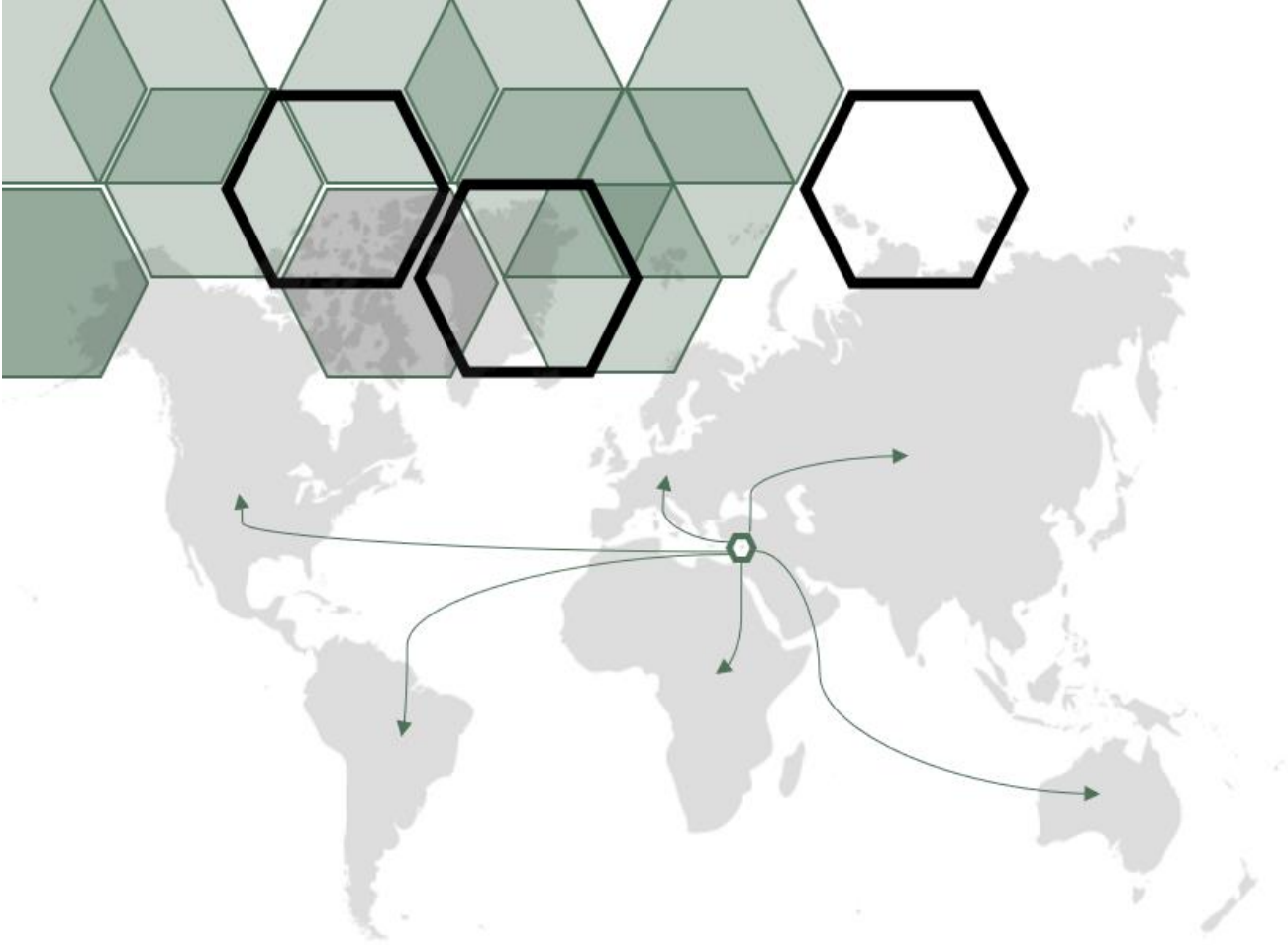

**JANUARY 23rd, 2023**

**INTEGRATED/0918/0008**

# SOUNDPET NEWSLETTER

## ISSUE 5

**Providing with news on MRI guided Focused Ultrasound technology in the field of oncology, in the framework of the SOUNDPET project!**

## INDEX




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## MRI Thermometry of Focused Ultrasound

The SOUNDPET robotic system was accommodated on the table of a 1.5 T (Signa HD16, GE Healthcare, Chicago, Illinois, USA) and 3 T (Magnetom Vida, Siemens Healthineers, Erlangen, Germany) MRI scanners and focused ultrasound (FUS) sonications were executed on agar-based phantoms. The in-house software platform developed in C# (Visual Studio, Microsoft Corporation), was employed for monitoring the sonications and generating MR thermometry data. MR thermometry data in the form of colour-coded thermal maps overlapped on MRI images and time-series temperature graphs, were presented on the software's interface, next to the treatment planning window, providing temperature monitoring during sonications. Dependencies of the temporal and spatial resolution of MR thermometry temperature measurements with the magnetic field strength, the FUS sonication parameters and the MRI image acquisition parameters were examined.

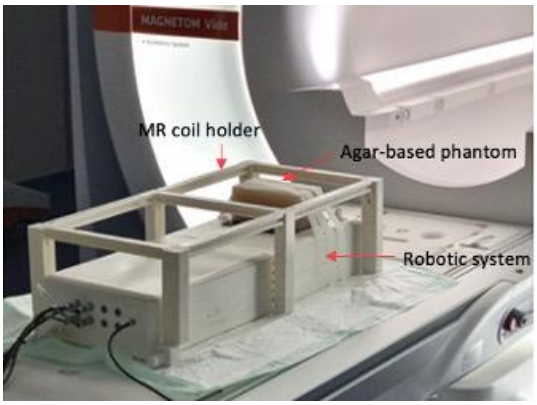
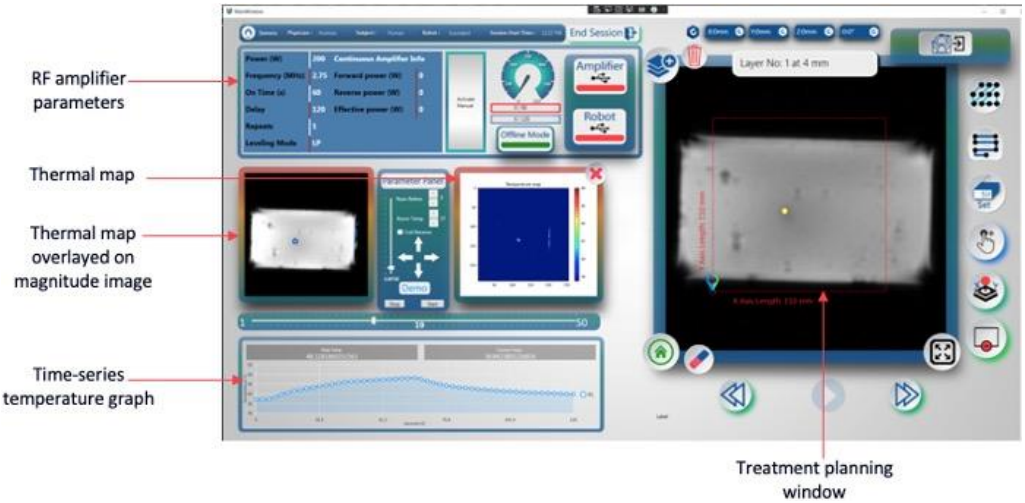



*Photo of the robotic system accommodated on the table of the MRI scanner with the agar-based phantom positioned on top for sonications.*




*Screenshot of the in-house software platform providing MR thermometry monitoring.*

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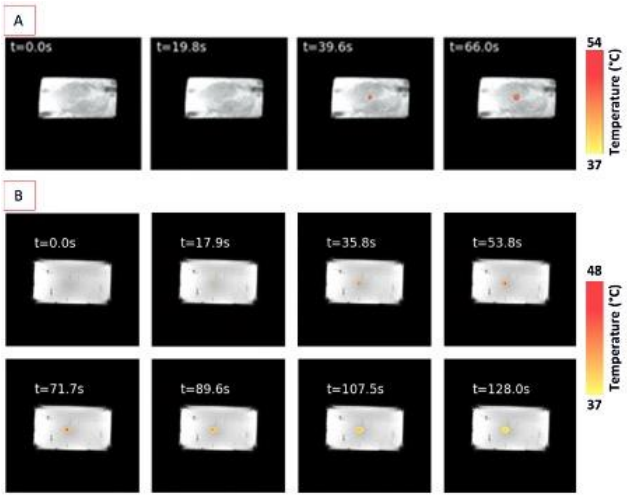
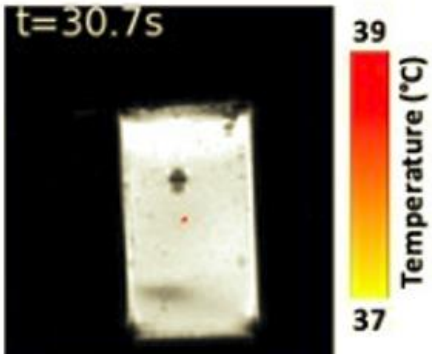
## MRI Thermometry of Focused Ultrasound (cont.)

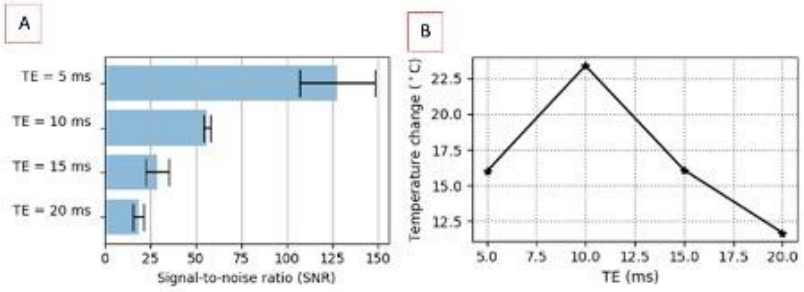
The effect of magnetic field strength was originally examined by executing identical sonications inside the 1.5 T and 3 T MRI scanners. MR thermometry data for sonications inside the 3 T scanner were produced 2.5 times more rapid compared to 1.5 T, while the generated thermal maps were of an increased image quality with decreased artifacts. Since the 3 T MRI scanner provided more accurate monitoring of the FUS sonications, it was employed to assess the effect of the sonication and imaging acquisition parameters on the MR thermometry. The effect of the applied acoustic power was investigated for a series of sonications executed at varied power for a constant sonication time. Increased acoustic power resulted in increased MR thermometry calculated temperature changes with the lowest acoustic power of 1.5 W producing reliable temperatures. Finally, a series of images were acquired with varied echo time (TE) during identical FUS sonications to evaluate the dependency of the temperature change with the acquisition parameters. Signal to noise ratio (SNR) measurements were performed for each TE to examine the image quality. Increased TE revealed a negative effect on image SNR with appropriate TE selection resulting in the highest temperature sensitivity.




*Coronal thermal maps of the agar based phantom obtained at different timepoints during sonications with a 2.6 MHz transducer at acoustic power of 60 W for a sonication time of 60 s at 40 mm focal depth inside A) a 1.5 T scanner, and B) a 3 T scanner.*




*Coronal thermal maps of the agar based phantom obtained at the end of sonication at acoustic power of 1.5 W for a 30 s sonication time at 45 mm focal depth inside a 3 T scanner.*




*A) Bar chart of SNR for images acquired with different TE values, and B) Maximum temperature change measured for different TE values as a result of sonications executed at acoustic power of 45 W for a sonication time of 30 s at 35 mm focal depth inside a 3 T scanner.*

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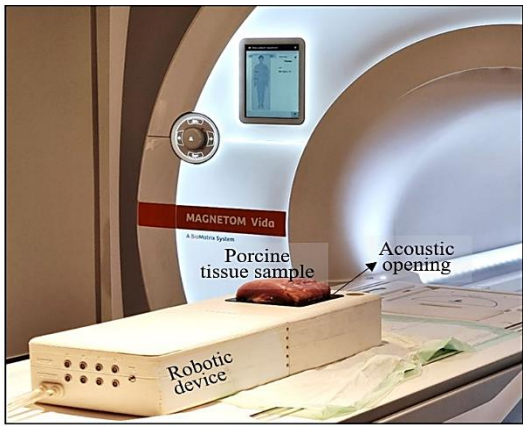
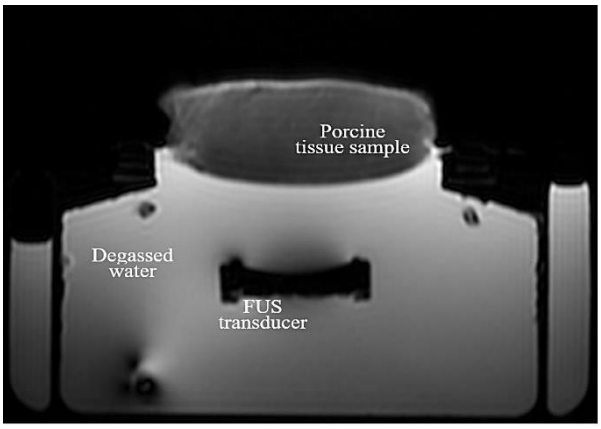
## MRI Monitoring of lesions induced by Focused Ultrasound

Multiple sonications were planned on the custom-made software and executed by the SOUNDPET system in freshly excised porcine tissue. The impact of critical imaging parameters on the resultant contrast to noise ratio (CNR) between ablated and intact tissue was investigated to optimize lesion discrimination on T1-W and T2-W Fast Spin Echo (FSE) images. Both discrete and overlapping lesions were inflicted in pork tissue samples with simultaneous acquisition of T2-W images to visualize the heated area and assess lesion progression with time.

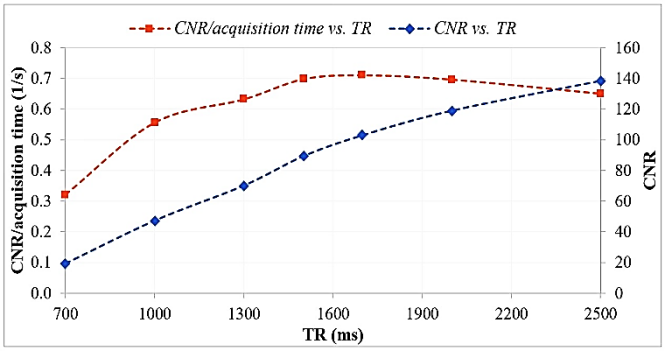



*The robotic device positioned on the MRI table of the 3 T MRI scanner with the piece of meat mounted on the acoustic opening for ablation experiments.*




*T2-W FSE image of the setup showing the concept of tissue sample placement above the FUS transducer.*

Critical MR parameters were optimized by balancing between the CNR and acquisition time, provided that the imaging time is an important parameter in the context of intraprocedural lesion monitoring. The use of CNR values above 80 was set as the criterion for proper lesion visualization on T1-W and T2-W FSE images.




*CNR between lesion (68 W acoustic power for 120 s at 2.6 MHz) and normal tissue and CNR/acquisition time of T1-W FSE images versus TR at 3 T.*

| MR parameter | T1-W FSE | T2-W FSE |
|---|---|---|
| TR (ms) | 1500 | 2000 |
| TE (ms) | 10 | 50 |
| ETL | 60 | 60 |
| NEX | 1 | 1 |
| pBW (Hz/pixel) | 150 | 150 |
| Matrix size | 256×256 | 256×256 |
| FOV (mm²) | 280×280 | 280×280 |
| Slice thickness (mm) | 5 | 5 |

*Summary of suggested MR parameters for optimizing CNR between lesion and tissue at the minimum time cost.*

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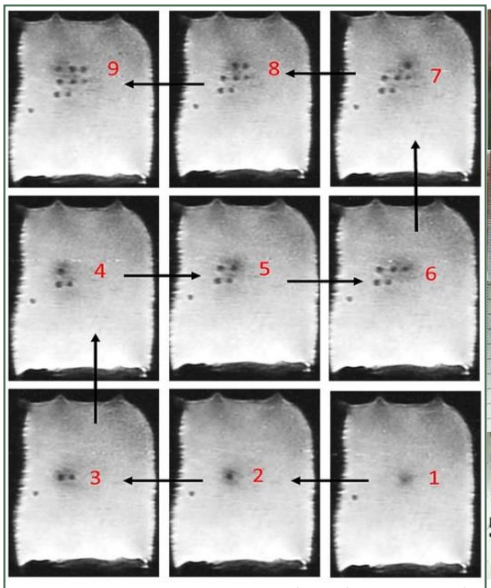
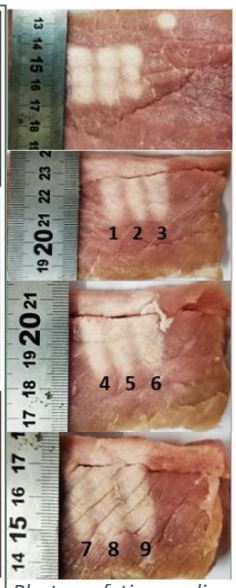
## MRI Monitoring of lesions induced by Focused Ultrasound (cont.)

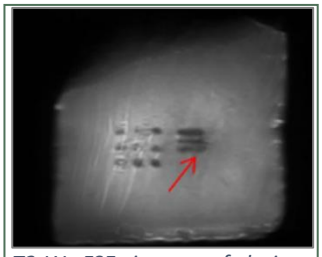
Lesion progression in both discrete and overlapping patterns was successfully monitored by MRI. During sonications, acute FUS lesions were visualized as spots of reduced intensity with excellent contrast from the surrounding intact tissue. It was demonstrated that multiple images should be acquired at varying depth in tissue to avoid non-detectability of shifted lesions. The T2-W FSE sequence yielded higher CNR and was considered preferred for lesion monitoring in *ex-vivo* tissue.




*T2-W FSE images acquired with optimized parameters during ablation in a 3×3 pattern (ac. power of 54 W for 120 s, 10-mm step, 60-s delay) in the 1.5 T MRI scanner.*




*Photos of tissue sliced horizontally (top) and vertically (bottom, 1-9) showing the formed lesions.*



*T2-W FSE image of lesions formed in 3x3 discrete (left, 10 mm step) and overlapping (right, 5-mm step) patterns in the 3 T MRI scanner.*

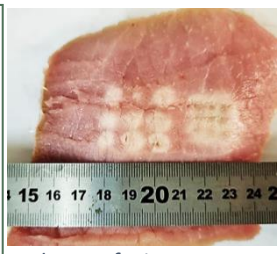


*Photo of tissue cut horizontally showing the formed lesions.*

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