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VFEL-based THz radiation sources with resonators formed by metallic wires

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Volume FEL (VFEL) lasing in centimeter and millimeter wavelength ranges [1-5] is an encouraging demonstration of the potential for the development of similar sources in other ranges of electromagnetic spectrum. This paper considers THz generation by a relativistic electron beam in a VFEL whose slow-wave structure (resonator) consists of a rectangular waveguide with an array of periodically strained metallic wires. Previous studies [6] have shown that the intensity of spontaneous quasi-Cherenkov radiation in
photonic crystals built from parallel metallic wires increases significantly when the wavelength becomes comparable with the wire radius (kR~1). This ensures that the efficiency of electron beam interaction with the slow-wave structure based on such photonic crystals might be substantially higher than that with conventional
structures (corrugated waveguides, combs, etc.).

When the typical diameter of the wire is about tens or hundreds of microns, the maximal radiated power corresponding to the condition kR~1 is achieved in the THz range. As a result, ultrashort (from a few to tens femtoseconds) electron bunches with energies up to tens–hundreds mega-electron volts, which are typical of the accelerators in currently used and constructed FELs, will enable one to obtain short THz pulses of GW power in the described structures. The frequency of thus generated radiation, due to Bragg diffraction, depends on the mutual orientation of the photonic crystal and the beam and can vary as the crystal is rotated.

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Primary authors: Mr GURNEVICH, Evgeny (Research Institute for Nuclear Problems of Belarusian State University); Prof. BARYSHEVSKY, Vladimir (Research Institute for Nuclear Problems)

Co-authors: Dr GURINOVICH, Alexandra (Research Institute for Nuclear Problems); Mr MOLCHANOV, Pavel (Research Institute for Nuclear Problems)

Presenter: Mr GURNEVICH, Evgeny (Research Institute for Nuclear Problems of Belarusian State University)

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