Laboratoire Lasers, Plasmas et Procédés Photoniques
UMR 7341 CNRS - Aix-Marseille Université - Campus de Luminy C917 - 13288 Marseille Cedex 09, France

Tcheremiskine Vadim,
PhD, Research Engineer (1 class)
Lasers, Plasma and Photonique Processes (LP3) Laboratory
Aix-Marseille University (AMU) – National Center of Scientific Research (CNRS),
163 Avenue de Luminy, Case 917
Marseille, France

**Review**
**of the author's abstract of the thesis manuscript**
**"Formation of a three-dimensional space-time intensity distribution of the femtosecond laser radiation",**
**by Mironov Sergey Yur'evich,**
**submitted for awarding the degree of Doctor of Physical and Mathematical Sciences of Russian Federation, specialty Laser Physics**

In the abstract to his thesis, S. Yu. Mironov presents a summary of the works, which he has conducted during the scientific carrier, and which form the basis of his thesis manuscript. The author discusses the topicality of the considered subject, formulates the main objectives, and introduces the main results of conducted investigations, communicating on his personal contributions and presenting the list of his relevant publications in the peer-reviewed international scientific journals. The work is of interest to specialists in the research and development of ultra-high intensity and high-power lasers and lasers for electron photo-injectors with controlled three-dimensional intensity distribution. The thesis manuscript contains an introduction, three topical chapters, a conclusion, and a list of cited publications.

The first chapter is devoted to the implementation of an additional temporal compression of ultra-intense laser pulses with a peak intensity of several TW/cm$^2$. The method has been proposed at the end of previous century and has been implemented for the laser pulses of millijoule energy level. Initially, such materials as optical fibers or gas-filled capillaries with an extended length have been used as a nonlinear medium. However, further increase in the pulse energy does not allow the use of such media due to the optical breakdown. As it is stated in the abstract text, the use of flat optical plates made of transparent solid-state dielectrics (glass, fused quartz, etc.) as a nonlinear medium can significantly increase the energy level of the post-compressed laser pulses. The author introduces experimental results, which are obtained for laser pulses with energies of hundreds millijoules under conditions of acceptable values of the B-integral (~3). These results demonstrate two-fold shortening of the femtosecond pulse duration, which would be impossible without the use of methods of the nonlinear optics described in the chapter. Clear theoretical considerations are given, which show the possibility of additional temporal compression of high-energy femtosecond laser pulses of up to tens and hundreds of joules on the basis of techniques available nowadays. So, an interesting and original idea is the use of polymer films for broadening the spectrum of ultra-intense optical pulses owing to the self-phase modulation. It removes the technological constraints related to the production of thin (much less than 1 mm) and large (more than 20 cm aperture) plane-parallel optical plates.

Laboratoire Lasers, Plasmas et Procédés Photoniques (LP3 UMR 7341 CNRS) - Campus de Luminy, case 917, 13288 Marseille cedex 9.
www.lp3.univ-mrs.fr Tel. +33.(0)4.91.82.92.80 Fax. +33.(0)4.91.82.92.89 email : delaporte@lp3.univ-mrs.fr

The second chapter is devoted to the methods allowing to increase the temporal contrast of ultra-intense (~TW/cm$^2$) laser pulses. The author considers the possibility of application of the second harmonic generation (SHG) in uniaxial crystals (KDP is considered), as well as the cascade SHG process. The latter can be realized using two uniaxial crystals positioned in series. The experimental studies of the SHG employing ultra-intense fundamental laser pulses of 30-50 fs duration are performed by the author on the basis of modern femtosecond laser systems PEARL (Nizhny Novgorod, Russia) and ASUR (Marseille, France).

The third chapter of the thesis is devoted to the research and development of femtosecond laser systems for the generation of electron bunches from the photocathode surface of a linear electron accelerator. It presents the principal features of the design and the method allowing spatial and temporal control of the intensity distribution of optical pulses produced by the laser system, which is built and put into operation in the DESY accelerating centre (PITZ). An important experimental result is the generation of 3D profiled infrared laser pulses in the form of a cylinder and an ellipsoid. An interesting approach is based on the implementation of an angular chirp, in order to preserve the desired 3D structure of an optical pulse at the fundamental frequency during the process of generation of the second and fourth harmonics.

Finally, I should mark a huge contribution of the author in our collaborative studies of the SHG in KDP and LBO crystals. These studies have been performed employing high-intensity (up to 5 TW/cm$^2$) femtosecond pulses at 800 nm wavelength delivered by ASUR laser system. The stuff of LP3 Laboratory was greatly impressed by the level of theoretical background and the experimental skills demonstrated by the author during his short working visits to Marseille.

In general, the text of the abstract is written in a clear scientific language. The obtained results are presented by the author in 23 scientific papers published in the peer-reviewed international journals. Moreover, S. Yu. Mironov is the author of one international patent and of a chapter in the book published by a well-known scientific edition. The content of the author's abstract fully meets the most rigorous requirements for this kind of publication (the thesis abstract of an applicant to the Highest Attestation Commission of the Russian Federation for the degree of Doctor of Physical and Mathematical Sciences, specialty Laser Physics).

S. Yu. Mironov is worthy of awarding the degree of Doctor of Physical and Mathematical Sciences of the Russian Federation.

Signature: 06/09/2018 /Tcheremiskine Vadim/

Certified by the Secretary of the LP3 Laboratory
Signature:

/Max Rolland/

06/09/2018

UMR7341 CNRS - AMU
Laboratoire LP3
Parc Scientifique et Technologique de Luminy
163, Avenue de Luminy - Case 917
13288 Marseille Cedex 9 - FRANCE
Tél. 04 91 82 92 92 - Fax 04 91 82 92 89