ASML

Applications Products and Business Opportunity

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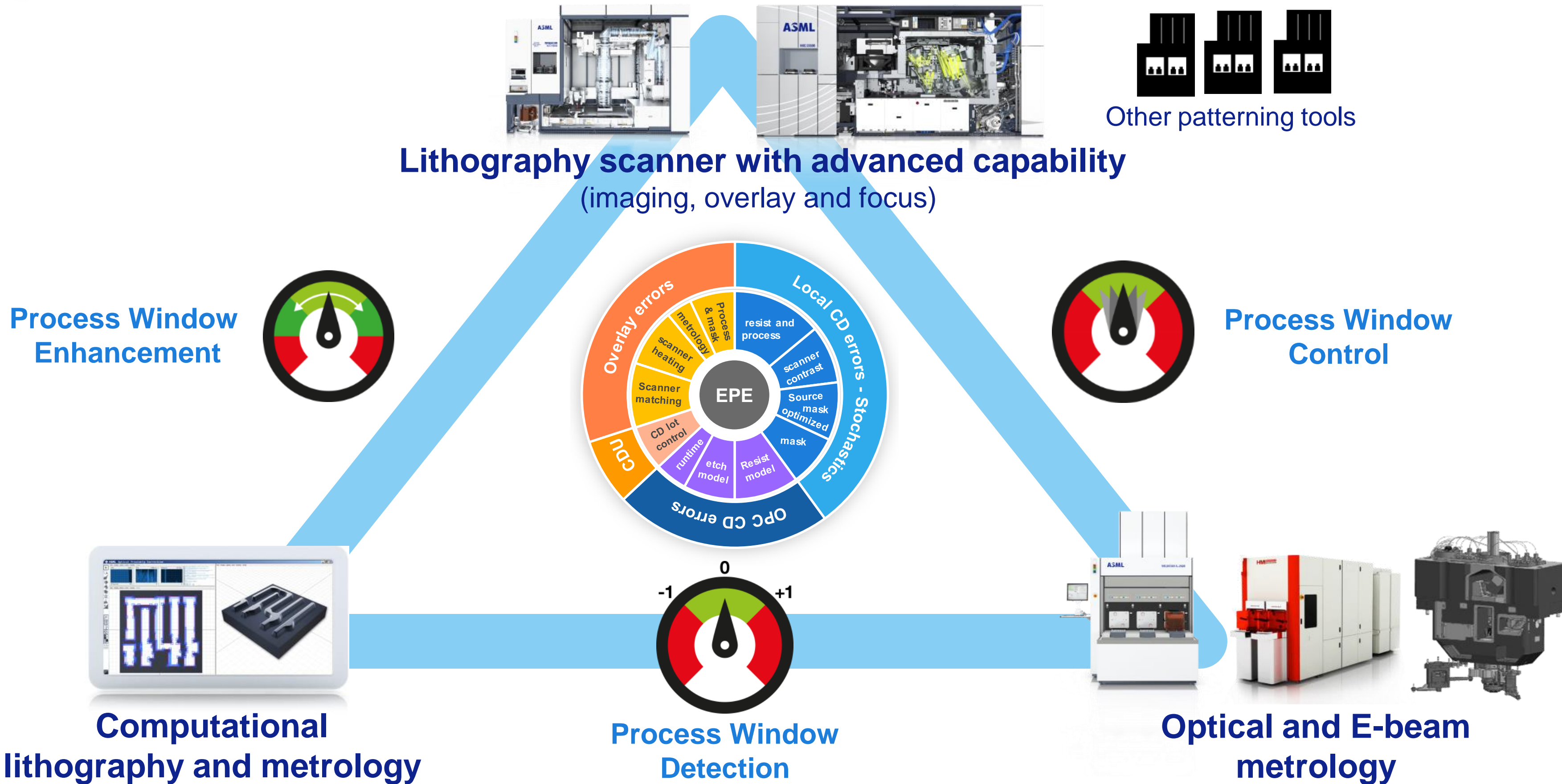
INVESTOR DAY
ASMLSMALLTALK2018
VELDHOVEN

Applications Products and Business Opportunity
Key messages

- The ASML Holistic Lithography roadmap is driven by ASML's unique capability to help customers achieve their pattern fidelity requirements
- 2018 will be another record year for the Applications business, with product wins across all customers and all market segments (Logic, DRAM, NAND)
- Primary driver of growth is the extension of our solutions into Pattern Fidelity control:
  - New offerings extend the roadmap with innovative products that combine ASML's computational technology with HMI's e-beam expertise.
  - Hardware and software products support the introduction of EUV into HVM
  - New applications of deep learning in both computational litho and defect inspection drive improved performance
- The Applications business is projected to continue to grow at 15-20% CAGR with strong gross margins for the period 2017 through 2025

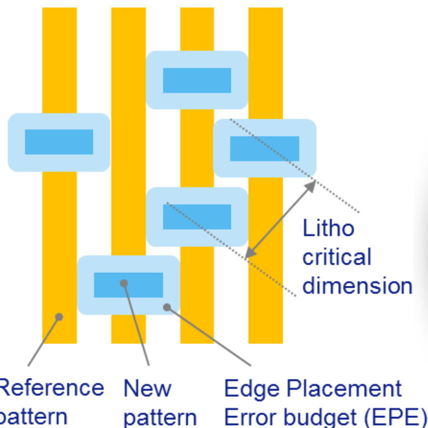
ASML's Holistic Lithography roadmap maximizes patterning performance by optimizing Edge Placement Error (EPE)



Scaling requires Edge Placement Accuracy improvements

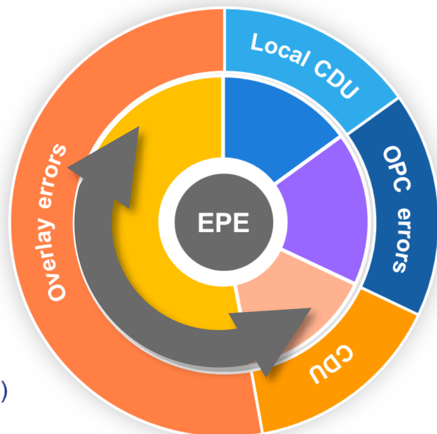
ASML continues to expand its portfolio to address total patterning error

Device Pattern



Edge placement error (EPE): combined error of overlay and CD uniformity

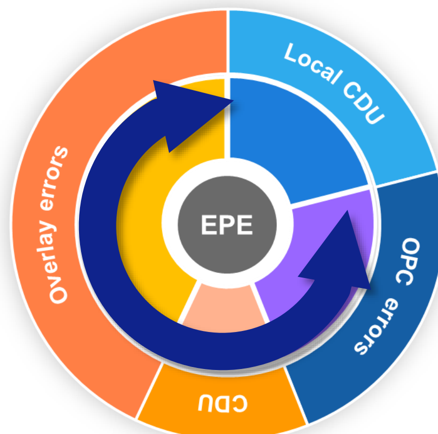
2005 65nm Node
XT:1400, ArF dry
Single Expose



Scanner only

>50% of EPE budget

2012 20nm Node
NXT:1950i, ArF immersion
Single Expose



Holistic Lithography

- Brion computational litho & OPC
- YieldStar optical metrology
- Scanner feedback and control

>75% of EPE budget

2020 5nm Node
NXT:2000i-NXE:3400 ArFi-EUV
Multiple Patterning

Pattern Fidelity Control

- HMI E-beam metrology & inspection
- YieldStar extension post etch, in-die
- Litho-Etch co-optimization

>90% of EPE budget

CD: Critical Dimension, OPC: Mask Optical Proximity Correction

Scanner only contribution

Holistic Litho contribution

Pattern Fidelity Control is next step in holistic lithography

Addition of E-Beam and Etch extends and improves the control paradigm

DUV and EUV Scanner Control

Scanner metrology (100% wafers)

wafers

After-Litho YieldStar Metrology

After-Litho E-beam Metrology

Etch Control

After-Etch YS & E-beam Metrology

Etch Suppliers

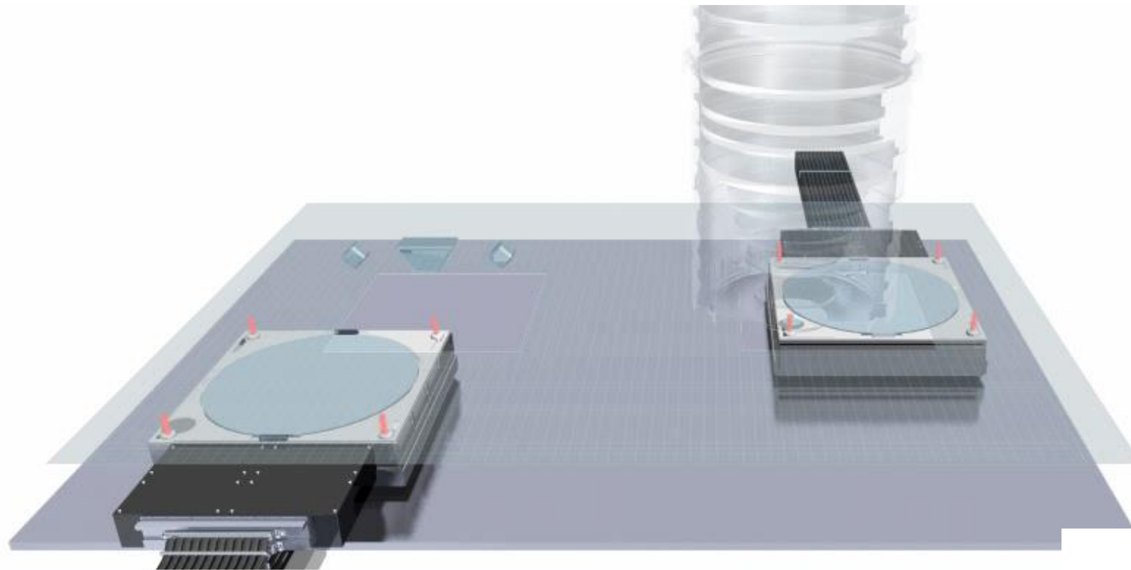
Guide to areas of interest

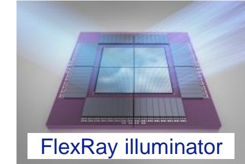
Computational Lithography

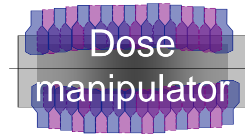
Improved algos, models

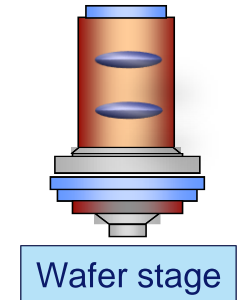
Scanner
Comp Litho
Optical Metro
E-Beam Metro
Etch

ASML scanners are uniquely able to find, measure and correct for patterning variations from the total process flow









Metrology stage

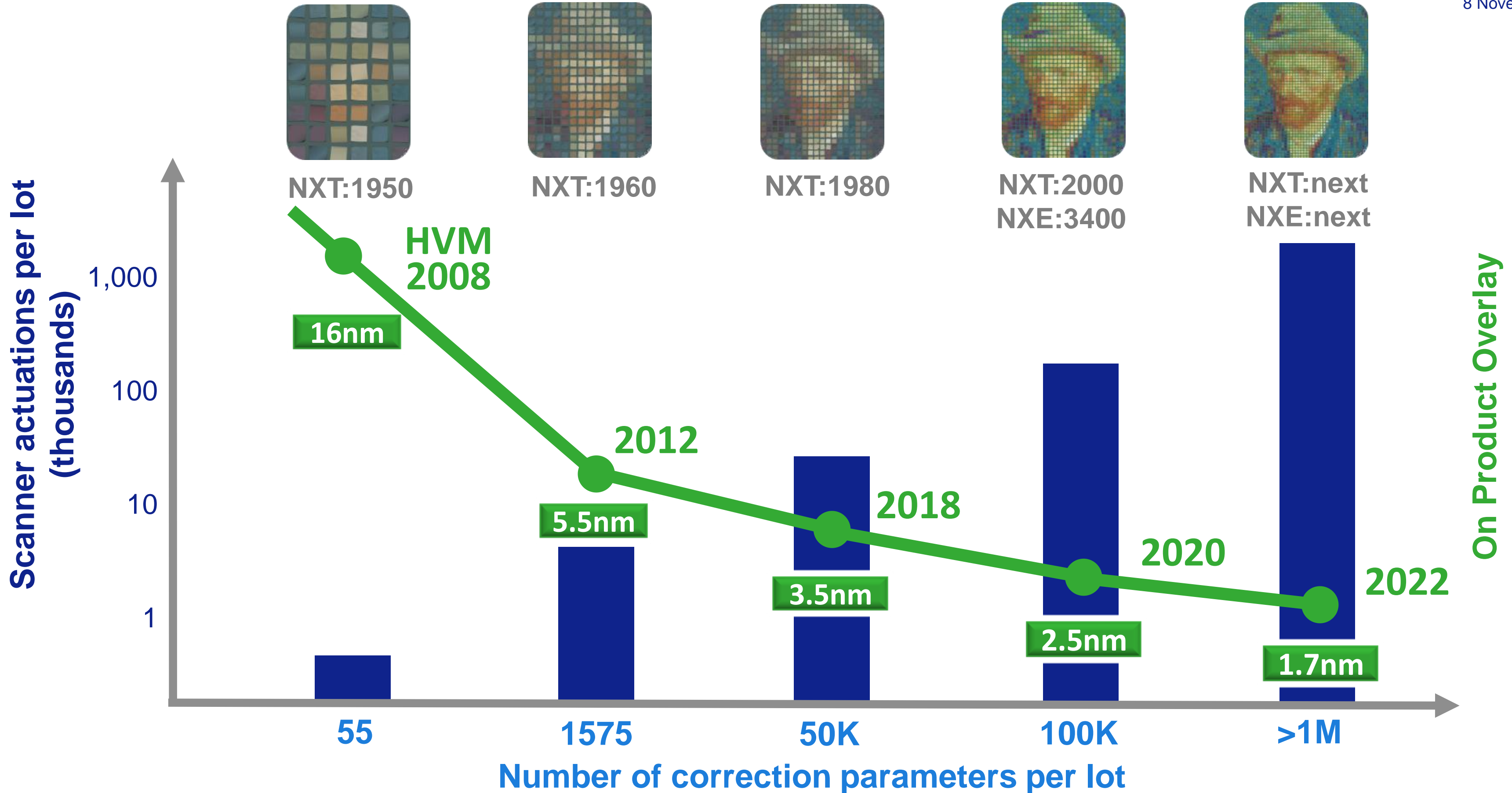
100% of the wafers are measured

Exposure stage

100% of the wafers are processed field-by-field

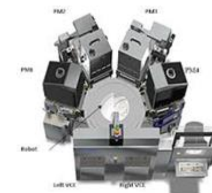
Scanner actuators correct on a field-by-field basis

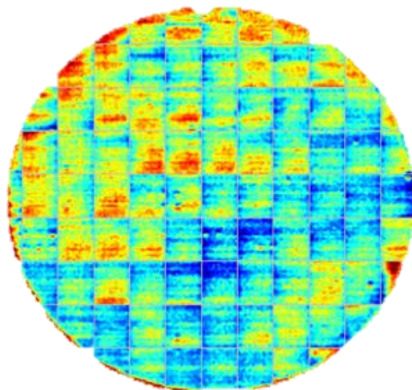
Denser measurements per wafer drive more scanner actuations improving on-product overlay for the customer

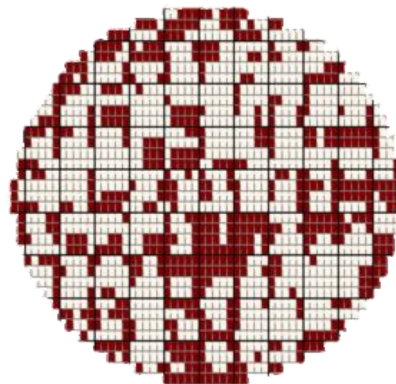


Measuring overlay after etch and in device unleashes the full correction capability of the scanner and improves yield

Low order corrections per wafer





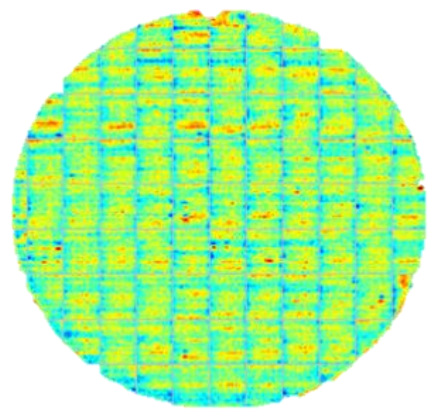


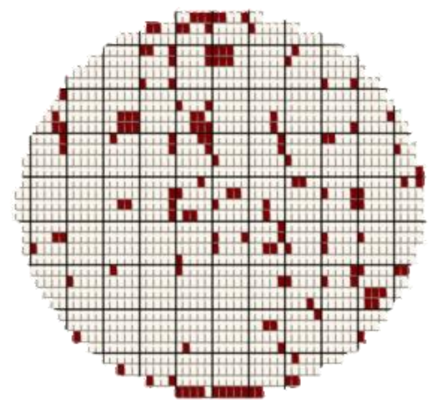
Overlay After Etch	5.35nm

Good die in spec	61%

Measuring overlay after etch and in device unleashes the full correction capability of the scanner and improves yield

Medium order corrections per wafer





Overlay After Etch

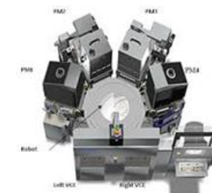
3.26nm

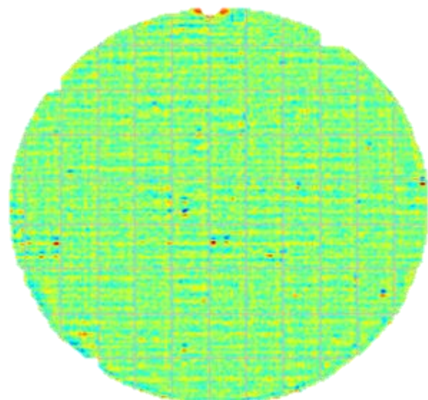
Good die in spec

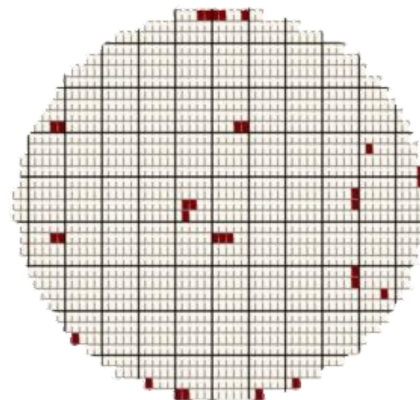
90%

Measuring overlay after etch and in device unleashes the full correction capability of the scanner and improves yield

High order corrections per wafer



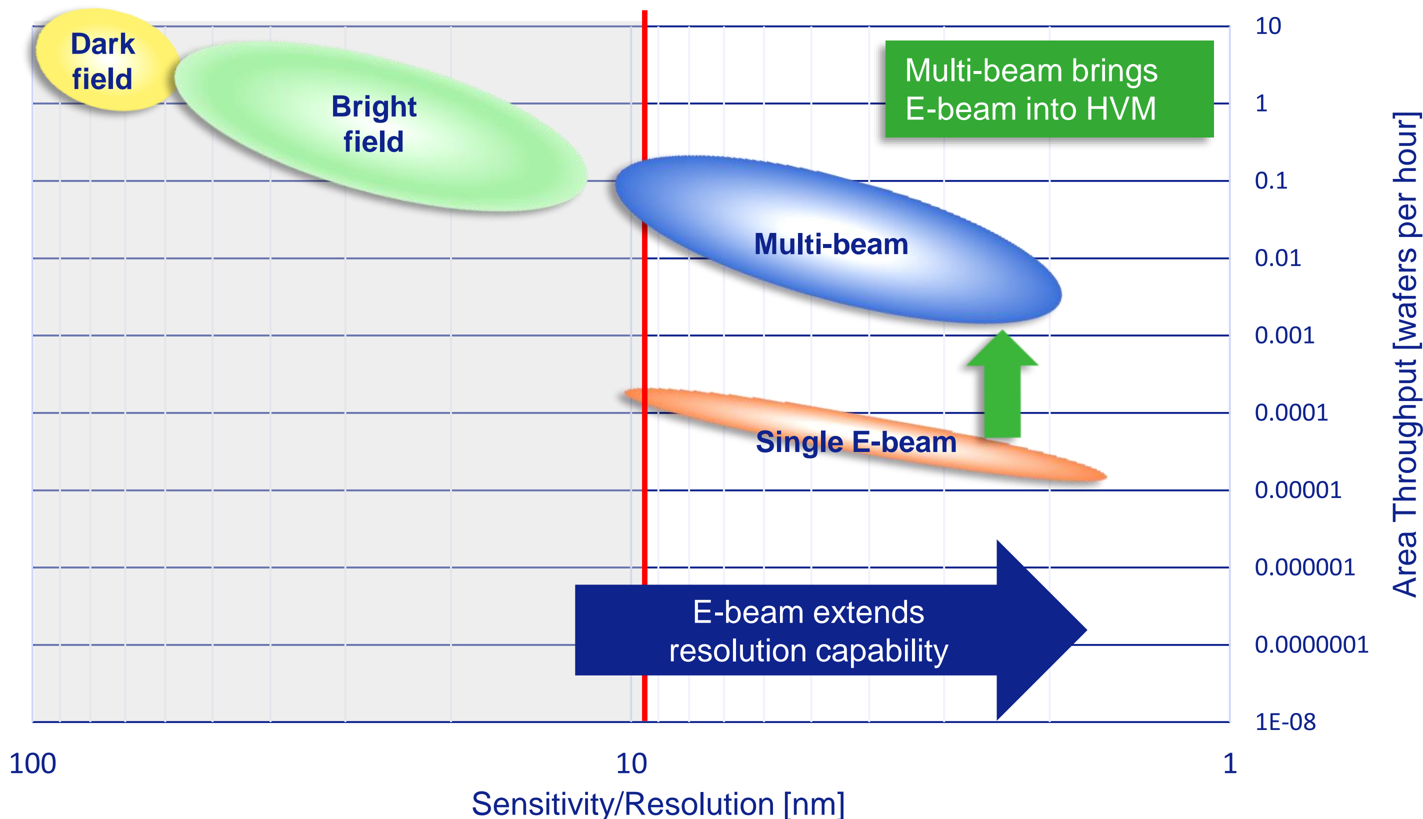




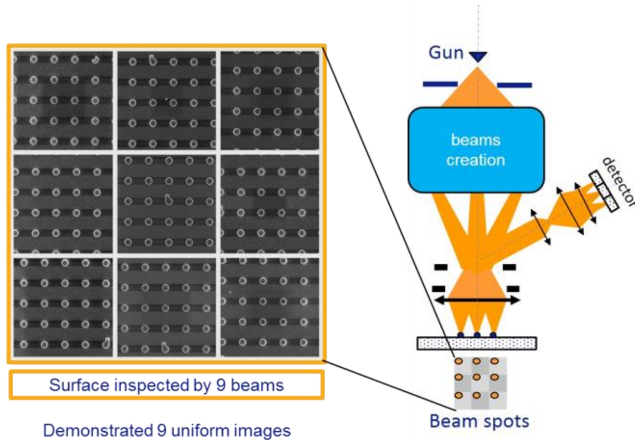
Overlay After Etch	2.1nm

Good die in spec	98%

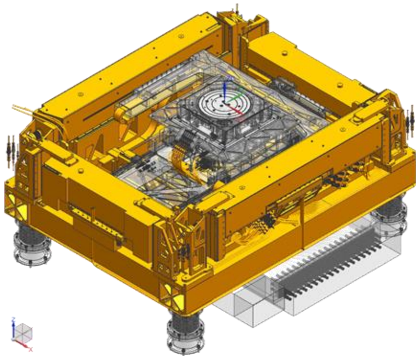
Multi-beam E-beam is required to support both R&D and HVM defect inspection at the 5nm node and below



Multi-beam inspection leverages competence in E-beam, fast and accurate stages, and computational technology



Demonstrated 9 uniform images



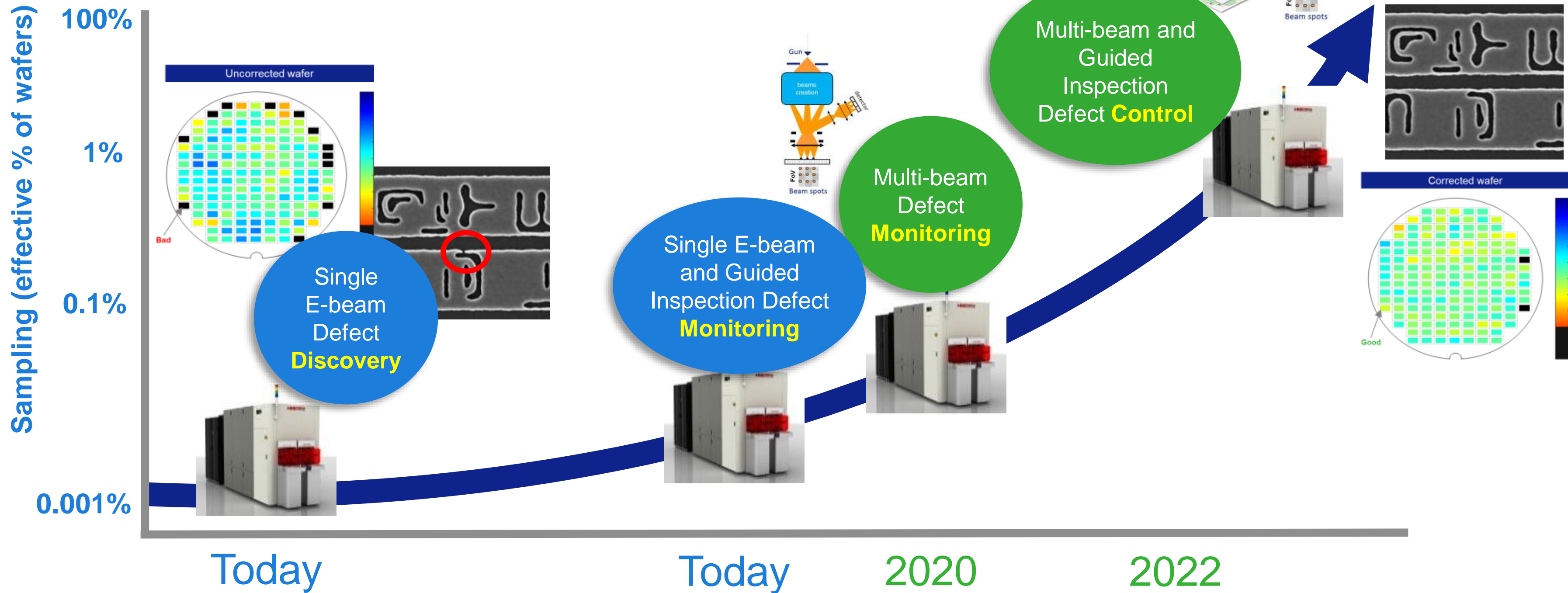
1. **SEM**: Building on top of HMI's unique electron optics and ultra low-noise SEM technologies to develop multi-beam and single-beam systems

2. **Stage**: Leverage ASML's world-class stage technology to achieve high-speed stage moves with high position accuracy

3. **Software and Simulation**: Leverage Brion and ASML process modeling and chip database competencies for computational defect prediction and guided care-area inspection to increase effective E-beam area coverage

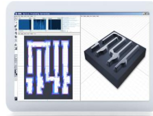
Multi-beam inspection technology together with holistic lithography enables defect control in HVM

Multi-beam expected to provide the volume and quality of data after etch to enable the next paradigm of patterning and defect control by the scanner

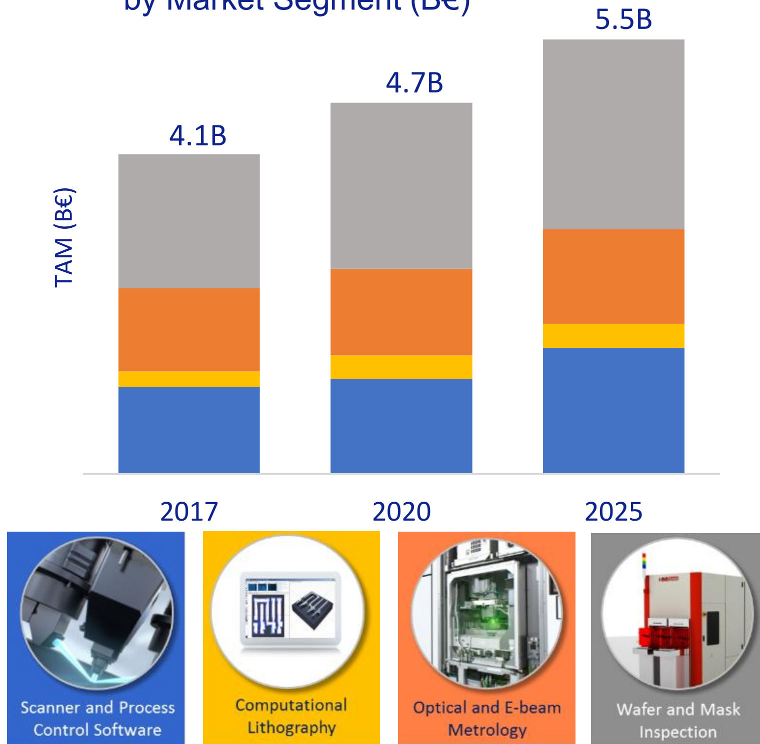


Applications Roadmap

Strong roadmap of technology advances will enable progress to continue

		2018	2019	2020	2021	2022	… 2025
Scanner Interfaces and Control Software			Increasing Scanner Actuation (DUV and EUV), Etch Co-Optimization, EPE Control				
Overlay Metrology YieldStar			Fast Stages, Multiple Wavelengths, Computational Metrology, In-Device				
E-Beam Defect Inspection			Multi-beam, Fast and Accurate Stages, Guided Inspection				
E-beam Metrology			Single Beam High Res, Large Field of View, Massive Metrology, EPE metrology				
Computational Lithography			Improved Accuracy, Inverse OPC, Machine and Deep Learning, Etch Models				

Our Applications portfolio has seen strong growth, and is projected to continue at 15-20% CAGR



- We expect 15-20% year on year growth for the period 2017 through 2025, which is higher than growth in TAM over same period
- We expect growth across all parts of our portfolio, with metrology and HMI inspection products being the most significant driver of growth going forward
- We expect the strong gross margins for the Applications portfolio to continue

Source: ASML market model and semiconductor capex simulations based on data by VLSI, Gartner, SEMI

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Summary

- The ASML Holistic Lithography roadmap is driven by ASML's unique capability to help customers achieve their pattern fidelity requirements
- 2018 will be another record year for the Applications business, with product wins across all customers and all market segments (Logic, DRAM, NAND)
- Primary driver of growth is the extension of our solutions into Pattern Fidelity control:
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  - Hardware and software products support the introduction of EUV into HVM
  - New applications of deep learning in both computational litho and defect inspection drive improved performance
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Forward Looking Statements

This document contains statements relating to certain projections, business trends and other matters that are forward-looking, including statements with respect to expected trends and outlook, strategy, bookings, expected financial results and trends, including expected sales, EUV revenue, gross margin, capital expenditures, R&D and SG&A expenses, cash conversion cycle, and target effective annualized tax rate, and expected financial results and trends for the rest of 2018 and 2019, expected revenue growth and demand for ASML's products in logic and memory, expected annual revenue opportunity in 2020 and for 2025 and expected EPS potential in 2020 with significant growth in 2025, expected trends in the lithography system market, fab capacity by segment, the automotive and artificial intelligence industries, connectivity, semiconductor end markets and new semiconductor nodes, expected acceleration of chipmakers' performance for the next decade, expected EUV insertion and transistor density growth, trends in DUV systems revenue and Holistic Lithography and installed based management revenues, statements with respect to expectations regarding future DUV sales, including composition, margins, improvement of operations and performance, DUV product roadmaps, expected benefits of the holistic productivity approach, including in terms of wafers per year, expected industry trends and expected trends in the business environment, statements with respect to customer demand and the commitment of customers to High NA machines and to insert EUV into volume manufacturing by ordering systems, expected future operation of the High NA joint lab, statements with respect to holistic lithography roadmaps and roadmap acceleration, including the introduction of higher productivity systems in 2019 (including the expected shipment of NXE:3400C and expected timing thereof) and the expected benefits, ASML's commitment to volume manufacturing and related expected plans until 2030, ASML's commitment to secure system performance, shipments, and support for volume manufacturing, including availability, timing of and progress supporting EUV ramp and improving consistency, productivity, throughput, and production and service capability enabling required volume as planned, including expected shipments, statements with respect to growth of fab capacity driving demand in lithography systems, planned customer fabs for 200 systems and expected first output in 2019, expected EUV value increase and increase in EUV margins and ASML's expectation of EUV profitability at the DUV level, expected installed base of EUV systems, expected customer buildout of capacity for EUV systems, EUV estimated demand by market, expected increase in lithography intensity, statements with respect to the expected benefits of EUV, including year-on-year cost reduction and system performance, and of the introduction of the new DUV system and expected demand for such system, the expected benefits of HMI's e-beam metrology capabilities, including the expansion of ASML's integrated Holistic Lithography solutions through the introduction of a new class of pattern fidelity control, the extension of EUV to enable cost effective single patterning shrink with EUV, statements with respect to ASML's applications business, including statements with respect to expected results in 2018, expected growth of the applications business and expected drivers of growth, expected growth in margins, continued shrink and drivers, and expected accuracy, defect control and performance improvements, shrink being a key driver supporting innovation and providing long-term industry growth, lithography enabling affordable shrink and delivering value to customers, DUV, Holistic Lithography and EUV providing unique value drivers for ASML and its customers, expected industry innovation, the expected continuation of Moore's law and that EUV will continue to enable Moore's law and drive long term value for ASML beyond the next decade, intention to return excess cash to shareholders through stable or growing dividends and regularly timed share buybacks in line with ASML's policy, statements with respect to the expectation to continue to return cash to shareholders through dividends and share buybacks, and statements with respect to the expected impact of accounting standards. You can generally identify these statements by the use of words like "may", "will", "could", "should", "project", "believe", "anticipate", "expect", "plan", "estimate", "forecast", "potential", "intend", "continue", "targets", "commits to secure" and variations of these words or comparable words. These statements are not historical facts, but rather are based on current expectations, estimates, assumptions and projections about the business and our future financial results and readers should not place undue reliance on them.

Forward-looking statements do not guarantee future performance and involve risks and uncertainties. These risks and uncertainties include, without limitation, economic conditions, product demand and semiconductor equipment industry capacity, worldwide demand and manufacturing capacity utilization for semiconductors, including the impact of general economic conditions on consumer confidence and demand for our customers' products, competitive products and pricing, the impact of any manufacturing efficiencies and capacity constraints, performance of our systems, the continuing success of technology advances and the related pace of new product development and customer acceptance of and demand for new products including EUV and DUV, the number and timing of EUV and DUV systems shipped and recognized in revenue, timing of EUV orders and the risk of order cancellation or push out, EUV production capacity, delays in EUV systems production and development and volume production by customers, including meeting development requirements for volume production, demand for EUV systems being sufficient to result in utilization of EUV facilities in which ASML has made significant investments, potential inability to successfully integrate acquired businesses to create value for our customers, our ability to enforce patents and protect intellectual property rights, the outcome of intellectual property litigation, availability of raw materials, critical manufacturing equipment and qualified employees, trade environment, changes in exchange rates, changes in tax rates, available cash and liquidity, our ability to refinance our indebtedness, distributable reserves for dividend payments and share repurchases, results of the share repurchase plan and other risks indicated in the risk factors included in ASML's Annual Report on Form 20-F and other filings with the US Securities and Exchange Commission. These forward-looking statements are made only as of the date of this document. We do not undertake to update or revise the forward-looking statements, whether as a result of new information, future events or otherwise.

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