The Australian Synchrotron Imaging and Medical Therapy Beamline

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The Australian Synchrotron Imaging and Medical Therapy beamline has a user base of about 150 researchers. Most users are interested in imaging and therapy studies involving animals and the beamline will be 'human studies capable', with clinical trials expected two to three years after opening the facility. A collaborative research centre in biomedical imaging is planned adjacent to the facility.

The medical research program priorities are high quality phase-contrast imaging, tomography and novel radiotherapy techniques. These require a high flux of high-energy x-rays, a long source-to-subject distance and a wide beam. Thus the beamline will be 150 metres long for high contrast imaging with a 60 cm wide beam to handle large subjects such as sheep and patients. Operation will begin in early 2008 with a 1.4 Tesla permanent magnet wiggler and later upgrade to a 4.2 Tesla super-conducting multipole wiggler.

In materials science, the requirements are for high speed, high resolution imaging, including tomography. Instrumentation developed for these techniques will also benefit the medical programs.

The project will include a satellite building housing two concrete radiation bunkers, a patient reception area and an animal holding and preparation facility. This facility will receive beam in early 2009 and will cater for high-resolution phase contrast imaging of large objects. Four radiation enclosures are planned in the main synchrotron building, three of which are currently under construction. The first experiment enclosure is optimised for high-flux radiotherapy and fast time resolved imaging; the second for semi-quantitative imaging of medium size samples, and point-projection imaging using focusing optics which will enable quantitative phase-contrast imaging with higher spatial and temporal resolution. All experiment enclosures will have near-beam surgery facilities for fast preparation-to-measurement animal transfers.

Capabilities to be added later include diffraction enhanced imaging, K-edge substraction imaging of medium size samples at 40 metres and large samples at 150 metres, micro-beam imaging using propagation-based and fluorescence techniques, hard x-ray microscopy, ultra-small-angle scattering and specialised sample environments.

The main challenges in instrument design are Laue-based monochromators and ultra-fast imaging shutters able to handle very high heat loads. Special attention will be paid to these in the presentation.

KEYWORDS: imaging, radiotherapy, tomography, clinical, beamline design, wiggler, Laue monochromator, fast shutter