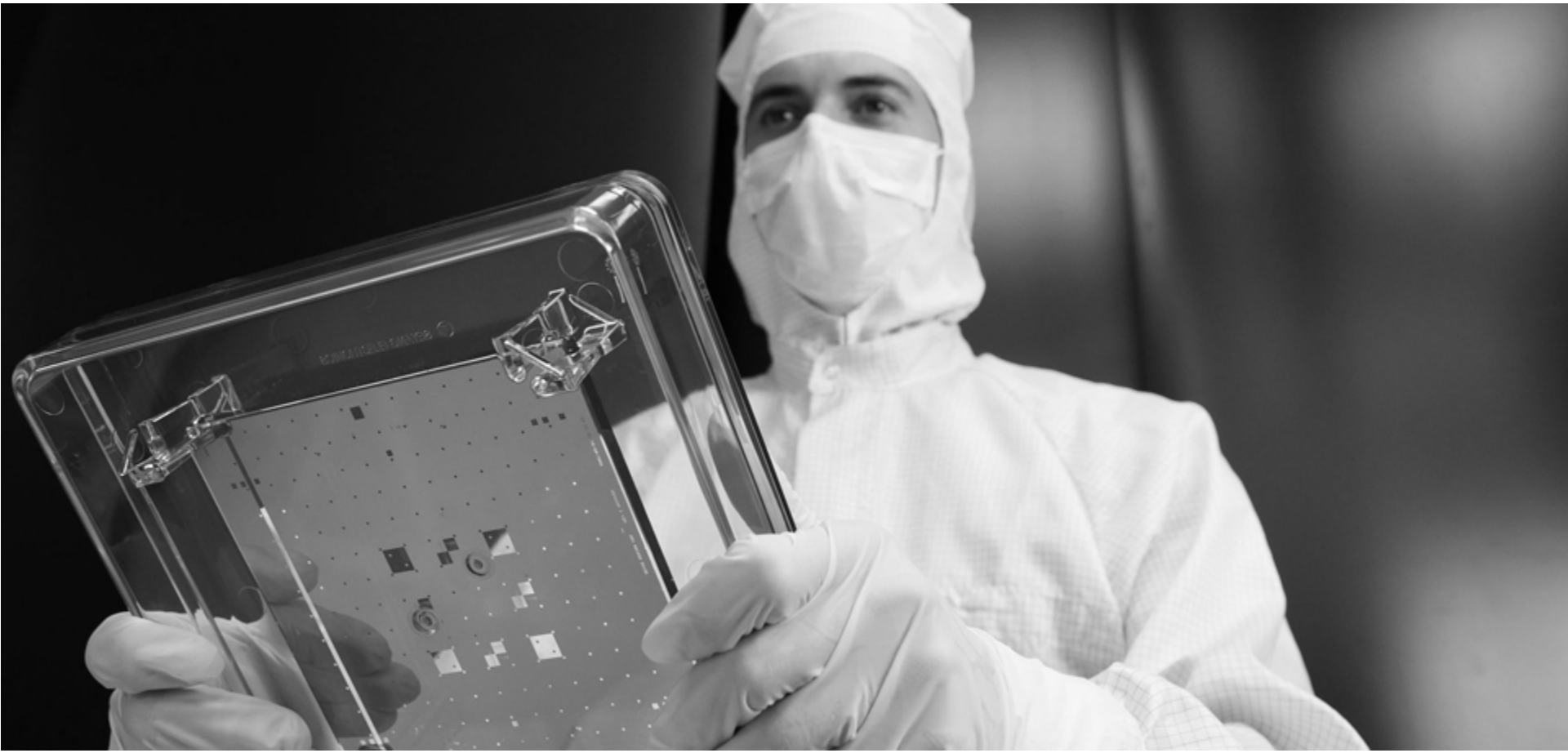
AIMS™ EUV Prototype Status and Development Performance



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2014-10-28

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1 AIMS™ EUV in the Mask Making Flow

2 Key Operational Considerations

3 First Light Defect Analysis

4 Timeline and Summary

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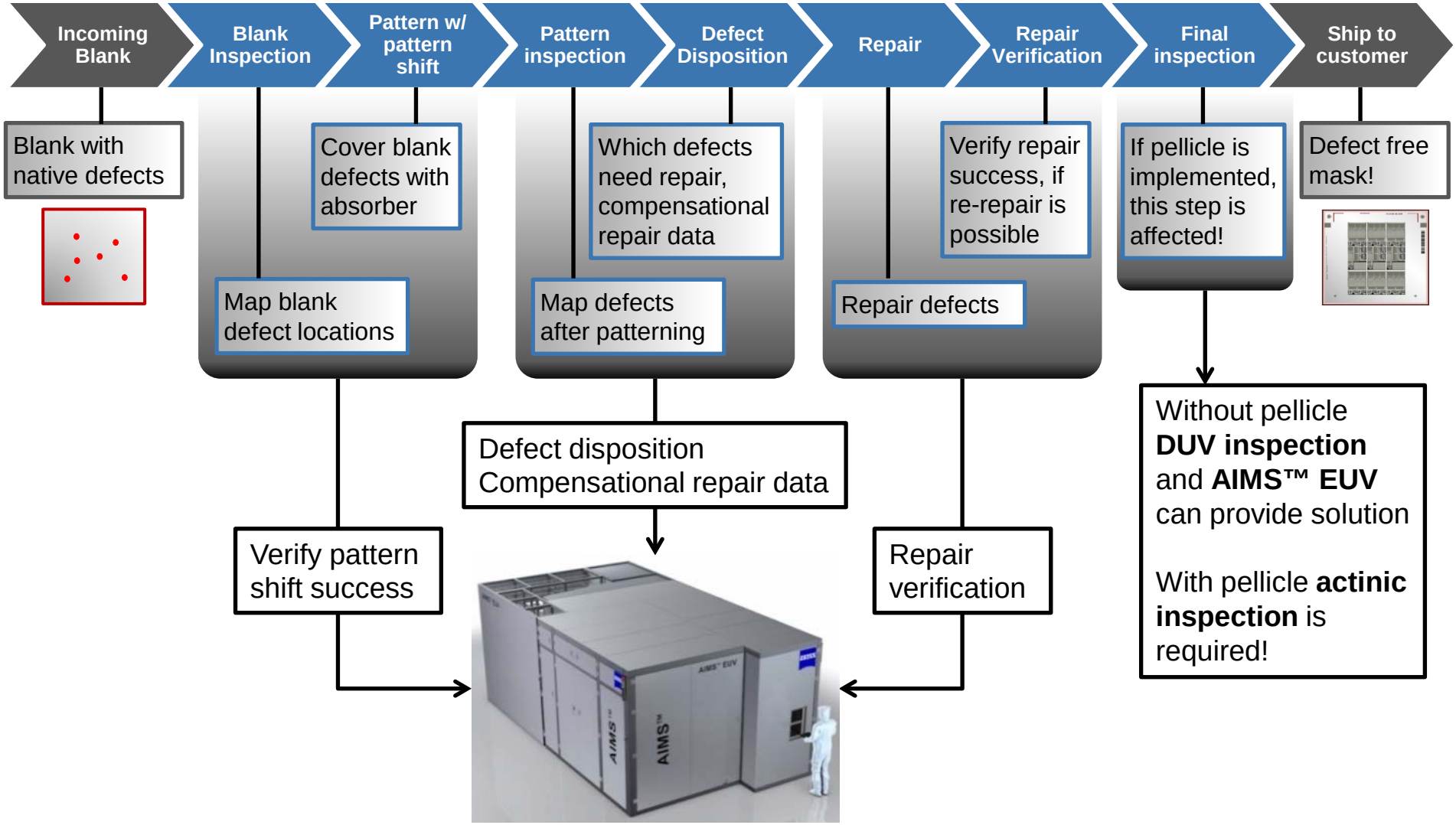
Role of AIMS™ EUV in the mask shop

As first actinic metrology tool, there are many aspects



AIMS™ EUV Performance Specifications

Performance Specifications		
Target node	**7nm logic** (16nm hp)	
Scanner emulation	Up to **0.33 NA**	
CD Reproducibility	**≤1.5 nm** (3σ, mask level)	
Run Rate standard 7 focus planes per site	**≥ 27.5/hr** **≥ 51/hr**	> 38.5% pupil fill > 77% pupil fill
Run Rate fast mode* 7 focus planes per site *CD-repro = 1.8 nm (3σ)	**≥ 55/hr**	>38.5% pupil fill

AIMS™ EUV targets NXE:3100 and NXE:33x0 aerial image emulation

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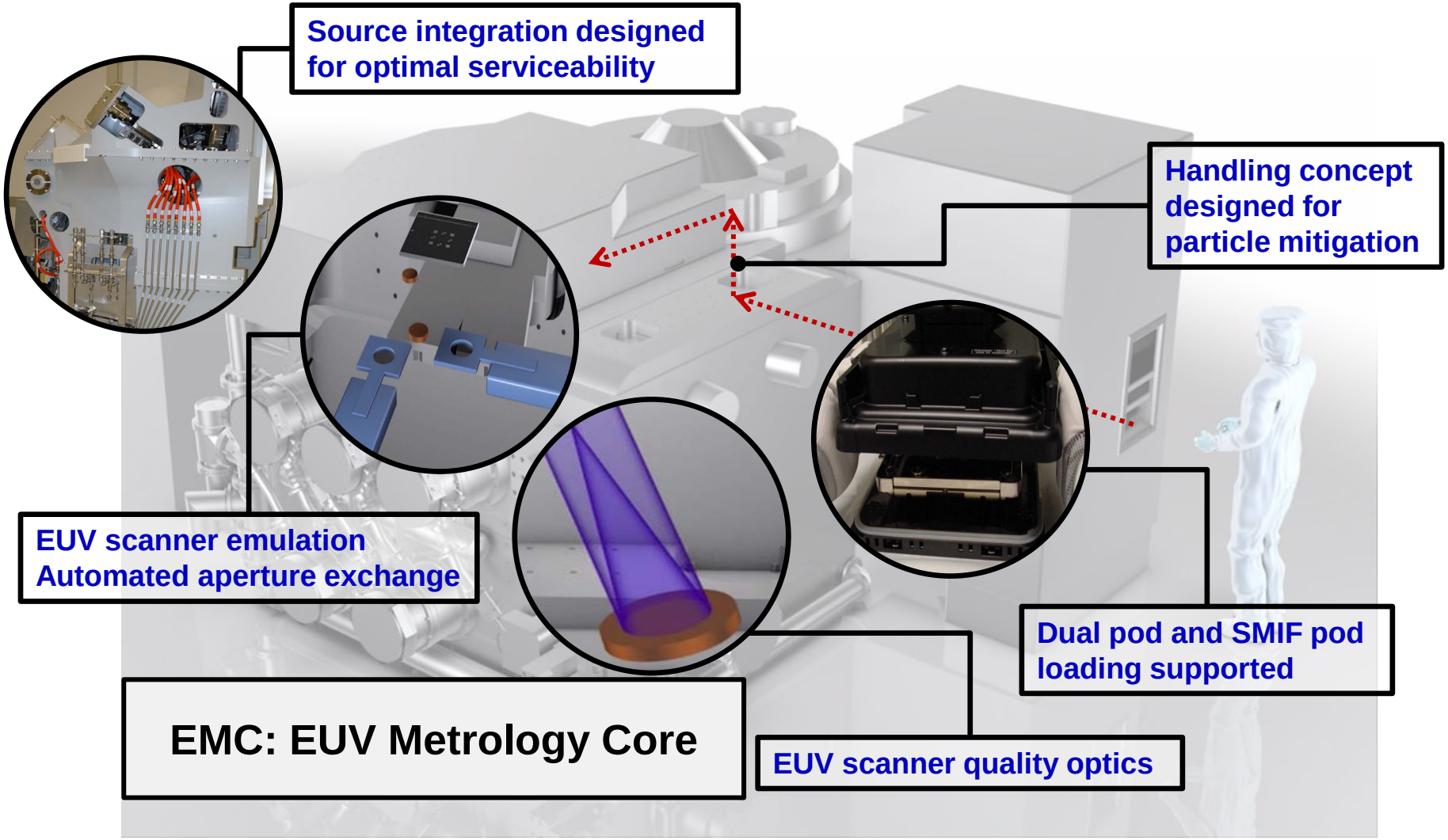
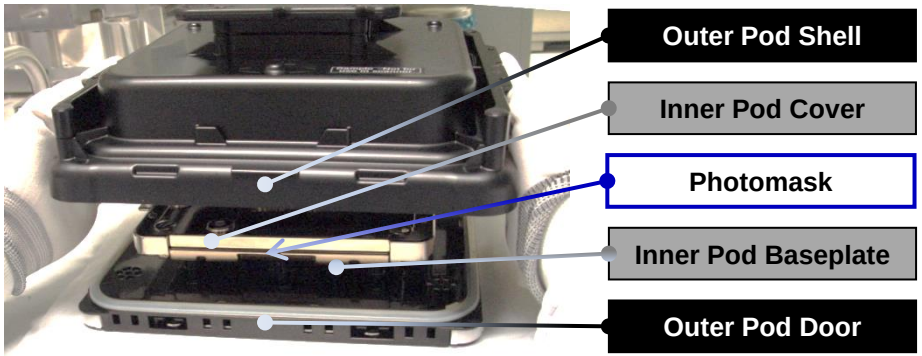
AIMS™ EUV Key Operational Features



Design of loading and handling concept driven by cleanliness and functionality

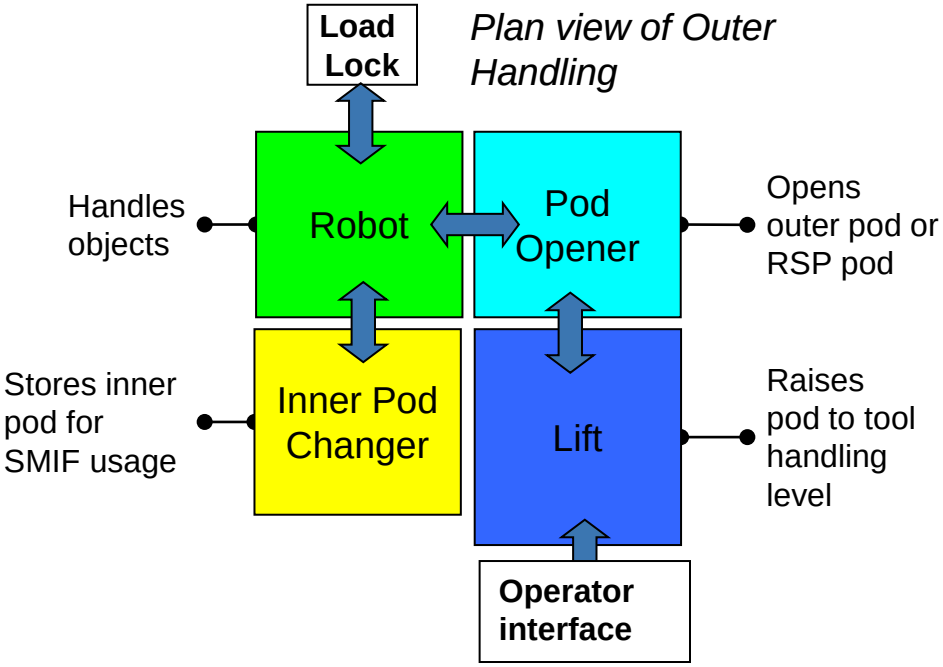
AIMS™ EUV accepts both SMIF Pod and Dual Pod loading

- Dual Pod → Outer pod removed, inner pod transferred to load lock
- SMIF Pod → Mask transferred to inner pod then to load lock



Considerations for the entire system design and handling concept

- Material and coating choices
- Mask handling path and method
- Compartmentalized functional units
- No moving parts above mask
- Moving parts outside environment when possible

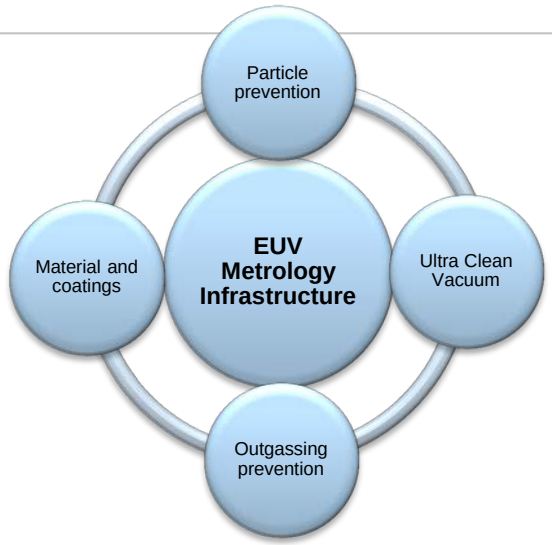


Establishment of a supplier base and processes to meet EUVL requirements

- AIMS™ EUV required the establishment of a working infrastructure for EUV metrology tools

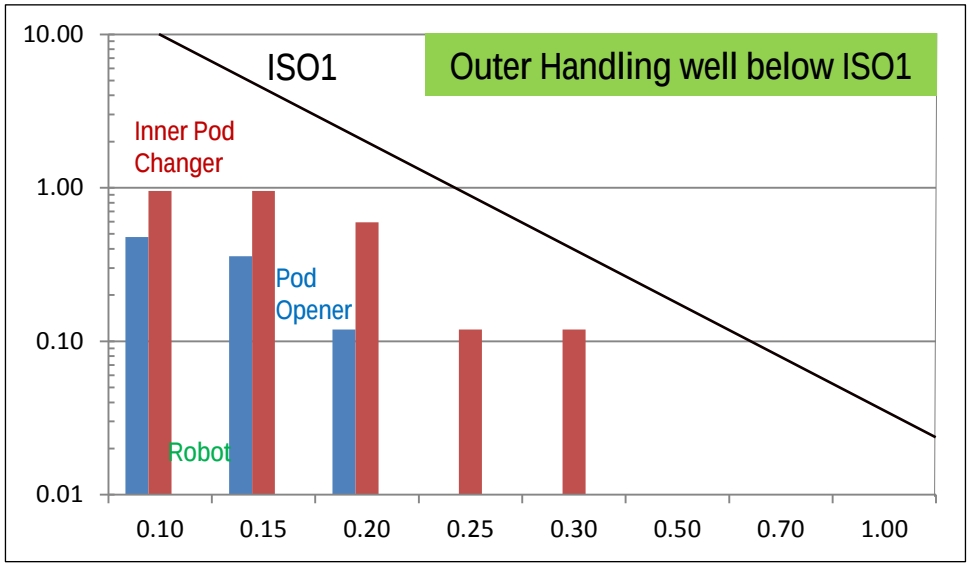
- Large supplier base capable of delivering according to ZEISS EUVL requirements
  - 134 component suppliers
  - 4,500 system components
  - 64,000 individual parts

- Comprehensive external and internal cleaning infrastructure for parts of all sizes
  - Including specialized internally developed equipment



Currently on track to achieving the AIMS™ EUV particle roadmap

Handling process flow:	Outer handling	Inner handling mask from inner pod	Inner handling mask to stage
Component pre-qualifications (before prototype assembly)	• ISO1 airborne particle qualification • Adder qualification	• Adder qualifications for major components	• Adder qualifications for major components
Prototype qualifications (after prototype assembly)	• Adder qualification	• Adder qualification for individual handling steps	• Initial adder qualifications for handling steps
Results	**Within budget**	**Within budget**	**Within budget**



In house metrology sensitivity down to 90nm particle size

Particle analysis capabilities for traceability

Next step is full cycle testing on the prototype after tool launch

AIMS™ EUV source currently fulfills performance and reliability specifications

For EUV actinic review brightness is the key metric, not overall source power

- With current source, sufficient brightness is achieved to reach specification

Source runs very reliably

- Over 100hrs stable operation in AIMS™ EUV prototype
- No unscheduled downtime

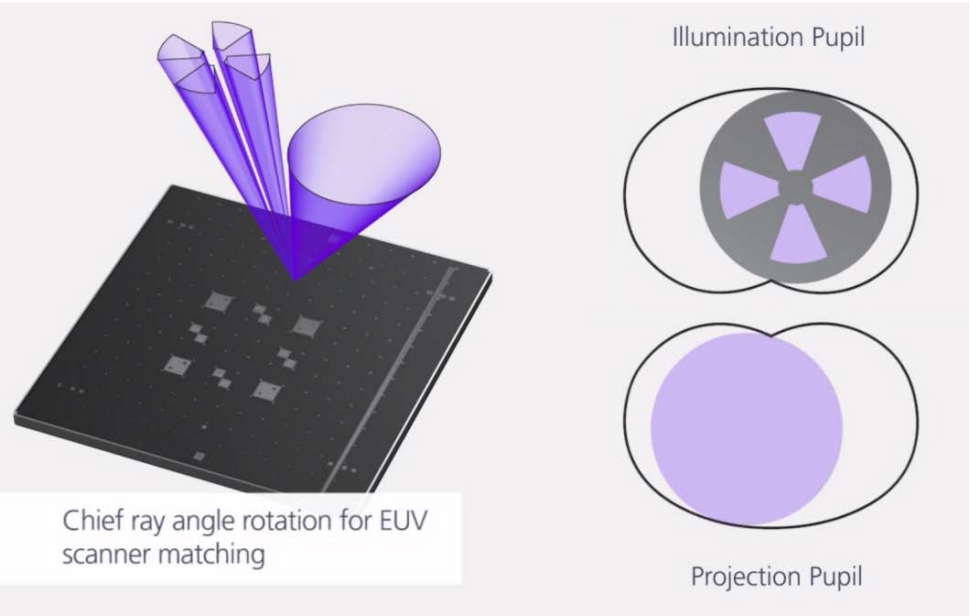
Designed to optimize serviceability and maintenance of source (cart, etc.)

AIMS™ EUV metrology source and service cart

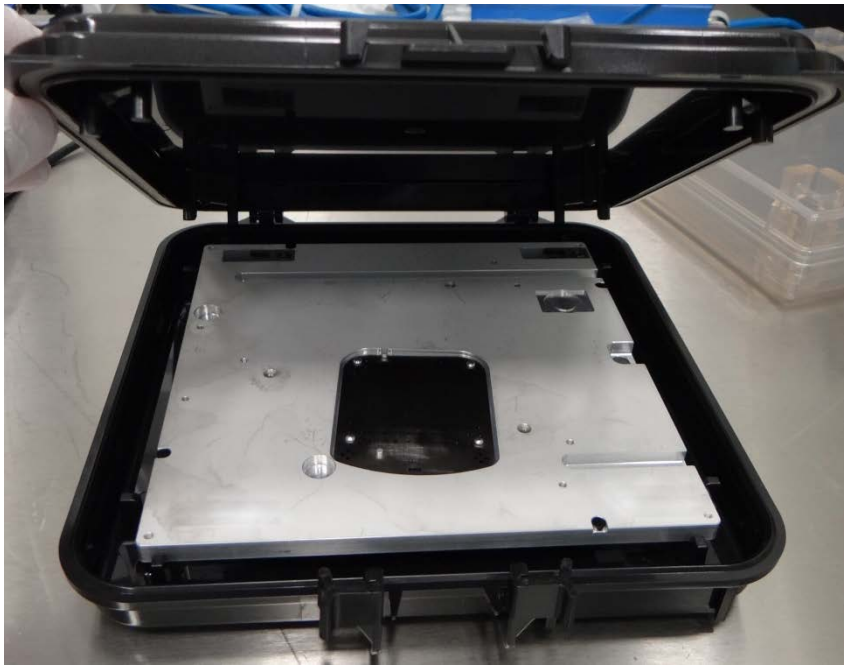
AIMS™ EUV fully emulates scanner and provides automated aperture exchange

AIMS™ EUV supports full EUV scanner emulation

- Illumination conditions (σ and NA)
- CRA including azimuthal angle component



Exchange of apertures is performed automatically with the mask handling system



Complexity of AIMS™ EUV optics are much higher than for previous AIMS™ generations

- AIMS™ EUV projection optics optical path length roughly 4x that of AIMS™ 32
- Project optics of AIMS™ EUV weighs about 130x that of AIMS™ 32
- Overall complexity for AIMS™ EUV projection optics is much higher
  - EUV scanner quality optics, vacuum and environmental requirements

AIMS™ EUV optics are EUV scanner level quality optics

- 3 optical columns finalized (prototype and first 2 commercial systems)
- Prototype and first commercial tool optics are integrated
- Mirror metrology data, intermediate measurements and wavefront prediction well within spec
- Final wavefront qualification will be performed inside completed AIMS™ EUV tool

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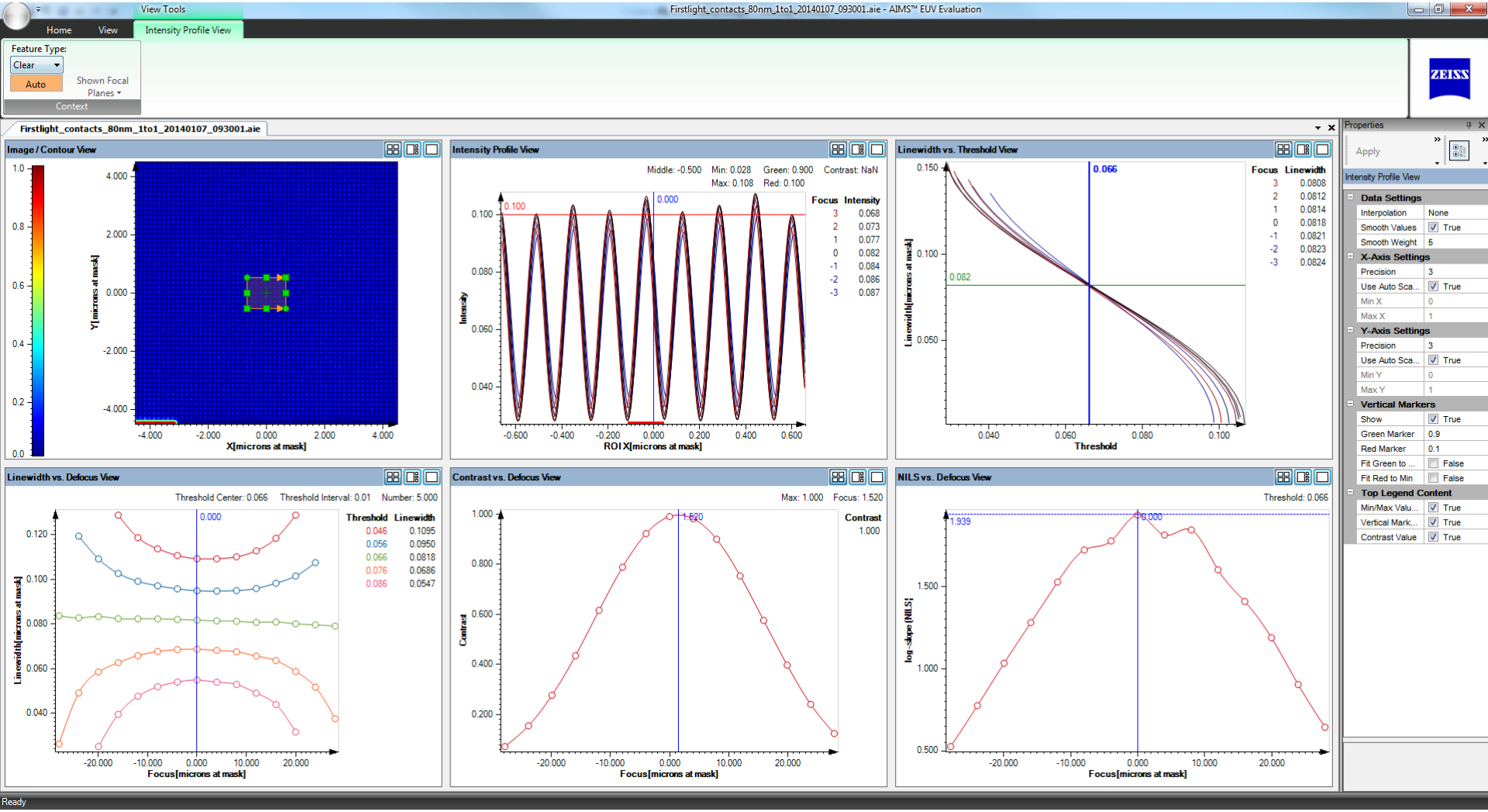
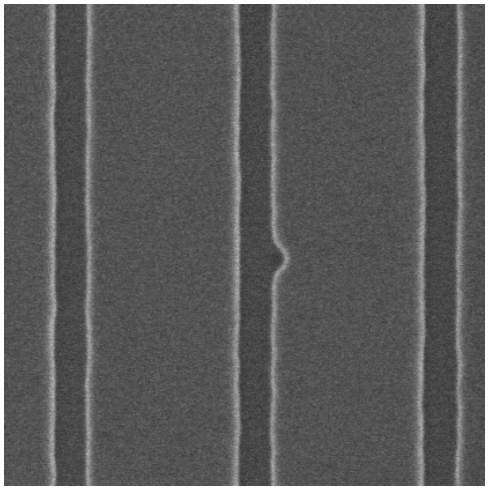
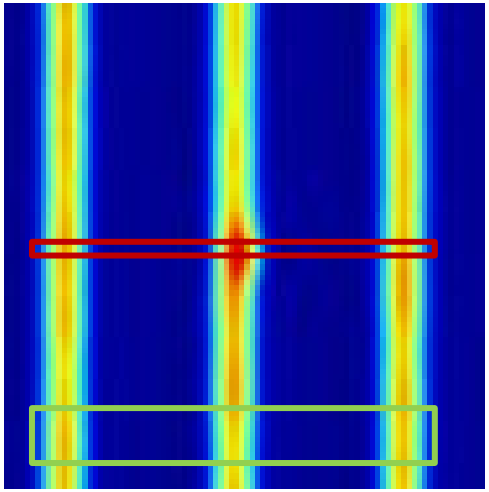
AIMS™ EUV Evaluation Application is under development

Currently being used to analyze data



64nm 1:5 pitch LS feature defect analysis



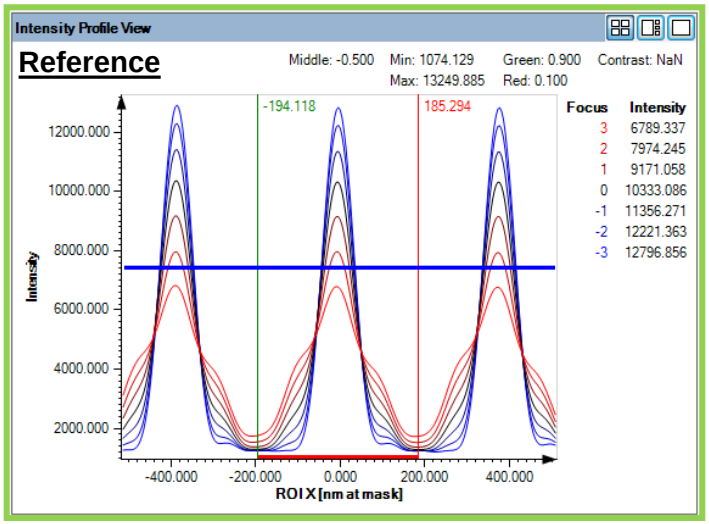


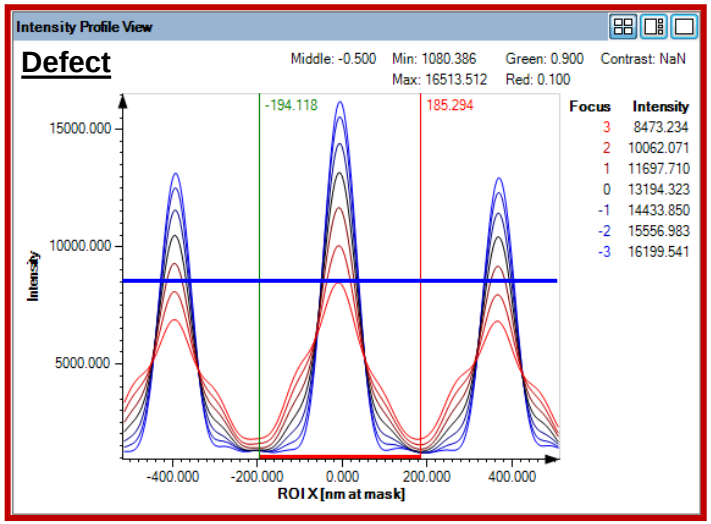
Defect analysis (best focus)

CD (design) = 64 nm

Nominal defect size = 35 nm

Aerial Image ΔCD = **24.1 nm**

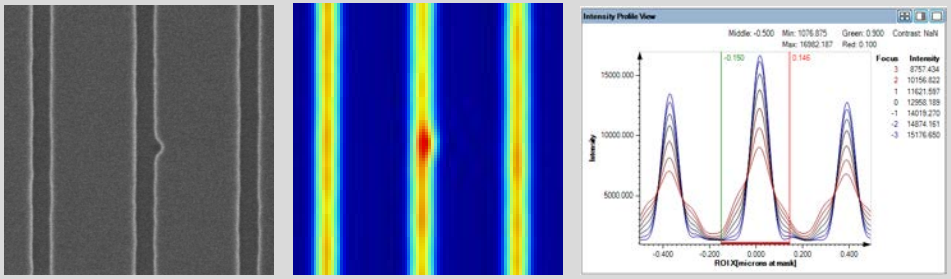




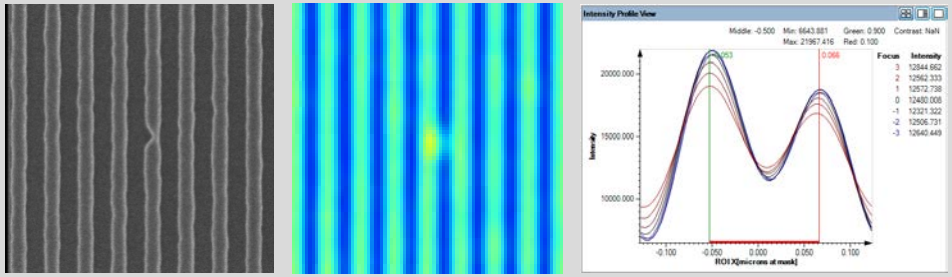
— Threshold

Examples of programmed defects analyzed and their relevance

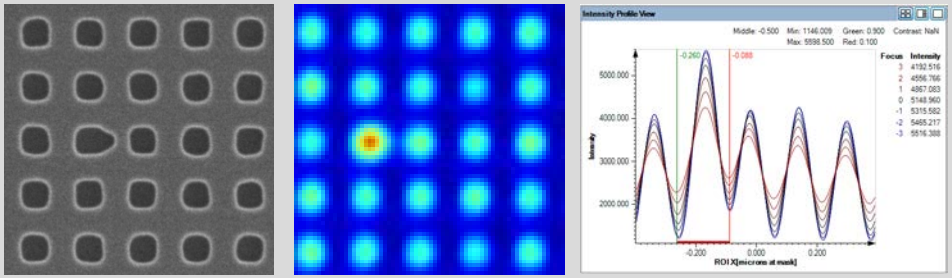
64nm 1:5 LS — Smallest printability deviation - **15.1nm**



64nm 1:1 LS — Smallest printability deviation - **12.7nm**



80nm CH — Smallest printability deviation - **29.3nm**



Industry Relevance

Node Name*	16	10	7
Logic HP*	40	32	25
DRAM HP*	28	24	20
Minimum Critical Defect**	**18-23**	**13-19**	**10-16**

*Based on ITRS Roadmap
**Depends on actual HP per technology node

Relevant defect sizes for the 16nm and 10nm nodes were already imaged at First Light!!

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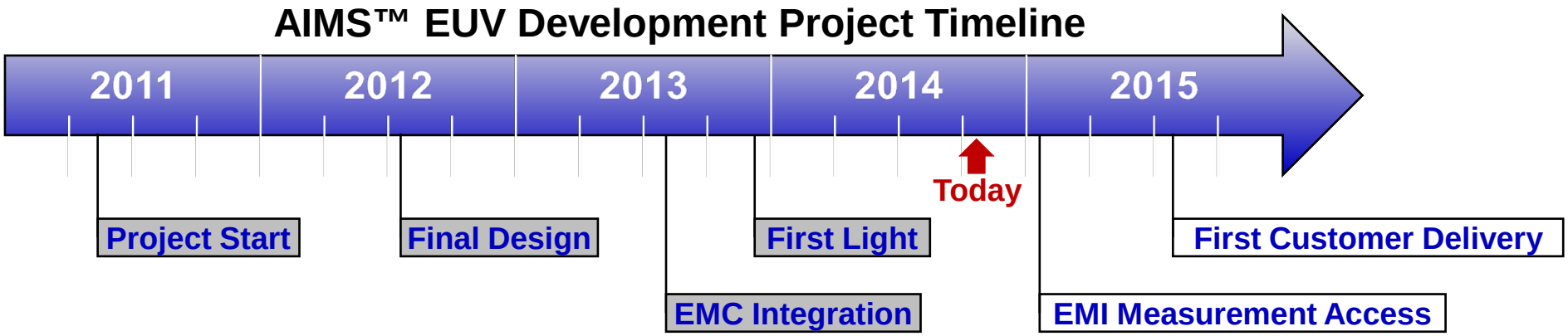
AIMS™ EUV Project Status and Timeline

Prototype hardware is integrated

Startup and launch is currently ongoing

Next major milestones:

- Second Light in the coming weeks
- EMI member measurements Q1 2015
- EMI member Prototype access Q2 2015
- First customer delivery Q3 2015



Acknowledgements

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