# Introduction to generic photonic IC technology

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Meint Smit

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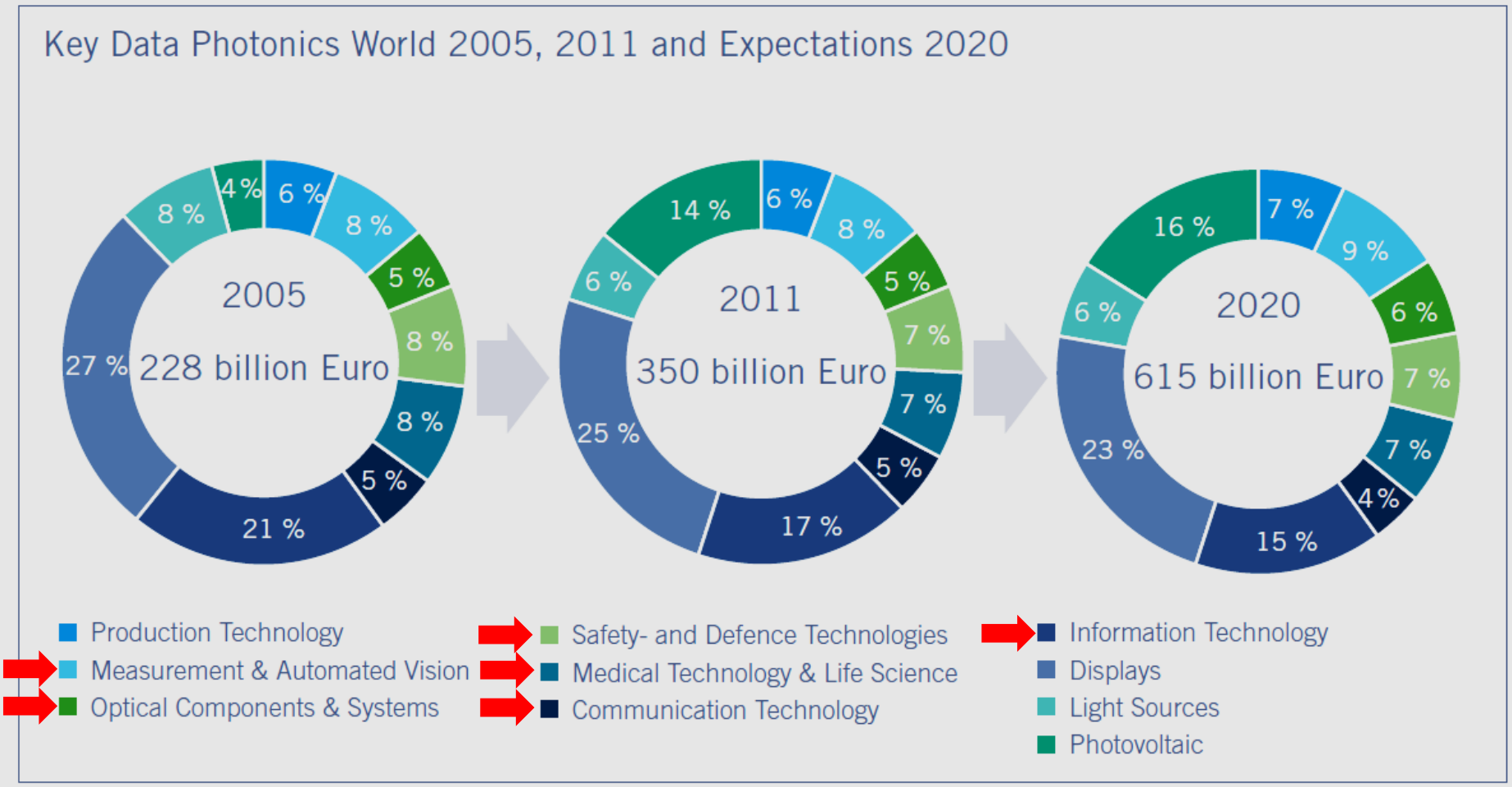
Where innovation starts

# Global Photonics Market Development




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

**Photonic ICs**

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# Microphotonic technologies

| | Performance | | |
|---|---|---|---|
| Building block | **InP** | **Si** | **TriPleX** |
| Passive components | ● | ●● | ●●● |
| Lasers | ●●● | o | o |
| Modulators | ●●● | ●● | ● |
| Switches | ●●● | ●●● | ● |
| Optical amplifiers | ●●● | o | o |
| Detectors | ●●● | ●●● | o |

| Performance | |
|---|---|
| ●●● | Very good |
| ●● | Good |
| ● | Modest |
| o | Challenging |

| | | | |
|---|---|---|---|
| Footprint | ●● | ●●● | ● |
| Chip cost | ● | ●● | ●● |
| CMOS compatibility | oo | ●● | ● |
| Low cost packaging | o | o[1]/●●[2] | ●● |

[1] Endfire coupling (low refl.)

[2] Vertical coupling (med. refl.)



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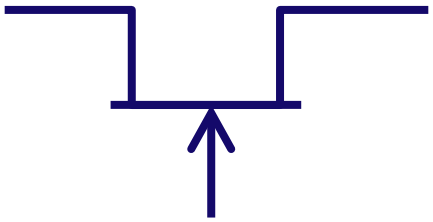
# Generic Integration philosophy



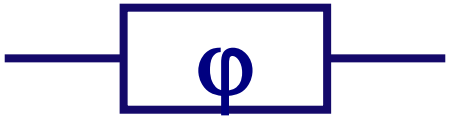
Transistor

Resistor

Capacitor

Interconnect


Optical amplifier




Phase Shifter


Polarisation Converter



Waveguide

## Electronic integration

## Photonic integration



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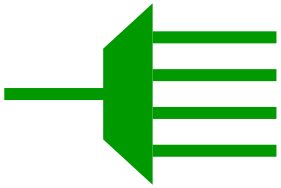
# What can you make with these Basic Building Blocks?

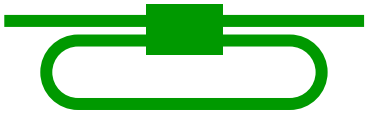
# All kinds of passive devices …

MMI-couplers and filters

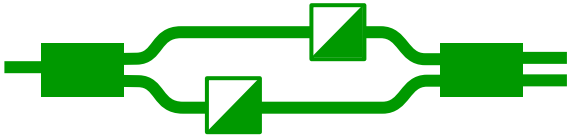
MMI-reflectors



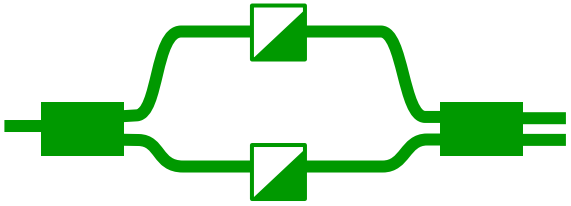
AWG-demux



ring filters



polarisation splitters
polarisation combiners



polarisation independent
differential delay lines



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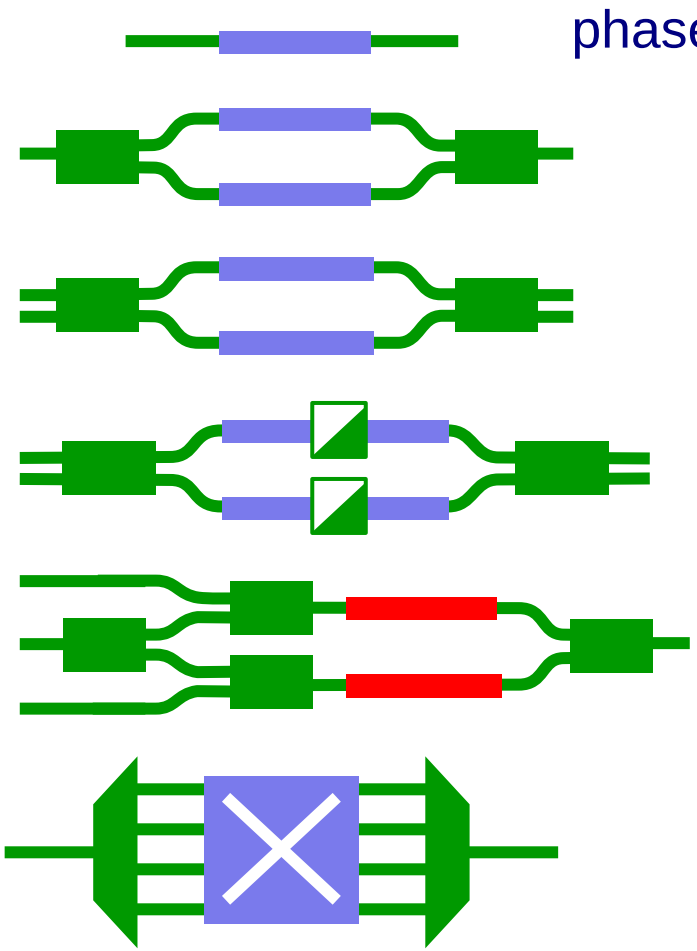
# switches and modulators …



phase modulator

amplitude modulator

fast space switch

polarisation independent 2x2 switch

ultrafast switch

WDM crossconnect
WDM add-drop



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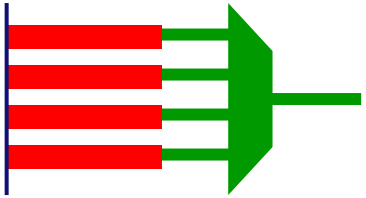
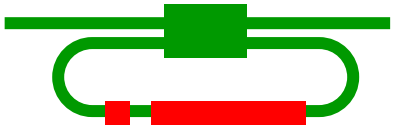
# All kinds of lasers …

Fabry-Perot lasers

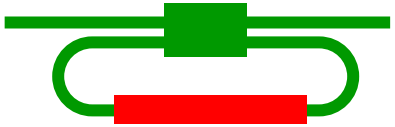
tunable DBR lasers



multiwavelength lasers



picosecond pulse laser



ring lasers

# And many other components …



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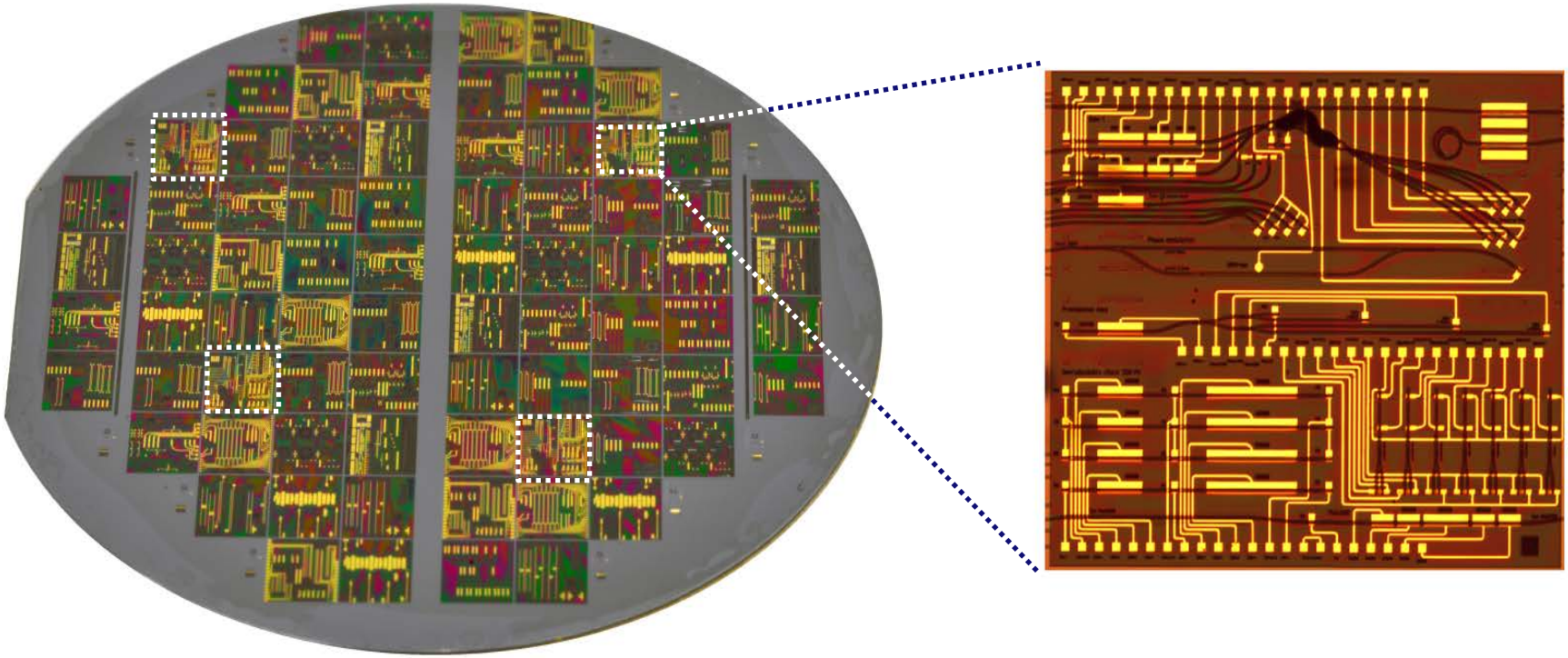
# Multi-Project Wafer run



Cost sharing in R&D phase



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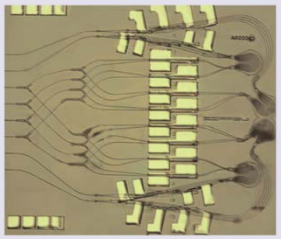
# Examples of Photonic ICs from MPW runs

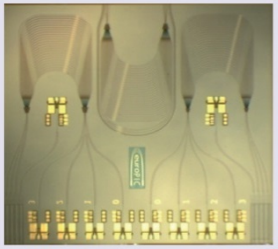
### Optical switching



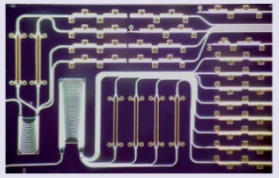
4x4 space and wavelength selective switch

Fast optical switch matrix

### Fiber to the home

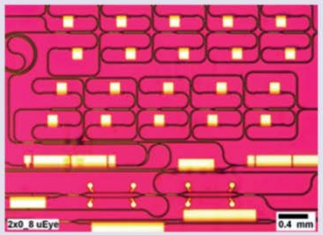


WDM receiver

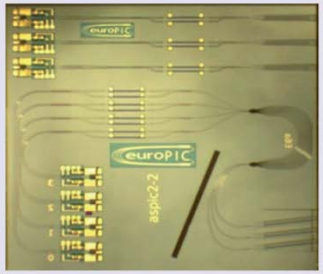


WDM transmitter

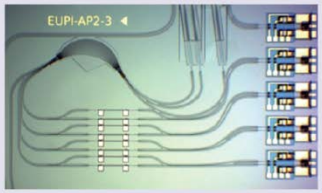
### Fiber sensor readout



Brillouin strain sensor readout

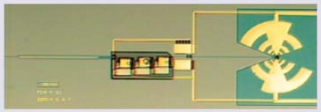



Fiber Bragg Grating readout

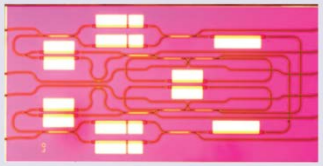



Fiber Bragg Grating readout

### THz Optical to RF converter

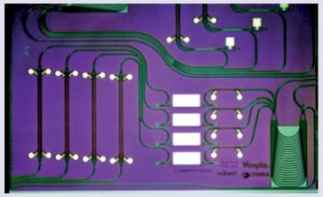


### Variety of lasers



Widely tunable ring laser

Variable repetition rate pulse laser

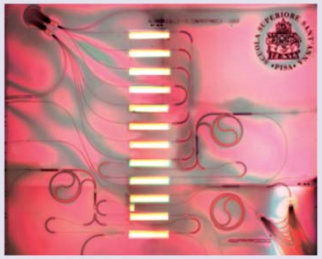


Filtered-feedback multi-wavelength laser

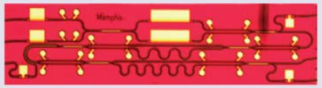
tunable laser with integrated MZI modulator

### QPSK receiver

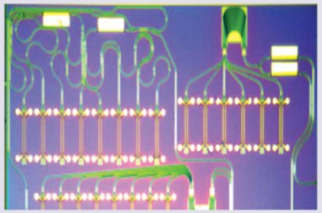
### Optical data handling



All-optical regenerator for constant envelope WDM signals

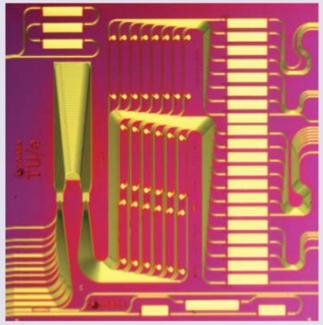


WDM to TDM Trans-Multiplexer

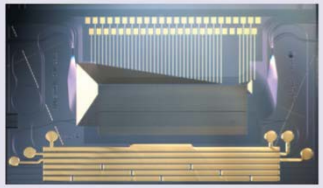


Pulse serialiser

### Medical and bio-imaging



Pulse shaper for bio-imaging



Integrated tunable laser for optical coherence tomography



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# A generic foundry model in Photonics

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