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Holographic Lenses to Enhance Thalamic Therapy through the Temporal Bone Window.

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We numerically investigate the performance of acoustic holograms at 650 kHz to correct the aberrations introduced by the skull and simultaneously target the thalamic nuclei through the temporal bone window.The influence of a misalignment in the skull-lens relative location is also studied in terms of focus pressure and treated volume.

We have designed five different holographic lenses to sonicate both thalami from the right temporal bone using k-space simulations and phase-conjugation methods.Results are compared to the performance of a curved transducer.

In all the studied cases (two single and three double focus holograms) there is an improvement on the sonicated target volume compared to the sonicated healthy brain tissue,from 1.5 to 9.5 times better,which implies that most part of the energy is concentrated in both thalami (Figures 1b-1e).Figure 1a demonstrates the ability of double-focus holograms to sonicate both thalami at once.Results of the influence of the skull-lens relative location show that for alignment errors lower than 3.75 degrees of rotation between the lens and the skull center the hologram produces a field with a peak pressure higher that -1 dB the maximum pressure in the correct position. For this misalignment error,the corresponding sonicated volume (threshold of -3 dB of the peak pressure) remains 56% of the target volume,while the sonicated volume outside the target also decreases to 38%.

Transtemporal acoustic holograms are a robust method to improve focus quality and to enhance sonicated volumes even under small misallocations that can be used for highly selective and low-cost therapeutic applications.

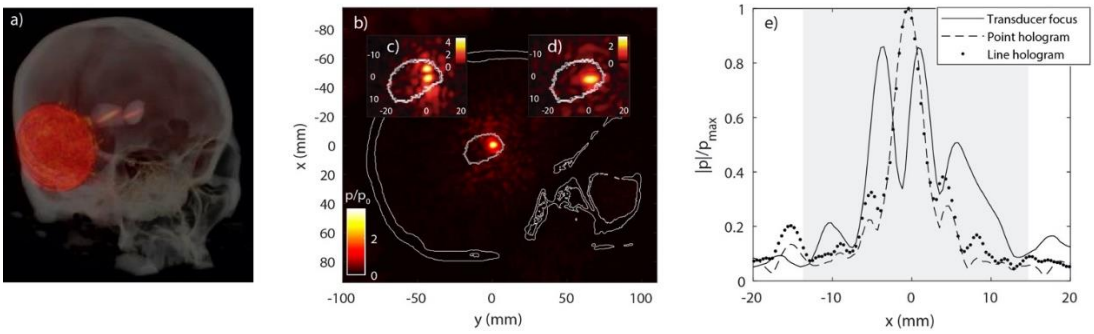


Figure 1: a) 3D-image of the acoustic field produced inside the brain by a double-focus holographic lens. b)-d) Acoustic fields produced by a point hologram, a focused transducer and a line hologram, respectively. e) x-axis lineal cut at the maximum pressure location for both holograms and transducer real focus.