X-RAY PERISCOPE DIAGNOSTIC SYSTEM MODERNIZATION On THE T-10 TOKAMAK

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One of the main threats to the safe operation of a tokamak are beams of runaway electrons. These beams are formed in strong electric fields that appear at the initial stage of the discharge, when a large number of impurities enter and when MHD develops perturbations with high rates of magnetic flux change [1] (magnetic reconnection). The energies of the runaway electrons can reach tens of MeV, and the heat release density of several GW / m2 [2]. The interaction of such a beam with the wall leads to damage to the surface of the intrachamber elements facing the plasma.

The T-10 tokamak is equipped with a number of diagnostics for the study of runaway electron beams. They are based on the measurement of the epithermal and hard x-ray radiation produced by the deceleration of runaway electrons on the thermal plasma and in the elements of the first tokamak wall. A feature of the bremsstrahlung of high-energy relativistic electrons is the predominant direction of this radiation in the direction of motion of the electrons. Therefore, the diagnostics used to measure X-ray profiles in the orthogonal direction cannot see the primary radiation of runaway electrons, and only scattered radiation is recorded when they interact with the first wall.

To investigate the space-time evolution of runaway electrons, a new diagnostic system based on the CdTe detector is equipped on the T-10 tokamak, which provides measurement of X-ray radiation in the direction along the motion of the electron beam. CdTe detector with dimensions of 10 × 5 × 1 mm. Detector is integrated with the signal amplifier and assembled in a miniature case (d9 × 60 mm) for placement inside the vacuum chamber. The bandwidth of the detecting unit is ~ 1-2 MHz with a characteristic rise time of a rectangular pulse of ~ 0.5-1 μs. The detector was calibrated on a light-emitting diode of an optical spectrum and an X-ray tube OI Eclipce IV with a maximum radiation energy of up to 50 keV.

To improve spatial resolution, a protective screen with a collimating tube d1 mm designed and protected against x-ray radiation with an energy of up to 300 keV was designed and manufactured. The screen is made of lead with a wall thickness of 17 mm and is located inside the steel hood. The detector assembly is inserted inside the vacuum chamber by means of a movable pin through the high-vacuum input of the movement. The change in the height of the detector installation inside the vacuum chamber changes the chord of the plasma observation line. In addition, the detector has the ability to rotate around its axis with a vacuum stepper motor.

The measurements with the help of an intra-camera detector are planned in conjunction with the spectrometers of epithermal and hard X-ray radiation located outside the vacuum chamber.

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References

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