Optimization of GEM-based detector readout electrode structure for SXR imaging of tokamak plasma

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In recent years, the GEM-based detectors were applied as a tool for registration of X-ray radiation from tokamak facilities [1,2]. The requirements for these detectors are, on the one hand, the best possible temporal resolution, i.e. the ability to record radiation with the highest achievable rate, and, on the other hand, the best possible spatial resolution.

The present work presents an optimization of a readout structure of the GEM-based detector designed for X-ray imaging for DTT tokamak in the energy range of 2-15 keV [3]. The readout electrode of approximately 100 cm^2 surface is composed of hexagonal pixels connected in a way that allows reducing the actual number of signal pixels (electronics channels). At the same time, based on time coincidence analysis, it makes possible to unambiguously identify the position of the recorded X-ray photon. For the input spectrum, the Detective Quantum Efficiency (DQE) of the detector was calculated using the Geant4 program and the spatial distributions of electron avalanches at the readout electrode were simulated using the Garfield++ program. These were conducted for a given energy range of radiation and a statistical distribution consistent with the shape of the spectrum considering the DQE of the detector. As a result, the size of a single hexagonal pixel was proposed to capture the position of the recorded radiation quanta in an optimal and effective way.

References

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