



Optics for the NXE:3300



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Agenda



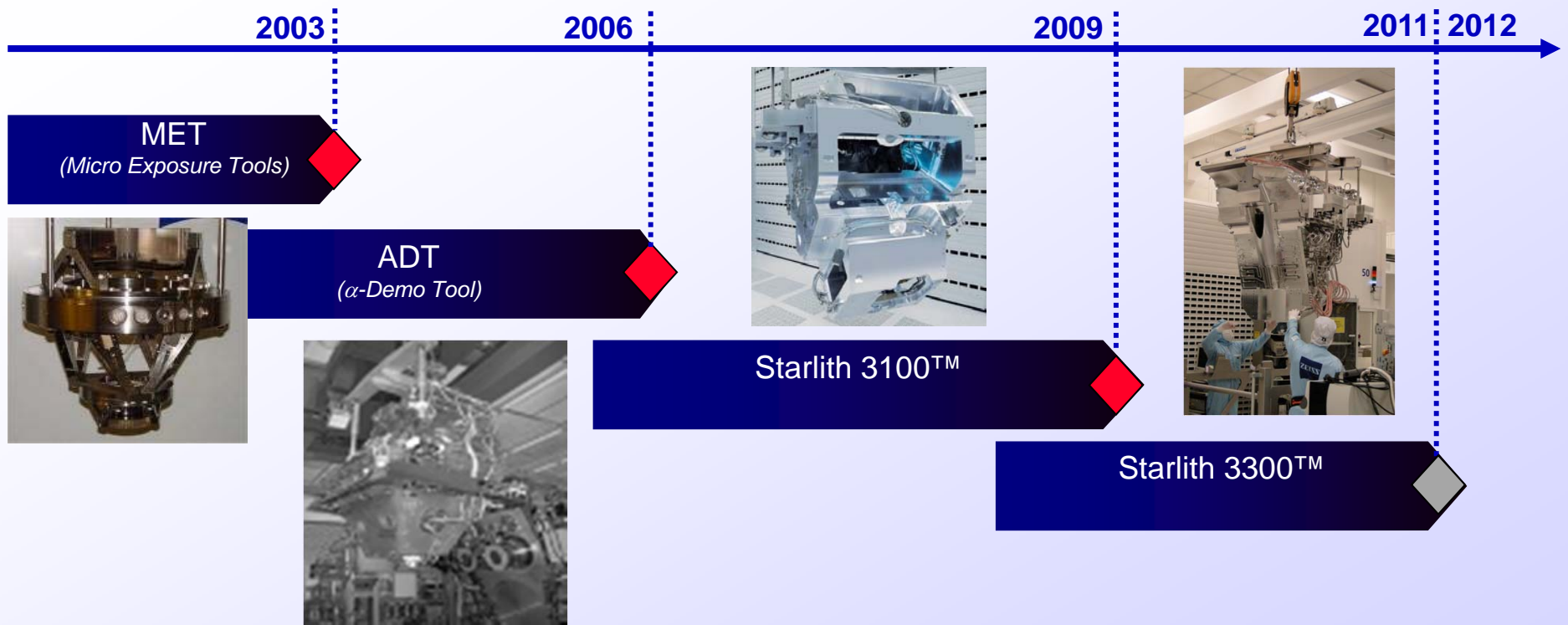
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- 1 Introduction
 - 2 3300 Illuminator
 - 3 3300 Projection Optics
 - 4 Outlook and Summary

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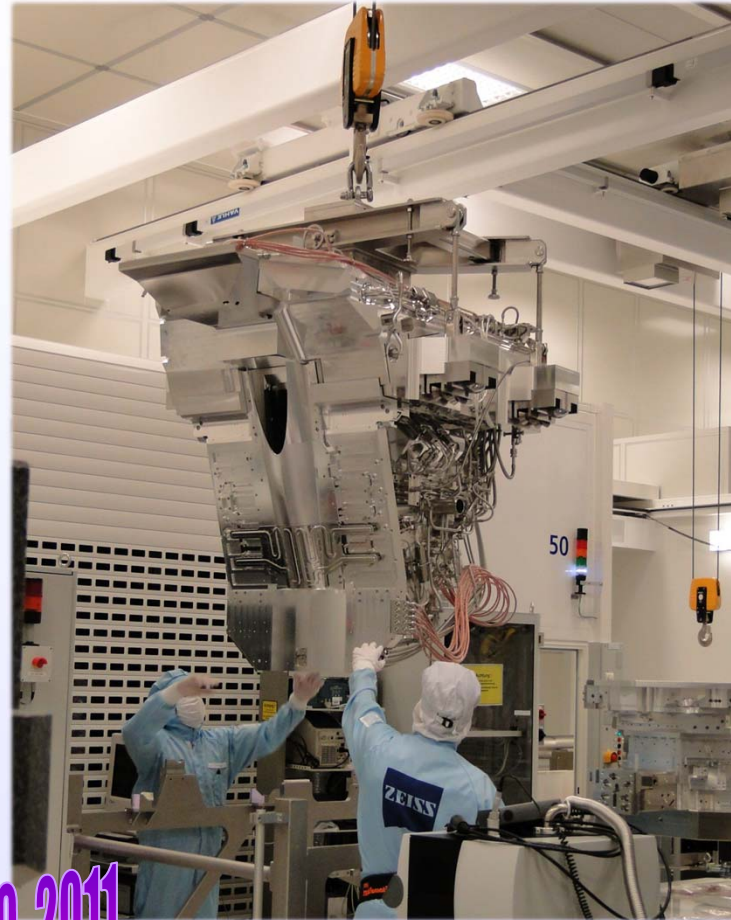
EUV program at Carl Zeiss SMT GmbH



A continuous EUV development program is running since more than 15 years

5 years after program start...

with lots of intermediate successes, new challenges and breakthroughs



Illuminator

First Shipment on Dec 30, 2011

Projection Optics

First Shipment on April 17, 2012

... we have shipped several optical trains for the NXE:3300

The optical train – Introduction



λ 13.5 nm
NA 0.33
Field 26 x 33 mm²
Mag 4x

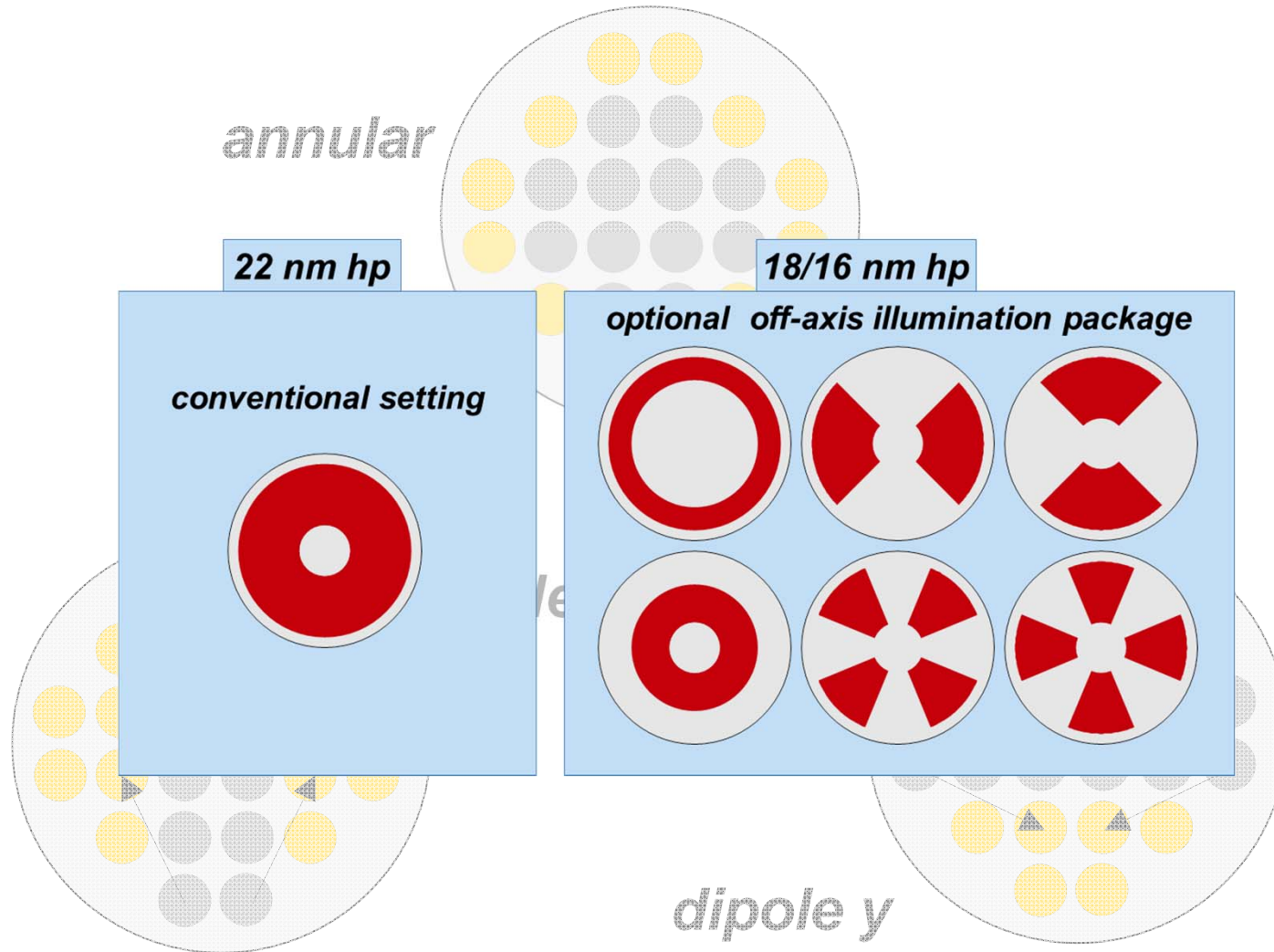


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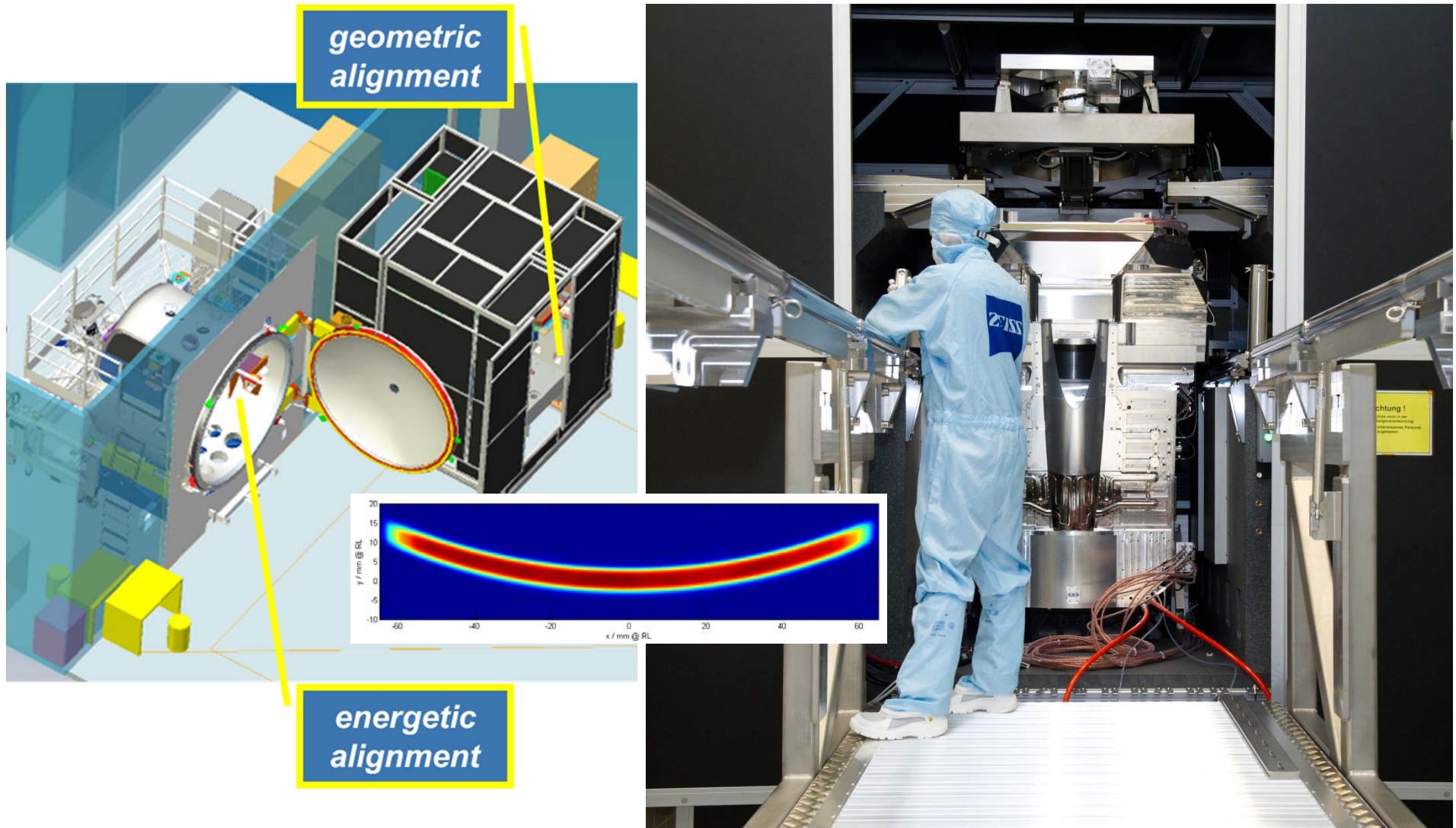


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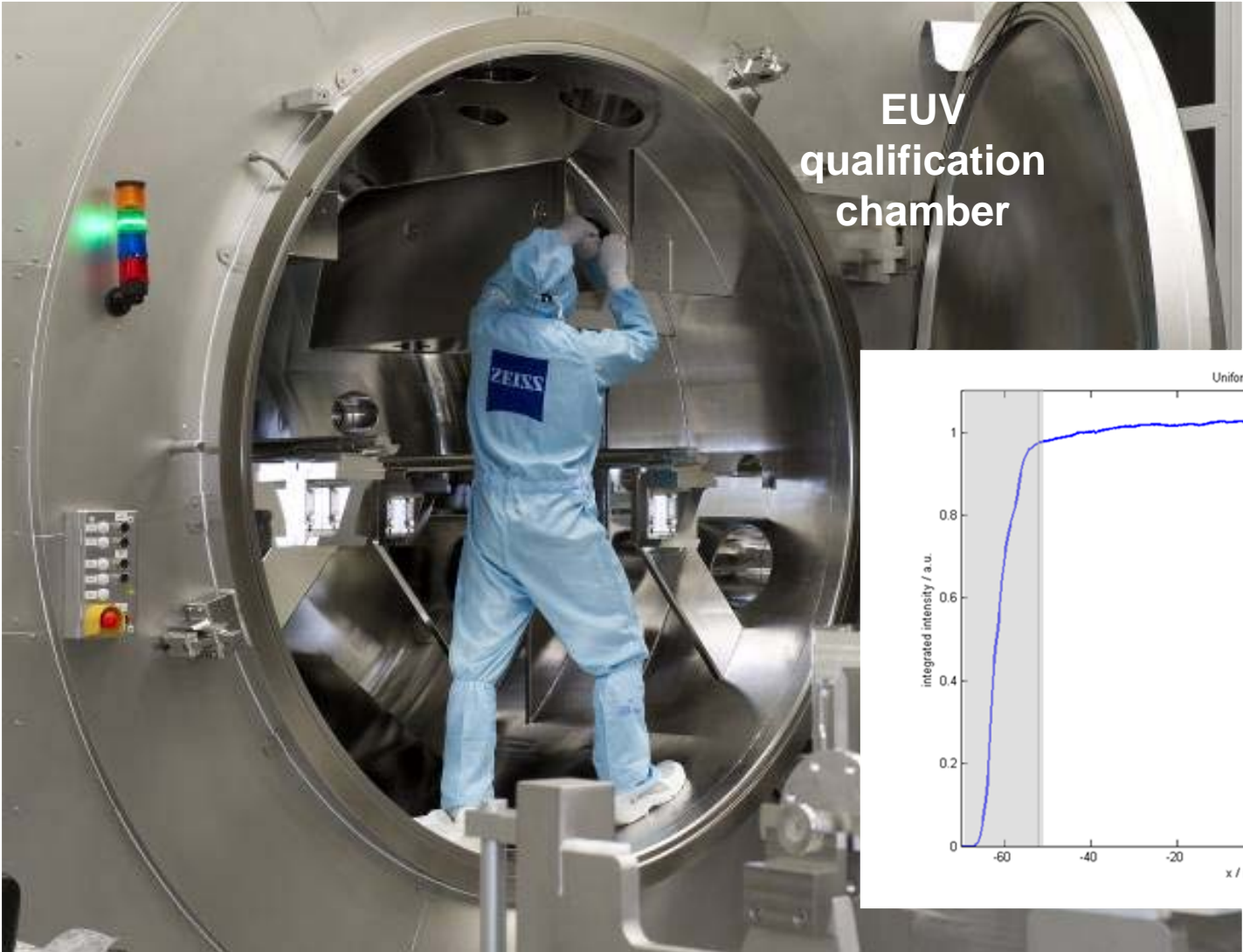
NXE 3300 - Off-axis illumination enables lossless setting changes



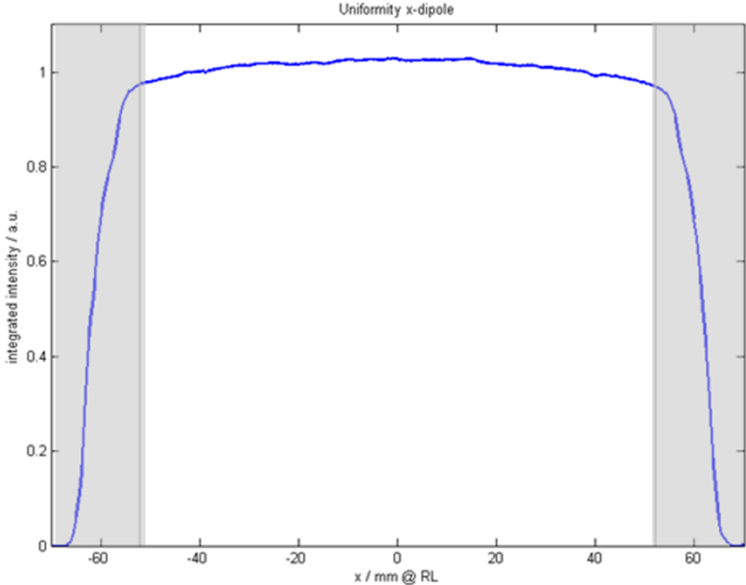
Visible Qualification of Illuminator performance



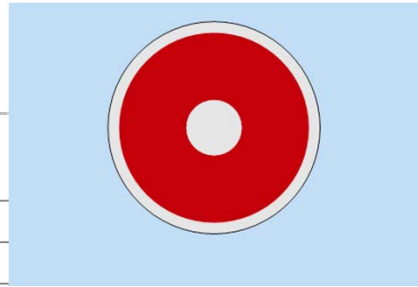
Illuminator qualification – split up in geometric and energetic alignment



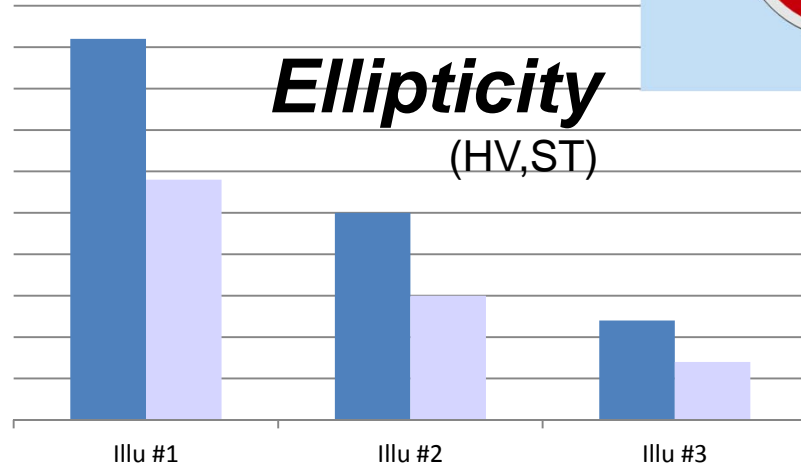
EUV qualification chamber



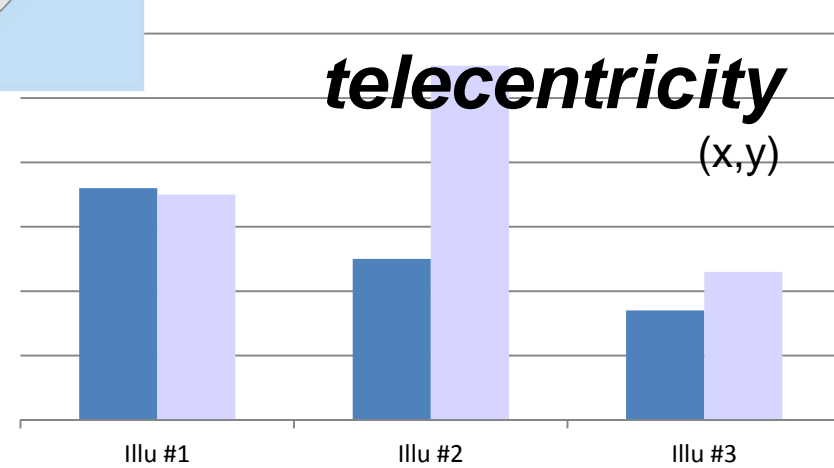
Illumination Settings and Performance



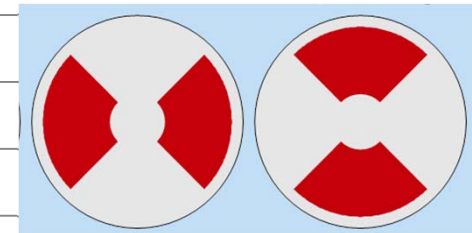
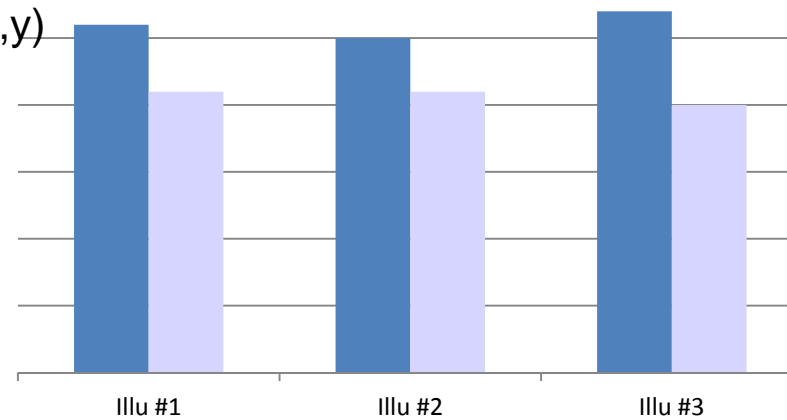
Ellipticity (HV,ST)



telecentricity (x,y)



Uniformity (dipole x,y)

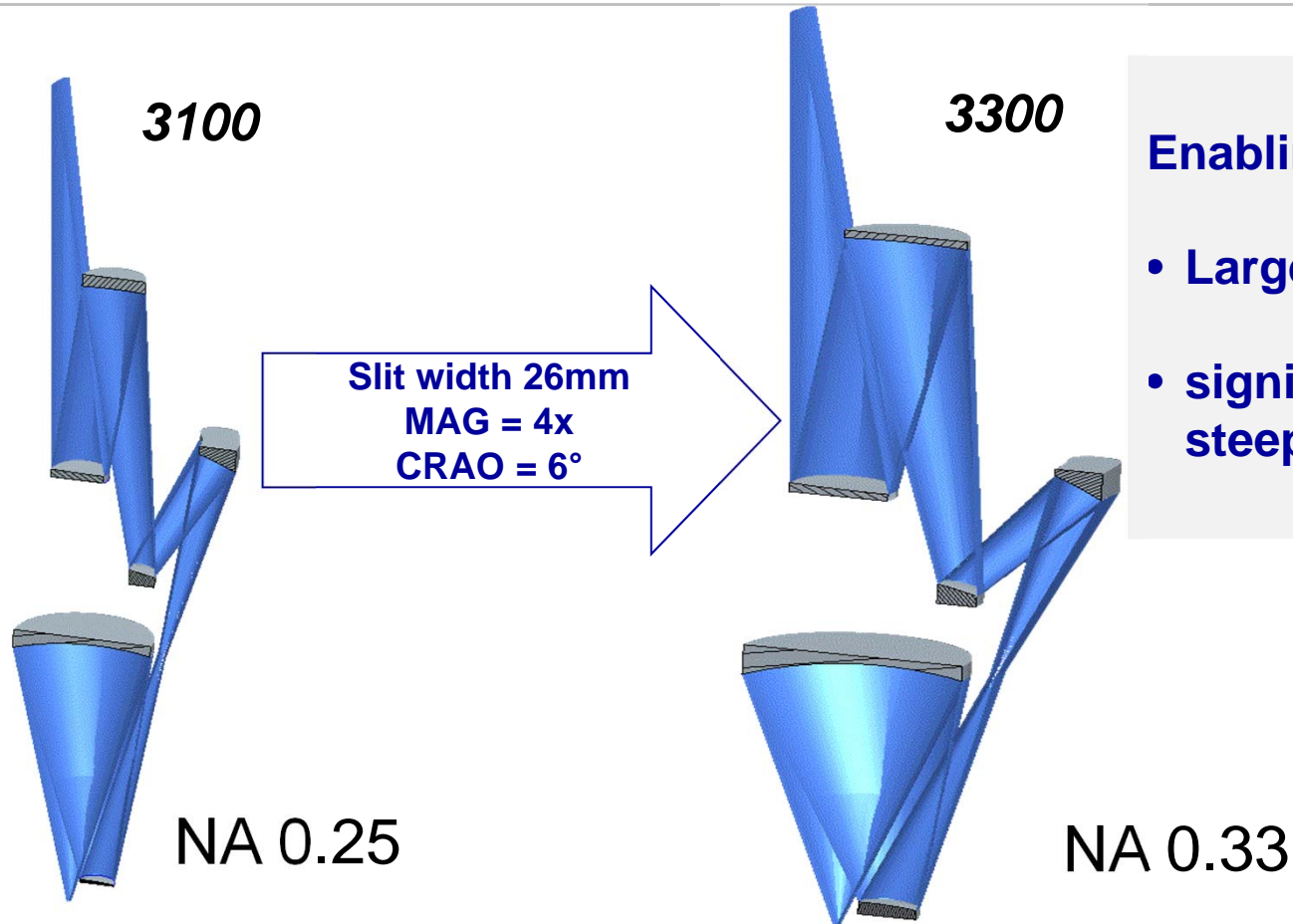


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NXE 3300 – Projection optics design for NA 0.33



Enabling for higher NA:

- Larger mirror sizes
- significantly (about 5x) steeper aspheres




Full field 6 mirror designs can be extended to NA 0.33

schematic designs – for illustration only.

Mirror fabrication:

The challenge gets bigger with each generation of EUV tools



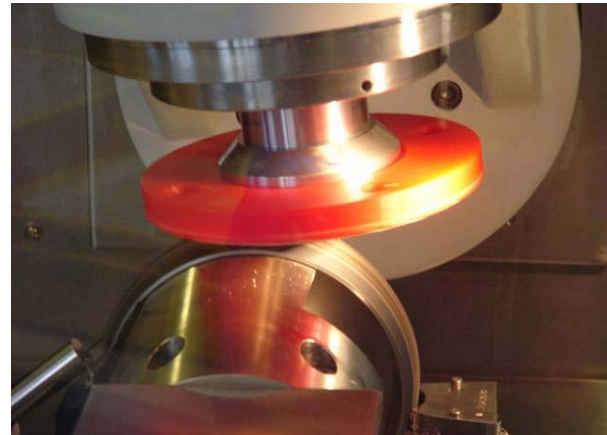
	MET	ADT	3100	3300	
Photos show relative mirror size					
Figure [pm rms]	350	250	140	90	→ aberrations
MSFR [pm rms]	250	200	130	100	→ flare

Challenge:

- reach spec for Figure, MSFR and HSFR simultaneously



**Computer Controlled
Polishing for
Deterministic Processes**



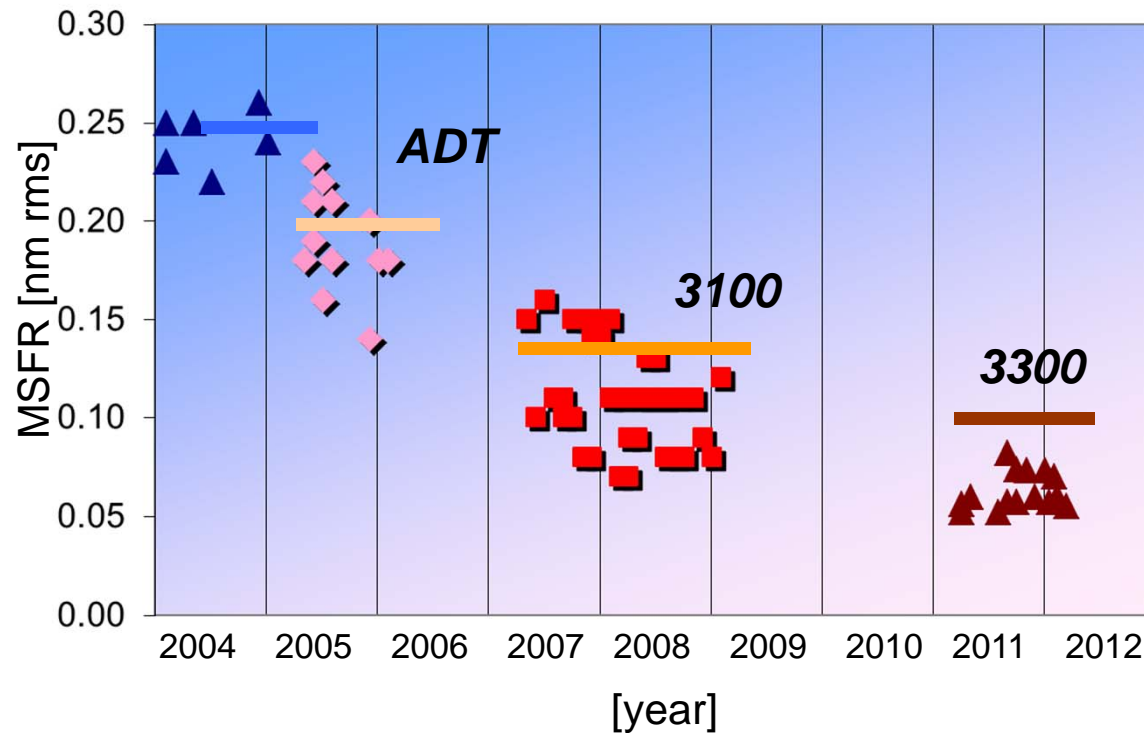
Fast Magneto Rheological Figuring



**Ion Beam Figuring:
Atomic Level Figure Control**

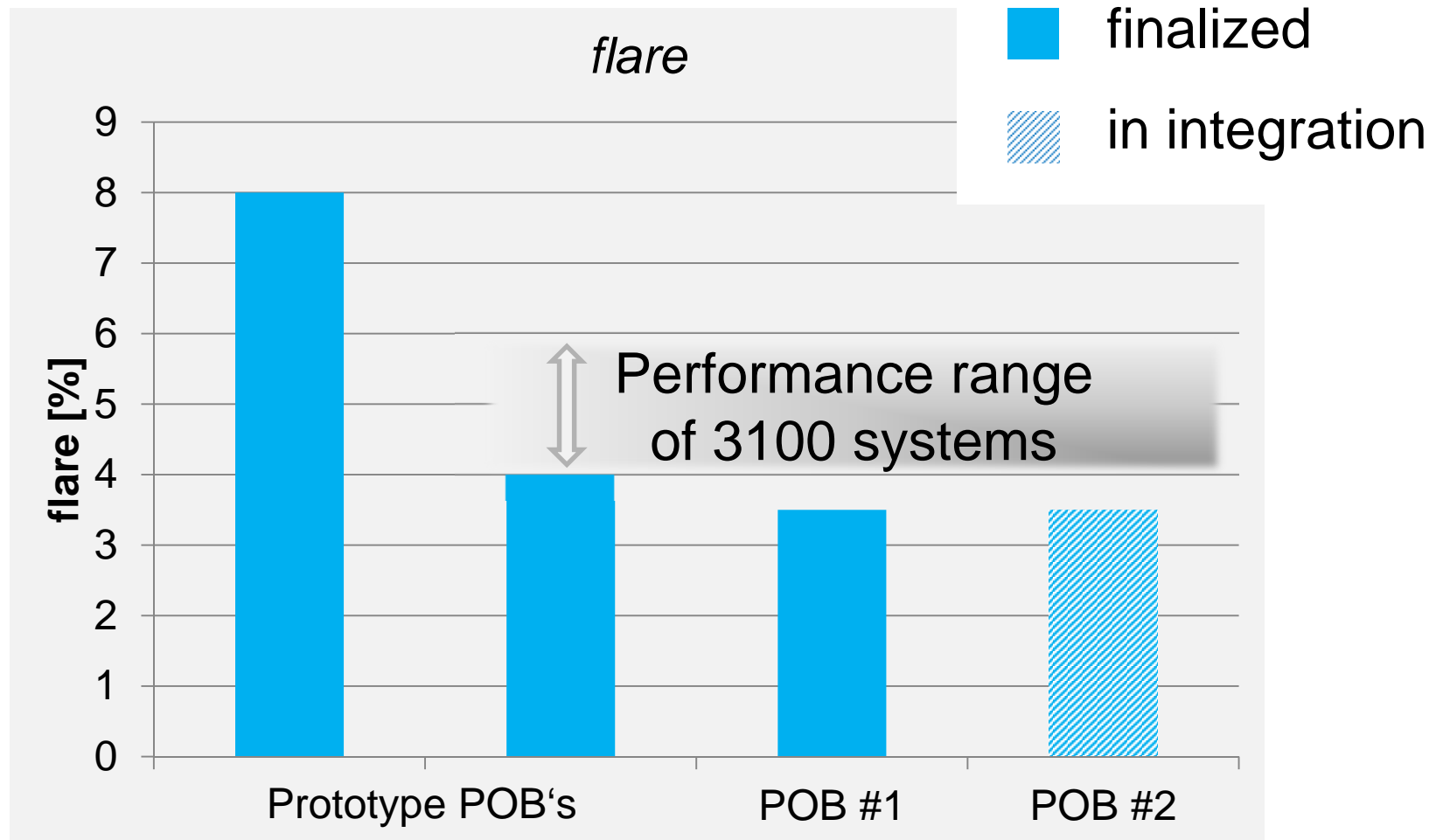
All processes are ready for volume manufacturing

NXE:3300 – first mirrors in flare specification

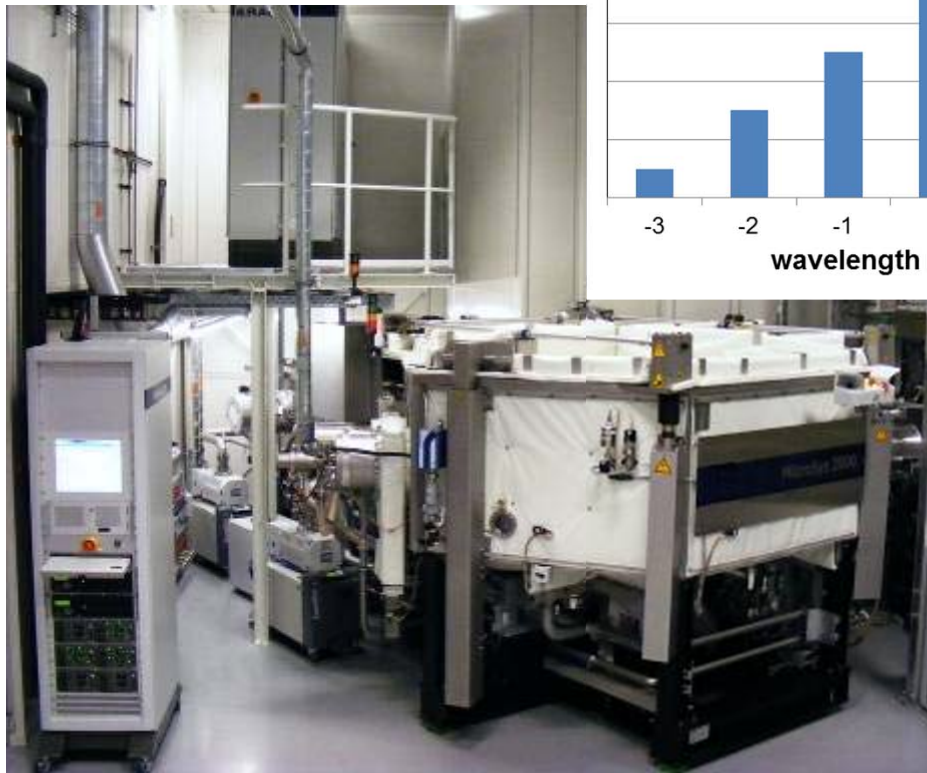


First results on 3300 mirrors well below the 6% flare Specification –
Flare level 4% (below a 2 μ m line) for customer optics

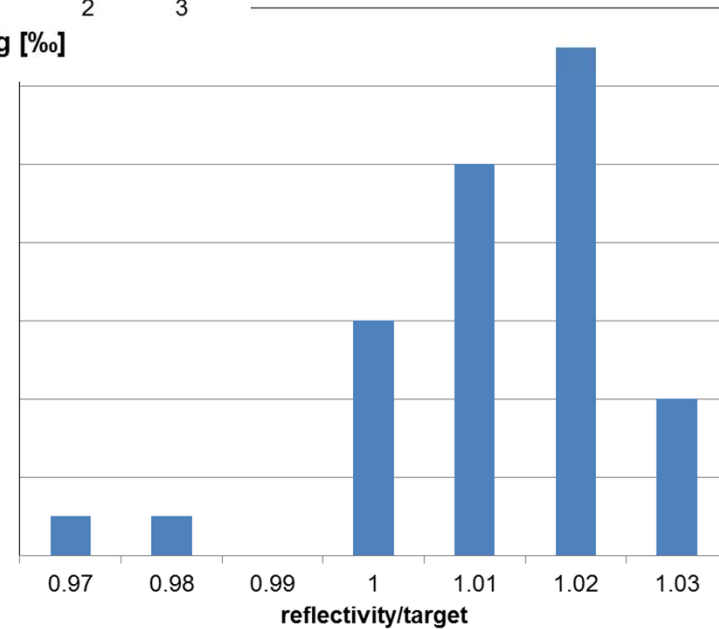
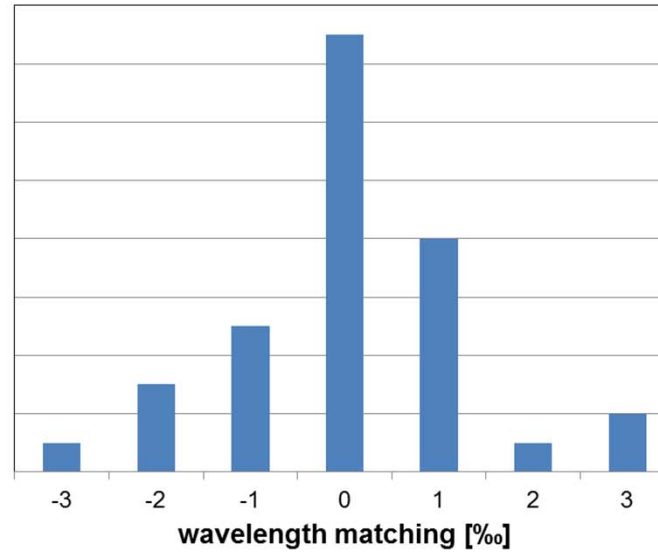
Performance overview of first systems



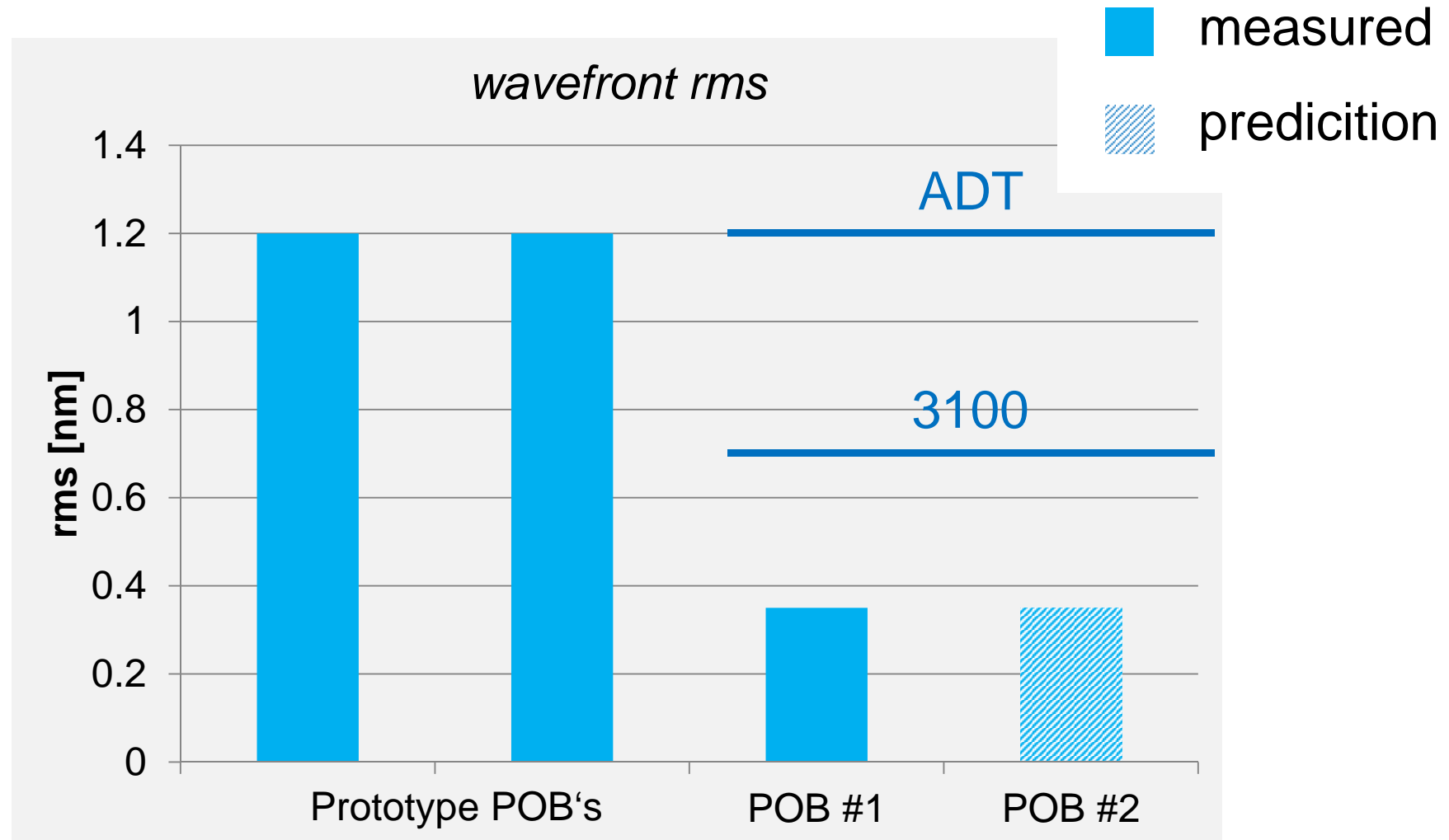
Optics fabrication is ongoing: more than 40 mirrors successfully coated



New coater at SMT



Performance overview of first systems



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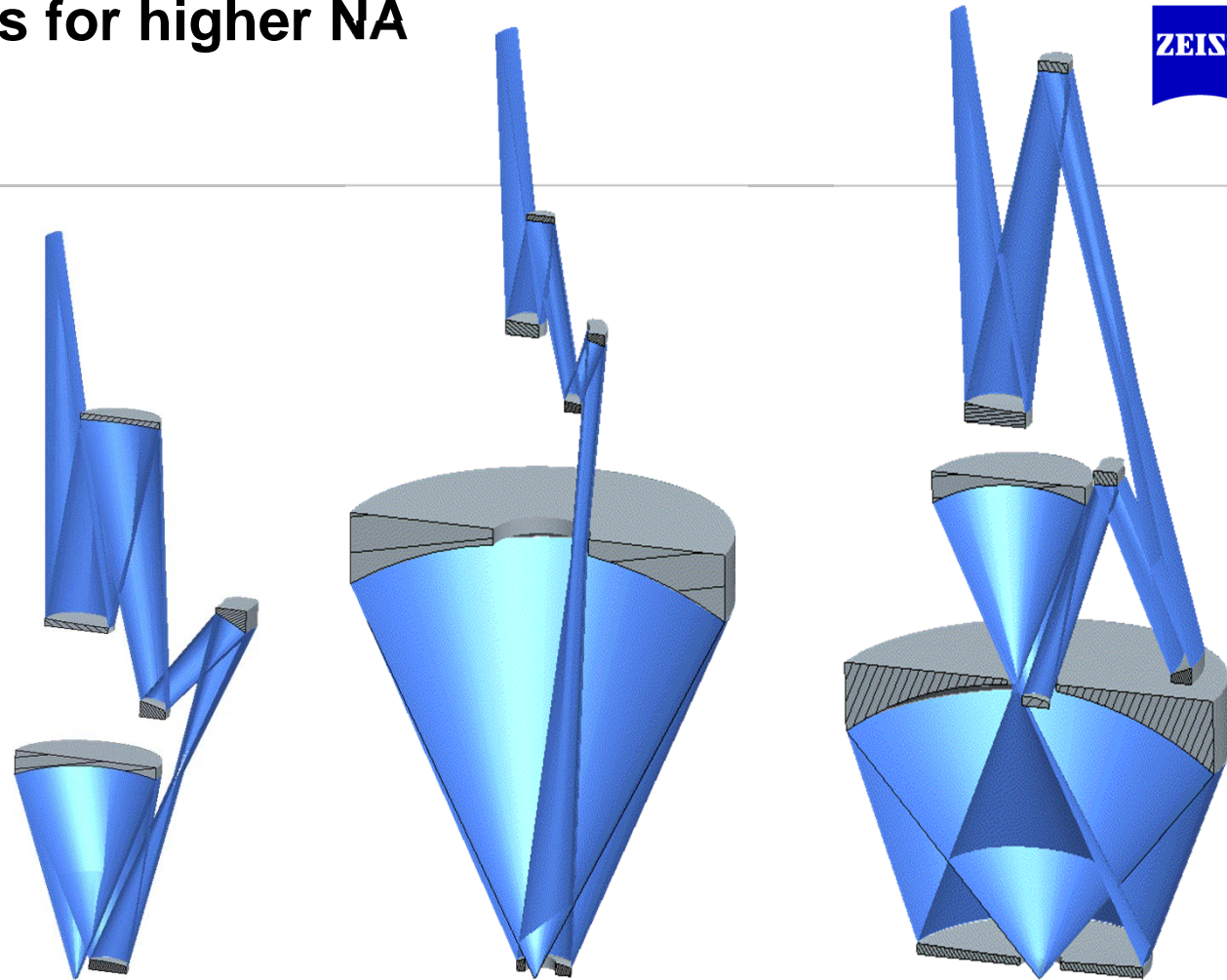
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Projection optics for higher NA



Challenges of projection optics for higher NA:

- Manufacturing of large mirror
→ production equipment & facilities
- Larger tracklength
→ larger machine height



NA	0.33	0.45	0.60
Field size / Mag	26 mm / 4x	26 mm / 6x	13 mm / 8x
# mirrors	6	6	8
Tracklength	1.65 m	2.2 m	2.2 m
Relative transmission	100 %	~100 %	<40 %

1 3300 Illuminator

- **three Illumination systems shipped to ASML**
- **flexible fly's eye mirror allows high efficiency in all settings**

2 3300 Projection Optics

- **mirror fabrication running**
 - **more than 40 mirrors coated**
 - **less than 4% flare expected**
- **three projection optics systems finalized**
- **first customer optics has reached a rms-level of <0.4 nm**



Thanks

**to the EUV teams at Carl Zeiss SMT and ASML
and our partners**

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We make it visible.