RADIATION MONITORING AT NOVOSIBIRSK FEL

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Abstract

The radiation diagnostics system controls the levels of radiation in the accelerator hall and in the adjacent rooms where the FEL personnel works. The system provides radiation safety for the personnel. The software performs data visualization and records measurement results in the database. There are special ionization chambers installed in the accelerator hall. They track beam losses in the vacuum chamber; this information is used for beam orbit correction. These sensors detect induced radioactivity. Based on these data, we can trace the degradation of the material of the construction under the action of radiation.

FEL PARAMETERS

Novosibirsk high-power FEL is based on the multiturn energy recovery linac (ERL), see Fig. 1. The FEL parameters are listed in Table 1.

Table 1: Parameters of FEL

Number of orbits	1	2	4
Electron energy, MeV	12	22	42
Average beam current, mA	10	10	10
FEL wavelength, micron	120 - 240	40 - 120	5 - 40
Max output power, kW	1	10	10

The accelerator hall is shown in Fig 2; the thickness of its concrete walls is 3 meters. This thickness provides radiation protection for the 1 GeV accelerator.

Current losses:

Injector $\delta I/I < 5\%$

Microtron $\delta I/I < 0.5\%$

Higher dose rates are observed in the area of the RF resonators, bending magnets and dump, where radiation sensors are installed.

HARDWARE AND SOFTWARE OF THE RADIATION DOSIMETRY SYSTEM

Our institute has developed a radiation monitoring system using two types of radiation detectors based on ionization chambers. The first-type detectors register radiation at the natural background level of 0.01 – 0.02 μSv/h. They are located in the rooms where people work.

The second-type detectors register radiation of about 10 Sv/h. These twenty gas-filled detectors are located in the accelerator hall and control photon radiation there.

The spherical ionization chamber is filled with air at a pressure of 4 atm. The chamber is made of polyamide with a thin layer of colloidal graphite; its wall thickness is 1.1 mm (Fig. 3.).

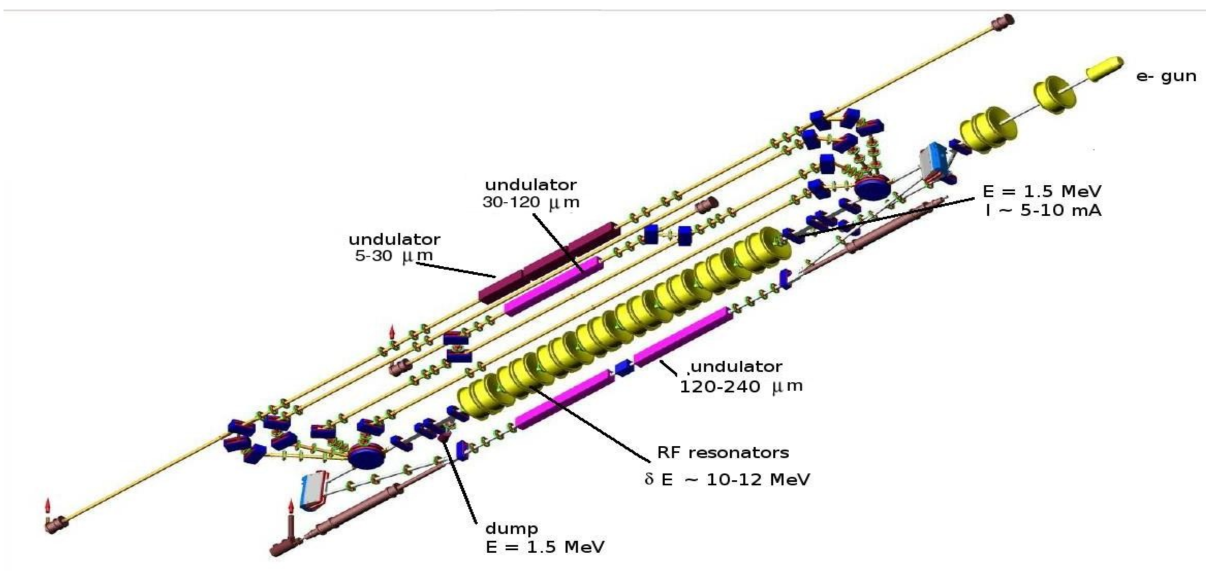

Figure 1: Novosibirsk ERL with the three FELs.

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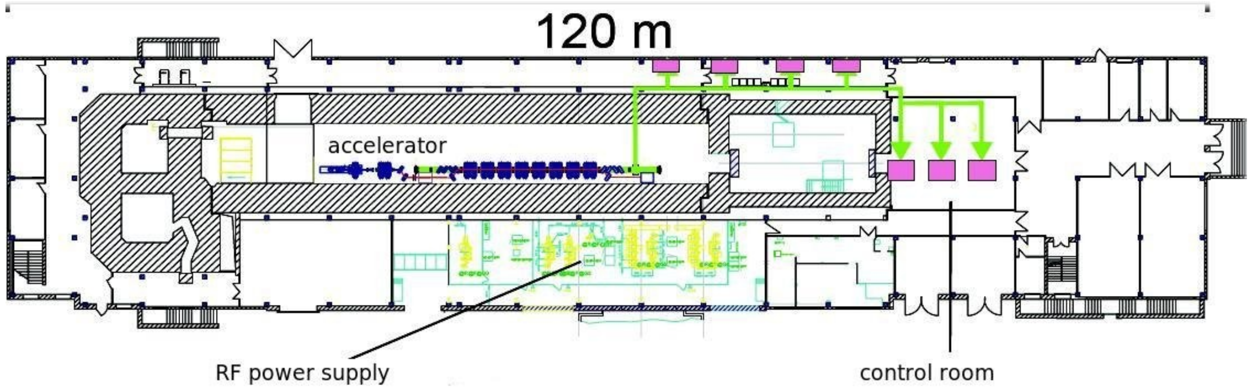

Figure 2: The layout of FEL systems

Figure 3: Ionization chamber.

The detectors that register small doses are connected to the microcontroller TINI with the Ethernet capability. The detectors that register large doses are connected to a module for preliminary processing of signals, which has the CANbus interface (Fig. 4).

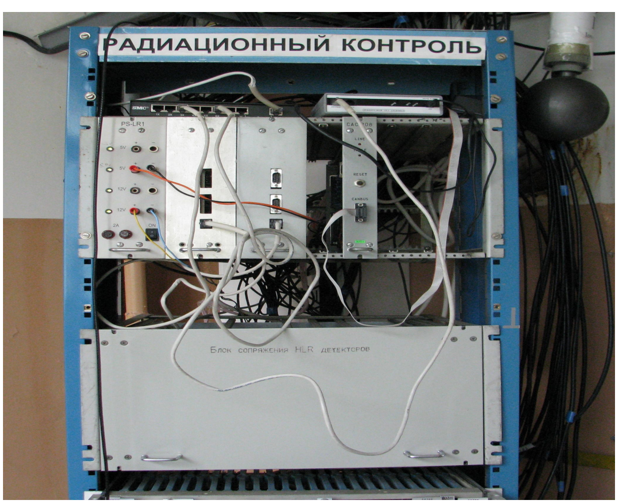

Figure 4: Hardware of the radiation safety system.

At FEL operation, the control system monitors dose rates and provides protection with the help of the user client “Xray”. The program “Xray” maintains a logbook; a record is created for each radiation transducer. Periodically, the program “Xray” records a timestamp and maximum and average values of dose rates for each transducer. The “Xray” program executes sampling from the transducers with a frequency of 1 Hz (Fig. 5). Besides, the "Xray" program allows watching the electron beam pass, since insignificant losses of electrons on the walls of the vacuum channel make the dose rate increase.

1. Radiation Monitoring in the accelerator hall. The program controls beam losses in the vacuum chamber. It enables the operator to adjust the orbit. Besides, it protects the vacuum chamber from heating (or burning). The information is input into the database, which helps us analyse the effects of radiation on materials and equipment and calculate the lifetime of the technological units.

2. Radiation Monitoring in the offices. The radiation levels do not exceed the federal limits and are mostly equal or less than the natural background radiation.

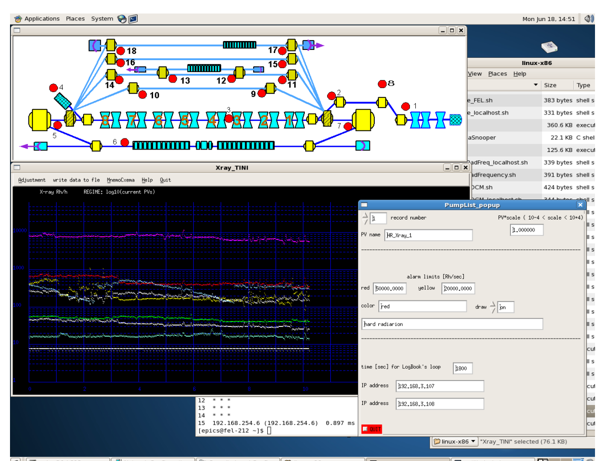

Figure 5: GUI client “Xray”.

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