

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

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 lines are more densely packed on the left and become more sparse as they move towards the right.

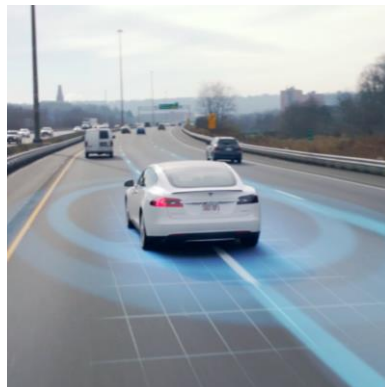
# Chips are everywhere

# It's hard to imagine a world without chips

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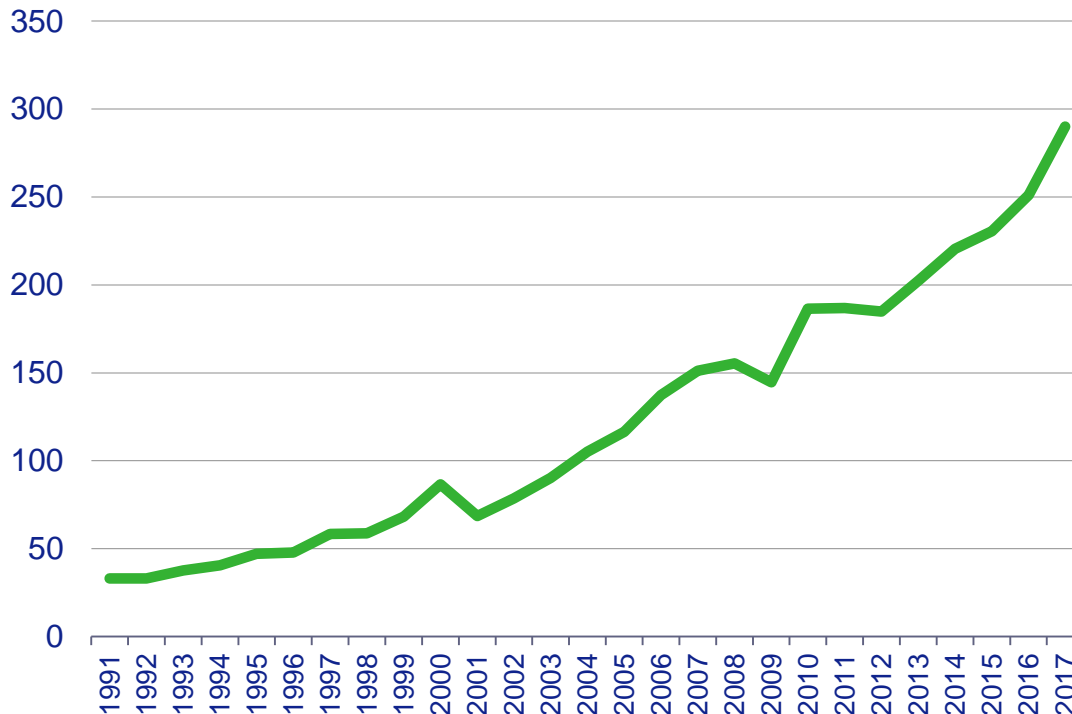
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# Nearly 300 billion ICs are made every year

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.

# 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 2<sup>nd</sup>  
biggest tech  
company by  
market cap  
(75B€+)

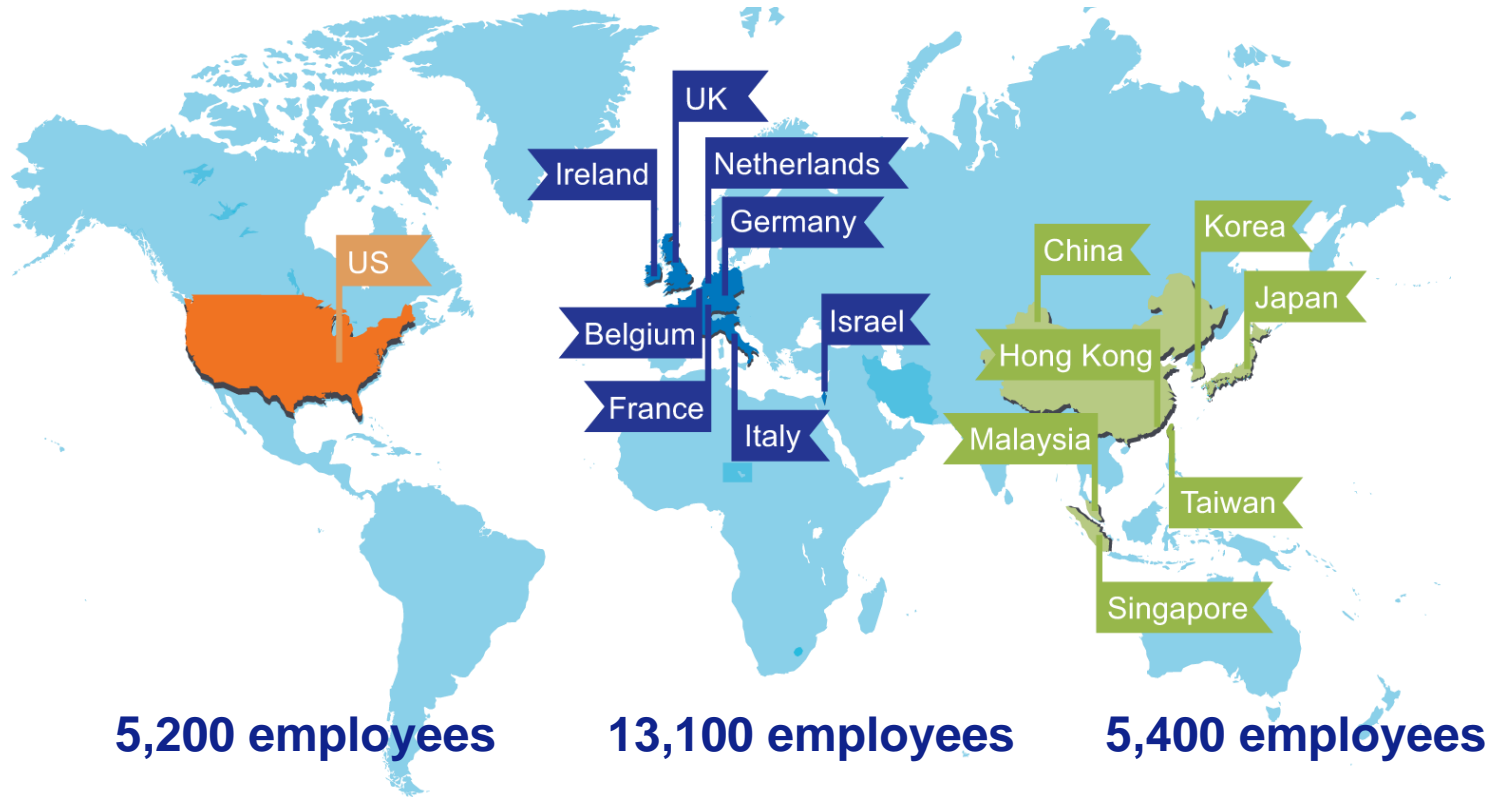
Annual R&D  
budget of  
1.6B€

# A global presence with >23,000 employees

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Offices in over 60 cities in 16 countries worldwide

# Our key locations

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Wilton (CT)



San Diego(CA)



Korea



Chandler (AZ)



Veldhoven














Taiwan

# All major chipmakers are our customers

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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  WD 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**.

# ASML's place in the industry

# Driving the semiconductor industry: Moore's Law

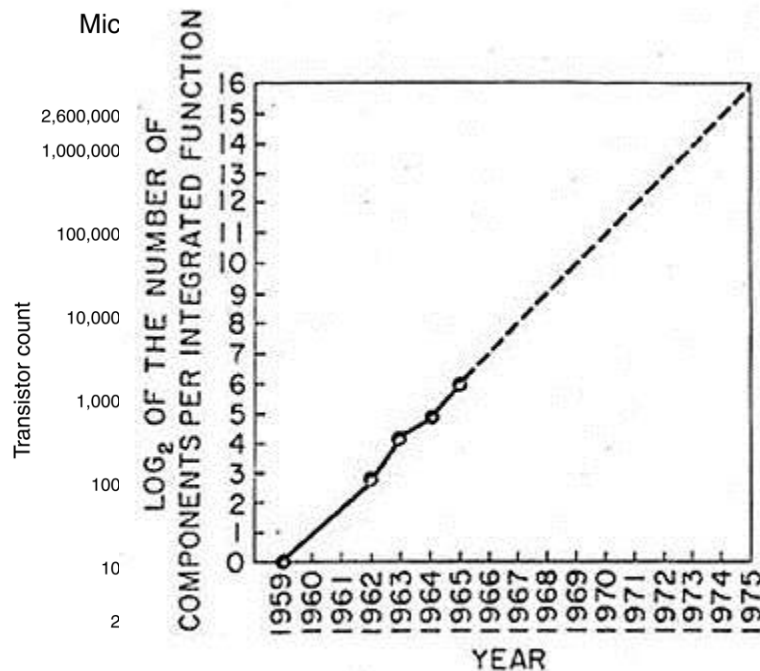


Fig. 2 Number of components per Integrated function for minimum cost per component extrapolated vs time.

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

14 pt

114 pages

227 pages

- You've halved the cost to print the book

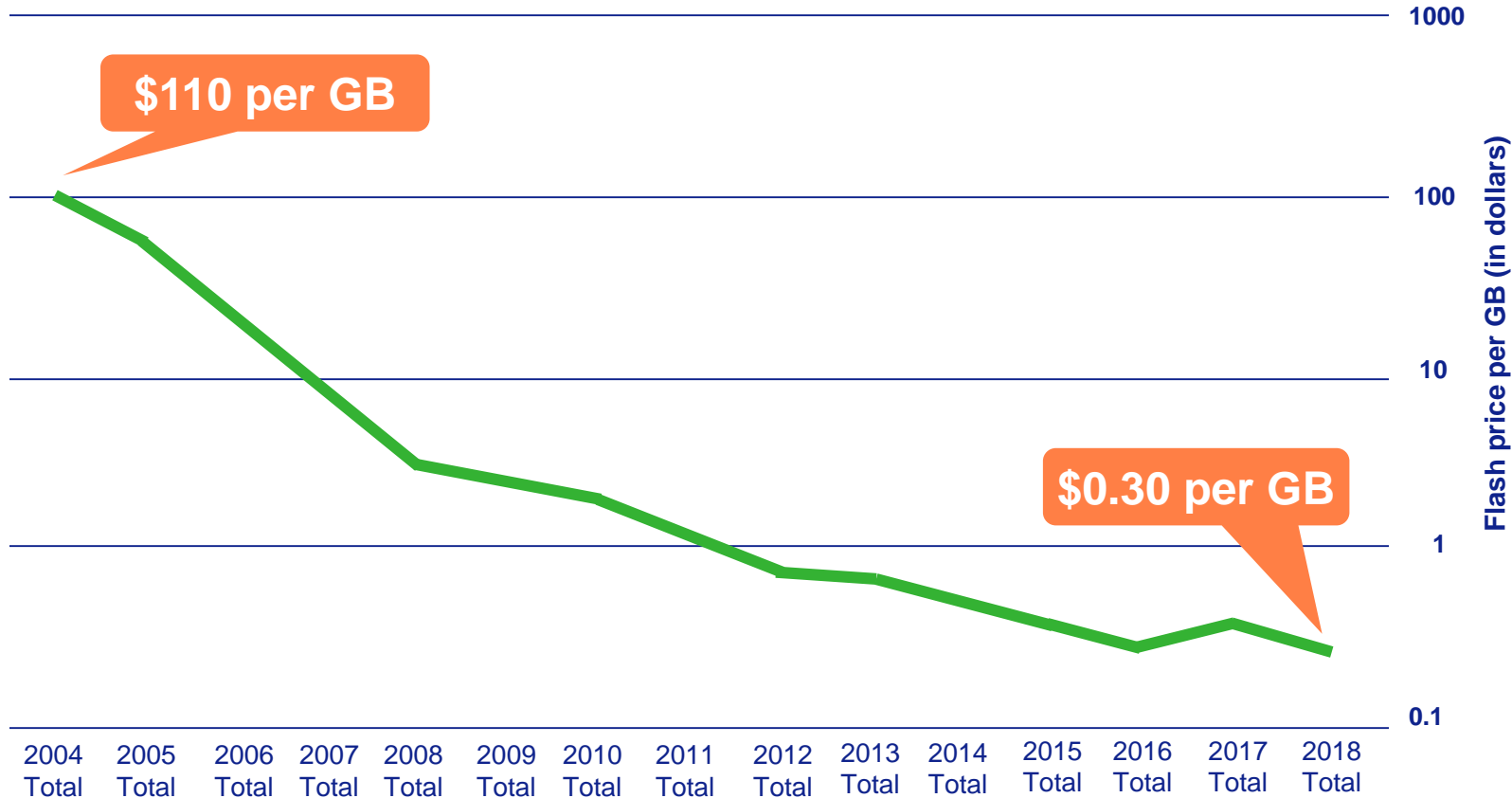
## THE HITCHHIKER'S GUIDE TO THE GALAXY

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...



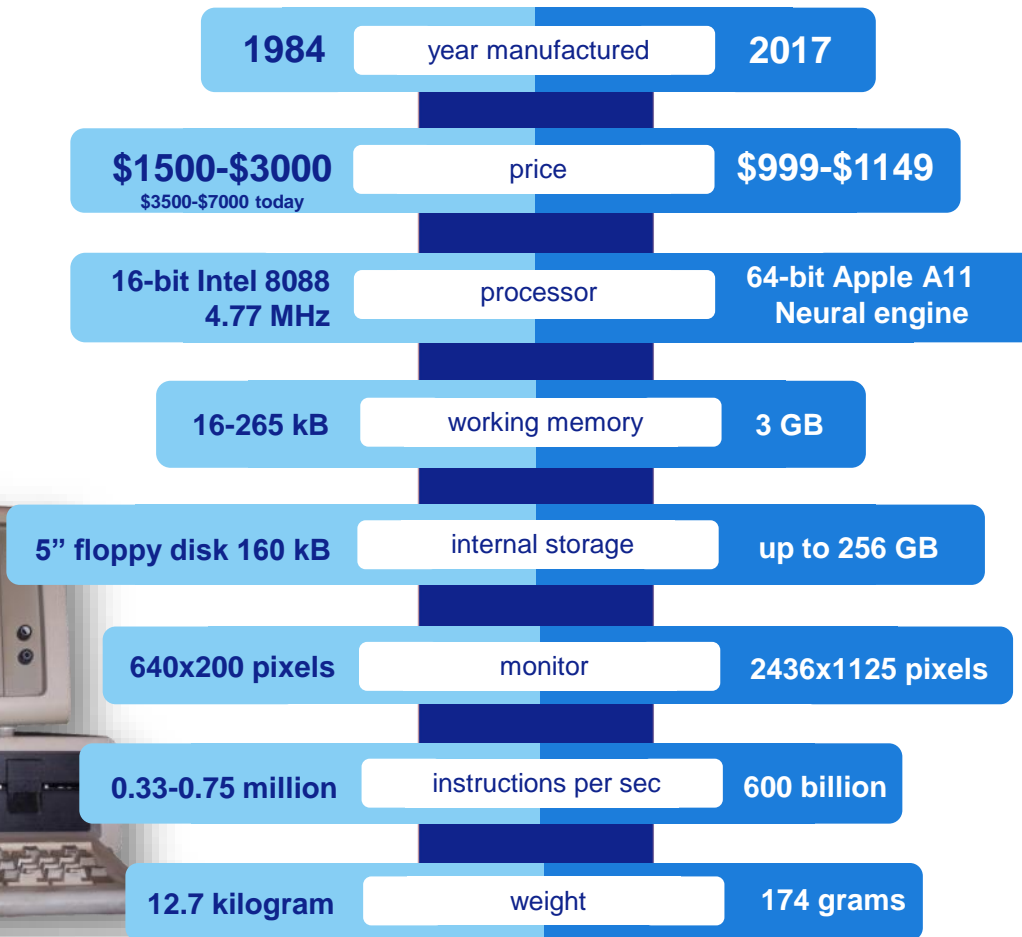
...and electronic devices much more powerful

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IBM  
5150



Apple  
iPhone X

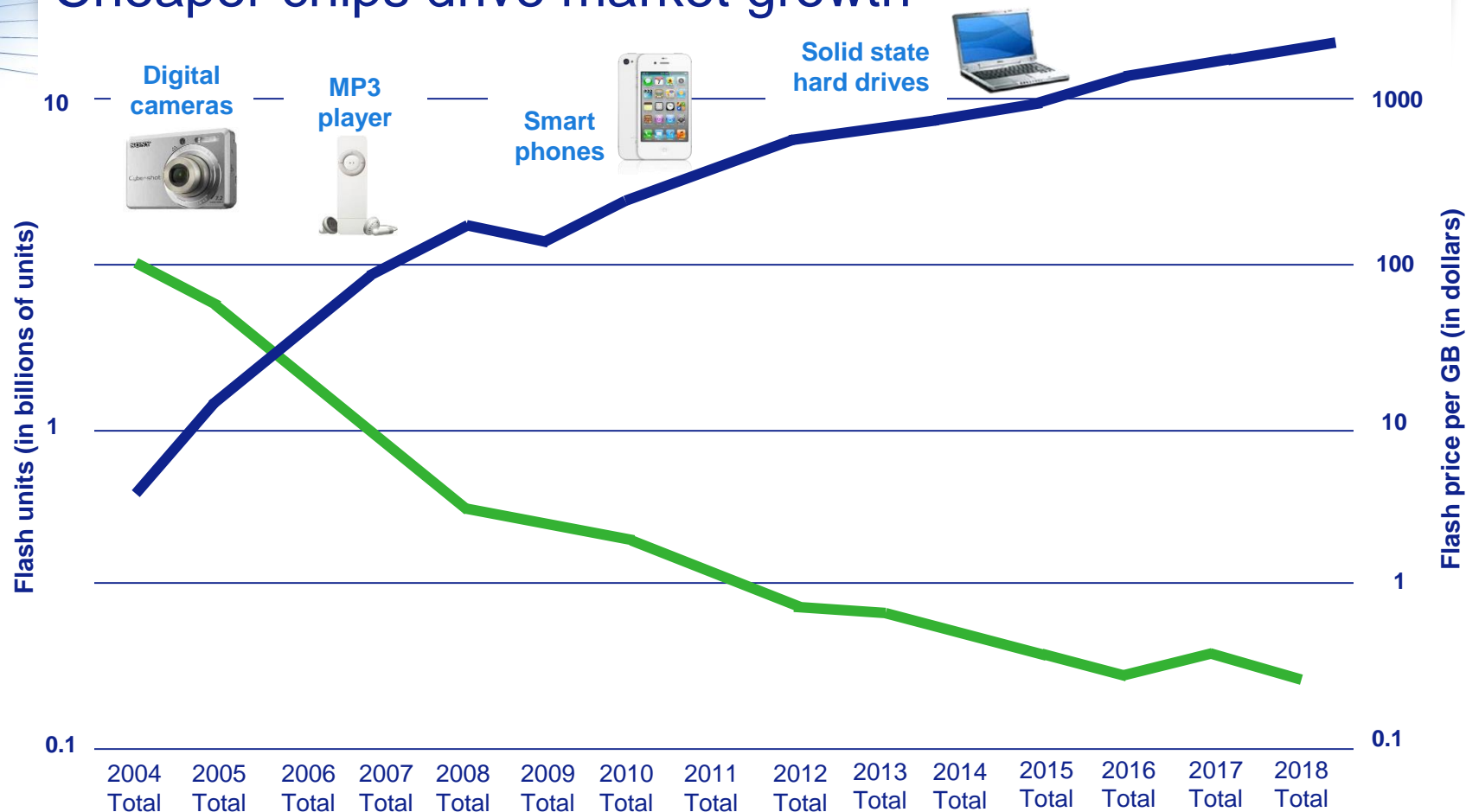


# Cheaper chips drive market growth

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# Moore's Law powers innovation and lowers cost

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**IBM  
5150**

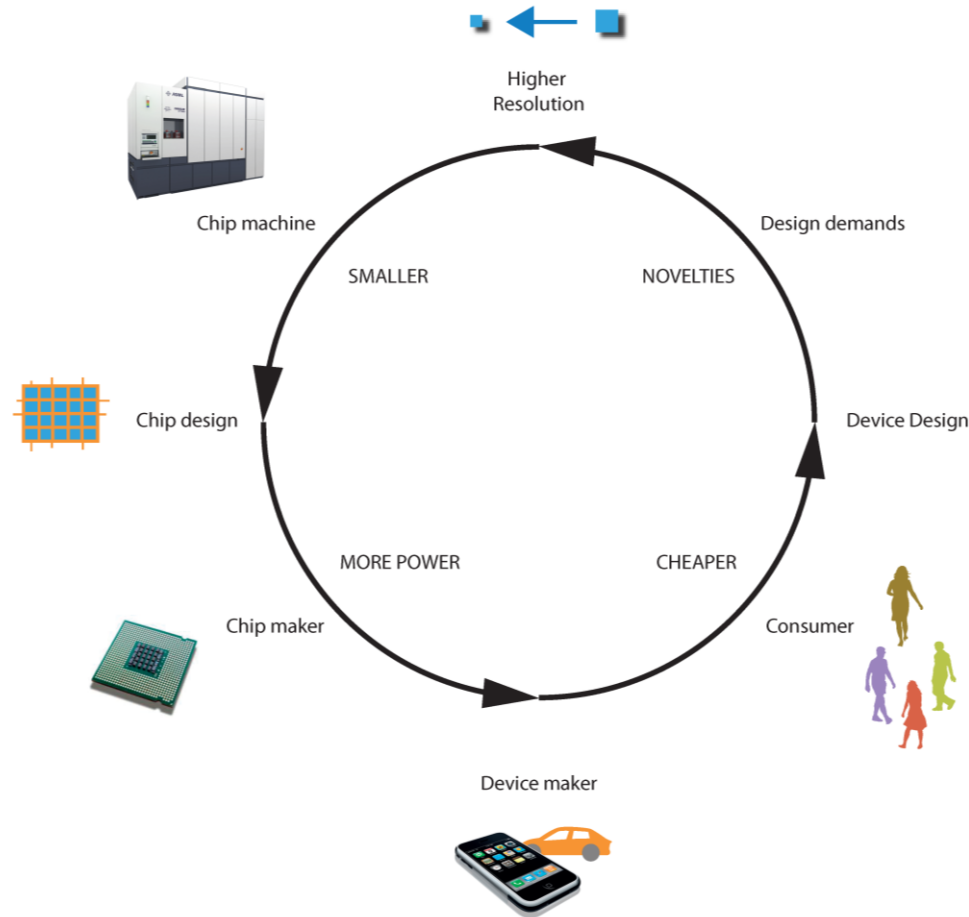


1984	year manufactured	2017
\$1500-\$3000 <small>\$3500-\$7000 today</small>	price	\$999-\$1149
16-bit Intel 8088 4.77 MHz	processor	64-bit Apple A11 Neural engine
16-265 kB	working memory	3 GB
5" floppy disk 160 kB	internal storage	up to 256 GB
640x200 pixels	monitor	2436x1125 pixels
0.33-0.75 million	instructions per sec	600 billion
12.7 kilogram	weight	174 grams

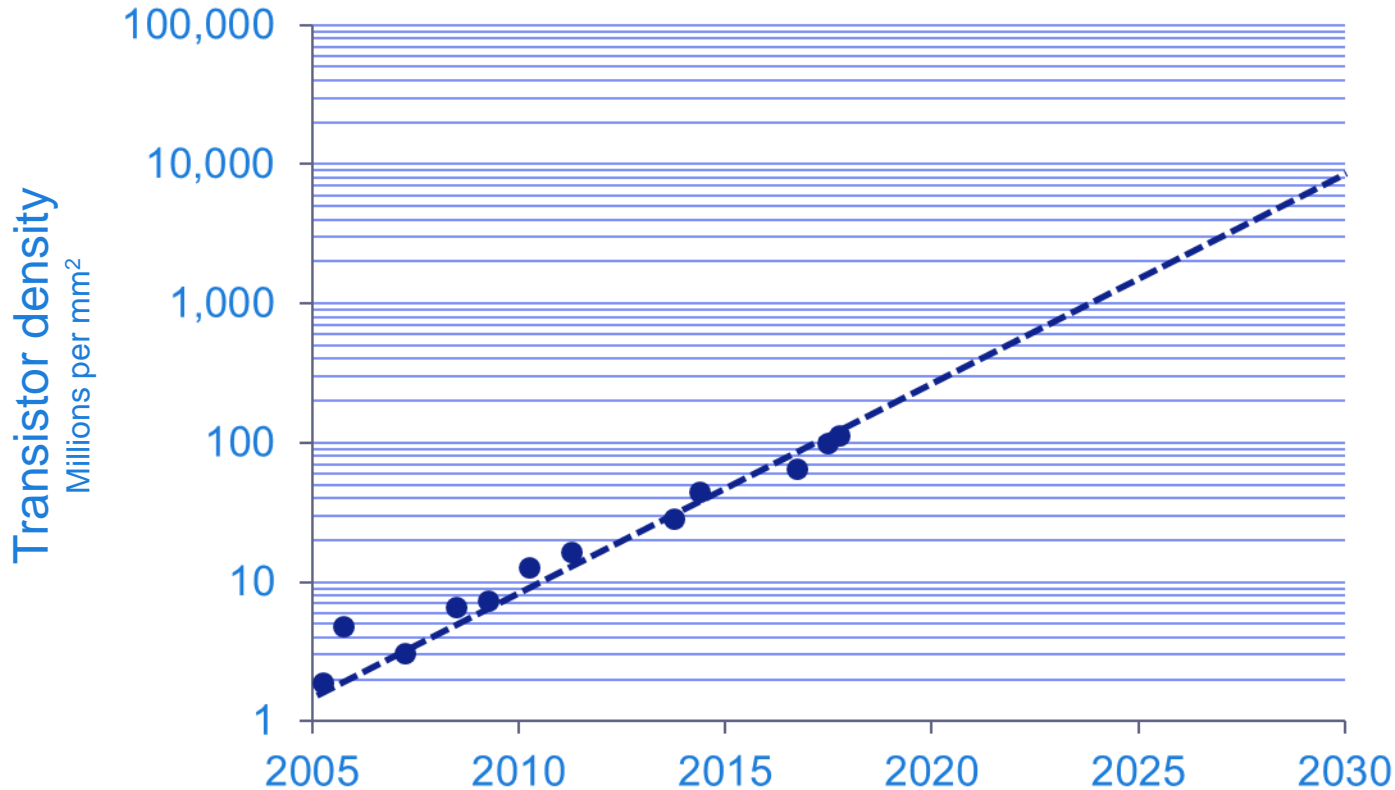
**Apple  
iPhone X**



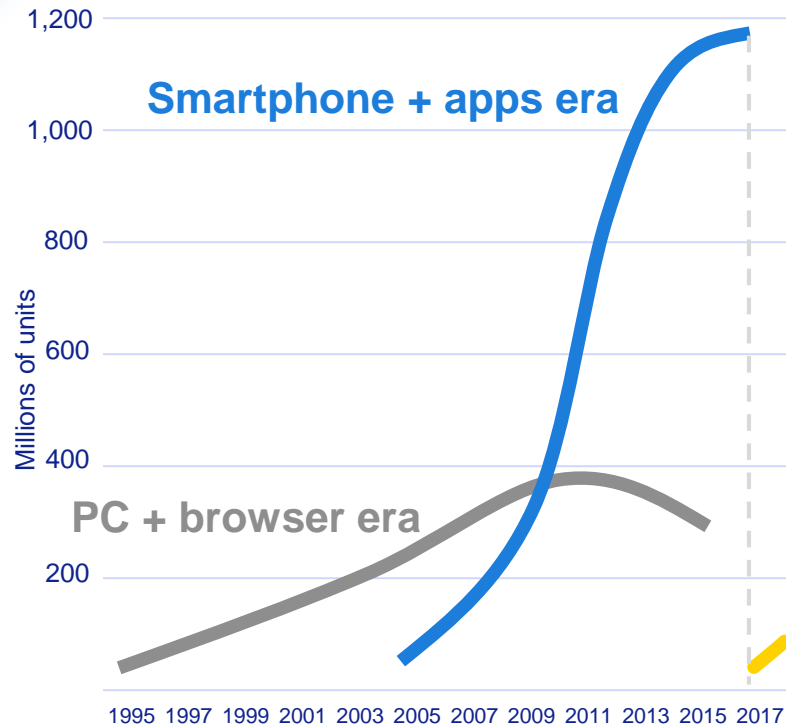
# A virtuous cycle that can create and transform markets



We see Moore's Law continuing beyond the next decade  
Our industry is moving towards 1 billion transistors per mm<sup>2</sup>



# Immersive devices will be the next wave



## 'Immersive era'



Resolution



Color accuracy



Frame rate



Contrast/brightness

Drivers

## Broad applications

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

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

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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

Source: Nintendo, HTC

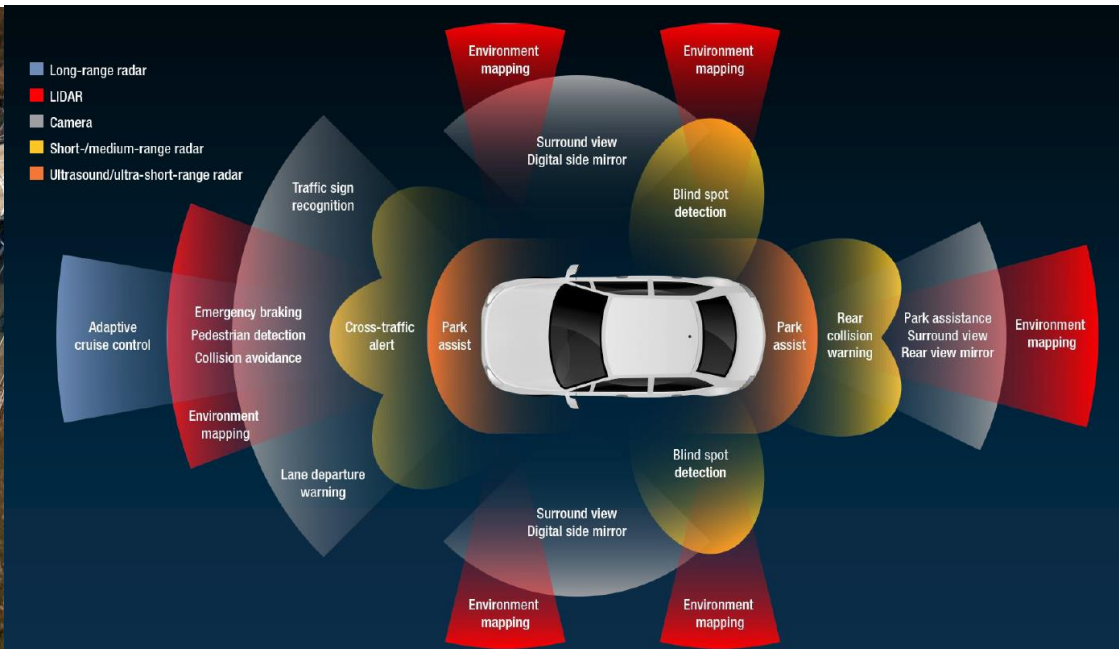
# Semiconductors are transforming automotive technology

## Doubling semiconductor content by 2024 to ~600 B€

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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/km<sup>2</sup>  
100 ms latency

<100,000  
connections/km<sup>2</sup>

**4G**

10 Gb/s/km<sup>2</sup>  
50 ms latency

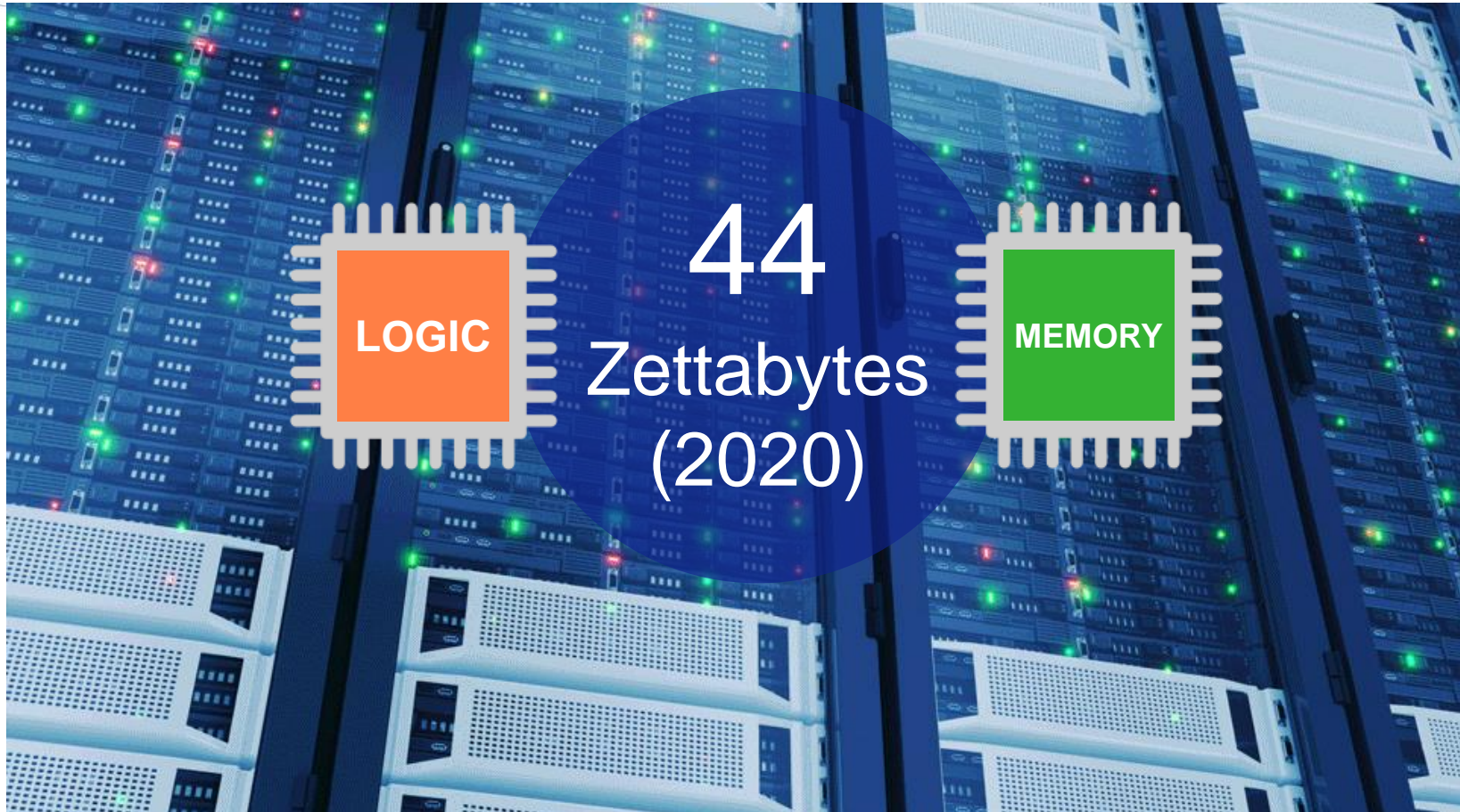
>1,000,000  
connections/km<sup>2</sup>

**5G**

100-1000 Gb/s/km<sup>2</sup>  
1 ms latency

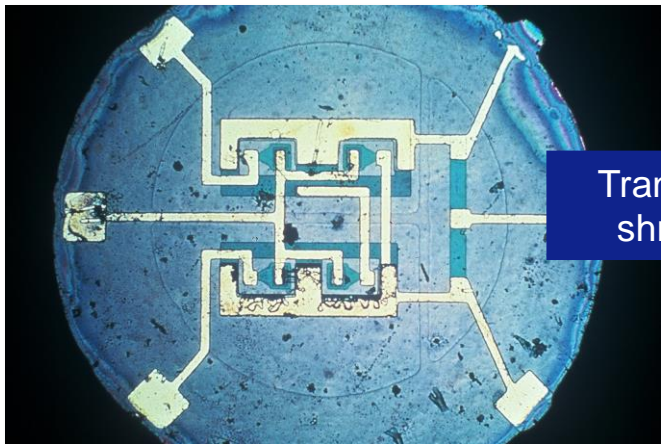
Time to download a 2-hour movie on your smartphone:  
3G @ 26 hours, 4G @ 6 minutes, 5G @ 3.6 seconds

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

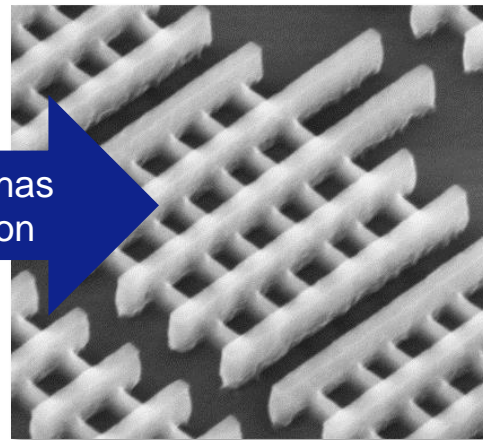


# Lithography drives IC innovation

# 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)

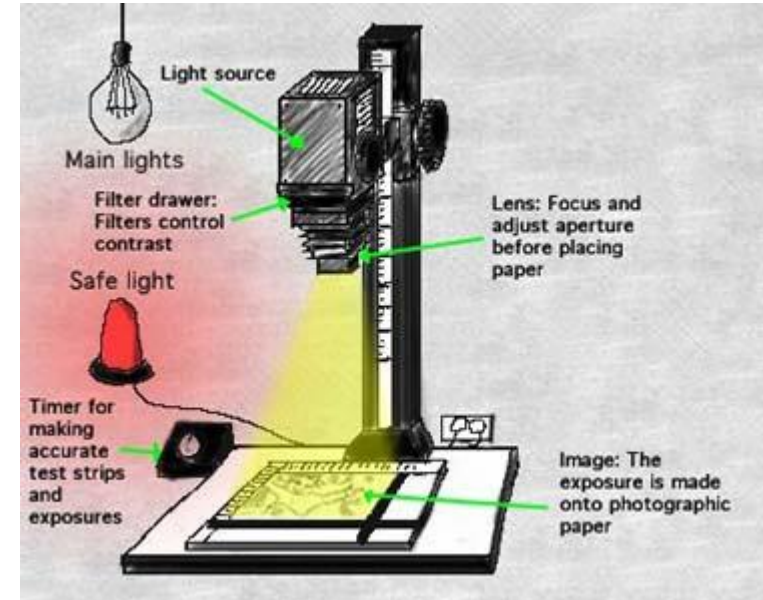
# Lithography is critical for shrinking transistors

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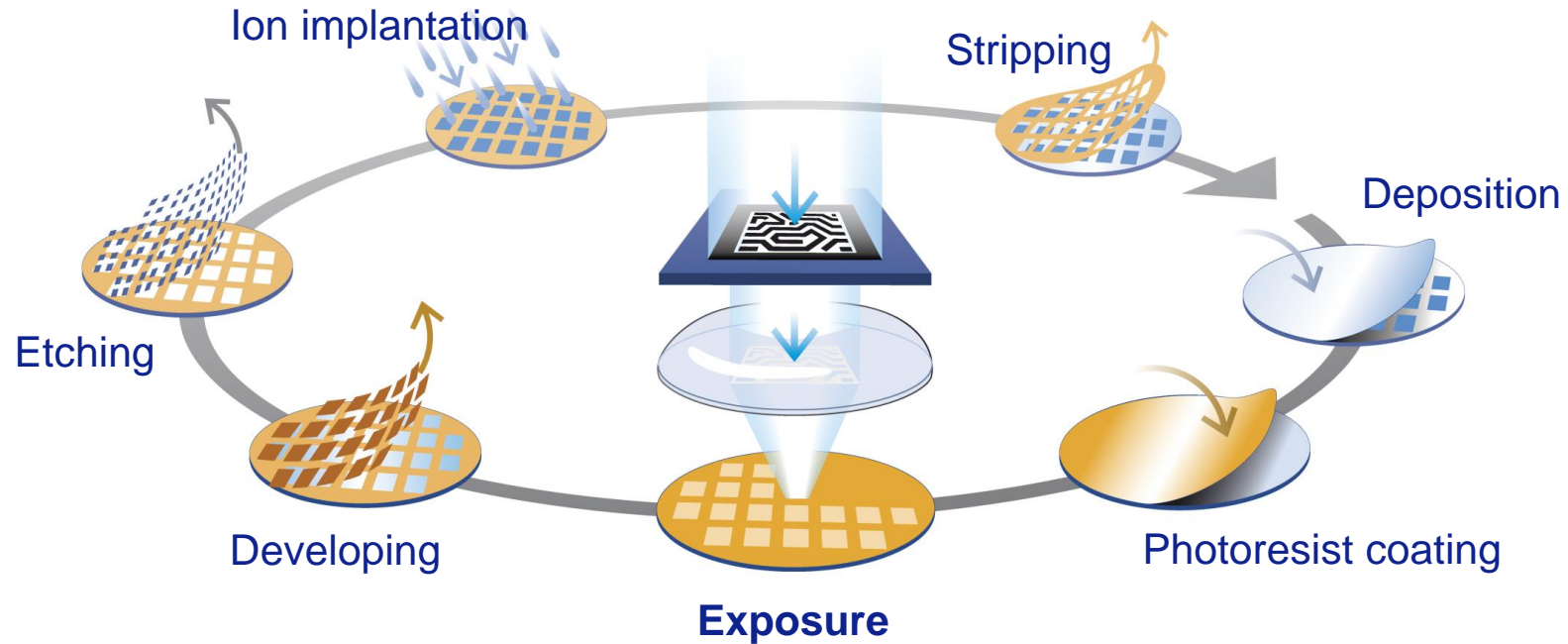
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Like a photo enlarger of old, lithography forms the image of chip patterns on a wafer



# The manufacturing loop



# Technology

# Keeping up with Moore's Law

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**1984**

**PAS 2000**

ASML's first stepper



**2015**

**TWINSKAN NXT:1980Di**

Our most advanced  
immersion system

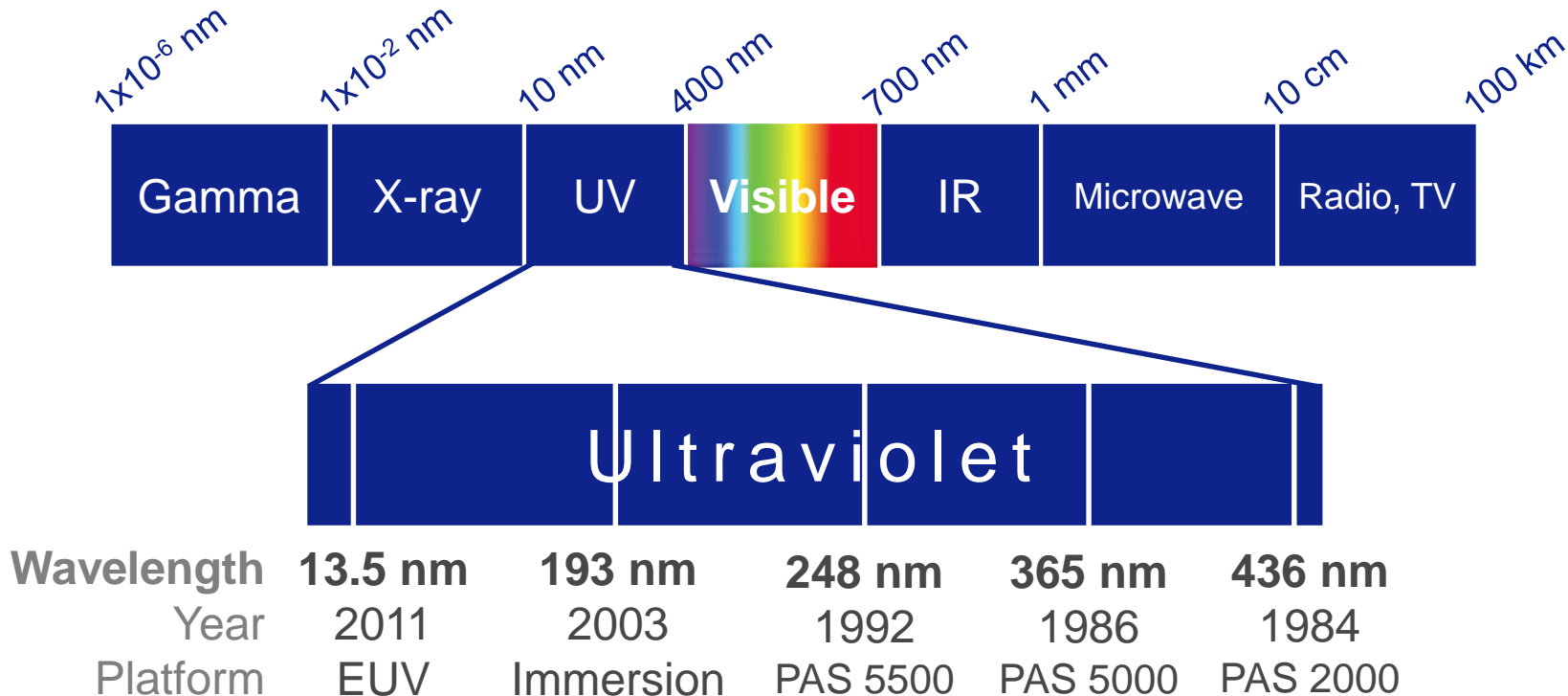


**2018**

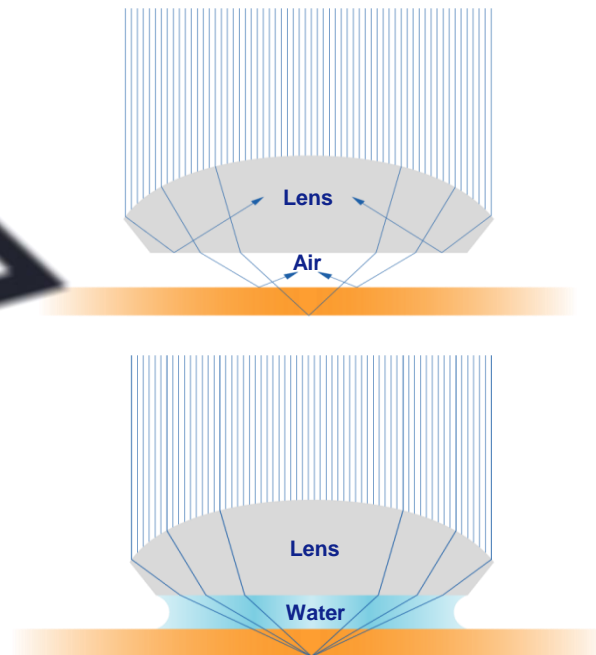
**TWINSKAN NXE:3400B**

High volume  
EUV system

# Key innovation: Wavelength changes



# Key innovation: Immersion lens



# Keeping up with Moore's Law

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**1984**

**PAS 2000**

ASML's first stepper



**2015**

**TWINSKAN NXT:1980Di**

Our most advanced  
immersion system



**TWINSKAN NXE:3400B**

Wavelength:  
193 nanometers

Resolution:  
 $\leq 38$  nanometers

Overlay:  
1.2 nanometers

Wafer size:  
300 mm

Productivity:  
275 wafers per hour

High volume  
EUV system

# Keeping up with Moore's Law

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Wavelength:  
13.5 nanometers

Resolution:  
 $\leq 22$  nanometers

Overlay:  
1.0 nanometers

Wafer size:  
300 mm

Productivity:  
125 wafers per hour



**1984**

**PAS 2000**

ASML's first stepper

**2015**

**TWINSKAN NXT:1980Di**

Our most advanced  
immersion system

**2018**

**TWINSKAN NXE:3400B**

High volume  
EUV system

# The future of lithography: EUV

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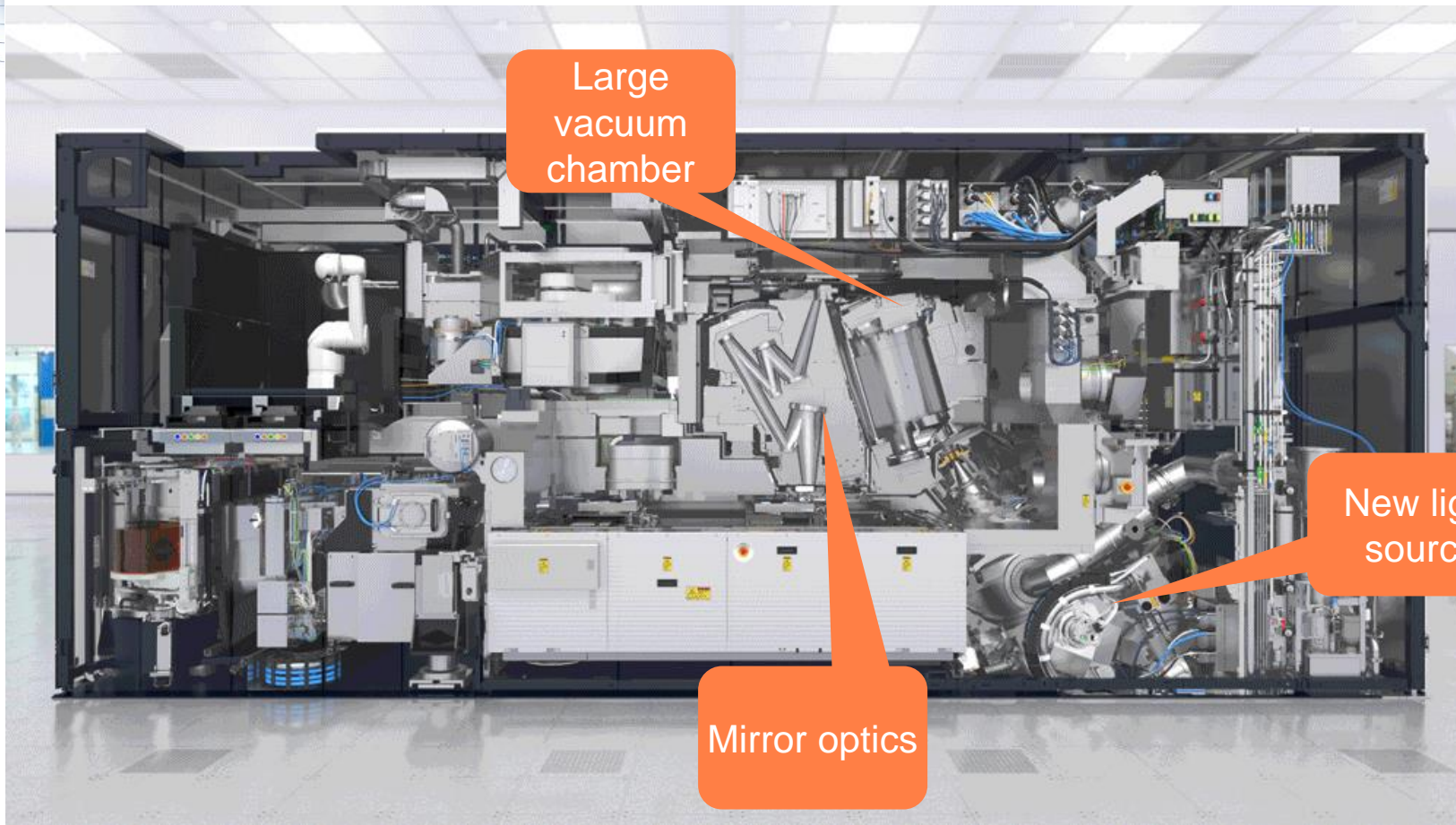
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Large  
vacuum  
chamber

New light  
source

Mirror optics

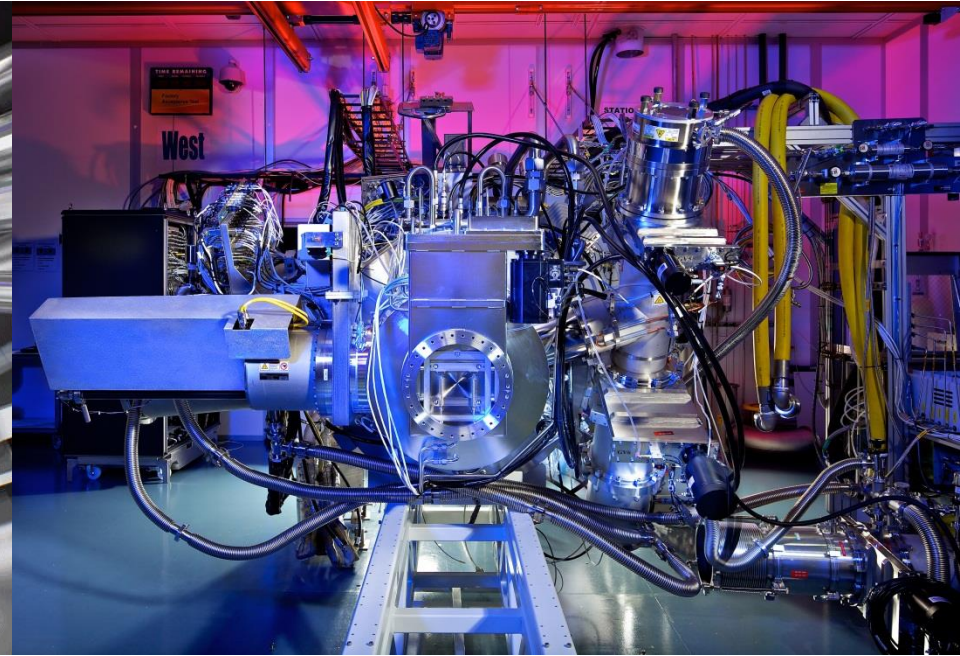
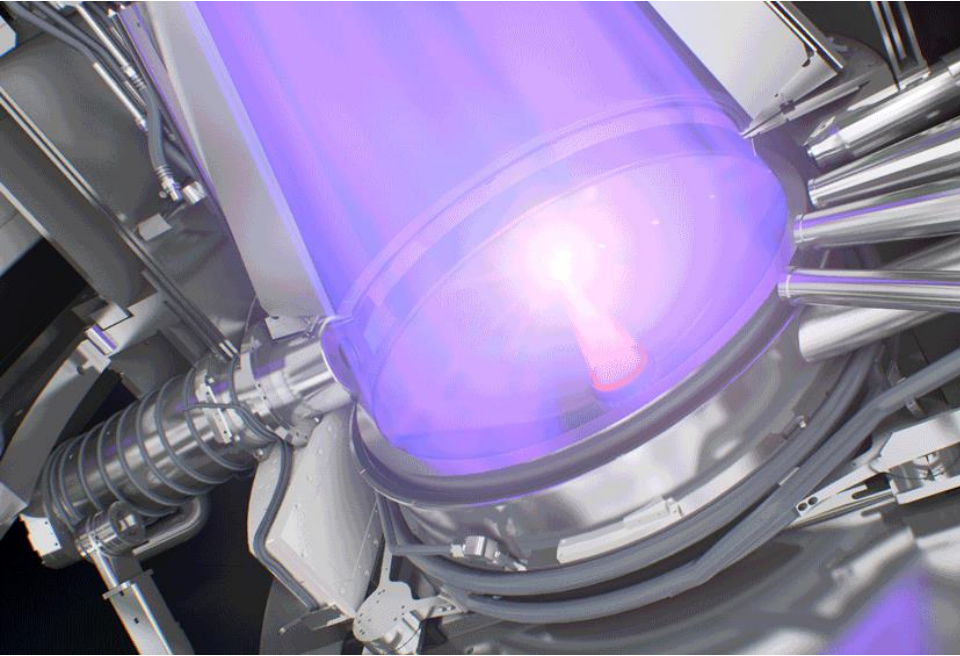


# Firing a laser on a tin droplet 50,000 times a second

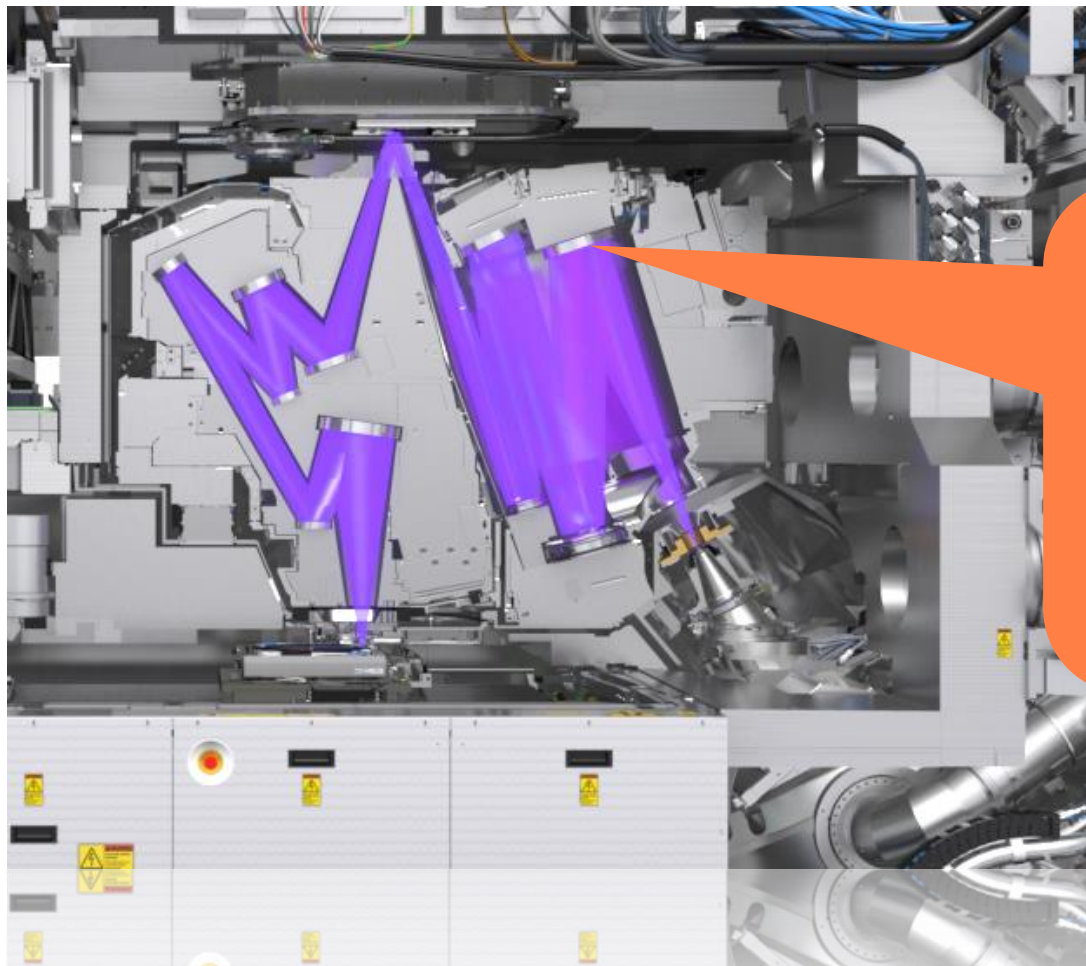
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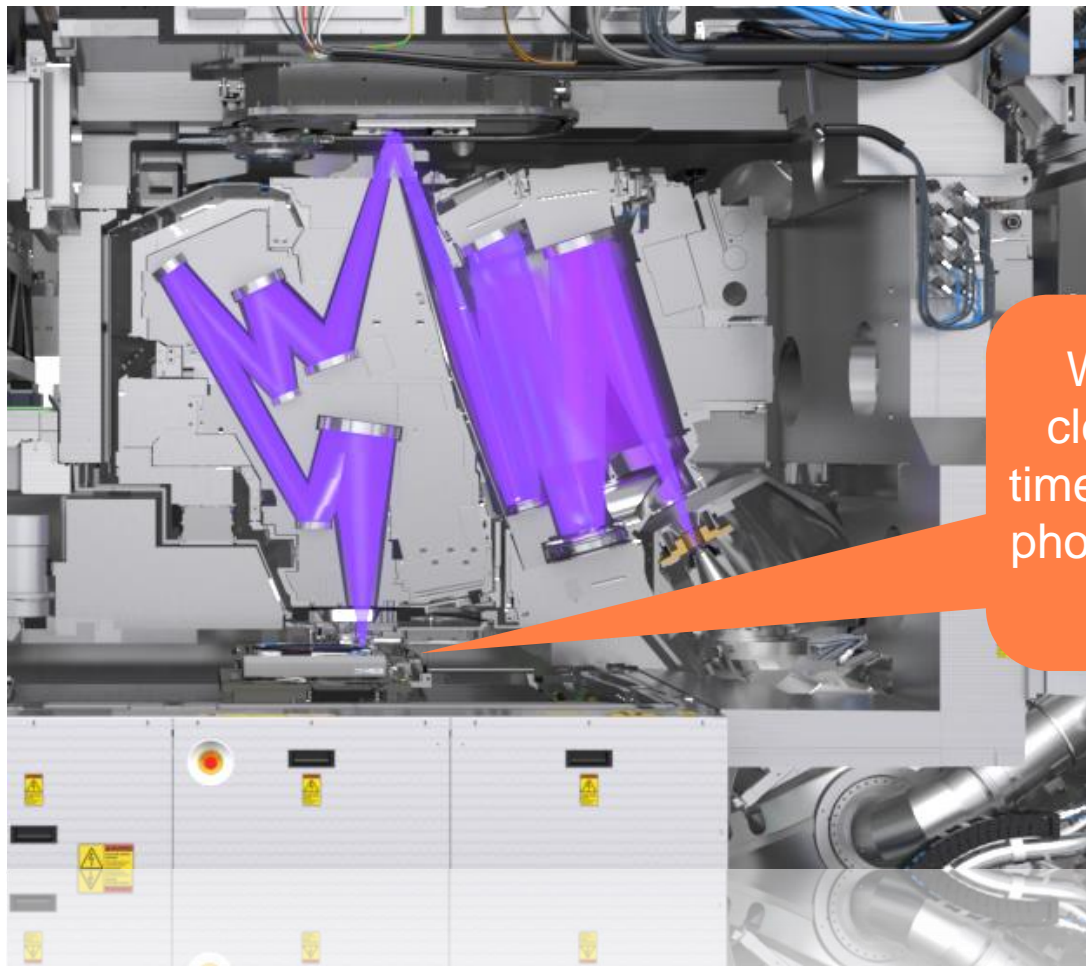
# Mirrors: Polished to sub-nanometer accuracy



EUV mirrors are polished to an accuracy of  $\sim 50$  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



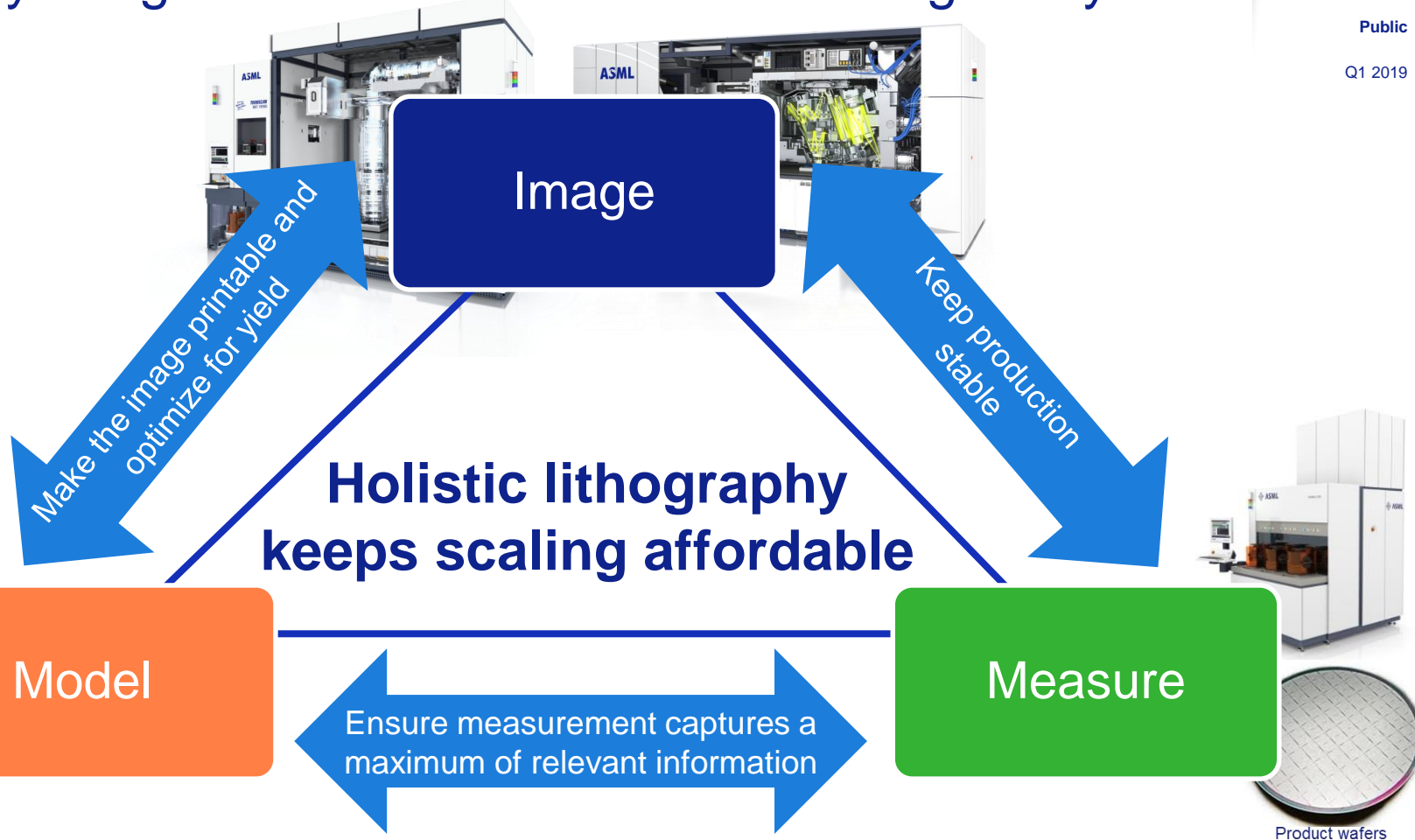
We need to maintain a clean vacuum, but every time we expose a wafer, the photoresist releases trillions of particles

# A tightly integrated set of solutions for scaling and yield

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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 closely spaced, with a slight gradient in color from a deeper blue on the left to a lighter blue on the right.

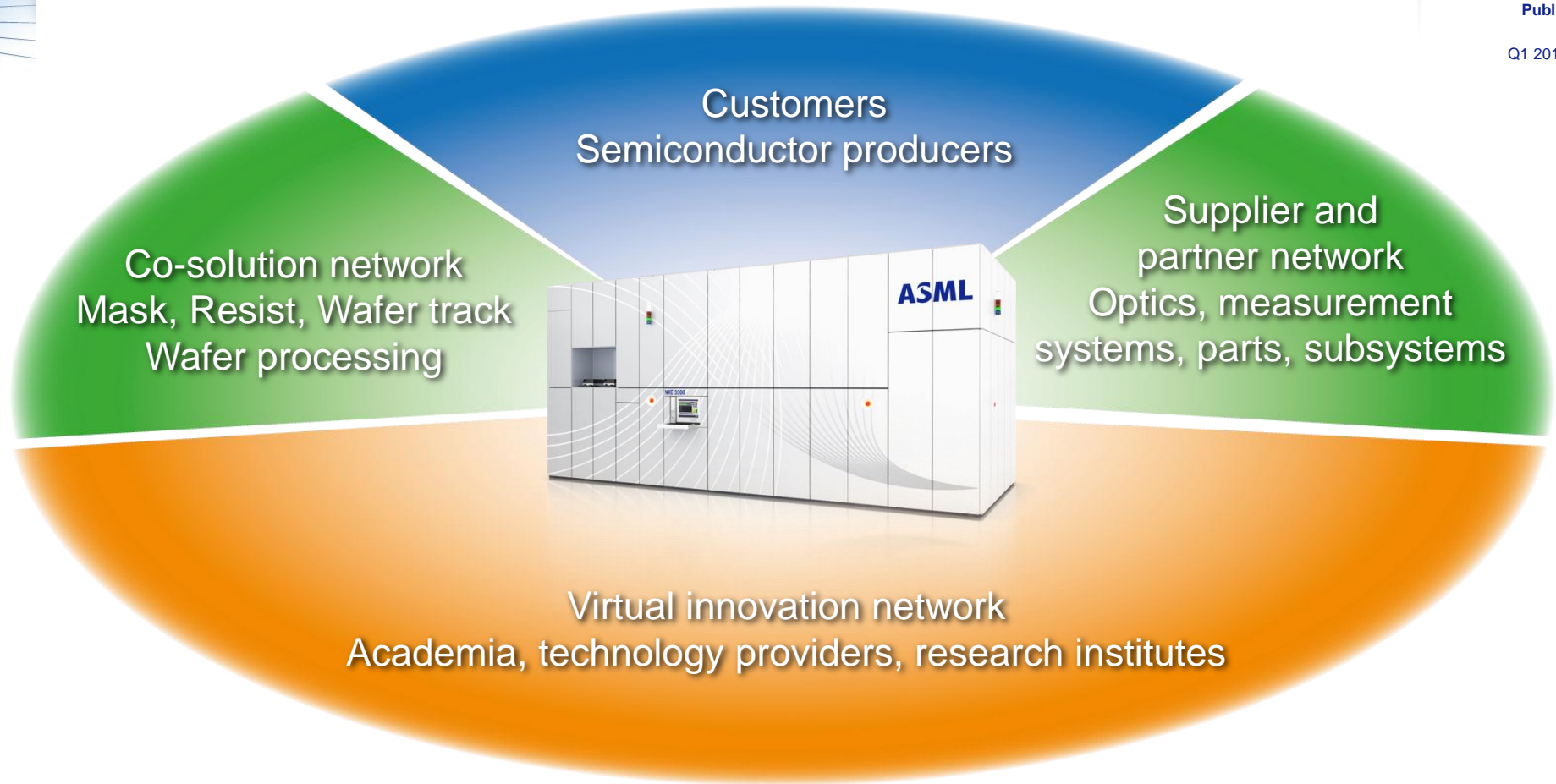
# How do we do it?

# Open Innovation from design to manufacturing

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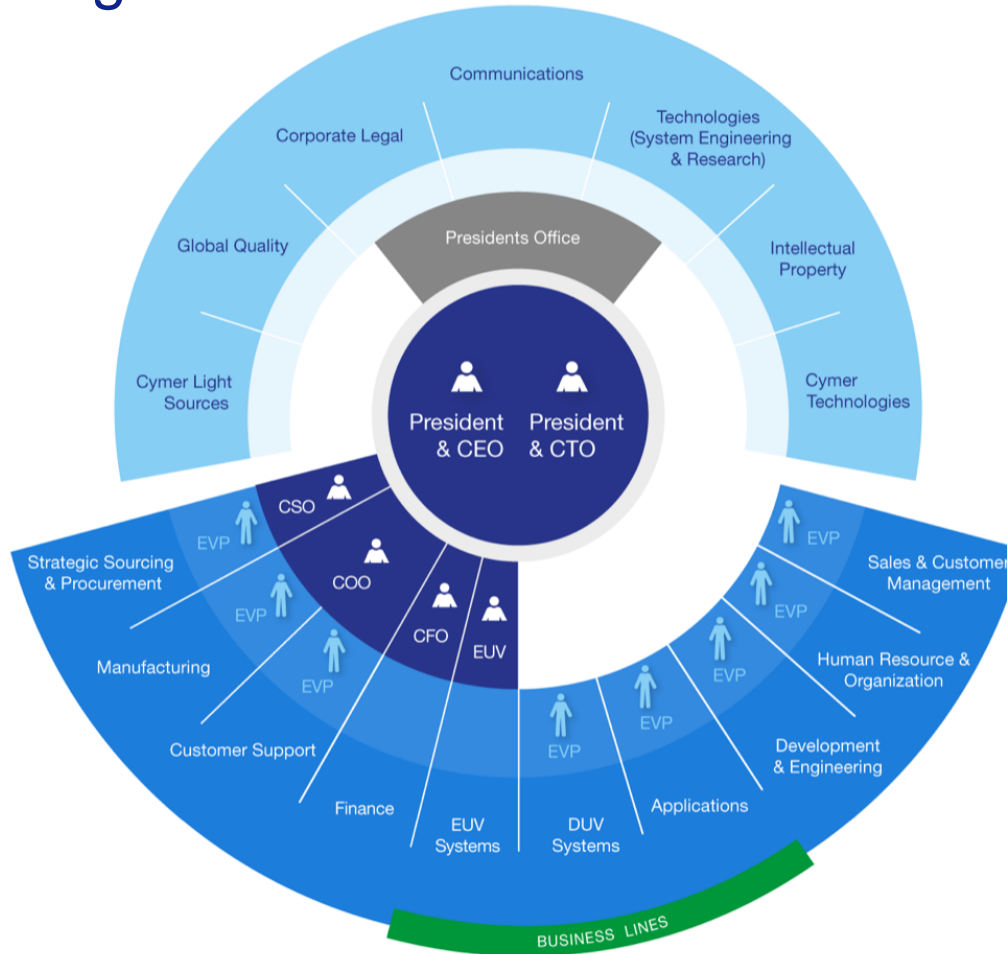


# How we are organized

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# High R&D spending to sustain technology leadership

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**1980s:**

PAS 2000/5000



**1990s:**

PAS 5500



**2000s:**

TWINSKAN



**2010s:**

NXE EUV

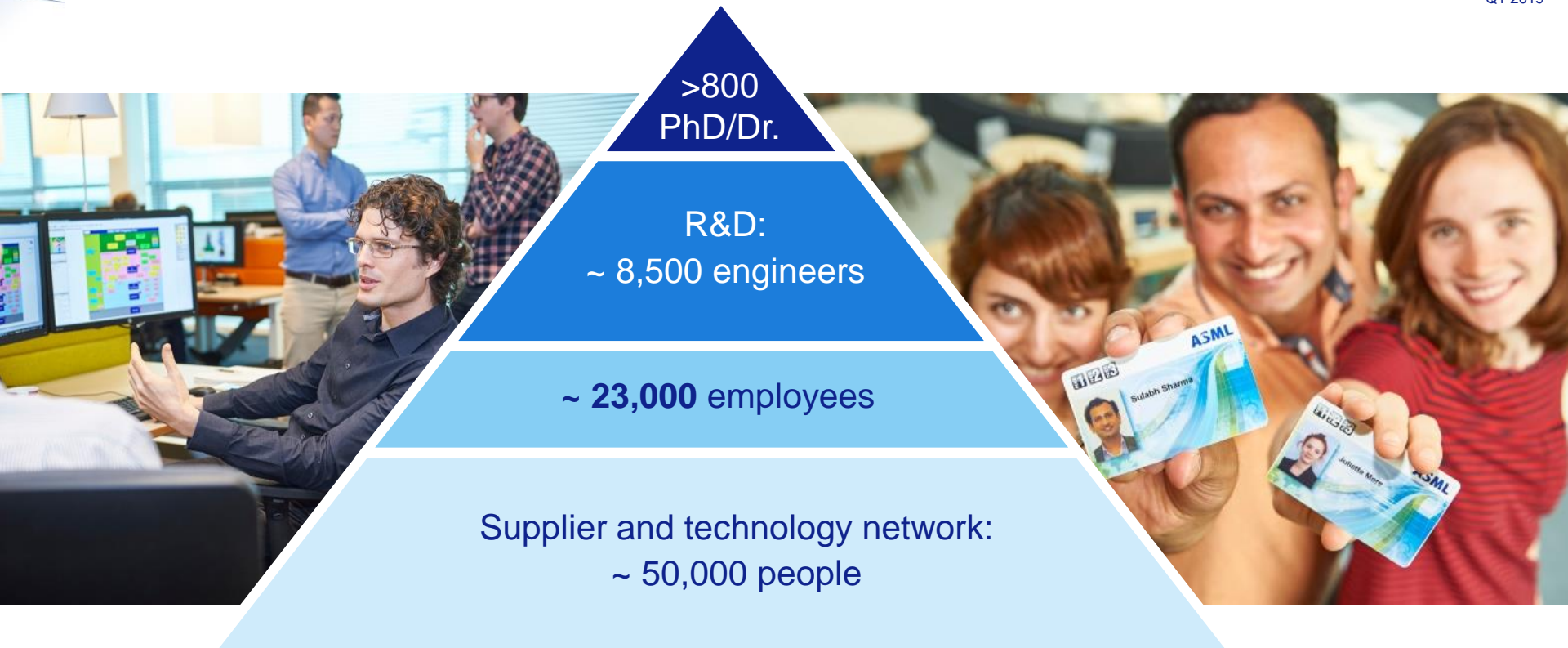
Our R&D investments amount to ~€1.5 billion per year

# Great people in an integrated supply chain

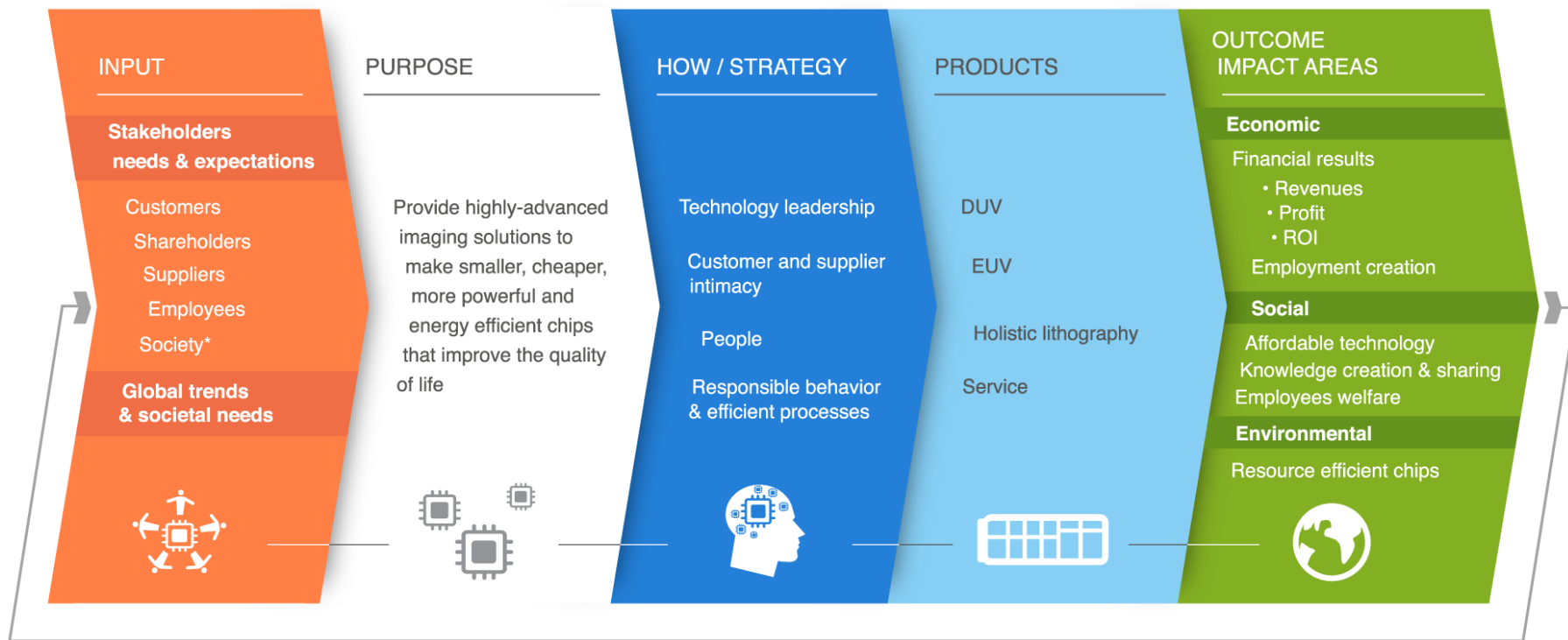
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# Serving our stakeholders



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

# Open Innovation from design to manufacturing

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# We develop and build technology in a vast ecosystem

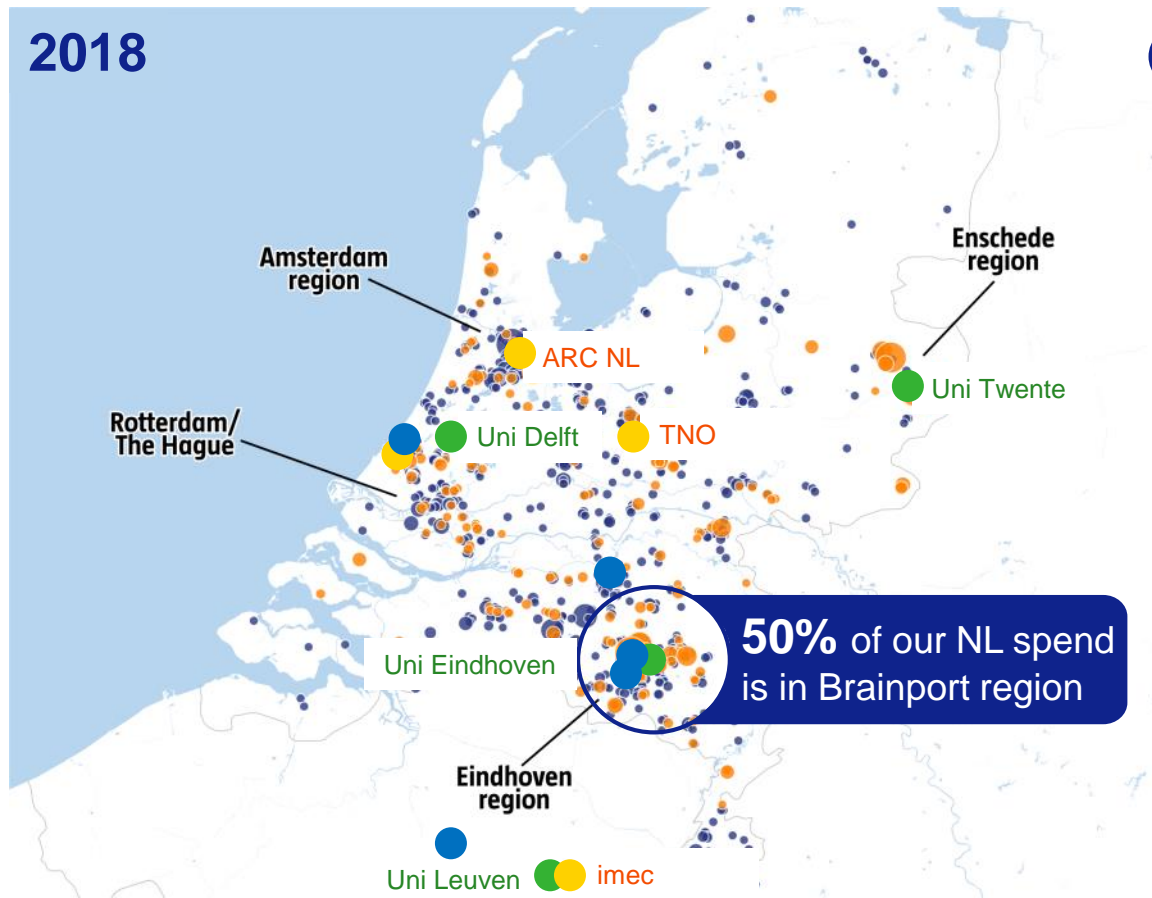
Example of our home base: ASML's supply chain is dependent on NL

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**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



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'

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**ZEISS**

Sharing risk and reward, creating value for stakeholders



R&D



Investments



Manufacturing



50,000 jobs  
in Europe



Leverage  
knowledge

# Business update

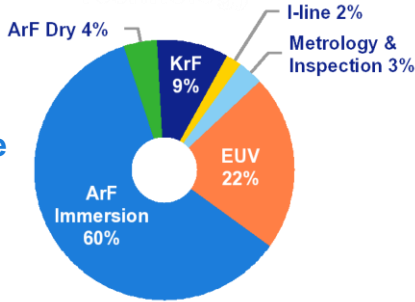
# Q1 results summary

- 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

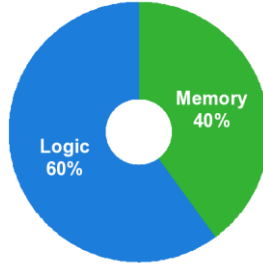
\* Installed Base Management equals our service and field option sales

# Net system sales breakdown in value

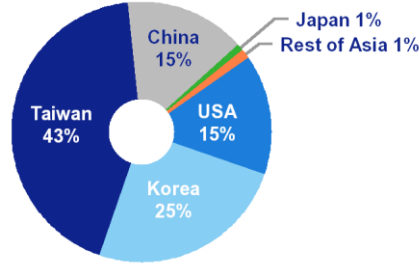
Q1'19  
total value  
€ 1,689  
million



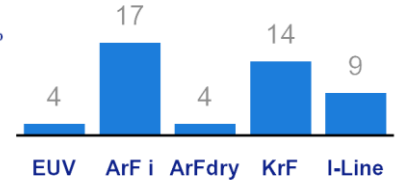
End-Use



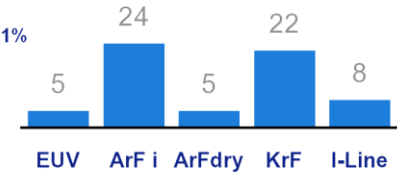
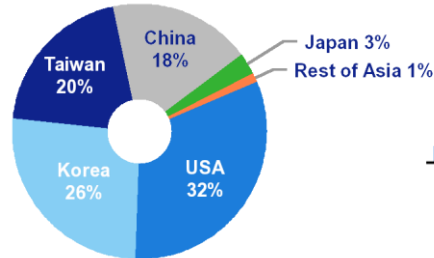
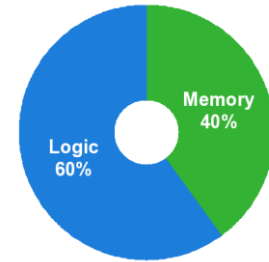
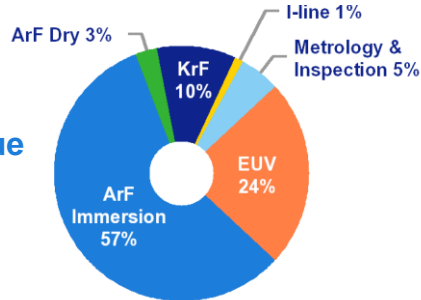
Region (ship to location)



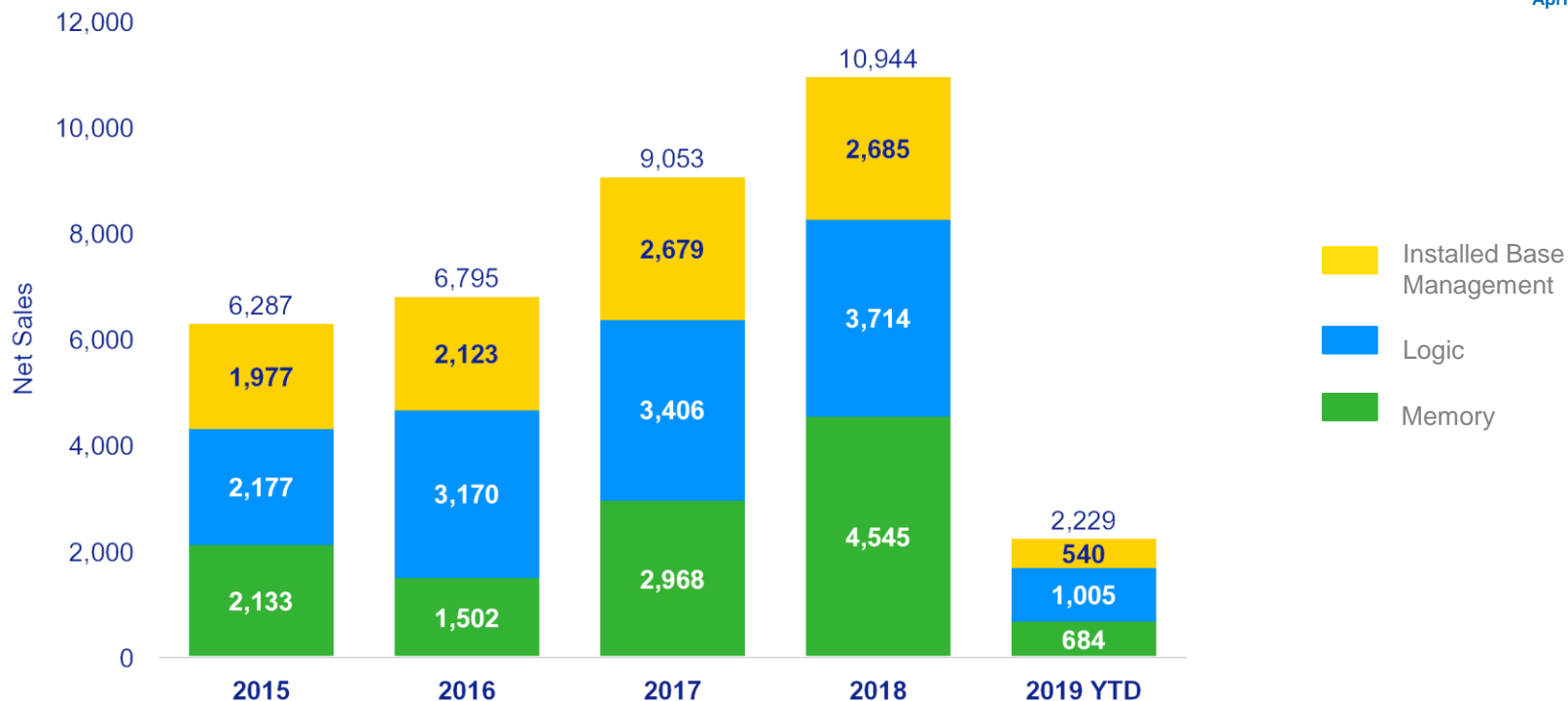
Sales in lithography units



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. The logo is positioned on the left side of the frame. The background is a light blue gradient with abstract, flowing white lines that sweep across the lower half of the image, creating a sense of motion and modernity.

**ASML**