Development of a cryogen-free $^{129}$Xe and $^{83}$Kr hyperpolarizer to enable and facilitate pre-clinical MRI of lungs.

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One person in seven is affected by lung disease in the UK but, in stark contrast to a 50% reduction in deaths from ischaemic heart diseases since the mid eighties, the percentile of pulmonary disease inflicted deaths has improved little during this period. The first significant advancement in lung functional diagnostics in decades comes from hyperpolarized (hp) helium-3 ($^3$He) and xenon-129 ($^{129}$Xe) MRI. In addition a third noble gas isotope, krypton-83 ($^{83}$Kr), is being exclusively developed at the Sir Peter Mansfield Magnetic Resonance Centre in Nottingham. The high MR signal intensity associated with the hyperpolarization of these non-toxic and non-radioactive noble gases is obtained through laser based methods and enables lung functional contrast.

Methodological development of hp pulmonary MRI is a quest for higher signal intensity and better spatial resolution but also a pursuit for novel sources of disease indicative contrast. The Royal Society funded development of a hyperpolarizer for pre-clinical pulmonary MRI advances the field in two key areas: (1) Producing hyperpolarized $^{83}$Kr, a completely novel pulmonary contrast agent, for the first time for in vivo MRI. (2) Streamlining the production process for hyperpolarized noble gases for pre-clinical settings. In particular, a hyperpolarizer is developed and constructed for the Small Animal Imaging Facility at Nottingham.

The hyperpolarizer supported through fund Paul Instrument Fund allows for cryogen free production of hp $^{129}$Xe and hp $^{83}$Kr. The test assembly of the instrument has already enabled biomedical research in explanted organs. Hp $^{83}$Kr is a completely novel and unique contrast agent that is sensitive to the lung surface. The new hyperpolarizer is the first of its kind to allow for in vivo preclinical hp $^{83}$Kr MRI.

My Paul Instrument Fund has enabled me to develop a unique hyperpolarizer for pre-clinical applications. It allows for the novel technology to move out of the physics laboratory into the biomedical environment of the small animal Imaging facility. This is an important step forward in the advancement hp $^{83}$Kr as a of the novel contrast agent. The hyperpolarizer will serve as a basis for a number of collaborations and as a platform for funding proposals. Even during the testing phase, two collaborations with biomedical groups have been established working on emphysema, fibrosis, and asthma. Since I only moved recently to the UK (2009), the Paul instrument Fund has been particularly valuable for me to establish my research here.