(Hybrid) PIC packaging and the volume scale up

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phix PHOTONIC ASSEMBLY

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  - Photonic Integrated Circuits
  - Photonics assembly vs Electronics
- PHIX
  - Packaging Examples
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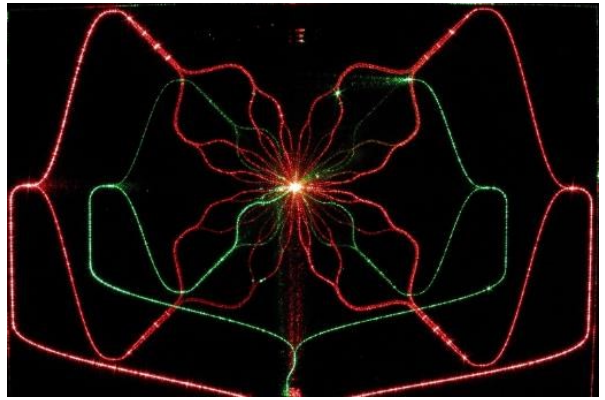
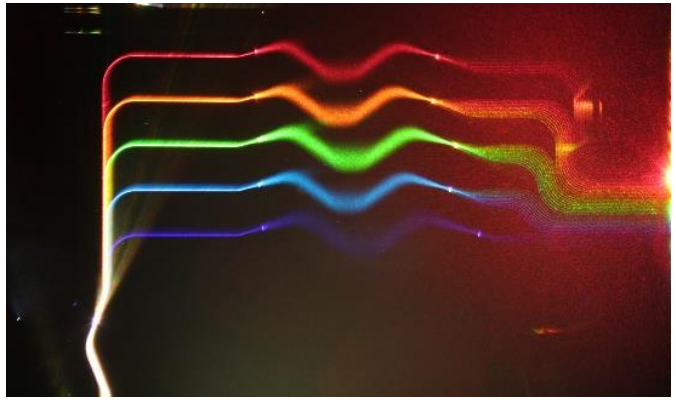
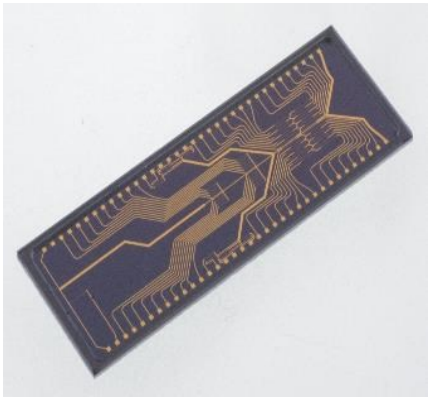
What are Photonic ICs (PICs)?



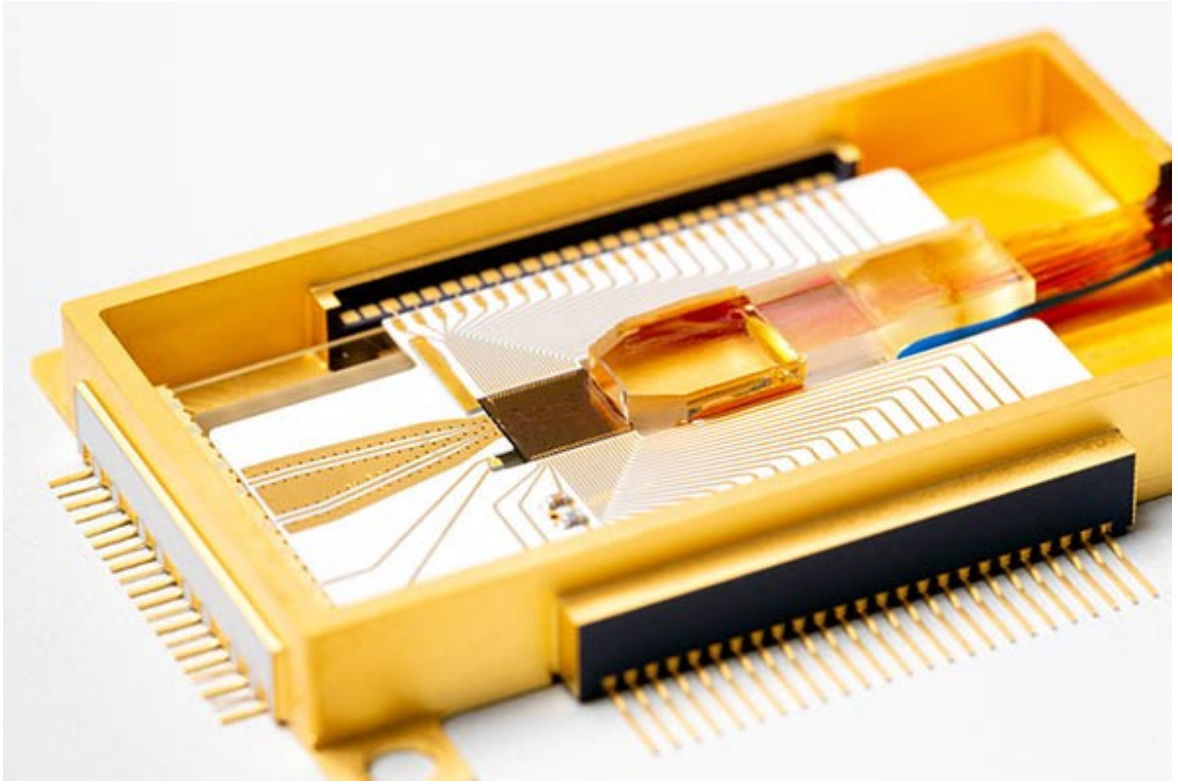



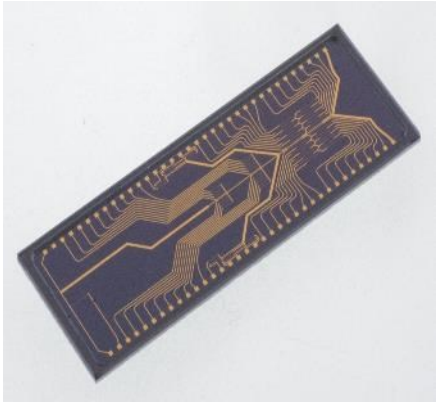
From vertical integration to fabless: maturing on chip level

- Software tools available:
  Synopsys, VPI, Photon Design, Nazca, Lumerical, Luceda, Mentor, Tanner etc
- R&D fabs are available with university's developing new building blocks
- Commercial fabs open for fabrication
  - InP: SMART Photonics, GCS, HHI, infinera
  - SI: IMEC, Global Foundries, AIM, freescale
  - SiN: LioniX, Ligentec, IMEC
  - SiO: TEEM Photonics
- PDK's, and building blocks are maturing
- Design houses
  Bright Photonics, VLC Photonics (Hitachi High Tech)
- MPW runs available for low entry access

A PIC by itself is not a product!

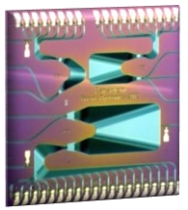
- Interfacing with fibers or free-space
- Interfacing with electronics
- Thermal interfacing
- Mechanical support





- Assembly is 60-80% of the costs

Photonic Integrated Circuits (the packaging technologies)



Photonic Integrated Circuit

- **Optical**
  - Interposer
  - Free Space
    - *Micro Optics*
  - Optical Fiber
    - *Grating Coupler*
    - *Edge Coupler*
      - *Lensed Fiber*
      - *Fiber Array*
- **Integration**
  - *Hybrid Integration*
    - *Micro Optical*
    - *End Facet*
- **Electrical**
  - Interposer
    - PCB
      - *Wirebonding*
      - *Flipchip*
        - *2.5D*
        - *3D*
    - Micro-Interposer
      - *Wirebonding*
      - *Flipchip*
        - *2.5D*
        - *3D*
- **Thermal**
  - *Active Cooling*
  - *Passive Cooling*
- **Mechanical**
  - *Hermetic*
  - *Non-Hermetic*

PIXAPP Photonic Packaging Pilot Line

Tyndall National Institute Institiúid Náisiúnta

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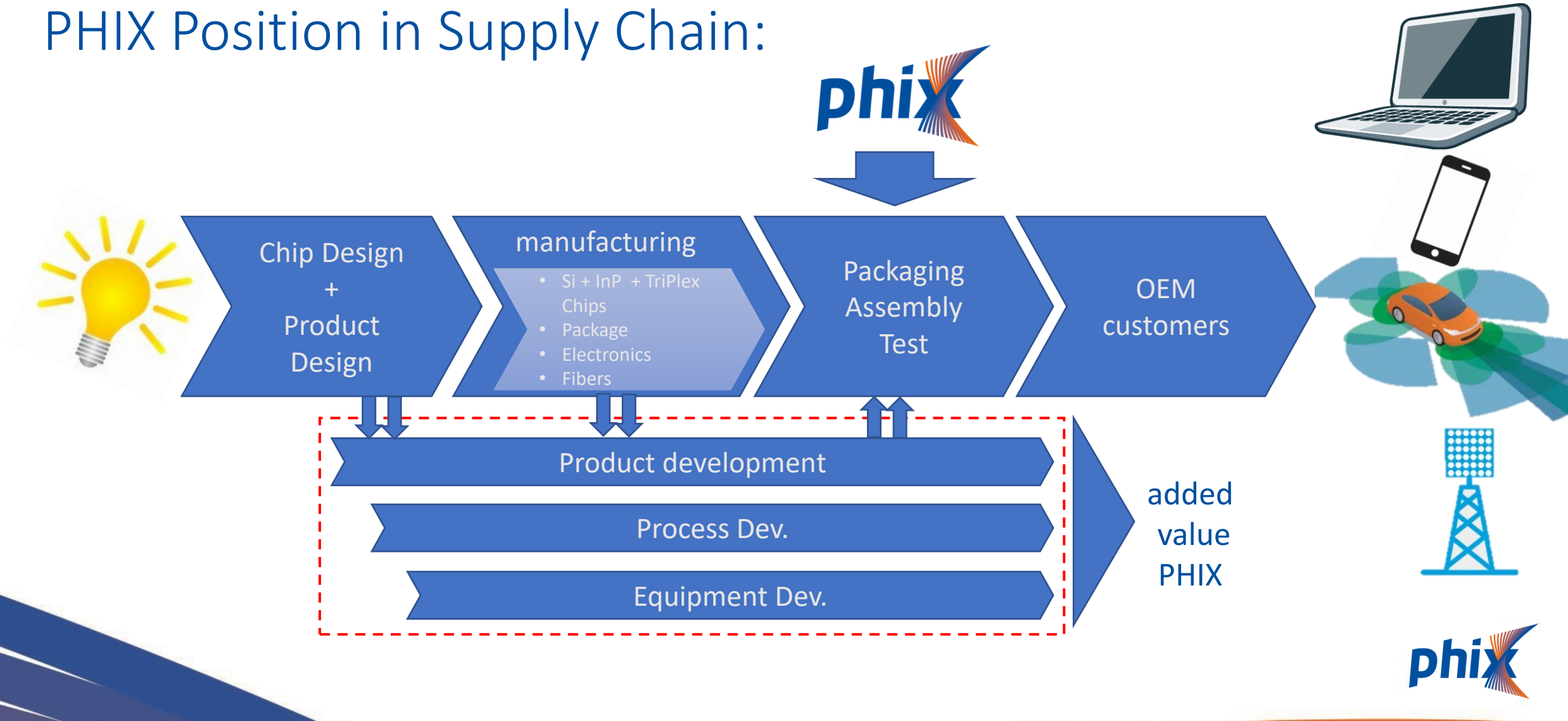
PHIX Mission

PHIX is to become a world leader foundry in packaging and assembly of Photonic Integrated Circuits (PIC's) by supplying PIC based components and modules in scalable production volumes.

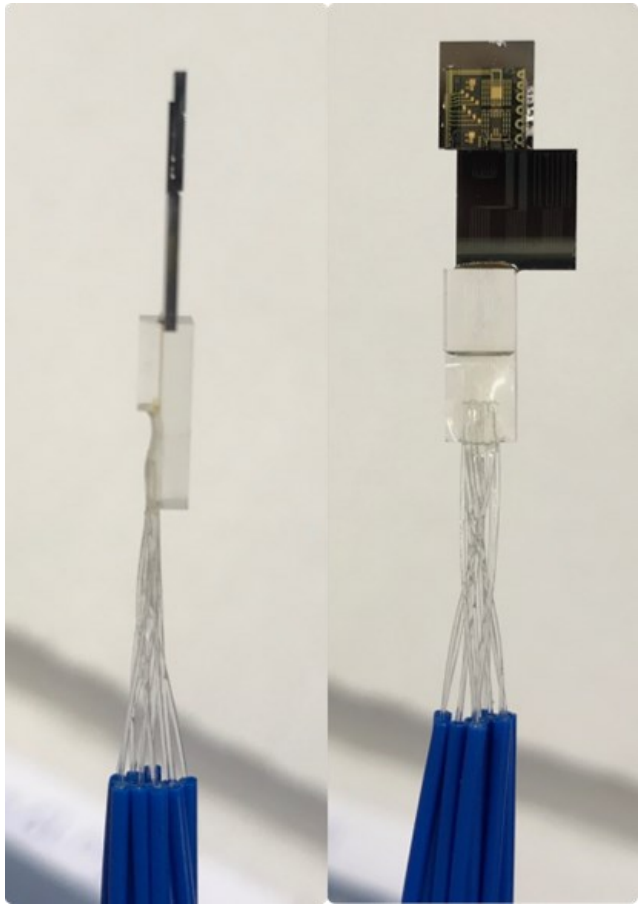
- Initiated by LioniX International in 2017
- Started operations in 2018
- Specialized in hybrid PIC assembly and fiber array interfacing
- Independent pure play packaging facility

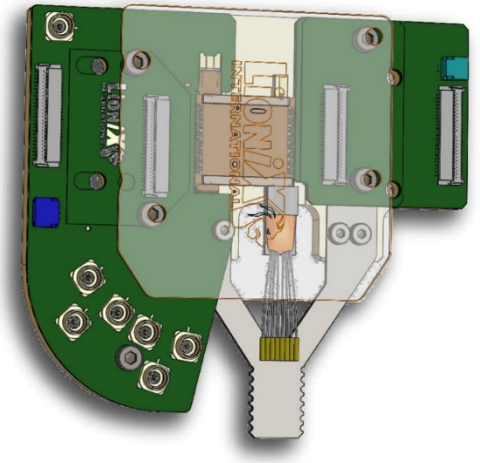
PHIX Position in Supply Chain:

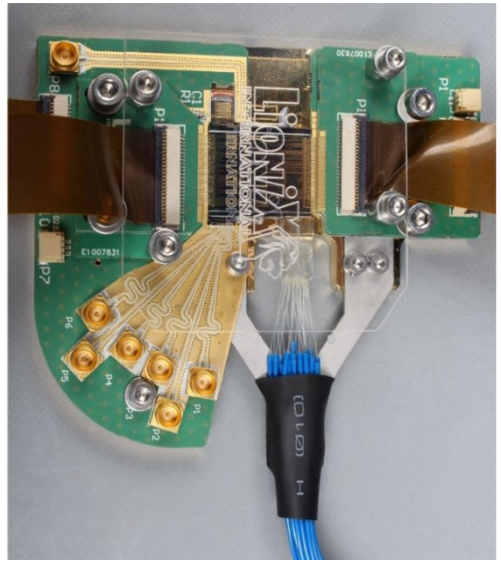


PHIX competences

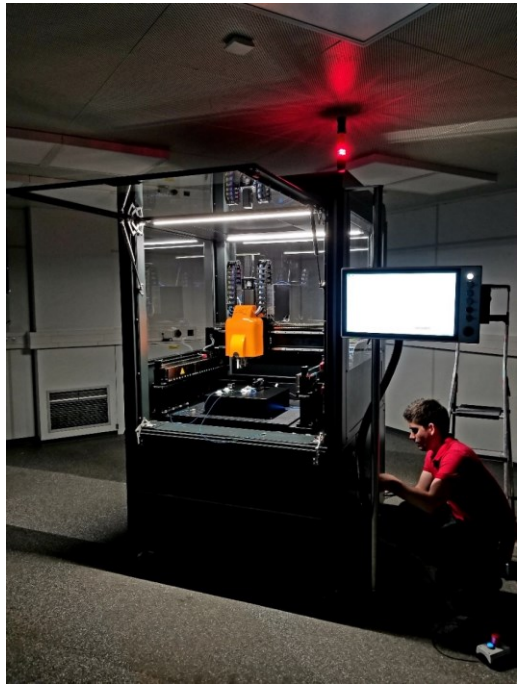
- Product design for assembly
- Manufacturing
  - Die preparation
  - Die alignment and bonding
  - Electrical interfacing
  - Thermal Packaging
  - (PM) Fiber Arrays
  - High Power interfaces
  - Free Space packaging
  - Hybrid assembly
- Capital equipment sourcing and management

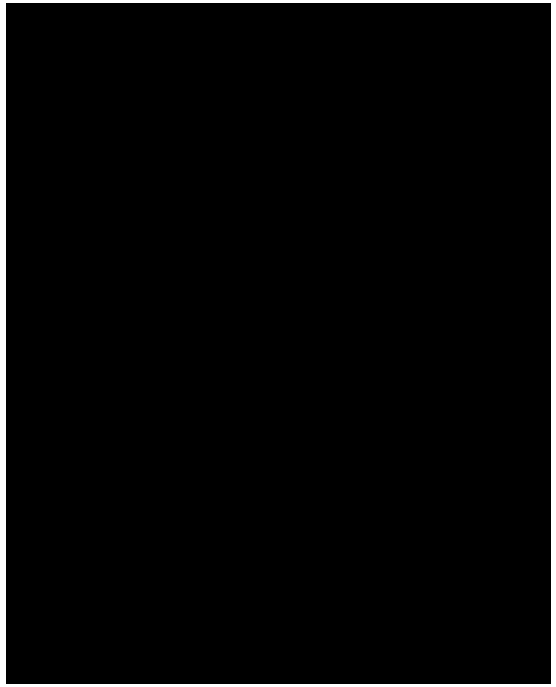


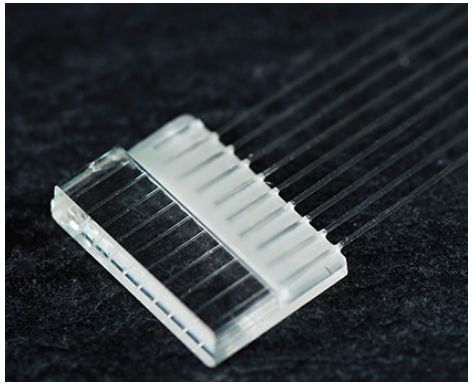


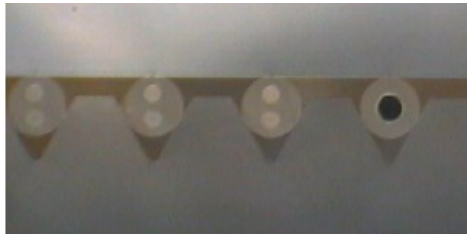


Automated fiber array assembly machine developed in conjunction with Fraunhofer IPT & Aixemtec



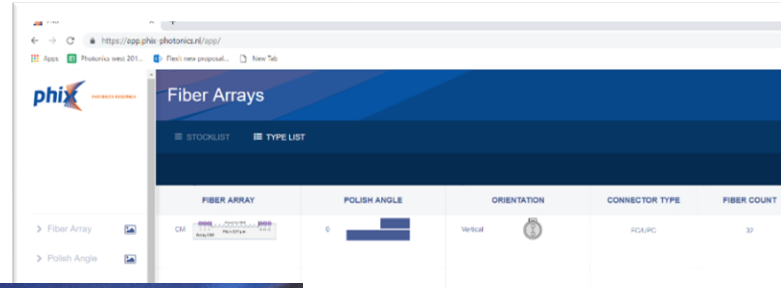


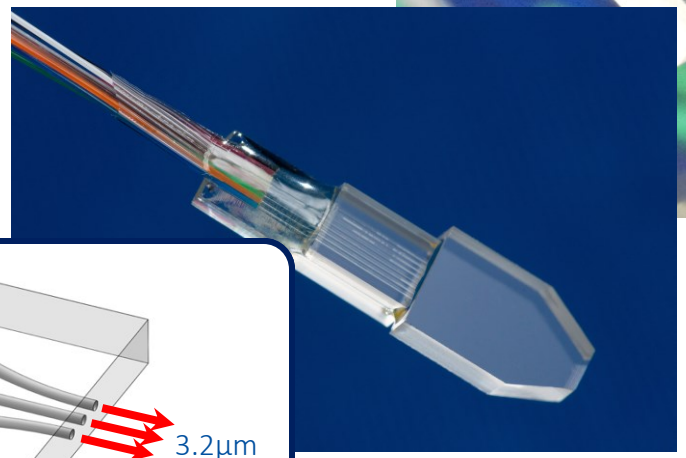


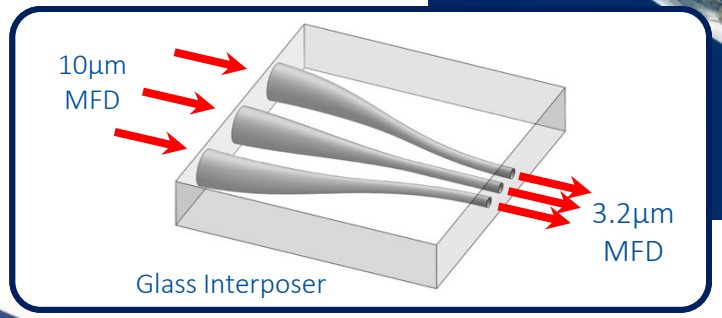


Wide variety of fiber array configurations

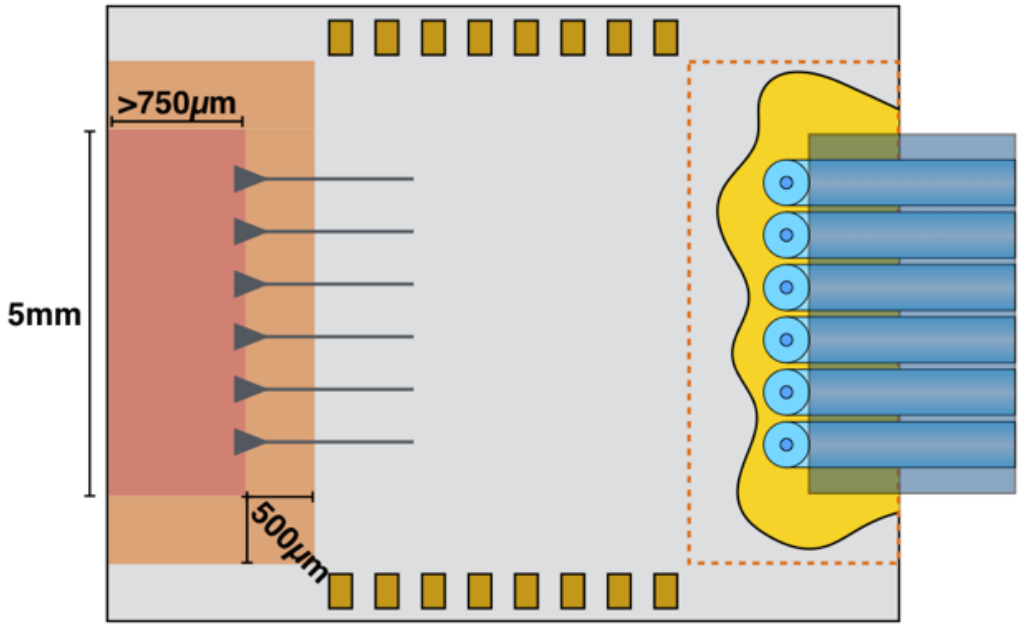
- 2, 4, 8, 16, 24, 32, 40 fiber
- Single Mode, Multimode, Polarization Maintaining
- High NA, SMF 28 small core (visible)
- Pitches 127 & 250 microns standard
- Flat, 8 degrees, any custom angle
- Different connector interfaces FC, SC, LC, SMA
- Different lengths, 1 m
- Spot Size Converter available

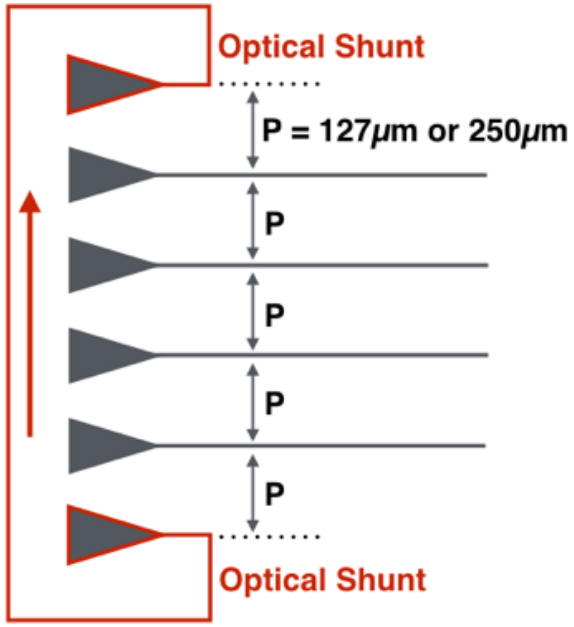


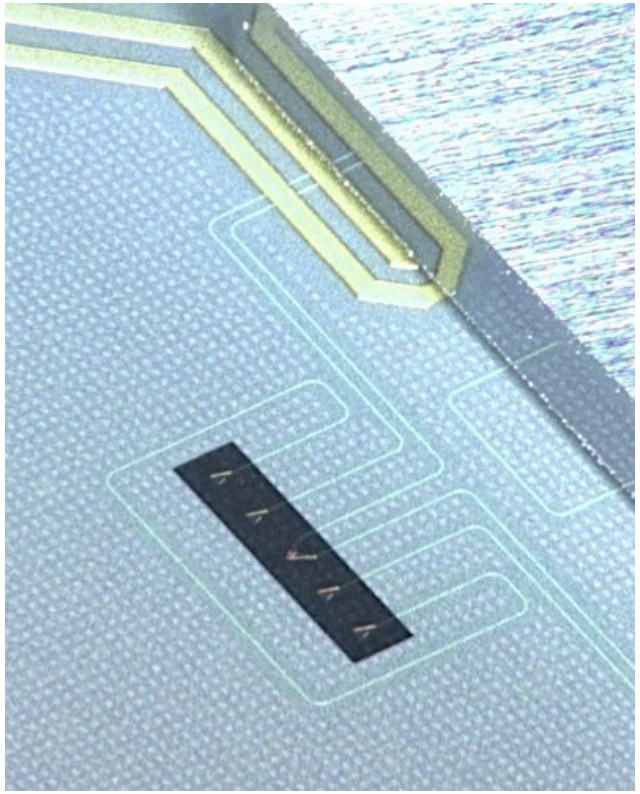




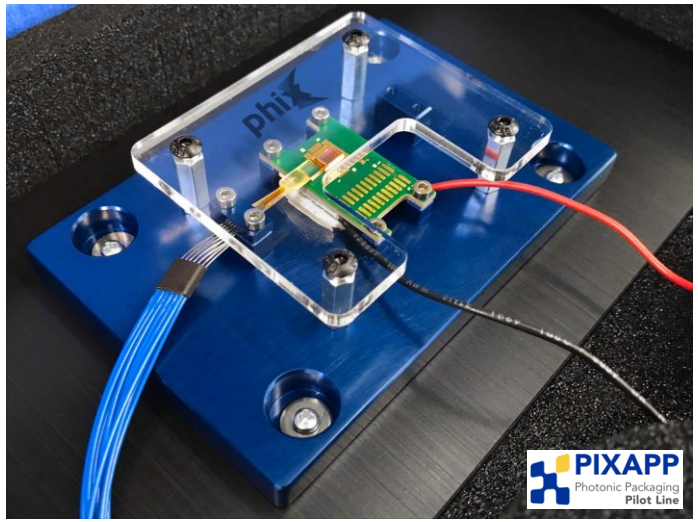
Design for assembly; design guidelines

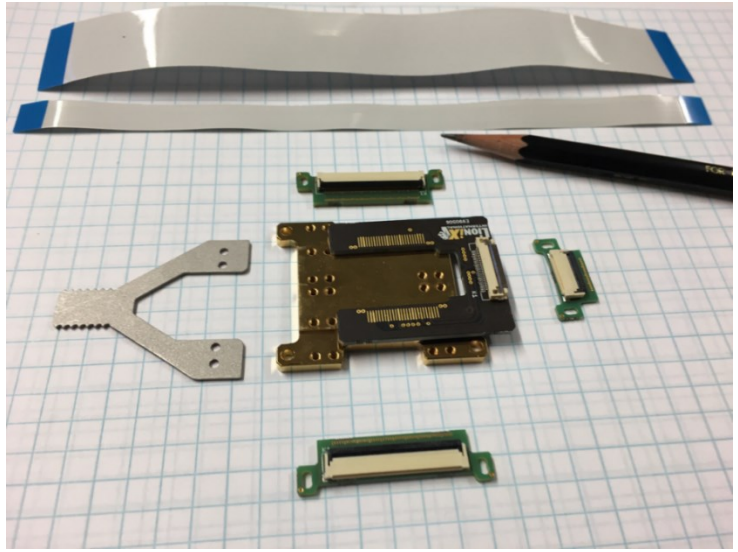


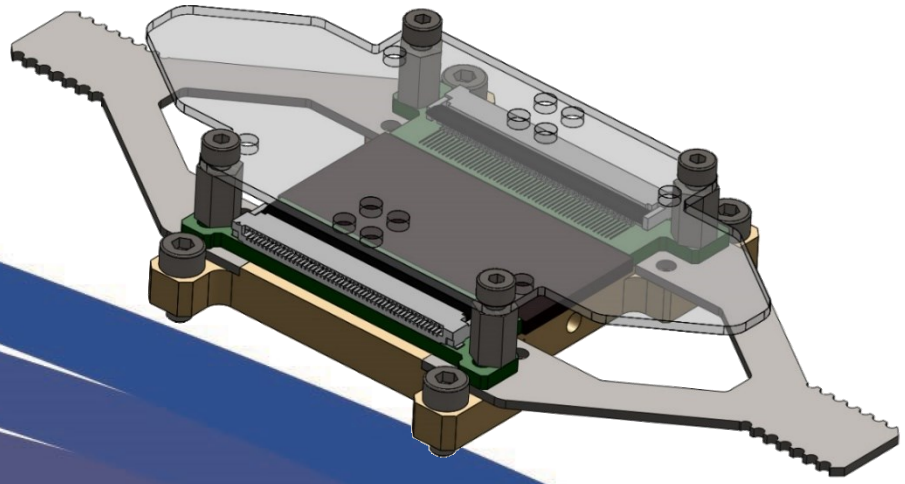




Characterization Packaging Service







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Characterization
Packaging Service

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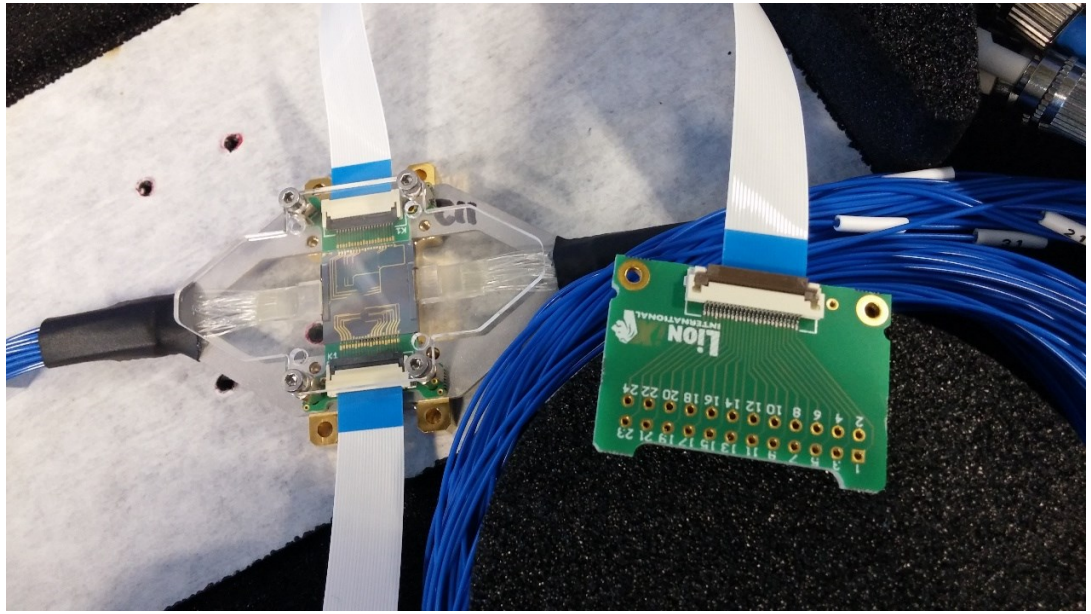
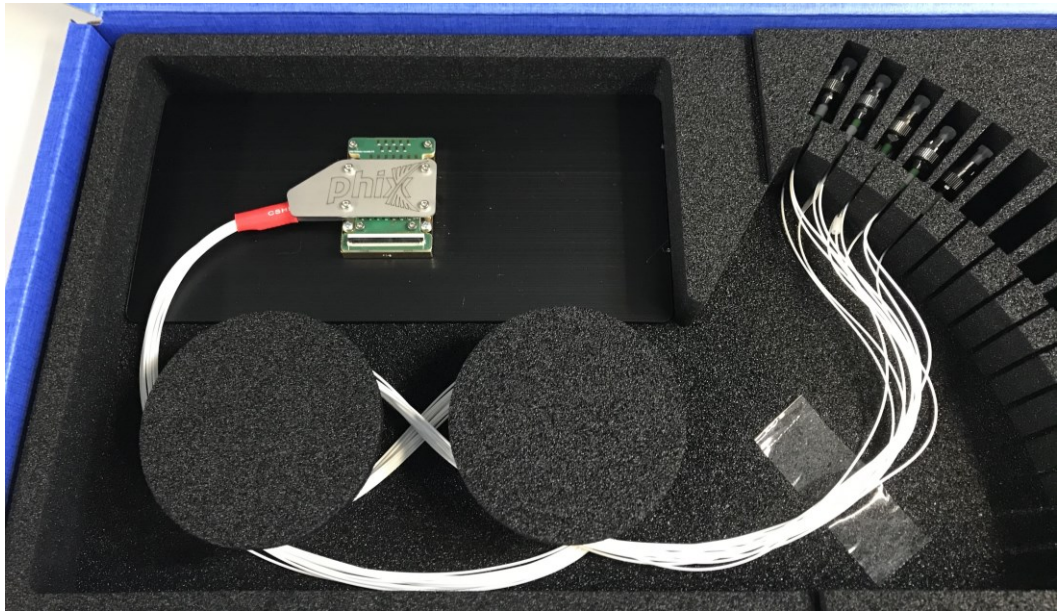
CPS Example: MPW customers

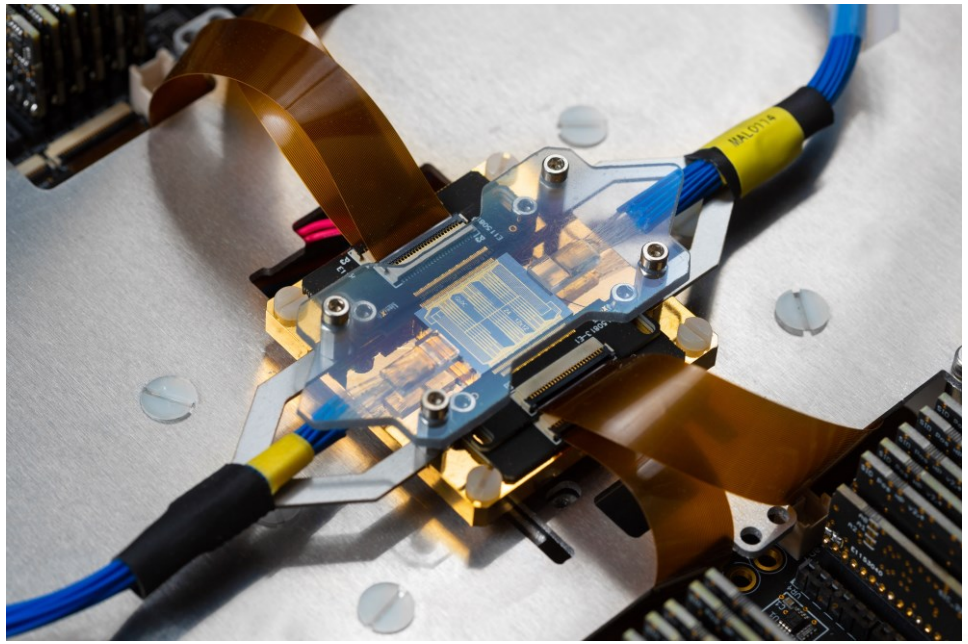




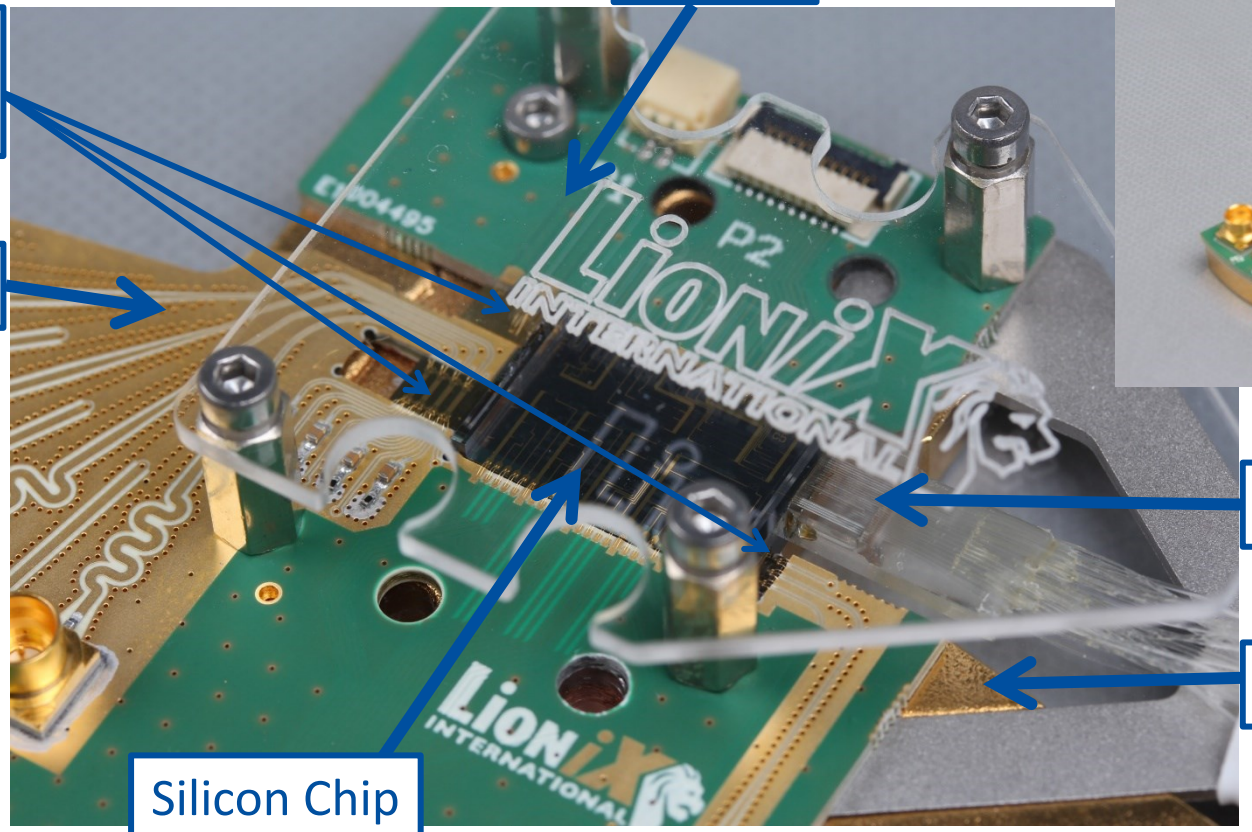
CPS Example - Quantum application

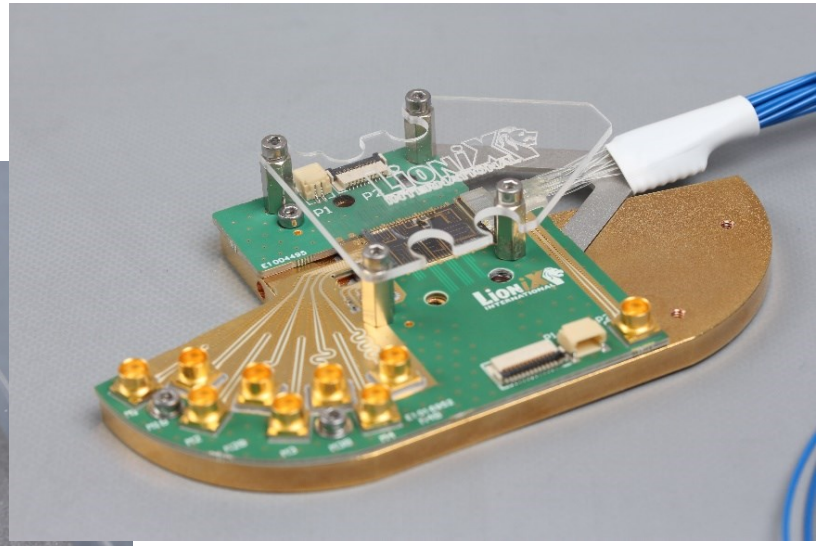
QuiX Quantum processor

- Universal multimode tunable interferometers.
- Wavelength range between 425 nm and 2350 nm.
- CPS Directly integrated into the control box



Hybrid integration; take the best of each PIC technology

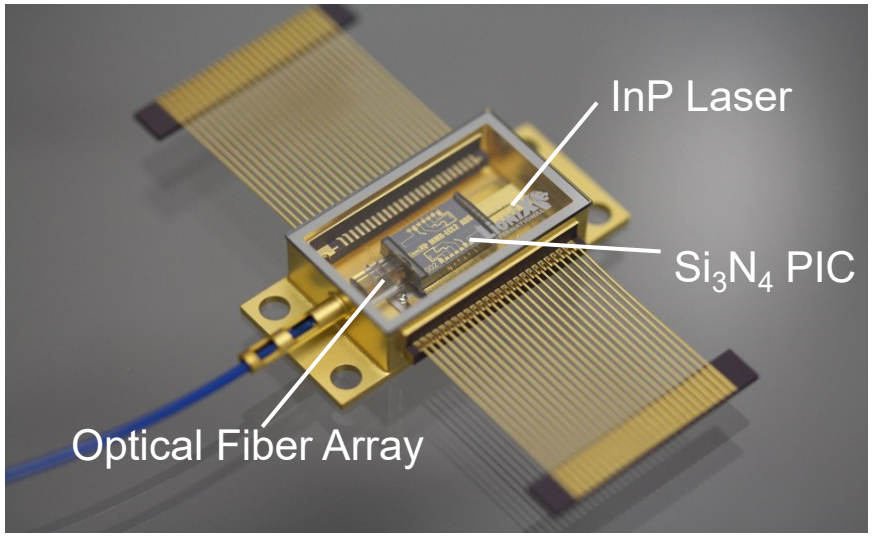


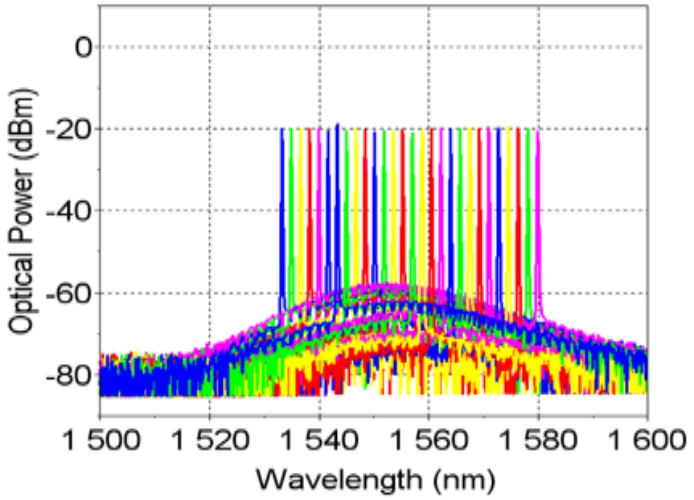


Automation of hybrid assembly of PICs through Ficontec

Full movie can be seen on PHIX youtube channel

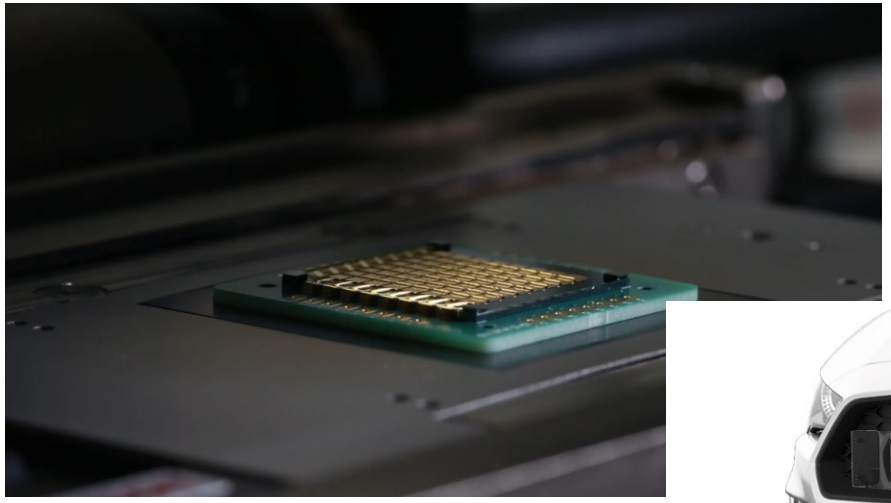
Hybrid laser assembly

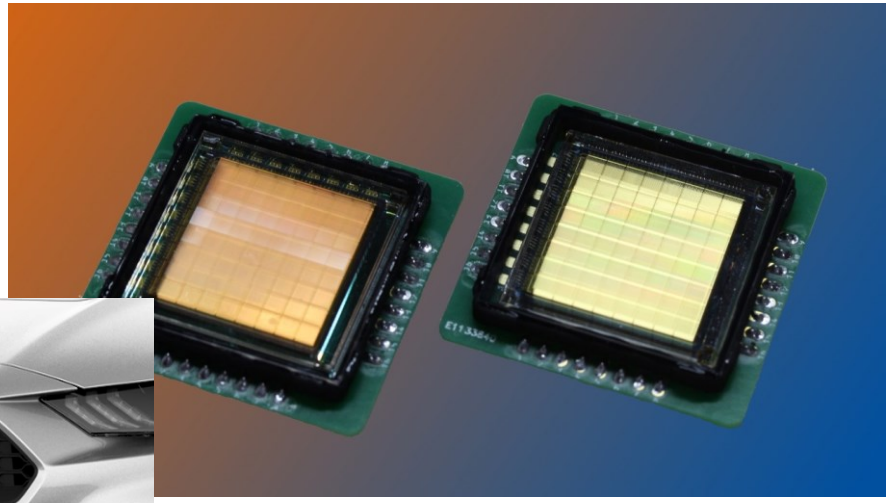


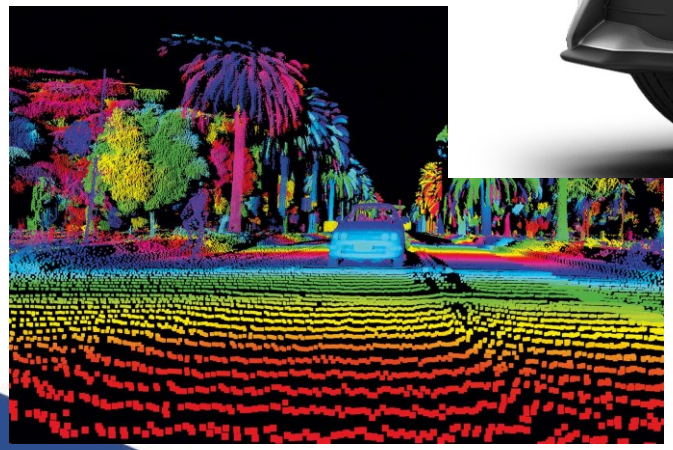


	Tuning range	Tuning speed	Linewidth	Output Power	Size
Tunable laser Module 25 kHz	C-band (40nm)	1 kHz	< 25 kHz	10mW	3x2x1 cm
Tunable laser Module 5 kHz	C-band (40nm)	1 kHz	< 5 kHz	10mW	3x2x1 cm
Tunable laser Module 1 kHz	C-band (40nm)	1 kHz	< 1 kHz	10mW	3x2x1 cm

Lidar applications

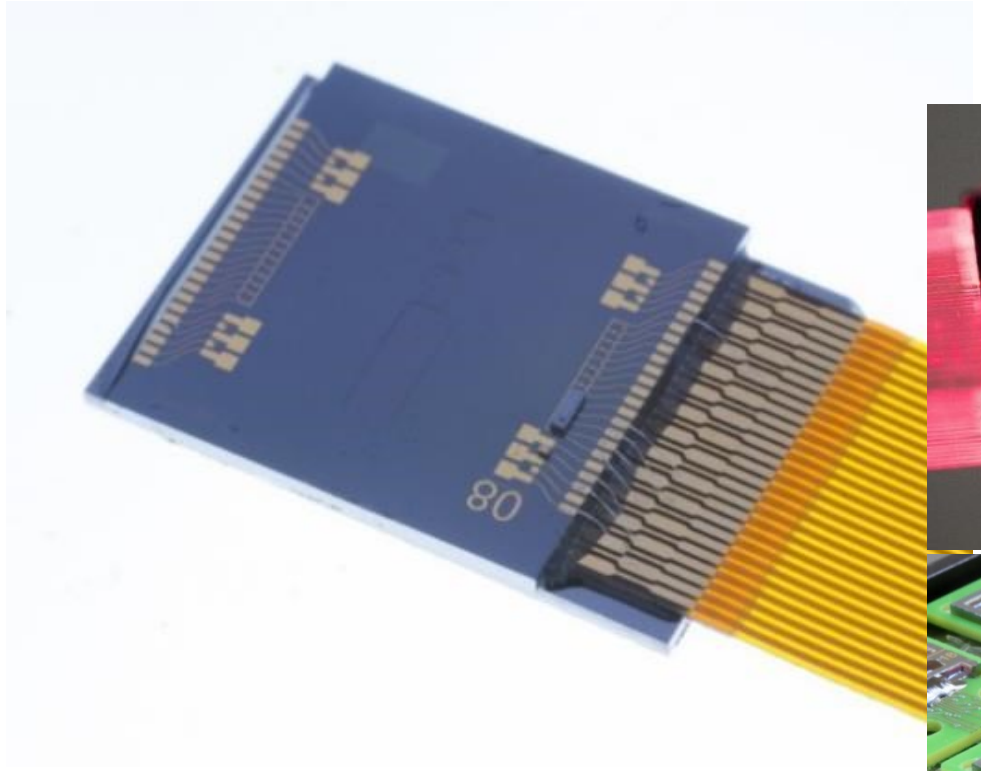


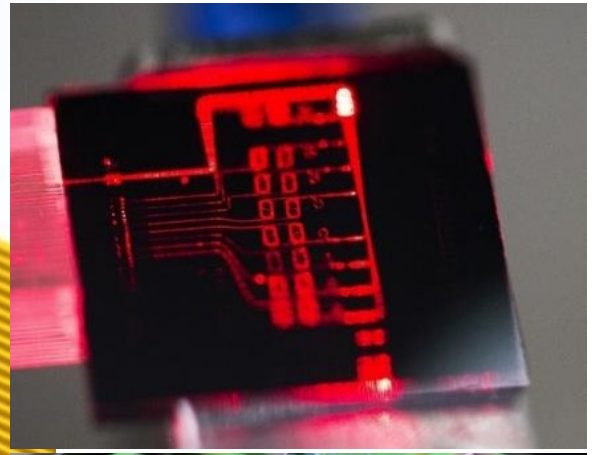


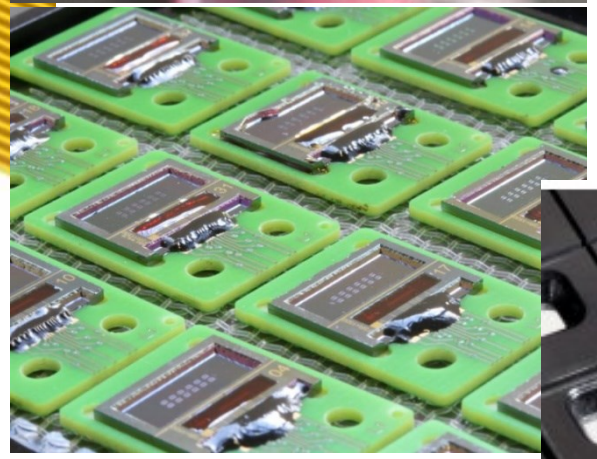


- ower laser integration challenges
- ver requirements feed 90V-30A
- rmal management
- Placement of individual chips / wafer parts
- Hight tolerance stacking, VCSEL aperture, Lens, Prism
- Prism alignment <1 micron
- Frequency Modulated Continuous Wave Lidar

Biosensor application



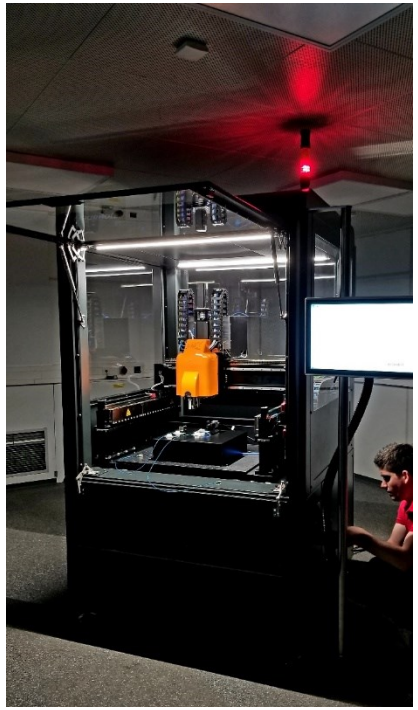




Ultra sensitive sensor arrays

- Flip-chip assembly of VCSEL's and detector arrays through grating couplers
- Cancer diagnostics

Scalable automation



Depending on your volume requirements

The possibilities are endless, what application will you drive

My full contact details

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