The Methods and Detection Systems for Synchrotron Infrared Nondestructive Diagnostics of Electron and Proton Bunches

A.A. Maltsev

JINR, 141980, Dubna, Russia E-mail: amaltsev@cv.jinr.dubna.su

Methods for measuring the current and geometrical parameters and estimating the energy parameters of electron and proton bunches in ring accelerators using synchrotron radiation in the infrared region are reviewed, together with the information-measuring systems designed to detect synchrotron radiation and realize these methods [1,2]. The synchrotron radiation spectrum that is used lies mainly in the infrared region. The detection systems incorporate specially designed infrared-optical elements (a high-vacuum window of optical ceramics and broad-band, long-focus optical channels). The radiation is detected in the spectral region 0.3 - 45 mkm by infrared detectors operating at low temperature or room temperature. Besides describing the methods based on the use of synchrotron radiation as a carrier of objective information about the parameters of beams in an accelerator, our objective in the present work is to call attention to a wide range of problems that could be solved with the aid of these synchrotron, primarily infrared, diagnostic methods. A wavelength range which includes the visible (from 0.3 mkm) and infrared (up to 45 mkm) regions of the optical wavelength spectrum is used; this greatly exceeds the spectral range presently employed for this purpose (0.3 – 1.1 mkm). Such a wide spectral range was not chosen accidently. This is the region of spectral sensitivity of many, easily available and simple to operate, infrared detectors, which, on account of their speed of operation and sensitivity, are capable of satisfying the requirements of an accelerator experiment. The synchrotron radiation diagnostics methods and systems were based on the results of spectral calculations and the latest achievements of infrared technology (optical materials and radiation detectors). This made it possible to solve the problems arising in an accelerator experiment of providing measurements and monitoring the instantaneous (with 1 mks) values of the following basic parameters and characteristics of a beam: particle number (current), geometric parameters (dimensions), position in the space of the accelerator, particle distribution in space and time, particle energy, and others.

References

[1]A.A. Maltsev, Phys. Part. Nucl., 27 (3) 1996, p.330.
[2]A.A. Maltsev and M.A. Maltsev - Atomn. Energy, 80 (3) 1996, p.190.