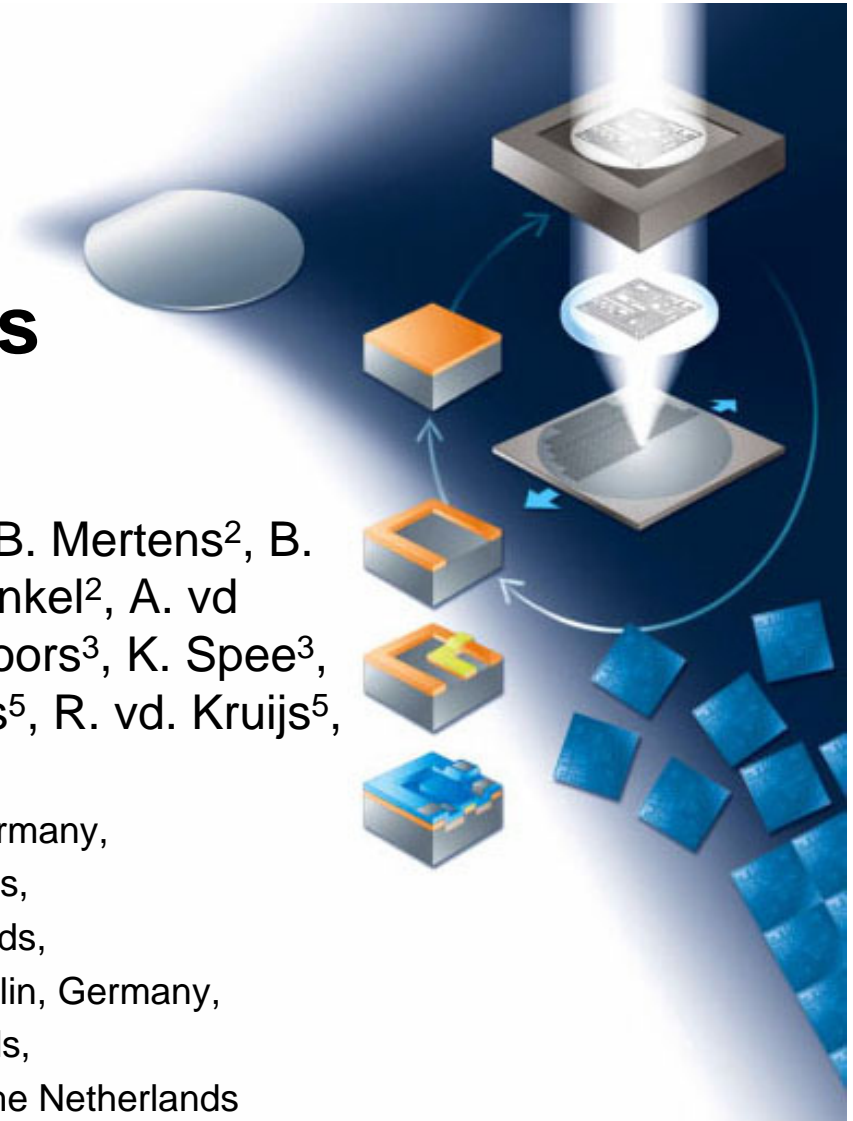


Carl Zeiss SMT AG
Enabling the Nano-Age World

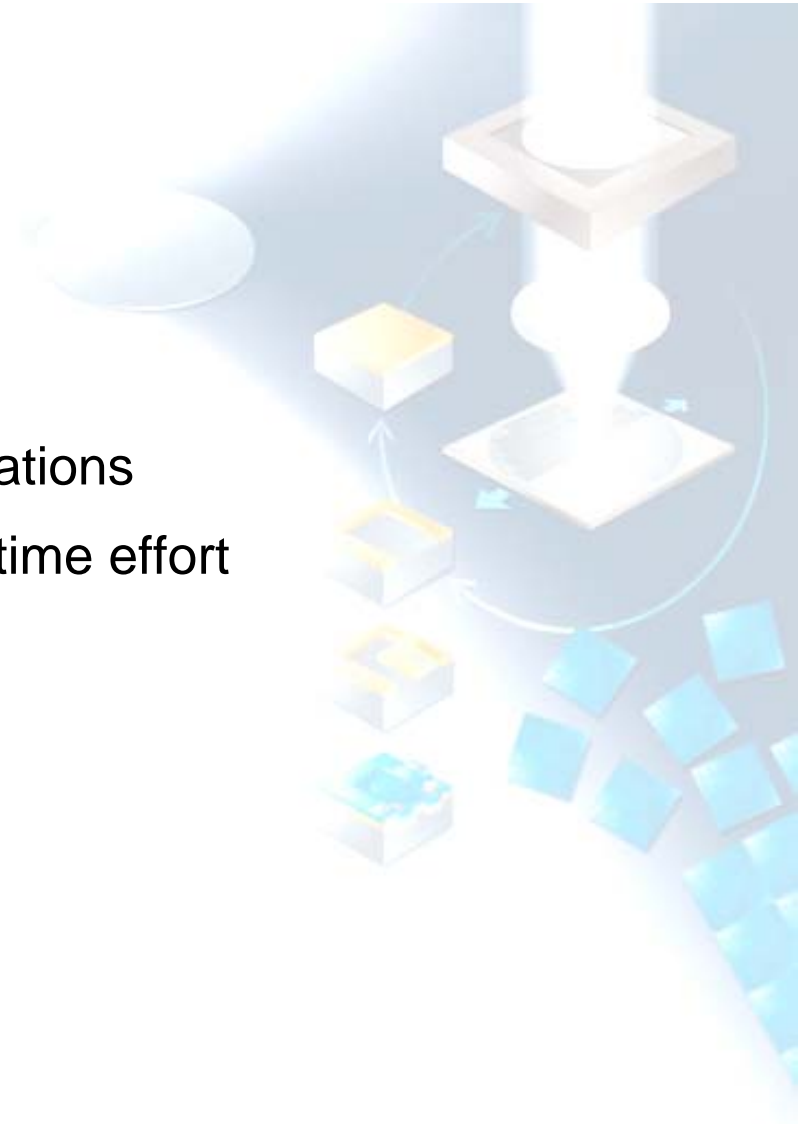
Progress in EUVL Optics Lifetime Expectations

M. Weiss¹, M. Wedowski¹, H. Trenkler¹, B. Mertens², B. Wolschrijn², R. Jansen², A. Duisterwinkel², A. vd Runstraat², H. Meiling³, V. Banine³, R. Moors³, K. Spee³, R. Klein⁴, S. Plöger⁴, F. Scholze⁴, E. Louis⁵, R. vd. Kruijs⁵, R. Kurt⁶

- 1) Carl Zeiss SMT AG, Oberkochen, Germany,
- 2) TNO-TPD, Delft, The Netherlands,
- 3) ASML, Veldhoven, The Netherlands,
- 4) Physikalisch Technische Bundesanstalt, Berlin, Germany,
- 5) FOM Rijnhuizen, The Netherlands,
- 6) Philips Research Laboratories, Eindhoven, The Netherlands

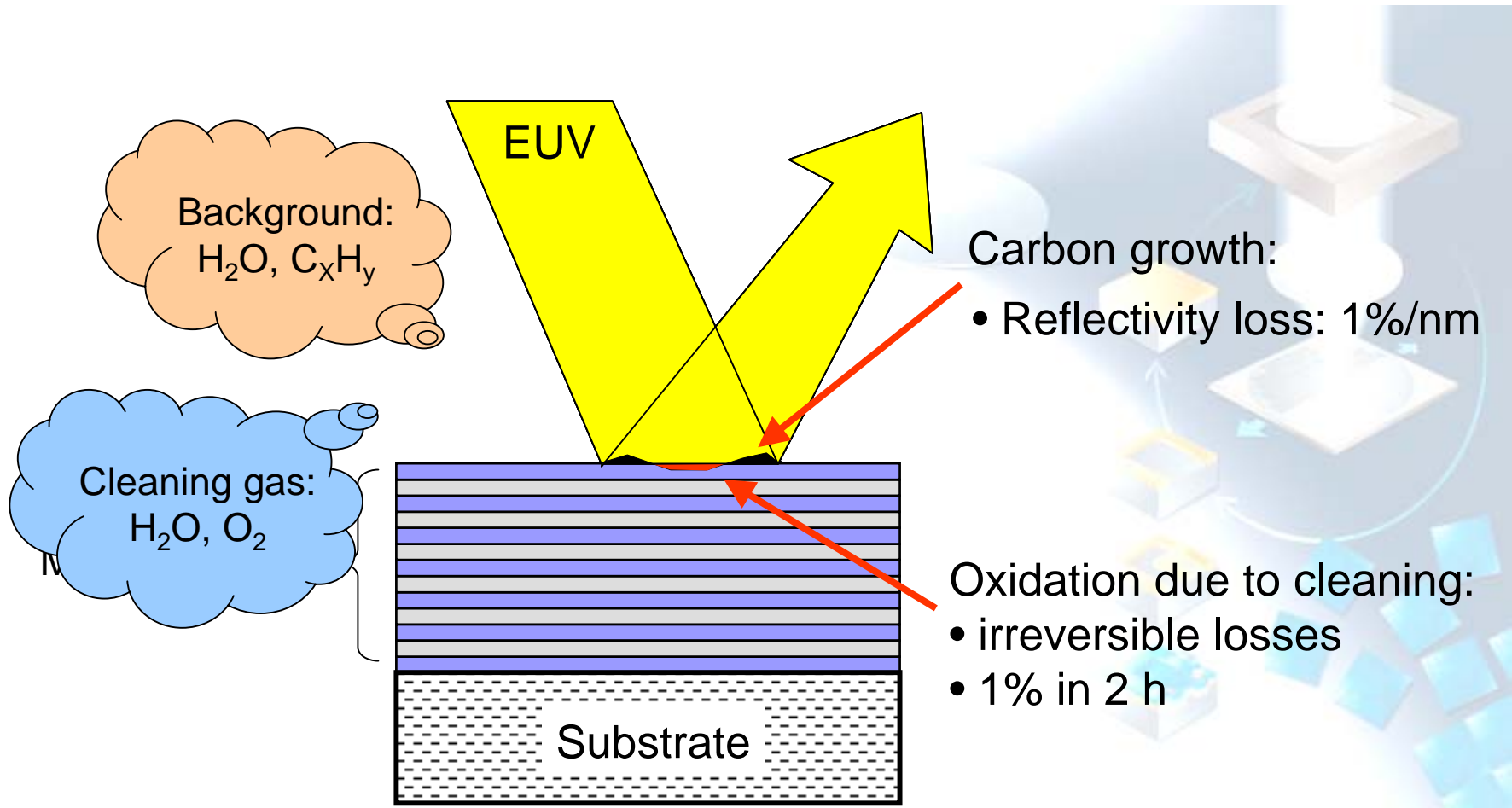


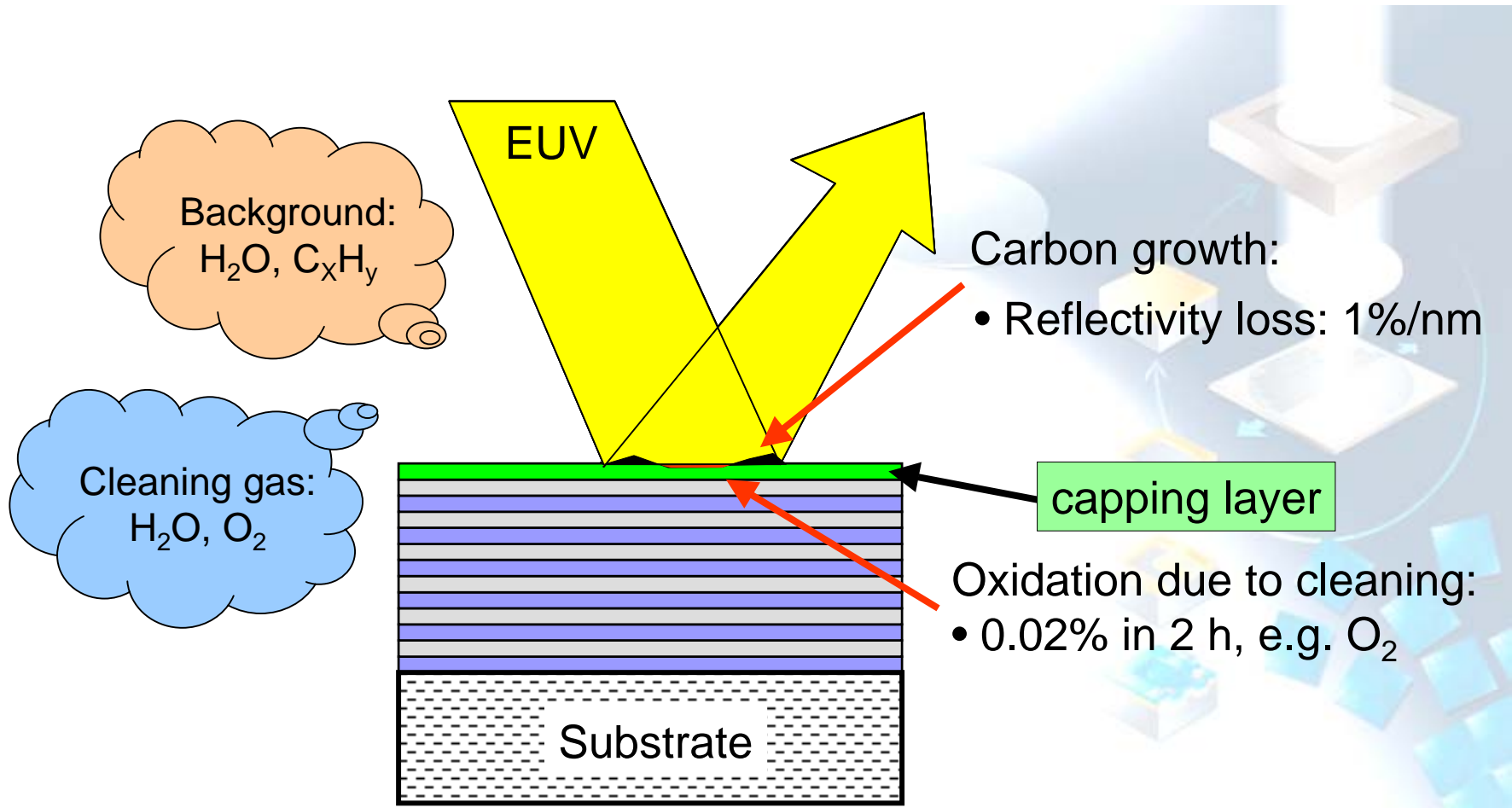
- Basic lifetime specs and issues
- Current understanding of processes
- Strategy to reach optics lifetime expectations
- Team and facilities of ZEISS/ASML lifetime effort
- Recent results on synchrotron
- Conclusions



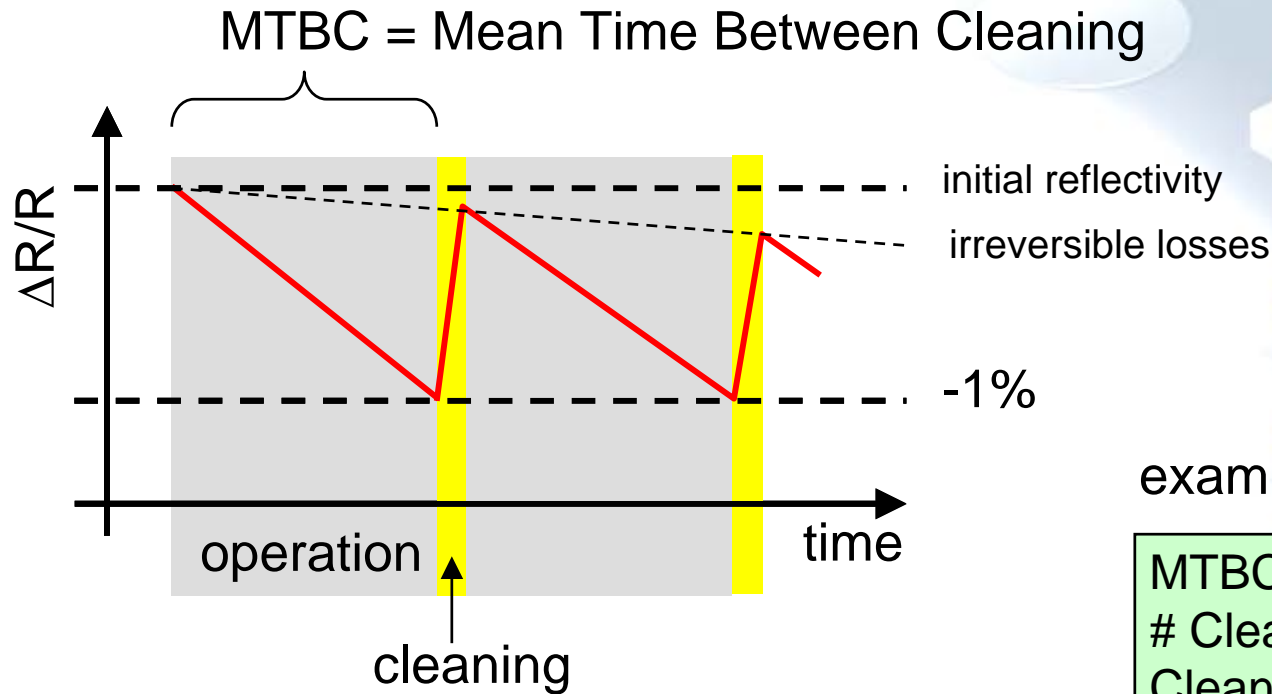
- **Optics Lifetime endangered by**
 - Carbon build-up -> reflectivity loss
 - Oxidation of multilayer -> reflectivity loss
 - sputter damage by source related ions and debris
- **Lifetime specs**
 - lifetime: > 30000 h illumination time
 - < 1% rel. loss per mirror during lifetime
 - uniformity of contamination





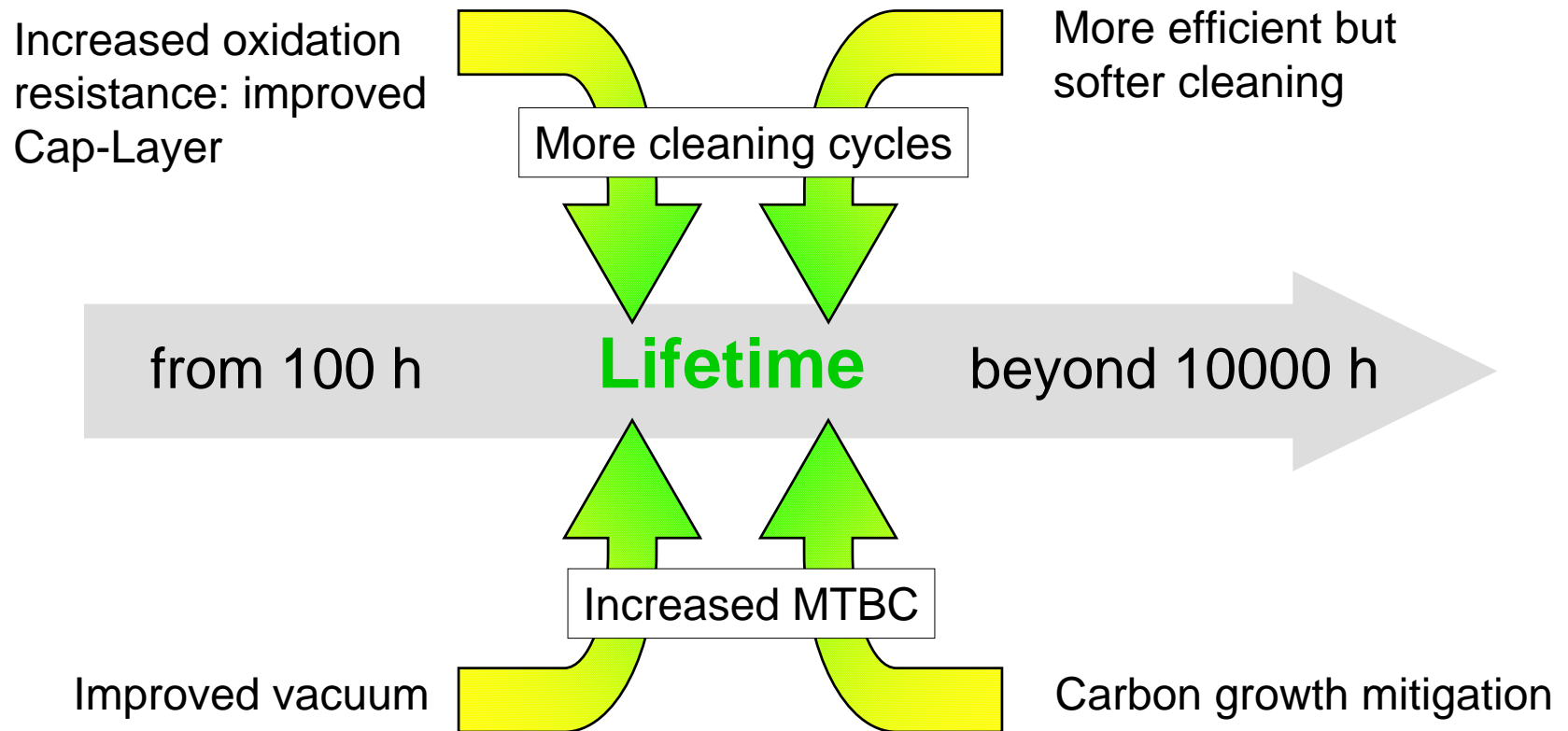


- based on C-cleaning a lifetime model can be defined as follows:



example calculation:

MTBC: 20 h
Cleaning Cycles: 25 h
Cleaning time: 1-2 h





ASML



PTB



ML development and
sample preparation



Coater, X-ray diffraction



Coordination and data
interpretation

vacuum test chamber



ZEISS
ASML

Photon contamination
tests and reflectivity



contamination beamline
Reflectometry



Electron contamination tests
and surface analysis

E-beam, SEM, Auger, SIMS, XPS
...

new:

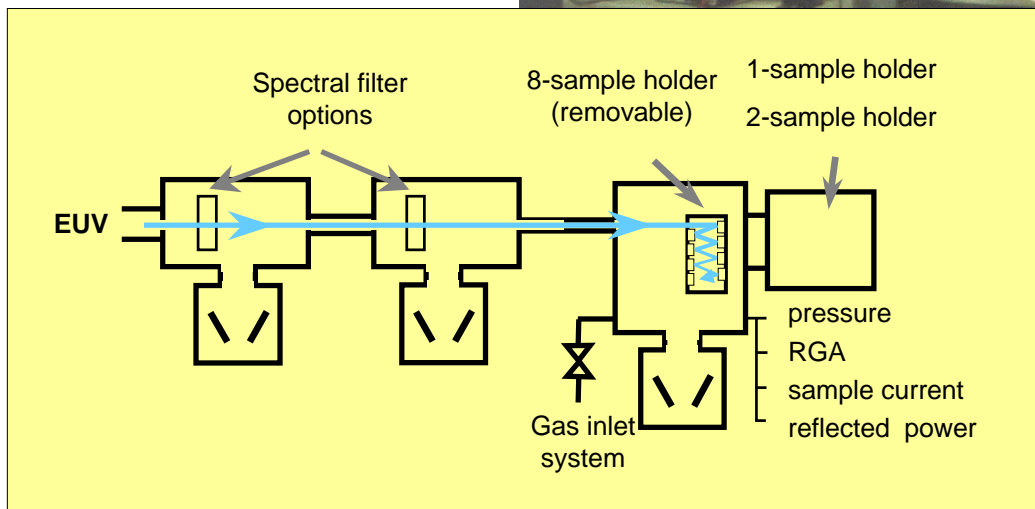
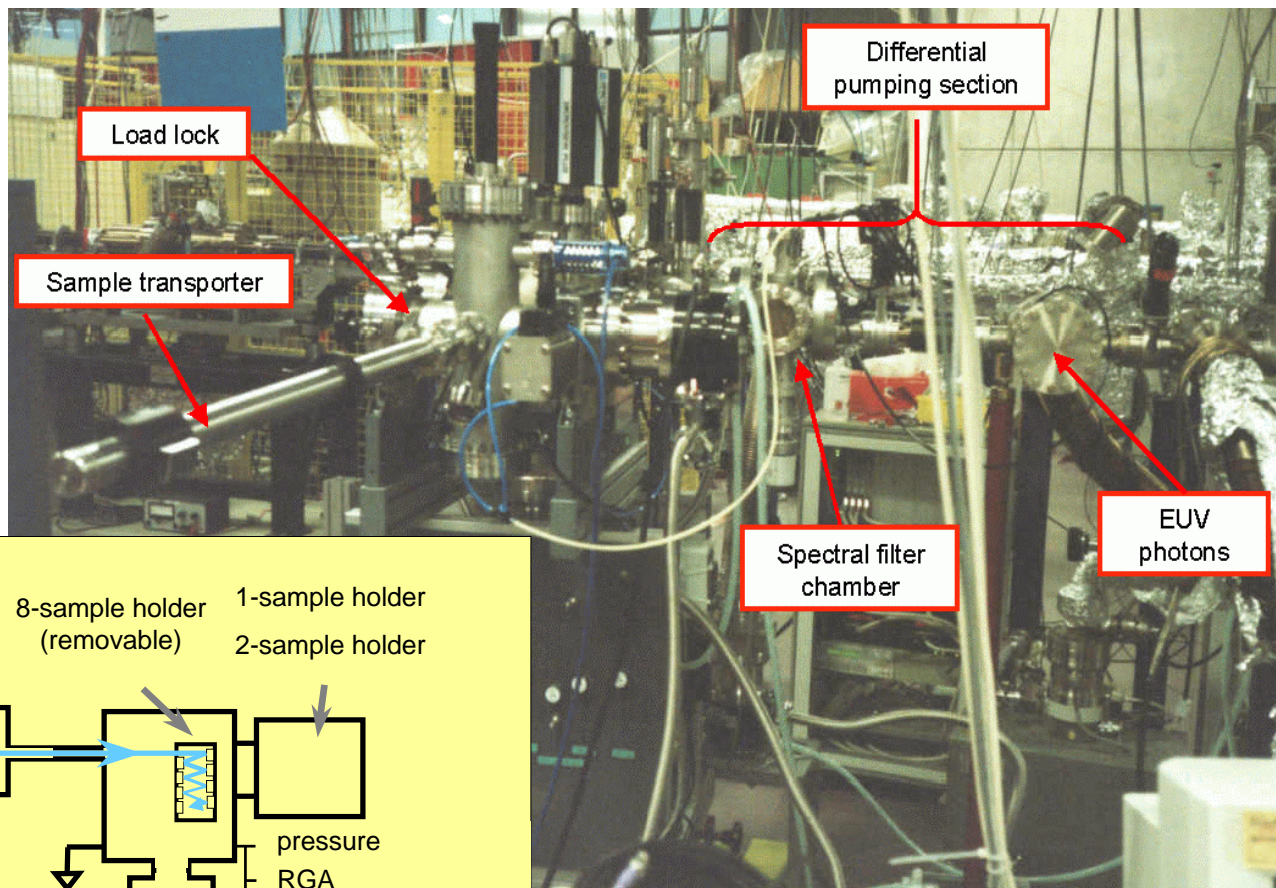


ASML

Pulsed source contamination
experiments

Xe discharge source

(see posters: #5: B. Mertens et al., "The Optics Contamination/Lifetime program...")



- up to 190 mW/mm²
- spectrum comparable

230 h exposure

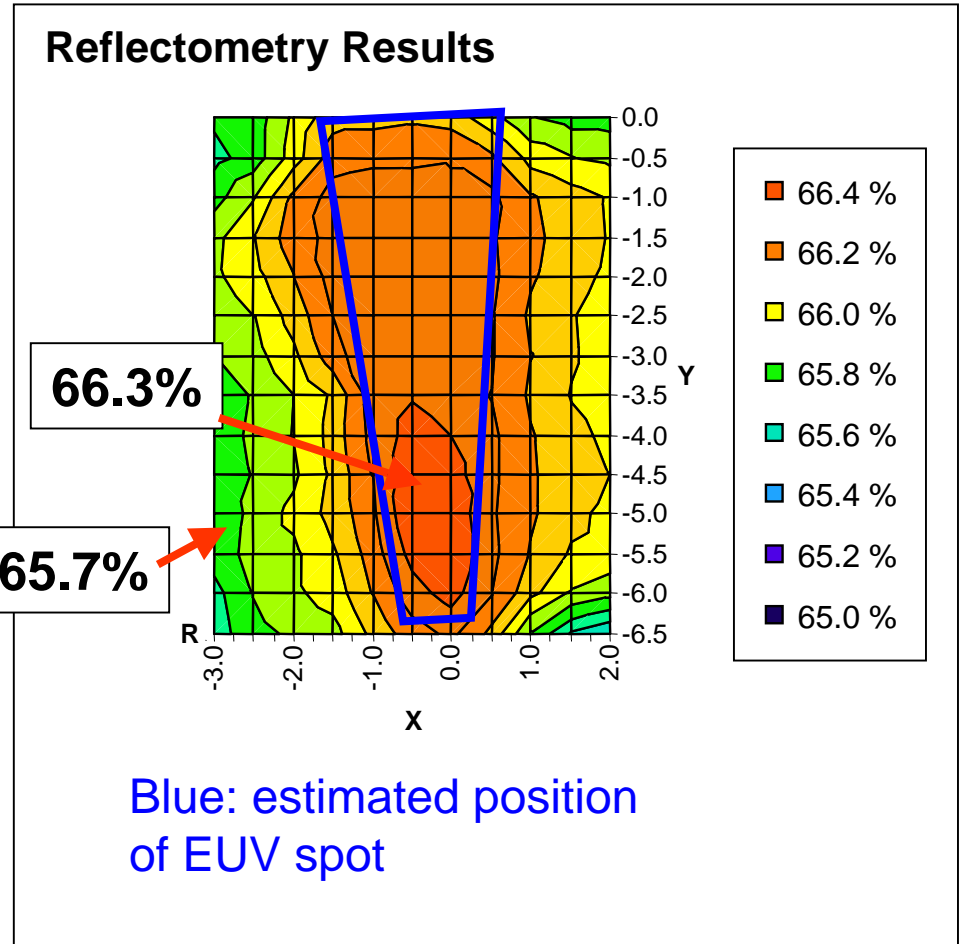
Gasses: C_xH_y , H_2O , O_2

Intensities: 0.05 - 30 mW/mm²

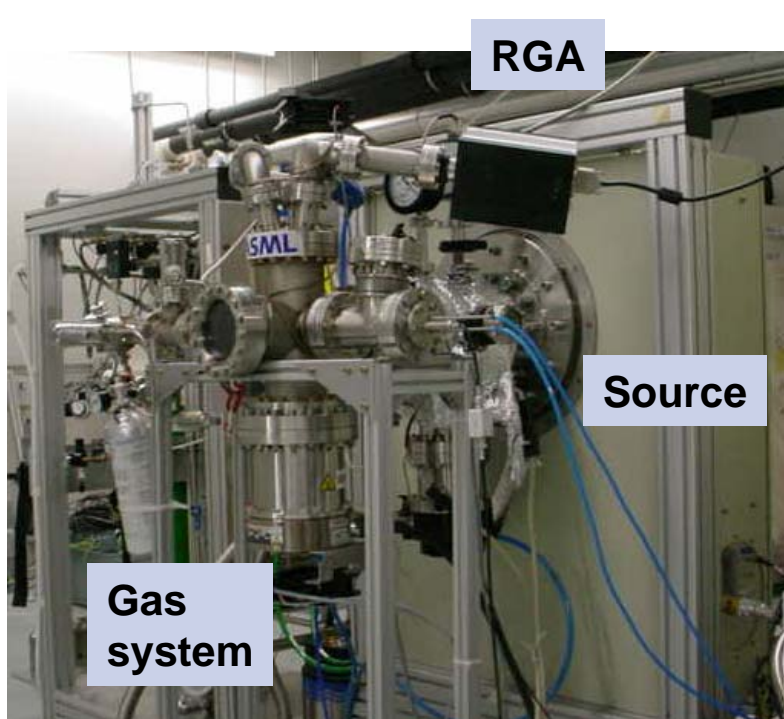
$R_0=66.4\%$

initial reflectivity recovered

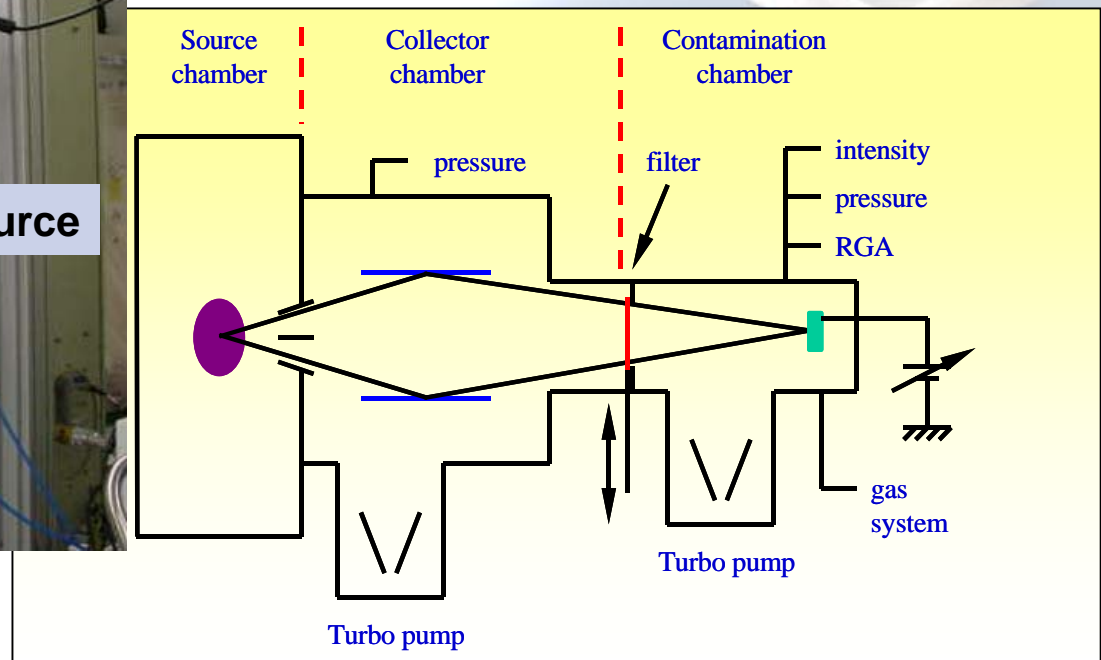
Surface analysis shows no
oxidation or other damaging
effect



(Poster #56: R. vd Kruijs/FOM et al. "Optimization of protective capping layer ...")



HCT Source at ASML



Status:

- first exps performed: less carbon growth at base pressure
- more tests planned

(see posters: #4: B. Mertens et al., "Optics Contamination Under Pulsed EUV Rad.")

- Strong partners team up to solve EUVL optics lifetime challenge
- Contamination studies ongoing at Synchrotron and Pulsed Source
- Progress so far: $-0.5\%/h \rightarrow -0.0008\%/h$ even for high load mirrors
- Lifetime test periods exceed manageable lengths \rightarrow basic understanding of processes required
- less contamination expected at pulsed irradiation
- Future activities focuses on pulsed irradiation effects and base process understanding

Support by Ministerium für Bildung und Forschung under contract 13N8088 and MEDEA+ Project "EXTATIC" is gratefully acknowledged.