Non-invasive brain surgery with an ultrasound transducer array

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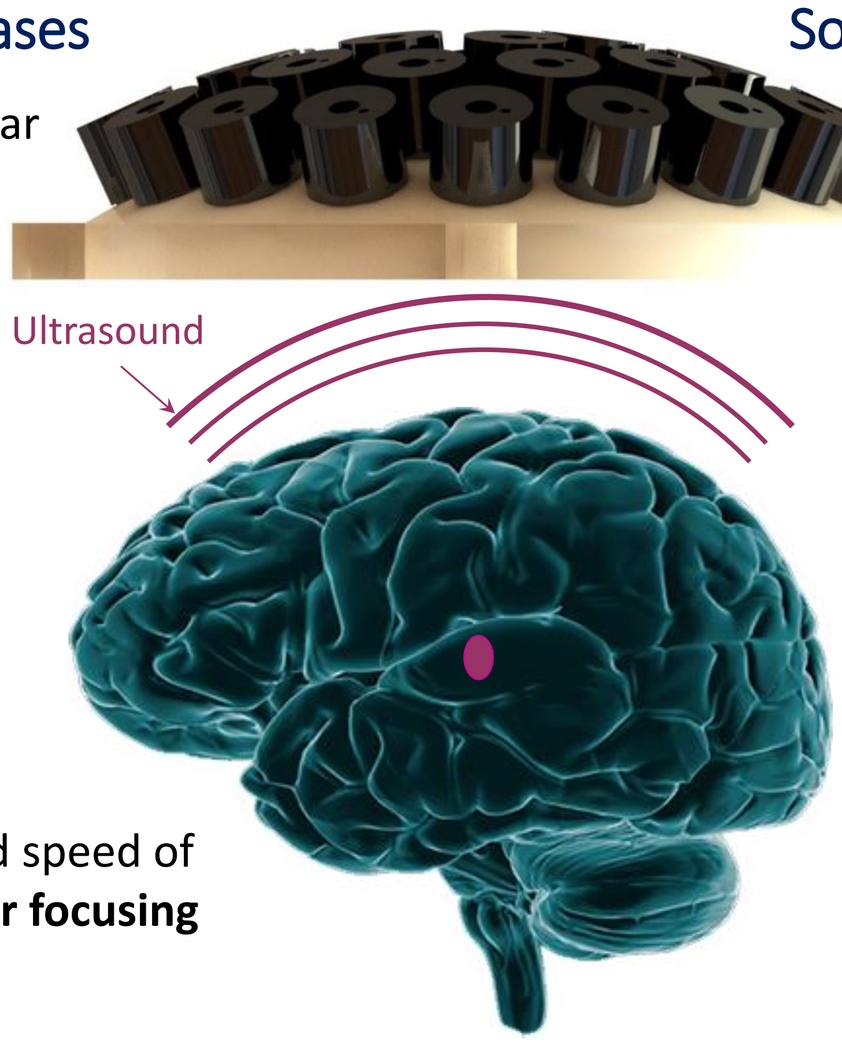
Problems in Treating Brain Diseases

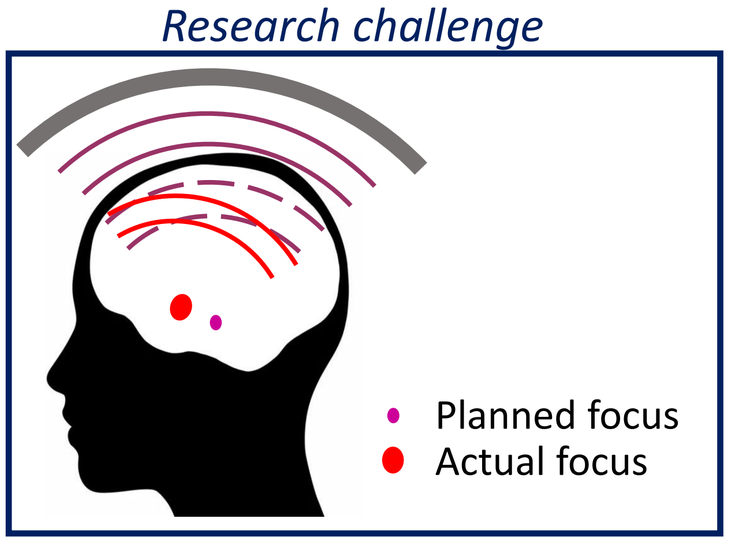
- UK is spending **£27 billion** every year on treating brain diseases.[1]
- Treating brain diseases is difficult due to the **skull** and **healthy brain tissue** blocking direct access to the disease.
- Non-invasive surgery can be achieved with **focused ultrasound**. However, it is challenging to do this across the thick human skull.
- **Research challenge:**
  The **skull** changes the direction and speed of the ultrasound, which leads to **poor focusing** and an **inaccurate focus location**.



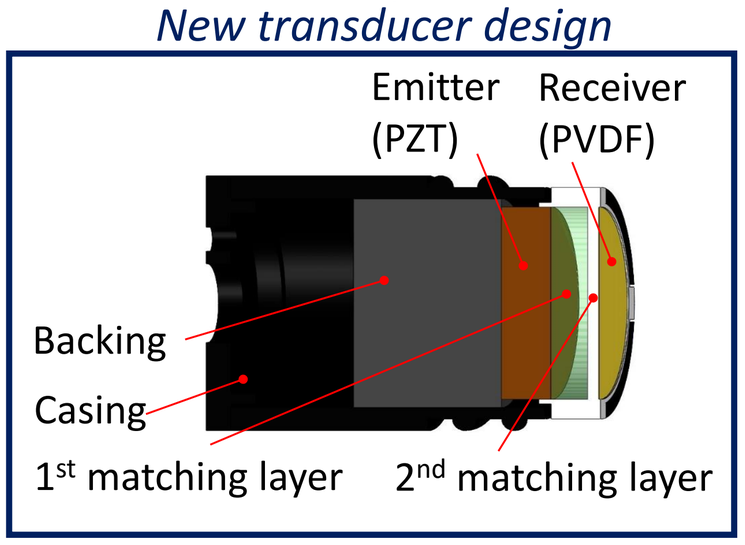
Solution: An Ultrasound Array System for Non-invasive Brain Surgery

- A new transducer that can **emit** and **receive** short pulses of ultrasound was designed and built.[2]
- 32 transducers were assembled onto a 3D-printed frame to form a focused transducer array.
- In combination with circulating **microbubbles**, this device can be used to focus ultrasound through the human skull and monitor treatments.

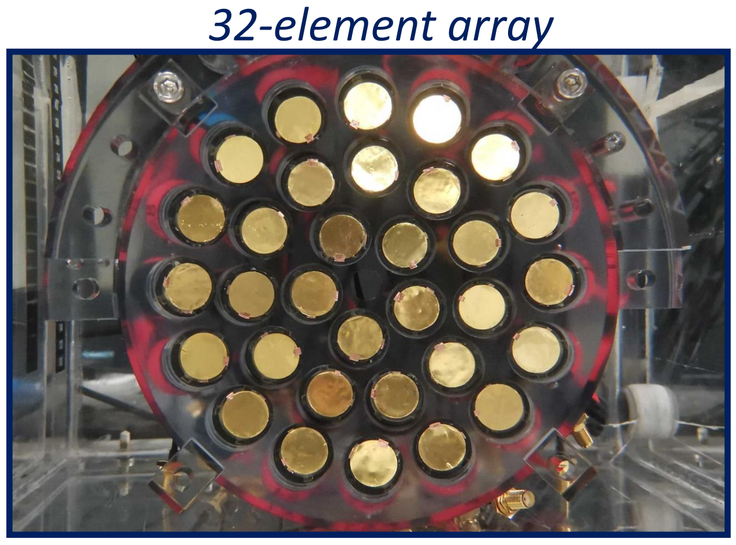
Research challenge



New transducer design

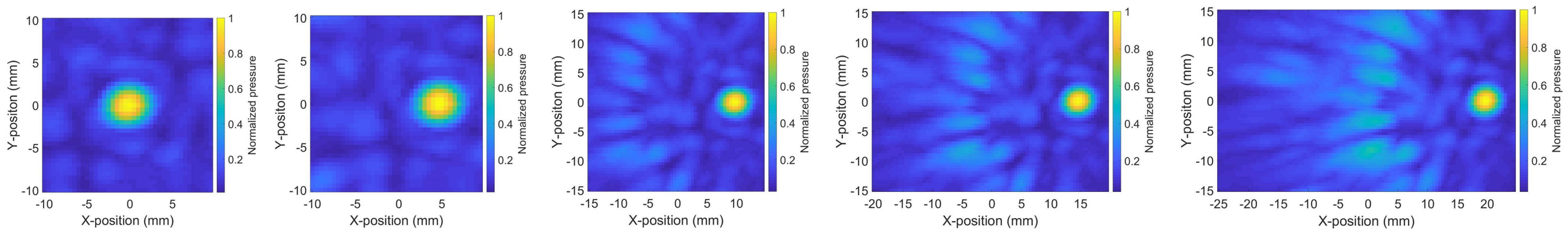


32-element array



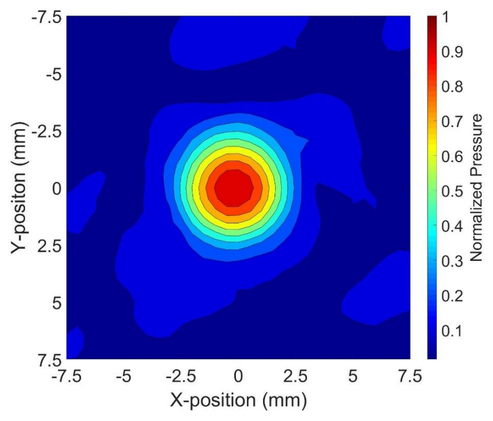
Focus and Steer Ultrasound

- The array was able to focus ultrasound and steer the focus by 40 mm in each direction.



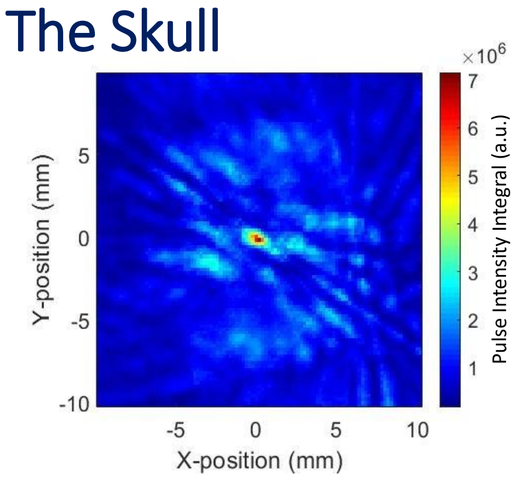
Focus through The Skull

- The array was able to focus through an **ex vivo human skull**.
- The focus achieved was as planned. The focus size and location were the same as when without the skull.



Monitor the Focus through The Skull

- The array was able to image the microbubbles through the **ex vivo human skull.**
- Hence it can be used to monitor focused ultrasound treatments of the brain.



Conclusion & Future Work

We built an ultrasound array system for non-invasive brain surgery. It can focus and steer ultrasound, focus through the human skull and monitor the treatment. Our next steps involve testing this system on a large animal model.

Acknowledgements

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References

[1] N.A.Fineberg,*JPsychparhm*,**2013**,27,761-70.
[2] Z.Jiang, *IEEE UFFC*, **2021**, 68(6), 2164-2171.