Thin Ionization Chambers for Multi-Angle Scanning Electron Beam Diagnostics: Development, Calibration, and Experimental Testing

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Today, there are various techniques available for beam diagnostics of charged particles, such as electron beams. One such technique is the multi-angle scanning method [1]. This method is based on the mathematical reconstruction of the two-dimensional transverse profile of the beam using intensity data obtained from one-dimensional scans of the beam at different angles. These scans are generated by directing the particle beam onto a detector that is significantly smaller in size than the beam being studied, allowing for more accurate measurements.

In this paper, we propose the use of thin ionization chambers as electron beam diagnostic detectors using the multi-angle scanning technique. These chambers exhibit high radiation resistance, real-time measurement capability, and applicability to a wide range of experimental conditions, having been specially developed at the Laboratory of Nuclear Reactions at JINR (Dubna, Russia). The chambers are cylindrical ionization detectors filled with air, with an anode tube diameter of 2 mm and a central cathode diameter of 0.2 mm. The ionization chambers operate in current mode, recording the ionization current that is proportional to the beam intensity. A digitization system based on SMARTBOX 6 modules [2] and proprietary software is employed to record the signal.

In [3], it was proposed to use a multi-channel detector system instead of a single detecting element in order to reduce the scanning time. To create such a system based on the ionization chambers proposed and successfully integrate them, it was necessary to conduct calibration tests using a high-energy electron beam, as each ionization chamber has a unique response.

For this purpose, a set of 16 ionization chambers was elaborated and experimentally tested on the electron beam from the MT-25 microtron with a particle energy of 5 MeV for calibration. Calibration coefficients for each detector were then obtained. The experimental data demonstrate that the ionization chambers record the same electron beam intensity profiles when calibrated in relative units.

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References

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