



## High Resolution Magnetic Resonance and Cryo-Imaging for Morphological Phenotyping

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In our laboratory, we are developing MRI and cryo-imaging, as well as image analysis methods, for phenotyping disease states in mice. The Case cryo-imaging system consists of a large-scale cryostat outfitted with a bright-field/fluorescence microscope that serially sections and images the block face of a frozen specimen. Currently, we have registered the super high resolution cryo-imaging data (40  $\mu\text{m}$  isotropic voxels) with MRI (100  $\mu\text{m}$  isotropic voxels) as obtained on a 9.4T system. The 48-bit RGB cryo-images were corrected for uneven illumination and serially aligned. The MRI data set and cryo-imaging volume were first rigidly registered using a normalized mutual information algorithm, and then non-rigidly warped through selection of corresponding control points. Image fusion, as well as volume and surface renderings confirmed the efficacy of the registration. The value of the cryo-image data set is immediately clear; the color images combined with the high resolution reveal anatomical details unavailable using MRI alone. Details such as spacing between vertebrae, heart valves, muscle fibers, differentiation of fat types, and small blood vessels can be clearly seen in the cryo-images while they are difficult or impossible to recognize in the MRI. We conclude that cryo-imaging will be a valuable adjunct to MR imaging, and other in vivo modalities, because it elucidates fine phenotypic details not found with other imaging modalities.

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