

Introduction to generic photonic IC technology

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Introduction to Generic Photonic IC technology

Meint Smit



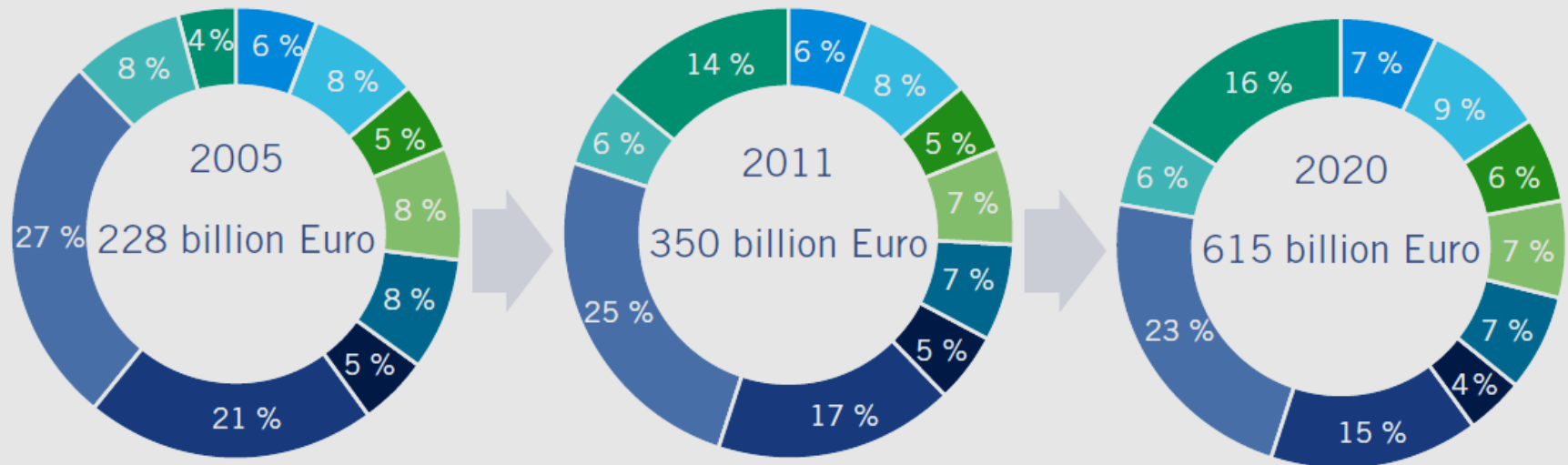
TU / **e**

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

Global Photonics Market Development

Key Data Photonics World 2005, 2011 and Expectations 2020



- Production Technology
- Measurement & Automated Vision
- Optical Components & Systems
- ➔ ■ Safety- and Defence Technologies
- ➔ ■ Medical Technology & Life Science
- ➔ ■ Communication Technology
- ➔ ■ Information Technology
- Displays
- Light Sources
- Photovoltaic

Source: BMBF, SPECTARIS, VDMA, ZVEI (pub.), 'Branchenreport Photonik 2013', Optech Consulting, Study 'Photonik 2013'/Own calculations

Photonic ICs ➔



Microphotonic technologies

Building block	Performance		
	InP	Si	TriPLeX
Passive components	●	●●	●●●
Lasers	●●●	○	○
Modulators	●●●	●●	●
Switches	●●●	●●●	●
Optical amplifiers	●●●	○	○
Detectors	●●●	●●●	○

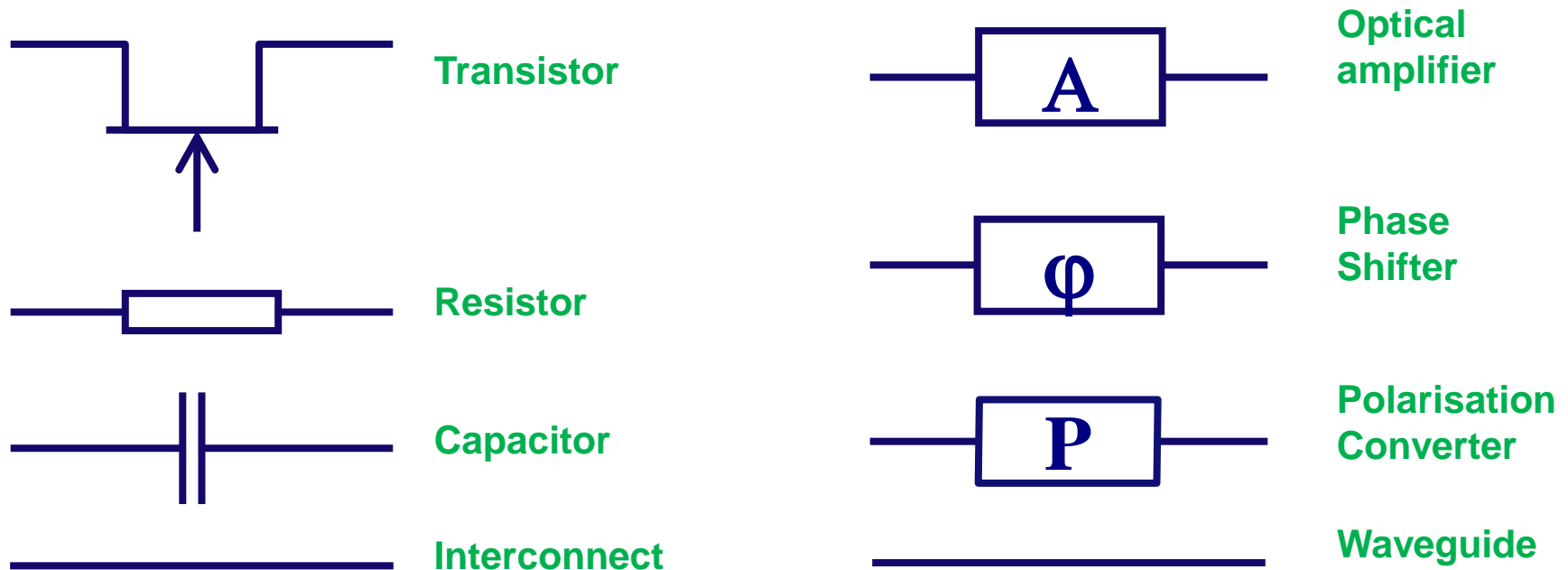
Performance	
●●●	Very good
●●	Good
●	Modest
○	Challenging

Footprint	●●	●●●	●
Chip cost	●	●●	●●
CMOS compatibility	○○	●●	●
Low cost packaging	○	○ ¹ /●● ²	●●

¹ Endfire coupling (low refl.)

² Vertical coupling (med. refl.)

Generic Integration philosophy



Electronic integration

Photonic integration

What can you make with these Basic Building Blocks?

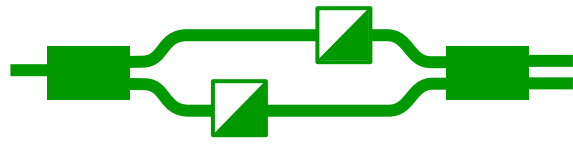
All kinds of passive devices ...

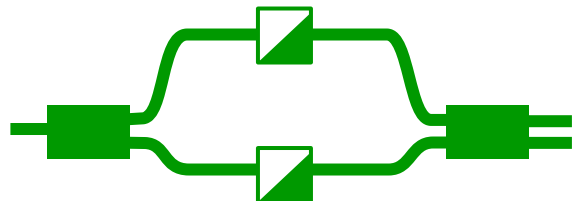
 MMI-couplers and filters

 MMI-reflectors

 AWG-demux

 ring filters

 polarisation splitters
polarisation combiners

 polarisation independent
differential delay lines

switches and modulators ...



phase modulator



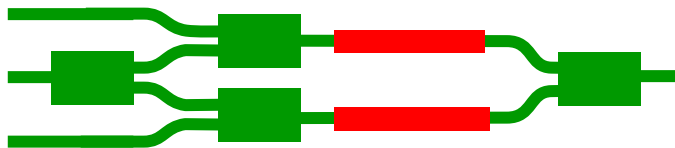
amplitude modulator



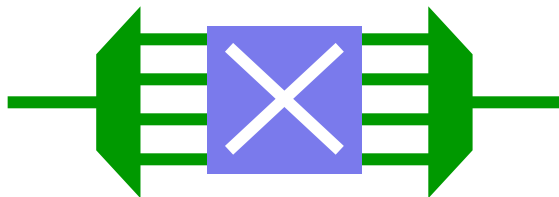
fast space switch



polarisation independent 2x2 switch



ultrafast switch



WDM crossconnect
WDM add-drop

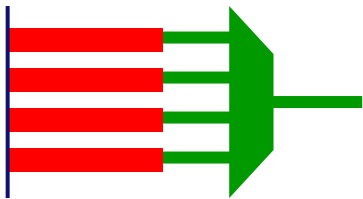
All kinds of lasers ...



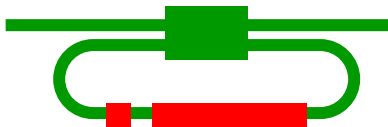
Fabry-Perot lasers



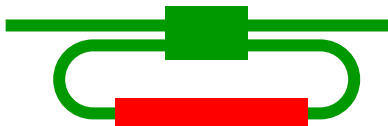
tunable DBR lasers



multiwavelength lasers



picosecond pulse laser

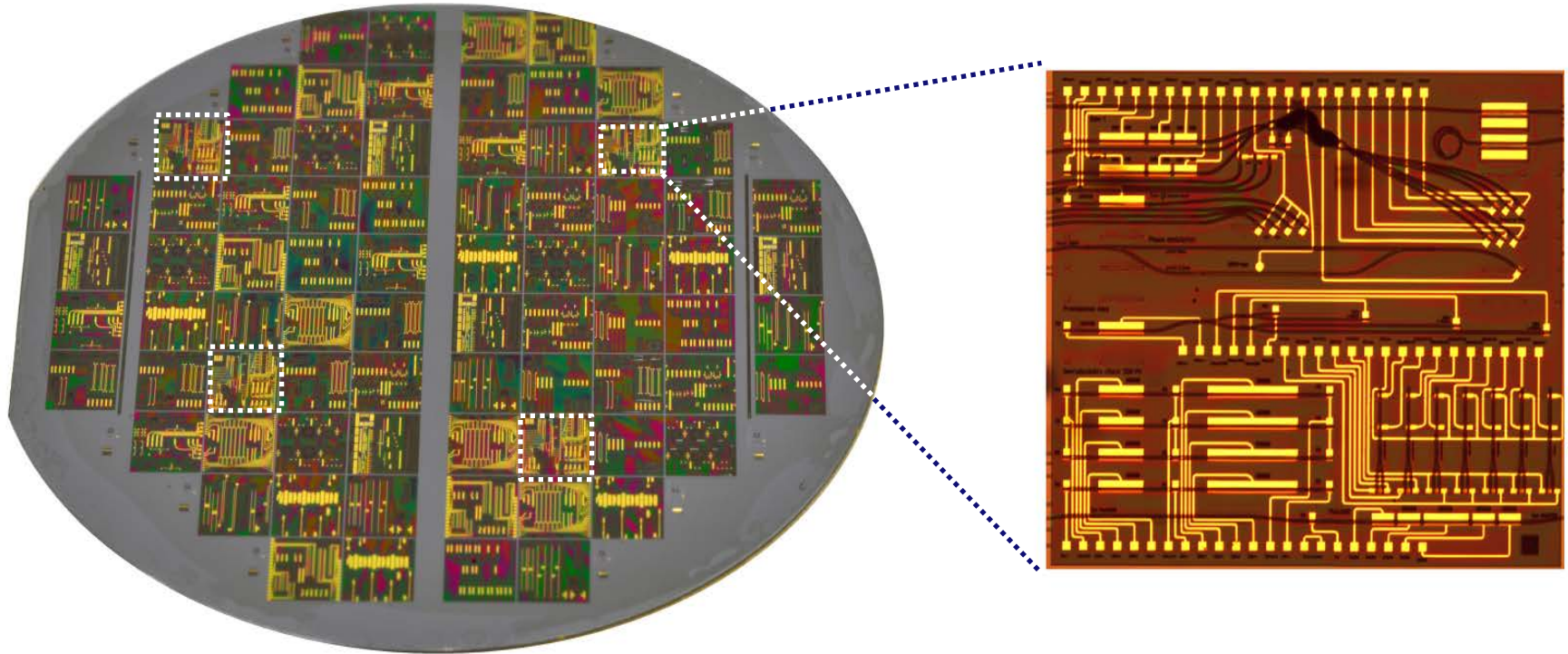


ring lasers

And many other components ...



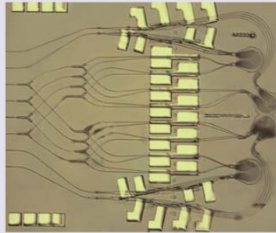
Multi-Project Wafer run



Cost sharing in R&D phase

Examples of Photonic ICs from MPW runs

Optical switching

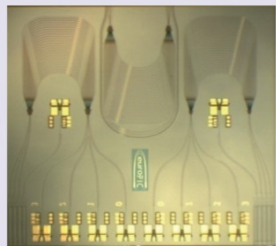


4x4 space and wavelength selective switch

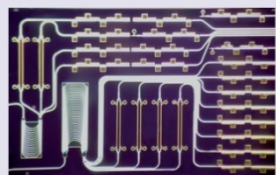


Fast optical switch matrix

Fiber to the home

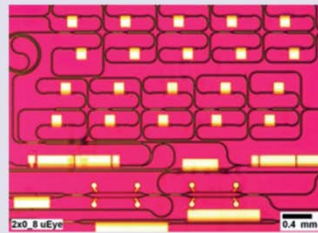


WDM receiver

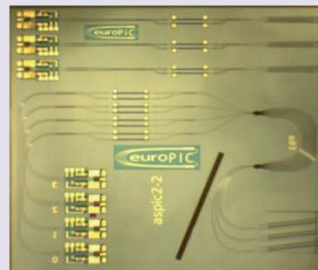


WDM transmitter

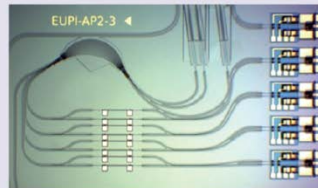
Fiber sensor readout



Brillouin strain sensor readout

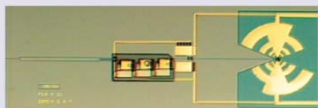


Fiber Bragg Grating readout

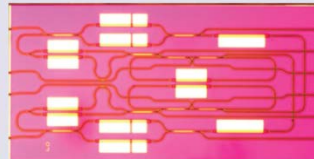


Fiber Bragg Grating readout

THz Optical to RF converter



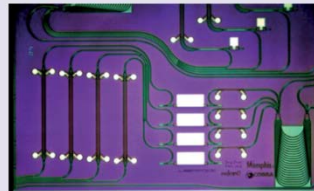
Variety of lasers



Widely tunable ring laser



Variable repetition rate pulse laser



Filtered-feedback multi-wavelength laser

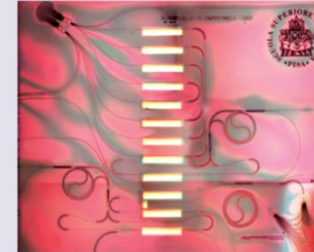


tunable laser with integrated MZI modulator

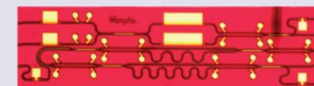
QPSK receiver



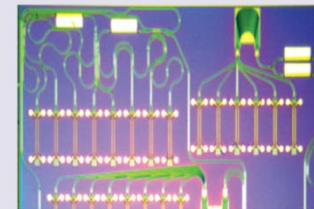
Optical data handling



All-optical regenerator for constant envelope WDM signals

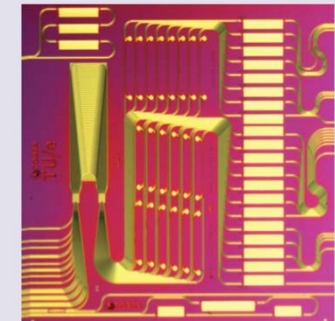


WDM to TDM Trans-Multiplexer

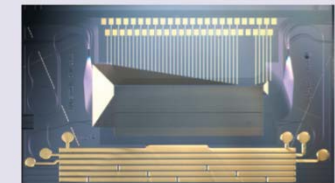


Pulse serialiser

Medical and bio-imaging



Pulse shaper for bio-imaging



Integrated tunable laser for optical coherence tomography

A generic foundry model in Photonics

- **Generic Integration Technology**
- **Generic Packaging**
- **Generic Testing**
- **Design Tools (PDK) and component libraries**
- ...