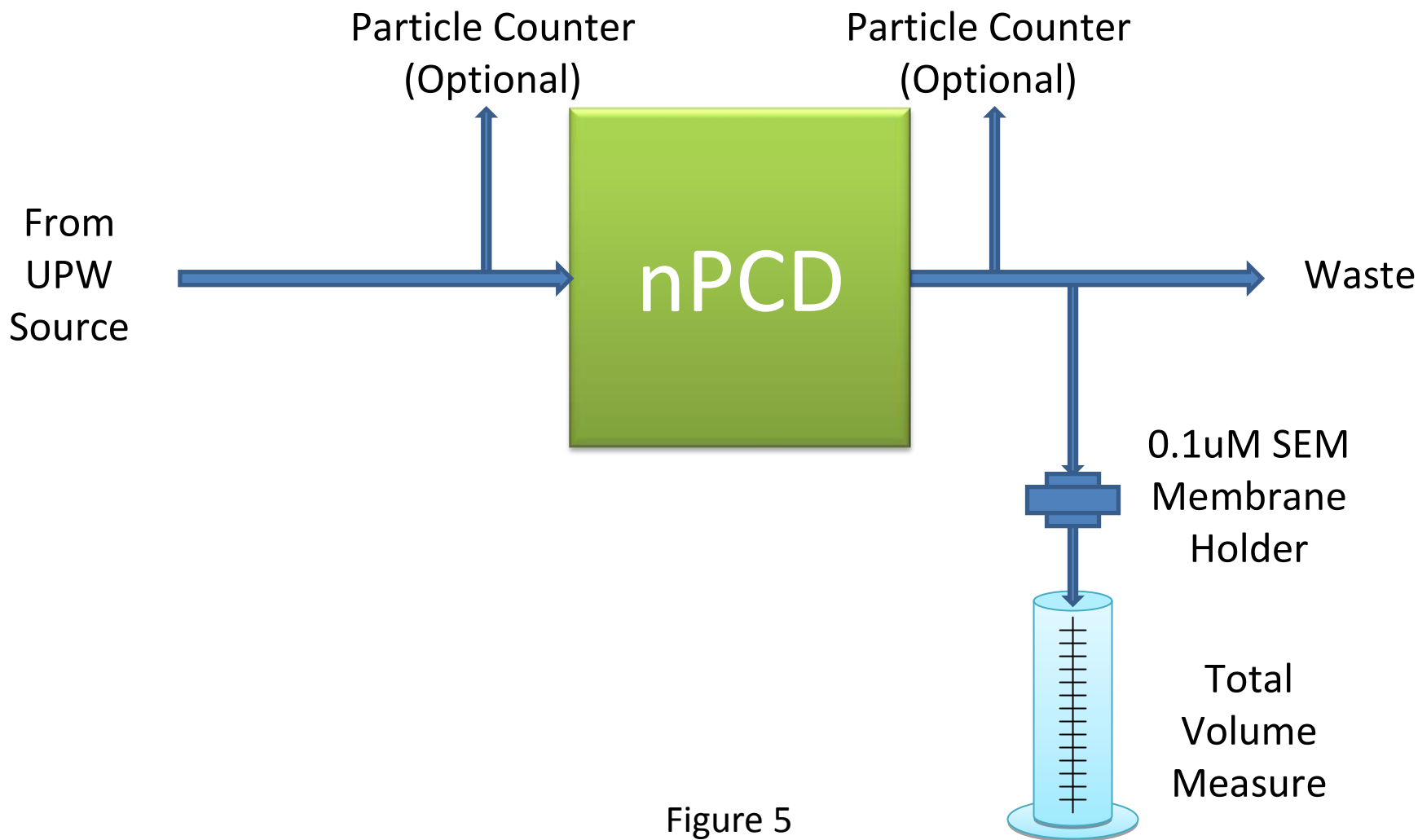


Figure 5

nPCD is Built for UPW Service

Separate Boxes Contain Wetted and Electrical Systems

Wetted Materials Include PFA, PVDF, and Electropolished 316L Stainless Steel



Figure 6

*n*PCD Agglomerates Sub-50 Nanometer Particles

PMS SO2 Laser Particle Counter

51 Hours of Capture

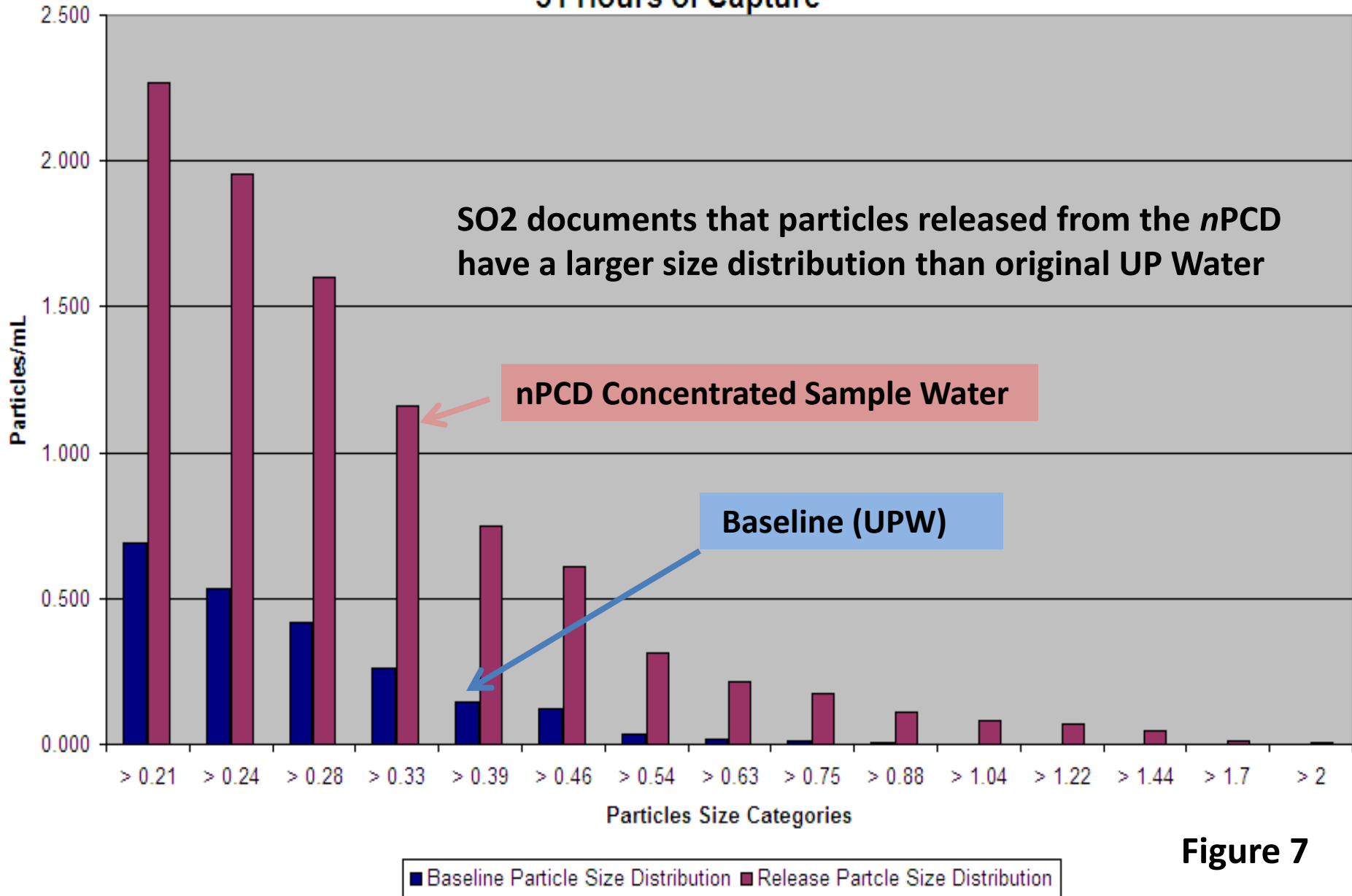
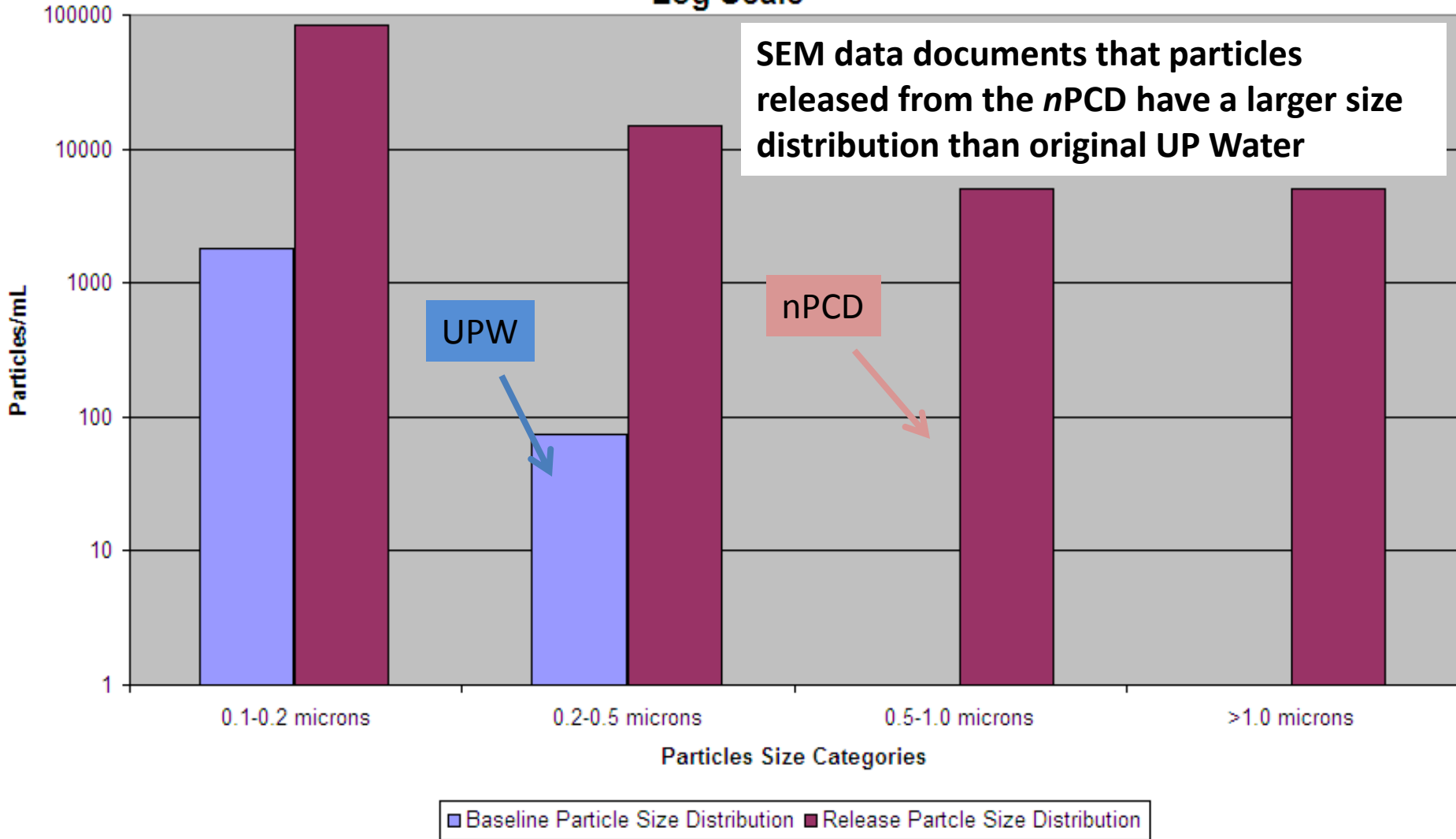


Figure 7

*n*PCD Agglomerates Sub-50 Nanometer Particles

SEM Membrane Particle Data
Capture Time of 44.3 Hours

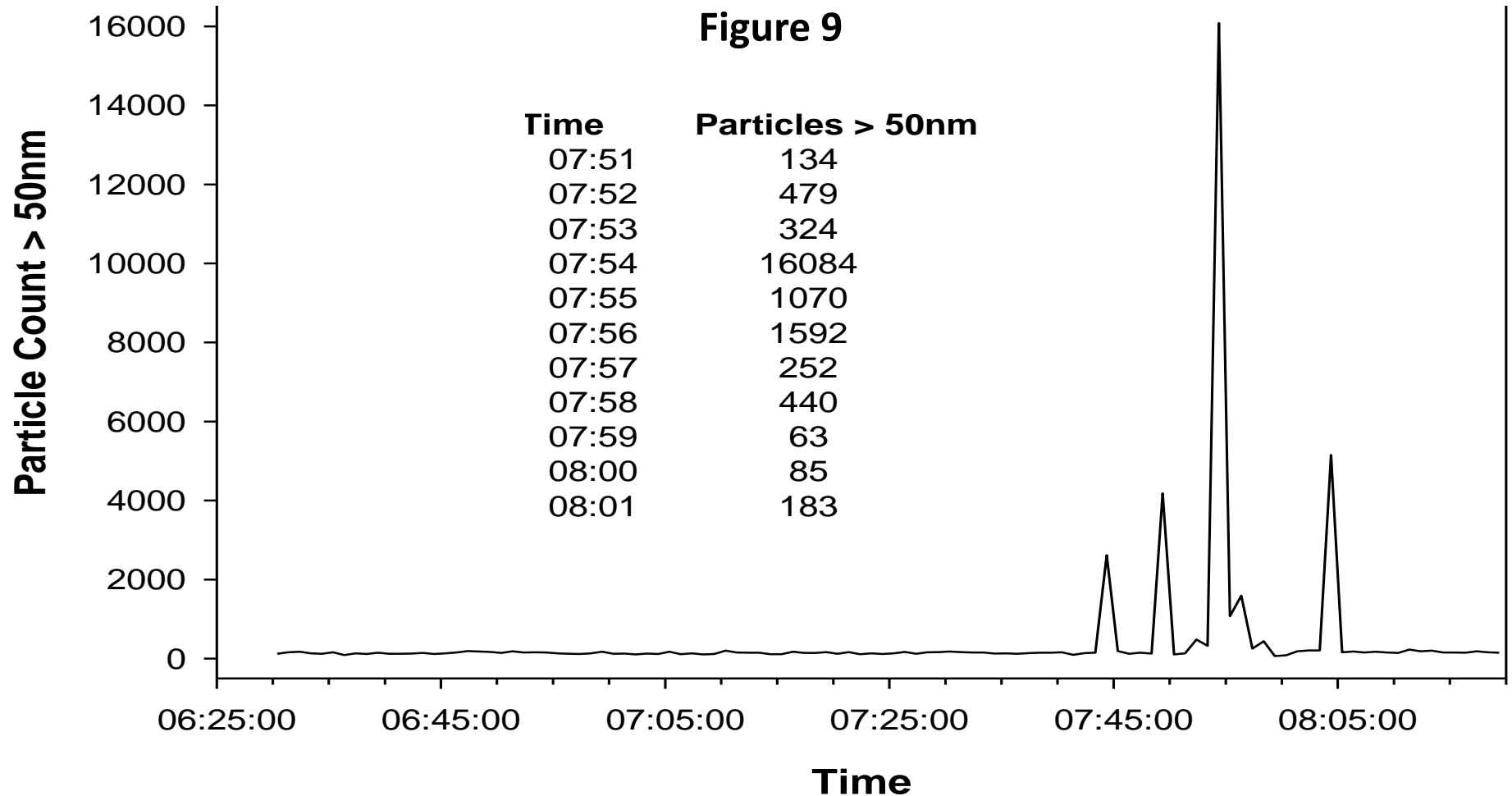
Log Scale



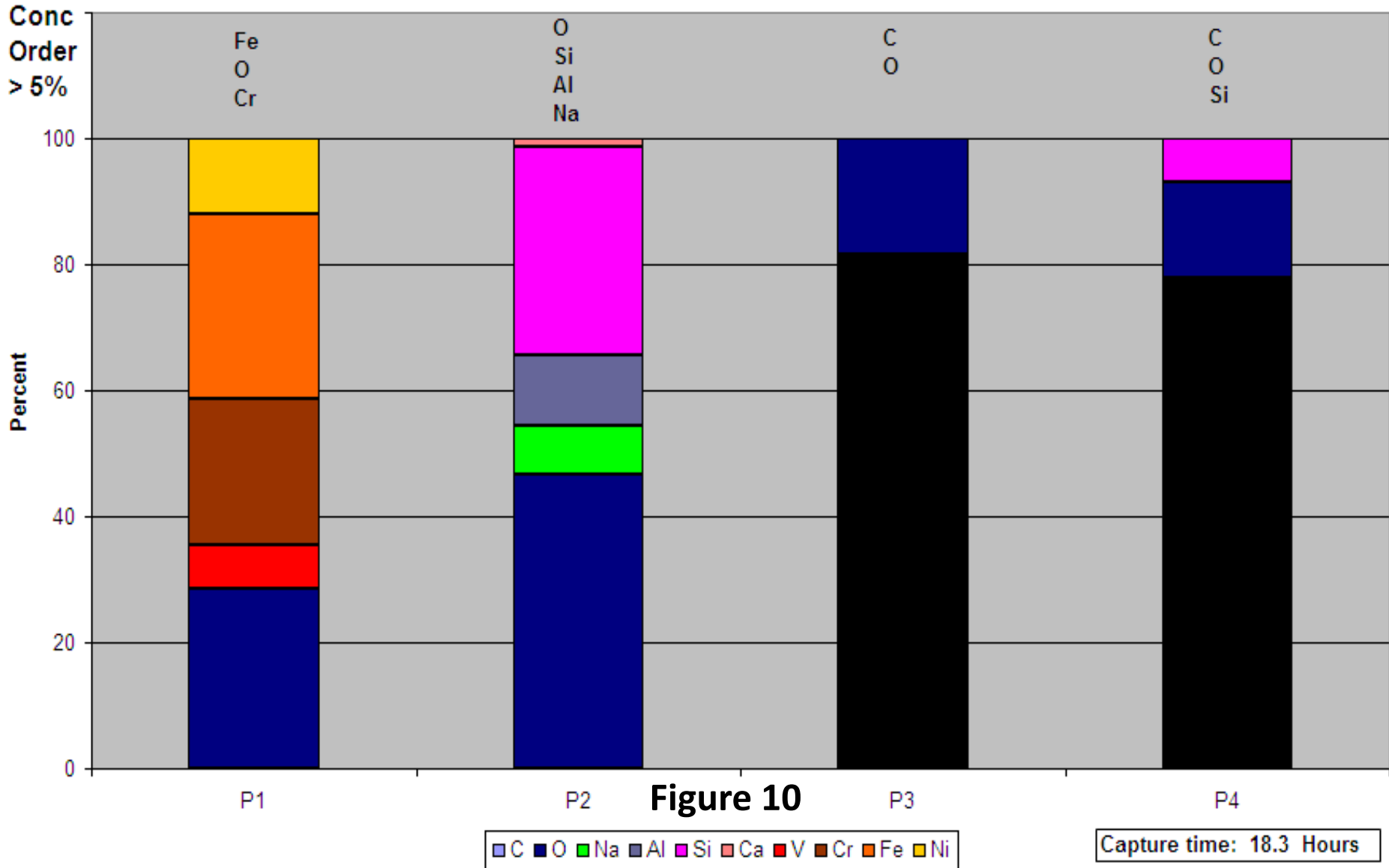
Laser Particle Counter Documented Agglomerated Particles Were Released from the *nPCD* during ITRS Round Robin Testing

All Particles Greater than 50 Nanometers (Nanocount 50)

Figure 9



nPCD Identified Elemental Composition of UPW Particles during ITRS Round Robin
 Percent Elemental Concentration in Particles



*n*PCD Testing Identified a Large Variety of Elements in UPW

- **Carbon**
- **Nitrogen**
- **Oxygen**
- **Fluorine**
- **Sodium**
- **Magnesium**
- **Aluminum**
- **Silica**
- **Phosphorus**
- **Sulfur**
- **Chloride**
- **Potassium**
- **Calcium**
- **Titanium**
- **Vanadium**
- **Chromium**
- **Iron**
- **Nickel**
- **Zinc**
- **Bromine**
- **Antimony**

*n*PCD Testing Identified the Most Common Nano-Contaminants in UPW

- **Carbon/Oxygen**
- **Silica /Oxygen/Aluminum**
- **Iron/Chromium/Nickel/Oxygen**
- **Fluorine/Carbon/Oxygen**

nPCD Collects Particles for Visual and Elemental Analysis

Carbon Particle – Bacterial Shape

Area 1
Edge
Spot 3



Signal A = SE1



Mag = 21.95 K X
2 μm

WD = 8.5 mm
EHT = 20.00 kV

Date :21 Sep 2009
Time :10:28:05



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nPCD Collects Particles for Visual and Elemental Analysis

Carbon Particle – Biological Material

Area 1
Spot 9

= 4.901 μm

Signal A = SE1

Mag = 20.43 K X
1 μm

WD = 7.0 mm
EHT = 20.00 kV

Date :19 Aug 2009
Time :10:50:19

 AIR LIQUIDE
11/5/2009

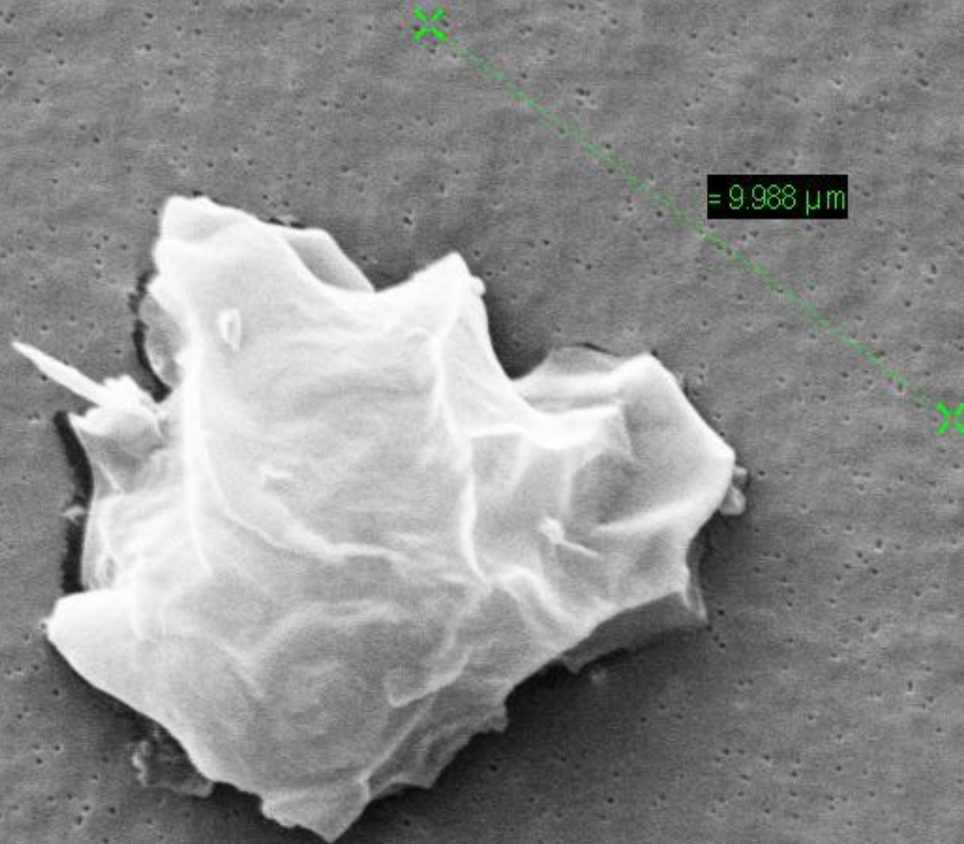
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nPCD Collects Particles for Visual and Elemental Analysis

Silica/Oxygen Particle

Area 1
Edge
Spot 5



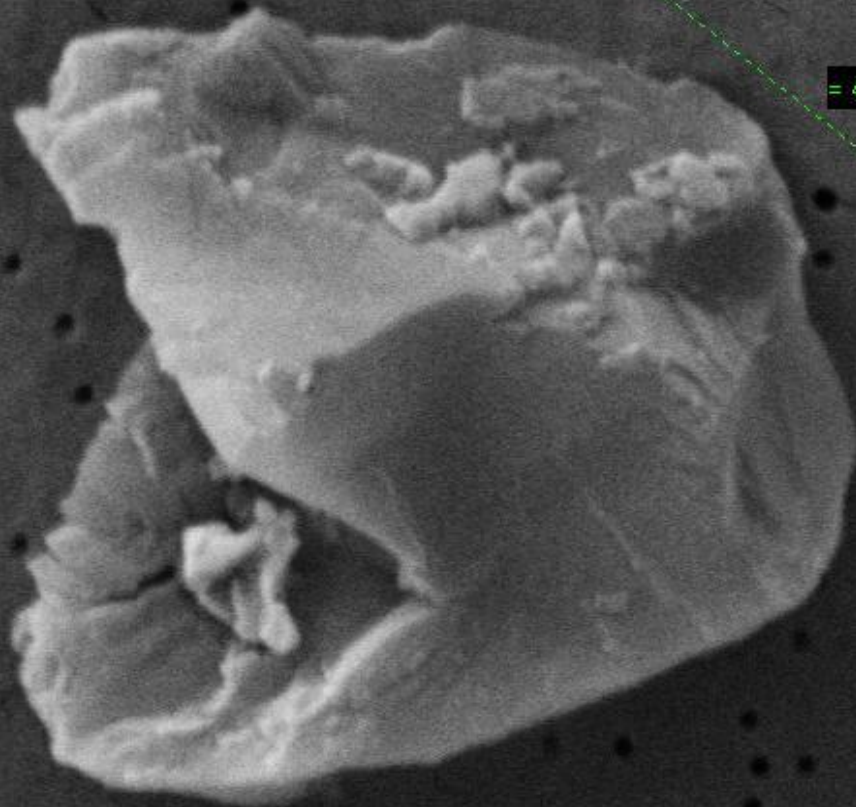
Signal A = SE1

nPCD Collects Particles for Visual and Elemental Analysis

Silica/Aluminum/Potassium/Oxygen Particle

Area 2

Spot 4



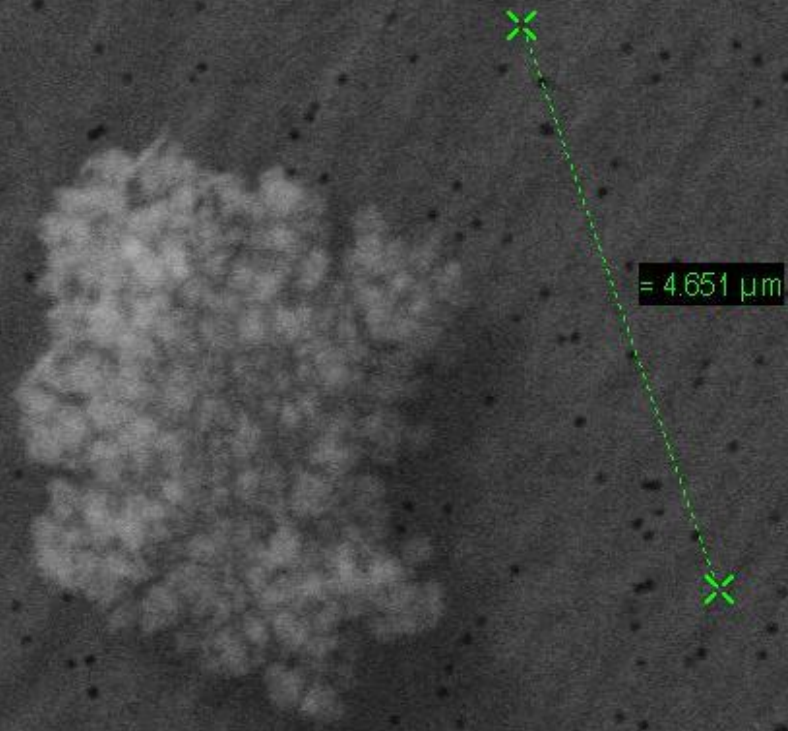
= 4.040 μm

Signal A = SE1

nPCD Collects Particles for Visual and Elemental Analysis

Iron/Chrome/Nickel/Oxygen Particle – Type One

Area 2
Filter Center
Particle 5



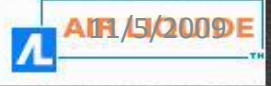
Signal A = SE1

Mag = 21.23 K X
1 μm

WD = 8.0 mm
EHT = 20.00 kV
Fluid Measurement Technologies Inc

Date :5 Aug 2009
Time :14:47:00

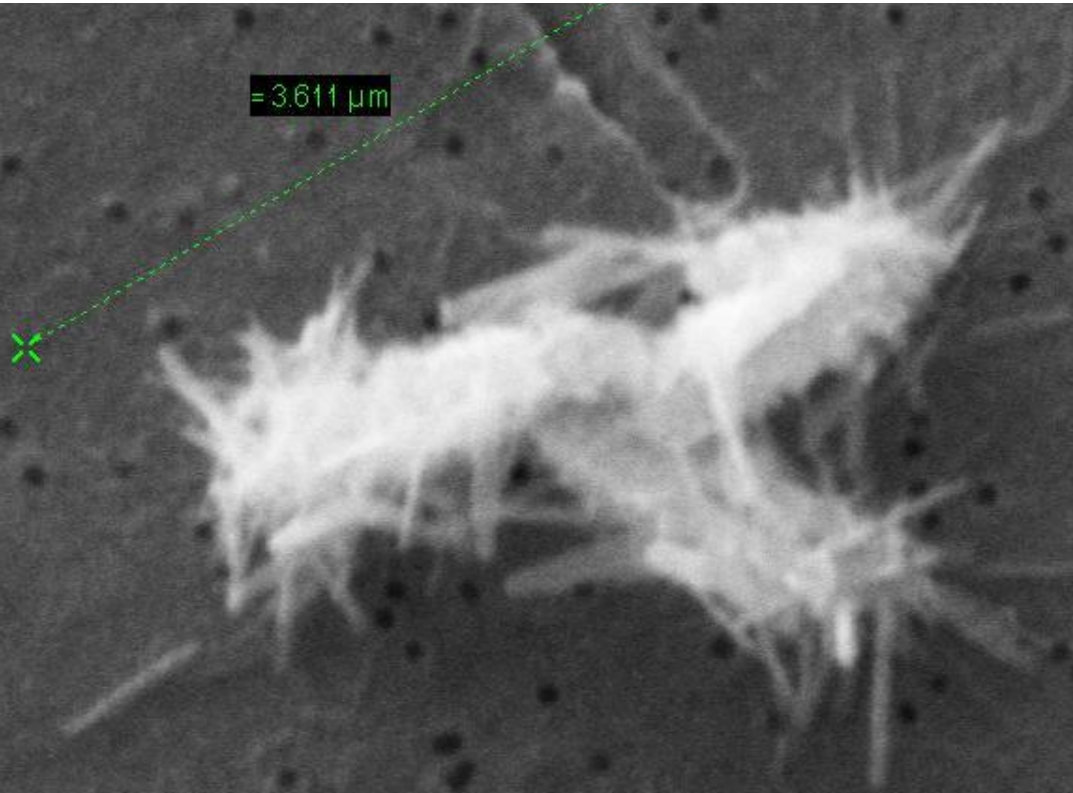
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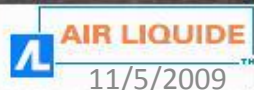
nPCD Collects Particles for Visual and Elemental Analysis

Iron/Chrome/Oxygen Particle – Type Two

Area 1
Filter Edge
Particle 4



Signal A = SE1



Mag = 42.48 K X
1 µm

WD = 8.0 mm
EHT = 20.00 kV

Date : 7 Aug 2009
Time : 9:44:55



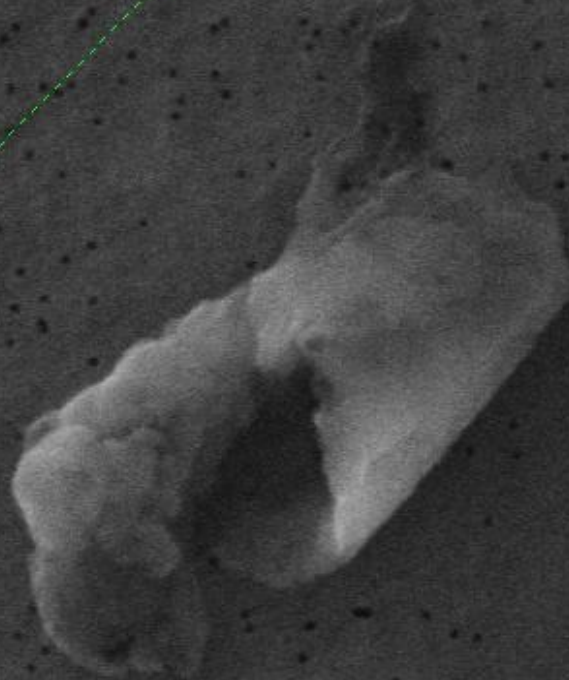
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nPCD Collects Particles for Visual and Elemental Analysis

Fluorine/Carbon/Oxygen Particle

Area 2
Center
Spot 7

= 6.212 μm



Signal A = SE1

Mag = 17.39 K X
1 μm

WD = 8.0 mm
EHT = 20.00 kV
Fluid Measurement Technologies Inc

Date : 2 Sep 2009
Time : 9:46:26



The *nPCD* Is a New Analytical Tool That Rapidly Identifies Sub-50 nm Elemental Contamination.

- Captures and Agglomerates Particles below 50 nm
- Enables visible and elemental identification of contamination
- Leverages and enhances proven SEM/EDS analysis
- Supports particle concentration and mass data calculation
- Provides fast and actionable data
- Standardizes data between process points and facilities

nPCD Supports the ITRS 2008 Front End Process Particle Metrology Needs for Ultrapure Water Process Control and Front End Defect Reduction

The next paper will provide specific elemental contaminant identification from five ITRS member fabs.