University of North Carolina at Chapel Hill
Certificate Program Application Form

Please use this application form as a guide for your Certificate Program proposal.

Name of Proposed Certificate Program: Biomedical Imaging Science

Sponsoring Academic Unit: Departments of Biomedical Engineering and Psychology, College of Arts and Sciences and UNC School of Medicine.

Administering Unit, if different: Biomedical Research Imaging Center

Primary Contact Name: Kelly S. Giovanello, Ph.D.; Paul Dayton, Ph.D.. Javed Mostafa, Ph.D.

Address and CB #: 3270

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First Term the Certificate Would be Offered: Fall 2015

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1. Describe the Certificate Program and provide a statement of educational objectives.

Biomedical Imaging is a critical area of research with far reaching clinical translational opportunities in several areas including cancer, developmental science, genetics, pharmacology, and neuroscience. The broader field of biomedical imaging includes multiple subdisciplines designed to enhance knowledge of how human systems are structured and function. The Biomedical Imaging Certificate will consist of a range of educational opportunities including didactic coursework, attendance at Biomedical Research Imaging Center (BRIC) symposia and workshops, and a practicum placement for research training in an on-campus laboratory utilizing biomedical imaging techniques.

The educational objectives are as follows:

(1) To provide students with a solid foundation in imaging science, including experimental design, image acquisition, image analyses, statistical modeling, and biomedical informatics.
(2) To expose students to a wide array of pre- and clinical imaging modalities available at the BRIC, including computed tomography, magnetic resonance imaging, optical imaging, ultrasound, single photon emission computed tomography and positron emission tomography.
(3) To provide students with the skills to critically review primary-source empirical articles to understand major trends in the current literature on biomedical imaging and to identify major leaders in the field and their theoretical and empirical contributions.
(4) To provide basic skills in computational techniques for image storage, retrieval, and distributed access, as well as instruction in statistical models for analyzing imaging data.
(5) To provide students with hands-on practicum experience in an on-campus laboratory utilizing biomedical imaging techniques.
(6) To provide students with knowledge imaging hardware.

2. Include a statement about the need for such a Certificate Program, and specifically why there is a need to offer this Certificate at UNC-Chapel Hill. Is the Certificate offered at other universities or community colleges?

The Biomedical Imaging Certificate will leverage the exceptional resources offered by the UNC Biomedical Research Imaging Center, both in terms of faculty expertise as well as imaging equipment infrastructure, to provide students with a unique opportunity to learn broadly about the biomedical imaging sciences, as well as to select a specific imaging modality for which to receive training in image acquisition, analysis, and statistics. Additionally, students will have the opportunity to learn about the benefits and practice of multi-modal imaging (i.e., inclusion of more than one imaging modality) in research projects that include various clinical populations. A distinctive dimension of the proposed Certificate is the hands-on knowledge students will gain on how different imaging modalities work, including both pre- and clinical imaging systems by leveraging the available resources in the BRIC. No other university or college in the state has the resources offered by the BRIC. To our knowledge, no other university or college in the state has a biomedical imaging certificate. One of the strengths of this certificate is that through the Joint Department of Biomedical Engineering, this certificate could further engage NC State based students as well as UNC based students, thus broadening the impact across UNC institutions without redundancy.

Although the Biomedical Engineering department currently provides M.S. and Ph.D. degrees with a focus on biomedical imaging, these degrees require a multiple year commitment and additional advanced mathematics and engineering classwork. The certificate will provide educational training for students wishing to obtain additional training in biomedical imaging without achieving a degree focused on imaging (such as students intending to earn graduate degrees in Psychology or Physics) or who do not have the prerequisites for the BME graduate program. Many of the students utilizing imaging tools in their research projects do not have the required engineering or the mathematical training needed to be successful in courses offered by the Biomedical Engineering department. Yet, as part of their career developments, it is of critical importance that students have a good understanding of how different imaging modalities work. The proposed certificate will bridge this critical gap in offerings at UNC to further enhance the educational missions of the University.

3. Describe the demographics of the target student population for the Certificate Program. Double click each box that applies and describe the intended audience.

- ☐ **Undergraduate Students**
- ☒ **Graduate Students**
- ☐ **Professional Students: _____**
- ☒ **Degree-seeking, Matriculated Students**
- ☐ **Non-Degree-Seeking Students**

4. Why is the Certificate Program necessary beyond offering the program as a minor, supporting area, or specialization/concentration/track?

The Biomedical Imaging Certificate is an interdisciplinary program that will attract students from graduate programs at UNC including the School of Medicine, College of Arts and Sciences (Departments of Biology, Computer Science, Chemistry, Physics, and Psychology), School of Public Health, School of Nursing, School of Dentistry, and School of Information and Library Sciences, as well as from the schools and colleges at NC State such as the College of Engineering and the College of Veterinary Medicine. Unlike minor or specialization tracks, a self-standing certificate program can address the needs of all of these diverse student populations. Courses relevant to imaging science are distributed across numerous academic units. The proposed Certificate program will allow for a logical and clear aggregation of courses, bringing together faculty who already share similar research interests and expertise, and engaging the students in a focused training program in an important area.

5. Provide specific courses and other requirements for the Certificate Program. Separate listings of courses may be included with the proposal.

The proposed Biomedical Imaging certificate program will require four 3-credit courses and a 3 credit practicum. Initially, students will enroll in a 3-credit seminar course that brings together all Biomedical Imaging Certificate students and serves to provide students with the foundations of biomedical imaging science. This class will be offered through the Biomedical Engineering Department. Currently, BMME 890-16 is listed as a special topics class from Prof. Paul Dayton in BME, which can be the initial offering for the Seminar on Biomedical Imaging Science. A formal course number will be applied for in the future. Additionally, students will choose 3 elective courses. The elective courses will be chosen such that a student learns in-depth about a specific imaging modality or imaging topic, including acquisition parameters and the experimental designs used with that type of modality, the image analysis procedures associated with the modality, the statistical procedures used to analyze data from that modality, and the informatics science associated with the imaging modality. Finally, students will enroll in a 3-credit practicum during which the student will receive hands-on experience conducting biomedical imaging research in their modality of choice. Thus, the requirements will consist of 15 credit hours.

The new 3-credit seminar course, Seminar in Biomedical Imaging Science, in which all certificate students must enroll, will be offered each academic year provided the certificate program has sufficient enrollment. Although Dr. Dayton will be the initial instructor of record, lectures in this seminar will be provided by BRIC and BME faculty members, as well as guest speakers in other schools and departments with clinical and basic science expertise relevant to imaging. Guest lecturing commitment will be equally distributed across faculty, with the expectation that each faculty member provides one lecture, and organizes the invitation of a guest speaker for a second lecture. Organizational details of the class will be managed by Ann Sherman, BRIC staff.

Additionally, the signed letters of support from unit Chairs and Deans, assure the availability of courses to Certificate program students. Furthermore, numerous BRIC faculty and their respective academic units are willing to accommodate and offer practicum opportunities for students to work alongside the faculty member in their laboratories.

6. Provide a statement on the relationship of the Certificate Program to degree programs within the unit(s). To what extent will requirements for the Certificate overlap with requirements for bachelor's, master's or doctoral degrees? Confirm how course credit transfer policies will be applied to students.

The Biomedical Imaging Certificate will be in addition to the student's Departmental or Program degrees. Students not enrolled in a UNC or NCSU degree program will not be eligible to apply. Degree-seeking students enrolled in existing affiliated programs, including Biomedical Engineering, would purse this certificate as an additional specialization. Although the requirements to fulfill the biomedical imaging certificate are not identical to the requirements of any graduate degree or other certificate on campus, the elective courses for the certificate fulfill requirements in other programs. Per the UNC Graduate School, 40% of the student's credit hours (i.e., 6 credit hours) may be counted toward both the major degree, as well as the certificate.

7. Will the Certificate Program be offered jointly with another university? If yes, describe the relationship with the joint unit.

Yes, the Certificate will be jointly offered with North Carolina State University since the Department of Biomedical Engineering spans both UNC Chapel Hill and NC State University. At this point, we have not initiated the Certificate review at NC State. We will start this process after approval at UNC.

8. Will the Certificate Program be offered on campus, as a distance education program, or a combination? Describe any distance education components in detail.

The Biomedical Imaging certificate will be offered on the UNC campus by the Departments of Biomedical Engineering and Psychology in partnership with the BRIC. Classes will be provided on campus in various Arts and Sciences and School of Medicine locations, and laboratory experiences will be offered in BRIC facilities or in laboratories of participating faculty. The NC State College of Engineering will be brought onboard as well as the certificate program is expanded to include NC State. There are currently no distance courses planned, although classes relevant to imaging offered by NC State or Duke will also be included as part of the elective certificate curriculum through the inter-institutional enrollment agreement.

9. Describe the admissions criteria and process in detail. Differentiate between processes for degree-seeking students and non-degree-seeking students, where applicable. Include information about residency for tuition purposes as needed.

The biomedical imaging certificate will be offered to degree-seeking graduate students. A three member faculty admissions committee will be established. Admission to the certificate program will consist of a three-step process:

1) Submitting an application: Matriculated students will be required to fill out a simple admission form, containing basic demographics, prior education, and current degree pursued. Additionally, they will be required to submit a brief 1-2 page statement of interest and proposed course of study plan.
2) Based on the application, particularly the statement of interest, the program coordinator the co-director will recommend a faulty advisor for the prospective applicant. The applicant will be expected to meet with the advisor to discuss her or his specific interests. The interview will also serve as a screening mechanism to ensure that the applicant's background is appropriate for the certificate coursework and that the program is a good match for her or his needs.
3) Advisor's approval of application and practicum plan will complete the admissions process (please see Appendix A for the planning form).

10. Provide a three-year, semester-by-semester projection of enrollments and course offerings.

The Certificate program will likely attract about half-a-dozen students in the initial year, grow to be about 10 students in year two, and reach a size of about 15 students in three years. There will be no additional charges to students pursuing the Certificate, over and above their major area tuition.
The following courses are currently offered at UNC and NC State and available for biomedical imaging certificate students:

Course Title	*Course Number*	*Credits*	*Faculty Instructor*
Seminar in Biomedical Imaging Science	TBA	3	Rotating BRIC Faculty
Biomedical Signal Processing	BMME 512	3	Lalush
Medical Imaging: Ultrasonic, Optical, and MRI	BMME 550	3	Gallippi, Lalush
Medical Imaging: X-Ray, CT, and Nuclear Medicine Systems	BMME 560	3	Lalush
Medical Image Analysis	COMP775	3	Niethammer
Optimal Estimation in Image Analysis	COMP790	3	Niethammer
Cognitive Neuroscience	PSYC 739	3	Giovanello
Functional Magnetic Resonance Imaging	PSYC 795	3	Giovanello and BRIC facul
Social Affective Neuroscience	PSYC 868	3	Lindquist
Translational Seminar in Cognitive and Clinical Neuroscience	NBIO 727	2	Belger
Nanomedicine	MOPH 738	3	Hingtgen and BRIC faculty
Statistical and Mathematical Methods for Medical Imaging	BIOS 772	3	Zhu
Distributed Systems and Administration	INLS 576	3	STAFF
User Interface Design	INLS 718	3	STAFF
Database Systems III: Advanced Databases	INLS 723	3	STAFF

Seminar in Human-Computer Interaction	INLS 818	3	STAFF
Practicum in Biomedical Imaging	BMME 890	3	Dayton

Although the students interested in pursuing the Biomedical Imaging Certificate will have diverse interests and backgrounds, below is an example for students who are interested in the cognitive neurosciences: Year 1: Fall – Seminar in Biomedical Imaging, Spring – BMME 550; Year 2: Fall - PSYC 739; Spring - PSYC 868 or NBIO 727; Year 3: Fall – BMME 890.

11. Provide a three-year projection of the Certificate Program's financial plan. Include the impact on campus resources, such as classrooms and instructional faculty/personnel. Also include plans for tuition and billing, if separate from standard rates across schools.

The proposed certificate will not require the creation of additional courses. There is only one required 3-credit seminar course for all students – the Seminar in Biomedical Imaging Science – and it is currently under planning and reserved as a special topics offering fall of 2015. The courses that comprise the certificate are offered in the College of Arts and Sciences, School of Information and Library Science, School of Medicine, College of Engineering, and School of Public Health. Additionally, the computational and statistical cores of the Biomedical Research Imaging Center will be utilized in the training of Certificate Students (please see attached Resources page). The advising and practicum supervision will constitute an addition to faculty academic activities and is recognized as such by the administrations of their respective academic heads (see letters of support). The program will be administered jointly by the Departments of Biomedical Engineering and Psychology and will require a coordinator.

12. List all faculty members who will be responsible for planning and participating in the Certificate Program. Programs are encouraged to provide advising for students through the identification of one faculty member as the director of the Certificate.

The certificate program will have an Advisory Panel of faculty to oversee admissions to the certificate program, to approve each trainee's program of study, and to evaluate the progress of trainees and the offerings of the program. The advisory panel will include:

1) Paul Dayton, Ph.D., certificate program co-director, Department of Biomedical Engineering and BRIC
2) Kelly Giovanello, Ph.D., certificate program co-director, Department of Psychology, and BRIC
3) Javed Mustafa, Ph.D., certificate program co-director, School of Information and Library Science and BRIC
4) Weili Lin, Ph.D., BRIC Director
5) Kevin Guskiewicz, Ph.D., Senior Associate Dean for the Natural Sciences, College of Arts and Sciences.
6) Terry Magnuson, Ph.D., Vice Dean for Research, School of Medicine

The advisory panel will meet once per year to decide on program admissions, and then meet an additional one time per year to evaluate student progress within the program. Drs. Dayton, Giovanello, and Mustafa will be available for individualized *ad-hoc* consultation with certificate trainees as needed.

Additionally, all BRIC faculty will be responsible for participating in the Biomedical Imaging certificate either by serving as Instructors of Record, provide guest lectures, or supervisor practicum students. Please see below for a list of BRIC faculty members.

Amelio, Antonio-	School of Dentistry and Lineberger Comprehensive Cancer Center
An, Hongyu	Radiology
Boettiger, Charlotte-	Psychology
Branca, Tamara-	Physics and Astronomy

Burger, Kyle-	Nutrition
Daughters, Stacey-	Psychology
Dayton, Paul-	BME
Gallippi, Caterina-	BME
Gao, Wei-	Radiology
Giovanello, Kelly-	Psychology
Henderson, Louise-	Radiology
Hingtgen, Shawn-	Molecular Pharmaceutics
Kuhnen, Camelia-	Kenan Flagler Business School
Lalush, David-	BME
Lee, Yueh-	Radiology
Li, Zibo-	Radiology
Lin, Weili-	Radiology
Lindquist, Kristen-	Psychology
Oldenburg, Amy-	Physics and Astronomy
Mostafa, Javed-	Information Science
Niethammer, Marc-	Computer Science
Parrott, Matthew-	Radiology
Shen, Dinggang-	Radiology
Shi, Feng-	Radiology
Shih, Yen Yu Ian-	Neurology
Smith, Eric	Radiology/School of Pharmacy
Terence Wong-	Radiology/Nuclear Medicine
Wu, Guorong-	Radiology
Wu, Zhanhong-	Radiology
Yap, Pew-Thian-	Radiology
Yuan, Hong-	Radiology
Zhu, Hongtu-	Biostatistics

13. Describe the evaluation plans for the Certificate Program.

At the end of each trainee's participation in the Biomedical Imaging Certificate, the trainee will complete an anonymous evaluation form (included with this application). The certificate program advisory panel will review these evaluations forms yearly and make adjustments to the program accordingly. Additionally, the advisory panel will meet once per year to review course offerings, the potential impact of this certificate program on time to degree, and to ensure the certificate program is meeting the needs of the students.

14. Appropriate letters of support should be included with the proposal. All units sponsoring and participating in a Certificate Program should approve the proposal and provide support letters, including letters from units supporting the Certificate through resources (e.g., faculty time, course slots). Approval letters from the home school should accompany the proposal submitted to the Graduate School for final approval.

Please see attached Letters of Support from

Nancy Allbritton, M.D., Ph.D. – Chair of Biomedical Engineering Department
Donald Lysle, Ph.D. – Chair of Psychology
Terry Magnuson, Ph.D. – Vice Dean for Research, School of Medicine
Kevin Guskiewicz, Ph.D. – Senior Associate Dean for the Natural Sciences, College of Arts and Sciences
Gary Marchionini, Ph.D. – Dean, School of Information and Library Science
Weili Lin, Ph.D. – Director, Biomedical Research Imaging Center

GRADUATE CERTIFICATE IN BIOMEDICAL IMAGING SCIENCE
Enrollment Form

Name: **PID:**

Dept. or School **Prior Degree(s):**

Email address: **Degree pursuing:**

Expected date of graduation:

Coursework (to be taken)

Three courses taken to meet requirement:

Dept. and Course #	Course Title	Semester Planned
1.		
2.		
3.		
4.		
5.		

*By signing below the student certifies that they understand only 40% of the credits (i.e., one course) can double count toward certificate and degree requirements.

Research Interests

Practicum Interests

Student signature:	**Date:**
Student Advisor's signature:	**Date:**
Director of Graduate Studies signature:	**Date:**

GRADUATE CERTIFICATE IN BIOMEDICAL IMAGING SCIENCE
Completion Form

Name: **PID:**

Dept. or School **Prior Degree(s):**

Email address: **Degree pursuing:**

Expected date of graduation:

Coursework

Three courses taken to meet requirement:

Dept. and Course #	Course Title	Semester Taken
1.		
2.		
3.		
4.		
5.		

*By signing below the student certifies that they understand only 40% of the credits (i.e., one course) can double count toward certificate and degree requirements.

Practicum Interests

The practicum requirement has been met by (briefly describe):

Student signature:	**Date:**
Student Advisor's signature:	**Date:**
Director of Graduate Studies signature:	**Date:**

Certificate in Biomedical Imaging

Evaluation Form

We would like to obtain feedback on your experiences regarding the biomedical imaging graduate certificate program. Please read each question and choose the appropriate answer:

1. The Biomedical Imaging Certificate courses fulfilled my training needs:

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

2. The Biomedical Imaging Certificate practicum fulfilled my training needs:

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

3. Please indicate your favorite aspect of the certificate program:
_____
_____
_____
_____

4. Please indicate the aspect of the certificate program that you like the least:
_____
_____
_____
_____

5. Overall, how would rate your satisfaction with the certificate program:

1	2	3	4	5
Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied

RESOURCES AT THE BIOMEDICAL RESEARCH IMAGING CENTER - UNC CHAPEL HILL

The Biomedical Research Imaging Center (BRIC) was formed in 2005 to support image-based biomedical research across the UNC System. The BRIC is a statewide resource serving researchers across the state of North Carolina in a central facility that handles the acquisition, processing, analysis, storage, and retrieval of images. In Spring 2014 the center relocated to the new Marsico Hall which is located one block south of the UNC Hospitals complex and houses both human and animal imaging equipment. The BRIC includes several core resources; information of each core is provided below.

Image Acquisition core

This core serves to establish, optimize, and develop imaging protocols for investigators. In addition, this core is also responsible to all aspects related to image acquisition. The core consists of three faculty members and a core manager and includes both Human Imaging Facility and Small Animal Imaging facility. Additional 0.5FTE staff member is responsible for all issues related to scheduling for both human and animal studies.

Human Imaging Facility

There are a total three MR technologists and one Nuclear Medicine technologist to run and maintain the imaging equipment which includes a 3T Siemens Tim Trio whole body MR and a Siemens Biograph mMR (aka hybrid MRPET scanner), Siemens MCT PET/CT and Siemens 7TMR scanners. All systems are dedicated for research projects.

Siemens TIM TRIO 3T MRI: The Siemens TIM TRIO scanner was installed in 2009 and is dedicated for research use and is available for use in both human and animal studies. The TIM TRIO scanner has 64 rf channels with parallel imaging capability. The system includes a variety of coils including 12 and 32 channel head coils, and a 32 channel body coil. The system features include:

- Gradient strength of 45 mT/m for longitudinal direction, and 40mT/m for horizontal and vertical direction.
- Slew rate of 200 T/m/s
- Variable FOV selection from 0.5 cm-50 cm
- AudioComfort which can reduce acoustic noise up to 20 dB compared to other systems.
- BLADE which is a TSE sequence that is less sensitive to motion and flow than conventional TSE. In the head, motion correction can also be used to further reduce motion artifacts.
- AutoAlign is an automated alignment for standardized and reproducible slice positioning in the head based on a 3D MR brain atlas and 3D AutoAlign scout.

Siemens Biograph mMR 3T MRI: This is a highly innovative and unique imaging system capable of acquiring both MR and PET images simultaneously. This system was installed in January 2012. Important specs of this system are provided below.

- 45cm field of view, which supports a range of clinical MR applications
- MQ-engine gradient -
- Positron emission tomography for imaging of metabolic and physiologic processes. - Anatomic (MR) and metabolic (PET) image registration
- Attenuation correction and scatter correction for PET imaging - Static, whole body, and list mode acquisition capability.
- A superconductive 3T magnet - Actively shielded water-cooled gradient system
- Digital RF Transmit and Receive System
- RF Coils (MR-PET Head/Neck, A Tim Coil, MR-PET Spine, A Tim Coil and MR-PET Body, A Tim Coil, 4-channel Flex Coils large/ small)
- High performance host computer and image processors
- PET detectors: material: LSO
- Crystal element dimension: 4 * 4 * 20 mm
- Crystal elements per block: 64
- Avalanche Photodiodes (APDs): 9 per block
- Detector ring diameter: 656 mm
- Blocks per detector ring: 56
- Transaxial FOV: 594 mm

- Plane spacing: 2.0 mm
- Crystal elements per ring: 448

Siemens Biograph MCT S-64 PET/CT: Installed in November 2013, this is a whole body PET/CT designed for the purposes of oncological, neurological and cardiac imaging. The fully integrated PET/CT gantry incorporates CT and PET detector assemblies and electronics in an efficient and compact design. The Biograph mCT will provide:

- CT imaging capability consists of a 64 slice CT featuring a full range of spiral CT applications.
- PET imaging capability consists of the multi-LSO detector ring system with 3D acquisition and reconstruction and 81 image planes with a 16.2 cm field of view.
- High quality attenuation correction and scatter correction for PET imaging.
- Stellant D PET/CT dual head Injector for contrast CT exams.
- Appropriate for imaging both humans and animals.

Siemens Magnetom 7T MRI: Installed in August 2014, for both human and animal research, this 7T whole body MR system provides:

- High performance for shorter TE and higher SNR; Whole body gradient strength of 70mT/m
- Slew rate of 200T/m/s
- 32 RF independent receive channels
- 8-channel RF transmit array (coming in 2015)
- RF power amplifier providing up to 8 kW peak power (8x2kW power coming in 2015)
- Multi-nuclei package for 19F, 31P, 7Li, 23Na, 13C and 17O
- Multinuclear Spectroscopy, Advanced Neuro, Angio, Cardiac, Body and Ortho packages
- Variable speed patient table for fringe field adjustment
- Head transmit 1H coil with 32 channel array receiver coil
- 32 channel 1H body array coil
- 28 channel 1H knee array coil
- 8 transmit channel/32 receive channel head coil (coming in 2015)
- MNO Volume head coil, for acquiring 31P data (coming in 2015)

All scanner rooms contain ancillary equipment for patient studies. They are outfitted with life support equipment including wall mounted medical gases (compressed air, suction, and oxygen) and in vivo monitoring system for BP and pulse oximetry. The rooms have visual presentation and responding systems available for functional studies and for subject entertainment.

The Center has a mock scanner available for training subjects undergoing MR studies. The mock scanner has a visual presentation and computer setup to simulate the scanner room experience for research subjects. The Center also has three patient preparation rooms, a patient waiting area, and four offices. With the move to the new imaging facility in Marsico Hall (Spring 2014) the center added 4 preparation rooms, 2 consultation rooms, and additional office space, including a work area for visiting staff and investigators.

<u>Small Animal Imaging Facility</u>

There is one full time facility manager, one faculty as MRI Imaging Director, and another two full-time technicians responsible for running and maintaining all of the imaging equipment.

The imaging equipment includes a 9.4T Bruker small animal MR scanner, two small animal high resolution ultrasound systems, four optical imaging systems, a small animal PET/CT scanner, a small animal SPECT/CT scanner, a carbon-nanotube-based in vivo microCT system, and a high resolution CT scanner for specimens. All of the imaging equipment is housed in adjacent rooms so as to facilitate multi-modal studies.

Bruker 9.4T Scanner: The Bruker 9.4T horizontal bore spectrometer is a dedicated system for small animal studies which was purchased through a high end shared instrumentation grant (PI: W Lin). The

higher sensitivity resulting in greater spatial and/or temporal resolution from the 9.4T magnet is critical for in vivo animal imaging.

- Actively-shielded superconducting wide-bore magnet with 9.4 T field strength
- Bore diameter of 30 cm
- Gradient strength of 200 mT/m and Max slew rate of 640 T/m/s
- Linearity 13/ 10 cm DSV: < ± 3%, < ± 2%
- ParaVision® software package provides a framework for multi-dimensional MRI/MRS data acquisition, reconstruction, analysis and visualization
- Numerous ready to use MRI methods and sequences available
- 4 RF independent receive channels
- Numerous RF Coils (20, 35, 72, and 150 mm quad-transceiver volume coils, 4-channel receive only rat brain phase array coil, quad-receive only mouse brain coil, 1H/13C double-tuned linear transceiver surface coil, and 1H/17O double-tuned volume coil)
- Small animal anesthesia and monitoring system available

GE eXplore Vista: The GE eXplore Vista small animal PET/CT system provides high-sensitivity functional imaging along with anatomical images within a single instrument. It utilizes dual scintillator and depth-of-interaction technology to provide extremely high resolution and high sensitivity for PET/CT imaging. The nature of good quantitation and functionality in PET imaging allows studies for tumor biology, pharmacodynamic studies of new drugs, such as effect on blood perfusion, and pharmacokinetic studies. The 7cm bore is suitable for mice and rats up to 400g. Both static and dynamic studies are possible with time-uptake analysis. Currently, 18F-FDG and 124I are approved and available for use, but studies requiring other longer-lived positron emitters may be discussed.

- Axial resolution of about 1.2 mm in the center of FOV
- Arial field-of-view of 4.6 cm
- Transaxial field of view of 7 cm
- CT X ray source energy: 4kV-50kV
- Normal CT resolution of 120 micron
- FBP, 2D-OSEM, or 3D-OSEM reconstruction available for PET imaging

GE eXplore speCZT/CT system: The GE eXplore speCZT system is the first full-ring solid-state detector small animal SPECT/CT system. The system is featured with:

- Solid-state CZT detector technology, Stationary, full-ring, 10 detector design,
- Interchangeable, rotating cylindrical collimators (multi-slit with 80mm axial FOV, full 360-degree coverage, and multi-pinhole with high resolution, full 360-degree coverage)
- High sensitivity and improved dynamic imaging and low activity (<1mCi) scan capabilities
- High energy resolution from the CZT detector;
- Multi-isotope imaging capabilities

The system will be highly beneficial for drug biodistribution studies, cardiac studies, and other molecular imaging studies.

SCANCO µCT 40: The SCANCO µCT 40 scanner is a desktop cone-bean X-ray scanner. It can provide high resolution of 6 µm. In addition to the high resolution capabilities, it also offers a larger specimen size (36 mm diameter, 8 cm specimen length).

- X-Ray-source: 50-70 kVp, 150 µA
- No shielding required
- Detector 2048x252 elements, 24 µm pitch Resolution 6 µm nominal, 9 µm (10% MTF @ 12 mm Ø)
- Specimen Size up to 38 mm in diameter, 80 mm in length
- Software offers complete 64-bit imaging solution, online/offline reconstruction, sophisticated 2D/3D evaluation, 3D-visualization/animation, and archiving data
- Perfect for animal bone or dental study

IVIS optical imaging systems: Three IVIS optical imaging systems, including Xenogen IVIS-100, IVIS-Lumina, IVIS-Kinetic systems, are available to all investigators. All systems are capable of bioluminescence and fluorescence imaging, with the Kinetic system being better suited for fluorescence imaging. In addition, IVIS-Kinetic system is equipped with highly sensitive EMCCD camera which allows much faster imaging and imaging for weak optical signals. The system also equips with a light-tight

injection port. Together with a syringe injector system, this new system enables real time compound and/or substrate administration. All the systems are equipped with a gas anesthesia system and a work station.

- Adjustable field of view, allowing 5 mice or 2 large rats to be imaged at the same time.
- Highly sensitive back-thinned, back-illuminated, cooled CCD camera
- Extremely light-tight, low background imaging chamber allows it to be used in standard lab lighting environments

The IVIS-Lumina is placed within animal housing facility, which facilitates longitudinal animal imaging without need to transport animals into the imaging facility.

Fluorescence Molecular Tomography (FMT) Optical System: The FMT 2500 system (PerkinElmers, Inc.) is a 3D tomography in vivo optical imaging system, which can provide much more accurate quantification and spatial distribution of fluorescent probes in live animals or specimens. Several major features include:

- providing quantitative tomography imaging;
- Four laser channels (635 nm, 670 nm, 745 nm, and 785 nm) for NIR imaging;
- Imaging field of view: 3x6 cm; resolution: 2 mm;
- Possible co-registration with microCT, PET, SPECT or MRI.

The system combined with NIR fluorescence probes will enable scientists understand biological targets, processes and pathways in physiologically-relevant environments non-invasively, and monitor disease progression and treatment efficacy longitudinally.

VisualSonics Ultrasound Imaging System: Two ultrasound imaging systems dedicated to small animal imaging are available. VisualSonics Vevo 2100 offers high resolution ultrasound imaging for small animal studies. The spatial resolution can be down to 30 microns using high frequency waves. The system is fully non-invasive, which allows longitudinal studies and fewer mice required. It provides a high-throughput method to study physiological/ pathological changes, such as blood perfusion, and tumor volume. Additional features Include:

- Multiple foci allow complete field of view in focus for better full organ imaging and large tumor imaging;
- Much faster B-mode frame rate (>250 fps vs. average 60 fps in Vevo770) for fast imaging, including fast 3-D imaging
- Improved Doppler imaging and quantification
- Solid-state array transducer
- Larger field of view (max. 36x36mm)

The two systems provide sufficient US imaging support for animal studies. One system is located in the imaging lab inside the Genetic Medicine Vivarium (Room UB61), which greatly facilitates longitudinal imaging studies as this eliminates the need to transport animals outside their housing facility. The second system is located in the Marsico Hall imaging facility.

Veterinary/Animal Support Core

This core serves to provide technical support for animal preparation and monitoring during imaging studies.

There is one full-time animal technician who supports handing and care during animal imaging studies. The technician works with the users to determine needed procedures for animal preparations as well as monitoring.

An animal surgical suite and a small animal housing area also reside within the BRIC. The animal surgical suite includes the surgical table, surgical light, surgical microscope, surgical tools, a blood gas analyzer, a temperature monitoring system, and a stereotaxic frame. Four sets of small animal monitoring systems are available to monitor vital signs during surgery and imaging procedures. An animal housing room for longitudinal imaging studies is also included within the imaging facility. This room is equipped with an automatic timer control for lighting and an independent HVAC system.

There are a total of four sets of animal monitoring systems, two of which are MR compatible. The MR compatible monitoring system allows continuous monitor when the animal is put inside the magnet for MR imaging. All the monitoring systems are able to monitor the ECG, respiration, temperature, and blood pressure for anesthetized mice, rats and larger animals. The system consists of a main data acquisition and processing

module located near the animal and a fiber optic transceiver module connected to a PC. The monitoring system also provides gating option. A sophisticated user configured gating interface allows gates generated to supply a trigger to the imager. The user can control the start, stop and width of each gate.

Center for Imaging Informatics (CII)

The CII serves to develop new tools for image analysis and to support the image storage and analysis needs of scientists who use the BRIC facilities. So far, the CII has developed various novel image segmentation, registration, and multivariate analysis methods, with applications to brain (including MCI, AD, Schizophrenia, and neonate study), heart, breast cancer, and prostate cancer.

Image Storage and Analysis Core in CII

Image Analysis Service: The image analysis services available are listed below.

- Brain
    - Automated brain tissue segmentation for gray matter, white matter, CSF, and/or lesions;
    - Automated brain image labeling and spatial normalization;
    - Atlas building;
    - Cortical surface reconstruction, labeling, and thickness analysis;
    - Group analysis;
    - Longitudinal brain development and aging study;
    - Diffusion tensor image analysis: fiber tracking, atlas building, and tensor-based disease diagnosis;
    - Identification of subtle brain structural differences in a wide variety of brain pathologies, by using multivariate high-dimensional pattern analysis method;
    - Resting fMRI analysis;
    - Brain network based disease diagnosis, using anatomical brain networks (from DTI) and functional brain networks (from resting fMRI);
    - Neonatal brain segmentation and early brain development study.
- Chest
    - Segmentation of chest and other boundaries from x-ray images or others.
- Breast cancer
    - Automated segmentation of parenchyma or tumor regions;
    - Separation between benign cancer and malignant cancer;
    - Registration between multimodality breast images, or consistent alignment of different time images.
- Heart
    - Accurate cardiac motion estimation by 4D registration method;
    - Detection of early-stage cardiac diseases using both structural and functional information.
- Prostate cancer
    - Optimal needle biopsy for cancer detection;
    - Segmentation of prostate from ultrasound, CT, and MR images using deformable appearance and shape models;
    - Registration between histological and MR images of prostate;
    - In vivo detection of suspicious caner tissues for biopsy needle guidance;
    - Segmentation and registration of prostate from daily treatment CT images of the patient for image-guided radiotherapy.
- Femur bone
    - Atlas construction;
    - 2D to 3D registration.

Personnel: There are a total of 2 faculty members (with two additional faculty members to recruit), one system administrator, one staff member, and a large number of postdoctoral fellows and students. The system administrator maintains the servers and accounts on the servers of the BRIC, and ensure routine backup. The staff person is responsible for maintaining a wide variety of image software, either developed in-house or commercially available software packages. In addition, the staff is responsible for training users in the use of these software packages.

Computational Equipment: The major equipment includes servers, storage devices, backup devices, and workstations to support scientists using the BRIC. There are 5 Dell PowerEdge 1950 servers with 2 quad-core processors and 16GB RAM in each. There are also 5 Dell Precision 390 workstations with a quad-core processor and 2GB RAM and a 24" high resolution wide screen monitor. This gives the lab a total of 72CPUs in computing cluster. All data is stored on a Dell PowerEdge 720XD that houses 21TB on 10K RPM SAS hard drives, which is backed up by a Dell PowerEdge 720 with 24TB capacity.

The IDEA Lab in the CII has 23 Dell windows workstations and 22 Apple iMac workstations. The IDEA Lab also houses 2 Dell PowerEdge R910 Servers each with 256GB RAM and dual 10 core Xeon processors,1 Dell PowerEdge R410 with 2 3.06Ghz quad core Xeon processors and 128GB of memory, and 2 Silicon Mechanics servers with 64GB of RAM and dual six core Xeon processors. Storage for the lab is housed on a Silicon Mechanics storage server with dual six core Xeon processors and 64 GB of RAM supplies 10TB as well as 2 Dell R515 servers with 32GB RAM each that supply 18TB.The storage is backed up by and EMC/Lenovo NAS appliance that has 48TB capacity. All these computers and servers are maintained by a full-time Red Hat and GIAC Unix Security certified system administrator. Also, a full-time software engineer helps pack the software developed in the lab.

Biostatistics Core

This core serves to provide statistical support to those using the BRIC for research projects.

Dr. Zhu will provide the following biostatistics support: 1) Collaborate on protocol development and the conduct of studies (including research design, sampling, measurement, and analysis); 2) Carry out power and sample size calculations; 3) Participate in the preparation of statistical results for abstracts and publication; 4) Analyze data using established statistical methods as well as novel statistical methods developed in-house for specific databases.

Design and Conduct of Studies. We will be involved in the design and implementation of all projects within the BRIC, providing guidance on study design, cost-effectiveness, and testability of hypotheses. This will ensure that the investigators properly address the statistical dimension of scientific questions and implement an adequate plan for statistical analyses, including a clear differentiation between confirmatory analyses and exploratory, or "hypothesis generating," analyses.

Power and Sample Size Calculations. Dr. Zhu will provide investigators with guidance regarding the quantitative properties of the study designs, including the correct power, best sample size, and optimal study duration. Several parameters related to the design of each project within the Center include: Type I and II error probabilities, power, sample size, study duration, and dropout rae. A variety of software packages are available in the Biostatistics Department at UNC-CH for calculating power and sample size. These software packages will be used for more standard designs and tests, such as comparison of means and correlations between imaging and behavioral measures using parametric or non-parametric tests.

Basic Data Analytic Strategies. Dr. Zhu will work closely with investigators on the conduct of data analyses. Investigators and Dr. Zhu will be strongly advised to routinely use the following basic data analytic strategies: *Nominal Type I Error, Descriptive Data Analyses, and Hypotheses-Driven Data Analyses*. The problem of multiple comparisons that arises as a consequence of many analyses can inflate the overall Type I error to unacceptable levels. As typical imaging projects in the BRIC, millions of imaging measures are collected from each subject. We will emphasize the importance of *hypothesis-driven* analytic strategies over an inductive, empirical, or *data-driven* search for associations. Prior to conducting confirmatory statistical analysis, we will conduct exploratory analyses to develop a solid descriptive understanding of our datasets. We will emphasize the difference between *a priori* formulation of research hypotheses and those secondary hypotheses suggested after exploring the data. We will guard against the tendency to force data to fit hypotheses.

Novel Statistical Methods. We will develop new analytical methods that are indispensible for analyzing much of the complex imaging and behavioral data collected in the BRIC and investigating the correlations of imaging and behavioral measures. The development of new methods and the possible integration of multiple measures (e.g., imaging and behavioral measures) will enhance statistical power and test specific hypotheses. Moreover, graduate students will be integral to this methodological development. For novel statistical methods on imaging analysis, Dr. Zhu has developed advanced voxel-based and deformation-based morphometric analysis

methods to detect statistically significant associations between imaging measures (MRI, fMRI, DTI) and clinical and behavioral measures from cross-sectional, longitudinal and family-based imaging studies. We have applied these statistical methods to over *1,000 MR images* with very successful results.

Radiochemistry

This facility was established to enhance the imaging capabilities of basic scientists and clinicians in nuclear medicine. Specifically, radiochemistry was founded to manufacture existing and experimental radiotracers for positron emission tomography (PET) and single photon emission computed tomography (SPECT). The facilities consist of two faculty members, a radiopharmacist, a cyclotron engineer, and a technical support team.

Radionuclide Production (Cyclotrons)

GE PETtrace 880 Cyclotron: The GE PETtrace 880 Cyclotron was installed in 2014 and is dedicated to both academic and clinical studies. The GE PETtrace 880 is capable of accelerating both protons and deuterons for maximum flexibility. The system can be configured with various targets and process systems to produce common PET radioisotopes.

- Proton beam current 130μA, deuteron beam current 60μA
- Simultaneous dual-target irradiation
- Fixed ion source
- Deliver consistently reproducible yields
- System configured to produce different PET radionuclides (^{11}C, ^{18}F, ^{13}N, ^{15}O)
- Housed within a shielded vault

ABT Biomarker Generator: The ABT-BG cyclotron was installed in 2012 and is dedicated to the production of 18F-FDG for clinical studies. The ABT-BG is a 7.5MeV (5μA) “mini”-cyclotron capable of generating 18F at a rate of 1mCi/min. This system was designed for dose on demand applications.

- Automated synthesis of 11C and 18F radiotracers
- Self contained system from irradiation to final product release (radionuclide production, synthesis, QC, final product preparation)
- Electronic batch reporting system (GLP/GMP compliant)
- Small foot-print and requires minimal shielding
- System based on the use of integrated cassettes where reagents and precursor can be loaded into ABT dose-synthesis cards.
- Built-in sensors for operation and synthesis process monitoring. Manual measurement avoided thus eliminating risk of human error.

Radiochemistry

Comecer Hot Cells: The Comecer hot cells were installed in 2014 and are dedicated to both academic and clinical studies. The hot cells are specially designed for research purposes and/or to house various radiochemistry modules. These systems can be configured with automated systems to produce common PET radioisotopes.

- 4x Comecer MIP1100 cells, 1100mm chamber dedicated to routine production or research equipment
- 2x Comecer MIP1390 cells, 1390mm chamber dedicated to routine production or research equipment
- 2x Comecer MIP1390 LAF sPC, 1390mm chamber and shielded prechamber for radiochemistry, dispensing, and radioisotope production
- 3x Tru-motion manipulators for hot cells designed for compact enclosures
- 1x Comecer BBS2 V75, design to house automated modules for routine production (^{18}F-FDG)

Completed and approved applications should be submitted to:

Stephanie Schmitt, Associate Dean for Academics, sschmitt@email.unc.edu

GE FASTlab Synthesizer: The GE FASTlab synthesizer is a versatile and automated PET radiochemistry synthesis box design for easy and efficient production of 18F PET tracers. Primarily utilized for 18F-FDG.

- Includes synthesis box, computer and FASTlab software for automation
- Most widely used for 18F-FDG
- System based on the use of integrated cassettes loaded with reagents and precursor. Manual measurement avoided thus eliminating risk of human error.
- Built-in sensors for operation and synthesis process monitoring.
- Automated data collection into a comprehensive batch record, helping reduce documentation burden.
- High reproducibility achieved through precise delivery of reagents, fine-tuned synthesis parameters, optimized cassette and system design.
- High yield independent of starting activity: for FDG, 74% uncorrected yield, 85% corrected yield, tested up to 19Ci starting activity.

Quality Control

QC Equipment: The QC equipment was installed in 2014 and is dedicated to both academic and clinical studies. The QC equipment is necessary to evaluate the yield, purity, and levels of contaminants in the final product. This equipment communicates with the LIMS system, where data is collected for a consolidated batch report. The radiochemistry QC suite is equipped with the following instruments:

- Radio-HPLC 1: Agilent 1260 Isocratic mode, outfitted with Lablogic rad-detector
- Radio-HPLC 2: Agilent 1260 Gradient mode, outfitted with Lablogic rad-detector
- GC: Agilent 7890A GC to determine levels of residual solvents in final product
- Radio-TLC for radiochemical purity
- Multichannel Analyzer for radionuclidic identity
- Charles River Endosafe-PTS for endotoxin detection and microbial identification
- Lablogic Software (Laura) that communicates with PETra LIMS
- 3x Dose Calibrators for monitoring the quantity of radioactivity

Laboratory Information Management System (LIMS)

PETra LIMS: The PETra LIMS was installed in 2014 and used for data collection, storage and reporting of PET radiopharmaceutical production. This includes monitoring from irradiation to final product release (radionuclide production, synthesis, QC, product release). This unique laboratory information management system controls all aspects of radiopharmaceutical development and compiles all necessary information into an electronic batch report.

- Communicates with cyclotron, synthesis box, and QC equipment
- Aids in production planning/setup
- Electronic Batch reporting (GLP/GMP compliant)
- Embedded standard operating procedures to minimize human error
- Notification of Corrective And Preventative Action (CAPA), Out Of Specification (OOS) and Deviation module
- Advanced Inventory/stock control (barcode driven) for raw materials and reagents

BRIC

BIOMEDICAL RESEARCH
IMAGING CENTER

March 31, 2015

Stephanie Schmitt
Associate Dean for Academics
The Graduate School
University of North Carolina at Chapel Hill

Dear Stephanie,

This letter is to express my highest support for the proposed Biomedical Imaging Science Certificate. The Biomedical Research Imaging Center (BRIC) will serve as the administrative unit for the proposed Certificate. The BRIC is committed to providing administrative support to this Certificate where a BRIC staff member will work with the co-directors on all administrative related issues.

One of the main missions of the BRIC is education. Specifically, through this proposed Certificate, the BRIC strives to extend our capabilities beyond developing imaging research by offering students a unique opportunity to learn and explore practical issues related to imaging acquisition, an essential component of imaging education. In addition, our faculty members are committed to working with the students to further expand training opportunities.

The BRIC currently houses a comprehensive collection of human and small animal imaging equipment, including MRI, PET, SPECT, CT, optical imaging and ultrasound. In addition, a state-of-the-art cyclotron and radiochemistry facility is scheduled to go live this summer. All of these resources will be made available for student training through this proposed Certificate.

In summary, I fully support the proposed Biomedical Imaging Science Certificate. As the Director of the BRIC, I can assure that the BRIC is fully committed to support this important educational task. I look forward to working closely with the co-directors on implementing this proposed Certificate.

Sincerely,

Weili Lin, Ph.D.
Director, Biomedical Research Imaging Center
Dixie Lee Boney Soo Distinguished Professor of Neurological Medicine
Professor and Vice Chair of Basic Research, Radiology
Professor, Biomedical Engineering, Neurology and School of Pharmacy

UNC
BIOMEDICAL RESEARCH
IMAGING CENTER

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THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Joint Department of Biomedical Engineering
The University of North Carolina at Chapel Hill and
North Carolina State University at Raleigh

NC STATE UNIVERSITY

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4130 Engineering Building III, Raleigh, NC 27695-7115
(919) 515-5252; (919) 513-3814 fax
http://www.bme.ncsu.edu

April 1, 2015

Stephanie Schmitt
Associate Dean for Academics
The Graduate School
University of North Carolina at Chapel Hill

Dear Stephanie,

This letter is to express support for the proposed Biomedical Imaging Science Certificate, from the Joint Department of Biomedical Engineering (BME). The Joint Department of Biomedical Engineering and the Department of Psychology will be the Sponsoring Academic Units for this Certificate, although the Biomedical Research Imaging Center will provide administration for the certificate. The BME Department also understands that the plan for the certificate is for it to become a jointly offered UNC-NC State offered certificate in the future. Certification at NC State will be initiated after approval from UNC.

One of the five educational foci of the BME department is medical imaging. This certificate program will provide BME students as well as students from other departments an additional educational experience to bolster their background in biomedical imaging.

The BME department already offers several classes which will be of interest to students participating in the certificate, including BMME 512: Biomedical Signal Processing, BMME 550: Medical Imaging: Ultrasonic, Optical, and MRI, and BMME 560: Medical Imaging: X-Ray, CT, and Nuclear Medicine Systems. Furthermore, BME will offer an additional class specifically for this certificate, tentatively titled “Seminar in Biomedical Imaging Science”. This seminar class will be taught by BRIC and BME faculty and their guest speakers.

This proposed Biomedical Imaging Science Certificate will be a great new educational opportunity for our students, and I strongly support the establishment of this new Certificate program.

Sincerely,

Nancy Allbritton MD, PhD

Nancy Allbritton, PhD, MD
Professor and Chair; Joint Department of Biomedical Engineering
North Carolina State University and the University of North Carolina at Chapel Hill

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DONALD T. LYSLE, PH.D.
Kenan Professor and Chair

March 30, 2015

The Graduate School
University of North Carolina Chapel Hill
200 Bynum Hall CB #4010
Chapel Hill, NC 27599

To Whom It May Concern:

I fully support the proposal for the Biomedical Imaging Science Certificate. The proposed Certificate in Biomedical Imaging Science is interdisciplinary and will attract diverse student populations within the Graduate School, including graduate students within the College of Arts and Sciences, School of Medicine, School of Public Health, School of Nursing, School of Dentistry, among others. This certificate will be offered in addition to the student's departmental or program degrees and is an excellent opportunity for interested students to receive educational training in biomedical imaging without obtaining an imaging-specific degree.

Biomedical Imaging is a critical area of research in many areas including cancer, developmental science, genetics, pharmacology, and neuroscience. Courses relevant to imaging science are distributed across numerous academic units, including the Department of Psychology.

Dr. Kelly Giovanello is a contributor to the project and would serve as the certificate program co-director on behalf of the Department of Psychology and the Biomedical Research Imaging Center. I support her efforts as a co-director to assist in overseeing admissions to the certificate program, advising participants, and evaluating program offerings. Furthermore, I support our Psychology/Biomedical Research Imaging Center faculty in participating in the proposed certificate program as instructors of record, guest lecturers, or practicum supervisors.

The Department of Psychology, in coordination with the Department of Biomedical Engineering, is committed to co-sponsoring the Biomedical Imaging Science Certificate.

Thank you,

Donald T. Lysle

Donald T. Lysle, Ph.D., Chair
Kenan Distinguished Professor

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March 31, 2015

Dr. Steve Matson
Dean, The Graduate School
214 Bynum Hall; CB#4010
Chapel Hill, NC
27599-4010

Dear Steve,

I am writing to enthusiastically support the proposal for a **Biomedical Imaging Certificate**. After several months of discussion and planning with colleagues at the Biomedical Imaging Research center (BRIC), Department of Psychology, and Department of Biomedical Engineering, I am convinced that unique interdisciplinary program will be an asset to our students at Carolina. Our research suggests that the program will attract students from graduate programs across our campus, including the School of Medicine, College of Arts and Sciences (Departments of Biology, Computer Science, Chemistry, Physics, and Psychology), School of Public Health, School of Nursing, School of Dentistry, and School of Information and Library Sciences, as well as from the schools and colleges at NC State such as the College of Engineering and the College of Veterinary Medicine.

As you know, we now have a state-of-the-art biomedical imaging facility – Marsico Hall, and we hope to extend the use of the facility to as many students and faculty as possible. This certificate program can serve as a gateway to accomplish this goal. Unlike minor or specialization tracks, a self-standing certificate program can address the needs of diverse student populations interested in biomedical imaging. Courses relevant to imaging science are currently distributed across numerous academic units, and this program will help to coordinate our efforts to create a logical and clear aggregation of courses. The program will bring together faculty who already share similar research interests and expertise, and engage students in a focused training program related to biomedical imaging.

The College of Arts and Sciences supports this initiative and will be an active participant working with the Graduate School and other units across the university to ensure its success. I hope you and your committee will see the value in supporting the certificate program. Should you have questions regarding the participation or commitment of the College in this endeavor, please feel free to contact me.

Sincerely,

Kevin M. Guskiewicz

Kevin M. Guskiewicz, PhD
Kenan Distinguished Professor, Exercise and Sport Science
Senior Associate Dean, Natural Sciences

UNC SCHOOL OF MEDICINE

Office of the Vice Dean for Research

March 31, 2015

Stephanie Schmitt
Associate Dean for Academics
The Graduate School
University of North Carolina at Chapel Hill

Dear Stephanie:

I am writing this letter in strong support of the proposed Biomedical Imaging Science Certificate. The School of Medicine has invested heavily in the Biomedical Research Imaging Center (BRIC) not only to recruit highly talented faculty, but also to furnish unique imaging equipment. The BRIC now houses four human imaging scanners and a wide array of small animal imaging systems. The imaging modalities include magnetic resonance imaging, ultrasound, computed tomography, single-photon emission computed tomography, positron emission tomography, and optical imaging systems. In addition to these imaging systems, the BRIC also houses well-versed research programs. These programs include neuroimaging, which investigates morphological and functional alterations in neurological and psychiatric disorders, as well as investigating normal brain development during early infancy. Additional programs include to develop novel imaging analysis and statistical tools, formulate novel imaging probes to shed light on molecular and cellular events, devise novel imaging equipment, develop innovative image acquisition approaches, informatics, epidemiology, and oncological imaging. The proposed Biomedical Imaging Science Certificate will leverage on the tremendous resources available in the BRIC to maximize their impact on education. In particular, one of the unique strengths offered by this Certificate is the opportunity for students to gain first-hand experience on how each different imaging modality operates. This exceptional opportunity is likely to be highly attractive to students who are interested in imaging training. In addition, the research expertise of BRIC faulty is diverse, so that students will have the opportunity to explore a wide array of imaging related topics.

Developing a world premier biomedical imaging research program has been one of the top research priorities in the School of Medicine. The proposed Biomedical Imaging Science Certificate is consistent with my vision of future development of research endeavors in the School of Medicine. Therefore, I support the proposed Biomedical Imaging Science Certificate with high enthusiasm.

Sincerely,

Terry Magnuson

Terry Magnuson, Ph.D.
Sarah Graham Kenan Professor
Vice Dean for Research, School of Medicine
Chair, Department of Genetics
The University of North Carolina School of Medicine
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