



CERN for Climate Action Day – CIPEA Event 2025

Structured laser beam for laser marking to save ink

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The Structured Laser Beam

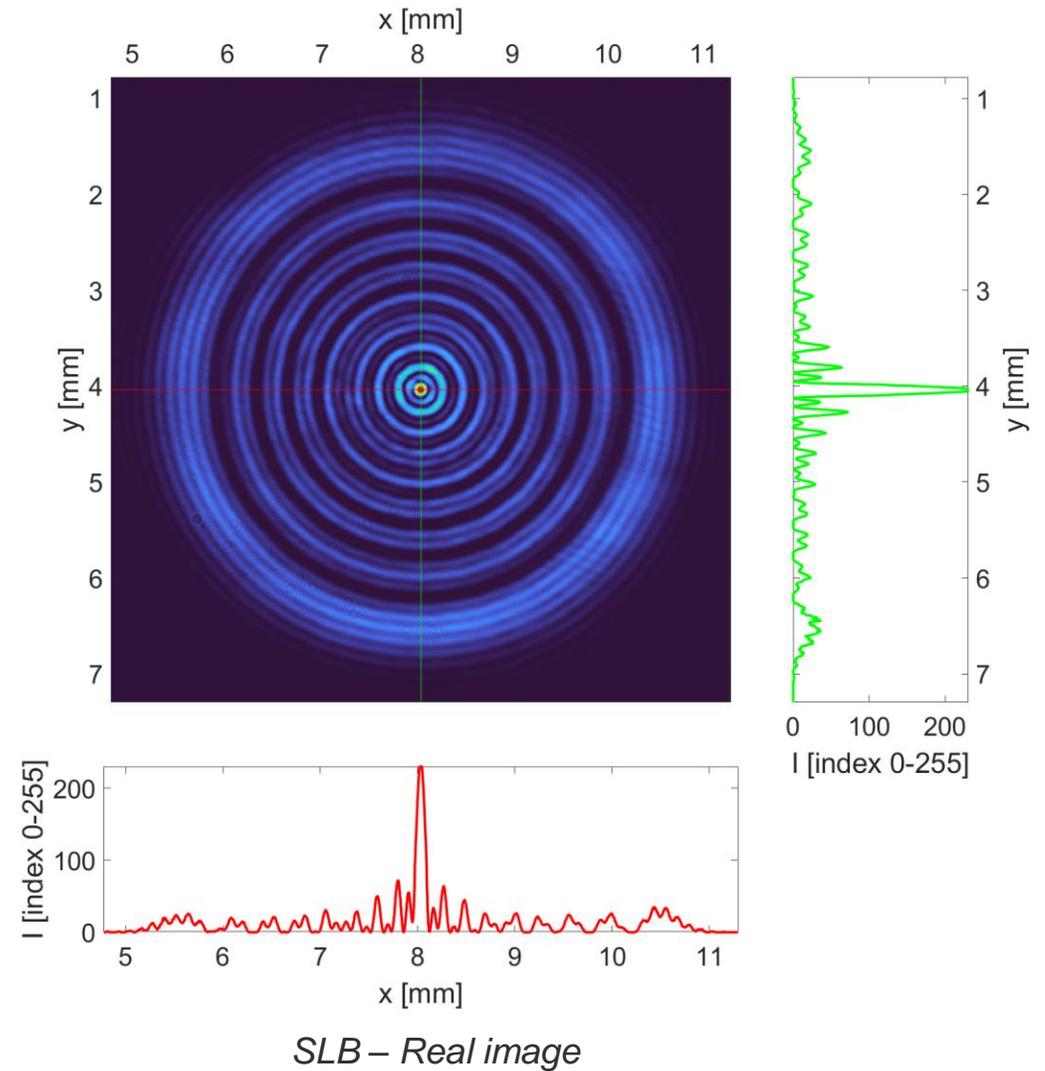
The Structured Laser Beam (SLB) is a pseudo non-diffractive optical beam



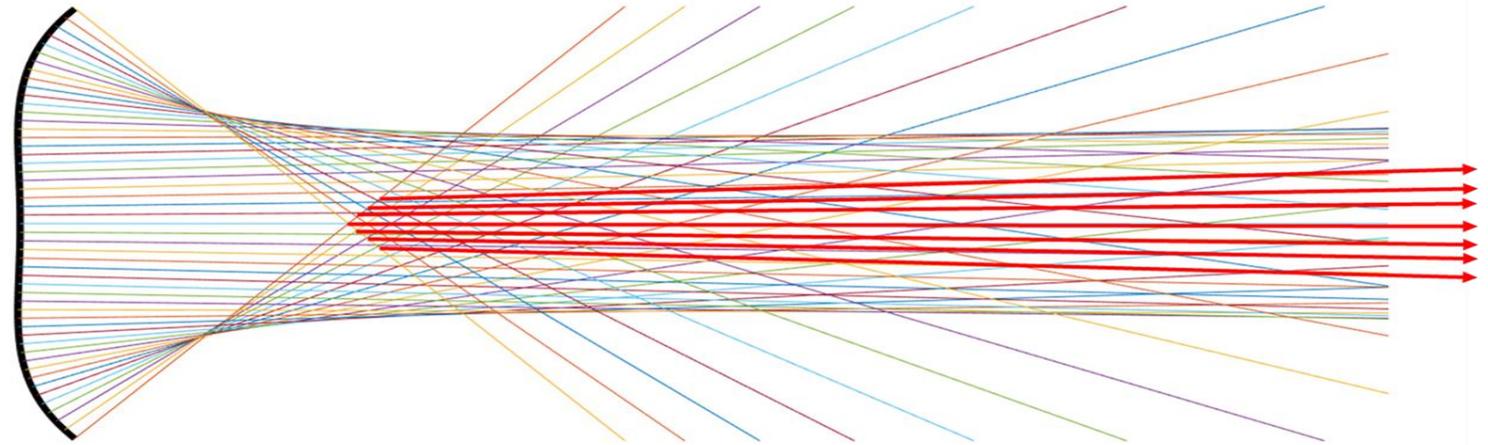
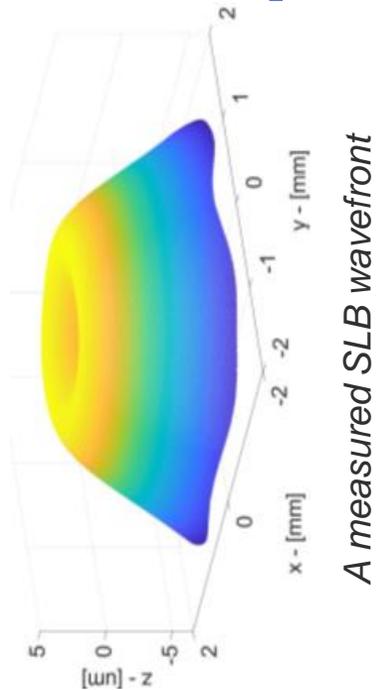
- Result from an R&D collaboration between CERN, IPP (CZ) and now TUL (CZ)
- Research supported by EN and BE departments, and by KT
 - <https://kt.cern/technologies/structured-laser-beam>

Some characteristics of the SLB

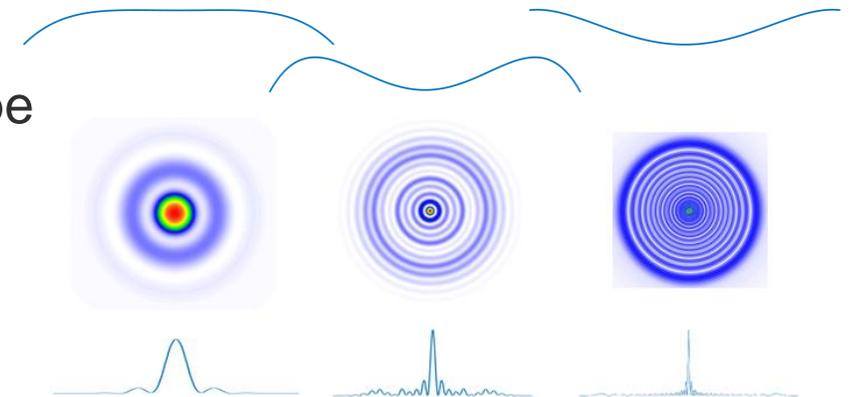
- Structure with bright and dark areas
- Extremely compact central spot size
- Low divergence of the Inner Core (IC)
- Propagation over long distances



Creation principle of SLBs

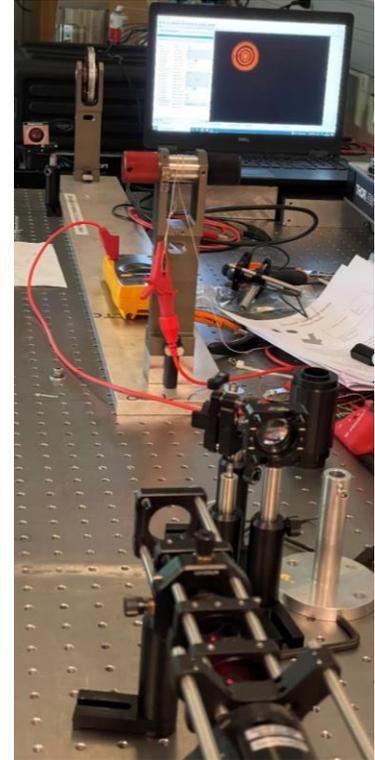


- Superposition of waves coming from a special wavefront shape
- Wavefront obtained by defocus and spherical aberration created with optical elements
- The generator allows to change the shape of the beam



Some properties of SLBs

- Intense central part with black and bright rings in a conical projection
- Low divergence of the beam Inner Core (tests show ~ 0.01 mrad)
- Very sharp profile of the central intensity peak
- Tunable symmetrical structure depending on the setup adjustment
- Possible to create in a wide range of wavelengths (typically Blue to IR)
- Non-standard polarization of the beam
- And also:
 - Creation of Hollow Structured Laser Beams (HSLBs) with longitudinal polarization in IC
 - Creation of Layer Beams (LBs)



SLB looks promising for use in different fields:

... industrial applications, optics, communication, optical tweezers, aerospace, physics ...

An example of industry interest in SLB

- 2018 - First contact with HighTechXL incubator
 - Visit at CERN
 - Discussions about the properties of SLBs
- 2021 - Creation of inPhocal (<https://inphocal.com>)
 - inPhocal is a start-up part of the CVC (Cern Venture Connect)
 - The goal is to use SLB for laser marking
- 2024 - License signed by inPhocal with CERN-KT

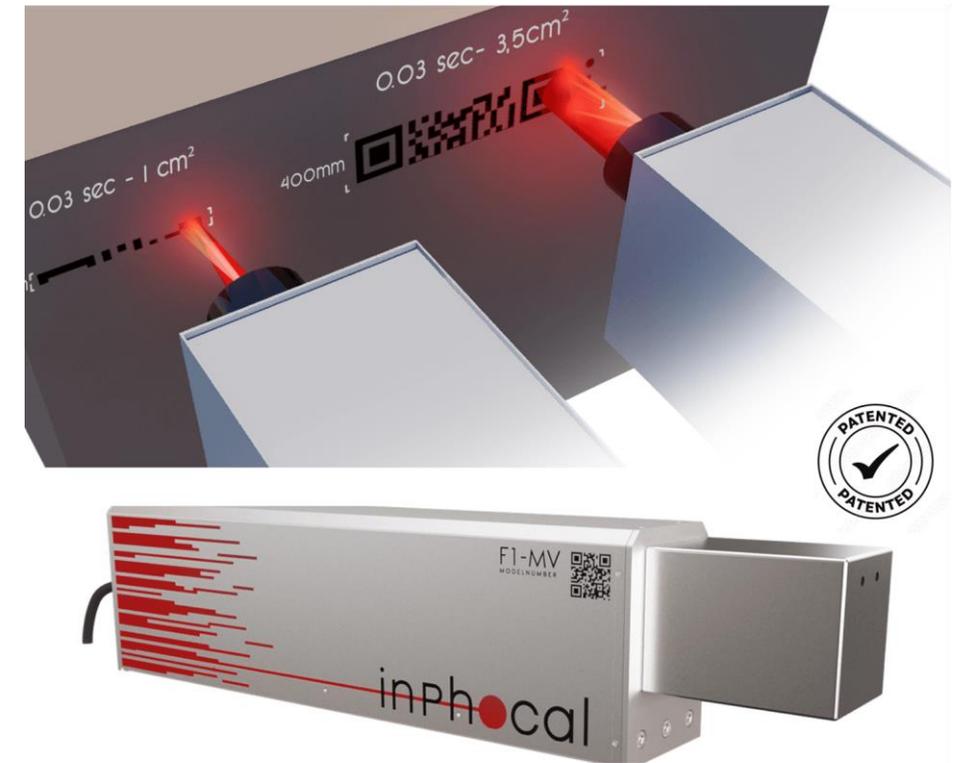
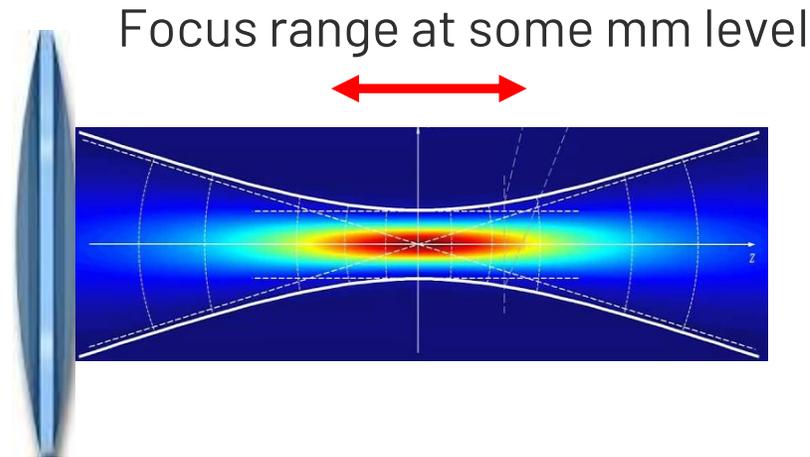


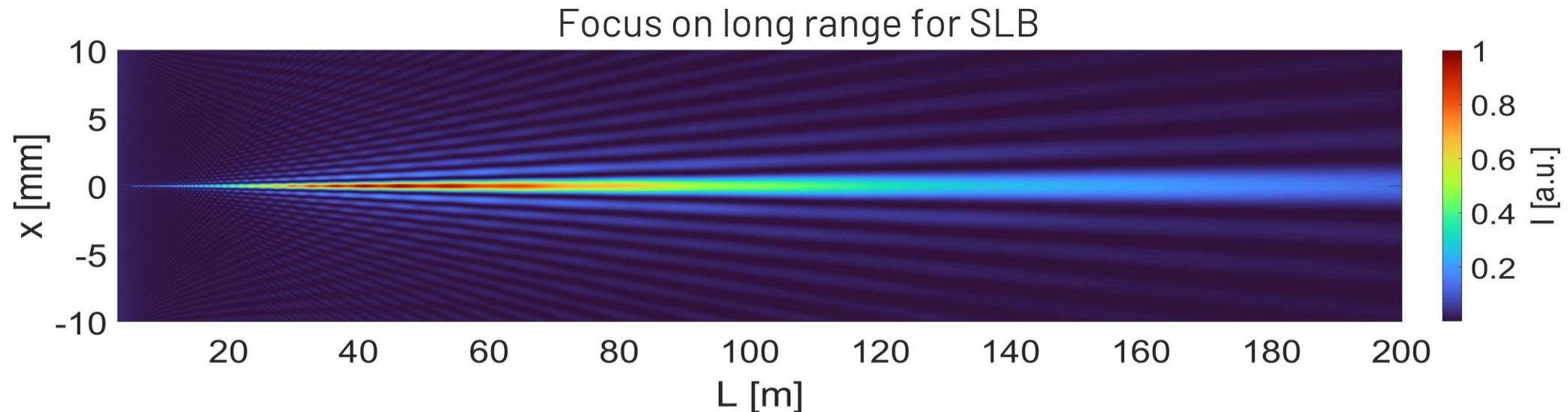
Image inPhocal website:
<https://inphocal.com>

Long range focus property of SLB



Focus on short range for Gaussian Beam (GB)

- inPhocal uses this long-range focus property
- Focus zone is extended to several cm



Application of SLB by inPhocal

- High speed laser marking
- Marking on large surfaces
- Engraving on non-flat surfaces
- Even on non-standard laser printed surface such as the skin of fruits



Image inPhocal website:
<https://inphocal.com>



Impact* of inPhocal SLB application on environment

- Ink saving
 - Worldwide more than **160 million litres of ink** are used yearly
 - Each litre of ink emits approximately **884 kg of CO2** per year
- Maintenance
 - Laser systems need **less maintenance** than ink-jet printers
- Energy saving
 - Ink-less marking significantly **reduces the energy consumption.**
 - inPhocal's laser systems **consume up to 50x less energy** than the conventional inkjet technologies
- Potential to reduce food waste
 - According to industry, unreadable expiration dates lead to destruction of entire shipments – 'recalls'
 - Laser markings are robust, decreasing significantly the risk of recalls
- And also potential saving on stickers, glue...



Image inPhocal website:
<https://inphocal.com>

* Numbers given here are from inPhocal

Conclusion

- The use of SLB technology by inPhocal for laser marking is a good example of how CERN technologies can contribute to sustainability
- inPhocal is already in contact with big companies (beverage industry ...)
- Other CVC partners are also interested in SLB for example for applications in organic agriculture

Thank you for your attention



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