MATHEMATICAL MODELLING OF THE ION MOTION IN THE ISOCHRONOUS MAGNETIC AND RADIO FREQUENCY ELECTRIC FIELDS

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The results of mathematical modelling of the ion motion show the possibility of the phase focussation of the ions with utilization of the radial force. This force is realized with a radial component of electric field. The beam monochromatization is analyzed simultaneously.

1 Equation of the ion motion

The trajectories have been calculated by numerical integration of the motion equation [1], which, in the polar axis frame, has the following form:

\[ y'' - \frac{2y'^2}{y} - y = -\frac{e\omega_0}{p} \left\{ \frac{(y'^2 + y^2)^{3/2}B_z}{y} + \frac{(y'^2 + y^2)}{y\beta c} (y' E_\varphi - y E_r) \right\}, \]

\[ \frac{d\tau}{d\varphi} = \frac{1}{\beta} \sqrt{y'^2 + y^2}, \]

where \( y' = \frac{dy}{d\varphi}, B_z = b_0 (1 - y^2)^{-1/2}, \tau = \omega_0 t, \omega_0 \) is the isochronous revolution frequency given by \( \omega_0 = eB_0/m_0, B_0 \) are the charge and the rest mass of the ion, \( E_r \) and \( E_\varphi \) are the radial and azimuthal components of electric field, \( y = r/r_\infty \), where \( r \) is the radial coordinate of the ion and \( r_\infty = c/\omega_0, c \) is the velocity of light and \( p, \) respectively \( \beta \) are the impulse and relative velocity of the ion. The motion along the vertical axis was omitted.

The equations mentioned above are described in [2] but the radial component \( E_r \) is not included there. In our work we have introduced the rectangular accelerated slots (RAS) with \( E_r \) component. Such a field causes the radial force. For this purpose we have modified the equation from work [2] to the form presented above.

2 Results

The dee structure, compounded from four dees, is schematically shown in Fig. 1. There are two radial slots with centers at 90°, 270° and two RAS with exit edges at 45°, 225° and 60 mm wide. There are applied RF electric fields with frequency \( \omega_2 = 2\omega_0 \) of 50 kV voltage amplitude and \( \omega_4 = 4\omega_0 \) of 10 kV. The time dependence of RF voltage is shown in Fig. 2.

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Fig. 1. The dee structure.

Fig. 2. The time dependence of RF voltages.