



IMPRS UFAST Call for PhD applications 2026/2027

TH2 - Ultrafast pulse generation for nonlinear sensing applications



Title of PhD Project	Ultrafast pulse generation for nonlinear sensing applications
Type	Experimental
Supervisor(s)	Tobias Herr, Franz Kärtner
Affiliation(s):	UHH, DESY
Number of positions:	1
Abstract:	Nonlinear optical microscopy and related sensing techniques use effects such as second- and third-harmonic generation or multi-photon absorption as contrast mechanisms. Accessing these effects requires high optical peak power, while the average power must stay low to avoid damaging the sample, particularly in bio-medical applications. Ultrashort pulses from table-top lasers meet both conditions, but their duration is usually limited to around 100 fs by the bandwidth of the laser gain medium. Since the peak power at fixed average power scales inversely with pulse duration, shorter pulses directly translate into stronger nonlinear signal, or the same signal at reduced sample exposure. This project explores integrated photonic devices and their ability to reshape ultrafast laser pulses through tailored dispersion and non-linearity. The goal is to generate pulses an order of magnitude shorter than those emitted by the pump laser, turning a standard fiber laser into a few-cycle source and removing the need for alignment-sensitive solid-state systems. The compact size and low complexity will make the approach useful for real-world application beyond specialized optics laboratories. The project will cover the full chain from nonlinear simulation and design of photonic chips to ultrafast characterization in our labs. Relevant references: Ludwig et al., Nature Comm. 15, 7614 (2024) Ludwig et al., Optics Letters 51, 7, 1708 (2026)
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