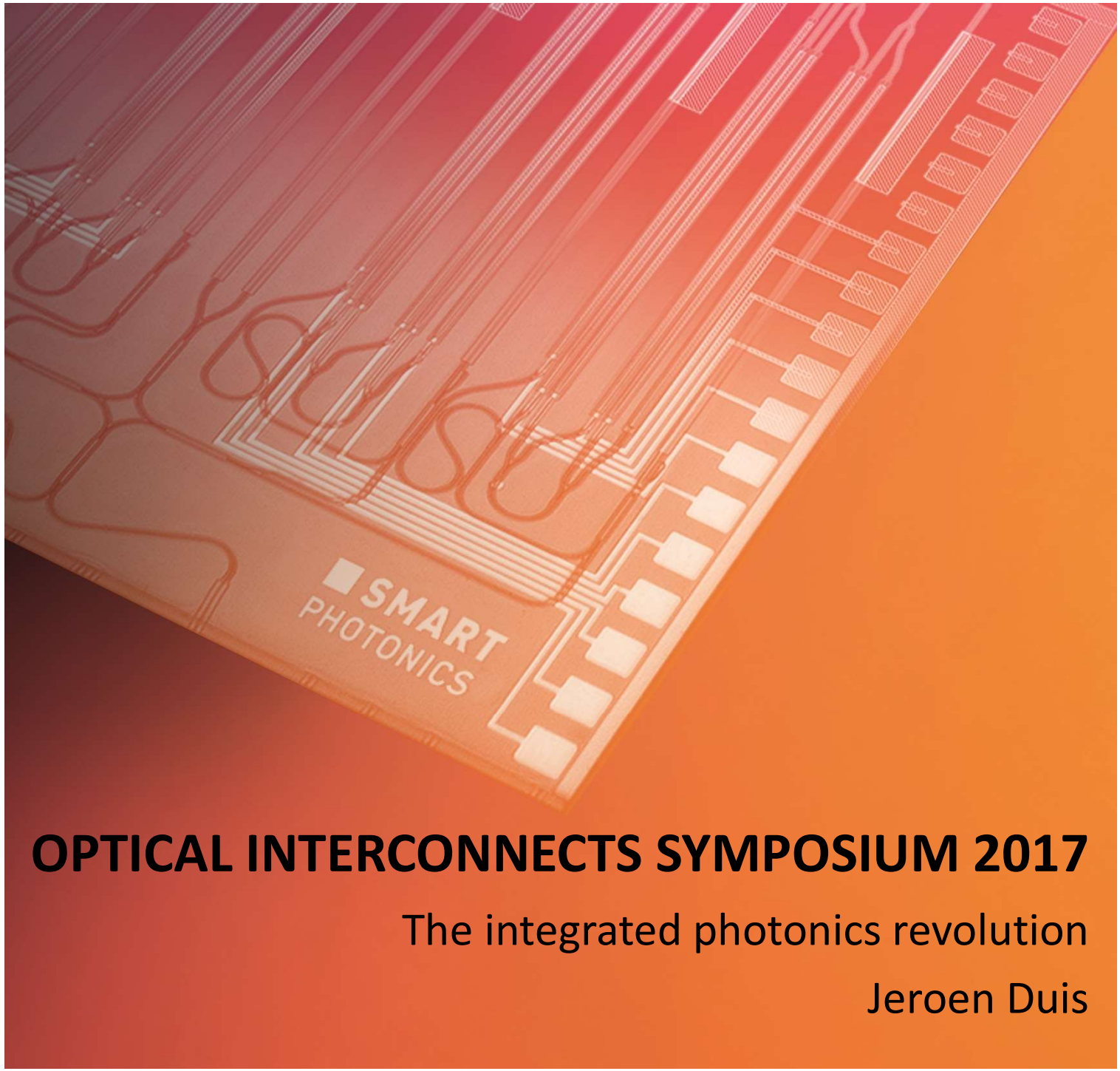

OPTICAL INTERCONNECTS SYMPOSIUM 2017

The integrated photonics revolution

Jeroen Duis

SMART PHOTONICS
Independent InP Foundry

OUTLINE

- Introduction to SMART Photonics
- Photonic integration
  - Generic platform
  - Applications and examples
  - MPW service
- Processes
- Future developments
- Summary

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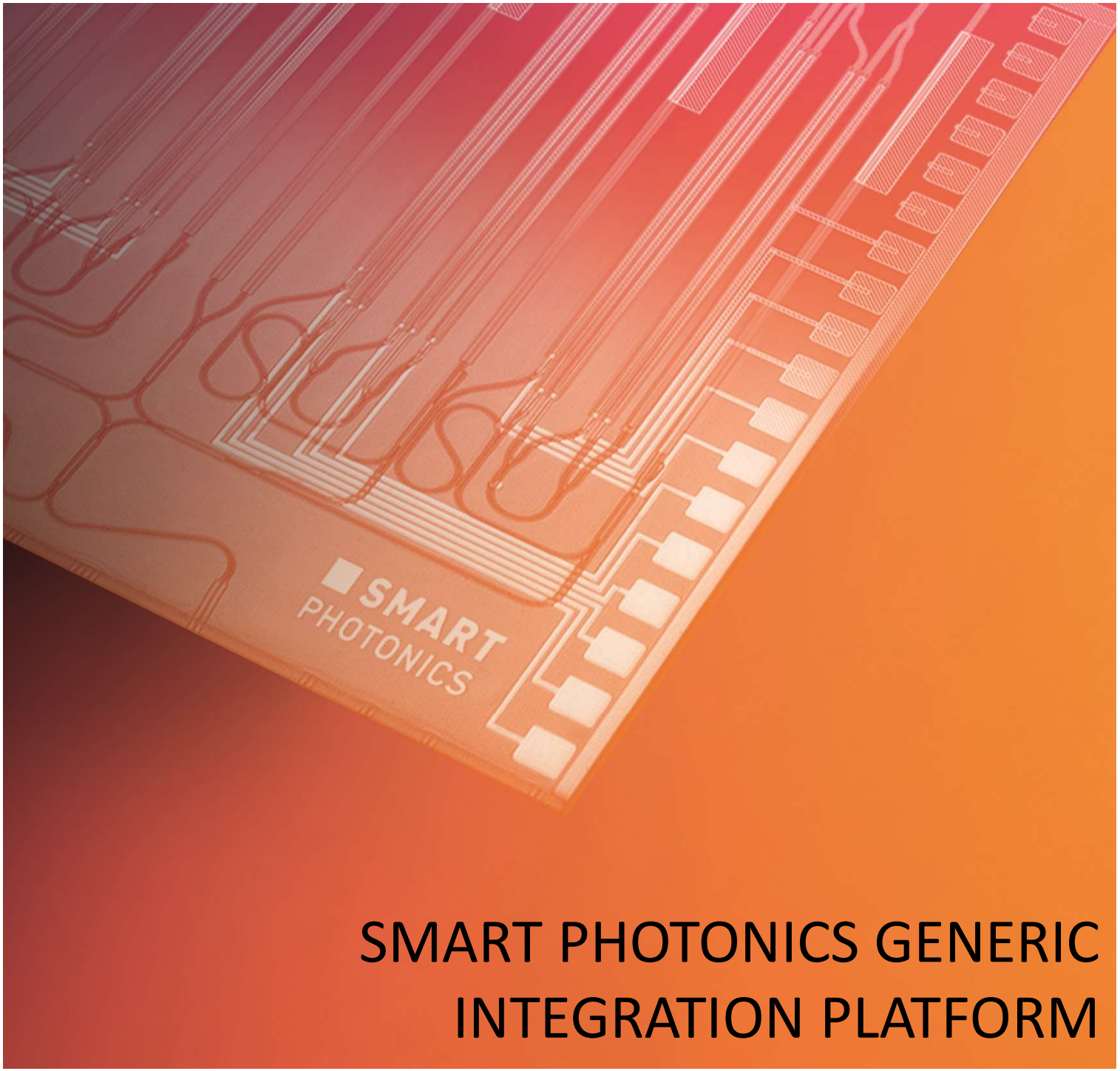

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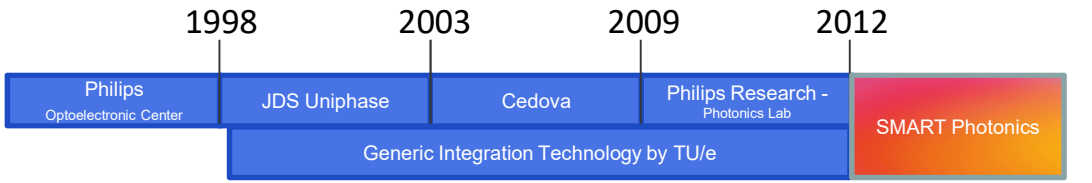
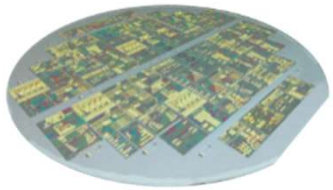
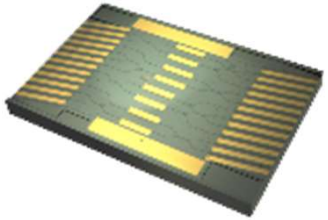
SMART PHOTONICS GENERIC INTEGRATION PLATFORM

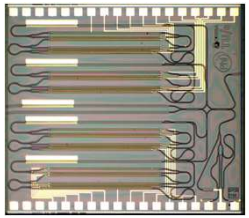
OUR HISTORY

SMART Photonics B.V. founded in 2012









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WE OFFER

- Processing services for making photonic components on InP
  - Both discrete and PICs
- Photonic components are used for
  - Tele- and Data communications
    - To meet technology requirements (Gb/s and J/bit)
    - To meet cost requirements (€/ bit and €/mm^2)
  - IoT
    - Sensing applications in Medical, Aviation, Automotive, Space, Machining etc.
  - Imaging/ Spectrum analysis etc.

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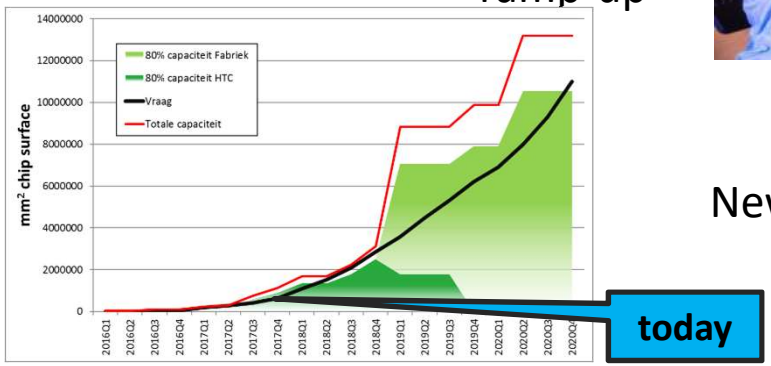
WE ARE MOVING FAST!

2012
Start-up

2015
Opening production cleanroom at HTCE

2016/2017
Production ramp-up



today

2019
New factory

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OUR FACILITIES

- SMART Photonics

  @High Tech Campus

  - 570m^2 3” Production cleanroom (Class 1000)
    - Processing and epitaxy

- SMART Photonics

  @NanoLab cleanroom Eindhoven

  - 850m^2 Fully equipped R&D facility

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OUR CAPABILITIES

Epitaxy	Multi-wafer MOVPE reactors for base wafer growth, regrowth and overgrowth
Lithography	High throughput, high resolution (>100 nm) - DUV scanner 0.7 µm projection litho – I-Line stepper High resolution (<100 nm) – E-beam 0.6 µm contact litho – contact aligner
Etching	Cassette-based wet etching ICP for single and multi-wafer etching RIE dedicated tools for photoresist, dielectric and polymer etching
Dielectrics	PECVD for SiO_x and SiN_x
Metallization	E-beam evaporation Sputtering Plating
Back-end	Grinding and polishing Scribe and break Optical coatings

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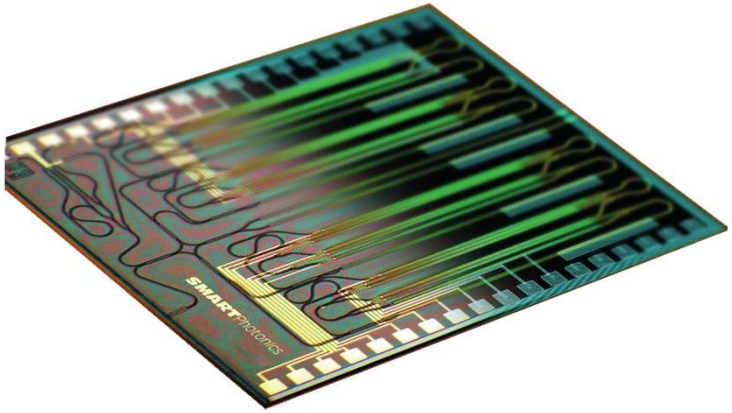
WHAT MAKES US SPECIAL

- People
  - Knowledge and experience in photonics and semiconductor processing
- Capabilities
  - Full process from Epi to coating of facets
  - Unique tools (3” ASML scanner for high resolution litho)
- Proposition
  - Unique PIC technology
  - Buried Hetero DFB process



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SEMICONDUCTORS

Products		Existing	New
	New	**Extended functionalities** High tech equipment Games Medical equipment Mobile Phones	**New functionalities create new applications** Computers/Notebooks Tablets Smart phones Google/Facebook
	Existing	**Same functionality on smaller footprint** High tech applications Radio Calculator TV	**Same functionality in new applications** Aviation/Space applications Car and mobile radio Flat screens
Markets			

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INP PHOTONICS

Products	Existing Markets	New Markets
New	**Extended functionalities** FBG for Medical sensing and positioning 5G Antenna systems LIDAR	**New functionalities create new applications** Gas detection What else?
Existing	**Same functionality on smaller footprint** Sensing for high tech applications (FBG/Analyzing) Telecom/Datacom	**Same functionality in new applications** Fiber to the chip FBG in aviation/ pace Point of care medical analysis

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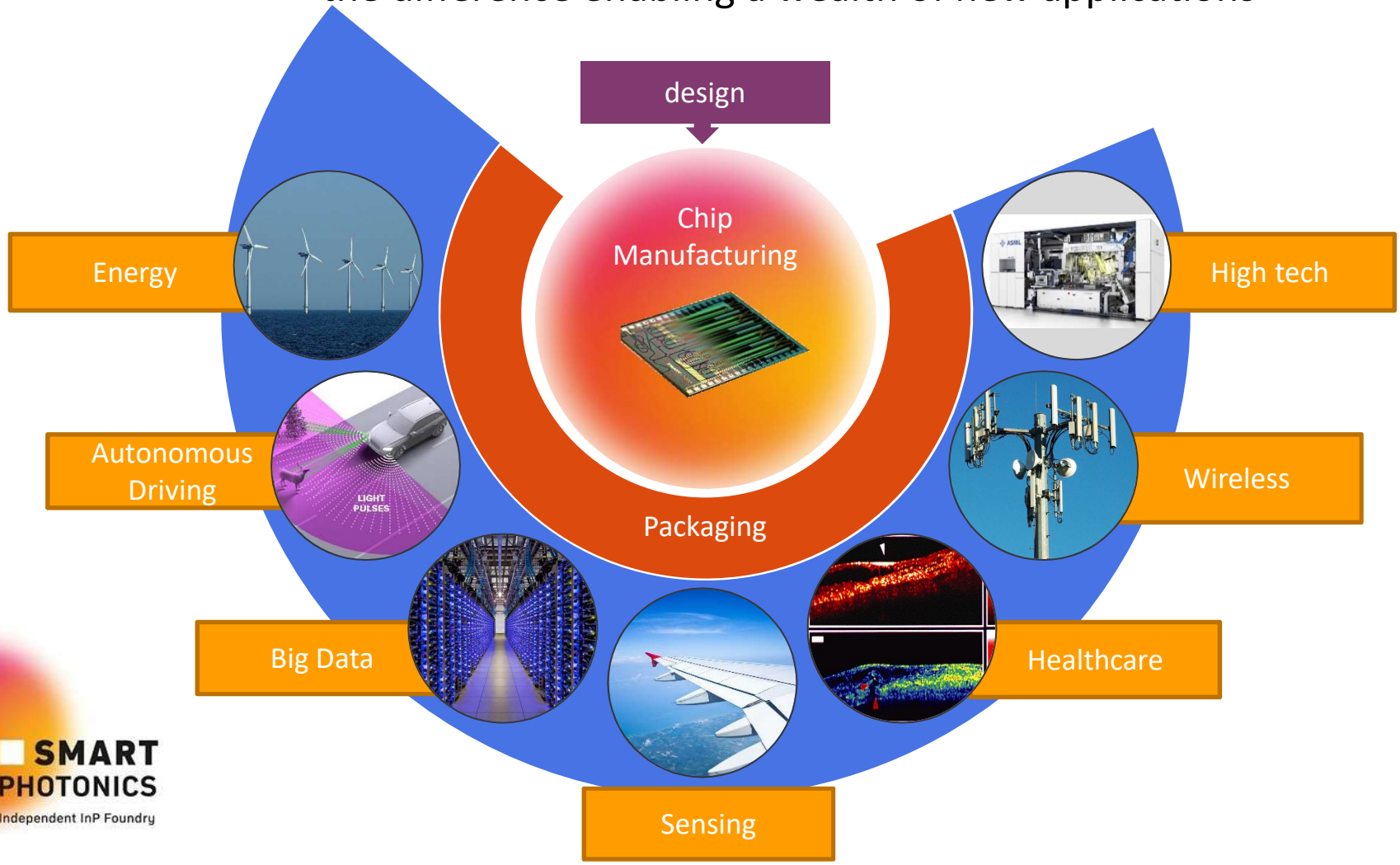
PHOTONIC INTEGRATION MAKES THE DIFFERENCE!

- The SMART Photonics Generic Integration Technology makes the difference enabling a wealth of new applications



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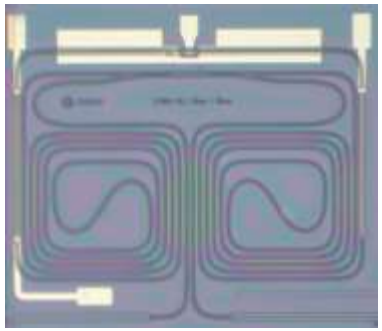
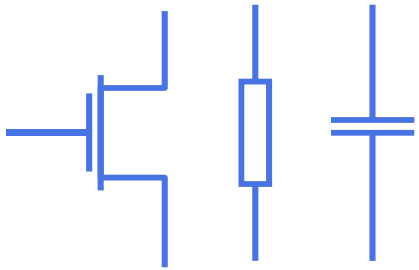
GENERIC INTEGRATION PHILOSOPHY

Electronic integration

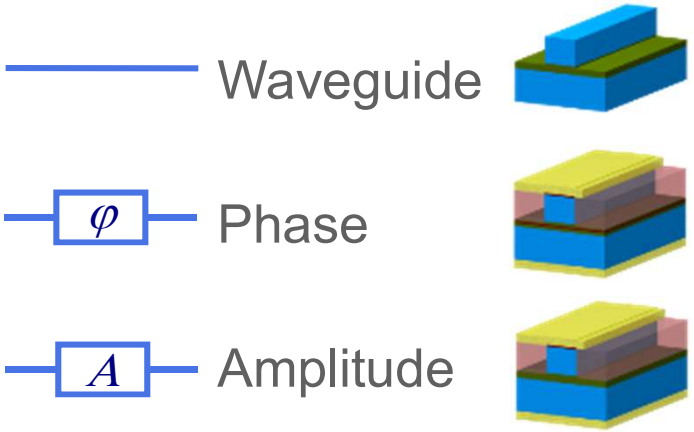
Photonic integration



Basic elements:



Basic elements:



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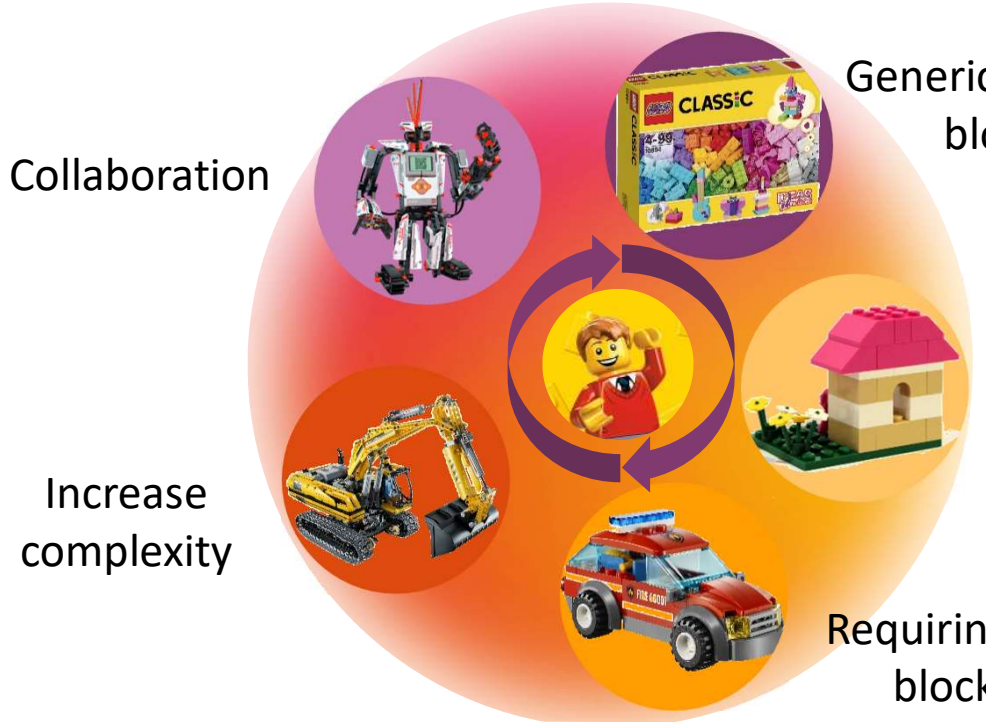
OUR GENERIC INTEGRATION PLATFORM

- *Standardized industrial* integration process
- Design on *functional level* by using *building block* approach
- Software design kits for fast and accurate design
- Multi-project wafer (MPW) runs for *fast* and *cost efficient* prototyping
- Enables *fast up-scaling* to high volume manufacturing



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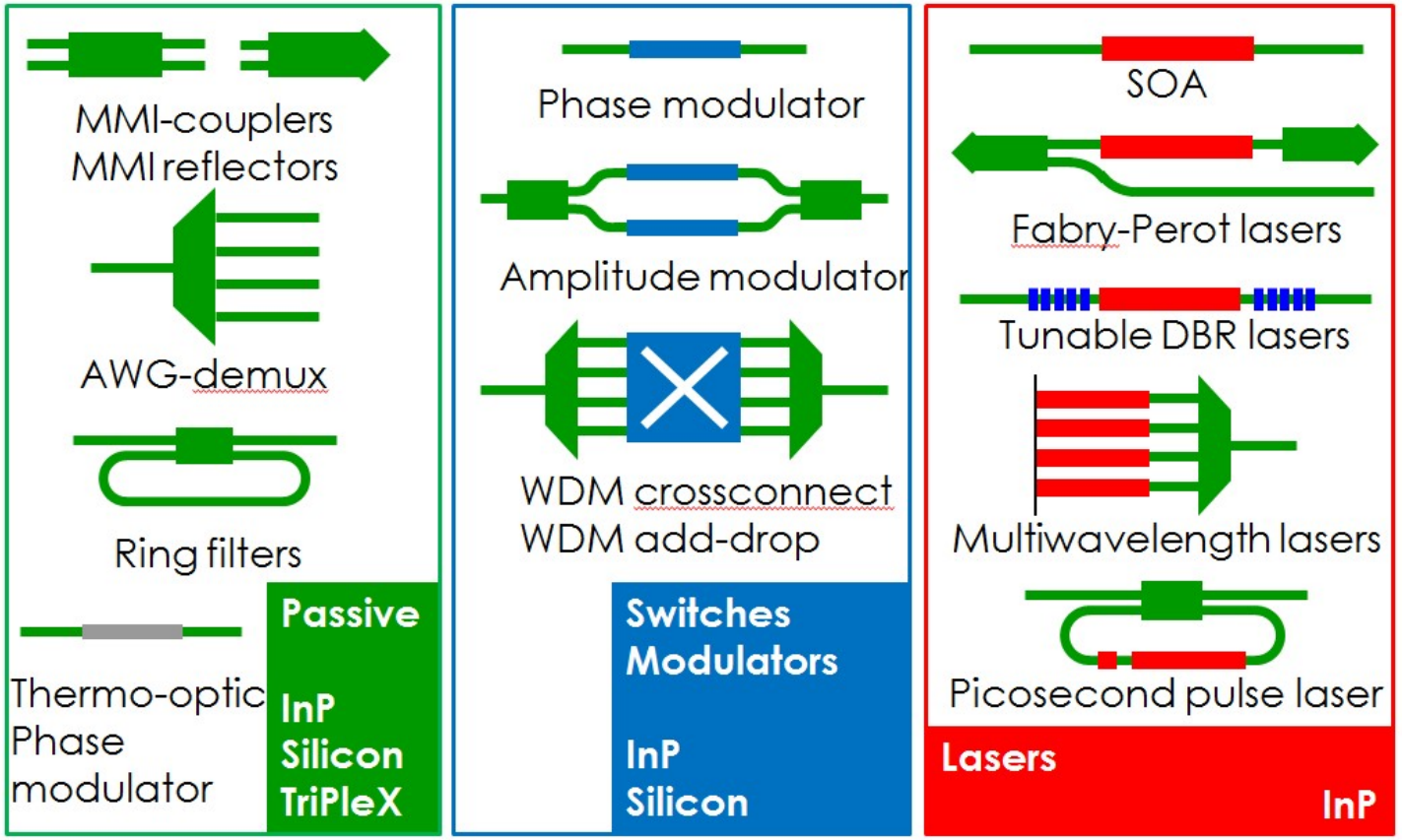
INP PLATFORM CAPABILITIES



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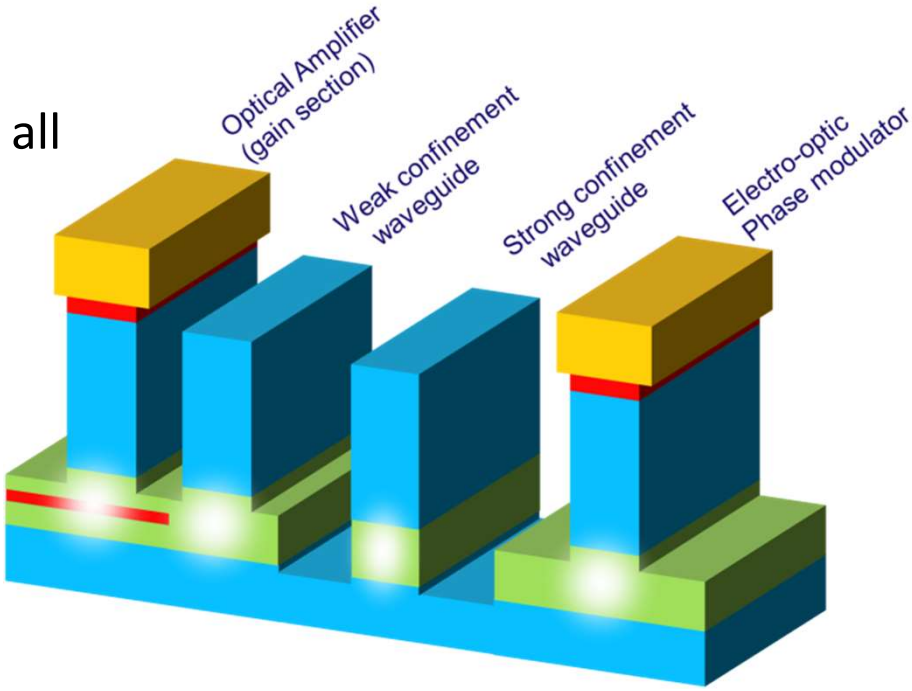
SMART PHOTONICS INTEGRATION PLATFORM

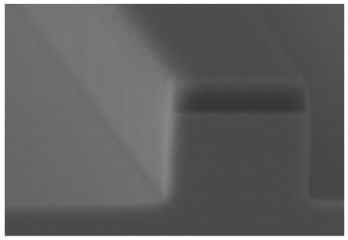
InP platform:

Monolithic integration of all functionalities!

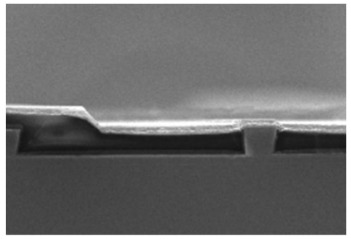
Si Photonics

InP Si Electronics

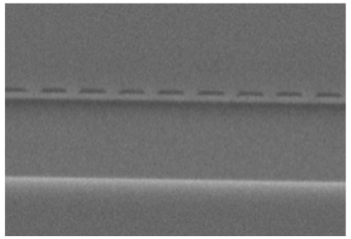




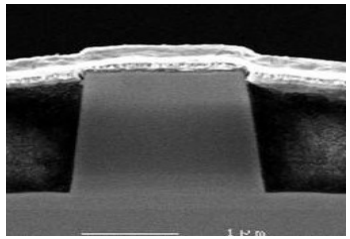
waveguides



phase modulators



gratings



Amplifiers/ laser gain section

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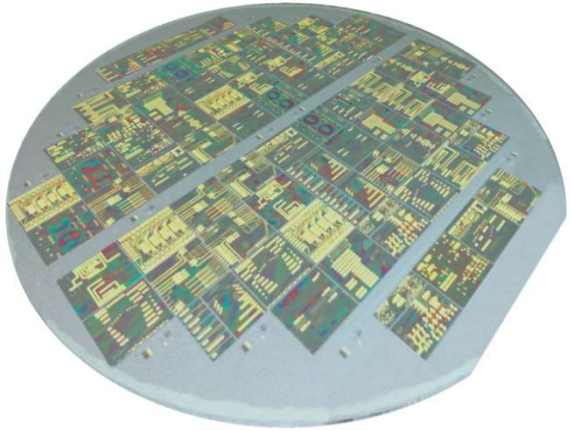
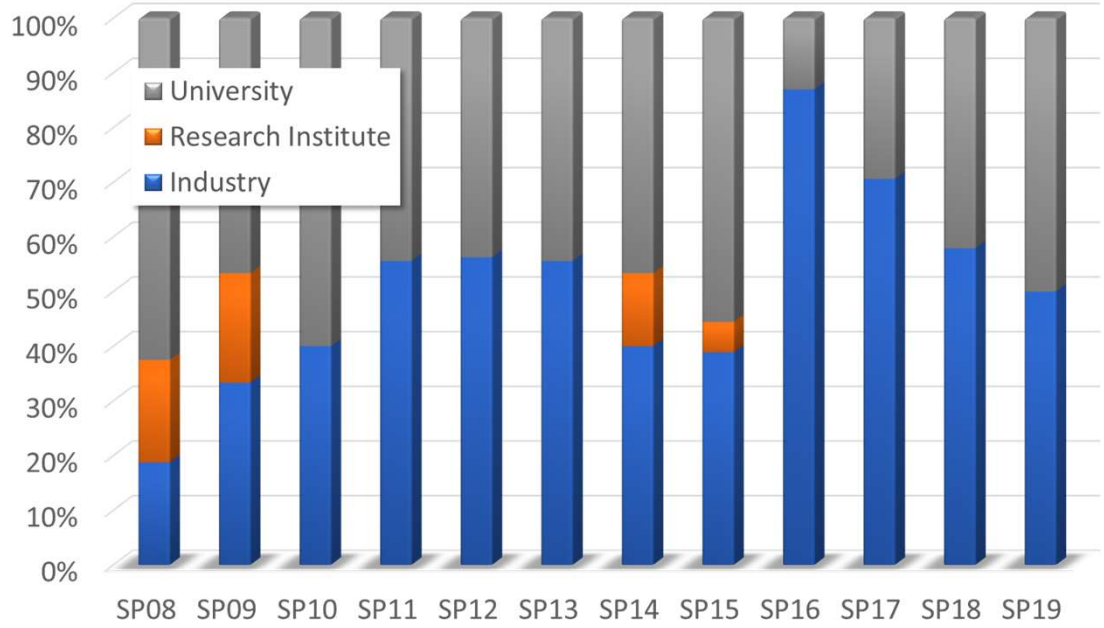
OUR MPW SERVICE

- World's first commercial MPW run on InP in July 2013
- MPW run starts every quarter
- Low threshold access to a new technology
- Over 200 designs fabricated!





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PDK: BUILDING BLOCK LIBRARY

- Process Design Kit is available
  - For **circuit simulation** and **mask design**
  - **Design manual** and **Functional** building block description
  - Full **layout-aware** design flow
  - Access via **state of the art software** tools

PhoeniX Software
Solutions for Micro and Nano Technologies

VPIphotonics
DESIGN AUTOMATION

Photon Design

nazcadesign
photonic IC design framework

Open source, lowering barrier to enter the PIC space

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APPLY NOW FOR THE PHOTONDELTA MPW INNOVATION GRANT

- PhotonDelta, in partnership with JePPix and Brainport Development, is now launching a photonics chip incentive scheme. They are reaching out to help global high-tech companies, large and small, design and build next-generation photonics chips specific to their business.
- If you're planning to fabricate your photonics chip with companies in Brabant, you may qualify for a PIC Innovation voucher, worth up to € 4,250.00. This is half the cost of an MPW run

- For more information check www.photondelta.eu

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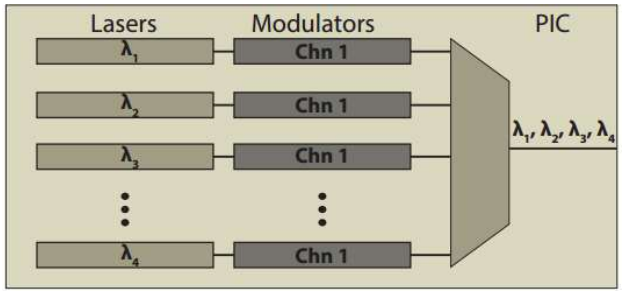
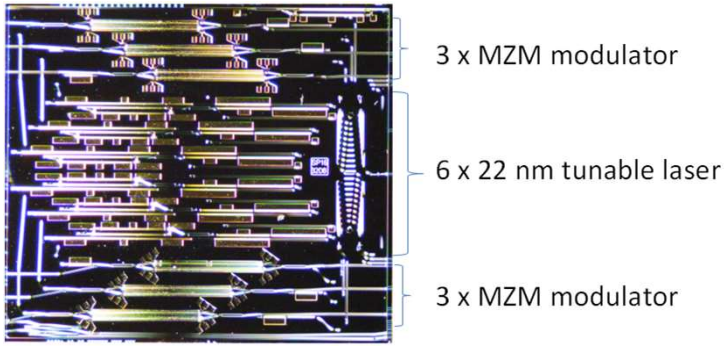
PhotonDelta
Integrated Photonics Ecosystem

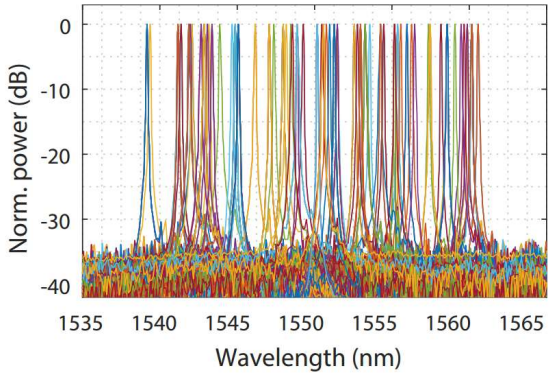
EXAMPLE: 100 GB/S TRANSMITTER

>100 Gb/s transmitter on single chip, fabricated in our powerful MPW platform

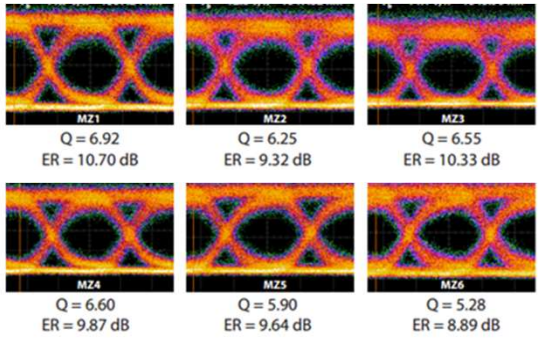




Wavelength tuning



20 Gb/s per channel



W. Yao, COBRA

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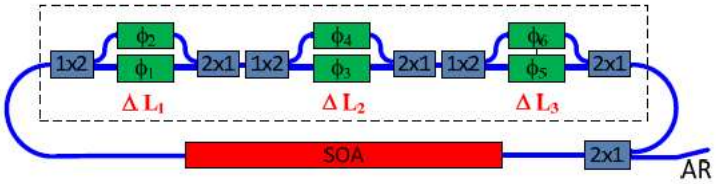
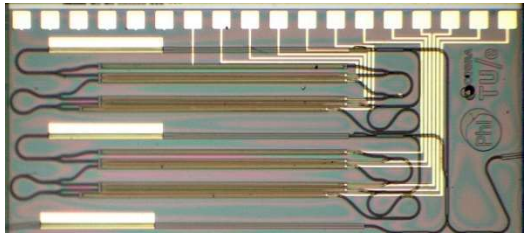
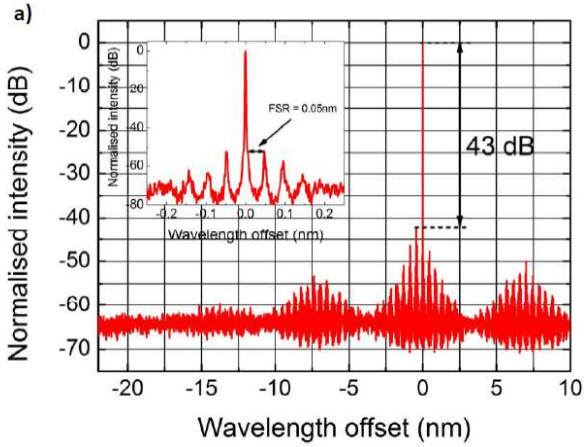
EXAMPLE: WIDELY TUNABLE LASER

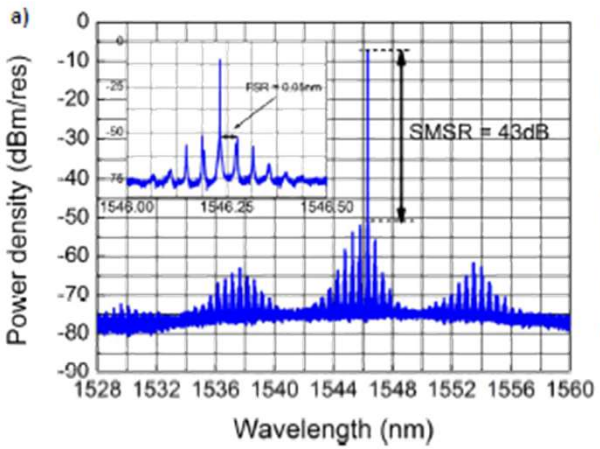


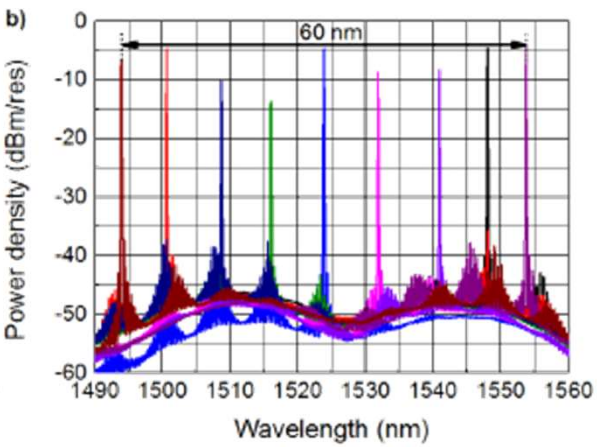


Simulations



Prototype





S. Latkowski, COBRA

Advanced PDK allowing first-time-right prototyping

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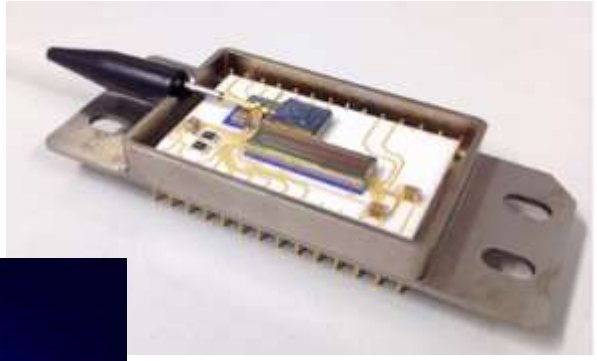
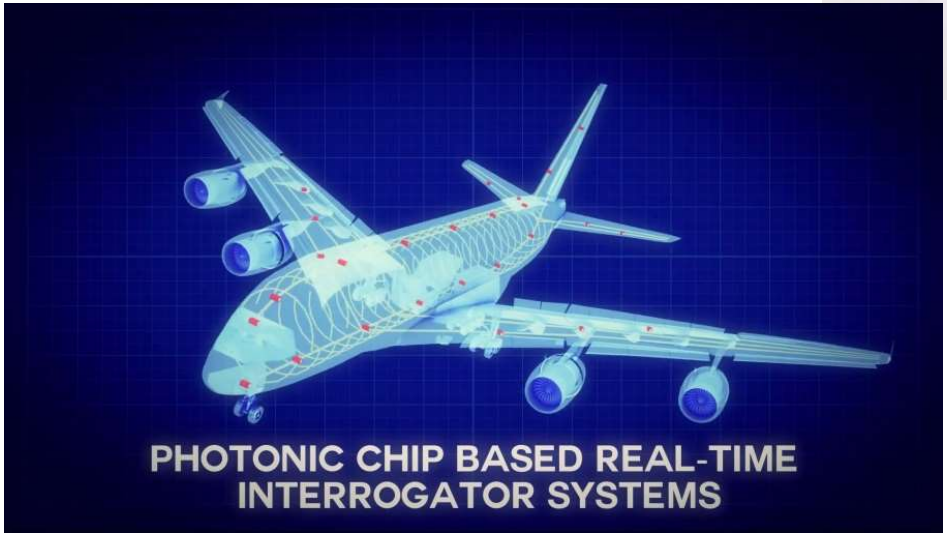
EXAMPLE: FBG INTERROGATOR

Distributed temperature and
strain measurement with embedded
fibers + PIC readouts





Wider possibilities for
structural
health monitoring

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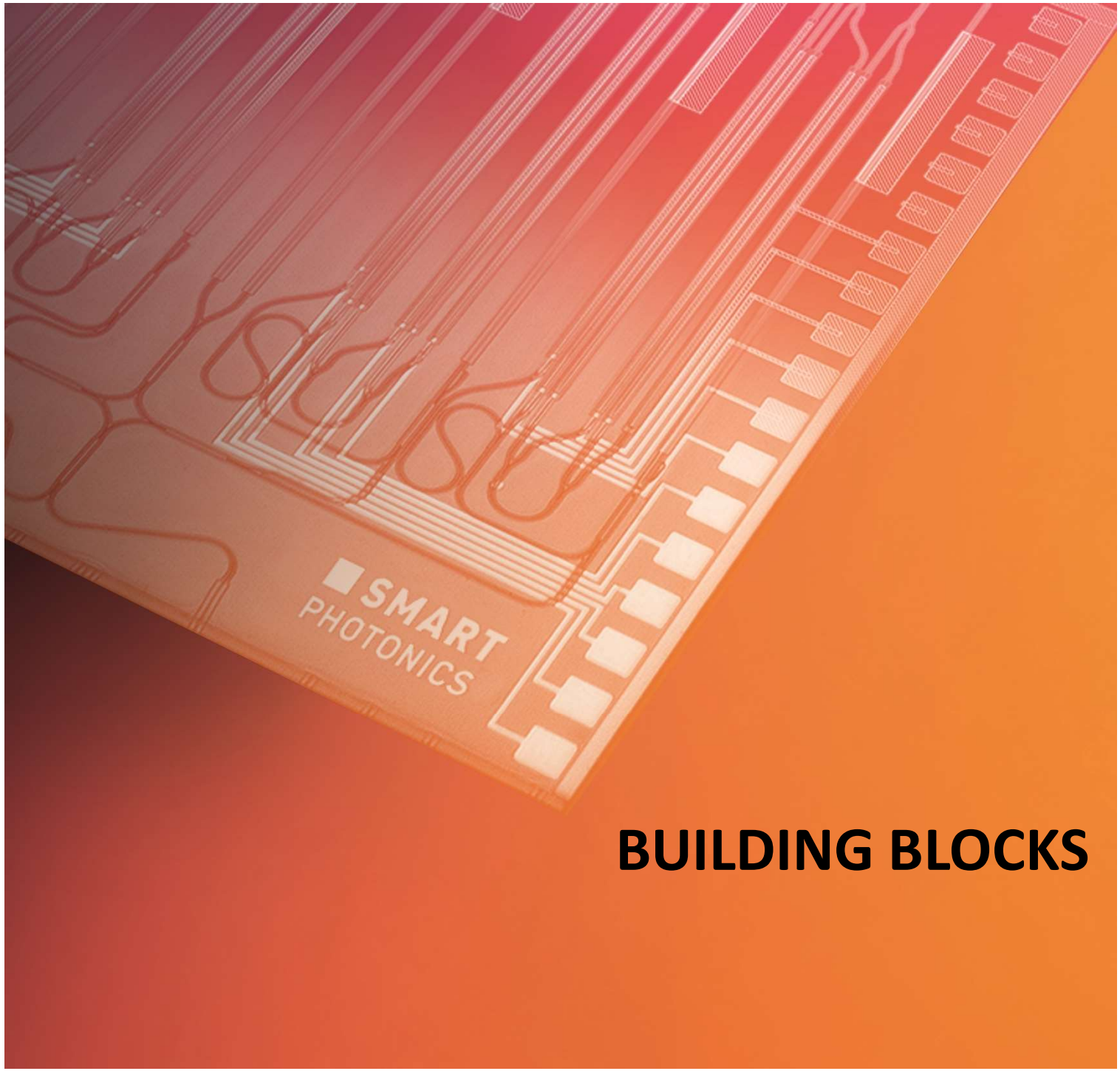

BUILDING BLOCKS

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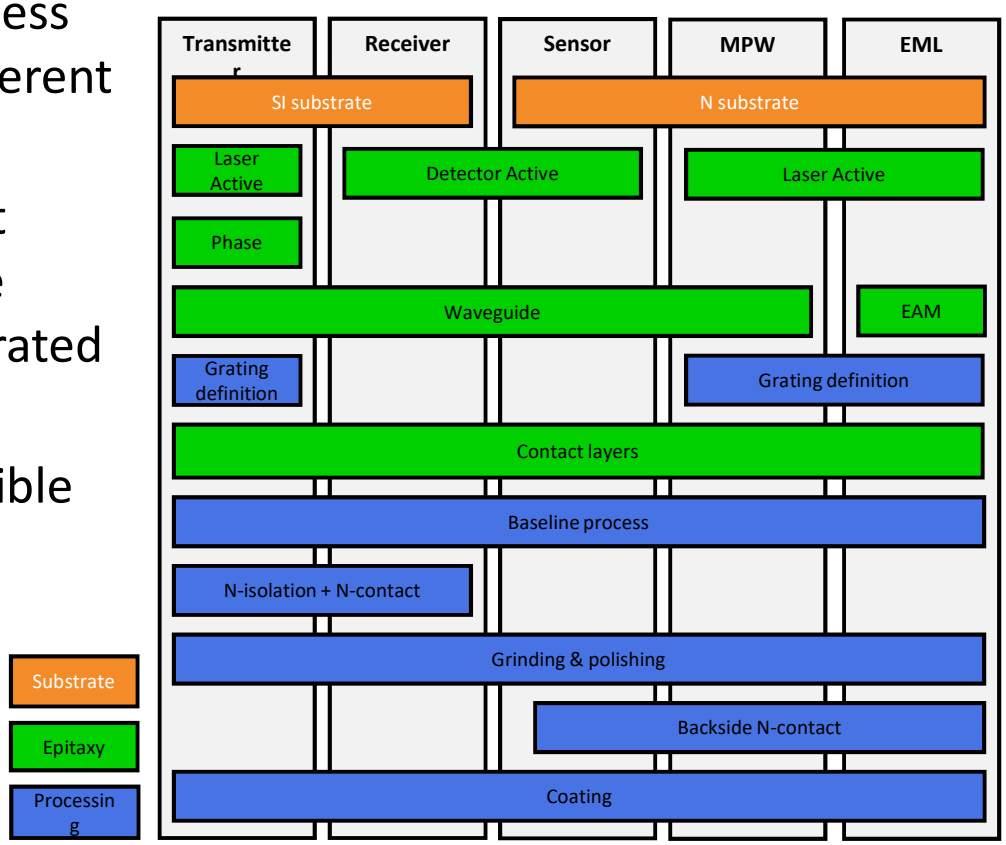
PLATFORM AND CUSTOMIZATION

- Different flavours of the generic process available for different applications
- Up to 3 different materials can be epitaxially integrated
- Customized layerstacks possible



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SHORT TERM EXECUTION PLAN FOR MPW

Technologies	2017				2018			
	SP19	SP20	SP21	SP22	SP23	SP24	SP25	SP26
High resolution waveguide definition								
DBR Gratings								
High speed platform 30Ghz performance								
Spot Size Converter								
EAM								
		Shipping	In Fab	Starting	Commercial Introduction in MPW			

- 4 month fab time -> 2 month fab time
  - Doubling number of design iterations per year from 2 to 4
- Scanner implementation -> SP20 -> All time low loss
  - 1,2 dB/cm shallow etch
  - 1,6 dB/cm deep etch
- Increased number of MPW chips from 6 to 8 for same price
- Multiple chip sizes

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SUMMARY

- Generic Integration Process available
  - Transmit and receive platform
- Large range of applications demonstrated
- Commercial, low threshold access to technology via quarterly MPW runs for proof of concept
- Industrial scale, production ready process

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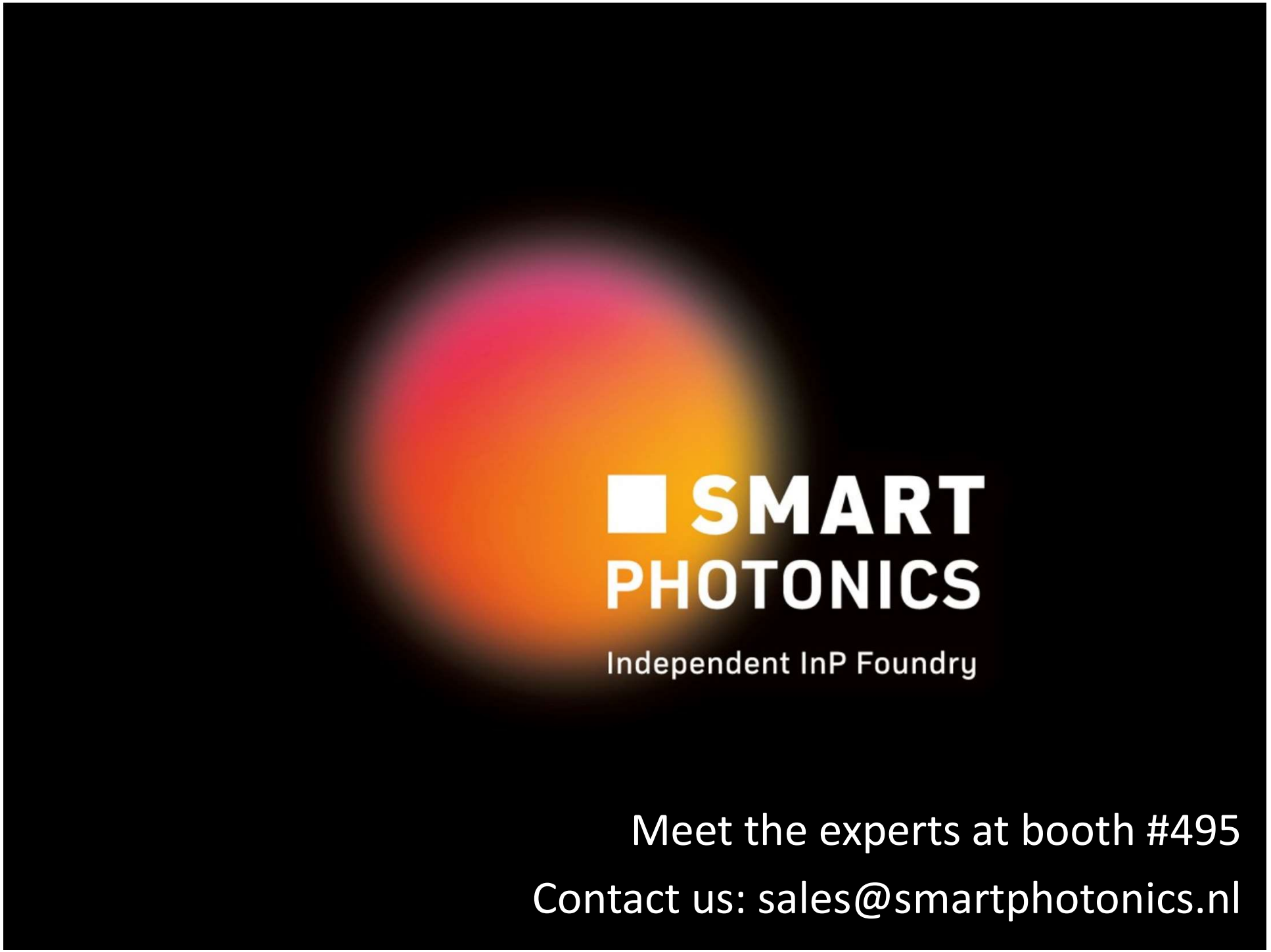
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Meet the experts at booth #495
Contact us: sales@smartphotonics.nl