To be solved until: 11.12.2019

Generation and Applications of Ultrahigh-Intensity Laser Pulses

Problem Set 7

1. Compression with Prisms

In your lab you have a Titanium:Sapphire oscillator with $\lambda = 800\,\text{nm}$ and a bandwidth of $\Delta\lambda = 75\,\text{nm}$. The pulses are compressed when they exit the oscillator. You now want to amplify the pulses further in a 10-pass Ti:Sapphire amplifier. In order not to destroy the active medium the pulses have to be stretched to 2 ps pulse duration (CPA-principle).

a) Design a prism compressor (Bk7) for the re-compression of the amplified pulses. Assume the pulses are linearly stretched inside the amplifier.

b) What are the limitations of using a prism compressor?

2. Grating Compressor

For the Petawatt Field Synthesizer a special pump laser has been developed. The active medium is Yb:YAG (1030 nm) and the bandwidth is measured to be 3 nm. The pulses are stretched with a grating stretcher to 3 ns and then amplified to around 1 J pulse energy. Afterwards the high energy pulses have to be compressed to the Fourier limit in a grating compressor. The incident angle is $59\,^\circ$ and the line density of the gratings is 1740 lines/mm. Calculate the grating separation needed for the compression. Assume that only D_2 has an effect on the pulse duration.

3. Higher order dispersion in a grating compressor

Consider a laser with a central wavelength of 800 nm. The bandwidth limited pulse has been stretched with a group dispersion delay of $D_2 = 1.81 \cdot 10^6$ fs^2 and a third order dispersion of $3.2563 \cdot 10^6$ fs^3. During propagation, the pulse additionally acquires GDD while traversing 10 cm of BK7. Considering a grating compressor with a line density of 1480 mm^{-1} and an angle of $\beta_0 = 20.2$ degree between both grating, which additional separation in the compressor is needed to compensate for the total GDD? Is the TOD also compensated for? If not, how can you solve this problem?