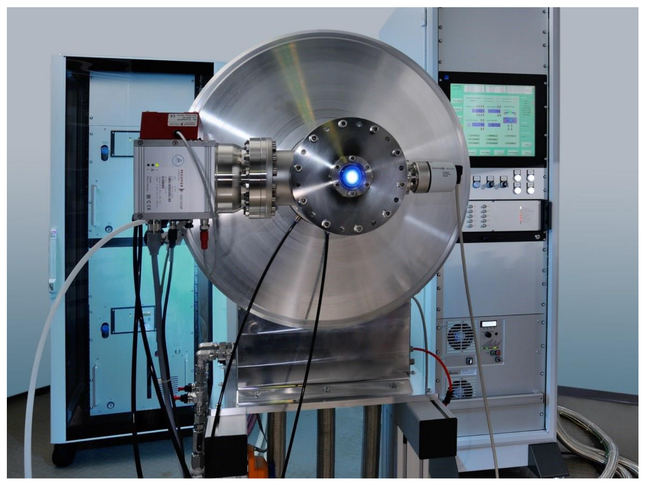
Compact discharge based EUV source for metrology and inspection

Jochen Vieker, Alexander von Wezyk and Klaus Bergmann

Fraunhofer Institute for Laser Technology ILT, Steinbachstraße 15, 52074 Aachen, Germany
www.ilt.fraunhofer.de

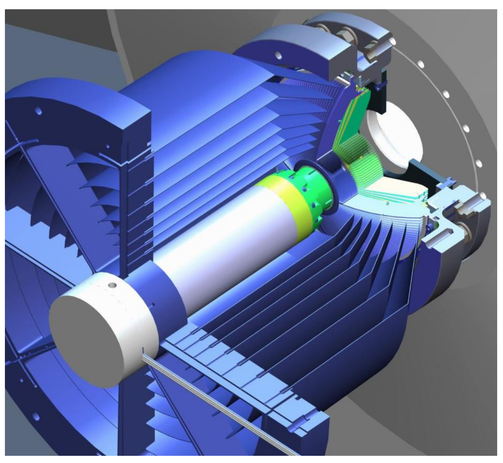
FS5420: 20 W EUV Source



Discharge source FS5420 (source, control unit, chillers)

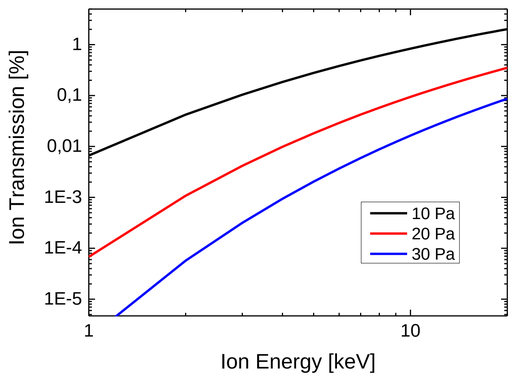
- Max. input power: 15 kW
- Max. pulse energy: 10 J
- Max. repetition rate : 2.5 kHz
- IF-intensity ~40 mW/mm² with matched collector
- Typical plasma length: 3-5 mm
- Typical emission diameter at 13.5 nm: < 300 µm (FWHM)
- Accessible collection angle: > 80°

Source Collector Module with Foiltrap



FS5420 Source Collector Module with integrated foiltrap

CLERMONT + PARTNER INGENIEURBÜRO



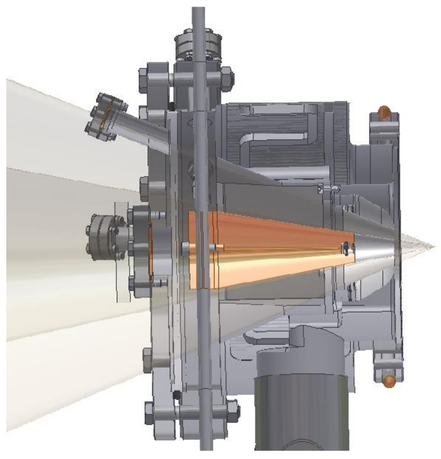
Monte Carlo simulation of foiltrap transmission propability of Xe-ions

- Mitigation of fast Ions in foiltrap in combination with buffer gas
- IF-intensity including foiltrap and gas transmission: **25 mW/mm²**

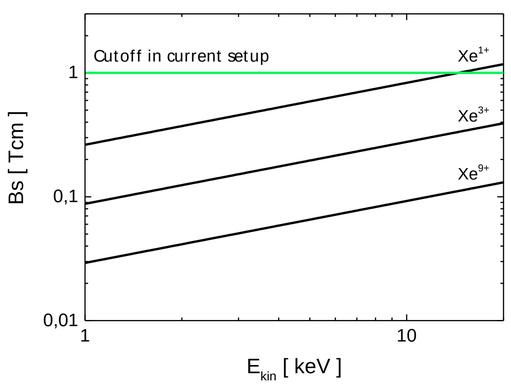
Gas Flow / Magnetic Debris-Mitigation

- Accessible collection angle:
  23° (no central stop)
  23°-45° (central stop)
- Magnetic counter pressure ($B^2/2\mu_0$) for slow expanding plasma
- Deflection of fast ions in B-Field
- Mitigation of electrode vapor by purge gas flow towards the source
- Up to 200–400 mT in shielded vessel

research instruments

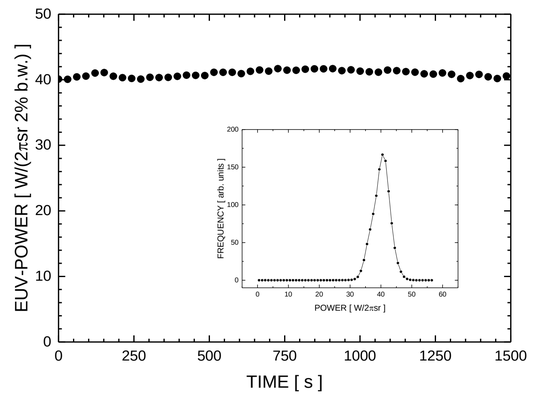


Magnetic debris-mitigation system with central-stop (top)

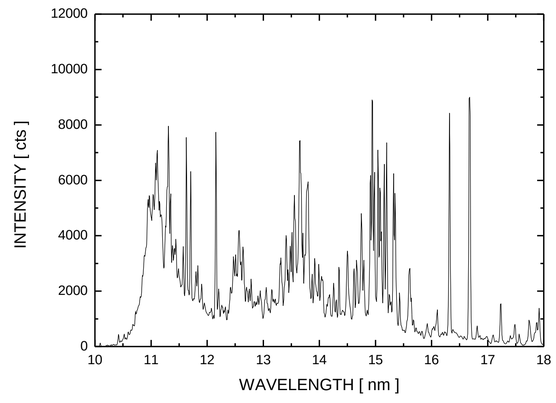


B·s for 20° deflection of Xe-ions (left)

Performance at 40 W



EUV inband power in a 30 min run

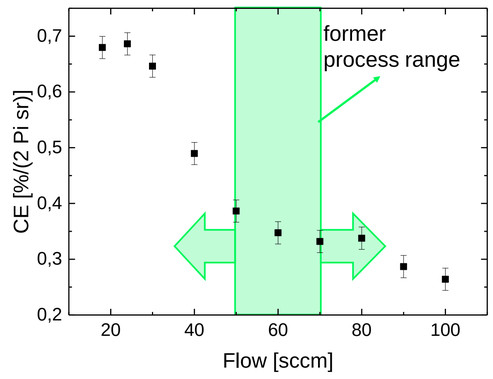


Typical xenon emission spectrum

- Standard deviation (pulse-to-pulse) : σ = 6.8 %

Efficiency optimization

- Extended range of operation for Xe- flow due to **advanced triggering**
- Higher tolerance towards electrode erosion
  (tested electrodes had >150 Mshot)
- Higher conversion efficiency (~0.7 %) at lower gas flows achievable



Flow dependence of CE at 6 kW input power

13.5 nm inband performance at 6 kW input:

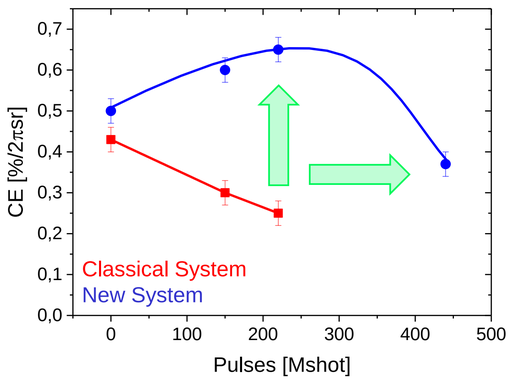
EUV Power	EUV Brigthness
40 W/(2πsr)	**12 W/(mm²sr)**

Increasing Lifetime

Classical System:

- Wear of IP (Intermediate Plate) is mainly determining the source performance
- Xe-flow increases with wear of IP
- Higher flow lead to lower CE and reduces the working range
- 100-250 Mshot maintenance interval

2% inband CE for used electrodes



New System:

- **Advanced triggering** allows operation at lower Xe-flow with increase of CE at higher tolerance towards electrode erosion
- Expected electrode lifetimes of **>1 Gshot**

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