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Narrow linewidth generation at 1 THz using cascaded Brillouin fiber lasers and quasi-optic UTC-PD

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Abstract—Narrow linewidth THz generation using a cascaded Brillouin fibre laser structure and a unidirectional carrier photodiode is proposed. Using two distributed feedback lasers separated by > 1 THz with 1 MHz initial linewidth, the linewidth of the realized THz source is found to be < 100 Hz at 1014.7 GHz without use of any active stabilization of the laser cavity or any microwave reference.

I. INTRODUCTION

THE generation using photomixing techniques is an efficient way to obtain a tunable THz emission, taking advantage of the large tunability of photonics compared to electronics. Moreover, THz generation using electronic multiplication chains suffers from phase noise degradation, increasing with the order of the harmonic generation (N). The proposed scheme for narrow linewidth THz generation is efficient for any laser wavelength, and the reported performance is < 100 Hz full width at half maximum (FWHM) at 1014 GHz without any stabilization system.

II. CASCADED BRILLOUIN FIBER LASER

The figure 1 shows the cascade Brillouin Fiber Laser (BFL) architecture. BFL are known since a long time to provide a narrow spectral linewidth emission, [1,2]. The outputted Stokes line is red-shifted by around 10 GHz (at 1550 nm) and might be narrower by a factor ~ 100 to ~ 1000 with respect to its pump. Such architecture has been used for coherent terahertz wave generation (~ 1 kHz FWHM) at 316 GHz [3].

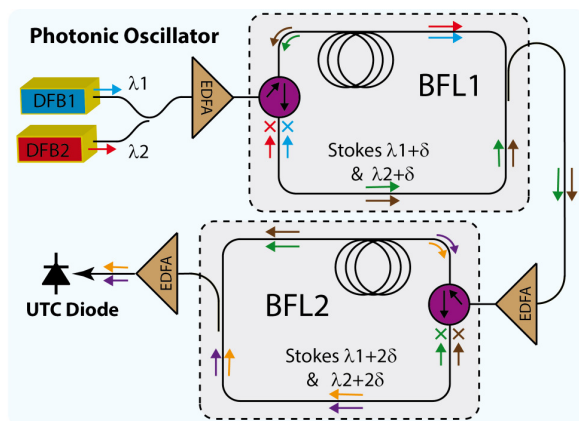


Fig. 1. Cascaded Brillouin fiber laser structure. After being amplified by EDFA1, the emission of two distributed feedback laser diodes (DFB1 and DFB2) seeds a first BFL cavity (BFL1). Two narrow Stokes lines are generated and seed a second BFL to be further narrowed. The resulting output is amplified and focused on an UTC photodiode producing a 1 THz line with a < 100 Hz FWHM.

The figure 2 shows the spectrum measured using a sub-harmonic mixer driven by an electrical spectrum analyzer (ESA). ESA intrinsic phase noise is shown for comparison.

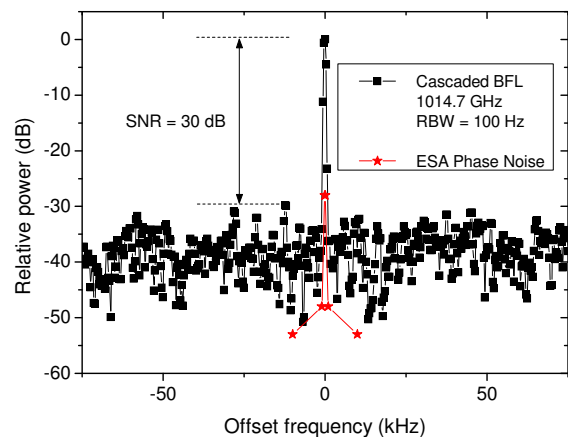


Fig. 2. Measured spectra at 1014.7 GHz, with ESA phase-noise level.

III. CONCLUSIONS

Narrow bandwidth THz generation is proposed using cascaded BFL above 1 THz, featuring a < 100 Hz FWHM generation.

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REFERENCES

- [1] Stokes, L. F., Chodorow, M., and Shaw, H. J.: ‘All-fiber stimulated Brillouin ring laser with submilliwatt pump threshold’, *Optics Letters*, 1982, 7, (10), pp. 509–511, doi: <http://dx.doi.org/10.1364/OL.7.000509>
- [2] Debut, A., Randoux, S. and Zemmouri J.: ‘Experimental and theoretical study of linewidth narrowing in Brillouin fiber ring lasers’, *J. Opt. Soc. Am. B*, 2001, 18, (4), pp. 556–567, doi: <http://dx.doi.org/10.1364/JOSAB.18.000556>
- [3] Ducournau, G., Szriftgiser, P., Akalin, T., Beck, A., Bacquet, D., Peytavit, E., and Lampin, J. F.: ‘Highly coherent terahertz wave generation with a dual-frequency Brillouin fiber laser and a 1.55 μm photomixer’, *Optics Letters*, 2011, 36, (11), pp. 2044–2046, doi: <http://dx.doi.org/10.1364/OL.36.002044>