

PROJECT COORDINATOR & BENEFICIARY OF MEDEA

Deutsches Elektronen- Synchrotron DESY

Center for Free-Electron-
Laser Science (CFEL)

Center for Ultrafast Imaging
(CUI)

HAMBURG, GERMANY



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General Contacts

www.controlled-molecule-imaging.org
www.cfel.de
www.desy.de

Scientist in charge

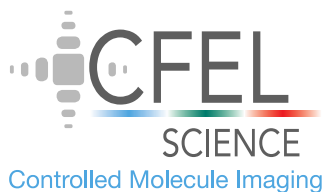
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Useful Links

www.medeahorizon2020.eu
www.cui.uni-hamburg.de/en
www.pier-hamburg.de
www.mpsd.mpg.de/IMPRS
www.hamburg.de
www.deutschland.de/de



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Home institution

Center for Free-Electron Laser Science (CFEL)

The Center for Free-Electron Laser Science is a joint enterprise of Deutsches Elektronen Synchrotron (DESY), the Max Planck Society (MPG), and the University of Hamburg and is designed to advance science with next generation light sources and lasers.

The three partners join forces to explore structural changes of atoms, molecules, condensed, biological, or warm dense matter on femtosecond time scales. CFEL envisions uncovering the "dynamics of matter" by uniting expertise from various disciplines and research institutions into a new interdisciplinary and synergistic effort.

CFEL was founded in 2007 and resides in the new "tower of light" building on the Science Campus Hamburg-Bahrenfeld/DESY since 2012. Currently CFEL hosts 29 independent research groups with over 400 scientists, engineers and technicians that are working in a broad range of research areas from medicine and biology to physics, including chemistry, materials and nano-sciences. CFEL scientist are involved in the three local graduate schools, the general PIER Helmholtz Graduate School, the International Max Planck Research School for Ultrafast Imaging & Structural Dynamics and the Graduate School of the Hamburg Centre for Ultrafast Imaging (CUI), the Hamburg Cluster of Excellence.

Controlled Molecule Imaging Group (CMI)

The Controlled Molecule Imaging group (CMI) started at CFEL in 2010 and is an independent research group embedded in the Coherent Imaging Division of CFEL. Our research focuses on (predominately) gas phase sample preparation, control and manipulation of these samples at both the quantum and macroscopic level, and the investigation of the electronic and nuclear structure and dynamics of these well-defined chemical samples at the spatial and temporal scales at which they occur. A plethora of novel techniques can be utilized for these investigations, such as electron and x-ray diffraction, as well as ion and photoelectron imaging. The culmination of all

the effort puts us in a position to be able to watch and understanding molecules at work.

Deutsches Elektronen-Synchrotron DESY

DESY is one of the world's leading accelerator centers. Researchers use the large-scale facilities at DESY to explore the microcosm in all its variety – from the interactions of tiny elementary particles and the behavior of new types of nanomaterials to biomolecular processes that are essential to life. The accelerators and detectors that DESY develops and builds are unique research tools. The facilities generate the world's most intense X-ray light, accelerate particles to record energies and open completely new windows onto the universe. That makes DESY not only a magnet for more than 3000 guest researchers from over 40 countries every year, but also a coveted partner for national and international cooperations. Committed young researchers find an exciting interdisciplinary setting at DESY. The research center offers specialized training for a large number of professions. DESY cooperates with industry and business to promote new technologies that will benefit society and encourage innovations. This also benefits the metropolitan regions of the two DESY locations, Hamburg and Zeuthen near Berlin.

Center for Ultrafast Imaging and Universität Hamburg

Counting more than 40.000 students Universität Hamburg is the largest research and educational institution in Northern Germany and the third largest university in Germany. The diversity of a full-scale university is reflected in approximately 170 courses of studies. More than 4.100 scientists, among them almost 700 professors, are doing research and teach. The research profile of Universität Hamburg is characterized by excellent individual projects and interdisciplinary main research areas. In the fields of physics and chemistry research is focused on the structure and dynamics of matter. Research groups tackle questions on the fields of quantum matter, nanostructures, ultrafast processes as well as physical chemistry and biological physics. Research groups on particle, astro and mathematical physics try to answer fundamental questions about our universe. Within the Excellence Initiative of the German Federal and State governments the main research areas in Earth Science as well as Photon and Nano Science each developed into clusters of excellence: „Integrated Climate System Analysis Prediction“ (CliSAP, 2007) and „The Hamburg Center for Ultrafast Imaging“ (CUI, 2012). The Hamburg Centre for Ultrafast Imaging addresses fundamental questions on chemical and physical processes in photon and nanoscience. The scientists of CUI hope to gain profound insight into fundamental phenomena such as the mechanisms of high temperature superconductivity, the appearance of different states of magnetism or the development of ordered molecular as well as biological and mesoscopic structures. Hamburg with its highly developed and advanced X-ray and electron sources as well as laser physics facilities offers a unique surrounding for the direct imaging of atomic processes. Since 2012, about 50 scientific teams from Universität Hamburg and its partners Deutsches Elektronen Synchrotron, European Molecular Biology Laboratory Hamburg, European XFEL and the Max Planck Institute for the Structure and Dynamics of Matter work together under the umbrella of the CUI cluster of excellence.



Group leader / Professor

Name: Jochen Küpper

Nationality: German

Date of birth: 22 April 1971

Short CV:

Awards

- Fellow of the Royal Society of Chemistry (invited 2014)
- ERC Consolidator Grant COMOTION (2013)
- Nernst-Haber-Bodenstein Prize of the German Bunsen Society for Physical Chemistry (2009)
- Feodor-Lynen Fellowship of the Alexander von Humboldt Foundation (2001)
- Rao Prize (2000)

Professional Experience

- Affiliate professor in the Department of Chemistry, University of Hamburg, Germany (since 2015)
- Member of Scientific Board, DESY Photon Science (since 2013)
- Research group leader at Center for Free-Electron Laser Science, DESY (since 2010)
- Professor in the Department of Physics, University of Hamburg, Germany (since 2010)
- Habilitation: Manipulating the motion of neutral molecules (Dr. habil.), Department of Physics, Free University of Berlin, Germany (2009)
- Group leader in the Department of Molecular Physics at the Fritz Haber Institute of the Max Planck Society, Berlin, Germany (2004-2010)
- PostDoc at the FOM Institute for Plasma Physics "Rijnhuizen" (Gerard Meijer), Nieuwegein, The Netherlands (2002-2003)
- PostDoc in the Department of Chemistry (Roger E. Miller[†]), University of North Carolina at Chapel Hill, NC, USA (2001-2002)
- Dissertation (Dr. rer. nat.), Heinrich Heine University, Düsseldorf, Germany (2000)
- Research associate in the Institute for Physical Chemistry, Heinrich Heine University, Düsseldorf, Germany (1996-2000)
- Diplom (Dipl. Chem.), Heinrich Heine University, Düsseldorf, Germany (1996)
- Research associate in the Department of Chemistry (David W. Pratt), University of Pittsburgh, PA, USA (1995)

For more details and a publication list, please see

https://www.controlled-molecule-imaging.org/team/jochen_kuepper

Offered training

Research Training Modules (RTMs)

- A. Techniques for molecular state-, structure-, and size-selection
- B. Introduction to experiments at the Free-Electron Laser FLASH

Scientific Courses of the Physics Department

There are tens of appropriate lectures accessible at the Universität Hamburg's Department of Physics and in various graduate schools on campus every term; topics include

- Molecular physics; Cold and controlled molecules; symmetry and spectroscopy; molecular imaging
- Laser physics; short-pulse lasers
- X-ray physics, (coherent) diffractive imaging, and structural determination
- Ultracold atoms; Quantum optics
- Precision spectroscopy
- Accelerator physics; laser-based acceleration

Transferable skills Modules (TSMs)

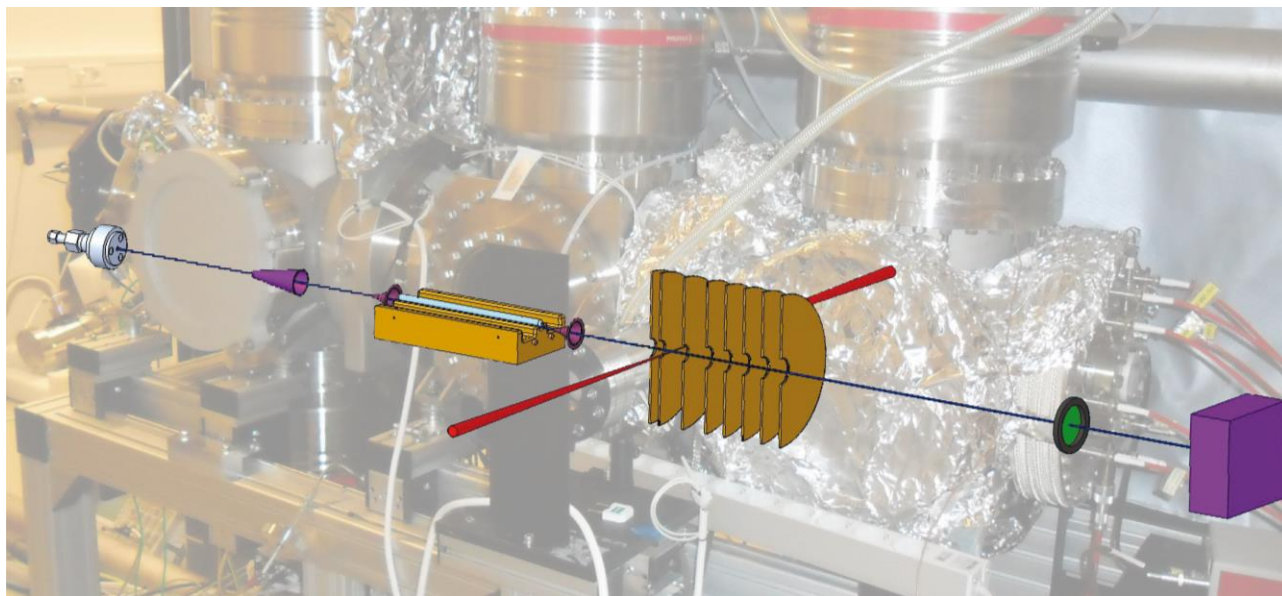
Career development workshops provided by the Center for Ultrafast Imaging (CUI), the PIER graduate school, and IMPRS-UFAST.

For all courses recognition of credits must be discussed with the supervisor

A. Techniques for molecular state-, structure-, and size-selection

Objective

The goal of the RTM is use, characterization, and application of the electric deflector to spatially disperse molecular beams according to quantum state. This allows for the spatial separation of structural isomers and cluster sizes. The produced samples allow for advanced alignment and orientation and imaging experiments on molecular dynamics. The experiments shall be quantitatively modeled.



Equipment

The ESRs will be provided with an experimental setup to perform the deflection and separation measurements as well as with codes to model the results.

Implementation

- The training will have a series of intermediate milestones and objectives:
- Introduction to the different methods of the spatial manipulation of neutral molecules
- Theory of the Stark effect and molecules in electric fields
- Generation of cold molecular beams
- Dispersion of the molecular beam with the electric deflector and laser-ionization ion imaging detection
- Simulation of the dispersion experiments
- Analysis of state-, conformer-, and size-separation
- Possible extension: Application of the controlled molecules in laser alignment and mixed-field orientation experiments

Duration

For the complete experiments a period of four–six weeks is planned. During this time the ESR will be involved mostly in the preparation of the experimental apparatus, in simulations of the experiment, and in the data acquisition and analysis. For the experimental part, the ESR will be able to use an existing experimental setup; computer programs for the simulations are also available but might need minor enhancements.

The period for the participation to the RTMs should be agreed upon with the tutors.

RTM at a glance

Title	Host institution	Objective	Duration/ Period	Tutors
State selection	DESY	Preparation of state-, conformer-, and size-selected molecules	4 weeks / to be discussed	Sebastian Trippel Sebastian.trippel@cfel.de Jochen Küpper jochen.kuepper@cfel.de

B. Introduction to experiments at the Free-Electron Laser FLASH

To be prepared by Daniel Rolles (I am waiting for input)

Objective

Equipment

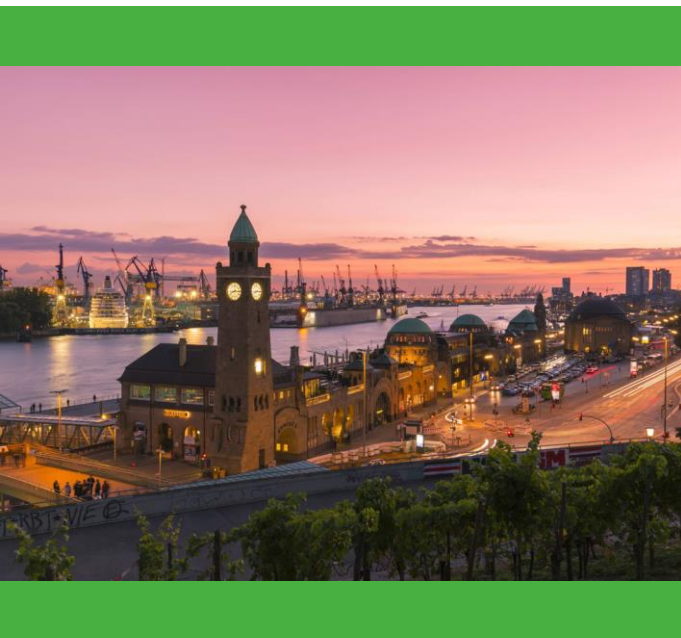
FLASH

Implementation

Duration

RTM at a glance

<i>Title</i>	<i>Host institution</i>	<i>Objective</i>	<i>Duration/ Period</i>	<i>Tutors</i>
Introduction to experiments at the Free-Electron Laser FLASH	DESY		6 weeks /to be discussed	Benjamin Erk Daniel Rolles



Hamburg - Quality of Life in a waterside Metropolis

Speicherstadt, Binnenalster, Außenalster, the port region and a vast network of canals - Hamburg is located in the middle of a one-of-a-kind waterscape. In addition, you will find patches of green all over the Hanseatic city. There are numerous parks, meadows and forests of all sizes wherever you go. The North Sea's fresh breeze, urban architecture and vast public green spaces add up to making Hamburg a real sight to see and a metropolis with almost unparalleled quality of life.

Despite its enormous industrial port area and 1.8 million inhabitants, Hamburg is one of Europe's greenest major cities. Almost a fifth of Hamburg is covered with meadows, woods, parks or water and almost half of it is designated as a conservation area. In relation to the relatively small size of the federal state, Hamburg has the largest share of [protected landscape](#) in all of Germany.

See <http://english.hamburg.de> for more info.

Welcome activities at the home institution

Guest Services is the central contact point for all German and foreign visitors, be it a guest scientist, a participant for a conference or a summer student. The following pages should help you to get prepared for a stay in Hamburg. The assistance comprises information on foreign law, reservation of guestrooms, house hunting, language courses and cultural events. Our aim is to simplify the lives of our scientists and their families and to enable them to do first steps in Germany independently.

The services are divided into 3 divisions:

The **International Office** provides support in regard to all necessary administrative processes, which involve a stay in Germany and simplifies the access to scientific life.

In addition to that the International Office is a centre of information: DESY people and guests from other institutes may obtain information just about anything and everything.

Through the **Hostel office** you can book accommodation in various guesthouses directly on the DESY premises- subject to availability.

The **Housing office** assists DESY campus scientists in finding suitable external accommodation.

For more info see <https://guest-services.desy.de> and http://guest-services.desy.de/e56138/Booklet_eng.pdf