INGENERIC GmbH, Aachen/ Germany
INGENERIC – COMPANY OVERVIEW

Mission
- Design, development and manufacture of optics and optical systems for high-end applications.

Company
- Established in 2001
- Space: 1.350 m² (14500 ft²)
- Staff: 70
- Since September 2013 part of TRUMPF Laser
- Main business outside the TRUMPF Group
- Total sales volume: 9 Mio EURO
- World wide customer base

Managing Directors
- Dr. Stefan Hambücker
- Dr. Olaf Rübenach

Location
Aachen, Germany
### INGENERIC – COMPANY OVERVIEW – TECHNOLOGY PLATFORMS

#### DIRECT MACHINING
- Advantages
  - Highest precision
  - Different
  - Flexibility in geometry
  - Flexibility in material
    - Glass
    - Copper
    - Aluminum
    - Germanium
    - Silicon
    - Tungsten carbide
    - PMMA
    - ...

#### PRECISION MOLDING
- Advantages
  - Highest reproducibility
  - Reduced production cost
  - Bi-aspherical components
  - Complete process chain
    - Optical design
    - Prototype manufacture
    - Preform design
    - Mold design
    - Mold manufacture
    - Precision molding
    - Aspheric metrology

#### ASSEMBLY
- Advantages
  - Highest precision
  - Customized assembly
  - Optical sub-modules to complete systems
  - Prototype to serial assembly
  - 100% quality control
  - Ready-to-use products

#### DEVELOPMENT
- Advantages
  - A team of experts in all relevant fields for a system development
  - Strong cooperation partners
  - Application specific design
  - Ready-to-use laser system
  - Benefit from our product platforms already realized
INGENERIC – PHILOSOPHY

- Our Mission is to provide the best solutions to our customers.

- Technological leadership and innovation are natural.

- We believe in a longstanding, successful, and confidential collaboration with our customers and partners.

- We operate a strict quality control policy.

- The key for a long-term successful company are our competent and highly motivated employees.

- We believe in a sustainable development by taking care of our economical, environmental, and social responsibility.
**INGENERIC – PRODUCTS**

- **Optical Components**
  - Fast-Axis-Collimation
  - Slow-Axis-Collimation
  - Beam Transformation Optics
  - C-Modules
  - Microlens Arrays
  - Aspheres and Acylindrical Lenses

- **Optical Systems and Laser Systems**
  - Laser Systems for scientific applications
  - Laser systems and OEM modules for medical applications
  - Lasers for measurement applications
INGENERIC – PRODUCTS – FAST-AXIS-COLLIMATION

INGENERIC FAC
- Most important optical component in the beam shaping of high-power diode lasers
- Characteristics are:
  - High numerical aperture
  - High index material
  - Acylindrical surface
  - High transmission
- Highest collimation quality

INGENERIC FAI
- FAI lens images the emitter directly to a fiber or a target plane.
- Characteristics as for the FAC lenses

DESIGNS: FAC, FAI, PRIFAC
EFL: 0.15 – 2.8 mm
NA: UP TO 0.6
FORM P.V.: < 250 nm

Product Spectrum
- Broad spectrum of optics from the shelf
- Customized solutions on request
INGENERIC FAc lenses with supports

- Simplify mounting processes by using FAC lenses with additional surfaces for mounting and/or support structures
- Automated assembly process
- Advantages:
  - Highest precision and reproducibility by using camera system
  - No damage risk by manual handling process
  - No damage risk by assembly devices used during manual handling process
  - Position accuracy is in the micrometer range
  - Assembly and packaging in clean environment
  - 100% measurement of dimension
  - Package usable for automated parts-removal

DESIGNS: FAC, FAI, PRIFAC

EFL: 0.15 – 2.8 mm

NA: UP TO 0.8

FORM P.V.: < 250 nm
INGENERIC – PRODUCTS – SLOW-AXIS-COLLIMATION

INGENERIC SAC
- Forming slow axis of diode laser bars
- Available as monolithic lens array or single component
- Characteristics are:
  - transmission up to 99%
  - Minimized dead zones
  - highest level of precision and uniformity
  - Customized solutions with small NRE-costs
  - Highly economical manufacturing process for large quantities
  - Reliable and stable quality

Product Spectrum
- Broad spectrum of standard lenses
- Customized solutions on request
- Special products with dimensions up to 30x30 mm² for homogenization (power levels < 2kW)

DESIGN: CYLINDRICAL
EFL: 1.0 – 10 (29) mm
PITCH: 0.2 – 1.0 (3.5) mm
DIMENSION: UP TO 14 X15 mm²
FORM P.V.: < 50 nm
INGENERIC – PRODUCTS – C-MODULES

INGENERIC C-Modules
- Highly efficient optic to reduce divergence in fast and slow-axis simultaneously
- Module of a FAC and a SAC lens assembled with a support structure
- Characteristics are:
  - efficient collimation
  - compact module
  - easy to mount
  - long term stability
  - optimized design

Product Spectrum
- In general a combination of our broad product spectrum of fast-axis and slow-axis collimators is possible

DESIGNS:  BT OR ST
INGENERIC beamPROP

- Key component for the
  - fiber coupling of diode bars
  - the dense wavelength beam combining
- Characteristics are:
  - complete utilization of the aperture by minimized transition zones
  - minimum aberrations achieved by highest level of precision and uniformity of single lenslets
  - exact rotation of the emitter through the defined center thickness accuracy
  - minimum pointing errors due to an exact position of front and back surfaces.

Product Spectrum

- Available as single component or as module combined with FAC on a support
- Module assembled with our automated assembly process

PITCH: 0.2; 0.4; 0.5 mm
DEAD ZONE: < 10 µm
CT ACCU.: < 15 µm
OFFSET S1, S2: < 5 µm
FORM P.V.: < 80 nm
INGENERIC Micro lens arrays

- Application for micro lens arrays are collimation, homogenization and combination
- Lateral dimensions of the arrays range from some millimeters up to 30 millimeters
- Array structures typically in the sub-millimeter-range
- Most lenses arrays are customized solutions design according to the needs of the application
- Lenses designs:
  - Spherical
  - Aspherical
  - Cylindrical
  - Acylindrical
- Apertures of lenses:
  - Round or rectangular
INGENERIC – PRODUCTS – SPHERICAL AND ASPHERICAL LENS ARRAYS

**MATERIAL:**
- OPTICAL GLASS (HIGH INDEX)

**MAX. ARRAY SIZE:**
- APP. 30 X 30 mm²

**EFL:**
- 0.3 … 5.0 mm

**LENS DIAMETER:**
- 0.2 … 3.0 mm

**LENS APERTURE:**
- ROUND, RECTANGULAR

**ARRANGEMENT:**
- LINEAR, HEXAGONAL

**NUMBER OF LENSLETS PER ARRAY:**
- 5 … 500

**PITCH:**
- 0.2 … 4.0 mm

**PITCH ACCURACY:**
- < 2 µm ACROSS 25 mm

**FORM ACCURACY:**
- < 250 nm

**EFL TOLERANCE:**
- < 1%
INGENERIC – PRODUCTS – MICRO LENS ARRAY

MATERIAL: GLASS (HIGH INDEX MATERIAL)
MAX. ARRAY SIZE 40.0 X 40.0 mm²
EFL: 1.0 … 35.0 mm
PITCH: 0.2 … 5.0 mm
PITCH ACCURACY: < 2 µm ACROSS 25 mm
FORM ACCURACY: < 100 nm
EFL-TOLERANCE: < 1%
TRANSITION ZONE BETWEEN LENSLETS: < 10 µm
INGENERIC Aspheres

- Using aspheres offers substantial advantages:
  - minimization of aberrations
  - increase in efficiency
  - reduction of optical elements and weight
- Molded optics can be curved on one or both sides with a large degree of geometrical freedom

<table>
<thead>
<tr>
<th>MATERIAL:</th>
<th>OPTICAL GLASS (HIGH INDEX MATERIAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENS DIAMETER:</td>
<td>2.0 mm ... 5.0 mm</td>
</tr>
<tr>
<td>DIAMETER TOLERANCE:</td>
<td>&lt; 0.30 mm</td>
</tr>
<tr>
<td>LENS APERTURE:</td>
<td>ROUND, RECTANGULAR</td>
</tr>
<tr>
<td>EFL:</td>
<td>2.0 mm ... 20.0 mm</td>
</tr>
<tr>
<td>CENTER THICKNESS:</td>
<td>1.0 mm ... 4.0 mm</td>
</tr>
<tr>
<td>EFL TOLERANCE:</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>FORM ACCURACY:</td>
<td>100 nm ... 260 nm</td>
</tr>
</tbody>
</table>
INGENERIC Acylinders

- Using aspheres and acylinders offers substantial advantages:
  - minimization of aberrations
  - increase in efficiency
  - reduction of optical elements and weight
- Direct machining of parts out of fused silica

<table>
<thead>
<tr>
<th>MATERIAL:</th>
<th>FUSED SILICA, GLASS (HIGH INDEX MATERIAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIMENSION:</td>
<td>LENGTH: 20.0 mm … 60.0 mm</td>
</tr>
<tr>
<td></td>
<td>HEIGHT: 40.0 mm … 120.0 mm</td>
</tr>
<tr>
<td>CENTER THICKNESS:</td>
<td>4.0 mm … 40.0 mm</td>
</tr>
<tr>
<td>EFL:</td>
<td>70 mm … 200 mm</td>
</tr>
<tr>
<td>EFL TOLERANCE:</td>
<td>&lt; 0.5 %</td>
</tr>
<tr>
<td>FORM ACCURACY:</td>
<td>&lt; 600 nm</td>
</tr>
</tbody>
</table>
INGENERIC – PRODUCTS

- Optical Components
  - Fast-Axis-Collimation
  - Slow-Axis-Collimation
  - Beam Transformation Optics
  - C-Modules
  - Microlens arrays
  - Aspheres and Acylindrical lenses

- Optical Systems and Laser Systems
  - Laser systems for Scientific applications
  - Laser systems and OEM modules for medical applications
  - Laser for measurement applications
In world wide tenders INGENERIC was selected to supply laser systems for high energy projects.

Projects: DiPOLE, HiLASE, X-FEL

In total the installed base is 650kW. Additional 550 kW will follow in short term.

The advantages of the systems are:

- Application specific design according to requirements of customer
- Application specific control and monitor unit
- Ready-to-use laser system
- Scalable and robust design

INGENERIC is responsible for mechanical and optical design and for system integration. Benefit from:

- a team of experts in all relevant fields
- strong co-operation partners
- our product platform to customize your solution

Our motivation is to deliver an outright laser system which will enable your scientists to effectively focus on their actual research.
# HIGH ENERGY PUMP DIODE LASER

939nm Diodes
1–1.5 ms, 10 Hz
Square Top Hat
Amplitude
Contrast < 7%

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Power</td>
<td>&gt; 250 kW</td>
<td>Top Hat Beam Size</td>
<td>78 x 78 mm²</td>
</tr>
<tr>
<td>Number of Stacks</td>
<td>27</td>
<td>Number of Stacks</td>
<td>3</td>
</tr>
<tr>
<td>Laser Diode Drivers</td>
<td>separated</td>
<td>Stacks on Manifold</td>
<td>triplet</td>
</tr>
<tr>
<td>Optic Set</td>
<td>external field lens</td>
<td>Optical Axis</td>
<td>centered</td>
</tr>
<tr>
<td>Beam Profile</td>
<td>soft-edged</td>
<td>Beam Divergence</td>
<td>2.5°(H) x 5°(V)</td>
</tr>
<tr>
<td>Beam Divergence</td>
<td>2.5°(H) x 5°(V)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

> 29 kW
24 x 24 mm²
5°(H) x 7°(V)
FROM POWER SOURCE TO TARGET

HIGH POWER DIODE LASER STACKS (12.5kW)

- High Power Diode Bars (25/stack)
- Compact & Efficient Stacks
- Customized Package

OPTICAL KEY COMPONENTS

- High Brightness Fast Axis Collimators (FAC)
- Large Format Acylinders (ACYL)
- Homogenizer Arrays (MLA)
## THE INGNITE SERIES – SCALE OPTIONS

<table>
<thead>
<tr>
<th>Stacking Options</th>
<th>Stack Configuration</th>
<th>Power Output</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 3 x 3 stacks</td>
<td>27 stacks</td>
<td>270 kW (INGnite 250)</td>
<td>1000 x 540 x <strong>520</strong> mm³</td>
</tr>
<tr>
<td>2 x 3 x 3 stacks</td>
<td>18 stacks</td>
<td><strong>180 kW</strong></td>
<td>1000 x 540 x <strong>400</strong> mm³</td>
</tr>
<tr>
<td>1 x 3 x 3 stacks</td>
<td>18 stacks</td>
<td><strong>90 kW</strong></td>
<td>1000 x 540 x <strong>350</strong> mm³</td>
</tr>
<tr>
<td>1 x 3 stacks</td>
<td>3 stacks</td>
<td><strong>30 kW (INGnite 25)</strong></td>
<td>1000 x 540 x <strong>350</strong> mm³</td>
</tr>
<tr>
<td>1 x 1 stacks</td>
<td>1 stacks</td>
<td><strong>10 kW</strong></td>
<td>1000 x 540 x <strong>350</strong> mm³</td>
</tr>
</tbody>
</table>
# THE INGNITE SERIES - SPECIFICATION

<table>
<thead>
<tr>
<th><strong>Product</strong></th>
<th><strong>INGnite 250</strong></th>
<th><strong>Options</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optical data</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulsed - nominal output-power</td>
<td>kW</td>
<td>250</td>
</tr>
<tr>
<td>Center wavelength</td>
<td>nm</td>
<td>939.5</td>
</tr>
<tr>
<td>Center wavelength variation (@ 25 °C)</td>
<td>nm</td>
<td>± 0.1</td>
</tr>
<tr>
<td>Spectral bandwidth (FW80%)</td>
<td>nm</td>
<td>&lt; 6</td>
</tr>
<tr>
<td>Intensity profile</td>
<td>Top-Hat</td>
<td>-</td>
</tr>
<tr>
<td>Intensity profile dimension</td>
<td>mm²</td>
<td>78 x 78</td>
</tr>
<tr>
<td>Amplitude contrast</td>
<td>%</td>
<td>&lt; 7</td>
</tr>
<tr>
<td>Slope Width</td>
<td>%</td>
<td>5</td>
</tr>
<tr>
<td>Plateau Dimension (FWHM)</td>
<td>%</td>
<td>95</td>
</tr>
<tr>
<td>Divergence (95%)</td>
<td>°</td>
<td>2.5(H) x 5.0(V)</td>
</tr>
<tr>
<td>Power source to target</td>
<td>m</td>
<td>5.0</td>
</tr>
<tr>
<td>Polarization (TE)</td>
<td>%</td>
<td>&gt; 93</td>
</tr>
<tr>
<td><strong>Electrical data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse duration</td>
<td>ms</td>
<td>0.2, 1.5</td>
</tr>
<tr>
<td>Pulse rise/fall time</td>
<td>μs</td>
<td>50</td>
</tr>
<tr>
<td>Repetition rate</td>
<td>Hz</td>
<td>0.1, 10</td>
</tr>
<tr>
<td>Typical operation current</td>
<td>A</td>
<td>550</td>
</tr>
<tr>
<td>Maximum operation current</td>
<td>A</td>
<td>600</td>
</tr>
<tr>
<td>Maximum operation voltage</td>
<td>V</td>
<td>&lt; 50</td>
</tr>
<tr>
<td><strong>Thermal data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>°C</td>
<td>20 - 30</td>
</tr>
<tr>
<td>Typical base plate temperature</td>
<td>°C</td>
<td>25</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>°C</td>
<td>5 - 60</td>
</tr>
<tr>
<td><strong>Other specifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected lifetime</td>
<td>month</td>
<td>&gt; 24</td>
</tr>
<tr>
<td>Operating conditions</td>
<td></td>
<td>non-condensing atmosphere</td>
</tr>
<tr>
<td>Length x Width</td>
<td>mm²</td>
<td>1000 x 540</td>
</tr>
<tr>
<td>Height</td>
<td>mm</td>
<td>520</td>
</tr>
<tr>
<td>Weight (app.)</td>
<td>kg</td>
<td>150</td>
</tr>
<tr>
<td>RoHS 2002/95EC compliant</td>
<td></td>
<td>yes</td>
</tr>
</tbody>
</table>

* Further options

- peak power of up to 750 W per bar
- ~ pulse duration and d.c.
  (typical maximum value: 550W - 1 ms - 2 %)
- pulse duration of up to 5 ms
- ~ pulse power and d.c.
- pulse repetition rate ~pulse power and duration

**based on existing platform - customized dimensions on request**
optics for superior solutions

Intelligent optics for your specific application!

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