

## Cutting of glass with an Airy Beam

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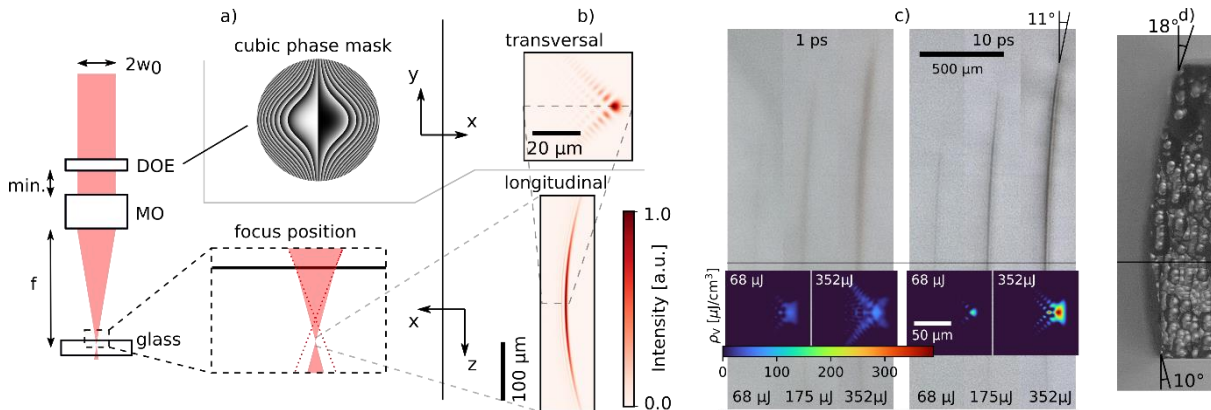
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When glass is cut to shape, ultra short pulse lasers used with beam profiles with an elongated focal volume (line focus) are increasingly replacing conventional cutting tools [1]. These straight line foci can be used to modify the workpiece throughout its entire depth with one single laser shot, effectively perforating it instantaneously, instead of having to dig into the material, as for example by ablation. At the same time, processed glass is often required to have a seamed or round edge. Currently this requires an extra grinding step to obtain for example the most common curved shape, the so called “c-cut”.

Here, we report on combining cutting and edge shaping of glass sheets in one laser process. To this end, we replace the commonly used Bessel-Gauss beam in the aforementioned line focus setup with an Airy-Gauss beam to directly achieve a curved edge as the result of the cutting process. The Airy beam is the most prominent non diffracting beam following a curved trajectory, that is to say its main lobe appears to be accelerated in the transverse plane during propagation [2]. Our results demonstrate curved modifications with lengths of up to 2 mm within borosilicate glass produced by single 1030 nm picosecond laser shots with an Airy beam profile. Plasma ignition in the side lobes of the beam as well as surface damage prove to be the crucial limitations for confined bulk energy deposition on a curved trajectory. A combined experimental and numerical analysis reveals optimum laser parameters for confined bulk energy deposition. This way we achieved single pass perforation of a 525  $\mu\text{m}$  thick glass sheet and separation by a subsequent etching step [3], resulting in a well defined convex edge down to a radius of curvature of 774  $\mu\text{m}$ .



**Figure 1 :** Experimental 2f-setup (a) used for creating an Airy-Gauss beam and resulting intensity profiles (b) for a focal length of  $f = 10$  mm. Light microscopy cross sections of permanent in-volume modifications in glass (c) also clearly follow the expected curved trajectory. Corresponding deposited energy densities in the focal plane (insets) obtained from numerical simulations confirm a higher confinement of deposited energy for long pulses. Result of cutting a 525  $\mu\text{m}$  thick glass sheet by perforation with an Airy beam and subsequent etching is shown in (d). The cross section view parallel to the line of laser modifications shows the curved profile of the cut.

[1] M. Jenne et al., “Facilitated glass separation by asymmetric Bessel-like beams”, *Opt. Exp.* 28, 6552–6564 (2020)

[2] G. A. Siviloglou et al., “Observation of accelerating Airy beams”, *Phys. Rev. Lett.* 99 213901 (2007)

[3] J. Gottmann, “Microcutting and hollow 3d microstructures in glasses by in-volume selective laser-induced etching (isle)”, *J. Laser Micro/Nanoengineering* 8, 15–18 (2013)