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X-ray tomography systems for observations of electron cyclotron heated plasmas using novel position-sensitive X-ray semiconductor-detector arrays

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Tomographic reconstructions of X-ray emission from hot electrons having a temperature of several tens of keV have been carried out by the use of the novel position-sensitive X-ray semiconductor detector array. The X-ray detection system in the thermal-barrier region of the GAMMA 10 tandem-mirror plasmas consists of a 48-channel silicon semiconductor detector array.

X-ray energy responses of the new detector array along with response uniformity of detector channels have been characterized by using synchrotron radiation at the Photon Factory of High Energy Accelerator Research Organization (KEK) in Japan. The X-ray reconstructed signals under standard thermal-barrier operational conditions indicate a good axisymmetric radial profile peaked on the magnetic axis. When we make outward shifts of the second-harmonic electron cyclotron layers radially by intensifying the mirror magnetic fields in the thermal-barrier region, tomographically reconstructed signals show hollow X-ray profiles. Several applications including investigations of these hot electrons due to the second-harmonic electron-cyclotron heatings are made with the novel position-sensitive X-ray semiconductor-detector array. For instance, essential investigations in relation to an internal transport barrier and intermittent turbulent vortex-like structures are carried out for the purpose of physics studies of universal effects of radially sheared electric fields on plasma-confinement improvements.

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