Opponent's review


Topic and content of the dissertation

The topic of the assessed dissertation is the design of an optical probing technique for the diagnostics of plasma generated in ion acceleration experiments performed with the ELIMAIA laser ion accelerator at the ELI Beamlines Facility in Dolní Břežany. The aim of the work was to develop an original optical probing technique capable of recording several consecutive snapshots of laser-target interaction in a single laser shot using off-harmonic frequencies to monitor early stages of plasma generation in ion acceleration experiments.

The 98-page, 58 000-word dissertation, illustrated by 59 pictures, is divided into 4 chapters, and a Conclusion. It cites 4 author's own publications (all in collaboration with several co-authors), 10 his other publications (as a co-author), and it is supplemented by a list of 194 references.

According to the author declaration the thesis is primarily focused on the plasma generated from overdense targets by short, intense laser pulses in experiments on acceleration of ions for various applications. The emphasis is given to the interferometric optical probing, as a principle tool for time- and space-resolved plasma density measurements.

Chapter 1, Diagnostics of laser-generated plasma, overviews the standard diagnostics techniques available for plasma density measurements, and discusses the influence of laser contrast on ion acceleration.

Chapter 2, Single-shot time-resolved optical probing and its utilisation, summarises the development and current status of single-shot ultrafast optical imaging techniques for the probing of laser-generated plasma.

Chapter 3, Methods, is focused on the practical implementation of Optical Parametric Amplification (OPA) as a source of probe pulses with tunable wavelength.

Chapter 4, Development of a single-shot time-resolved off-harmonic optical probe, describes the first experimental tests of the two-frame optical probe based on polarisation multi-plexing, and a single-shot, three-frame interferometer developed for laser-plasma diagnostics, as well as their implementation at the ELIMAIA ion accelerator.

Chapter 5, Conclusions and future perspectives, summarises the results and proposes further development and improvement of the developed technique.

Characterization of the results

The detailed information contained in the first three chapters demonstrates the considerable professional erudition of the author and his extensive knowledge of the given issues. Most of the text there would rightfully have a place in a special textbook.

However, the structure of the sentences in the dissertation reveals that the author is not a native English speaker. The opponent's work is made more difficult also by a number of not quite common terms (for instance synergistically - fewer than 0.01 occurrences per million words in modern written English), by an excess of special technical nomenclature, and by an overload of not very common abbreviations. The readability of the text is not made much easier by the appa-rently additionally and inorganically inserted intertitles.
The polarisation-resolved optical probing technique, briefly summarized in Chapter 4.1 of the dissertation has been implemented during an experiment on ion acceleration from solid cryogenic laminar targets at the VULCAN PW target area of the Central Laser Facility at Rutherford Appleton Laboratory. However, the author says: Many pictures were unfortunately deteriorated by strong target self-emission. There are two more ‘unfortunately’ in the Summary of the main results: Unfortunately, due to safety precautions, the proposed setup inside the ELIMAIA interaction chamber was not used to measure plasma dynamics ... under real experimental conditions. And, a few pages further: The auxiliary laser used for the probe setup alignment was unfortunately broken before starting the experiment, so that the thesis ends with predictions only. My message to the author at this point is the following: Never use the word unfortunately in your technical texts!

Evaluation of the dissertation

The content of Filip Grepl´s dissertation is undoubtedly highly topical. The text of the entire dissertation has the required professional level. The results presented in the work are original and their scientific contribution is undoubted. Thus, in my opinion, the dissertation achieved all its goals.

Conclusion

I rate Filip Grepl's doctoral dissertation as very high quality, so that I recommend it for defense without any substantial comments.

At the same time, I am attaching a list of the relatively small number (of grammatical errors and mistakes 96, i.e. approximately 1 per page only) that I have found in his work.

Questions

A project is one thing, its implementation another. The main criterion of project quality is its successful implementation. This leads to my main question:

Are there any new prospects of applying the proposed setup at the Eli Beamlines Facility?

Secondly, are there any real prospects for possible transfer of the developed optical setup to other laser facilities, as mentioned at the page 91?

According to the author’s contribution statements, the original scientific results of the dissertation are based on four publications only, of which you are the first author of only one. That is not too much. Can we look forward to your next publications on the given topic?

Finally, which of the ultrafast imaging methods mentioned in par 5.3.1 do you consider to be the most efficient one?

Elaborated by                        Date

Ing. Jiri Ullschmied, PhD.          May 14, 2024
Diagnostics of Plasma Produced by Short Intense Laser Pulses
Ing. Filip Grepl

ERRATA

1. Wavelength => Wavelength
2. phase shift => phase shift
3. Spectra => Spectra
4. ultraintense => ultra intense
5. various energy => various amounts of energy
6. amplifier´s ... medium => amplifier ... medium
7. component´s ... position => component ... position
8. with a duration of => with the duration of...
9. polarisability => polarizability
10. Dependence => Dependence (in Fig. 1.3)
11. the ion layer that follows electrons => the ion layer that follows electrons
12. acceleration => acceleration
13. for a very short time (...) while => for a very short time (..., while
14. Interactions => Interactions (in Fig. 1.5)
15. Positive delays (...) bigger than => Positive delays (...) bigger than
16. Nomarski interferometer => Nomarski interferometer (těž str. 86 a 94)
17. Similarly to ... photography, that results => Similarly to ... photography, this results
18. data set which records => data set which records
19. beamsplitters (AM) => raději: beam splitters (BR) (mnohokrát dále)
20. Part of both ... experience ... rotation => A part of both ... experiences ... rotation
21. both the on-state and off-state => both the on-state, and off-state
22. scheme => scheme (in Fig. 2.10)
23. tradeoff => raději: trade-off (stejně jako na str. 44)
24. spatiotemporal-spectrotemporal integration ?? => wave vector
25. Nomarski => Nomarski
26. beam splitter additionally splits => beam splitter additionally splits
27. to generate a plasma => to generate (the) plasma
28. S3 (right), for eighth => S3 (right), for eighth (in Fig. 4.11)
29. pulse needs to be shorter than the rapidity of the transient event ??? => pulse was shifted (ale fuj!)
30. autocorrelator => autocorrelator
31. Additional optics allows => Additional optics allows
32. a priori => a priori

Místy nesrozumitelné dlouhé věty - např. str. 34.

J. Ullschmied 14.5.2024