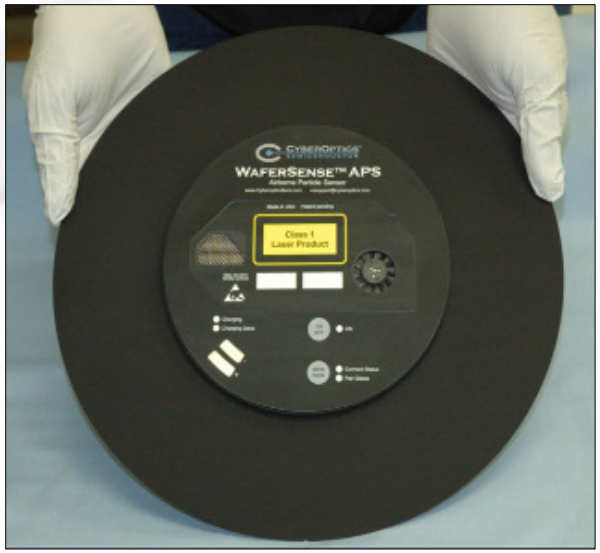
WaferSense APS Wireless Particle Counting Wafer

Improves Semiconductor Tool Particle Qualification

Case Studies

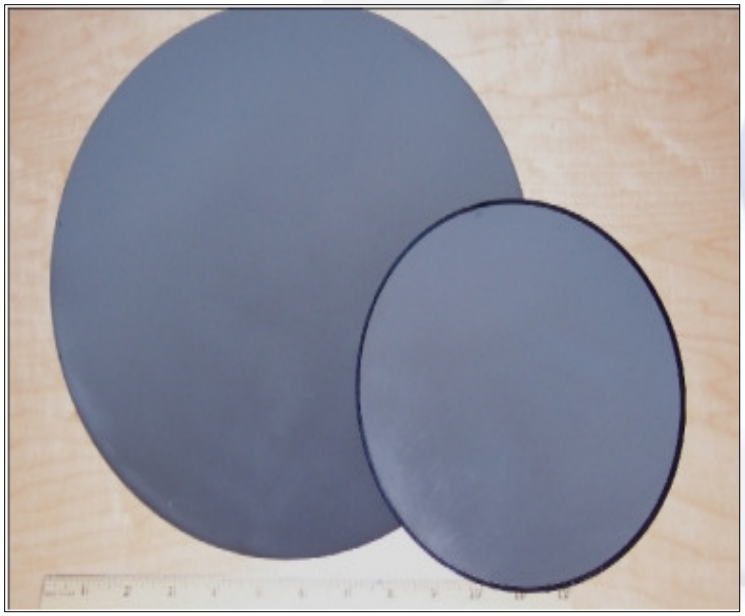


WaferSense Field Application Engineering
CyberOptics Semiconductor, Inc.
www.cyberopticssemi.com
(503) 495-2200

Contents:

- APS Technology review
- 300mm HDP Tool particle reduction case study
- 200mm Cassette & Lot Box particle control case study
- APS ROI and Benefit Summary

Traditional Semiconductor Particle Counting Methods



Monitor Wafers & Surface Scanning

Bench top

Hand held

Particle Qualification Technology

- **Particle Counting with Monitor Wafers:**
  - Monitor wafer surface scanning is the popular method to qualify a tool for production
  - High performance surface scanners can detect 50 nM particles
  - Monitor wafer scanning is time consuming; sometimes long delays waiting for results
  - 100nM and smaller particles sometimes "jump off" monitor wafers; results sometimes ambiguous
  - Surface scanning is not "real time"; so difficult to know "when" and "where" monitor wafers became contaminated
  - Monitor wafers follow the path of the wafer but provide little information about the location of contamination in the tool
  - Partitioning with multiple monitor wafers is often required to locate the source of particle contamination

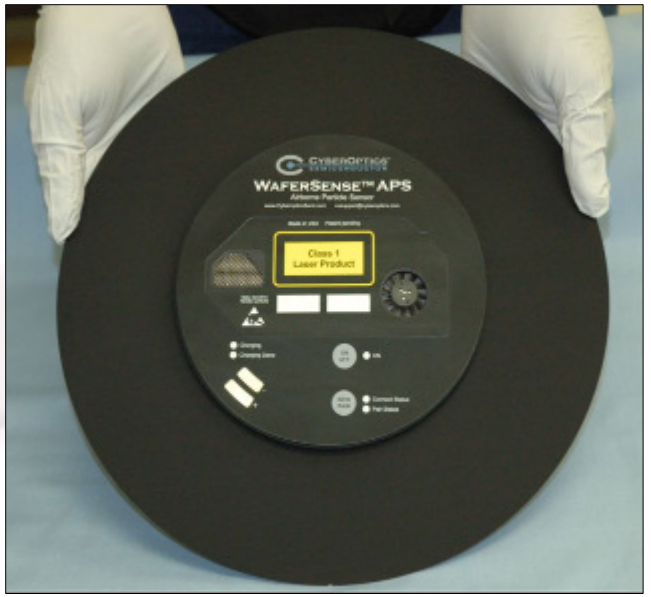
Legacy Troubleshooting Technology

- **Particle Counting with Bench Top Airborne Particle Counters:**
  - High performance bench top counters can detect 0.1 Micron particles
  - Bench top counters require long hoses to reach into the tool
  - Bench top counters cannot follow the wafer path
  - Equipment Engineers sometimes must crawl through and/or climb up to make measurements
- **Particle Counting with Hand Held Airborne Particle Counters:**
  - High performance hand held counters can detect 0.3 Micron particles
  - Difficult to reach all locations of interest
  - Equipment Engineers sometimes must crawl through and/or climb up to make measurements

Alternative Technology:

WaferSense® Airborne Particle Sensor (APS)

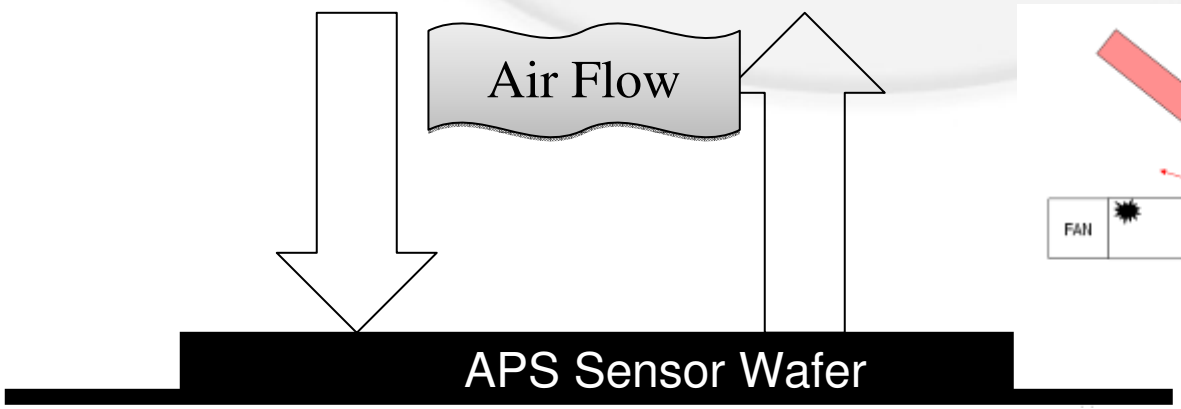
- **Wafer-like, wireless, 100 nM capable**
- **Moves through semiconductor process equipment and automated material handling systems to monitor airborne particles inside the systems**
- **Follows the wafer path to detect where particles fall on the wafer in REAL-TIME**
- **Particle data can be recorded to compare past to present as well as tool to tool**

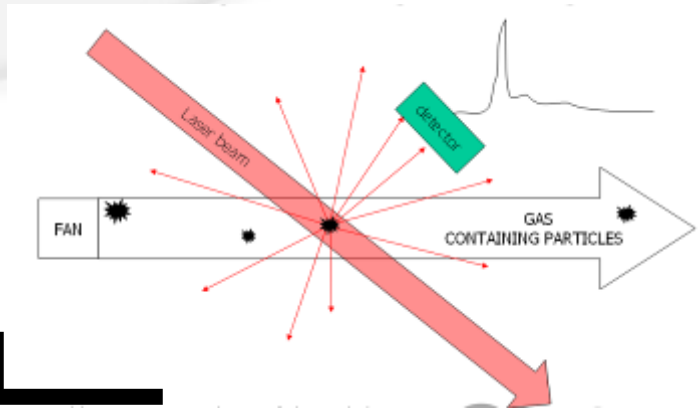


APS300

APS Concept

- Some partial pressure of air or inert gas carries particles to APS, active airflow across detector region
- Laser based particle detector inside APS sensor
- Uses light scattering to detect particles in gas stream
- Wireless communication of particle data in "real-time" to PC





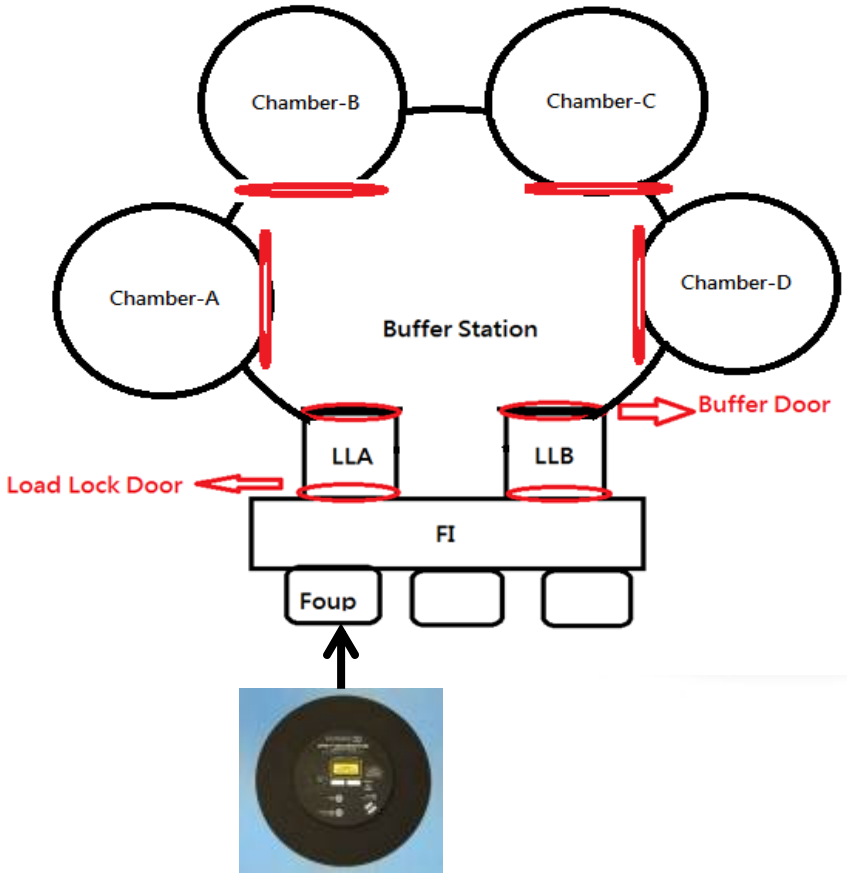
300mm HDP Tool Particle Reduction

Case Study

Problem Statement:

High wafer defect rate of unknown origin

HDP Tool APS Test Procedure:



- **Wafer Path**

Place APS into FOUP

> FI > LLA > Buffer Station

> Rotate robot (In buffer Station)

> Chambers A through D

- **Additional Monitoring**

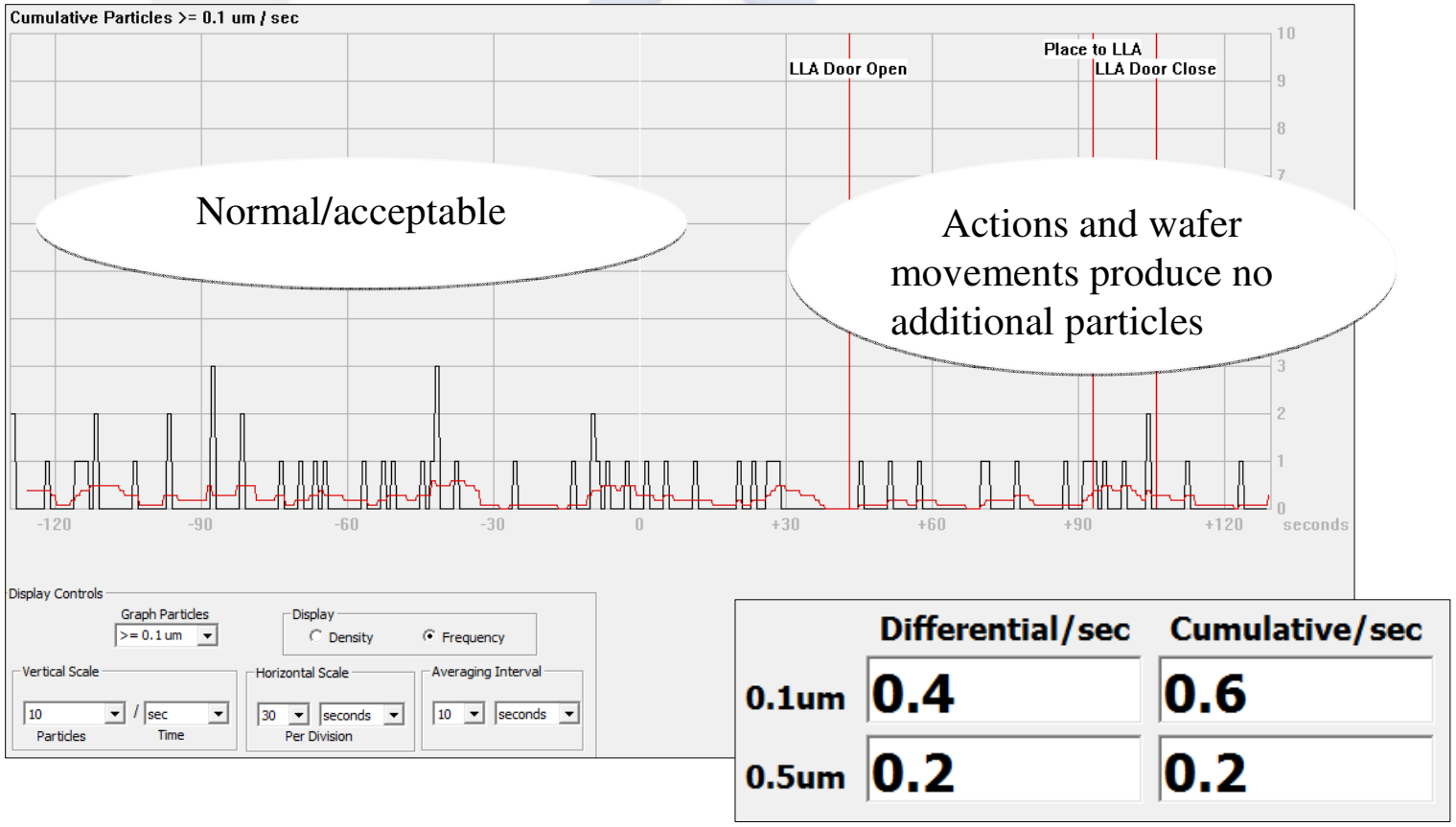
➢Check Door Open/Close

➢Check all handoffs

➢Check all robot motions

Typical normal particle count real-time results
APS Path > FI Robot → LLA

- The >0.1um~<0.5um size particle cumulative avg. count is ~0.4/sec
- The >0.5um size particle cumulative avg. count is ~0.2/sec
- The Particles count per sec around **1 ~ 3**



Problem discovered in real-time:
Rotate to Chamber-A > Open Chamber-A Door

- In Buffer, the total particle cumulative avg. count is **~0.1/**sec ➔ 4.5
- The >0.5um size particle cumulative avg. count is ~0/sec ➔ 2.5 (Total->7.0)
- The Particles count per sec around **1 ~ 2 ➔ 6~15**

HDP tool APS Test Results

- ✓ Chamber-A door was shedding particles
- ✓ Replace Chamber-A door Door Slider Assembly even though NOT DUE yet
- ✓ Chamber-A contaminated with particles and needs cleaning even though NOT scheduled for PM yet
- ✓ All other chambers and robot moves were OK
- ✓ Tool now ready for final particle qualification

200mm Cassette & Lot Box Particle Control

Problem Statement:

- 10,000 cassettes & lot boxes need scheduled particle monitoring
- Legacy method with monitor wafers is time-consuming and costly
- Carts may be causing wafer particle contamination during wafer transport
  - Bench-top and hand-held counters cannot be used without opening lot boxes
- Want a cost effective and complete cassette and lot box monitoring system

APS Test Plan for Identifying Particles in Real-Time

Test Condition-1: New vs. Old Cassette

1.New Cassette

2.Old Cassette (when should they be replaced?)

Test Condition-2: New vs. Old Lot Box

1. New type Lot Box (Is the new type cleaner?)
2. Old type Lot Box (Currently used)

Test Condition-3: Cart vs. Hand Place

1. Use Rod Shelf Cart for transport
2. Hand Pick/place lot box on cleanroom shelf

Old Cassette/Box Maintenance Method

- **Daily Resource Requirements**

- 2 cassette / 2 lot box
- Booking surface scanning inspection equipment
- 4 Monitor Wafers (Cleaned)

- **Particle adder measurement time**

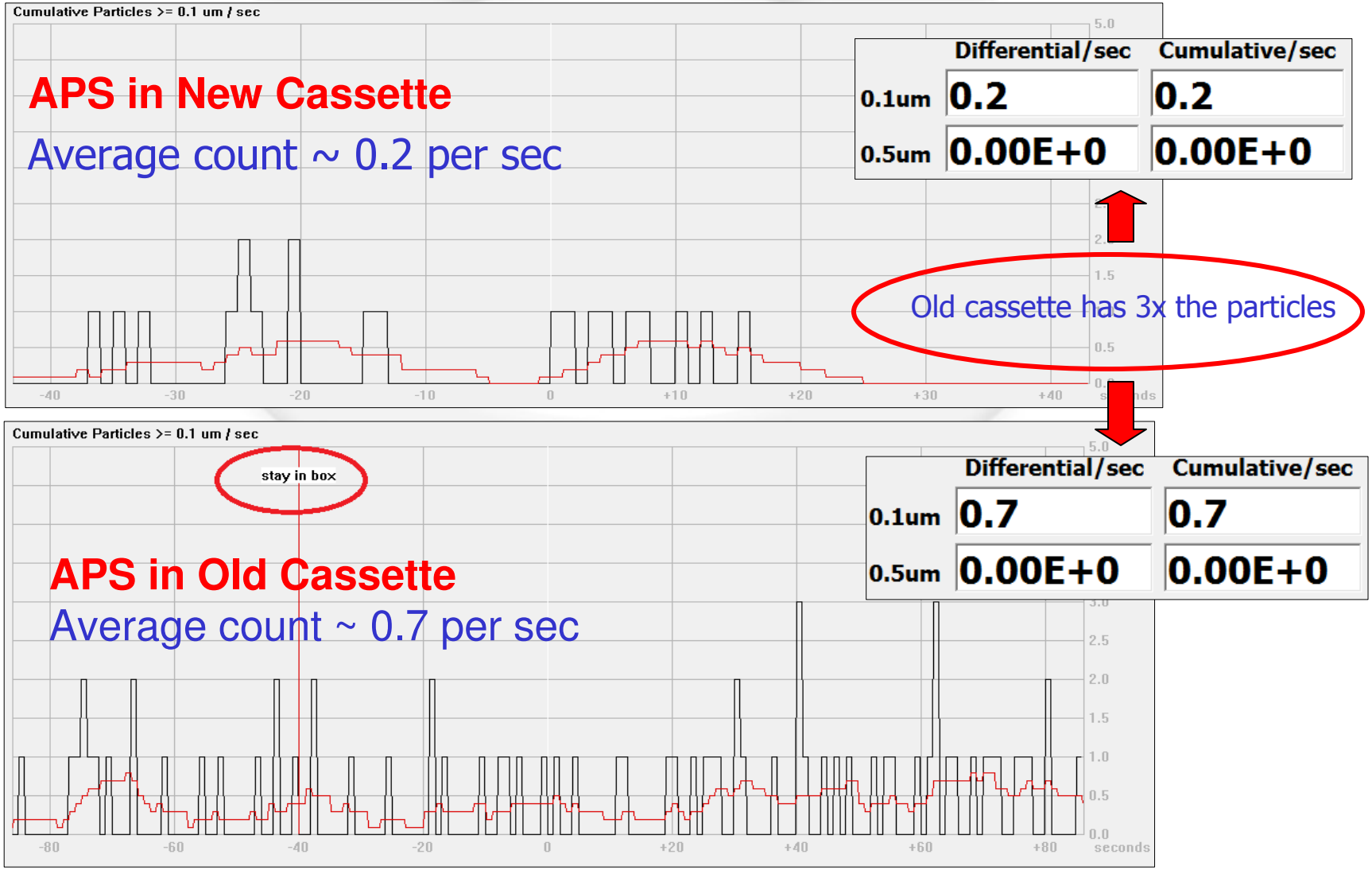
- Inspection EQP -> Waiting tool time >30 min x2 (Before/After)
-> Inspection Time >5 min x 4 (Per piece of monitor wafer)
-> Measurement Time > 1 Hour

- **Manpower**

- One MFG-engineer for material arrangement
- One for surface scanning inspection tool operation & report recording

APS Test Results - Example

New Cassette vs. Old Cassette in New Lot Box



Cassette and Lot Box WaferSense APS Benefits

✓ Significant time savings; no waiting for monitor wafer results

✓ Very quickly measures numerous combinations potential particle source elements such as old/new cassettes, old/new lot boxes, and shelf cart transportation procedures

✓ Identifies previously unidentified sources of particle generation such as bumps in clean room floor and manual lot box handling methods

✓ Quickly and easily identifies cassettes and lot boxes that need to be pulled from production for cleaning

Cassette & Lot Box Particle Control
WaferSense APS ROI Case Study

- Time Savings
- Measurement Throughput
- Man Power Savings

Time Savings

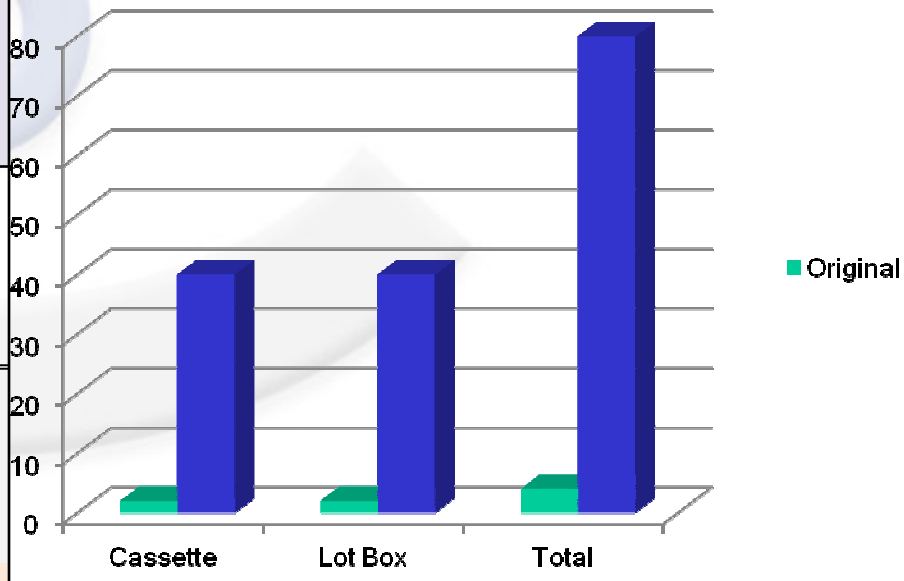
- ✓ **BIG Time Saving for daily monitor**
- ✓ **Decrease Mean Time to Recovery (MTTR)**
- ✓ **Reduced maintenance times >90%**

Summary				
Daily Particle Monitor	Original		**APS User**	
	Time	Engineer	**Time**	**Engineer**
Cassette	>2HRs	2	**<10 Min**	**1**
Lot Box	>2HRs	2	**<10 Min**	**1**
Total	>4HRs	2	**< 20 Min**	**1**

Measurement Throughput

Monitor Rule : - monitor place on cassette/box 1 HR
- APS place on cassette/box 3 Min

#Use same working time measure cassette/box			
Robot	**Legacy**	**APS**	**Total Working Hours**
Cassette	2	40	2
Lot Box	2	40	2
Total	4	80	4



Gain of 20X throughput!

Manpower Saving

# Monthly and Yearly Manpower Comparison		
Method	**Legacy**	**APS**
Engineer	2	1
Working Hours	4	0.33
Total	8	0.33
Monthly Spend Time	240 HRs	10 HRs
Yearly Spend Time	2880 HRs **(120 Days)**	120 HRs **(5 Days)**

Summary

- ✓ Surface Scanning is the standard for tool qualification
- ✓ Bench top and Hand held airborne particle counters have limitations
- ✓ WaferSense APS is an alternative instrument which reduced qualification times and improved throughput
- ✓ Time Savings – up to 90% reduction
- ✓ Measurement Throughput – up to 20X improvement
- ✓ Labor Savings – Significant

WaferSense Sales & Support Resources

Visit the web at: http://www.cyberopticssemi.com
Technical Support: (503) 495-2200 ex: 4
WaferSense Sales: (503) 495-2200 ex: 1
Tool Free: (800) 366-9131
Email technically related questions to:
CSSupport@CyberOptics.Com
Email WaferSense sales related questions to:
CSSales@CyberOptics.Com

Asia

CyberOptics Semiconductor Customer Support Office
Representative: Mr. Yukinobu Hayashi
Mobile Phone: +81.80.3974.0253
Email: yhayashi@cyberoptics.com

Representative: Terry Huang
Mobile Phone: +886.920.366999 / +886.972.763278
Email: thuang@cyberoptics.com

Ferris Chen陳振隆
Asian Sales Director
Mobile: +886.912.543323
Email: fchen@cyberoptics.com