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Novosibirsk free electron laser as a user facility

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Abstract

The Novosibirsk free electron laser is the first multi-turn energy-recovery linear accelerator with three separate laser systems (the terahertz, far-infrared and mid-infrared ones). The facility is well equipped with optical elements and instrumentation available to Russian and foreign users. In this paper, we describe in brief the workstations of the facility and survey selected recent experiments using intense monochromatic terahertz laser radiation, which can be tuned from 90 to 240 μm.

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Keywords: free electron laser, workstations, terahertz radiation, optics, spectroscopy, biology

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1. Introduction

The Novosibirsk free electron laser (NovoFEL), a user facility [Kulipanov et al. (2015)] consisting of three laser systems (the terahertz, far-infrared and mid-infrared ones), is part of the Siberian Synchrotron and Terahertz Radiation Center. It emits monochromatic high-power radiation in spectral ranges from 5 to 240 μm. The terahertz laser system has been in operation since 2003, and most experiments have been performed using terahertz radiation. This system emits radiation in the spectral range of 90 μm to 240 μm as a continuous stream of 100-ps pulses with a repetition rate of 5.6 MHz and a line width of less than 1%. In a routine regime, the average power of radiation at the user stations is 50-150 W at λ = 130 μm. The high-power radiation, relatively narrow linewidth and tunability of the radiation wavelength enable a wide variety of experiments. Terahertz methods and techniques are rapidly developing fields of science, the potential of which is obviously far from being exhausted. The unique characteristics of the NovoFEL radiation and the techniques developed at the facility during past 10 years enabled experiments most of which would be impossible with conventional terahertz sources. The NovoFEL opened new possibilities for original experiments and novel methods and techniques in the field. Twenty eight research groups from Russia (Novosibirsk, Tomsk, Krasnoyarsk, Samara, Nizhny Novgorod, and Moscow) and abroad (South Korea and Germany) have worked at the facility. In this paper, we survey selected recent experiments on the terahertz line of the NovoFEL.

2. Beamline and workstations

Characteristics of the Novosibirsk free electron laser facility achieved by the summer of 2016 are described in the paper [Shevchenko et al. (2016)]. The accelerator and the laser resonators are situated underground in the radiation protected hall. The beam emitted from a separate laser resonator passes through the primary beamline and then enters the main beamline, in which the mirror system directs the beam to a selected workstation. A sketch of the beamlines and workstation positions is shown in Fig. 1 [Kubarev (2016)]. Stations 1 – 7 are situated on the first floor, whereas stations 8 – 13 are on the second floor. The beamline sections shown in the figure in the left side have been already assembled, and workstations 1 – 7 and 12 – 13 are available to users. Outputs 8 – 11 can be used for construction of new workstations. The beamline sections shown in the right will be assembled in near future.

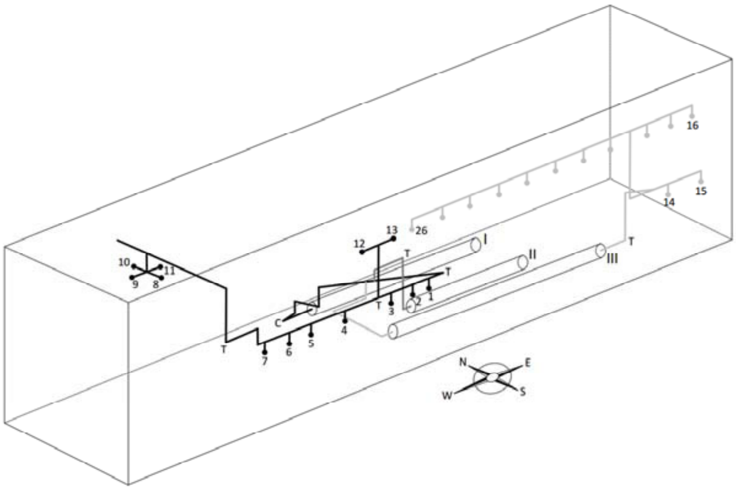

Fig. 1. Beamline system at NovoFEL. T – toroidal mirrors, C – spherical mirror, 1, 2, 3, …– workstations. I – terahertz FEL, II - far infrared FEL, III - infrared FEL.