Singapore
Bioimaging
Consortium
A*STAR

BEDSIDE

COMMUNITY

INDUSTRY

BENCH

SINGAPORE BIOIMAGING CONSORTIUM

Creating Value
Advancing Knowledge
Imaging Today the Medicine of Tomorrow

Executive Director's Message

Prof. Patrick J. Cozzone

The Singapore Bioimaging Consortium (SBIC) **is a Research Institute** of the Biomedical Research Council under the Agency for Science, Technology and Research (A*STAR) in Singapore. SBIC is located on 5 levels of the Helios building, in the heart of Biopolis, Singapore's premier international Research and Development hub for Biomedical Sciences.

OUR MISSION

As a Research institute, with a multidisciplinary team of biologists, physiologists, chemists, physicists, electrical/electronic engineers, computer scientists and clinicians, SBIC investigates human diseases which are major public health issues using molecular physiology and advanced bioimaging tools, in a translational and pivotal mode with the medical community and industrial partners (MNCs and SMEs). SBIC also works on strategic bioimaging projects, including the synthesis and development of novel imaging probes. As a National Consortium, SBIC aims to harness and coordinate existing imaging expertise and capabilities in Singapore, bringing together substantial strengths in the physical sciences and engineering with those in the biomedical and clinical sciences.

SBIC: AN INTEGRATED R&D ORGANIZATION

In order to reach its R&D objectives, SBIC has built a competitive state-of-the-art multimodal bioimaging platform comprising 3 Laboratories all located in the Helios Building in Biopolis:

- **Laboratory of Molecular Imaging (LMI)** with all modalities of *in vitro* and *in vivo* cellular imaging (optical imaging, MR spectroscopy and imaging, C-13 hyperpolarization, micro CT, nanoSPECT-CT, microPET-CT, MR-PET, NIRS-MRI, signal and image processing and analysis).
- **Laboratory of Metabolic Medicine (LMM)** for molecular physiology and metabolic phenotyping.
- **Laboratory of Molecular Chemistry (LMC)** for the development of chemical / biological probes, with advanced synthetic medicinal chemistry and radiochemistry capabilities.

The 3 Laboratories host 14 research groups, with a total head count of 125 including 80 postdoctoral scientists and engineers (21 nationalities).

SBIC: A UNIQUE CAPACITY TO PROMOTE RAPID TRANSFERS OF RESULTS

The vertical integration of multidisciplinary competences from genes to humans within SBIC, and the extensive horizontal network of transverse collaborations across institutions and disciplines in Singapore and overseas, confers SBIC a unique capacity to promote rapid transfer of results in animal and human imaging research onto the clinical environment, to the immediate benefit of patients. It also ensures the development of financially sound and sustainable contractual research with industrial partners (pharmaceutical industry, food & nutrition, personal care). SBIC currently operates 5 joint laboratories with industrial partners under the form of public-private partnerships – Nikon, Bruker, iThera, Mediso, MicroPhotoAcoustics – and has long term research agreements with Siemens Healthcare.

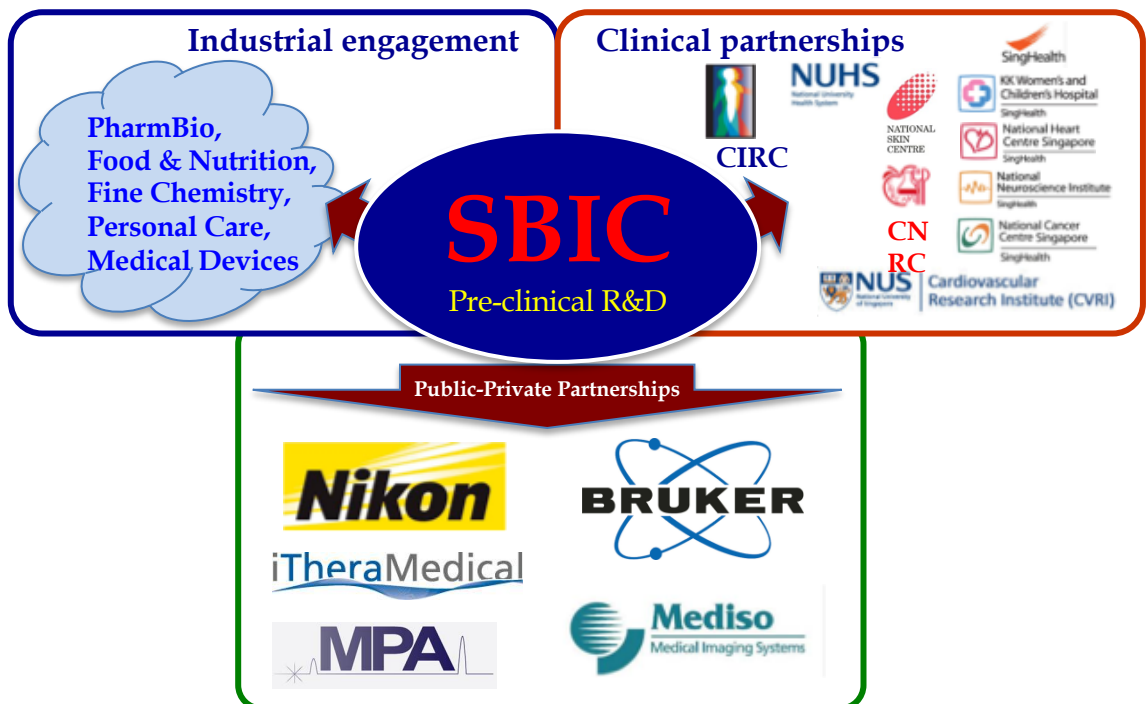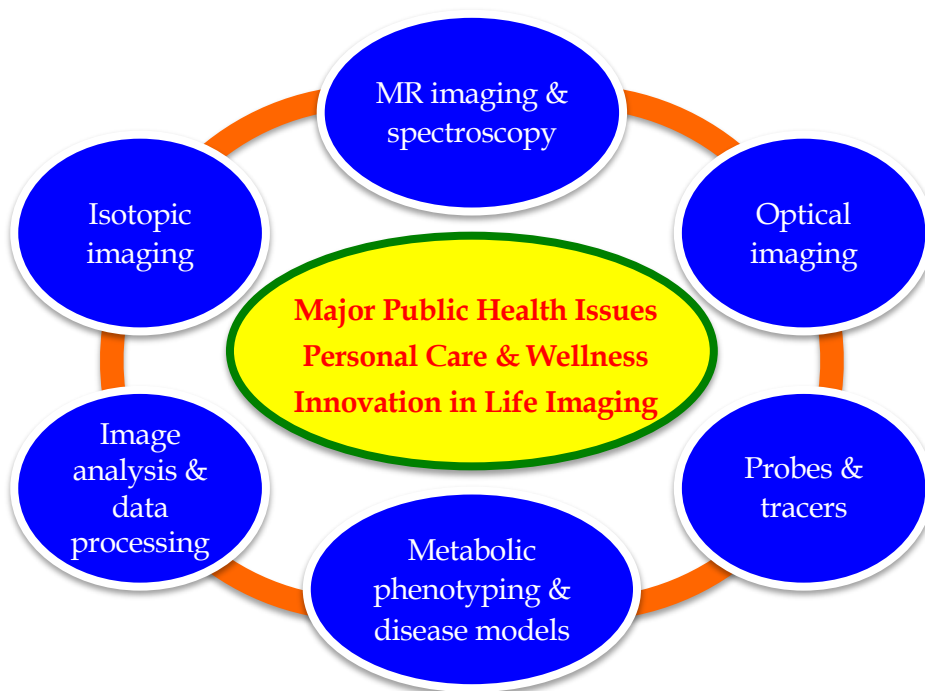|		
A leading multimodal bioimaging platform in Asia and in the world	A close interface with the industrial sector	A demonstrated ability to attract, develop and retain talents
A proven success in capturing economic opportunities in order to create value	A multidisciplinary R&D activity focusing on human diseases which are major public health issues	A high societal impact with rapid bench-to-bedside transfers in collaboration with the clinical community

ENABLING TECHNOLOGIES

- MR imaging & spectroscopy
- Isotopic imaging
- Optical imaging
- Image analysis & data processing
- Probes & tracers
- Metabolic phenotyping & disease models

Major Public Health Issues
Personal Care & Wellness
Innovation in Life Imaging

Industrial engagement

PharmBio,
Food & Nutrition,
Fine Chemistry,
Personal Care,
Medical Devices

SBIC
Pre-clinical R&D

Clinical partnerships

SingHealth

NUHS
National University Health System

CIRC

KK Women's and Children's Hospital
SingHealth

NATIONAL SKIN CENTRE

National Heart Centre Singapore
SingHealth

National Neuroscience Institute
SingHealth

National Cancer Centre Singapore
SingHealth

CN
RC

NUS National University of Singapore
Cardiovascular Research Institute (CVRI)

Public-Private Partnerships

Nikon

BRUKER

iTheraMedical

MPA

Mediso
Medical Imaging Systems

Principal Investigators & Group Leaders

Kishore BHAKOO, PhD
**Director, Translational Imaging/Head, Isotopic Imaging Laboratory (IMIL)**

Prof. Bhakoo received a PhD in Neurochemistry of Stroke at Institute of Neurology, University of London in 1983. His interests lie in translational medicine using multimodal imaging in drug discovery pipelines. He worked at Ludwig Institute for Cancer Research, as Wellcome Research Associate at Royal College of Surgeons Unit at Institute for Child Health, as Staff Scientist and University Research Lecturer at University of Oxford, and as Group Head and Senior Lecturer at MRC Clinical Science Centre at Imperial College London. From 2009-2016, he was appointed as Head of Translational Molecular Imaging Group at SBIC. He also holds external academic posts including Adjunct Associate Professor of Biochemistry and Orthopedic Surgery, NUS.
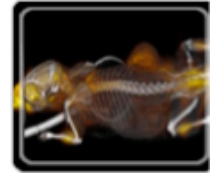
Bhanu PRAKASH KN, PhD
**Group Leader, Signal and Image Processing Group (SIP)**

Dr. Prakash HN obtained his Ph.D. from Indian Institute of Science, Bangalore in 2002 and did his postdoctoral work at I2R, A*STAR. He later joined the Biomedical Imaging Laboratory, SBIC as Research Scientist in 2005. His Signal and Image Processing Group (SIP) focuses on the development of novel post-processing algorithms and tools by combining machine learning techniques, biological vision models and signal statistics for MRI/MRS, fat metabolism, neuroimaging and multi-modal imaging studies.
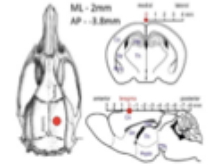
Dr Joyce CHAN
Group Leader, Translational Cardiovascular Imaging Group (TCIG)

Dr. Chan graduated in Medicine from University of Southampton in 2002 and did postgraduate fellowship in vascular surgery at St. Mary's Hospital, Imperial College. She obtained a PhD in molecular imaging of atherosclerosis at Imperial College London, and an MBA from The Chinese University of Hong Kong. Her group focuses on developing translational molecular imaging and theranostic strategies aimed at improving selection of high-risk patients for prophylactic intervention, paving way for personalized management of cardiovascular diseases. Her research interests also include understanding biological processes in cardiovascular diseases and tracking drug delivery from angioplasty and stent grafts for vascular pathologies.
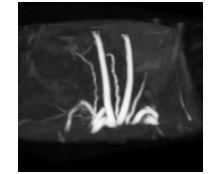
### FU Yu, PhD
Group Leader, Brain Plasticity Group (BPG)

Dr. Fu received his PhD from Stony Brook University in 2011 and postdoctoral training at UC San Francisco. He also holds an Adjunct Assistant Professor, Department of Physiology, Yong Loo Lin School of Medicine, NUS. His group focuses on understanding the mechanisms of brain plasticity and exploring strategies for improving brain plasticity in aging people and patients. His current research interests include the roles of different classes of neurons in visual cortical plasticity and the circuit mechanisms of modulating cortical functions by neuromodulators. His group is also developing molecular, genetic and viral tools for specifically tracing and manipulating different types of neurons, aiming to elucidate functions of neural circuits in certain animal behaviors.

Julian GOGGI, PhD
**Group Leader, Isotopic Molecular Imaging Laboratory (IMIL)**

Dr Goggi obtained his PhD in Neurochemistry from Imperial College London, UK in 2002. He completed his postdoctoral training in PET imaging at the Hammersmith Hospital in the Dept of Psychiatry before moving into pharmaceutical research at the MSD Neuroscience Research Centre in the UK, working in the Alzheimer's franchise. Subsequently he joined GE Healthcare Medical Diagnostics Discovery developing novel PET and SPECT diagnostics and MR contrast agents. Julian joined SBIC in 2010 and currently holds an adjunct position in the Department of Physiology Yong Loo Lin School of Medicine, NUS. His research focusses on the development of novel radiopharmaceuticals for the detection, stratification and treatment of disease in the fields of oncology, neurology and regenerative medicine.
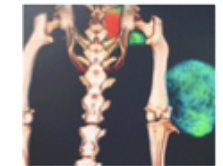
HAN Weiping, PhD
Deputy Director, SBIC/Head, Laboratory of Metabolic Medicine (LMM)

Dr. Han received his Ph.D. from Cornell University in 1996, and then worked at University of Pittsburgh and UT Southwestern Medical Centre before joining SBIC. Currently he is Deputy Director of SBIC with concurrent appointment as Head of LMM. He is also Research Director at Institute of Molecular and Cell Biology; Professor in the Department of Biochemistry at National University of Singapore and Program in Cardiovascular and Metabolic Disorders, Duke-NUS. His research aims to understand the molecular basis of diabetes and diabetic complications, to discover and validate targets for drug development, and to develop mouse models for understanding and evaluation of therapeutic interventions. His laboratory uses molecular genetics and physiology techniques to analyze genetically modified animals and cells.
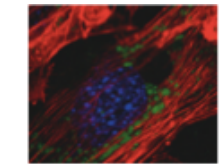
Sangyong JUNG, PhD
**Group Leader, Neuro Modulator and Neuro Circuitry (NMNC)**

Dr. Jung obtained his Ph.D. degree from Dep. of Physiology and Biophysics, School of Medicine, Inha University, South Korea. During his postdoctoral training, he studied synaptic plasticity at Pohang University of Science and Technology (POSTECH), South Korea (2005) and at Max Planck Institut-Experimental Medizine (MPI-EM), Germany (2009). He is also an Adjunct Assistant Prof. at Department of Physiology, Yong Loo Lin School of Medicine, National University of Singapore (NUS) in 2016. His projects aim at discovering novel metabolites and neuronal circuitries which regulate feeding behaviors and metabolic inflammations in the brain.
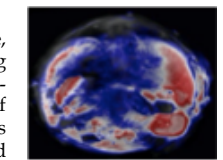
LEE Kuan Jin, PhD
Senior Clinical Scientist, MR Methods Development Group (MRMD)

Dr. Lee obtained his PhD in Magnetic Resonance Imaging from the University of Sheffield in 2003. He did postdoctoral research at the Academic Unit of Radiology at the University of Sheffield, and then in Jürgen Hennig's Magnetic Resonance laboratory at the University Medical Center, Freiburg. Dr Lee worked at Siemens Healthcare before joining SBIC in 2014. His current interests at SBIC include development of MR sequences for fast, motion insensitive imaging, and vascular imaging.
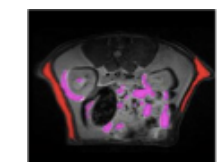
Principal Investigators & Group Leaders

Philip LEE, PhD
**Group Leader, Functional Metabolism Group (FMG)**

Dr. Lee received his PhD from NUS in 2010 and completed his postdoctoral training at SBIC. Dr. Philip Lee has keen interests in discovering and understanding the role of metabolism in disease pathology. He takes advantage of the arsenal of imaging modalities and transgenic animal technology to study metabolic alterations in diabetes, liver cancer and heart failure. Trained as a MRI physicist, he is also interested in developing new MRI pulse sequences and hyperpolarization techniques for rapid metabolic imaging and *in vivo* modeling of enzyme kinetics. He is also actively involved in the clinical study of skeletal muscle metabolism in human thyroid diseases.

Malini OLIVO, PhD
**Director of Biophotonics/Head, Laboratory of Bio-optical Imaging (LBOI)**

Dr. Olivo obtained a PhD in biomedical physics in 1990 and did postdoctoral training at University of Toronto and Princess Margaret Cancer Hospital, Canada, before coming to Singapore in 1996 to join Singhealth. She holds an adjunct Stokes Professorship at the National University of Ireland, Royal College of Surgeons, Dublin Ireland. She joined SBIC in 2012 to lead the optical imaging and biosensing research effort. In 2015, she was recognized for her pioneering contribution to biophotonics for clinical diagnostics and therapeutics by the Optical Society of America. Her current research interest is *in vivo* optical imaging, optical nano-biosensing and clinical translational nano-biophotonics.
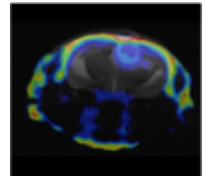
Edward ROBINS, PhD
**Head, PET Chemistry Group (PCG)**

Dr. Robins received a BSc. Hons. in Chemistry from the University of Newcastle-upon-Tyne (1994) and a Ph.D. in inorganic/organometallic chemistry from Bristol University (1997). Since 2011, Dr Robins has been Head of Radiochemistry at SBIC and holds a joint-appointment at the Clinical Imaging Research Centre (CIRC). His main areas of interest are the development of synthetic methods for the development of both radiolabelled and isotopically labelled small molecules as PET and MR imaging biomarkers. In particular, the development of novel PET tracers has focussed predominantly on fluorine-18 as the radioisotope of choice. More recently, the research has explored the addition of other isotopes to our PET chemistry portfolio, such as gallium-68, as well as the chemistry of both ^{13}C and ^{15}N for applications in Dynamic Nuclear Polarization magnetic resonance (DNP-MR).
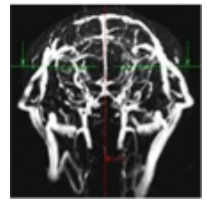
Shigeki SUGII, PhD
**Group Leader, Fat Metabolism and Stem Cell Group (FMSCG)**

Dr. Sugii graduated from Kyoto University and obtained his PhD from Dartmouth College in 2003. The long-term goal of his group is to develop applications of adipose-derived cells for treating metabolic diseases. His goal is to investigate therapeutic use of adipose-derived stem cells (ASCs) and understand biological mechanisms at the stem cell level that lead to depot specific differences of adipose tissue. His group currently works with other investigators to develop novel imaging methods of different adipose tissues (white, beige, and brown), explore potential therapeutic use of ASCs through reprogramming into induced pluripotent stem (iPS) cells, and study depot-specific molecular differences between subcutaneous and visceral fat-derived ASCs.
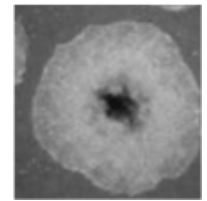
TANG Jiong, PhD
Group Leader, Neuro Modulator and Neuro Circuitry (NMNC)

Dr. Tang graduated with B.S. and M.S. from Fudan University in Biochemistry and Molecular Biology. He then went to UT Southwestern Medical Center, Dallas to pursue his PhD degree in Neuroscience Program in Dr. Thomas C. Südhof's laboratory. In 2016, he moved to Singapore, joined A*STAR and started his laboratory in SBIC. The main interests of Dr. Tang's group are to understand molecular mechanisms of neurological diseases, to generate animal diseases models for behavior test and to identify targets for drug screen. Currently, his group works on Nicolaides Baraitser Syndrome (NBS).
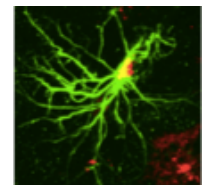
Sendhil VELAN, PhD
Head, Metabolic Imaging Group (MIG)

Dr. Velan received his PhD in Magnetic Resonance from University of Madras (1997). After his post-doctoral research at NIA/NIH (1997-98) he worked as a senior scientist at California Institute of Technology (1999-2003) and also served as a faculty in Radiology, West Virginia University (2004-2009). He joined SBIC with concurrent appointment at Singapore Institute for Clinical Sciences in mid 2009 as the head of Metabolic Imaging Group. Current focus of his group is on translational imaging studies of metabolic diseases including white and brown adipose tissue function, fat partitioning during obesity, fat mobilization and nutrition, energy balance in rodents and humans.

A*STAR Visiting Investigator

Thomas C SÜDHOF, M.D. - Visiting Consultant

Prof. Südhof is Avram Goldstein Professor in the School of Medicine at Stanford University, and has been an Investigator of the Howard Hughes Medical Institute since 1986. Among his numerous honors and awards, he was elected to the National Academy of Sciences (USA) in 2002, and Institute of Medicine (USA) in 2008, and received the Kavli Prize in Neuroscience in 2010, the Lasker Basic Medical Research Award (2013), and the Nobel Prize in Physiology or Medicine (2013). Prof. Südhof is Visiting Consultant for the focused neuroscience program at SBIC, which includes support from the A*STAR Visiting Investigator Program (VIP).

Our Resources

Magnetic Resonance Imaging & Spectroscopy

SBIC's MR imaging capabilities in high field MRI/MRS scanners include two **9.4 Tesla (Bruker Biospec)** systems, a **large animal 3T** MR system (**Siemens Skyra**), a **7T Bruker Clinscan** and an **ultra-high field 11.7T Bruker BioSpec**. SBIC's MR suite also features two Dynamic Nuclear Polarization (DNP) systems (**HyperSense** and **SpinLab**) for dynamic visualization and quantification of metabolic fluxes *in vivo*. In addition to preclinical scanners, two vertical bore high field Nuclear Magnetic Resonance spectrometers (**Bruker 400MHz**, and **600MHz**) machines support regular liquid state applications including biofluids and high resolution magic angle spinning spectroscopy (HR MAS) of intact tissues *ex vivo*.
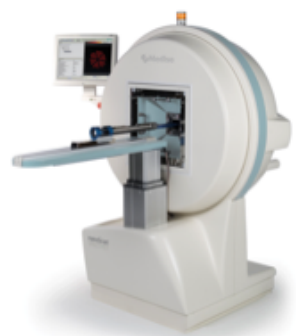
Isotopic Imaging

Isotopic molecular imaging is an indispensable tool in routine clinical practice and in preclinical research and drug development. Dual-modality isotopic imaging platforms available at SBIC include a **Siemens Inveon PET-CT**, **Mediso Nano SPECT-CT** and the world's first pre-clinical **Mediso 7T MRI-PET** system. These state-of-the-art imaging capabilities are supported by dedicated pre-clinical laboratory facilities for both imaging and radiochemistry for the production of PET and SPECT radiolabeled tracers for *in vivo* applications. These imaging modalities can be applied across a wide spectrum of drug development pipelines and characterization of disease pathologies, from assessment of target specificity, to *in vivo* therapeutic efficacy and evaluation of drug kinetics.

Metabolic phenotyping and mechanistic studies

SBIC is equipped with a full range of molecular and cell biology, biochemistry and molecular physiology capabilities. Studies on metabolic phenotyping and mechanistic analysis are routinely performed by using these and molecular imaging techniques. Metabolic phenotyping covers glucose homeostasis, energy balance, and motor behavior. These studies provide a systemic understanding of whole body metabolic homeostasis, which is extended to include interactions between the brain and the peripheral metabolic organs.

Optical Imaging

Optical imaging encompasses a variety of techniques that use light to visualise cellular and molecular functions with high resolution and sensitivity in living systems. Optical methods include Raman microscopy, surface plasmon resonance, diffuse speckle contrast analysis, multifunctional fiber optic spectroscopy and multi-modal near infrared spectroscopy (NIRS)-Fluorescence-MRI. SBIC collaboration includes the development of cell-specific markers (**SBIC-Nikon**), and optoacoustic imaging technologies for high resolution & deep penetration imaging such as multi-spectral optoacoustic tomography (**SBIC-iThera Medical**), Raster scanning optoacoustic mesoscopy (**SBIC-TUM**) and photoacoustic microscopy (**SBIC-MPA**).

Chemistry

SBIC's Laboratory of Molecular Chemistry (LMC) comprises of two laboratories, a synthetic chemistry laboratory for organic and organometallic medicinal chemistry and a dedicated radiochemistry laboratory (located within the Clinical Imaging Research Centre **(CIRC)** on the National University of Singapore (NUS) campus) for the preparation and handling of cyclotron-produced, short-lived positron-emitting (β+ decay) radionuclides for the production of PET radiopharmaceuticals/tracers.

Joint Laboratories with Industrial Partners

The SBIC-Nikon Imaging Centre (SBIC-NIC) was established as a joint venture in 2007. It is the only centre in Asia outside of Japan, providing state-of-the-art biological microscopy to researchers across Singapore and the region. The mission of the centre is to promote innovation in biological research and is committed to providing access to cutting edge microscopy and imaging technologies. The joint centre also organises training courses on microscopy techniques for the benefit of A*STAR and regional research community.

The SBIC-Bruker Preclinical Imaging (PCI) Centre was opened in 2014. The centre is the first facility of its kind in Asia, and only the second in the world. The PCI Centre is currently equipped with an In Vivo Xtreme system for optical imaging and a Skyscan 1176 microCT scanner. The PCI Centre provides demonstration, training and applications support for SBIC's and Bruker's preclinical multi-modal imaging platforms for researchers across Singapore and the region. The mission of the PCI centre is to foster closer collaborations between the academic and clinical communities, as well as the pharmaceutical companies.

The SBIC-iThera Medical Imaging Centre was established in 2016, as the first of its kind in the world. It has been expanded in 2018. iThera Medical is a pioneer in multispectral optoacoustic tomography (MSOT), capable of real-time, tomographic imaging of optical contrast. Through this imaging centre, we investigate the use of proprietary MSOT technology in both pre-clinical and clinical applications, primarily in skin, fat and brain imaging. The MSOT technology promises to revolutionize imaging for point-of-care diagnostic purposes in the clinic.

The SBIC-Mediso Joint Laboratory was established in 2016. The centre is the only such facility in the world, and equipped with the first of its kind state-of-the-art combined high-field 7T-MRI-PET imaging system. The centre's mission is to design and develop components dedicated for the integrated MRI-PET system, as well new applications for translational research. This reference site allows demonstration of pre-clinical applications and feasibility of using integrated MRI-PET technologies in the context of cardiovascular, oncology and neuro-imaging research.

The SBIC-MicroPhotoAcoustics (MPA Inc) Imaging Centre was established in 2016, as the first of its kind in the world. MPA are pioneers of 3-D photoacoustic microscopy (PAM).The technology offers rapid-scanning optical-resolution (OR) and acoustic-resolution (AR) photoacoustic microscopy which enables imaging of endogenous and optical absorbers at high-axial (micron) and spatial (mm) resolution. This joint laboratory provides cutting edge photoacoustic microscopy technology to promote innovation in pre-clinical in-vivo imaging.

Singapore Bioimaging Consortium

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