An Asymmetric Insert Quadrature Birdcage Coil for Hyperpolarised ^{129}Xe Lung MRI at 1.5 T

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Introduction: The objective was to develop an insert body transmit-receive birdcage RF coil for imaging of hyperpolarised ^{129}Xe in the lungs at 17.7 MHz at 1.5 T. The design makes efficient use of the available bore space within a clinical MR system, has homogenous B_1 field and is transparent to the ^1H body coil making anatomical ^1H imaging of the chest possible without moving the coil.

Materials and Methods: For patient comfort and for future accommodation of a receive array, the coil size is maximised to make full use of the magnet bore. The mesh of the coil's conducting elements follows the pattern of a coil previously developed for ^3He lung MRI[1]. The positions of the coil's 12 elements were designed using conformal mapping methods[1] to produce a highly homogeneous B_1 field. **Fig. 1** shows a photograph of the coil mesh and the finished coil on the patient bed. The coil has a band-pass design, with capacitors located on the mid-points of the legs and rungs. To determine the approximate capacitor values required to resonate the coil at 17.7 MHz, an algebraic method[2], which uses the measured self and mutual inductances of the 12 meshes. By inversion of Leifer's expression[3] for the eigen-modes of the coil, the resulting capacitance values provided the first iteration. Due to inductive coupling of the xenon coil to the ^1H body birdcage coil of the magnet (Signa HDx, GE), a decrease in all of the simulated capacitances was needed and the final values are summarised in **table 1**. Mesh #1 is located at the top of the coil. Lattice matching networks were connected across end-ring capacitors at mesh positions 6 and 9 for quadrature excitation (**Fig. 1 top**).

Experiments were performed on a healthy volunteer (26 years old, 50 kg). ^{129}Xe was polarised by Rubidium (Rb) spin exchange using a homebuilt regulatory-approved polariser system.[4] After an hour accumulation, the frozen xenon was then sublimated and collected in a 500 mℓ dose in a 1 ℓ Tedlar bag which was filled up with medical grade N_2 gas. The typical polarisation of the gas after thawing was ~10%. ^{129}Xe ventilation images were obtained at breathold with 3 image acquisitions per slice to obtain ventilation images as well as a B_1 map. The sequence was a 2D spoiled gradient echo, parameters were: 20 mm coronal slices covering the whole lung, FOV of 40 cm x 40 cm, resolution of 64 x 64 matrix, BW of 8 kHz, TE/TR of 4/10.2 ms, flip angle of 4°.

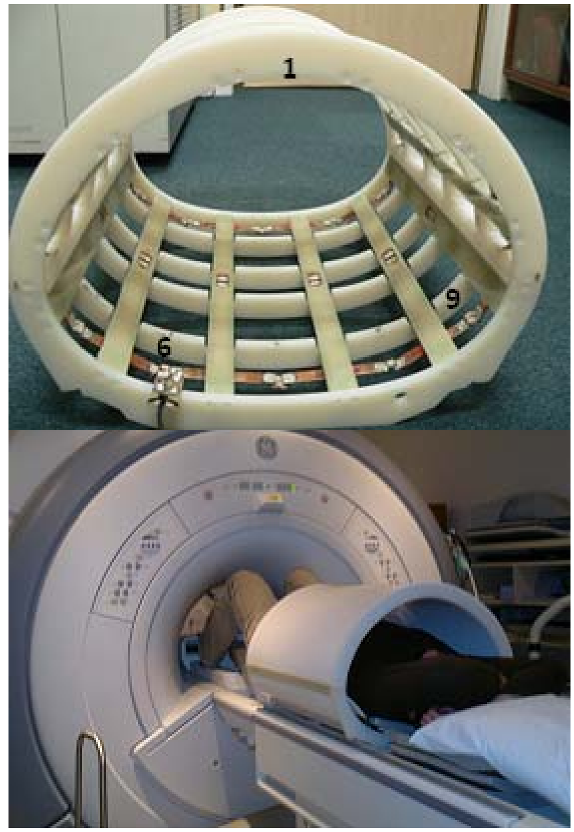

Figure 1. Insert xenon body coil with 12 mesh (top) and setup on a clinical 1.5 T system with patient access (bottom).

Mesh Position	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_{12}	C_{23}	C_{34}	C_{45}	C_{56}	C_{67}
Cap. value [pF]	620	640	790	820	979	640	550	1700	4420	2220	∞	1860	840

***Table 1.** Capacitor values at their corresponding mesh position of half the xenon body coil, as it is symmetrical along the vertical line.* Single subsripts indicate end-ring capacitors and double subscripts indicate leg capacitors.

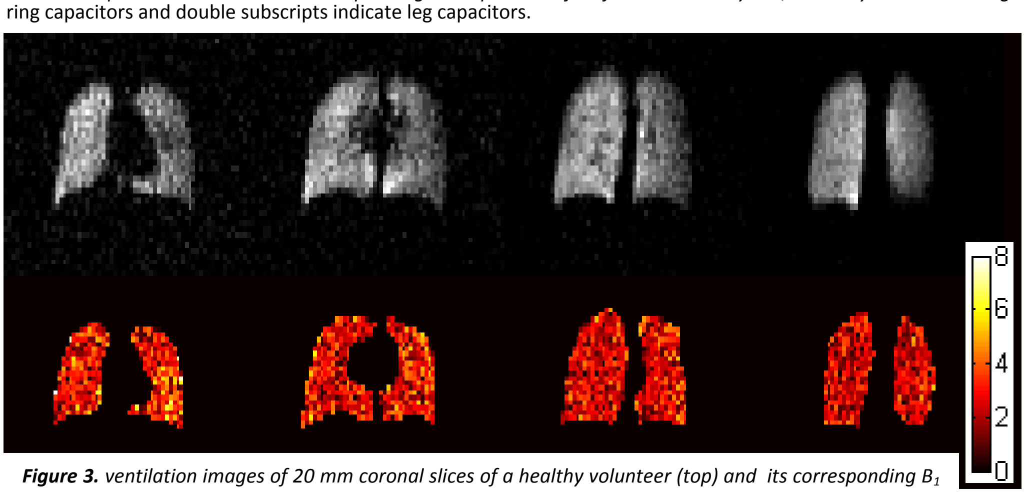

***Figure 3.** ventilation images of 20 mm coronal slices of a healthy volunteer (top) and its corresponding B_1 maps (bottom).*

Results and Discussion: Fig. 2 shows preliminary in-vivo images obtained from a healthy volunteer along with their corresponding B_1 maps, both show a high degree of spatial homogoneity . A whole body asymmetric birdcage transmit receive coil is demonstrated for hyperpolarised ^{129}Xe MR lung imaging. In future work the coil will be used as a transmit-only coil in conjunction with a custom receive array.

References: [1]De Zanche et al,. MRM 53(1):201-211 (2005). [2]ESMRMB #824 (2006). [3]Leifer et al,. JMR 124(1): 51-60 (1997). [4]Parnell et al,. JAP 108:064908 (2010). ***Acknowledgements**: EPSRC. EP/D070252/1.*