On the characterization of unstable ultra-short laser pulse trains with D-SCAN

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Due to time-lengths in the femtosecond regime, ultra-short laser pulses can not be measured directly and indirect measurements must be made. Recovering the original pulse from those leads to ill-posed nonlinear inverse problems. Typical methods include the variants of FROG, SPIDER, or D-SCAN.

Since the reaction time of electronics spans several cycles of a modern high-end pulse laser, the measured data can be seen as an average over an unknown number of individual pulses. If all the individual pulses are identical, then this poses no harm. If there are differences from one pulse to another we speak of an unstable pulse train. A problem that is known in the literature but only recently gained more attention is that unstable pulse trains my lead to incorrect reconstructions and thus misinterpretation of the results.

Of course it is impossible to recover individual pulses in an unstable pulse train. Instead, one is interested in key quantities such as the average duration of each pulse. In this talk we explain these technicalities in more details and show how the model for D-SCAN for stable pulses is used to estimate the average lengths of pulses in an unstable pulse train. The key to this is treating an in practice known quantity as unknown and comparing its reconstruction with the data from the measurement setup. Mathematically, this corresponds to a phase retrieval problem including the blind estimation of a kernel function.

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