Single-Frequency Raman Laser

Ultra-compact laser system designed for high-power output with spectral purity, capable of operating at virtually any wavelength.

Highlights

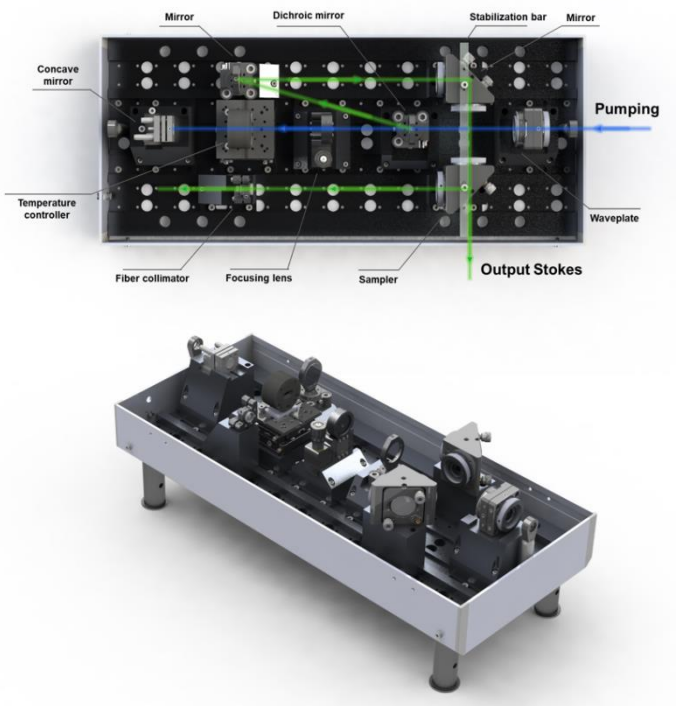
Ultra-Narrow Linewidth
Achieves an outstanding 100x reduction in linewidth compared to traditional multi-mode lasers.

High Stability
Intrinsically stable laser performance without the need for complex feedback control systems.

Multi-Wavelength Output
Capable of producing multiple single-frequency outputs at different wavelengths simultaneously.

Patented Technology
Patent No. US20240055821A1

Keywords
Single frequency laser, Brillouin scattering, Raman laser, multi-wavelength output



Description

The low-cost single frequency Brillouin/Raman laser technology exploits the Brillouin scattering effect to refine continuous wave integrated laser sources to their Fourier limit, producing ultra-narrow linewidths with remarkable stability. Unlike traditional single-frequency lasers, which require intricate optical arrangements and feedback control systems, the technology offers a streamlined, automated solution that simplifies the conversion of multi-mode lasers into single-frequency outputs.

The core innovation lies in the utilization of a Brillouin process within solid-state media such as Raman crystals, achieving single-mode operation without the need for additional optics or electro-mechanical controls. The laser operates within a Fabry-Pérot resonator setup, meticulously constructed to ensure intrinsic stability. This design enables the device to maintain a stable single-frequency output by carefully managing the pump laser focusing and selecting Raman media with optimal characteristics. The system achieves a high Raman gain in a single pass, essential for efficient single-frequency lasing. The choice of Raman crystals such as synthetic diamond or $Ba(NO_3)_2$ provides an exceptionally narrow linewidth, significantly enhancing spectral purity.

Single-Frequency Raman Laser

Advantages

Precision and Stability
Achieves high precision and stability without the need for complex stabilization techniques, ideal for applications requiring long coherence lengths.

Cost Effectiveness
Reduces the cost per unit significantly by leveraging existing laser sources and simplifying the conversion process.

Versatility
Offers multiple single-frequency outputs at various wavelengths simultaneously, enhancing its applicability across different fields.

Compact Design
Features an ultra-compact and thermally stable design that integrates seamlessly with existing systems, making it suitable for various industrial and research applications.

Applications

Ideal for:

- Quantum Computing and Communication
- High-Resolution Spectroscopy
- Atomic Clocks
- Optical Metrology
- Holography and Optical Data Storage
- Coherent Remote Sensing

The applications illustrate the versatility of CERN's single-frequency laser, encouraging further exploration of application fields.

Publications

Granados, E. et al. (2023). In-Source High-Resolution Spectroscopy Using an Integrated Tunable Raman Laser. Link

Granados, E., Stoikos, G. (2023). Spectral purification of single-frequency Stokes pulses in doubly resonant integrated diamond resonators. Link

Granados, E. et al. (2022). Tunable spectral squeezers based on monolithically integrated diamond Raman resonators. Link

Granados, E. et al. (2022). Spectral synthesis of multimode lasers to the Fourier limit in integrated Fabry–Perot diamond resonators. Link

The simplest path to single-mode tunable light

High
Raman Gain

100x
Linewidth reduction

For further information and licensing requests, please reach out to the CERN Venture Connect Program Manager.

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