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ANALYSIS OF X-RAY RADIATION OF ELECTRON BEAMS OF THE GYROTRON T-15MD *)

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Microwave radiation generators (gyrotrons) are effectively used in tokamak experiments for additional plasma heating and non-inductive current drie, as well as for preliminary gas ionization at the initial stage of the discharge. Safe and reliable operation of such a gyrotron complex requires the use of effective protection measures not only from microwave radiation, but also from x-ray radiation from gyrotrons. Measurement of x-ray radiation and the development of shielding systems to reduce radiation fluxes during operational maintenance of gyrotrons are of interest when conducting experiments on tokamaks and design of the tokamak-reactor (ITER).

On the T-15MD tokamak it is planned to equip a gyrotron complex consisting of 7 gyrotrons. The microwave radiation power generated by each of the gyrotrons must be at least 1 MW per pulse lasting from 20 to 30 seconds with a generation efficiency of at least 50% (it is assumed that a system for recovering residual energy of the electron beam is used). The high-voltage power supply system for gyrotrons provides accelerating voltage up to U ~ 70 kV (cathode voltage – 46.5 kV, anode voltage + 24.5 kV, cathode current Ic up to 37 A) [1].

The report presents the results of measuring x-ray radiation during operation of the 82.6 GHz gyrotron in the standard mode for up to 1 s. To record the x-ray spectra, a NaI spectrometric detector (d150×80 mm) was used. The spatial distribution of the radiation was determined using two Canberra LaBr3(Ce) scintillation detectors (d38.1×38.1 mm) with a 2007P signal preamplifier, placed in different positions relative to the gyrotron. Additionally, a set of semiconductor detectors made of cadmium telluride CdTe (1×1×1 mm) and silicon Si (Ø5×1 mm) is equipped for recording x-ray radiation in the current mode.

The spectrometric analysis carried out in the gyrotron operating mode with an accelerating voltage U = 47.6 kV showed a continuous energy distribution of x-ray radiation with a maximum in the range of 15-20 keV. The maximum radiation intensity is observed near the output window of the microwave path and in the lower part of the gyrotron. A significant (up to 3 times) increase in the intensity of x-ray radiation is observed in the mode of disruption of the generation of microwave radiation.

Installation of protective lead screens (up to 4 mm thick) near the electron beam collectors and in the area of the output window of the microwave path ensures attenuation of the X-ray radiation intensity by up to 5-10 times.

The project of a mobile measuring complex based on LaBr3(Ce) and NaI detectors in spectrometric mode to determine the absolute values of X-ray fluxes is considered.

References

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*) abstracts of this report in Russian