Review of the Ph.D. thesis of Ing. Martin Duda "Harmonic frequency generation and nonlinear compression of ultrashort pulses"

The Ph.D. thesis is devoted to the development and optimization of the second harmonic generator as well as to the numerical and experimental study of nonlinear pulse shaping.

The work is divided into six chapters. The first chapter provides a detailed introduction to the topic and used experimental methods. There are also defined goals of the work. The second chapter describes the design, building, and properties of the second harmonic generator. The key part of the thesis are the next three chapters which contain numerical simulation and experimental results of pulse shaping. The method is based on a group velocity mismatch and time predelay of the pulses. Numerical simulations show that this method provides decreasing duration and enhancing peak power of the up-converted pulses. This behavior was proved by experiments. The last chapter is the conclusion.

The work has two main goals:

1) Build a universal stage for a high efficient generation of the second harmonic frequency which could be used with various high average power picosecond laser systems. The result of careful work is a second harmonics generator with LBO crystal which achieved a conversion efficiency of 75 % while maintaining a very good quality of the beam.

2) Numerical and experimental study of nonlinear pulse shaping caused by group velocity mismatch in a nonlinear crystal with type II phase matching. The process is controlled mainly by a time predelay of the faster pulse. The author investigated pulse shaping due to the backconversion, and second, pulse shaping with a group velocity manipulation through tilting of the pulse front. The first method led to 3-fold pulse compression with a conversion efficiency of 11 %. The second method resulted in almost 20-fold pulse compression with a high conversion efficiency of 48 %.

All goals of the thesis were successfully met. The obtained results author published in three papers in international peer-reviewed journals (Martin Duda is the first author on two papers of them) and in two conference proceedings.

The work is written in a very good level of English. The text is clear, well arranged, and logically coherent. There is a very small number of typographical and typing errors. The graphic design of the work is excellent. The used theoretical and experimental methods and procedures are fully adequate for the studied topics. The work brings very interesting results from the point of view of both nonlinear optics and especially applications.

I have a couple of questions and comments regarding the theses:

1) You stated that the main limiting optical element in the second harmonic generator is the harmonic separator. Would it not be possible to do wavelength separation in another way?

2) You mentioned that the setup is being prepared for the third and fourth harmonic generation. Are you involved in its development? If so, what setup are you going to use?

3) Could you compare the suitability (pros and cons) of type I and II phase matching for your second harmonic generator?

4) Did you observed some non-linear effects caused by passing of the beam through the focal point inside the telescope? Would it not be more appropriate to use the Galileo telescope?

I conclude that Martin Duda reached the given goals and he presented original results and constructions. The Ph.D. thesis "Harmonic frequency generation and nonlinear compression of ultrashort pulses" proves the qualifications of the author for independent creative scientific work. I fully recommend the dissertation for the defense.

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doc. RNDr. František Trojánek, Ph.D.
Department of Chemical Physics and Optics
Faculty of Mathematics and Physics
Charles University