

Time reversal, medical applications

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The evolution of modern medicine is contributing to increase the life expectancy thanks to new diagnostic and therapeutic techniques. Ultrasound brings their lots of innovations, mostly known for fetal imaging but is also positioned for non-invasive therapy like the destruction of kidney stones. Contrary to kidney, the brain therapy focus ultrasound is transmitted through two different media in terms of sound speeds. A spherical phase law does not achieve a correct focalization through skull bone and brain. That is why the use of ultrasound for brain treatment has remained only possible via craniotomy for a long time. For a while, the procedure was invasive and partially lost its interest compared to a classical brain surgery. But the development of a protocol based on time reversal to focalize ultrasound through an aberrating media has changed the paradigm, by controlling the shape of the emitting wave front. Moreover, since it is based on numerical simulation, this protocol can be achieved totally non-invasively, limiting the risks while operating. This approach has become very attractive compared to classical brain surgery by craniotomy. Two major applications using focused transcranial ultrasound are currently being tested: BBB opening using focused ultrasound combined with UCA injection and thermal necrosis by HIFU.