The Effect of Gas Admixture on the Operation of a Discharge based EUV Source

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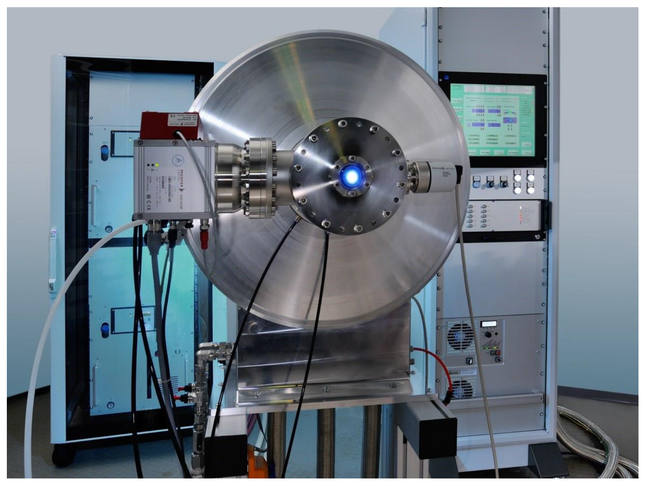
EUV Source FS5440



Gas discharge based EUV-source FS5440

		typ. emission parameter:	
Repetition rate	< 2500 Hz	13.5 nm; 2% b.w.	20-40 W/2πsr
Input pulse energy	< 6 J	13.5 nm; 4% b.w.	35-70 W/2πsr
typ. input power	< 8 kW	10-18 nm	350-700 W/2πsr
max. input power	< 15 kW	pinch diameter	500 µm (at 13.5 nm)

Why add Helium… ?

- higher ionization potential (24 eV vs. 12 eV)
- low mass compared to Xenon
- low EUV absorption

Potential benefits[1]:

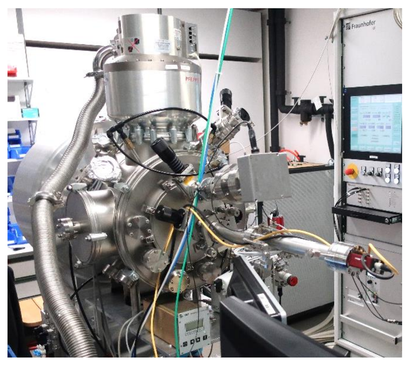
- No ionization close to electrode surface
- Neutral gas carpets reduce electrical field
- Suppression of misfired shots due to arcing over electrodes
- Larger degree of freedom for adjusting the initial Xenon number density in the pinch region
- Optimizing the EUV emission with changing shapes of electrodes due to erosion

To clarify:

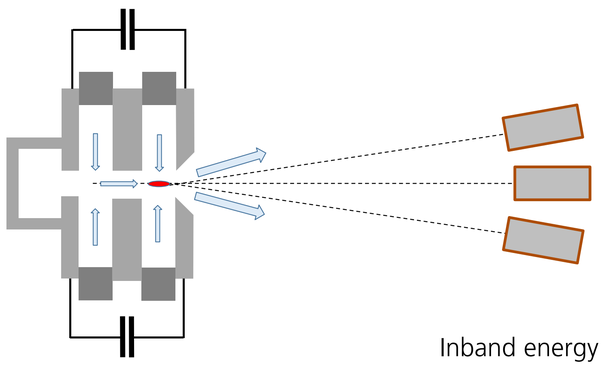
- Influence of Helium admixture on EUV emission (conversion efficiency, spatial profiles)
- Accessible range for the Helium flow
- Comparison of different flow configurations
- Influence on long term stability of the source

[1]Stephen F. Horne et al., "Mixed gases in the EQ10, Mostly about Helium and Stability", 2018 Source Workshop Prague, (2018)

Experimental set-up



EUV source with vessel and attached diagnostics

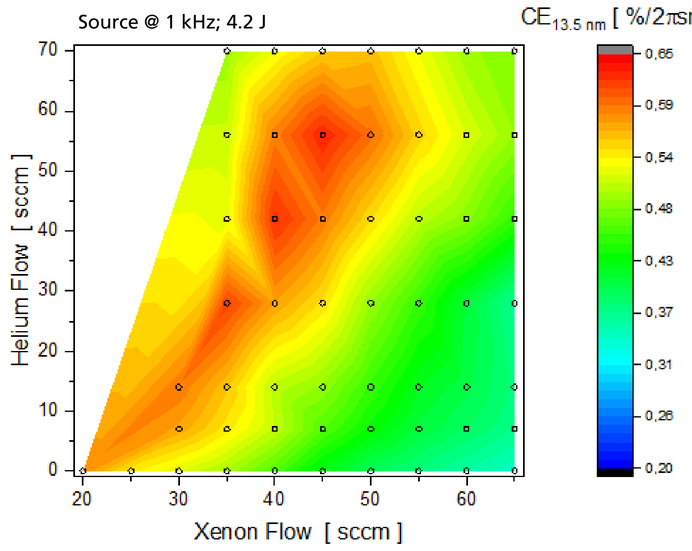


Scheme of electrode system and gas flows

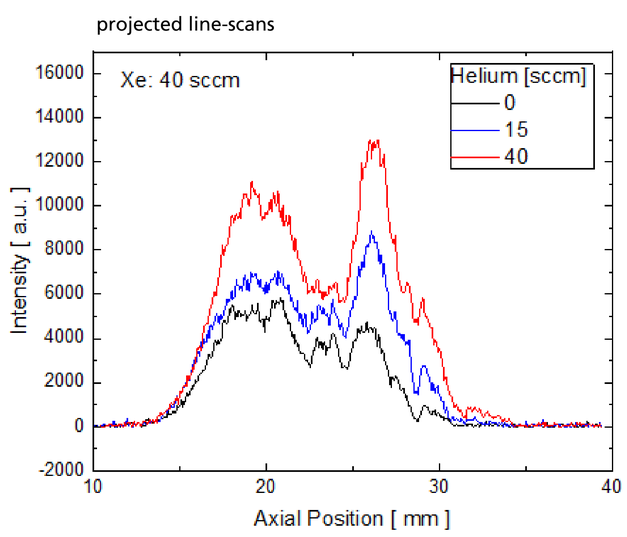
Inband energy monitor

Inband camera (2x) on-axis and off-axis

Results with Helium operation

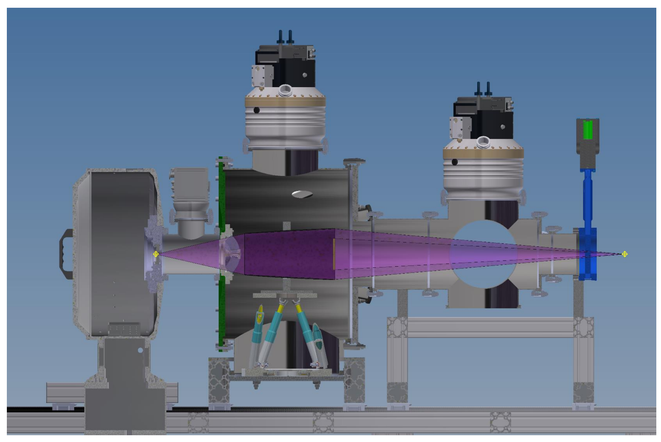


- Source @ 1kHz, 4.2 J
- max. conversion efficiency shifts to higher Xe flows with increasing He low

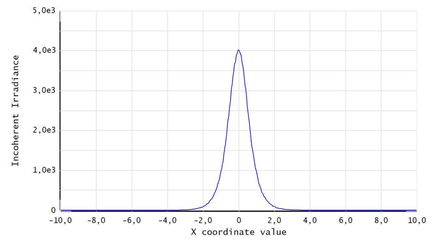


- Line-scan of image under 18° against reconstructed z-axis
- Helium improves emission towards collector and allows better collection efficiency

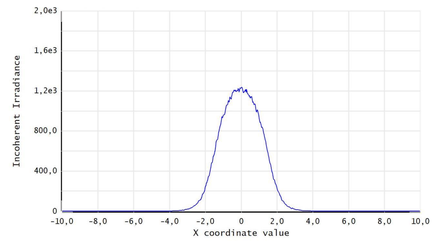
Proposal for Irradiator



Simulated focal intensity profiles:



in focus
diameter >1,3 mm



out of focus
diameter >2,9 mm

	single beamline	multiplexed beamline 4 sources
broadband irradiance	40 W/cm^2	> 10 W/cm^2
inband irradiance	4 W/cm^2	> 0,6 W/cm^2
AOI range on sample	± (3° - 5°)	± (3° - 10°)
spot diameter	> 1,6 mm	> 2,0 mm
typical repetition rate	2000 Hz	10000 Hz

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