Technology Offer:

Noise Free Imaging: Incoherent Light Source for Microscopy

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The invention relates to a new light source exhibiting a high level of spatial incoherence. This enables microscopic imaging with reduced artefacts and low intensity noise. It comprises a pulsed laser whose beam properties are improved is by a multimode optical fiber.

Full field microscopic imaging is an essential technique in medicine and beyond, but the occurrence of noise strongly limits its applicability. Coherent light contributes considerably to the formation of artefacts. Hence the imaging quality can be improved by incoherence of the illuminating beam.

The invention is a simple and robust setup in which the broad spectrum of a pulsed laser is used in order generate a high level of spatial incoherence. It is based on imposing a spatially dependent propagation delay onto the broad-spectrum light. Existing microscopes can be extended easily as the invention only affects the light source.

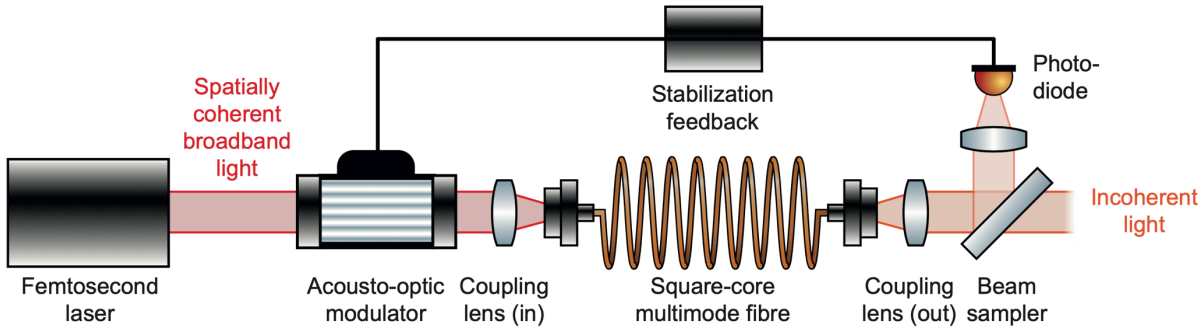

Fig.1 Illustration of the light source

Advantages

- High intensity light source
- Low temporal intensity noise
- Speckle-Free Imaging
- Easy integration into existing microscopes
- Robust setup
- Low requirements for alignment accuracy

Applications

- Light microscopy
- Atom trapping

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Background

In full-field imaging applications, imaging artefacts appear by partially reflections and scattering. Coherent light strongly enhances these artefacts since it allows for interference patterns to emerge. Reducing temporal coherence thus reduces reflective noise and reducing spatial coherence reduces scattering noise. At the same time however the degree of spatial incoherence should be controllable, as the focusing ability of light decreases with spatial incoherence. Temporal intensity noise as well as stability are additional requirements unreached with state-of-the-art technology.

Technology

A new light source (cf. Fig. 2) has been designed to overcome the aforementioned shortcomings. The invention is based on transforming spectral width i.e., temporal incoherence, into the desired level of spatial incoherence.

A pulsed laser (21) is used as a primary source delivering a spatially coherent light beam (2) with a spectral width of several nanometers. This beam is then fed onto a coupling lens (22) and into the input end (12) of a square-core multimode optical fiber (11). A spatially dependent propagation delay is imposed onto the light, as the light entering the fiber in a straight direction is passing it faster than the light reflected under steeper angles. Behind the fiber output end (13) another coupling lens (14) is arranged from which the desired spatio-temporally incoherent light field is provided.

An additional feedback-based intensity stabilization further minimizes temporal noise. A semi-transmissive plate (34) decouples a portion of the light from the output beam of the fiber and a further lens (35) illuminates a photodiode (31). The feedback control unit (32) monitors changes in the light intensity and regulates an acousto-optical modulator (AOM, 33) to accordingly adjust the light intensity that is fed into the fiber to further improve the temporal stability of the output beam (1). The latter is transmitted to the regarded application (210).

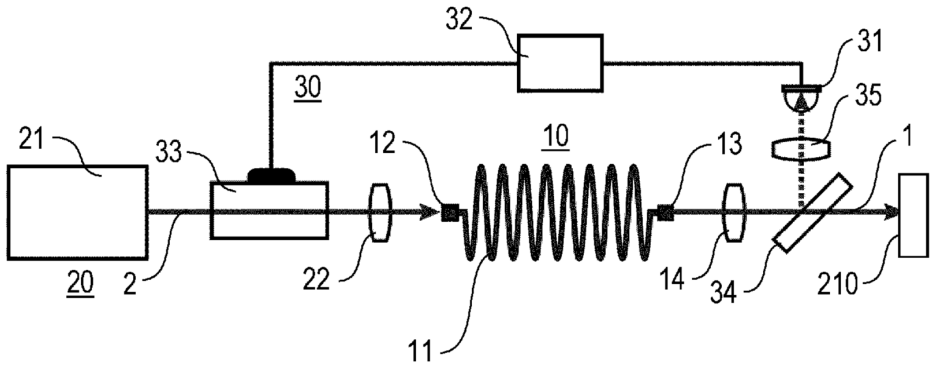

Fig. 1: Illustration of the arrangement including the primary source device (20), the waveguide device (10) and the feedback device (30)

Patent Information

PCT *(WO2021048287A1)*, EPO *(EP3793043A1)*

Publications

D. Wei, “Development of a spatially incoherent laser source”, Master’s thesis (2019).

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