

Exercise #9: Form factor



Calculate the form factor F_{SE} for the following situation:

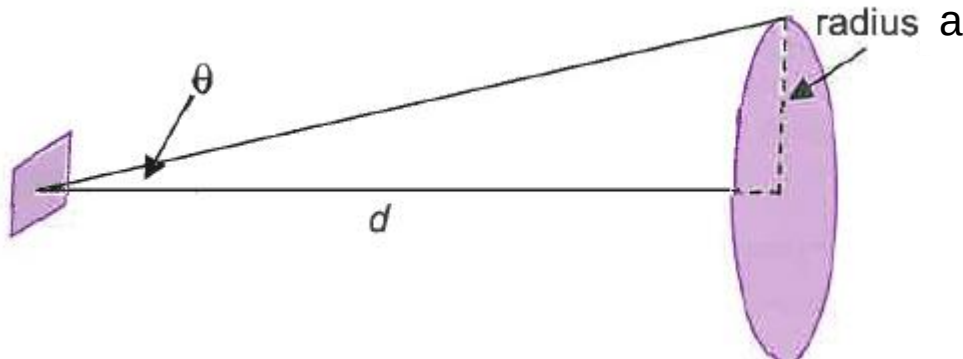
Small (differential) source element centered on the axis in combination with an extended circular disk of radius a at distance d , also centered on the axis.

Hint#1: Two solutions are possible

Hint#2:
$$\int \frac{x}{(x^2 + c)^2} = \frac{1}{2} \frac{1}{x^2 + c}$$

$$F_{SE} = \frac{1}{\pi \cdot A_S} \int_{A_S} \int_{A_E} dA_S \cdot \cos \theta_S \cdot \frac{dA_E \cdot \cos \theta_E}{r^2}$$

$$\int \sin \theta \cdot \cos \theta \cdot d\theta = \frac{1}{2} \sin^2 \theta$$



Exercise #10: Etendue Conservation



The amount of concentration of direct sun-light is limited.

Concentration C is defined as the ratio between input area A_{in} to output area of the concentrator A_{out} . $C = A_{In} / A_{Out}$

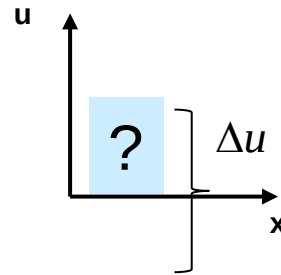
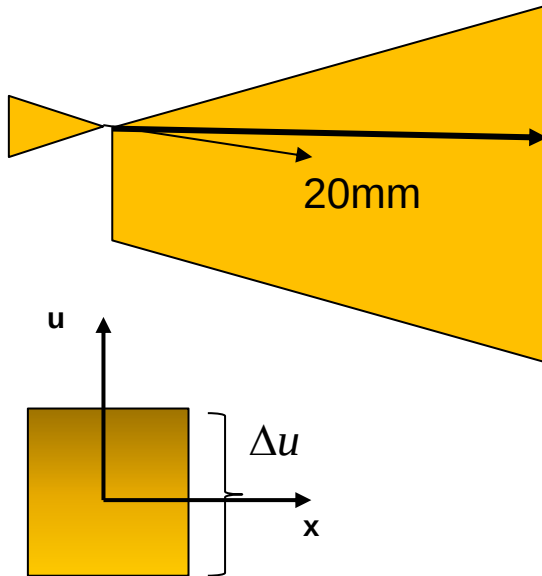
Estimate the maximum amount of concentration, using etendue conservation

$$H = A \cdot \Omega_p = \text{const.}$$

Exercise #11: Phase space transformation



Using ABCD-matrix methods calculate the final phase space distribution of the following source: spatial extend (-10mm, 10mm), angular extend (-0.1,0.1) (i.e. NA=0.1) after 20mm propagation. Estimate the irradiance profile in this plane.



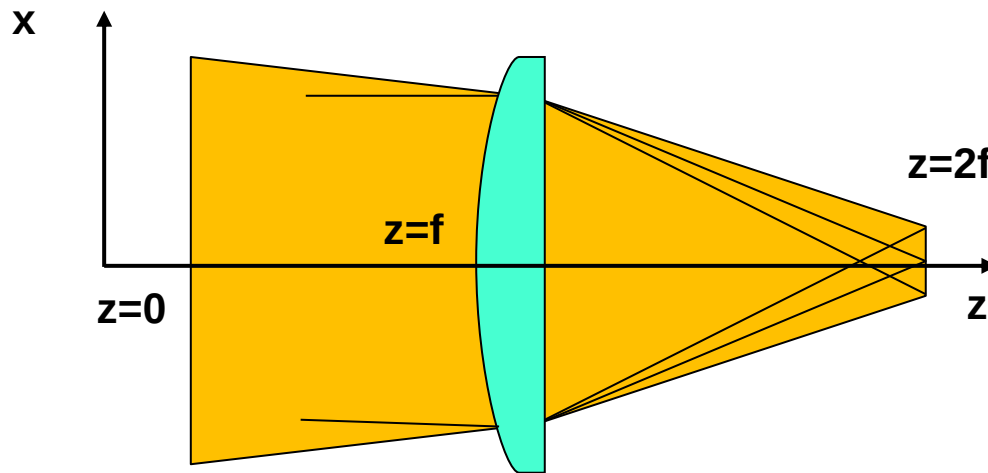
Free
Propagation

$$\begin{pmatrix} x' \\ u' \end{pmatrix} = \underbrace{\begin{pmatrix} 1 & z \\ 0 & 1 \end{pmatrix}}_M \cdot \begin{pmatrix} x \\ u \end{pmatrix}$$

Exercise #12: Phase space transformation



Using ABCD-matrix methods prove, that the propagation from the front focal plane to the back focal plane of a paraxial lens corresponds to a rotation in phase space



Free
Propagation

$$\begin{pmatrix} x' \\ u' \end{pmatrix} = \underbrace{\begin{pmatrix} 1 & z \\ 0 & 1 \end{pmatrix}}_M \cdot \begin{pmatrix} x \\ u \end{pmatrix}$$

Paraxial lens

$$\begin{pmatrix} x' \\ u' \end{pmatrix} = \underbrace{\begin{pmatrix} 1 & 0 \\ -\frac{1}{f'} & 1 \end{pmatrix}}_M \cdot \begin{pmatrix} x \\ u \end{pmatrix}$$