Journal of Zhejiang University-SCIENCE A

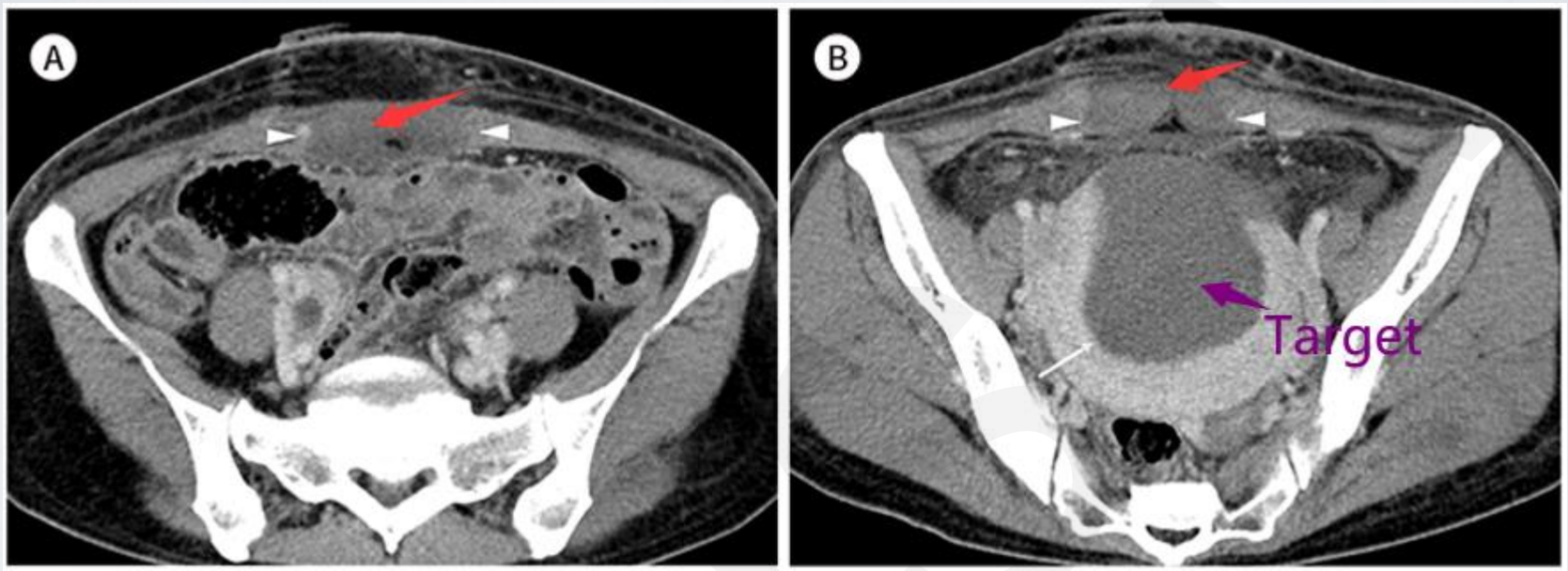
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Mitigating pre-focal heating using a spherical Fibonacci lattice high-intensity focused ultrasound array and a near-field focusing strategy

Key words:

High-intensity focused ultrasound (HIFU); Phased array; Element arrangement; Focus steering

Why does HIFU sometimes heat the wrong place?



Hong S H , Hong G S , Lee C W ,et al.Complication Following Ultrasound-Guided High-Intensity Focused Ultrasound for the Treatment of Uterine Adenomyosis: Case Report of CT Imaging Features[J].Journal of the Korean Society of Radiology, 2019, 80(3):579.DOI:10.3348/jksr.2019.80.3.579.

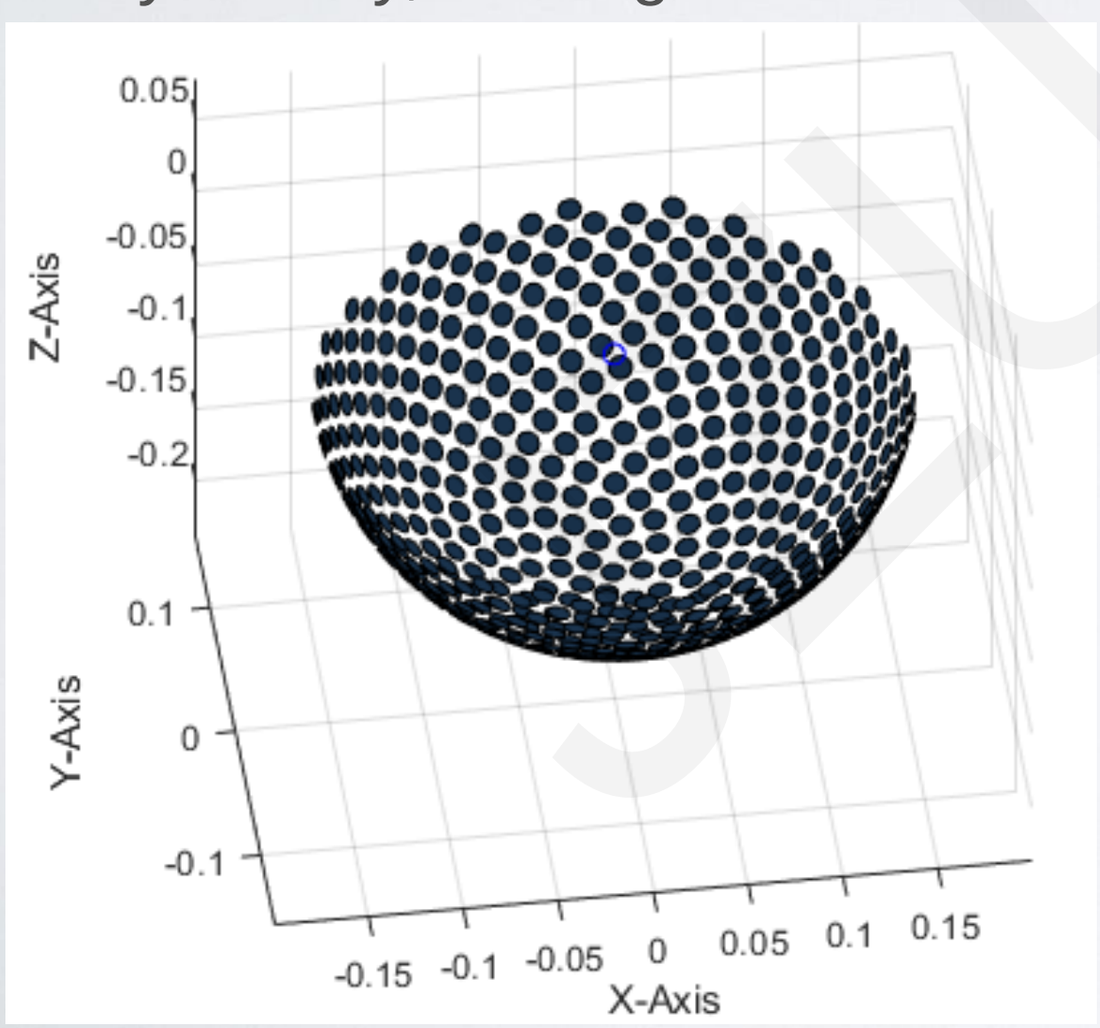
Prefocal overheating limits the safety of phased-array HIFU treatments:

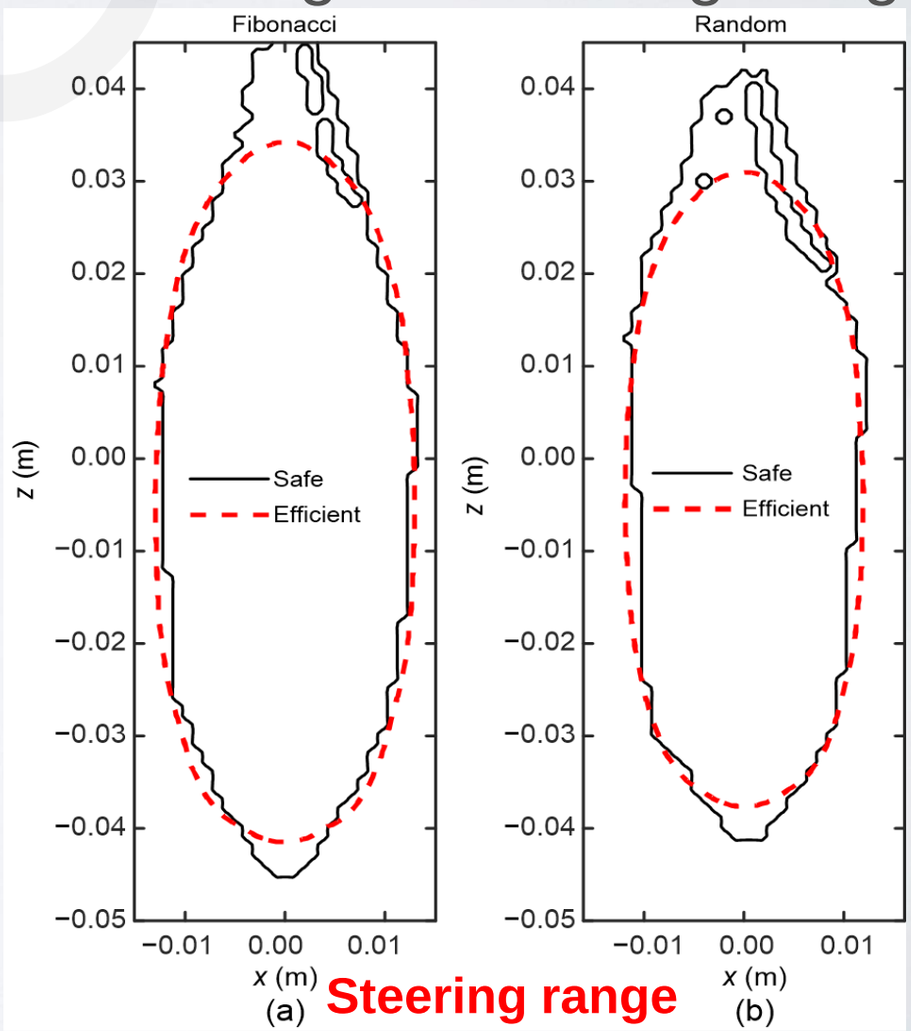
> During large-volume HIFU ablation, repeated electronic focus steering can cause unwanted temperature rise in front of the focal zone, increasing the risk of skin burns and abdominal edema.

A more “ordered” way to arrange HIFU array elements

Spherical Fibonacci lattice enables uniform and asymmetric element distribution

> By arranging piston elements on a spherical Fibonacci lattice, the array achieves a more uniform surface coverage and reduced symmetry, leading to more stable beam focusing and lower grating

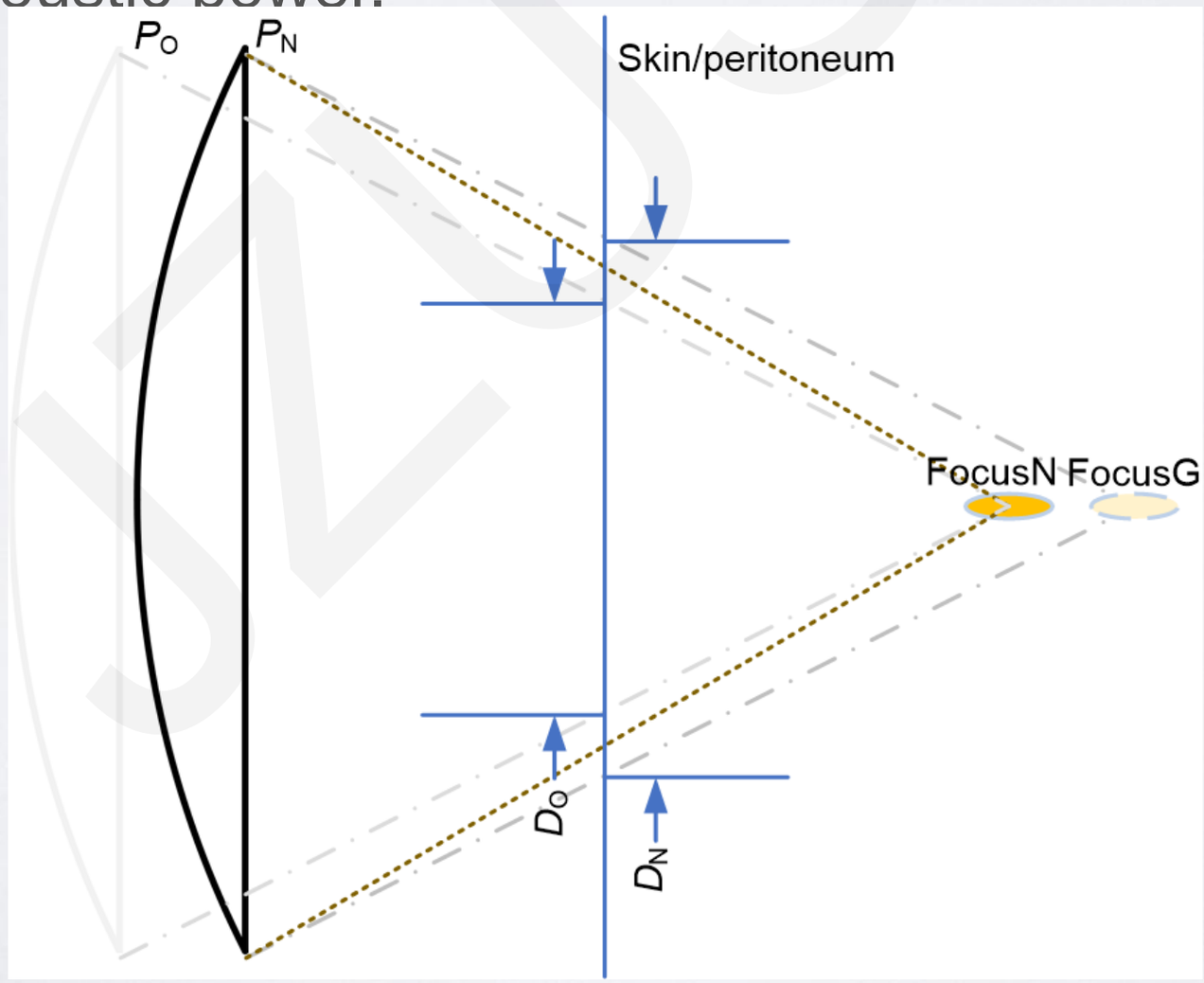




Can moving the transducer closer make treatment safer?

Near-field focusing spreads acoustic energy at the skin surface

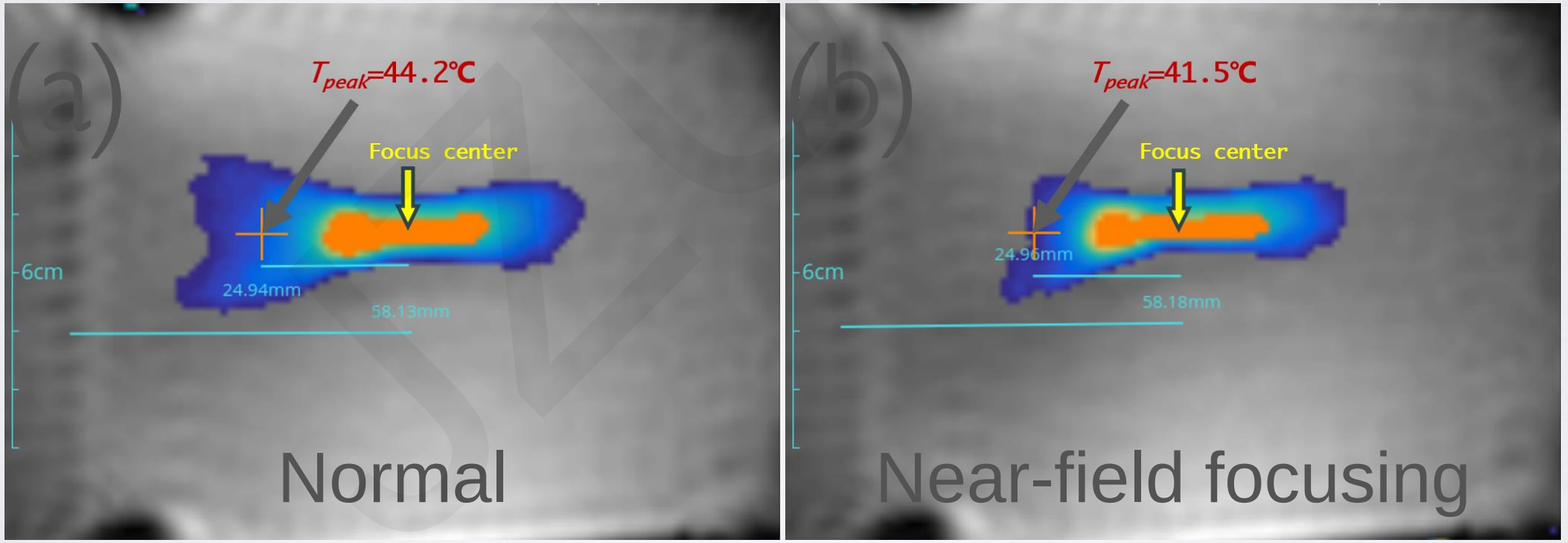
> When the transducer is positioned closer to the body and the focus is electrically steered back to the target, the beam footprint at the skin becomes larger, reducing average surface intensity without lowering acoustic power.



Less prefocal heating, same ablation outcome

MR-guided phantom experiments confirm the benefit

> Near-field focusing with a Fibonacci lattice array significantly reduces prefocal temperature rise while maintaining comparable ablation volume, as verified by MR thermometry.



Towards safer and more efficient HIFU ablation

A practical strategy for large-volume and rapid focus scanning

> Combining Fibonacci-based array design with near-field focusing expands the safe steering range and mitigates treatment risks, offering a promising pathway for safer clinical phased-array HIFU therapy.

Paper summary:
This study demonstrates that a uniformly distributed, symmetry-free spherical array can improve beam steering performance, and that near-field focusing effectively suppresses prefocal heating without compromising ablation efficacy.