

# Abgabe Übung 2

## Übung zur Einführung in die Beschleunigerphysik

Jonathan Pieper

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### Aufgabe 2.1 Relativistische Kinematik

$$p = \sqrt{2mT}$$

$$E = T + mc^2$$

#### Fixed Target

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

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

#### Collider

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

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

### Aufgabe 2.2 Tandemgenerator

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

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

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

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