

Date of submission:  
Project title: Improved diagnostics for  
magnetic resonance imaging in  
microvascular stroke and ageing

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## SINAPSE PhD Project Proposal Template for PhDs with Industry starting in 2010

### PROJECT

#### Title:

Improved diagnostics for magnetic resonance imaging in microvascular stroke and ageing

#### Planned start date (month/year):

October 2010

#### SINAPSE Centre (i.e. primary university to which this studentship will be attached):

Edinburgh

#### University first supervisor: contact details

Name: Dr Mark Bastin (Prof Joanna Wardlaw)  
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#### Second academic supervisor/ other university or other people in primary university involved with project

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#### Industry

GE Healthcare

#### Industry main contact details

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#### Key Other Industry people involved with Project including Industry Supervisor (if different to Industry main contact above)

Dr Scott Reid, GE

Once completed, please return to Dr Janet De Wilde [jdewilde@staffmail.ed.ac.uk](mailto:jdewilde@staffmail.ed.ac.uk)

**Likely background of suitable student (eg. Neuroscience, MR Physics, Chemistry, Engineering, Informatics, Psychology) and essential skills required prior to starting this PhD:**

Medical physics, physics, signal processing, engineering.

**Summary of proposed project (approximately 200 words):**

A quarter of all strokes are due to abnormal microvessels, but this small vessel disease is also a major cause of age-related cognitive impairment and dementia. Some features of small vessel disease are visible on conventional structural MRI, but by the time these changes are visible, much damage may already have been done to the brain. Recently developed techniques enable detection of subtle early changes that may relate to small vessel and brain tissue damage. These include new methods that enable visualisation of the venular system (e.g. 3D multi-echo T2\*-weighted sequences and phase mapping in conventional gradient echo MRI), of blood brain barrier function (permeability imaging using gadolinium and mathematical modelling), small vessel perfusion and brain mineralisation (iron in the form of basal ganglia deposits and microbleeds as well as calcium and other minerals). Realisation of the important role that brain mineral deposition may play in pathological processes is only now emerging so methods for detection and quantification of brain iron and of other minerals would be particularly valuable. All these techniques are only beginning to emerge, require further development and refinement particularly if quantitative measurements are to be made, and application in human studies to improve understanding of small vessel disease.

In this collaborative project with GE, the student will implement, modify and evaluate methods to increase sensitivity of sequences to brain mineralisation and other features of small vessel disease and to improve analysis of this novel imaging data. Of particular interest are developing and evaluating fast T1 and T2-mapping sequences, incorporating phase information from 3D susceptibility-weighted acquisitions (e.g. GE's "SWAN" sequence), improving segmentation of grey and white matter volumes using double inversion prepared isotropic T2-weighted acquisitions (e.g. GE's "modified CUBE" sequence) and measuring small vessel perfusion. This will involve work with phantoms to characterise mineral signals *ex vivo*, sequence programming using GE's EPIC programming language, evaluation in normal volunteers and existing data from patients with stroke and in studies of ageing in which phase information from gradient echo sequences has been acquired. The student will work as part of a team that is focussing on a range of methods for imaging and quantifying the development and effects of small vessel disease in stroke, ageing and dementia.

**Key references (up to five):**

1. Wardlaw JM, Doubal F, Armitage P, Chappell F, Carpenter T, Maniega SM, Farrall A, Sudlow C, Dennis M, Dhillo B. Lacunar stroke is associated with diffuse blood-brain barrier dysfunction. *Ann Neurol* 2009;65(2):194-202.
2. Valdes Hernandez MC, Armitage PA, Wardlaw JM. Automatic assessment of iron deposits in MR brain images. *Proceedings of the Thirteenth Annual Conference: Medical image understanding and analysis 2009*, 249-253.
3. Valdes Hernandez MC, Ferguson KJ, Chappell FM, Wardlaw J. New multispectral MRI data fusion technique for white matter lesion segmentation: method and comparison with thresholding in FLAIR images. *Eur Radiol* 2010,
4. McAuley G, et al. Quantification of punctate iron sources using MR phase. *MRM* 2010;63:106-15
5. Haake EM, et al. Imaging iron stores in the brain using magnetic resonance imaging. *MRM* 2005;23:1-25.