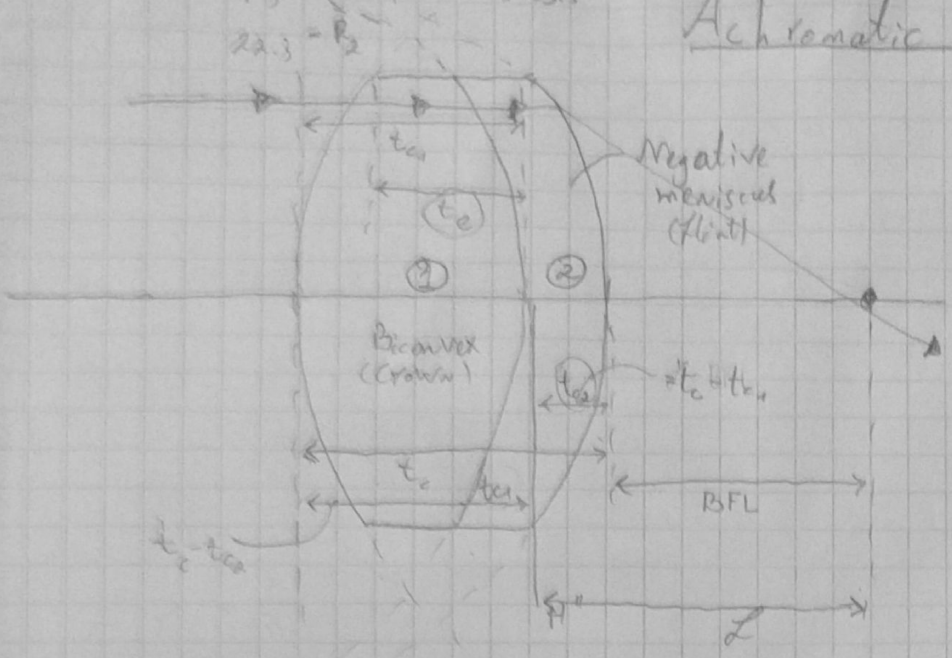
Achromatic Doublet



t_{c_1} - 11.5 mm

t_c - 11.5 mm

Dia - 25.4 mm

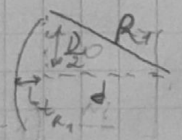
lensmaker's equation: $\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2} + \frac{(n-1)d}{nR_1R_2}\right]$

let us have $\lambda_{nm} = 565 \cdot 10^{-9}$ (mean of visible spectrum (380 - 750 nm))

$\Rightarrow \lambda_{\mu m} = (565 \cdot 10^{-3}) \cdot 10^{-6} = 0.565\,\mu m$ $\Longrightarrow$ $n_1 = 1.67$, $n_2 = 1.72$ (some sort of glass compounds ?)

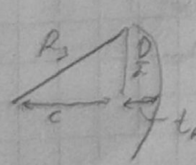
$f_1 = -\left[\frac{1.67 - 1}{1}\left(\frac{1}{-22.3} - \frac{1}{33.3} - \frac{9}{33.3(-22.3)}\left(1 - \frac{1}{1.67}\right)\right)\right]^{-1} = 18.72$

$f_2 = -\left[\frac{1 - 1.73}{1.73}\left(+\frac{1}{-291.1} - \frac{1}{-22.3} - \frac{2.5}{(-291.1)(-22.3)}\left(1 - \frac{1.73}{1}\right)\right)\right]^{-1} = -57.63$



t_e ...

$d = \sqrt{R_1^2 - \left(\frac{D}{2}\right)^2} = \sqrt{33.3^2 - \left(\frac{25.4}{2}\right)^2} = 30.78\,mm$, $t_{R_1} = R_1 - d = 2.51\,mm$



$c = \sqrt{R_3^2 - \left(\frac{D}{2}\right)^2} = \sqrt{291.11^2 - \left(\frac{25.4}{2}\right)^2} = 290.82\,mm$, $t_{R_3} = R_3 - c = 0.27\,mm$

$\Longrightarrow t_e = t_c - t_{R_1} - t_{R_3} = 8.706\,mm$

lense 1: $\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 - \frac{d}{R_1}\left(1 - \frac{n_1}{n_2}\right) & d\frac{n_1}{n_2} \\ -\frac{1}{f_{thick}} & 1 + \frac{d}{R_2}\left[1 - \frac{n_1}{n_2}\right] \end{pmatrix} = \begin{pmatrix} 1 - \frac{9}{33.3}\left[1 - \frac{1}{1.67}\right] & 9 \cdot \frac{1}{1.67} \\ -\frac{1}{18.72} & 1 - \frac{9}{-22.3}\left(1 - \frac{1}{1.67}\right) \end{pmatrix}$

$= \begin{pmatrix} 0.89 & 5.39 \\ -0.04 & 0.84 \end{pmatrix} = M_1$

lense 2: $\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 - \frac{2.5}{-22.3}\left(1 - \frac{1}{1.73}\right) & 2.5 \cdot \frac{1}{1.73} \\ -\frac{1}{-57.63} & 1 - \frac{2.5}{-291.1}\left(1 - \frac{1}{1.73}\right) \end{pmatrix} = \begin{pmatrix} 1.04 & 1.43 \\ 0.02 & 1 \end{pmatrix} = M_2$

$M_T = M_2 \cdot M_1 = \begin{pmatrix} 1.04 & 1.43 \\ 0.02 & 1 \end{pmatrix}\begin{pmatrix} 0.89 & 5.39 \\ -0.04 & 0.84 \end{pmatrix} = \begin{pmatrix} 0.86 & 6.78 \\ -0.02 & 0.94 \end{pmatrix} \Longrightarrow f_{eff} = 50.0\,mm$

$\begin{pmatrix} y_{out} \\ \theta_{out} \end{pmatrix} = \begin{pmatrix} 1 & f_b \\ 0 & 1 \end{pmatrix} \cdot M_T \cdot \begin{pmatrix} y_{in} \\ 0 \end{pmatrix} = \begin{pmatrix} 1 & f_b \\ 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 0.86 y_{in} \\ -0.02 y_{in} \end{pmatrix} = \begin{pmatrix} 0.86 y_{in} - 0.02 y_{in} f_b \\ -0.02 y_{in} \end{pmatrix}$; BFL ...

$\Longrightarrow f_b = \frac{0.86}{0.02} = 43\,mm$