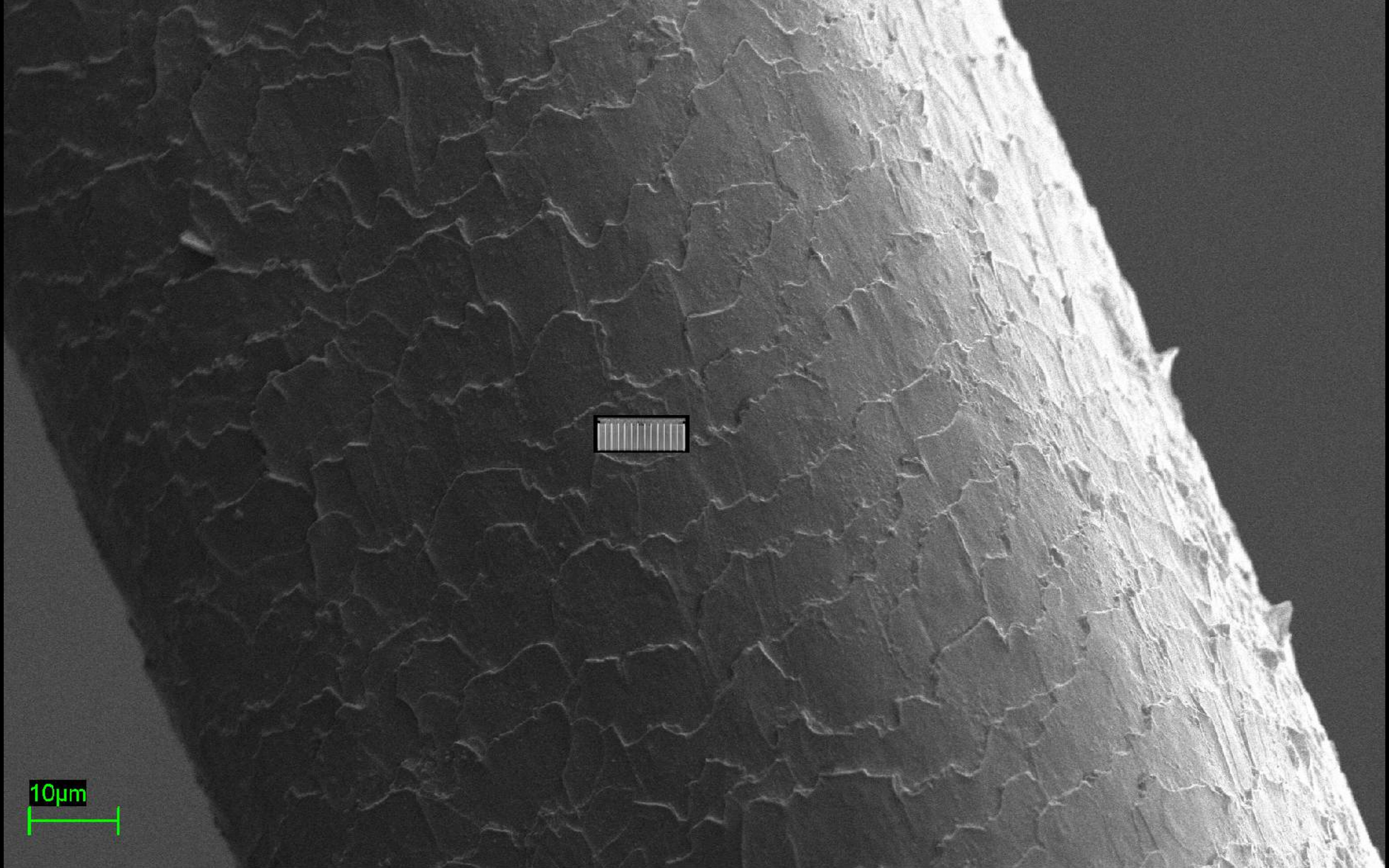
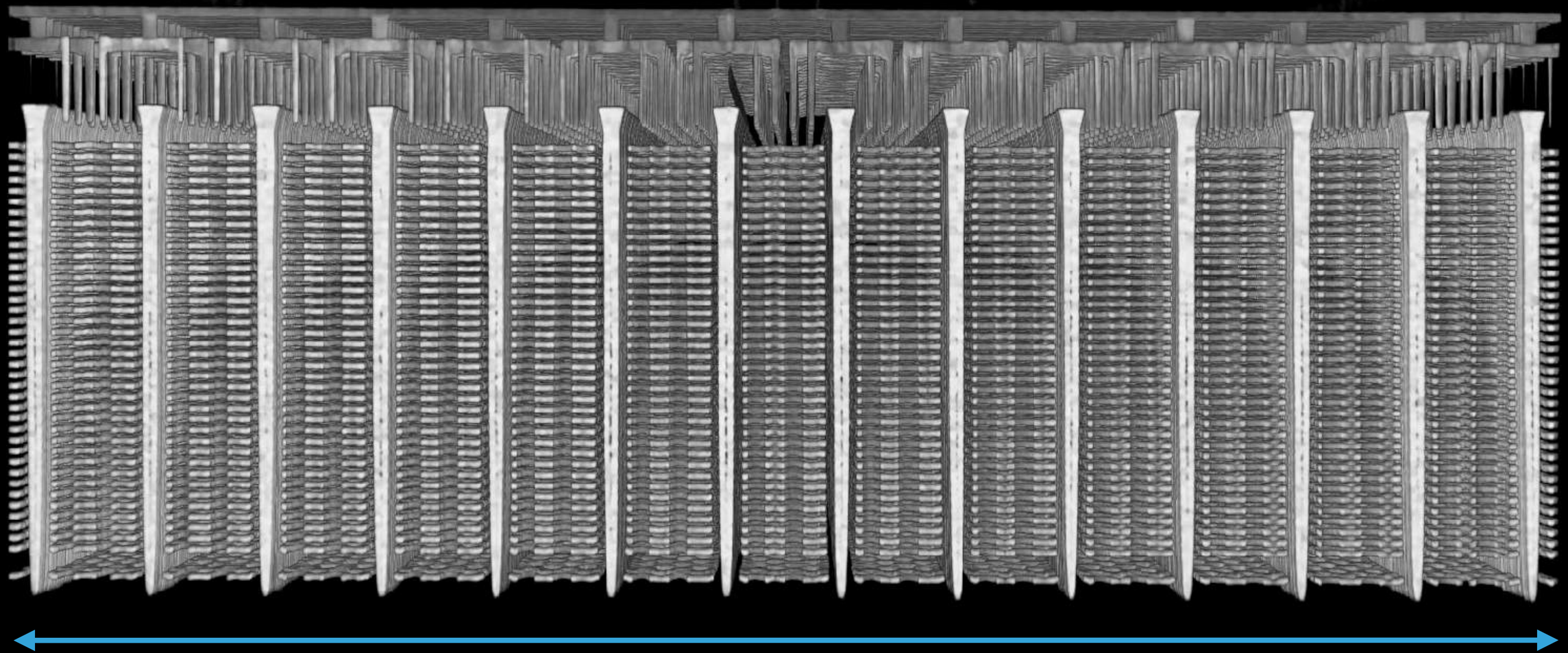
HOW ADVANCED CHIPS ARE REDEFINING GLOBAL DOMINANCE

FROM SILICON TO SOVEREIGNTY

THORSTEN HELLERT


10µm

SAMSUNG V-NAND SSD, ELECTRON MICROSCOPY BY ZEISS CROSSBEAM (2015)

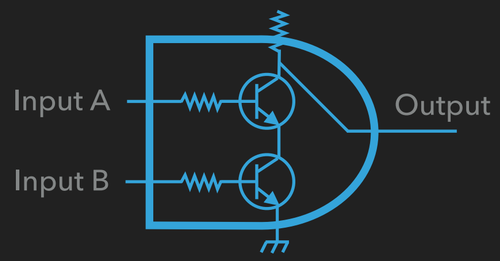


10µm

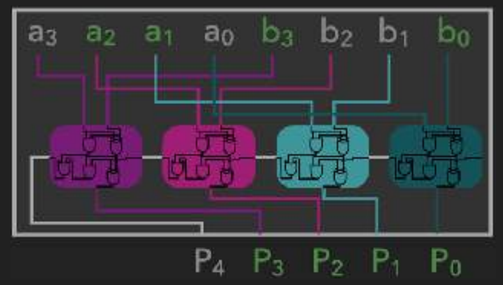
Courtesy Heiko Stegmann, © Carl Zeiss Microscopy GmbH

PRINCIPLES OF TRANSISTORS

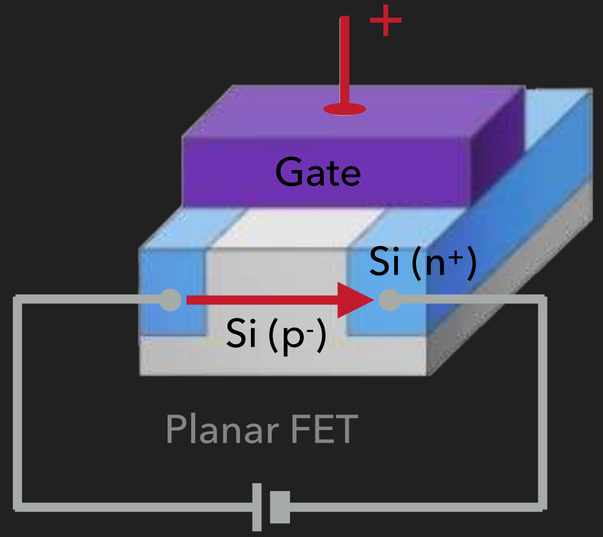
AND gate



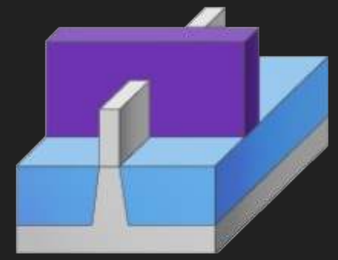
A = 6 = [0 1 1 0] plus B = 9 = [1 0 0 1]



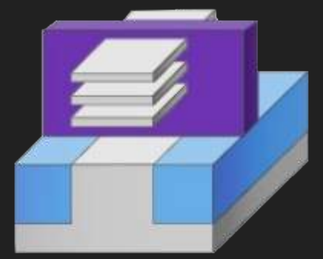
is equal to P = 15 = [0 1 1 1 1]



FinFET

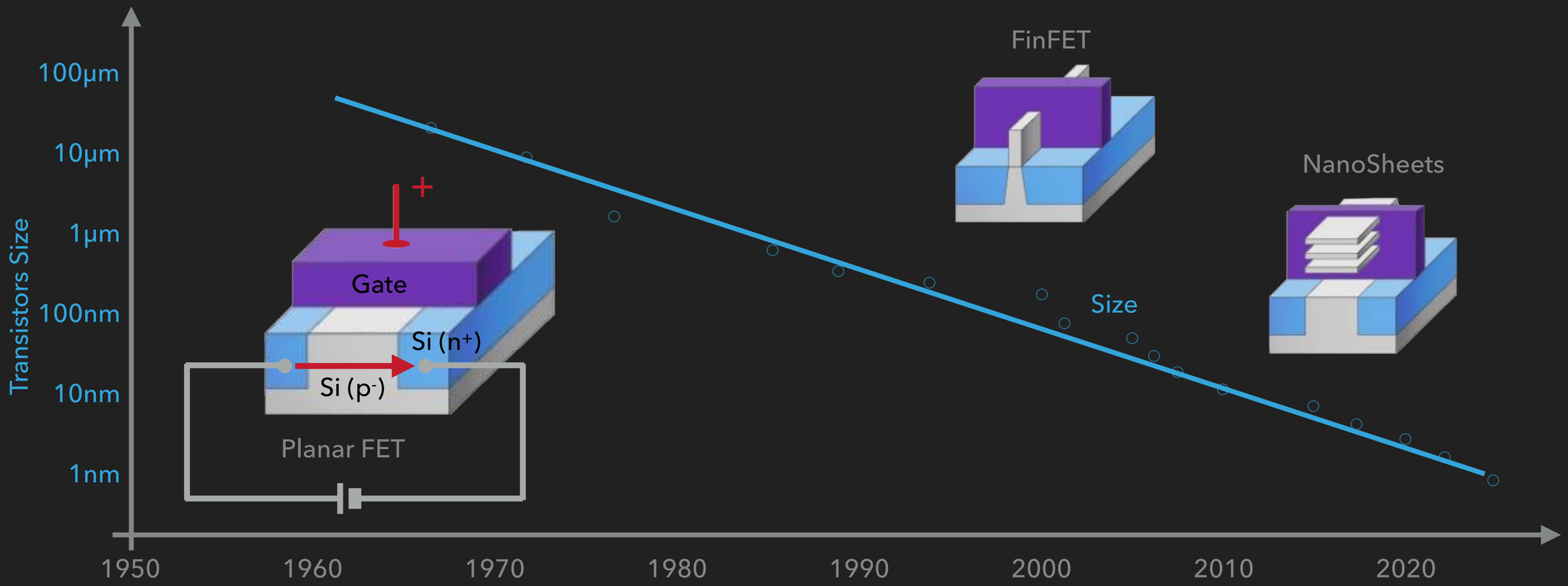


NanoSheets



1950 1960 1970 1980 1990 2000 2010 2020

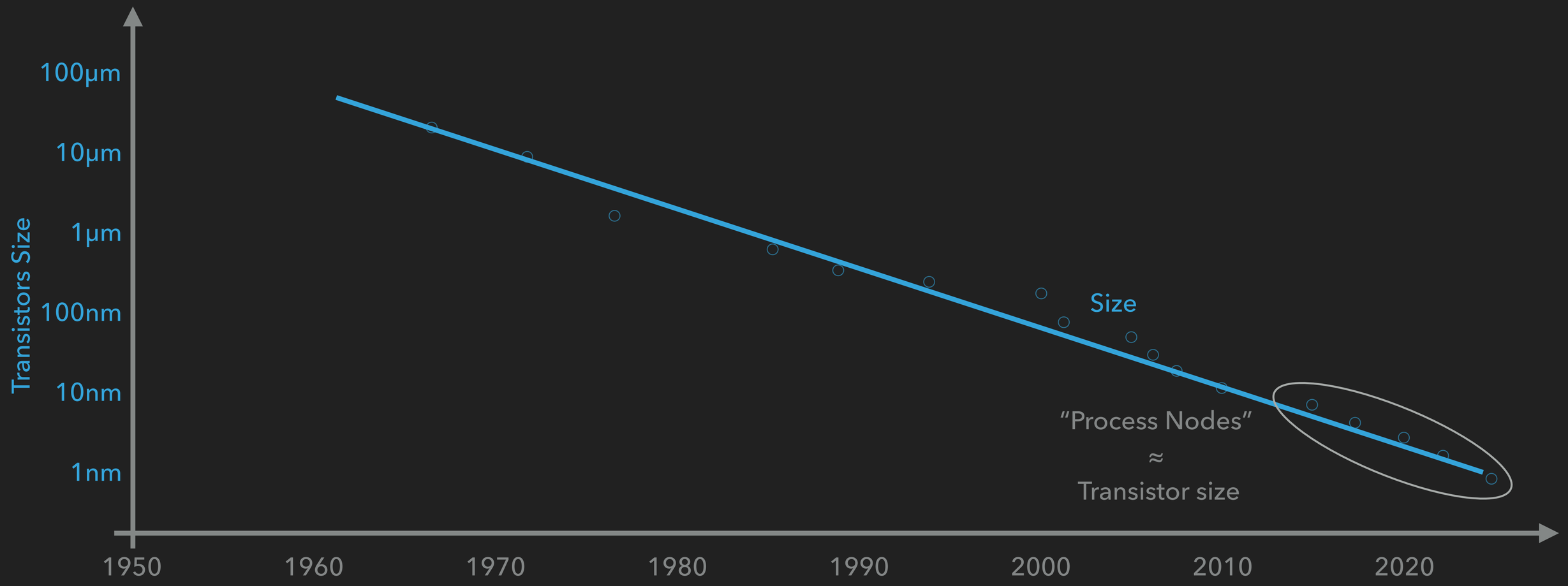
HUMAN MANUFACTURING OF TRANSISTORS



https://ourworldindata.org
https://aiimpacts.org/electrical-efficiency-of-computing/
https://semiengineering.com/

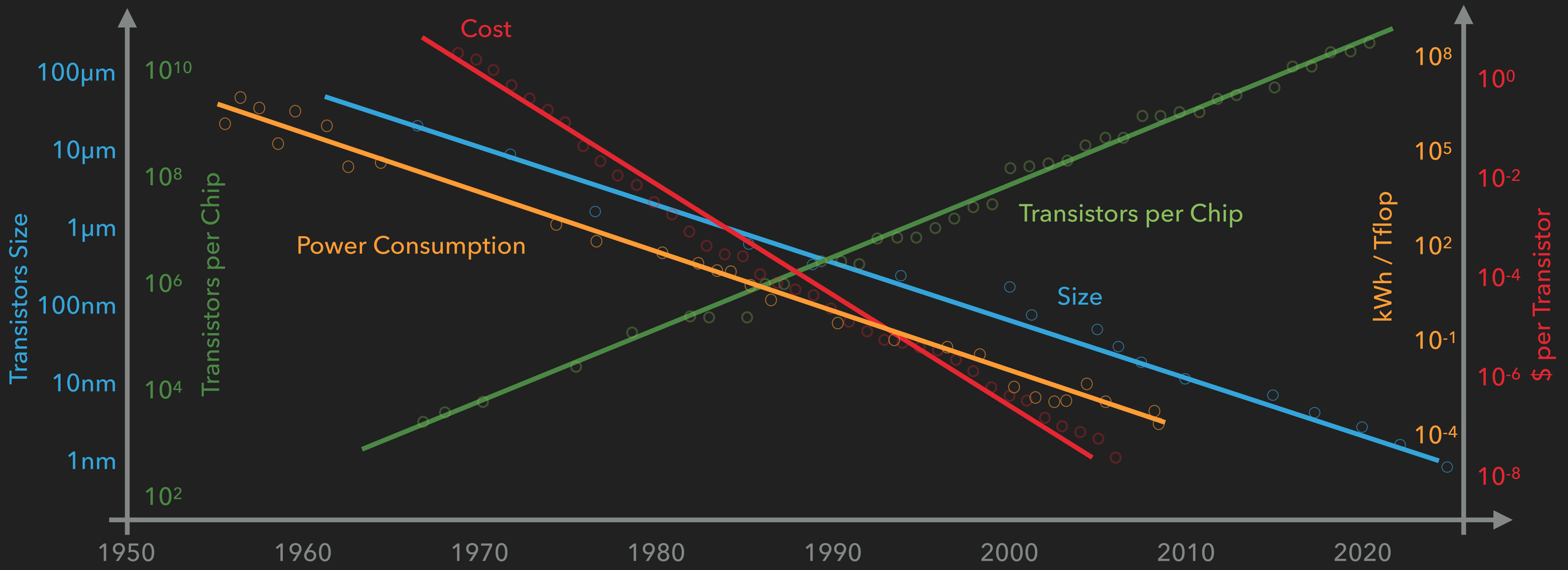
@38C3

HUMAN MANUFACTURING OF TRANSISTORS



https://ourworldindata.org
https://aiimpacts.org/electrical-efficiency-of-computing/
https://semiengineering.com/

HUMAN MANUFACTURING OF TRANSISTORS



https://ourworldindata.org
https://aiimpacts.org/electrical-efficiency-of-computing/
https://semiengineering.com/

@38C3

HUMAN MANUFACTURING OF TRANSISTORS

2010 VW Golf => $100

Cost

Power Consumption

Transistors per Chip

Size

Transistors Size
100µm
10µm
1µm
100nm
10nm
1nm

Transistors per Chip
10^{10}
10^{8}
10^{6}
10^{4}
10^{2}

kWh / Tflop
10^{8}
10^{5}
10^{2}
10^{-1}
10^{-4}

$ per Transistor
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}

1950 1960 1970 1980 1990 2000 2010 2020

IBM 360

HP-35

Commodore

IBM PC

IBM Thinkpad

BlackBerry

iPhone

iPad

BD: Atlas

Vision Pro

https://ourworldindata.org
https://aiimpacts.org/electrical-efficiency-of-computing/
https://semiengineering.com/

@38C3

HUMAN MANUFACTURING OF TRANSISTORS

Transistors Shipped

10^{22}

10^{19}

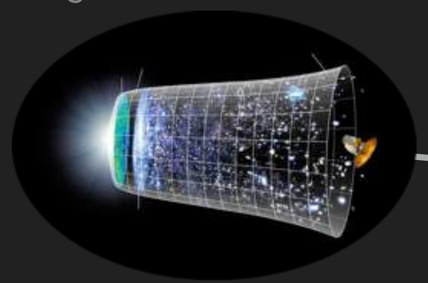
10^{16}

10^{13}

10^{10}

Bell Labs

Age of Universe: 10^{17} s



Rice on Chessboard: 10^{21}

Stars in Universe: 10^{24}

Transistors in the World

Stars in Milkyway: 10^{11}

1950 1960 1970 1980 1990 2000 2010 2020

IBM 360

HP-35

Commodore

IBM PC

IBM Thinkpad

BlackBerry

iPhone

iPad

BD: Atlas

Vision Pro

https://ourworldindata.org
https://aiimpacts.org/electrical-efficiency-of-computing/
https://semiengineering.com/
https://science.nasa.gov/universe/stars/

@38C3

HUMAN MANUFACTURING OF TRANSISTORS

Transistors Shipped

10^{22}

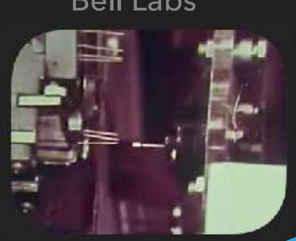
10^{19}

10^{16}

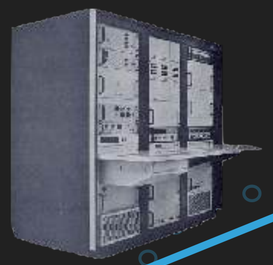
10^{13}

10^{10}

Bell Labs



IC Test System
Fairchild 4000M



Wafer Stepper
CDA DSW 4800

KrF Scanner
Nikon NSR-201A

Immersion Lithography
ASML NXT:1900i

EUV Lithography
ASML NXE:3300

Transistors in the World

1950 1960 1970 1980 1990 2000 2010 2020

IBM 360

HP-35

Commodore

IBM PC

IBM Thinkpad

BlackBerry

iPhone

iPad

BD: Atlas

Vision Pro

https://www.chiphistory.org/
Atsuhiko Kato: "Chronology of Lithography Milestones"
Yole Development : "High-End Performance Packaging: 3D/2.5D Integration Report"
https://www.youtube.com/watch?v=7PZWxm1MlvM

HUMAN MANUFACTURING OF TRANSISTORS

Transistors Shipped

10^{22}

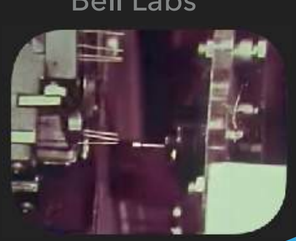
10^{19}

10^{16}

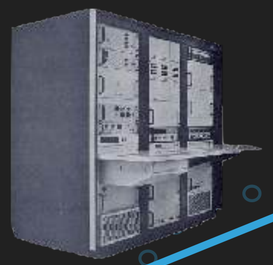
10^{13}

10^{10}

Bell Labs



IC Test System
Fairchild 4000M



Wafer Stepper
CDA DSW 4800

KrF Scanner
Nikon NSR-201A

Immersion Lithography
ASML NXT:1900i

EUV Lithography
ASML NXE:3300

Transistors in the World

1950 1960 1970 1980 1990 2000 2010 2020

Radar

Minuteman I
ICBM Guidance Computer

GPS I Satellite

MQ-1 Predator

F35 Lightning

Drone Swarm

https://www.chiphistory.org/
Atsuhiko Kato: "Chronology of Lithography Milestones"
Yole Development : "High-End Performance Packaging: 3D/2.5D Integration Report"
https://www.youtube.com/watch?v=7PZWxm1MlvM

HUMAN MANUFACTURING OF TRANSISTORS

Transistors Shipped

10^{22}

10^{19}

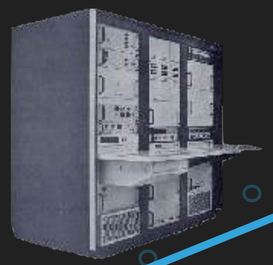
10^{16}

10^{13}

10^{10}

Bell Labs

IC Test System
Fairchild 4000M

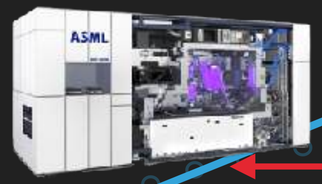


Wafer Stepper
CDA DSW 4800

KrF Scanner
Nikon NSR-201A

Immersion Lithography
ASML NXT:1900i

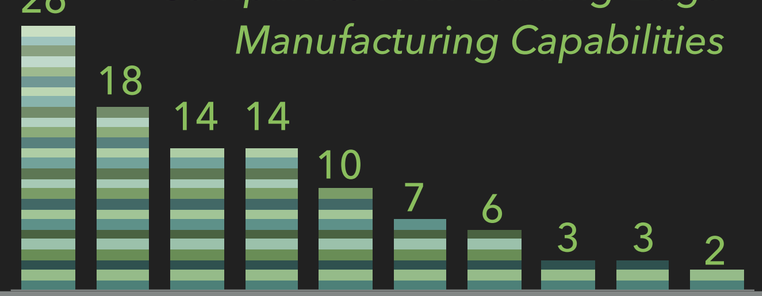
EUV Lithography
ASML NXE:3300



99% of all chips ever made

Transistors in the World

Companies With Leading-Edge Manufacturing Capabilities



1950 1960 1970 1980 1990 2000 2010 2020

Radar

Minuteman I
ICBM Guidance Computer

GPS I Satellite

MQ-1 Predator

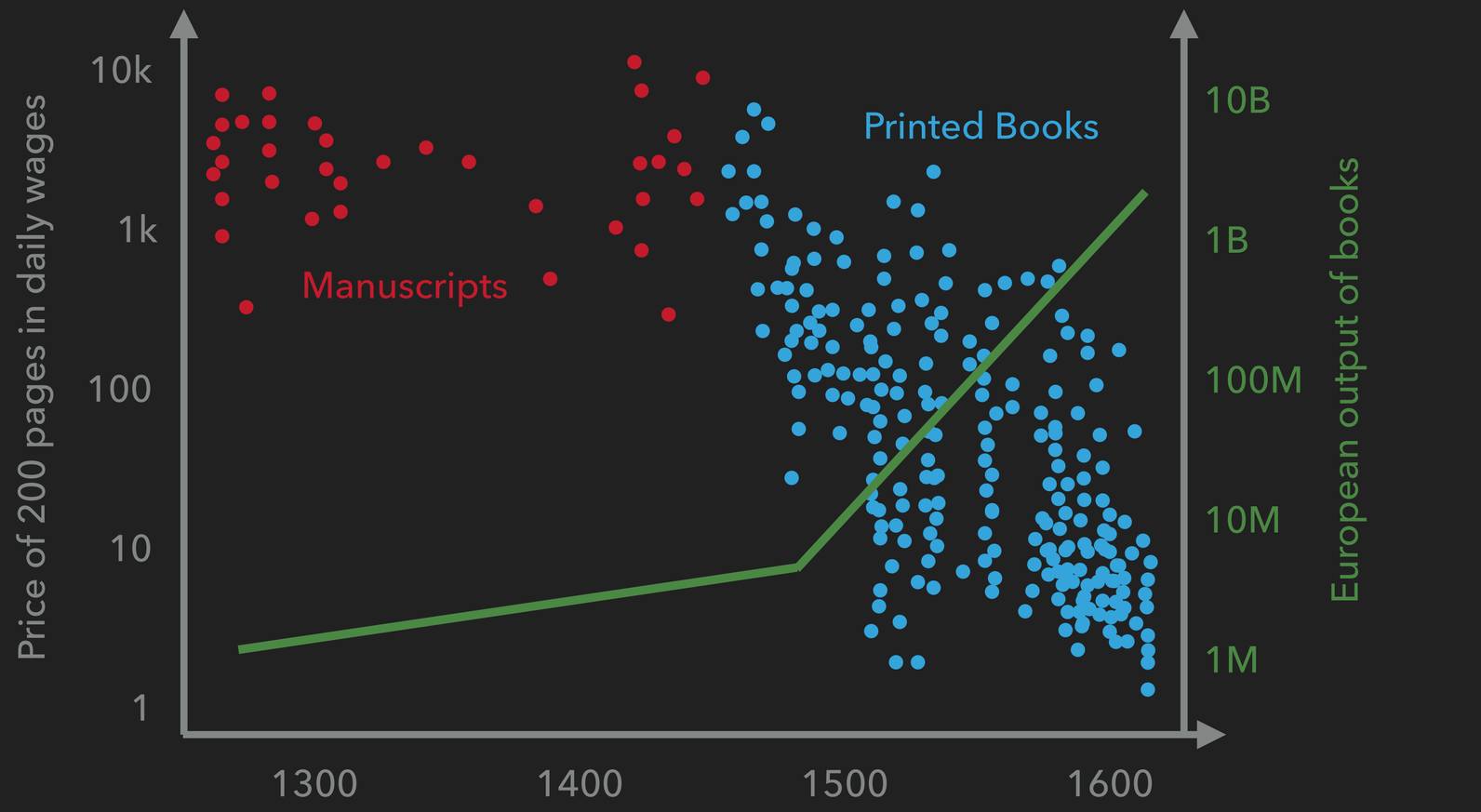
F35 Lightning

Drone Swarm

https://www.chiphistory.org/
Atsuhiko Kato. "Chronology of Lithography Milestones"
Yole Development : "High-End Performance Packaging: 3D/2.5D Integration Report"
https://www.youtube.com/watch?v=7PZWxm1MlvM

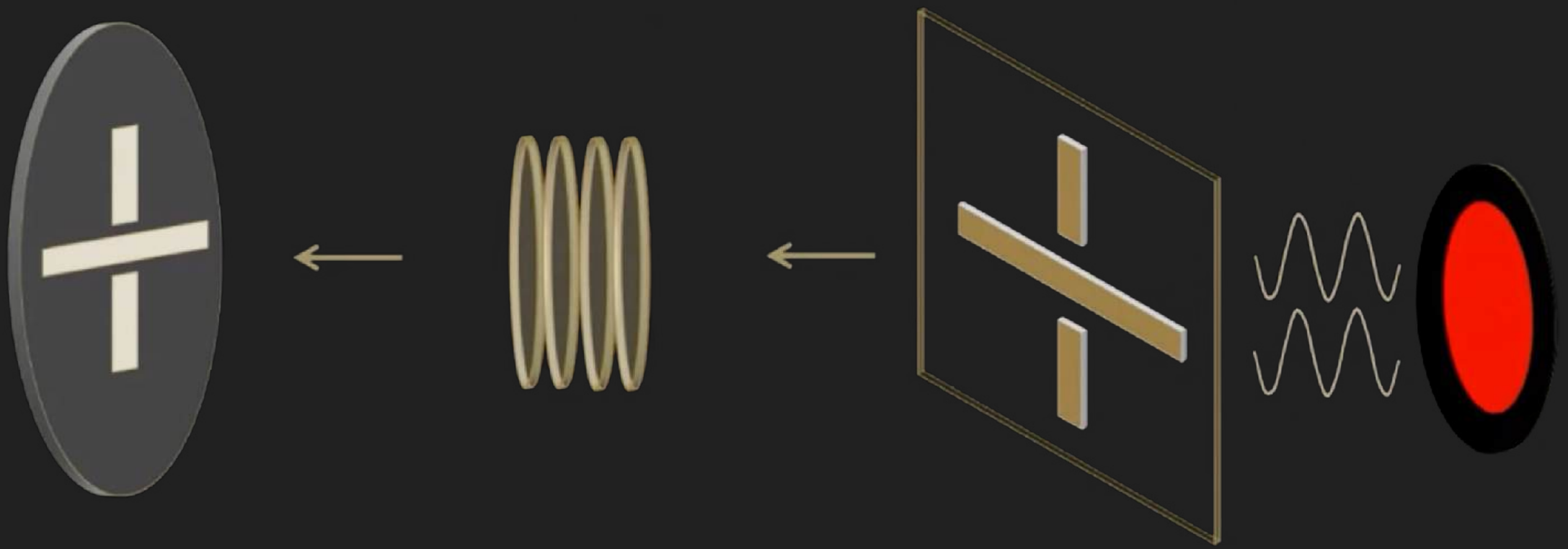
@38C3

THE PRINTING PRESS – A REVOLUTION IN MASS PRODUCTION



https://blogs.lse.ac.uk/businessreview/2019/03/19/gutenbergs-moving-type-propelled-europe-towards-the-scientific-revolution/
https://www.zdf.de/dokumentation/terra-x/videos/buchdruck-geschichte-100.html
https://commons.wikimedia.org/wiki/File:European_Output_of_Books_500–1800.png

PRINCIPLES OF PHOTOLITHOGRAPHY

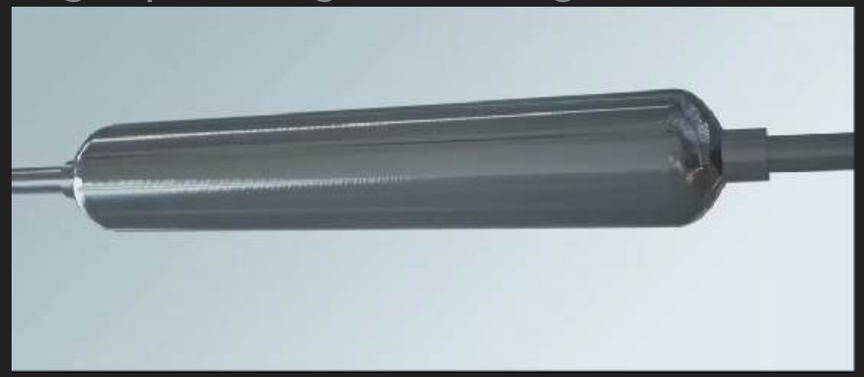


Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

SILICON WAFER PRODUCTION

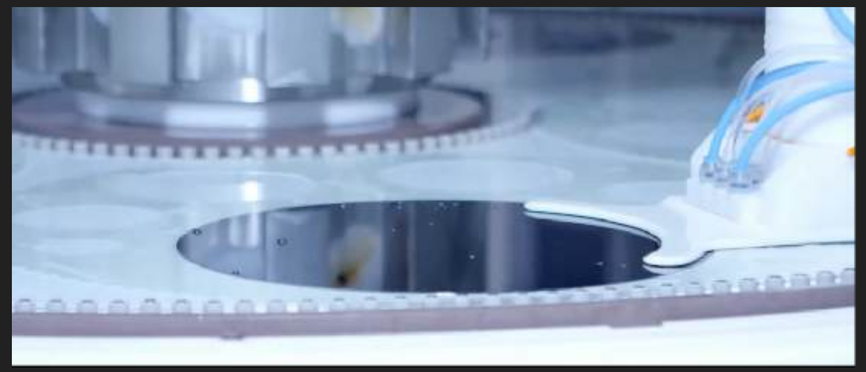
Ultra pure quartz mining

Ingot polishing and slicing



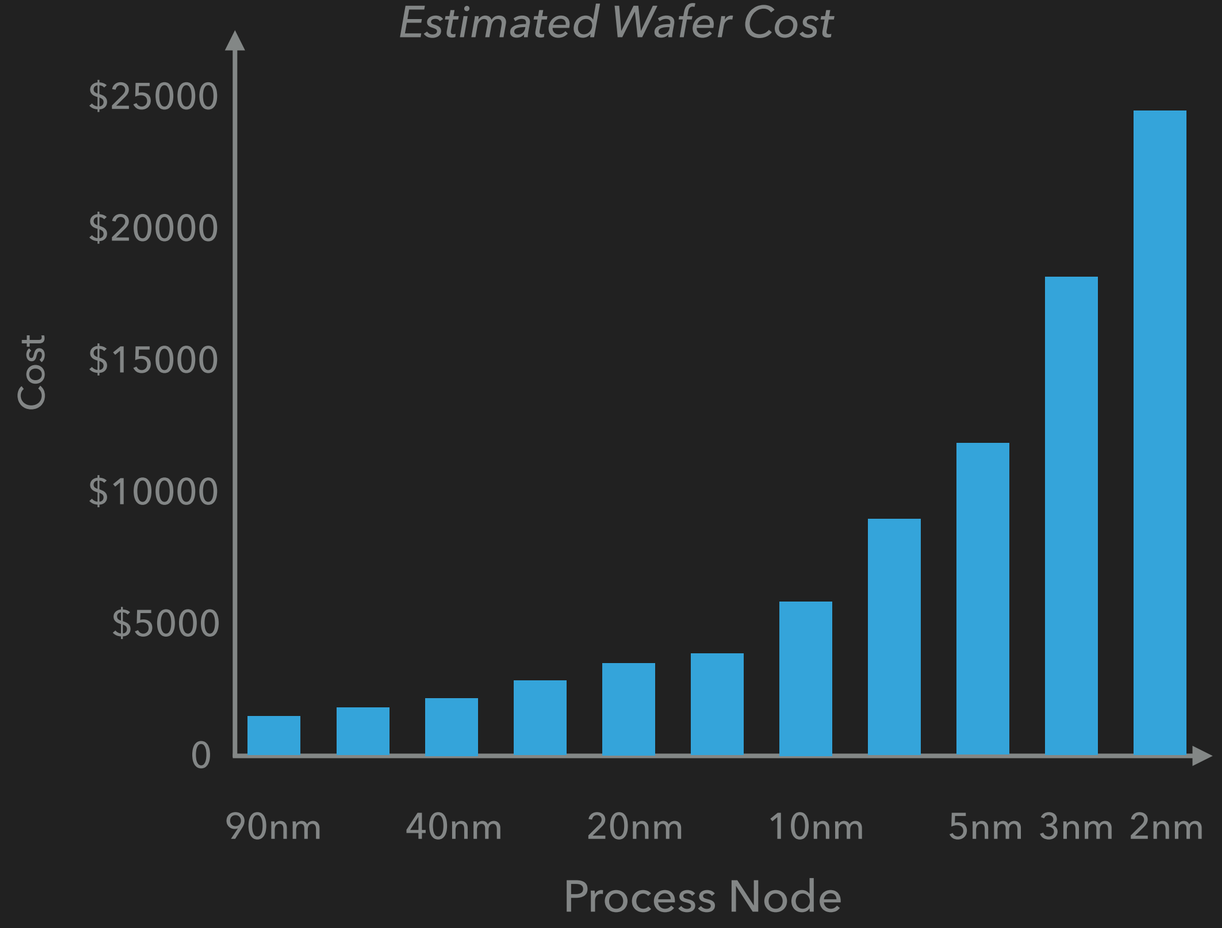
Silikon ingot crystal growing

Wafer chemical and mechanical processing

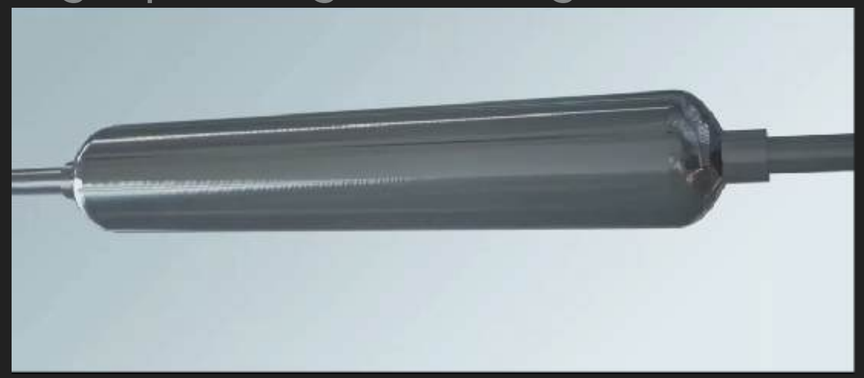


Semiconductor: "300mm silicon wafer manufactoring process" (https://www.youtube.com/watch?v=jnnXZa_hWq4)

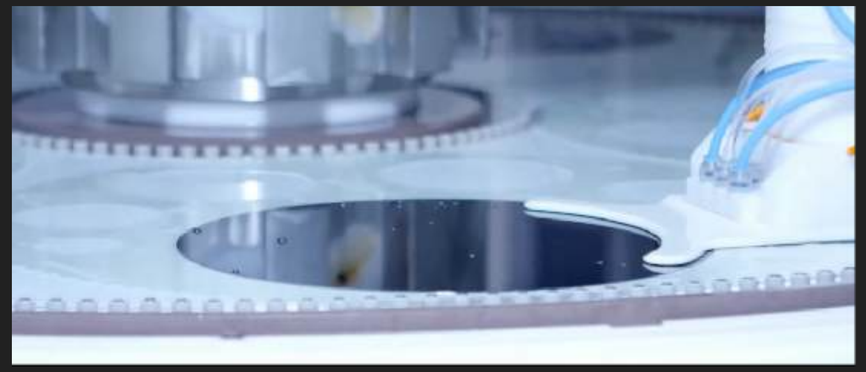
SILICON WAFER PRODUCTION



Ingot polishing and slicing



Wafer chemical and mechanical processing



Semiconductor: "300mm silicon wafer manufactoring process" (https://www.youtube.com/watch?v=jnnXZa_hWq4)

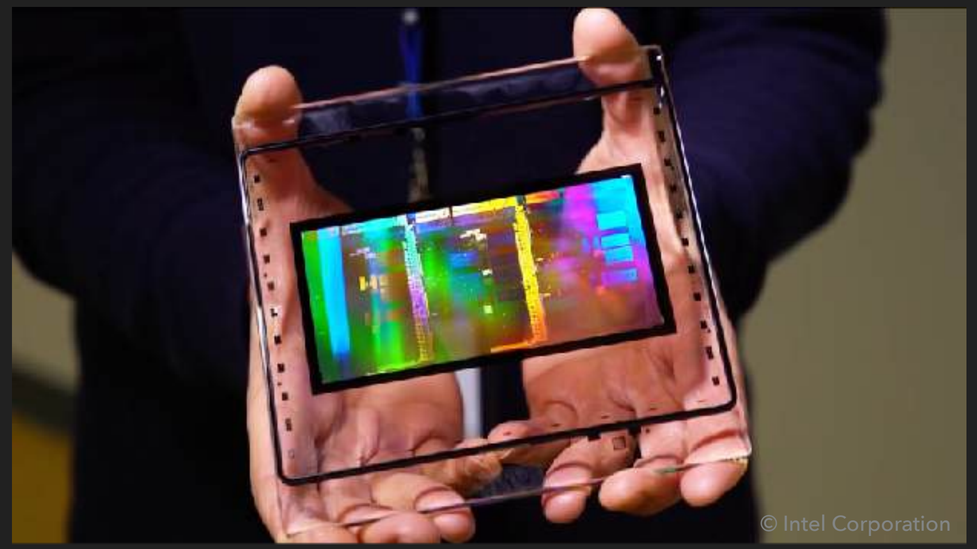
ZEISS: "How Chips Are Made" (https://www.youtube.com/watch?v=bUJiMJwel8M&t=85s)

PHOTOMASK

- Electron beam printing
- Zero defects
- X: 33mm/13nm = 2.5x10^6 pixel
- Y: 26mm/13nm = 2x10^6 pixel
- 5T Pixel Screen

How it started…

…and how it’s going.



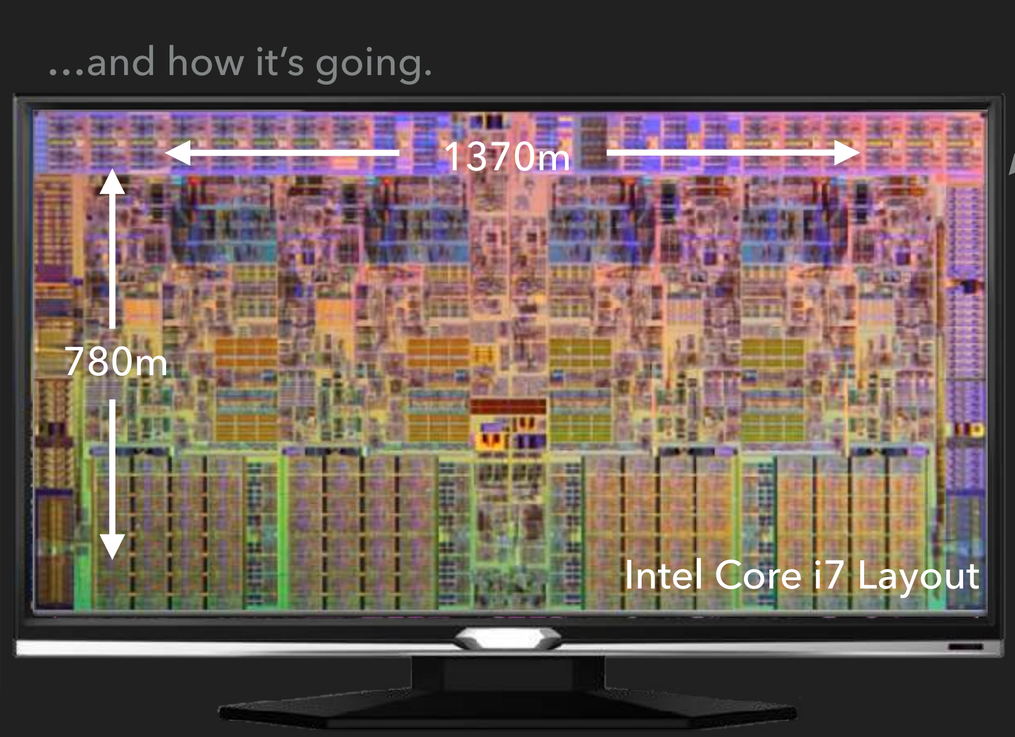
Asianometry. “The History of the Semiconductor Photomask” (https://www.youtube.com/watch?v=Pt9NEnWmyMo)
ZEISS Group. “How Extreme Ultraviolet Lithography works II” (https://www.youtube.com/watch?v=wKWKq7TJSoU)

PHOTOMASK

- Electron beam printing
- Zero defects
- X: 33mm/13nm = 2.5x10⁶ pixel
- Y: 26mm/13nm = 2x10⁶ pixel
- 5T Pixel Screen

How it started…

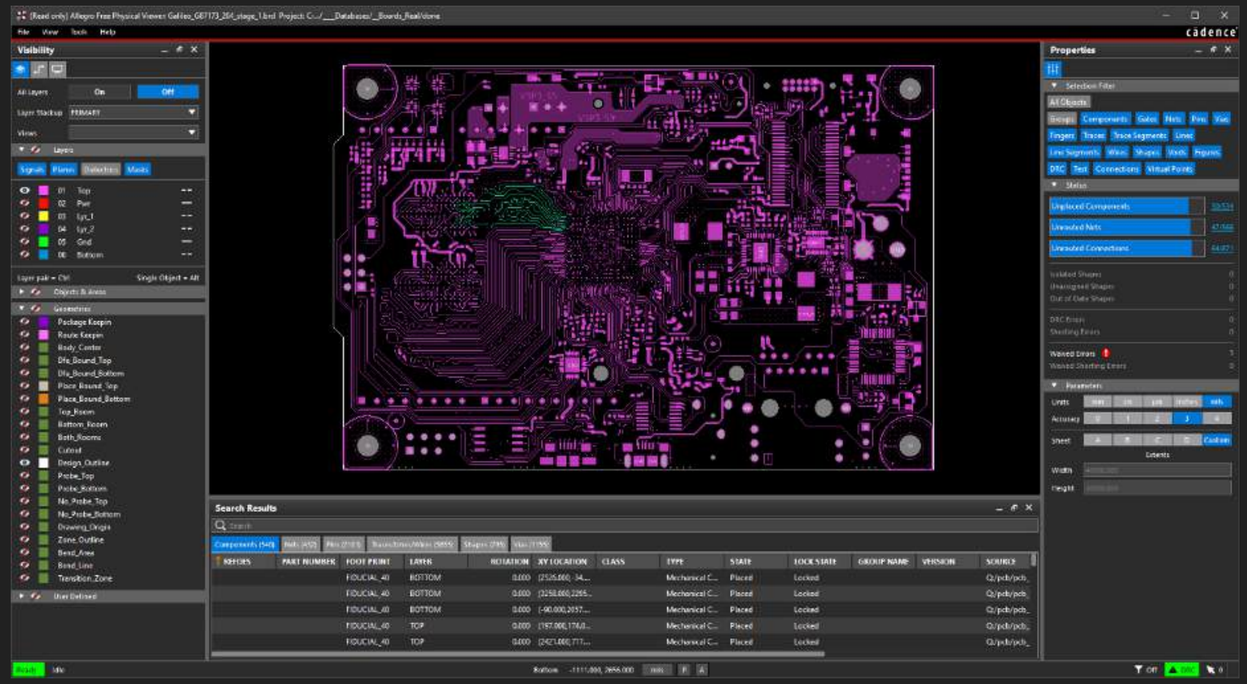
…and how it’s going.



Asianometry, “The History of the Semiconductor Photomask” (https://www.youtube.com/watch?v=Pt9NEnWmyMo)
ZEISS Group, “How Extreme Ultraviolet Lithography works II” (https://www.youtube.com/watch?v=wKWKq7TJSoU)

ELECTRONIC DESIGN AUTOMATION

- NVIDIA ‘Hopper’: 80B Transistors
- Designed in about 2 years
- ‘100M transistors per day’
- 1-Layer Photomask File: 150GB
- About 100 Layers in latest 3nm Process



Cadence Design Systems, “Introduction to Electronic Design Automation” (https://www.youtube.com/watch?v=HkT363NUOBA)
Synopsis, “World of Chips” (https://www.youtube.com/watch?v=o31uckqYchE)

ELECTRONIC DESIGN AUTOMATION

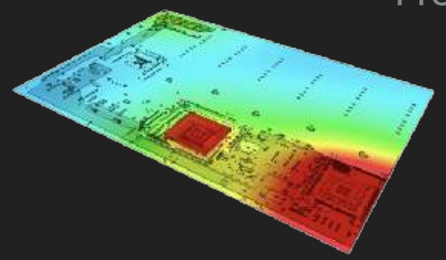
- NVIDIA ‘Hopper’: 80B Transistors
- Designed in about 2 years
- ‘100M transistors per day’
- 1-Layer Photomask File: 150GB
- About 100 Layers in latest 3nm Process

Prototyping on FPGAs

SYNOPSYS®

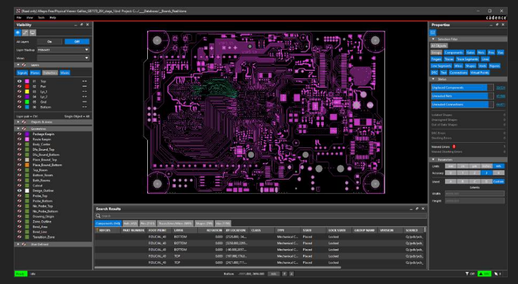
≈100% market share

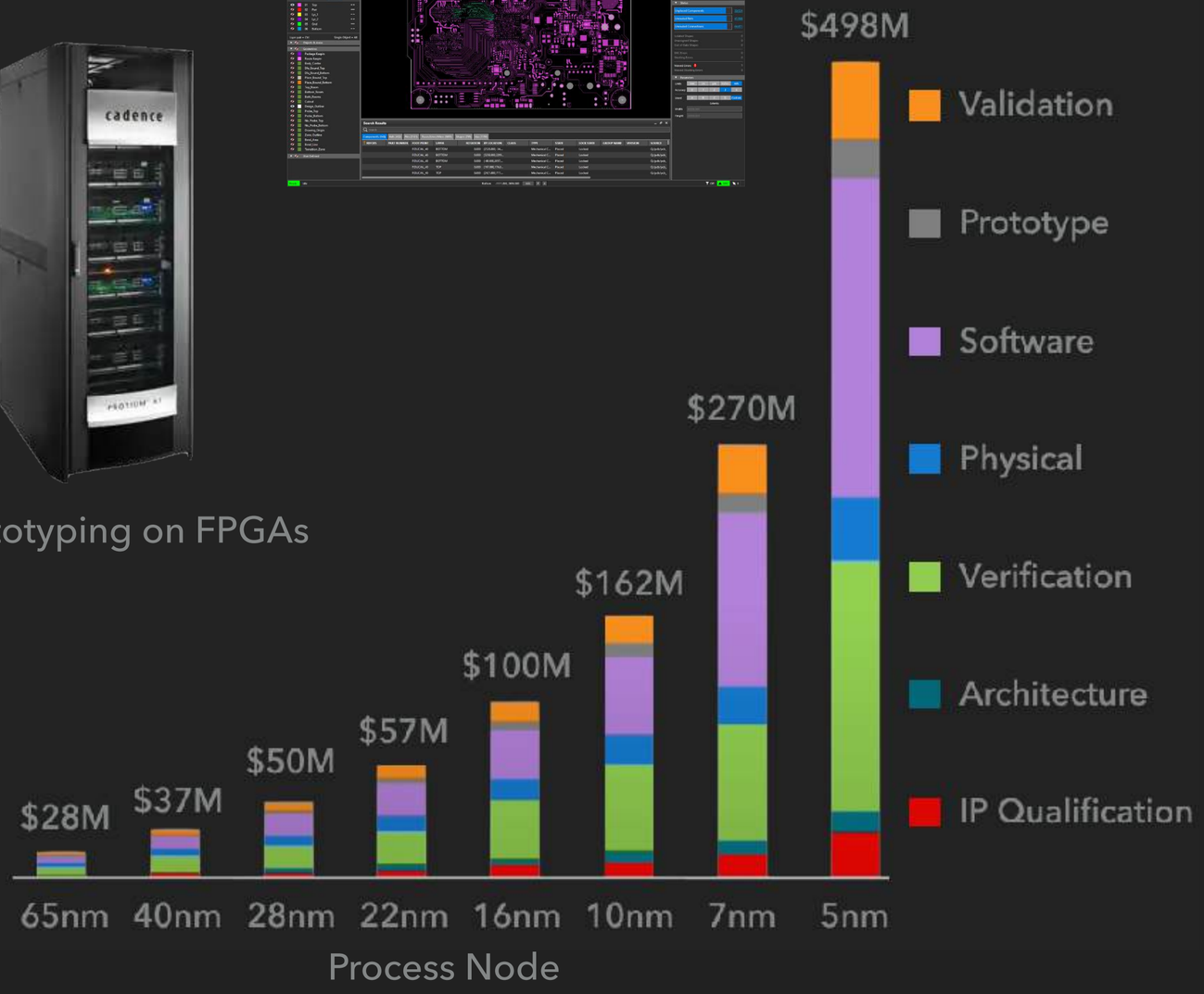
cadence®



Thermal Simulations

Layout Optimization





Cadence Design Systems, “Introduction to Electronic Design Automation” (https://www.youtube.com/watch?v=HkT363NUOBA)
Synopsis, “World of Chips” (https://www.youtube.com/watch?v=o31uckqYchE)

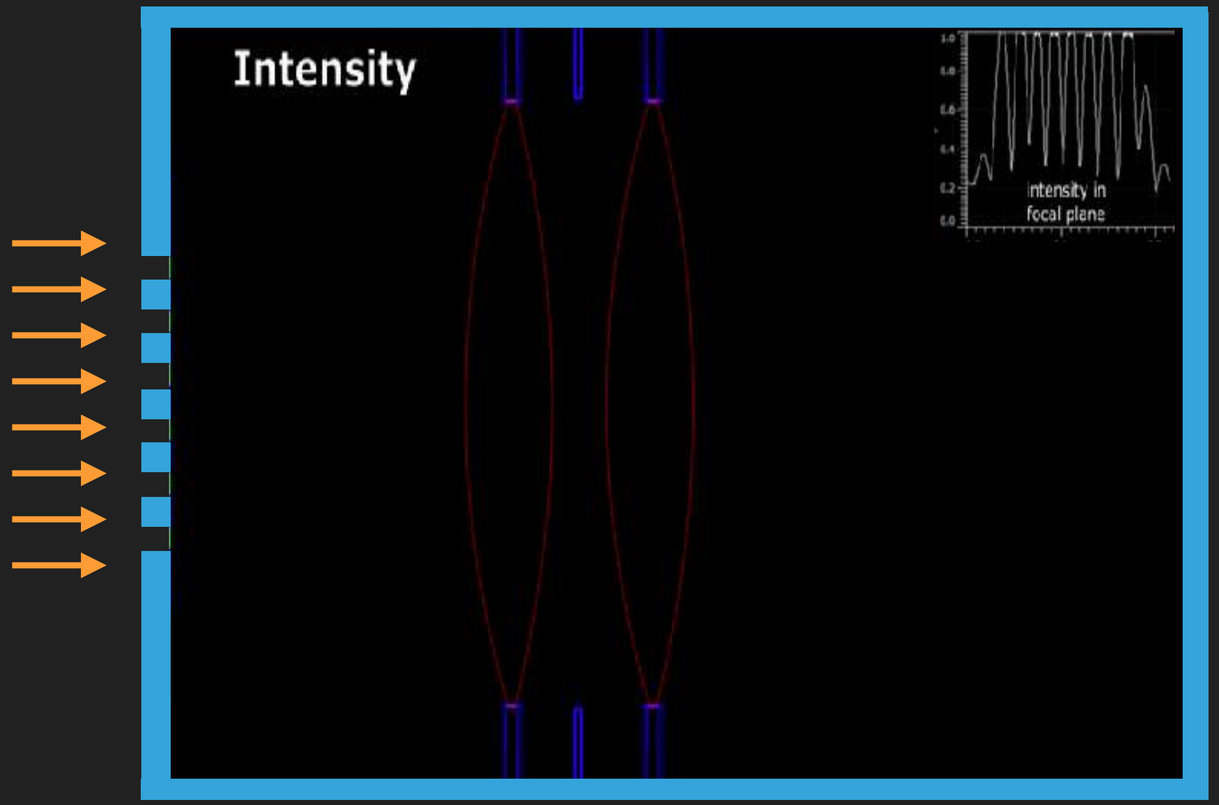
DIFFRACTION

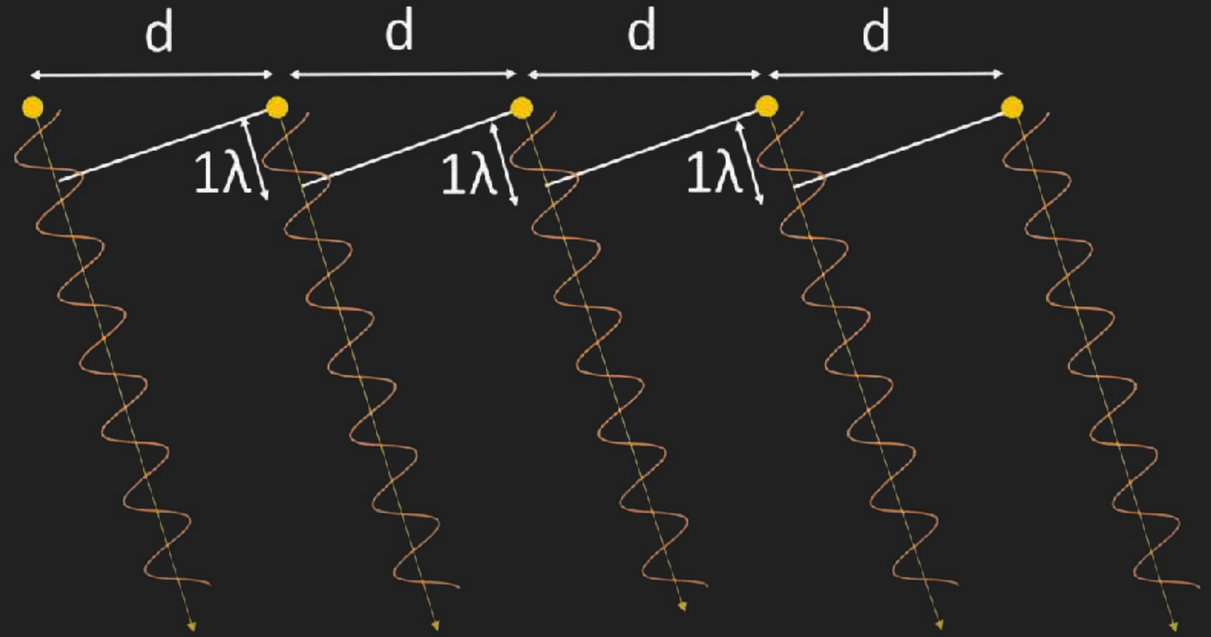
$$\text{Smallest Feature Size} = k_1 \cdot \frac{\lambda}{\text{NA}}$$

k_1 factor

Wavelength

Numerical Aperture





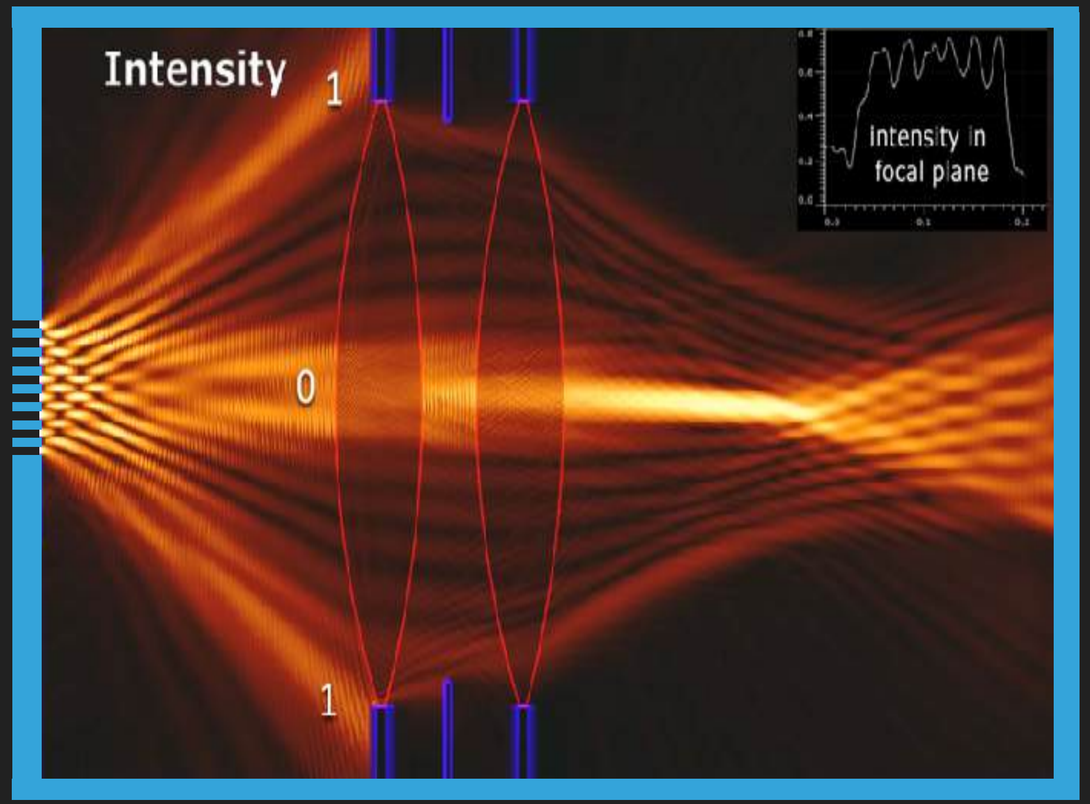
Huygens Optics, 'Imaging at ASML' (https://www.youtube.com/watch?v=rdIZ8KYVtPU)
Nan Fu et al. "EUV Lithography: State-of-the-Art Review" (http://www.jommpublish.org/p/29/)

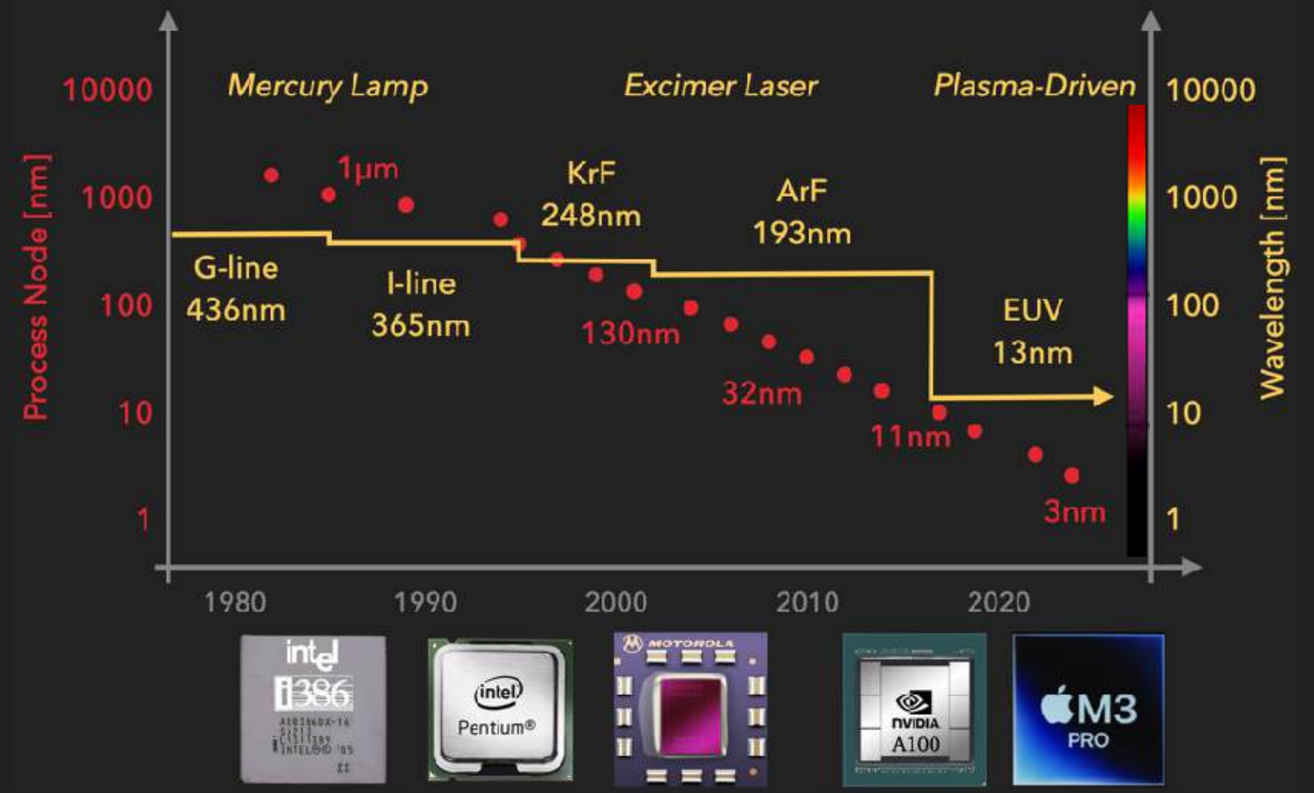
DIFFRACTION

Illumination Tricks

Physics and Geometry

$$\text{Smallest Feature Size} = k_1 \cdot \frac{\lambda}{\text{NA}}$$





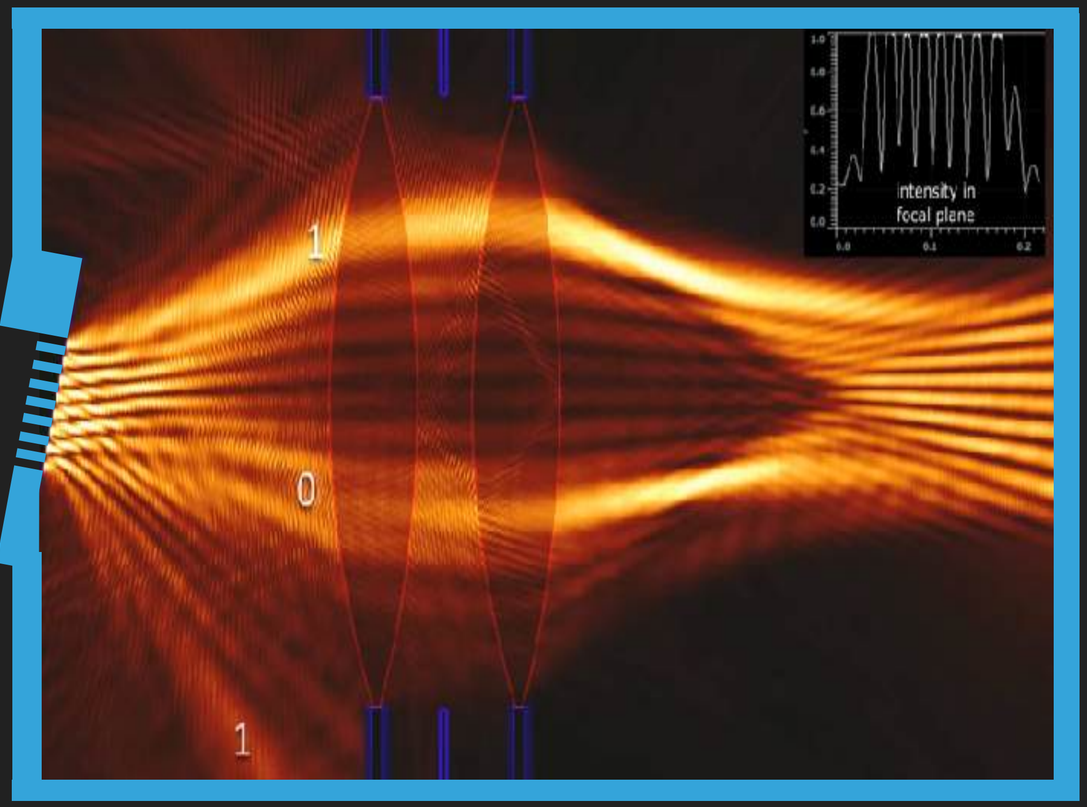
Huygens Optics, 'Imaging at ASML' (https://www.youtube.com/watch?v=rdlZ8KYVtPU)
Nan Fu et al. "EUV Lithography: State-of-the-Art Review" (http://www.jommpublish.org/p/29/)

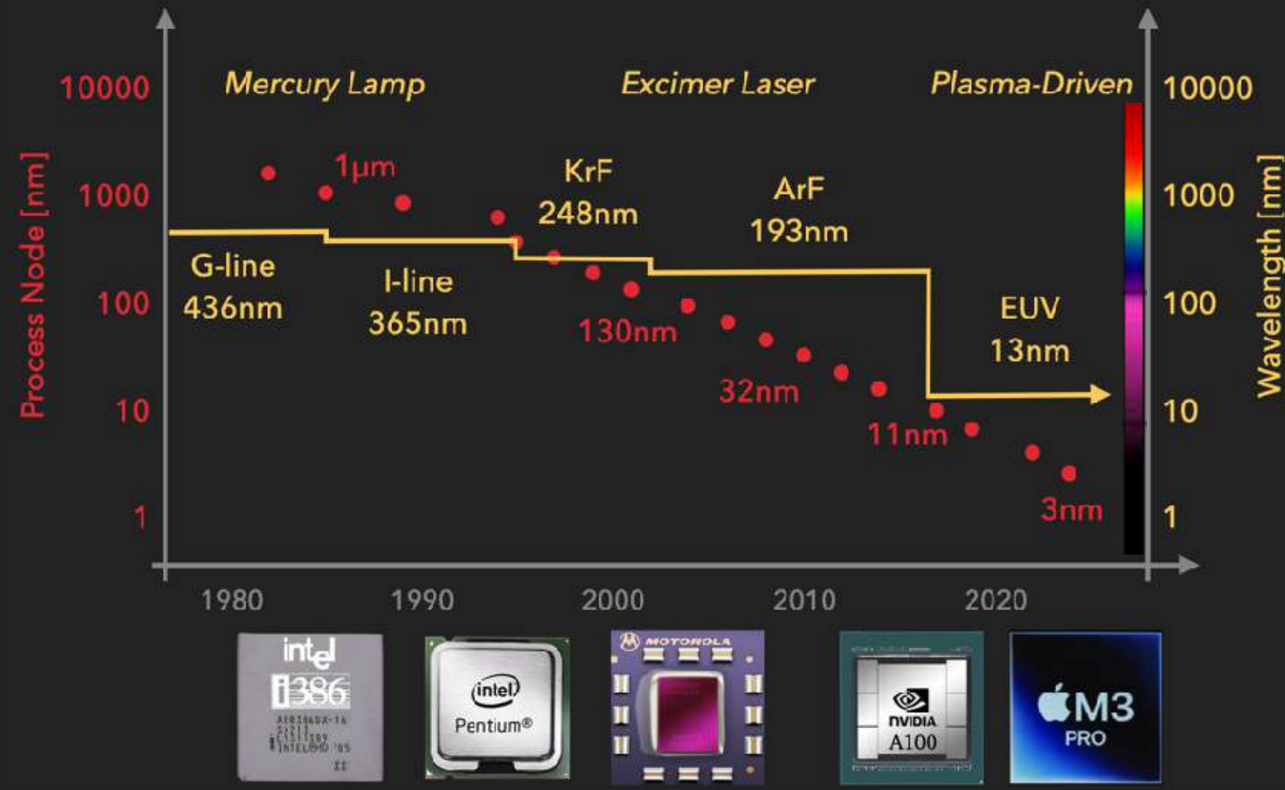
DIFFRACTION

Illumination Tricks

Physics and Geometry

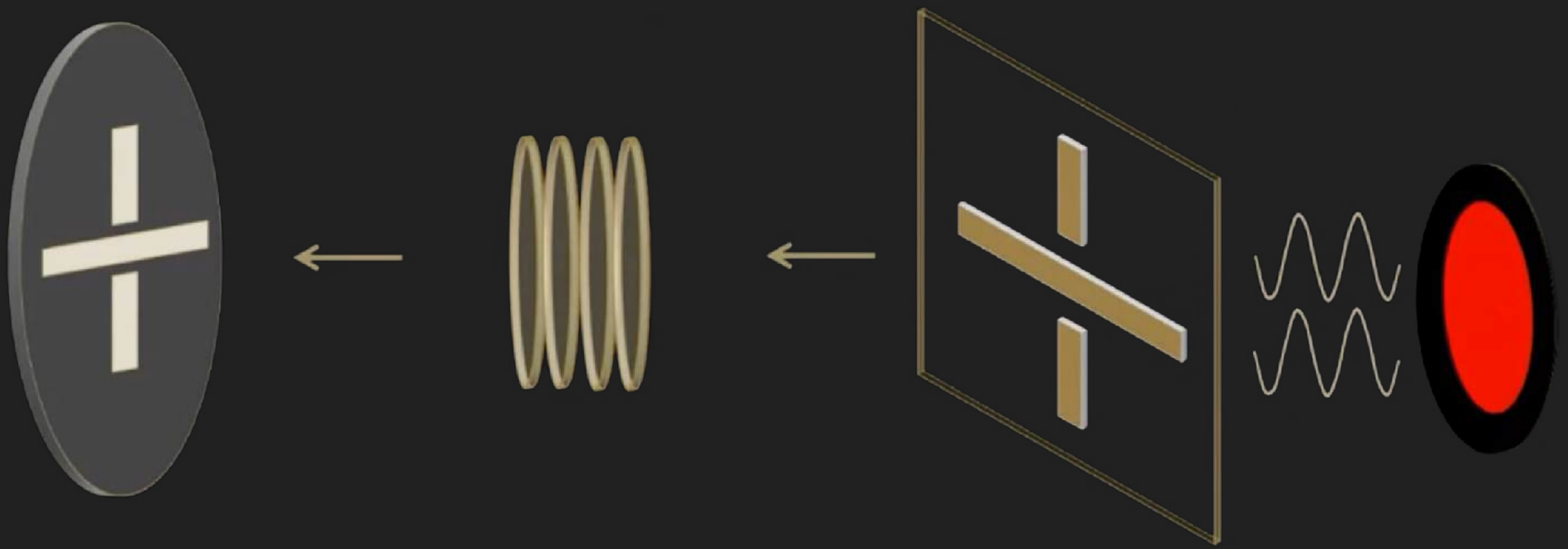
$$\text{Smallest Feature Size} = k_1 \cdot \frac{\lambda}{\text{NA}}$$





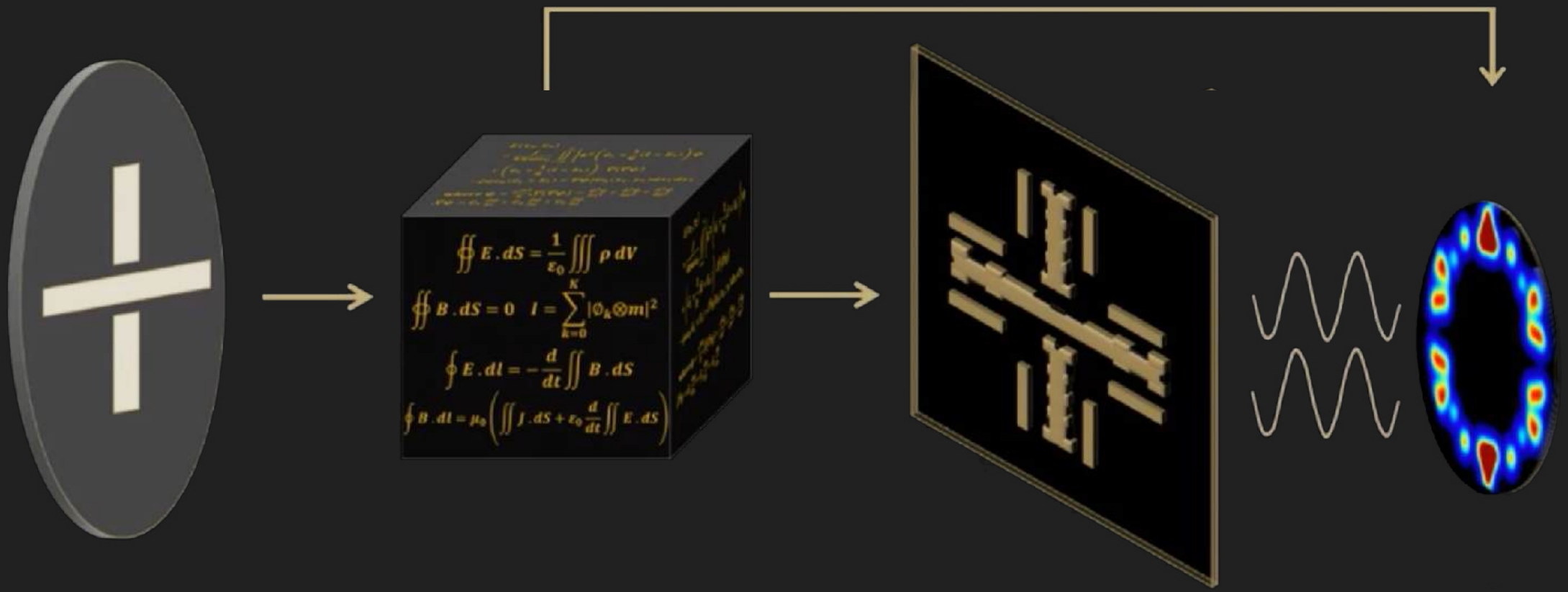
Huygens Optics, 'Imaging at ASML' (https://www.youtube.com/watch?v=rdlZ8KYVtPU)
Nan Fu et al. "EUV Lithography: State-of-the-Art Review" (http://www.jommpublish.org/p/29/)

PRINCIPLES OF PHOTOLITHOGRAPHY



Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

COMPUTATIONAL LITHOGRAPHY

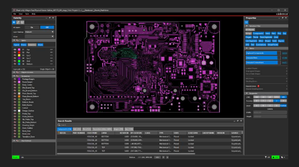


Wafer Numerical Optimization Mask Lightsource

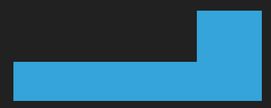
Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

OPTICAL PROXIMITY CORRECTION

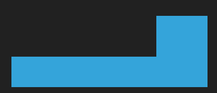
Design



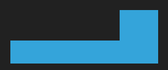
250nm



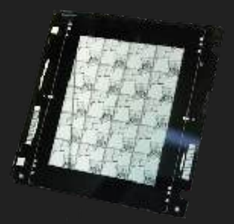
180nm



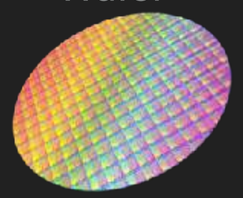
90nm

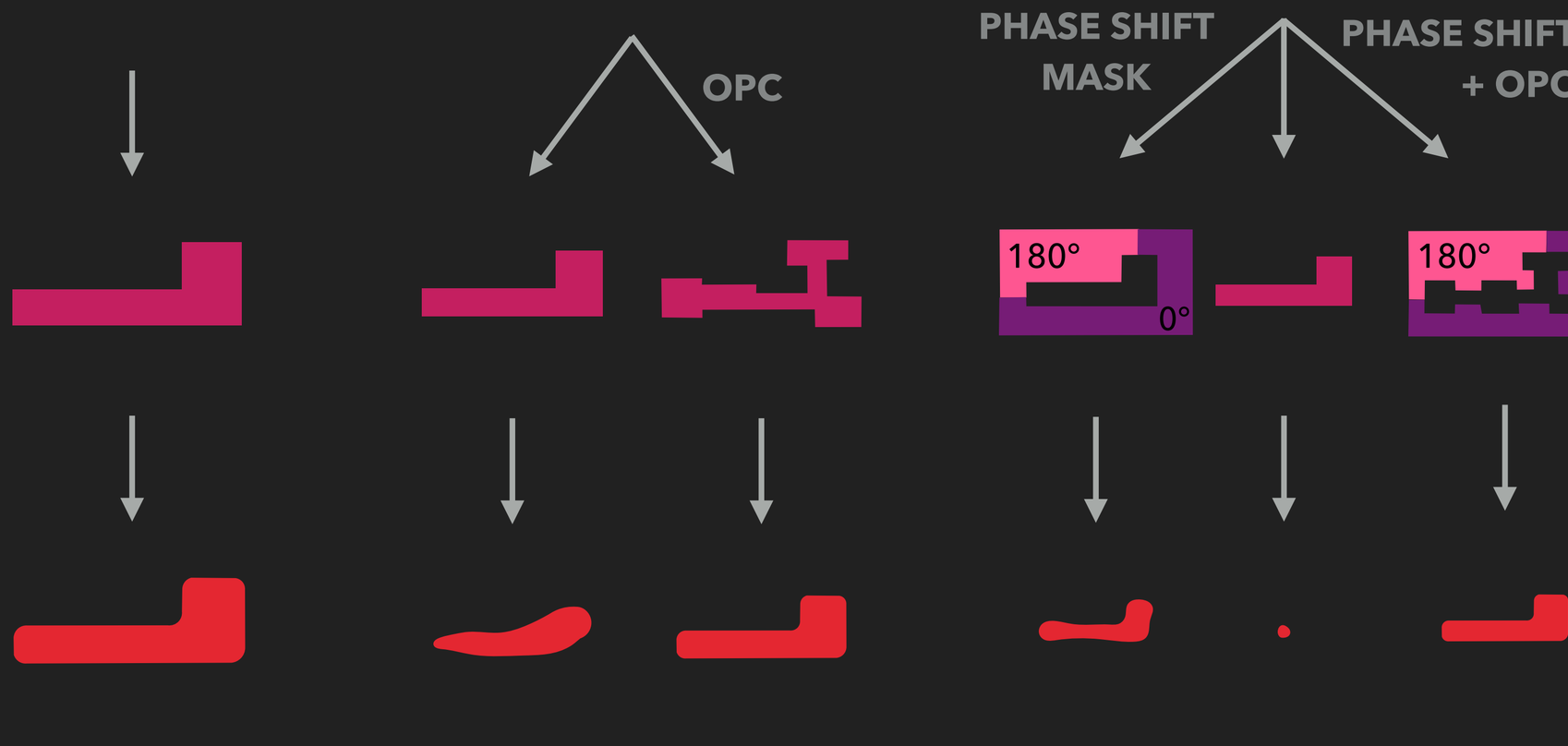


Mask



Wafer

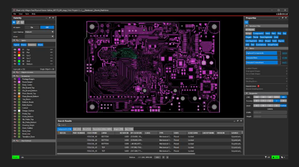




Synopsis, "Chip Design Flow" (https://www.youtube.com/watch?v=etj2h6R-QYg)

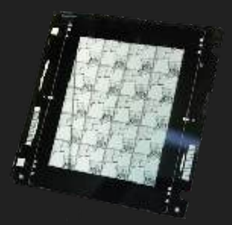
OPTICAL PROXIMITY CORRECTION & SOURCE-MASK OPTIMIZATION

Design

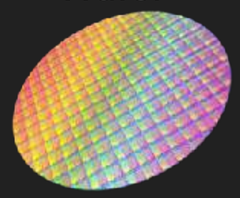


Source

Mask



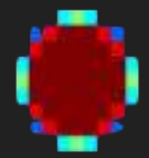
Wafer



32nm

45nm

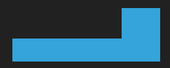
90nm

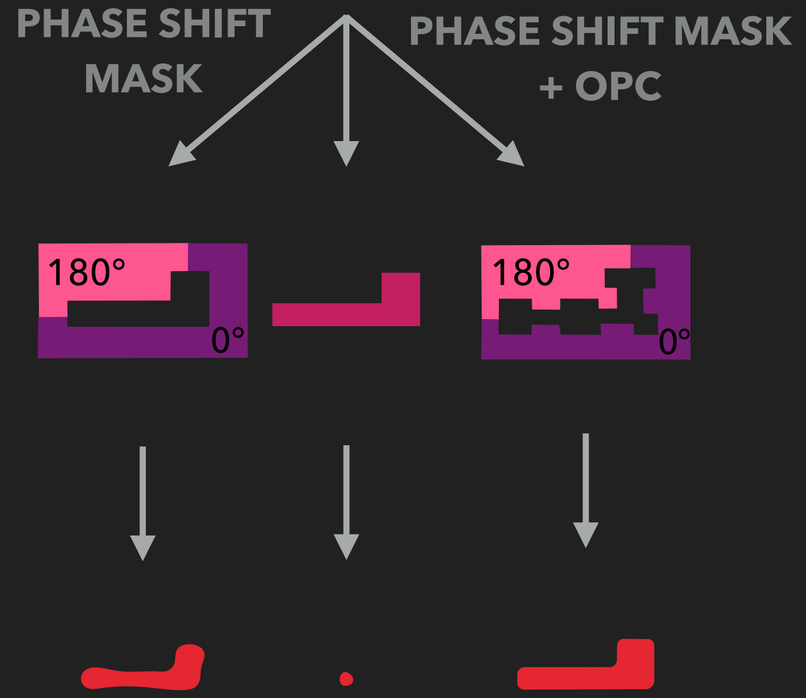


0 1

Intensity

90nm

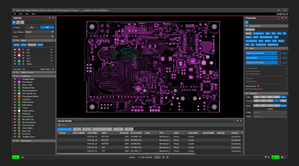




Synopsis, "Chip Design Flow" (https://www.youtube.com/watch?v=etj2h6R-QYg)
Jia Li, "Hotspot-aware fast source and mask optimization" (DOI:10.1364/OE.20.021792)
ASML, "Computational lithography" (https://www.youtube.com/watch?v=9RZreu5z_Gc)

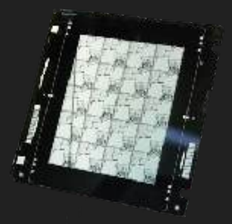
OPTICAL PROXIMITY CORRECTION & SOURCE-MASK OPTIMIZATION

Design

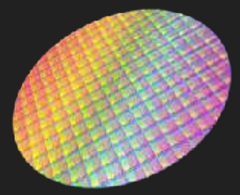


Source

Mask



Wafer



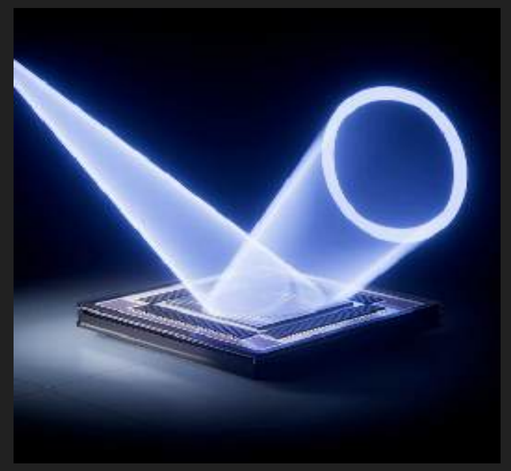
32nm

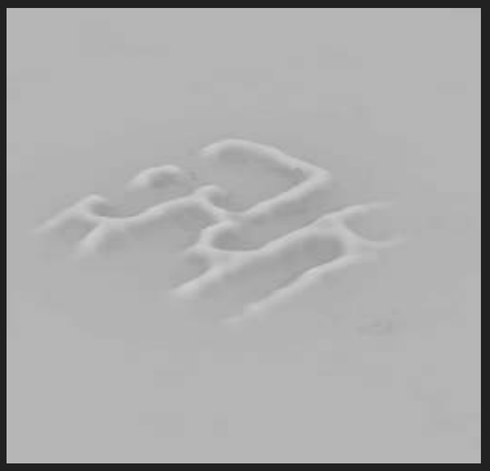
45nm

90nm

Intensity

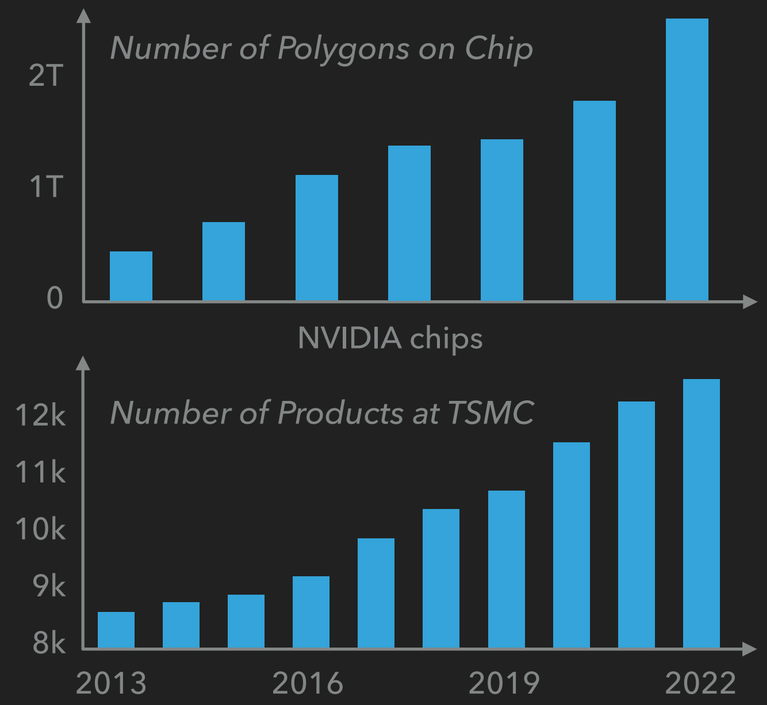
ASML TwinScan NXT:1980Di

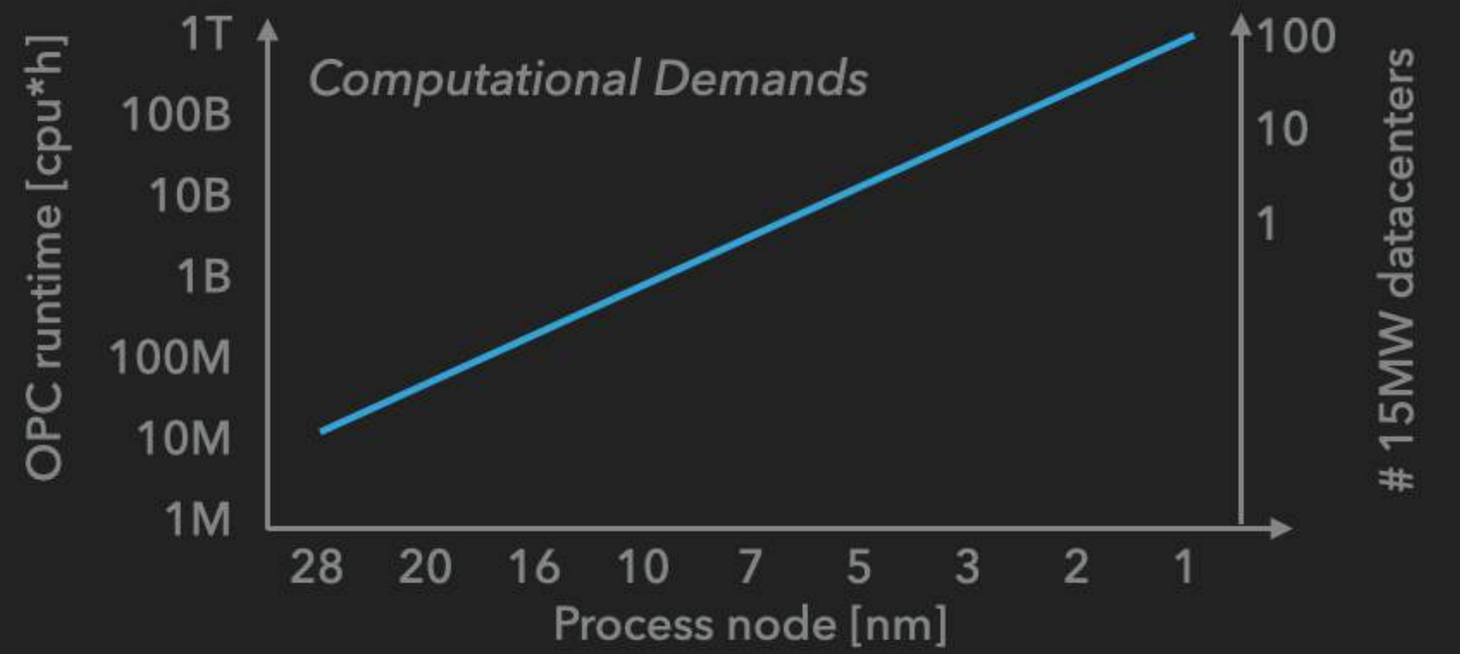




Synopsis. "Chip Design Flow" (https://www.youtube.com/watch?v=etj2h6R-QYg)
Jia Li. "Hotspot-aware fast source and mask optimization" (DOI:10.1364/OE.20.021792)
ASML. "Computational lithography" (https://www.youtube.com/watch?v=9RZreu5z_Gc)

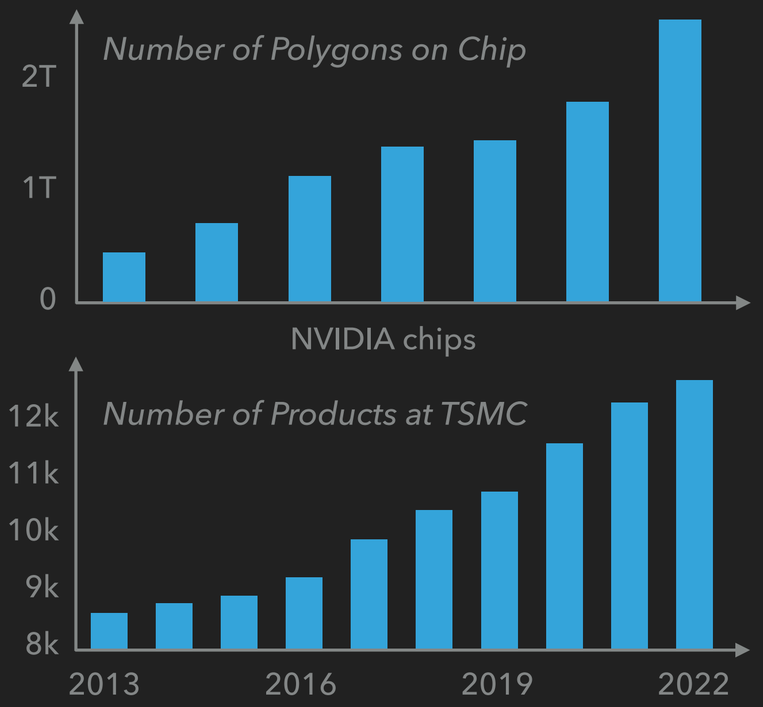
COMPUTATIONAL DEMANDS IN CHIP DESIGN

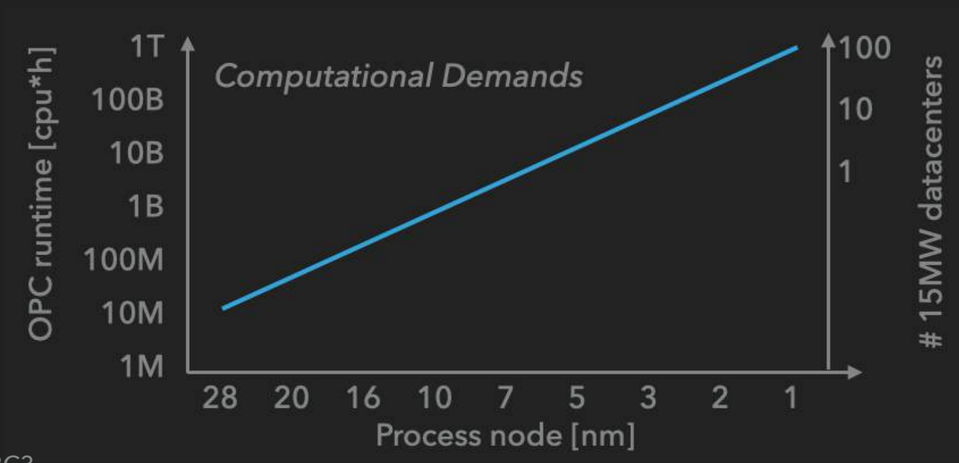




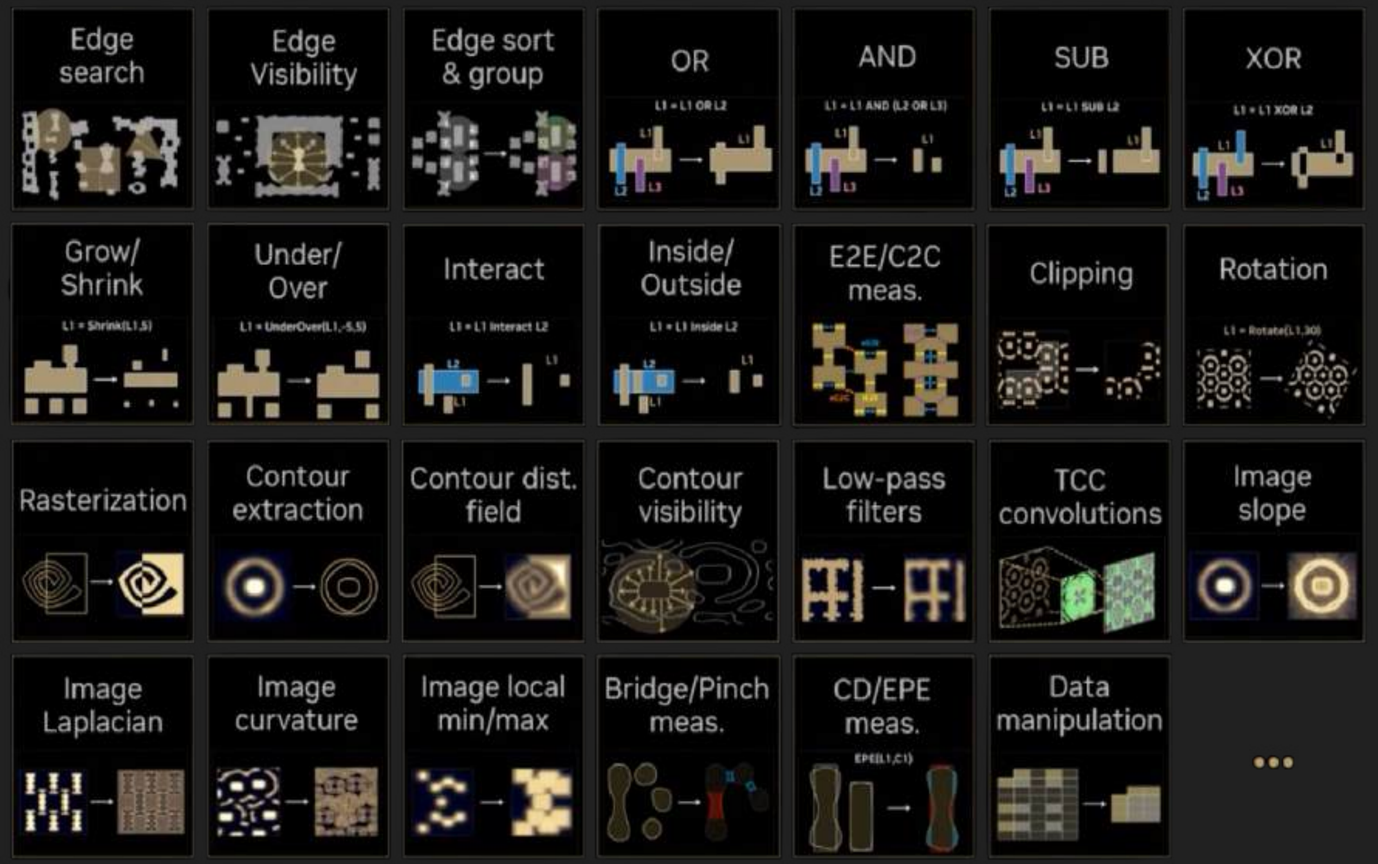
Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

COMPUTATIONAL DEMANDS IN CHIP DESIGN



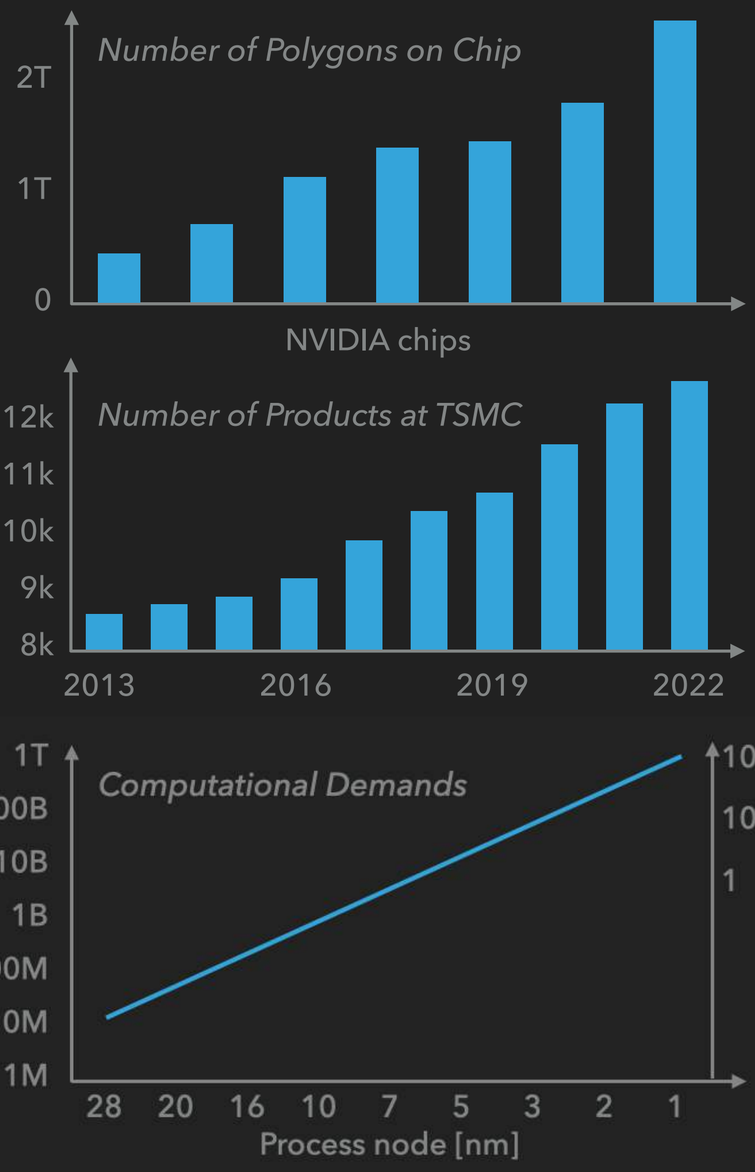


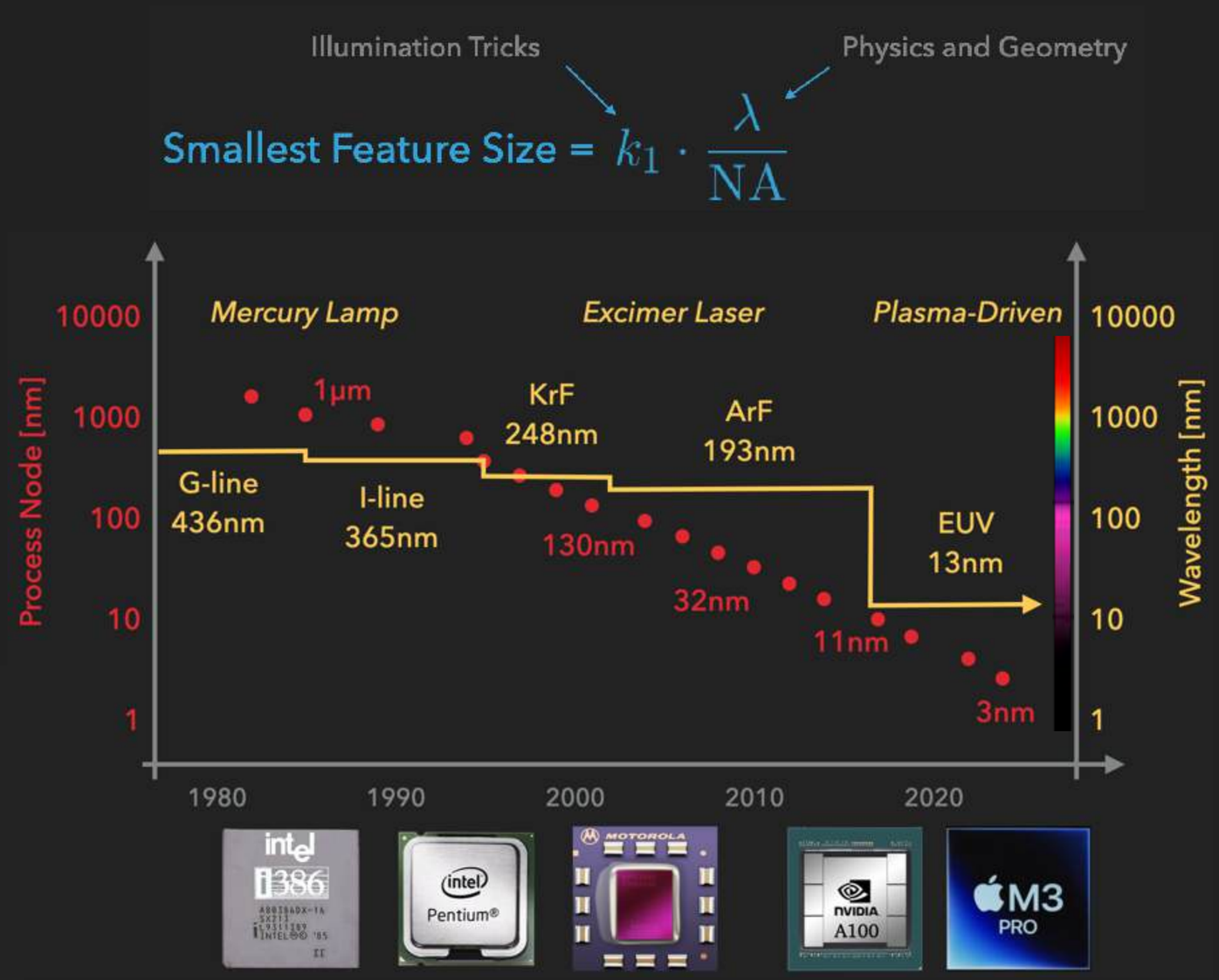
NVIDIA cuLITHO: Parallel Algorithms for Primitive Operations



Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

COMPUTATIONAL DEMANDS IN CHIP DESIGN

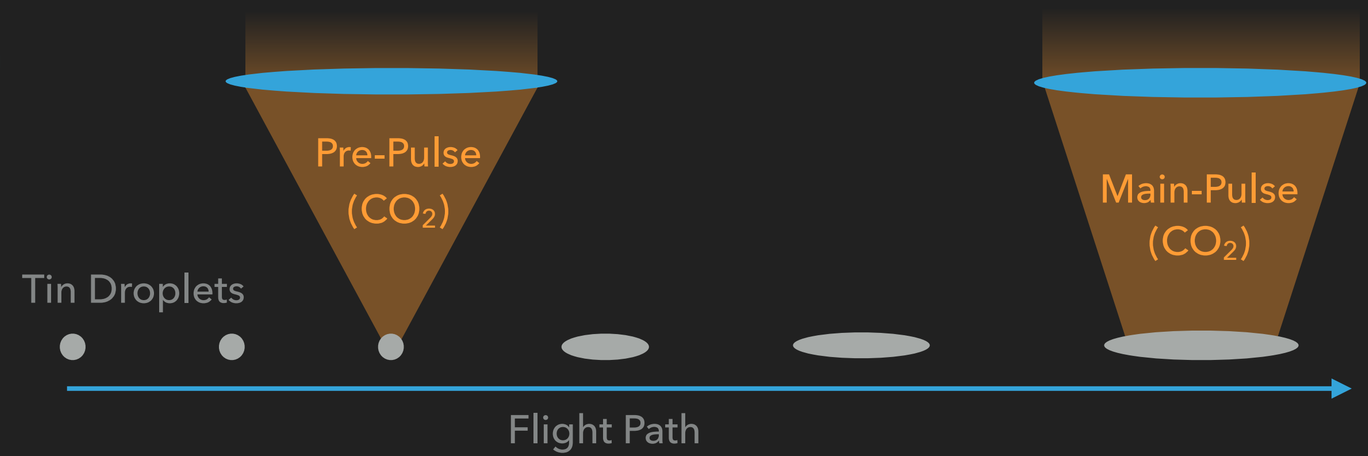




Vivek Singh (NVIDIA): "Accelerating Computational Lithography" (GTC Spring 2023)

THE EUV LIGHT SOURCE

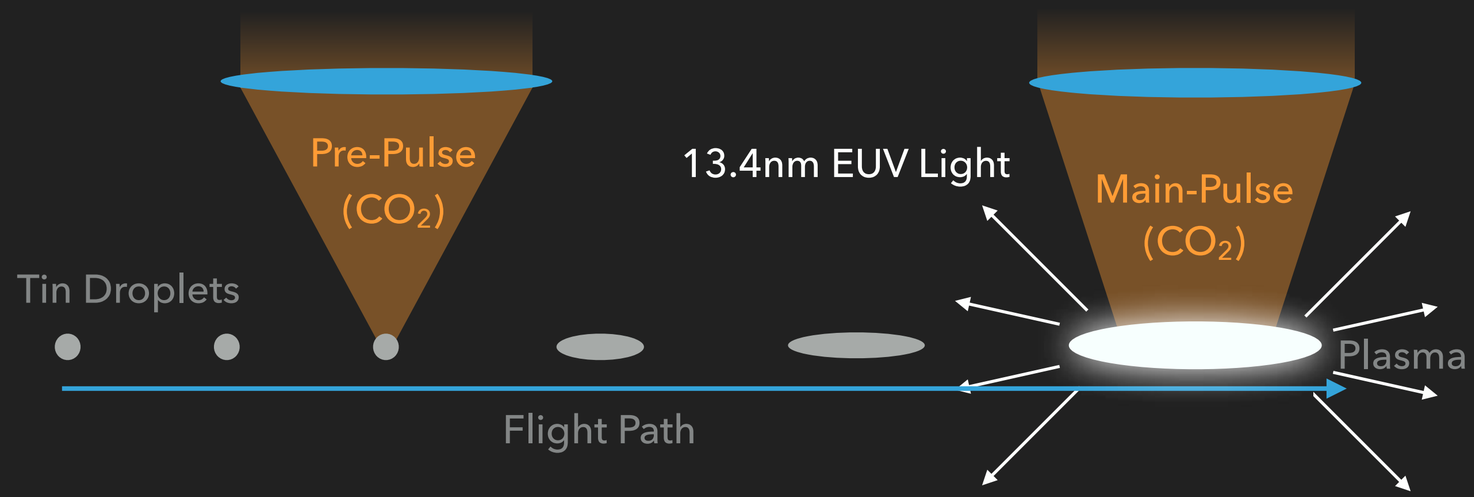
- Droplet Size: 27 µm
- Droplet Frequency: 50kHz
- Droplet Speed: 280km/h
- Droplet Distance: 1.6mm
- CO2 Drive Laser Power: 30kW



SemiSlides: "ASML EUV Light Source" (https://www.youtube.com/watch?v=LnsuCp1xt3w)

THE EUV LIGHT SOURCE

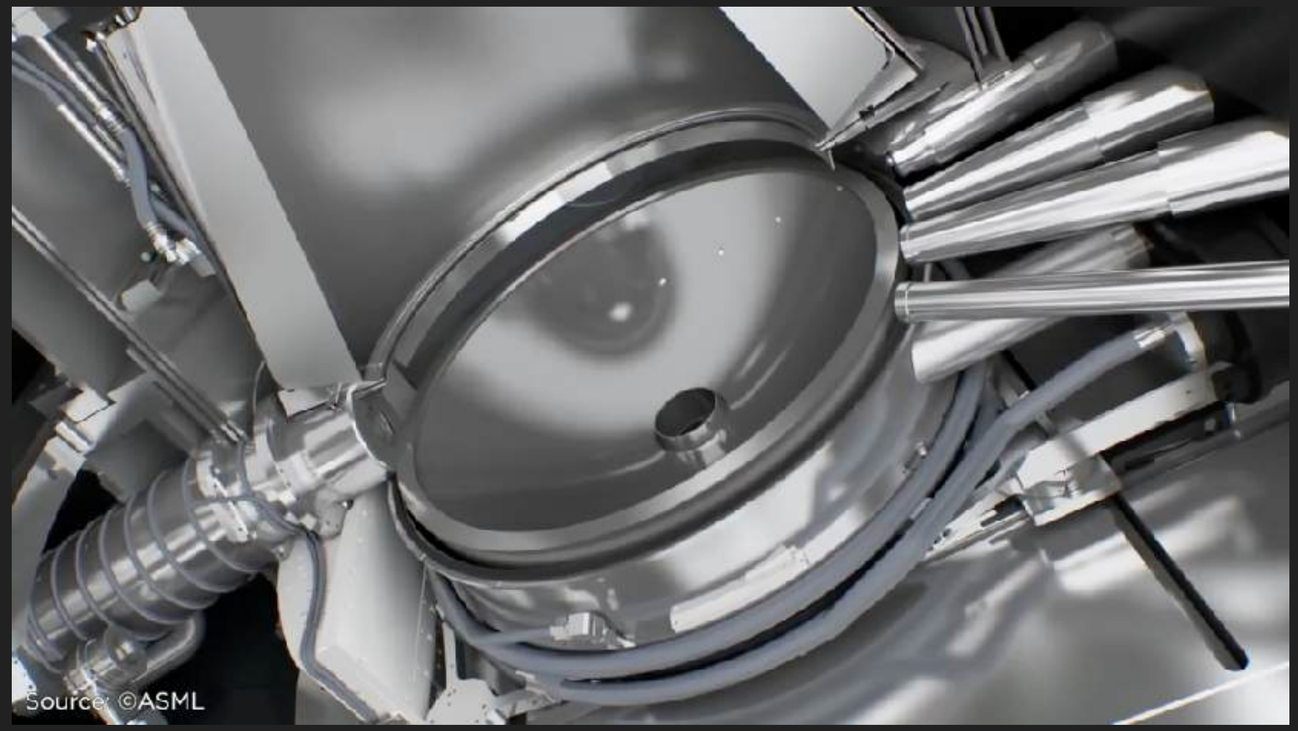
- Droplet Size: 27 µm
- Droplet Frequency: 50kHz
- Droplet Speed: 280km/h
- Droplet Distance: 1.6mm
- CO2 Drive Laser Power: 30kW
- Plasma Temperature: 220k K
- EUV Wavelength: 13.4nm



SemiSlides: "ASML EUV Light Source" (https://www.youtube.com/watch?v=LnsuCp1xt3w)

THE EUV LIGHT SOURCE

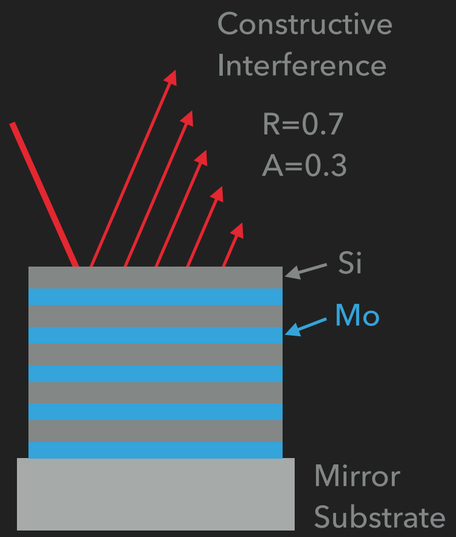
- Droplet Size: 27 µm
- Droplet Frequency: 50kHz
- Droplet Speed: 280km/h
- Droplet Distance: 1.6mm
- CO2 Drive Laser Power: 30kW
- Plasma Temperature: 220k K
- EUV Wavelength: 13.4nm

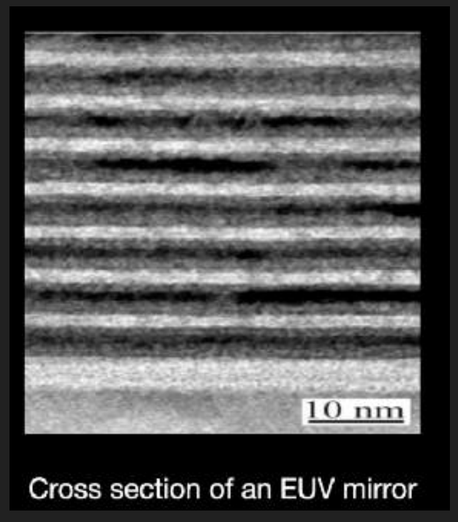


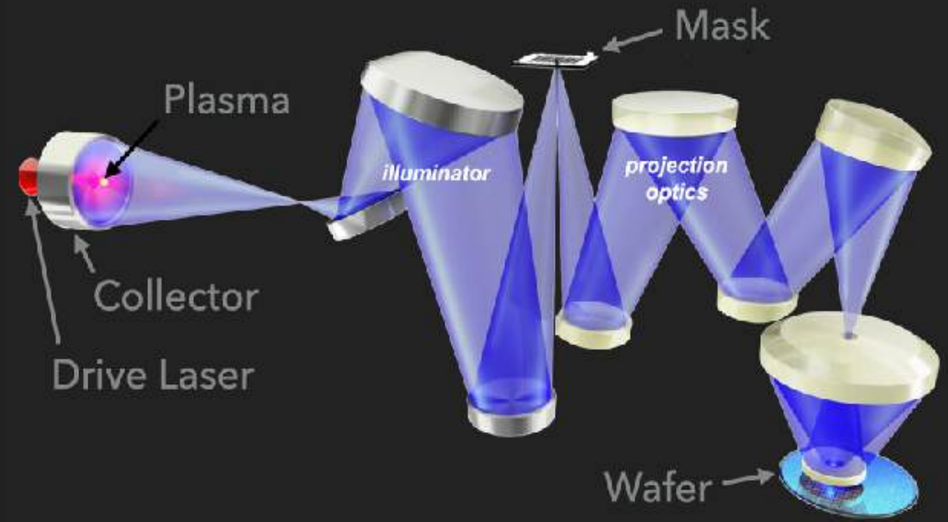
SemiSlides: "ASML EUV Light Source" (https://www.youtube.com/watch?v=LnsuCp1xt3w)

EUV MIRRORS BY ZEISS

- EUV gets absorbed by matter
- Lenses => Bragg Mirrors
- Single atom layer deposition



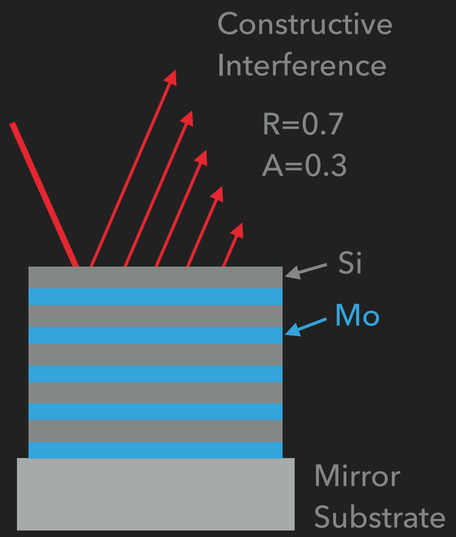


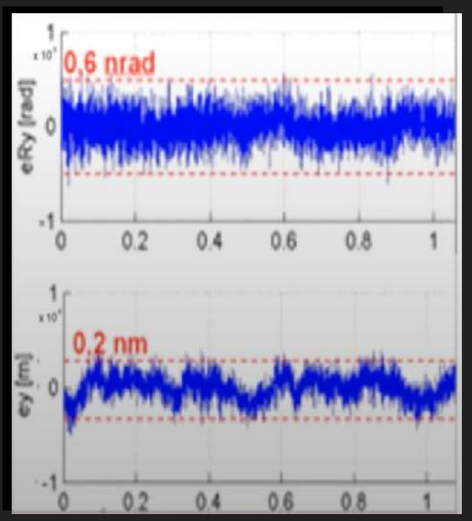


ZEISS Group, "How Extreme Ultraviolet Lithography works III" (https://www.youtube.com/watch?v=_JCAmQXpdDs&t=8s)
ZEISS Group: "High NA EUV optics preparing lithography for the next big step"

EUV MIRRORS BY ZEISS

- EUV gets absorbed by matter
- Lenses => Bragg Mirrors
- Single atom layer deposition
- Position control < 1nm

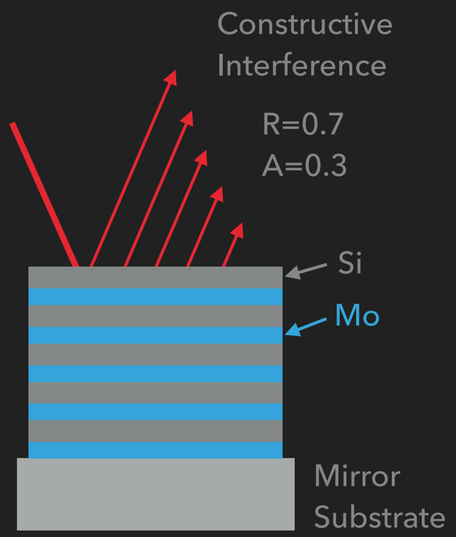


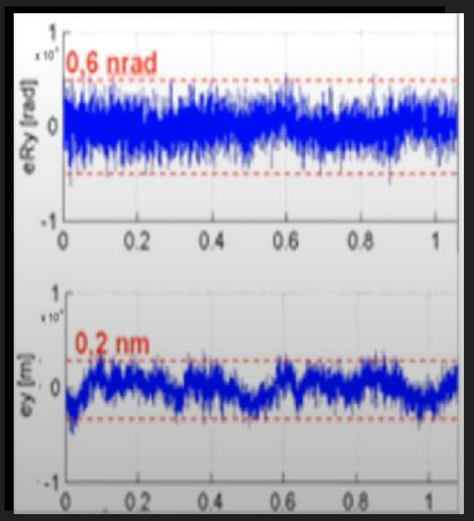


ZEISS Group, "How Extreme Ultraviolet Lithography works III" (https://www.youtube.com/watch?v=_JCAmQXpdDs&t=8s)
ZEISS Group: "High NA EUV optics preparing lithography for the next big step"

EUV MIRRORS BY ZEISS

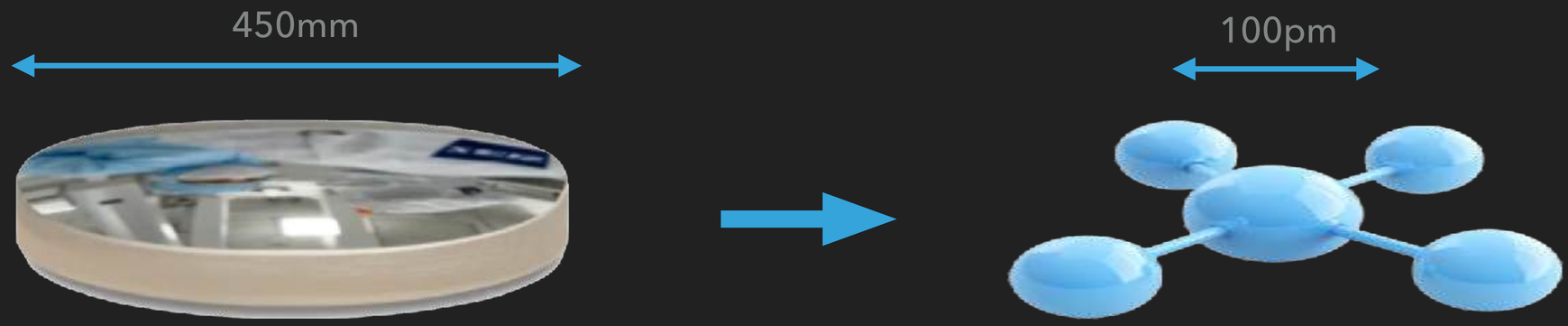
- EUV gets absorbed by matter
- Lenses => Bragg Mirrors
- Single atom layer deposition
- Position control < 1nm





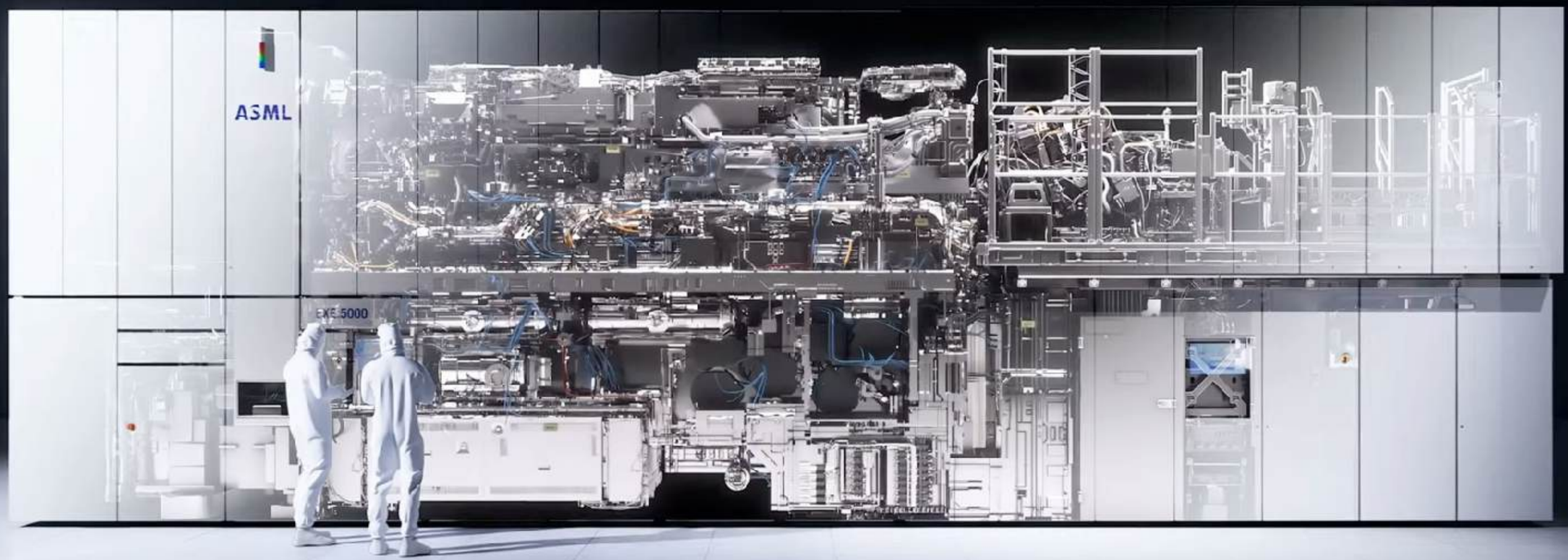
ZEISS Group, "How Extreme Ultraviolet Lithography works III" (https://www.youtube.com/watch?v=_JCAmQXpdDs&t=8s)
ZEISS Group: "High NA EUV optics preparing lithography for the next big step"

EUV MIRRORS – 100PM ACCEPTABLE SURFACE DEVIATION



ASML TWINSCAN EXE:5000 - HIGH NUMERICAL APERTURE EUV

PRICE: $350M



ASML, "Unveiling High NA EUV" (https://www.youtube.com/watch?v=h_zgURwr6nA)

ASML

- Founded by Philipps in 1984
- Today worth $400B

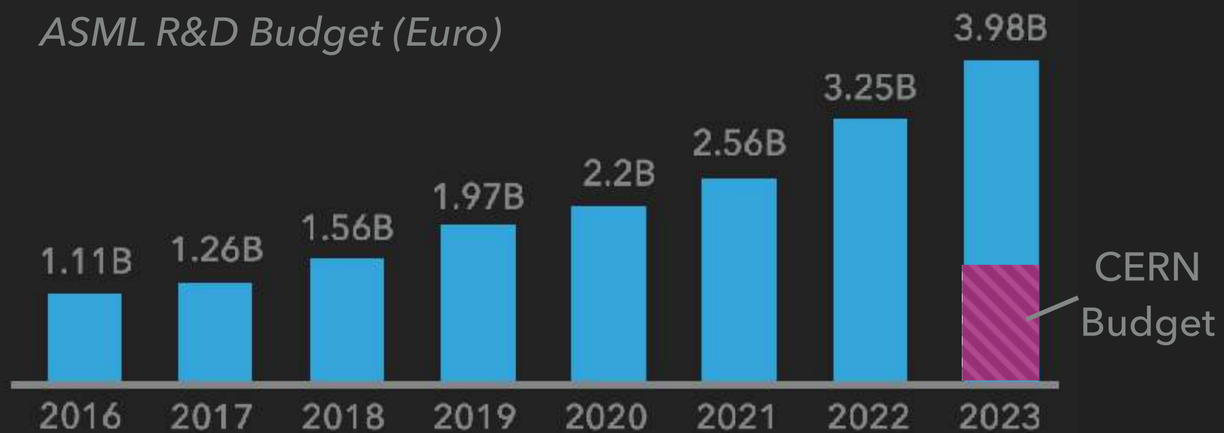
ASML headquarter in 1984

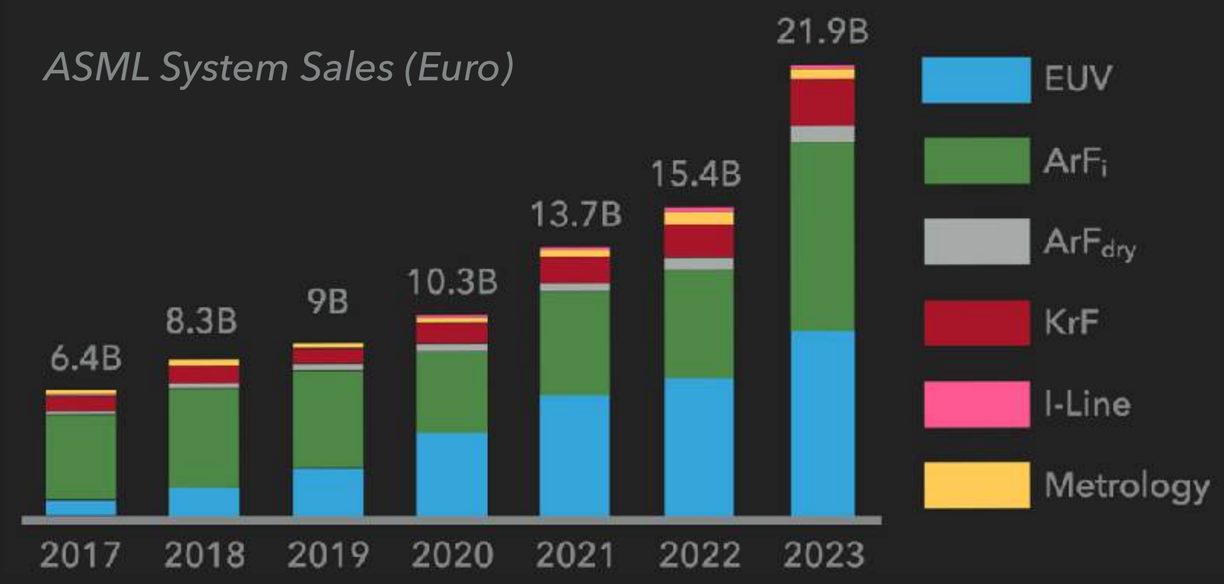
ASML headquarter in 2024

https://www.asml.com
statista.com

ASML

- Founded by Philipps in 1984
- Today worth $400B

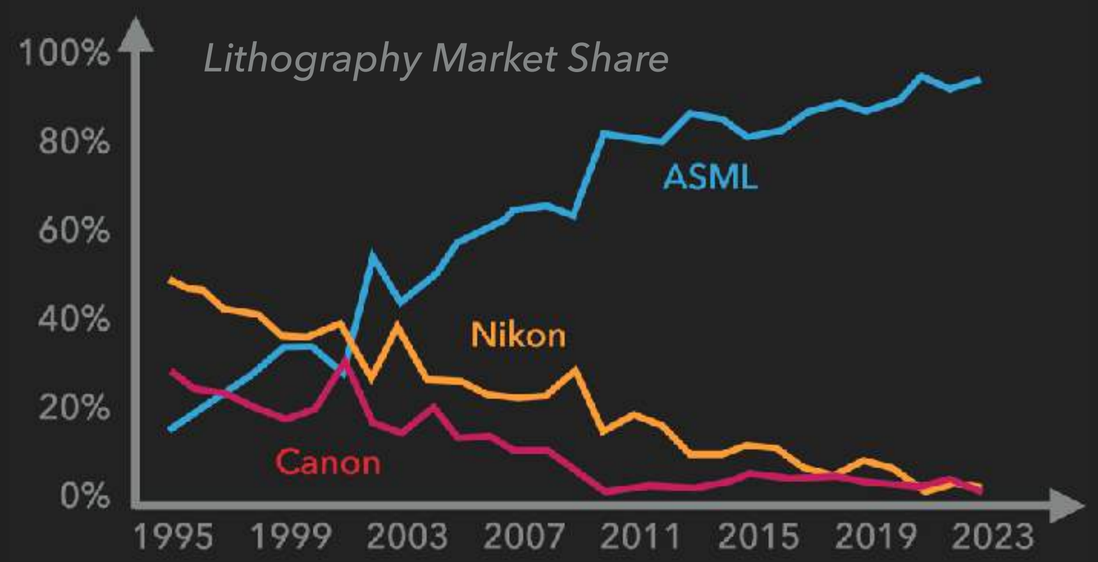




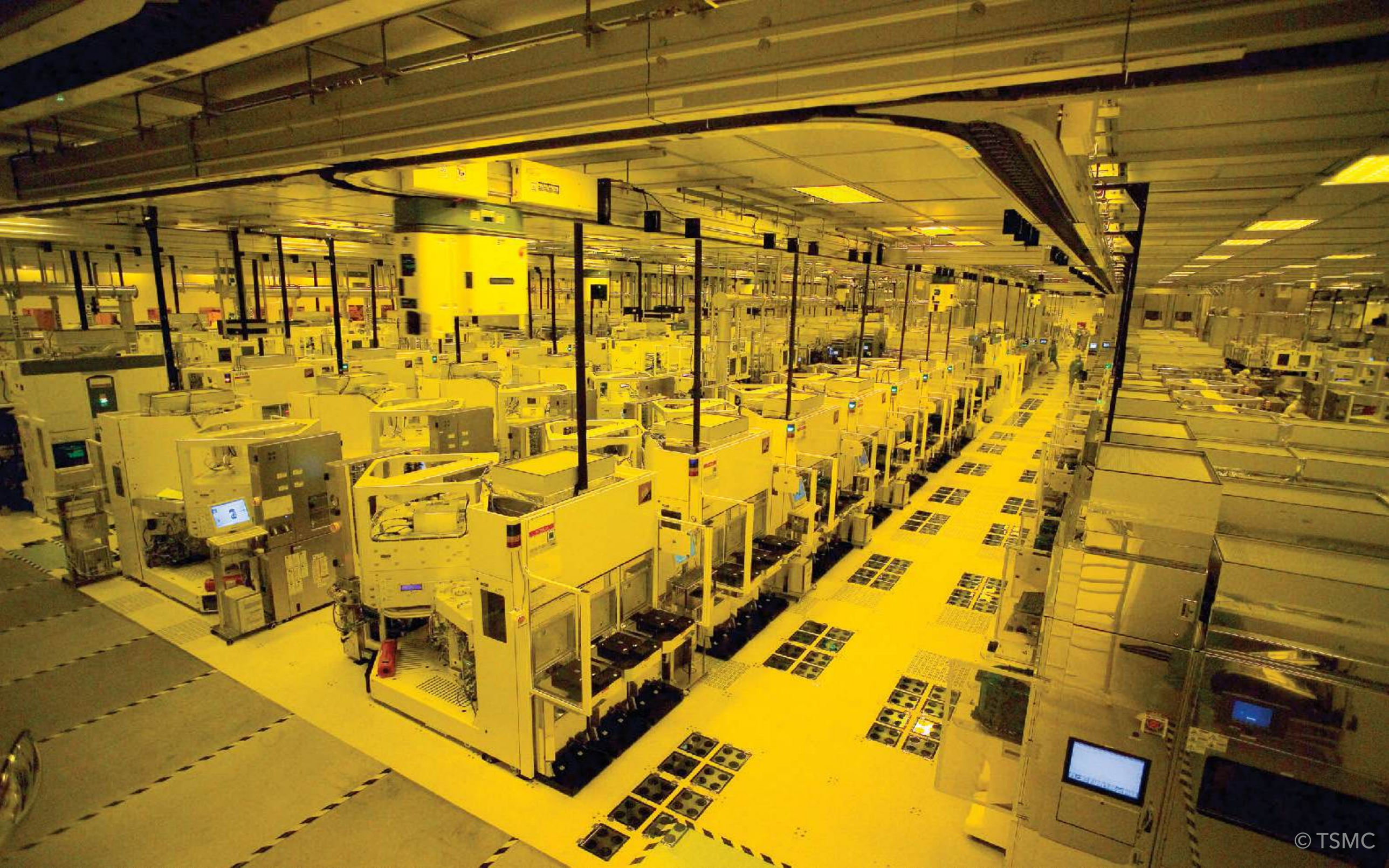
https://www.asml.com
statista.com

ASML

- Founded by Philipps in 1984
- Today worth $400B
- Lithography market share ≈ 90%
- Single source for EUV technology



https://www.asml.com
statista.com


© TSMC

TSMC

FAB 21, Arizona, USA

https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before

TSMC – GIGAFABS™

- FAB Cost: $20B
- FAB Power Consumption: 1GW
- FAB Water Consumption: 8M l/day
- FAB Output: 120k Wafer per month

FAB 20, Hsinchu, Taiwan

FAB 18, Tainan, Taiwan

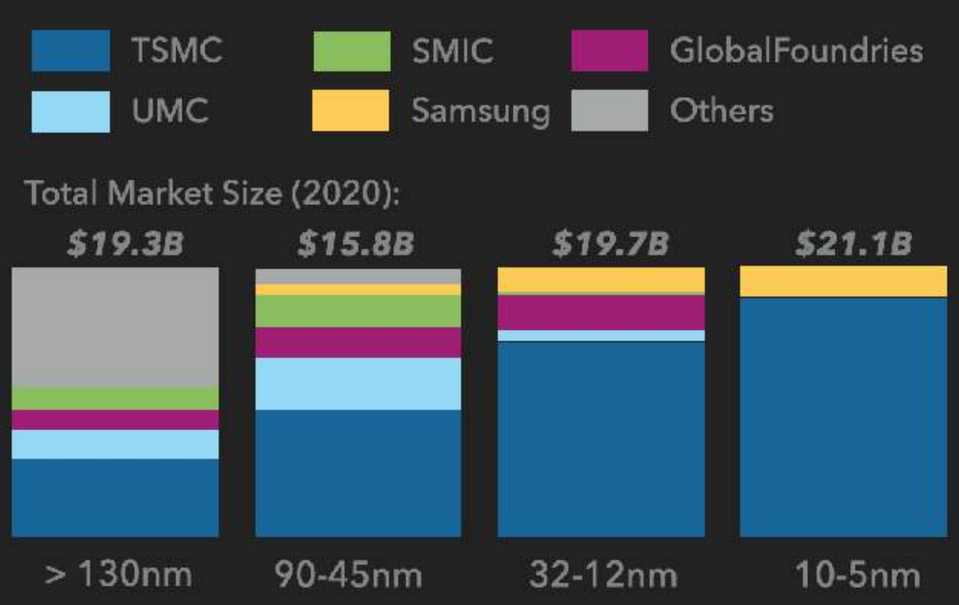
FAB 14, Tainan, Taiwan

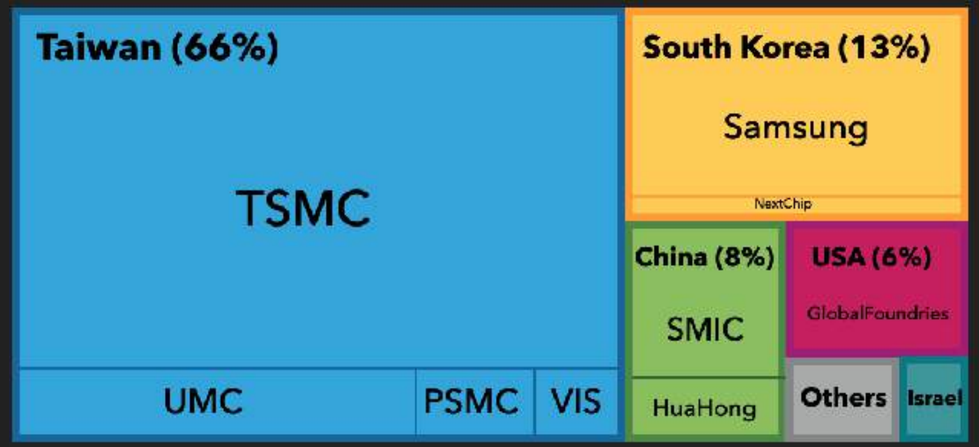
https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before

TSMC – DOMINATING GLOBAL CHIP SUPPLY

- 60% market share of all chips
- 92% market share of advanced chips
- Capital Expenditure ≈ $30B / year
- R&D budget ≈ $6B / year

FAB 20, Hsinchu, Taiwan

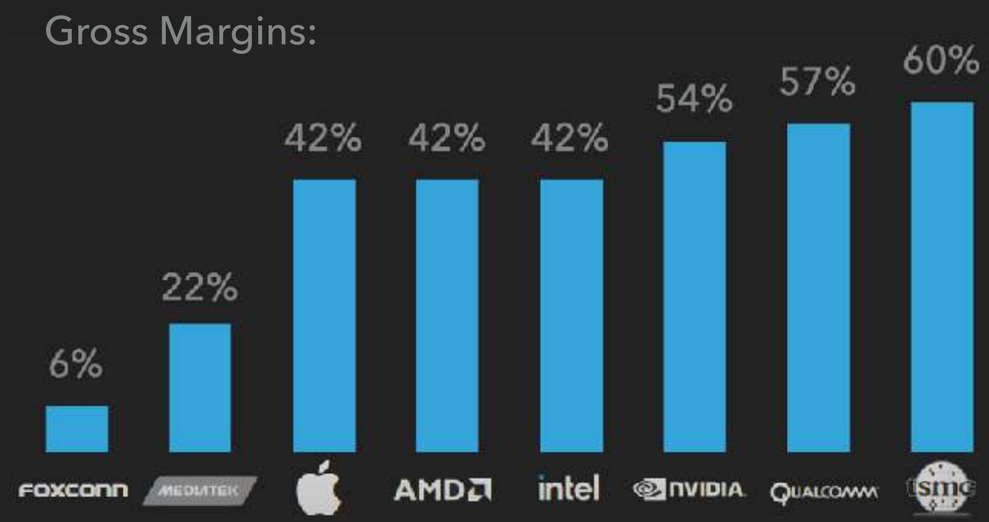


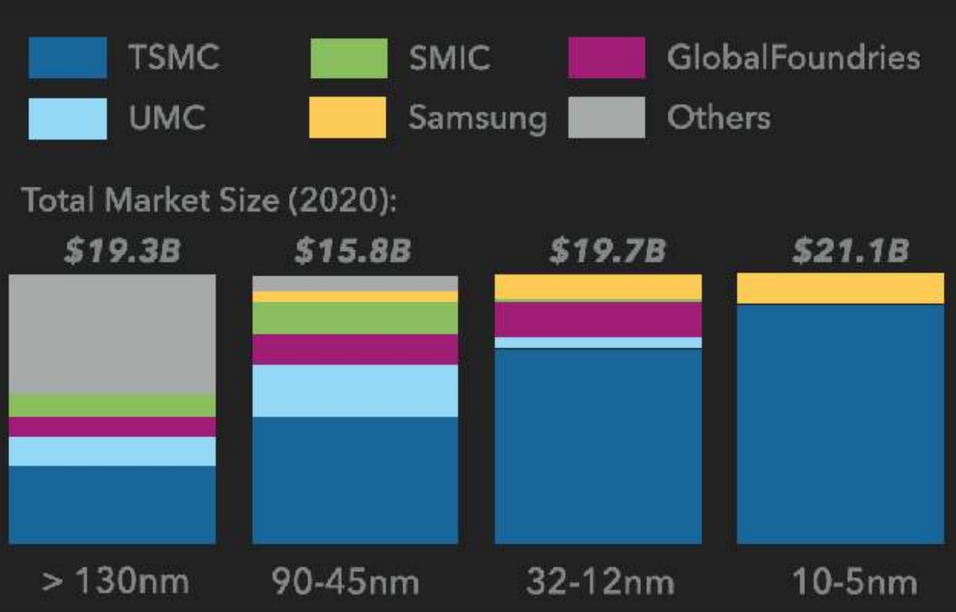


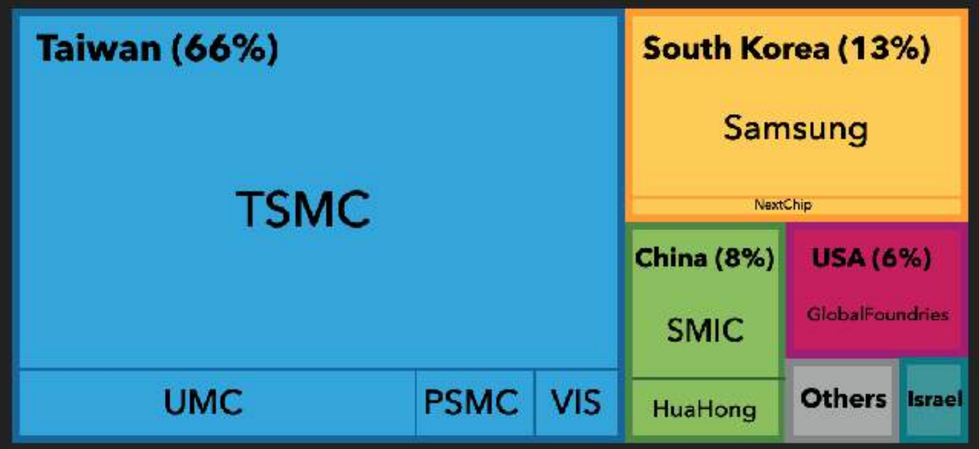
https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before
Bain/IC Insights/Gartner
Azeem Azhar, Bloomberg
TechAltar, "The fight for TSMC is heating up" (https://www.youtube.com/watch?v=qmn46KrzIJ0)
https://thenewglobalorder.com/world-news/the-disillusion-of-the-silicon-shield-myth/

TSMC – DOMINATING GLOBAL CHIP SUPPLY

- 60% market share of all chips
- 92% market share of advanced chips
- Capital Expenditure ≈ $30B / year
- R&D budget ≈ $6B / year



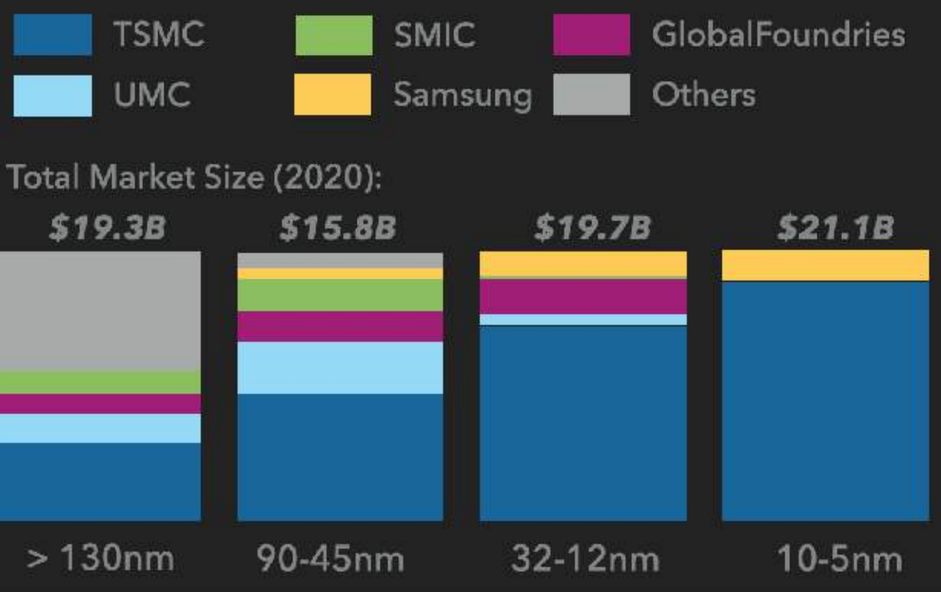


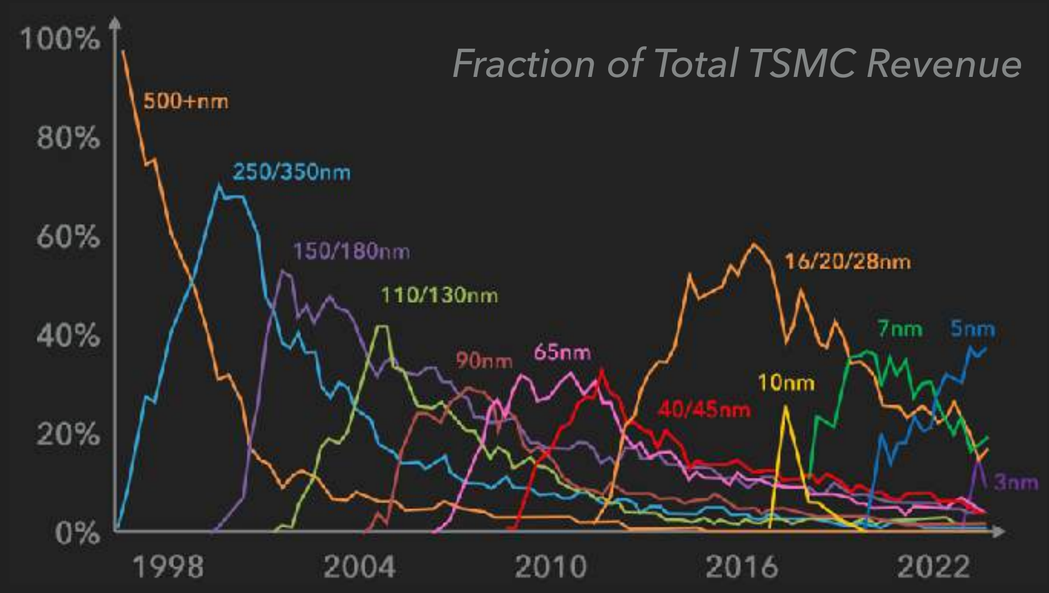


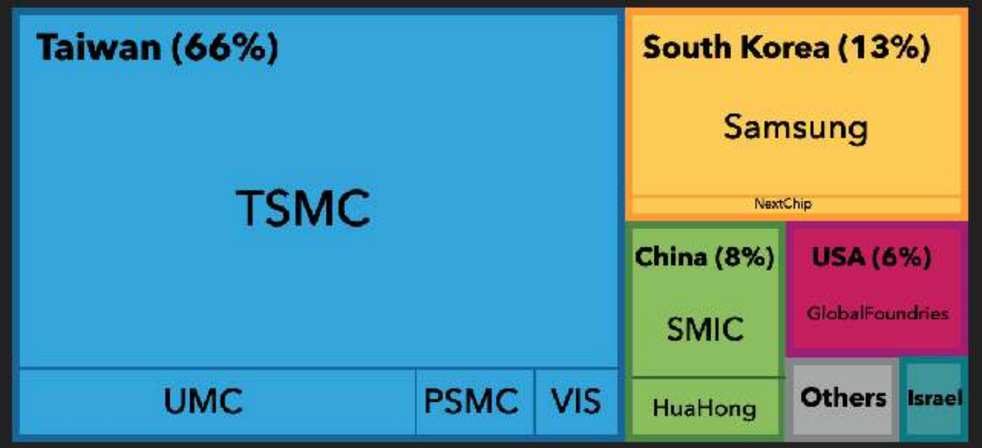
https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before
Bain/IC Insights/Gartner
Azeem Azhar, Bloomberg
TechAltar, "The fight for TSMC is heating up" (https://www.youtube.com/watch?v=qmn46KrztJ0)
https://thenewglobalorder.com/world-news/the-disillusion-of-the-silicon-shield-myth/

TSMC – DOMINATING GLOBAL CHIP SUPPLY

- 60% market share of all chips
- 92% market share of advanced chips
- Capital Expenditure ≈ $30B / year
- R&D budget ≈ $6B / year



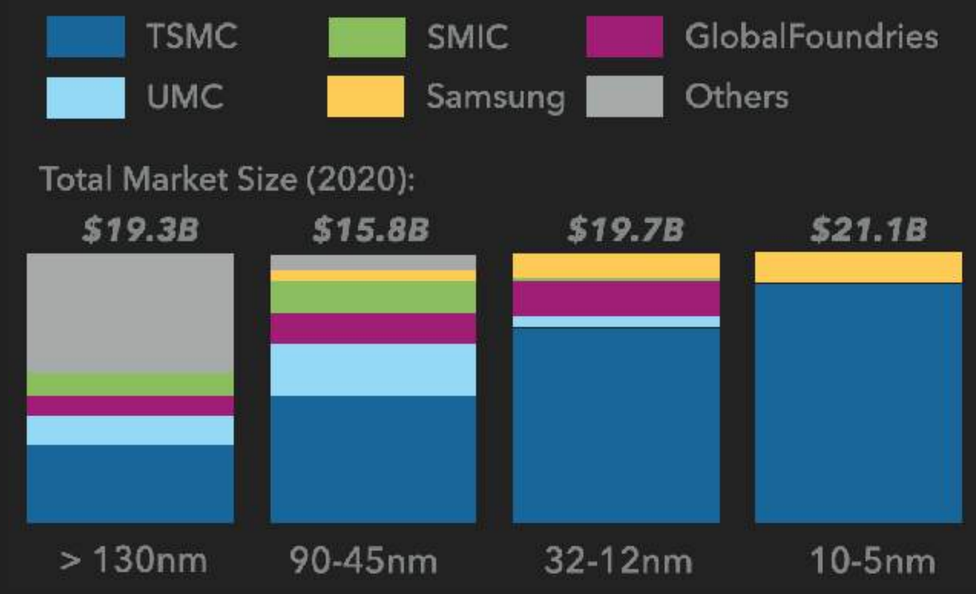


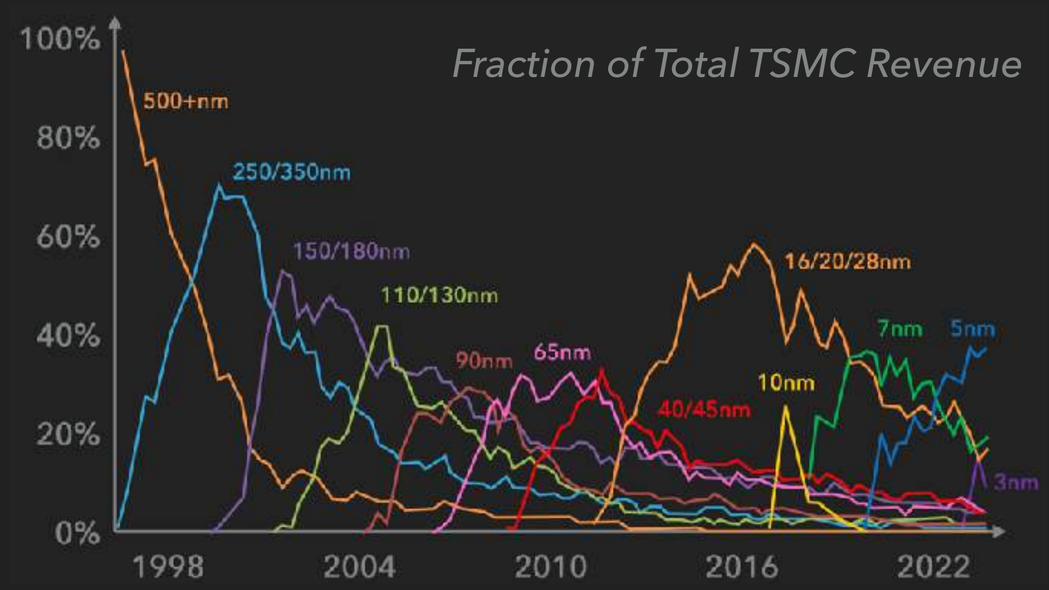


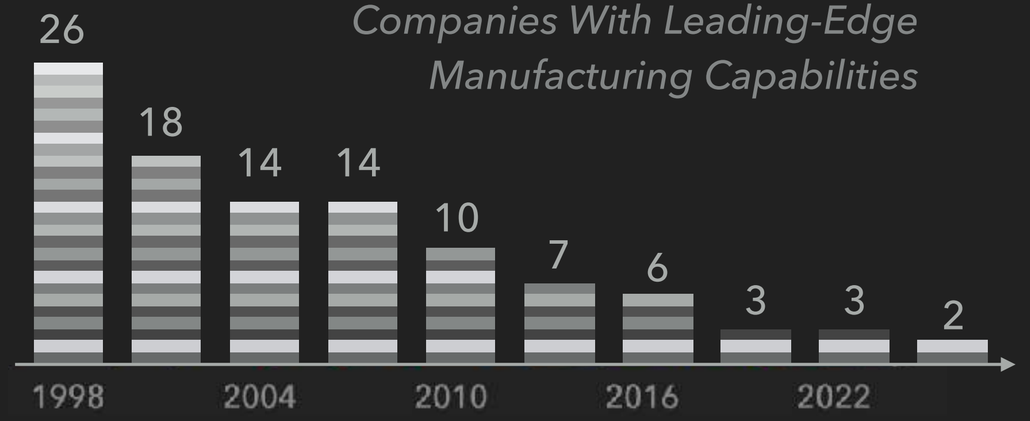
https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before
Bain/IC Insights/Gartner
Azeem Azhar, Bloomberg
TechAltar, "The fight for TSMC is heating up" (https://www.youtube.com/watch?v=qmn66KrzJ0)
https://thenewglobalorder.com/world-news/the-disillusion-of-the-silicon-shield-myth/

TSMC – DOMINATING GLOBAL CHIP SUPPLY

- 60% market share of all chips
- 92% market share of advanced chips
- Capital Expenditure ≈ $30B / year
- R&D budget ≈ $6B / year



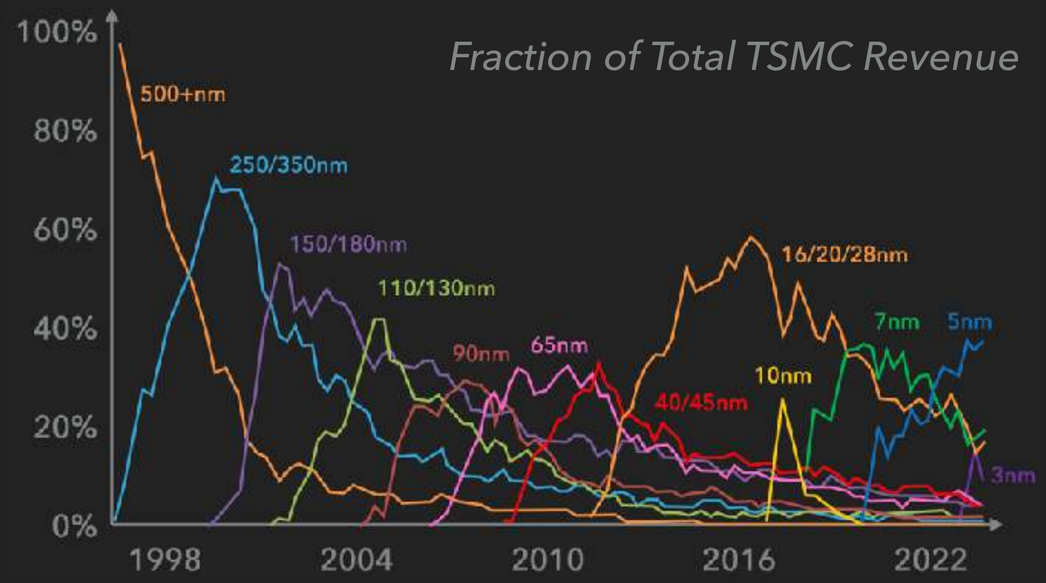


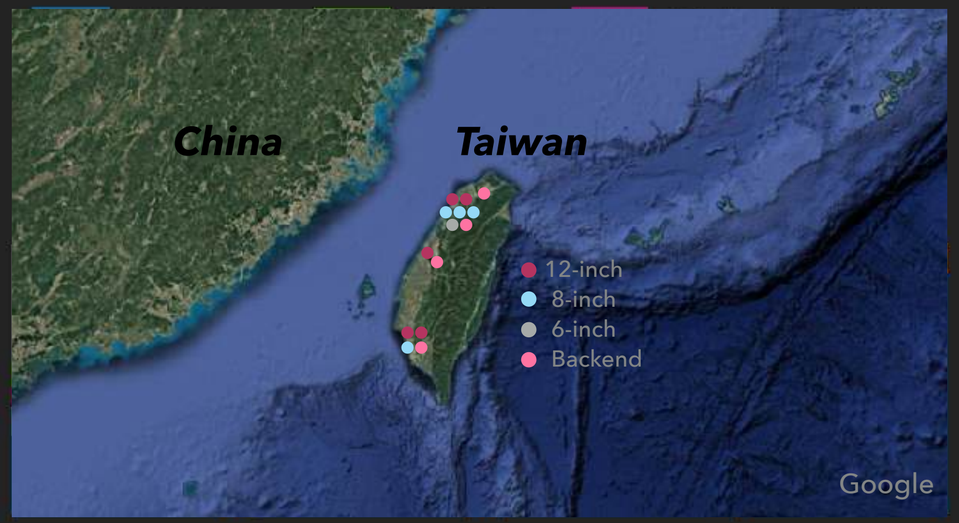


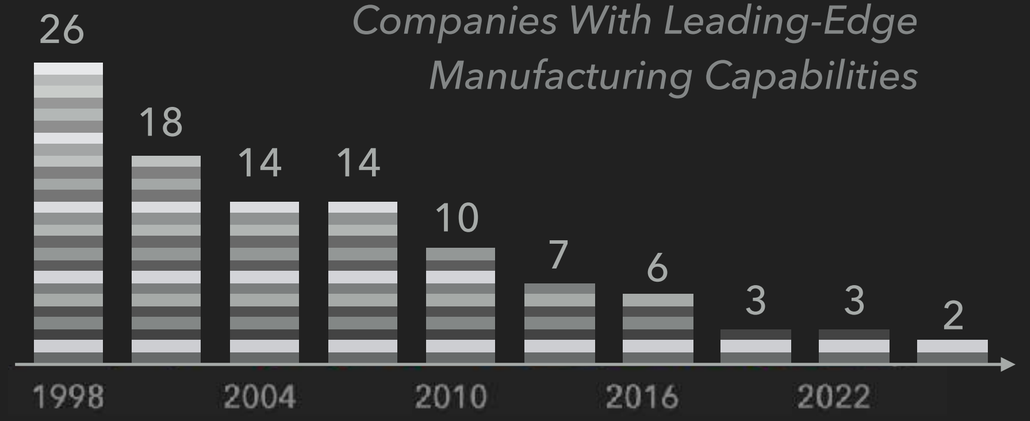
https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before
Bain/IC Insights/Gartner
Azeem Azhar, Bloomberg
TechAltar, "The fight for TSMC is heating up" (https://www.youtube.com/watch?v=qmn46fKrzJ0)
https://thenewglobalorder.com/world-news/the-disillusion-of-the-silicon-shield-myth/

TSMC – DOMINATING GLOBAL CHIP SUPPLY

- 60% market share of all chips
- 92% market share of advanced chips
- Capital Expenditure ≈ $30B / year
- R&D budget ≈ $6B / year

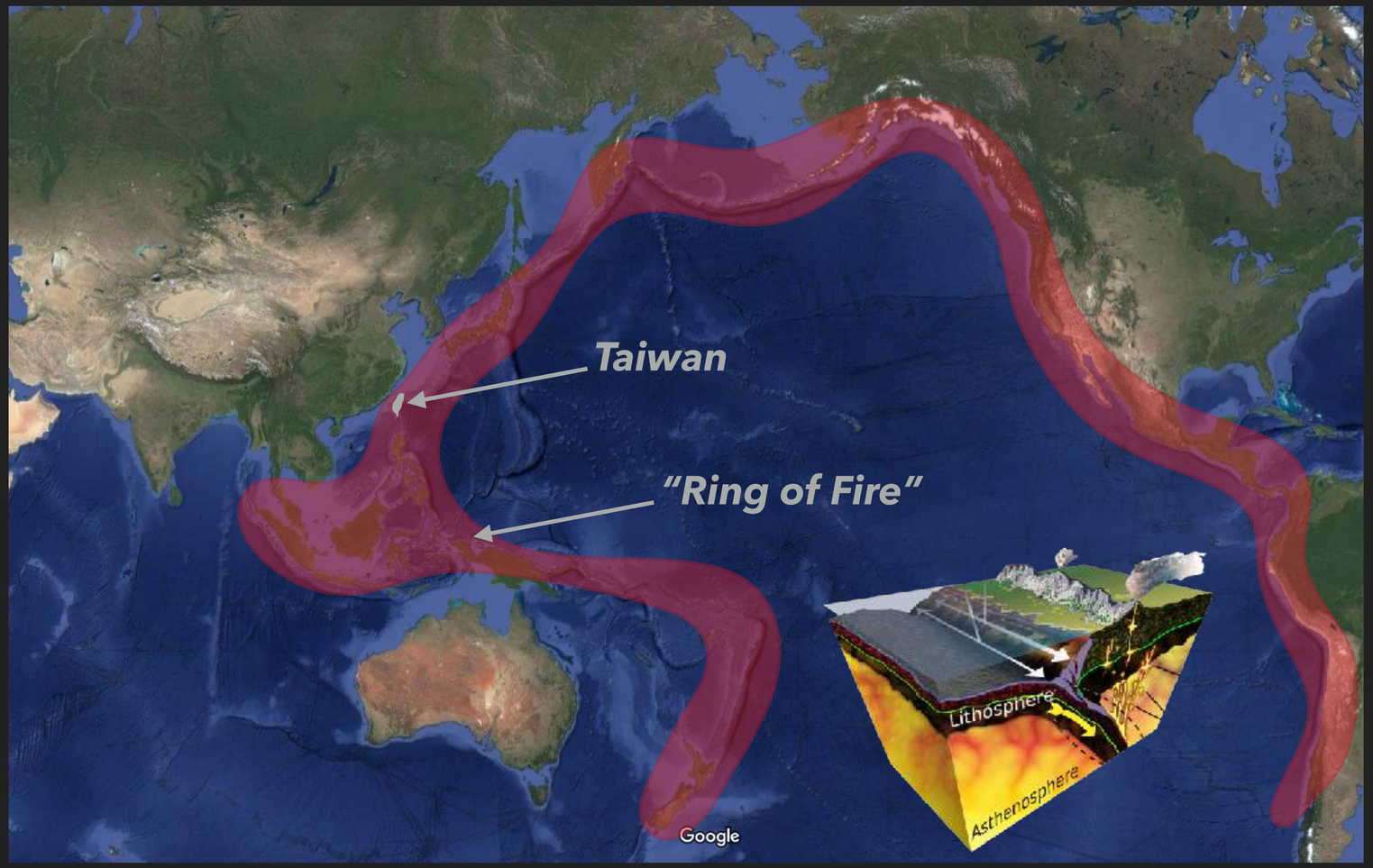


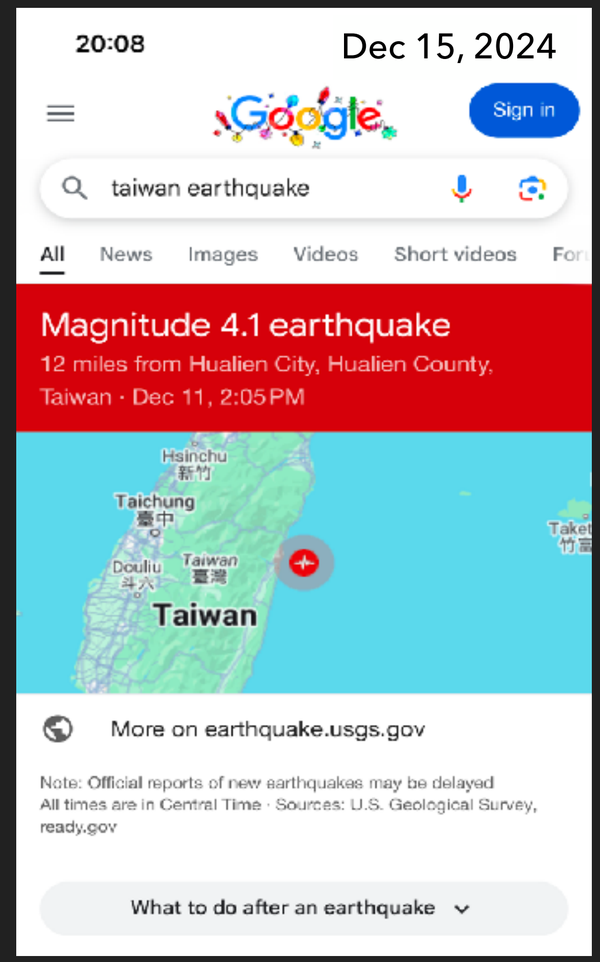




https://www.nextplatform.com/2023/10/25/tsmc-makes-the-best-of-a-tough-chip-situation/
https://www.acquired.fm/episodes/tsmc
https://clausaasholm.substack.com/p/the-state-of-the-foundry-market-before
Bain/IC Insights/Gartner
Azeem Azhar. Bloomberg
TechAltar. "The fight for TSMC is heating up" (https://www.youtube.com/watch?v=qmn46KrzJ0)
https://thenewglobalorder.com/world-news/the-disillusion-of-the-silicon-shield-myth/

THE CHIHSHANG FAULT





https://asia.nikkei.com/Business/Technology/Taiwan-quake-highlights-risks-and-readiness-of-Asia-s-chip-sector
https://en.wikipedia.org/wiki/Ring_of_Fire
The Times (https://www.youtube.com/watch?v=JhtJMBihySA)
https://www.newsflare.com/video/636926/motorcyclists-sway-as-bridge-shakes-violently-during-taiwan-earthquake

THE CHIHSHANG FAULT

3. April 2024 - 7.2 earthquake

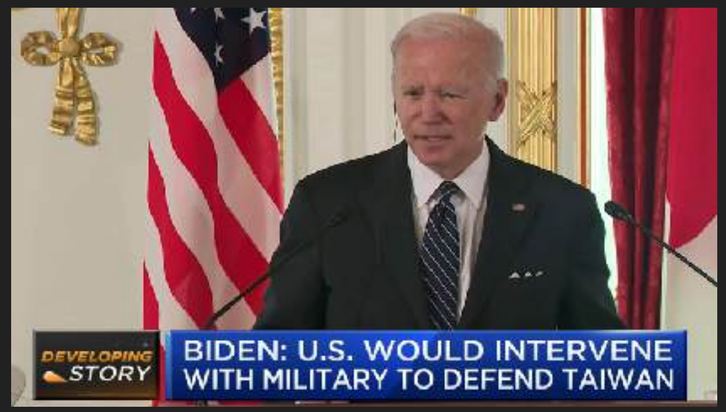
https://asia.nikkei.com/Business/Technology/Taiwan-quake-highlights-risks-and-readiness-of-Asia-s-chip-sector
https://en.wikipedia.org/wiki/Ring_of_Fire
The Times (https://www.youtube.com/watch?v=JhtJMBihySA)
https://www.newsflare.com/video/636926/motorcyclists-sway-as-bridge-shakes-violently-during-taiwan-earthquake

PIECE IN THE TAIWAN STRAIGHT

Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQlTXlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

“TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT.”

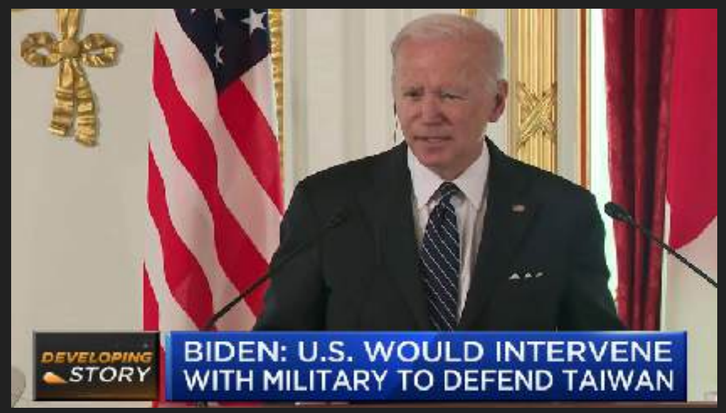
CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)

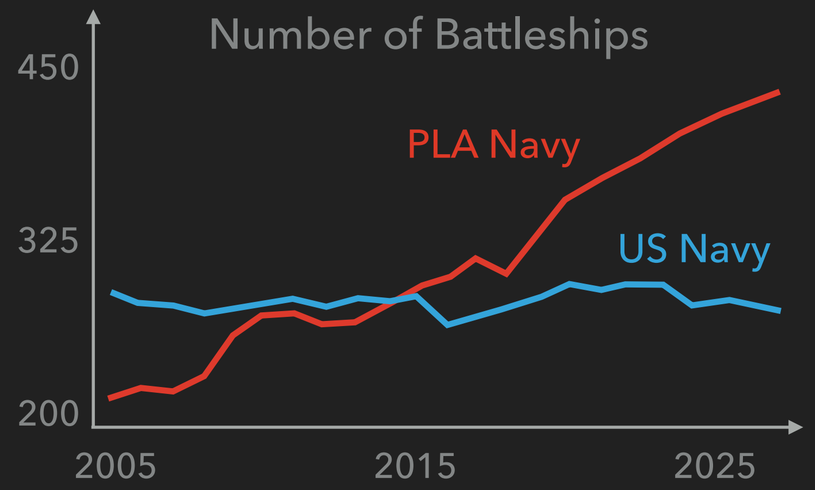


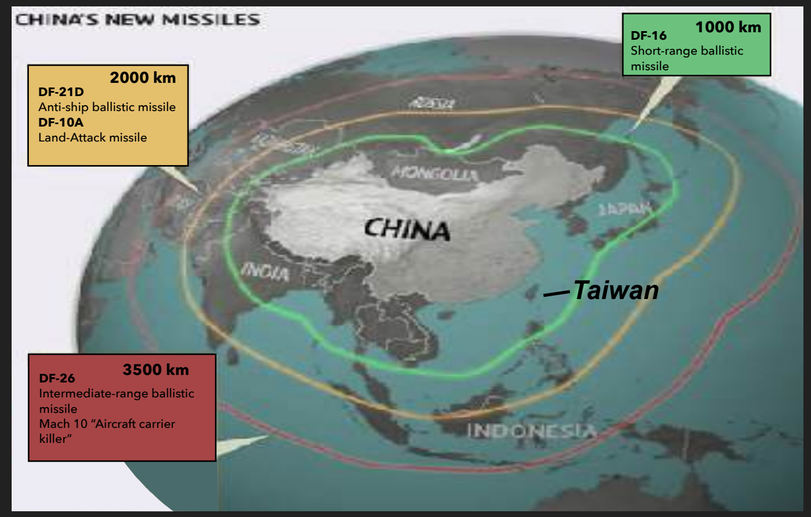
Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

"TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT."

CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)



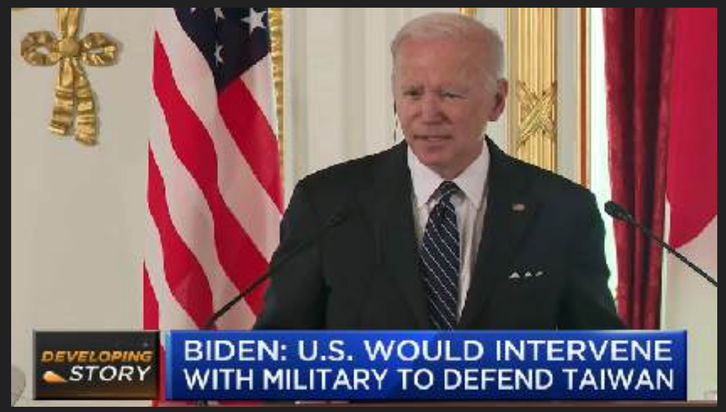


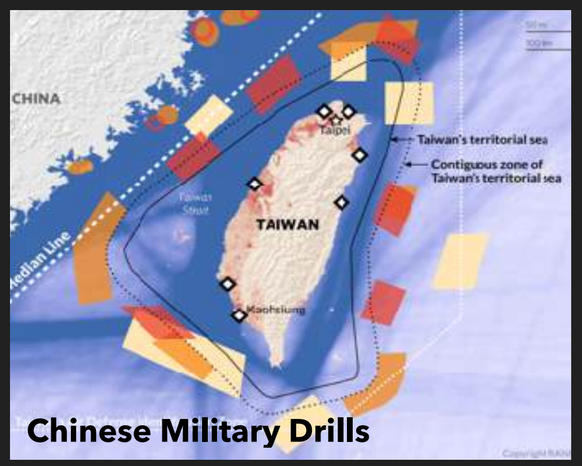


Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

“TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT.”

CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)



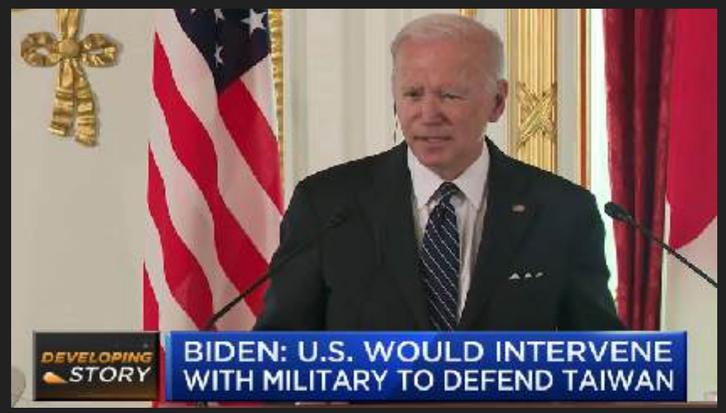


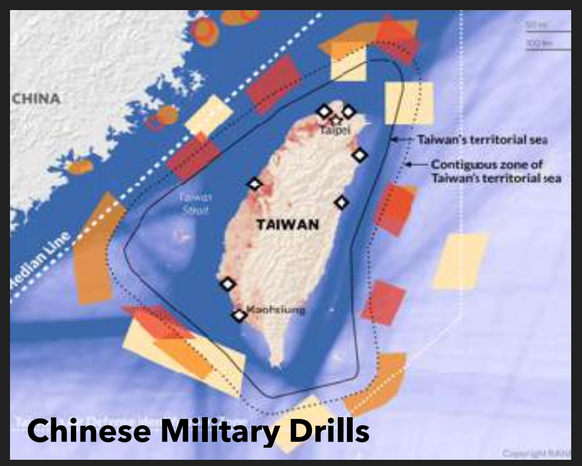
Oct ‘24 | May ‘24 | Aug ‘22

Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

“TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT.”

CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)



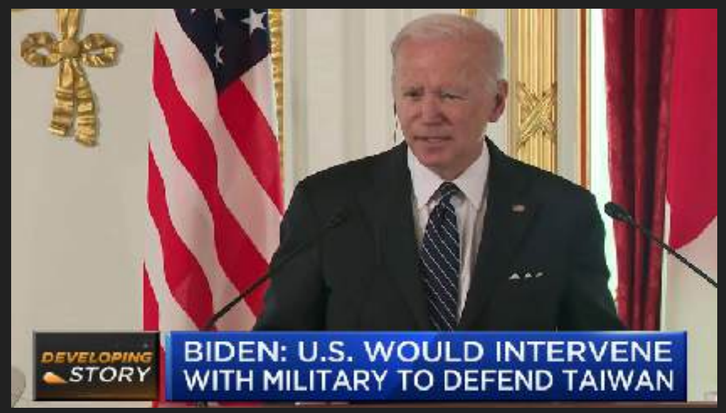


Oct ‘24 | May ‘24 | Aug ‘22

Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

“TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT.”

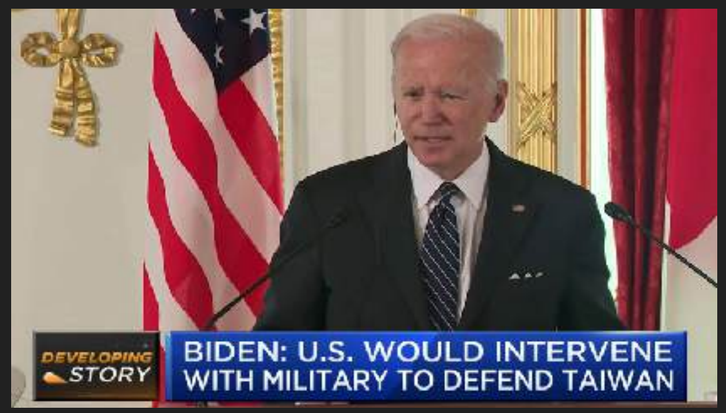
CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)

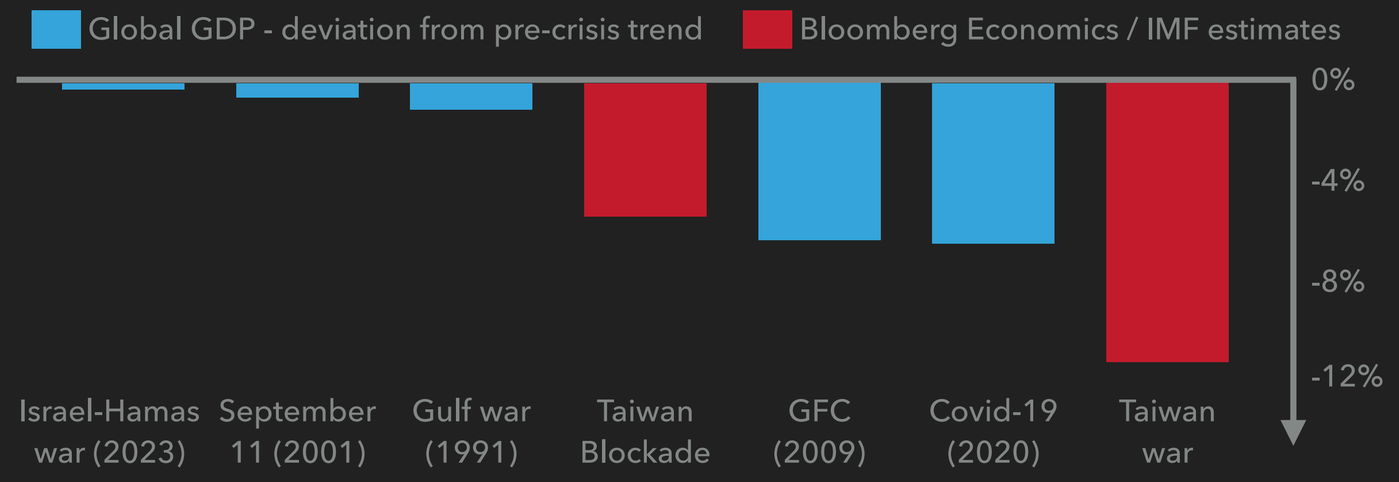


Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

"TAIWAN INDEPENDENCE IS INCOMPATIBLE WITH PEACE IN THE TAIWAN STRAIGHT."

CHINA MINISTRY OF FOREIGN AFFAIRS (OCT '24)





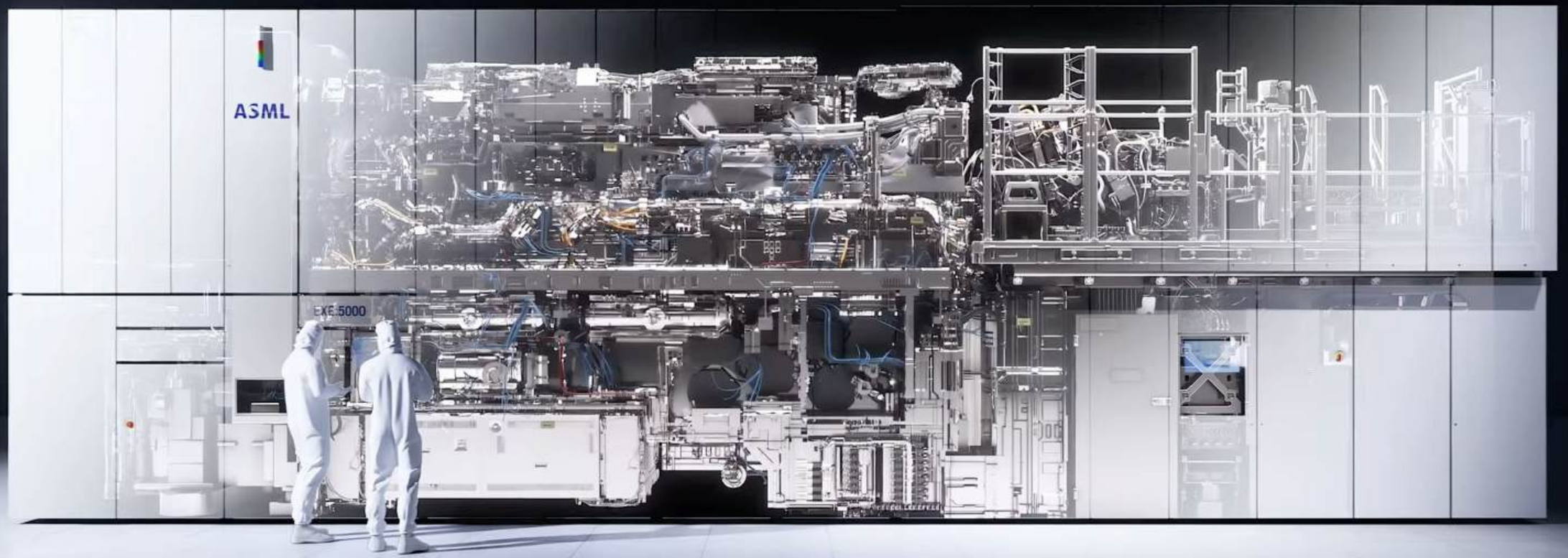
Chris Miller: "Chip War: The Fight for the World's Most Critical Technology"
https://thesoundingline.com/chart-chinese-navy-vs-us-navy/
TVP World, "The secret behind China's military rise" (https://www.youtube.com/watch?v=QQl1XlJkRzk)
https://worldview.stratfor.com/article/chinese-drills-around-taiwan-practice-blockade-even-if-one-isnt-imminent
https://thaimilitaryandasianregion.wordpress.com/2016/02/10/df-21d-medium-range-ballistic-missile/
https://www.bloomberg.com/news/newsletters/2024-01-09/economy-risks-latest-taiwan-war-would-cost-world-10-trillion

“ANY SUFFICIENTLY ADVANCED TECHNOLOGY IS INDISTINGUISHABLE FROM MAGIC”
ARTHUR C. CLARKE

ASML

“ANY SUFFICIENTLY ADVANCED TECHNOLOGY IS INDISTINGUISHABLE FROM MAGIC”
ARTHUR C. CLARKE

THANKS FOR YOUR ATTENTION



SPECIAL THANKS TO:

Asianometry: https://www.youtube.com/asianometry

Semislides: https://www.youtube.com/@SemiSlides

Chris Miller: "Chip War: The Fight for the World's Most Critical Technology”

Contact: thellert@lbl.gov