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TECHNOLOGY DAYS**
POLAND – EAST
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Photonic integrated devices for research institutes, SMEs and large companies

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NATIONAL COHESION STRATEGY



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POLITECHNIKA WARSZAWSKA

Photonic integrated devices

for research institutes, SMEs and large companies

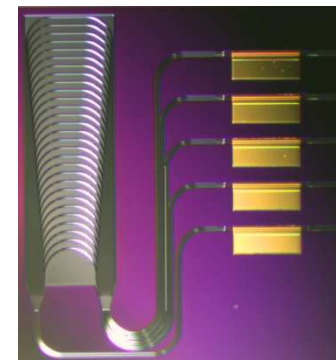
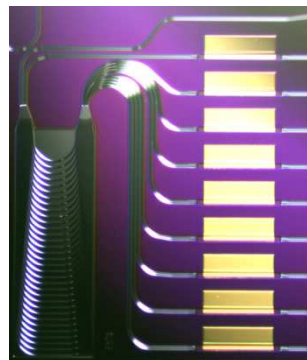
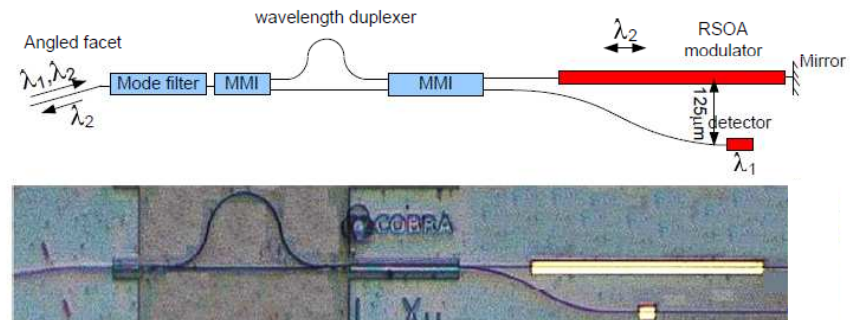
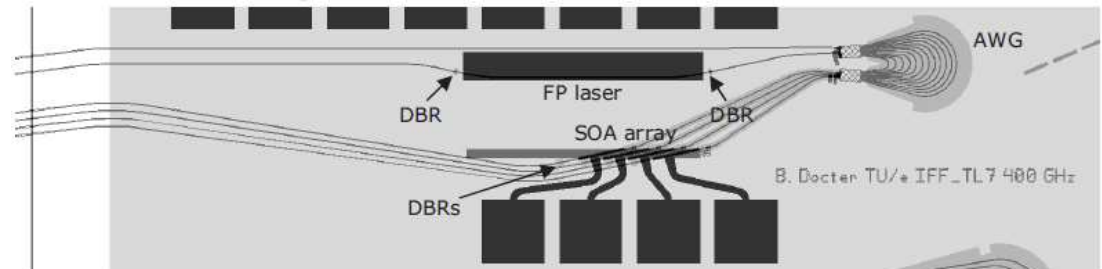
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Photonic Integrated Circuits

- Integration of multiple optical components into a single device

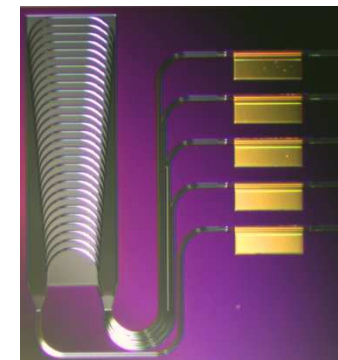
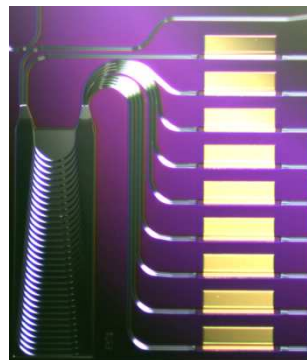
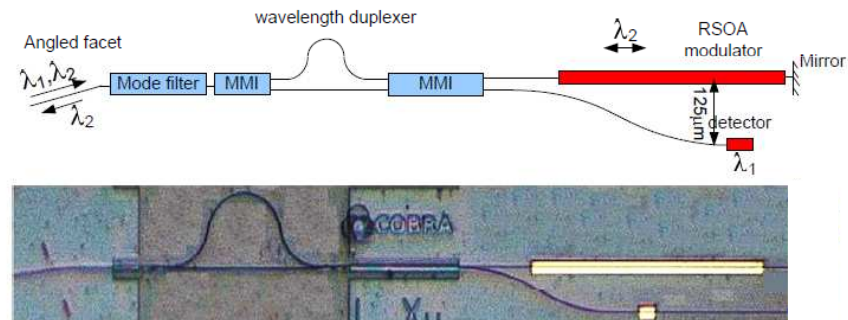
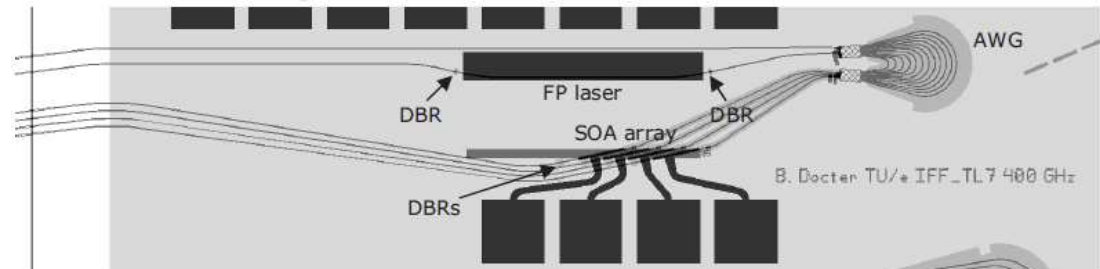


Photonic Integrated Circuits

- Integration of multiple optical components into a single device

- Optical components:

- Waveguides
- Wavelength filters
- Power couplers/splitters
- Optical amplifiers
- Photodetectors
- Modulators

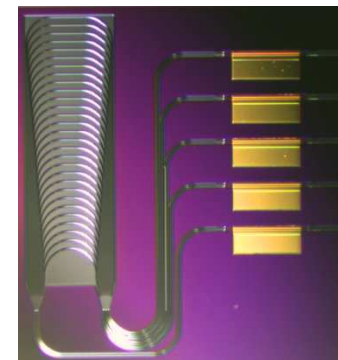
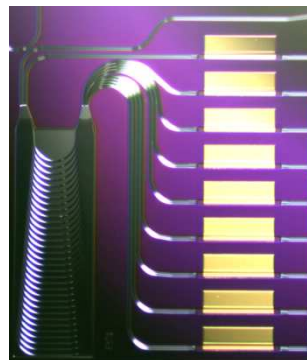
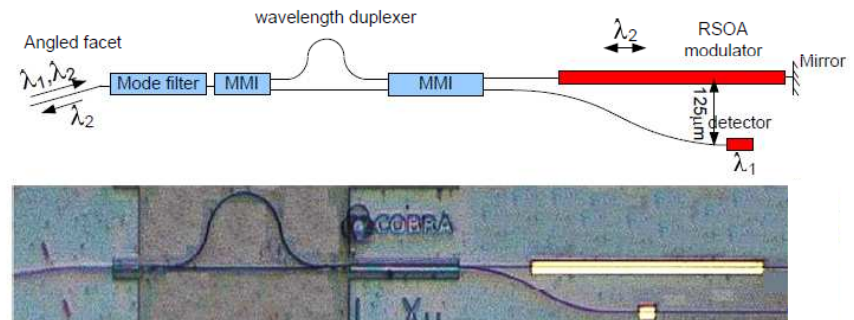
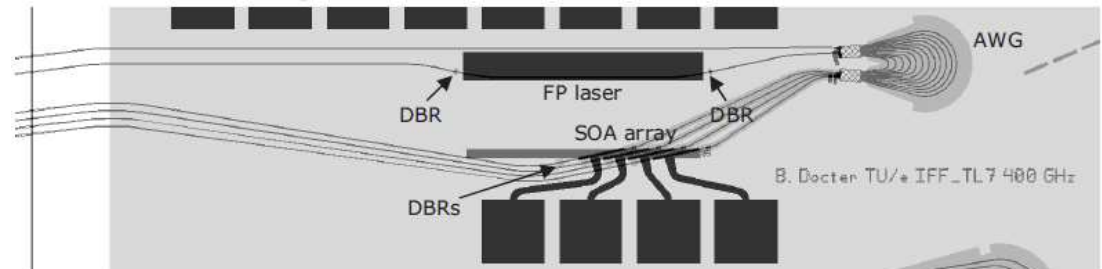


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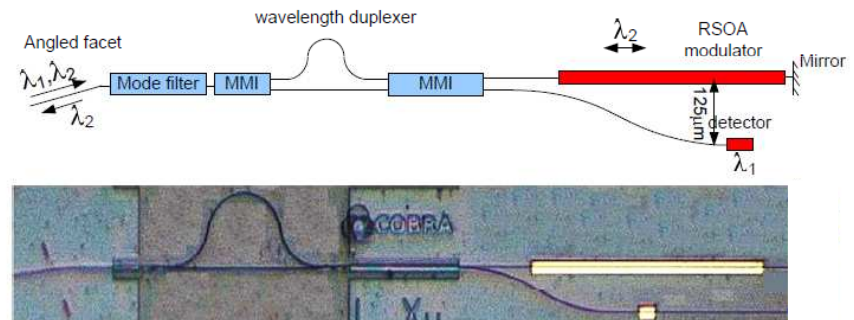
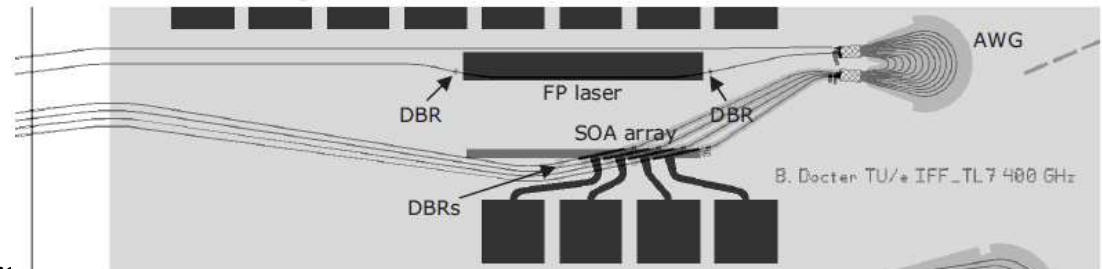


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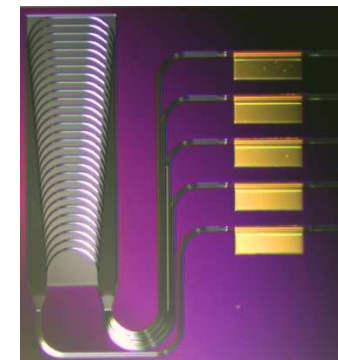
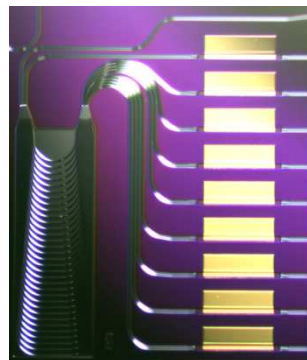
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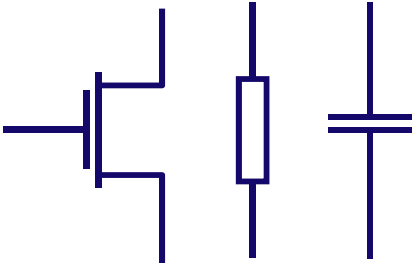
- Materials:

- Si, InP, GaAs, LiNbO₃
- GaAs lasers:
 $\lambda = 700 - 900 \text{ nm}$
- InP lasers:
 $\lambda = 900 - 1600 \text{ nm}$

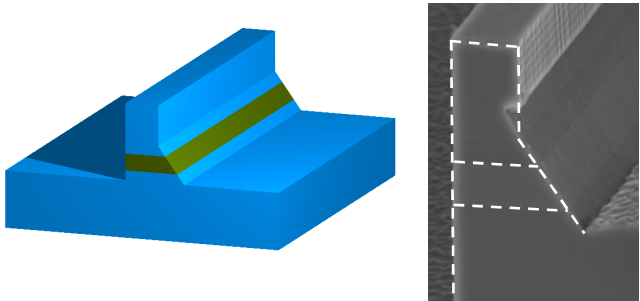
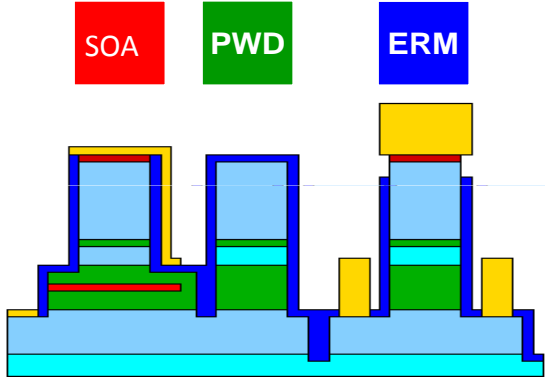
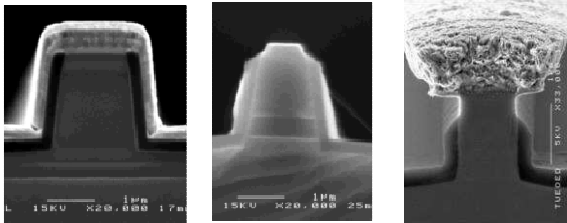
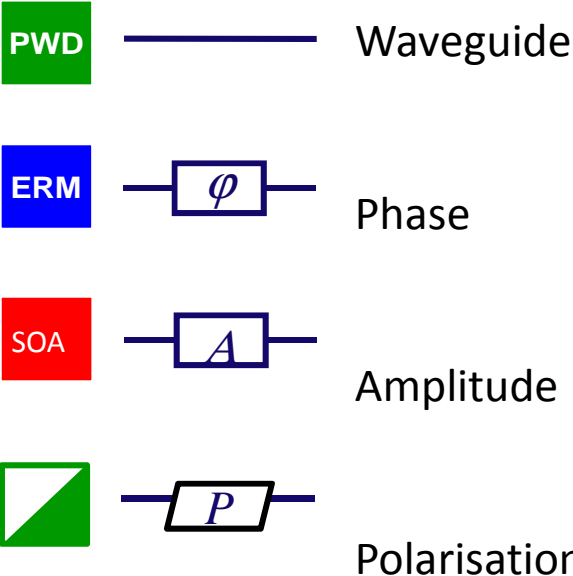


Generic Integration Philosophy

Electronic integration
3 basic elements




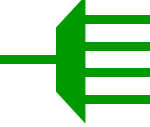


Photonic integration
4 basic elements




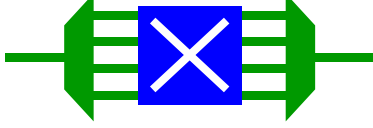


4 Basic Building Blocks


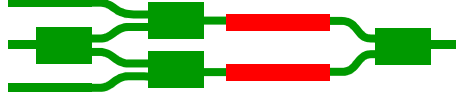

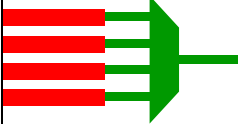
Passive

 waveguide
 curve
 MMI-coupler
 AWG-demux




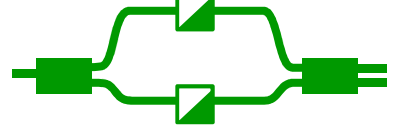
Phase

 phase modulator
 amplitude modulator
 2x2 switch
 WDM OXC

Amplitude

 optical amplifier
 λ converter, ultrafast switch
 picosecond pulse laser
 multiwavelength laser

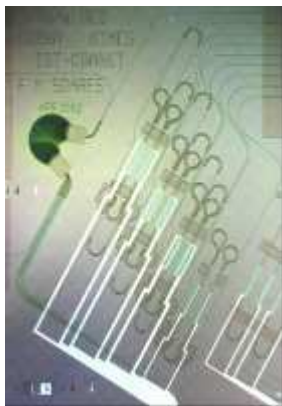
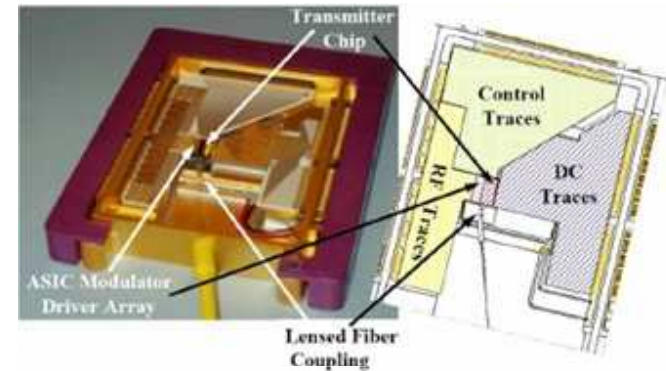
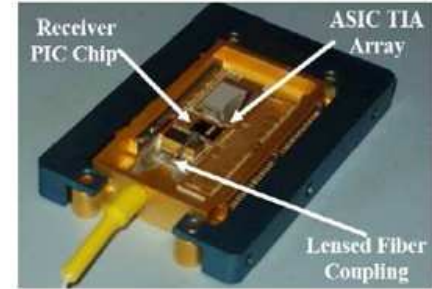
Polarisation

 polarisation converter
 pol. splitter / combiner
 pol. indep. 2x2 switch
 pol. indep. diff. delay line

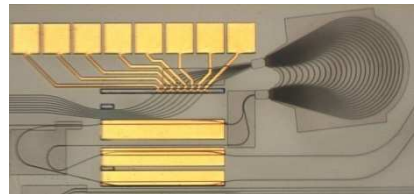
Application Areas

- **Telecomms - main driver for PIC development**

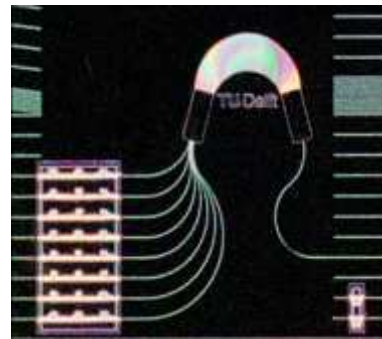
Transmitters and Receivers
 Access networks / Fiber-To-The-Home systems
 Radio-over-Fiber applications in wireless access
 Many other optical functions:
 Data encoders/decoders,
 wavelength (de-)multiplexers, regeneration...



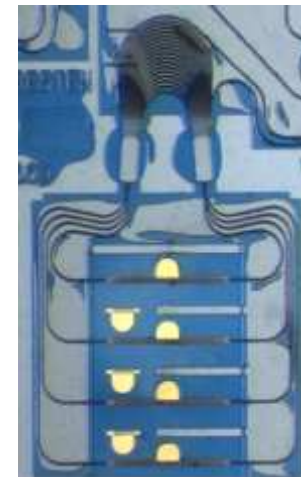
WDM-TTD switch



Tunable WDM laser



multiwavelength laser



WDM ring laser



COBRA

Application Areas

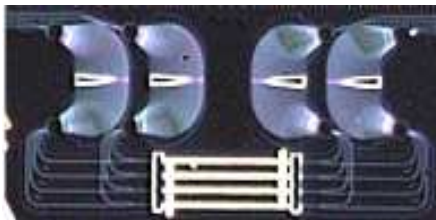
- **Datacomms**

Fast photonic switches for server backplanes

Photonic interconnect in computer backplanes



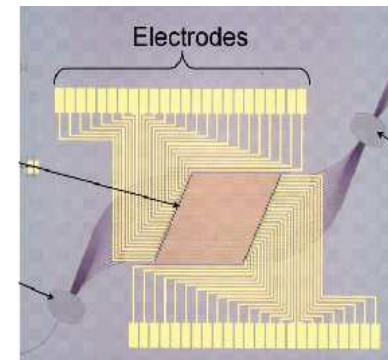
Computer backplane



optical crossconnect



optical crossconnect



optical switch

Application Areas

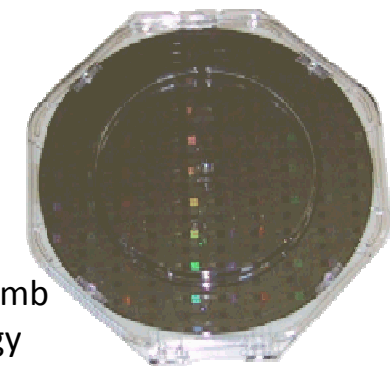
- **Fibre Sensors:**

Integrated measurement modules for fiber Bragg sensors

Readout chips for sensors based on strain using Brillouin backscattering

Monitoring the integrity of large constructions like: bridges, dikes, roofs of large buildings, windmill propeller blades, large reservoirs for storage of oil or chemicals, offshore platforms etc.

Strain sensors, heat sensors and a variety of chemical sensors



Compact Frequency-comb generators for metrology



Application Areas

- **Medical**

Optical coherence tomography at $\sim 1.55 \mu\text{m}$

Raman scatterometry

Diagnostic analysis of opaque tissue

Analysis of suspect skin tissue

Analysis of intra-arterial diagnostics

Non-linear microscopy using short pulse lasers



picosecond pulse laser



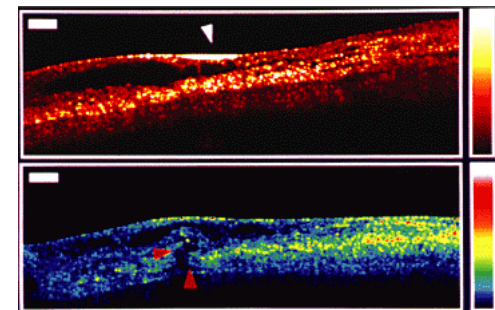
tunable multiwavelength laser



Multi-photon microscopy



Skin Analysis



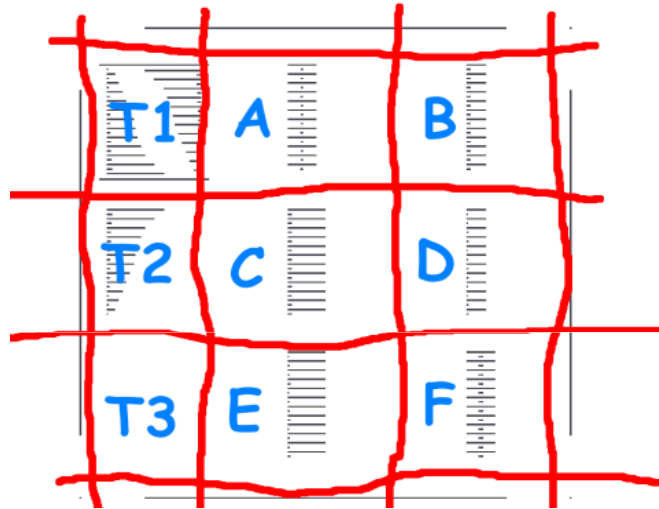
Optical Coherence Tomography



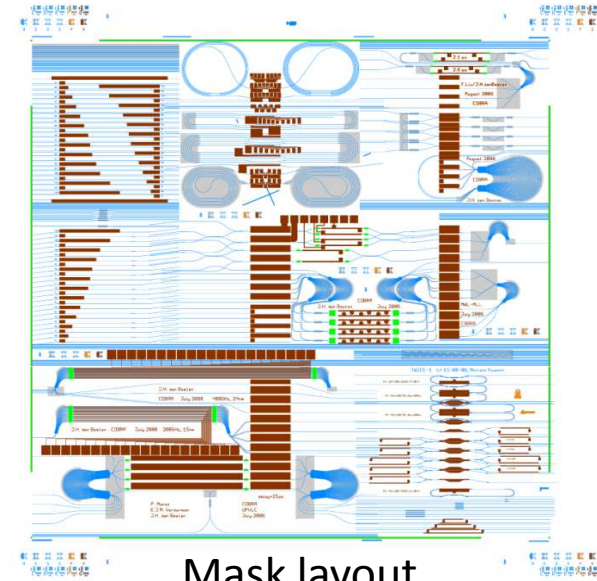
Multi-Project Wafer Run

The processed area is split into nine blocks (typically 4x4mm²); three are reserved for test structures (to qualify the processing) and six blocks host the PIC designs of the users.

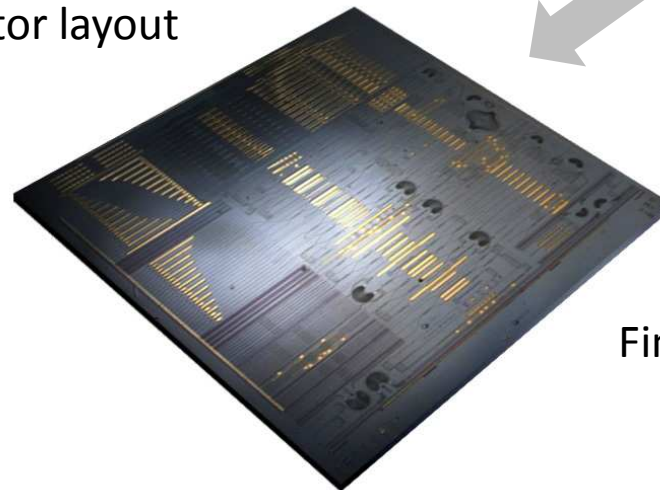
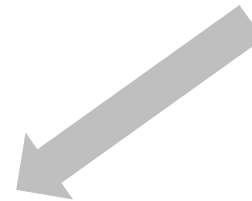
Test Sectors T1-T3 for wafer scale verification



Sector layout



Mask layout



Final Processed Circuits

Design centers



Eastern Europe design center at Warsaw University of Technology

Expertise in research and development of:

- novel photonic materials and devices
- fiber-optic components
- integrated optics
- optoelectronics

Laboratories of:

- Microelectronic Integrated Circuit Design and Application
- Microelectronic and Nanoelectronic Devices
- Microsystems Technology
- Fiber-Optic Photonics
- Microwave Photonics
- 2D/3D Vision Systems
- Laser Spectroscopy
- Photovoltaics
- Integrated Photonics – in development



Eastern Europe design center at Warsaw University of Technology

- state-of-the-art expertise in design, development and characterization
- support the non-expert application users and help them to make their own design
- enable access to highest-level photonic technologies
- train users and disseminate the knowledge of photonic devices and its potential



Who are we looking for?



Who are we looking for?

... partners interested in co-operation and in developing, testing and using photonic devices in their institutes, companies, enterprises ...





POLITECHNIKA WARSZAWSKA

TU/e Technische Universiteit
Eindhoven
University of Technology
Where innovation starts

Questions?



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