

*Applications and **Challenges** with high power diode
laser fast axis collimation*

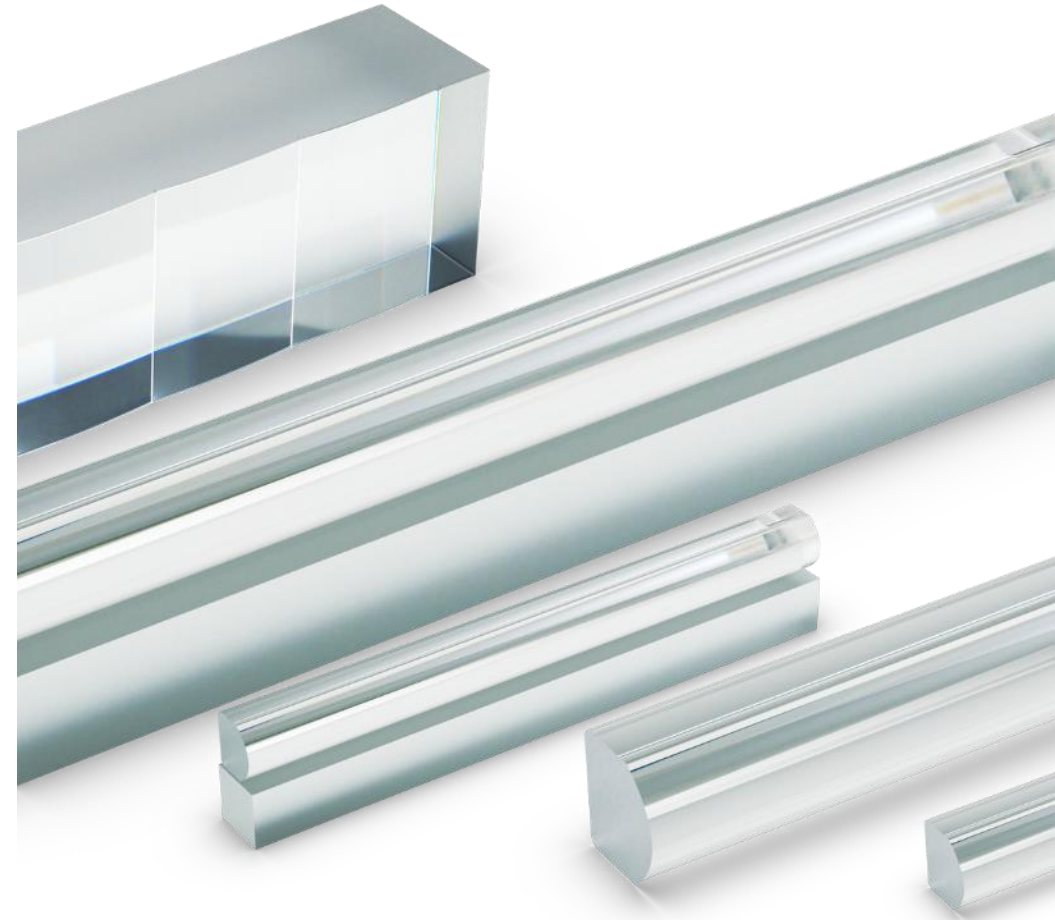
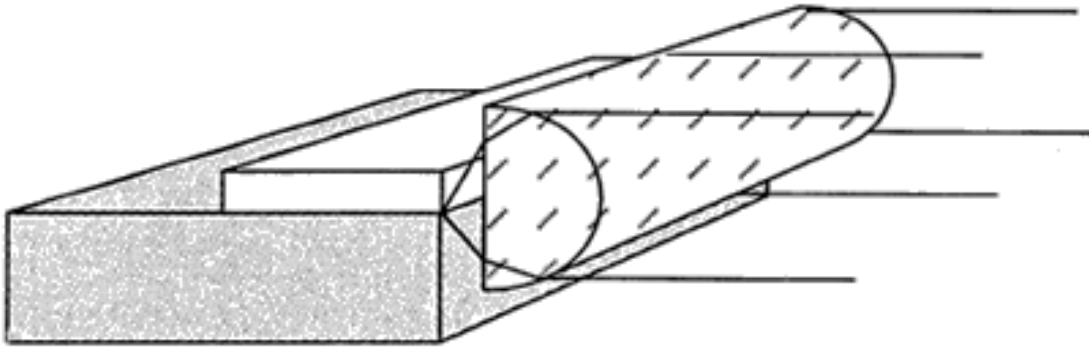
Martin Forrer, FISBA AG

29.5.2026 SwissPhotonics Workshop

Our Family of

Micro Optics for Laser Diodes

- Fast Axis Collimation Lenses (FAC)
- Fast Axis Collimators (FAC) pre-assembled on tabs
- Slow Axis Collimation Lenses (SAC) for Single Emitters
- Slow Axis Collimation (SAC) arrays for Diode Laser Bars



Why FAC Is Hard to **Manufacture at Scale**

FAC is easy to describe but exceptionally difficult to produce consistently at high volume. These barriers explain the concentrated market structure and protect the leading specialists.

High-NA Acylindrical Glass

Precision molding of aspherical/acylindrical surfaces with tight form tolerances at sub-millimeter dimensions.

Coating Under High Power

Low-absorption AR coatings must survive sustained high optical intensities without degradation or thermal damage.

Dicing & Handling

Tiny cylindrical lenses require specialized dicing, handling, and cleanliness protocols to maintain surface quality and yield.

Metrology & Qualification

Beam-quality metrology is demanding. Customer qualification cycles are long, creating strong switching-cost moats for incumbents.

Mechanical Integration

Customer-specific mounting formats and assembly compatibility requirements drive significant engineering and NRE investment per design win.

Business setup for the FAC market

- Independent global FAC manufacturer
- Standard and customized
- Stable high-volume production
- Mass production goes into the Fiber Laser Market
- FISBA serves many demanding customers with rather low quantity requirement in the field of direct Laser processing, Defense, LiDAR and Life Sciences

Challenge Scaling 10x more every 5 years

2000 up to 1000 FAC per year internal use for diode lasers

2005 up to 0.01 M pces / year

2010 up to 0.1 M pces / year for several industrial global customers

2015 more than 1 M pces / year with production capex

2020 *more than 10 M pces / year performance, quality and market scaling*



FACs

- Wide range of more than 150 articles
- 18 different versions with regards to EFL and BFL, ranging from EFL = 180 μm to EFL= 1700 μm
- Large variety of coatings, ranging from blue 395 nm to SWIR 2225 nm
- Customized length easily available (e.g. 1.8 mm up to 25 mm)

History

1992 internal product technology within CTI Project

2004 first sale of external FAC 900

2010 FAC1200 TIR-FAC with internal TIR-reflection and 2 aspherical surfaces

2012 single emitter FAC-> start volume scalability program for fiber laser pumps

2016 fully automated 24/7 inspection and packaging automation release

2017 Coating investigation and improved understanding of critical issues

2019 FAC scaling to 10 Mio pcs / year -> improved quality with better measurement and deformation control

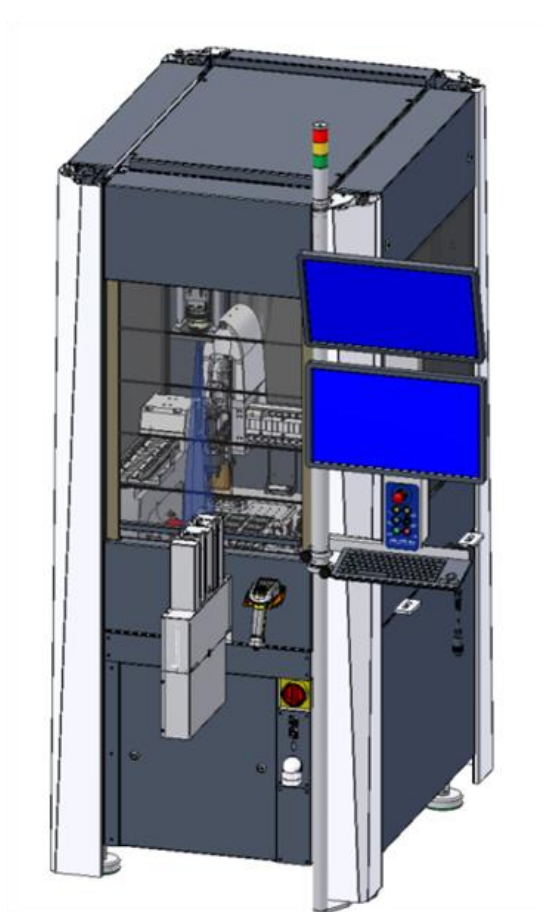
2020 FAC with proprietary low absorption glass-> addressing the rising the demand for blue laser diodes

Challenge: Business Case Management with Product Variety and Production Scaling



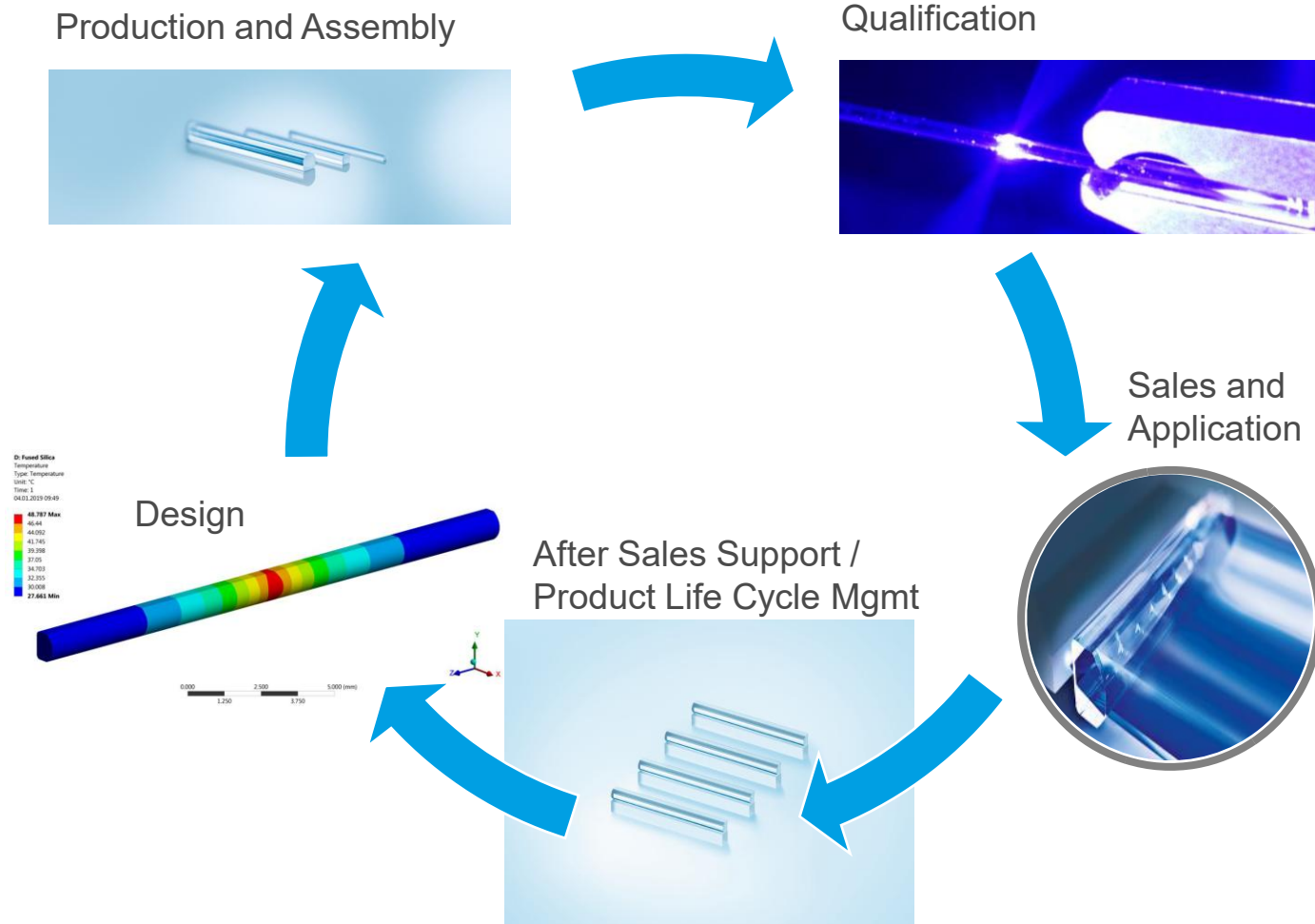
Generic description of quality and packing instrumentation

- operating at FISBA 24h/7d since July 2016
- image processing based inspection of optical surface imperfections compliant with ISO-10110-7 / 14997
- inspection cycle time of micro optics < 10''
- digital microscopy based imaging system developed by FISBA
- deploying specifically selected illuminating conditions allowing the detection of the imperfections all over the clear aperture of the specimens
- automated handling system developed by specialized supplier



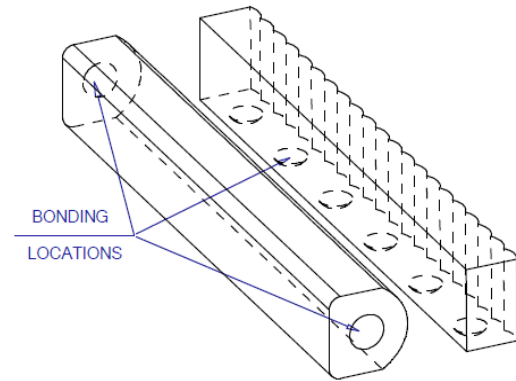
Focus Technology: Fast Axis Collimator (FAC)

- high power diode lasers
- high numerical aperture
- standard focal lengths
- NIR, BLUE coatings
- different glasses
- optimized for lowest absorption cw
- qualified measurements
- highest scalability
- stringent packaging conditions

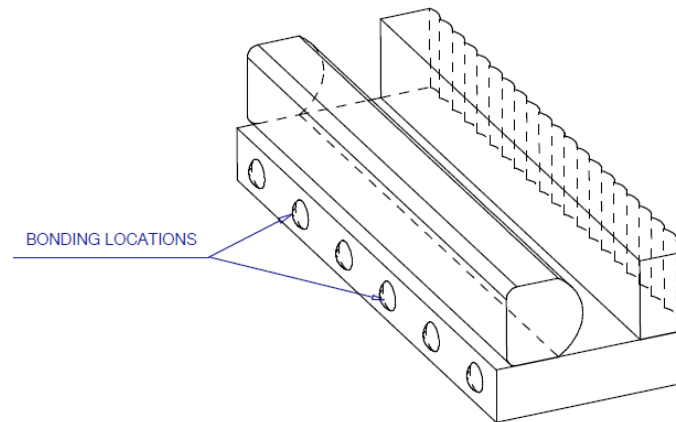


FAC assembly and bonding options

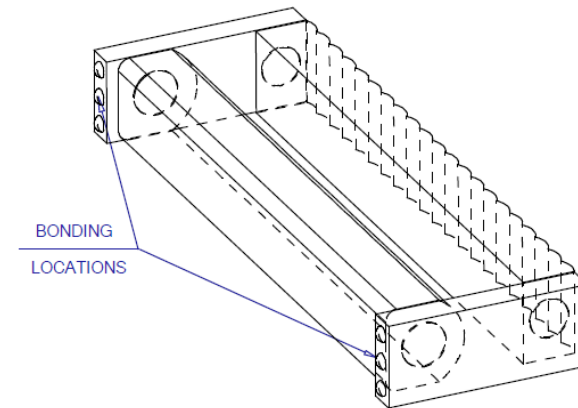
- No tab: bonding in the invariant direction of the cylindrical optics, perpendicular to FAC and SAC
- Bottom tab: bonding with a support structure in direction towards the Diode Laser
- Side tab: a variant to economize the height, e.g. for Diode Laser Stacks



NO TAB



BOTTOM TAB

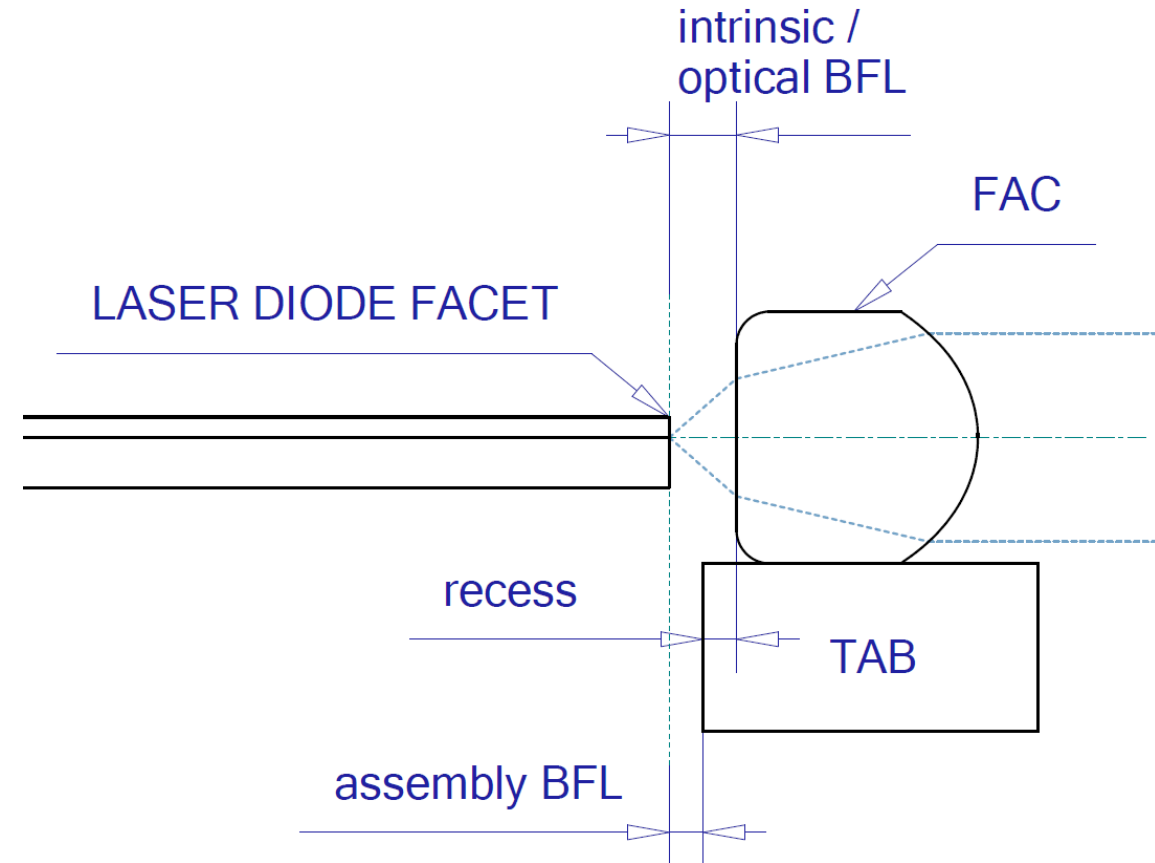


SIDE TAB

FAC on bottom tab:

Actively aligned to required assembly BFL

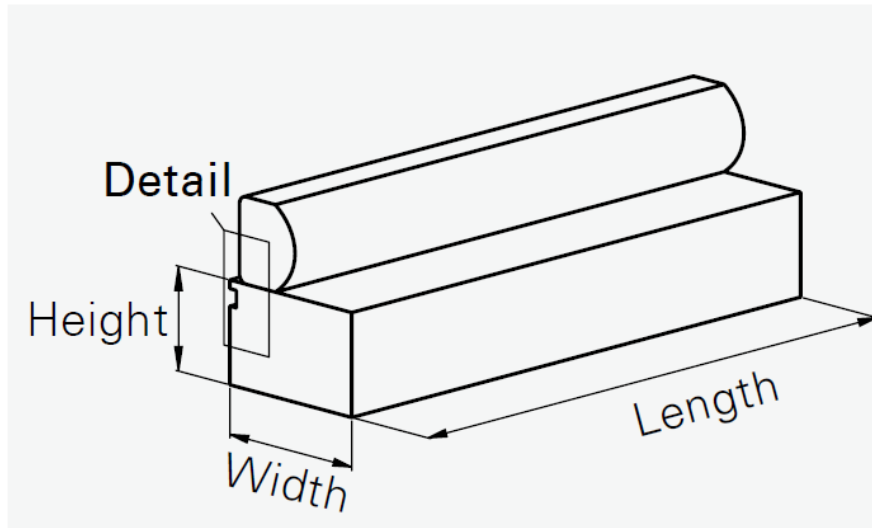
- Optical back focal length (BFL) determining the distance to the Diode Laser Facet
- The “assembly BFL” plus recess add up to BFL
 - Enables constant glue gap in your Application



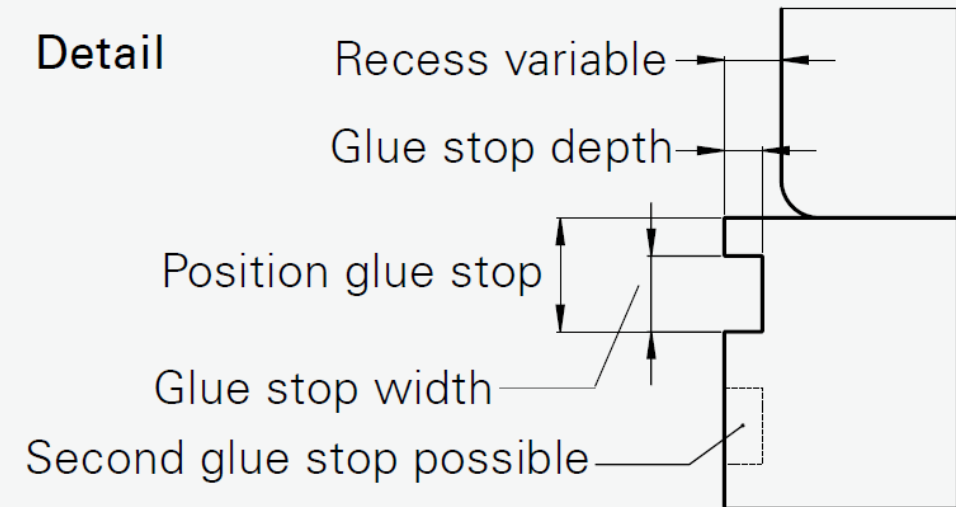
FACs on bottom tabs:

Tolerances and features

- Positioning tolerance on tab: $\pm 2 \mu\text{m}$
- Recess can be tailored to individual BFL of lens ($\pm 5 \mu\text{m}$)
- Tabs can be tailored to your needs, optionally with glue stop



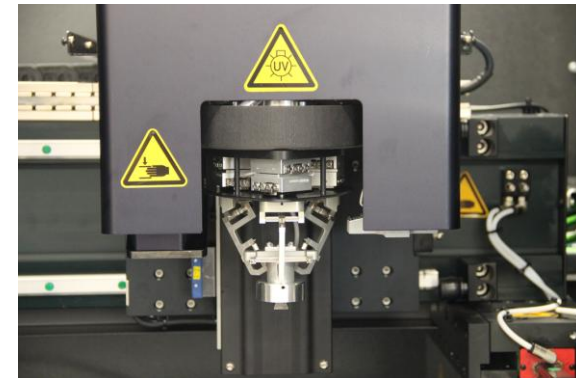
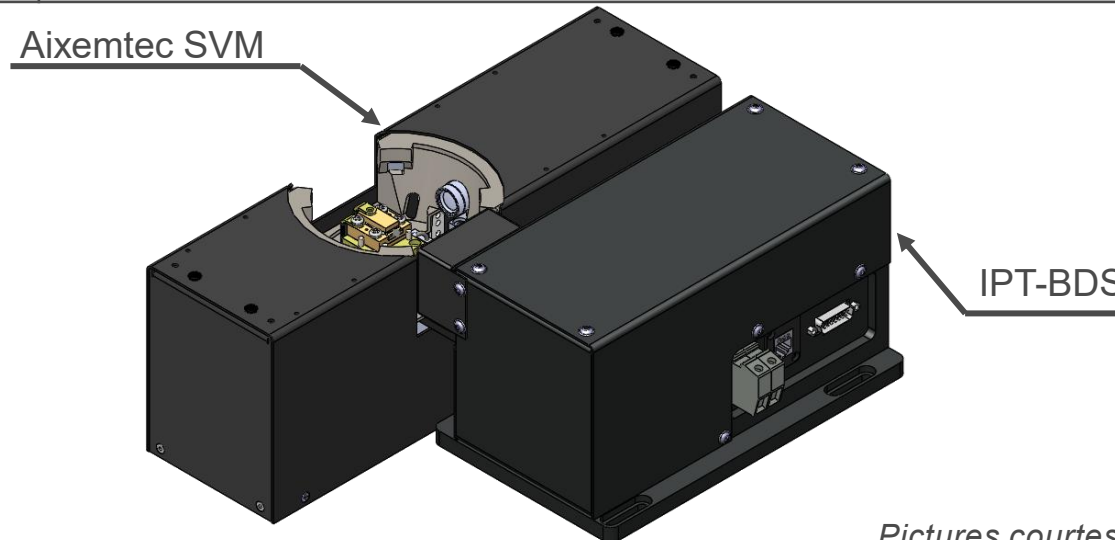
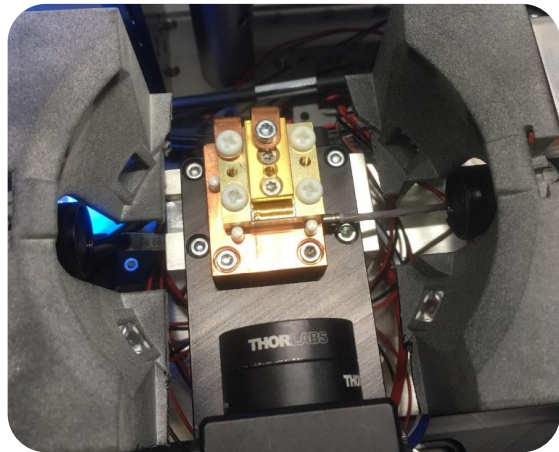
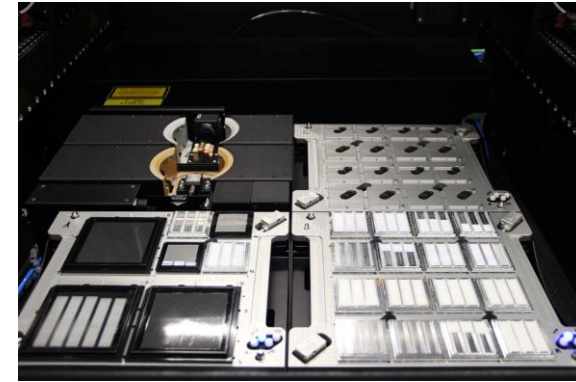
Detail



FAC Assembler with beam diagnostic system



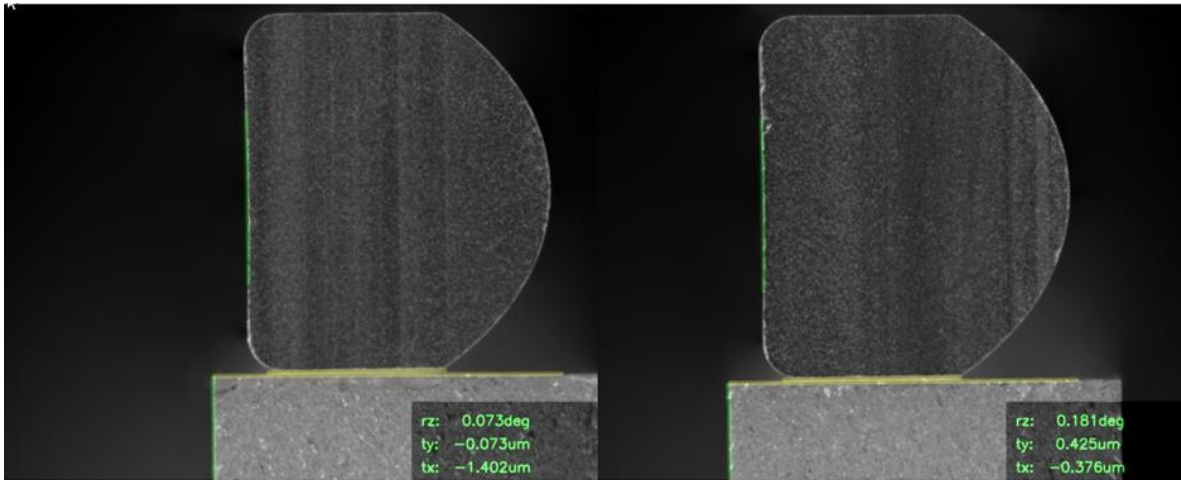
Specification:	
depth x width x height (incl. SVM)	250 x 350 x 127 mm
poser:	5V DC
Max. Diode Current:	50A
Max. optic Power Ausgangsleistung:	dependent on diode laser used
Measurement resolution passive image:	1,325 $\mu\text{m}/\text{px}$
Measurement resolution active position (Fast-Axis):	dependent on EFL (f) [mm] of FAC-Lens under test: $A = 5,3 * 10^{-5} * f_{FAC}$ for a FAC-Lens with f=0,6mm this results in a resolution of 0,032 [$\mu\text{m}/\text{px}$]



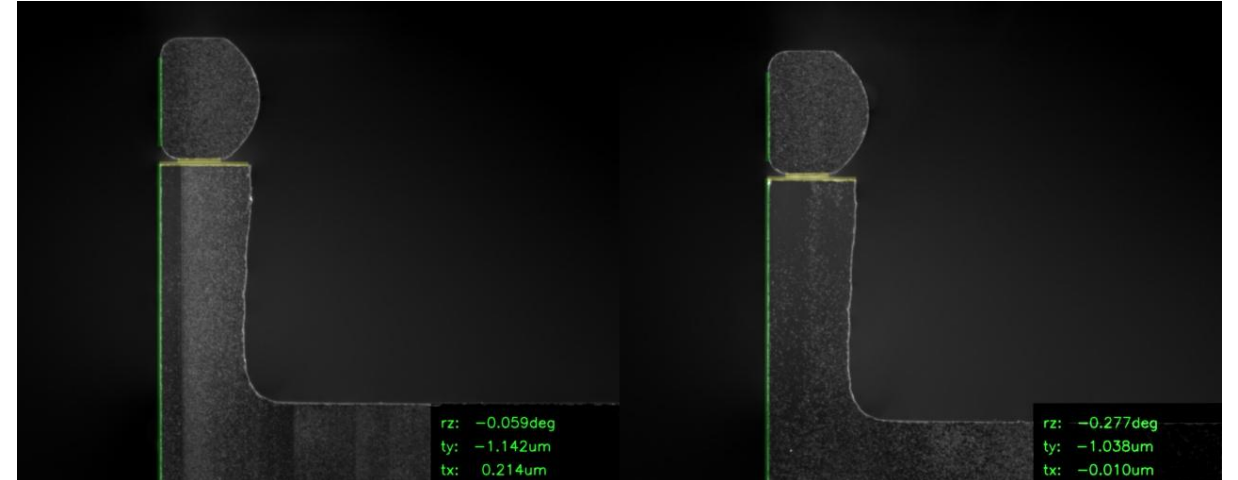
Pictures courtesy to IPT / AIXEMTEC

FAC on bottom tab: Assembly examples

FAC 600 (EFL 600 on bottom tab)

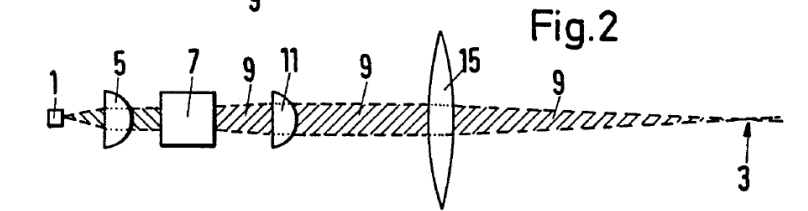
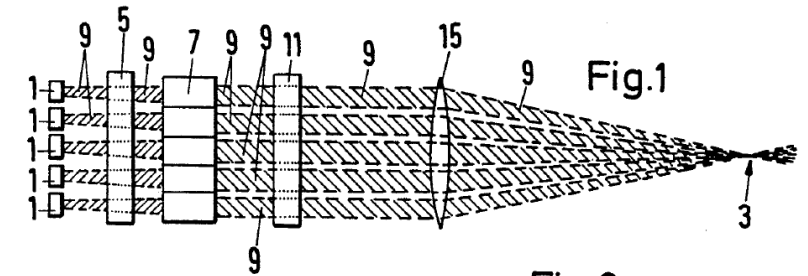


FAC 200 (EFL 200 on bottom tab)



How did it start

- CTI project with IAP University of Berne
- High power diode lasers become available in bar form
- FISBA micro-optic solution, first variant of “beam-twister”
- Laserpumping for solid state lasers
- IP generated together with Bystronic



U.S. Patent

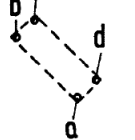
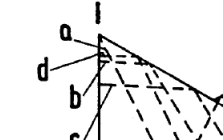
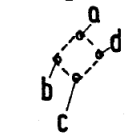
Sep. 7, 1993

5,243,619

Fig. 4a

Fig. 4b

Fig. 4c

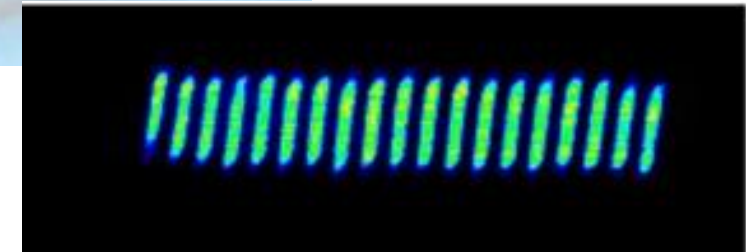
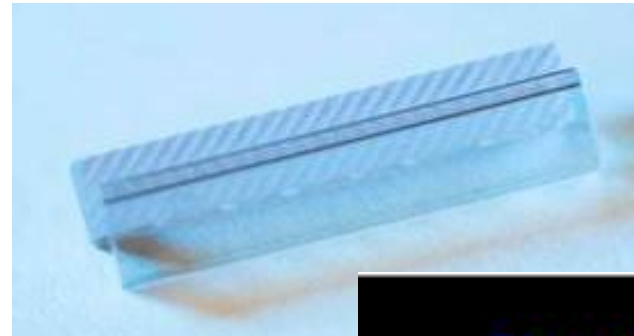
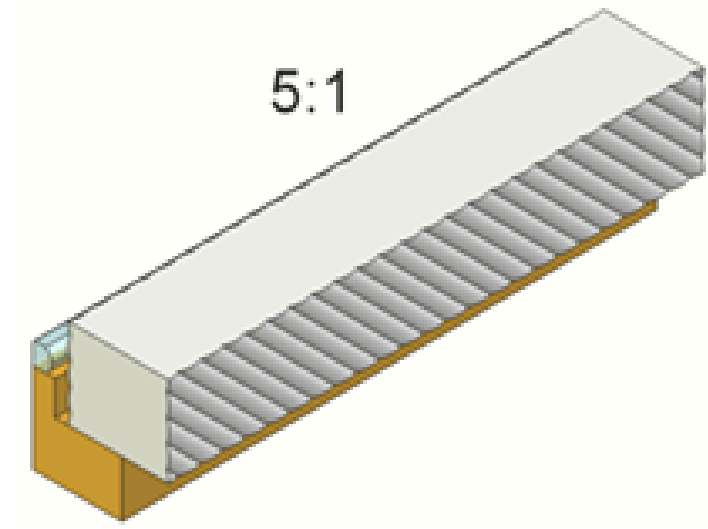


Challenge: Business Case Development based on Customer Need, not Technology Need

Facet to Focus: Business Proposition

Beamtwister

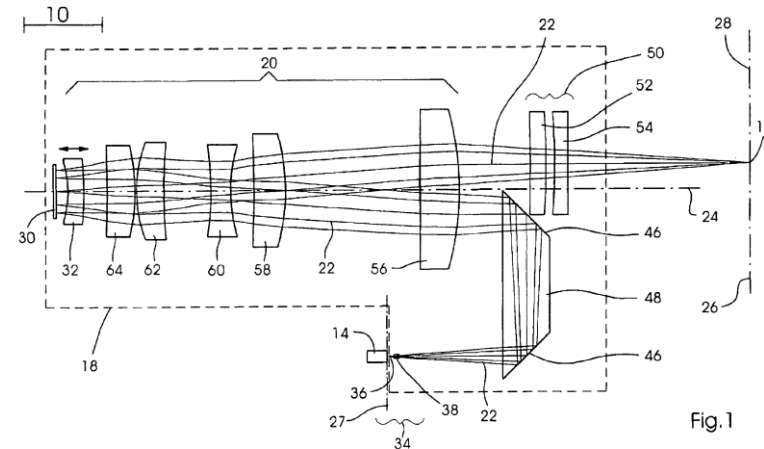
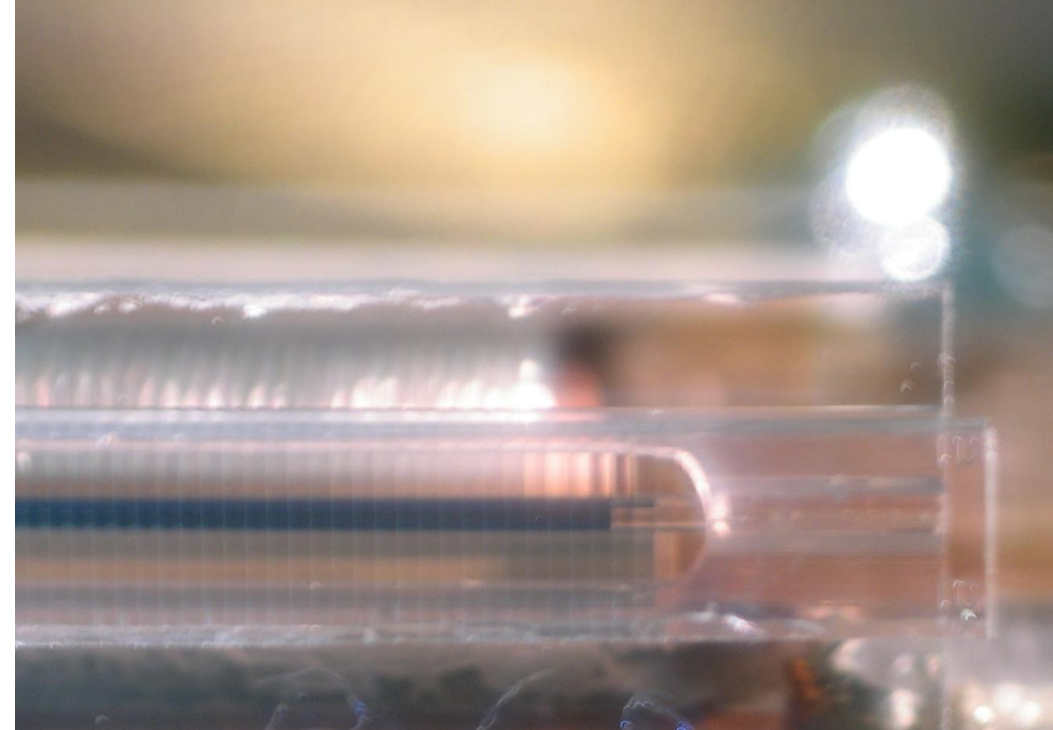
- Includes the FAC lens and the beam rotation lens array
- Further options for customers: laser diode pitch, wavelength,
- All-inclusive solutions
 - *FISBA offers all optical components or complete customized systems for Facet-to-Focus (F2F) solutions, i.e. for fiber coupling or for beam symmetrization*



Challenge: Business Case Management with Product Technology and Production Scaling

FAC specialty I for CTP module

- Individual 64 channel individually addressable single mode laserdiode array with micro-optics assembly
- fast and slow axis magnification of beamwaists
- positioning accuracy < 300 nm
- Thermal imaging of beamwaist on Computer to Plate for latent image transfer in Offset Printing



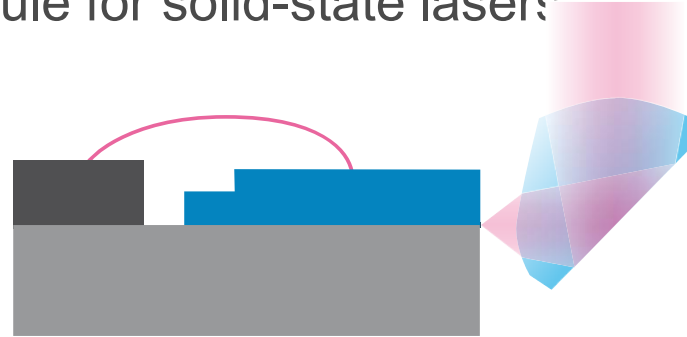
U.S. Patent Jul. 19, 2005 Sheet 1 of 5 US 6,919,997 B2

Challenge: need for actively controlled alignment

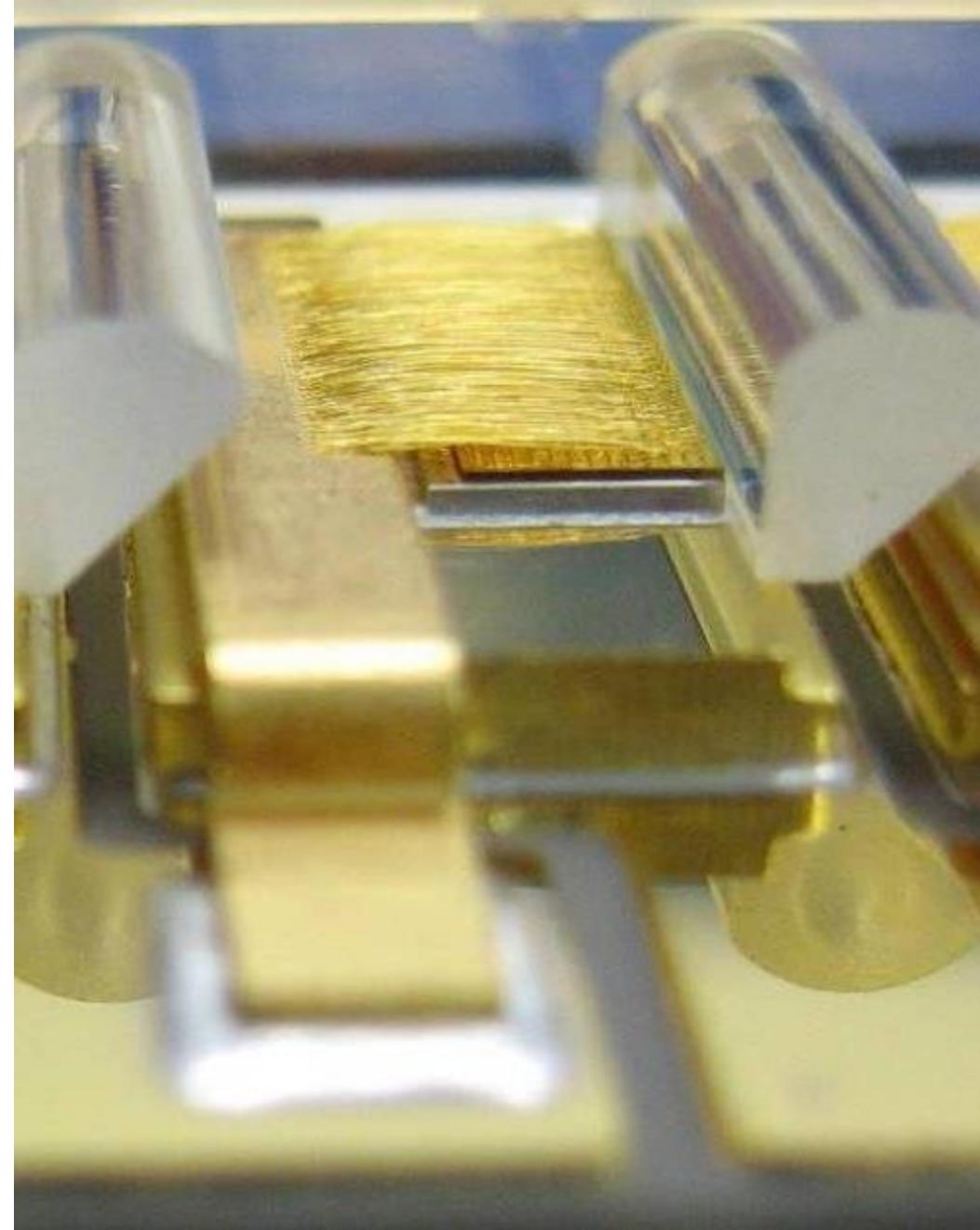
FAC Specialty II with deflection

TIR-FAC

- Application: Horizontal stack with bifunctional FAC components:
 - collimation and 90° deflection
- Deflection based on total internal reflection
- High power Pump-Module for solid-state lasers



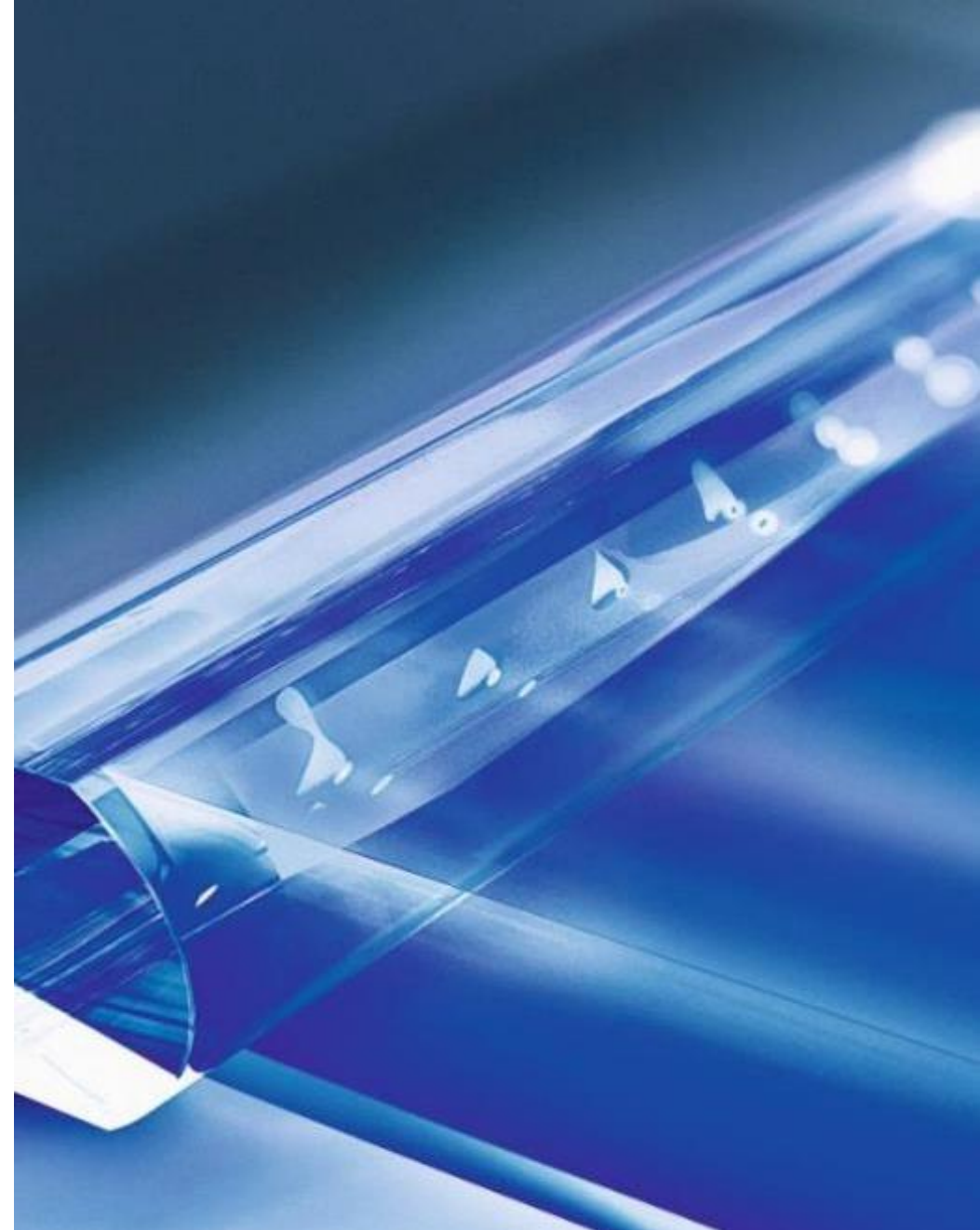
Challenge: Performance and alignment with customer specific collimation requirements



FAC specialty III for blue laser

- Customized FACs feasible with excellent transmission from 400 nm upwards
- Available in lengths from 1.8 mm to 25 mm
- Available EFL: 310 / 380 / 600 and 1700 μm
- FAC1700 comes with large BFL=1.15 mm in order to be applied in front of closed TO-cans

Challenge: Market Scaling and Application growth



THANK YOU

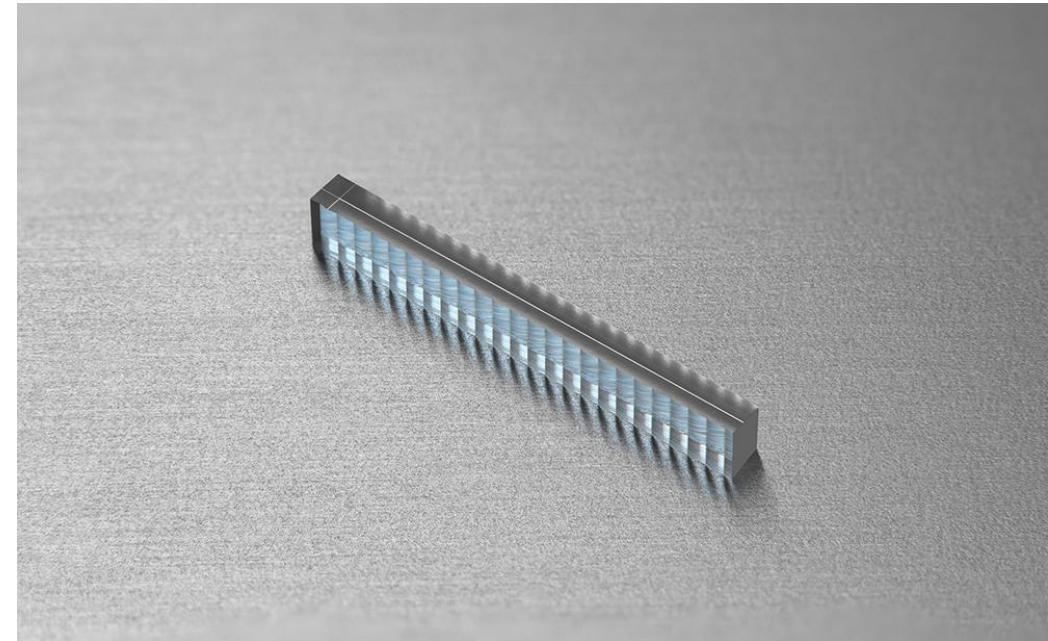
SAC lenses and SAC arrays

SAC lens (for single-emitters):

- Focal lengths: 4 - 12 mm
- AR-coating: Customized in the range of 400 – 1600 nm
- Numerical Aperture <math><0.2</math>
- Aspherical shape: better collimation performance, especially for high SA divergence and small emitter (attractive option for blue laser diodes)

SAC lens array:

- Pitch: 500 μm , 1'000 μm
- Focal length: 2.6 – 8 mm
- AR-coating: customized in the range of 400 – 1600 nm
- Numerical aperture: <math><0.2</math>

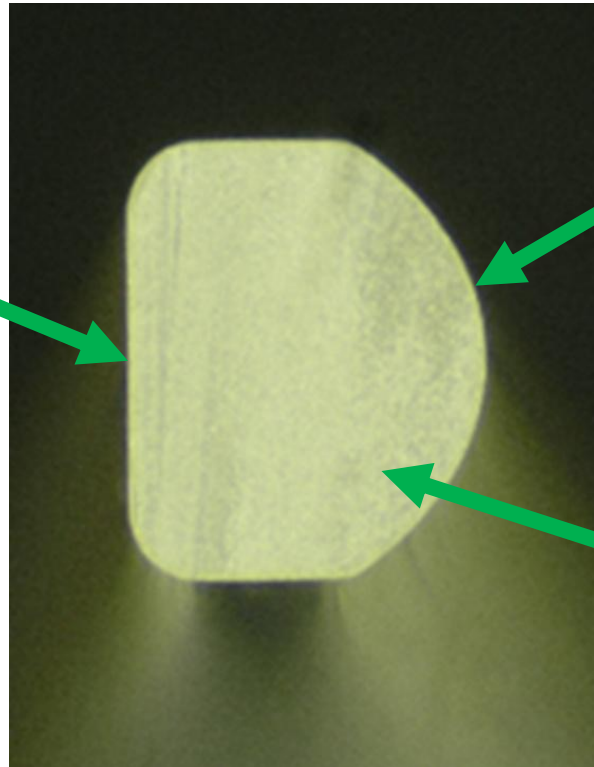


Fast Axis Collimator Requirements

Plano-Aspheric FAC in «standard» high index material S-TIH53

1. Plano Surface

- Form / Figure
- Coating for high NA
- Low surface roughness
- Cleanliness



2. Aspheric Surface

- Form / Figure
- Coating for oblique incidence angle
- Low surface roughness
- Surface Imperfections

3. Glass Material

- Absorption
- High refractive index and index distribution