Optical modules
for laser material processing

Product overview of beam shaping and optical systems

PULSAR
PHOTONICS

Foreword

- 2 -

Dear Ladies and Gentlemen,
Dear customers and business partners,

We are pleased to present you our products and competences in the field of optical system technology with the product overview Optics Modules.

Since the beginning of the company, our goal has been to provide our customers with beam shaping and optical systems that can be integrated into machines to increase the economic efficiency of laser micromachining or to expand the limits of laser technology.

The company history of Pulsar Photonics started with the development of the MultiBeamScanner in 2013.

Since then, we have developed an extensive optics kit in many customer and development projects.

In addition to standardised assemblies for beam guidance and beam shaping, this kit also includes suitable measurement technology and software.

This enables us to develop industrially suitable, self-adjusting optics systems for various applications.

We look forward to your questions!

Patrick Gretzki,
Head of Systems Engineering Pulsar Photonics GmbH
&
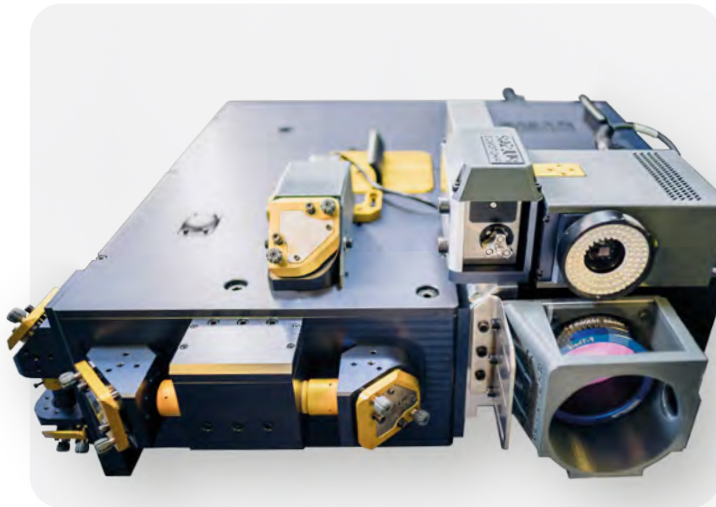*the management of Pulsar Photonics GmbH*

1   M.Sc. Patrick Gretzki,
Head of Systems Engineering

2   Dr. Jens Holtkamp, Dr. Stephan Eifel
and Dr. Joachim Ryll, management

Our Optical Systems at a glance

dynamic beam shaping:

for your process acceleration:

for ultra high resolution applications:

for your quality standard:

customized optics modules:

FlexibleBeamShaper FBS-G3

Dynamic beam shaping system

flexible **beam shaping**
and integrated **scanning combined**

digital tool change
via software

Beam shaping and splitting
with up to **100W laser power**
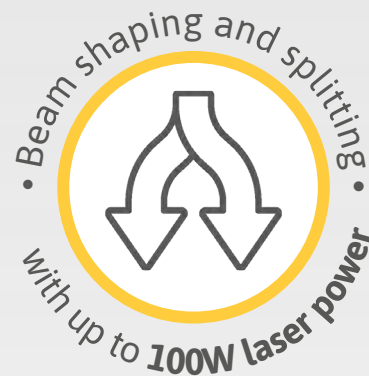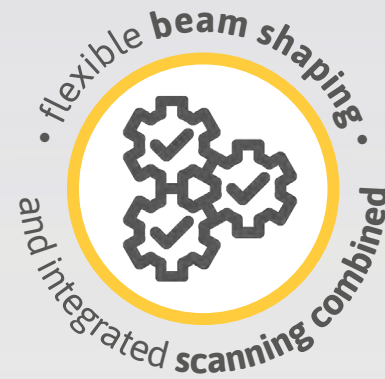
Beam shape on demand

With the FlexibleBeamShaper (FBS) Pulsar Photonics GmbH offers a machine integrable beam shaping system for laser micromachining, that can generate freely designed beam distributions.

To achieve this, the FBS is equipped with an electronically controllable optical phase modulator. It allows to utilize the FBS as a photonic tool magazine with predefined beam shapes on demand. In addition, the FBS is equipped with a classic galvanometer scanner, so the generated intensity distribution can be scanned over the workpiece.
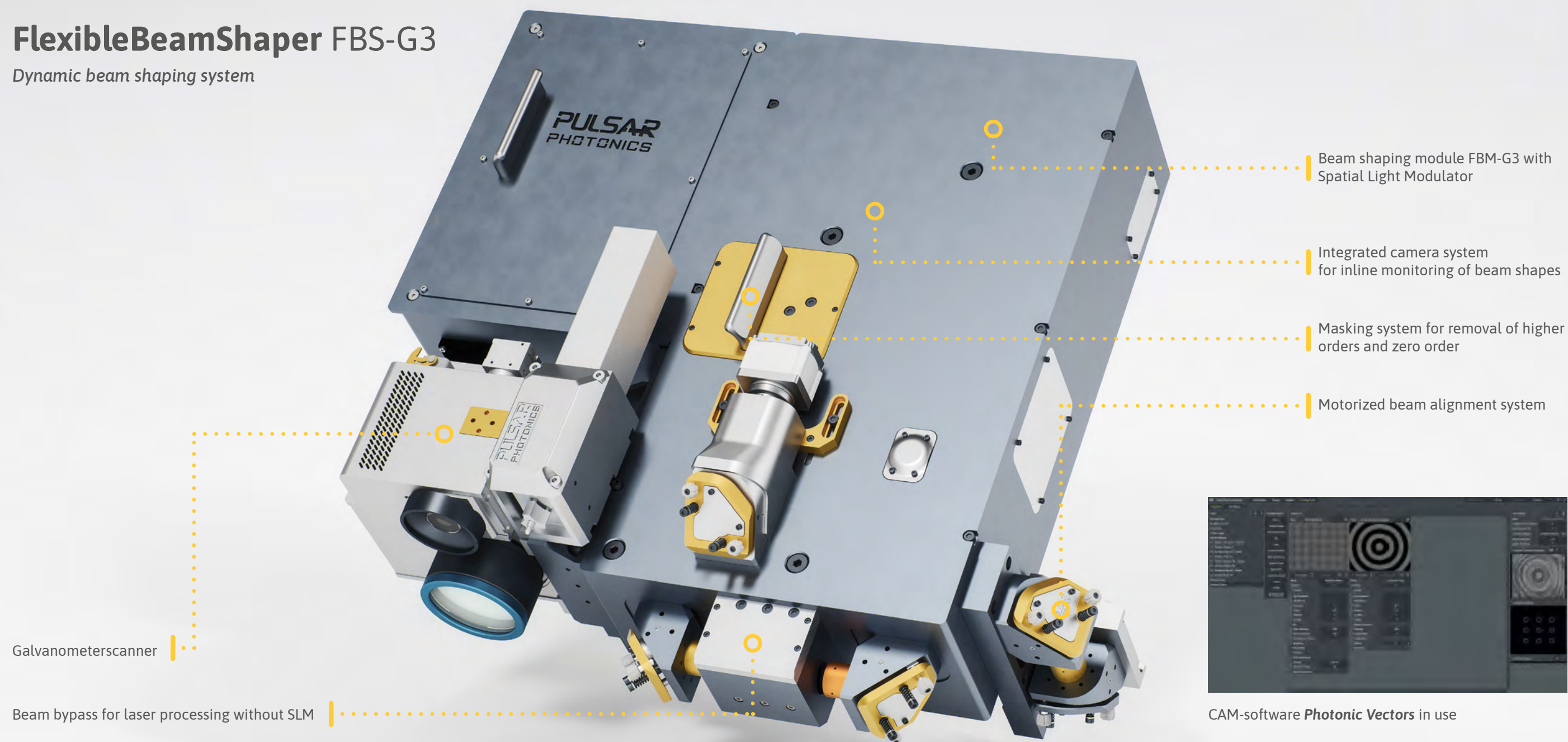
These combined tools in a single system open up new ways in laser micromaching: faster, more flexible and more efficient.

PULSAR PHOTONICS
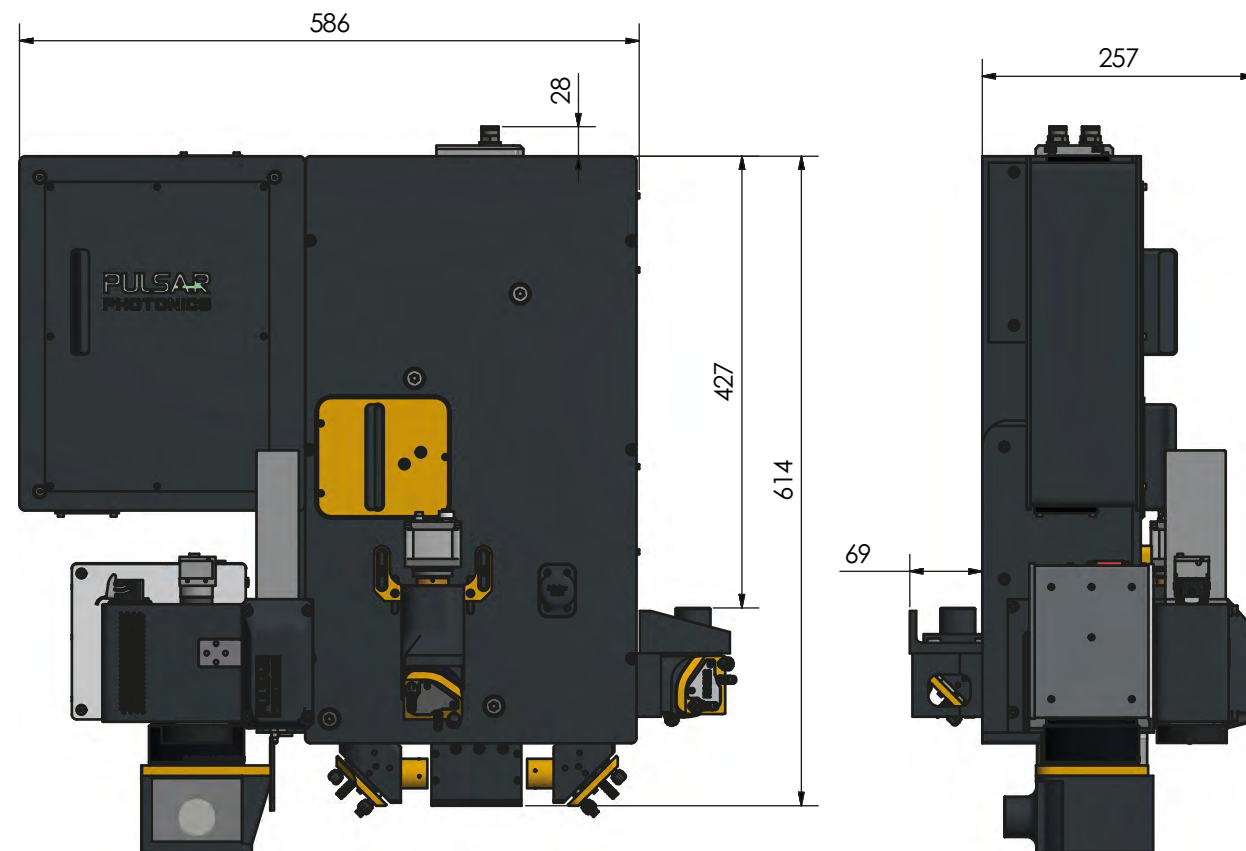
FlexibleBeamShaper FBS-G3

Dynamic beam shaping system

Beam shaping module FBM-G3 with
Spatial Light Modulator

Integrated camera system
for inline monitoring of beam shapes

Masking system for removal of higher
orders and zero order

Motorized beam alignment system

Galvanometerscanner

Beam bypass for laser processing without SLM

CAM-software *Photonic Vectors* in use

Photonic tool change (examples for laser tools)

Ring Tool

Matrix Spot

Single Spot

Custom Tool

Cleaning Tool

Multi Tool

FlexibleBeamShaper FBS-G3

Dynamic beam shaping system
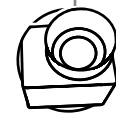
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28

427

614

257

69

Technical data

FlexibleBeamShaper FBS-G3

- **Max. Dimensions:** (L x W x H): 650mm x 680mm x 340mm
- **Addressable field size** with SLM: approx. 4mm x 4mm @ f = 100mm

Galvanometer scanner:
- Manufacturer: e.g. Scanlab, Newson, Raylase
- Focal lengths: 50mm-500mm (typ. 100mm)

Wavelengths:
- IR (1030-1070nm)
- VIS (515nm / 532nm) on request

Laser input:
- Max. beam diameter: 6 mm
- TEM00, $M^2 <= 1.3$

Suitable laser beam sources
- nanosecond / picosecond / femtosecond (>800fs)
  (low spectral bandwidth recommended)
- max. Power: 100 W (IR)
- max. Pulse energy: 500 µJ @ 1ps (IR)

Suppression of higher orders

Control software - Photonic Tools:
- Software for **adjustment, calibration and control** of the system
- Camera-supported adjustment and calibration
- Software kit for creating complex profiles
- Generation of 2D and 3D distributions
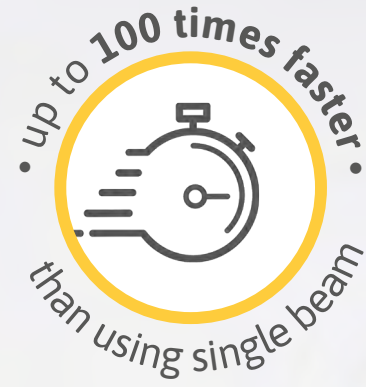- **Digital tool-changing** system

Optional components:
- Switching between single beam and multiple beam processing
- Motorized alignment of laser beam into the module
- Coaxial camera
- Ext. Camera system for intensity measurement

MultiBeamScanner MBS-G4

Massive process acceleration through parallel machining

drills up to
14.000 holes per second

up to 100 times faster
than using single beam

reduction of
laser processing costs

Parallel processing system using beam splitting

The unique combination of a precise galvanometric scanning system and beam splitting in one system allows to multiply laser cutting, drilling or ablation processes without loosing the freedom of geometry of the scanner. Using diffractive optical elements (DOEs) the incoming laser beam is split up into multiple beams, generating multiple laser spots in the work plane of the scanning system.

This way multpile structures can be processed in parallel or for example complex cut patterns can be realized while multiplying the production output. The MultiBeamScanner is the solution to significantly reduce production costs in laser micromachining of peridodic structures up to two orders of magnitude.
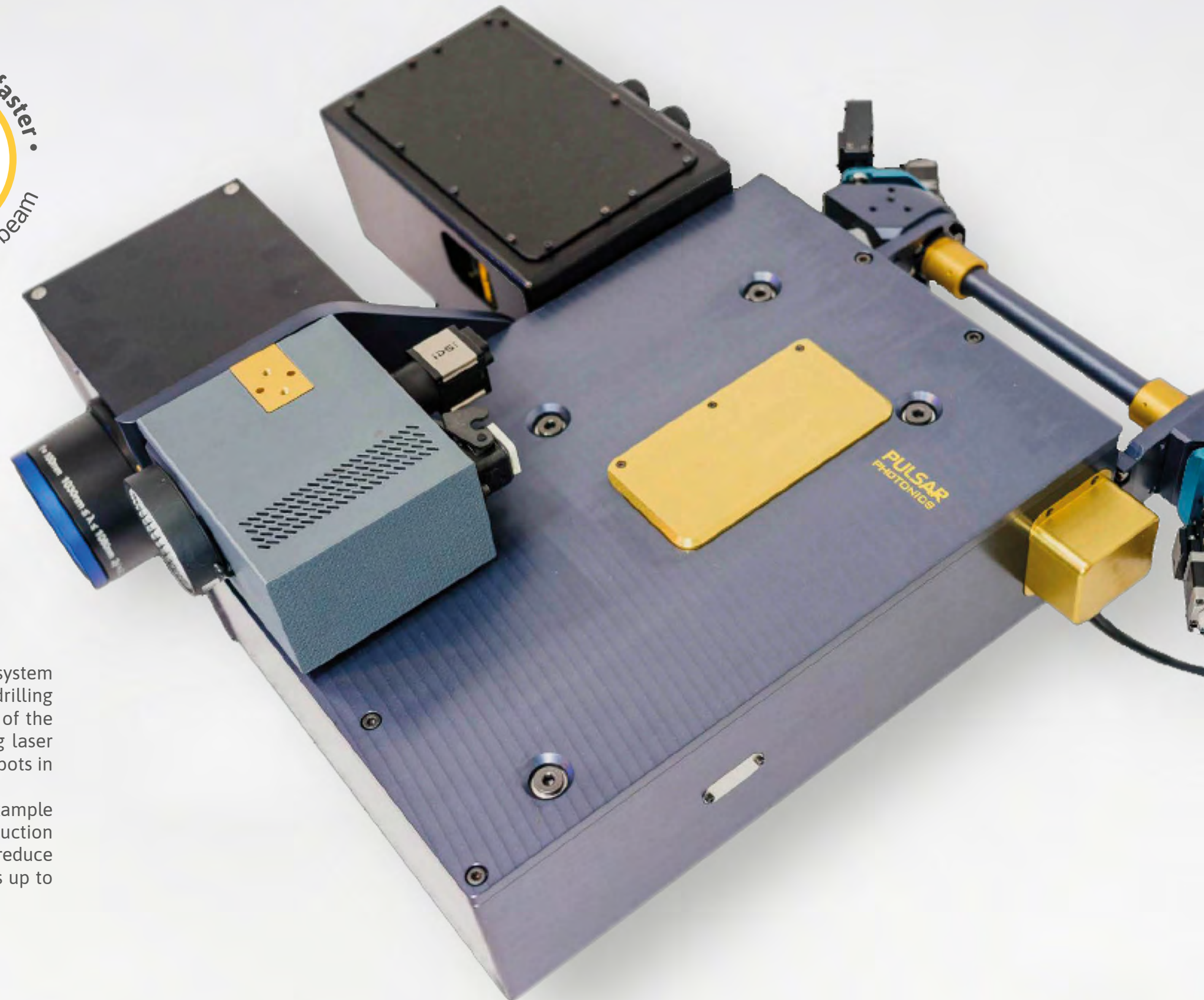
MultiBeamScanner MBS-G4

Massive process acceleration through parallel machining

Beam entrance
& automated beam adjustment unit

High speed laser drilling

Multi beam laser processing is the perfect solution for drilling or trepanning large numbers of precise holes into metal or ceramic foils by multiplying the the speed of drilling processes. With drilling rates in the multi kHz-range the system is well suited for large area applicatons. Drilling rates of up to 14 kHz have been demonstrated.

Application example:
Multibeam laser drilling of microsieves

MBM-G4 MultiBeamModule

Galvanometerscanner

Surface functionalization

Micro- or nanostructured surfaces can extend the functions of a work piece by additional optical, hydrodynamic or wetting properties. These functional surfaces often consist of periodic structures (e.g. dimples), that are distributed over the surface of the work piece.
Especially in production environments with short cycle times the Multi Beam Scanner can reduce processing times and thus to enable economical ways for high quality laser ablation.

Parallel processing of multiple parts

The unique combination of a precise galvanometric scanning system and beam splitting in one system allows to multiply laser cutting, drilling or ablation processes without losing the freedom of geometry of the scanner.
This way multpile parts can be processed in parallel or for example complex cut patterns can be realized while multiplying the production output.
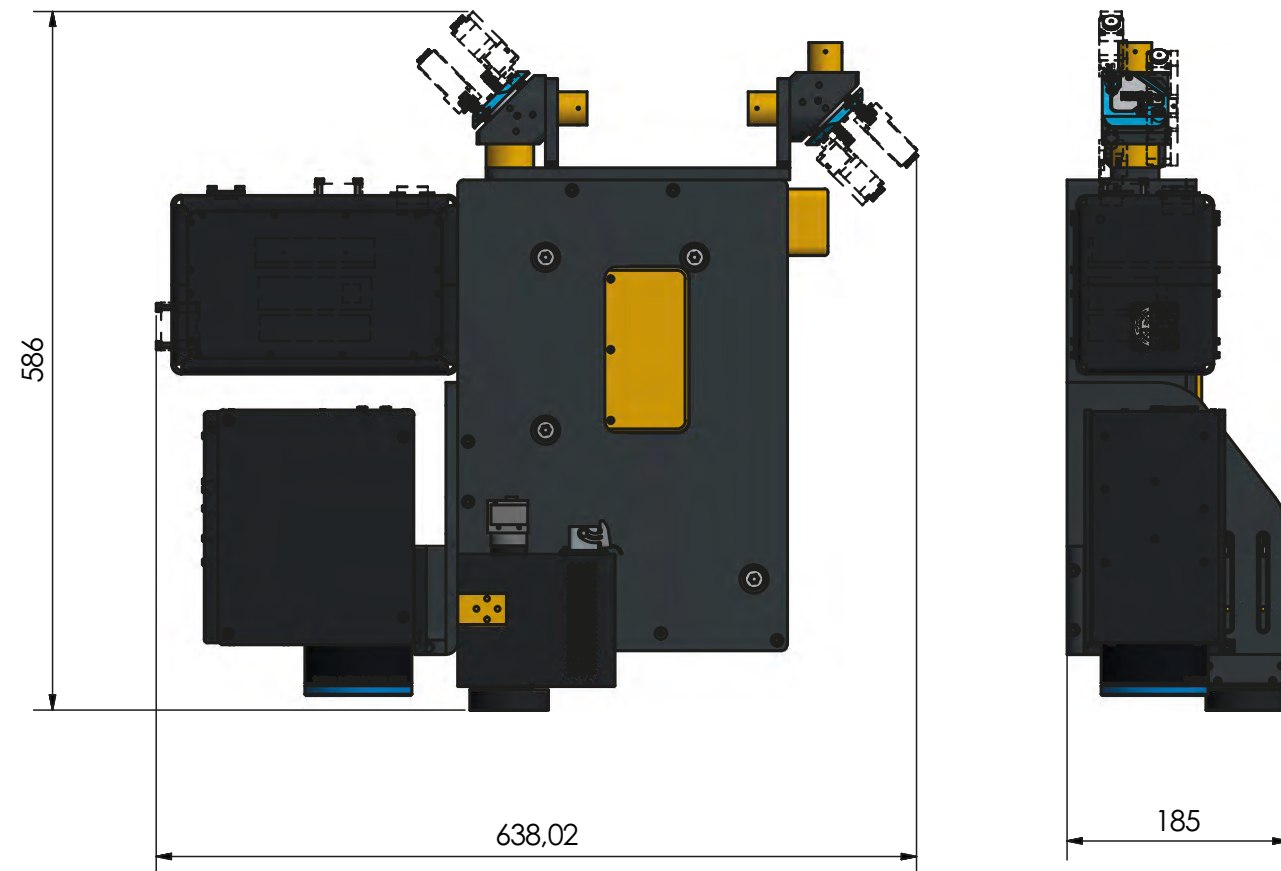
MultiBeamScanner MBS-G4

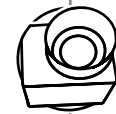*Massive process acceleration through parallel machining*

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638,02

185

Technical data

MultiBeamScanner MBS-G4

- **Max. Dimensions:** (L x W x H): 638mm x 586mm x 185mm
- **Adresssable area with DOE:** Max. 5mm x 5mm @ f=100mm

Spot distributions:
- e.g. 2×2, 4×4,...8 x8, free distributions

Galvanometer-Scanner:
- Manufacturer: e.g. Scanlab, Newson, Raylase

Wavelengths:
- IR (1030-1070nm)
- VIS (515nm/532nm)
- UV (343nm-355nm)

Suitable pulse durations:
- Nanosecond / Picosecond / Femtosecond
- Max. Power: 150 W
- Max. Pulse energy: 1 mJ @ 1ps

Functions:
- Masking of higher orders
- Integrated beam position stabilisation to ensure alignment
- Rotation of beam distribution
- Fine adjustment of spot pitch
- Switching between single-beam and multi-beam processing

Spot position error:
- <3 µm @ f=100mm

Control software - Photonic Tools:
- Software for adjustment, calibration and control of the system
- Camera-assisted adjustment and calibration

Optional components:
- Ext. camera system for intensity measurement

Microscan Extension MSE-G2

Scan lens for ultra-high resolution applications
,the 1µm laser knife'

spot diameters · **down to 1µm** in UV

Enhance your machine · into a **microscan system**

compatible with · variety of **galvo scanners**

Extend your laser machine with a High-NA scanning solution
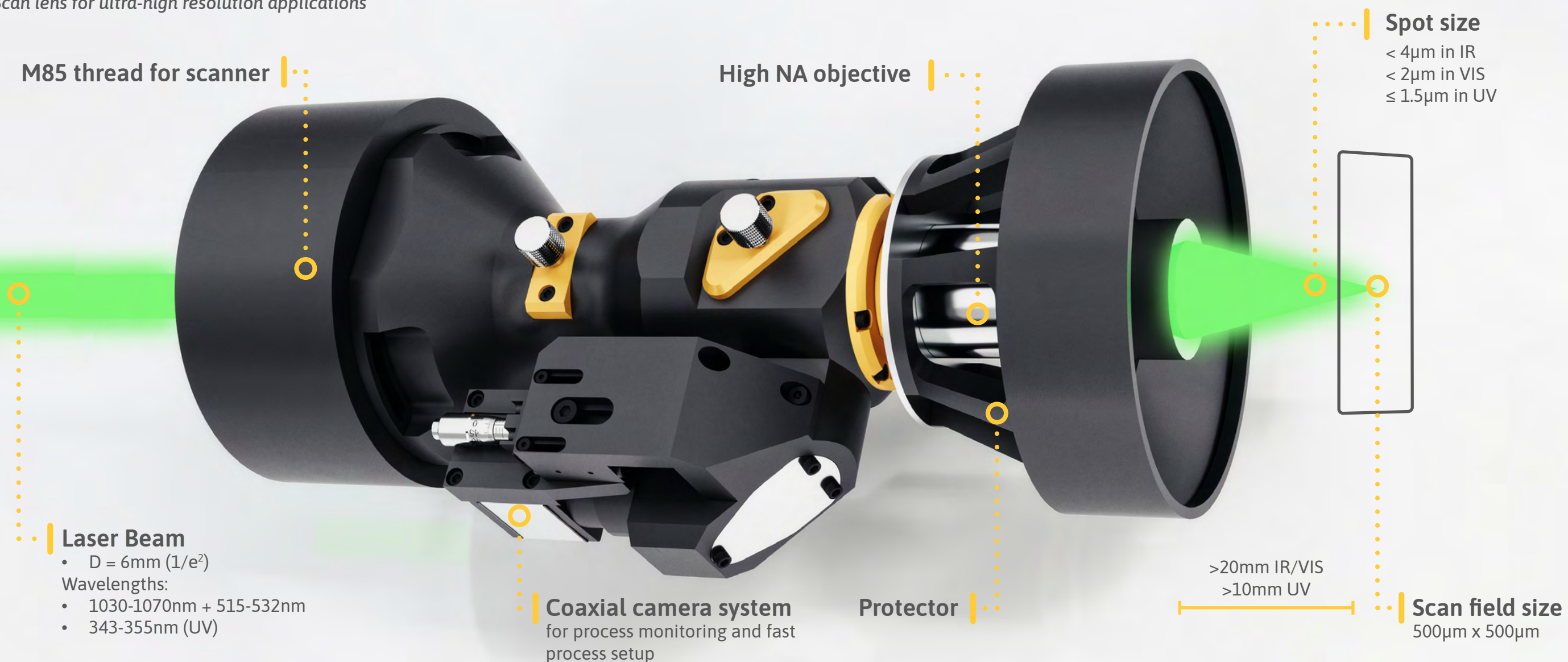
With the Microscan Extension MSE Pulsar Photonics offers a simple but powerful extension for any galvo scanning system. By simply exchanging a conventional scan lens by the MSE-G2, the user can convert his machine to a micro spot scanning system. The combination of galvanometer scanner and MSE-G2 allows high-precision processing with a focus diameter of less than 4µm. This enables the production of the smallest components with unmatched accuracy and level of detail. We offer the system for IR, VIS and UV wavelengths.
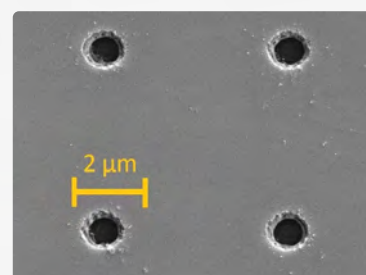
Microscan Extension MSE-G2

Scan lens for ultra-high resolution applications

Spot size
< 4µm in IR
< 2µm in VIS
≤ 1.5µm in UV

M85 thread for scanner

High NA objective

Laser Beam
- D = 6mm $(1/e^2)$
Wavelengths:
- 1030-1070nm + 515-532nm
- 343-355nm (UV)

Coaxial camera system
for process monitoring and fast
process setup

Protector

>20mm IR/VIS
>10mm UV

Scan field size
500µm x 500µm

Application examples

Production of micro-apertures

Micro-apertures
with diameters
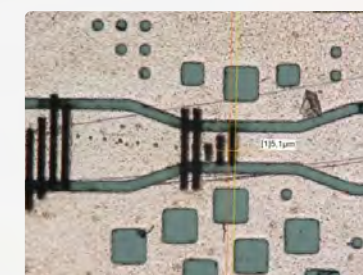down to 1.6µm

2 µm

Micro-drilling of thin foils

High-precision
bores with
diameters close to
the sub-µm area

High-resolution micro marking

Microscan

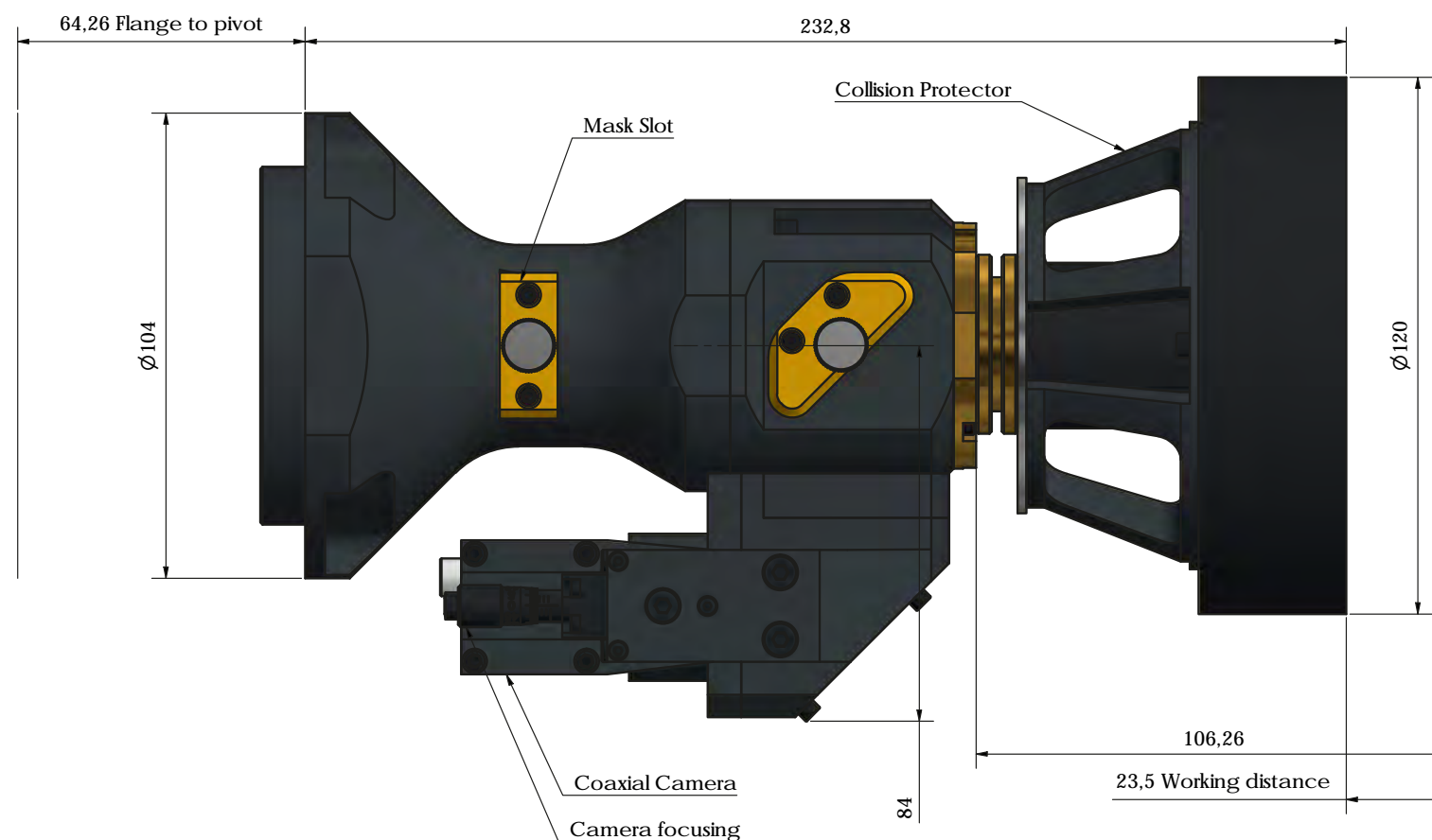High-resolution
QR code with
Dimensions 300
µm x 300 µm

Electronic repair - micro ablation

Creating
isolation
trenches in
electronic
circuits

Microscan Extension MSE-G2

Scan lens for ultra-high resolution applications
Technical data

64,26 Flange to pivot

232,8

Collision Protector

Mask Slot

Ø104

Ø120

106,26

23,5 Working distance

84

Coaxial Camera

Camera focusing

- **IR/VIS Version: MSE-G2 IR (1030-1070nm) + VIS(515nm-532nm)**
- **UV Version: MSE-G2 UV (343-355nm)**

- **Max. Dimensions:** (L x W x H): 245mm x 145mm x 120mm
- **Working distance:** > 20 mm (IR/VIS), > 10 mm (UV)
- Scan field size: typ. 500µm x 500µm
- Integrated coaxial camera

- Fastening thread: M85x1 (standard galvo scanner)
- Integrated collision protection

- ⚠ Only suitable for low average laser powers and pulse energies

Integrated coaxial camera
- FOV: > 500µm x 500µm
- for fast process setup
- Lateral and axial adjustment of the focus position

Spot sizes (for laser beam source with $M^2 < 1.3$):
IR+VIS Version:
- < 4µm in the IR
- < 2µm in the VIS
UV Version:
- < 1.5µm

- LIDT coating @ 355nm; 10ps [mJ/cm^2] < 0.5
- LIDT coating @ 532nm; 10ps [mJ/cm^2] < 3
- LIDT coating @ 1064nm; 10ps [mJ/cm^2] < 6

Beam Alignment Module – BAM-G1

Constant quality under industrial conditions

safe and encapsulated
beam guidance

active correction
of the beam position

constant process results

Active beam alignment for constant process results

When it comes to the accuracy and robustness of processes and machines, beam alignment plays an important role in addition to a reliable laser source and precise optics. When parts are to be processed precisely and with high repeatability, active beam position stabilization can make all the difference.

Beam Alignment Module – BAM-G1

Laser beam housing

Camera deflector for coaxial beam size and position measurement
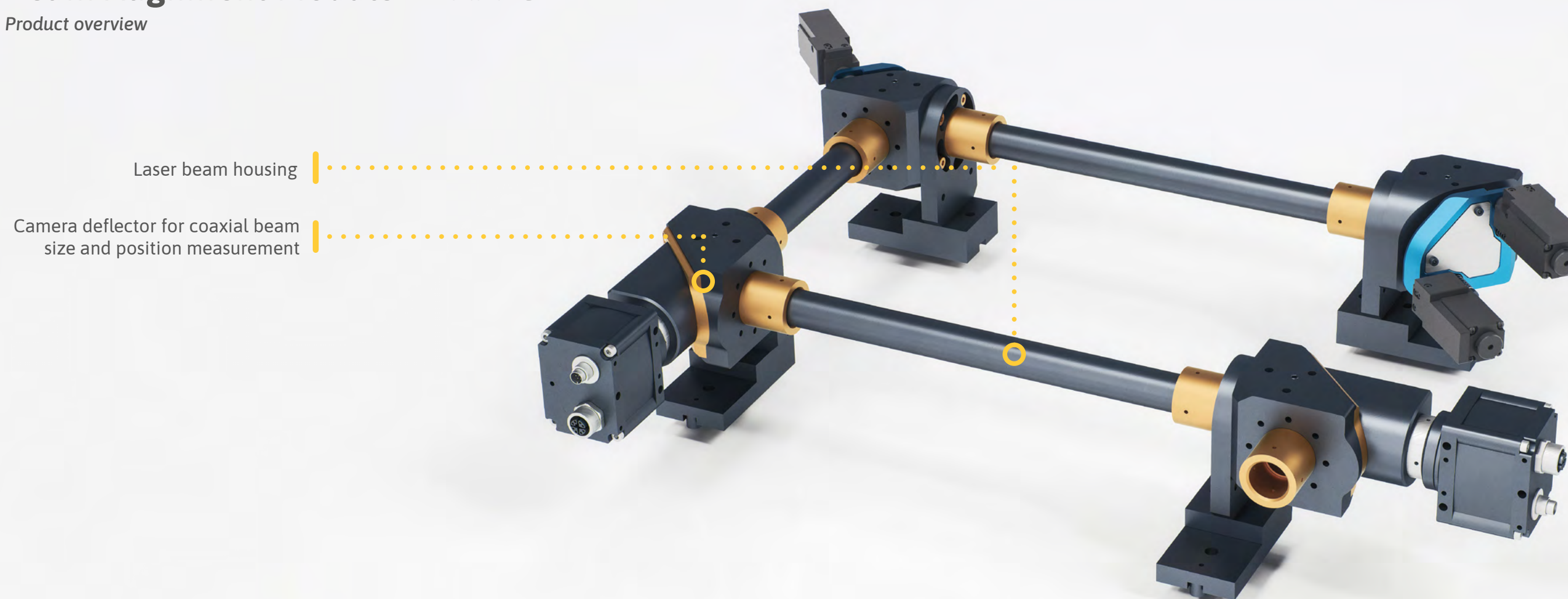
The product

The beam stabilization unit from Pulsar Photonics is a modular solution for active beam position stabilization. Effects on the beam position due to e.g. pointing errors and thermal effects of laser sources or fluctuations of the ambient temperature can be measured and actively compensated. Thus, constant process results are possible even under fluctuating initial conditions.

Beam Alignment Module

Due to its modular design, the BAM can be flexibly adapted to different machine types, designs and applications. Furthermore, the connection of a gas or overpressure purge and the use of the Pulsar Tube System can guarantee a high degree of dust-free operation, making the module suitable for laser sources with high pulse energy and high beam quality.
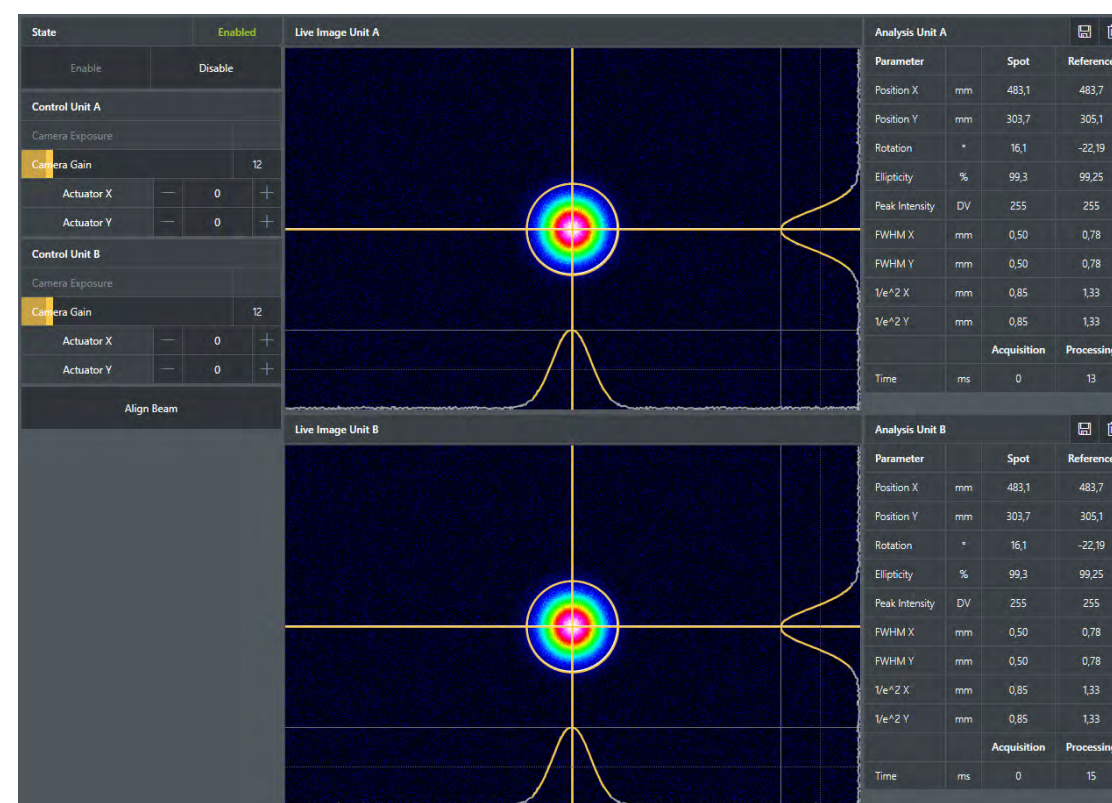
Beam Alignment Module – BAM-G1

Beam parameters

In addition to the right hardware, the right software is also required for optimum control of your beam position.

In the BAM software module, not only can the correction of the beam position be activated and monitored, but the beam position can also be adjusted manually.

Due to the camera-based mode of operation of the BAM, the software determines numerous other beam parameters in addition to the position of the laser beam on the camera:

• Rotation
• Ellipticity
• FWHM diameter
• $1/e^2$ Diameter

Software Module for Beam Alignment Module - Beam position and beam shape always in focus

Due to the deep integration of the software module into the Photonic Elements machine software, correction within a process can be automated, enabling consistent results when handling complex and time-consuming processes.

The software module also offers an observation-only mode. Here, beam parameters can be measured over a longer period of time and the data can be stored for later evaluation. Thus, the BAM can also be used for laser diagnostics and for monitoring the aging of a laser source
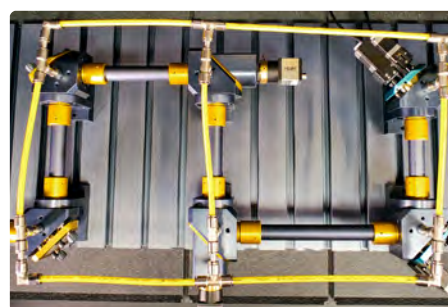
Application examples

Expandability

Separate control of different wavelengths and installation of several beam layers per system possible.

Beam encapsulation

Compatibility with the Pulsar Tube System and connection option for gas or positive pressure flushing guarantee dust-free operation.
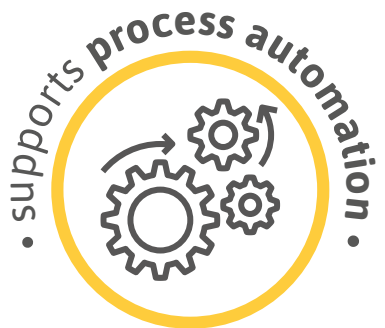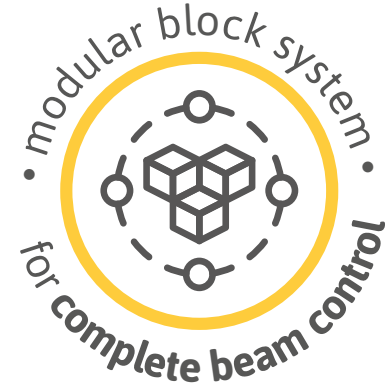
Modular system

Modular system compatible with different application scenarios, also for use on optical table.

Customized optical systems

Customized optics modules for laser material processing

all from one hand: from design to process validation

modular block system for complete beam control

measurement and **controlling** technology

supports **process automation**

Tailor-made optical modules for your applications

Pulsar Photonics develops and produces optical systems for laser material processing. Based on many years of experience in the field of beam shaping, optical design, measurement technology, construction and process development, machine-integrated optical modules are created that take on complex dynamic beam shaping tasks. We develop systems for guiding and shaping laser beams and for process-specific processes. For this purpose, Pulsar Photonics uses a self-developed modular system with which easily complex optical systems can be put together and set up. Module-integrated measuring technology supports the beam adjustment and leads to a stable beam position even in high-end applications.

Our services

- Concept studies for the design of optical systems for laser material processing
- Optical design for beam shaping systems, especially multibeam systems
- Mechanical design of optical modules
- Integration of measuring systems
- Software development for module control
- Characterization and process validation of optical system
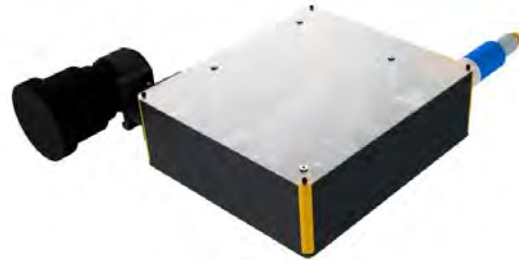
Applicable technologies

- Diffractive optics
- Spatial light modulators
- Acousto-optics
- Spherical optics
- Scanning systems

Customized optical systems

### DynamicBeamShaper (Ultrasurface)

Processing head for dynamic beam shaping during laser scanning with multi-kW cw lasers based on diffractive beam shaping in combination with a deformable mirror.


Multi-beam helical drilling system

for parallel cutting with up to 4 beams (scancut). Processing head for parallel helical cutting based on diffractive beam splitting.
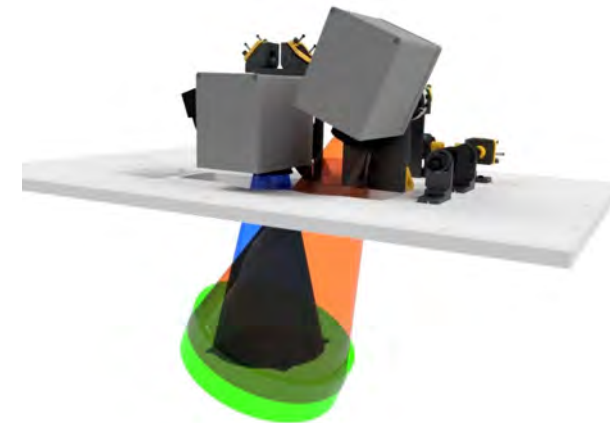

Multi-scanner system for process-synchronous workpiece irradiation (ATSM)

Optical module with two combined galvanometer scanners and a focus shifter to compensate for tilting the image field.
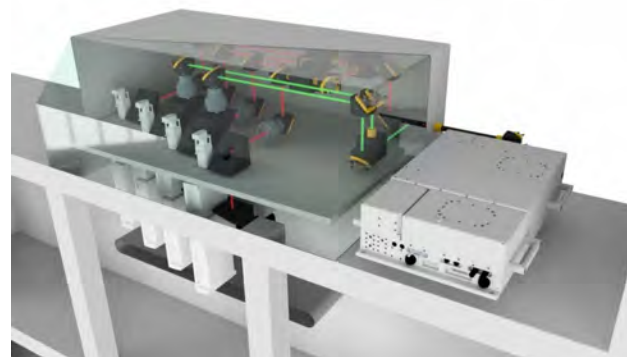
Multi-beam system for roll-to-roll processing (MBS-LA)

Optics module for massive parallelization of structuring processes for roll-to-roll processes, whereby the laser beam is distributed over four scanner systems and divided into partial beams by means of diffractive elements.
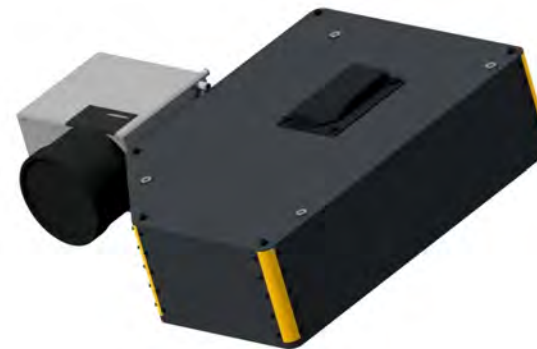
MultiBeamScanner with dynamic distortion correction (MBSS)

Multibeam scan system with dynamic distortion correction for imaging larger scan fields in multi-beam processing.

Process head for helical drilling

Concept study for a compact twist drill head for simple drilling applications with a high aspect ratio.

WE ARE LASER MICROMACHINING.

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