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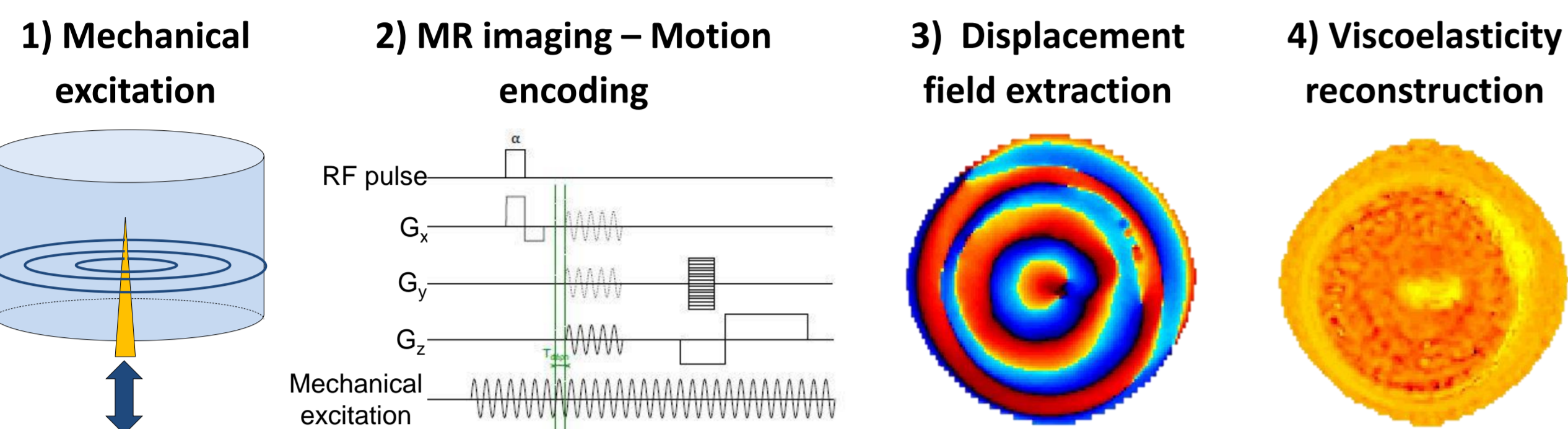
Development of an elastography bench for MR exam of small samples

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Introduction

Extraction of biomechanical parameters for small samples via **Magnetic Resonance Elastography (MRE)**:



Need of: - Wave amplitude > μm
 - High signal to noise ratio (SNR) with high resolution
 - Low cost and handy design

Methods

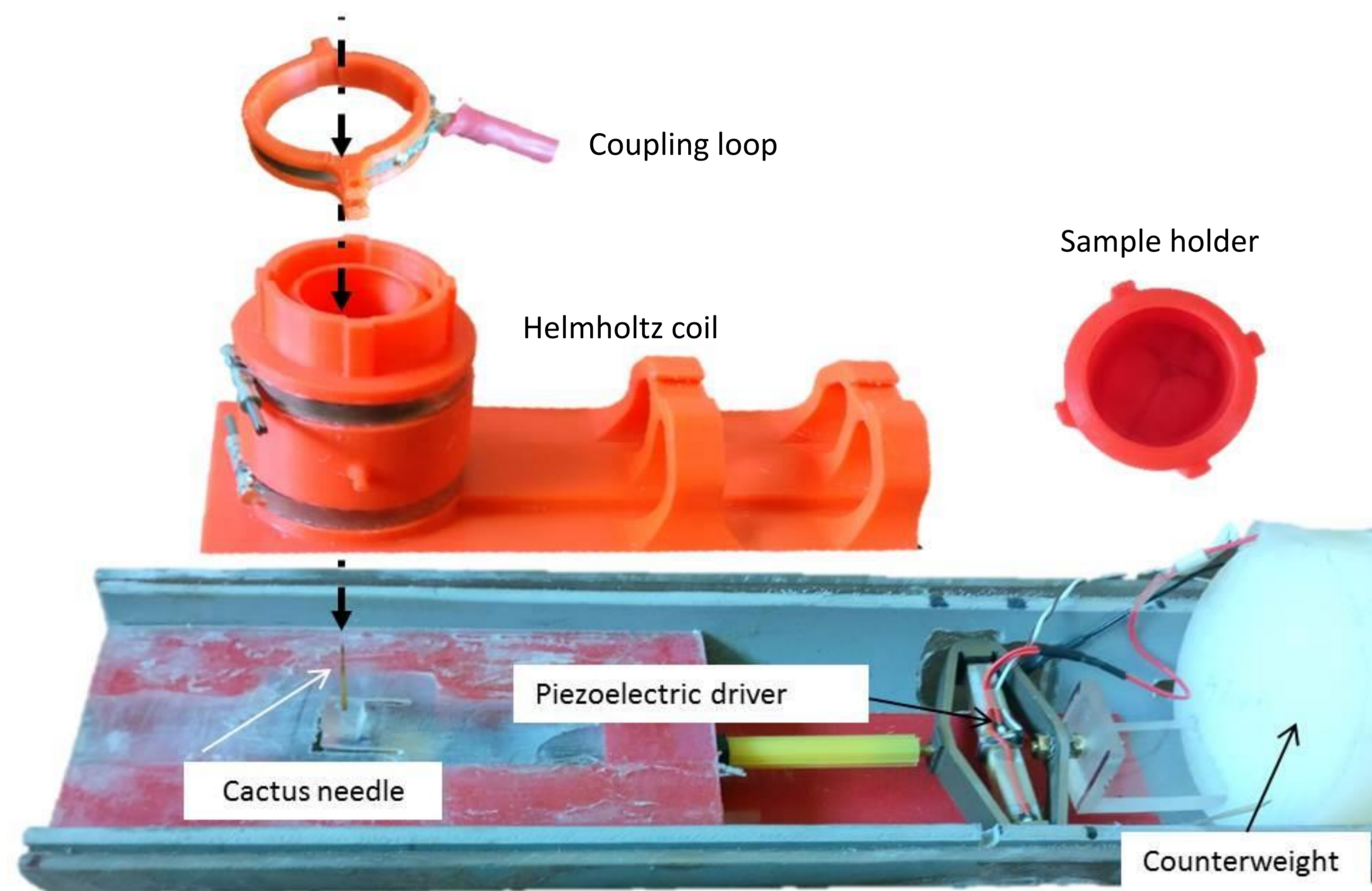


Figure 1. 3D-printed device on top of a classical elastography setup:

- Helmholtz coil ($\varnothing = 36 \text{ mm}$):
Tuning: capacity trimmers
Matching: Coupling loop (inductive coupling)
- Sample holder gliding into the coil

Acquisition on a Bruker 4.7 T scanner for fibrin and agarose 1,5% gels and an *ex vivo* rat brain:

Acquisition parameters	FLASH 3D	Turbo spin echo (MRE)
TR/TE (ms)	15/6	2000/18 - 24
Voxel size (mm)	0.312x0.312x0.625	0.312x0.312x0.625
FOV (mm)	40 x 40	40 x 40
Flip angle (°)	15	X
Reception bandwidth (kHz)	50	50
Acquisition time (min)	2	17
Excitation frequency (Hz)	X	600 - 1000

Table 1. Acquisition parameters for an anatomical (FLASH) sequence and a conventional spin echo based elastography sequence

Results

Figure 2. SNR worked out on central slices of a **FLASH sequence** for a bioengineered gel and a rat brain:

$\text{SNR}_{\text{gel}} = 83$
 $\text{SNR}_{\text{brain}} = 64$

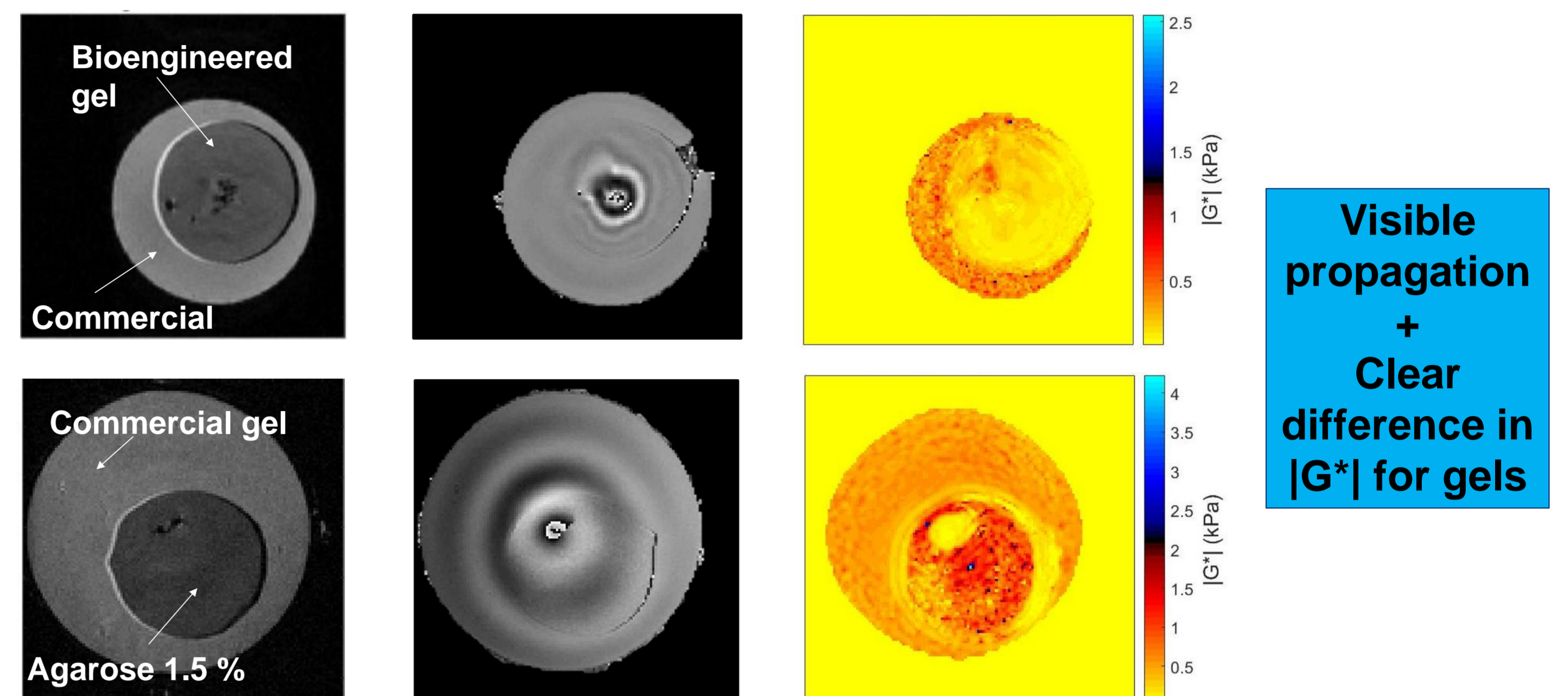
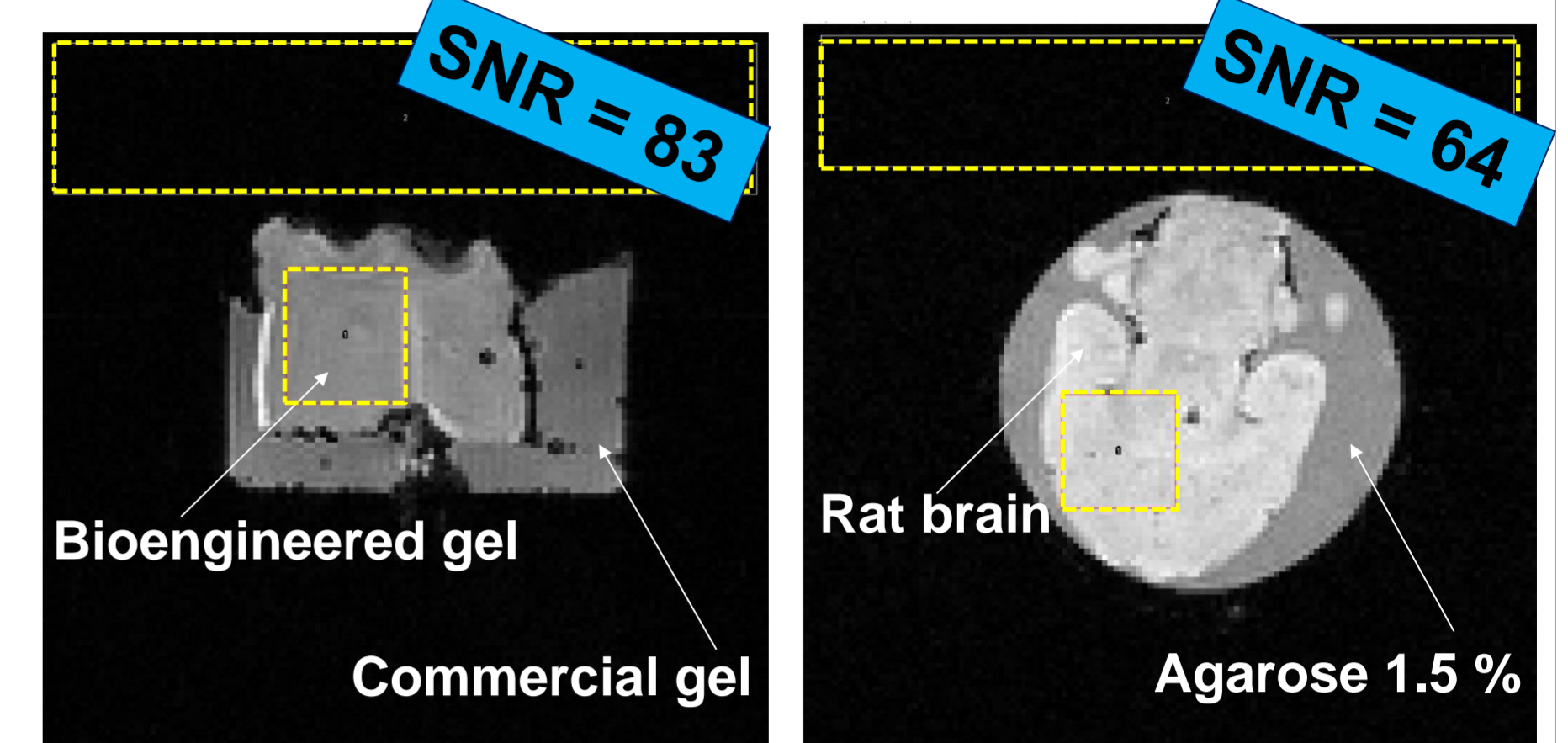


Figure 3. Magnitude, phase and reconstructed magnitude of the complex shear modulus $|G^*|$ obtained by MRE at 600 Hz for the bioengineered gel and an 1.5% agarose gel, both embedded in a commercial gel. Total displacement magnitude $\langle A \rangle$ was $3.8 \mu\text{m}$ for the first gel and $25.5 \mu\text{m}$ for the agarose gel after bench improvement. $|G^*| = 1.4 \pm 0.5$ and $7.3 \pm 3.9 \text{ kPa}$, respectively.

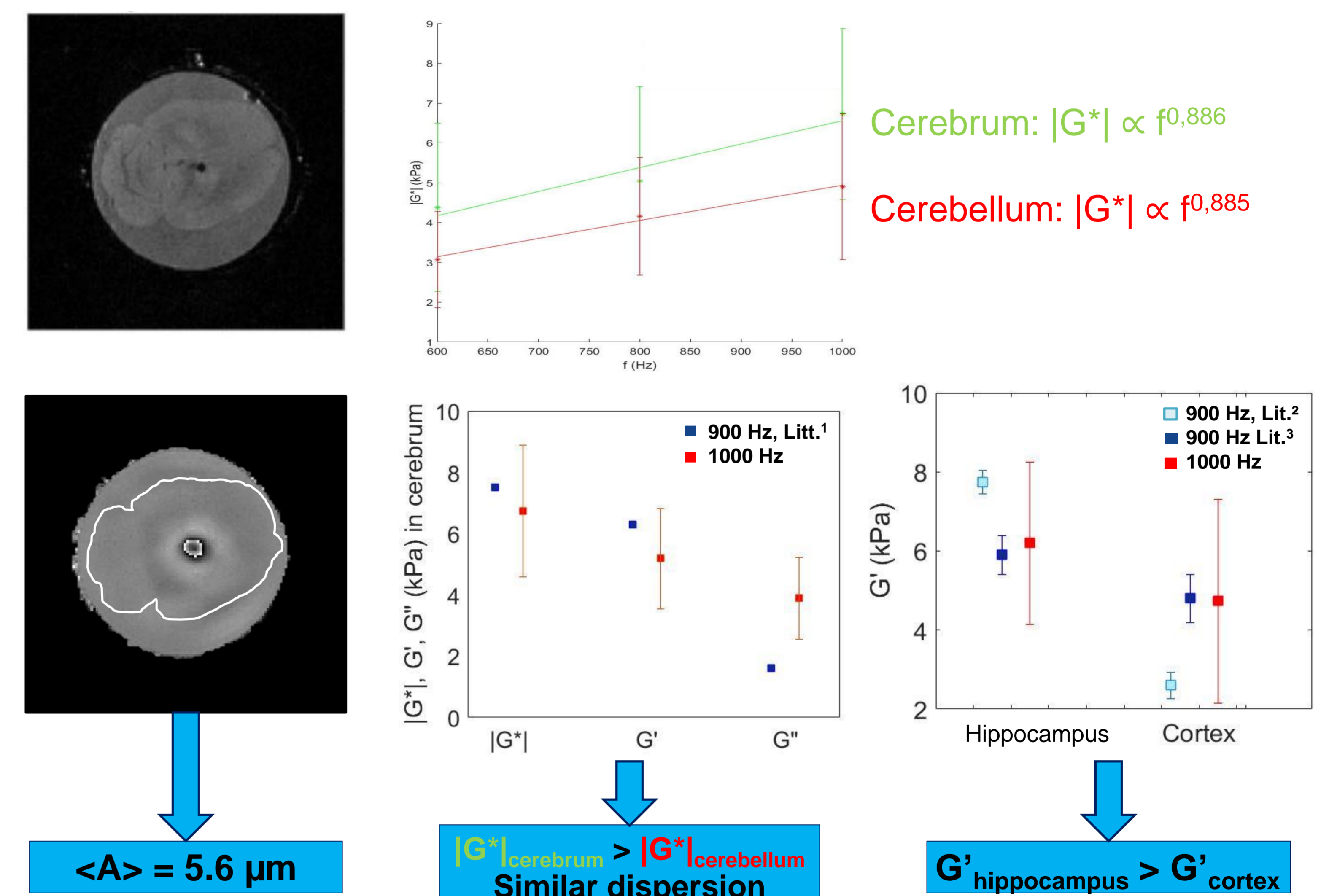
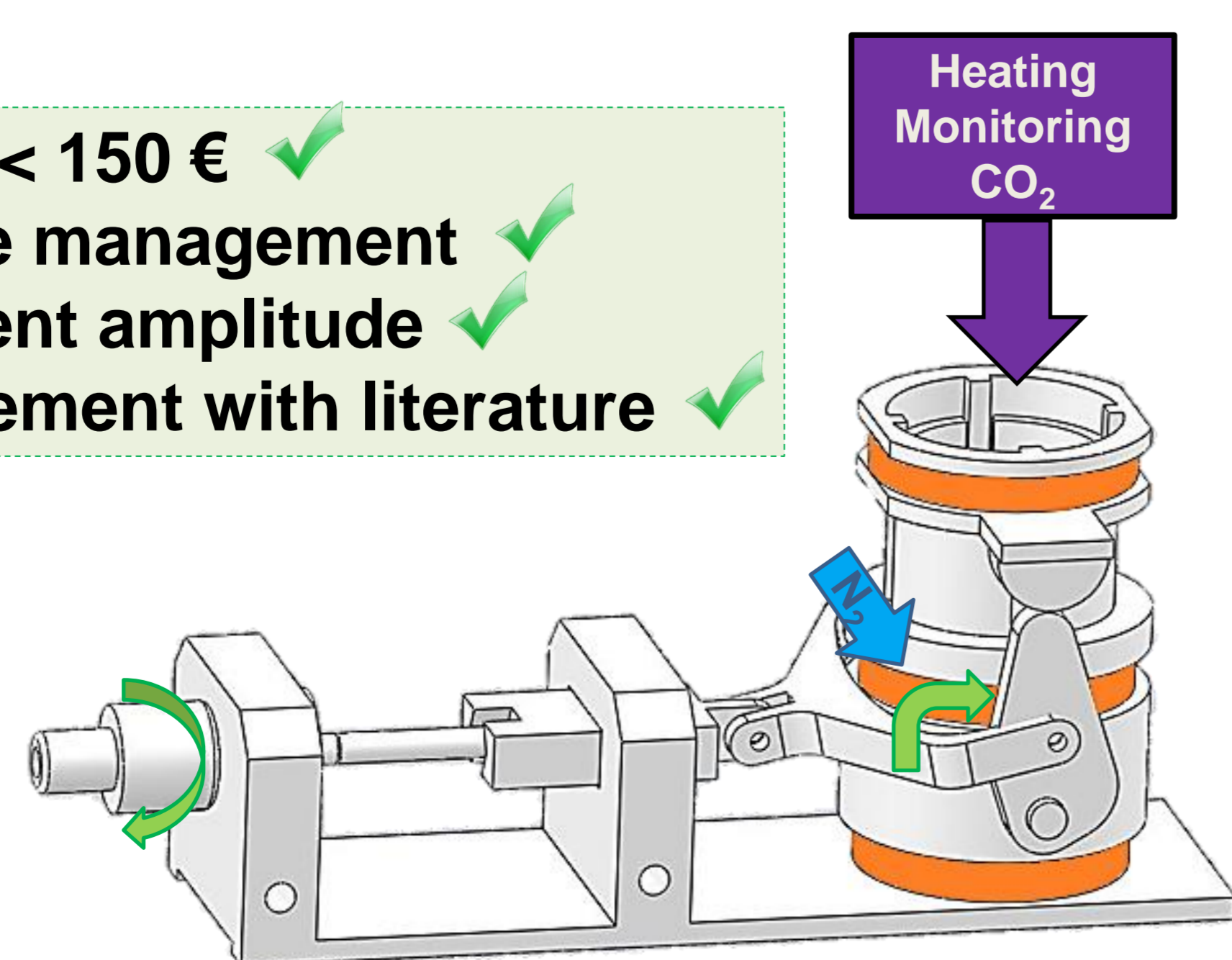


Figure 4. Magnitude and phase images of a fresh *ex vivo* rat brain for an excitation frequency of 600 Hz. Comparison of extracted biomechanical parameters G' (conservation modulus), G'' (loss modulus) and $|G^*|$ with literature data

Discussion and Conclusion

- Cost < 150 € ✓
- Easy sample management ✓
- Displacement amplitude ✓
- Brain data in agreement with literature ✓



Planned **improvements**, in order to enable:

- imaging of samples containing living cells: heating and its monitoring + gas arrival
- further improvement the SNR: N_2 arrival for coil cooling
- easier matching: lever system for the coupling loop.

Perspectives: *ex vivo* acquisitions on rodent brains with neurological lesions (fibrillar aggregates of proteins, demyelination).

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References: (1) Millward *et al.*, NMR Biomed., vol 28 2015. (2) Munder *et al.*, J. Magn. Reson. Imaging, 2017. (3) Boulet *et al.*, J. Neurosci. Methods, vol 201, 2011.

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