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Integration Effectiveness of In Situ Optical Metrology for CMP

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Integration Effectiveness

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.

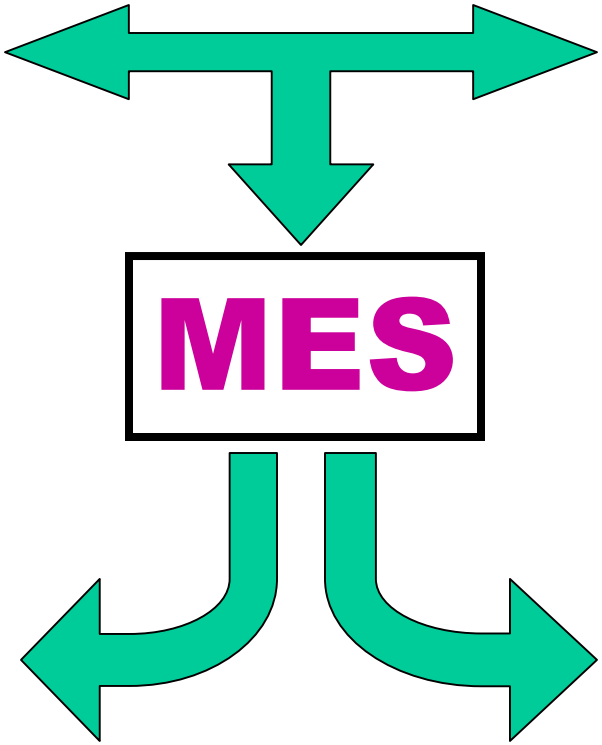
Optimized Utility:

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

Integrated System

Optical Metrology Instrument

CMP Tool

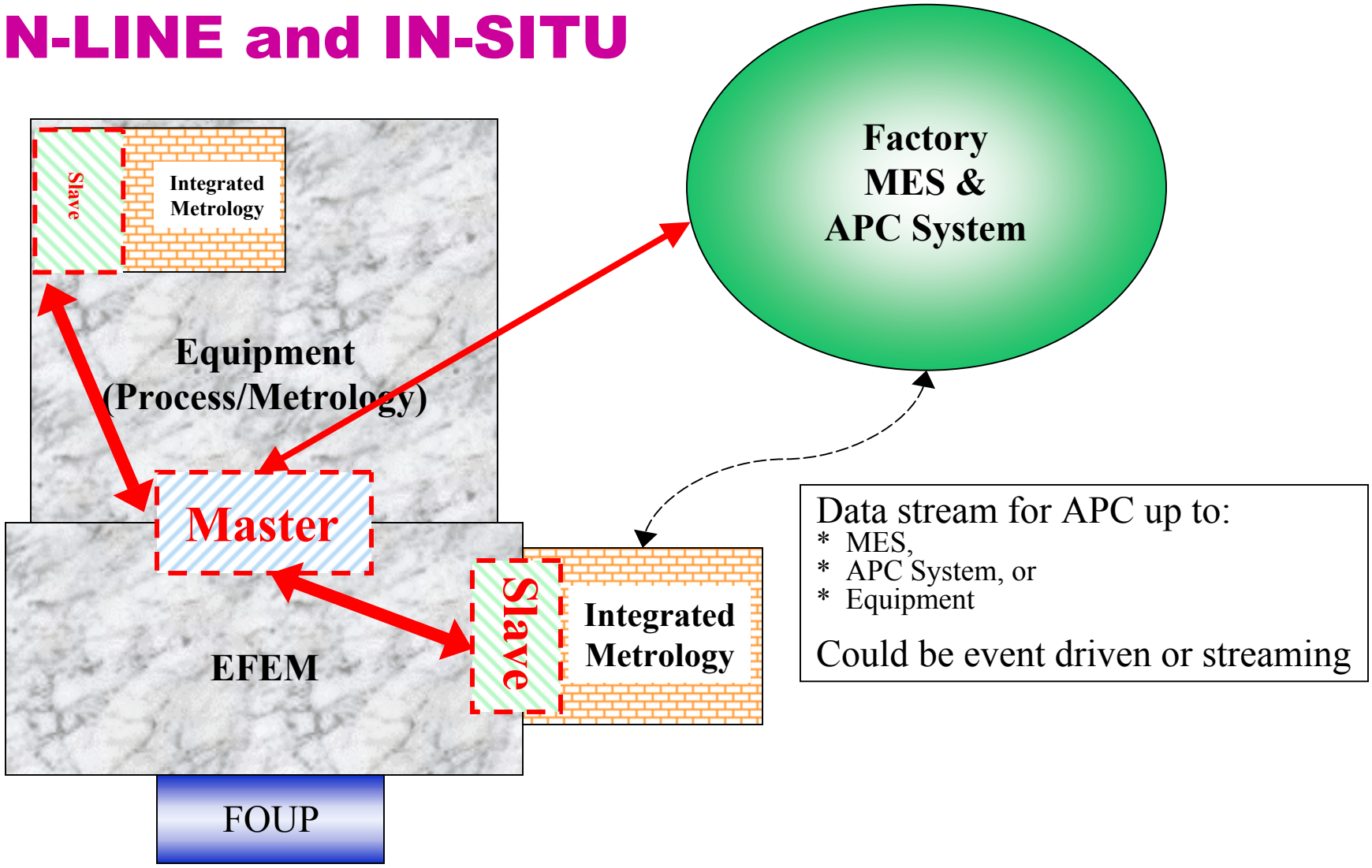


Copper Electrofill Tool

PECVD Tool

300 mm IM Com Strategy

IN-LINE and IN-SITU



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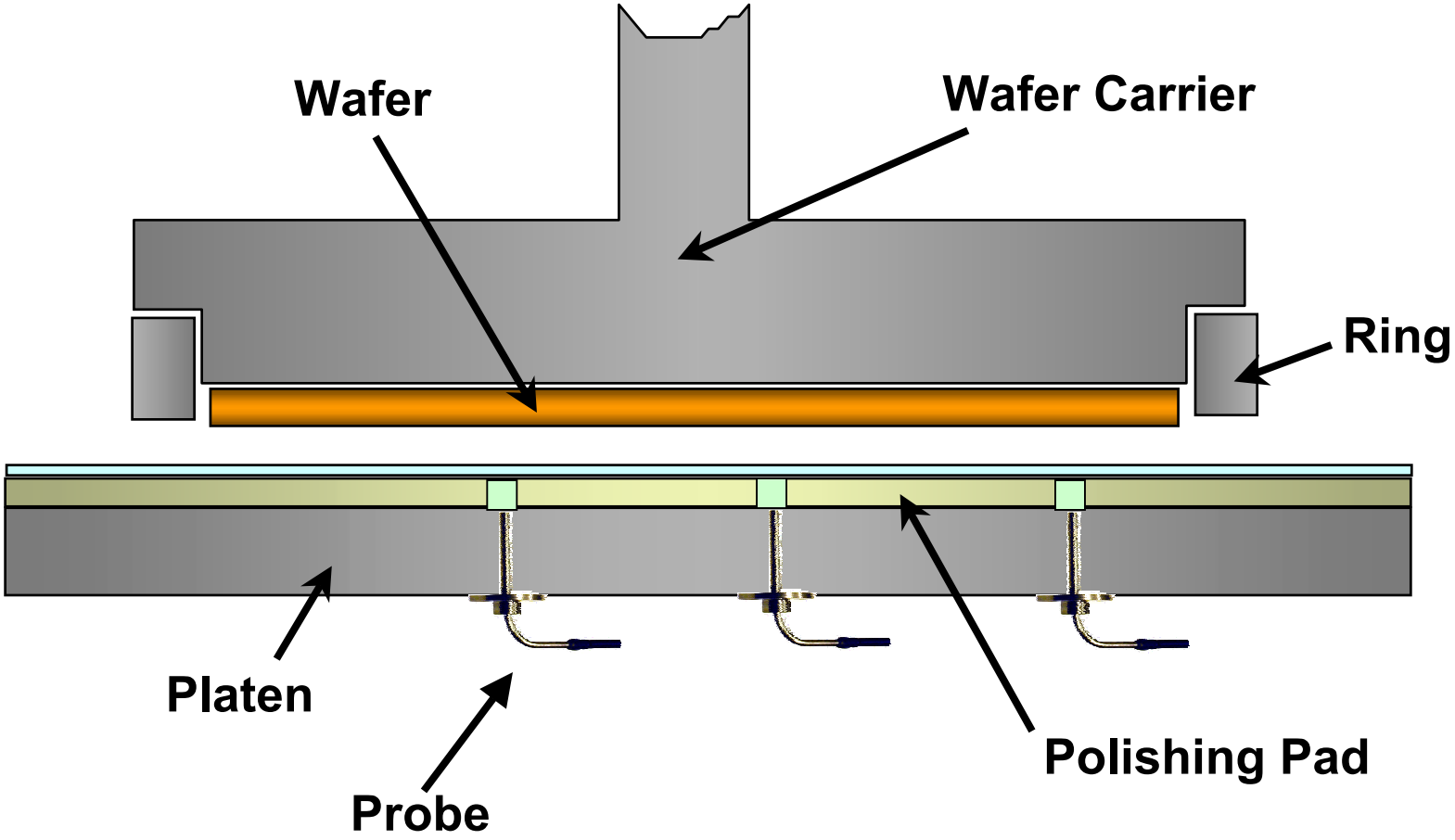
Wafer Inspection



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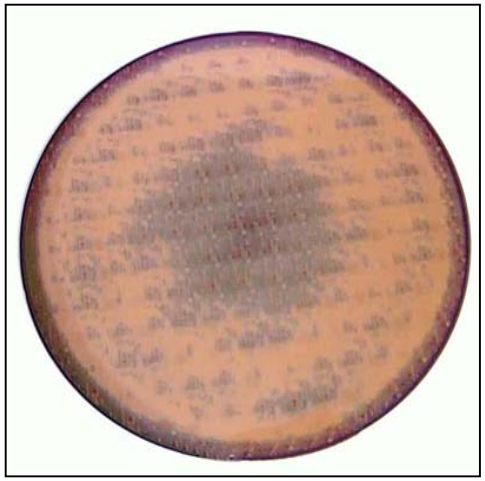
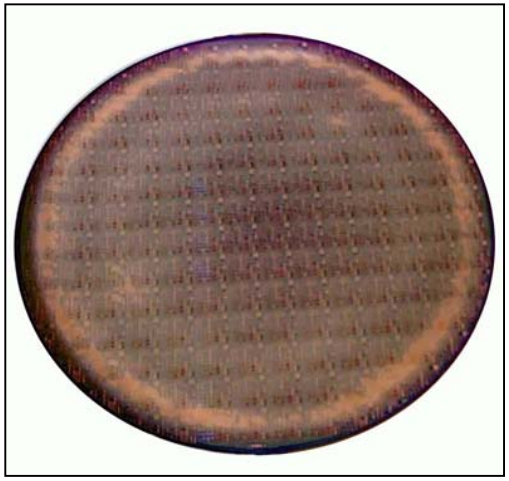
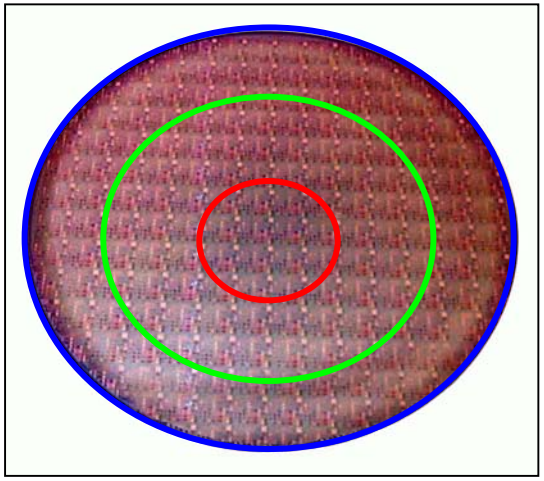
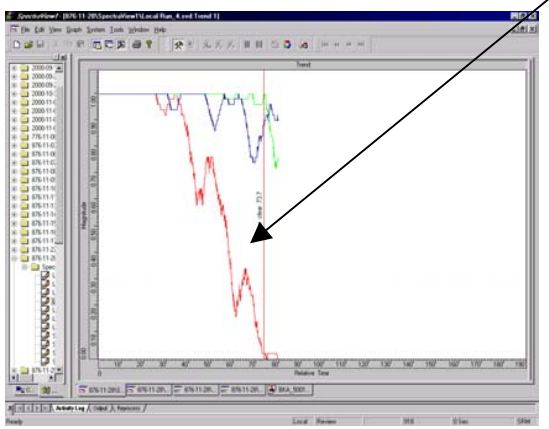
Wafer State Data

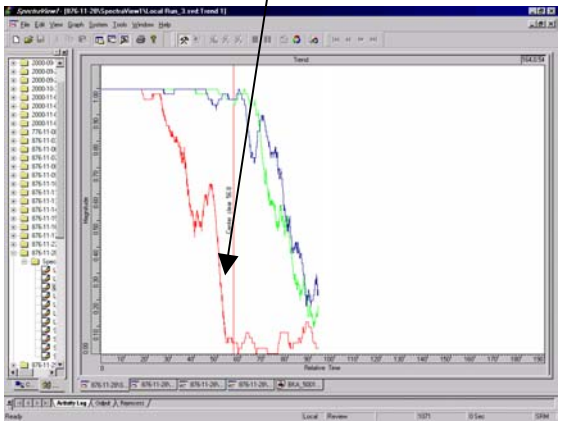


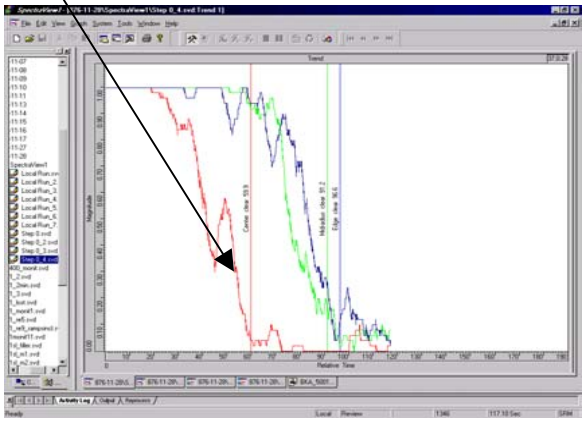




Center-fast polish







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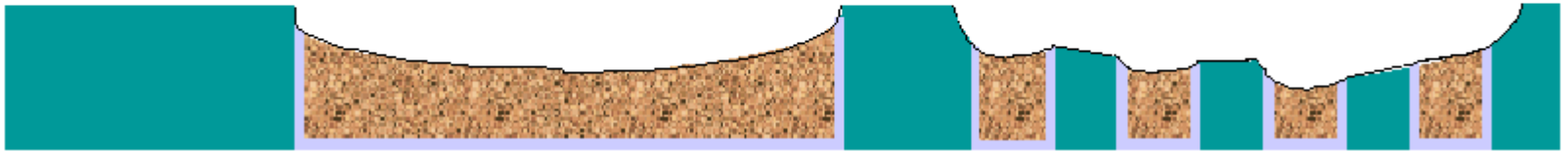
Correlated Data

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.

Increasing Effectiveness

Optical Metrology Instrument

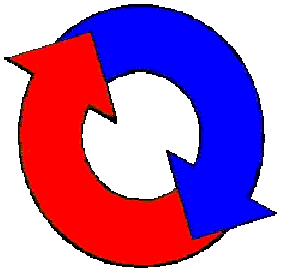
CMP Tool

REQUIREMENTS

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

Moderate Effectiveness

Optical Metrology Instrument

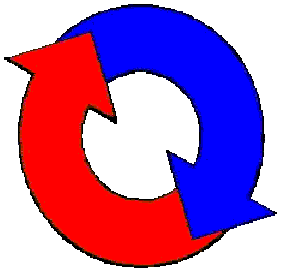


CMP Tool

- 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.

Increasing Effectiveness

Optical Metrology Instrument



CMP Tool

REQUIREMENTS

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

Optimized Effectiveness

- 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.

Increasing Effectiveness

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.

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Summary & Future

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