

Public

ASML

Faster, smaller, greener

Agenda

- Chips are everywhere
- Introducing ASML
- ASML's place in the industry
- Lithography, the driving force behind Moore's Law
- Technology
- How do we do it?
- Business update

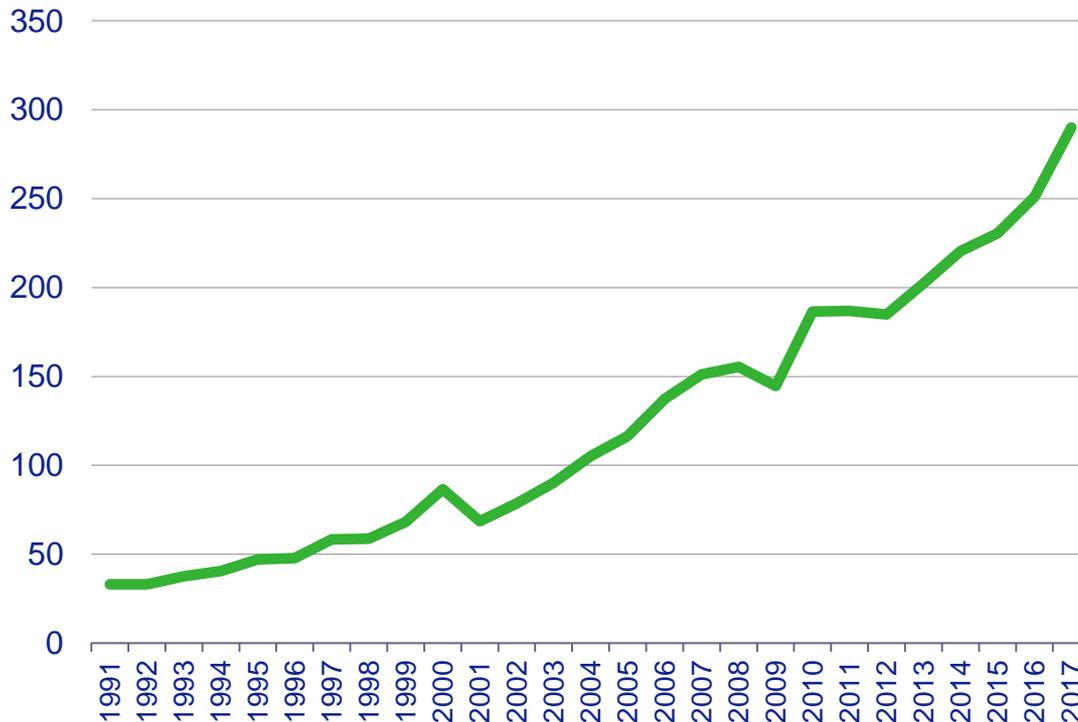
Chips are everywhere

It's hard to imagine a world without chips



Nearly 300 billion ICs are made every year

IC units, in billions



In 2017, 290 billion ICs were produced — nearly 40 for every man, woman and child on the planet.

Global semiconductor industry sales were \$369 billion.

The background of the slide features a series of light blue, wavy lines that originate from the left side and curve towards the right, creating a sense of motion and depth. The lines are thin and spaced out, with a gradient that fades from a medium blue on the left to a very light blue on the right.

Introducing ASML

ASML makes the machines for making those chips

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- Lithography is the critical tool for producing chips
- 2018 sales: €10.9 billion
- More than 23,000 employees (FTE) worldwide, out of which more than 8,500 in R&D

Our story begins in the Philips lab in 1984

Humble beginnings make for a strong can-do culture



Started as a joint venture by Philips and ASMI

Just 31 employees— with a can-do attitude

It took a decade of perseverance to break into the market

Innovation and perseverance have brought us to here

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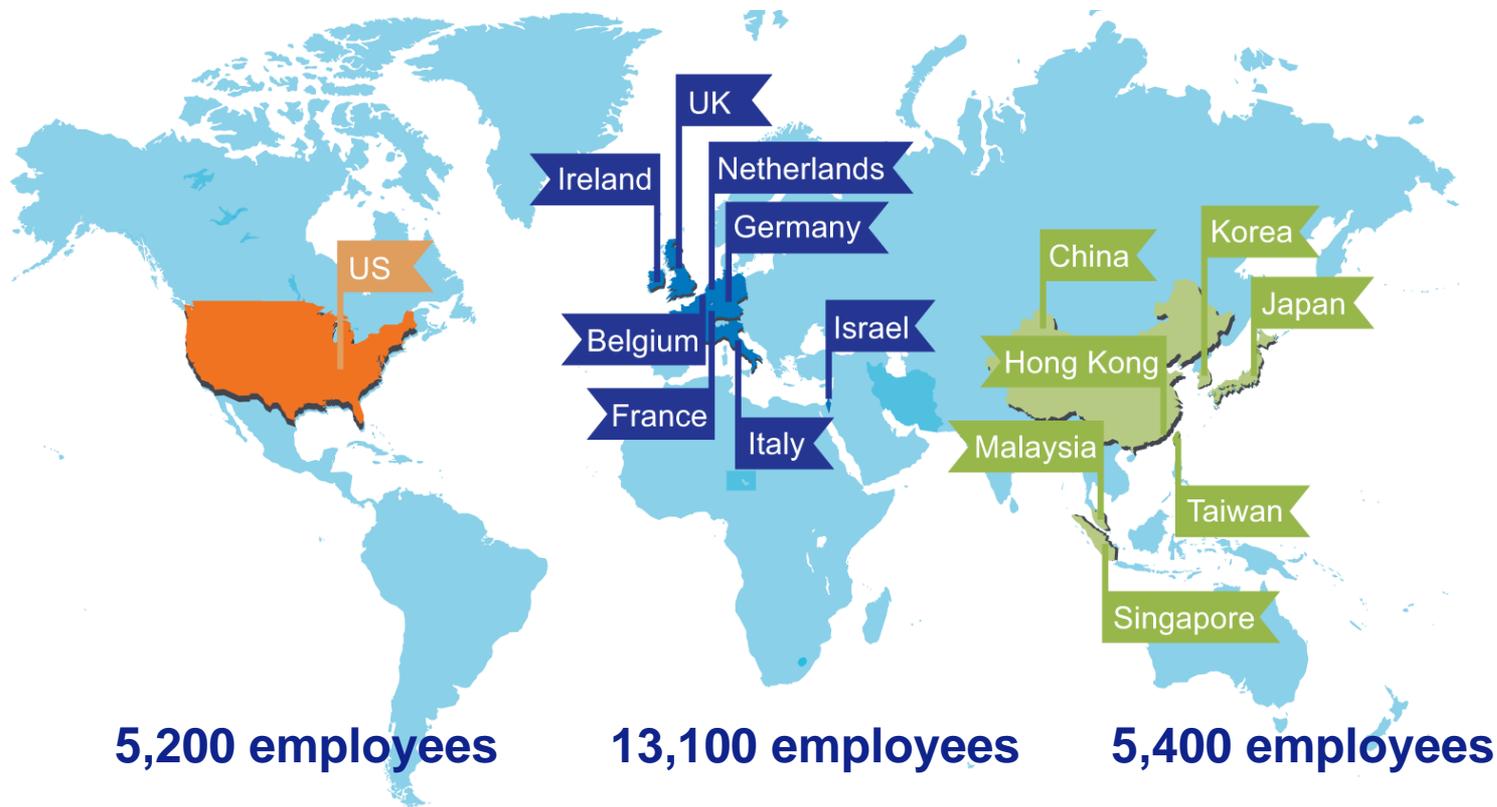


All major
chipmakers
use ASML's
technology

Europe's 2nd
biggest tech
company by
market cap
(75B€+)

Annual R&D
budget of
1.6B€

A global presence with >23,000 employees



Offices in over 60 cities in 16 countries worldwide

Our key locations

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Wilton (CT)



San Diego(CA)



Korea



Veldhoven



Chandler (AZ)



Taiwan

All major chipmakers are our customers

Company	Segment	2018 capex (est., \$B)
 SAMSUNG	Foundry + Memory	24.0
 intel	Integrated Devices	14.0
 tsmc	Foundry	11.0
 SK hynix	Memory	11.0
 Micron	Memory	8.5
 TOSHIBA  Western Digital	Memory	7.3
 GLOBALFOUNDRIES	Foundry	4.5
 SMIC	Foundry	1.9
 UMC	Foundry	1.1
 SONY	Others	1.0
Others		30.7
Total		115.0

Our vision: Semiconductor technology everywhere

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Our vision is a world in which **semiconductor technology is everywhere** and helps to **tackle society's toughest challenges**.



We contribute to this goal **by creating products and services that let our customers define the patterns that integrated circuits are made of**. We continuously raise the capabilities of our products, enabling our customers to increase the value and reduce the cost of chips.

By helping to make chips cheaper and more powerful, we help to make semiconductor technology more attractive for a larger range of products and services, which in turn **enables progress in fields such as healthcare, energy, mobility and entertainment**.

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ASML's place in the industry

Driving the semiconductor industry: Moore's Law

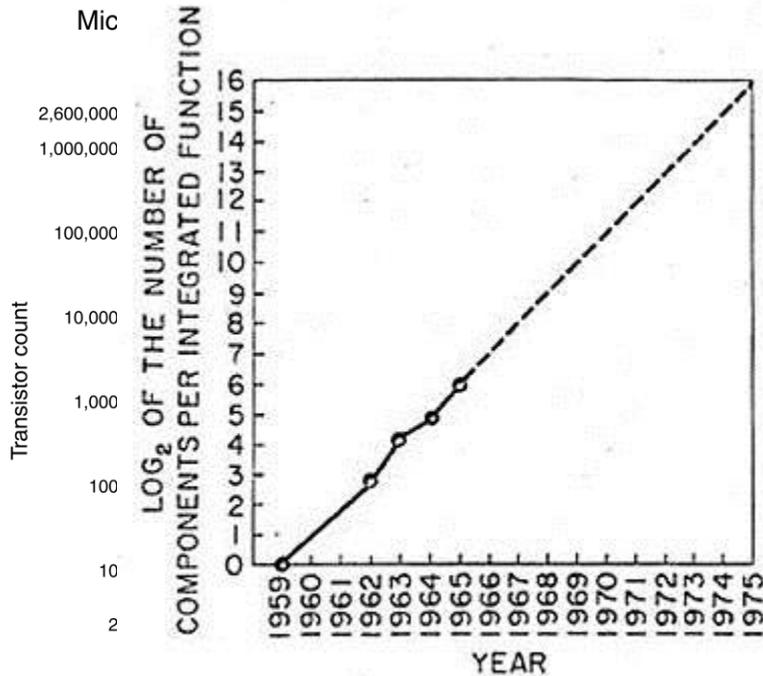


Fig. 2 Number of components per integrated function for minimum cost per component extrapolated vs time.

Gordon Moore (1965):
Number of transistors per chip doubles every year.

Later adjusted to two years,
the trend has held for more
than four decades.

Moore's Law is a law of economics

- Imagine printing the book *The Hitchhiker's Guide To The Galaxy* (by the late great Douglas Adams)
- That's 227 pages at font size 14
- Now shrink all text to font size 7 and observe Moore's Law at work

17 pt
14

114 pages

227 pages

- You've halved the cost to print the book

THE HITCHHIKER'S GUIDE TO THE GALAXY

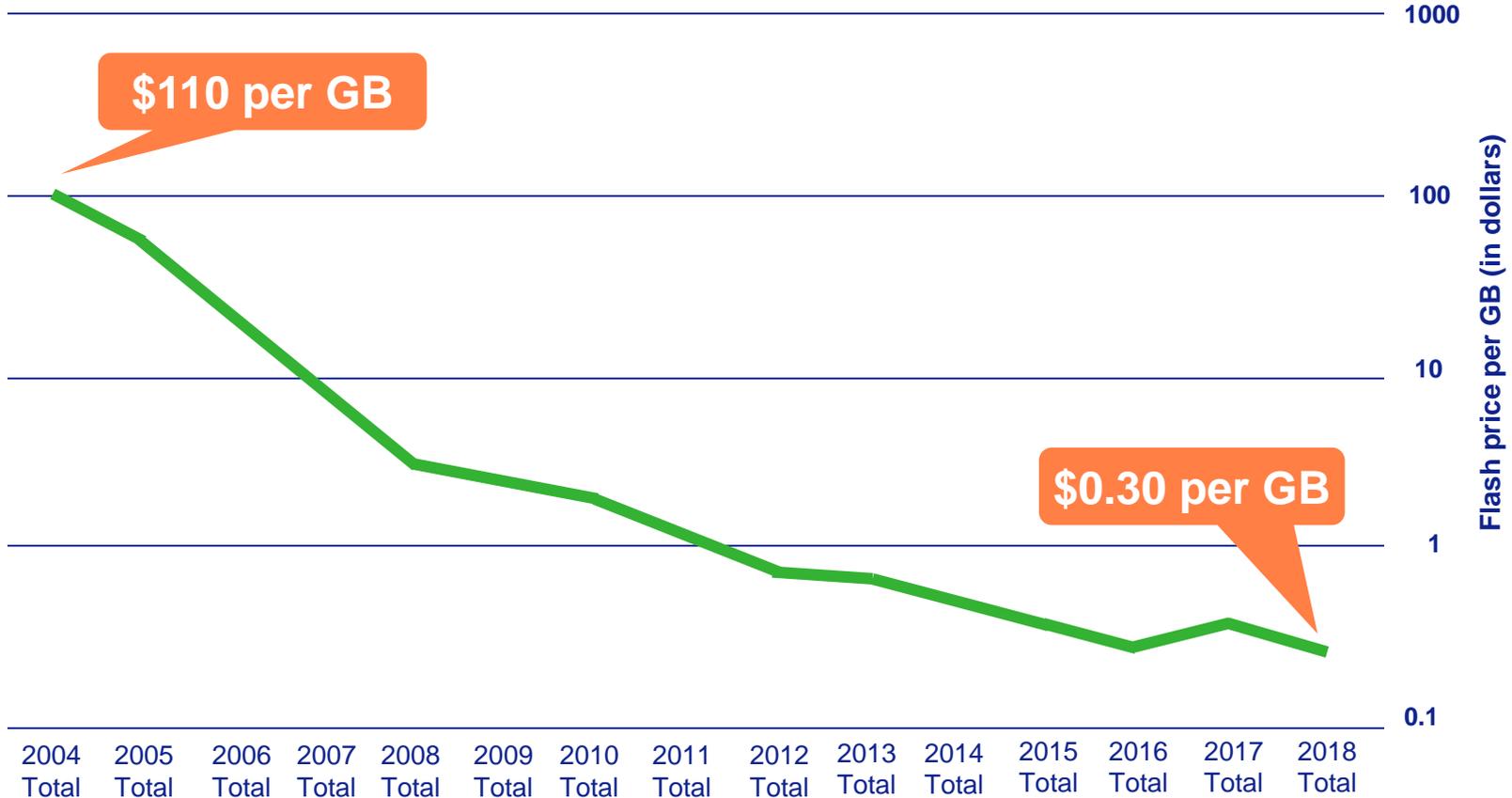
BY DOUGLAS ADAMS

- You've halved the time to print the book

- You've doubled the information density of the book

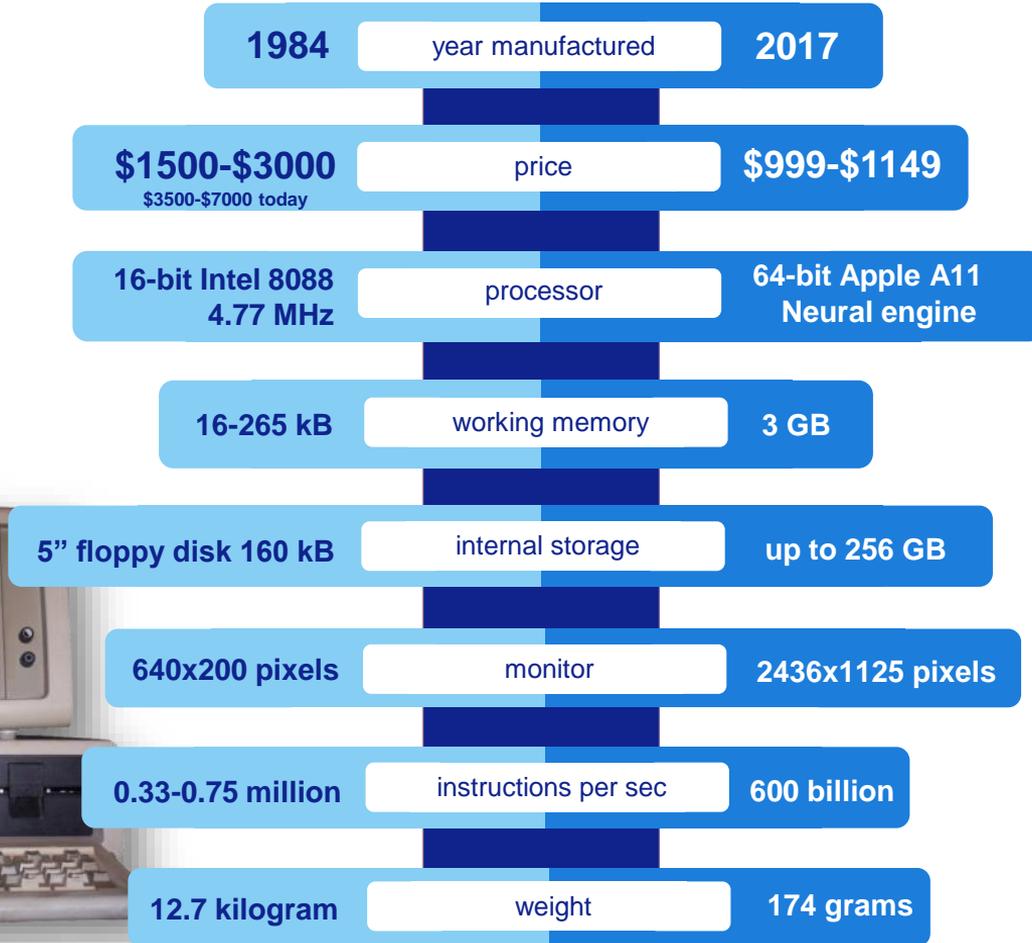


So Moore's Law makes chips cheaper...



...and electronic devices much more powerful

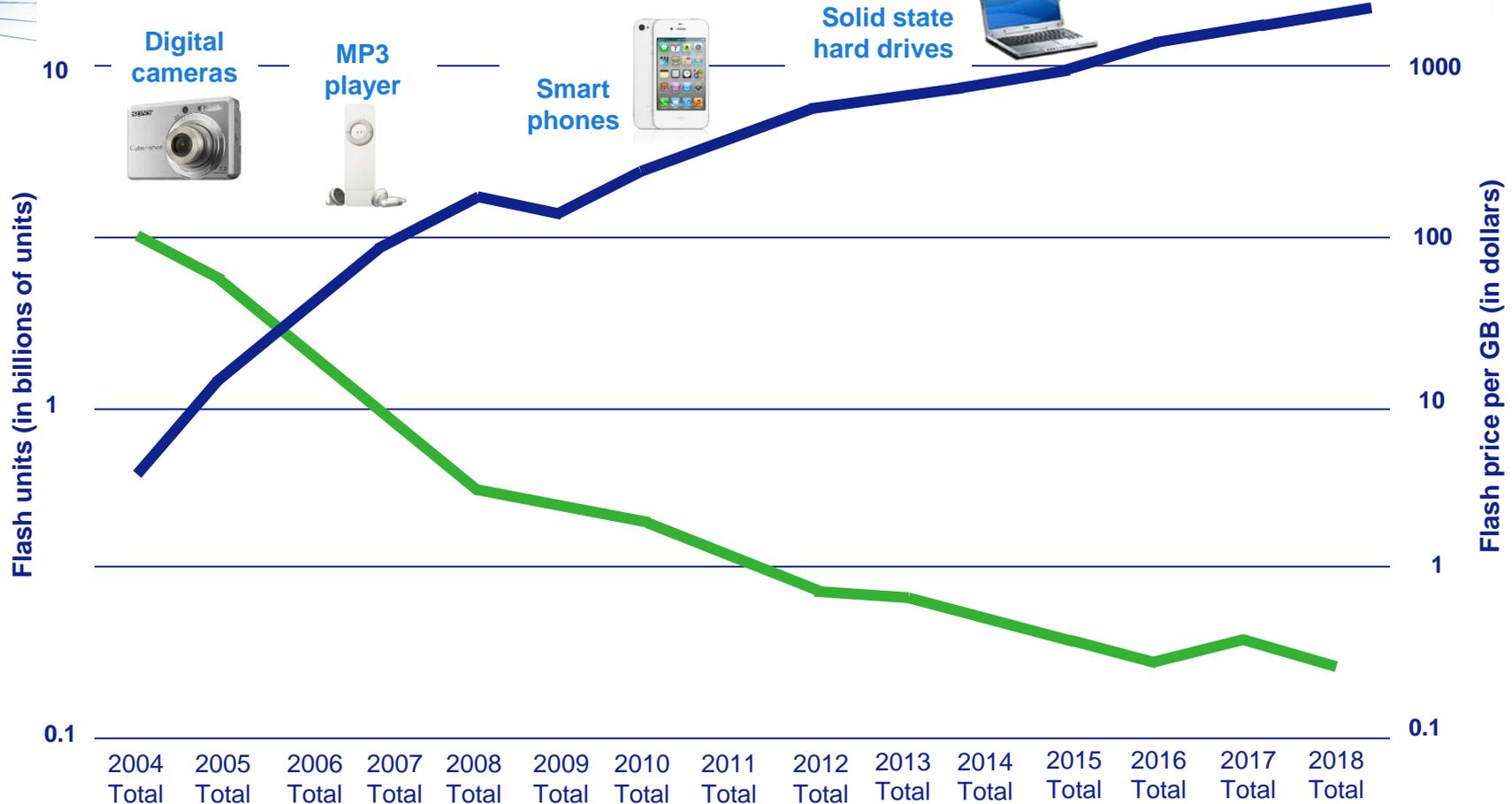
**IBM
5150**



**Apple
iPhone X**

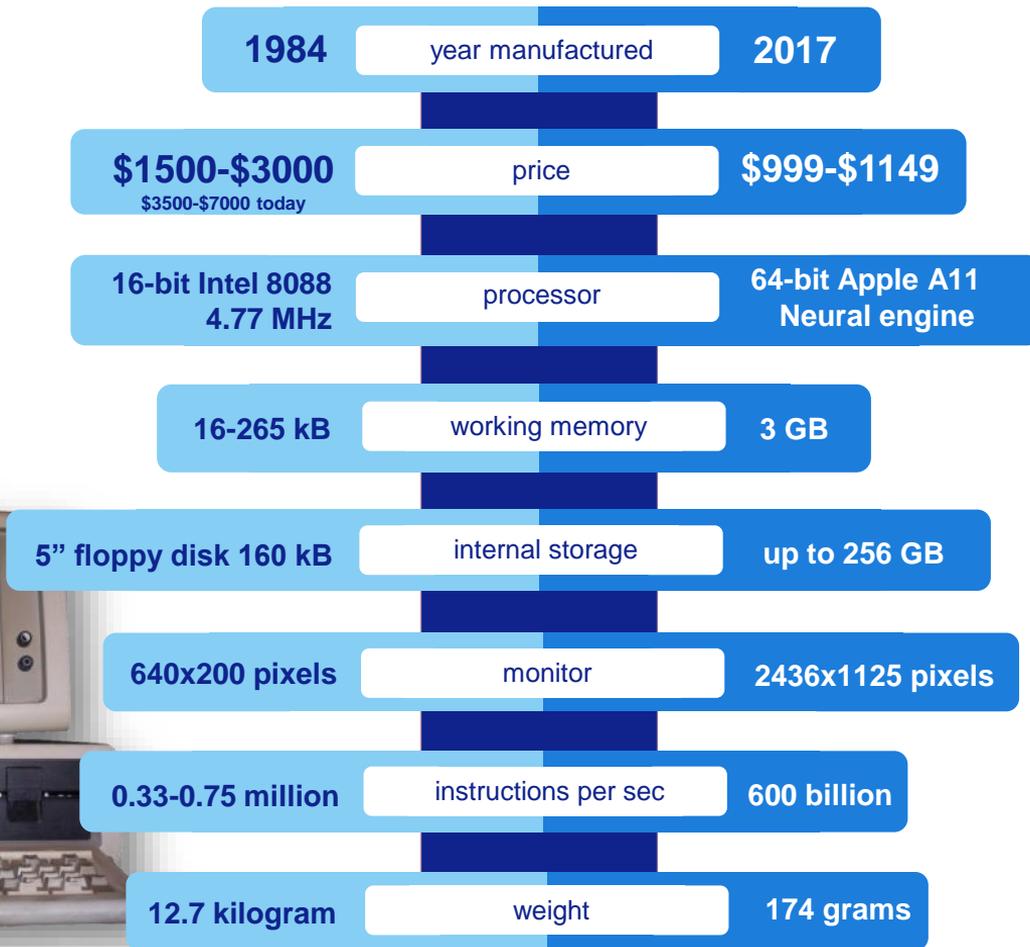


Cheaper chips drive market growth



Moore's Law powers innovation and lowers cost

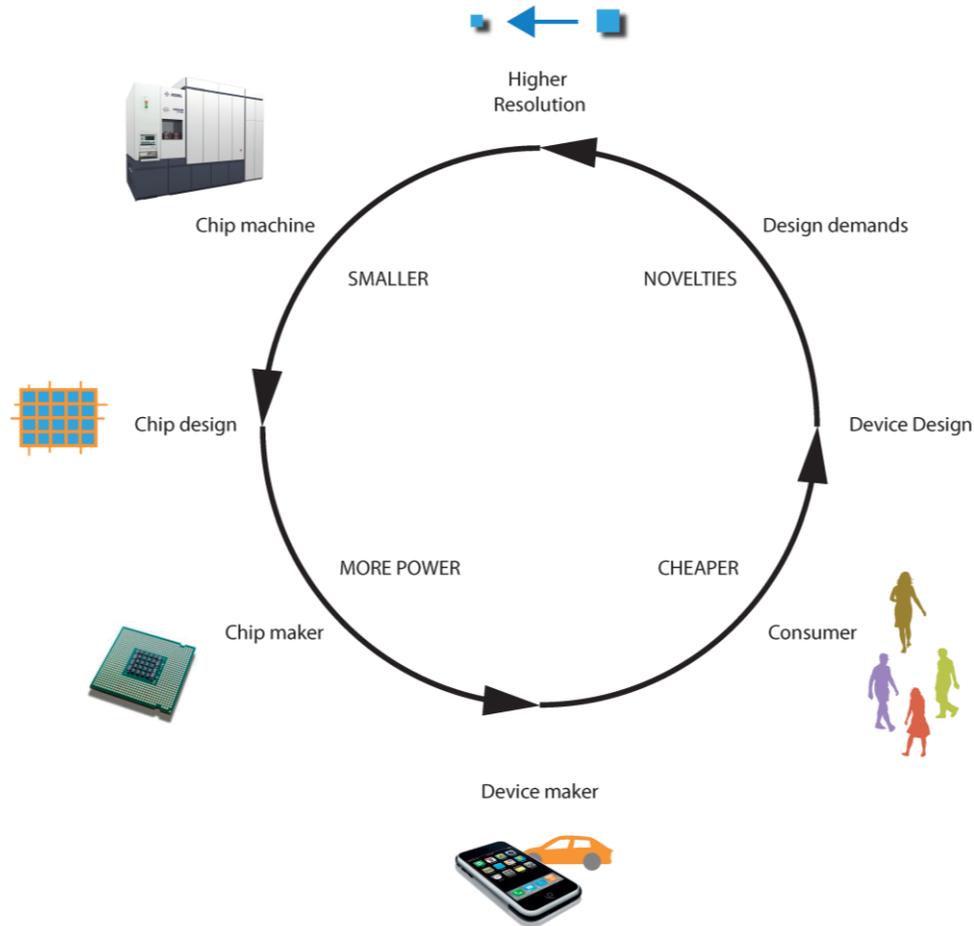
**IBM
5150**



**Apple
iPhone X**

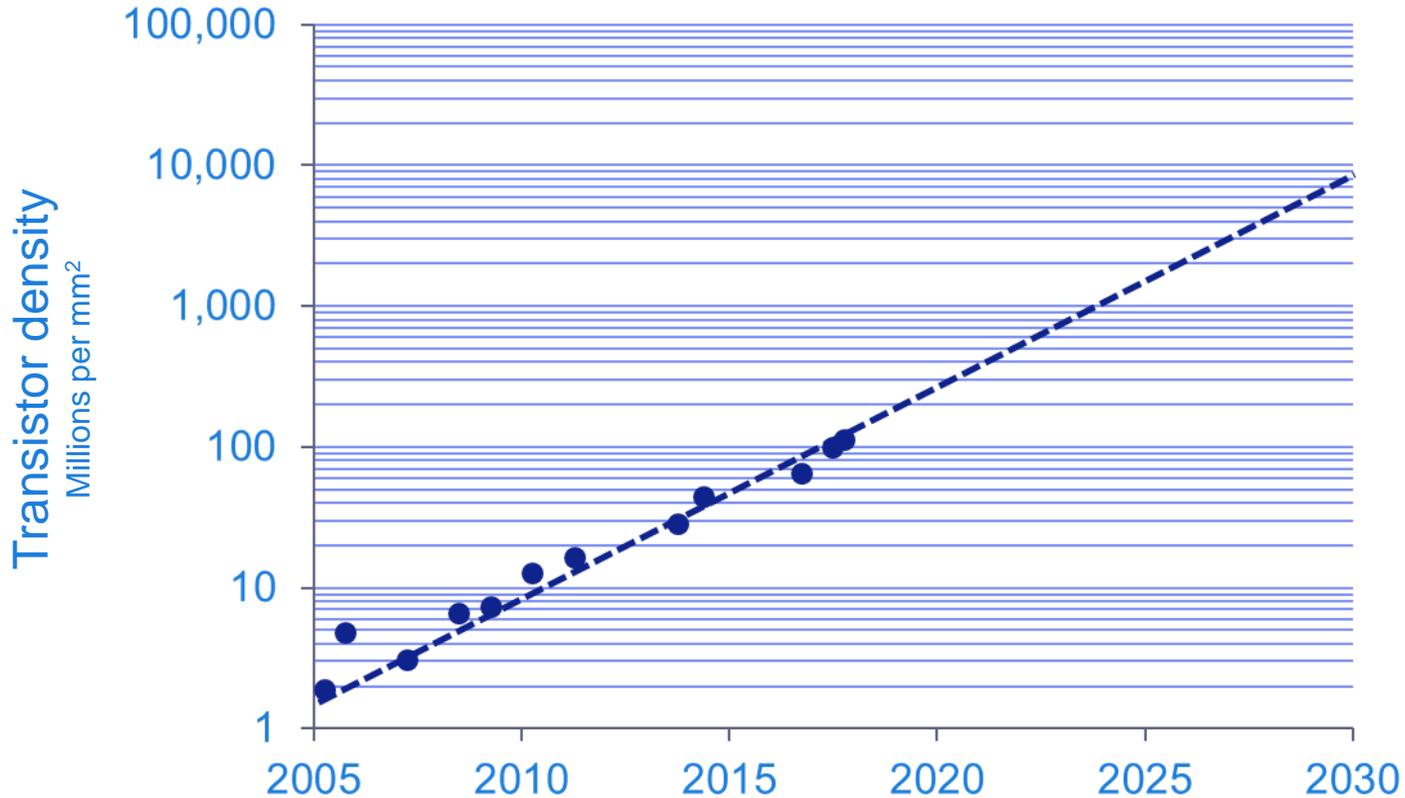


A virtuous cycle that can create and transform markets

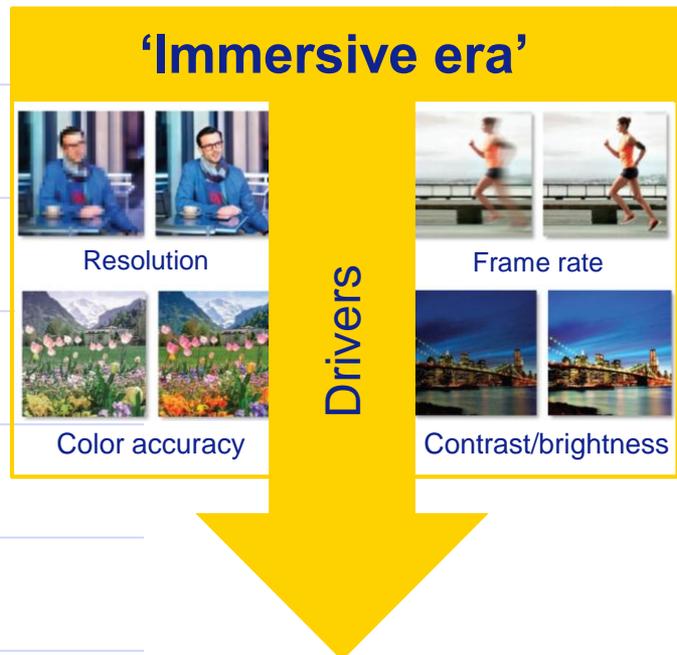
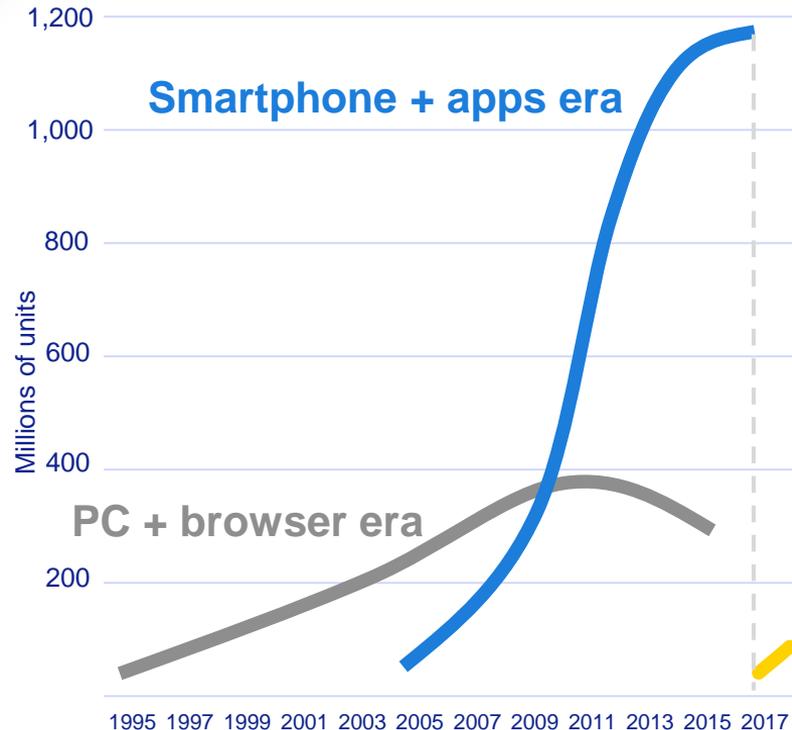


We see Moore's Law continuing beyond the next decade

Our industry is moving towards 1 billion transistors per mm²



Immersive devices will be the next wave



Broad applications

- Entertainment
- Visualization
- Gaming
- Journalism
- Medicine
- Education

Source: Lisa Su, AMD, "Immersive era in consumer computing", IEDM, Dec 2017

Immersive gaming will further boost an industry that's already worth 100 B€

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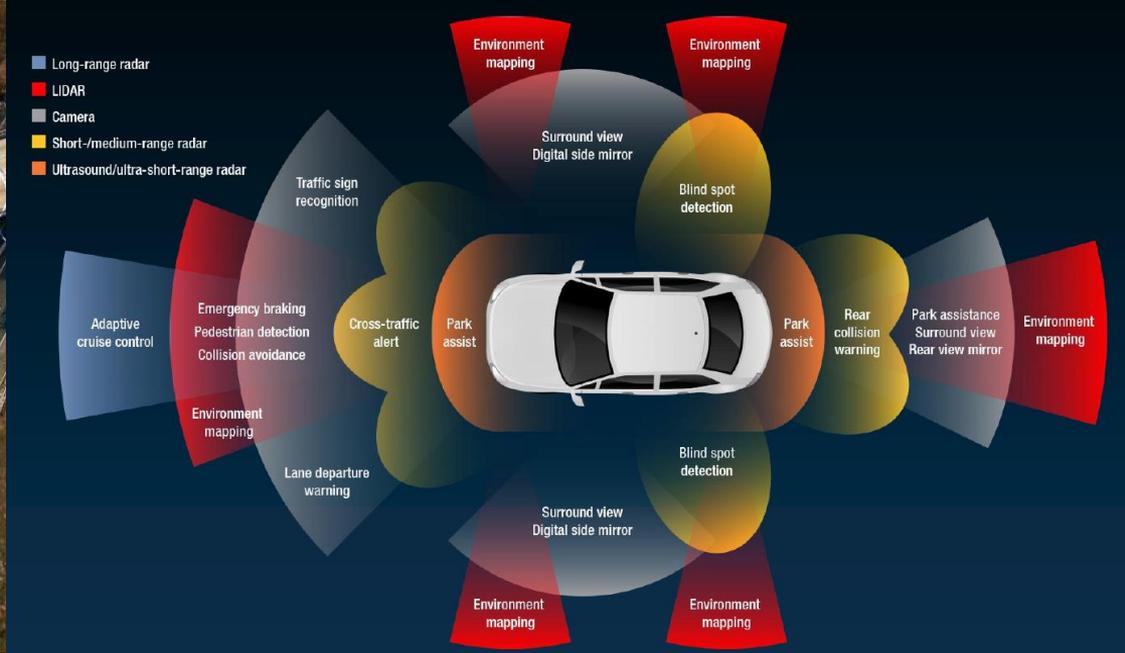
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Today's VR games are a prelude to tomorrow's fully immersive games with 64x HD-quality, rivaling the human eye

Semiconductors are transforming automotive technology

Doubling semiconductor content by 2024 to ~600 B€



Automotive sensors are mapping the world in millions of data points per second, enabling the road to autonomous driving

Our industry benefits from infrastructure improvements

This drives applications with more data volume and real-time use

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Source: Qorvo, CNET

3G

1 Gb/s/km²
100 ms latency

<100,000
connections/km²

4G

10 Gb/s/km²
50 ms latency

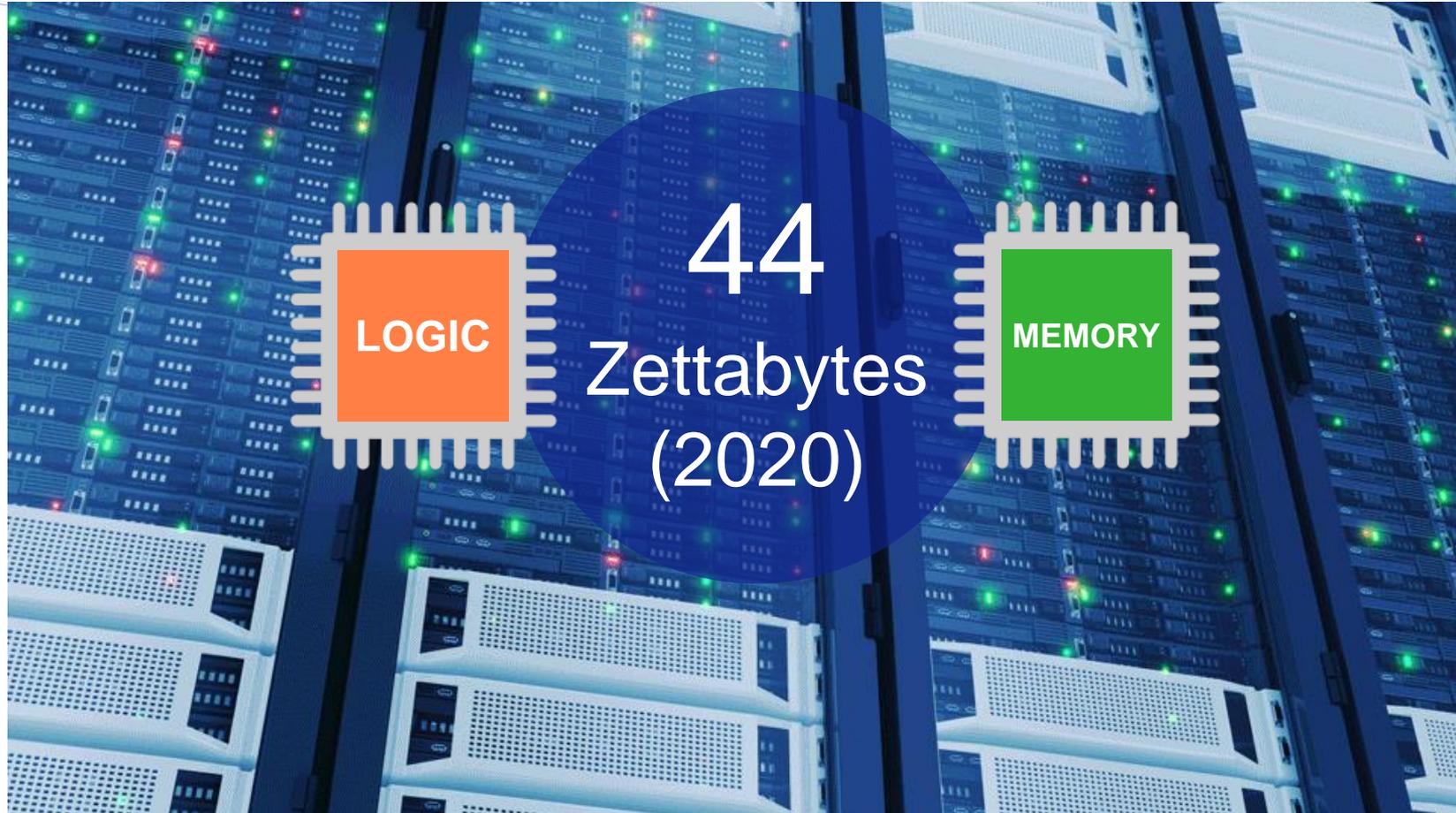
>1,000,000
connections/km²

5G

100-1000 Gb/s/km²
1 ms latency

Time to download a 2-hour movie on your smartphone:
3G @ 26 hours, 4G @ 6 minutes, 5G @ 3.6 seconds

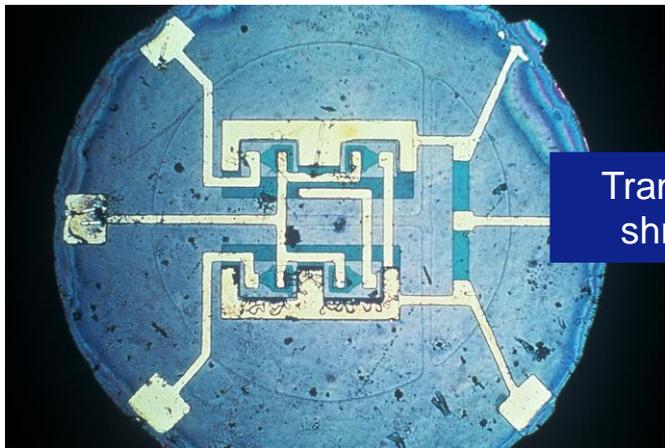
The world needs advanced chips to store and crunch that data
Global data going up from 4 Zetabytes (2013) to 44 Zetabytes (2020 est)



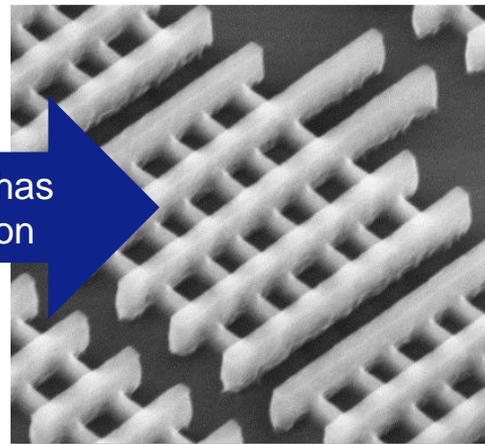
The background of the slide features a series of thin, light blue wavy lines that originate from the left side and curve towards the right, creating a sense of motion and depth. The overall color palette is a gradient of light blues.

Lithography drives IC innovation

Key to Moore's Law: Making smaller transistors



Transistor length has
shrunk by a million

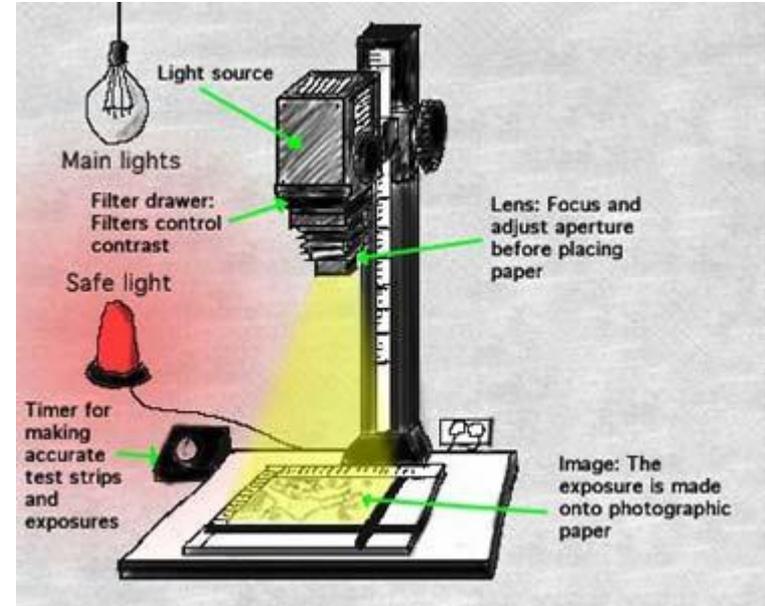
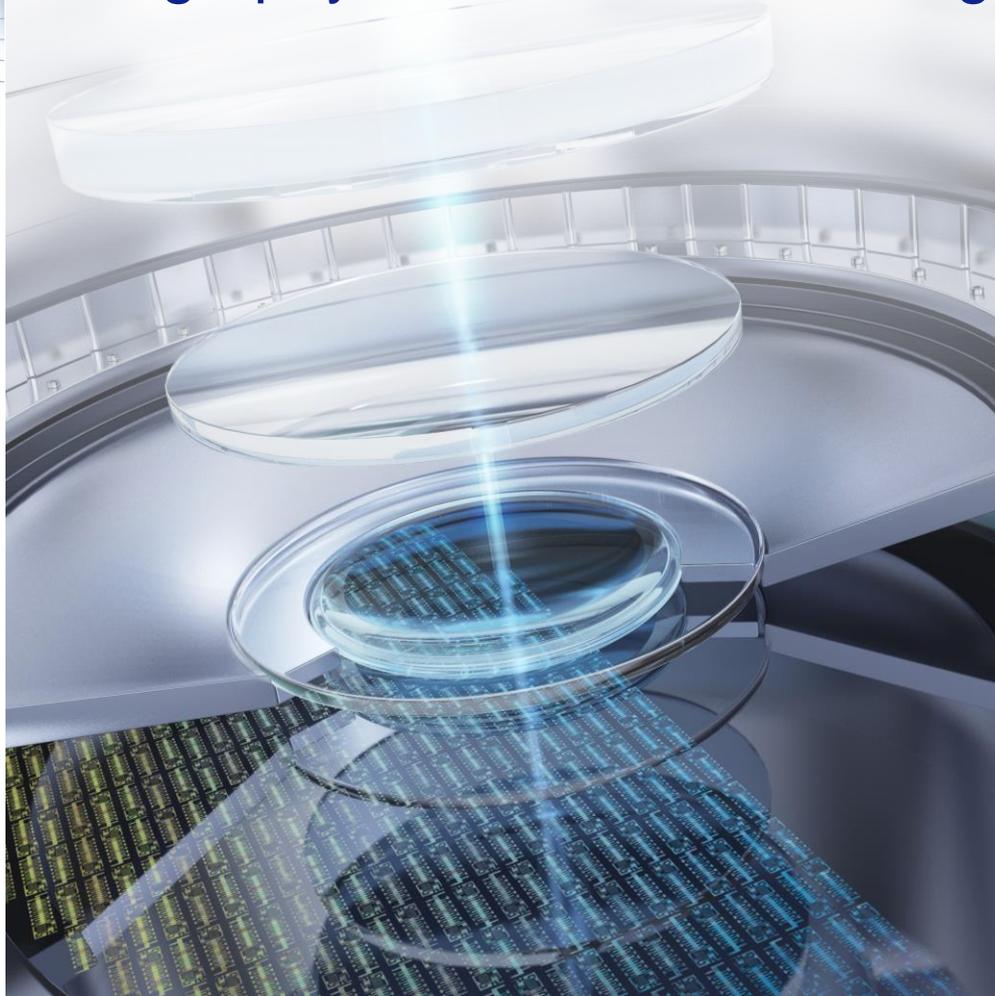


The first integrated circuit
on silicon, on a **wafer the size
of a fingernail**
(Fairchild Semiconductor, 1959)

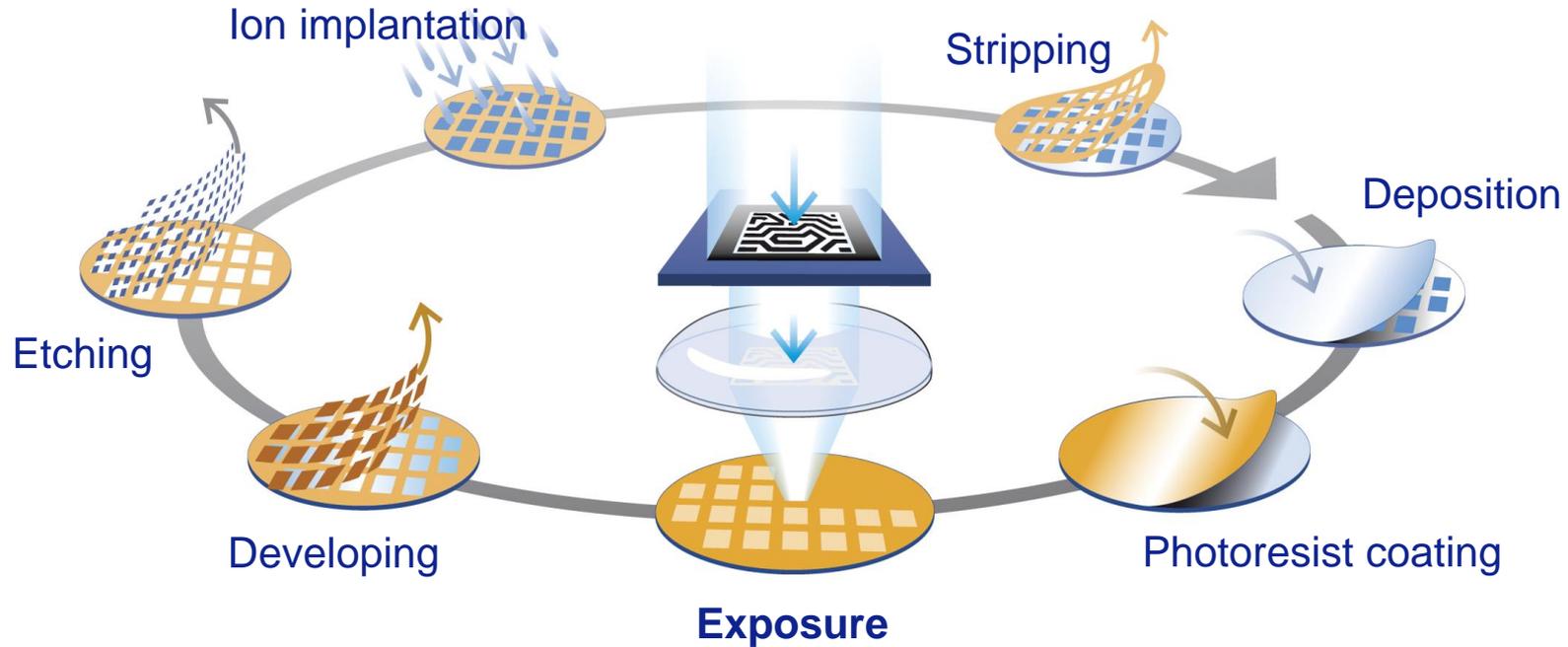
Today: **More than a
billion transistors on
the same area**
(Intel, 2012)

Lithography is critical for shrinking transistors

Like a photo enlarger of old, lithography forms the image of chip patterns on a wafer



The manufacturing loop



Technology

Keeping up with Moore's Law



1984

PAS 2000

ASML's first stepper



2015

TWINSKAN NXT:1980Di

Our most advanced immersion system

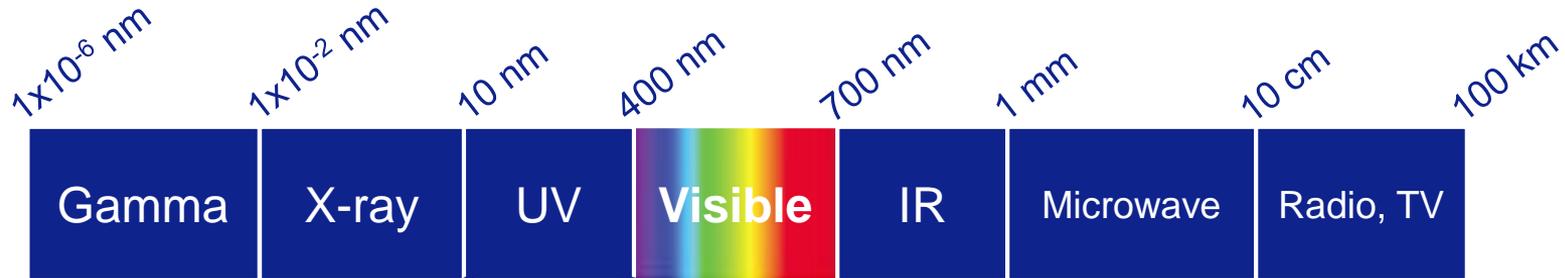


2018

TWINSKAN NXE:3400B

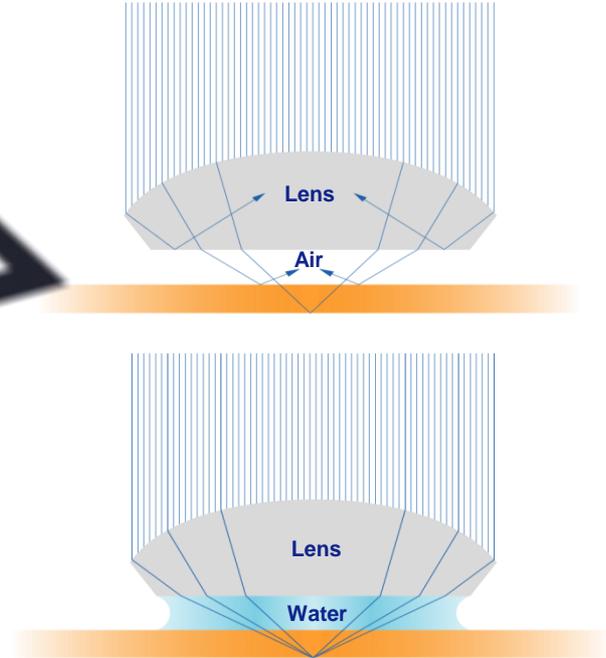
High volume EUV system

Key innovation: Wavelength changes



Wavelength	13.5 nm	193 nm	248 nm	365 nm	436 nm
Year	2011	2003	1992	1986	1984
Platform	EUV	Immersion	PAS 5500	PAS 5000	PAS 2000

Key innovation: Immersion lens



Keeping up with Moore's Law



1984

PAS 2000

ASML's first stepper



2015

TWINSKAN NXT:1980Di

Our most advanced immersion system



Wavelength:
193 nanometers

Resolution:
 ≤ 38 nanometers

Overlay:
1.2 nanometers

Wafer size:
300 mm

Productivity:
275 wafers per hour

TWINSKAN NXE:3400B

High volume EUV system

Keeping up with Moore's Law

Wavelength:
13.5 nanometers

Resolution:
≤ 22 nanometers

Overlay:
1.0 nanometers

Wafer size:
300 mm

Productivity:
125 wafers per hour



1984

PAS 2000

ASML's first stepper

2015

TWINSCAN NXT:1980Di

Our most advanced immersion system

2018

TWINSCAN NXE:3400B

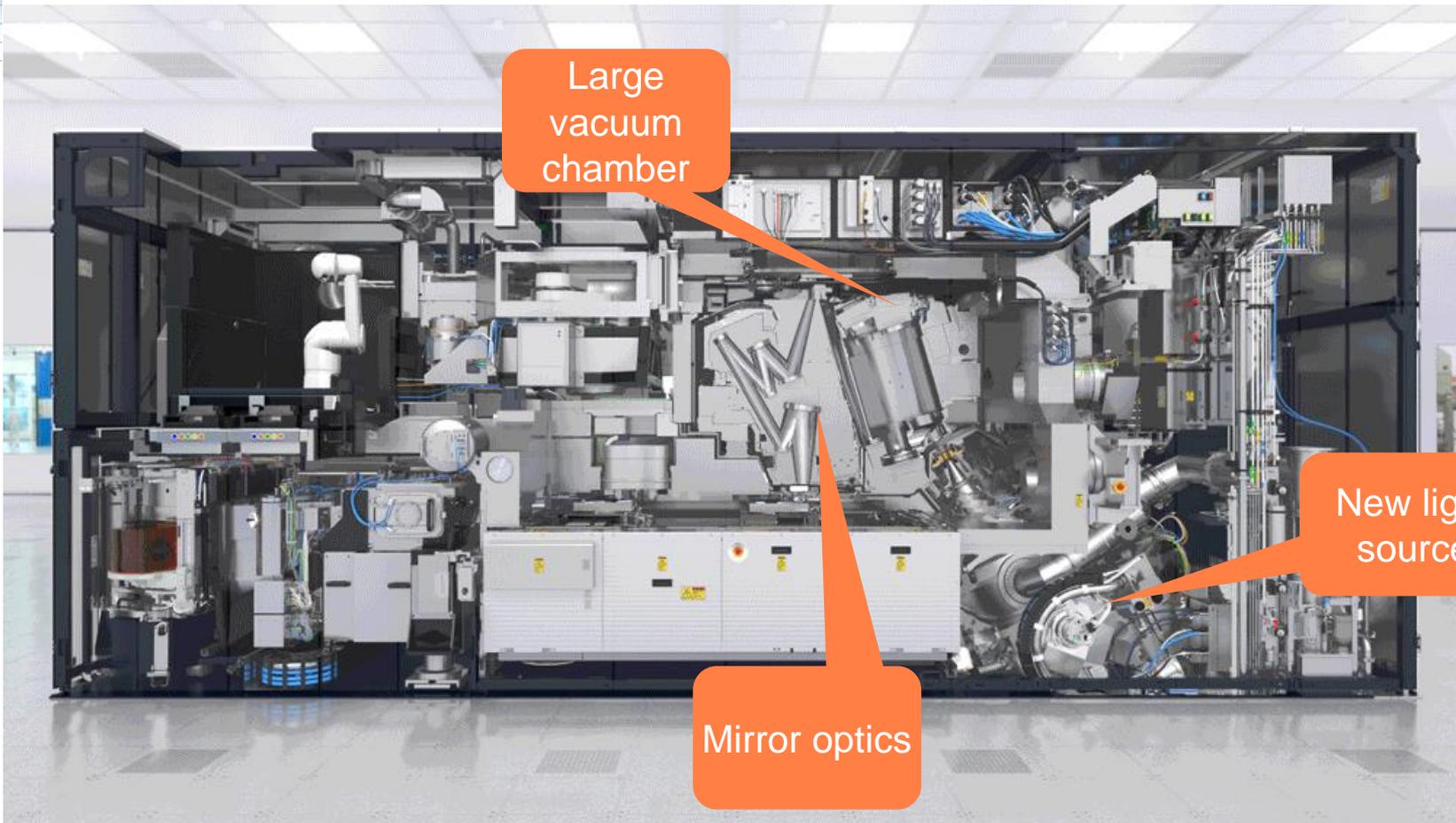
High volume EUV system

The future of lithography: EUV

Large vacuum chamber

New light source

Mirror optics

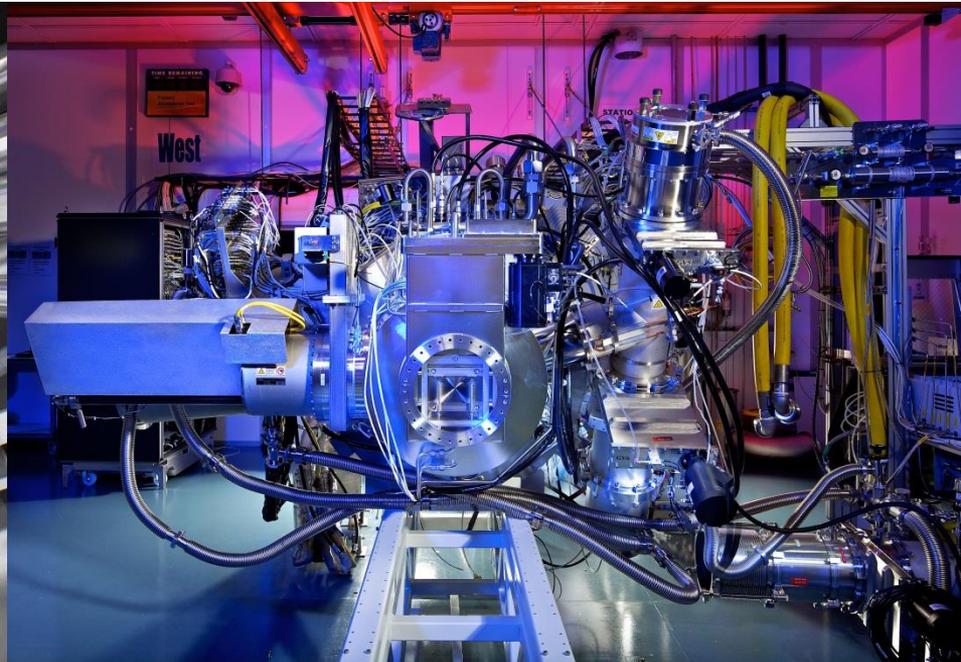
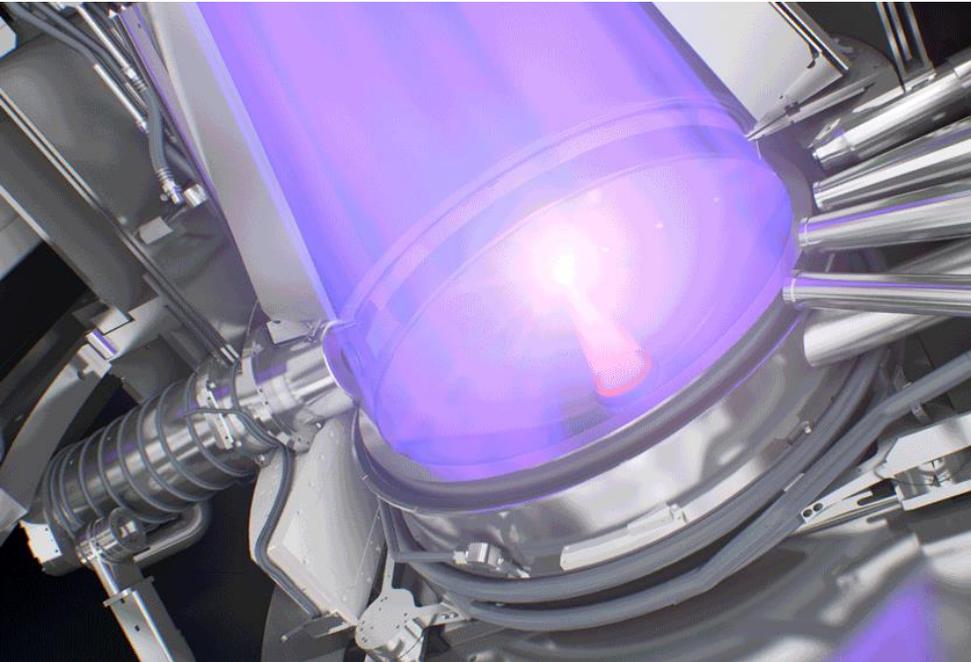


Firing a laser on a tin droplet 50,000 times a second

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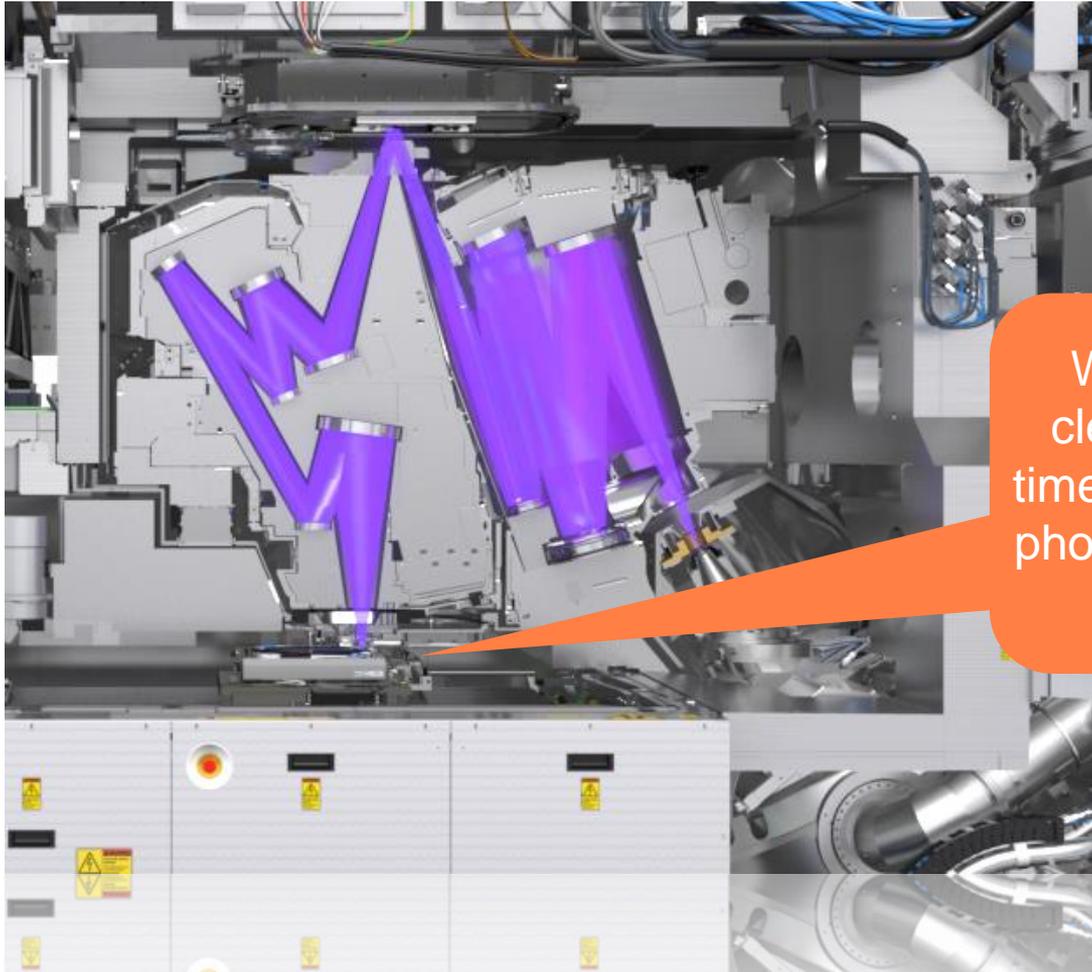
Mirrors: Polished to sub-nanometer accuracy



EUV mirrors are polished to an accuracy of ~ 50 picometers – less than the diameter of a silicon atom.

Blown up to the size of Germany, the biggest difference in height would be less than a millimeter.

Maintaining a clean vacuum



We need to maintain a clean vacuum, but every time we expose a wafer, the photoresist releases trillions of particles

A tightly integrated set of solutions for scaling and yield



Image

Make the image printable and optimize for yield

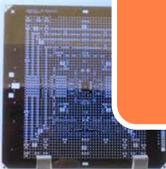
Keep production stable

Holistic lithography keeps scaling affordable

Model

Measure

Ensure measurement captures a maximum of relevant information



Product reticles

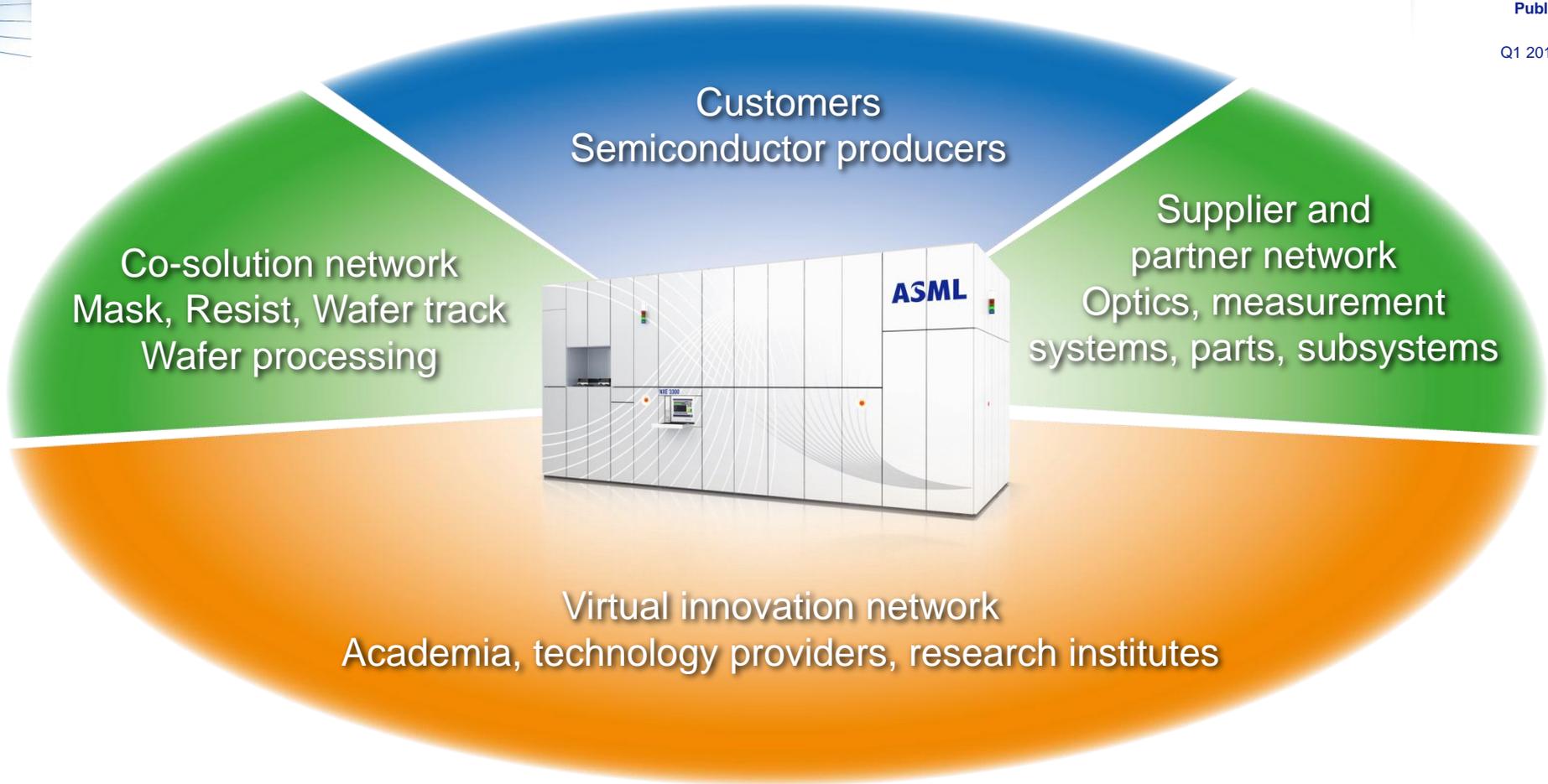


Product wafers

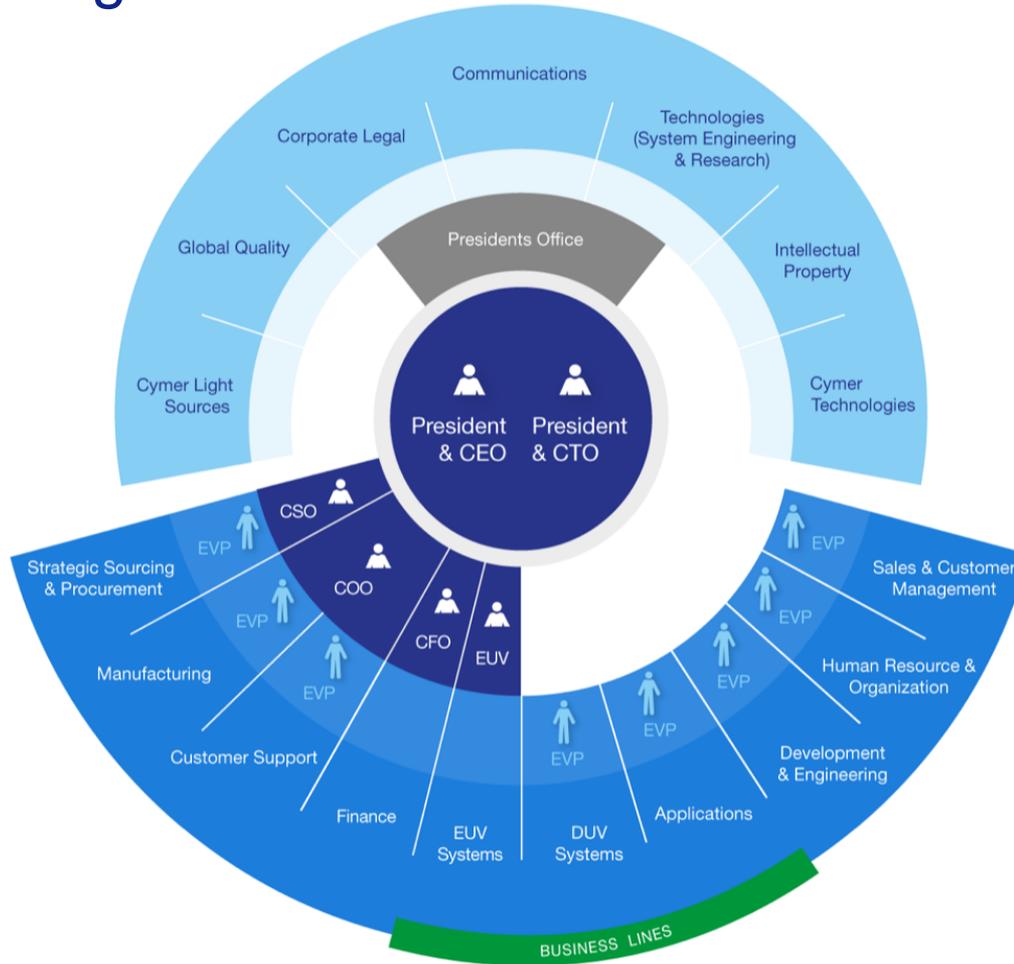
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How do we do it?

Open Innovation from design to manufacturing



How we are organized



High R&D spending to sustain technology leadership

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1980s:

PAS 2000/5000



1990s:

PAS 5500



2000s:

TWINSCAN



2010s:

NXE EUV

Our R&D investments amount to ~€1.5 billion per year

Great people in an integrated supply chain

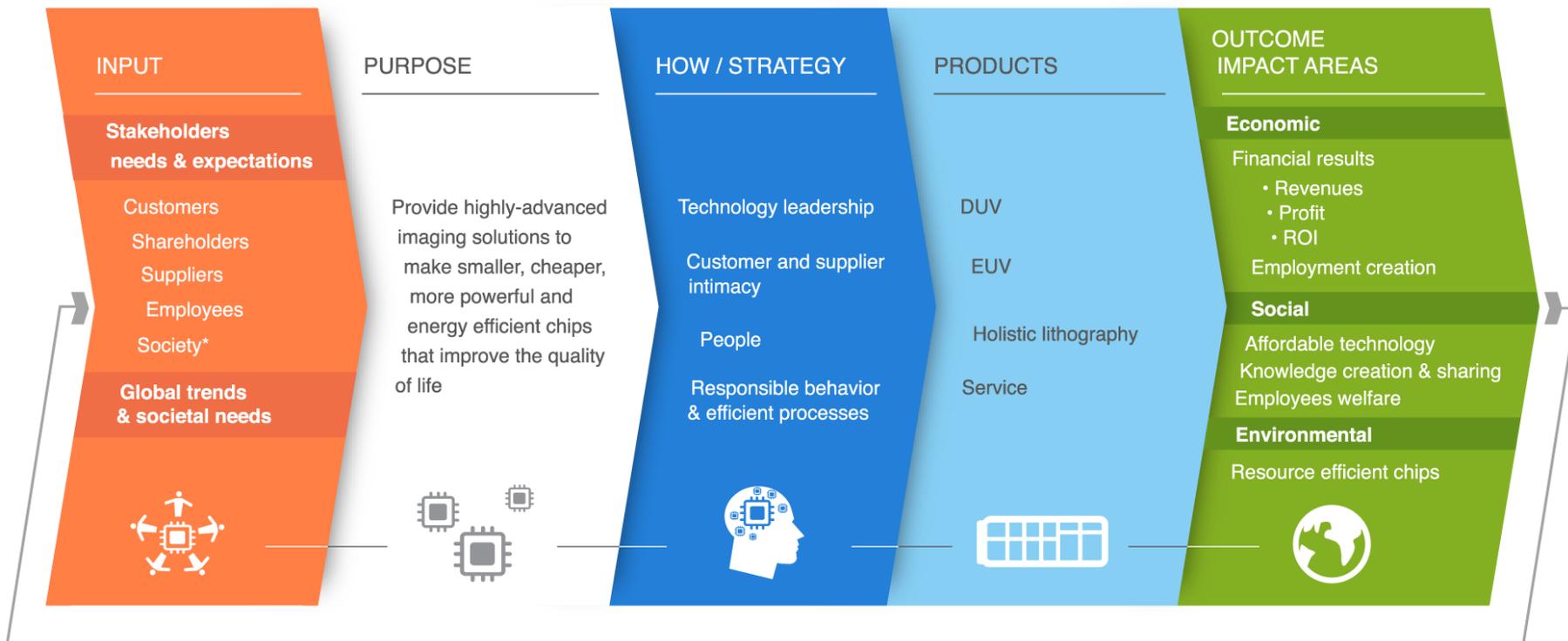
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Serving our stakeholders



* Society comprises peers (e.g. SEMI, EICC), governments, universities, local communities

Open Innovation from design to manufacturing

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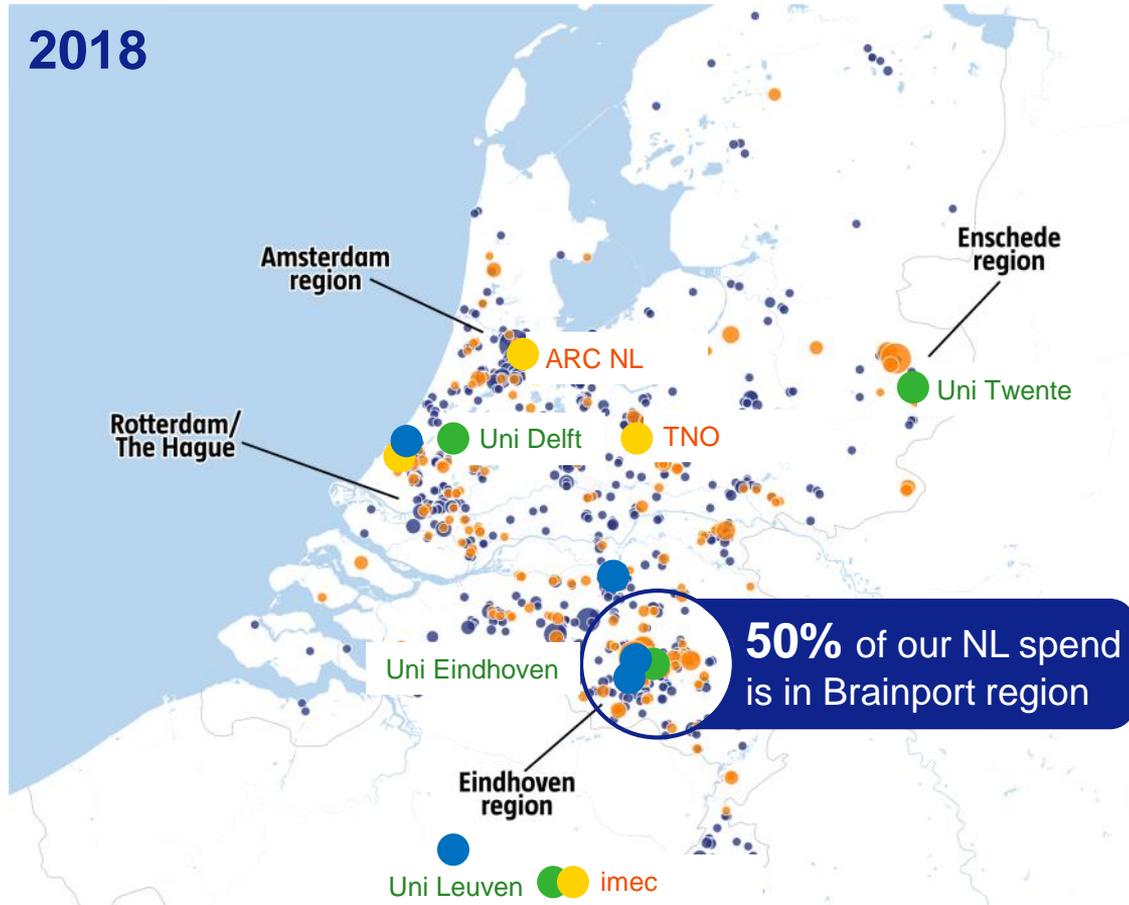
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We develop and build technology in a vast ecosystem

Example of our home base: ASML's supply chain is dependent on NL

2018



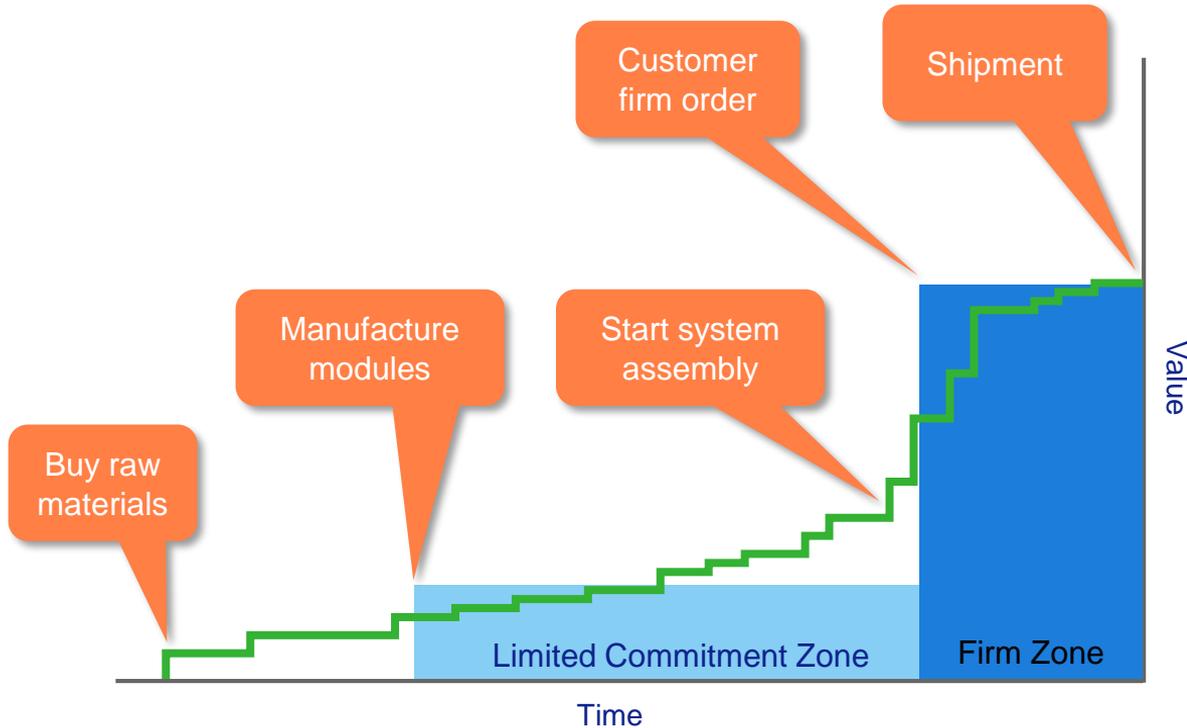
● ● Suppliers

We see ourselves as **architects and integrators:**

Some **85%** of the bill of materials of our machines is **manufactured by suppliers**

- Universities
- Research institutes
- Government

Sharing risk and reward



Suppliers bear some of the risk and participate in the rewards.

Mutual transparency ensures that risks are well understood and minimized.

“QLTC” sourcing model (Quality, Logistics, Technology, Cost) means that suppliers do not compete solely on cost.

ASML and ZEISS makes for another perfect example

Long-time partnership under the creed 'two companies, one business'



Sharing risk and reward, creating value for stakeholders



R&D



Investments



Manufacturing



50,000 jobs
in Europe



Leverage
knowledge

Business update

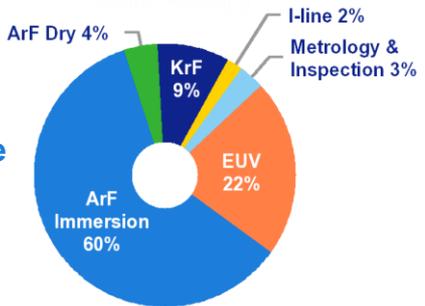
Q1 results summary

- Net sales of € 2,229 million, net systems sales valued at € 1,689 million, Installed Base Management* sales of € 540 million
- Gross margin of 41.6%
- Operating margin of 15.0%
- Net income as a percentage of net sales of 15.9%
- Net bookings of € 1,399 million, including 3 EUV systems

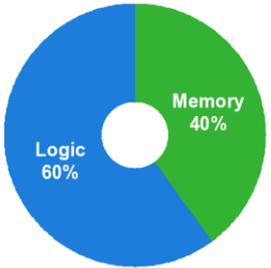
* Installed Base Management equals our service and field option sales

Net system sales breakdown in value

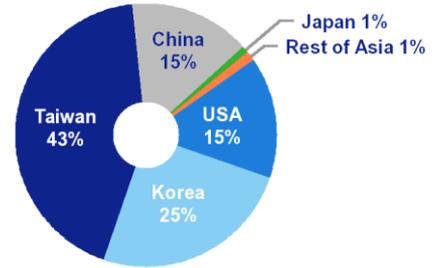
Q1'19
total value
€ 1,689
million



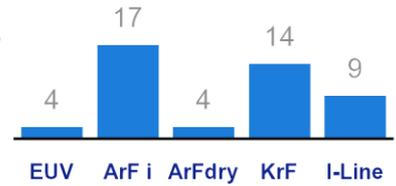
End-Use



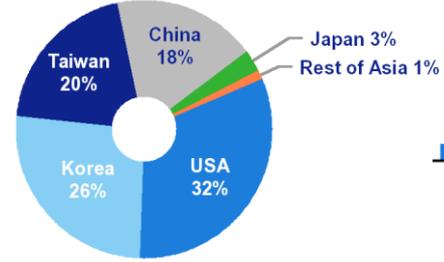
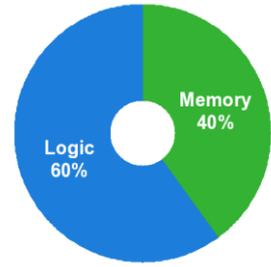
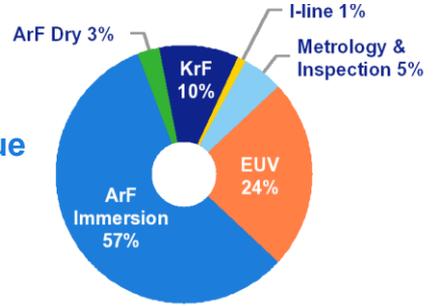
Region (ship to location)



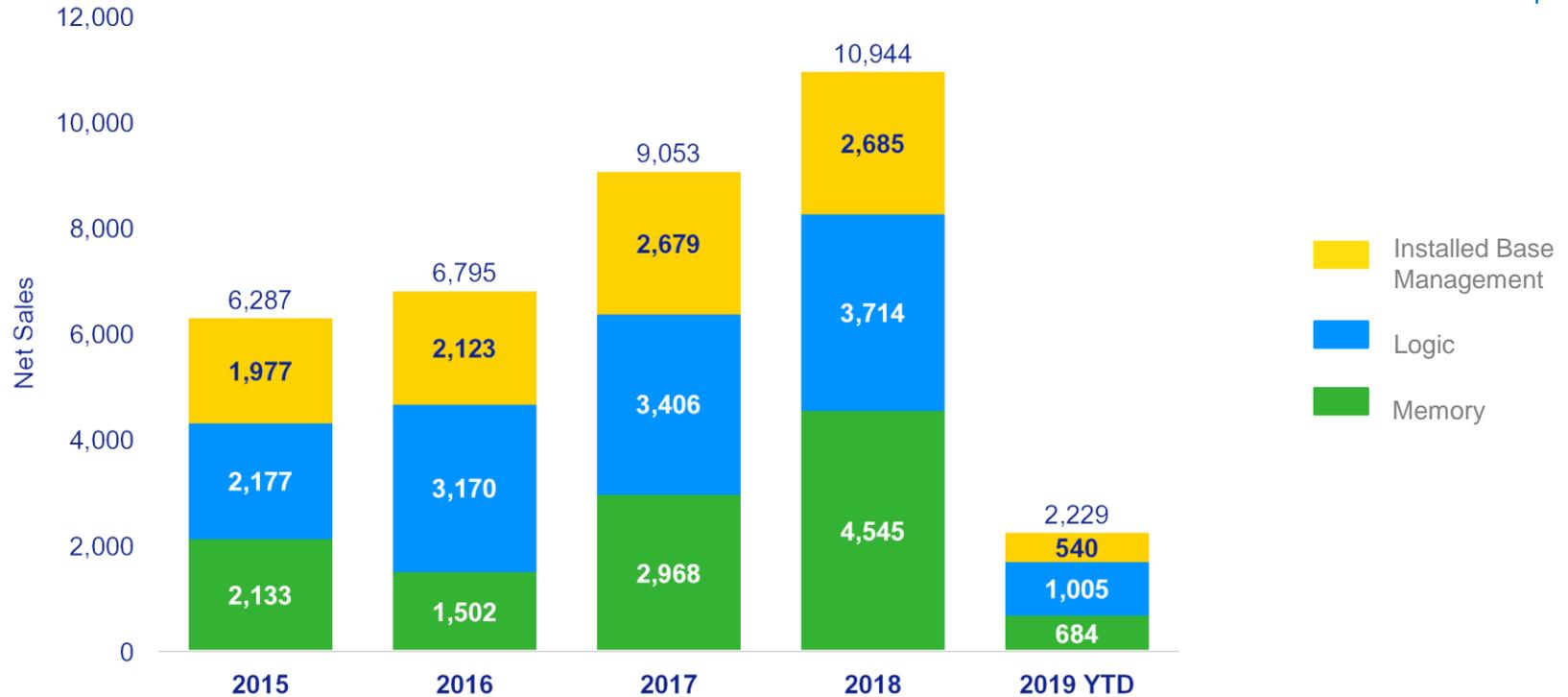
Sales in lithography units



Q4'18
total value
€ 2,424
million



Total net sales € million by End-use



As of January 1, 2018, ASML has adopted the new Revenue Recognition Standard (ASC 606) and Lease Standard (ASC 842). The comparative numbers presented above have not been adjusted to reflect these changes in accounting policy.

Q2 Outlook

- Q2 2019 net sales between € 2.5 billion and € 2.6 billion
 - including EUV system revenue of around € 600 million
- Gross margin between 41% and 42%
- R&D costs of around € 485 million
- SG&A costs of around € 125 million
- Estimated annualized effective tax rate around 11% for 2019

The image features the ASML logo in a bold, dark blue, sans-serif font on the left side. The background is a light blue gradient with several decorative elements: a large, semi-transparent, curved shape on the left; a series of thin, white, wavy lines that originate from the right side of the logo and extend across the bottom of the frame; and a solid light blue area at the top. The overall aesthetic is clean and modern.

ASML