Massachusetts AI & Technology Center

for Connected Care in Aging & Alzheimer's Diease

Request for Applications, 2021-2022

1. Program Overview

The *Massachusetts AI and Technology Center for Connected Care in Aging and Alzheimer's Disease (MassAITC)* is a multidisciplinary National Institute of Aging (NIA) P30 Research Collaboratory (1P30AG073107-01) spanning five sites – the University of Massachusetts Amherst, Brigham and Women's Hospital, Massachusetts General Hospital, Brandeis University and Northeastern University. The Center aims to foster multidisciplinary research on the development, validation and translation of emerging AI-enhanced technologies to more effectively support healthy aging and the care of patients with Alzheimer's Disease and Alzheimer's Disease Related Dementias (AD/ADRD) in their home environments.

MassAITC is pleased to issue a call for proposals to support pilot studies on wearables, contactless sensors, emerging machine learning, AI and data-driven visualization technologies that have the potential to improve the health of older adults and individuals with Alzheimer's Disease and related dementias. MassAITC has a particular focus on supporting successful aging at home through the development of technologies that better connect older adults, caregivers, and clinicians.

2. Funding Opportunity Description

For the upcoming year, the MassAITC will fund up to 15 pilot projects. Although most projects will be funded for a 12-month period with a maximum budget of $100,000 in direct costs, higher levels of funding (i.e., up to $200,000 in direct costs) and multi-year projects will also be considered with appropriate justification.

We encourage pilot investigators to leverage the state-of-art research facilities, diverse cohorts, and translation services provided by the MassAITC partner institutions. The Center can also provide guidance for investigators regarding the design and conduct of interdisciplinary pilot projects that address stakeholder needs and leverage promising technologies suitable for pilot research projects. Learn more at https://www.massaitc.org/

Key dates and URLs:

- Application Submission: https://www.a2collective.ai/pilotawards
- Applications Open: Jan. 10, 2022
- Q&A Webinar: Jan. 18, 2022
- Applications Close: Feb. 18, 2022
- Awards Granted: May 30, 2022

If prospective applicants would like assistance in assembling an appropriate investigative team, we would be pleased to provide consultative assistance. Please contact: pilot-info@massaitc.org

3. Pilot Research Focus Areas

Most older Americans want to age at home, yet chronic physical and cognitive conditions or environmental barriers pose challenges for them to do so. Successful aging at home will require effective ways for older adults to utilize and access health care services from their homes, but barriers currently exist including a lack of technologies that have been specifically developed for older adults, cognitively-impaired older adults, caregivers, and their clinicians, as well as a lack of decision support tools that consider the unique needs of monitoring older adults in their homes while helping them maintain functional independence.

We solicit pilot projects that focus on bridging these gaps by improving accuracy, decreasing algorithmic bias, enhancing usability, decreasing burden, and improving accessibility of AI-enhanced technologies. MassAITC anticipates that addressing these challenges will require cross-cutting technology solutions proposed by interdisciplinary teams. In this application cycle, MassAITC solicits pilot projects focused in three broad areas:

1. *Development and validation of AI-enhanced devices with lower burden, reduced algorithmic bias, improved accuracy, improved access and/or enhanced usability for patients and caregivers.*
2. *Development and validation of AI-enhanced data analytic solutions to distill multi-modal sensor and cognitive performance data into interpretable and actionable information to enhance self-care, support caregivers, and/or improve clinical and caregiving decision making.*
3. *Development and validation of data-driven visualization technologies and systems that distill large volumes of data for patients, caregivers and/or clinicians.*

All pilot applications must describe why the problem that they are addressing is a critical barrier to achieving successful aging and/or Alzheimer's Disease care at home, and how the AI methods and technologies that they propose are well-suited to address the problem. We briefly describe two illustrative examples below.

3.1 Aging Pilot Project Example

- **Problem**: Aging-related declines in gait speed, balance, and muscle strength can compromise the ability to maintain an active and independent lifestyle. Yet, most older adults do not engage regularly in physical activity, which can impact functional health and independence in later life. Further, wearable devices that detect steps and other forms of physical activity can perform poorly for older adults due to difference in gait and other characteristics relative to the population current such devices are optimized for.
- **Example Solutions**: A potential pilot could validate new AI-enhanced devices and/or algorithms that are specifically tailored to older adults or provide new capabilities such as the ability to adapt monitoring outputs to individual impairments to improve accuracy.

3.2 AD/ADRD Pilot Project Example

- **Problem***:* The progression of cognitive, psychiatric, and motor symptoms is an unfortunate hallmark of AD/ADRD and neurodegenerative diseases in general. For patients, this progression of symptoms often leads to a need for more care to maintain patient safety and quality of life. Clinicians are often asked to advise families on how to navigate transitions such as hiring a professional caregiver or moving to assisted living or nursing home care, but have do so with limited objective information on changes in caregiver burden and the level of support patients need to perform activities of daily living (ADLs, e.g., eating, dressing, toileting).

- **Example Solutions**: Technology and AI tools in the homes of individuals with AD/ADRD can provide objective data to support decision making about the level of caregiver support needed. A potential pilot could assess changing levels of independence through developing AI-assisted monitoring of ADLs as well as the level of caregiver assistance that is required.

4. Eligibility

4.1 Institution

- Eligible institutions include colleges, universities, medical or nursing schools, health care systems or settings, or other fiscally responsible organizations including for-profit corporations within the United States. No research may be performed outside of the United States.

4.2 Principal Investigator

- Any individual(s) with the skills, knowledge, and resources necessary to carry out the proposed research is invited to work with their organization to develop an application.
- Applicants must hold an appropriate position at an eligible institution by the start date of the award or be otherwise eligible to serve as a Principal Investigator as determined by their organization.
- Applicants from under-represented racial and ethnic groups as well as individuals with disabilities are strongly encouraged to apply for funding.

5. How to Apply

Interested applicants should submit a completed application at https://www.a2collective.ai/pilotawards by no later than Feb 18, 2022.

Proposals will be reviewed and applicants who have submitted highly rated proposals may be invited for a presentation and Q&A if reviewers have additional questions. Final selections will be made thereafter.

Proposals that have been selected for funding will be required to submit additional documentation to NIH including a detailed budget, a project management plan, human subjects protections information and recruitment criteria, and other information.

6. Pilot Selection Criteria

The review process will consider the following criteria and weigh them as appropriate for each application to assign an overall score. Note that an application does not need to be strong in all categories to be judged likely to have significant impact and be a strong fit for this pilot program.

6.1 Scientific Merit

- Does the project explore innovative technologies and propose forward-looking solutions with the potential to significantly improve successful aging and AD/ADRD care?
- Does the project focus on development, validation, and translation of AI-enhanced technologies?
- Are the proposed analytic methods, technological approaches and/or study design technically feasible and deployed appropriately?
- Are health equity considerations integrated into the design elements of research plan?

- Can the study be feasibly completed within the proposed timeline?

6.2 Strengths of the Investigators

- Do the investigator(s) have a track record of innovative and high-impact research?
- Does the team's prior work and expertise support the likelihood that they can accomplish the proposed project?
- Does the team include both technology and clinically-oriented collaborators?

6.3 Impact and Translation

- If successful, does the pilot project have the potential to lead to high-impact publications, future grants and/or translation opportunities.
- Does the project strengthen a connection with industry, foster a new start-up venture, or enable a translational grant submission?

6.4 Human Subjects

- Investigators will need to present a clear plan for how human subjects and data privacy risks will be managed.

6.5 Leveraging MassAITC Resources

- Does the project leverage the resources in the center to improve efficiency (e.g. use of MassAITC core facilities, cohorts or other resources)?

6.6 Resources Sharing

- *Datasets*: Will the project produce datasets that are properly anonymized and curated with high quality ground truth that can be used by future MassAITC researchers or the research community at large?
- *Software/Hardware*: Will software and/or hardware developed using pilot project resources be made available to future MassAITC pilot projects or to the research community at large?

7. Pilot Grant Recipient Expectations

The pilot project PI will meet with an assigned mentor from the MassAITC at quarterly intervals during the lifecycle of the pilot project. The assigned mentor will be available to help strategize, identify resources that are available, assist with navigating pitfalls, etc. Pilot investigators will be required to engage with the MassAITC by:

- Participating and offering new content in their area of expertise to enhance the training activities of the Center (e.g., tutorial on relevant topic, developing a "best practices" document).
- Attending and presenting at the in-person MassAITC Annual Meeting in Boston, MA
- Presenting webinars in the Center's seminar series.
- Exploring methods for sharing datasets, software and hardware platforms, and other artifacts across center investigators to enhance future pilot studies.

Facilities & Other Resources

A. OVERVIEW

This document describes how the scientific environment of the *Massachusetts AI and Technology Center for Connected Care in Aging and Alzheimer's Disease* (MAITC) contributes to the probability of success of the Center's research and broader pilot research program. The MAITC spans five institutions within the commonwealth of Massachusetts including the University of Massachusetts Amherst (UMass Amherst), Massachusetts General Hospital, Brigham and Women's Hospital, Brandeis University and Northeastern University. Via its member institutions, the MAITC will bring to bear the combined resources of multiple existing centers and institutes including UMass Institute of Applied Life Sciences (IALS), two NIA Roybal Centers, the Massachusetts Alzheimer's Disease Research Center, and the Northeastern Consortium for Proactive Care. These institutions, centers, and institutes comprise the MAITC's scientific environment. Through them, the MAITC will bring to bear extensive leadership experience, comprehensive research expertise, and state-of-the-art research facilities. We first describe this environment, followed by a description of specific research and administrative facilities and other resources.

B. Scientific Environment

B1. University of Massachusetts Amherst. The University of Massachusetts Amherst, located in Amherst MA, is ideal for studies of research on technologies that support aging at home. UMass Amherst is home to NIH- and NSF-funded investigators housed in four colleges and schools across campus who focus on research in aging. The MAITC will benefit from advances in realizing the campus strategic plan for research, guided by the Vice Chancellor for Research and Engagement Michael Malone (see letter of support), to invest in comprehensive infrastructure for life sciences research, community engagement, and diversity and inclusiveness. Engagement of state and industry stakeholders is also a campus strategic priority. Investments in infrastructure have been made to support large scale, integrative, and translational research in the life sciences, including dedicated buildings, new, interdisciplinary research facilities, and equipment cores. In addition, investments have been made to support strategic development of large scale, complex research initiatives, comprehensive administrative support for proposal development and submission, and post-award administration. Preparation of this application was supported by administrative staff from several offices within the Office of Research and Engagement. The Office of the Vice Chancellor for Research and Engagement established a Project Management and Training Office to support startup and operations of large sponsored research programs, which will be instrumental in the successful launch of the proposed Program Project. Beyond facilities and administration, the UMass Amherst Office of the Chancellor has made strategic investments to strengthen community outreach and engagement, and recruit and retain an increasingly diverse faculty, postdoctoral workforce, and student body in the context of a sustained campus-wide campaign to create a campus environment exemplifying commitment to diversity, equity, and inclusion. UMass Amherst is home to the Institute for Applied Life Sciences, where MAITC co-director Dr. Ganesan leads the Center for Personalized Health Monitoring.

B.2 Brigham and Women's Hospital. Brigham and Women's Hospital (BWH), located in Boston MA, is home to one of the largest biomedical research institutes in the world. With total research expenditures topping $400 million (64% attributed to NIH grants), BWH has 2,600 professional and technical staff devoted to research, including over 1,000 Primary Investigators (PIs) and 800 research fellows. The BWH Biomedical Research Institute is the umbrella organization for all research efforts at the hospital. BWH is a 747-bed tertiary care facility that is recognized internationally for its excellence in patient care and commitment to educating and training research scientists, physicians, and other health care professionals. Along with its modern inpatient facilities, it boasts extensive outpatient services and clinics, neighborhood primary care health centers, practice-based research networks, state-of-the art diagnostic and treatment technologies and research laboratories. The hospital and outpatient facilities maintain electronic medical records that are accessible to hospital research faculty with appropriate IRB approval. BWH is located in the Longwood Medical Area, which is home to Harvard Medical School (HMS), Harvard T.H. Chan School of Public Health (HSPH), Harvard Dental School, Dana Farber Cancer Center and the Beth Israel Deaconess Medical Center. These

institutions provide a wealth of research activities and seminars. Faculty and researchers at BWH also benefit from the BWH Biomedical Research Institute (BRI), which has a mission to accelerate the pace of scientific discovery by fostering groundbreaking, interdepartmental and interdisciplinary research within the hospital's research community, as well as to provide a clear voice both within the hospital and outside its walls. The BRI includes eight research centers that develop and support collaborative research initiatives not tenable by individuals and single departments along. The BRI also provides a large offering of services, educational and training opportunities, resources, and hosts events for researchers. These include, but are not limited to, research management and administrative support, seminars on careers in research, and clinical research training courses. BWH is home to the NIA P30-funded Center for Therapeutic Optimization using Behavioral Science, a Roybal Center led by MAITC co-director Dr. Choudhry.

B.3. Massachusetts General Hospital. The Massachusetts General Hospital (MGH), located in Boston MA, is the home of the NIA P30-funded Massachusetts Alzheimer's Disease Research Center (MADRC) where MAITC investigator Dr. Blacker is a core lead and MAITC investigator Chhatwal is a member. MGH is also home to the Partners Neurology Residency Training Program. The MGH Charlestown campus is home to the Martinos Center for Biomedical Imaging, a world-class facility for state-of-the art MR image acquisition and analyses. The MGH PET Core, a renowned nuclear medicine clinical research facility has major facilities in the MGH Main campus. The MassGeneral Institute for Neurodegeneration (MIND) was founded in 2001 is a center with 27 investigators studying Alzheimer, Parkinson, and Huntington diseases and ALS. Core facilities include an animal care unit, a bioinformatics/biostatistics unit, and a neurodegenerative disease Brain Bank. The BWH Center for Neurologic Diseases (CND) provides a rich basic neuroscience laboratory environment for collaboration on the study of Alzheimer's disease (AD) biology. There are more than 240 scientists working at the bench, and their expertise spans biochemistry, immunology, genetics, molecular biology, cell biology, neuropathology, electrophysiology, pharmacology, and medicinal chemistry. The Center for Alzheimer Research and Treatment (CART) at MGH, led by Dr. Reisa Sperling, is the clinical trial arm of the Alzheimer's program across BWH and MGH. In addition, the broader Harvard Medical School community provides an ideal environment for collaboration, including the core resources of the Harvard NeuroDiscovery Center Biomarkers Study, as well as the Harvard Catalyst Clinical and Translational Science Center (CTSC). The Harvard Aging Brain Study also has collaborations with investigators at the Massachusetts Institute of Technology (MIT), the Broad Institute, and the Harvard University College of Arts and Sciences. The intellectual environment at MGH, the larger Harvard Medical School community, and in other leading institutions in Boston will greatly enhance the work of the MAITC.

B.4 Brandeis University. Brandeis University, located in Waltham, MA, 8 miles west of Boston, is a member of the Association of American Universities and is accredited by the New England Association of Schools and Colleges. Because of its research capabilities and size, Brandeis is able to combine the breadth of academic and research programs usually found at much larger universities. Brandeis enrolls 3,300 undergraduates and also serves 2,300 graduate students in the Graduate School of Arts and Sciences and two professional schools – the Heller School for Social Policy and Management and the International Business School – as well as the Rabb School of Continuing Studies. Brandeis is home to the NIA P30-funded Boston Roybal Center for Active Lifestyle Interventions led by MAITC investigator Dr. Lachman.

B.5 Northeastern University. Located in Boston, MA, Northeastern faculty members direct more than 35 research and education centers, including a National Science Foundation (NSF) Engineering Research Center, an NSF Nanomanufacturing Center, and seven health sciences cetners. Over the past five years, the university has appointed more than 250 tenured- and tenure-track faculty members, with a focus on scholars who collaborate across disciplines. Northeastern offers undergraduate majors in 65 departments. At the graduate level, there are 125 programs. Academics at Northeastern is grounded in a liberal arts education and the integration of classroom studies with experiential learning opportunities, including cooperative education, student research, service learning, and global experience, including study abroad and international co-op. The Northeastern Bouvé College of Health Sciences and Khoury College of Information Science are jointly home to the Northeastern Consortium on Technology for Proactive Care, led by MAITC investigator Dr. Jimison.

C. Clinical and Laboratory Facilities

The MAITC Clinical Translation and Validation core will leverage laboratory facilities in the UMass Amherst Institute of Applied Life Sciences (IALS). Pilot projects will also have the ability to leverage IALS facilities and core services for lab-based validation testing on a fee-for-service basis. Lab facilities will also be available to pilot investigators at Northeastern University, and standing patient cohorts will be available through the MADRC at MGH. Investigators from MGH, BWH and Brandeis will have access to additional facilities at these sites.

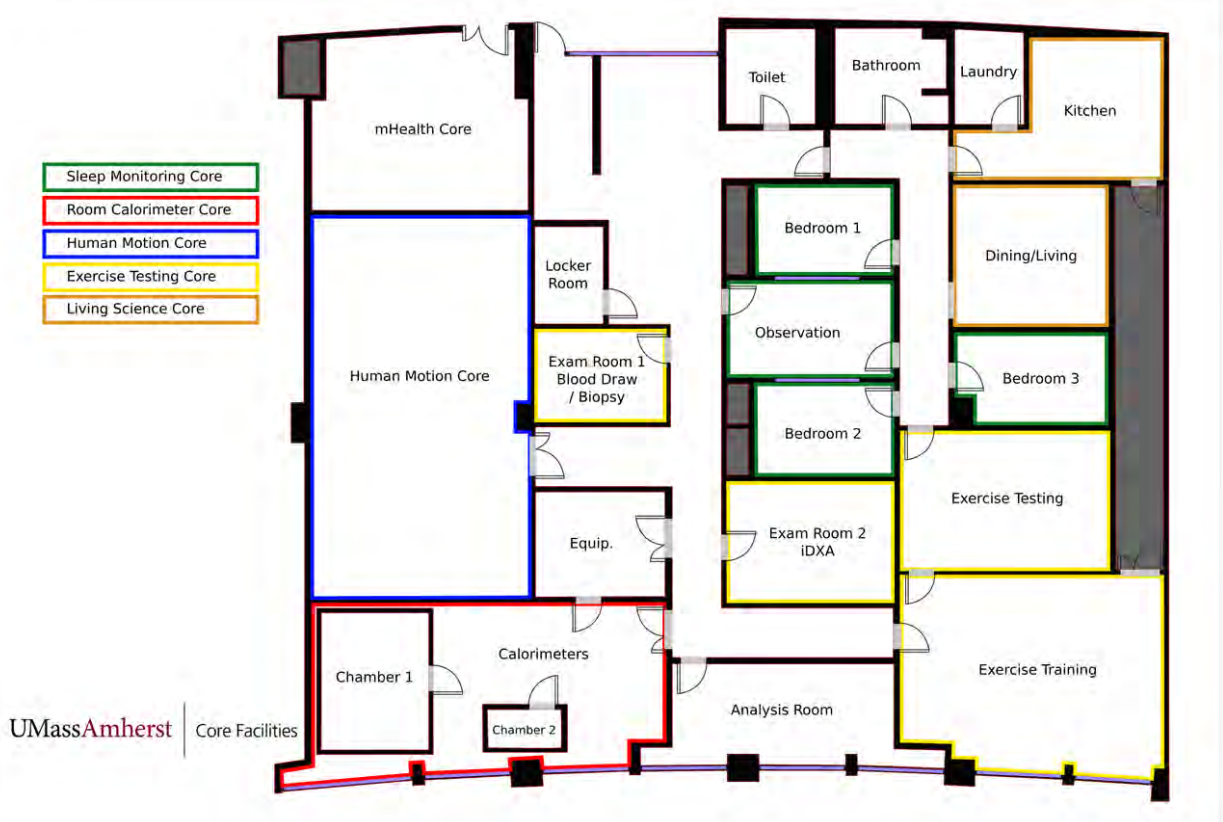
C.1 University of Massachusetts Amherst. The Institute of Applied Life Sciences is located in the Life Sciences Laboratories building (>400,000 square feet) opened in 2014. The south side of the building was designed expressly for IALS and is now home to three 3 IALS centers and 30+ core facilities. The Center for Personalized Health Monitoring (CPHM) in IALS contains professionally-staffed Core Facilities that will support the aims of this Program Project Grant. These Cores are spread over three floors of the LSL building, including the Human Magnetic Resonance Center (hMRC, 2nd floor) and the Human Testing Center (HTC; 3rd floor). The HTC provides comprehensive facilities and equipment dedicated to human testing and interventions, including the Exercise Intervention and Outcomes and Human Motion Cores. IALS provides meeting rooms for face-to-face and video conferencing, a conference center that accommodates meetings of up to 90 participants, and office spaces for faculty and staff. The administrative offices of IALS Core Facilities that will support this project (see letter of support, Andrew Vinard, Core Facility Director) are located on the 3rd floor of LSL, across the hall from the HTC. Reserved parking for study participants is available adjacent to the LSL building.

Figure 1 - Life Science Laboratories Building, home to IALS

C.1.1. Center for Human Health and Performance. Located on the 3rd floor in the Life Science Laboratories the Center for Human Health and Performance (CH2P), the core facilities associated with the CH2P will be integral to MAITC research. CH2P allows for the comprehensive investigation of physiological, biomechanical and behavioral studies and is comprised of five core facilities including the Human Motion Core, Living Science

Core, Sleep Monitoring Core, and the Exercise Interventions and Outcomes Core, all of which will be important resources for the MAITC.

Figure 2 - Center for Health and Human Performance, Floorplan



The Human Motion Core Facility, which will be used by MAITC investigators to assess and validate sensing technologies aimed at quantifying biomechanical targets relevant to movement, balance, and gait, is designed and equipped for assessment of human movement (with and without robotic assistance) and the evaluation of wearable technologies that aim to quantify human motion. The Human Motion Lab is a large open space (38’ x 20’) with a 10’ ceiling and is located within the Center for Human Health and Performance. Having the Human Motion Lab located within the Center for Human Health and Performance allows us to conduct a wide variety of studies evaluating the effects and interactions of human motion with behavior, sleep, aerobic fitness, strength, body composition and muscle function. The lab is equipped with nine high speed infrared motion analysis cameras, three force platforms and a collaborative robot arm. The equipment in the Human Motion Lab enables precision evaluation of human motion and the forces acting on and within body during movement. This equipment in the Human Motion Lab also provides the capability to assess and validate wearable technologies aimed to quantify biomechanical targets relevant to movement or balance. Knowledge gained by the study of human motion provides specifications and targeted outcomes for biomechanically assistive devices aimed to improve or restore motion. A featured piece of equipment in the Human Motion Lab is the KUKA LBR robot arm. The KUKA LBR is one of the most advanced and sensitive robotic arms available, and can be used to interact directly with people. It is used to enhance understanding of human-machine interaction with a focus on improved medical rehabilitation techniques and the manufacturing and validation of assistive devices. The combination of this interactive robot with a motion capture system is a unique capability in the world. The robot also allows for characterization of sensor technologies through emulation of human movement for stability or variability testing.

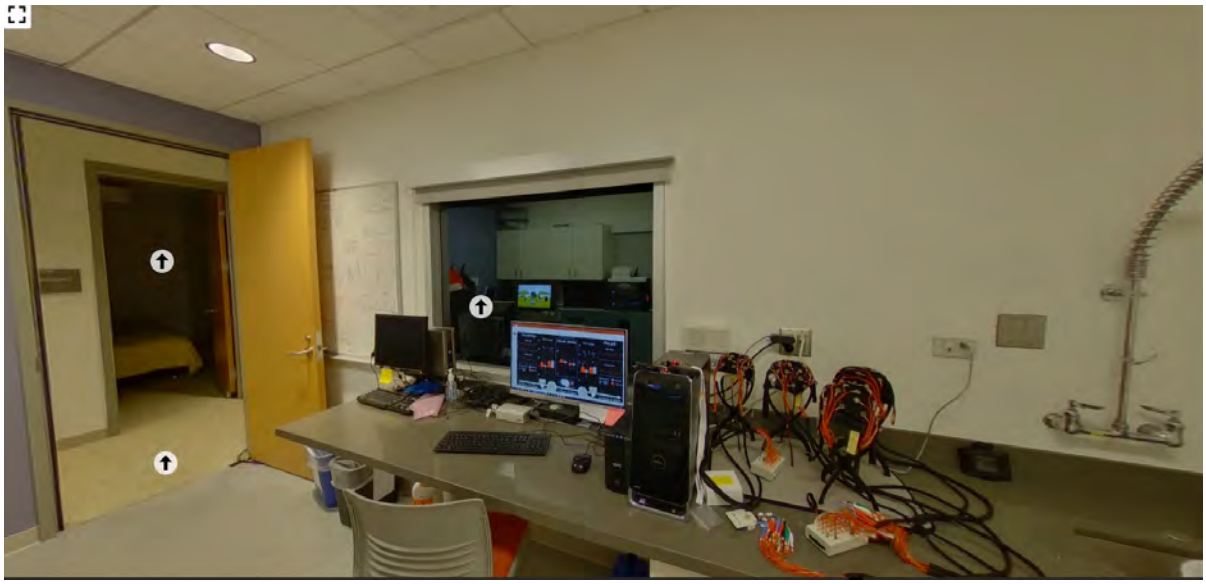
Figure 3 - Human Motion Core Facility

The Living Science Core Facility, a two-bedroom fully instrumented facility that will be used by MAITC to enable clinical validation of technologies that identify, measure, or predict clinical, biological, physical, or functional state under controlled settings with high-quality ground-truth. It is a unique home-like setting where researchers are able to investigate human behavior and validate the data from wearable activity/health monitors for prolonged periods. Measurements gathered from the instrumentation allow researchers to gain the information necessary for the calibration and/or validation of wearable activity monitors. Data generated can serve many research study designs, ranging from the development of the next generation of wearable and embedded monitoring devices to basic studies looking to objectively evaluate how individuals spend time in a natural setting. The Living Science core provides:

- Viso video capture and Observer XT video coding software by Noldus, allowing researchers the ability assess both the quality and duration of activity where participants can act “naturally” in this home-like setting.
- Equipped with an Oxycon Mobile metabolic system that can be used to assess energy expenditure and macro-nutrient utilization, for short durations (i.e. 1-2 hours).
- Houses several research grade wearable activity monitors, which allow newly designed devices to be compared to industry standards.

Figure 4 - Living Science Core Facility, Kitchen

Figure 5 - Living Science Core Facility, Observation Room



The Sleep Monitoring Core, Directed by MATIC Investigator Rebecca Spencer, is the only sleep research facility in the region equipped for overnight sleep studies to access sleep and sleep physiology. The center has three bedrooms that can be used for polysomnography, the gold standard for sleep measurement. On-line sleep monitoring from a central control room allows for sleep stage specific manipulations.

Figure 6 - Sleep Monitoring Core

The Exercise Interventions and Outcomes Core houses a wide variety of equipment that provides researchers with facilities in which they can:

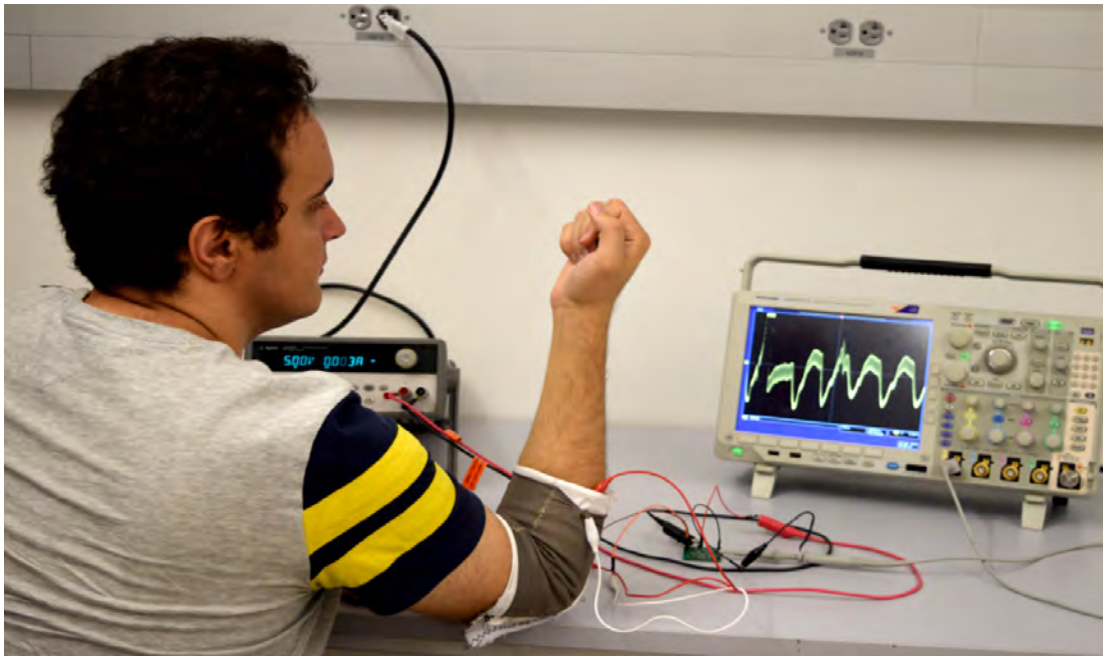
- Evaluate clinical markers of health: height, weight, cardio-metabolic function, strength, and blood/biopsy generated measures.
- Complete participant characterization: strength, metabolic capacity, cardiac function, body composition (bone, fat, muscle) – including separation of visceral and subcutaneous abdominal fat
- Conduct exercise intervention studies in a controlled setting. Participants can be closely monitored to ensure compliance to ensure precision in dose/response measures.
- Evaluate a wide range of health-related biomarkers in the core or utilize other IALS Cores for additional characterization

C.1.2. Usability Lab. The usability lab provides support for developing usability surveys, multimodal sensor data summarization/visualization tools, and configurable alert/intervention tools.

C.1.3. mHealth Lab. mHealthLab, directed by MAITC Co-PI Ganesan, provides a state-of-the-art testbed for performing mobile health experiments at scale, and developing robust and personalized mHealth detectors.

mHealthLab is designed to enable continuous personalization of detection models to individual users through a design methodology that takes into account the constraints and opportunities of wearable-smartphone-cloud platforms. The lab's goal is to design a personalized mobile healthcare system that obtains timely information from individuals to personalize detectors, and continually re-learns how to split sensing and computation across diverse devices to provide accurate real-time health and wellness information. The software infrastructure provided by mHealthLab includes: a) Subject recruitment tools that will solicit potential participants from the pool of users, b) Data collection methods to continuously collect data from the phone, either through the LTE network or via WiFi access points on campus, c) Access to de-identified data for specific research purposes, d) Access to a variety of plugins to obtain different types of sensor data from the mobile phone or specific health accessories, e) Data storage and access methods on a private cloud, e) Inference toolkit to extract specific high-level inferences from raw sensor data including activities, social interaction patterns, stress, sleep, eating, drinking, and other behaviors, and f) Web-based visualization to digest multi-modal multi-user stream.

Figure 7 - mHealth Laboratory

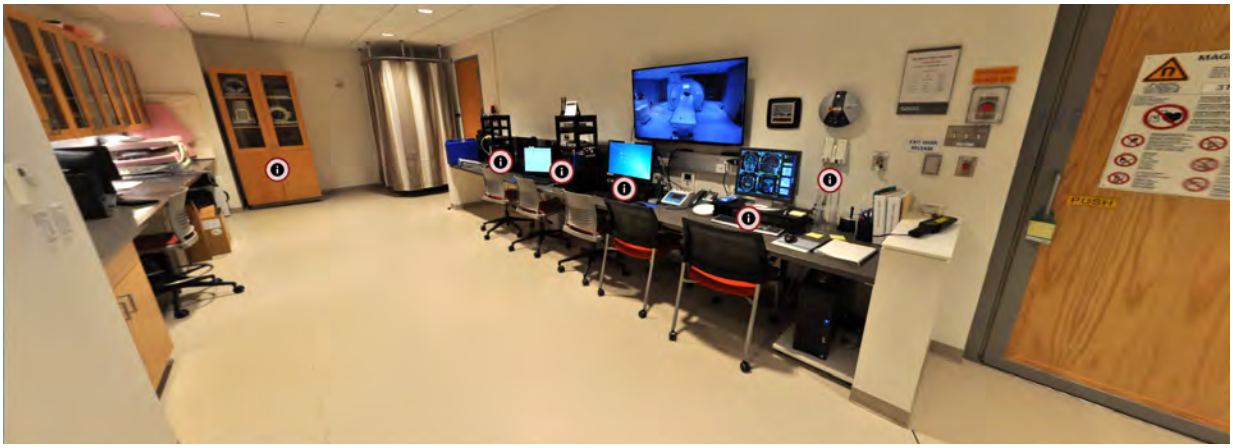


C.1.4. Sensor Development and Integration Lab. The Sensor Integration includes capabilities for integrated circuit packaging and prototyping important to the MAITC Clinical Translation and Validation Core. Tools and equipment are available for wafer dicing, die mounting and alignment, and wirebonding and metal trim providing a complete set of capabilities for preparing sensors and integrated systems for evaluation and test.

- Vector Network Analyzer E5071c 8.5 GHz
- Flip Chip Bonder Finetech FINEPLACER
- Wafer Saw Advanced Dicing Technology 7122

C.1.5 Human Magnetic Resonance Center (hMRC). The Human Magnetic Resonance Center (hMRC) provides state-of-the-art, non-invasive neuroimaging, whole body imaging, and spectroscopy technologies for academic and industry-based research in central and western Massachusetts. This is the only research-dedicated 3T MRI/MRS system in western Massachusetts. This system is ideal for investigating questions regarding normal and abnormal changes in human brain and whole body structure and function across the lifespan.

Figure 8 - Human Magnetic Resonance Imaging Core



C.1.6. Human Performance Laboratory. The Human Performance Lab includes an advanced fixed-based driving simulator located in a dedicated laboratory space and comprises a full vehicle cab surrounded by front side and rear projection screens providing a 330 degrees horizontal visual field of view. Drivers in the simulator cab are able to drive through a virtual reality environment projected on the screens using the vehicle controls as if in a real automobile. The visual representation of the virtual environment changes appropriately in response to drivers' actions. The virtual environment, i.e., the "simulated world", is designed and created in-house which allows customizability of the simulations to suit various research purposes. In addition to the ability to craft the virtual physical environment (roadways, pavements, traffic control devices, vegetation, buildings, etc.), it is also possible to program the other actors in the virtual environment including other traffic, pedestrians, and the interaction between these and the driver (normally the research participant). The in-vehicle user interface can also be programmed, leading to customizable instrument clusters, center displays, and audio and other feedback to drivers. This programmable flexibility creates a versatile platform for studying driver behaviors and other automotive human factors related issues including human-machine interface design, traffic engineering, signs/signal, etc.

The University of Massachusetts Amherst Driving Simulator

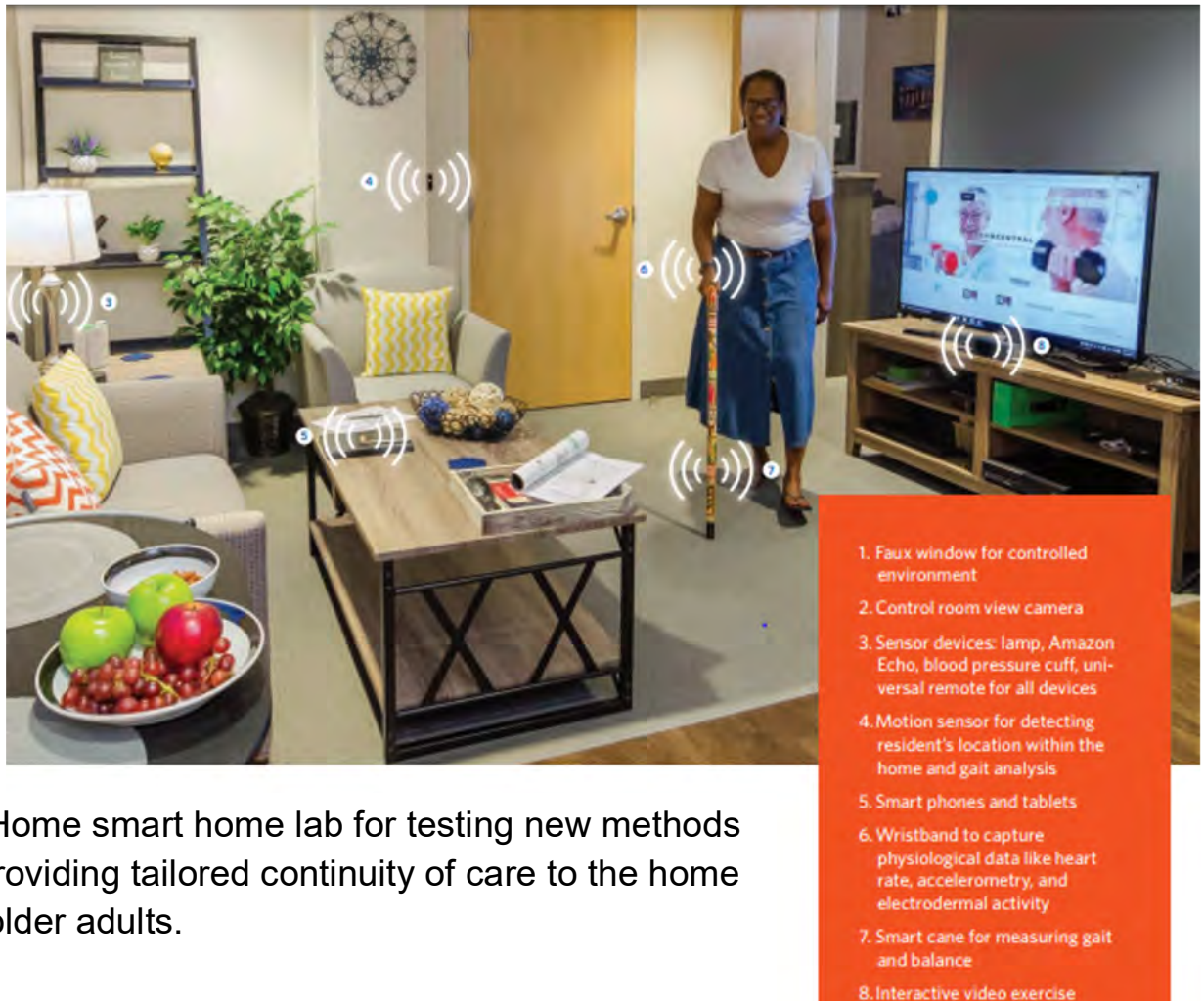
C.1.7 IALS Recruitment Services. Pilot project that leverage IALS facilities will have access to on-site subject recruitment services on a pay-per-use basis to assist with recruiting subjects for lab-based studies.

C.2 Northeastern University. MAITC pilot research investigators will have access to several services and facilities through the Northeastern Consortium on Technology for Proactive Care.

C.2.1 NUCoach Platform. NUCoach is the Consortium's modular health coaching and research platform available for all members of the Consortium. NUCoach is a framework (and a flexible, collaborative platform) for designing ubiquitous monitoring and health coaching solutions by organizing sensor data (inputs from patients) in a secure, flexible and yet scalable manner permitting distributed data processing and data analytics. The design is based on reusable modules that collect, analyze data and interface with diverse types of users (administrators, researchers, coaches, patients and, other modules). Research projects can utilize multiple NUCoach features and modules, including text reminders and mobile surveys, and support the development of many new features. Additional functionality is developed as needed using the Module Builder module. The NUCoach system provides a suite of services and built-in support, include server space (Digital

Ocean), integration with text message subscription services (Twilio) and Amazon Web Service's Lambda function for serverless computation, SSL maintenance, and domain name registration.

C.2.2 Smart home laboratory. Drs. Jimison and Pavel recently opened their smart home environment laboratory, NUHome, which can be used for stakeholder focus groups to demonstrate visioning exercises for how technology could be used to enhance health interventions for older adults, patients with dementia and caregivers of Alzheimer's patients. We also will make the NUHome Laboratory available to pilot projects to test technologies and in-home protocols for their studies. Located on the 4th floor of Richards Hall at 360 Huntington Avenue, the NUHome Lab is a 600 square foot enclosed space architected as a one-bedroom apartment with an adjacent computer control room. It is equipped with a full spectrum of sensors, including a set of 2D and 3D cameras, passive infrared sensors, contact switches, microphones, etc., that are used to



NUHome smart home lab for testing new methods of providing tailored continuity of care to the home for older adults.

make an accurate assessment of the participants' actual behaviors during testing the systems to be deployed in several studies.

C.2.3. Other Facilities. In addition to NUHome, Northeastern has several laboratories that would be available on a sharing basis to the pilot projects. For example, the College of Computer and Information Science houses the Human-Computer Interaction (HCI) Laboratory, where mobile phone software development and pilot usability testing can take place. The HCI Laboratory is a 1,500 square foot facility dedicated to supporting the development and evaluation of advanced human computer interface technologies. The laboratory includes rooms used for interviewing and observing human subjects and testing in-home and mobile sensor technologies, in addition to space for development computers. The laboratory is housed in Northeastern's West Village H building, which aggregates most Computer & Information Science College functions in one

location, including classrooms, computing laboratories, and faculty and graduate student office space. There is adequate laboratory space for the faculty and staff involved in the proposed project.

The Bouve College of Health Sciences houses, among many other facilities, a Human Physiology Laboratory. This facility can be used for pilot testing of motion sensors using research-grade treadmills, exercise and strength measurement equipment, and calorimeters. The Computational Behavioral Science Lab (CBSL also resides in the Bouve College of Health Sciences. The lab consists of the following four connected spaces, totaling 1,500 square feet: (1) Behavioral observation room (218 square feet) is equipped with 4 high-resolution, discretely mounted ceiling and wall cameras; 2 Kinect cameras, and 1 wearable point-of-view camera; 1 ceiling mounted boundary layer and 2 wearable lapel microphones; and a suite of wireless, wearable physical activity (3-axis accelerometers) and autonomic nervous system sensors (heart rate, heart rate variability, respiration, electrodermal activity, body temperature). All sensors are time synchronized with obtained data recorded in the adjacent control room. (2) Control room (290 square feet) contains a one-way glass to observe data collection; PC and Mac computers equipped with specialized software needed for data capture, storage, and analysis; independent workspace for four graduate students; and a common meeting space/lounge. (3) Waiting room for family members or peers of research participants (200 square feet); and (4) Manufacturing room (89 square feet) that contains a soldering station to build and repair electronic circuits and a workstation for mocking up industrial designs.

Bouve also offers access to the Goldstein Simulation Laboratory Suite, which comprises four simulation labs, a control room, a viewing area, and debriefing rooms. Each lab can be set up as a variety of practice environments including, hospital rooms, operating rooms, exam rooms, office spaces, conference rooms, home care settings or even a dorm room. Each lab contains video and audio capture technology used to record student experiences as they interact with the latest high-fidelity human patient simulators, patient actors, faculty and other students. Students' recorded simulation experiences are played back and analyzed during structured debriefing sessions.

C.3 Massachusetts General Hospital. The MGH Department of Neurology has clinical research space located in Building 149 of which is in the Charlestown Navy Yard in Boston (CNY). The Gerontology Research Unit is on the second floor of the building, located one floor above the Martinos Biomedical Imaging Center. The Unit contains offices, and clinical research space consisting of over 3,500 square feet for the evaluation of research subjects.

C.3.1 MARDC Longitudinal Cohort. The MAITC AD/ADRD Pilot Core is based in the MADRC at MGH and as such the AD/ADRD Pilot Core can provide access to a source of pilot subjects (see letters of support from Drs. Hyman and Sperling). Pilot awardees may choose, with logistical help from the AD/ADRD Core leaders and the MADRC administrator, to pilot their technologies in the MADRC Longitudinal Cohort. This cohort currently includes 516 deeply phenotyped older adults spanning the gamut from dementia to normal cognition. Annual cognitive assessments are available for all individuals in the cohort, and biomarkers are available for most.

C.3.2 The Harvard Neurodiscovery Center Biomarker Study Laboratory. This lab contains equipment for performing biochemical, molecular biological, gene expression, physiological, and morphological studies. This includes Agilent 2100 Bioanalyzer, Applied Biosystems 7900HT Real-Time PCR System, semi-automated Applied Biosystems 7100 Nucleic Acid Extraction Station, power supplies, gel boxes, sequencing apparatus, gel dryers, hybridization ovens, shaking water baths, balances, tabletop centrifuge, microcentrifuges, light boxes, refrigerators, 1 thermocycler, spectrophotometer, speed vac, bacterial incubators, fume hood, four upright - 80C freezers, -20C freezers, and liquid nitrogen storage tanks. The cell culture room contains incubators, laminar flow hoods, water baths, and a microscope. Shared equipment within the Landsdowne Building includes scintillation counters, gamma counters, film processor, lightfield/darkfield fluorescence microscope, cryostat, fluorescence plate reader, spectrophometers, ice machine, polytron, Milli-Q water system, and ultracentrifuges. Aliquots for each HABS and ADRC participant are barcoded and tracked with the freezer inventory software, Freezerworks Unlimited, v.5.2.

C.3.3 The MGH PET Imaging Facility. This facility is located on the main campus of the MGH in Boston, 15 minutes from the MGH-NMR Center in Charlestown, with frequent shuttle transportation provided between the

two campuses for both researchers and ambulatory patients. It is the site of numerous research resources, including imagers, laboratories, and the MGH medical library. The PET facilities occupy approximately 10,000 square feet on the main campus of the Massachusetts General Hospital with laboratories located in several buildings to allow access for both clinical research and basic research. These facilities are available to the HABS Program Project. Dr. Keith Johnson is the Director of Molecular Neuroimaging at MGH, within the Division of Nuclear Medicine and Molecular Imaging, and is also co-leader of the Massachusetts ADRC Imaging Core.

C.3.4 MRI Facilities. The Athinoula A. Martinos Center at MGH and affiliated programs have clinical and research facilities at the MGH Main campus and at MGH East in Charlestown. The MGH operates 14 MR instruments, 8 of which are designated for research at the Charlestown campus where MAITC investigator Dr. Chhatwal has laboratory space.

C.3.5 Athinoula A. Martinos Center for Biomedical Imaging. This facility occupies ~40,000 square feet of space and contains the majority of the neuroimaging research effort. The Center is comprised of clinical, research, educational, and administration areas. The Gerontology Research Unit and Psychiatric Neuroimaging Research Program are located within contiguous space to the Martinos Center and create a large and diverse community of investigators interested in the application of neuroimaging methods. A large expansion of office space as well as some clinical and experimental space was recently completed.

C.3.6 Behavioral Testing Laboratory. The behavioral testing suite, located on the second floor of Building 149 at Charlestown Navy Yard, provides a quiet and controlled environment for neuropsychological testing, developing and piloting behavioral paradigms, and running pre- and post-scan experiments with children and adults. It consists of two testing rooms with one-way mirrors (Rooms 2236, 2234), separated by a control room (Room 2235), which may also serve as an observation station or additional testing space. Each of these rooms is equipped with a PC, a MAC and a button-press response box (with millisecond accuracy), identical to those used in the MR research bays thereby allowing for portability of the paradigms developed in the behavioral setting. Auditory stimuli may be presented via speakers in sound-field or over headphones. A digital audio tape recorder, a microphone, a touch-screen monitor, a video projector and a projection screen will also be available for stimulus presentation and/or recording subject responses.

C.3.7. Biomaterials Laboratory. This laboratory, physically integrated within the High Field Spectroscopy room, contains a Carver (Wabash, IN) 25 ton microprocessor controlled hydraulic press, a Spex Industries (Edison, NJ) cryogenic grinder, and a computer controlled Lindberg/Blue M (Watertown, WI), 1200C 3-inch tube furnace, which are used for preparation and analysis of biomaterial specimens and implants. A special MRI- compatible furnace, capable of 950C operation within the 4.7 T magnet, equipped with a quadrature birdcage RF coil, was engineered and fabricated in the Biomaterials Laboratory for in situ studies of high temperature materials processing.

C.3.8. Electronics and Machine Shops. Instrumentation for design, construction, and repair activities is distributed among four locations: (1) Bay 2/Bay 3/High Field Laboratory; (2) Bay 4/Bay 5/9.4 T Lab; (3) Photon Migration Lab; and (4) the Building 75 RF laboratory. The shops are equipped with tools for working with electronic circuitry, fiber optics, and mechanical devices; equipment for fabrication of printed circuit boards; instrumentation for electronic testing and measurement of digital, analog, and RF circuitry (power supplies, voltmeters, R/L/C meter, RF power meter, oscilloscopes, gaussmeters, RF sweepers, an analog impedance meter, a digital impedance analyzer, and 5 HP RF network analyzers); and machine tools (drill presses, belt sander, grinder, band saw, 13 inch lathe, small milling machine). A stock of materials, hardware, and electronic components is maintained. Machine tools are available to carry out complete computer-assisted design and fabrication of probes, animal carriers, gradient coils, etc. In addition to these capabilities, we have access to the MGH machine shop. Design and simulation tasks are supported within the Center with Windows 2000 based multiprocessor workstations running Remcom (State College, PA) BioPro 5.2 FDTD software for simulation of electromagnetic fields, Electronics Workbench Multisim 2001 (Toronto, Canada) for simulation of electrical networks, and IMSI TurboCad (Novato, CA) for mechanical design.

C.3.9. Outpatient Exam Rooms. The outpatient exam rooms next to the MRI suite support all clinical imaging studies that include complex cognitive, pharmacological, and physiological challenges and monitoring both before and during imaging. Physical examinations, cognitive testing, insertion of intravenous lines, and other patient-centered activities are carried out in the exam rooms. There are four semi-private (curtains can separate the patient recliners) exam areas in one large room, and two private rooms with stimulus presentation capabilities that replicate what is in the imaging environment. The private exam rooms are sound-attenuated and equipped for performing physical exams. One of the private rooms is shielded and thus appropriate for conducting electrical and optical imaging studies. This electrically shielded exam room is equipped for physiological monitoring, blood sampling, and drug infusions. The modular physiological monitoring system enables noninvasive and invasive measurement of blood pressure, heart rate, EKG, oxygen saturation, temperature, skin conductance, expired oxygen and carbon dioxide concentrations and respiration rate. The Bay 4 MR suite is also equipped with medical grade air, O2 and CO2.

C.3.10. Clinical Laboratory / Pharmacy Locker. The MRI Core facility includes a small clinical laboratory for specimen preparation and temporary storage of specimens with centrifuges and 4C and –20C refrigerator/freezer space. The Biomedical Imaging Core maintains code carts equipped with pediatric supplies adjacent to the CTSC dedicated space as well as at appropriate sites near each of the imaging systems that are supporting invasive studies. The Bioimaging Core also maintains a medication closet for investigators to store a supply of investigational drugs that can be dispensed on site. The MGH Research Pharmacy provides logistical support for pharmacy services such as special formulations, drug procurement, storage, record keeping, study fees, inventory control, drug distribution, packaging and labeling, randomization and blinding. This ensures that clinical trials that have biomedical imaging as outcome measures are in compliance with federal regulations. The laboratory is outfitted with both clean and dirty areas for storage with separate wash facilities.

C.3.11. CTSC Biomedical Imaging Core Facility. The Biomedical Imaging Core is located on the second floor of Building 149 in approximately 1,500 ft2 and is situated directly above the dedicated research MR scanners and close to the MEG/EEG imaging site. The space contains a patient reception/waiting area, two outpatient exam rooms, computing resources, laboratory/storage space, and office space for the staff. Scheduling for use of the outpatient exam rooms, mock scanner, and nursing support is done through the main CTSC. Research subjects use this waiting area whether they are scheduled for a visit to one of the exam rooms or one of the imaging facilities.

C.4 Brigham and Women's Hospital. The Division of Pharmacoepidemiology and Pharmacoeconomics is located within the Department of Medicine at Brigham and Women's Hospital and has 4,400 square feet of research/office/conference space at 1 Brigham Circle, one of the hospital's newest office spaces, plus an additional 2,800 square feet of office space on 41 Avenue Louis Pasteur in the middle of the Harvard Medical Campus. The office architecture enables Division investigators to connect frequently and share ideas in a highly collaborative research environment. Division offices are located near to the Department of Medicine's administrative offices, as well as near faculty from other Divisions. The main hospital building, which is in the center of the Harvard Medical Campus (comprising Harvard Medical School, Harvard School of Public Health, and Harvard Dental School), is across the street. Additionally, the Division maintains hardware and software to conduct on-demand, high quality live video conferencing across locations to multiple viewers

C.5 Brandeis University. The Heller School for Social Policy and Management has been committed to developing new knowledge and insights in the field of social policy and in health and human services management. Through the education of students and pursuit of research, Heller is actively engaged in examining policies and programs that respond to the changing needs of vulnerable individuals and social groups in our society. Heller and its nationally renowned research centers and institutes have pioneered in a variety of policy areas including: health; substance abuse; mental health; children, youth, and families; aging; and work, inequality, and social change. and offers a Ph.D. in social policy as well as several masters' programs. The Heller School includes four Research Institutes Schneider Institutes for Health Policy (SIHP): Brandeis Institute for Behavioral Health (IBH); Institute for Healthcare Systems (IHS); Institute on Global Health & Development (IGHD). The Heller Ph.D. program hosts training grants from the National Institute on Alcohol Abuse and Alcoholism (NIAAA) (focusing on alcohol-related health services research) and the Agency for Healthcare Research and Quality (AHRQ) (focusing on organizations and health care).

D. Computing, Analytics and Data Management Facilities

D.1 University of Massachusetts Amherst. The College of Information and Computer Sciences has over 1000 computer systems. These systems are maintained by the Computer Science Computing Facility (CSCF). The computers are connected to a Gigabyte switched network. The CSCF also maintains a wireless network (IEEE 802.11b/g/n and 802.11a/n) that provides up to a 130Mbs connection to the department's switched Ethernet network. The College of Information and Computer Sciences is connected to the campus via a high-speed link. The campus maintains a high-speed connection to the Internet. The computing environment is primarily made up of UNIX systems along with a large number of Macintosh and Windows systems. Computer Science services are supported by multiple virtual server environments in high availability configurations, supporting around 25 virtual machines. Additionally, there are approximately 50 research group servers including several Hyper-V and Xen virtual environments. Also supported are 5 large Clusters of Linux systems. The Swarm 2 cluster includes 1 head node (24 cores/128G RAM/200G SSD);105 compute nodes providing a total of 3,340 cores, 17T RAM; and 2 data storage nodes providing approximately 400T shared disk space and backups.

Figure 9 - Massachusetts Green High-Performance Computing Center

The College also maintains a High Performance Cluster at the Massachusetts Green High Performance Computing Center (MGHPCC) which provides state of the art infrastructure for computationally intensive research that is indispensable in the increasingly sensor and data-rich environments of modern science and engineering. Computers at the MGHPCC run millions of virtual experiments every month, supporting thousands of researchers in Massachusetts and around the world.

The Gypsum cluster is a large collection of GPU servers, with a total of 54T of RAM and 1,024 GPUs. 75 nodes contain four NVIDIA Titan-X GPUs, 25 nodes contain four NVIDIA M40 nodes, 53 nodes contain eight NVIDIA 1080 Ti GPUs and 25 nodes contain eight NVIDIA 2080 Ti GPUs. There are also two storage nodes providing approximately 350T shared disk space and backups.

The IALS Center for Human Health and Performance (CH2P) also houses computing workstations that will be utilized as part of the MAITC Clinical Translation and Validation Core. This professionally managed 15–blade Synology RS18016xs+ RackStation is made up of 192 individual Western Digital Gold – Data Center grade hard drives for a total capacity of 1.4PB (1,400 TB). The server is set up in a RAID 6 configuration to ensure a high failure tolerance and there are spare disks on stand-by to repair/restore the full RAID backup in the event that any drives fail. The data server is connected to the instrumentation in the CH2P on 1GB connections. The entire system is currently undergoing a comprehensive audit to ensure compliance with NIST SP 800-66 (HIPPA) data security standards throughout the system (workstations, network, and data storage).

The CH2P houses 4 professional-grade workstations (Dell Precision 5810/Intel Xeon E5-1603v3, NVIDIA Quadro K2200 4GB, 32GB ram). These workstations house the software necessary for analyzing all data collected in the CH2P including: Qualisys Track Manager, C-Motion Visual3D, Matlab, R-Studio, Actigraph Actilife, Adobe Creative Cloud, jMRUI, and Microsoft Office.

D.2 Massachusetts General Hospital. MGH researchers have access to the Harvard Catalyst Clinical and Translational Science Center's (CTSC) IT infrastructure consists of over 300 Linux workstations and 150 Windows and Macintosh desktops on users desks owned by individual research. There is a server farm of over 25 Linux servers handling central storage, e-mail, web, and other services. Overall storage capacity of the center exceeds 100 terabytes. There is also a 290 node computing cluster for batch analysis; 124 of the nodes are Dual Opterons (64 bit) and 18 of these nodes have 16 GB of RAM. The total CPU count is 450. The IT facilities are supported by a small IT staff of two full time PhD-level network administrators and several additional full-time professionals, including three full-time programmers supporting in-house-developed software tools. Available commercial software includes AVS (Advanced Visual Systems, Waltham, MA), IDL (Research Systems), Mathematica (Wolfram Research, Champaign, IL), MATLAB (The MathWorks, Natick, MA) and MEDx (Sensor Systems, Sterling, VA) for general-purpose computation, simulation and image analysis; and XWIN-NMR (Bruker BioSpin), Origin (OriginLab Corp., Northampton, MA), Nuts (Acorn NMR, Livermore, CA) for analysis of NMR spectra and the Siemens IDEA development environment for pulse sequences and image reconstruction software (Siemens, Erlangen, Germany). A substantial level of internal software development for image and data analysis is ongoing, using HTML, C, C++, Java, FORTRAN, Pascal, Perl and TCL/TK. For high-performance image reconstruction, the Center is equipped with a custom-designed ScaleMP vSMP computer equipped with 128 Xeon E5472 3.0 GHz cores and 1TB shared RAM. It uses a 40 GBit/s QDR Infiniband backplane and is equipped with a Rackswitch G8000 48 port aggregation switch with two 10 Gbit/s Ethernet links with fiber-optic extenders for real-time data streaming from the MRI machines. It is capable of running the Siemens image reconstruction software, and can therefore be fully integrated in any of the Center's MRI machines for online image reconstruction of the very large or very high data rate scans produced by the large array coils.

The Partners Healthcare data center is a secure facility that houses both computing environment as well as clinical systems and electronic medical records for several large hospitals in Eastern Massachusetts. Entry into the computer room requires passing through staffed building security, a successful fingerprint scan, and then passing through staffed computer room security. The Division's servers and appliances are connected to the Partners networking backbone with 10 gigabit-per-second fiber links. Network security is overseen by Partners Healthcare Information Security, who apply the same standards used for the hospital's electronic medical records systems to the research team's data. All data are transmitted to programmers' workstations in an encrypted state. Backups are created using 256-bit AES encryption, the current Department of Defense standard for data security. A dedicated storage management group of Partners employees (TSM) is performing all activities related to encryption, storage and transfer of back-up tapes to the FISMA High, ISO 27001, PCI DSS Level 1, HIPAA, and SOC 2 Type II compliant Boston (BOS-1) facility of Iron Mountain Inc. The redundancy, extensive data power, and security of our computer facility confirms our capacity to collect and manage data and ensures confidentiality for all project participants. A complete mirror system is available in a second data center managed by Partners, which provides uninterrupted data access and computing in case the first data center fails.

The MGH Biostatics Unit and is located at the main campus of the Mass General Hospital, a short shuttle bus ride from the CNY facilities. The close connections between the MGH Biostatistics Unit, the MGH Neurology Department, and the Harvard School of Public Health make an extensive array of statistical expertise available

to this and other projects. In addition to individual workstations, the MGH Biostatistics Center collaborates with several other MGH and Partners departments to fund and utilize a 20-36 node Linux-based computing cluster (often called "Beowulf cluster"). This cluster is composed of 3GHz Xeon based Dell 1750 computers. We have developed software that allows Matlab to be used in a cluster environment, and also have licenses for Matlab and SAS on the cluster.

D.3 Brigham and Women's Hospital. BWH investigators have access to a secure, state-of-the-art computing facility housed at Partners Healthcare' data center. BWH server environments are Linux-based with SAS, Stata, Aetion Evidence Platform, and R software installations. The primary production analytics server boasts 40 hyper-threaded CPU cores and over 1TB of RAM. We maintain 300TB of scalable enterprise-grade redundant storage for maximal data integrity and high-speed data access. Our computing environment includes HITRUST-certified Cleardata servers and AWS servers, which are used to analyse data in the Aetion software platform.

Members of the Patient-Centered Comparative Effectiveness Research Center have access to databases and expertise around data management that can be leveraged by members of the BWH community. These include expertise related to: major commercial health insurers, Medicaid and Medicare claims, i2b2, the Medicare Current Beneficiary Survey, the National Inpatient Survey, Partners' Healthcare's Electronic Medical Records (EMR) and more. Local EMR cohorts are now being linked with insurance claims databases; these linked cohorts will be available through the PCERC. The Center is acting as a hub of resources for the development of methods for researchers working in this area. In addition to the database access and management, there is strong expertise in the methods for large database analyses. PCERC investigators have begun to develop a "catalogue" of analytic methods that different research groups in our community can access. Many state of the art CER methods have been developed here at BWH or at the Harvard School of Public Health, facilitating access to this expertise for members of the PCERC.

D.4. Brandeis University. The Brandeis University technology system includes the computer resources of the Psychology department, and additional resources through the University's Library and Technology Services (LTS), which maintains all networking and e-mail services and provides technical support. Excellent computer facilities are available for use, supported by Brandeis LTS. These resources will enable collaboration across the other Center institutions. All offices and laboratories have computers with appropriate software for conducting experiments, word processing and statistical analysis necessary for research, linked by the network to the university server. LTS provides support for both hardware and software including statistical packages such as SPSS, SAS, and Stata, as well as updating of versions as they are released. Other more specialized software is available in the Psychology department (e.g., HLM, LISREL, MPlus, Media Lab, Direct RT, MatLab). Brandeis has extensive resources that will ensure the successful administration and completion of the Center projects. Personnel are supported by integrated information systems with the flexibility to address all research, teaching, and operational needs, including solving the complex communication issues frequently associated with multi-site projects. Brandeis has a full fiber-optic backbone with additional upgrades installed on an ongoing basis as required. All e-mail accessed through the University's e-mail servers is encrypted. When required, research data can conform to HIPAA privacy requirements. Data on workstations can be encrypted and secure data transfer software is available. As a premier research university, Brandeis handles data of a highly sensitive nature. Brandeis has extensive experience working with highly sensitive personally identifiable data (PID). Security measures will be put in place as required. In addition to these specific activities, IHS data security policies and practices are further reinforced by Brandeis University's Information Security Plan.

D.5. Northeastern University. The Northeastern HCI Laboratory has a range of computer workstations designed for advanced software development, especially with mobile devices. The lab includes a variety of mobile phones (Android and iOS) and equipment for mobile phone system programming, including Bluetooth headsets and nine Google Glass devices. The mHealth research group operates a secure Dell Poweredge 710 Server with 4TB storage and a Dell Raid Array 1220 with 18TB, used for data storage and backup to support the group's health studies. Other computers are specially equipped for video capture, reviewing and editing, and 3D modeling and animation work. The lab has a range of display devices for experimentation including a 50" plasma screen, as well as custom-built mechanical shaker machines for testing motion sensors (and phones with motion sensors). The College of Computer and Information Science has shared computer labs

and wired and wireless networks that support research and teaching and meet the needs of the proposed work. Access to mathematical modeling and pattern recognition software such as Matlab is also available. Additional computer resources available in the College of Computer and Information Science and the Bouve College of Health Sciences include Dell Opti-Plex PCs for all staff, networked to Northeastern University via the NUNet server. NUNet enables staff to download and update broad ranges of software and utilities that include essentials such as antivirus, MS Office, and Endnote but also research and statistical analysis programs such as SAS, Stata, and SPSS. NUNet links the research faculty to a university-wide shared drive that is backed up daily.

E. Administrative Facilities

E.1 University of Massachusetts Amherst. MAITC Co-Director Dr. Ganesan and investigator Dr. Marlin have fully equipped private offices located in the CS building, which houses the College of Information and Computer Sciences and its administrative offices. MAITC investigators Dr. Marquard and Dr. Spencer have offices in nearby campus buildings. All are affiliated with IALS. Postdoctoral fellow and graduate students will be allocated office or lab space in the same building as their advisors. All buildings include suitable conference rooms for small group meetings. Large group meetings will be hosted in IALS.

E.2 Massachusetts General Hospital. Drs. Chhatwal and Blacker have private offices and laboratory space in the Charlestown Navy Yard (CNY) complex. The MADRC Clinical Core office suite contains 23 PC and Apple computers, which are connected to and supported by the Partners HealthCare Information Systems network. The network provides regular upgrades to the standard software packages for word-processing and data-manipulation (e.g., Word, Excel, Access, etc.). The Athinoula A. Martinos Center for Biomedical Imaging. Education Area. This area contains a conference room, audio visual laboratory (equipped with computers, TV monitors, VCRs, carousels, teaching files and tapes), staff offices, and general desk space for graduate students, postdoctoral fellows, and junior faculty.

E.3 Brigham and Women's Hospital. The Division of Pharmacoepidemiology and Pharmacoeconomics is located within the Department of Medicine at Brigham and Women's Hospital and has 4,400 square feet of research/office/conference space at 1 Brigham Circle one of the hospital's newest office spaces, plus additional 2,800 square feet of office space on 41 Avenue Louis Pasteur in the middle of the Harvard Medical Campus. The office architecture enables Division investigators to connect frequently and share ideas in a highly collaborative research environment. Division offices are located near to the Department of Medicine's administrative offices, as well as near faculty from other Divisions. The main hospital building, which is in the center of the Harvard Medical Campus (comprising Harvard Medical School, Harvard School of Public Health, and Harvard Dental School), is across the street.

E.4 Brandeis University. Dr. Lachman has well-furnished office space adjacent to her laboratory in the the Brown Social Sciences Building. All research staff, and any pilot investigators will be provided with dedicated office space, telephone, computer and printing facilities, and office furniture. The Research Assistant will have an office in the PI's lab. The laboratory housed in the Brown Social Sciences Building, has approximately 1200 square feet of space. The lab is a suite with multiple rooms that can be utilized for recruiting and testing research participants and for conducting research meetings, computer work, research assistant offices, and research meetings. In addition to the physical space, equipment, and staff, the university also had adequate parking for participants in Center meetings and research studies, with easy access to the meeting rooms and laboratories, which are all handicapped accessible. The administrative offices of the Psychology Department, in the Brown Social Sciences Building offer good staff support with state-of-the-art office equipment. Shared resources include network printers, fax machines, photocopying machines & scanners, LCD projectors & laptop computers, and additional rooms for meetings or subject testing.

E.5 Northeastern University. The College of Computer & Information Science encompasses five buildings across campus totaling 51,115 square feet. This includes space in the new state-of-the-art Interdisciplinary Science and Engineering Complex. Drs. Jimison and Pavel are located on the 9th floor of 177 Huntington Avenue. Office space is shared with other faculty from Personal Health Informatics and Data Science. There is adequate office space for faculty and desk space for graduate assistants.

F. Resources to Support the Protection of Human Subjects

F.1 Institutional Review Board Review and Protocol Resources. All pilot studies and studies conducted by the MAITC Stakeholder core and the Clinical Translation and Validation core will require approval from the UMass Amherst IRB. The Stakeholder core and the Clinical Translation and Validation core will work with the Technology Identification and Training core to design protocols to assess technologies through focus groups and lab evaluation studies respectively. We will leverage existing protocols held by the UMass Amherst MAITC investigators for the use of IALS core facilities to bootstrap the creation of a set of protocol modules that can be used by pilot project investigators to streamline the protocol preparation process when using these facilities. The MAITC Pilot cores and Administrative core will work with pilot project investigators to ensure that approval of the UMass IRB is obtained in a timely manner and that all necessary reliance agreements are in place.

F.2 Informed Consent Resources. Informed consent will be required for all MAITC studies including MAITC focus groups, lab studies and pilot studies. The MAITC will use standardized consent form templates and/or components for different types of studies both for internal use and for use by pilot project teams. These templates will include standard assurances regarding protection of confidentiality and ability of the participants to withdraw from the research without negative consequences. For studies using MAITC facilities, we will make consent form components describing facilities, activities, devices, data and/or any associated risks available to pilot project teams to streamline the process of creating consent forms.

F.3 Resources to Protect Confidentiality and Privacy. To protect participants from a breach of privacy and confidentiality, we will require all MAITC studies to follow standard data privacy and security guidelines for collection of human subjects data. All access to study data must be authorized by the study's lead investigator and will follow the policy of least privilege where each user's access will be restricted to the minimum amount necessary.

For all studies, each study participant will be assigned a subject identification number (ID) so that the subject's name will never be used in any way that might endanger the subject's privacy. All hard copy research records will be kept in locked secure file drawers with access only by the appropriate research team and coded only with subject ID numbers. Records associating the identities of subjects with their ID numbers will be stored securely and separately from other research records. All MAITC investigators have access to suitable physical space resources for secure storage of hard copy research records, and we will ensure that this is also the case for pilot project investigators.

All digital study data will be required to be password-protected and encrypted. Digital data will be associated with the ID assigned to the participant. All data transmitted across networks will be associated with the subject ID number and delivered over encrypted connections. Servers holding digital study data will only be accessible to study staff via a password protected login over encrypted SSH connections. Following the policy of least privilege, access to digital data will be restricted to the minimum amount necessary. All MAITC sites have suitable computing resources to enable secure storage of and access to digital study data. We will ensure that this is also the case for all pilot project investigators.

G. Additional Research Facilities and Resources Directly Relevant to this Project

The University of Massachusetts Amherst is a public institution with a "Doctoral/Research Universities – Extensive" classification, and national rankings that confirm its reputation for excellence. Annual enrollment is approximately 20,000 undergraduates and 8,000 graduate students, and the campus community is racially and ethnically diverse due to the presence of U.S. minority students and large numbers of international students. Students can earn bachelor's degrees in nearly 100 areas, associate's degrees in 6, master's degrees in 68, and doctorates in 50, within the University's 10 undergraduate schools and colleges and the Graduate School. The University of Massachusetts has a strong history of supporting faculty research. The University has invested heavily in building and maintaining the Library System including two additional science libraries, and in building and recently updating the Office of Information Technologies and associated infrastructure to support general computing, campus networking and telecommunications. There has been a significant focus

on enhancing data security within the campus-wide network to support human subjects' research. New research resources include increased infrastructure in the Vice Chancellor for Research Affairs Office, as well as extensive investment in renovation and construction of research spaces, and additional research-intensive faculty hires.

G.1. Institute of Applied Life Sciences (IALS). The overall goals of the proposed project are strongly aligned with the new IALS on the University of Massachusetts Amherst campus (see letter of support, Peter Reinhart, Director). This institute, which officially opened in October 2016, was funded by a $95M grant from the Massachusetts Life Sciences Consortium, along with another $50M from the University of Massachusetts. IALS offers exceptional research space and unique adjacencies that foster a dynamic "team science" atmosphere, including collaboratories available to industry researchers for easy access to cores and ongoing research collaborations. There are three Centers within IALS, including the Center for Personalized Health Monitoring (CPHM). Dr. Ganesan is co-Director of the CPHM The core facilities associated with the MAITC are managed by IALS. State-of-the-art human sensor development, testing and implementation research takes in this center, via collaborations between kinesiology, computer science, engineering, nursing, and polymer science faculty. IALS houses 30+ core facilities ranging from microscopy to exercise intervention cores. In addition to those cores described above, IALS also houses the: Room Calorimeter Core, Sleep Monitoring Core, and Living Science Core. In addition to space and facilities, the campus is investing in multiple tenure-track faculty hires for IALS, including 2 in Kinesiology.

IALS also provides support for Business Innovation Fellows from the Isenberg School of Management to support the commercialization process including development of industry partnerships, and providing strategic, operational, and business development. Further, IALS includes research lab space for industry partners including sixteen spaces for start-up companies (developed at or external to UMass). Established companies can directly work with IALS staff and researchers to develop and validate next generation health monitoring technologies and products.

G.2. Public Engagement Project. The Public Engagement Project supports and trains faculty members to use their research to contribute to social change, inform public policy, and enrich public debate. Through a Scholars Program faculty learn new skills from experts and from each other to improve their communication and engagement with the media, community groups, policymakers, and practitioners. The project also helps faculty members build their own networks of institutions and individuals who can apply their research findings, and it helps create institutional spaces for communication between academics and non-academics who do applied work in common areas of expertise. By developing a new generation of public intellectuals, the project enhances the public's understanding, value, and use of research, and promotes greater integration of research and its application. This public engagement not only expands the impact of research on society, it also improves the quality of research. Key concepts and activities promoted by the Public Engagement Project will support the activities of all Cores and Projects.

G.3. Chancellor's Office of Equity and Inclusion. The Office of Equity and Inclusion champions the role of diversity in achieving institutional excellence and works with campus leaders and units to develop strategic goals and provides guidance on national best practices to accomplish them. The office is responsible for implementing the campus's Diversity Strategic Plan, which aims to nurture a campus-wide culture of inclusion, develop an affirmative emphasis on workplace climate, and support diversity, inclusivity, and equity goals within schools and colleges. A recently-awarded NSF ADVANCE grant was developed by a team from the UMass Amherst Institute for Social Science Research and is administered out of this office. Its purpose is to support the development of an innovative professional advancement model for underrepresented faculty in science, technology, engineering and mathematics (STEM). The university will separately fund the extension of relevant grant activities to school/colleges outside of the core NSF-funded disciplines. The Associate Chancellor for Equity and Inclusion, Dr. Enobong (Anna) Branch, is leading the project to ensure that the successful ADVANCE project activities and practices are sustained beyond the award term and systematically integrated into the existing campus structure. This project will inform the activities of and be a resource to our investigative team.

G.4. Vice Chancellor's Office of Research and Engagement. The major functions of the Office of Research and Engagement encompass two broad areas: Research Administration and Compliance, and Research Development and Engagement. Constituent units work collaboratively to provide faculty and staff with the administrative support, services, and resources necessary to secure research funding and effectively manage grants and contracts and requisite compliance with state and federal laws. Research and Engagement also oversees large, multi-college institutes and affiliated core facilities and provides support for over 60 interdisciplinary research centers and institutes campus-wide. The new Office of Project Management and Training coordinates strategic programs and provides project management to support campus research initiatives. Integral to research development and engagement, UMass Innovation Institute expedites research partnerships with industry to move university discoveries and technologies forward into society and the Technology Transfer Office spurs the commercialization of university research for public benefit while protecting intellectual property and ensuring recognition for researchers and inventors. The University of Massachusetts Press is the book-publishing arm of the University of Massachusetts, producing and disseminating more than two million volumes to date that contribute to the university's role as a major research institution.