A low-intensity ultrasound delivery system using acoustic holograms

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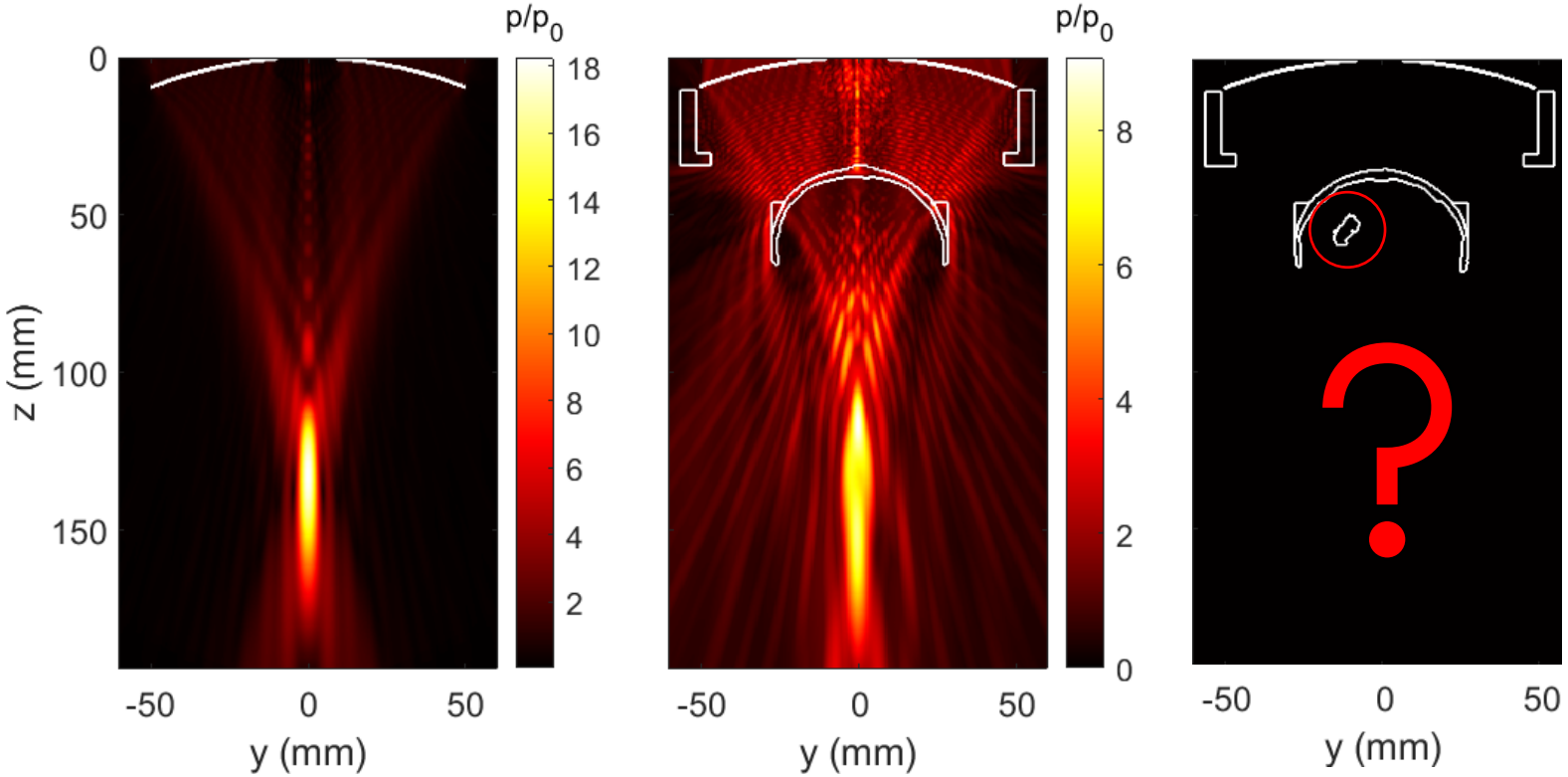
Objectives

- Large-apperture focused transducer for BBB-Opening in non-human primates
  - Apperture OD = 100 mm, Inner hole ID = 20 mm
  - Radius of curvature R = 140 mm
  - Central frequency f = 500 kHz

- Adapt focal spot to the target (left posterior putamen)

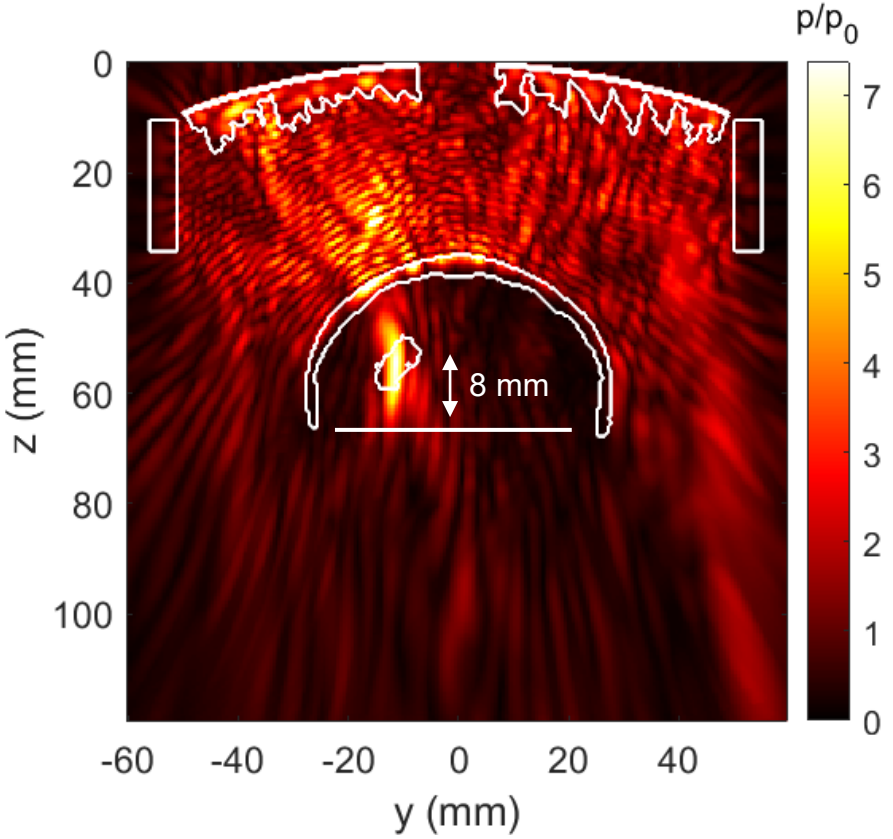
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Holographic lenses

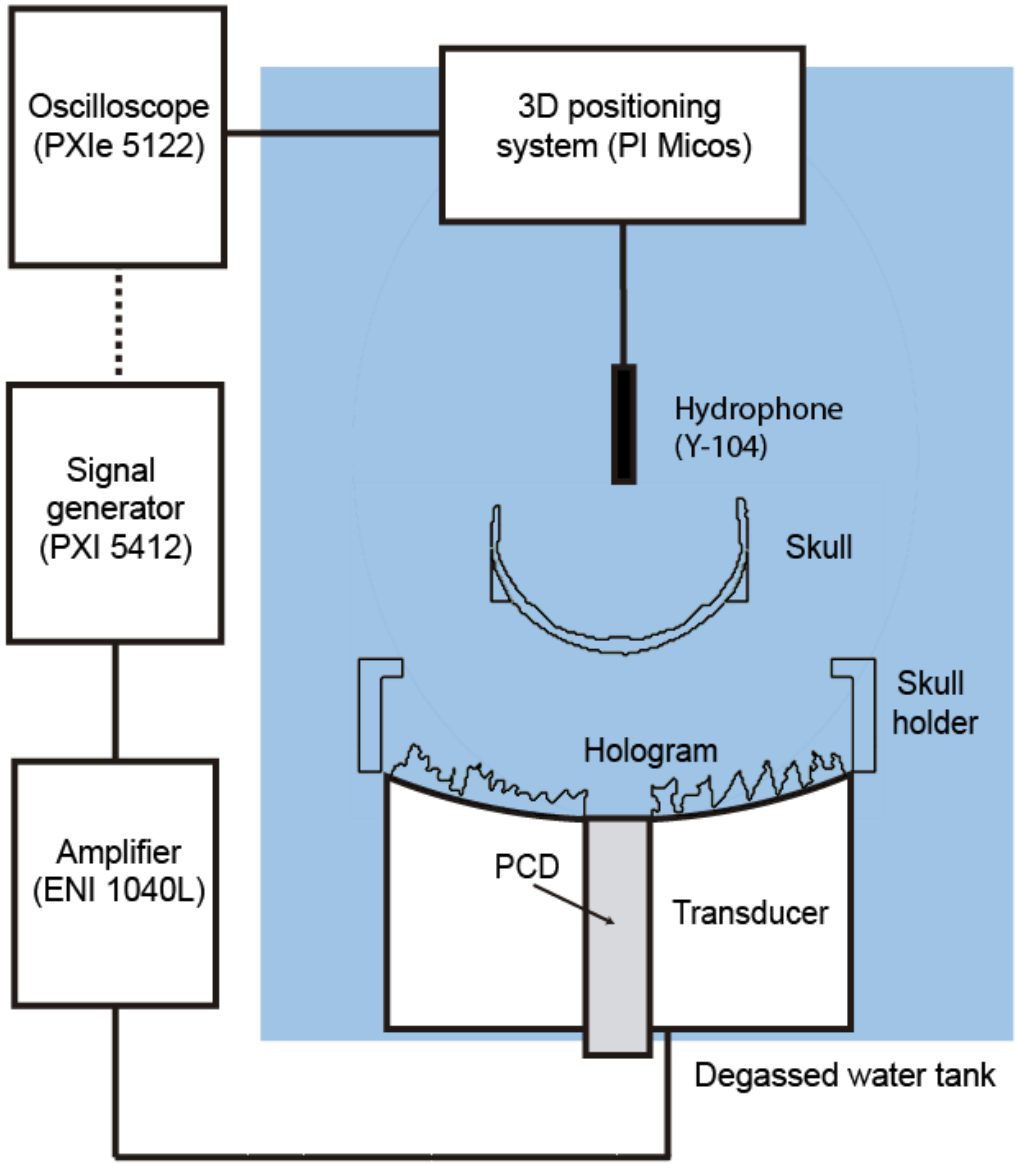


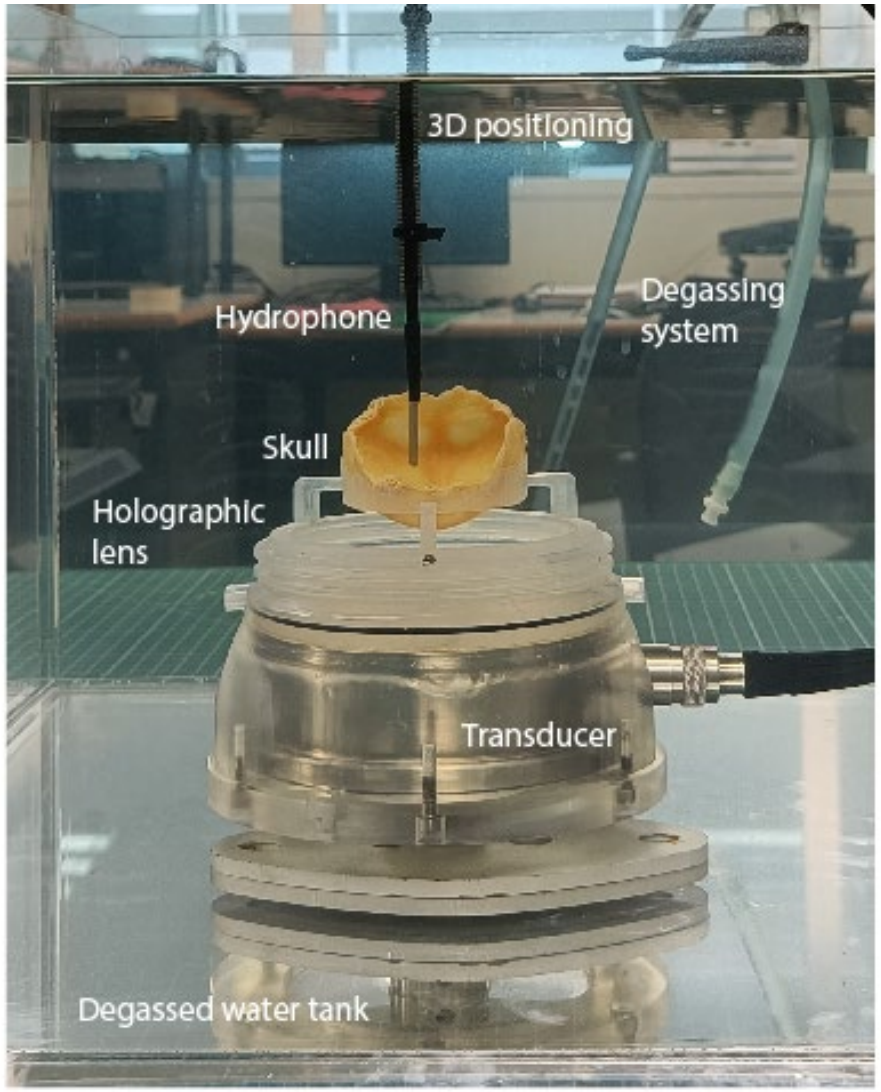
Methods

- Acoustic holograms made with time-reversal methods
  - 3D printing of the holographic lens
- Long time realistic pseudoespectral simulations
  - Capture reflections (backward propagation)
  - Quasi-rigid transducer surface
- Direct measurements in degassed-water tank
- Holographic projection to reconstruct 3D acoustic hologram
  - 2D plane measurement at 8 mm above the focus



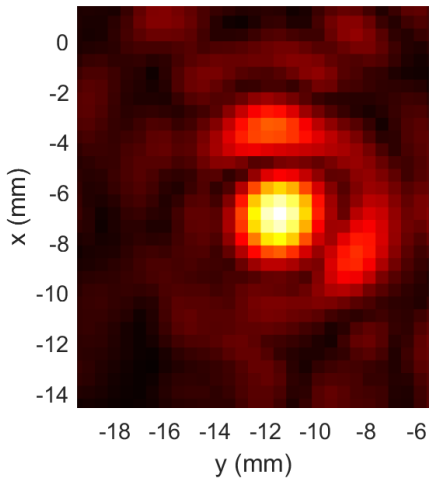
Experimental setup

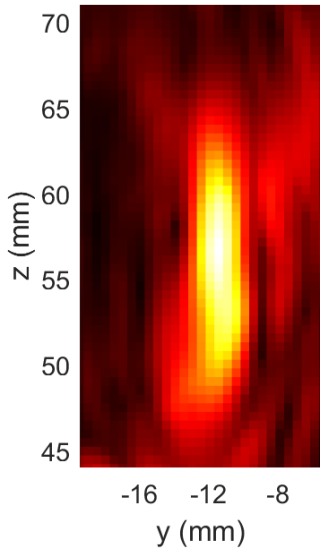




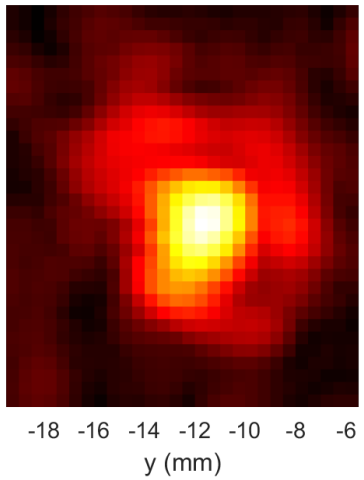
Results

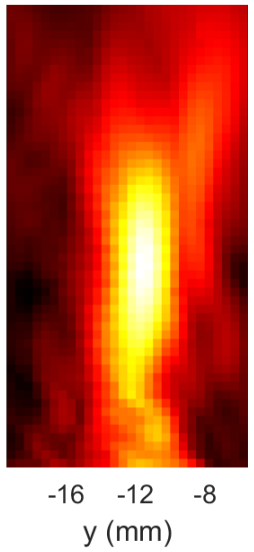
Simulación



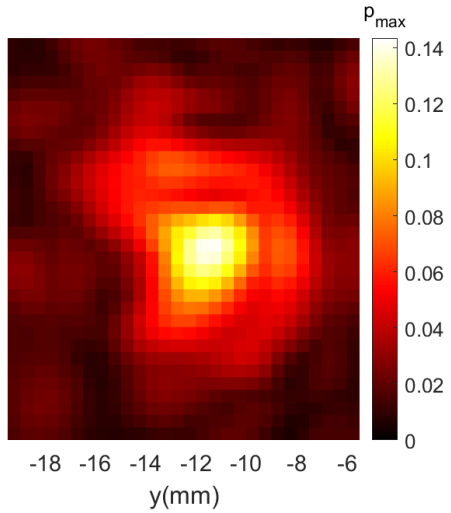


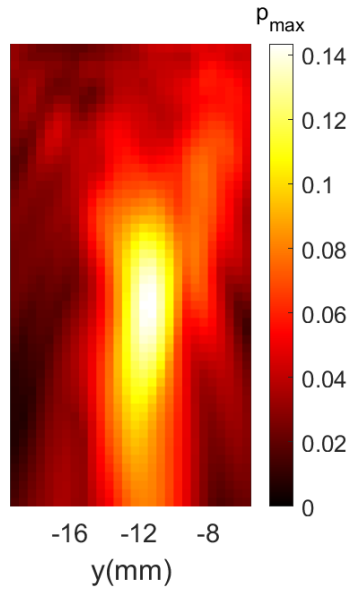
Experimento



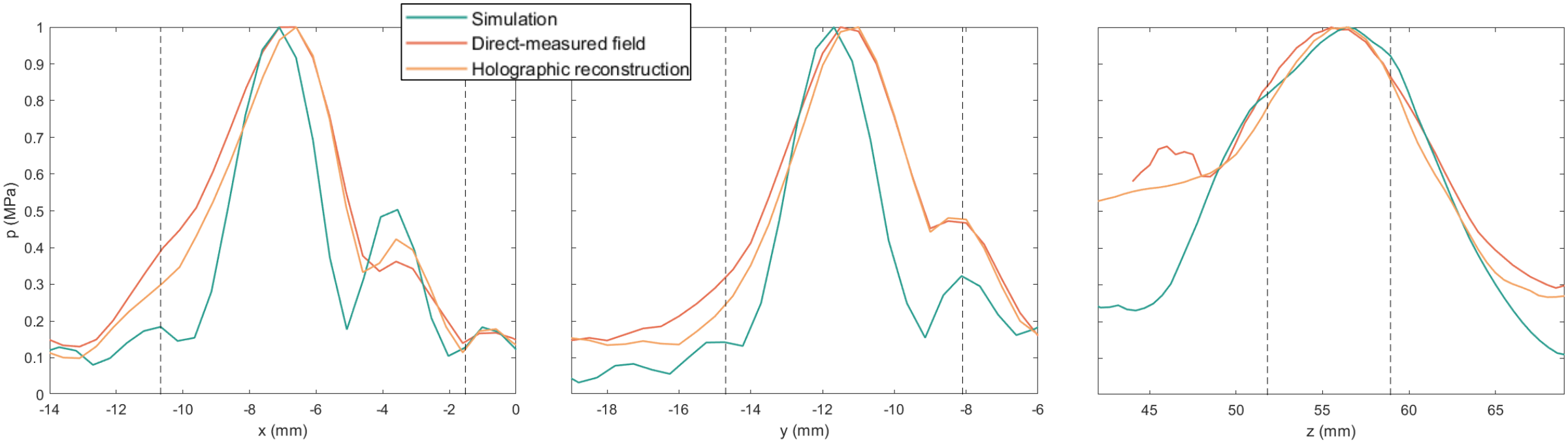


Proyección holográfica





Results



	Simulation	Direct-measured field	Holographic reconstruction
Focus sizes (-3 dB)	3 x 3 x 14 mm^3	4.5 x 4.5 x 15.5 mm^3	4 x 4 x 14 mm^3
Focus in the target	55 %	-	40 %
% target sonicated	14 %	-	38 %

Conclusions

- Robust method to adapt large-apperture focused transducers beam to a small target
- Holographic projection match with direct measurement
  - 3D acoustic focus volume with a single measurement → Much less time, no artifacts
- Highly selective and low-cost system for blood-brain barrier opening applications

Future steps

- In-vivo experiments with BBB-opening assessment - Passive acoustic cavitation monitoring

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