To be solved until: 29.01.2020

Generation and Applications of Ultrahigh-Intensity Laser Pulses

Problem Set 11

1. Regenerative Amplifier

You have a Nd:YAG ($\sigma = 4.1 \cdot 10^{-19}\,\mathrm{cm}^2$) regenerative amplifier. The crystal length is $L = 5\,\mathrm{mm}$. The losses inside the cavity are $\gamma = 20\%$. With the pump diode you can store an energy of $E_{st0} = 400\,\mu\mathrm{J}$ inside the crystal and reach a homogeneous inversion of $\Delta N_0 = 3.4 \cdot 10^{18}\,\frac{1}{\mathrm{cm}^3}$. Calculate the maximal extractable energy.

2. Wavefront measurements

Most high-intensity lasers use deformable mirrors to correct for aberrations in the laser. For this you need an accurate measurement of the wavefront. Which methods can be employed for this task and how do they work? How is the wavefront related to the phase of the laser?

3. Spectral Interferometry

One method to measure the duration of ultrashort laser pulses involves what is called *spectral interferometry*. Assume two copies of the same pulse which are delayed in time by Δt, i.e.

$$E_{interference}(t) = E(t) + E(t - \Delta t).$$

Show that the delay in time domain leads to an intensity modulation in the spectral domain with

$$I(\omega) \propto \cos^2(\omega \Delta t/2).$$

Assuming that your spectrometer covers a range of 750 - 850 nm, which is the minimal delay for which you can still observe an entire modulation in the spectrum?