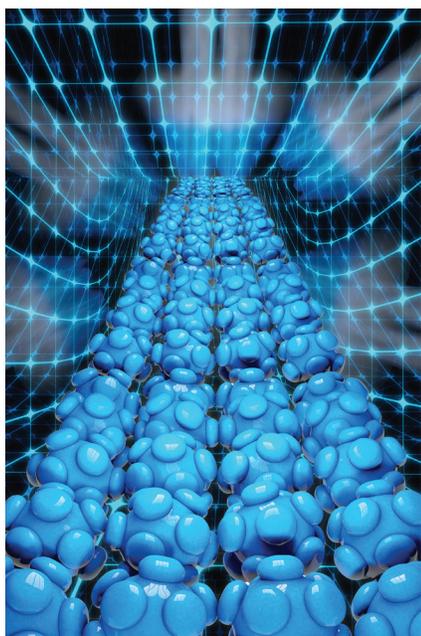


# AGILENT'S COMPREHENSIVE SOLUTIONS FOR THE ANALYSIS OF NANOPARTICLES BY ICP-MS



## Introduction

The use of engineered nanoparticles to enhance the performance or properties of products ranging from semiconductor materials to foods, drugs, cosmetics and consumer goods is increasing at a rapid rate. Because of the novel physical and chemical characteristics of these materials, much remains unknown of their environmental fate and toxicological properties. As a result, there is growing need for a rapid, accurate, sensitive technique for characterizing and quantifying nanoparticles in a wide range of sample types. ICP-MS has demonstrated the ability to meet these requirements through the recent implementation of some application specific enhancements to both hardware and software.

- High sensitivity – signal intensity for small particles decreases as the cube root of the diameter
- Low background to improve the detection of small particles
- Fast scanning in time resolved mode with minimum settling time between scans
- Effective polyatomic interference removal even in fast scanning mode
- Dedicated software to manage complex calculations and very large data sets

## Agilent's Portfolio of Solutions

The requirements for analyzing nanoparticles vary with the type of nanoparticles, the sample matrix and the type of information that is needed. No single method is applicable to all nanoparticle applications. For this reason, Agilent has introduced a flexible portfolio of solutions ranging from support of FFF-ICP-MS for bulk characterization of samples containing multiple sizes and types of nanoparticles, to high speed single particle mode capable of determining the size, mass and composition of a single nanoparticle in solution. All this capability is tied together by Agilent's easy to use Single Nanoparticle Application Module from within the ICP-MS MassHunter software.



**Agilent Technologies**

## Optional Single Nanoparticle Application Module for ICP-MS MassHunter

Agilent's fully integrated nanoparticle application module incorporates the entire process of nanoparticle determination into ICP-MS MassHunter software. The Method Wizard guides the user through the automated creation of new nanoparticle methods for ICP-MS and ICP-QQQ instruments and supports data acquisition in both FFF-ICP-MS and single nanoparticle modes. With a few mouse clicks, a complete analytical method including optimized acquisition parameters, reference material values, and data analysis parameters is set up and ready to run. Reference Material and sample results for an entire batch are summarized in the familiar "Batch at a Glance" table. Detailed graphical results are displayed for selected samples, permitting visual confirmation and optimization of results if needed. Paper or electronic reports including all data and graphics are automatically generated.

**MassHunter Method Wizard**

**Analysis Mode**  
Select appropriate Analysis Mode. Also make the following changes to radio button selections.

**Conventional Analysis**

- Spectrum/TRA  
Spectrum: Conventional Mass Spectra are acquired.  
TRA: Conventional Time Resolved Data are acquired.

**Nanoparticle**

- Single Element / Isotope  
Single Particle Analysis using fast TRA mode.
- Multi-Element Screening  
Fast Time Program Analysis for multi-element nanoparticle screening.
- 2 Elements / Isotopes  
Average element/isotope ratios of multiple particles.
- FFF ICP-MS  
Particles acquired using conventional TRA mode after separation.

**Single Particle Analysis Configuration**  
Set parameters for Single Particle Analysis.

Sample Pump Tube ID: 1.02 mm

Sample Inlet Flow: 0.346 ml/min

Response Factor Calibration Solution:

Ionic Standard Concentration at 197 amu: 1.000 ppb

Reference Material: NIST RM 8012

Reference Element Mass: 197 amu

Mean Reference Particle Diameter: 27 nm

Reference Material Density: 19.32 g/cm<sup>3</sup>

Concentration of Reference Material: 5.0 ng/l

Unknown Sample:

Target Element Mass: 197 amu

Analyte Mass Fraction: 1.000

Particle Density: 19.32 g/cm<sup>3</sup>

MassHunter Method Wizard automates the process of setting up a nanoparticle analysis method from hardware setup and data acquisition through to data analysis with a few simple mouse clicks.

Offline ICP-MS MassHunter - nanotes5.b

File Edit View Instrument Hardware Startup Batch Queue Tools Help

Hardware Plasma Tune Batch Queue Data Analysis Report

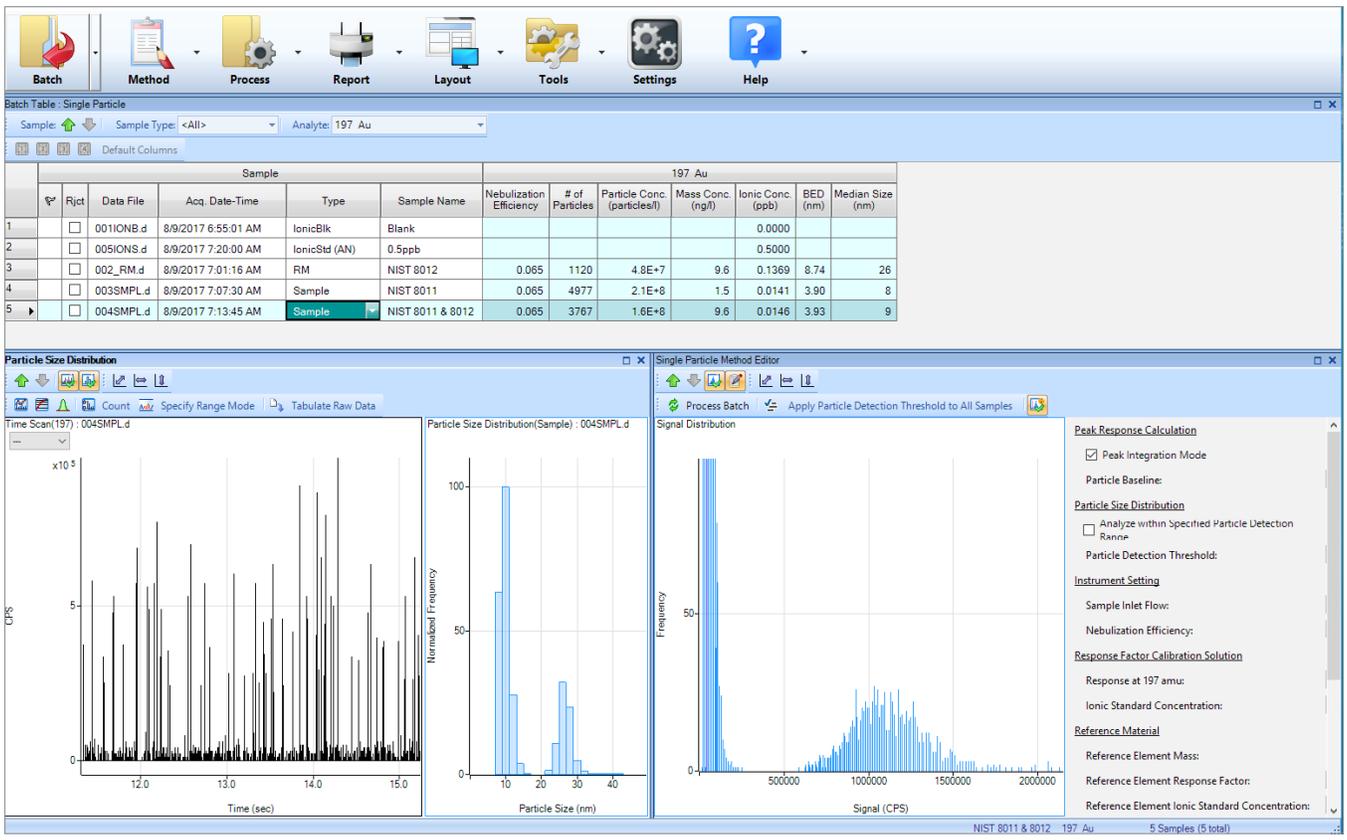
Batch - nanotes5.b

Save Batch Add to Queue Validate Method Import Sample List Auto Sampler Nebulizer Pump Speed

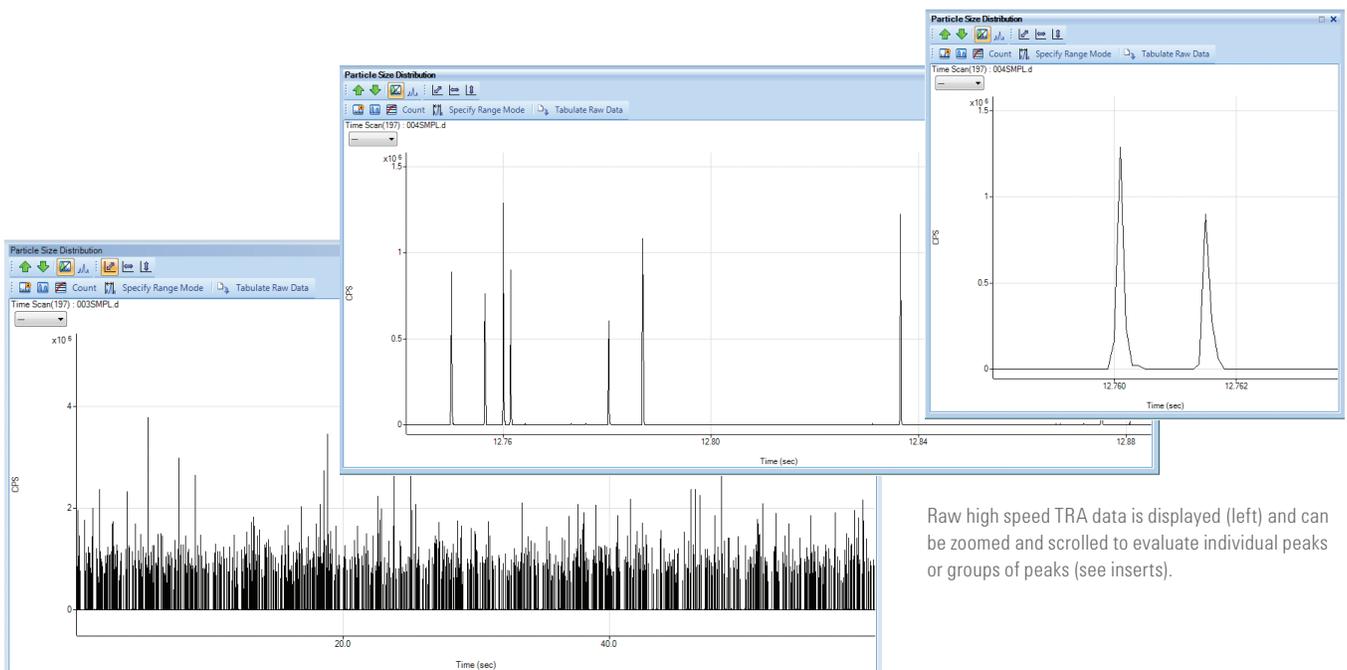
Acq Method	Data Analysis Method	Sample List					
Skip	Sample Type	Sample Name	Comment	Vial#	Replicates	Dilution	
<input type="checkbox"/>	IonicBlk	Ionic Blank		1101			
<input type="checkbox"/>	IonicStd	Ionic Standard	10 ppt Ag	1102			
<input type="checkbox"/>	RM	NIST RM 8012	30nm RM	1103			
<input type="checkbox"/>	Sample	Unknown 1		1104			
<input type="checkbox"/>	Sample	Unknown 2		1105			
<input type="checkbox"/>	Sample	Unknown 3		1106			
<input type="checkbox"/>	Sample	Unknown 4		1107			
<input type="checkbox"/>	Sample	Unknown 5		1201			
<input type="checkbox"/>	Sample	NIST RM 8012		1202			
<input type="checkbox"/>							

Load Option: Standard Tune

Ionic calibration standards, reference materials and samples are entered into sample list and Queued for automated acquisition, calibration and data analysis (left).



Final batch results are reported both in tabular and graphical format. User can tab through individual samples in table and review individual graphical results, utilizing powerful manual optimization tools if necessary.



Raw high speed TRA data is displayed (left) and can be zoomed and scrolled to evaluate individual peaks or groups of peaks (see inserts).

## 7800 Quadrupole ICP-MS

The Agilent 7800 ICP-QMS provides a high-performance solution for nanoparticle analysis in a cost-effective package. Benefits include high sensitivity, low background, and Agilent's proven helium (He) collision mode for unparalleled interference removal. Optional fast time resolved analysis (FTRA) data acquisition capability permits microsecond sampling rate with no settling time, to provide optimum resolution of nanoparticle peaks.

## 7900 Quadrupole ICP-MS

With industry-leading sensitivity and low background, the 7900 ICP-MS provides the lowest guaranteed detection limits of any quadrupole ICP-MS, giving it the capability to detect the smallest particles that less sensitive instruments would miss. Remember, reducing the particle diameter by half will result in an 8X reduction in signal! The 7900 ICP-MS also incorporates fast TRA (time resolved analysis) mode, permitting single element scans as fast as 100  $\mu$ s with no settling time. Fast TRA mode allows the user to visually characterize the shape and duration of the ion plume from a single nanoparticle.

## 8900 Triple Quadrupole ICP-MS

The 8900 remains the world's only true ICP-QQQ defined as utilizing a unit mass quadrupole before the collision/reaction cell. This configuration allows complete control over ions that enter the cell and results in the most efficient removal of polyatomic and isobaric interferences possible in a quadrupole ICP-MS. No conventional quadrupole instrument can reduce interferences simultaneously from polyatomic and isobaric sources as effectively. The result is that in many cases, the background of the 8900 ICP-QQQ, even for difficult elements, is essentially zero. The 8900 ICP-QQQ also boasts extremely high sensitivity and much lower background compared to conventional quadrupole ICP-MS instruments. This combination of high sensitivity, low background, and superior interference removal enables the determination of much smaller nanoparticles, including those composed of problematic elements such as silicon and titanium. Since  $\text{SiO}_2$  and  $\text{TiO}_2$  are among the most commonly used nanomaterials in consumer products, the capability of the 8900 ICP-QQQ is critical.

## Support for legacy Agilent ICP-MS instruments

ICP-MS MassHunter Single Nanoparticle Applications Modules is also compatible with other Agilent ICP-MS mainframes supported by ICP-MS MassHunter revision 4.2 and later. For 7700 Series ICP-MS and 8800 ICP-QQQ instruments, the ICP-MS supports TRA analysis of nanoparticle samples at a minimum dwell time of 3 ms. This measurement speed is suitable for most NP applications, except where the measurement requires the profile of each individual particle signal plume to be measured.



The 7800 ICP-MS, with optional fast TRA capability, provides a cost effective solution for single nanoparticle analysis



Agilent 7900 ICP-QMS coupled to PostNova AF2000MT AF4 FFF system



Agilent 8900 ICP-QQQ with high speed TRA capability and MS/MS mode to remove challenging interferences that affect the measurement of analytes such as titanium and silicon by quadrupole ICP-MS

For more information:  
Contact your local Agilent representative  
or visit:

[www.agilent.com/chem/atomic](http://www.agilent.com/chem/atomic)

This information is subject to change without notice.

© Agilent Technologies, Inc. 2017  
Published August 30, 2017  
5991-5536EN



**Agilent Technologies**