Fall 2022

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Scientific Computing and Imaging Institute
at the University of Utah

From the Director

The Scientific Computing and Imaging (SCI) Institute at the University of Utah has had another banner year with new hires, awards, grants, publications, software deployments, and other accomplishments, all with tremendous impact. I am delighted to share some of these accomplishments with you in this issue of FreshTracks.

During the past year, SCI has continued to advance its mission to transform science and society through translational research, collaboration, and innovation in computer, computational, and data science.

To expand the core research expertise at SCI, further enhance its outstanding research portfolio, and continue to broaden the diversity of faculty, students, and staff, SCI has launched an ambitious initiative seeking to hire several new faculty members over the next three years with specialties that integrate computational science, data science, and science and engineering broadly (including social sciences).

This strategic initiative also aims to create new partnerships across the University of Utah, including a faculty cluster in computational oncology in partnership with the Huntsman Cancer Institute and a partnership with the Department of Biomedical Informatics. The initiative has resulted in five outstanding faculty joining SCI this year, whom I am thrilled to introduce in this issue. And we plan to continue this growth in the coming year.

Recognizing the essential role of cyberinfrastructure professionals (CIP) in a research and innovation enterprise that is being transformed by an explosion of data and computation, as well as the many challenges being faced nationally in developing and sustaining this critical workforce, SCI launched the Cyberinfrastructure Professionals Cooperative (CIP-Co-Op). The overarching goal of the CIP-Co-Op is to foster a vibrant and sustainable CIP community at SCI and the U that strengthens its academic and research missions. The CIP-Co-Op will establish a community of CIP along with models and structures for training, professional development, and sustainability, and will be a model for institutions nationwide.

Advancing the strategic goal of SCI to foster synergistic collaborations among computational, data, and domain experts across the U, and in alignment with the university's Strategy Refresh 2025 strategic roadmap, we have partnered with the College of Humanities to establish the SCI-HUM Research Initiative. This pilot partnership aims to bring together inspired technology-driven humanities research ideas with the technological innovation and research at SCI and explores models and mechanisms that can be expanded to other units and communities across the U. Central to this initiative is the role of CIPs to catalyze, nurture, and advance transdisciplinary research partnerships.

This academic year promises to be equally exciting as SCI continues to advance its mission of transforming science and society through translational innovations across computational and data science with its leading research and training programs.

I remain committed to building on the impressive expertise, strategic assets, and achievements at SCI to connect with and complement the strengths across the U, to promote diversity and equity at SCI and, more broadly, to lead SCI to a future of even greater achievements and a transformative impact on science and society.

- Dr. Manish Parashar
  Director, Scientific Computing and Imaging Institute

In This Issue

SCI Welcomes New Faculty

The SCI Institute is pleased to announce five new faculty hires whose combined expertise will not only enhance the current research at the Institute, but also lay the path for future endeavors. The SCI Institute's overarching vision is the transformation of science and society through translational research and innovation in computer, computational, and data science. Its mission is to bring together excellence in diverse domains applied to multidisciplinary and interdisciplinary problems of scientific and societal importance. The Institute accomplishes these goals through the collaborative development, assembly, and/or application of applied scientific and data computing, imaging, and visualization tools. These new hires will expand the core research expertise at SCI, and will continue to broaden the diversity of faculty, students, and staff.

Kate Isaacs

Associate Professor, Computer Science

Dr. Isaacs joins the SCI Institute from the University of Arizona, where she was an assistant professor in the Department of Computer Science since 2016. Dr. Isaacs is a recipient of a Department of Energy Early Career Research Program award in 2021 for research on visualizing program behavior in high-performance computing contexts and a National Science Foundation CAREER award in 2019 for visualizing networks derived from computing systems. In 2015, Dr. Isaacs received her Ph.D. in computer science from the University of California at Davis.

In her research, Dr. Isaacs develops visualization approaches that address the complex analysis scenarios of active research teams, often with application to software and computing systems. She works closely with collaborators from those research teams to identify and push past the limitations of available visual tools and develop more interpretable and scalable visual representations that fit into their workflow. Dr. Isaacs deeply believes that pushing past the analysis challenges of exploratory analysis in large and complex data requires meeting users where they are, and thus her solutions aim to identify and then computationally enhance their analysis processes.

Shireen Elhabian

Associate Professor, Computer Science

Dr. Elhabian received her Ph.D. in Electrical and Computer Engineering from the University of Louisville in 2012 in the field of statistical and mathematical modeling of photographic images, with a focus on computer vision and medical image analysis. She was a postdoctoral fellow from 2013 to 2016 and a research scientist from 2016 to 2017, both at the SCI Institute, University of Utah. Before joining the tenure-line faculty, she was a research computer scientist within the SCI Institute and a research assistant professor with the School of Computing from 2017 to 2022. She is also an adjunct assistant professor in the Department of Electrical & Computer Engineering at the U.

Dr. Elhabian has established her research program around biomedical problems that entail collaborating with scientists and domain experts in different disciplines and backgrounds to conduct interdisciplinary research projects. Her research spans foundational and translational advances at the intersection of image analysis and statistical machine learning with a focus on clinical and biomedical applications.

Dr. Elhabian's vision is that deployable image analysis systems empowered by machine learning can transform the way biomedical researchers and clinicians interpret imaging data in an objective, thorough, efficient, and reproducible manner, thereby maximizing the benefit-to-cost of imaging technologies and enabling early diagnosis and patient-specific treatment and prognosis. Her long-term goal is to accelerate the adoption and increase the clinical utility of machine-learning-based image analysis systems. Progress in this domain will mitigate critical bottlenecks in attaining an expert-level understanding of the complexities of imaging data and have a broad impact in a range of clinical and biomedical research disciplines. To attain this goal, Dr. Elhabian has been establishing foundational methods to solve complex problems in image analysis and quantitatively interpret imaging data using minimal expert supervision, and then translating these methods to application domains through robust, flexible, and usable open-source software packages.

Paul Rosen

Associate Professor, Computer Science

Dr. Rosen joins the SCI Institute from the University of South Florida Department of Computer Science and Engineering, where he was an associate professor. Dr. Rosen received his Ph.D. from the Computer Science Department of Purdue University in 2010. Following that, Dr. Rosen served as a research assistant professor at the SCI Institute before departing in 2015. Along with his collaborators, he has received awards for best paper at PacificVis 2016, IVAPP 2016, PacificVis 2014, and SIBGRAPI 2013 and honorable mentions at the VAST Challenge 2017 and CG&A 2011 best paper. He also received an Outstanding Faculty Award from the University of South Florida in 2020. His research has been supported by the National Institutes of Health, the National Radio Astronomy Observatory, the Defense Intelligence Agency, and five National Science Foundation (NSF) grants, including an NSF CAREER Award in 2019. Dr. Rosen is also the General Chair for IEEE VIS 2024, which will be held in Tampa, FL.

In his research, Dr. Rosen studies approaches to improving the efficacy of visualization tools by utilizing a mix of human-centered design and geometry- and topology-based methods to extract and emphasize important data features. He has studied these techniques in the context of many data types, including scalar and vector fields, multidimensional data, and graphs. Further, these techniques have been used to solve important problems in wide-ranging collaborations, including in affective computing, nuclear engineering, biomedical engineering, radio astronomy, software performance analysis, and 3D printing. Dr. Rosen believes strongly in the need for visualization capabilities with robust theoretical and practical capabilities that simultaneously consider the needs of visualization users and enable the process of developing insights about data that are as unambiguous as possible.

Amir Arzani

Assistant Professor, Mechanical Engineering

Dr. Amirhossein (Amir) Arzani received his BS, MS, and Ph.D. in Mechanical Engineering from Isfahan University of Technology, Illinois Institute of Technology, and UC Berkeley, respectively. Prior to joining SCI, he was an assistant professor of Mechanical Engineering at Northern Arizona University (NAU) for 5 years.

In his research, Dr. Arzani develops computational models for fundamental understanding of blood flow and cardiovascular disease. Broadly, he is interested in understanding the role of blood flow in the heart and cardiovascular system, developing predictive computational models that can predict disease, and using modern data-driven modeling techniques for improving the fidelity and accuracy of current experimental and computational blood flow models.

His research is interdisciplinary and integrates fluid mechanics, solid mechanics, mass transport, scientific machine learning, computational mechanics, and dynamical systems theory. Dr. Arzani is also interested in fluid flow problems beyond cardiovascular flows, for example chaotic advection in unsteady flows, respiratory flows, and convective heat transfer.

Dr. Arzani supports student success in research. Prior to joining SCI, his students at NAU had published 12 first-author journal papers. In 2022, he received NAU's College of Engineering, Informatics, and Applied Sciences Distinguished Mentorship Award. Dr. Arzani has recently received an NSF CAREER award from NSF's Office of Advanced Cyberinfrastructure.

Dr. Arzani's research fits with the key strengths of SCI (imaging, visualization, and scientific computing). Specifically, Dr. Arzani and his collaborators are creating machine learning approaches for improving blood flow quantification from medical imaging. Additionally, Dr. Arzani has previously collaborated with SCI alumni and visualization experts in surface and vector-field modeling and visualization. Finally, his research involves a wide range of scientific computing approaches, such as computational mechanics and scientific machine learning.

Aik Choon Tan

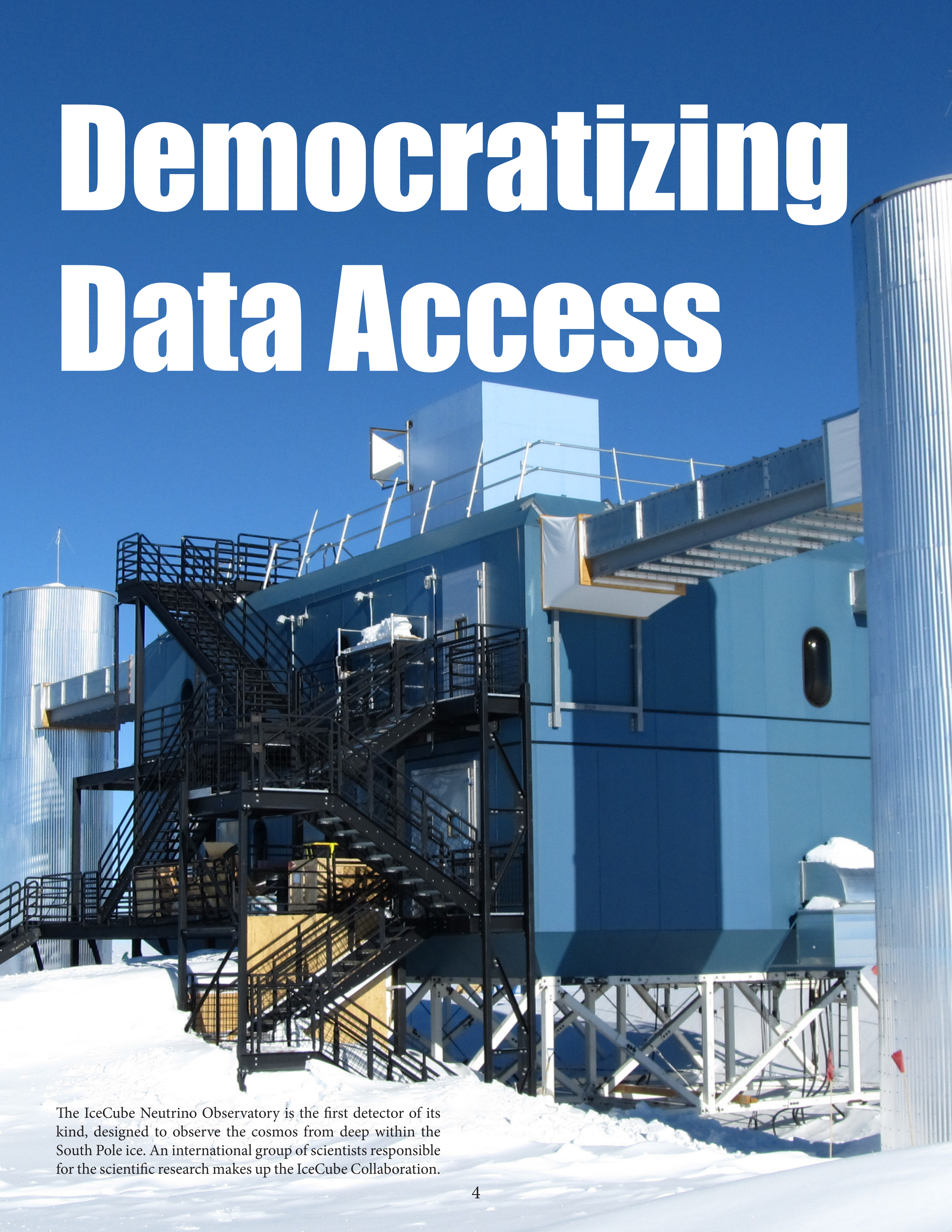
Professor, Oncological Sciences

Aik Choon Tan, Ph.D., has been appointed senior director of data science at Huntsman Cancer Institute, professor at the University of Utah Department of Oncological Sciences, member of the Scientific Computing and Imaging Institute, and Jon M. and Karen Huntsman Endowed Chair in Cancer Data Science. He will also serve as a member of the research executive committee and research leadership council within the Comprehensive Cancer Center at Huntsman Cancer Institute. He will play a key role in the close collaboration between Huntsman Cancer and the SCI Institute and will serve as an affiliate SCI faculty member.

Tan received his Bachelor of Engineering from the University of Technology Malaysia, and earned his Ph.D. from the University of Glasgow in computer science and bioinformatics. He received postdoctoral fellowships at Johns Hopkins University Whiting School of Engineering and School of Medicine.

As a scientist in cancer translational bioinformatics and cancer systems biology, Tan's research focuses on computational and statistical learning methods to overcome treatment resistant barriers in cancer. He is most interested in research that goes from the lab to bedside, providing data-driven precision oncology for patients. With grants from the National Institutes of Health and Florida Biomedical Research Program, Tan has focused his research on understanding tumor microenvironments such that effective drug combinations could be delivered to patients based on their individual genomic profiles. He has published more than 200 articles.

Democratizing Data Access



The IceCube Neutrino Observatory is the first detector of its kind, designed to observe the cosmos from deep within the South Pole ice. An international group of scientists responsible for the scientific research makes up the IceCube Collaboration.

Dr. Steve Petruzza presenting at the first NSDF all-hands meeting.

The University of Utah's Scientific Computing and Imaging (SCI) Institute is leading a new initiative to democratize data access.

The National Science Foundation (NSF) awarded a $5.6 million grant to a team of researchers, led by School of Computing professor Valerio Pascucci, who is also director of the Center for Extreme Data Management in the College of Engineering, to build the critical infrastructure needed to connect large-scale experimental and computational facilities and recruit others to the data-driven sciences.

With the pilot project, called the National Science Data Fabric (NSDF), the team will deploy the first infrastructure capable of bridging the gap between massive scientific data sources — including state-of-the-art physics laboratories generating mountains of data — and the computing resources that can process their results, including the Internet 2 network connectivity, and an extensive range of high-performance computing facilities and commercial cloud resources around the nation.

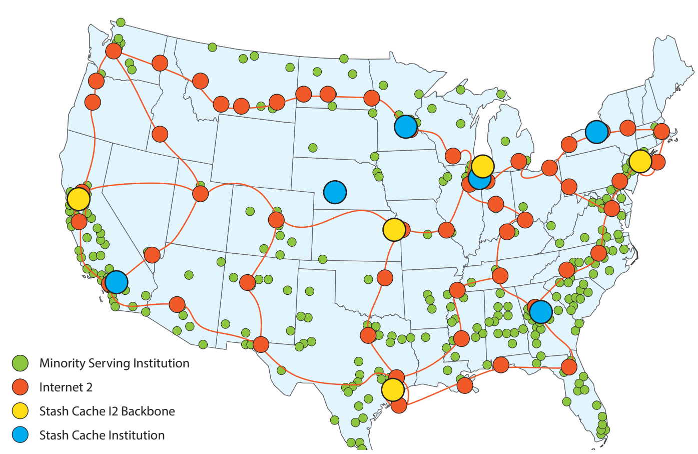
Pascucci says progress toward technological advances that benefit society will require a cyberinfrastructure that enables high-speed access to the data generated by large experimental facilities around the world. He points to several centers generating data that will benefit from the project: the IceCube neutrino detector at the South Pole, the XENONnT dark matter detector in Italy, and the Cornell High Energy Synchrotron Source (CHESS).

"By democratizing data access for large-scale scientific investigations, NSDF will lower the cost of entry for scientists who want to participate in cutting-edge research," Pascucci says. "Piloting this innovative cyberinfrastructure component will connect a much broader community of researchers with massive data sources that only a selected few can manage today."

Students will be able to work with data streamed directly from High Energy Synchrotron Sources, he added. Institutions will be able to innovate education, workforce training, and research. Pascucci predicts scientific discoveries will accelerate with the infrastructure in place.

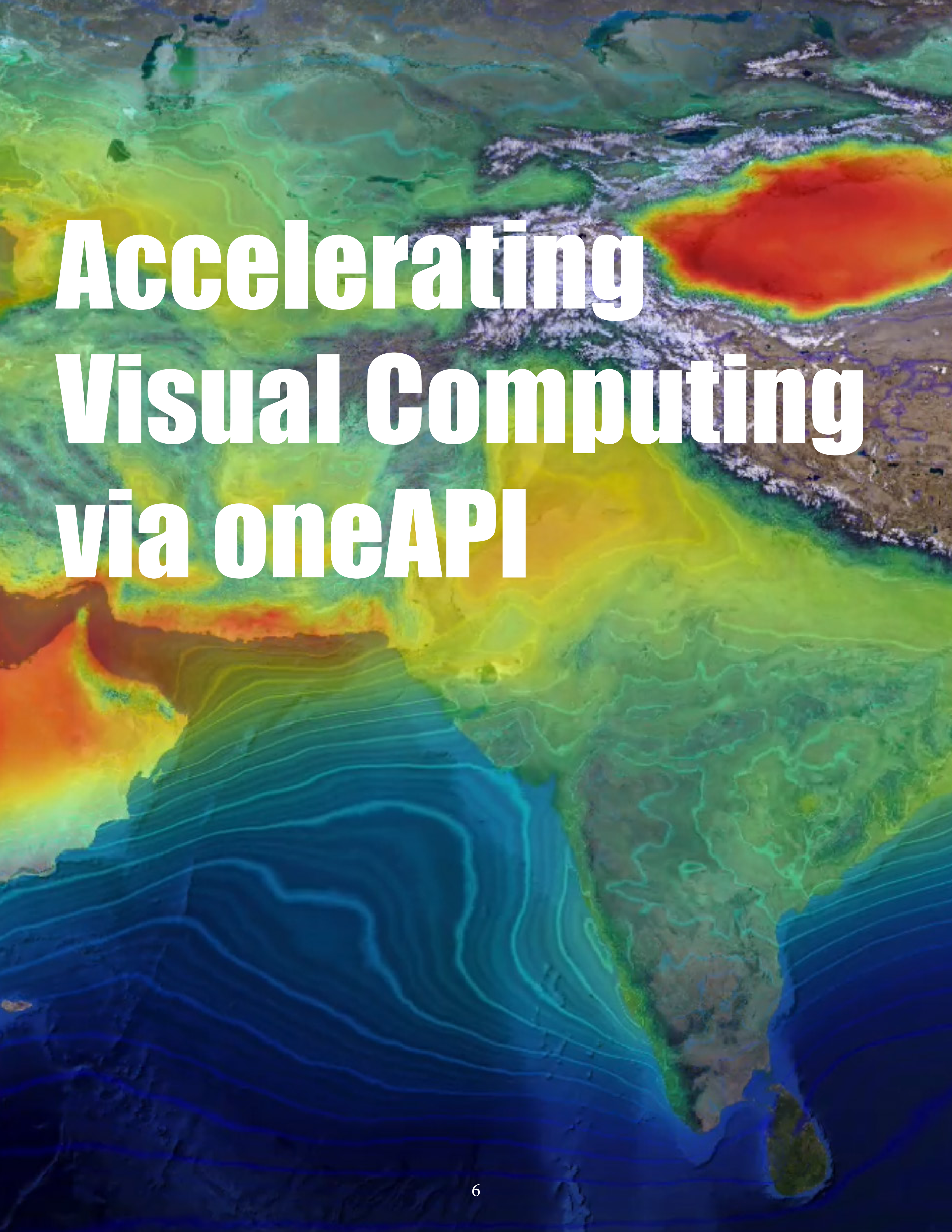
Pascucci's team includes co-principal investigators (PIs) Frank Würthwein, interim director of the San Diego Supercomputer Center; Michela Taufer, professor at the University of Tennessee, Knoxville; Alex Szalay, a professor of physics and astronomy and computer science at the Johns Hopkins University; and John Allison, a professor of materials science and engineering at the University of Michigan at Ann Arbor. The team will partner with NSF-funded efforts such as Fabric and Open Science Grid (OSG), and industry partners including IBM Cloud and Google Cloud.

"The National Science Data Fabric is an effort that aims to transform the end-to-end data management lifecycle with advances in storage and network connections; deployment of scalable tools for data processing, analytics, and visualization; and support for security and trustworthiness," said Würthwein.



Ensuring access to data regardless of connectivity is a key goal of the National Science Data Fabric project.

Accelerating Visual Computing via oneAPI



The Scientific Computing and Imaging (SCI) Institute at the University of Utah is pleased to announce it is expanding its Intel Graphics and Visualization Institute of Xellence (Intel GVI) to an Intel oneAPI Center of Excellence (CoE). The oneAPI Center of Excellence will focus on advancing research, development, and teaching of the latest visual computing innovations in ray tracing and rendering, and using oneAPI to accelerate compute across heterogeneous architectures (CPUs, GPUs, including future upcoming Intel Xe architecture, and other accelerators).

The SCI Institute's pioneering research in visualization, imaging, and scientific computing and its long track record in creating open-source scientific software will enable their work on oneAPI to help scientists, engineers, and biomedical researchers focus on their research instead of the details of the underlying software.

Over the past two years, principal investigators Chris Johnson, Valerio Pascucci, and Martin Berzins led more than 20 research papers, developed the OpenViSUS and Uintah software, and created rendering and scientific visualization algorithms for advanced graphics and visualization deployed within Intel OSPRay's ray tracing API and engine through the Intel GVI.

The SCI Institute oneAPI Center of Excellence team is extending its Intel GVI work to pursue new high-performance visual computing methods that utilize oneAPI cross-architecture programming, which delivers performance and productivity, and provides the ability to create single-source code that takes advantage of CPUs, GPUs, and other accelerator technologies that can be deployed across a variety of architectures. For infrastructure, the Utah project provides an end-to-end computing and data movement environment using oneAPI to achieve seamless integration of large-scale simulations, data analytics, and visualization in practical scientific workflows. In particular, the team will deploy an innovative data movement and streaming infrastructure based on a novel encoding approach that enables expressing new quality-vs-speed tradeoffs by modeling spatial resolution and numerical precision of the data independently. This model organizes scientific data in a single layout that allows decoding the data in various incremental decoding streams, each satisfying a different scientific workflow requirement. We use this data model as the foundation for a new generation of tools that combines Intel® oneAPI technology with the OpenViSUS and Uintah frameworks to efficiently manage, store, analyze, and visualize scientific data.

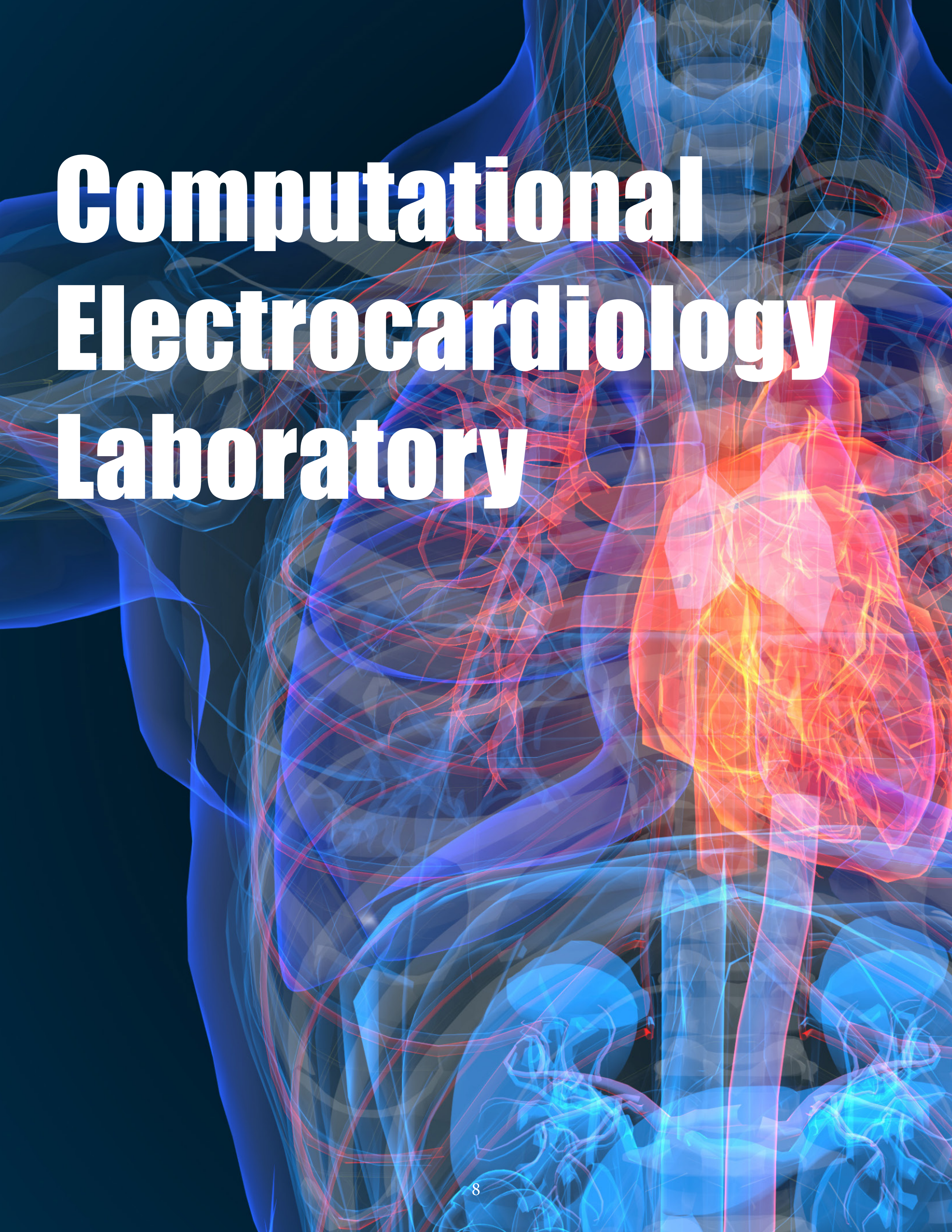
Projects include scalable ray tracing for adaptive mesh refinement data, multidimensional transfer function volume rendering, in situ visualization, multifield visualization, and uncertainty visualization applied to large-scale problems in science, engineering, and medicine. Much of this work uses the Academy Award® winning Intel® Embree, Intel® OSPRay, and other components of the Intel® oneAPI Rendering Toolkit.

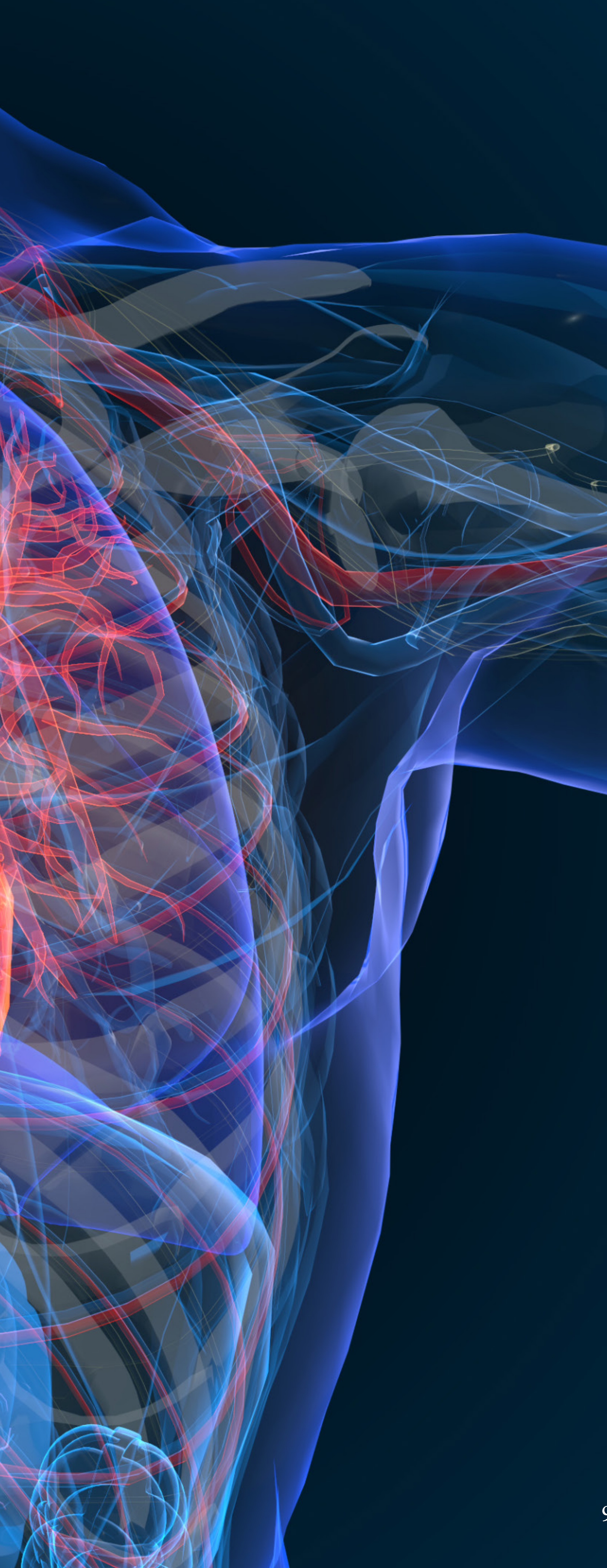
In particular, the OpenViSUS framework (visus.org) provides advanced data management and visualization infrastructure enabling data sharing and collaborative activities for national resources such the National Ecological Observatory Network (NEON) or the Materials Commons. Integration of OpenViSUS with the Uintah simulation code also allows archiving scalable computing and streaming of massive simulation data on leadership-class computing resources in DOE national laboratories.

oneAPI cross-architecture programming is key to advancing simulations for challenging engineering problems using the Utah Uintah software on forthcoming exascale architectures, such as the Argonne Leadership Computing Facility's Aurora supercomputer.

ViSUS allows for interactive visualization of large-scale data. Here we see a mixing simulation visualized on a multiscreen power wall.

Computational Electrocardiology Laboratory





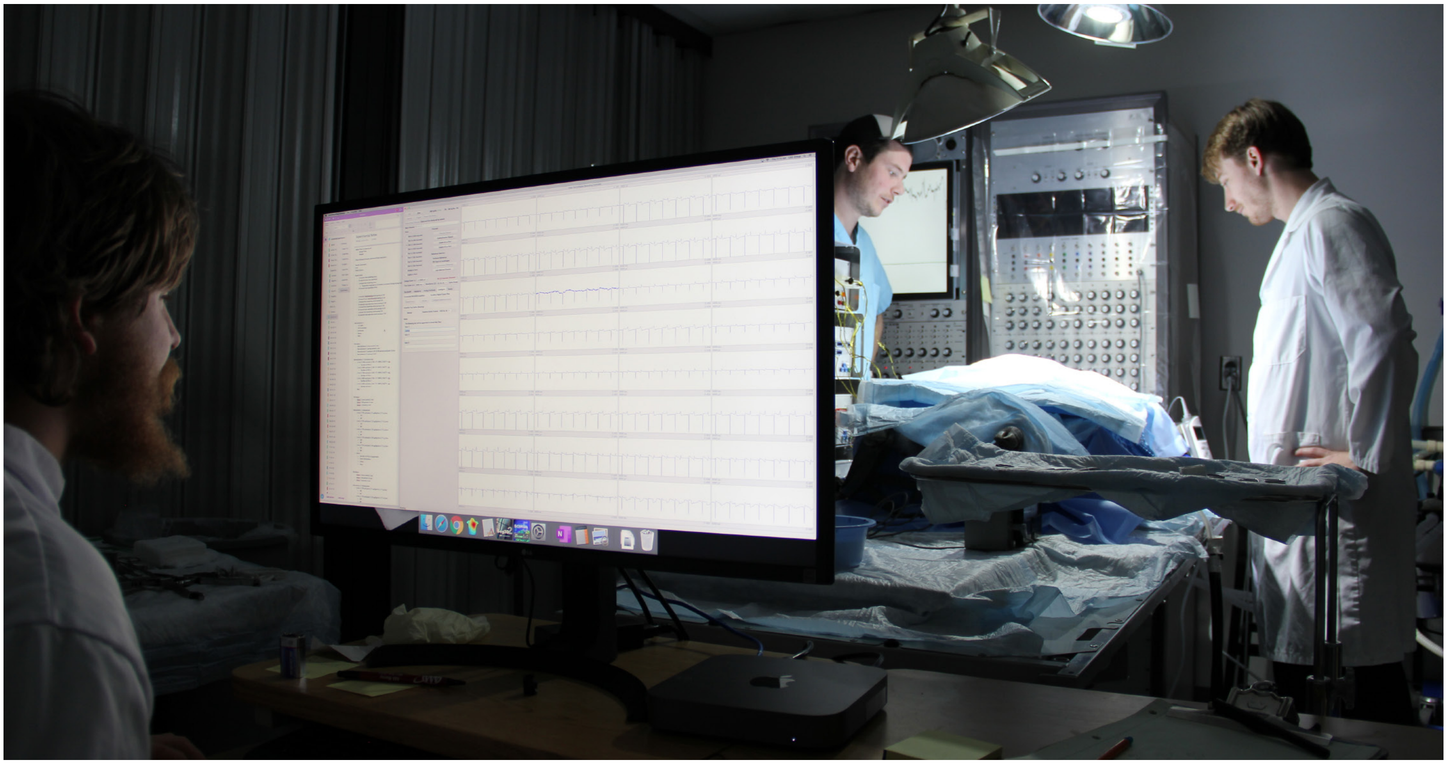
The Computational Electrocardiology Group (CEG) focuses on research studies based on electrocardiographic mapping of the heart and body surface. Specific research areas include cardiac electrophysiology in the study of acute ischemia and repolarization abnormalities, simulation and estimation of the spread of excitation in normal and diseased heart tissue, cardiac rhythm disorders, and novel approaches for ECG Imaging, i.e., reconstructing the electrical activity of the heart from noninvasive body-surface electric potentials (ECGs).

What Is Electrophysiology and Its Relation to Heart Health?

We all know the feeling of our heart racing or fluttering as we get excited, nervous, or stressed. But how does the heart have a rhythm in the first place and what makes an abnormal rhythm? The heart contracts and relaxes again 50 to 100 times per minute throughout our lives and pumps blood through the body. This mechanical behavior is driven by electricity, starting with a stimulus that originates in the upper chambers of the heart. That stimulus then travels through all four chambers of the heart in a sequence that is carefully controlled and results in a subsequent mechanical sequence of contraction and relaxation. Electrophysiology is the study of this entire electrical behavior, and clinical electrophysiologists are doctors who specialize in identifying and treating the range of abnormal forms of initiation or spread of the stimulus, or what are known as 'arrhythmias'. A second major form of heart disease occurs when the blood supply to the heart itself is compromised, resulting in what is known as 'myocardial ischemia' and even a heart attack. This event often arises from arteries that have become partially or fully blocked, a condition known as 'coronary artery disease'.

An Overview of Heart Arrhythmias and Atrial Fibrillation

Arrhythmias are abnormal rhythms of the heart and can feel like the heart has fluttered, skipped a beat, suddenly started racing, or is beating very slowly. These sensations of changing heart rhythm can occur normally during exercise or when experiencing different



Integrated, computer-controlled data acquisition. CEG investigators have constructed state-of-the-art systems to acquire up to 1000 independent channels of signals from studies of the electrical activity in the heart. Visualization and analysis of this information are essential to understanding the normal and disease states of the heart during conditions such as coronary artery disease and rhythm disturbances. Left to right: Jake Bergquist, Brian Zenger, and Wilson Good.

emotions. However, in patients with arrhythmias, these changes arise because of a disruption in the heart's electrical pathways.

Arrhythmias are electrical abnormalities that cause the heart to contract and relax either too rapidly or slowly, causing blood in the body to flow improperly. Electrophysiologists identify potentially dangerous arrhythmias as early as possible and treat them with medications or with devices and interventions that seek to restore normal rhythm.

The most common form of arrhythmia involves only the upper to chambers, called the atria. The atria can experience either atrial flutter or atrial fibrillation (Afib), and in both cases, the mechanical function virtually disappears, reducing the overall efficiency of the heart. More dangerous, Afib can induce clots to form, leading to stroke. Atrial fibrillation is a severe worldwide disorder and is expected to affect around 40 million people. Early diagnosis of Afib is vital to ensure successful outcomes.

What Is an Electrophysiology Study of the Heart?

Electrophysiologists conduct electrical measurements on patients to map the electrical activity in the heart and diagnose arrhythmias and atrial fibrillation. As part of these studies, electrophysiologists pinpoint where the electrical pattern is disrupted and determine the best treatment option: routine monitoring, medications, or destroying the abnormal tissue, known as `ablation therapy'. Even with such electrophysiology studies, arrhythmias can be difficult to diagnose, sometimes because they occur only intermittently. A less invasive form of monitoring the patient can be based on some form of ECG, some that involve portable devices, or even wearing electrodes for 24-96 hours. Research by the CEG team is focused on improving detection of arrhythmias, either from mapping studies or from ECGs, by applying advanced computational techniques.

Right: The CEG team ready for action. Left to right are: Olivia Walker, Jake Bergquist, Lindsay Rupp, Rob MacLeod, Ben Orkild, Andie Sieja, and Anna Busatto. The students are all in the Biomedical Engineering program at the University of Utah.

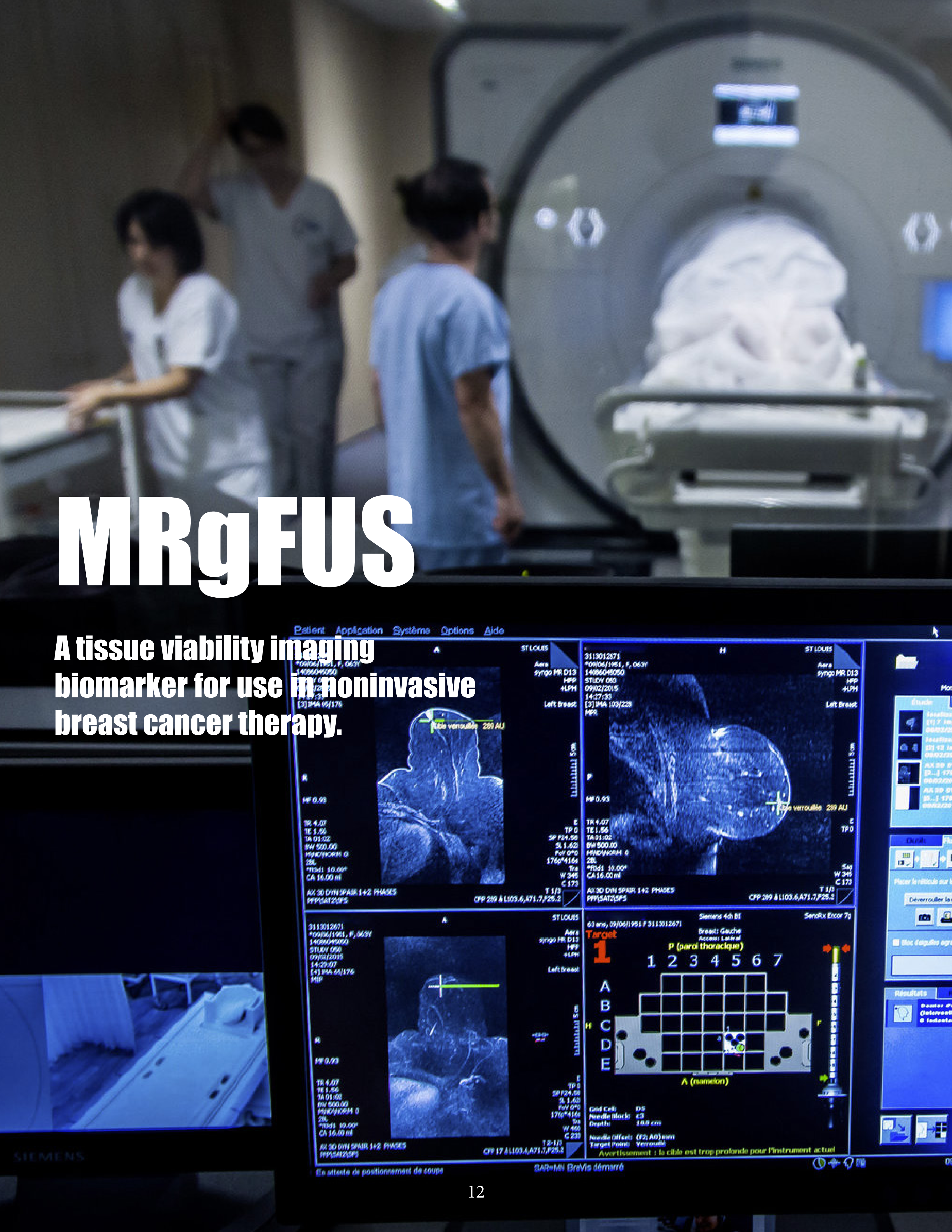
CVRTI's Research in Electrophysiology & Abnormal Heart Rhythms

The CEG team conducts their experimental studies at the Nora Eccles Harrison Cardiovascular Research and Training Institute (CVRTI), which houses a group of researchers committed to discovering the basis of the heart's electrical patterns. The team has focused on cardiac rhythm, ischemia, and the resulting disorders since the foundation of the institute. From such studies, the CEG team members have helped change the landscape of electrophysiology by understanding how cardiac bioelectricity creates the electrocardiographic signal, both in health and disease. One recent major focus has been to understand the structural basis of atrial fibrillation using pioneering imaging studies. The CVRTI and CEG continue to lead the way in understanding how rhythm disorders develop and creating tools to study and treat them in patients.

Left: A sock electrode used to capture electrical signals from the heart. Sock electrodes enable comprehensive sampling of the response of the heart to interventions to replicate heart diseases. They also provide data to validate and refine computational models of the electrical activity of the heart. Tools developed and distributed at the SCI Institute provide the means to visualize such signals and compare them to predictions based on comprehensive models of cardiac electrical activity.

MRgFUS

A tissue viability imaging biomarker for use in noninvasive breast cancer therapy.



Congratulations to Sarang Joshi and Allison Payne on their five-year funding for "A tissue viability imaging biomarker for use in non-invasive breast cancer therapy." This collaborative project is between the Scientific Computing and Imaging (SCI) Institute and the Utah Center for Advanced Imaging Research (UCAIR).

More women are diagnosed with breast cancer than any other type of cancer, besides skin cancer. This year, an estimated 281,550 women in the United States will be diagnosed with invasive breast cancer, and 49,290 women will be diagnosed with noninvasive (in situ) breast cancer. From 2008 to 2017, invasive breast cancer in women increased by half a percent each year.

While improved early detection methods and treatments have reduced breast cancer mortality, a sizable portion of patients remains overdiagnosed and overtreated, warranting the development of more conservative breast cancer treatments. Magnetic resonance guided focused ultrasound (MRgFUS) is one of the most attractive, emerging procedures for breast cancer as it can safely and efficaciously treat localized breast tumors noninvasively.

Focused ultrasound (FUS) has been around for a century – the first high-frequency ultrasound device called a hydrophone was used in World War I to monitor German U boats. In the 1940s and 50s, brothers William and Francis Fry developed a way to focus this high-frequency ultrasound and burn brain tissue. However, scientists could not accurately see the exact location of where their focused ultrasound was being applied. Thus, although the therapeutic potential was great, it was not until the 1990s that FUS was combined with MRI technology and MRgFUS was born.

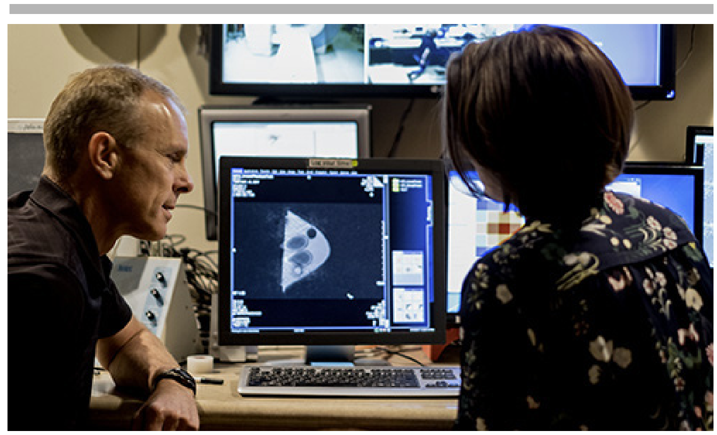
The first FDA-approved medical device using MRgFUS came in 2004, used to treat uterine fibroids. This noninvasive technology shows particular promise in treating brain disorders and disease because brain tissue is difficult to access and is easily damaged with other treatments. In fact, MRgFUS has recently been approved by the FDA for essential tremor, and in fall 2017, UCAIR had one of the first brain MRgFUS devices used for this treatment.

Payne and her mentor, Dennis Parker, Ph.D., realized in 2008 that focused ultrasound could offer women a completely noninvasive treatment for breast tumors with no scarring or other side effects. Nine years later, she is the first researcher in the world to develop a fully functional system customized for breast tumor ablation.

Currently, clinical MRgFUS ablation treatments are assessed with MRI metrics that primarily quantify thermal and vascular effects. While there is evident MR sensitivity for tissue changes induced by MRgFUS thermal ablation, no single metric or combination of metrics has demonstrated adequate accuracy in predicting tissue viability during or immediately post-MRgFUS ablation treatment. In addition, the use of gadolinium contrast agent-based assessment techniques precludes further ablation treatment if positive tumor margins are suspected. This work proposes to address this critical unmet need through developing a deep neural network noncontrast imaging biomarker that would provide an immediate and accurate assessment of tissue viability and could be applied repeatedly for an iterative assessment of tissue viability during the MRgFUS ablation procedure, assuring complete noninvasive tumor treatment. This objective will be accomplished with three specific aims.

- Aim 1: Develop and validate a 3D multiparametric MRI protocol for efficient acquisition of qualitative and quantitative MR images in the breast MRgFUS therapeutic environment.
- Aim 2: Develop, train, and validate a deep neural network biomarker for predicting tissue viability in a tumor model during MRgFUS ablation treatments.
- Aim 3: Integrate the tissue viability biomarker in an existing breast MRgFUS ablation clinical workflow and demonstrate complete treatment volume ablation using the noncontrast, deep neural network biomarker as the treatment assessment metric.

The group has developed an innovative, volumetric histopathology diffeomorphic registration procedure that allows the voxel-wise comparison of in vivo MR images to histopathological data, providing the gold-standard labeled data set needed to develop this imaging biomarker. Training and validation of the imaging biomarker will be performed in preclinical models designed to allow immediate generalizability and translation to ongoing clinical trials. This imaging biomarker will provide accurate assessment of tissue viability during MRgFUS ablation treatments, revolutionizing minimally invasive breast cancer treatments and directly addressing the critical issue of overtreatment.



Rock Hadley and Allison Payne at the computer control console outside the MRI room.

Cyberinfrastructure Professionals Cooperative

A key aspect of the Scientific Computing and Imaging (SCI) Institute's mission is to distribute computational tools and software to assist broader research communities and general scientific pursuits. SCI has decades of experience producing and distributing research tools across a broad set of research areas, including biomedical computing (FEBio, SCIRun, Seg3D), energy simulation (Unitah), and large-scale scientific visualization (VisTrails, ViSUS). SCI cyberinfrastructure professionals (CIPs) have been instrumental in bringing these projects to light and are a crucial part of many of the research goals from the myriads of projects at SCI.

What is CIP?

CI professionals refers to the community of individuals who provide a broad spectrum of skills and expertise to the scientific and engineering research enterprise by inventing, developing, deploying and/or supporting research CI and CI users. Examples of CI professionals include CI system administrators, CI research support staff, CI research software engineers, data curators, and CI facilitators, and may also include computational research scientists and engineers who are not in traditional academic paths.

What is the SCI CIP Co-Op?

The SCI CIP Co-Op is a voluntary community of research computing and data experts at SCI working together in supporting and sustaining SCI's world-class research efforts. These experts (CIP) hold various titles, including software developer or software engineer, and perform a wide range of advanced services fostering the growing SCI research enterprise.

The Co-Op provides researchers and CIP at SCI with a unified environment whereby software development, communication, and training and planning efforts can be coordinated seamlessly across the various research projects at SCI. While the individual projects might use one or two CIPs, the Co-Op offers the support, collaboration, and resources of a larger development team by pooling the collective efforts of the dozens of CIPs across SCI.

SCI's CIPs provide high-quality and reliable software in support of SCI research projects. The Co-Op also provides a stable lifecycle for software projects, maintain an efficient development process, and create a community whereby CIP and research projects will continue to thrive.

Photo: SCI software developer, Jack Wilburn, presenting an overview of git and GitHub.

How is Co-Op participation beneficial to both CIP and principal investigators?

SCI has many CIPs with different skill levels and areas of expertise. A PI project may require knowledge in a variety of areas, making it difficult to find a single person to fill this need. The Co-Op can provide access to multiple CIPs at different time allocation levels, instead of hiring and supporting multiple CIPs individually. Additionally, leveraging the skills of various CIPs, rather than a single person, provides greater continuity during personnel turnover.

From a CIP perspective, the Co-Op can overcome some of the limitations of academic funding cycles, notably research grants. With the Co-Ops resources and spread of developers, the ability to work between projects and bridge funding gaps can increase stability and satisfaction, and thus improve retention. Additionally, the collaboration, training, and support from the broader Co-Op will be better than what is available to individual project groups.

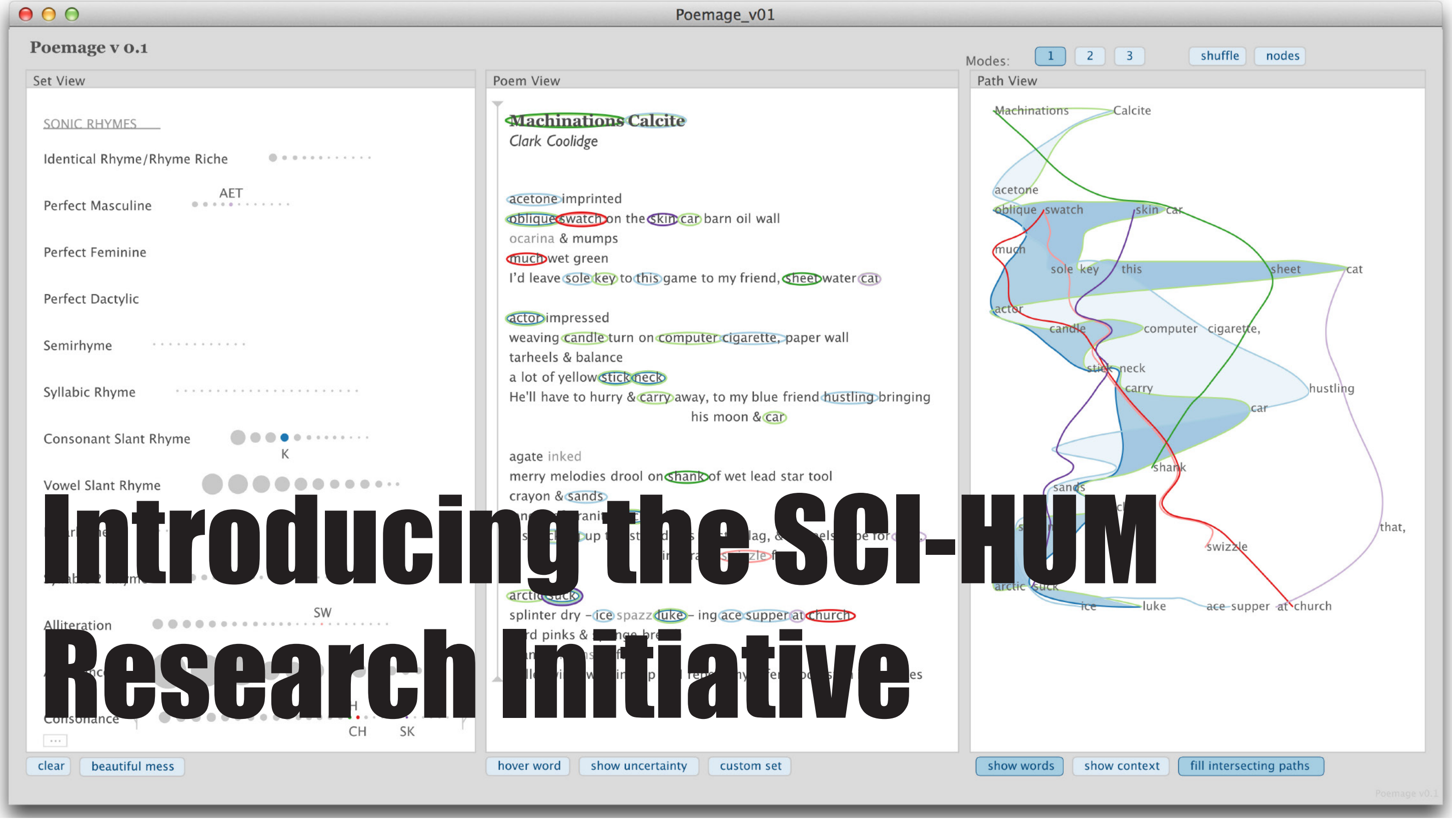
With CIP working beyond a single isolated project, there is an increased awareness of other research work at SCI. Familiarity with the areas of expertise of other CIP, and the projects they are working on, helps collaboration. Increased communication among CIPs allows for mentoring, training, peer review, and general feedback.

What are the major components of the Co-Op?

While there are a wide range of benefits to CIPs and PIs by participating in the Co-Op, the primary components of the community include the following:

- Skills training for existing and future projects
- Bridge funding as ramp up or ramp down
- Career planning and retention
- Uniform annual goal setting and evaluation
- SCI-wide coordination with PIs of personnel, workload, and communication

Introducing the SCI-HUM Research Initiative



Above: The Poemage interface comprises three linked views: (Left) the set view allows users to browse detected rhyme sets (words linked through instances of sonic and linguistic devices). (Middle) the poem view allows users to explore the sonic topology directly via the text. (Right) the path view presents the sonic topology of a poem.

We are pleased to announce that the Scientific Computing and Imaging Institute (SCI) and the College of Humanities have established a pilot partnership to conduct collaborative research projects. The initiative aims to bring together inspired technology-driven humanities research ideas with the technological innovation and research at SCI. The motivation for this initiative was based on the supposition that faculty members within the College of Humanities with great digital humanities and other technology-driven ideas could benefit through collaboration with faculty at the Scientific Computing and Imaging Institute (SCI).

A key component of this initiative is the inclusion of a new staff position at SCI that will provide program management and cyberinfrastructure professional (CIP) support to the College of Humanities and SCI researchers throughout the submission, research, development, and funding processes for humanities-driven research projects.

The SCI-HUM Research Initiative is aligned with the Strategy Refresh 2025 strategic roadmap. In particular, the initiative is meant to explore the possibility and feasibility of a future university-wide CIP effort (involving SCI, the Center for High-Performance Computing (CHPC), and other possible units) that would encourage technology-enabled research across campus.

The College of Humanities will determine the project selection process within their college.

John Gordon to Manage the SCI-HUM Research Initiative

John joins us as the new SCI-HUM program manager. He brings a broad background in both computing and humanities through his work and educational experiences in the information systems industry, computer science, information systems, business analytics, english and writing and rhetoric.

John served 12 years of active duty in the US Air Force and is a Gulf War Veteran. He has over 30 years of experience in the information systems industry in various roles, including programmer, systems administrator, software engineer, database administrator, data warehousing, and data analytics engineer. In addition, he has held leadership positions in the industry, including project manager, chief technology officer (CTO), and chief information officer (CIO). His hands-on experience spans local, national, and international projects in commercial, non-profit and government environments.

John's academic background includes degrees in Computer Science (BS), English (BA), Information Systems (MS), and Business Analytics (GC). Currently, he is Ph.D. candidate in the Writing and Rhetoric Department at the University of Utah.

News and Notes

Chuck Hansen Elected to IEEE Board of Governors

Chuck Hansen has been elected to the IEEE Board of Governors for 2022. The IEEE Computer Society relies on a fully elected Board of Governors to drive its vision forward, provide policy guidance to program boards and committees, and review the performance of the organization to ensure compliance with its policy directions.

Brian Zenger Receives Outstanding Dissertation Award for 2021

Brian Zenger is the recipient of the College of Engineering outstanding Dissertation Award for his Ph.D. dissertation entitled, "Experimental Examination of Partial Occlusion Acute Myocardial Ischemia". The selection committee evaluated the nominated dissertations based on intellectual merit and knowledge advancement, broader impacts and societal benefits, and the extent to which the research explored creative, original, and transformative concepts.

Valerio Pascucci Wins a NASA Earth Exchange Award

Valerio Pascucci won a NASA Earth Exchange (NEX) award entitled "A Flexible Encoding Framework and Autonomic Runtime System for Progressive Streaming of Scientific Data." The one-year, $100K award will help climate scientists study several terabytes of climate simulation datasets, manage workflows, and reduce data management costs. The proposed software systems will advance the study of extreme-scale scientific data.

Best Paper Awarded at IEEE Pacific Visualization 2022

Congratulations to Harsh Bhatia (LLNL/SCI Alumnus), Duong Hoang (SCI), Nathan Morrical (SCI), Peter Lindstrom (LLNl), Peer-Timo Bremer (LLNL/SCI), and Valerio Pascucci (SCI) for receiving the Best Paper Award at the IEEE Pacific Visualization 2022 Conference for their paper "AMM: Adaptive Multilinear Meshes."

Best Paper Award at Platform for Advanced Scientific Computing Conference, PASC22

Congratulations to John Holmen, Damodar Sahasrabudhe, and Martin Berzins for their best paper award at PASC22, "Porting Uintah to Heterogeneous Systems."

Bei Wang Receives NSF Career Award

Congratulations to Bei Wang on her NSF career award titled "A Measure Theoretic Framework for Topology-Based Visualization." This project develops a new set of approaches to support the core tasks in scientific data visualization (such as feature tracking, event detection, ensemble analysis, and interactive visualization) in a way that is more reflective of the underlying physics using measure theory. The project leverages tools from geometric measure theory, information theory, and transportation theory for topology-based visualization, which utilizes topological concepts to describe, reduce, and organize data for scientific understanding and communication.

Alex Lex Receives NSF Award for reVISit

Congratulations to Alex Lex on his NSF award from the CISE Community Research Infrastructure program titled "reVISit: Scalable Empirical Evaluation of Interactive Visualizations". The project is in collaboration with WPI and the University of Toronto.

This project furthers progress in our understanding of data visualization by developing infrastructure to allow researchers to conduct feature-rich online experiments.

Bei Wang Receives U SEED2SOIL Grant

The project will utilize a combination of geographical information system (GIS), data science, and visualization methods to identify the underutilized fleet and service coverage gaps, and inform strategic decision-making related to consolidated services and zero-emission vehicle deployment. This will be a joint project between PI Xiaoyue Cathy Liu in the Civil And Environmental Engineering Department and Co-PI Bei Wang Phillips from the SCI Institute.

Bringing Fairness in AI to the Forefront of Education

Bei Wang Phillips, a faculty member in the SCI Institute and an assistant professor in the School of Computing, and Arul Mishra and Himanshu Mishra, both professors of marketing in the David Eccles School of Business, applied for the competitive Deep Tech grant offered by the State of Utah's Office of the Commissioner of Higher Education. They were awarded a three-year grant of about $340,000 for developing courses/modules on AI ethics and fairness that would bring fair and equitable AI to the forefront of education.

Manish Parashar Named Presidential Professor

The title of Presidential Professor is reserved for those with achievements that "exemplify the highest goals of scholarship as demonstrated by recognition accorded to them from peers with national and international stature and whose record includes evidence of a high dedication to teaching."

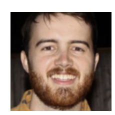
Recent SCI Ph.D.s

Kris Campbell - Metric Methods for Shape Analysis of Cortical Functional Regions, Subcortical Structures, and Structural Connectomes

Vidhi Zala - Convex Optimization-Based Structure-Preserving Filtering for Polynomial-Based Numerical Methods

Jimmy Moore - The Personal Informatics Analysis Gap

John K. Holmen - Portable, Scalable Approaches for Improving Asynchronous Many-Task Runtime Node Use



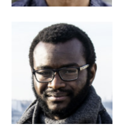
Steven LaBelle - Matrix Structural Regulation of Neovessel Guidance in Angiogenesis

Lin Yan - Merge Trees and Their Variants for Scientific Visualization

Cuong Ly - Characterizing Surface Structures Captured in Scanning Electron Microscopy Images with Convolutional Neural Networks

Riddhish Bhalodia - Reimagining Statistical Shape Modeling Pipelines via Deep Neural Networks

Archit Rathore - Topological Data Analysis and Visualization for Interpretable Machine Learning



Timbwaoga Aime Judicael Ouermi (TAJO) - Accelerating Physics Schemes in NWP Codes and Preserving Positivity in Physics-Dynamics Coupling

THE UNIVERSITY OF UTAH®

Scientific Computing and Imaging Institute
72 S. Central Campus Drive, Room 3750
Salt Lake City UT 84112
www.sci.utah.edu