

# Medical Physics

The Department of Radiation Oncology at the School of Medicine currently offers three programs for graduate and postgraduate physics students who are interested in exploring pathways to prepare for residency programs as well as for careers in the field of medical physics: the Master of Science in Medical Physics (MSMP) (<https://radonc.wustl.edu/education/master-of-science-in-medical-physics/>), the **new** Doctor of Philosophy (PhD) in Medical Physics (<https://radonc.wustl.edu/education/doctor-of-philosophy-phd-in-medical-physics/>), and the Post-PhD Graduate Certificate in Medical Physics (<https://radonc.wustl.edu/education/post-phd-graduate-certificate-in-medical-physics/>).

## Contacts for Programs

### Program Director

Michael Altman, PhD

### Associate Program Director

Tiezhi Zhang, PhD

### Program Coordinator

Julie Follman, MBA

## Degrees & Offerings

- Master of Science in Medical Physics (<http://bulletin.wustl.edu/medicine/degrees-offerings/msmp/>)
- Doctor of Philosophy (PhD) in Medical Physics (<https://radonc.wustl.edu/education/doctor-of-philosophy-phd-in-medical-physics/>)
- Post-PhD Graduate Certificate in Medical Physics (<http://bulletin.wustl.edu/medicine/degrees-offerings/med-phys-grad-cert/>)

## Research

### Master of Science in Medical Physics

Established in 2020, the MSMP program offers two different pathways to allow students to choose either a thesis option or a clinical option. Students who choose the thesis pathway will be required to complete 6 credits of thesis research, with the option for additional research opportunities over the summer semester as part of the 30-credit requirement. Students who choose the clinical pathway will be required to complete a 1-credit clinical rotation and a 3-credit clinical project, with the option for additional clinical rotations over the summer. Each pathway takes two years to complete.

## Doctor of Philosophy (PhD) in Medical Physics

**New** in 2022, the Doctor of Philosophy (PhD) in Medical Physics program is designed for full-time study with a minimum of 70 credit units required for degree completion. The program is comprised of 34 credit units of didactic course work, which are largely completed over the first two years of the program; this includes 22 credit units of medical physics “core” classes and 12 credit units of elective course work, as well as a minimum of 36 credit units of thesis research. The program commences in the fall semester, and didactic courses will run over traditional 16-week schedules during the fall and spring semesters. During the summer, students will be expected to work on their thesis research projects. Clinical shadowing opportunities will also be available for those who have interest.

## Post-PhD Graduate Certificate in Medical Physics

The medical physics division in the Department of Radiation Oncology currently provides research and training opportunities to a large number of PhD researchers in different areas of science and engineering as applied to radiation oncology. The Department of Radiation Oncology established the Post-PhD Graduate Certificate in Medical Physics program in 2017, with the intent of providing a pathway for postdoctoral fellows to enter into clinical physics residencies.

Our post-PhD certificate program focuses on providing students with the medical physics background necessary for future success in medical physics while also offering students the opportunity to perform cutting-edge research in patient-focused areas. Didactics include 18 credits and can be completed over the course of one or two years.

## Faculty

### Program Director

**Michael Altman, PhD** (<https://radonc.wustl.edu/people/michael-altman-phd/>)

Associate Professor of Radiation Oncology

BA, Physics, University of Chicago, 2002

MS, Physics, Drexel University, 1999

PhD, Medical Physics, University of Chicago, 2010

Medical Physics Residency, Henry Ford Health System, 2012

### Associate Program Director

**Tiezhi Zhang, PhD** (<https://radonc.wustl.edu/people/tiezhi-zhang-phd/>)

Associate Professor of Radiation Oncology (primary appointment)

BS, Physics, Jilin Medical University, 1994

MS, Physics, Drexel University, 1999

PhD, Medical Physics, University of Wisconsin–Madison, 2004

## Instructors

**Jose Garcia-Ramirez, MSc** (<https://radonc.wustl.edu/people/jose-garcia-ramirez-ms/>)

Assistant Professor of Radiation Oncology  
BS, Physics, University of Puerto Rico, 1995  
MS, Medical Radiation Physics, Finch University of Health Sciences (Rosalind Franklin University), 1997

**Yao Hao, PhD** (<https://radonc.wustl.edu/people/yao-hao/>)

Instructor in Radiation Oncology (primary appointment)  
BS, Physics, Shanxi University, 2004  
MA, Logic, Shanxi University, 2007  
PhD, Medical Physics, University of Massachusetts, 2016

**Joseph O'Sullivan, PhD** (<https://engineering.wustl.edu/faculty/Joseph-OSullivan.html>)

Samuel C. Sachs Professor of Electrical Engineering  
BS, Electrical Engineering, University of Notre Dame, 1982  
MS, Electrical Engineering, University of Notre Dame, 1984  
PhD, Electrical Engineering, University of Notre Dame, 1986

**Naim Ozturk, PhD** (<https://radonc.wustl.edu/people/naim-ozturk-phd/>)

Chief Physicist, Cox Health Springfield  
BS, Physics, Bogazici University (Turkey), 1984  
MS, Physics, University of Toledo, 1989  
PhD, Physics, University of Toledo, 1993  
MS, Medical Physics, East Carolina University, 2003

**Michael Prusator, PhD** (<https://radonc.wustl.edu/people/michael-prusator-phd/>)

Assistant Professor of Radiation Oncology  
BS, Chemistry, University of the Ozarks, 2012  
MS, Radiological Sciences, University of Oklahoma, 2014  
PhD, Radiological Sciences, University of Oklahoma, 2018

**Buck Rogers, PhD** (<https://radonc.wustl.edu/people/buck-rogers-phd/>)

Professor of Radiation Oncology (primary appointment)  
Adjunct Professor of Chemistry (courtesy affiliation)  
Professor of Radiology  
BS, Chemistry, Loyola University Chicago, 1989  
MA, Chemistry, Washington University in St. Louis, 1991  
PhD, Inorganic Chemistry, Washington University in St. Louis, 1995

**David Strait, PhD** (<https://anthropology.wustl.edu/people/david-strait/>)

Professor of Anthropology  
BA, Anthropology, Harvard College, 1991  
MA, Anthropological Sciences, State University of New York at Stony Brook, 1995  
PhD Anthropological Sciences, State University of New York at Stony Brook, 1998

## Courses

Visit online course listings to view offerings for M91 MedPhys (<https://courses.wustl.edu/CourseInfo.aspx?sch=M&dept=M91>).

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### M91 MedPhys 501 Clinical Imaging Fundamentals

This course will discuss the main imaging modalities used in the clinic. This includes x-ray, magnetic resonance, ultrasound, and nuclear imaging. Applications with an emphasis on diagnostic imaging and image-guided radiotherapy will be covered. The focus of this course is on the underlying physical principles, technical implementations, image reconstruction algorithms, and quality assurance. In addition to the didactic component, there will be hands-on laboratory sessions on CT, cone-beam CT, planar x-ray imaging, mammography, MRI, ultrasound, and nuclear medicine. Prerequisite: ESE589; permission of the program director.  
Credit 2 units.

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### M91 MedPhys 502 Radiological Physics and Dosimetry

This class is designed to construct a theoretical foundation for ionizing radiation dose calculations and measurements in a medical context and prepare graduate students for proper scientific presentations in the field of x-ray imaging and radiation therapy. This course will cover the fundamental concepts of radiation physics, how ionizing radiation interact with matter, and how the energy that is deposited in the matter can be measured in theory and practice. Specifically, a student completing this course will be able to do the following: 1. Understand and apply key concepts specific to energy deposition for both ionizing photon interactions and transport in matter and for energetic charged particle interactions and transport in matter. Radiation sources include radioactivity, x-ray tubes, and linear accelerators. 2. Understand the theoretical details of ion-chamber based dosimetry and of cavity-theories based clinical dose measurement protocols. 3. Perform and present real world style research projects as a group, and present these projects in a typical professional scientific format and style. 4. Achieve an appreciation of the history and potential future developments in ionizing radiation detection and dosimetry. Prerequisite: Physics and calculus; permission of the program director  
Credit 3 units.

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### M91 MedPhys 503 Independent Study

The independent study course is designed to provide graduate students with an opportunity to gain insight into an aspect of the field of medical physics. The goal of the course is to provide introductory experience on a focused project with one or more faculty mentor(s). Graduate students will be matched with a project/mentor based on a number of factors, including student interest in the area of study and availability. Prerequisite: Physics and calculus; Permission of the program director.  
Credit 1 unit.

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### M91 MedPhys 503C Clinical Project

Students will complete a clinically-focused, hands-on project under the supervision of a faculty mentor. Students will learn background as to the impetus of this project, will develop a plan or procedure for completing the project, and will take a major role in performing and completing the developed tasks. The goal of this is to simulate and gain an understanding of the workflow needed to achieve advancements in the clinic and/or patient care, as well as for students to gain a deeper understanding about a clinically focused topic. An oral presentation and written report describing the completed project work is required. Prerequisite: 2 semesters of MP503; Permission of the program director  
Credit 3 units.

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### M91 MedPhys 503P PhD Thesis Research

Doctor of Philosophy in Medical Physics students will work on their thesis research under the guidance of their thesis advisor(s). Students will work on various elements of their thesis including research, writing, and other relevant tasks. Student progress will be assessed regularly

throughout their doctoral thesis, including the achievement of required tasks and milestones. Prerequisite: MP503R and/or permission of the program director Prerequisite: MP503R and/or permission of the program director  
Credit variable, maximum 9 units.

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**M91 MedPhys 503R Phd Research Rotation**

The PhD Research Rotation course is designed to provide students with an experience working with one or more potential thesis mentors on a focused research opportunity. Students will gain insight into an aspect of the field of medical physics and a program of academic research, as well as cultivating a relationship with a potential thesis mentor. PhD students will be matched with a project/mentor based on a number of factors, including student interest in the area of study and availability. Prerequisite: Permission of the program director.  
Credit 3 units.

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**M91 MedPhys 503T MS Thesis Research**

Students will complete a research project under the supervision of a faculty mentor. Thesis students will develop a thesis proposal, conduct mentored research, and disseminate this research in the form of an oral defense and written thesis. The goal of this project is to gain an in-depth understanding about an area of development or research in the medical physics field, as well as to gain an understanding about how to structure, perform, and present academic work. Students may also learn about academic publication composition and submission. An oral presentation and written report describing the completed project work is required. Prerequisite: two semesters of MP503; Permission of the program director.  
Credit 3 units.

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**M91 MedPhys 504 Ethics, Professionalism and Current Topics**

This course prepares students to critically evaluate ethical, regulatory and professional issues and for leadership in clinical practice and research. The principal goal of this course is to prepare students to recognize ethics and compliance resources in clinical research and the situational factors that give rise to them, to identify ethics and compliance resources, and to foster ethical problem-solving skills. In addition, the course introduces professionalism, core elements, common traits of the medical physics profession, confidentiality, conflict of interest, interpersonal interactions, negotiations and leadership skills. Characteristics of successful leadership are also identified. Interaction with patients, colleagues, vendors, and clinic staff will also be emphasized. Prerequisite: Permission of the program director.  
Credit 1 unit.

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**M91 MedPhys 505 Radiobiology**

This class is designed to establish a foundation for ionizing radiation interaction with biological tissues. It will cover the fundamental concepts of cell biology, how ionizing radiation interacts with cells, radiation damage and carcinogenesis, radiation therapy fractionation and related concepts. The effects of ionizing radiations on living cells and organisms, including physical, chemical, and physiological basis of radiation cytotoxicity, mutagenicity, and carcinogenesis are also covered. Prerequisite: College level biology or BIOL4581; Permission of the program director.  
Credit 2 units.

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**M91 MedPhys 506 Radiation Oncology Physics**

This course is designed to build on the concept of radiation dosimetry techniques and bring them into the clinical realm. The students will learn clinical applications of radiation dose measurements as used in radiation therapy for the treatment of cancer. Ionizing radiation producing devices such as external beam, brachytherapy, protons and

charged particles, imaging modalities, simulation, radiation delivery, treatment verification imaging, quality assurance, motion management and image-guided techniques will be the major focus. Prerequisite: MP502; Permission of the program director.  
Credit 3 units.

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**M91 MedPhys 521 Radiation Protection and Safety**

This class is designed to further the concepts of radiation interactions and dosimetry to radiation protection and safety and biological consequences of radiation exposure in humans. Protection and safety of the radiation worker and patient, as well as detection equipment and shielding analysis will be main focus. This course will briefly cover regulations, and radiological protection in various clinical environments. Prerequisite: Physics and calculus; Permission of the program director  
Credit 2 units.

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**M91 MedPhys 522 Clinical Rotations**

The student will rotate through various areas within the Radiation Therapy Clinic and develop an understanding of the applications of physics in the use of radiation for the treatment of cancers. This will include simulation, quality assurance of various imaging and radiation sources, dose calculation, intensity modulation treatments, radiosurgery, stereotactic body radiotherapy, brachytherapy, radiopharmaceutical therapy, and more. Prerequisite: MP502, MP506, and MP521; Permission of the program director  
Credit 1 unit.

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**M91 MedPhys 523 Advanced Clinical Medical Physics Laboratory**

The objective of this course is to reinforce and enhance the understanding concepts developed in didactic medical physics courses through practica, laboratory work, and/or special lectures. Students will gain a deeper understanding of the physics and methods involved in clinical imaging and/or radiation therapy treatment processes. The various practica will cover an array of topic areas including absolute dosimetry, relative dose measurements, patient QA, imaging QA, radiation beam modeling, treatment planning, proton therapy, brachytherapy, stereotactic radiotherapy, and adaptive radiation therapy. Prerequisite: MP502, MP506, and MP521; permission of the program director.  
Credit 2 units.