

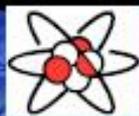
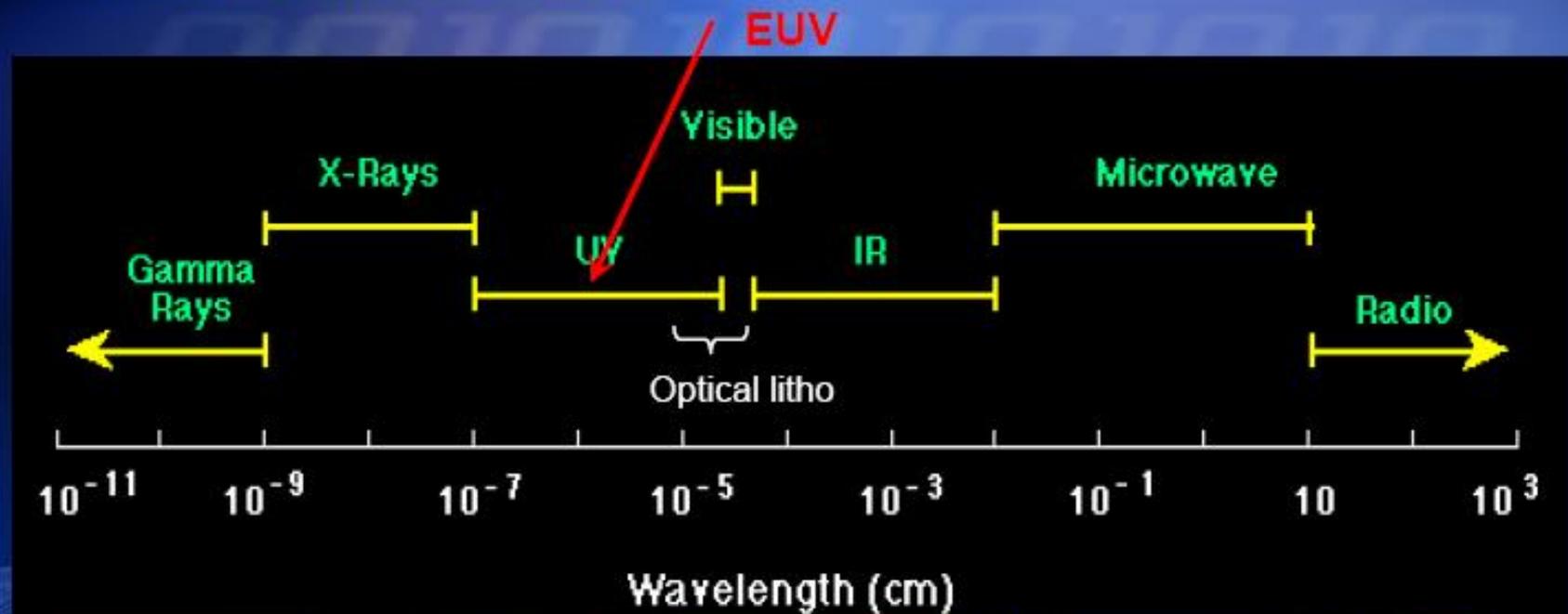
What's next?

- EUV
- 3D

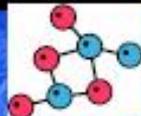
[Intel web site; spectrum 01/12
and 09/16]

What is EUV Lithography

- Uses light with a very small wavelength (13.5 nm, or 1.3×10^{-6} cm) -from the Extreme Ultra Violet region of the light spectrum - to transfer images from a mask onto a silicon wafer



atom



molecule



thickness of a dollar bill



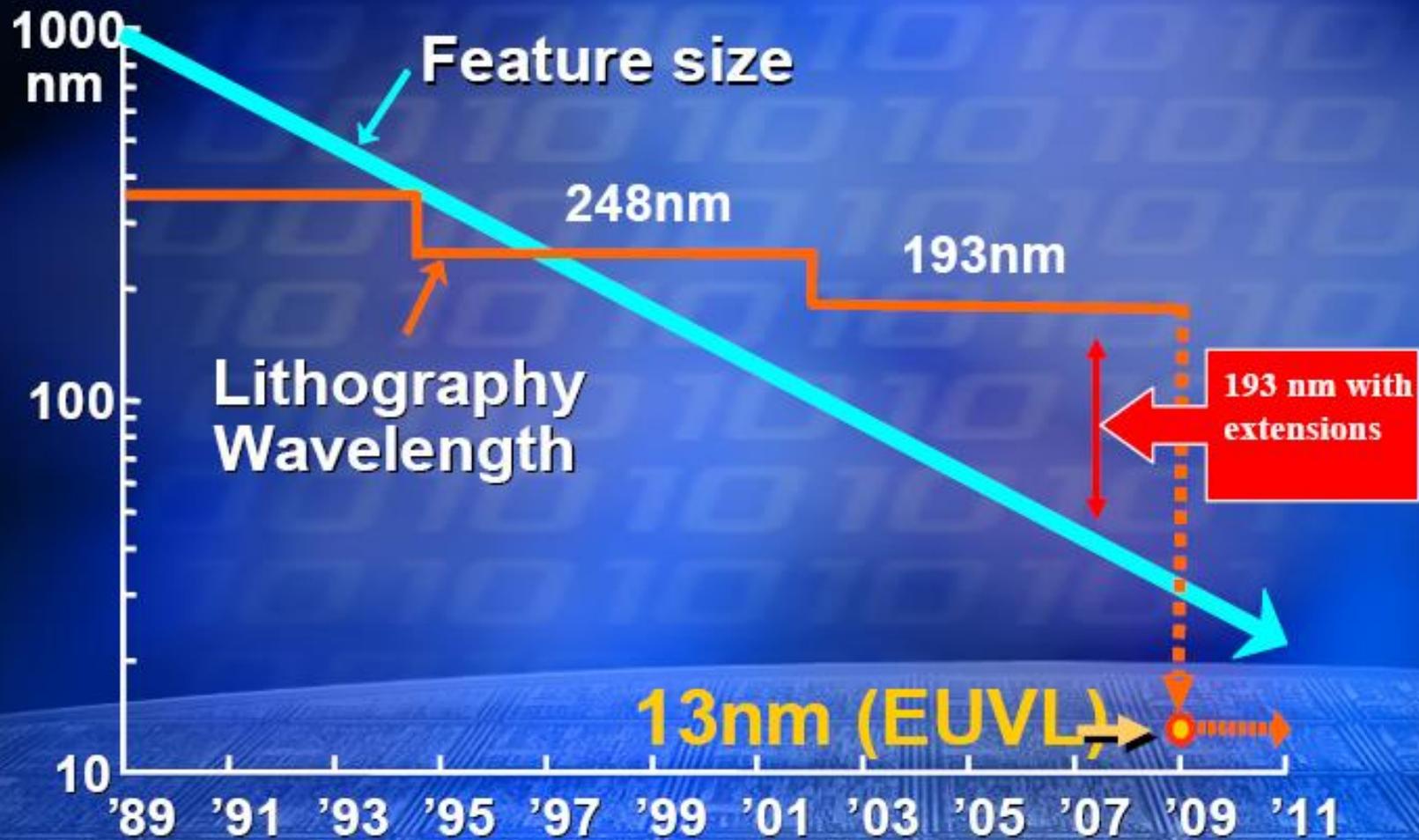
softball



house

Lithography Challenge

Feature size scaling faster than wavelength reduction

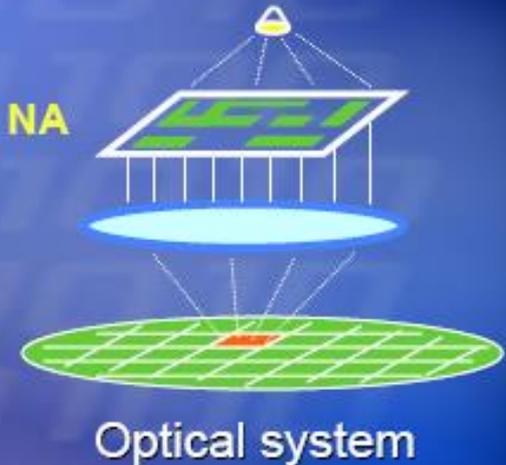


PSM used extensively in today's technology

EUV is an extension of optical Lithography

Similarities

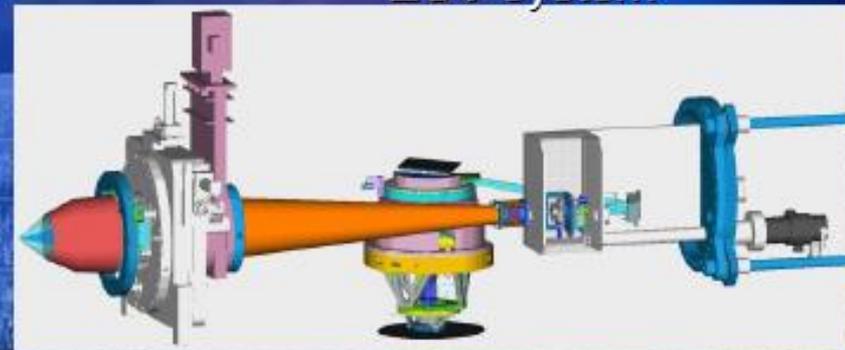
- Resolution and Depth of focus scale with NA and wavelength **Minimum Feature Size = $k_1 \lambda / NA$**
- Uses reduction optics
- Builds on optical lithography experience base
- Supports optical extension tricks – off axis illumination, phase shift masks, OPC
- Employs step and scan printing



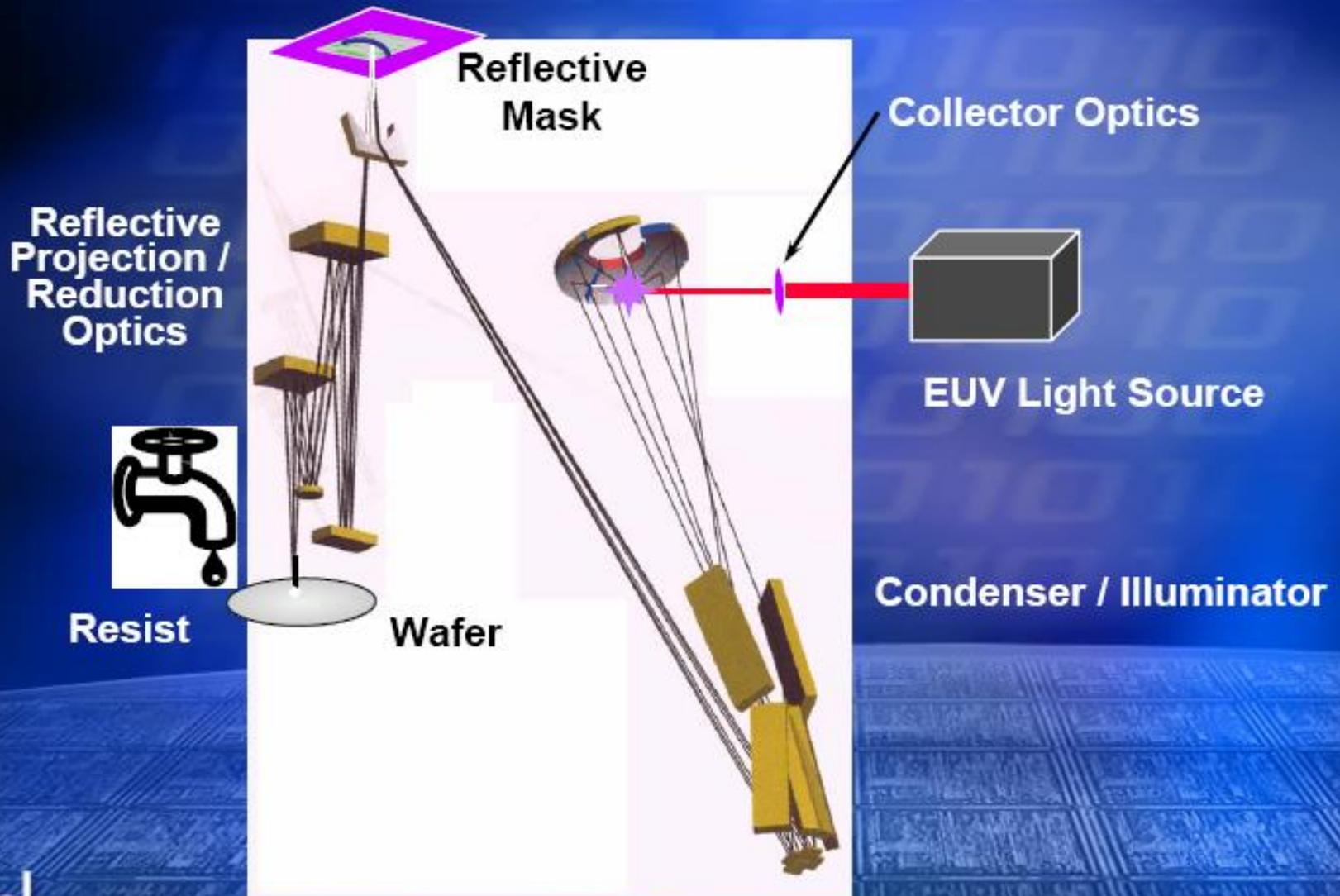
Differences

- Uses very short wavelength 13.5 nm light
- 13.5 nm radiation absorbed by all materials
- All optics are reflective
- Uses reflective masks
- No mask protective cover during exposure
- Vacuum operation
- Unique source for EUV light

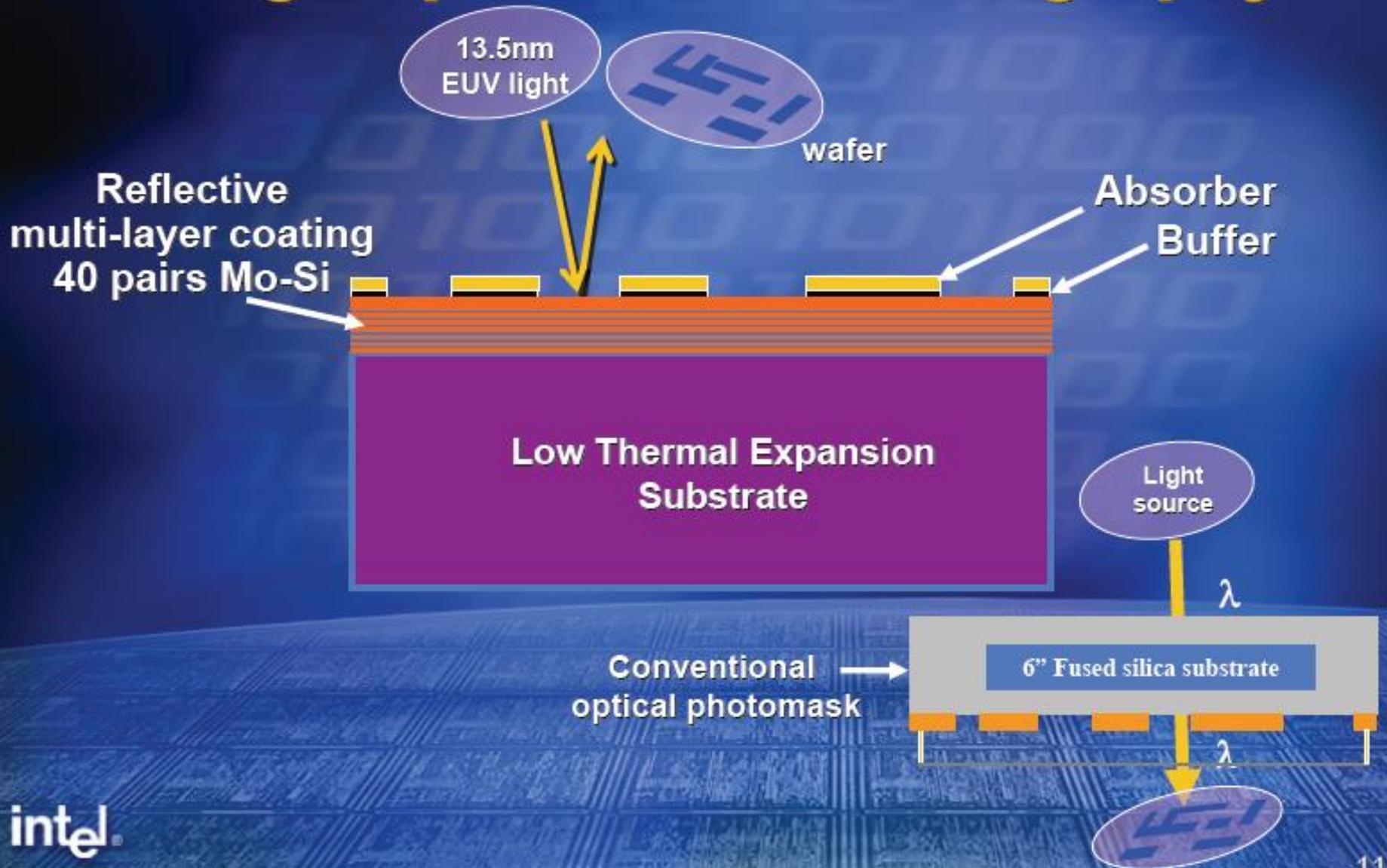
EUV system



Light path in an EUV exposure tool



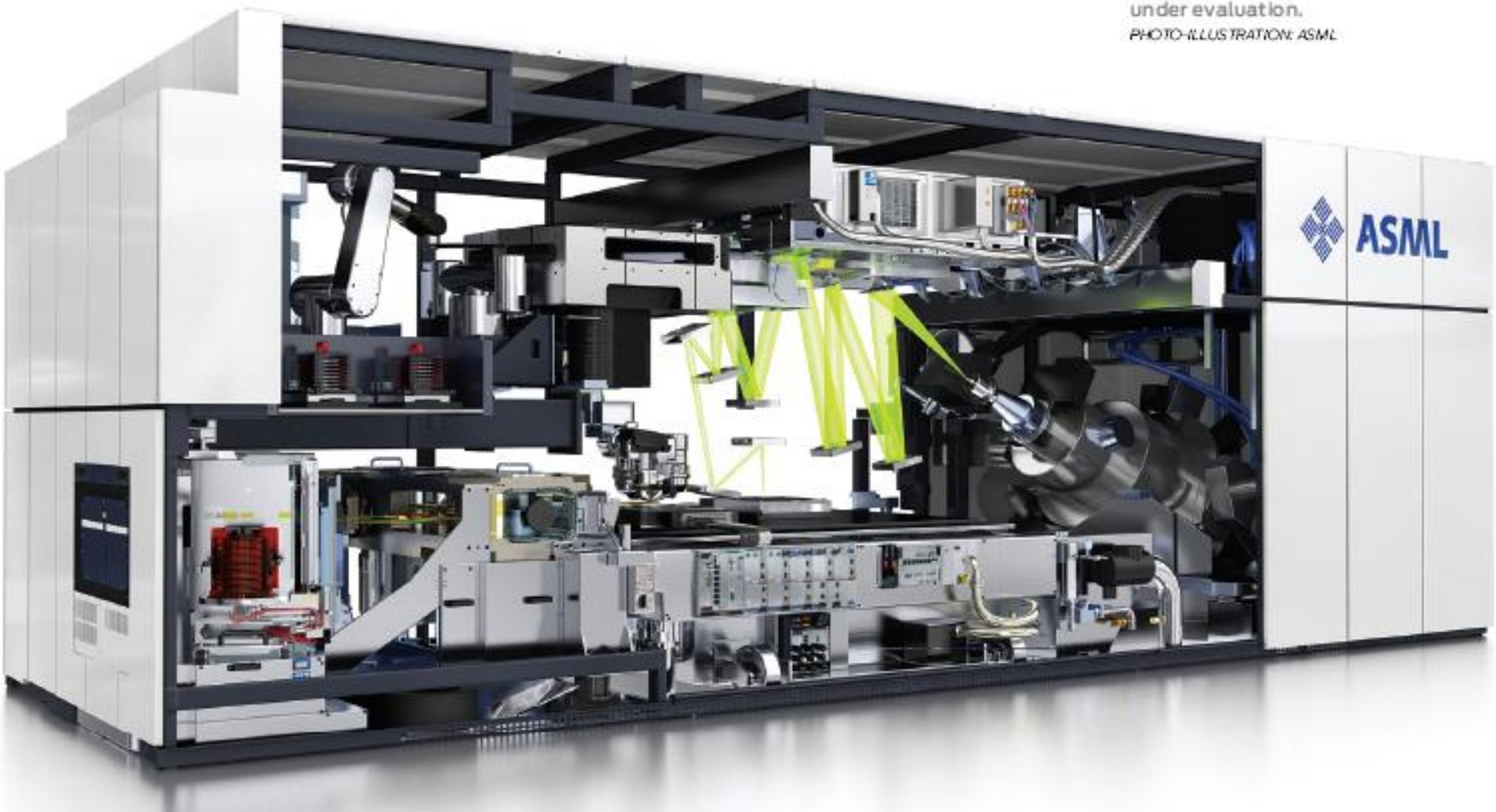
EUV Reflective Mask is an Integral part of EUV Lithography



SILICON SAVIOR?

A SML's second-generation tool for extreme ultraviolet lithography is under evaluation.

PHOTO-ILLUSTRATION: ASML



Problems of EUV lithography

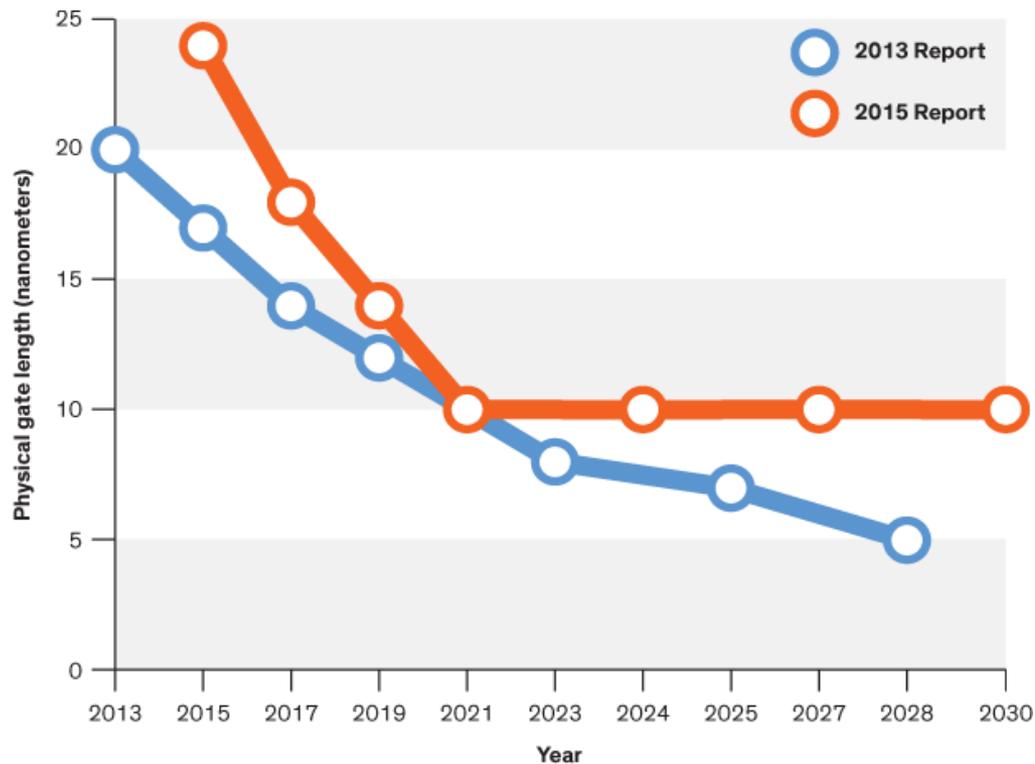
[Spectrum, Aug 07]

- No powerful enough (~ 200 W) light sources available, and
 - no sensitive enough ($\sim 5\text{mJ}/\text{cm}^2$) photoresist available
- > no way, at the moment, to have ~ 100 wafers per hour (acceptable commercial throughput)
- Deployment is expected around 2018-2020

Transistors could stop shrinking in 2021

[Spectrum, Sept 16]

After more than 50 years of miniaturization, the transistor could stop shrinking in just five years. That is the prediction of the 2015 International Technology Roadmap for Semiconductors (ITRS)



Transistors could stop shrinking in 2021

[Spectrum, Sept 16]

After 2021, the report forecasts, it will no longer be economically desirable for companies to continue traditional transistor miniaturization in microprocessors.

Instead, chip manufacturers will turn to other means of boosting density, namely

- turning the transistor geometry from horizontal to vertical and
- building multiple layers of circuitry, one on top of another
- replacing traditional silicon channels by channels made with alternative materials, namely silicon germanium, germanium, and III-V compounds

