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Title: Simultaneous imaging of lung structure and function with triple nuclear MRI

Prof. J.M. 223 Wild j.m.wild@sheffield.ac.uk [1], Dr. Helen 224 Marshall h.marshall@sheffield.ac.uk [2], Mr. Graham 225 Norquay g.norquay@sheffield.ac.uk [3], Ms. Peggy 226 Xu x.xu@sheffield.ac.uk [4] and Dr. Juan 227 Parra-Robles j.parra-robles@sheffield.ac.uk [5]. [1] Academic Radiology, University of Sheffield, United Kingdom, S10 2JF .

Body: Rationale In this work, we re-engineer a standard clinical MRI scanner to allow spatially registered human lung imaging from three different nuclei simultaneously with 1H anatomical images and hyperpolarized 3He and 129Xe lung ventilation images. Methods This is achieved by the use of geometrically nested, decoupled radio-frequency (RF) coil hardware resonating at the respective resonant frequencies. Multi-nuclear RF transmission and reception is achieved by rapid switching (< 10 ms) between the signals from the respective nuclei. The technique is demonstrated with simultaneous imaging of 3He, 129Xe and 1H in the lungs of healthy normal's following an inhalation of a 1 litre bag of gas containing 300 ml 3He and 400 ml N2 Main Results

See Fig. 1 Images of 1H, 3He (red), and 129Xe (blue) acquired from a healthy volunteer in the same breath containing 300 ml of 129Xe and 300 ml of 3He; the anatomical 1H images show excellent spatial registration with the 3He and 129Xe ventilation images as demonstrated by the overlaid fused image (purple). Conclusions The precise temporal and spatial registration of these images is impossible to achieve in separate breath-hold scans. This new system opens up the possibility of simultaneous capture of regional lung function by exploiting the different properties of 3He and 129Xe gases (eg different diffusivities) with lung structure and anatomy from the 1H MRI without reliance on ionizing radiation.