Optimization of the target thickness

Primary reaction rate:

$$\phi_f\left[s^{-1}\right]=\phi_p\left[s^{-1}\right]-\phi\left[s^{-1}\right]=\phi_p\left[s^{-1}\right]\cdot\left\{1-e^{-N_t\left[cm^{-2}\right]\cdot\sigma_f\left[cm^2\right]}\right\}$$

$$\phi\left[s^{-1}\right]=\phi_p\left[s^{-1}\right]\cdot e^{-\frac{x\left[g/cm^2\right]\cdot 6.02\cdot 10^{23}\sigma_f\left[cm^2\right]}{A[g]}}$$

Primary + secondary reaction rate:

$$\phi_f\left[s^{-1}\right]=\phi_p\left[s^{-1}\right]\cdot\frac{6.02\cdot 10^{23}\cdot\sigma_f\left[cm^2\right]}{A_2[g]}\cdot\frac{1}{\mu_f-\mu_p}\cdot\left(e^{-\mu_p\cdot x\left[g/cm^2\right]}-e^{-\mu_f\cdot x\left[g/cm^2\right]}\right)$$

$$with \quad \mu=\frac{6.02\cdot 10^{23}}{A_2[g]}\cdot\sigma_{reaction}\left[cm^2\right]$$

$x\left[g/cm^2\right]$	$\frac{1}{\mu_f-\mu_p}\left[e^{-\mu_p\cdot x}-e^{-\mu_f\cdot x}\right]$
1	0.79
2	1.25
3	1.48
4	1.56
5	1.54
6	1.46

Example: $^{124}Xe\ \ on\ \ ^{9}Be\rightarrow{}^{100}Sn,\quad\sigma(^{124}Xe+^{9}Be)=3.65[b]\ \rightarrow\ \mu_p=0.244\left[cm^2/g\right]$

$$\sigma(^{100}Sn+^{9}Be)=3.40[b]\ \rightarrow\ \mu_f=0.227\left[cm^2/g\right]$$

Reaction Parameters for Heavy-Ion Collisions

The relevant formulae are calculated if $\mathbf{A_1, Z_1}$ and $\mathbf{A_2, Z_2}$ are the mass (in amu) and charge number of the projectile and target nucleus, respectively.

Nuclear radius for homogeneous (sharp) mass distribution:

$$R_i = 1.28 \cdot A_1^{1/3} - 0.76 + 0.8 \cdot A_1^{-1/3} \quad [fm]$$

Nuclear radius for diffuse (Fermi) mass distribution:

$$C_i = R_i \cdot \left(1 - R_i^{-2}\right) \quad [fm]$$

Nuclear interaction radius:

$$R_{\text{int}} = C_1 + C_2 + 4.49 - \frac{C_1 + C_2}{6.35} \quad [fm]$$

Nuclear reaction cross section at relativistic energies:

$$\sigma_{reaction} = \pi \cdot R_{\text{int}}^2 \quad \left[fm^2\right]$$