

Image Guided Cancer Therapy Research Program

Annual Update – FY2021

A NOTE FROM EXECUTIVE DIRECTOR DR. KRISTY K. BROCK



Hello and Happy New Year! I hope that 2022 is off to a healthy, rested, and renewed start for all of you. Life has definitely continued to be challenging as we navigate the pandemic and the impact it has on translational research. It has been a year since we published our first Annual Report, covering the first 3 years of the program. I wanted to provide a brief update to celebrate the numerous successes of IGCT Investigators and introduce new IGCT faculty, staff, and new – and improved – initiatives in the program. Before we dive into the updates, I wanted to take the opportunity to thank everyone for their support of the program. To the 75 faculty who are committed to our mission of empowering multidisciplinary teams to address clinical challenges and technology barriers in pursuit of improving local regional tumor control and reduced toxicities – thank you for making this program possible! Thank you to Drs. John Hazle, Marshall Hicks, Albert Koong, and Stephen Swisher for your support of the vision of this program and to Drs. Dave Fuller, Bruno Odisio, and Jeff Weinberg for your innovative leadership as IGCT Medical Directors. Thank you to the Imaging Physics Grants Team, led by Erica Cantu, whose endless support has enabled so much over the past year. And finally, an enormous thank you to Dr. Kari Brewer Savannah, who joined the IGCT as Program Manager, more details below, for providing your transformational vision and support to the IGCT! I look forward to an exciting year of progress! Best,

Kristy K. Brock



Kari Brewer Savannah, PhD joined the IGCT as Program Manager in October of 2020. Dr. Brewer Savannah holds a BS in Chemistry from Hillsdale College and a PhD in Biochemistry and Biomedical Sciences from the MD Anderson UTHealth Graduate School of Biomedical Sciences. She previously served as Assistant Professor at

The University of Texas at Brownsville and at Houston Baptist University, and as Program Manager for a large cancer research training program comprising undergraduate researchers, graduate students, and postdoctoral fellows. Dr. Savannah has significant experience in the design, management, and assessment of research training programs, educational programming, and in initiatives to expand diversity, equity, and inclusion for underrepresented minorities in STEM fields. Dr. Savannah brings a strong background in research administration, scientific project management, and program management to her role in the IGCT. We are incredibly excited to have her on the IGCT Team!



FISCAL YEAR 2021 IGCT PROGRAM HIGHLIGHTS

- ◇ IGCT Investigators were awarded competitive funding for innovative projects in image-guided cancer therapy. These included first time R01 awards.
- ◇ The IGCT T32 submission in May 2021 received an impact score of 16 and is anticipated to be funded.
- ◇ Research by IGCT investigators made great strides in Artificial Intelligence for cancer research this year.
- ◇ The IGCT hosted 13 seminars and 2 webinars with record attendance at these events.
- ◇ The IGCT welcomed 7 new investigators, a dedicated Program Manager, and several research staff in FY2021.

IGCT FEATURED GRANTS IN FY2021

Radioimmunogenic Habitat Phenotypes to Predict Efficacy of Neoadjuvant Immunotherapies in Non-Small Cell Lung Cancer



Jia Wu, PhD
Department of Imaging Physics
NIH NCI R01

Assistant Professor Jia Wu, PhD was awarded an NCI R01 in FY2021 with his Co-PI, Tina Cascone, MD, PhD (Department of Thoracic-Head & Neck Medical Oncology), for their cross-disciplinary project. The research seeks to develop computational tools to extract quantitative imaging biomarkers from serial PET and CT scans and enable evaluation of the biological and clinical relevance of these imaging biomarkers. The new imaging biomarkers will close the unmet clinical need in immunotherapy for early-stage lung cancer by identifying those patients most likely to benefit from treatment, maximizing the clinical effectiveness of immunotherapies, and thus promoting a major paradigm shift of the role of radiographic imaging to serve as an important approach in precision cancer management.

“As junior faculty, the IGCT program offers a unique opportunity to gain critical mentorship from leaders like Dr. Brock, which has significantly shaped our grant preparation and directly contributed to its success. Further, IGCT has many resources to help integrate our multi-disciplinary team and many ideas to help boost our impact on research and cancer care.”

Jia Wu, PhD

A Comprehensive Clinical fMRI Software Solution to Enable Mapping of Critical Functional Networks and Cerebrovascular Reactivity in the Brain



Ho-Ling Anthony Liu, PhD
Department of Imaging Physics
NIH NCI R01

Imaging Physics Professor Ho-Ling “Anthony” Liu, PhD, submitted an R01 scoring in the 4th percentile in FY2021. The project, which is anticipated to be funded, is focused on improving functional MRI (fMRI), which is a non-invasive clinical tool for presurgical localization of eloquent brain areas (e.g., motor and language areas) and is used to prevent post-surgical deficits for patients with brain cancers, epilepsy, and other focal pathologies undergoing surgical resection of the lesion. Task-based fMRI fails in patients who cannot perform the tasks and in brain areas with impaired neurovascular coupling induced by the lesion. The proposed research aims to create robust and vetted clinical software solutions that will enable emerging fMRI methods, including resting-state fMRI and cerebrovascular reactivity mapping. These tools will greatly increase the patient population who can benefit from presurgical fMRI and will improve confidence in functional localization for surgical planning.

“As a clinical faculty, the advice and encouragement I received from the IGCT program was invaluable to my continued pursuit of research and to my R01 submission. I’m grateful to be a part of such an impactful program.”

Ho-Ling Anthony Liu, PhD

Building Research Infrastructure and Data Generation Engine to Enable Automated AI on Standardized Ontology and Big Data Repositories (BRIDGE2AI – SOAR)

Kristy K. Brock, PhD (Imaging Physics)
Chuck S. Mayo, PhD (University of Michigan)

Through multidisciplinary efforts supported by the IGCT, a \$40M Bridge2AI SOAR grant was submitted in August 2021. The grant leverages the expertise of >70 investigators from >30 institutions and professional societies worldwide. This monumental effort seeks to enable automated artificial intelligence and statistical-based learning that operates on federated and cloud-based databases generated using standardized ontologies developed in collaboration with multi-disciplinary professional societies. The OT2 grant is currently under review by the NIH. The IGCT would like to extend our gratitude to Dr. Kari Brewer Savannah and the Imaging Physics and Cancer Systems Imaging grants teams for their extensive efforts to facilitate this large submission.

Image Guided Cancer Therapy Training Program

Kristy K. Brock, PhD (Imaging Physics)
Stephen Lai, MD, PhD (Head & Neck Surgery)
C. Dave Fuller, MD, PhD (Radiation Oncology)

A cross-disciplinary team of IGCT investigators from three divisions at MD Anderson (Diagnostic Imaging, Surgery, and Radiation Oncology), joined forces to design a comprehensive training program in image guided cancer therapy and submitted a T32 grant to the NCI in FY2021. Receiving an impact score of 16, the T32 is anticipated to be funded and will bring additional post-doctoral training opportunities with the IGCT Program. The T32 program will provide integrated cross-disciplinary education needed for tomorrow’s pioneering researchers to advance the field of image guided cancer therapy.

NIH FUNDING GRANTED TO IGCT INVESTIGATORS IN FY2021

IGCT Investigator	Department	Grant/Role	Grant Title
Suprateek Kundu, PhD	Biostatistics	NIMH R01 PI	Integrative brain network-based analysis for heterogeneous and multimodal imaging
Suprateek Kundu, PhD	Biostatistics	NIA R01 Co-PI	Statistical modeling of Alzheimer's Disease progression integrating brain imaging and -omics data
David Piwnica-Worms, MD, PhD Lilie Lin, MD	Cancer Systems Imaging Radiation Oncology	NCI R01 Co-PIs	A novel PARP inhibitor PET tracer for breast cancer
H. Charles Manning, PhD	Cancer Systems Imaging	NCI U24 Co-PI	MDACC-PREDICT
H. Charles Manning, PhD	Cancer Systems Imaging	NCI R01 PI	Quantitative PET imaging of hepatocellular carcinoma (HCC)
Ann Gillenwater, MD	Head & Neck Surgery	NIDCR R21 Co-PI	Mobile imaging for oral cancer screening programs in rural US settings
David Fuentes, PhD Jim Bankson, PhD	Imaging Physics Imaging Physics	NCI R21 Co-PIs	An information-theoretic approach to HP signal acquisition in brain
Jia Wu, PhD	Imaging Physics	NCI R01 Co-PI	Radioimmunogenomic habitat phenotypes to predict efficacy of neoadjuvant immunotherapies in non-small cell lung cancer
Kostantin Sokolov, PhD Richard Bouchard, PhD	Imaging Physics Imaging Physics	NIBIB R21 Co-PIs	Development of fluorinated dyes for deeper tissue photoacoustic imaging with phase changing nanodroplets
Rick Layman, PhD	Imaging Physics	NIH S10 PI	Photon counting detector MicroCT
Anirban Maitra, MBBS	Pathology	NIDDK U01 Co-PI	The Texas-Louisiana Alliance to study chronic pancreatitis, diabetes, and pancreatic cancer
C. Dave Fuller, MD, PhD	Radiation Oncology	NIDCR R01 Diversity Suppl., Co-PI	Development of functional magnetic resonance imaging-guided adaptive radiotherapy for head and neck cancer patients using novel MR-Linac device
C. Dave Fuller, MD, PhD	Radiation Oncology	NCI R01, Co-PI	Longitudinal spatial-nonspatial decision support for competing outcomes in head and neck cancer therapy
C. Dave Fuller, MD, PhD	Radiation Oncology	NCI R01, Co-PI	SCH: Personalized rescheduling of adaptive radiation therapy for head and neck cancer
C. Dave Fuller, MD, PhD	Radiation Oncology	NCI R01 Diversity Suppl., Co-PI	SCH: Personalized rescheduling of adaptive radiation therapy for head and neck cancer
Lilie Lin, MD	Radiation Oncology	NCI R01 Co-PI	Breast cancer PARP PET imaging AIP to support FDA approval and commercialization
Gabriel Sawakuchi, PhD	Radiation Physics	NCI R21 Co-PI	Augmenting anti-tumor immunity using radiation in the setting of DNA repair defects

*While this list is meant to be inclusive, we acknowledge that we may have missed a grant or two. We kindly request that IGCT investigators please let us know if we've missed any of your recent funding.

FEATURED IGCT RESEARCH: ARTIFICIAL INTELLIGENCE (AI)

AI-Based Segmentation of Tumor and Normal Tissues



Laurence E. Court, PhD
Associate Professor
Dept. of Radiation Physics

The Radiation Planning Assistant team is developing a series of web-based tools to support radiation therapy clinics across the world, bringing automated contouring that we use at MD Anderson to clinics with limited resources in low- and middle-income countries (RPA.mdanderson.org). MD Anderson clinics are already using our tools, and we hope to start using them in South Africa later in 2022. Our team of dedicated researchers has developed automated contouring and planning tools for head and neck, cervical, post-mastectomy breast, and whole brain treatments. This year we expect to further develop our portfolio, with extensive contouring and planning for breast and head and neck (with a focus on nasopharyngeal cancer). We will also add contouring and treatments for palliative spine (including automatic labeling of vertebral bodies), prostate (intact and prostate bed), anal, and pediatric CSI. All of these developments involve extensive collaborations with our clinical colleagues at MD Anderson and at our collaborating centers in South Africa and beyond. In addition, we have worked closely with IGCT investigators to exchange curated data and developed models. Other projects that our team is working on include the development of tools for contour QA (to check whether manual or automatic contours are reasonable), radiotherapy plan QA (to automatically assess the quality of the plan), and other decision support tools (specifically, toxicity prediction tools). We are always looking for collaborators to share and test current models, and for the development of future models.

For more information on this project, please contact Dr. Laurence Court at LECourt@mdanderson.org.

Pipeline for Validation and Deployment of AI Algorithms in Cancer Research



David T. Fuentes, PhD
Associate Professor
Dept. of Imaging Physics

Our group has developed a pipeline of algorithms via interdisciplinary studies with neuroradiology and neurosurgery. The algorithms use AI-based segmentation to analyze imaging data and segment tumor and normal brain tissue from 1,181 previously untreated glioma patients. This infrastructure enables image-based estimation of key pathology variables, including glioma cellularity, which has been shown to be a promising biomarker for predicting glioma survival. It does so early in treatment with low risk and at low cost, while complimenting WHO grading. We are happy to share these algorithms with new collaborators. Our future work and challenges are to extend these analysis efforts to post-op resection cases. Additional work is needed to validate pre-op and post-op image registration to achieve reliable results. Discussions with the IGCT helped to support development of applications and clinical translation in this project.

For more information on this project, please contact Dr. David Fuentes at DTFuentes@mdanderson.org.

Anatomical Gardens for Cancer Diagnosis, Treatment, and Response Assessment



Kristy K. Brock, PhD
Professor
Dept. of Imaging Physics


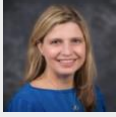

The Morfeus Lab has invested significantly over the past year in the development and deployment of deep learning-based, automated segmentation algorithms. The algorithms, which run in under 5 minutes per model, have been deployed in the RayStation Treatment Planning System and within the XNAT infrastructure. To date, all of our models are based on CT images, but we look forward to moving into multi-modality images in the near future. Models include thorax (lungs and lung tumors, as well as some preliminary automated methods to segment tissue changes in the lung due to COVID and radiation therapy), abdomen (liver, liver segments, primary and metastatic liver tumors, ablation regions, duodenum, stomach, kidneys, and pancreas), and pelvis (uteroCervix, bladder, rectum, sigmoid, vagina, parametrium, femurs, spinal cord, bowel space, iliac veins, and iliac arteries). These models were developed in collaboration with numerous IGCT members including Drs. Bruno Odisio, Eugene Koay, Ann Klopp, Laurence Court, Sireesha Yedururi, Caroline Chung, Myrna Godoy, Carol Wu, and many others! We look forward to sharing these models with collaborators, so please contact us if they will be helpful for your research. We are working to use these models to overcome technology barriers that often arise due the manual process of segmenting tissues. Many of these models have been deployed clinically in Radiation Oncology, thanks to the support of Dr. Mary Martel. The liver models are currently being used in the Cover-All Trial (PI: Bruno Odisio), which is a randomized Phase II trial supported by the NIH, and within Nuclear Medicine.

For more information on this project, please contact Dr. Kristy Brock at KKBrock@mdanderson.org.

IGCT SEMINARS AND WORKSHOPS

The IGCT holds monthly workshops from internal and external speakers that are focused on image guided cancer therapy research and clinical applications. The seminars and workshops are attended by faculty and trainees from departments across MD Anderson as well as faculty and trainees from our collaborating institutions, such as UT Austin and Rice University.

FY2021 IGCT Seminars		
 <p>September 30, 2020</p>	<p><u>Konstantin V. Sokolov, PhD</u> - Professor, Dept. of Imaging Physics, MDACC</p> <p><u>Richard R. Bouchard, PhD</u> - Associate Professor, Dept. of Imaging Physics, MDACC</p>	<p><i>"Point of Care Molecular Cancer Imaging"</i></p>
 <p>October 15, 2020</p>	<p><u>Weili Nie, BS</u> - PhD Candidate, Dept. of Neuroscience, Baylor College of Medicine; PhD Candidate, Dept. of Electrical & Computer Engineering, Rice University</p>	<p><i>"Semi-Supervised StyleGan for Disentanglement Learning"</i></p>
 <p>November 12, 2020</p>	<p><u>Clemens Grassberger, PhD</u> - Assistant Professor, Dept. of Radiation Oncology; Head, Radiation-Drug Treatment Design Lab, Harvard Medical School and Massachusetts General Hospital</p>	<p><i>"Integrating Radiotherapy with Targeted Agents - Mechanistic Models to Learn from Patient Data"</i></p>
 <p>November 18, 2020</p>	<p><u>Darren Lurie</u> - CEO, OptiScan</p> <p><u>Lindsay Bussau, PhD</u> - Application Specialist, OptiScan</p> <p><u>Camile Farah, MDSc, PhD</u> - Professor, Australian Centre for Oral Oncology Research and Education</p>	<p><i>"Optimum Clinical In Vivo Imaging with InVivage by OptiScan"</i></p>
 <p>December 10, 2020</p>	<p><u>Gregory N. Fuller, MD, PhD</u> - Professor, Dept. of Pathology; Section Chief, Neuropathology Section, MDACC</p>	<p><i>"Leveraging Our Legendary Clinical Volume: The MDACC Diagnostic Medicine Team Science Initiative"</i></p>
 <p>February 11, 2021</p>	<p><u>Dawid Schellingerhout, MD</u> - Professor, Dept. of Neuroradiology, MDACC</p> <p><u>David Fuentes, PhD</u> - Associate Professor, Dept. of Imaging Physics, MDACC</p>	<p><i>"The Stereotactic RadPath Trial: Clinical Aspects and Analysis"</i></p>
 <p>February 23, 2021</p>	<p><u>Rachael Siriani, PhD</u> - Associate Professor, Dept. of Neuroscience, UTHealth McGovern School of Medicine</p> <p><i>"Nanoparticle Drug Delivery in Pediatric Neuro-Oncology"</i></p> <p><u>Chun Li, PhD</u> - Professor, Dept. of Cancer Systems Imaging, MDACC - <i>"Multifunctional Nanoparticles for Image-Guided Photothermotherapy"</i></p>	<p><i>"Advances in Theranostics - Nanoparticle Applications in Cancer Therapy"</i></p>
 <p>March 12, 2021</p>	<p><u>Colin McCarthy, MD</u> - Assistant Professor, Dept. of Interventional Radiology, MDACC - <i>"Virtual and Augmented Reality for Image-Guided Procedures - Beyond the Hype"</i></p> <p><u>Erez Lieberman Aiden, PhD</u> - Associate Professor, Dept. of Human and Molecular Genetics, Baylor College of Medicine - <i>"Human Vision Modification Using Augmented Reality"</i></p>	<p><i>"Augmented and Virtual Reality Applications in Biomedical Sciences"</i></p>
 <p>March 24, 2021</p>	<p><u>Suzanne E. Lapi, PhD</u> - Professor, Depts. of Radiology and Chemistry; Vice Chair of Translational Research, Dept. of Radiology, University of Alabama at Birmingham</p>	<p><i>"Expanding the Imaging Toolbox with Radiometal PET Imaging Agents"</i></p>
 <p>April 26, 2021</p>	<p><u>Stephen Y. Lai, MD, PhD</u> - Associate Professor, Dept. of Head & Neck Surgery, MDACC</p> <p><u>James A. Bankson, PhD</u> - Professor, Dept. of Imaging Physics, MDACC</p>	<p><i>"First-in-Human Hyperpolarized MRI for Thyroid Cancer"</i></p>

 <p>May 12, 2021</p>	<p><u>Amer N. Najjar, PhD</u> - Assistant Professor, Dept. of Pediatrics, MDACC</p> <p><u>Richard R. Bouchard, PhD</u> - Associate Professor, Dept. of Imaging Physics, MDACC</p> <p><u>Kristy K. Brock, PhD</u> - Professor, Dept. of Imaging Physics, MDACC</p>	<p><i>"Advanced 3D Imaging and Correlative Pathology with Xerra CFT"</i></p>
 <p>June 30, 2021</p>	<p><u>Julie Pilitsis, MD, PhD</u> - Professor and Chair, Dept. of Neuroscience and Experimental Therapeutics, Albany Medical College</p>	<p><i>"Can Focused Ultrasound Change the Pain Game?"</i></p>
 <p>August 5, 2021</p>	<p>2021 Awardees:</p> <p>Best Design & Graphics Award - Maggie Lee</p> <p>Best Scientific Progress Award - Richard Lee</p> <p>Best Speaking Skills - Brandon Curl</p> <p>People's Choice Award - Aparajith Kannapiran</p>	<p><i>"IGCT Summer Undergraduate Student Showcase"</i></p>
<p>FY 2021 IGCT Workshops</p>		
<p>January 6, 2021</p>	<p><u>William (Joe) Allen, PhD</u> - Research Associate, Texas Advanced Computing Center, University of Texas at Austin</p> <p><u>Pingjun Chen, PhD</u> - Postdoctoral Fellow, Wu Lab, Dept. of Imaging Physics, MDACC</p>	<p><i>"An Overview and Workshop on Docker"</i></p>
<p>May 28, 2021</p>	<p><u>Kristy K. Brock, PhD</u> - Professor, Dept. of Imaging Physics; Executive Director, Image Guided Cancer Therapy Research Program, MDACC</p> <p><u>Mat Brevard</u> - Co-Founder and CEO, Emit Imaging</p> <p><u>Charles V. Kingsley</u> - DI Operations Manager, MDACC</p> <p><u>Natalie W. Fowlkes, DVM, PhD</u> - Assistant Professor, Dept. of Veterinary Medicine and Surgery, MDACC</p> <p><u>Mark D. Pagel, PhD</u> - Professor, Dept. of Cancer Systems Imaging, MDACC</p> <p><u>Rony Avritscher, MD</u> - Associate Professor, Dept. of Interventional Radiology, MDACC</p>	<p><i>"Bridging In Vivo Imaging and Histopathology with the Emit Xerra System: Applications in Biomedical Sciences"</i></p>

NEW IGCT INVESTIGATORS AND STAFF IN FY2021

 <p style="font-size: 2em; font-weight: bold; letter-spacing: 0.5em;">I N V E S T I G A T O R S</p>		<p>H. Charles Manning, PhD Professor Dept. of Cancer Systems Imaging</p>		<p>Andrew G. Sikora, MD Professor Dept. of Head & Neck Surgery</p>
		<p>Jia Wu, PhD Assistant Professor Dept. of Imaging Physics</p>		<p>Rick R. Layman, PhD Associate Professor Dept. of Imaging Physics</p>
		<p>Justin E. Bird, MD Associate Professor Dept. of Orthopaedic Oncology</p>		<p>Suprateek Kundu, PhD Associate Professor Dept. of Biostatistics</p>
		<p>Rony Avritscher, MD Professor Dept. of Interventional Radiology</p>		

THE IGCT STAFF IS GROWING



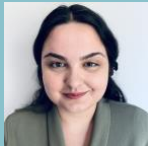
John Wood, MS joined the IGCT as a Computational Scientist in Fall 2020. John earned his BS in Biological Engineering and MS in Biomedical Engineering from Mississippi State University. He facilitates critical integration of IGCT research with numerous MD Anderson data platforms, giving the IGCT access to additional computational resources, scaling up research capabilities, and enabling faster forward progress for IGCT research.



Caleb O'Connor, MS joined the IGCT as a Physics Assistant in Summer 2021. Caleb earned his BS and MS in Physics from the University of Louisiana at Lafayette. In his role in the IGCT, Caleb works on scripting automation of existing algorithms for clinical research and deployment.



Emma McCollum, BS joined the IGCT as a Research Assistant I in June of 2021. Emma is a graduate from Washington University in St. Louis, where she earned a BS in Biomedical Engineering. Emma's projects include assessing accumulated dose delivery of intensity modulated photon therapy in prostatic adenocarcinoma patients and ongoing collaborations with Dr. Justin Bird and the Surgery Innovation Program at MD Anderson. Prior to joining the IGCT full time, Emma spent summers in 2019 and 2020 as an undergraduate researcher with IGCT.



Androniki Mitrou, MS joined the IGCT as a Physics Assistant in Fall 2021 (FY22) after completing her MS in Medical Physics at the University of Massachusetts Lowell. Androniki's projects include dose accumulation using deformable image registration in head and neck cancer patients and correlative pathology.

COMING IN FY2022

◇ Upcoming IGCT Workshops

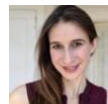
- Getting Started in AI (Nov 2021)
- Navigating Team Science (Mar 2022)
- Deformable Image Registration (May 2022)
- Considerations for Commercialization & IP (Oct 2022)

** Workshops & seminars will be recorded and available on demand on the IGCT website starting in 2022.*

◇ Multi-disciplinary, team-science oriented grant submissions

◇ IGCT website redesign

Upcoming IGCT Seminars



Interpretable Neural Networks - Jan 2022
Cynthia Rudin, PhD - Duke University



AI & Computational Imaging - Feb 2022
Pallavi Tiwari, PhD - Case Western



Critical Evaluation of Trials & Data - Mar 2022
Soren Bentzen, PhD - University of Maryland



Image Guided Biopsy - Apr 2022
Ignacio Wistuba, MD - MD Anderson
Alda Tam, MD - MD Anderson

To learn more about the Image Guided Cancer Therapy Program at MD Anderson Cancer Center, please visit our website at www.mdanderson.org/IGCT or email us at igctr@mdanderson.org.