technology

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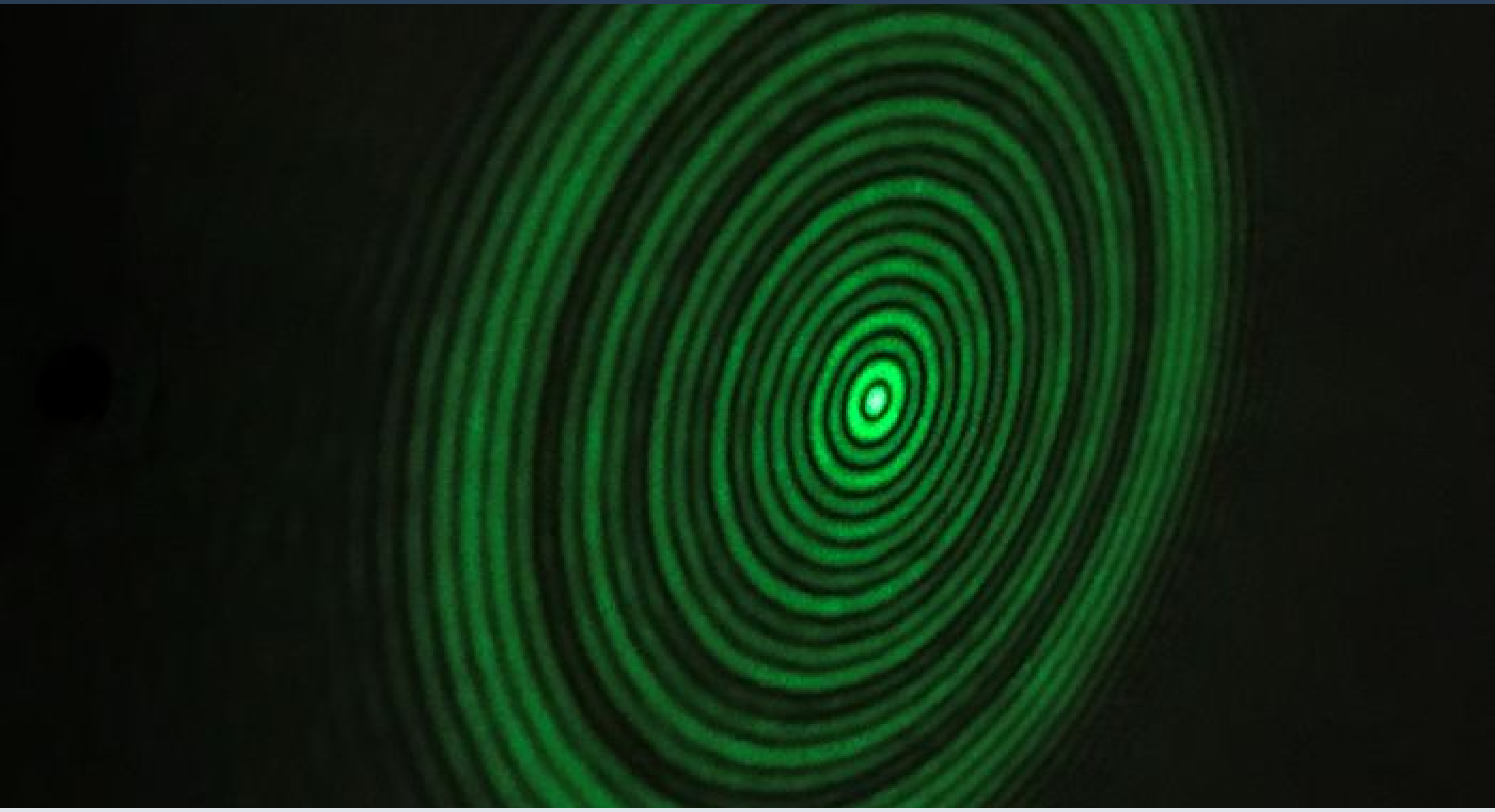
Long-distance, low-divergence Structured Laser Beam (SLB)

A system and method for generating a laser beam that can propagate over hundreds of metres while maintaining a small central spot size.



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IP Status

Patent application submitted

Seeking

Development partner, Commercial partner, Licensing, University spin out, Seeking investment

About **CERN**

By uniting engineers, technicians and scientists from all over the world, CERN develops pioneering technology and expertise with the potential of leading to applications in areas beyond high-energy physics.

Background

Developed in collaboration with the Institute of Plasma Physics in Prague (IPP), the Structured Laser Beam (SLB) was invented to help meet the large-scale metrology and alignment requirements at CERN. With a very low divergence that keeps the central spot size within a few millimetres even at distances of hundreds of metres, the SLB may enable lasers to be used for applications not previously possible, or to improve precision in existing applications.

Tech Overview

Structured beams - sometimes called non-diffractive beams (NDBs) - are able to propagate over large distances while maintaining a well-defined small central spot size. This is in contrast to Gaussian - or "classical" - beams, which increase more rapidly in divergence with distance. Today, NDBs are created primarily by the use of axicons. These can only generate NDBs over a small portion of the beam, typically limited to a few tens of centimetres.

In contrast, the SLB is able to maintain its central axis over several hundred metres. This is achieved by use of a coherent beam of electromagnetic radiation illuminated on an optical system in such a way as to produce a structured beam. 200 metres from the system, the central axis of the laser measures only a few millimetres in diameter.

The SLB exhibits other properties, unique to this beam. The SLB can be produced from source laser beams in a wide range of wavelengths and its geometry can be easily adapted (diameter of the central divergence, number of circles in the halo, etc.) The generator itself can be very compact (the size of a matchbox) and adjustable, while still being fairly inexpensive.

The invention is a novel method of generating a structured/non-diffractive beam over large distances:

- The central spot of the SLB has a much smaller diameter than a conventional Gaussian laser.
- The SLB is composed by an inner central spot with high intensity, surrounded by concentric rings with particularly clear contrast between them.
- Like a Bessel beam, the SLB is self-reconstructing after obstacles.
- Depending on the setup, the system is very robust with respect to the incoming beam. An angular displacement of the input beam gives a much smaller angular displacement in the output beam (tested up to a factor 100+).
- The diameter and number of rings can be tuned over a wide range.
- Intensity is decreasing with the square of distance from the source.

Benefits

- Extremely compact spot size and very low divergence.
- Vast improvement in distance over present-day Structured Beams.
- Self-reconstruction after obstacles.
- Very robust to jitter, vibrations, and variations in the angle of the input beam; it also shows some robustness to fluctuations in air temperature.

Applications

Further tests are needed to explore the variety of possible uses, but the SLB may have application in:

- Metrology
- Communication
- Gas detection
- Microscopy
- Medicine
- Optical tweezers
- Laser light shows
- Other applications benefiting from a non-diffractive, low-divergence beam

Opportunity

We are seeking collaboration partners and licensees to explore the potential of the SLB in application areas outside of High Energy Physics. A prototype has been developed by CERN and IPP that has demonstrated the characteristics of the beam. The system will need adapting and testing for other uses.

Patents

- Priority application filed 2nd May 2018 (EP18305552)
- PCT filed 2nd May 2019 (PCT/EP2019/061279)