

## Simultaneous detection of magnetic nanoparticles and the surrounding elasticity by pulsed magneto-motive ultrasound imaging for tumor diagnosis

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### Background

Since the introduction of ultrasound contrast agents, ultrasound have been applied for molecular imaging. However, microbubble-based contrast agents cannot cross endothelium wall, which will prevent them from reaching cancer cells located beyond the capillary vasculature. Nanobubbles are small enough to leak through the pores of tumor vessels, but still face the shortage in the abnormal lifetime and the limited targeting performance. Thus, the precise diagnosis of early tumor based on conventional methods is extremely challenging.

### Methods

Here, we present a new method for simultaneous detection of magnetic nanoparticles (MNPs) and the surrounding elasticity by pulsed magneto-motive ultrasound imaging (PMMUI). The mechanism is based on the motion of MNPs excited by pulsed magnetic field, which can be detected by Doppler ultrasound technique. Meanwhile, the induced vibration of MNPs will lead to shear wave (SW) propagation away from the region of excitation. By estimating the SW velocity, we can obtain the tissue elasticity information.

### Results

Fig. 1A was B-mode image of phantoms with local regions of MNPs and non-magnetic nanoparticles (non-MNPs). In the B-mode image, there was no significant differences between these two regions, which indicated that it was difficult to distinguish the targeted signal from the background. In contrast, the motion signal of targeted area was significantly distinguished from the background by PMMUI (Fig. 1B). Meanwhile, as shown in Fig. 1C, the SW propagation away from the region of MNPs was also detected. Finally, the time of flight method was used to calculate the SW velocity and then the elasticity of the region adjacent the MNPs can be obtained (Fig. 1D).

### Discussion

Tumor diagnosis relies upon the integration of multiple data-driven decision making. MNPs are well-known contrast agents in magnetic resonance imaging for tumor imaging. Recently, Riegler et al. (Clin Cancer Res, 2018) has proved that ultrasound elastography provides correlated information in tumor development. Thus, simultaneous detection of MNPs and elasticity distribution by ultrasound system will offer synergistic advantages for the early diagnosis of tumor.

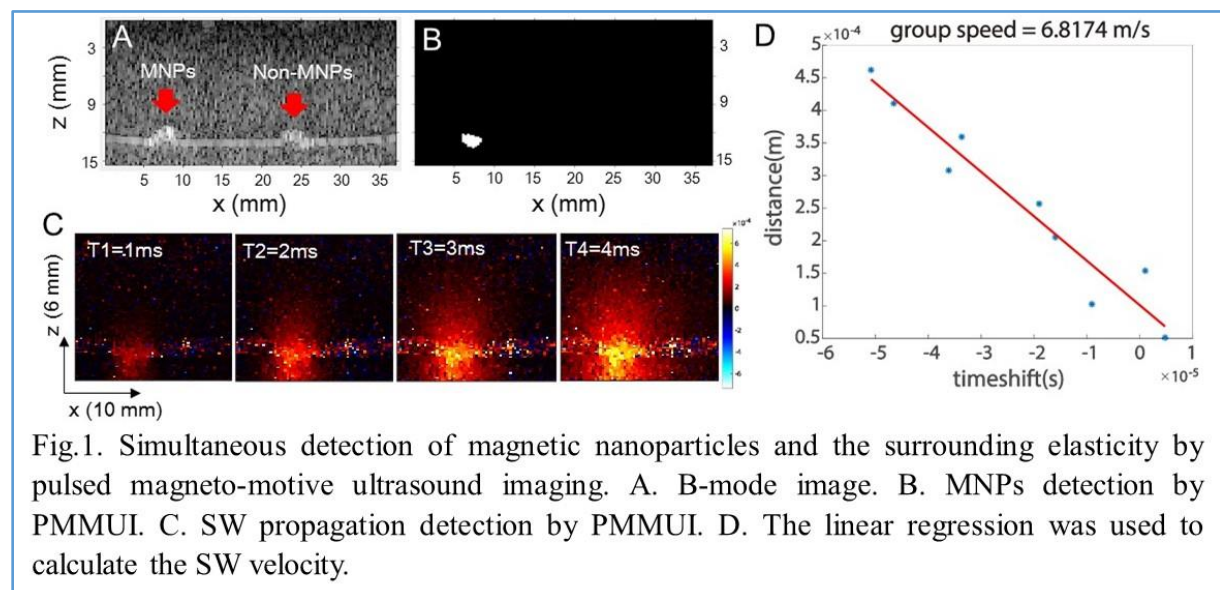


Fig.1. Simultaneous detection of magnetic nanoparticles and the surrounding elasticity by pulsed magneto-motive ultrasound imaging. A. B-mode image. B. MNPs detection by PMMUI. C. SW propagation detection by PMMUI. D. The linear regression was used to calculate the SW velocity.