Abgabe Übung 2

Übung zur Einführung in die Beschleunigerphysik

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Aufgabe 2.1 Relativistische Kinematik

$$p = \sqrt{2mT} \qquad\qquad E = T + mc^2$$

Fixed Target

$$p_1 = \sqrt{2m_e 27.5\ \text{GeV}} = 8.959 \cdot 10^{-20}\ \text{Ns} = 168\ \text{MeV/c} \qquad p_2 = 0$$
$$E_1 = (27.5\ \text{GeV} + m_e c^2) \qquad E_2 = (0 + m_p c^2)$$

$$\begin{aligned} s^2 = m_{\text{inv}}^2 &= (E_1 + E_2)^2 - (p_1 c + p_2 c)^2 \\ &= ((27.5\ \text{GeV} + m_e c^2) + (0 + m_p c^2))^2 - 2m_e \cdot 27.5\ \text{GeV} \cdot c^2 \\ &= 8.087 \cdot 10^{20}\ \text{eV}^2 \\ \Rightarrow s &= 28.44\ \text{GeV} \end{aligned}$$

Collider

$$p_1 = \sqrt{2m_e 27.5\ \text{GeV}} = 168\ \text{MeV/c} \qquad p_2 = \sqrt{2m_p 920\ \text{GeV}} = 2.22 \cdot 10^{-17}\ \text{Ns} = 42\ \text{GeV/c}$$
$$E_1 = (27.5\ \text{GeV} + m_e c^2) \qquad E_2 = (920\ \text{GeV} + m_p c^2)$$

$$\begin{aligned} s^2 = m_{\text{inv}}^2 &= ((27.5\ \text{GeV} + m_e c^2) + (920\ \text{GeV} + m_p c^2))^2 - (168\ \text{MeV} \cdot c + 42\ \text{GeV} \cdot c)^2 \\ &= 8.978 \cdot 10^{23}\ \text{eV}^2 \\ \Rightarrow s &= 947.5\ \text{GeV} \end{aligned}$$

Aufgabe 2.2 Tandemgenerator

$$E = (e + q)U$$

Ar^{3+} $E = 4eU = 4\ \text{MeV}$

Ar^{4+} $E = 5eU = 5\ \text{MeV}$

Ar^{5+} $E = 6eU = 6\ \text{MeV}$