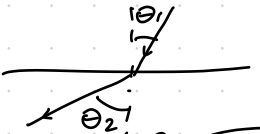
1.2 geometric Optics.

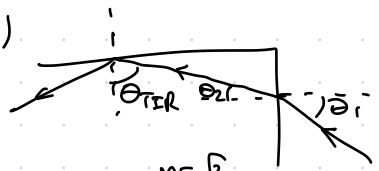
(i) From Snell's law:



$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\theta_{2\,MAX} = 90°$ $\therefore \sin\theta_{1,MAX} = \frac{n_2}{n_1}\sin\theta_2 = \frac{\sqrt{2}}{2}$ $\boxed{\therefore \theta_{1\,MAX} = 45°}$

(ii)



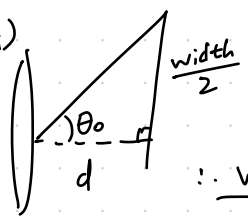
$\sin\theta_1 \cdot 1 = \sqrt{2}\cdot\sin\theta_2$

$\theta_2 = 90° - \theta_{TIR} = 30°$

$\therefore \sin\theta_1 = \frac{\sqrt{2}}{2}$

$\boxed{\theta_1 = 45°}$

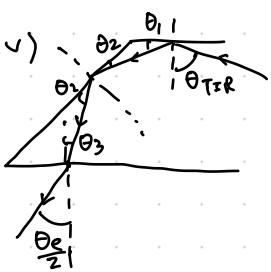
(iii)



$\tan\theta_0 = \tan\theta_1 = \frac{\text{width}/2}{d}$

$\therefore$ Width $= 2d\tan\theta_1 = 2\times 60mm \times 1 = \boxed{120mm}$

(iv)



$\theta_1 = 90° - \theta_{TIR} = 30°$, $\theta_2 = 180° - 135° - \theta_1 = 15°$,

$\theta_3 = 180° - 135° - \theta_2 = 30°$,

$\sin\left(\frac{\theta_e}{2}\right)\cdot 1 = \sqrt{2}\cdot\sin(\theta_3) = \frac{\sqrt{2}}{2}$

$\therefore \frac{\theta_e}{2} = 45° \Rightarrow \boxed{\theta_e = 90°}$

(v) To boost up FoV to 120°: $\theta_e = 120°$. $\sin\left(\frac{\theta_e}{2}\right) = n\sin\theta_3$

$\theta_3 = 90° - \theta_{TIR} = \theta_1$, $\sin(\theta_0) = n\sin(\theta_1) = n\sin(\theta_3) = \sin\left(\frac{\theta_e}{2}\right)$

$\therefore$ Needs incident angle from air to glass guide: $\theta_0 = 60°$

To have the TIR work we need $\boxed{\theta_1 \le 90° - \theta_{TIR}}$

$n\sin(\theta_{TIR}) = 1$, $n\sin(\theta_1) = \sin(60°) = \frac{\sqrt{3}}{2}$

$\sin(\theta_1) \le \sin(90° - \theta_{TIR}) = \cos(\theta_{TIR}) \Rightarrow \frac{\sqrt{3}}{2} \le n\cos(\theta_{TIR})$

$\therefore \frac{3}{4} \le n^2\cos^2(\theta_{TIR}) = n^2 - n^2\sin^2(\theta_{TIR}) = n^2 - 1$ $\boxed{\therefore n \ge \sqrt{\frac{7}{4}} = \frac{\sqrt{7}}{2}}$

minimum $\boxed{n_2' = \frac{\sqrt{7}}{2} = 1.32}$ Teflon AF, Cryolite, Water ice are in the range.