Towards Systematic Characterization of Ring-shaped Laser Beams

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Laser beams, along with their established quantities of 2-nd order moment beam width (d4σ), Rayleigh length (zR) and beam propagation factor (M^2), are commonly characterized by the framework set out in ISO 11146. This framework delivers appropriate and reliable results for typical beam shapes ranging from Gaussian to top-hat form. On the other hand, a wide range of technologies to generate ring shaped beams has been established for various applications and has reached a maturity for use in industry. These include structured fibers, specialty optics, dynamic beams (e.g. wobbling) and coherent beam combining. The above-mentioned established quantities are usually insufficient to describe these beams in a meaningful manner. This issue is amplified by combinations of beam profiles, where a ring-shaped beam surrounds a central peak for example.

We present a range of novel parameters that are used to adequately describe arbitrary ring-shaped beams with a focus on applications. These include ring and core parameters, as well as the combination of these, at single plane level and also caustic beam parameters like structure depth and structure focus position. In addition, the measurement strategy has to be adopted for these new beam shapes. The new method is compared with the approach laid out in ISO 11146 with the aid of examples. Looking forward, the presented method can be used as a reliable basis for a new norm on ring-shaped beam analysis.