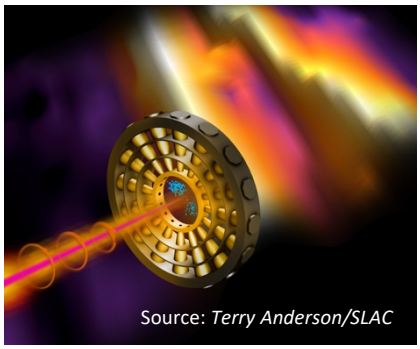
technische universität
dortmund

Spectrometer with angular resolution for ultrafast experiments at X-ray FELs

Project Description: For the investigation of the fundamental functional dynamics of molecules it is necessary to follow the motion of their basic constituents in real time. Specifically, the electrons' motion is played out on few and sub-femtosecond (fs) time scales, which are comparable to the oscillation period of one cycle of the electromagnetic field for the optical wavelength range (2.7 fs at 800 nm). Even shorter "pump" pulses to trigger the studied molecular changes necessitate driving wavelengths in the extreme ultraviolet (XUV) and X-ray regime. These ultrashort pulses can best be produced at X-ray free-electron lasers (XFELs) like the *European XFEL* in Hamburg or the *LCLS* in California, USA. In the framework of a project funded by the German *Bundesministerium für Bildung und Forschung* (BMBF) we are developing a novel detection method for a class of ultrafast experiments that combine high energy, spatial and temporal resolution with high repetition rates, leading to fast acquisition times or adequate statistics for single-event, non-reproducible measurements. This detector consists of multiple time-of-flight (TOF) tubes for the measurement of electron kinetic energies that are circularly arranged in a plane around the sample under investigation and cover the full 360° of electron or ion emission directions. The design and construction of this device will be conducted in close cooperation with experts from the *Helmholtz Zentrum Berlin* (BESSY) and from the *European XFEL*.


Source: *Terry Anderson/SLAC*

Position: We offer two PhD positions in the field of experimental X-ray laser physics and ultrafast electron spectroscopy. The candidates will join the group of Jun.-Prof. Wolfram Helml at TU Dortmund[†], where the dedicated synchrotron DELTA is available for X-ray related experiments and instrument tests. In addition, there exists a state-of-the-art femtosecond optical laser system as a complimentary light source for lab-based experiments. During the first design steps and initial detector setup, part of the work will also be done at the *European XFEL*/Hamburg, with which we pursue a long-standing and fruitful collaboration. Close connections also exist with the *Swiss XFEL* and the *LCLS*, opening the prospect of scientific exchange at world-leading facilities and unique experimental capabilities.

Qualification: We are seeking candidates with experimental experience in electron spectroscopy, ultrashort laser or X-ray-related work and/or knowledge of detector design and construction. Familiarity with Matlab or Python for simulations and data analysis as well as Inventor or SolidWorks for 3D design of the detector are desirable. We expect fluency in English (written and spoken) and above all a broad interest for all kinds of physical problem solving and an open mind for working in a team. The candidate must hold a Master degree in physics or a related subject.

Application procedure: Suitable candidates are requested to submit:
- A short introductory letter (max. 1 A4 page)
- A Curriculum Vitae, including full address, a contact phone number and e-mail address
- Name and address of, at least, one potential referee

For further information on the research project or organizational details, as well as for submitting an application, please directly contact Wolfram.Helml@tu-dortmund.de.

Deadline: 15.10.2019

[†] Some relevant recent publications:

N. Hartmann *et al.* Attosecond time–energy structure of X-ray free-electron laser pulses. *Nat. Photonics* **12**, 215–220 (2018).

W. Helml *et al.*, Ultrashort Free-Electron Laser X-ray Pulses. *Appl. Sci.* **7**, 915–956 (2017).

G. Hartmann *et al.*, Circular dichroism measurements at an x-ray free-electron laser with polarization control. *Rev. Sci. Instrum.* **87**, 083113 (2016).

W. Helml *et al.*, Measuring the temporal structure of few-femtosecond free-electron laser X-ray pulses directly in the time domain. *Nat. Photonics*. **8**, 950–957 (2014).