**Facilities**

Dr. XX has dedicated lab space (XX sq ft) plus office space (XX sq ft) for XX people within the Gordon Center for Medical Imaging. The lab has XX benches/hoods/sink/storage. In addition, the XX lab has access to all the facilities at the Gordon Center for Medical Imaging and Partners Research Core Facilities (htts://researchcores.partners.org/).

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| **GORDON CENTER FOR MEDICAL IMAGING (MGH)** |

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| **MGH Main Campus** |

MGH Gordon PET Core: The MGH Gordon PET Core of the Gordon Center for Medical Imaging (Director: Dr El Fakhri) has been in operation for more than forty years, providing radioisotope production, radiopharmaceutical syntheses, quantitative imaging, data analysis and experimental design services to investigators at the MGH and in the Boston research community. During that time, the MGH PET Core has synthesized, certified and used over 35 labeled compounds for human research studies. The PET Core facilities include the Cyclotron and Radionuclide Production Facility, the PET Nuclear Pharmacy, the Chemistry/Radiochemistry Facility, the Clinical Imaging Laboratory, the PET Data Analysis Laboratory, the Preclinical Imaging Laboratory, and Biological and Histological Analysis Facilities. In Summer 2010, MGH completed a comprehensive renovation and major expansion of the PET Core and PET Nuclear Pharmacy. In 2019, a new PET/CT suite was opened within the Gordon Center and PET Core that is exclusively for research subjects and large animals.

PET-CT Research and Clinical Scanners:

A **GE Discovery DMI 5-Ring TOF PET/CT** clinical research scanner is available exclusively for research studies and can be used for sequential CT and PET scans on the same machine. The scanner is sited in a fully self contained clinical research suite within the Gordon Center for Medical Imaging on the main MGH campus in the Edwards Building across from the cyclotron. The PET scanner is composed of 34 detector modules each consisting of four blocks, yielding 136 detector blocks per ring. Each detector block is comprised of 4 (transaxial) x 9 (axial) LYSO scintillator crystals of dimensions 3.95x5.3x25 mm. Transaxial FOV is 700 mm and Axial FOV is 250 mm. It has sub-400 ps timing resolution for time-of-flight (TOF). The CT scanner has energy capability of 80, 100, 120, or 140 kVp.

A **Siemens ECAT HR+** is exclusively dedicated to animal and clinical research brain studies. The HR+ scanner is equipped with BGO crystals, with a bore diameter of 82.4 cm, an axial field of view of 15.5 cm and a transaxial field of view of 58.5 cm. This system is located on White II and is maintained by the PET Core personnel

A dedicated brain **NeuroPET-CT** for human brain research and large-animal imaging funded under a Shared Instrumentation Grant (1S10RR028110, High Sensitivity Mobile PET for Brain Imaging; PD/PI: El Fakhri). The dedicated brain PET-CT imaging system has a FOV of 25-cm in diameter and 21-cm in length. It uses 155316 2.3x2.3x10mm LYSO crystals (dual-layers) and 12096 SiPMTs. The PET scanner was designed to achieve high sensitivity, and good spatial resolution. The CT has 3264 detector channels with 8 axial channels at spacing of 1.25mm. The X-ray source, capable of 100, 120, and 140 kVp at 7.0 mA, can rotate at 60 rpm for 1440 views/sec.

**A Siemens BiographTruePoint HD PET/CT** clinical scanner is available 3 hours/day for research studies and can be used for sequential CT and PET scans on the same machine. The PET scanner has LSO-based detectors, 4x4x20 mm crystals, detector elements per block: 169; Detector ring diameter: 656 mm; Blocks per detector ring: 192; Transaxial FOV: 605 mm; Axial FOV: 216 mm; Plane spacing: 2.0 mm; Qty detector element rings: 52; Timing window 4.5 ns; Energy window 425-650 keV.

The CT scanner has a rotation time of 0.33 seconds; 0.24 mm isotropic resolution; 80, 110, or 130 kVp.

**A Siemens mCT Flow** PET/CT scanner was installed in February 2018 and can be used for sequential CT and PET scans on the same machine. The PET scanner has LSO-based detectors, 4x4x20 mm crystals, 169 detector elements per block, 48 blocks per detector ring and 4 rings. Transaxial FOV: 700 mm; Axial FOV: 221 mm; Plane spacing: 2.0 mm; Timing window 4.07 ns; Energy window 435-650 keV, TOF performance of 540 ps. The CT scanner has a rotation time of 0.33 seconds; 0.24 mm isotropic resolution; 70, 80, 100, 120, or 140 kVp.

The Siemens PET/CT cameras used for clinical imaging are each available after clinical hours for research studies. All PET, PET-CT and SPECT scanners are connected through high-speed ethernet to the research facilities within the Nuclear Medicine and Molecular Division allowing access to all clinical and experimental studies.

**A GE Signa Time-of-Flight PET/MR** is being installed in Q1 of 2021. Will be dedicated 70% of the time for research studies.

PET-MR Clinical Research Scanners: The MGH is equipped with a brain simultaneous PET-MR and a whole-body simultaneous PET-MR (mMR), both manufactured by Siemens Healthcare. The mMR has received 510K clearance from FDA.

**The BrainPET** is a 3D dedicated-brain scanner designed to operate inside the bore of the Siemens Medical MAGNETOM Trio, a TIM system 3T MR scanner. The combined MR-PET scanner is the first system capable of simultaneously imaging the human brain in one bed position. The PET system consists of the following major components: PET gantry with 32 detector cassettes, gantry handling device with cable handling function, cooling system, acquisition electronics module, processing reconstruction station and power supply cabinet

**The mMR** is a whole-body 3D simultaneous PET-MR. It includes the Tim Application Suite. The Tim Application Suite provides clinical sequences, protocols and workflow functionalities for clinical indications. Nine dedicated application packages are available:

- Neuro Suite, - Angio Suite, - Cardiac Suite, - Body Suite, - Onco Suite, - Breast Suite (MR-only), - Ortho Suite

- Pediatric Suite, - Scientific Suite

The system is comprised of:

*Magnet*: Whole-body superconductive 3T magnet with active shielding (AS), and External Interference Shielding (E.I.S.). The helium capacity of the magnet is 1,500 liters. It has an integrated magnet cooling system.

*Gradient System*: Prepared for an actively shielded, water-cooled, gradient system; - All axes force compensated; - TrueForm Gradient Design; RF Transmit/Receive System; - Air-cooled RF amplifier with 35 kW peak power; - Integrated electronics cabinet water cooling; - Integrated, circularly polarized Body Coil; - Total imaging matrix allows a number of coil elements to be integrated into one examination together with a large number of RF channels.

*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; Qty detector element rings: 64

Total detector blocks: 448; Total # of crystal elements: 28 672; Image planes: 127

A new **Siemens Skyra platform 3 Tesla MRI** system was installed in 2010. The system comes with 64 RF channels, 45 mT/m gradients and a 70cm patient bore for improved subject comfort and stimulus access. In 2011 the system was upgraded with the AS302 whole-body gradient array featuring a maximum strength of 300 mT/m and slew rate 200 T/m/s to enable very high fidelity diffusion imaging. The upgrade reduced the bore diameter to 56 cm. A custom in-house-built 64-channel head array coil is available as well as a custom, in-house-built 60-channel head-neck array, allowing high quality 3D imaging with high acceleration factors. Bay 8 also contains an assortment of audio, visual, and sensory stimulus equipment for fMRI studies including rear projection, audio stimulation, subject response device. Stimuli can trigger or be triggered by the scanner. The stimulus equipment can be run using either of the PC or Macintosh computers installed and available for use in the Bay; alternatively, the user may operate the stimulus equipment from a personal laptop computer. This system is dedicated to connectomics imaging, in support of the multi-site Human Connectome Project consortium.

Small animal imaging:

A **Sedecal Argus microPET-CT** is available for small animal imaging including mice and rats. It has two 11.8 cm rings with 36 detector modules. Each module consists phoswich elements in square columns arranged in 13 x 13 arrays of 7mm LYSO crystals coupled to 8mm GSO crystals. It has 6.7 cm transverse and 4.8 cm axial fields of view.

{DETAILS?}

White Imaging Facilities: In the White building, adjacent to the Nuclear Medicine Department, the Center has 1,200 ft2 suite housing the ECAT HR+ and NeuroPET/CT scanners. They are supported by injection rooms, waiting rooms, and computing facilities.

Bulfinch Research Facilities: In the Bulfinch Basement, the Gordon Center has 3680 sq ft of dedicated research space housing cell and tissue culture facilities; a cold chemistry laboratory; a radioactive chemistry room; four imaging bays (two suites for rodent and primate imaging, two suites for human brain imaging); a dark room for light-sensitive procedures, and a biology lab outfitted for measurement of radioactivity concentration and radiometabolite analysis in kinetics studies (fully redundant equipment permitting blood processing for overlapping or parallel studies systems), Western blotting, and autoradiography.

Edwards Research Imaging Facilities: The GE DMI PET/CT scanner occupies a 1500 ft2 suite in the Edwards Research Building basement, which also consists of a waiting area, injection room, clean room, and private bathroom/changing room.

Edwards Research Chemistry Facilities: In the Edwards Research Building basement, The Gordon Center has research chemistry facilities consisting of a 400 ft2 cold chemistry lab for the development of novel radiopharmaceutical ligands and a 400 ft2 hot chemistry lab equipped with shielded fume and iodination hoods for the low-level radiolabeling of research radiopharmaceuticals, as well as supporting analytical equipment, including HPLC and TLC. Supporting labs include a 600 ft2 Cell Culture Lab containing fume and laminar air flow hoods and 300 ft2 of Chemical and Cold Storage.

Cyclotron/Developmental Radiochemistry: This facility is located in the basement of the Edwards Research building. The facility resides in approximately 2,000 ft2. The shielded cyclotron vault of 900 ft2 contains a GE PETtrace 18/9 MeV Dual Particle cyclotron capable of accelerating protons and deuterons to maximum energies of 18 and 9 MeV, respectively. Two simultaneous beams can be extracted with independently variable intensities up to a total beam current of 100 µA. Cyclotron electronics, control room, gas room and shop occupy approximately 725 ft2. Developmental radiochemistry space with a high-level radioactivity lab containing 3 Hot Cells and 3 Mini Cells and associated automated radiochemistry equipment for F-18 and C-11 chemistry occupy approximately 200 ft2. There are supporting synthesis set-up and QC labs with associated analytical equipment including fume hood, HPLC and TLC, occupying approximately 200 ft2.

PET Nuclear Pharmacy: The PET nuclear pharmacy facilities have recently been completely renovated and meet current and future FDA standards, 21 CFR Part 212 and USP Chapters <797> and <823> for production of human PET radiopharmaceuticals. The cGMP compliant facility is located in the basement of the Edwards Research Building and consists of approximately 1100 ft2. A 200 ft2 ISO Class 7 clean room contains 2 ISO Class 5 laminar flow hoods and an ISO Class 5 shielded isolator for the aseptic processing of PET radiopharmaceuticals for human use. A 500 ft2 ISO Class 7 manufacturing area contains 11 ISO Class 5 Mini Cells and 6 automated chemistry modules for the synthesis of F-18 and C-11 PET radiopharmaceuticals. The automated chemistry modules include: 2-FDG synthesis modules, 1-GE FX-N F-18 synthesis module, 2-GE FX-C C-11 chemistry modules, and an Eckert and Zielger Modular Lab. The lab also contains associated support equipment and fume hood. A 300 ft 2 analytical lab contains a fume hood, a Agilent GC, a Waters Alliance HPLC, a Bioscan TLC, a Canberra High-Purity Germanium Detector and other analytical equipment. A 70-ft2 packaging and shipping area contains survey and packing equipment for outside shipping of radiopharmaceuticals. We have standing DOT Level 3 shipping in place for transport of up to 2.5 Ci between Main Campus and Charlestown Navy Yard MGH research facilities.

SPECT Instrumentation Research Laboratories: The SPECT Instrumentation Research Lab is equipped with a Siemens Symbia SPECT/CT, two Symbia E-Cam system and two planar/SPECT gamma cameras. The gamma cameras are equipped with low energy ultra high resolution collimators, as well as high sensitivity, medium energy low penetration and cone beam collimators that allow cardiac, brain and whole-body explorations with most radionuclides (e.g., Tc-99m, I-123, In-111, I-131, Ga-67, Tl-201). Time on these systems is available for research studies up to four hours per day. The lab is also equipped with a dedicated DSI Ceraspect brain scanner, with cylindrical NaI(Tl) crystal with 21.3 cm diameter and 10.6 cm axial length. The camera is equipped with a custom-build collimator characterized by a continuously varying centrally peaked sensitivity that it yields a 3.4 folds improved sensitivity throughout the reconstruction volume. Anthropomorphic numerical and physical phantoms (cardiac, brain, etc.) are also available.

Autoradiography: The GCMI laboratory is fully equipped to perform autoradiography with long- and short-lived radioisotopes in human and animal tissue samples. Key resources available for use include cryostats/microtomes for preparation of frozen and fresh tissue slices, several -80°C freezers for storage of frozen samples, PerkinElmer Cyclone Plus Storage Phosphor screens and imaging system, and dedicated bench space for incubation and screen exposure using compounds labeled with 11C, 18F, 3H, and other suitable isotopes.

Cardiac Electrophysiology Lab: The CEL includes an EnSite NavXTM cardiac mapping system used for electroanatomic mapping (EAM). Uses a roving catheter contact with the myocardial surface to record local electrograms.

The MGH Cardiac Arrhythmia Research Laboratory: Established in 1978 by Dr. Jeremy Ruskin, which has supported a number of innovative research efforts ranging from basic cardiac electrophysiology research on the mechanisms of ventricular arrhythmias in acute ischemia and evolving and healed myocardial infarction, to preclinical studies of new device technologies including implantable defibrillators, new energy sources and delivery platforms for catheter based ablation systems, and new electrophysiologic mapping systems. Multiple species have been used to study cardiac physiology and devices in this facility, including rabbit, dog, sheep, goat and swine. The laboratory, which is fully staffed and includes a full operative suite, occupies approximately 500 square feet on the MGH main campus. All of the equipment found in a typical clinical cardiac electrophysiology laboratory is present in this research laboratory including invasive electrophysiological recording equipment, three-dimensional electroanatomic cardiac mapping systems and fluoroscopy, as well as intracardiac and transthoracic echocardiography. Over the past several years, we have developed models of acute and chronic myocardial infarction in both rabbit and swine. Assessment of experimental infarctions in swine is performed using multiple imaging modalities available at MGH, including electroanatomic mapping, PET, MR, and CT scanning.

Radiation Oncology: The main radiation oncology facility is located in the Lunder Building. It has 6 linear accelerators and 2D simulator. In addition, the radiation oncology facility operates a high dose rate (HDR) brachytherapy treatment unit and 2 CT scanners dedicated to radiation treatment planning. A seventh accelerator is located in the operating room is used in selected cases to deliver a single large dose to patients during surgery to remove tumor (intraoperative radiation therapy).

The Francis H. Burr Proton Therapy Center (FHBPTC):The Francis H. Burr Proton Therapy Center (FHBPTC) occupies a 2-story, 44,000 square ft. facility within the Yawkey Ambulatory Care Building at MGH. The Yawkey Building also houses the majority of MGH Cancer Center clinics and programs and is adjacent to all other hospital services. The FHBPTC proton accelerator is a 230 MeV IBA proton cyclotron that feeds two rooms equipped with 360-degree rotational, isocentric gantries, one fixed field room with two beam lines for eye treatment and stereotactic radiotherapy/radiosurgery, and a beam line for experimental and developmental use. Imaging support with two CT scanners for treatment simulation and a conventional simulator is available in the Department of Radiation Oncology at MGH in the nearby Cox Building. The facility also includes a treatment planning area; a machine shop, which produces brass apertures and compensators; and a physics lab, which houses the requisite equipment for clinical commissioning and quality assurance.

The FHBPTC has three treatment rooms (two gantry rooms and one fixed field rooms) treating patients on a daily basis. All treatment stations have orthogonal x-ray imaging systems with flat panel imagers to acquire images for patient treatment setup. One gantry room is equipped with a respiratory-gated control system. The proton radiation treatment planning system is the XiO Treatment Planning System, which has been developed by CMS in close collaboration with MGH to meet the unique needs of proton treatment planning workflow. For treatment planning research and especially for IMPT, the KonRad planning system and in house developed optimization codes (Opt4D) and dose computation algorithms are available, as well as ancillary support software. The proton therapy treatment rooms and beam time are available for experimental use outside of treatment hours (M-F 7:30-5), by request. Patients studies may be scheduled within treatment times, typically at the end of the day.

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| **MGH Charlestown Navy Yard (CNY) Research Campus** |

The Gordon Center for Medical Imaging also occupies about 10,000 square ft of research space on the MGH Research Campus in the Charlestown Navy Yard (CNY) Building 149. The facility is equipped with animal imaging equipment for nuclear (microPET, microSPECT) and fluorescent imaging, a pre-clinical hot lab for synthesis and purification of both single photon and positron based radiotracers, full synthetic and analytical chemistry capabilities, biochemistry facilities, cell culture facilities, histology facilities, molecular biology facilities, and engineering laboratories including a machine shop, for preclinical PET, SPECT, and fluorescent imaging system development. Preclinical MR and PET-MR capabilities are available in conjunction with the Martinos Center located on the first floor of the same building.

Small animal imaging:

**TriFoil Triumph II triple-modality microPET/SPECT/CT system** allows for mouse and rat imaging with digital PET with three different axial fields of view, CT, and digital gamma detectors for SPECT. The PET subsystem uses avalanche photodiode detectors and digital signal processing with no resolution loss from light sharing or electronic coding. Includes list mode data acquisition, automated multiple bed positions, and various reconstruction algorithms. The ring diameter is 15.6 cm. The resolution is less than 1 mm with iterative reconstruction. The SPECT subsystem uses cadmium zinc telluride detectors with < 4.5% energy resolution at 140 keV. High spatial resolution is achieved with a combination of single and multiple pinhole collimators. Radius of rotation is variable from 1.5 to 17.5 cm. Acquisition can be planar static, planar dynamic, tomographic, and dynamic tomographic. The integrated CT provides attenuation correction and anatomical localization for PET and SPECT.

{What about the other microPETs on the list? Are those still operational and available? Are they part of GCMI or another center/lab?}

Preclinical Imaging/Analysis: Four imaging suites are located immediately adjacent to animal housing and surgical suites. Imaging equipment includes a **GE eXplore Vista microPET scanner**. This scanner is based on a dual-scintillation, depth-of-interaction technology that enables extremely high sensitivity and high spatial resolution. The scanner has an axial 4.6 cm FOV, a transverse 6.7 cm FOV, 36 depth of interaction modules, 12,168 crystals, and has 28.8M coincidence lines. The central spatial resolution is 1.2 mm using 3D OSEM reconstruction. The system has 15 ns timing resolution, and a 4% sensitivity. For fluorescence and bioluminescence imaging, four systems are available: a **Kodak FX Multispectral Imaging** system (29 excitation and 4 emission wavelengths, overlay of white light and x-ray images, and bioluminescence-level sensitivity), a **Maestro CRI multichannel fluorescence imaging system**, a **homebuilt bioluminescence imaging system** based on a high sensitivity Roper Scientific CCD camera, and a **home built fluorescence imaging minimally invasive system** for murine endoscopy.

Blood Sampling and Gamma Counter: Blood sampling resources will be provided by the **PerkinElmer Wizard2 2480 gamma counter** and **Swisstrace “twilite two”** continuous blood counting system that is being installed in our laboratory. Together with our existing **column-switching radioHPLC** system for metabolite analysis, these components provide the ability to measure the arterial input function with extremely high temporal precision using the twilite two as well as to measure plasma concentration and HPLC eluent activity using the Wizard2, allowing ideal measurement of model input functions used to quantify the PET image data. Of note, the twilite two continuous sampler can be configured as part of an arterial-venous shunt, allowing us to measure arterial input functions in rodents for which blood sampling is normally prohibitive due to volumetric constraints. The purchase of the blood sampling equipment was funded by NIH grant number 1S10OD018035 (Co-PIs: El Fakhri and Normandin).

Synthetic chemistry laboratory: The chemistry laboratory is specifically designed for the synthesis of novel pharmaceuticals. This laboratory consists of 2500 sq. ft. of modern research and production dedicated space equipped with acid resistant benches. This laboratory holds over 1000 reagents and all necessary glassware and small equipment. In addition to bench space, there are two walk-in refrigerators, four fume hoods, equipped with gas, vacuum, and water.

Radiochemistry facilities: A radioisotope laboratory (150 sq foot) is available on CNY-149-5. The laboratory is equipped with a shielded, vented hood. A Varian HPLC with UV detector and an IN/US systems flow through detector for HPLC effluent radioactivity is present. Additional equipment includes 2 Capintec CRC-25 dose calibrators, and a IN/US Systems multi-scanner for the scanning of TLC radioactivity. The facility is adjacent to the preclinical imaging suites.

Radiochemistry Support Facilities: Located adjacent to CNY 149 in CNY 75, are radiochemistry support facilities including a 500 MHz Varian NMR and Agilent Single Quad LC/MS and Ion Trap LC/MS/MS.

Cell culture: There are four tissue culture rooms on CNY149-5. Each room (150-250 sq. ft) is equipped with a laminar flow hood (Forma Scientific model 1132), CO2 incubators (Forma Scientific water jacketed), a microscope (Nikon TMS), waterbaths (Labline), and benchtop centrifuges. There is a liquid nitrogen freezer (Thermoscientific CryoPlus 2) for long term storage of cell lines. An Olympus Microscope Imaging System w/Phase contrast & Fluorescence (IX51/DP-72) is available for publication quality micrographs. Flow cytometers (FACSCalibur, LSR II) and a fluorescence-activated cell sorter (FACSAria, all from Becton Dickinson) are available for use.

Optical Imaging Facility: The Optical Imaging Facility is composed of an anti-vibration table and a black anodized stage contained within a light tight enclosure. Within the enclosure are fiber optic bundles for subject illumination and attached to the enclosure is a custom video coupler attached to an AD-130GE camera (JAI, Yokohama, Japan) to obtain simultaneous color images (512 × 512 pixels) with the choice of either 700 nm or 800 nm fluorescence images with custom dual bandpass prism (channel 1: 710/50, channel 2: 780lp). Sample excitation is from an RS-232-controlled LMI-6000 LED Fiber Optic Illuminator (Dolan-Jenner) equipped with custom excitation filters (Chroma Technology) or custom 1-5 W 660-nm and 760-nm LDX laser diode systems (RPMC) to produce 1-10 mW/cm2 fluence rate at a 13” working distance. The imaging system is remotely controlled by custom FLARE software at rates up to 15 Hz, although the field of view is manually adjusted by a 3CCD zoom lens (Goyo Optical Inc., Saitama, Japan). A duplicate system is mounted on a custom steel cart (Mobiletronics) and is controlled via LabView v 6.1 using a PC running Windows 7. The mobile system is also equipped with custom optics to accommodate endoscopes of various sizes, including the laboratory’s Olympus XP-40 flexible bronchoscope.

GCMI has the following optical measurement instruments:

SPECTRAmax Gemini XS fluorescence microplate reader (Molecular Devices; 250-820 nm range), USB-2000-UV-Vis absorbance spectrophotometer (Ocean Optics; 200-850 nm range), USB-2000-FL Vis/NIR fluorescence spectrophotometer (Ocean Optics 340-1000 nm range), and a full-range Beacon 2000 fluorescence polarization system with near-infrared optimized photomultiplier tube (Pan Vera Corporation; 254–850-nm range).

A near-infrared compatible microscope composed of a Nikon TE2000 inverted epifluorescence unit equipped with a 75 W Xenon light source, a 100 W Mercury light source, NIR-compatible lenses and optics, and custom fluorescence filter sets. Two custom filter sets (Chroma, Brattleboro, VT, USA) composed of 650 ± 22-nm and 750 ± 25-nm excitation filters, 675-nm and 785-nm dichroic mirrors, and 710 ± 25-nm and 810 ± 20-nm emission filters are used. The microscope is mechanically isolated from all fan-containing components using an anti-vibration table. Near-infrared (NIR) fluorescence imaging is performed using a cooled, NIR-compatible CCD camera (Photometrics Sensys) with the heat filter removed using IPLab software (Scanalytics). A Nikon E800 light microscope equipped with Nomarski DIC optics and a Zeiss Axiocam digital camera may be used for light or fluorescence microscopy. An additional fluorescence microscope (Nikon Diaphot) is located in the BL-2 tissue culture room.

Mass Spectrometry Facility: The Mass Spectrometry Facility, staffed by a Ph.D. level scientist and an assistant, is a research resource to provide a full range routine service in analysis of a wide range of organic and biological molecules by mass spectrometry, including synthetic organic molecules, polymers, peptide and proteins, and nucleotides, while remaining available for collaborations with principal investigators in solving research problems. The Mass Spectrometry Facility has a wide range of mass spectrometers available, including a Waters Q-TOF micro LCMSD combined with photodiode array (PDA), NIR fluorescence using a fluorescence detector (FLD), evaporative light scatter detection (ELSD), and QDa Mass Detector. In addition, Bruker Aurora M90 ICP-MS and Bruker UltraFlex III MALDI-TOF mass spectrometry are available for further analyses of chemicals. The Facility also routinely conducts exact mass and elemental composition determination, tandem (MS/MS) experiments and HPLC separations with MS detection as requested by researchers. For protein and biomaterials analyses, gel filtration chromatography (GFC) is performed on an AKTA Prime pump system (GE Healthcare) equipped with 2 flow cells (Starna Cells) and online absorbance and fluorescence spectrophotometers (Ocean Optics).

Laser micromachining facility and crystal polishing facility: The Laser micromachining facility is a restricted lab designed for class IV lasers and is equipped with a 20W Pharos laser system integrated with high-resolution Aerotech XYZ motorized linear stage. Pharos provides up to 20 W average power at 200 kHz pule repetition rate and 232 fs duration. Pulse duration (232 fs to 10 ps), pulse energy (up to 20 W for 1030 nm, and up to 11.6 W for 515 nm), repetition rate (single-shot to 1 MHz), and wavelength (1030/514/343 nm) are user selectable. Aerotech stage is comprised of ANT130-110-XY with 110 mm traveling distance, 350 mm/sec speed, and ANT95-25-L-Z-RH vertical stage with 25 mm traveling distance and 200 mm/sec maximum speed. The XYZ stage system has 75 nm bidirectional repeatability, and 1g acceleration. The lab is equipped with various beam shaping and delivery optics, and two cameras to monitor the workpiece one during laser processing and one after processing with high magnification. This Lab is also equipped with NOVA programmable polishing machine to polish crystals with various dimensions.

Detector/system integration and characterization facility: This Lab space is filled with multi-channel data acquisition systems, Nuclear Modular Electronics (NIM) crates, NIM-bins, power supplies, motorized linear stages, oscilloscopes, and a multi-channel analyzer for detector instrumentation for PET, SPECT and CT applications. A total of 21 single-anode photomultipliers (Hamamatsu PMTs), 4 position sensitive Hamamatsu PMTs, over 35 silicon photomultipliers with different pixel and array sizes (1x1 mm2, 2x2, 3x3, 4x4, 6x6 mm2 pixels), ample monolithic and pixelated scintillation detectors, as well as general electronic components are available to support detector instrumentation research. The Lab is equipped with 3 workstation computers: 1) Windows-based OS with Autodesk Inventor for mechanical drawing, plus MATLAB and LabView for general use with DAQs and data analysis, 2) Linux-based OS to control 768-ch PETsys DAQ with MATLAB for data analysis, 3) Dual-boot workstation with 10 core (20 thread) CPU and 128 GB memory with DETECT-2000, GEANT4, and GATE Monte-Carlo simulation tools, single GP100 NVIDIA GPU, and MATLAB for data analysis.

Magnetic Resonance Imaging Facilities: This facility provides state-of-the-art technology and has full-time staffing with extensive MRI expertise to facilitate biomedical research and new imaging technology development. The MGH Martinos Center operates eight Siemens whole body systems in Charlestown dedicated to research use. All these systems are flagship configurations, fully optioned with 32 or 64 receive channels, the fastest available reconstruction and processing, powerful and fast field gradients, linked to automatically transfer data to the hospital PACS system, as well as optionally save data to local research computing.

The 3T Siemens Prisma is a 128-channel whole-body MRI with a two-channel transmit system. The system features the Siemens XR200 gradient system with 80 mT/m gradient strength and 200 mT/m/ms maximum slew rate. The facility is equipped with a full assortment of body imaging coils as well as Siemens 32-channel and 64-channel head-neck coils. The facility is also multi-nuclear capable and an MGH-built 8-channel 31P head array is available. In addition, it contains a noise cancelling MR compatible microphone and an assortment of audio, visual, and sensory stimulus equipment for fMRI studies including rear projection, audio stimulation, a subject response device, and an eye tracking setup. The facility has also been configured to allow simultaneous TMS stimulation as well as recording of simultaneous EEG.

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| **Computing** |

Computing consists of a recently installed global shared memory (ccNUMA interconnect) Silicon Graphics UV 2000 supercomputer at MGH. The hardware consists of 32 2-processor 8-core Intel Xeon E5-4640 2.4 GHz processing nodes (512 cores, 1024 threads), 3 terabytes of RAM and 120 terabytes of disk storage. System performance is 9.83 teraflops and includes the high-performance SGI InfiniteStorage 5000 storage system with 4 GB cache and 6Gb/s Fibre Channel architecture for data throughput. This computer running SLES Linux will be used for Monte Carlo CT and PET simulations as well as image reconstruction. The purchase of this equipment was funded by NIH grant number 1S10OD011928-01A1 (PI: El Fakhri).

Additional computing resources are provided by a Beowulf Linux cluster dedicated to high-performance computing that currently has one master node and three computing nodes, including a total of 18 logical processors, 12 GB memory, and 4 TB disk space, and is capable of running both 32- and 64-bit applications.

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, Sterlingg, 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

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| **Animals**  |

Animal housing is performed by the Center for Comparative Medicine at MGH located in main campus in Edwards and Thier Research Buildings and in CNY Building 149. The MGH Center for Comparative Medicine (CCM) orders, receives and houses all animals in compliance with USDA law and AALAS regulations. MGH complies with the provisions of the Animal Welfare Regulations and is registered with the US Department of Agriculture as an approved research facility (Reg. No. 14-R-014). MGH has an assurance statement on file with the Office for Protection from Research Risks at the NIH; the institutional assurance number is A3596-01.

Center for Comparative Medicine (CCM)/oversight over animal handling: Massachusetts General Hospital maintains the Sub-Committee on Animal Research Care (SRAC), serving as the Institutional Animal Care and Use Committee as required by the Public Health Service (PHS) Policy on Humane Care and Use of Laboratory Animals. Animals are maintained in accordance with the "Guide for the Care and Use of Laboratory Animals" (National Research Council, 1996), and all animal protocols must be approved by the SRAC before animals can be ordered.

The hospital is registered with the U.S. Department of Agriculture Animal and Plant Health Inspection Service (Certificate No. 4-R-014) and the Massachusetts Department of Public Health (License No. 11-0022) as a licensed animal research facility. MGH files an annual Letter of Assurance (File No. A3596-01) with the NIH Office of Laboratory Animal Welfare confirming compliance with PHS regulations pertaining to laboratory animal care and use. In addition, the hospital has been accredited by the Association for the Assessment and Accreditation of Laboratory Animal Care International (AAALAC) since 1993.

The laboratory animal care and use program is operated by the Center for Comparative Medicine (CCM) and Laboratory Animal Services, under the direction of Donna Jarrell, DVM, Diplomate, American College of Laboratory Animal Medicine and Attending Veterinarian. CCM administers an animal health surveillance program that monitors for presence of infectious disease agents in each animal room. Commercial suppliers providing animals for use at MGH are required to submit results of their monitoring programs on a regular basis. Similar requirements are enforced for animals transferred from other institutions, with coordination and veterinary assessment provided by CCM staff. Veterinary medical care is available on a 24-hour basis year-round.

The Gordon Center operates a **satellite mouse housing facility on CNY 149-5** to facilitate transfers of mice to our surgery room or to imaging equipment located in additional rooms adjacent to the satellite holding room. The satellite mouse holding room is built to barrier facility standards (with special paint, flooring, ceilings, humidifiers and exhaust), and positive air pressure. The room contains a 144-cage Alternative Design Manufacturing racks with a Gentle-Air Ventilated System, and Max75 microisolator cages. Each cage holds up to 5 mice for a total of 720 mice. Mice in each cage are environmentally separated from all others, as the cages are micro-isolator cages. Exhaust from each cage is filtered through a HEPA filter in the holding rack prior to recirculation. The room contains a Lab Products Stay Clean L/F-B Work Bench laminar flow hood for mouse cage changes in an isolated environment without the risk of cross contamination between cages. The facilities were designed in conjunction with the MGH Center for Comparative Medicine (CCM) to exceed all requirements for long-term holding of rodents. Since the facility has been operational (2003), no contamination has occurred or infection has occurred.

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| **Office Space** |

The Gordon Center for Medical Imaging has administrative and research space (~1,000 ft2 on White Bldg 2,4, ~500 ft2 in Bartlett Bldg, ~2000 ft2 in Nashua Bldg) that is equipped with conference rooms, access to computers, especially a large computing cluster accessible to members of the Center.

Office and conference space, XXX ft2, is also available in CNY Building 149.