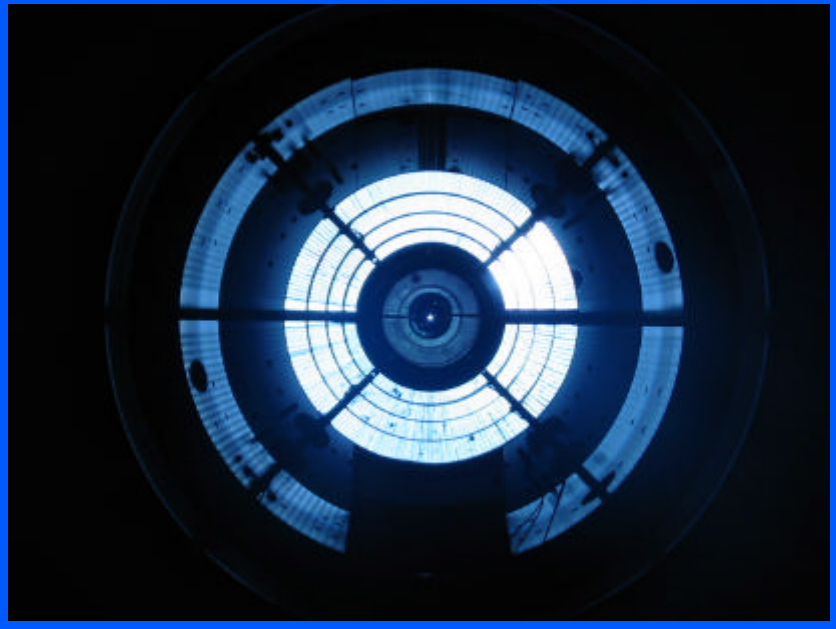
PHILIPS

Philips's EUV Source:

Update and Issues



J. Pankert,

EUVL Symposium Miyazaki 2004

Outline

- Introduction
- Progress on integration of Xe source
  - collector lifetime
  - dose stability
- Progress on Sn-based source
  - power and frequency scaling
  - stability and pinch size
  - debris mitigation
- Summary and outlook

Expected limit of source power

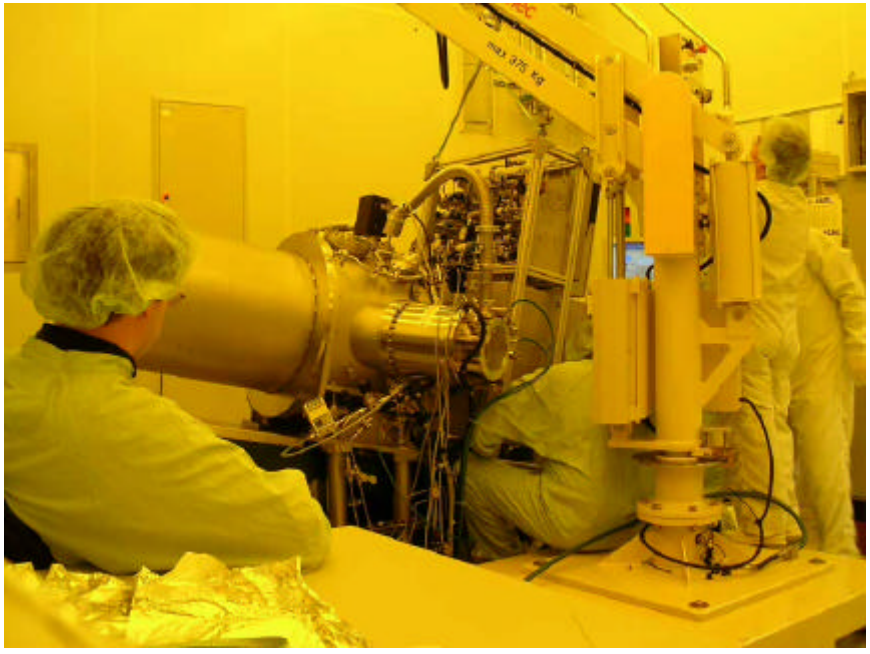
	extrapolation Xe	Sn	Sn
Input power [kW]	30,0	30,0	30,0
conv. Efficiency [1/2π]	0,50%	**2,00%**	**2,00%**
Collection eff. [2π]	20,0%	25%	45%
collector reflectivity	70%	70%	60%
debris system	80%	80%	80%
Gas transmission	90%	90%	90%
EUV 2nd focus [W]	**15,1**	**75,6**	**116,6**

- We need Sn as radiator
- Need for larger collector opening (55º-60º)
- Optics compatible with 30 kW input

Progress in sources soon determined by collector (-integration)

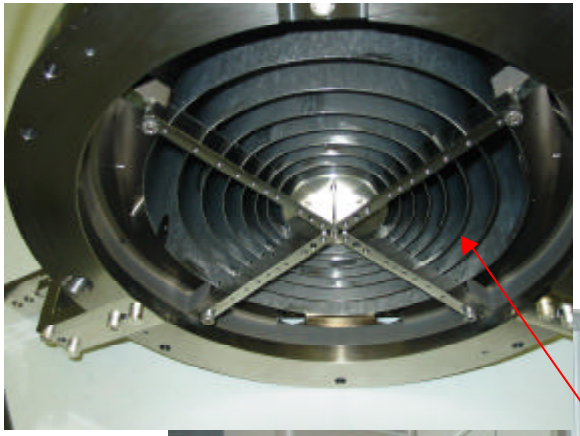
Integration of Xe lamp into α-tool

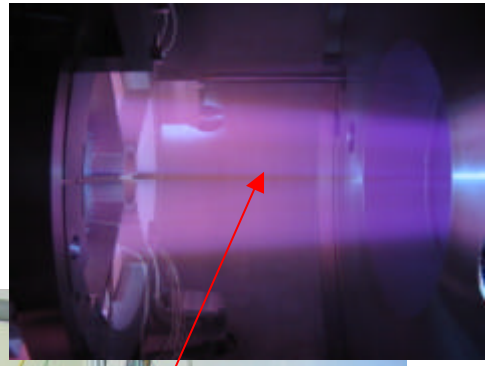
- electrode lifetime
- collector lifetime
- dose stability
- operation reliability
- scanner control
- power (discontinued)



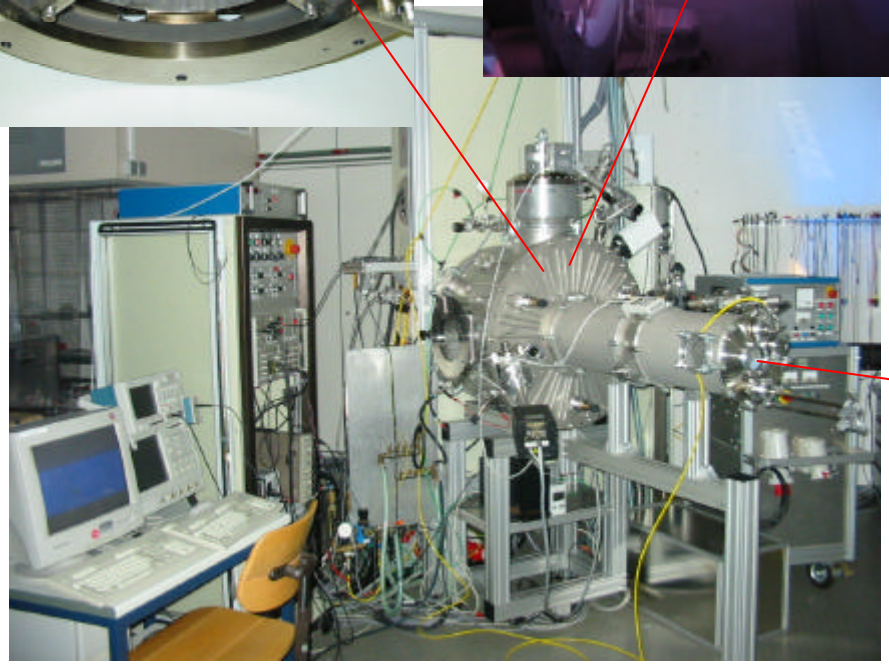
Courtesy of ASML

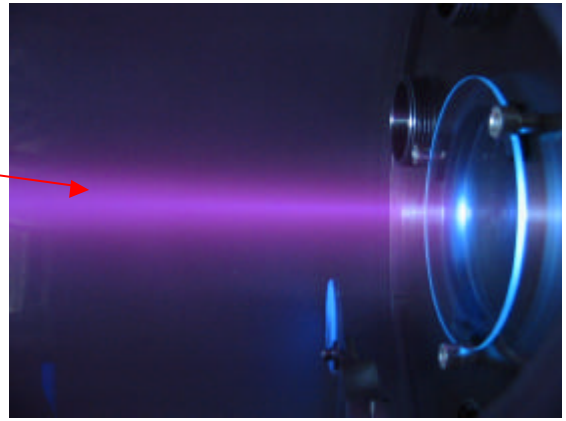
500 Mio Pulses Collector Test



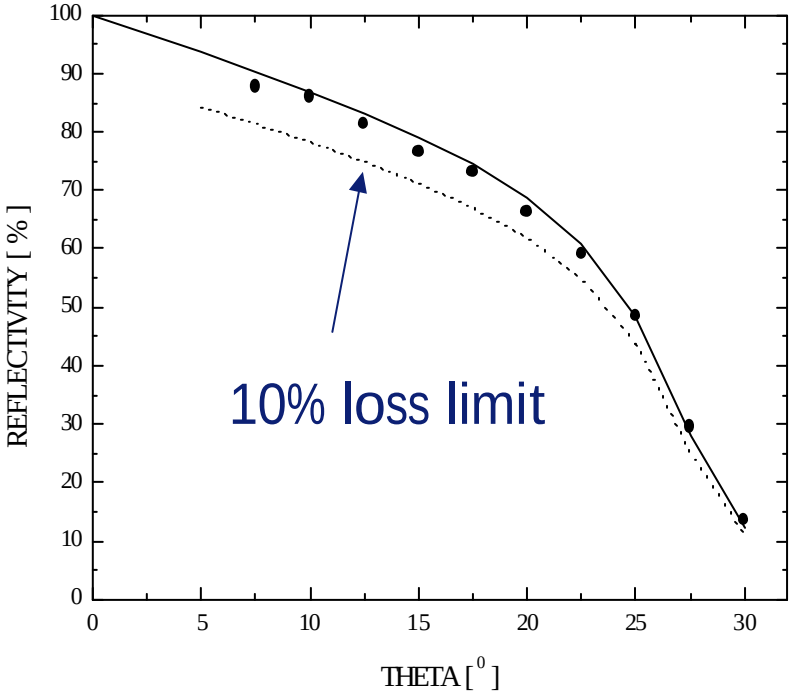


- 96 samples
- different positions
- different materials
- different suppliers





EUV Reflectivity – Philips' Ru/Si

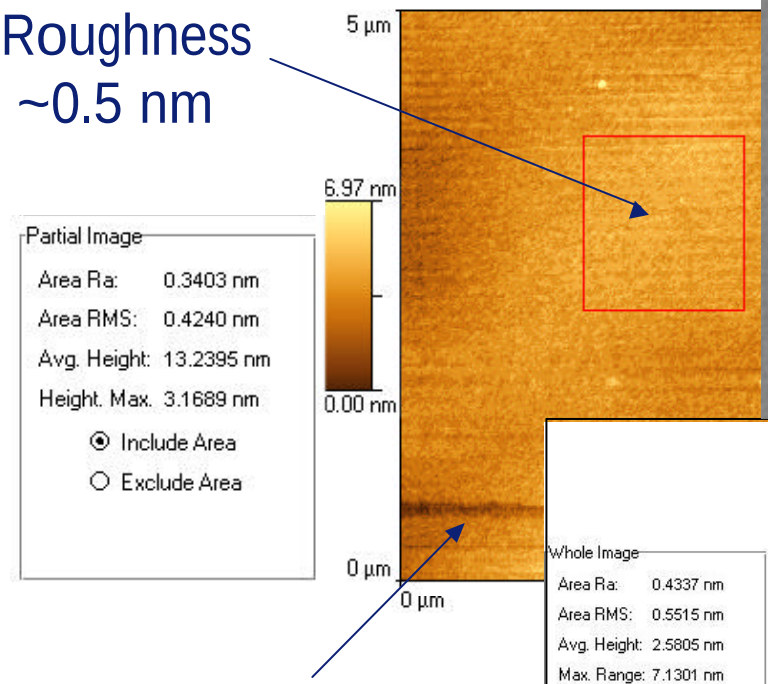


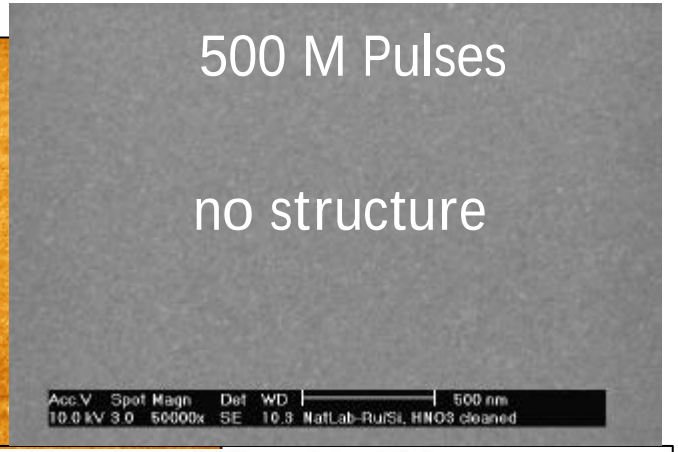
-500 Mshots
-12 cm distance to plasma
-GI middle position

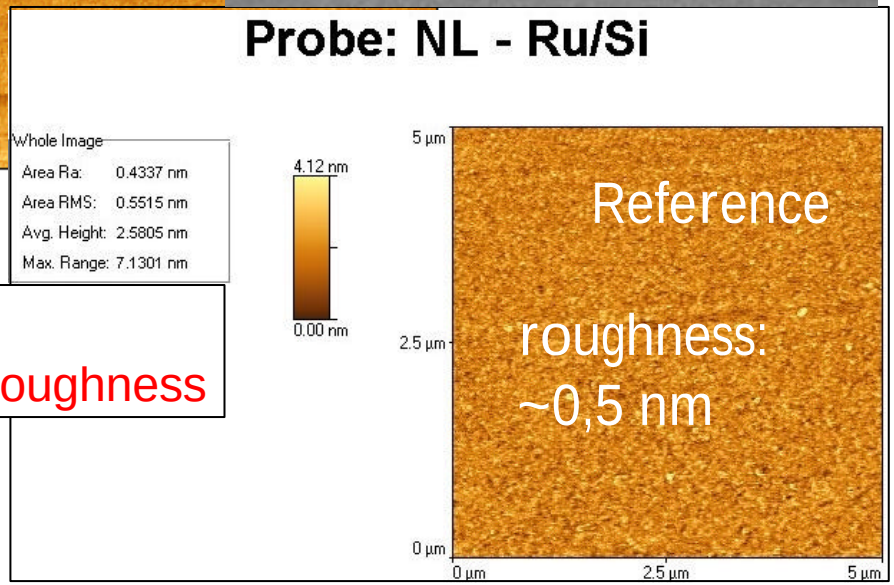
virtually no reflectivity loss:
Collector will support 2-3 Bln shots

Extensive in-depth analysis of all damage processes

Roughness
~0.5 nm

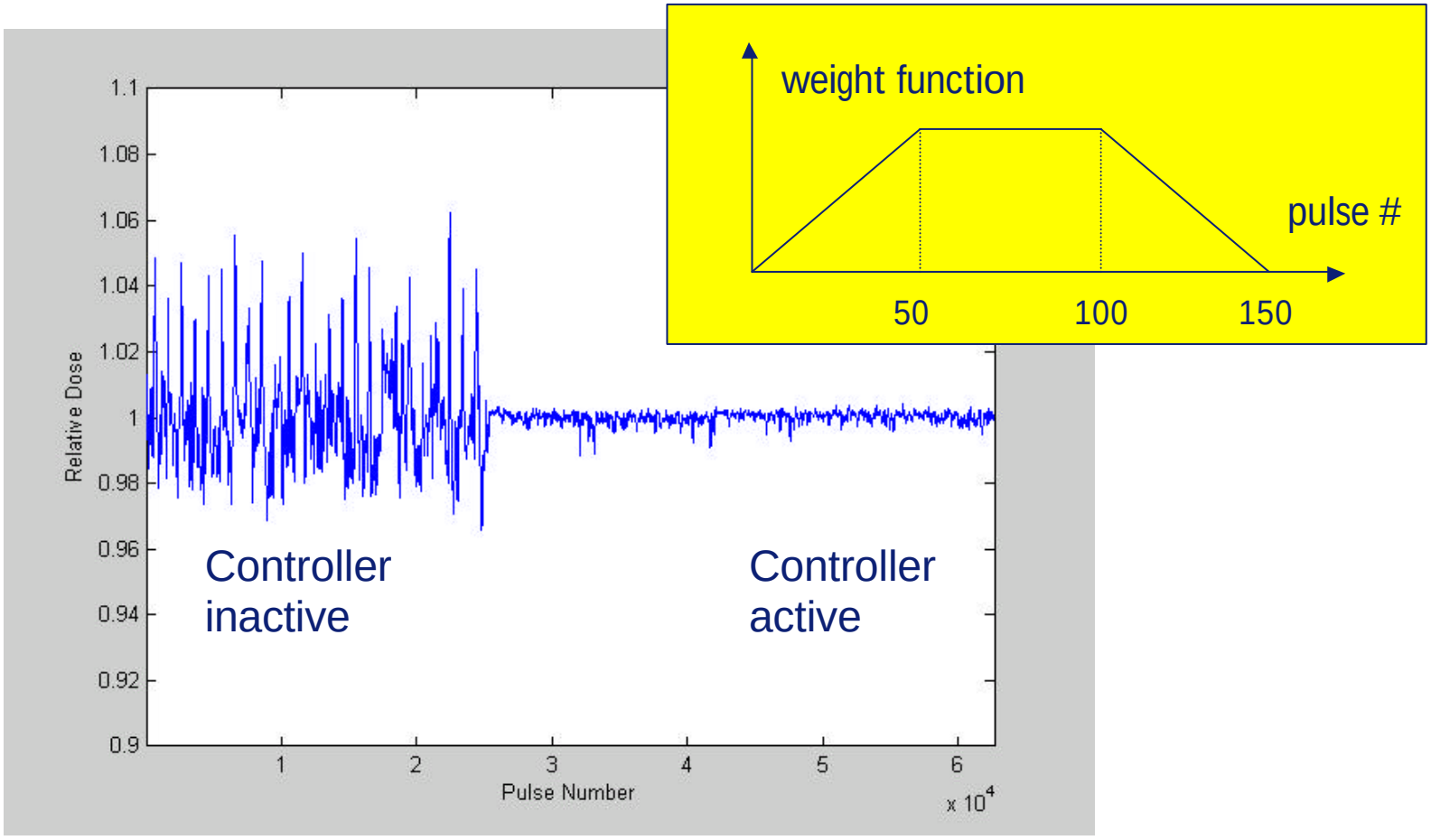




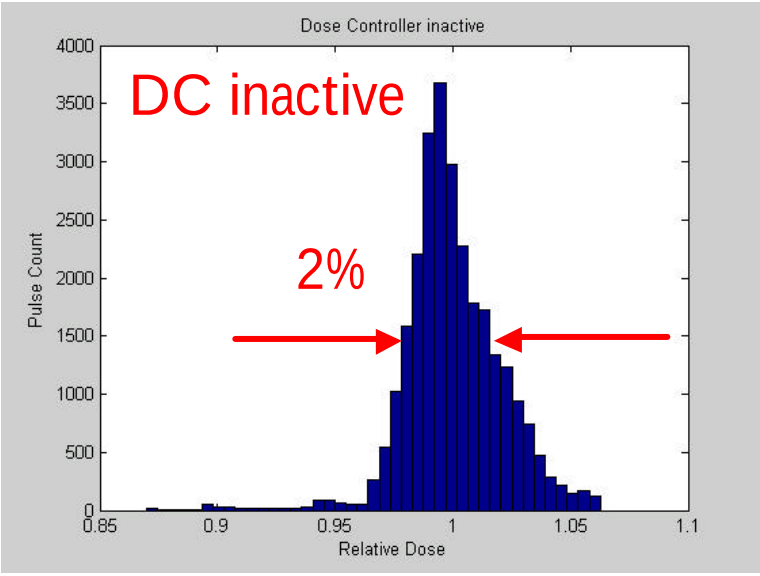


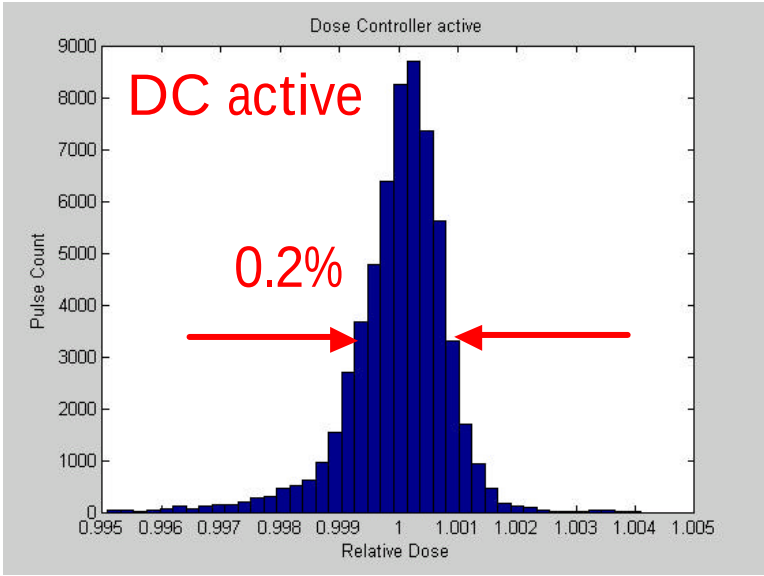
Philips‘ Ru/Si:
no increase in surface roughness

Active dose control: < 0.2% stability



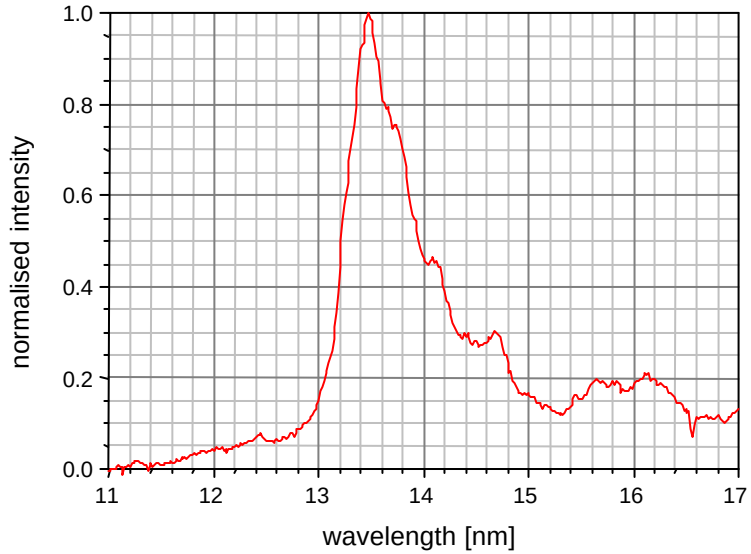
Histograms over ~50000 shots





- pulse-to-pulse fluctuation of free running source: 6% (1σ)
- no active control: ~2% dose stability
- active control: ~0.2%, well within specification

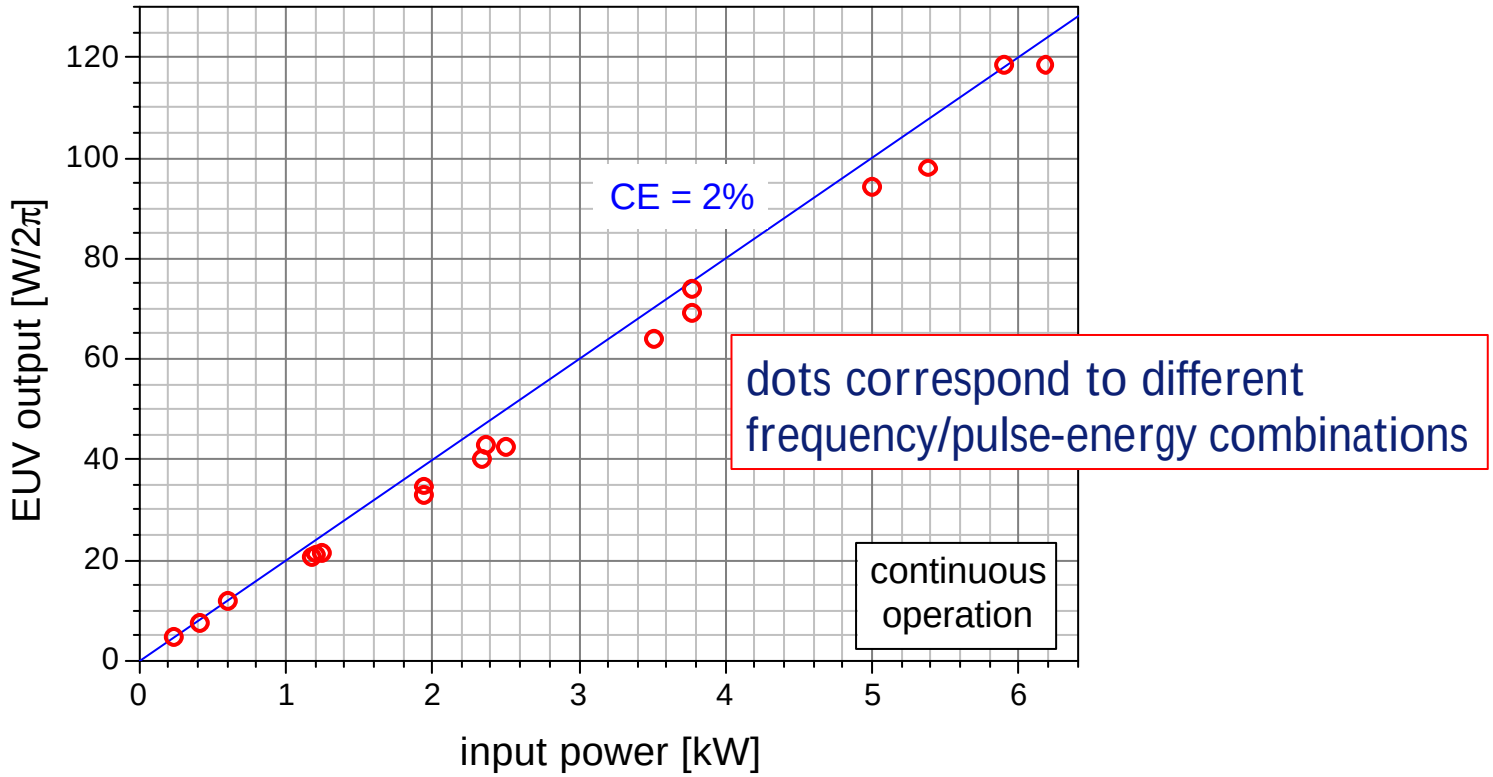
Progress on Sn-discharge lamp



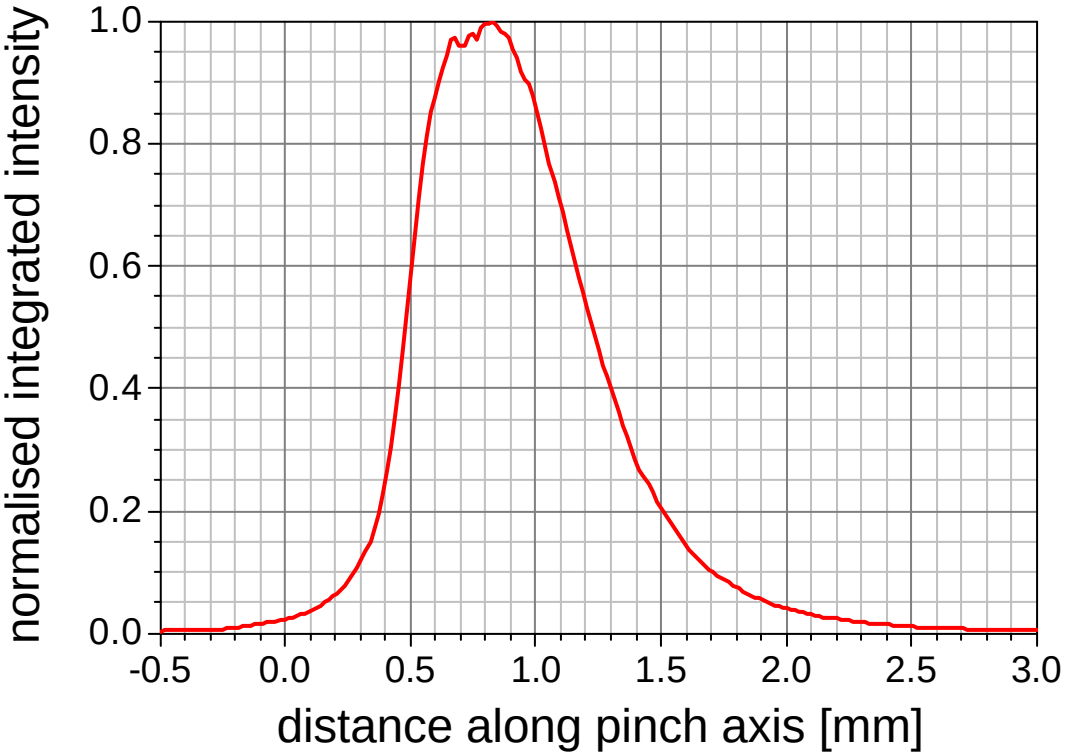
~20% spectral efficiency

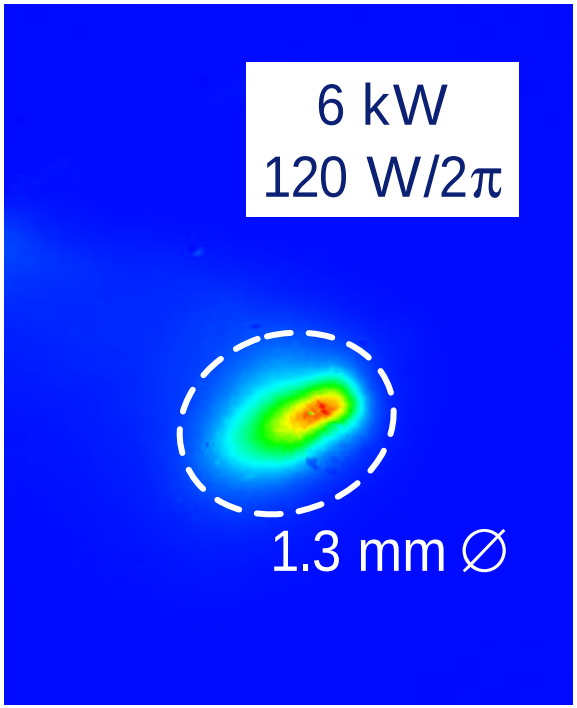
Power scaling:

- Continuous mode of operation
- >300 Mshots electrode lifetime
- commercial product next year



23% collection efficiency (~80% × 28%)





Corresponds to 22 W@IF on a p sr collector

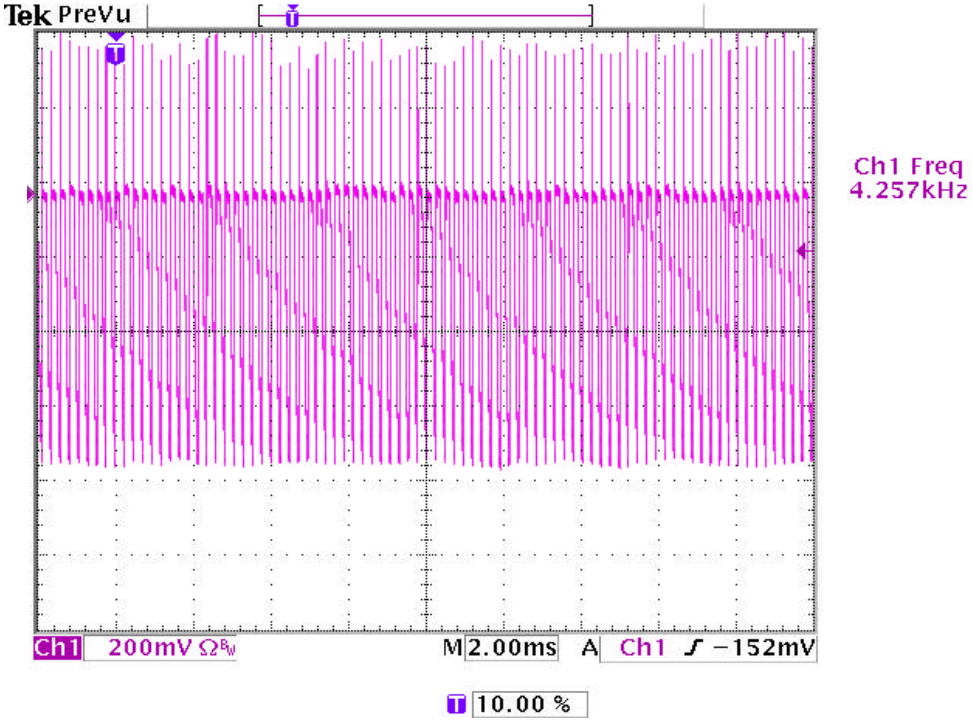
Short-time operation (minutes)

Frequency **4.26 kHz**

Input **13.4 kW**

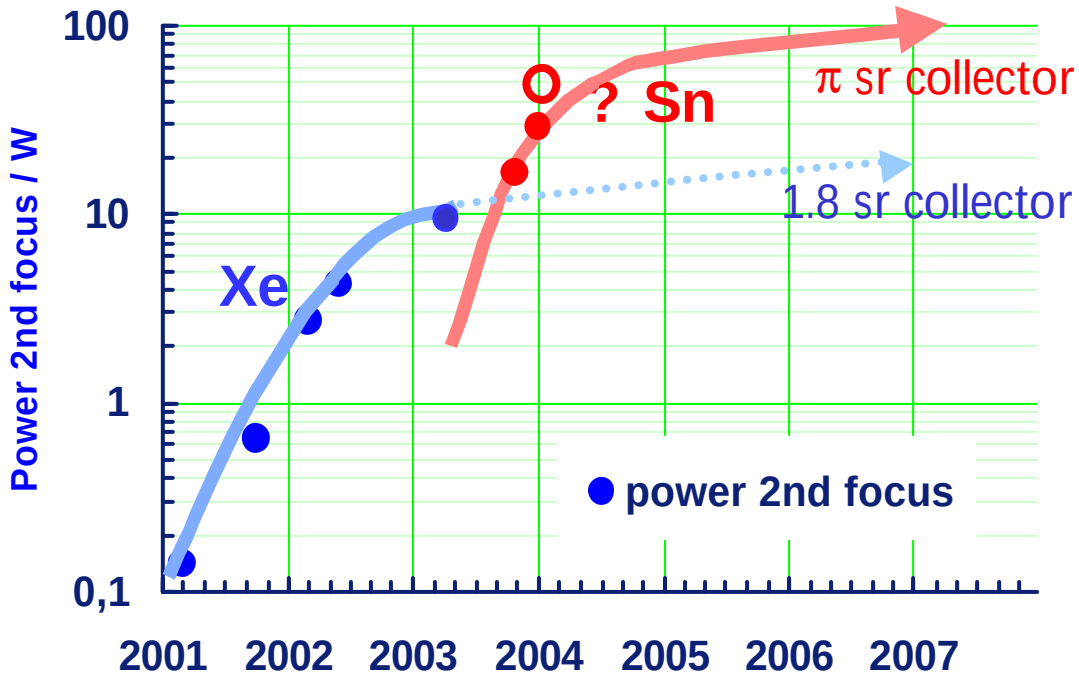
Output **257 W/2p**

collection efficiency: 80%

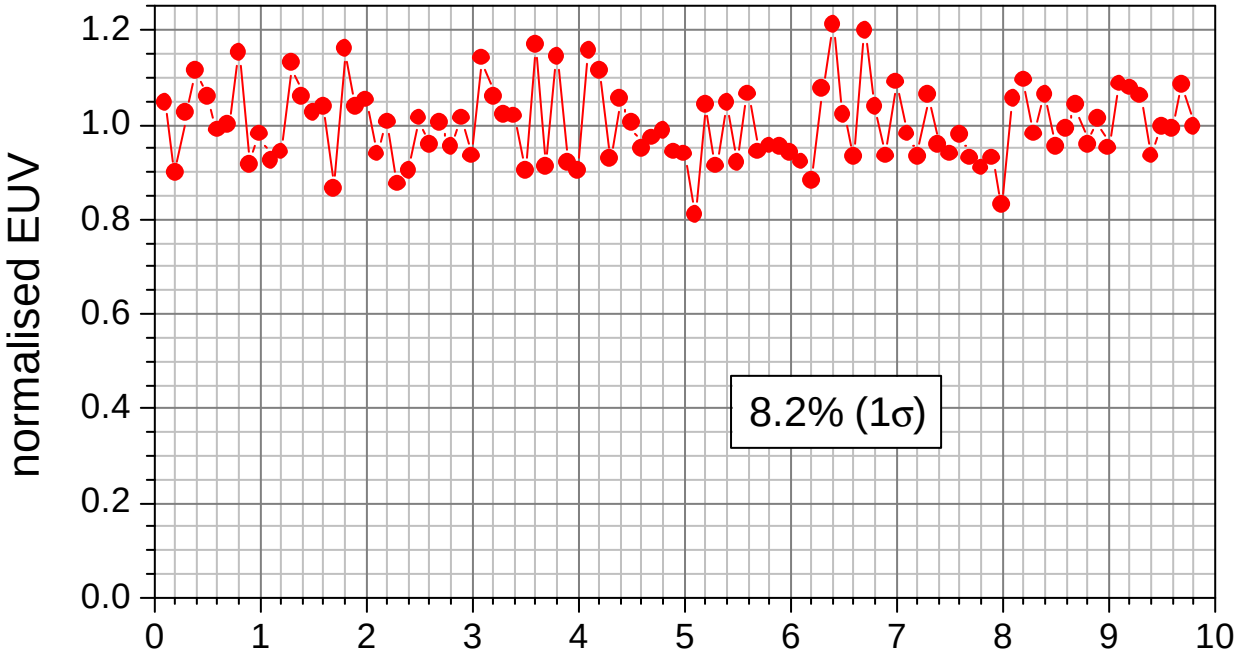


Corresponds to 46W@IF on a p sr collector

Historical development of power



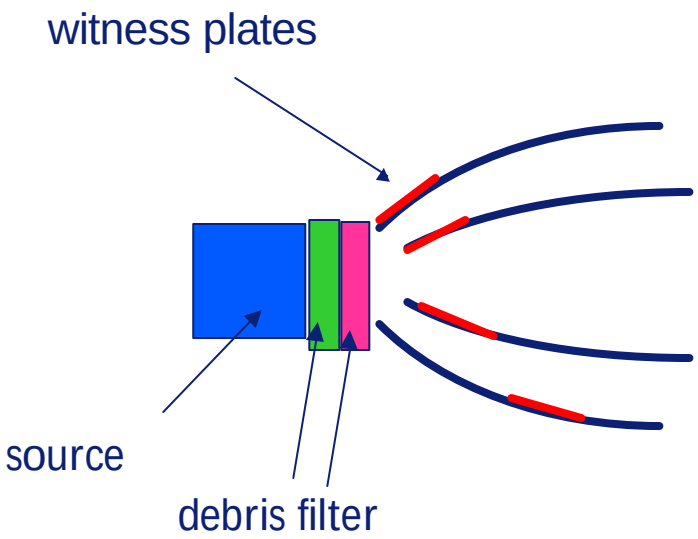
Dose stability: comparable with Xe lamp

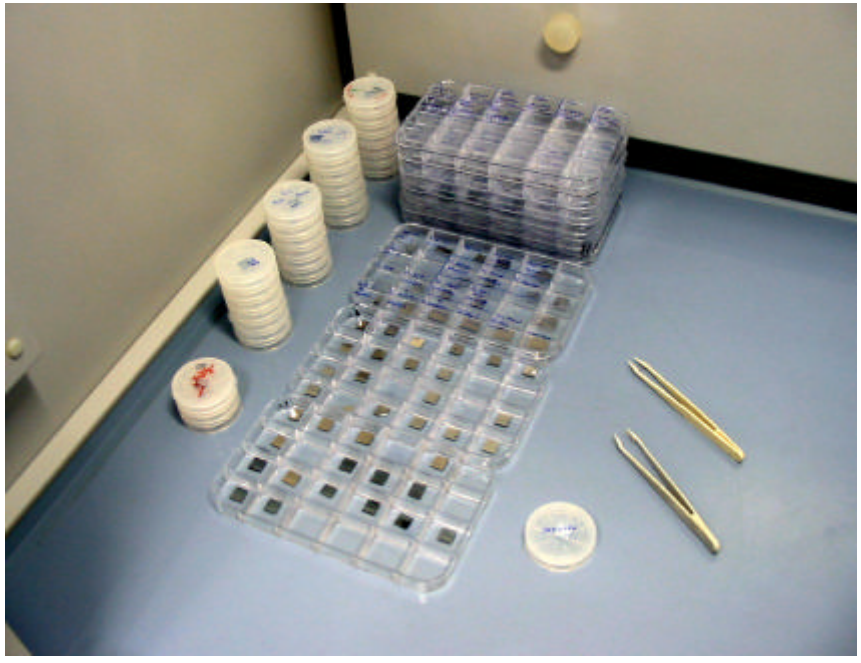


Expected dose repeatability with full active dose control: 0.2%

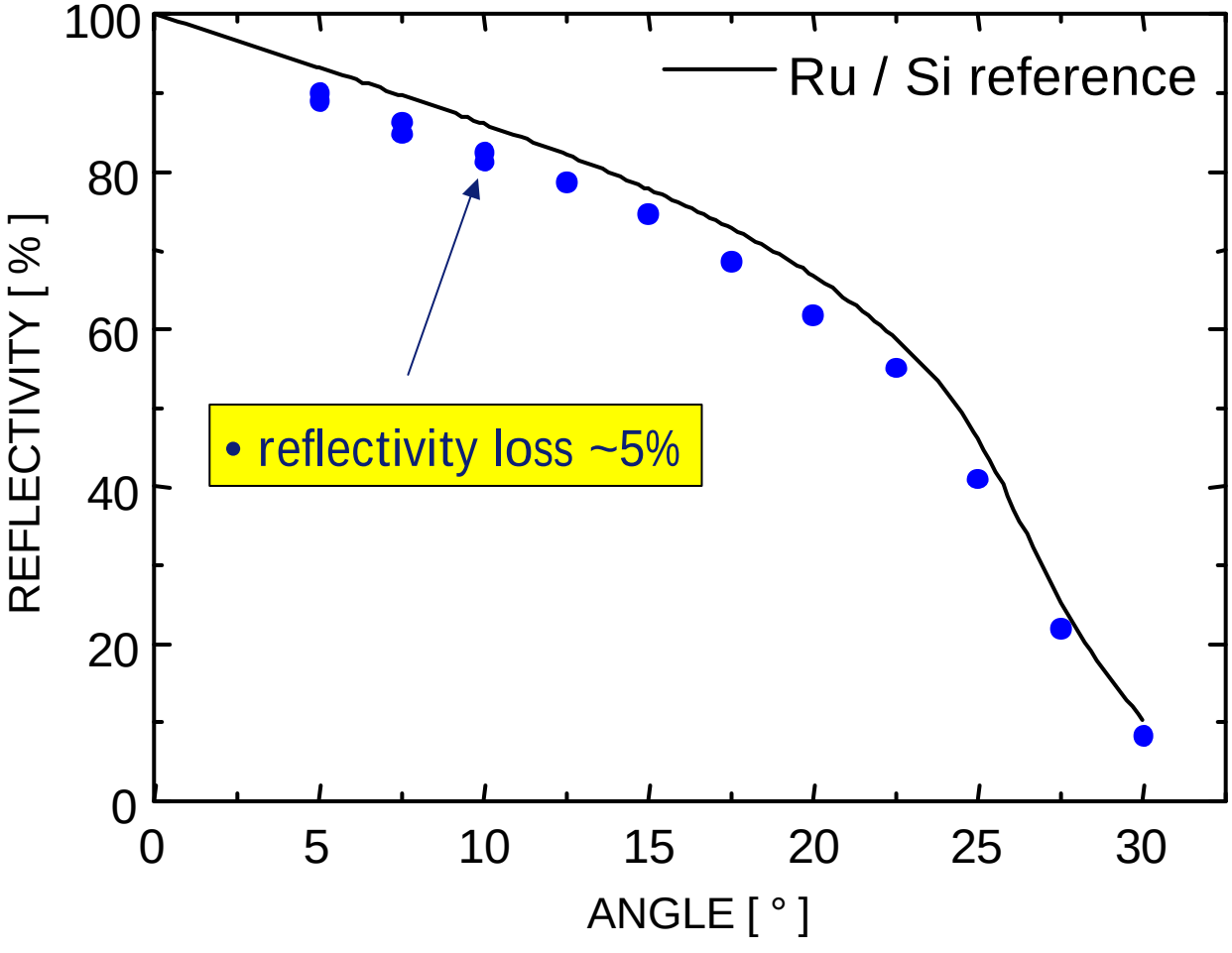
Debris Mitigation:

- test of different mitigation schemes (independently)
- exposure of hundreds of different samples
- analysis of all kind of debris (particles, atomic, ionic,...)





GI, 40 M shots: ~100 Mshots life time with one method



Plot : Graph1
File : Z:\EUVLQUEL\MESSUNGEN\ROSIER\DATEN\2004\Samples reflectivity II.opj

In preparation: Combination of two methods

	method 1	method 2	expected	final target
Atoms in Pi sr (# per shot)	3,0E+15	3,0E+15	3,0E+15	3,0E+14
Mitigation 1 (suppression)	10000		10000	10000
Mitigation 2 (suppression)		300	300	1000
1 nm on collector (pulses)	5,1E+07	1,5E+06	1,5E+10	5,1E+11

Target for next year: >1 bln shot collector lifetime

Collector vessel with combined mitigation schemes in progress

Conclusions

- Xe-source: On a good way to complete integration
  - >0.5 bln shots collector lifetime demonstrated, 2-3 bln extrapolated
  - active dose control demonstrated
- Sn-source:
  - 5-8 times higher overall efficiency
  - high frequency operation demonstrated (>5 kHz)
  - 22 W cw (46 W short time) demonstrated
  - power not the key issue anymore, but collector design and protection!

Critical issue list

move down

move up

1. Source output (2)
2. Defect-free multilayer coated mask blank mfg, including inspection (1)
3. Source & condenser optics reliability (5)
4. CoO of EUV lithography (3)
5. Defect-free patterned mask manufacturing/commercial availability (4)
6. Reticle defect protection (from inspection through exposure) (6)
7. Effective contamination control of optical path (lifetime) (7)
8. High NA optics manufacturing (9)
9. Thermal management of reticle & projection optics at high throughput (8)
10. Resist – high sensitivity at low power with low LER (new)

Source: 2nd International EUV Symposium (2002 Steering Committee)

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