The 7th International Symposium on Focused Ultrasound is the world’s leading forum for sharing translational and clinical advances in focused ultrasound.

We asked each researcher who submitted an abstract to summarize his/her work in a brief sentence. Browse this list of “take-home messages” for an overview of the week’s topics. This list is organized alphabetically by name.

**SYMPOSIUM 2020 TAKE-HOME MESSAGES**

**Mohamad Abedi**  
California Institute of Technology

We engineered gene circuits providing transient and sustained activation of gene expression in T-cells in response to brief thermal stimuli. We demonstrate the use of these circuits to control the secretion of a therapeutic gene, expression of a CAR, and killing of tumor cells.

**Abdul-Kareem Ahmed, MD**  
University of Maryland School of Medicine

MR-guided focused ultrasound thalamotomy of the central lateral nucleus is feasible and results in a sustained clinical response one year after treatment for neuropathic pain. Patients often experience a reduction in their analgesic use, and improvement in pain symptoms.

Unilateral MR-guided focused ultrasound thalamotomy has lower treatment requirements than unilateral pallidotomy. This reflects the treatment envelope of current systems. These findings can inform patient selection and treatment planning for new, peripheral cerebral targets.

**Shaikhah Alkhadhr**  
Penn State University

The numerical representation used to compose the acoustic properties of the skull in transcranial focused ultrasound (tFUS) has a direct impact on the resulting intracranial fields. These properties should be represented carefully to carry out meaningful tFUS simulations.

**Irving C Allen**  
Virginia Maryland College of Veterinary Medicine

These data support the feasibility of using the immunocompromised pig model for the design and evaluation of clinically relevant, novel medical devices to treat pancreatic cancer and beyond.

**Steven P. Allen**  
University of Virginia

Experiments in a preclinical model demonstrate that MRI diffusion weighted imaging can detect thermal ablation in the thalamus within minutes after treatment.

We present a method for estimating and predicting the effects of magnetic field aberrations induced by focused ultrasound devices inside an MRI scanner.

Iron oxide nanoparticles promise to improve MR guidance during FUS. Prefocal cavitation remains a primary concern for nanoparticle design.
Simone Ambrogio, PhD  
St Thomas Hospital  
Development of reliable MRgHIFU test objects may be crucial for training, R&D, device calibration, definition of exposure parameters for optimizing procedures, comparison of results between different centers, and development of protocols for Quality Assurance.

Diana Andrés  
Universitat Politècnica de València  
Acoustic holograms are a cost-effective solution for focusing ultrasound beams in the brain. They have demonstrated their capability to correct skull aberrations, and, simultaneously, to adapt the ultrasonic focus to the shape of complex bilateral deep-brain structures.

Kimberey Anneveldt, MD  
Isala Hospital  
When implementing MR-HIFU treatment, a learning curve should be considered. After overcoming this curve however, MR-HIFU for uterine fibroids leads to clinically successful treatments.

By performing a long-term randomized controlled trial comparing MR-HIFU with standard care, we will provide currently unavailable data about the proper place of MR-HIFU when it comes to uterine fibroid treatment.

Lauren Arnold  
Virginia Tech  
Histotripsy is a promising future treatment for primary canine and human osteosarcoma (OS). Feasibility treatments demonstrated successful generation of well-confined histotripsy bubble clouds and cell ablation zones in excised canine OS tissues.

Sandeep Arora, MBBS  
Vanderbilt University Medical Center  
Two-year follow-up of MRI-guided transurethral ultrasound ablation (TULSA) in men with localized prostate cancer demonstrates effective disease control with low toxicity and stable quality of life.

Harshini Ashar  
Oklahoma State University  
A combination of focused ultrasound heating with antibiotic-laden thermally-sensitive liposomes can achieve high microbicide concentrations locally to induce clearance of bone infections, obviating the need for long-duration antimicrobial therapies and surgeries.

FUS can be used for non-invasive treatment of spontaneously occurring canine cancers. FUS ablation of solid tumors can also enhance the local and systemic populations of anti-tumoral macrophages and activated T-cells to improve immunity against cancer.

David Attali  
Physics for Medicine Paris, Inserm, ESPCI Paris, CNRS, PSL Research Univ., Univ. de Paris, GHU Paris  
Using Transcranial Ultrasound Stimulation directed toward oculomotor regions, we provide evidence for sustained, reversible, and specific modulation of oculomotor behavior in non-human primates and quantify the return to baseline.

Haim Azhari  
Technion Institute of Technology  
Electrical impedance tomography can serve as a cost effective radiation free modality for thermal monitoring during HIFU breast treatment.

Joe Baal, MD  
UCSF Department of Radiology & Biomedical Imaging  
MRgFUS has a favorable safety profile and high efficacy in pain score reduction of symptomatic bone metastases. MRgFUS may
be a viable alternate first option for the palliative treatment of bone metastases in patients with suspected radio-resistant primary cancers.

Bashar Badran, PhD
Medical University of South Carolina

Transcranial focused ultrasound (tFUS) is a promising, noninvasive, and focal method of stimulating deep in the brain. tFUS to stimulate the anterior thalamus produced antinociceptive effects on heat pain threshold. Further tFUS investigation is warranted.

Hongchae Baek
Washington University in St. Louis

The mechanothermal effect of FUS was proven to have a higher success rate in evoking motor responses than mechanical effects alone. The mechanothermal mechanism warrants further investigation to improve the FUS neuromodulation technique.

Thomas Bancel
Physics for Medecine Paris - ESPCI

Computation time for transcranial HIFU brain surgery to assess phase shifts induced by the human skull can be reduced by an order of magnitude when simulations are performed at half the frequency (450kHz) of the transducer transmit frequency (900kHz).

For central brain targets, the clinical manufacturer provided ray-tracing algorithm for transcranial aberration correction shows only a 2% loss in pressure compared to 3D finite-difference algorithms.

Avinoam Bar-Zion
California Institute of Technology

Air-filled proteins allow genetically engineered tumor-homing bacteria and mammalian cells to be remotely detonated with ultrasound. Gas vesicle cavitation enables triggered payload release and propulsion and produces controlled damage to surrounding cells and tissue.

Alec Batts
Columbia University

Patient-specific simulation of transcranial acoustic wave propagation requires high-resolution CT scans with resolved trabecular microstructure to accurately predict acoustic beam distortion and signal attenuation.

Ethan Bendau, MS
Columbia University

Low-intensity focused ultrasound-mediated hyperthermia (<3.5°C) in the thalamus and hypothalamus of anesthetized mice results in modulation of autonomic regulatory function, including reversible modulation of heart rate and respiratory rate.

Chenchen Bing
University of Calgary

The feasibility of blood-nerve barrier (BNB) disruption has been demonstrated using focused ultrasound and microbubbles in a rodent model. A higher dosage of microbubble might be required compared to the brain to achieve BNB disruption.

Torsten Bove
TOOsonix A/S

This study presents a new 20 MHz HIFU system for clinical dermatology. Treatments were applied successfully to actinic keratosis, basal cell carcinoma and Kaposi's sarcoma. Results demonstrate close to 100% efficacy, low treatment time, and reduced pain level for patients.

Boris Breuer, MSc
Eindhoven University of Technology

The raytracing approach by (Modena et al., 2018) can be used to simulate HIFU induced heat production and temperature profiles
Mechanical forces from non-ablative pulsed focused ultrasound to different tumor cell types induce cytosolic Ca2+ transients that cause mitochondrial formation of superoxide and H2O2 which leads to double-stranded DNA breaks without apoptosis.

Nonablative pulsed focused ultrasound initiates complex cellular calcium dynamics to induce NFκB, which is a major mediator of bioeffects necessary for ultrasound-induced stem cell homing.

Samuele Cabras
Istituto Neurologico Carlo Besta

MRgFUS is a technique for creating thermal lesions within dysfunctional brain circuits. The aim of this study is to assess the stereotactic accuracy of VIM thalamotomy in a cohort of patients treated for tremor using Kranion, an open-source software.

Elodie Cao, MD
LabTAU INSERM U1032

Cardiac arrhythmia treatment is challenging. HIFU therapy is a promising alternative method to induce full thickness transmural thermal lesions. Ex vivo experiments were conducted with a new transesophageal probe. Results demonstrated the ability to produce transmural lesions.

Jennifer Carroll, BVMS
Virginia Tech

HIFU can be used for the treatment of canine subcutaneous solid tumors. It is feasible and generally safe, resulting in discrete regions of coagulative necrosis. Treatment results in a pro-inflammatory changes to the tumor microenvironment that may have an anti-tumor effect.

Juan Castillo, PhD
University Hospital of Cologne

HIFU-Hyperthermia using TSLs is a suitable method for local drug release of doxorubicin and cisplatin in large animals. This method is suitable to treat tumors such as sarcomas located in non-moving regions and is a promising step towards clinical translation.

FANT Cécile, DVM
LabTAU INSERM U1032

Pulsed cavitational ultrasound can potentiate anti-PD1 in a partially sensitive tumor model. The enhanced treatment efficacy is immune dependent, at least partially through a CD8+ T-cells mediated response, and potentially through an increased DC-mediated response.

Parwathy Chandran, PhD
National Institutes of Health

This study demonstrates the immunomodulatory potential of non-ablative pulsed focused ultrasound in altering an anti-inflammatory, tumor microenvironment towards a pro-inflammatory, anti-tumor landscape by engaging both innate and adaptive arms of immunity.

Jin Woo Chang
Yonsei University College of Medicine

With the newly developed Auto-Focusing(AF) Echo imaging technique, MRgFUS was successfully performed for patients with low SDR, achieving a therapeutic temperature (>54°C) without any adverse effects.

Additional studies examining the combination of BBBD with other therapeutic agents, such as antibodies or stem cells, to enhance the beneficial effects of BBBD for AD patients will be necessary.
Andrew Chen, BS  
The George Washington University  
Autofluorescence imaging of ultrasound effects on the pancreas can provide information on metabolic activity. Thermal effects of ultrasound may counteract the upregulation of metabolic activity induced by mechanical effects.

Bingbing Cheng, PhD  
University of Calgary  
It is feasible to perform non-invasive targeted brain mild hyperthermia in small animal models with MR-guided focused ultrasound. The introduction of microbubbles can reduce the ultrasound power required for hyperthermia and potentially improve the safety.

Xinghao Cheng  
University of Oxford  
We use ultrasound simulations to demonstrate targeting of the hippocampus for transcranial ultrasound stimulation (TUS) using a single element transducer with a lens. The simulations employ geometries from subject-specific MRIs and at 500 kHz the focal volume is < 30 mm$^3$.

Chris Childers  
Virginia Tech Carilion School of Medicine  
Histotripsy is a promising novel technology for prophylaxis or treatment of catheter-associated urinary tract infections. Initial data support the need for future work in treating medical device related biofilms with histotripsy.

Clifford Cho, MD  
University of Michigan Medical School  
Non-thermal focused ultrasound ablation induces a stronger systemic immunostimulatory response than thermal focused ultrasound ablation.

William Chu Kwan, MD  
Hospital for Sick Children  
The interaction between MRgFUS boiling histotripsy and ablation can reduce the energy and limit the thermal spread in ablative treatments of ex-vivo tendons, making this method a potential modality to resect tendon contractures in patients with cerebral palsy or stroke.

Daria Chupova  
Lomonosov Moscow State University  
We demonstrate the theoretical feasibility of using a new class of fully populated multi-element phased arrays to achieve shock-forming conditions at the focus and tight focusing through an intact skull over a wide 40 mm range of depths.

Sam Clinard  
Focused Ultrasound Foundation  
The FUS Foundation made available instructions and software to build and control a hydrophone scanning tank, using 3D printing and sourced parts, for a total cost of about $1k. This is an open-source alternative to commercial systems.

Gadi Cohen  
National Institutes of Health  
Temporal alterations of non-ablative pulsed focused ultrasound exposure display a pro-inflammatory proteomic profile within the tumor microenvironment, thus underscoring the potential use of pFUS as neoadjuvant treatment approaches in cancer immunotherapy.

Christian Coviello, PhD  
OxSonics Therapeutics  
Penetration of drugs into and throughout solid tumors is recognized as a major limitation to their effectiveness. SonoTran is a drug
agnostic solution requiring no reformulation. This work validates the preclinical safety and performance of the system leading to clinical trial.

John Cressman, PhD
George Mason University

We computationally model the effects of the acoustic radiation force on neuronal tissue. The model is able to reproduce experimental results and provide a detailed explanation of the mechanisms of action.

Daniel Dahis, MSc
Technion Institute of Technology

Copper Oxide nanoparticle (NP) accumulation in the brain following FUS-mediated BBB disruption induced an increase in contrast to noise ratio of the targeted tissue on MRI. This effect can be leveraged for the development of CuO NP-based theranostic agents for tumor imaging and treatment.

The Golay coded sequences offer an opportunity to monitor FUS thermal brain treatments. These sequences can be implemented in the same FUS probe used for treatment. The obtained echo-shifts vs. temperature trajectories can serve as a tool for temperature estimation of the brain.

Bianca Dang
UCLA

tFUS is a new and non-invasive neuromodulation technique that can selectively target deeper regions of the brain, extending the bounds of current non-invasive neuromodulation treatment techniques. We show this via selectively increasing AG perfusion via tFUS targeting.

Benjamin Davidson, MD
Sunnybrook Research Institute

MRgFUS capsulotomy is an extremely promising treatment option for severe psychiatric illness. Despite being minimally invasive, it can effectively interrupt aberrant limbic circuitry, resulting in widespread metabolic normalization throughout the brain.

Alessandro De Maio
Sapienza, Rome University

MRgFUS confirmed significant advancements in pain palliation from bone metastases and, compared to first-line external radiation therapy, provided further benefits on: rate, likelihood and degree of improvement, no ionizing radiation-related morbidity and survival.

Lynn Dengel, MD, MSc
University of Virginia

The presented trial of FUS ablation of metastatic solid tumors with/without systemic therapy has obtained FDA approval. 2/32 participants have enrolled and received FUS without immediate complications. Data analysis will evaluate changes in the tumor microenvironment.

Aline Desoutter
LabTAU

Radiotherapy decreases bone quality and bone mineral density. A radiation protocol delivering 8.5Gy weekly in five sessions seemed to be valuable for evaluating postextractional bone healing in the rabbit. Low intensity FUS seem to have a positive impact on trabecular number in irradiated bone.

Patrick Dillon, MD
University of Virginia

FUS combined with checkpoint inhibitor therapy appears to be safe in metastatic breast cancer. Immunologic outcomes suggest that a degree of local and systemic modulation occurs. The impact on long-term outcomes is unknown.
Andrew Drainville, PhD
LabTAU INSERM

Parametric simulation studies were used to quantify the sensitivity of transcranial focalization to uncertainties in estimated skull acoustic properties. Errors in density and sound speed can translate into significant errors in focalization, whereas attenuation has less impact.

Gil Dubernard, MD, PhD
Hospices Civils de Lyon - LabTAU

We report for the first time that transrectal HIFU therapy for rectosigmoid endometriosis is feasible. No major complication was observed after 20 procedures with a significant impact on gynecological and digestive symptoms.

Phillip Durham
UNC Chapel Hill

Focused ultrasound therapy with phase-change contrast agents can temporarily disrupt tumor blood vessels, and this disruption can be visualized immediately following treatment via acoustic angiography.

Zachary Englander
Columbia University

Focused ultrasound mediated blood-brain barrier opening is safe and feasible following radiotherapy in a murine diffuse intrinsic pontine glioma model.

Avinash Eranki, PhD
Indian Institute of Technology, Hyderabad

Boiling histotripsy (BH) mechanically fractionates neuroblastoma tumors, resulting in a significant intratumoral infiltration of immune cells compared to untreated neuroblastoma tumors.

Mechanical fractionation using boiling histotripsy induces systemic immune sensitization in an established and refractory murine neuroblastoma model, opening a window for effective immunotherapy that promises a novel yet efficacious immuno-adjuvant modality to overcome therapeutic resistance.

Hector Estrada
ETH and University of Zurich

Our bidirectional transcranial ultrasound (TUS) platform is suitable for preclinical studies targeting the mouse brain. It provides unprecedented spatial resolution below 400 µm through the skull in conjunction with brain-wide real time volumetric imaging of the optical absorption contrast.

Nikolas Evripidou
Cyprus University of Technology

MRI guided positioning device using focused ultrasound for treatment of prostate cancer is described.

We demonstrate a pre-clinical MRI-guided robotic device using focused ultrasound.

Marc Fournelle
Fraunhofer Institute for Biomedical Engineering

Acoustic back-propagation simulations can be used to determine patient-specific delay patterns that allow compensation for skull-bone related sound field distortion. Matrix arrays or phase plates can be used to generate these specific delays.

Rezida Galimova, MD, PhD
Intelligent Neurosurgery Clinic

Despite COVID infection limitations, innovative digital technologies allow us to perform MRgFUS neurosurgical procedures remotely. Intelligent Neurosurgery Clinic experience shows that even difficult neurosurgical procedures can be launched remotely with good results.
Yekaterina Gilbo  
University of Virginia

Skull heating is not currently measured during FUS brain surgery. MR T1 thermometry uses T1 mapping to measure skull temperature but requires long acquisitions. Here we demonstrate rapid volumetric thermometry by using a 3D spiral UTE sequence with variable density acceleration.

David Goertz, PhD  
Department of Medical Biophysics, University of Toronto

In this work, we demonstrated that ultrasound stimulated microbubbles can profoundly enhance the clinical drug combination of anti-PD-L1 + paclitaxel in the treatment of murine triple negative breast cancer.

Juergen Goetz, PhD  
The University of Queensland

Therapeutic ultrasound applied with microbubbles is a treatment modality to improve cognition in brain diseases, with amyloid-beta being an easier therapeutic target than tau. Therapeutic US is also a modality to improve cognition in physiological ageing.

Michael Gray, PhD  
University of Oxford

The TarDox study confirmed the safety and feasibility of USgFUS-mediated mild hyperthermia for drug release within oncologically relevant volumes. This approach may be applied to a range of thermally-activated chemotherapeutics and tumour indications, including pancreatic cancer.

Samuel Groth  
University of Cambridge

OptimUS is a fast Python-scriptable computational suite for modelling therapeutic ultrasound. OptimUS includes efficient implementations of modern integral equation and finite element methods, and is straightforward to use on a single workstation and in highly parallel settings.

Juanjuan Gu, PhD  
North Carolina State University

We introduce mSOUND, a user-friendly toolbox for the simulation of acoustic wave propagation in heterogeneous media. It is developed to fill an unmet need for an accuracy-efficiency balanced solver for modeling medical ultrasound, especially HIFU.

Sijia Guo, PhD  
University of Maryland School of Medicine

Effective heating can be achieved in the mesial temporal lobe by MRgFUS, and potential skull heating can be reduced by blocking certain transducer elements. Large volume lesions will require multiple sonication targets.

Yutong Guo  
Georgia Institute of Technology

Our integrated experimental and computational framework revealed that microbubble-enhanced FUS in combination with 40 nm cationic nanoparticles results in robust nucleic acid delivery in brain tumors.

Edwin Heijman  
University of Cologne, Philips Research Eindhoven

We propose a new measure, Thermal Dose Performance Temperature (TDPT), to evaluate MR-HIFU hyperthermia treatments regardless of the target temperature & treatment time. MR-HIFU hyperthermia therapy clinical data was used to assess the TDPT.

Alissa Hendricks  
Virginia Tech

The current work shows specific DAMPs and immune cell populations responding to histotripsy ablation of pancreatic cancer in
vitro and in vivo, showing similar or improved effects when compared to established ablation modalities.

Yoni Hertzberg, PhD
NINA Medical

A new method of real-time US imaging of a HIFU field is evolving. The method can be used safely during USgHIFU procedures to provide a live image of the treatment beam to the practitioner as well as focal point tracking and improvement in treatment efficacy and safety.

Jake Hesselink, BSc
University of Calgary

The delivery of FUS for non-invasive neuromodulation produces measurable vibrations at the skull, likely linked to the pulse repetition frequency (PRF) of the signal. Further study should attempt to avoid the auditory artifact by adjusting PRF, and investigate the mechanism underlying motor responses to FUS.

Lorne Hofstetter
University of Utah

Elastography metrics may help improve treatment assessment of many MRgFUS therapies. In this work, feasibility of an elastography technique that leverages the use of conventional MRgFUS hardware was presented and demonstrated in phantom experiments.

Xuandi Hou
The Hong Kong Polytechnic University

We developed an ultrasonic mechanogenetic tool to manipulate neuronal activity and signaling with excellent precision by introducing nano-materials.

Sam Howard, PhD
Onda Corporation

The combination of this scatterer-free phantom with the reflectance-type fiber-optic hydrophone is a promising tool for treatment planning and quality assurance for HIFU.

Kenneth Hoyt
University of Texas at Dallas

Multifocused ultrasound therapy spatially enhances microvascular permeabilization and represents a promising approach for improved drug delivery and accumulation in the cancerous mass.

Ming-Yen Hsiao, MD, PhD
Duke University

Acoustic waves induce changes in calcium signaling and permeability change of an endothelial monolayer, possibly by acoustic streaming-induced shear stress. The system provides a useful platform for exploring the mechanical effect of US on BBB opening.

Zhongtao Hu, PhD
Washington University in St. Louis

This study demonstrated the feasibility of using a four-sensor network to transcranially locate cavitation sources in 3D. The proposed method has the unique advantages of being low-cost in manufacturing and low-cost in computation. Future studies are needed to improve accuracy.

Ayesha Jameel, DPMSA, BSc, MBBS, FRCR
Imperial College

In this pilot study, bilateral MRgFUS treatment for refractory essential tremor has proven to be safe and effective with no persistent adverse effects at 12 months. Further studies are needed with detailed analysis on the effect of bilateral MRgFUS treatments on speech.
**Ayesha Jameel, DPMSA, BSc, MBBS, FRCR**
Imperial College

Targeting VIM and ZI in the same procedure provides both contralateral and ipsilateral effects. VIM plus ZI provides additional tremor suppression compared to VIM alone. Spot elongation should be considered when targeting deeper tissues.

**Rohan Janwadkar**
Florida Atlantic University, Charles E. Schmidt College of Medicine

Focused ultrasound therapy in pediatric patients provides a uniquely advantageous therapeutic platform with no radiation exposure and no incisions.

**Robin Ji, MS**
Columbia University

The results presented in this study suggest a relationship between cavitation signals and the immune response to FUS-induced BBB opening, which ultimately may be used to modulate the immune response for more effective therapies.

**Noé Jiménez, PhD**
Universitat Politècnica de València

We demonstrate that contactless particle trapping can be performed through the skull bones using acoustic holograms. The benefit is twofold: holograms allow the generation of the vortex trap using low-cost system; and the skull aberrations can be compensated.

**Sergio Jimenez Gambin**
Universitat Politècnica de València

We demonstrate how a single-element transducer with a 3D-printed holographic lens allows (1) simultaneous production of bilateral BBB opening in anesthetized mice in vivo, and (2) compensation of the aberrations due to both the skull and the water cone.

**Jordan Joiner**
UNC Chapel Hill

Low-intensity focused ultrasound and microbubbles can transiently increase immune cell infiltration in murine pancreatic tumors and draining lymph nodes. In future studies, this treatment will be combined with immunotherapy.

**Sumeeth Jonathan, PhD**
Vanderbilt University

A multi-voxel MR-ARFI-based autofocus method is proposed for rapid aberration correction of MR-guided focused ultrasound acoustic pressure fields. We demonstrate that as few as two MR-ARFI acquisitions can be used to refocus a programatically aberrated pressure field.

**Minoo Kabir**
Stanford University

We propose a novel technique for in-situ acoustic characterization of the skull based on acoustic microscopy. It is able to provide a full characterization including both longitudinal and shear velocities and attenuations.

**Peter Kaczkowski, PhD**
Verasonics, Inc.

The new HIFUplex PLUS™ 1000 and 3000 platforms from Verasonics and Sonic Concepts are turnkey commercial systems for preclinical research in focused ultrasound therapeutic applications, enabling typical experimental USgFUS preclinical workflows.

**Ki Chang Kang**
Hanyang University

We propose and present the concept and feasibility of the dual-mode conversion technique using an array of wedge transducers,
which is able to reduce skull heating, and extend the focal spot range.

**Woongbin Kang, BS**  
*Jeju National University*

Kranion software is a good tool for patient selection and validation of the treatment for thermal ablation.

**Maria Eleni Karakatsani**  
*Columbia University*

Bilateral sonication significantly ameliorates Alzheimer's pathology and improves the spatial memory of transgenic animals with complex AD phenotype.

Diffusion tensor imaging may be used in the clinic for detecting BBB opening following FUS treatment and/or to evaluate BBB integrity in brain-related pathologies.

**Rajwinder Kaur**  
*Ryerson University*

Pulsed FUS was used successfully to induce primary injury to the nuclei of mouse brain endothelial cells. It was insufficient to directly deform the nuclei, but sufficient to irreversibly affect their integrity. Therefore, nuclei became more vulnerable to hypoxia – a well-known secondary process in TBI.

**Tatiana Khokhlova**  
*University of Washington*

Inertial cavitation produced by pulsed high intensity focused ultrasound in pancreas tumors may be a promising therapy that would not only enhance chemotherapeutic drug concentration in the tumor but also reduce the tumor chemoresistance and immunosuppressive microenvironment.

**Vera Khokhlova**  
*University of Washington*

Mechanical ablation of tissue volumes with real-time ultrasound control of the degree of tissue liquefaction is feasible using boiling histotripsy (BH) technology combined with electronic focus steering and Doppler-type imaging.

**Sait Kilinc**  
*Georgia Institute of Technology*

According to a figure of merit based on the ratio of ultrasound power transmission to maximum temperature rise in the skull, mode conversion in the skull does not provide an advantage for tFUS over normal or close to normal incidence.

**Chulyong Kim**  
*Georgia Institute of Technology*

Ultrasonic thermal stress promotes acute changes in the transvascular transport dynamics in brain tumors and promotes the delivery of chemotherapy encapsulated in heat sensitive nanoparticles.

**Evgenii Kim**  
*Korea Institute of Science and Technology*

FUS was introduced as a noninvasive technique to modulate spinal cord activity. The results demonstrated that FUS could temporarily suppress limb movement induced by electrical stimulation of the motor cortex. This study may open new applications for FUS.

**Hyun-Chul Kim**  
*Brigham and Women’s Hospital*

Pulsed application of low-intensity transcranial FUS can safely and temporarily modulate regional-specific brain functions in awake sheep.
Jinwook Kim, PhD
The University of North Carolina at Chapel Hill

Nanodroplet-mediated pulsed focused ultrasound generates higher cavitation intensity compared to microbubble-induced cavitation or free-field cavitation. Cavitation enhanced sonothrombolysis by nanodroplets outperforms conventional HIFU or microbubble-assisted therapy.

Kisoo Kim, PhD
University of California, San Francisco

For volumetric hyperthermia treatments using the ExAblate body system, we investigated sector vortex beamforming methods as a sonication strategy for HT and developed an acoustic and biothermal simulation framework for rapid evaluation of the sector vortex approach.

Motion-robust, multi-slice, real-time MR thermometry was developed for the monitoring of ultrasound thermal therapy in abdominal organs. This all-in-one MR thermometry is available for accurate and stable temperature measurements in abdominal organs.

Young Hun Kim
Hanyang University

The skull’s effect on the pattern interference radiation force created by focused transducers using the Fresnel lens was measured. By using two transducers with the same design, we measured the radiation force at the focal point without the skull.

Alina Kline-Schoder
Columbia University

In this study, infiltration of macrophages was detected 24 hours after BBB opening.

Elena Konnova
Lomonosov Moscow State University

The use of graphic accelerators in modeling nonlinear ultrasound beams speeds up simulations several times compared to those performed on central processors and makes such simulations feasible for practical implementation in HIFU using a personal computer.

Vibhor Krishna, MBBS, SM
OSU Wexner Medical Center

Unilateral anterior thalamic nucleus ablation using focused ultrasound is feasible for patients with intractable partial-onset epilepsy. Detailed neuro-psychological assessment is important to detect changes in memory and mood.

Reversible and focal BBB opening with FUS was safe and feasible in Alzheimer’s Disease patients.

Thermal neuromodulation was observed in a minority of subthreshold sonications. Higher temperatures and bigger spot sizes were associated with thermal neuromodulation.

The lesion mapping technique proved useful in localizing tremor network. Functional connectivity in the tremor network was significantly higher in essential tremor patients. Therapeutic FUS ablation restored functional connectivity in the tremor network.

Taylor Kuhn
UCLA

tFUS can selectively increase regional blood flow, modulate functional connectivity, and possibly affect associated cognitive performance in the targeted subcortical brain region.

Uday Kumar
Stanford University

Ultrasound in the presence of microbubbles can trigger non-destructive widening of intercellular spaces between blood vessel epithelial cells and increase the penetration of microRNAs loaded nanoparticles for improved therapeutic outcome.
Varsha Kumar
University of Michigan

The results from K-wave simulations that quantify the focal shift due to aberration reveal the necessity of performing real time corrections during each treatment. It is also critical the media surrounding the transducer better matches the speed of sound in skin.

Wojciech Kwiecinski, PhD
Cardiawave

Noninvasive ultrasound therapy generated by Valvosoft (Cardiawave, France) is feasible and safe in patients \( n = 10 \) with severe aortic valve stenosis and can improve aortic valve area and hemodynamic parameters. Larger clinical studies need to be conducted.

Grace Lai, MD, PhD
The Hospital for Sick Children

HIFU sonothrombolysis in an in vivo porcine intraventricular hemorrhage model can result in far field effects due to air in nasal sinuses and near field effects at higher powers but can be safe and effective given proper precautions.

We propose an optimal set of sonothrombolysis parameters for a 1MHz HIFU transducer through systematic testing of a range of cavitation parameters on in vivo porcine blood clots.

Benoit Larrat, PhD
Commissariat à l’Energie Atomique et aux Energies Alternatives

In a rat syngenic brain tumor model, FUS induced BBB opening significantly enhances delivery and efficacy of a cocktail composed of anti-PD1 antibody together with drugs limiting pro-tumoral inflammation.

FUS and MB significantly increase the delivery of cetuximab across the BBB. PET is a powerful method to assess the pharmacokinetics of the passage of mAb through the BBB. 89Zr-DFO-CTX was synthetized and used to quantify the enhancement of brain exposure to CTX.

Hohyun Lee
Georgia Institute of Technology

To address the possible downsides of MRI-guided FUS systems, we developed and evaluated an US-guided FUS system for BBB opening and targeted drug delivery in central nervous system with sub-millimeter accuracy. The system is also capable of real time closed-loop control using PCD.

Jooho Lee, MS
Jeju National University

A carbon nanotube transducer can be used for the application of therapeutic ultrasound by increasing the negative pressure of the shock wave.

Stephen Lee, MS
Columbia University

Treatments of neuropathic pain are still limited in scope and efficiency. Moreover, pain has several complex pathways as it travels from the periphery to the brain. We show that FUS can subdue pain at the PNS level, paving the way for more targeted and noninvasive therapies.

Gerhard Leinenga
The University of Queensland

Focused ultrasound can be used to deliver aducanumab to the brain which improves memory function and lowers plaque burden in a mouse model of Alzheimer's Disease.

We show unique microglia responses to opening of the blood brain barrier by focused ultrasound in plaque-bearing mouse model of Alzheimer's Disease.
Robert Lemme  
A.T. Still University - Kirksville College of Osteopathic Medicine  
HIFU is a safe and effective treatment option for prostate cancer that can be applied in the community setting with excellent potency and continence preservation along with good short-term disease control.

Beatrice Lena  
UMC Utrecht  
Interleaving fat and water MR thermometry allows temperature monitoring in muscle and fat. This will help create a complete view of the temperature distribution when heating bone lesions and to prevent damage to healthy tissue present in the target area.

Steve Leung  
Stanford University  
MR-simulated-CT images are a promising alternative to CT images for treatment planning of transcranial focused ultrasound.

Xiaoyue Li, MS  
Columbia University  
We show that Harmonic Motion Imaging (HMI) can be used to monitor Focused Ultrasound Surgery (FUS) ablation in mammary breast tumors in mice using simultaneous 2D imaging for the first time.

Defei Liao  
Duke University  
The optimal pulse length of US for activating Piezo1 in HEK293t cells under 60 s total treatment time and at 20% duty cycle is 20 ms. Fine-tuning the PL of US may significantly improve the efficacy and safety of sonogenetic applications.

Chia-Jung Lin  
NaviFUS Co. LTD  
Focused ultrasound combined with clinical microbubbles can raise cerebral oxygen content, which may also contribute to the effect of radiation therapy for brain tumor treatment.

Xilun Liu, MS  
The Pennsylvania State University  
In this study, to create and control tumor ablation, we propose combining CGM, SGC using the adjoint method. Our results show that our proposed method is computationally more efficient than the SGC method.

Asis Lopez, PhD  
FDA  
The outcomes of these in vivo experiments are expected to assist in predicting the rupture probability for HIFU + Microbubble procedures.

Ning Lu  
University of Michigan  
The feasibility of transcranial histotripsy has been demonstrated in the in vivo pig brain. No excessive hemorrhage or edema occurred post-treatment.

Michael Malmberg  
University of Utah  
Fast T1 mapping is needed for simultaneous proton resonance frequency/T1 thermometry. A T2* correction was applied via simulation to a single reference variable flip angle method of T1 mapping that can eliminate the calculation’s bias, showing potential viability of fast, accurate T1 thermometry.
Staged focused ultrasound bilateral thalamotomy might be safe and effective for the treatment of essential tremor.

Tamotsu Maruyama
Teikyo University

We developed lipid microbubbles (LMBs) that are more stable in blood flow by using DSPG. The optimal DSPG content was about 60% in the lipid shell of LMBs. LMBs with DSPG could be applicable for development of an effective ultrasound diagnostic and therapeutic system.

Jaime Mata, MS, PhD
University of Virginia

Noninvasive ablation and debulking of lung tumors seems possible with the novel method proposed using MRgFUS. We successfully ablated lung tissue deep in the lung without incisions, reducing the risk for infection and other complications.

Nathan McDannold
Brigham and Women’s Hospital, Harvard Medical School

Our method to estimate the accumulated thermal dose predicted the shape of the resulting lesions segmented 24 h after treatment. The 17 CEM43 threshold used by the device software, matched well on average with the lesions segmented 24 h after treatment.

This approach can visualize anatomic landmarks that are useful in refining atlas-based targeting for MRgFUS. Since the same data is used for MRTI and anatomic visualization, there are no errors induced by registration errors or image distortion, and no extra time is needed.

McKenzie McLean
University of Utah

Errors in proton resonance frequency thermometry can occur when fatty tissues are heated. A correction method using T1 times to estimate temperature change is proposed and evaluated, demonstrating that this correction may improve MR thermometry results during MRgFUS treatment.

Chitra Meduri, MS
Virginia Tech

We designed a custom, image-guided FUS system to identify and characterize FUS regimes capable of producing a range of mechanical, thermal, or combined mechanical-thermal effects in mouse Achilles tendons in vivo, enabling us to study effects of FUS on tendon healing.

Hossein Mehrad, PhD
Islamic Azad University- Tabriz Branch

Ultrasound-mediated transfection therapy is a feasible and efficient method for improving vascular endothelial dysfunction.

David Melodelima, PhD
LabTAU

We demonstrated in 35 patients that the use of an ultrasound-guided intra-operative toroidal HIFU transducer was feasible, safe and effective in ablating liver metastases with safety margins. The sonication time was six minutes.

An intraoperative HIFU treatment at the pancreas-mesenteric artery interface was shown to be safe and feasible without vascular thrombosis using a toroidal HIFU transducer under Doppler guidance.

Ying Meng, MD
Sunnybrook Research Institute

Blood-brain barrier opening of multiple distributed brain regions with transcranial MR-guided focused ultrasound can be precisely achieved and reasonably tolerated in a single sitting for patients with Alzheimer’s disease without any serious adverse events.
Ying Meng, MD (continued)
Sunnybrook Research Institute

In this study, we will investigate the safety and feasibility of MRgFUS induced BBB opening for trastuzumab delivery for intracranial metastatic lesions in Her2-positive breast cancer patients.

Robb Merrill, MS
University of Utah

A conformable, convective skin-cooling device that can be integrated with existing MRgFUS systems to effectively prevent skin burns and reduce lengthy treatment times is presented. Superficial targets were treated without causing skin burns during ablative in vivo large animal model studies.

Kaylee Meyers
Michigan Technological University

To accelerate repair in tendon tissue, our group has developed an injectable adhesive hydrogel containing fibrin µ-particles with the capacity for thermal and mechanical controlled release of nitric oxide, an antimicrobial signaling molecule that influences ECM turnover, via FUS.

Ali Mohammadabadi, PhD
University of Maryland School of Medicine

Pulsed focused ultrasound nondestructively reduced interstitial fluid pressure in solid tumors, increasing penetration and overall delivery of nanoparticle probes. These results support our therapeutic studies and may facilitate future clinical translation for cancer treatment.

Martin Monti
University of California, Los Angeles

Thalamic Low Intensity Focused Ultrasound Pulsation might provide for a safe and potentially effective approach to enhancing behavioral responsiveness in vegetative state and minimally conscious state patients.

Sophie Morse
Imperial College London

By emitting ultrasound in a rapid short-pulse (RaSP) sequence we can open the blood-brain barrier in a safer way with less microglial activation and a reduced amount of blood-borne substances entering the brain.

Pierre Mourad, PhD
University of Washington

Ultrasound capable of activating central neurons can also activate oligodendrocytes and microglia to therapeutic effect in mouse models of multiple sclerosis and of Alzheimer’s Disease, respectively.

Petros Mouratidis, PhD
The Institute of Cancer Research London

Heating can be combined with therapies targeted against the heat shock response to provide a synergistic cytotoxic effect against various cancer cell types. The mutational status of client proteins may predict which cell types respond to these treatments.

pHIFU treatments using “low” rarefactional pressures combined with microbubbles can induce acoustic cavitation in pancreatic tumours and decrease tumour growth. It is under investigation whether these treatments could also mount an effective anti-cancer immune response.

Anirudh Natarajan
University of California, Berkeley

Automated post-processing of imaging data will rapidly speed up and simplify analysis allowing researchers to focus on optimizing their experimental preparations. Creating an analysis pipeline in Python will also capitalize on the most current image analysis algorithms.
William Apoutou N’Djin
INSERM

FUS exposures can trigger Ca2+ fluxes whose spatial-temporal dynamics can be studied at the cell scale in in-vitro human neural networks, using a mixed FUS / Fluorescence microscopy research platform.

Kei Nirasawa
Tokyo University of Pharmacy and Life Sciences

We have developed nanobubbles in which ultrasound contrast agent gas is encapsulated in liposomes, and have shown that they can be a useful delivery system in CRISPR-based genome editing for restoring dystrophic skeletal muscle.

Pavel Novak, PhD
Storz Medical AG

Shockwaves are a special, unique form of ultrasound with high pressure amplitudes and very short durations. They have been used in medicine since 1980 for stone disintegration and soft tissue stimulation and regeneration.

Daiki Omata
Teikyo University

The effect of lipid-based microbubbles (LBs) containing various gases on ultrasound (US) triggered drug delivery to the brain was examined. The treatment of LBs containing perfluoropropane or perfluorobutane with US showed efficient drug delivery.

Kota Ono
Tokyo University of Pharmacy and Life sciences

By loading miRNA on nanobubbles coated with cationic polysaccharides, efficient miRNA delivery after systemic injection is possible using ultrasound.

Mehmet Ozdas, PhD
ETH Zurich

FUS and microbubbles induced BBB opening causes micro-seizure like activity in the brain and induces inhibition of evoked local field potentials.

We developed a reliable and safe method for targeted, non-invasive, receptor specific neuromodulation of brain circuits. Our in-vivo results prove that drugs can be delivered to targeted brain regions with high resolution without BBB opening.

Christopher Pacia
Washington University in St. Louis

FUS-liquid biopsy is a promising noninvasive tool for the diagnosis of brain tumors, providing valuable molecular and genetic information. Optimization of FUS-LBx parameters, such as FUS pressure, microbubble dose, and blood collection time, will improve its efficacy and safety.

Frederic Padilla
Focused Ultrasound Foundation

Contrast enhanced US (CEUS) intraoperative images can be quantified for accurate analysis of microbubble distribution in the human brain, allowing discernment between brain tissues and tumor types. Such quantitative imaging will have implications for MB-based imaging and treatments.

Ultrasound molecular imaging (USMI) can be used to plan ultrasound-triggered drug delivery and to monitor treatment at the anatomical, functional and molecular levels. USMI-guided cavitational ultrasound can potentiate liposomal doxorubicin.

Ki Joo Pahk, PhD
Korea Institute of Science and Technology (KIST)

In addition to boiling histotripsy, this proposed pressure-modulated shockwave histotripsy method could be employed for precise tissue fractionation and tissue decellularisation.
So Hee Park, PhD  
Yonsei University College of Medicine  
The survival rate up to 1 year was 100% in six patients who underwent BBBD for GBM. The median PFS in patients with recurrence was 13.5 months. None of the patients had immediate or delayed BBBD-related complications.

Thomas Payen, PhD  
LabTau, U1032 INSERM  
Higher performance in lesion monitoring is needed for widespread use of focal HIFU treatments in prostate cancer. Passive elastography can be modified to provide stiffness maps using slow-rate B-mode images acquired on a conventional clinical ultrasound systems which can be used to guide treatment.

Chenguang Peng  
Brigham and Women’s Hospital  
We tested phase change nanoemulsions for facilitating transcranial ablation of healthy and tumor tissues. The results suggest that nanoemulsion-mediated ablation can provide better spatial control of lesion formation and destroy a larger fraction of tumor compared to microbubble-mediated ablation.

Kaitlyn Perry, BSc  
Sunnybrook Health Sciences Centre and University of Toronto  
We have created a workflow and software solution that can be applied to diagnostic MRIs prior to having patients on the MR-HIFU tabletop, reducing treatment time and cost. Virtual MR-HIFU planning is feasible and can be used in future studies of primary rectal and other tumours.

Samuel Pichardo  
University of Calgary  
Hyperthermia treatment of locoregional head and neck tumours with MRigFUS and radiation therapy is feasible and safe with adequate patient selection and intra-operative communication with the patient and the team.

Antonios Pouliopoulos, PhD  
Columbia University  
Neuronavigation-guided FUS allows bedside brain treatments without the need of on-line MRI guidance and with minimal focal distortions or skull heating. Additionally, clinically-relevant FUS-mediated BBB opening may lead to a reversible immune response and cognitive improvement.

Francesco Prada, MD  
Fondazione IRCCS Istituto Neurologico  
Sonodynamic therapy is feasible and safe. No damage occurred in the healthy brain when combining low-intensity ultrasound with sonosensitizers.

Richard Price, PhD  
University of Virginia  
The underlying transcriptomic response to FUS-mediated blood-brain barrier disruption may be strongly influenced by the choice of anesthetic. Such responses may synergize and/or conflict with responses generated by the therapeutic approach itself.

We develop and report a computational fluid dynamic model of the BBB capable of mimicking the influence of FUS-mediated BBBD and antibody delivery by altering the intrinsic permeability of the endothelial lipid bilayer.

We unveil a critical role for adaptive immunity in the efficacy of the combination of FUS and GEM against breast cancer. These findings generate support for translating the FUS + GEM combination to clinical trials for women with metastatic breast cancer.

Immuno-PET revealed that mCD47 timing relative to FUS blood brain/tumor disruption markedly impacts antibody penetrance in murine gliomas. A rational FUS-mediated mCD47 delivery paradigm leveraging these insights constrained glioma outgrowth and offered survival advantage.
Richard Price, PhD
University of Virginia

Cells of the NVU (neurons, astrocytes, microglia, endothelial cells, pericytes, and oligodendrocytes) are differentially transfected and transcriptomically impacted by low vs high PNP in the context of FUS mediated BBB disruption.

Opening the blood-tumor barrier in intracranial melanoma with focused ultrasound (i) elicits transcripts associated with inflammation, (ii) increases antigen within the tumor, and (iii) contributes to dendritic cell maturation. Nonetheless, the response is mild and transient.

We demonstrate the capacity of FUS to enhance delivery of exogenous mitochondria into infarcted brain tissue following ischemic stroke.

Through computational simulation of the glymphatic system, we demonstrate that augmentation of perivascular spaces during FUS-induced blood-brain barrier opening is predicted to increase solute clearance.

We develop a Boolean logic-based model for brain endothelial cell signaling which we use to predict how transcriptomic changes, resulting from FUS treatment of the brain, could impact BBB integrity.

Ashish Ranjan, BVSc, PhD
Oklahoma State University

Encapsulation of doxorubicin in thermally sensitive liposomes, and its combination with local focused ultrasound heating of solid tumors, can improve local and systemic chemo-immunotherapy of colon cancer.

Deepika Reddy
Imperial Prostate

In select patients with non-metastatic prostate cancer, focal therapy achieves similar medium-term oncological outcomes to radical prostatectomy.

Focal HIFU provides a safe alternative management option to gain cancer control in the medium term for men with localised clinically significant prostate cancer.

Focal ablative salvage therapy produces good medium term cancer control, with minimal severe complications, in patients with radio-recurrent localised prostate cancer.

Jade Robert
LabTAU INSERM U1032

Electromechanical wave imaging (EWI) could provide mapping of cardiac activation. EWI feasibility was assessed in-vivo on two swines using an intracardiac probe. EWI acquisitions depicted the source of cardiac activation consistent with the pacing site in the RVOT region.

Fareeha Safir
Stanford University

We designed an acoustic droplet ejection technique operating at 150 MHz that rapidly splits a blood sample into single-cell droplets using focused ultrasonic waves. When coupled with spectroscopy and a convolutional neural net, it allows for culture-free bacterial bloodstream diagnosis.

Malia Sanghvi
Sonacare Medical

Lung tissue can be imaged by ultrasound technology. It responds to therapeutic ultrasound and cavitation can be sustained at very low power levels. There is potential for focused ultrasound application in lung tissue.

Narendra Sanghvi, MSEE
SonaCare Medical, LLC.

Novel applications of LoFU (AKA-LIPUS, pHIFU) can help accelerate regeneration of the micro-vascular system by homing of stem cells.
Transrectal boiling histotripsy (BH) of the prostate is feasible with a preclinical device. Both canine and human tissue are susceptible to BH. Future studies will examine treatment optimization and resistance mechanisms.

The usability of commercially available HIFU probes can likely be extended for applications in ultrasound image-guided ablation of venous malformations, significantly reducing the introduction time of this technology into clinical practice.

Low intensity transcranial focused ultrasound stimulation of the left dorsolateral prefrontal cortex may be a safe and effective treatment option for patients with major depressive disorder.

Local focused ultrasound heating along with intratumoral anti-CD-40 agonist antibody therapy improves T cell recruitment, preserves T cell function, and suppresses the treated and untreated murine melanoma tumor growth rate.

Sonodynamic therapy (SDT) coupling high frequency focused ultrasound and 5-ALA can induce apoptotic cell death in high grade glioma models. The system that we built will allow for additional testing of sonosensitizers and optimization of SDT parameters.

Accurate focal therapy was performed with HIFU based on the locations of mpMRI-visible csPCa. Follow-up biopsy was avoided in the patients who had PI-RADS category <3 and PSAD <0.068 ng/mL after the treatment. Post-procedural ED and ejaculation were 86% and 70%.

Low-frequency imaging can be used to estimate the characteristics of layered material with mm-sized precision. These properties can be used to correct the skull aberrations for targeting brain regions, enabling precise targeting of ultrasound for neurostimulation studies.

Using MRI guided focused ultrasound, non-invasive and precise induction of localized hyperthermia in small animals can be achieved. Coupling this with encapsulated-drug in thermosensitive liposomes can potentially improve targeted drug-delivery in tumours of small rodent models.

Combination of boiling histotripsy (BH) and anti-CD40 agonistic antibody transforms the immunologically cold murine melanoma into an activated one, resulting in an improved sensitization to immune checkpoint inhibitors and antitumor effects.

Focused ultrasound therapy with microbubble contrast agents significantly improves liposomal doxorubicin uptake in
neuroblastoma. Tumor perfusion can help predict when they are most amenable to drug uptake and help monitor therapy. Nanoparticle drug delivery to neuroblastoma with focused ultrasound and microbubbles (sonopermeation) can significantly enhance chemotherapy while minimizing off target effects. 2D and 3D contrast enhanced imaging can help monitor the bioeffects of sonopermeation.

Emma Slominski  
The University of Utah  
We show that the method of phase correction for improving the focus for neurological treatment depends on the method used to obtain phase correction value.

Molly Smallcomb, MS  
Pennsylvania State University  
Highly collagenous tissues, like tendon, have shown resistance to mechanical disruption from focused ultrasound. This study histologically evaluates whether this mechanical disruption is achievable without thermal denaturation in ex vivo rat tendon for therapeutic application.

Cameron Smith, M.Eng  
University of Oxford  
Passive acoustic mapping (PAM) derived cavitation dose can monitor ultrasound enhanced drug delivery to solid tumours. PAM's ability to spatially localize cavitation can be utilized to exclude cavitation occurring outside of the tumour to improve this monitoring.

Atsushi Sofuni, MD, PhD  
Tokyo Medical University  
HIFU therapy for unresectable pancreatic cancer, when used in combination with chemotherapy, showed significant differences compared with chemotherapy alone, with increased anti-tumor and symptom-relief effects. HIFU therapy has the potential to be a component of new method of combination therapy.

Lin Song, PhD  
The Hong Kong Polytechnic University  
Gas-filled Protein Nanostructures can be used as cavitation nuclei for Molecule-Specific Sonodynamic Therapy.

Kyriakos Spanoudes, DVM  
Cyprus University of Technology.  
A reliable MRgFUs system, compatible with multiple MR systems, will offer a solution for incisionless intervention for tumour ablation in veterinary hospitals. Its utilisation can be of therapeutic or palliative intent.

Norman M Spivak  
UCLA  
Transcranial focused ultrasound to the right amygdala has the potential to be a disruptive new modality for the treatment of anxiety disorders. Data is presented regarding the ability of tFUS to change negative reactivity and cognitive reappraisal capabilities.

Ex-vivo sonication of brain tissue does not induce histologic damage until intensity levels are above 25 W/cm². Sonication below this value is likely safe, but further safety testing is needed.

Sonication of the scapula at 14 W/cm² Ispta does not lead to heating that could potentially be dangerous and cause burns.

Eleanor Stride  
University of Oxford  
Sonodynamic therapy offers a new treatment option for recalcitrant tumours for which existing therapeutic options are extremely limited. Its efficacy is significantly enhanced through the use of oxygen microbubbles as a therapeutic adjuvant.
Janina Strobel  
University of Cologne  
Larger multicenter trials with different MR-HIFU systems require standardized treatment protocols to achieve reliable results. To address this issue we developed a reusable bone phantom for comparison of different MR-HIFU treatment protocols.

Juliette Strubel  
Focused Ultrasound Foundation  
We provide an overview of the various classes and sizes of therapeutics that have successfully crossed the BBB with ultrasound and summarize these findings in a comprehensive illustration and video.

Ivan M. Suarez Castellanos, PhD  
INSERM  
Focused Ultrasound (FUS) is capable of modulating the inherent electrical activity and properties of individual neurons while also triggering new activity in the form of perturbations to the cell membrane potential. The stimulated activity can be either immediate or delayed.

Focused Ultrasound is capable of stimulating field Post-Synaptic Potentials (fEPSPs) from neural structures of hippocampal brain slices. As opposed to electrical stimulation, fEPSPs can be stimulated across the entire hippocampus within the region targeted by the focal spot.

Jonathan Sukovich, PhD  
University of Michigan  
A system for controlling transmit-receive capable histotripsy array elements on a per-channel basis is described. Its capabilities for localizing cavitation events and assessing induced tissue damage transcranially using the received acoustic signals are demonstrated.

Tao Sun, PhD  
Brigham and Women’s Hospital, Harvard Medical School  
Our results provide preclinical proof-of-principle for pairing FUS with PD-1 blockade therapy in treating GBM. FUS has been demonstrated to enhance anti-tumor immunity by the recruitment and activation of immune effectors, and to reduce tumor burden in a mouse GBM model.

Ryo Suzuki  
Faculty of Pharma-science, Teikyo University  
We induced an effective antitumor immune response by combining sonotherapy and dendritic cell (DC)-based immunotherapy. Sonotherapy induced immunomodulation in tumor tissue and enhanced the effect of DC-based immunotherapy.

Yuno Suzuki  
Teikyo University  
We developed an anticancer drug delivery system with doxorubicin encapsulated liposomes-loaded microbubbles and ultrasound. In this combination, the doxorubicin was effectively delivered to pancreatic cancer cells and cell growth suppression was observed.

Catherine Swytink-Binnema, MSc  
University of Calgary  
Although the thalamic Vim nucleus is involved in proprioception, proprioceptive changes following MRgFUS Vim thalamotomy have never been quantified. Using the Kinarm exoskeleton robot, we show that proprioception does not significantly change following Vim thalamotomy.

Jerzy Szablowski, PhD  
Rice University  
We developed a new viral vector that improves the efficiency and tissue-specificity of gene delivery to the brain when used in conjunction with FUS-BBBO. We engineered this new vector, which we called AAV.FUS, using high-throughput capsid mutation and in vivo screening methods.
Sean Taffler, DPhil
Acouстиc Inc

Acoustic presents a therapy system that leverages emission plane electronics that allow the construction of arrays with up to 20w/cm² emission power, generating ultra dense widefield HIFU arrays that are usable within an MR system.

Travis Tierney, MD, PhD
Imperial College London

Image-guided high-energy focused ultrasound is a method for introducing non-ionizing energy deep into the brain without a craniotomy and may be especially useful in a number of pediatric conditions where alternatives to conventional (open, endoscopic or laser) surgery are needed.

Nick Todd
Brigham and Women’s Hospital

FUS-BBB opening can safely deliver AAV vectors into the brain of a Huntington’s disease mouse model, with the promise of delivering a gene therapy micro-RNA targeted to lowering the expression of the neurotoxic mutant huntingtin protein that is the root cause of this disease.

Marie-Hélène Tomé
Albert Einstein College of Medicine

Chemical disruption of the cytoskeleton alters cell shape, disorients cells, and inhibits their ability to move directionally. LOFU could have similar effects thereby modulating cellular metastatic potential through interference with cytoskeletal elements.

Chih-Hung Tsai, PhD
NaviFUS Co. Ltd.

We developed a real-time acoustic emission feedback control algorithm that can be implemented on NaviFUS system to monitor and control the procedure in real-time.

Petr Tvrdík, PhD
University of Virginia

The objective of the proposed research is to utilize Focused Ultrasound (FUS) to target and treat cerebral cavernous malformations (CCM) in a mouse model of the disease.

Caitlin Tydings, MD
Children’s National Hospital

Volumetric analysis provides a more detailed and meaningful approach to measuring treatment effect of targeted therapies for irregularly shaped desmoid tumors.

Boiling histotripsy with immunotherapy has the potential to promote an anti-tumor response. While HIFU thermal ablation did not demonstrate the same findings, further work investigating protumoral factors and other tumor cell lines needs to be performed.

Lennart Verhagen
Radboud University

Long-lasting non-invasive modulation of neural activity and behaviour is now possible in primates using low-intensity focused ultrasound. This opens up exciting new possibilities for the development of novel targeted treatment options in human neurology and psychiatry.

Diya Wang, PhD
University of California, San Francisco

This study investigates a new clinical breast exam imaging approach for real-time monitoring of thermal processes and to assess the ablation area with high contrast.
Yak-Nam Wang
University of Washington, Center for Industrial and Medical Ultrasound, Applied Physics Lab

Focused ultrasound, specifically histotripsy, may be a viable technology for in situ treatment of acoustically accessible abscesses, obviating the need for percutaneous drainage.

Pete Weber
Virginia Tech Carilion School of Medicine

Histotripsy is capable of successfully ablating both hepatocellular carcinoma tumors and colorectal liver metastases. Higher treatment doses are likely required to achieve complete ablations for intrahepatic cholangiocarcinomas.

Hong-Yan Wei, PhD
Columbia University

With the advancement of ultrasound technology and the feasibility of clinical applicability, there is an emerging need for research to advance the field. Our study provides preclinical rationales for testing the combination of FUS-mediated BBB opening with etoposide in GBM patients.

Kuochen Wei, MD
Chang Gung Memorial Hospital

Neuronavigation-guided FUS can effectively enhance the delivery of chemotherapeutic agents and improve tumor control.

Beat Werner, MSc
University Children’s Hospital Zurich

Dedicated FUS system carrying a central ultrasound imaging probe, and a suitably positioned, acoustically transparent cranial substitute serving as an acoustic keyhole, might enable ultrasound-guided, frameless interventions for opening the BBB in deep-lying brain tumors.

Frank Wolfram, PhD
SRH Wald-Clinic

One Lung Flooding (OLF) for Lung FUS can be performed safely in supine, lateral left & right position. The use of superimposed Jet ventilation during OLF enables continuous ventilation whilst reducing motion to an extent that no motion compensation of intra-pulmonary targets is needed.

Claire Wunker, MD
Luenfeld-Tanenbaum Research Institute

Rhabdomyosarcoma requires new treatments to improve survival and decrease long term side effects. TLD with MRgHIFU is a promising treatment combination. We found higher doxorubicin levels in the tumor after 20 minutes of heating compared to controls in a murine RMS model.

Kristiana Xhima
Sunnybrook Research Institute

MRigFUS-induced BBB opening is a promising approach for noninvasive drug delivery to the basal forebrain. MRigFUS-mediated delivery of TrkA-specific ligands represents a novel therapy that can restore cholinergic neurotransmission and cognition in a preclinical model of AD.

Quanxiang Xian
The Hong Kong Polytechnic University

This paper explores targeted surface and deeper brain stimulation by non-invasive ultrasound.

Xinqiang Yan, PhD
Vanderbilt University Medical Center

This work proposes a simpler solution that alleviates the curved dark band problem in brain images of the FDA-approved Insightec tcMRgFUS system, involving placing a passive reflecting antenna or resonator above the patient’s head, with a “propeller-beanie”
Yaoheng Yang  
Washington University in St. Louis  
This work establishes that TRPV1-based sonogenetics enables noninvasive, cell-type specific, precisely controlled modulation of mammalian neuronal activity in vivo.

Dezhuang Ye  
Washington University in Saint Louis  
This study found FUS + intranasal drug delivery efficiency depends on several key experimental parameters, including the time delay between intranasal administration and FUS sonication, the FUS pressure, and the waiting time to sacrifice the mouse post-FUS.

Hsiang-Yu Yu, MD  
Taipei Veterans General Hospital  
Low intensity focused ultrasound targeting epileptogenic zones for neuromodulation with simultaneous intracranial EEG recording was done in four cases. EEG showed band power changes during and after treatment. No unanticipated side effects or lesioning effects on MRI were reported.

Yuana Yuana, PhD  
Technical University of Eindhoven  
US microbubbles triggered the release of extracellular vesicles (EV) containing CTG or BSA FITC in the cell supernatant after treatment, and the amount of EV released correlated with increases in acoustic pressure. These EVs were taken up within 4h after co-culturing with tumor cells.

Jiejun Zhu  
The Hong Kong Polytechnic University  
Ultrasound neuron modulation is mediated by piezo1 in vitro. This result also suggests a possible mechanism for in vivo modulation. By controlling the expression of piezo1 we may able to target specific neuronal pathways or nuclei for study in both basic and clinical neurosciences.

Lifei Zhu  
Washington University in Saint Louis  
MRgHIFU-induced large-volume (tROI diameter of 58 mm) hyperthermia is feasible in both deep and superficial targets achieving satisfactory temperature characteristics. Feedback control could be used to tailor the thermal dose distribution to critical structures.

Blake Zimmerman  
University of Utah  
Non-contrast enhanced multiparametric MR biomarkers outperform contrast-enhanced based nonviable tissue predictions for assessing MRgFUS procedures. Non-contrast assessment of MRgFUS procedures may potentially lead to more efficacious and safer MRgFUS treatments.