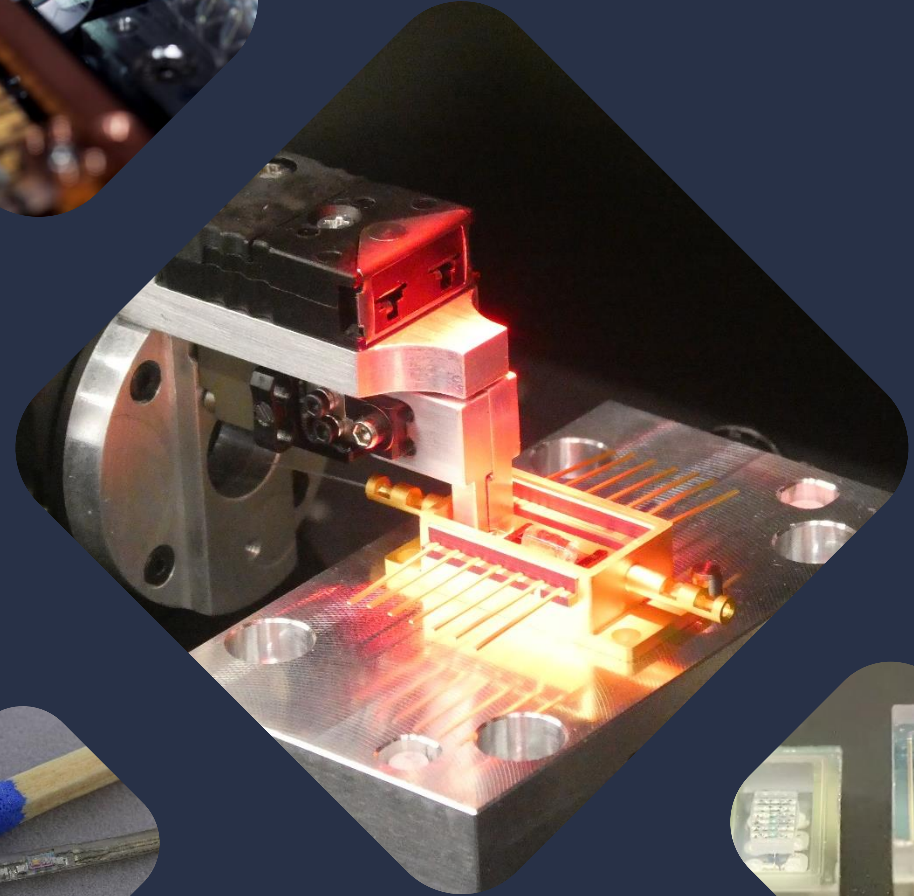
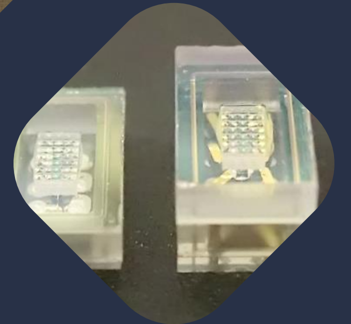


Sub-micron assembly of photonic components

Ivan-Lazar Bundalo
February 2022



Swiss Center for Electronics and Microtechnology

Mission:

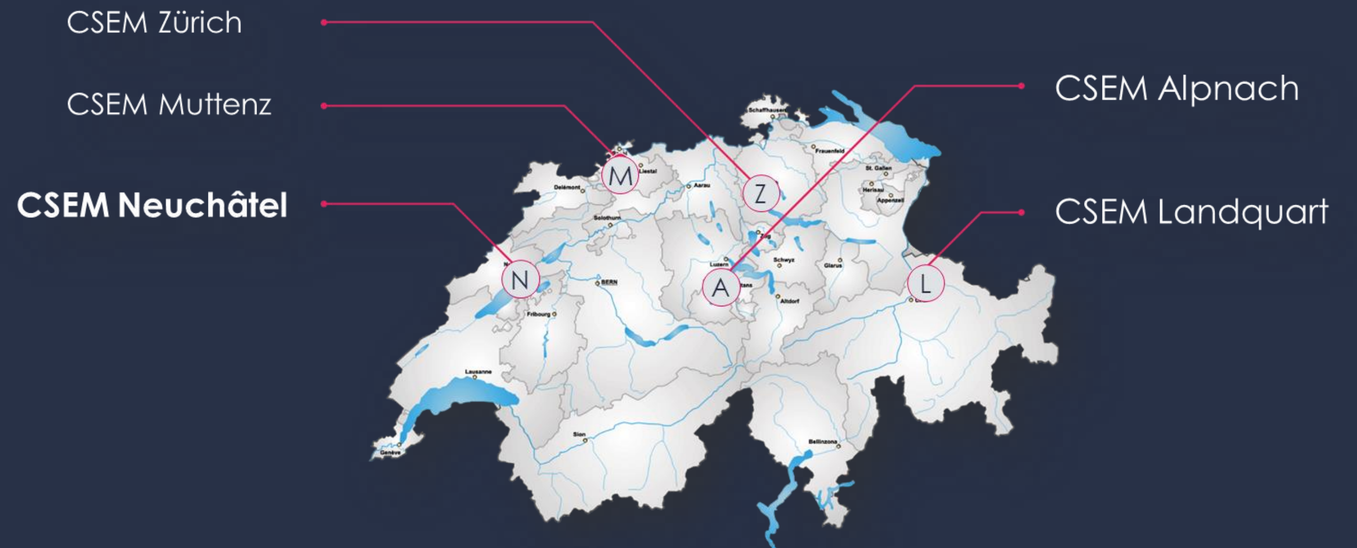
Development and transfer of **microtechnologies** to the **industrial sector**

- Close to industry, leveraging Swiss academic research
- Cooperation agreements with established companies and SME's
- Over 20 years, 44 new ventures (start-ups and spin-offs)

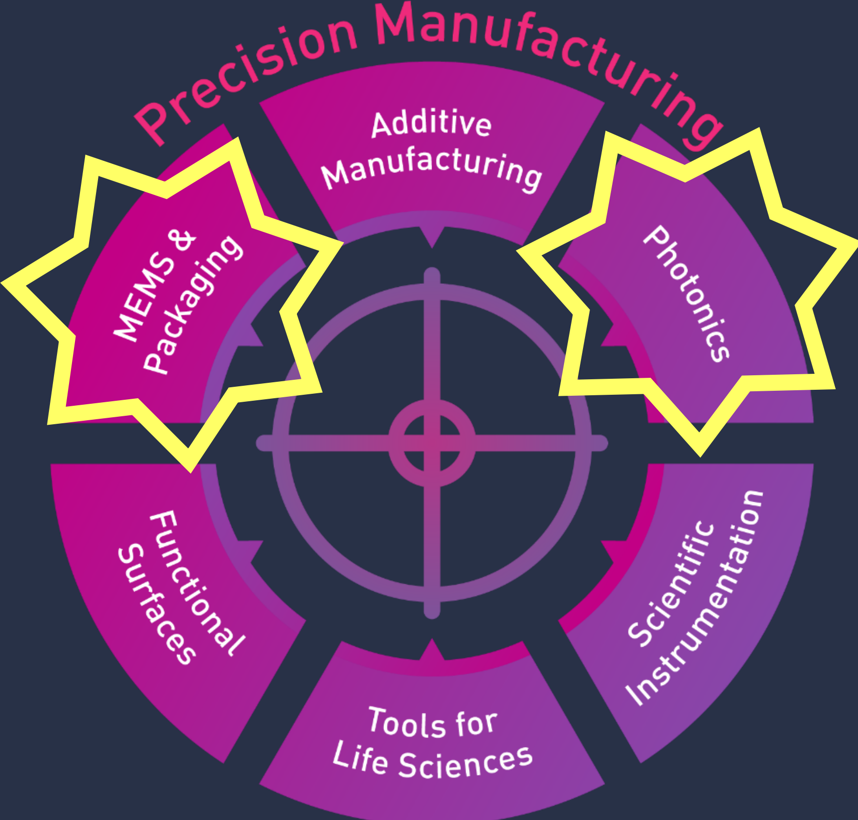
1

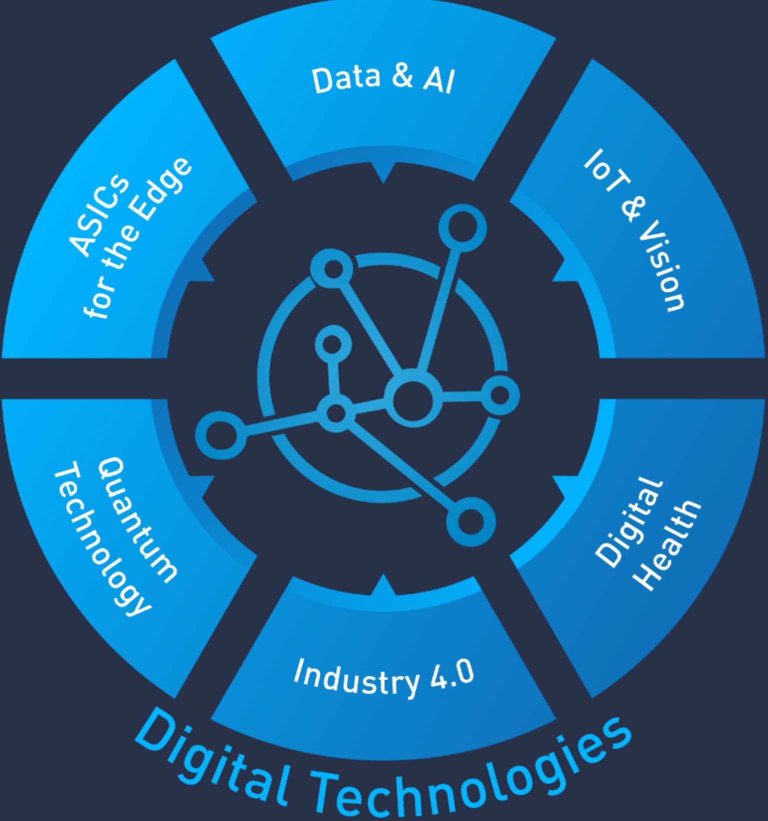
Non-profit organization

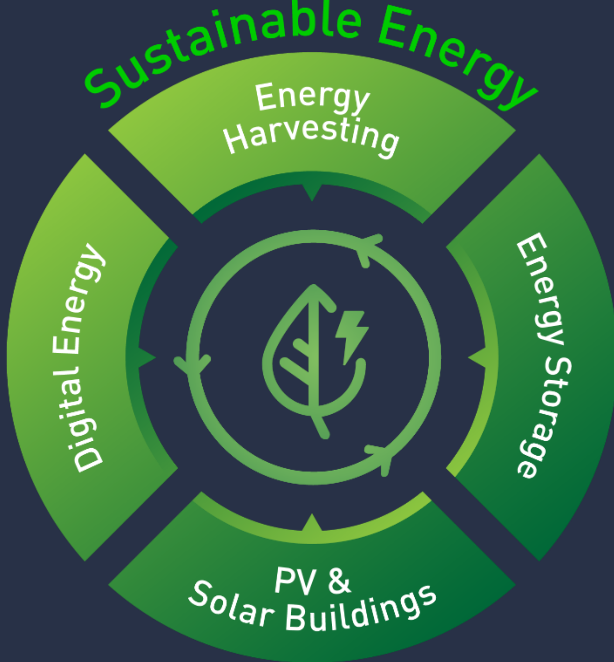
- Public private partnership
- 525 people



Technologies **in focus** that **foster innovation**







csem

Photonics @ CSEM

35+ years at the cutting-edge of photonics technologies

Specialties

Solutions

- Packaging & integration
- Integrated photonics
- Micro-optics & free-form optics
- Nano-optics & diffractive elements
- Lasers
- Vision systems
- Instruments & sensing

- Communications
- Life sciences & Healthcare
- Manufacturing
- Imaging
- Metrology
- Energy

…and many other

Electronic Packaging vs. Optical Packaging

CMOS chip + electrical interposer + PCB

- DC and RF Bonds
  - Wire and Ribbon
- Flip Chip Bonding
- Interposers
- PCBs

High Speed Package Design
… & Assembly
…& Thermal management

Lasers + microoptics + optical interposer + fiber (array)

- Fibre Attach
  - Edge Coupling
  - Grating Coupling
- Fibre Array attach
- Laser Welding or Gluing
- Directly Written Micro Lenses
- Photonic Wire Bonds
- PIC to PIC Coupling
- …

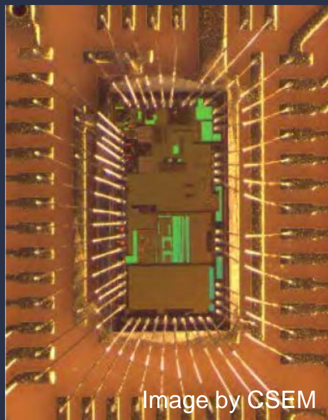


Image by CSEM

Image by Argotech

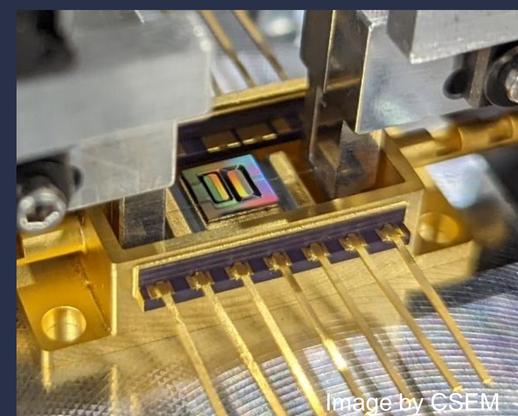


Image by CSEM

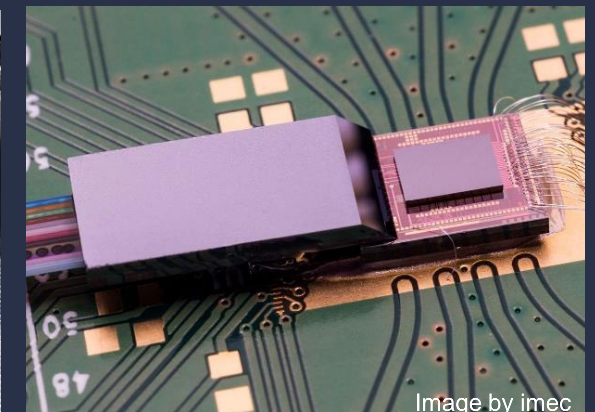


Image by imec

Photonic Packaging

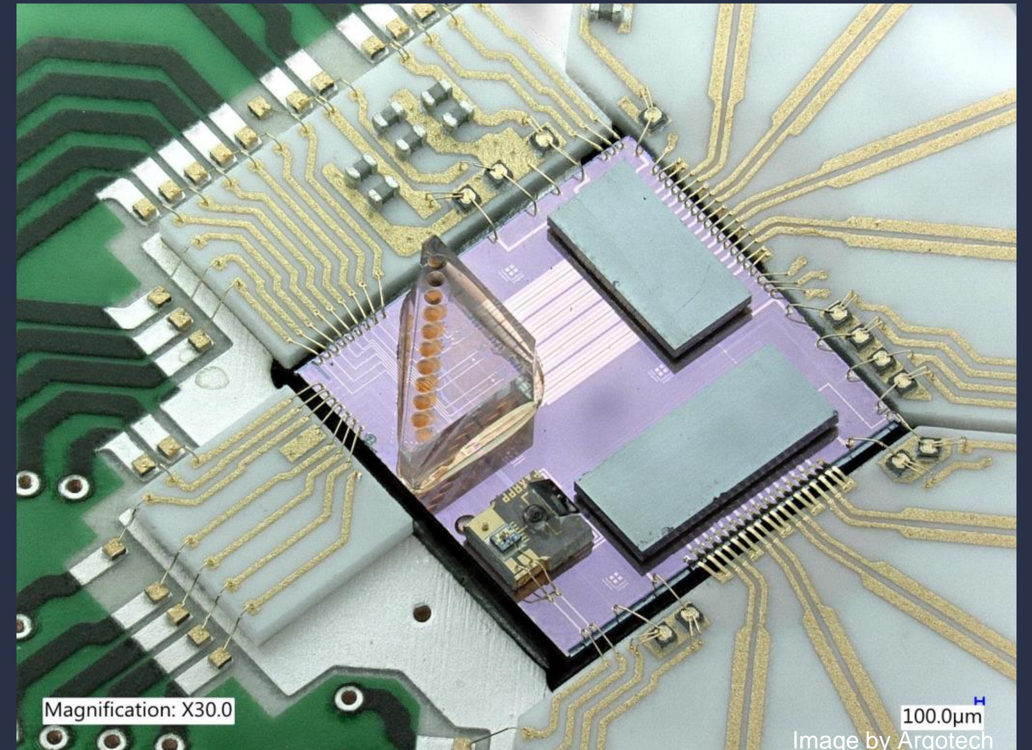
Optics

Electronics

Thermal Management

Mechanical Design

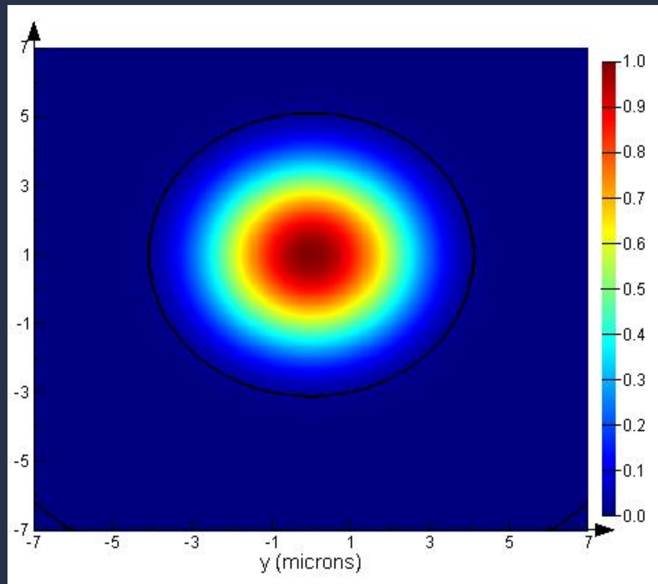
How hard can it be?

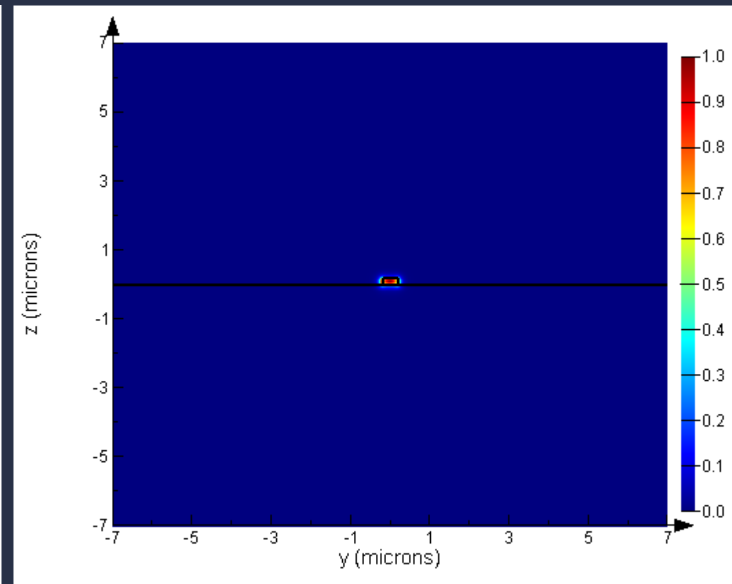


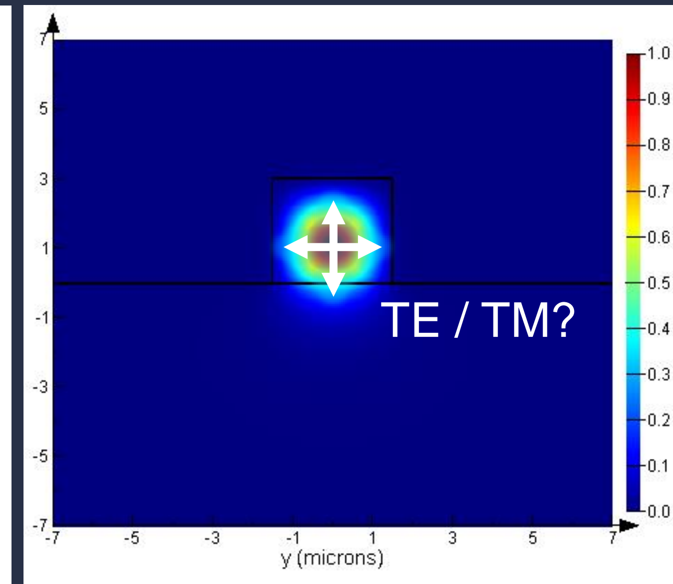
Photonic Packaging

Mode matching

SMF28 fibre | *PIC* | *Edge couplers*







Alignment Tolerances	*1-3 µm*	*> 100nm*	*> 1 µm*

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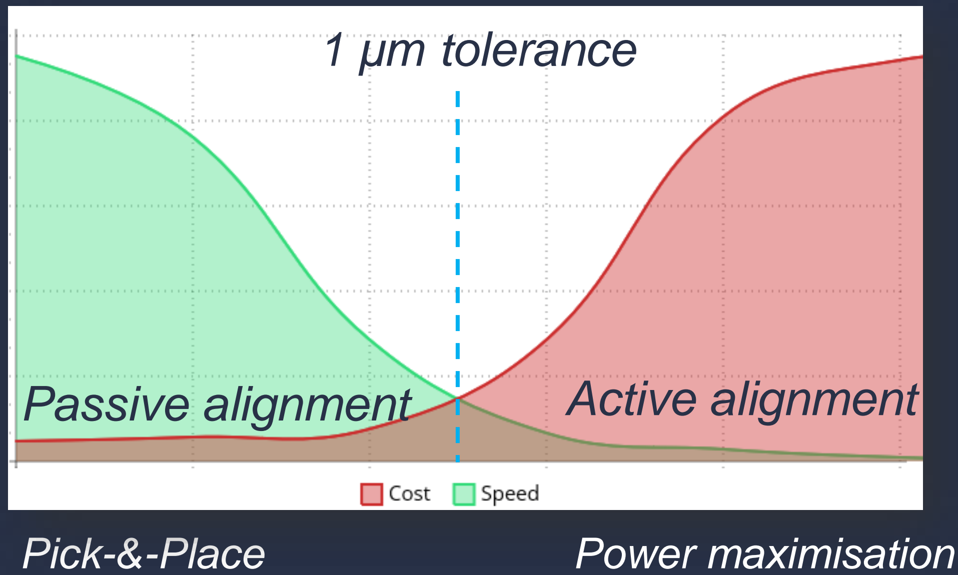
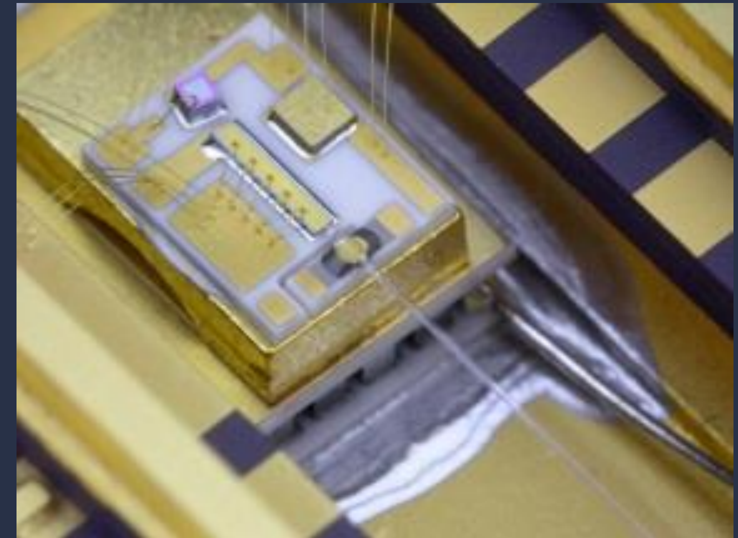
Photonic Packaging

Assembly



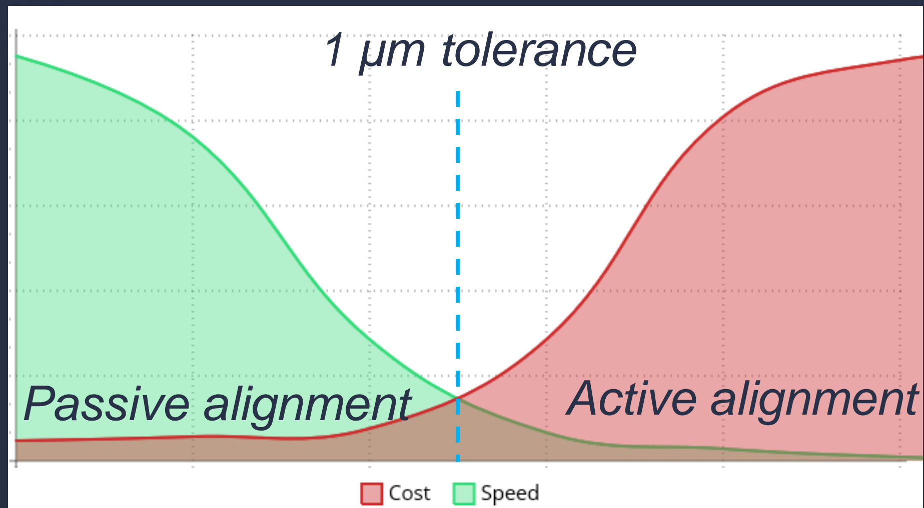
Pick-&-Place

Power maximisation



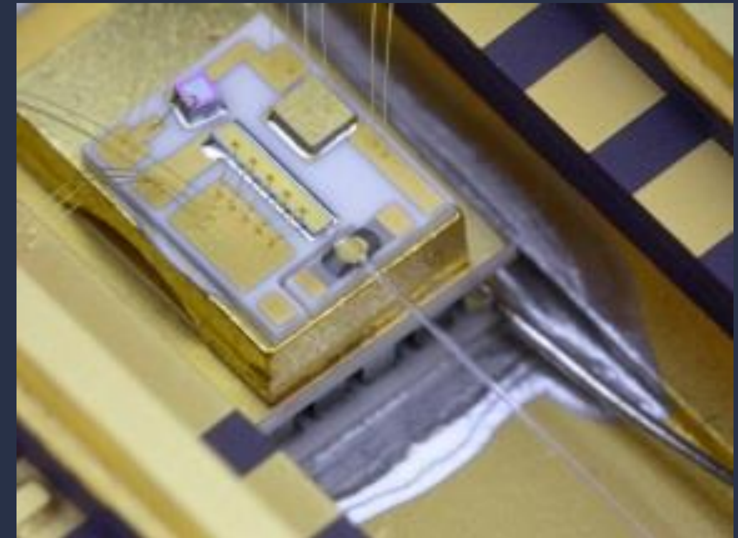
Photonic Packaging

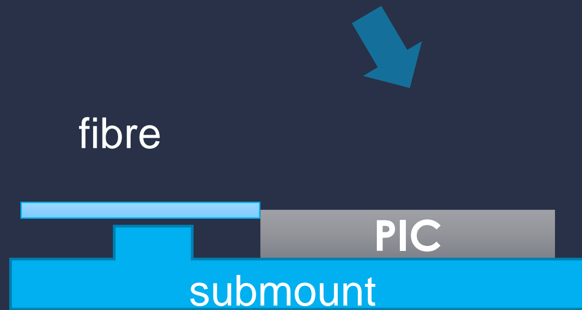
Assembly

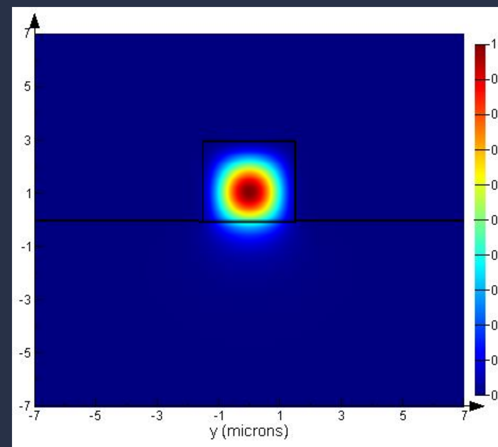


Pick-&-Place

Power maximisation







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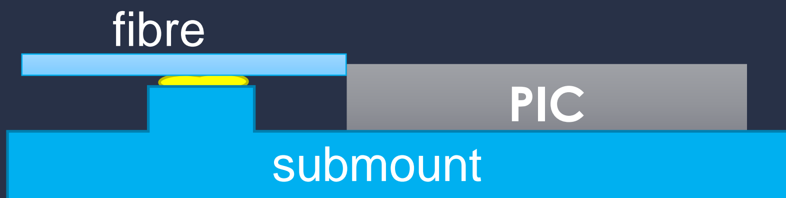
Photonic Packaging

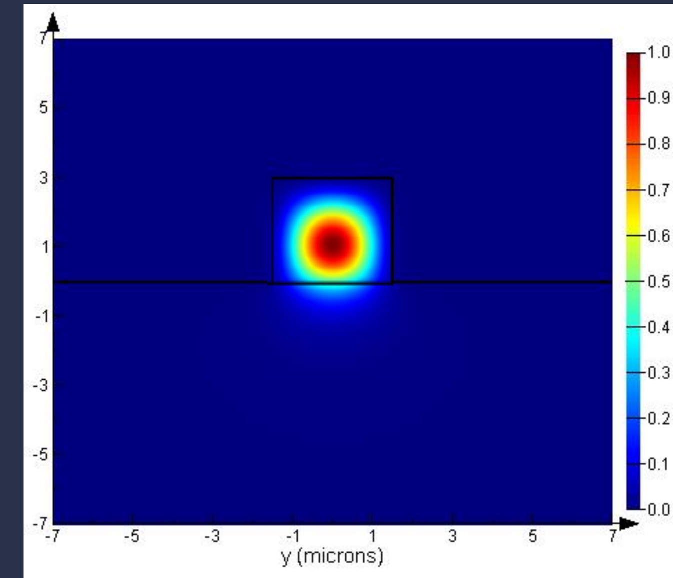
Optical Coupling Losses



Glue Shrinkage

Thermal expansion

Stability…?



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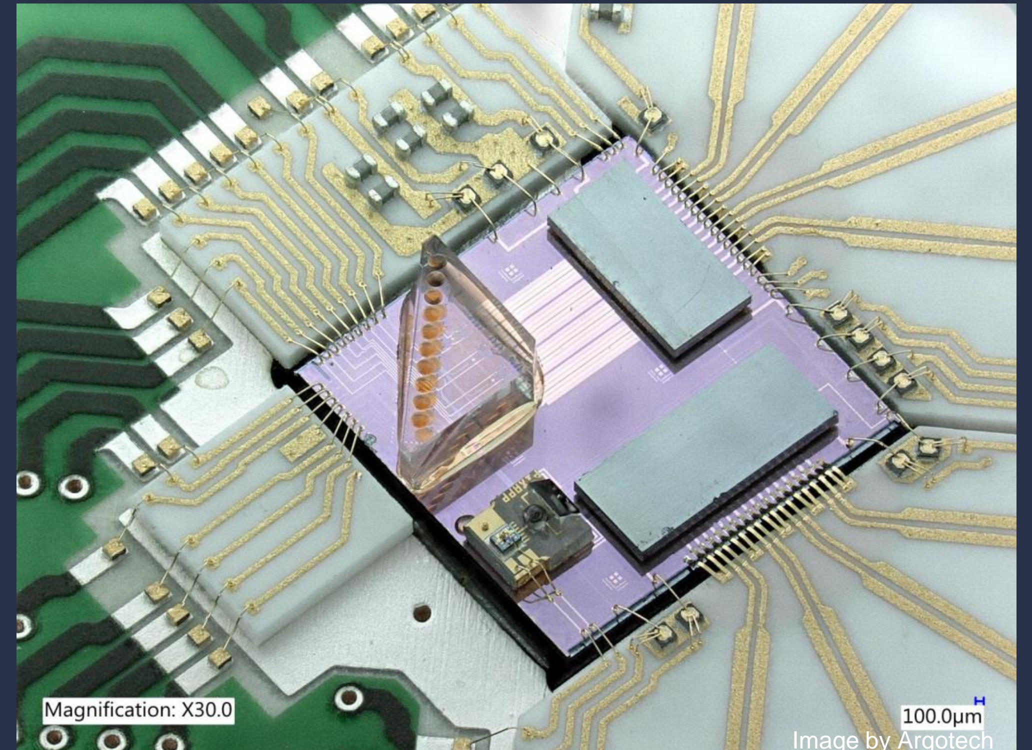
Photonic Packaging

Optics
Electronics
Thermal Management
Mechanical Design

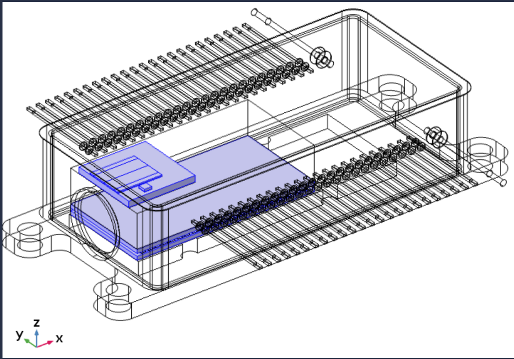
How hard can it be?



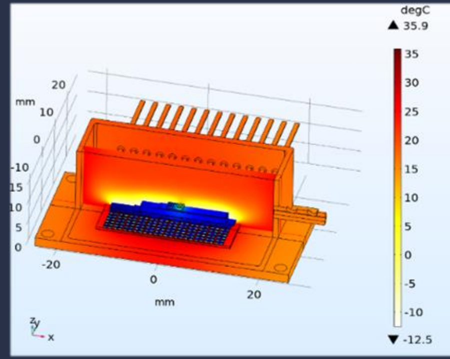
Optics makes it hard
but there are smart solutions!

Photonic Packaging at CSEM

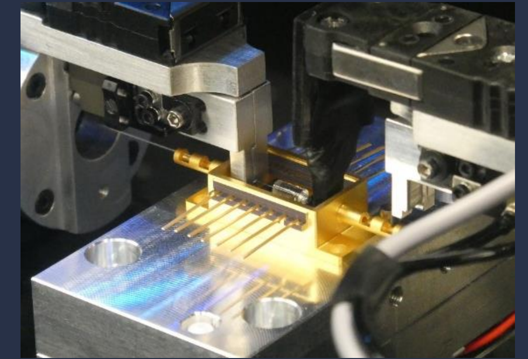
Mechanical design



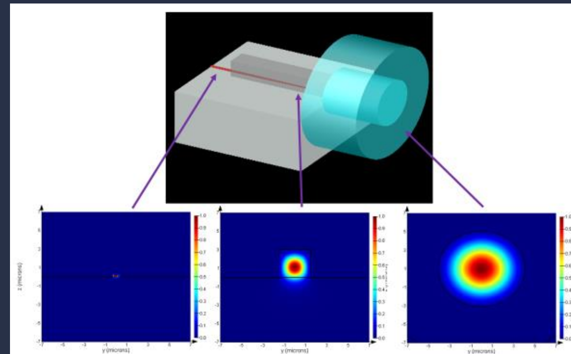
Thermal simulations



Micro-assembly



Optical design



Material expertise

Collaboration - *from prototype to series production*

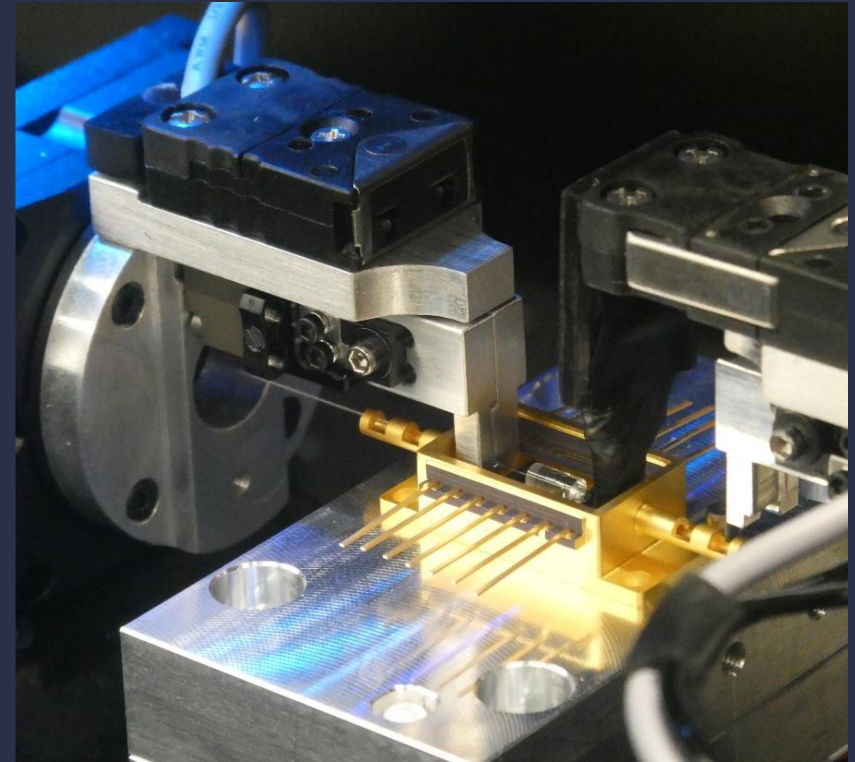
+

Prototyping & process development

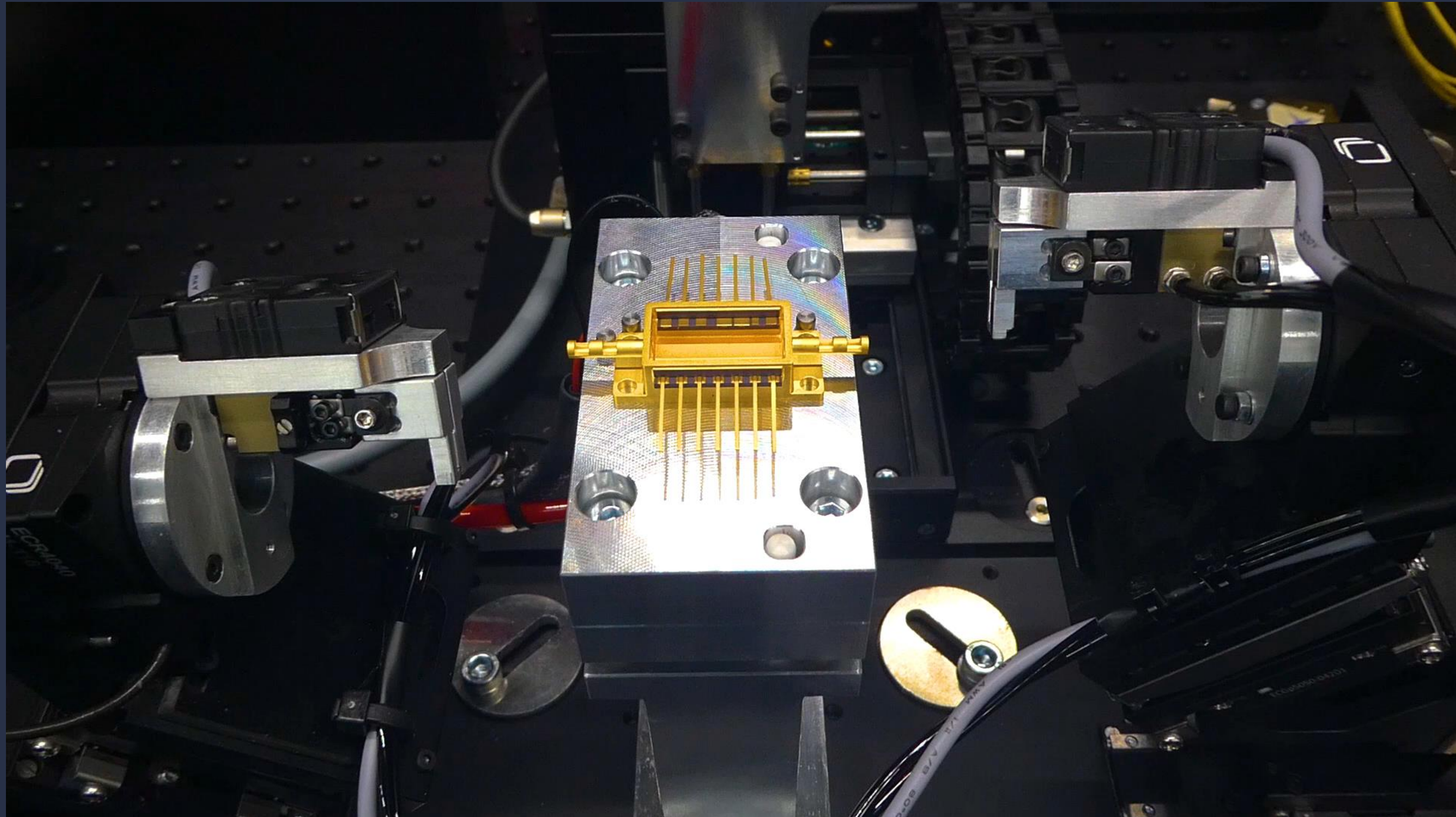
- Passive assembly
  - Machine vision
- Simplifying Active alignment
- Fixation
- Encapsulation / hermetic housings

Series production

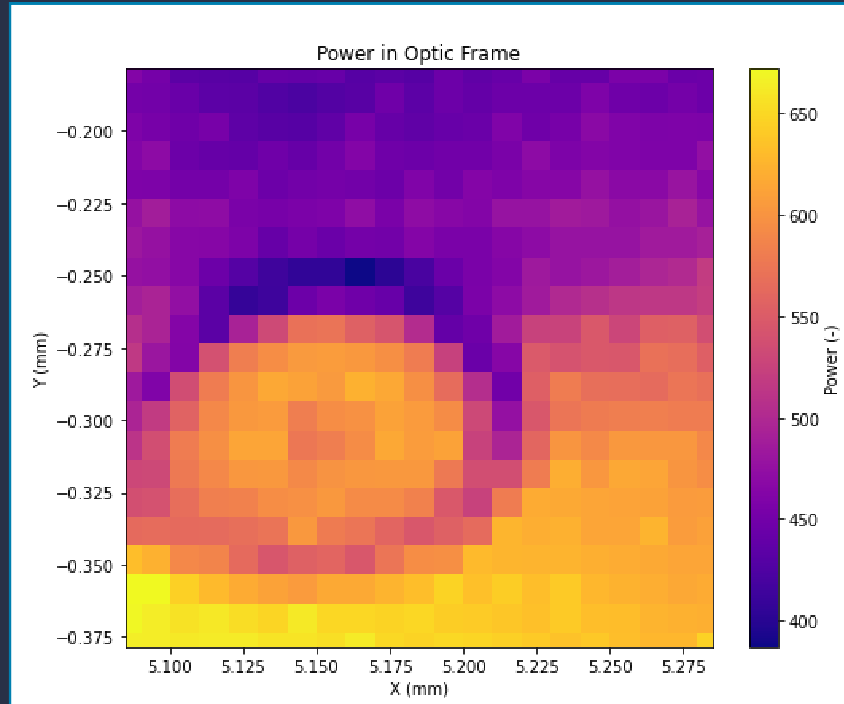
- Multi-part feeding
- Parallelisation
- Machine deliveries

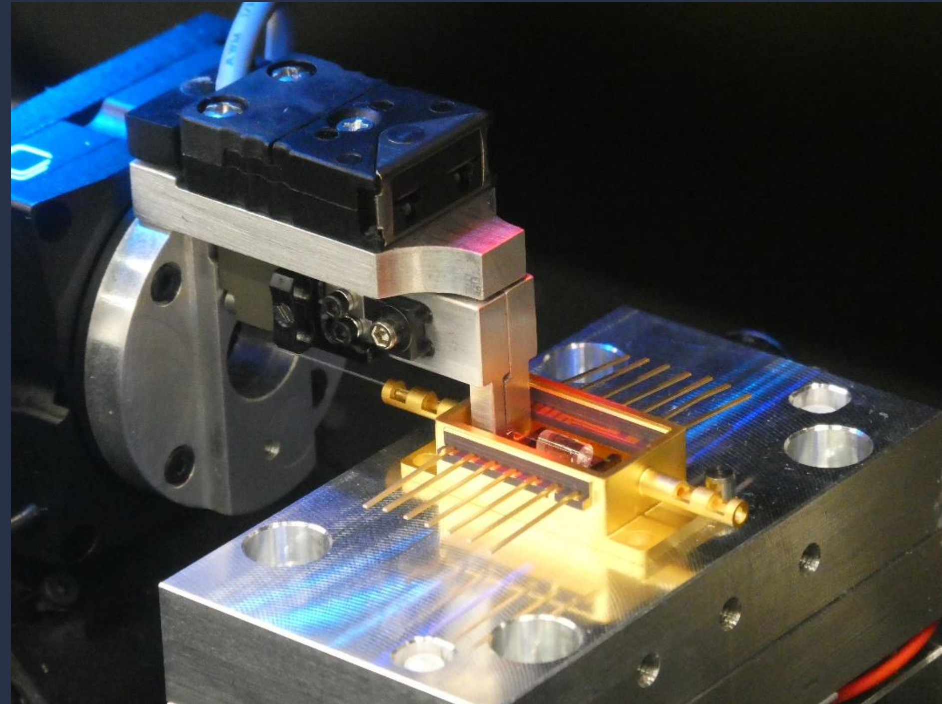


2 fibre butterfly package



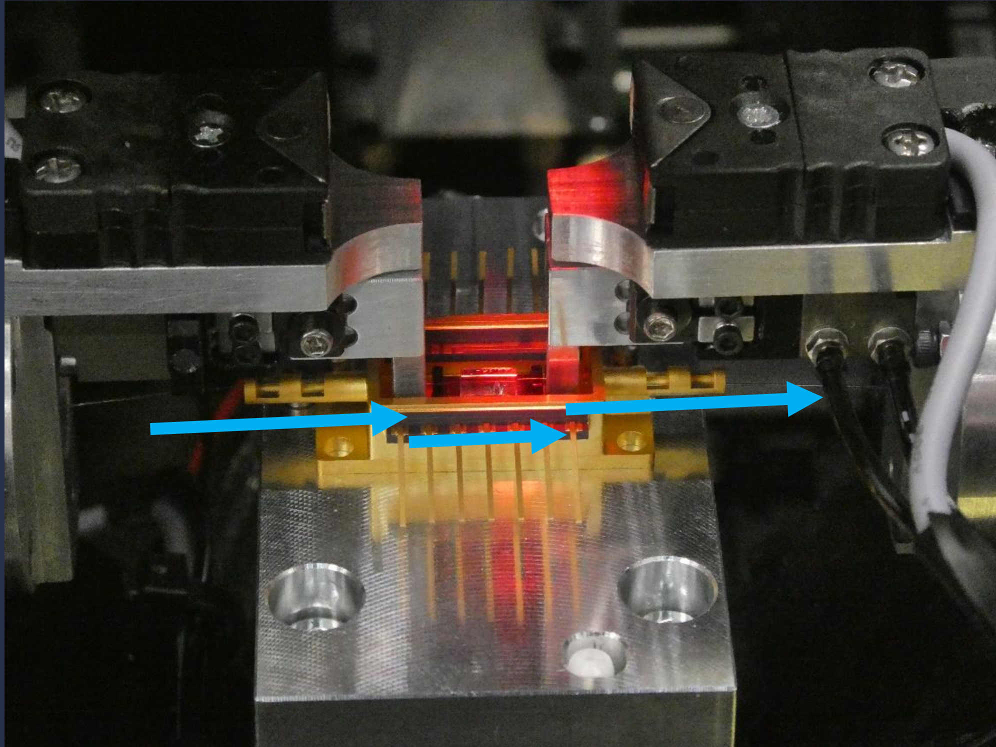
Speeding up coupling small modes



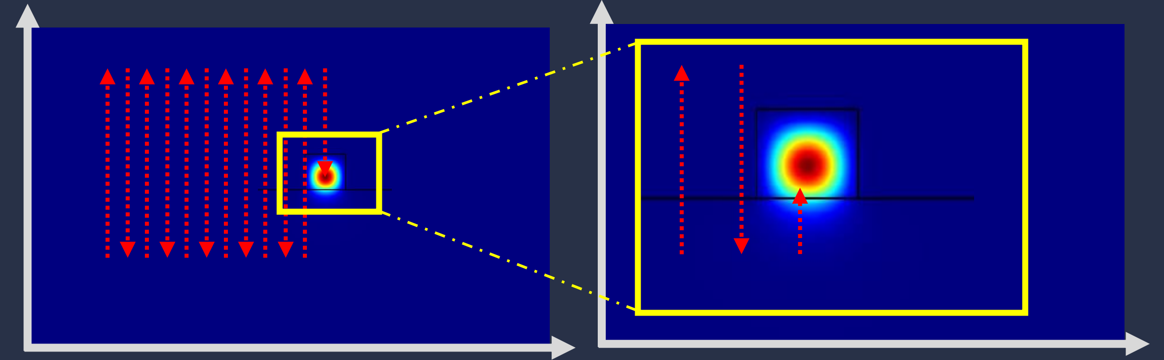


- First light detector – coarse alignment for enclosed packages
- Machine vision – requires clear camera view

Alignment

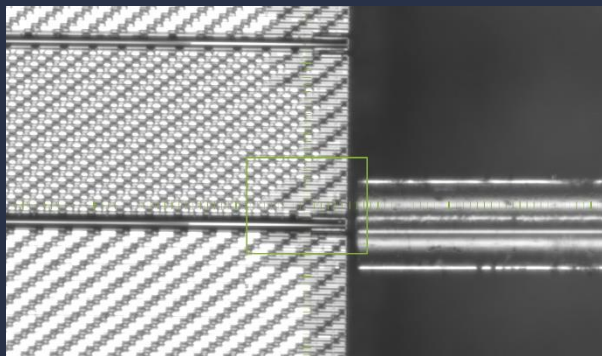


1. Getting the first light signal through the system



2. Maximization of signal on both sides

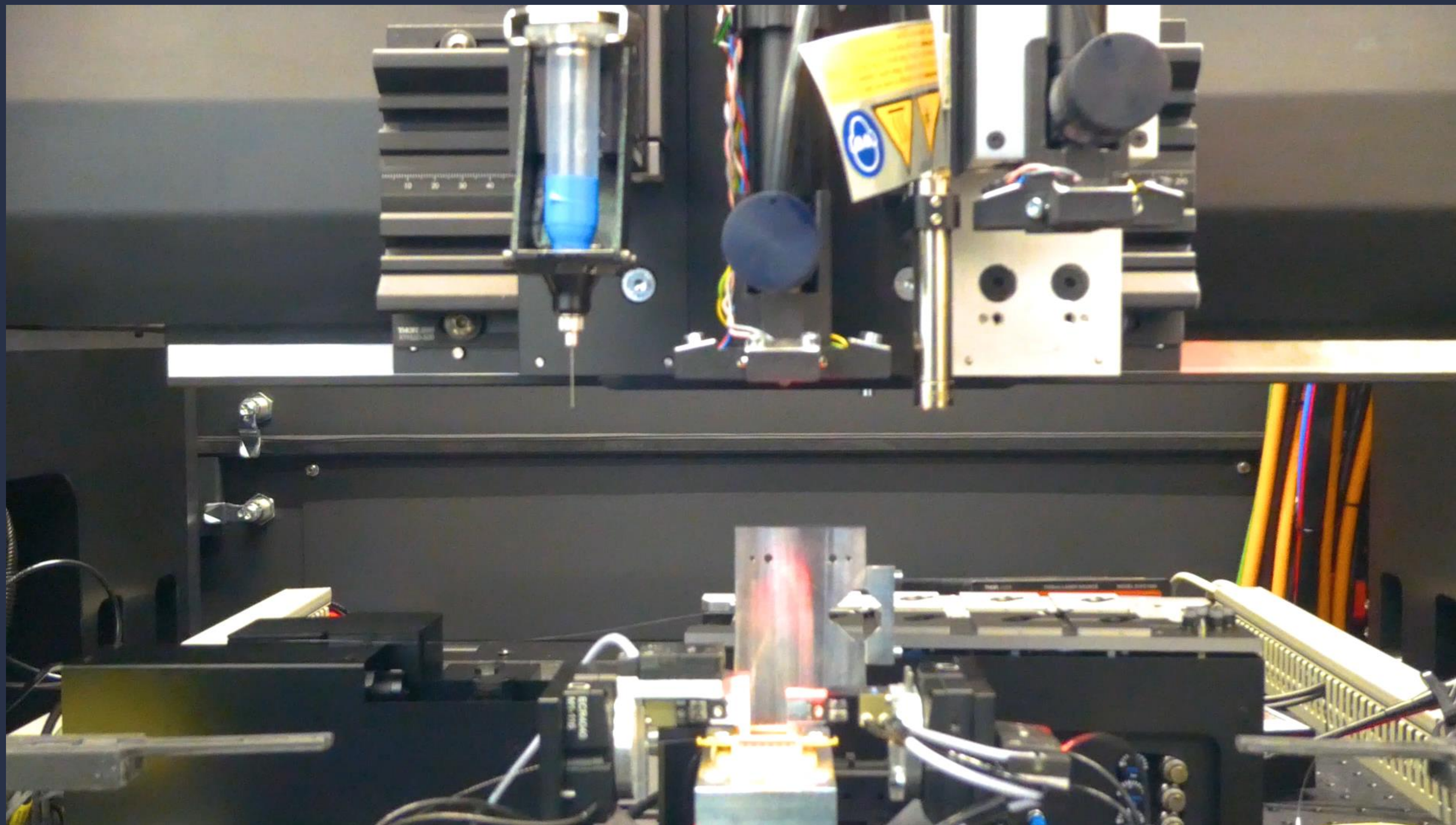
Bottleneck – *time consuming step for serial assembly*



1st light detection +
Machine learning +
automatic pre-alignment +
smart scanning algorithms

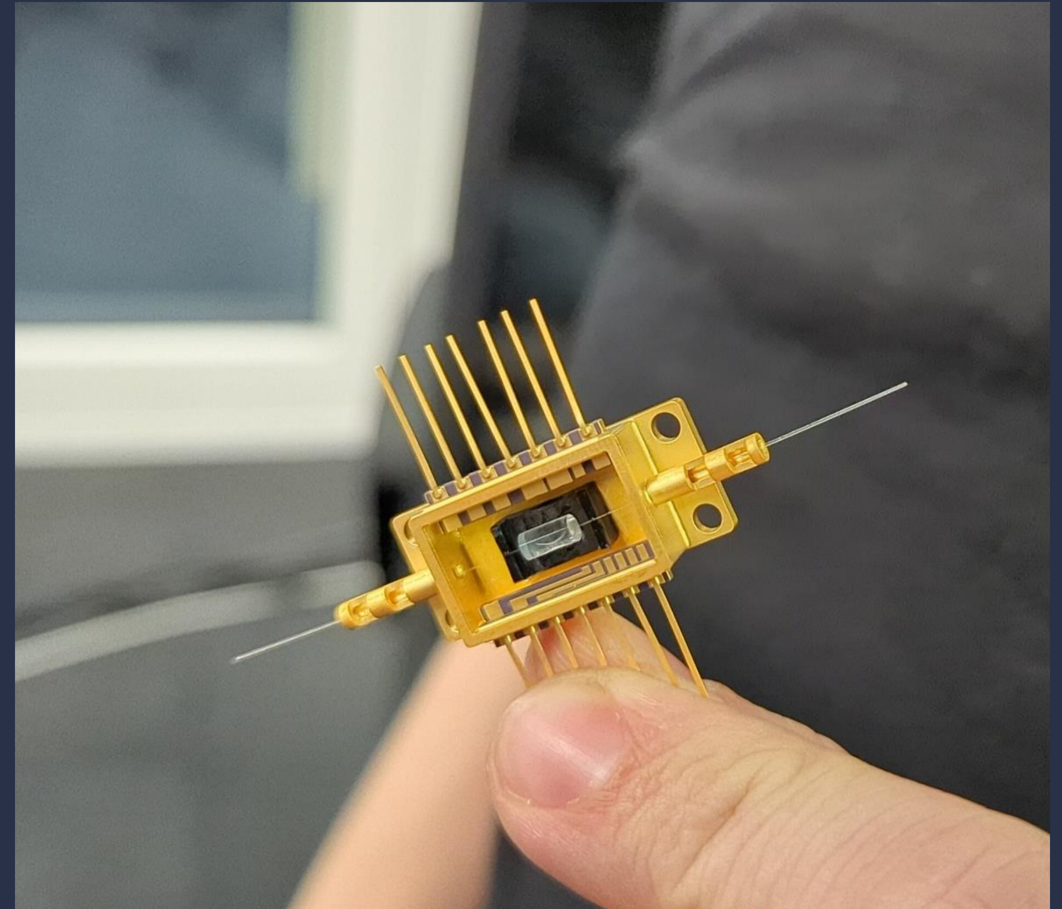
faster and **cheaper** assembly

Calibration and Gluing



Gluing / Fixation

- Right choice of materials
  - Environment?
  - Durability?
  - Shrinkage?
  - Compatibility?



Gluing / Fixation

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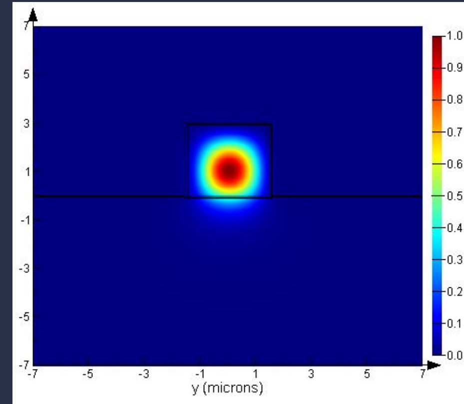
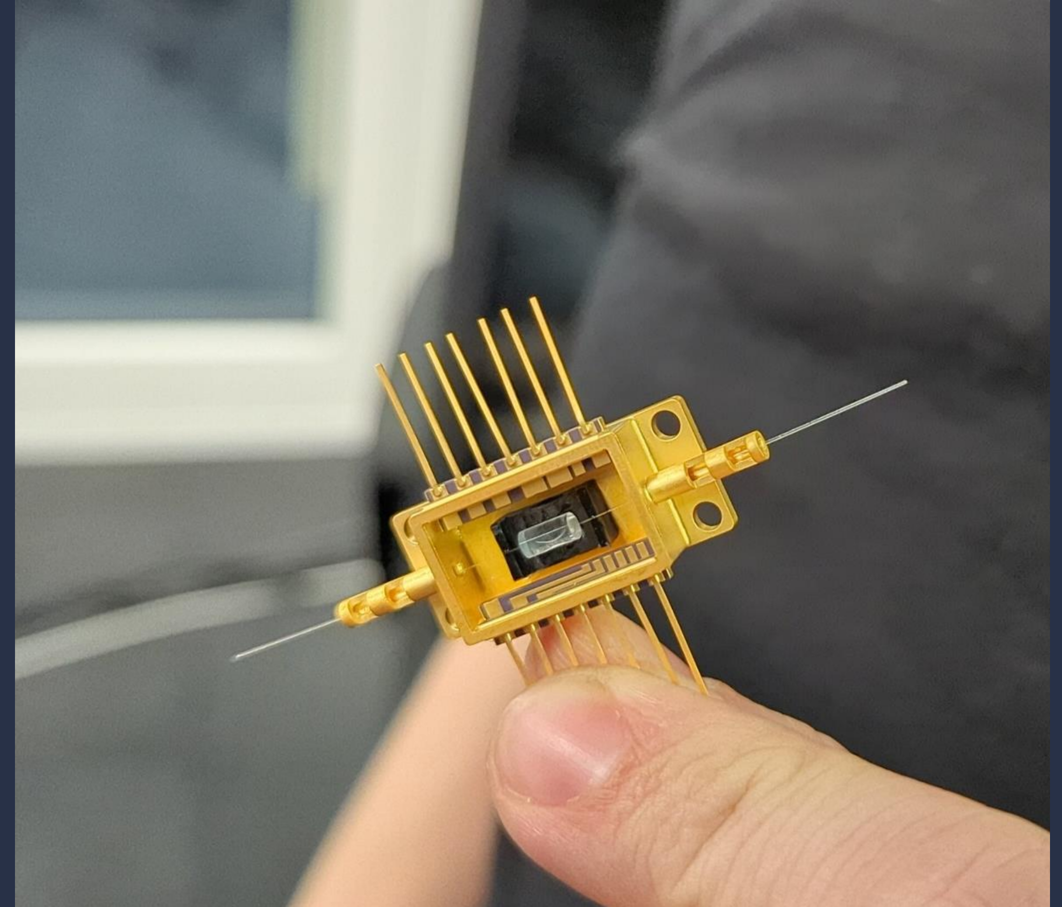
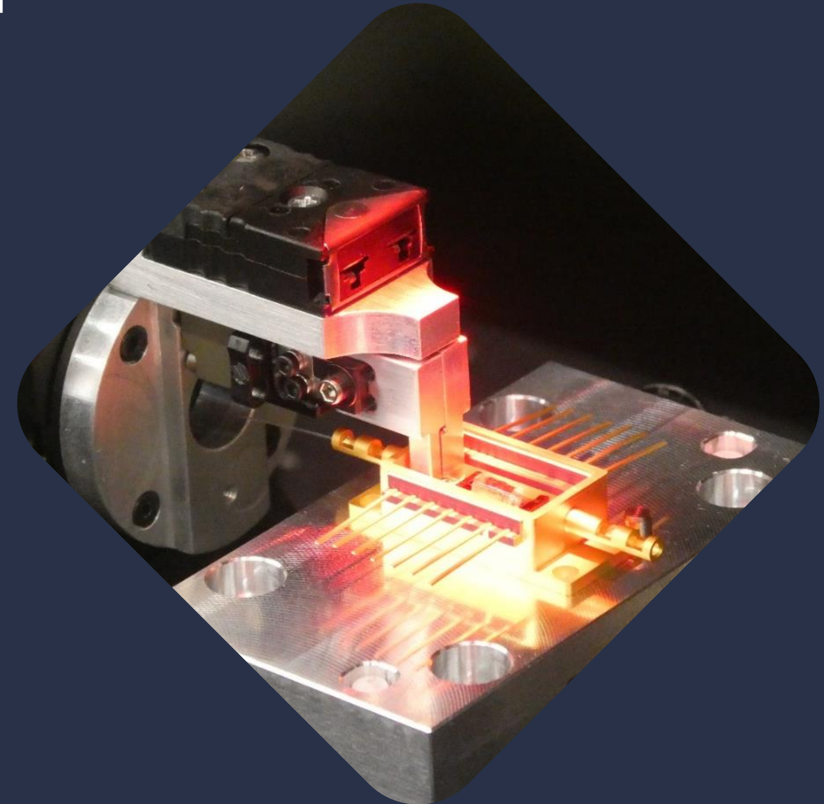




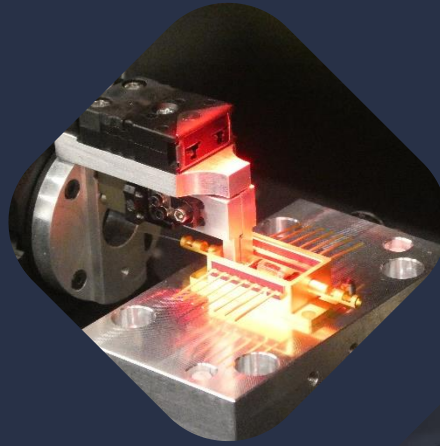
- Critical consideration
  - Un-gripping
  - Temperature fluctuations
  - Post-curing movements

Key take-aways

- Submicron assembly is a **Major bottleneck** in hybrid integration
  - High processing time
  - A significant cost driver



- CSEM can
  - Get your prototypes to industry levels, to «bridge the gap»
  - Develop optical, RF, thermal and encapsulation solutions
  - Make transferable processes for the industrial (series) production



Your partner for photonic assembly and integration

ivan-lazar.bundalo@csem.ch