

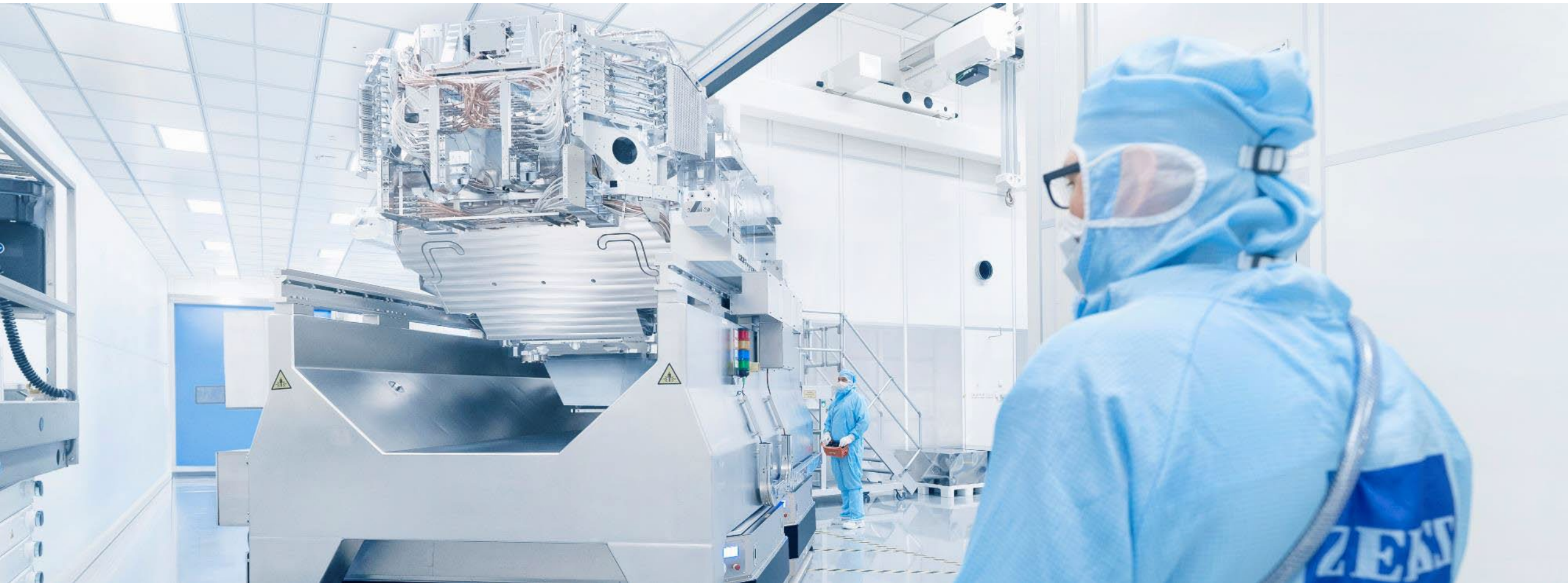
Status and outlook of EUV optics at ZEISS

Carl Zeiss SMT GmbH



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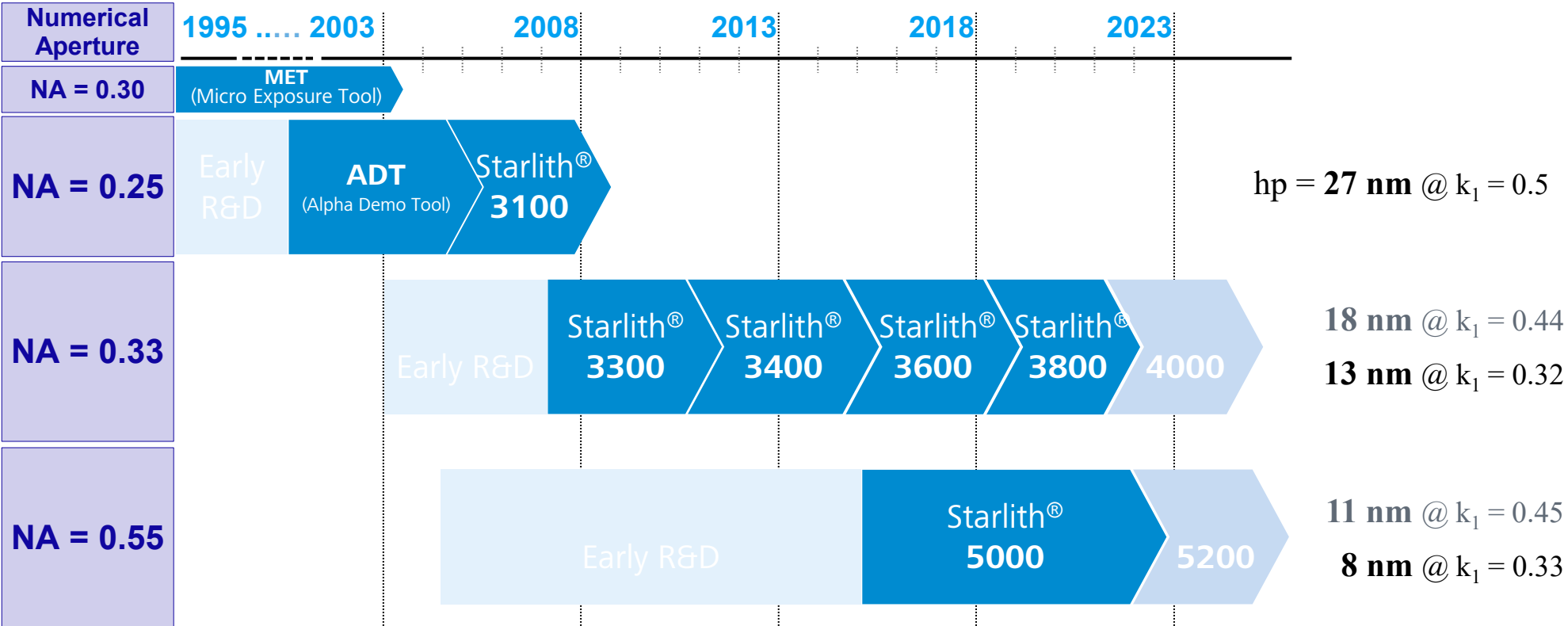
06 June 2024



EUV lithography optics program at ZEISS

Evolving EUV optics continuously enabling the roadmap

$$\text{half-pitch} = k_1 \frac{\lambda}{NA}$$



MET



ADT/3100 POB



3100 Illu



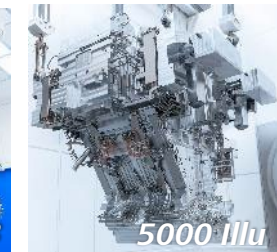
3400 POB



3400 Illu



5000 POB



5000 Illu

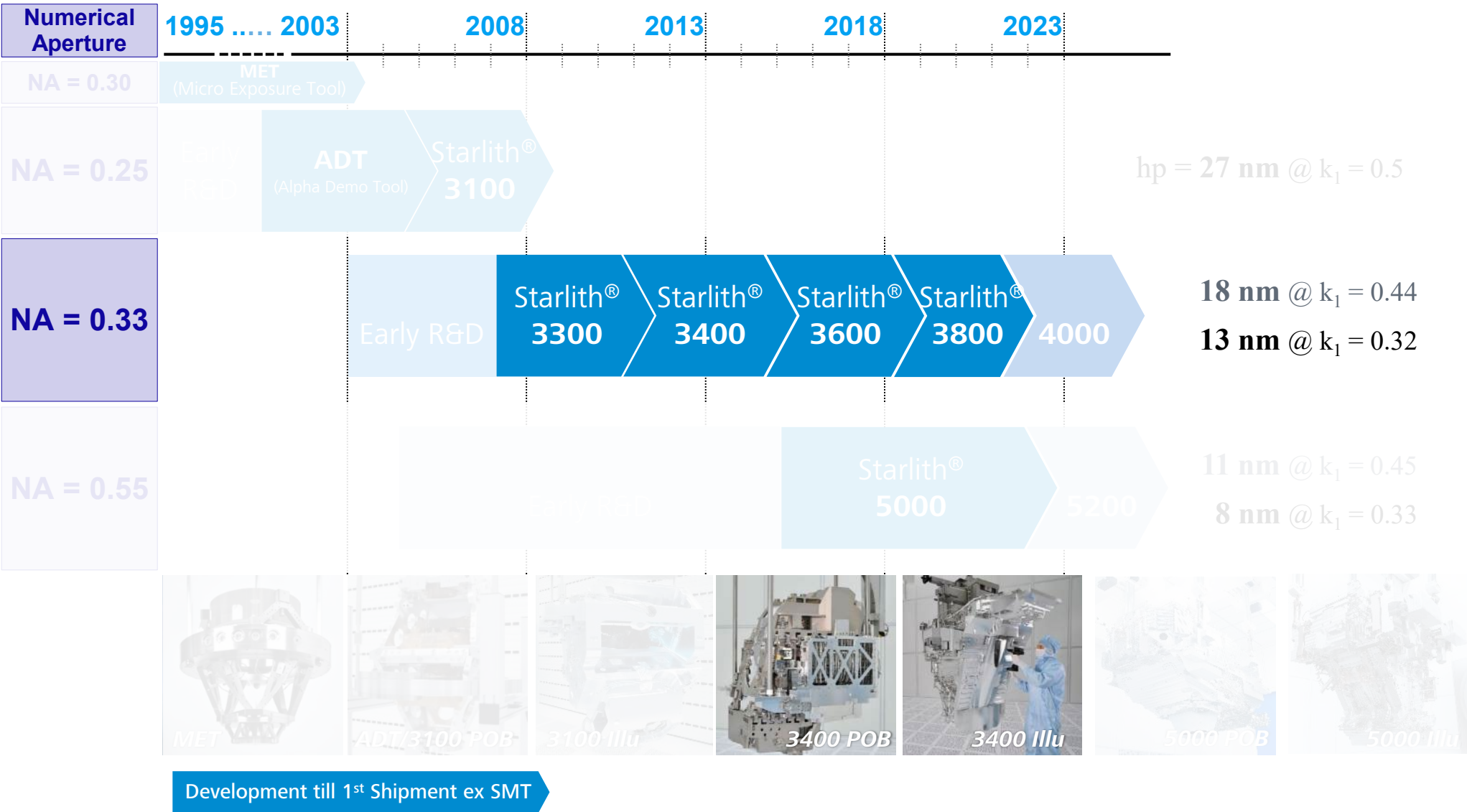
Development till 1st Shipment ex SMT

EUV lithography optics program at ZEISS

Evolving EUV optics continuously enabling the roadmap

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The newest NA 0.33 family member: The Starlith® 3800



First NXE:3800 delivery to customer (Ex ASML in March 2024)



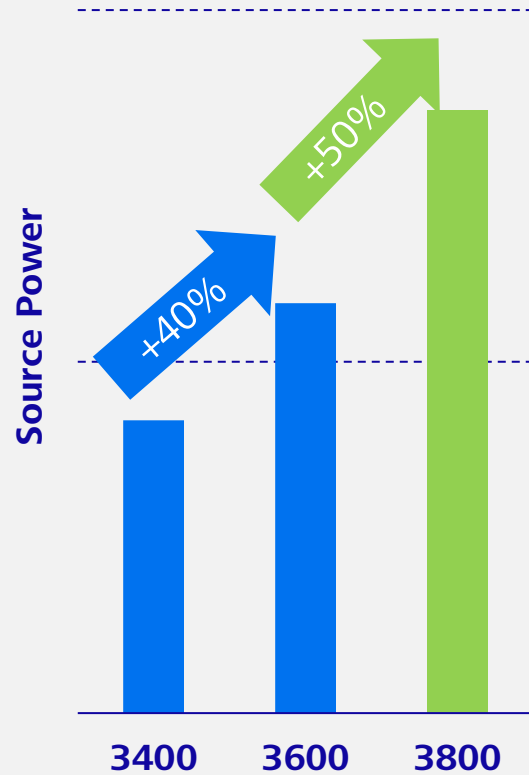
- **Starlith® 3800**: Close to 20 systems shipped to ASML
- In total, **>280 EUV systems** with 0.33 NA shipped to ASML
- More to come due to strong market pull.

Extending the Roadmap for 0.33 NA

0.33 NA EUV development continues at higher source power for more throughput



ASML NXE Scanner



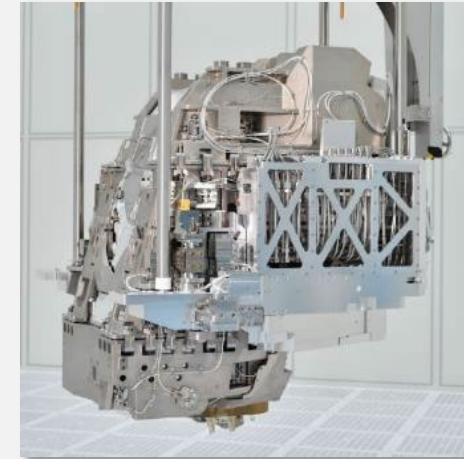
Source: ASML



0.33 NA Illuminator

Key developments:

- Support of higher EUV power



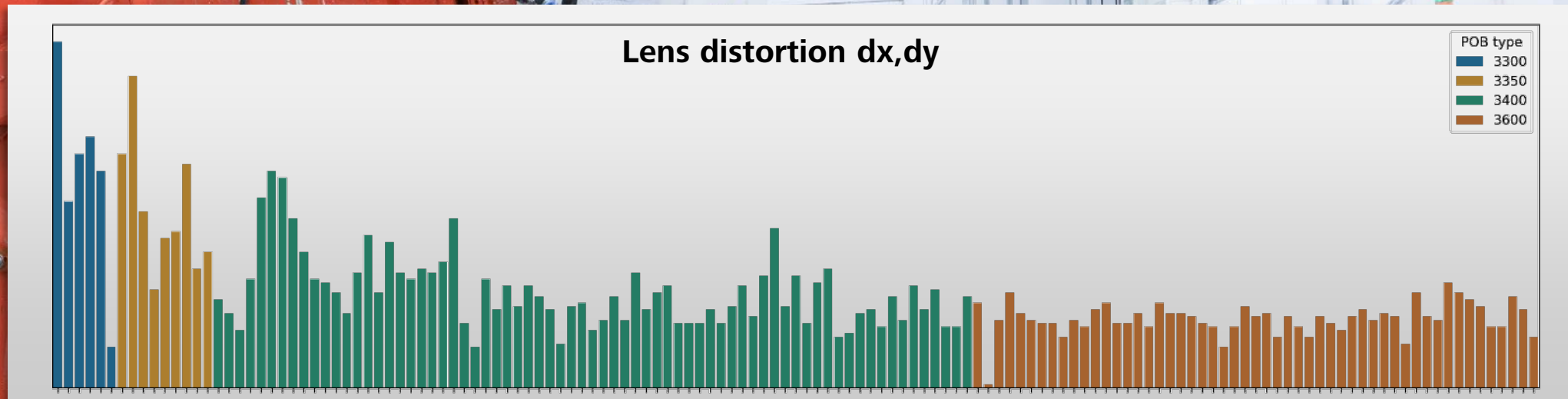
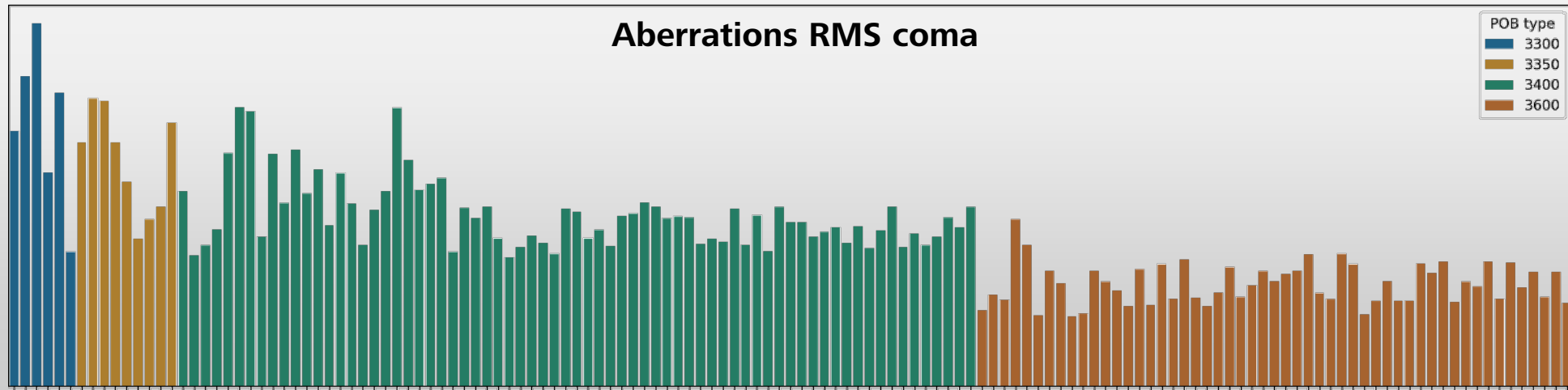
0.33 NA Projection Optics

Key developments :

- Support of higher EUV power
- Improved wavefront performance
- Improved distortion

Improving the Optical Performance

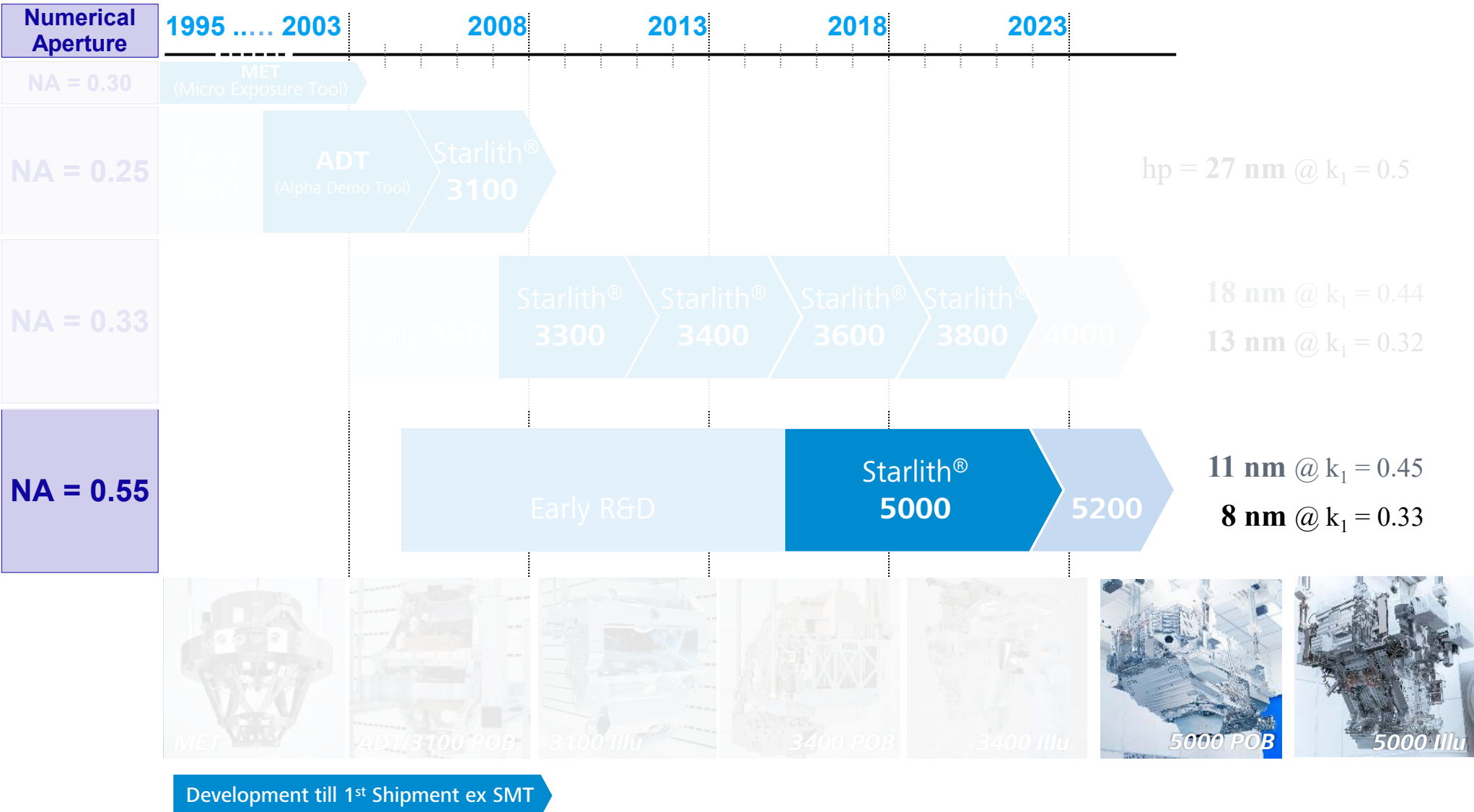
Key performance parameters improve over product generations



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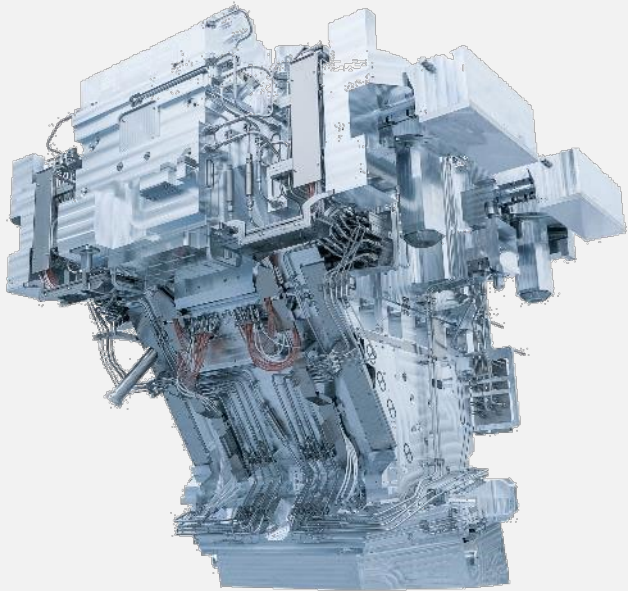


Creating the heart of NA 0.55 EUV technology...

High-precision optics with two function modules

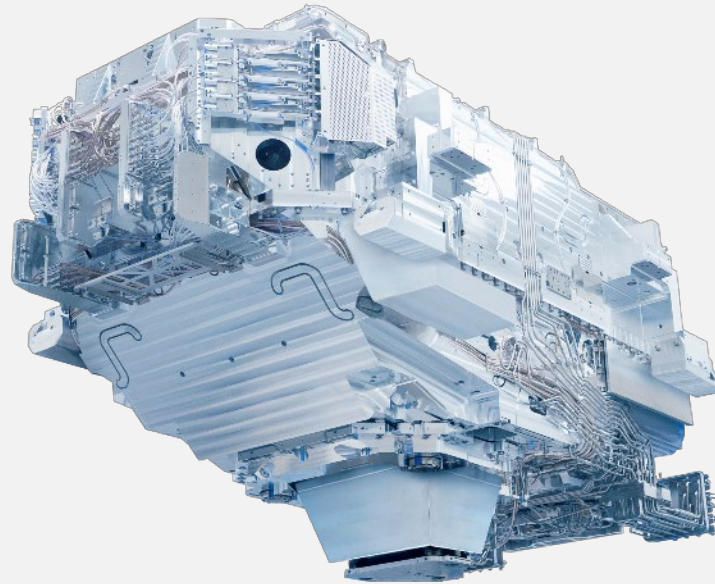


Illumination system



> 25.000 individual parts
~ 6 t weight

Projection optics



> 40.000 individual parts
~ 12 t weight



< 1 Å mirror surface figure control
< 0.1 nrad mirror tilt control

Anamorphic design: limit angles at reticle and deliver high contrast

Central obscuration: enable high EUV transmission



Anamorphic design

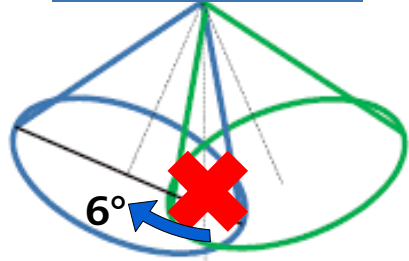
Central obscuration

4x/4x demagnification

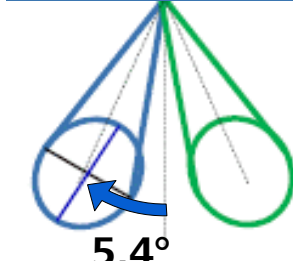
4x/8x demagnification

Reticle

Reticle



NOK: overlapping light cones



OK: works

Anamorphic lens design

4x reduction in non-scan direction

8x reduction in scan direction

Last mirror

High NA
unobscured

High NA
obscured

Second to last mirror

Wafer level

Central obscuration

Reduces angular load and angle variation
→ High-transmission design solution

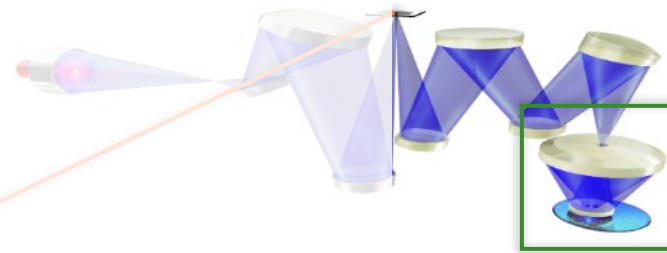


Aberration pupil after 1st lens optimization, taken from J. Garcia-Santaclara, Proc. SPIE Advanced Lithography 2024

Anamorphic design: limit angles at reticle and deliver high contrast

Central obscuration: enable high EUV transmission

Anamorphic design



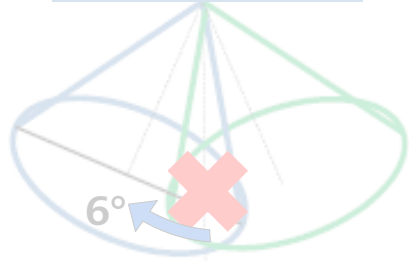
Central obscuration

4x/4x demagnification

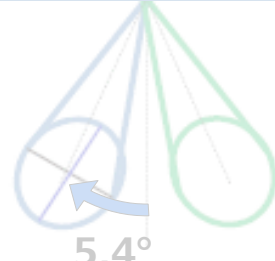
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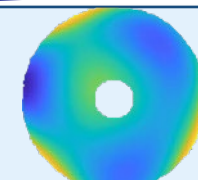
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Central obscuration

Reduces angular load and angle variation

→ High-transmission design solution



Aberration pupil after 1st lens optimization, taken from J. Garcia-Santaclara, Proc. SPIE Advanced Lithography 2024

First NA 0.55 systems shipped to end customer!

Five systems shipped to ASML so far, further systems in production / integration



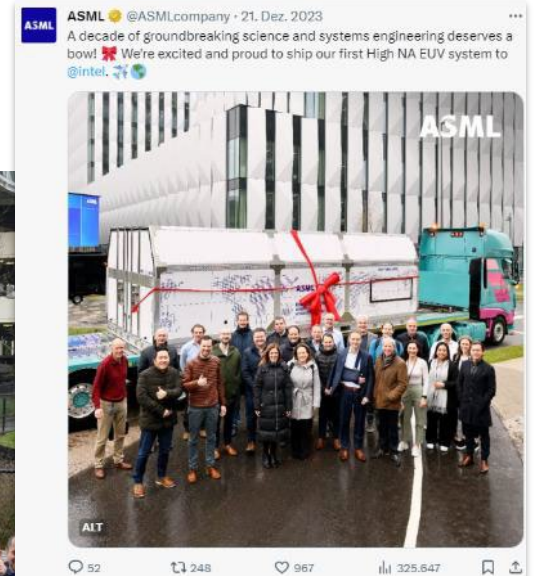
ILLU #1: 31.03.2023



POB #1: 11.07.2023



1st shipment ex ASML:
21.12.2023



successful
in-resist images
10nm half-pitch
(Spring 2024)

Ramp up of production capacity ongoing to satisfy customer demands.

Outlook

Next steps in EUV optics

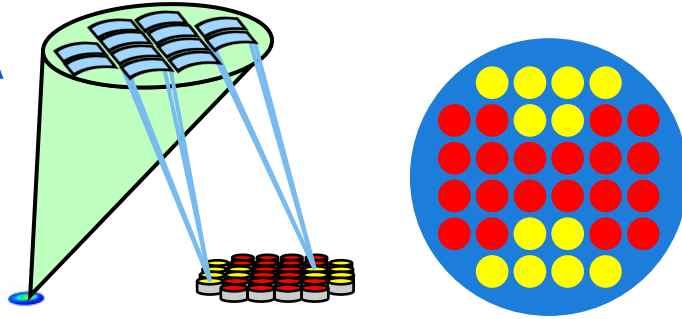


High-Transmission / High-Flexibility Illumination for EUV

Enabling low- k_1 imaging at high productivity



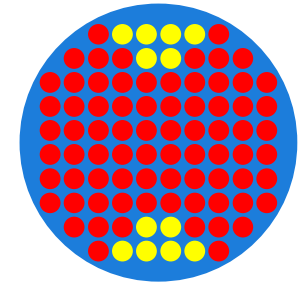
Current 0.55 NA



Pupil Fill Ratio 20%



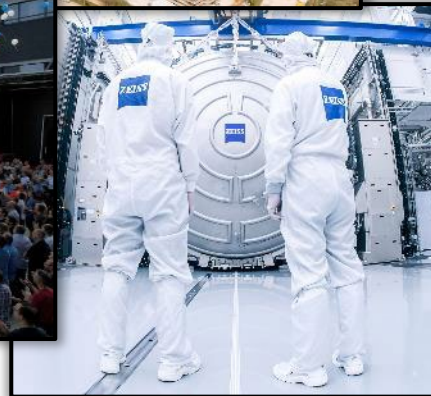
Concept 0.55 NA



Pupil Fill Ratio ~10%
High transmission



Summary



- **First 0.55 NA systems** have been shipped to ASML, overall **good performance** and successful **first in-resist images**
- We ship **high volumes** of EUV **0.33 NA** systems to ASML, continuing progress by the newest member of the NXE fleet **3800**
- **Ramp up** continues for EUV production capacities
- We continuously **extend the roadmap** for EUV lithography optics by increasing transmission for **higher productivity** while striving for lower pupil fill ratio and higher NA for **imaging improvement**

The EUV teams at ZEISS and ASML

Our suppliers, customers, and project partners around the globe



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A technician in a blue cleanroom suit and mask is working on a large, circular, highly reflective optical component mounted on a precision machine. The component's surface is so smooth it reflects the technician's face. Another person in a similar suit is partially visible in the foreground, their back to the camera. The background shows a clean, industrial environment with various equipment and pipes.

Thank you!

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ZEISS