

# AI-assisted Photoacoustic Spectral Unmixing Algorithm for the Micro to Macro Resolution Bladder Tumor Imaging

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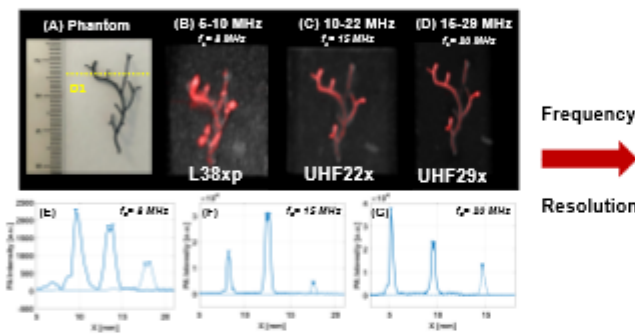
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## INTRODUCTION

- ✦ Ultrasound (US) transducers are **limited in frequency bandwidth**.
- ✦ As frequency increases, **resolution** increases, imaging **depth** decreases.
- ✦ Photoacoustic (PA) signals have **broadband frequency** content which could be leveraged to extract micro to macro level information of tissues.

### Tissue Mimicking Phantom

- ✦ A 3D printed (Formlabs Inc.) **blood vessel phantom** coated with black ink and embedded in tissue mimicking material.
- ✦ Imaged at **750 nm** using **Vevo F2 LAZR-X** system (FUJIFILM VisualSonics, Inc.) with **L38xp**, **UHF22x**, and **UHF29x** transducers.

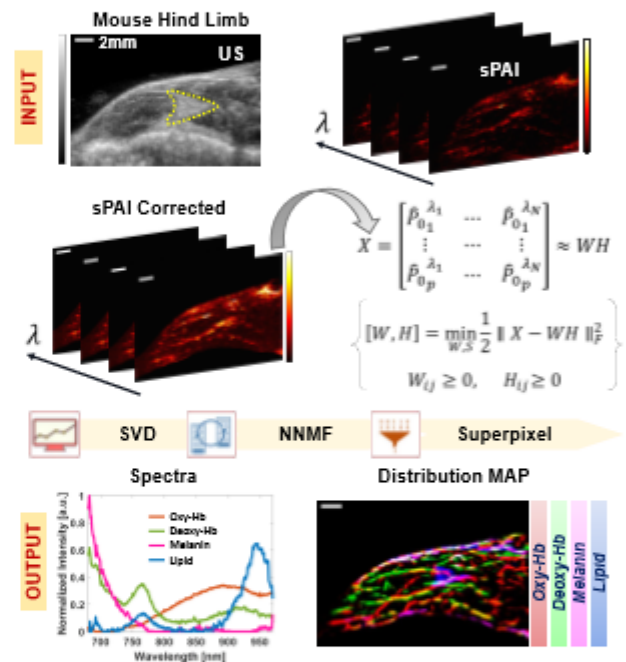


### Multi-Spectral PA Imaging (sPAI)

- ✦ Tissues illuminated with pulsed laser light at **different wavelengths** within the near-infrared (NIR) range.
- ✦ Different wavelengths **absorbed differently** by the distinct tissue components.
- ✦ **Spectral profiles of individual chromophores** must be efficiently distinguished through **unmixing** to know tissue composition.

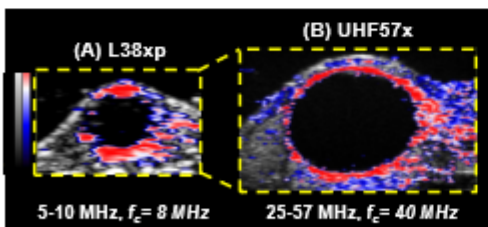
## SUPERPIXEL PHOTOACOUSTIC UNMIXING (SPAX)

- ✦ Standard unmixing: Require **input reference spectra**, extract mainly **prominent** absorbers.
- ✦ SPAX: A novel AI-assisted (**data-driven**) **spectral** unmixing.
- ✦ Features: US-guided **spectral fluence compensation**, extraction of **prominent** and **non-prominent** absorbers.



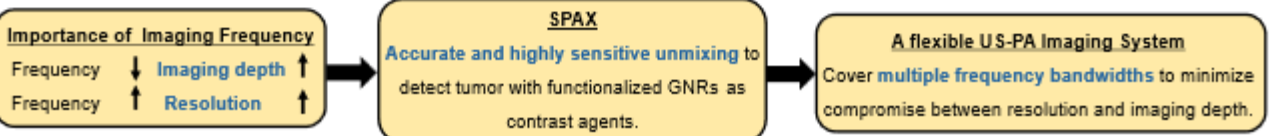
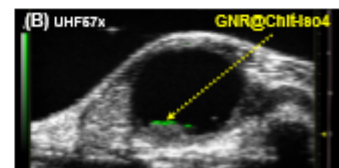
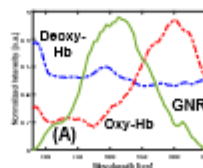
## MURINE BLADDER IMAGING

Imaging using **Vevo F2 LAZR-X** system with **L38xp**, **UHF57x** transducers.



- ✦ Instillation of **functionalized gold nanorods** as contrast agents (**GNR@Chit-Iso4**) into the bladder.

- ✦ **SPAX** efficiently unmixes the GNR spectrum to **specifically recognize GNR@Chit-Iso4** in the luminal area of tumor, but not the surrounding non-neoplastic urothelium.



## ACKNOWLEDGMENTS

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