High Average Power Ultrafast Fiber Amplifiers

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We report on high average power, high energy ultrafast fiber amplifiers. Different configurations, using chirped pulse amplification, and advanced control of non linear amplification are used to produced pulses as short as 60 fs, pulse duration up to 100 W, and high pulse energy.

High peak power and high average power femtosecond laser systems are required in a large number of industrial and scientific applications such as waveguide writing, micro-machining, frequency conversion, and spectroscopy. In the past years, thermo-optical limitations of ultrafast bulk laser systems have been overcome thanks to the development of new concepts of diode-pumped solid-state lasers. Among these new concepts, ytterbium-doped double clad fiber amplifiers offer a promising alternative to conventional solid-state lasers. There excellent heat dissipation together with the long interaction between the signal, to be amplified, and the pump make these systems extremely efficient and almost insensitive to heat.

Although high energy and very high average power has been already demonstrated in both nanosecond and CW operation, power scaling of ultrafast single-mode fiber amplifiers has been restricted by the non-linearities induced phase distorsions.

The well-know approach, named Chirp Pulse Amplification (CPA) rely on a sufficient pulse stretching in the time domain prior to amplification and recompression. The peak power and thus the non-linearities are considerably reduced into the gain material leading to a limited pulse distortion. Although efficient, applying this amplification regime to ultrafast fiber amplifiers has limitations requiring specific engineering. However, the non-linearities produced during the propagation and the amplification of ultrafast pulses can be used to overcome these limitations. Self Phase Modulation (SPM)-induced spectral compression picosecond fiber amplification systems and femtosecond parabolic pulse fiber amplifiers are good examples of highly nonlinear fiber amplifiers where non-linearities are used in presence of positive dispersion and gain to achieve high peak power in the picosecond or in the femtosecond regime. Another example is the use of large mode area, photonics crystal fibers to decrease the pulse intensity in the fiber amplifier

We will report on high peak power, high average power fiber amplifiers, using chirped pulse amplification, spectral compression, or non linear optimisation. Average power range from 10 to 100W, pulse energy up to several hundreds of microJoules, and pulse duration in the picosecond or femtosecond regime, as low as 60 fs.

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