Modeling of frequency domain mode-locked fiber lasers

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Abstract

Frequency domain mode locked (FDML) fiber lasers is a type of wavelength sweep lasers in which the sweeping period of the narrowband scanning filter equals to the cavity round trip time [1]. As a result, the speed of the scanning filter can be much higher than conventional wavelength sweep lasers because the scanning speed is no longer limited by the laser buildup time. FDML fiber lasers find applications in optical coherency tomography and many other sensing systems. It is challenging to numerically simulate FDML fiber lasers because of the large time-bandwidth product, ~10^8. Recently, using the sweeping filter as the frame of reference, a theoretical model was derived to characterize the laser dynamics of FDML fiber lasers [2,3]. However the model remains computational intensive and cannot be used for analysis and optimization of the FDML fiber laser performance. We observe that further simplification of the model is possible because some of the physical effect such as dispersion, nonlinearity can be neglected in some physically important parameter regimes. Without the time-consuming Fourier transforms, the simulation speed can be increased by two order of magnitude. It is then possible to determine point spread functions which is important for the design and optimization of the FDML fiber laser systems. In this paper, we report a systematic study of the FDML fiber lasers in different parameter regime. We will investigate the impact of different physical parameters including the linewidth enhancement factor of the amplifier on the FDML fiber laser dynamics.

References

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