

Prism-based compression of femtosecond laser pulses

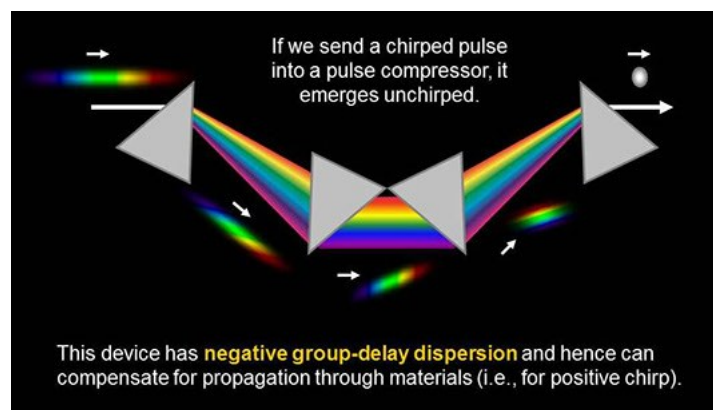
Project supervisors: Dr Erika Keil (erika.keil@matfyz.cuni.cz), Dr Malcolm Garrow (malcolm.garrow@matfyz.cuni.cz)

Location: Institute of Physics (FUUK), Ke Karlovu 5, Praha

Keywords: Ultrafast spectroscopy, technical optics, pulse compression

The speed and efficiency of many light-driven biological and physical processes is defined at the molecular scale – for example, by the formation and breaking of chemical bonds, or by energy transport within and between individual molecules. These processes occur very fast – usually on a femto-to microsecond (10^{-15} – 10^{-6} s) timescale. An example are the primary steps of photosynthesis: here, energy from sunlight is transferred across a vast pigment network and converted to chemical energy on a picosecond timescale [1]. To resolve these dynamics in real time, we employ ultrafast, time-resolved spectroscopic techniques that rely on very short laser pulses, ideally with a duration on the order of femtoseconds (fs).

Producing short laser pulses can be tricky; usually, the spectrum of a laser pulse consists of many different frequency components (colors), and light of different colors travels at different speeds through materials, including air. Therefore, after a bit of traveling, the red components of a light pulse arrive at a fixed target earlier than the green and blue components. The light pulse is now ‘long’ or ‘chirped’, its frequency components are stretched in time [2]. To compensate for this effect, we need to manipulate the light with special optics. One possibility to remove chirp from laser pulses is to use prism-based compressors. Prisms diffract light of different colors at a different angle, a characteristic that can be used to change the relative timing between the frequency components of a pulse and make it shorter in time [2]. In this project, you can help us build such a prism-based device to compress our pulses to a few tens of fs. This will contribute to an improved spectroscopic setup in our lab.



Functioning principle of a prism compressor: the temporal chirp in the laser pulse is compensated by path length differences between individual frequency components induced by the prisms.

[1] Blankenship, R. E. *Molecular Mechanisms of Photosynthesis*. 2nded.; Wiley/Blackwell: Chichester, West Sussex, **2012**.

[2] Akturk S., Gu X., Timmel M., Trebino R. *Extremely simple single-prism ultrashort-pulse compressor*, Optics Express 14 (21), **2006**.