

2023

Centers of Excellence



FOCUSED
ULTRASOUND
FOUNDATION

Overview

The ten research/treatment sites highlighted in this report are the Focused Ultrasound Foundation designated Centers of Excellence, COEs. They are also listed on our website.

Established in 2009, the COE program brings together the best people and technical resources at luminary sites across the globe. The Centers are created through partnerships of academia, industry, and the Foundation to showcase focused ultrasound technology and serve as hubs for collaboration. They are the powerhouses of focused ultrasound research; in 2022, they collectively published 202 scientific journal articles on their accomplishments. These sites, which include some of the most influential leaders in the field, are cultivators of the next generation of researchers and physicians for focused ultrasound and are creating the intellectual property that will spur the next iteration of commercialization efforts. We encourage you to review these pages in detail, look up the publications that might interest you, and reach out to the contacts we list for each site, if you are interested in a potential collaboration.

This portion of the 2022 State of the Field Report contains a summary of self-reported data from the COEs.

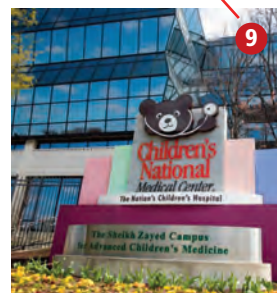
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Locations



Years Established

Name	Location	Established
University Medical Center Utrecht	Utrecht, The Netherlands	2020
Children's National Hospital	Washington, DC	2020
Physics for Medicine Paris	Paris, France	2019
Inserm - LabTAU	Lyon, France	2017
Stanford University School of Medicine	Stanford, CA	2016
Sunnybrook Health Sciences Centre	Toronto, Canada	2016
University of Maryland School of Medicine	Baltimore, MD	2016
Brigham and Women's Hospital	Boston, MA	2015
The Institute of Cancer Research and The Royal Marsden	London, England	2013
University of Virginia Health System	Charlottesville, VA	2009

University Medical Center Utrecht

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Publications

University Medical Center Utrecht | The Netherlands

The University Medical Center Utrecht, UMC Utrecht, is the fourth Center of Excellence in Europe. UMC Utrecht is striving to improve current cancer therapy with MRI-guided focused ultrasound, often in combination with other modalities, such as radiotherapy, chemotherapy, and surgery, leading to higher efficacy, fewer side effects, and lower costs. The emphasis of the clinical translation, in close collaboration with other nearby medical centers and international consortia, is on breast cancer, bone cancer, immune stimulation, and drug delivery for brain tumor treatment.

Contacts

Helena M Verkooijen, MD, PhD,

Program Co-director | h.m.verkooijen@umcutrecht.nl

Clemens Bos, PhD, Program Co-director | c.bos@umcutrecht.nl

Chrit T.W. Moonen, PhD, Program Co-director | c.moonen@umcutrecht.nl

Commercial treatments

Musculoskeletal Bone metastases, Desmoid tumors

Women's health Endometriosis, Uterine fibroids

Clinical research

Cardiovascular Peripheral artery disease

Musculoskeletal Bone metastases, Desmoid tumors

Women's health Breast tumors, malignant; Uterine fibroids

Preclinical research

Miscellaneous Head & neck tumors

Neurological Pontine glioma

Mechanisms of action research

Histotripsy Immunomodulation, Tissue destruction

Hyperthermia Drug delivery, Radiosensitization

Nonthermal BBB opening; BBB opening, drug delivery; Drug delivery; Drug delivery, vehicle; Immunomodulation; Liquid biopsy; Tissue destruction

Thermal ablation Tissue destruction

Technical research

Drug delivery technology

FUS Image guidance, MR

FUS Image guidance, Ultrasound

FUS Physics

FUS Transducer technology, Histotripsy

FUS Treatment monitoring

University Medical Center Utrecht continued



Publications—2022

The Effect of Microbubble-Assisted Ultrasound on Molecular Permeability across Cell Barriers. Rousou C, de Maar J, Qiu B, van der Wurff-Jacobs K, Ruponen M, Urtti A, Oliveira S, Moonen C, Storm G, Mastrobattista E, Deckers R. *Pharmaceutics*. 2022 Feb 24;14(3):494. doi: 10.3390/pharmaceutics14030494. PMID: 35335871; PMCID: PMC8949944.

Increased MR-guided high intensity focused ultrasound (MR-HIFU) sonication efficiency of uterine fibroids after carbetocin administration. Anneveldt KJ, van 't Oever HJ, Verpalen IM, Nijholt IM, Bartels W, Dijkstra JR, van den Hoed RD, van 't Veer-Ten Kate M, de Boer E, Veersema S, Huirne JAF, Schutte JM, Boomsma MF. *Eur J Radiol Open*. 2022 Mar 21;9:100413. doi: 10.1016/j.ejro.2022.100413. PMID: 35340827; PMCID: PMC8942847.

Safety and feasibility study of non-invasive robot-assisted high-intensity focused ultrasound therapy for the treatment of atherosclerotic plaques in the femoral artery: protocol for a pilot study. Simons MV, Groen MHA, de Borst GJ, Leiner T, Doevendans PAF, Ebbini E, Slieker FJB, van Es R, Hazenberg CEVB. *BMJ Open*. 2022 May 2;12(5):e058418. doi: 10.1136/bmjopen-2021-058418. PMID: 35501090; PMCID: PMC9062820.

Ultrasound-directed enzyme-prodrug therapy (UDEPT) using self-immolative doxorubicin derivatives. Roemhild K, Besse HC, Wang B, Peña Q, Sun Q, Omata D, Ozbakir B, Bos C, Scheeren HW, Storm G, Metselaar JM, Yu H, Knüchel-Clarke R, Kiessling F, Moonen CTW, Deckers R, Shi Y, Lammers T. *Theranostics*. 2022 Jun 6;12(10):4791-4801. doi: 10.7150/thno.69168. PMID: 35832083; PMCID: PMC9254251.

Synthetic CT for the planning of MR-HIFU treatment of bone metastases in pelvic and femoral bones: a feasibility study. Lena B, Florkow MC, Ferrer CJ, van Stralen M, Seevinck PR, Vonken EPA, Boomsma MF, Slotman DJ, Viergever MA, Moonen CTW, Bos C, Bartels LW. *Eur Radiol*. 2022 Jul;32(7):4537-4546. doi: 10.1007/s00330-022-08568-y. Epub 2022 Feb 21. PMID: 35190891; PMCID: PMC9213310.

Research not involving thermal ablation, tissue destruction

Clinical Research - Women's health

Breast tumors, malignant	Hyperthermia - Drug delivery
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Preclinical Research - Miscellaneous

Head & neck tumors	Nonthermal - Sonoporation
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Preclinical Research - Neurological

Pontine glioma	Nonthermal, BBB opening - Drug delivery
	Nonthermal - Drug delivery

Publications—2022 continued

Early economic modeling of magnetic resonance image-guided high intensity focused ultrasound compared to radiotherapy for pain palliation of bone metastases. Simões Corrêa Galendi J, Yeo SY, Grüll H, Bratke G, Akuamo-Boateng D, Baues C, Bos C, Verkooijen HM, Shukri A, Stock S, Müller D. *Front Oncol*. 2022 Sep 23;12:987546. doi: 10.3389/fonc.2022.987546. PMID: 36212449; PMCID: PMC9537476.

Diffusion-weighted MRI with deep learning for visualizing treatment results of MR-guided HIFU ablation of uterine fibroids. Slotman DJ, Bartels LW, Zijlstra A, Verpalen IM, van Osch JAC, Nijholt IM, Heijman E, van 't Veer-Ten Kate M, de Boer E, van den Hoed RD, Froeling M, Boomsma MF. *Eur Radiol*. 2022 Dec 6. doi: 10.1007/s00330-022-09294-1. Epub ahead of print. PMID: 36472702.

Focused Ultrasound and RadioTHERapy for non-invasive palliative pain treatment in patients with bone metastasis: a study protocol for the three armed randomized controlled FURTHER trial. Slotman DJ, Bartels MMTJ, Ferrer CJ, Bos C, Bartels LW, Boomsma MF, Phernambucq ECJ, Nijholt IM, Morganti AG, Siepe G, Buwenge M, Grüll H, Bratke G, Yeo SY, Blanco

Children's National Hospital

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Publication

Children's National Hospital | Washington, DC

In September 2020, Children's National Hospital, CNH, in Washington, DC, became the first Center of Excellence focused exclusively on pediatrics. The COE includes a multidisciplinary team of clinicians and investigators from radiology, oncology, surgery, orthopedics, neurosurgery, and urology. In recent years, the CNH team has become a leader in the translation of focused ultrasound for treating pediatric solid tumors. They are currently investigating the treatment of malignant solid tumors with focused ultrasound alone and combined with chemotherapy. Moving forward, the team plans to further explore oncological applications of focused ultrasound, particularly to augment chemotherapy and immunotherapy for hard-to-treat pediatric cancers.

Contacts

Karun V. Sharma, MD, PhD | Program Co-director | kvsharma@cnmc.org

AeRang Kim, MD, PhD | Program Co-director | aekim@childrensnational.org

Commercial treatment

Musculoskeletal Osteoid osteoma, Soft tissue cancer

Clinical research

Gastrointestinal	Liver tumors
Miscellaneous	Multiple tumors ¹
Musculoskeletal	Bone metastases, Osteoid osteoma, Soft tissue cancer
Neurological	Brain tumors, general; Neurofibromatosis; Pontine glioma

Preclinical research

Musculoskeletal	Osteoid osteoma, Soft tissue cancer
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Mechanisms of action research

Histotripsy	Immunomodulation, Tissue destruction
Hyperthermia	Tissue destruction
Nonthermal	Drug delivery, vehicle; Neuromodulation
Thermal ablation	Immunomodulation, Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Image guidance, Navigation
FUS Image guidance, Ultrasound
FUS Simulation & treatment planning
FUS Transducer technology, Histotripsy
FUS Treatment evaluation
FUS Treatment monitoring
Standards & quality assurance

¹ Protocols inclusive of more than one indication

Children's National Hospital *continued*

Research not involving thermal ablation, tissue destruction

Clinical research - Miscellaneous

Multiple tumors ¹	Hyperthermia - Chemosensitization
	Hyperthermia - Drug delivery

Clinical research - Musculoskeletal

Bone metastases	Thermal ablation - Chemosensitization
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Clinical research - Neurological

Pontine glioma	Nonthermal, BBB opening - Drug delivery
	Nonthermal - Sonodynamic therapy

Preclinical research - Musculoskeletal

Soft tissue cancer	Histotripsy - Immunomodulation
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Publications—2022

Focused Ultrasound for Pediatric Diseases. Janwadkar R, Leblang S, Ghanouni P, Brenner J, Ragheb J, Hennekens CH, Kim A, Sharma K. *Pediatrics*. 2022 Mar 1;149(3):e2021052714. doi: 10.1542/peds.2021-052714. PMID: 35229123.

¹ Protocols inclusive of more than one indication

Physics for Medicine Paris

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Publications

Physics for Medicine Paris | France

In December 2019, Physics for Medicine Paris became the third Center of Excellence in Europe. The site focuses on accelerating the development of ultrasound-based technologies and translating these innovative technologies to the clinic, with an emphasis on cardiovascular and neurological disorders. Physics for Medicine Paris is a technological hub for new modalities of ultrasound guidance, monitoring, and treatment. The team also undertakes the training of many PhD students, assuring it a pivotal role in the education of young researchers.

Contacts

Mickael Tanter, PhD | Program Director | mickael.tanter@espci.fr

Jean-François Aubry, PhD | Scientific Director | jean-francois.aubry@espci.fr

Clinical research

Neurological Essential tremor

Preclinical research

Cardiovascular Heart valve calcifications

Neurological Depression; Parkinson's disease, underlying cause

Mechanisms of action research

Histotripsy Tissue destruction

Nonthermal BBB opening, drug delivery; Neuromodulation

Thermal ablation Tissue destruction

Technical research

Drug delivery technology

FUS Image guidance, MR

FUS Image guidance, Navigation

FUS Image guidance, Ultrasound

FUS Physics

FUS Simulation & treatment planning

FUS Transducer technology, Histotripsy

FUS Transducer technology, Thermal ablation

FUS Treatment monitoring

Research not involving thermal ablation, tissue destruction

Preclinical research - Cardiovascular

Heart valve calcifications Histotripsy - Alteration of tissue mechanics

Preclinical research - Neurological

Depression Nonthermal - Neuromodulation

Parkinson's disease, underlying cause Nonthermal - Neuromodulation

Physics for Medicine Paris continued



Publications—2022

Retinal functional ultrasound imaging (rFUS) for assessing neurovascular alterations: a pilot study on a rat model of dementia. Morisset C, Dizeux A, Larrat B, Selingue E, Boutin H, Picaud S, et al. *Sci Rep* 2022;12:19515. doi: 10.1038/s41598-022-23366-8. PMID: 36376408; PMCID: PMC9663720.

Fluoroscopy-Guided High-Intensity Focused Ultrasound Neurotomy of the Lumbar Zygapophyseal Joints: A Clinical Pilot Study. Perez J, Gofeld M, Leblang S, Hananel A, Aginsky R, Chen J, et al. *Pain Med*. 2022 Jan 3;23(1):67-75. doi: 10.1093/pm/pnab275. PMID: 34534337; PMCID: PMC8723143.

Assessing cardiac stiffness using ultrasound shear wave elastography. Caenen A, Pernot M, Nightingale KR, Voigt JU, Vos HJ, Segers P, D'hooge J. *Phys Med Biol*. 2022 Jan 17;67(2). doi: 10.1088/1361-6560/ac404d. PMID: 34874312.

Publications—2022 continued

Carotid Plaque Vulnerability Assessed by Combined Shear Wave Elastography and Ultrafast Doppler Compared to Histology. Goudot G, Sitruk J, Jimenez A, Julia P, Khider L, Alsac JM, El Batti S, Bruneval P, Amemyia K, Pedreira O, Mortelette H, Calvet D, Tanter M, Mirault T, Pernot M, Messas E. *Transl Stroke Res*. 2022 Feb;13(1):100-111. doi: 10.1007/s12975-021-00920-6. Epub 2021 Jun 28. PMID: 34181190.

Ret kinase-mediated mechanical induction of colon stem cells by tumor growth pressure stimulates cancer progression in vivo. Nguyen Ho-Bouldoires TH, Sollier K, Zamfirov L, Broders-Bondon F, Mitrossilis D, Bermeo S, et al. *Commun Biol*. 2022 Feb 17;5(1):137. doi: 10.1038/s42003-022-03079-4. PMID: 35177769; PMCID: PMC8854631.

Endothelial Zeb2 preserves the hepatic angioarchitecture and protects against liver fibrosis. de Haan W, Dheedene W, Apelt K, Décombas-Deschamps S, Vincikier S, Verhulst S, Conidi A, Deffieux T, Staring MW, Vandervoort P, Caluwé E, Lox M, Mannaerts I, Takagi T, Jaekers J, Berx G, Haigh J, Topal B, Zwijsen A, Higashi Y, van Grunsven LA, van Ijcken WJ, Mulugeta E, Tanter M, Lebrin FPG, Huylebroeck D, Luttun A. *Cardiovasc Res*. 2022 Mar 25;118(5):1262-1275. doi: 10.1093/cvr/cvab148. PMID: 33909875; PMCID: PMC8953454.

Ultrasound localization microscopy and functional ultrasound imaging reveal atypical features of the trigeminal ganglion vasculature. Réaux-Le-Goazigo A, Beliard B, Delay L, Rahal L, Claron J, Renaudin N, et al. *Commun Biol*. 2022 Apr 7;5(1):330. doi: 10.1038/s42003-022-03273-4. PMID: 35393515; PMCID: PMC8989975.

Boosting transducer matrix sensitivity for 3D large field ultrasound localization microscopy using a multi-lens diffracting layer: a simulation study. Favre H, Pernot M, Tanter M, Papadacci C. *Phys Med Biol*. 2022 Apr 7;67(8). doi: 10.1088/1361-6560/ac5f72. PMID: 35313289.

Ultrafast Doppler imaging and ultrasound localization microscopy reveal the complexity of vascular rearrangement in chronic spinal lesion. Beliard B, Ahmanna C, Tiran E, Kanté K, Deffieux T, Tanter M, et al. *Sci Rep*. 2022 Apr 21;12(1):6574. doi: 10.1038/s41598-022-10250-8. PMID: 35449222; PMCID: PMC9023600.

Intensity distribution segmentation in ultrafast Doppler combined with scanning laser confocal microscopy for assessing vascular changes associated with ageing in murine hippocampi. Anzibar Fialho M, Vázquez Alberdi L, Martínez M, Calero M, Baranger J, Tanter M, et al. *Sci Rep*. 2022 Apr 26;12(1):6784. doi: 10.1038/s41598-022-10457-9. Erratum in: *Sci Rep*. 2022 May 10;12(1):7626. PMID: 35473942; PMCID: PMC9042937.

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Publications—2022 continued

Covariations between pupil diameter and supplementary eye field activity suggest a role in cognitive effort implementation. Claron J, Royo J, Arcizet F, Deffieux T, Tanter M, Pouget P. *PLoS Biol.* 2022 May 26;20(5):e3001654. doi: 10.1371/journal.pbio.3001654. PMID: 35617290; PMCID: PMC9135265.

Increased Capillary Permeability in Heart Induces Diastolic Dysfunction Independently of Inflammation, Fibrosis, or Cardiomyocyte Dysfunction. Abelanet A, Camoin M, Rubin S, Bougaran P, Delobel V, Pernot M, Forfar I, Guilbeau-Frugier C, Galès C, Bats ML, Renault MA, Dufourcq P, Couffignal T, Duplâa C. *Arterioscler Thromb Vasc Biol.* 2022 Jun;42(6):745-763. doi: 10.1161/ATVBAHA.121.317319. Epub 2022 May 5. PMID: 35510550.

Coronary Flow Assessment Using 3-Dimensional Ultrafast Ultrasound Localization Microscopy. Demeulenaere O, Sandoval Z, Mateo P, Dizeux A, Villemain O, Gallet R, et al. *JACC Cardiovasc Imaging.* 2022 Jul;15(7):1193-1208. doi: 10.1016/j.jcmg.2022.02.008. Epub 2022 Apr 13. PMID: 35798395.

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Functional ultrasound localization microscopy reveals brain-wide neurovascular activity on a microscopic scale. Renaudin N, Demené C, Dizeux A, Ialy-Radio N, Pezet S, Tanter M. *Nat Methods.* 2022 Aug;19(8):1004-1012. doi: 10.1038/s41592-022-01549-5. Epub 2022 Aug 4. PMID: 35927475; PMCID: PMC9352591.

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Proof of Concept of 3-D Backscatter Tensor Imaging Tomography for Non-invasive Assessment of Human Breast Cancer Collagen Organization. Guillaumin J-B, Djerroudi L, Aubry J-F, Tardivon A, Tanter M, Vincent-Salomon A, et al. *Ultrasound Med Biol.* 2022 Sep;48(9):1867-1878. doi: 10.1016/j.ultrasmedbio.2022.05.017. Epub 2022 Jun 23. PMID: 35752513.

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Local Arterial Stiffness Assessment: Comparison of Pulse Wave Velocity Assessed by Ultrafast Ultrasound Imaging versus the Bramwell-Hill Equation. Rasouli R, Baranger J, Slorach C, Nguyen M, Segers P, Guerra V, Pernot M, Hui W, Mertens L, Villemain O. *J Am Soc Echocardiogr.* 2022 Nov;35(11):1185-1188. doi: 10.1016/j.echo.2022.07.011. Epub 2022 Jul 19. PMID: 35863547.

Publications—2022 continued

Global dissociation of the posterior amygdala from the rest of the brain during REM sleep. Matei M, Bergel A, Pezet S, Tanter M. *Commun Biol.* 2022 Nov 28;5(1):1306. doi: 10.1038/s42003-022-04257-0. PMID: 36443640; PMCID: PMC9705305.

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A guide for assessment of myocardial stiffness in health and disease. Villalobos Lizardi, J.C., Baranger J., Nguyen, M.B. et al. *Nat Cardiovasc Res* 1, 8–22 (2022). <https://doi.org/10.1038/s44161-021-00007-3>.

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Inserm - LabTAU

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Commercial Treatment

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Publications

INSERM - LabTAU | Lyon, France

In February 2017, INSERM Unit 1032, the Laboratory of Therapeutic Applications of Ultrasound, LabTAU, at the French National Institute for Health and Medical Research, INSERM, was named a Focused Ultrasound Center of Excellence. LabTAU conducts significant translational and clinical research with a multidisciplinary, highly qualified, and complementary team of physicians and scientists. The COE has special expertise in commercializing technology and creating strategic interfaces between engineering and medicine.

Contact

Cyril Lafon, PhD | Program Director | cyril.lafon@inserm.fr

Commercial treatment

Urological Prostate cancer, *Hôpital Edouard Herriot*

Clinical research

Cardiovascular Varicose veins
Neurological Glioblastoma, *Hôpitaux Universitaires Pitié-Salpêtrière & Hôpital Pierre Wertheimer*
Urological Prostate cancer, *Hôpital Edouard Herriot*
Women's health Endometriosis, *Hôpital Croix-Rousse*

Preclinical research

Cardiovascular Twin-twin transfusion syndrome, Ventricular tachycardia
Gastrointestinal Liver tumors; Pancreatic tumors, malignant
Musculoskeletal Osteoradionecrosis
Neurological Cancer pain
Ophthalmological Presbyopia
Urological Prostate cancer
Women's health Breast tumors, malignant; Endometriosis

Mechanisms of action research

Histotripsy Tissue destruction
Nonthermal BBB opening; BBB opening, drug delivery; Chemosensitization; Drug delivery; Immunomodulation; Neuromodulation; Sonodynamic therapy; Sonoporation; Tissue destruction
Thermal ablation Tissue destruction

Technical research

Drug delivery technology
 FUS Image guidance, MR
 FUS Image guidance, Ultrasound
 FUS Physics
 FUS Simulation & treatment planning
 FUS Transducer technology, Other
 FUS Treatment monitoring

Research not involving thermal ablation, tissue destruction

Clinical research - Cardiovascular

Varicose veins	Thermal ablation - Vascular occlusion
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Clinical research - Neurological

Glioblastoma	Nonthermal, BBB opening
	Nonthermal, BBB opening - Drug delivery

Preclinical research - Gastrointestinal

Pancreatic tumors, malignant	Nonthermal - Drug delivery
	Nonthermal - Sonodynamic therapy
	Nonthermal - Tissue destruction
	Thermal ablation - Immunomodulation

Preclinical research - Neurological

Cancer pain	Nonthermal - Neuromodulation
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Preclinical research - Ophthalmological

Presbyopia	Nonthermal - Tissue destruction
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Preclinical research - Women's health

Breast tumors, malignant	Nonthermal - Immunomodulation
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Publications—2022

High intensity focused ultrasound: a future alternative to surgery for the treatment of localized pancreatic tumors? Fabritius M, Lambin T, Cao E, Robert J, Milot L, Lafon C, Pioche M. *Endoscopy*. 2022 Jan;54(1):E17-E18. doi: 10.1055/a-1338-0293. Epub 2021 Feb 16. Erratum in: *Endoscopy*. 2021 Feb 22. PMID: 33592643.

Correction: High intensity focused ultrasound: a future alternative to surgery for the treatment of localized pancreatic tumors? Fabritius M, Lambin T, Cao E, Robert J, Milot L, Lafon C, Pioche M. *Endoscopy*. 2022 Jan;54(1):C2. doi: 10.1055/a-1394-0547. Epub 2021 Feb 22. Erratum for: *Endoscopy*. 2022 Jan;54(1):E17-E18. PMID: 33618371.

Neurostimulation success rate of repetitive-pulse focused ultrasound in an in vivo giant axon model: An acoustic parametric study. Vion-Bailly J, Suarez-Castellanos IM, Chapelon JY, Carpentier A, N'Djin WA. *Med Phys*. 2022 Jan;49(1):682-701. doi: 10.1002/mp.15358. Epub 2021 Dec 7. PMID: 34796512.

Detection of ISUP ≥ 2 prostate cancers using multiparametric MRI: prospective multicentre assessment of the non-inferiority of an artificial intelligence system as compared to the PI-RADS V.2.1 score (CHANGE study). Rouvière O, Souchon R, Lartizien C, Mansuy A, Magaud L, Colom M, Dubreuil-Chambardel M, Debeer S, Jaouen T, Duran A, Rippert P, Riche B, Monini C, Vlaeminck-Guillem V, Haesebaert J, Rabilloud M, Crouzet S. *BMJ Open*. 2022 Feb 9;12(2):e051274. doi: 10.1136/bmjopen-2021-051274. PMID: 35140147; PMCID: PMC8830410.

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Publications—2022 continued

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Stanford University School of Medicine

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Preclinical Research

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Mechanisms of Action Research

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Commercial Treatments

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Clinical Research

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Technical Research

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Publications

Stanford University School of Medicine | California

Established in 2016, Stanford's COE focuses on several clinical and preclinical projects. These include industry-sponsored trials using focused ultrasound to treat bone metastases, uterine fibroids, essential tremor, and prostate cancer, as well as investigator-initiated trials to treat soft tissue tumors. Preclinical projects have included developing referenceless methods for MR (Magnetic Resonance) thermometry in the brain and respiratory-compensated focused ultrasound in treatment of porcine liver during free-breathing. These clinical and preclinical projects involve close collaboration with colleagues in radiology, obstetrics and gynecology, medical and radiation oncology, neurosurgery, neurology, orthopedic surgery, urology, pathology, immunology, and electrical and mechanical engineering.

Stanford University | California University of California Davis | California

A collaboration between Stanford and UC Davis investigating the use of focused ultrasound for the treatment of liver cancer in canines is underway. The research team is using focused ultrasound to deliver microRNA to the tumors, demonstrating efficient drug delivery and a significant change in the immunogenicity of the tumor.

4

Veterinary Research

Contacts

Pejman Ghanouni, MD, PhD | Program Co-director | ghanouni@stanford.edu

Kim Butts Pauly, PhD | Program Co-director | kbpauly@stanford.edu

Commercial treatments

Cardiovascular	Arteriovenous malformations
Musculoskeletal	Bone cancer, Bone metastases, Desmoid tumors, Osteoid osteoma
Neurological	Essential tremor; Parkinson's disease, tremor
Urological	Prostate cancer
Women's health	Uterine adenomyosis, Uterine fibroids

Stanford University School of Medicine continued



Clinical research

Gastrointestinal	Pancreatic tumors, malignant
Musculoskeletal	Bone metastases, Osteoid osteoma
Neurological	Epilepsy

Preclinical research

Gastrointestinal	Pancreatic tumors, malignant
Miscellaneous	Melanoma
Musculoskeletal	Muscle atrophy
Neurological	Epilepsy, Glioblastoma, Neuropathic pain
Urological	Kidney disease, acute
Women's health	Breast tumors, malignant; Ovarian tumors

Mechanisms of action research

Hyperthermia	Drug delivery
Nonthermal	BBB opening; BBB opening, drug delivery; Drug delivery; Drug delivery, immunotherapeutic; Drug delivery, vehicle; Gene delivery; Neuromodulation; Sonoporation; Stem cell delivery; Stem cell trafficking; Tissue destruction
Thermal ablation	Amplification of cancer biomarkers, Chemosensitization, Immune cell trafficking, Immunomodulation, Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Physics
FUS Simulation & treatment planning
FUS Transducer technology, Nonthermal
FUS Transducer technology, Thermal ablation
FUS Treatment evaluation
FUS Treatment monitoring

Research not involving thermal ablation, tissue destruction

Clinical research - Gastrointestinal

Pancreatic tumors, malignant	Thermal ablation - Immunomodulation
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Preclinical research - Gastrointestinal

Pancreatic tumors, malignant	Thermal ablation - Immunomodulation
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Preclinical Research - Miscellaneous

Melanoma	Thermal ablation - Immunomodulation
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Preclinical research - Musculoskeletal

Muscle atrophy	Nonthermal - Gene delivery
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Preclinical research - Neurological

Epilepsy	Nonthermal, BBB opening - Drug delivery
Glioblastoma	Nonthermal, BBB opening - Drug delivery
Neuropathic pain	Nonthermal - Drug delivery, vehicle

Preclinical research - Urological

Kidney disease, acute	Nonthermal - Stem cell delivery
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Preclinical research - Women's health

Breast tumors, malignant	Nonthermal - Gene delivery Thermal ablation - Immunomodulation
Ovarian tumors	Thermal ablation - Immunomodulation

Veterinary research - Gastrointestinal

Liver tumors	Nonthermal - Drug delivery, vehicle Nonthermal - Gene delivery Nonthermal - Immunomodulation
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Sunnybrook Health Sciences Centre

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Preclinical Research

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Mechanisms of Action
Research

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Commercial Treatments

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Clinical Research

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Technical Research

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Publications

Sunnybrook Health Sciences Centre | Toronto, Canada

Established as a COE in 2016, the Sunnybrook Health Sciences Centre is conducting research for focused ultrasound in neurology, neurosurgery, urology, orthopedics, gynecology, radiation oncology, and biomedical engineering, and has studies underway for Alzheimer's disease, obsessive-compulsive disorder, depression, Parkinson's disease, ALS, breast cancer brain metastases, and others.

Contacts

Nir Lipsman, MD, PhD | Clinical Research Director | nir.lipsman@utoronto.ca

Kullervo Hynynen, PhD | Scientific Director | khynynen@sri.utoronto.ca

Commercial treatment

Neurological Essential tremor

Urological Prostate cancer

Clinical research

Gastrointestinal	Pancreatic tumors, malignant
Miscellaneous	Head & neck tumors
Musculoskeletal	Bone cancer
Neurological	Alzheimer's disease; Amyotrophic lateral sclerosis; Brain metastases, breast cancer; Brain metastases, lung cancer; Depression; Essential tremor; Glioblastoma; Multiple sclerosis; Obsessive-compulsive disorder; Pontine glioma
Urological	Prostate cancer
Women's health	Breast tumors, malignant

Preclinical research

Cardiovascular	Atrial fibrillation, Deep vein thrombosis
Gastrointestinal	Colorectal tumors
Musculoskeletal	Bone metastases
Neurological	Alzheimer's disease; Amyotrophic lateral sclerosis; Brain metastases, breast cancer; Depression; Epilepsy; Glioblastoma; Parkinson's disease, underlying cause; Spinal cord injury; Stroke, intracerebral hemorrhage; Stroke, thromboembolic
Ophthalmological	Retinal injury
Women's health	Breast tumors, malignant

Sunnybrook Health Sciences Centre continued



Mechanisms of action research

Hyperthermia	Drug delivery, radiosensitization
Nonthermal	BBB opening; BBB opening, drug delivery; Chemosensitization; Clot lysis; Drug delivery; Drug delivery, immunotherapeutic; Neuromodulation; Sonoporation; Stem cell delivery; Vascular occlusion
Thermal ablation	Immune cell trafficking, Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Image guidance, Ultrasound
FUS Physics
FUS Simulation & treatment planning
FUS Transducer technology, Histotripsy
FUS Transducer technology, Hyperthermia
FUS Transducer technology, Nonthermal
FUS Transducer technology, Other
FUS Transducer technology, Thermal ablation
FUS Treatment monitoring
Standards & quality assurance

Research not involving thermal ablation, tissue destruction

Clinical research - Gastrointestinal

Pancreatic tumors, malignant	Nonthermal - Drug delivery
	Nonthermal - Immunomodulation

Clinical research - Miscellaneous

Head & neck tumors	Hyperthermia - Radiosensitization
	Nonthermal - Radiosensitization

Clinical research - Neurological

Alzheimer's disease	Nonthermal, BBB opening - Drug delivery
Amyotrophic lateral sclerosis	Nonthermal, BBB opening - Drug delivery
Brain metastases, breast cancer	Nonthermal, BBB opening - Drug delivery
Brain metastases, lung cancer	Nonthermal, BBB opening - Drug delivery, immunotherapeutic
Glioblastoma	Nonthermal, BBB opening - Drug delivery Nonthermal - Liquid biopsy
Pontine glioma	Nonthermal, BBB opening - Drug delivery, immunotherapeutic

Clinical research - Women's health

Breast tumors, malignant	Hyperthermia - Radiosensitization
	Nonthermal - Radiosensitization

Preclinical research - Cardiovascular

Deep vein thrombosis	Histotripsy - Tissue destruction
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Preclinical research - Neurological

Alzheimer's disease	Nonthermal, BBB opening - Drug delivery Nonthermal, BBB opening - Gene delivery
Amyotrophic lateral sclerosis	Nonthermal, BBB opening - Drug delivery
Brain metastases, breast cancer	Nonthermal, BBB opening - Drug delivery
Epilepsy	Nonthermal - Neuromodulation
Glioblastoma	Nonthermal, BBB opening - Drug delivery
Parkinson's disease, underlying cause	Nonthermal, BBB opening - Drug delivery
Spinal cord injury	Nonthermal, BBB opening - Drug delivery
Stroke, intracerebral hemorrhage	Nonthermal, BBB opening - Drug delivery
Stroke, thromboembolic	Nonthermal, BBB opening - Drug delivery

Preclinical research - Ophthalmological

Retinal injury	Nonthermal - Gene delivery
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Sunnybrook Health Sciences Centre continued

Publications—2022

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University of Maryland School of Medicine

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Preclinical Research

12

Mechanisms of Action
Research

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Commercial Treatments

3

Clinical Research

7

Technical Research

10

Publications

University of Maryland School of Medicine | Baltimore, MD

The COE at the University of Maryland, UMD, was established in 2016. At present, the UMD departments of neurosurgery, radiology, and neurology are collaborating to study the treatment of movement disorders, chronic neuropathic pain, brain tumors, and the use of enhanced drug delivery. In addition, their immunomodulation studies range from investigating cell systems to animal models and human clinical trials

Mechanisms of action research

Histotripsy	Immune cell trafficking
Nonthermal	BBB opening; BBB opening, drug delivery; BBB opening, drug delivery, immunotherapeutic; Chemosensitization; Immunomodulation; Liquid biopsy; Neuromodulation; Radiosensitization; Sonodynamic therapy; Tissue destruction
Thermal ablation	Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Image guidance, Ultrasound
FUS Physics
FUS Simulation & treatment planning
FUS Treatment monitoring
Standards & quality assurance

Contacts

Howard M. Eisenberg, MD |
Program Co-director | heisenberg@som.umaryland.edu

Elias R. Melhem, MD | Program Co-director | emelhem@umm.edu

Commercial treatment

Neurological Essential tremor; Parkinson's disease, tremor

Clinical research

Neurological Brain metastases, lung cancer; Glioblastoma; Trigeminal neuralgia

Preclinical research

Miscellaneous Infection

Neurological Brain tumors, general; Epilepsy; Glioblastoma; Opioid and other addictions

University of Maryland School of Medicine continued

Research not involving thermal ablation, tissue destruction

Clinical research - Neurological

Brain metastases, lung cancer	Nonthermal, BBB opening - Drug delivery, immunotherapeutic
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Glioblastoma	Nonthermal - Liquid biopsy
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Preclinical research - Miscellaneous

Infection	Nonthermal, BBB opening - Drug delivery
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Preclinical research - Neurological

Brain tumors, general	Nonthermal - Amplification of cancer biomarkers
	Nonthermal, BBB opening
	Nonthermal, BBB opening - Drug delivery
	Nonthermal, BBB opening - Drug delivery, immunotherapeutic
	Nonthermal - Gene delivery
	Nonthermal - Immunomodulation
Epilepsy	Nonthermal - Gene delivery
	Nonthermal - Neuromodulation
Glioblastoma	Nonthermal - Immune cell trafficking
	Nonthermal - Immunomodulation
Opioid and other addictions	Nonthermal - Neuromodulation

Publications—2022

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Brigham and Women's Hospital

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Preclinical Research

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Mechanisms of Action
Research

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Commercial Treatments

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Clinical Research

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Technical Research

17

Publications

Brigham and Women's Hospital | Boston, MA

Brigham and Women's Hospital was named a COE in 2015. More than 50 focused ultrasound researchers in three different laboratories span the Boston campus of Brigham and Women's Hospital where, in conjunction with Harvard Medical School, they are pioneering innovative uses of focused ultrasound and advancing these new approaches from bench to bedside.

Contacts

Nathan J. McDannold, PhD | Program Co-director | njm@bwh.harvard.edu

Clare M. Tempany, MD | Program Co-director | ctempany@bwh.harvard.edu

Commercial treatments

Musculoskeletal	Bone metastases
Neurological	Essential tremor
Urological	Prostate cancer
Women's health	Uterine fibroids

Clinical research

Neurological	Epilepsy, Glioblastoma
Urological	Prostate cancer

Preclinical research

Miscellaneous	Niemann-Pick disease
Neurological	Alzheimer's disease; Epilepsy; Glioblastoma; Huntington's disease; Parkinson's disease, tremor

Mechanisms of action research

Hyperthermia	Tissue destruction
Nonthermal	Amplification of cancer biomarkers; BBB opening, drug delivery; BBB opening, gene delivery; Drug delivery, vehicle; Immunomodulation; Liquid biopsy; Neuromodulation; Radiosensitization; Stem cell delivery; Tissue destruction
Thermal ablation	Tissue destruction

Technical research

FUS Image guidance, MR
FUS Image guidance, Ultrasound
FUS Physics
FUS Simulation & treatment planning
FUS Treatment evaluation
FUS Treatment monitoring

Brigham and Women's Hospital continued

Research not involving thermal ablation, tissue destruction

Clinical research - Neurological

Epilepsy	Nonthermal - Neuromodulation
Glioblastoma	Nonthermal, BBB opening - Drug delivery

Preclinical research - Miscellaneous

Niemann-Pick disease	Nonthermal, BBB opening - Gene delivery
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Preclinical research - Neurological

Alzheimer's disease	Nonthermal, BBB opening - Drug delivery
Epilepsy	Nonthermal - Neuromodulation
Glioblastoma	Nonthermal, BBB opening - Drug delivery Nonthermal - Tissue destruction
Huntington's disease	Nonthermal, BBB opening - Drug delivery
Parkinson's disease, tremor	Nonthermal - Neuromodulation



Publications—2022

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Brigham and Women's Hospital continued

Publications—2022 continued

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ICR and The Royal Marsden

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Preclinical Research

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Mechanisms of Action
Research

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Commercial Treatment

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Clinical Research

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Technical Research

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Publications

The Institute of Cancer Research and The Royal Marsden | London, England

In 2013, the Focused Ultrasound Foundation and Philips entered an innovative public-private collaboration with the Institute of Cancer Research, ICR, and The Royal Marsden National Health Service Foundation Trust to create a COE in London. The Center created a state-of-the-art resource for clinicians and scientists working on focused ultrasound therapy, developing clinical evidence in oncology, and establishing best practices, treatment standards, and protocols.

1

Veterinary Research

Preclinical research

Cardiovascular	Twin-twin transfusion syndrome
Gastrointestinal	Liver metastases; Liver tumors; Pancreatic tumors, malignant
Neurological	Cancer pain, Glioblastoma

Mechanisms of action research

Histotripsy	Tissue destruction
Hyperthermia	Drug delivery, Radiosensitization
Nonthermal	Chemosensitization; Drug delivery; Drug delivery, immunotherapeutic; Tissue destruction; Vascular occlusion
Thermal ablation	Immune cell trafficking, Immunomodulation, Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Image guidance, Ultrasound
FUS Physics
FUS Simulation & treatment planning
FUS Transducer technology, Thermal ablation
FUS Treatment monitoring
Standards & quality assurance

Contact

Gail R. ter Haar, PhD, DSc | Program Director | gail.terhaar@icr.ac.uk

Commercial treatment

Urological Prostate cancer

Clinical research

Gastrointestinal Colorectal tumors

Urological Prostate cancer

ICR and The Royal Marsden continued



Publications—2022

Latest Advances in the Use of Therapeutic Focused Ultrasound in the Treatment of Pancreatic Cancer. Mouratidis PXE, ter Haar G. *Cancers* (Basel). 2022 Jan 27;14(3):638. doi: 10.3390/cancers14030638. PMID: 35158903; PMCID: PMC8833696.

Methods of monitoring thermal ablation of soft tissue tumors - A comprehensive review. Geoghegan R, ter Haar G, Nightingale K, Marks L, Natarajan S. *Med Phys*. 2022 Feb;49(2):769-791. doi: 10.1002/mp.15439. Epub 2022 Jan 10. PMID: 34965307.

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First in-human use of high-intensity focused ultrasound to occlude placental vessels non-invasively in TTTS. Shaw CJ, Rivens I, Symonds-Taylor R, Giussani D, ter Haar G, Lees C. *Ultrasound Obstet Gynecol*, 2022;60: 41-41. <https://doi.org/10.1002/uog.25095>.

Research not involving thermal ablation, tissue destruction

Clinical research - Gastrointestinal

Colorectal tumors	Nonthermal - Drug delivery
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Preclinical research - Cardiovascular

Twin-twin transfusion syndrome	Nonthermal - Vascular occlusion
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Preclinical research - Gastrointestinal

Pancreatic tumors, malignant	Nonthermal - Immunomodulation
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Preclinical research - Neurological

Glioblastoma	Nonthermal - Drug delivery, vehicle
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Veterinary research - Urological

Bladder tumors	Thermal ablation - Immunomodulation
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University of Virginia Health System

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Preclinical Research

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Mechanisms of Action Research

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Commercial Treatments

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Clinical Research

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Technical Research

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Publications

University of Virginia Health System | Charlottesville, VA

The Foundation's first COE was inaugurated at the University of Virginia in September 2009 through a public private partnership between the Foundation, the Commonwealth of Virginia, the University of Virginia, Insightec, and GE. The COE has a strong history in brain research, having pioneered clinical trials for essential tremor and Parkinsonian tremor, as well as technical and preclinical studies for neurological disorders. The center also treats uterine fibroids and bone metastases and conducts cancer research.

Contacts

Alan H. Matsumoto, MD | FUS Center of Excellence Director | ahm4d@virginia.edu

Craig L. Slingluff, MD | FUS Cancer Immunotherapy Center Clinical Co-Director | cls8h@hscmail.mcc.virginia.edu

Richard J. Price, PhD | FUS Cancer Immunotherapy Center Research Co-Director | rprice@virginia.edu

Commercial treatments

Neurological	Essential tremor; Parkinson's disease, dyskinesia; Parkinson's disease, tremor
Women's health	Uterine fibroids

Clinical research

Gastrointestinal	Esophageal tumors, Gastric tumors
Miscellaneous	Melanoma, Multiple tumors ¹
Neurological	Cancer pain, Epilepsy
Pulmonary	Lung cancer
Women's health	Breast tumors, benign; Breast tumors, malignant; Cervical tumors; Ovarian tumors

Preclinical research

Cardiovascular	Arteriovenous malformations, Peripheral artery disease
Gastrointestinal	Pancreatic tumors, malignant
Miscellaneous	Melanoma
Neurological	Brain metastases, breast cancer; Brain metastases, melanoma; Brain tumors, general; Cavernomas; Epilepsy; Glioblastoma; Parkinson's disease, underlying cause; Stroke, thromboembolic
Pulmonary	Lung cancer
Women's health	Breast tumors, malignant

¹ Protocols inclusive of more than one indication.

University of Virginia Health System continued



Mechanisms of action research

Histotripsy	Amplification of cancer biomarkers, Chemosensitization, Immune cell trafficking, Immunomodulation, Liquid biopsy, Tissue destruction
Hyperthermia	Drug delivery
Miscellaneous	Melanoma
Nonthermal	Amplification of cancer biomarkers; Angiogenesis; BBB opening; BBB opening, drug delivery; BBB opening, drug delivery, vehicle; BBB opening, gene delivery; BBB opening, immune cell delivery; BNB opening, drug delivery; Clot lysis; Drug delivery; Drug delivery, immunotherapeutic
Thermal ablation	Chemosensitization, Immunomodulation, Tissue destruction

Technical research

Drug delivery technology
FUS Image guidance, MR
FUS Image guidance, Ultrasound
FUS Treatment evaluation
FUS Treatment monitoring

¹ Inclusive of more than one indication

Research not involving thermal ablation, tissue destruction

Clinical research - Gastrointestinal

Esophageal tumors	Thermal ablation - Immunomodulation
Gastric tumors	Thermal ablation - Immunomodulation

Clinical research - Miscellaneous

Melanoma	Thermal ablation - Immunomodulation
Multiple tumors ¹	Thermal ablation - Immunomodulation

Clinical Research - Pulmonary

Lung cancer	Thermal ablation - Immunomodulation
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Clinical Research - Women's health

Breast tumors, malignant	Nonthermal - Immunomodulation
Cervical tumors	Thermal ablation - Immunomodulation
Ovarian tumors	Thermal ablation - Immunomodulation

Preclinical research - Cardiovascular

Arteriovenous malformations	Nonthermal - Tissue destruction
Peripheral artery disease	Nonthermal - Drug delivery, vehicle

Preclinical research - Gastrointestinal

Pancreatic tumors, malignant	Thermal ablation - Immunomodulation
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Preclinical research - Miscellaneous

Melanoma	Thermal ablation - Immunomodulation
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Preclinical research - Neurological

Brain metastases, breast cancer	Nonthermal, BBB opening - Drug delivery; immunotherapeutic Nonthermal - Immunomodulation
Brain metastases, melanoma	Nonthermal, BBB opening - Drug delivery; immunotherapeutic Nonthermal - Immunomodulation Nonthermal - Sonodynamic therapy
Brain tumors, general	Nonthermal, BBB opening - Gene delivery
Cavernomas	Nonthermal - Sonodynamic therapy
Epilepsy	Nonthermal, BBB opening - Drug delivery Nonthermal - Neuromodulation
Glioblastoma	Nonthermal, BBB opening - Drug delivery Nonthermal, BBB opening - Gene delivery Nonthermal - Drug delivery, vehicle Nonthermal - Immunomodulation Nonthermal - Radiosensitization Nonthermal - Sonodynamic therapy Nonthermal - Vascular occlusion

Parkinson's disease, underlying cause Nonthermal, BBB opening - Drug delivery

Stroke, thromboembolic Nonthermal - Sonoporation

Preclinical research - Women's health

Breast tumors, malignant	Thermal ablation - Immunomodulation
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University of Virginia Health System continued

Publications—2022

Low-Cost 3-D Hydrophone Scanning Tank with MATLAB GUI Control. Clinard S, Wettstone E, Moore D, Snell J, Padilla F, Eames M. *Ultrasound Med Biol*. 2022 Jan;48(1):157-163. doi: 10.1016/j.ultrasmedbio.2021.09.022. Epub 2021 Oct 23. PMID: 34702638.

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Publications—2022 continued

Toward Reduction in False-Positive Thyroid Nodule Biopsies with a Deep Learning-based Risk Stratification System Using US Cine-Clip Images. Yamashita R, Kapoor T, Alam MN, Galimzianova A, Syed SA, Ugur Akdogan M, Alkim E, Wentland AL, Madhuripan N, Goff D, Barbee V, Sheybani ND, Sagreya H, Rubin DL, Desser TS. *Radiol Artif Intell*. 2022 May 11;4(3):e210174. doi: 10.1148/ryai.210174. PMID: 35652118; PMCID: PMC9152684.

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Magnetic resonance imaging-guided focused ultrasound thalamotomy for essential tremor: 5-year follow-up results. Cosgrove GR, Lipsman N, Lozano AM, Chang JW, Halpern C, Ghanouni P, Eisenberg H, Fishman P, Taira T, Schwartz ML, McDannold N, Hayes M, Ro S, Shah B, Gwinn R, Santini VE, Hynynen K, Elias WJ. *J Neurosurg*. 2022 Aug 5:1-6. doi: 10.3171/2022.6.JNS212483. Epub ahead of print. PMID: 35932269.

Comparison between MR and CT imaging used to correct for skull-induced phase aberrations during transcranial focused ultrasound. Leung SA, Moore D, Gilbo Y, Snell J, Webb TD, Meyer CH, Miller GW, Ghanouni P, Butts Pauly K. *Sci Rep*. 2022 Aug 4;12(1):13407. doi: 10.1038/s41598-022-17319-4. PMID: 35927449; PMCID: PMC9352781.

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University of Virginia Health System continued

**The University of Virginia
Focused Ultrasound Cancer Immunotherapy Center
Charlottesville, VA**

In 2022, UVA Health and the Focused Ultrasound Foundation launched the Focused Ultrasound Cancer Immunotherapy Center, the world's first center dedicated specifically to advancing a focused ultrasound and cancer immunotherapy treatment approach that could revolutionize 21st-century cancer care. The center is designed to capitalize on UVA's strengths including cancer immunotherapy, focused ultrasound, and medical imaging.

Research not involving thermal ablation, tissue destruction

Clinical research - Gastrointestinal

Esophageal tumors	Thermal ablation - Immunomodulation
Gastric tumors	Thermal ablation - Immunomodulation

Clinical research - Miscellaneous

Melanoma	Thermal ablation - Immunomodulation
Multiple tumors ¹	Thermal ablation - Immunomodulation

Clinical research - Pulmonary

Lung cancer	Thermal ablation - Immunomodulation
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Clinical research - Women's health

Breast tumors, malignant	Nonthermal - Immunomodulation
Cervical tumors	Thermal ablation - Immunomodulation
Ovarian tumors	Thermal ablation - Immunomodulation

Preclinical research - Gastrointestinal

Pancreatic tumors, malignant	Thermal ablation - Immunomodulation
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Preclinical research - Miscellaneous

Melanoma	Thermal ablation - Immunomodulation
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Preclinical research - Neurological

Brain metastases, breast cancer	Nonthermal, BBB opening - Drug delivery; immunotherapeutic Nonthermal - Immunomodulation
Brain metastases, melanoma	Nonthermal, BBB opening - Drug delivery; immunotherapeutic Nonthermal - Immunomodulation
Brain tumors, general	Nonthermal, BBB opening - Gene delivery
Glioblastoma	Nonthermal, BBB opening - Gene delivery Nonthermal - Immunomodulation

Preclinical research - Women's health

Breast tumors, malignant	Thermal ablation - Immunomodulation
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Mechanisms of action research

Histotripsy	Immune cell trafficking, Immunomodulation
Nonthermal	BBB opening, immune cell delivery; Drug delivery, immunotherapeutic; Immune cell delivery; Immune cell trafficking; Immunomodulation
Thermal ablation	Immunomodulation

¹ Inclusive of more than one indication

Publications—2022 continued

- Profiling of the immune landscape in murine glioblastoma following blood brain/tumor barrier disruption with MR image-guided focused ultrasound. Sheybani ND, Witter AR, Garrison WJ, Miller GW, Price RJ, Bullock TNJ. *J Neurooncol.* 2022 Jan;156(1):109-122. doi: 10.1007/s11060-021-03887-4. Epub 2021 Nov 3. PMID: 34734364; PMCID: PMC8714701.
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- Focused ultrasound for the treatment of glioblastoma. Roberts JW, Powlovich L, Sheybani N, LeBlang S. *J Neurooncol.* 2022 Apr;157(2):237-247. doi: 10.1007/s11060-022-03974-0. Epub 2022 Mar 10. PMID: 35267132; PMCID: PMC9021052.
- Sonodynamic therapy: Rapid progress and new opportunities for non-invasive tumor cell killing with sound. Nowak KM, Schwartz MR, Breza VR, Price RJ. *Cancer Lett.* 2022 Apr 28;532:215592. doi: 10.1016/j.canlet.2022.215592. Epub 2022 Feb 11. PMID: 35151824; PMCID: PMC8918024.
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- Applications of focused ultrasound-mediated blood-brain barrier opening. Gorick CM, Breza VR, Nowak KM, Cheng VWT, Fisher DG, Debski AC, Hoch MR, Demir ZEF, Tran NM, Schwartz MR, Sheybani ND, Price RJ. *Adv Drug Deliv Rev.* 2022 Dec;191:114583. doi: 10.1016/j.addr.2022.114583. Epub 2022 Oct 19. PMID: 36272635; PMCID: PMC9712235.
- Combination of Focused Ultrasound, Immunotherapy, and Chemotherapy: New Perspectives in Breast Cancer Therapy. Dahan M, Cortet M, Lafon C, Padilla F. *J Ultrasound Med.* 2023 Feb;42(3):559-573. doi: 10.1002/jum.16053. Epub 2022 Jul 23. PMID: 35869903.