"Developing nuclear science and technologies applied to the investigation of physio-pathological mechanisms and variations in response to external challenges"

Note that the following topics / projects are only an indication. If your research aligns with the overall theme above, please apply.

Project 1.
Role of mitochondrial protein in neuroinflammation

Our research focuses on mitochondrial proteins that have a variety of potential functions in both health and disease, notably during the activation of microglia, the brain's resident immune effector cell. We are currently investigating the function, structure, ligand binding response and distribution of a protein that regulates energy production in mitochondria. This is highlighted by our recent work on the generation and characterisation of mice that lack the mitochondrial 18 kDa translocator protein/peripheral benzodiazepine receptor (TSPO/PBR; Banati *et al.*, Nature Communications, 2014). For this project, we are particularly interested in the impact of radiation on mitochondria and role of this protein in neuroinflammation including Alzheimer's Disease, multiple sclerosis and neuronal injury. The project involves the measurement of mitochondrial protein expression and its correlation with neuronal and glial proteins (markers) in normal and transgenic mice. The techniques used will include cryo-sectioning of tissue, histology, immunohistochemistry, immunofluorescence, autoradiography, and radioligand binding assays. A background in medical sciences, or biology, or neuroscience and/or pharmacology is desirable, but the necessary technical skills will be acquired during the project.

Contact:
Dr Guo-Jun Liu, Biology Group Leader, gdl@ansto.gov.au

Project 2.
Three-dimensional reconstruction of serial sections and multimodality registration to an anatomical template and corresponding atlas.

Background:
The 3D reconstruction of biological volumes (e.g. brain) arising from large cohorts of consecutive sections (histological, autoradiographic, XFM…), offers significant advantages to the interpretation of *in vivo* 3D datasets resulting from PET/SPECT or MRI. Merging postmortem data sets with *in vivo* imaging allows bridging the gap between fundamental biological research relying on *postmortem* microscopic material analysis and preclinical applications relying on *in vivo* molecular imaging.

The aims of this project are to:

1) Pursue the development of tools, set-up and data workflow to perform 3D reconstructions from 2D sections (i.e., histology, autoradiography and also other modalities such as x-ray fluorescence microprobe (XFM; Australian Synchrotron, Melbourne)).

2) Perform 3D registrations of those various reconstructed volumes with anatomical templates (MRI) and corresponding atlases.

Good programming and scripting skills are required for this project.

Contact:
Dr Arnaud Charil, Imaging Group Leader, arnaudc@ansto.gov.au

Project 3.
Multimodal 3D Image Registration

Multiple imaging modalities are used for *in vivo* studies to provide both functional and anatomical information. Individual subjects are invariably placed in slightly different postures during different phases of a longitudinal study, or while being imaged using different modalities; additionally, while each individual have essentially equivalent anatomy, there is a degree of physical variation between individuals in any given population (organ dimensions, body fat content etc.). To account for these differences, an *anatomical atlas* can be used as a standard geometric reference to facilitate the segmentation, combination and co-registration of data between different subjects, imaging modalities and instances, enabling meaningful quantitative comparisons for individuals over time and between individuals.

The aim of this project is to develop a deformable atlas, based on a segmented voxelised Roby phantom. Segmentation boundaries will be determined by iteratively deforming elements of Roby's anatomical model to maximise 3D cross-covariance with the test image. The developed method will ideally be robust with respect to variations in image resolution and completeness. The accuracy of the registration technique will be evaluated by comparing the spatial overlap of manual and automated segmentation for a series of test images featuring varying degrees of difference in posture and geometry.

Good programming, image analysis skills are required for this project. The emphasis will be on the implementation and validation rather than on developing new mathematical techniques.

Contact: Dr. Mitra Safavi-Naeini, Imaging group