Diploma thesis abstract

Energy deposition in air under multiple filamentation and superfilamentation of powerful femtosecond laser pulses

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The superfilamentation of high-power femtosecond laser radiation was studied using lenses with different focal lengths. When the radiation is focused, several filaments fuse and a superfilament is formed, what is a filament containing a much higher intensity and electron density in comparison with a conventional filament.

We used the radiation generated by a laser system on a Ti: Sa crystal (805 nm wavelength, pulse repetition rate 1-10 Hz, pulse energy up to 20 mJ, beam diameter at half-height 7 mm). The filament was created in air focusing radiation with various lenses. Lens with focal lengths F = 20 - 300 cm were used. The regular structure of the filament was created using an amplitude mask with four holes located at the vertices of a square.

Two independent methods were simultaneously used for the filament diagnostics. Firstly, the acoustic method. A broadband piezoelectric transducer utilizing a 110 mkm thick polyvinylidene fluoride (PVDF) polymer film (working bandwidth is up to 6 MHz) with working area 6 mm in diameter was used. The signal from the transducer was amplified using a broadband amplifier with different gains and recorded on a personal computer. Secondly, the mode of radiation in the filament was recorded. The radiation from the filament region was reflected by a quartz wedge and transferred to a CCD camera. After each shot, the wedge, if necessary, moved for reflecting from a clean surface.

An acoustic method was used to calculate the parameters of the filament. It is possible to determine the size of the thermal source and the volume density of the absorbed energy in the filament measuring the amplitude and width of the acoustic signal. The linear density of the absorbed energy was calculated from the formula of the previous two parameters.

For a filament formed by a lens with a focal length of 3 m, a nonlinear increase in the linear energy density was observed with an increase in the number of merging filaments -- the formation of a superfilament. With a decrease in the focal length of the lens, the fusion occurred less efficiently, which is explained by the large convergence angles of the individual filaments.