Optoelectronic packaging: from challenges to solutions

Seminar on Optical Packaging

Alpnach Dorf

Mai 16, 2012

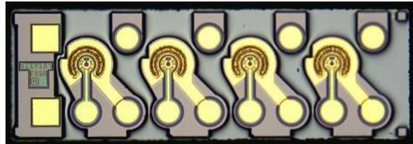
Christian Bosshard
CSEM Center Central Switzerland

General challenges

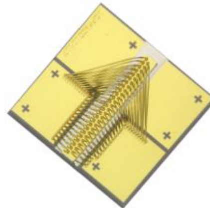
- Multidisciplinarity

Components

Finisar



oclaro

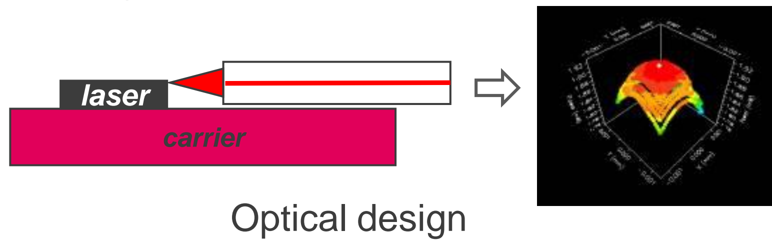


axetris
A Division of Leister

General challenges

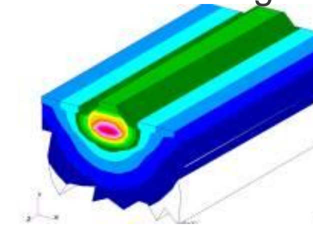
- Multidisciplinarity

Modelling and simulation



Optical design

Thermal modelling



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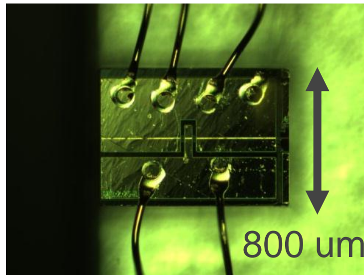
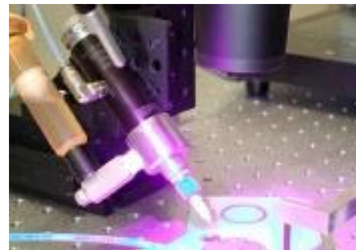
General challenges

- Multidisciplinarity

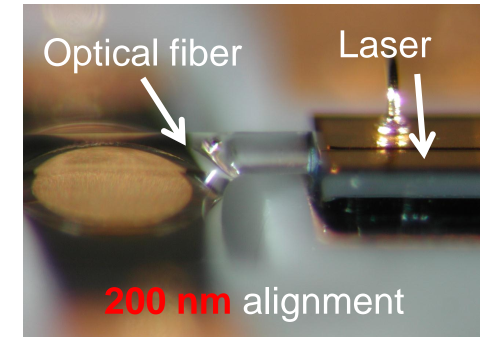
Bonding



Flip-chip



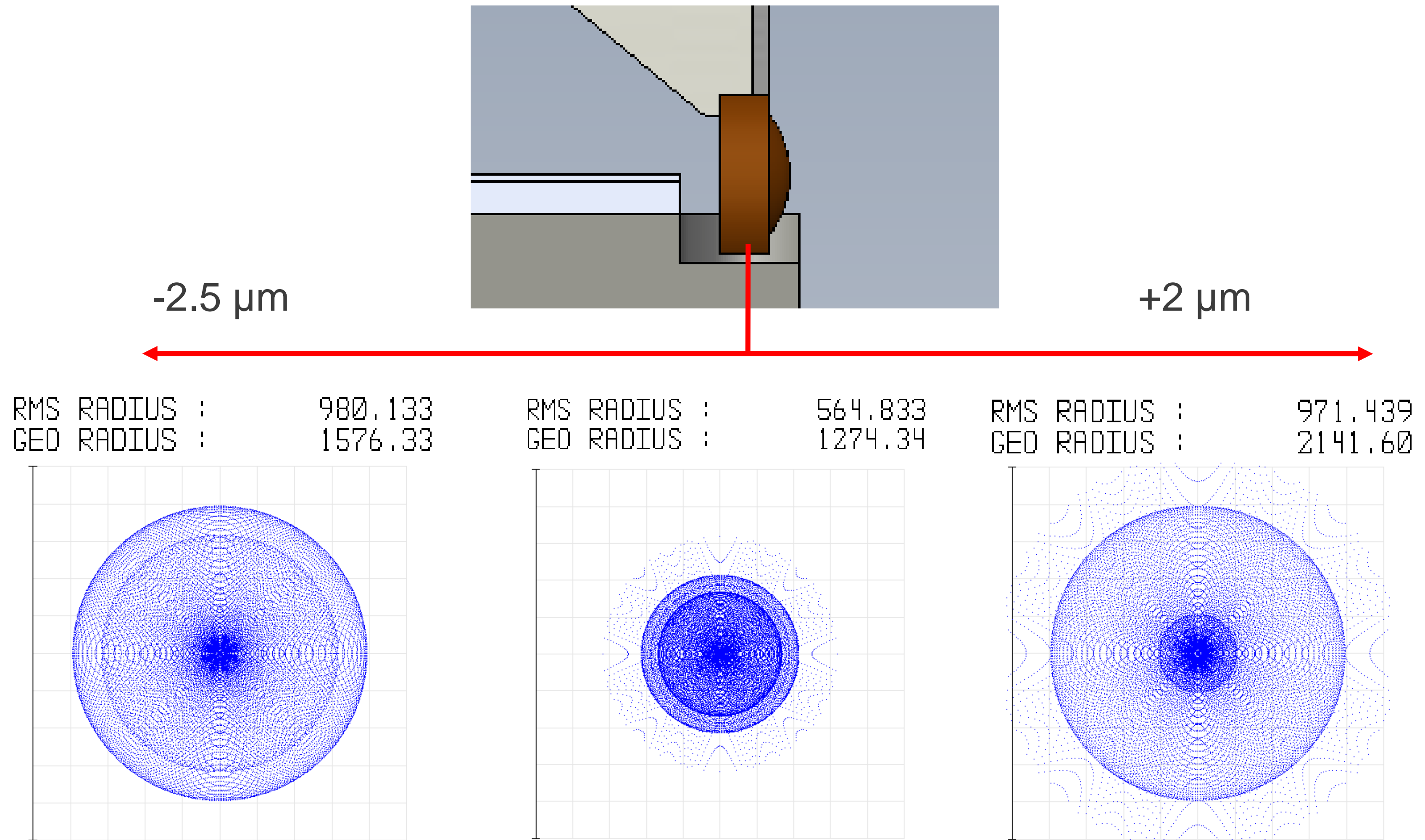
Adhesive fixing



Optical fiber assembly

- Automation yes/no
  - Assembly costs: ‘chinamation’
  - Quality assurance/yield

Beam waist change due to axial shift of lens



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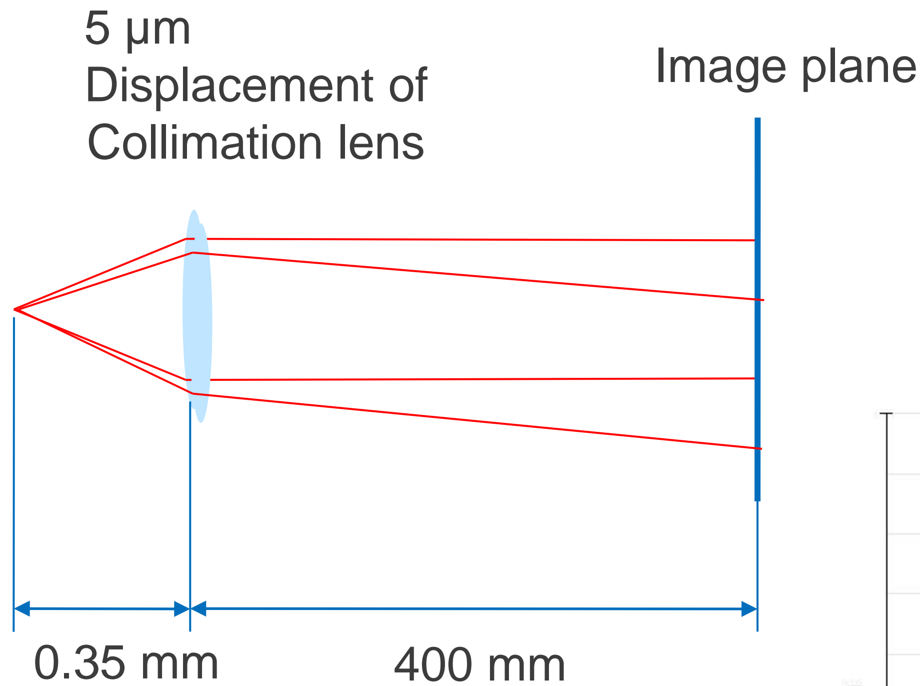
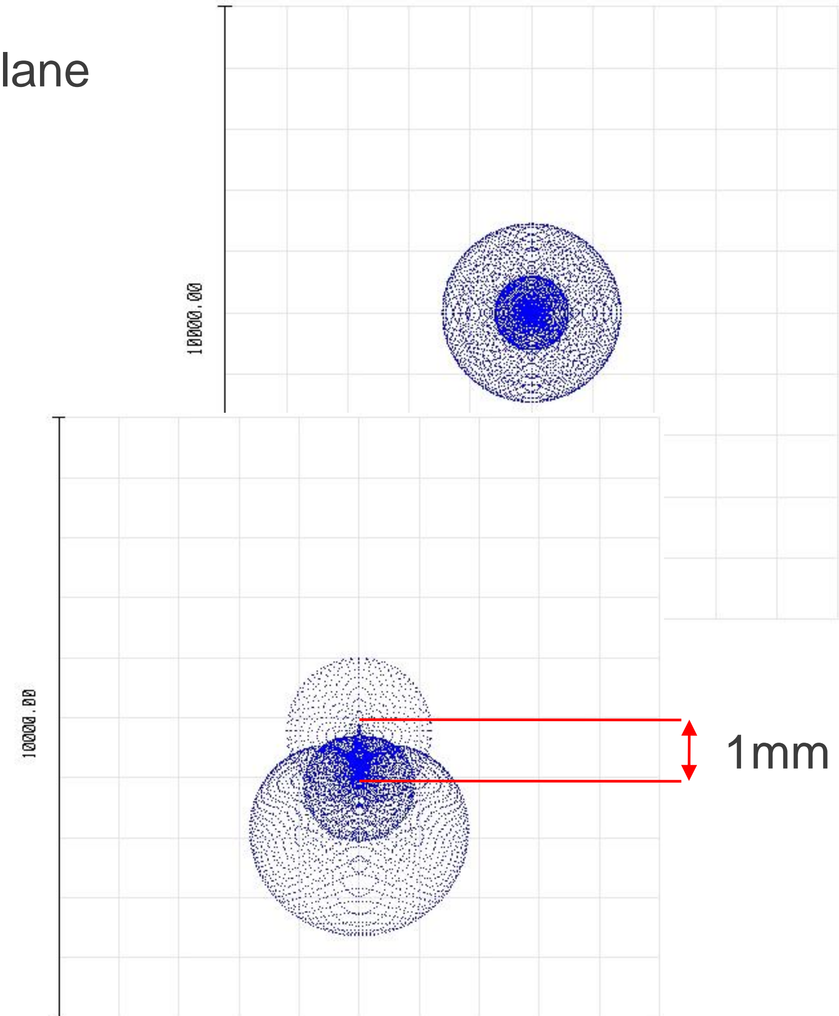
Influence of lateral shift of lens on beam pointing





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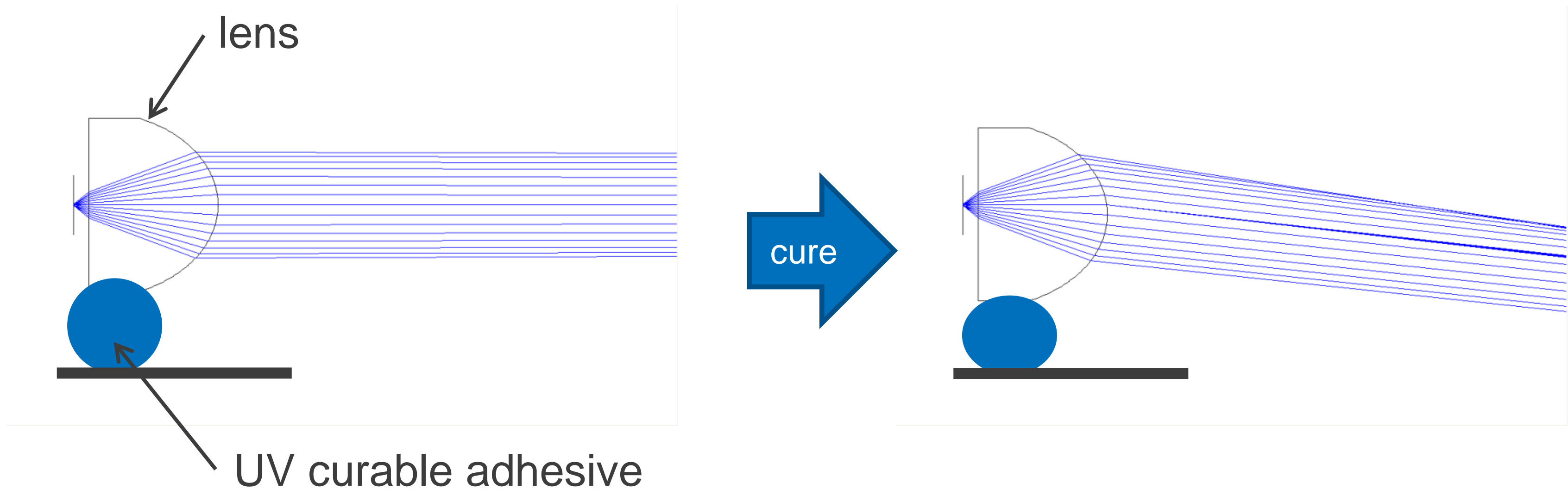
Component fixing



Effect of adhesive shrinkage due to curing has to be minimized through:

- amount of adhesive
- position of adhesive
- mechanical design
- curing procedure

high repeatable processes
→ pre-cure offset to be realized

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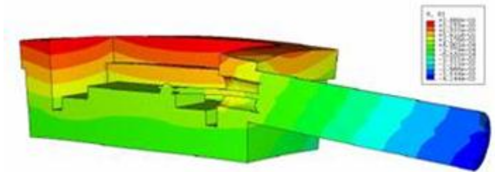
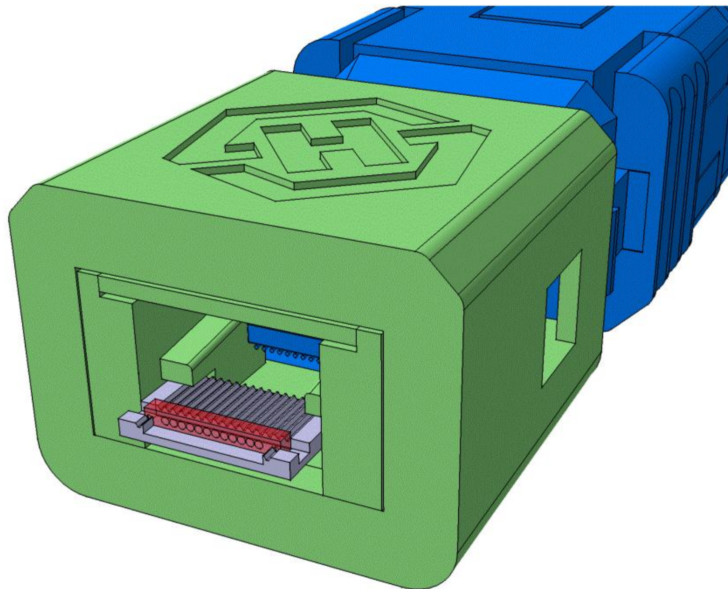
Development and manufacturing approach

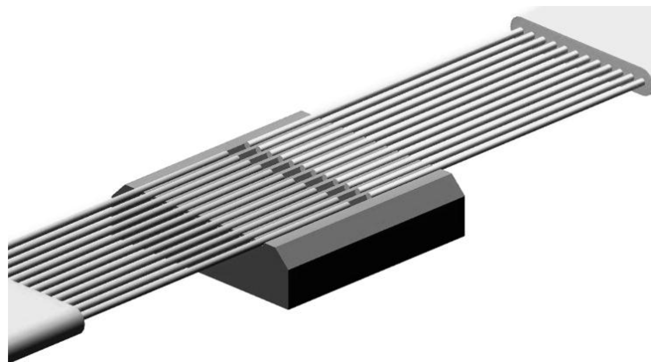
- Concept
- Design (for assembly)
- Optical modelling
- (Thermal & thermomechanical modelling)
- Assembly strategy
- Process development
- Prototyping
- (Small) series production

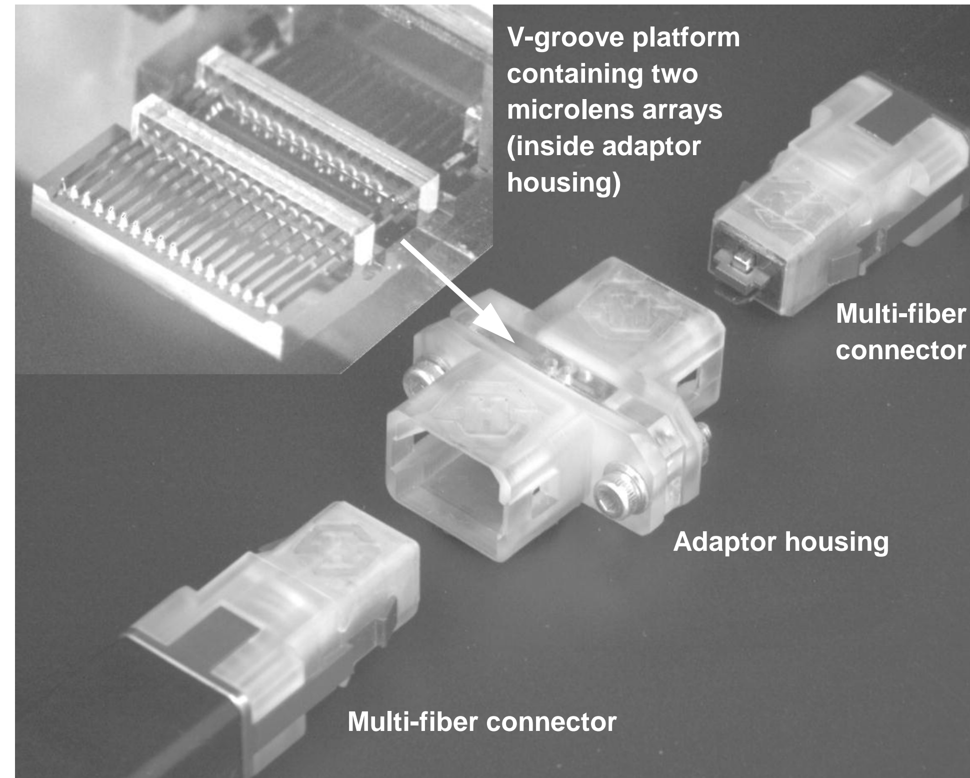


Testing

Ultracompact multifiber connector







Insertion loss fiber-to-fiber:

MMF	$< 2.0 \pm 0.2$ dB @ 800, 1300, 1550nm
SMF	$\approx 1.0 \pm 0.2$ dB @ 1300, 1550nm

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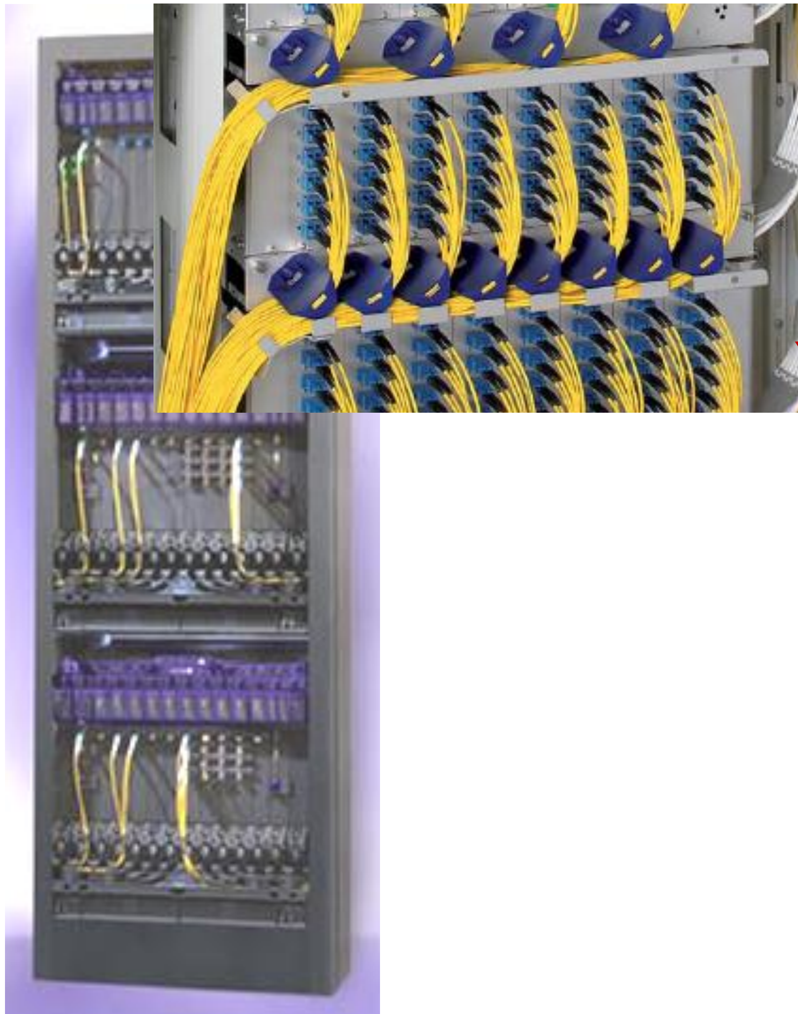
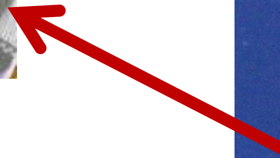
HTA LUZERN

Folded ultracompact multifiber connector

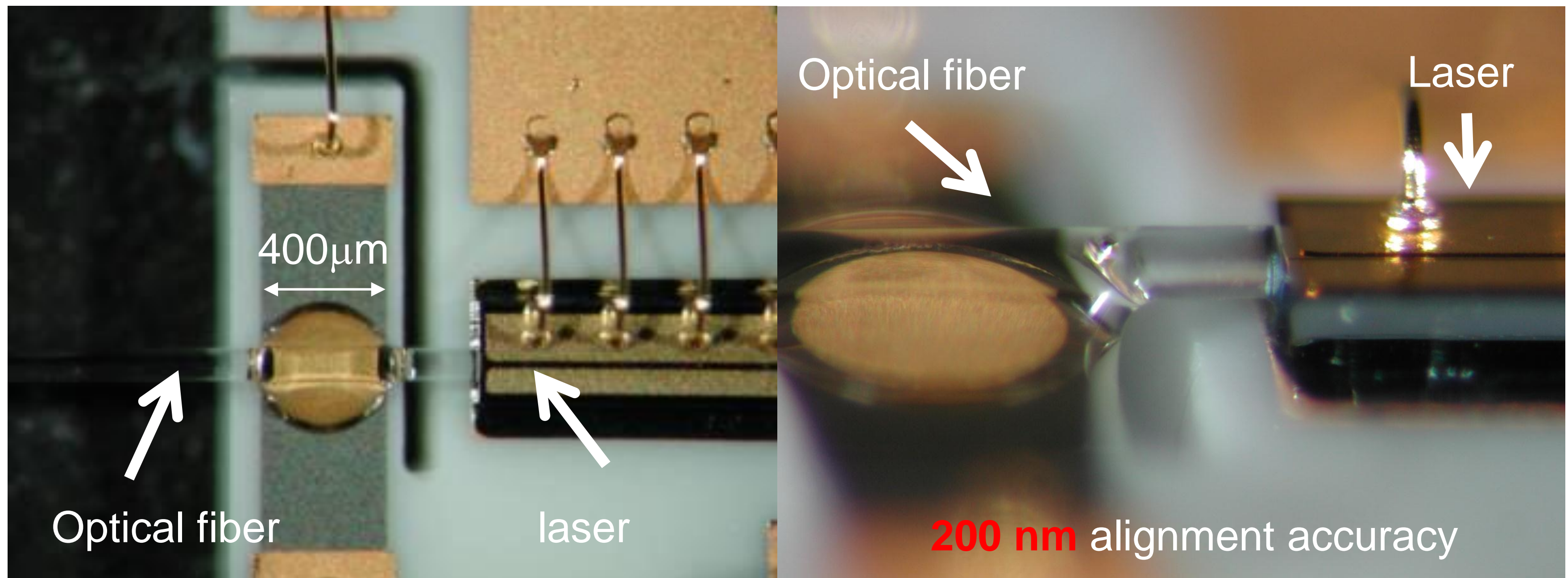




Bookham™

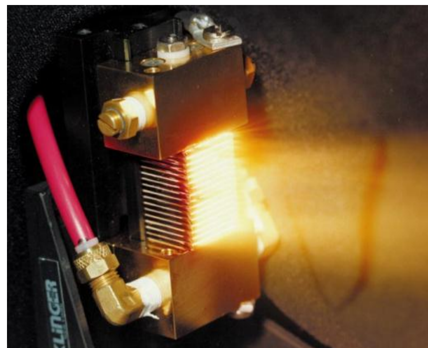
High-precision adhesive bonding: fiber pigtailing

- Passive/active alignment of optical fibers
- Adhesive bonding of optical fibers

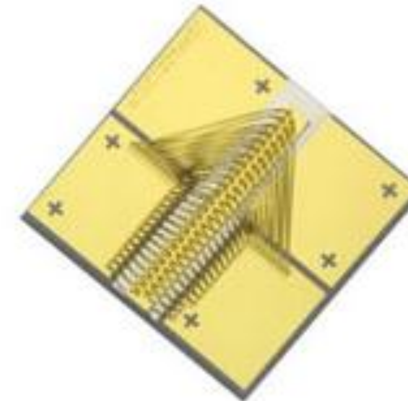


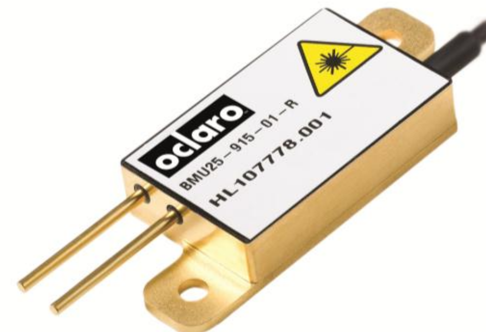
Direct diode approaches

Single Mode Diode Laser Bars



Multimode Single Emitter





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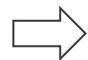
FISBA OPTIK oclaro

Single Mode Diode Laser Bars

- 150 W (@ λ=980nm)
- small volume: 26mm x 36mm x 35mm
- low cost package solution



Place a FAC and SAC lens in front of typ. 4 x 50 single - mode laser diodes

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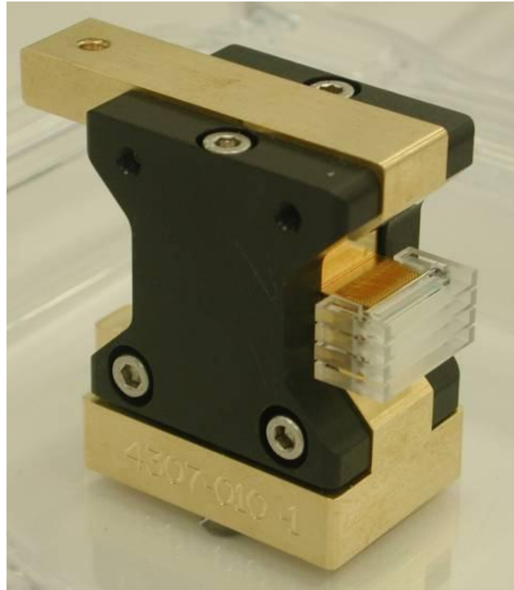
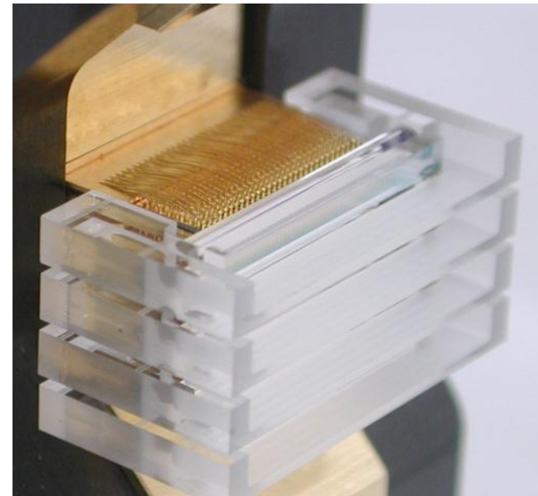
Case: High power laser diodes

FISBA OPTIK oclaro

150W CW single mode laser diode stack





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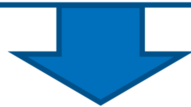
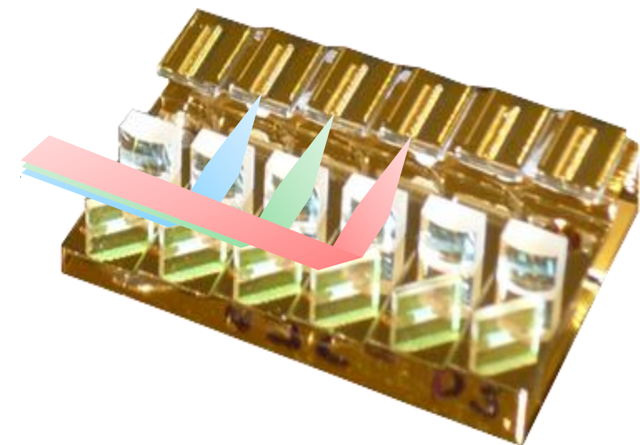
Multimode single emitter laser diode modules

- **12 multi mode single emitters in one module**
- **coupled to 105 µm / NA 0.15 fiber**



- 2 groups of 6 lasers vertically stacked
- both combined by polarization multiplexing
- 100 W out of fiber



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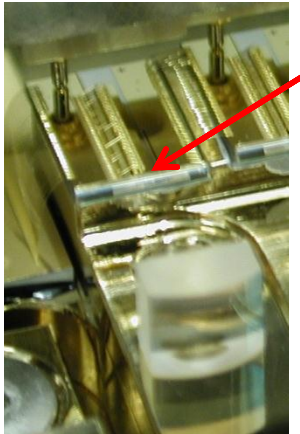
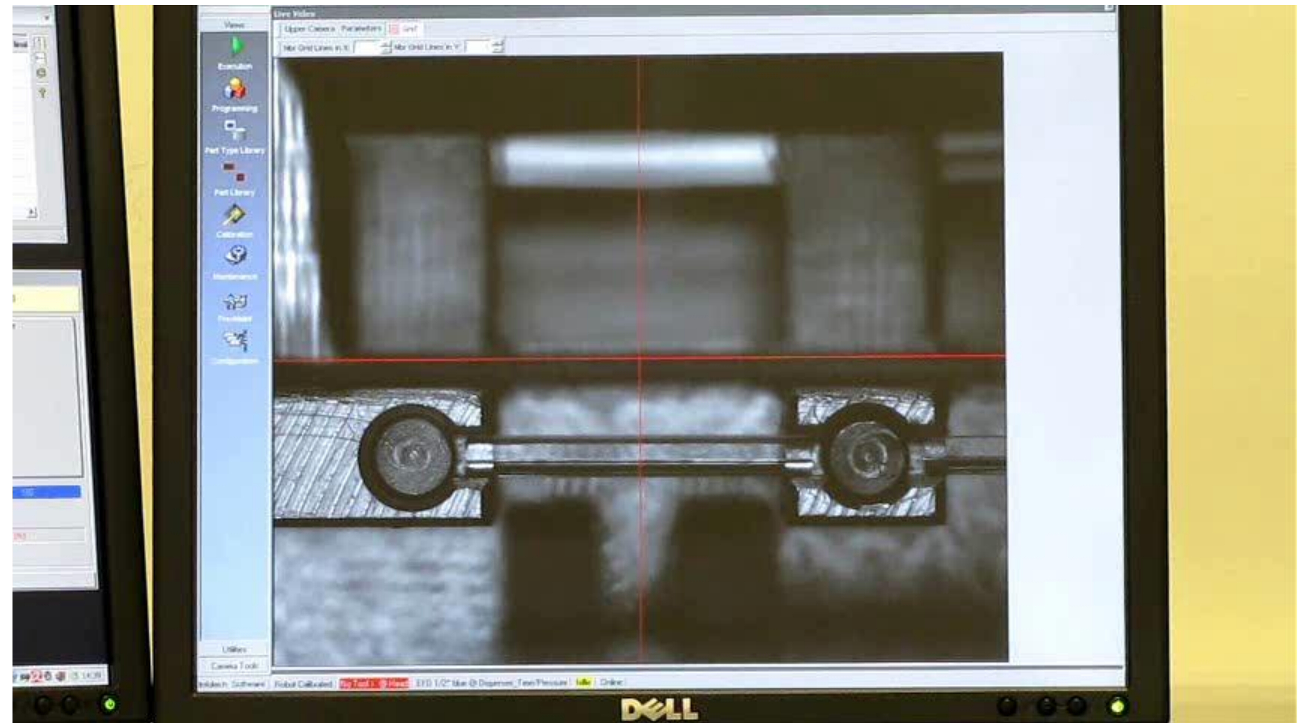
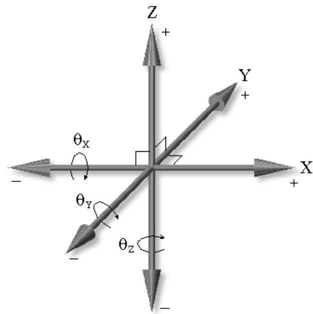
Fast axis collimation lens alignment

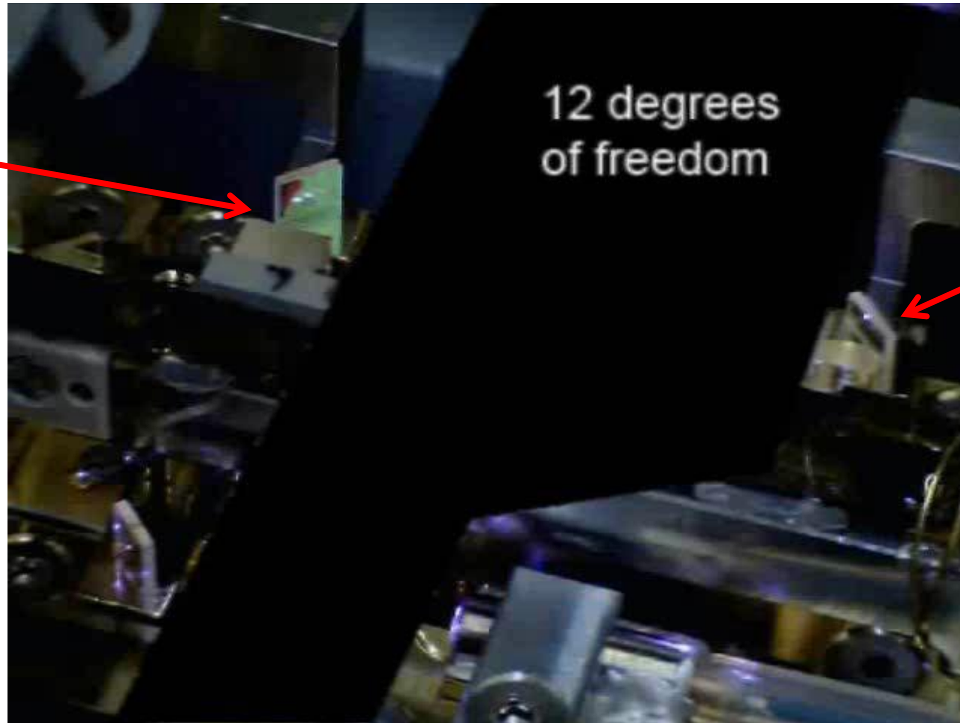


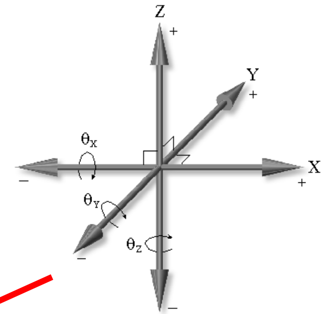


Multimode single emitter laser diode modules

- Semiautomated assembly tools



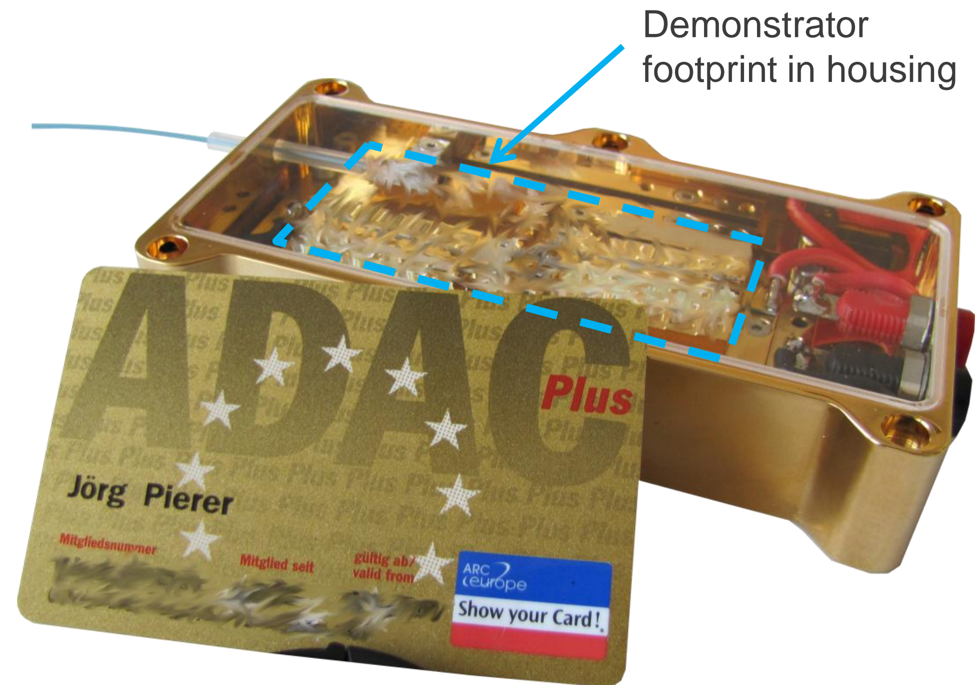




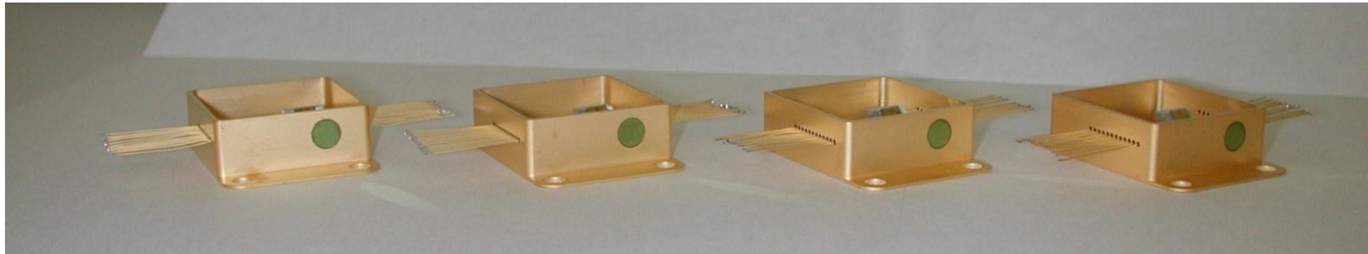
Semi-automated assembly of 100 W demonstrated

- highly repeatable processes
- very fast assembly (more than 40 optical components in less than 2 hours)
- easy process adaptation to
  - different product lines
  - miniaturized modules

- high yield rates
- reliable products



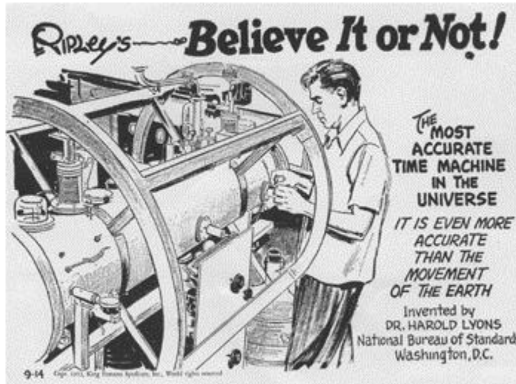
Full device development



- Assembly and packaging concept
- Process development
- Fabrication and testing of first prototypes

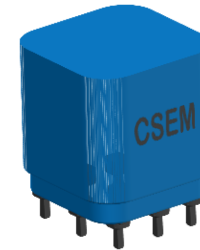
LaserFocus World, Jan. 2009

Miniature atomic clock: general



Optical Pumping

Coherent Population Trapping (CPT)

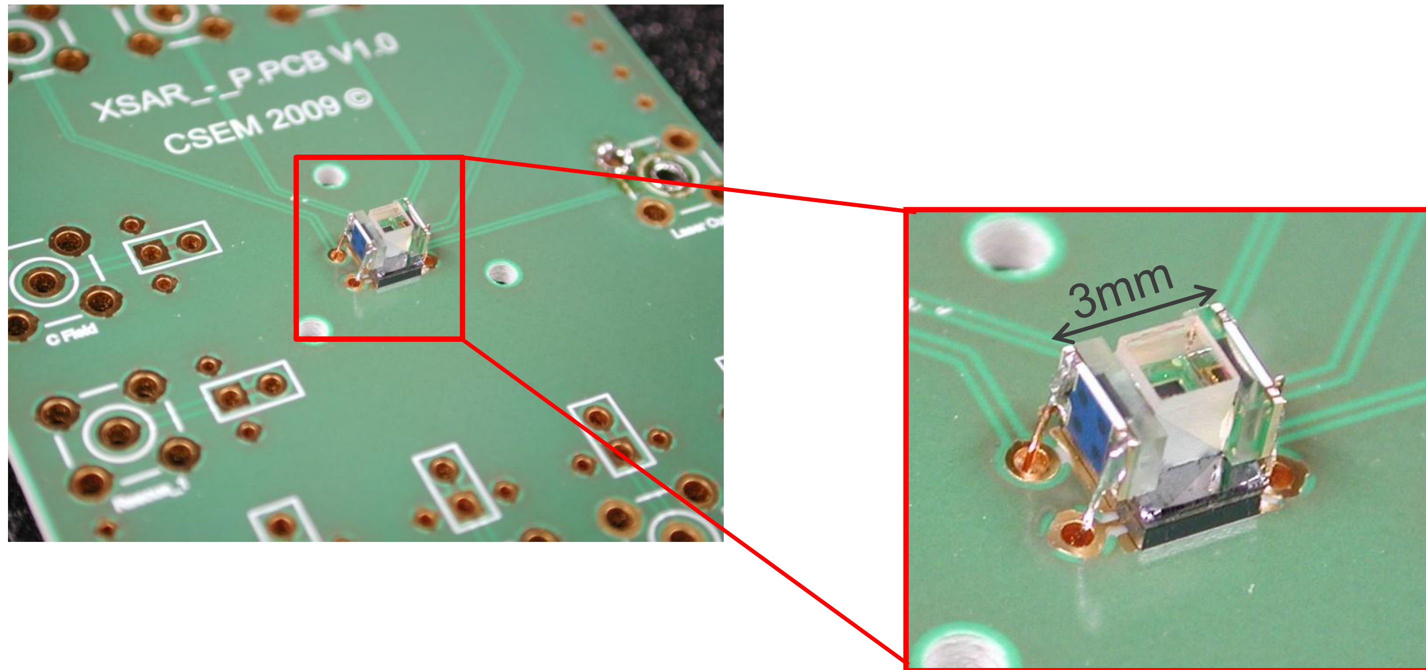


Applications
- GPS
- Mobile base stations
- Time signal radio transmitters
- …

commercial X72 Stand. Rb clock
125 cm^3
8 W
$3 \cdot 10^{-11}$ @ 1 second

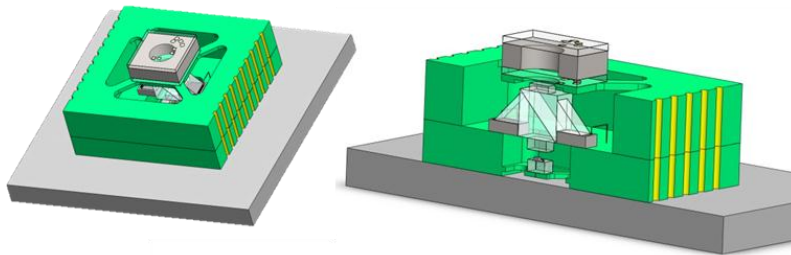
CSEM CPT Rb clock
10 cm^3
< 100 mW
$2 \cdot 10^{-10}$ @ 1 second

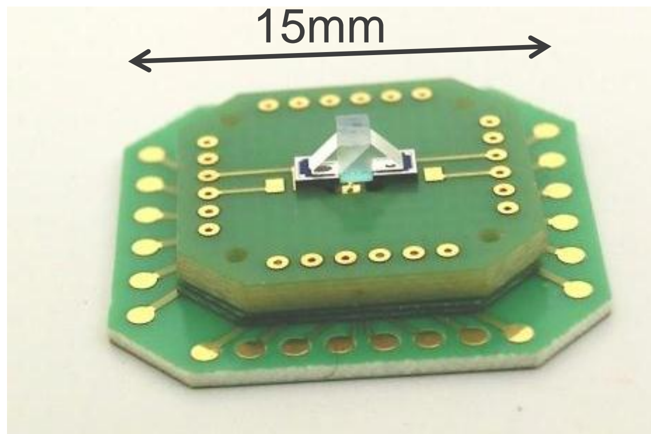
Miniature atomic clock: optical assembly

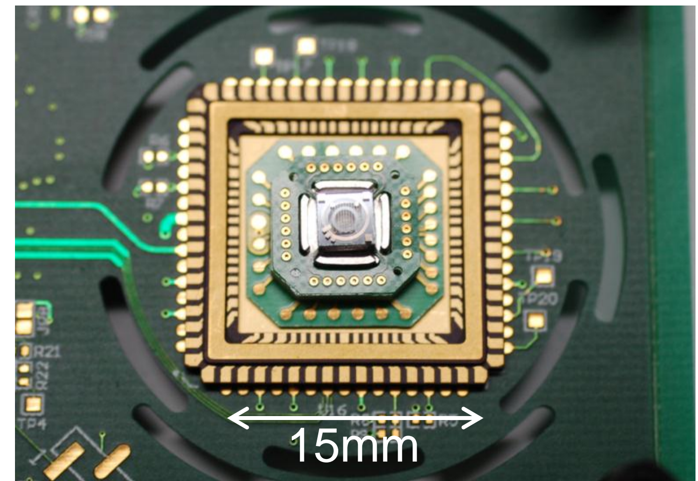


Miniature atomic clock: next level of integration

- 3D integration
- Highly accurate optical assembly, adhesive and solder bonding







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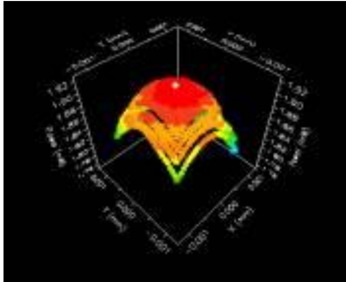
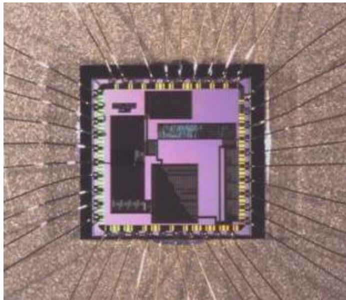
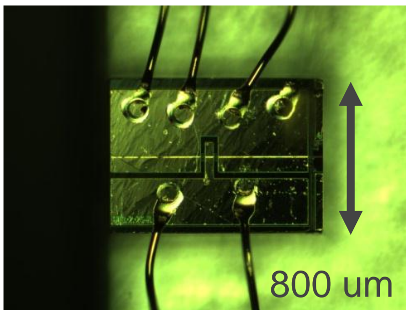
Microsystems Packaging



Design, Simulation, Prototyping, Small Series Production

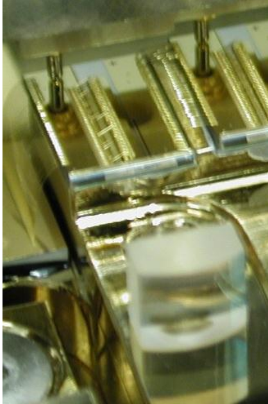


Chip/Wafer Bonding (Vacuum Encapsulation, Controlled Atmosphere): Eutectic, Adhesive Bonding, …

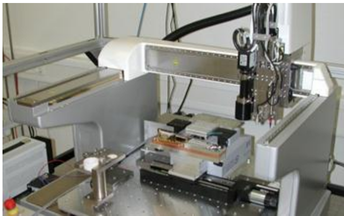


Die and Flip-Chip Bonding (AuSn,…)

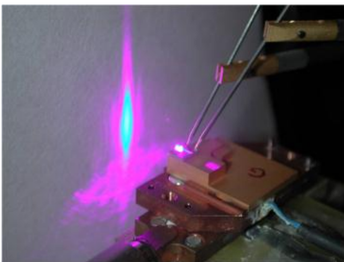
Microsystems Packaging



High-Precision Assembly



Automated Assembly / Manufacturing



Reliability & Functional Testing

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Packaging infrastructure

- Class 10‘000
- Temperature controlled
- Humidity controlled

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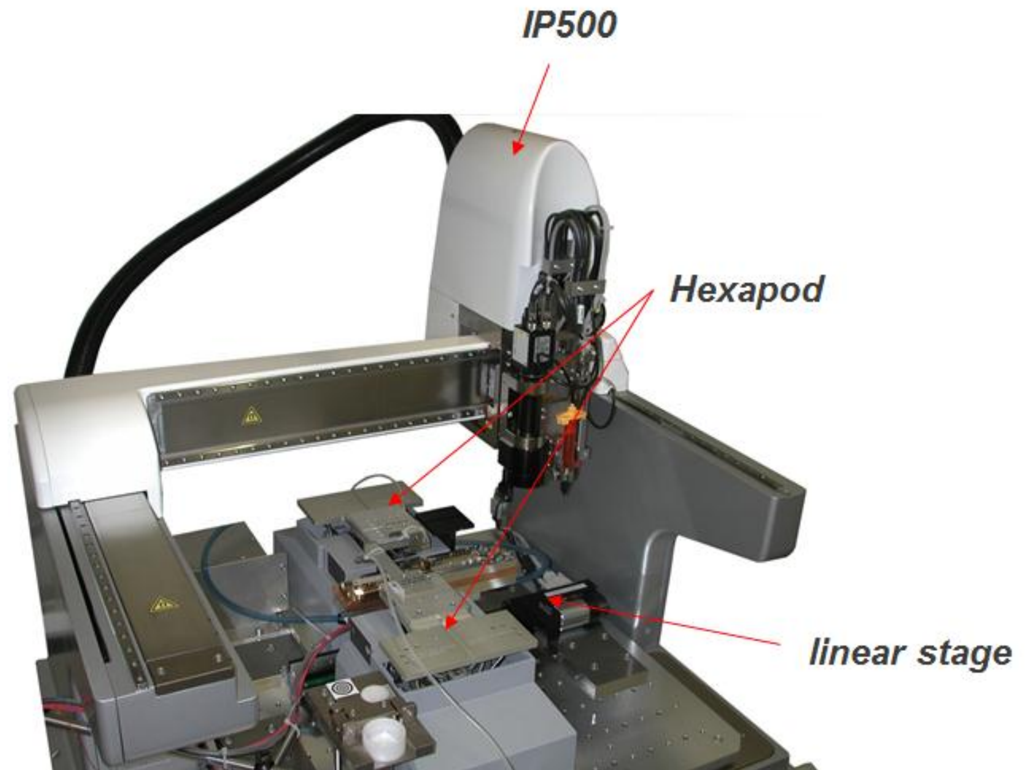
Flip-chip, die-bonding, optical component bonding

Flip-chip bonding of laser dies



High-precision adhesive fixing of optical elements

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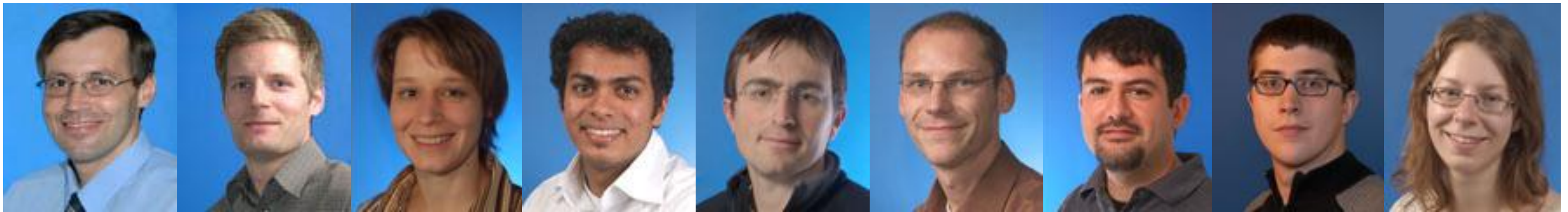

Thank you for your attention!

Project support by the CTI, the Swiss innovation promotion agency, is gratefully acknowledged