

Prague August 20th, 2024

Assessment of the dissertation of Alexandr Vendl
“Nonlinear optical effects and applications
in high energy laser systems”

Introductory part: submitted dissertation is the result of author's doctoral study at the Czech Technical University in Prague, FNSPE, Department of Physical Electronics during years 2018 – 2024 which followed his bachelor's and master's studies in 2013-2016 and 2017-2018. The submitted thesis is devoted to the propagation of ultrashort laser pulses in a nonlinear medium – the theoretical as well as practical solution of the problems that appear during this propagation. The experimental part of the work was verified and implemented at the cooperating workplace ELI-Beamlines Laser Center.

Stating part: the thesis is divided into 7 chapters, has 72 pages and at the end there are two important author's articles published in renowned journals. Next is a list of the author's works related to the dissertation and other results where the author participated with his program in laboratory experimental work. The text is supplemented by 22 pictures and 1 table.

The introductory part shows the possibilities and use of nonlinear phenomena. After mentioning the objectives of the work and summarizing the state of the art in the second and third parts, the author presents the propagation model in the fourth part and mentions which phenomena are included in it. He considers second-order nonlinearity, the Kerr effect, self-focusing, self-phase modulation, and optical field ionization. At the end of this chapter the author states the numerical model used in this work, he shows the model architecture, an envelope approximation, and propagation. The fifth chapter contains a comprehensive overview of the results of his research, which includes both numerical simulations and experimental results. The sixth section summarizes the obtained results, and in the seventh chapter the author shows future possibilities to extend the model to include other nonlinear phenomena and make it more friendly to the laser community.

Evaluation part of the thesis: The results of the dissertation can be summarized in the following points corresponding to the set objectives:

- the development of a numerical model for simulating the propagation of ultrashort laser pulses through the nonlinear medium was done;
- the applications of this numerical model, particularly in understanding the complex interplay of nonlinear effects during supercontinuum generation and in the design of a bulk compressor to avoid undesired nonlinearities;
- the model was implemented into the experimental system, according to it the design and optimization of the L2-DUHA frontend in ELI Beamline was made. Particularly analyzation of nonlinearities during the supercontinuum generation and compression of mid-IR and near IR seed pulses was made;
- the model was applied also to improve the performance of the L1-Allegra laser (ELI Beamlines) in scientific experiments, including high-harmonic generation and electron acceleration.

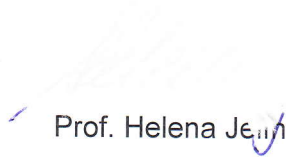
The results were published in eleven renowned journals with a wide scope and presented at ten prestigious international conferences, where they were positively received by the scientific community.

Formal level of the work: from a technical point of view, the work is written very comprehensible, technically precise, the facts are arranged logically, the explanation of the methods used is complete. The author's statements are accurate, the description of the methods and instruments used is complete. The text contains the goals that the author was supposed to fulfilled and which were achieved. The thesis includes extensive documentation including major publications and a list of other articles and conference contributions. On the formal side, it can be stated that the thesis is prepared according to the criteria set for dissertations and has all the necessary requirements. The methods and procedures used were adequate to the given goal, the thesis is written logically and at a professional scientific level. The work as a whole is a significant contribution to knowledge in the field of nonlinear optical phenomena.

Author's evaluation: Ing. Alexandr Vendl approached his doctoral studies very responsibly, conscientiously and purposefully solved individual sub-tasks. He passed all the prescribed exams on time. During the solving the task of his PhD he worked in theory and modelling as well as he was very active in the laboratory. He demonstrated the ability of independent creative scientific work and teamwork. In solving problems, he has shown that he has deep theoretical knowledge and mastery of scientific methods of work. The author has fully joined the team of scientists at ELI BEAMLINES and has become a valid member of scientific group. It can be stated that it has all the prerequisites for further professional growth in the field.

Conclusion: It can be stated that **Ing. Alexandr Vendl** is a very talented young scientist with wide theoretical as well as experimental experiences. The results of the dissertation correspond to the set objectives: the thesis's form, content, method of processing, scientific contribution and contribution practical scientific work meets the conditions set out in the Collection of Laws No. 111/1998 Coll., § 47, section 4 for doctoral dissertations.

Based on the facts and opinions stated above, I recommend Ing. Alexandr Vendl' s dissertation "Nonlinear optical effects and applications in high energy laser systems" be accepted for defense and after a successful defense, I recommend awarding him the scientific degree of Doctor of Philosophy degree (PhD.) in the field of Applied Natural Sciences.


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Supervisor