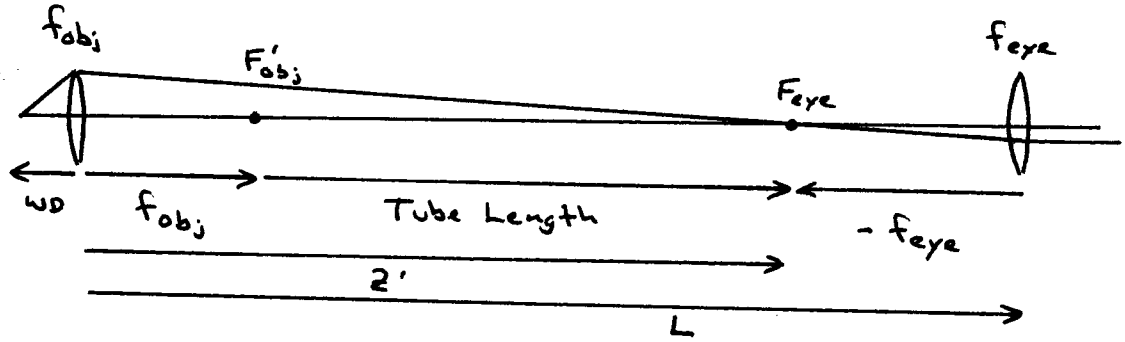
200X Microscope - Finite Tube Length

Tube Length = 200 mm

Objective : 20X

Exepiece : 10X

a) Exepiece: $MP = 10 = \frac{250\ mm}{f_{eye}}$ $f_{eye} = 25\ mm$



Objective: $m = -20 = z'/z$ $z = WD$

$z' = f_{obj} + \text{tube length} = f_{obj} + 200\ mm$

$z = z'/-20 = \frac{f_{obj} + 200}{-20}$

$\frac{1}{z'} = \frac{1}{z} + \frac{1}{f_{obj}}$ $\frac{1}{f_{obj} + 200} = \frac{-20}{f_{obj} + 200} + \frac{1}{f_{obj}}$

$f_{obj} = 10\ mm$

$WD = z = -10.5\ mm$ $L = f_{obj} + \text{tube length} + f_{eye}$

$L = 235\ mm$

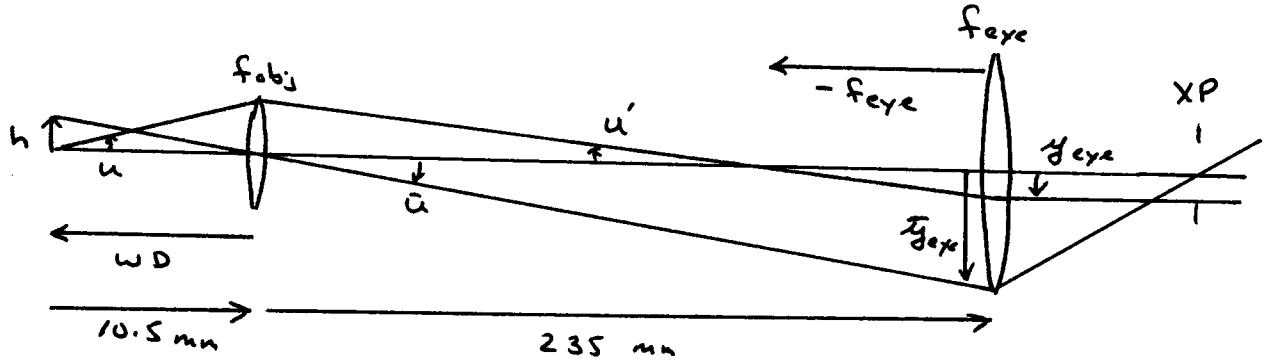
Note: Using Newtonian Distances

$z' = \text{tube length}$ $m = -20 = -\frac{z'}{f_{obj}}$ $f_{obj} = 10\ mm$

b) Field of View

$D_{obj} = 6.0\text{ mm}$ $\quad$ $D_{eye} = 5.0\text{mm}$

Since the objective is the stop, vignetting will occur at the eye lens. Determine y_{eye} and $\bar{y}_{eye}$ as a function of object height.



$$\bar{u} = \frac{h}{10.5} \qquad \bar{y}_{eye} = \bar{u} \cdot L = 235\,\bar{u} = \frac{235\,h}{10.5} = 22.38\,h$$

$$u = -\frac{D_{obj}/2}{f_{obj} + \text{tube length}} = \frac{-3.0\text{ mm}}{210\text{ mm}} = -.0143$$

$$y_{eye} = u \cdot f_{eye} = -.0143 \cdot 25\text{mm}$$

$$y_{eye} = -.357\text{ mm}$$

For unvignetted:

$$a_{eye} = D_{eye}/2 = |y_{eye}| + |\bar{y}_{eye}| = 2.5\text{ mm}$$

$$.3571 + 22.38\,h = 2.5\text{mm}$$

$$h = \text{HFOV} = .096\text{ mm}$$

$$\underline{\text{FOV} = .192\text{ mm}}$$