

Sub- μm alignment approaches

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Micro & Nano Engineering
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Representing Marcel Tichem
Sub-micron alignment approaches

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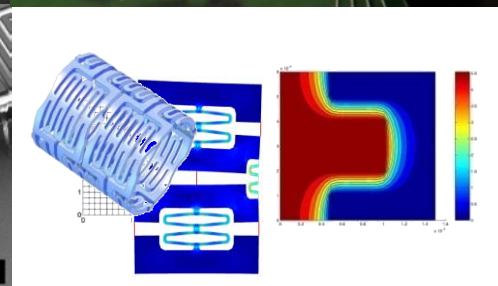
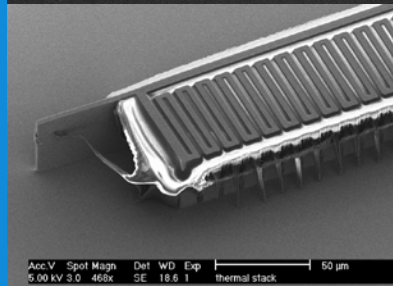
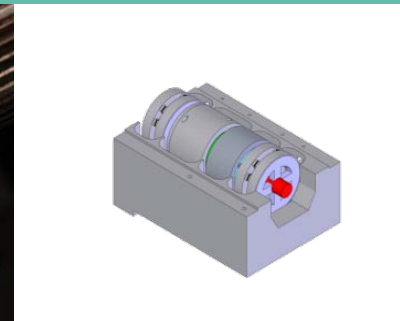
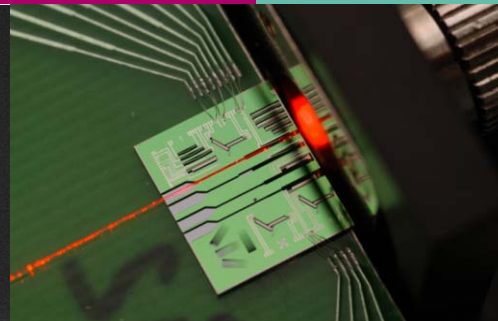
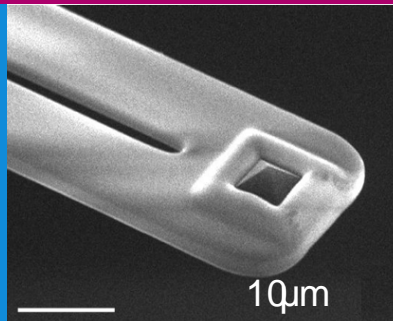
- Micro and nano scale assembly @ TU Delft
- Projects in detail:
 - MEMS for fibre-to-chip alignment and fixing
 - Passive chip-to-chip alignment
 - New projects (now starting)
- Future perspective

Precision and Microsystems Engineering: the ultimate in mechanical engineering

Micro- and Nano engineering
Urs Staufer

Mechatronic System Design
Rob Munnig Schmidt, Jan van Eijk(PT)

Micro and Nano
Devices and Systems

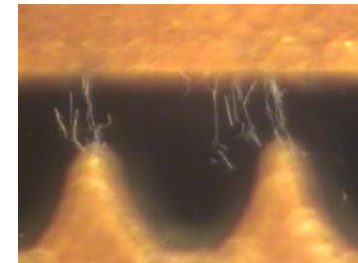
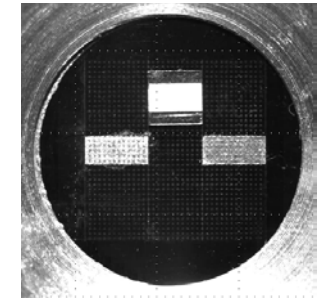
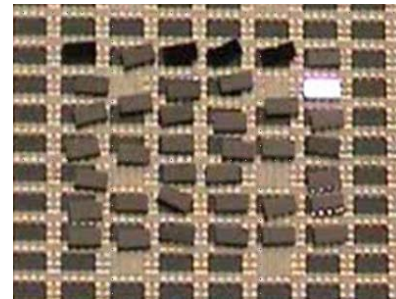
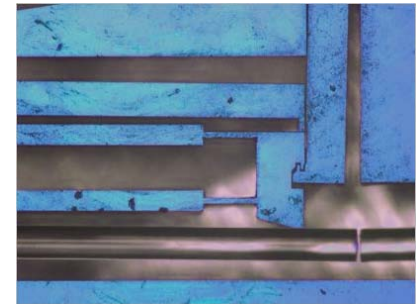
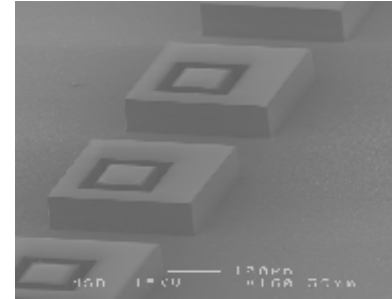


Precision equipment

Applied Mechanics
Daniel Rixen, Fred van Keulen

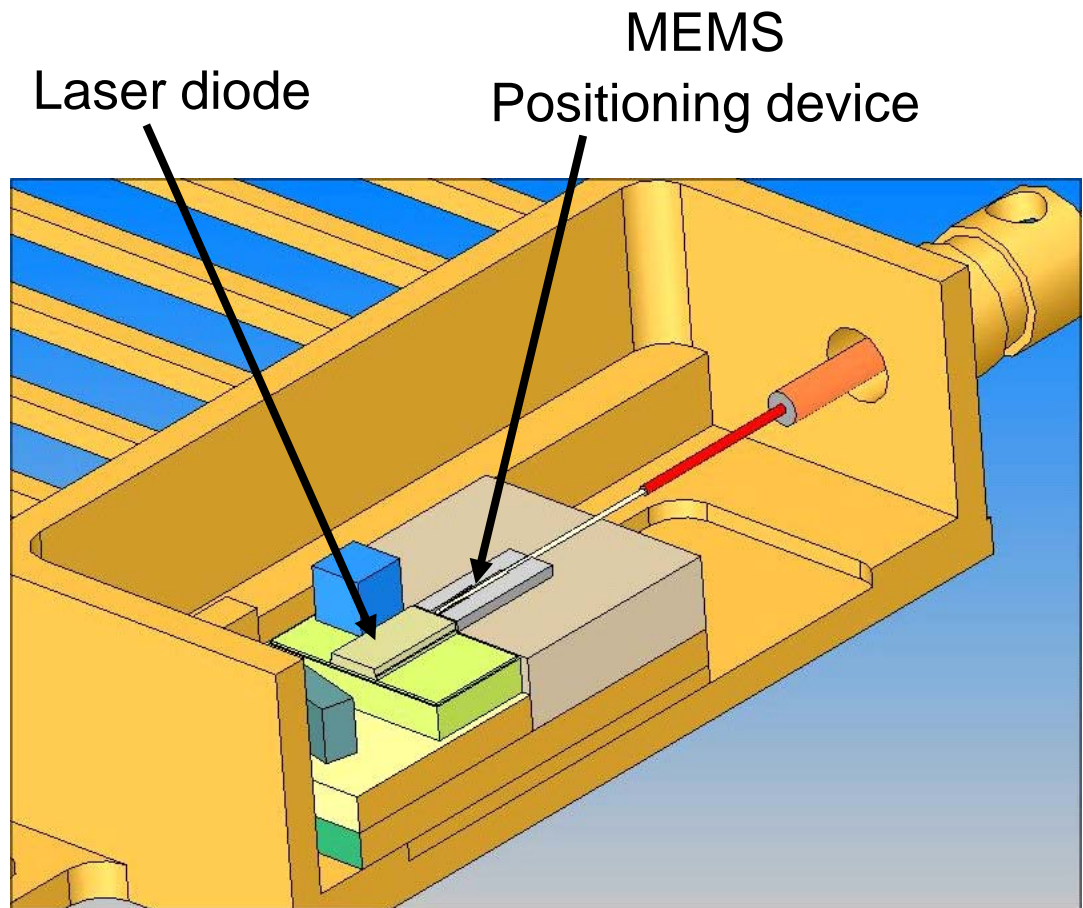
Research program micro- and nano-scale assembly

- Extreme precision
Photonic alignment and fixing with sub- μm precision
- Extreme quantities
Self-assembly at micro-scale
- Extreme small length scale
Discrete patterns of nano-scale objects

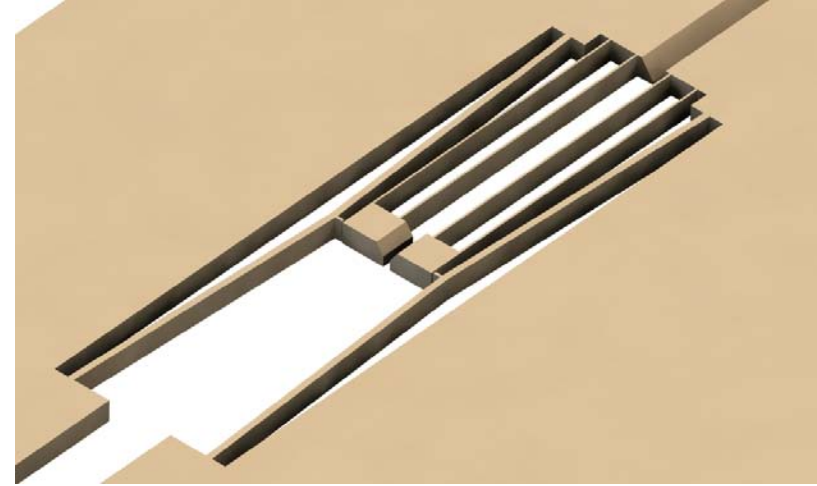


MEMS for fibre alignment

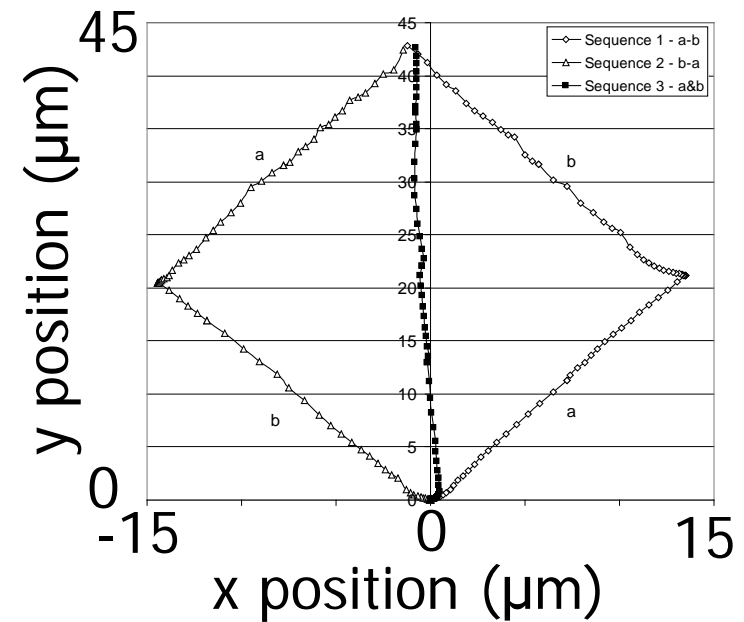
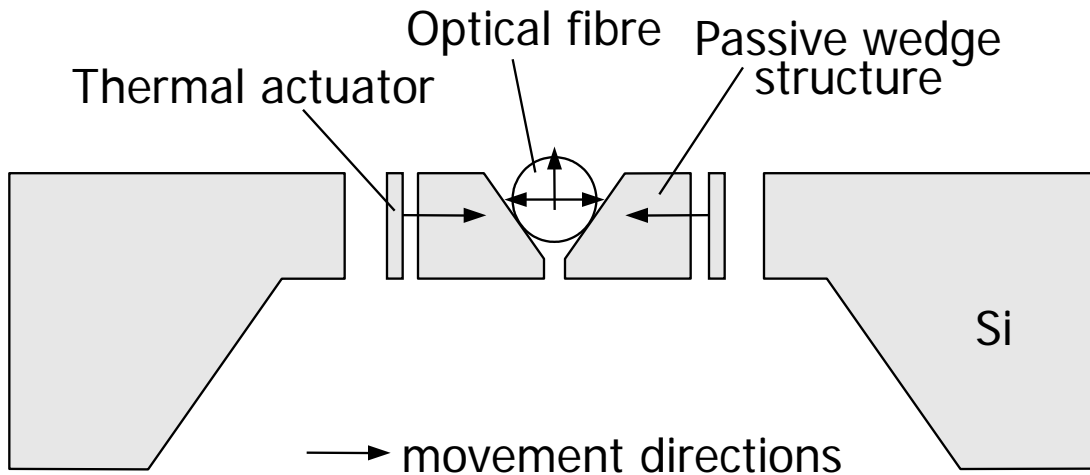
- Sub- μm positioning *and* fixing in 2 lateral fibre directions
- Integrated MEMS actuator
- Two-step assembly procedure



Positioning function



- 2DOF out-of-plane motion by in-plane thermal actuators and wedges

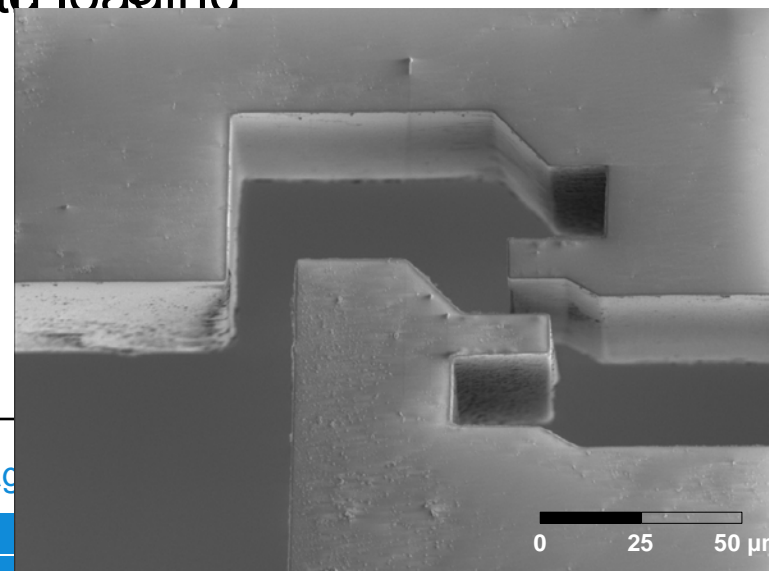


Clamping function

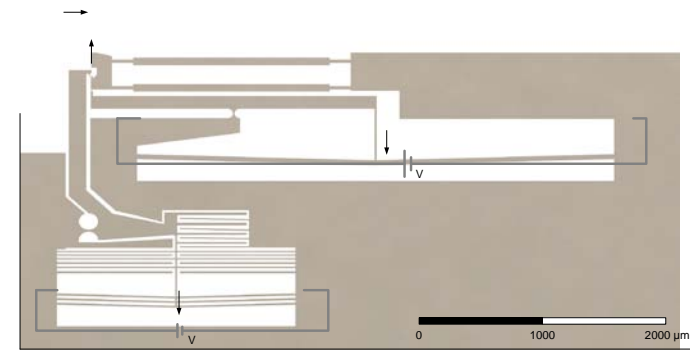
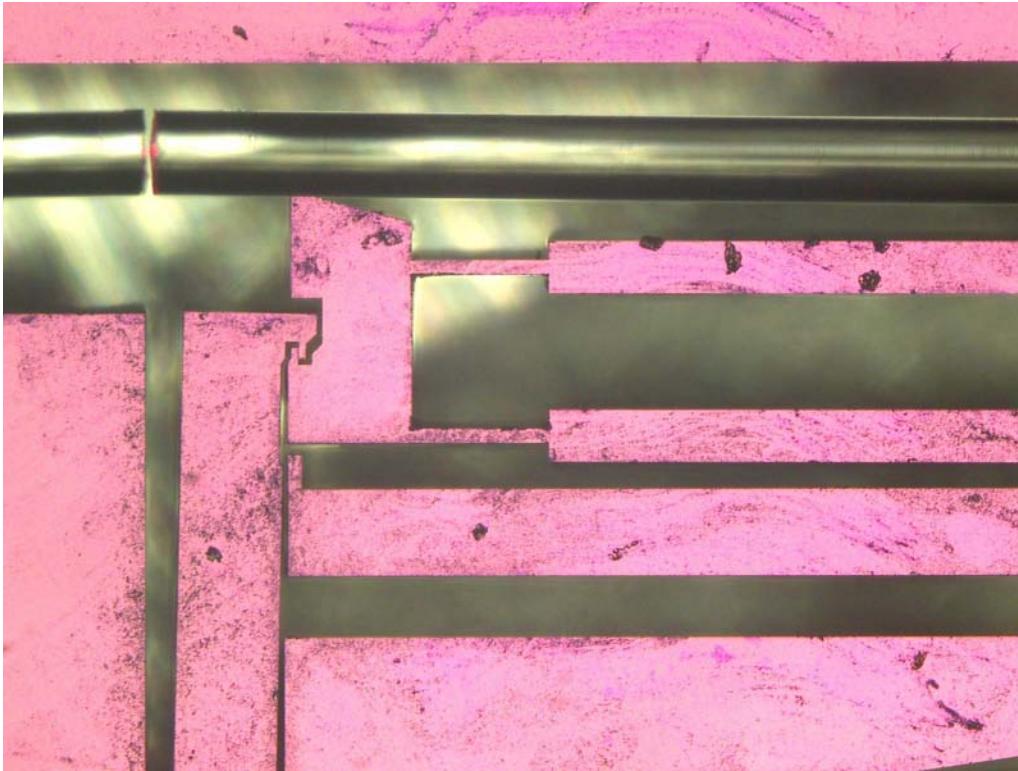
- Rack-and-tooth mechanism



Only one clamping actuator required
for each fibre mechanism



Clamping sequence

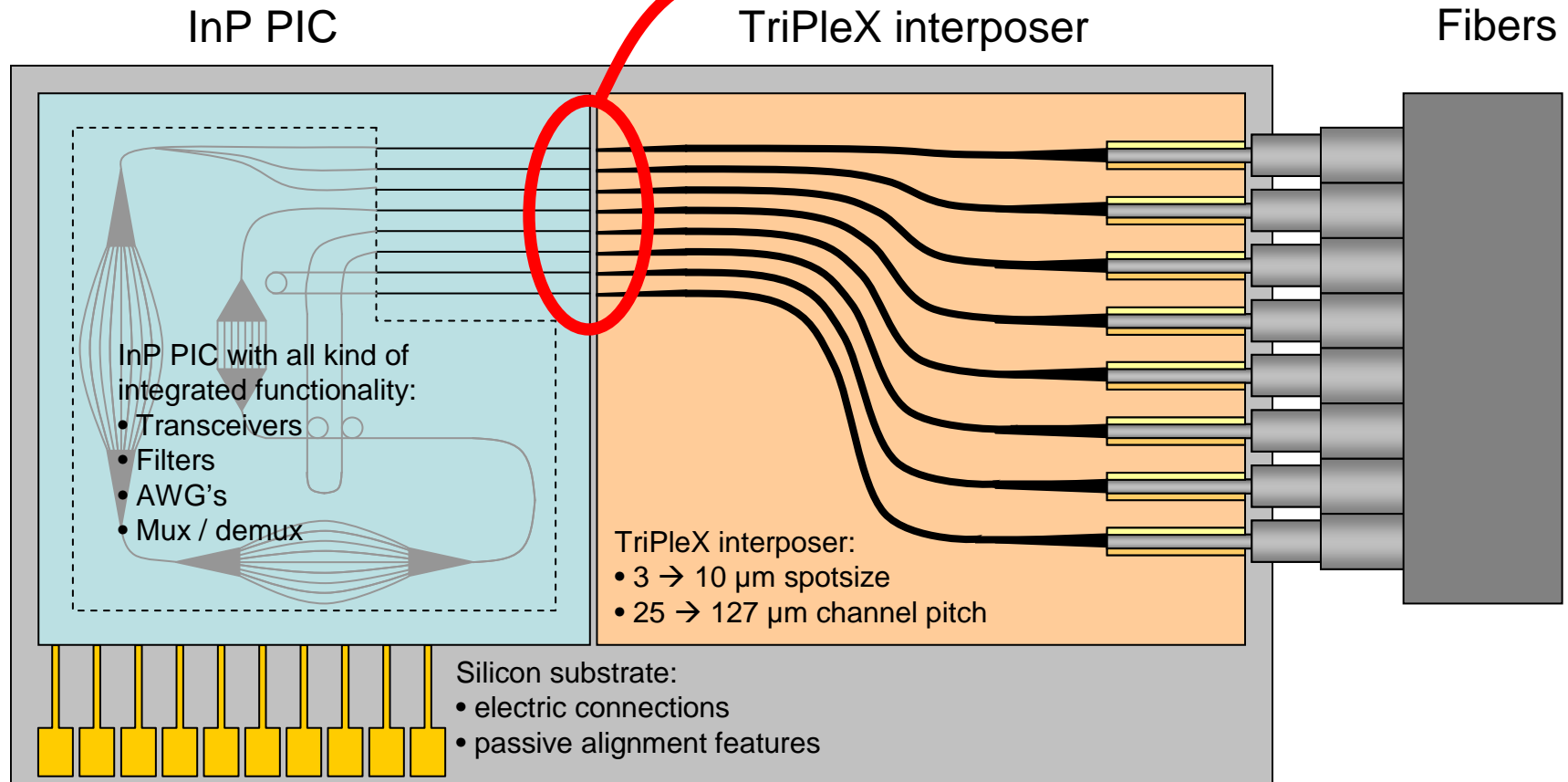


Fabricated position

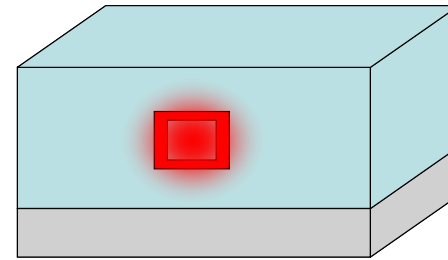
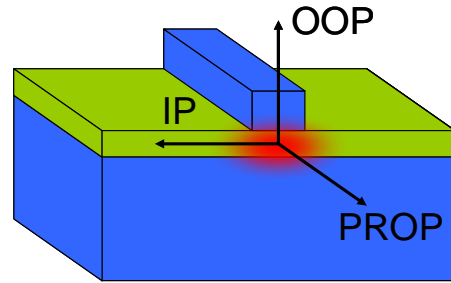
- (1) Fibre insertion
- (2) Actuating the clamp
- (3) Actuation of positioner
- (4) Releasing the clamp
- (5) Releasing positioner

Photonic alignment

Passive alignment
100 nm accurate

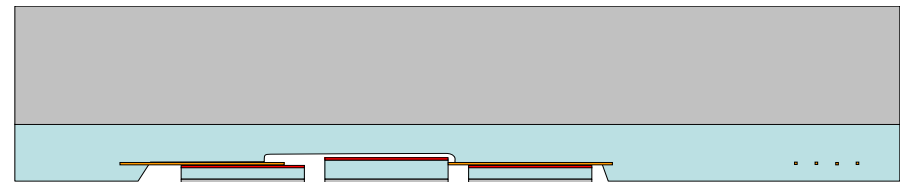
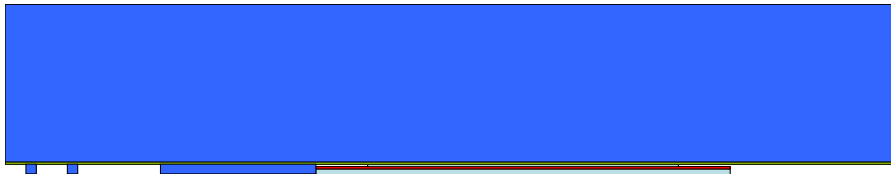


Towards sub-micron Passive Alignment: Alignment Features Defined in Waveguiding Layers

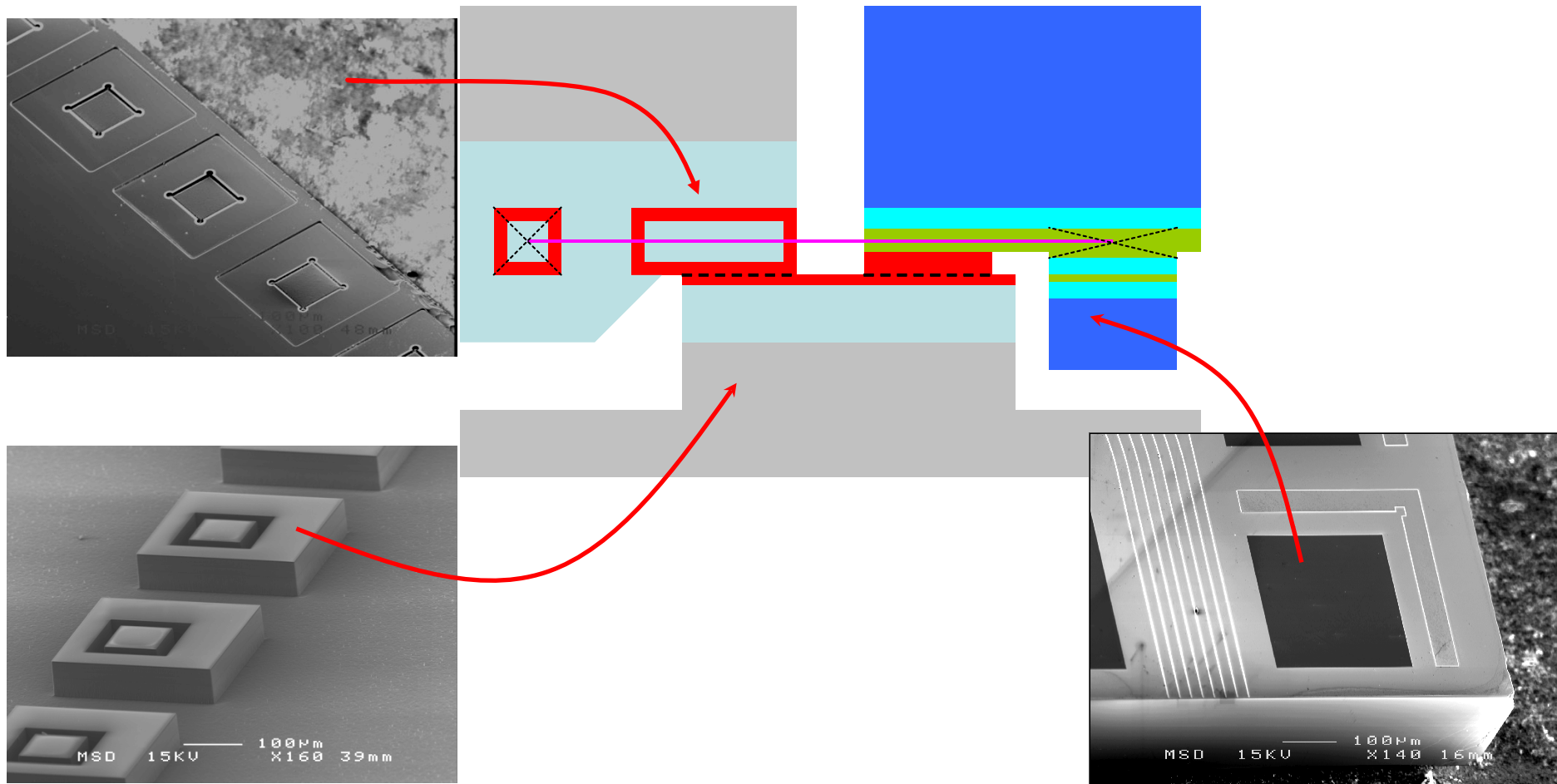


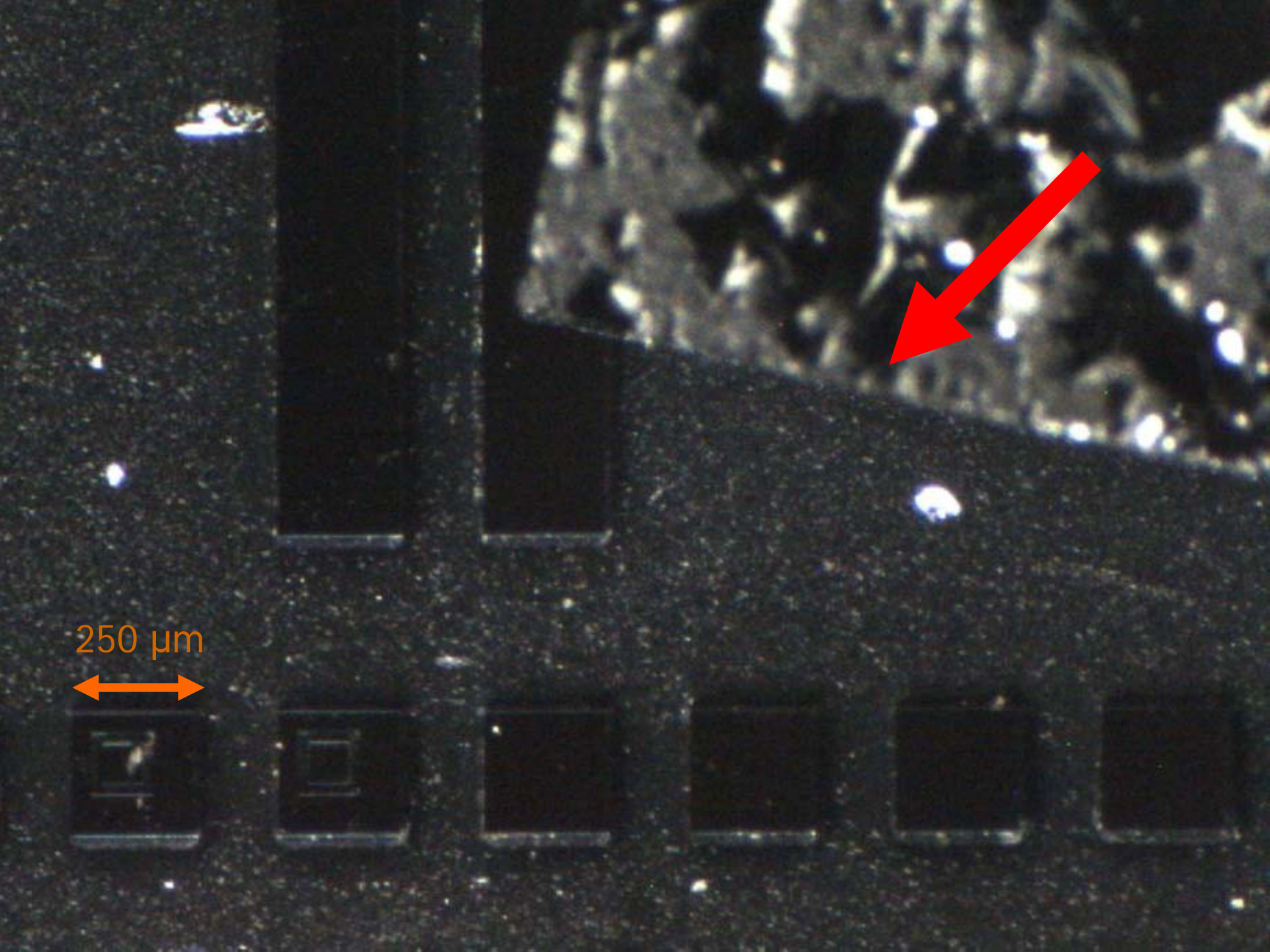
InP

TriPleX



Towards sub-micron Passive Alignment: Alignment Features Defined in Waveguiding Layers



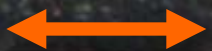


250 μm

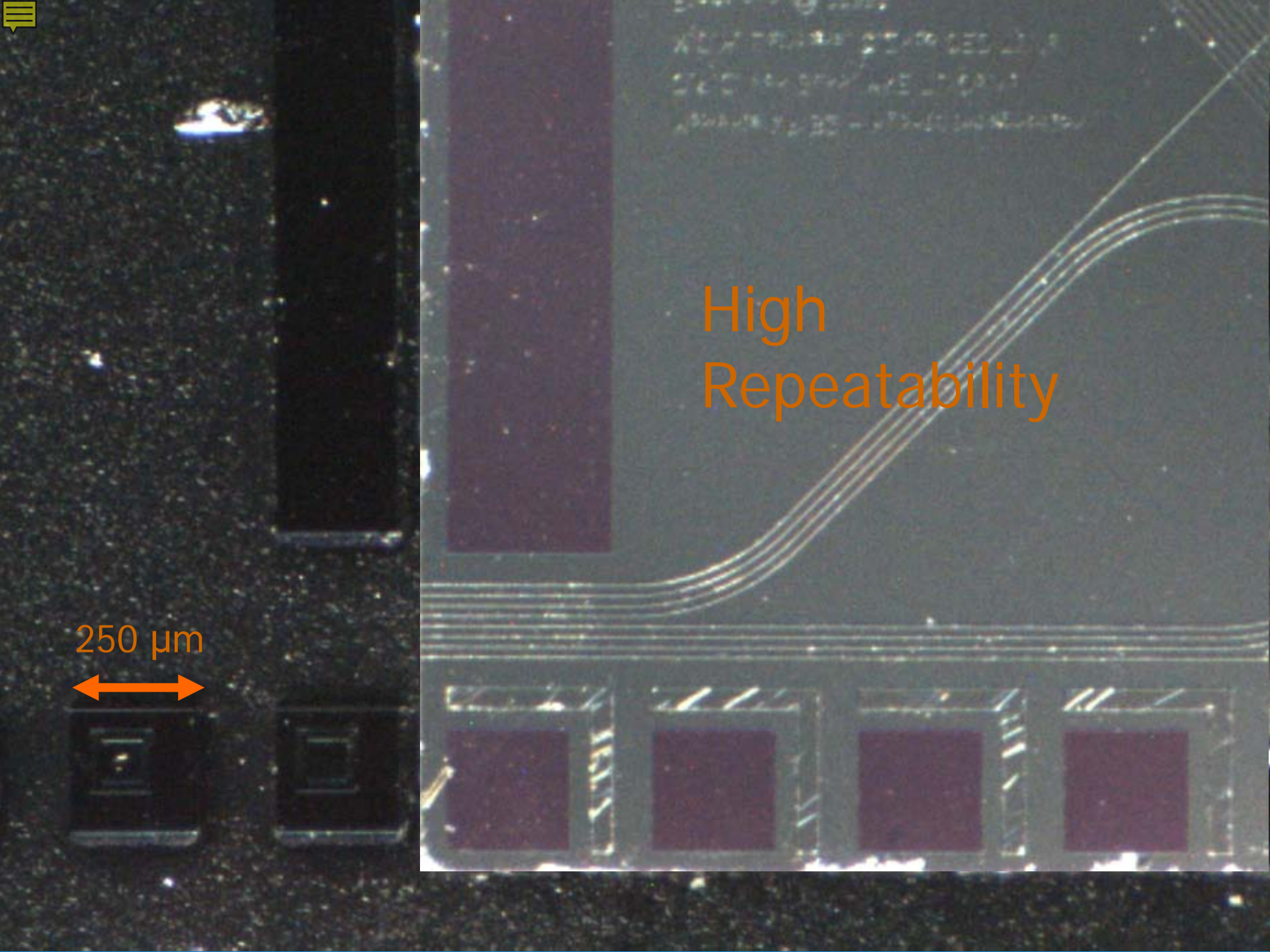




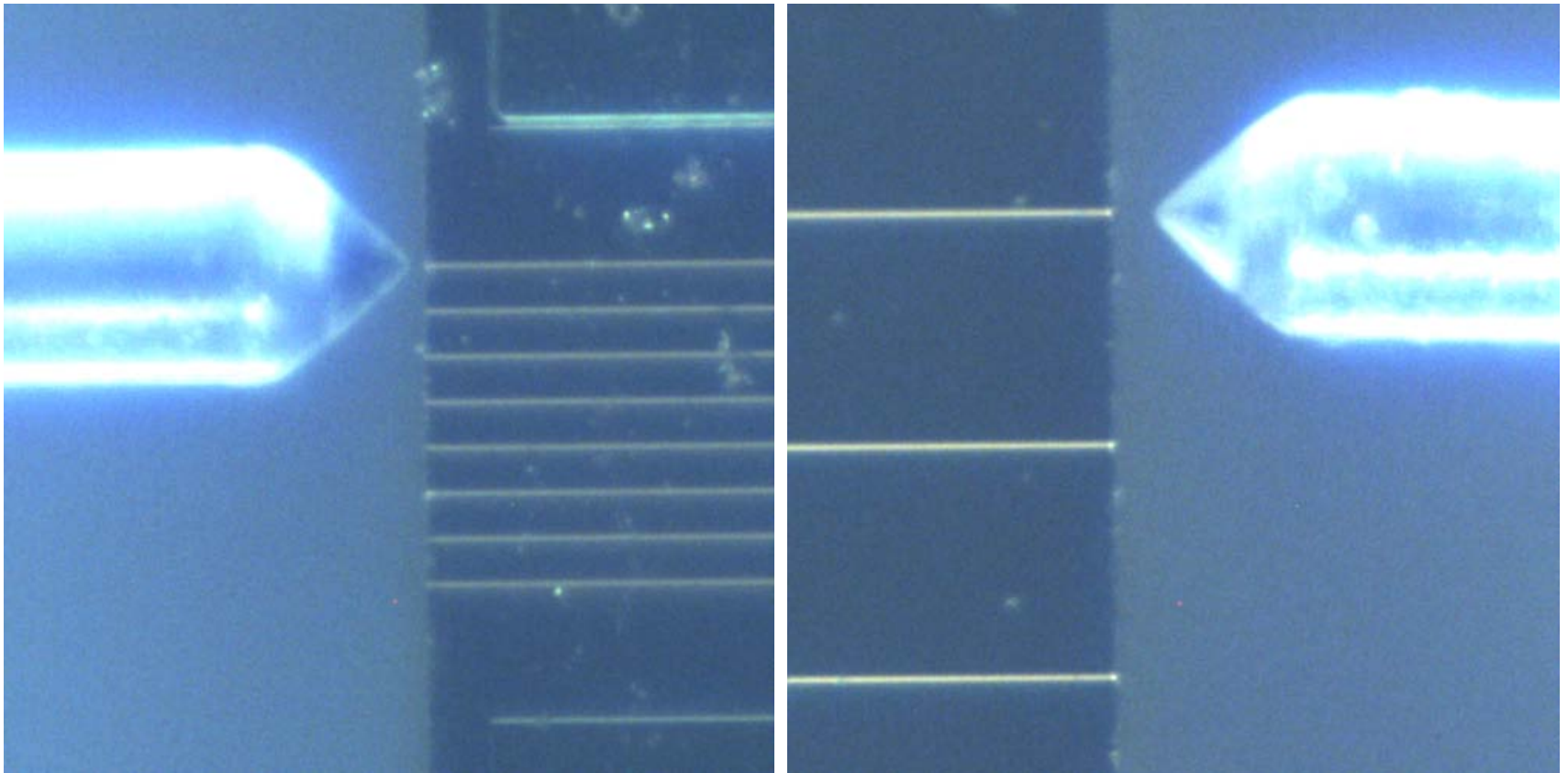
250 μm



High
Repeatability

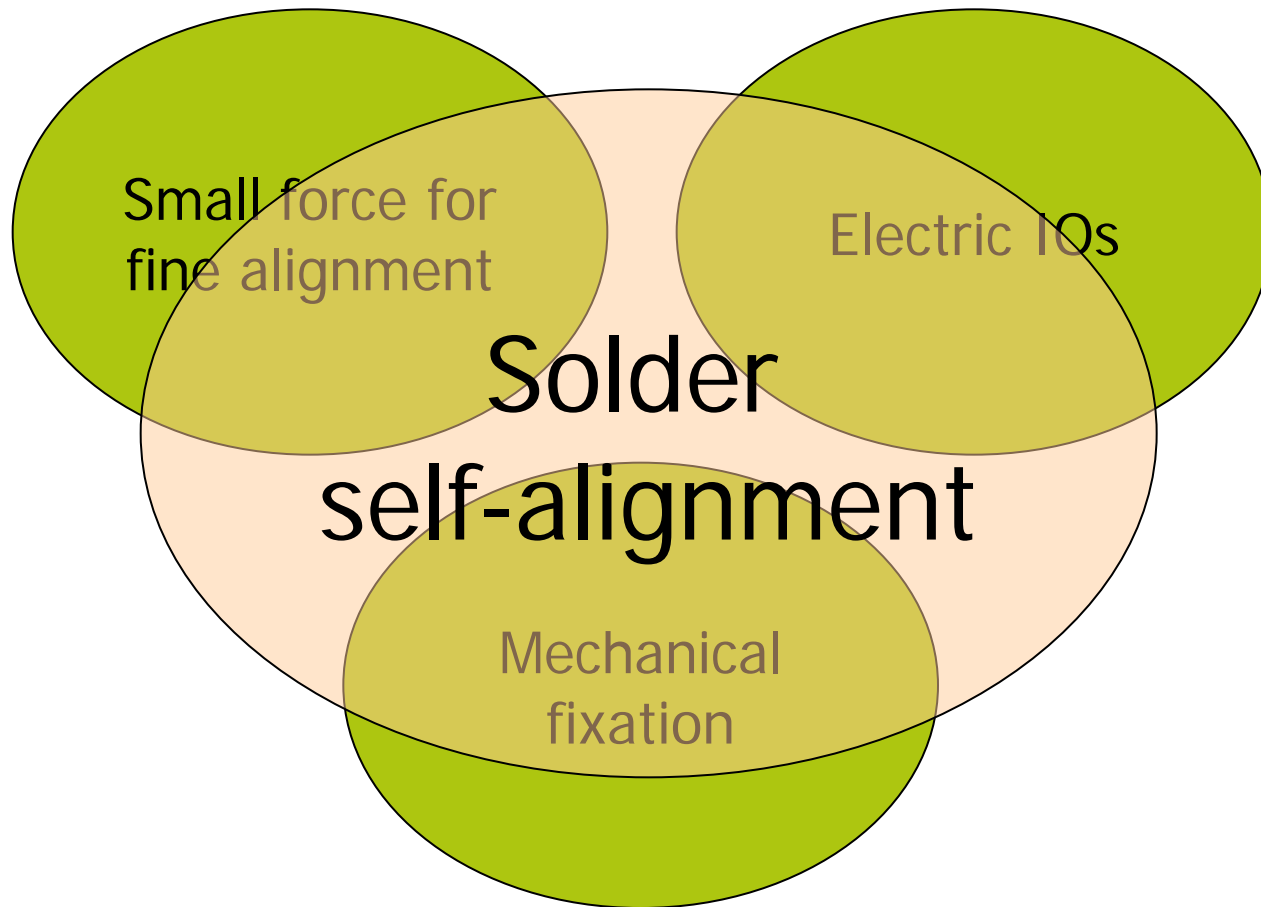


Alignment performance evaluated via optical coupling (in progress)



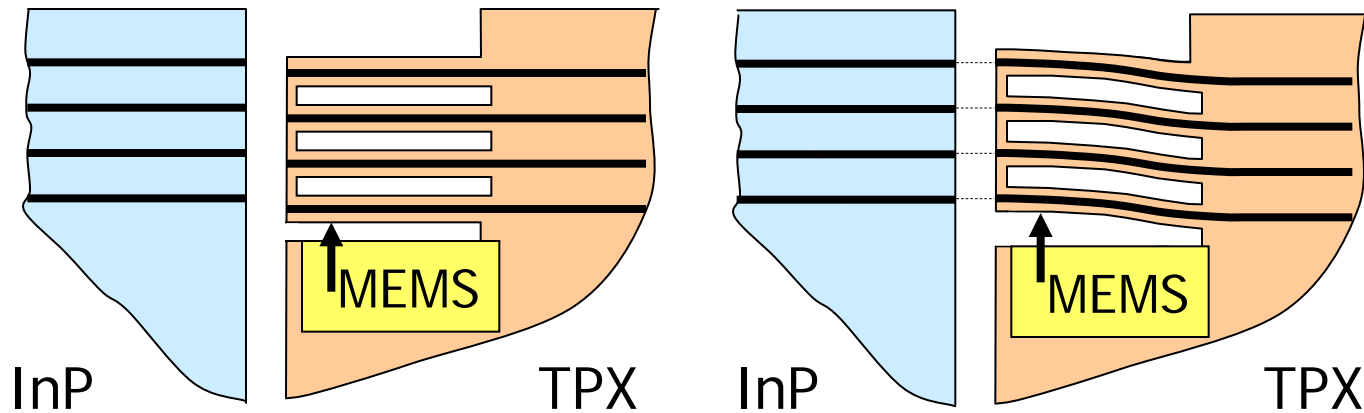
Achievable precision levels and robustness yet to be quantified

From lab setup to production



New projects - MEMS for photonic alignment and fixing

- Chip to chip alignment (STW GTIP – Flex-O-Guides)
 - Flexible optical waveguide structures actuated by in-package MEMS



- Fibre to waveguide array alignment for UV/R/G/B (IOP-PD)
 - Modular approach: single fibre alignment unit, heavily based on microfabrication technology (positioning, fixing)

Future of sub- μm alignment

- THE winning approach?
 - Depending on technical and economic demands
 - Requires rigorous total package definition in the field from perspective of applications, e.g. layouts, form factors, cost targets
- To achieve sub- μm precision relax alignment demand essential, e.g.:
 - InP material system: good approach is to use interposer with SSC
 - FAU: minimise relative errors between fibres to allow handling of array rather than single fibres

Sub- μm chip to chip alignment

- Fully passive approach in all DOFs (project Hans van Gurp)
 - Achievable precision levels and robustness yet to be quantified
- Increased use of microfabrication technology
 - Define end-positions in at least some of the DOFs
 - Integrate fixing step (material connection like solder, clamp)
- Positioning functions
 - Currently best approach precision manipulators, industrially available
 - MEMS likely winner given delicacy of alignment process, if package standard can be defined

Questions and contact

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