Passive Mode-Locking of Two Helical-Type Gyro-TWTs at sub-THz Frequencies

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ABSTRACT

New sources for the generation of ultra-short coherent radio frequency (RF) pulses at a reasonable output power of more than a few Watts in the sub-THz frequency range are gaining fundamental interest in the research community. Those RF sources might become the key components of future THz diagnostic and spectroscopy systems [1].
In this presentation, a new sub-THz source for the generation of trains of coherent high-power ultra-short pulses at 263 GHz is presented. The investigated frequency is an established figure for continuous wave DNP-NMR (400 MHz) application and, therefore, the investigated source could lead to the development of novel time-domain DNP-NMR methods [1].
The new pulsed source uses the mechanism of passive mode-locking of two helically gyro-TWTs [2] as it was first proposed in [3] and experimentally shown in [4] for the Ka-band. The principle of passive mode-locking is well known from laser physics. At microwave frequencies, it can be realized in a feedback loop of two vacuum electron tubes, one operated as amplifier, the other one as nonlinear saturable absorber [3]. The nonlinear absorber strongly attenuates low-power signals while it is almost transparent at high-power levels. In this way, it narrows the pulses. A fraction of the oscillating pulses is decoupled from the feedback loop, which results in a train of coherent high-power ultra-short pulses.
The pulsed source presented here is an extended version of the originally proposed setup in [3,4] with the aim to increase the possible fields of application. The usage of a high-gain helical gyro-TWT [5] instead of an ordinary helical gyro-TWT as amplifier enables the operation of the passive mode-locked oscillator in the hard excitation regime, while the original proposal is limited to an operation in the soft excitation regime. Further benefits are provided by a novel feedback system [6], which enables alternative operation regimes for the two coupled helical gyro-TWTs. Besides the original purpose as a mode-locked oscillator, the developed feedback system allows the realization of a two-stage amplifier and the possibility of operating the devices as backward wave oscillators.
In combination, these extensions make such a system of coupled helical gyro-TWTs a promising new microwave source for future time-domain spectroscopy applications.

References

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