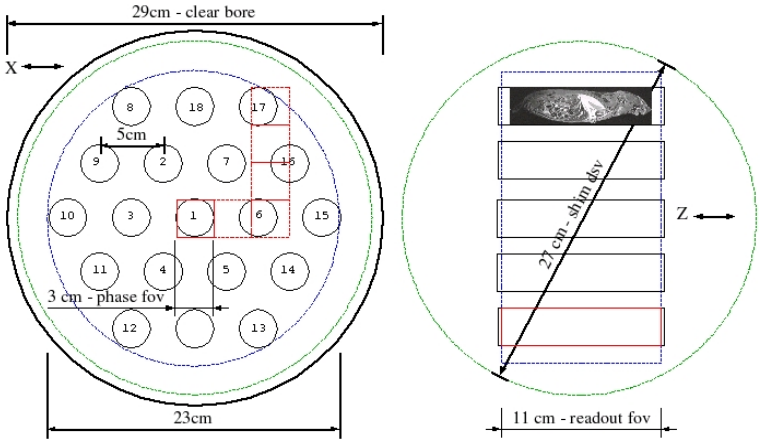
Multiple Mouse MRI of 16 Mice

J. Bishop[1], N. Bock[2], B. Nieman[2], J. Dazai[1], L. Davidson[1], M. Henkelman[1,2]

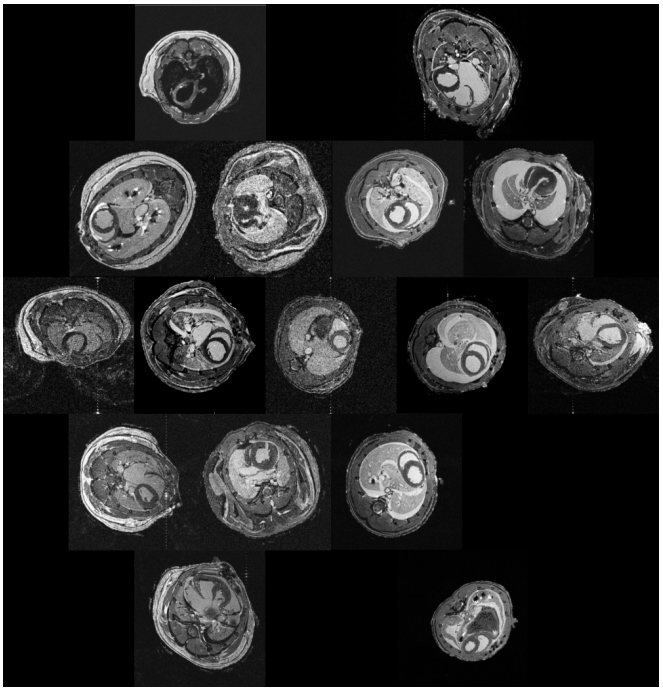
[1]Hospital for Sick Children, Toronto, ON, Canada, [2]Medical Biophysics, University of Toronto, Toronto, ON, Canada

Introduction We have previously demonstrated multiple mouse MRI with four live mice.[1] Other researchers have demonstrated parallel MRI of eight fixed mice.[2] In this work we extend the concept to show whole-body imaging of 16 fixed mice.

Materials and Methods A 7T MRI scanner (Varian INOVA) with four rf channels and a 29 cm bore gradient coil was used. Additional custom hardware multiplexed 16 coils into the four Tx/Rx channels in a simple TR-interleaved fashion. The isolation of the rf channels was previously shown to be < 2%[1] and the multiplexing hardware added several dB to the noise floor. Normal and mutant mice of 20-30 grams (live) weight were fixed with Gd and Mn. Millipede[3] coils of 3 cm i.d. were positioned in the Z=0 plane of the magnet in a hexagonal array (figure 1). The maximum imaging field-of-view for each mouse was roughly 3x3x11 cm (red outline), and the entire array was contained within a cylindrical volume of 23 cm diameter by 11 cm length (blue outline).



Total setup time, including manual prescan and coil tuning, was about 45 minutes. Prescan did not include any shimming. Instead, the superconducting shim d.s.v. was increased from 20 to 27 cm (green line) for optimal homogeneity over the 23x11 cm cylindrical imaging volume. Three-dimensional spin-echo imaging with tr/te = 650/15 ms was performed for 13 hours to achieve 100 μm isotropic resolution. The total data set of 4.5 Gb was transferred offline to a multi-processor computer (SGI Origin) for reconstruction. In addition, gradient and B_0 field non-uniformity in the magnet Z=0 plane were measured at coil positions 1 (0,0 cm) and 16 (7.4,4.3 cm).



Results Figure 2 shows axial slices of the 16 fixed mice. The images are positioned at their corresponding XY offsets in the array, minus air gaps between the coils. The images have been shifted to account for the offset phase field-of-view (figure 1, red outlines). Signal/noise ratio and contrast differ between images due to variations in coil/sample loading and contrast perfusion. The maximum distortion due to gradient non-linearity in coil position 16 was < 10% and B_0 inhomogeneity was equivalent for coil positions 1 and 16.

Conclusions We have shown a technique for multiple mouse MRI that may be conducted with up to 16 fixed mice. The present configuration of TR-multiplexing 16 samples into 4 rf channels, combined with limited heat extraction from our gradient coil, precludes fast gradient-echo imaging but permits separate control of frequency per coil for precise placement of slab-selective observation and saturation pulses.

1 Bock N, Beatty P, Chen X et al. Proc. 11th ISMRM, p 1304 (2003).

2 Matsuda Y, Utsuzawa S, Kurimoto T, et al. Magn. Reson. Med 50: 183-189 (2003).

3 Wong WH et al. Proc 8th ISMRM, p 1399 (2000).