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Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	The Johns Hopkins University

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No	Payment Type: ( ) R*STARS # 12039345 (●) Check # 12039345	Payment Amount: $850	Date Submitted: 05/01/202

Department Proposing Program	School of Medicine
Degree Level and Degree Type	PhD
Title of Proposed Program	Medical Physics
Total Number of Credits	48
Suggested Codes	HEGIS: / CIP: 51.2205
Program Modality	(●) On-campus ( ) Distance Education (*fully online*) ( ) Both
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources
Projected Implementation Date	(●) Fall ( ) Spring ( ) Summer Year: 2025
Provide Link to Most Recent Academic Catalog	URL: https://e-catalogue.jhu.edu/
Preferred Contact for this Proposal	Name: Westley Forsythe
	Title: Academic Compliance Officer
	Phone: (410) 516-0188
	Email: wforsythe@jhu.edu
President/Chief Executive	Type Name: Ray Jayawardhana
	Signature: Ray Jayawardhana Date: 05/01/2024
	Date of Approval/Endorsement by Governing Board:

Revised 1/2021

JOHNS HOPKINS
UNIVERSITY

May 1, 2024

Sanjay Rai, PhD
Secretary
Maryland Higher Education Commission
6 N. Liberty Street, 10th Floor
Baltimore, MD 21201

Dear Secretary Rai,

On behalf of Provost Jayawardhana, I write to request your review and endorsement of the enclosed proposal. The university proposes a new **PhD in Medical Physics.**

The proposed PhD in Medical Physics will train the next generation of PhD medical physicists in both basic and translational research applied to medicine and human health. The program will provide aspiring students with the knowledge that they will need as medical physicist professionals. The program emphases preparation for careers in academia, industry, and/or clinical service roles. Medical physics applies the principles of the physical sciences to biomedical problems. The activities of medical physicists cover a broad spectrum from the study of basic biomedical processes to the diagnosis and treatment of disease, and thus, the training of a medical physicist must be broad.

The proposed program is consistent with the Johns Hopkins mission and the State of Maryland's Plan for Postsecondary Education. The proposal is endorsed by The Johns Hopkins University.

Should you have any questions or need further information, please contact Westley Forsythe at (410) 516-0188 or wforsythe@jhu.edu.

Thank you for your support of Johns Hopkins University.

Sincerely,

Janet Simon Schreck, PhD
Senior Associate Vice Provost for Academic Affairs

cc: Dr. Ray Jayawardhana
Dr. Westley Forsythe

Enclosures

PROPOSAL FOR A NEW ACADEMIC PROGRAM

Doctor of Philosophy (PhD) in Medical Physics

A. Centrality to Institutional Mission and Planning Priorities:

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

The Johns Hopkins University School of Medicine proposes a new academic program for Doctor of Philosophy (PhD) in Medical Physics. The goal of the proposed Medical Physics PhD program is to train the next generation of PhD medical physicists in both basic and translational research applied to medicine and human health. The program will provide aspiring students with the knowledge that they will need in their future profession as medical physicists. Our program leads to the PhD degree with emphasis on preparation for careers in academia, industry, and/or clinical service roles.

Below we outline (a) what Medical Physics and Medical Physicists are; (b) Master of Science (MS) in Medical Physics program that is closely related to this proposed program; (c) the proposed PhD in Medical Physics program; (d) research training, (e) how it is related to the institution's approved mission; and (f) the expectation.

a) What are Medical Physics and Medical Physicists?

Medical Physics is an applied branch of physics and medical physicists provide clinical service to radiology, radiation oncology, and other areas. Medical physicists providing clinical services are required to be certified, e.g. by the American Board of Radiology (ABR). They work with MDs, nurses, technologists and other team members to provide the care for the patients. Medical physicists hold an MS or PhD, go through medical physics residency training and receive ABR certification in technical–clinical capacities, akin to MDs in process. The degree training is typically 2 years (MS) or 5 years (PhD) and the medical physics residency is 2 years (Clinical Only) or 3 years (Clinical plus Research). Similar to the board certification process of the physician colleagues in Radiology and Radiation Oncology, medical physicists currently go through the same computer-based exams (Part 1 and Part 2) and the oral exam (Part 3) and get certification in one of the three specialties of medical physics of ABR in therapeutic medical physics, diagnostic medical physics, and nuclear medical physics. Maintaining certification in medical physics requires adherence to the ABR's Maintenance of Certification (MOC) program requirements. Commission on Accreditation of Medical Physics Education Programs (CAMPEP) has been established to promote consistent quality education of medical physicists by evaluating and accrediting Graduate, Residency, Professional Doctorate in Medical Physics (DMP), Certificate, and Continuing Education programs that meet high standards established by CAMPEP in collaboration with its sponsoring organizations. Since 2012, candidates seeking for ABR board certification must receive training in a CAMPEP-accredited education program. Aiming at meeting CAMPEP standards and training high-quality medical physicists for clinical services, we submitted CAMPEP accreditation application for our existing MS in Medical Physics program in late 2022, and successfully received accreditation on February 1, 2023.

Medical physics applies the principles of the physical sciences to biomedical problems. The activities of medical physicists cover a broad spectrum that ranges from the study of basic biomedical processes to the diagnosis and treatment of disease, and thus, the training of a medical physicist must be broad. To participate fruitfully in this interdisciplinary profession, a medical physicist must be thoroughly competent in the physical and mathematical sciences related to imaging physics and radiation physics, must understand biological principles, and must be able to communicate with physicians. They provide essential clinical services and consultations, ensuring quality control, safety, and the development of effective protocols. In the realm of research and development, they spearhead innovations in medical technology and treatment methodologies. Additionally, they are integral to teaching and education, imparting knowledge and training the next generation of medical professionals.

Medical physicists are high paying job with high job satisfaction. Currently despite the national-wide growth of the medical physics graduate program, student demand for medical physics graduate education exceeds supply significantly.

b) Existing Master of Science (MS) in Medical Physics program

<u>We started a new MS in Medical Physics program in fall 2021</u>, which has enhanced this mission by training future medical physicists and <u>was the first Medical Physics program in the state of Maryland</u>. The MS Medical Physics program requires a successful completion of a minimum of 36 credits for master's degree, followed by completion of a (short) research thesis. Full-time master's students will complete the program in two years. The MS in Medical Physics program was accredited by CAMPEP in February, 2023. Thus, students graduating from this program are qualified to take the ABR Part 1 exam and to start medical physics residency training.

c) Proposed Doctor of Philosophy (PhD) in Medical Physics program

<u>Currently there is no PhD program in Medical Physics in the state of Maryland</u>, and it leaves a geometrical void in the need. There are a few motivations for students to choose a PhD program instead of an MS program. First, national and international leaders in Medical Physics are often those who have a PhD degree and lead research activities in the community. Medical Physics is a multi-disciplinary, technology-driven, fast-advancing field with new imaging and therapy modalities being developed by manufacturers and academia. Thus, aspiring students wish to choose a PhD program. Second, the acceptance rate for residency programs is higher with a PhD degree than with an MS degree (96% vs 78%). When residency training spots are filled, applicants with a PhD degree in Medical Physics are preferred to those with an MS degree in Medical Physics. Third, PhD training programs involve creative research activities, and motivated students are attracted to it. This will be the first Medical Physics PhD program in the state of Maryland. With excellent research activities in the School of Medicine, we believe that it is a part of Johns Hopkins Medicine's mission to have a PhD program in Medical Physics.

The PhD in Medical Physics program is designed for full-time students who wish to pursue a career as a medical physicist, either as a researcher or a certified clinical profession. The proposed program is a dual-track training program, which full-time PhD students are expected to complete in five years. Graduating students will receive a PhD degree in Medical Physics upon the completion of the training.

Admission: We plan to admit approximately 6 new students per year to the program. Students will be directly admitted to principal investigators' (PIs) laboratories (i.e., a direct match) and be on either "Clinical–Research Track" or "Research Track." Students on Clinical–Research Track need to satisfy additional criteria required by CAMPEP (e.g., Bachelor of Science with major in Physics). PIs are faculty members with a PhD degree and the primary appointment at either the Department of Radiology and Radiological Science or the Department of Radiation Oncology and Molecular Radiation Sciences. PIs will provide each student with stipend and health and dental insurance. The tuition will be waived by Johns Hopkins University School of Medicine.

Course training (Years 1–2): Students will earn a minimum of 36 credits, which is the same requirement as the MS Medical Physics program. In addition, students will conduct small-scale research under a supervision of their PI and pass a Doctoral Board Oral (DBO) examination.

Research training (Years 3–5): Students on Clinical–Research Track are required to pass the ABR Part 1 exam (those on Research Track are not required). All of students will conduct research under a supervision of their PI, present their work at conferences and in journals, write and defend the thesis (i.e., dissertation).

Post-PhD: All of the students will receive a PhD degree in Medical Physics. Upon graduation, students on Clinical–Research Track are qualified to start medical physics residency training, while those on Research Track are not qualified.

d) Research training

The proposed PhD program will provide students unique opportunities with top of the world research experiences. The proposed program will be the first PhD program for both the Department of Radiology and Radiological Science and the Department of Radiation Oncology and Molecular Radiation Sciences. Between the two Departments, there are more than 27 PIs with more than 200 million dollars of research grant funds, either active or completed within the past 3 years, and they wish to hire 58 graduate students from the proposed PhD program. It means that there are opportunities for ~12 new students per year, which is a good demand for the proposed program with ~6 new students per year.

The Department of Radiology and Radiological Science at Johns Hopkins University received research grant funds from NIH, which was ranked 5th in the U.S.A. in 2021. Four Johns Hopkins Radiology principal investigators (PIs) were ranked among the top 50 Radiology PIs receiving NIH funds. Among universities ahead of Johns Hopkins, University of Pennsylvania is the only one which has a CAMPEP accredited Medical Physics PhD program. The proposed Medical Physics PhD program has potential to become one of the top Medical Physics research programs in nation supported by extensive NIH research grants.

As for the Department of Radiation Oncology and Molecular Radiation Sciences which was established in 2003, due to much smaller research faculty team, the annual research grants from NIH was ~3 million per year over the past 5 years, ranking 10–15 in the academic Radiation Oncology departments in the U.S.A. Among universities ahead of Johns Hopkins, only four institutions have a CAMPEP accredited Medical Physics PhD program. Similar to Department of

Radiology, the proposed Medical Physics PhD program has potential to become one of the top Medical Physics PhD research programs in nation for Radiation Oncology as well. This proposed program will be able to closely connect our research mission and world-leading activities to enhance educational mission.

e) Relation to Institution's approved mission

The proposed program will fill the existing void and need for PhD in Medical Physics programs in the State of Maryland and it fits the institution's approved mission exceptionally well.

The mission of Johns Hopkins Medicine is to improve the health of the community and the world by setting the standard of excellence in medical education, research and clinical care. Diverse and inclusive, Johns Hopkins Medicine educates medical students, scientists, health care professionals and the public; conducts biomedical research; and provides patient-centered medicine to prevent, diagnose and treat human illness.

The mission of Johns Hopkins University is to educate its students, to cultivate their capacity for life-long learning, to foster independent and original research, and to bring the benefit of discovery to the world. The mission of the Johns Hopkins University School of Medicine, as it relates to graduate education, is to educate graduate students (in accordance with the highest professional standards) to identify and answer fundamental questions in the mechanisms, prevention, and treatment of disease and in the basic sciences. While many of the doctoral programs offered by the Johns Hopkins University School of Medicine cover various research fields, currently there is no PhD program in Medical Physics.

f) Expectation

We expect that this Medical Physics PhD program will be accredited by CAMPEP a few years after the start of the program, being the first certified PhD program in the State of Maryland. This accreditation will allow us to train next generation medical physicists with strong research focus, while providing clinical services, to enable them focusing on the most important problems arising from clinical care and translating research outcomes to clinical practice, thereby generating substantial healthcare impacts.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

One of the priorities of the Johns Hopkins Strategic Plan is to "Lead the world in the education and training of physicians and biomedical scientists," with the first goal within this priority to "Build an effective culture for learning and education across all JHM member organizations, leverage the University's infrastructure, and facilitate interprofessional educational programs" (https://www.hopkinsmedicine.org/strategic_plan/education.html). The proposed new PhD program directly addresses these priorities and goals by providing excellent education and training in medical physics, making use of existing university infrastructure, research activities (e.g. radiology labs), and clinical environment (e.g. proton therapy center), and taking advantage of existing interdisciplinary research opportunities through the Johns Hopkins Health System.

3. Provide a brief narrative of how the proposed program will be adequately funded for

at least the first five years of program implementation. (Additional related information is required in section L.)

The program expects six new students every year for five years of graduate training. Based on similar peer programs in other states and CAMPEP data, we expect 60–150 applications per year. As outlined below, we fully expect that the program will become self-sustained after Year 3 and generate annual revenue of $22k or more in Year 5 and beyond. The Radiological Physics Division and Medical Physics Program will cover the negative balance for the first 3 years. When the number of students increases, so does the program revenue. See Table 0.

Table 0: Program account balance					
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Program resources	$ 30,000	$ 61,800	$ 95,400	$ 130,800	$ 168,000
Program expenditures	$ 69,920	$ 83,059	$ 96,933	$ 111,575	$ 127,017
Balance	$ (39,920)	$ (21,259)	$ (1,533)	$ 19,225	$ 40,983

Resources: The primary advisors of students (i.e., the PIs) will also contribute $5k per year per student to support the program, with an annual increase of $150 per student. In Year 5, the program support revenue will reach $168k per year with 30 students active in the program. The PIs will use their research grants and cover the stipend ($38k/year), health and dental insurances ($12k/year) for their students. We anticipate that the tuition for graduate students will be waived by School of Medicine. See Table 1, Sec. L for more detail.

Expenditures: The expenditures of the program are for teaching and administrative faculty, administrative staff, and other expenses. The students' costs will be covered by the PI as outlined above; and the program support revenue described above will cover the rest of the expenses—the teaching faculty (0.15 FTE), rotating administrative faculty being in charge of student selection and admission process (0.05 FTE), administrative staff (0.10–0.50 FTE), and other expenses ($11k/year). The PhD Medical Physics program students will take the same courses as MS Medical Physics program students during the first two years of their training. Teaching faculty's salaries and benefits are covered by the MS Medical Physics program for up to 2.5 FTE; the additional 0.15 FTE will be sufficient to cover the increased class sizes with additional PhD students. See Table 2, Sec. L for more detail.

The PIs will hold PhD degrees and have primary appointments in either Department of Radiology or Department of Radiation Oncology and Molecular Radiation Sciences. Currently, a large number of PIs with active grants who have expressed interest in hiring Medical Physics PhD students for their programs (see Appendix C). Overall, 27 PIs with over 204 million dollars research grants wish to hire 58 new PhD students over 5 years. We fully expect, based on the funding history in previous years and active grants, that the pool of potential PIs will be sustained or increasing in the coming years.

In addition, we will plan to secure a National Institutes of Health Training (NIH T-32) grant to support 2–3 new students per year for this program.

In summary, we fully expect that the program will become self-sustained by Year 3.

4. **Provide a description of the institution's commitment to:**

   a) **ongoing administrative, financial, and technical support of the proposed program**

   This Medical Physics PhD program will tap into existing support provided to Medical Physics MS program. The Johns Hopkins School of Medicine has already committed resources for administrative and financial management for this MS Medical Physics graduate program. Salary support is provided for both administrative staff and faculty within the Radiological Physics Division. The program receives support from the Offices of the School of Medicine that support graduate education. Technical support is provided through existing graduate school resources.

   b) **continuation of the program for a period of time sufficient to allow enrolled students to complete the program.**

   We anticipate launching this initially as a five-year PhD program with 6 new students enrollment per year. We expect that PIs will have secured longer-term grants such as R01s and U01s to support the students until thesis defense and the completion of the training. We anticipate that infrastructure support in terms of enrollment, tuition billing, and credit tracking not already provided by the School of Medicine will be undertaken by the Radiological Physics Division, in coordination with the Department of Radiology and Radiological Science, and the Medical Physics Division, Department of Radiation Oncology and Molecular Radiation Sciences (see Sections A3 and L).

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan:

1. **Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:**

   a) **The need for the advancement and evolution of knowledge**

   Medical physics applies the principles of the physical sciences to biomedical problems. It is required by law to have onsite certified medical physicists in radiation oncology facilities. Certified medical physicists are also required in diagnostic imaging and nuclear medicine to perform quality control and assurance of imaging instrumentation. There is a high demand for certified medical physicists. However, currently, there is no Medical Physics PhD program offered by any institutions within the State of Maryland. The Medical Physics specialty body responsible for clinical medical physicist certification, CAMPEP, requires that medical physicists graduate from a certified graduate program in order to qualify for a residency program and to obtain Medical Physicist Certification. Therefore, it is important to establish a Medical Physics graduate program here in Maryland. We also anticipate increasing demand for certified medical physicists who have knowledge and experience in both therapy and diagnosis to satisfy upcoming needs, related to physics support for radiopharmaceutical therapy.

Medical Physics is a technology-driven, fast-advancing field with new imaging and therapy modalities being developed by manufacturers and academia. Most of the national and international leaders in Medical Physics have PhD degrees and often lead research activities in the community. As the nation's top-ranked research medical school, Johns Hopkins will be an ideal institution to have a Medical Physics PhD program. Having Medical Physics PhD program will also strengthen our CAMPEP accredited Medical Physics MS program, as MS students will be learning next to PhD students.

b) Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education

Johns Hopkins University is committed to sharing values of diversity and inclusion in order to achieve and sustain excellence. The promotion of excellence is best achieved by recruiting and retaining a diverse group of students, faculty, and staff and by creating a climate of respect that is supportive of their success. This climate for diversity, inclusion and excellence is critical to attaining the best research, scholarship, teaching and other strategic goals of the University. Taken together, these values are recognized and supported fully by the Johns Hopkins Institutions leadership at all levels. The Johns Hopkins School of Medicine actively recruits and admits students from underrepresented minorities into all graduate programs, including the proposed new PhD program. Specifically, the National Institutes of Health provides additional administrative supplemental funds to the grant when underrepresented PhD students are working on NIH-funded projects. The scheme encourages financially disadvantaged or underrepresented candidates to apply and matriculate. The proposed program follows the AAPM's policy effort to address the gender unbalance among Medical Physicists (AAPM average female 23.3%, clinical leadership role 12.0%). Our MS program currently achieved an average female students' rate of 37.5%. In addition, our Medical Physics faculties have been actively participating in the AAPM Diversity Recruitment through the Education and Mentoring Program (DREAM) to offer research opportunities and the proposed new PhD program will further expand the educational opportunities and choices for the minority and educationally disadvantaged students.

c) The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs

We anticipate that the program will attract applications from graduates of historically black institutions (HBI's). In the recent AAPM survey, the AAPM membership has only 2% of Black or African American members and there is a great interest from the AAPM and its members to attract more Black or African American students to develop careers in Medical Physics. We believe the proposed program will provide high quality and unique education opportunities for HBIs, such as nearby institutions of Morgan State University and Howard University.

Our current Medical Physics MS program is partnered with Howard University, private, federally chartered historically black research university in Washington, D.C. Under the agreement between Johns Hopkins University, on behalf of its School of Medicine, and Howard University, a framework for a collaborative program focusing on providing graduate students the opportunity to enroll in medical physics courses hosted by either party has been established in November 2022. Further along this direction, a formal collaboration between the Department of Radiation Oncology and Molecular Radiation Sciences in the School of Medicine at Johns Hopkins University and the Department of Physics and Astronomy at Howard University is under development to foster cooperation in the graduate study program in medical physics at Howard University, with specific goals including, but not limited to, to develop an academic medical physics graduate program of excellence at Howard University training M.S. and PhD students, to secure and maintain CAMPEP accreditation status for the graduate program, to develop/exchange/update all educational materials pertinent to the program, to conduct joint research and academic meetings pertinent to the program, and to enroll one medical physics resident in the Johns Hopkins Medical Physics Resident Program for graduates from the medical physics program at Howard University.

We expect such a framework will be continued and expanded after the proposed PhD program is launched, which will contribute significantly to strengthening the capacity of Howard University to provide high-quality Medical Physics training.

2. Provide evidence that the perceived need is consistent with the 2022 Maryland State Plan for Higher Education.

The proposed PhD program addresses the priorities articulated in the 2022 Maryland State Plan for Higher Education in several areas as outlined below.

Student Access: Ensure equitable access to affordable and high-quality postsecondary education for all Maryland residents.

Overall, our program will admit a diverse group of students and provide full financial support with stipend, benefits, health insurance, and tuition (waived). Its emphasis on cross-disciplinary skills may have advantages for non-traditional graduate students. By allowing options in coursework, the program is tailored to the students' needs which will (by design) facilitate prompt completion of degree requirements. These setups facilitate equitable access to affordable and high-quality eduation. Below are detailed information how our program will address priorities in Student Access.

- **Priority 1.** Study the affordability of postsecondary education in Maryland

  Enrolled students will be fully funded by our program. The tuition will be waived, the stipend and health insurance will be provided by their primary advisors (also called the principle investigator). In addition, The National Institutes of Health, the major source of research funding for the principle investigators, is expected to provide administrative supplement (funds) for under-represented miniority students.

- **Priority 2.** Examine and improve financial literacy programs for students and families to encourage financial planning to pay for postsecondary education

  The financial support outlined in Priority 1 will be explained in the website where applicants will access first. The Johns Hopkins University provides health insurance to family members.

- **Priority 3.** Analyze and improve systems that inform and evaluate a student's academic readiness for postsecondary education

  Student's academic readiness will be assessed by grade point average (GPA) of undergrad courses, graduate record examinations (GRE) scores, and test of English as a foreign language (TOEFL) scores. Applicants will be requested to submit these materials, hence, be made aware that they are part of the qualification review.

- **Priority 4.** Analyze systems that impact how specific student populations access affordable and quality postsecondary education

  Admission and enrollment processes and requirements, as well as financial support, will be clearly presented in the webpage where applicants will have access. As medical physics is a relatively less known area to applicants with qualified background (physics, engineering etc.), our program will prmote the access to medical physics education in Maryland. These efforts will facilitate first-generation to navigate the higher education system.

Student Success: Promote and implement practices and policies that will ensure student success.

Overall, being the first Ph.D. program in Manyland, our program is expected to provide rigorous graduate training in both research and clinic to our students, fostering their successful career development in medical physics, an area that plays a critical role in medical imaging, radiation therapy, and many other fields. We will also implement a rigorous training and education system to ensure success of education.

- **Priority 5.** Maintain the commitment to high-quality postsecondary education in Maryland

  Our program will be the first Ph.D. in Medical Physics program in Maryland, which aligns well with Priority 5 to provide high-quality postsecondary education in Maryland.

  Our program is also committed to deliver high-quality education to prepare qualified candidates towards medical physics career. Medical Physicist is a well-paid job with many opportunities and also a high job satisfaction rate. Graduate students with PhD degree in Medical Physics, compared to those with Master of Science degree in Medical Physics, will have a higher acceptance rate for residency training program (96% versus 78%), a better chance for top-tier academic–clinical institutions, and become an international leader of the Medical Physics community.

Moreover, our Master of Science in Medical Physics program has established a partnership on memorandum of understanding (MOU) basis with Howard University in Washington, D.C. in order to enhance the regional educational mission. We plan to continue the discussion to expand the relationship including the proposed PhD in Medical Physics program.

- **Priority 6.** Improve systems that prevent timely completion of an academic program

  By allowing options in coursework, the program is tailored to the students' needs which will (by design) facilitate prompt completion of degree requirements. The mentors of students will work closely with the students in supervising their research progress and the progress towards Ph.D. degree and career advancements.

  Student handbook provides an expected timeline to complete the program within 5 years with milestones and deadlines such as doctoral board oral (DBO) exam completed by the end of Year 2, the PhD thesis committee formed by the end of Year 3, etc. These guidelines will help students to stay on the track and recognize if off-schedule.

- **Priority 7.** Enhance the way postsecondary education is a platform for ongoing lifelong learning

  Medical equipments and their standards evolve over time. Thus, Medical Physicists are required to continue life-long learning after graduation. In particular, for students who will persue clinical medical physics career, they will be board certified and maintance of board certification will require continues education in multiple ways, such as earning a certain number of continuing medical education (CME) credits per year, completing quality improvement projects over the years, etc. Our faculty members will be engaged with such lectures to provide continous education and CME credits.

Innovation: Foster innovation in all aspects of Maryland higher education to improve access and student success.

Our program will offer the opportunity for qualified students to take the medical physics career, a specialized area that is important in healthcare.

- **Priority 8.** Promote a culture of risk-taking

  There is no undergraduate programs for Medical Physics. Many Physics-graduate students will take a risk of jumping into a new field (Medical Physics) and starting a new professional career. This promotes a culture of risk-taking and provide rewarding experiences. The new PhD degree is an innovative program that combines existing resources at the Johns Hopkins School of Medicine to provide education and training specifically focused on medical physics.

Medical Physcis is a relatively less known highly specialized field to qualified students (e.g. in physics and engineering). Yet the market for PhD level medical physicists is diverse in terms of job functions (government, industry, university, hospital, medical physics service providers) and growing, and attractive in terms of job satisfaction. Our program will provide an innovative and alternative way for qualitfieid students to receive postsecondary education and develop their careers.

Additionally, our program is also aligned with the action of "Develop and publicize "credit for prior learning" policies". When newly enrolled students have completed courses from CAMPEP-accredited programs, credits will be waived. The number of credits to be waived and the qualitication will be posted on the website for potential applicants.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State:

1. Describe potential industry or industries, employment opportunities, and expected level of entry (*ex: mid-level management*) for graduates of the proposed program.

This program will consist of two tracks, Clinical Medical Physics track and Research Medical Physics track. The former will be a CAMPEP accredited program, while the latter will not be.

Students in the Clinical Medical Physics track of this program will take the initial exam of ABR (American Board of Radiology) certificate of medical physics. They are expected to attend a resident program to receive further training towards clinical medical physicists for 2–3 years after graduating from our program. The Department of Radiation Oncology at Hopkins offers a CAMPEP certified resident program (accredited in 2011) with a long history of success. After the resident program, the students are expected to be fully certified by ABR in one of the medical physics disciplines: radiation oncology, diagnostic imaging, or nuclear medicine. The expected jobs are in hospitals as clinical physics, consulting companies that certify medical imaging equipment for hospitals, companies that are developing medical equipment, and colleges/institutes as teaching or research positions.

Graduates from the Research Medical Physics track of this program have the same qualification as those in the Clinical track except for ABR certification. The expected jobs are non-clinical ones such as companies that are developing medical equipment, and colleges/institutes as teaching or research positions.

2. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.

Medical physicists are in high demand in the job market. According to the CAMPEP annual graduate report, in 2021 there were 113 PhD graduates and 203 MS graduates from a Medical Physics program. Among PhD graduates, 52% joined a residency program (47% in radiotherapy and 5% in medical imaging, 127 programs available), 5% became junior medical physics in a clinic, 12% started an academic position, 13% went to industry, 1% in government, and 4% were employed outside the medical physics field.

Medical physicists are also among high paying jobs. According to the American Association of Physicists in Medicine (AAPM) 2021 salary survey, the median salary of a PhD level medical physicist is $161,000 without certificate, and $212,000 with certificate.

3. **Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.**

There are only a limited number of CAMPEP accredited Medical Physics PhD programs (44 in the U.S., 15 in Canada, and 3 outside North America, 33 for PhD and MS, 8 for PhD only, 21 for MS only). The number of graduated students is steady over the past 5 years, with 94–113 graduates each year. According to the U.S. Bureau of Labor Statistics, during the 2018–2028 decade, physicists across all areas of concentration would experience 9% employment growth. The fields of radiology and nuclear medicine may experience a substantial increase in the coming years, with the demand for some positions growing by as much as 24% in the next decade. The healthcare industry has a need for the development of high-tech medical equipment and for specialists such as medical physicists who can operate this equipment in a clinical setting.

4. **Provide data showing the current and projected supply of prospective graduates.**

No comparable degree programs with the CIP Code of 51.2205 were found in the Maryland Higher Education Commission's graduation trend database. Given the academic trends noted above, the supply should be ample. There were 8,633 physics bachelor's degrees conferred in the class of 2017. The number of physics bachelor's degrees conferred at US physics departments has increased every year since 1999 (Source: aip.org/statistics).

D. Reasonableness of Program Duplication:

1. **Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.**

There are no Maryland schools that currently offer a PhD program in Medical Physics. This is supported by lists of the certified Medical Physics programs on the CAMPEP website (https://www.campep.org/campeplstgrad.asp).

2. **Provide justification for the proposed program.**

There are no Maryland schools that currently offer a PhD program in Medical Physics. Certified Medical Physicist with PhD degree is a high-pay profession that is demanded by hospitals, universities, industry and government. It is important to have a medical physics program inside Maryland to train students in this field to fill the demand inside Maryland and neighboring states.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

1. **Discuss the program's potential impact on the implementation or maintenance of**

high-demand programs at HBI's.

We anticipate that the program will substantially contribute to the development of Medical Physics training in HBI's. In the recent AAPM survey, the AAPM membership has only 2% of Black or African American members and there is a great interest from the AAPM and its members to attract more Black or African American students to develop careers in Medical Physics. We believe the proposed program will provide high quality and unique education opportunities for historically black institutions, such as nearby institutions of Morgan State University and Howard University.

Our current Medical Physics Master program is partnered with Howard University, private, federally chartered historically black research university in Washington, D.C. Under the agreement between Johns Hopkins University, on behalf of its School of Medicine, and Howard University, a framework for a collaborative program focusing on providing graduate students the opportunity to enroll in medical physics courses hosted by either party has been established in November 2022. Further along this direction, a formal collaboration between the Department of Radiation Oncology and Molecular Radiation Sciences in the School of Medicine at Johns Hopkins University and the Department of Physics and Astronomy at Howard University is under development to foster cooperation in the graduate study program in medical physics at Howard University, with specific goals including, but not limited to, to develop an academic medical physics graduate program of excellence at Howard University training M.S. and PhD students, to secure and maintain CAMPEP accreditation status for the graduate program, to develop/exchange/update all educational materials pertinent to the program, to conduct joint research and academic meetings pertinent to the program, and to enroll one medical physics resident in the Johns Hopkins Medical Physics Resident Program for graduates from the medical physics program at Howard University.

We expect such a framework will be continued and expanded after the proposed program is launched, which will contribute significantly to strengthening the capacity of Howard University to provide high-quality Medical Physics training.

F. Relevance to the identity of Historically Black Institutions (HBIs)

1. Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.

Among the current CAMPEP-accredited Medical Physics programs, there is no program from HBIs. Our current partnership with Howard University on their Master of Science (MS) degree in Medical Physics education will enhance the quality of their program, potentially making it the first CAMPEP-accredited Medical Physics program from an HBI, which will significantly increase the uniqueness of Howard University and its institutional identity. Further along this direction, the proposed PhD degree program at Johns Hopkins will contribute to the expansion of the Howard Medical Physics education program to the PhD level, again potentially being the first one among HBIs.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10):

1. **Describe how the proposed program was established, and also describe the faculty who will oversee the program.**

The program is established by core faculty from the Radiological Physics Division (RPD) of the Department of Radiology and Radiological Science, and the Medical Physics Division of the Department of Radiation Oncology and Molecular Radiation Sciences, both at the Johns Hopkins University School of Medicine. It is a collaboration of RPD with other divisions inside Radiology such as MRI, Nuclear Medicine, etc. The program will be administrated by the RPD.

The co-directors of the entire Medical Physics programs will be Dr. George Sgouros of Radiology and Dr. Xun Jia of Radiation Oncology.

The co-directors of the PhD program will be Dr. Katsuyuki Taguchi of Radiology and Dr. Kai Ding of Radiation Oncology. The members of the steering sub-committee and the PhD program committee are listed in Appendix A.

2. **Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.**

The educational objectives of the program are to prepare graduates for the field of medical physics and to become certified clinical physicists or academic/industry researchers. During the first two years, students will receive training in basic medicine, anatomy, physiology, and also related physics aspects. They will also receive training in equipment, instrumentation, and safety. Over the five years, each student will be required to propose a thesis research project and defend the thesis in the related field advised by one of the PhD faculty members of either the Department of Radiology or Radiation Oncology. The class will be face-to-face courses and individualized meetings with primary advisors. They will also receive training in ethics, research integrity, HIPPA, professional communication, and related topics that are important to clinical work and research.

3. **Explain how the institution will:**

    a) **provide for assessment of student achievement of learning outcomes in the program**

    School of Medicine's learning outcomes and assessment methods do not differ from peer PhD programs at Johns Hopkins.

    Upon completion of this degree, all graduates will have the knowledge and skills to:

    1. Participate actively and take initiatives in research activities promoting evidence-based practices through the application of rigorous methodology.
    2. Select and utilize techniques appropriate to the question asked, and collect data that is robust and reproducible.
    3. Demonstrate the skills to record and store accurate data in a matter that affords data validation when necessary.

4. Identify significant and original problems that will impact medical physics and biomedical science.
5. Create theoretical frameworks based on relevant literature and information from validated sources.
6. Apply appropriate data analytic techniques and interpret results correctly.
7. Provide leadership in the field by developing an independent line of ethical and culturally responsive research.
8. Demonstrate scholarly oral and written communication skills.
9. Engage in activities relevant to securing future employment in the field.
10. Demonstrate the depth and breadth of knowledge needed to make original contributions to the field.

Our assessment of student completion of these outcomes utilizes:

- Participation in mentored research work
- Coursework
- Written qualification examination of core courses
- Doctoral Board Oral examination
- Thesis preparation and defense
- Presentations
- Publications
- Grant preparation
- Individualized (professional) development plans

b) document student achievement of learning outcomes in the program

The primary advisor will document the student's progression through the program and their achievement of the learning outcomes. The primary advisor will discuss it with the student at least once a year, and they will send a co-signed report to the program administration office. Once the thesis committee is formed for the student, the committee will document the student's progress; the committee's decisions and actions will be documented in the committee note, which is filed in the program administration office. The link to JHU resources is here.

4. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements

A full course listing, with course titles, credits, and descriptions is provided in Appendix B.

Program Requirements

The proposed program will require successful completion of the following requirements. Full-time PhD students will complete the program in five years.

- Passing all 10 courses for a minimum of 36 credits by the end of Semester 4.

- Maintaining a GPA of at least 3.0
- Passing a Doctoral Board Oral (DBO) exam by the end of Semester 4
- Constituting a dissertation committee by the end of Semester 6
- Presenting a dissertation proposal by the end of Semester 7
- Passing progress review of dissertation committee every 6–12 months
- Writing and defending the dissertation

The below will be necessary for PhD students in the Clinical Medical Physics track:

- Passing the ABR Part 1 exam

5. Identify any specialized accreditation or graduate certification requirements for this program and its students.

Our Medical Physics MS degree program has been CAMPEP accredited on February 1, 2023. We will apply for the CAMPEP accreditation of this PhD program for the Medical Physics 2 years after the program starts. The PhD program will be given the initial status by CAMPEP, allowing graduating students to participate in certifying exams and resident program. After a three-period, the program will be fully certified. As our MS degree program has already been CAMPEP accredited, we fully expect that this PhD program will be accredited.

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6. **If contracting with another institution or non-collegiate organization, provide a copy of the written contract.**

   Not applicable.

7. **Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.**

A full description of the program, including its purpose and expected outcomes, admission requirements, course and degree requirements, tuition and fees, with links to general medical school and university websites with more information on academic support and financial aid support services will be given on our website.

Links to websites that provide information about student services, faculty / student interactions, financial aid, technical support and relevant websites.

Organization & governance
Johns Hopkins School of Medicine is made up of 30 Departments & Divisions. The Johns Hopkins Institute for Basic Biomedical Sciences includes nine basic science departments.

All of the graduate programs fall under the Vice Dean of Education in the School of Medicine. The Office oversees all the educational programs including the medical students, residents & clinical fellows, graduate students, postdoctoral research fellows, plus other learners in the

School of Medicine. Offices supporting graduate education in the School of Medicine include the following:

- Office of Academic Computing
- Office of Assessment and Evaluation
- Office of Financial Affairs (Business Office)
- Office of Financial Aid
- Office of Graduate Student Affairs
- Office of Information Technology
- Office of the Registrar
- Professional Development and Career Office

Johns Hopkins School of Medicine is committed to investing in graduate education.
Academic support websites include:

- Course catalog & course registration
- New Innovations
- Blackboard
- Student Information System (SIS)

- SIS Course search
- Support: Office of Academic Computing
- Technology support
- Welch Library access
- Welch Informationists

8. Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.

The description of the program on our website (once endorsement is received) will be listed as follows:

Doctor of Philosophy (PhD) in Medical Physics

<u>Purpose</u>
The Medical Physics program will provide aspiring students with the knowledge that they will need in their future profession as medical physicists. Our program leads to the Doctor of Philosophy (PhD), with emphasis on preparation for careers in academia, industry, and/or clinical support roles

<u>Program</u>
The program is designed for full-time students who wish to pursue a career as a medical physicist either as a researcher or a certified clinical profession. The program consists of two tracks—Clinical Medical Physics track and Research Medical Physics track—for the corresponding career. The admitted students will be directly matched to the lab of principal investigator (PI) with research projects under the PI's supervision. Switching tracks will be reviewed and approved the program committee. We anticipate that the proposed program, set to commence in fall 2025, will require successful completion of a minimum of 36 credits (18 core and rest elective), obtaining a medical physicist certificate (for Clinical Medical Physics track), proposing and defending a research thesis. Full-time PhD students will complete the program in five years. The course training is completed in years 1–2 and the CAMPEP accredited courses same as the MS program in addition to the research project under PI and Doctoral Board Oral (DBO) exam during this time. The research training will be performed in years 3–5, where the students will complete the ABR Part 1 exam (clinical track only), Annual Individual Development Plan (IDP), research project under PI, thesis committee meeting, and to write and defend thesis.

<u>Admission Requirements</u>
- For Clinical Medical Physics track: B.S. degree or B.A. degree in physics, applied physics, or one of the physical sciences, including physics training at least equivalent to a minor
- For Research Medical Physics track: B.S. degree or B.A. degree in physics, engineering, computer science, or related field
- General GRE exam scores and grade transcripts are required. The Physics GRE is recommended for Clinical Medical Physics track
- Proficiency at written and spoken English and a working knowledge of computer programming and probability and statistics are also required.

- A personal statement
- Three letters of recommendation

<u>Tuition and Fees</u>
The tuition will be waived by School of Medicine. The program via the primary advisor provides stipend of $37,600 per year and health and dental insurance ($5,400 per year).

<u>Contact Information</u>
Debbie Race (drace1@jhu.edu, 443-287-2425)

H. Adequacy of Articulation

1. If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.

Not applicable.

I. Adequacy of Faculty Resources (as outlined in COMAR 13B.02.03.11).

1. Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faulty member will teach (in this program).

The Department of Radiology at Johns Hopkins University received 26 million dollars from NIH research grant funds in 2021, which was ranked 5th in the U.S.A. Four Johns Hopkins Radiology PIs were ranked among the top 50 Radiology PIs receiving NIH funds. The Department of Radiation Oncology faculty routinely provides radiotherapy clinical services with state-of-the-art technologies including, but not limited to stereotactic body radiotherapy, proton therapy, brachytherapy etc, as well as conducting research funded by NIH. The faculty in both departments are qualified to teach medical physics curriculum. The main and critical part of PhD training is high quality research experiences, and there are abundant of world-class researchers in both Radiology and Radiation Oncology departments to supervise students in their research activities.

See Appendix A for a list of faculty who will oversee the proposed program. Each faculty is distinguished and experienced professionals and all have advanced degrees. The Executive Steering Sub-Committee consists of 4 Full professors and 2 Associate Professors. The program Committee consists of 13 members: 7 Full Professors, 3 Associate Professors, and 3 Assistant Professors. A list of faculty who wishes to become the primary advisors is provided in Appendix C (Table L3).

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2. **Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:**

   a) **Pedagogy that meets the needs of the students**

   Pedagogical performance of all faculty engaged in educational activities within the Johns Hopkins School of medicine is regularly assessed through student evaluations and faculty monitoring by department directors and education deans.

   All faculty supervising graduate students in the School of Medicine will participate in PhD mentor training developed by the Office of Faculty Development. Compliance is monitored by the Office of Assessment and Evaluation. All faculty are experienced instructors who are regularly evaluated via course and faculty evaluation process.

   b) **The learning management system**

   Blackboard is a university-wide learning management system designed to deliver fully online courses, as well as supplement courses taught in the face-to-face environment. Through the effective use of tools such as announcement, discussions, assignments, test and quizzes, journals, and wikis, instructor can create innovative and interactive learning environments for their students.

   c) **Evidenced-based best practices for distance education, if distance education is offered.**

   Not applicable as the program will only be offered in the face-to-face modality.

J. Adequacy of Library Resources (as outlined in COMAR 13B.02.03.12).

1. **Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for library resources to meet the program's needs.**

The Welch Medical Library serves the informational needs of the faculty, staff, and students of Johns Hopkins Medicine, Nursing and Public Health. The Welch Service Center provides in-person circulation and document retrieval, reference and searching assistance, and reserves services. Informationists offer a variety of professional tailored services, including individual and group consultations, searching-from general reference and evidence-based precision, to full-scale systematic review participation; citation management; curriculum, classroom and online instruction; and collaborations on grants and research projects from beginning to end, as they evolve. Informationists are experts at navigating the publishing landscape to respond to complex requests related to research impact, scholarly output and dissemination.

The library collects current scholarly information that supports the research, clinical, administrative, and educational needs of the Johns Hopkins School of Medicine, School of Nursing, School of Public Health, and Health System. Because the library's emphasis is on providing materials at point of need, the collection is primarily in electronic format. It covers health, the practice of medicine and related biomedical and allied health care disciplines, public health and related disciplines, nursing, research literature, methodological literature, reviews or state-of-the-art reports, and in-depth, authoritative analyses of areas influencing biomedicine and health care. The Welch online collection includes more than 7,200 electronic journals, over 400 databases, more than 13,000 e-books and more than 2,500 videos.

Johns Hopkins Medicine, Nursing, and Public Health users have access to both the print and online collections of the other Johns Hopkins libraries including over 150,000 journals and just under a million e-books. The William H. Welch Medical Library, located at 1900 East Monument Street, was founded in 1929 with the merger of three libraries: the School of Medicine, the School of Hygiene and Public Health, and Johns Hopkins Hospital. From its inception, the Library has been used by the faculty, students, and staff of the Schools of Medicine, Public Health, and Nursing as well as by the staff and attending physicians of the Johns Hopkins Hospital. In 2012, Library staff relocated to offices in the 2024 building and in the Mt. Washington campus. Today, the building houses the print collection of the Welch Medical Library, the offices, and collections of the Institute of the History of Medicine, as well as the Center for Computational Biology. Study space is available on the second floor of the library in the East and West Reading rooms as well as the central lobby.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment (as outlined in COMAR 13B.02.03.13)

1. **Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.**

Classroom space and technology infrastructure for existing and proposed new courses, including for lectures, small group activities, and laboratories are already available through facilities at all Johns Hopkins School of Medicine and School of Public Health campuses. Faculty members have their own laboratory spaces for research activities, which is spread over Johns Hopkins School of Medicine. Our newly renovated Johns Hopkins DC campus at 555 Pennsylvania Ave and our clinical training facility at the Johns Hopkins Sibley Memorial Hospital in DC and Suburban Hospital in Bethesda are also included in addition to the Baltimore facilities.

2. **Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:**

    a) **An institutional electronic mailing system, and**

Johns Hopkins utilizes Microsoft Teams and Outlook and has an extensive system of IT support. Students have email addresses assigned upon matriculation. However, this section is not applicable as this program will only be offered in the face-to-face modality.

b) A learning management system that provides the necessary technological support for distance education

Not applicable.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

The program expects six new students every year; the primary advisors of the students will provide the financial support, as outlined below. In addition, we provide in Appendix C a list of potential PIs, their recent track record of mentees' training, and their plan for 5 years.

1. **Complete Table 1: Resources and Narrative Rationale. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.**

TABLE 1: RESOURCES					
Fill in items highlighted in blue only					
Resources Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Reallocated Funds[1]	**0**	**0**	**0**	**0**	**0**
2. Tuition/Fee Revenue[2]	**30,000**	**61,800**	**95,400**	**130,800**	**168,000**
a. Annual Full-time Revenue of New Students	**0**	**0**	**0**	**0**	**0**
Number of Full-time Students	6	12	18	24	30
Annual Tuition Rate	$0	$0	$0	$0	$0
Subtotal Tuition	$0	$0	$0	$0	$0
Annual Fees	$5,000	$5,150	$5,300	$5,450	$5,600
Subtotal Fees	$30,000	$61,800	$95,400	$130,800	$168,000
Full-time Revenue of New Students	$30,000	$61,800	$95,400	$130,800	$168,000
b. Annual Part-time Revenue	0	0	0	0	0
Number of Part-Time Students	0	0	0	0	0
Credit Hour Tuition Rate	0	0	0	0	0
Annual Fees Per Credit Hour	0	0	0	0	0
Annual Credit Hours Per Student	0	0	0	0	0
Subtotal Tuition	$0	$0	$0	$0	$0
Subtotal Fees	$0	$0	$0	$0	$0
Total Part Time Revenue	$0	$0	$0	$0	$0
3. Grants, Contracts & Other Source	**$0**	**$0**	**$0**	**$0**	**$0**
4. Other Sources	**$0**	**$0**	**$0**	**$0**	**$0**
TOTAL (Add 1 - 4)	$30,000	$61,800	$95,400	$130,800	$168,000

1. Reallocated Funds: No reallocation of funds is necessary for this proposed program.
2. Tuition/Fee Revenue: Tuition will be waived by the School of Medicine.
3. Program support Revenue: The primary advisors of students will pay $5k per year per student to support the program. This will be the only resource to support the revenue of this program.
4. Grants, Contracts & Other External Sources: Not applicable
5. Other Sources: Not applicable

2. **Complete <u>Table 2: Program Expenditures and Narrative Rationale</u>. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each expenditure category.**

TABLE 2: EXPENDITURES					
Fill in blue shaded areas only.					
Expenditure (	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Total Facu	$47,880	$49,316	$50,796	$52,320	$53,889
(b + c below)	$0	$0	$0	$0	$0
a. #FTE	0.2	0.2	0.2	0.2	0.2
b. Total	36,000	37,080	38,192	39,338	40,518
c. Total	11,880	12,236	12,603	12,982	13,371
2. Total Admi	11,040	22,742	35,137	48,255	62,128
(b + c below)	0	0	0	0	0
a. #FTE	0.1	0.2	0.3	0.4	0.5
b. Total	8,000	16,480	25,462	34,967	45,020
c. Total	3,040	6,262	9,675	13,288	17,108
3. Total	0	0	0	0	0
(b + c below)	0	0	0	0	0
a. #FTE	0.0	0.0	0.0	0.0	0.0
b. Total	0	0	0	0	0
c. Total	0	0	0	0	0
4.	0	0	0	0	0
5. Library	0	0	0	0	0
6. New or	0	0	0	0	0
7. Other	11,000	11,000	11,000	11,000	11,000
TOTAL (1-7)	$69,920	$83,059	$96,933	$111,575	$127,017

1–4 reflect the administrative costs of the program.
6. Library: Existing Library facilities are sufficient to meet the needs of the program.
8. Other Expenses: advertising ($2,000); students campus visit ($1,000/student); students social events ($2,000); miscellaneous expenses related to instruction ($1,000)

M. Adequacy of Provisions for Evaluation of Program (as outlined in COMAR 13B.02.03.15).

1. Discuss procedures for evaluating courses, faculty and student learning outcomes.

Course evaluations accompany each course in the form of surveys given to students at the end of the course. These evaluations are designed and analyzed by the Office of Assessment and Evaluation in the School of Medicine. Faculty evaluation surveys are also completed by students and analyzed by the Office of Assessment and Evaluation in the School of Medicine.

2. Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.

We will focus on evaluating three major elements of the proposed program: (1) Admissions and individualized curriculum design; (2) curriculum; and (3) overall program.

Admissions and individualized curriculum design.

The executive steering sub-committee of the program will review the admissions process and elements considered during this process annually to determine the efficacy of the admissions process at identifying, recruiting, and selecting well-matched students for the program. Primary supervisors and students will have regular (e.g., at least annually) formal meetings to discuss program fit and modifications needed to provide students with the ability ot meet their program learning objectives. As part of this process, the primary supervisors will review student performance (e.g., grades) in curricular events and discuss with students the extent to which these data indicate modifications needed to the course selection and placement process. This information will be formally captured and retained by the program.

Curriculum.

The director of the program will have regular (quarterly) meetings with students to discuss progress through the program and any concerns regarding the curriculum. Student perspectives on the curriculum will also be obtained through formal evaluations of each course.

Overall program.

The program committee will perform annual reviews of the entire program to evaluate whether the curriculum is meeting program objectives, and to consider possible modifications based on course reviews and other student feedback. Program data such as time to completion, student retention, graduation rates, and publication metrics will be reviewed on an annual basis. Alumni reflections will be obtained through the JHU Doctoral Exit Survey, as well as through focus group or interviews in the years following graduation.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR 13B.02.03.05).

1. Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.

Johns Hopkins is a community committed to sharing values of diversity and inclusion in order to achieve and sustain excellence. We firmly believe that we can best promote excellence by recruiting and retaining a diverse group of students, faculty and staff and by creating a climate of respect that is supportive of their success. This climate for diversity, inclusion and excellence is critical to attaining the best research, scholarship, teaching, health care and other strategic goals of the Health System and the University. Taken together these values are recognized and supported fully by the Johns Hopkins Institutions leadership at all levels. Further, we recognize that the responsibility for excellence, diversity and inclusion lies with all of us at the Institutions: leadership, administration, faculty, staff and students. Specifically, we will seek development support so that we launch the program with substantial (if not full) tuition support for at least one position. We will also seek for administrative supplement from the National Institutes of Health for an R01 or U01 grant for the primary supervisors. The intent is to encourage financially disadvantaged or underrepresented candidates to apply and matriculate.

O. Relationship to Low Productivity Programs Identified by the Commission:

1. **If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.**

   Not applicable.

P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)

1. **Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.**

Not applicable as this program will only be offered in the face-to-face modality.

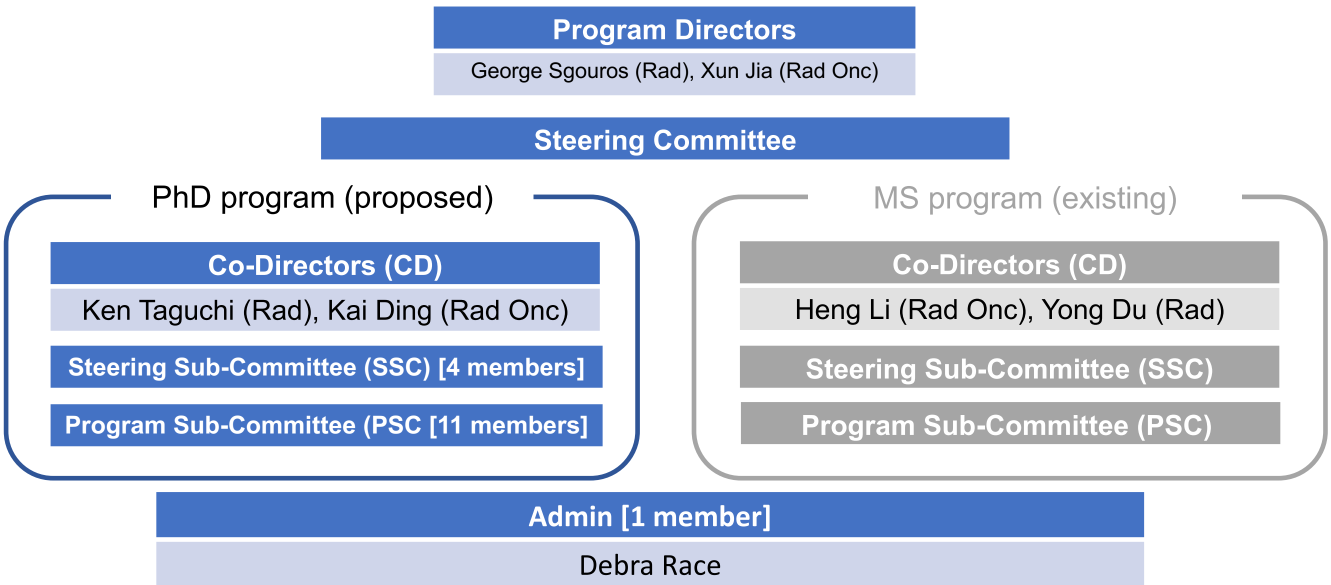
2. **Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.**

Not applicable as this program will only be offered in the face-to-face modality.

Appendix A:

Program organizational structure

The organizational structure of the entire Medical Physics program is shown below.



Committee members balanced among Radiological Phys division, Radiation Oncology Phys division, and MR division

Medical Physics Programs Directors

Faculty	Rank	Discipline	Status	Role	Degree
Sgouros, George	Professor	Radiology and Radiological Science	Full-time	Director	Ph.D.
Jia, Xun	Associate Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Co-Director	Ph.D.

Directors and committee members of the proposed PhD in Medical Physics program are shown below.

Medical Physics PhD program Directors

Faculty	Rank	Discipline	Status	Role	Degree
Taguchi, Katsuyuki	Professor	Radiology and Radiological Science	Full-Time	Director	Ph.D.
Ding, Kai	Associate Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Co-Director	Ph.D.

Medical Physics PhD program Executive Steering Sub-Committee

Faculty	Rank	Discipline	Status	Role	Degree
Taguchi, Katsuyuki	Professor	Radiology and Radiological Science	Full-Time	Director	Ph.D.
Ding, Kai	Associate Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Co-Director	Ph.D.
Du, Yong	Associate Professor	Radiology and Radiological Science	Full-Time	Executive Steering Committee	Ph.D.
Lu, Hanzhang	Professor	Radiology and Radiological Science	Full-Time	Executive Steering Committee	Ph.D.

Medical Physics PhD program Committee

Faculty	Rank	Discipline	Status	Role	Degree
Taguchi, Katsuyuki	Professor	Radiology and Radiological Science	Full-time	Director	Ph.D.
Ding, Kai	Associate Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Co-Director	Ph.D.
Du, Yong	Associate Professor	Radiology and Radiological Science	Full-Time	Executive Steering Committee	Ph.D.
Lu, Hanzhang	Professor	Radiology and Radiological Science	Full-Time	Executive Steering Committee	Ph.D.
Barker, Peter	Professor	Radiology and Radiological Science	Full-Time	Program Committee	Ph.D.
Van Zijl, Peter	Professor	Radiology and Radiological Science	Full-Time	Program Committee	Ph.D.
Knutsson, Linda	Professor	Radiology and Radiological Science	Full-Time	Program Committee	Ph.D.

Xu, Jingyan	Assistant Professor	Radiology and Radiological Science	Full-Time	Program Committee	Ph.D.
Yusufaly, Tahir I	Assistant Professor	Radiology and Radiological Science	Full-Time	Program Committee	Ph.D.
Lee, Junghoon	Associate Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Program Committee	Ph.D.
Rezaee, Mohammad	Assistant Professor	Radiation Oncology and Molecular Radiation Sciences	Full-Time	Program Committee	Ph.D.

A list of potential PhD students' advisors is presented in Appendix C.

Appendix B:

Course List and Descriptions

https://www.hopkinsmedicine.org/radiology/education/ms_medical_physics/index.html

Core Medical Physics Courses (20 Credits)
All MP students are required to take the following courses (per CAMPEP).

ME 420.702 Radiological Physics and Dosimetry (3 cr)
Robert Hobbs, Ph.D. *et al*
Course covers the fundamental physics behind radiation production and interaction, including a review of pertinent mathematics, classical mechanics, and nuclear physics. Topics covered: radioactive decay, radiation producing devices, characteristics of different types of radiation, mechanisms of radiation interaction, and essentials of the determination of absorbed doses.

ME 420.703 Radiation Therapy Physics (3 cr)
Robert Hobbs, Ph.D. *et al*
Course will provide a comprehensive survey of basic radiotherapy physics, fundamental radiation therapy, and contemporary radiation therapy. Topics to be covered include: external beam radiation therapy, brachytherapy, and special procedures. Image guidance methods will be discussed as well as patient and machine quality assurance.

ME 420.704 Radiation Protection and MR Safety (3 cr)
Mahadevappa Mahesh, Ph.D.
Course covers the fundamental principles of radiation protection and safety. Topics covered include: principles of radiation protection, radiation units, radiation measurements, practical aspects of the use of radionuclides, ionizing radiation and public health, regulations regarding radiation protection, and radiation shielding of x-ray facilities.

ME.420.705 Medical Physics Seminar (.5 cr)
Heng Li, Ph.D.

ME 420.706 Radiation Biology (3 cr)
Tahir Yusufaly, Ph.D.
Course covers the current state-of-the-art knowledge of the biological consequences of ioning radiation at multiple length and time scales, including molecular, cellular, whole-body, and population effects, as well as how this knowledge relates to and is continually informed by applications in radiation therapy and radiation safety.

ME.420.707 Nuclear Medicine Imaging (3 cr)
Yong Du, Ph.D., Martin Lodge, Ph.D.

ME.420.709 Radiopharmaceutical Therapy
George Sgouros, Ph.D. *et al*

ME.420.710 Medical Imaging Systems (3 cr)
Linda Knutsson, Ph.D.

This course gives the student an introduction to the fundamentals of the most-important clinical medical imaging modalities: X-ray, Mammography, Computed Tomography, Ultrasound, Nuclear Medicine, and MRI. Students will gain a basic understanding of the physical principles, instrumentation design, and imaging algorithms of these systems. They will be able to discuss the relative strengths and weaknesses of the various medical imaging modalities. Students will gain knowledge of the most common clinical uses of each imaging technique.

PH 183.631 Fundamentals of Human Physiology (4 cr)
Mark Kohr, Ph.D., Wayne Mitzner, Ph.D.
Provides an in-depth view of integrated human systems physiology by covering the key aspects of a number of different organ systems. Offers a unique perspective on physiology by incorporating environmental, clinical and public health aspects, where possible.

Research Ethics *University Requirement for graduation; no credit*
All graduate students must receive training in the Responsible Conduct of Research (RCR).

Other Required Courses (6 Credits)
All MP students are required to take the following additional courses.

ME.420.707 Nuclear Medicine Imaging (3 cr)
Course covers the physics and methodology aspects of Nuclear Medicine imaging and Positron Emission Tomography.

ME.420.709 Radiopharmaceutical Therapy (3 cr)
Learn about radiopharmaceutical therapy imaging, dosimetry and radiobiology by pretending you are a medical physicist tasked with helping your physician optimize different RPTs and identify the best and most logistically feasible way to treat patients with RPTs. The course is less lecture and more collaborative problem-based learning.

Elective Courses (6 Credits)
Students shall take 6 (or more) additional credit hours from the following list of courses or other courses as approved by the Program Director.

SoM Medical Physics (Homewood campus and EB campus)

- EN 520.623. Medical Image Analysis (3 cr) Jerry Prince, Ph.D.
- EN 520.631. Ultrasound and Photoacoustic Beamforming (3 cr) Muyinatu Bell, Ph.D.
- EN.520.659 Machine Learning for Medical Applications (3 cr) Laureano Moro Velazquez, Ph.D.

PH Biostatistics (EB campus)

- SPH.140.615 Statistics for Laboratory Scientists I (4 cr) Ingo Ruczinski, Ph.D.
- SPH 140.615 Statistics for Laboratory Scientists II (4 cr)) Ingo Ruczinski, Ph.D.
- SPH 140.651 Methods in Biostatistics I (4 cr) Ciprian Crainiceanu, Ph.D.

Biomedical Engineering (Homewood campus)

- EN.580.640 Systems Pharmacology and Personalized Medicine (4 cr) Feilim Mac Gabhann, Ph.D

- EN.580.674 Introduction to Neuro-Image Processing (3 cr) Siamak Ardekani, Ph.D.
- EN.580.679 Principles and Applications of Modern X-ray Imaging and Computed Tomography (3 cr) Wojciech Zbijewski, Ph.D.
- EN.580.693 Imaging Instrumentation (4 cr) Web Stayman, Ph.D.

Electrical and Computer Engineering (Homewood campus)

- EN.520.623 Medical Image Analysis (3 cr)
- EN.520.631 Ultrasound and Photoacoustic Beamforming (3 cr)
- EN.520.659 Machine Learning for Medical Applications (3 cr)

Appendix C:

Course Instructor List

A list of instructors for required courses:

Faculty	Faculty title	Degree	Degree field	Course(s) taught
Robert Hobbs	Associate Professor	Ph.D.	Medical Physics	ME 420.702 Radiological Physics and Dosimetry; ME 420.703 Radiation Therapy Physics
Mahadevappa Mahesh	Professor	Ph.D.	Medical Physics	ME 420.704 Radiation Protection and MR Safety
Heng Li	Associate Professor	Ph.D.	Medical Physics	ME.420.705 Medical Physics Seminar
Tahir Yusufaly	Assistant Professor	Ph.D.	Physics	ME 420.706 Radiation Biology
Yong Du	Associate Professor	Ph.D.	Physics	ME.420.707 Nuclear Medicine Imaging
George Sgouros	Professor	Ph.D.	Medical Physics	ME.420.709 Radiopharmaceutical Therapy
Linda Knutsson	Professor	Ph.D.	Medical Physics	ME.420.710 Medical Imaging Systems

A list of instructors for elective courses:

Faculty	Faculty title	Degree	Degree field	Course(s) taught
Jerry Prince	Professor	Ph.D.	Physics	EN 520.623. Medical Image Analysis
Muyinatu Bell	Associate Professor	Ph.D.	Electrical Engineering	EN 520.631. Ultrasound and Photoacoustic Beamforming
Laureano Moro Velazquez	Assistant Research Professor	Ph.D.	Electrical Engineering	EN.520.659 Machine Learning for Medical Applications
Feilim Mac Gabhann	Associate Professor	Ph.D.	Biomedical Engineering	EN.580.640 Systems Pharmacology and Personalized Medicine
Siamak Ardekani	Lecturer	M.D., Ph.D.	Biomedical Engineering	EN.580.674 Introduction to Neuro-Image Processing
Wojciech Zbijewski	Associate Professor	Ph.D.	Physics	EN 580.679 X-ray Imaging and Computed Tomography
J. Webster Stayman	Associate Professor	Ph.D.	Electrical Engineering	EN 580.693 Imaging Instrumentation
Ingo Ruczinski	Professor	Ph.D.	Biostatistics	SPH 140.615 Statistics for Laboratory Scientists I; SPH 140.615 Statistics for Laboratory Scientists II
Ciprian Crainiceanu	Professor	Ph.D.	Biostatistics	SPH 140.651 Methods in Biostatistics I

A list of primary advisors for research activities:

Katsuyuki “Ken” Taguchi, Ph.D., Professor

Funding source	Grant number	Research Projec Title
Siemens	JHU-2021-CT-01-01-TAGUHI_C002	Photon Counting CT Project Neuro Phase 5
NIH	R21 EB029049	Intra-operative 4-D soft tissue perfusion using no gantry rotation (IPEN)
NIH	R21 EB029739	Quasi-Ideal Photon Counting X-ray CT with Multi-Energy Inter-Pixel Coincidence Counter (MEICC)
NIH	R01 NS126256	Assessing brain perfusion using IPEN during intra-arterial stroke intervention
Canon	PD 157523	Spectral distortion correction for photon counting CT using parallel processing of detector energy channels
Siemens	JHU-2023-CT-01-01-TAGUCHI_00074699	JHU_Taguchi_High_Reso_Combination_CT

Hanzhang Lu, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R01NS106702	An integrated vascular MR imaging suite in brain diseases
NIH	R01NS106711	MR fingerprinting (MRF) perfusion imaging in cerebral vascular disease
NIH	R01AG064792	Non-contrast MR imaging of blood-brain-barrier permeability in Alzheimer's disease
NIH	RF1AG071515	Blood-brain barrier dysfunction in Alzheimer's disease: from humans to animal models
NIH	UF1NS100588	Validation of small vessel vascular contributions to cognitive impairment and dementia (VCID) biomarkers
NIH	P41EB031771	MRI Resource for Physiologic, Metabolic and Anatomic Biomarkers

Hye-Young Heo, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	R01EB029974	Chemical Exchange Saturation Transfer MR Fingerprinting
NIH	R01NS112242	Ultrafast Quantitative pH MRI for Acute Ischemic Stroke Patients

Jeff Bulte, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NMSS	RG 4994-A-3	Immunomodulation and remyelination by transplanted stem cells and progenitors: A two-pronged approach

Maryland Stem Cell Research Fund	MSCRFII-1706	Development of imaging biomarkers for stem cell transplantation in amyotrophic lateral sclerosis
Maryland Stem Cell Research Fund	MSCRFD-3899	Non-invasive imaging of hydrogel scaffold biodegradation and cell survival
NIH	R24 MH109085	VIrtual Brain Electrode (VIBE) for imaging neuronal activity
Amyotropic Lateral Sclerosis Association	ALSA 16-IIP-252	Immunomodulation and glia restoration by transplanted stem cells: Use of novel imaging biomarkers
NIH	R56 NS098520	A multimodal MRI approach for probing ALS pathophysiology and neurorepair
NMSS	PP-1901-33148	OnVDMP CEST MRI detection of primary CNS metabolites as a novel imaging. biomarker for EAE disease progression
NIH	R01 DK106972	Dual-mode MRI for in vivo sensing of microcapsule stability and biocompatibility
NIH	S10 OD026740	Magnetic particle imaging scanner
NMSS	RFA-2104-37460	MALDI identification of CEST MRI biomarkers that may precede and predict the onset of disease in MS.
NIH/NIBIB	UH2/UH3 EB028904	Non-invasive tracking of genome-corrected iPS cells in ALS
NIH/NIBIB	R01 EB030376	Intracellular self-assembly of theranostic nanoparticles for enhanced imaging and tumor therapy
NIH/NIBIB	R01 EB023647	Label-free imaging of composite hyaluronic acid hydrogels in regenerative medicine
NIH/NCI	R01 CA257557	Precision magnetic hyperthermia by integrating magnetic particle imaging
Maryland Stem Cell Research Fund	MSCRFD-5416	Developing MPI for tracer-based, non-radioactive, and quantitative whole-body imaging of cell delivery
Philips Healthcare		Developing cell tracking with MPI
NIH/NIBIB	P41 EB024495	Resource for molecular imaging agents in precision medicine
NovaDip Biosciences SA		Non-invasive imaging studies of NVD003

Jiadi Xu, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	R01 AG080104-01	Cerebrospinal fluid exchange in Alzheimer's disease characterized by advanced MRI techniques

NIH	1R01HL149742-01A1	MRI based phosphocreatine mapping method to assess patients with peripheral arterial disease
NIH	R21AG074978	Altered pH in early Alzheimer's disease detected by creatine chemical exchange saturation transfer MRI

Yong Du, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	R01NS094227	Optimization and Validation of Improved Quantitative I-123 Brain SPECT Imaging
NIH	R01 EB031023	Hyperspectral Single Photon Imaging of Targeted Alpha-Emitters
NIH	R01EB031023-02W1 supplement	Hyperspectral Single Photon Imaging of Targeted Alpha-Emitters
NIH	U01 EB031798	High Energy and Spatial Resolution Multi-Isotope SPECT Imaging of Targeted Alpha- Emitters and Their Daughters
NIH	U01 CA140204	Multi-modality Quantitative Imaging for Evaluation of Response to Cancer Therapy
NIH	R01 CA239041	Alpha-Particle Emitter Radiopharmaceutical Therapy for Liver Cancer

George Sgouros, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R01CA184228	Small Molecule PSMATargeted Alpha Therapy
NIH/NCI	R01CA187037	Combined Biologic and Radiopharmaceutical Therapy of Breast Cancer
NCI	75N91019C00040	Treatment optimization by combined alpha-emitter (alphaRPT)/ /radiotherapy (XRT) dosimetry for prostate cancer patients
NIBIB	R01EB013558	Dose Reduction in Pediatric Molecular Imaging
NCI	R01CA116477	Dose-Response in Radionuclide Therapy
NCI	R01CA240779	Combination Radiopharmaceutical Therapy and External Beam Radiotherapy
NIH	R01EB031023	Hyperspectral Single Photon Imaging of Targeted Alpha-Emitters
NIH	U01EB031798	High Energy and Spatial Resolution Multi-Isotope SPECT Imaging of Targeted Alpha-Emitters and their Daughters

Kristine Glunde, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R01CA213428	Molecular studies of the MR-detectable oncometabolite glycerophosphocholine

NIH	R01CA213492	Hypoxia-derived molecular MSI signatures to predict breast cancer outcome
NIH	S10OD030500	timsTOF fleX with MALDI-2 for advanced mass spectrometry imaging
NIH	R01CA264901	Reprogramming of creatine metabolism in breast cancer metastasis
NIH	P30CA006973	Mass spectrometry molecular imaging and multi-omics
NIH	R01AG078830	Imaging mass spectrometry-based metabolomic analysis of the Alzheimer's brain

Xun Jia, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
CPRIT	RP200573	Low-cost and non-conventional ultra-low-field MRI for the next-generation MR-guided radiation therapy
CPRIT	RP160661-4	Monte Carlo based biological treatment plan optimization
NIH	R37CA214639-S1	Diversity supplement, Next generation small animal radiation research platform
NIH	R01EB032716	Adversarially Based Virtual CT Workflow for Evaluation of AI in Medical Imaging
NIH	R01CA227289	Precise image guidance for liver cancer stereotactic body radiotherapy using element-resolved motion-compensated cone beam CT
NIH	R37CA214639	Next generation small animal radiation research platform
NIH	R01CA237269	Intelligent treatment planning for cancer radiotherapy
NIH	R01CA254377	Human-like automated radiotherapy treatment planning via imitation learning

James J. Pekar, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R21 EB030009	Gastric Electrical Slow Wave Functional MRI of the Human Brain
NIH	U01DA55350	Healthy Brain and Child Development National Consortium
NIH	R44 MH121276	Solving the MRI motion problem with Framewise Integrated Real-Time MRI Monitoring (FIRMM) software
NIH	FIRMM 2	Motion-robust brain MRI for infants

Ann S. Choe, Ph.D., Assistant Professor

Funding source	Grant number	Research Projec Title
NIH	R21 NS104644	Cortical functional connectivity as an early biomarker of recovery in spinal cord injury

Johns Hopkins	47	Cortical functional connectivity as an early biomarker of recovery in spinal cord injury

Manisha Aggarwal, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	R21 NS096249	Oscillating gradient diffusion MRI and quantitative susceptibility mapping in the epileptogenic brain
	R01 AG057991	Imaging platform and computational HARDI atlas of the human hippocampus

Xu Li, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	R01AG063842	Contribution of Cerebral Iron Load to Cognitive Function in Older Adults with High Risk to Develop Alzheimer's Disease

Peter van Zijl, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R01CA166171	Academic-Industrial Partnership to Develop Clinical Brain Cancer Imaging
NIH	R01EB019934	Development and Translation of D-glucose as a Diagnostic Agent for MRI of Cancer
NIH	S10OD021648-01	State of the Art 3T Research Scanner
NIH	R01EB015032-Yrs1-8*	Novel Approaches for CEST Labeling, Detection, Quantification and Translation
NIH	R01EB015032-Yrs5-8*	Novel Approaches for CEST Labeling, Detection, Quantification and Translation
NIH	P41EB015909; yrs1-20*	Resource for Quantitative Functional MRI
NIH	P41EB015909-yrs16-20*	Resource for Quantitative Functional MRI
NIH	P50 HD103538	Intellectual and Developmental Disabilities Research Centers 2020
NIH	P41EB031771	MRI Resource for Physiologic, Metabolic and Anatomic Biomarkers

Tahir Yusufaly, Ph.D., Assistant Professor

Funding source	Grant number	Research Projec Title
SNMMI	Mitzi and William Blahd, MD Pilot Research Grant	Biophysical techniques for the refinement of radiopharmaceutical imaging and dosimetry

Wilfred Ngwa, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	5R01CA239042-03	Biomaterial Drones for Image-Guided Drug Delivery during radiotherapy

NIH	1R42CA272056-01	Radio-immunotherapy dose-painting (RAID) treatment for hormonal resistant prostate cancer

Junghoon Lee, OPh.D., Associate Professor

Funding source	Grant number	Research Projec Title
Canon		Big data and decision support for radiation treatment of lung cancer
Rayence		Development of a software-based x-ray scatter correction algorithm for digital radiography
AHN-Hopkins		Develop and validate nodule probability of malignancy score Pm for lung cancer early diagnosis
Rad Onc Discovery Fund		Predicting radiation-induced toxicity by quantitative radiation dose and multimodal image feature analysis in head and neck radiotherapy
Varian		Personalized treatment planning to mitigate the risk of treatment-related xerostomia in head and neck cancer radiotherapy
NIH	U01NS107133	Imaging, guidance, and QA for emerging high-precision neurosurgical techniques
NIH	R01CA237005	Changing brachytherapy with MRI remnant-tumor segmentation and active-catheter placement
NIH	R37CA229417	Spacer enabled robust radiation therapy (SERRT)
NIH	R01CA151395	PET-determined prostate brachytherapy dosing using intraoperative image-guidance
Canon		Establishing effectiveness of neoadjuvant radiation therapy for chordoma using personalized biomarkers
KIAT		Integration of novel wearable monitoring devices with artificial intelligence technology for scalable cardiopulmonary management
Commonwealth		Improving the reproducibility of biological dose delivered by proton radiotherapy using artificial intelligence and longitudinal plan quality assessment
Rad Onc pediatric program		Pediatric radiation therapy (Radiation Oncology internal program)

Kai Ding, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
Micropos		Imaging guidence for prostate SBRT
NIH	R37CA229417	Spacer enabled robust radiation therapy (SERRT)
Elekta		Optimizing Advanced Image Guidance and Treatment Solutions for Radiation Therapy in China

Mohammad Rezaee, Ph.D., Assistant Professor

Funding source	Grant number	Research Projec Title
ASTRO-AAPM		FLASH radiotherapy of murin eye model

NIH	R01 CA262097	An ultra-high (FLASH) dose rate x-ray cabinet system for pre-clinical laboratory radiation research
AHN	80058649	FLASH Radiotherapy for Preclinical Pancreatic Tumors: A Novel Therapeutic Modality to Enhance Survival of Pancreatic Cancer Patients
Hopkins (De'Weese Innovation)	80058779	Radiation-activated immune responses by spatial and temporal modulation of kV x-ray beam: A radiation research platform for pre-clinical studies

Robert Ivkov, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH/NCI	R01 CA194574	Enhancing liver cancer treatment with image-guided magnetic hyperthermia
JKTG Foundation	N/A	Nanoparticles and their targeting in preclinical models
DoD CDMRP PCRP	CDMRP PC140189	Immune-stimulating combinatorial therapy for prostate cancer
NIH/NCI	R01 CA247290	Translational application of magnetic hyperthermia therapy with adjuvant therapies for glioblastoma
NIH/NCI	R01 CA257557	Precision magnetic hyperthermia by integrating magnetic particle imaging
NIH	R01 DK135399	Image-guided bariatric arterial embolization (BAE) for the treatment of obesity
JKTG Foundation	N/A	Development of a cancer immune therapy paradigm with iron oxide nanoparticles
AHN	N/A	Neoadjuvant nanoparticle therapy with combination radio-immunotherapy for pancreatic cancer

Tom Hrinivich, Ph.D., Assistant Professor

Funding source	Grant number	Research Projec Title
AAPM	90090293	Artificial intelligence-based decision support to improve the reproducibility of metastasis-directed therapy for oligometastatic prostate cancer
The Commonwealth Fund	80059339	Improving the reproducibility of the biological dose delivered by proton radiotherapy using artificial intelligence and longitudinal plan quality assessment

Xu Li, Ph.D., Associate Professor

NIH	R01AG063842	Contribution of Cerebral Iron Load to Cognitive Function in Older Adults with High Risk to Develop Alzheimer's Disease

Guanshu Liu, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title

NIH	R01CA211087	Noninvasive prediction of tumor response to gemcitabine using MRI
NIH	R21CA215860	CEST MRI assessment of tumor vascular permeability using non-labeled dextrans
NIH	R01CA261974	Multimodal MRI for guiding bacterial cancer therapy
NIH	R33HL161756	MPI/MRI bimodal imaging for non-invasive tracking of extracellular vesicles targeted to infarcted myocardium

Shanshan Jiang, Ph.D., Assistant Professor

Funding source	Grant number	Research Projec Title
JHU		Johns Hopkins University Provost's Post-doctoral Fellowship
NIH	R37 CA248077	Quantitative CEST MRI for GBM Early Response Prediction and Biopsy Guidance

Jinyuan Zhou, Ph.D., Professor

Funding source	Grant number	Research Projec Title
NIH	R01 CA166171	Academic-Industrial Partnership to Develop Clinical Brain Cancer Imaging
NIH	R01 CA228188	Amide Proton Transfer (APT) MRI of Brain Tumors at 3T
NIH	UG3/UH3 NS106937	Development of Novel Functional Markers for TBI Using Molecular MRI
NIH	R01 AG069179	Developing Protein-based MRI Biomarkers for Alzheimer's Disease

Jun Hua, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title
NIH	1R01NS108452	Imaging small blood and lymphatic vessel abnormalities of the olfactory system in schizophrenia
NIH	1R01AG064093	Advanced MR Imaging of Olfactory Impairment in Prodromal Alzheimer's Disease
NIH	1R01NS120879	Advanced MRI studies of cerebrovascular and lymphatic abnormalities in LRRK2 mouse models of Parkinson's disease
NIH	R01 AG082257	Interaction between microvascular function and CSF clearance in Lewy body dementia
NIH	1 U01 NS122764	A Placebo-Controlled Effectiveness in INPH Shunting (PENS) Trial

Nirbhay Yadav, Ph.D., Associate Professor

Funding source	Grant number	Research Projec Title

NIH	R21EB025295	MRI Imaging of receptor binding
NIH	R01NS127280	Non-Invasive Imaging of Neurological Glycogen Storage Disease
Ultragenyx		MRI Imaging glycogen storage disease