# Creation of a donut-beam-array for high numerical apertures with a single spatial light modulator

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In stimulated emission depletion (STED) microscopy a donut beam overlayed with a gaussian intensity profile is scanned over a particular sample in order to record a super-resolved image. While small areas can be scanned rather quickly, due to the serial nature of the scanning process, imaging larger fields of view requires a long time. Here, parallelization is an interesting alternative, since it would drastically speed up the process, thus extending live cell imaging studies to faster frame rates or larger fields of view.
A technique from laser communication technologies is the multiplexing of laser beams through the superposition of phase profiles imprinted in the height profile of phase plates. Here, we adapt the calculations behind these patterns to create phase profiles for liquid crystal spatial light modulators (SLM), which are a more flexible tool, often used in aberration corrections and adaptive optics.
The calculations are based on a minimization routine, that punishes deviations from gaussian beam profiles, while optimizing uniformity and efficiency. The resulting profiles transform a single laser beam into a highly uniform array of up to 64 laser beams, each with a gaussian beam profile. The addition of a vortex phase mask results in optimized donut beam profiles even in systems with high numerical apertures and the system can therefore be applied for parallel STED microscopy.