CONFIDENTIAL

VULQ1-M from QiOVA

Accelerating ultrafast laser processing x10

with dynamically programmable
multibeam technology

Agenda

- QiOVA® at a glance
- Multibeam laser processing
- VULQ1 offering
- Examples of ACCELERATION with VULQ1-M

Qiova at a glance

CONFIDENTIAL

Pioneers of multibeam laser processing for industry

2011

Founded, pionneering multibeam laser technology application to material processing

Releasing VULQ1 Module Gen1

First OEM beam shaping module in the market

2015

kreaxi

LOIRE HAUTE-LOIRE

investissement

2021

Raised 1,3M€ to boost deployment of multibeam solutions into the market

Releasing VULQ1 Module Gen2

2022


#LWOP22AWARDS
WINNER
OF THE
LASER SYSTEMS FOR INDUSTRIAL PRODUCTION ENGINEERING
QIOVA
VULQ1 Multibeam marking solutions
WORLD-OF-PHOTONICS.COM
26-29 APRIL 2022

2022

Award Winner – Laser system for industrial production engineering

Horizon Europe project « OPeraTIC » (500k€)

To develop high throughput laser surface texturation

2022

horizon europe

eurostars™

2022

Eurostars project laureate « BrandGuard » (500k€)

To market novel high security marking system

VULQ1 Multibeam laser

Standard offering

2023

FRANCE 2030

2023

France 2030 laureate

Individual project (800k€]

Smart laser tools for the industry of the future

Strategic partnership with Neyret Group – focus on multibeam solutions for Luxe segment

2023

NEYRET

TISSEUR D'INNOVATION

2024

Serie A 2,25M€

Industrial group leading round

CONFIDENTIAL

Latest news 2024

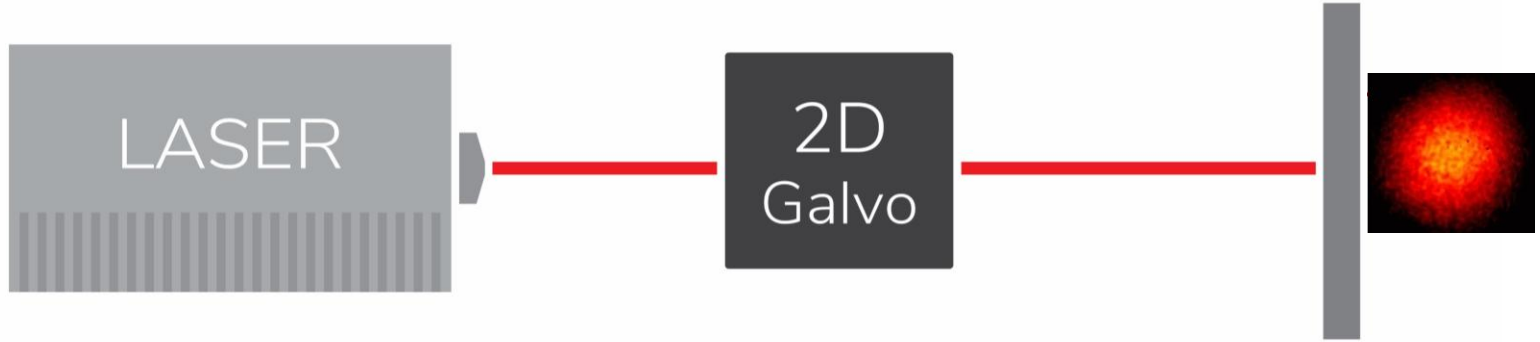
- Serie A funding – 2M€+ to accelerate market penetration
  - Led by top french Luxe industrial group

- >1 M€ booking by May
  - Pharmaceutics and luxe sectors leading, marking systems driven
  - Electronics and industrial goods to follow

- x3 revenue in FY2024 vs FY2023

- Consolidating team with 8 new hires

Current bottlenecks in laser processing



Standard laser processing
Sequential, like a pen on a sheet of paper

Using <u>only scanning</u> for laser beam delivery creates limitations in:

1. Throughput
2. Efficiency, especially for USP processing
3. Flexibility

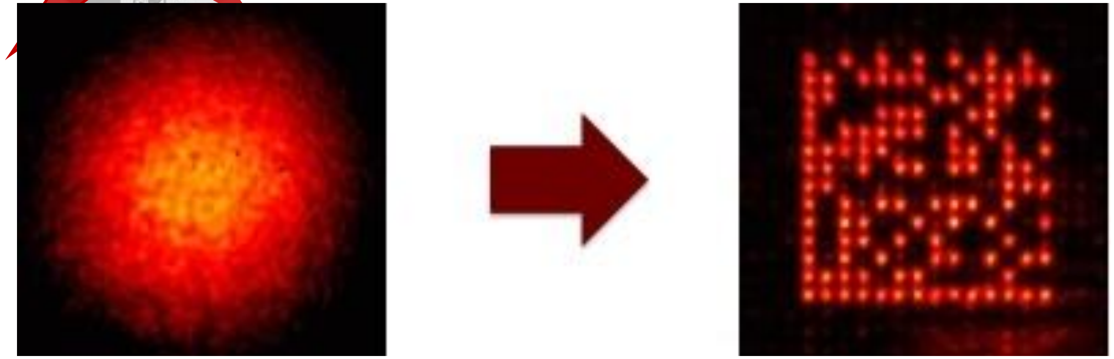
Our solution: dynamically programmable multibeam laser processing

Standard laser processing
Sequential, like a pen on a sheet of paper

Programmable multibeam laser processing
Dynamically parallelized, like a digital mask approach

Faster
More efficient
More flexible

The programmable multibeam technology



VULQ1 programmable multibeam technology

shapes light from the laser beam

on-demand and in real time

to maximize process performance at each step

VULQ1 generates up to hundreds laser beamlets on-demand, from one single laser beam.

The beamlets characteristics are individually and dynamically controlled by software - in position, profile and energy - to create the "*multibeam pattern*" fitted to the process needs.

The many beamlets composing the "*multibeam pattern*" are applied simultaneously to the material, scaling up throughput with no compromise on quality.

Multifold process throughput & efficiency increase
Spatial resolution < 50µm

Our purpose: Better laser solutions for a better manufacturing

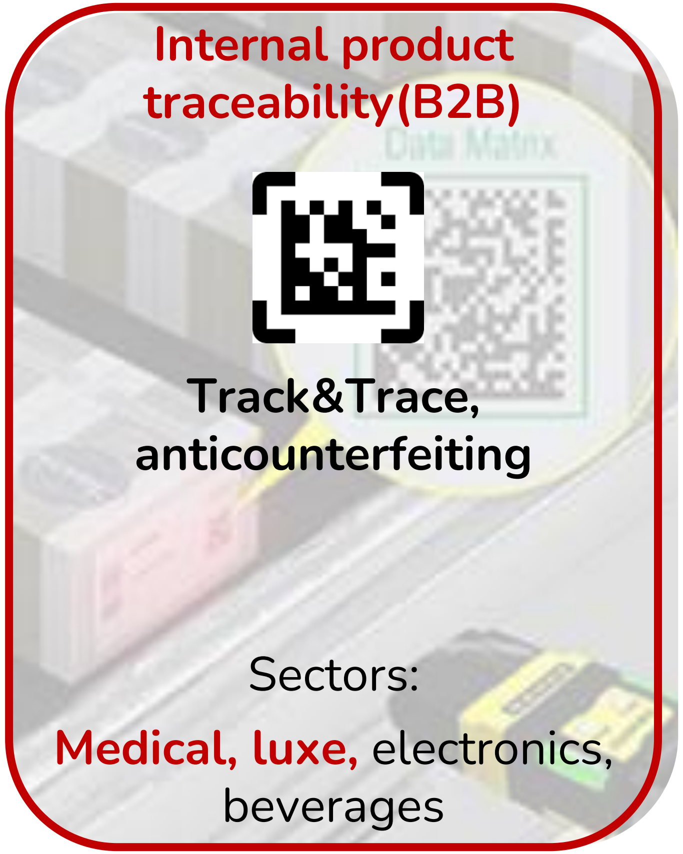
Since 2011, QiOVA pioneers multibeam laser solutions to **enable cost-effective and ecofriendly late-stage personalization** of industrial goods

Surface treatment

Sustainable decoration, functionalisation

Sectors :

Luxe, beverages, cosmetics, automotive



Internal product traceability(B2B)

Track&Trace, anticounterfeiting

Sectors:

Medical, luxe, electronics, beverages

External product traceability (B2C)

Digital marketing, Digital Product Passport

Sectors:

Durable consumer goods, luxury goods, electronics

Industrial applications

POCHET DU COURVAL

NEYRET

TISSEUR D'INNOVATION

©: Pochet Ducourval

Sustainable glass decoration

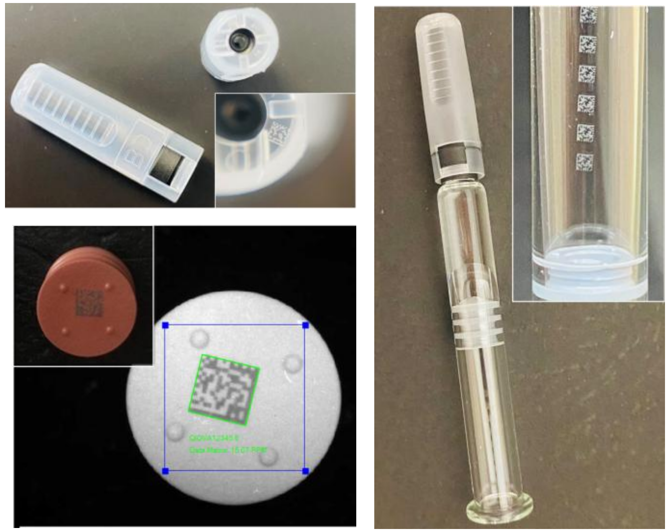
New design possibilities, permanent, no addings

5x faster than standard laser

SCHOTT
glass made of ideas

Lilly

BD



Serialization of medical devices

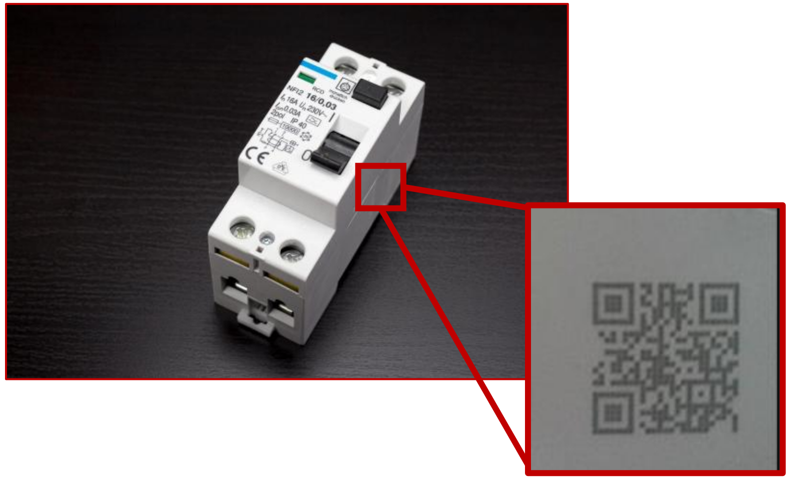
Permanent, seamless integration in-line

72 000 parts / hour

BIOMÉRIEUX

Sidel

Macsa id
a code you can trust



Serialization of electrical goods

4x faster than current UV laser marking

14 400 parts/hour

An unique offer of products and expertise to deliver superior throughput for industrial applications

Pre-sales service

Defining custom solution

- *Feasability studies*
- *Application development*
- *Pre-series*

VULQ1 Multibeam OEM offer

Delivering higher performance

- *Manufactured in our factory*
- *Standard and custom OEM systems*
- *Retrofit/integration in environment*

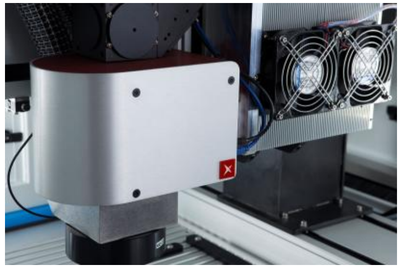
VULQ1-M
Optical module

VULQ1-S
Laser marking systems

After-sales service

Maximizing uptime

- *Maintenance*
- *Warranty extension*
- *Contracted services*

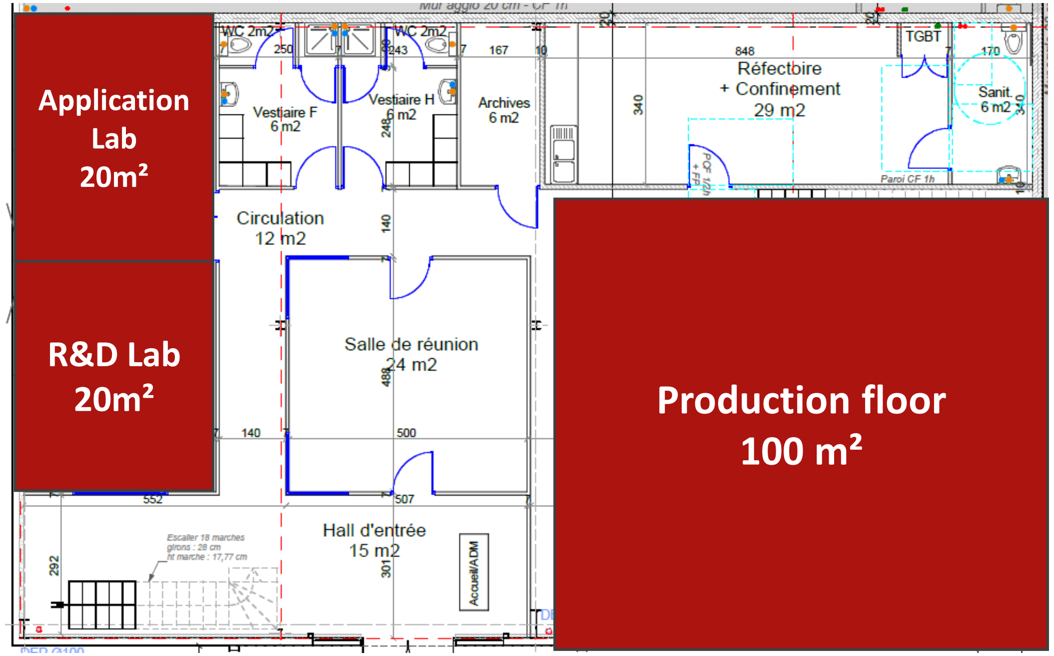


Custom Laser marking systems

QiOVA – Our factory

- **Factory located in the region of Saint-Etienne**
- Brand new industrial activity park
- 5min from highway, 1h from Lyon airport

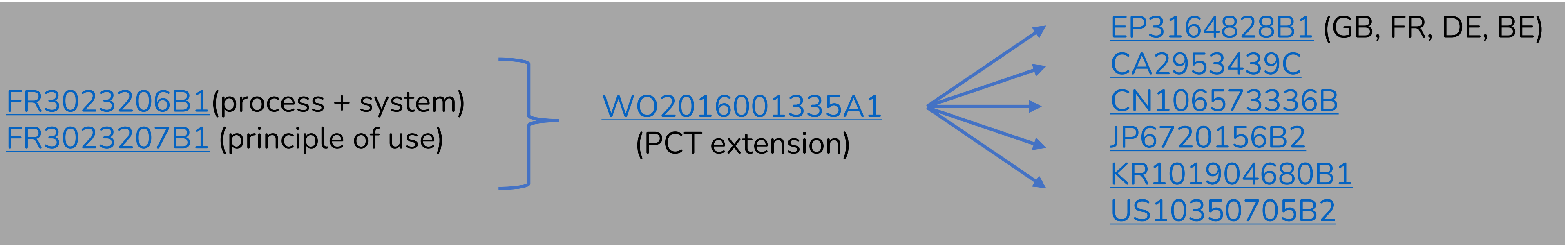
- **Laser R&D laboratory**
  - Lasers: NIR & visible, up to 30mJ, 25W, nanosecond to femtosecond
  - Equipment: 3D printer, charaterization
- **Application laboratory**
  - VULQ1 STAMP marking systems
- **Production**
  - 50-100 VULQ1 modules / year
  - 20 VULQ1 systems / year



CONFIDENTIAL

IP Qiova – A growing international patent portfolio

Patent family n°1
FLASH marking



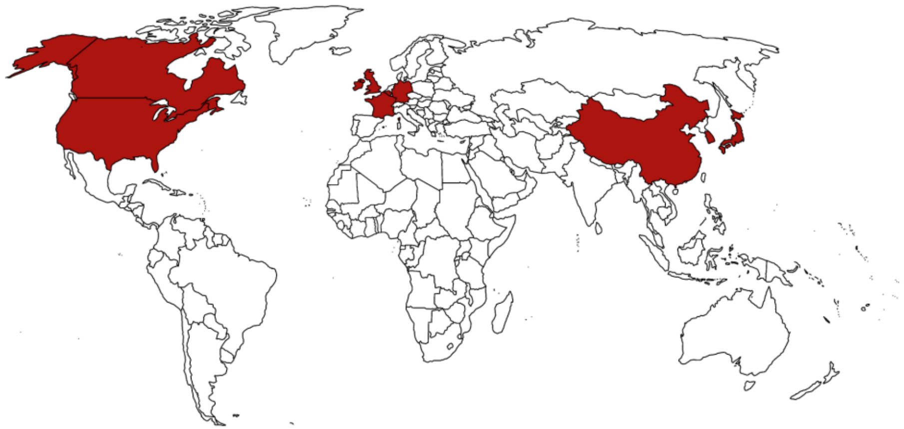
FR3023206B1(process + system)
FR3023207B1 (principle of use)

WO2016001335A1
(PCT extension)

EP3164828B1 (GB, FR, DE, BE)
CA2953439C
CN106573336B
JP6720156B2
KR101904680B1
US10350705B2

Patent family n°2
High-speed printing

France - FR 3121060
International Extension – WO/2022/208020



Additional IP pending for the micromachining sector

From standard laser processing to multibeam laser processing

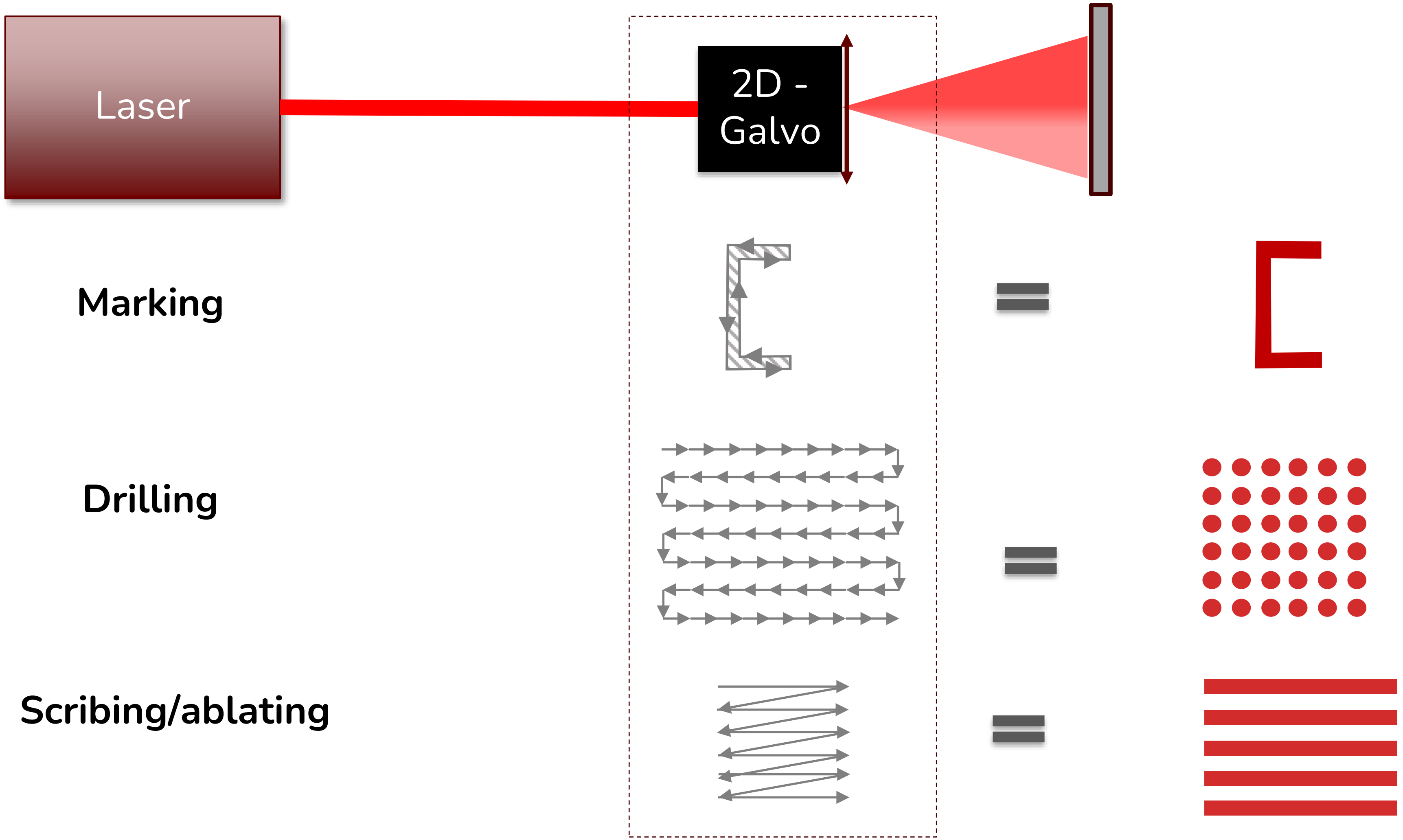
CONFIDENTIAL

Standard laser processing

Typical operation modes:

1. Marking
2. Drilling
3. Scribing/ablating

Beam movement



Marking

Drilling

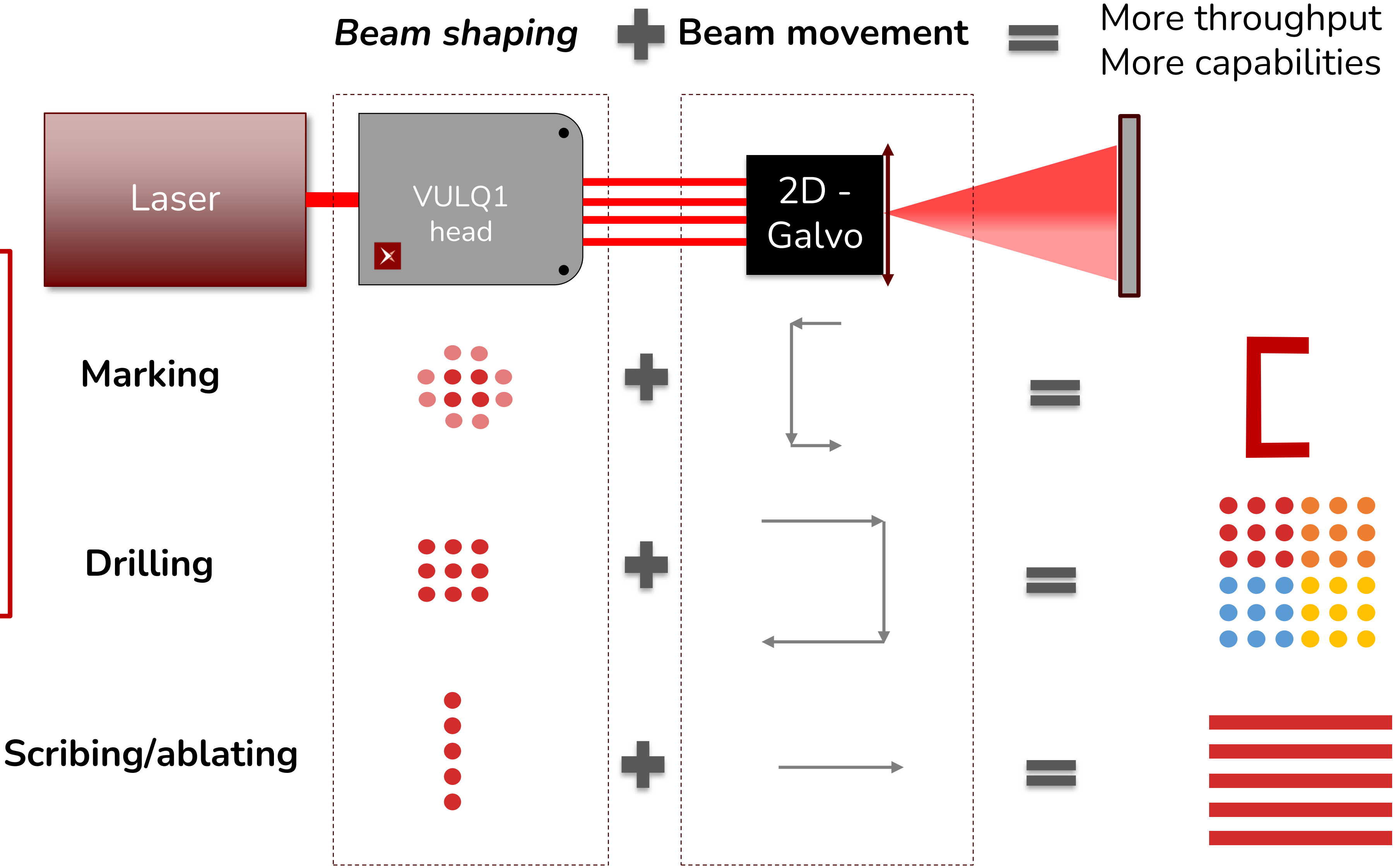
Scribing/ablating

Multibeam laser processing eliminates useless movements

Less beam movement

=

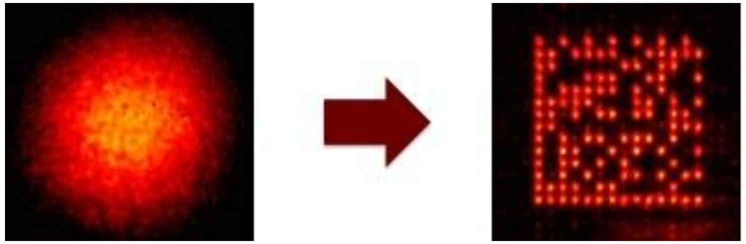
More throughput



VULQ1 unique marking methods = laser stamping

PATENT#1
FULL-STAMP marking method

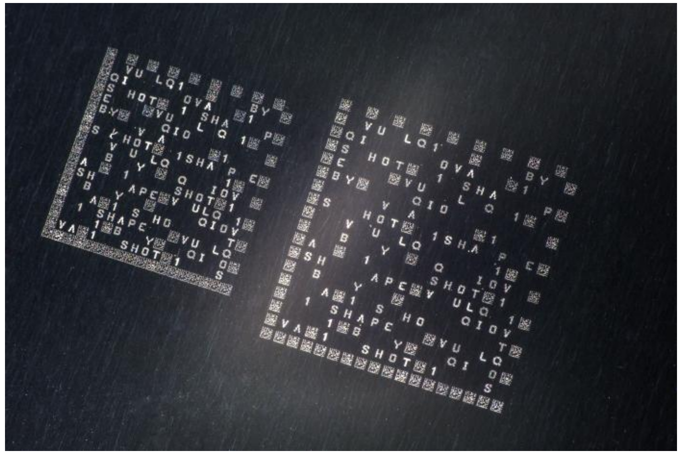
ONE LASER PULSE = ONE MARKING



Link to youtube video

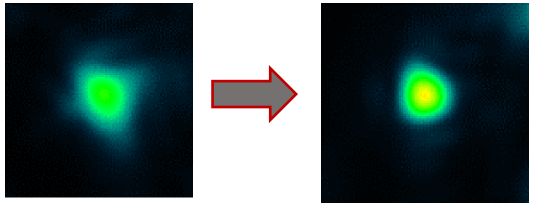
PATENT#2
PIXEL-STAMP marking method

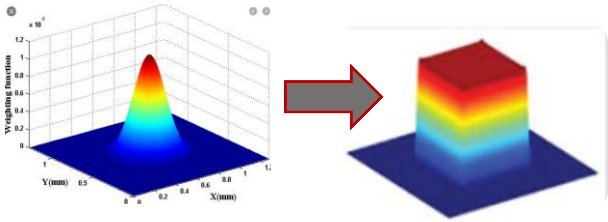
HIGH SPEED LASER STAMPING



Unleash the full potential of laser processing with VULQ1

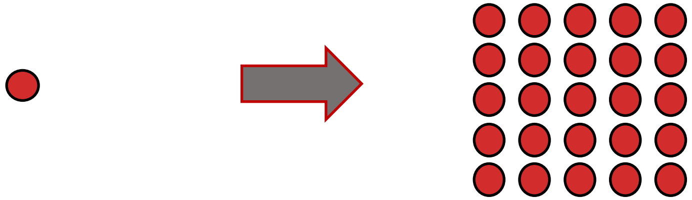
1. Optimal and homogeneous processing quality with active beam profile control

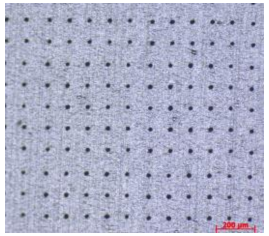




Process optimization
Output standardisation
Remote maintenance

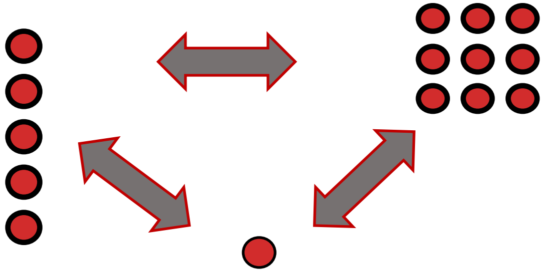
2. Multiply throughput with parallelization

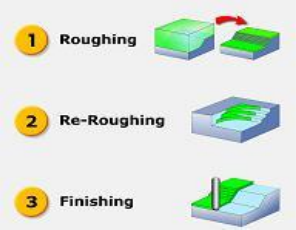




12500 holes/s in SS with 12,5W
20µm diameter holes
92% roundness

3. Switch between ‘*multibeam patterns*’ to optimize efficiency





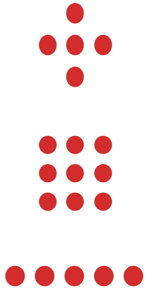
Same processing strategy as on a CNC machine
Switching time < 100ms

Programmable multibeam processing is operated like standard laser processing

Standard
Laser marking sequence

1. Configure scanner software
   a) Load laser settings:
      - Power
      - Repetition rate
   b) Load scanner settings
      - Trajectories
      - Scanning speed
2. Start laser marking job

Multibeam
Laser marking sequence



1. **Configure BeamForge API**
   a) Choose pre-loaded laser beam shape
   b) Define custom laser beam shape
2. Configure scanner software
   a) Load laser settings:
      - Power
      - Repetition rate
   b) Load scanner settings
      - Trajectories
      - Scanning speed
3. Start multibeam laser marking job

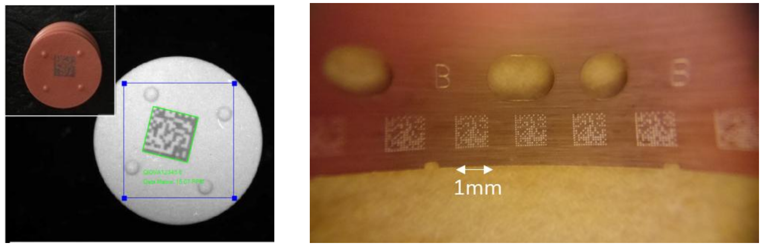
- Same method to define laser marking jobs, also similar HMI
- Gaussian laser physics is the same in multibeam processing: no change defining focusing lens, spot sizes, etc..

VULQ1 offer

VULQ1™ Product Offer:
From optical module to stand-alone laser marking system

VULQ1-S Systems FLASH series

- Model NS NIR
- Model NS VIS



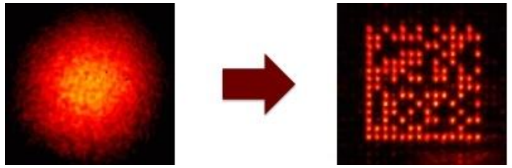
VULQ1-S Systems BEAMS series

- Model NS NIR
- Model NS VIS
- Model FS NIR

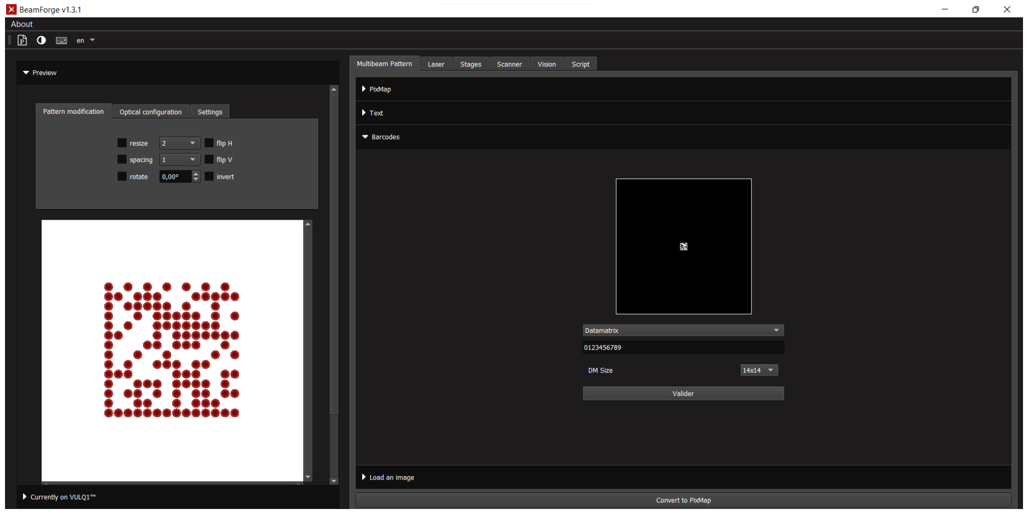
©: Pochet Ducourval

VULQ1-M Modules

- BBD-P010
- NIR-P050
- VIS-P050
- NIR-P100



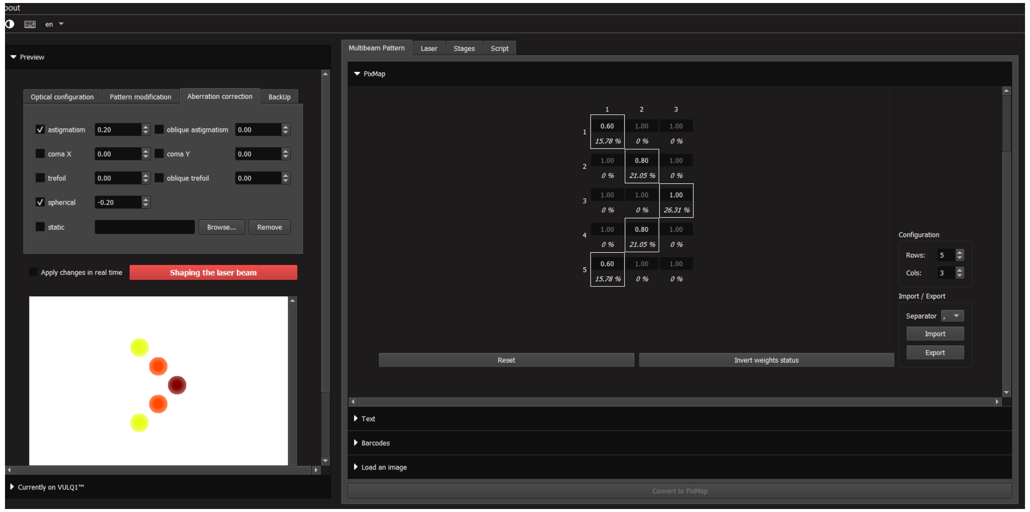
All powered by our proprietary software suite BeamForge



☐ resize 2
☐ spacing 1
☐ rotate 0,00°

Datamatrix
0123456789
DM Size 14x14

Generate 2D codes automatically from data

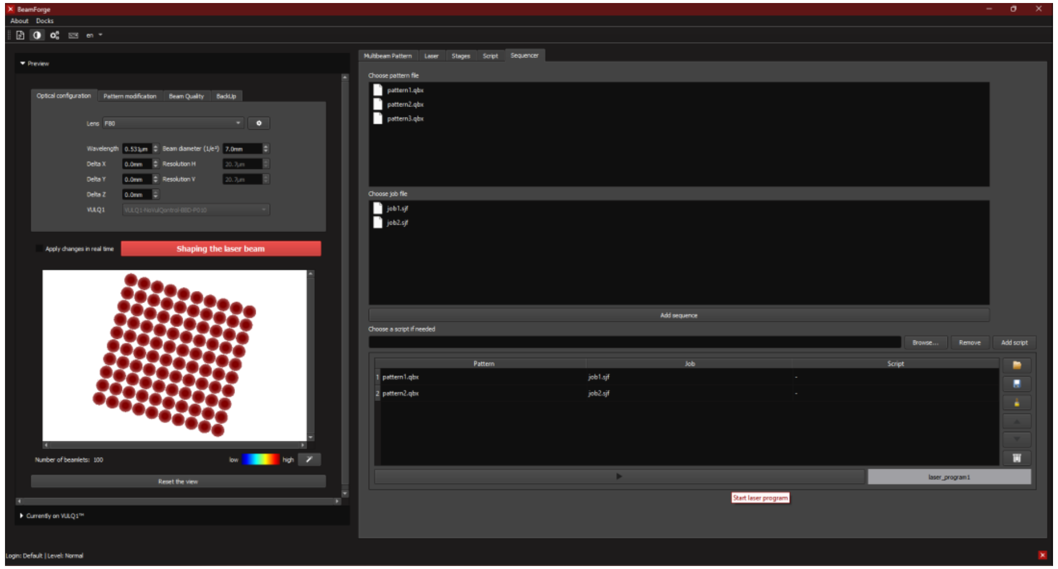


☑ astigmatism 0.20
☐ oblique astigmatism 0.00
☐ coma X 0.00
☐ coma Y 0.00
☐ trefoil 0.00
☐ oblique trefoil 0.00
☑ spherical -0.20
☐ static
☐ Apply changes in real time

	1	2	3
1	0.60 15.78 %	1.00 0 %	1.00 0 %
2	1.00 0 %	0.80 21.05 %	1.00 0 %
3	1.00 0 %	1.00 0 %	1.00 26.31 %
4	1.00 0 %	0.80 21.05 %	1.00 0 %
5	0.60 15.78 %	1.00 0 %	1.00 0 %

Rows: 5
Cols: 3
Separator ,

Create your own multibeam shapes interactively, save and reload on demand.



Lens F80
Wavelength 0.531µm
Beam diameter (1/e²) 7.0mm
Delta X 0.0mm
Resolution H 20.7µm
Delta Y 0.0mm
Resolution V 20.7µm
Delta Z 0.0mm
VULQ1 VULQ1-NoVulControl-BBD-P010
☐ Apply changes in real time
Number of beamlets: 100

Choose pattern file
pattern1.qbx
pattern2.qbx
pattern3.qbx

Choose job file
job1.sjf
job2.sjf

Choose a script if needed

	Pattern	Job	Script
1	pattern1.qbx	job1.sjf	-
2	pattern2.qbx	job2.sjf	-

laser_program1

Login: Default | Level: Normal

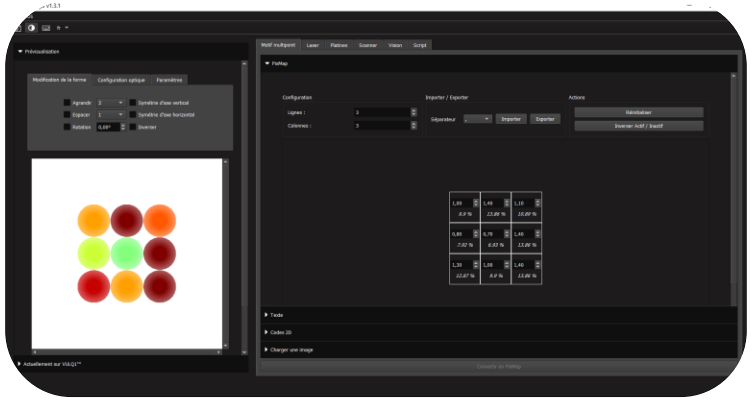
Drag-and-drop beam shapes, scanning jobs and scripts **to create custom marking sequences**

VULQ1-M
Optical modules

VULQ1-M multibeam laser module - Components

1. **VULQhead = VULQ1-M optical head**
    - Wavelength range: NIR or Visible
    - Up to 30mJ energy
    - Up to 100W power
    - Down to fs pulse duration range

2. **VULQontrol = VULQ1-M controller**
    - 2U rack 19'' format
    - 5m cable length between head and controller



Agrandir 2
Espacer 1
Rotation 0,00°
Symétrie d'axe vertical
Symétrie d'axe horizontal
Inverser

Lignes : 3
Colonnes : 3
Séparateur ,

1,00 9.9 %	1,40 13.86 %	1,10 10.89 %
0,80 7.92 %	0,70 6.93 %	1,40 13.86 %
1,30 12.87 %	1,00 9.9 %	1,40 13.86 %

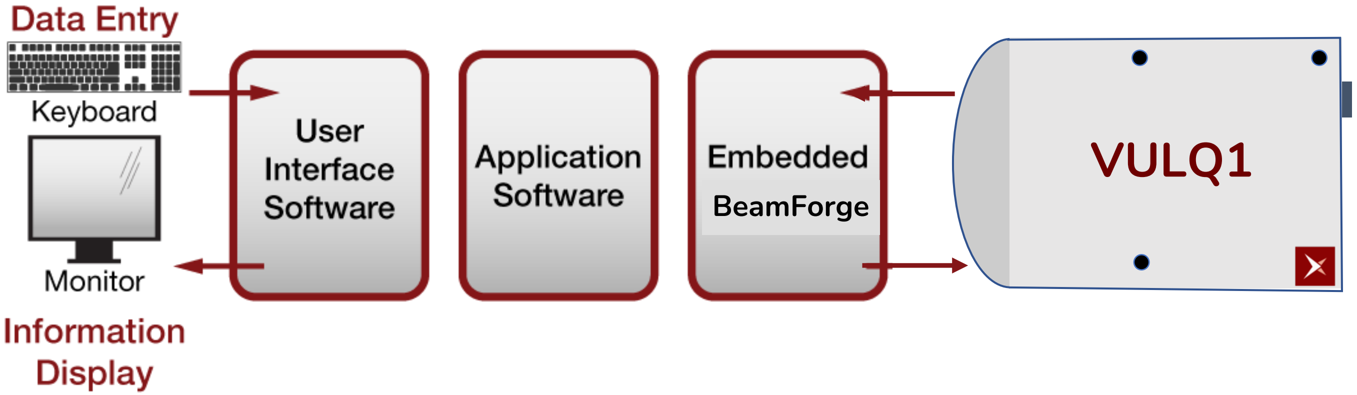
3. **BeamForge software**
    - Main software with interactive graphic tools
    - Embeddable API version for integration

VULQ1-M Module standard offering

VULQ1-M product line	Scientific applications	Industrial applications		
		Marking		Micromachining
Model	**NS-BBD-P010**	**NS-VIS-P050**	**NS-NIR-P050**	**FS-NIR-P100**
Wavelength range	500-1100nm	500-550nm	1000-1100nm	1000-1100nm
Maximum power	10W	50W	50W	100W
Pulse duration	>1ns	>1ns	>1ns	>250fs
Maximum energy	10mJ	30mJ	30mJ	0,6mJ
Beam diameter input	5-7.5mm	5-7.5mm	5-7.5mm	6-10mm
Optical transmission	70%	90%	90%	90%
Switching time	60ms	65ms	115ms	100ms
Serialization rate	-	20Hz	10Hz	-
Minimum beamlet diameter (f80)	10µm	10µm	20µm	15µm
Minimum distance between beamlets (f80)	20µm	20µm	40µm	30µm
Maximum multibeam pattern dimension (f160)	5,6mm	2,8mm	5,6mm	5,6mm

Increasing maximum power to 200W in 2025!

BeamForge API delivers functions within *your* software environment


Data Entry
Keyboard
Monitor
Information Display
User Interface Software
Application Software
Embedded BeamForge
VULQ1

1. BeamForge software controls the **generation and display of Laser Light Tool**

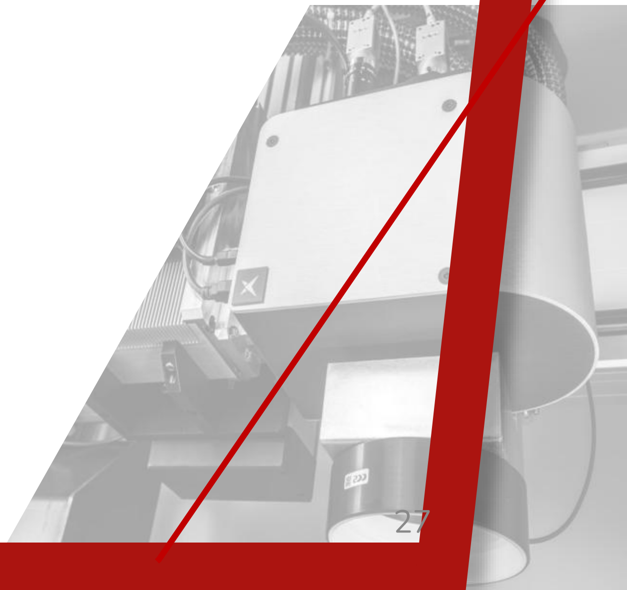
2. BeamForge control software is **delivered as an API**
   - Seamless integration in HMI and customer experience
   - Minimal custom software development for integration

Laser marking program

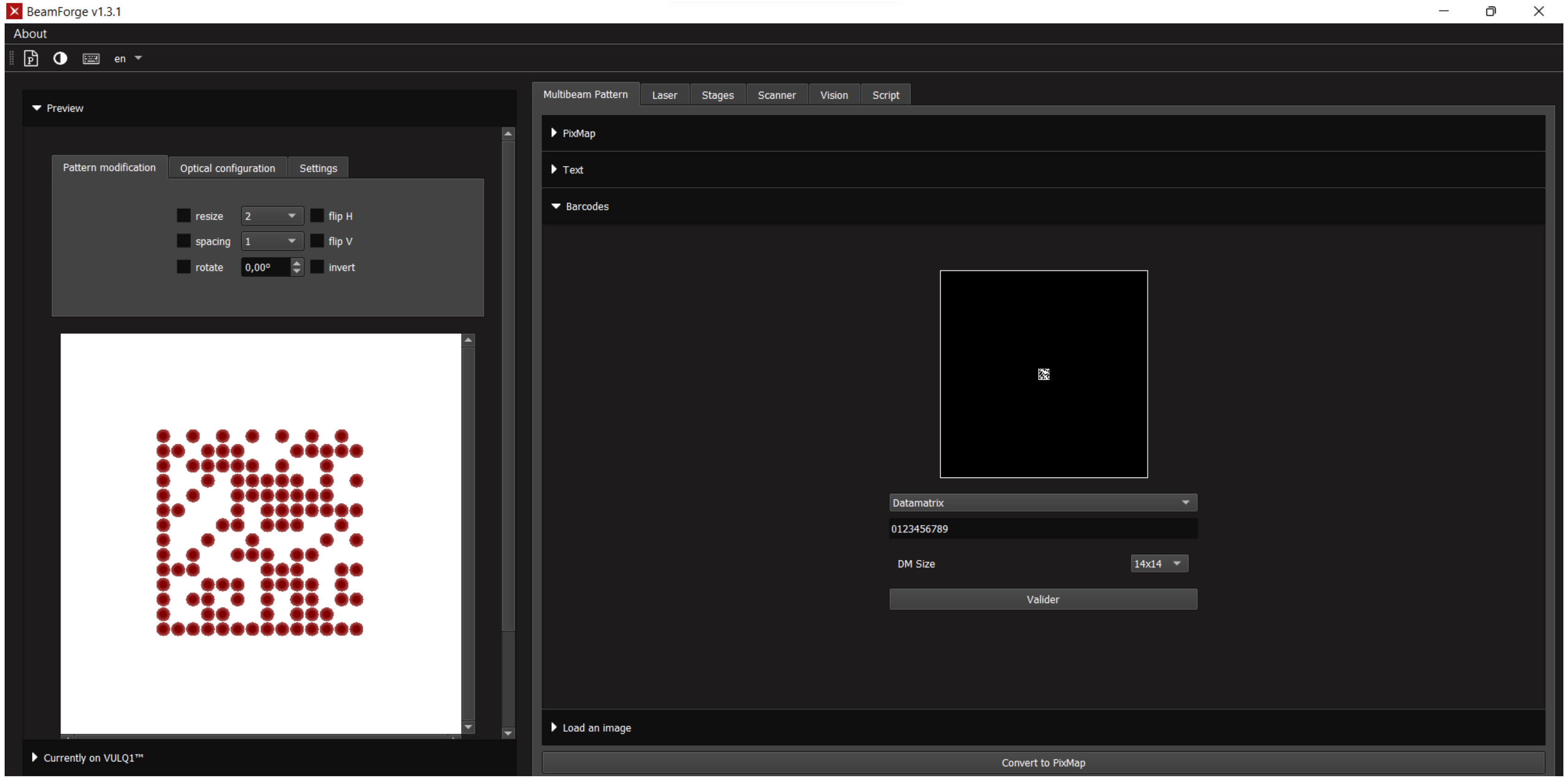
Multibeam marking sequence #1 | **Sequence #2** | **...**

Multibeam pattern #1 | **Scanning job #1** | **...**

BeamForge
Software

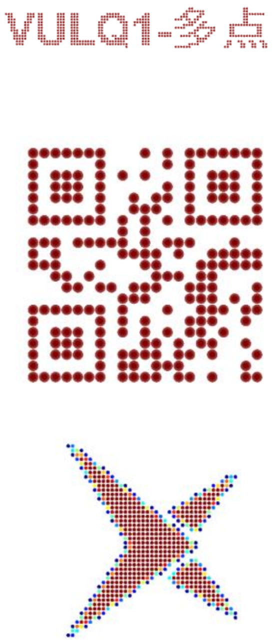


Built-in automated *multibeam patterns* generators



☐ resize 2
☐ spacing 1
☐ rotate 0,00°

Datamatrix
0123456789
DM Size 14x14

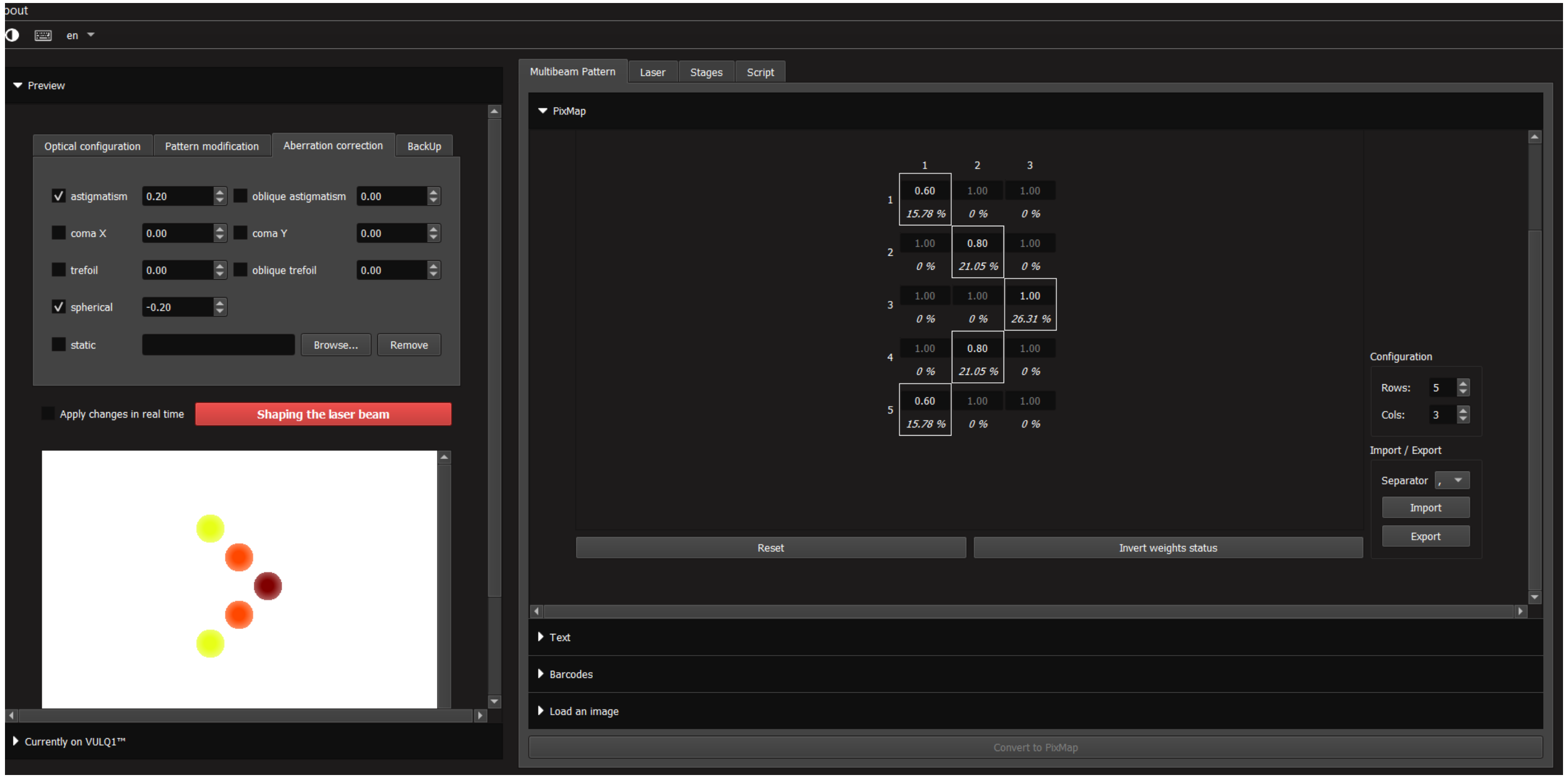


BeamForge automatically creates the Laser Light Tool from input data, in the targeted format

Input: alphanumerics or picture

Output format: Datamatrix, QR code, Dotcode, formated text or picture

BeamForge software / MULTIBEAM marking method



☑ astigmatism 0.20

☐ oblique astigmatism 0.00

☐ coma X 0.00

☐ coma Y 0.00

☐ trefoil 0.00

☐ oblique trefoil 0.00

☑ spherical -0.20

☐ static

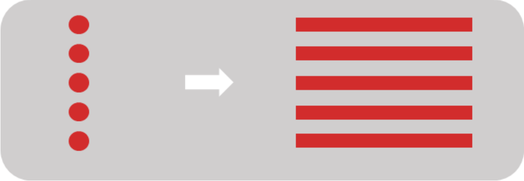
☐ Apply changes in real time

	1	2	3
1	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*
2	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
3	1.00 *0 %*	1.00 *0 %*	1.00 *26.31 %*
4	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
5	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*

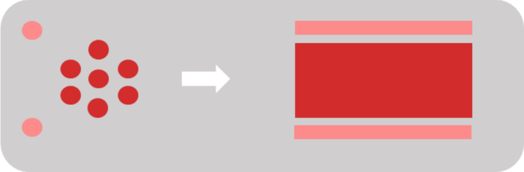
Rows: 5

Cols: 3

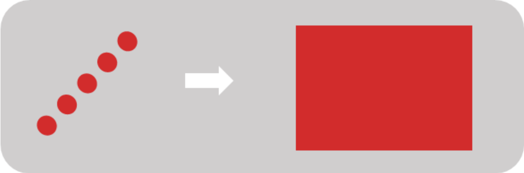
Separator ,



Parallel Processing



1 pass, several process steps

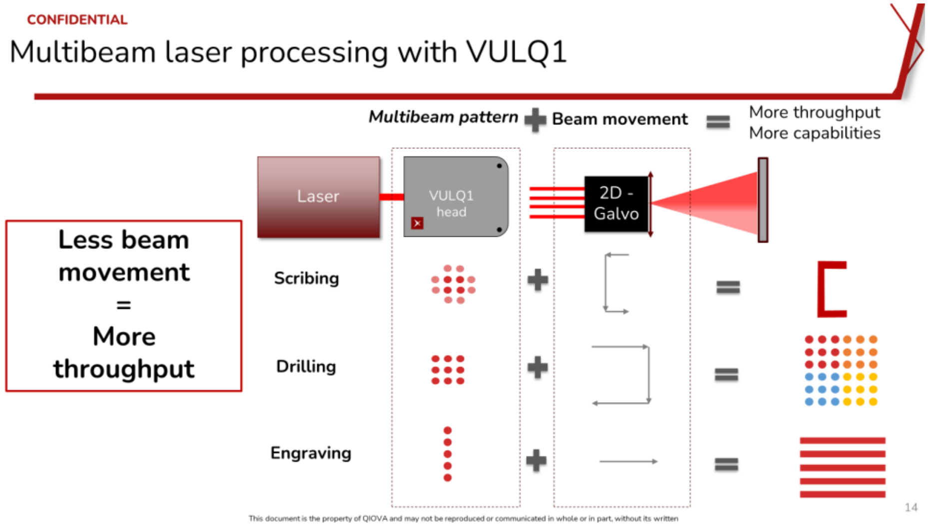


Linebeam-like processing

User can directly draw its Laser Light Tool from BeamForge PIXMAP interactive design tool

Here, a Datamatrix module with a pre-compensated 11° orientation to operate with a scanner.

A 3-steps process to create custom *Multibeam patterns*



CONFIDENTIAL

Multibeam laser processing with VULQ1

Multibeam pattern **+ Beam movement =** More throughput
More capabilities

Less beam movement = More throughput

Scribing

Drilling

Engraving

This document is the property of QIOVA and may not be reproduced or communicated in whole or in part, without its written

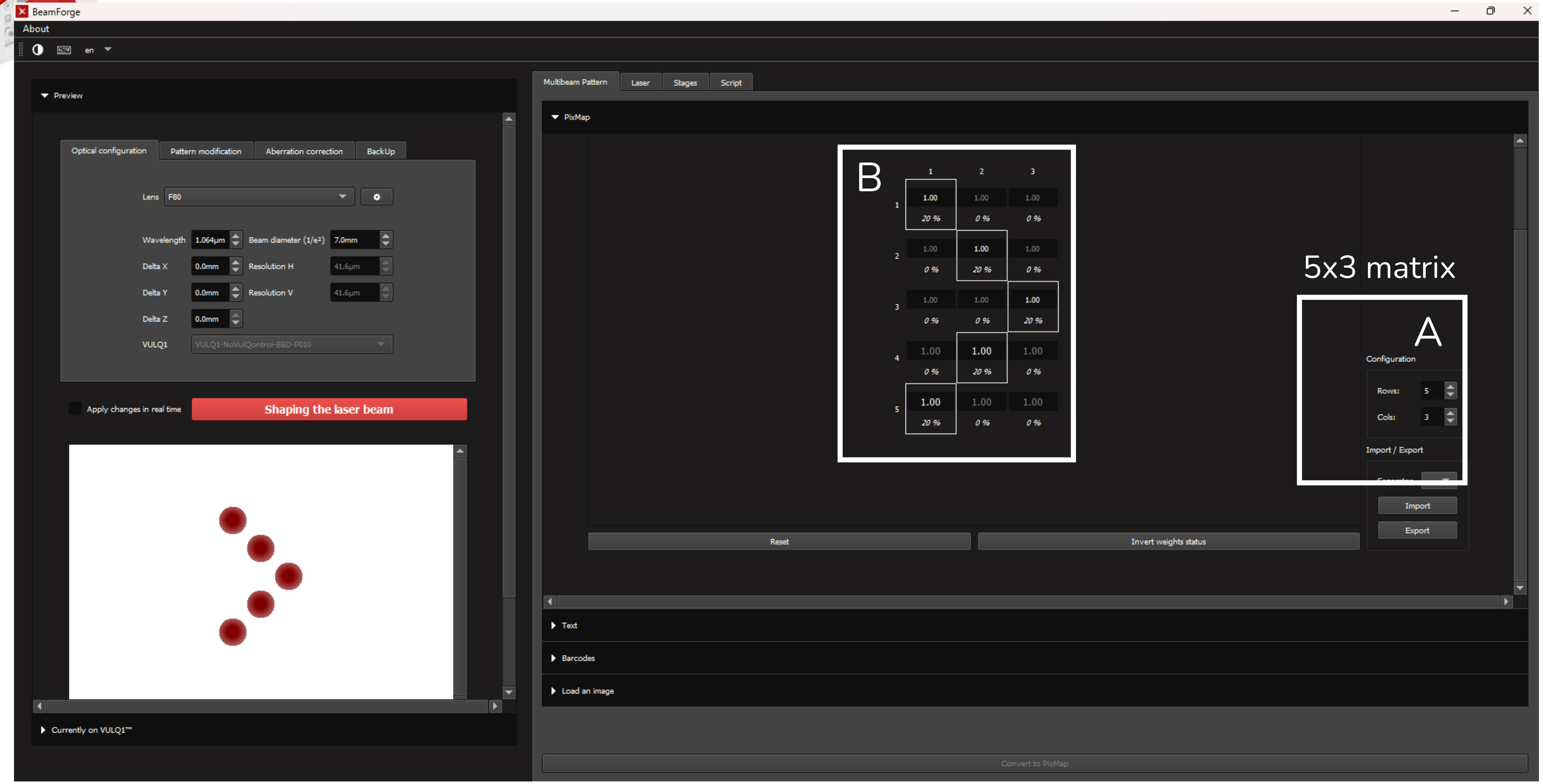
14

***Multibeam patterns* allow to use a maximum of available laser power in every context, therefore ensuring optimal throughput and efficiency.**

Step	Action	BeamForge function	
1	Define	PixMap	Sketch the beam pattern in a few clicks
2	Set	Pattern modification	Modify beam pattern globally: rotate, expand, ..
3	Configure	PixMap, DeltaZ, Beam Quality Control	Fine tune beam pattern energy distribution, dimensions, quality to finalize 'laser brush'

CONFIDENTIAL

Step 1 - Define with PixMap



Lens: F80

Wavelength: 1.064µm
Beam diameter (1/e²): 7.0mm
Delta X: 0.0mm
Resolution H: 41.6µm
Delta Y: 0.0mm
Resolution V: 41.6µm
Delta Z: 0.0mm
VULQ1: VULQ1-NoVulQontrol-BBD-P010

☐ Apply changes in real time

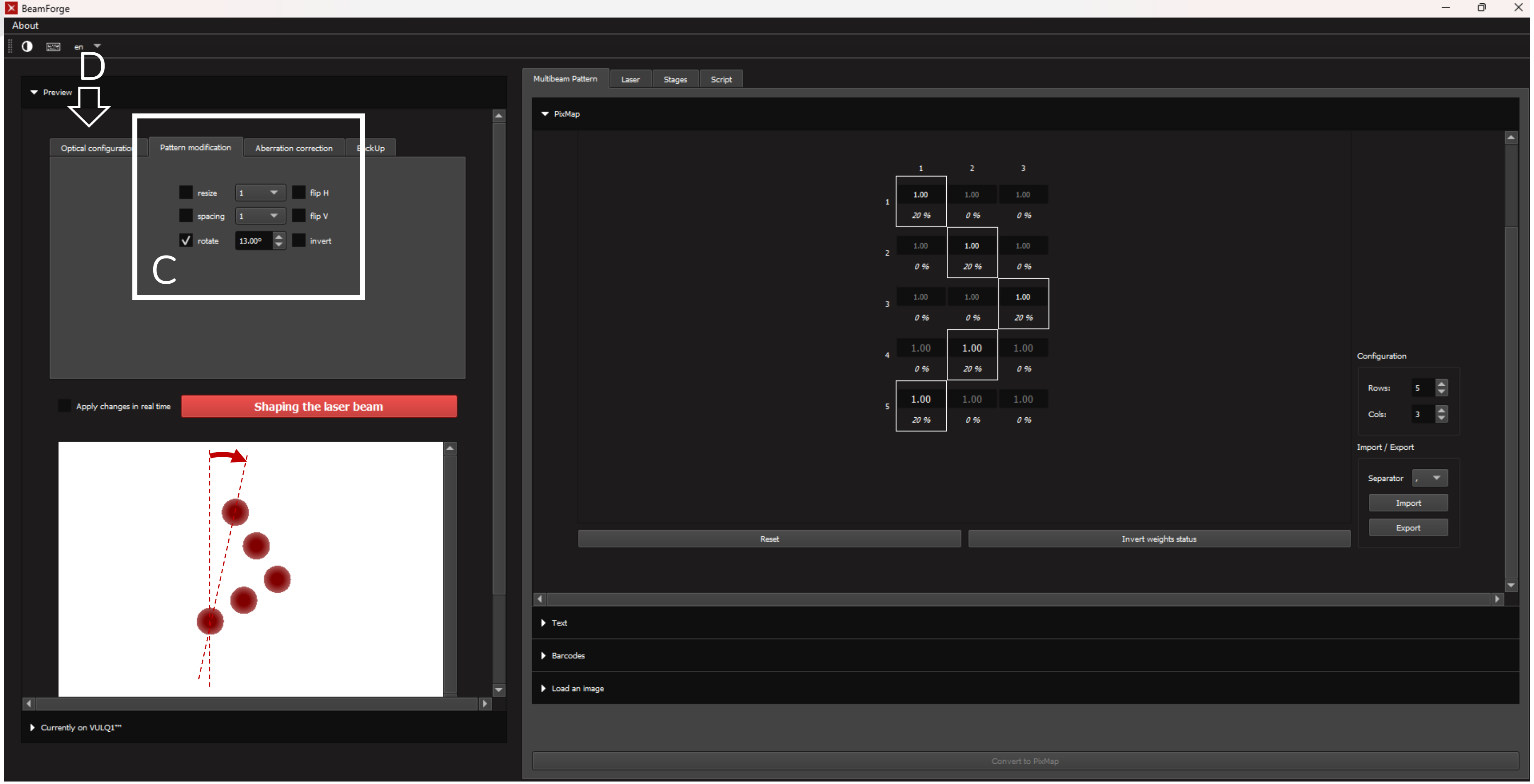
Rows: 5
Cols: 3

	1	2	3
1	1.00 20 %	1.00 0 %	1.00 0 %
2	1.00 0 %	1.00 20 %	1.00 0 %
3	1.00 0 %	1.00 0 %	1.00 20 %
4	1.00 0 %	1.00 20 %	1.00 0 %
5	1.00 20 %	1.00 0 %	1.00 0 %

BeamForge PixMap
Interactive design tool

- Define the virtual 2D matrix supporting the pattern (A)
- Click on the cells you want to activate (B)

Step 2 – Set to the optical setup



☐ resize: 1
☐ spacing: 1
☑ rotate: 13.00°
☐ flip H
☐ flip V
☐ invert

☐ Apply changes in real time

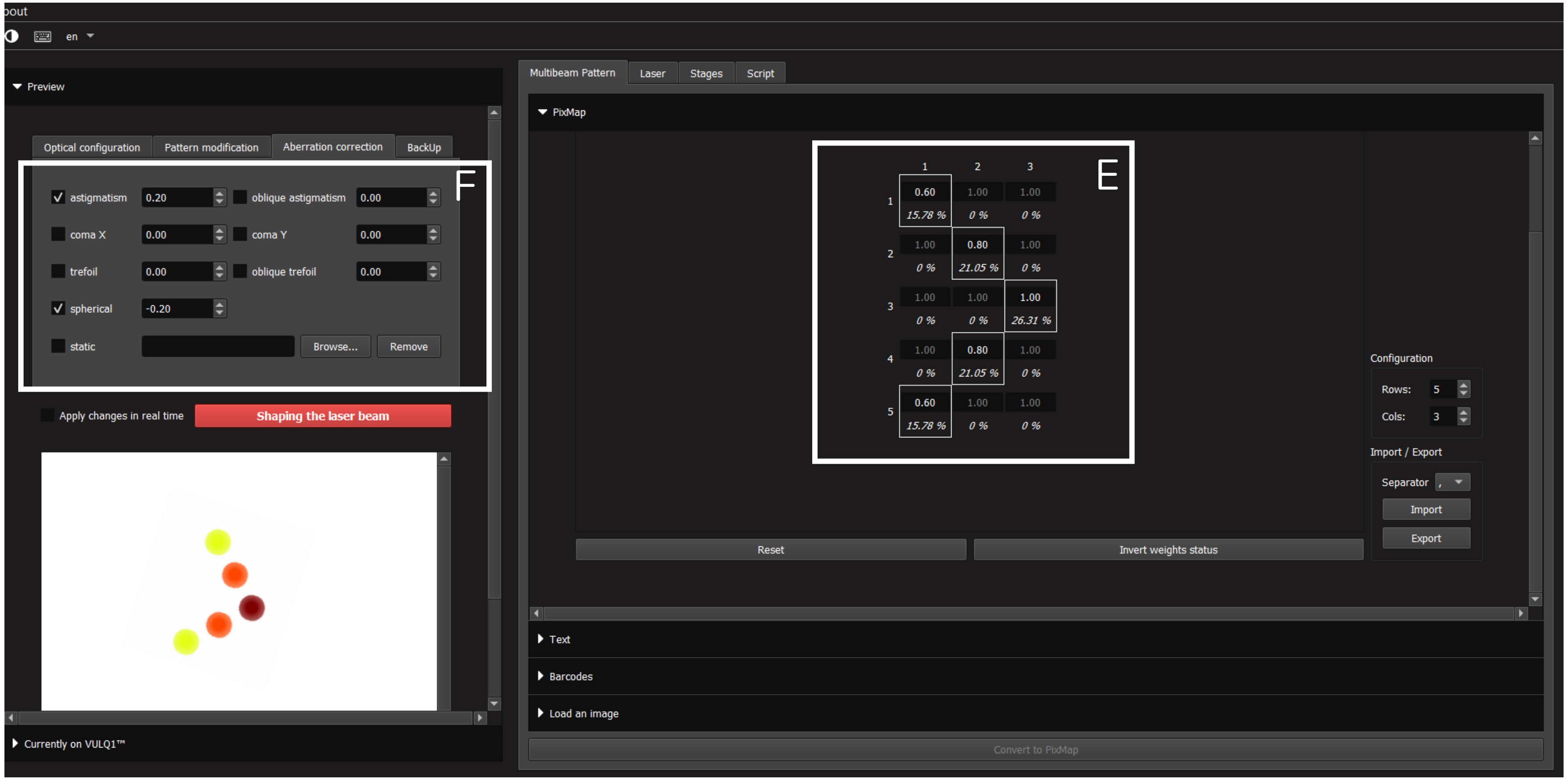
Shaping the laser beam

Rows: 5
Cols: 3
Separator: ,

	1	2	3
1	1.00 20 %	1.00 0 %	1.00 0 %
2	1.00 0 %	1.00 20 %	1.00 0 %
3	1.00 0 %	1.00 0 %	1.00 20 %
4	1.00 0 %	1.00 20 %	1.00 0 %
5	1.00 20 %	1.00 0 %	1.00 0 %

- Globally modify pattern with Pattern modification functions (C)
  - Here: 13° pattern rotation to pre-compensate rotation in scanning head
- Eliminate central spot with “DeltaZ” function (D)

Step 3 – Configure to application



☑ astigmatism 0.20
☐ oblique astigmatism 0.00
☐ coma X 0.00
☐ coma Y 0.00
☐ trefoil 0.00
☐ oblique trefoil 0.00
☑ spherical -0.20
☐ static

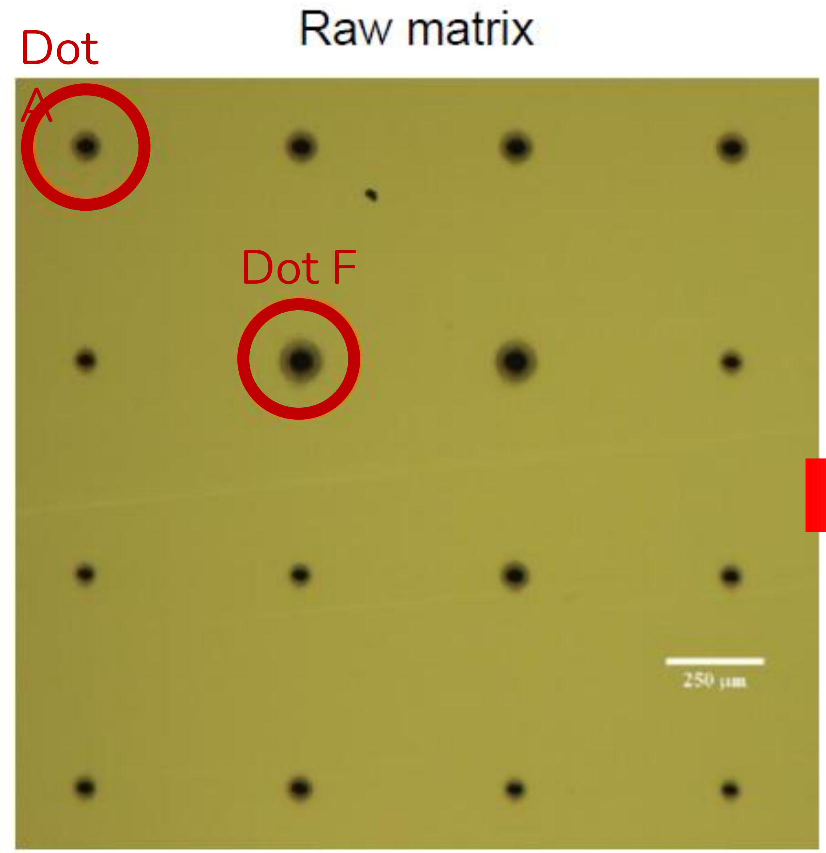
☐ Apply changes in real time

	1	2	3
1	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*
2	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
3	1.00 *0 %*	1.00 *0 %*	1.00 *26.31 %*
4	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
5	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*

Rows: 5
Cols: 3
Separator ,

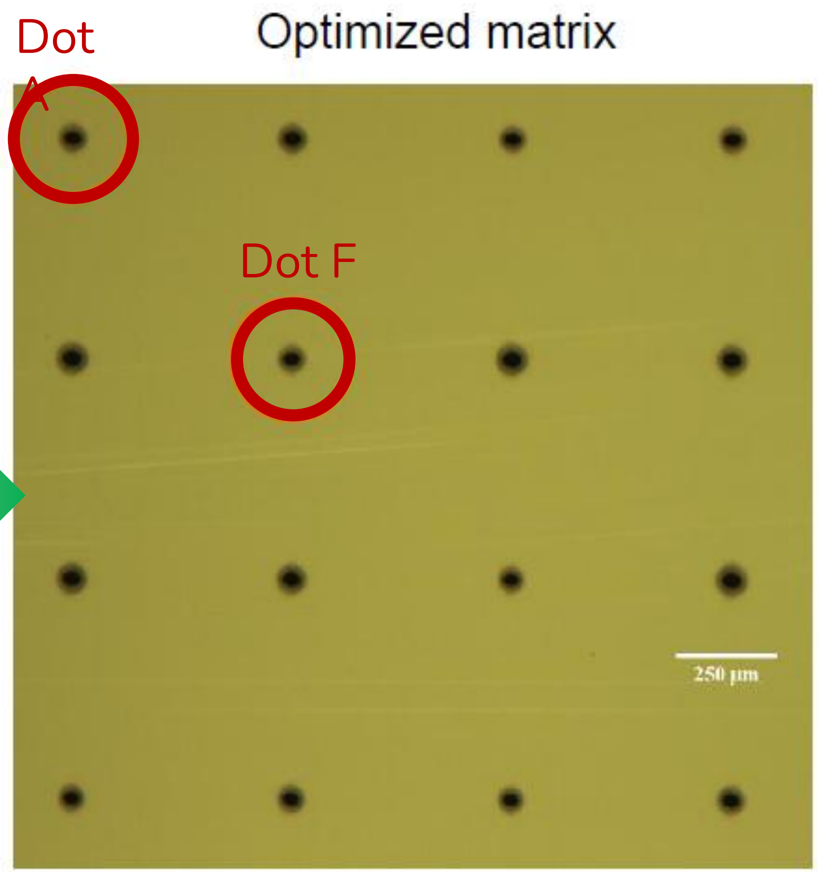
- Tune beamlets energy with PixMap individual energy control (E)
- Optimize beam profile with “Beam Quality Control” menu (F)

Energy fine tuning is critical for micromachining



	Diameter (µm)	Depth (µm)
Dot A raw	40,000	0,982
Dot F raw	50,120	2,107
Difference D (%)	**25%**	**115%**

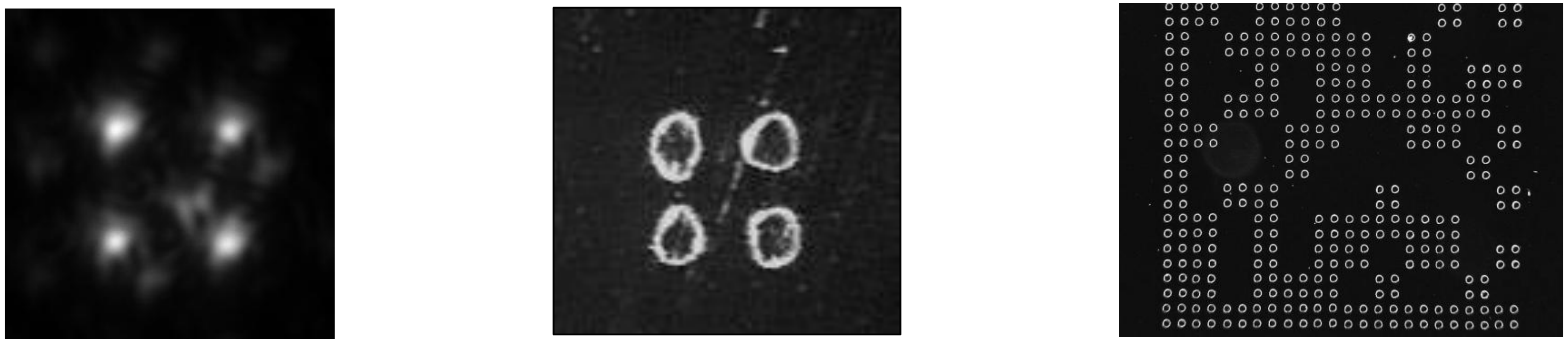
Optimization with VULQ1



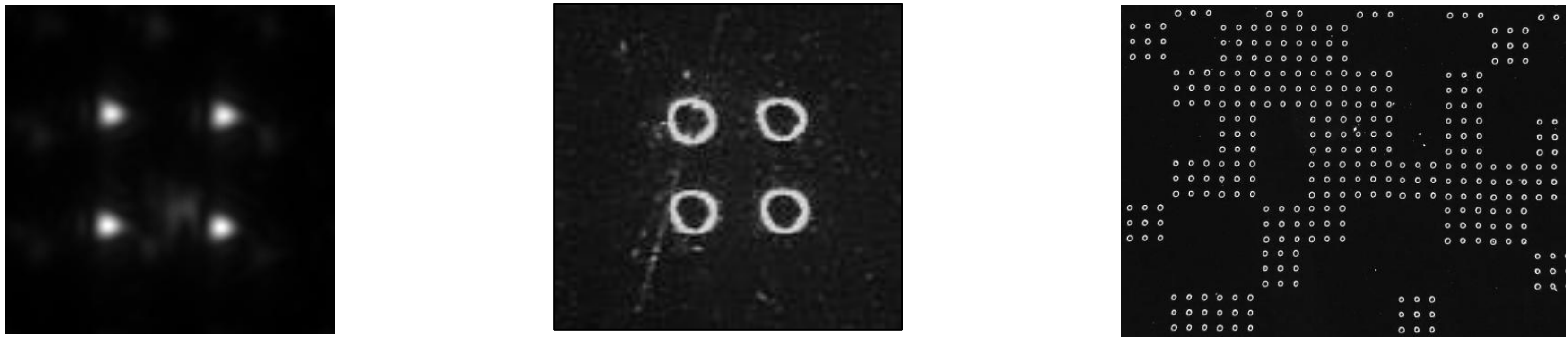
	Diameter (µm)	Depth (µm)
Dot A optimized	37,590	0,932
Dot F optimized	36,627	0,951
Difference D (%)	**3%**	**2%**

Beam Quality Control, a lever to improve global performance

WITHOUT
VULQ1



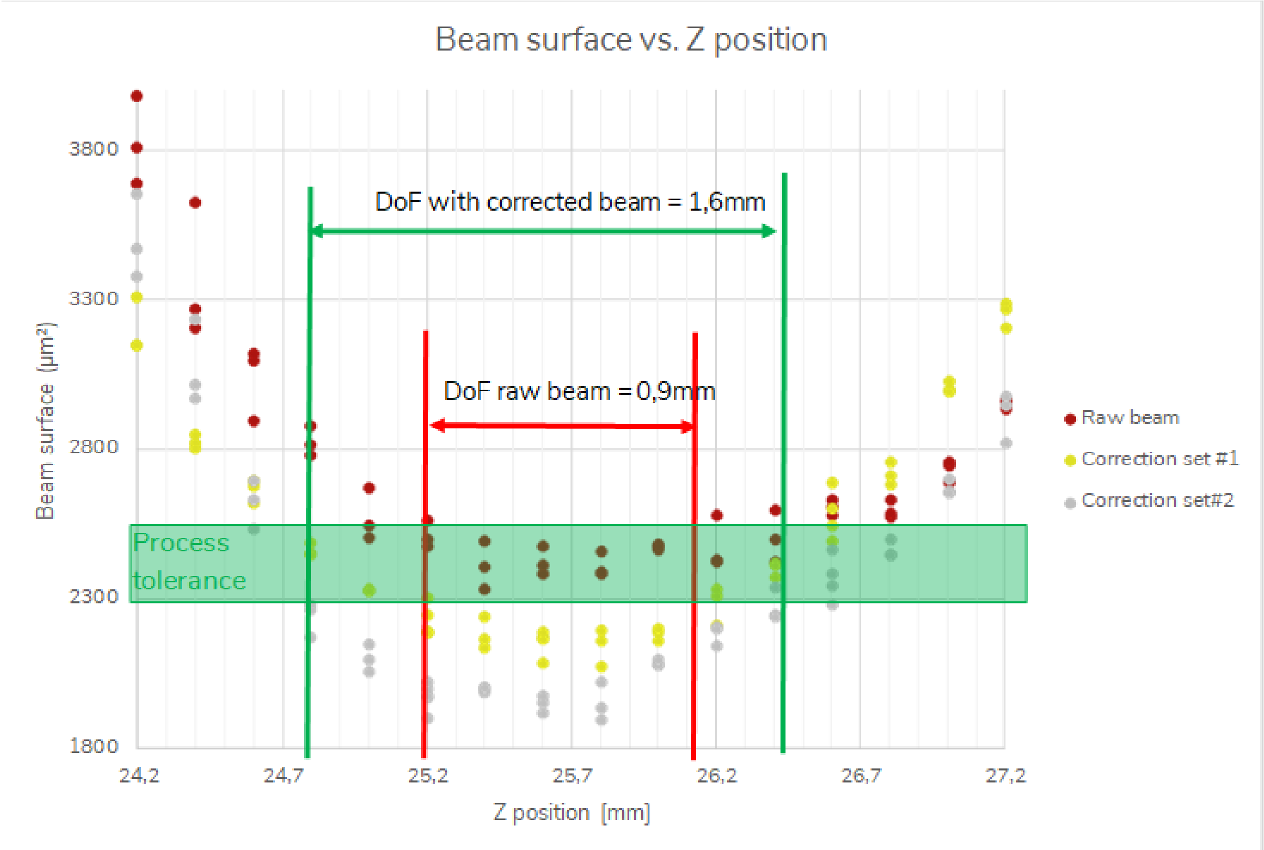
WITH VULQ1
BEAM
QUALITY
CONTROL



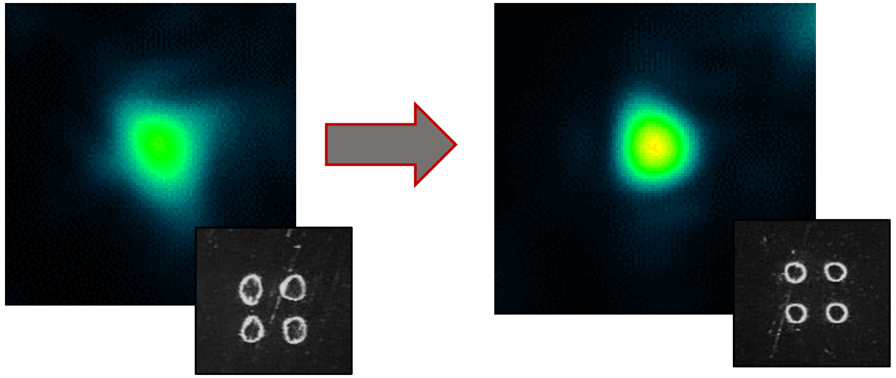
- **Improved process robustness:** larger depth of focus
- **Improved processing quality**: rounder beam, tighter focusing,
- **Standardisation of output performance** for large installations
- **Reduced downtime** with dynamic management of laser beam quality along lifetime

Beam Quality Control benefits process robustness

- For laser processing: depth of focus (DoF), typicall ~mm
- Brings strong mechanical positioning constrains for industries

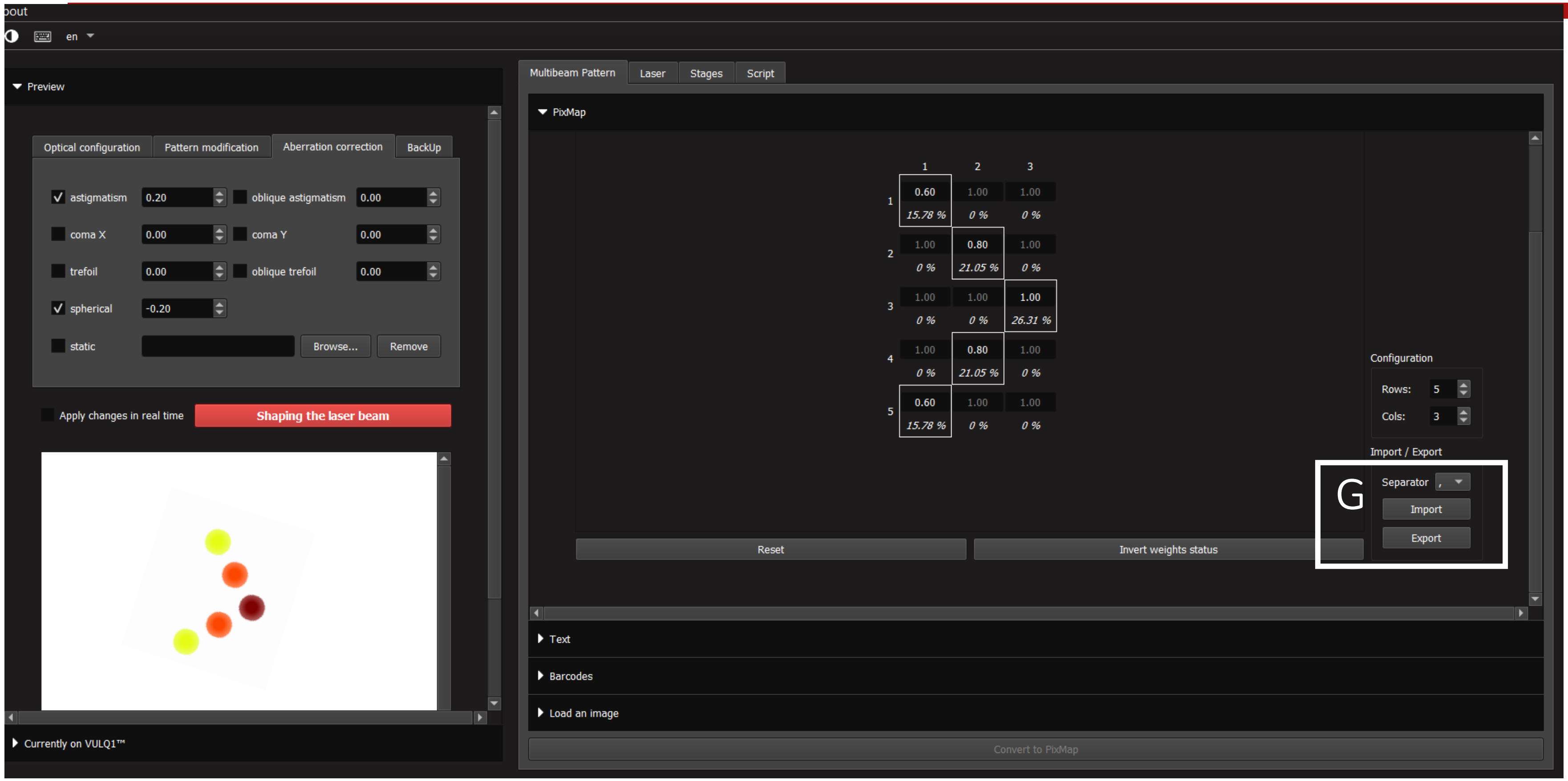


Currently available in VULQ1



Improving laser beam quality increases process DoF by 75%

Save and load your multibeam patterns on demand



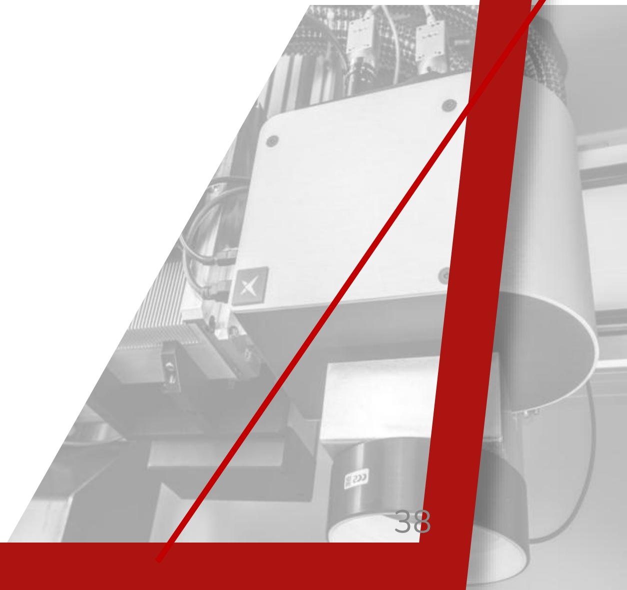
☑ astigmatism 0.20
☐ oblique astigmatism 0.00
☐ coma X 0.00
☐ coma Y 0.00
☐ trefoil 0.00
☐ oblique trefoil 0.00
☑ spherical -0.20
☐ static
☐ Apply changes in real time

	1	2	3
1	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*
2	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
3	1.00 *0 %*	1.00 *0 %*	1.00 *26.31 %*
4	1.00 *0 %*	0.80 *21.05 %*	1.00 *0 %*
5	0.60 *15.78 %*	1.00 *0 %*	1.00 *0 %*

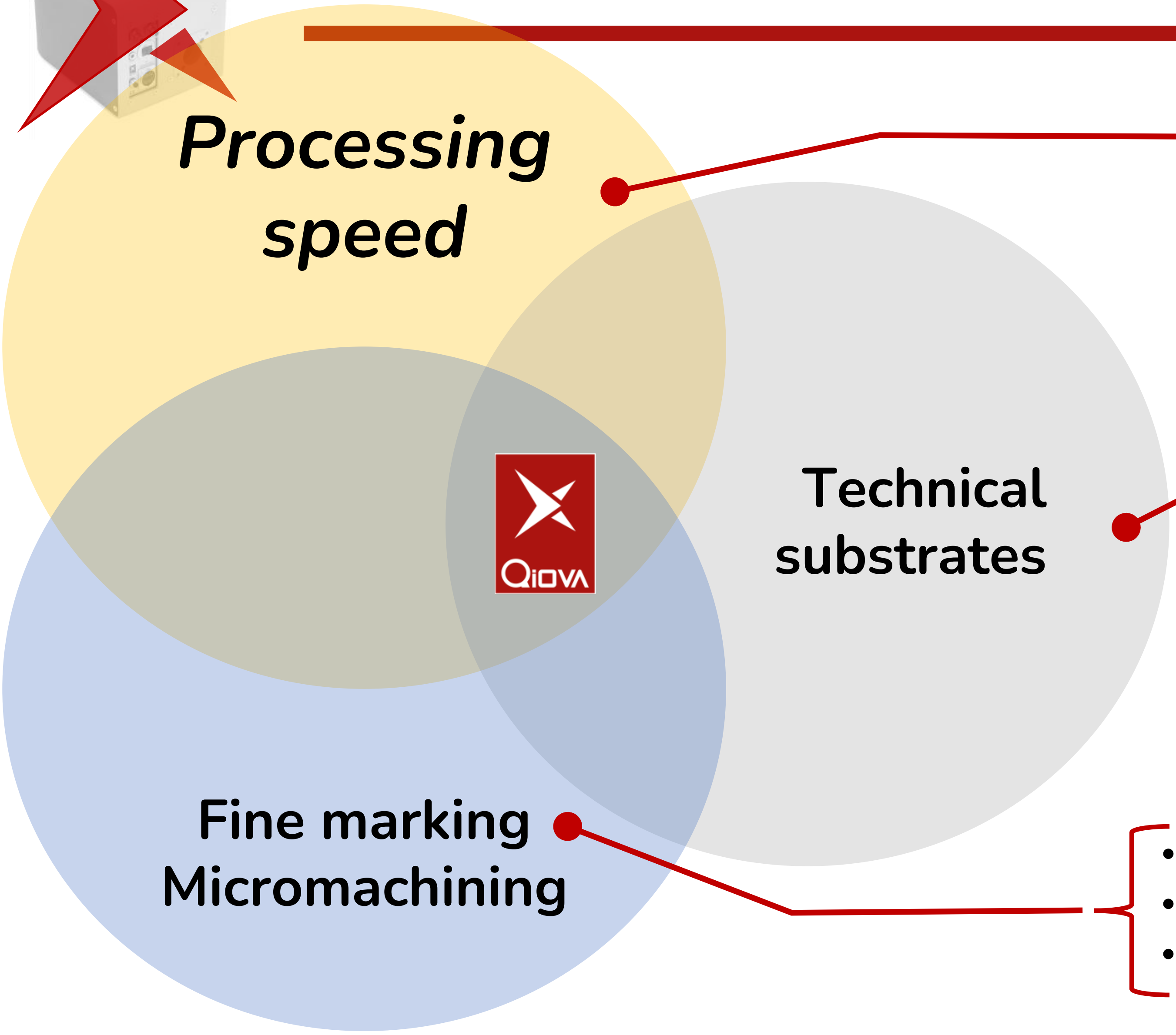
Rows: 5
Cols: 3
Separator ,

- The multibeam patterns are stored in .csv and recalled at wish (G)
- Changing one multibeam pattern to another takes 50-100ms

VULQ1 multibeam applications



Technology differenciation regions



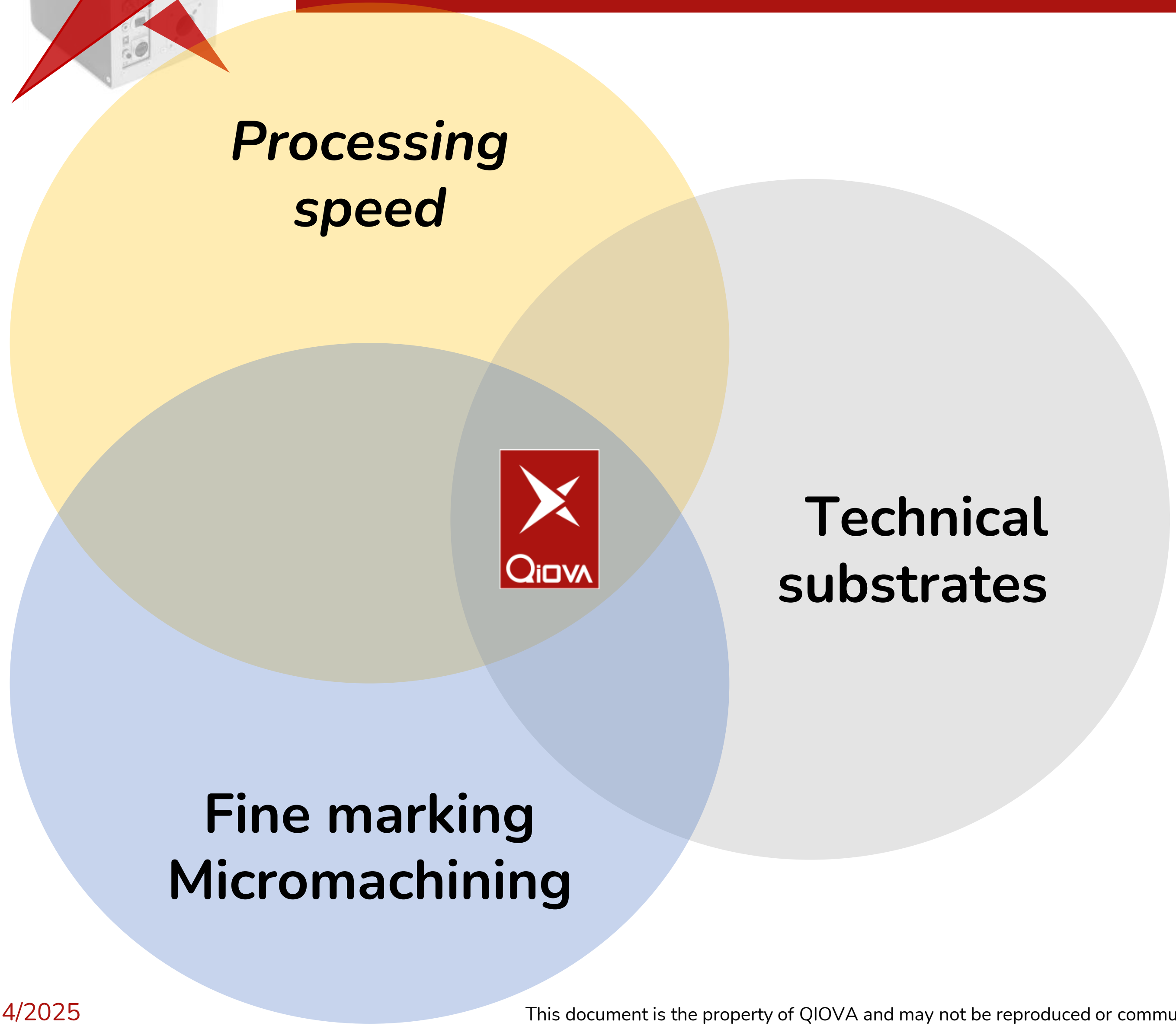
- Line-speed >100m/min
- Roll-to-roll
- Automated lines

- Polymers
- Glass
- Ceramics
- Thin-layers

- High resolution
- High selectivity: shallow marking
- Discrete: covert marking

CONFIDENTIAL

Target sectors

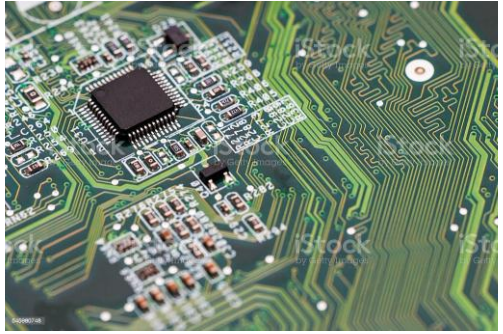


Electrical products

Medical devices

Luxe

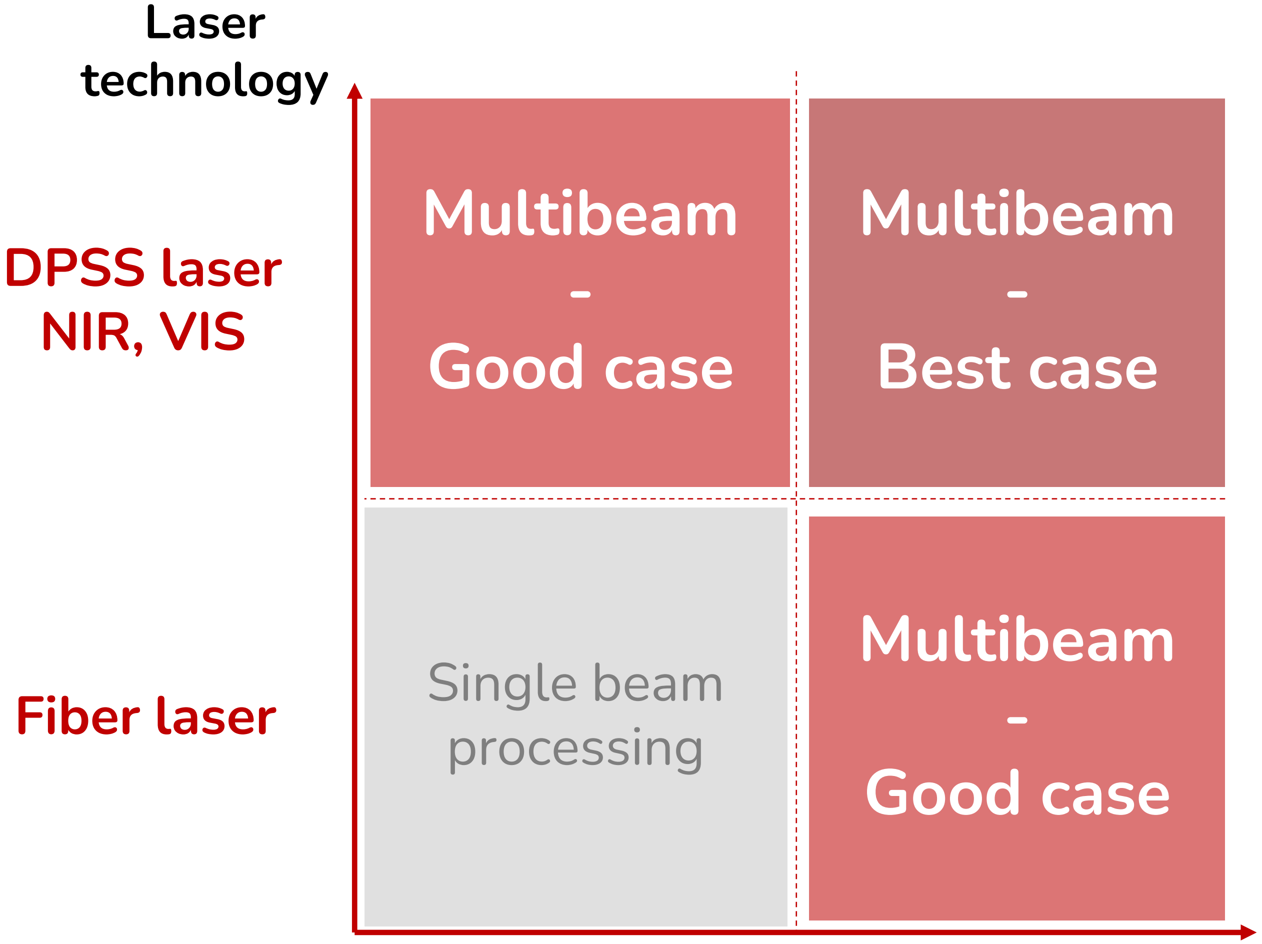
Electronics



FMG packaging

Beverages

Wondering if multibeam processing could help?



Laser technology

DPSS laser NIR, VIS

Fiber laser

Multibeam - Good case

Multibeam - Best case

Single beam processing

Multibeam - Good case

2

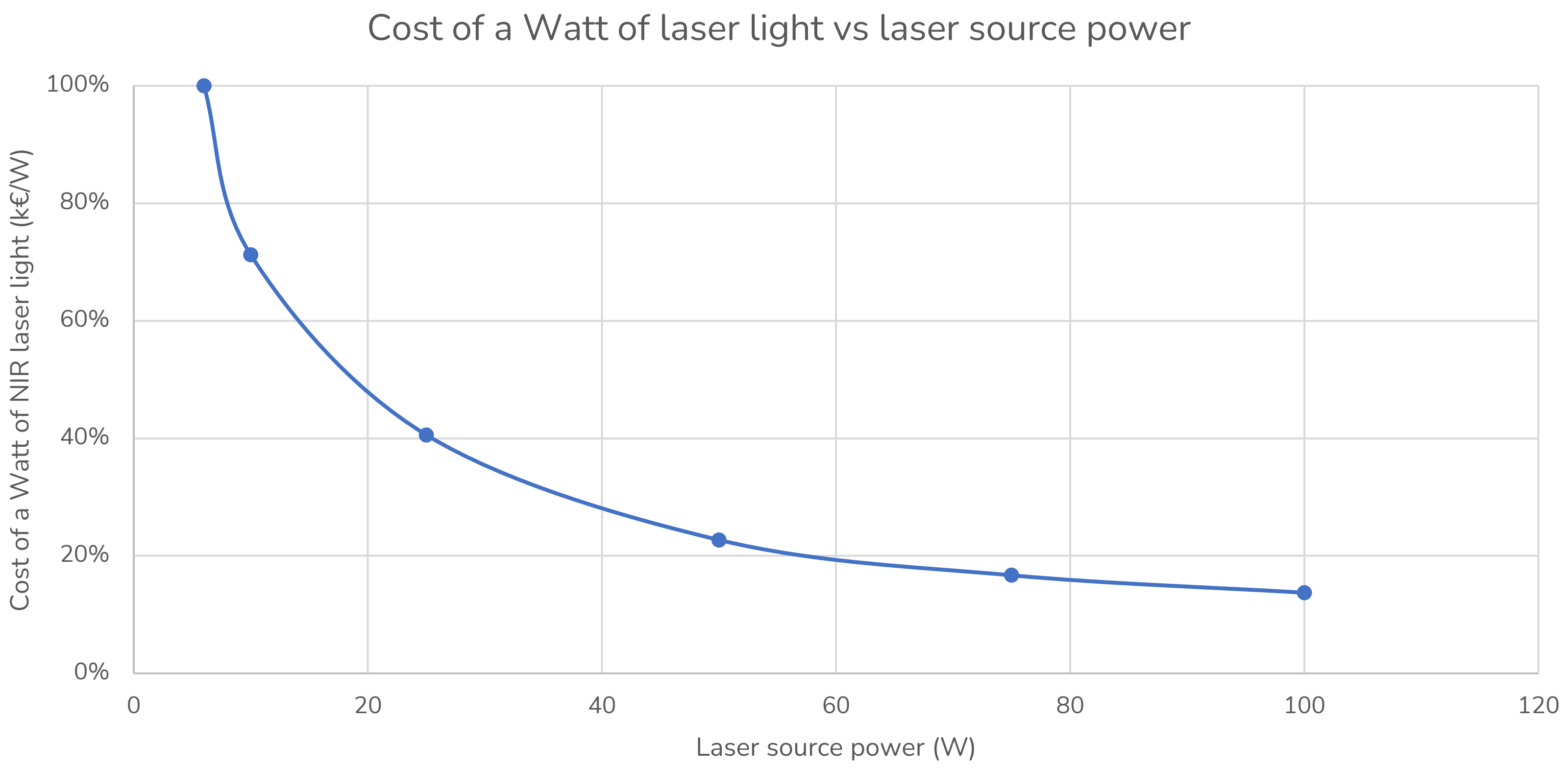
100W

Single beam processing point (W)

Multibeam processing could be very beneficial to your application if:

1. Your laser is a DPSS operating in NIR or VIS
2. Single beam process point is < 50W (the lower, the better)

High power laser source brings reduction cost indeed…



€/W is 5x lower with a 100W laser

…but only if the process uses the full power available

Examples of ACCELERATION with VULQ1-M

Metal surface texturing with femtosecond laser

5 % additional CAPEX investment

=

500% productivity

Multibeam processing is 5x faster

On Youtube:
https://www.youtube.com/watch?v=CuglV8akasY

Decoating of thin metal layer with ns laser

- **Current laser solution**
  - Process point = 20W, limited by quality consideration

Selective ablation quality comparison
single beam vs multibeam

- **Multibeam processing**
  - 60W on the sample, same scanning method

Multibeam processing is 3x faster

Marking of additived PET bottles with ns laser

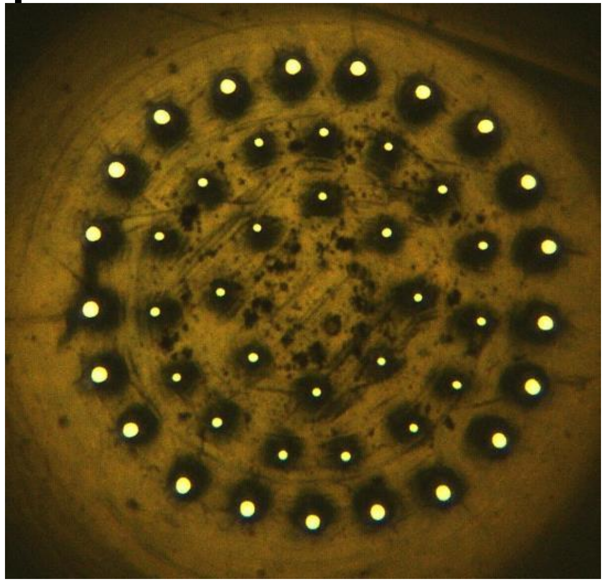
Multibeam processing is:

- **3x faster for alphanumerics**
- **x5 for drawings**

Multibeam processing

Industrial use case

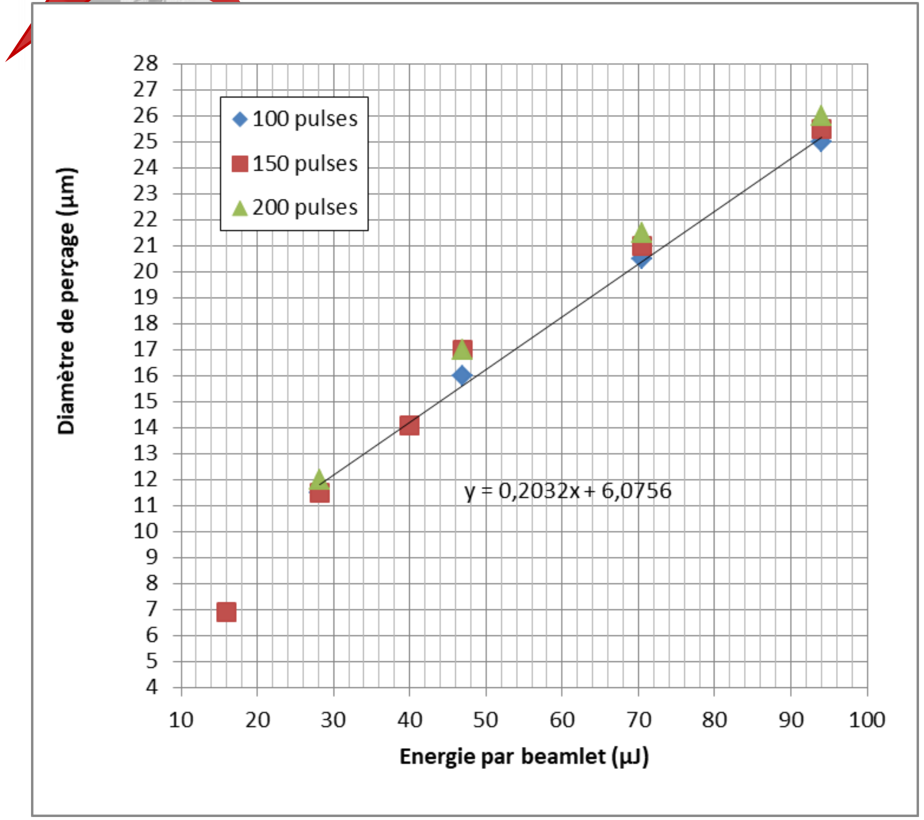
Example of industrial use case: micro-drilling



- Micro-drillling polymer material (thickness ~250µm)
  - Set of 44 micro-holes, with 2 sub-sets diameters:
    - D1 (<10µm)
    - D2 (<20µm)
  - Heat-sensitive material
  - Spatial distribution of holes is critical to function
    - Tolerance in relative position <5µm
- Exit diameter of holes is critical to function, caracterized by quality factor Δ :
  - $\Delta_{\{1,2\}} = \mathrm{Max}(D_{\{1,2\}}) - \min(D_{\{1,2\}}) < 2\mu m$
- Cycle time <1s
  - The lower the better, projected production volume in millions/year

CONFIDENTIAL

Laser matter interaction – single beam!



	Small holes diameter (D1)	Large holes diameter (D2)
Drilling process energy	14µJ	25µJ

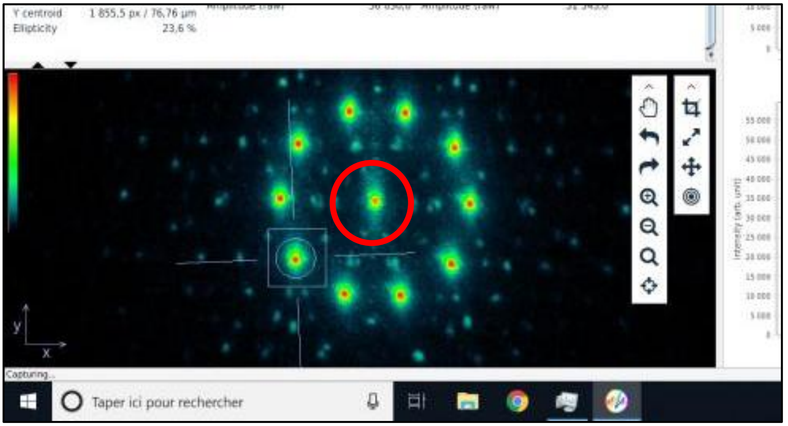
Drilling rate	Quality factor for small holes (Δ_1)	Quality factor for large holes (Δ_2)
1 kHz	2,25µm	1,48µm
3 kHz	3,57µm	2,24µm
Δ (3kHz) / Δ (1kHz)	59%	51%

- **Study performed with a single beam, results translate into multibeam**
- ☺ Robust 1st order correlation between energy and exit diameter : beam energy ⇔ hole diameter
- ☹ The higher the repetition rate, the larger the quality factor Δ (thermal sensitivity!)

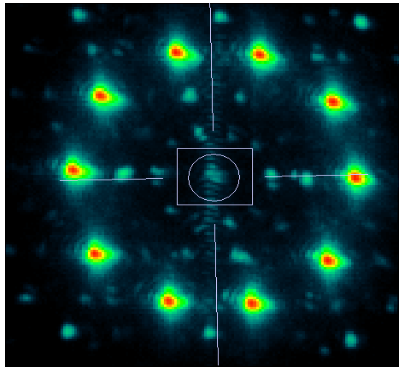
Creating the right ‘laser brush’ set: initial step

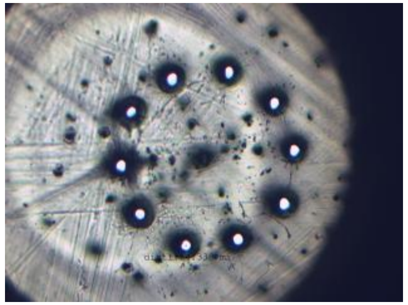
Central spot
management
Function

95% reduction

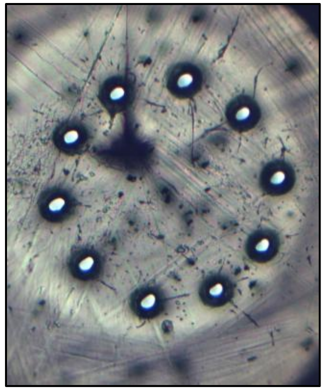


Y centroid 1 855,5 px / 76,76 µm
Ellipticity 23,6 %

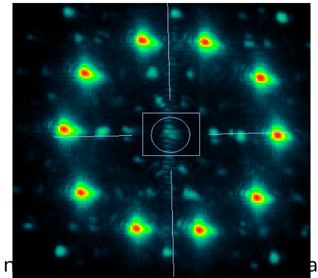


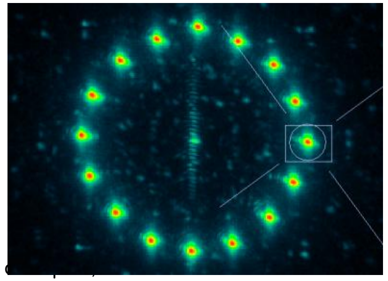


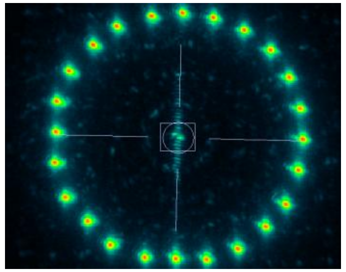
250fs, 1kHz
50µJ/beam
100 pulses/site



250fs, 1kHz
50µJ/beam
150 pulses/site



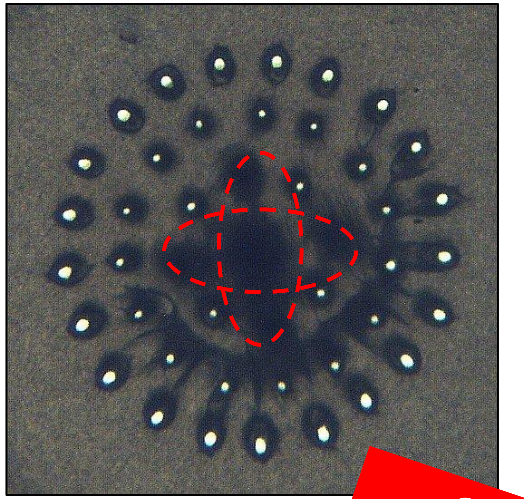


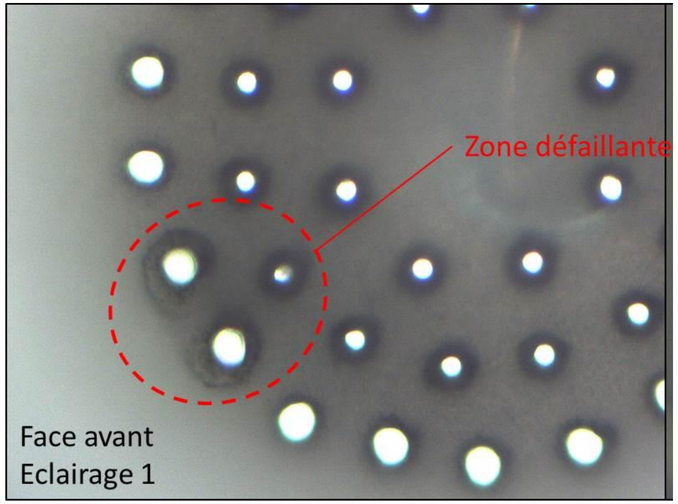


CONFIDENTIAL

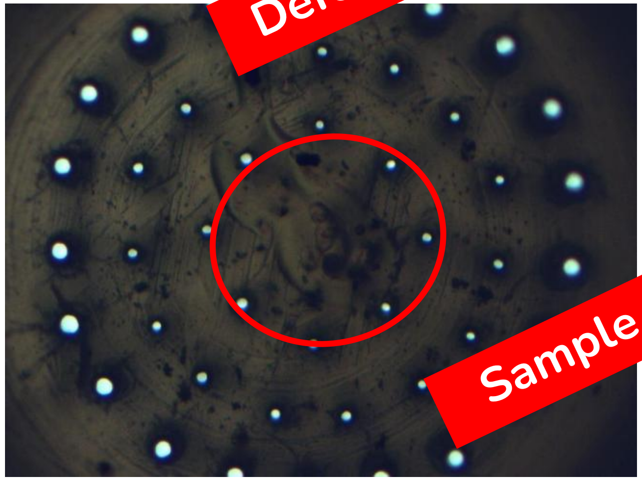
Real-life problems...

Defects in molded polymer





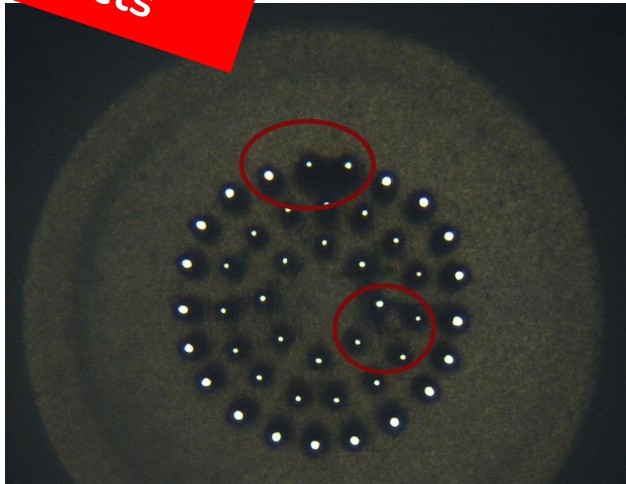
Cross-thermal effects



Sample variation from batch to batch

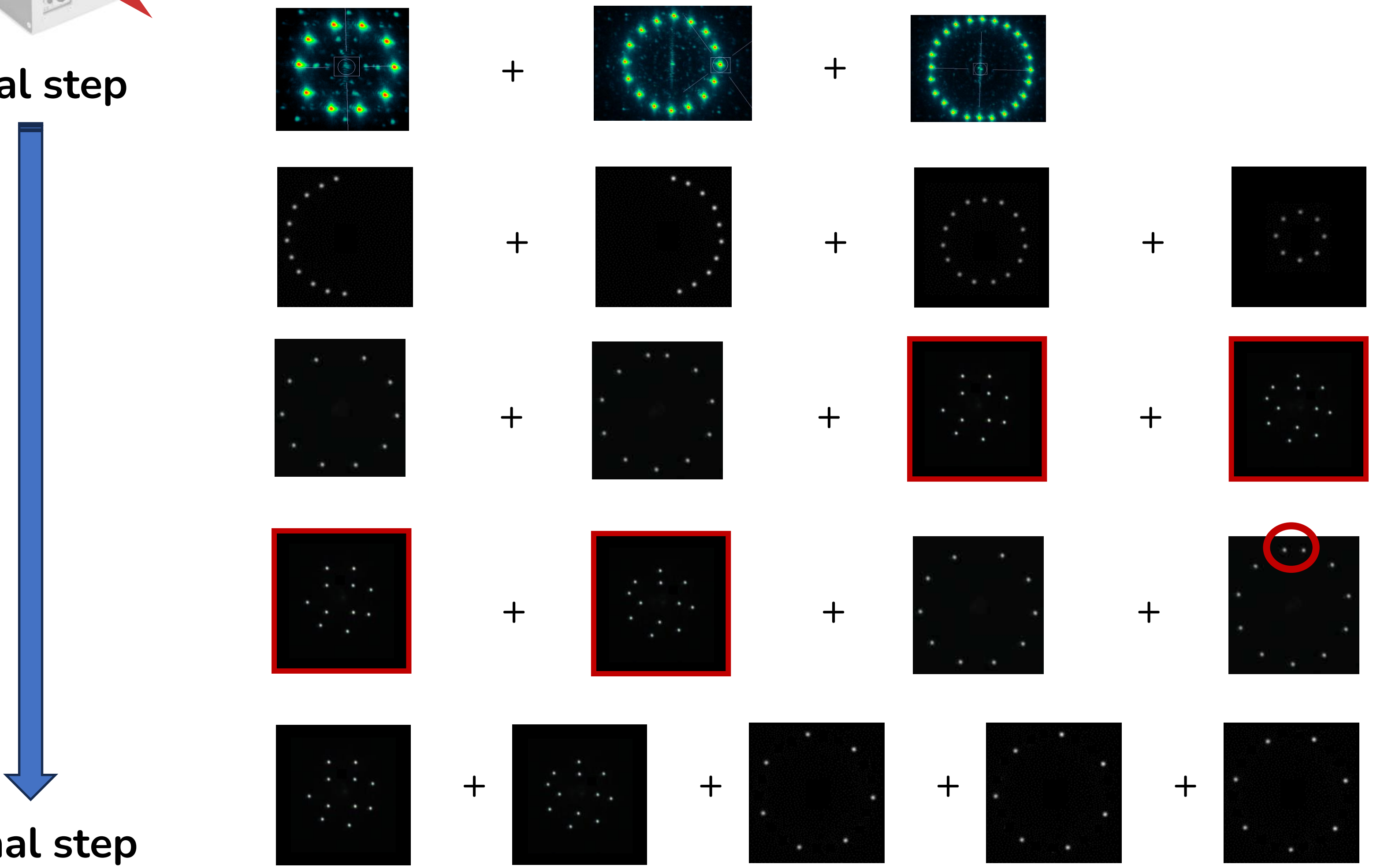
€

Application economics



… solved with 'laser brush'optimisation

Initial step



Final step

Why?

Use cheaper laser with less energy

Increase distance between beams to lower local heat deposition

Switch sequences to minimize cross-thermal effects in the center where holes density is higher

Add one step to unlock quality bottleneck, given chosen polymer behavior vs thermal effects

CONFIDENTIAL

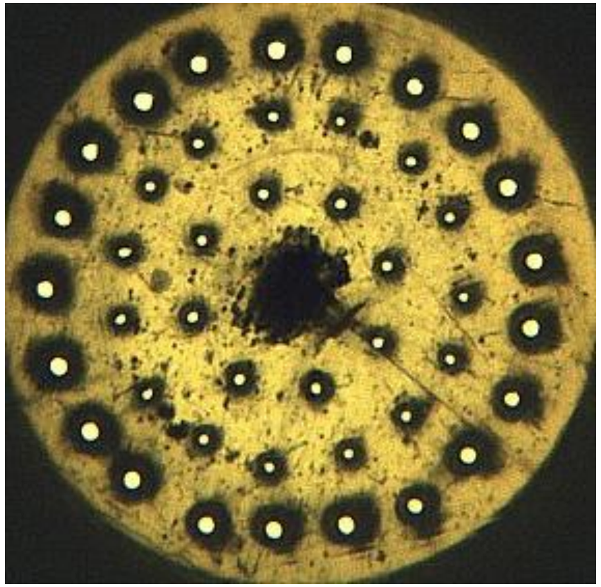
Before vs after

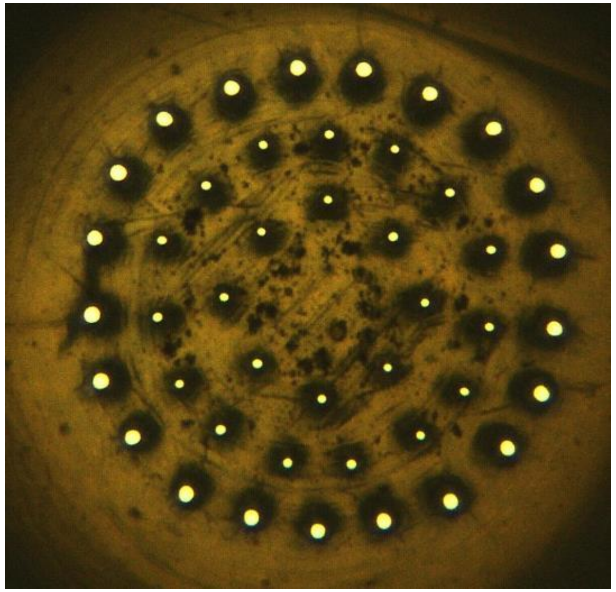
12 units sample set

✓ **0,9s/unit**

✗ **Δ_1= 3,86μm**

✗ **Δ_2= 5,22μm**





50 units sample set

0,58s/unit ✓

Δ_1= 1,68μm ✓

Δ_2= 1,75μm ✓

From end-customer perspective

Cost divided by 8 compared to actual: 780€/ooo → 90€/ooo

Throughput: 90 parts per min with one single laser drilling system

Agility: technically validated new design in < 1weeks

Simplicity: customer fully autonom in a couple weeks, intern level

Thank you for your trust !

If you have any questions, we will be happy to answer them.

QIOVA SAS
828 rue Adrienne Bolland
ACTIPARC
42160 Andrézieux-Bouthéon, France
Tel: +33 (0)4 77 93 71 85
E-mail: info@qiova.fr