

New and emerging transcranial ultrasound brain therapies



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Medical high intensity focused ultrasound (HIFU) concentrates acoustic energy within a precise region of the body, killing tissue in a targeted volume while leaving other areas unaffected. HIFU's effectiveness in soft tissues is well established, however until recently it was largely believed that severe aberration caused by the skull made noninvasive brain therapy impossible. It has now been established that transcranial focusing can be reliably achieved via waveform-correction techniques that offset the skull's distorting effects. Technological advancements in transducer arrays, high power multi-channel amplifiers, and high-performance computers have all helped to make these correction techniques practically feasible, while real-time methods for targeting and monitoring ultrasound energy deposition have made transcranial HIFU safer and more consistent. Meanwhile, high-resolution X-ray computed tomography (CT) maps fused with magnetic resonance imaging (MRI) and thermometry have led to millimeter-precision registration with brain structures. This culmination of technologies led to the 2016 FDA approval of transcranial HIFU to treat essential tremor, with clinical trials ongoing for brain tumors, Alzheimer's disease, Parkinson's disease, epilepsy, obsessive compulsive disorder (OCD), stroke, and others. Advances continue in the laboratory toward expanding both the number of treatable disorders and the mechanisms of treatment. This talk will highlight the importance of applied physics in developing the technology while providing an example of how academically-based research can directly benefit the clinic.

Biography: Greg Clement is a Research Physicist at the U.S. Food and Drug Administration's Office of Science and Engineering Laboratories. For over 25 years he has been developing new methods for ultrasound imaging and therapy, most notably for transcranial brain applications. He came to the FDA in 2017 from Cleveland Clinic, where he was Principal Investigator and Director of the Clinic Ultrasound Laboratory. Prior to this, he was Associate Professor of Radiology at Harvard Medical School, Head of Imaging for the National Center for Image Guided Therapy, and Technical Director of the Focused Ultrasound Laboratory at Brigham and Women's Hospital. He additionally held positions at University of Electro-Communications (Tokyo) and Sofia University (Sofia, Bulgaria). A Fellow of the Institute of Physics, Dr. Clement is Associate Editor of IEEE Transactions on Ultrasonics Ferroelectrics and Frequency Control and sits on the International Advisory Board of Physics in Medicine and Biology.

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Krasnow Institute, Room 229