

Exercise #18: axial coherence length



In your Lab you have an Excimer-laser ($\lambda=248\text{nm}$), which you want to do interferometry with. All you know is that the spectral bandwidth of the laser is $\Delta\lambda=0.1\text{nm}$

From the excellent lecture of Prof. Herkommer 10 years ago you remember:

$$\tau_c = \frac{2\pi}{\Delta\omega}$$

Starting from this - prove that you can calculate the axial coherence length to be:

$$l_c = \frac{\lambda^2}{\Delta\lambda}$$

What maximum path difference you can accept in your setup ?

Exercise #19: Max. intensity



Consider a cw -Nd:YAG-Laser with a optical power /flux of $\Phi = 15W$

$$\lambda_{Nd:YAG} = 1064nm$$

You focus the beam with a NA=0.1 system.

What is the beam waist in the focus ? – remember the beam parameter product

$$w_0 \cdot \theta_0 = \frac{\lambda}{\pi}$$

$$\theta_0 = 0.1 \quad w_0 = \frac{\lambda}{\pi \cdot NA} = \frac{1\mu m}{\pi \cdot 0.1} \approx 3\mu m$$

What is the max. irradiance at the focus ?

$$I_0 = \frac{2 \cdot \Phi}{\pi \cdot w_0^2} = \frac{30W}{\pi \cdot (3)^2 \mu m^2} \approx 1.4 \frac{W}{\mu m^2} = 1.4 \cdot 10^6 \frac{W}{mm^2}$$

What is the max. irradiance in 1mm distance from the focus

$$z_R = \frac{\pi w_0^2}{\lambda} = \frac{\pi \cdot (3)^2 \mu m^2}{1\mu m} \approx 21\mu m \quad \Rightarrow \quad I_{Max}(z = 1mm) \approx I_0 \left(\frac{z_R}{z} \right)^2 \approx I_0 \cdot 0.0004$$

Exercise #20: beam quality



Consider the same cw -Nd:YAG-Laser as before.

$$\lambda_{Nd:YAG} = 1064nm$$

You focus the beam with a NA=0.1 system, but in reality you can only achieve a minimum beam waist of $15\mu m$.

$$w_0 \cdot \theta_0 = \frac{\lambda}{\pi}$$

What could be the reasons ?

If you have done everything right what M^2 would you estimate ?

$$\theta_0 = 0.1 \quad w_0 = \frac{\lambda}{\pi \cdot NA} = \frac{1\mu m}{\pi \cdot 0.1} \approx 3\mu m \quad M = \frac{W}{w_0} = \frac{15\mu m}{3\mu m} \approx 5$$

What is now the max. irradiance at the focus ?

$$I_0 = \frac{2 \cdot \Phi}{\pi \cdot W^2} = \frac{1}{M^2} \cdot I_{Gauss}$$