Transcranial Magnetic Resonance Guided Focused Ultrasound Surgery
Professor Ferenc A Jolesz
Brigham and Women's Hospital Harvard Medical School Boston MA, USA

MRgFUS is uniquely capable of producing a broad spectrum of bioeffects that can be used for treatment of potentially extensive range of brain diseases and disorders. It is a noninvasive, targeted, and repeatable method. It can be performed within an MRI unit, enabling precise anatomical and functional guidance unlike any other technology. Capabilities of MRgFUS include the ability to noninvasively ablate tissue volumes (replacing neurosurgery and radiosurgery), non-invasively liquefy hematomas, produce thrombolysis (that will change treatment of strokes), deliver drugs to targeted brain regions through a temporary disruption of the Blood-brain barrier, potentially revolutionizing neurooncology and neuropharmacology, and reversibly modulate neuronal function with higher precision and deeper than TMS. All these are providing a tool with unprecedented abilities that can transform neuroscience. In recent years, with the development of devices capable of focusing ultrasound through the human skull, the demonstration of feasibility in humans, and the large number of pre-clinical studies that have been published, it has become clear that this technique is mature and ready to be moved to patients. However, this translation will be difficult as to most people the therapeutic use of ultrasound in the brain is a radical concept, and significant work is needed to prove that it can be applied safely before wide-scale tests and adoption can occur. Indeed, progress has been excruciatingly slow, with feasibility of transcranial MR-guided FUS (TcMRgFUS) thermal ablation in humans only being reported within the past two years. Early applications include thermal ablations of brain tumors, thalamotomy for functional neurosurgical applications (pain, essential tremor).

Despite its great potential and promise, this enabling technology has several critical hurdles to overcome before widespread clinical translation is possible; a large-scale effort is necessary by a diverse team of scientists, engineers, and clinicians to advance three areas where FUS will have the greatest impact. The presented work build upon innovations made by our group and others that have demonstrated the promise of MRgFUS. There is no prior example of any other technology that has the same disruptive and transformative potential on any other field of medicine. If translated into clinical practice, this enabling technology will change neurosurgery and all aspects of clinical neuroscience.