
EUVL

Optics lifetime and contamination

—

European Update

EUVL Symposium 2007
TWG Optics Contamination and Lifetime
Sapporo

Bas Wolschrijn, TNO



ASML



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Status EUVL symposium 2006

Progress in the optics usage programme for ASML EUV Lithographic Tools

1. FOM Rijnhuizen, Philips Eindhoven, PTB Berlin, ALS Berkeley, The Netherlands
 2. ASML, OY-Academy, The Netherlands
 3. Carl Zeiss SMT, Carl Zeiss, Germany

Introduction

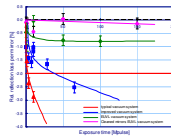
In order to make EUV economically viable, optics usage should be in the range of 7-10 years (tens of thousands of illumination hours).

The ASML strategy to reach the specification for optics usage includes:

- good vacuum
- reduced C-growth
- improved oxidation resistance of mirrors
- fast carbon cleaning, without mirror degradation

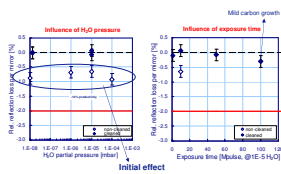


Optics reflectivity is influenced by C-growth

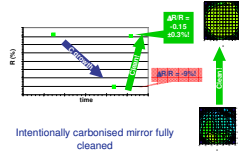


Given experimental data, we expect mild carbon growth for lithotool vacuum environment

Optics reflectivity is not influenced by H₂O



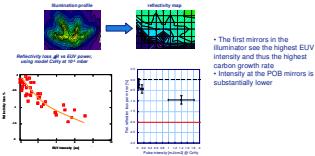
Cleaning result



← On the left: poster contribution EUVL symposium 2006, Barcelona

See also EU update Optics Lifetime and contamination TWG meeting Barcelona 2006

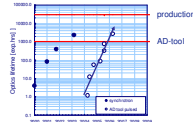
Amount of C-growth on mirror depends on EUV intensity and hydrocarbon (CxHy) partial pressure



Summary

- Carbon growth expected in lithotool
- No oxidation expected
- Optics degradation intensity dependent
- Cleaning proven and implemented

Progress in Optics Usage



Acknowledgements: FOM Rijnhuizen, Philips Eindhoven, PTB Berlin, ALS Berkeley



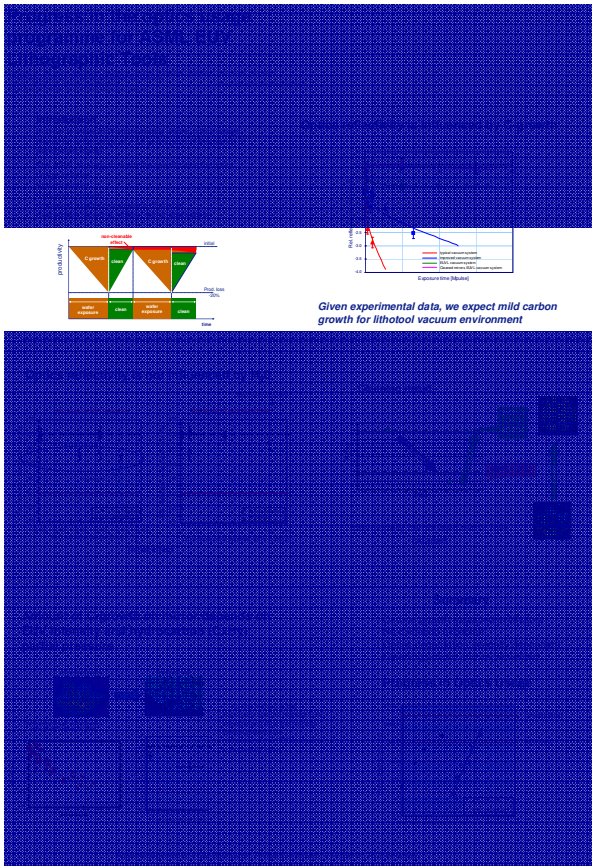
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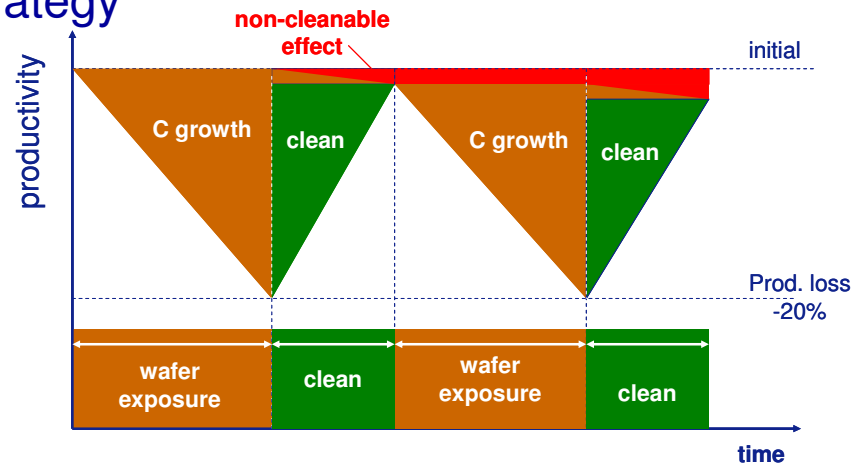
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Strategy



- **Given experimental data, we expect mild carbon growth for lithotool vacuum environment**



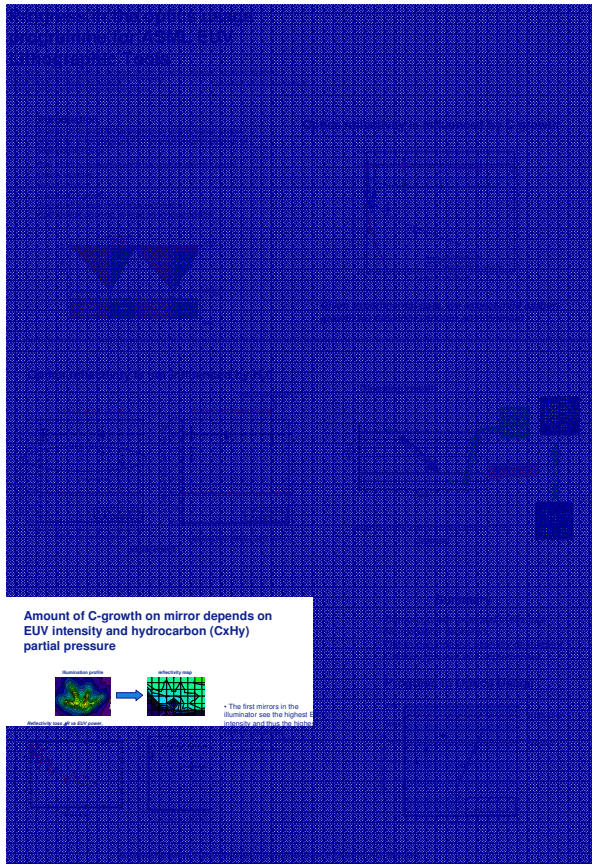
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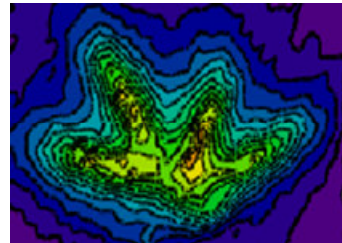
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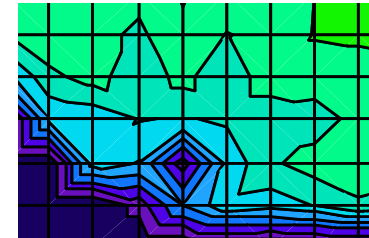
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Illumination profile



reflectivity map



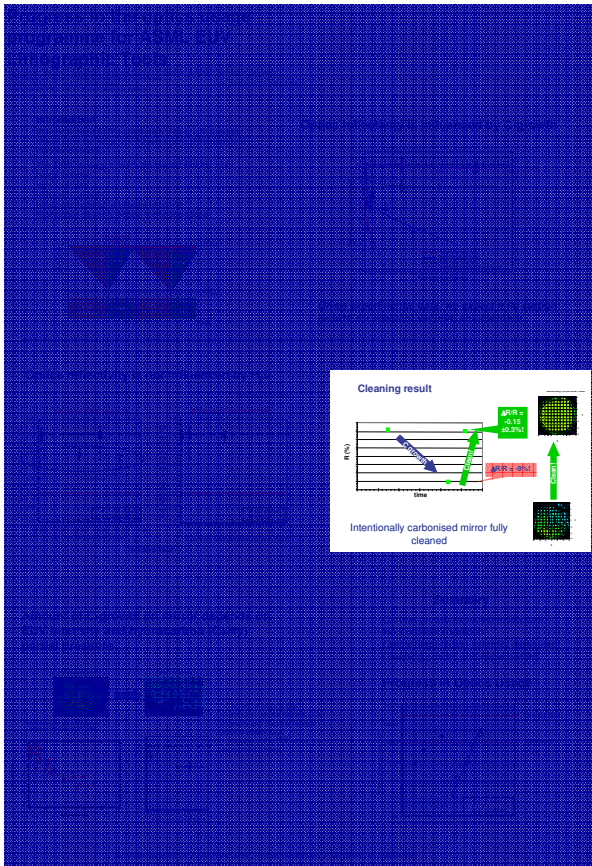
Residual carbon growth is expected to be intensity dependent



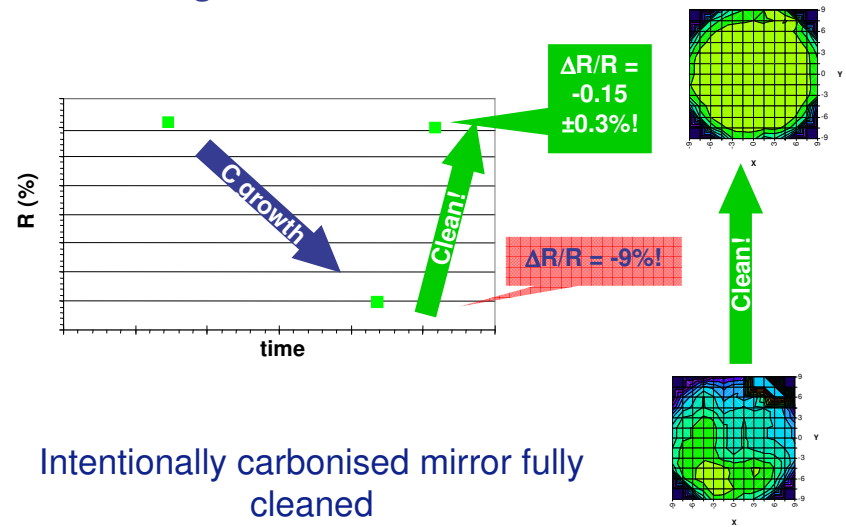
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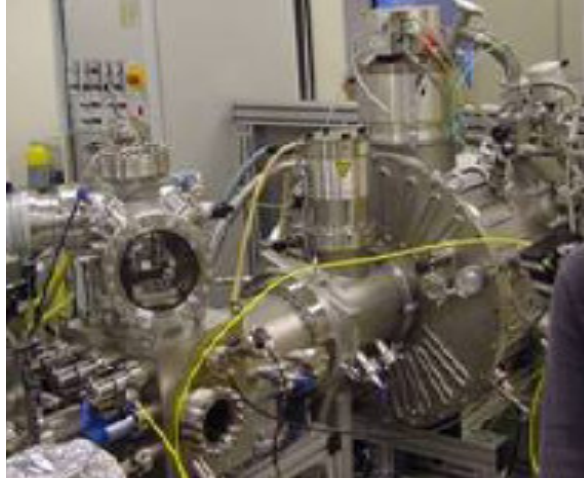
Cleaning result



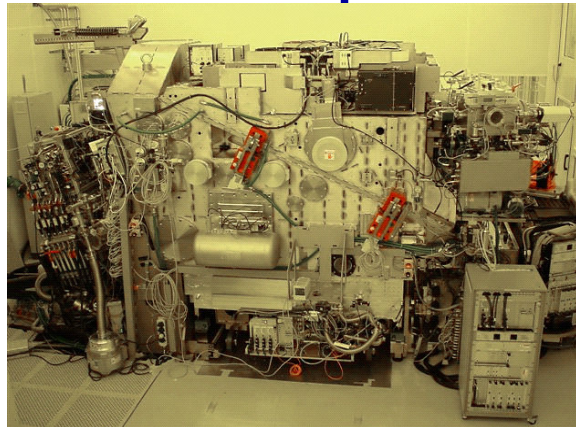
Intentionally carbonised mirror fully cleaned

Losses due to any carbon growth will be cleaned

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- So far for the observation from experimental program

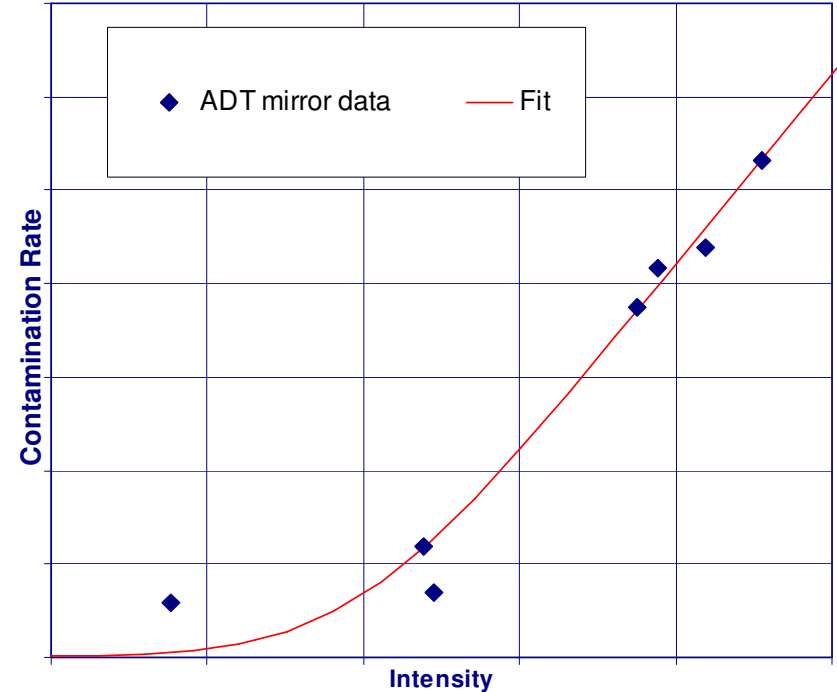
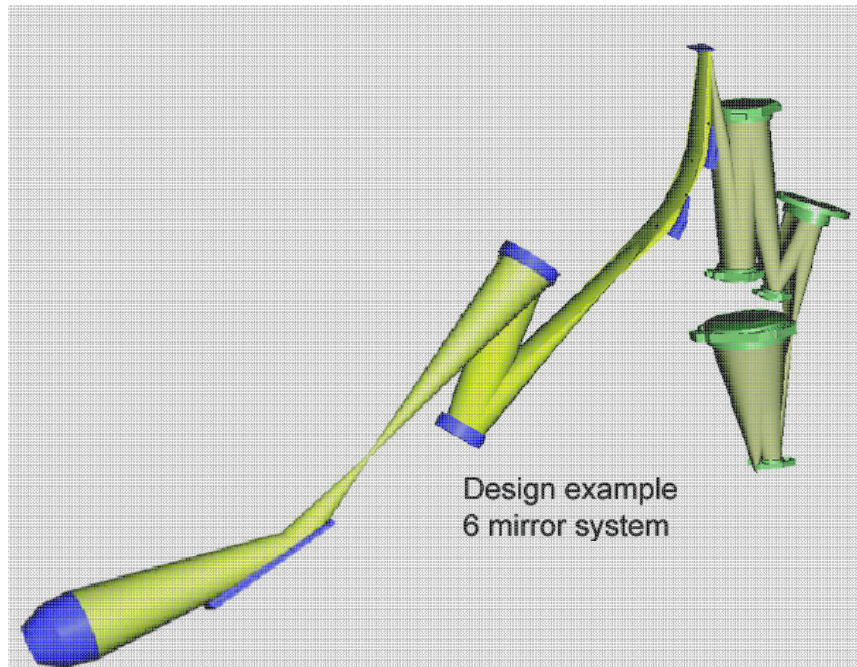


- What do we observe at when Alpha Demo Tools are operational?



ADT data

- During usage of ASML Alpha tools, the mirror contamination behavior has been investigated for several mirrors
- The observed contamination rate is different for various mirrors → contamination rate depends on intensity, similar to the findings in our experimental setups
- Contamination is proven to be reversible (cleanable) with implemented cleaning method → as expected



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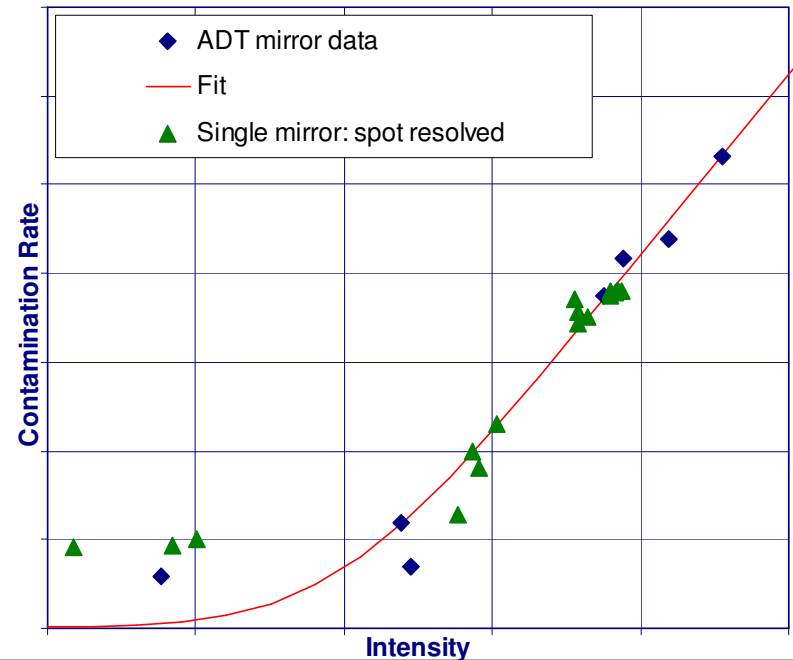
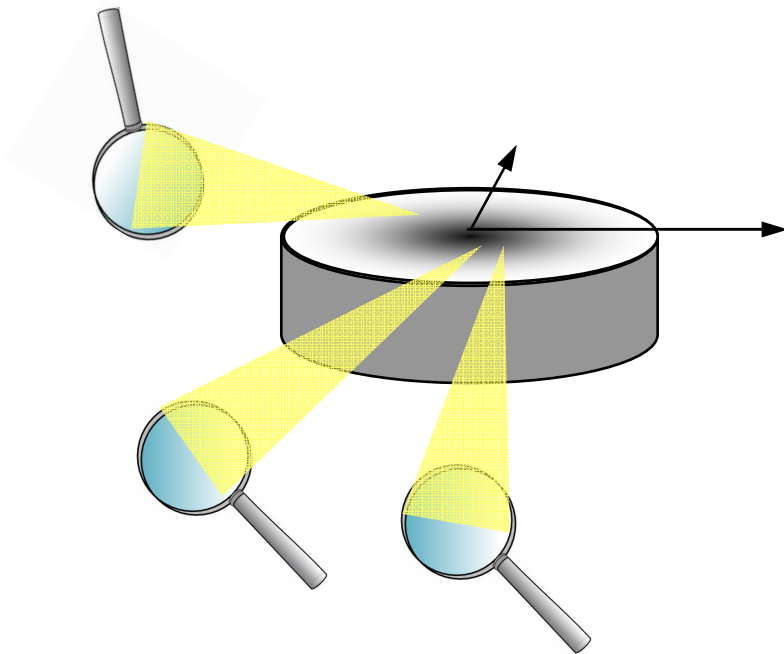


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ADT data

- We measured the contamination distribution on one single mirror ('spot resolved') → Intensity dependence also observed *within* one single mirror



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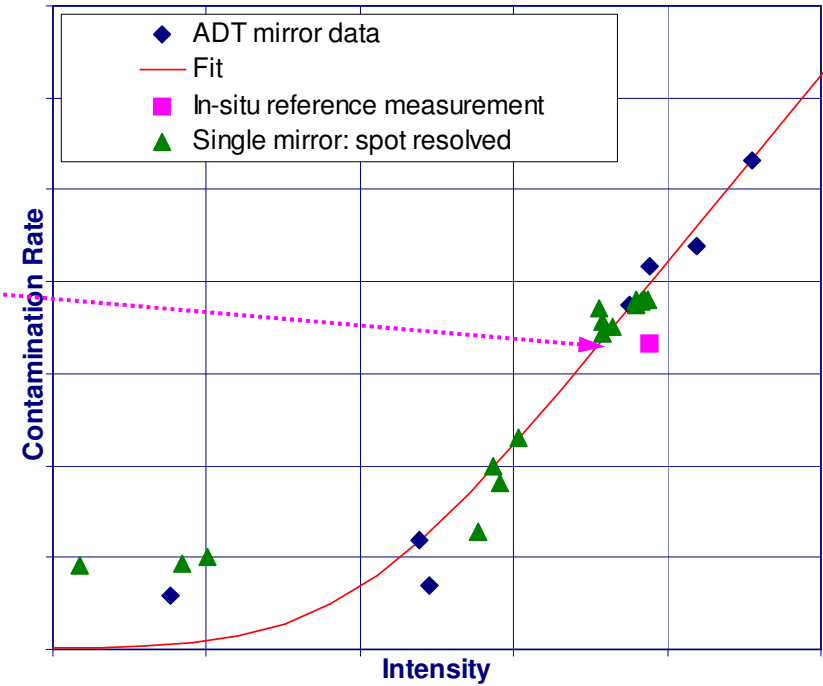
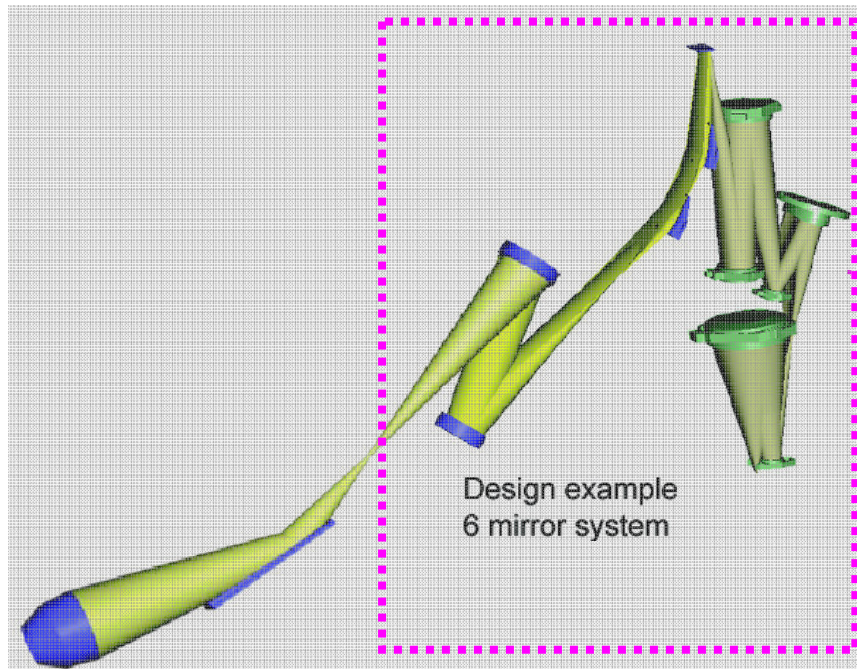


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ADT data

- Intensity dependence also observed by *in-situ measurement(s)* (dedicated experiment)



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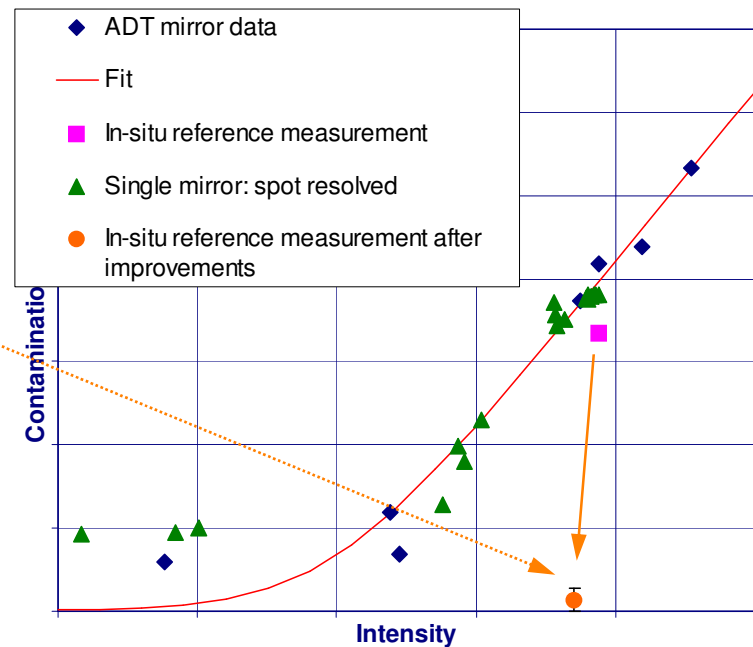
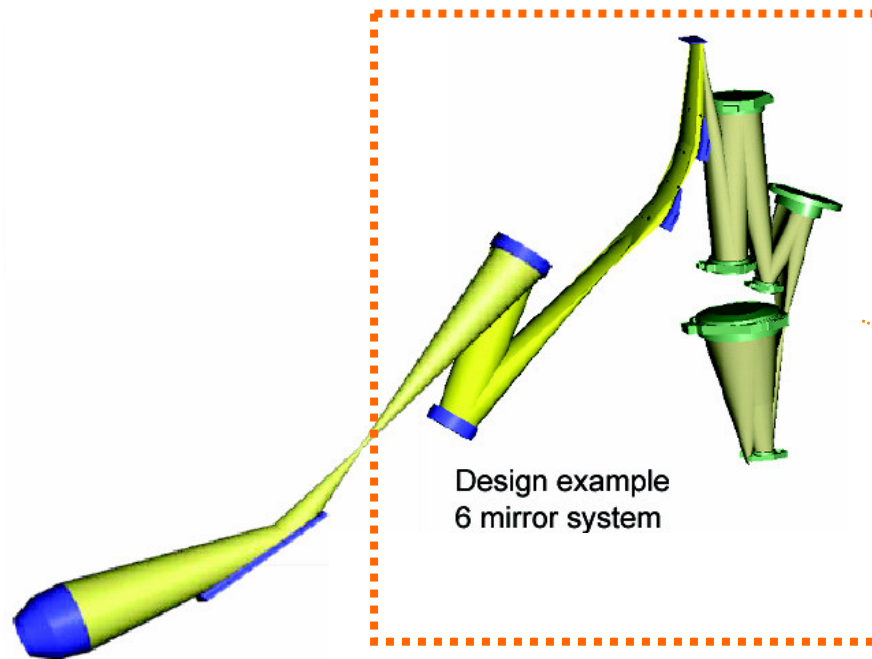


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ADT data: after cleanliness improvements

- Reason for contamination is known/understood
- Additional vacuum improvements further enhanced the cleanliness of the Alpha Tools below detectable levels (!)



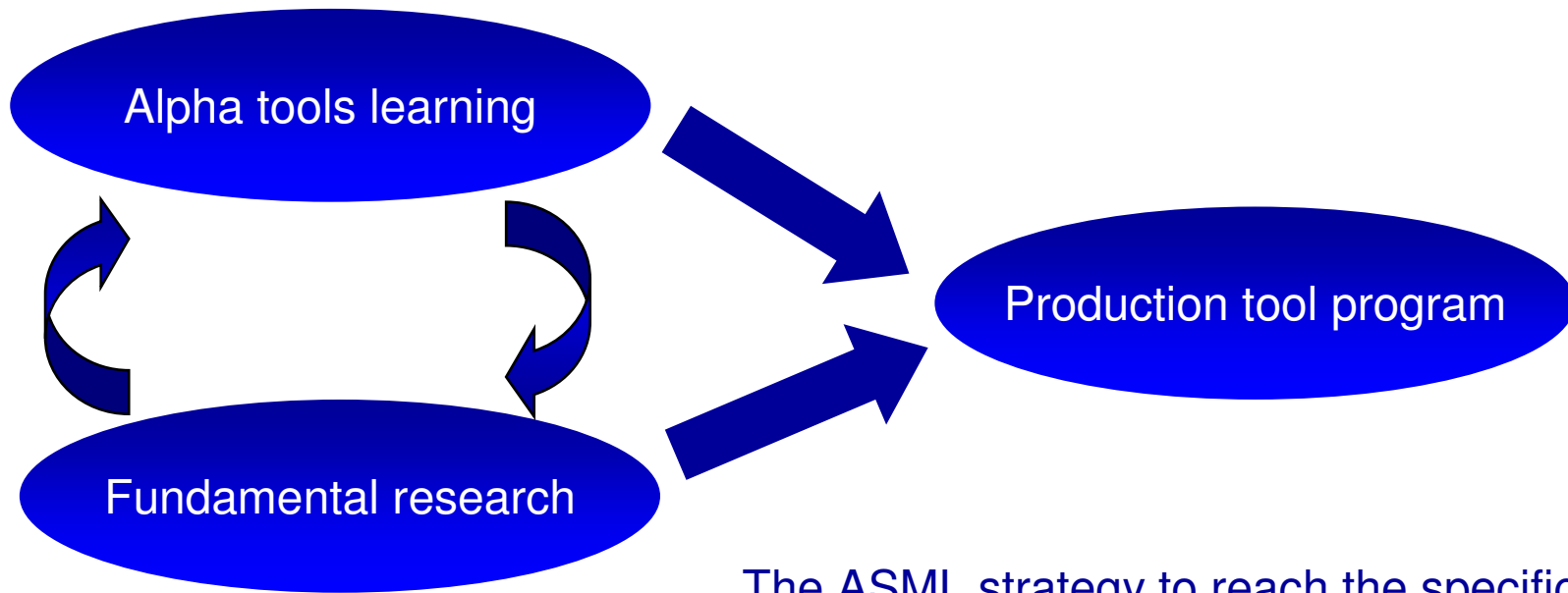
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Towards Production tools



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**Carl Zeiss SMT AG, Oberkochen,
Germany**

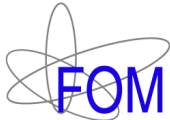


ASML

ASML, Veldhoven, The Netherlands



**TNO Science and Industry, Delft/Eindhoven,
The Netherlands**



FOM, Nieuwegein, The Netherlands



PTB, Berlin, Germany



Philips, Eindhoven, The Netherlands



ALS, Berkeley, USA



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