Novosibirsk high-power THz FEL facility*

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***Abstract*—Novosibirsk free electron laser (FEL) facility contains three FELs operating in the wavelength range 8 – 240 micron at average power up to 0.5 kW and peak power about 1 MW. Radiation users works at 6 user stations performing biological, chemical, physical and medical research.**

Keywords—free electron laser; terahertz radiation; electron accelerator.

The Novosibirsk FEL facility [1] is based on the multiturn energy recovery linac (ERL). At present the Novosibirsk ERL is the only one multiturn ERL in the world. It has rather complicated lattice as it can be seen from Fig. 1. The ERL can operate in three modes providing electron beam for three different FELs. The whole facility can be treated as three different ERLs (one-turn, two-turn and four-turn) which use the same injector and the same linac. The first, one-turn, ERL [2] is placed in vertical plane. It works for the THz FEL (80 – 240 micron) which undulators are installed at the floor. The other two ERL beamlines and FELs are placed in horizontal plane at the ceiling (see Fig. 1).

The first stage FEL includes two electromagnetic undulators with period 12 cm, phase shifter and optical cavity. Undulator pole shape is chosen to provide equal electron beam focusing in vertical and horizontal directions. The matched beta-function is about 1 m. The phase shifter is installed between undulators and it is used to adjust the slippage. The optical cavity is composed of two copper mirrors covered by gold. The distance between mirrors is 26.6 m which corresponds to the repetition rate 5.64 MHz. Radiation is outcoupled through the hole made in the mirror center.

The FEL generates coherent radiation tunable in the range 120-240 micron as a continuous train of 40-100 ps pulses at the repetition rate of 5.6 - 22.4 MHz. Maximum average output power is 500 W, the peak power is more than 1 MW. The minimum measured linewidth is 0.3%, which is close to the Fourier-transform limit.

The second FEL includes one electromagnetic undulator with period 12 cm and optical cavity. The undulator is installed on the bypass where the electron energy is about 22 MeV. Therefore the FEL radiation wavelength range is 40 - 80 micron. The undulator design is identical to the first stage one

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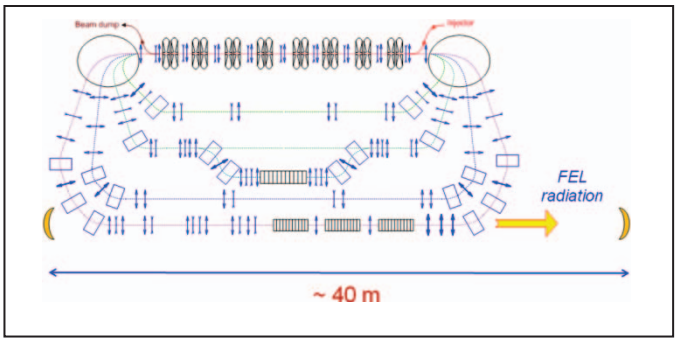

Fig. 1. Scheme of ERL with second and third FELs.

but it has smaller aperture and higher maximum magnetic field amplitude. The optical cavity length is 20 m (12 RF wavelengths). Therefore the typical bunch repetition rate is 7.5 MHz.

The third FEL is installed on the fourth track of the ERL. It includes three undulator sections and 40-meters-long optical cavity. The design tuning range of this FEL is from 5 to 20 microns and the design average power at bunch repetition rate 3.74 MHz is about 1 kW. The third FEL was commissioned in 2015.

In the nearest future we plan to build and install the permanent magnet variable period undulator [3], to deliver the third FEL radiation to existing user stations, and to demonstrate feasibility of so-called “electron outcoupling” [4].

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