

Program PREUVE

Description of the French PREUVE R & D Program on EUV sources, reflective optics, masks and relevant metrologies for EUV Lithography.

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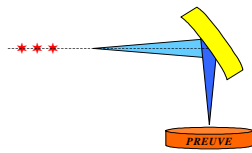
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Participants in PREUVE

PREUVE is a **National Federative** R&D program aimed at developing knowledge concerning the critical issues of **EUV lithography**.

Participants in **PREUVE** program are National Research Laboratories, Universities, a leading company in optics and precision engineering, and two high-tech SME's:

CEA/DAM

CEA/DRECAM

CEA/LETI

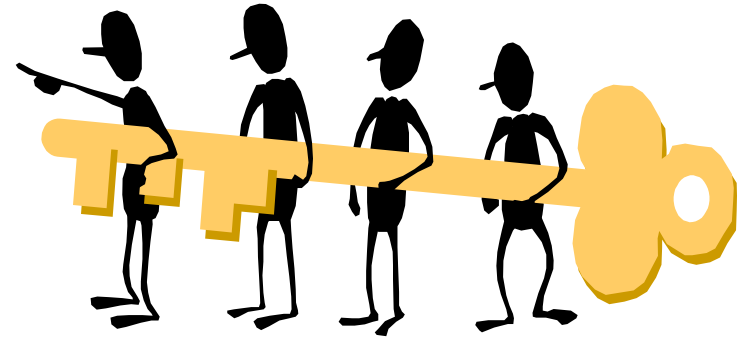
GREMI-Université d'Orléans

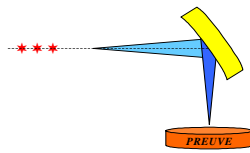
SAGEM/REOSC

SESO

SOPRA - Coordinator

UDESAM/L2MP/LORXM



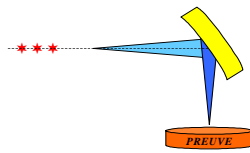


The objectives of PREUVE

PREUVE is aimed at :

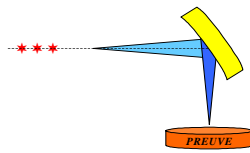
- Federating French abilities** (industrials and laboratories) for EUV lithography developments
- Developing **knowledge** concerning some critical issues of EUV Lithography
- Developing** parts of the future EUV steppers and at-wavelength metrologies
- Promoting the **worldwide cooperation**

PREUVE is not aimed at manufacturing an EUV stepper



Frameworks of PREUVE

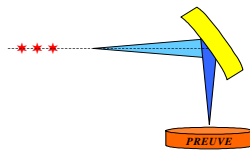
- ❑ PREUVE was labelled by the « Réseau Micro-Nano Technologies » (RMNT).
- ❑ The first 24 months-period of PREUVE is financially supported by the **MEFI-STCI** (French Ministry of Industry) (nov.1999 - nov. 2001).
- ❑ PREUVE is the first step towards broader National and International cooperations. At the end of the program, parts developed in the framework of PREUVE are expected to be integrated in EUV lithography tools.



R & D Tasks -PREUVE

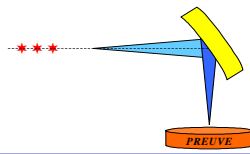
PREUVE is focused on :

- ➔ **EUV Sources** @ 13 nm for the purposes of lithography and metrology
- ➔ Reflective **Optics and Multilayer Coating** for the illuminating and the projection optics
- ➔ Reflective **Masks** (substrate, multilayer coating, reticules) and relevant **Metrology** namely reflectivity measurements and defects detection techniques
- ➔ The construction of a **laboratory exposure bench** for EUV lithographic developments (Banc d'Essai de Lithographie *B.E.L.*) *B.E.L.* is designed to be used for development of **Resist Processes**



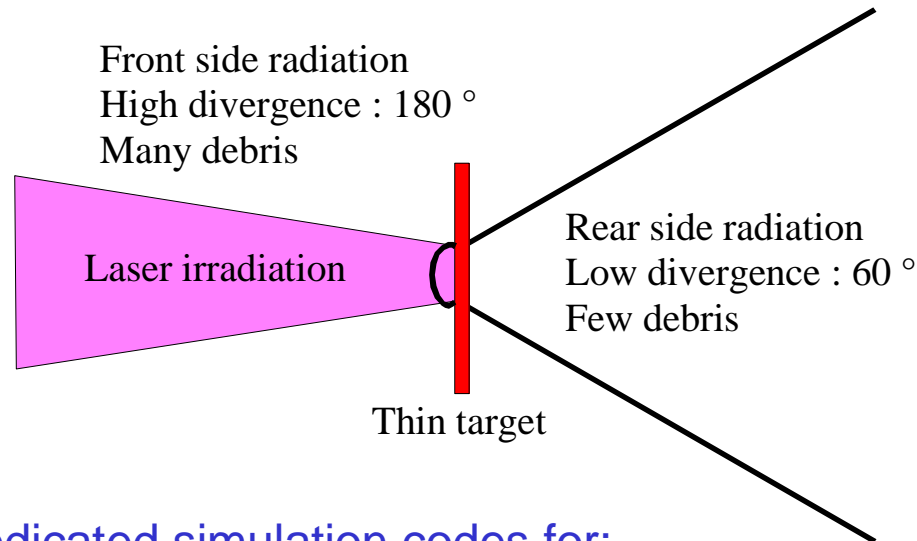
□ Purposes :

- Development of EUV sources following **original** approaches
- **Comparison** of these sources to the performances of existing sources
- **Construction of set-ups** allowing for evaluation of these sources in order to meet the needs for future EUV stepper machines and EUV metrology

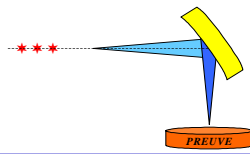


Design of an E-UV Source by CEA/DAM

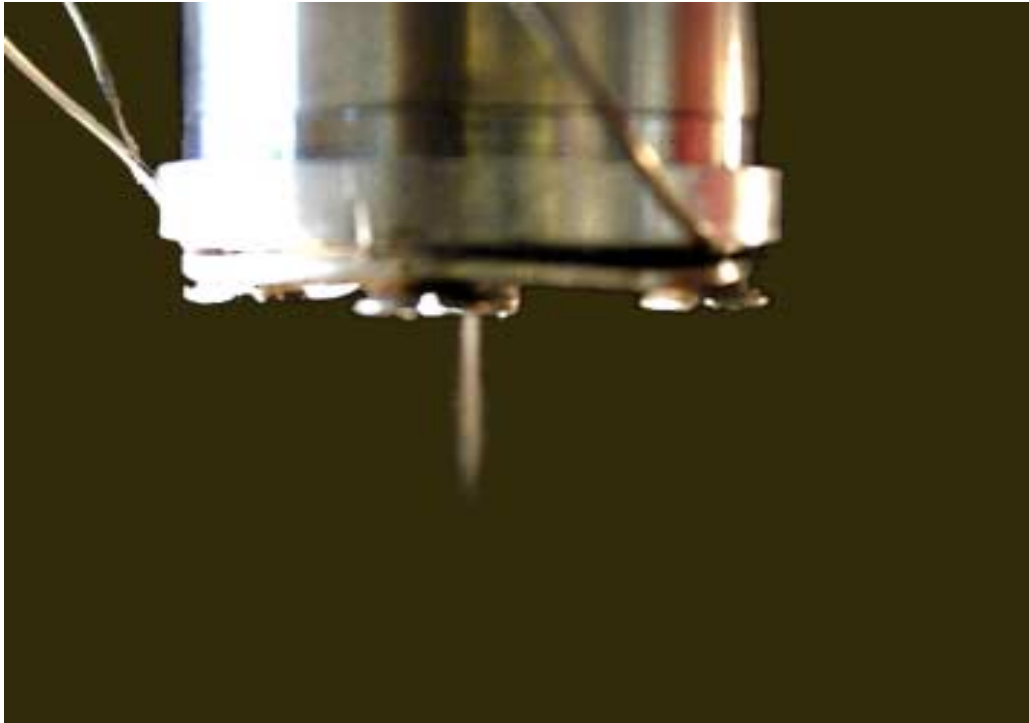
- Principle: Rear side radiation from a thin solid target irradiated by a moderate flux laser



- Use of dedicated simulation codes for:
 - Optimisation of laser parameters, target and irradiation geometry
 - Design of an adequate projection system



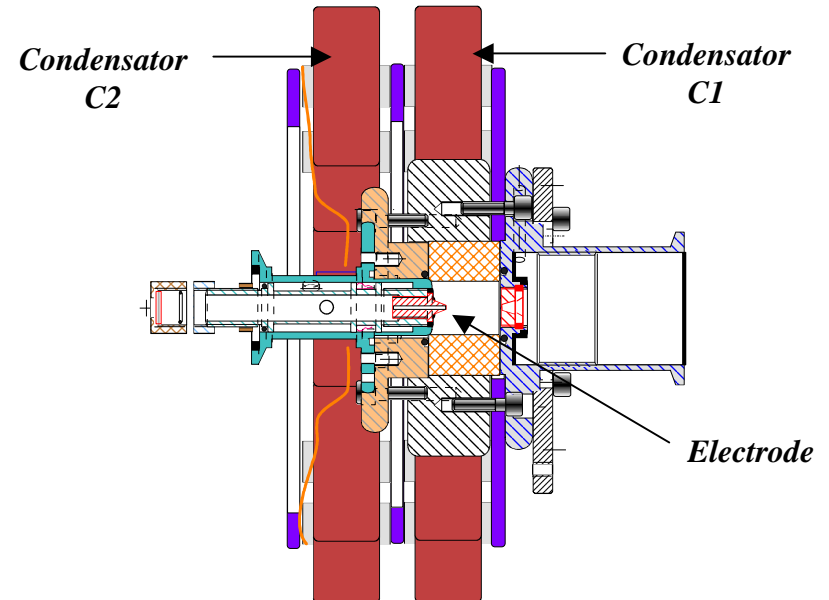
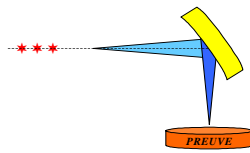
EUV sources



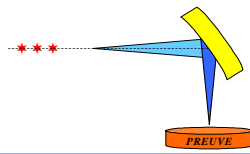
Strongly confined jet target
(~ 5° opening angle)

- low reabsorption of EUV in jet corona
- interaction zone @ 1-5mm from nozzle
- good coupling of the laser
- efficient vessel pumping
- simple and reliable device

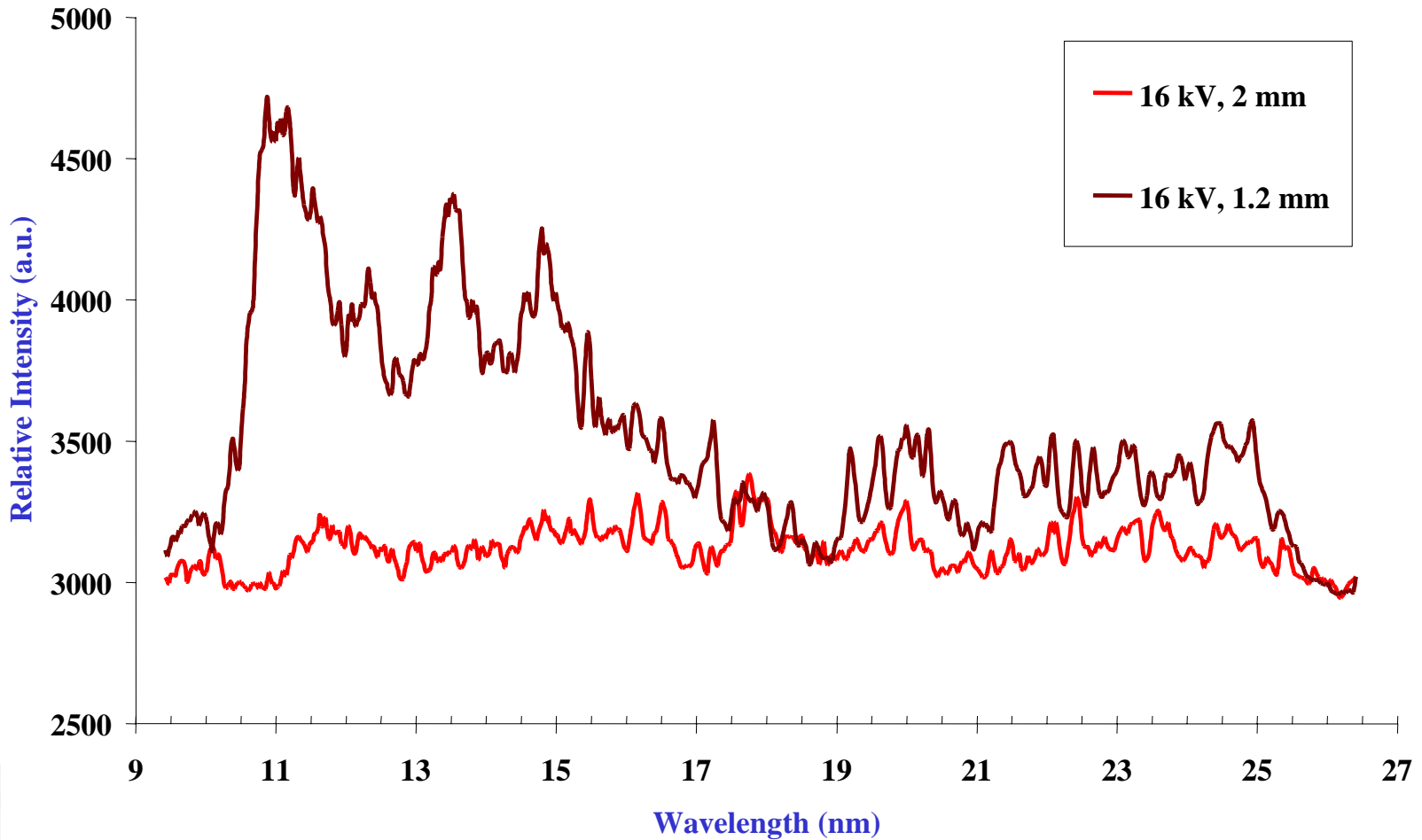
Refer to the paper of M. SCHMIDT in the pre-session on EUV sources last monday



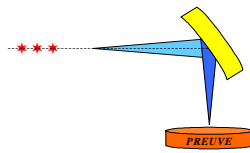
**Capillary source created by electrical discharge developed by
GREMI**



Time Integrated ($\phi = 1.2$ mm, $l = 1$ cm) and ($\phi = 2$ mm, $l = 2$ cm) Capillary Radiation in pure Xe



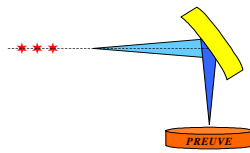
First results: effect of the capillary diameter



□ PURPOSES

- To design optics for illumination and projection including mechanical design and demonstration
- To optimise the optical production technology
- To realise multilayer coating
- To develop metrology and procedure for optical control
- To define and realise illumination and reduction optics for the B.E.L. (Banc d'Essai de Lithographie)
- **PARTNERS : REOSC - UDESAM**

Refer to next paper of Roland GEYL (SAGEM)



Improving state of the art optical fabrication technology



Plano polishing



NC polishing

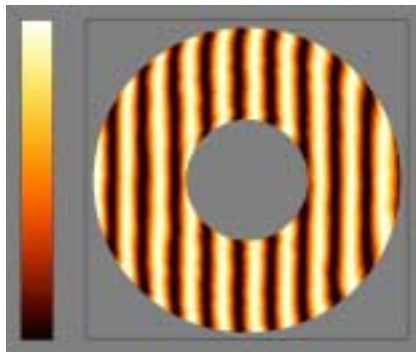


Ion beam figuring

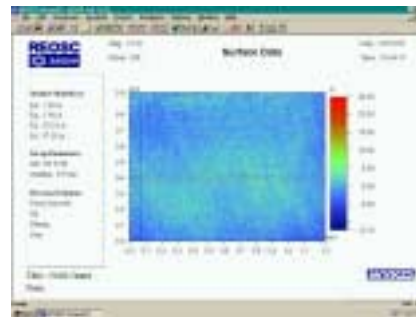


Bowl feed smoothing

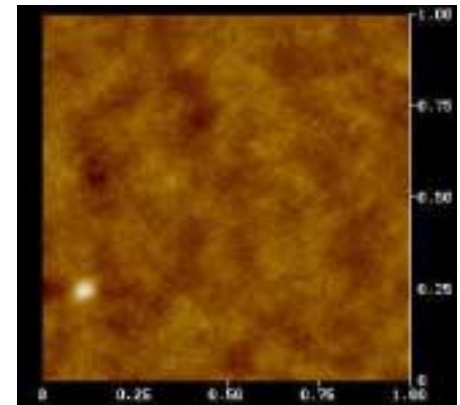
Leveraging optical metrology science



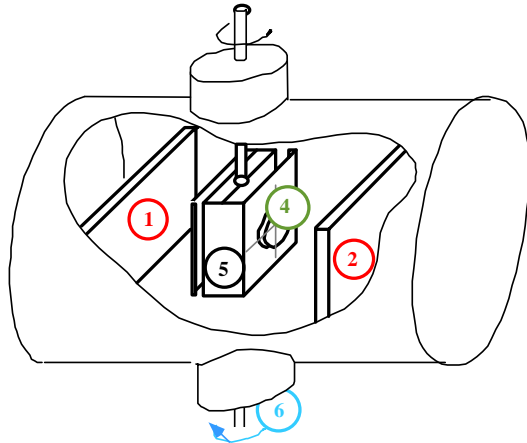
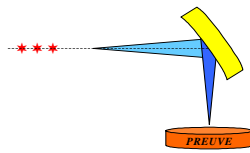
Interferometry



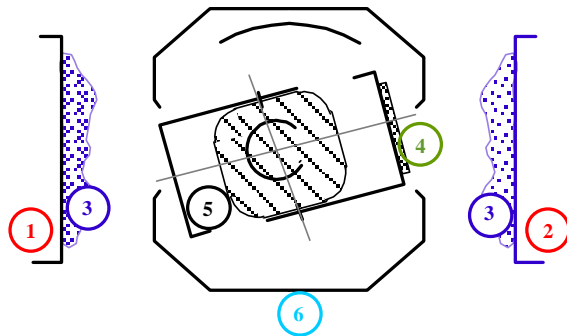
Micro-Interferometry



AFM



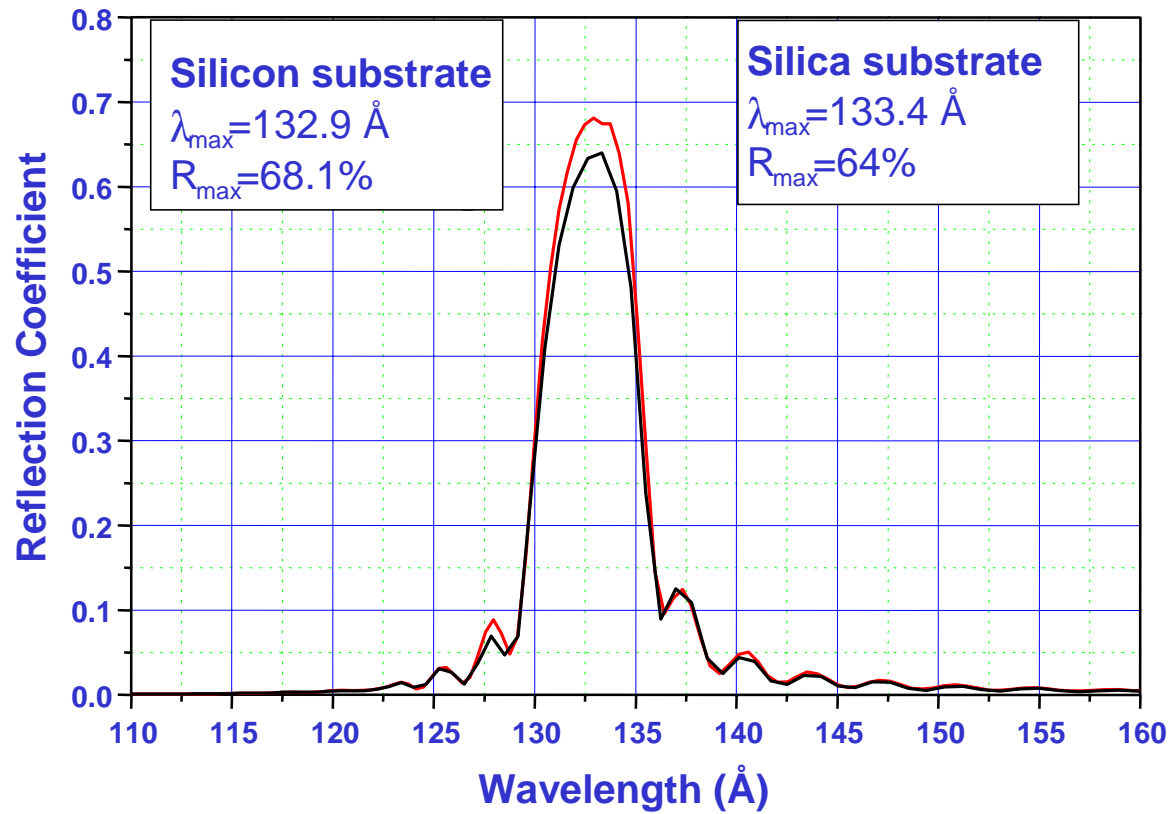
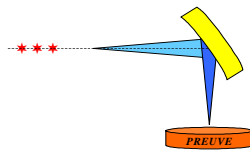
- 1 - 2 Cathodes
- 3 Argon Plasma
- 4 Sample
- 5 Rotating sample holder
- 6 Rotating screen



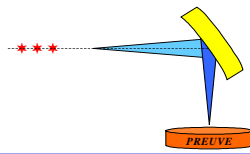
Schematic diagram of the deposition system



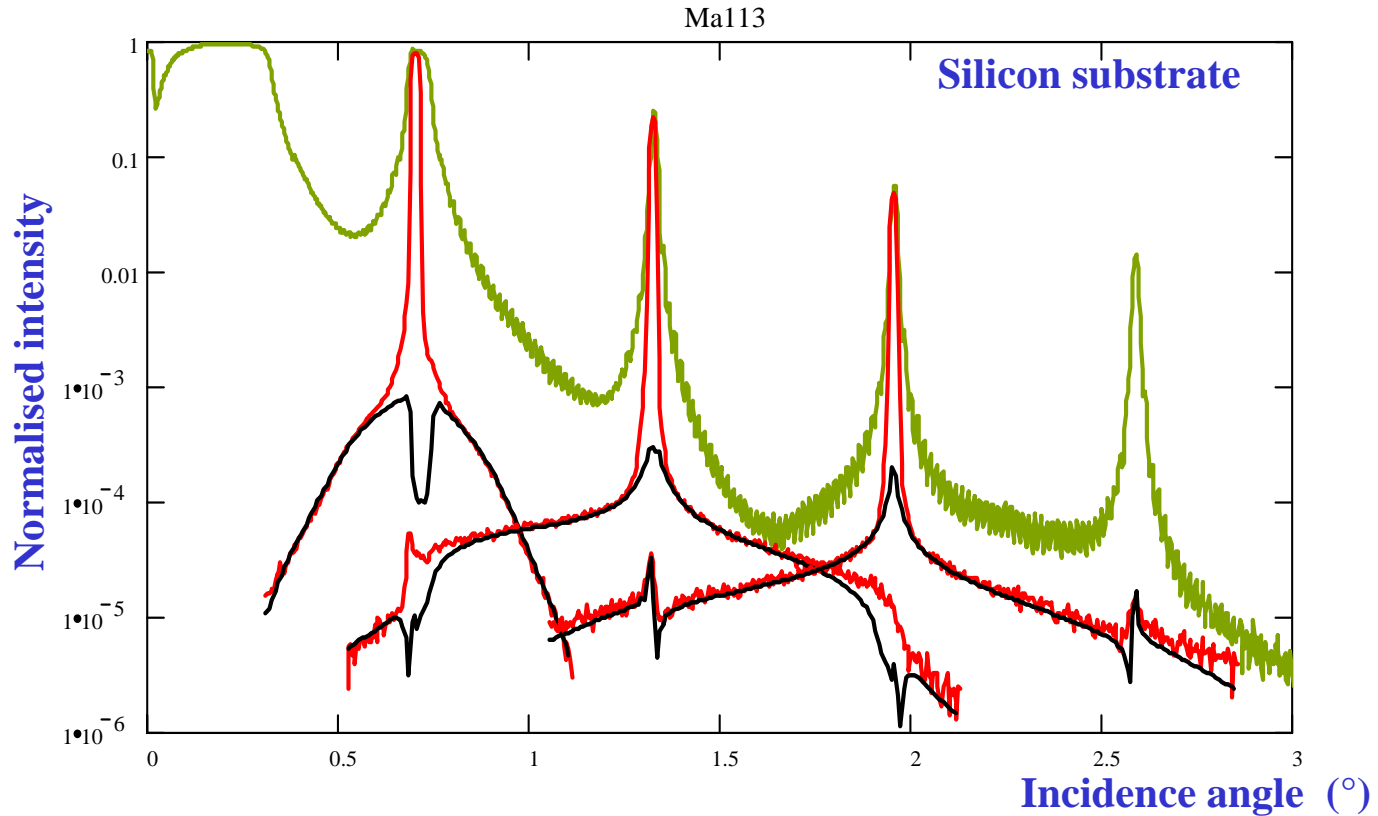
Photograph of the deposition system



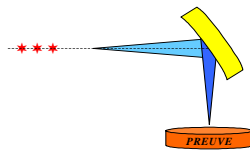
Substrate influence on the reflectance of Mo/Si mirrors



Precise analysis of the roughness properties of Mo/Si stacks



- Extracted parameters:**
- σ Means roughness height
 - ξ Lateral correlation length
 - h Fractal dimension
 - ξ_v Vertical correlation length

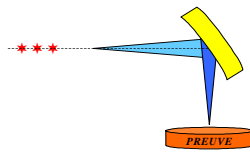


□ PURPOSES

- To develop **substrate** for the EUV mask
- To develop **Mask blank** with Low defect multilayer coating
- To develop **Mask patterning** manufacturing
- To develop **At-wavelength metrologies** for multilayer mirror reflectivity and defects inspection

□ **Partners : SESO, LETI, UDESAM, SOPRA**

□ **Refer to the paper of Jean Yves ROBIC (LETI) on Wednesday**



SUBSTRATES MANUFACTURING FOR MASKS

PROGRAMME OBJECTIVE

Polishing

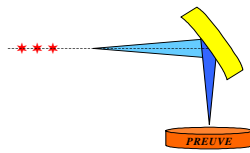
	EUV LLC 1998	EUV LLC 1999-2002	PREUVE 1 st Year	PREUVE 2 ^{ne} Year
Material	Silicon	Silicon or ULE	Silicon, ULE, Zerodur, SiC	The material chosen in 1 st Year
Dimension (Ø mm)	150	200	50	150
Thickness (mm)	0.75	0.75 à 25	5	To be defined
Variation of thickness (µm)	< 0.5	< 0.2	< 0.5	< 0.2
Roughness	Not specified	Not specified	1 Å RMS	1 Å RMS
Defects	Unknown	Unknown	0.5 µm	0.2
Defects density	Unknown	Unknown	Non defects visible to the naked eye	Some 10 ⁻² defects/cm ² metrology by diffusion

Mask holding

Realisation of interface allowing a handling and a use without deformation.

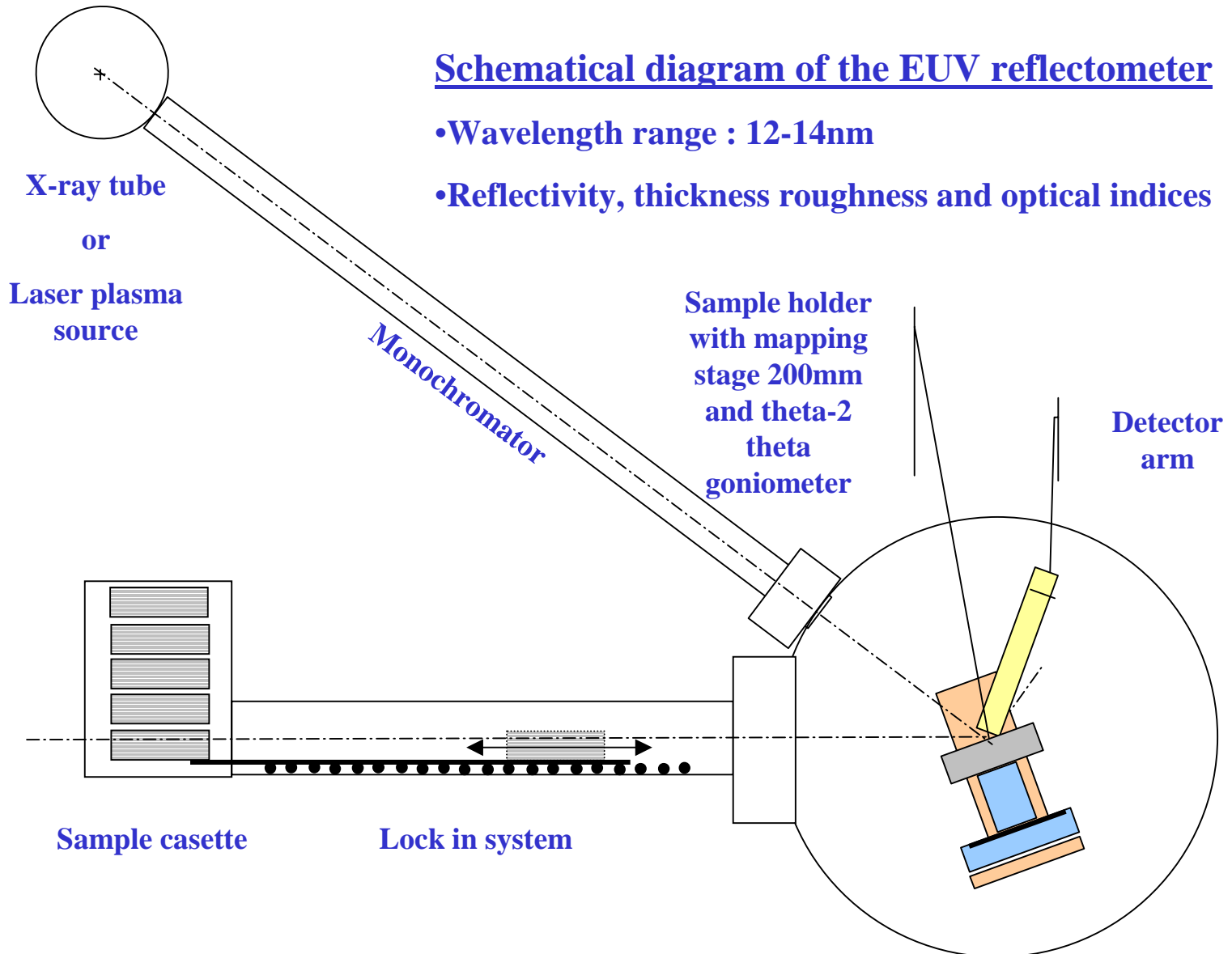
FINALITY

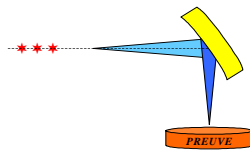
To become a supplier of masks at two levels: - bare substrate
- substrate + multilayers



Schematical diagram of the EUV reflectometer

- Wavelength range : 12-14nm
- Reflectivity, thickness roughness and optical indices



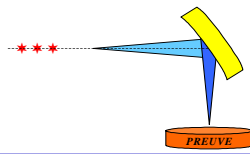


□ PURPOSES

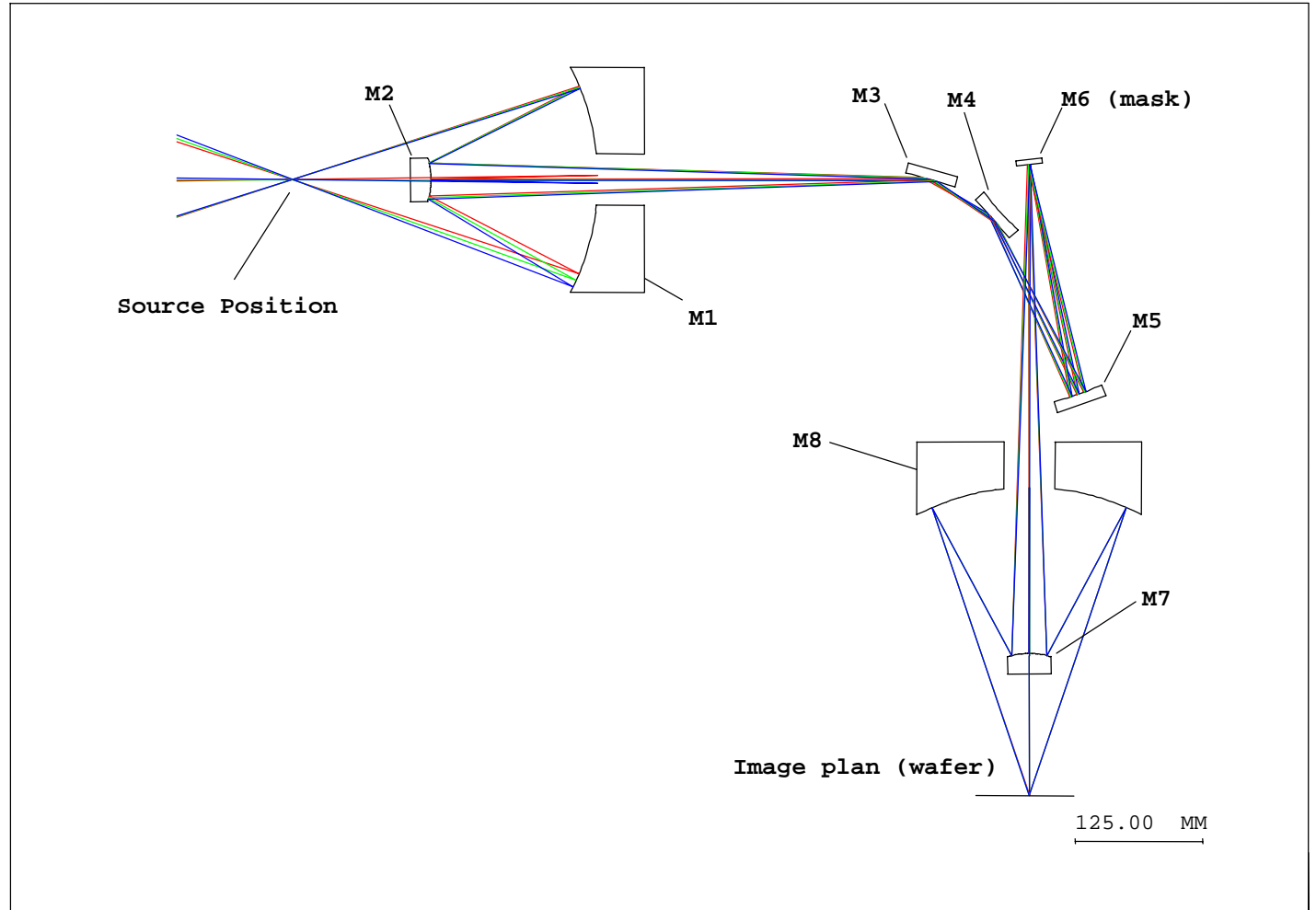
- To construct an **exposure bench for lithography** developments (Banc d'Essais pour la Lithographie B.E.L.) by integration of subsets (source, P. O. Box, mask) developed in previous tasks
to Realise and test this laboratory tool
- To study EUV lithography @ EUV wavelength for sub-0.1 μ m features

□ PARTNERS

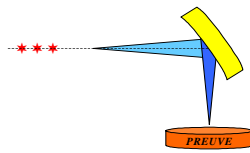
ALL with leadership of CEA LETI



"Banc d'Essai de Lithographie" B.E.L.



Optical pass of the Laboratory Exposure Bench BEL



□ UNDER WAY

- Three kinds of EUV sources are under investigation (two patents already deposited)
- Optics already designed are under fabrication for the BEL. Multilayer coating expertise already demonstrated
- Different mask fabrication procedures are studied (one patent pending). New methods for defect detection are under investigation
- EUV reflectometer for masks and optics operational beginning 2001.
- BEL operational mid 2001.

□ TO BE STARTED

- Resist process when BEL operational