Medical University of South Carolina

College of Graduate Studies &
Center for Biomedical Imaging

Proposed New Program

Ph.D. in Biomedical Imaging

Submitted January 15th, 2014

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New Program Proposal: Ph.D. in Biomedical Imaging

Program title:	Ph.D. in Biomedical Imaging
Concentrations, options, and tracks:	Post-Baccalaureate
Academic Unit:	College of Graduate Studies
Designation, type, and level of degree:	Entry-level doctoral degree
Proposed date of implementation:	Fall 2015
CIP code:	26.1103
Site:	Medical University of South Carolina (MUSC)
Qualifies for Palmetto Fellows or Life Scholarship awards:	No
Delivery mode:	Traditional

INSTITUTIONAL APPROVAL
This proposal has been reviewed and approved by the following internal review bodies at MUSC:
College of Graduate Studies (CGS) Graduate Council – August 30th, 2013
MUSC Dean's Council –September 16th, 2013
MUSC Board of Trustees –will be presented to the BOT at its meeting in Feb. ,2014

PURPOSE

Mission

> The **MUSC Biomedical Imaging Ph.D. Program** proposes to provide a comprehensive and integrated graduate training program with a curriculum covering imaging science and biomedical applications leading to a Ph.D. in Biomedical Imaging. Our faculty has identified a basic core of knowledge and skills which will prepare our graduates to become leaders in basic and/or clinical research in biomedical imaging and its applications. This core consists of a strong foundation in the fundamentals of image acquisition technologies and data analysis methods. The students will also receive training in research practice, experimental design, and the application of specific imaging modalities through a series of individual electives in their chosen area of interest.

Although many biomedical imaging-related doctoral programs train students to be experts in specific techniques, there is a growing need for expertise in the application of these imaging technologies to solve important biomedical problems. The Bureau of Labor Statistics estimates that nationally, "Employment of biomedical engineers is projected to grow by 62% from 2010 to 2020, much faster than the average for all occupations" (http://www.bls.gov/ooh/architecture-and-engineering/biomedical-

engineers.htm). Further, the South Carolina Department of Employment and Workforces estimates that by 2020 employment of biomedical engineers will grow in South Carolina by 75%. (http://lmi.dew.sc.gov/lmi%20site/Documents/CommunityProfiles/01000000.pdf) These employment opportunities will create demand for a wide variety of engineering skills including digital imaging, an increasing component of all aspects of modern technology. Thus, as healthcare, biomedical research, and biotechnology industries become increasingly invested in using imaging technologies, the demand for individuals with expertise in the appropriate applications of these tools and skills to develop their novel use will necessarily grow.

No university in South Carolina offers a graduate degree in Biomedical Imaging at either the M.S. or Ph.D. level. Although both M.S. and Ph.D. programs are ultimately needed, we propose to initially establish a new program for a Ph.D. in Biomedical imaging and will independently address the need for an M.S. degree in Biomedical Imaging in the future. While both degrees would enable a graduate to work in industry and academia at advanced levels, the Ph.D. is specifically designed to establish its graduates as independent, creative scientists able to drive innovation in the field. Establishing this program falls within the mission of MUSC to "educate students to become creative biomedical scientists" and addresses its strategic initiative area of innovation.

The objectives of the program are to:

1. Provide a broad-based educational program for our students with both didactic and practical research experience with sufficient instruction in advanced technology, and analysis methods to enable them to become independent research scientists, application innovators, and bioimagining experts.
2. Prepare students with the skills and expertise to meet the increasing need for individuals in biomedical imaging that have a broad background in both theory and application.
3. Prepare our graduates for productive and successful careers in the imaging related aspects of biomedical research and development by developing their independent research skills.
4. Provide appropriate employment opportunities for our graduates by developing industrial and academic connections to organizations using imaging in their products and research. We expect that our graduates will have the education and skills to assume leadership roles in their future employment.

JUSTIFICATION

Program Description

The **MUSC Biomedical Imaging Ph.D. Program** will provide a comprehensive and integrated graduate training program combining biomedical sciences through the College of Medicine's core curriculum, with a strong emphasis on imaging science and its biomedical applications leading to a Ph.D. in Biomedical Sciences with a concentration in Biomedical Imaging. This degree will provide students with the education and training needed to pursue careers applying cutting edge developments in biomedical imaging to solving scientific and healthcare problems within academia or industry. It is intended for students with Bachelor's degrees or advanced pre-doctoral students who wish to master biomedical imaging and research methods to enhance or broaden their application-oriented investigations.

The core curriculum is designed to provide a strong foundation in the fundamentals of imaging acquisition technologies, data analysis methods, and research design, all within the context of applying these techniques in clinical and basic research projects in academic and industrial medical and research settings. Through this program, students will be able to gain hands-on experience with advanced imaging systems dedicated to both preclinical (bioluminescence, fluorescence, Micro-CT/PET, 7T MRI) and human (3T MRI) research. The students will have opportunities to rotate as research assistants in laboratories of professors who actively conduct research within many departments throughout the university, such as Neurosciences, Psychiatry, Radiology, Rehabilitation, Cardiology, Pediatrics, Surgery, and Oncology. The students will be required to demonstrate scientific proficiency in the area of biomedical sciences, with an emphasis on biomedical imaging through the completion of a qualifying examination and an individual doctoral dissertation.

Upon the completion of this degree, graduates will have the foundation on which they can build careers as independent investigators or key collaborators who possess a unique combination of skills: a fund of technical knowledge of imaging sciences and its most critical innovations as well as a distinct perspective that is focused on applying these advances in biomedical imaging to a breadth of preclinical and human research areas, from basic physiological processes to phenotypically complex diseases.

Need for the Proposed Program

Biomedical imaging is an inherently multidisciplinary field requiring the expertise of clinicians, medical physicists, computer scientists, biomedical engineers, chemists, pharmacologists, and biologists. This interdisciplinary group has and will continue to revolutionize healthcare by develop new technological tools and techniques to use in the detection, diagnosis, and treatment of human disease (1).
The utilization of imaging across multiple biomedical disciplines will drive the development of a well-educated and highly trained work force using new biomedical imaging tools and techniques. This growing work force will apply these tools and techniques in different applications from the organ level to the cellular level in manufacturing, laboratory, and clinical domains. MUSC recognized the need to strengthen the biomedical imaging research community at MUSC and in 2011 the Board of Trustees established the Center for Biomedical Imaging (CBI). The mission of the CBI is to provide state-of-the art imaging resources, train and mentor young investigators, and provide opportunities for basic and clinical scientists to collaborate on new biomedical imaging discoveries (3).

The primary rationale for the development of a Ph.D. program in Biomedical Imaging at MUSC is to develop a structured group of faculty, graduate students, post-docs and research staff who will focus on the application of biomedical imaging tools in laboratory and/or clinical settings in Neuroscience, Radiology, Pathology, and Psychology. MUSC has active clinical and basic science research programs in these departments so advanced image acquisition and image analysis skills will provide a strong complementary component to the MUSC research and educational mission. . With graduate students, medical students, faculty and staff trained in biomedical imaging tools and techniques and exposed to industrial and other academic research institutional partners, the biomedical imaging-based laboratories at MUSC will have a pool of talented individuals that will lead in the development of novel biomedical imaging tools and techniques. A formal Ph.D. program will strengthen the research competitiveness of MUSC across these disciplines and lead to more technological innovation in the State ultimately contributing to the creation of more knowledge-based companies and employment opportunities in South Carolina.

The multidisciplinary nature of biomedical imaging results in a variety of career path options for holders of these degrees. While many will seek employment as medical scientists, biomedical engineers, biophysicists, medical physicists, or biochemists in academia, government, or industry, there are also many biomedical imaging Ph.D.s who will work in industry or manufacturing in product development, venture capital, and marketing; as well as in legal fields such as regulatory, technology transfer, and patent law. According to the Bureau of Labor Statistics 2012-2013 Occupational Outlook

Handbook these are professions that can expect better than average increases in employment through 2020 across the nation (2).

Centrality of the Program to the Institutional Mission

The proposed **MUSC Biomedical Imaging Ph.D. Program** supports the mission of MUSC in several ways: 1) fostering an inter-professional educational experience; 2) advancing economic development through the introduction of new biomedical imaging technology; and 3) building collaborations with industry and other academic institutions (4).

The **Biomedical Imaging Ph.D. Program** will be offered through the MUSC College of Graduate Studies and will include the core coursework of the Biomedical Sciences Program. The core classes will expose these students to the scientific skills necessary to function in laboratory settings. The mathematical and statistical classes contained in the program's curriculum will expose students to the fundamentals of image formation, acquisition, and analysis techniques and a multiplicity of clinical and laboratory based applications. Together these skill sets will create well-rounded graduate students uniquely prepared to apply state-of-the-art, cutting-edge imaging and analysis techniques to important biomedical questions.

Relationship of the Proposed Program to Other Related Programs with the Institution

The proposed **MUSC Biomedical Imaging Ph.D. Program** will unite faculty in the Departments of Radiology, Neuroscience, Psychiatry, Pediatrics, Surgery, and Pathology and Laboratory Science, many of whom are faculty in the Center of Biomedical Imaging. The Departments of Radiology and Psychiatry currently have only residency training programs for MDs, but no graduate student programs. The Departments of Neuroscience and Pathology have residency training programs for MDs and well-established M.S. and Ph.D. programs for graduate students through the MUSC College of Graduate Studies. Students graduating through this program receive their doctorates in Biomedical Sciences with Departmental specializations. All doctorate programs in the Biomedical Sciences require a common first year curriculum focused on providing a foundation across all Biomedical Sciences areas on campus including, fundamental coverage of Neuroscience, Cell and Molecular Pharmacology, Pathology and Laboratory Medicine, Microbiology and Immunology, Department of Public Health Sciences, Drug Discovery, Molecular and Cellular Biology, Pathobiology, and Bioengineering. In addition to a common first year curriculum, these students are required to participate in laboratory rotations in order to broaden students' scientific training and to assist the

students in identifying an appropriate Ph.D. track and Ph.D. mentor. Students pursuing a Ph.D. in Biomedical Imaging would take the first semester core curriculum from the College of Graduate Studies to provide appropriate biomedical background. Further specific didactic course work, laboratory experience with Biomedical Imaging faculty, and an approved dissertation would complete their program of study.

Comparisons and Relationships with other Programs in the State, Region, and Nation

There are currently no Biomedical Imaging Ph.D. programs in South Carolina. Nationally, there are 25 biomedical imaging tracks associated with Biomedical Engineering Ph.D. programs but no programs solely offering a Biomedical Imaging Ph.D. (5).

The University of South Carolina (USC) offers a Biomedical Engineering Ph.D. but does not have a specialization in biomedical imaging. Likewise, Clemson University offers a Ph.D. in Bioengineering, but also has a strong focus in the area of biomaterials and not imaging..Currently, Clemson and MUSC have a Cooperative Agreement which permits MUSC dental and medical students to pursue joint degree programs, DMD or MD respectively, with a Ph.D. in Bioengineering from Clemson. The courses in this program will be open to students in the joint program. If there is sufficient interest from Clemson students we will also arrange for remote classes at Clemson for the courses.

There are no other regional Biomedical Imaging Ph.D. programs with the training emphasis described in this proposal. There are specialized biomedical imaging training specializations imbedded within various Biomedical Engineering programs within adjacent states. In North Carolina, there are two Ph.D. programs in Biomedical Engineering with a biomedical imaging track at 1) Duke University and 2) a joint program between the University of North Carolina at Chapel Hill and North Carolina State. In Georgia, there is a joint Biomedical Engineering program between the Georgia Institute of Technology and Emory University.

References

1. Sun Z, Ng KH, Ramli N. Biomedical imaging research: A fast-emerging area for interdisciplinary collaboration. Biomed Imaging Interv J. 2011 Jul-Sep;7(3):e21.

2. Occupational outlook handbook - healthcare occupations [Internet].; 2012. Available from: http://www.bls.gov/ooh/healthcare/home.htm.

3. Center for biomedical imaging [Internet].; 2013. Available from: http://academicdepartments.musc.edu/cbi/.

4. MUSC strategic plan 2010-2015 [Internet].; 2010. Available from: http://etl2.library.musc.edu/strategicplan/.

5. Biomedical imaging graduation programs imaging curricula and imaging courses [Internet]. Available from: http://www.bmesphotos.org/WhitakerArchives/academic/ferrara.pdf.

ADMISSION CRITERIA

Individual applicants will be evaluated on undergraduate/graduate records, GRE scores and letters of recommendation. In addition, the department will consider current project, lab, and research area availability when evaluating applicants. Previous research experience or employment in areas relevant to bioengineering will carry significant weight.

Generally, applicants will require:

- an undergraduate GPA of 3.3/4.0 or higher
- GRE verbal score: 70th percentile or higher
- GRE quantitative score: 70th percentile or higher
- GRE analytical writing score: 70th percentile or higher
- Either TOEFL score: 100 or higher OR IELTS of 7.0 or higher (international students only)

Specific Biomedical Imaging Entrance Requirements

The basic requirement for admission to the **MUSC Biomedical Imaging Ph.D. Program** is a Bachelor's degree from an accredited undergraduate science program. Students will most commonly be trained in engineering, physics, or life sciences. However, due to the interdisciplinary nature of biomedical imaging, it is to be expected that some students may need to take additional courses to supplement their first year of graduate work. It is expected that all Biomedical Imaging Ph.D. students will have adequate prerequisites for acquiring additional knowledge in biochemistry, physiology and statistics.

Students can enter the program prior to meeting all the prerequisites if approved by the admissions committee. These students must plan to complete the prerequisites during their enrollment in addition to the requirements stipulated for the Ph.D. Credits from prerequisites are not applied toward a graduate degree, and students can be restricted to

a minimum assistantship until undergraduate prerequisites are completed. Under special circumstances, a petition to the Biomedical Imaging Ph.D. program director may allow certain of these prerequisites to be waived.

ENROLLMENT

The **MUSC Biomedical Imaging Ph.D. Program** is proposed to start in the Fall semester of 2015. The program will recruit U.S. and international students who have STEM undergraduate degrees. However, due to proximity, the program will primarily recruit students from 4-year institutions in South Carolina. Students will be a part of the incoming graduate class and have a minimum of a Bachelor's degree and meet the requirements for admission described in the previous section. It is expected that some students may transfer from existing programs at MUSC. New students will start in the Fall semester each year.

It is estimated that 3-4 students will enroll in the first year. The number of new students is expected to increase during the first few years of the program. It is assumed that all students will take a full academic load of five 3-credit courses or 15 credits per semester and that all Ph.D. students will conduct full-time research during the summer. The typical student will complete the Ph.D. program in approximately 5 years. After 5 years, the anticipated average total enrollment will be 20 students although the long term steady state will be 25 students (5/yr x 5 years). (see Table A).

Table A – Projected Total Enrollment

Year	Fall		Spring		Summer	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2014-2015	3	45	3	45	3	45
2015-2016	6	90	6	90	6	90
2016-2017	10	150	10	150	10	150
2017-2018	15	225	15	225	15	225
2018-2019	20	240	20	240	20	240

Assumptions:

1. Students will take a full academic load (5 courses/15 credits per semester).
2. Students will complete the Ph.D. program in an average of 5 years.
3. All students will take summer courses (i.e. research credit).
4. New students will enter in the fall semester.

CURRICULUM

The course requirements and program structure are designed to provide the needed foundational knowledge, primarily during the first two years of didactic courses. These are listed below. This course work is followed by a qualifying exam in the early summer semester of the second year and the completion of 6 more credit hours of electives and a doctoral dissertation.

The 8 new required courses to be taken during the student's first two years of study are listed below together with their scheduling. A total of 15 credit hours per semester is required so that the student will have taken 60 hours of didactic study before taking their qualifying exam and formally starting their dissertation which must be approved by a 5 member dissertation review committee chaired by a member of the Biomedical Imaging faculty other than their advisor.

New Required Courses

Year One

First Semester

None – Standard first year first semester Graduate School requirements

Second Semester

Quantitative Physiology with imaging specific examples
Mathematical Methods
Introduction to Biomedical Imaging Modalities
Laboratory Rotations

Year Two

First Semester

Probability and Statistics
Methods in Molecular Imaging
Research

Second Semester

Methods in MRI
Signal processing/Image analysis
Research

Summer Semester

Qualifying exam for Ph.D. candidates

Year Three plus (Two electives must be taken before graduation)

First Semester

Elective
Research

Second Semester
Elective
Research

A typical Course of Study

	Year 1	Year 2	Year 3 +
Fall Semester	• Foundations of Biomedical Sciences (10) • Essential Scientific Practices (1) • Diversity in Science (1) • Important Unanswered Questions(1) • Laboratory Rotation (2)	• Methods of Molecular Imaging (3) • Probability and Statistics (3) • Seminar (1) • Journal Club (1) • Research (7)	• Research (10) • Elective as needed (3) • Seminar (1) • Journal Club (1)
Spring Semester	• Quantitative Physiology using Imaging (3) • Mathematical Methods (3) • Intro to Biomedical Imaging methods (3) • Elective (3) • Laboratory Rotations (2) • Important Unanswered Questions (1)	• Methods of MRI (3) • Signal & Image Processing (3) • Seminar (1) • Journal Club (1) • Research (7)	• Research (10) • Elective as needed (3) • Seminar (1) • Journal Club (1)
Summer Semester	• Research (13) • Essential Scientific Practices III (2)	• Qualifying Exam (5) • Research (10)	• Research (15)

In addition to the core course requirements described above several new imaging related electives are being designed to emphasize the practical applications of imaging to biomedical research and will be fully developed during the first years of the program

Functional neuroimaging
Techniques for observing regional neural activity, e.g. functional MRI, PET

Cancer imaging
Techniques for imaging tumors, particularly with molecular probes

Cardiovascular imaging
Specific techniques for cardiovascular imaging using CT, MRI, PET

Two-photon imaging
Non-linear optical methods to probe neural activity at the cellular level

Chemical shift imaging of the brain
Metabolic studies of *in vivo* brain metabolism using spectroscopy

Brain stimulation
Methods of direct neural stimulation, e.g. transcranial magnetic or electric stimulation

Computational neuroscience
Mathematical models of neural systems at multiple scales
Medical imaging device development and bioscience entrepreneurship
Case studies of new instrumentation development and commercialization
Advanced clinical imaging
How new technical developments move into clinical practice

ASSESSMENT

The **MUSC Biomedical Imaging Ph.D. Program** will prepare students for careers in academic research and in the healthcare industry. The students will develop the skills needed to become leaders in both basic and clinical biomedical imaging research. Core concepts to be taught include biomedical imaging technology, applications of biomedical imaging, data analysis and research design. Concepts presented in the course curriculum are reinforced and applied in students' original dissertation research projects. The program will assess both program outcomes and student learning outcomes.

Program Outcomes

Assessment of program outcomes will consist of both metrics to measure student perceptions of program quality and objective measures of success of our graduates. The following metrics will be monitored:

1. Percent of students who graduate on time.
2. Percent of graduating students who agreed that they made the right choice in selecting MUSC for their education.
3. Percent of graduating students who agreed that they would recommend the program to other prospective students.
4. Percent of graduating students who rated the quality of their education as satisfactory to excellent.
5. Percent of employers who indicated graduates have demonstrated competency.
6. Percent of students who obtain full-time employment in a biomedical imaging field within one year of graduating.

7. Percent of students who obtain tenure-track faculty positions within 7 years of graduating.
8. Number of publications while students are attending MUSC.
9. Percent of graduates who successfully obtain a grant within 7 years of graduating.

Data for these measures will be collected through surveys conducted by the University at time of program completion.

Student Competencies

Specific measures of the competencies related to the program objectives will be developed by the program faculty. Achievement of these competencies will be assessed using a combination of the following metrics:

1. Student self-assessments performed at the beginning of the program and at the end of the program. This will demonstrate the students' perception of their progress through the program.
2. Faculty evaluation of satisfactory demonstration of competencies for each individual core curriculum course.
3. Evaluation by faculty of the key competencies demonstrated by students during their written and oral qualifying exams.
4. Annual evaluation by faculty mentors of the student mentees' performance during their dissertation research.
5. Reports from thesis committees of the quality of final dissertations.

Program faculty will establish target values for all measures of program outcomes and student competencies. All program outcomes and summaries of student competency achievement will be presented to the program faculty annually. The faculty will review the measures and make recommendations to program administration for adjustments in program content and delivery where indicated.

FACULTY

The program faculty are predominantly members of the Center for Biomedical Imaging, a new MUSC-wide Center established by the Board of Trustees in 2011. The remainder of the faculty are recruited from the Departments of Radiology, Neuroscience, Psychiatry, Pediatrics, Surgery, Medicine and the College of Health Professions with projects in the application of imaging techniques to their research activities (see Table B). New faculty hires are not anticipated as the teaching requirements of the new program will be fulfilled by existing faculty.

Table B– Faculty List

Rank	Highest Degree Earned	Field of Study	Teaching in Field (Yes/No)
Professor #1	Ph.D.	Physics	YES
Professor #2	Ph.D.	Physics	YES
Professor #3	Ph.D.	Physics	YES
Associate Professor #1	Ph.D.	Biomedical Engineering	YES
Associate Professor #2	Ph.D.	Psychology	YES
Associate Professor #3	Ph.D.	Psychology	YES
Assistant Professor #1	Ph.D.	Electrical Engineering	YES
Assistant Professor #2	Ph.D.	Psychology	YES
Assistant Professor #3	Ph.D.	Physics	YES
Assistant Professor #4	Ph.D.	Biomedical Engineering	YES

One FTE represents a full-time faculty member who has been appointed to the MUSC faculty by the Vice President for Academic Affairs and Provost and who receives 100% of compensation through MUSC or though MUSC authorized activities. The faculty member engages in clinical practice, instruction, research, and/or administrative activities on the MUSC Campus or any of its affiliated locations. All junior faculty have a career development plan monitored by senior faculty. The faculty position may be tenured, tenure eligible, or non-tenured.

Table C – Unit Administration, Faculty & Staff Support

UNIT ADMINISTRATION, FACULTY, AND STAFF SUPPORT						
YEAR	NEW		EXISTING		TOTAL	
	Headcount	FTE	Headcount	FTE	Headcount	FTE

Administration						
2017 – 18			1	0.05	1	0.05
Faculty						
2014 – 2018			9	1.8	9	1.8
Staff						
2014 – 2018			1	0.1	1	0.1

PHYSICAL PLANT

Given that anticipated annual enrollment in this program is small relative to the total annual enrollment in the College of Graduate Studies at MUSC, the current physical plant will be adequate to meet the educational needs of the students. The core classes taught to students in this program will be conducted in existing classrooms in the basic science building, bioengineering building, and drug discovery building as needed. These classrooms are all equipped with SmartBoard technology, high definition cameras, high-fidelity projection systems, and all necessary audiovisual equipment.

EQUIPMENT

It is not anticipated that additional equipment will be necessary. The current audiovisual equipment and imaging equipment will be updated and replaced using the normal acquisition process.

LIBRARY RESOURCES

The proposed program modification will require library resources pertinent to both the ***biomedical*** and ***imaging*** sciences.

In the ***biomedical sciences***, current library resources are adequate to support the proposed program. The MUSC Library serves as a database and knowledge center, academic computing support unit, electronic education center, and leader in information planning. Pertinent online resources include the full catalog as well as major biomedical databases (e.g., MEDLINE, CINAHL, PsycINFO, SciFinder, and PubMED). A wealth of worldwide information is provided, including online catalogs of other libraries, drug information (MicroMedex, Mosby's Drug Consult), consumer health (Hands on Health, MEDLINEPLUS, Health Reference Center), clinical decision

support systems (eMedicine, UpToDate, InfoPOEMS), Clinical Practice Guidelines and alerts, reviews of clinical trials, evidence-based practice (Cochrane database, INFOPOEMS), government resources (Toxnet, Federal Register, Code of Federal Regulations), electronic books (MD Consult, Harrison's Online, Access Medicine) and e-journal packages with literature search capabilities (ScienceDirect, ejournals@MUSC, Journals@Ovid, American Chemical Society), and statewide shared academic databases (Collegiate DISCUS, DISCUS)

In the ***imaging sciences***, consultation with Dr. Thomas Basler, Director of Libraries and Learning Resource Centers, has shown that any additional resources needed (the engineering, physics and mathematics references and electronic journals) are available through Inter-library loan and the existing MUSC Clemson Joint Bioengineering program.

ACCREDITATION, APPROVAL, LICENSURE, or CERTIFICATION

Not applicable for this program.

ARTICULATION

The proposed Ph.D. program is a terminal degree and, as stated elsewhere, it is the only program of its kind in South Carolina. MUSC does not generally participate in the South Carolina Transfer and Articulation (SC TRAC) program and is not a receiving school for transfer students (see: http://www.sctrac.org/MedicalUniversityofSouthCarolina-/Transfer-Profile/tabid/476/Default.aspx), as MUSC does not offer general undergraduate education coursework. However, with permission, individuals from other in and out of state intuitions will be allowed to register for courses on a non-degree basis.

In 2003 MUSC and Clemson University established an active collaborative relationship in bioengineering. The CU-MUSC Bioengineering Program is on the MUSC campus in Charleston. Faculty from Clemson University and their staff have laboratories and office space on the MUSC campus. Students from Clemson, with the approval of their institution, will be allowed and encouraged to take courses offered in MUSC's Biomedical Imaging program. In the future, we will work closely with other area universities and colleges to provide similar access to courses offered through the Biomedical Imaging Ph.D. program.

ESTIMATED COSTS AND SOURCES OF FINANCING

The implementation of this program will not incur any unique costs or special state appropriations. Tuition and research grants to the faculty will be the primary source of

funding along with the anticipated typical funding the College of Graduate Studies receives from state appropriations provided to MUSC. It is anticipated that this proposal will result in a total of $50,000 of expenses for course instruction and staff support.

The percentage of in-state students who matriculated into the MUSC College of Graduate Studies varied from 50% to 60% over the last three years. It is expected that the cohort of students matriculated into the Ph.D. program will follow a similar profile. However, if the number of national programs offering a similar degree is still limited at the time of implementation of this proposed program, the percent of out-state applicants may be higher.

This program will be a new addition to the College of Graduate Studies' existing doctoral programs in biomedical sciences so the program will be administered through the same general process. The total costs of the program will depend on the number of students accepted and are expected to be approximately the same per student as in other programs. Much of the necessary infrastructure is pre-existing, so there will be few new costs directly associated with the program administration (see Table D). Faculty for the program (primarily from MUSC's Center for Biomedical Imaging, see http://academicdepartments.musc.edu/cbi/), are supported by research grants that will also support projects that the Biomedical Imaging Ph.D. students will engage in as part of their independent research and experiential learning.

Table D – Estimated Costs and Sources of Financing by Year

ESTIMATED COSTS BY YEAR						
CATEGORY	**1st**	**2nd**	**3rd**	**4th**	**5th**	**TOTALS**
Program Administration	0	0	0	2000	2000	4000
Faculty Salaries	0	0	0	0	0	0
Graduate Assistants	0	0	0	0	0	0
Clerical/Support Personnel	1000	1000	1000	2000	3000	8000
Supplies and Materials	1000	1000	1000	1000	1000	5000
Library Resources	0	0	0	0	0	0
Equipment	0	0	0	0	0	0

Facilities	0	0	0	0	0	0
Other (Identify)	0	0	0	0	0	0
TOTALS	2000	2000	2000	5000	6000	17000
SOURCES OF FINANCING BY YEAR						
Tuition Funding	0	0	0	0	0	0
Program-Specific Fees	0	0	0	0	0	0
State Funding	0	0	0	0	0	0
Reallocation of Existing Funds	2000	2000	2000	5000	6000	17000
Federal Funding	0	0	0	0	0	0
Other Funding (Specify)	0	0	0	0	0	0
TOTALS	2000	2000	2000	5000	6000	17000

PROGRAMS FOR TEACHERS AND OTHER SCHOOL PROFESSIONALS (ONLY)

Not applicable to this program