

Metryx

Innovative Metrology Solutions

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*...rethink your **M**etrology*

NCCAVS Plasma Etch Users Group

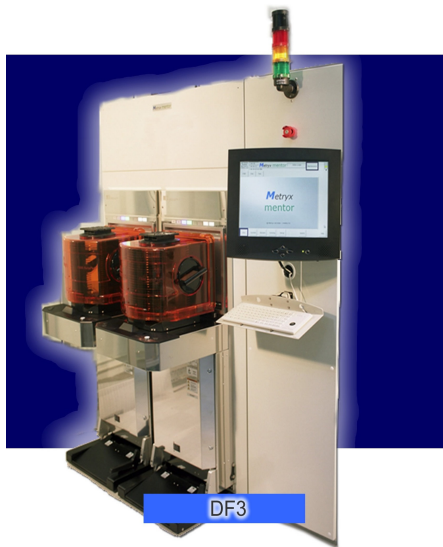
Plasma Etch Related Metrology and Diagnostics
August 13, 2008

Presentation Outline

- **Brief Introduction to Mass Measurement Technology.**
 - Metryx .
 - What is Mass Metrology
- **STI process Flow Outline.**
 - Challenges for STI at 65 nm and below.
- **STI Process Improvements with Mass in High Vol. Manufacturing (HVM).**
 - Process Stability:
 - Mass Monitoring of the pad oxide/nitride deposition
 - Process Improvement
 - Identifying and prioritizing variability in STI etch
 - Early identification of Process excursions:
 - STI cavity etch
 - Process Monitoring
 - Advanced STI trench fill process
- **Q & A**

About Metryx

- Metryx is a UK based innovative metrology company with an installed base of ~30 systems in 200mm and 300mm memory and logic fab installations in Europe, Asia and the USA
- Recognised through Queen's Award for Enterprise 2007 and 2008 and Semiconductor International Best Product Award in 2007



Mass Metrology

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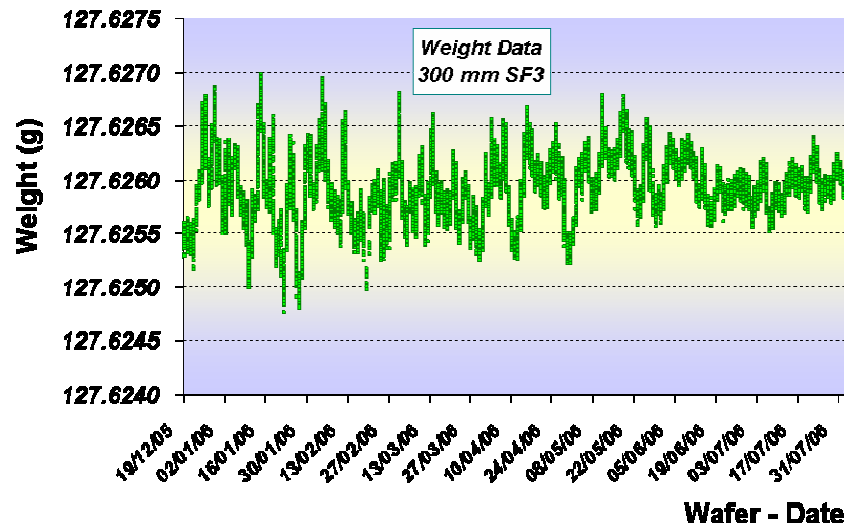
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Mass Measurement

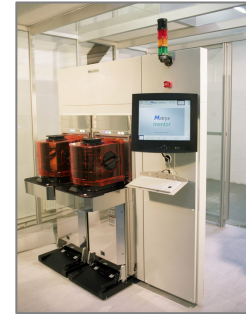
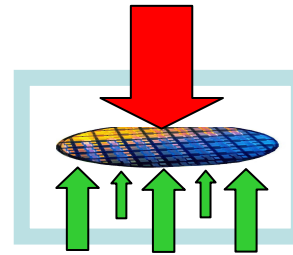
- Weight Measurement



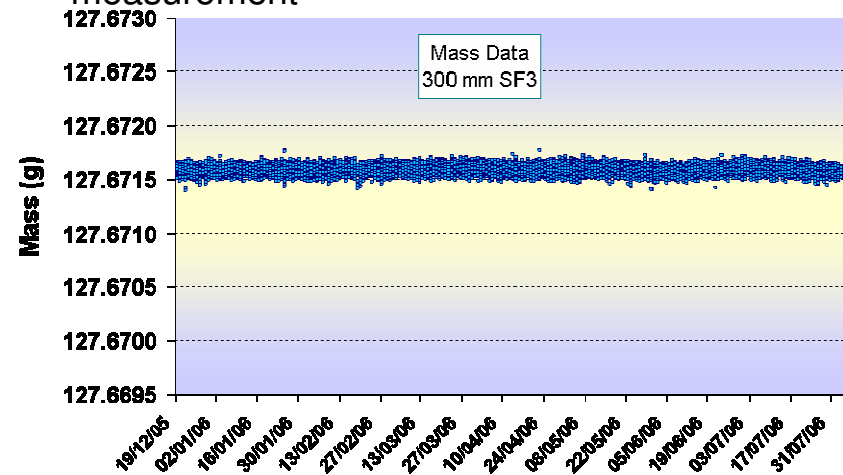
- An unstable, inaccurate, irreproducible measurement
- Not suitable for semiconductor R&D or Production



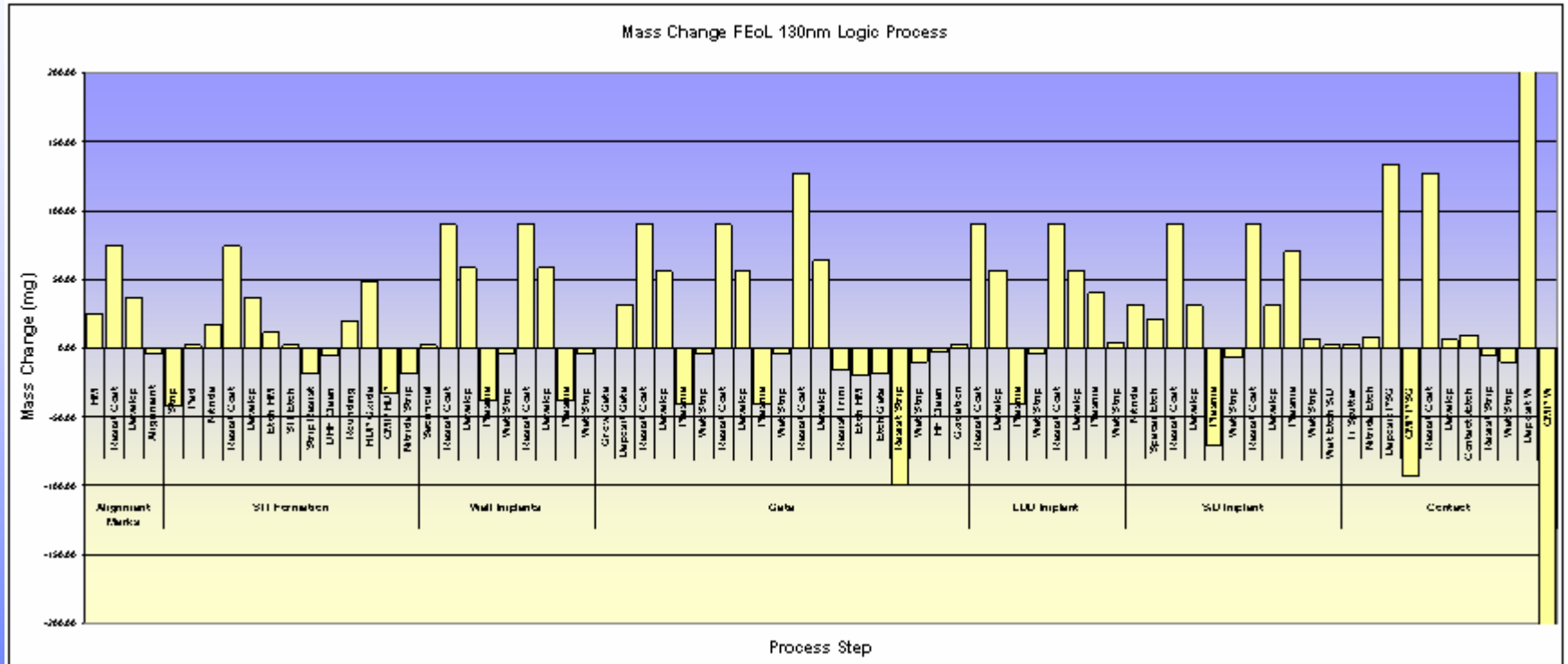
- Mass Measurement



- Complex Force measurement load-cell, both measuring and correcting for internal and external forces which affect weight measurement

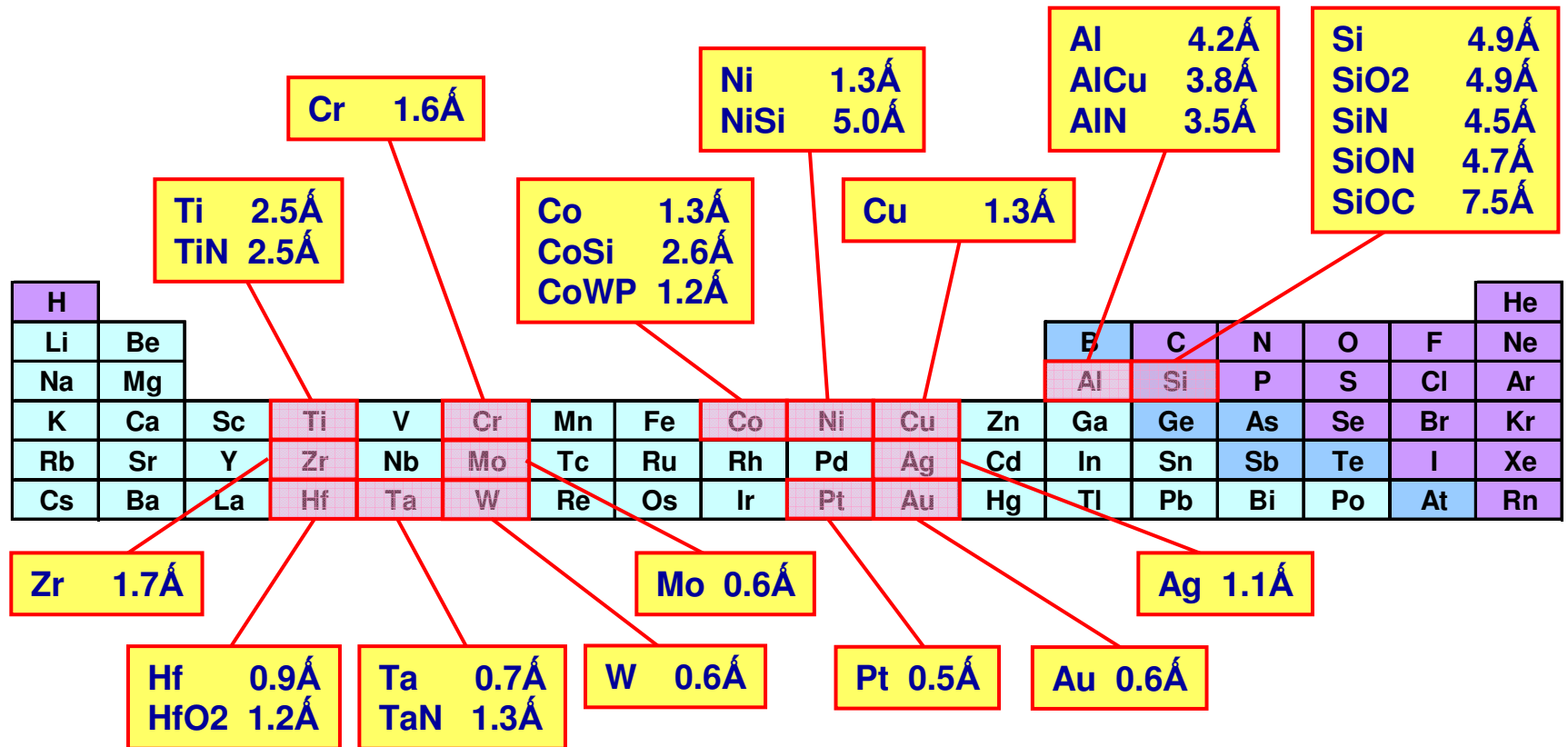


Mass Metrology



- All process steps create a wafer *mass change*
- This *mass change* reflects all aspects of process performance within a wafer
- Metryx Mass Metrology provides passive data collection on product wafers to assess process performance

Measurement Capability



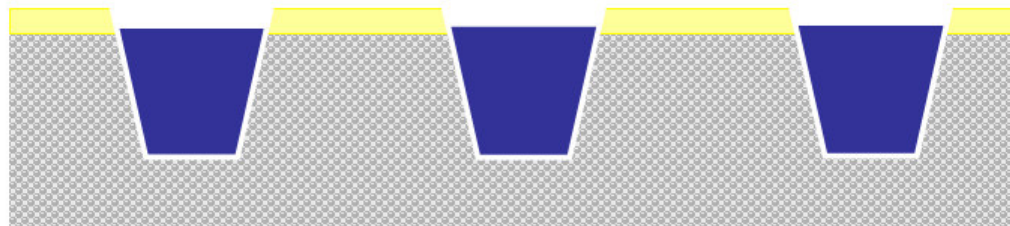
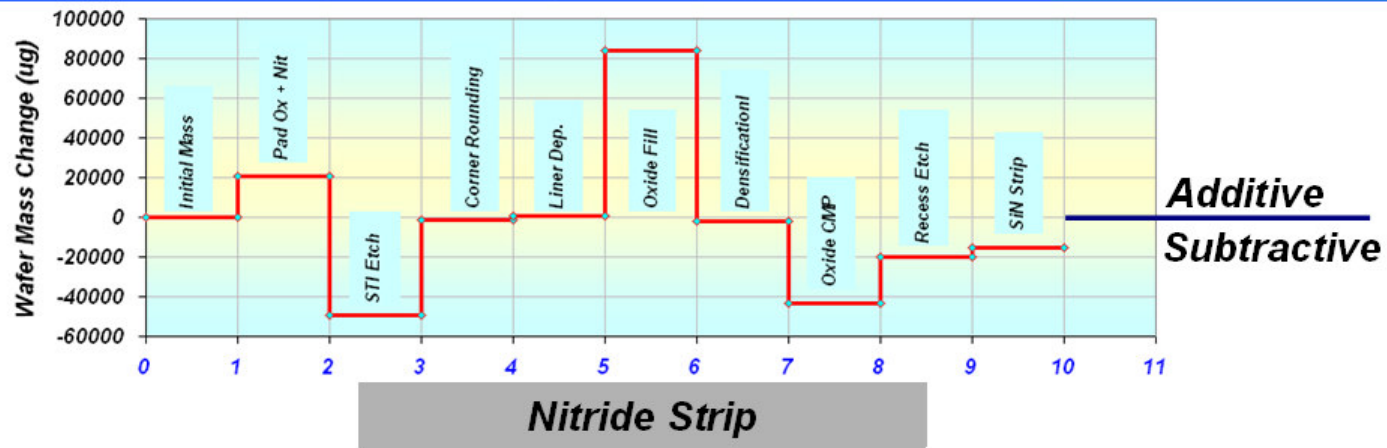
- 1 σ thickness repeatability for 200mm & 300mm wafers

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 - *Advanced STI trench fill process*
- **Q & A**

Mass Flow Diagram – STI Module

PAD Oxide & Nitride Dep	STI Etch	Liner Deposition	Oxide CMP
Lithography	Cavity / Corner Rounding	Oxide Fill	Recess Etch
PAD Oxide & Nitride Etch	Photo resist Strip	Oxide Densification	SiN Removal



Presentation Outline

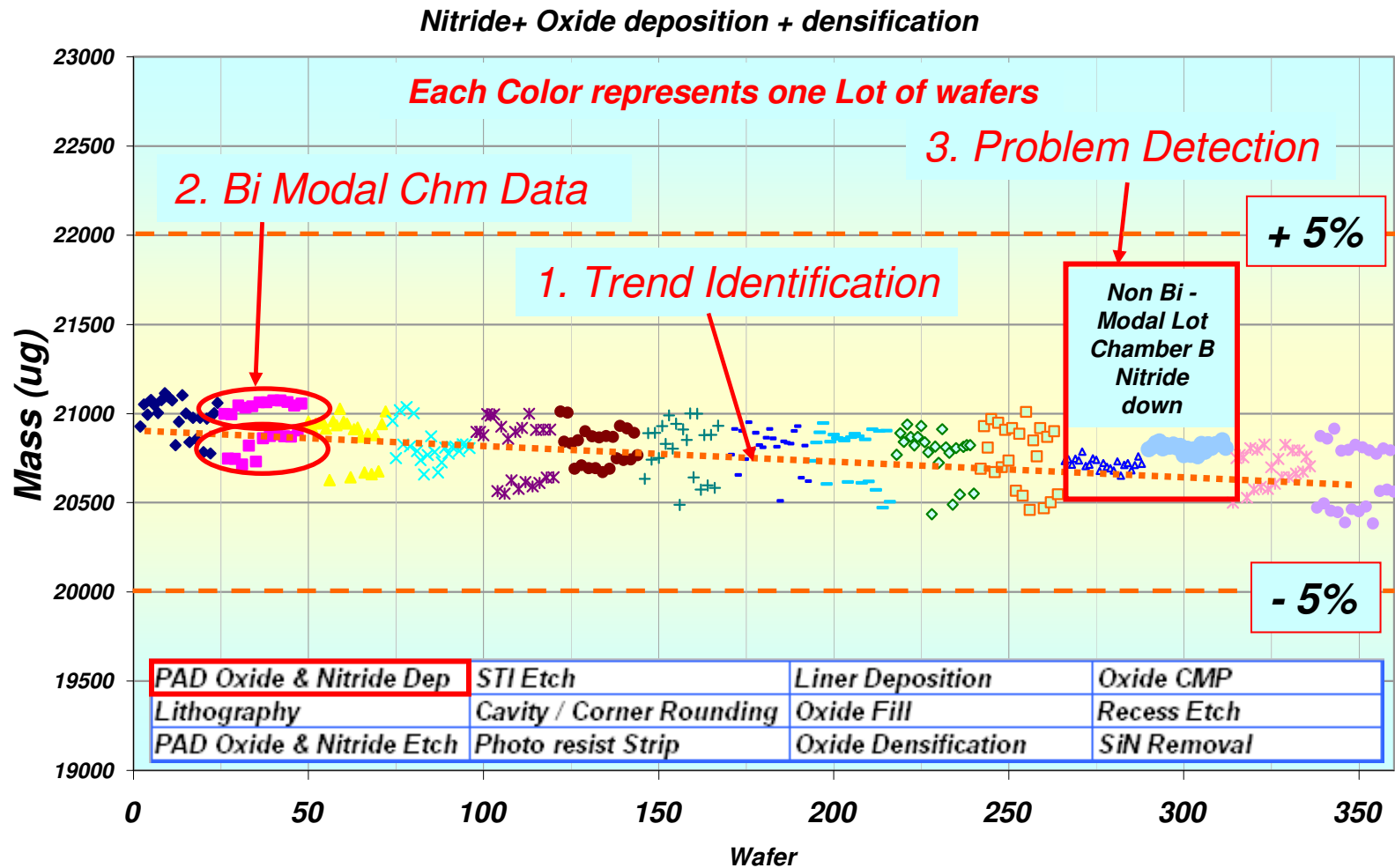
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Pad Oxide/Nitride Deposition

- ***Process Stability***

PAD Oxide & Nitride Dep	STI Etch	Liner Deposition	Oxide CMP
Lithography	Cavity / Corner Rounding	Oxide Fill	Recess Etch
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HVM Data Resolution



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- **What process insight is the Mass Data providing ?**



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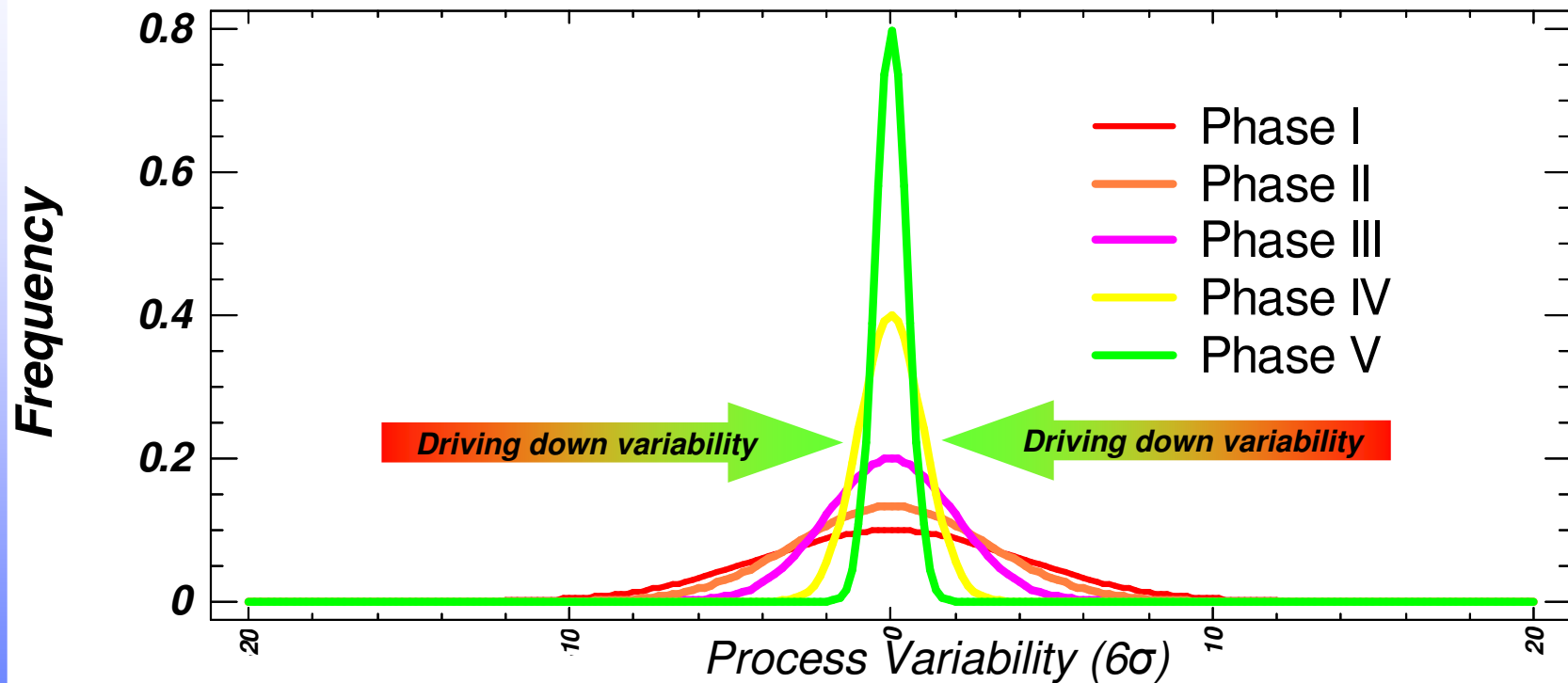
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STI Etch

- ***Process Improvement***

PAD Oxide & Nitride Dep	STI Etch	Liner Deposition	Oxide CMP
Lithography	Cavity / Corner Rounding	Oxide Fill	Recess Etch
PAD Oxide & Nitride Etch	Photo resist Strip	Oxide Densification	SiN Removal

Process Improvement Phases

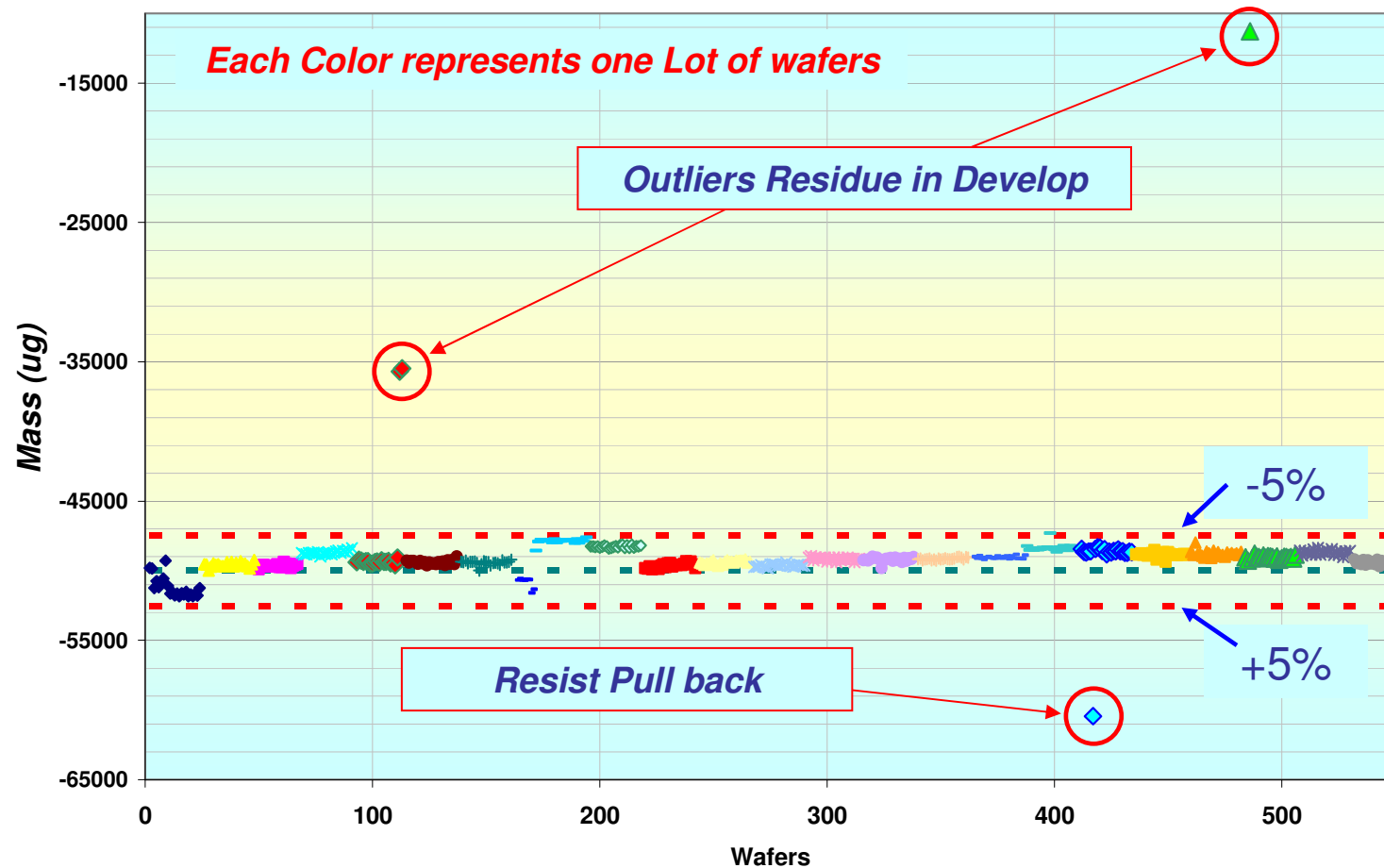


- *Process Improvement is achieved through first understanding the sources of variability then focus on the larger order of magnitude noise.*

Ranking Process Variability in HVM

- *In order to successfully improve a process, the sources of process variability must be identified and prioritized:*
 - *Wafer to Wafer Variability*
 - *Chamber Trends*
 - *Lot to Lot Variability*
 - *Chamber to Chamber matching – systematic offset.*
 - *Outlier Frequency*
 - *In-coming material variability*
- *Mass Metrology has the resolution to resolve the sources of Process Variability in HVM.*

STI Etch – Low Resolution View



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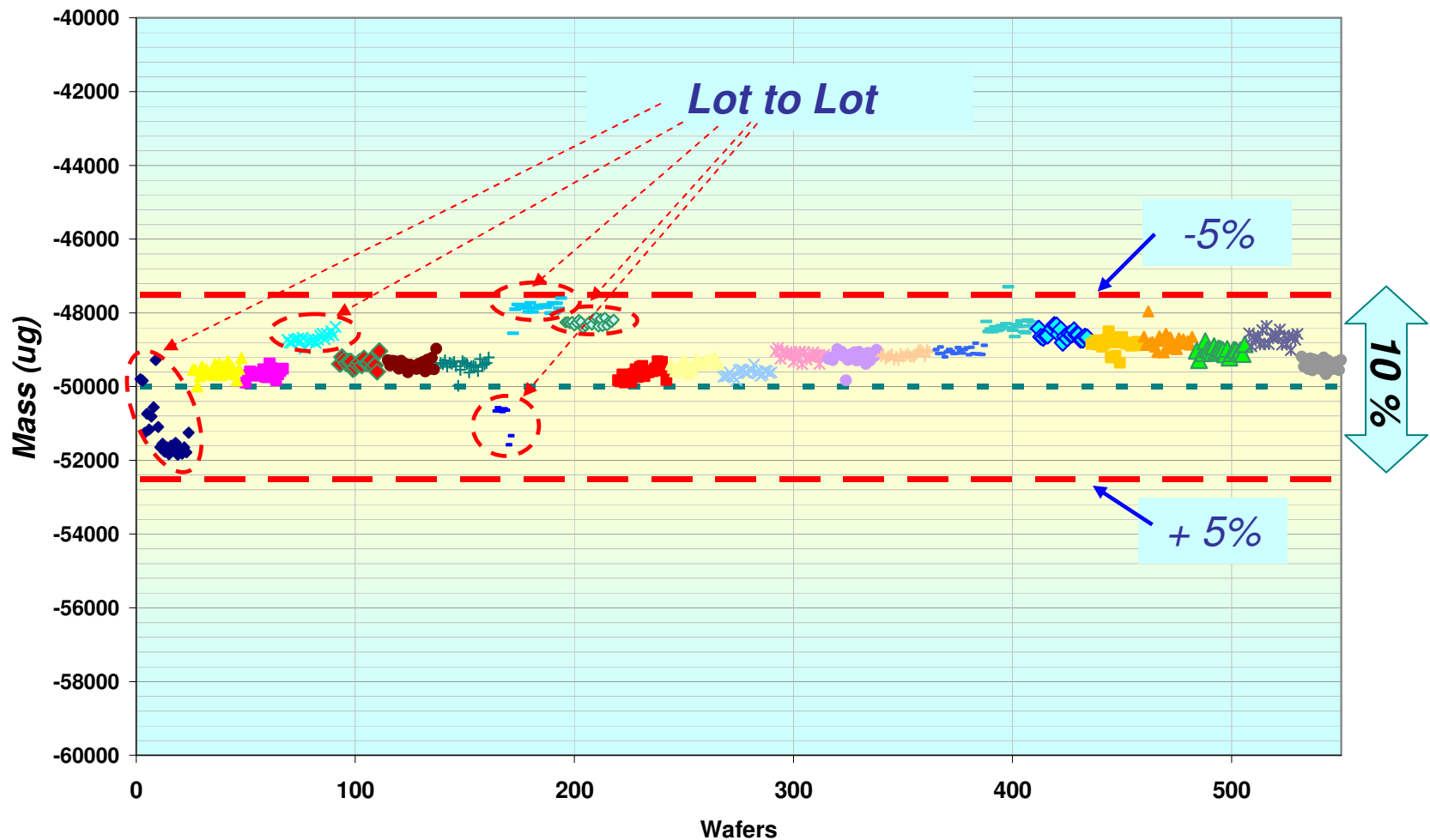
- *Outliers are easily distinguished at a low level view.*



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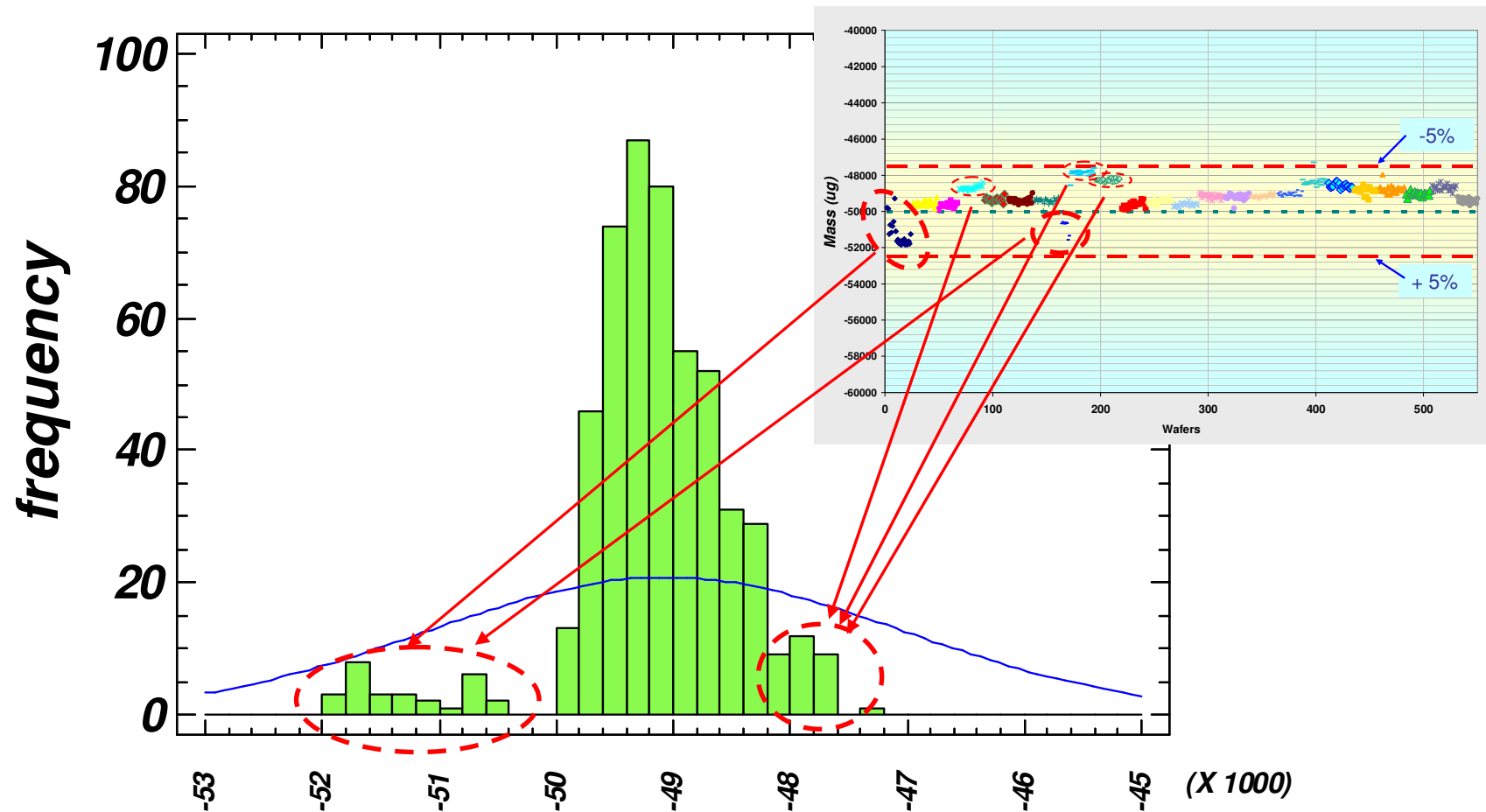
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STI Etch – Medium Resolution View



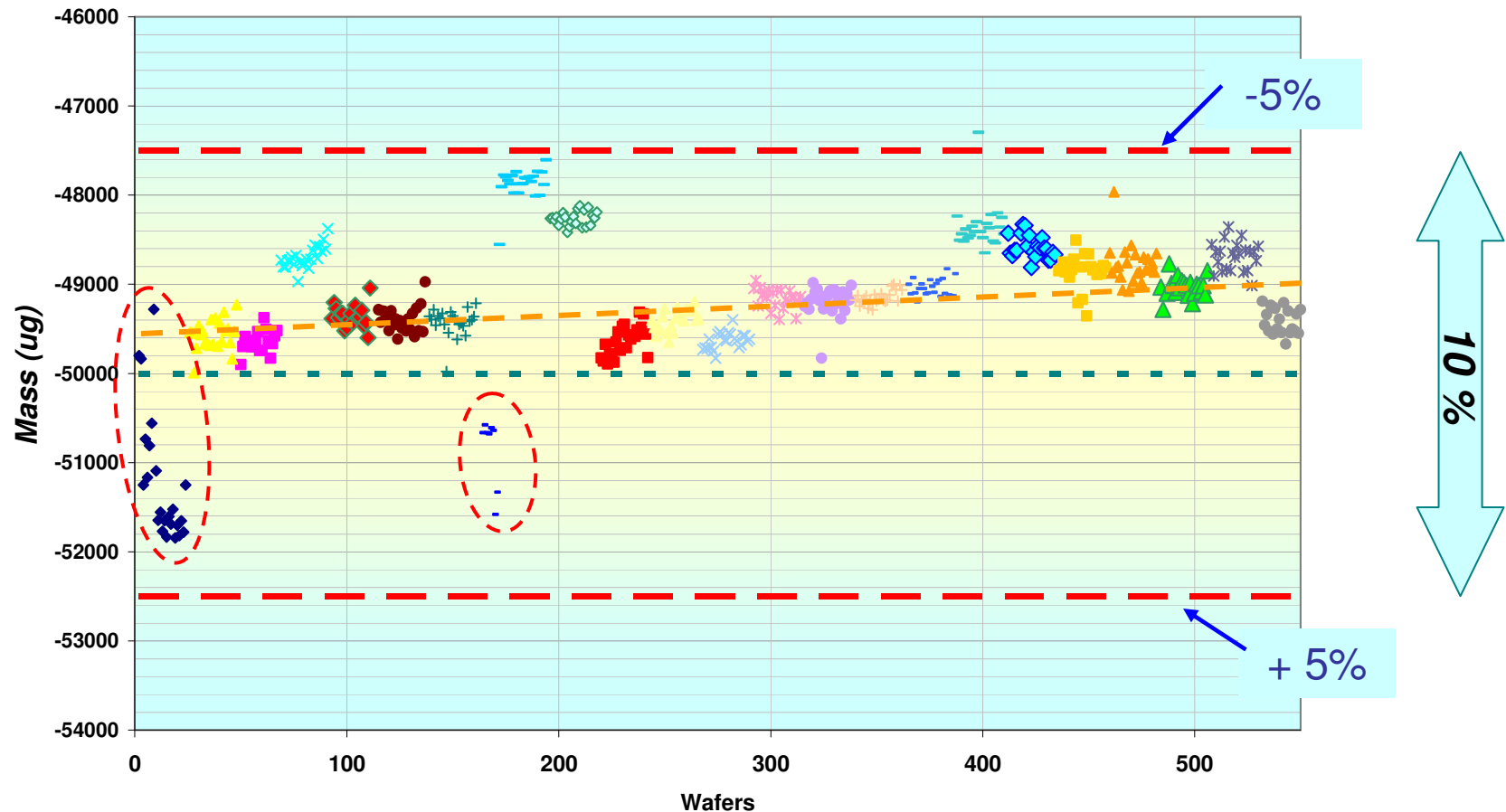
- ***Lot to Lot Variability is apparent at the medium level view.***

Lot to Lot Variability Identified



- ***Lot to Lot Variability identified as a significant source of variability.***

STI Etch – High Resolution View



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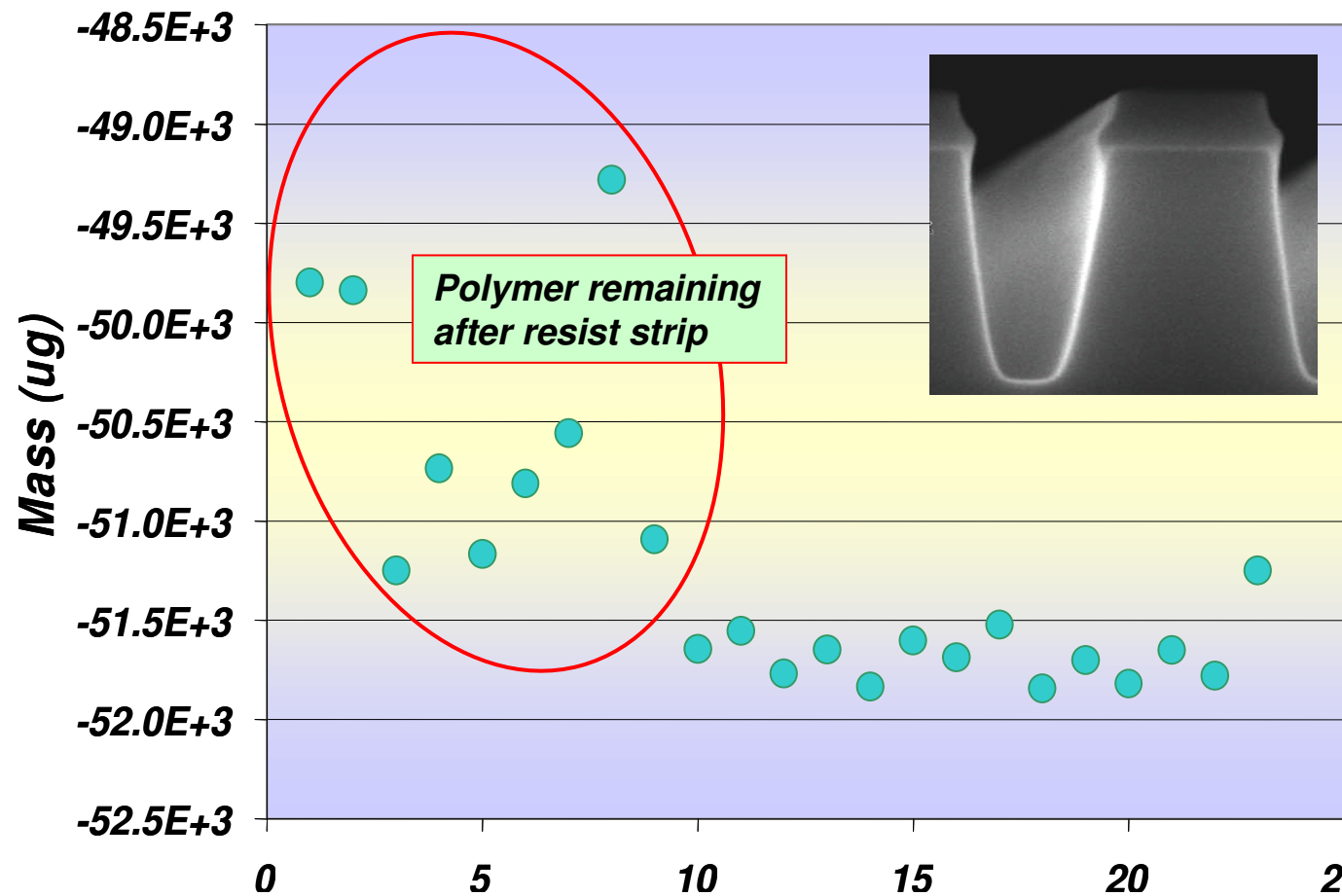
- *With a high Resolution view we see that some lots exhibit a large within lot variability.*



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Within Lot Analysis



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- Problem identified and associated with post chamber wet clean – process window too small.

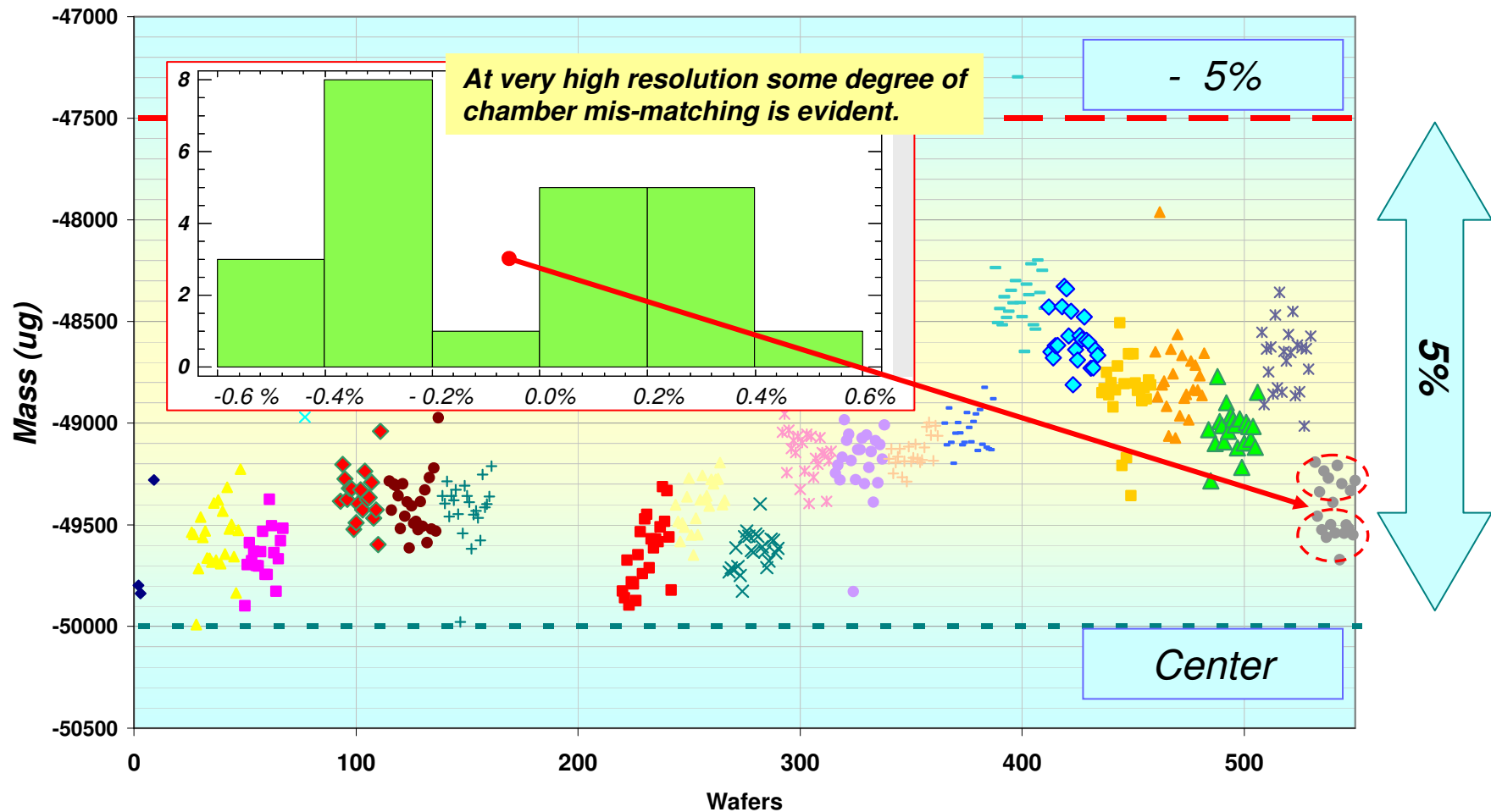
Mass Metrology for controlling and understanding processes ISSM Paper: PE-0-089



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STI Etch – Very High Resolution View



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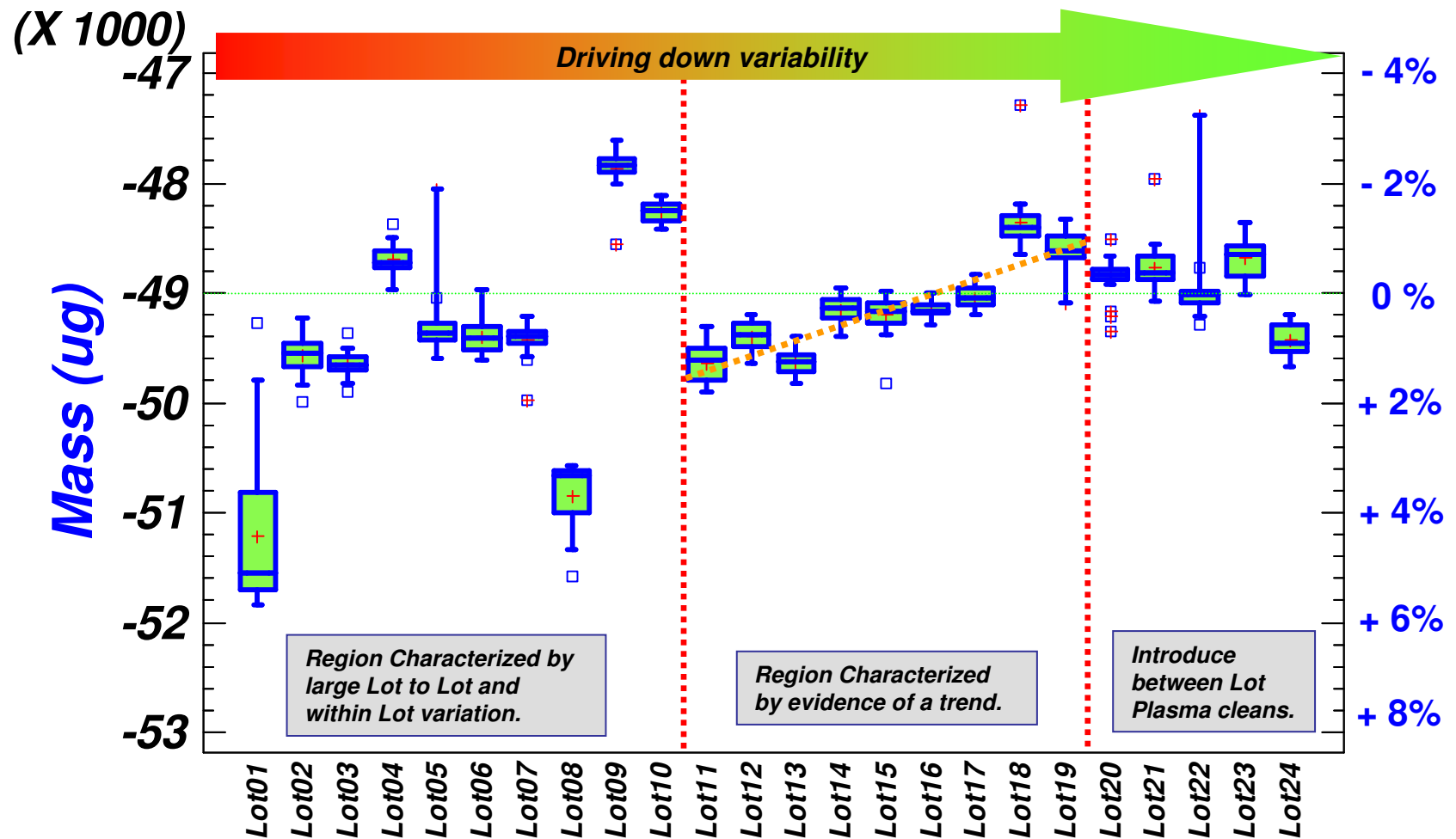
- **Mass has the ability to resolve less than 0.5% difference in Chambers.**



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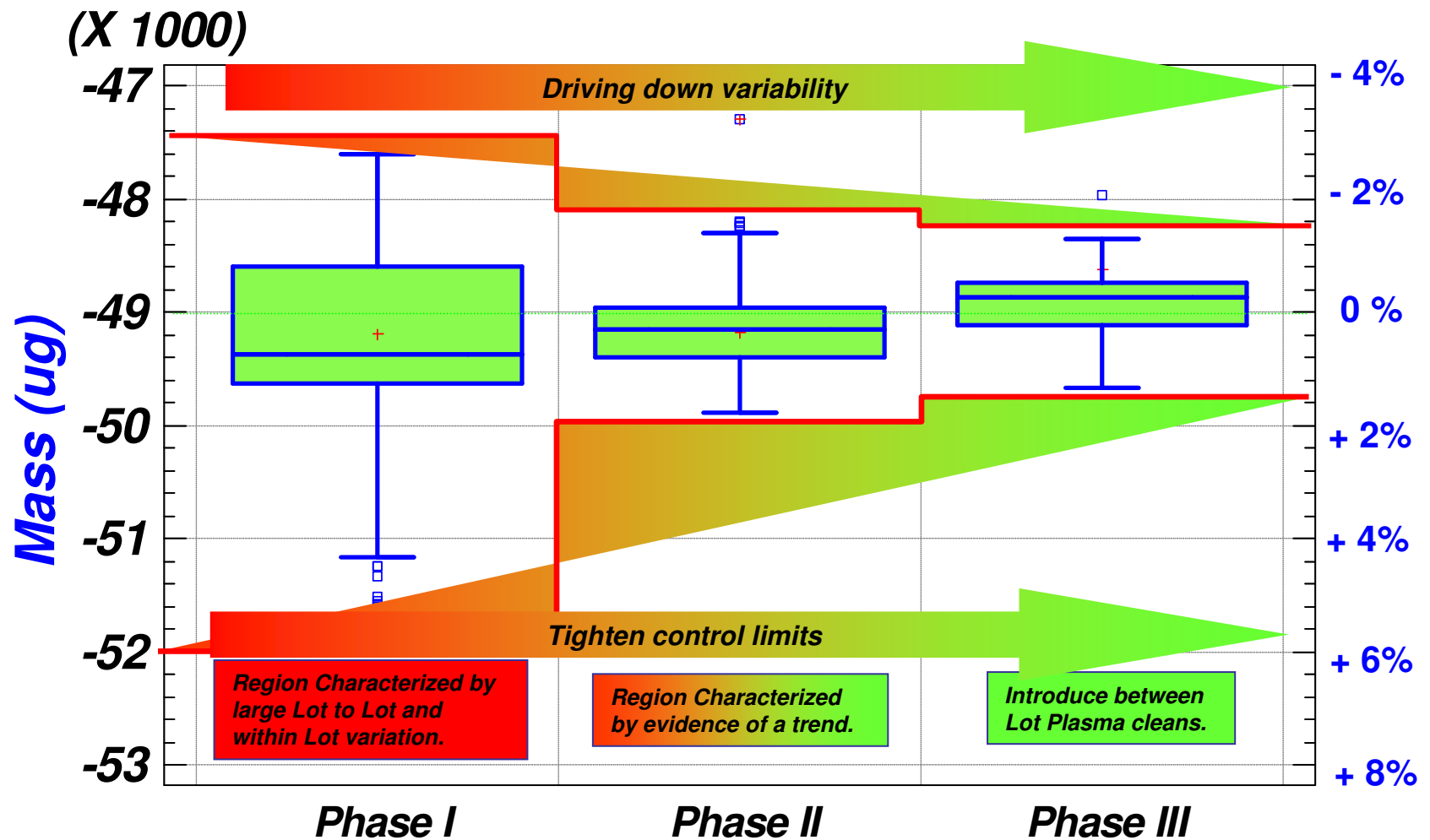
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Process Stability Optimization



- **Improve process by understanding the sources of variability.**

STI Etch Phased Optimization



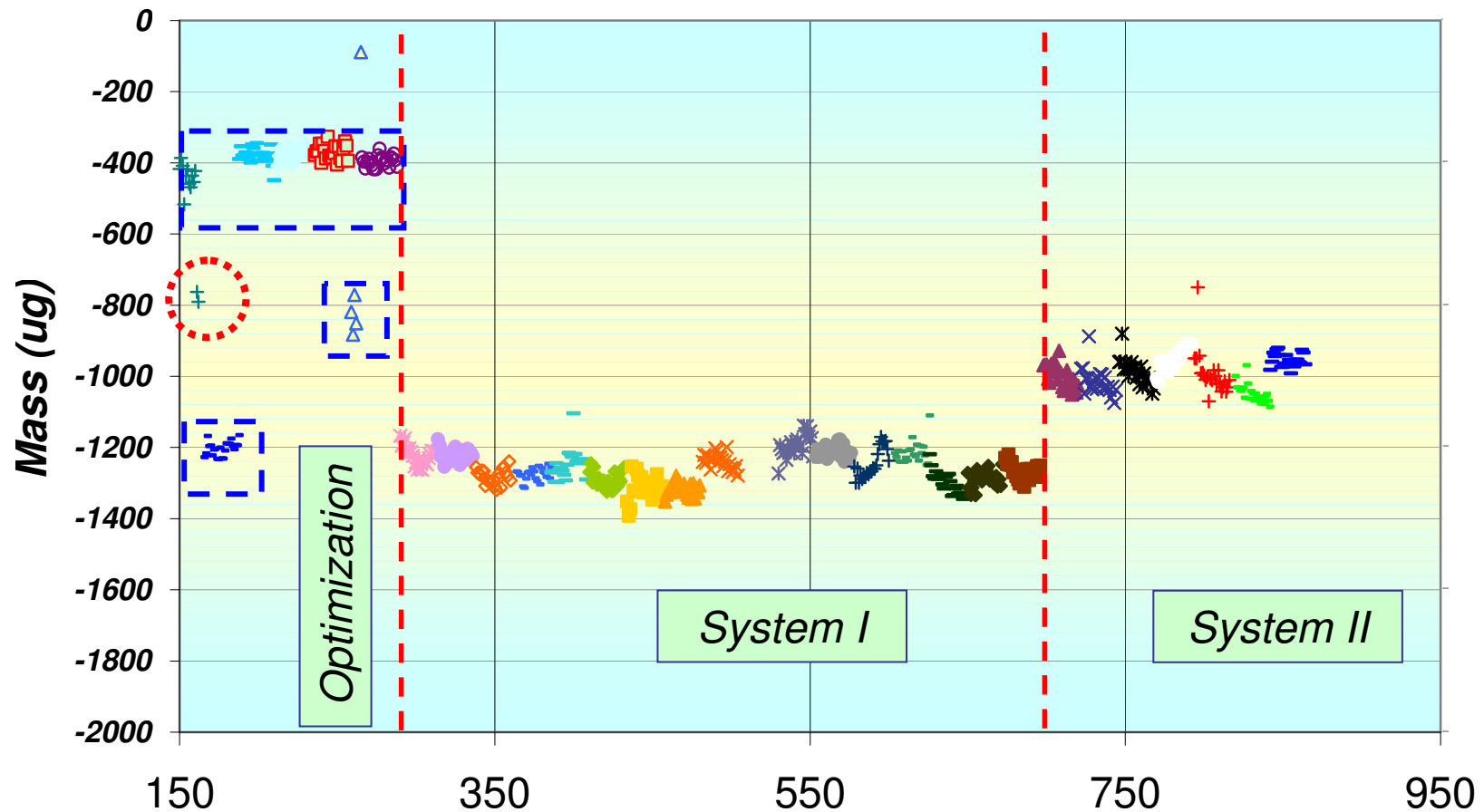
- Variability is driven down in a phased approach.

STI Cavity Etch (Rounding)

- ***Early Identification***

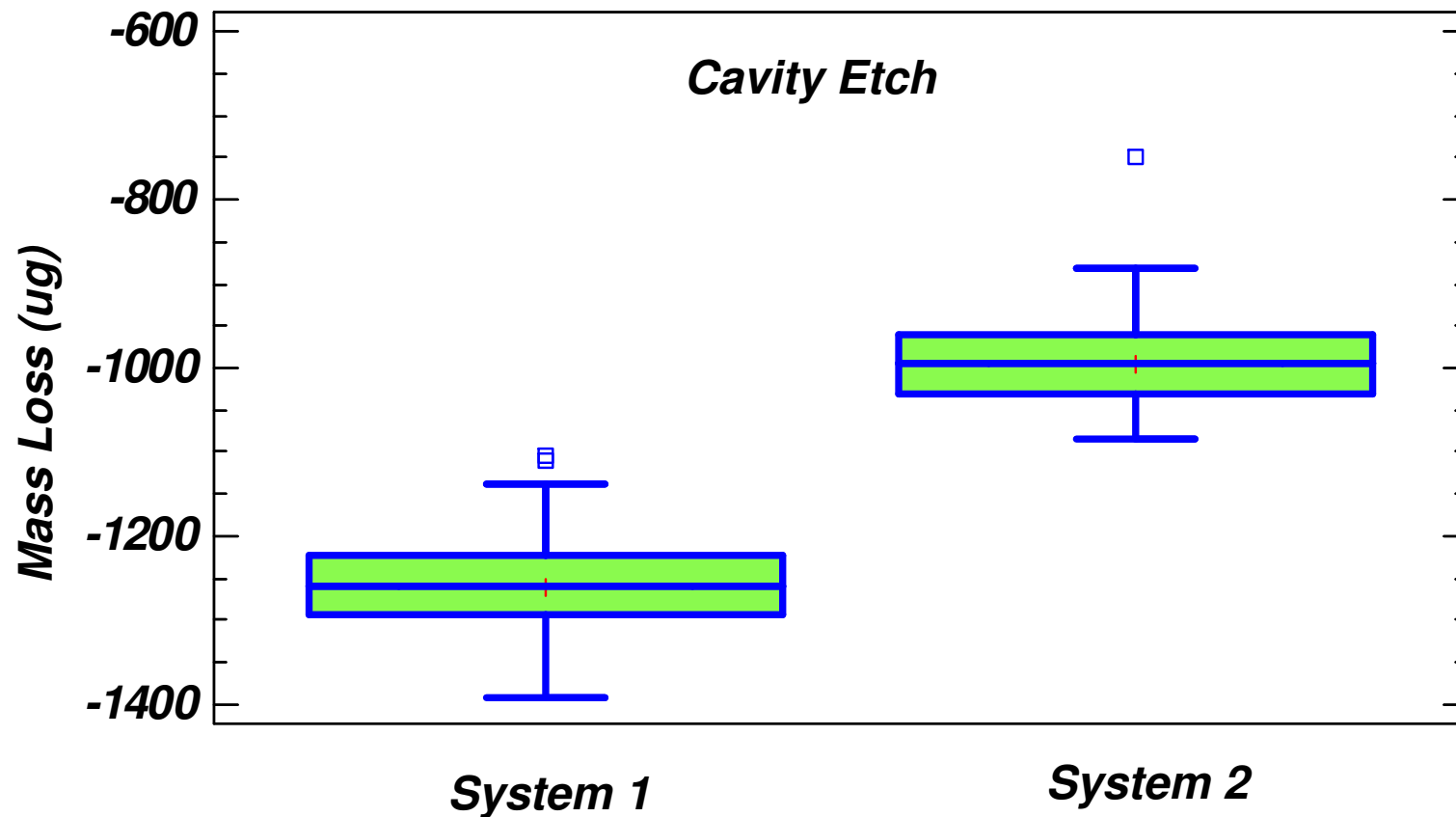
PAD Oxide & Nitride Dep	STI Etch	Liner Deposition	Oxide CMP
Lithography	Cavity / Corner Rounding	Oxide Fill	Recess Etch
PAD Oxide & Nitride Etch	Photo resist Strip	Oxide Densification	SiN Removal

Cavity Etch Splits



- ***The Cavity etch is optimized in phases.***

System to System Matching



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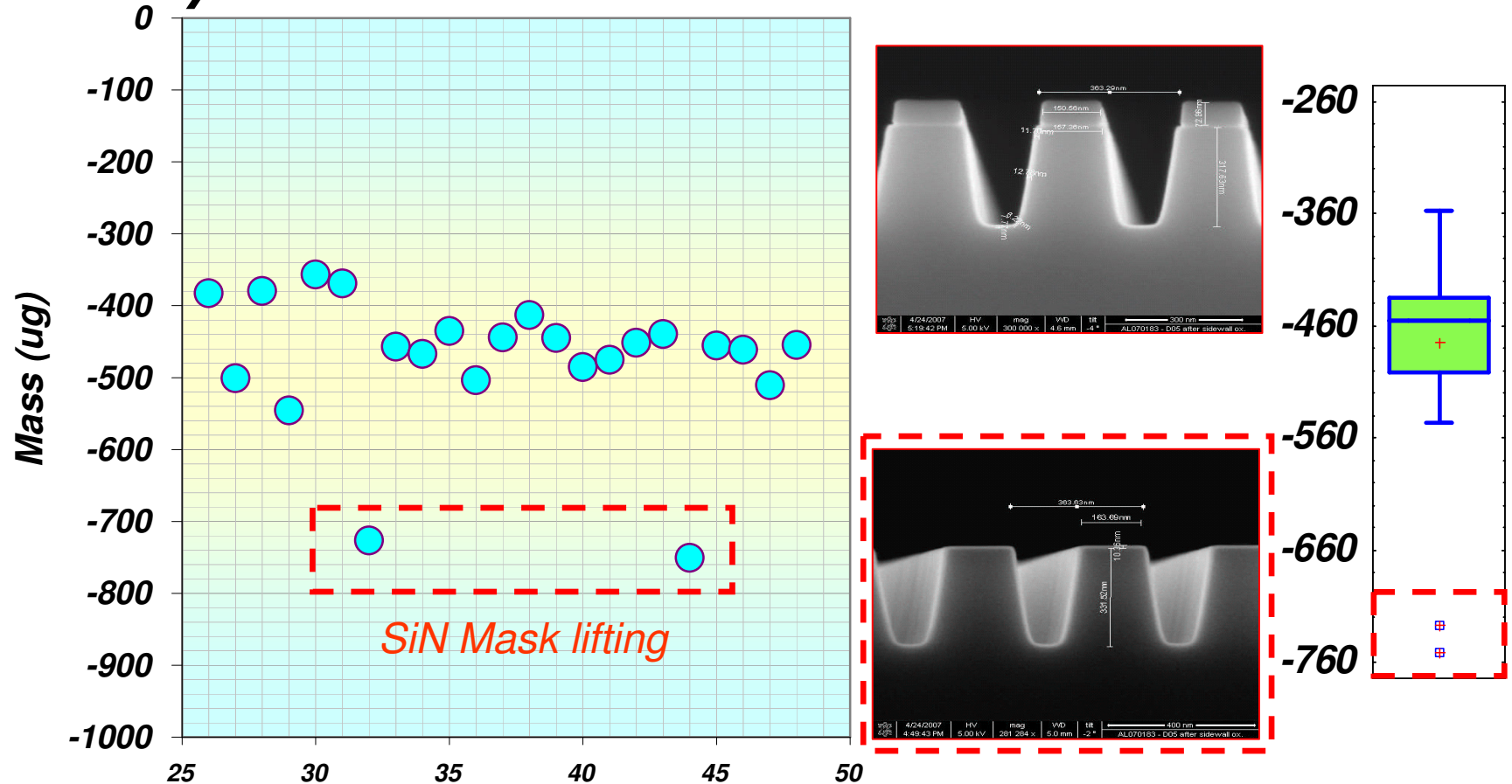
- **System 1 (400 samples) System 2 (150 samples)**



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Cavity Etch Outliers



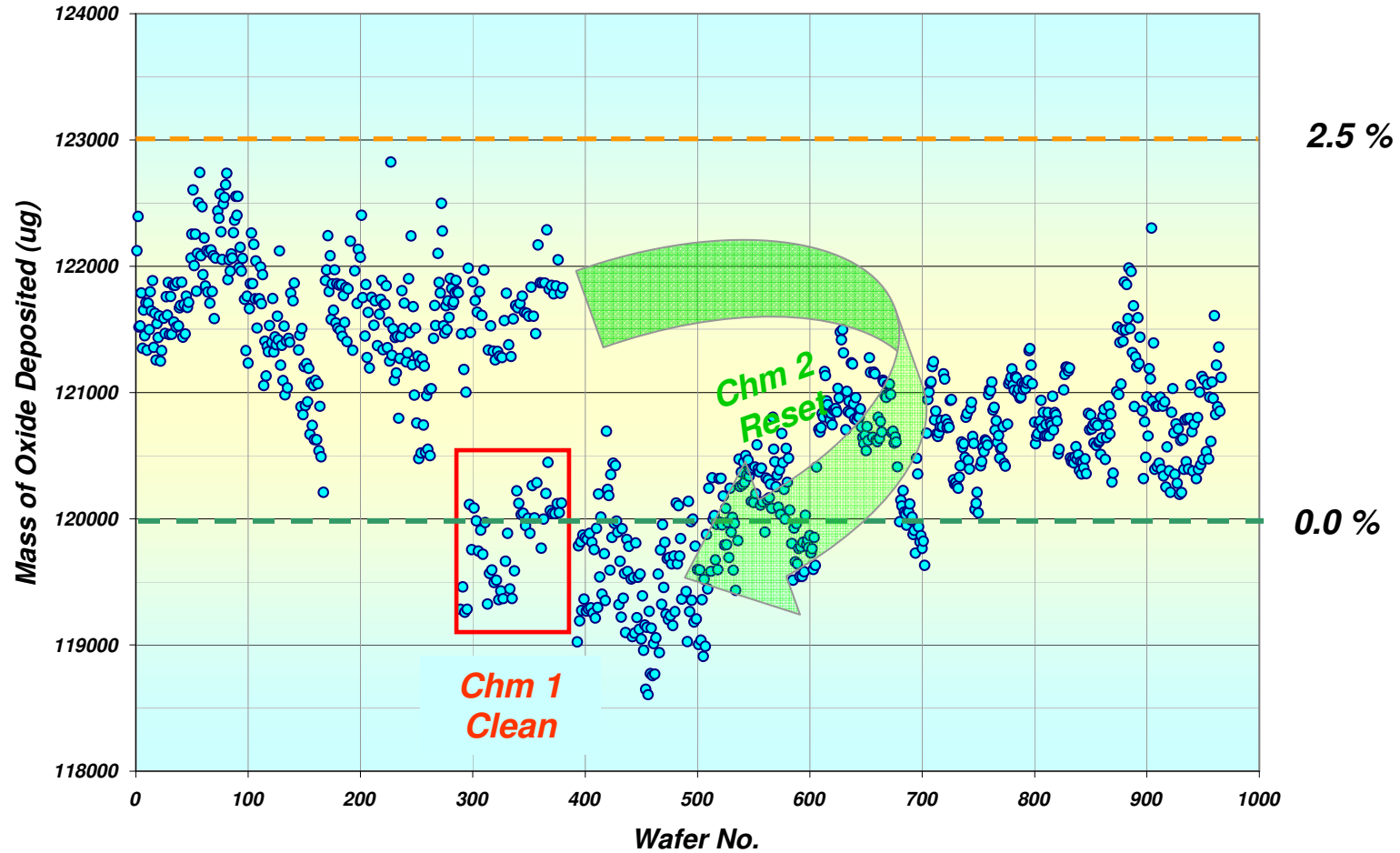
- Outliers are due to SiN mask lifting post HF dip. Cause isolated to residual HF present on wafer after rinse resulting attack of the mask.

STI Oxide Fill

- **Process Monitoring**

PAD Oxide & Nitride Dep	STI Etch	Liner Deposition	Oxide CMP
Lithography	Cavity / Corner Rounding	Oxide Fill	Recess Etch
PAD Oxide & Nitride Etch	Photo resist Strip	Oxide Densification	SiN Removal

STI Oxide Fill Process



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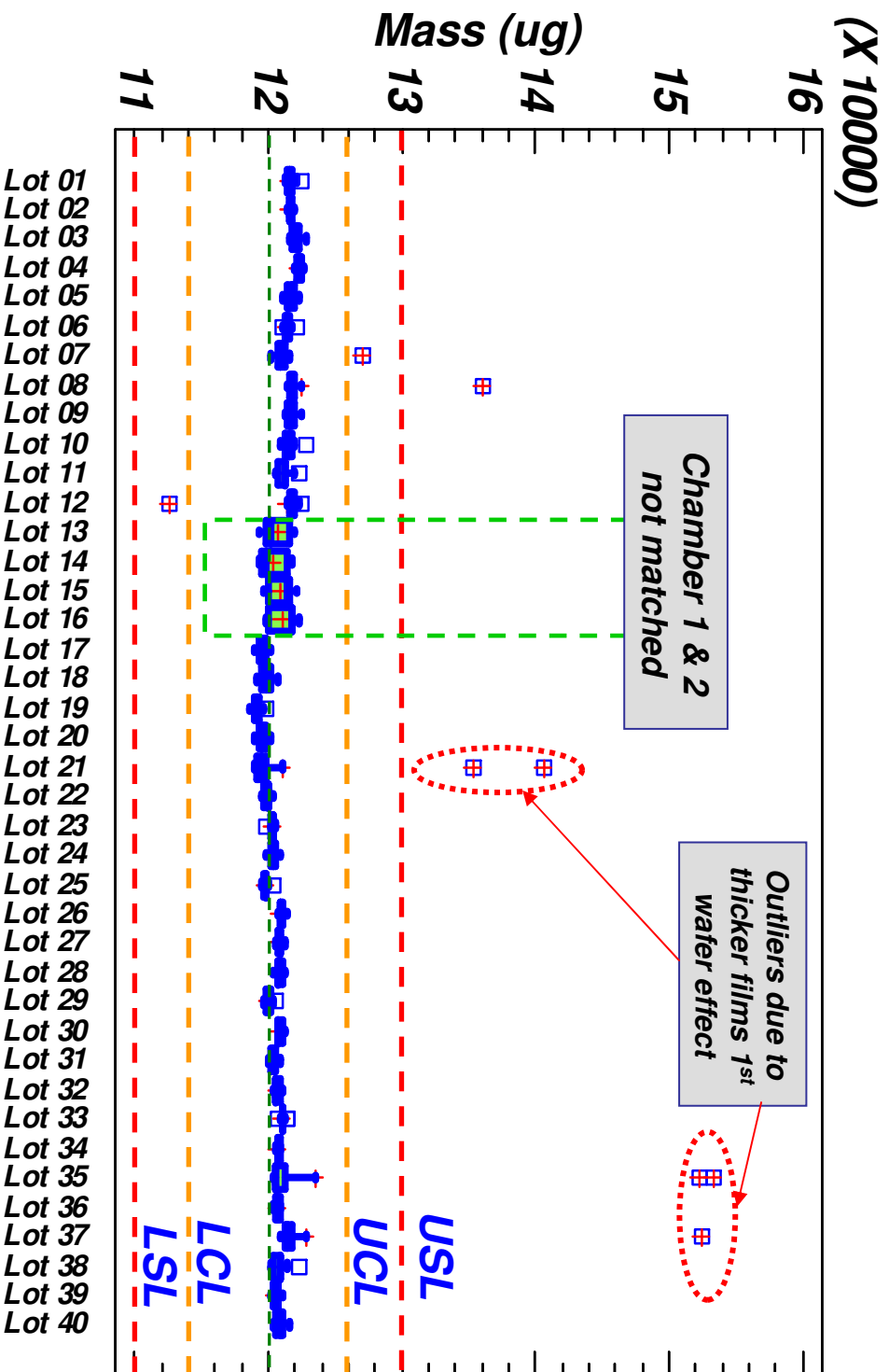
- **Data from Oxide Fill Process.**



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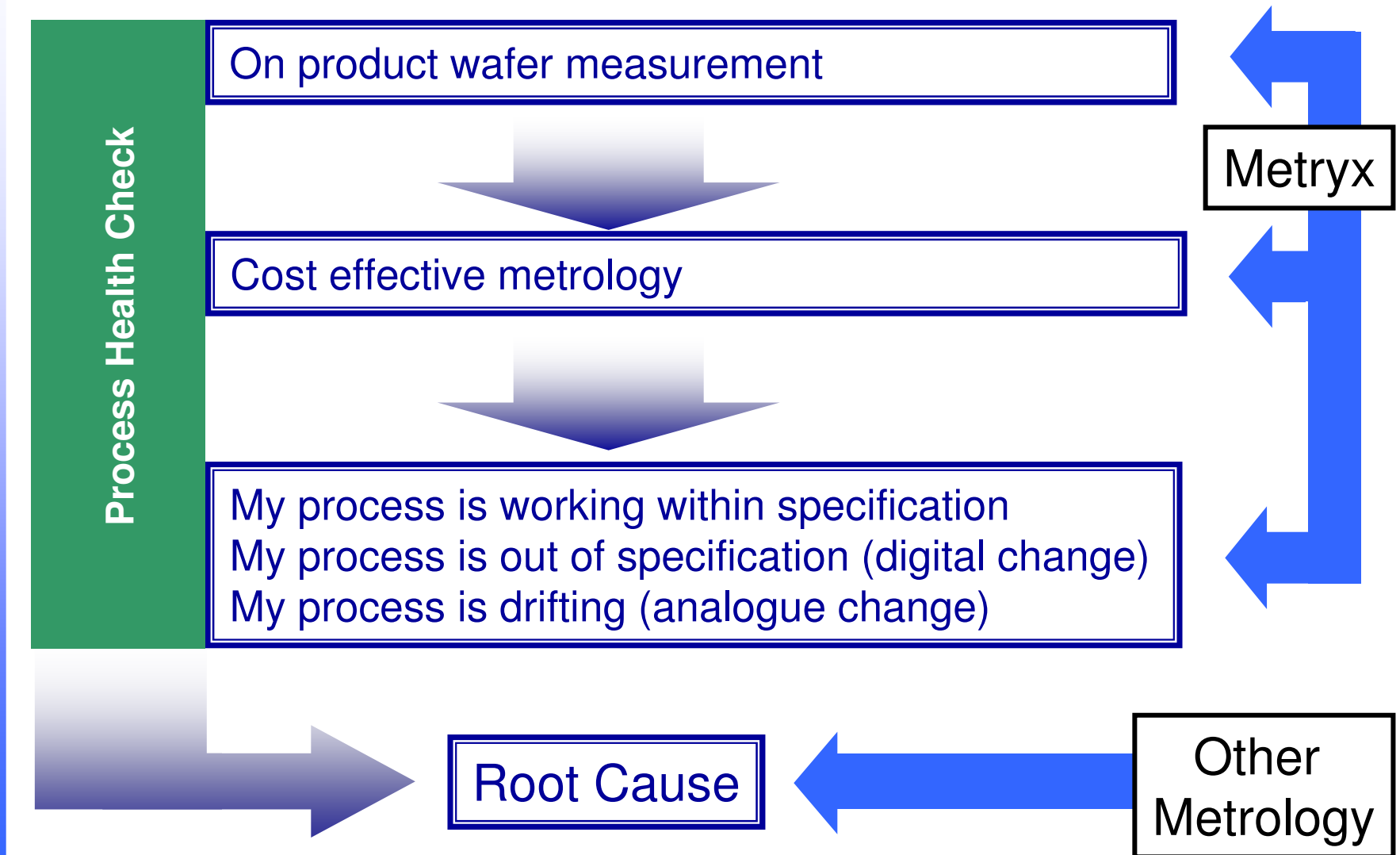
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STI Oxide Fill Deposition Process



- Lot to Lot Stability

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