

# **Integration Effectiveness of In Situ Optical Metrology for CMP**

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## Minimal Utility:

Stop the polish process in a timely manner so that wafers are properly processed.

## Moderate Utility:

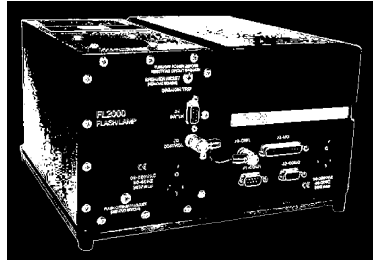
Enable local tool closed-loop-control for the current wafer or lot.

## Optimized Utility:

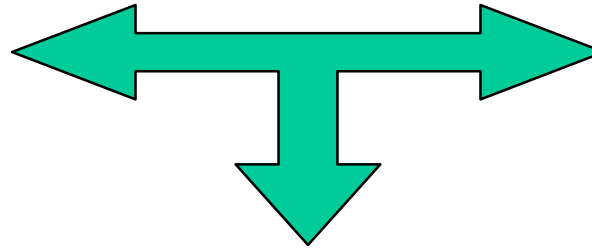
Provide feed-forward and feed-backward data for complimentary process optimization.

# Integrated System

**Optical Metrology Instrument**



**CMP Tool**



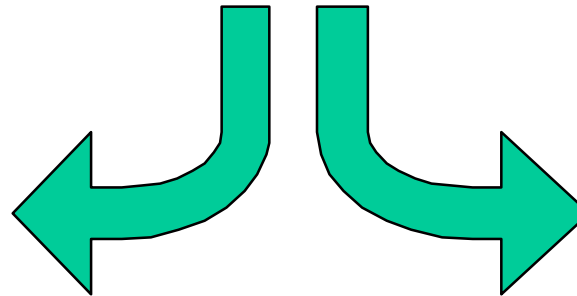
**MES**



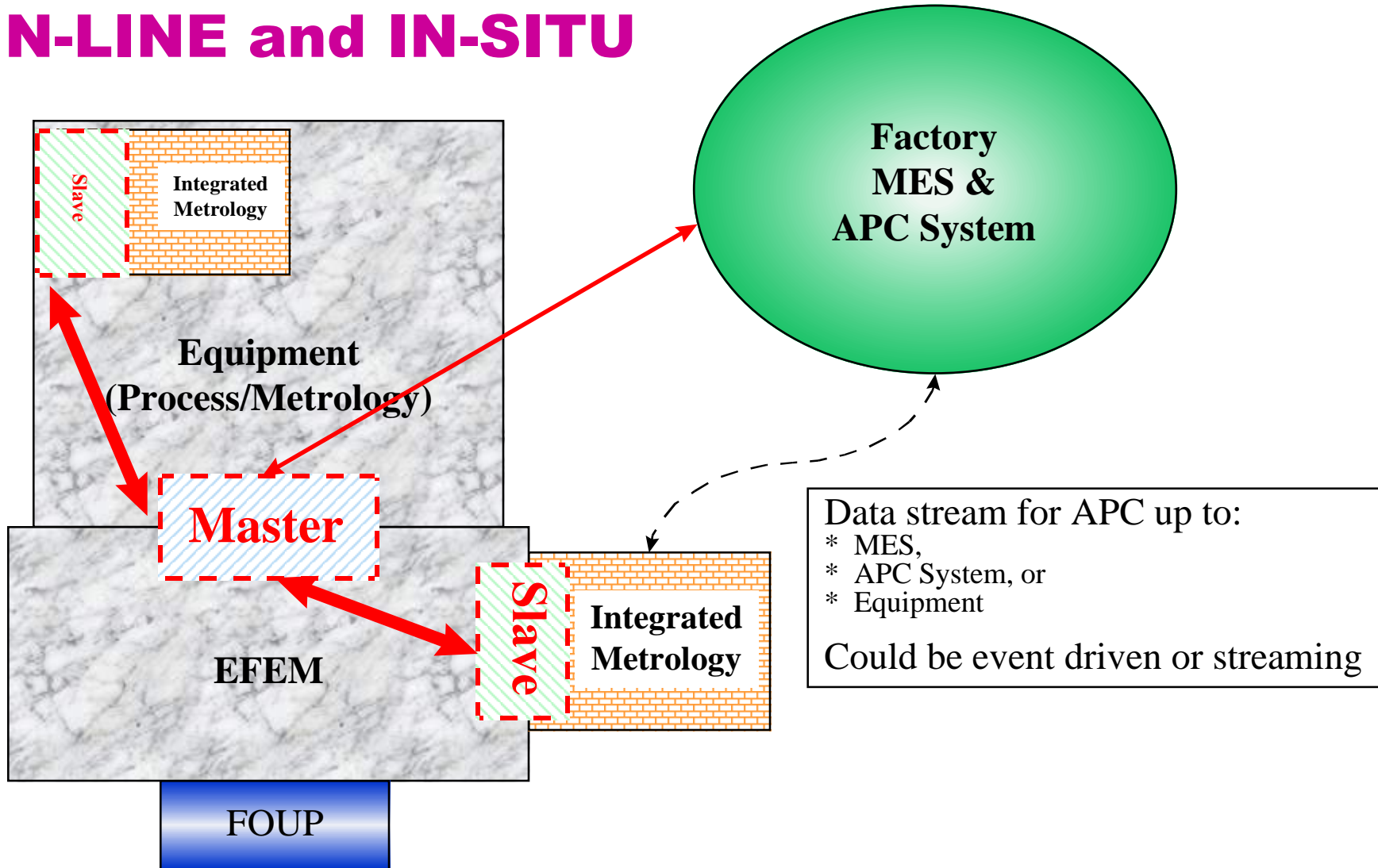
**Copper Electrofill Tool**



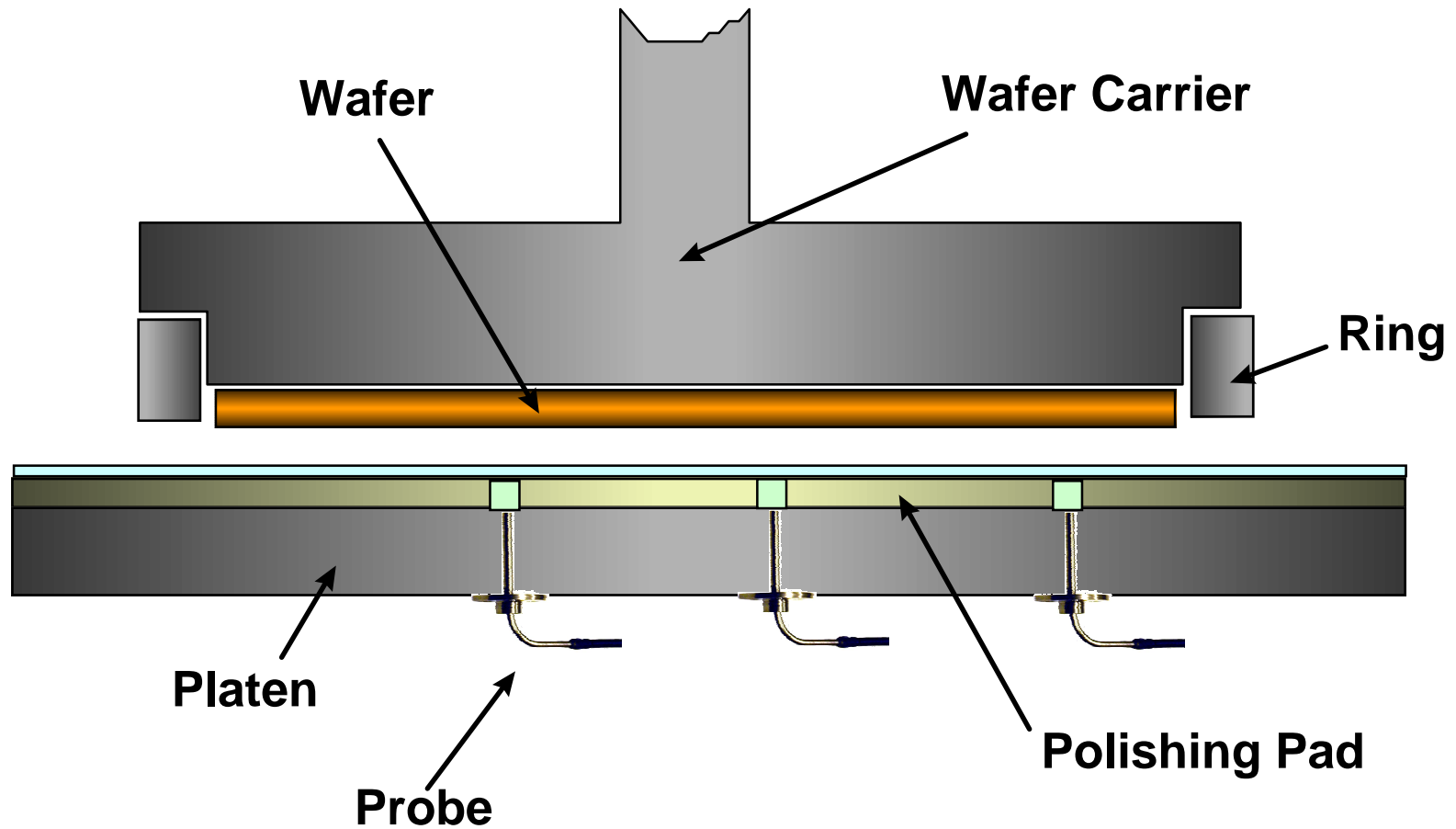
**PECVD Tool**



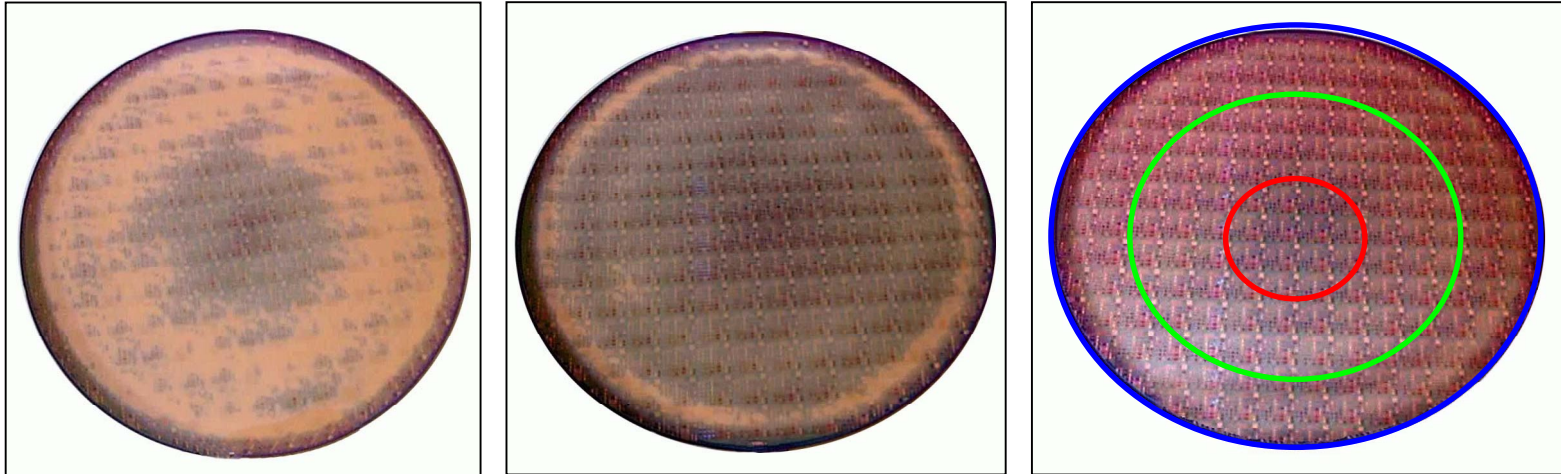
## IN-LINE and IN-SITU



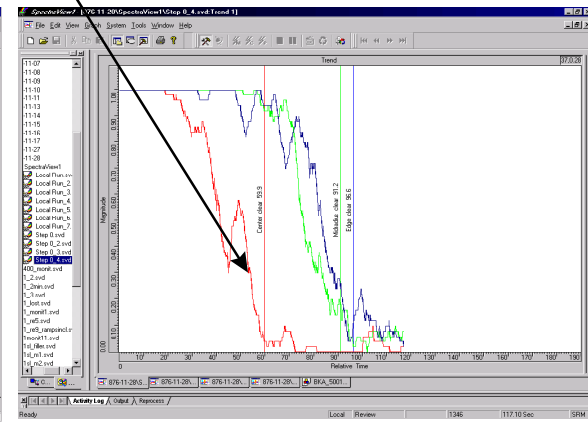
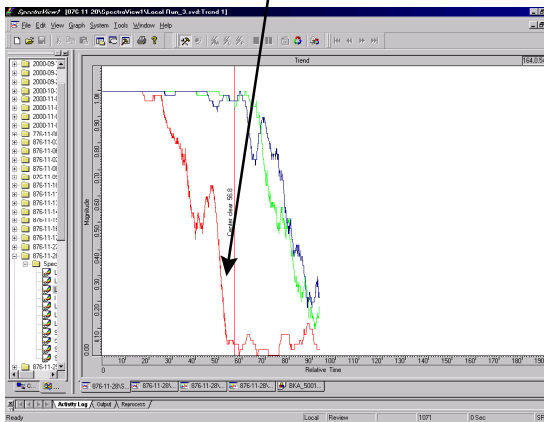
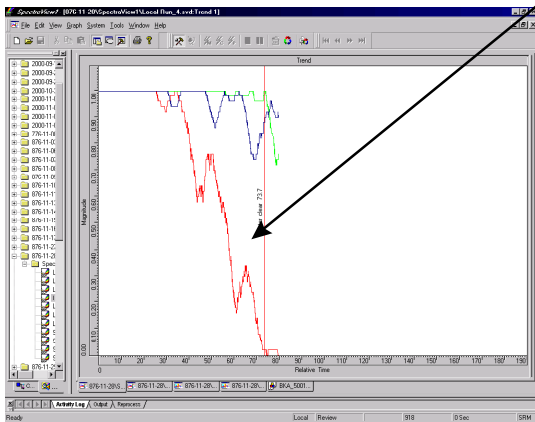
# Wafer Inspection



# Wafer State Data



Center-fast polish



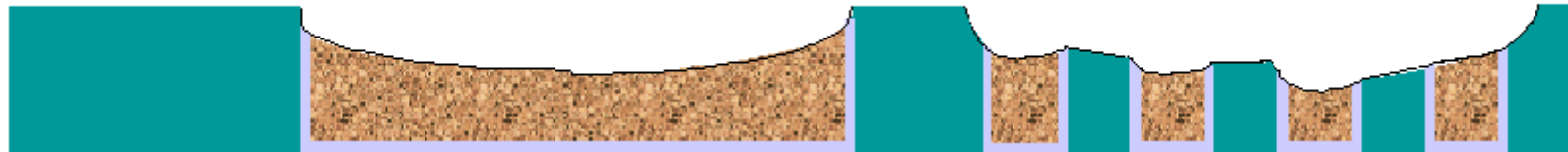
# Correlated Data

## Observed

- 
- Polish Endpoint Times
- Radial Polishing Uniformity
- Azimuthal Polishing Uniformity
- 

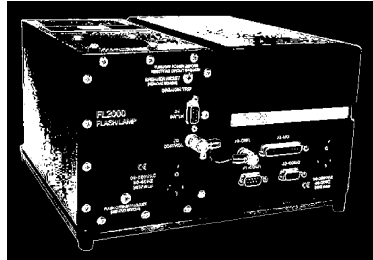
## Correlated

- 
- Copper Removal Rate
- Copper Thinning, Erosion, Recess
- Copper Deposition profile
- Field Oxide Loss



# Minimal Effectiveness

**Optical Metrology  
Instrument**



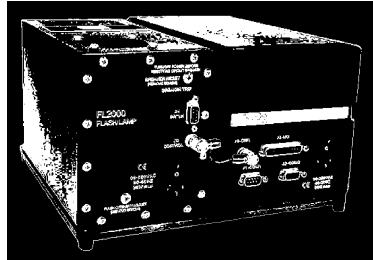
**CMP Tool**



- Endpoint functionality only
  - Stop on time
- Limited improvement for process non-uniformity control.



**Optical Metrology  
Instrument**



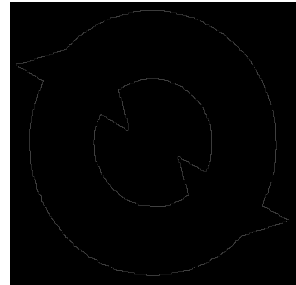
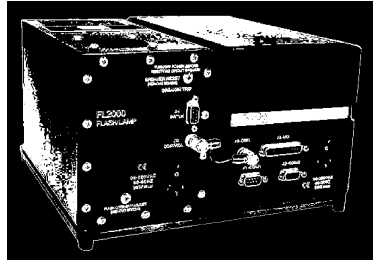
**CMP Tool**



## REQUIREMENTS

- Standardization for historical data management and data mining.
- Definition of common communication interfaces and protocols.

## Optical Metrology Instrument



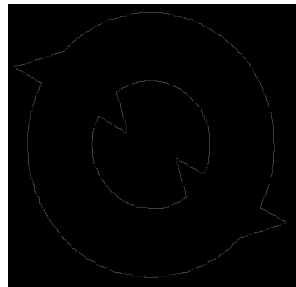
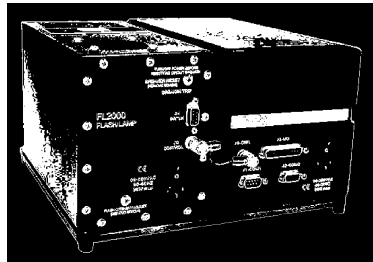
## CMP Tool



- Inter-polish closed-loop-control and endpoint functionality
- Automatic and local Stop/Start/Change process recipe on conditions
  - Enhanced improvement for process non-uniformity control.



**Optical Metrology  
Instrument**



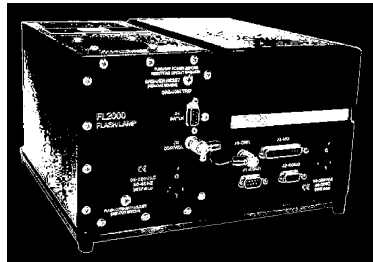
**CMP Tool**



## REQUIREMENTS

- Acceptance of common advanced process control and recipe management structures and interfaces.

**Optical Metrology  
Instrument**



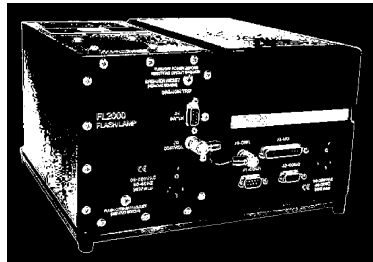
**CMP Tool**



**Copper Electrofill  
Tool**

- Provide feed-forward and feed-backward data for complimentary process optimization. Inter-polish closed-loop-control and endpoint functionality
  - Enhanced improvement for process non-uniformity control across multiple process steps.

**Optical Metrology  
Instrument**



**CMP Tool**



**Copper Electrofill  
Tool**

## REQUIREMENTS

- Acceptance of common advanced process control and recipe management structures and interfaces.
- Application of enhanced integration of process tools and the fab MES backbone.

# Summary & Future

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- “CMP In-situ metrology” provides capabilities beyond “endpoint”.
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- Fully integrated system enables real-time AEC/APC both for the local tool and related processes.
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- Integration is limited by the lack of accepted standards for the communication systems and protocols as well as the desired data.