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Using SPIDER for time-resolved plasma characterization

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In the past decades, considerable progress has been made in the acceleration of particle beams using ultra-intense laser pulses, but, so far, the predicted particle energy lags behind the energy predicted by numerical simulations. A possible reason for this might be the discrepancy between the initial plasma conditions assumed in simulations and the actual conditions during laser-based particle acceleration experiments. In order to further progress in this field, means have to be developed, to diagnose the occurring plasma conditions. A method that is capable of performing such a measurement is the characterization of the reflected laser pulse, after the interaction [1]. The spectral properties of a laser pulse, which is reflected during the interaction with a plasma, can be used to gain insights into the interaction itself , as well as information about the properties and state of the preplasma at the time when the laser peak intensity is arriving at the target [2]. In order to gain access to this information, it is important to measure the spectral evolution of the reflected pulse in a time-resolved manner. Such measurements have been performed at the PHELIX system at the GSI Helmholtzzentrum für Schwerionenforschung GmbH in Germany, using a FROG device to successfully deliver first results of this complex interaction [1]. However, the convergence of the FROG algorithm is tedious for complex pulse shapes and an uncertainty in the time direction exists for SHG-FROG. To alleviate these drawbacks, we developed a diagnostic based on SPIDER, which is capable of performing an unambiguous spectral-temporal characterization of the reflected light.

In this contribution, we report on the design and first test of this SPIDER during a laser-plasma experiment conducted at the PHELIX facility in Darmstadt, Germany. Compared to FROG measurements, SPIDER delivers better spectral data. However, the field reconstruction suffers from the non-global approach and is not able to resolve non-continuous spectra. Other aspects like usability and design constraints to improve the device robustness will be discussed.

References

[1] F. Wagner *et al.*, Backreflection diagnostics for ultra-intense laser plasma experiments based on frequency resolved optical gating, Review of Scientific Instruments, **88**(2):023503, 2017, doi:10.1063/1.4975827

[2] J. Hornung *et al.*, this conference

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