SIGNAL FREQUENCY CONTENT AND APPEARANCE OF TUMORS IN PHOTOACOUSTIC BREAST TOMOGRAPHY: A SIMULATION

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1. PROBLEM STATEMENT

- Photoacoustic tomography (PAT) setups increasingly used in clinical studies
- PA tumor appearance differs per system due to lack of standardization in technical system specifications
- More information about tumor appearance required to improve image interpretation

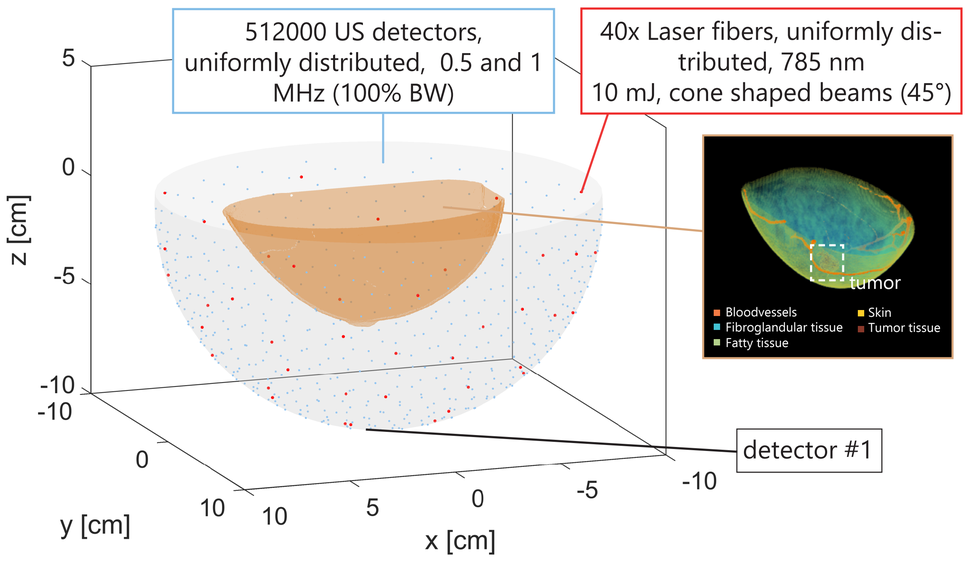
This study investigates:

- PA frequency content of tumors with different vessel distributions: homogeneous (solid) and superficial (hollow)
- Their PA appearance with 0.5 and 1 MHz transducers

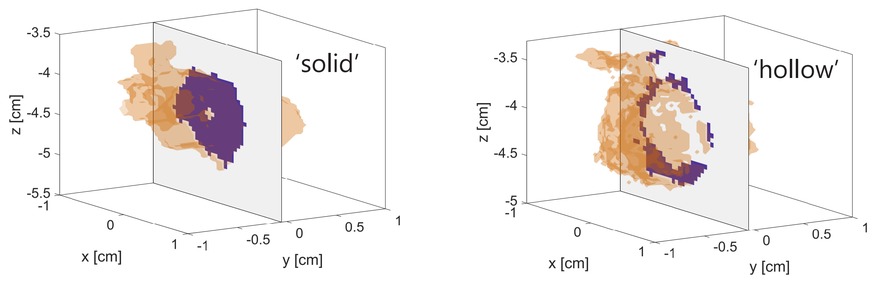
2. RESEARCH METHOD

I. Simulation geometry

- 20 cm diameter spherical bowl, filled with water
- 500 µm isotropic pixel size
- MRI segmented breast [1] pendant in bowl
- CE-MRI segmented 1.5 cm tumor (solid or hollow) embedded in breast at 1/8 depth



CE-MRI segmented tumors



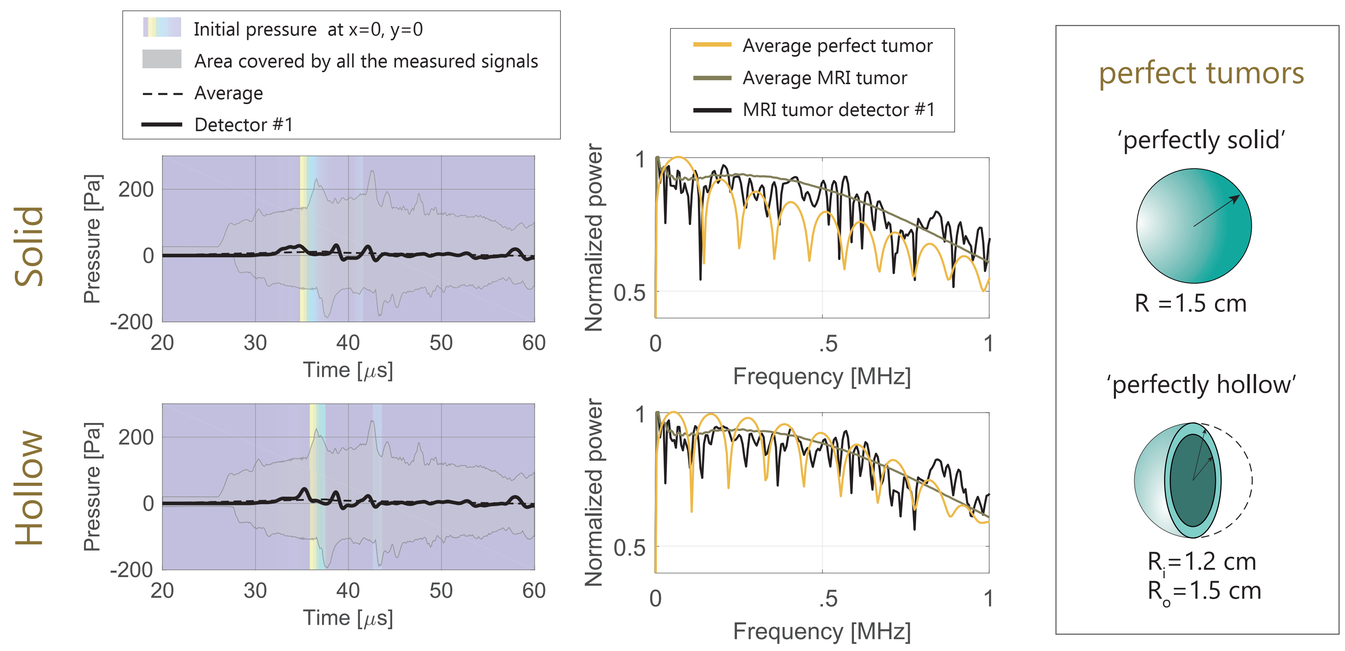
II. Algorithm

1. Acoustical and optical properties [1-4] assigned to tissues
2. Illumination simulated with Monte Carlo (MCX [5], GPU accelerated)
3. Obtained fluence map converted into a pressure map using Grüneisen coefficient
4. Acoustical propagation modeled with k-wave [6] (GPU accelerated).
5. Iterative image reconstruction using a speed of sound map

3. RESULTS

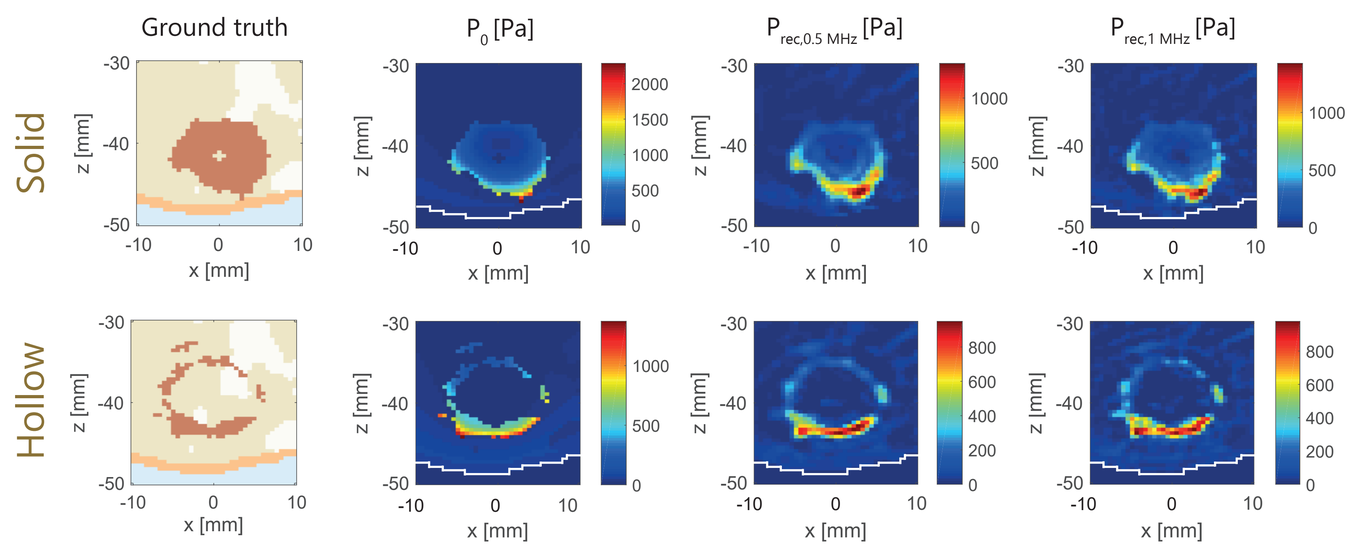
I. Signal content

Measured power spectra are compared with spectra from a similar sized perfect tumors with an homogenous initial pressure.



II. Reconstructions

Converged solution was found after 25 iterations. Slices at y=0 are shown.



4. CONCLUSION AND FUTURE WORK

I. Main conclusions

1. Both a solid and a hollow tumor appear as hollow in the PA image due to light absorption by tumor tissue.
2. The transducer center frequency mainly affects the resolution of the reconstruction, but has little influence on the reconstructed tumor shape.
3. A theoretical difference between the frequencies emitted by a sphere and a spherical shell exists but cannot be observed in the breast, due to the decaying fluence with depth.

II. Outlook

Further investigating the effect of technical system specifications
High resolution 3D blood vessel networks inside tumor

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BMPI Biomedical Photonic Imaging

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