THE EXTREME ULTRAVIOLET SOURCE DEVELOPED AT CEA SACLAY IN THE FRAME OF THE FRENCH NATIONAL PROJECT PREUVE

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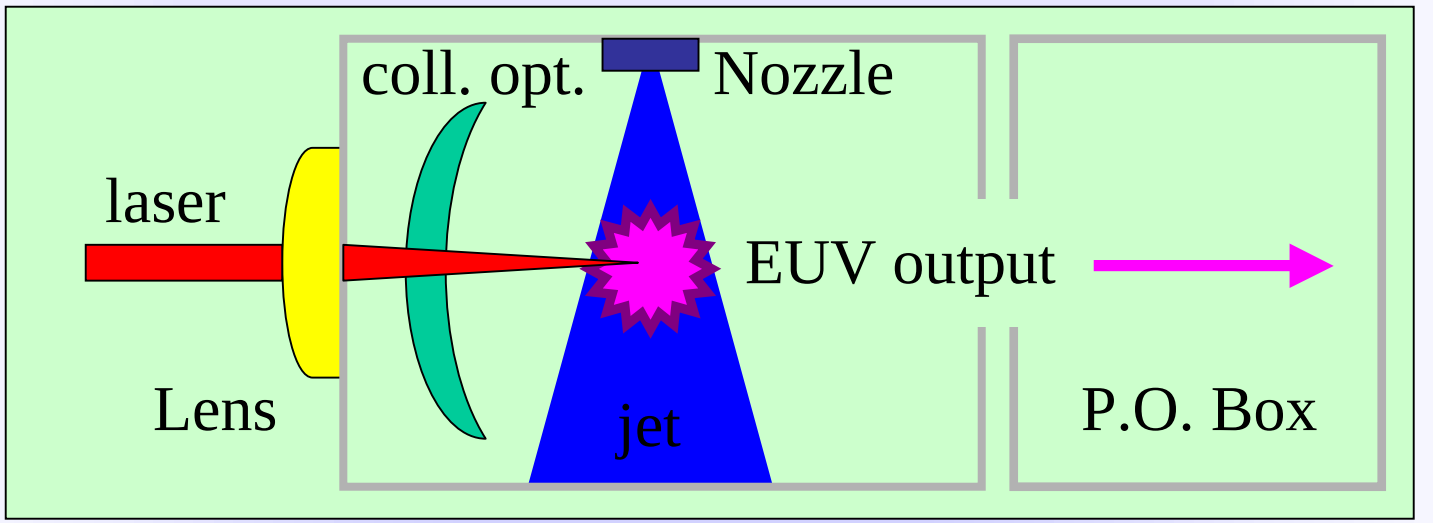
Modular design of the EUV source

- Mastered development costs
- Increased reliability by the redundancy of pumping laser sources
- Facilitated maintenance
- Easy extrapolation towards higher powers if required (α-tool, β-tool, commercial tool)

Solution based on high repetition rate lasers is preferred for economic, technical and industrial reasons

Plasma laser source for EUV lithography

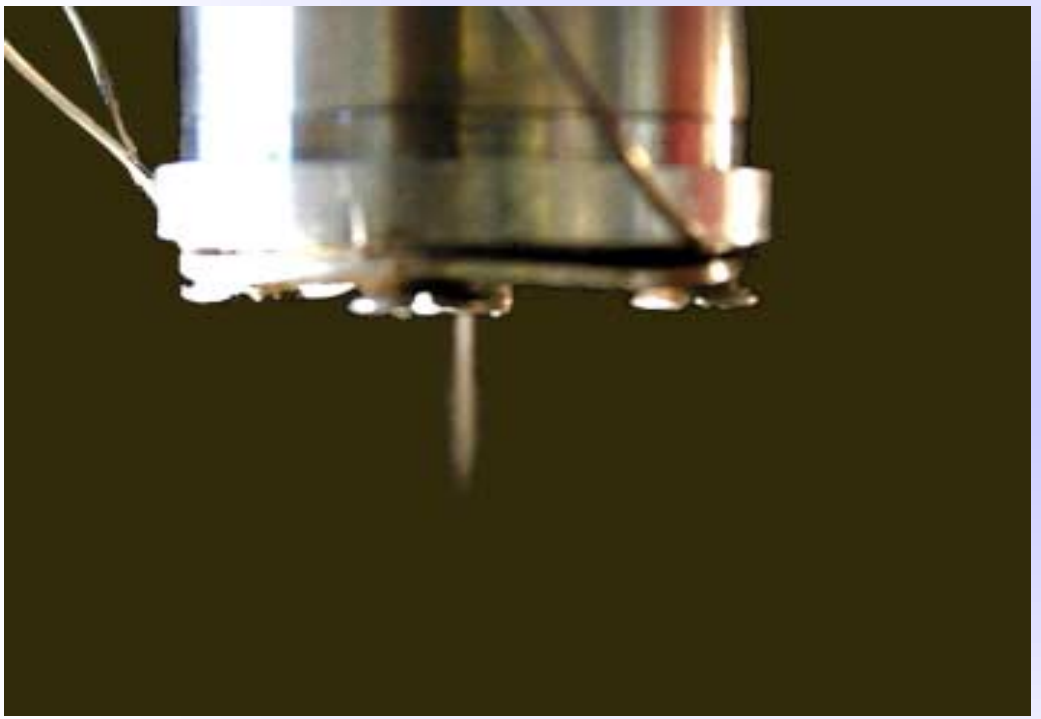
- Plasma excitation : laser ns (e.g. Nd :YAG)
- Target : Clusters jet



- cw target (high repetition rate)
- Low debris level
- Efficient laser-target Coupling (~ 100%)
- Compact and modular design
- Relatively simple technical solution

Low rep rate EUV source set-up

Jet target design



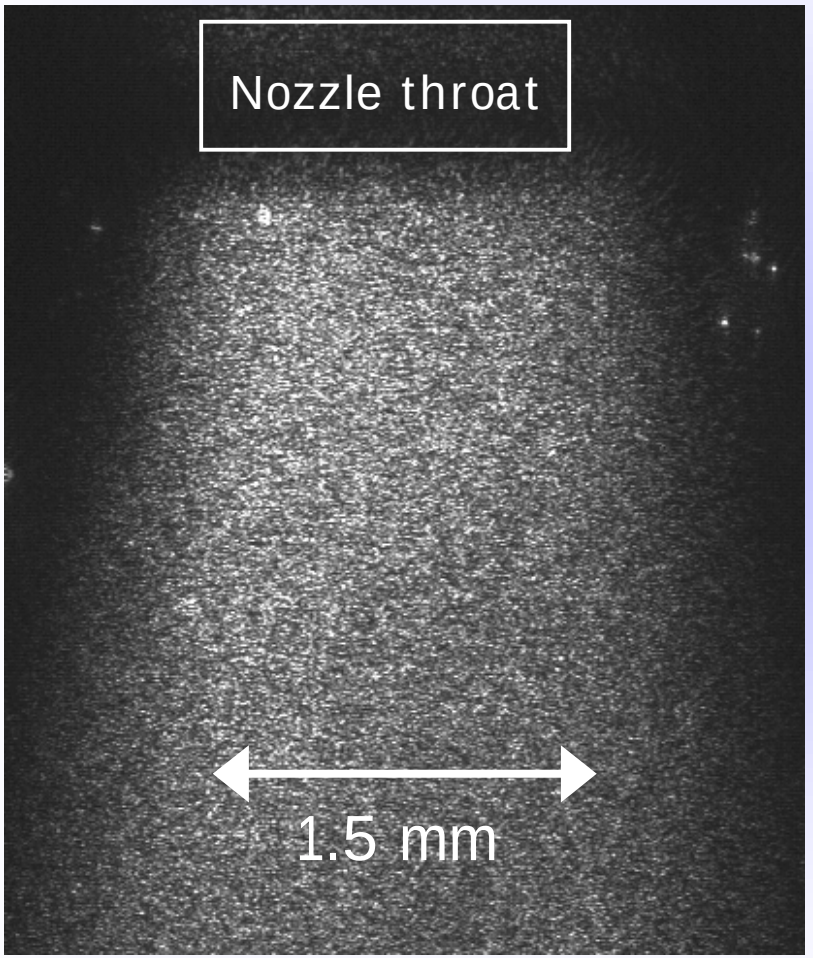
Directive jet target :

(~ 5° opening angle)

⇒ no re-absorption
in jet corona

⇒ interaction zone
@ 1-5mm from nozzle

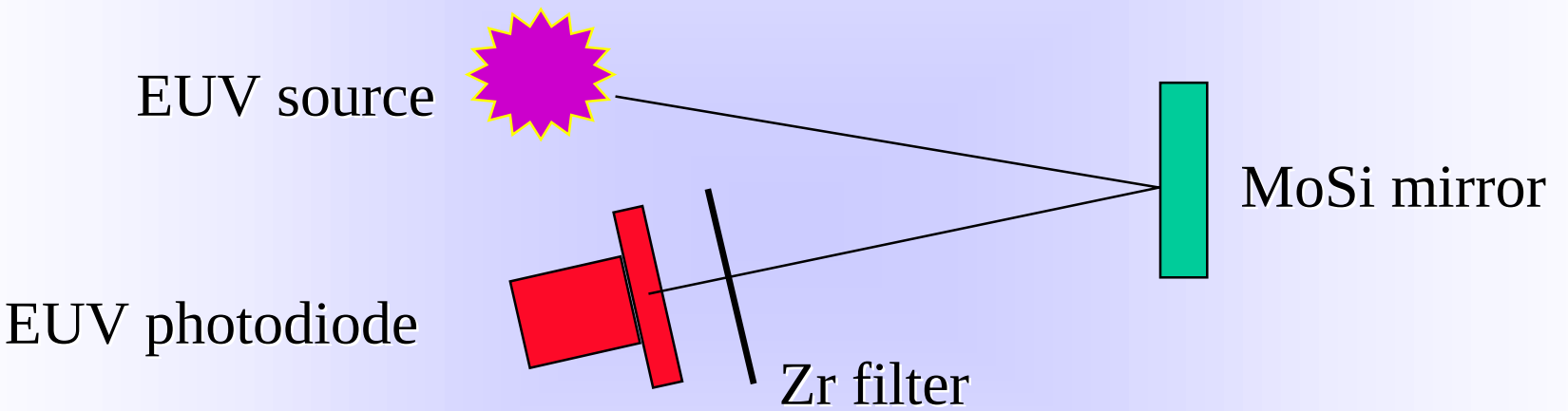
Zoom on the Saclay jet target



- Low cost target material (i.e. no recycling)
- Jet density = 10^{20} atoms/cm^3 @ interaction zone (cf. less than critical density @ λ = 1μm)
- Particle size 1μm ... 100μm
- Target flow speed ~ 100m/s $\Rightarrow$ laser rep. rates of 10kHz are possible

Preliminary photonflux and conversion efficiency of the Saclay source

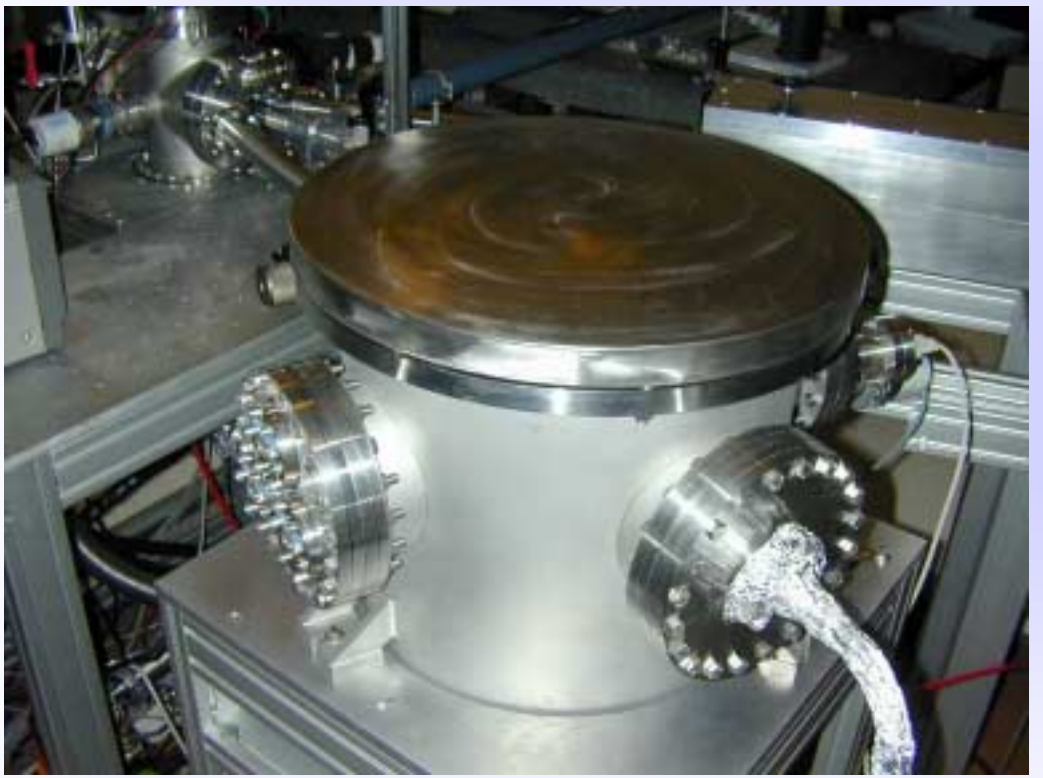
Method of measure : « multilayer monochromator »



A - mirrors (B. Vidal, Marseille - PREUVE)
calibration by CEA/DAM @ LURE, Orsay

B - photodiodes (UDT UVX-100)
calibration by PTB @ Bessy 2, Berlin

EUV photon counting device

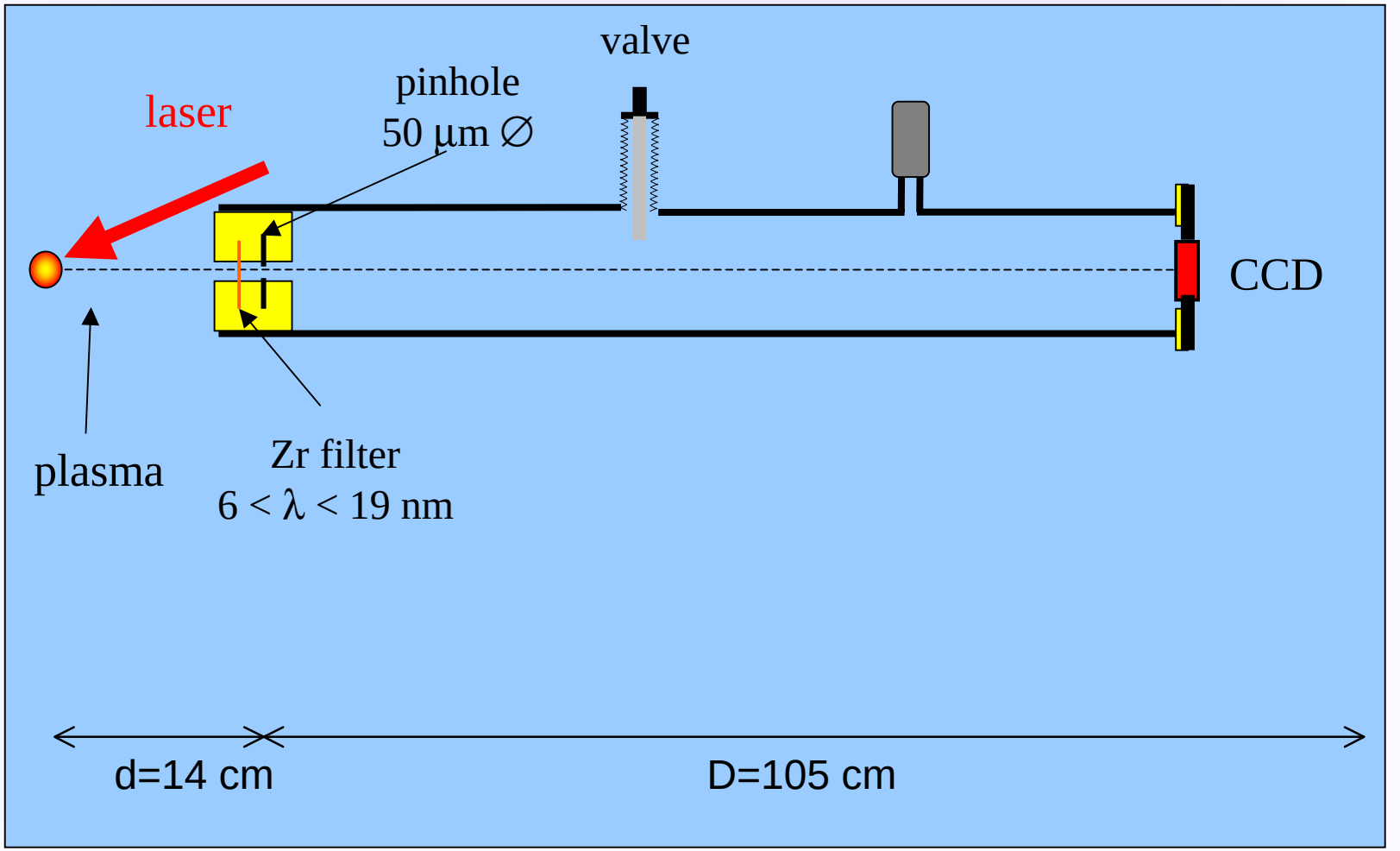


- Multilayer monochromator
- Zr filters
- calibrated EUV diodes

Transmission grating Spectrograph*

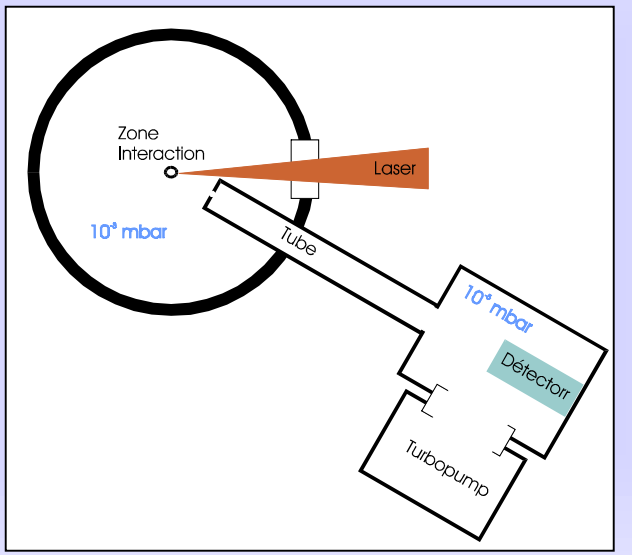
* courtesy of : Prof. Schmahl, Institut für Röntgenphysik

Pinhole imaging



Debris analysis and impact on collector optics

« Plunging pinhole » time-of-flight mass-spectrometry for direct debris ion measurements (energy + charge)



Empiric studies of MoSi multilayer mirror lifetimes

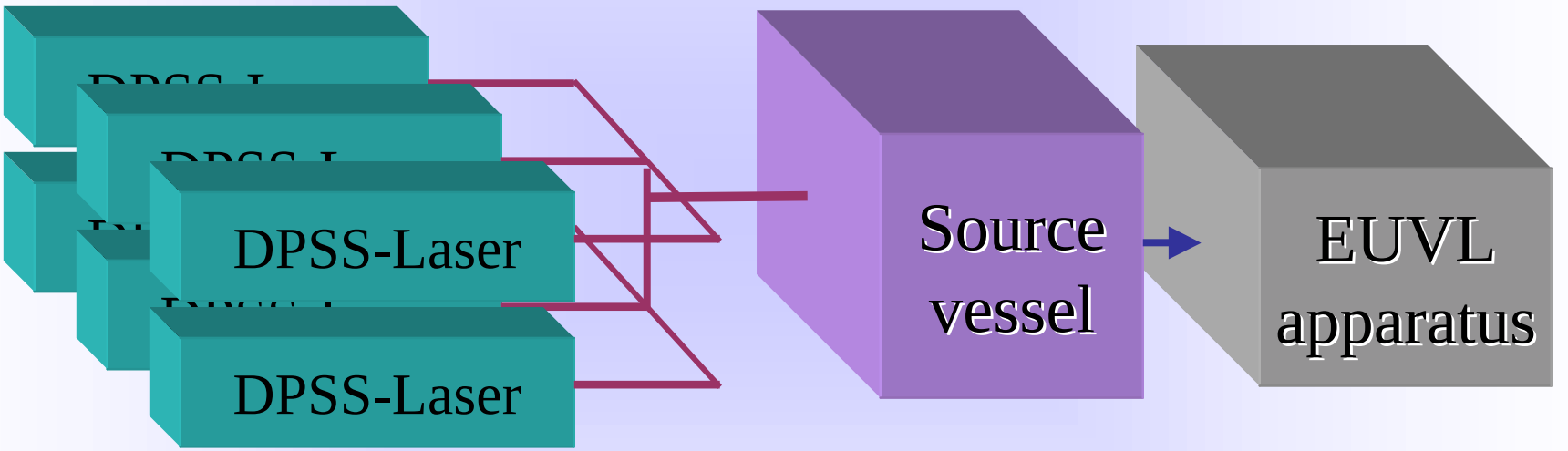
Optimisation of an anti-debris device*
(patent for anti-debris device in preparation)

Sketch of the Saclay cw EUV source set-up (PREUVE)

DPSS pump laser design

- home-made (TCL) cw diode pumped Nd:YAG
- one power unity : pure oscillator design (no amps)
- n identical power units for EUV source pumping
- high repetition rates achievable (≥ 10kHz)
- spatial “multi-beam” multiplexing

Schematic presentation of the EUV source apparatus



Evolving pump power management

Conclusions