Ringbeschleuniger und Speicherringe
Übungsblatt 1
Lösungen

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1 Zyklotronfrequenz

$$\omega_C = \frac{q}{m} B_z = \frac{1,602 \times 10^{-19}\mathrm{As}}{1,673 \times 10^{-27}\mathrm{kg}} \cdot 1,2\ \mathrm{T} = 1,15 \times 10^8 \frac{1}{\mathrm{s}} \quad \Rightarrow \quad f_C = 18,29\ \mathrm{MHz}$$

2 Relativistik

$$E = E_0 + E_{\mathrm{kin}} = 500\,\mathrm{MeV} + 938,272\,\mathrm{MeV} = 1,438\,\mathrm{GeV}$$
$$\gamma = 1 + \frac{E_{\mathrm{kin}}}{m_0 c^2} = 1 + \frac{500\,\mathrm{MeV}}{938,272\,\mathrm{MeV}} = 1,533$$
$$\beta = \sqrt{1 - \frac{1}{\gamma^2}} = 0,758$$
$$p = \beta\,\gamma\,m_0\,c = 580,9\,\frac{\mathrm{MeV}}{c}$$

3 Radius des Synchrotrons

$$\gamma = 1 + \frac{E_{\mathrm{kin}}}{m_0 c^2} = 1 + \frac{50 \times 10^6\,\mathrm{MeV}}{938,272\,\mathrm{MeV}} = 53290,45 \quad \Rightarrow \quad \beta = \sqrt{1 - \frac{1}{\gamma^2}} = 0,9999999998 \approx 1$$

$$\rho = \frac{(E_{\mathrm{kin}} + E_0) \cdot \beta}{q\,c\,B} = \frac{50000938,27\,\mathrm{MeV}}{e\ \cdot\ 2,998 \times 10^8 \frac{\mathrm{m}}{\mathrm{s}}\ \cdot\ 16\,\mathrm{T}} = 10,4\,\mathrm{km}$$

4 Synchrotron

$$\gamma\,m_0\,\frac{\beta^2 c^2}{\rho} = q\,\beta\,c\,B$$
$$B\rho = \gamma\,m_0\,c^2\,\frac{\beta}{q\,c} = E_{\mathrm{kin}}\frac{\beta}{q\,c}$$