
Particle Detection Methods and Protection Schemes for Mask Carriers



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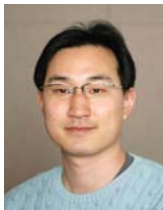
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Outline

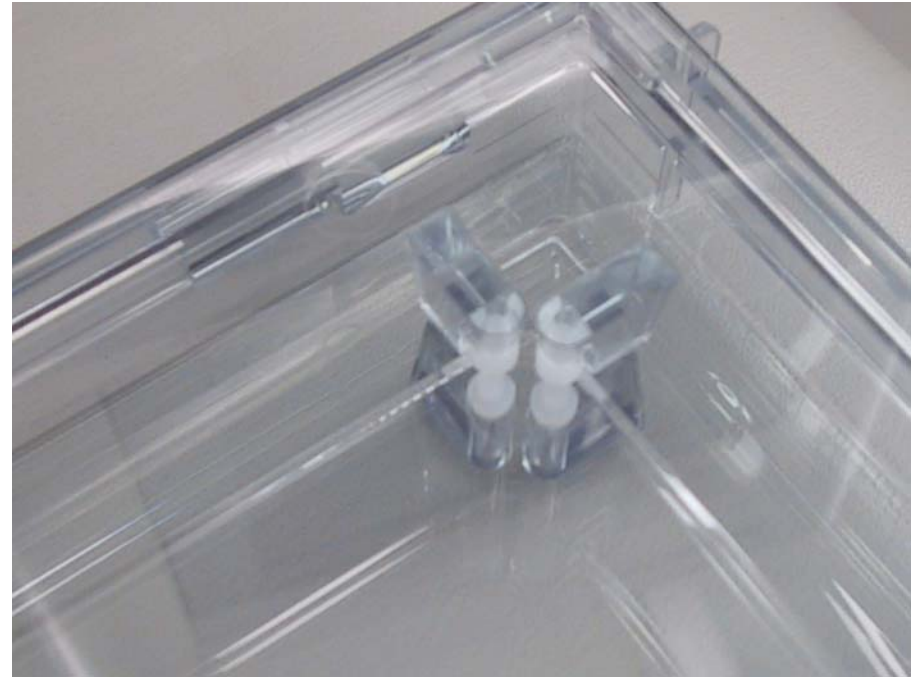
- Particle Detection Methods

- Surface Detection
- Airborne Detection

- Protection Schemes

- Cover Plate
 - Electrophoresis
 - Thermophoresis
-

Objectives



- **Shipping carrier: POZZETTA PZT600 Series**
 - **Know where and how particles are generated during shipping**
 - **Need to develop particle sampling/detection techniques**
-

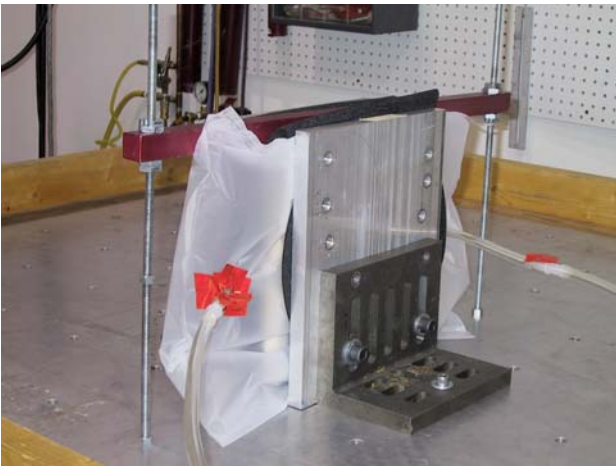
1. Surface Particle Detection

- Mask scanner
- Witness-wafer scanner

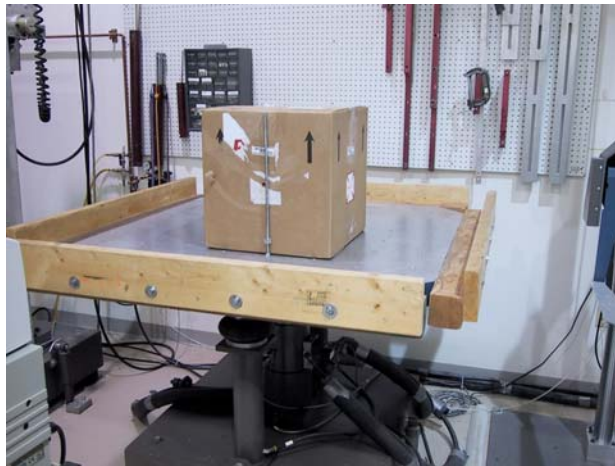


Vibration Test Setup at Entegris

Vibration Condition: ISTA, 1.150 g_{rms}



Airborne particle test
with clean air flow
(Entegris RSP200)



Vibration with
Secondary Packaging
(POZZETTA)

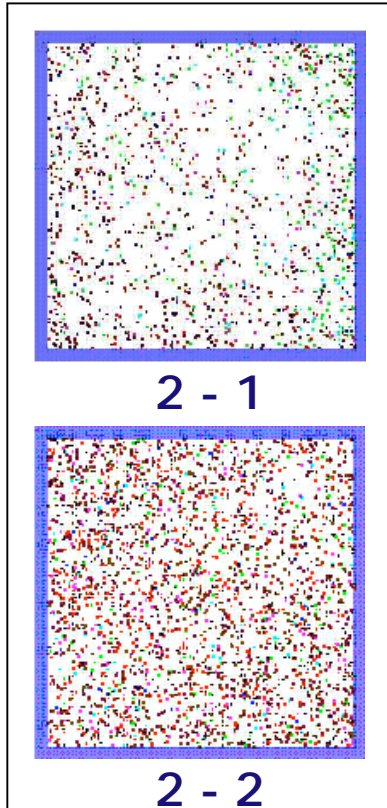


Vibration without
Secondary Packaging
(POZZETTA)

Reticles were positioned vertically.

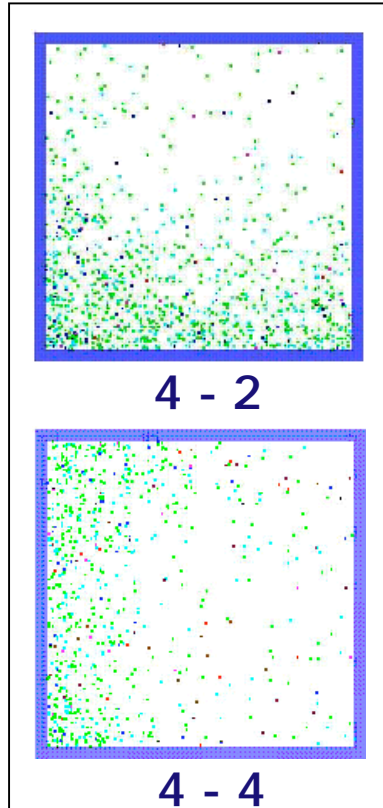
Mask Surface Scan (Added/Shifted Particles)

RSP200



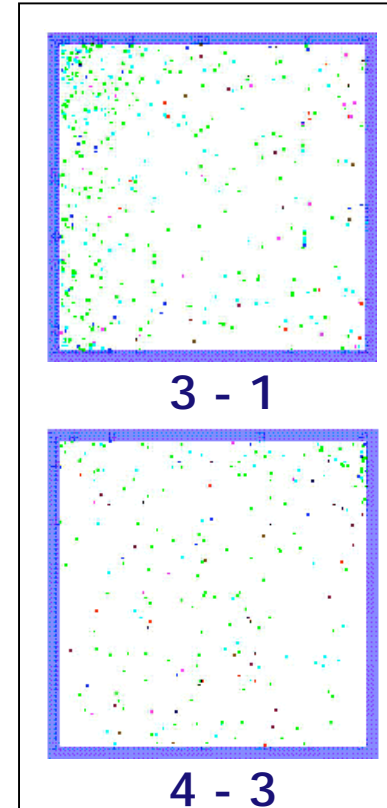
With clean air flow

POZZETTA



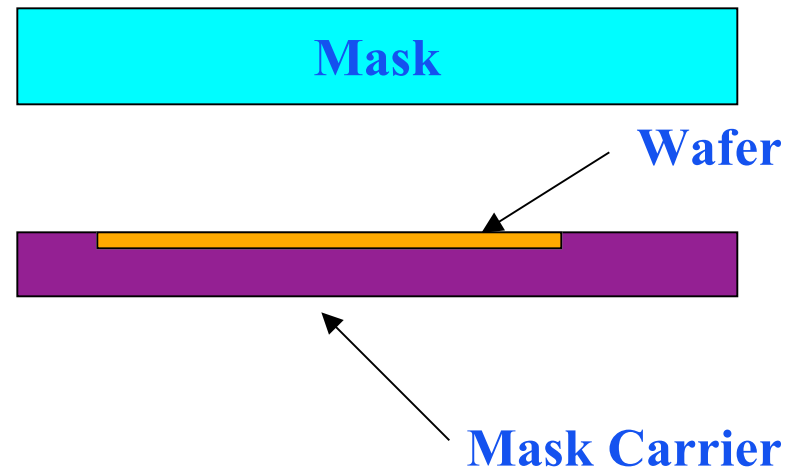
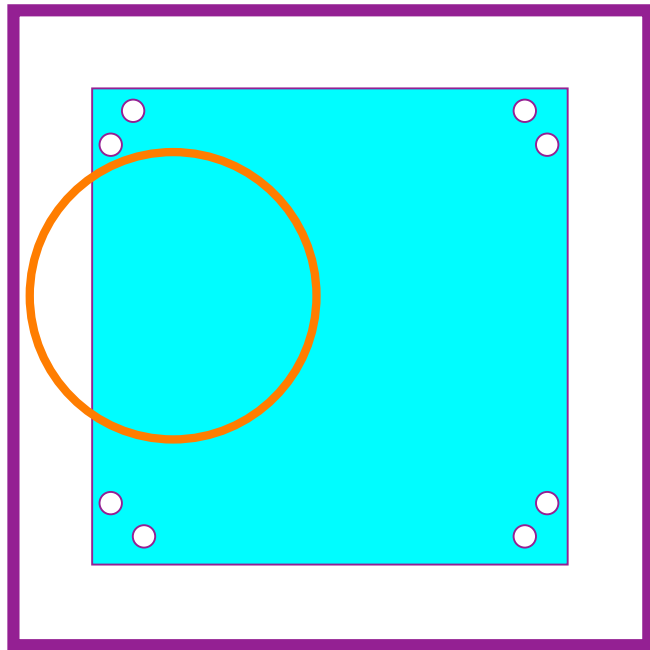
Vibration without
Secondary Packaging

POZZETTA

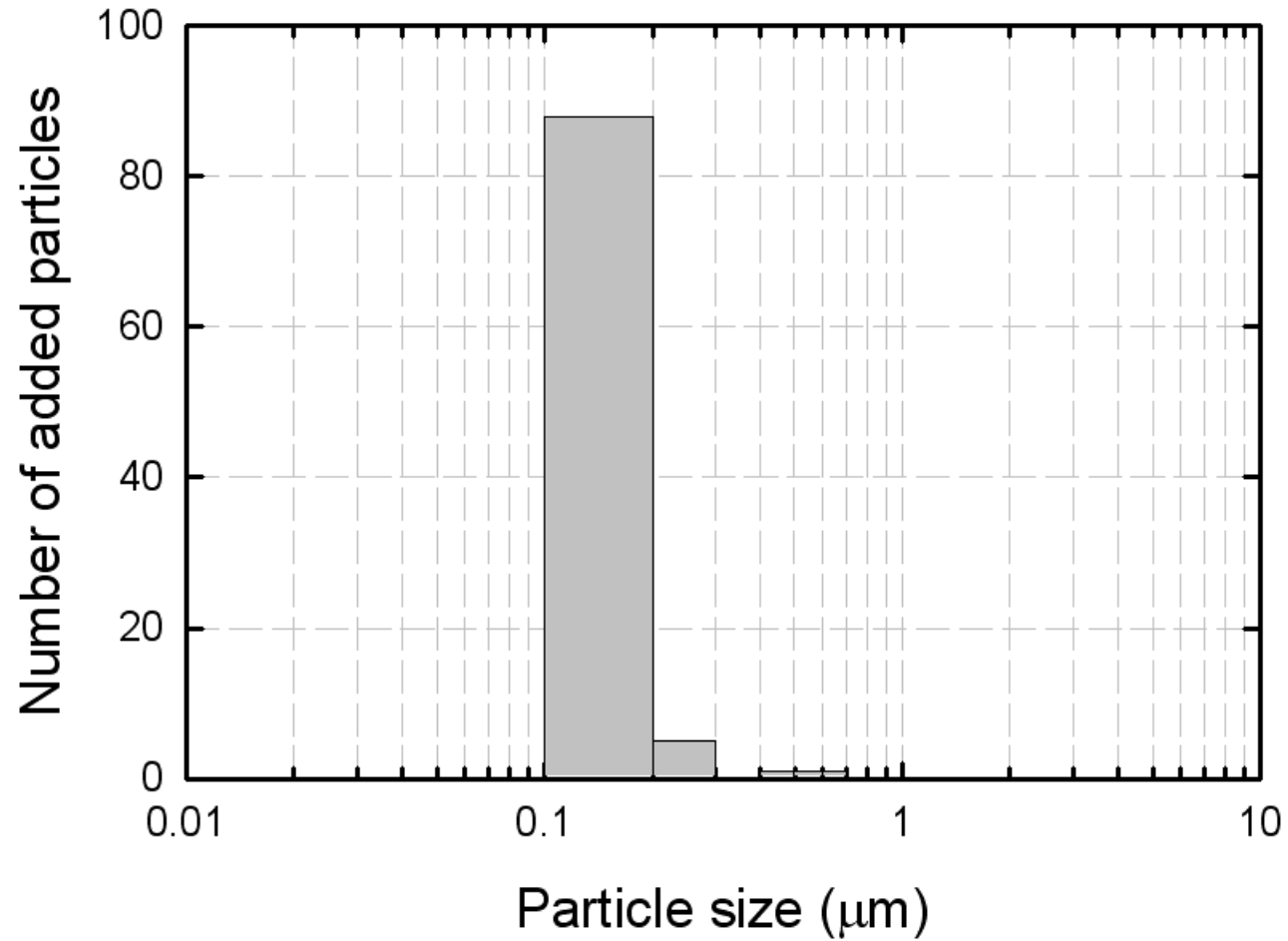


Vibration with
Secondary Packaging

Placement of 4'' Witness Wafer



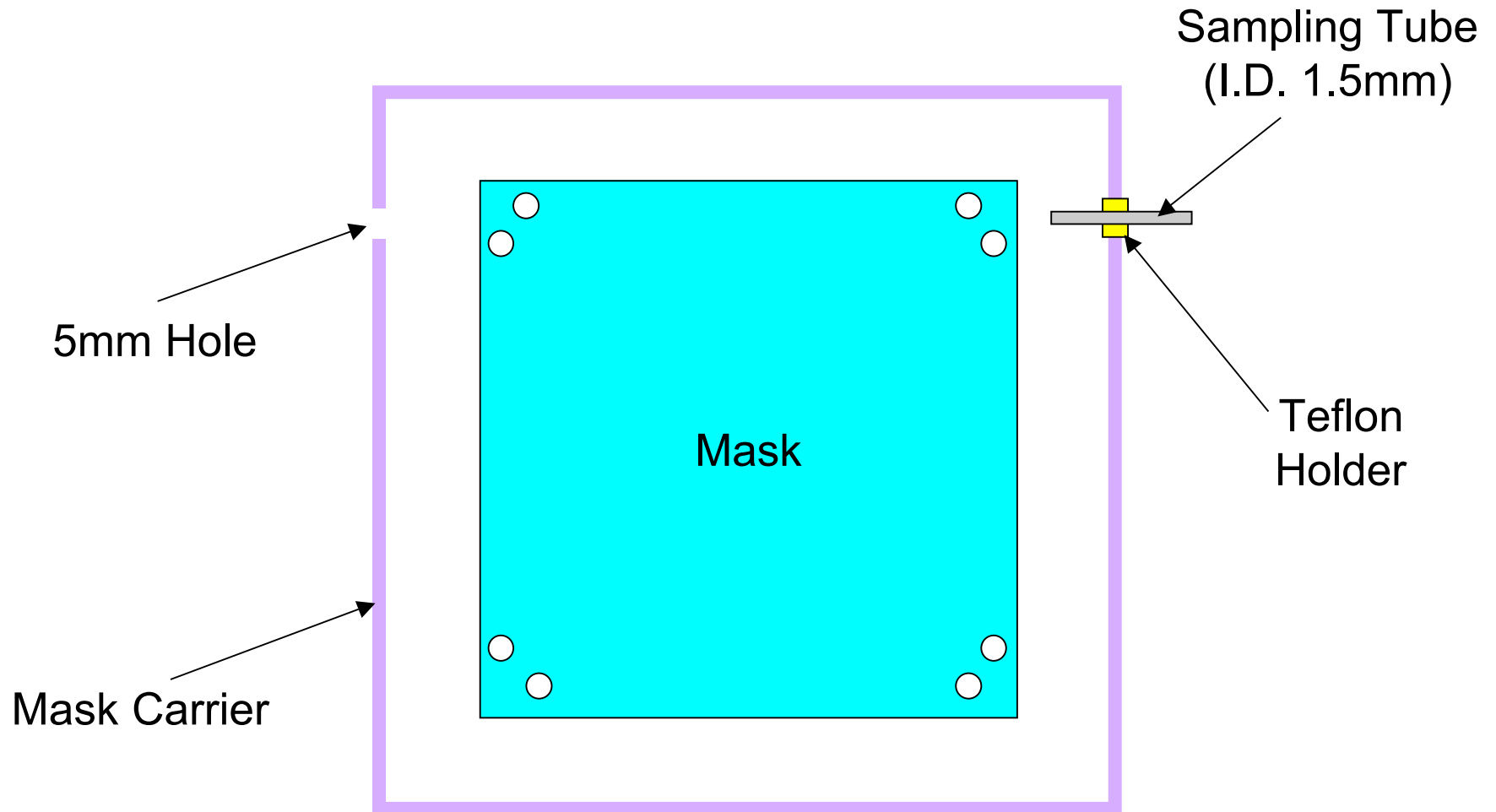
Wafer Surface Scan



2. Airborne Particle Detection

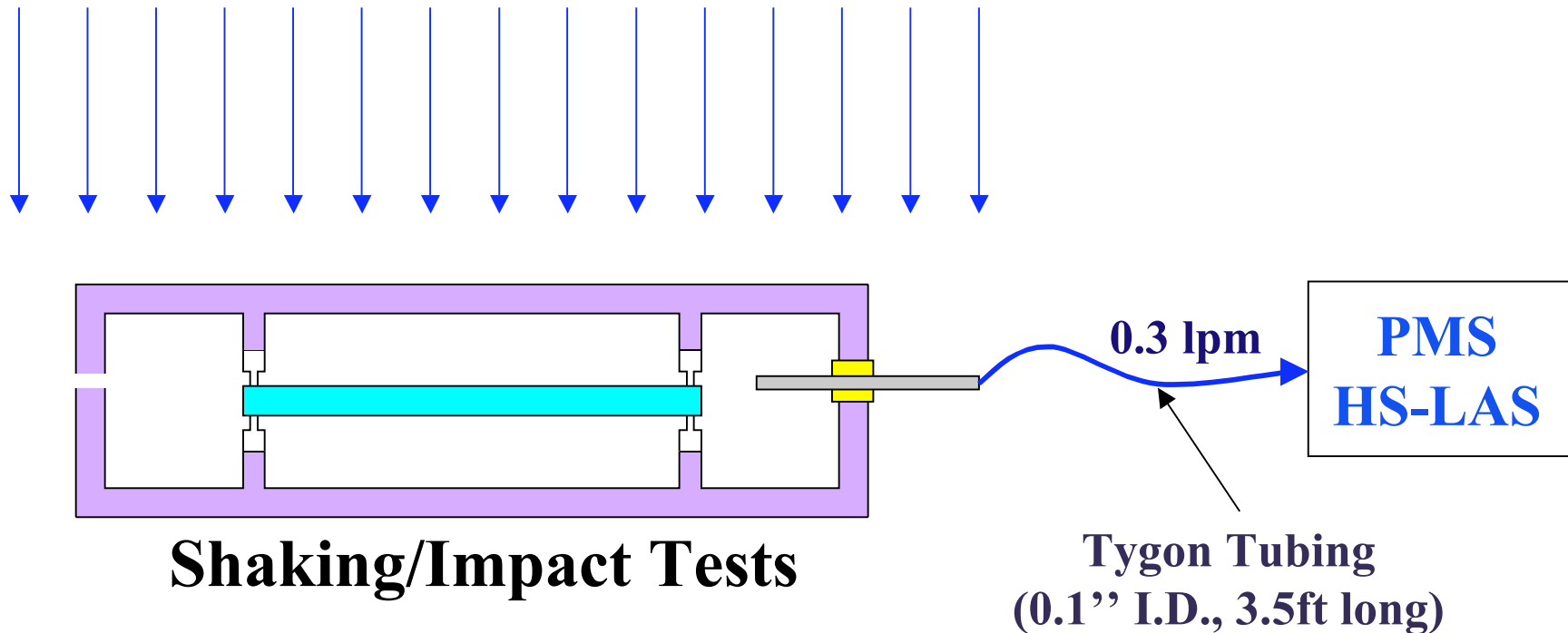
- Airborne particle concentration by Laser Particle Counter (LPC)
 - Particle chemical composition by Aerosol Time-of-Flight Mass Spectrometer (ATOFMS)
-

Carrier Modification for Airborne Particle Detection



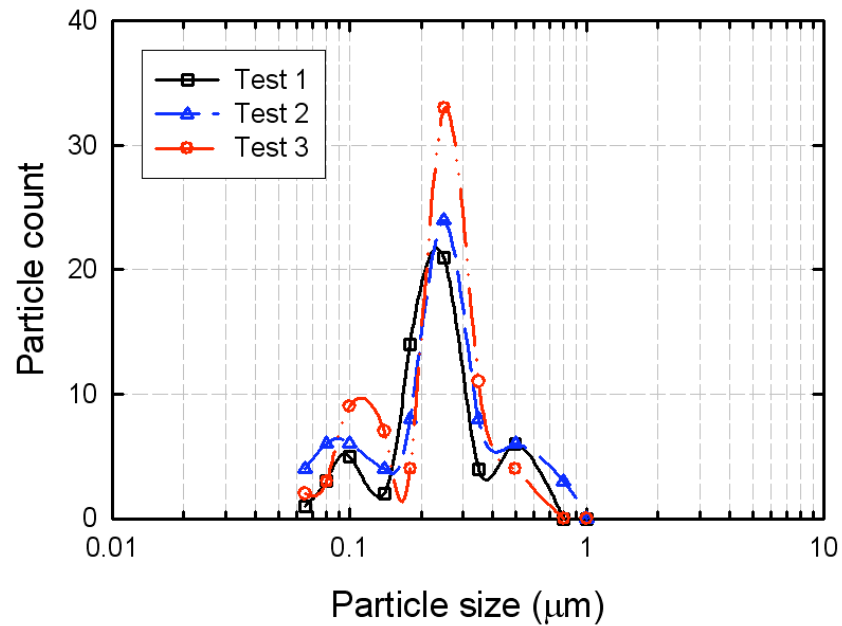
Airborne Particle Detection Using a HS-LAS Counter

Unidirectional Clean Air Flow

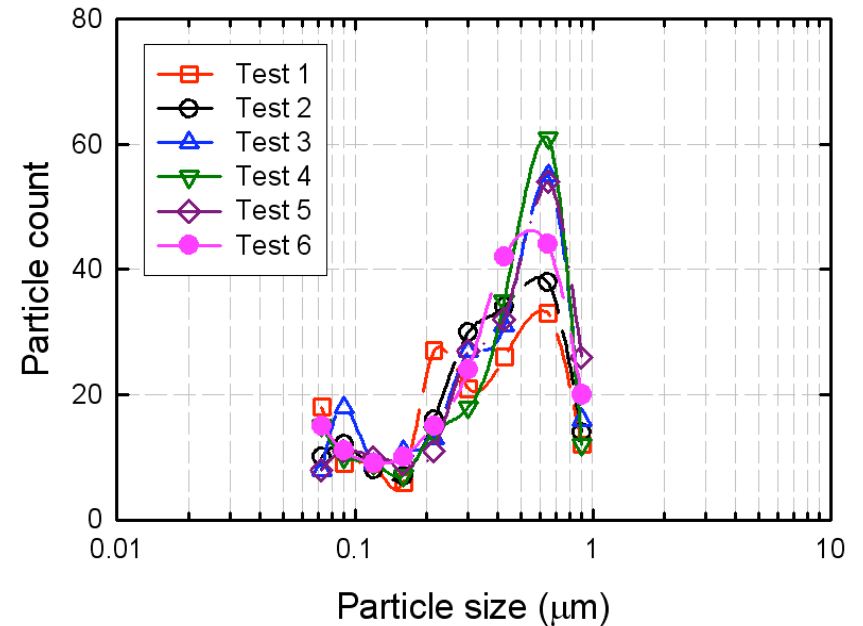


HS-LAS: High Sensitivity Laser Aerosol Spectrometer (**0.065~1.0 μ m**)

Airborne Particle Size Distributions

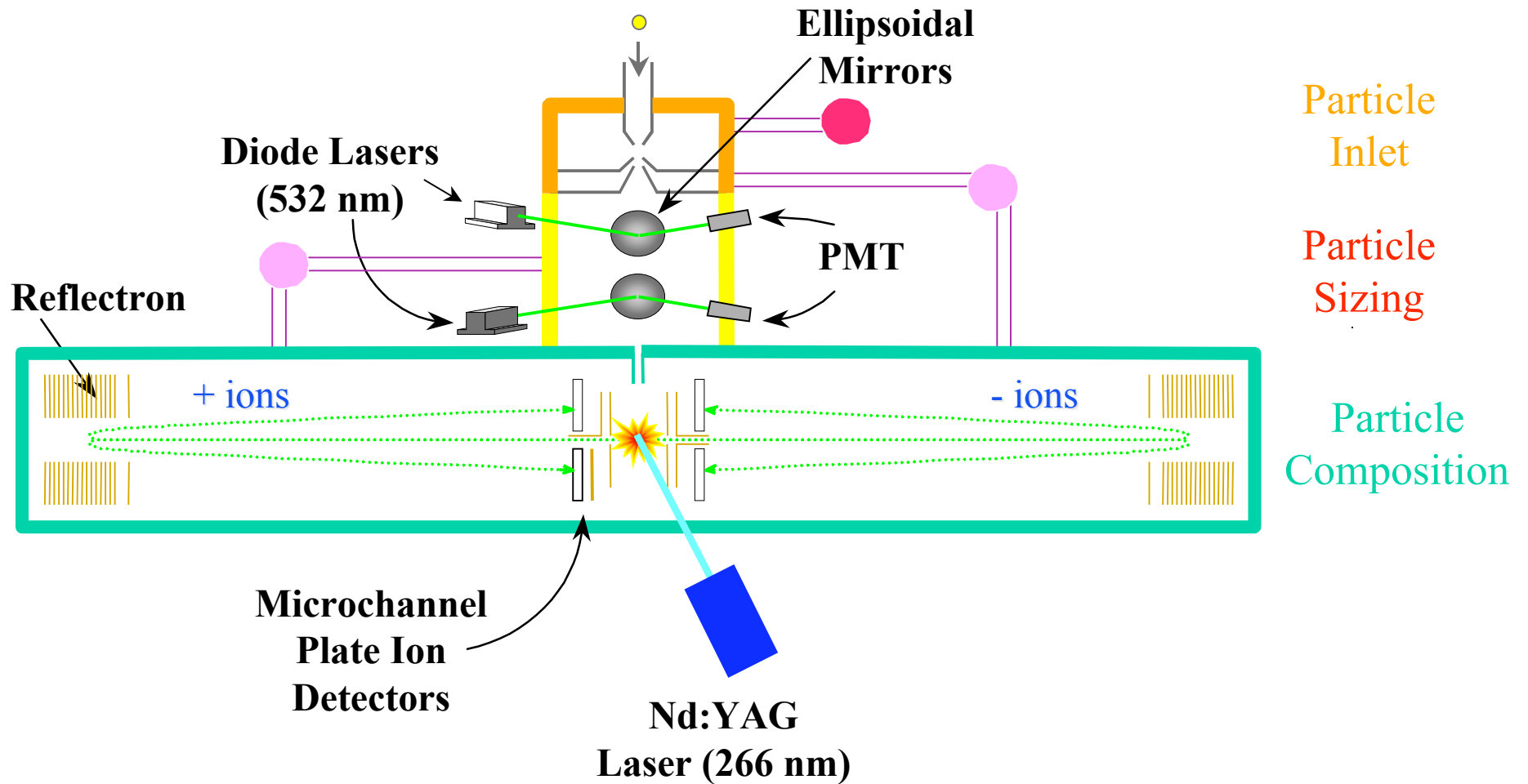


Shaking (10min)



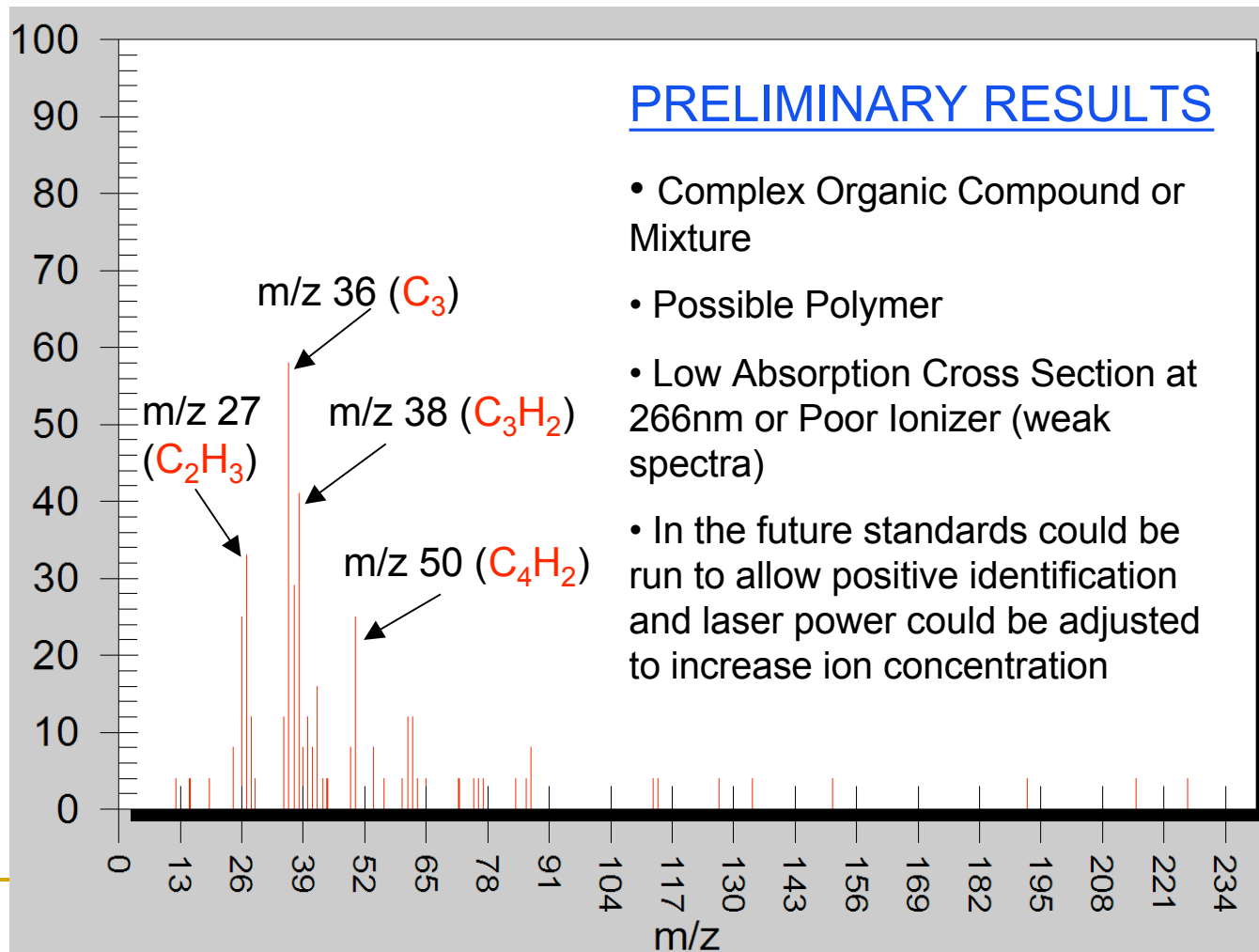
Shaking and Impact (10min)

TSI 3800 ATOFMS



adapted from Dabrina D. Dutcher-Stolzenburg

Averaged Positive Spectra of Particles Produced by Shaking and Impact Tests





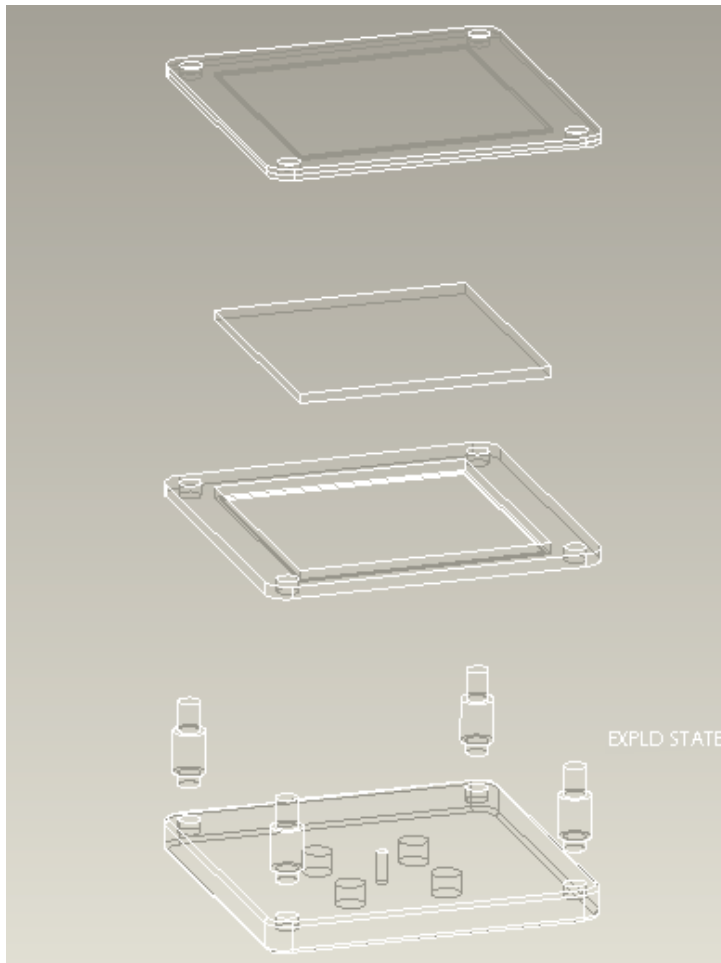
Protection Schemes



Objectives

- Build an atmospheric chamber for nanoparticle deposition studies
 - Evaluate protection schemes using electrophoresis and thermophoresis
-

Mask/Wafer Mount



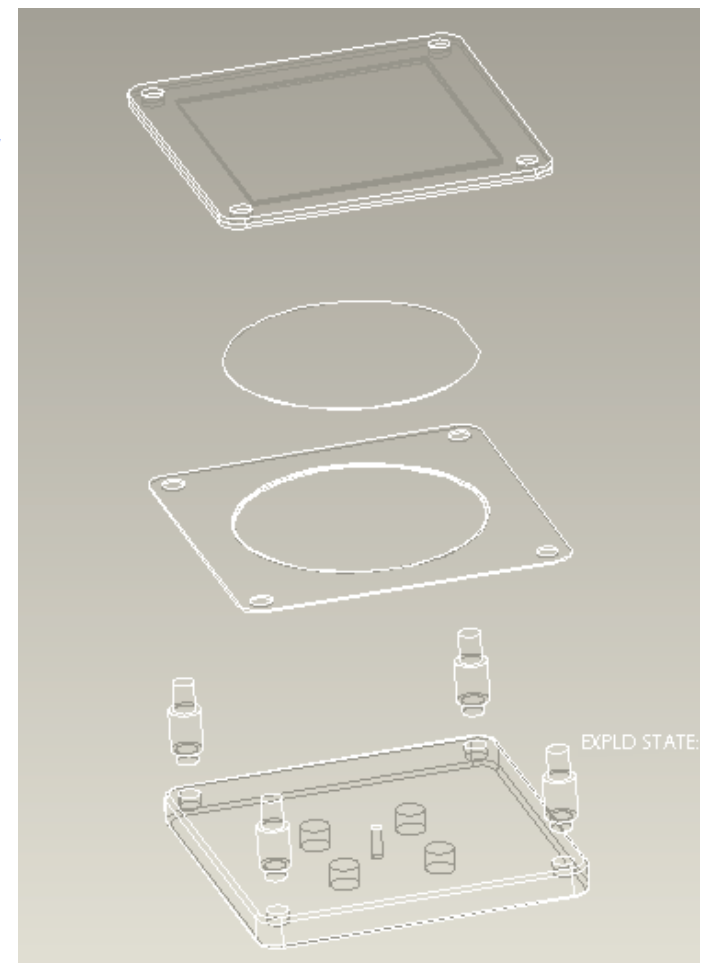
Heating Plate
with
Thermofoil Heater

Mask/Wafer
(upside down)

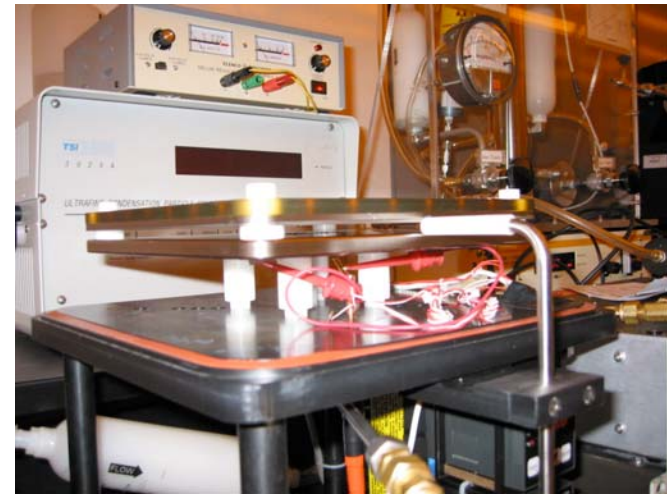
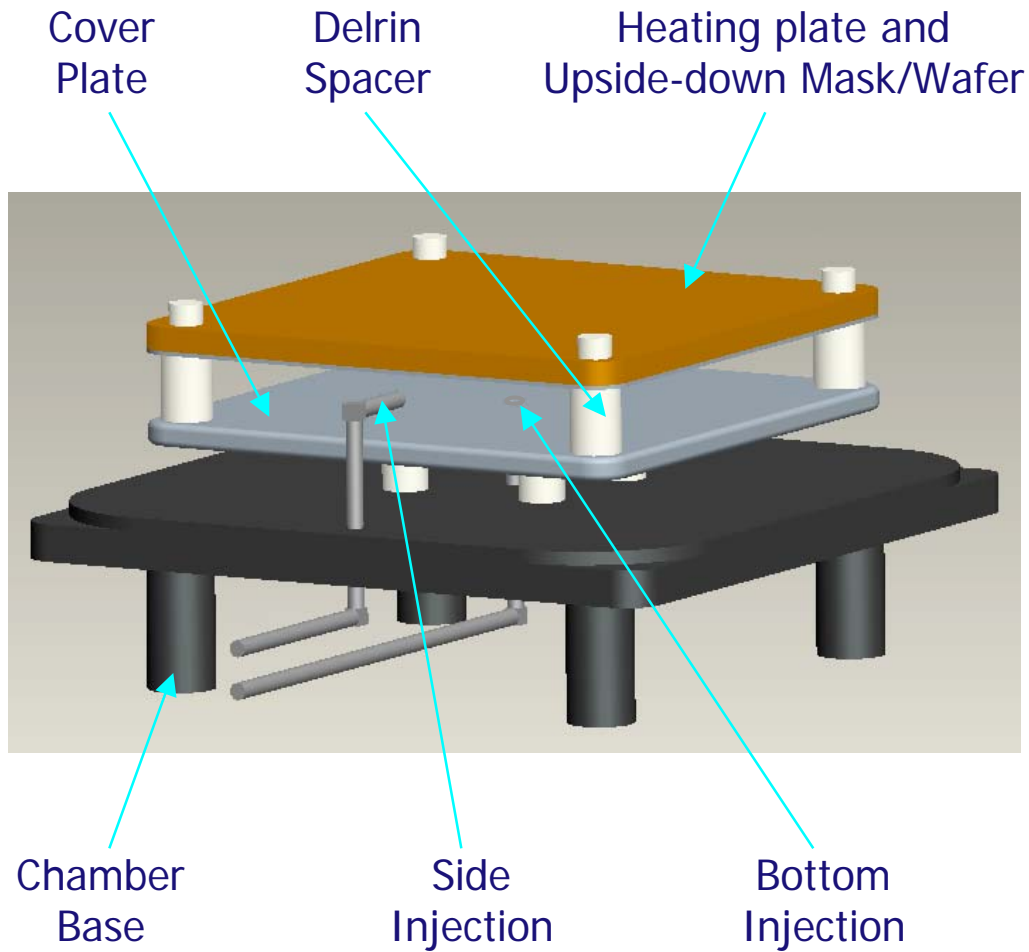
Wafer Mount

Delrin
Spacers

Cover Plate

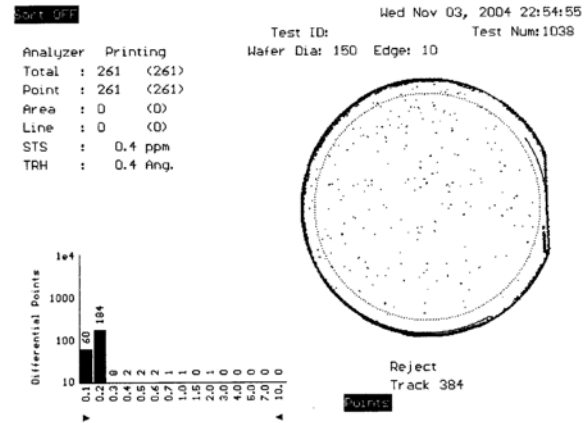
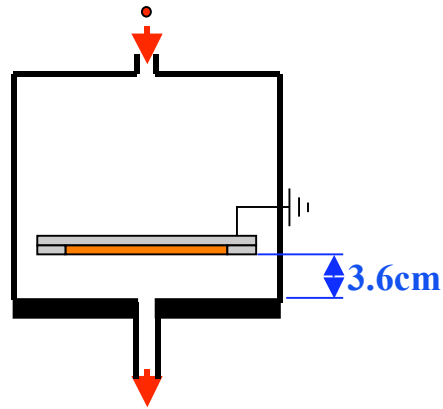


Atmospheric Deposition Chamber



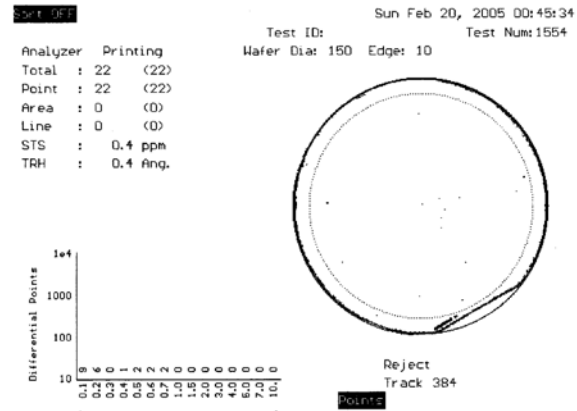
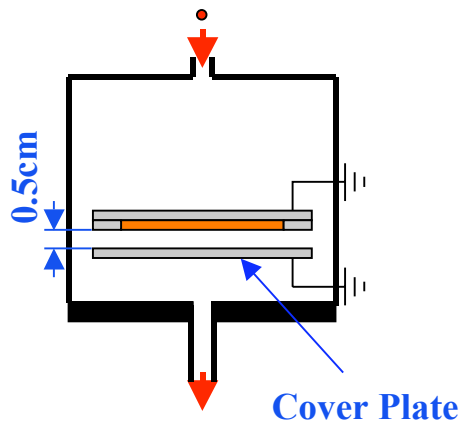
Cover Plate Evaluation ($D_p=220\text{nm}$)

Face-Down



Added (220)

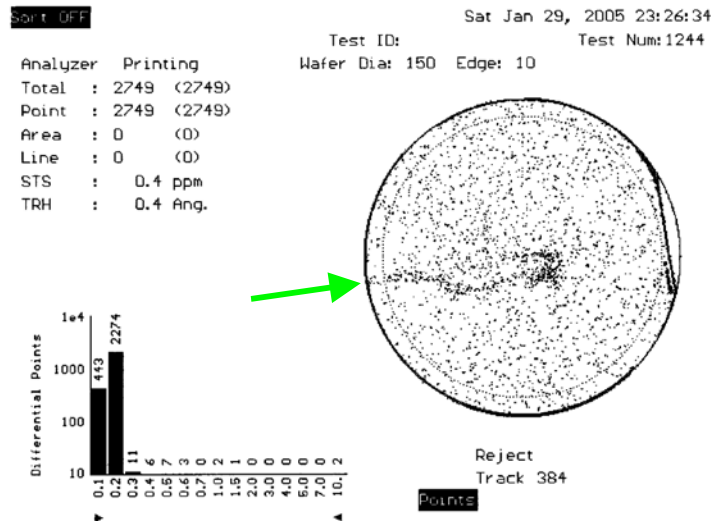
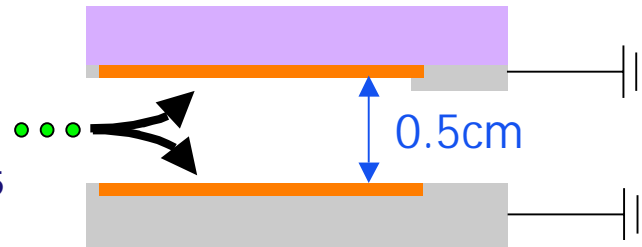
Cover Plate



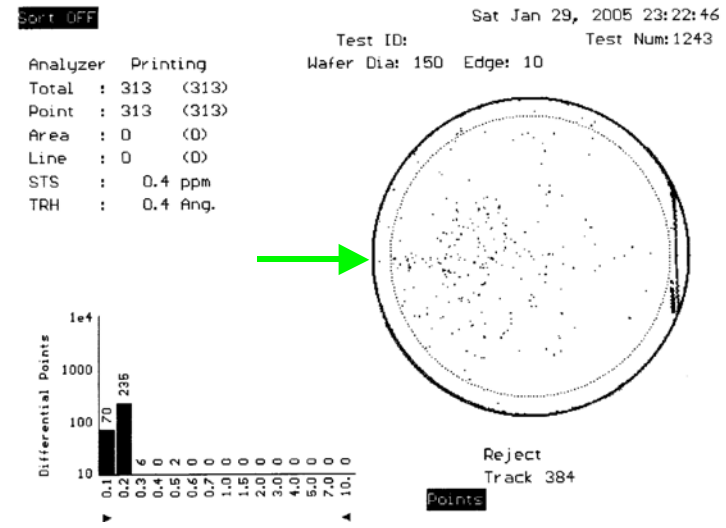
Added (0)

Particle Penetration into Mask-Cover Gap -- Side Injection

- Zero charge
- $D_p = 220\text{nm}$
- $\#_{in} = 3.82 \times 10^5$

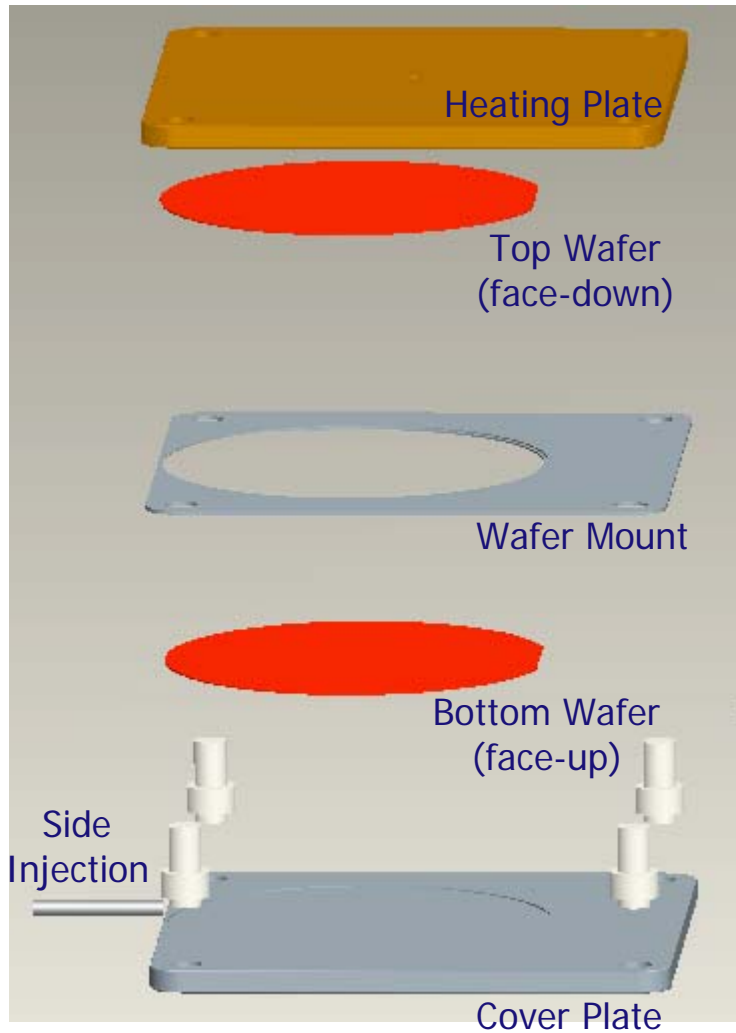


Bottom Wafer (Face-up)

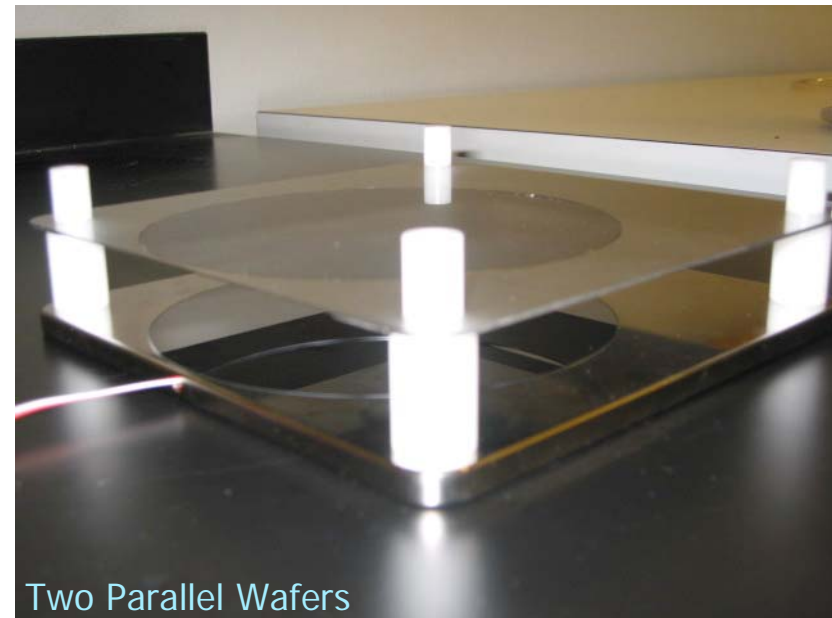
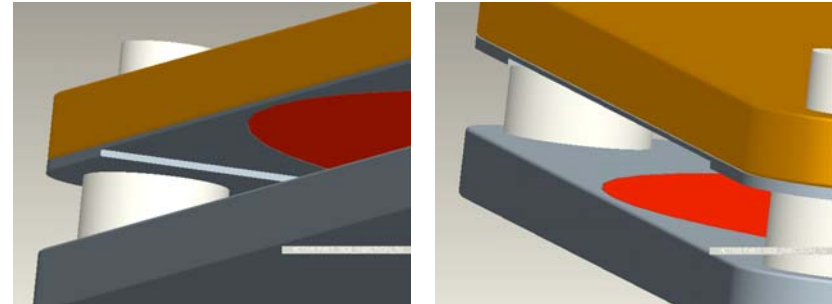


Top Wafer (Face-down)

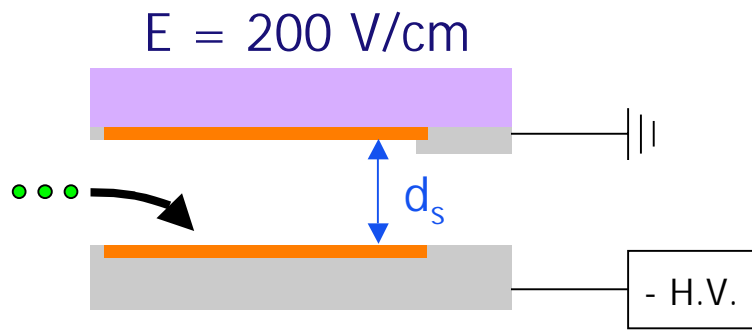
Side Injection Test System



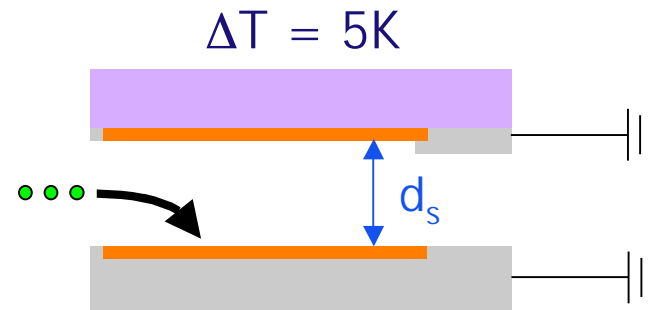
No Flow Disturbance



Protection Schemes



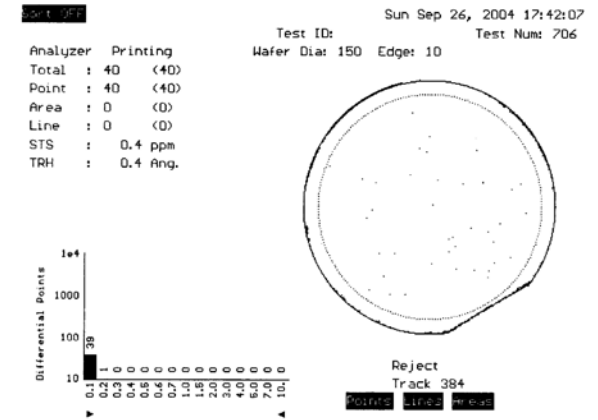
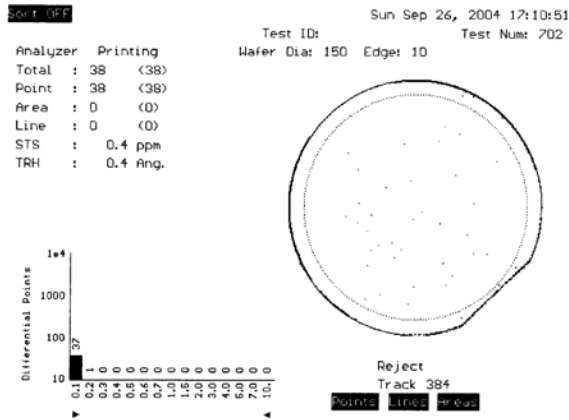
Electrophoresis
(Positively Charged Particles)



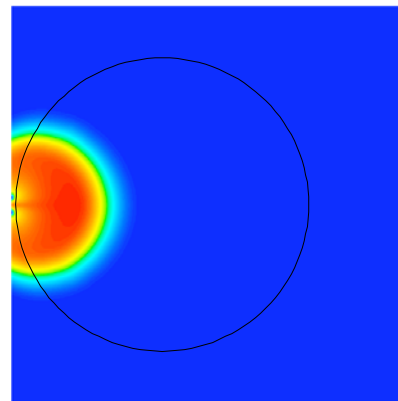
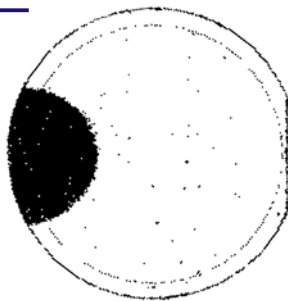
Thermophoresis
(Zero Charge Particles)

Electrophoresis ($D_p=125\text{nm}$, $E=200\text{V/cm}$)

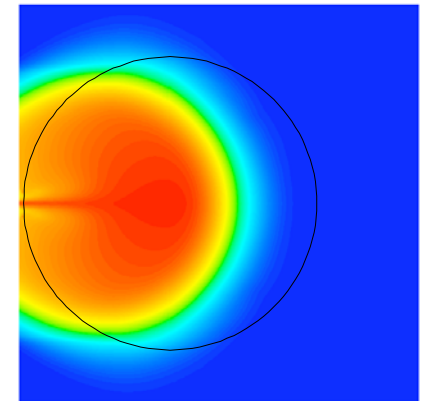
Top Wafer



Bottom Wafer



0.1L/min

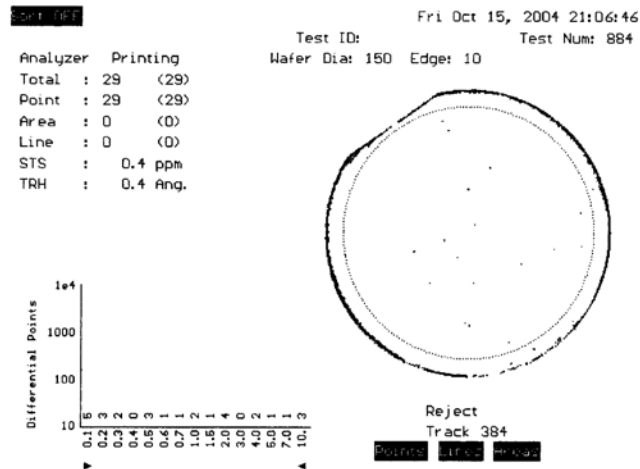


0.3L/min

No particles to top wafers → But, dangerous with wrong polarity

Thermophoresis ($D = 220\text{nm}$, $\Delta T = 5\text{K}$)

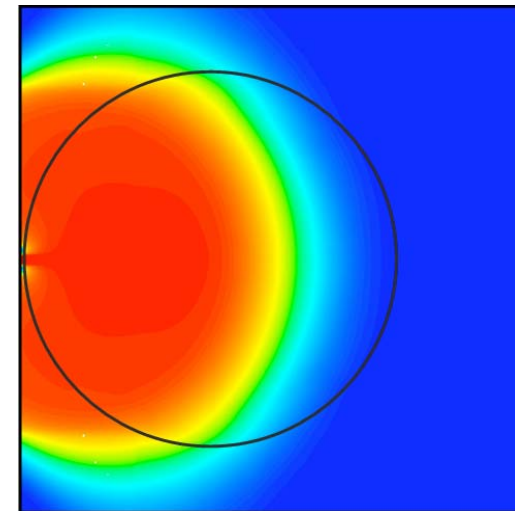
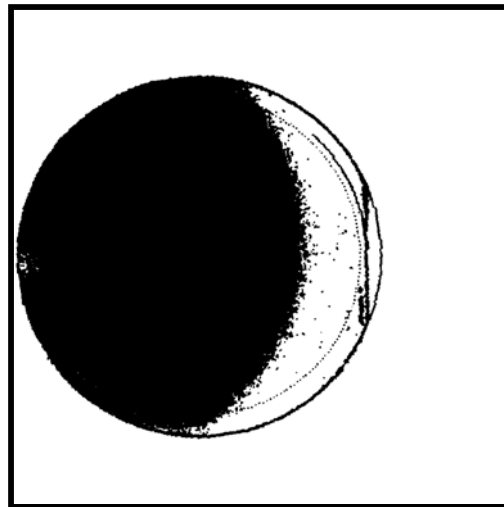
Top Wafer



- Zero charge
- $D_p = 220\text{nm}$
- $Q_a = 0.1\text{L/min}$
- $\Delta T = 5\text{K}$
- $d_s = 0.5\text{cm}$

Bottom Wafer

0.1L/min



No particles were added to the top wafer.

Summary

- Particle detection methods have been developed for mask carrier vibration studies
 - The cover plate is effective in protecting the upside-down mask under low particle flow from top injection
 - Models have been developed to study the effectiveness of thermophoresis and electrophoresis in protecting the mask from particles penetrated into the gap between the mask and the cover plate
-