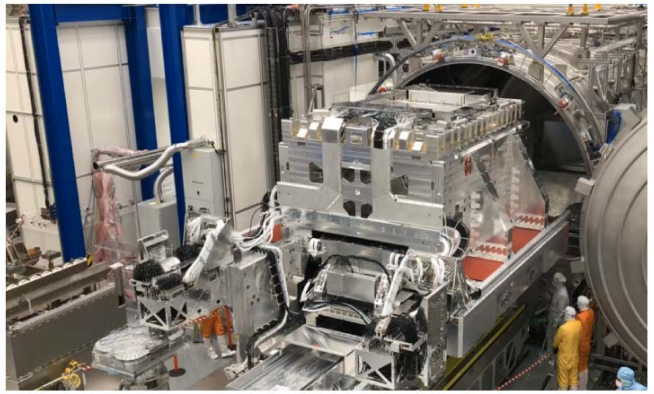
Achievements of the
Important Project of Common European Interest on Microelectronics

Technology Field 4: Advanced Optical Equipment

ZEISS

ADVANCED MASK TECHNOLOGY CENTER



Technology Field 4 - Advanced Optical Equipment

Project Overview & Background

- TF4 part of „Moore Moore“ domain of semiconductor industry
- Emphasis on developing the „Equipment & Material“ sector for future advanced IC technologies
- Key IC manufacturing technology for the next 2 decades
- Field of activity
  - EUV optics systems
  - EUV masks
  - Advanced Methods for Chip Manufacturing Enhancement
- Strengthen the leading position of Europe‘s semiconductor equipment supplier industry

- Jan 2017 – Dec 2020
- Balanced R&D and FID
- Significant measured spillover
- National Funding

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Objectives

- Provide the basis for manufacturing of advanced optics systems to enable the steady miniaturization of electronic devices in the next decade by
  - defining appropriate technical solutions (optics design) and technological processes for optics manufacturing
  - developing equipment and instruments for optics manufacturing
  - providing the infrastructure, e.g. production buildings, cleanrooms, facilities etc.
  - development of integration processes for advanced optics systems
  - starting with EUV optics manufacturing targeting 1st system supply yearly this decade
- Develop EUV masks and appropriate technical and the environmental infrastructure for sub-10nm EUV lithography
- Develop Advanced Methods for Chip Manufacturing Enhancement focusing on logic IC technologies

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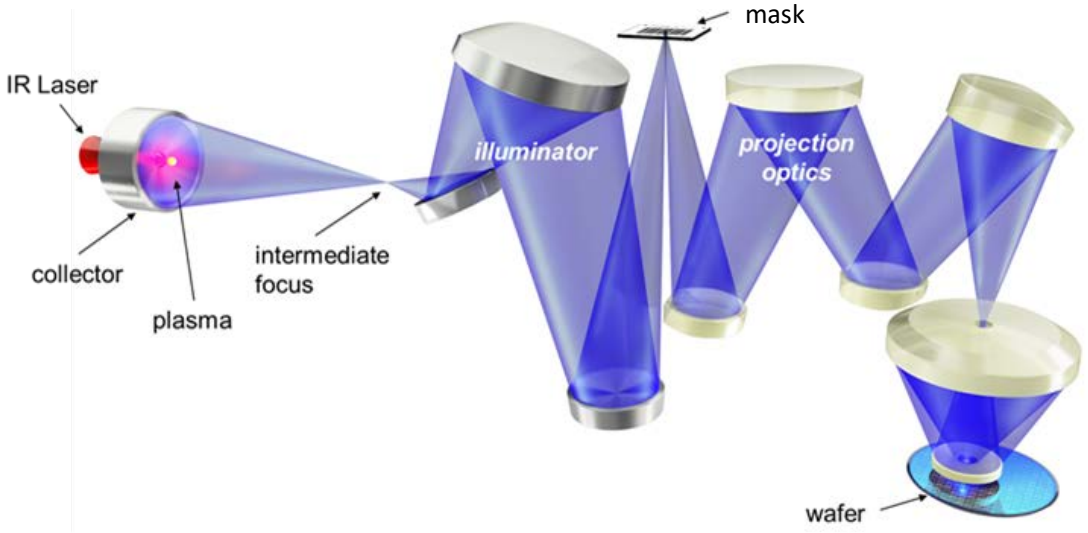
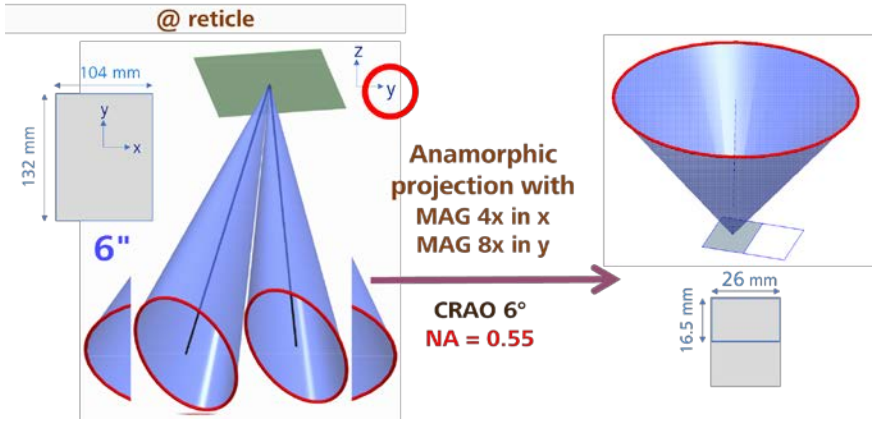
Achievements – Overview Results

- Design concept EUV optics worked out
- Integration technology concept for EUV optics systems developed
- Equipment and instruments development for optics manufacturing, installation and integration almost finalized
- Process development for the optics manufacturing equipment progressing
- New optics manufacturing buildings, cleanrooms and its facilities made available
- Fabrication of key optics components and modules has started
- Development of Advanced Methods for Chip Manufacturing Enhancement & evaluation in logic fab

Achievements – Development & FID Results (I)





Optics Design 0.55NA POB accomplished

- A highly innovative anamorphic Design Concept for EUV optics system has been developed
- Magnification different in both mask orientations at 0.55NA, λ = 13.5nm
- Resolution limit ~8nm
- Important milestone was achieved with successfully completing the design

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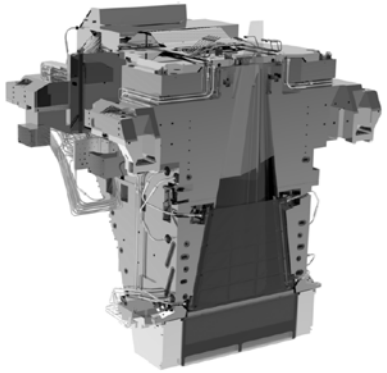
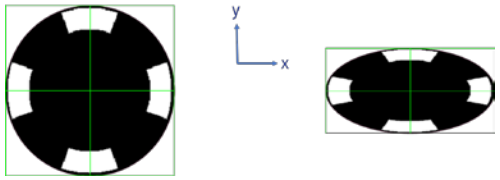
Achievements – Development & FID results (II)

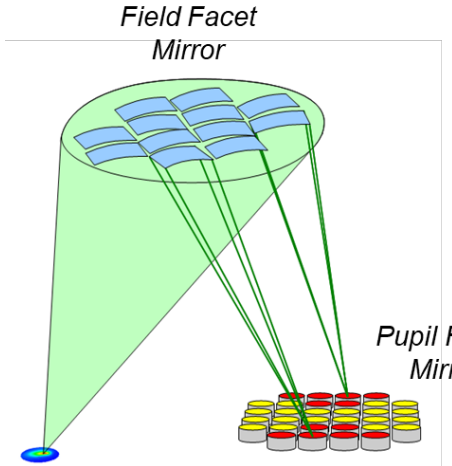


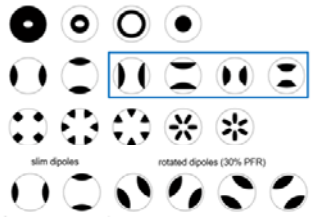
Illumination Pupil
at c-quad illumination setting



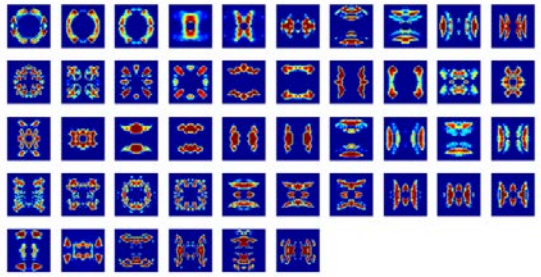
isomorphic
MAG 4x, FF

anamorphic
MAG 4x/8x, HF





Illumination settings



Optics Design Illumination System accomplished

- Optics design ready
- Adaption to anamorphic approach finalized
- Required illumination settings for IC manufacturing can be made available

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Achievements – Development & FID results (III)

mirror grinding

CCP

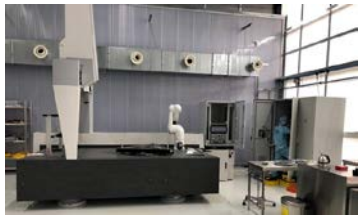
IBF

optics cleaning

Integration

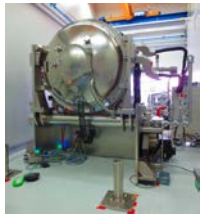
mirror coating

positioning

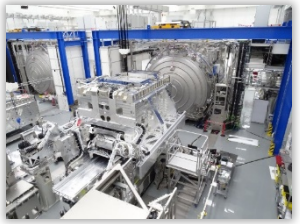


assembly

fine tuning



metrology



Manufacturing Equipment for 0.55NA POB available

- Development of a multitude of equipment and instruments for optics components and sub-systems finalized
- Numerous new tools w/ significant tighter specifications developed
- Installation & site acceptance done
- POB mirrors manufacturing has started

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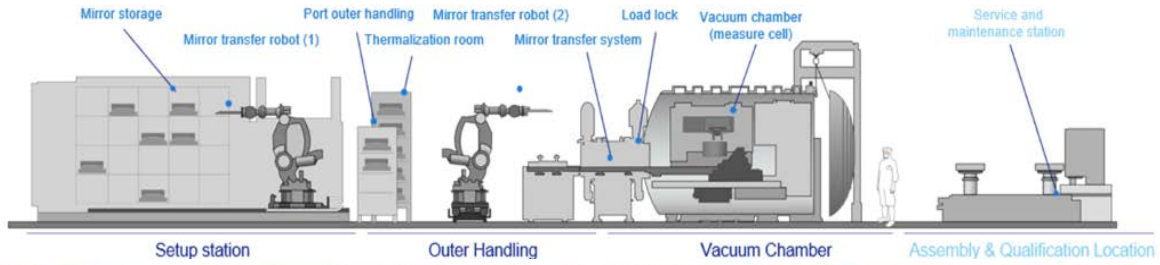
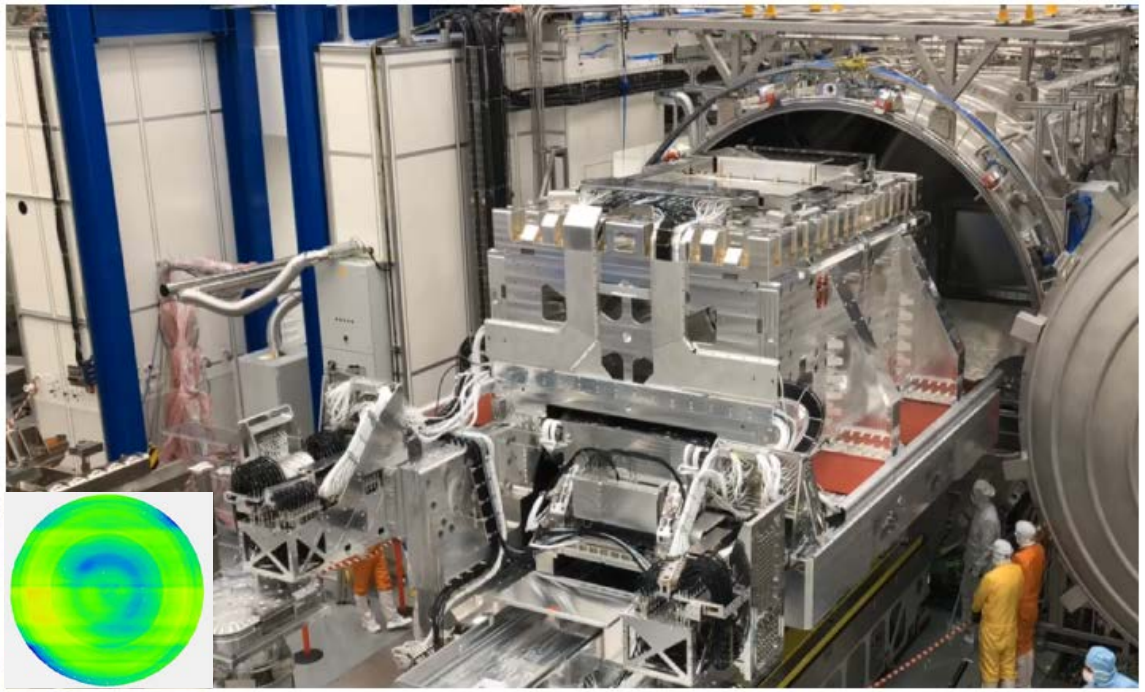
Achievements – Development & FID results (IV) - HIGHLIGHT





Mirror Surface Metrology Equipment

- Novel measurement system for mirror surface shapes has been developed from scratch
- Vacuum environment, tight thermal control, fully automatic handling and measurement, mirror/DOE storage systems
- Mirrors w/ strong aspheres
- Unprecedented measurement precision target
- Installation/site acceptance/initial operation done
- First sharp mirrors have been successfully measured
- World's most precise optics metrology tool ever

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Achievements – Development & FID results (V)

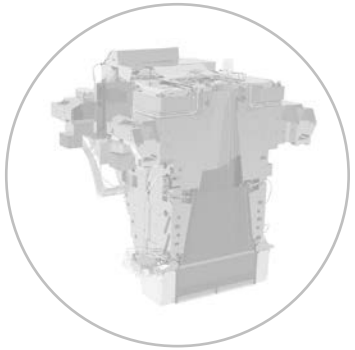
drilling

shaping

polishing

measuring 1

measuring 4



separating

coating

inserting

sorting

measuring 3

cleaning

measuring 2

Illumination system

- Multitude of equipment and instruments for optics components and sub-systems developed and manufactured
- Numerous new tools w/ significant tighter specifications developed
- Installation & site acceptance done
- Mirrors & frames manufacturing has started

- Close cooperation with European partners for equipment and material development

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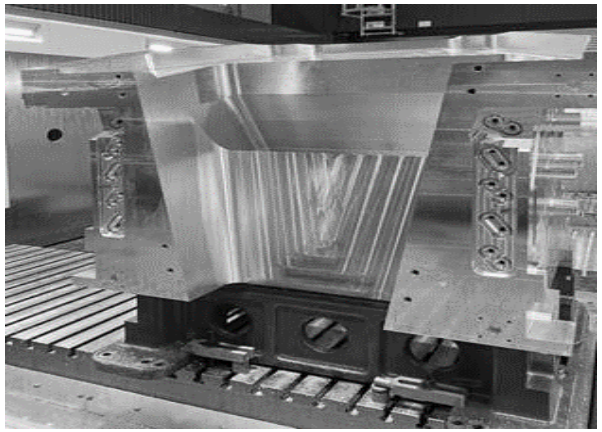
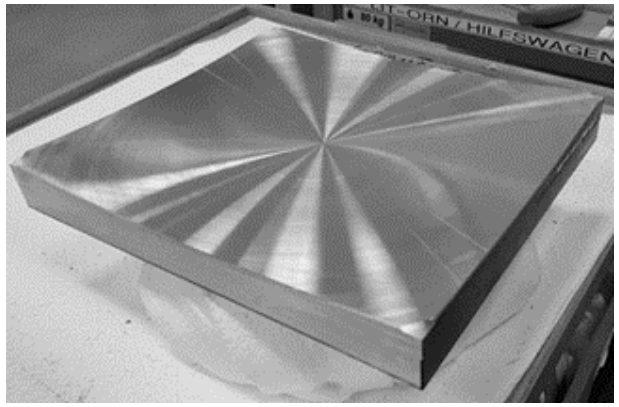
Achievements – Development & FID results (VI)

Largest mirror POB

POB frames

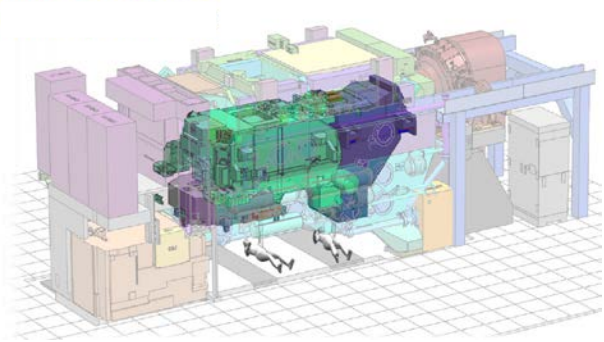


Mirror mother sphere



Multitude of optics components / mirrors / modules have been prepared

- Manufacturing of POB mirrors has started; full swing for planned pilot systems
- Manufacturing of illumination system mirrors and components ongoing
- Optics system frames in preparation
- Preparation of integration systems for POB and illumination system has started



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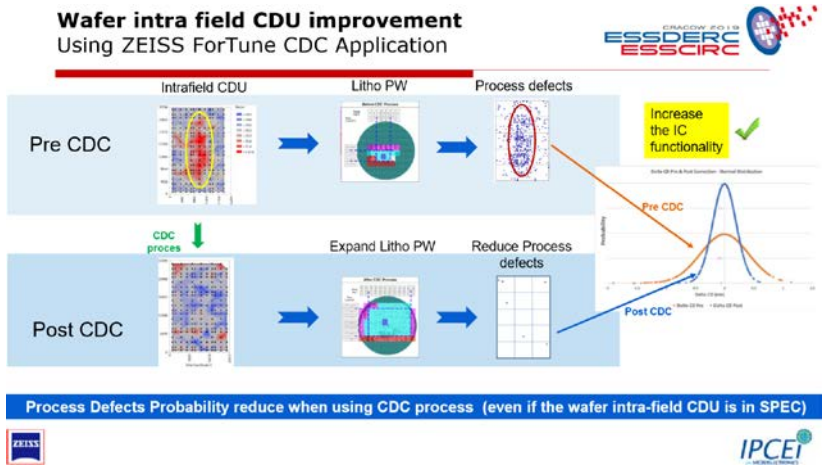
Achievements – Development & FID results (VII)

- All planned FID & manufacturing buildings completed
- Manufacturing area has been more than doubled
- Number of offices enlarged by factor 1.5
- Number of employees was increased from 2600 to 3800 at campus

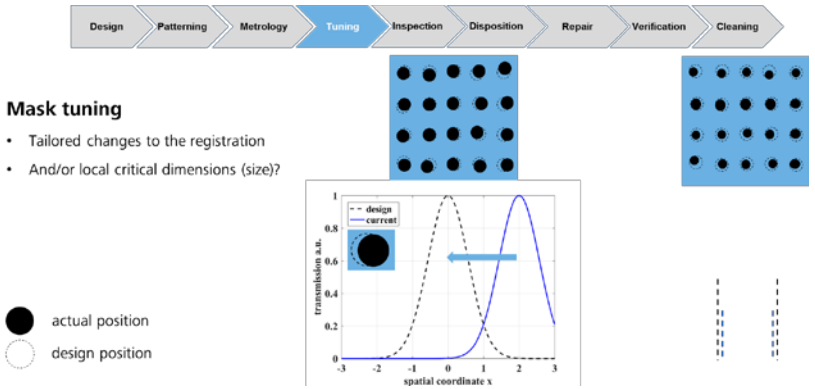
Making this infrastructure available is an essential requirements for a successful completion of the project task:
a **EUV projection system with sub-10nm resolution** for IC manufacturing

Achievements – Development & FID results (VIII)

Progress on Advanced Methods for Chip Manufacturing Enhancement



- Improved CD control on logic IC demonstrated
- Mask tuning at AMTC
- Wafer tests at GlobalFoundries



- Improved registration / Overlay control demonstrated

- Equipment for both AMCME techniques developed

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Achievements – Overall summary

- Tremendous progress in achieving the technical objectives
- Enormous progress in realizing the manufacturing infrastructure for both, manufacturing equipment and buildings
- More than half a billion of Euros invested
- Significant strengthening of European cooperation and network
- Strong increase in employment initiated by the IPCEI project, not only at Zeiss
- Great success of the IPCEI project already until now

Thank you for your attention !

You can ask questions during the planned Q&A session on Nov 25-26 from 10-12am and 2-4p.m..