Efficient Testing Solutions

PVD Cluster Tool Integrated Measurement Solutions

SURAGUS GmbH

SURAGUS
Sensors & Instruments

Sensors and Instruments for Non-Contact Electrical Characterization by High-frequency Eddy Current Technology

2010	100	2000	50	1
Founded in Dresden with research and manufacturing facilities in a high-tech innovation hub in Germany	**„100 Eyes of Argus“** on surfaces and thin films **SURface ArGUS** *(Surface Guard)*	**1500+ units** successfully installed in production lines and measurement labs across the globe	**~50 vibrant employees** form the multicultural (7 nationals), multilingual (8 languages) and diverse workforce	**1 Testing Technology** High frequency eddy current sensors for material and thin-film characterization

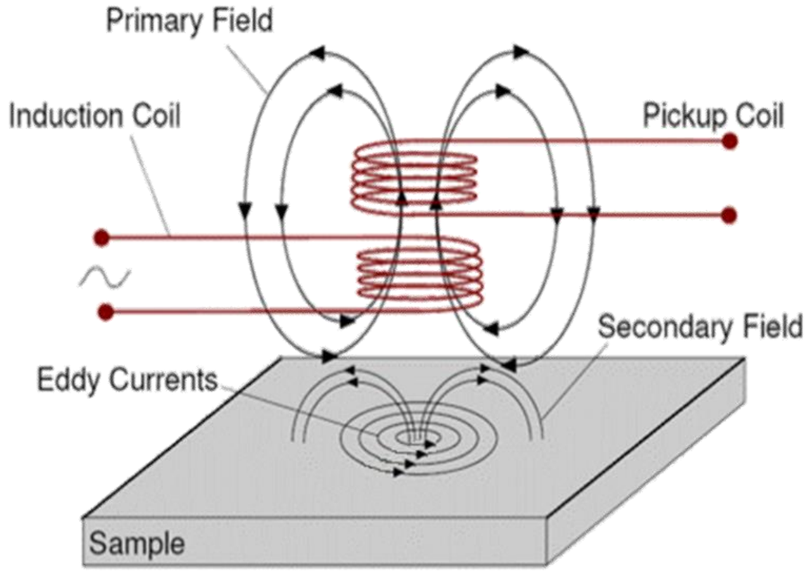
How does Eddy Current Testing Work?

Technology

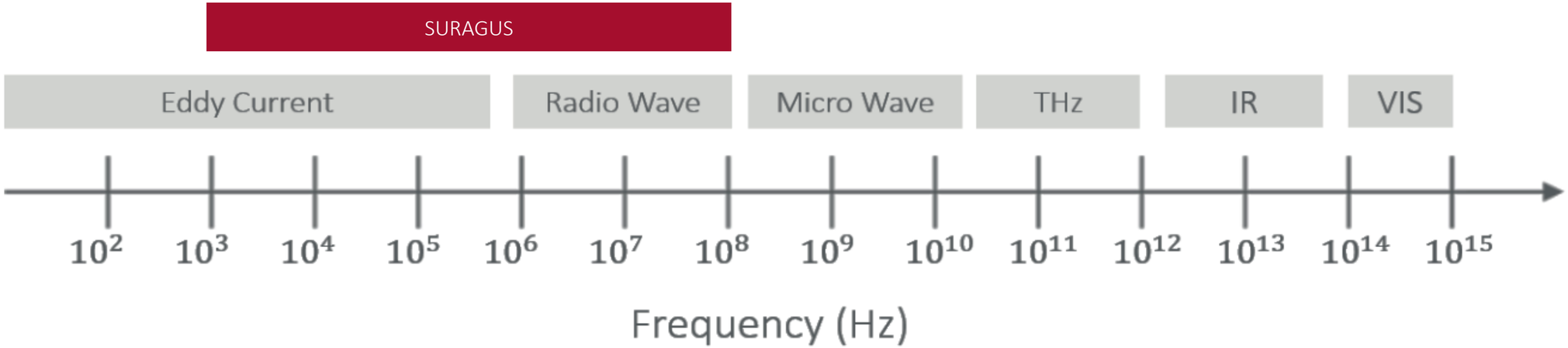
- Relies on non-contact current induction and electromagnetic field measurement

Characteristics

- High sample rate, high sensitivity, non-contact, but limited to conductive materials

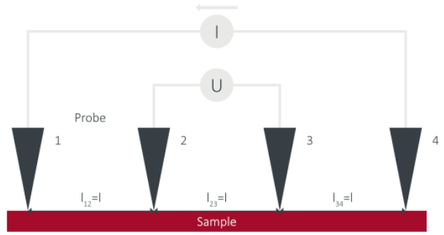


Wide frequency range for high sensitivity



Comparison of Electrical Testing Methods

4-point-probe testing



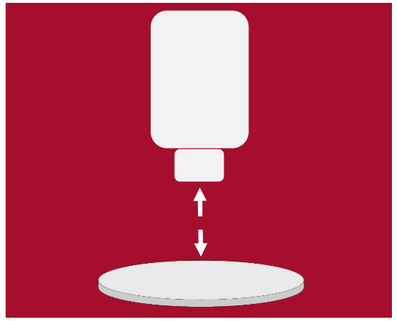
- Contact / Contact quality influences measurement
- Single point and mapping solutions
- Possible damage to sensitive layers
- Single point sheet resistance testing only
- Wearing of probe with time
- No measurement of encapsulated films

Non-contact eddy current testing by EddyCus®

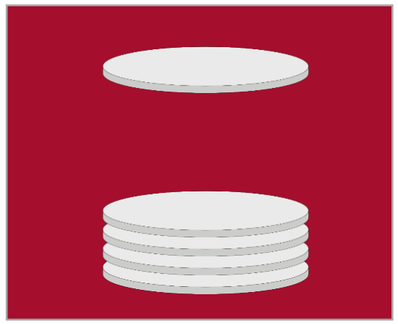
- Non-contact & real-time, no wearing
- **High accuracy** without influence of contact resistance
- **No harm** or artifacts to sensitive films
- **High resolution mapping**, inline measurement for **process control**
- **Encapsulated films & multilayer systems**
- **Best usage for touch-sensitive layers**

Main Advantages of Eddy Current Inspection

Non-contact
Non-destructive



Single and Multilayer Systems



Sample rate for
Wafer and layers testing

1,000‘s
measurements/sec

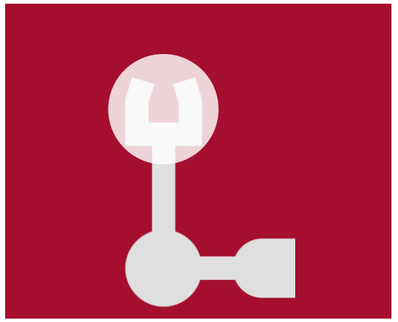
Versatile processing
conditions

In-vacuo
Ex-vacuo
Cold / Hot

High repeatability
and long-term stability

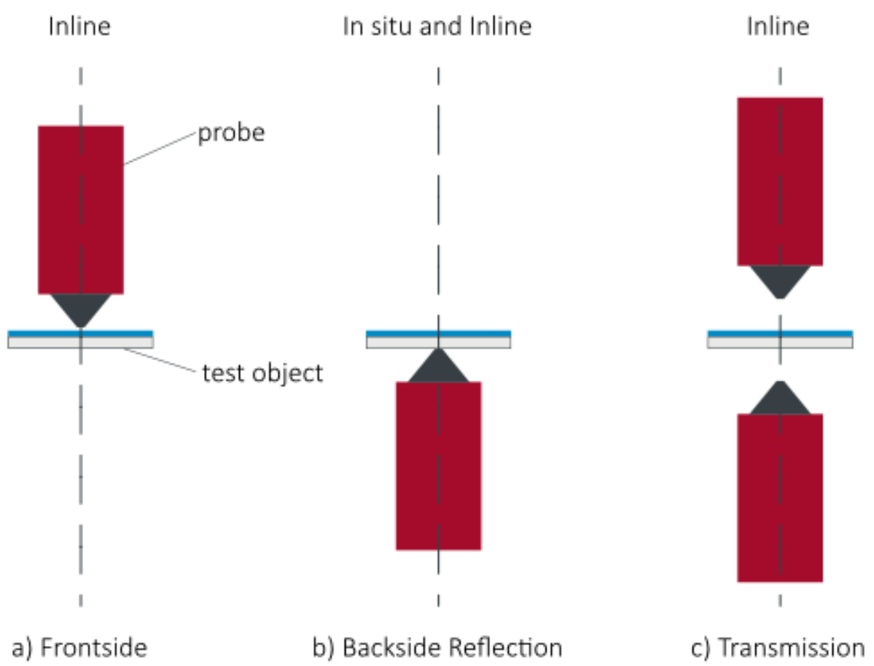
Low σ

Automation-ready,
Easy integration into tools



Measurement Modes and Layer Stacks

Measurement Setup



Layer Characterization

- Single layer system

Conductive layer [ρ,t]
Non-conductive substrate [t]

- Multi layer system

R_1 layer 1	Coating top
R_2 layer 2	Conductive substrate
R_3 layer 3	Coating bottom

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Applications Relying on Conductive Materials

ELECTRICAL FUNCTIONS

Predominantly Transparent and Non-transparent Electrodes

- SEMICONDUCTOR
- PHOTOVOLTAICS
- BATTERY
- TOUCH PANEL
- DISPLAY
- FUEL CELL
- PRINTED ELEC
- PCB/ FPC
- SENSOR
- MEMS
- MEDICAL

OTHER FUNCTIONS

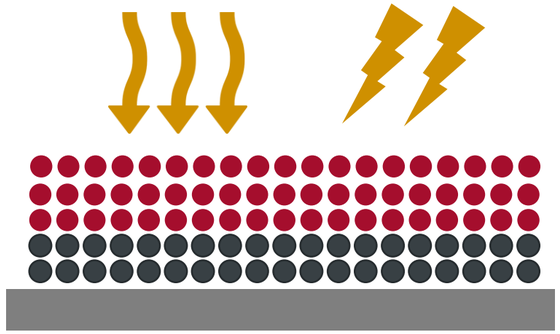
- PACKAGING — Air Barrier
- MIRROR — Reflection
- GLASS — Emissivity
- HEATER — °C Regulation

Processing of Conductive Materials

Layer Deposition

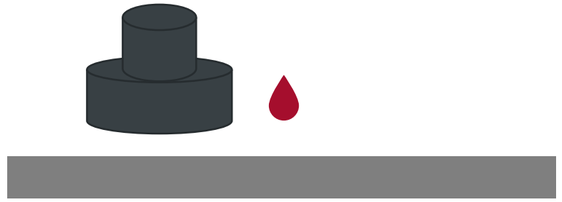
- PVD, CVD, ALD
- Plating
- Epitaxy
- Wet deposition – slot die, doctor blade, spray coating etc.

Layer Modification



- Drying, Sintering
- Annealing / Tempering
- Doping, Implantation

Layer Removal



- Etching
- Polishing, Planarization (CMP)
- Lift-off
- Scribing

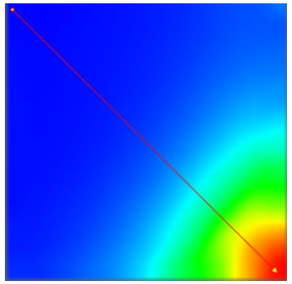
General Testing Types For Metrology

Portable Testing

Single Point Measurement

2.35	1.73	1.84	1.89	1.79	2.01	3.48
1.68	1.13	1.20	1.23	1.17	1.19	1.95
1.62	1.14	1.21	1.25	1.15	1.16	1.94
1.65	1.17	1.26	1.35	1.20	1.21	1.94
1.71	1.14	1.21	1.24	1.16	1.19	1.99
1.76	1.14	1.19	1.20	1.15	1.22	2.14
4.20	2.01	2.13	2.00	1.96	2.34	4.24

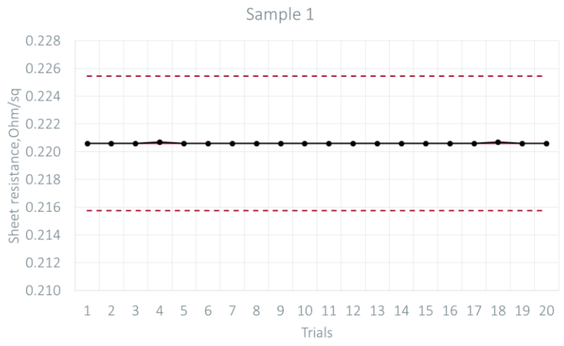
Mapping Solutions



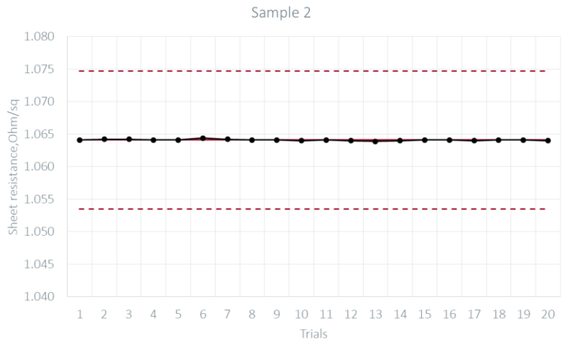
Inline / Tool Integrated

Repeatability and Stability

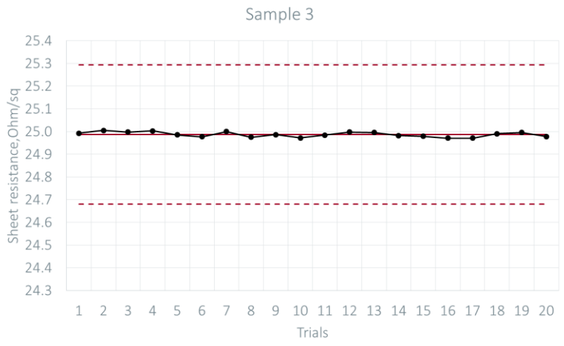
Low Ohm



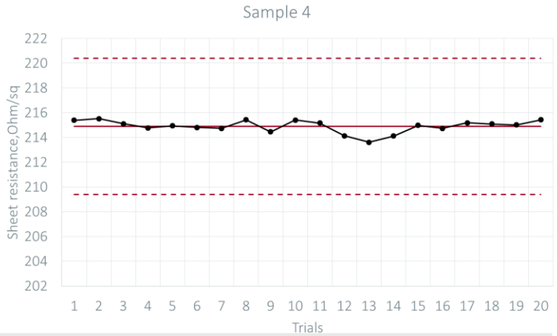
Medium Ohm



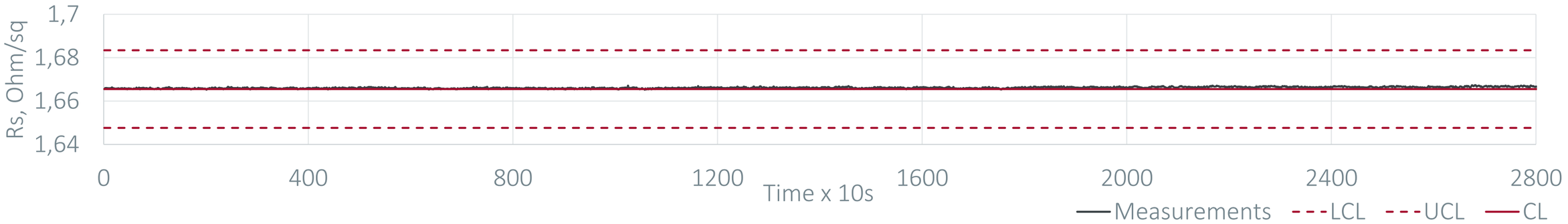
Medium Ohm



High Ohm

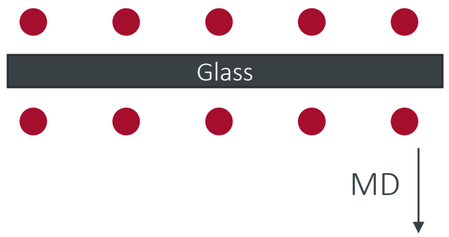


Long-time stability (8 hours)



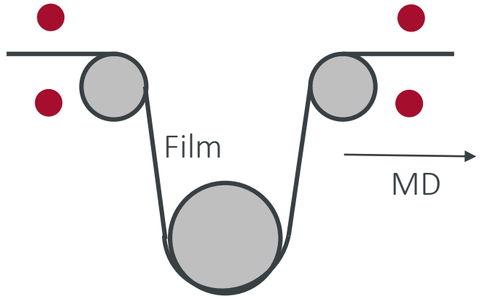
Inline Processing

Existing



Existing

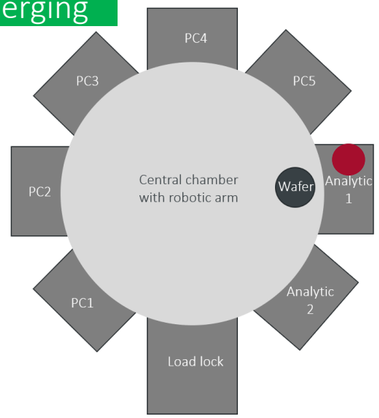
Existing



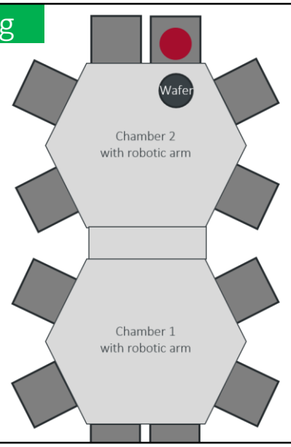
Existing

Batch Processing

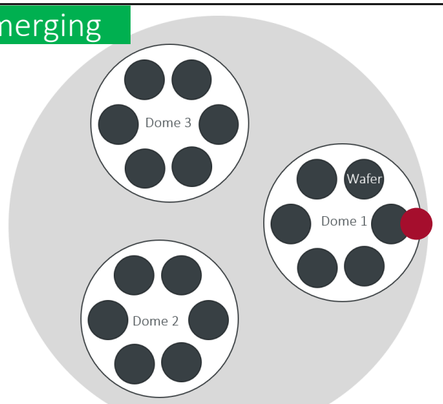
Emerging



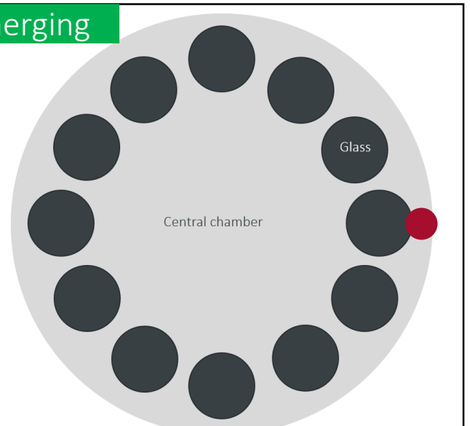
Emerging



Emerging



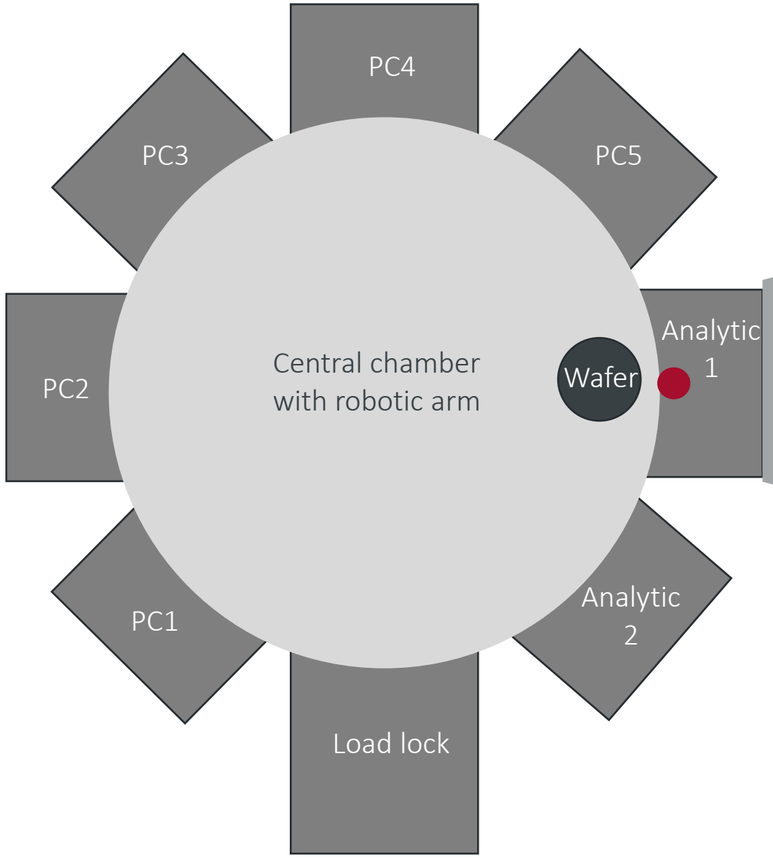
Emerging

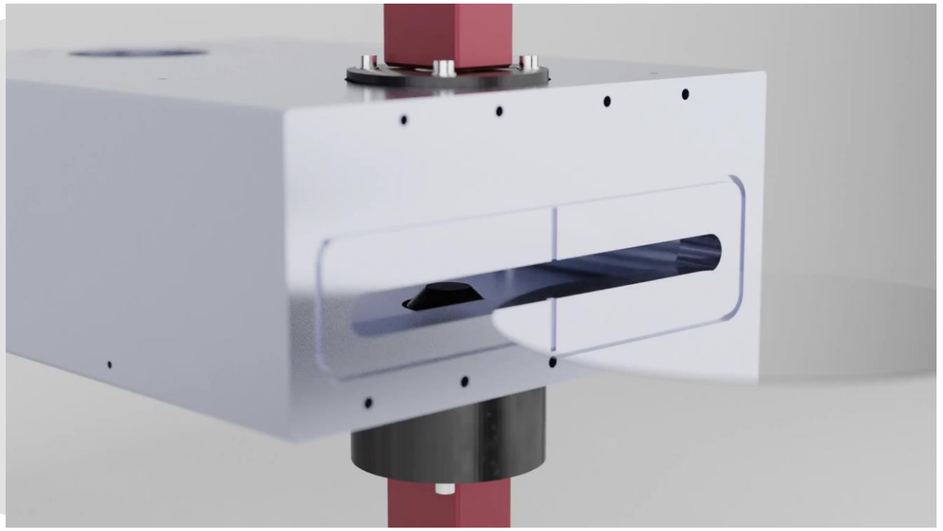


● Denotes Eddy Current Metrology

Sensor Integration – Cluster Deposition Tool

- Wafer transfer from cassette to process and analytic chambers
- Wafer/layer characterization in test chamber dedicated to non-contact electrical metrology



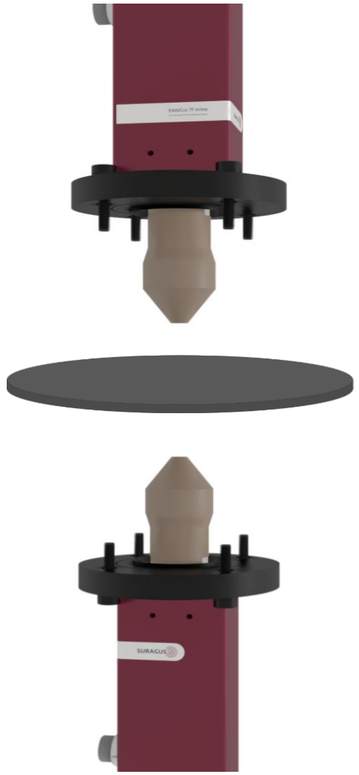


Sensor pair in test chamber
Sheet resistance measurement
Metal thickness measurement
Wafer resistivity measurement

● Denotes Eddy Current Metrology

Benefits of Process-near Sensor Integration

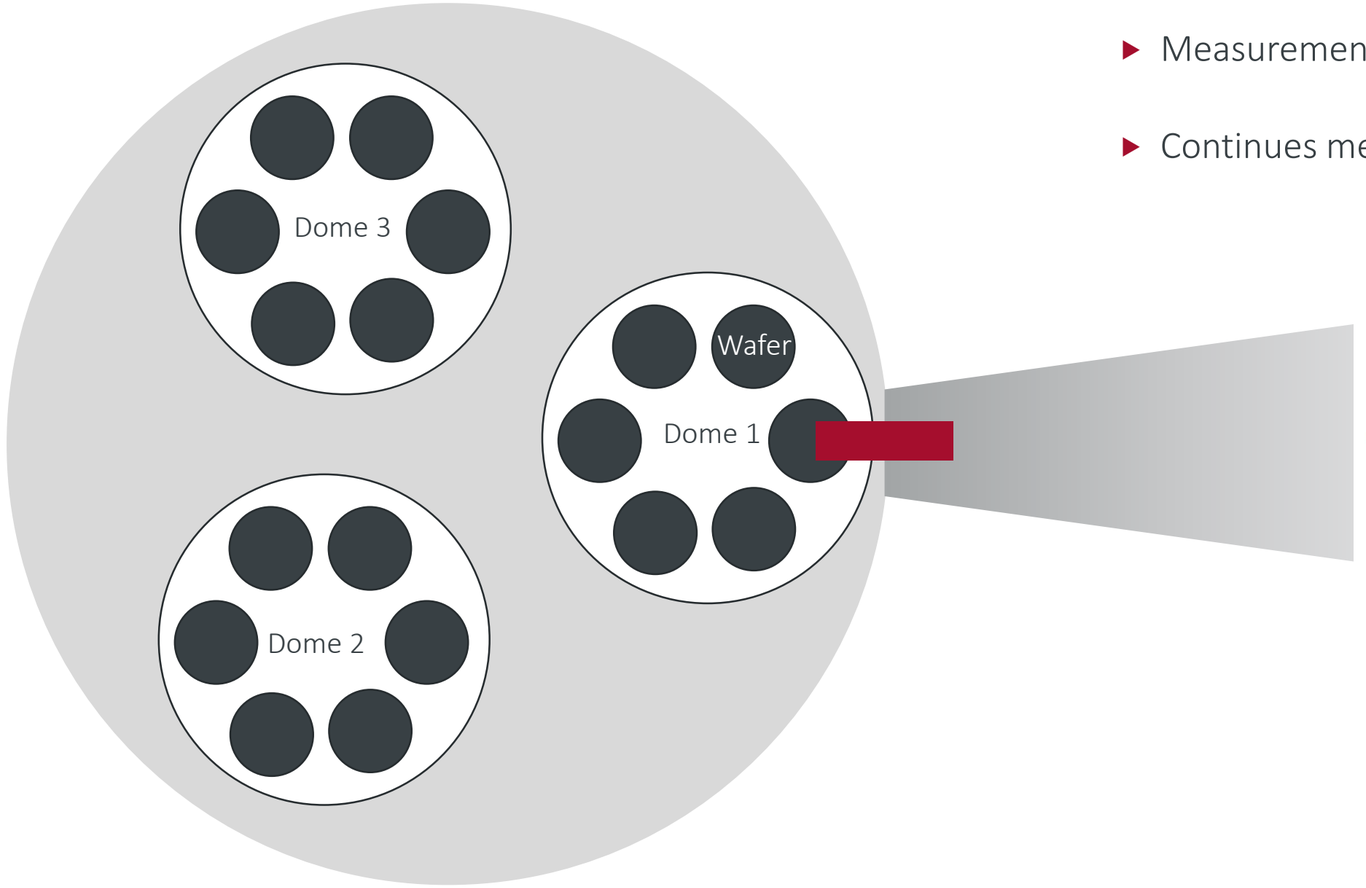
- Instantaneous measurement in non-contact mode
  - Eliminate time-consuming, quality-impairing contact-based measurement
  - High-speed measurements with no contact to layers
  - Higher wafer yield and higher wafer throughput
- Increase system up-time
  - Higher throughput to customer
  - Reduce tool CoO
  - Reduce coating cost per wafer
- In-chamber testing
  - Quick decisions on process optimization
  - Improve process parameters live
  - Better device performance and improved yield



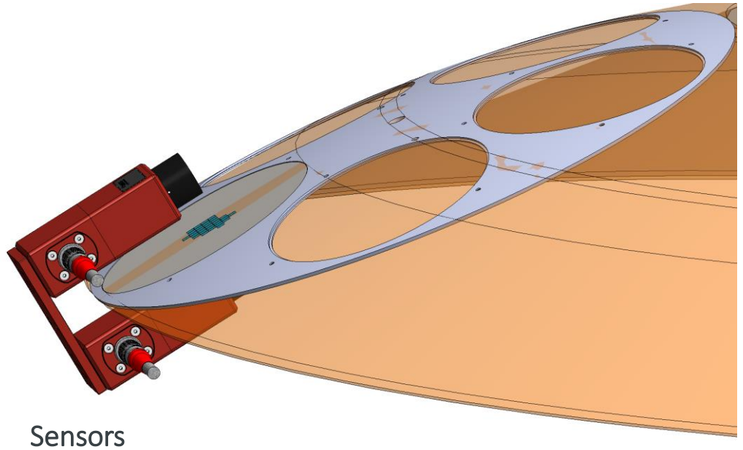
Higher throughput and higher yield through electrical characterization of wafers and layers

Sensor Integration - Metallization Coater

- Rotating domes carrying wafers



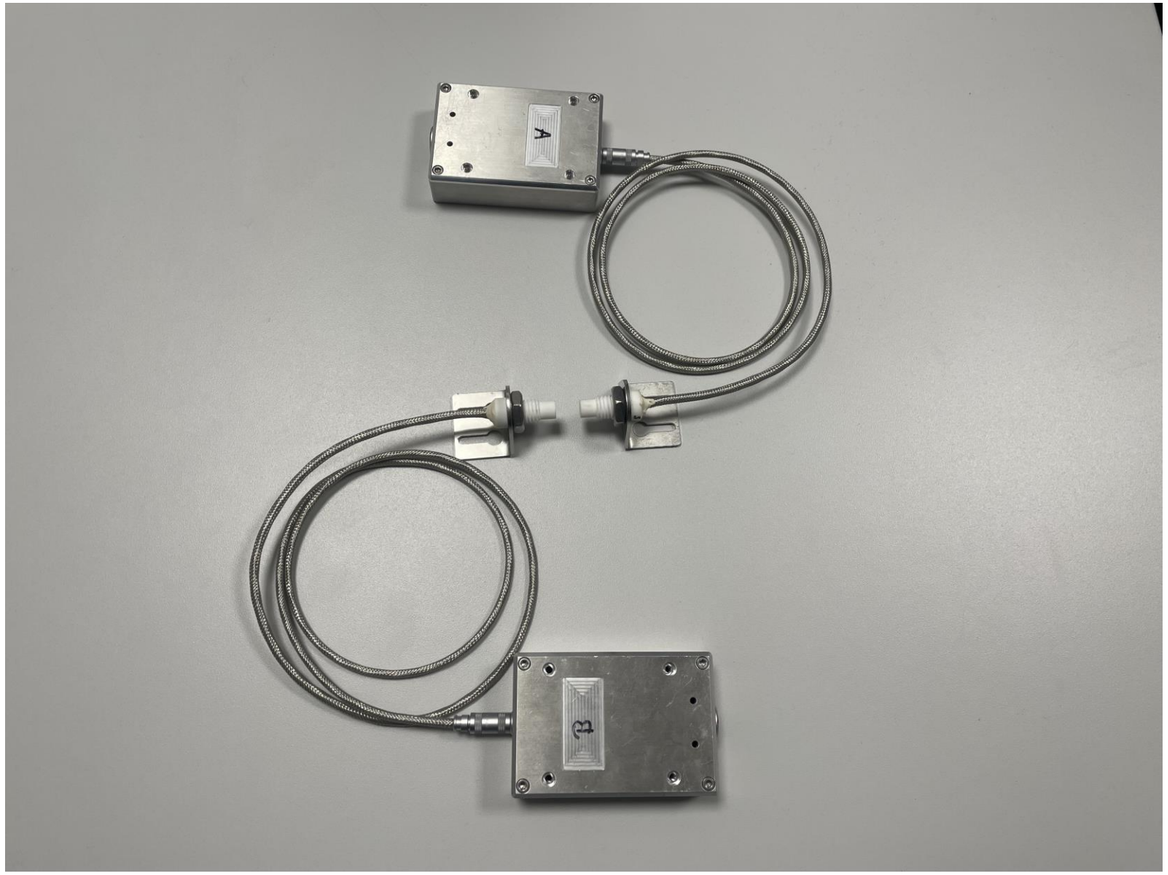
- In-situ measurement during metal deposition (Ti, Cu, Al, Ag, Au…)
- Measurement during wafer rotation
- Continues measurement with automatic wafer detection



Sensors
Sheet resistance
Metal thickness
Wafer resistivity

XXS Sensor for Hot Environment

- Minimized footprint
- Separated probe and preamplifier

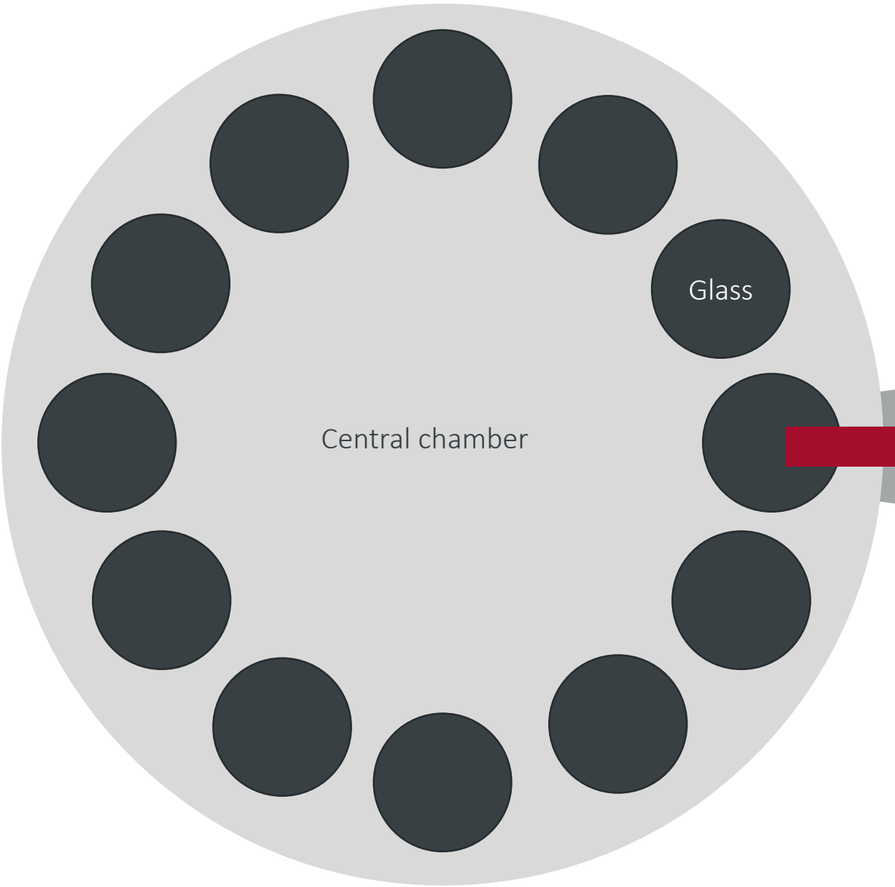


Setup in Demonstration Chamber

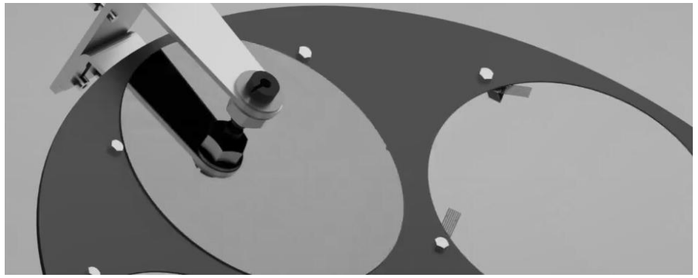
FEP LOGO

Sensor Integration - Optical Coater

- Rotating platform with glass substrates



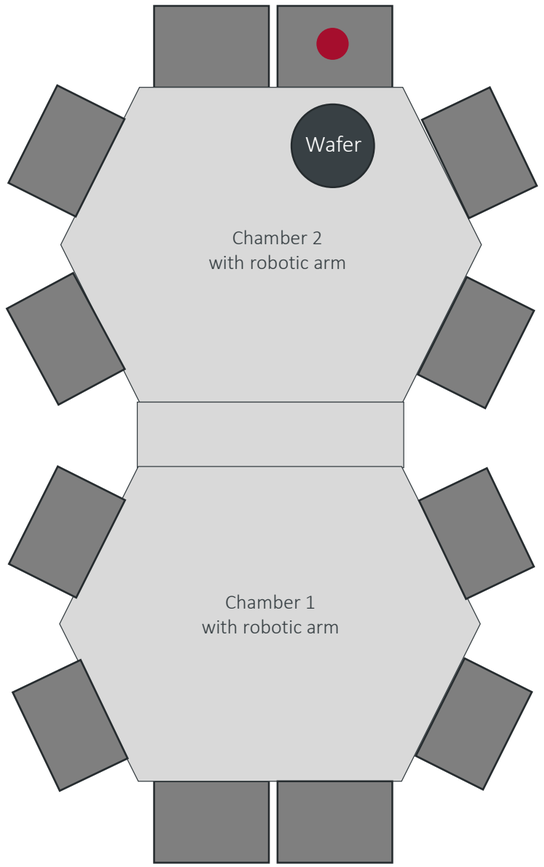
- In-situ measurement during metal deposition (Ti, Cu, Al, Ag, Au…)
- Measurement during substrate rotation
- Sheet resistance / metal thickness logging over time



XXS Sensor

Sensor Integration – Inline Wafer Coater

- Inline horizontal testing

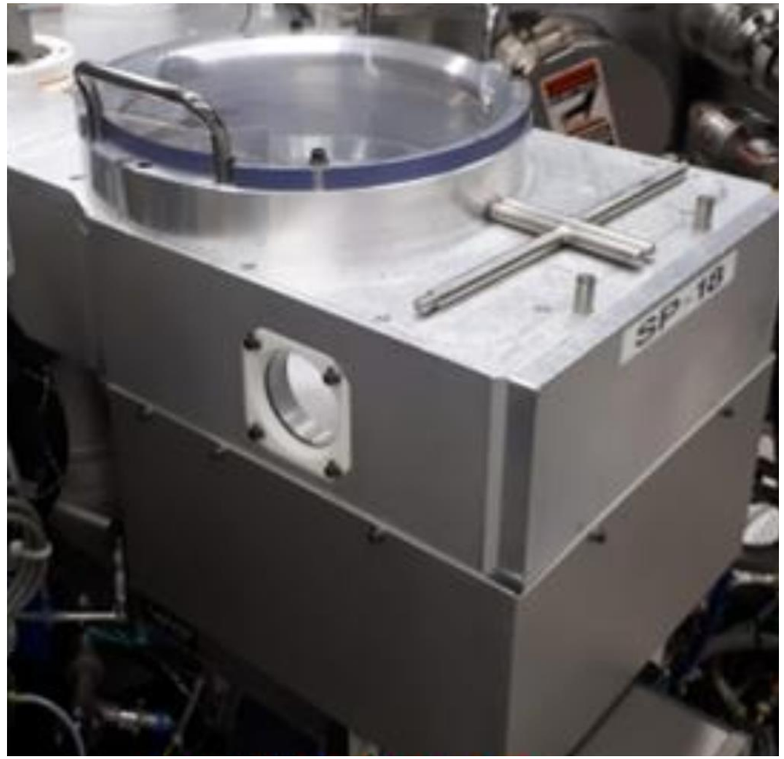


- In-situ measurement during metal deposition (Ti, Cu, Al, Ag, Au…)
- Measurement during substrate rotation
- Sheet resistance logging over time

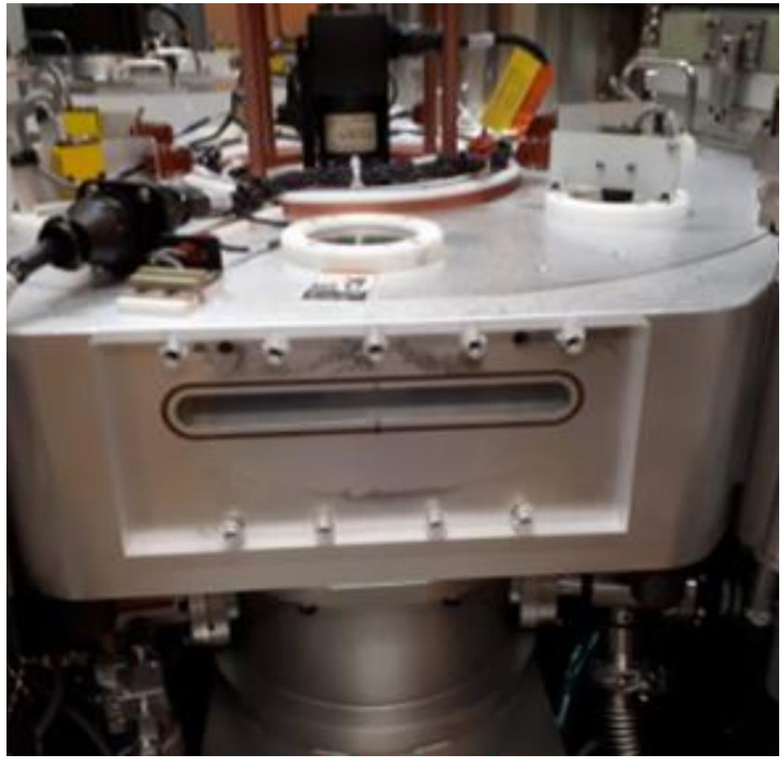
Sensor pair in test chamber
Sheet resistance measurement
Metal thickness measurement

Endura 5500 Integration

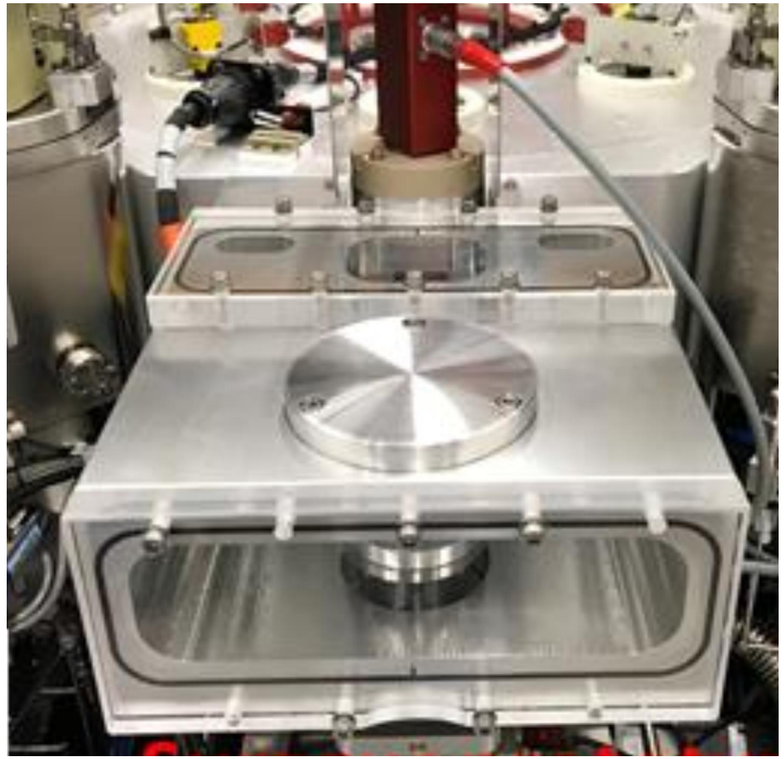
Standard AMAT CHAMBER 5



No CHAMBER 5

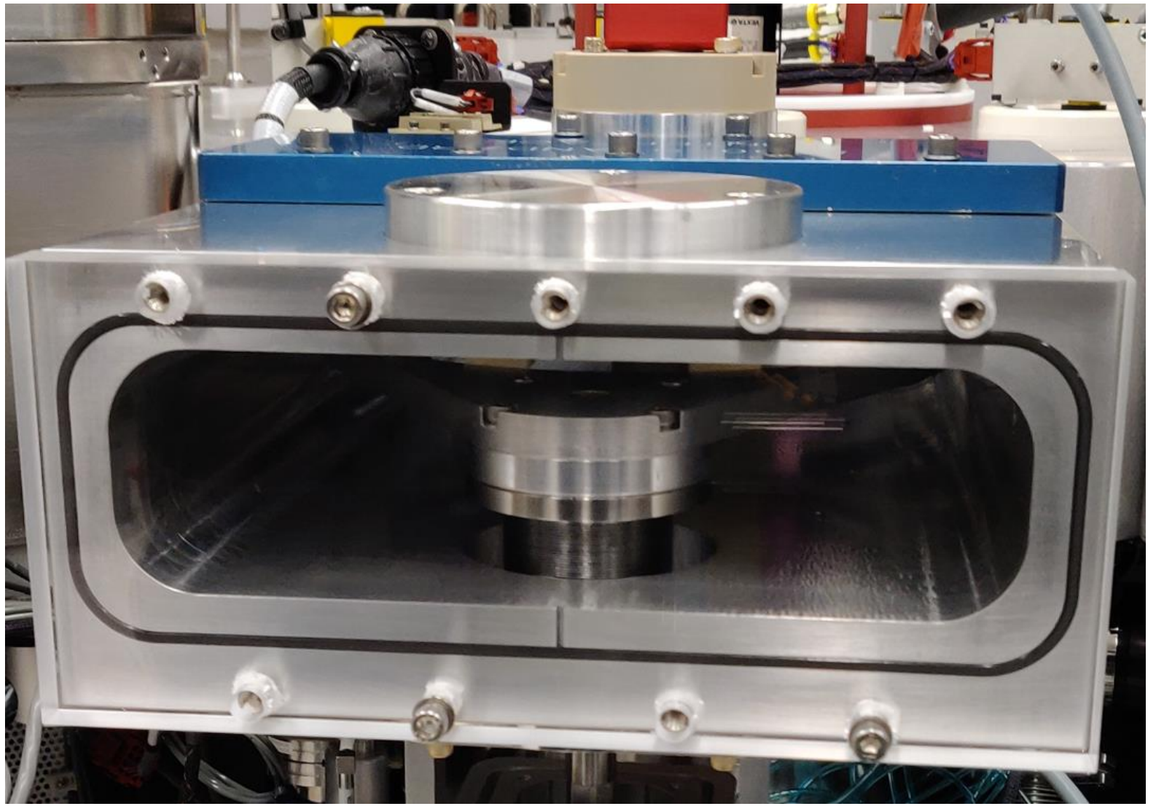


SURAGUS MEASUREMENT CHAMBER

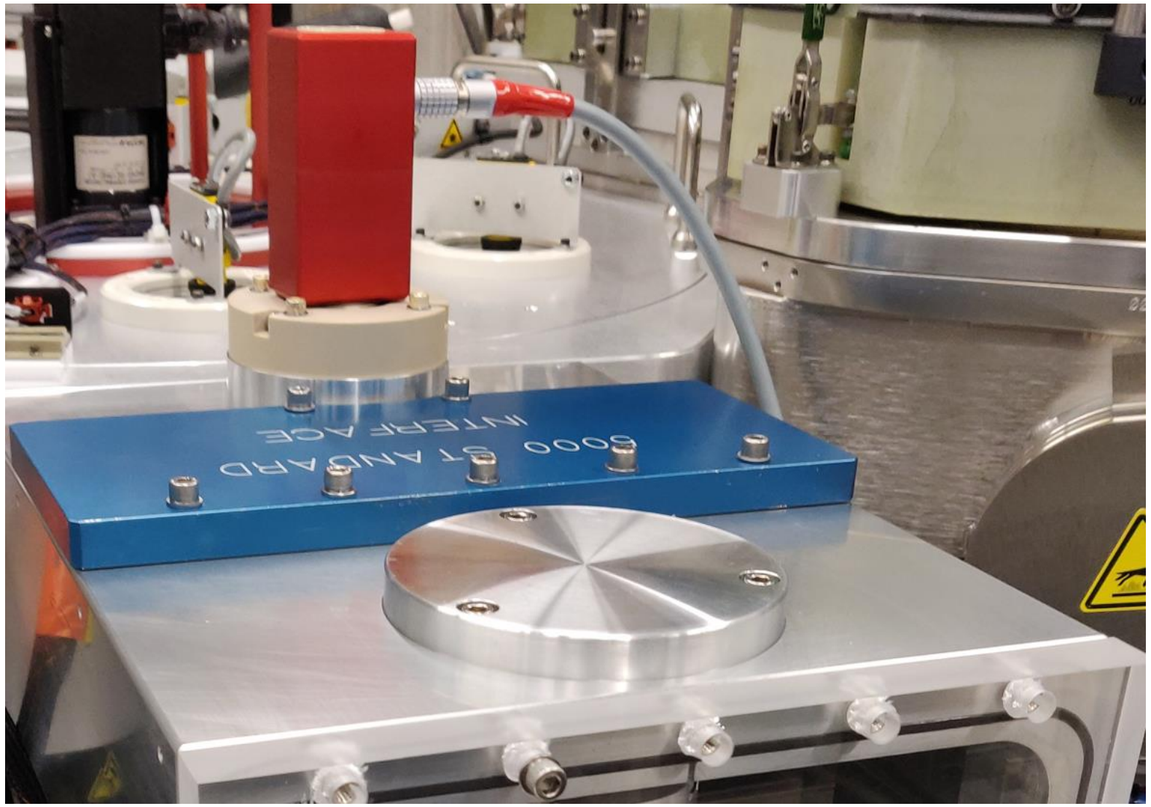


Installation in PVD Cluster Tool

Transparent Window

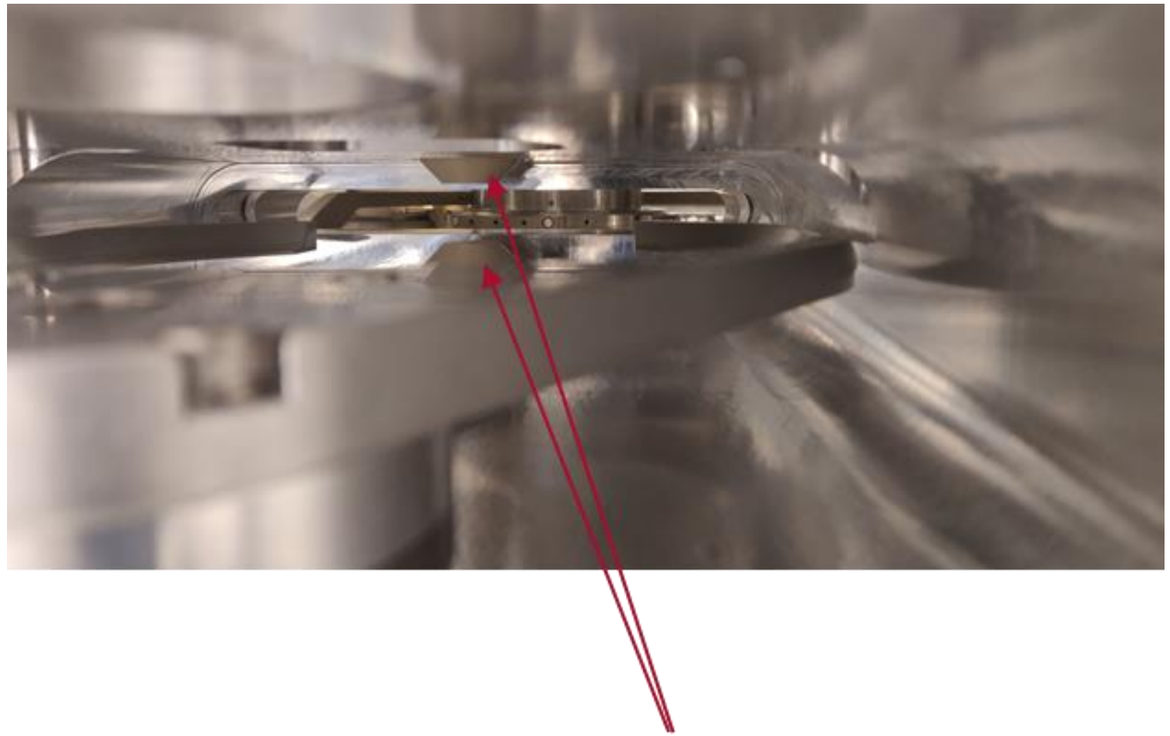


Sensor Integration Top Side

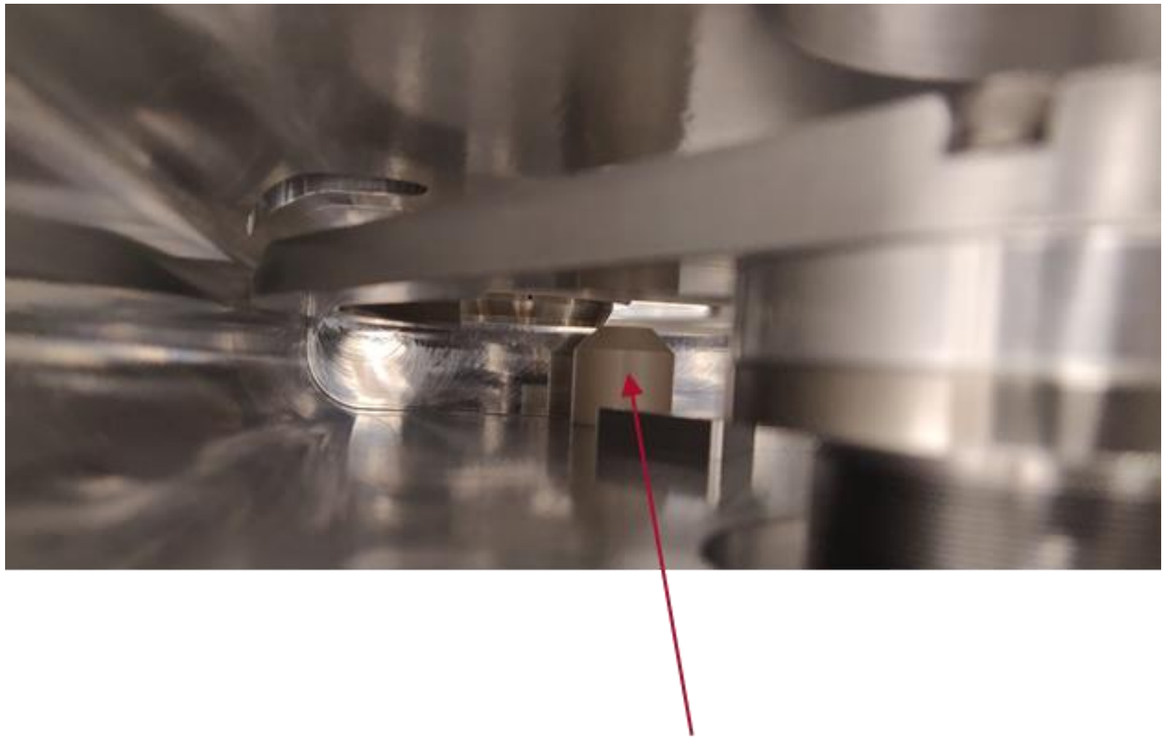


In-Chamber Wafer Monitoring

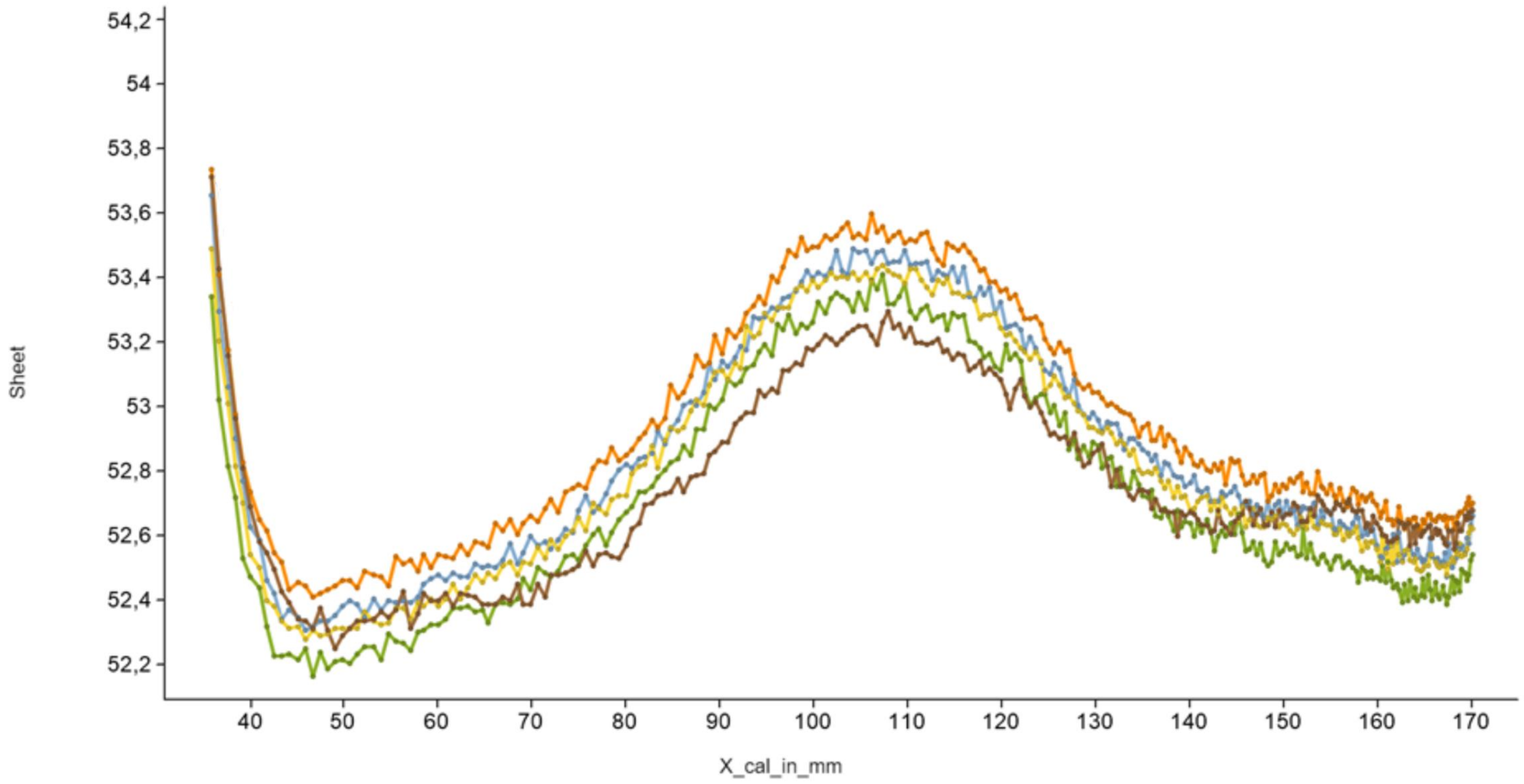
View 1



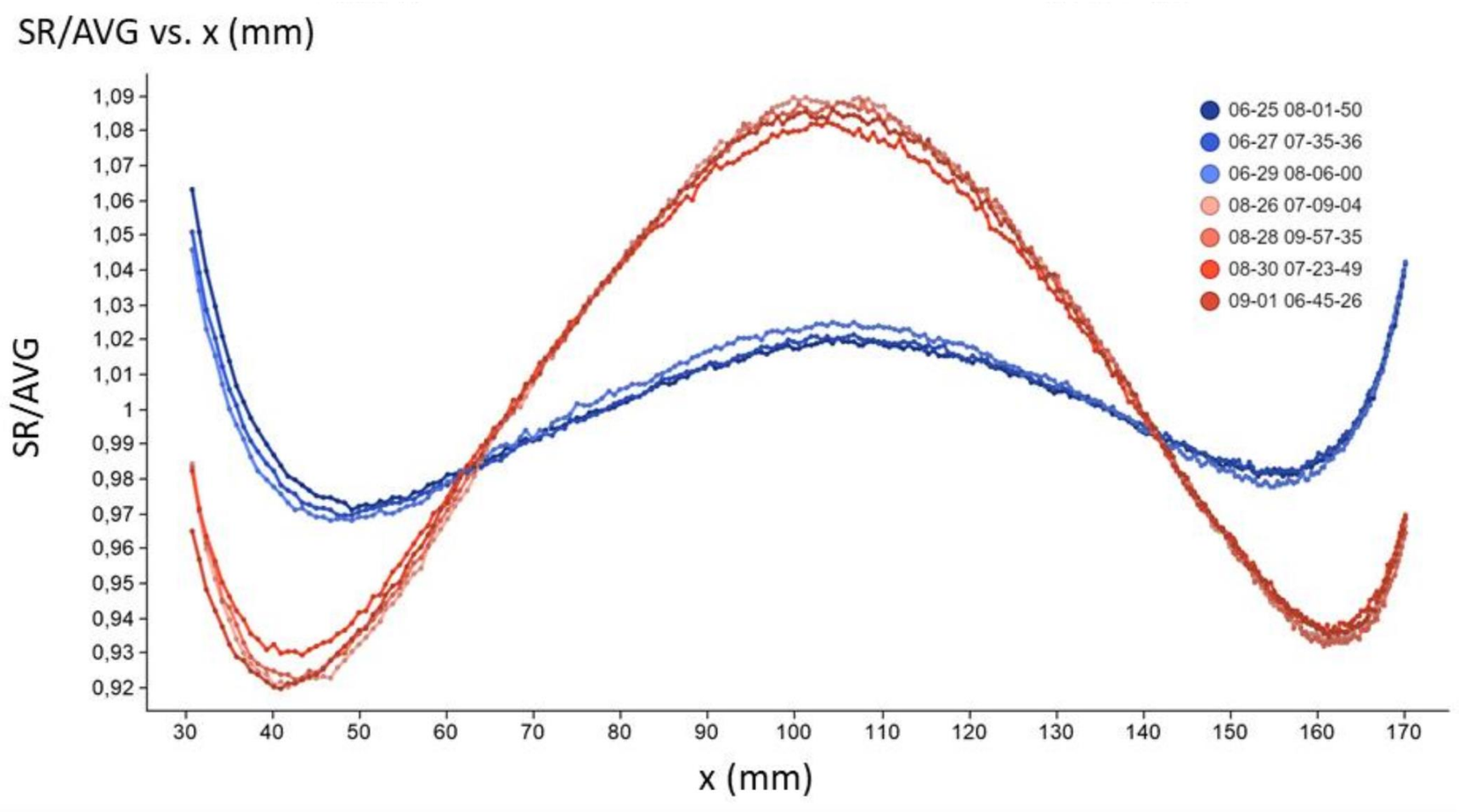
View 2



Repeatability Measurements



Target Life Affects The Deposition Profile



Wafer to Wafer and Chamber to Chamber Effects