



**PARTICLE
MEASURING
SYSTEMS®**

a spectris company

MICRO ELECTRONICS AND INDUSTRIAL CAPABILITIES

Without measurement there is no control®





We continually push the boundaries of contamination monitoring and control to enable clean manufacturers' success by providing invaluable insights through:

- Leading technology
- Quality service
- Collaborative solutions; and
- Unmatched expertise.

All made possible by our global team of dedicated and creative individuals.

We are committed to doing things the right way, whether we're interacting with our customers, employees, or technology. Our values of **Be True**, **Own It and Aim High** drive our pursuit of excellence. We're proud to produce and reward a culture of ethical behavior at all levels and in all circumstances.










Without measurement there is no control



A History of Innovation

How did we get to be the largest particle counter manufacturer in the world? Since 1972, we have solidified our technology leadership position by continually pursuing advanced detection technologies and regularly releasing new products that focus on current challenges and future needs of the industries we serve. Acquired by Spectris in 1996, Particle Measuring Systems is one of many operating companies focused on providing productivity-enhancing instrumentation and controls.



1972 Founded. First laser optical particle counter, the Knollenberg Probe, developed. 	 1978 Pioneer Venus Probe integrates first Particle Spectrometer for space exploration.	1985 Introduction of first Facility Monitoring System, the FMS 100. 	 1987 Creation of first 100 nm reactive gas particle counter, the HPGP-100.	1990 First 50 nm liquid particle counter, the HSLIS-M50, produced. 	 1992 First in-situ vacuum particle counter, the FiberVac, introduced.	1994 First 100 nm wafer surface particle counter, the SAS-3600 developed. 	<i>Particle College®</i> 1998 Accredited multi-day professional training program, Particle College® instituted.	2010 UltraChem® Liquid Particle Counter enables specialty chemical monitoring. 	 2015 First 20 nm liquid optical particle, the Ultra DI® 20 introduced.
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Office and Distributors Worldwide

Headquarters

Boulder, Colorado USA

Global Offices

Austria
Belgium
Brazil
China

France
Germany
Ireland
Italy

Japan
Korea
Nordic
Puerto Rico

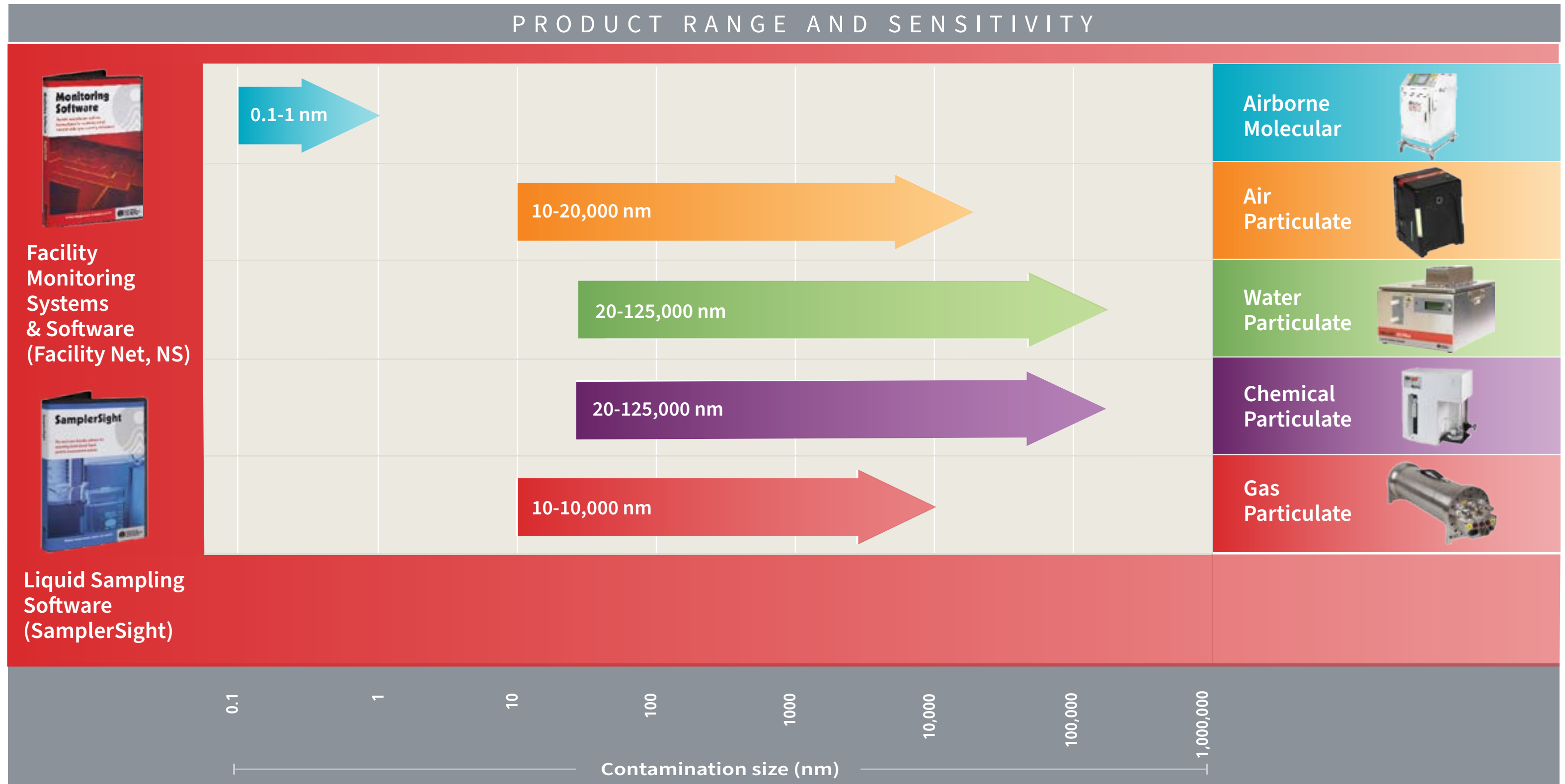
Singapore
Switzerland
Taiwan
UK

With more than 500 employees, over 35 distributors, and local sales and services in more than 50 countries, we're local everywhere.





To find and contact your local office / distributor scan the QR code or go to pmeasuring.com/contact

High-Performance Products



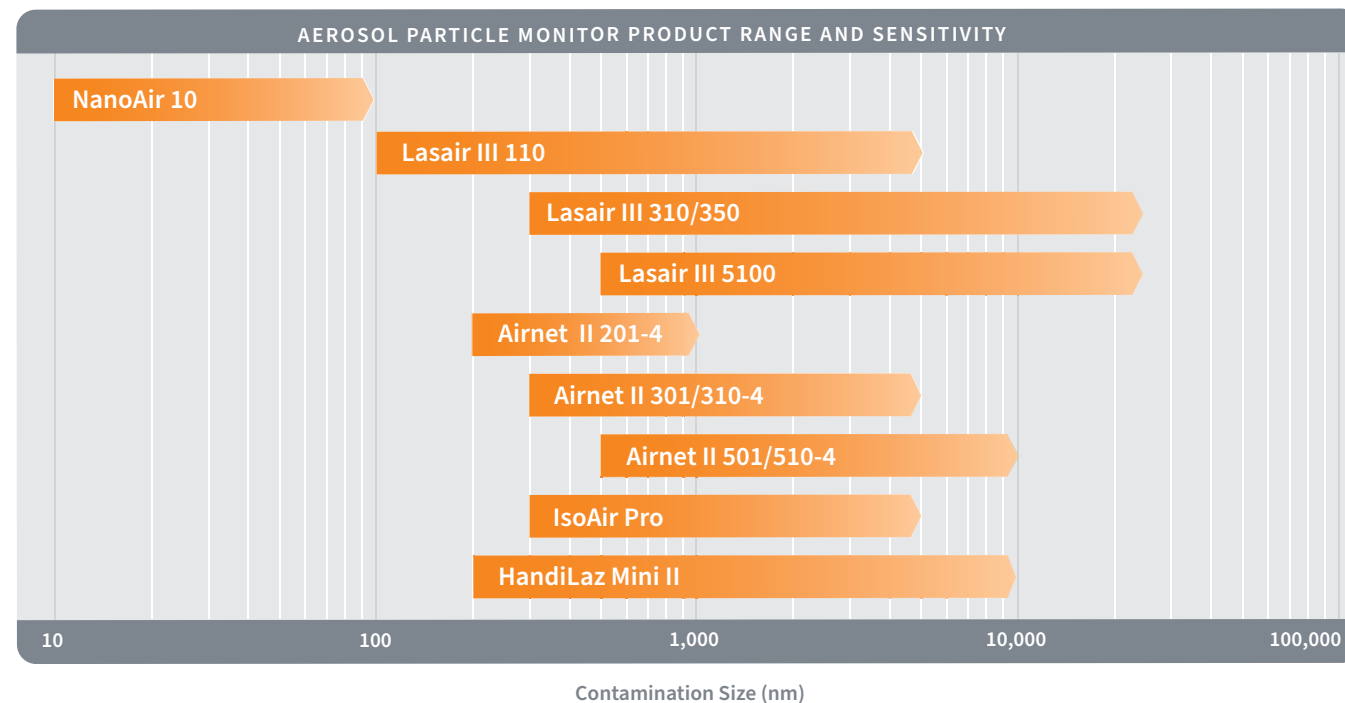
Application by Industry

 ≤10 nm
  ≤20 nm
  ≤40 nm
  50-100 nm
  100-200 nm
  ≥200 nm
  AMC Monitoring Required

		Semiconductor Manufacturing					Semiconductor Equipment				Material Suppliers					Display Manufacturing			Data Storage	Photonics			Power / Energy			Aerospace		Clean Manufacturing		Auto-motive	
		Logic	Memory	Discrete	Sensors	MEMs	Lithography	Vacuum Systems	Wet Process	Transport	Filters	Chemicals	Gases	Slurries	Substrates	Garments	LCD	LED	OLED	HDD	LED	Optics	Lasers	Solar	Oil	Gas	Aviation	Space	Electronics	Critical Clean	
Air Monitoring	Mobile	◆	◆	◆	◆	◆	◆		◆	◆	◆			◆	■	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	◆	◆	+
	Manifold Multipoint	◆	◆	◆	◆	◆	◆			◆	◆				■	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	◆	◆	+
	Continuous	◆	◆	◆	◆	◆	◆			◆	◆	◆			■	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	◆	◆	+
	Filter Test	◆	◆	◆	◆	◆	◆	◆		◆		■			■	■	■	■	■	■	■	■	■	+	+	+	+	+	+	■	+
Gas	Compressed Gas	◆	◆	◆	◆	◆	◆		◆			◆		◆	■	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	◆	◆	+
	IQ/OQ	◆	◆	◆	■	■	◆	■		■		■		■	■	■	■	■	■	■	■	■	■	+	+	+	+	+	+	■	+
Chemical Monitoring	Blend & Dispense	●	●	●	○	○	●		●	○	●	●			●	■	■	■	■	○	■	■	■	+	+	+	+	+	+	■	+
	Wet Process Tools	●	●	●	◆	◆	●		●		●	●		○	●	+	■	■	■	■	■	■	■	+	+	+	+	+	+	◆	+
	Component Test	●	●	●	◆	◆	●		●		●	●		○	●	+	■	■	■	■	■	■	■	+	+	+	+	+	+	◆	+
	Continuous Monitoring	●	●	●	◆	◆	●		●		●	●		○	●	+	■	■	■	■	■	■	■	+	+	+	+	+	+	◆	+
	Lab Testing	●	●	●	◆	◆	●		●		●	●		○	●	+	■	■	■	■	■	■	■	+	+	+	+	+	+	◆	+
Water	Continuous Monitoring	●	●	●	◆	◆	●		●		●	●		●	+	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	+	●	+
	Troubleshooting	●	●	●	◆	◆	●		●		●	●		●	+	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	+	●	+
	Facility Monitoring	●	●	●	◆	◆	●		●		●	●		●	+	◆	◆	◆	◆	◆	■	■	■	+	+	+	+	+	+	●	+
AMC	Continuous Monitoring	★	★	★	★	★		★	★	★	★	★		★	★	★	★	★	★	★	★	★	★				★	★			
	Troubleshooting	★	★	★	★	★		★	★	★	★	★		★	★	★	★	★	★	★	★	★	★				★	★			
	Facility Monitoring	★	★	★	★	★		★	★	★	★	★		★	★	★	★	★	★	★	★	★	★				★	★			

The above are general guidelines. Your application requirements may have differing needs.

Aerosol



Cleanrooms are controlled environments where product manufacturing quality can be impacted by particulate contamination. These cleanrooms use active air filtration systems that reduce airborne particulates to specified limits. Monitoring these airborne particulates provides useful data

on the environment's filtration, sources of contamination, and potential impact to the product or process. Selecting an aerosol particle counter is a choice influenced by the specific application and budget.



MOBILE MONITORING



The most basic approach to cleanroom monitoring is the use of mobile particle counters which are moved throughout the facility to periodically measure current contamination levels. This approach requires little capital investment but significant labor to implement.

- Advantages**
- Deploy rapidly
 - Lower capital cost than dedicated system
 - Useful for troubleshooting

MANIFOLD MULTI-POINT MONITORING



Manifold systems collect air samples from many different locations continuously and deliver them to a single particle counter for analysis. Only one sample location is typically analyzed at a time, but the system is a cost-effective way to characterize contamination trends with little if any labor. Since the manifold cycles between sample locations, infrequent particle excursions may escape detection.

- Advantages**
- Lowest capital cost per sample point
 - Low labor costs
 - Automated monitoring of large areas

CONTINUOUS MONITORING



In critical areas or where periodic contamination events would cause problems, continuous monitoring is the best approach. These areas may be in the cleanroom, mini-environments, or other process-critical locations. These instruments are always on and always looking for contamination even if an event lasts only a few seconds.

- Advantages**
- Always measuring
 - Sample close to product
 - Improved process event correlation

FILTER TEST



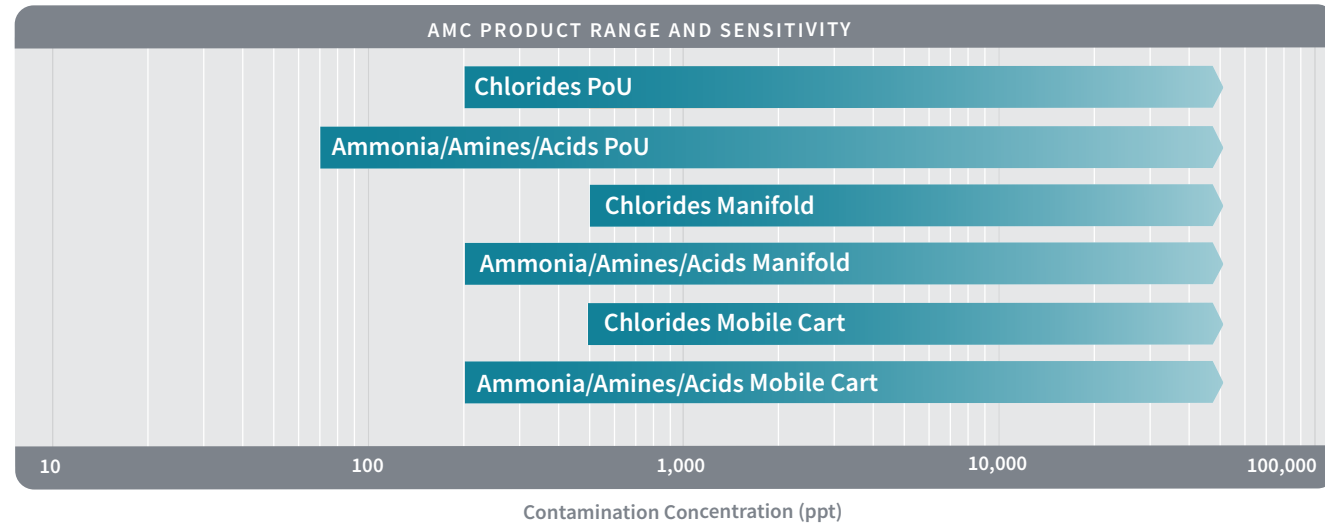
Filter testing is typically specific to a single filter element. Data are normally collected both upstream and downstream simultaneously with short sample intervals while scanning across the filter surface. Detecting penetrating particles requires a particle counter with at least 0.3 μm sensitivity for HEPA filter testing and 0.1 μm sensitivity for ULPA filter testing. In both cases, peak penetrating particles are nominally 0.12 μm .

- Advantages**
- Precisely locate filter leaks
 - Verify filter efficiency performance
 - Rapid method for ceiling or tool filter installations



Scan the QR code to learn about aerosol particle counters

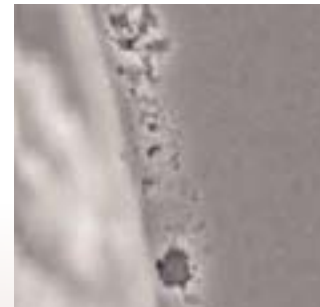
Airborne Molecular Contamination



By changing the chemical, physical, electrical, or optical properties of highly engineered surfaces, airborne molecular contamination (AMC) can cause yield loss, product degradation, and loss of process control.



Acidic gases can cause corrosion of precision metallic thin films



Molecular contamination can result in optical hazing in DUV photolithography



Ammonia and amines can interact with acid catalyzed photoresists, resulting in t-topping



CONTINUOUS MONITORING OF CRITICAL AREAS



AirSentry® II Point of Use AMC Monitoring System

Point of Use analyzers provide real-time, continuous monitoring at the lowest detection limits in locations where products are at risk and where contamination sources may originate. This allows AMC contamination excursions to be identified immediately, minimizing impacts to products and processes. The high sensitivity offered by the AirSentry II product family allows even the cleanest chemically filtered environments to be verified and controlled.

Advantages

- Always measuring
- Sample close to product
- Improved process event correlation

TROUBLESHOOTING



AirSentry® II Mobile AMC Monitoring System

Who wants to wait for laboratory test results when you suspect there is an AMC excursion occurring? Get data now with the AMC Mobile Cart. Decrease the time to detect, contain, and mitigate AMC sources by quickly deploying a real-time mobile monitoring solution.

Advantages

- Deploy rapidly
- Lower capital cost than dedicated system
- Useful for troubleshooting

FACILITY AMC MONITORING



AirSentry® II Multi-point Monitoring System

Environmental monitoring with an AMC Manifold Monitoring System accurately tracks trends in AMC contamination in a facility while offering the lowest cost per sample point.

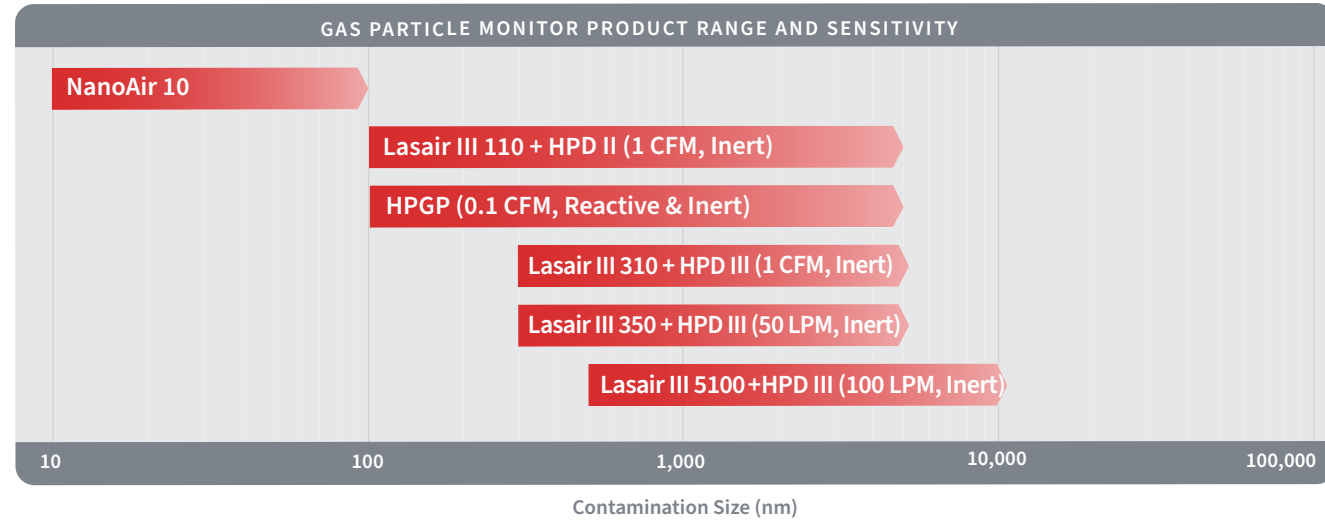
Advantages

- Lowest capital cost per sample point
- Low labor costs
- Automated monitoring of large areas



Scan the QR code to learn about airborne molecular contamination monitoring

Gases



Sophisticated technology manufacturing relies on ultra-high purity gases in order to produce leading edge semiconductors, LED/OLED displays, disk drives, and precision optics with high yields. These gases are ultimately supplied directly to process tools to purge and protect the product, or to contribute to process reactions which positively transform the product. However, when poor quality gas is delivered, yields decrease due to a contribution of point defects, reduced thin film adhesion, and electrical property changes due to ionic contaminants.

To ensure gas quality meets particle specifications, monitoring is implemented at the gas source and within Continuous Quality Control (CQC) systems. Aerosol particle counters combined with high pressure diffusers are used to check and troubleshoot gas quality in the downstream distribution piping or as a validation test of gas component cleanliness. An effective strategy combines continuous and periodic monitoring throughout the gas flow path to ensure the highest purity gas is delivered to the final point of use.

MOBILE GAS MONITORING AND HIGH PURITY GAS COMPONENT TESTING



Lasair III 110 Aerosol Particle Counter with HPD II

In mobile gas monitoring, a high pressure diffuser reduces the non-reactive sample gas to atmospheric pressure, allowing a low cost portable aerosol particle counter to be used for quick troubleshooting anywhere along the gas line. Because they are not dedicated to any one location, the diffuser and particle counter can be rapidly deployed for immediate use. Fast sample intervals can identify transient events, and a simple setup and touchscreen user interface eases data collection and analysis.

Advantages

- Reduced capital cost compared to continuous fixed monitoring
- Deploys to any location needed for further analysis
- Identifies and isolates particle contributing lines and components
- Lower gas consumption than continuous fixed monitoring



Lasair III Aerosol Portable Particle Counter with HPD III

Validating cleanliness of ultra-high purity components is critical for many OEMs, ensuring the parts do not add particles to their tools. Using N₂ or CDA as the purge gas, both static and dynamic tests are run to promote particle removal from the components. Detecting particles from these tests requires instruments which handle high frequency, short-duration pulses from pressure or valve actuation cycles. Graphical display, data storage and networked data allow quick result interpretation in preparation for additional test runs.

Advantages

- Characterizes particle shedding in live, stressed conditions
- Allows pressure variation and valve actuation during testing
- Internal wetted parts are subjected to gas flow and dynamic conditions
- Receive results faster than alternative laboratory techniques

CONTINUOUS GAS MONITORING



HPGP-Ultra High Purity Gas Particle Counter

Used in Continuous Quality Control (CQC) systems and within bulk gas distribution systems, an inline gas monitor continuously samples at line pressure. In addition to inert gases, reactive gases such as H₂ and O₂ are safely monitored through the use of a robust safety containment vessel design. Using one dedicated instrument for each gas line allows periodic and isolated event detection, as well as understanding of long term particle trends.

Advantages

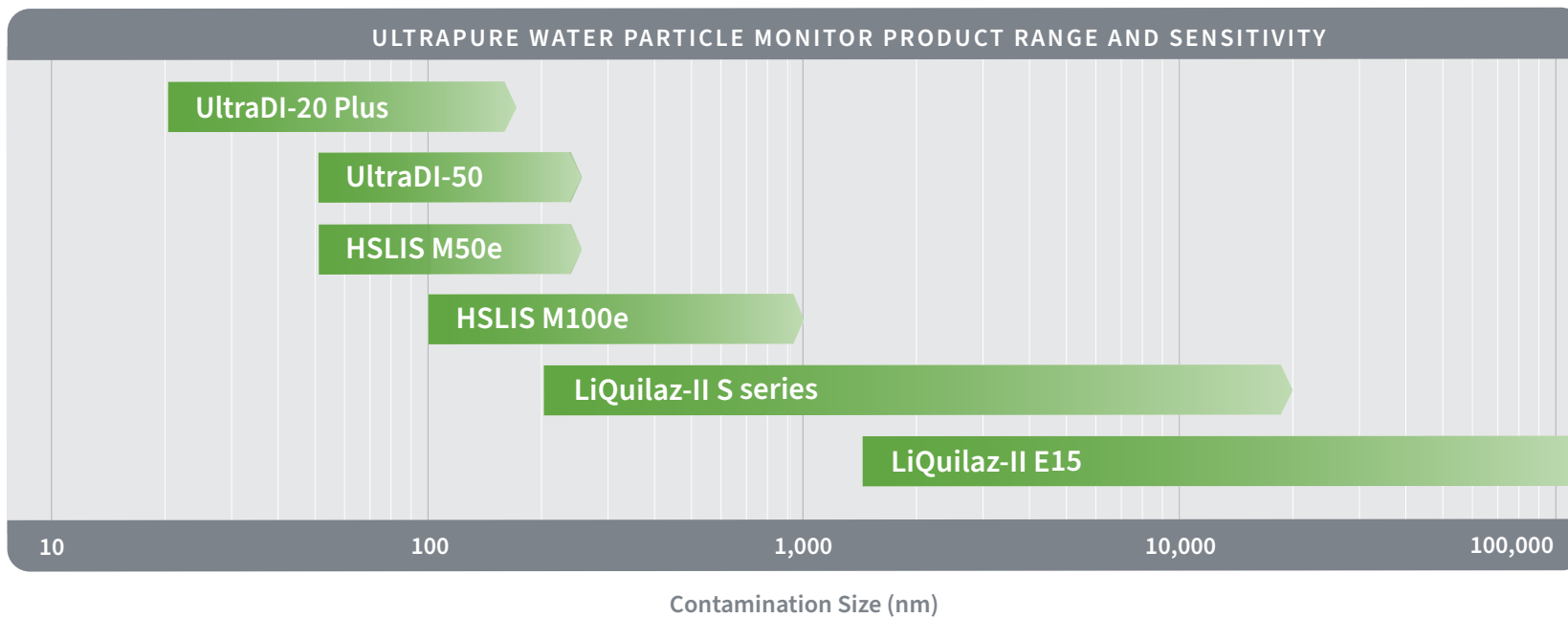
- Continuous sampling – no missed events
- Samples and detects at line pressure
- Monitors either reactive or inert gases
- Data constantly supplied to facility or data management software



Scan the QR code to learn about continuous gas monitoring

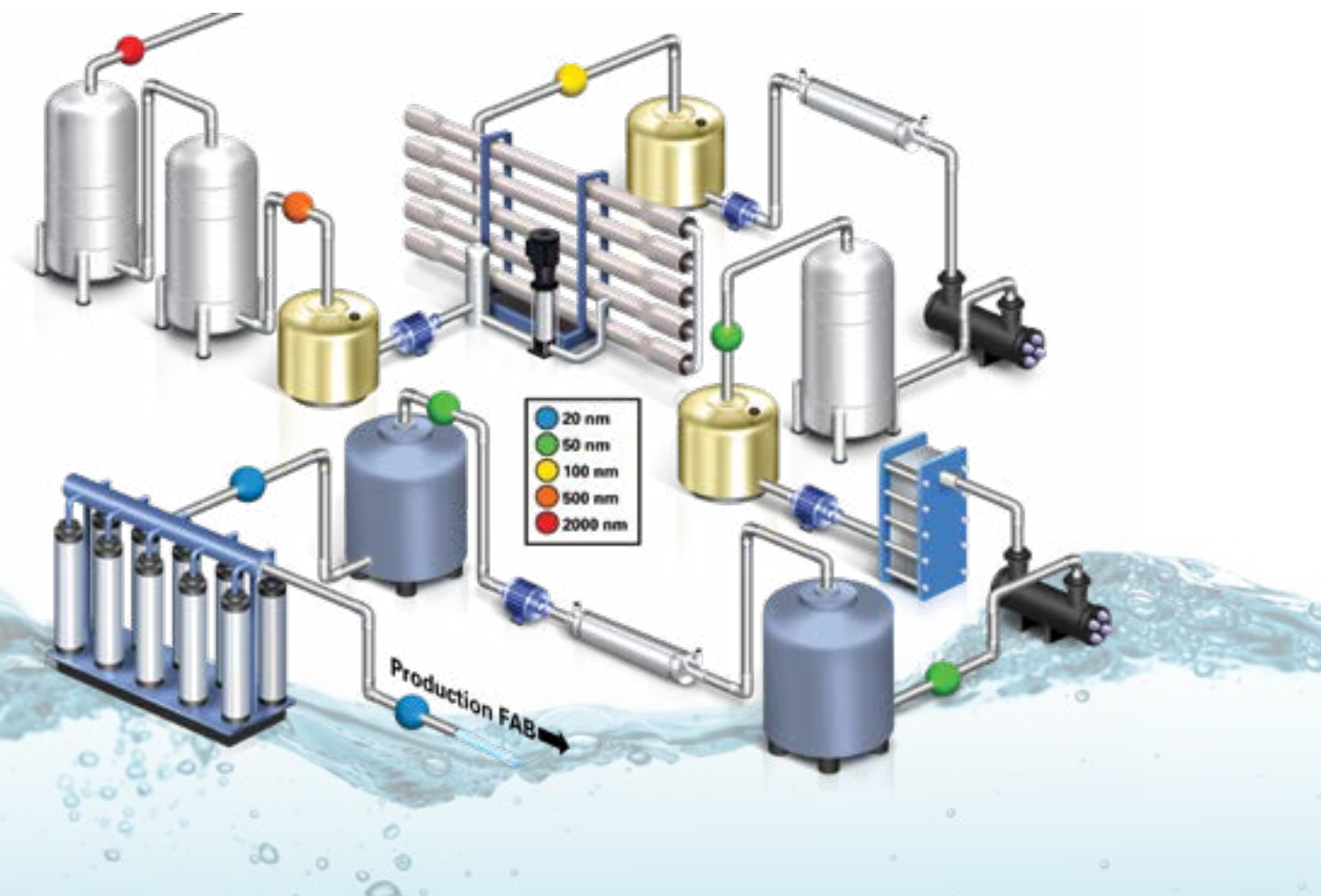


Ultra Pure Water



Many precision manufacturing processes use ultra pure water (UPW) for critical cleaning and rinsing steps. For advanced semiconductor processing, UPW processes must maintain very low particle concentration levels, measured at the 20 nm level. UPW is also commonly used for chemical dilution and flushing steps within

chemical blending and distribution systems. The use of continuous, online particle monitoring, either at the final water purification step or at the wafer point-of-use, provides UPW facility and fab process engineers the critical particle data needed to effectively manage the water purification and wafer cleaning processes.



ULTRAPURE WATER PLANTS



Ultra DI® 20 Plus Water Particle Counter



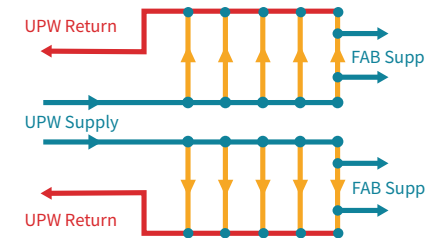
Ultra DI® 50 Water Particle Counter

This is particle monitoring of the highest quality. Ultrapure water systems used in semiconductor processing require very sensitive and stable particle counting instruments. These instruments provide actionable data throughout the UPW purification plant through unparalleled instrument matching to ensure optimized and stable system performance. A comprehensive UPW monitoring strategy is often used, utilizing progressively more sensitive particle metrology within the UPW process.

Advantages

- Characterization of particle levels throughout the UPW process
- Online particle monitoring to provide actionable data in response to particle events
- Useful for measuring particle performance of large ultra-filter banks
- Isolate particle issues within UPW distribution loops

MONITORING OF UPW DISTRIBUTION LOOPS



Maintaining the cleanliness of ultrapure water throughout the UPW distribution loop requires significant design attention as well as empirical validation. Components such as valves and weldments, as well as long lengths of distribution piping can contribute significant levels of bacteria and particles to the UPW loop if not balanced properly. A comprehensive particle monitoring strategy for the UPW distribution system is important to maintain UPW purity where it is needed.

Advantages

- Measure UPW particle levels at strategic points in the distribution system
- Ensure that UPW purity is not compromised within the distribution loop
- Portable UPW particle monitoring set-ups are effective as a contamination troubleshooting tool

IN-FAB PROCESS MONITORING



HSLIS M-100e Liquid Particle Counter



LiQuilaz® II Liquid Particle Counter

Critical component and wafer surface cleaning processes depend on high purity water delivered to the cleaning tool within the process facility. Improperly installed or maintained water distribution systems or process tools can contribute to the degradation of water quality between the purification plant and the end-product. Liquid particle sensors are used throughout semiconductor and other process facilities to ensure consistently clean process water wherever it is needed.

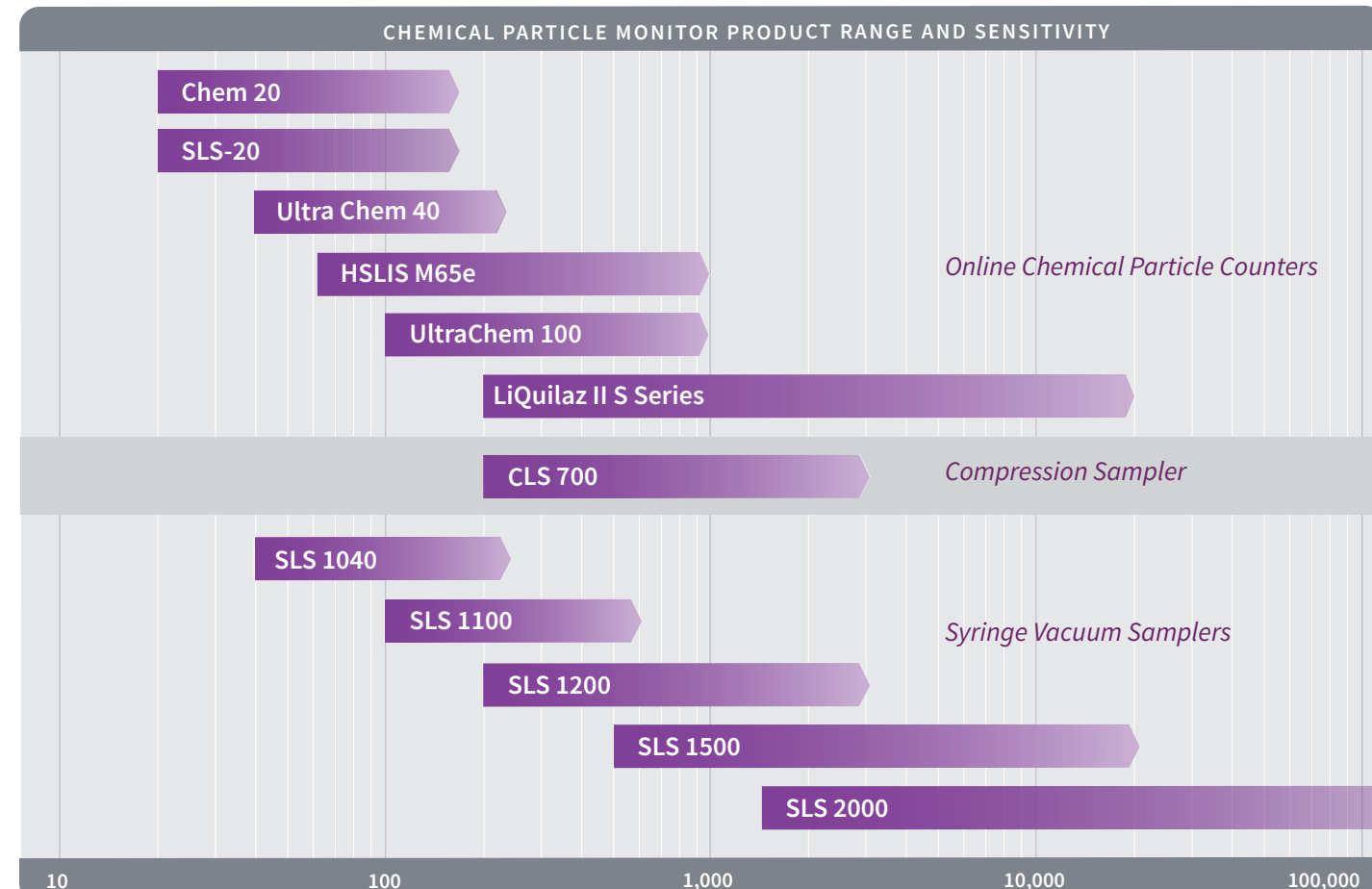
Advantages

- Online particle monitoring to provide actionable data in response to UPW particle events
- Measurement of incoming UPW quality from the facility plant
- Characterization of particle levels within the wafer process tool



Scan the QR code to learn about liquid particle counter monitoring

Chemicals



Process chemicals are used in many steps to fabricate semiconductors and other critical products, and their purity is critical to maximize product yields and performance. Monitoring particles in process chemicals, from the chemical manufacturing point to the final use-point

of the product, is extremely important in today's clean processes. The use of on-line continuous particle monitoring enables process or facility engineers to respond rapidly to changes in chemical purity levels throughout the chemical distribution process.

INCOMING & OUTGOING QUALITY ASSESSMENT



SLS-1040 Chemical Particle Sampler

Whether certifying outgoing chemical packages in a high-purity chemical packaging plant or testing incoming chemical tankers in a semiconductor manufacturing facility, chemical particle counters, samplers, and data analysis systems deliver critical particle data used to certify chemical purity levels. On-line or batch sampling systems enable testing and qualification of incoming or outgoing process chemical purity.

Advantages

- Certification of packaged chemical products within chemical facilities
- Qualification of incoming chemical particle levels
- Fast identification of lot-to-lot variability of process chemicals

MONITORING OF CHEMICAL BLEND & DISPENSE SYSTEMS



LiQuilaz II Online Particle Sensor

Online monitoring of chemical systems is an effective means for identifying actionable particle events that occur in real time. Timely response to online data help the customer manage and optimize their chemical blending and dispense systems.

Advantages

- Fast determination of particle events and sources
- Identification of particle issues before they impact process purity
- Monitoring and optimization of chemical filtration systems
- Continuous monitoring to identify failing chemical lots, component failures, etc.

MEASUREMENT OF WET PROCESS TOOLS



UltraChem 40 Chemical Particle Counter

Monitoring of high purity streams within both batch and single-wafer process tools enables process engineers to identify and eliminate particle sources that cause critical wafer defects. Integration of online chemical particle sensors within wet process tools provide critical data that enables detection of process contamination problems. Online particle sensors support rapid sample intervals and ease of integration into wafer process tools.

Advantages

- Verification of incoming process chemical purity
- Fast determination of particle sources inside process tools
- Validation of chemical filtration performance

COMPONENT TEST



High purity components are essential for clean and reliable operation of chemical systems and wafer cleaning tools. Liquid particle data are essential for determining cleanliness of key components such as filters, valves and pumps.

Advantages

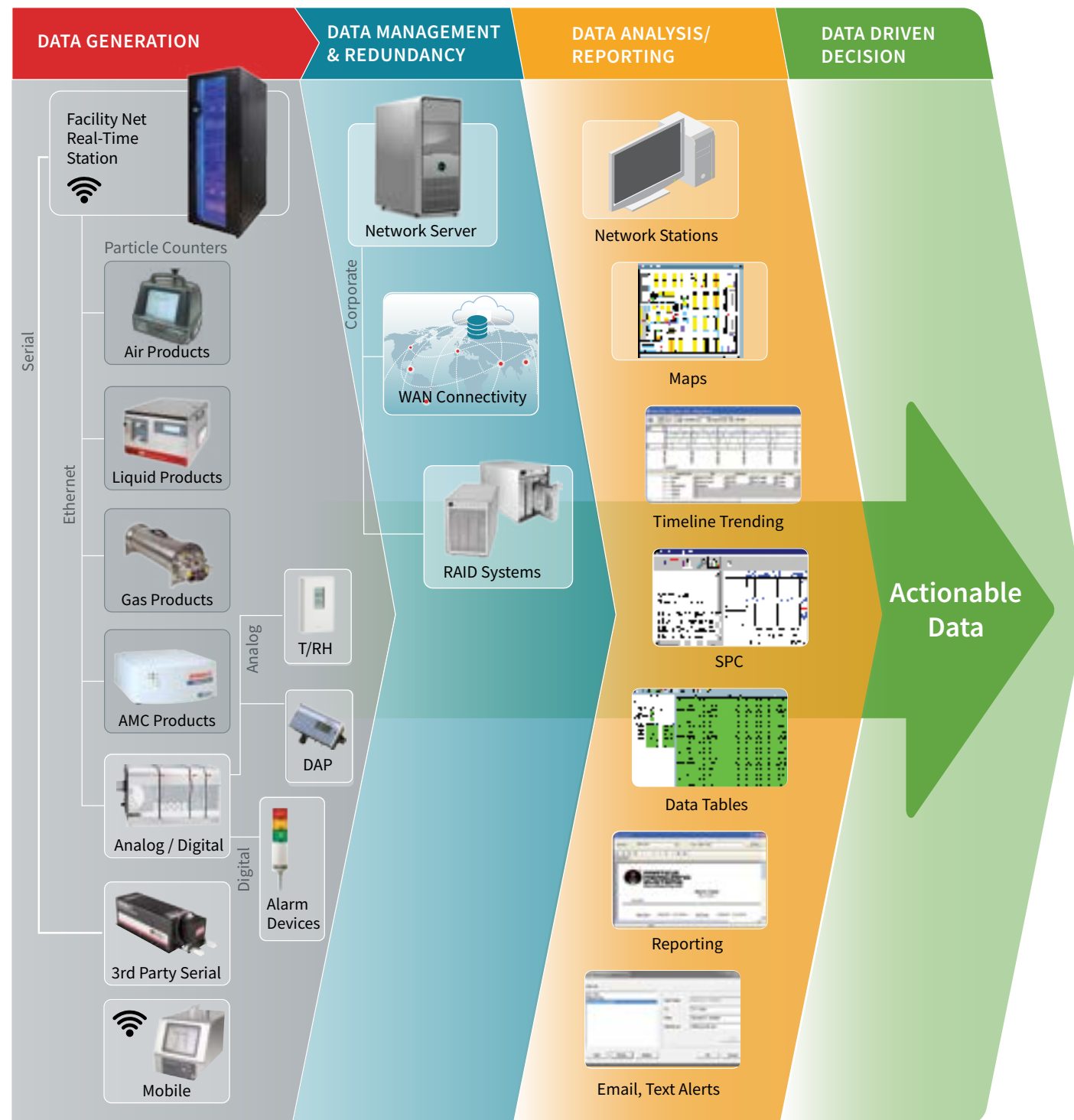
- Characterization of particle cleanliness of critical performance
- QC testing of critical chemical components
- Validation of chemical filtration performance



Scan the QR code to learn about chemical safety accessories

Facility Management Systems

Even small businesses with a single particle counter or other analyzer can benefit from a real-time monitoring system. Real-time monitoring systems can integrate data from a number of sources into a stable centralized database while providing powerful analytical and data mining tools to guide decision making. As systems become more complex, integrating data from many devices and processes, a powerful and centralized data management system becomes critical. In large corporations with many sites, wide area network connectivity allows data review across the corporation. Particle Measuring Systems' Facility Monitoring Software provides a scalable solutions to meet your evolving needs.

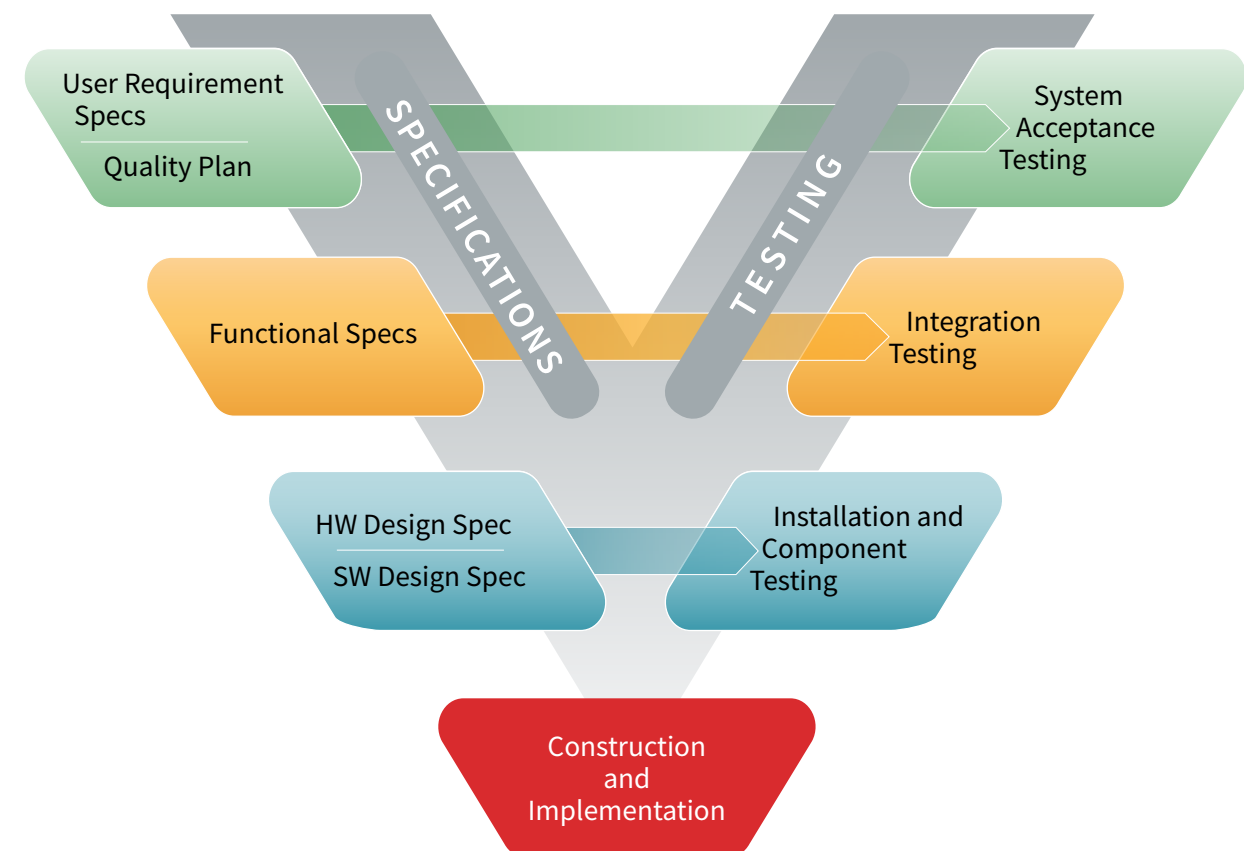


Project Services

From system design to installation, commissioning, and validation, we can guide you through a project from conception to completion.

Subject-matter experts provide you with design and analytical consulting services, including:

- Risk assessment
- Facility monitoring system design
- Design specifications
- Validation
- Project management
- User training
- Application support



Knowledge and Quality Service

EDUCATION AND TRAINING

Companies have relied on our accredited Particle College® to educate thousands of individuals on contamination monitoring and control. In addition, we offer a wide variety of pre-set and customized training services to meet the exact needs of each customer.

APPLICATIONS EXPERTISE

We partner with customers to ensure the best known methods are implemented. We have an international team of application engineers who can help you choose the right equipment solution for your specific needs and provide training on how to optimally install and implement your solution. We continue support with data analysis and advanced troubleshooting as needed.

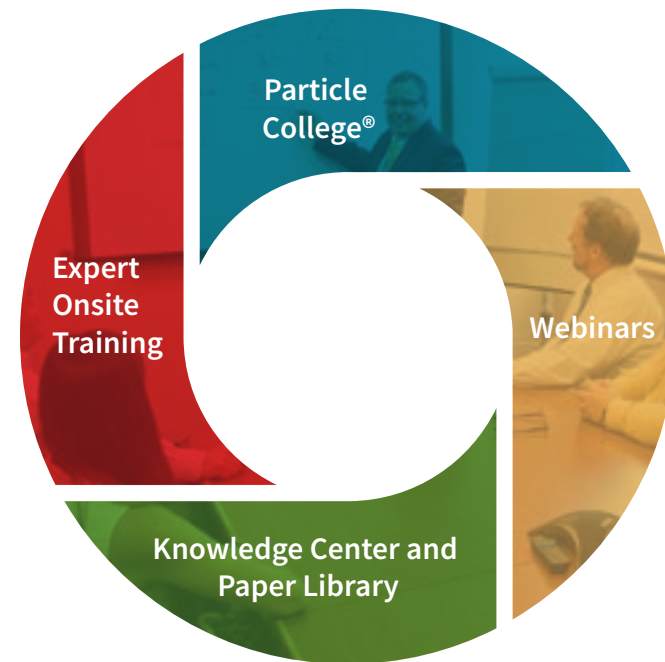
QUALITY CALIBRATION & SERVICE

Service technicians are specially trained to calibrate your instruments to the highest standards, and our software-controlled approach automates critical steps that drive consistency in each calibration. This ensures the same result and performance, consistent with factory calibration, regardless of where the calibration is performed—anywhere in the world.

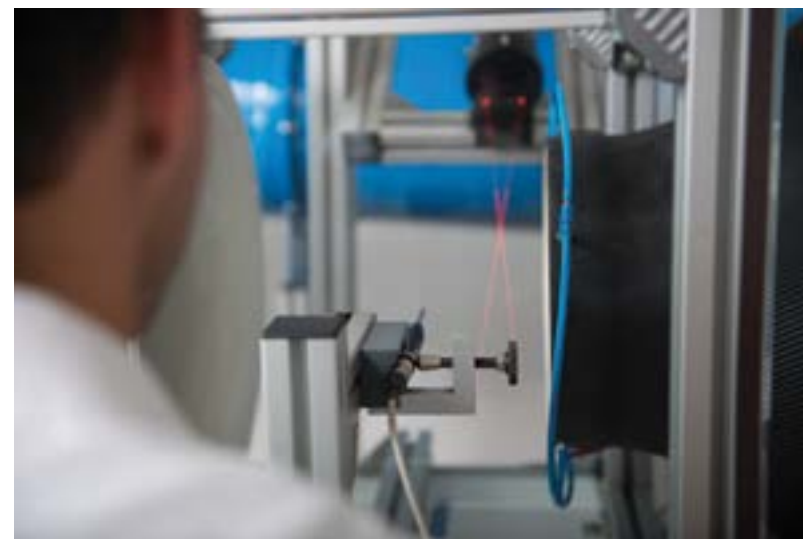
Calibration Services

- Calibration and adjustment back to factory standards
 - As Found/As Left data available
- Preventative maintenance
- Technical support
- NIST traceable
- ISO 9001:2015
- ISO 21501-4:2007
- ISO/IEC 17025*

*available at specific service centers



- Dedicated Particle Measuring Systems technician available year-round at your facility
- Service contracts for on-site calibration and repair at your facility or return-to-factory service
- Extended warranty for calibration and unexpected repairs
- Rentals and spare instruments while your particle counter is in factory for service



Why Particle Measuring Systems

SUPERIOR KNOWLEDGE

Particle Measuring Systems (PMS) is the inventor of laser-based particle counting, and we continue to lead the field with our dedication to hiring and training industry professionals. Our experts are recognized as thought leaders, evidenced through our speaking requests, webinars, authored papers, and high education levels. Our experts actively participate with customers and industry standards committees to understand the evolving needs and challenges faced by our broad customer base. Our renowned Particle College® program includes a two-day series of lectures and hands-on labs covering basic particle measuring concepts to advanced applications of contamination monitoring and control.

SUPERIOR TECHNOLOGY

A core investment in research, engineering, and product manufacturing has resulted in more than 60 patents related to our products and applications. We create the technology that enables you to make fact-based decisions, improve process yield, and comply with changing regulatory requirements. Our technology can measure particle sizes as small as 20 nm in water, 10 nm in air, and molecular contamination concentrations in parts per trillion.

SUPERIOR QUALITY

Particle Measuring Systems sets the standard for contamination monitoring in semiconductor, data storage, display, pharmaceutical, nanomaterial, aerospace, and associated industrial manufacturing applications. Grounded by a strong technical foundation, our market leadership is demonstrated through advanced detection technologies and systematic releases of innovative solutions for contamination monitoring applications.

SUPERIOR SERVICE

Our service technicians are well trained to calibrate your instruments to the highest standards, and our software-controlled approach automates critical steps that drive consistency in each calibration. All calibrations are completed in strict accordance with ISO guidelines. Particle Measuring Systems provides an unequalled counting efficiency test for first-channel sensitivity. For pharmaceutical applications, particle counters must be calibrated to the exacting standard of ISO 21501-4:2007, which includes measurements to verify and set flow rate, counting efficiency, particle sizing, resolution, signal ratios and zero count. Each calibration is also completed using NIST-traceable standards, and a certificate is provided with each calibration.

PARTICLE MEASURING SYSTEMS

Particle Measuring Systems, Inc. is the technology leader in contamination monitoring around the globe and the inventor of laser particle counting. Particle Measuring Systems has expanded into most forms of contamination monitoring, including microbial detection, airborne molecular contamination, and traditional particle counting, and PMS is a leading supplier of advisory services related to contamination control.

VALUES

Be True. We believe in absolute integrity. It's how we win for stakeholders, the environment and each other. **Own it.** We believe in teamwork and keeping our promises. It's how we build our brands and businesses. **Aim High.** We believe in being bold and positive. It's how we perform at our best and achieve greater success.

MISSION STATEMENT

We continually push the boundaries of contamination monitoring and control to enable clean manufacturers' success by providing invaluable insights through:

- Leading technology
- Quality service
- Collaborative solutions; and
- Unmatched expertise.

All made possible by our global team of dedicated and creative individuals.

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**PARTICLE
MEASURING
SYSTEMS®**

a spectris company