THE HAMBURG CENTRE FOR ULTRAFAST IMAGING

The Hamburg Centre for Ultrafast Imaging

The Graduate Days 2017

Hamburg

March 13 – 16

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

DESY

EMBL

MAX-PLANCK-GESELLSCHAFT

European XFEL

Contents

Programme

Monday, March 13, 2017

8:30 Registration (CFEL, Bld. 99, Foyer)

9:30 **Dr. Davide Rossini**
Many-body physics in open quantum systems
(ZOQ, Bld. 90, Seminar room, ground floor)

Dr. Hans Behringer
Introduction to molecular dynamics simulations
(CFEL, Bld. 99, Seminar room I-II, ground floor)

Prof. Gerhard Nägele
Structure and dynamics of colloidal soft matter
(ILP, Bld. 69, Seminar room, ground floor)

10:50 Coffee Break (CFEL, ILP, ZOQ)

11:10 **Dr. Davide Rossini**
Many-body physics in open quantum systems
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Prof. Gerhard Nägele
Structure and dynamics of colloidal soft matter
(ILP, Bld. 69, Seminar room, ground floor)

12:30 Lunch (DESY-Canteen, Bld. 09)

14:00 **Dr. Christian Ott**
Attosecond flashes of light: Illuminating electronic quantum dynamics
(ZOQ, Bld. 90, Seminar room, ground floor)

Prof. Steve Meech
Photodynamics in biomolecular systems
(CFEL, Bld. 99, Seminar room I-II, ground floor)

Prof. Stefan Eisebitt
Ultrafast x-ray scattering and holography
(ILP, Bld. 69, Seminar room, ground floor)

15:30 Free time

Tuesday, March 14, 2017

9:30 **Dr. Davide Rossini**
Many-body physics in open quantum systems
(ZOQ, Bld. 90, Seminar room, ground floor)

Dr. Hans Behringer
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15:40 Lab tour #1

16:20 Lab tour #2

17:00 Colloquium
Prof. Elspeth Garman
104 years of chrystallography: what has it taught us and where will it lead us?
(CFEL, Bld. 99, Seminar rooms I-II-III)

18:00 Barbeque (CFEL, Bld. 99, Foyer)

Wednesday, March 15, 2017

9:30 **Dr. Davide Rossini**
Many-body physics in open quantum systems
(ZOQ, Bld. 90, Seminar room, ground floor)

Dr. Hans Behringer
Introduction to molecular dynamics simulations
(CFEL, Bld. 99, Seminar room I-II, ground floor)

Prof. Gerhard Nägele
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(ILP, Bld. 69, Seminar room, ground floor)

10:50 Coffee Break (CFEL, ILP, ZOQ)

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15:30 Free time

16:30 Industry event
Dr. Alexander van Staa and Dr. Johanna Busch
NXP semiconductors – Secure connections for a smarter World
(CFEL, Bld. 99, Seminar rooms I-II-III)

17:30 **Reception** (CFEL, Bld. 99, Foyer)

Thursday, March 16, 2017

9:30 **Bernd Klein**
Introduction into Phyton for scientists
(Physics department, Jungiusstr. 9, 20355 Hamburg, Pool room 3 – No. 302, 3rd floor)

Bodo P. Krause-Kyora
Matlab: Introduction and real world use-case for measurements and simulation
(Physics department, Jungiusstr. 9, 20355 Hamburg, Pool room 1 – No. 306, 3rd floor)

Rob Thompson
Communication – Negotiate – Resolve
In cooperation with the PIER Helmholtz Graduate School
(Bahrenfeld Campus, CFEL, Bld. 99, room 02.104, 2nd floor)

Dr. Peter Schröder
Project management throughout the doctorate: From conception to implementation everything under control
(Bahrenfeld Campus, CFEL, Bld. 99, Seminar room IV, 1st floor)

Dr. Simon Golin
Project management in academia: From conception to implementation everything under control

(Bahrenfeld Campus, CFEL, Bld. 99, Seminar room V, 1st floor)

10:50 Coffee Break (CFEL, Physics Dep.)

11:10 **Bernd Klein**
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14:00 **Bernd Klein**
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17:00 End of the Graduate Days of CUI

Abstracts

Morning long courses (Mon-Wed, 9:30-12:30)

***Many-body physics in open quantum systems*: Dr. Davide Rossini (Scuola Normale Superiore di Pisa, Pisa, Italy)**

The recent development of quantum technologies has drastically enhanced our capability to control quantum coherence at the level of the single particle in a variety of physical systems, ranging from atomic and molecular optics, to trapped ions, semiconducting nanodevices, and cavity/circuit quantum electrodynamics (QED). In several cases, it is even possible to control the action of the coupling to an external environment, such as for certain quantum optical systems and for coupled QED cavities. The system can be thus driven, with a good accuracy, into specific quantum states.

As a consequence to these advancements, nowadays the quest for a careful theoretical modeling and study of quantum many-body physics in a driven-dissipative context is crucial, and goes well beyond the simple understanding of the breakdown of quantum coherence. Moreover, one cannot even prescind from a careful treatment of interactions beyond the perturbative limit, since dramatic many-body effects due to strong correlations can be envisaged even in the open scenario.

These lectures will be introduced by an overview of the available experimental platforms where the many-body physics of open quantum systems can be readily accessed and tested. Due to the formidable difficulty in approaching their description, unfortunately most of our theoretical understanding for these systems is limited to the mean-field level, where interactions are treated crudely. I will present the most recent numerical approaches that are able to shed light on the many-body driven-dissipative realm beyond that limit. Specifically, I will provide a pedagogical introduction to a variety of methods including quantum trajectories, matrix product operators, cluster mean-field approaches, and linked cluster expansions. I will then show how one can envisage a combination of some of them in order to extend their capabilities in treating larger systems and higher dimensionalities.

In the second part of my lectures, I will enter the details of some interesting results that have been recently achieved using the above mentioned methods. Emphasis will be put on the significant differences that may emerge with respect to the mean-field treatment, after a thorough treatment of the role of interactions. As expected, discrepancies generally become more pronounced in a reduced dimensionality, but can be anyway of fundamental importance even in other subtler contexts, due to the fact that short-range correlations and fluctuations may have a dramatic influence.

The range of outcomes that I will present includes the characterization of exotic quantum phases that can be stabilized in non-equilibrium steady states under driven-dissipative conditions, the quantum transport properties in a non-perturbative interacting regime for the open scenario, and some prominent features of the steady-state many-body phase diagram.

***Introduction to molecular dynamics simulations*: Dr. Hans Behringer (The Hamburg Centre for Ultrafast Imaging and Universität Hamburg, Hamburg, Germany)**

Complex systems with their many degrees of freedom on different length and time scales exhibit fascinating characteristics and properties. Although their description can in principle be formulated in terms of a quantitative theory on the microscopic level, mathematical solutions for particluar systems are hardly feasible. Theoretical investigations into the underlying principles that govern the systems are therefore strongly relying on approximations, however, often systems are to complicated and defy a systematic treatment. An alternative route to look into such problems is provided by computational physics where simulations on a computer are used to reproduce and eventually understand the behaviour of systems.

This lecture course is directed at students with no background in computational physics and gives an introduction to the basics of classical molecular dynamics simulations. The lecture develops and discusses why and how this method works and demonstrates its practical application for simple physical problems. After having established the key ingredients of molecular dynamics simulations the lecture concentrates on a particular example from current research, namely the modelling and simulation of protein dynamics. The lecture will finally give an outlook to more advanced methods.

***Structure and dynamics of colloidal soft matter*: Prof. Gerhard Nägele (Institute of Complex Systems, ICS-3 and Forschungszentrum Jülich GmbH, Jülich, Germany)**

Mesoscale particles dispersed in a viscous fluid are found in numerous technological processes and products including paints, pharmaceuticals and food products, and in biological systems such as cells. The particles size spans a broad range, from micron-sized synthetic colloidal particles down to nano-sized proteins and even smaller electrolyte ions. The equilibrium microstructure, thermodynamics and phase behavior of colloidal systems is determined by direct particle interaction including van der Waals attraction and steric repulsion, and screened Coulomb repulsion in case of charged particles. Additionally to direct interactions, the colloid dynamics is strongly influenced by Brownian motion, and by the long-range hydrodynamic particle interaction (HI) transmitted quasi-instantaneously by the solvent flow. The HI gives rise to a plethora of phenomena that are often unexpected. It changes the diffusion and rheological properties of concentrated dispersions, and it affects the kinetic pathways and resulting phase diagram in non-equilibrium phase transitions.

In this lecture series, I give an overview over the statistical physics and low-Reynolds number hydrodynamics of globular colloidal particles undergoing correlated Brownian motion in a Newtonian fluid. Theoretical methods are described allowing for the calculation of microstructural, diffusion, rheological and electro-kinetic properties characterizing a colloidal system. Applications of these methods to experimental systems are discussed including suspensions of microgels and charge-stabilized particles, and protein solutions. The performance of the methods is illustrated by the comparison with computer simulation results. After an introduction where examples of colloidal dispersions are presented, the following topics are addressed:

- Static Properties

The salient concept of effective particle interactions is illustrated for charge-stabilized particles where the microionic degrees of freedom are integrated out, giving rise to renormalized particle charges and electrostatic screening parameters. The subtle question of how effective interactions are related to thermodynamic properties is discussed using the example of the osmotic pressure. Effective pair potentials are used as input to self-consistent Ornstein-Zernike methods for calculating radial distribution functions and static structure factors measured, respectively, in video microscopy and in laser light, x-ray and small-angle neutron scattering experiments. Recent theoretical, experimental and computer simulation results for these functions are presented for protein solutions with competing short-range attraction and long-range repulsion (SALR systems) where dynamic clustering is observed, and for non-ionic microgels having short-range soft interactions.

- Colloidal Hydrodynamics

I discuss here the friction-dominated, quasi-inertia-free related motion of mesoscale particles and dispersing fluid under low-Reynolds-number conditions. Characteristic features of this peculiar dynamics are described (e.g., kinematic reversibility and instantaneity), and highlighted using illustrative examples and movie clips. The concept of hydrodynamic mobility is introduced, and used to describe theoretically the HI of particles with a confining wall for different hydrodynamic boundary conditions. Moreover, the HI of particles settling in the bulk fluid region is analyzed, and for this purpose an astonishing example of many-particles sedimentation is shown.

- Dynamics of colloidal systems

The configurational evolution of correlated Brownian particles under the influence of direct and hydrodynamic interactions is governed by a many-particles diffusion equation termed generalized Smoluchowski equation. This equation constitutes the base for the calculation of dispersion-averaged transport properties such as collective and self-diffusion coefficients and viscosities, and dynamic scattering functions characterizing the suspension as a whole. I shall focus on easy-to-apply analytic methods of calculating transport properties that require the radial distribution function and hydrodynamic mobilities as input and are derived using linear response theory. Recent applications of these methods to suspensions of solvent-permeable microgels and SALR systems (low-salinity lysozyme solutions) are presented, and compared with experimental and computer simulation results. Finally, electro-kinetic effects arising from the non-instantaneous response of the microion clouds surrounding charged colloidal particle are explored, for the examples of colloidal electrophoresis and self-diffusion.

Afternoon short courses (Mon-Wed, 14:00-15:30)

***Attosecond flashes of light: Illuminating electronic quantum dynamics*: Dr. Christian Ott (Max Planck Institute for Nuclear Physics, Heidelberg, Germany)**

Attosecond technology has been pushing the frontier of time-resolved experiments in the past decades. The bandwidth of such pulses normally covers the extreme ultraviolet part of the electromagnetic spectrum, thus directly accessing bound electronic quantum states and their dynamics via the superposition principle, but research is now also pushing with increased attention towards the x-ray domain, to access isolated core-level dynamics of atoms, molecules and solids. The pulses typically exist either in precisely timed (with respect to the infrared or optical driving field) trains, or even in an isolated form by using appropriate temporal gating techniques. This lecture series will give an introduction to the field of attosecond physics, and covers both the basic concepts as well as applications to the measurement of multi-electron dynamics.

The first lecture will be dedicated to discuss fundamental concepts of ultrashort laser pulses. Special emphasis is put on the time-frequency correspondence by means of the Fourier transform. Topics such as nonlinear pulse propagation, self-phase modulation and pulse compression, as well as characterization techniques for ultrashort laser pulses will be covered.

In the second part of the lecture series we will discuss several aspects of the generation mechanism of attosecond pulses, i.e., from a spectral perspective, the concept of high-order harmonic generation. This also includes an overview of gating techniques and macroscopic phase matching effects with emphasis to explain the necessary ingredients for the generation of such pulses in the lab. Also their characterization via interferometric cross-correlation methods and temporal gating will be introduced, leading into the discussion of selected experiments that demonstrate electron dynamics on the attosecond timescale.

In the final part of the lecture, special emphasis will be put on very recent developments of attosecond transient absorption spectroscopy. This will cover the concept of the optical dipole response of a quantum system and its manipulation by means of strong electric fields. With emphasis on own research, this topic covers the formation and control of spectroscopic line shapes, and how to relate their appearance to multi-electron dynamics of the investigated system. This includes aspects of the intrinsic interaction of different electron quantum configurations and Fano interference, and how to control these effects experimentally on ultrafast timescales.

***Photodynamics in biomolecular systems*: Prof. Steve Meech (University of East Anglia, Norwich, United Kingdom)**

Understanding dynamics in biological systems is a vast subject. What optical spectroscopists can bring to the party are techniques, which can be applied to complex media and are able to record data that was not previously accessible. In this series of three talks I plan to introduce three experiments, which have in common their reliance on ultrafast laser pulses and their applicability to probing dynamics in biology (mainly in proteins and peptides). The focus will be on methods, which are (or have been) used in my own group, but I will aim to compare and contrast those with other approaches. I will not (could not) attempt to cover the whole field of protein dynamics, and in particular I will hardly touch on NMR or the key role of theory and simulation.

The first lecture will describe the ultrafast optical Kerr effect (OKE) as a probe of structure and dynamics in liquids. OKE is a nonresonant method and among the simplest of the third order nonlinear optical experiments, yet provides an excellent signal-to-noise view of liquid dynamics – a neat illustration of the power of optical heterodyne detection. The OKE will be compared with THz transmission spectroscopy, transient IR, 2D infra-red (IR) and dielectric relaxation in the context of a discussion of the dynamics of waters of solvation surrounding peptides and proteins.

The second lecture will focus on time resolved fluorescence. Fluorescence is probably the most widely used spectroscopic tool in biology, largely because it is a background free signal detectable down to the single molecule level. However it can be time resolved, rather easily for picosecond resolution and – with a little more difficulty – on the tens of femtosecond timescale. The methods will be described and illustrated with an application to reactive dynamics in the green fluorescent protein and solvation dynamics as a probe of reactive sites in proteins.

The final lecture will focus on transient vibrational spectroscopies, especially transient IR and femtosecond stimulated Raman spectroscopy (FSRS). These methods will be described and illustrated with applications to fluorescent and photoactive proteins such as dronpa and the LOV domains.

***Ultrafast x-ray scattering and holography*: Prof. Stefan Eisebitt (Technische Universität Berlin, Berlin, Germany)**

In many areas of physics, the temporal response of a system and its nanoscale structure are coupled. Excitations can drive solids into transient phases, altering the material properties on short timescales and making unusual properties transiently available. For example, optical excitation can turn antiferromagnets into ferromagnets – for a few picoseconds. In complex materials, different phases such as insulating and metallic regions can coexist already in the ground state, with the details of this coexistence (spatially as well as temporally after exciation) defining macroscopic properties. It is thus often helpful to be able to combine spatially and temporally resolved information on the nanometer lengthscale and pico- to femtosecond temporal scale.

In this lecture, I will introduce basic concepts of time resolved (resonant) scattering and holographic imaging using x-rays and extreme UV radiation. Furthermore, the combination of such techniques with spectroscopic information is discussed. After introducing the concepts of x-ray scattering as well as the sources of femtosecond x-ray pulses in the lab and at large scale facilities, I will focus on time resolved x-ray holography. You will see how not only amplitude and phase of an object, but also the appearance of an object at different times or at different x-ray energies can be encoded in a hologram. And if you have recorded a x-ray hologram, do you always have 3D information on your object? The lecture will transport the general concepts in this field with examples from current research, with a variety of examples focusing on ultrafast magnetic phenomena.

Colloquium (Tue, 17:00)

***104 years of crystallography: what has it taught us and where will it lead us?:* Prof. Elspeth Garman (University of Oxford, Oxford, United Kingdom)**

What has the art of the chocolatier got to do with drug discovery, proteins and DNA? The linking theme is crystals, which allow us to determine the three-dimensional shapes of all sizes of molecules, ranging from the tiny chocolate moiety to the much larger proteins that allow our bodies to function through to the DNA that carries our genetic information. Crystallography was born in 1913 with the determination of the 3-D structure of sodium chloride (salt) by the Bragg father and son team. It has flowered to elucidate many disciplines since then, with applications in engineering, physics, chemistry, earth sciences and biology. Using crystallography, we can unravel the shapes of biomolecules in our bodies that are targets for drugs against disease, and thus identify new treatments. I will focus on this last field, and give an overview of what is currently achievable and what may be possible in the future (my crystal ball permitting!).

Industry event (Wen, 16:30)

***NXP Semiconductors – Secure Connections for a Smarter World*: Dr. Alexander van Staa and Dr. Johanna Busch (NXP Semiconductors Germany GmbH, Hamburg, Germany)**

“Isn’t that the semiconductor company? What exactly do they do?” Get yourself more familiar with NXP Semiconductors in a brief presentation about the company, its business units and exciting possibilities for Graduates!

NXP Semiconductors enables secure connections and infrastructure for a smarter world, advancing solutions that make lives easier, better and safer. As the world leader in secure connectivity solutions for embedded applications, we are driving innovation in the secure connected vehicle, end-to-end security & privacy and smart connected solutions markets.

The business units Automotive and Security & Connectivity are located in Hamburg. NXP’s Automotive business unit offers sensor and processing technology that drives all aspects of the secure connected cars of today and the autonomous cars of tomorrow. NXP’s Security & Connectivity business unit offers best-in-class security, contactless performance and the most complete solutions to produce unmatched mobile and Internet of Things (IoT) solutions.

NXP Semiconductors offers exciting possibilities for Graduates e.g. the Trainee Programs in Hamburg for technical and commercial roles embedded in a 2-year-program, comprising high-impact work in important projects, technical and professional training and ongoing exchange with top colleagues from around the world.

Practical information

Location

Campus Bahrenfeld
Notkestraße 85 (Main Entrance)/Luruper Chaussee 149 (Side Entrance)

- Center for Free-Electron Laser Science (CFEL), Building 99
- Zentrum für Optische Quantentechnologien (ZOQ), Building 90

Physics Department
Jungiusstraße 9

- Pool room 1 – No. 306 3rd floor
- Pool room 3 – No. 302, 3rd floor

Contact

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Registration

The registration to the graduate days takes place on Monday, March 13, 2017, in the foyer of the CFEL (Bld. 99) from 08:30 to 09:20. All registered participants and invited speakers will be provided with a badge and meal vouchers.

Lunch and group photo

The common lunches will take place at the Desy-canteen (Bld. 09) from 12:45 to 13:50.
A group photo of all participants of the graduate days as well as of the invited speakers is scheduled for Tuesday, March 14, 2017, at 12:40. All participants meet in the foyer of the CFEL (Bld. 99).

Lab tours

Time-resolved crystallography
Meeting point: CFEL Foyer (CFEL Café)
Contact: Marta Sans Valls

Quantum condensed-matter dynamics
Meeting point: CFEL Foyer (information desk)
Contact: Daniele Nicoletti

Controlled molecule imaging
Meeting point: CFEL Foyer (entrance of seminar room I)
Contact: Daniel Horke and Sebastian Trippel

Structure and dynamics of cold and controlled molecules
Meeting point: Foyer, building 67
Contact: Sergio Domingos, Sabrina Zinn, Benjamin Arenas

Femto BEC: Combining ultrafast physics with ultracold quantum matter
Meeting point: ZOQ Foyer
Contact: Philipp Wessels

Quantum matter
Meeting point: ILP Foyer
Contact: Henning Moritz

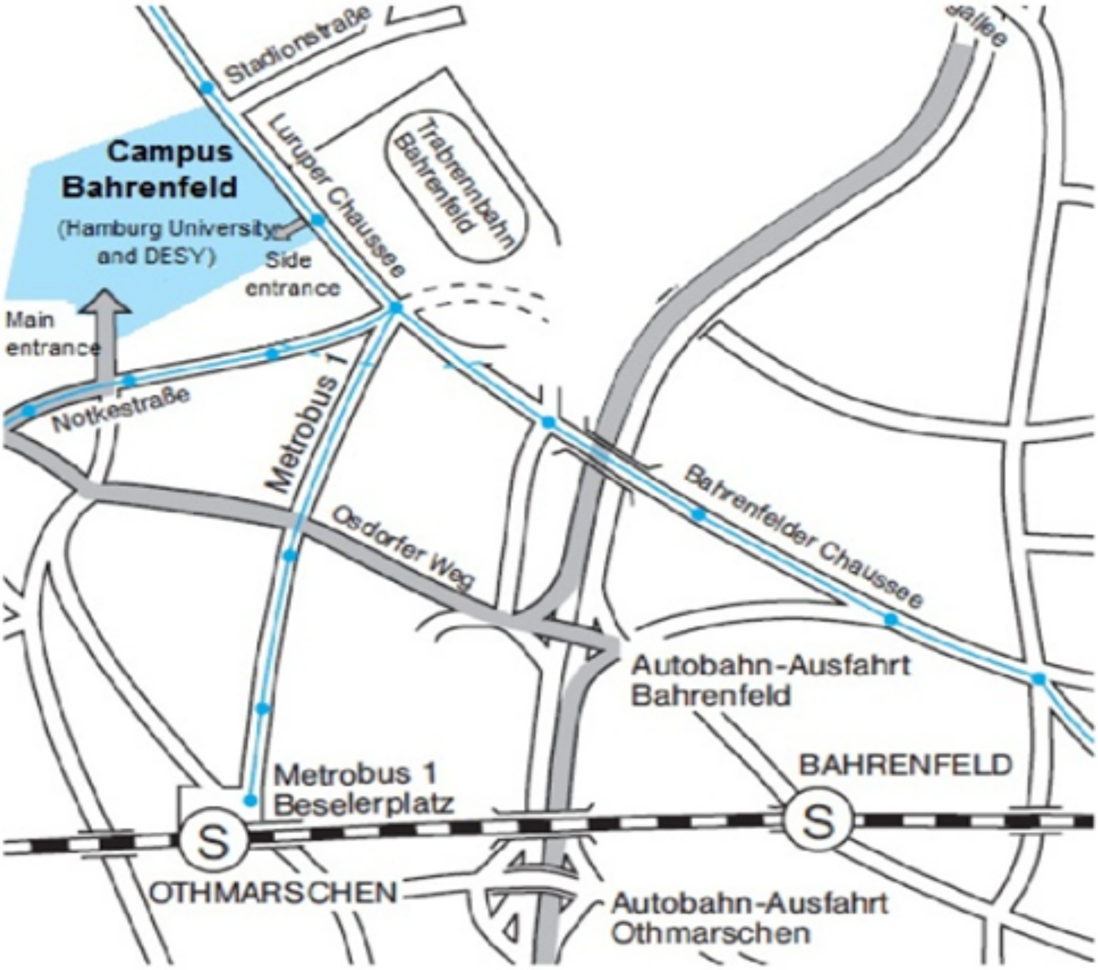
Solid-state laser
Meeting point: ILP Foyer
Contact: Daniel-Timo Marzahl

Coherent x-ray scattering
Meeting point: Entrance of building 25f (ground floor)
Contact: Joana Valerio

Biochemistry and molecular biology
Meeting point: Seminar room, building 22a (1st floor)
Contact: Markus Perbandt

Petra III
Meeting point: Main entrance of PETRA III building 47c
Contact: Oliver Seek

Directions



By train: to Hamburg-Altona station, then continue by taxi (travelling time about 15 minutes) or take a bus (see below).

By bus: To reach the side gate (recommended), take bus line 2 (direction Schenefeld Mitte) from Altona train station and get off at "Luruper Chaussee/DESY", travelling time about 20 minutes.

From train station "S-Bahn Othmarschen", take bus line 1 (direction "Schenefelder Holt") directly to the main entrance of the campus (bus stop "Zum Hünengrab/DESY"), travelling time about 25 minutes.

By plane: The campus can be reached from Hamburg airport by taxi in about 30 minutes. Alternatively, take suburban train S1 to Altona or Othmarschen (about 40 minutes, direct train) and a bus from there (see above).

Laboratory 1 01-01e
Directorate 01
Press and public relations 01
Company medical officer 01a
Library 01d
Laboratory 2a, Theory 02a
Computer Centre, UCO 02b
Laboratory 02g
Laboratory 3 03
Caretaker 03a
Storage building 03b
Gas station 04
Auditorium, entrance building 6 05
Administration building, **Guest services 06**
Administration building 07
Guest house 8 07a
Cafeteria, Bank 09
Bistro 09a
Workshop 10
Purchasing department 11
Central warehouse 11a
Cable hall 11b
Gate lodge Notkestraße 12
(main gate)
Gate lodge Luruper Chaussee 12a
(side gate)
Liquifying plant 13
Gas cylinder building 13a
Helium container building 13b
Vacuum laboratory 14
Office building 15a, b
Power station 16
10 kV main station 16a, b
Cooling plant DESY II 16d
Filter network switchyard 16e
Emergency power switch facility 16f
Storage building 16h
Heating plant 17
Maintenance building 18, 18a
Carpenters' building 19
Synchrotron building 20
Filtering hall 20a
10 kV substation 5a 20b
Power house DESY 20c
Vacuum engineering 22
Laboratory of the Universities of Hamburg and Lübeck 22a
LINAC I 23
LINAC II 24
PIA 24a
HASYLAB laboratory 25
EMBL 25a
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HASYLAB X-ray wiggler hall, HZG / GFZ 25c
HASYLAB laboratory 4 25d
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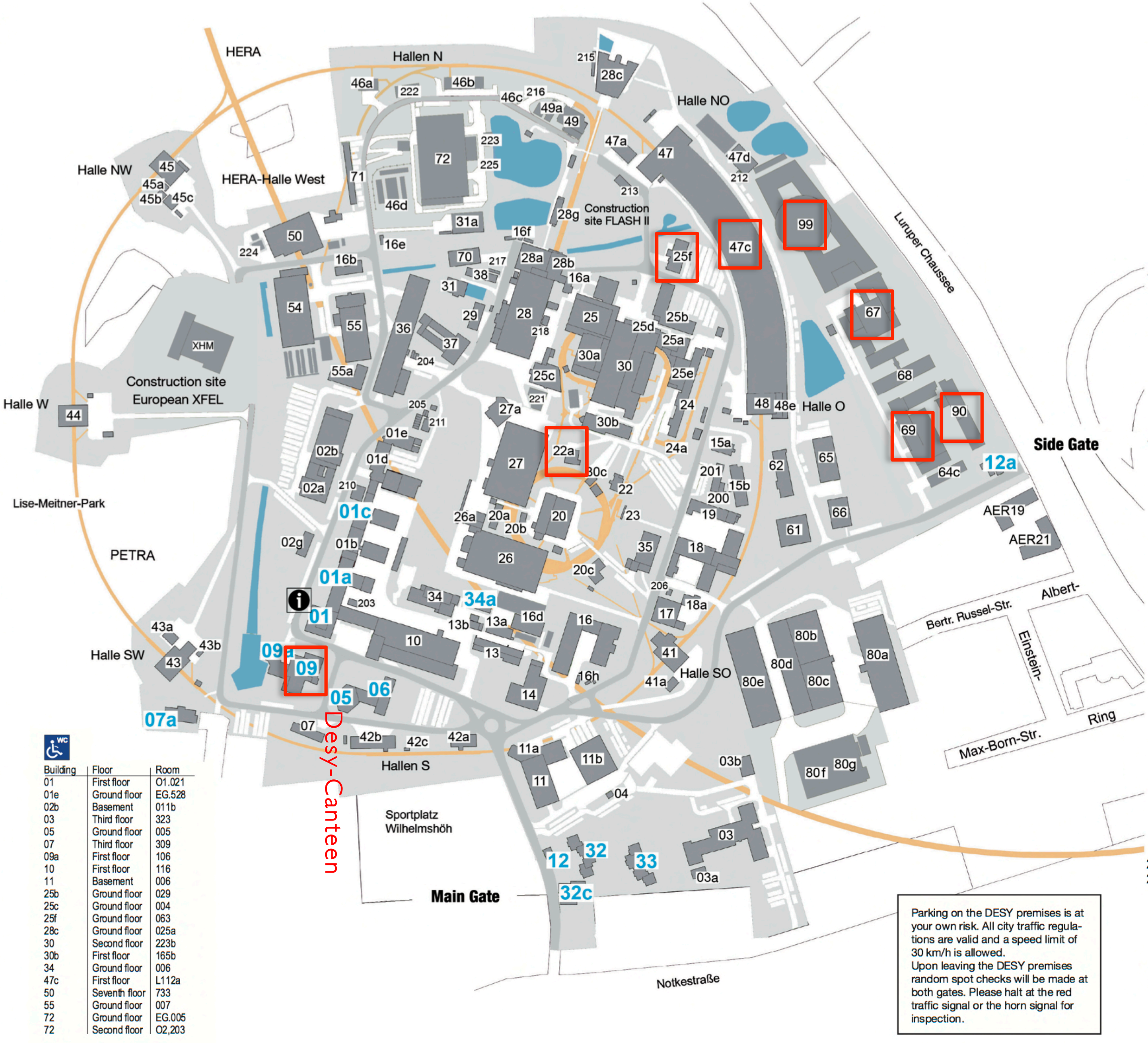
Experimental hall II 27
Testing area 27a
TTF / experimental hall III 28
Cryogenic hall 28a
FLASH tunnel 28b
FLASH experimental hall 28c
FLASH laser hut 28g
Iron removal plant 29



Building	Floor	Room
01	First floor	O1.021
01e	Ground floor	EG.528
02b	Basement	011b
03	Third floor	323
05	Ground floor	005
07	Third floor	309
09a	First floor	106
10	First floor	116
11	Basement	006
25b	Ground floor	029
25c	Ground floor	004
25f	Ground floor	063
28c	Ground floor	025a
30	Second floor	223b
30b	First floor	165b
34	Ground floor	006
47c	First floor	L112a
50	Seventh floor	733
55	Ground floor	007
72	Ground floor	EG.005
72	Second floor	O2,203

Parking on the DESY premises is at your own risk. All city traffic regulations are valid and a speed limit of 30 km/h is allowed.
Upon leaving the DESY premises random spot checks will be made at both gates. Please halt at the red traffic signal or the horn signal for inspection.

30 Storage ring DORIS / experimental hall IV
30a DORIS supplying hall
30b Accelerator operation building
30c Power station
31a Accelerator components building
32 Guest house 2
32c Kindergarten
33 Guest house 3
34 Training area
34a physik.begreifen@desy.de
35 Safety group / Communication engineering
36 Preparation hall, experimental hall V
37 Assembly hall
38 Storage building
41, 41a PETRA halls SO
42, a-c PETRA halls S
43a, b PETRA halls SW
44 PETRA hall W
45, a-c PETRA halls NW
46a-c PETRA halls N
46d Power station, cooling plan
47, a PETRA halls NO
47c PETRA III experimental hall
47d PETRA III cooling plant
48, e PETRA halls O / EMBL
49, 49a Office building
50 HERA hall west
54 Refrigeration technology hall
55 Magnet measurement hall
55a Proton vacuum building

61-69 University Hamburg
61 Auditorium
62 Institute of experimental physics
64c Preparation building
65 Workshop
66 Theory
67 Institute of experimental physics
68 Institute of experimental physics
69 Institute of laser physics

70 Modul test hall
71 XTL mock up
72 AMTF hall

80a-g Storage buildings

90 Zentrum für Optische Quantentechnologie (ZOQ)
99 CFEL

200 Office container MPG
201 Office container MPG
202-207 Container
210-218 Container

Off-site buildings:
51 HERA hall north
52 HERA hall east
53 HERA hall south
AER19 European XFEL
AER21 Project management agency PT-DESY

September 2012

Directions

From *Dammtor* station (public transport timetables on www.hvv.de) to the ***Physics Department***

Exit Dammtor station: direction taxi rank. Turn *West* on Dag-Hammarskjöld-Platz. Pass the *Radisson Blu* on your right side. Enter the garden *Planten and Blomen* and follow the path (glass roofing) toward the Hamburg fair. At the end turn left. Cross Marseiller Strasse toward Jungiusstrasse. Cross again the Jungiusstrasse. Please enter Jungiusstraße 9, 3rd floor.