THE POTENTIALITIES OF $H^-$ BEAM DIAGNOSTICS BY DETACHED PARTICLES

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Abstract

A comparative analysis of proposed methods of $H^-$ beam diagnostics by secondary particles, which are produced from the detachment of a part of the ions in thin probing particle or photon targets, is presented. The estimate of the measurement accuracies for various beam parameters and used targets is made. As shown, using a photon target, wider potentialities of nonperturbative beam diagnostics can be achieved from the viewpoint of accuracies and the spectrum of compact diagnostic apparatus.

1. INTRODUCTION

For measuring the profile and phase-structure of ion beams, the emission of electrons from a probing particle target, is broadly used [1-4]. Using some analogous devices separated by a drift distance allows one to measure the transverse [5] and longitudinal [6] emittances of a beam. Broader potentialities of the diagnostics by means of one measuring device are opened up for negative ion beams, in particular $H^-$. Due to the atomic structure of these particles, it is possible to fulfill the conditions when the flux of electrons and neutral atoms, which are produced on a probing particle or photon targets, is presented. The estimate of the measurement accuracies for various beam parameters and used targets is made. As shown, using a photon target, wider potentialities of nonperturbative beam diagnostics can be achieved from the viewpoint of accuracies and the spectrum of compact diagnostic apparatus.

2. $H^0$-ATOM AND ELECTRON PERTURBATIONS IN THE $H^-$-ION DETACHMENT

Maximum accuracies of the coincidence of the $H^-$ ion, $H^0$ atom and electron distributions in a beam at angle $(\Delta \theta_0, \varphi)$ and relative energy $(\Delta E_{0,\varphi}/E_{0,\varphi})$, where $E_0 = E \cdot m_e / M$, $E_{0,\varphi}$ is the electron mass, $M$ and $E$ are the mass and energy of $H^-$ ion) are determined by the value and nature of the perturbation that the atoms and electrons get in elementary acts of their creation as a result of ion detachment, and depend on the type of the used probing target. A comparative analysis of these accuracies can be realized by means of the experimental [14-23] and theoretical [24-28] dependences for electrons and $H^0$ atoms presented respectively in figs. 1 and 2. The half-amplitude widths of the corresponding distributions

Figure 1: The maximum accuracies of the coincidence of the $H^-$ ion and electron distributions at relative energy $(\Delta E_{0,\varphi}/E_{0,\varphi})$ and angle $(\Delta \theta_0, \varphi)$ for different particle ($1, 6 \sim \odot K\alpha$, $\ast Ne, C, H, Cl$, $\odot He$, $\times Ar$, $\bullet C$) and photon $(\lambda = 10600 \text{Å} - 2,3,7,8$, $\lambda = 16300 \text{Å} - 4,5,9,10$) targets versus ion energy.
perpendicular to the interaction plane. The experimental results of ref.[23] for photon target, which polarization is perpendicular (\(\times\)) or parallel (\(\odot\)) to the interaction plane, are obtained by means of the method of ref.[20] and correspond to the half-amplitude widths of the angular distributions of \(H^0\) atoms.

High monochromaticity and orientation of laser radiation, relative simplicity of its space control allow one to exploit the Doppler-effect efficiently for the realization of the distribution coincidence with a maximum accuracy on high energy beams, and also to form photon targets with small sizes in space-time and to develop compact multifunctional devices. Compactness of these devices is achieved by using the photoelectrons produced as a result of near-threshold photodetachment of \(H^-\) ions or intermediate \(H^0\) atoms, at the final stage of beam information readout [10,13].

1 REFERENCES
