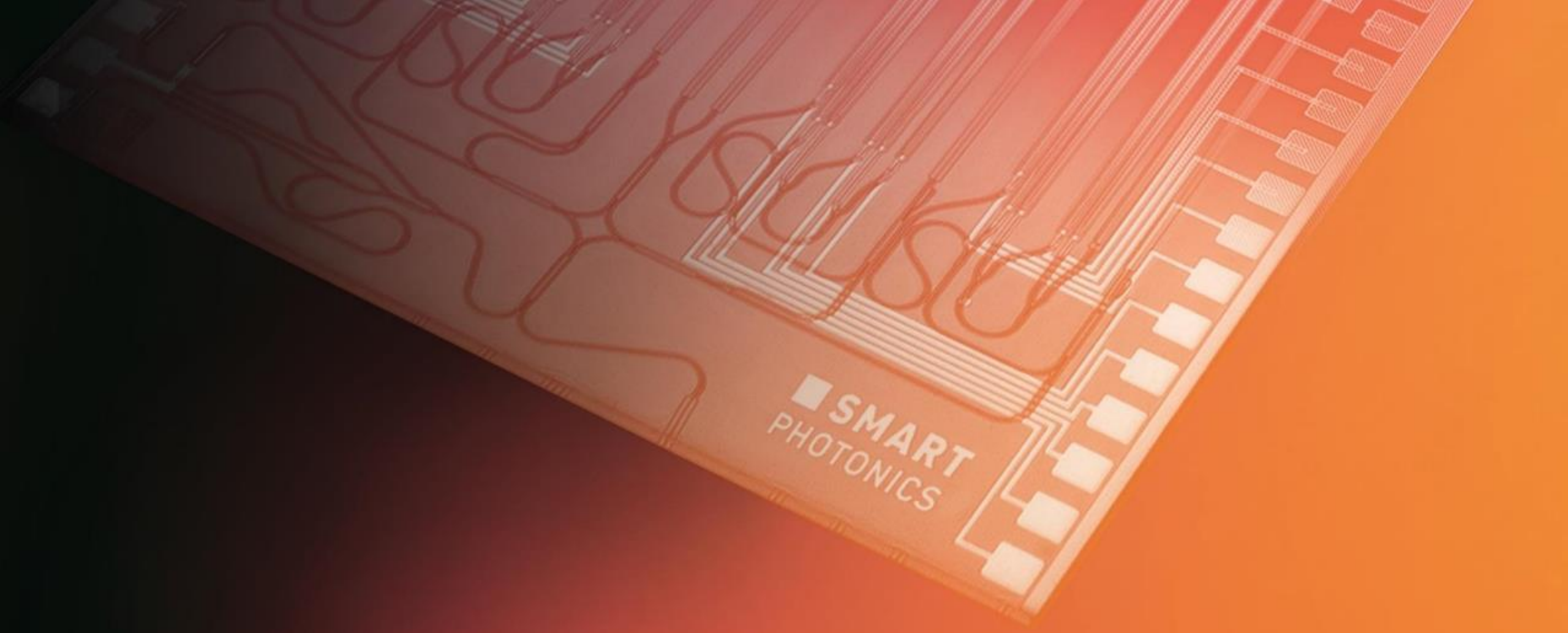
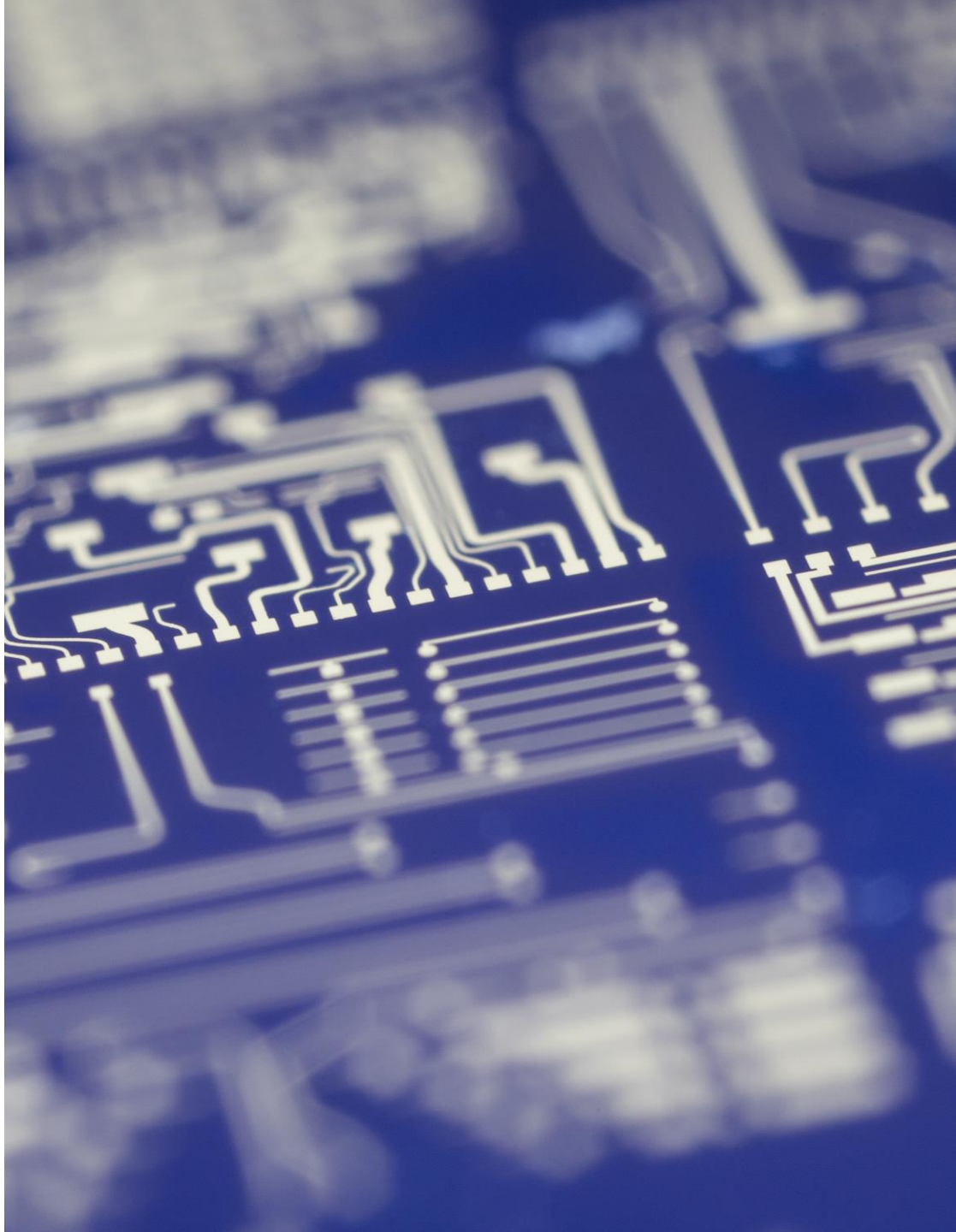


SMART PHOTONICS

EPIC General meeting – April 7th 2022

AGENDA

- Introduction to SMART Photonics
- Industry developments
- InP pilot line building
- Dedicated Wafers and Multi-Project Wafer Runs
- PDK approach
- Summary



SMART PHOTONICS

OUR HERITAGE: MADE IN EINDHOVEN

PHILIPS

Early 1980s: start of activities

1991

First commercialization of components

1994

TU/e

Eindhoven University starts R&D on monolithic integration

JDS Uniphase

Acquisition by Uniphase for €1.2B

1998

2002

NanoLab

Established first shared facility for integrated Photonics prototyping

SMART PHOTONICS

2012: Spin-off as independent pure-play foundry

2013

First Multi Project Wafer produced

2017

Move to own cleanroom at High Tech Campus

2020

New Investment for capacity ramp up

SMART PHOTONICS

VISION AND MISSION FOR SMART PHOTONICS

OUR VISION

Integrated Photonics is used everywhere around us and improves the quality of our everyday lives.

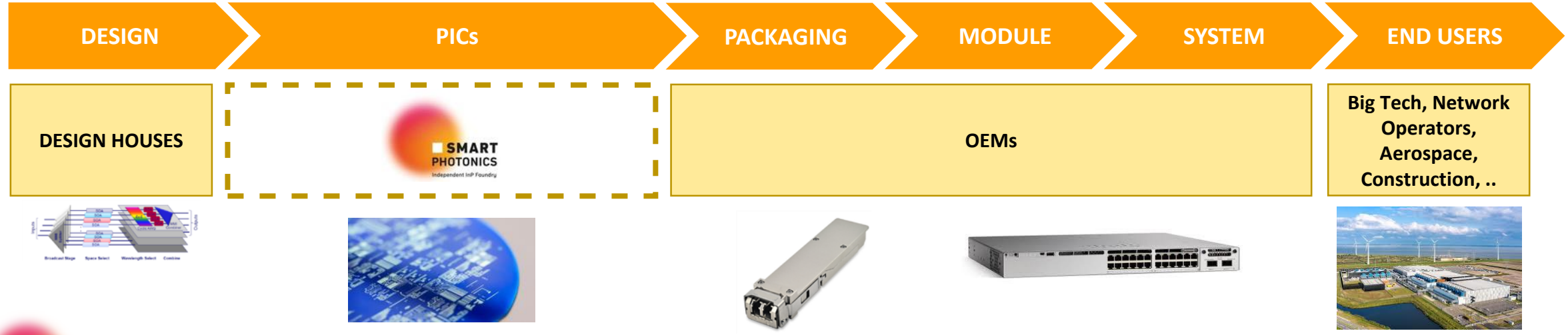
OUR MISSION

To be the leading foundry and development partner in integrated photonics that works closely together with our customers to create innovative products that improve people's lives.

SMART
PHOTONICS

SMART PHOTONICS

- We are producing Photonics chips: chips based on light instead of electronics
- We are the first player offering **production of integrated photonic chips as a foundry**.
- Our customers are predominantly OEMs and system companies
- Providing prototyping services and volume production



SMART PHOTONICS

PHOTONICS FOLLOWS SEMICON IN VALUE CHAIN DEVELOPMENT

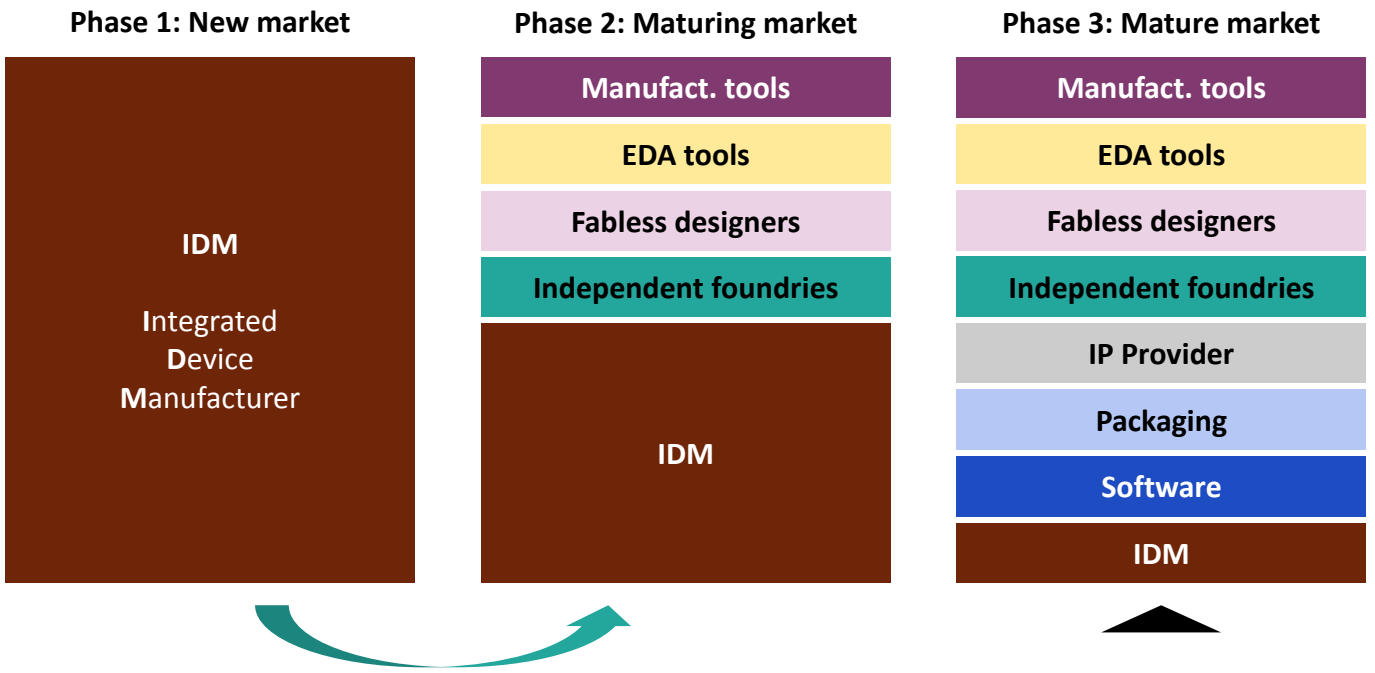
Trends in the market…

Fast growing demand of customer without manaufacturing capabiilty ✓

Development of new and more complex designs ✓

Consolidation in the industry ✓

… driving a similar shift from integrated manufacturers to foundries



Photonics is maturing *as companies enter the market requiring independent capacity with the broad scope of PDKs needed, which IDM's can't provide…*

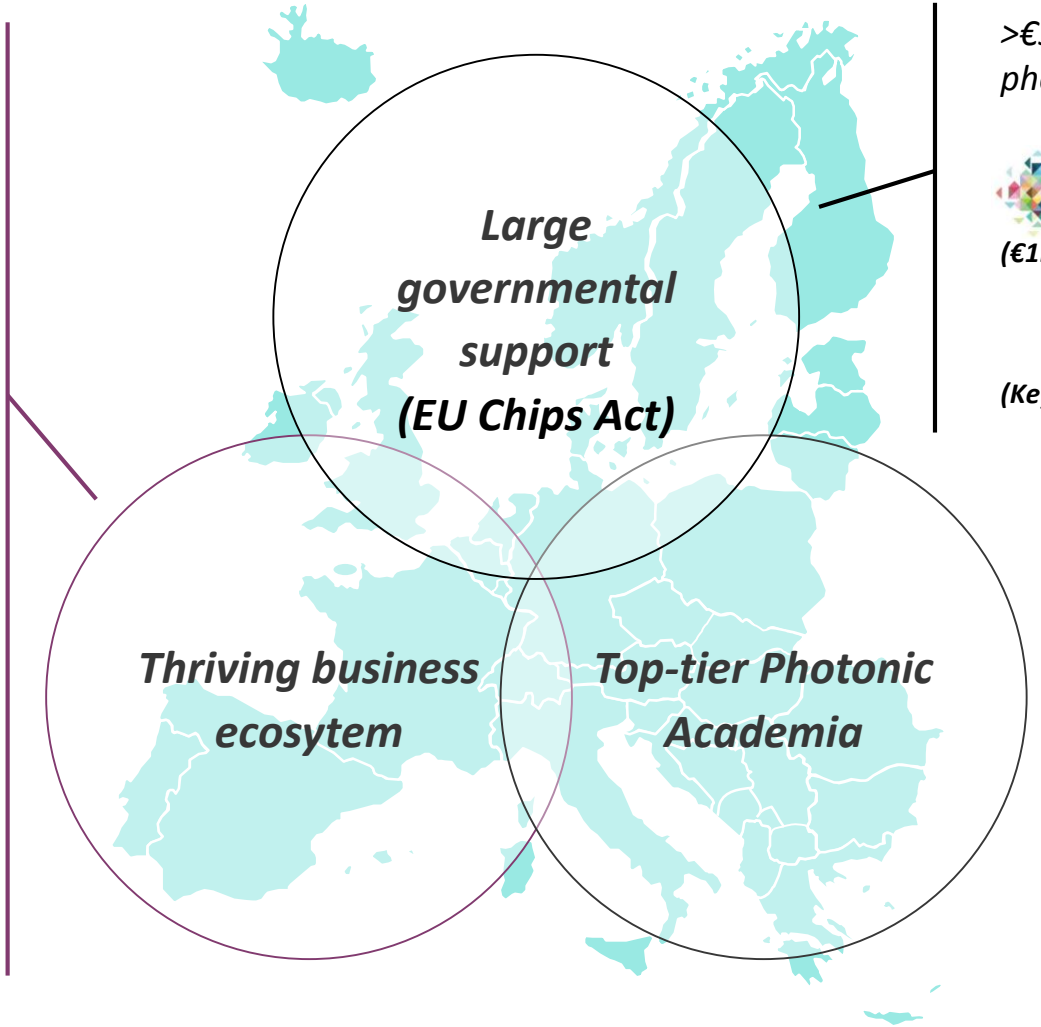
… and will eventually reach semiconductor maturity, ***where foundries represent an ~50% market share***

SMART PHOTONICS

GEOPOLITICS DRIVES EU TO STRONGLY INVEST IN PHOTONICS

Large ecosystem of fabless designers, system integrators, design tool providers, packaging companies, …

BRIGHT Integrated PHOTONICS
eblanaphotonics
phix
COMPOUND SEMICONDUCTOR TECHNOLOGIES
Almae Technologies
WAVE PHOTONICS
aryballe
EFFECT PHOTONICS
DAS Photonics
OMMIC innovating with III-V'S
IQE
iPRONICS Programmable Photonics
LUCEDA PHOTONICS
LIONIX INTERNATIONAL
LIGENTEC
MBRYONICS
VPIphotonics
ALIGHT technologies
VERTILAS
OPTOSCRIBE
SCINTIL PHOTONICS
VLC PHOTONICS
AIXTRON
bay photonics Advanced Photonics Assembly and Packaging



>€3B available in EU and NL for Integrated photonics infrastructure (focus on foundries)

PhotonDelta Gateway to Integrated Photonics
PHOTONICS21
InPULSE
(€1B Dutch Photonics fund)
PhotonicLEAP
PhotonHub Europe
(Key enabling technology)
IPC
Interreg North-West Europe OIP4NWE

Many research institutes at the cutting-edge of Integrated Photonics ready to commercialize innovations

CARDIFF UNIVERSITY Institute for Compound Semiconductors Sefydliad ar gyfer Lled-ddargludyddion Cyfansawdd
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
FBH Ferdinand Braun Institut
Fraunhofer
Photonics France
TNO

SMART PHOTONICS

FUNDING 2020/21

- Realized major funding round of € 35 M – June 2020
- Added € 13 M non-equity financing in June 2021

Major targets

- Demonstrate Low Volume Manufacturing
- Increased capacity and yield
- Customers in production phase

SMART PHOTONICS

STATE OF THE ART MANUFACTURING FACILITIES

SMART Photonics at High Tech Campus Eindhoven

- 1400m^2 Production facility
  - >1000m^2 3" Production cleanroom (Class 1000)
  - Back-end, testing and layer growth capabilities

SMART Photonics at Nanolab

Eindhoven University of Technology Science Park

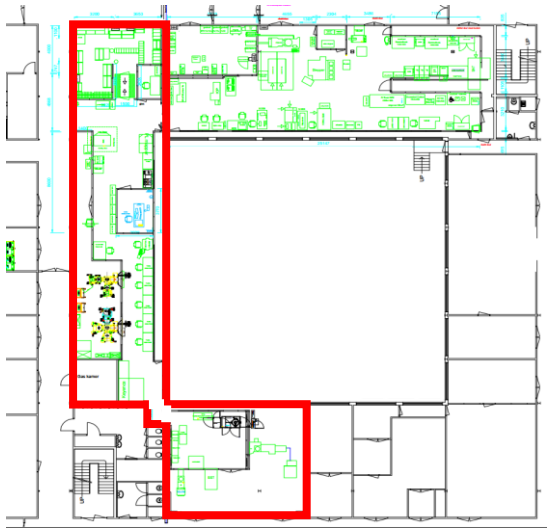
- 850m^2 Fully equipped R&D facility

Processing and epitaxy expertise at both sites

SMART PHOTONICS

BUILD-OUT IN NUMBERS

- 25 Tools
  - ~60 vendors contacted and ~75 tools assessed
  - More than 2000 pages of specification
- Close to 200 process steps to be transferred, modified, reconfigured or newly developed
  - Move from shared facilities at University to own facility
  - And/or between tools
  - Fully new processes
- More than 2 x size of cleanroom
- Building the ICT infrastructure to monitor, control and plan the line
- Close to 60 new FMEA's, Control Plans and SPC implementations
- Integrate/train 70 new people
- And deal with corona....



SMART PHOTONICS

SMART IS COVERING THE OVERALL PROCESS

Growth active/passive materials	Definition and etching of (waveguide) structures	Isolation & Passivation	Planarization & Metallization	Final process steps
▪ Epitaxial deposition of InGaAsP materials	▪ Lithography ▪ Scanner & stepper ▪ Semiconductor etching	▪ Deposition and etching of SiN / SiOx layers	▪ Planarization for RF performance ▪ Deposition of P/N contacts	▪ Grinding & Polishing ▪ Dicing & Antireflection coating ▪ Cleaving into single ICs

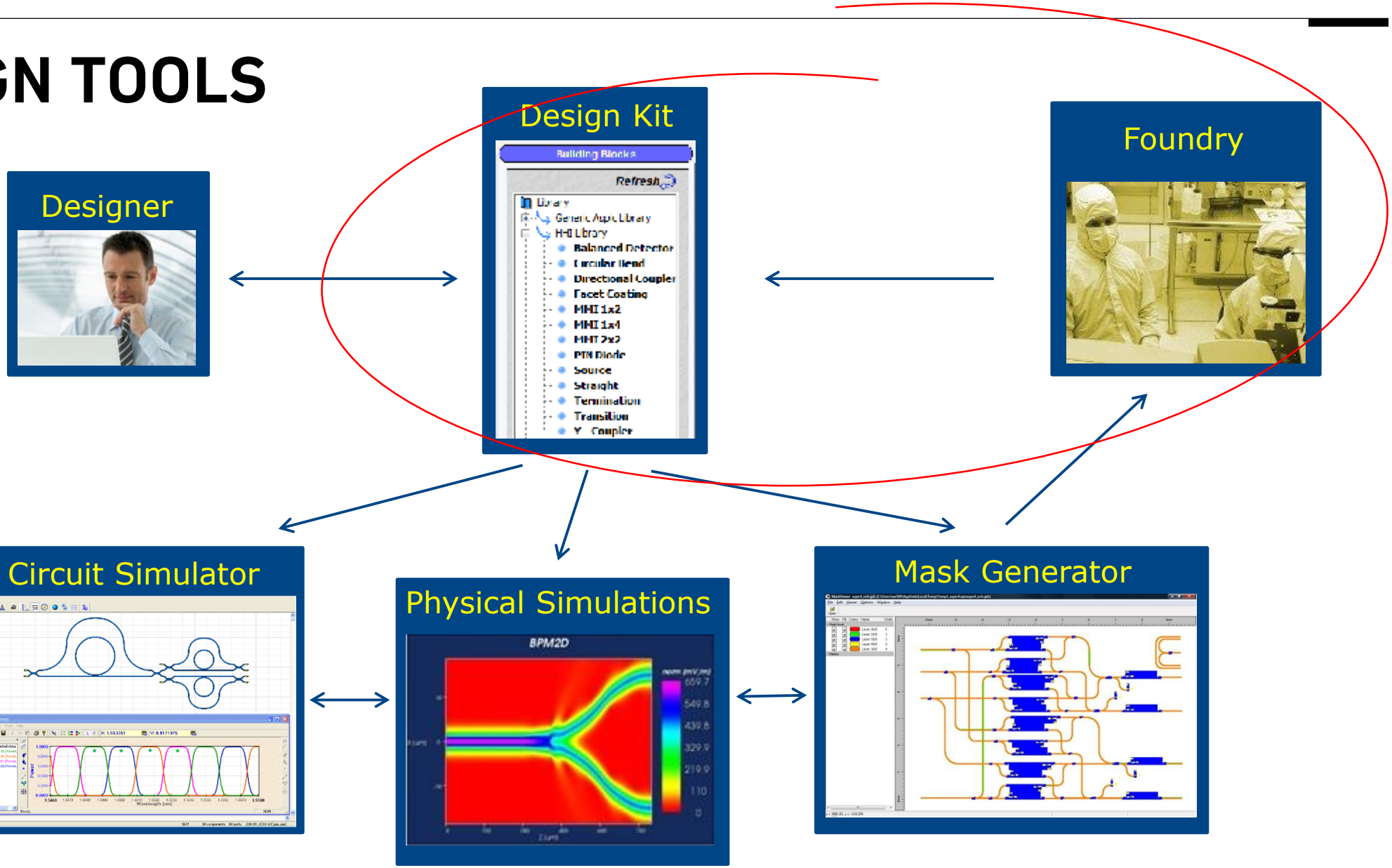
STATUS AND GROWTH PLANS

- Release of production line
  - All equipment released
  - Transition from manual process to semi-automated realized. Nearly all process modifications released.
  - Scale up to 3k wafer/yr (3”) by end of 2022, 5k wafers/yr by end of 2023
  - Production line is 4” capable – first demonstration in 2022
  - Split production line and R&D facilities
- Increase wafer and die testing capabilities

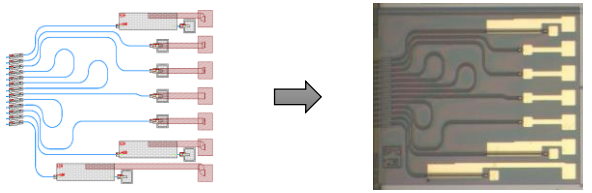
- Longer term, we intend to expand further, based on blue-print of current facility

SMART PHOTONICS

DESIGN TOOLS

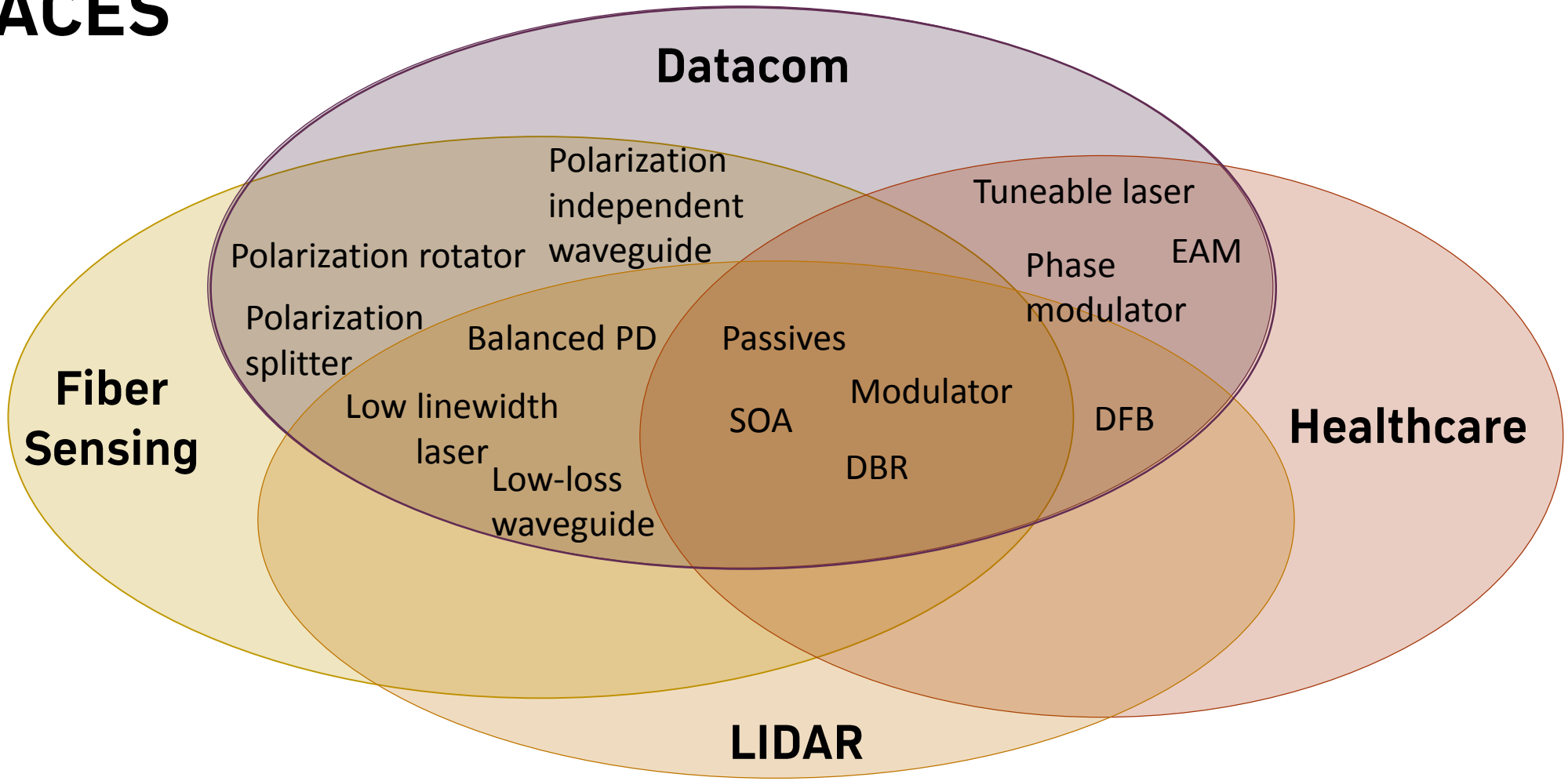


PROCESS DESIGN KIT APPROACH



- **Generic Integration**
  - **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 **early access** prototyping
  - Enables **easier scale up** to high volume manufacturing
- **PDK Building Block Library**
  - 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

SHARED DEVELOPMENT ACROSS APPLICATION SPACES



SMART PHOTONICS

SUMMARY

- Integrated photonics is growing rapidly and finding broader and higher volume applications
- Multiple factors are supporting a move to a foundry offer
- SMART Photonics has demonstrated blue print of pilot facility and is poised to fill the foundry role.
- We are investing heavily into growing capability and volumes as well as technology development

SMART PHOTONICS