



# eBeam Technology and Product Launch

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December 14, 2022

# Forward-Looking Statements and Other Information

This presentation contains forward-looking statements, including those regarding anticipated growth and trends in our businesses and markets, industry outlooks and demand drivers, technology transitions, our business and financial performance and market share positions, our capital allocation and cash deployment strategies, our investment and growth strategies, our development of new products and technologies, our business outlook for the first quarter of fiscal 2023 and beyond, the impact of new export regulations on our ability to export products and provide services to customers and on our results of operations, our intent to seek additional licenses pursuant to new export regulations, and other statements that are not historical facts. These statements and their underlying assumptions are subject to risks and uncertainties and are not guarantees of future performance.

Factors that could cause actual results to differ materially from those expressed or implied by such statements include, without limitation: the level of demand for our products, our ability to meet customer demand, and our suppliers' ability to meet our demand requirements; global economic, political and industry conditions, including rising inflation and interest rates; the interpretation and implementation of new export regulations and license requirements; global trade issues and changes in trade and export license policies; our ability to obtain licenses or authorizations on a timely basis, if at all; the concentrated nature of our customer base and suppliers; supply chain and transportation interruptions and logistics constraints; the continued effects of the COVID-19 pandemic and other health epidemics; consumer demand for electronic products; the demand for semiconductors; customers' technology and capacity requirements; the introduction of new and innovative technologies, and the timing of technology transitions; our ability to develop, deliver and support new products and technologies; our ability to expand our current markets, increase market share and develop new markets; market acceptance of existing and newly developed products; our ability to obtain and protect intellectual property rights in key technologies; our ability to prevent or remediate cybersecurity threats; acquisitions, investments and divestitures; changes in income tax laws; our ability to achieve the objectives of operational and strategic initiatives, align our resources and cost structure with business conditions, and attract, motivate and retain key employees; the variability of operating expenses and results among products and segments, and our ability to accurately forecast future results, market conditions, customer requirements and business needs; our ability to ensure compliance with applicable law, rules and regulations, and to achieve environmental, social and governance commitments and targets; and other risks and uncertainties described in our SEC filings, including our recent Forms 10-K, 10-Q and 8-K. All forward-looking statements are based on management's current estimates, projections and assumptions, and we assume no obligation to update them.

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# WELCOME

**Michael Sullivan**

Corporate Vice President

Head of Investor Relations

DECEMBER 14, 2022



# eBeam Technology and Product Launch

**Keith Wells**

Group Vice President and General Manager  
Imaging and Process Control Group

DECEMBER 14, 2022

# AGENDA

Technology Primer: Optical and eBeam

eBeam Market Segments and Applications

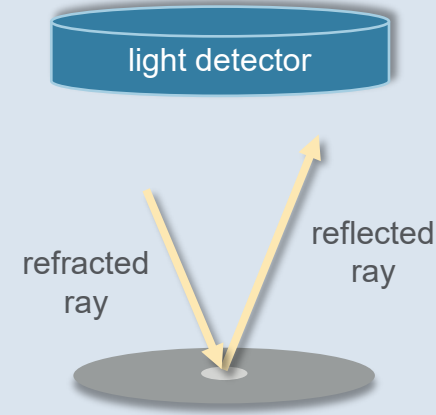
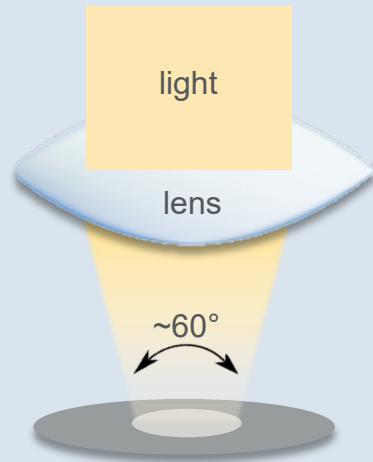
Cold Field Emission Technology

New eBeam Products

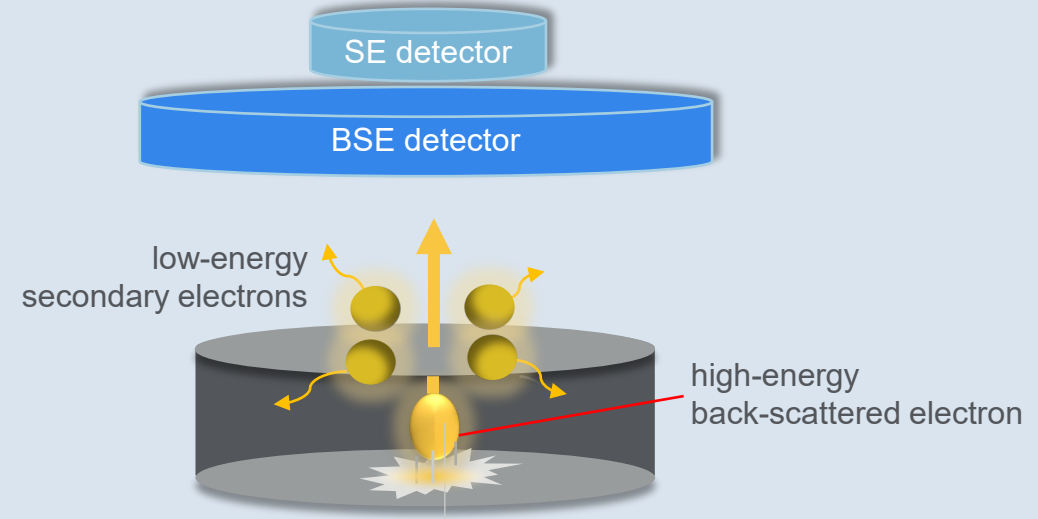
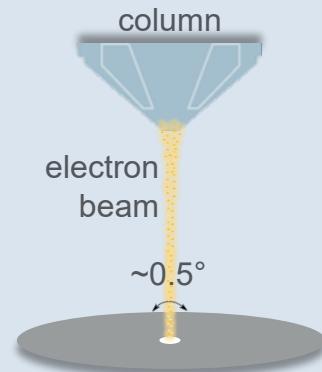
Q&A

# How Optical and eBeam Imaging Work

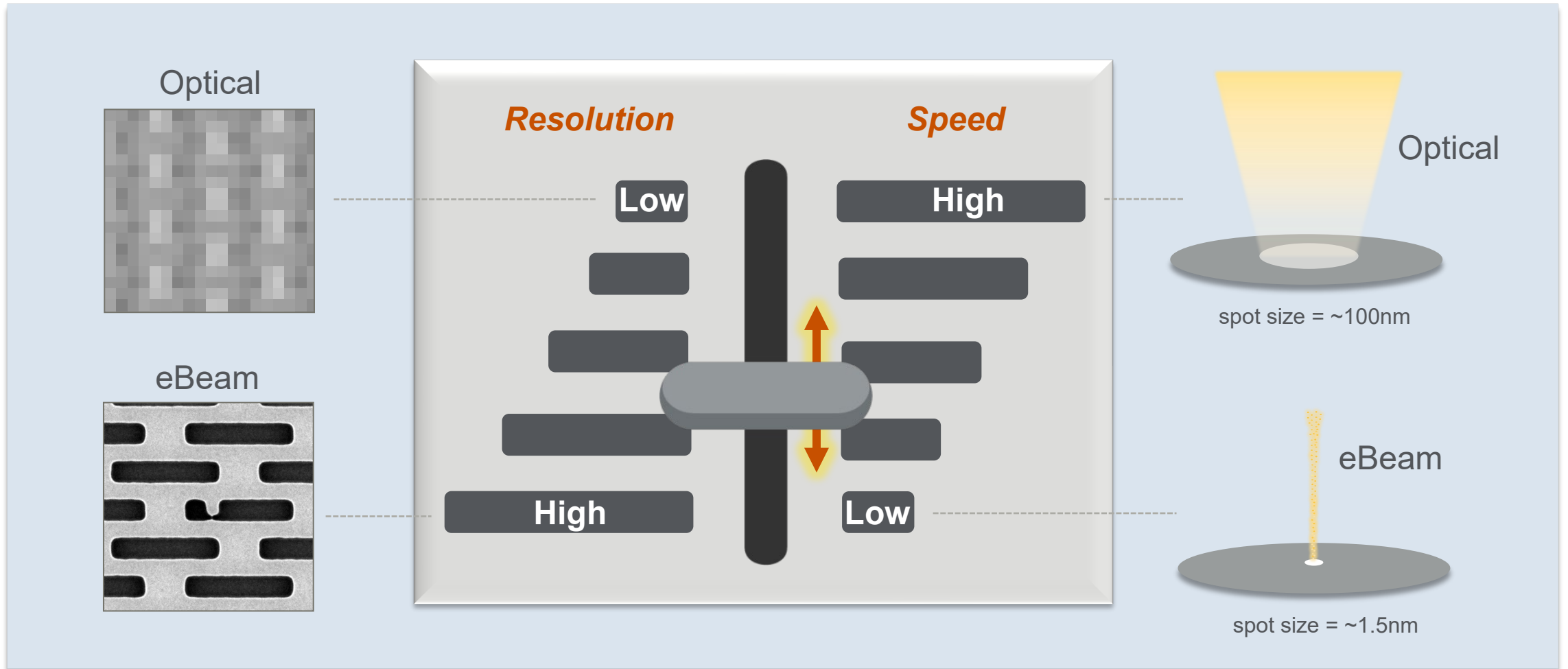
## Optical



## eBeam

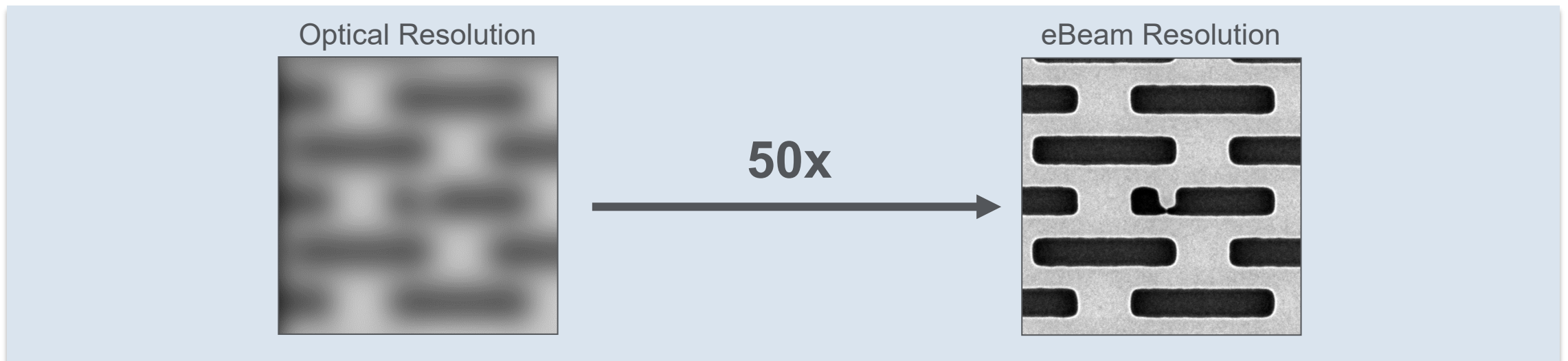
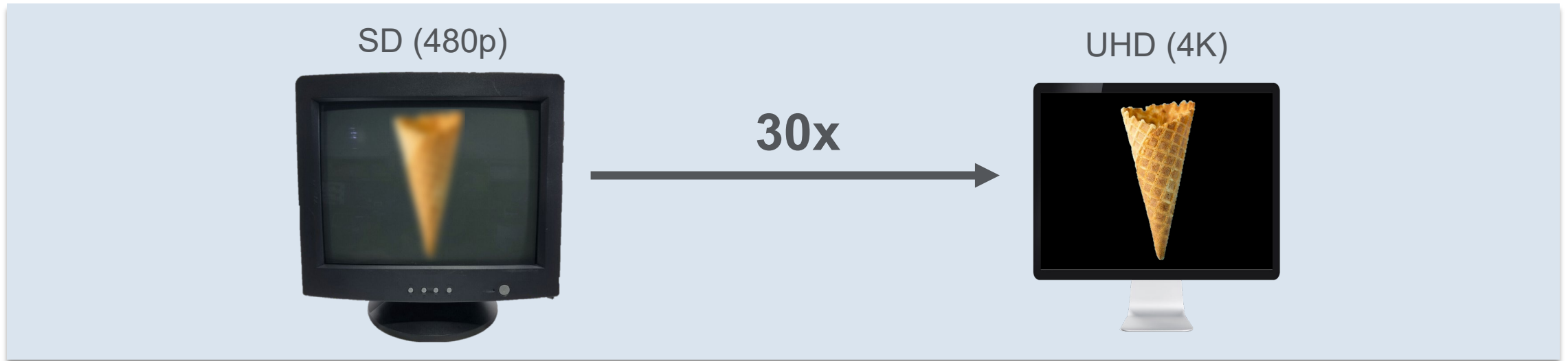


# Optical and eBeam: Complementary Technologies



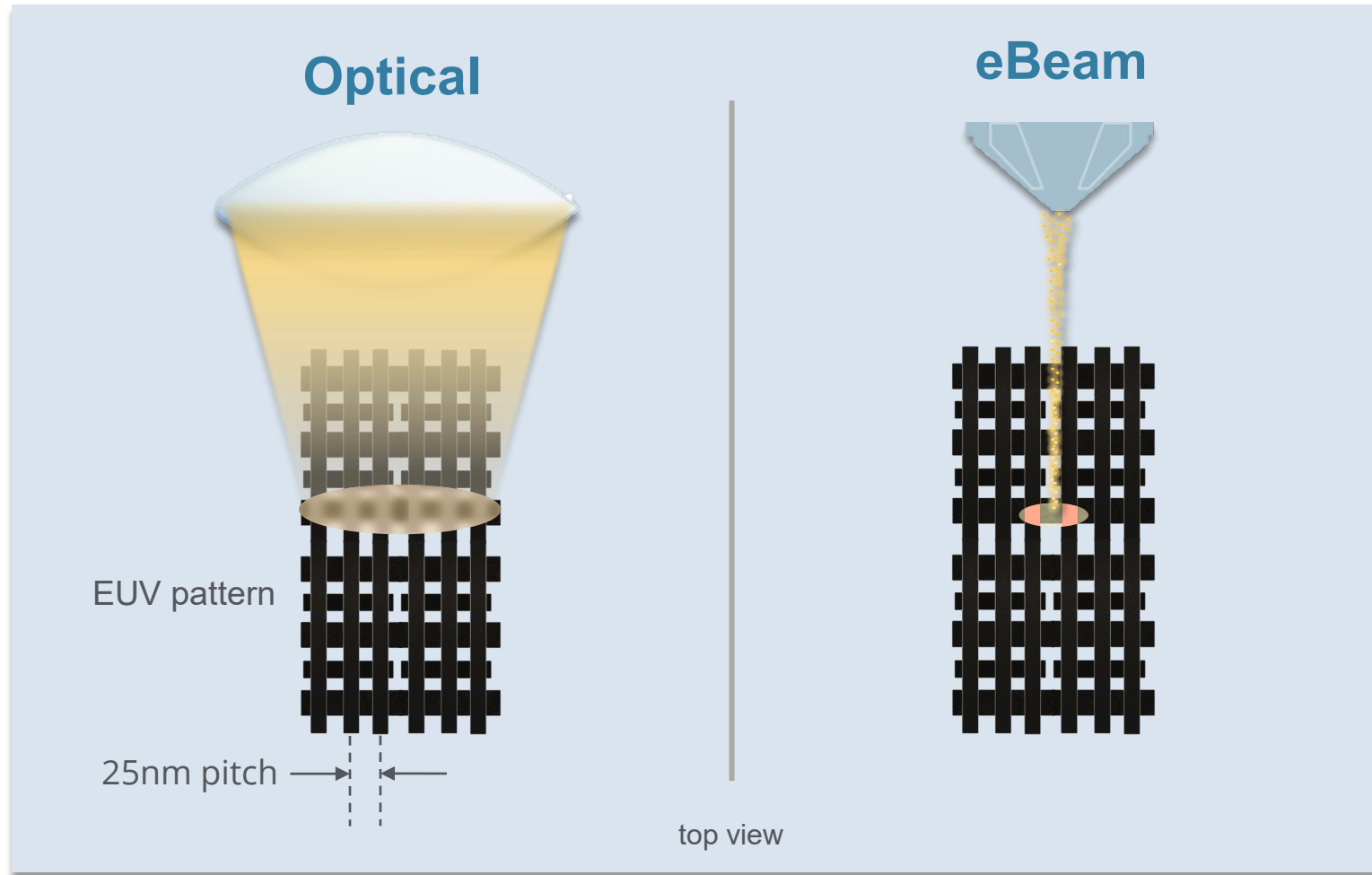
Optical provides lower resolution imaging at faster speed,  
eBeam provides higher resolution imaging at slower speed

# Resolution is the Amount of Detail in an Image



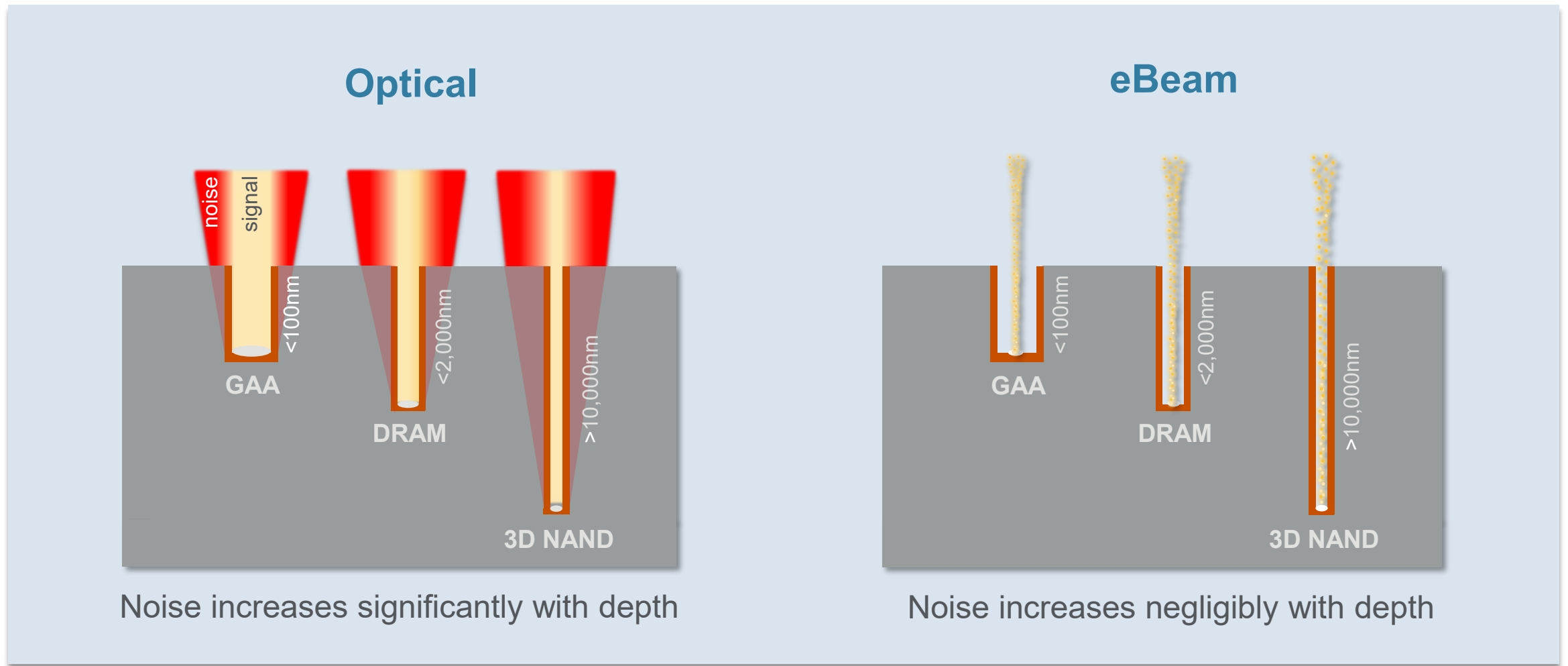


# Surface Imaging with Optical and eBeam



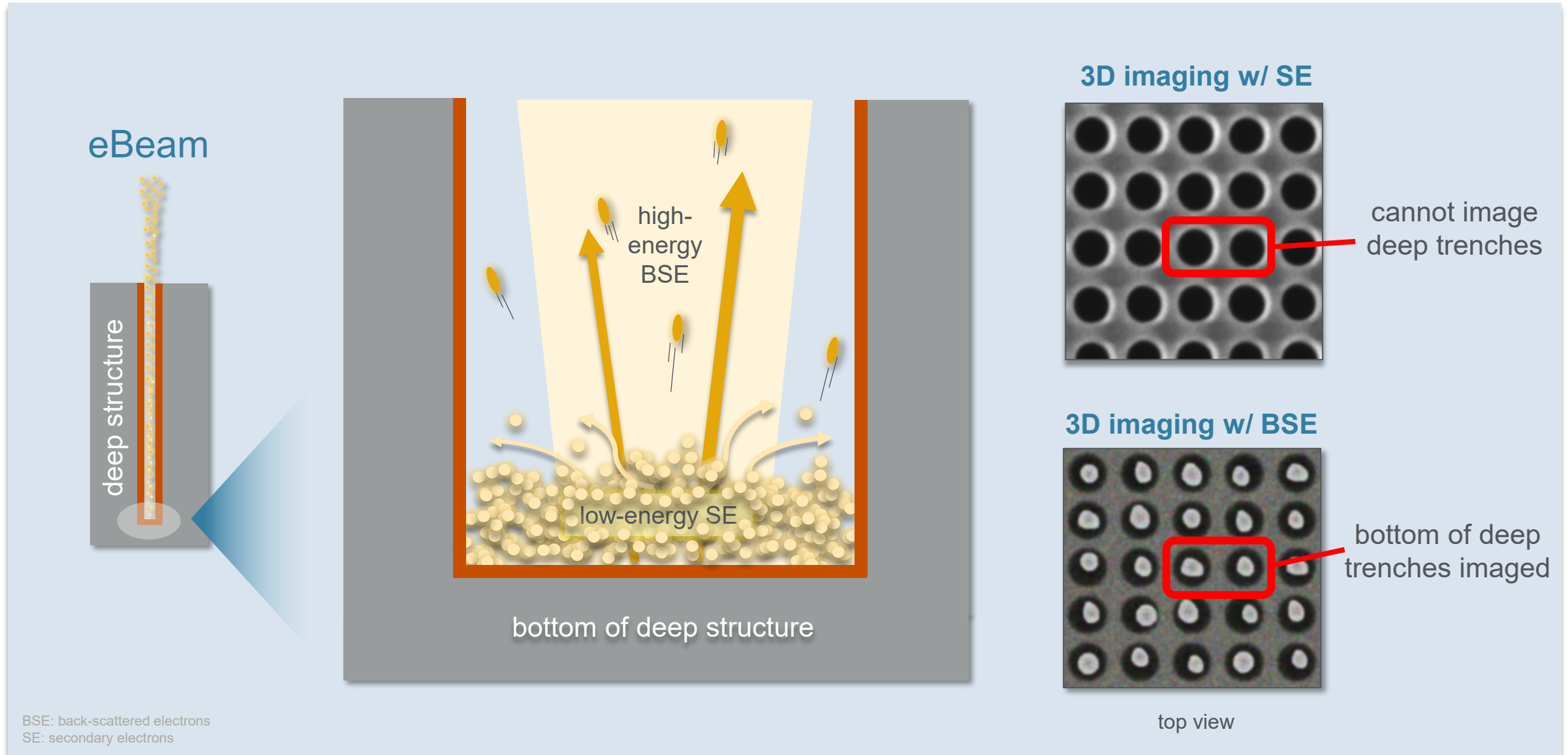
High-resolution eBeam imaging enables critical dimension measurements and detection of very small defects in EUV patterning

# 3D Imaging with Optical and eBeam

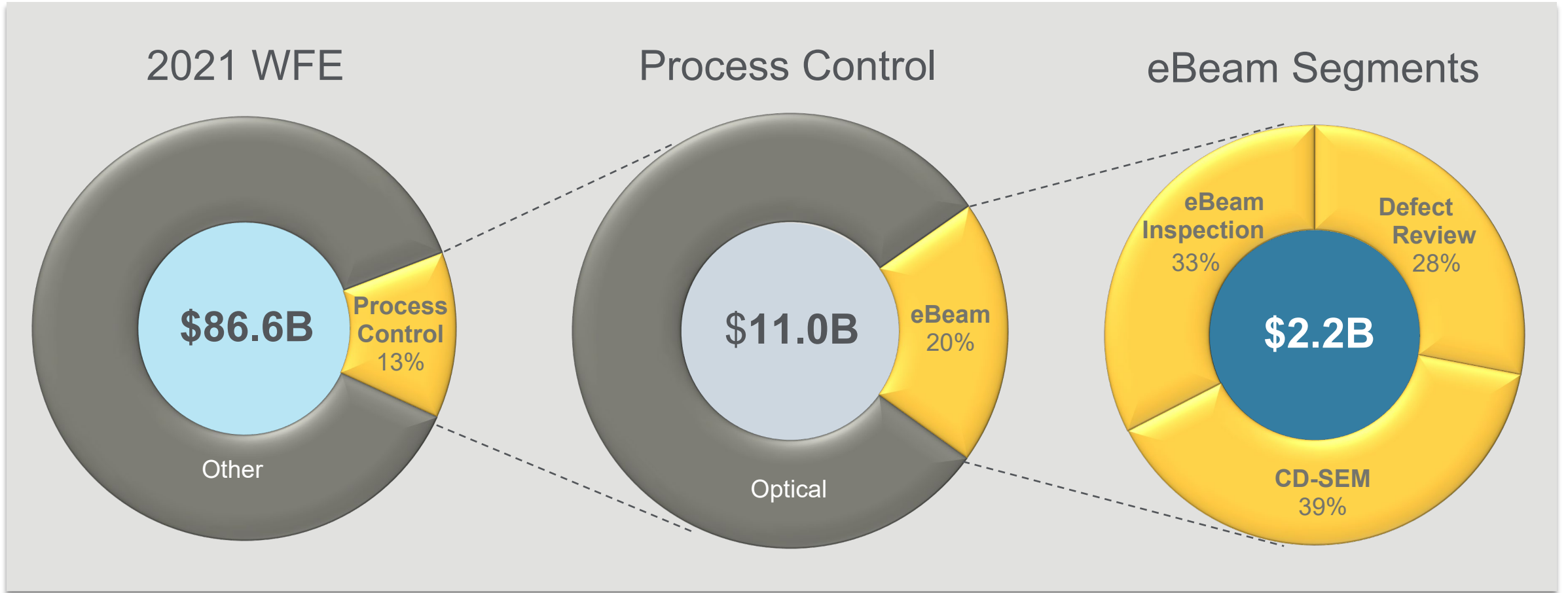


Narrow eBeam helps characterize deep 3D structures and detect buried defects

# Imaging Deep 3D Structures with Back-scattered Electrons



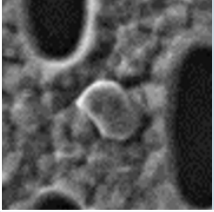
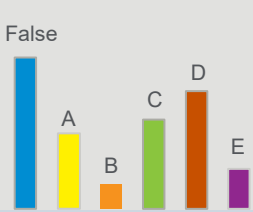
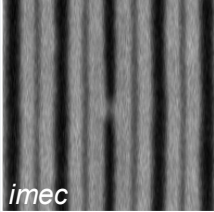
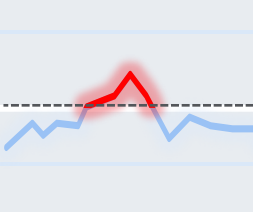
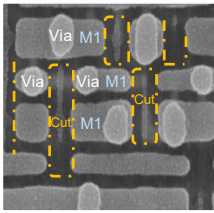
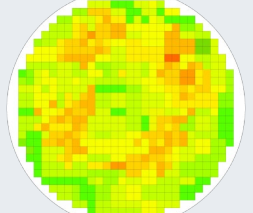
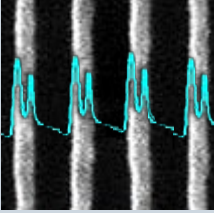
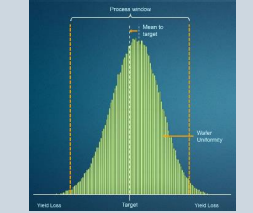
# eBeam Market and Segments




Market	WFE	Process Control	Optical	eBeam	eBeam Inspection	Defect Review	CD-SEM
<b>Growth ('19-'21)</b>	68%	72%	67%	95%	142%	108%	62%

\*Source: TechInsights Inc

# eBeam Market Segments

TechInsights Segments	Applications	Purpose	Image	Actionable Insight
DR-SEM	Defect Review <b>SEMVision®</b>	<p><b>SEE</b></p> <p>to distinguish critical defects from noise, enable root cause analysis</p>		
eBeam Inspection	Defect Inspection <b>PrimeVision®</b> <b>(New)</b>	<p><b>DETECT</b></p> <p>small, buried and electrical defects</p>		
	Metrology <b>PROVision®</b>	<p><b>MEASURE</b></p> <p>millions of locations across the wafer to characterize overlay and edge placement errors (EPE), assess CD uniformity and identify process signatures</p>		
CD-SEM	Critical Dimension Metrology <b>VeritySEM®</b>	<p><b>CALIBRATE</b></p> <p>lithography scanner performance to maximize yield</p>		

# eBeam Market Participants

Company	eBeam Revenue (2021)	eBeam Market Share (2021)	eBeam Market Share Growth (2016-2021)
 APPLIED MATERIALS®	\$1,082M	50%	+13%
Hitachi	\$596M	28%	-14%
ASML	\$323M	15%	0%
KLA	\$138M	6%	+1%

Source: TechInsights Inc. 2021

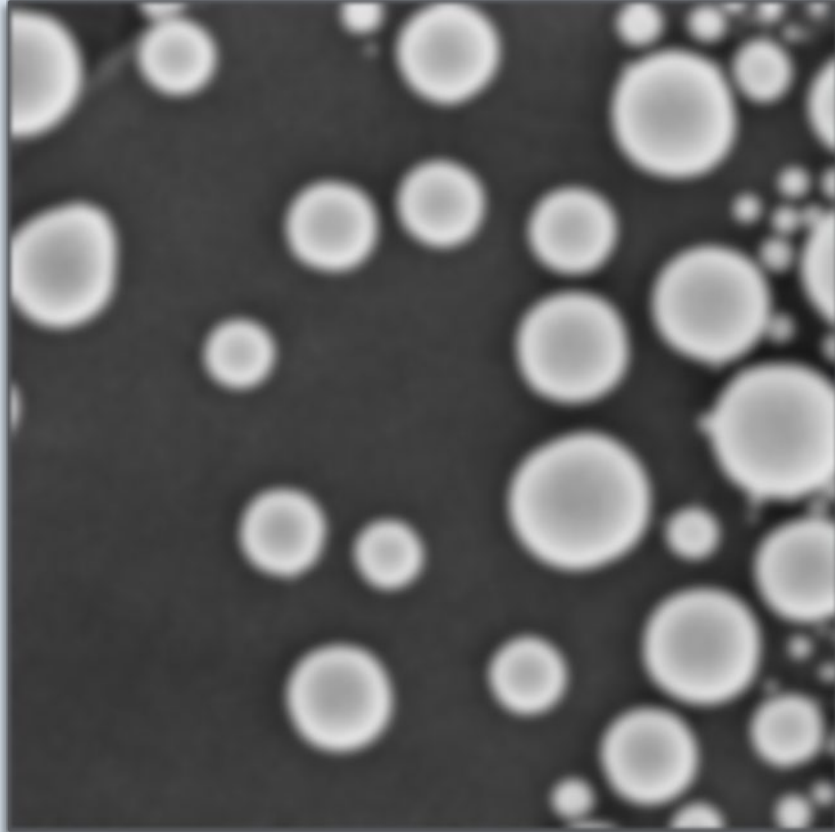
# Introducing Cold Field Emission (CFE) Technology

eBeam Source	Thermal source (1970)	<b>Thermal Field</b> Emission (1990)	<b>Cold Field</b> Emission (New)
Operating Temperature	2,700K (2,426°C)	<b>1,800K (1,526°C)</b>	<b>300K (26°C)</b>
Resolution (nm)	>5	1-5	<1
Imaging Speed	1x	3-6x	9-100x

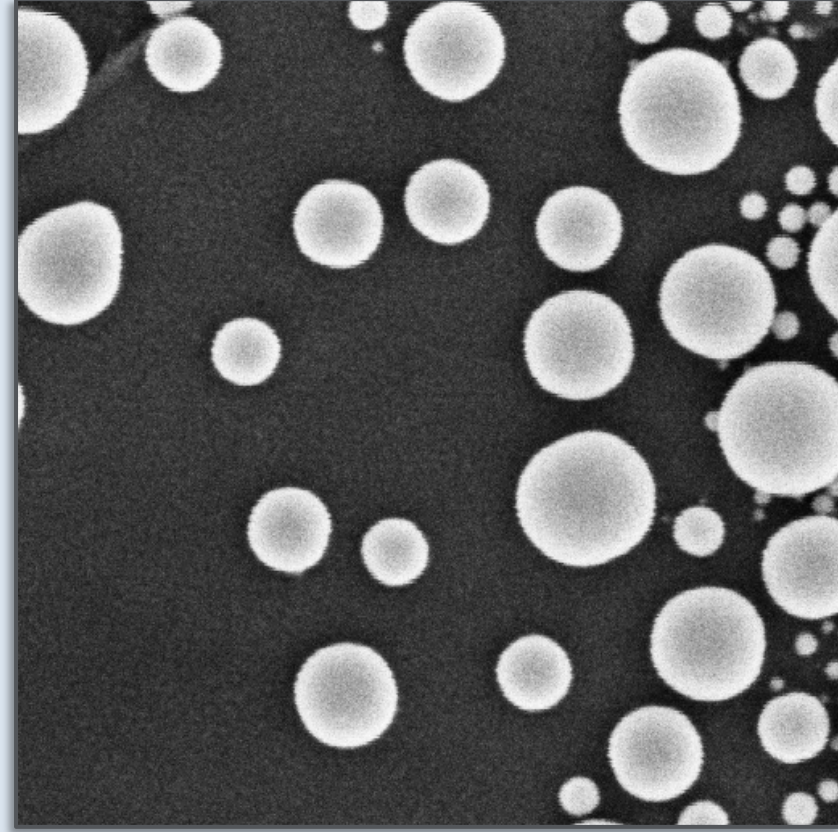
Applied's CFE technology increases eBeam resolution and speed

# CFE: The Next Generation of eBeam Imaging

**TFE**



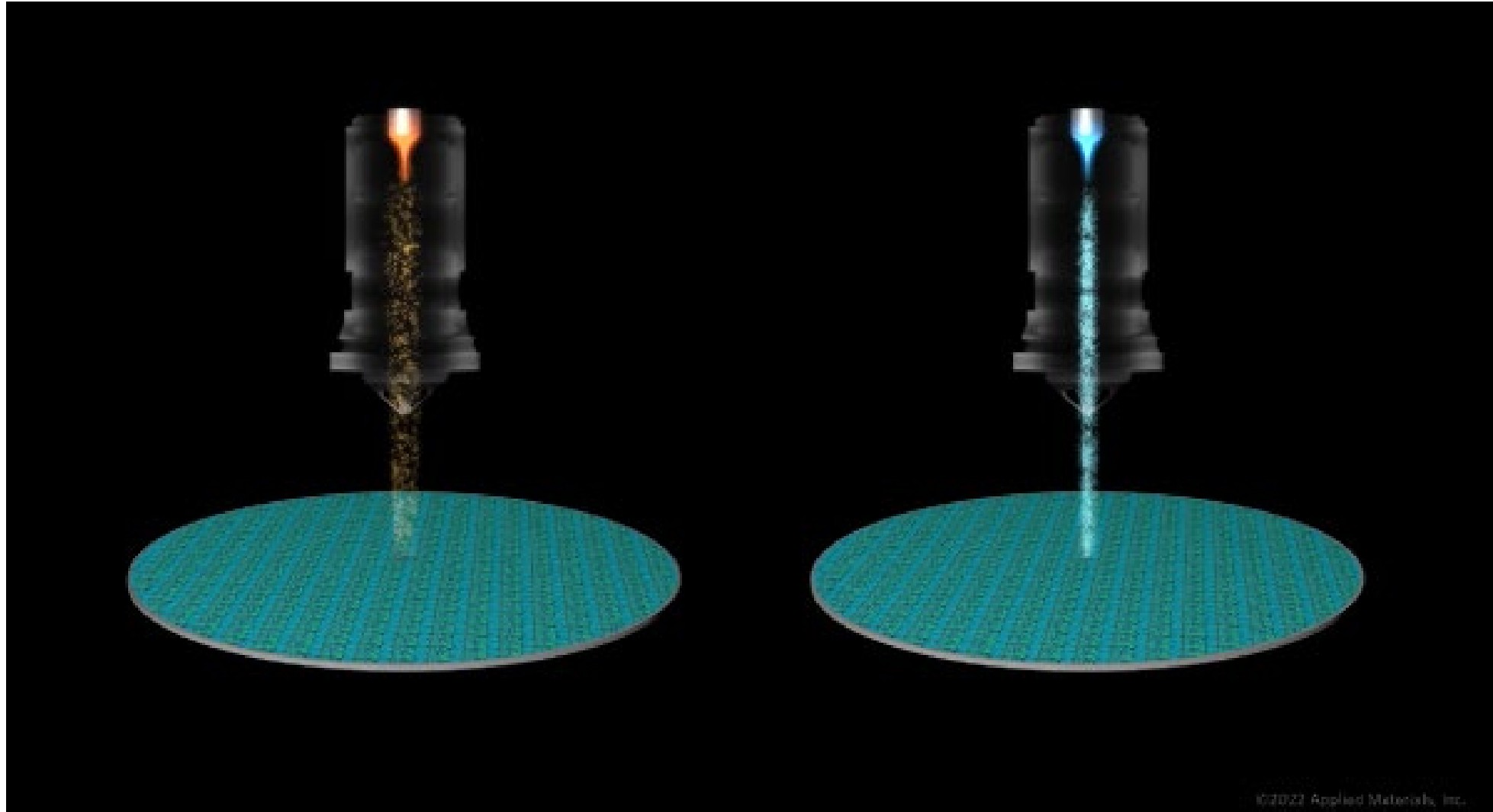
**CFE**



Higher resolution, faster throughput, production-worthy



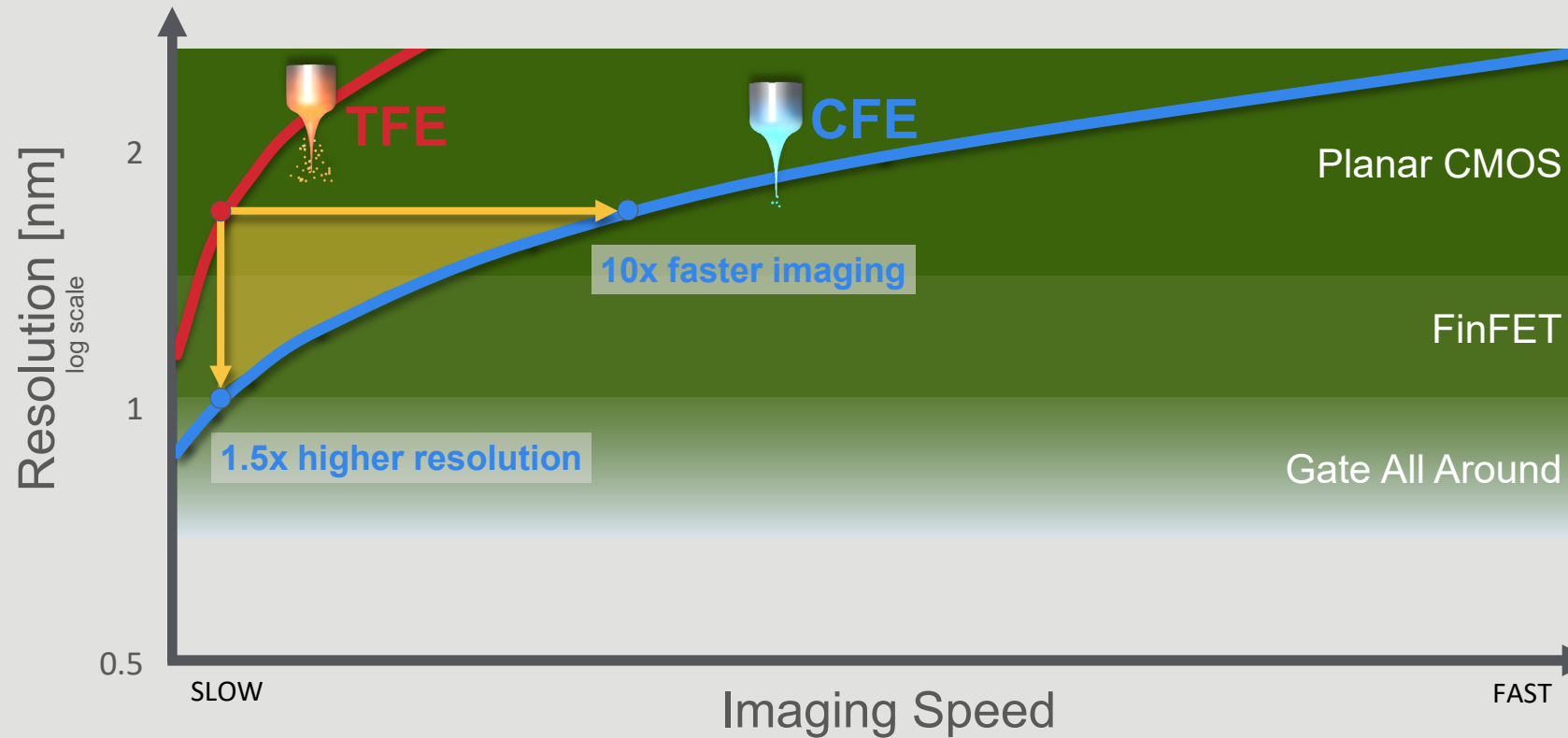
# CFE Animation



YouTube link: [https://youtu.be/k\\_nE2taufD8](https://youtu.be/k_nE2taufD8)

# CFE Accelerates Development of Industry's Most Advanced Nodes

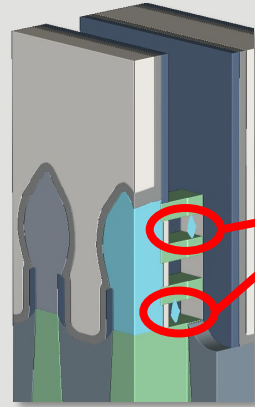
## R&D Technology Development Use Scenario



eBeam imaging with CFE gives GAA process engineers the ability to characterize new processes in minutes versus the days required by transmission electron microscopy (TEM) approaches

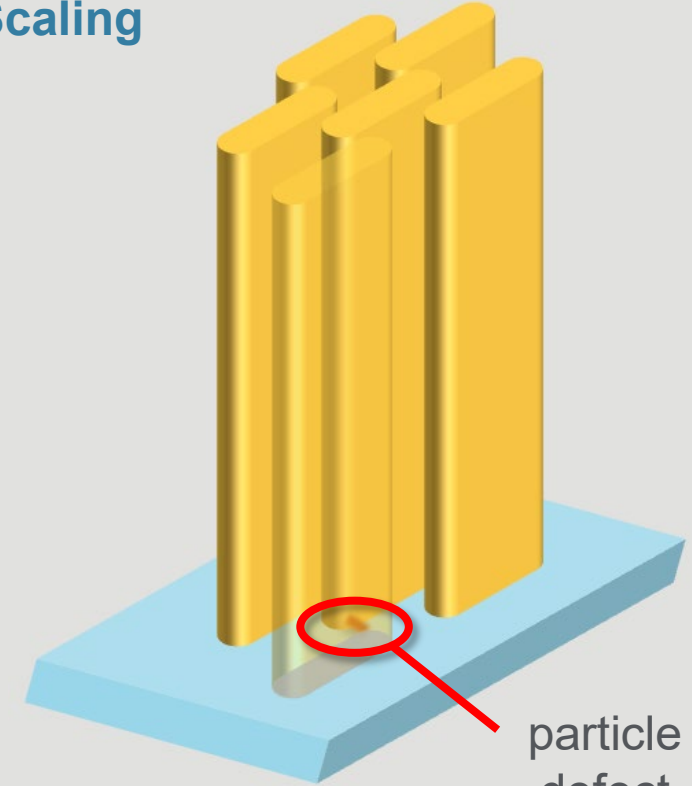
# Customers Using CFE to Discover Process Issues

GAA



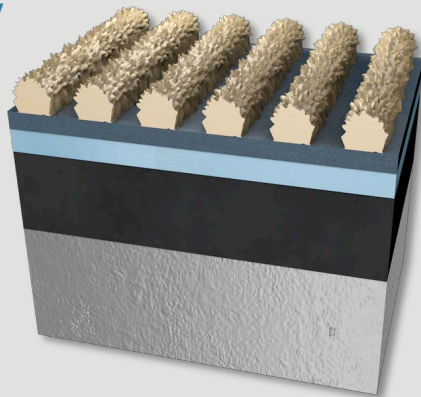
SiGe  
residue

DRAM  
Scaling



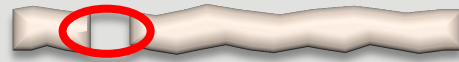
particle  
defect

EUV



stochastic defects

open



short

# Launching SEMVision® G10 with CFE for Defect Review



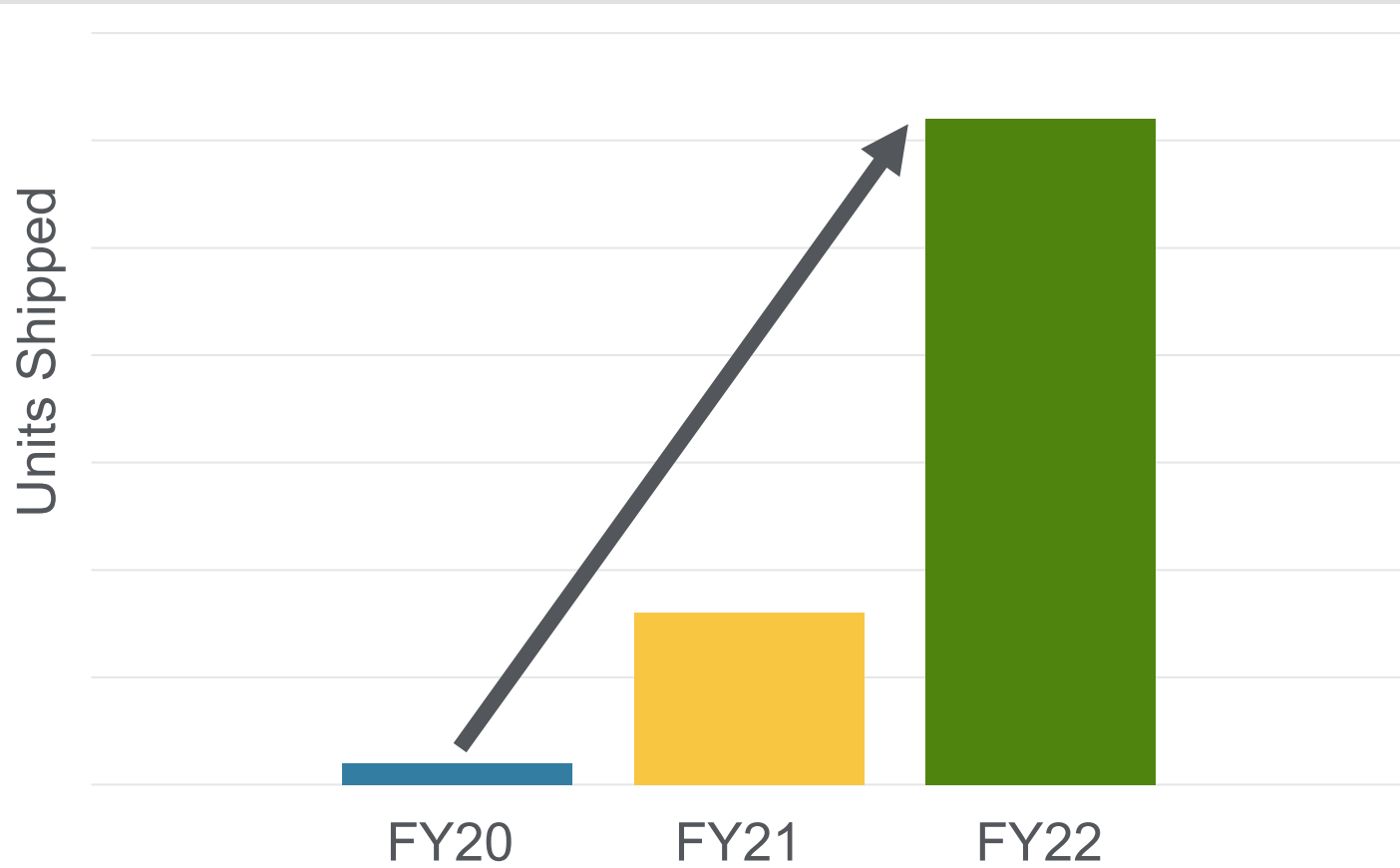
## Sub-nanometer resolution for logic and memory scaling

- ✓ 1.5x higher imaging resolution of smallest defects
- ✓ 3x higher BSE collection efficiency for imaging buried defects
- ✓ 2x higher resolution at 10x lower dose for EUV resist imaging
- ✓ Up to 3x faster throughput

FinFET and memory: in production at leading customers

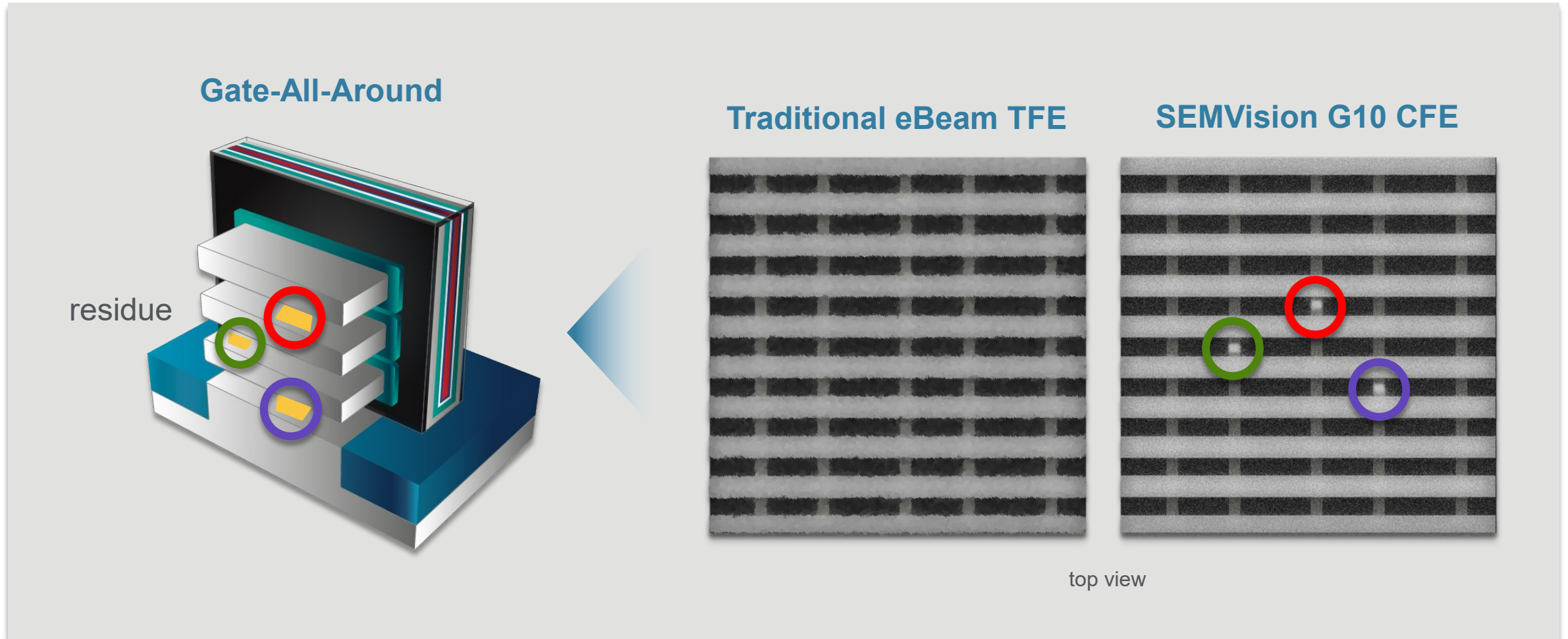
GAA: being adopted as development tool of record

# Strong Customer Pull for SEMVision® G10



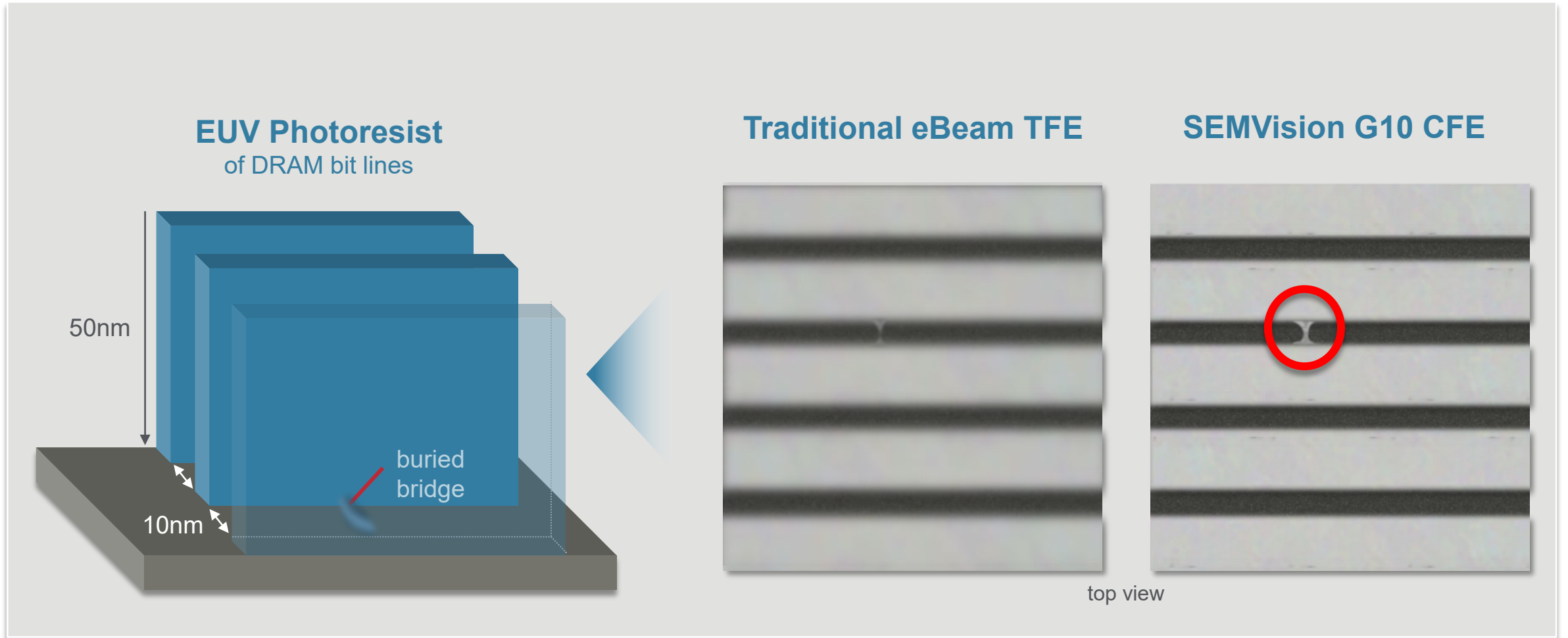
>\$400M in cumulative revenue

# SEMVision® G10 for GAA Defect Review



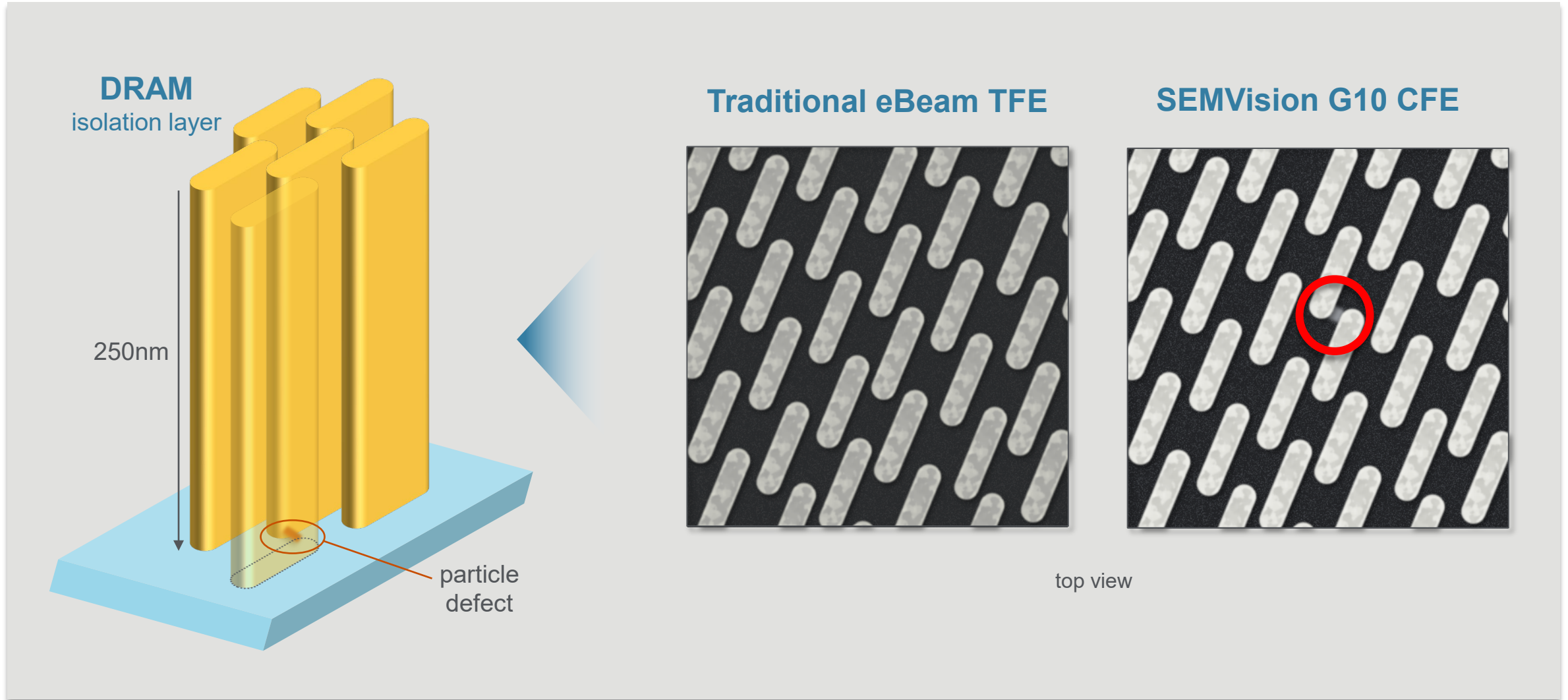
Unique detection and 3D-depth analysis for critical GAA defects

# SEMVision® G10 for EUV Photoresist Review



Increased photoresist review sensitivity with >2x higher resolution and >10x lower eBeam dose

# SEMVision® G10 for DRAM Defect Review



CFE reveals yield-killing defects in DRAM



# Introducing PrimeVision<sup>®</sup> 10 with CFE for Defect Inspection

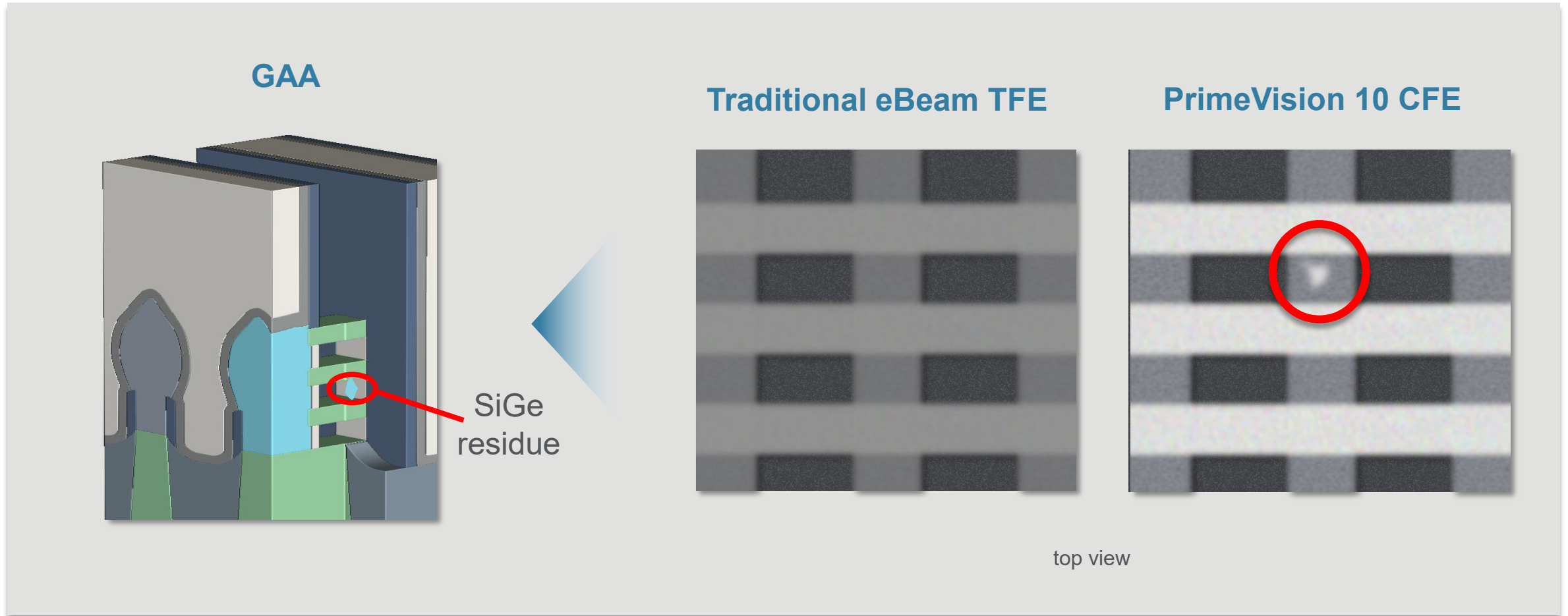


## CFE improves detection of surface and buried defects

- ✓ Resolution of up to ~1nm to detect smallest surface defects
- ✓ New 3D detection channel finds buried defects
- ✓ Up to 10x speed for greater area coverage

Best-in-class inspection for every defect type

# PrimeVision<sup>®</sup> 10 for GAA SiGe Residue



New CFE 3D detection channel enables identification of residue in complex 3D structures

# PrimeVision<sup>®</sup> 10 for DRAM Bit Line Inspection

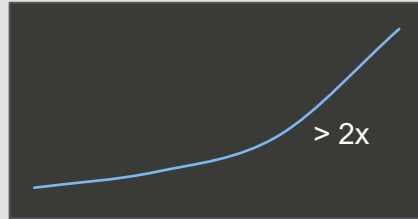


CFE resolution enables detection of tiny yield-critical defects

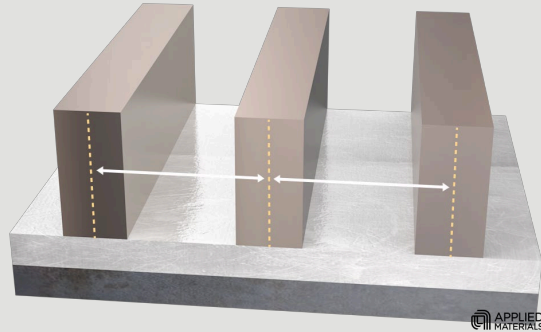
# EUV Patterning Challenges

## Size variation across features

Variation as % of CD



Node 10nm 7nm 5nm 3nm



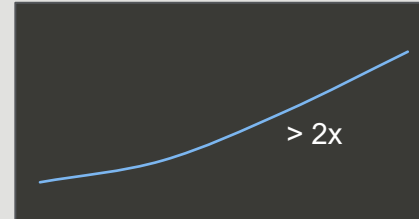
APPLIED MATERIALS

Variation increasing in local and across-wafer CDU

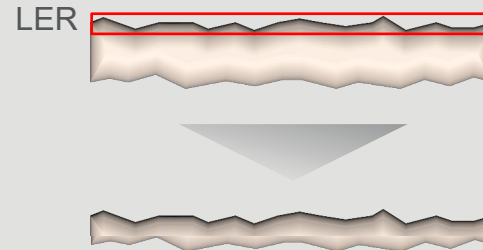
CDU = Critical Dimension Uniformity  
LER = Line Edge Roughness

## Variation within a feature

LER as % of CD



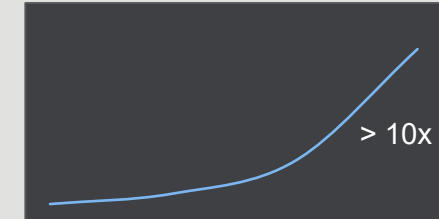
Node 10nm 7nm 5nm 3nm



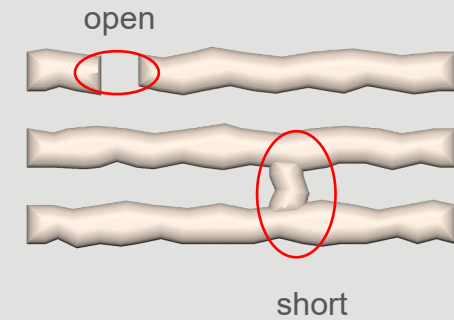
Line edge roughness approaching 30% of line width

## Stochastic defects

Defects per cm<sup>2</sup>

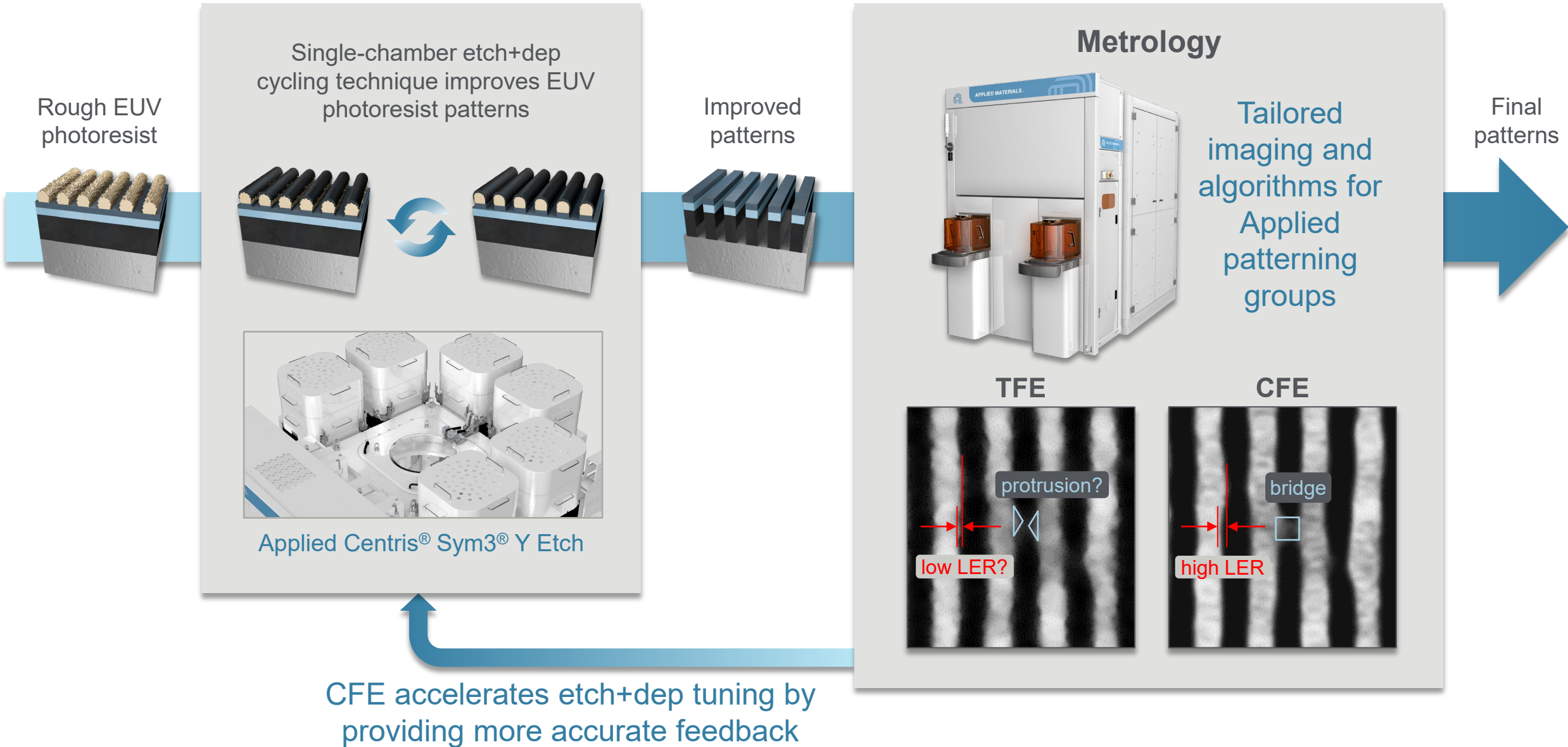


Node 10nm 7nm 5nm 3nm



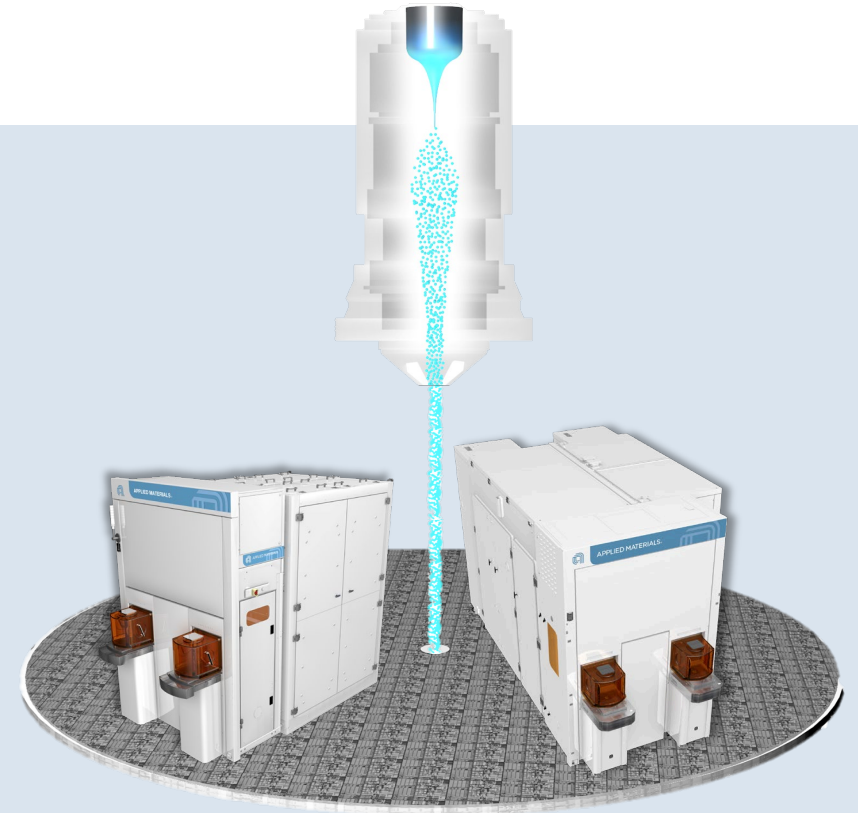
>10x increase in stochastic pattern defects – opens and shorts

# CFE Accelerates EUV Process Development at Applied



# Applied's eBeam Momentum

- **CY21 eBeam System Revenue: \$1.08B, ▲95% YoY**
- **CY21 eBeam Services**
  - » >90% of revenue from subscriptions
  - » >90% subscription renewal rate
- **SEMVision® G10: >\$400M cumulative revenue**
  - » **GAA:** process development tool of record at all customers
  - » **FinFET:** adopted for HVM by all leading customers
  - » **Memory:** adopted for advanced node process development by leading customers
- **PrimeVision® 10**
  - » CFE technology provides up to 10x increase in eBeam inspection speed
  - » Industry's best detection of surface and buried defects





APPLIED  
MATERIALS®

make possible