Supervisor's review, PhD thesis of Huang Zhou

„Wavefront correction for mid-IR pulses"

The submitted dissertation is a result of the author's five-year doctoral studies at the Department of Physical Electronics, FJFI CVUT in Prague, and research carried out at the HiLASE Centre of the Institute of Physics of the CAS in the period of October 2017 - September 2022. Although the title of this work refers to wave-front analysis and correction systems covering mid-infrared spectral range, participation on development of a picosecond optical parametric amplifier emitting close to wavelength of 2 um and its advanced high power pump laser based on Yb:YAG thin disk was also an inherent part of the research and the thesis.

The submitted thesis has two main objectives. The first one is the development of a novel wave-front Shack-Hartmann sensor for mid-infrared radiation based on relatively cheap and fast broadband industrial camera and a tailored micro-lens array. Author also made significant effort in fast real-time collection and processing of experimental data from this sensor, and solving a parasitic effect of thermal afterimage negatively influencing measurement accuracy. The other objective is focused on development of a complex tunable high-power picosecond mid-infrared optical parametric photon source, its Yb:YAG pump laser, and a wave-front correcting feedback loop. Huang Zhou participated on or fully independently developed all parts of the advanced system. Especially the adaptive optics with closed loop feedback designed specifically for this complex laser is quite unique, and the very first one demonstrated experimentally. Report on the successful demonstration of such a kind of device was published in the Applied optics journal. Plenty of time spent the author also on building and optimization of the Yb:YAG thin-disk laser pump for the optical parametric photon source. Because of its nonlinear nature, long-term stability of pulse energy, beam parameters, and pulse duration of the pump laser is extremely important. Huang Zhou invested lot of time in studying and correcting observed fluctuations of these parameters, which finally led to better understanding these processes and long term stability of the Yb:YAG thin disk laser. The author's paper in Optical Engineering journal describes a negative role of a pulse compressor in beam size fluctuation, which finally led to very poor first results measured on the optical parametric system.

The thesis is written in English language and has totally 164 pages including all sections and appendices. It is divided into eight chapters and contains four appendices. First, introductory, chapter with motivation and goals of the work is followed by two chapters giving a general overview and state-of-the-art in the field of wave-front analysis and wave-front correction of optical beams (chapter 2), and construction of thin-disk lasers driving the optical parametric mid-infrared light source (chapter 3). Chapter 4 brings one of the author's main contributions - design of the in-house developed Shack-Hartmann wave-front sensor and adaptive optical system for mid-infrared radiation, which is followed by data processing description and feedback loop code development and demonstration in the chapter 5. Author's original results in construction and optimization of a stable high energy Yb:YAG thin disk laser are given in chapter 6. Complexity of optical parametric amplifiers, stability issues of the pump laser, delays during the pandemy, etc., caused the author was not able to fully demonstrate optical parametric photon source in its final configuration. However, very first results from the development, and future outlook and design of the final setup are showed in the chapter 7. Chapter 8 concludes all the results. Four appendices of the thesis contain rich description of key sections of a software code done in Matlab, and also a copy of author's most important papers published in impacted journals. Extensive list of references, figures, and tables are attached as well.

During his PhD study, the author published two papers directly related to his PhD in impacted journals like a first author, and presented the results at several international conferences. Besides, he contributed to an impacted paper related to his PhD like a co-author. The author closely collaborated with other members of Advanced laser development department of the Hilase centre, and contributed to reaching of many valuable scientific results, which may be included in future publications of the team. His work is pioneering in the field of mid-infrared beam improvement at the HiLASE centre and its importance will be expectedly even more appreciated in the future.

Besides the above mentioned scientific work, Huang Zhou participated on solving of various scientific problems, research projects, collaborative research, and other activities of the Hilase centre. He was directly involved in solving of the EU Horizon 2020 and MSMT funded project Hilase – Centre of Excellence.

During his PhD study period, the author has demonstrated, among others, purposefulness, skill and precision in designing and execution of experiments. He was very proactive and enthusiastic member of the laser team, and proved ability to integrate state-of-the-art knowledge and technology to experiments. Results published in impacted journals and presented at international conferences were well accepted by international scientific community. The dissertation thesis covers very broad range of scientific topics, from laser construction to data analysis and writing of software codes, and has very good formating and graphical design. It can very well serve as a textbook for other undergraduate and postgraduate students in the future.

It can be clearly concluded that the results correspond to the set objectives in the form, methodology, content, scientific achievemnets, contribution to potential industrial use, and conditions given by the law for PhD theses. Therefore I strongly recommend to accept this PhD thesis to defence.

Ing. Martin Smrž, Ph.D.

Digitally signed by Ing. Martin Smrž, Ph.D.
Date: 2022.10.21 02:30:37 +02'00'

In Prague, October 20, 2022

Ing.Martin Smrž, PhD.

Supervisor