Structured Laser Beam

Advanced wavefront shaping, achieving tuneable long-range structured laser light propagation with sub-millimetre accuracy.

Highlights

Pseudo Non-Diffractive

Utilizes wavefront shaping for precise control of beam core divergence, achieving figures as low as 10 microradians.

Compact and Adjustable

Features a highly compact central spot size, as small as 0.01 mm at 3 meters distance. Shape of the beam can be adjusted, including the creation of a hollow beam.

Self-Reconstruction

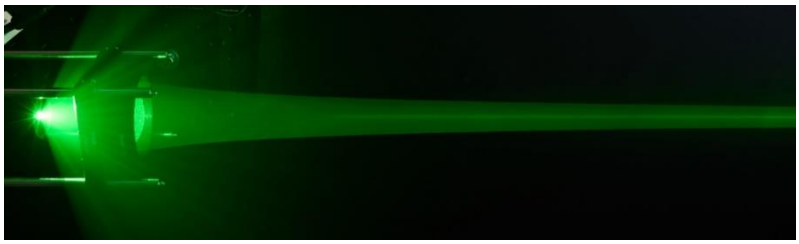
Employable in challenging environments due to self-healing properties.

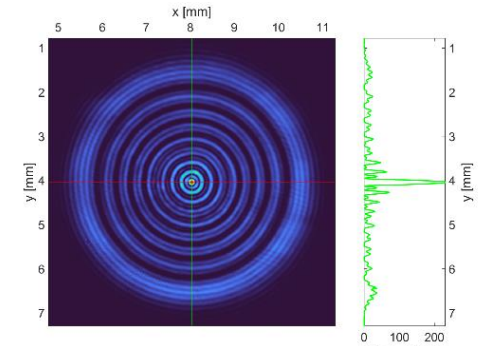
Patented Technology

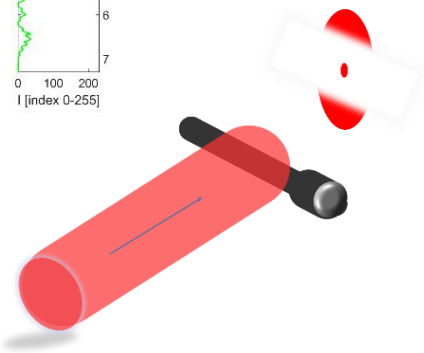
Patent No. US20210191134A1, EU patent pending, second patent application to be filed.

Keywords

Structured laser light, long-distance propagation, hollow beam, layer beam, low diffraction, low divergence.







Description

The Structured Laser Beam (SLB) is an innovative optical technology designed to produce highly focused, pseudo non-diffractive beams that can propagate over long distances without significant spreading of the beam core. Developed through collaboration among CERN, IPP, and TUL, the SLB employs unique wavefront shaping to achieve minimal divergence—approximately 0.01 milliradians (mrad)—and adjustable focus. Its intense central part, characterized by a conical projection of bright and dark rings, demonstrates a sharp and tunable beam profile. The beam exhibits a very long pseudo-Rayleigh length and a small beam core diameter.

The SLB also features a distinctive reconstruction property, allowing it to reform its structure post-obstacle interaction. It supports a broad wavelength range from ultraviolet to infrared and incorporates non-standard polarization to further manipulate beam characteristics. Additionally, the SLB can generate secondary and layered beams, enhancing its utility in various scientific and industrial applications. The SLB exhibits diverse polarization distributions both in cross-section and longitudinally. In the dark regions of hollow beams, for example the core, a longitudinal component of the electric or magnetic field is present.

Structured Laser Beam

Advantages

Technical Precision

Demonstrates exceptional precision with a central beam divergence of approximately 10 microradians and a spot size that remains consistent over extended distances.

Validated in Rigorous Environments

Proven effective in both controlled laboratory conditions and outdoor testing environments, illustrating robust performance metrics such as a 0.01 mm beam diameter at 3 meters and 1.5 mm at 150 meters.

Adaptable Beam Configuration

The SLB technology allows for dynamic adjustment of beam characteristics, making it suitable for a wide array of applications from precise measurements to materials processing.

Self-Reconstruction Capability

Utilizes advanced optics to allow the beam to reconstruct after disruptions like obstructions. This maintains beam integrity over long distances or challenging environments, crucial for precision applications where preserving beam quality is essential.

Potential Applications

- **Optical Communication**: Enhances long-distance optical signal integrity.
- **Industrial Machining:** Enables precision in material processing, microfabrication, surface treatment, additive manufacturing, and quality control.
- **Precision Measurement Systems:** For environments requiring precise alignment and measurements.
- **Aerospace and Physics Research:** Provides reliable and precise beam control in complex experiments.
- **Manipulation of Particles:** Trapping and moving of microscopic objects in the nanometer to micrometer range.

The applications listed above are examples of where the Structured Laser Beam could be utilized. The versatility of the technology encourages further exploration.

Publication

SULC, M., & GAYDE, J. C. (2022). Low divergence structured beam in view of precise long-range alignment. In EPJ Web of Conferences (Vol. 266, p. 10024). EDP Sciences. Link

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