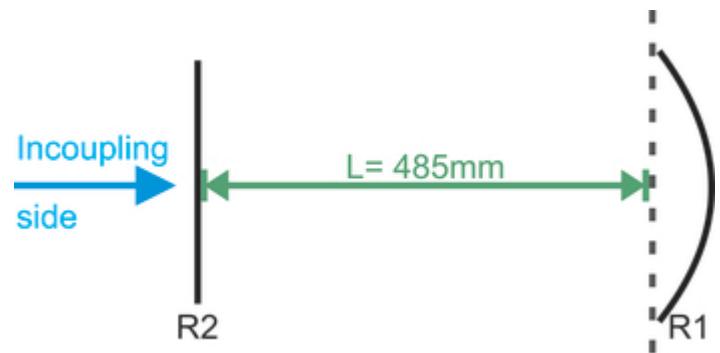


Mode matching - first try

Mirror configuration



Parameter

- Radius of curvature of mirror R1: $R_1 = 1 \text{ m}$
- Radius of curvature of mirror R2: $R_2 = \infty$ (Incoupling side)
- Wavelength: $\lambda = 1.55 \times 10^{-6} \text{ m}$
- Length between the resonator mirrors: $L = 485 \text{ mm}$
- Beam radius at waist: w_0
- Beam radius at mirror: w_1, w_2
- Stability parameter of the resonator: g_1, g_2
- Distance between mirror and the waist: t_1, t_2

Beam waist calculation from resonator

Step 1: Calculate the stability parameters

$$g_1 = 1 - \frac{L}{R_1} \quad \text{and} \quad g_2 = 1 - \frac{L}{R_2}$$

Step 2: Calculate the beam waist radii on the mirrors

From thesis of Sana:

- Beam Radii, $1/e^2$ of the intensity

$$\begin{aligned} w_1 &= \sqrt{L \cdot \frac{\lambda}{\pi}} \cdot \left(\frac{g_2}{g_1} + \frac{g_1}{g_2} \right)^{1/4} \\ w_2 &= \sqrt{L \cdot \frac{\lambda}{\pi}} \cdot \left(\frac{g_1}{g_2} + \frac{g_2}{g_1} \right)^{1/4} \end{aligned}$$

Alternative from rom Appl. Opt. 5, 1550 (1966):

$$\begin{aligned} w_1 &= \sqrt{\frac{\lambda}{\pi} \cdot R_1} \cdot \left(\frac{(R_2 - L) \cdot L}{(R_1 - L) \cdot (R_1 + R_2 - L)} \right)^{1/4} \\ w_2 &= \sqrt{\frac{\lambda}{\pi} \cdot R_2} \cdot \left(\frac{(R_1 - L) \cdot L}{(R_2 - L) \cdot (R_1 + R_2 - L)} \right)^{1/4} \end{aligned}$$

$$w_0 = \sqrt{\frac{\lambda}{\pi}} \cdot \left(\frac{L}{R_1} + \frac{L}{R_2} - L \right)^{1/2}$$

In our case: $w_2 = w_0$

Step 3: Calculate the distance of beam waists on the mirrors and focus

Position of the beam waist on the two mirrors:

$\$t_1 = L \cdot \frac{R2 - L}{R1 + R2 - 2 \cdot L}$ $\$t_2 = L \cdot \frac{R1 - L}{R1 + R2 - 2 \cdot L}$
In our case: $L=t_1+t_2$ and t_2 is ≈ 0

Step 4: Calculate the focal length of your collimator

Take the radii on the plane $w_2=w_0=496.567\mu m$ and curve mirror $w_1=691.95\mu m$ and calculate the focal length f : $f=D \cdot \left(\frac{\pi \cdot w}{4 \cdot \lambda}\right)$ D is the beam waist diameter of the collimated beam after the collimator and w is mode beam diameter of the fiber output. In our case is: $D=2 \cdot w_0$. The diameter from the light, which comes out of the fiber (1550 nm) is $w=10.5 \pm 0.5\mu m$. That gives us a focal length $f=5.32044mm$.

Step 4b



We did the calculation wrong. We used $D=w_0$ and got $f=2.66022mm$.

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