NanoParticle Collection Device for Ultra-Pure Water

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

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- Participating Fabs
- Balazs NanoAnalysis
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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

System is Designed to Address ITRS Particle Metrology Needs by:

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

Operation 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, it removes particles from ultra-pure water**

Electrical Design of the Chamber

Electromagnetic Field moves charged particles through UPW

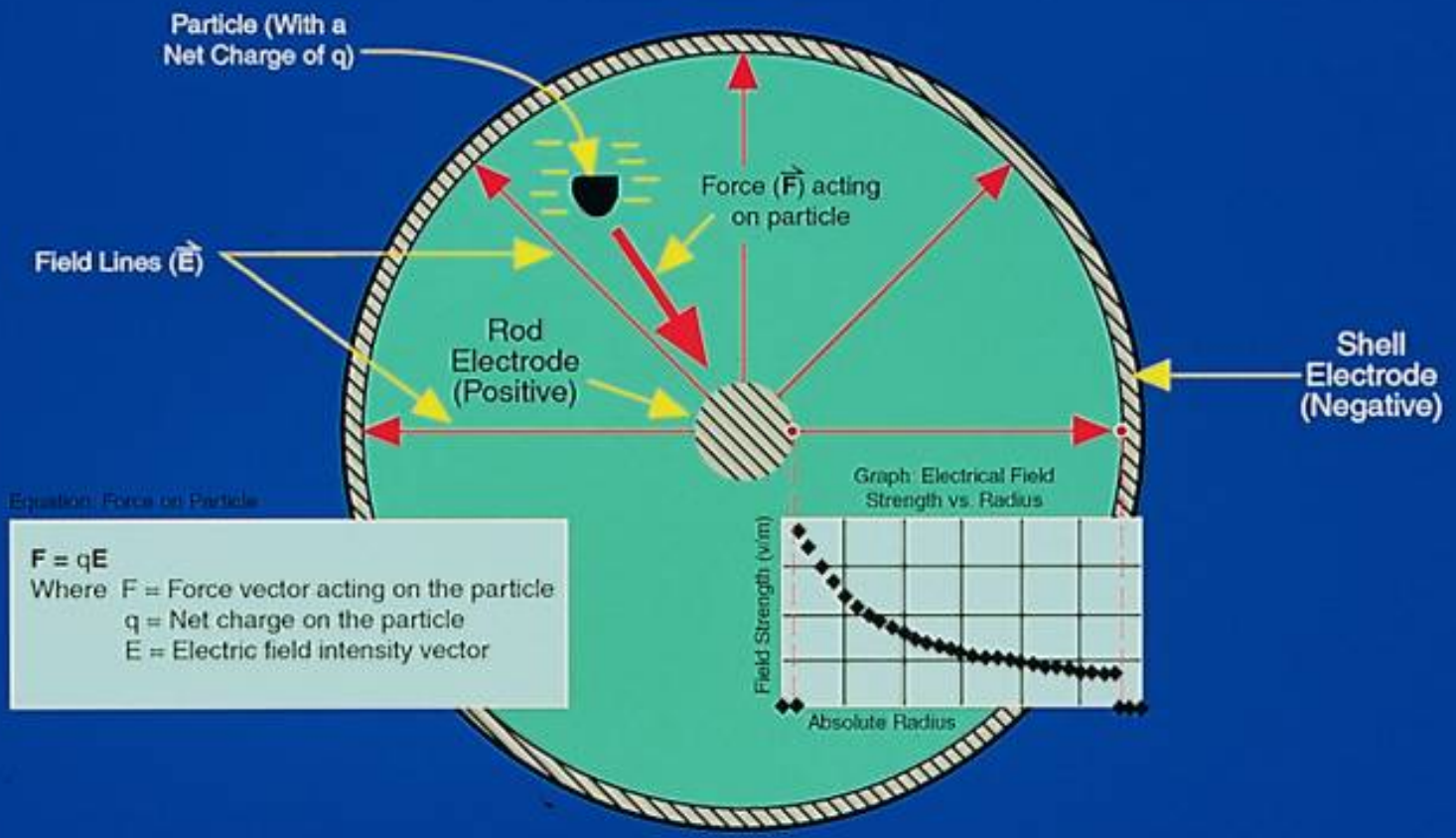

Figure 1

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Hydraulic Design of the Chamber

Laminar Flow and Radial Separation Efficiently Capture Particles

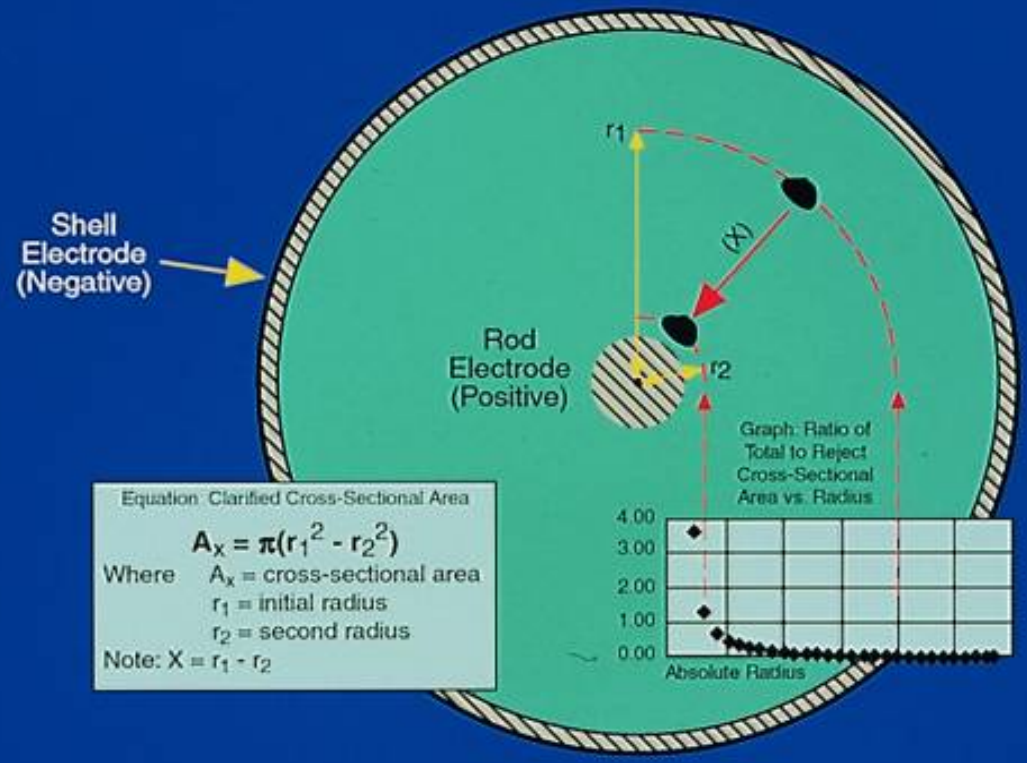
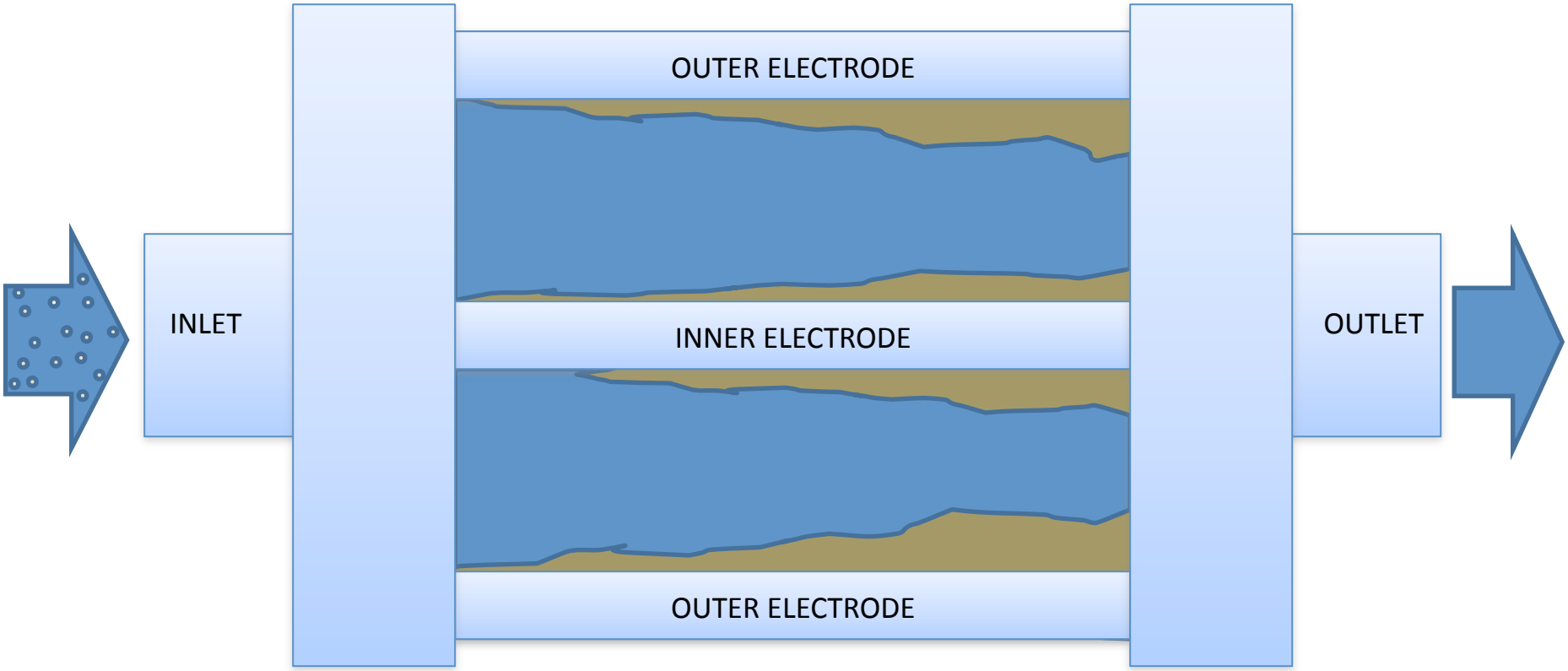
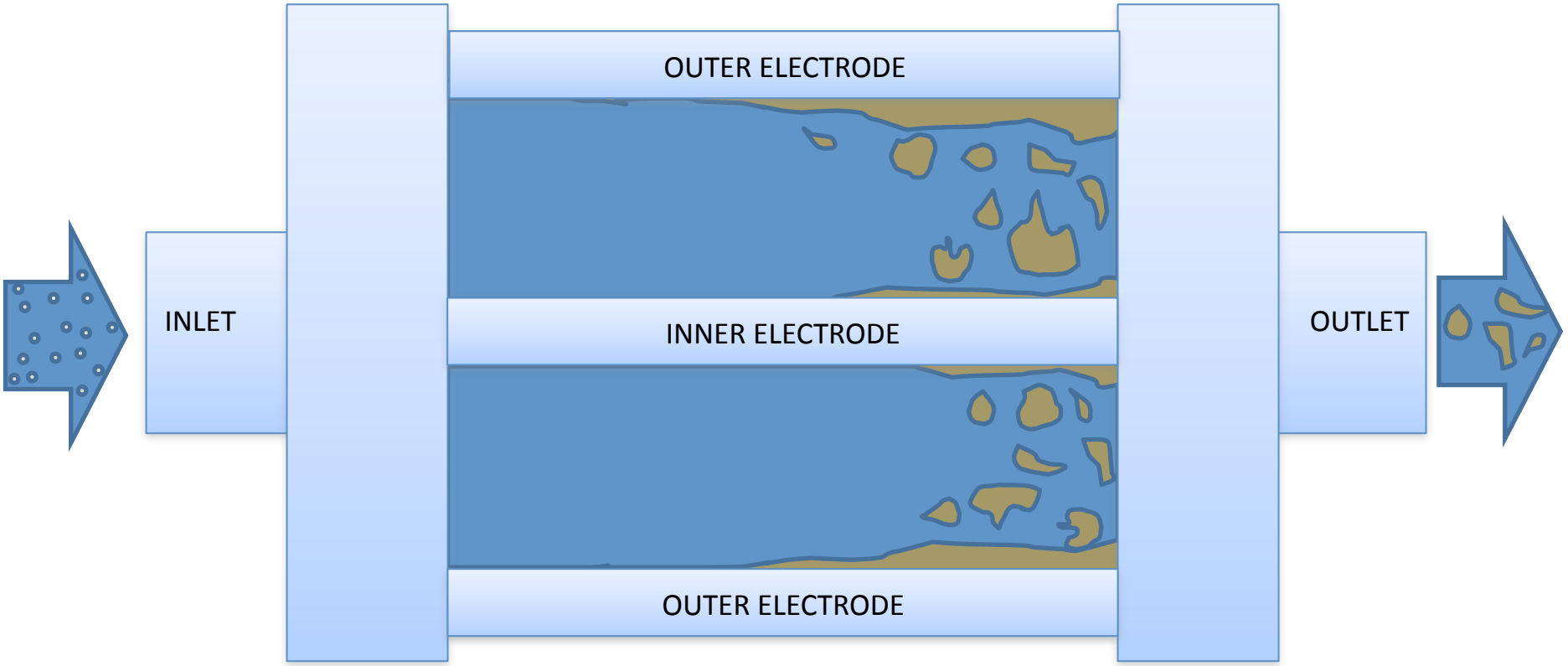


Figure 2

The Chamber Captures and Agglomerates Contamination on Electrodes



Release mode drives agglomerated contaminants back off the electrodes.



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

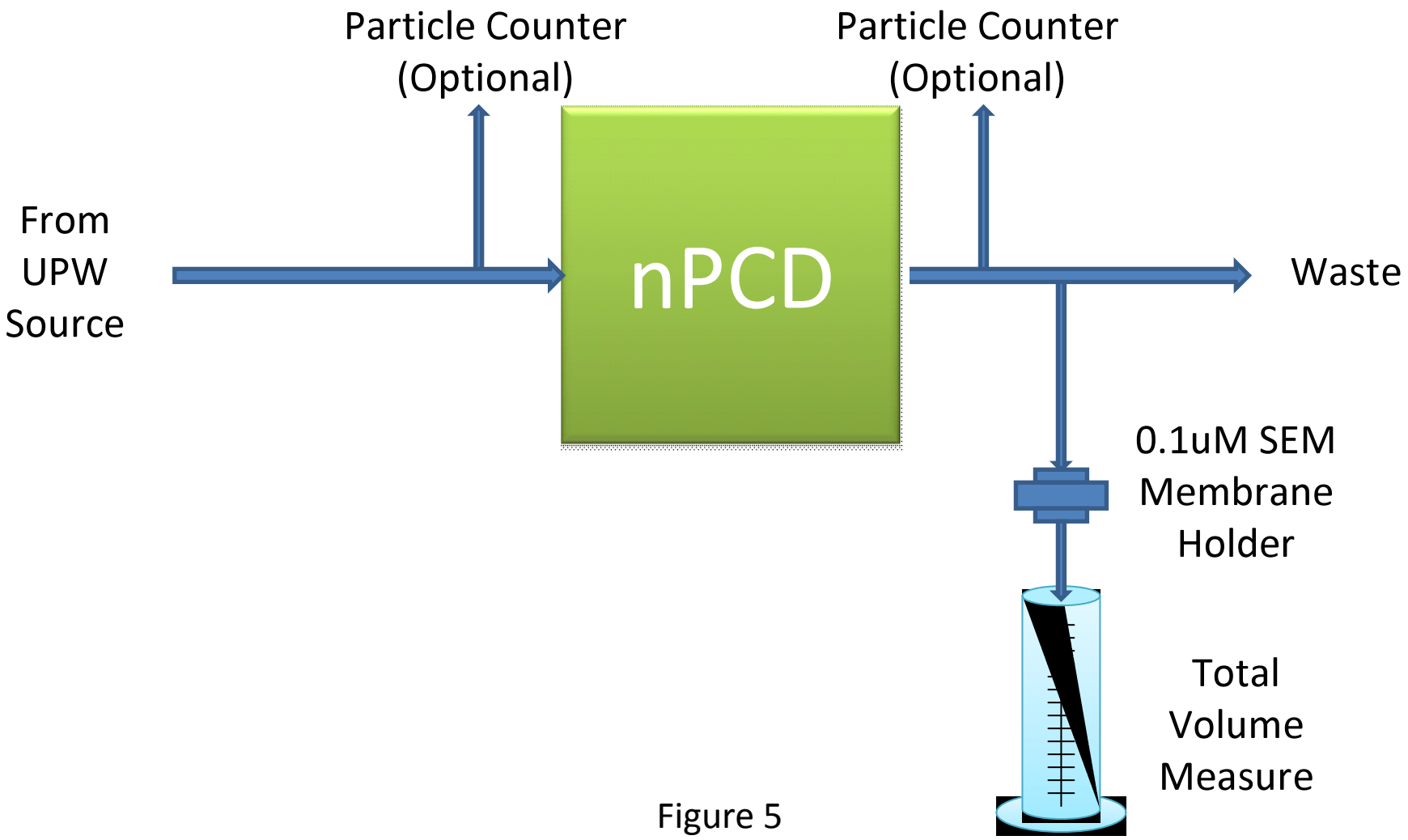


Figure 5

NanoLyzer is Built for UPW Service

Separate Boxes Contain Wetted and Electrical Systems

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

Figure 6

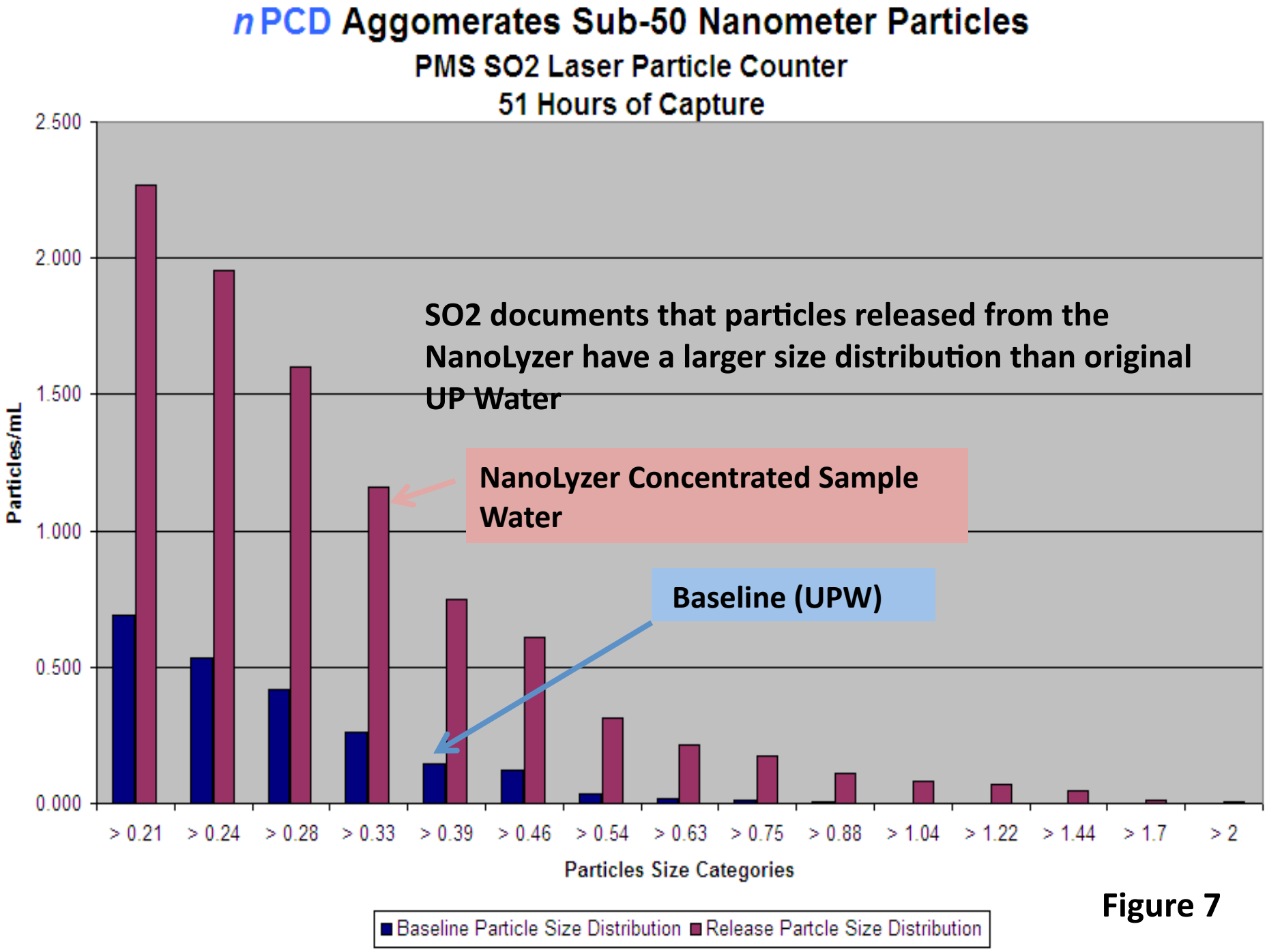
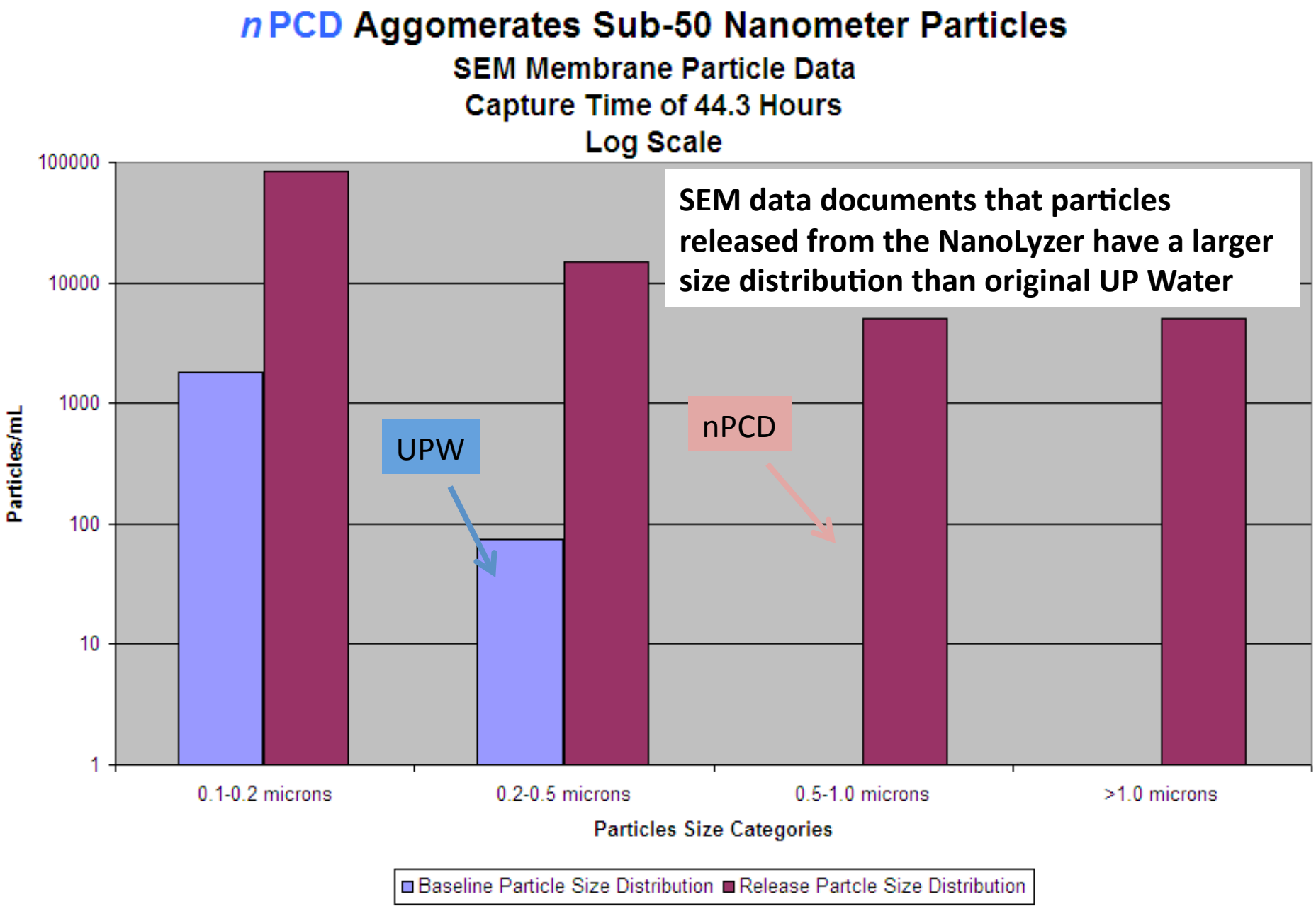

nPCD Aggomerates Sub-50 Nanometer Particles
PMS SO2 Laser Particle Counter
51 Hours of Capture
SO2 documents that particles released from the NanoLyzer have a larger size distribution than original UP Water
NanoLyzer Concentrated Sample Water
Baseline (UPW)
Particles/mL
2.500
2.000
1.500
1.000
0.500
0.000
> 0.21
> 0.24
> 0.28
> 0.33
> 0.39
> 0.46
> 0.54
> 0.63
> 0.75
> 0.88
> 1.04
> 1.22
> 1.44
> 1.7
> 2
Particles Size Categories
Baseline Particle Size Distribution
Release Partcle Size Distribution

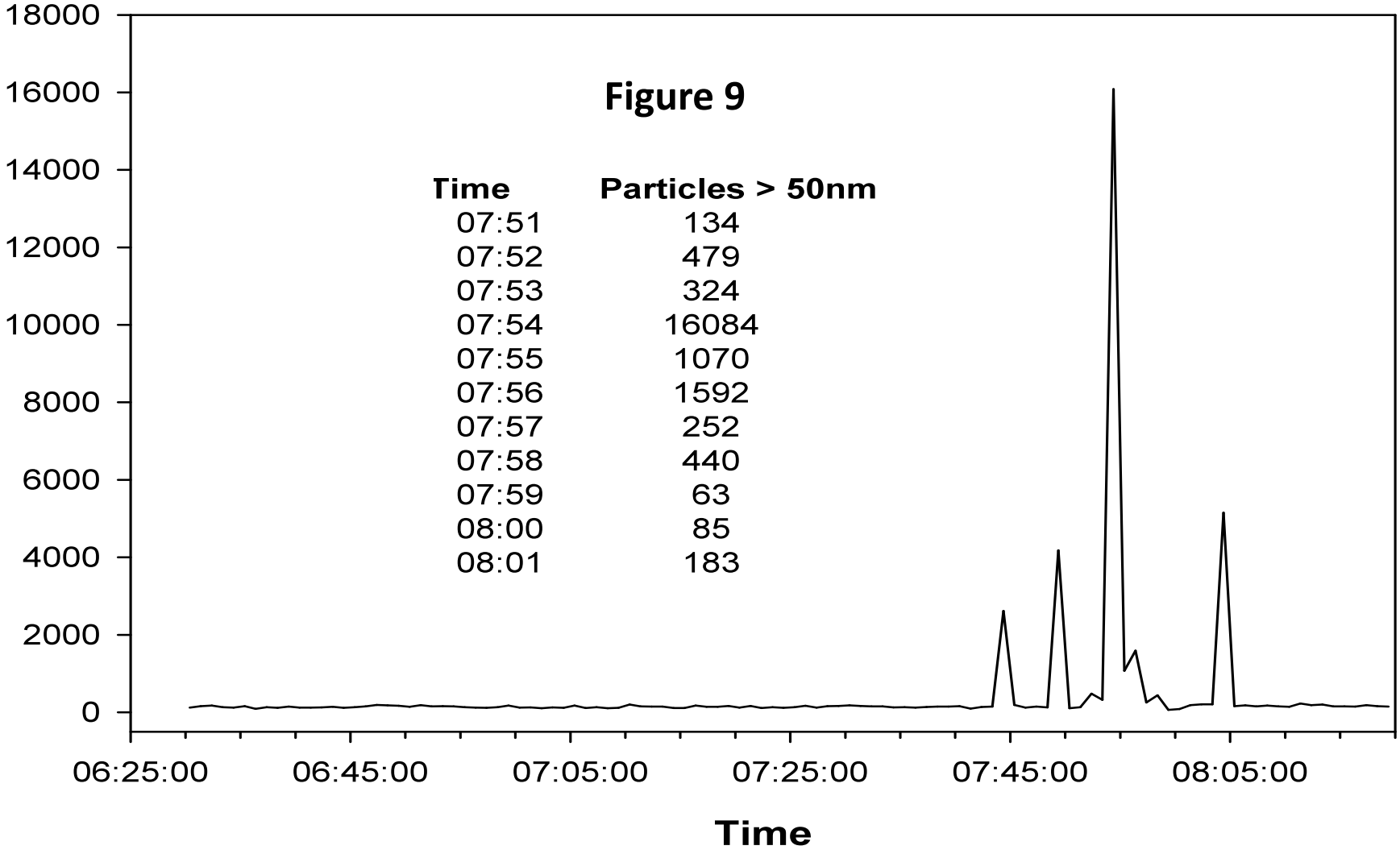
Figure 7

*n*PCD Aggomerates Sub-50 Nanometer Particles



Laser Particle Counter Documented Agglomerated Particles Were Released during ITRS Round Robin Testing

All Particles Greater than 50 Nanometers (Nanocount 50)



NanoLyzer Identified Elemental Composition of UPW Particles during ITRS Round Robin

Percent Elemental Concentration in Particles

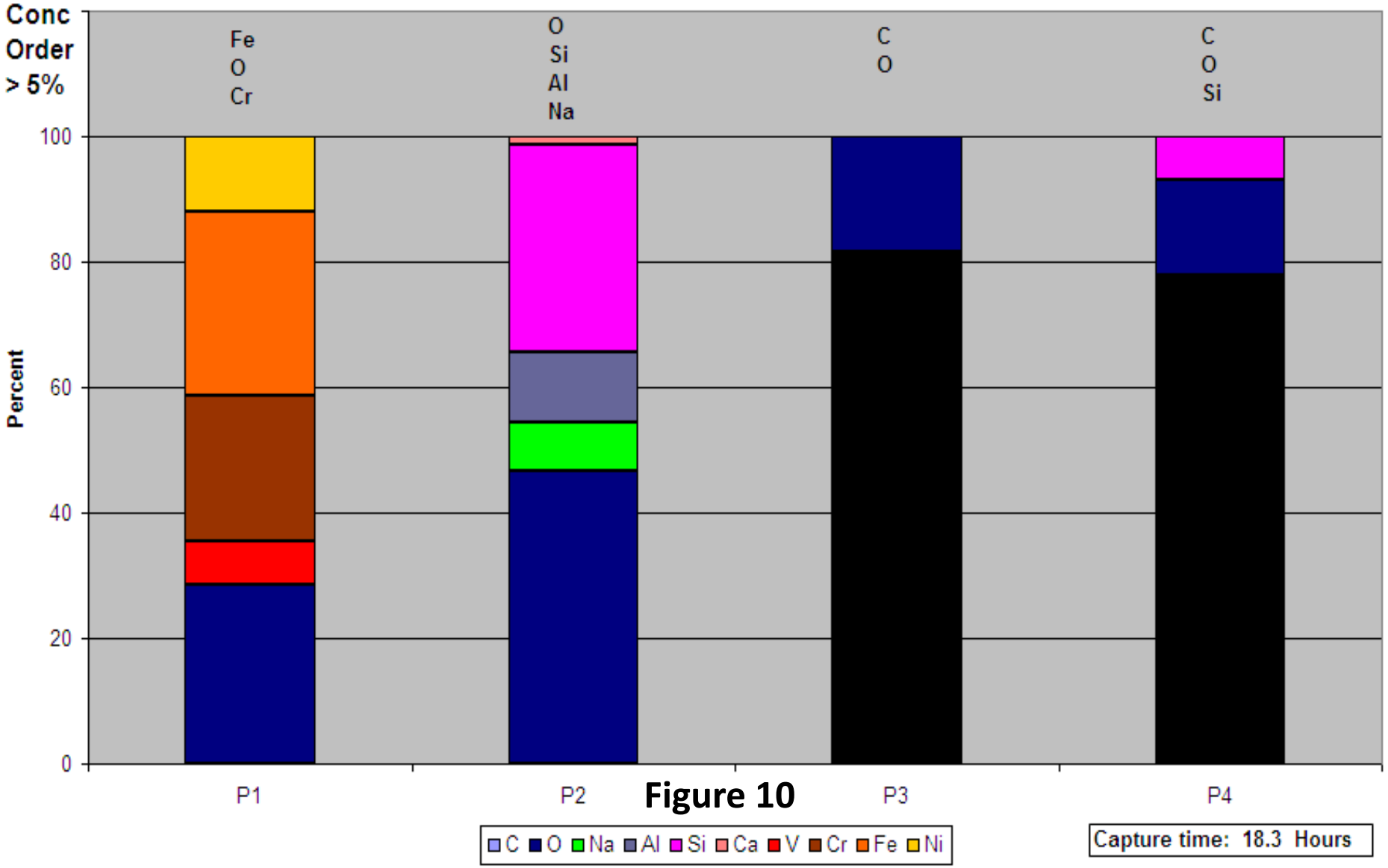


Figure 10

NanoLyzer 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**

NanoLyzer Testing Identified the Most Common Nano-Contaminants in UPW

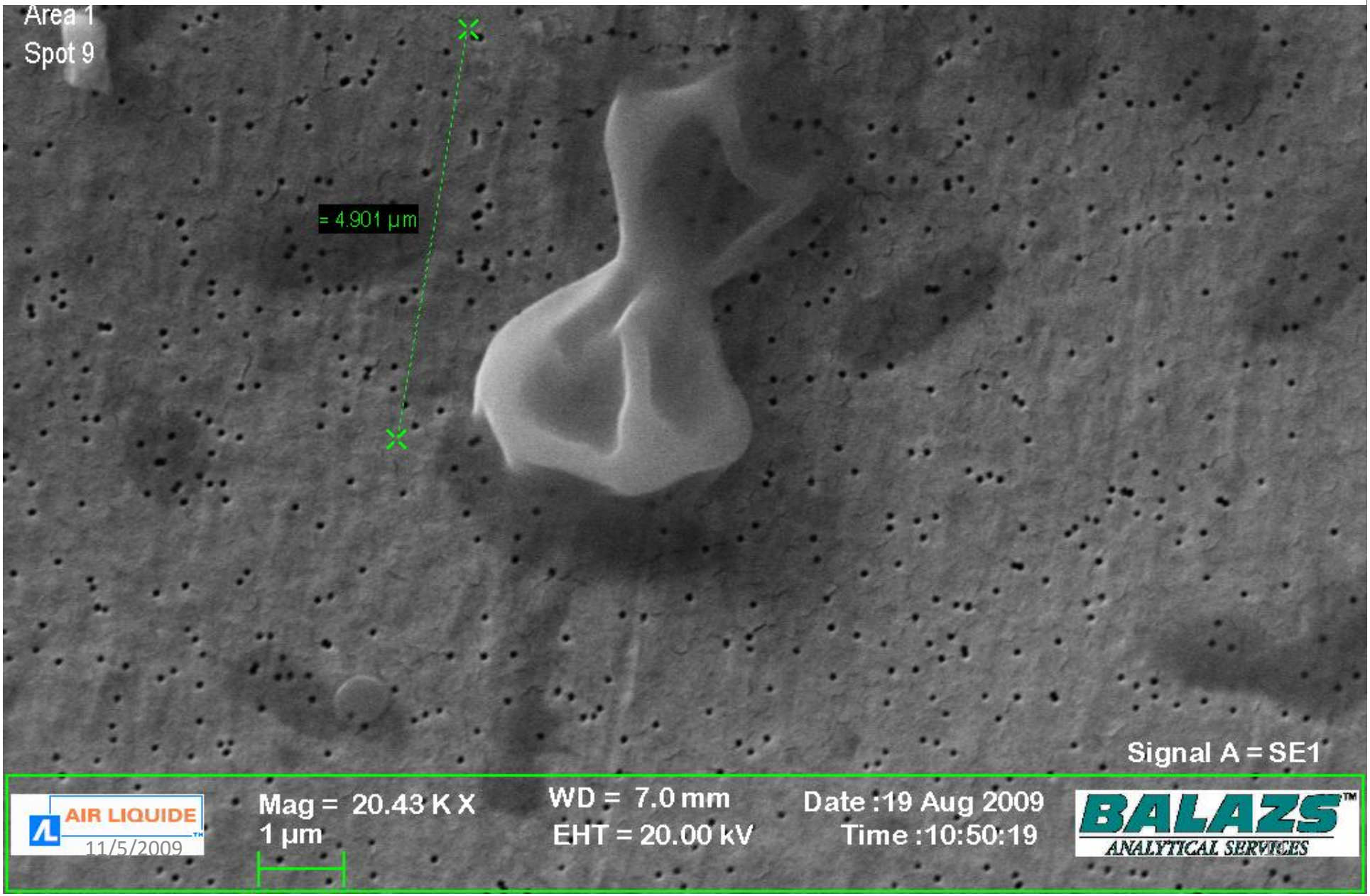
- **Carbon/Oxygen**
- **Silica /Oxygen/Aluminum**
- **Iron/Chromium/Nickel/Oxygen**
- **Fluorine/Carbon/Oxygen**

NanoLyzer Collects Particles for Visual and Elemental Analysis

Carbon Particle – Bacterial Shape

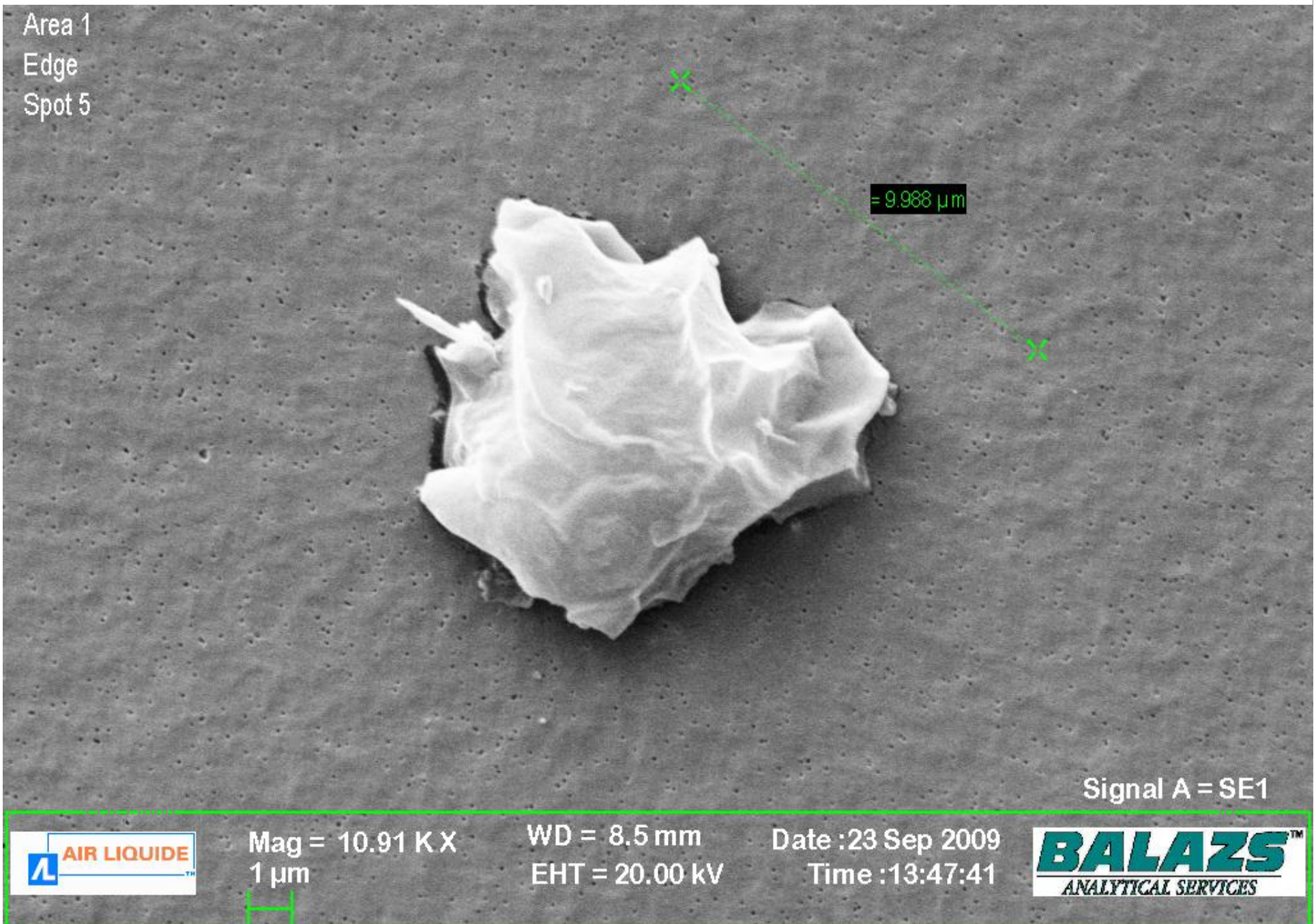
NanoLyzer Collects Particles for Visual and Elemental Analysis

Carbon Particle – Biological Material



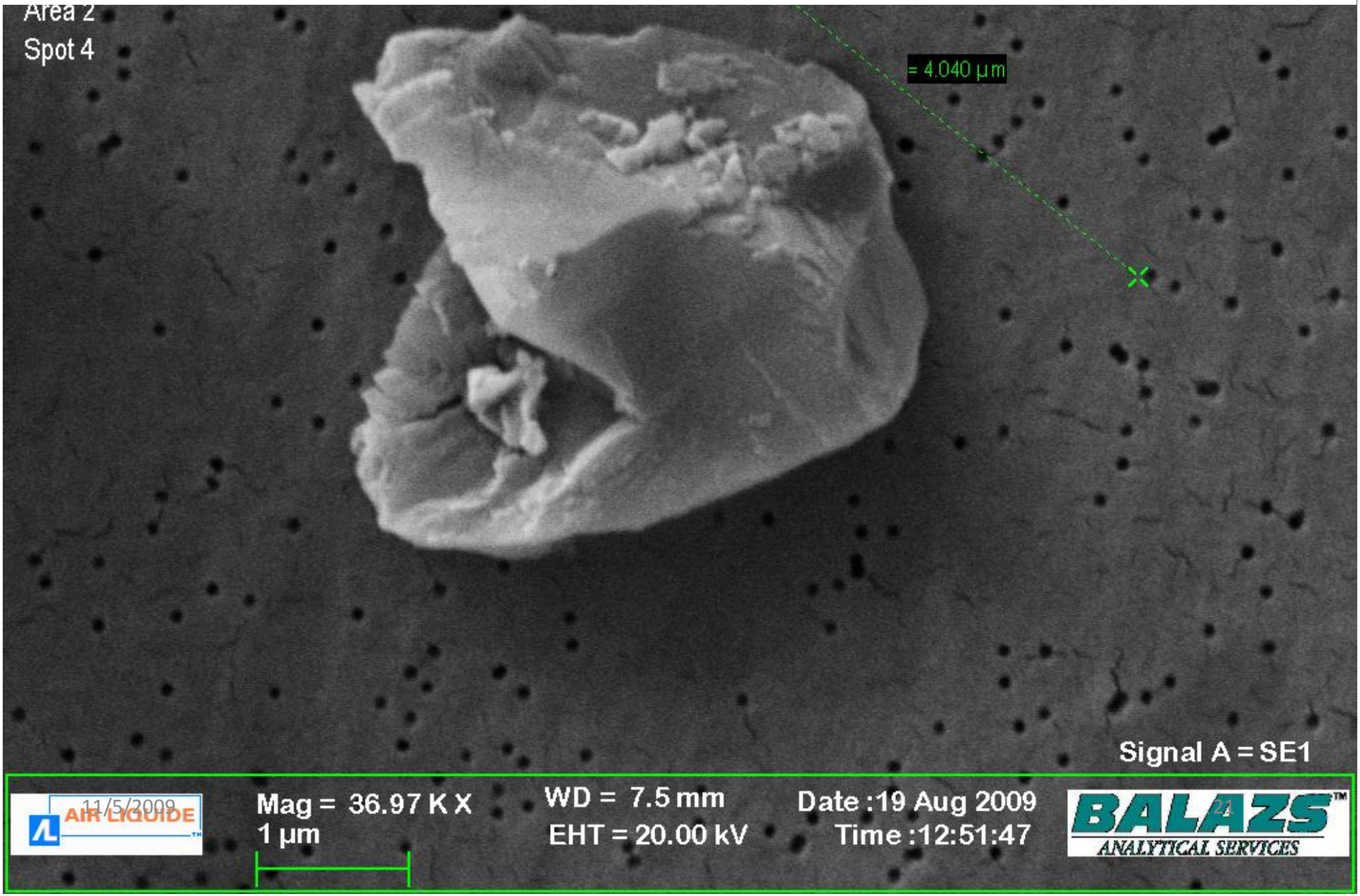
NanoLyzer Collects Particles for Visual and Elemental Analysis

Silica/Oxygen Particle



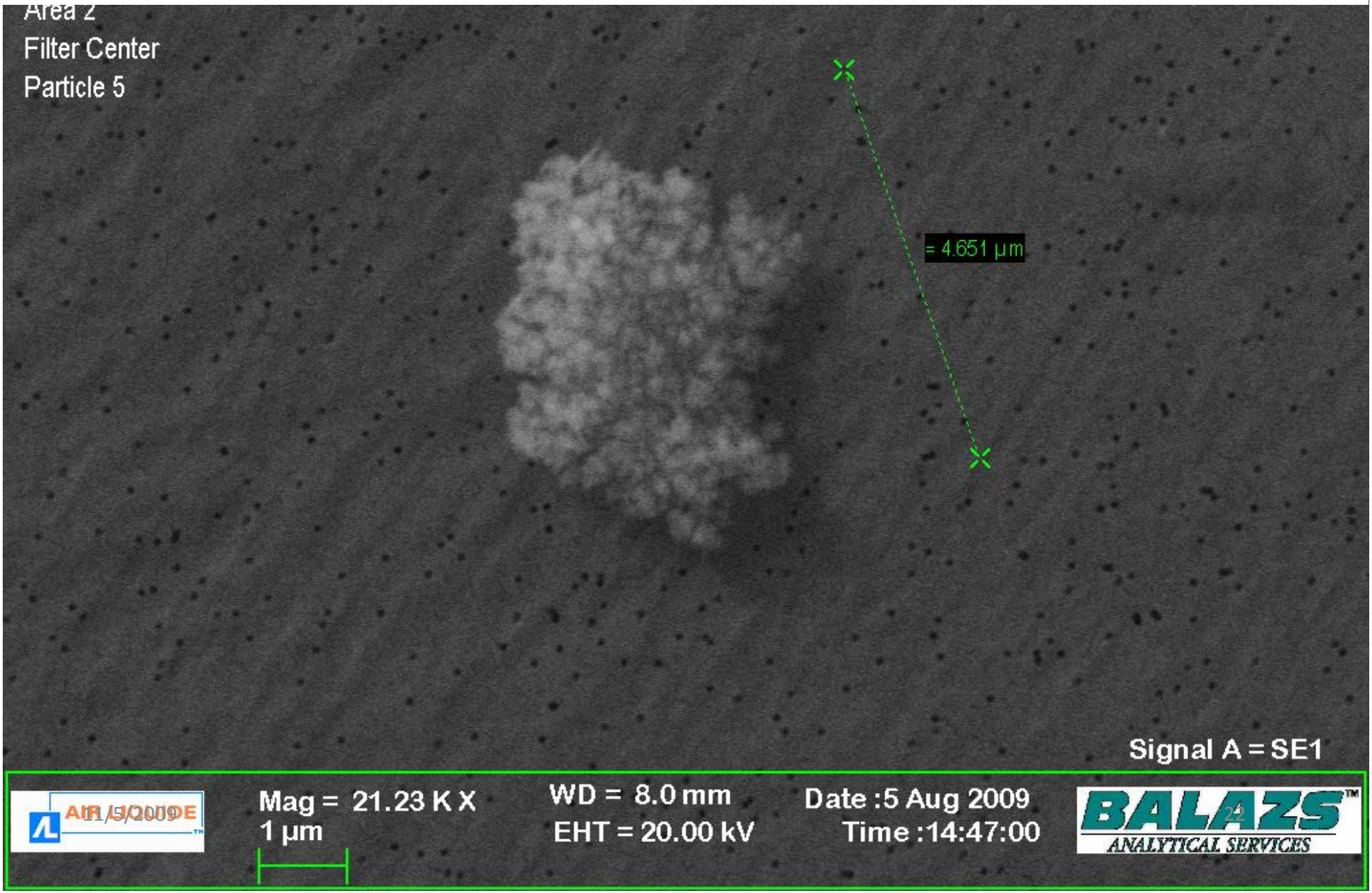
NanoLyzer Collects Particles for Visual and Elemental Analysis

Silica/Aluminum/Potassium/Oxygen Particle



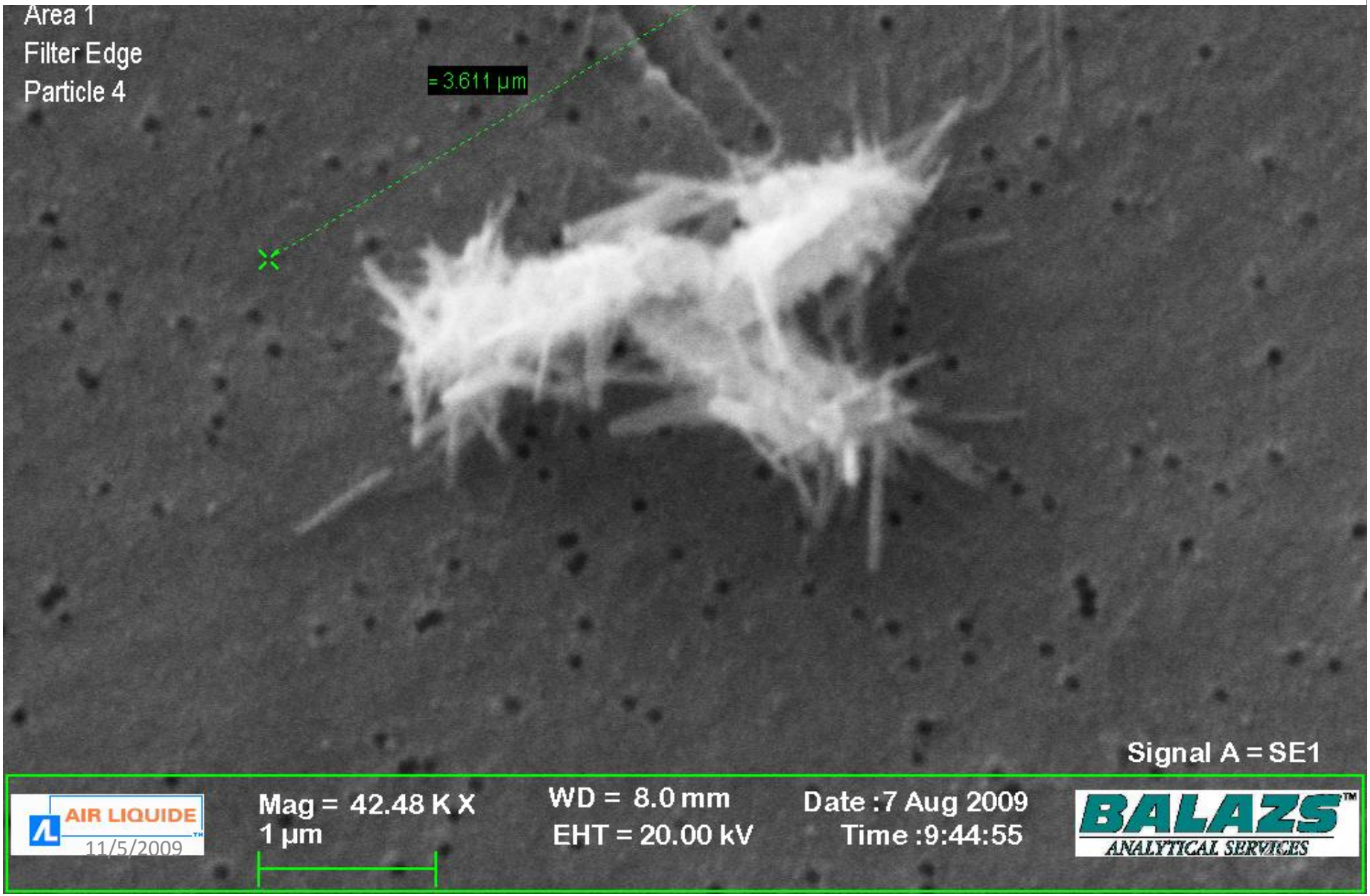
NanoLyzer Collects Particles for Visual and Elemental Analysis

Iron/Chrome/Nickel/Oxygen Particle – Type One



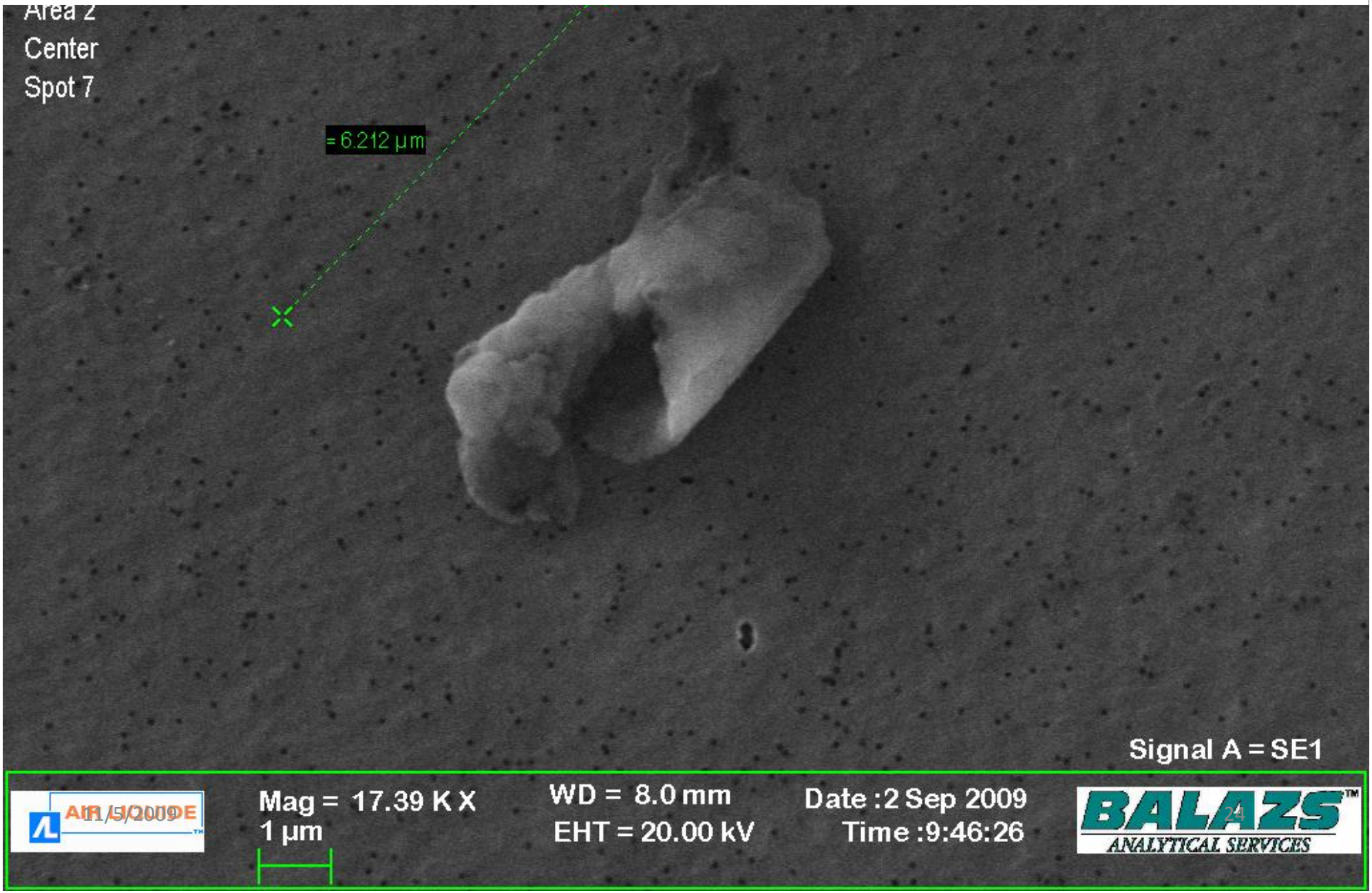
NanoLyzer Collects Particles for Visual and Elemental Analysis

Iron/Chrome/Oxygen Particle – Type Two



NanoLyzer Collects Particles for Visual and Elemental Analysis

Fluorine/Carbon/Oxygen Particle



The NanoLyzer 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

NanoLyzer 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.