Towards generating high-power structured light for biomedical applications

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We demonstrate a completely new concept for simultaneous generation and amplification of ultrashort pulses (USP) with high-order, high-purity structured beams, in both low and high-power regimes, which enables manipulation and directing matter at micro, nano and atomic scales. The concept is based on novel Active Helical Tapered double-clad Fiber (AHTF) technology (Fig. 1a) capable of realizing high-power, compact and versatile ultrafast laser sources delivering structured beams with higher orders. High-power structured light could lead to advances in laser-plasma interaction by generating a strong solenoidal magnetic field by means of the inverse Faraday effect. This can open a pathway to efficient and compact medical isotope separation systems or downscaling of Laser Wakefield Acceleration (LWFA) down to just tens of meters.
I will demonstrate the first results with active helical tapered double-clad fiber with the ring-shaped core as a gain medium for structured light carrying picosecond pulses. This approach allows the achievement of a high-contrast beam avoiding amplification in the dark zone and preserving the beam shape with minimum perturbations.
The MOPA system generates an output power of 14.5 W for the directly amplified short-pulsed signal at the 27 W pump power. Output beam profiles with 1.9 W (M2 = 2.05) and 14.5 W (M2 = 2.05) output power demonstrates high beam quality preservation during the amplification process (Fig.1 (b,c)). At the same time, the amplified beam is characterized by high homogeneity of polarization state along the azimuth orientation. The further amplification of the beam iss limited by growing amplified spontaneous emission, distorting polarization profile, and intensity distribution contrast.

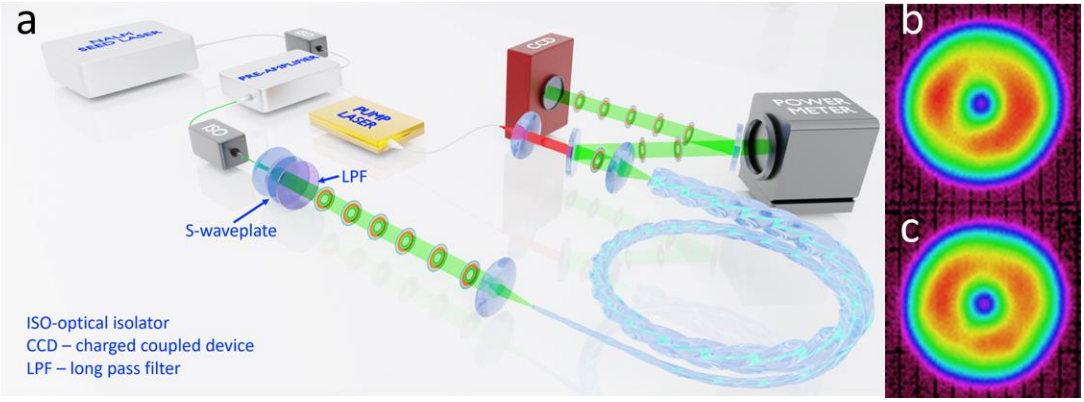

Fig. 1: a) The schematic of the experimental setup. Experimental output intensity distributions in the near-field for (b) 1.9 W and (c) 14.5 W output power b)