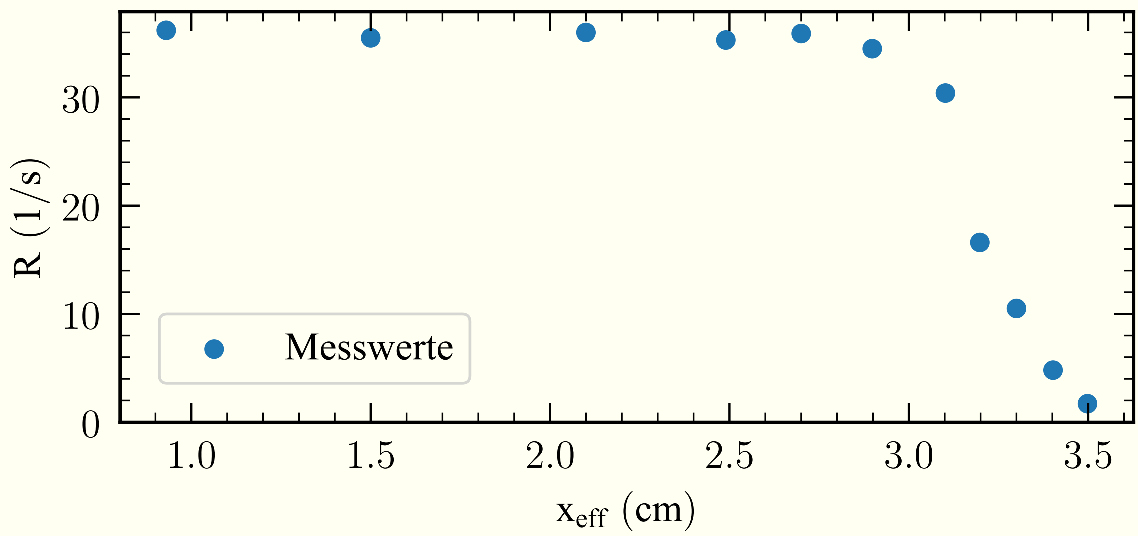
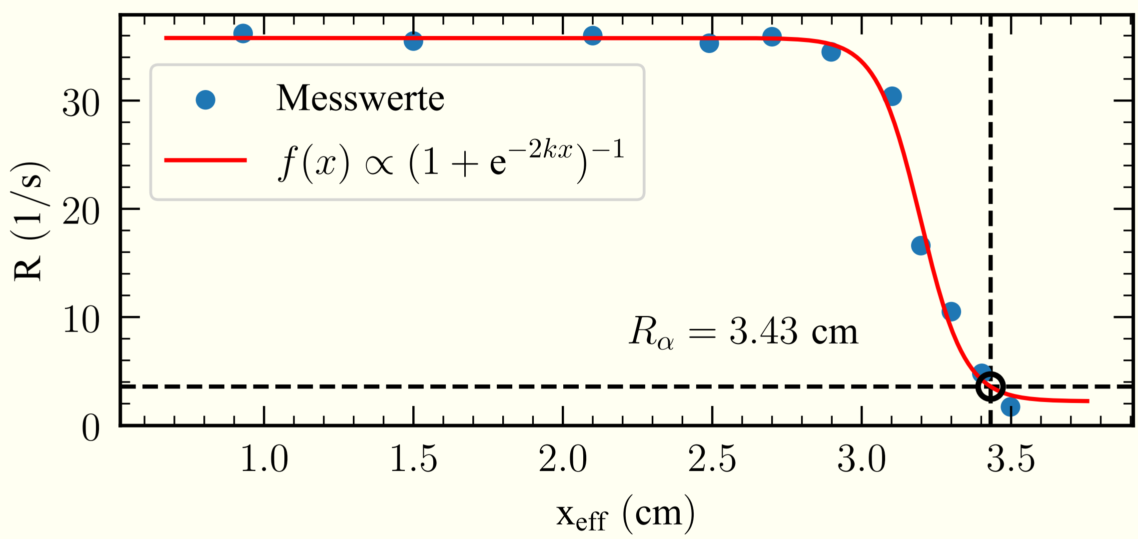
## Reichweite von Alpha-Strahlung

| p | 0.155 | 0.25 | 0.35 | 0.415 | 0.45 | 0.483 | 0.517 | 0.533 | 0.55 | 0.567 | 0.583 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R | 36.2 | 35.5 | 36.0 | 35.3 | 35.9 | 34.5 | 30.4 | 16.6 | 10.5 | 4.8 | 1.7 |

a) $x_0 = 6$ cm; $\quad x = px_0$

| p | 0.155 | 0.25 | 0.35 | 0.415 | 0.45 | 0.483 | 0.517 | 0.533 | 0.55 | 0.567 | 0.583 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R | 36.2 | 35.5 | 36.0 | 35.3 | 35.9 | 34.5 | 30.4 | 16.6 | 10.5 | 4.8 | 1.7 |
| x | 0.93 | 1.5 | 2.1 | 2.49 | 2.7 | 2.9 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 |



Fitfunktion als angepasste Heaviside Funktion [1] scheint recht gut zu passen. $f(R_\alpha) \stackrel{!}{=} \frac{f_{\max}}{10} \quad \Rightarrow \quad R_\alpha = 3.43\ \mathrm{cm}$

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$$R_\alpha = 0.31 \left(\frac{E_{\mathrm{kin}}}{1\ \mathrm{MeV}}\right)^{3/2}\ \mathrm{cm} = 3.43\ \mathrm{cm}$$

$$E_{\mathrm{kin}} = \underline{\underline{4.97\ \mathrm{MeV}}}$$

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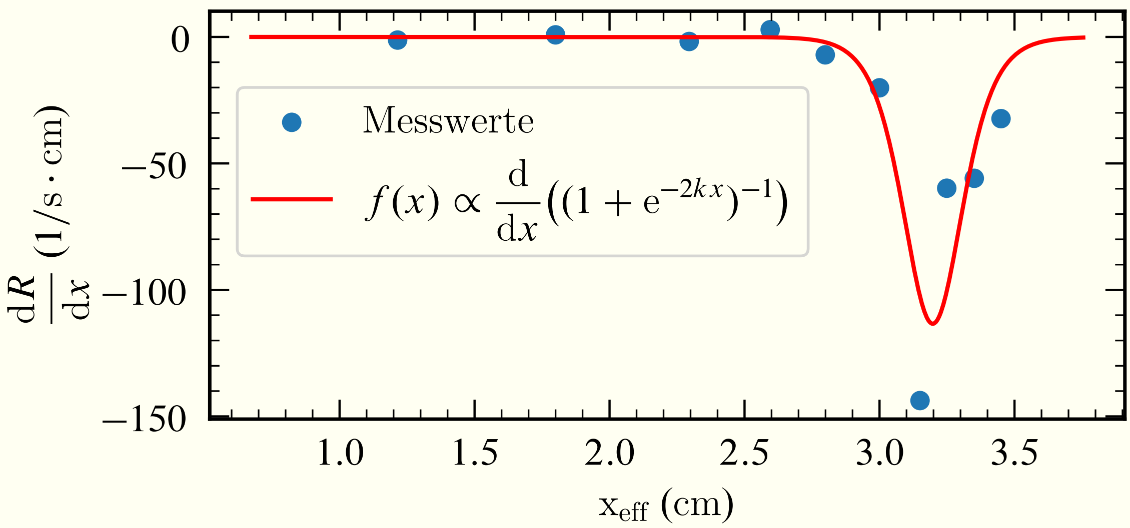


In blau numerisch differenzierte Werte (über $f'(x_n) = \frac{f(x_{n+1})-f(x_n)}{x_{n+1}-x_n}$). In rot Ableitung der Fitfunktion aus c). Man erkennt sehr gut, dass bei ca. 3.2 cm ein starker Fall ist, was physikalisch bedeutet, dass bei dieser Entfernung die $\alpha$−Teilchen ihre Energie deponieren.

## Bethe-Bloch-Formel

```
T = 2 * u"GeV"  2 GeV

d = 1 * u"cm"  1 cm
ρ = 2.7 * u"g/cm^3"  2.7 g cm^-3
Zal = 13  13
Aal = 26.98 * u"g/mol"  26.98 g mol^-1

mα = 3727.4 * u"MeV/c^2"  3727.4 MeV c^-2
mp = 938.3 * u"MeV/c^2"  938.3 MeV c^-2
md = 1875.6 * u"MeV/c^2"  1875.6 MeV c^-2

Zα = 2  2
Zp = 1  1
Zd = 1  1

I(Z) = 16*Z^0.9 * u"eV"
gamma(m, T) = T/(m*c_0^2) + 1
beta(m, T) = sqrt(1 - 1/gamma(m, T)^2)

k = 1/(4π*ε_0)^2 * (4π*e^4/(m_e*c_0^2)) * N_A * ρ * Zal/Aal  6.4005887402183545e-18 C^4 s^2 F^-2 kg^-1 cm^-3

dE(m, T, Z) = k * (log(2 * m_e * c_0^2 * beta(m, T)^2 * gamma(m, T)^2/I(Z)) - beta(m, T)^2)

Eα = dE(mα, T, Zα) * d |> u"MeV"  4.063901453508626 MeV
Ep = dE(mp, T, Zp) * d |> u"MeV"  4.93059955054809 MeV
Ed = dE(md, T, Zd) * d |> u"MeV"  4.587616861209597 MeV
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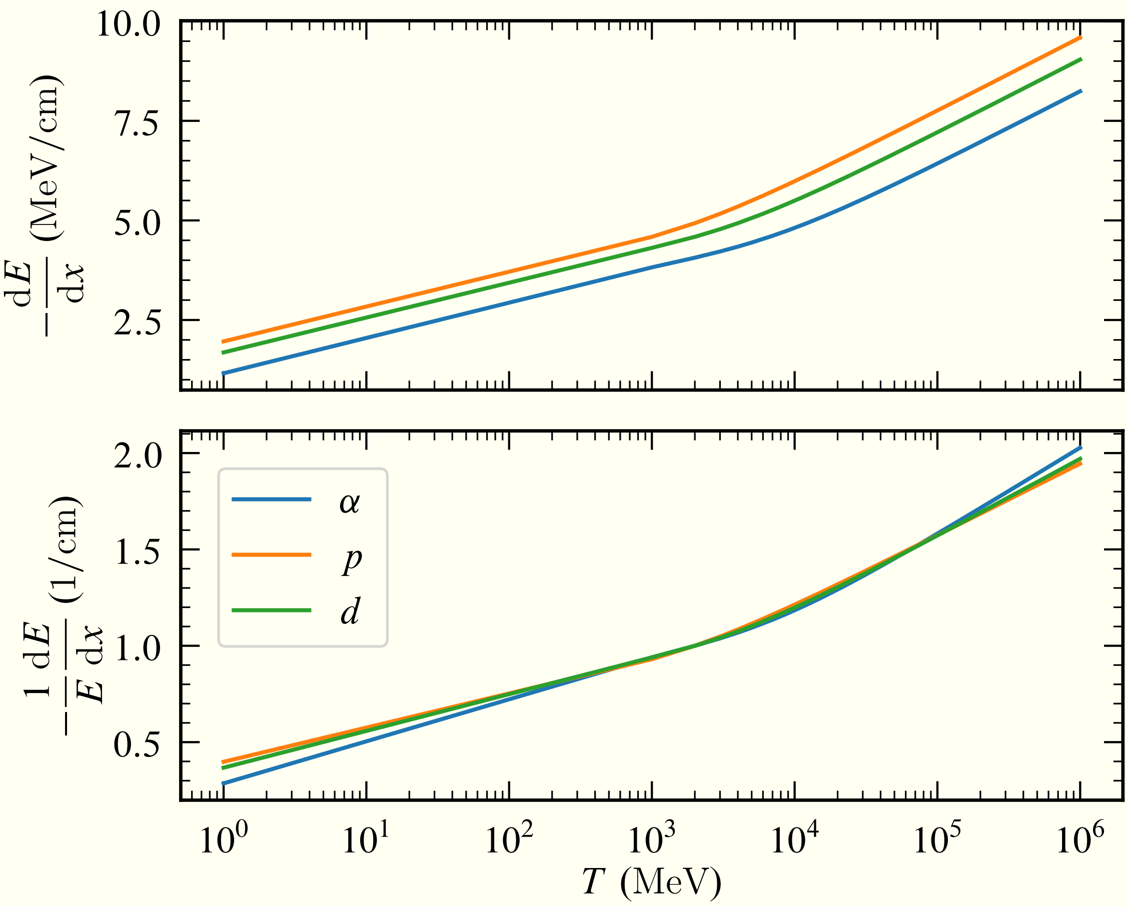
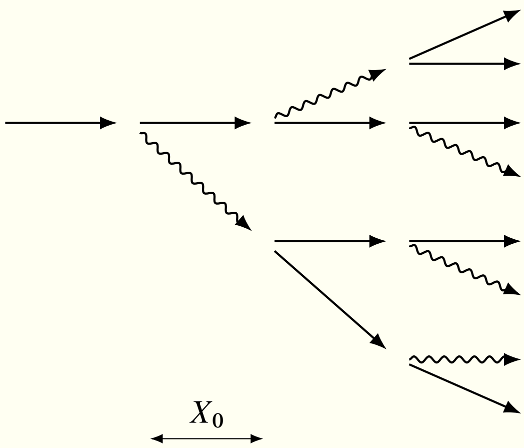
$E_\alpha = 4.06$ MeV; $\quad E_p = 4.93$ MeV; $\quad E_d = 4.59$ MeV



Nein, aufgrund der geringen Masse ist Bremsstrahlung bei Elektronen weitaus dominanter als Ionisierungsprozesse.

# Elektromagnetische Teilchenschauer

a)




b)

$$E_{n\cdot X_0} = \frac{E_0}{2^n}$$
$$X_{\max} = \frac{\ln\left(\frac{E_0}{E_c}\right)}{\ln(2)} X_0$$

c) $E_c = 84\ \text{MeV}; \quad E_1 = 1\ \text{TeV}; \quad E_2 = 10^8\ \text{TeV}$

$$X_1 = \frac{3}{2}\frac{\ln\left(\frac{E_1}{E_c}\right)}{\ln(2)} X_0 = \underline{\underline{20.31 X_0}}$$

$$X_2 = \frac{3}{2}\frac{\ln\left(\frac{E_2}{E_c}\right)}{\ln(2)} X_0 = \underline{\underline{60.17 X_0}}$$

d) $H_0 = 8\ \mathrm{km}; \quad X_E = \ \mathrm{g/cm^2}; \quad X_0 = 37.8\ \mathrm{g/cm^2}$

$$X_1 \stackrel{!}{=} X_E\, \mathrm{e}^{-\frac{h}{H_0}}$$

$$\Rightarrow h = -\ln\left(\frac{X_1}{X_E}\right) H_0 = \underline{\underline{2.35\ \mathrm{km}}}$$

$$X_2 \stackrel{!}{=} X_E\, \mathrm{e}^{-\frac{h}{H_0}}$$

$$\Rightarrow h = -\ln\left(\frac{X_2}{X_E}\right) H_0 = \underline{\underline{-6.34\ \mathrm{km}}}$$

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e) $h = 575\ \mathrm{m}$

$$X_{\max} = \frac{\ln\left(\frac{E_0}{E_c}\right)}{\ln(2)} X_0 \stackrel{!}{=} X_E\, \mathrm{e}^{-\frac{h}{H_0}}$$

$$E = 2E_c \exp(2X_E/3X_0 \exp(-h/H_0)) = \underline{\underline{10.32\ \mathrm{TeV}}}$$