



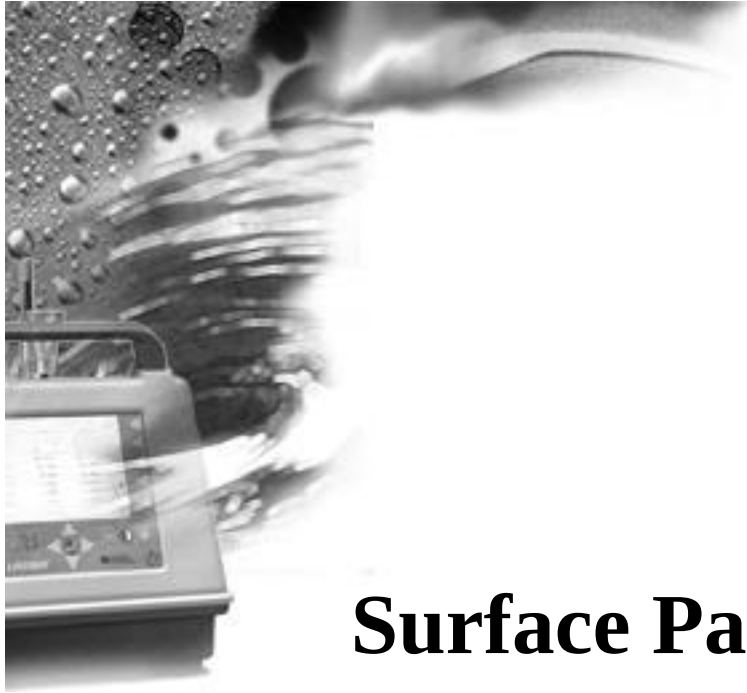
New Applications



Agenda



- **Surfex tool for parts cleanliness testing**
- **Monitoring CMP slurries**
- **Monitoring process gases**
- **Facility Monitoring Systems**



Surfex

**Surface Particle Extraction System
for
Cleanliness Testing of Complex Parts**

Motivation



- **Increased cleanliness requirements in many industries**
- **Good methods exist to measure cleanliness of flat parts**
 - Surface scans in semiconductor manufacturing
 - Particle counters for flat surfaces
- **Need tool for measuring cleanliness of FOUPs, cassettes, and other complex parts**

Surfex



Innovation



Ultrasonic energy removes particles from part, particle counter measures particle concentration

- **Only complete, integrated system available for testing of complex parts**
- **Interactive software allows recipes to be configured by the user**
- **Consistent results**

Benefits



- **Controls test system, environment, and extraction procedure to provide significantly better data**
 - Consistent time, ultrasonic energy, and sample procedure
 - Simple to use
- **Eliminate operator error and variability**
 - User configurable recipes assure the testing is done the same every time.
- **Ideal for analysis of irregular shaped objects, or parts constructed with multiple materials**
 - Ultrasonic energy effectively extracts particles for measurement
 - Multiple ultrasonic frequencies available



Applications

■ **Semiconductors**

- Particles could “kill” a microelectronics chip
- FOUP, SMIF, wafers
- Cleaning process evaluation
- Evaluate the cleanliness of parts for process tools
- Assess cleanliness of gloves and other consumables

■ **Disk drives**

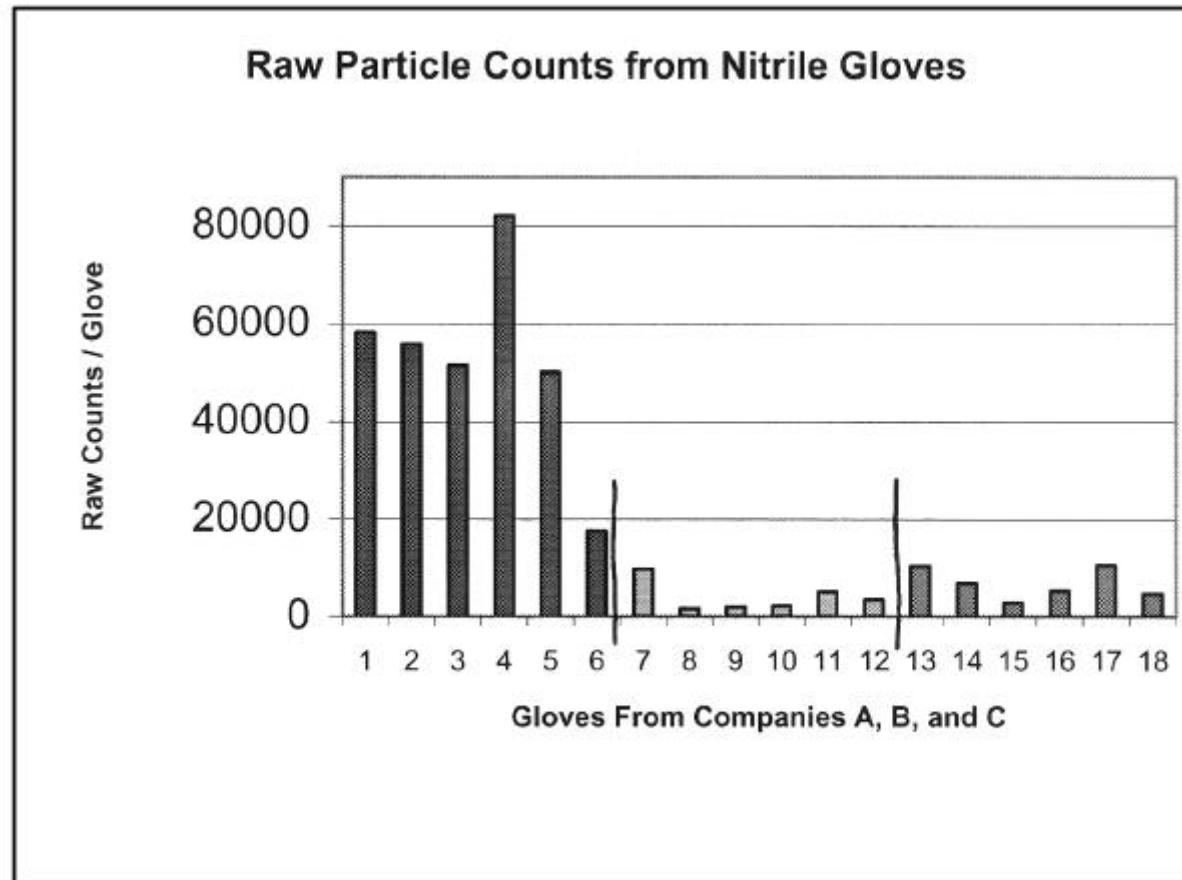
- Particles on disk might cause ‘Head Crash’
- HAS, Media, fasteners, cases



Glove Testing

- **3 different manufacturer's gloves tested**
- **Widely different cost**
- **Showed 2 are of similar cleanliness, one much dirtier**
- **Chose least expensive of the 2 clean gloves**

Glove Testing

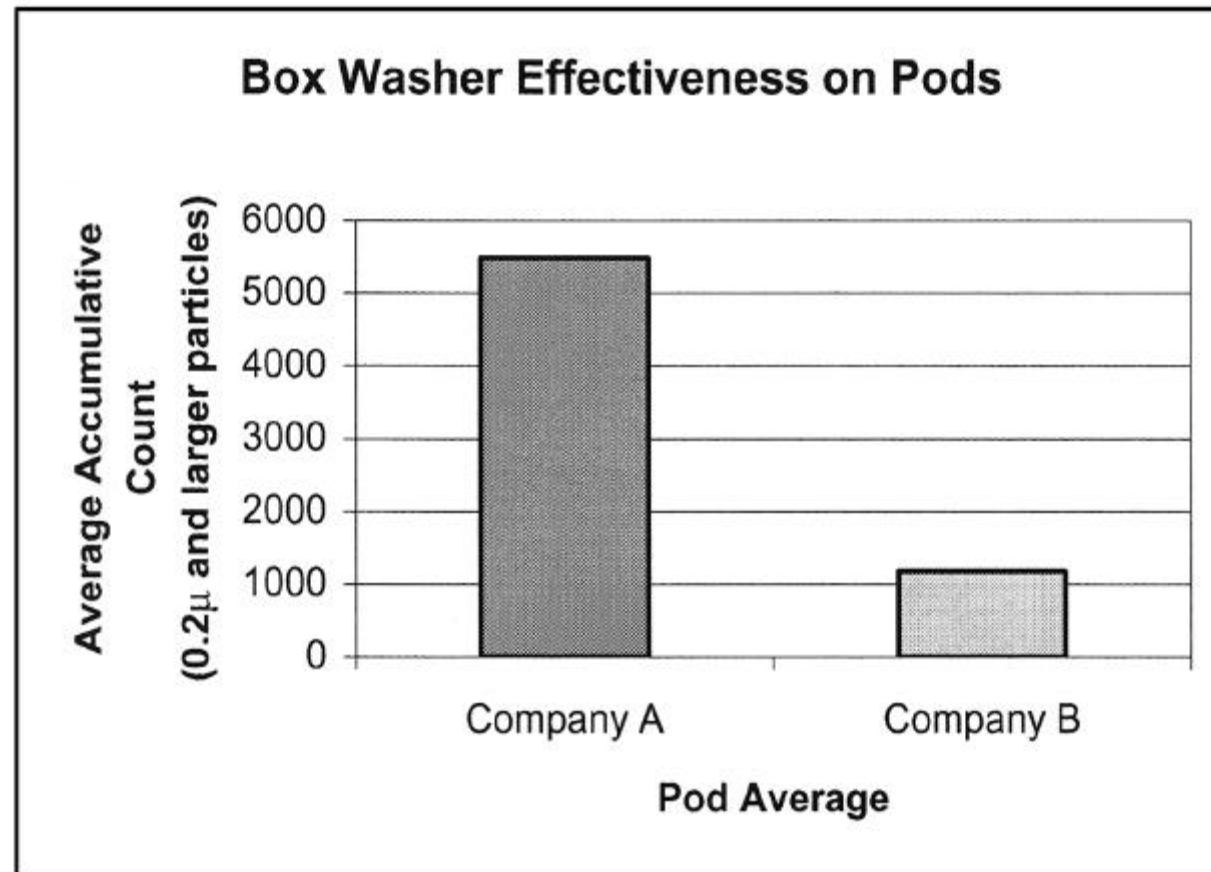


Pod and Cassette Testing:

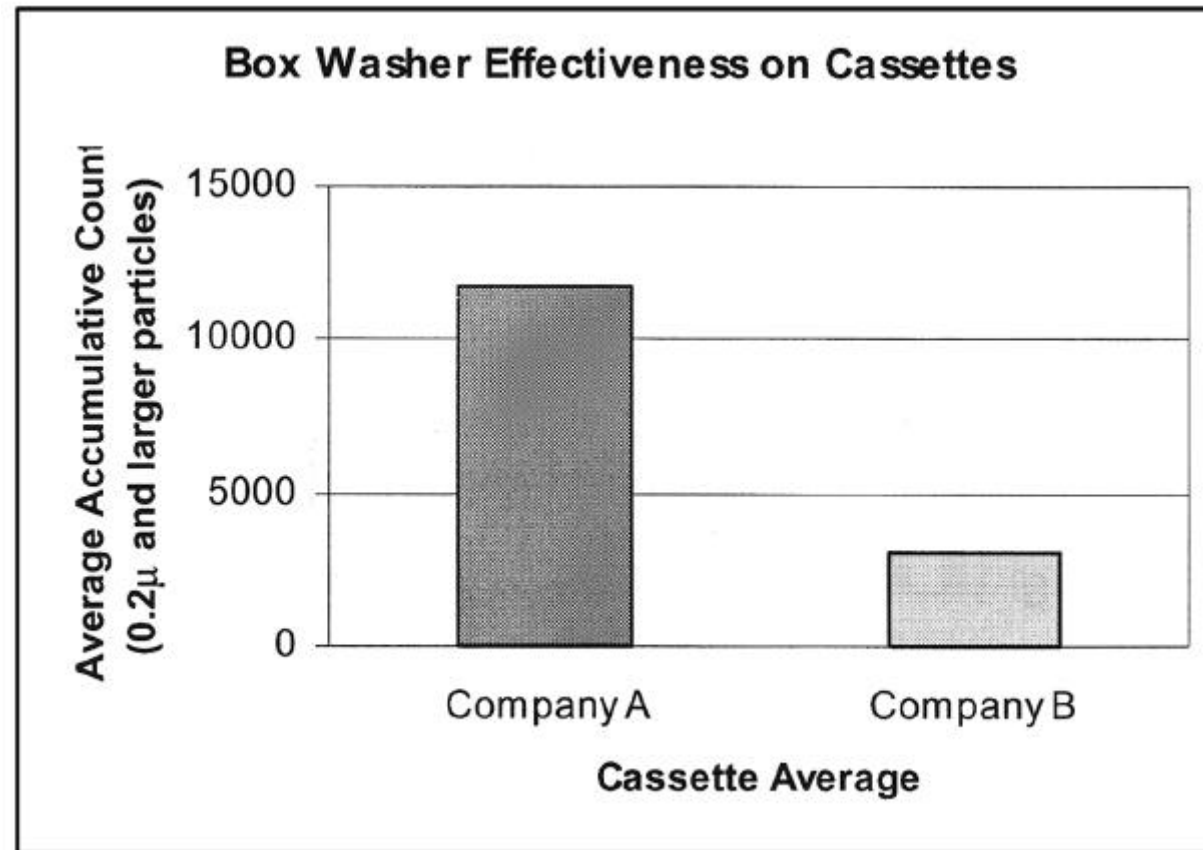


- **Needed to evaluate cleaning tools from different manufacturers**
- **Test 12 Pods through each cleaner, Pods similarly dirty before cleaning**
- **Test 12 cassettes through each cleaner**
- **Able to see clear difference in cleaning ability of different tools**

Pod Testing



Cassette Testing



Conclusion



- **Complete integrated system for testing FOUPs and other complex parts**
- **Interactive recipe driven software to control testing**
- **Achieve consistent results by eliminating operator error and variability**





Monitoring CMP Slurries

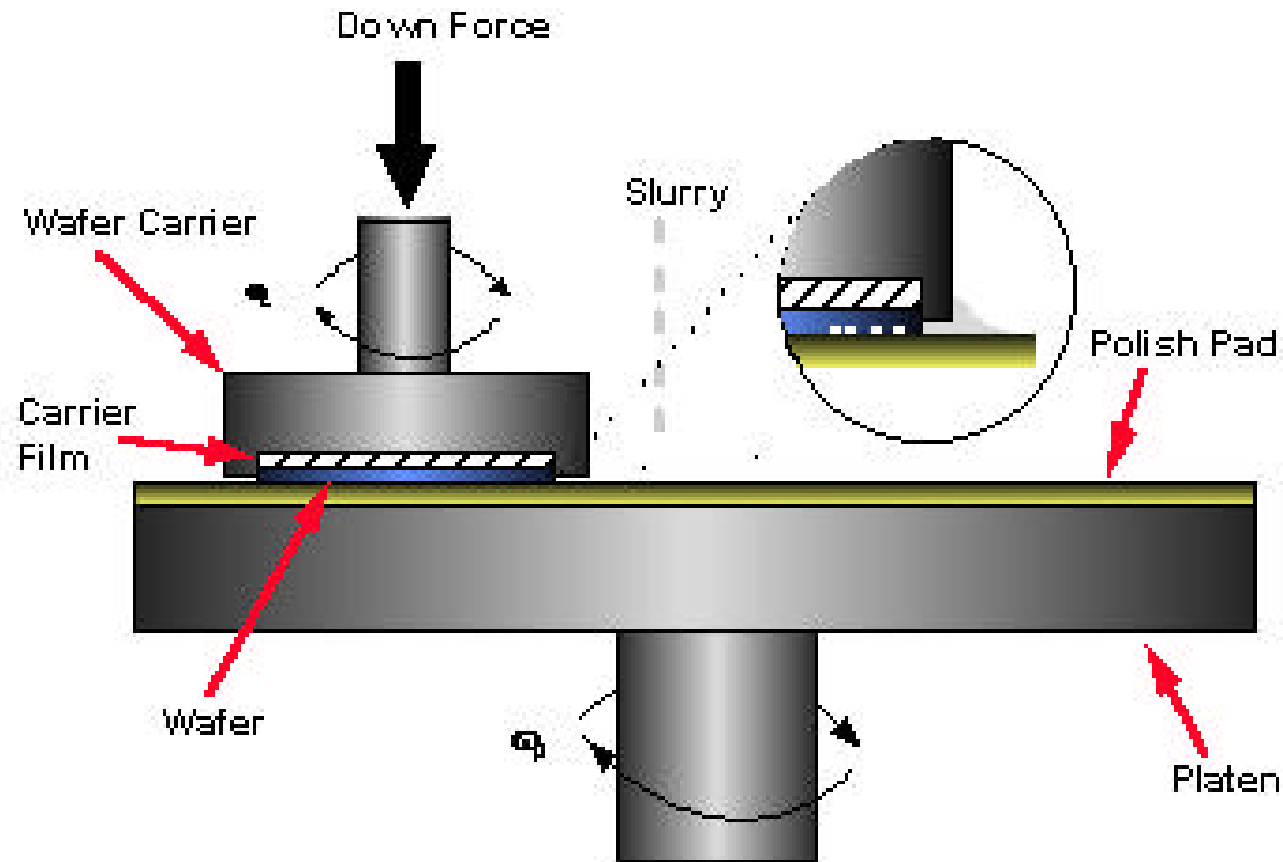


CMP: Chemical Mechanical Planarization



- **CMP slurry is used to planarize semiconductor wafers, disk media, glass panels and optics**
- **CMP process removes precise amounts of material from a wafer to create a very flat surface**
- **CMP process minimizes device failures and improves processing yield**
- **CMP is the most yield critical process in the Fab**

CMP: Chemical Mechanical Planarization



Monitoring Techniques CMP Slurry



- **Particle counters using dilution**
- **Dynamic light scattering**
- **Spectral Transmission**



Optical Particle Counters



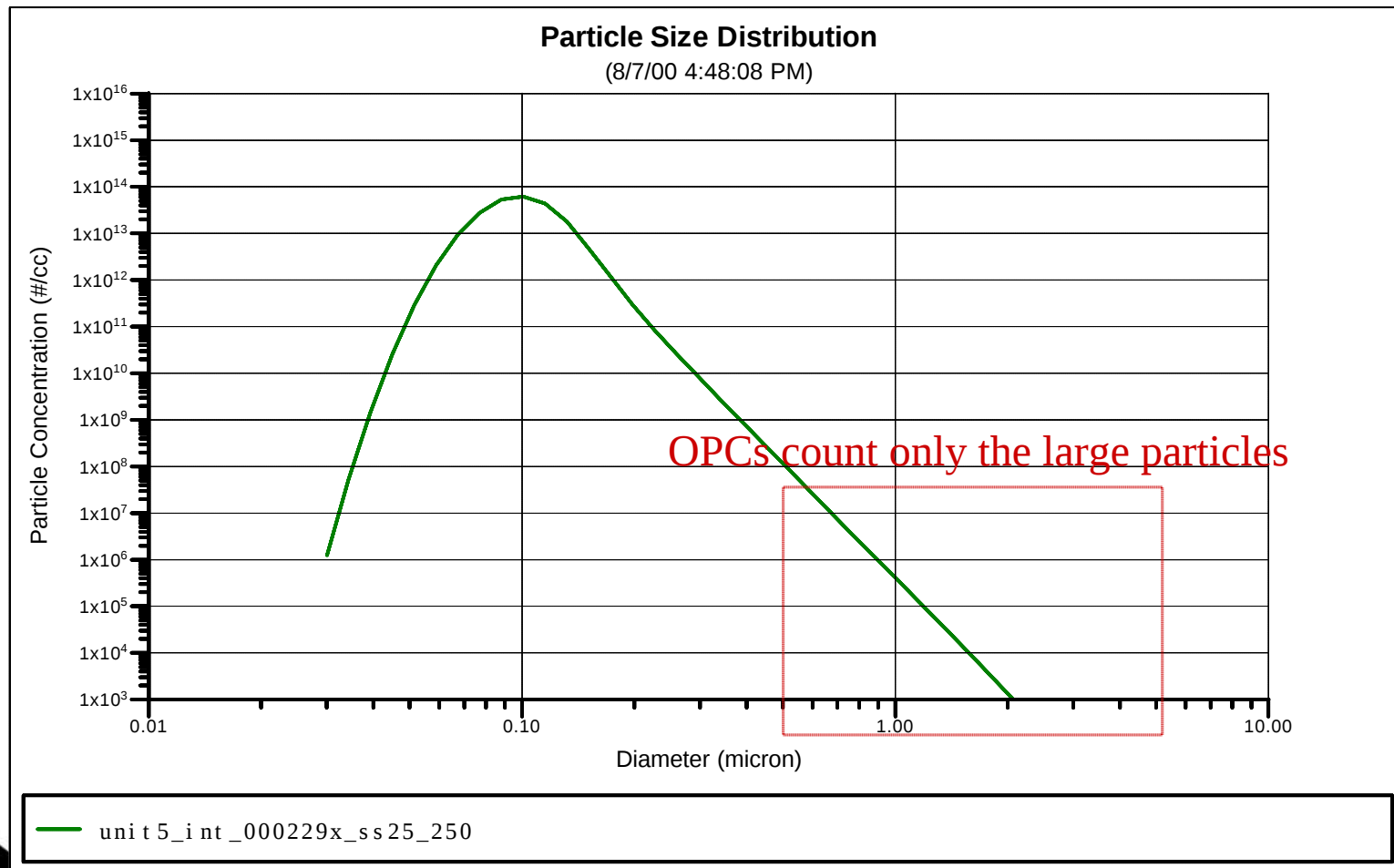
- **Dilute slurry so only one particle >0.5 microns goes through the laser at a time**
- **Particle counter counts and sizes particles**
 - Only larger than 0.5 microns
- **Pros**
 - Easy to understand
 - Very quantitative
 - <10 particles/ml larger than .5 microns (example)

Particle Counting Drawbacks

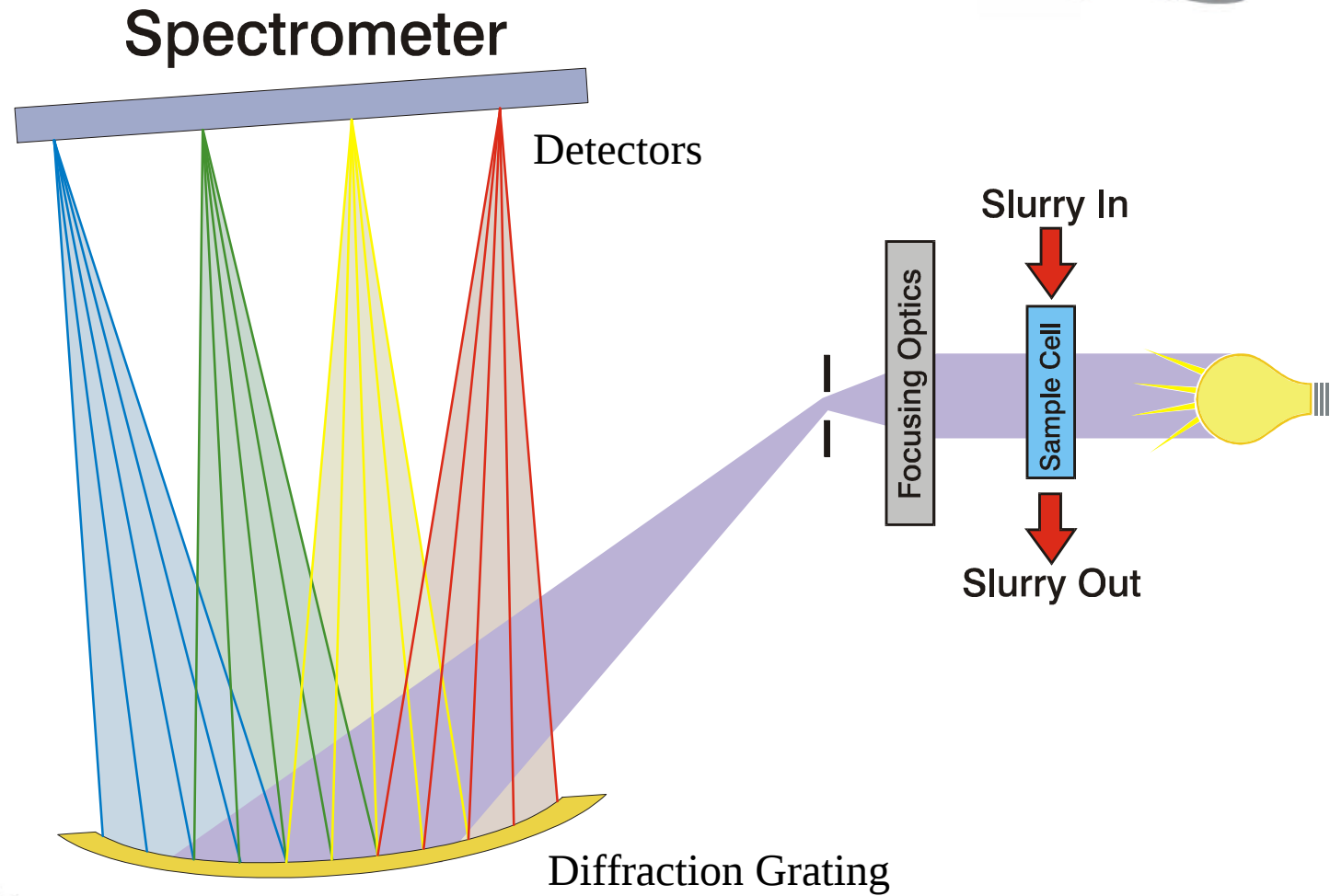


- **Designed to count relatively few particles**
 - High purity acids and DI water
- **Must dilute the sample (typically 1000x)**
 - Dilution may change the slurry
 - Dilution systems unreliable
- **Optical coincidence**
 - High number of particles in slurry
 - Cause inconsistent results
- **Particle counters only measure the large particles in dilute slurry**
 - No information on the mode

Particle Counting Drawbacks



Spectral Transmission



Spectral Transmission Products

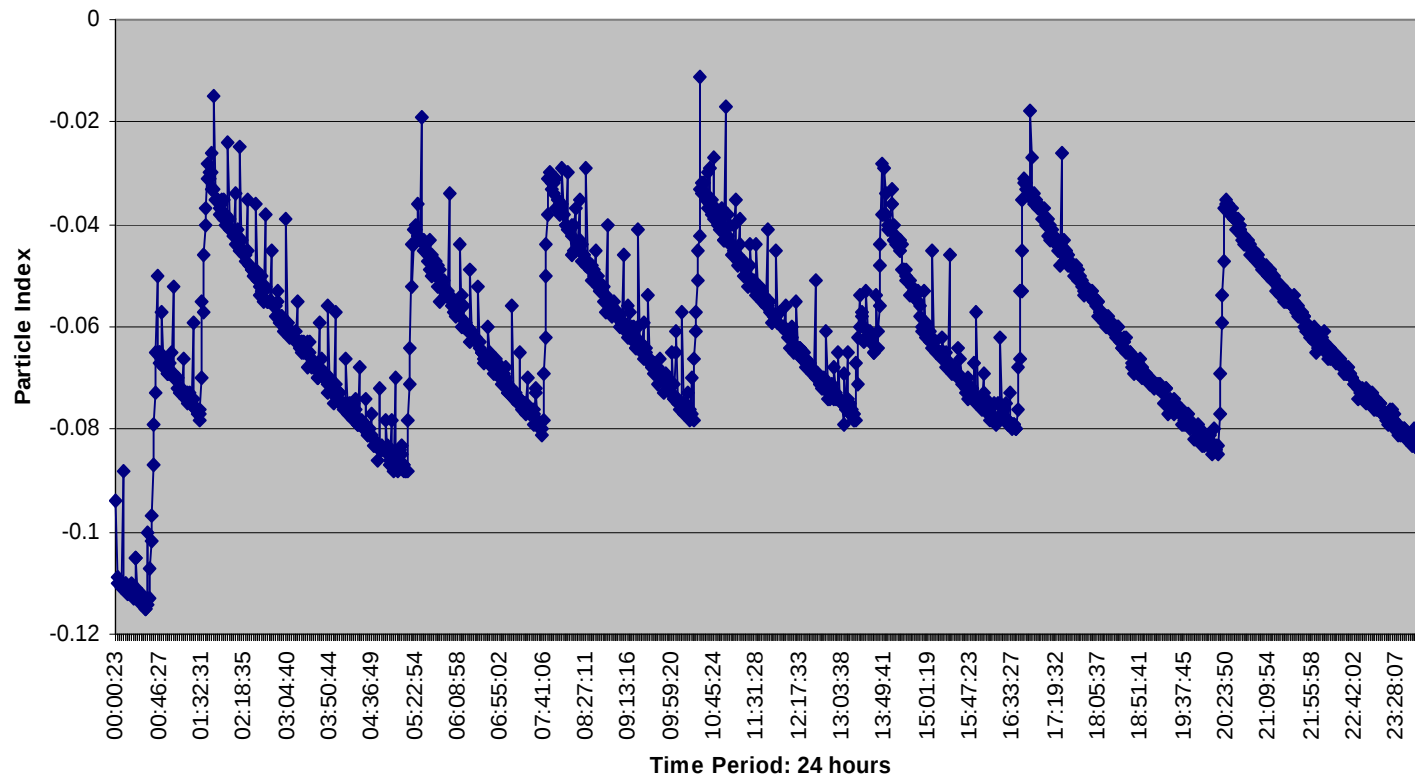


- **No dilution**
- **Very sensitive to changes in Slurry**
- **Low maintenance**
- **Two products available**
 - SlurryChek
 - Full PSD, container sampling, on-line
 - SlurryAlert
 - Very sensitive
 - Low cost
 - On-line monitoring

Filter Breakthrough Online monitoring



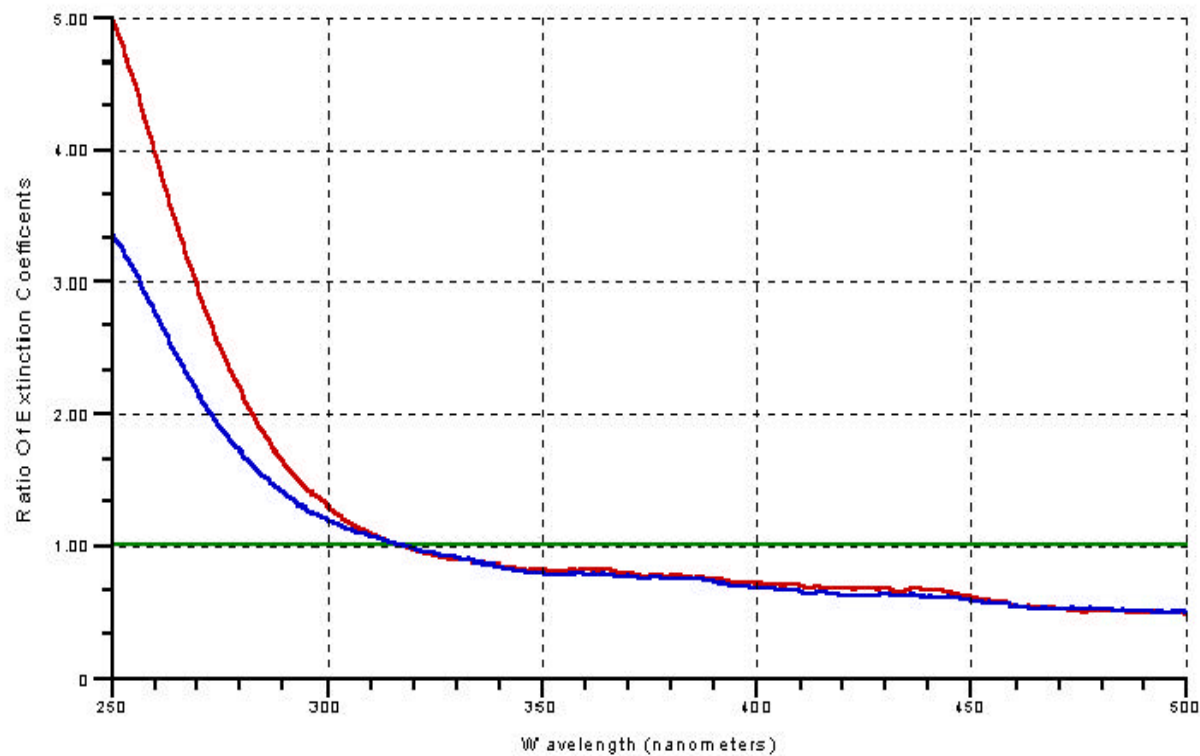
Alumina Slurry Particle Index DAY 2



Hydrogen Peroxide Sensitivity



Extinction: UV Thin



0% H₂O₂ 3% H₂O₂ 6% H₂O₂ in Silica Slurry

Summary



- **Continuous monitoring of undiluted slurry**
- **Reduce defects**
 - Identify increases in the number of large diameter particles responsible for wafer scratching
- **Improve consistency of the CMP process**
 - Provide correlation to removal rates and time to endpoint
 - Detect change in percent solids and mean particle size
- **Multiple monitoring locations:**
 - In-coming quality control
 - Post mixing distribution
 - Point of use

Online monitoring of CMP slurry reduces process variability

Monitoring Gases

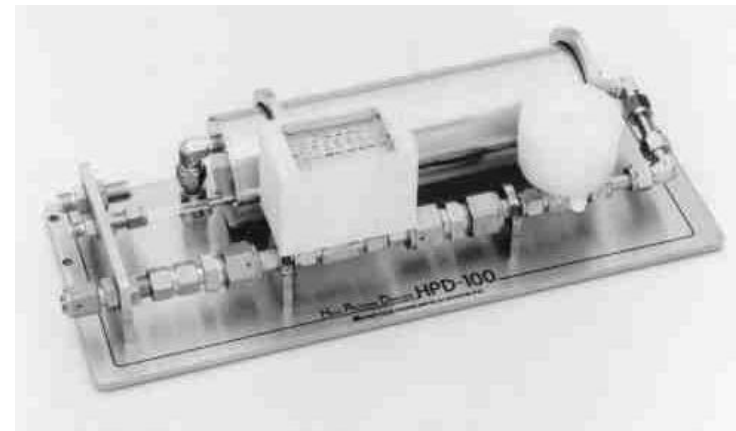
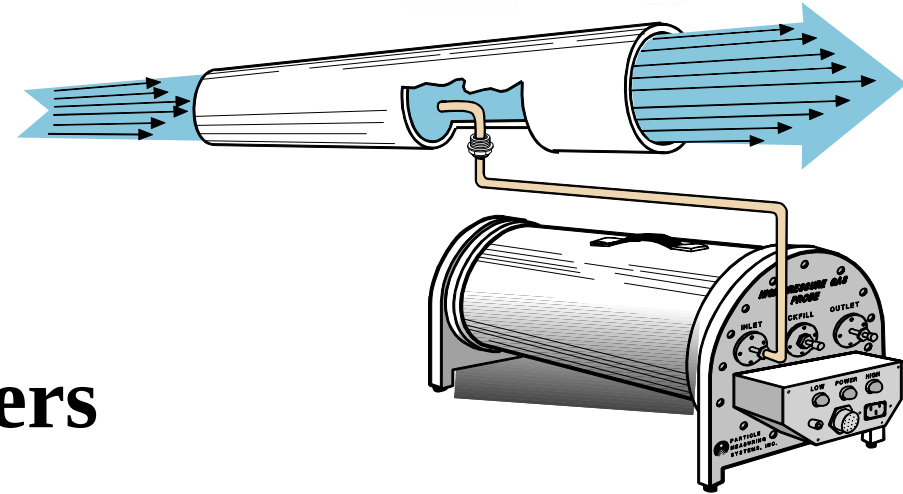


- **Direct impact on process**
 - Gases must be very pure
- **Particles**
- **Moisture**
- **Molecular contamination**



Gas Line Monitoring for Particles

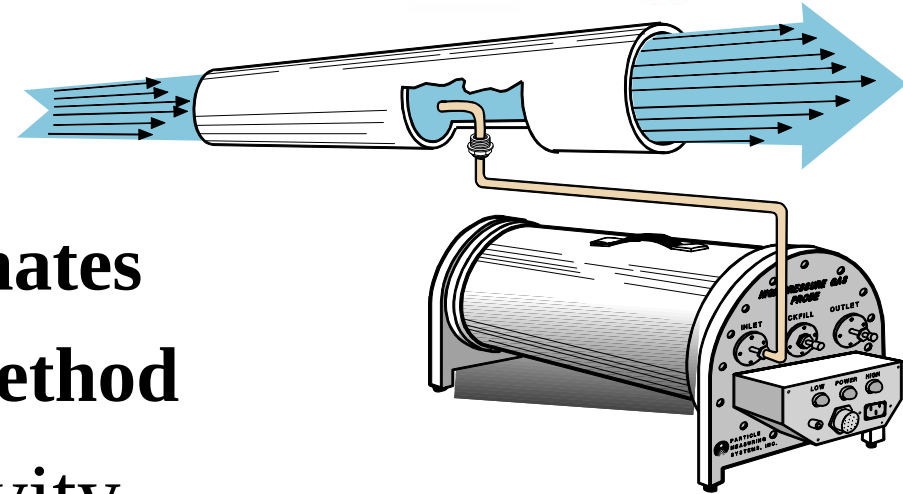
- High pressure gas or air lines
 - High Pressure Gas Probes (HPGP)
- High pressure diffusers
 - Reduces gas pressure to ambient
 - Adapts to aerosol counters or CNCs



High Pressure Gas Probe



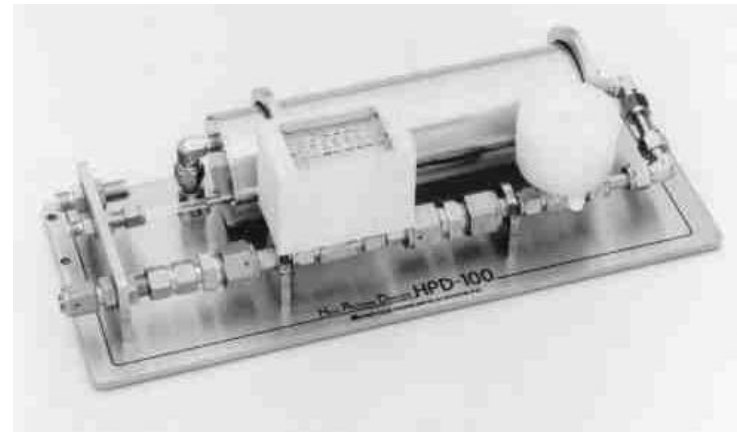
- Measures gases at pressure
 - Reduce contaminates
 - Most accurate method
- 0.1 micron sensitivity
- Measure reactive gases
 - Oxygen and Hydrogen
- Also measure non-reactive gases



High pressure diffusers



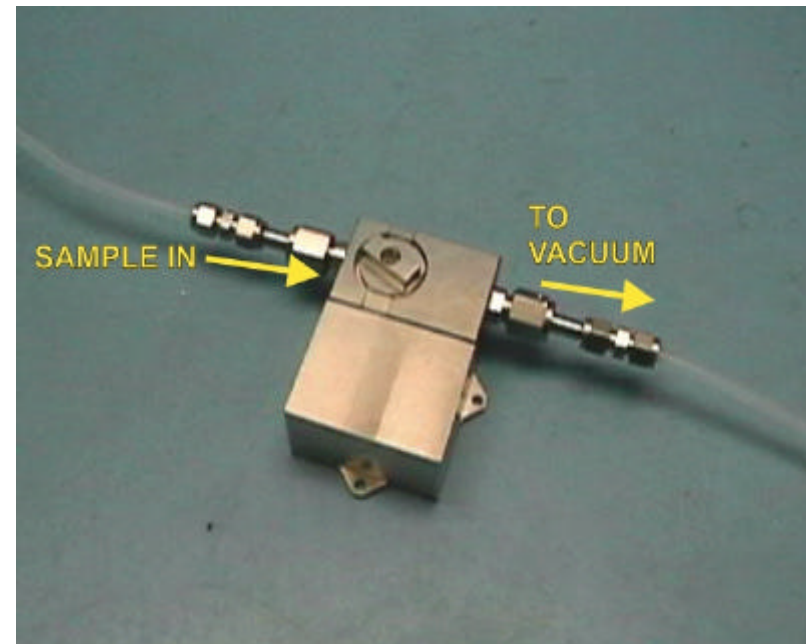
- **Connect to separate particle counter**
 - 0.1 micron Lasair
 - 0.06 microns UltraAir 0610
- **Only for non-reactive gases**
 - Nitrogen
 - Clean dry air
 - Argon
 - Helium



Molecular Contamination



- **Molecular contamination very important in process gases**
 - Moisture
 - Oil
- **AiM-FT for monitoring gases up to 100 psi**
- **Use regulator to measure contamination in gas cylinders**



Gases summary



- **Gas touches product many times – Need Monitoring**
- **HPGP most accurate and versatile tool**
- **HPD for inert/non-reactive gases**
- **AiM-FT for molecular contamination**



Facility Monitoring Systems

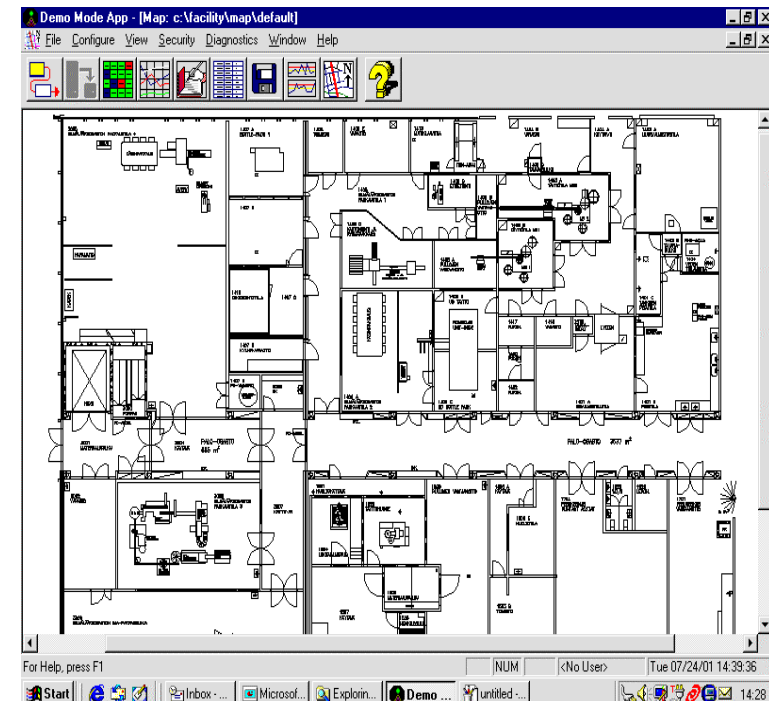
Monitor particles and environmental conditions throughout your cleanrooms.



FMS Outline



- **Benefits of automating and centralizing data collection, and de-centralizing information distribution**
- **System Requirements & Functions**
- **Ability and importance of mixing multiple sampling techniques**
- **User interfaces – changing data to information**



Facility Monitoring System Benefits

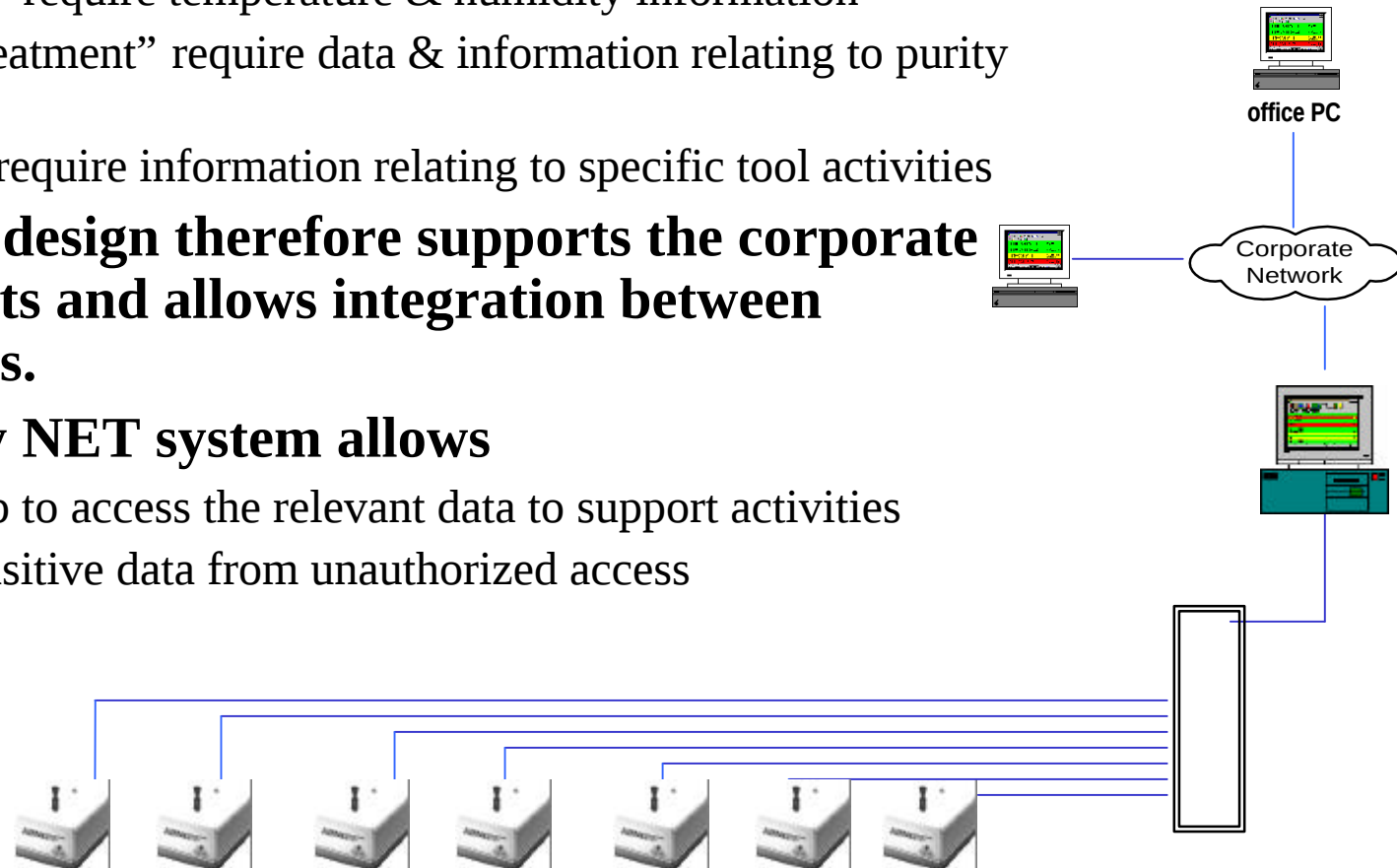


- **Proves maintained compliance with cleanroom standards**
 - ISO14644–1
 - FS209E (being phased out)
- **Centralized data collection and data reduction**
 - Improved monitoring
 - Real-time, all the time
 - Reduced employee workload
 - Improve facility coverage
 - Isolate users from instrument idiosyncrasies
- **Data analysis reduced and distributed automatically**
 - Fast data analysis and communication of process information
- **Integrate data from multiple sources**
 - Environmental sensors – particle counters
 - Process tools
 - Operator data entries

System Requirements



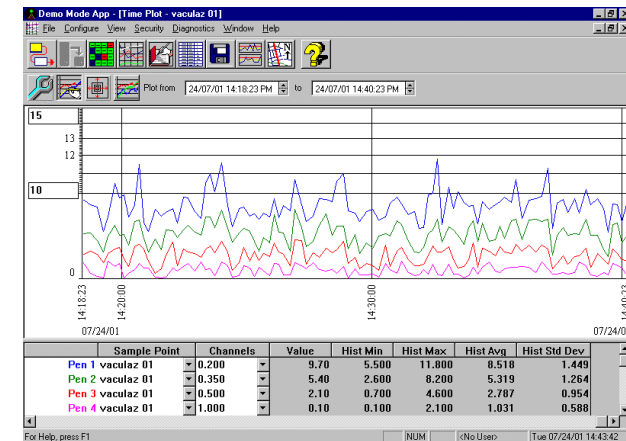
- **Different departments have responsibilities for different types of sample data**
 - “Facilities” require temperature & humidity information
 - “Water Treatment” require data & information relating to purity levels
 - “Process” require information relating to specific tool activities
- **The system design therefore supports the corporate requirements and allows integration between departments.**
- **The Facility NET system allows**
 - Each group to access the relevant data to support activities
 - Protect sensitive data from unauthorized access



System Functions



- **Built in data storage redundancy and auto-archiving.**
- **Data export to other packages**
 - OPC – Ethernet standard data exchange protocol
 - TCP/IP database export
 - RS232 ASCII data export
 - Reported data as *.csv; jpeg; *.bmp; *.wmf & HTML
- **Standard graphs and charts**
 - Trend analysis
 - Event correlation
 - Statistical Process Control (SPC)
- **Communications capabilities**
 - TCP/IP Ethernet
 - RS232/485
- **Facility Net data networking,**
 - Allows operators to review data anywhere in the facility

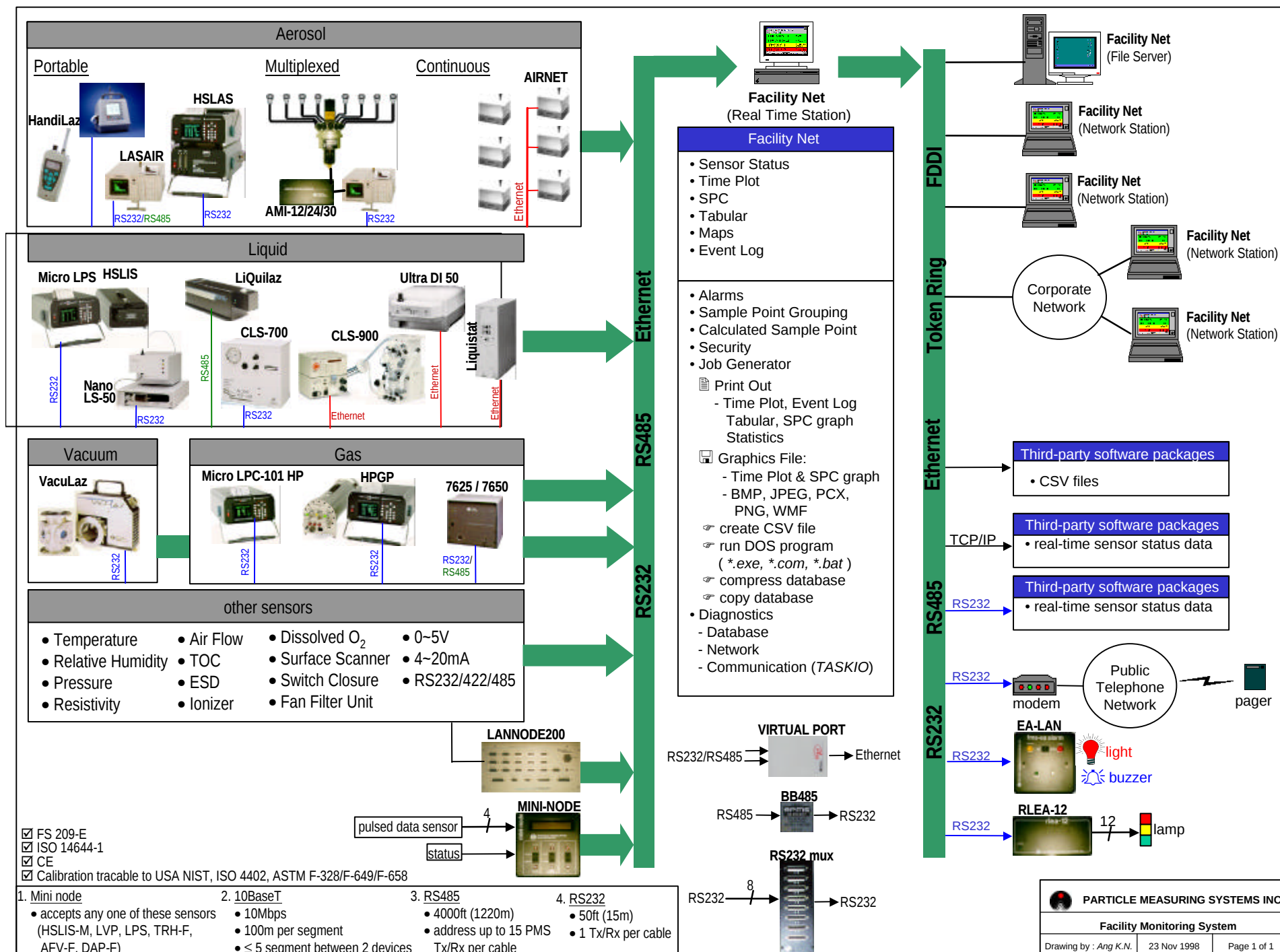


System Functions



- **Facility Net systems integrate sensors from ALL media types – Gas – Liquid – Aerosol & Vacuum**
 - Instrument configuration done on-line & on-the-fly
- **Environmental monitoring sensor input capabilities**
 - Differential Pressure; Temperature & Humidity; Air flow velocity; Resistivity; Conductivity...
 - Molecular Contamination
 - ESD monitors
 - TOC Sensors
- **User configurable alarms**
 - 4 level, on-the-fly alarm configuration
 - SPC alarm thresholds
- **System Alarm outputs**
 - Paging & Email
 - Alarm beacons and sirens (traffic lights)
 - Remote activation of process operations (start-up/shut-down)

Sensor Status			
ALARM2	0.00	R112 H03	65.68
ALARM3	0.00	R112 P07	
PR T18	8.41	R112 T03	-4.65
PR T19	38.61	R112 T09	-0.23
R10 T12	9.54	R114 D07	4.97
R10 T13	2.54	R114 H04	88.54
R10 T14	-44.51	R114 M09	78
R10 T15	69.29	R114 P08	
R10 T16	-20.52	R114 T04	57.97
R10 T17	-39.46	R115 D08	27.39
R101 D01	10.65	R115 H11	57.86
R101 P01	166	R115 P10	
R105A D02	14.91	R115 T11	5.53
R105A P02	82	R202 D09	60.41
R106 D03	13.56	R202A D10	48.10
R106 P03	100	R202A P11	
R109 D04	55.96	R203 D12	32.33
R109 P05	96	R203 P12	
R111 D05	6.60	R207 D11	13.06
R111 H01	64.56	R207 D13	53.96
R111 P06		R207 P13	
R111T01	-46.42	R207 P14	
R112 D06	-48.49	R208 D14	9.67
		R208 H05	92.13
		R208 P15	
		R208 T05	4.77
		R210 D15	28.31
		R210 H06	18.93
		R210 M16	50
		R210 P17	
		R210 T06	25.55
		R211 D16	55.94
		R211 H07	90.91
		R211 M19	62
		R211 P18	
		R211 T07	-4.92
		R212 D17	38.46
		R212 P20	
		R214 D18	39.45
		R29 T08	-0.43
		settle plate	
		vacuaz 01	7
		WH T20	-39.36
		WH T21	-26.62

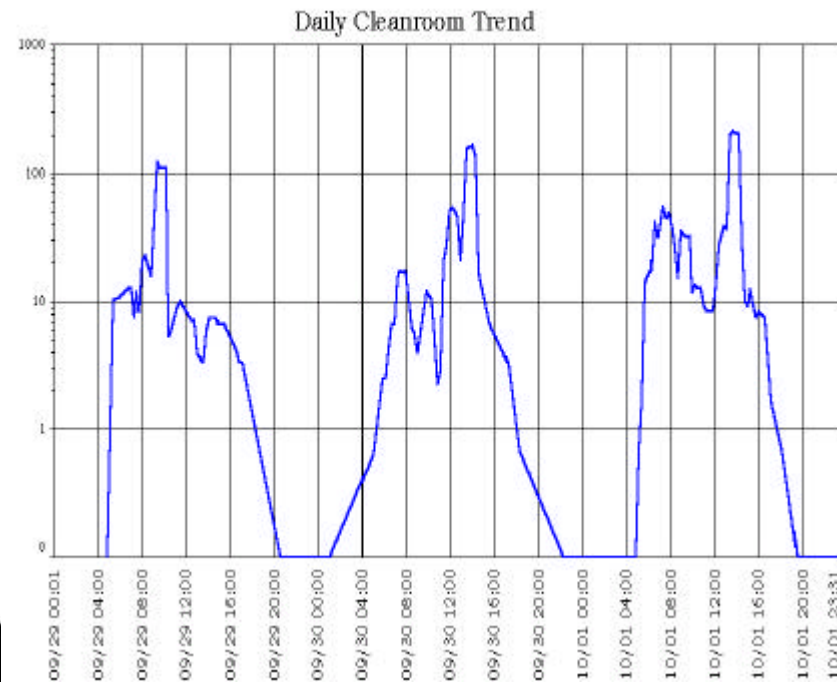


Particle Data Interpretation

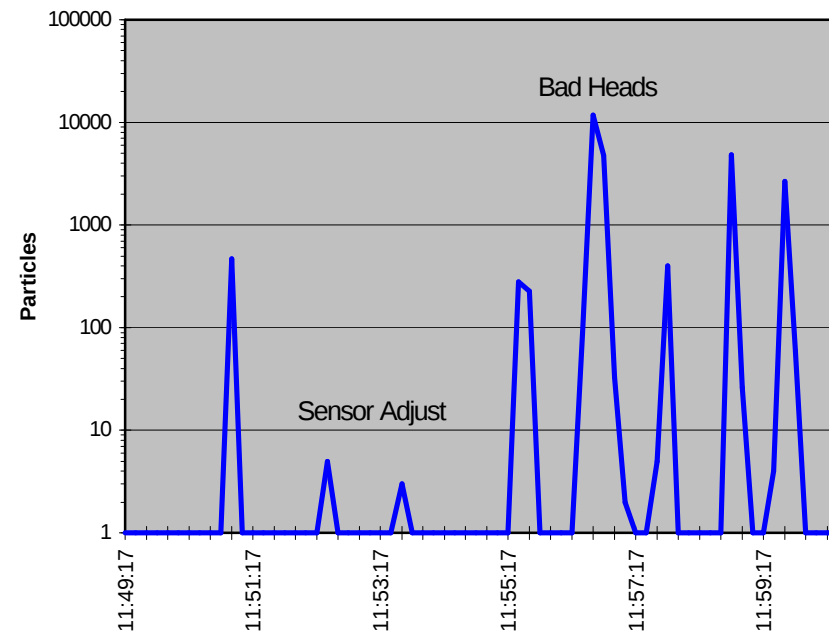
Cyclic Data



- Activity patterns
 - manufacturing shifts
 - Work flow



- Process signature
 - Recipe flow
 - Sequencing



Facility Monitoring Summary



- **Facility Monitoring software ties all the applications together**
- **Makes the data more useful**
 - Becomes information
 - Alarms
 - Reports
 - SPC
- **Provides better monitoring than other approaches**
- **Reduces manpower requirements**