Telephoto-Thin Lens Design

Design a thin-lens telephoto lens with a back focal distance of 50 mm and an effective focal length of 200 mm.

Solution

\[ f_E = 200 \text{mm} \quad \text{and} \quad \phi = 0.005/\text{mm} \quad f_E = f'_R \]

\[ BFD = 50 \text{mm} \quad \text{and} \quad d' = \delta' = BFD - f'_R = -150 \text{mm} \]

\[ \phi = \phi_1 + \phi_2 - \frac{\phi_1 \phi_2 t}{t} \]

\[ d' = \delta' = -\frac{\phi_1}{\phi} t \]

\[ \phi_1 = -\frac{\phi d'}{t} \]

\[ \phi = -\frac{\phi d'}{t} + \phi_2 + \phi_2 d' \]

\[ \phi_2 = \frac{\phi + \phi d'}{1 + \phi d'} \]

For a given \( t \), values for \( \phi_1 \) and \( \phi_2 \) will be defined. Pick a \( t \):

\[ t = 50 \text{mm} \quad t = 100 \text{mm} \]

\[ \phi_2 = -0.040/\text{mm} \quad \phi_2 = -0.010/\text{mm} \]

\[ f_2 = -25 \text{mm} \quad f_2 = -100 \text{mm} \]

\[ \phi_1 = 0.015/\text{mm} \quad \phi_1 = 0.0075/\text{mm} \]

\[ f_2 = 66.67 \text{mm} \quad f_2 = 133.33 \text{mm} \]

A larger spacing requires less power in the lenses.