SubTHz frequency synthesizer based on a femtosecond-laser comb: the spectrum purity demonstration

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Growing requirements in the spectroscopic measurement accuracy lead to a necessity of a radiation source with a narrow spectra and low phase noise. The most accepted technique in mm-submm wave range is phase-locking the frequency of the primary cw radiation source (such as BWO or Gann diode) against a harmonic of microwave synthesizer. This technique multiplies frequency of mw signal to obtain the necessary frequency of mm-submm radiation which entails growth of the phase noise. Radiation spectrum purity is crucial, especially in the case of measuring some narrow spectral features, such as sub-Doppler line profiles and Lamb-dip spectra.

Frequency combs generated by femtosecond lasers have already been used for both precision measurements and the generation of a coherent cw subterahertz radiation [1-3]. Each component of the comb was shown to have subherz width and phase stability corresponding to one of the reference source used for phase-locking of the laser pulse repetition frequency. Frequency comb optical-to-terahertz down-conversion allows to cover the mm-submm region with equidistant frequency markers of high spectral purity, which can be used as a reference signals for phase locking of primary radiation sources. The possibility of such stabilization was shown in [4]. Current report presents results of the direct comparison of radiation spectrum purity between traditional and the laser frequency comb based synthesizers.

A backward-wave oscillator OB-71 covering a frequency range of 70-120 GHz was stabilized by both mentioned ways at frequency of about 110 GHz and used for recording the high-Q (1.5×10^6) Fabry-Perot resonator response at selected eigen-frequency as described in [5]. This allows to use sharp slopes of the Fabry-Perot response as a phase discriminator converting phase noise of the radiation source into amplitude noise. Analysis of the curve recordings demonstrates that phase noise of the BWO radiation frequency phase-locked with a femtosecond laser comb at least does not exceed one of the BWO frequency phase-locked against modern Agilent E8257D centimeter-wave synthesizer (phase noise power was measured in the band 0 – 10 kHz).

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