Latest Development of EUV-Sources for Flexible Laboratory Use

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AIXUV's EUV-Lamps have already shown a long record of use and high flexibility in integration into systems like resist exposure tools, EUV-reflectometers, EUV-Microscopes, and in developing tools for source metrology. The focus on EUV-Lamp development at AIXUV was driven by the demands based on the applications and customer specific tools.
Low cost of ownership (e.g. 120 €/h) and operation (about 50 €/h) with > 500 J/(2 pi sr) / hour of in-band EUV) is achieved due to the long lifetime HCTP concept. More than 250 million pulses have been demonstrated with the system still under operation. AIXUV can supply EUV-Lamp systems for various power levels. To extend the power range AIXUV licensed the Xe-source technology from Philips EUV so that we now can offer EUV-Lamps of higher power and fully HVM-compatible small etendué.
The work at AIXUV was focused on the development of beamline solutions to deliver clean EUV-photons to the application and system integration. In this paper we will discuss the latest developments and present recent results.

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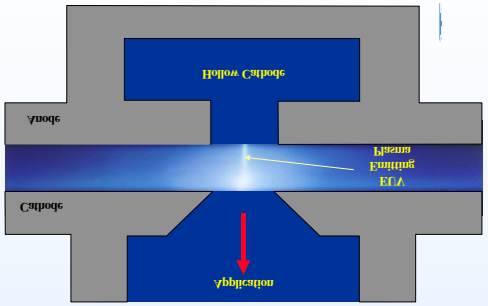
EUV-Technology

EUV-LAMP Systems



EUV	> 30-60 mJ/Pulse / (2πsr)
Inband	> 3-6 mJ/Pulse / (2πsr)
Source diameter:	400 µm
Repetition Rate:	10-400 Hz
Inband Power	< 750 mW / (2πsr)
Lifetime	> 250.000.000 Pulses
Nearly all gases can be used	
Customer specific interfaces	
CE, SEMI, US compliant	

Automatic EUV-LAMP System

Compact EUV-LAMP for Research

EUV-LAMPs supply parameters suited for flexible "in-house beamlines", tool integration and for calibrated metrology

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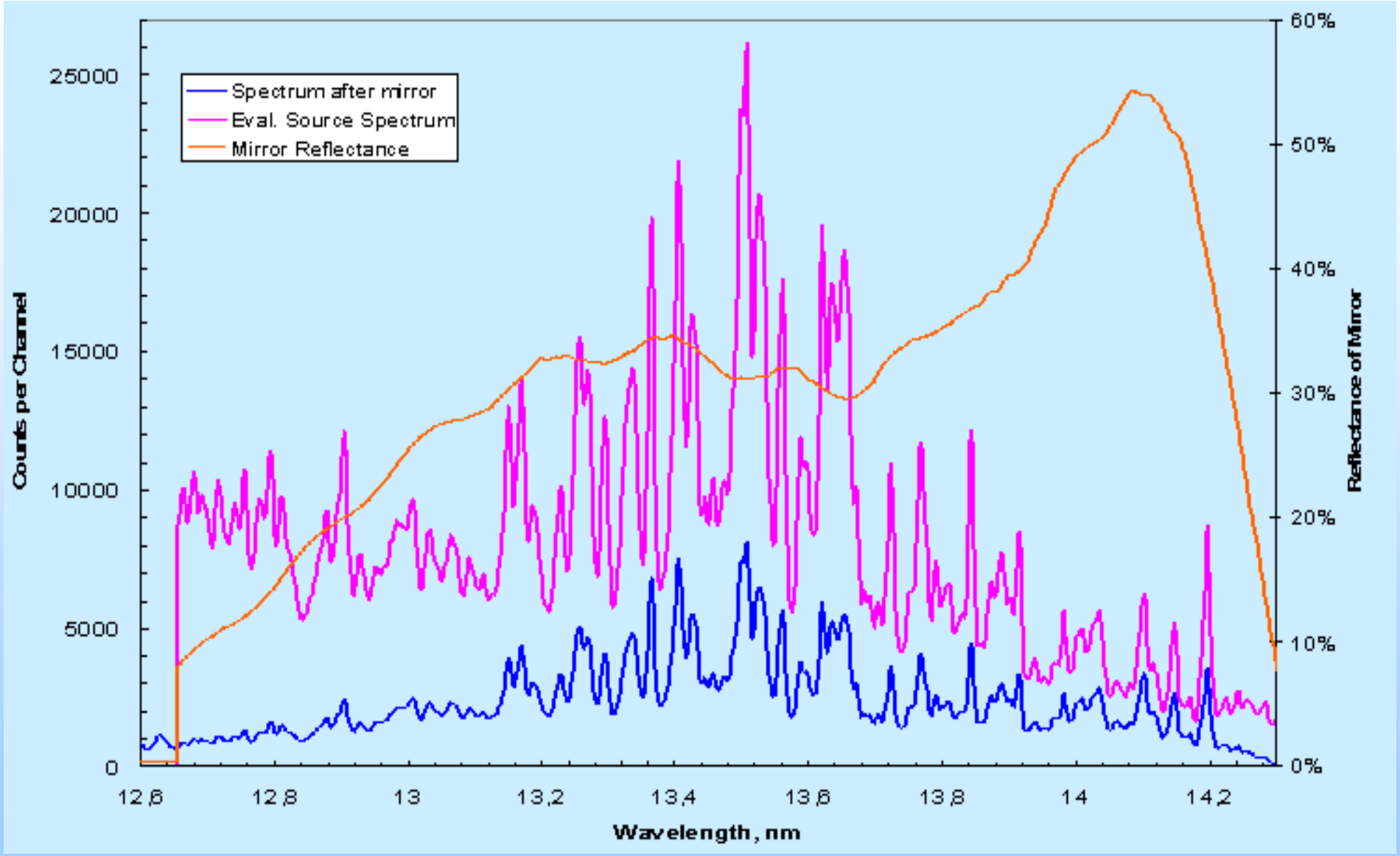
XENON-EUV-Emission Spectrum



Highly resolved Emission Spectrum of Xenon ($\lambda/\Delta\lambda > 2000$)
as emitted and reflected from broadband ML mirror

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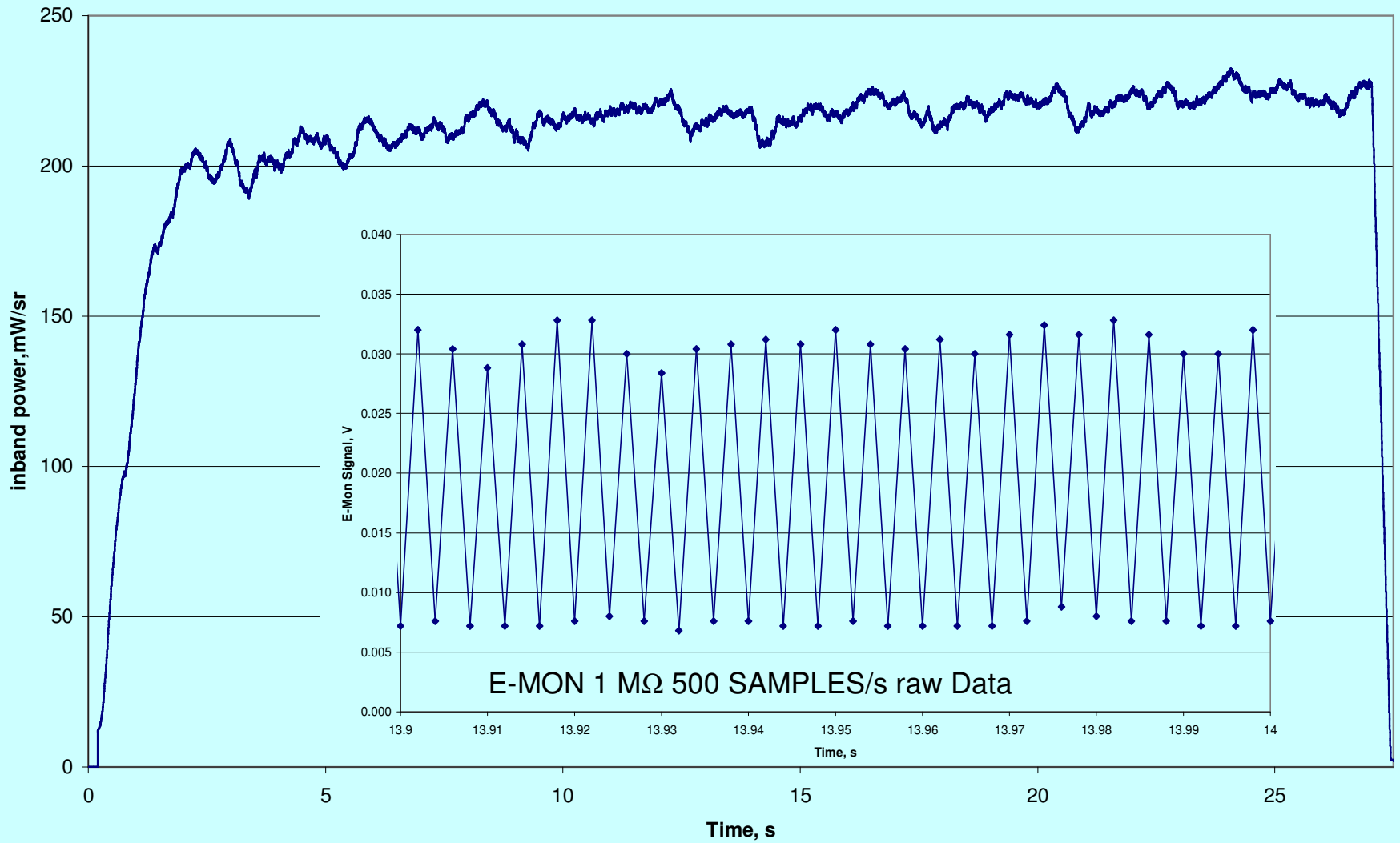
Burst Operation



5000 Pulses burst mode with 40 % duty cycle implemented

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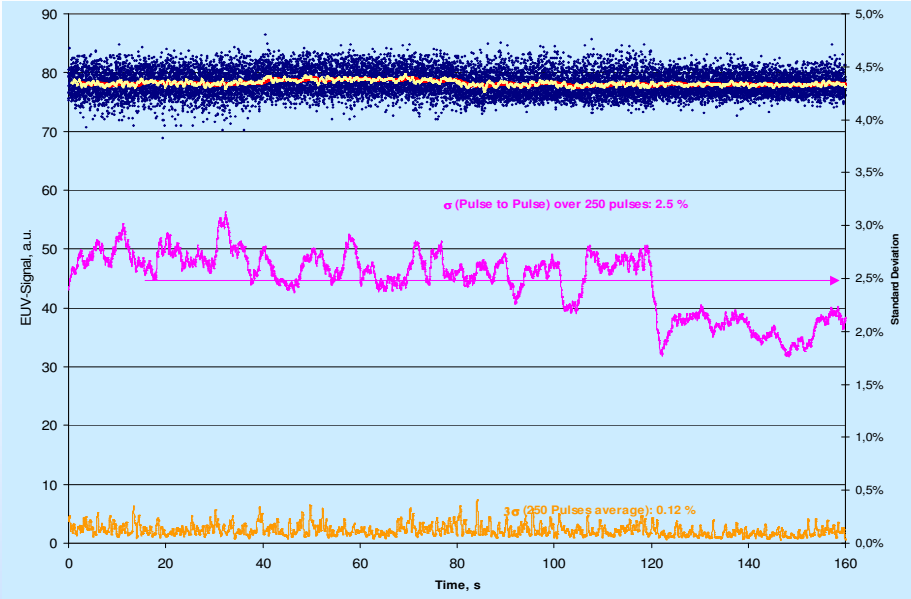
High temporal and spatial stability



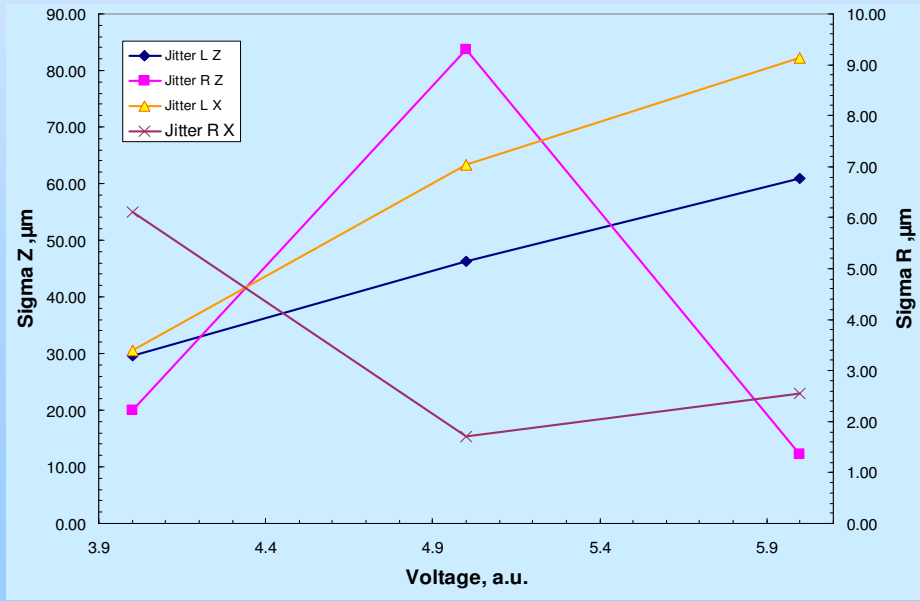
50 Hz operation

Typical values on EUV-inband yield

- **Typical yield : 1 mJ/sr; up to 250 Hz**
- **< 10 % pulse to pulse RMS**
- **< 10 % long term stability**
- **< 3 % rms on 250 pulse average**
- **< 5 % rms on > 200 pulses burst**

Typical values on position stability:

- **Source diameter < 500 µm FWHM**
- **Source Length < 6 mm FWHM**
- **20 µm pulse to pulse rms in radial position**
- **< 0.5 % on 250 pulse average**



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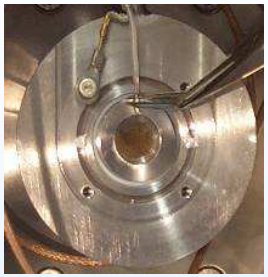
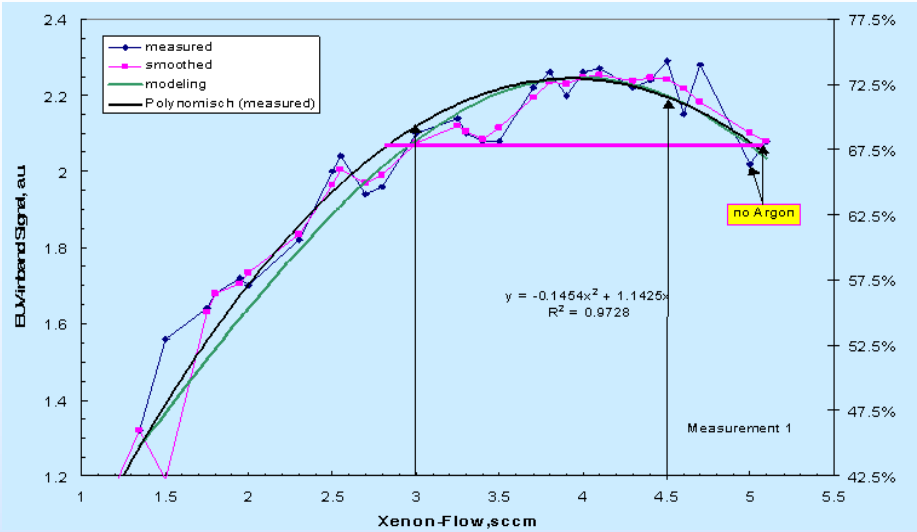
EUV-LAMPs are of temporal and spatial stability

Beamline solution



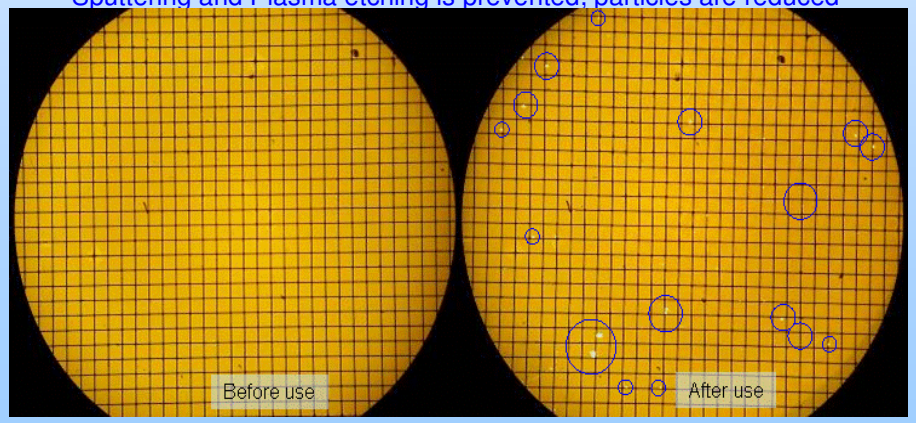
Features:
- magnetic trap (350 mTesla)
- Argon counter-stream
- electrical field shielded

EUV-LAMP with Clean-Photon Window 100 mm from source.

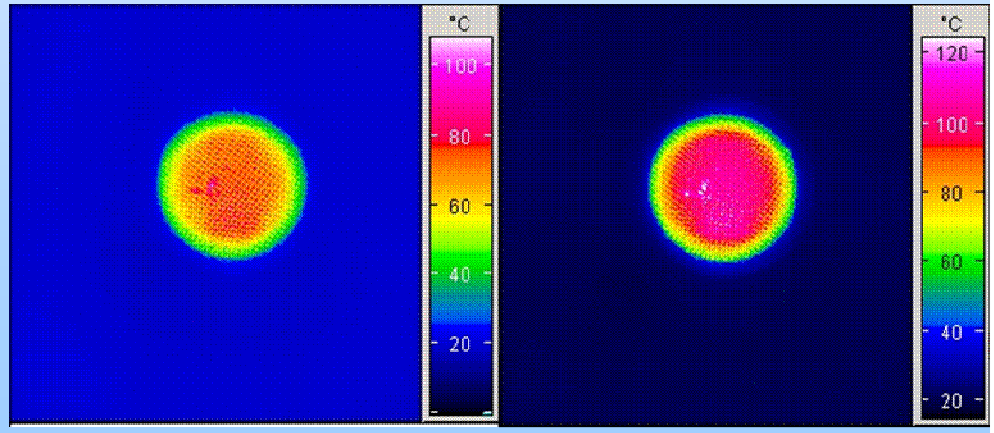


EUV inband flux is increased with counterstreaming Argon in beamlines

Sputtering and Plasma etching is prevented; particles are reduced



100 nm Silicon windows show only holes from dust particles after 5 Million pulses in 100 mm distance from the source



Beamline exit window is heated to > 100°C at 250 Hz

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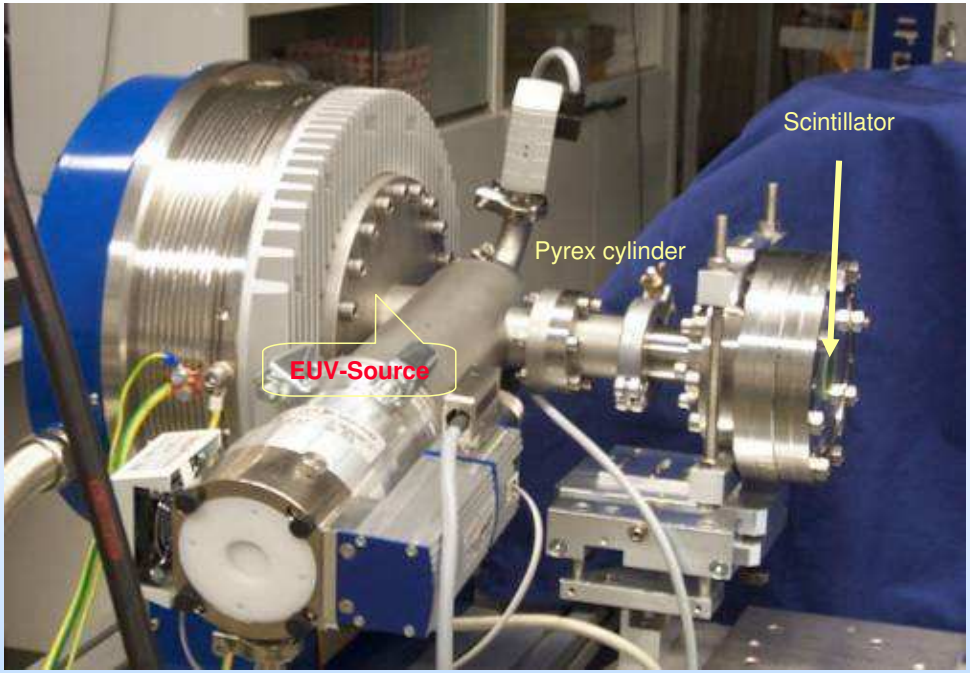
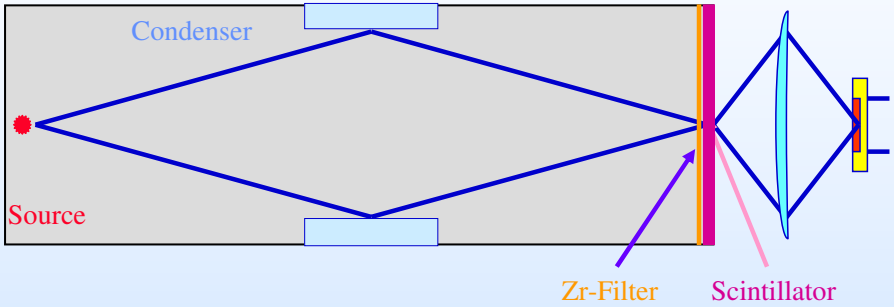
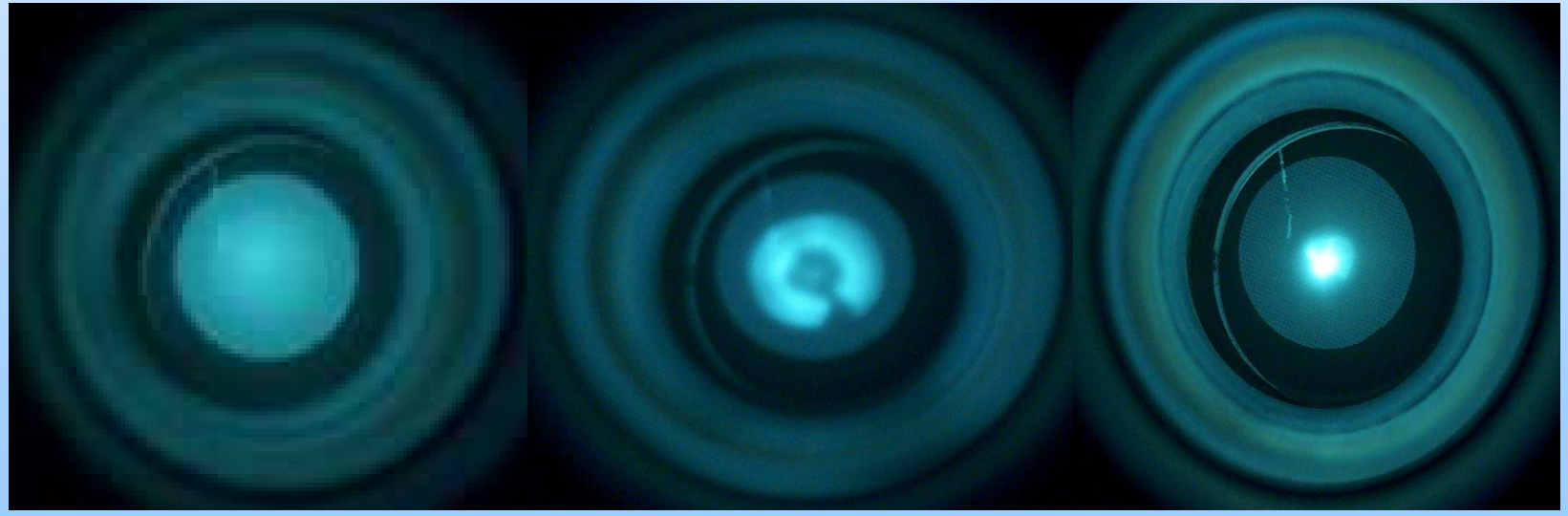
EUV-LAMPs with Beamline solutions deliver debris free EUV on application side UHV

Budget collectors for intensified photon flux of EUV-Lamps





Set-Up for testing budget collectors



Collimated flux distribution depends on collector position.
> 20* enhanced intensity and focussed flux is achieved.

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PLC-controlled Lamp System

PLC in control rack

Industrial standard architecture

SIMATIC PLC
Controller and Interfaces

PLC can

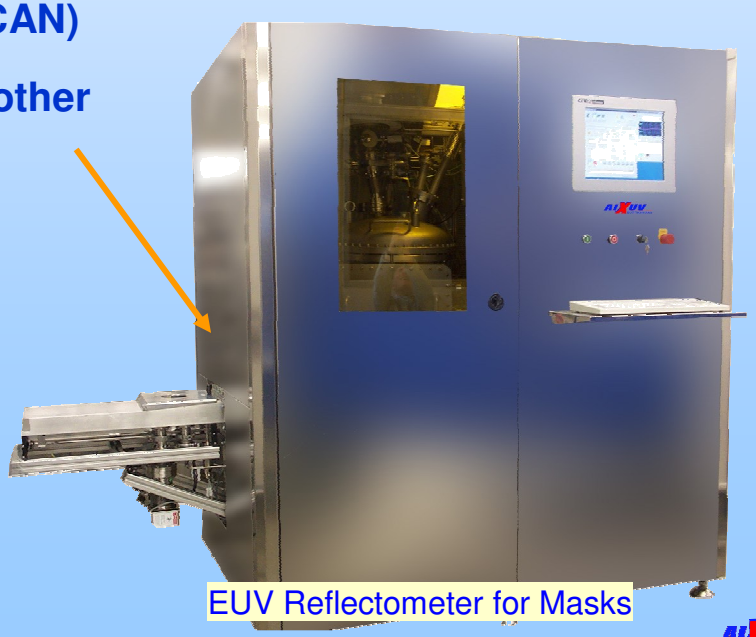
•control other components

and/or interact with any other control master or slave (PC; RS-485; Profibus, CAN)

or can be transferred to other system (to be discussed)

Interfaces for external control

TEUVL at Infineon



EUV Reflectometer for Masks

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HCTP concept is used for Metrology and Alpha-HVM (ADT: Philips)

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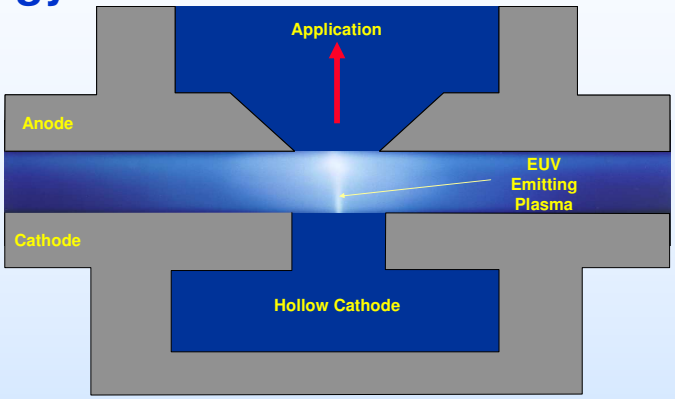
PHILIPS

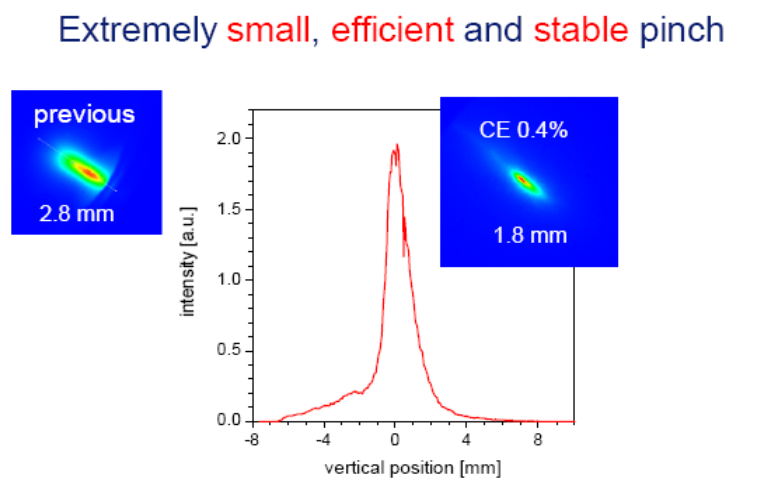
Xe-HCTP for Metrology



Fraunhofer HCTP-Patent used by AIXUV and Philips

Xe-HCTP for ASML ADT

Optimized and priced for metrology tasks



Optimized for etendué and high power

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Outlook

Philips EUV will be concentrating on TIN technology for HVM sources.
AIXUV will make Philips EUV Xenon source technology available for metrology
Down-engineered HVM-source technology to AIXUV's Metrology Source Technology.

	Philips Xe-Alpha	AIXUV V1	AIXUV V2	Hybrid	Hybrid
				9 months	2 years
Rep Rate , Hz	3000	50	220	333	667
Input per Pulse, J	4	2	2.5	3	3
Total Input, W	12,000	100	550	1,000	2,000
CE	0.55%	0.15%	0.25%	0.40%	0.50%
Inband per Pulse, mJ/sr	3.5	0.5	1.0	1.9	2.4
Inband / 2 π sr	66	0.15	1.38	4	10
Source Diamater	0.4	0.5	0.4	0.4	0.4
Source Length	2	8	6	3	2
Etendue (Area, mm²)	0.8	4.0	2.4	1.2	0.8

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