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Few-cycle surface plasmon enhanced electron acceleration

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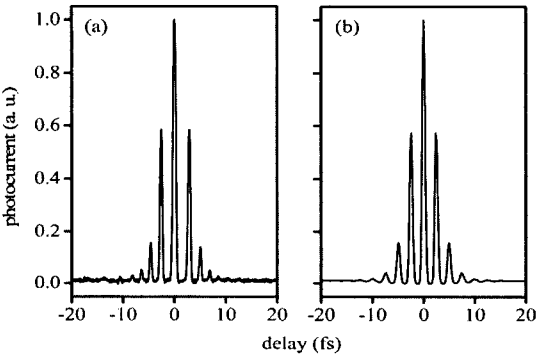
It is possible to generate high-quality ultrafast electron beams with keV energy based on surface plasmon-enhanced electron acceleration [1-3]. The beam generated this way can be also used to investigate ultrafast phenomena in the plasmon field. For the better undersanding of the temporal behavior of these ultrafast surface processes we carried out time-resolved experiments with 5.5 fs laser pulses for the first time. In this experiment, we executed an autocorrelation measurement with an ultra-broadband interferometer. By generating surface plasmons at the output of the interferometer, we measured the plasmonic photocurrent as a function of the delay between the interferometer arms. Figure (a) shows a typical measuared result, and figure (b) shows the fourth order calculated autocorrelation function of the 5.5 fs long laser pulse, corresponding to the fourth order nonlinearity of the electron emission process. According to the correspondence of these two curves, we can also state that the length of the generated surface plasmon pulse is only 2-3 optical cycles.



As a further exeperiment, we executed spectrally resolved measurements of the electron beam at higher intensities. According to these results, it is possible to reach electron beams with keV energy in the few-cycle regime too. It was found that the field strength of the surface plasmons is ×7...×30 higher than that of the focused laser pulse.

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[2] S. E. Irvine, P. Dombi, G. Farkas and A. Y. Elezzabi, Phys. Rev. Lett. **97**, 146801 (2006).

[3] P. Dombi & P. Rácz, Opt. Express **16**, 2887 (2008).

[4] P. Dombi et al., submitted (2010).