



**Berlin School of Optical Sciences and  
Quantum Technologies (BOS.QT)**



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## Berlin School of Optical Sciences and Quantum Technologies (BOS.QT)

The Berlin School of Optical Sciences and Quantum Technology (BOS.QT) is a joint Graduate School of the Physics Departments of Humboldt-Universität zu Berlin (HU Berlin), Technische Universität Berlin (TU Berlin), and Freie Universität Berlin (FU Berlin) in partnership with non-university research institutions and offers an academic training and research environment for acquiring a doctoral degree in natural sciences (Dr. rer. nat.) at one of the participating universities. Research at BOS.QT is focused on key topics of optical sciences and quantum technologies with strong links to applications. BOS.QT aims at a broad international participation of excellent students and offers academic training and communication in English. The Berlin university campuses offer a variety of opportunities to interact with other students and faculty members from all over the world.

Our regional network of expertise in optical sciences and quantum technologies provides research-oriented PhD education on an internationally excellent level, an exceptional scientific environment, and an advanced lecture and mentoring program at all participating universities and research institutes. BOS.QT enables PhD students to individually design the content and scope of additional qualifications besides their actual research projects and to build their own scientific network. The BOS.QT faculty offers excellence in fundamental and applied sciences, ensures high-standard education and actively supports knowledge transfer in the Berlin-Potsdam area.

BOS.QT represents a high-quality doctoral program, incorporating joint supervision by internationally renowned scientists from various institutions, peer mentoring and mentoring by BOS.QT faculty members, equal opportunity tools in the admission process and efficient administration by the BOS.QT office funded by the Joachim-Herz Foundation within the “*Graduiertenförderung vernetzen*” program (from 2019 to 2023).

### BOS.QT RESEARCH PROGRAM

The Berlin School of Optical Sciences and Quantum Technology (BOS.QT) will focus on fostering the fundamental scientific understanding of photons and light-matter interaction, breaking new ground in technical implementation, and creating a new generation of expert researchers in advanced optics/photonics and quantum technologies. BOS.QT offers topics from a broad range of basic and applied research in optical sciences, photonics, and quantum technologies. The program includes experimental research, theory, and simulation.

#### The main research areas are:

Nonlinear light-matter interactions and ultrafast dynamics: nonlinear elementary excitations of matter up to the non-perturbative regime, nonlinear charge transport, quantum coherences and optical control, atto- and femtosecond processes and spectroscopy, ultrafast research with x-rays.

Quantum optics and quantum devices: ultracold quantum gases, fluctuation-induced phenomena, precision experiments on fundamental physical quantities, single photon sources, heterogeneous quantum systems, quantum communication, quantum networks, quantum sensors, optical clocks.

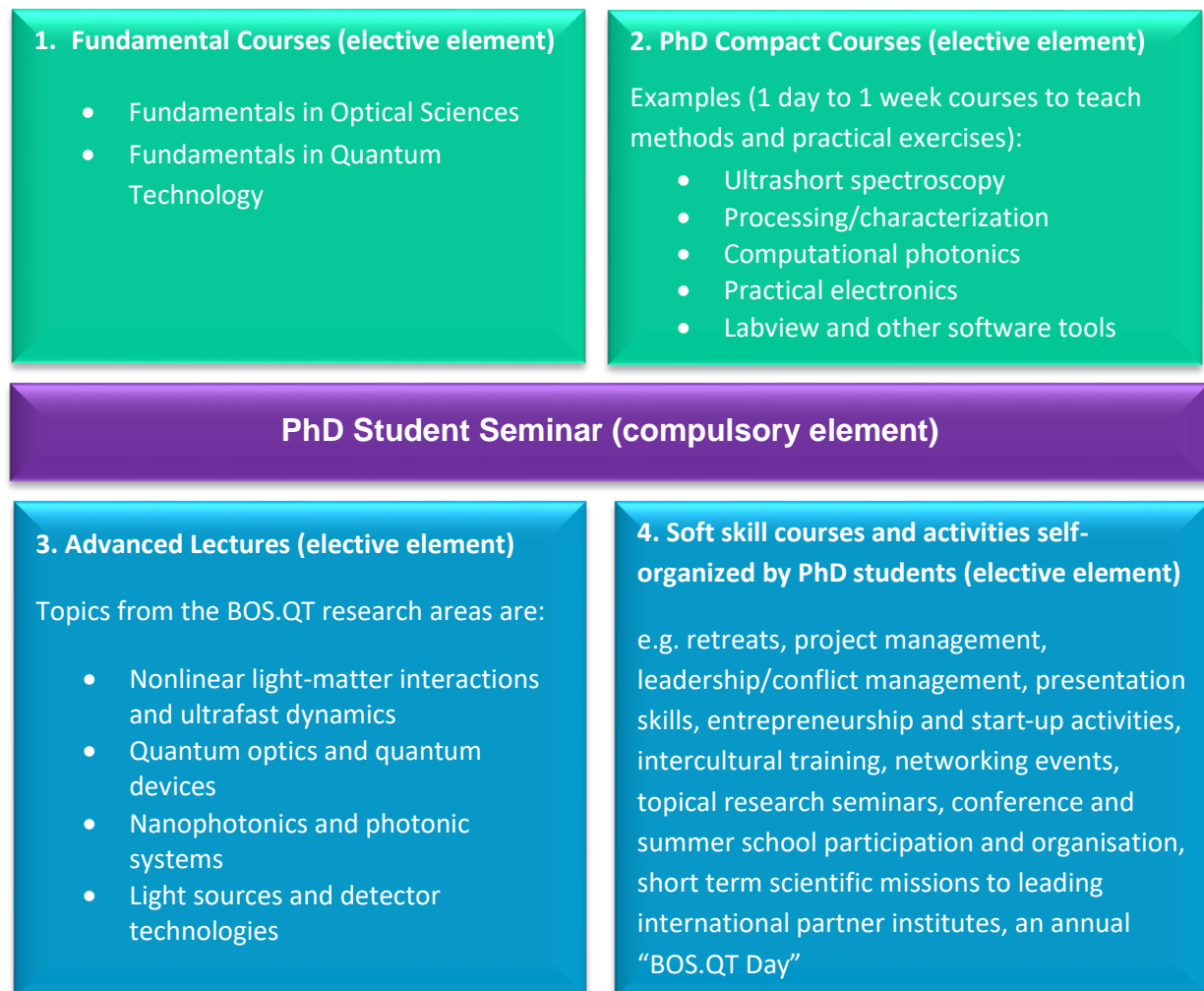
Nanophotonics and photonic systems: nanophotonics, nanoprobles and nanoplasmonics, 2D-quantum materials, hybrid systems, micro-resonators and photonic crystals, topological photonics, optoelectronic devices and photonic systems.




Light sources and detector technologies: Lasers and light sources from terahertz to hard x-rays, advanced detector technologies including space experiments, FT-signal analysis, x-ray imaging.


## BOS.QT STUDY PROGRAM

The primary focus of BOS.QT's PhD education is on the student's research work and its high-standard scientific supervision. However, BOS.QT recognizes that success in science and/or an industrial career requires additional components in the doctoral training that allow the student to achieve optimal research success and to develop leadership skills. BOS.QT's research-oriented study program fosters various elements, each covering a broad but coherent part of optical sciences and optical quantum technologies including both fundamental and applied research topics. The PhD program is intended to provide doctoral students with great flexibility to individually design the content of additional qualifications alongside their actual research projects. The study program contains compulsory and elective elements and leads to a separate BOS.QT certificate upon successful completion.

These BOS.QT elements are fundamental courses, PhD compact courses, a specialized advanced lecture program, soft skill courses and activities organized by the PhD students on their own responsibility complemented by a monthly discursive PhD seminar (see table). Elements of the program are also open to interested master students.



-  **Recommended for year 1 of the PhD program**
-  **Recommended for years 2 and 3 of the PhD program**
-  **Compulsory participation for all PhD students**



**1. Fundamental courses:** These courses are designed as an integrated lecture comprising theory and experiment. The Fundamental courses aim at imparting a broader knowledge and fundamentals in the main objectives of the graduate education of BOS.QT. It is recommended to take these courses at the beginning of the PhD program.

**2. PhD compact courses:** BOS.QT acknowledges that regular attendance of university lecture courses may often clash with the students' research work plan/project schedule. It is thus considerably more beneficial for the students to acquire additional knowledge and skills through compact (one-day up to one-week) courses. In response to this, BOS.QT offers a set of compact PhD courses that facilitate the acquisition of new knowledge and skills and, at the same time, serve as networking events between the BOS.QT PhD students. Specifically, in the initial phase of a student's research work, he/she typically has to acquire additional technical knowledge and skills in order to produce high-calibre scientific results. Consequently, BOS.QT offers compact courses that provide a comprehensive "hands-on" introduction to advanced experimental and/or computational methods. Depending on their background and research project, BOS.QT PhD students are expected to take these courses during their first year.

**3. Advanced lectures:** This lecture program will introduce PhD students to research in a given BOS.QT research area, while illuminating interdisciplinary connections and applications, modern trends and current problems. The BOS.QT advanced lectures vary from semester to semester. They are offered as rotating courses between the participating Berlin universities. They will be given by BOS.QT faculty members, renowned guest scientists from Berlin/Brandenburg research institutions, and international and national guest scientists. The BOS.QT advanced lectures provide PhD students with the necessary foundation to directly join research projects in one of the BOS.QT research areas. It is recommended to take these courses after the first year of PhD study.

**4. Soft skill courses and activities organized by PhD students on their own responsibility:** Equally important for a PhD student's success are well-developed management and leadership skills. While still conducting their research work, most PhD students encounter management challenges and problems related to scarce resources and time constraints. Further, the acquisition of interdisciplinary knowledge, for instance, with regards to entrepreneurial activities or intellectual property, will be highly beneficial for students. In response, BOS.QT provides courses that are designed to enhance the students' non-scientific skills, or will mediate the offers of the participating institutions (e.g. Dahlem Research School, Humboldt Graduate School, TU-DOC – Office for Doctoral and Postdoctoral Services and TU-ZEWK). BOS.QT expects students to participate on these courses after the first or second year of their PhD program. In addition, PhD students are encouraged to build their own scientific working groups by means, for example, of networking events, topical research seminars, conference and summer school participation and organisation, short term scientific missions to leading international partner institutes to encourage networking and international visibility, as well as gain teaching experience, for instance by working as an assistant for one of the BOS.QT courses.

**5. Monthly discursive PhD seminar:** The PhD seminar develops the scientific environment for the research projects of PhD students and provides peer-oriented scientific exchange of ideas and experiences, scientific discourse, feedback and stimulation. The seminar takes place at least three times per semester. Seminar presentations and short talks will focus on the research results of PhD students.

## ADMISSION AND CERTIFICATE

### Eligibility

Students with a master's degree in physics or closely related master's degrees such as the international master's program in optical sciences offered at HU Berlin can be admitted to BOS.QT if they demonstrate the excellence, depth and breadth expected. Research leading to a doctoral degree will focus on a topic offered and supervised by a member of the BOS.QT faculty.

To apply for participation as a PhD student in BOS.QT, the applicant needs to provide the following:

- Master's degree certificate
- Research statement about the proposed dissertation project
- Letter of support from the prospective primary supervisor (member of the BOS.QT faculty)

The supervisor, who nominates the PhD candidate, provides a letter which should explain the capabilities of the student and the expectations for the dissertation. Applications to the program can be submitted throughout the entire academic year.

The student must be enrolled as a doctoral student at the university where the primary supervisor is located (obligatory, otherwise membership in BOS.QT will cease). The degree will be awarded by that university, following its doctoral regulations (*Promotionsordnung*).

The PhD student's research work will be complemented by BOS.QT coursework and training in soft skills as per the BOS.QT study regulations.


Excellent master's students enrolled in a physics master's course at one of the participating universities providing special training in optics or photonics, or master's students of the international master's program in optical sciences offered by HU Berlin, can be admitted to BOS.QT to participate in its course program. After successful completion of the master's program, they can be granted a priority admission to the BOS.QT PhD program.

The admission of a student to the BOS.QT study program will ultimately be decided by the steering committee. The chairperson will inform the applicant of acceptance in a formal letter. BOS.QT applies a scientifically high-standard admission procedure which also takes account of gender equality and the international profile of applicants.

### Requirements that lead to the BOS.QT certificate

The recommended membership duration in the BOS.QT is three years and it should not exceed four years for an individual student. During the BOS.QT membership, PhD students will participate in the PhD student seminar and shall select additional activities from the different elective areas 1 to 4. It is recommended that the chosen activities cover at least two of the elective areas 1 to 4. The acquisition of these additional qualifications will be documented in the BOS.QT certificate by course content (no marks or credit points). The lecturer of any BOS.QT course will determine and announce how the BOS.QT students demonstrate that they have successfully acquired the corresponding qualifications. The BOS.QT certificate serves as a "hallmark" for the profile of graduate education within BOS.QT and within the Berlin universities and research institutions.





Accepted students will usually receive a contract of employment with the institution of the supervisor. The salary will be at least 75% of a regular scientist's salary, subject to deductions of income tax and social security contributions. Alternative financing via scholarships is possible, if the amount of the scholarship complies with DFG recommendations.

In addition to their dissertation research, BOS.QT students will deepen and broaden their knowledge via the BOS.QT study program organized to reflect the advice of their supervisor(s). BOS.QT students are expected to regularly attend additional BOS.QT offers, particularly the compulsory PhD seminar.

The certificate of successful participation in BOS.QT will be provided after completion of the research project (successful PhD defence and awarding of the doctoral degree) and completion of the BOS.QT study program. The regulations of the individual university govern the submission and defence of the dissertation. With the award of the doctoral degree, the BOS.QT student is welcomed into the ranks of BOS.QT alumni and BOS.QT student membership ends.

### **Supervision**

Regular BOS.QT students work on research for their dissertation, supervised by a tandem of BOS.QT faculty members with the indication of the primary supervisor. In addition, each candidate is free to choose an additional mentor from the BOS.QT faculty. The student and supervisor(s) sign a supervision agreement, outlining their various duties and responsibilities. All members of BOS.QT are obliged to comply with principles of good scientific practice, as outlined by the DFG (German Research Foundation) criteria. Should the supervising relationship end, for instance because the supervisor takes up employment at another institution, BOS.QT will help the student to find a replacement.

## **BOS.QT FACULTY AND MANAGEMENT**

BOS.QT faculty members are scientists representing the main research areas of the BOS.QT research program. They are appointed university professors at Humboldt-Universität zu Berlin (HU Berlin), Freie Universität Berlin (FU Berlin) and Technische Universität Berlin (TU Berlin) (or fulfil the requirements for appointment at professorial level in compliance with § 100 BerlHG).

### **Management structure**

A steering committee is elected by the BOS.QT faculty assembly (by simple majority of the present faculty members) and consists of five members: four BOS.QT faculty members and one spokesperson for PhD students and postdoctoral researchers. The Steering committee elects the chairperson and vice-chairpersons for a period of two years. PhD students and postdoctoral researchers within BOS.QT will be represented within the committee by a spokesperson nominated by them and also elected by the BOS.QT assembly for a period of two years. The chairperson is supported by a project manager.



## Bodies and their tasks

- Faculty members/ PIs: supervision of PhD students and postdoctoral researchers, willingness to give lectures at all institutions, ensure as primary supervisors the organisation of PhD examination according to the corresponding university regulations (*Promotionsordnungen der jeweiligen Universitäten*), willingness to serve as a mentor, scientific advisory for BOS.QT course program, election of the steering committee.  
The BOS.QT faculty assembles at least once a year for reporting on the development of the school and to decide on the admission of new faculty members and termination of membership.
- Steering committee: monitoring of all aspects including graduate students' progress, personal mentoring, evaluation of scholarship holders, course work and seminar organization, scientific focus and peer-to-peer interactions. Approval on the admission of PhD students to BOS.QT, management and financial issues. Conflict management and quality assurance.
- Project manager: assisting the chairperson, coordination of the activities of the study program and PhD student networking.

A complete list of BOS.QT faculty members is provided in the Appendix and will be updated annually.



**BOS.QT Faculty Members**

Prof. Dr. Oliver Benson (HU Berlin)  
Prof. Dr. Kirill Bolotin (FU Berlin)  
Prof. Dr. Kurt Busch (HU Berlin)  
Prof. Dr. Stefan Eisebitt (TU Berlin, Max-Born-Institut- MBI)  
Prof. Dr. Jens Eisert (FU Berlin)  
Prof. Dr. Thomas Elsässer (HU Berlin, Max-Born-Institut- MBI)  
Prof. Dr. Heinz-Wilhelm Hübers (HU Berlin, Deutsches Zentrum für Luft- und Raumfahrt- DLR)  
Prof. Dr. Tobias Kampfrath (FU Berlin)  
Prof. Dr. Michael Kneissl (TU Berlin)  
Prof. Dr. Andreas Knorr (TU Berlin)  
Prof. Dr. Achim Peters (HU Berlin)  
Prof. Dr. Arno Rauschenbeutel (HU Berlin)  
Prof. Dr. Stephan Reitzenstein (TU Berlin)  
Prof. Dr. Martin Schell (TU Berlin, Fraunhofer HHI)  
Prof. Dr. Olga Smirnova (TU Berlin, Max-Born-Institut- MBI)  
Prof. Dr. Ulrike Woggon (TU Berlin)

**BOS.QT Junior Faculty**

Dr. Alexander Carmele (TU Berlin)  
Dr. Tobias Heindel (TU Berlin)  
Dr. Francesco Intravaia (HU Berlin, Max-Born-Institut- MBI)  
Dr. Markus Krutzik (HU Berlin, Joint Lab Integrated Quantum Sensors, Ferdinand-Braun-Institut, Leibniz Institut für Höchstfrequenztechnik)  
Dr. Sven Ramelow (HU Berlin)  
Dr. Tim Schröder (HU Berlin)  
Dr. Markus Wagner (TU Berlin)  
Jun. Prof. Dr. Janik Wolters (TU Berlin, Deutsches Zentrum für Luft- und Raumfahrt- DLR)