MAR17-2016-020540

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Ultra-low noise combs in the palm of your hand[1]

THOMAS R. SCHIBLI, University of Colorado, Department of Physics, Boulder, CO 80309-0390

Mode-locked lasers are attractive tools for precision measurements and for photonic microwave generation. The technology around these lasers has rapidly evolved, and with the invention of optical frequency combs, fs-technology has become a ubiquitous tool science and engineering. At first, most of these combs were generated by bulky and delicate Kerr-Lens mode-locked Ti:sapphire systems, but have now been mostly replaced by the much more robust and compact fiber lasers. However, the move from table-top solid-state lasers to the fully self-contained fiber systems came with a price: the optical phase noise performance degraded due to design constraints. While this is of no concern for most spectroscopic applications, it poses a challenge for applications that require excellent short-term phase noise performance, such as, for example, required for photonic microwave generation. While much of this has been improved by ingenious laser designs, it remains a challenge to obtain ultra-low phase-noise combs from high-repetition-rate fiber lasers. Here we present a new approach consisting of a monolithic cavity design, in which the laser light is fully confined inside an optical material. Thanks to this monolithic design, these solid-state lasers are inherently robust against environmental perturbations, such as acoustics, vibrations, air pressure and humidity. Opposed to the omnipresent mode-locked fiber lasers, these monolithic lasers exhibit very low round-trip loss, dispersion and nonlinearities. As a result, they produce highly stable pulse trains, with free-running relative line-widths of the order of a few Hz in the optical domain, despite their moderately high fundamental repetition rates of 1 GHz. The compact design further simplifies integration into complex systems, and eliminates the need for an optics bench or a vibration isolated platform. These lasers produce less than 0.2 W of heat, and are fully turn-key.

[1]This work was supported by the DARPA PULSE program with a grant from AMRDEC and by the NSF Early Career Award.