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Characteristic X-Ray Wire-Scanner for Fast Charged and Neutral Particle Beams Diagnostics

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Diagnostics of transverse phase space of charged particle beams is an important task for modern scientific research. Solid wire-scanners are still very popular due to their simplicity, robustness and sufficient resolution. In high energy linear accelerators bremsstrahlung photons are highly collimated, therefore a detector have to be placed very far downstream that implies difficulties with alignment and constructional constraints. We propose the method for measuring the transverse phase-space characteristics of particle beams which can ionize a medium. The method is based on the measurement of the Characteristic X-ray spectra generated during the monitored beam interaction with a wire-scanner.
The electron beam diagnostics system of the experimental station developed to study mechanisms for electromagnetic radiation generation presented in [1] was modernized. The main part of the experimental station is a DC electron gun, which produces an electron beam with energy up to 100 keV. Five wires are located in different places along the beam axis. After the upgrade, wire scanners of different materials (Ti, W, Mo, Cu, Pt) are used. The different materials of the wires were chosen to generate Characteristic X-ray lines (CXR) at different energies. The X-rays are measured while scanning by the wires across the beam. The use of a semiconductor detector makes it possible to separate signals from different wires.
The presented scanner allows measuring spatial profiles, dimensions, trajectory, divergence and emittance of beams of charged particles in a wide energy range from few of keV to tens of GeV, as well as the characteristics of atomic, X-ray and gamma-ray beams. Since CXR distribution is isotropic, there are no requirements and limitations on the location of the X-ray detector relative to the beam axis.

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[1] Nazhmudinov R. M., Karataev P., Kubankin A., Lekomtsev K., Potylitsyn A., Vukolov A. Experimental station with continuous electron beam for investigation of various mechanisms of EM radiation generation. Journal of Instrumentation 13 (2018) C06007.

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