Blatt 1 Exphy 6 Julian Bergmann

Kr. 1

a) $E_{cm} = 2\underbrace{\sqrt{(m_p c^2)^2 + (p_p c)^2}}_{E_p} \stackrel{!}{=} m(\eta_c)c^2 = 2,980\,GeV$

$\Rightarrow E_p = \frac{m(\eta_c)c^2}{2} = 1,49\,GeV$

$\Rightarrow p_p = \sqrt{\left(\frac{m(\eta_c)c^2}{2}\right)^2 - (m_p c^2)^2} \cdot \frac{1}{c} = \frac{1}{c}\cdot\sqrt{(1,49\,GeV)^2 - (0,93827\,GeV)^2}$

$= 1,157\,GeV/c$

b) $p_{cm} = (E/c\,; p_x; p_y; p_z)^{-1} = \left(1,49\,\frac{GeV}{c}; 0; 0; \pm 1,157\,\frac{GeV}{c}\right)^{-1}$

$p_{lab} = L\,p_{cm} = \begin{pmatrix} \gamma & 0 & 0 & \beta\gamma \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ \beta\gamma & 0 & 0 & \gamma \end{pmatrix} \begin{pmatrix} E/c \\ p_x = 0 \\ p_y = 0 \\ p_z \end{pmatrix} = \begin{pmatrix} \gamma E/c + \beta\gamma p_z \\ 0 \\ 0 \\ \beta\gamma E/c + \gamma \cdot p_z \end{pmatrix}$

$p_{lab,1} = \left(\frac{5}{3}\cdot 1,49\,\frac{GeV}{c} + \frac{4}{3}\cdot 1,157\,\frac{GeV}{c}; 0; 0; \frac{4}{3}\cdot 1,49\,\frac{GeV}{c} + \frac{5}{3}\cdot 1,157\,\frac{GeV}{c}\right)$

$= \left(4,026\,\frac{GeV}{c}; 0; 0; 3,915\,\frac{GeV}{c}\right)$

$p_{lab,2} = \left(\frac{5}{3}\cdot 1,49\,\frac{GeV}{c} - \frac{4}{3}\cdot 1,157\,\frac{GeV}{c}; 0; 0; \frac{4}{3}\cdot 1,49\,\frac{GeV}{c} - \frac{5}{3}\cdot 1,157\,\frac{GeV}{c}\right)$

$= \left(0,941\,\frac{GeV}{c}; 0; 0; 0,0583\,\frac{GeV}{c}\right)$

$\Rightarrow T_1 = E_1 - m_0 c^2 = 4,026\,GeV - 938,27\,MeV = 3,088\,GeV$

$T_2 = E_2 - m_0 c^2 = 0,941\,GeV - 938,27\,MeV = 2,73\,MeV$

$\Rightarrow$ nur pos. z-Richtung!

c) $p_{cm} = (E/c; \pm p_c; 0; 0)$

$p_{lab} = L_z\,p_{cm} = (\gamma E/c; \pm p_x; 0; \gamma\beta E/c)$

$= \left(2,48\,\frac{GeV}{c}; \pm 1,157\,\frac{GeV}{c}; 0; 1,99\,\frac{GeV}{c}\right)$

$\alpha_{p_1} = -\alpha_{p_2} = \arctan\left(\frac{p_x}{p_z}\right) = \arctan\left(\frac{1,157}{1,99}\right) = 30,17°$

Nr 2

a) $\omega_c = \frac{e}{m_*} B_z = \frac{e}{m_p + 2m_e} B_z = \frac{c^2 \cdot 1\,\mathrm{T}}{939{,}292\,\mathrm{MV}} = 95{,}68\,\mathrm{MHz}$

$\omega_{c,rel} = \omega_c \gamma = \omega_c \cdot \frac{m_0 c^2}{T + m_0 c^2} = 95{,}68\,\mathrm{MHz} \cdot \overbrace{1{,}013}^{\uparrow} = 94{,}59\,\mathrm{MHz}$

b) $\frac{72\,\mathrm{MeV} - 200\,\mathrm{keV}}{800\,\mathrm{eV}} = 147{,}5 \approx 148$ Schritte

c) $R_i = \frac{m}{eB} v_i$ (i: Umläufe)

$\Rightarrow \Delta R_{74} = \frac{m}{eB}\sqrt{\frac{2}{m}}\left(\sqrt{T_{148}} - \sqrt{T_{146}}\right) = \frac{\sqrt{2m}}{eB}\left(\sqrt{72{,}04\,\mathrm{MeV}} - \sqrt{72{,}04\,\mathrm{MeV} - 7{,}6\,\mathrm{keV}}\right)$

$= 3{,}34\,\mathrm{mm}$

Nr 3

a) $\Delta E = \frac{ec^2 B}{2\pi \nu_{HF}} = \frac{ec^2 \cdot 1\,\mathrm{T}}{2\pi \cdot 2{,}45\,\mathrm{GHz}} = 5{,}84\,\mathrm{MeV}$

b) $\Delta R_i = \frac{1}{ec^2 B}\left(v_i E_i - v_{i-1} E_{i-1}\right) \approx \frac{1}{ecB} \cdot 5{,}85\,\mathrm{MeV} = 0{,}0194\,\mathrm{m}$

($v_i \approx c$)

c) $\Delta t = kT = \frac{2(\pi R + d)}{v_y \approx c} \approx \frac{2\pi E_0}{ec^2 B} + \frac{2d}{c} \Rightarrow d = \frac{1}{2} kTc - \frac{\pi}{ecB} E_0$