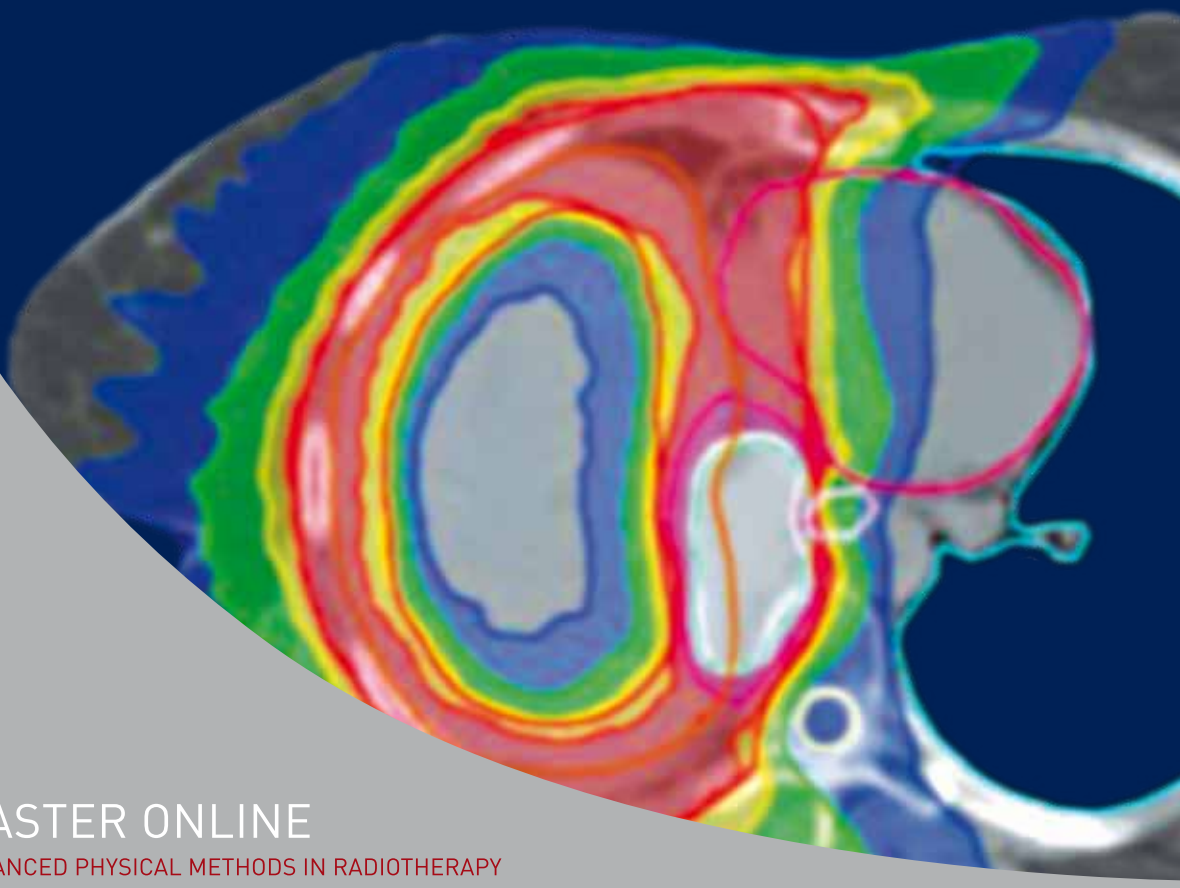


MASTER ONLINE

ADVANCED PHYSICAL METHODS IN RADIOTHERAPY

# Postgraduate, distance learning programs in Medical Physics at Heidelberg University, Germany

Medical Faculty Heidelberg

dkfz.

HIT

Heidelberg Ion-Beam Therapy Centre

# CONTENTS

Prof. W. Schlegel, PhD, Prof. J. Debus, MD, PhD, Prof. O. Jäkel, PhD

# WELCOME

## PROGRAM LEADERS

*Dear Colleagues,*

*As the program leaders, we are pleased to note your interest in the Master's (MSc) program or the Postgraduate study certificates in "Advanced Physical Methods in Radiotherapy" (APMR). The focus of these programs is on medical physics in radiation therapy – a vibrant field in which innovations and ongoing developments over the last few years have contributed significantly to the improvement of cancer therapies. In particular, three areas stand out with respect to these advancements:*

*Intensity Modulated Radiotherapy (IMRT), Image Guided Radiotherapy (IGRT), and Ion Beam Therapy.*

*We are often reminded by our colleagues in institutions working in radiation therapy that it is difficult to keep up with all areas of modern radiation therapy, medical physics and medical technology, and to incorporate these into daily practice.*

*Currently, there is no place in the world that offers an exhaustive academic training that fully integrates the modern methods of both medical physics and radiation therapy fully aligned to emerging scientific research issues and technological developments. The Master program in "Advanced Physical Methods in Radiotherapy" has been established to address this deficit in order to best prepare medical physicists for their increasing new responsibilities.*

*The MSc and the Postgraduate study certificates in "Advanced Physical Methods in Radiotherapy" are accredited postgraduate study programs on the cusp of relevant therapeutic developments. Designed to provide work based training on location in Heidelberg, it contributes directly to the improvement of patient care.*

*Your training will take place in Heidelberg, one of the world's most famous and scientifically acclaimed centers in the field of medical physics and radiation therapy. The internationally renowned German Cancer Research Center (DKFZ) is home to the largest research department for medical physics in Germany. Here, major progress was made in the 1980s in the development of IMRT, and in 1997 the DKFZ also was one of the first centers to implement IMRT in clinical practice.*

*In that same year under the auspices of the Radiologic University Hospital, one of the largest radiation oncology university hospitals in Europe, a scanned ion beam consisting of carbon ions was employed for the very first time in a clinical setting. This was performed in close collaboration with the DKFZ and the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt. The pilot project ultimately culminated in the world's most modern and unique ion-beam therapy facility "HIT" at the University Hospital of Heidelberg opened for clinical operation in 2009.*

*Many of the scientists at the DKFZ, the hospital and the GSI who have pioneered this field have been enlisted to teach on our postgraduate programs. This in turn presents the unique opportunity for you to academically engage with many of the world's most experienced, leading experts and thus to deepen your understanding of current research in this area.*

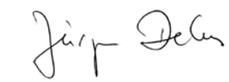
*In addition to the facilities in Heidelberg already mentioned above, the National Centre for Tumour Diseases (NCT) is seen to strengthen Heidelberg campus' extraordinarily strong oncological research network even further.*

*As a program participant you will be instructed online in the theoretical underpinnings of modern radiation therapy from the convenience of your home. During the attendance phases you will supplement your knowledge through work-based activities and hands-on training in imaging and image analysis, therapy planning, irradiation, dosimetry, quality assurance and verification. The practical exercises will be supported by equipment and accelerators at the participating institutes. The spectrum of facilities in Heidelberg ranges from modern linear accelerators with IMRT and IGRT capabilities, to tomotherapy and ion therapy.*

*Surely this is an unparalled opportunity not to be missed!*

*In case you are having doubts about studying on a program delivered predominantly online, then consider the following: The student support provision on the APMR ensures that students new to online learning have the time and assistance necessary to feel comfortable using online technologies for studying. In using these new technologies you are certain to experience the benefits of an "anytime, anywhere" program. You will find an effective balance between individual self-study elements and collaborative activities online that foster lively discourse and critical discussion between your peers and esteemed subject experts from around the world – without ever leaving the comfort of your own home!*

*The flexible format of the APMR programs meets the needs of the working adult and we would be pleased to see you continue your education with us.*



Prof. J. Debus, MD, PhD

Prof. W. Schlegel, PhD

Prof. O. Jäkel, PhD

## UNIVERSITY RECTORS

*As a university with a proven research record, Ruperto Carola plays a key role in our society. In international rankings Heidelberg holds its own as one of Germany's top universities.*

*We aspire to excellence and continue to improve our teaching and research activities, so as to rise to the ranks of the very best universities of the world. As we know: the challenges that lay ahead are enormous – not least because our remit goes well beyond imparting knowledge. We are committed to preparing students for their journey through life, to stimulate them to discuss scientific and social issues. We want to create opportunities for researchers to raise new questions and to set out in new directions, to network and to inspire their students with their curiosity. It is a matter of finding answers to the urgent and complex questions the future holds in store. Relevant here is the "creative mind" (in German "Lebendiger Geist").*

*Our outstanding reputation fills us with both pride and joy, and more than that: It attracts students and researchers from all over the world. The University of Heidelberg has an international profile – whilst firmly anchored in the town and the region. In numerous conversations with students, scholars and visitors from around the globe, it is precisely this synergy of town and research that is interlaced with the name Heidelberg and that is seen as unique.*

*We offer our students and academic staff excellent study facilities and outstanding opportunities for education and training, in and across the various disciplines. With this we rise to the demands that are placed on a university of excellence, such as with a progressive program like the Master Online "Advanced Physical Methods in Radiotherapy" where its distance education students are assured to receive the opportunities they can expect from a leading university in a superb academic environment.*

Heidelberg University Rector
Prof. Bernhard Eitel, PhD



Dean of Medical Faculty, Heidelberg
Prof. Claus R. Bartram, MD

*As has been consistently demonstrated by numerous studies and rankings, the Medical Faculty of Heidelberg is one of today's leading scientific institutions in Germany.*

*A fact that is further underlined by its top level acquisition of research funds – over 70 million euros per annum. Moreover, the university hospital and the faculty – including some 20 academic teaching hospitals – constitute one of the largest medical training centers in Germany.*

*The main aim of the physicians in Heidelberg is the application of innovative concepts from the realms of pure research into medical practice. Their success to date lies in the close ties between the faculty and the hospital, as well as with other institutions at the university and within clinical research networks both at home and abroad.*

*The collaborative activities with top-ranking research establishments outside of the university system – the German Cancer Research Center (DKFZ), the European Molecular Biology Laboratory (EMBL), and the Max Planck Institute for Medical Research – secures a firm foundation for a host of projects.*

*With its Master's degree program, the Faculty carries on long-standing traditions of the university: The close collaboration with the German Cancer Research Center in radiation therapy and the involvement of the Heidelberg Ion-Beam Therapy Center exposes students to cutting-edge research findings and opportunities to gain insider knowledge of the latest therapy methods.*

*A significant part of the profile of Heidelberg University is its international outreach and its involvement in international collaborative networks linking research and teaching.*

*It is a founding member of the League of European Research Universities, an affiliation of now twelve European universities with a strong focus on research, and member of the Coimbra Group, an association of the 37 oldest and most acclaimed universities in Europe. Furthermore, it has entered into intense partnerships with universities around the entire world. With regard to the exportation of state-of-the-art teaching resources, the "Heidelberg Center", a hub for postgraduate and continuing education in Santiago de Chile stands out as one of four "Centres of Excellence in Research and Teaching" worldwide. Furthermore, the "School of German Law" in Krakow and the university's involvement in the programs of the German-language Andrássy University in Budapest deserve mention as examples of the university's impact beyond its German campus.*

*Life-long learning together with excellence in science and practice is a central directive at Heidelberg University. Both in medicine as well as in its neighbouring interdisciplinary subjects, continued professional development at the highest level is of key importance. The postgraduate Master Online "Advanced Physical Methods in Radiotherapy" at the University of Heidelberg constitutes a novel and progressive means for medical physicists to gain specialist qualifications. E-learning units are tailored to the needs of the adult learner supplemented by practical training sessions at the university. The program is supported by the Baden-Württemberg Ministry of Science, Research and Art as part of its "Master online" funding stream.*

*As Prorector of Teaching and Studies, I wish all of the participants an excellent start and every success on this program!*

Vice Rector for Education,
Heidelberg University
Prof. Friedericke Nüssel, DD

# WHERE



## RADIOTHERAPY IN HEIDELBERG: INTERNATIONALLY GROUNDBREAKING

Radiotherapy in Heidelberg has a long tradition of excellence. The great surgeon and radiotherapist Vinzenz Czerny (1842 - 1916) of Heidelberg was one of the first physicians to recognize the significance of interdisciplinary cancer treatment. He established the “Samariterhaus” which combined treatment and research under one roof in addition to the “Institute for Experimental Cancer Research”. From this emerged the “three pillars” of cancer therapy in Heidelberg:

- The clinic for Radiation Oncology and Radiation Therapy at Heidelberg University Hospital
- The National Center for Tumor Diseases (NCT)
- The German Cancer Research Center (DKFZ)

These centers are testament to Heidelberg’s top international position in therapy, research and science. In this setting it is not surprising that key developments in radiotherapy stem from the Heidelberg facilities each in turn setting new international quality standards in oncology radiotherapy.

With the launch of “The Heidelberg Ion-Beam Therapy Center” (HIT) in 2009 a fourth unique cancer treatment center supplements the esteemed earlier facilities.

With HIT new hope for recovery has been given to many patients with tumors previously difficult to treat in conventional radiotherapy.

## Heidelberg University Hospital and Medical Faculty Heidelberg

Heidelberg University Hospital is one of the largest and most prestigious medical centers in Germany. The Medical Faculty of Heidelberg University belongs to the internationally most renowned biomedical research institutions in Europe. Both institutions have the common goal of developing new therapies and implementing them rapidly for patients. With about 10,000 employees, training and qualification is an important issue. Every year, around 550,000 patients are treated on an inpatient or outpatient basis in more than 50 clinics and departments with 2,000 beds. Currently, about 3,600 future physicians are studying in Heidelberg; the reform Heidelberg Curriculum Medicinale (HeiCuMed) is one of the top medical training programs in Germany.

## Clinic for Radiation Oncology and Radiation Therapy

The Clinic for Radiation Oncology and Radiation Therapy is one of the few centers in the world that offers radiotherapeutic treatment meeting highest international standards. It is equipped with the complete spectrum of modern radiation oncology, including:

- Intraoperative Radiotherapy
- Intensity Modulated Radiotherapy
- Stereotactic Radiotherapy
- Extracranial Stereotactic Radiotherapy
- Tomotherapy
- Brachytherapy
- Total Body Irradiation
- Ion Beam Therapy
- Virtual Simulation
- Radiotherapy of Children

Only the most advanced, high-performance procedures available today are used in treatment planning and patient positioning.



University Hospital Heidelberg, Germany

## German Cancer Research Center (DKFZ)

The German Cancer Research Center (Deutsches Krebsforschungszentrum, DKFZ) is the largest biomedical research institute in Germany. More than 2,500 staff members, including 1,000 scientists, are investigating the mechanisms of cancer and are working to identify cancer risk factors. They provide the foundations for developing novel approaches in the prevention, diagnosis, and treatment of cancer. The DKFZ is a member of the Helmholtz Association of National Research Centers.

In 2003, DKFZ, Heidelberg University Medical Center, and Heidelberg Thorax Clinik together established Germany's first comprehensive Cancer Center: The National Center for Tumor Diseases (NCT) Heidelberg was launched with the mission of combining optimized interdisciplinary patient care with excellence in translational cancer research.

Within the National Consortium for Cancer Research, DKFZ serves as the nationwide hub for excellent partners from Germany's University Medical Centers. The consortium is supported by the German Federal Ministry of Education and Research and the German Cancer Aid. The DKFZ's Office of Technology Transfer works at the interface between research and industry. By securing, marketing and licensing patented and non-patented research results obtained at DKFZ, the Office helps to facilitate the introduction of novel products including anti-cancer drugs, diagnostic assays, and research tools. Strategic alliances with Siemens Healthcare and with Bayer-Schering Pharma are aimed at developing new imaging diagnostics, new methods of radiotherapy, and innovative substances to treat cancer.

Over 60 divisions and Junior Research Groups are allocated to 7 Research Programs:

- Cell Biology and Tumor Biology
- Structural and Functional Genomics
- Cancer Risk Factors and Prevention
- Tumor Immunology
- Imaging and Radiooncology
- Infection and Cancer
- Translational Cancer Research.

Core Facilities:

- Genomics and Proteomics
- Microscopy
- Information Technology
- Chemical Biology Core Facility
- Animal Laboratory Services
- Library



German Cancer Research Center (DKFZ): Largest biomedical research institute in Germany

## Heidelberg Ion-Beam Therapy Center (HIT)

Heidelberg University Hospital is proud to operate the HIT therapy center, which provides a radiotherapy service for many patients and at the same time helps to confirm the scientific basis for this new cancer therapy. The opening ceremony for the Heidelberg Ion-Beam Therapy Center HIT was held on November 2nd, 2009 and patient treatment started on November 15th.

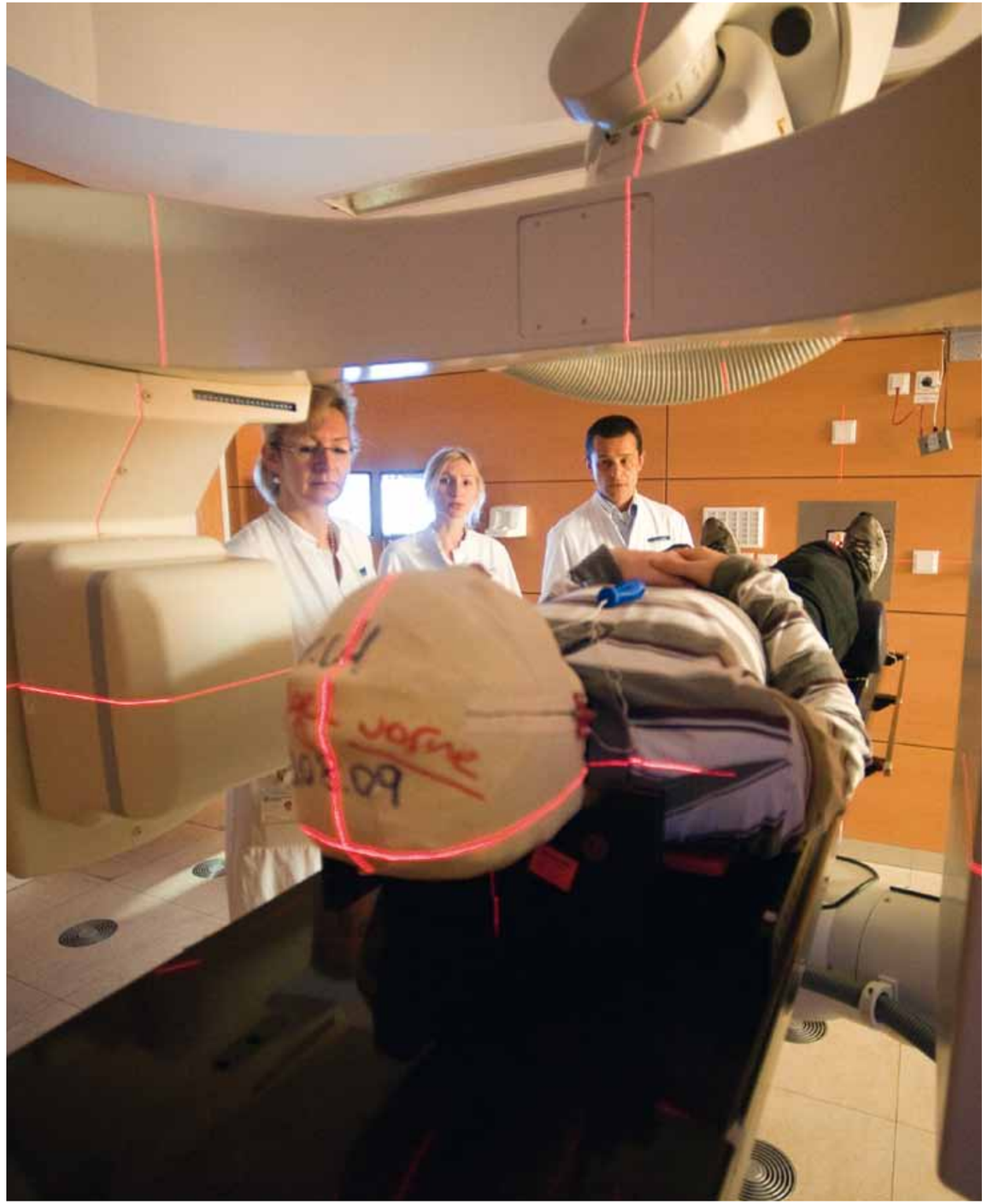
HIT is the first hospital-based treatment facility in Europe offering radiotherapy treatment with protons and Carbon ions. Furthermore, additional heavy-ion treatments with e.g. Helium, Oxygen are in process of preparation. Ion therapy offers a very high precision and is a biologically very effective method for tumor irradiation. Only 30 facilities exist worldwide (mainly in the USA, Japan and Europe) for proton radiotherapy and only 4 facilities (Japan and Germany) providing heavier ions. Proton and ion treatments are a promising and rapidly evolving technology and many new centers are currently under construction.

HIT is a prototype heavy ion therapy facility for several reasons:

- It is the first and only heavy ion therapy facility which operates a movable radiation source (gantry) that can rotate 360º around the patient so that the tumor can be irradiated from all directions.
- It is the first ion therapy facility using the intensity-modulated raster scanning technique – an irradiation method, which allows a very precise and conformal irradiation of tumors. At the same time, a real-time control system ensures a very high level of safety.
- It is the only facility, where not only protons and carbon ions, but also other ions are available. Currently Helium and Oxygen ions are prepared for pre-clinical research.
- For the first time, computer-guided robots are used to position and image the patients in the treatment room with very high precision.



Heidelberg Ion-Beam Therapy Center (HIT)



Heidelberg Ion-Beam Therapy Center (HIT), treatment room with rotating X-ray systems

# WHO





Online guest lecture with Prof. Thomas Bortfeld, PhD, Boston, USA

## MSc study track

The Master Online APMR is a two year part-time postgraduate program that leads to an MSc in “Advanced Physical Methods in Radiotherapy” awarded by the University of Heidelberg.

## Postgraduate (PG) study tracks

The Postgraduate (PG) study certificates in “Advanced Physical Methods in Radiotherapy” are available in form of either a PG short study track (3 Modules – 30 ECTS “European Credit Transfer and Accumulation System“) or a PG full study track (6 Modules – 60 ECTS).

## General

The programs adopt the espoused blended study approach aimed at medical physics professionals and those in related fields aspiring to continue their academic careers and refine skills in cancer treatment techniques without interrupting their professional and personal lives.

APMR students are working adults with diverse educational backgrounds and professional experience which these flexible study programs are tailored to accommodate. Participants will become conversant in the physical applications of the most modern radiotherapy techniques as well as their clinical relevance and implications.

Successful graduates are then well positioned to seek careers at the most advanced IMRT, IGRT and ion therapy facilities worldwide where they will stand out as medical physics innovators among those defining the next research questions.

Heidelberg offers an excellent medical physics research infrastructure which is only one of the reasons the MSc and the Postgraduate study certificates in “Advanced Physical Methods in Radiotherapy” are such unique programs. The programs are supported by an interdisciplinary teaching team of esteemed subject experts who are accustomed to a “bench to bedside” research environment and whose contributions to the modules are certain to reflect the very latest developments in advanced treatment methods.

Despite the wealth of expertise available at its doorstep, however, the APMR programs are not constrained by geographic boundaries – in fact, online, there are none! By drawing on the affordances of internet communication technology its virtual classroom is designed to bring in pioneering experts from around the world, enriching an educational experience that already builds upon the innovative spirit and technological drive the local academic community is known for.

The best part? Except the attendance phases, students never have to leave their home to be there. Notwithstanding its international flair, however, it is Heidelberg’s key clinical and scientific competences that penetrate the module lessons throughout the program. This climaxes during the practical attendance phases on location in Heidelberg where students become directly engrossed in the cutting-edge clinical and research environment that brought forth APMR’s own pioneering expert teaching team.

# WHAT



## PROGRAM STUDY TRACKS

### MSc study track

The program is broadly split up into three sets over the course of two years: A taught online modular set for 3 semesters including 4 short attendance phases and on-site internships of approx. 7-14 days, and the Master's Thesis in the final semester.

### Postgraduate (PG) study tracks

#### PG short study track (30 ECTS)

The program comprises two core modules that are mandatory, (M 2 and M 4) and one custom-picked module (M 1, M 3 or M 5).

#### PG full study track (60 ECTS)

The Postgraduate full study track entails all 6 taught modules that comprise the Master Online APMR program prior to the Master's Dissertation (M 1 - M 5 and M P).

### Curriculum design in general

The programs are delivered predominantly online (80%) supplemented by a series of short practical attendance phases (20%) aligned to each of the 5 themed modules.

Videotaped lectures, supporting online course material, independent and interactive learning activities underpin the modular phase comprised of 5 taught online modules:

The first modules provide students with a thorough grounding in the classical disciplines of anatomy, physiology, radiological imaging (CT, MRI, MR,…) and conventional methods of radiotherapy. Progressively students become conversant in the theory and practice of the more advanced physical radiotherapy treatment techniques including IMRT, IGRT and ion therapy.

The periodic attendance phases offer hands-on opportunities to apply theory to practice at some of the most modern treatment facilities in the world. Students are expected to travel to Heidelberg, Germany in order to complete the practical work during the attendance phases. During the Master's Thesis APMR students have access to leading-edge research opportunities at facilities in Heidelberg and affiliated institutions. Some students may elect to carry out their thesis research at their home institutions.

The online study environment is one of openness and collaboration. Whilst emphasis is placed on rigorous, theoretical instruction, exposure to different perspectives fostered by an open exchange of ideas is actively promoted by the availability of formal and informal online communication spaces in which students, peers and expert friends interact. APMR prides itself in a student-centred curriculum design where internationally respected academics and researchers can be found in easy conversation with aspiring APMR candidates both online and on-site during the attendance phases.



| Semester 1 | | | | | | Semester 2 | | | | | | Semester 3 | | | | | | Semester 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Module 1 | | | | Module 2 | | Module 3 | | | | Module 4 | | Module 5 | | | | Module P | | Master´s Thesis | | | | | |
| Start Attendance phase 1 (1.5 days) | | | Attendance phase 2 (1.5 days) | | | | | | Attendance phase 3 (4 days) | | | | | | Attendance phase 4 (4 days) | | Attendance phase 5 (7-14 days) | | | | | Defense | |
| I1 | | | W 1 | | | I3 online | | | W2 | | | I5 online | | | W4 | | 4 Internships | | | | | | |
| | | | E1 (M1) | | | | | | E2 (M2) | | | | | | E4 (M4) | | | | | | | | |
| | | | I2 | | | | | | W3 | | | | | | W5 | | | | | | | | |
| | | | | | | | | | E3 (M3) | | | | | | E5 (M5) | | | | | | | | |
| | | | | | | | | | I4 | | | | | | | | | | | | | | |

I: Introduction W: Workshop E: Exam P: Internships

## M 1 Anatomy and Imaging for Radiotherapy
## Module Leader

**Prof. Wolfgang Schlegel, PhD** studied physics, mathematics and microbiology in Berlin and Heidelberg from 1964 to 1970. He was awarded his PhD in physics from the Max Planck Institute for Nuclear Physics in Heidelberg in 1972. His career in medical physics began at the German Cancer Research Center (DKFZ) in Heidelberg in 1973, where he first worked in the field of image processing in nuclear medicine and later entered the field of medical physics in radiotherapy. He has been involved in a wide range of projects concerning CT-based 3D treatment planning, 3D conformal radiotherapy, stereotactic radiotherapy, and IMRT.

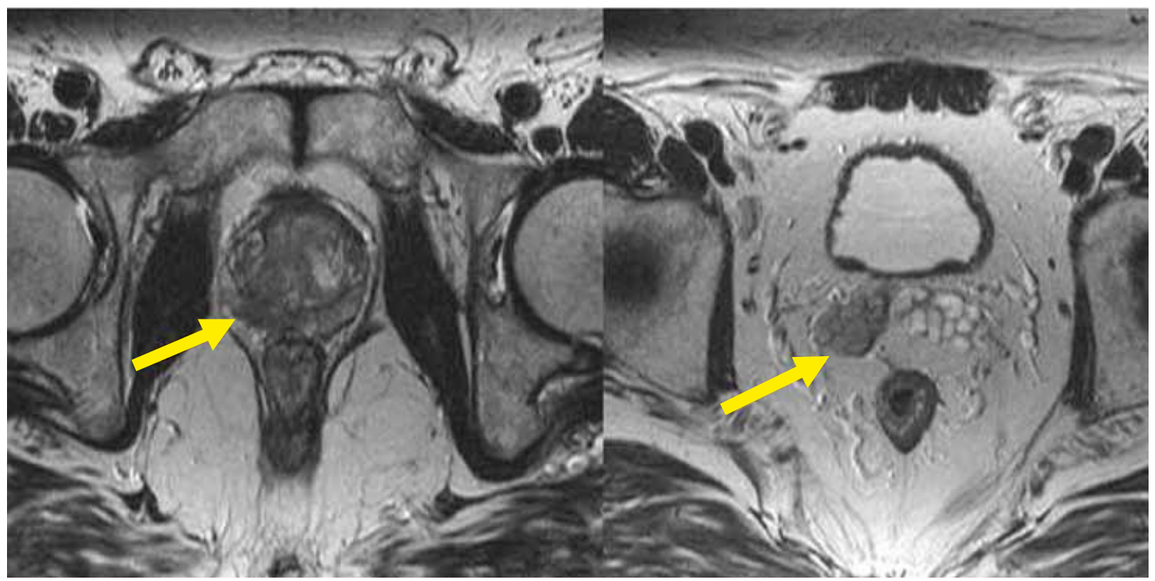
Wolfgang Schlegel is Professor of Medical Physics, member of the Faculty of Medicine, and member of the Faculty of Physics at the University of Heidelberg.

Since 1994 he has been Head of the Department of "Medical Physics in Radiooncology" within the research program "Imaging and Radiooncology" run by the DKFZ.

His current fields of interest include the physics of radiotherapy using photons and charged particles, including 3D conformal radiotherapy, stereotactic radiotherapy, IMRT and IGRT.

### Topics
- Introduction Module 1
- Anatomy for Physicists and Engineers
- Imaging for Radiotherapy
- Radiological and Virtual Anatomy
- Diagnostic Radiology
- M 1 Attendance Phase

Module 1 begins with a review of basic anatomy with lessons effectively designed within the context of latest improvements in radiological imaging, including modern X-ray CT, dual energy CT, morphological and functional MRI and MR spectroscopy, as well as modern techniques in molecular imaging. Participants will gain the skill necessary for optimum application of the latest cancer treatment techniques.



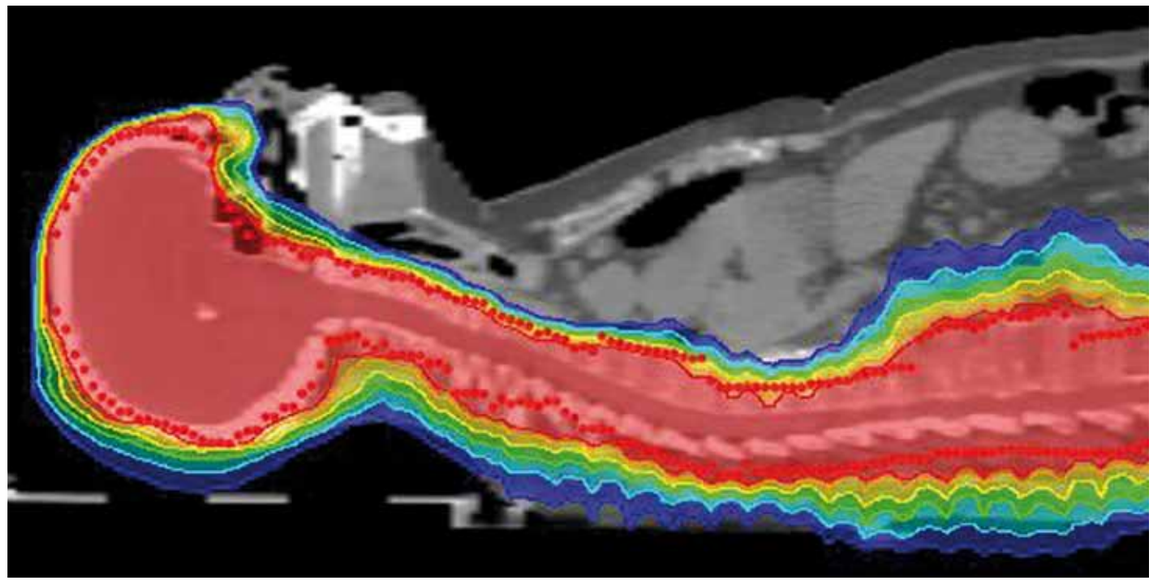
MR-images of prostate cancer patients

## M 2 Intensity Modulated Radiotherapy (IMRT)
## Module Leader

**Prof. Uwe Oelfke, PhD** holds a professorship of Medical Radiation Physics at the Faculty of Physics and Astronomy of Heidelberg University and heads the DKFZ Research Group 'Physical Models' at the department of Medical Physics in Radiation Oncology. His research interests are wide spread, ranging from conventional IGRT topics like compensation of organ motions for IMRT dose distributions and probabilistic, robust inverse therapy planning for photon and particle therapy to more exotic topics, like spectral CT imaging or the investigation of biological effects for microbeam therapy. More details can be found on www.dkfz.de. Besides his teaching at the University of Heidelberg, he also serves as a faculty member for three different ESTRO courses and the European School of Medical Physics (ESMP).

### Topics
- Introduction Module 2
- Introduction to IMRT
- IMRT in Daily Clinical Work
- Advanced Application Techniques for IMRT
- M 2 Attendance Phase

After an overview of the basic features of IMRT, participants are introduced to the different technical implementations of modern IMRT and to applications in clinical practice. Building upon problem- and work-based scenarios participants are given the unique occasion to gain hands-on experience at the Heidelberg facilities with opportunities to discuss their activities on-site with the IMRT innovators.



Typical IMRT dose distribution

## M 3 Ion Therapy
## Module Leader

Prof. Christian Karger, PhD first studied physics at the University of Heidelberg from 1986 to 1992 before completing his PhD in physics at the German Cancer Research Center (DKFZ). He obtained his postdoctoral lecture qualification (Habilitation) at the Medical Faculty of the University of Heidelberg in 2002.

Prof. Karger received his certification in radiation protection in 1996, his certification as a medical physicist (DGMP/EFOMP) in 1997, and in radiation protection for particle therapy in 2010.

That year he was accredited to supervise education in medical radiation physics (DGMP/EFOMP). From 1997 to 2008 Prof. Karger was responsible as a Medical Physics Expert for the heavy ion therapy project at GSI. Since 2004 he heads the research group „Applied Medical Radiation Physics“. In 2007 he was promoted to Associate Professor at the Medical Faculty of the University of Heidelberg, and since 2009 he has been a consultant for the ICRU-committee “Prescribing, Recording and Reporting Ion-Beam Therapy”.

### Topics

- Introduction Module 3
- Fundamentals of Physics
- Beam Generation and Application
- Radiobiology
- Ion Treatment Planning
- Clinical Application
- M 3 Attendance Phase

Module 3 focusses first on reinforcement of basic physical interaction processes of protons and ions, while demonstrating how these can be harnessed to the benefit of the patient. An understanding of these interactions also forms the basis for the biological effects of high LET radiation, which are studied in detail. Furthermore, module lessons cover technical features of accelerators, beam delivery systems, treatment planning and the implications for clinical practice in ion beam therapy.

Ion gantry at the HIT facility



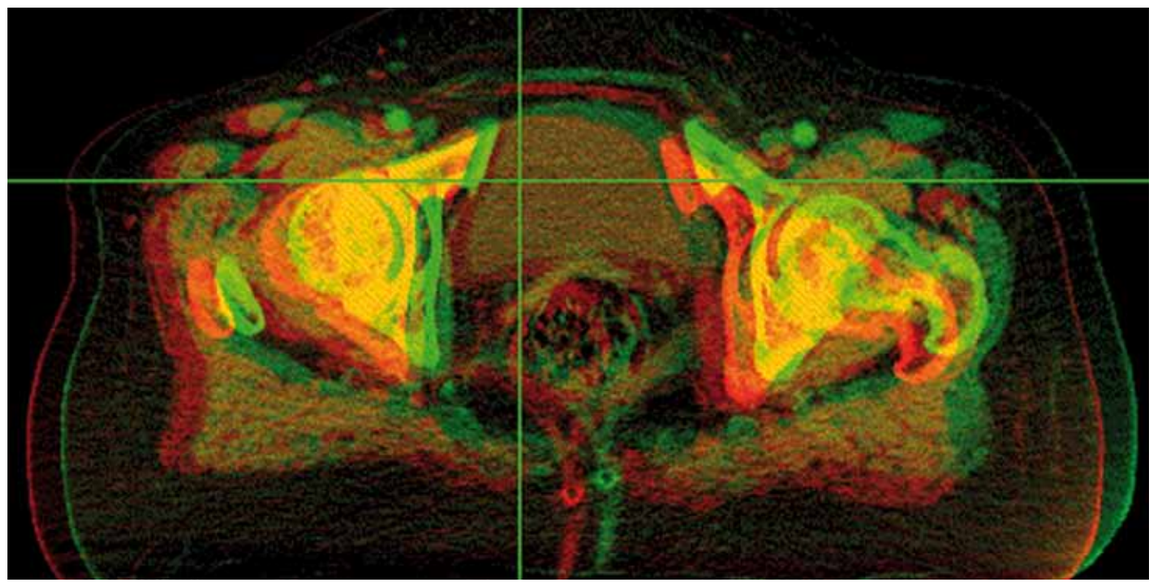
## M 4 Image Guided Radiotherapy (IGRT) and Adaptive Radiotherapy (ART)
## Module Leader

Prof. Uwe Oelfke, PhD see page 19.

### Topics

- Introduction Module 4
- IGRT Techniques (Physics)
- Clinical Application of IGRT (Medicine)
- Moving Targets and Adaptive Radiotherapy (Medicine/Physics)
- M 4 Attendance Phase

More recently IGRT has become an important new paradigm. In this module participants discover that applications of IGRT are not merely restricted to accurate patient positioning, but include further the resolution of inter- and intrafractional motion in order to arrive at a true 4D dose conformation. The basics of modern biological imaging techniques and their implication for radiotherapy will also be explored.



CT/MRI image registration

## M 5 Advanced Dosimetry and Quality Assurance (QA)
## Module Leader

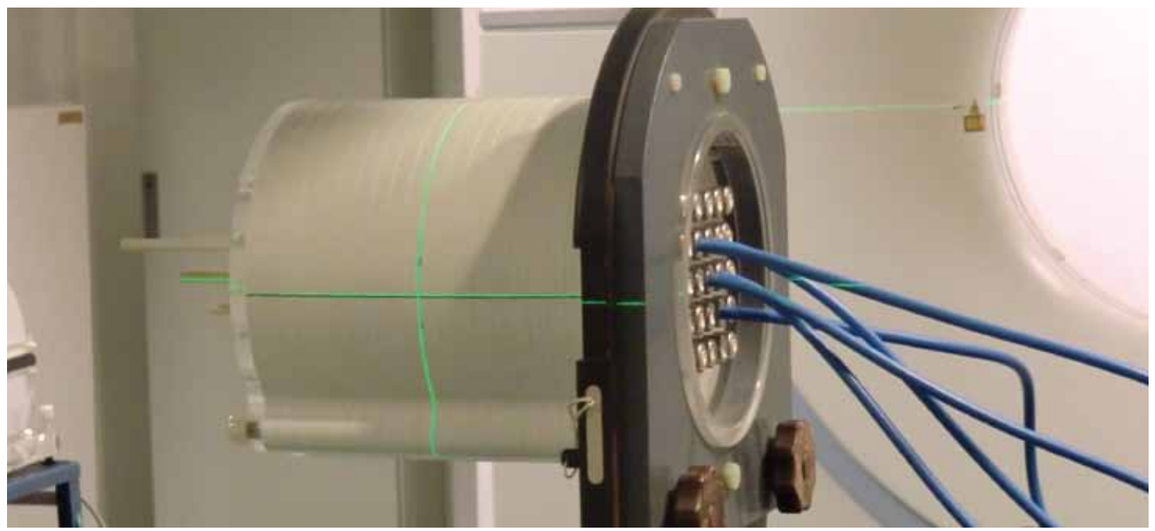
Prof. Günther H. Hartmann, PhD read physics at the Technical University Munich and at the University of Erlangen-Nürnberg from 1967 to 1972 followed by a position at the German Cancer Research Center (DKFZ) in 1973. While working at the cyclotron unit and later in the radiation protection unit, he completed his doctorate in physics (1979). Prof. Hartmann was awarded his certification in radiation protection in 1981, his certification as a medical physicist (DGMP/EFOMP) in 1987 and obtained his postdoctoral lecture qualification (Habilitation) in medical physics at the Medical Faculty of the University of Heidelberg (1990). In 1991 he transferred to the Department of Biophysics and Medical Radiation Physics at the DKFZ (now Department of Medical Physics in Radiotherapy). Since 1995, he acts as a mentor for the DGMP where he is responsible for the supervision of education in medical radiation physics.

From 1978-1990 Prof. Hartmann was deputy Head of the Department for Radiation Dosimetry and Protection at DKFZ. From 1981 to 1983 he was Medical Physics Expert at the Co-60 unit and from 1991 to 2011 head of the research group "Dosimetry and Radiation Physics". In 2000 he was awarded an associate professorship at the Medical Faculty of the University of Heidelberg.

### Topics

- Introduction Module 5
- Fundamentals of Dosimetry
- Dosimetry for Current Radiotherapy Techniques
- Quality Assurance
- M 5 Attendance Phase

The highly advanced techniques of IMRT, IGRT and ion beam therapy require complex solutions for dosimetry and quality assurance. In Module 5 participants scrutinize relevant guide-lines for the design of dedicated QA procedures adapted to the unique requirements of these modern techniques. Dosimetric principles will be studied in depth and then applied to special dosimetry techniques for small fields, ion dosimetry and dynamic fields. A key feature of this module is the practical training side by side with world renowned experts during the practical training sessions at Heidelberg's flagship facilities.



QA phantom

## M P Internships
## Module Leader

Prof. Wolfgang Schlegel, PhD see page 18.

### Topics

- Internship in Treatment Planning
- Internship in IMRT
- Internship in ART
- Internship in Ion Therapy
- Internship in Dosimetry and QA

Participants have the exclusive opportunity to visit the DKFZ, recognized as one of the birthplaces of IMRT in the 90's. Furthermore, the rare opportunity to train at the world's first scanning beam ion facility, HIT, is a fixed element of the module. Here, participants will engage in discourse with the expert developers whilst experiencing state-of-the-art radiotherapy and its implementation in one of the largest radiotherapy centers in Europe.

Control panel of the HIT-synchrotron

## M T Master's Thesis Module Leaders

**Prof. Jürgen Debus, MD, PhD** received his doctorate in physics in 1991 and was awarded an M.D. in medicine in 1992. From 1991 to 1996 he specialised in radiation oncology at the Dept. of Clinical Radiology in Heidelberg, and during this period undertook a clinical fellowship at the Department of Radiation Oncology at Massachussets General Hospital in Boston. In 1996 he received his board certification in radiation oncology, followed by his postdoctoral lecture qualification (Habilitation) in radiology at the University of Heidelberg. Prof. Debus has held many senior posts including Chair of the Clinical Cooperation Unit Radiotherapeutic Oncology (1997-2003) at the German Cancer Research Center (DKFZ) and is currently Chair of the German Heavy Ion Radiotherapy Project (since 1997), and Chair of Radiation Oncology at the University of Heidelberg (since 2003). Prof Debus' professional activities have seen him act as coordinator of both the European Society for Radiation Oncology (ESTRO) and the American Society for Therapeutic Radiology and Oncology (ASTRO). His board memberships include the scientific council for clinical and basic research for German cancer aid (Deutsche Krebshilfe) and the "Research Committee" of the University Hospital Heidelberg. Prof. Debus has been the recipient of numerous prestigious awards.

**Prof. Oliver Jäkel, PhD** studied physics at the University Erlangen, where he also obtained his PhD in theoretical particle physics in 1994. In the same year, he started to work for the Department of Medical Physics at the DKFZ, where he was involved in the preparation of patient treatments with carbon beams at the Ion Research Facility, GSI. He obtained his qualification as a Medical Physics Expert in 1997. Since 1998 he leads the medical physics team responsible for carbon ion therapy at GSI and followed by the group leadership of the research group "Heavy Ion Therapy" at DKFZ. In 2001 he obtained his postdoctoral lecture qualification (Habilitation) in medical physics at the Medical Faculty of the University of Heidelberg.

In 2007 he was appointed Medical Physics director of the HIT facility and was strongly involved in the preparation and clinical startup of the facility in 2009.

In 2010 he was awarded a professorship and became one of the program leaders of the online master program, APMR, while continuing his work at DKFZ and HIT.

During their dissertation students will be supervised by a subject expert member of the program teaching team. Topic to be selected from modules 1 - 5.



## MSC PROGRAM STRUCTURE

| Semester | Modules | | ECTS Credits |
|---|---|---|---|
| | Induction: Attendance phase (1.5 days) | | |
| 1 | M 1<br>Anatomy and<br>Imaging for Radiotherapy | M 2<br>Intensity Modulated Radiotherapy (IMRT) | 15 |
| | Attendance phase M1 (1.5 days) | | |
| 2 | M 3<br>Ion Therapy | M 4<br>Image Guided Radiotherapy (IGRT) and<br>Adaptive Radiotherapy (ART) | 15 |
| | Attendance phase M2, M3 (4 days) | | |
| 3 | M 5<br>Advanced Dosimetry and<br>Quality Assurance (QA) | M P<br>4 Internships | 15 |
| | Attendance phase M4, M5 (4 days) | Attendance phase (4 x 3 days) | |
| 4 | M T<br>Master's Thesis | | 30 |
| | | | 75 |
| Prerequisites | _ Degree of higher or further education institute (Bachelor, Diploma, Master)<br>_ Proof of at least two years of professional experience following the first degree or proof of an employment contract before the Master Online APMR program start<br>_ Competency in medical physics is subject to scrutiny by admission panel | | 45 |
| | | | 120 |

Note:
The workload of the program is defined by the European Credit Transfer and Accumulation System (ECTS, which can be found at http://ec.europa.eu/education/lifelong-learning-policy/doc48_en.htm, where 1 ECTS-Credit corresponds to 30 hours of work).

This results in a weekly workload of about 15 hours during online phases depending on the individual educational background.

## APMR PROGRAM STAFF

60+ Internationally based teaching staff and prominent experts

### Program Leaders

**Prof. Jürgen Debus, MD, PhD**
Professor for Radiation Oncology at the Medical Faculty Heidelberg, Heidelberg University.

Medical Director of the Department of Radiation Oncology and Radiation Therapy, Heidelberg University Hospital and CEO of HIT GmbH, Heidelberg.

**Prof. Oliver Jäkel, PhD**
Professor for Medical Physics at the Medical Faculty Heidelberg, Heidelberg University and Medical Physics Director of HIT GmbH, Heidelberg.

Group Leader „Heavy Ion Therapy“, DKFZ, Heidelberg.

**Prof. Wolfgang Schlegel, PhD**
Professor for Medical Physics at the Medical Faculty Heidelberg, Heidelberg University.

Head of the Department of Medical Physics in Radiation Oncology, DKFZ, Heidelberg.



### Module and Subject Leaders

**Prof. Marc Bischof, MD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

**Prof. Jürgen Debus, MD, PhD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany
HIT GmbH, Heidelberg, Germany

**Frederik Giesel, MD, Privatdozent**
Heidelberg University Hospital, Nuclear Medicine, Heidelberg, Germany

**Prof. Günter Hartmann, PhD**
German Cancer Research Center (DKFZ), Heidelberg, Germany

**Prof. Oliver Jäkel, PhD**
German Cancer Research Center (DKFZ), Medical Physics in Radiation Oncology, Heidelberg, Germany
HIT GmbH, Heidelberg, Germany

**Alexandra Jensen, MD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

**Prof. Christian Karger, PhD**
German Cancer Research Center (DKFZ), Medical Physics in Radiation Oncology, Heidelberg, Germany

**Prof. Marc Münter, MD**
Medical Clinic Stuttgart, Medizinisches Versorgungszentrum (MVZ), Stuttgart, Germany

**Simeon Nill, PhD**
German Cancer Research Center (DKFZ), Medical Physics in Radiation Oncology, Heidelberg, Germany

**Prof. Uwe Oelfke, PhD**
German Cancer Research Center (DKFZ), Medical Physics in Radiation Oncology, Heidelberg, Germany

**Jaane Rauschenberg, PhD**
German Cancer Research Center (DKFZ), Medical Physics in Radiology, Heidelberg, Germany Heidelberg

**Bernhard Rhein, PhD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

**Prof. Wolfgang Schlegel, PhD**
German Cancer Research Center (DKFZ), Heidelberg, Medical Physics in Radiation Oncology,

**Florian Sterzing, MD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

**Thomas Welzel, MD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

**Prof. Angelika Zabel-du Bois, MD**
Heidelberg University Hospital, Radiation Oncology and Radiation Therapy, Heidelberg, Germany

From left to right: T. Welzel, MD, C. Karger, PhD, Prof. A. Zabel-du Bois, MD, Prof. W. Schlegel, PhD, S. Nill, PhD, Prof. G. Hartmann, PhD, B. Rhein, PhD, A. Jensen, MD, Prof. O. Jäkel, PhD, F. Giesel, MD

## Guest Lecturers

Prof. Thomas Bortfeld, PhD
Harvard Medical School,
Director Physics Division
Massachusetts General Hospital,
Department of Radiation
Oncology, Boston, USA

Prof. Marco Schippers, PhD
Paul Scherrer Institut,
Section Medical
Accelerators, Villigen,
Switzerland

Prof. Ben Heijmen, PhD
Erasmus MC-Daniel den Hoed
Cancer Center,
Department of Radiation
Oncology Medical Physics,
Rotterdam, The Netherlands

Assistant Prof. Jan Unkelbach, PhD
Harvard Medical School,
Physics Division
Massachusetts General Hospital,
Department of Radiation
Oncology, Boston, USA

Prof. Steve Webb, PhD, DSc
The Institute of Cancer Research (ICR),
Joint Department of Physic,
Team Leader Radiotherapy
Physics Research Team
Royal Marsden NHS Trust,
London, UK

Tom Depuydt, PhD
University Hospital of Brussels, Radiation Department,
Brussels, Belgium
Heinz Deutschmann, MSc
Paracelsus Medical University, Department of Radiation
Oncology, Salzburg, Austria,
radART–Institute for Research and Development on Advanced
Radiation Technologies, Paracelsus Medical University,
Salzburg, Austria
Assistant Prof. Emily Heath, PhD
Ryerson University, Department of Physics, Toronto, Ontario,
Canada
Prof. Robert Krempien, MD
Helios Klinikum Berlin-Buch, Radiation Therapy, Berlin, Germany
Prof. Jan Lagendijk, PhD
University Medical Center Utrecht, Department of
Radiotherapy, Utrecht, The Netherlands
Ursula Nestle, MD, Privatdozentin
University Hospital Freiburg, Hospital for Radiotherapeutics,
Freiburg, Germany
Mike Patridge, PhD
The Institute of Cancer Research (ICR), Division of Radiotherapy
and Imaging, Royal Marsden, Sutton, UK
Prof. Bas Raaymakers, PhD
University Medical Center Utrecht, Department of Radiation
Oncology, Utrecht, The Netherlands
Jan Jakob Sonke, PhD
The Netherlands Cancer Institute/Antoni van Leeuwenhoek
Hospital, Radiotherapy Department, Amsterdam, The Netherlands



## Teaching Staff

Prof. Peter Bachert, PhD
German Cancer Research Center (DKFZ),
Medical Physics in Radiology, Heidelberg, Germany
Prof. Rolf Bendl, PhD
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Christoph Bert, PhD
GSI Helmholtz Center for Heavy Ion Research,
Darmstadt, Germany
Prof. Stefan Delorme, MD
German Cancer Research Center (DKFZ),
Radiology, Heidelberg, Germany
Prof. Antonia Dimitrakopoulou-Strauss, MD
German Cancer Research Center (DKFZ),
Nuclear Medicine, Heidelberg, Germany
Julien Dinkel, MD
German Cancer Research Center (DKFZ),
Radiology, Heidelberg, Germany
Gernot Echner, Dipl.-Ing. (FH)
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Malte Ellerbrock, PhD
HIT, GmbH, Heidelberg, Germany
Martin Fast, Dipl.-Phys.
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Prof. Lars Grenacher, MD
Heidelberg University Hospital, Radiology, Heidelberg, Germany
Prof. Peter Hallscheidt, MD
Heidelberg University Hospital, Radiology, Heidelberg, Germany
Peter Häring, PhD
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Prof. Klaus Herfarth, MD
Heidelberg University Hospital, Radiation Oncoloy
and Radiation Therapy, Heidelberg, Germany
Prof. Claus-Peter Heußel, MD
National Center for Tumor Diseases (NCT), Heidelberg, Germany
Tobias Heye, MD
Heidelberg University Hospital, Radiology, Heidelberg, Germany
Angelika Höss, Dipl. Inf. Med.
HIT GmbH, Heidelberg, Germany
Klaus-Vitold Jenderka, PhD
Hochschule Merseburg, University of Applied Sciences,
Department INW, Merseburg, Germany
Jürgen Jenne, PhD
Mediri GmbH, Heidelberg, Germany
Andreas Krauß, Dipl.-Phys.
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Katja Lindel, MD, Privatdozentin
Heidelberg University Hospital, Radiation Oncology,
Heidelberg, Germany
Oliver Nix, PhD
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Dieter Oetzel, PhD
Heidelberg University Hospital, Radiation Oncology
and Radiation Therapy, Heidelberg, Germany
Katia Parodi, PhD, Privatdozentin
HIT GmbH, Heidelberg, Germany
Peter Peschke, PhD
German Cancer Research Center (DKFZ),
Radiation Oncology, Heidelberg, Germany
Maria Rius-Montraveta, PhD
German Cancer Research Center (DKFZ),
Epigenetics, Heidelberg, Germany
Falk Röder, MD
Heidelberg University Hospital, Radiation Oncology,
Heidelberg, Germany
Prof. Heinz-Peter Schlemmer, MD, PhD
German Cancer Research Center (DKFZ),
Radiology, Heidelberg, Germany
Martina Schmaus, MD
Heidelberg University Hospital, Radiation Oncology, Heidelberg,
Germany
Prof. Michael Scholz, PhD
GSI Helmholtz Center for Heavy Ion Research,
Darmstadt, Germany
Kai Schubert, PhD
Heidelberg University Hospital, Radiation Oncology,
Heidelberg, Germany
Joseph Stancanello, PhD
GE Healthcare, MRI Research, Vélizy, France
Prof. Ludwig Strauss, MD
German Cancer Research Center (DKFZ),
Nuclear Medicine, Heidelberg, Germany
Christian Thieke, MD, PhD
German Cancer Research Center (DKFZ),
Radiation Therapy, Heidelberg, Germany
Matthias Uhl, MD
Heidelberg University Hospital, Radiation Oncology
and Radiation Therapy, Heidelberg, Germany
Silke Ulrich, PhD
German Cancer Research Center (DKFZ),
Medical Physics in Radiation Oncology, Heidelberg, Germany
Christian Zechmann, MD
German Cancer Research Center (DKFZ),
Radiology, Heidelberg, Germany
Felix Zwicker, MD
Heidelberg University Hospital, Radiation Oncology
and Radiation Therapy, Heidelberg, Germany

# WHY

Group photo of the first Master Online APMR class (2010)



## WHY JOIN US?

1. Expert teaching staff (60+) of international repute contribute to the program as authors, lecturers and supervisors.

2. The program is in line with the new “German Radiation Protection Ordinance“ as of November 1st, 2011 (http://www.dgmp.de/service/gesetze/2011-rl-strlschmed.pdf) and accredited by ACQUIN the German Accreditation Institute.

3. The program is carefully designed to offer the flexibility of online study that working adult learners expect alongside work-based training sessions on location.

4. The successful Master Online APMR graduate will hold an MSc degree from a top-ranking university with a longstanding reputation for excellence in research, teaching and learning.

5. Practical training is offered on-site at flagship radiotherapy facilities including the internationally celebrated German Cancer Research Center (DKFZ) home to the Nobel Prize in Medicine in 2008 (Prof. Harald zur Hausen).

6. Internships are available at the Heidelberg University Hospital with one of the largest radiation oncology units in Europe and site of the unique (world‘s prototype) heavy ion beam facility, Heidelberg Ion-Beam Therapy Center, HIT.

7. Graduates leave the program with promising new career prospects in teaching, research or care services in medical centers, national laboratories, academic institutions, governmental regulatory agencies, and in medical and nuclear industrial facilities.

9. Be among one of the first medical physics professionals with the sought after practical skills and specialist knowledge in advanced cancer treatment techniques increasingly relevant at new facilities for IMRT, IGRT, and ion beam therapy under construction throughout Europe.

10. Last but not least, hear what our current students recently remarked:

*“I think this is the way to educate people who are already in a job. Go on doing what you are doing – you are on the right path.“*

*“The level of material offered helped me to understand many things for the practical work in the daily clinical routine.“*

*“I very much appreciate the motivation of the lecturers and program coordinators.”*

*“The new learning contents and especially the innovations in radiotherapy inspired me most”*



# HOW

## ENTRY REQUIREMENTS - MSC

### General
The Master in APMR is an international program delivered in the English language and welcomes students of all cultural and ethnic backgrounds.

APMR is aimed at applicants from higher or further education institutions who have completed a Bachelor's degree in a subject related to physics or physical technology or have a diploma in physics, biomedical technology or equivalent engineering studies.

Furthermore, prospective students will have at least two years of professional experience in the field of medical radiation physics or proof of an employment contract for a minimum of two years before the Master Online APMR program start. They will be profi-cient in the English language.

### Prior knowledge
The applicant can demonstrate specialized prior knowledge as follows:

- Fundamental knowledge of anatomy and physiology
- Knowledge of biometry and statistics
- Basic knowledge of the organizational and legal infrastructure of their national health care system
- Fundamental knowledge of the methods of medical physics and engineering science (medical technology) and the application of this knowledge in medical procedures used in the treatment and care of patients
- Knowledge of physics and engineering for radiotherapy and nuclear medicine
- Knowledge of image generation and image processing (X-ray, CT, US, MRI)
- Basic knowledge of dosimetry and radiation safety (basic course in radiation safety according to the German guideline on radiation safety in medicine, "Strahlenschutz in der Medizin" which can be found online at http://www.bmu.de/ strahlenschutz/ doc/5613.php)

*Please note:*
It is at the discretion of the Admissions Committee (in German "Zulassungsausschuss") whether or not prior learning and qualifying academic degrees can be recognized. The recommendations of the Conference of German Cultural Ministers (in German "Kultusministerkonferenz") and the agreements reached within the partnerships of higher education institutions will be considered in the recognition of foreign degrees. Any ambiguous cases will be referred to the Central Office for Foreign Education (in German "Zentralstelle für ausländisches Bildungswesen, ZAB").

If the candidate has not met the prerequisites for admission by the application deadline, conditional admission can nonetheless be granted on the basis of provisional documentation, issued by the institutions concerned, which certify that the candidate is expected to meet the prerequisites for admission by the date the course commences in the semester for which admission is being sought.

### Computer equipment and skills
This is a distance education program delivered predominantly online which requires regular access to a personal computer (PC or Mac), graphic and audio/video-enabled with high-speed internet access. In order to be an active participant in the collaborative online study sessions prospective students will also need to aqcuire a headset (or microphone and speakers) and a webcam.

### Application forms
Further details to the above including all relevant application documents can be found at our APMR Homepage:
www. apmr.uni-hd.de under "Application Procedure".

### Application deadline
15 July (later applications may be accepted depending on number of participants.)

### Facts
Program duration: 4 semesters
Program start: October every year
Maximum number of participants: 20

### Fees
The fee for the regular 4 semester program is €16,426 (from October, 2011). A longer period of study will incur supplementary costs of €106,50 per semester (as of October 2011).

### Funding
Costs for postgraduate studies can be offset against tax as special, professional or recurrent expenses. Please get in contact with your local inland revenue office or tax advisor for more information.

Additionally, most of the employers are willing to support 50% to 100% of their employees training fees.

However, as we try to find alternative solutions please feel free to contact the APMR program coordinating team or refer to our website: www.apmr.uni-hd.de for further details.

# ENTRY REQUIREMENTS - POSTGRADUATE (PG) STUDY CERTIFICATES

## General

As the Master Online APMR program carries ACQUIN accreditation so do each of the individual modules taken in fulfillment of either of the PG study tracks. Completers of the PG short or full study track are awarded certification over accredited MO APMR modules accordingly. Each module is worth 7.5 ECTS points.

Whether a student opts to study for the PG short or PG full study track the two core modules 2 and 4 must be taken. PG full study track completers have the option of continuing their studies to then exit the program with the MSc award.

## Prior knowledge

The entry requirements for the PG study tracks are slightly modified compared to the MSc track and the admissions procedure is simplified. In order to qualify the potential candidate must demonstrate the following:

- Relevant degree (related to physics or physical technology or biomedical technology or an equivalent course of engineering studies) of higher or further education institute (Master, Bachelor, Diploma)
- 1 year professional work experience in medical physics following the first degree or proof of an employment contract before program commencement
- Proof of English language proficiency at a level comparable to C1 of the Common European Framework of Reference (see http://www.examenglish.com/CEFR/cefr.php for self checks)

## Computer equipment and skills

Please refer to details on page 33.

## Application forms

Please refer to our APMR homepage:
www. apmr.uni-hd.de under “Application Procedure”.

## Application deadline

Please contact the Program Coordinating Team.

## Fees

The individual module fee runs at €2.500 to €2.600 which is paid by bank transfer and normally due on a module by module basis always 5 working days prior to the commencement date of each module, respectively, for which the student has enrolled.

## PG short

The PG short study track incurs a total fee of
(€2.600 x 3) = €7.800.

## PG full

The PG full study track incurs a total fee of
(€2.500 x 6) = €15.000

## Funding

Please refer to details on page 33.

## Contact

Main Office
Heidelberg University
Postgraduate Studies
Bergheimer Str. 58A, Building 4311
69115 Heidelberg, Germany
Phone: +49 (0) 6221 54-7812/13
Fax: +49 (0) 6221 54-7819
Email: apmr@uni-hd.de



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German Cancer Research Center (DKFZ),
Heidelberg, Germany

**Compiled by**
Lena Gebauer-Hötzel
Marcel Schäfer

**Editor**
Christina Mainka, PhD, MPhil

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