

Generation and Applications of Ultrahigh-Intensity Laser Pulses

Problem Set 10

1. Mode-Locking ... again

Describe the physical principal of mode-locking. What determines the emission spectrum of a mode-locked oscillator and how does it look like? Can you explain why you can mode-lock an oscillator with a Kerr-lens? Sketch a typical setup. Do you know another device which is used for passive mode-locking?

2. Gain Narrowing

Calculate the pulse lengthening due to gain narrowing for a high power Nd:Glass (silicate) amplifier ($\lambda_0 = 1062$ nm). Your initial pulse duration is 30 fs. Assume you have a maximum small signal gain of $G_0 = 5$. Check the lecture notes for further material parameters.

3. Regenerative Amplifier

You have a Nd:YAG ($\sigma = 4.1 \cdot 10^{-19}$ cm²) regenerative amplifier. The crystal length is $L = 5$ mm. The losses inside the cavity are $\gamma = 20\%$. With the pump diode you can store an energy of $E_{st0} = 400$ μ J inside the crystal and reach a homogeneous inversion of $\Delta N_0 = 3.4 \cdot 10^{18}$ $\frac{1}{\text{cm}^3}$. Calculate the maximal extractable energy.