

Integrating Photonics into Semiconductor Industry

Dr. Ivan Nikitski, EPIC – European Photonics Industry Consortium

European Photonics Industry Consortium



TECHNOLOGY



MARKET REPORTS



NETWORKING



**ACCESS TO
MARKETS**



MENTORSHIP



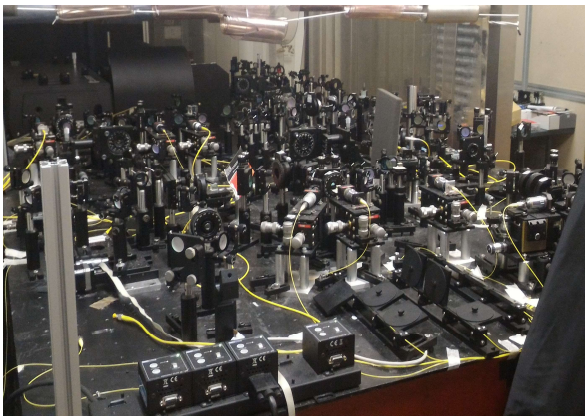
HR SUPPORT



INVESTMENT



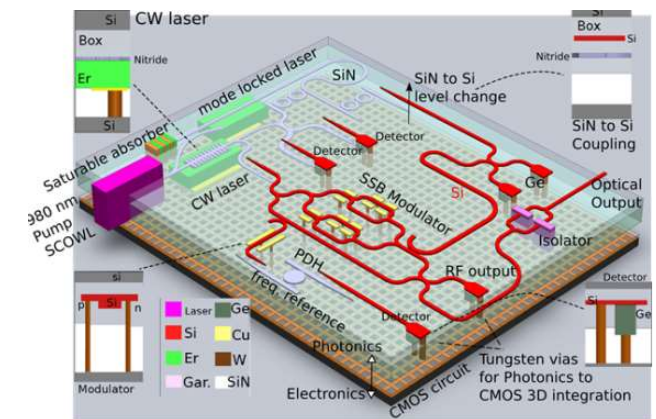
Different forms of photonics



Free space photonics
technology



Fiber photonics
technology

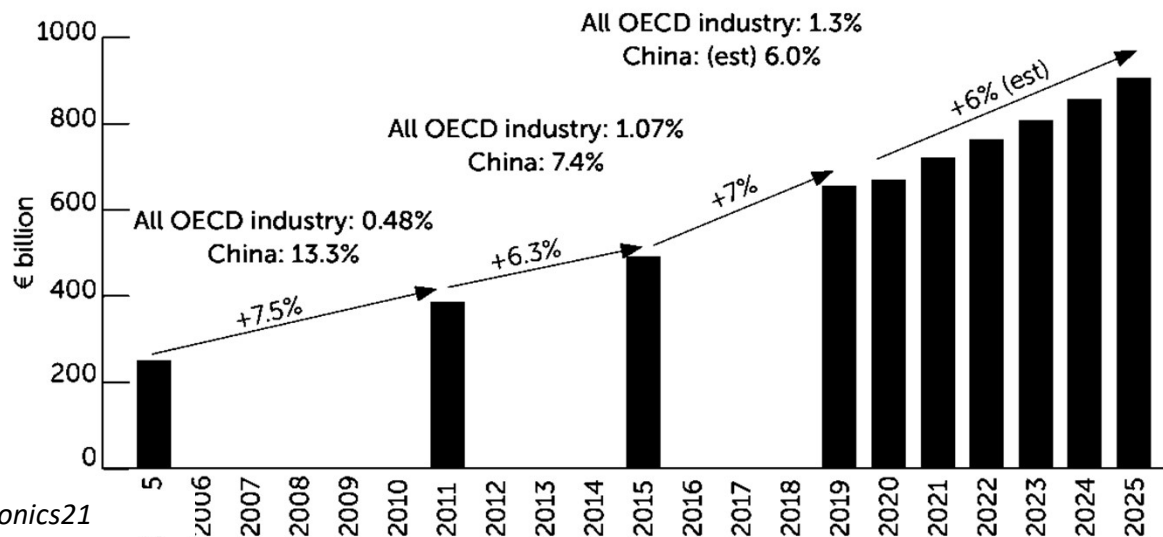


Integrated photonics
technology

Photonics worldwide

- The global photonics market accounted for €400 billion in 2015 and is expected to reach €900 billion in 2025.

Photonics worldwide market size

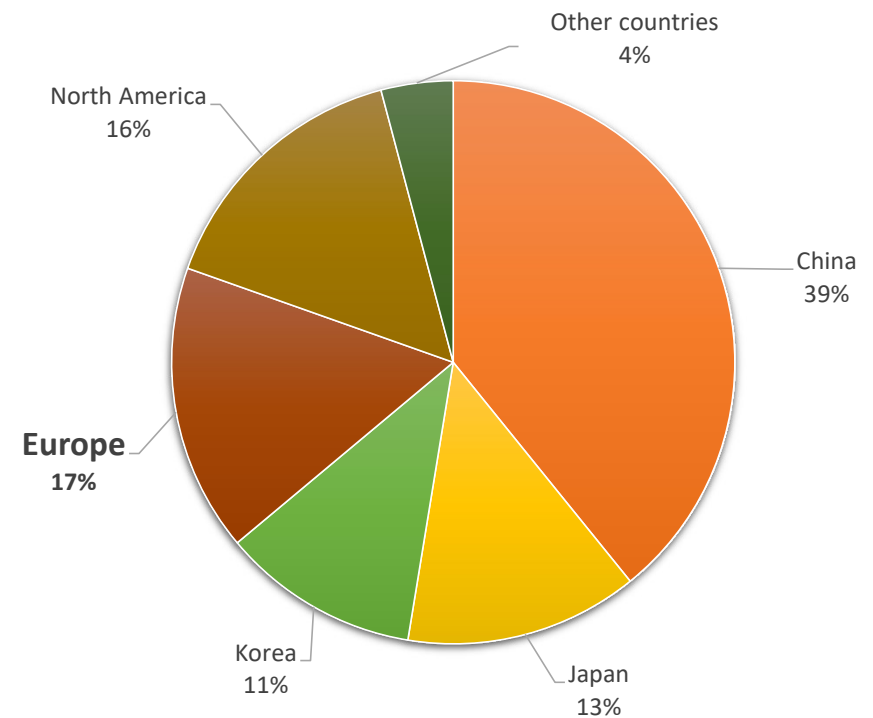


Source: Tematys/Photonics21

Photonics worldwide

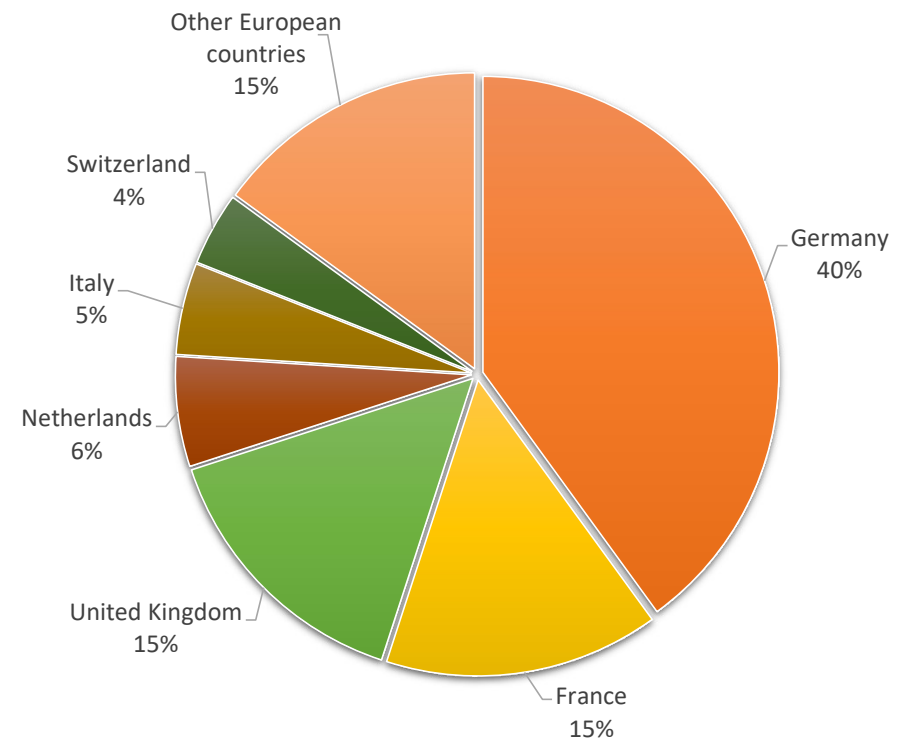
- Since 2015 the share of the European photonics industry of the global market **maintained around 17%**
- The Asian photonics industry is dominated by displays, PV, and LED production
- Europe leads in optical components and customization

Source: Tematys/Photonics21



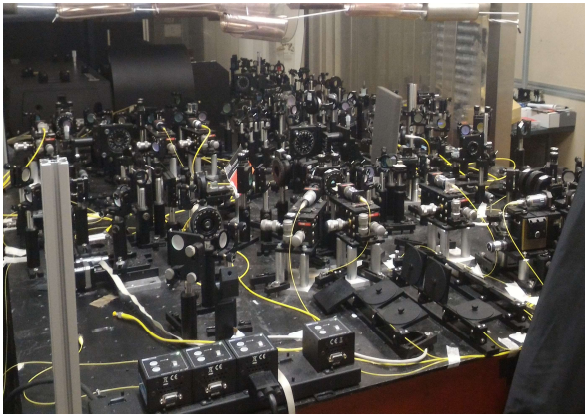
Photonics in Europe

- **Photonics production distribution within Europe:**
 - Germany - **40%**
 - France - **15%**
 - United Kingdom - **15%**
 - Netherlands - **6%**
 - Italy - **5%**
 - Switzerland - **4%**
 - Other European countries - **15%**
- **Many global photonics companies based in Europe**



Source: Tematys/Photonics21

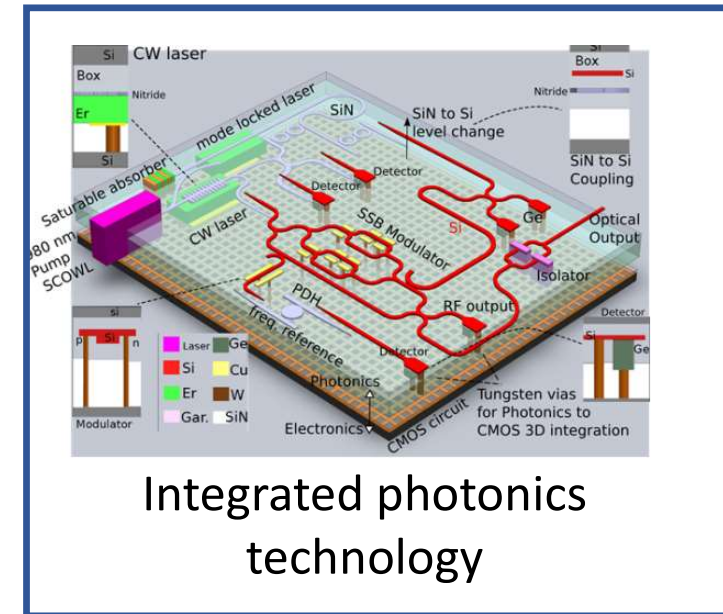
Different forms of photonics



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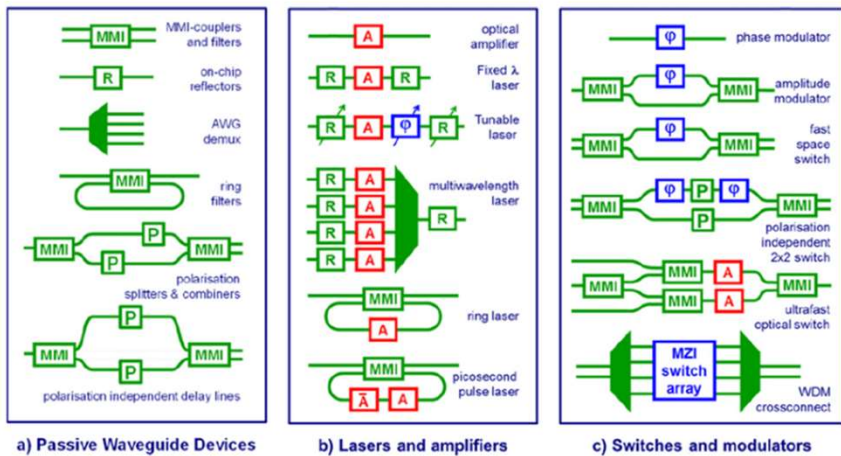


Integrated photonics
technology

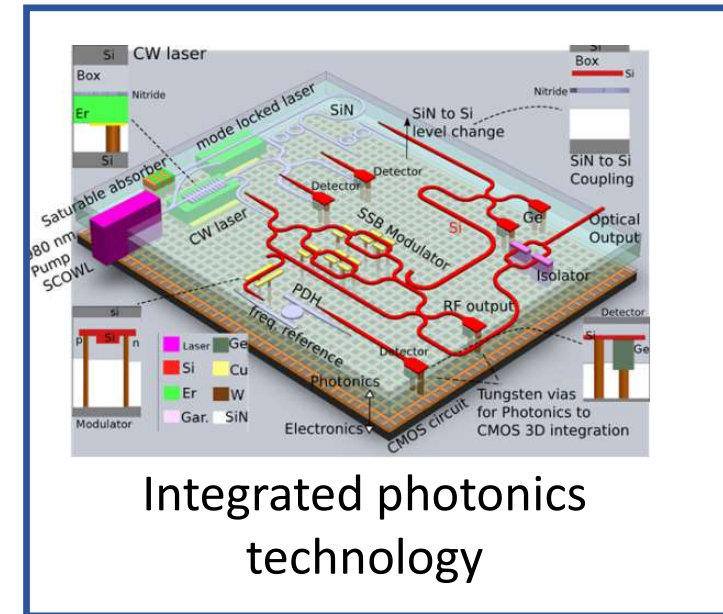
Photonics Integrated Circuits (PICs)

- PICs provide a route to commoditize photonics at larger volumes and lower costs

Photonic integrated circuit (PIC): A device that integrates multiple (at least two) photonics functions, the optical equivalent of an electronic IC.



And
photodetectors

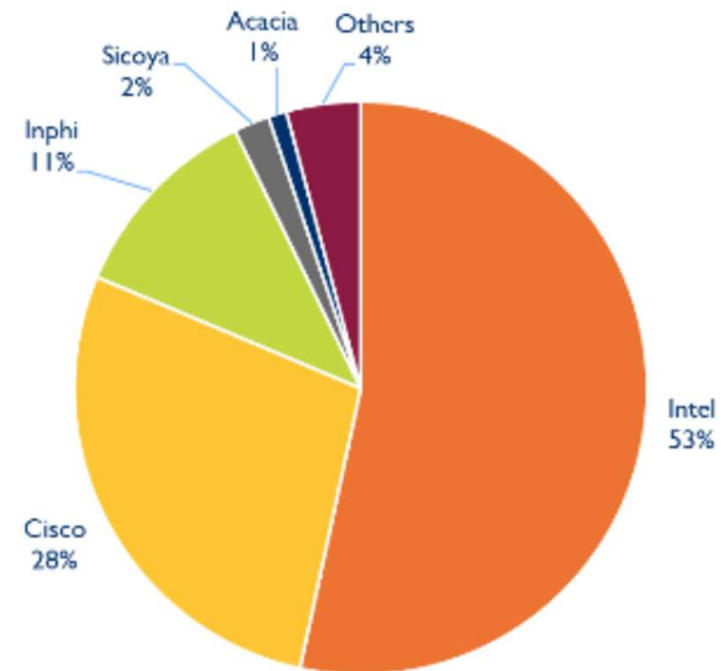


Chovan, Jozef & Uherek, F. (2018). Photonic Integrated Circuits for Communication Systems. Radioengineering. 27. 357-

Source: EECS Berkeley

Datacenter silicon transceiver market:

- Main product today: transceivers for datacom and telecom
- Currently: Data rate: 800 Gb/s, Symbol rate: 100 Gbaud



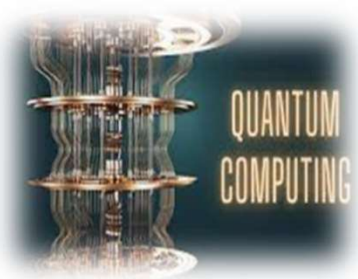
Source: Yole Group

Silicon Photonics: value chain



Other silicon photonics markets

Quantum & HPC



X-Ray Detector



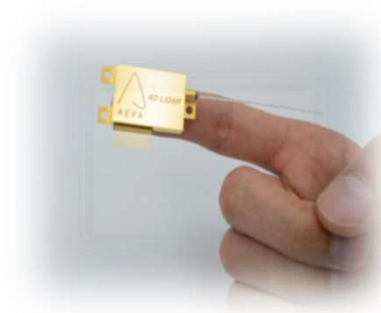
Endoscopy



3D Sensing



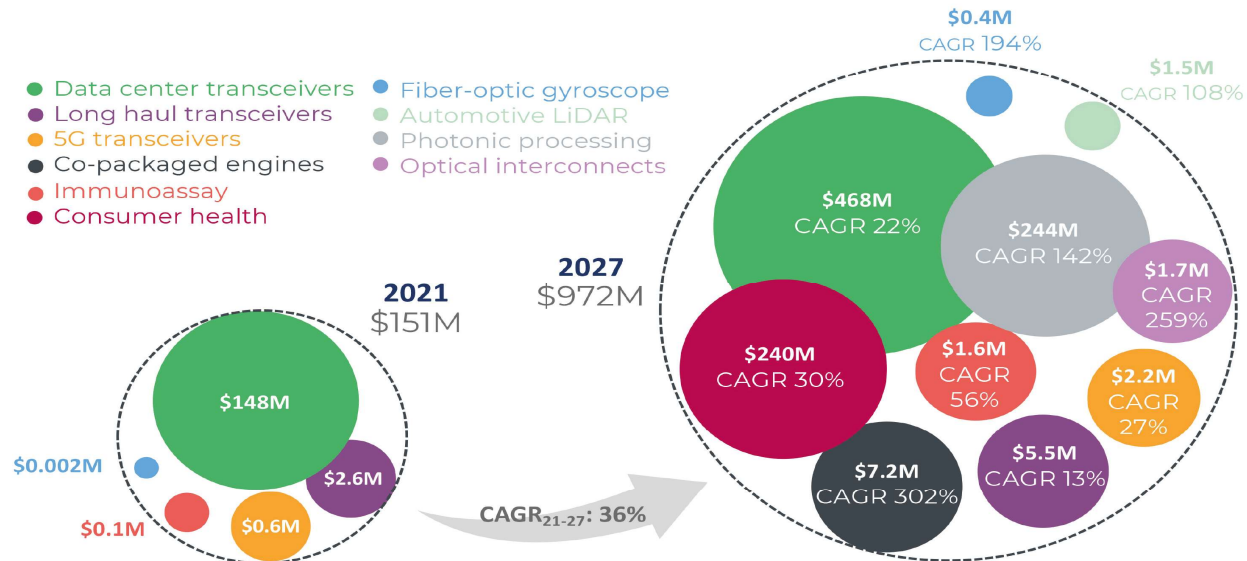
LIDAR



Silicon photonics market size

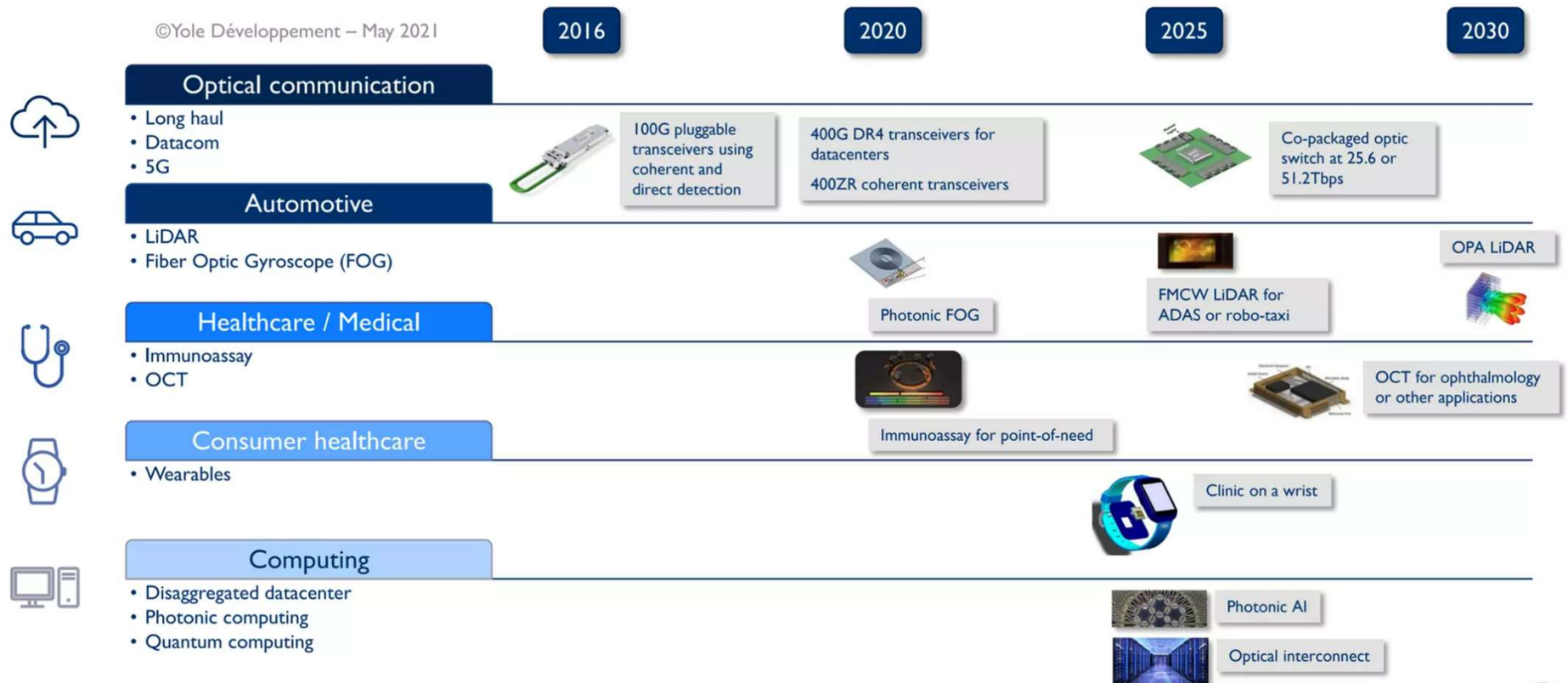
2021-2027 SILICON PHOTONIC DIE FORECAST BY APPLICATION

Source: Silicon Photonics 2022 Report, Yole Intelligence, 2022



Silicon Photonics (SiPh) roadmap

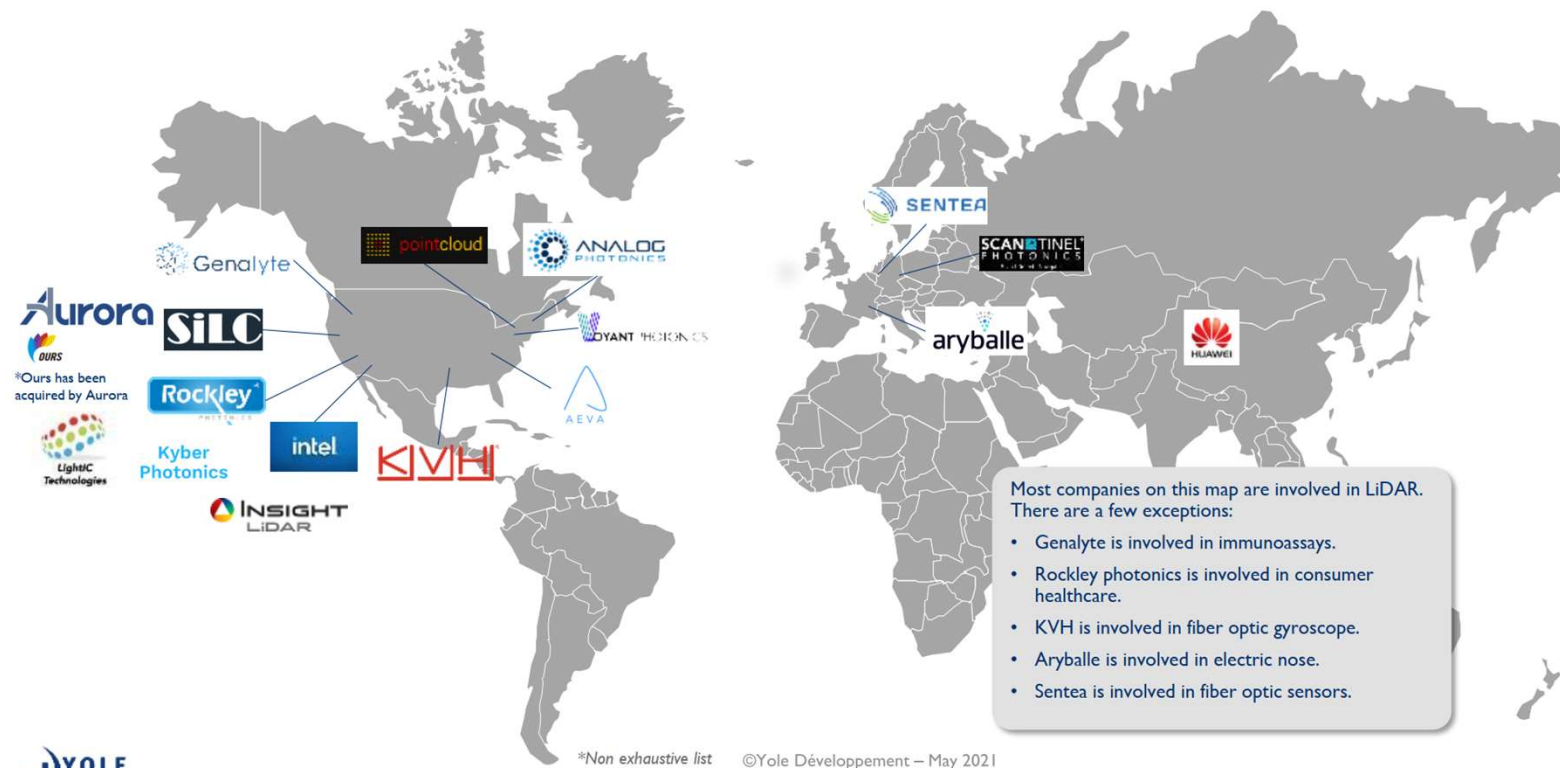
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SiPh optical communication players



SiPh sensors players



SiPh optical computing players



SIPh photonic quantum computing players



Silicon photonics can be used in two ways for quantum computing:

- Silicon photonics can be used to manipulate photonic qubits.
- Silicon photonics can be used to manipulate ion qubits.

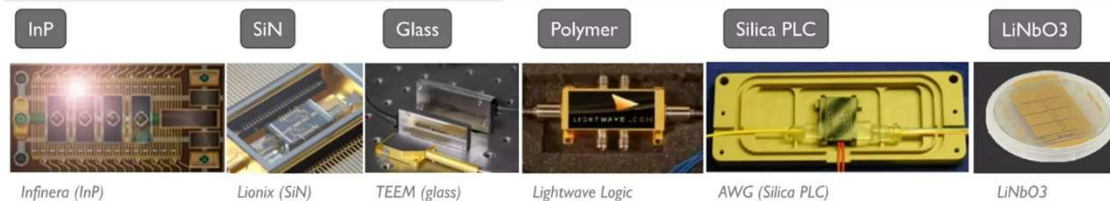
SiPh: some foundries and fabs



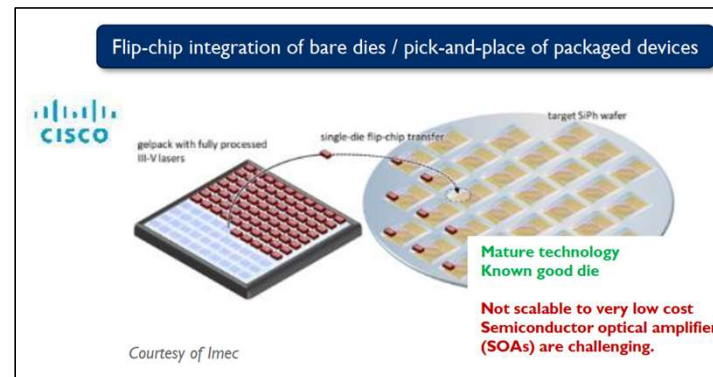
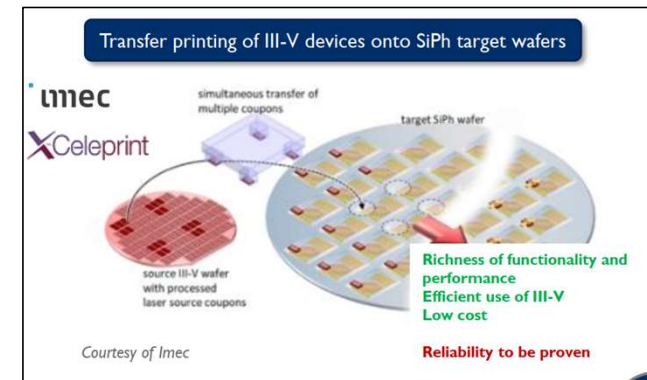
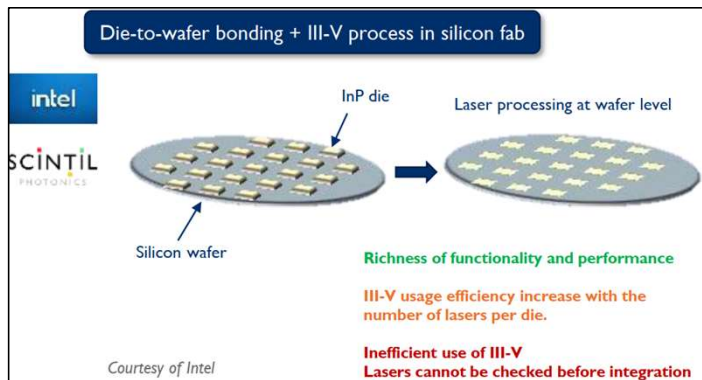
there are more...

Trends: new material platforms

	SIGNAL MODULATION	EMISSION	AMPLIFIER	WAVEGUIDE	PASSIVE FUNCTION	FILTERING	DETECTION	CONVERSION	ELECTRONICS CONTROL	COUPLING
Si photonics	SiPh die			SiPh die (SOI)	SiPh die (SOI)	SiPh die (SOI)	SiPh die (PN photodiode or PIN diode: Si or Ge)		SiPh die	
InP	EML: EAM + DFB/DBR	EML: EAM + DFB/DBR	PIN diode	WG			InP PN			
InP	EML: EAM + DFB/DBR	EML: EAM + DFB/DBR	PIN diode	WG				EML w/ SOA		
InP		Laser			DWDM		APD			
SiN				Low loss WG						Coupler
Polymer	Modulator			WG	Mux/Demux					Spot converter
GaAs		VCSEL					PIN			
Silica				Splitters	AWG					
LiNbO3										
Glass				WG	splitters, taps, Mux/Demux, polarizers					Coupler



Trends: light source integration



Trends: co-packaged optics

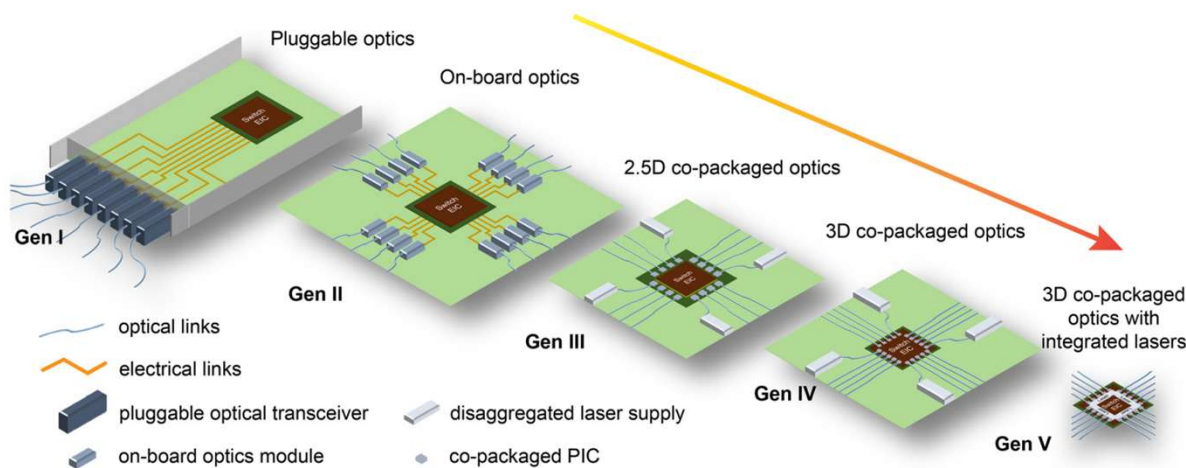


FIG. 1. Generations of optics and the evolution of co-packaging technologies used in data center applications. The generational progression drives tighter integration between network switching and optical I/O that will probably culminate with 3D co-packaged optics with integrated lasers on chip.

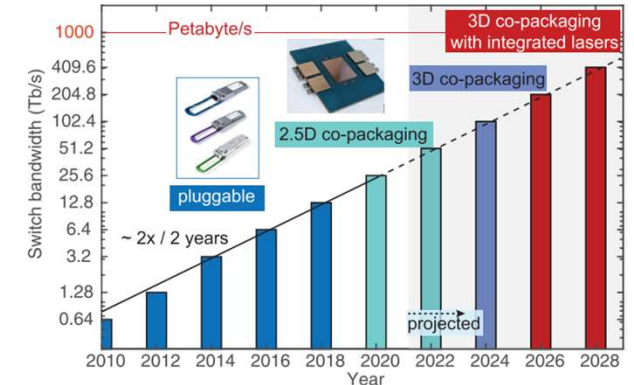
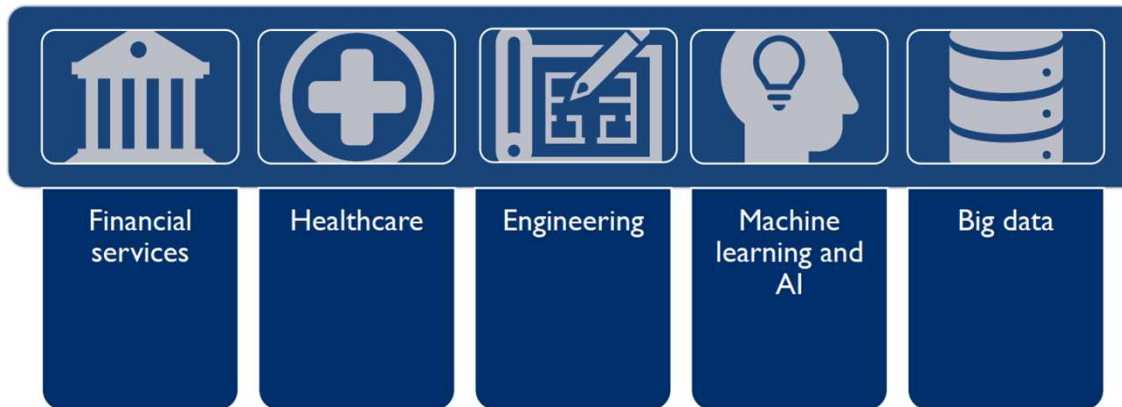


FIG. 7. Switch bandwidth evolution and outlook over the years with four generations. Inset pictures show commercially available pluggable transceivers from Intel and a 2.5D co-packaged PICs and switch from Broadcom. The year indicates when the technology is first deployed.

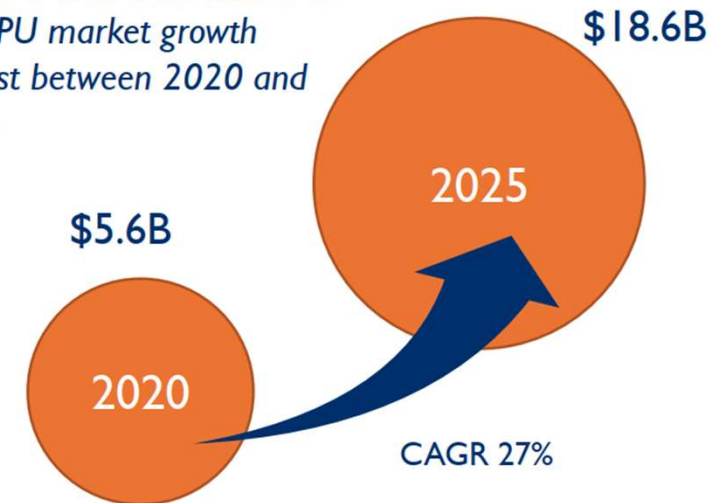
Source: *Appl. Phys. Lett.* 118, 220501 (2021)

Trends: high performance computing

- Moore's law continue and Bandwidth/Watt becomes the key
- Increasing the bandwidth will require optical connectivity
- Main HPC applications:



Global HPC as a service. CPU and GPU market growth forecast between 2020 and 2025.



Source: Yole Group

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March 7, 2022

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GlobalFoundries Announces Next Generation in Silicon Photonics Solutions and Collaborates with Industry Leaders to Advance a



GlobalFoundries Announces Next Generation in Silicon Photonics Solutions and Collaborates with Industry Leaders to Advance a New Era of More in the Data Center

March 7, 2022

News:

June 28, 2022

The screenshot displays the Intel Newsroom website. At the top, the Intel logo is followed by navigation links: PRODUCTS, SUPPORT, SOLUTIONS, DEVELOPERS, PARTNERS, and FOUNDRY. Below this, a breadcrumb trail reads "Intel Newsroom > New Integrated Photonics Research from Intel Labs". The main header features the "intel newsroom" logo and links for "Newsroom Home", "Newsroom Search", "International Sites", and "Email Opt-in". The featured article is titled "Intel Labs Announces Integrated Photonics Research Advancement" with a sub-headline: "Intel demonstrates a tightly controlled eight-wavelength laser array on a silicon wafer with matched power and uniform spacing." To the left of the article is a sidebar with social media icons for Facebook, Twitter, LinkedIn, and YouTube, and a "News" section listing "June 28, 2022" and "Contact Intel PR", with a "More New Technologies News" button. The article content includes a large image of a silicon wafer with a complex, glowing, multi-colored waveguide pattern. A play button icon is overlaid on the image. Below the image, the text reads: "The solution includes lasers integrated into the silicon that generate light at various wavelengths."

News:



HOME COMPUTE STORE CONNECT CONTROL CODE AI HPC ENTERPRISE HYPERSCALE CLOUD EDGE

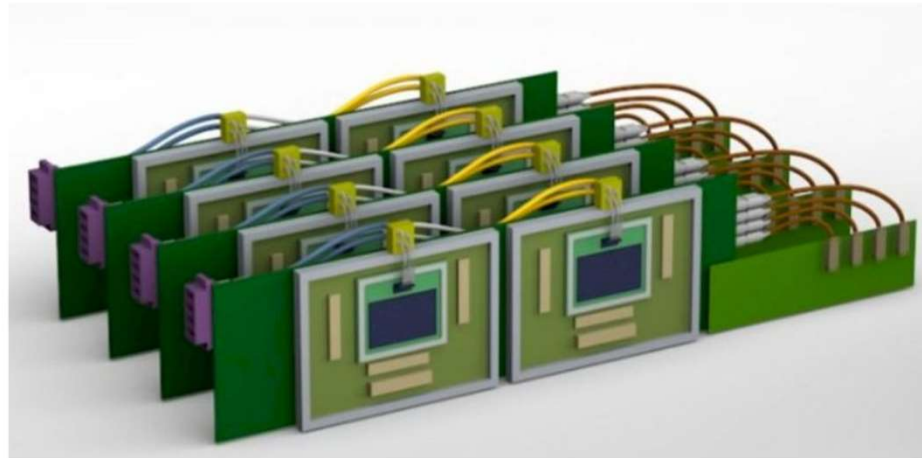
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NVIDIA SHOWS WHAT OPTICALLY LINKED GPU SYSTEMS MIGHT LOOK LIKE

August 17, 2022 Timothy Prickett Morgan



August 17, 2022

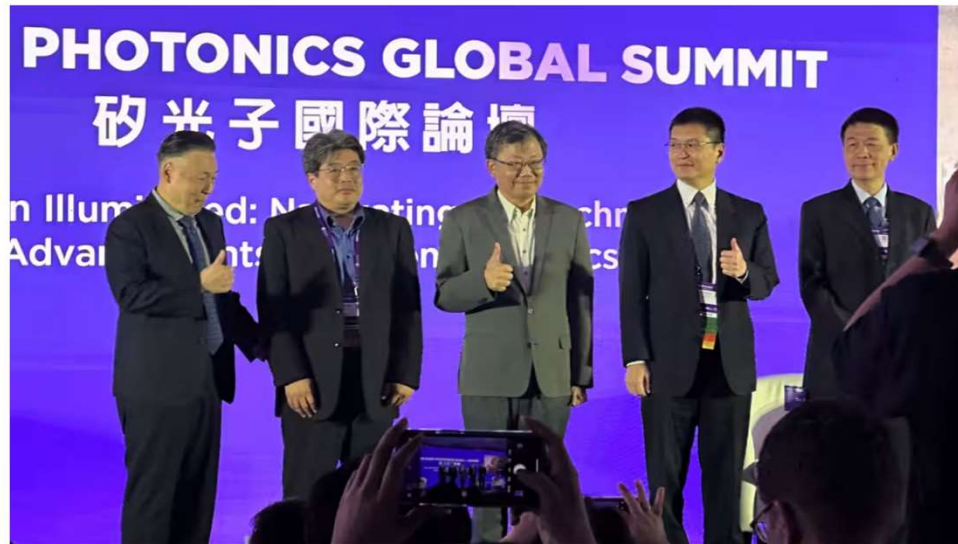
News:

September 6, 2023

SEMICONDUCTORS

TSMC bets on silicon photonics to enable more powerful ChatGPT

Emerging field becomes new battleground for major tech players



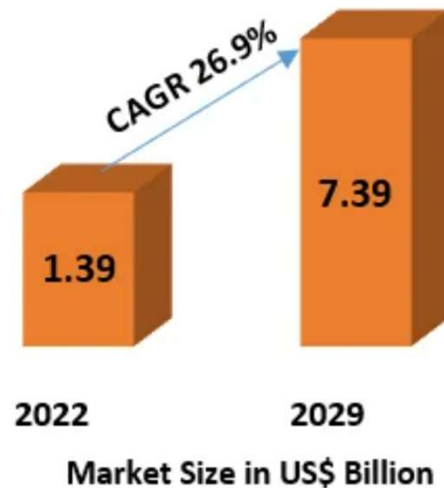
Douglas Yu, far right, TSMC vice president of pathfinding for system integration, said the company is betting big on silicon photonics. (Photo by Cheng Ting-Fang)

CHENG TING-FANG, Nikkei Asia chief tech correspondent

September 6, 2023 10:31 JST

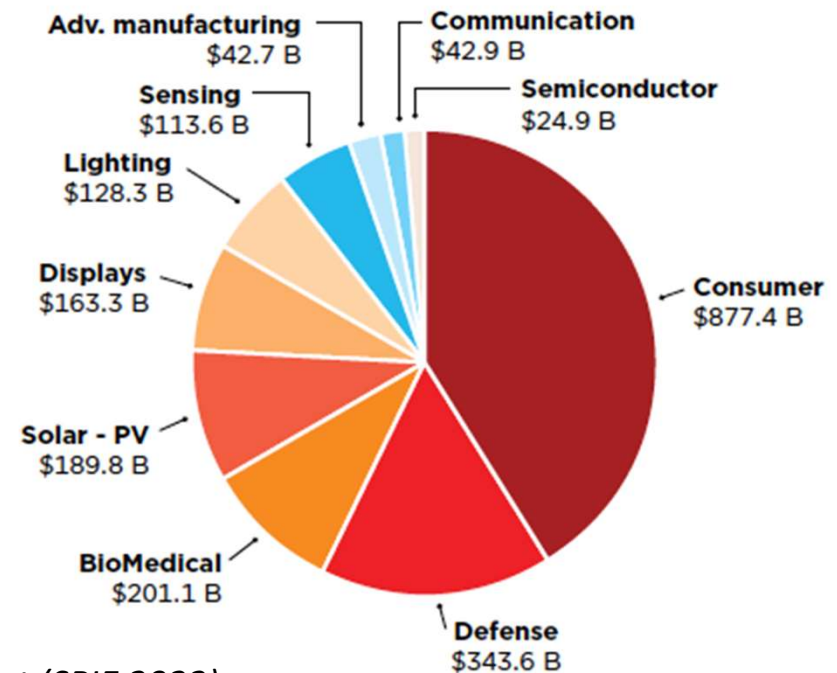
Economic impact of photonics

SiPh market forecast 2022



Enabled Markets Economic Impact 2021

Global Total \$2.12 Trillion



Source: Maximize Market Research; Optics and Photonics Industry Report (SPIE 2022)

Thank you for your attention!

Ivan.Nikitski@epic-assoc.com

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New Logo
Same Mission**



Conclusions:

- The semiconductor industry is facing increasing bandwidth/watt demand
- Increasing the bandwidth will require optical connectivity
- The rapid growth of SiPh pluggable optics and soon co-packaged optics.
- The use of silicon photonics for sensing applications
- Photonics enables huge advanced-CMOS markets