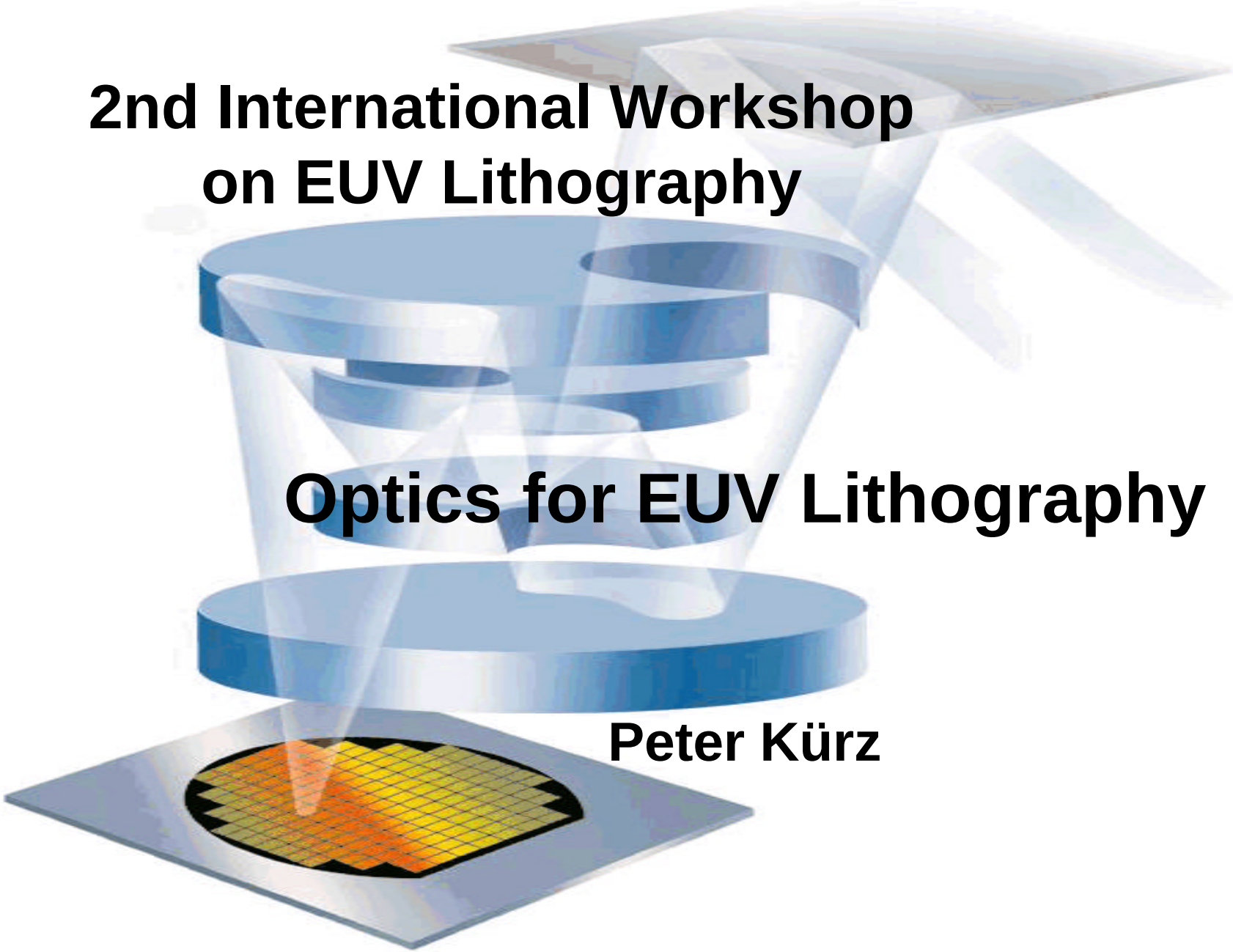
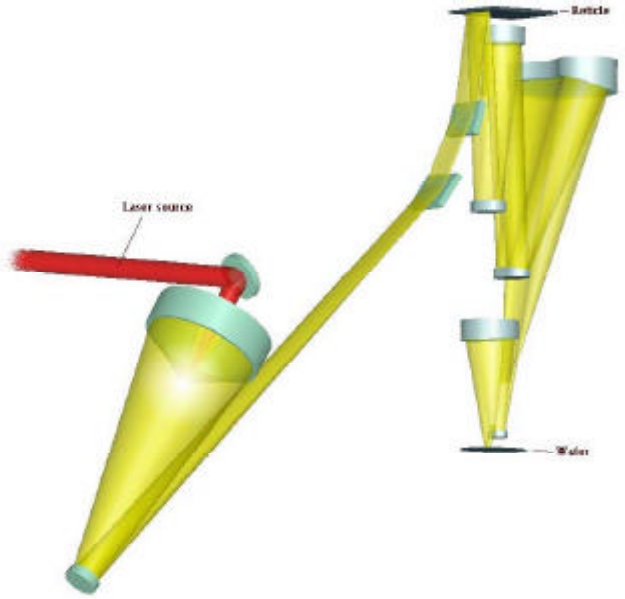
2nd International Workshop on EUV Lithography

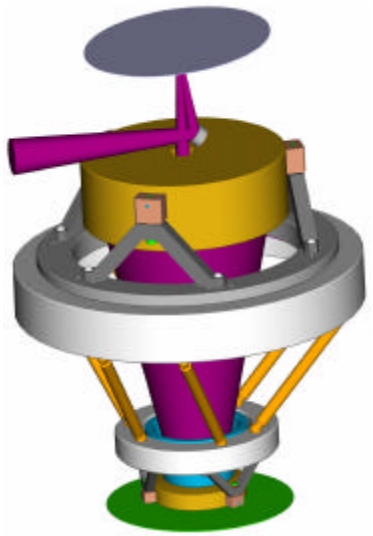


Optics for EUV Lithography

Peter Kürz

Zeiss is working on two imaging systems





a-tool

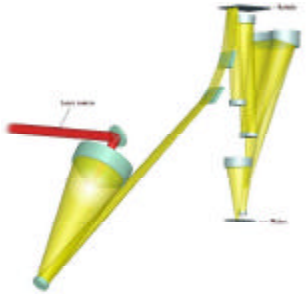
to be integrated into ASML scanner

Micro Exposure Tool

collaboration with
Lawrence Livermore National Labs

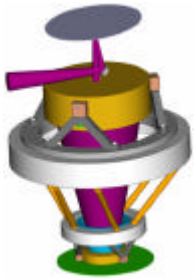
Overview

1) Optical Design
   - Illuminator
   - Projection Optics Box



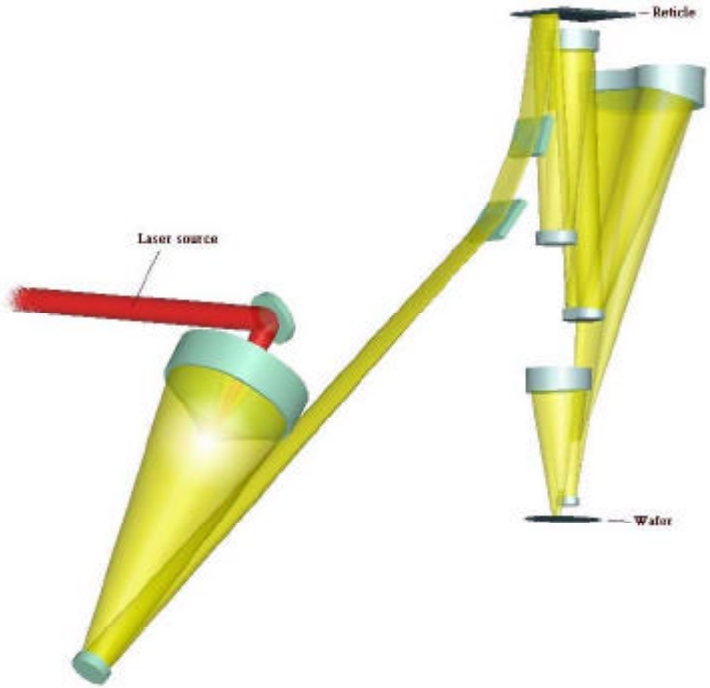
2) Optics Metrology

   Optics Fabrication



3) Conclusion

EUV a-tool: Specs + Design



a-tool

NA = 0.25, resolution = 50 nm

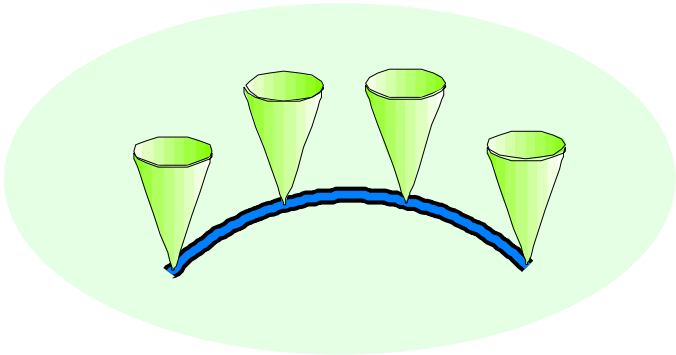
source: LPP or discharge source

illuminator:
- 2 normal incidence mirrors
- 2 grazing incidence mirrors
- special component (integrator) required

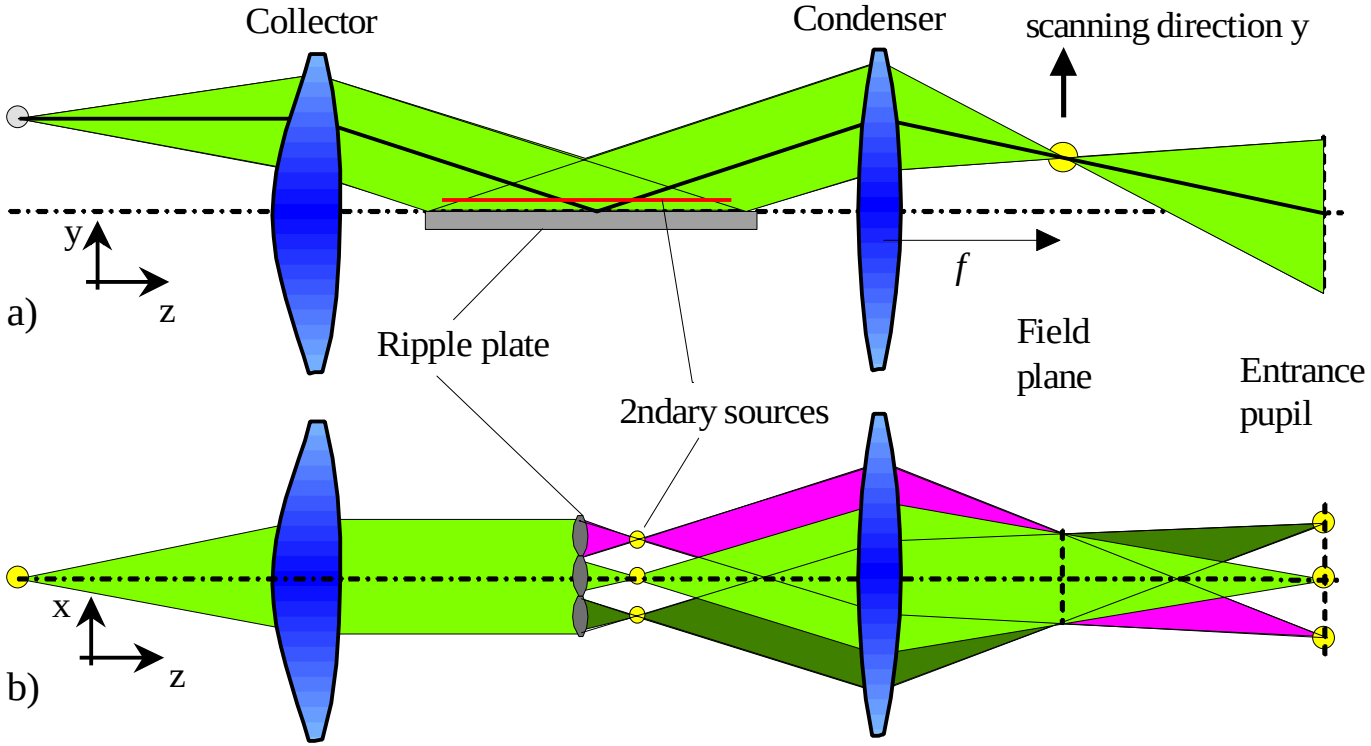
projection optics:
- 6 off-axis aspheres

Illuminator: Basic Requirements

- adapt design to:
  - source type (Laser produced plasma or discharge source) AND
  - source characteristics (i.e. angular divergency, size, coherence properties)
- challenges are:
  - efficient coupling of light
  - uniform ring field fill
  - uniform pupil fill
  - telecentricity

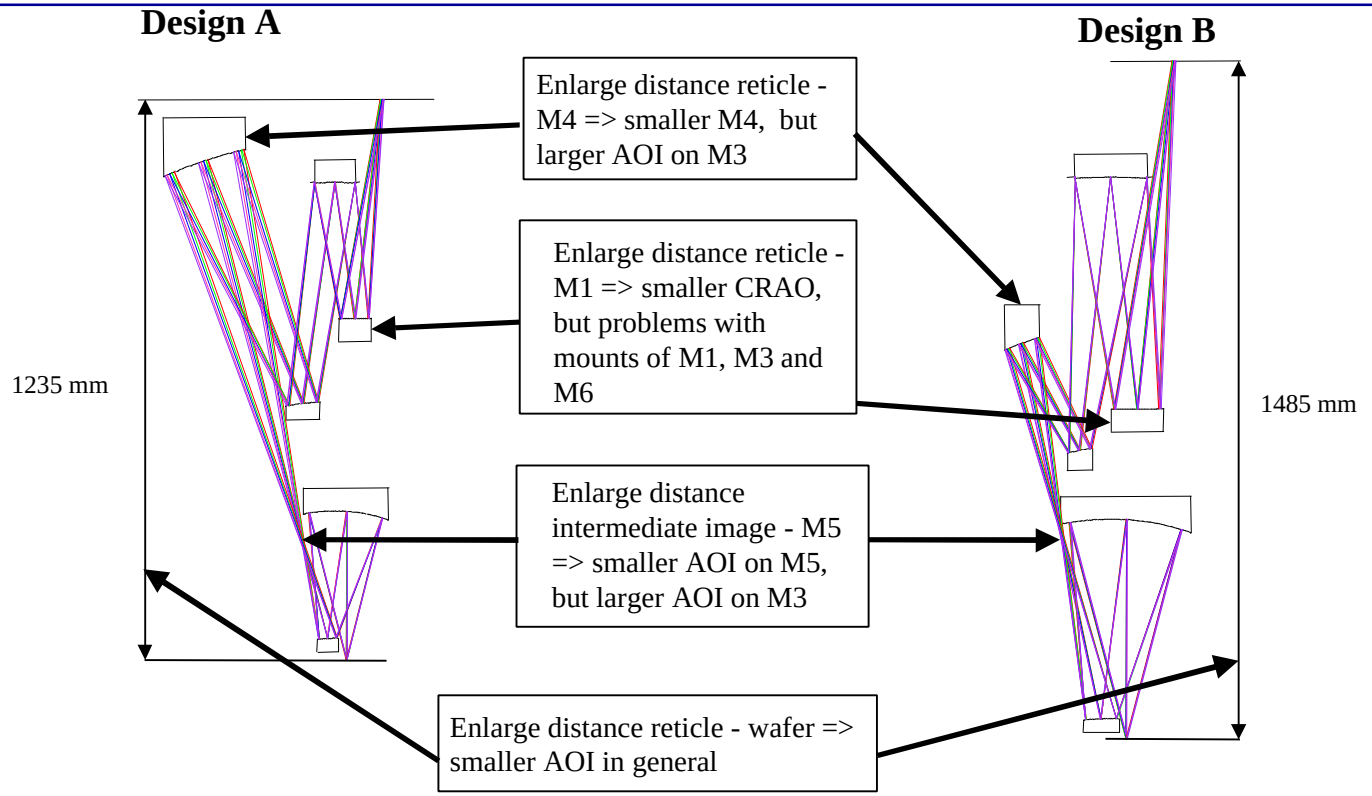


Illuminator: possible design solution



- use of Ripple Plate as integrator element
- images of 2ndary light sources fill pupil (segmentation of pupil)
- critical: manufacturability of integrator element

Projection Optics box: Design optimization



Requirements are:

- **mirror sizes < 400 mm**
- **small angle of incidence (AOI) on mirrors and small bandwidth of AOI**
- **small aspherical sag and small asphrical gradient**

Overview

1) Optical Design
   - Illuminator
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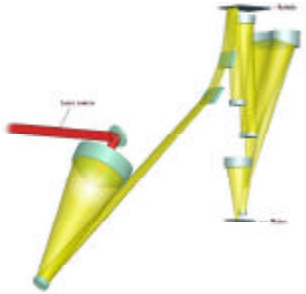
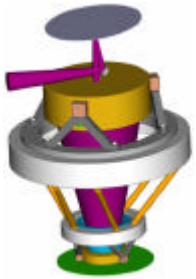


2) Optics Metrology

Optics Fabrication



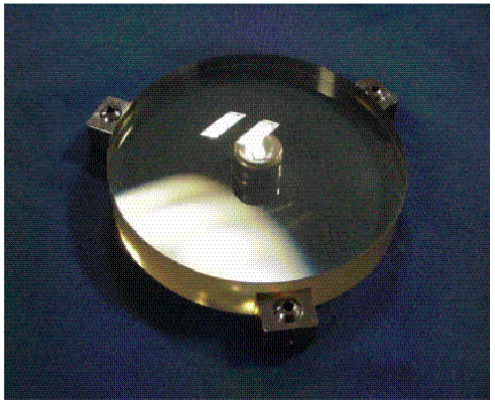
4) Coating Technology

5) Conclusion

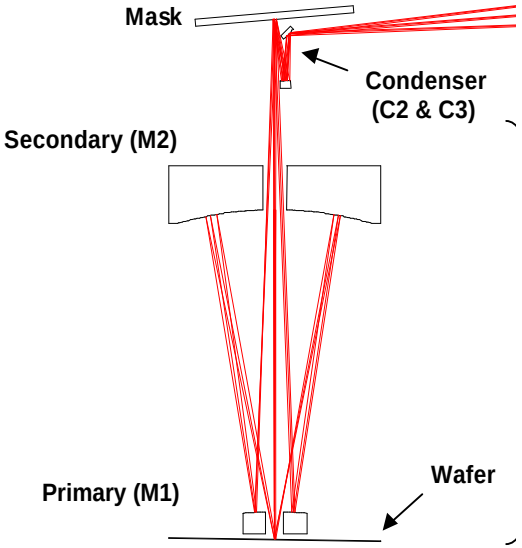
EUV aspheres at Zeiss

Mirror	aspherical sag	aspherical gradient	Activities at CZ
ELT 2	2 µm	0.5 µm/mm	1997-1999
MET M1	4 µm	1.2 µm/mm	1999-2000
MET M2	6 µm	0.5 µm/mm	
Alpha-tool	≤15µm (?)	≤2.0 µm/mm (?)	2000-....

MET primary

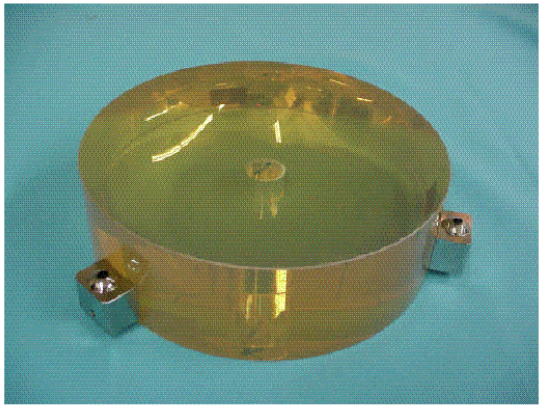


100mm



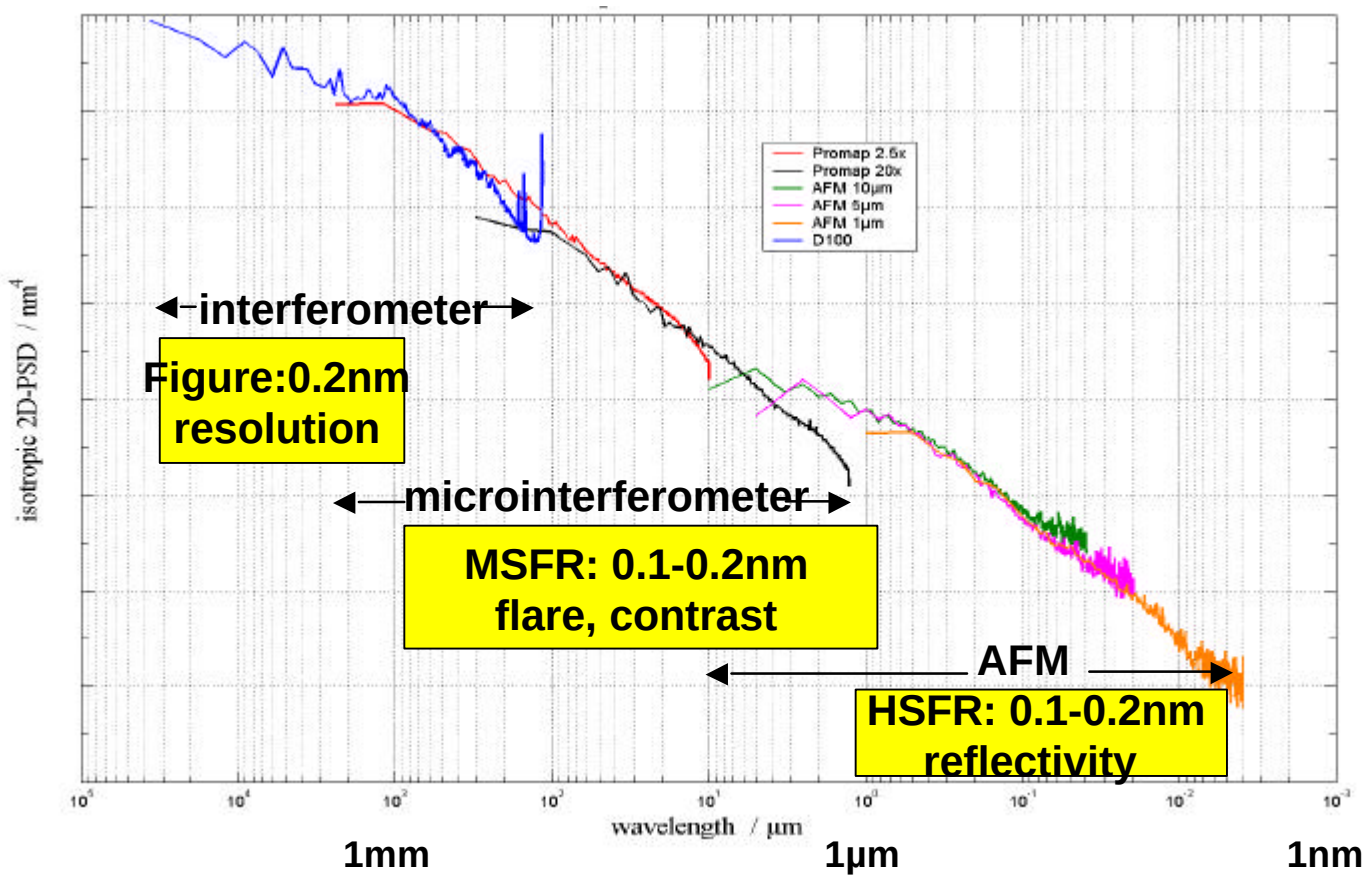
MET

MET secondary



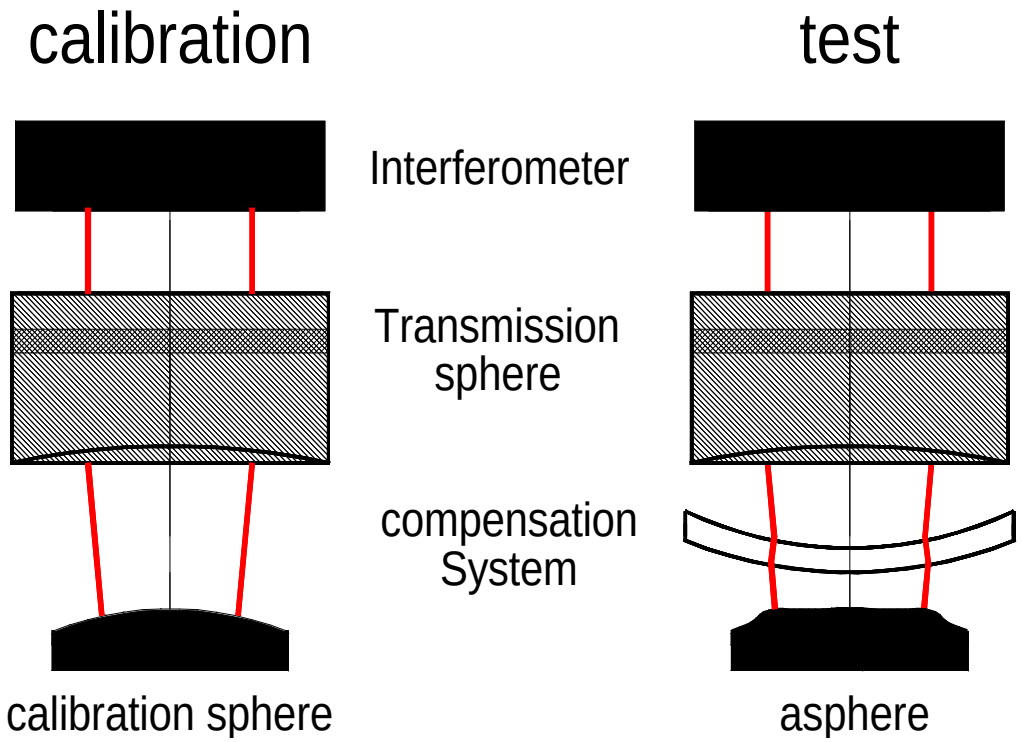
220mm

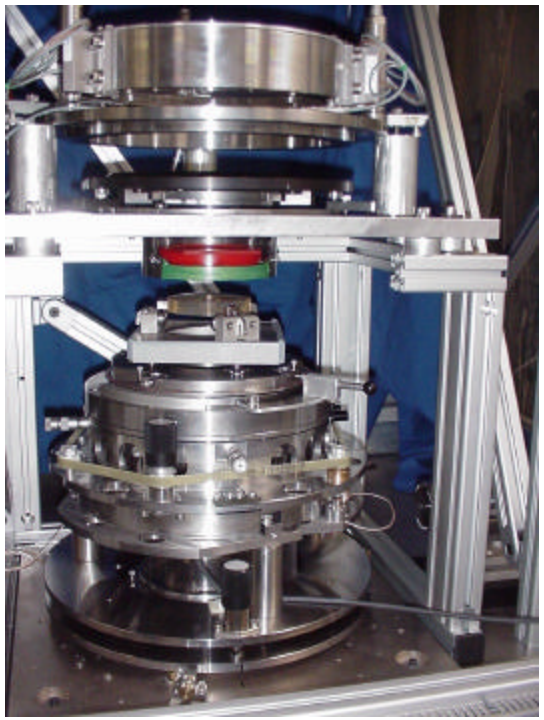
Optics metrology



2 D isotropic Power Spectral Density and surface specifications

Calibration approach for accuracy



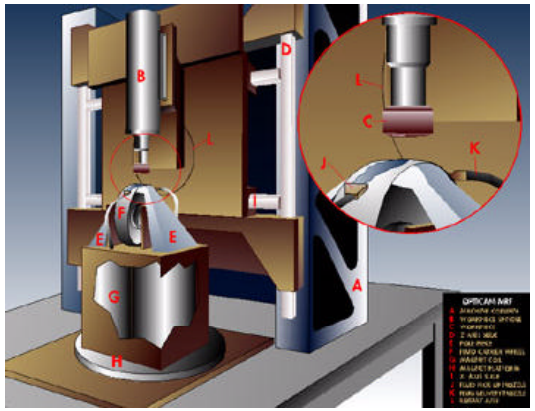


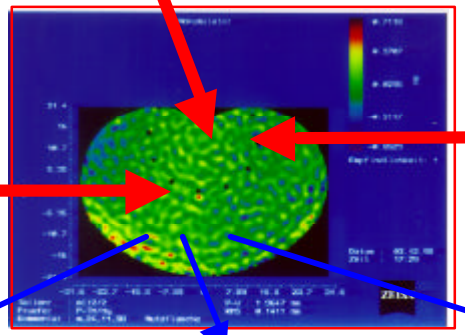
Precision: **0.061nm rms**

Estimated accuracy: **0.15nm rms**

Optics fabrication: Fine correct. techniques

Ion beam figuring





Small tool polishing

Magnetorheological finishing

Figure: 0.14nm rms

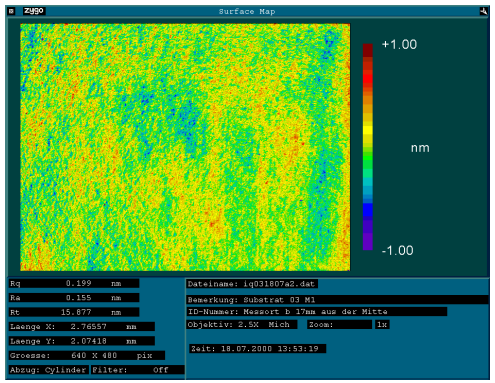
MSFR: 0.10nm rms

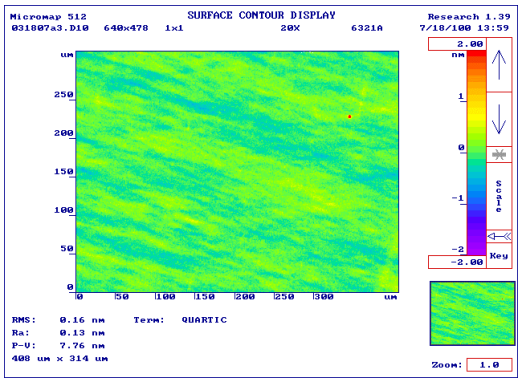
HSFR 0.13nm rms

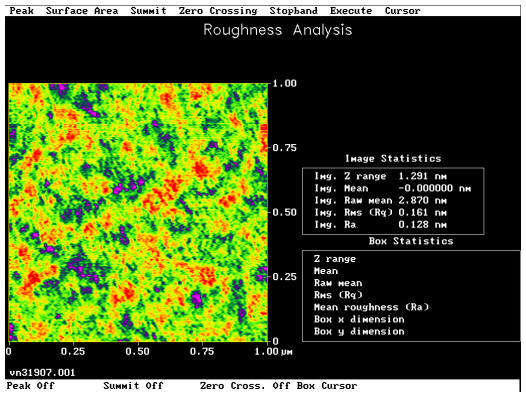
Challenges: - reach Spec for Figure, MSFR and HSFR simultaneously
- develop processes for volume production

In Process Results for MET mirrors

	Specifications		In process data	
	MET Set 2	MET Set 1	M1	M2
Figure [nm rms]	0.25	0.35	0.35	1.6
MSFR [nm rms]	0.20	0.35	0.25	0.35
HSFR [nm rms]	0.10	0.50	0.45	0.45







Conclusion

- design solutions for an EUV illuminator are available
- a manufacturable 6-mirror design for the PO box has been developed
- Optics fabrication technology and Optics Metrology are progressing towards the very demanding specifications

EUVL optical systems are expected to be manufacturable

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