



Focal Shaping:

A Novel 3D Beam Shaping Technology for Robust High-Power Laser Cutting

Focal Shaping is a novel 3D beam shaping technology that stabilizes high-power laser cutting by extending the effective focal range and reducing sensitivity to thermal drift. It delivers more consistent cut quality, a wider process window and higher real-world reliability, enabling machine builders to push performance at 10–50 kW and beyond.

The Challenge

Laser cutting systems operating at 10–50 kW and beyond push optical components to their thermal limits. Even small amounts of **thermal lensing** in collimators or focusing optics shift the focal position and destabilize the process.

Real-world effects:

- fluctuating kerf width
- increased burr and melt instability
- loss of cut quality over long paths
- narrow, drift-sensitive process windows
- higher sensitivity to nozzle distance and material variations
- more recalibration and more service interventions

In high-power cutting, **a few hundred micrometers of focus drift** are enough to degrade performance and reduce OEE.

Innovation: Reflective Focal Shaping – a Novel 3D Beam Shaping Approach

Focal Shaping extends the effective focal zone and makes the cutting process significantly more tolerant to focus shifts. Instead of relying on a single tight focal point, the optic creates **a stable axial intensity distribution** over a larger z-range.

Key principles:

- engineered phase front for an extended depth of focus
- strong reduction of thermal-drift sensitivity
- stable energy delivery even under thermal load
- reliable shaping via all-reflective micro-structured mirror technology supporting 50 kW+

This new class of **3D beam shaping** components opens a more robust operating regime for high-power cutting.



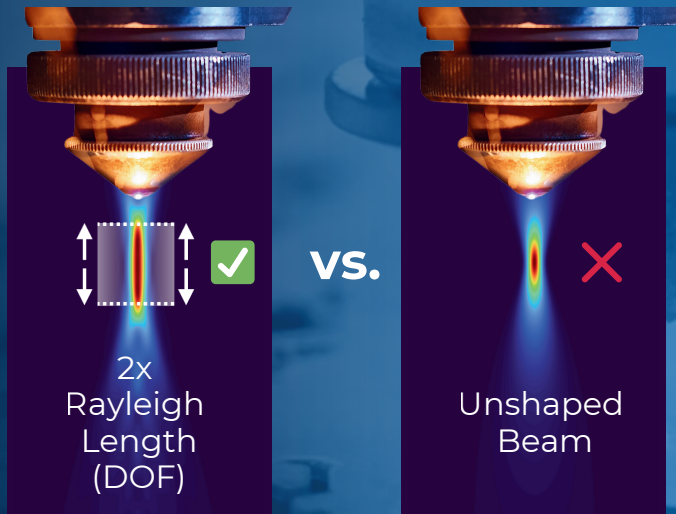
IWHITE PAPER: Laser Cutting

Focal Shaping: A Novel 3D Beam Shaping Technology for Robust High-Power Laser Cutting

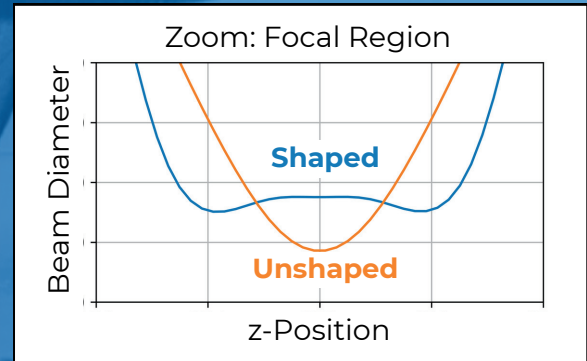
Midel
Photonics

YOUR SOLUTION
PROVIDER FOR
BEAM SHAPING

Focal Shaping - Example



Robust Beam Caustic



Benefits for Cutting Machine OEMs

1. Consistent cut quality under thermal drift

- stable kerf width
- reduced burr formation
- improved robustness for aluminium, copper and thicker materials
- less sensitivity to heat accumulation

2. A significantly larger axial process window

- more forgiving to nozzle distance and material variations
- fewer interruptions for parameter tuning
- reduced dependence on autofocus compensation
- higher process stability over full production shifts

3. High-power-ready architecture

- ideal for 10–50 kW systems and beyond
- stable performance even at high feed rates
- removes a key limiter of high-power system productivity

4. Easy integration

- placed in the collimated beam
- compatible with standard cutting heads
- no mechanical or software changes required
- reversible, suitable for pilot phases

Impact

Focal Shaping provides measurable **productivity and quality gains**:

- higher uptime
- reduced scrap and rework
- lower service effort
- stable performance at high speeds
- clear differentiation in a competitive OEM market

Conclusion

Thermal focus drift limits today's high-power cutting performance.

Focal Shaping, a novel 3D beam shaping technology, stabilizes the axial energy delivery, extends the usable focal range and makes cutting processes far more robust – especially above 10 kW.

It enables **consistent cut quality, larger process windows and superior real-world performance**, giving machine builders a powerful lever for next-generation cutting systems.

Interested in Learning More?

Call us +49 (0)228/28-679710

Write us info@midel-photonics.de

Check us out www.midel-photonics.de

Get a coffee Bonn, Germany