Low frequency noise fiber delay stabilized laser with reduced sensitivity to acceleration

B. Argence
C. Clivati
J.-L. Dournaux
D. Holleville
et al.
Lasers with sub-hertz line-width and fractional frequency instability around 1x10^{-15} for 0.1 s to 10 s averaging time are currently realized by locking onto an ultra-stable Fabry-Perot cavity using the Pound-Drever-Hall method. This powerful method requires tight alignment of free space optical components, precise polarization adjustment and spatial mode matching. To circumvent these issues, we use an all-fiber Michelson interferometer with a long fiber spool as a frequency reference and a heterodyne detection technique with a fibered acousto optical modulator (AOM). At low Fourier frequencies, the frequency noise of our system is mainly limited by mechanical vibrations, an issue that has already been explored in the field of optoelectronic oscillators.

After extensive study of the spools with Finite Element Modeling (FEM), we realize and test a novel spool design (Fig. 1) which is optimized for low vibration sensitivity along all spatial directions and insensitive to the way it is held. We measure a sensitivity of about 10^{-11}/ms^{2} in all direction for the complete oscillator of 2 km fiber length, limited by the out of spool elements (AOM, coupler, Faraday mirrors). The composed interferometers spool of two symmetrically mounted shows a sensitivity of about 5-8x10^{-12}/ms^{2}. At the conference we will also show frequency noise measurements and the prototype of a simplified oscillator aiming to realize a robust and cost effective very low noise agile laser with acceleration sensitivity below 3x10^{-11}/ms^{2} in all spatial directions.