Contribution ID: **27** Type: **Contributed Talk (15 min)**

Characterization of Few-femtosecond Near-infrared Pulses using Machine Learning approach

Monday, 19 September 2022 10:30 (15 minutes)

The analysis of the absorption and emission of electromagnetic radiation is a powerful method for exploring the quantum world of atoms and molecules. The ability to use well-defined laser pulses provides an opportunity to study the underlying structure and mechanisms of these microscopic systems with a very high resolution. A large number of techniques developed up to date for the characterization of laser pulse rely on dedicated optical setups and, consequently, are commonly employed in ex-situ measurements, i.e., far from the light-target interaction. Such implementations can give rise to inaccuracies in estimating the in-situ properties of ultrashort laser pulses; thus, direct in-situ characterization methods are desirable.
In our work we theoretically investigate the in-situ characterization of few-femtosecond near-infrared laser pulses through strong-field-ionization driven autocorrelation using machine learning approach. The process of ionization by a strong field is nonperturbative and nonlinear, and thus it cannot be represented by a simple analytical autocorrelation function of the field. In this context, we employ first-principles quantum-mechanical calculations to model the strong-field ionization of rare gas atoms and produce autocorrelation patterns for a range of laser parameters. Then, in order to retrieve the properties of the laser field driving the ionization, such patterns are used as a database for a machine learning algorithm. In our work we compare two approaches: the one based on the Random Forest algorithm and the one utilizing our novel machine-learning-based algorithm. We demonstrate that the combination of first-principles calculations and machine-learning method allows for the retrieval of key parameters of the laser, such as pulse duration and bandwidth as a promising way for the in-situ characterization of ultrashort low-frequency laser pulses.

Primary author: KOLBASOVA, Daria (CFEL DESY, Department of Physics UHH)

Co-authors: TRABATTONI, Andrea (CFEL DESY; Institute of Quantum Optics, Leibniz University Hannover, Welfengarten 1, 30167 Hannover, Germany); Prof. CALEGARI, Francesca (CFEL DESY, Department of Physics UHH); GEFFERT, Otfried (CFEL DESY); Prof. SANTRA, Robin (CFEL DESY, Department of Physics UHH)

Presenter: KOLBASOVA, Daria (CFEL DESY, Department of Physics UHH)

Session Classification: Optimization and Control

Track Classification: Optimization and Control