ASML

EUVL into production – Update on ASML's NXE platform

Judon Stoeldraijer, David Ockwell, Christian Wagner

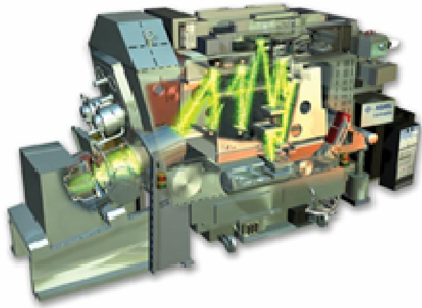
2009 EUVL Symposium, Prague

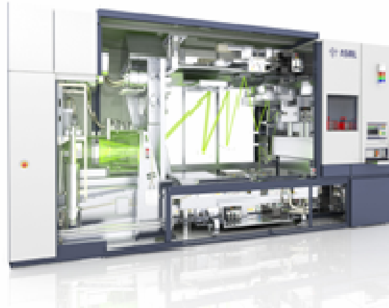
Outline

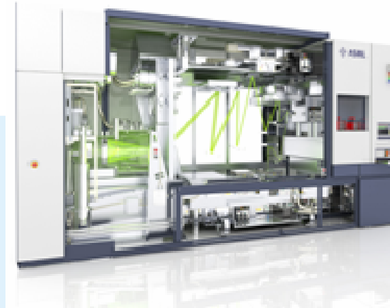
- Introduction
    - System roadmap
    - Platform layout
- Building the NXE:3100
    - NXE3100 main specifications & technology
    - Vacuum technology
    - Design & integration strategy
    - Status of main system modules
    - Preparation for volume production & shipment
- Outlook & summary

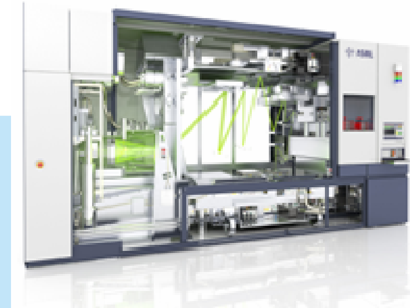
ASML

TWINSCAN EUV Product Roadmap









2006	2010	2012	2013
ADT	**NXE:3100**	**NXE:3300B**	**NXE:3300C**
Resolution = 32 nm	**Resolution = 27 nm**	**Resolution = 22 nm**	**Resolution = 18/16* nm**
NA = 0.25, σ = 0.5	NA = 0.25, σ = 0.8	NA = 0.32, σ = 0.2-0.9	NA = 0.32, OAI
Overlay < 7 nm	Overlay < 4.5 nm	Overlay < 3.5 nm	Overlay < 3 nm
Throughput 5 WPH	**Throughput 60 WPH**	**Throughput 125 WPH**	**Throughput 150 WPH**

Main improvements

1) New EUV platform :NXE
2) Improved low flare optics
3) New high σ illuminator
4) New high power LPP source
5) Dual stages

Main improvements

1) New high NA 6 mirror lens
2) New high efficiency illuminator
3) Off-Axis illumination option
4) Source power increase
5) Reduced footprint

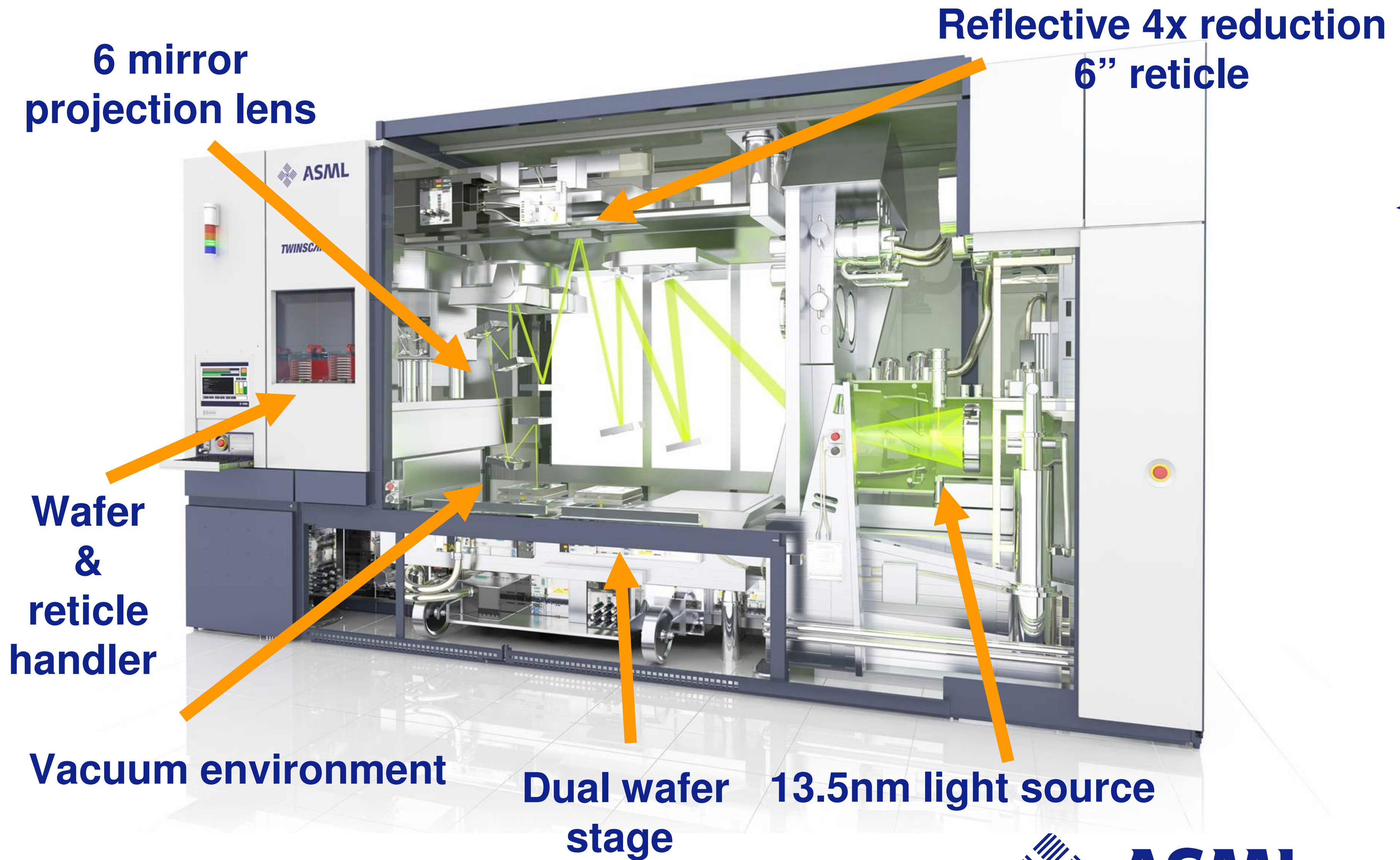
Platform enhancements

1) Source power increase

***** Requires <7nm resist diffusion length***

ASML

NXE lithography platform system layout



ASML

Outline

- Introduction
    - System roadmap
    - Platform layout
- Building the NXE:3100
    - NXE3100 main specifications & technology
    - Vacuum technology
    - Design & integration strategy
    - Status of main system modules
    - Preparation for volume production & shipment
- Outlook & summary

NXE:3100 main specifications

- NA=0.25
- Sigma=0.8
- Resolution 27nm
- SMO=4.5nm
- MMO=7.0nm

- TPT=60wph (10mJ/cm^2 resist)
- 1st generation of NXE platform

ASML

NXE platform leverages on its predecessors

Module	Learning from
Optics	Based on ADT Optics, improved wave front and flare, higher sigma in illuminator (0.5 to 0.8)
Metrology (TIS, ILIAS)	Proven XT principle adapted to vacuum
Reticle Stage	Building on Alpha and advanced TWINSCAN; E-clamp from Alpha; new REMA (X and Y)
Reticle Handler	Fully automated using in-vacuum robot and internal library with 6 slots
Wafer Stage	Dual planar stage + balance mass; E-clamp
Alignment/Level sensor	Vacuum compatible Smash & XT level sensor
Wafer Handler	New vacuum robot, load-lock and pre-aligner, NXT robot for atmospheric part
Vacuum System	Based on ADT layout, factory way of working adapted to material specification and handling

ASML

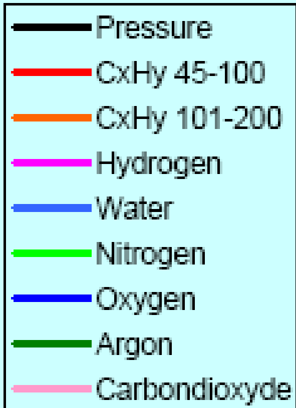
Achieving an Ultra Clean Vacuum (UCV) by right material selection, equipment invests & procedures

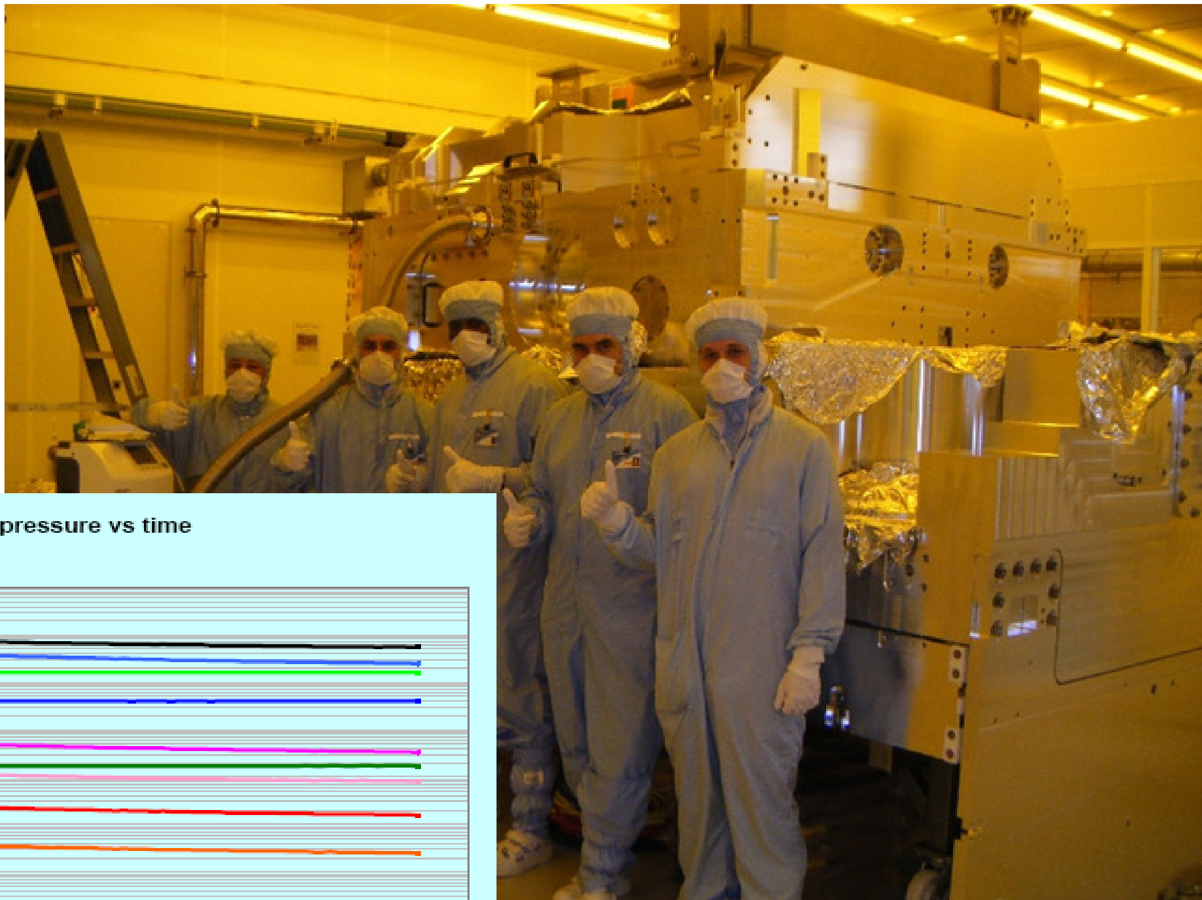
- Outgassing budget for all modules
- Every material is being tested
- Investments made in the right equipment to enable clean production and qualification
- Cleaning of all materials and modules is integrated as a part of Supply Chain and internal assembly
- Procedures and training for handling and manufacturing, in-house and at suppliers

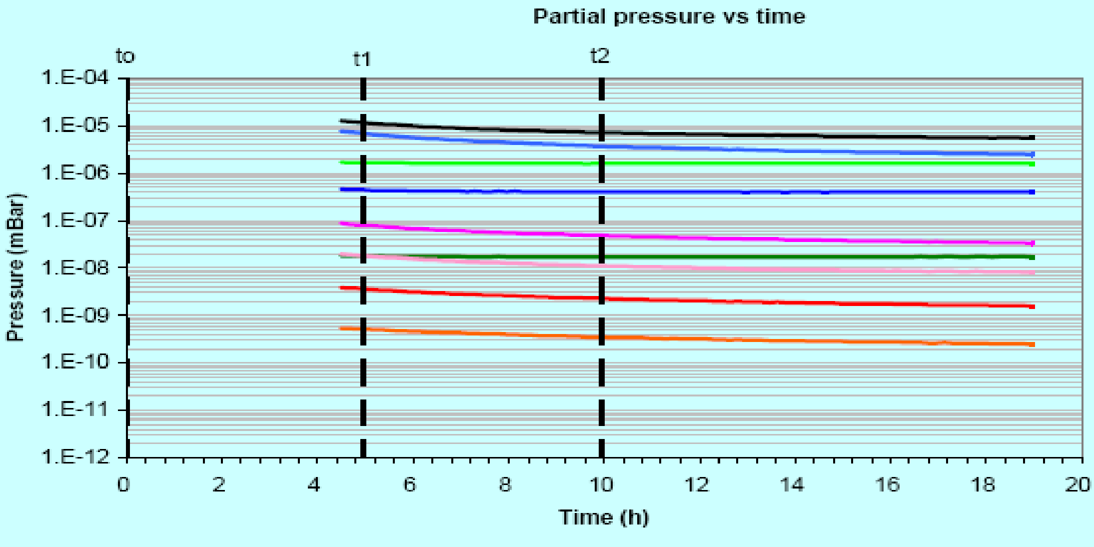
High vacuum test chamber + mass spec for qualification

ASML

Vacuum Vessels
Outgassing requirements reached in practice







Building the NXE:3100

TOP

Reticle flow → Scanning reticle

BOTTOM

Wafer flow → Measure wafer

MID/SOURCE

Dose at reticle level → Correct light wafer level

→ Full functional machine → Reliability, TPUT, System dynamics, Imaging, Overlay

Expose Tool

H2/2009=now

H1 2010

ASML

Proto source is Installed and Operational at ASML

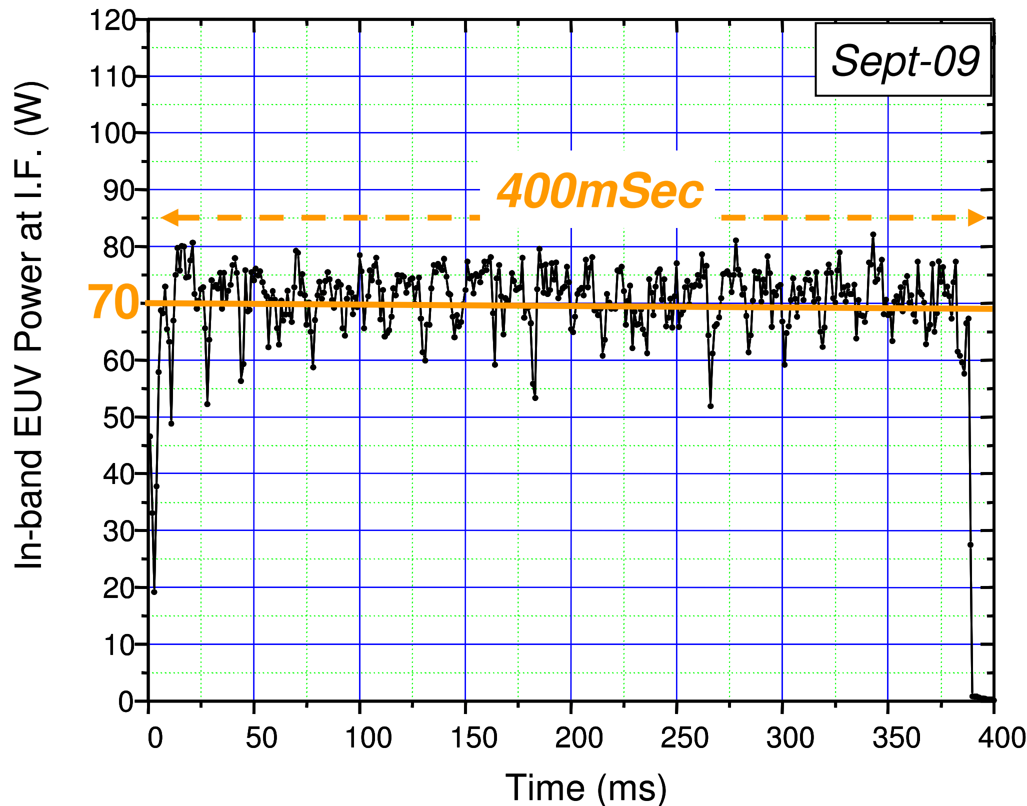
- Source integrated in exposure
- tool frame & operational

- Droplet generation (30μm diameter) and laser targeting confirmed
- Control system is operational

CO_2 Laser amplifiers in subfab

- Next steps:
  - Integrate scanner source control
  - Dose control using ASML sensors
  - Integrate in situ plasma positioning control

Excellent EUV Source Progress: 70W EUV Power at required system operation conditions



2H-08

- Demonstration of source feasibility
- Burst length = 1mSec
- Power = 20W

Sept-09

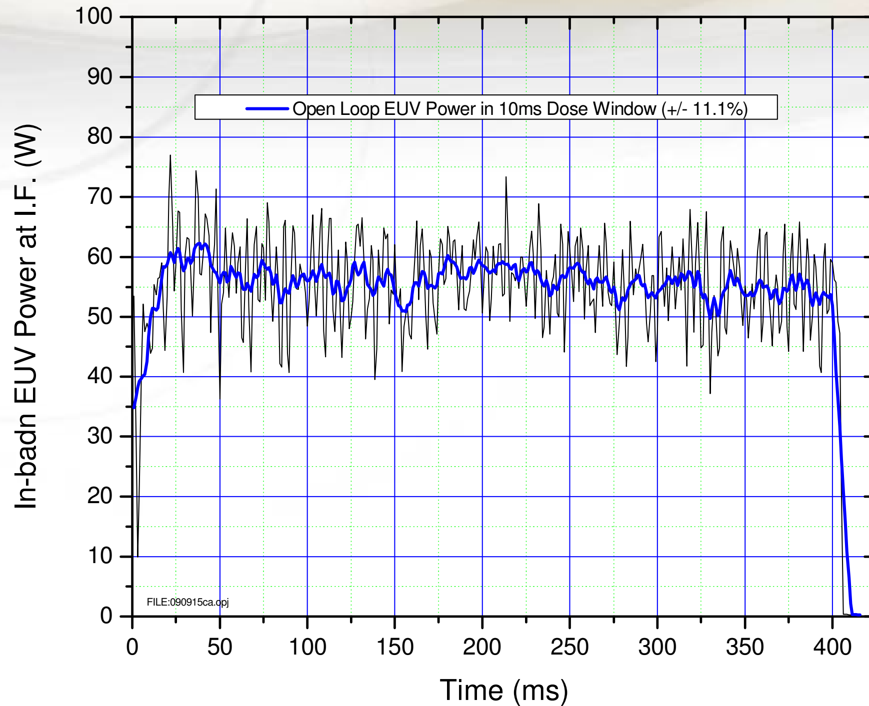
- Full size collector implemented
- Dose control implemented
- 30mu droplets
- Debris mitigation operational
- Burst Length = 400mSec (full exp. field)
- Power = 70W (>3x improvement)

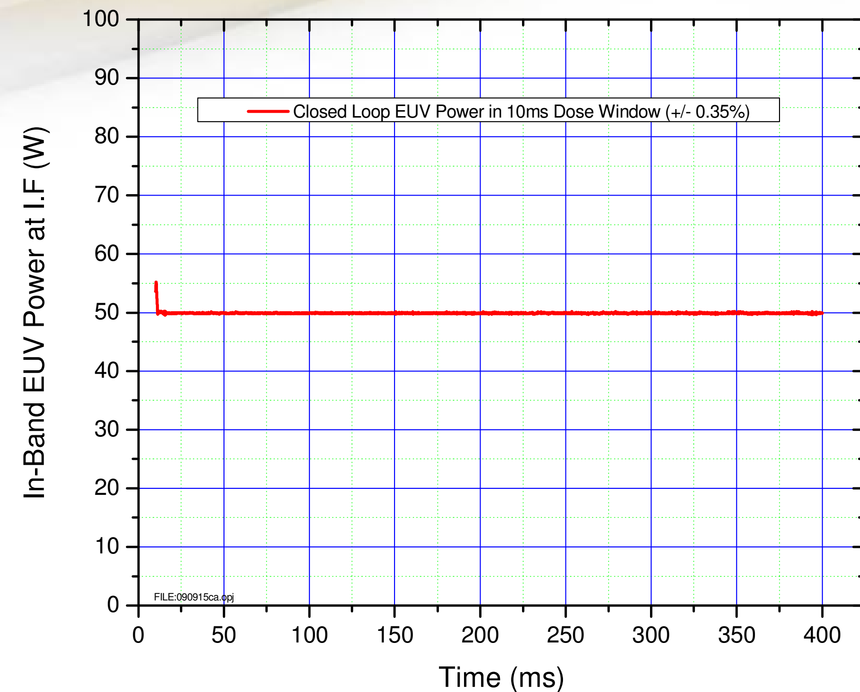
~2x power increase required for 60 WPH

Source: Cymer, LT1 setup data

ASML

Dose Stability of ±0.35% demonstrated by applying Closed Loop Control



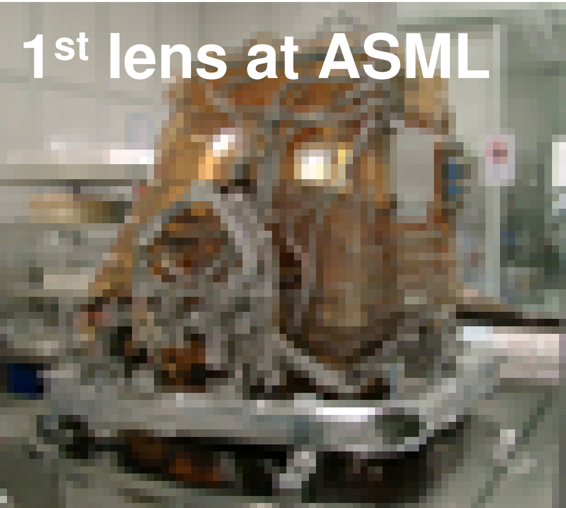


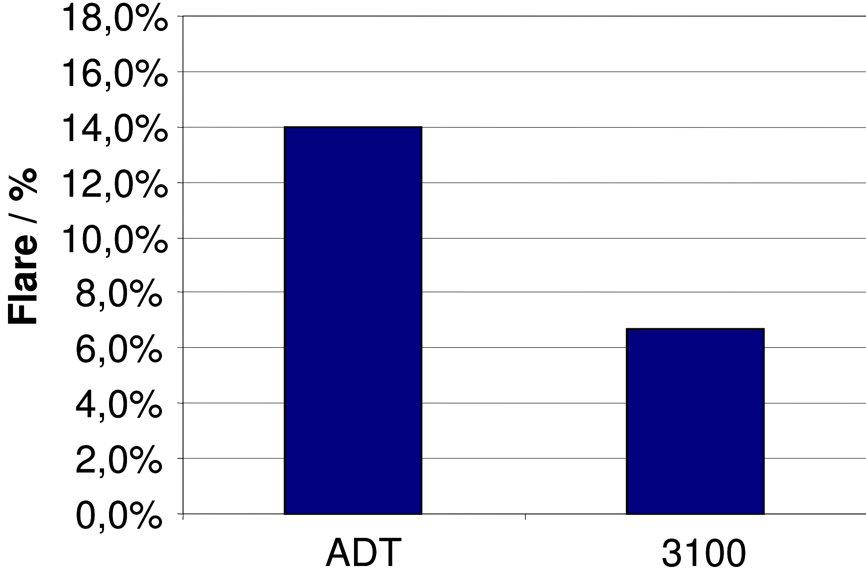
- Open loop dose performance is +/-11% (10ms window)

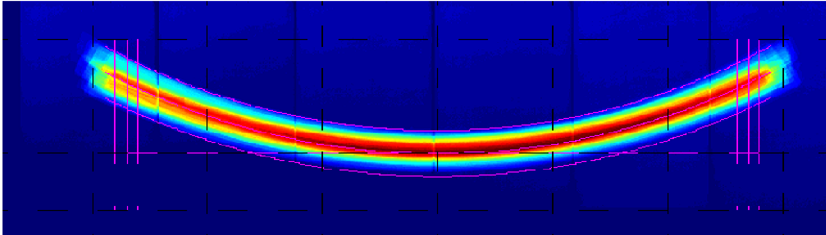
- **Closed loop dose performance is +/-0.35%.**
- EUV power level set point for closed loop control was 50W

Public © 2009 Cymer, Inc.

Optics: NXE:3100 Flare <7%, good uniformity







NXE:3100 has 30% more transmission then ADT

Relative Transmission

1,60
1,40
1,20
1,00
0,80
0,60
0,40

ADT
NXE:3100

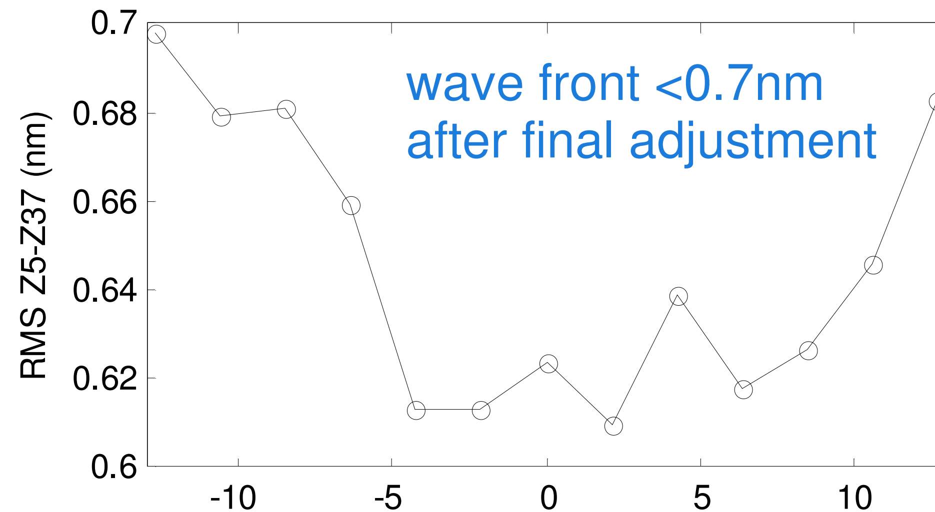
Reflectance

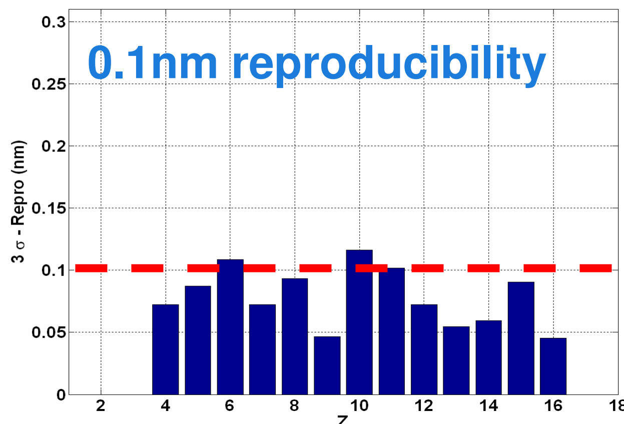
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%

12.75 13 13.25 13.5 13.75 14 14.25

Wavelength (nm)

Lens quality measured with EUVL interferometer





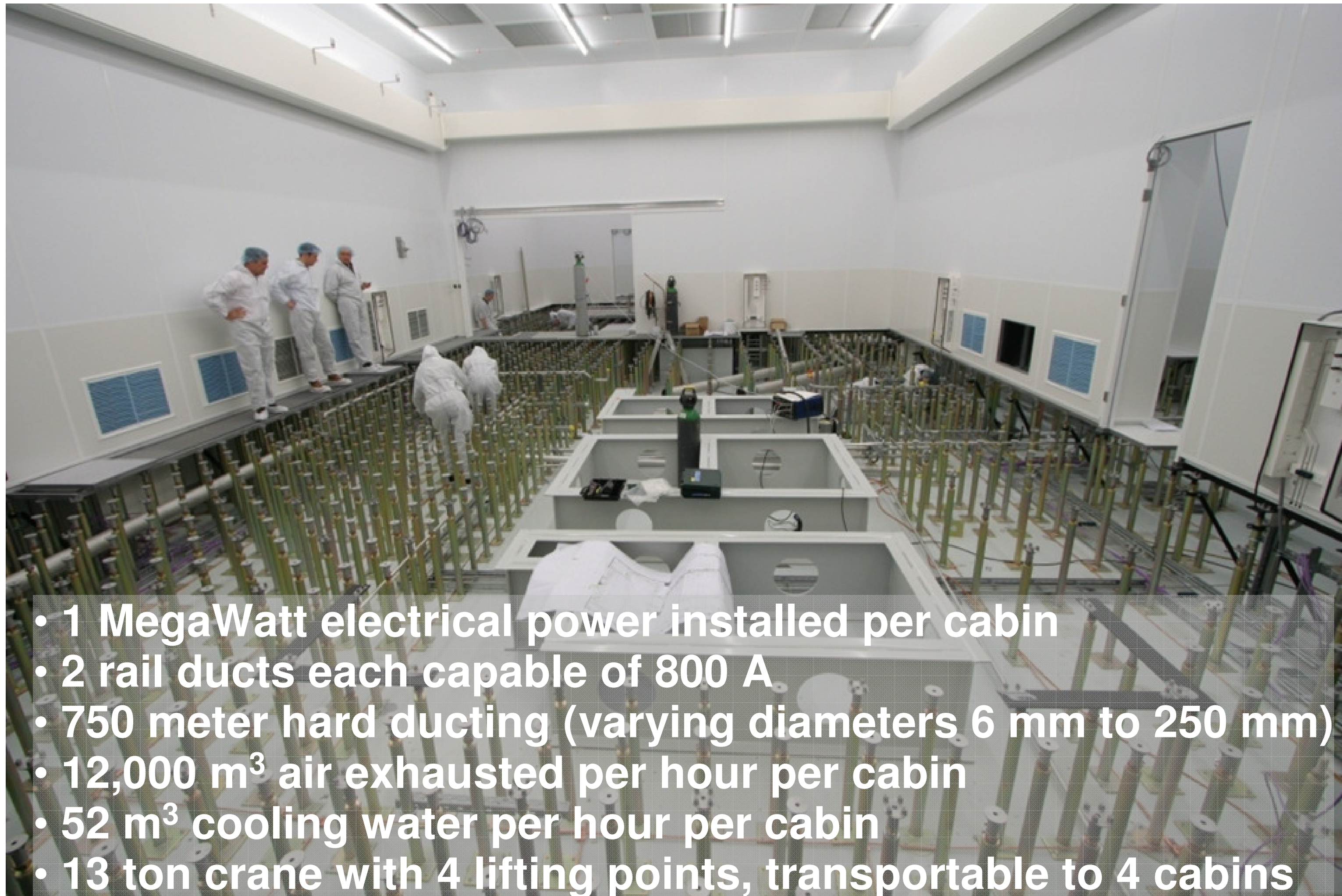
- 13.5nm interferometer used to qualify lenses
- 0.1nm reproducibility
- 0.7nm wavefront rms

Shipment container tests completed (B747)

- Loading & fit test in B747 was successful, MOU signed by KLM/AF

ASML

ASML EUVL manufacturing area operational
Photo during Install of raised floor in EUV Cabin



ASML

Outline

- Introduction
  - System roadmap
  - Platform layout
- Building the NXE:3100
  - NXE3100 main specifications & technology
  - Vacuum technology
  - Design & integration strategy
  - Status of main system modules
  - Preparation for volume production & shipment
- Outlook & summary

ASML

Outlook NXE:3300 main specifications

- 1st shipment: 1Q 2012
- NA = 0.32
- Sigma = 0.9, conventional
- Resolution 22 nm hp
-     (18 nm with optional off-axis)
- SMO = 3.5 nm
- MMO = 5.0 nm
- TPT = 125 wph (15 mJ/cm^2 resist)

- 2nd generation of NXE platform

ASML

Summary

- NXE platform design in place
- Optics and source delivered to ASML and integrated
- Modules like wafer-/reticle stage, reticle-/wafer handler, reticle masking, alignment-/level sensors build and functionally integrated
- System top/mid/bottom build and integration ongoing
- NXE:3100 system in build phase
- 1st shipment NXE3100 mid 2010
- Second generation with high NA optics planned for 1st half 2012

ASML

Acknowledgements

- The work presented has been the result of a hard work by teams at ASML and many technology partners worldwide over many years with a common goal to make EUV lithography happen.

- Grateful acknowledgement is expressed to the Public Authorities of The Netherlands, Germany and France for their outstanding support of the **EAGLE**- **E**UV **A**dvanced **G**eneration **L**ithography in Europe - project, as well as the MEDEA+ organization.

EUREKA

MEDEA+ Σ!2365 is the industry-driven pan-European program for advanced co-operative R&D in microelectronics to ensure Europe's technological and industrial competitiveness in this sector on a worldwide basis

ASML