



3D-TOP-HAT BEAM SHAPERS

STABLE TOP-HATS FOR REAL INDUSTRIAL PRODUCTION CONDITIONS.



Beam
Shaper

Also available from our Partners



In laser micro-machining applications like **precision marking, laser lift-off, precision drilling, fine cutting, or surface structuring**, shaping Gaussian laser beams to **smallest Top-Hat** profiles creates significant benefits in quality or speed. **Yet in production their stability is often limited.** Tight process windows and high sensitivity to focus position make robust operation challenging.

3D-Top-Hat Beam Shapers are designed to **extend the usable working range and support more stable top-hat processes under real industrial conditions.**

INDUSTRIAL CHALLENGE

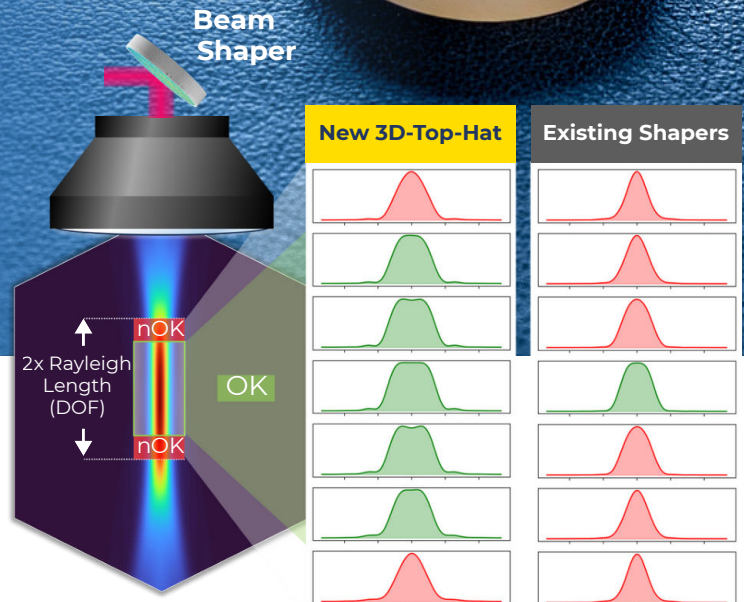
Top-Hat beams are typically stable only very close to the focus position.

In industrial environments this leads to:

- tight alignment tolerances
- frequent re-adjustment
- limited process windows
- reduced yield stability and rejects

Result:

Higher scrap rates, longer setup times and increased cost per part.



OUR APPROACH

3D-Top-Hat Beam Shapers address this challenge by **engineering the depth of field** of the top-hat profile.

Instead of changing the principle of Top-Hat shaping, we focus on making it **more robust for 24/7 production use.**

BENEFITS

Up to 5x larger usable process window

→ less downtime, less rework

Lower sensitivity to focus shifts and alignment

→ stable results across shifts and machines

Consistent energy distribution for smallest spot sizes → higher process quality and yield

Designed for industrial laser systems

→ not only for ideal lab setups

IS THIS THE RIGHT BEAM SHAPER FOR YOU?

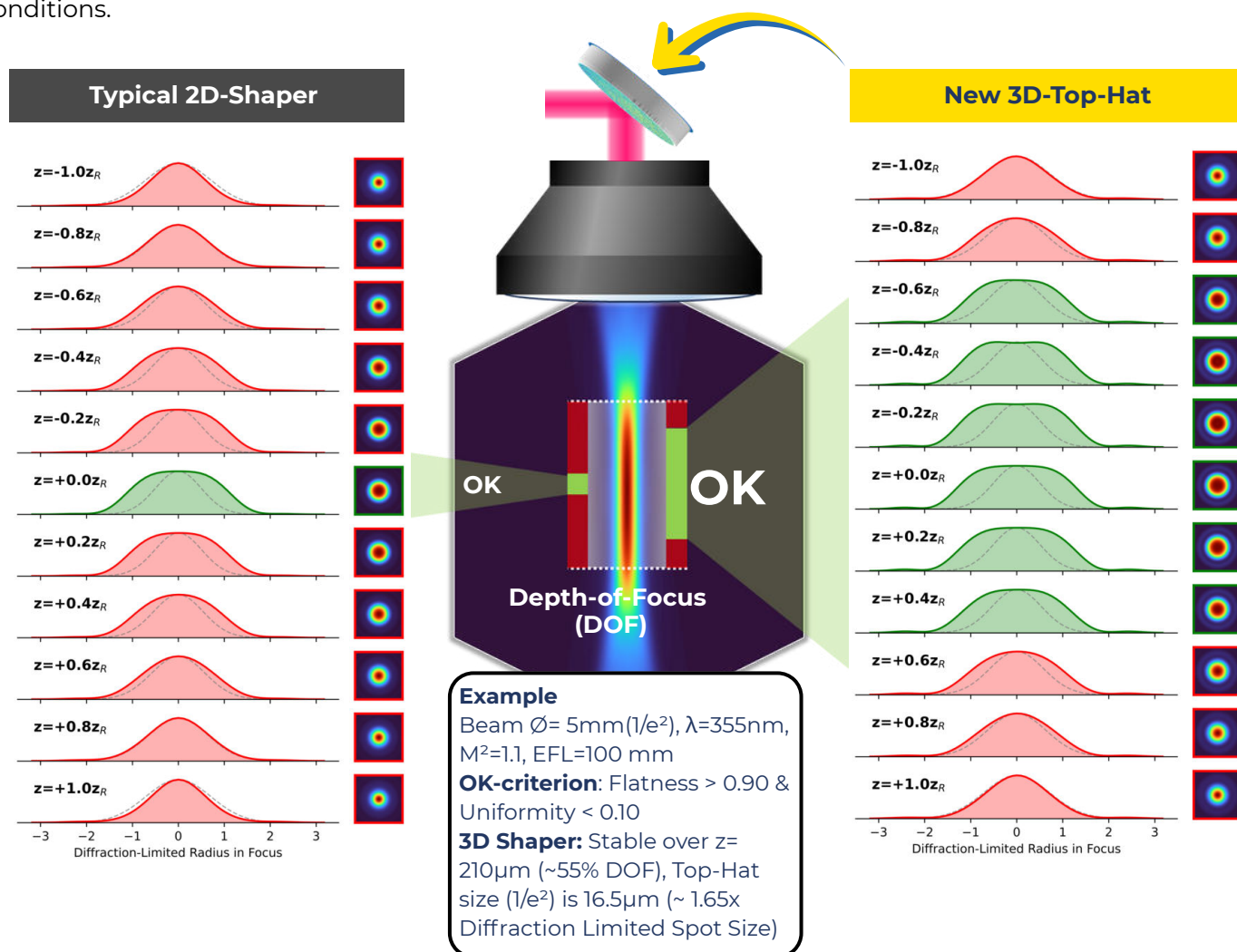
3D-Top-Hat Beam Shapers are made for you if:

- Your top-hat is stable in the lab - but not in production
- Your process is sensitive to focus position
- You need reproducible results across shifts and machines
- You work with small spot sizes and tight tolerances

Then it is time for depth-of-field engineered Top-Hat shaping.

DEPTH-OF-FIELD ENGINEERED TOP-HAT SHAPING

Conventional Top-Hat solutions shape the beam mainly in the focus plane. In production, however, process stability depends on behavior across depth of field. 3D-Top-Hat Beam Shapers are designed to keep the top-hat stable over a defined axial range - extending the usable working range under realistic system conditions.



PERFORMANCE

- **Usable DOF:** stable top-hat across $\pm 60\%$ z_{Rayleigh}
- **Flatness:** > 0.9 across usable DOF
- **Plateau uniformity:** < 0.1 across usable DOF
- **Beam shaping efficiency:** > 82 %
- **Side lobes:** < 5 % of $I_{\text{TopHat-Plateau}}$
- **Reflectivity:** > 99.9 % (Dielectric-HR-coating)

(values refer to aberration-free optical systems, $M^2 = 1.0$, System aberrations and beam quality may influence the achieved results)

FOR INDUSTRIAL CONDITIONS

3D-Top-Hat Beam Shapers are made for real industrial laser systems.

- **Input beam:** $M^2 \leq 1.3$, TEM_{00} , CW to ultrashort pulses down to 300 fs
- **Optical design:** Continuous DOE based on micro-structured mirror (All reflective approach, dielectric HR coating)
- **Made for Power** → See specs on our website
- **Dimensions:** $\varnothing 25.0\text{ mm} \times 6.35\text{ mm}$

WHAT YOU GAIN IN PRACTICE

- Larger usable process window compared to conventional Top-Hat solutions
- Lower sensitivity to small focus shifts and alignment tolerances
- More consistent energy distribution in smallest spot applications
- Higher confidence when scaling from pilot to series production



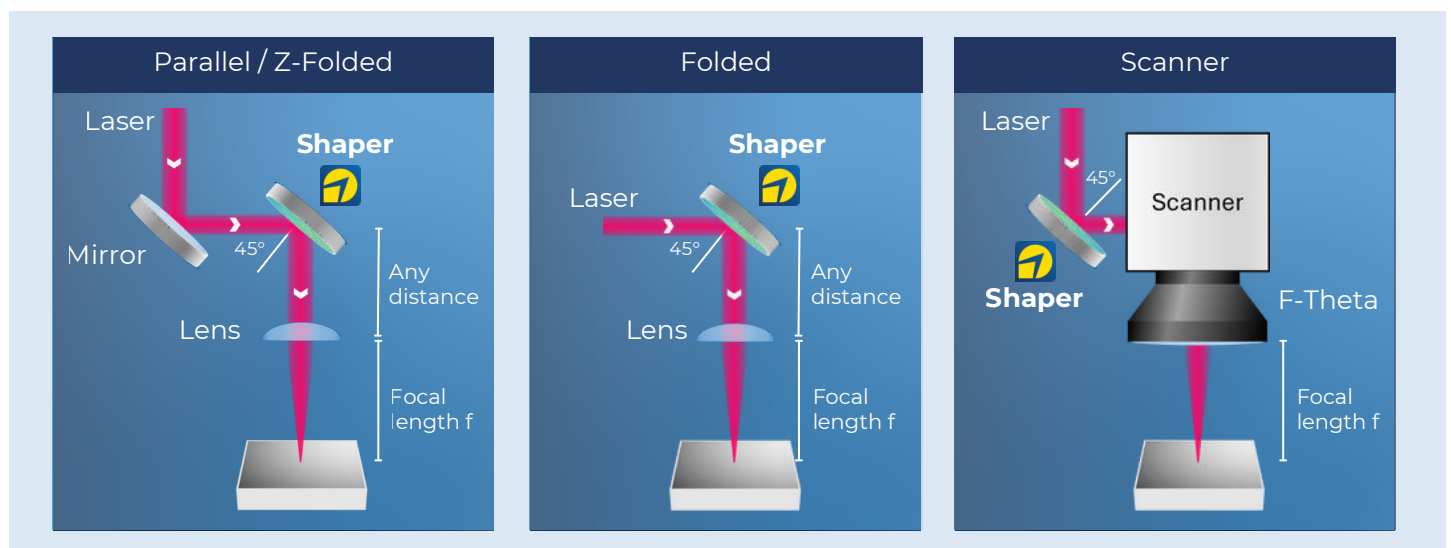
WHERE STABLE TOP-HATS MATTER

Stable Top-Hat profiles are especially critical in applications that require uniform energy delivery, small spot sizes and challenging tight process windows.

3D-Top-Hat Beam Shapers are typically used in the following scenarios:

Application	Usecase	Key Industries
High-Quality (Black) Marking	Deep, uniform contrast; no hot spots → premium quality	Consumer electronics, Automotive
Laser Lift-Off (LLO)	Controlled delamination; homogeneous energy delivery	Displays (OLED, μ LED, flexible)
Precision Drilling	Minimal taper; minimal heat-affected zone	PCB, Semiconductor packaging, TGV, Glass
Surface Microstructuring	Repeatable textures; functionalized surfaces	Medical devices, Automotive, PV
Fine Cutting	Smooth edges; minimal recast/burr	Wafer Dicing, Medical Tech, Displays

INTEGRATION OPTIONS



Specifications & About



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YOUR SOLUTION
PROVIDER FOR
BEAM SHAPING

TOP-HAT PARAMETERS

Output Shape	Round Top-Hat (Gaussian to Top-Hat Conversion)			
Shaped Beam Diameter (x Diffraction Limit of Unshaped Beam)	For $M^2=1.0$ 1.8 x DL ($1/e^2$)	$M^2=1.1$ 1.7 x DL ($1/e^2$)	$M^2=1.2$ 1.6 x DL ($1/e^2$)	$M^2=1.3$ 1.5 x DL ($1/e^2$)
Efficiency	$\geq 85\%$ (Encircled energy ($1/e^4$)/ Total Energy)			
Top-Hat Quality	Plateau Uniformity ≤ 0.1 & Flatness ≥ 0.9 (ISO 13694)			
Strongest Side Order	Intensity $\leq 5\%$ (Relative to Top-Hat Plateau)			
Stable z-Region (x Rayleigh Length of Unshaped Beam)	For $M^2=1.0$ 1.2 x z_{RL}	$M^2=1.1$ 1.0 x z_{RL}	$M^2=1.2$ 0.6 x z_{RL}	$M^2=1.3$ 0.3 x z_{RL}

INPUT BEAM REQUIREMENTS

Input Beam	Gaussian, TEM ₀₀ , $M^2 \leq 1.3$, CW to ultrashort pulses down to 300 fs
Input Beam Diameter ($1/e^2$)	Available for 2.5mm 5.0mm 8.0mm
Wavelengths	Available for 1030-1064nm 515-532nm 343-355 nm
System Requirements	Clear aperture $\geq 2x$ beam diameter ($1/e^2$), Integrate into collimated beam with a focusing lens. Lateral alignment required
Angle of Incidence	45.0°

ELEMENT PARAMETERS

Element	Micro-structured Mirror (Continuous Reflective DOE)
Coating	$>99.9\%$ at 45.0° Dielectric HR Coating on flat fused silica substrate
Dimensions	Diameter: Ø25.0mm (+0.0mm -0.1mm) Thickness: 6.35mm (+/- 0.10mm)

Performance values are specified for a TEM₀₀ Gaussian input with diffraction-limited wavefront quality at the DOE plane ($\lambda/10$ RMS or better) and sufficient clear aperture.

FIND YOUR CONFIGURATION AND GET STARTED

Use our online tool to check
performance for your laser parameters



<https://midel-photonics.de/3d-top-hat-tool>

ABOUT MIDEL PHOTONICS

Founded in 2022, Midel Photonics GmbH is revolutionizing the photonic industry through innovative beam shaping. Our award-winning high-tech company sets new standards for precision and efficiency. With over 100 individually developed optical solutions, our team of experienced specialists provides customers with decisive competitive advantages.

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