



ISTITUTO NAZIONALE DI RICERCA METROLOGICA
Repository Istituzionale

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

Original

Low frequency noise fiber delay stabilized laser with reduced sensitivity to acceleration / Lemonde, P.; Faure, B.; Holleville, D.; Clivati, C.; Argence, B.; Santarelli, G.; Dournaux, J. L. - (2018), p. 133. [10.1117/12.2309248]

Availability:

This version is available at: 11696/57431 since: 2021-01-29T22:05:20Z

Publisher:

Published

DOI:10.1117/12.2309248

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

International Conference on Space Optics—ICSO 2012

Ajaccio, Corse

9–12 October 2012

Edited by Bruno Cugny, Errico Armandillo, and Nikos Karafolas



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

B. Argence

C. Clivati

J.-L. Dournaux

D. Holleville

et al.



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

B. Argence, C. Clivati[†], J. L. Dournaux⁺, D. Holleville, B. Faure*, P. Lemonde and G. Santarelli

LNE-SYRTE, Observatoire de Paris, CNRS, UPMC, 61, Av. de l'Observatoire, Paris, France

[†]Instituto Nazionale di Ricerca Metrologica (INRIM), Torino, Italy

⁺GEPI, Observatoire de Paris, CNRS, Meudon, France

*CNES, Centre National d'Etudes Spatiales, 99 Av. E. Belin, Toulouse, France.

Corresponding author: Berengere.Argence@obspm.fr

Lasers with sub-hertz line-width and fractional frequency instability around 1×10^{-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)¹. 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.^{2,3,4}

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 $10^{-11}/\text{ms}^{-2}$ 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 $5-8 \times 10^{-12}/\text{ms}^{-2}$. 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 $3 \times 10^{-11}/\text{ms}^{-2}$ in all spatial directions.

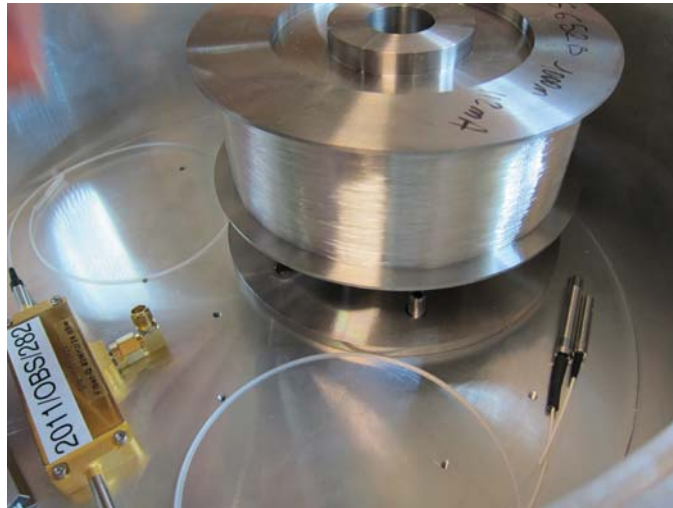


Fig. 1: Low vibration sensitivity spool set up

¹ H. Jiang et al, "An agile laser with ultra-low frequency noise and high sweep linearity", Opt. Exp., vol.18, pp.3284-3297, 2010.

² S.Huang, M.Tu, S.Yao, and L.Maleki. "A turn-key optoelectronic oscillator with low acceleration sensitivity". Proc. of the IEEE IFCS, pp. 269-279, 2000.

³ J.Taylor et al., "Vibration-induced pm noise measurements of a rigid optical fiber spool", Proc. of the IEEE IFCS, pp. 808-810, 2008.

⁴ C.W. Nelson, A. Hati, D.A. Howe, "Common-Arm Counterpropagating Interferometer for Measurement of Vibration-Induced Noise in Fibers," Photonics Technology Letters, IEEE, vol.23, no.21, pp.1633-1635, 2011